The Wicked Nature of Social Systems

A complexity approach to sociology

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Abstract

This thesis investigates how the interdisciplinary field of Complexity Science can inform both sociological theory and methodological practice.

Non-linearity and complexity dynamics such as *emergence* and *positive/negative feedback* are central in many social phenomena, but have until recently not only been hard to grasp though intuition, but have been just as vexing for our social scientific theories and methods. These phenomena tend to defy deeply ingrained assumptions of regularity, linearity, and proportionality between cause and effect, as seemingly insignificant factors may set off avalanches of change. For instance, as in the case of Tunisia when the self-immolation of a street vender sparked a range of international revolts. Similarly, personalized memes in social media can spread like global electronic wildfires, reaching millions of people in a matter of hours.

Complexity science shows that patterns and system dynamics in complex systems cannot be understood only through the properties of system components, but emerge through the intricate interactions *between* these components. Complexity science is now a dominant perspective within the natural sciences and has proven useful to analyze complex systems ranging from flocks of birds to the financial market, traffic congestion and emergency evacuations.

The fact that complexity dynamics are general and can be found in many scientific fields and disciplines raises some pertinent and intriguing questions. Can complex social systems be approached in a similar way as complex systems in nature? Are methods such as computer simulations also useful within the social realm to investigate how collective patterns emerge from micro-level interactions? Or does the complexity of social systems resist reductionism to lower-levels, thus requiring us to acknowledge the causal power of higher-level social entities and social structures? And perhaps most importantly: can these approaches be combined?

This thesis addresses these questions and through four theoretical and empirical studies it explores different approaches to social complexity and show how they can be combined. *Paper I* critically engages the notion of complexity and introduces a theoretical tool that distinguishes between different types of complexity and charts the relation between systems, problems and methods. The notion of *wicked systems* is introduced to describe the category most social systems belong to. *Paper II* focuses on radical societal transitions that are driven by social movements. The paper develops an integrated theoretical framework by combining social movement literature with Transition Studies—an interdisciplinary field that focuses on large scale socio-technical transitions. This con-

ceptual framework builds upon complexity-thinking and focuses on the type of multi-level causality that typically characterizes social change. *Paper III* develops a computer simulation to investigate the emergent network structural effects of *free social spaces* on the diffusion of social mobilization, thus illustrating the potential of integrating formal modeling in research on social movements. *Paper IV* investigates discursive connections between Islamophobia and anti-feminism in a corpus of 50 million posts extracted from an Internet forum. The paper develops a methodological synergy that combines *Critical Discourse Analysis* and *Topic Modeling*—a type of statistical model for the automated categorization of large amounts of texts. This is complemented with tools from *Social Network Analysis* to illustrate discursive connections.

By employing different approaches to social complexity, each of these studies contributes to answering open issues in its field and thus provides a concrete illustration of how a complexity-based inquiry can inform sociology. By discussing, elaborating and refining various theories and notions, the introductory chapter then provides a re-contextualization of these studies and illustrates how they constitute complementing approaches that can be combined. The main conclusion is that most social systems can be conceptualized as *wicked systems*: they are open, nebulous systems, characterized by multi-level causation which makes them recalcitrant to formalization and reductionism. This calls for a method-pluralist approach that combines individualist strategies such as computer simulations with process-based frameworks that address multi-level causation and the co-evolution of causal mechanisms on higher levels. This approach to social complexity thus enables a way of capturing parts of the analytical sociology position, but embedded within a critical realist ontology that acknowledges the social as an emergent reality with its own specific powers. It also offers a contribution to critical realism by enabling us to systematically explore emergent processes. Hence, complexity science furnishes what critical realism lacks by affording both conceptual and technical means to study the emergent interplay between human action and social structure.

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Andersson Claes, Törnberg Anton and Törnberg Petter. (2014). "Societal systems – complex or worse?". *Futures* 63:145-157.

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Törnberg Anton and Törnberg Petter. (2017). "Modelling free social spaces and the diffusion of social mobilization". *Social Movement Studies* 16(2):182-202

Paper IV

Törnberg Anton and Törnberg Petter. (2016). "Combining CDA and topic modeling: Analyzing discursive connections between Islamophobia and anti-feminism on an online forum". *Discourse & Society* 27(4):401-422.

Preface

Let us start at the beginning; the relation between the individual and the collective has always been central in sociology. It was because of this fundamental issue that my interest in complexity science started to arise some years ago. At the time, I was writing my bachelor thesis in sociology, wrestling with questions concerning how the increasing use of modern information and communication technology has affected collective action in social movements. Central issues that nagged at my mind at the time concerned how we can understand the rise of regular, collective social patterns in mobilizations; forms of collective action such as swarm mobilization and flash mobs that often appear as if they were guided and regulated from above. Nonetheless, these collective patterns often form spontaneously and from below, without any form of global, central coordination. These collective patterns thus seem to rise from the very interactions between individuals.

At the same time, my brother was also writing his bachelor thesis, which focused on complex adaptive systems and touched on issues relating to artificial neural networks and the motion of dust particles in turbulent air. Despite being shrouded behind different terms and conceptualizations that act as disciplinary smokescreens, we realized that we are actually dealing with similar types of dynamics, and that these distinct disciplines in fact share similar problems; after all, it all boils down to a matter of the relation between micro- and macro-levels.

No matter whether we are dealing with biological, physical, chemical or social systems, many of the dynamics we observe are indeed similar. This includes system phenomena such as *tipping points*, *cascades*, *lock-in effects*, *path dependency* and the fact that small causes sometimes have large, unpredictable consequences. However, and interestingly, mainstream sociology and complexity science tend to have quite different ideas on how to approach these kinds of dynamics; which methods are considered suitable and what conclusions that can be drawn.

This of course raised questions about whether we can make use of the same types of methodologies. Can we, as sociologists, apply similar methods to address some of the problems we are facing within the discipline, despite the fact we are generally more interested in the behavior of humans rather than that of dust particles and robots? Should we perhaps even stop studying people and instead start focusing on the dynamics of a flock of birds if we are to understand collective behavior? Or does sociology have something to teach complexity science regarding for instance the difficulties of delineating and confining open systems and the limits of formal approaches? Are there perhaps some fundamental differences that inevitably distinguish most social systems from

natural systems, and make such comparisons problematic? Is the nature of social systems complex in a unique way?

This thesis is, in a sense, the emergent result of these discussions, claiming not to provide any final answers but hoping to contribute with a small piece to the puzzle of challenging the disciplinary silos that are effectively hindering us from dealing with some of the most pressing societal problems that face us today, both as scientists and as human beings.

Acknowledgement

Just like the human brain is a complex adaptive system where mental states, or what we call thinking, emerge from the interaction between multiple physical and functional levels, writing is essentially a collaborative enterprise. Texts do not emerge fully formed in perfection from the mind of the solitary writer, but from social interaction with many people. Sometimes we may be fully aware of this as it happens, for instance at those critical moments during intense discussions at seminars when a new idea suddenly strikes us. But other times an idea that was seeded at one point, slowly grows to an important insight that we may only first realize many years later.

With this said, I owe this thesis and the ideas within it to countless conversations with many people. Some of you have had a more profound impact and it is not only out of civility on my part to thank you. Rather, many of you have actually played a decisive role in the process of research, suggesting and developing ideas, recommending literature, and, not least, criticizing some of my most misinformed and misleading ideas. So apart from my more explicit co-authors in this thesis, I also want to thank some of the people that I consider the most important implicit — or secret—co-authors.[1]

First of all, I would like to warmly and sincerely thank my outstanding supervisor Carl Cassegård. Thank you for your patience, humility, knowledge, support and dedication and for your often subtle, but always brilliant, comments

1 I also wish to acknowledge the financial support of the EU-FET grants MD (no. 284625) and INSITE (no. 271574).

and feedback. Your support has been essential for this thesis, not least for helping me translate some of the more obscure ideas within complexity science to better fit a sociological audience. I also wish to thank my excellent assistant supervisor, Justus Uitermark at UvA in Amsterdam. I am grateful for your sharp and distinguished feedback on articles and texts, and for making me feel welcome during my time as a visiting scholar in Amsterdam.

Many people have contributed significantly to this thesis by reading and commenting texts. Kerstin Jacobsson and Christofer Edling were both of great help by serving as reviewers of the full manuscript at the final seminar. Kerstin's constructive criticism and careful advices were very helpful in improving both the introduction chapter and paper II. Upon presenting papers and ideas at the department seminars (particularly the CSM seminar), I have also received many valuable remarks and comments. I would particularly like to thank Mattias Wahlström, Abby Peterson, Håkan Thörn, and Bengt Larsson.

Two other people that have been essential for this thesis are my two intellectually flexible complexity gurus; Claes Andersson at Physical Resource Theory at Chalmers Technical University, and David Lane at ECLT Ca'Foscari University of Venice. My time as *assegno di ricerca* in Venice was eye-opening; not only for complexity science, but also for *spritz con campari* and *tramezzino al tonno*. I am grateful also to Stellan Vinthagen for making me feel welcome during my stay at Amherst University in Massachusetts, and for making it impossible to forget that science should not only be about understanding the world, but to change it.

As I see it, the PhD-program provides something of a *social haven* or a *free social space*. During four intense years, we are practically shielded from the hegemonic discourses of mainstream society and the dominant research funders, thus offering us a unique possibility to develop innovative ideas that may be in opposition to the prevailing scientific ideas and deeply-rooted paradigms. Therefore, I would like to express my gratitude to all my colleagues at the Department of Sociology and Work Science for making this academic space free, and for creating such a stimulating, humorous and enabling environment. I am particularly grateful to Patrik Vulkan (for his help and practical tips before printing this thesis), Olof Reichenberg (for stimulating discussions and his always sharp comments and suggestions), Johan Alfonsson (for so strictly and unfailingly enforcing my dress code), Johan J (for providing cues and tips that made the sometimes tedious academic board meetings much more interesting) and to Carl Wilén (for his invaluable help particularly during the process of writing the introductory chapter, that included everything from minor semantic details to deeper ontological and political matters). I am also grateful to my colleagues among the administrative staff at the department, particularly to Anna-Karin Wiberg and Pia Jacobsen who deserve special mention for their help.

Lastly and foremost, I want to warmly and sincerely thank my friends and family. To my brother Petter who started his PhD in the same day as I did less than five years ago, and who will defend his thesis two weeks from now. It is a rare luxury to be able to combine blood line, friendship and collegiality without killing each other. And to the rest of my extended family, my friends and particularly to Lovisa who has put up with me during all these years: your support has been invaluable for this thesis. Your wickedness has been an inspiration, your stability has been a prerequisite.

Anton Törnberg, Göteborg, 1 February 2017

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Prologue: The debate between Tarde and Durkheim

Do you recall the discussion between Durkheim and my father, at the Ecole des Hautes Etudes Sociales? Before they had even said a word, one sensed by their faces, their looks, their gestures, the distance that lay between these two men. One knew that such a discussion was sheer madness.

Guillaume de Tarde

It is easy to get caught up in the excitement surrounding the study of complexity and how insights generated in this field might be related to and help address some of the challenges we face today in sociology. As complexity theorist Warren Weaver (1948) once said, we may often feel like pioneers in a new land, making new discoveries. Indeed, for those involved in charting such a course, it is easy to lose historical perspective and the path already taken by others, thus forgetting that "new" ideas are in fact merely rediscovered.

So let us again start at the beginning, at the early dawn of sociology as a discipline.

By the end of the 19th century there was an extensive debate, in fact even an infected conflict, between Gabriel Tarde and Émile Durkheim. At the time, Tarde was a leading figure in sociology in France. He was older and had a higher academic position than the younger, less experienced and overall less successful Durkheim. But Durkheim was an ambitious man; "bald, bespectacled, wispy-bearded, intensely serious, [he] applied himself to sociology with rabbinical devotion" (Collins and Makowsky, 1978: 99), setting out to do for sociology what Wilhelm Wundt had done for psychology; to liberate it from philosophy and establish it as a discipline in its own right, firmly resting on the bases of the empirical sciences. In this attempt, Durkheim strived to decouple it from surrounding disciplines, arguing that social facts need social explanations. He thus

distinguished "the social" as an external entity *sui generis*; as something that must be studied in its own right and is irreducible to its constituent parts and to individual-level psychological explanations. If there is such a thing as sociology, he argued, it must study phenomena different from those explored by other sciences. In Durkheim's (1895) words, we must delineate the exact field of sociology and let "[i]t embrace one single, well defined group of phenomena" (p.54).

Tarde, on the other hand, was critical against any distinct separation between external social facts and individuals. He argued that society is made up of individuals, and that the social psychology of their interactions brings about social structures as well as social change. His central focus thus lay on the role of *imitation* and *suggestion*. While he accused Durkheim of focusing on the norms that constrain behavior as if these were imposed from somewhere "outside", Tarde saw these norms as the *products* of interaction (Katz, 2006). Accordingly, Tarde had no ambition to separate the sciences, but saw it as a form of egoism, a "scientific individualism", to distinguish sociology as being apart from adjacent disciplines such as psychology. Such radical separation, an absolute duality between collective fact and individual fact, was in his view deeply flawed. On the contrary, he argued, there are many common denominators and phenomena studied in different sciences, for instance a shared focus on universal repetitions.

Instead of focusing on structures as stable, fixed and external entities, as he claimed Durkheim was guilty of, Tarde was more interested in investigating the continual formation of structures. Structures *are* not, they *become*. They are constantly reproduced through a dynamic process. Once this process stops, the structure dissolves. A structure is thus never in balance and we can therefore never take it for granted. On the contrary, we must focus on what produces the structure. By implication, there is no social milieu or structure *sui generis* that can explain behavior, and therefore we cannot use structure as explanation for societal changes or particular events; it is the structure itself that we need to explain, i.e. the myriad of imitations and inventions that give rise to what we call structures. Thus, the main difference from Durkheim is quite palpable. Instead of focusing on the external, objective structure or "social fact", we must focus on the dynamic in the tiniest components, and the continual constitution of the structure. This, Tarde argued, means that there is no point in distinguishing "collectivity/society" from the "individual", since sociology and psychology are both, after all, studying the same thing. There is no "inside" of the human that should be studied by psychologists, nor an "outside" that should be studied by sociologists. Our minds are connected with other minds, and open to contagious thoughts, ideas, behaviors etc.

What we need to study, he argued, is how social behaviours and ideas devolve and pass on, not from the social group collectively to the individual, but

from one individual to another, to yet another. And how, in the passage of one mind to another, they change and refract, much like the bending of a wave as it passes from one medium to another.

> The sum of these refractions, from the initial impulse of an inventor, a discoverer, an innovator or modifier, whoever it might be, unknown or illustrious, is the entire reality of a social thing at a given moment; a reality which is constantly changing, just like any other reality, through imperceptible nuances; this does not prevent a collectivity from emerging out of these individual varieties, an almost unchanging [constant] collectivity, which immediately strikes the eye and gives rise to Mr. Durkheim's ontological illusion. ([Tarde 1895:66-67] Vargas et al., 2008).

The classic debate finally ended up with the two accusing each other of non-science; Durkheim was fiercely attacked for hypostatizing structures and for his "ontological illusion" that led him to invent invisible ghost structures that one could not see, but that yet somehow existed "out there"[2]. And when Durkheim furthermore ascribed causal forces in coercive terms to these social structures, Tarde reacted by exclaiming in harsh terms that "the error here is so palpable that we must wonder how it could arise and take root in a mind of such intelligence" (de Tarde, 1969: 118). Tarde, on the other hand, was heavily criticized by Durkheim for dealing with "the very negation of science" (Durkheim, 1903: 479) and for advocating a proposition that was "purely arbitrary" since he could not prove how immaterial "contagions" really exist, and how they can lead to aggregated structures[3].

In the end, Durkheim came out of the debate as the winner for reasons that go beyond the scope of this text to thoroughly elaborate on. But part of the

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2 In Tarde's words; "Here we have once again this hallucination: the social as distinct and separate from the individual. What is this social suicide rate which remains blissfully unaffected by the greater or lesser number of individual suicides? [Allow me to answer:] the social rate, the social milieu, the collective state, etc [are] as many nebulous divinities which save [you, Mr Durkheim] when [you have] entangled [your]self. [You do] not want me to resolve them into individual contagious facts, and [you are] right, for once the mystery is dissolved, the prestige disappears and this phantasmagoria of words ceases to impress the reader." (Vargas et al., 2008: 769).

3 As Durkheim argued: "[Tarde] may of course state that in his personal opinion nothing real exists in society but what comes from the individual, but proofs supporting this statement are lacking and discussion is therefore impossible" (Durkheim, cited in Candea, 2010: 33).

reason may be that Tarde simply lacked any practical tools that would enable him to further investigate and explore this relational approach empirically, and to turn his arguments into sound empirical cases. His theories remained largely abstract, vague and theoretical, something which Durkheim persistently took every chance to point out. Another key to Durkheim's success probably lies in his focus on social facts as segmented macro-structures/collective representations, which fitted well with the needs of the contemporary bio-political state at the time to represent and intervene in societal processes. In any case, Tarde was largely neglected within the sociological discipline thereafter, branded as metaphysical and dealing with psychologism and mysticism (Candea, 2010). Instead, the 20th century came to be strongly influenced by Durkheim, and his perspective has in a sense come to characterize much of contemporary sociological approaches. Thus, whether a heritage from Durkheim or simply a mere coincident, the quantitative methods that have dominated social science thereafter have largely focused on attributes rather than relations and interactions, which as we will see has had important consequences for how social scientists approach social phenomena.

Setting the table: the chasm between holism and individualism

The purpose of bringing this age-old debate back to life is not to provide any genealogy of the historical roots or the precursors of the field of complexity theory and sociology. Instead, what is interesting about this debate is that, despite being swamped by both intentional misreading and accidental misinterpretation, Tarde and Durkheim nonetheless identified a shared problem or a tension that since then lies at the very heart of sociological theorizing; that between *individualism* and *holism*. Or put differently, a disjunction between those who understand the world in terms of structures that create regularities, and those who see the world as springing from the action of individuals. Using Hannah Arendt's (1958) metaphor of a table around which people are gathered, this problem can be seen as an *in-between*; a shared space around which we can communicate and that relates and separates individuals at the same time.

But Tarde and Durkheim did not just identify this fundamental and shared problem. In the heat of the debate, as the two rivals came to inflate and exaggerate their own positions as well as misrepresenting those of their opponent, they arguably also came to represent two ideal-typical and often juxtaposed positions. Durkheim was thus claimed to epitomize a holist position, arguing that the social, and ultimately society, is *sui generis*; it is an emergent whole that cannot simply be reduced to underlying levels or mechanisms. Therefore it is necessary to assume emergence and focus on the aggregated and emergent

outcomes of the interactions of the individuals and regard this as an independent force, or a higher-level entity, simply because we lack any means to study this process of emergence. Tarde, on the other hand, found himself on the opposite side of the table, wanting to follow the actors and their interactions and investigate how social phenomena are spread and repeated between individuals, how they unfold and eventually emerge into patterns on a higher level. In other words, he came to represent an individualist position, as he wanted to study the process of emergence from the bottom up. Thus, his ideal methodology was to link statistics capable of following interactions and relations to enable a deep analysis of social phenomena, but without reducing events and individuals to bodiless aggregates.

These ideal typical positions are central parts of what is sometimes referred to as the *fact paradigm* and the *action paradigm* (Gilje et al., 1993), that represent two classical scientific approaches to the study of society that differ in both their ontology and epistemology, meaning that they have different ideas regarding the very nature of reality and how we may study and approach it. While the fact paradigm rests on a holist ontology and views society as an emergent totality that cannot be reduced to its members, the action paradigm is based on an individualist ontology and sees society merely as a collection or aggregation of individuals and their interactions. As we will see, these two positions are in fact also reflected within the intersection of complexity science and sociology, where they are incarnated as two fundamentally different approaches to how we should deal with complexity in social systems; should we study the emergence of social patterns from the bottom up, or does the complexity of social systems resist any type of reduction to lower levels, thus requiring us to assess the emergent causality of social systems and structures?

The fundamental problem of the relation between individualism and holism that Tarde and Durkheim identified has also been discussed extensively by more contemporary sociologists, trying to go beyond this binary situation and attempting to include both agency and structure in sociological explanations (e.g. Giddens, Archer, Bourdieu, Parson, Elias, among many others). While there are indeed many alleged solutions to this dilemma, scholars like Archer, Bhaskar and Elder-Vass have argued that we may identify two main tracks or alternative ways of reconciling the two; *structurationist theories* (e.g. Giddens, Bourdieu, and Bauman) that focus on the *duality* between structure and action and that view

structures as something that partly reside within human individuals rather than as something external[4]; and *post-structurationist theories* (e.g. Archer, Mouzelis) that focus on the *dualism* between the two. Following an emergentist ontology, the latter theories view agents and structures as inter-related but distinct — each having causal powers in its own right.

While we will have reasons to return to and further elaborate on these issues later, I will for the present conclude that in broad terms, my intention in this thesis is to employ a complexity theory perspective to illustrate the value of both holism and individualism as methodological approaches to the study of society. In this way, one could say that I aim to give credit to both Tarde and Durkheim and argue that these do not represent incompatible paradigms, but in fact mutually informing perspectives that can be fruitfully combined.

4 For instance, as Giddens (1984: 25) argues: "Structure is not 'external' to individuals: as memory traces, and as instantiated in social practices, it is in a certain sense more 'internal' than exterior to their activities in a Durkheimian sense".

2
Introduction

Linear methods in an unruly reality

Many social phenomena that interest us as social scientists are deeply characterized by nonlinear dynamics. These types of dynamics are observable in all types of social phenomena and across many fields: we know that social uprisings often occur quickly and unexpectedly, as seemingly loyal and subordinate populations may suddenly shift to mass defiance and open rebellion. Similarly, banks across the globe may collapse overnight as a consequence of complex cascades in mortgage systems that few seem to understand, or even less predict (despite the strong incentives to do so). Diseases may spread quickly from a malignant cough in an isolated village in Cambodia, to just a few days later pose a severe and impending global pandemic. Likewise, society is often stuck with certain technological solutions for decades — despite the fact that they may be suboptimal in relation to functionality or environmental consequences — when a novel technology suddenly manages to break through, thus changing the overall socio-technical system in a fundamental way.

Similar nonlinear dynamics are also apparent in the diffusion of symbols in social media. Personalized memes spread like global wildfires, and a previously unknown mobile game may quickly become a viral success with millions of users worldwide hunting artificial monsters on the streets. Sometimes these online phenomena also have large societal consequences, for instance when the photograph of the three-year-old Syrian boy, Alan Kurdi, washed up on a shore in Turkey, quickly spread in the media and dramatically increased attention on the ongoing refugee crisis, initiating protests all across Europe in favor of more humane immigration politics. But the discursive backlash came just as suddenly, resulting in closed borders and an impending humanitarian catastrophe.

We have in recent decades seen a growing interest in these kinds of nonlinear dynamics where small causes may have large consequences, and where a seemingly insignificant event or even a rumor may shift the entire system in a

qualitatively different, and sometimes completely unexpected, direction. Parallel to this increased interest, we have also seen a growing realization that our contemporary scientific approaches are perhaps not always sufficient to deal with these types of dynamics. In fact, a growing number of influential scholars in the social sciences have argued that our established methodological approaches have serious shortcomings in understanding such nonlinear phenomena that do not respect our deeply rooted ideas of cause and effect (e.g. Abbott, 2001; Capra, 1996; Nicolis, 1995; Prigogine and Stengers, 1997).

While linear models and the variable-centered approach that have so far dominated the social sciences have indeed proven powerful and highly useful in many cases, this strength also comes with significant limitations. These statistical models often fit well for phenomena that stay within certain (constructed) boundaries and behave in a linear and quantitatively accumulative way, but they often have a harder time to account for situations when the system transcends these boundaries. In these cases, when complex causality and non-linear dynamics such as threshold effects and feedback dynamics dominate the outcome of the system, linear models that are completely predicated on straightforward linear modeling are clearly less useful. For instance, the very existence of chaos means that the capacity of predictive formalization and linear laws breaks down in practice. This has led some scholars to even go so far as arguing that "[t]he tendency within the nomothetic scientist approaches to transfer the languages of variables to the social world has — in brutal summary — been largely useless." (Byrne et al., 2009: 520).

There are several, interrelated, reasons for this.

First of all, following the path set by Durkheim, a basic tendency in any statistical explanation is to focus on the attributes of individuals, and based on this provide an explanation by decomposing or breaking down the relevant population into different categories or subpopulations (Hedström, 2005). If the decomposition indeed eliminates the differences, they are considered explained. Statistical correlations between variables are thus assumed to be probabilistic causes of the outcome. This means that conventional statistical analysis shifts the focus away from the interactions between actors and towards labels that we treat as properties of individuals, and thus the social part of behavior is neglected, regarding the ways people interact and influence each other. In this way, the prevailing variable-centered approach "features a compelling imagery of fixed entities with variable attributes that interact in causal or actual time, to create outcomes, themselves measurable as attributes of the fixed entities" (Abbott 1988:170). Allen Barton (1968: 1) has aptly described this using an allegory, comparing sample surveys with a "biologist putting his experimental animals through a hamburger machine and looking at every hundredth cell through a

microscope; anatomy and physiology get lost, structure and function disappear, and one is left with cell biology". I will later show that this strategy of decomposing phenomena into their constituent parts is deeply problematic when it comes to analyzing complex dynamics.

Secondly, and closely related, quantitative studies based on regression often strive to isolate and study the net effects and causal influence of specific variables (Ragin, 2014). A main problem is that these methodological approaches have a hard time to account for the fact that the impact of certain factors and variables is often context-dependent. This means that conventional regression-based methods face difficulties in accounting for *causal complexity,* i.e. that there may be many causal pathways to the same outcome (e.g. Ragin, 2014; Jervis, 1998) and *circular causality*; a type of causal loop when a certain cause is affected by its own outcome[5].

While most practitioners in the field are perhaps aware of these methodological limitations, there is nonetheless an impending risk when using a specific set of methods that our means of approaching reality influence our very understanding of it. This includes the possibilities that we may adapt our research questions in accordance with the methods we employ and the data we have access to. But there are also deeper potential consequences. The assumptions of a general reality that often accompany standard quantitative methods may also have consequences beyond the purely methodological dimension by preventing the analysis of many phenomena that do not meet these assumptions, thus blinding us to situations that require different approaches. As Thomas Kuhn once expressed it: our current methods prevent our seeing to the myriad of situations to which they apply. Or put differently, if we have a hammer we tend to see nails everywhere.

Thus, the general difficulties of statistical approaches in dealing with interaction effects and emergence risk enforcing the belief that complex actions can be treated as "reducible to some simple combination of simple behaviors which in turn are regular responses to set stimuli, as if each stimulus and action had the same meaning regardless of context" (Sayer, 1992: 200). In other words, when

5 Other terms often related to causal complexity are *equifinality* (when a certain outcome can follow from different combinations of causal conditions) and *multifinality* (when similar conditions may lead to dissimilar outcomes). Terms often related to circular causality in e.g. the philosophy of science literature are *causal chains* or *causal ropes*, both of which are well-established terms that date back at least to Venn (1866).

adapting an unruly social reality in accordance with a set of formal methods, there is always a risk that one may "reify an entailed mathematics into a representation of reality" (Abbott, 1988). In a similar way, Hedström and Swedberg (1998) have argued that the widespread use of statistical techniques has fostered a variable-centered type of theorizing that tends to conflate theoretical thinking and statistical analysis, which has led to a confusion of explanation with statistical correlation.

There is no general agreement whether these problems are inherent and thus unsolvable within the current quantitative paradigm, or whether acknowledging the problem and employing complementary techniques can get us far enough. It is acknowledged that quantitatively oriented scholars have struggled with these issues for a long time and have developed a range of advanced methods and techniques to identify and deal with complex causation and non-linearity, including but not limited to structural equation models, latent variables, multiple correspondence analysis, multi-level analysis and hierarchical models. But while these techniques indeed bring important affordances, the lack of data and other issues have contributed to the fact that they remain relatively uncommon in actual empirical research, compared to more conventional methods. Thus, regardless of the view one takes when it comes to the possibilities and limitations of the quantitative paradigm, the fact remains: symmetry breaking and non-linear transformations present formidable challenges for quantitative models.

While conventional qualitative approaches do not suffer from the same problems, they do have a corresponding problem in that they tend to lend heavily upon human cognition, which is — as we will see — often highly unreliable when we are dealing with complex nonlinear dynamics, which often lead to unexpected and counter-intuitive consequences. Hence, while these approaches are indeed more suitable for dealing with a complex and highly uncertain reality, they often need the support of formal analytical tools. We will have reasons to return to this argument later.

These problems of causal complexity and non-linearity are of course further escalated due to the arrival of digital data which have provided researchers with unprecedented access to detailed relational and interactional data, thus opening up new possibilities to study social complexity in detail. However, for the above-mentioned reasons, our established methods have problems to harvest the full potential of this data, and the sheer amount and intangible, unstructured character of this data has so far made this goldmine relatively inaccessible. So, regardless of our faith (or lack thereof) in established quantitative approaches, most scholars would probably agree that we need new, complementary approaches that focus on incorporating interactions and relations and that are

capable of handling complexity. And some scholars take an even more radical stance, like Abbott (2000: 299), who argues that:

> [w]e have to rethink data analysis from the ground up. In the short run, we are going to have to jettison the idea of causality that has led us to denigrate precisely the analytic tools necessary to address the problems of huge data sets. We have to give up the futile quest for effects 'net of other variables' and wallow in the endless multiplexity of data.

To conclude, I want to emphasize that my point here is not that conventional quantitative methods such as regression are of no use to us, but rather that we need to be aware of their epistemological limitations. While they are in general useful for descriptive purposes and for testing theories, they are less useful for *generating* theories and for dealing with complexity and nonlinear dynamics. In which case, as a consequence of this growing misfit between dominant scientific approaches and the type of phenomena that we are interested in (and the type of data we have access to) there has been an increased interest in new approaches that focus on incorporating interactions and relations and are capable of handling complexity and nonlinearity. After all, if we are interested in non-linearity, and non-linearity is undeniably a product of emergence, it does make sense to develop an approach that takes its very starting point in emergence, not an approach that is pretty much inherently incapable of this.

The emergence of complexity science

The application of *complexity science* is today increasingly suggested as a solution to this new set of challenges. We have seen growing interest in complex systems in all fields of science, and Stephen Hawking (2000) has even proclaimed that the 21st century and its sciences is shaping up to be the century of complexity. A foundational idea within complexity science is that patterns and system dynamics in complex systems can seldom be understood based only on the properties of the constituent parts of the system, but rather emerge from the intricate interactions between these very parts. These interactions are woven together in a complex mass dynamic where a multitude of agents affect each other in long chains of causation that lead to collective patterns and often unexpected and unpredictable phenomena. A canonical example of such system is an anthill: an anthill cannot be understood by studying the individual ants; it is only by focusing on what happens between the ants that we may understand the collective behavior of the anthill. In fact, these intrinsic interactions between the individual ants enable them on a colony level to pursue highly advanced collective pro-

jects such as building bridges to cross chasms, building anti-flooding systems in anticipation of storms, and even maintaining advanced climate control. The same perspective has been used for a range of different systems and phenomena, ranging from particle interactions and schools of fish, to the financial market, traffic and emergency evacuations. In recent decades, complexity science has thus come to be a powerful, if not dominant, perspective within large parts of the natural sciences.

This idea that we can understand and analyze social systems and social phenomena as complex systems, characterized by emergence and feedback processes, has also had both methodological and theoretical impact within the social sciences. A range of disciplinary subfields and strands of social theory has been inspired from complexity science, and influential scholars such as Urry (the *complexity turn*), Luhmann (*system/communication theory*), Deleuze and Guattari (*assemblage theory*), Wallerstein (*world-system theory*), Latour (*Actor-Network Theory*) and Castells (*network society*) have to a various degree started to incorporate complexity-related concepts into their theoretical frameworks. Complexity science has also been argued to represent a foundational ground for such widely differing theoretical approaches as *postmodernism* (Cilliers, 1998; Lyotard, 1984) and *critical realism* (Byrne and Callaghan, 2014; Harvey, 2009; Walby, 2007). Similarly, various methodological individualist scholars have presented it as a promising approach to study how social patterns and structures can be explained based on individuals and their actions (Epstein and Axtell, 1996; Hedström, 2005; Holland, 2006), while more holistically oriented scholars at the opposite pole have argued that complexity science provides a formidable challenge to reductionism and rather illustrates the impossibilities of formally delimiting and isolating social systems (Byrne and Callaghan, 2014; Jepperson and Meyer, 2011; Wynne, 2005). In which case, complexity-related concepts such as *path dependency*, *tipping points* and *chaos* have proven to be useful in upsetting and transforming our deeply seated ideas about causality in society and have contributed greatly to social theories and perspectives.

A simple search for complexity science/theory in Google N-gram reveals that the use of the term has undergone a dramatic increase since the 1990s (see Figure 4 in Attachments). This general trend also seems to apply specifically to the social sciences, as illustrated by the Gulbenkian Commission's (1996) suggestions for future directions for the social sciences, criticizing the traditional nomothetic approach and the increasing fragmentation into specific subfields and instead proposing a breakdown of disciplinary boundaries, explicitly informed by a complexity perspective. The growing attention to complexity also goes hand in hand with both the technological development of advanced computer-based methods such as simulations and modelling, which have generated

new and unique possibilities to carefully and systematically study how various rules and behavior on lower-levels emerge to higher-level patterns. At the same time, increasing access to digital data has enabled us to empirically follow individuals and their interactions over time and explore the emergence of social patterns. Complexity simply seems to be an idea whose time has come.

Key concern and purpose

Embarking from a fundamental belief that complexity science is crucial to improve our basic understanding of how social systems work, the overall purpose of this thesis is to discuss and elaborate on how a complexity-based inquiry can inform both sociological theory and methodological practice. Through a number of empirical and theoretical studies I intend to explore different approaches to social complexity, and investigate how these approaches are related to each other. This rather broad purpose can be formulated into three sets of more specific problems. Rather than serving as targets for any complete and exhaustive solutions, these problems should be read as guiding questions that point out the general direction that this thesis explores as a whole.

- The development of complexity science has evoked a new plea for naturalism and the idea that complex social systems can be approached using the same methods and perspectives as other types of complex systems, such as biological and physical systems. Is this idea tenable? How can the complexity of social systems be characterized? Are there differences between different types of complexity, and what consequences do such differences have on the way that these systems should be studied and approached?

- How can we handle the tension between reductionism and holism when approaching complex social systems? Should we study the emergence of social entities from the bottom up, or does the complexity of social systems resist reductionism to lower levels, and require us to acknowledge the reality and causal power of higher-level social entities and social structures, such as social movements and normative systems? And perhaps most importantly: can these approaches be combined? Are formal computational models, which tend to build upon reductionist assumptions, useful for studying complex social systems? If so, how?

- The fast growth of digital data has opened up a new realm of social inquiry by creating unique possibilities for empirical studies of social complexity. How can we approach such immensely complex data sets, and how is this relevant for a complexity-based inquiry?

The four studies that comprise this thesis are situated in different research fields. This means that they do not share empirical data, nor the specific methods or even the theoretical perspectives employed in each study. Instead, what unites them is that they all constitute different approaches to social complexity that, as I will show, can be fruitfully combined.

Therefore, instead of giving a mere outline or résumé of the studies and presenting the method, theoretical perspectives and previous research as separate sections, as is perhaps conventional in an introductory chapter to a thesis, my aim here is instead to focus on the internal bond that unites these studies. Thus, the purpose of this introduction chapter is to go beyond each study and show how they fit together into a whole or a totality that, for reasons of brevity, cannot be explicit in the separate studies. I do this by providing a meta-theoretical discussion; by elaborating, distinguishing, articulating and refining various concepts and discussing how they are connected to each other.

In this way, while indeed based upon the separate studies, the introduction chapter recontexualizes the papers and provides a whole that reveals new relations and meanings that are not otherwise given or explicit. Thus, their connection is made evident through arguments of a more general character, which enable us, I think, to embrace within a single point of view these four separate studies of a common thought — these *disjecta membra*, as it were, of a single body of ideas. This meta-theoretical discussion should be read as an exploration or an informed reflection on the relation between the different studies, and as such it should be read as a starting point that aims to provide leads for further exploration rather than definite or exhaustive answers. The different parts of the argument are then further elaborated and practically illustrated in each of the studies.

Beyond this main purpose, each study also makes a more concrete field-specific contribution. By contributing to the development of each theoretical and empirical field in this way, this constitutes a more tangible and perhaps more convincing way to illustrate and concretize the practical significance of a complexity-based inquiry within a broad range of fields in sociology. This field-specific contribution is further discussed at the end of this introduction chapter, where I briefly summarize and discuss the different studies in their own right.

Disposition

As always when approaching a particular scientific problem, the nature of what exists cannot be unrelated to how it is studied. Or put somewhat more modestly: what social reality is deemed to consist of must affect how it is approached, studied and explained. As Archer (1995) has declared, a social ontology, an explanatory framework, and a practical theory constitute each other and should therefore correspond. But such correspondence does not however mean that there are any strict boundaries between ontology and methodology, since description and explanation are of course not discrete from one another. After all, "[w]hat social reality is held to *be* also *is* that which we seek to explain" (Archer, 1995: 17). So the necessity of a consistency between them generally requires a continuous two-way adjustment between ontology and methodology to be achieved and sustained. Therefore, for reasons of clarity, this introduction chapter is structured in such a way that I will start by discussing some questions relating to social ontology, and then proceed to more epistemological and methodological issues.

First, I will start by defining the notion of complexity and elaborate on what I refer to here as *mainstream complexity science*. This will inevitably lead us to the question whether social systems should be conceptualized as complex systems, which also marks the starting point for Paper I. Whereas this article originally targets primarily complexity scientists, I here extract, contextualize and further extend the main argument in the article and reformulate it more explicitly for a sociological audience. By distinguishing between *open* and *closed* systems and extending this binary by using Simon's (1962) notion of *decomposability*, I argue that social systems tend to exhibit *wickedness*; an emergent combination of complexity and complicatedness that entails plasticity and deep ontological uncertainty. I relate this to Archer's discussion on the relationship between agency and structure, and contribute by further distinguishing between *structure* and *system,* and problematize the type of causal role these play in social systems. I conclude that the reductionist program is futile when approaching most social systems, regardless of whether it is based on componential or relational reductionism; the very nature of social systems entails a different approach.

Second, based on these ontological claims I argue that our theoretical frameworks require more flexibility and softer knowledge claims. Instead of reductionism, the wicked nature of most social systems calls for narrative explanations and process-focused approaches that acknowledge multi-level causality. This approach is illustrated in Paper II, which investigates whether theoretical frameworks developed in the field of socio-technical change can also be helpful in addressing nonlinear dynamics within social movements. Relating to this, I argue for the necessity of incorporating complexity-thinking into our narrative

frameworks; both in order to provide conceptual tools to deal with nonlinear dynamics, but also as a stepping stone to facilitate the incorporation of computer simulations.

Third, coming from this understanding of social systems as ontologically uncertain and recalcitrant to reductionism and formalization, I then argue that formal models may actually play an important, albeit more restricted, role in order to understand complex dynamics in social systems. Models provide an experimental setting *in silica* that enable us to at least glance into the realm of nonlinear mechanisms, and help us deal with complex causality that otherwise tends to evade the grasp of our unaided cognitive abilities. This argument is practically illustrated in Paper III, where we develop a formal network model to investigate how the structural properties of free social spaces in a social movement context impact the diffusion of collective mobilization. Thus, this article practically illustrates how we can incorporate models into our theoretical frameworks to analyze emergent dynamics. Employed in this way, models may thus serve an important complementary function by helping us to *narrativize or de-mystify mass dynamics.*

Fourth, the explosive development of digital data has radically changed the landscape of sociological theory and practice, creating a pressing need to develop integrating approaches to deal with social complexity. Digital data contains both complexity and wickedness, and thus demand a method-pluralist approach: while we need formal models to investigate micro-emergence, the constant qualitative change and uncertainty characterizing the medium itself also calls for intensive approaches. This provides the underlying motif for Paper IV, in which we develop a methodological synthesis to deal with digital data by combining qualitative text analysis with tools for text mining, developed in computer science.

Finally, I conclude the main results and then wrap up by returning to Tarde and Durkheim and show how the approach to complexity endorsed in this thesis can help to bring order to this historical debate, and illustrate how these approaches can be fruitfully combined. A brief summary of each of the studies is attached in the Appendix.

3
What is Complexity (science)?

Let us start by defining what I here refer to as *complexity science*. Complexity science is itself a broad and intangible field with many roots and branches that evade any simple definition or delineation. As Mitchell (2009) has pointed out, complexity science does not constitute a singular science or theory, but rather numerous overlapping complexity science*s* and theorie*s*. In this sense, it is often used as a broad and highly inclusive umbrella term, embracing seemingly different fields and concepts ranging from computational modeling and cellular automata, swarm intelligence and big data, agent-based simulation and artificial neural nets, socio-cybernetics and social physics, chaos theory and social networks, to post-humanism and the global network society.

Since these various perspectives and notions have different theoretical roots in various disciplines, there are many different stories of the origin of complexity science. Some trace its roots to old-school social systems thinking in social science, for example in Spencer's evolutionary theory; Marx's dialectics and historical materialism; Parson's structural functionalism; Durkheim's concept of social fact; Pareto's 80/20 rule; and Comte or Quetelet's social physics (Sawyer, 2005). A uniting factor for these classical social theorists was that they all shared the notion of society as not static, but rather as a constantly evolving, functionally differentiated system with emergent properties, consisting of internal subsystems (Castellani and Hafferty, 2009). Others may emphasize the development of connectionism in mathematics (von Neumann, [1945] 1987), cybernetics (Capra, 1996), early discoveries in fractal geometry (Mandelbrot, 1983) or the early version of chaos theory first developed by Poincaré at the end of the 19th century. But many agree that the early use of the term complexity by Weaver (1948) in the 1940s served as an important foundation for a broad scientific interest in complex systems in general.

Thus, clearly the plurality of the complexity sciences crosses the entire academy, with a growing number of new fields constantly pushing the limits of this paradigm, as scholars tend to appropriate the term to legitimize where they came from and how they got here; resulting in ever new histories of the "com-

plexity" present. While such interdisciplinary appropriation and conceptual wrestling between different perspectives and disciplines within the same paradigm can indeed be positive, pushing social inquiry, as Abbott (2001) has argued, into new areas of thinking, it is nonetheless important to be aware of Byrne and Callaghan's (2014) warning: not all complexity sciences or theories are the same; and all are not equally useful for social inquiry.

With this background in mind, I do not intend to provide an extensive overview of how complexity science has influenced various strands of sociology and social theory. This has been done very well elsewhere (e.g. Castellani and Hafferty, 2009; Sawyer, 2005). Relating and citing literature that may use the same word, but attributed with different meanings and based on fundamentally different strands of social theory would contribute little to my purpose here. Instead, in accordance with Byrne and Callaghan (2014), I suggest that complexity science should be understood as both a collection of methods *and* as an ontological framework*,* rather than as a unified theory (Castellani and Hafferty, 2009; Reed and Harvey, 1992; Thrift, 1999). While traditional theories provide concepts and causal connections, attempting to explain social phenomena, it makes more sense to think of complexity theory as an ontologically founded framework that asserts the specific ontological position that the social world consists of complex systems, and if we wish to understand it, we need to analyze it in those terms (Byrne and Callaghan, 2014: 8)[6].

In my view, it is vital to be aware and mindful of this ontological foundation of complexity science. Ontology and methodology are intrinsically intertwined and the ontological assumptions we bring to a scientific investigation tend to have a decisive impact on shaping the theories, methods and analysis that we arrive at[7]. If we fail to acknowledge this, there is a risk that it instead works the

6 For a comprehensive map of the complexity sciences, see http://www.art-sciencefactory.com/complexity-map.html. My approach to complexity in sociology circulates primarily around the bottom-right corner of this map, and concerns issues such as social complexity, complex realism, epistemology and case-based complexity, but also stretches into adjacent areas such as computational modeling, data mining and network analysis.

7 As Archer (1998: 194) puts it: "A social ontology does not dictate a specific form of practical social theory, but since it commits itself (corrigibly) to what exists, then it necessarily regulates the explanatory program because its specification of the constituents (and non-constituents) of reality are the only ones which can appear in explanatory statements."

other way around; that the methods we employ have an impact on how we understand the world that we study. In fact, such conflation of methodology and ontology has as I see it been a central factor behind the development of what I refer to as *mainstream complexity science*.

Mainstream complexity science

While from the perspective of social science it might seem as if complexity science originated in systems theory (Sawyer, 2005; Tainter, 2006; Vasileiadou and Safarzyska, 2010), we have seen that there are in fact many parallel strands of complexity science that are entangled, but yet lack a common foundation or essence. But within this complex ecology that constitutes complexity science, the strongest impetus today is clearly the tradition that formed around the Santa Fe Institute (SFI). This represents a form of mainstream complexity science that has come to outflank or outshine other currents in the field. The SFI was the first dedicated research center for complexity science, founded in Santa Fe, New Mexico in 1984, in large part by researchers at the nearby Los Alamos National Laboratory with roots in the Manhattan Project and thereby also in the origins of scientific computing and dynamical systems theory in general (see e.g. Galison, 1997). The main roots from which complexity science keeps drawing its nutrition must therefore be sought in physics, chemistry and computer science.

Although many ideas about complexity are of course older than SFI and may have been developed in completely different fields of science, the institute nonetheless has come to bring together various ideas and methods under the same banner, serving as a central hub in the community and also having a central role in forming the meaning of the concept of complexity as understood by scientific scholars, policymakers and the public. Most scholars and theoretical perspectives within the complexity science sphere relate in one way or another to the Santa Fe type of complexity, which is also why I chose to start from this position.

While being a fundamentally interdisciplinary institute, dedicated to the study of complex adaptive systems and with the explicit intention to provide an alternative to the increasing specialization observed in science, the methodologi-

cal scope applied at SFI is however less diverse, close to natural science and quantitative social science. At the very heart of this methodology lie various types of computer simulations, typically studying how the interaction between components in a predefined environment can emerge into patterns and structures on a higher level. In other words, the main focus lies on developing formal models that permit analysis of dynamics and long causality chains that are beyond the ability of our unaided human cognition to follow, thus making possible a systematic inquiry into the processes of emergence in complex systems.

Interestingly, this dominant methodological approach, which is primarily based on different types of computer models, has also come to constitute a way of defining complexity. In other words, it has changed from simply being a methodology and in a sense attained ontological status; the methodological toolkit has thus transformed into a corresponding ontology that understands complex systems by emphasizing micro-level interaction. This characterization and definition of complexity can also clearly be found among the most central and established complexity scientists in the field.

For instance, Johnson (2009) defines complexity as "the study of the phenomena which emerge from a simple collection of interacting objects". Similarly, Mitchell (2009) describes a complex system as "a system in which large networks of components with no central control and simple rules of operation give rise to complex collective behavior, sophisticated information processing, and adaptation via learning and evolution". Holland (2006) agrees, but is almost even more restrictive by stating that complex systems "are systems that have a large numbers of components, often called agents, that interact and adapt or learn". He continues by stating that the coherent behavior of the system arises from competition and cooperation among the agents themselves and "[t]he overall behavior of the system is the result of a huge number of decisions made every moment by many individual agents". This is very much in line with Epstein and Axtell (1996), who see complexity as something that *grows from the bottom up*.

Mainstream complexity science has thus come to be understood as a science that studies the emergence of novel macro-patterns/structures from the interaction of micro-entities. This is in fact, as we will see, a particular type of emergence that is sometimes referred to as *micro-emergence* (Morin, 2007). When a particular higher level has emerged, this can in turn serve as a micro-level in a multi-level system where each level can be studied in isolation. So, emergence in this mainstream version of complexity is thus a matter of *mass dynamics*: the interaction of a multitude of entities generates aggregated results that we are not cognitively equipped to handle; the chain of causation is simply too long and complex to follow. This means that we need an external tool in the form of

computer models to bridge this cognitive gap in order to not only assume, but also study the process of micro-emergence.

Distinguishing complexity and complicatedness

Following the mainstream complexity tradition, the nature of complex systems is often explained through a fundamental disjunction between *complexity* and *complicatedness*[8] (Cilliers, 2001). These two system qualities are hence often juxtaposed and contrasted for the purpose of explaining what complexity science is really about. When these properties are opposed in this way, complicatedness is set to represent top-down optimized systems where each component of the system has particular functions in relation to the whole and each follows a separate logic (such as a car, a computer or a spaceship), while complexity is associated with bottom-up self-organization, like a flock of birds, a hive of insects or a crowd of pedestrians.

Complicatedness, on the one hand, can generally be fully described using equation-based models and through a reductionist approach consisting of reducing the system to underlying components. These systems are organized in reducible and scale-separated level hierarchies, which means that each part of the system consists of a number of parts that in turn consist of other parts, which can in turn be understood by further reducing them downwards. By dissecting the system into its constituent parts and disassembling it into its bits and bolts we can thus fully understand and predict the behavior of, for instance, a car. This is in fact also the reason why we can construct such immensely effective systems such as a spacecraft: they comprise different levels which provide different functions, and we can use these levels as a basis or building blocks when we construct even more advanced systems. Additionally, these systems have typically low redundancy, in the sense that components cannot generally take over the role of other components, and specific mechanisms are typically located in certain parts or components.

Complex systems, on the other hand, are fundamentally different. These systems are *emergent*, in the sense that the whole is greater than the sum of its parts. They consist of multiple interacting entities whose behavior often leads to un-

8 This is also sometimes referred to as *dynamical* and *structural* complexity (Érdi, 2007).

expected outcomes on a macro-level. This means that traditional Newtonian methods that rely on reducing the system to its atomic elements do not allow us to gain any deeper insights into these systems. No matter how thoroughly we study the individual birds in a flock, carefully investigating the shape of their wings and dissecting them into their smallest possible parts, we will never be able to deduce the behavior of a flock of birds. The point is that the elements in this type of system are secondary: *the magic resides in their interactions*. In fact, this description of complex systems fits well with the original meaning of the Latin-term *complexus*: what is woven together.

A distinctive feature of this kind of system is that we often have many components on the same organizational level, but few component classes. In other words, these systems typically consist of a rather homogenous population and thus have high redundancy; components may replace each other without too much effort. This means that specific mechanisms are typically distributed within the system, rather than located in any specific parts. Just think of the consequence of replacing a bird in a flock, compared to removing the carburetor from a car.

Complex systems typically balance between stability and instability. While they can remain in a state of relative stability for long periods of time, they also have the potential for radical change that may or may not be instantiated. This means that they are generally *far from equilibrium*, in the sense that when exposed to disturbances/perturbation, the system's stable behavior may give way to random fluctuation and radical transition from one state to another (Harvey and Reed, 1996). These critical moments in the changing dynamics of systems into a different equilibrium state are often referred to as *tipping points*. While the exact definition of this concept varies in the literature, it typically refers to the effect when relatively small sets of changes suddenly result in large-scale global consequences (Castellani and Hafferty, 2009). Examples may include economic collapses, riots and revolutions. These processes are also connected to the notion of *positive feedback loops* — the process through which certain factors can become self-reinforcing and amplified over time, sometimes leading to *cascades of changes* throughout the entire system. Interestingly, the same interdependencies and strong intercoupling between components in complex systems that enable cascades also explain the relative stability of complex systems, and closely relate to dynamics such as *lock-in* and *path dependency,* which implicate the inability of a

system to coordinate and leave a local optimum[9]. In broad terms, stability can thus be derived from the entrenchment of various components and subsystems; they are entangled, enmeshed and deeply interdependent upon each other which, up to a certain point, tend to lead to stability and resilience. Such stabilizing dynamics are often related to *negative feedback loops;* processes than dampen and stabilize the system, and thus act to maintain a system's current stable state.

These notions are intrinsically connected to *emergence*, which as we have seen is a key defining feature of complex systems. Emergence is closely connected to non-linearity and is here broadly defined as ontological novelty at a higher/systemic level. More specifically, emergence is typically described as interaction between elements on the same ontological level that result in macroscopic qualitative novelty (e.g. Bedau 1997; Holland 1998; Corning 2002). Often, but not necessarily, these emergent dynamics may appear counter-intuitive and surprising to us, due to our cognitive inability to follow complex dynamics. Later, I will further distinguish between this specific type of *bottom-up emergence* that is common in complex systems, and the broader type of emergence that often characterizes social systems. But it is important to note here that in my view, emergence is an ontological concept (see also Bunge, 2003a; Elder-Vass, 2010; Wan, 2011; Harré and Madden, 1975)[10]. This means that even if we can indeed fully explain a higher-level phenomenon in terms of the underlying components and their relations, *the property itself is still emergent*. As Bunge (2003a) effectively argues, explaining it does not "explain away the power" or make it

9 An epitomizing example of a lock-in is the QWERTY keyboard layout. It was originally designed to avoid the problem that the type bars often jammed in early typewriters, by putting keys that are commonly used in succession as far away from each other as possible. This means that the layout is optimized for maximal finger movement, which obviously decreases both typing comfort and speed. Despite the fact that modern keyboards no longer have these technical limitations, we are nonetheless locked-in with this design due to a variety of factors associated with switching costs, such as sunk investments, coordination problems etc.

10 As Wan (2011) points out, this differs from Luhmann's epistemological understanding of emergence, defining a certain property as emergent based on its derivability or explicability on the basis of lower-level facts. But as Bunge argues, emergence is an aspect of dynamical complexity, implying relationally distributed mechanisms, not a function of our knowledge. There is no reason for us to accept that emergence must be mysterious. The behavior of a flock of birds is no less emergent because we manage to derive the relational rules that give rise to the flock behavior. As Bunge Bunge (2003a) claims, emergence is a fact about being, not about knowledge.

less real; the emerging phenomena and its underlying mechanisms still have separate properties or powers.

The main lesson here is that complicated systems and complex systems are two fundamentally different types of system that exhibit different types of dynamics, and also require different theoretical and methodological approaches. While the former can be fully understood using mathematical approaches founded on linearity, and by dissecting the system into constituent parts, complex systems tend to exhibit nonlinear dynamics that require a relational focus to analyze[11]. Think of, for instance, the three-body problem in celestial mechanics. While the case of two celestial bodies interacting gravitationally is a straightforward task to calculate and predict, just adding a third body to the system makes the dynamics chaotic, with paths no longer repeating themselves. There is currently no comprehensive analytical solution to this type of problem.

This insight, together with the parallel arrival of complexity science and its associated tools, truly revolutionized science in many ways, opening up unique new possibilities to study a wide range of phenomena that were previously difficult, if not impossible, to study, ranging from the behavior of a flock of birds to particle interaction, traffic jams and certain types of crowd behavior. This new field of inquiry has thus come to change large parts of the natural sciences in a fundamental way (Gell-Mann, 1992; Wolfram, 2002). We suddenly gained a range of new tools to deal with complex and nonlinear system dynamics.

11 While relatively simple complex systems such as a flock of birds or particle interactions can indeed be studied using computer models; the high level of instability, the chaotic tendencies, and the sensitivity to initial conditions that characterize complex systems often make such models very difficult to use for exact prediction. This is, for instance, what makes precise weather forecasting beyond a few days impossible.

4

Social systems: complex or complicated?

Coming from this fundamental distinction between complexity and complicatedness, the question that naturally follows is how we should regard the type of system that we as social scientists are generally interested in: are social systems complex or complicated? Where on the line between these supposedly opposed properties should we place them? Should we approach social systems as complex systems in the mainstream meaning of the word?

This very question marks the basis for Article I: *societal systems – complex or worse?* In this article, we embark from the idea that social systems tend to be both complex and complicated at the same time. Characterized by varying degrees of structural hierarchies, multi-level structures and subsystems but at the same time clearly complex systems, the structures of most social systems are constantly transforming and evolving partly from below through emergent bottom-up self-organizing processes, and can thus not be understood by simply breaking them down into their constituent parts. However, the crux of the matter is that this mix between complexity and complicatedness is not simply additive but emergent, forming a third and distinct category of systems that we call *wicked systems*. The term wicked systems is a reference to the notion of "wicked problems" in the management literature (Churchman, 1967), which describes problems that lack definitive formulation, are characterized by complex interdependencies and are often difficult or impossible to solve in a finite manner. Thus, the term is here used to denote the nebulous character of these systems and their resistance to simple solutions, rather than imply that they are "evil". Wicked systems are not just a type of complex system, but rather a type of system where complexity is mixed with complicatedness, yielding a new emergent property — *wickedness* — to which neither mainstream complexity science, analytical models or a combination between them lend themselves very well. In other words, both large-scale societal systems and most small-scale social sys-

tems such as group interactions, social movements and organizations are not merely complex systems, at least not in the mainstream micro-emergent sense, they are a type of wicked system.

In fact, this insight is far from trivial, but carries some important implications. These different systems tend to generate different types of problems and also require a different set of methods to analyze. Wicked systems thus represent an emergent combination that does not yield itself easily to the methods adapted for either complex or complicated systems. These systems require a fundamentally different approach.

Open and Closed systems

In the philosophy of sciences a common way to distinguish between different types of systems and decide what methods are suitable for studying them is to distinguish between *open* and *closed* systems (Bhaskar, 1978; Collier, 1998; Sayer, 1992). Generally speaking, systems are considered "closed" if they are cut off and isolated from external influence. Thus, closed conditions are present when generative mechanisms can operate in isolation and independently from other intervening mechanisms. More specifically, Bhaskar (1978) sets up two basic conditions that are required for closure to apply in a system: the *intrinsic condition* stresses that there must be no change or qualitative variation within the object in question, while the *extrinsic condition* demands that the relationship between the causal mechanisms within the object under study and causal mechanisms in the surrounding environment must be constant. If both of these conditions are met, we have a closed system in which regularities are produced, which opens up for powerful scientific and formalistic methods such as experimentation (Sayer, 1992: 122). The distinction between open and closed systems can also be plotted as a graph (see Figure 1), thus illustrating how both complex and complicated systems can be conceptualized as relatively closed systems, while wicked systems can generally be categorized as open systems.

But the distinction between openness and closure says little about what actually makes these different systems approachable; why are closed systems easier to attack using formal approaches and what is it about open systems that makes them so elusive to formalism? This distinction also appears unnecessarily binary. In Paper I, we use the terminology of Simon (1962) to further specify in detail what it is about closed systems that makes them possible to study in a scientifically formal way. Thinking of systems in terms of *decomposability* creates more of a continuum between openness and closure and illustrates that this is rather a matter of scale than a simple dichotomy. The more open they are, the less propitious are methods relying only on strict formalism.

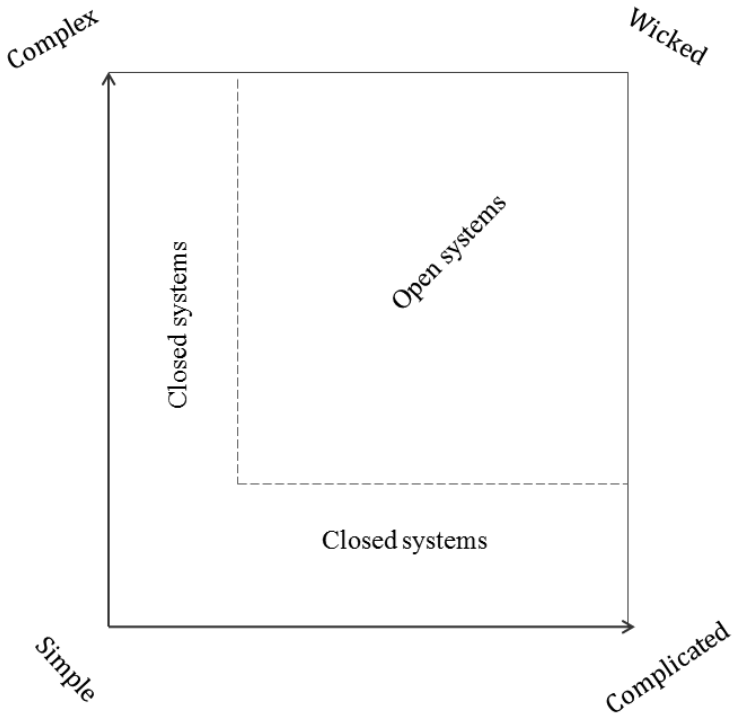

Figure 1: Illustrates how open and closed systems correspond to complex or complicated systems. Wicked systems tend to be open systems, while both complex and complicated systems tend to be closed.

Near-decomposable systems

Closed systems can be conceptualized in terms of what Simon (1962) refers to as *near-decomposable systems*. This basically means that these systems can be separated into distinct organizational levels. We can distinguish between an *inner environment* where the dynamics that we study takes place, and an *outer environment* that can be assumed to be static or at least vary only in highly regular ways. These are separated by an *interface*, which can be understood as the emergent totality of the component. The ontology of near-decomposable systems is relatively fixed, at least for a limited time period, which means that the inner environment will not be importantly disturbed from the outer environment. In simple terms, this implies that there are more interesting things going on between the sub-components within a system (inner environment) compared to

what is going on between the actual component itself and other components on its own level of organization (outer environment) (see Figure 2).

But the condition for near decomposability is valid only for a certain time period, which Simon refers to as "the short run" (Simon, 1996). If the time period is too long, then factors outside of the system will begin to disturb the inner dynamics and the assumption of scale separation and enclosure will no longer hold. In other words: this implies sufficient time for interesting dynamics to occur, while short enough for the system not to change in any qualitative way. The greater the separation of scales between inner and outer environment, the greater is the difference in speed, size and characteristics of the dynamics between these levels, and hence the more generous is the time period for which a fixed ontology can be assumed. For instance, for a flock of birds these assumptions are valid for a comparably long time, since the dynamics steering the flock will not suddenly change dramatically in the short run due to external influence. Similarly, for the study of traffic, a suitable "short run" would be minutes and hours. For time scales shorter than minutes, not much would happen, and if we move to several days, the dynamics would just repeat itself. In the course of weeks and months, roads, traffic regulations and the type of vehicles would start to change.

The consequence of near-decomposability is of course that the system in question can be more easily delineated, separated from its surroundings and studied in isolation. It is relatively easy to locate the boundaries of the system and study the internal dynamics as they operate undisturbed by external influence: i.e. in a metaphorical way to cut off the system at its joint. This permits valuable simplifications and thus opens up for rigorous and powerful methods such as experiments and various quantitative approaches such as formal modelling. In this sense, near-decomposability is a prerequisite for formal scientific methods.

This also explains the relative success of the natural sciences over the social sciences when it comes to the possibilities of explanation and prediction. Often, systems that are studied within the natural sciences are assumed to be more closed in the sense that they can be separated into distinct organizational levels. Traditionally, such closure may also be artificially created in experiments by producing the appropriate intrinsic and extrinsic conditions (Bhaskar, 1993; Bhaskar, 1978). In this sense, the success of natural science is thus partly a result of the achievement of physical control over nature, rather than the other way around (Sayer, 1992); we understand the world by changing it.

These conditions for near-decomposability generally apply for both complex and complicated systems. As we have seen, complicated systems are structured in such a way that reduction is possible by focusing on the attributes of the

underlying components, while complex systems are less clearly structured and require a more relational focus. While the mode of reduction is undoubtedly an important difference, the point here is that both types of systems are nonetheless structured into a near-decomposable, nested hierarchy, with each level forming the building blocks for the next, much like Legobricks[12]. This is what allows the system to be broken down into distinguishable subsystems, the implication of which can be addressed using both systematic and formalist approaches based on reductionism; either statistical methods that focus on attributes of the components, or simulation models that focus on the emergence of macro-patterns from lower-level interactions (micro-emergence or first-order emergence). To sum up, it is essentially the near decomposability of closed systems that makes them easier to approach using formal methods. Let's now focus on non-decomposable systems and delve deeper into the characteristics of wicked systems, the category to which most social systems belong.

12 For instance, complicated systems such as engineering systems are generally constructed based on top-level functionality. They are intentionally designed as hierarchical systems with near decomposable levels, basically since this enables the use of one level as a base on which to construct higher levels. This is in fact what allows us to build complicated engineering systems: we do not need to know the detailed working of a component on a lower level as long as we are familiar with the interface and the function of the component. For instance, we can use and install a carburetor in a car even without the vaguest understanding of how it actually works on an underlying level. By implication, this also means that each level can be improved independently, or even replaced, as long as the functions are retained and the interface is not altered.

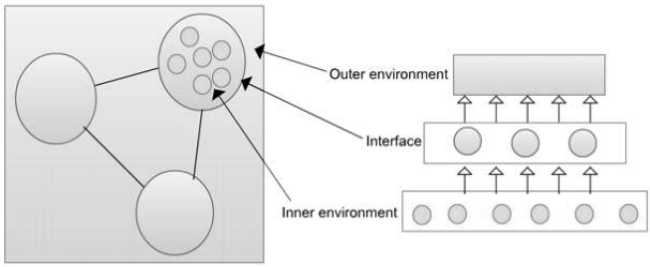

Figure 2.1: A near-decomposable system, illustrated in two ways. Due to timescale separation we may distinguish between an inner and outer environment of the system, and interaction only occurs through the system interface. This constitutes a closed system.

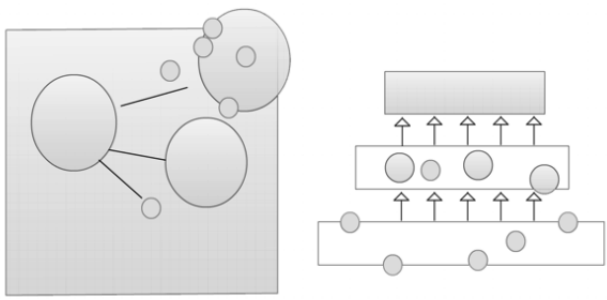

Figure 2.2. A poorly decomposable system. Because of the lack of any clear system demarcations and timescale separation, it is difficult to determine what belongs to the inner and outer environments respectively. This means that the system cannot be decomposed into separate levels; there there are no closed borders and interaction occurs between levels, thus breaking any clear separation between inner and outer environment, which is a precondition for formalization.

Social systems as non-decomposable systems

When it comes to wicked systems[13], which is the category to which most social systems belong, we are not as lucky. Social systems are inherently open systems,

13 Unless otherwise stated, I will henceforth refer to wicked systems and social systems equivalently.

which means that they are generally not decomposable into stable subsystems. They are what Simon (1962) calls *non-decomposable systems*[14]. These systems lack clear boundaries and have less clear separation between inner and outer environment. In this sense, they are difficult to delineate or decompose in a meaningful way into stable hierarchies and analyzed in relation to any fixed external environment, even in "the short run". In contrast, they are characterized by many types of processes on different levels that co-exist, co-evolve and influence each other on overlapping timescales and levels of organization. Different structures of wicked systems are intertwined in complex ways, and subsystems may be part of many different systems simultaneously. While the complexity of these systems is indeed the consequence of interactions, it is not only a matter of micro-emergence, but "interactions of parts of the system with each other; interactions of parts of the system with the system as a whole; and interactions of the system with other systems with which it intersects, within which it is nested, and with which it may share interpenetrating components" (Byrne and Callaghan, 2014: 173). As Cilliers (2001) states, these systems:

> … have structure, embodied in the patterns of interactions between the components. Some of these structures can be stable and long-lived [...], whilst others can be volatile and ephemeral. These structures are also intertwined in a complex way. We find structure on all scales. [...] [N]on-contiguous sub-systems could be part of many different systems simultaneously. This would mean that different systems interpenetrate each other, that they share internal organs. How does one talk of the boundary of the system under these conditions? (p. 4-6)

As I will discuss now, a main reason for this is that unlike atoms, the objects of social systems have histories and geographies, and these not only provide a setting or back-cloth but can make a difference to the social structures themselves (Sayer, 1992: 145).

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14 One possible objection that could be raised here is whether we should even use the term "system" to describe wicked systems, since they have unclear boundaries and lack functionalities. But in my view, besides that they clearly exhibit typical system dynamics, wicked systems also fulfil most common and basic definitions of systems, for instance Cambridge dictionary's definition of systems as "connected things or devices that operate together".

Social structures and reflexive emergence

Humans are reflexive and adaptive agents, endowed with the unique ability to detect and interpret emergent structures and patterns, to build narratives based on an interaction with reality and then act upon these constructions. Thus, humans do not generally just follow simple rules, but constantly and reflexively adapt to new situations, adopt new behaviors and are thus constantly changing the very rules of the game.

Archer (1995) has approached this dialectic relationship between agency and structure by developing the morphogenetic approach of analytical dualism. In this way, she charts a middle course between the Scylla of *downward conflationists* (e.g. Parsons, Althusser) and their one-sided focus on structures, which consequently neglects agency, and the Charybdis of *upward conflationists* (e.g. symbolic interactionists) on the other hand, who see the world as merely a product of a myriad of actions of currently living individuals. Archer also criticizes what she refers to as *central conflationism* (e.g. Giddens and Bourdieu), which in her view represents a problematic attempt to overcome these issues by transcending the structure and agency dualism. This implies a conflation of these issues as merely two sides of the same coin. By collapsing the structure (i.e. external objective structures, the external normative environment) as nothing but individuals' *conception* of these, this consequently makes it impossible to study the relation between them. According to Archer, this central conflation "deprives *both* elements of their relative autonomy, not through *reducing* one to another, but by compacting the two together inseparably" (Archer, 1995: 101).

In contrast to this, the morphogenetic approach attempts to go beyond both voluntarism and determinism and depicts social structure and agency as separate, and explanation thus corresponds to mapping and analyzing the dialectical interplay between them. Accordingly, she develops the morphogenetic *cycle*, which describes a process of change that emerges from social interactions, but that also serves by conditioning the very same interactions. The cycle consists of three analytical phases: [i] *structural conditioning* (prior to agency), [ii] *social interaction* (in the context of structural conditions) and [iii] *structural elaboration* (the outcome of the interaction between the two former over time). These phases constitute a continuous cycle, so the last step becomes the first, and so on. Existing social structures thus arise from the actions of people in previous cycles; "[w]e are all born into a structural and cultural context which, far from being of our making, is the unintended result of cultural context which, far from being our making, is the unintended resultant of past actions among the long dead" (Archer, 1995: 253). The latter point is crucial here; while she argues that society *does* emerge from the agency of its actors, their collective goals, conflict and preferences, we must remember that at the end of the day, "the majority of

actors are the dead" (Archer, 1996). Thus, this temporal dimension is what gives social structures a relative independence, and it also serves as an important criticism against voluntarism and the tendency to approach society as merely the product of the actions of current agents.

This also implies that the elaborated structure is emergent; while it is indeed the result of actions of individuals, it cannot be reduced to these. The social world is always *pre-structured*; structure precedes agency since agents occupy structural position *before* they act upon and change them, so agents confront and transform pre-existing social structures, they do not construct them from scratch. This interplay between structure and agency occurs over time; it is a continuous causal chain, a cyclical relationship. But an essential point here is that individuals are both agents and actors, they are agents in certain positions in structures, and actors with numerical identities, who also possess reflexivity and critical thinking. In this way, individuals develop a personal identity through a process of "reflexive deliberation" or "internal conversation", and by monitoring ourselves in relation to our context. This has the important implication that "structural and cultural factors do not exert causal powers that become efficient in relation to human beings, but rather in relation to our emergent powers to formulate social objectives" (Archer, 2003: 130)[15]. These emergent powers thus arise out of the interaction of ontologically distinct but interacting structures and agency. The role of "internal conversation" or "inner dialogue" is essential here, since we reflect upon our social objectives and projects, and re-phrase and re-formulate them in a process that is "genuinely interior, ontologically subjective and causally efficacious" (Archer, 2003: 16). In this way, reflexive deliberation is the process that links social structure and agency. Or, as Archer (2003:

15 While I essentially agree with Archer, I do believe that her focus on the reflexive elements of human action is at the cost of neglecting the less conscious aspects of action, and how we unthinkingly may reproduce structures. Here, I side with Elder-Vass (2007), arguing that Archer's perspective can be complemented with Bourdieu's notion of *habitus*, which explains why and how reproduction occurs unconsciously. As Byrne and Callaghan (2014: 124) also point out, we can thus interpret Bourdieu's discussion of the internalization of externality in Elder-Vass in a more metaphorical sense, "on the basis that habitus is a set of dispositions that tend to causally influence us". Following this interpretation, there is not necessarily any contradiction between Bourdieu's work and the ontological approach of Archer. Conversely, by connecting Archer and parts of Bourdieu, we can approach human actions as co-determined or emerging from the interaction of habitus and internal conversation.

130) expresses this: "reflexive deliberations constitute the mediatory process between 'structure and agency', they represent the subjective element which is always at interplay with the causal powers of objective forms".

Accordingly, we should in general not talk about mechanism in social systems in the same way as in natural systems. Mechanisms in natural systems generally exist regardless of their meaning, while social structures are what they are through their meaning for the individuals (Geertz, 1994). This is not a matter of "the push and pull of external forces", but interpretation tends to be a precondition and a continuous aspect of mechanism-based explanations in social systems. As we have seen, Archer's morphogenetic approach offers a set of real structures interacting with agents over time to explain both reproduction and change. Structures are seen as emergent relationships that arise from actions of both the living and the long-dead, and continue to manifest in structures that do not just exist out there, but are constantly reproduced. For this reason, they constitute layers that cannot simply be reduced. This account thus provides space for both the causal influence of structures and reflexive agency, and is all baked together in a system-theoretic perspective that clearly resonates well with complexity thinking. Social reality is not law-like, but dynamic and unpredictable, and thus difficult to capture in formal approaches.

Causal power and causation

The discussion above inevitably leads us to the question whether emergent social structures possess causal power in themselves. This constitutes a key question that has spawned profound disagreements among critical realists. While Bhaskarian realists (or "social realists") often and happily assign causal power to social structures (e.g. Hamlin, 2004; Lawson, 1989; Mouzelis, 2008; Sayer, 2000), non-Bhaskarians are often highly critical of this, since, as they argue, attributing agency to entities that are not actors/agents runs the risk of reification, or the "the agentification of social structures" (Varela, 2007: 201).

I believe that part of this disagreement may derive from a conflation of the notions of *systems* and *structure*. In the next section, I will argue that it is necessary to distinguish between these two and acknowledge that each possesses different types of causal impact. Additionally, through this distinction we may also clarify a central contribution that complexity theory makes in relation to the critical realist position and Archer's morphogenetic approach. But before delving deeper into this, we first need some clarifications and definitions.

First of all, what is meant here by causal power and causation?

The realist tradition is based on a *thing-based ontology* (Bhaskar, 1978; Bunge, 2006; Bunge, 2003b; Harré and Madden, 1975). In essence, this means that only

concrete, material things, or *powerful particulars*, have causal power and can act. These are "powerful" since they possess causal powers or generative capacities in virtue of their intrinsic nature (Harré and Madden, 1975; Varela, 2009). As Bhaskar (1978: 51) explains: "[t]he world consists of things, not events. Most things are complex objects, in virtue of which they possess an ensemble of tendencies, liabilities, and powers. It is by reference to the exercise of their tendencies, liabilities and powers that the phenomena of the world are explained". These concrete things are (in the domain of the real) endowed with causal powers that combine and interact to produce actual events, some of which are observed by us as sense data. Accordingly, following a realist approach, "causes" are not understood as variables or events but are "seen as those things, forces, powers, mechanisms or sets of relations that make things happen or 'trigger' events" (Kurki, 2008: 174). This applies for both the social and natural realms.

Clearly, this approach to causation stands in sharp conflict with the classic *regularity* or *successionist* theory of causation that is most closely associated with empiricism and the positivist mode of explanation, in which causation essentially is about empirical regularities of observable events (Wan, 2011: 117). By contrast, critical realism builds upon a *generative* theory of causation (Harré, 1984; Kurki, 2008). Following this approach, what matters when tracking causal connections is not to identify law-like regularities or patterns of empirical observables, but rather "the description of the real properties, structures, and generative mechanisms that underlie the actualization of events and their empirical observations" (Kurki, 2008: 166). This means that causal power is defined as the capability or capacity of an object/entity to have an emergent causal impact. So, causal power is related to *potentiality* rather than empirical regularities or laws.

This means that a powerful particular can possess causal power even though it may not be practically actualized or exercised, and when exercised it may or may not lead to certain empirical regularities or particular outcome patterns. Or, as Little (1998: 205) clarifies, to possess causal power means "to have a capacity to produce a certain kind of outcome in the presence of appropriate antecedent conditions". As I will discuss more thoroughly in the following chapters, causation typically occurs in open systems, which means that the impact of certain causal mechanisms depends on the context and on any potential countervailing mechanisms. For instance, a planet (or any large physical body) possesses causal power in that it has the potential to have causal impact on other physical bodies through gravity, but whether this causal power is actually manifested empirically as a measurable phenomenon depends on the presence of other potentially countervailing mechanisms, such as gravitational forces from other adjacent planets.

Distinguishing between structure and system

Now that we have straightened out some important definitions, let us return to the question whether social structures possess causal power. As we have seen, according to the critical realist position, the notion of causal power should be confined to those complex things which *do* things by dint of their intrinsic nature. So, does this apply to social structures? As noted above, there is a widespread disagreement about this and I believe that part of the reason for this is that there appears to be a tendency in much sociological literature, including parts of the critical realist strand, to conflate the notions of *structure* and *system* (see also e.g. Bunge, 1999; Wan, 2011)[16].

For instance, Porpora (1998), a distinguished critical realist, has created a well-known typology of different approaches to social structure that he argues are incompatible. Each approach represents a particular position between methodological individualism and collectivism/holism. The position typically associated with a Marxian or critical realist position basically defines structure as "systems of human relationship among social positions" (p. 343). Or more specifically:

> Social structure is a nexus of connections among [human actors], causally affecting their actions and in turn causally affected by them. The causal effects of the structure on individuals are manifested in certain structured interests, resources, powers, constraints and predicaments that are built into each position by the web of relationships. These comprise the material circumstances in which people must act and which motivate them to act in certain ways (Porpora, 1998: 344).

Similarly, the Marxist theorist Callinicos (2006: 189) defines a social structure as "a relation connecting persons, material resources, supraindividual entities (social institutions of some kind), and/or other social structures by virtue of which persons […] gain powers of a specific kind".

16 Elder-Vass (2010: 85-86) appears to pursue a related argument when he makes a distinction between two structural elements: *structure-as-relation* defined as "the way a group of things is related to each other", and which seems to correspond to what I here refer to as structure; and *structure-as-whole*, which he defines as a "whole entity that is structured by the relations between its parts". This appears to be equivalent to what I refer to as system.

In both these definitions, the notions of structure and system appear to be amalgamated, thus comprising both [i] structural positions that provide access to different resources, and [ii] substantial, and empirically observable relations between social actors. In my view, this conflation is problematic since there is a risk of reification when treating formal or categorical collections as actual systems, and since it makes it difficult to distinguish between different types of causal impact. Let me clarify this.

Following Archer's discussion and conceptualization of social structures above, I believe that it is clear that social structures cannot be conceptualized as things or "powerful particulars". Social structure is a set of relations that provides different access to resources, and as such "it is a *concept*, not a concrete thing such as an organism, a person, or a group" (Wan, 2011: 127). This means that they are not "efficient causal entities"; they do not consume, act or produce by themselves, but can only be effective in terms of the agency of social actors (I use the term broadly here to include both individuals and groups). Emerging from the interaction of social actors, social structure is a *property of systems, not a thing* (Bunge, 1999: 65, my emphasis)[17]. While structures are indeed objective and represent real commonalities among individuals, they are constituted by formal relations that are *not* necessarily substantial or empirically observable. For instance, two individuals belonging to the same social class may have similar access to various resources, but they are not necessarily bound together through social ties (Bunge, 1999: 69).

While this means that social structures do not possess effective causal power, they do however contribute by shaping the formation of goals, beliefs and preferences for individuals, who in turn produce causal changes. Or, to put it somewhat differently: "they bring changes about which, if they were different, would not occur in the same way" (Carter and New, 2004: 10). In Archer's words, they condition social action, and accordingly I think it makes sense to use the term *causal influence*, instead of causal power, when talking about social structures.

Systems, on the other hand, are substantial and (at least hypothetically) empirically observable; they comprise actual relations and interactions, constituted by agents that are in one way or another connected to each other (c.f. Bunge,

17 As Bunge (1999: 23) states, "[t]here are structureless objects, such as photons, but not objectless structures: every structure is the structure of some object".

1999; Bunge, 2006; Wan, 2011). In this sense, this definition of a system is similar to how social networks are typically defined: as a set of social relations between components that interact in some way. The central difference from structures is that systems may be powerful particulars with emergent properties that have a downward causal impact on their components and subsystems, in other words they can possess causal powers.

In this sense, systems can be regarded as objects. Of course, this statement is trivial when dealing with biological entities or pretty much anything below cell-level, since these are typically bounded systems, contained in physical shells that spatially separate them from their environment. This is an obvious difference from social systems that typically lack such clear physical boundaries. But in truth, the existence of physical boundaries is of no crucial significance here. After all, the same applies to ecosystems, which like human societies lack any clear physical boundaries and are not constrained, but are distinguished and treated as separate strata or entities in evolutionary biology, for instance. These systems are integral entities; they are born, mature, and die, and they are composed of elements that share a common history and fate. Thus, ecosystems represent substantial and observable relations among concrete individuals and therefore *do* have causal power. Similarly, while human beings ultimately are biological systems that depend upon various particles and their interactions, we would hardly refuse to acknowledge that humans are indeed entities with causal powers in their own right, powers that are not possessed by their constituent parts.

In which case, the notion of social system is broad and comprises a variety of different types of systems, including both what Elder-Vass (2010) refers to as *supra-individual entities*, and larger systems that may not be as tightly integrated.

Within the former category we may find e.g. various groups, firms, social movement organizations and unions. These social entities are "concretively structured groups and collectives (and perhaps combinations of these) that function as relatively enduring dynamic social systems" (Kaidesoja, 2007: 84) and in which interconnected individuals interact in relatively stable ways. Or in Tilly's (1995: 1595) words, they are "coherent, durable, self-propelling social unit[s]". As Elder-Vass convincingly argues, such supra-individual entities may possess systemic or emergent properties (or causal powers) absent from the individuals that make up the particular entity, and that may do certain things in certain circumstances. In the words of the philosopher Raimo Tuomela (2007: 388, quoted in Wan, 2011), these entities are typically characterized by *we-mode thinking and acting,* in that "the members, while functioning as group members, think and act for the group (for its use and benefit) and are collectively committed to the contents of their thoughts". Accordingly, these supra-individual enti-

ties may fall within the definition of a social/collective actor, endowed with a form of agential causal power.

But the notion of systems also includes large social systems/networks that may not fall within the category of supra-level entities but are less internally integrated; in fact, the members themselves may not even be aware that they are part of them. Nonetheless, these systems may have emergent properties that have a downward causal impact on components and subsystems. For instance, certain network properties such as *density* may have a causal impact on diffusion processes (e.g. how information, diseases and behavior spread) and the overall resilience of the network, i.e. the sensitivity to external disturbance. Similarly, path dependency, lock-in, tipping points and cascades are all dynamics that are inherently related to the system/network structure. Accordingly, these system dynamics have indeed a causal impact on social processes, although it may not be agential in the sense that it is not mediated through the conscious actions of agents. In other words, this causal impact may be independent of the agents' reflexivity or awareness of them. My point here is that while Archer (1995) correctly states that pre-existing structures have a causal influence on social action, my argument is that the actual relations and interactions within systems that individuals are embedded in may in themselves possess and exert causal powers that affect social action.

Let us summarize the argument so far. Social systems (e.g. unions, groups, movements, and essentially also society as a whole) constitute substantial and, at least hypothetically, observable relations and make up a whole that is different from the parts, and that may possess emergent causal power. Structures emerge from systems; they are a set of relations among member of a given social system and its environment. In this sense, they are a property of systems, not a concrete thing. While they do not exert any effective form of causal power, they do have causal influence since they are associated with formal and material causes that contribute to the formation of intentions, preferences, capacities and dispositions of individuals that condition social action, which in turn may generate change (Wan, 2011). In this sense, they provide the raw materials that actors use and that constrain and enable certain forms of social action. Thus, social structures have a type of emergent downward causal influence on lower levels — mediated through social agents.

I believe that this distinction that I have argued for here between system and structure is vital in order to avoid reification of formal or conceptual collections as a concrete system, but also by helping to clarify a key contribution of complexity science to critical realism — and to sociological theorizing in general. This distinction reminds us that although social systems undoubtedly belong to a special kind of system with components that are reflexive, they are nonetheless

systems, and as such they also exhibit typical system-related dynamics. Complexity science contributes essential (but complementary) theoretical and practical tools for analyzing these dynamics, and thus enables us to study the impact of system dynamics on societal processes. Additionally, Archer's depiction of a temporal cycle that goes back and forth between agency and structure appears in my view as too tidy and rigid. Although this distinction is indeed analytical, the risk is that it gives the false impression that these processes can always be neatly separated in empirical analysis. In my view, emergence and downward causation often occur simultaneously, something that I will further elaborate on in the section below[18].

It is important to note that although it is necessary to analytically distinguish between them, system and structure are however closely connected and mutually embedded (which is probably also why they are frequently conflated). Social systems tend to change in relation to emerging social structures, and vice versa. For instance, the development of class consciousness may lead to changing social networks, since our political views may lead us to acquire new friends while losing others. Likewise, concrete changes in our social networks (e.g. social mobility) may lead to changing norms and values. Clearly, there is an interesting and close relation between system and structure, and this constitutes two fields of literature with interrelations and overlaps that I believe need more attention.

Multi-level causation

While the relation between social systems and social structures is undeniably complex and in dire need of further theoretical elaboration, we may conclude that due to the unique human capacity to interpret and act upon emergent social structures, social systems are not only characterized by micro-emergence, i.e. emergence from the bottom up. Social structures emerge from actors and their relations, and these structures in turn have causal influence on the very same actors. Social structures are thus both the cause for and caused by action. Additionally, as I have argued, the way individuals are organized into patterns of

18 A more practical example of the often messy co-evolution between different levels in societal processes can be found in Paper II, which approaches societal transitions by analyzing the co-evolution between the external *landscape*, the established *socio-political regime* and *free social spaces*.

interactions may in itself have direct downward causal impact on the behavior of both the system and the constituent individuals. Hence, social systems are characterized by various forms of *reconstitutive downward causal powers* (Hodgson, 2002) and *causal influences*; the whole to some extent and in various ways reconstitutes the parts.

Individuals exist within several (sub)systems and on several levels at the same time. We occupy positions in structures of e.g. gender, class and ethnicity, but also in specific and concrete group constellations, and these positions in various ways condition our behavior, both consciously and unconsciously. Additionally, these different systems and structures are entangled; they are deeply connected to each other and difficult to neatly separate in an empirical analysis. For instance, individuals interpret emergent processes at both meso-levels (e.g. group interaction) and higher levels (e.g. social segregation) and these processes often occur in parallel, they are intersected. In this sense, there is a social element at every level, from the smallest collective assemblage of human beings to the level of the world system as a whole.

This means that social systems are multi-level systems, with causal processes going in all directions. So, while the natural world is often described as hierarchical, this description appears misleading when it comes to the social world. The social world is better imagined as constituted by sets of nested[19] but interpenetrating systems with causal powers and causal influence running in all directions. The effects on individuals takes the form of, as Dyke (1988: 64) puts it: "a plurality of interpenetrating constraints deriving from many recognizable 'levels' looping back and around each other". Consequently, social systems lack clear boundaries, and it is very difficult to separate them into distinct and persistent levels of organization: there is no clear separation between inner and outer environment. There are simply no joints to cut, or rather, there are too many. Wicked systems are composed of intersecting, closely intertwined complex systems (including material and other "non-social" systems) and affected by causal mechanisms and feedback processes both within and between many levels. Accordingly, wicked systems are not only characterized by the bottom-up type of emergence that typically embodies complex systems, but also by inter-

19 The notion of nested systems means that the components of a complex system are in themselves complex systems. For instance, a social movement may be set up by organizations, which in turn are set up by individuals, which are made up of cells — all of which are complex systems.

penetrations and overlaps and multi-directional emergent causality. They are deeply entrenched in downward causation, horizontal causation and just general causation in all kinds of direction. A more accurate description of social systems is that they are often a messy entanglement of causation and emergence from all levels, as surrounding systems constantly impact each other. In other words, these systems are not like a Russian doll or an onion that can easily be peeled into separate layers to be studied in isolation, but rather resemble a mango; a messy entanglement of gummy strings and smudgy threads, where any effort to disentangle it all too often only results in sticky hands and a massacred fruit.

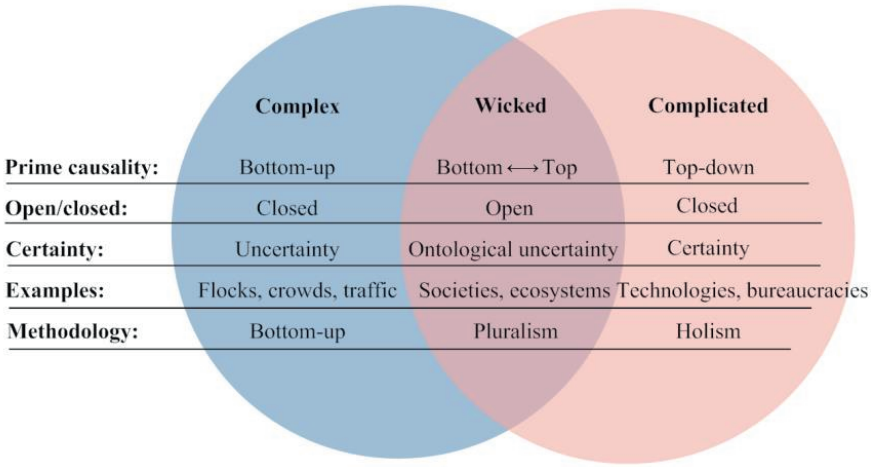


Figure 3. A conceptual graph illustrating the relation between complex systems, complicated systems and wicked systems, as well as some typical properties and features of each type of system. The graph also serves to provide a metaphor; in the same way as the blue and pink colors in the diagram blend to create a new color, complexity and complicatedness mix — creating something qualitatively different.

Ontological uncertainty and qualitative change

As a result of these entangled causations and overlapping levels of organization, wicked systems tend to exhibit a highly uncertain — and often only temporal — stability. While slow, quantitative changes are ubiquitous in these systems, these also lay the ground for more radical transformations to occur: quantitative changes thus become qualitative changes (Carneiro, 2000; Törnberg, 2014). While an engineer is not very likely to find the laws of physics changing in her attempts to apply them, social scientists face deep qualitative changes in both the systems and the underlying components. And the development of knowledge of the system itself can generate changes in its own object. While the agents themselves undergo changes, the underlying foundations that condition these very changes also transform the system in a qualitative way. In this sense, it is indeed a paradox that "the very things which make knowledge possible — our ability to monitor our own monitoring, to learn and hence to change our interpretations, actions and responses — are also things which make social science difficult" (Sayer, 1992: 252).

Accordingly, there is simply no fixed point or stable foundation on which one can rest and build upon when making assumptions about wicked systems. After all, how would we set up rules governing the behavior of the agents, when the very rules of the game may undergo qualitative changes at any time scale? While complicated systems can as we have seen be measured, calculated and predicted, complex systems on the other hand are more uncertain. Due to their nonlinearity, chaotic behavior and sensitivity to initial conditions, we cannot in general predict their future state, although we can often predict their general dynamics. But wicked systems are an even tougher nut to crack; because the rules of the games are constantly changing, these systems are typically characterized by deep uncertainty and may oscillate between stability and qualitative transformation in the very nature of the entity itself, which Lane and Maxfield (2005) refer to as *ontological uncertainty* (see Figure 3).

Clearly, this description of social systems as wicked and far from equilibrium is far from the Parsonian order-seeking and near-to-equilibrium system theory that has been rightly criticized for overemphasizing maintenance, equilibrium, homeostasis and stable institutions. The Parsonian perspective of society is thus inherently conformist in its nature, conceptually neglecting and hence obstructing structural change (Von Bertalanffy, 1969). As I see it, a central factor behind this neglect of social change within functionalist system theory comes from the exclusive focus on negative feedback. An informed complexity approach, on the other hand, understands society as inherently innovative, and capable of revolutionary change; societies are peripatetic boundary-testing entities with internally

generated innovative power. They change from within through the notion of positive feedback (Harvey and Reed, 1994; Reed and Harvey, 1992).

As will become apparent to the reader of this thesis, my main focus in this thesis has been on change rather than stability. One reason for this is the above-mentioned general negligence and inattention to this topic in previous system perspectives in sociology. Another central reason has more of a philosophic character; in the same way as studying resistance can be a way of understanding the dynamics of power, and studying deviance and norm-breaking behavior can make norms visible, I believe that focusing on change can enable us to understand important aspects of stability. Change and stability are thus inextricably and inevitably linked.

Recalcitrance to reductionism and formalization

Let us now return to Simon's argument regarding decomposability. As we can conclude from the discussion above, wicked systems do not fulfill the conditions for decomposability, which essentially makes them recalcitrant to reductionism, and reductionism is generally a requirement for formalization since reducing complexity is an essential step in order to create a model (i.e. certain parts of the system need to be left out). This obviously becomes a problem when dealing with wicked systems, since what is excluded in the model may in reality interact and have a decisive impact on the system in a nonlinear and highly unexpected way (Cilliers, 2001; Cilliers, 2005; Cilliers, 2008). The consequence is that, strictly speaking, a wicked system can only be properly represented by nothing less than an exact copy of the system itself.[20]

In fact, due to their strong and heterogeneous interconnectedness, it is not even possible to extract small bits or pieces of the system empirically to create a "realistic picture". Any attempt to strictly and formally approach wicked systems involves a decision where to make the "cut" between what is considered as part of the system and what is part of the environment. This is essentially a subjective decision, based on certain ideas, conceptions and interests, and also has a profound impact on how we perceive the system, and ultimately our conclu-

20 I will in a later chapter argue that models can indeed be useful, if not by constituting representations of the system in question, but rather as practical tools for investigating aspects of systems.

sions about it. Thus, science is not objective and external, but an inseparable part of the object of study (Bhaskar 1979).

This implies weaker knowledge claims, since our representation or "realistic picture" of the system is ultimately a *perspective,* and rarely subject to universal agreement. And even if we could manage to produce a realistic picture, this would not help us since the system tends to change not only while we are investigating it, but *because* we are investigating it (Cilliers, 2001). This means that any empirical project is inevitably enmeshed with ethics and politics; by cutting off a system, we also frame it in a certain way[21]. Accordingly, knowledge cannot be seen as "atomised 'facts' that have objective meaning", but rather as something that "come to be in a dynamic network of interactions, a network that does not have distinctive borders." (Cilliers, 2005: 608).

However, as I will discuss further in chapter 5, the fact that our possibilities of description, representation and prediction is limited in wicked systems does in no way mean that we should refrain from scientific analysis. Some form of reduction and analytical delineation is always necessary in any scientific approach, and the fact that this cannot be done "objectively" does not imply that "anything goes". Instead, my point here is twofold. Firstly, this does not imply any extreme relativist notion of knowledge as purely subjective, since in our construction of boundaries reality has a voice by constraining where the boundaries can be drawn. As Cilliers (2005: 141) states: "Boundaries are simultaneously a function of the activity of the system itself, and a product of the strategy of description involved. […] The boundary of the system is therefore neither a function of our description, nor is it purely a natural thing". Secondly, any delineation and reduction of social phenomena can only be done at a certain cost and as researchers we need a critical awareness of its limitations. For instance, theoretical perspectives and methodological approaches are rarely analytically exhaustive. They illuminate certain aspects of reality, and how we chose to delineate a certain phenomenon should depend upon specific circumstances and

21 As I see it, this is essentially what large parts of the discourse analytical literature and approaches such as Science and Technology Studies (STS) focus on: to put technology and science in a social and historical context and investigate how social, political and ideological processes have an impact on how the boundaries for certain phenomena are constructed.

the purpose of the analysis[22]. This calls for a pragmatic approach, and to combine and integrate different approaches and methodologies.

Restricted complexity and general complexity

This argument, that wicked system cannot be approached using the same methods as other complex systems, corresponds to Morin's (2007) distinction between *restricted complexity* and *general complexity*[23]. Morin presents these as two competing perspectives on how to approach complex systems, where the former corresponds to what I have referred to as mainstream complexity and the micro-emergentist approach. This perspective focuses on underlying patterns and universal principles and is based on the fundamental idea that — complicated or not — social systems are essentially complex systems and should therefore be approached by applying the same methods as for other complex systems, i.e. reductionist approaches focusing on micro-emergence. General complexity, on the other hand, bears more resemblances with how we have described wicked systems. Morin (2007) summarizes the differences between these perspectives as:

> Restricted complexity made possible important advances in formalization, in the possibilities of modelling, which themselves favour inter-disciplinarity. But one still remains within the epistemology of classical science. When one searches for 'laws of complexity', one still attaches complexity as a kind of wagon behind the truth locomotive, that which produces laws. [...] Actually, one avoids the fundamental problem of complexity which is epistemological, cognitive, paradigmatic. To some extent, one recognizes complexity, but by decomplexifying it. [...] In opposition to reduction, [Generalized] complexity requires that one tries to comprehend the relations between the whole and the parts. The knowledge of the parts is not enough, the knowledge of the whole as a whole is not enough… (p.6).

22 I discuss this further in Paper II in relation to how to define, delineate and apply various concepts in the theoretical framework that is developed, such as the concept of *socio-political regime* and *free social spaces*.

23 Byrne and Callaghan (2014) make a similar distinction between *simple complexity* and *complex complexity*.

An important contribution in Study I is thus to clarify that these are in fact not only competing perspectives on the same thing, but also correspond to fundamentally different types of systems. Restricted complexity is thus highly useful for studying merely complex systems where a myriad of interactions between components emerge into sometimes unexpected patterns and structures on higher levels. General complexity, on the other hand, is a description of something of which restricted complexity is a component, but that is qualitatively different from restricted complexity. This implies that the problem is not actually restricted to complexity/mainstream complexity itself, but rather when this approach is extended and applied for a type of system to which it does not apply. This fundamental problem of confusing complex systems and wicked systems, and approaching social systems as if they were merely complex is in fact quite common in the literature.

The problem of conflating complexity and wickedness

There are different versions of this problem. Within the more radical flank fall scholars with a mainstream understanding of complexity, such as Epstein and Axtell (1996), Gilbert and Troitzsch (2005), Conte et al. (2013) Axelrod (1997), and various scholars associated with the Journal of Artificial Societies and Social Simulation (JASSS), which is generally regarded as the leading journal in the field and a central hub for these types of perspectives. Returning to Figure 1, this approach corresponds to basically dragging approaches from the top-left corner to the top-right corner, arguing that micro-emergence is sufficient to understand wicked systems. Thus, in this perspective, complex social systems are not qualitatively any different from merely complex systems. All types of social structures and group behavior ranging from group formation, cultural transmission, combat and trade emerge from the interactions of individual agents. This represents a classic ontological individualist perspective of society, albeit with an explicit focus on interactions and relations.

A somewhat more sophisticated — yet not less problematic — version of this fallacy is imminent within e.g. analytical sociology, which in the past decade has grown to become one of the most established perspectives within contemporary sociology (Jepperson and Meyer, 2011). Peter Hedström, one of the most prominent proponents of this perspective, argues that the general goal of sociology should be to explain social phenomena according to the analytical method, i.e. by "carefully dissecting" complex social processes and seeking "precise, abstract, realistic and action-based explanations for various social phenomena". While Hedström (2005) refers to this approach as "structural individualism", in

order to distinguish it from any "extreme form of methodological individualism", he nonetheless states that "the core entity always tends to be the actors in the social system being analyzed, and the core activity tends to be the actions of these actors". In fact, this type of individualism is not merely strategic, but also applies on the ontological level, as Hedström rejects the existence of any social entity with an existence and dynamic of its own, and remains skeptical towards any inclination to see the social world as ontologically stratified, constituted by different irreducible levels of reality (Hedström, 2005: 73). He illustrates his argument with a thought-experiment: "The causal efficacy of actions would be readily seen if we were able to press a pause button that suddenly froze all individuals and prevented them from performing any further actions. All social processes would then come to an immediate halt." (p. 28)"

Instead, he argues, we should understand social phenomena by focusing on mechanisms on the underlying level that give rise to social patterns and structures on a macro-level. Here, formal methods are necessary since sociological empiricism and quantitative sociology cannot support micro/macro causal explanations but only, at best, give first instance descriptions of social phenomena. This means that the focus should always lie on micro-emergence; how mechanisms and interactions between entities on a lower level give rise to emergent macro-patterns, since, as he argues, "changes in collective properties must be either intended or unintended outcomes of individuals' actions — how else could they possibly be brought about — they should be analyzed as such" (Hedström, 2005: 5). Thus, what he is arguing is (quite legitimately indeed) that social patterns only exist insofar as they are instantiated by particular people behaving in certain ways.

Hedström does, albeit reluctantly, accept Sawyer's (2005) argument that in some circumstances, there might hypothetically exist situations when we for pragmatic reasons are forced to take a *methodological* collectivist approach — although of course still firmly resting on an ontological individualist perspective — and couch explanations in terms of social-level factors. However, Hedström adds, these situations are extraordinarily uncommon, if they even exist at all (Hedström 2005:73). As we have seen, in this regard my position is basically the opposite of that of Hedström. While individualist reductionist approaches fo-

cusing on micro-emergence may be fruitful when analyzing some types of social systems, this is rather the exception than the rule[24].

One could of course adopt Hedström's position and argue that, ontologically speaking, structures and the social are comprised of nothing else than individuals and their interactions. Without individuals, there would be no structures. However, this is a rather platitudinous argument, corresponding to arguing that neurons and molecules are the proper level to study humans and social behavior since, ontologically, humans do not exist separately; they are only emergent outcomes of billions of individual cells interacting with each other. Hedström (2005) tries to avoid this theoretical inconsistency by vaguely stating that "there exist discipline specific relevant criteria and stopping rules" (p.27).

Apart from being a somewhat unexpected argument coming from an anti-instrumentalist, there is undeniably plenty of research in the adjacent cognitive and behavioral sciences, and the fact that these sciences have not yet produced a sound common theory of human and social behavior should not be an excuse for locking the black box of cognition from sociological models and theories. Nevertheless, this appears to be the logical conclusion if one consequently follows Hedström refusal to distinguish different ontological levels of reality. [25]

I do agree that some types of social systems, more specifically those that approximate hierarchically ordered, near-decomposable systems that are deeply characterized by micro-emergence, can indeed be treated as (simply) complex systems, and are thus receptive to reductionist approaches such as Hedström's analytical approach. This is also the reason why micro-emergentist methods such as agent-based modelling have been so successful in studying (quasi-social) phenomena such as traffic systems, crowd dynamics and emergency evacuations (e.g. Helbing and Johansson, 2011). However, a vast majority of the systems that sociology is dedicated to studying are arguably wicked systems, and are thus

24 A weaker version of this problem is also apparent in Sawyer's (2005) account of complexity in social systems. Sawyer chooses to embrace methodological collectivism for analytical/methodological reasons, but refuses to acknowledge the existence of any ontological, independent reality with collective social entities or structures which persist in some way over and above the actions of individual humans and have a reality beyond them.

25 Furthermore, one could further pursue this reductionist argument until we arrive at elementary particles. And as Porpora (1998: 350) points out, at that point, a surprise awaits the reductionist. According to modern physics, at the level of solid bottom reality, relationships are more real than particulars. "An elementary particle is not an independently existing unanalyzable entity. It is, in essence, a set of relationships that reach outward to other things".

generally not reducible to lower-level mechanisms alone. This inherent resistance to reductionism is not merely a matter of epistemological stratification founded in any limitation of human cognitive capacities, but in a real ontological stratification of the objects of science. Naturally, this also implies the impossibility of any unitary science, for it is the real distinctions between various strata and their irreducibility one to another that explains the distinctions between the various sciences (Collier, 1998). Of course, this does not mean that we should build high walls on the grounds/basis of these boundaries but rather implies that the types of questions we pose as sociologists cannot in general be answered through advances within physics.

Extending the notion of emergence

As I have argued, the problem lies in the fact that mainstream complexity and scholars who focus on micro-emergence as a basis for approaching social systems tend to neglect the fundamental difference between complexity and wickedness. By approaching all types of social systems as merely complex systems, they are trapped within a traditional rationality that builds on reductionism and logical deduction, but spruced up with a flavor of complexity[26]. But complex or not, this is still individualism. These scholars neglect that the difference in complexity between complex and wicked systems is a matter of kind rather than degree. Using the distinction between open and closed systems, extended with Simon's notion of decomposability, I have argued that a shared feature of complex and complicated systems is that both approximate a nested hierarchical system structure. This implies that both these systems can be addressed using systematic and formalist approaches based on componential reductionism and/or relational reductionism. Wicked systems, on the other hand, are non-decomposable and are therefore not fully open to either of these reductionist approaches. They are nested but interpenetrating systems with causal powers

26 In fact, this appears to reflect a general and not too uncommon tendency within the social sciences, when scholars are blinded and tantalized by the formalism and robustness of models and methods developed within the natural sciences, and thus naively and unthinkingly employ similar approaches in their own territory — regardless and uncaring of any differences in the actual object of studies. This tendency is perhaps best illustrated in the previously predominant focus on positivism and logical empiricism within large parts of social science.

running in all directions, and thus require a fundamentally different approach. Wickedness and formalism just don't marry very well.

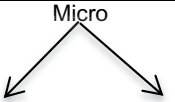
	Fact paradigm	**Action paradigm**	**Post-structurationism**
Ontology	Holism	Individualism	Both
Reductionism	Macro	Micro  Componential Relational	Non-reductionist (dialectic)
Complexity	Structured (complicated)	Dynamical (complex)	Wicked
Examples	Functionalism, (Durkheim)	Analytical sociology, symbolic interactionism, mainstream complexity science	Marxism, complex realism

Table 1. This table depicts the *fact paradigm* and the *action paradigm* as representing two different types of reductionist strategies, and contrasts this to the *post-structurationist* approach.

The discussion so far enables us to sketch and categorize various approaches to the relation between agency and structure (see Table 1). As we have seen, both the *action paradigm* and the *fact paradigm* can be categorized as subsets of reductionism as a research strategy. The action paradigm attempts to explain how causal powers work in terms of lower-level forces, analyzing the whole into their component parts and their relations. Systems and structures are thus seen as stable patterns that either aggregate or emerge from individual actions. In this sense, it treats society as ontologically flat. This represents a micro-reductionism that can come both in the form of *componential reductionism* and *relational reductionism*. Thus, while these may differ regarding the means of reduction, both are none the less reductionist. Both traditional individualist methodological individualism and contemporary relational approaches such as analytical sociology and mainstream complexity science belong to this category.

The social fact paradigm epitomizes an ontological holist perspective, attempting to explain the micro-level in terms of its role and function in a whole. In this perspective, social facts are viewed as having their own existence, and social systems have intrinsic causal power that reproduce them. This represents a macro-reductionist approach (or reductionism to the whole), and typically overlooks the role of underlying system components and their interactions. Methodologically, this tends to result in collectivism, and typically relates to

functionalism and various system-focused approaches. Although a contested issue (e.g. Cherkaoui et al., 2008; Jacobsson, 2006), Durkheim is traditionally appointed as a precursor to this perspective.

The approach to complexity in social systems that I propose here is based on the post-structurationist perspective of Archer and critical realism, which implies a rejection of both macro- and micro-reductionism. Instead, this represents an attempt to take both agency and structure into account, and social reality is seen as a dialectic between them. As Archer (1996: 691) argues:

> The realist ontology furnishes that which Collectivism lacked, an activity-dependent concept of structure, which is both genuinely irreducible yet in no danger of hypostatization, and a non-atomistic conception of agents, to rectify the deficiencies of Individualism's individual — without, however, regarding the two elements as part of an inseparable 'duality'.

I have argued that social reality is a multi-layered system with higher levels, or strata, that are conditioned by, but not reducible to, underlying levels. While micro-emergence does matter in these systems, it is far from the only kind that matters. Wicked systems are characterized by emergent patterns and properties that have to do not only with their components and their structured interactions, but also with the higher-level systems of which they are a component (Wan, 2011: 74). In this sense, a system may acquire emergent properties "by virtue of being incorporated into a system — as in the cases of a firm that hires a worker (who becomes an employee answering to his superiors) or a bride incorporated into her husband's family (who becomes a daughter-in-law under her mother-in-law's rule)" (Bunge, 2003a: 17,18). Bunge has referred to this type of reconstitutive downward causation as *relational* or *contextual emergence*. This explains why micro-reductionism is often necessary, but not sufficient, and therefore serves, as Wan (2011: 75) points out, as a counter-argument to the claim of some mainstream complexity scientists and analytical sociologists that "[i]f ... there is something in the whole which is irreducible to the interaction of its parts and their causal effect, then we are dealing with a metaphysical claim that conceals a 'divine hand' (or any supernatural factor) at some level of reality" (Noguera, 2006: 19, quoted in Wan, 2011: 75).

Clearly, this implies a broader and more inclusive definition of emergence than is commonly ascribed by mainstream complexity scholars, thus including but not limited to micro-emergence. Emergence in wicked systems is not exclusively a bottom-up process where macro-patterns grow from the dynamics of the micro, but is rather a matter of a continual process between levels. This calls for a research process and explanations that do not merely focus on underlying

elements, but that trace processes and causal mechanisms in and between many different levels.

As should be clear now, the approach to wickedness/complexity in social systems that I propose here is not that of naturalism, nor any new envy of physics. Nor is it a claim that the kind of knowledge generated in the frameworks of the natural sciences trumps other forms of knowledge and that these sciences therefore should form the criteria for proper work in the social sciences. As we have seen, the relative success of the natural sciences lies in their objects of study, not in any superior methods or approaches. In contrast, by emphasizing the wickedness and ontological uncertainty of social systems, I have argued for the general irreducibility of these systems. This means that the idea of any comprehensive social science capable of exact prediction of social processes and societal change is chimerical; it does not correspond to the nature of the social world. It fails to recognize essential features of social systems: their heterogeneity, causal complexity, contingency, path dependency and overall nebulous character. Hence, the approach to social complexity that I put forward here does not offer any specific tools for solving our wicked problems, but rather provides us with an explanation as to why these systems and the problems they generate tend to be so damn difficult to deal with.

5
Approaching the Wicked

My argument so far has not been in favor of any subjective relativism, nor any cry for the intrinsic hopelessness of social science as a scientific inquiry. Instead, it has been a clarification of the uniqueness of our object of study, which is important to articulate explicitly since *what* we study has consequences for *how* we should study it.

As we have seen, social systems should typically be described as open, heterogeneous and ontologically uncertain systems. Deeply entrenched and stratified, the very nature of these systems is the product of causal circles between the whole and its parts, and with feedback tentacles reaching out into the environment and back in time, leading to an impending risk of qualitative transformations at any timescale. The program of reductionism and its associated method of formalization and controlled experimentation is generally insufficient since we cannot decompose these systems in such a way that these approaches demand. Their boundaries are far from as clear as the positivist sciences imagine them to be; in fact they are partly a social construction.

Consequently, there is no stable ground to stand on, which is a requirement for reductionism; our models and representations are therefore always inherently limited. Our objects of study are not ontologically fixed, but tend to change as we are studying them. We never approach them in an objective way; any representation or extraction of the system is always framed and made from a certain perspective. As Cilliers (2016: 113) quite succinctly puts it:

> The contingent and historic nature of complex systems entails that our understanding of the system will have to be continually revised; the frames of our models will have to change. The boundaries of complex systems cannot be identified objectively, finally and completely. This supports the argument that our knowledge of complex systems cannot be reduced to formal algorithms, but has to incorporate consideration of what the knowledge is for. The criteria used to evaluate the knowledge are not independent things; they co-determine the nature of the knowledge.

Clearly, and in line with Cillier's argument, this calls for a less universal conception of scientific knowledge, and to approach it instead as contextual, local and more specific in time and space. While this obviously has implications for positivism, it is important to note that it is in no way a call for radical relativism, nor an effort to downplay the importance of scientific work. In fact, one could argue for quite the opposite; the fact that our knowledge of a system is only local and temporary further accentuates the importance of knowing how to learn about a system. This approach to the social world and our knowledge about it clearly resonates with Law's (2004: 7) perspective;

> [I]n this way of thinking the world is not a structure, something that we can map with our social science charts. We might think of it, instead, as a maelstrom or a tide rip. Imagine that it is filled with currents, eddies, flows, vortices, unpredictable changes, storms, and with moments of lull and calm. Sometimes and in some locations we can indeed make a chart of what is happening round about us. Sometimes our charting helps us to produce momentarily stability. Certainly there are moments when a chart is useful, when it works, when it helps us to make something worthwhile […] But a great deal of the time this is close to impossible, at least if we stick to the conventions of social science mapping.

In order to match this nebulous social world, we need a more flexible epistemological approach, which naturally comes at the cost of predictive capacity and rigidity. We need a science that treats society as ontologically open and historically constituted; composed of nested but interpenetrating systems, interactively complex, yet non-reductive and indeterminate (Reed and Harvey, 1992). As I will argue now, this calls for narrative- or process-based explanations and case study research as the foundation for a complexity approach to social phenomena.

Narrative explanations and processual analysis

It is common to distinguish between two general types of explanations: [i] when outcomes are explained through cause-and-effect explanations, and [ii] when the unfolding of processes is explained by identifying mechanisms and patterns (Grin et al., 2010).

> There are two ways of seeing…historical processes more generally. One focuses on stochastic realizations and aims to find causes; the other focuses on narratives and aims to find typical patterns. (Abbott, 2001: 164).

These types of explanations are related to *variance theory* or the *variable-based approach* (Byrne, 2009a) and *narrative explanations or processual analysis* (Abbott, 2001; Abell, 2004; Calhoun, 1998; Griffin, 1993; Pentland, 1999; Pettigrew, 1997; Poole et al., 2000). As I have argued, the former approach is of limited value when analyzing most nonlinear phenomena, since it generally has problems handling complex causality and emergence, i.e. when interactions between elements themselves lead to structures that cannot be linearly decomposed into their interacting parts. The former category of explanations can however also include computer models that focus on interactions and micro-emergence instead of attributes, and thus indeed encapsulate non-linear dynamics. While different in many ways, both are nonetheless formalist approaches that share similar assumptions of reductionism.

Narrative explanations or processual analysis, on the other hand, have considerable affordances when it comes to dealing with time, causal complexity and multi-level explanations. The strength of theorizing social processes through narratives lies in the capacity of narratives to enable us to capture complex interactions between agency and changing environment, time and the sequence of events.

> [T]heorizing the social process via narrative is a deep tradition in both history and sociology. If there is any one idea central to historical ways of thinking, it is that the order of things makes a difference, that reality occurs not as time-bounded snapshots within which "causes" affect one another (…), but as stories, cascades of events. And events in this sense are not single properties, or simple things, but complex conjunctures in which complex actors encounter complex structures. On this argument, there is never any level at which things are standing still. All is historical. Furthermore, there are no independent causes. Since no cause ever acts except in complex conjunctures with others, it is chimerical to imagine the world in terms of independent causal properties acting in and through independent cases. (Abbott, 1991: 101).

Narrative explanations differ from the variable-based approach in several important regards (Grin et al., 2010). First, variance theory tends to assume entities that are fixed over time; they exhibit a fixed set of variable attributes. The world is thus variabilized, i.e. viewed as consisting of interrelated variables (Poole et al.,

2000: 32). In narrative theories, the focus is shifted to events rather than variables, and the entities participate in events, and may change over time. In other words, the units of analysis may undergo metamorphosis over time and change identity, preferences and meaning, also as a result of studying them. Second, in contrast to variance theory, the temporal sequence of causal forces is crucial and may produce different outcomes. Narrative explanations thus take the form of "an unfolding, open-ended story fraught with conjunctures and contingency, where what happens, an action, in fact happens because of its order and position in the story" (Griffin, 1993: 1099). Narratives therefore enable a form of sequential causation that "allows for twisting, varied, and heterogeneous time paths to a particular outcome" (f.f.). This is related to a third point; while variance theory focuses on immediate causation, a "push-type causality" (Poole et al., 2000: 3), narratives require the tracing of events, twists and turns and acknowledge that events may have different durations. Consequently, explanations should incorporate layers that range from immediate to distant explanations, i.e. macroscopic and long-term processes and structural patterns can be incorporated alongside with immediate events (see e.g. the MLP-framework in study II). For this reason, narrative explanations tend to be "causally deep" (Abbott, 1988). This narrative causality is probabilistic, which means that it does not exert deterministic influence over events (Poole et al., 2000).

To sum up, I agree with the conclusion of Byrne and Callaghan (2014:202):

> Time matters, sequence matters, things play out over time and sometimes not in an exact temporal sequence. All this reinforces the significance of the construction of very careful narratives as a fundamental foundation of complexity research.

Narrative explanations and the shift from a variable-based view of causality to set-theoretic relationships, which emphasize that variables are always contingent and context-dependent, also fit well with a case-based mode of analysis, or what Byrne and Ragin (2009) have described as *casing through an explicit complex realist lens*. According to this perspective, cases are generally identified as complex systems, in that they are: "both real and constructed, fuzzy realities with complex properties, that have a holistic element whilst being constituted from complex configurations, intersected with their environment with boundaries being not the things that cut off but rather the domain of intercommunication" (Byrne and Callaghan, 2014: 154).

Also Ragin (2004: 125) uses a similar terminology, describing cases as "meaningful but complex configurations of events and structures — singular whole entities purposefully selected […] not homogenous observations drawn at

random from a pool of equally plausible selections". Abbott (1992: 65) similarly describes cases as "fuzzy realities with autonomously defined complex properties [...] engaged in perpetual dialogue with their environment, a dialogue of action and constraint that we call plot".

This systemic approach to cases as complex systems contradicts the radically analytic approach of most quantitative work and clearly falls close to my conceptualization of wicked systems delineated above. Case objects are seen as evolving, socio-historical entities, minimally bounded and dissipative systems that interact with their material and social environment in such ways that it is very difficult or even impossible to find any clear boundaries (Harvey, 2009). There are simply no clear joints separating the case-object from its surroundings. Such boundaries are by necessity constructed, or framed by the researcher. So, while the case-object do not ontologically exists "out there" as a bounded phenomenon, we as scientists create the boundaries when we delineate and approach it as a "case of" something. But while these boundaries, and thus also the elements of our scientific practices, are indeed social constructions, they are not made out of nothing—they are shaped from reality (Byrne, 2009a). In other words, cases are *empirically founded social constructions*[27]. This is captured well by Ragin and Becker's (1992) notion of *casing* rather than *case-object*, since this term emphasizes that this is a matter of a dynamic and active process rather than a static, fixed object that is somehow captured. When we delineate or frame a case, or as Harvey (2009: 16) puts it "whenever casing construct goes into its case-object", the social reality of the case-object is never exhausted, we rather focus on certain parts of it while leaving out others. The uncritical use of the notion of "case-object" risks obscuring the epistemological work and reflexivity necessary to produce the relevant category, and thus runs the risk of reifying the case itself.

Of course, it is fairly easy to criticize narrative explanations and casing for incompleteness, lack of rigor and for its relatively informal overall character. But it is difficult to see what else one could expect of research on this kind of subject. After all, this uncertainty in the theoretical frameworks reflects the ontolo-

27 Cilliers (2001) summarizes this in a good way: "Boundaries [of complex systems] are simultaneously a function of the activity of the system itself, and a product of the strategy of description involved. In other words, we frame the system by describing it in a certain way (for a certain purpose) but we are constrained in where the frame can be drawn. The boundary of the system is therefore neither purely a function of our description, nor is it a purely natural thing" (p.141).

gy and the open nature of the very things we study. Thus, any verdict on the respective efficiency or suitability of formal or narrative approaches must first and foremost depend on the object of study, and the purpose of the study. Formalist approaches are indeed suitable when we are dealing with stable, highly durable objects and more or less context-independent mechanisms, while narratives and thick descriptions are necessary for phenomena with histories and geographies, intrinsic meanings that are often multiple and transient, and therefore are characterized by considerable historical specificity and change (Sayer, 1992: 262). However, and importantly, the contingency and historical specificity that characterize most social phenomena do not preclude the possibility of going beyond the specific to the general and finding generalized causal mechanisms in social systems.

Generalizing cases: from individual narratives to general processes and mechanisms

As I have argued, narrative explanation through casing provides an important foundation for a complexity-informed inquiry into social phenomena, advocating a more flexible approach and softer knowledge claims. Case studies have the potential to reveal the working of generative mechanisms in specific contexts, which can be achieved both by identifying causal mechanisms in individual cases, and through comparative case studies that compare situations or contexts in which similar mechanisms operate. In which case, in order to search for causality and generate knowledge that can be extended beyond the specific case, we need more disciplined ways of specifying mechanisms and conditions at various levels that shape specific sequences in social phenomena. There are of course various ways to do this, and these include both within-case analyses using e.g. *process tracing* (Hall 2006, Beach and Pedersen 2013), and various comparative approaches that generally build upon the logic of similarity/difference[28] (Mill,

28 Mill's *method of agreement* basically implies the study of similar cases in order to find their causes, while the *method of difference* implies investigating contrasting cases in order to find their causes. Thus, the former is generally associated with a *most-similar design* (to compare cases that are as similar as possible in order to isolate the factors responsible for the difference in outcome), while the latter is generally associated with a *most-different design* (comparing cases that are as contrasting as possible in

1884), such as Qualitative Comparative Analysis (QCA) (Ragin, 2014). These approaches can in practice often be combined, since we may use within-case inference to identify certain causal mechanisms in a certain case, and then investigate whether these mechanisms also operate in other, similar cases.

> The case study goes beyond the case history in attempting a range of analytical purposes. Firstly there is a search for patterns in the process and presumably some attempt to compare the shape, character and incidence of this pattern in case A compared with case B. Secondly, there is a quest to find the underlying mechanisms which shape any patterning in the observed processes … The teasing out of these mechanisms… represents one of the greatest inductive challenges for process scholars and an area of intellectual challenge. (Pettigrew, 1997: 339).

A typical example of the value of such comparative case study-design is Darwin's *Origin of Species*, in which he, based on a large range of qualitative, detailed case studies, discovers a universal generative mechanism in the form of natural selection (Byrne and Callaghan, 2014: 196). While this theory is not predictive, it does undeniably offer a highly significant contribution in the form of explanatory power.

Following this reasoning, Paper II uses a case-based approach and narrative/processual explanations to study societal change driven by social movements. It employs a type of *typological theorizing* to investigate whether theoretical frameworks in the field of socio-technical change are also useful to address societal transition dynamics driven by social movements. In brief terms, the focus of typological theorizing is to bring order to narratives by teasing out patterns and mechanisms from individual cases, or causal pathways that lead to certain outcomes. This means that typologies often draw together in one framework the work of several researchers, "cumulating their individual efforts into a larger body of knowledge" (George and Bennett, 2005: 7). As George and Bennet put it:

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order to investigate the robustness of a relationship between conditions and outcome. If the relationship holds in a range of contrasting settings, this supports the argument).

> [T]ypological theory identifies both actual and potential conjunctions of variables, or sequences of events and linkages between causes and effects that may recur. In other words, it specifies generalized pathways … A pathway is characterized in terms of variables, often with nominal cut off points distinguishing among types … Such generalized pathways are what is distinctive about typological theory. They are abstract and theoretical even though they are closer to concrete historical explanations than are claims about causal mechanisms. (George and Bennett, 2005: 236).

The purpose of typological theorizing is to develop contingent generalizations about how combinations of variables or conditions tend to produce a certain outcome[29]. Typologies are thus useful by helping us to "wrap our heads around" complex matters, to bring order to the shapeless spaghetti of data, and to specify which elements of the argument are specific to the case, and which parts are potentially generalizable. In this sense, typologies can be compared to the definition of models given by Büthe (2002: 487): they "hypothesize parsimonious abstraction or simplification of 'reality'".

What I do in Paper II is to investigate whether a typological theory that focuses on socio-technical change and innovation can also be useful to understand radical societal changes that are driven by social movements. Or put differently: whether certain causal mechanisms that are stipulated by the theory are also present in this particular empirical field. This approach thus enables us to go beyond the specific case towards discovering generalized mechanisms. Rather than being viewed as a ready and delivered framework, this study should be viewed as a demonstration of a possibility and a starting point that is sufficiently developed to provide leads for further exploration.

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29 As Grin et al. (2010: 100) explain; "Typological theory is a form of configuration analysis, which acknowledges that the entities being classified are too complex to decompose into variables. They are premised on the assumption that the character of an entity emerges from the entire configuration of its properties and their interrelationship […] The construction of a clean 2*2 matrix is not possible, because too many entities and processes are involved. Instead, multiple variables are combined in configurations that have an inherent logic that binds them together (e.g. archetypes, ideal types)"

There are three main underlying purposes behind the approach taken in this article. The first is to facilitate knowledge-sharing across different fields that arguably share similar dynamics. The idea here is that generalized transition typologies may be useful beyond the specific context in which they were developed, and may thus also apply to dynamics in adjacent fields. A similar cross-disciplinary approach was also undertaken in another paper published in *Current Anthropology*, but which is not included in this thesis (Andersson et al., 2014). In this article we develop a provisional evolutionary developmental theory to explain the evolution of culture by combining insights from evolutionary biology and transition study frameworks, theories that illuminate innovation processes in different ways and on different levels of organization.

Secondly, while narrative explanations and case studies are indeed often applied in social movement research, these studies rarely or never incorporate a complexity-related terminology. The typological theories developed in Transition Studies, on the other hand, build upon complexity thinking, which is essential to understand and conceptualize complex system dynamics. In this way, the article practically illustrates the value of integrating complexity thinking into our theoretical frameworks in order to understand and analyze both the often relative stability of established regimes (may they be socio-technical or socio-political), but also to understand those unique moments of change when challenging innovations manage to break through and change the overall system in a fundamental way. To understand these processes we need to include central concepts such as tipping points, positive/negative feedback, emergence, lock-in and path dependency. Such complexity terminology also provides a stepping stone to facilitate the incorporation of computer simulations into our theoretical frameworks. As I will argue in the next chapter, models may not provide an omnipotent solution to our problems, but they may in fact serve as an important complement to narrative approaches.

Thirdly, the Transition Studies frameworks distinguish between different functional scale levels, the macro-, meso- and the micro-levels, and investigate how radical socio-technical transitions take place as a consequence of the relations and co-evolution between these levels. The main idea here is that understanding transformative societal change demands *multi-level theorizing*. We need to take into account dynamics both within and between these separate scale levels, and not focus solely on individual-level mechanisms as advocated by micro-emergentist perspectives such as analytical sociology. Thus, these frameworks include both *vertical explanations* (to explain higher-level social patterns in terms of individual-level processes, and the opposite: to include the impact of macro-level patterns/structures on lower-level processes) and *lateral/horizontal explanations* (to explain one set of factors in terms of other factors on the same level).

In this sense, the frameworks acknowledge reality and *causal power* to higher-level social entities such as groups and social movement organizations, and the *causal influence* of social structures, such as normative systems. Clearly, this fits very well with the complex realist position I have argued for here.

An interesting way to develop and extend the results from Paper II would be to employ QCA. This is a complementary approach to achieve generalization which is based on casing, and is also fully compatible with a complexity-informed inquiry. Briefly formulated, QCA combines within-case analysis and in-depth knowledge with cross-case analysis (Ragin, 2008; Ragin, 2014). The basic idea is that by systematically comparing multiple stories, "we can tease out comparable elements and absences and thus create a narrative that is a general account of more than one instance" (Byrne, 2009b: 108). This enables us to discover strong necessary and/or sufficient relationships between individual conditions, or combinations of multiple conditions, and the outcome of interest. The basic procedure of QCA allows it to embrace *causal complexity*, i.e. the fact that whether a condition is causally relevant often depends on the presence or absence of other conditions. It also permits the investigation of situations when the outcome of interest can follow from different combinations of causal conditions (*equifinality*) and when similar conditions may lead to dissimilar outcomes (*multifinality*) (Ragin, 2008).

Like process tracing and typological theories, QCA approaches cases as complex entities — as a whole — in which the causal significance of an event or structure is always local and context dependent. In this way, by combining the strength of narrative explanations within cases, and systematic comparison across cases, this approach thus charts a middle path between quantitative and qualitative social research (Ragin, 2008). An integrated approach that combines typological theorizing, process tracing and QCA would be an interesting way to test and further develop the tentative theoretical framework developed in Article II. Employed in this way, these approaches may serve complementary functions (see e.g. Beach and Rohlfing, 2015; Schneider and Rohlfing, 2013; Schneider and Rohlfing, 2014). QCA often takes a macro-perspective and employs a systematic, large-scale comparative approach that enables us to assess the validity of general typologies generated from empirical analysis of individual cases. Process tracing on the other hand enables causal inference and centers on the underlying mechanisms behind the patterns, aiming to provide explanations by dissecting causality.

6

Models as gateway to micro-emergence: disentangling traces of complexity

For every complex problem, there is a solution that is simple, neat and wrong.

Henry Louis Mencken

At the heart of the matter ... our technologies have become more powerful than our theories. ... We can do with technology what we cannot do with science.

Paul Cilliers

Coming from this understanding of social systems as ontologically uncertain and thus recalcitrant to reductionism and formalization, does this mean that formal approaches such as experiments and computer simulations are always a forlorn cause when dealing with these types of systems? I will now argue that formal models and simulations may actually play an important, albeit more restricted, role even when investigating wicked systems. In short, they enable the investigation of *aspects* of wicked systems by helping us to develop *small causal theories* (Little, 2016) about nonlinear mechanisms that may play a central role in concrete, social phenomena. Relating to this, I will also respond to the criticism raised by scholars such as Bhaskar, Sayer and Collier against experimental approaches in the social realm, and problematize the schism between *abstraction* and *experiments*.

As we have seen, the flexibility of narrative explanations makes them useful to deal with social systems. But embedded in the key to their success there also lies an inherent limitation: they rest heavily upon our cognition, which tends not

to be very trustworthy when we are dealing with complex dynamics. The problem is that wicked systems tend to exhibit more complexity than we can handle; we have an eminently poor, even outrageously misguided, intuition for complexity. Our technically unaided cognition simply cannot handle mass dynamics, which arise from long chains of causation, vicious and benevolent causal circles all bound together in a seamless web that generates emergent outcomes.

Micro-emergence is indeed an important type of emergence in wicked systems as well, but it is far from the only one. Or put differently, the type of hierarchy that micro-emergence assumes *does* matter in wicked systems, but neither causality nor structure is restricted to the hierarchies. As Cilliers (2001) argued above, we have interpenetration and overlaps, as well as multi-directional causality. Nonetheless, micro-emergent dynamics often "shine through" in the overall dynamics of the system, and may characterize the system in fundamental ways. Social systems are often characterized by tipping points, diffusion processes, cascades and lock-in dynamics; in other words various types of system dynamics that are typically related to micro-emergence. For instance, while the process in which a protester set himself on fire in Tunisia and thus sparked a wide-scale social uprising cannot be captured in its full complexity in a formal model, this process can nonetheless be strongly characterized by bottom-up dynamics such as diffusion.

This means that we may often find similar mechanisms at work in open systems as in closed system, with the important difference that in open systems we can never assume that they produce empirical regularities due to the existence of potentially countervailing forces. Models can provide a useful tool here as a way of investigating these nonlinear dynamics. They provide a way to delve deeper into the realm of micro-mechanisms that yield these non-linear patterns. While the models cannot represent the system in its totality, nor make exact predictions of how the mechanisms will play out in reality, they do enable us to focus on certain key *aspects* or "master keys" of system behavior in wicked systems. In this way, they can help us to develop small causal theories about certain nonlinear mechanisms that can help to explain certain real-world patterns. Before I illustrate this argument, it is worth repeating that I have an ontological concept of emergence, meaning that even if we may fully explain an emergent higher-level phenomenon in terms of the underlying components and their relations, the property itself is still emergent; it remains unaffected by our knowledge about it (see also Bunge, 2003a; Elder-Vass, 2010; Wan, 2011).

Let me now illustrate the above point with a concrete example: the well-known simulation of urban segregation by Thomas Schelling (1971). Schelling was curious as to why ethnic and racial segregation so readily forms in urban populations. Social segregation qualifies as a typical wicked problem; it is very

hard to pinpoint or delineate and is likely the result of many causes on many different levels that together lead to this emergent outcome. Realizing this, Schelling did not attempt to produce a realistic reduction of the phenomenon in question, but instead used a simple model to isolate or abstract what he believed could be a key mechanism and investigate whether this mechanism is sufficient to yield a certain pattern. What he discovered was a surprising and interesting relation between micro and macro, showing that very strong segregation patterns can emerge on a macro-level even from a very tolerant population as seen on the individual level. Clearly, the strength of his model lies not in the realistic operationalization of human agency or the implementation of the intricate processes that produce social segregation, but rather in that the model captures a non-linear mechanism that appears to explain a central tendency in the empirical phenomenon in question. In fact, the simplicity and abstractness of his model makes it just as suitable to explain why oil and water tend to separate, even though there is no repelling force between their constituent molecules.

Of course, an important difference from closed systems is that in open social systems there is no guarantee that the mechanisms in question produce a certain outcome in reality. Once active and operating in open systems, countervailing mechanisms may enforce, decrease or completely eliminate the effect of the specified mechanism. This is in fact also the reason why there is a general and widespread skepticism among many scholars towards experimentation and thus also simulations in the social realm. Highly influential scholars such as Bhaskar, Sayer and Collier have thus argued for the general inability of the social sciences to achieve meaningful experimental control[30]. To investigate the effect and working of mechanisms, they argue, requires that these mechanisms operate undisturbed; the flux of conditions must be controlled for or held constant, which consequently presupposes closure (Lawson, 1998: 147). As a consequence

30 Some scholars have even gone so far as arguing that some of the main problems that we face today within parts of the social sciences can be derived from the tendency to use experimental models. For instance, as Lawson (1998: 169) rather harshly puts it: "Rather, the continuing failure of the discipline must be put down to the often quite irrelevant, typically formalistic, methods and techniques which economists naively and unthinkingly wield in a forlorn hope of thereby gaining illumination of a social world that they do not fit". While I do partly agree with Lawson's criticism, I argue that the problem here lies in how models are applied and interpreted, rather than in any inherent flaws in the logic of the method itself.

of the fact that our social scientific objects tend to manifest themselves in open systems, experiments are thus, for these scholars, a lost cause.

Interestingly, *abstraction* is often presented as an alternative and more fruitful approach, sometimes to the extent that it is even regarded as an indispensable method in science (Lawson, 1998: 179; Danermark et al., 1997). Abstraction isolates in thought a one-sided or partial aspect of an object, while temporarily ignoring others (Sayer, 1992: 87). Focus thus lies on the specific mechanism in question, with the intention of cognitively isolating it from any eventual countervailing mechanisms. An alleged key difference from experiments is thus that abstraction only *momentarily leaves out of focus* something real, to focus on something else. Experiments and modeling, on the other hand, *exclude something real*, assuming it away entirely (Lawson, 1998).

I do agree that there is an important difference between leaving something (temporarily) out of focus, and on the other hand treating it as though it does not exist. But this difference does not form a perfect cut between experiments and abstractions, but is rather a matter of how the method is employed and how its results are interpreted.

As I see it, we may think of abstraction as a form of *thought experiment*: the purpose being to focus and isolate one or more features, aspects, components or attributes and their relationship in order to understand them better, while others remain in the background. The difference from experiments is of course that this is done entirely as a mental process instead of through the construction of an artificially closed system. When understood in this way, the difference between experiments and abstraction appears less crucial/decisive. Computer models provide a fixed, experimental setting *in silico* that is more efficient in exploring the effects of specific abstractions while excluding other potentially countervailing mechanisms. In the artificially closed system that models provide, mechanisms and their effects thus stand in stable/stark relationship, with the clear advantage (compared to abstractions) that we may alter and test different parameter settings and investigate the results. In this way, models can be understood as a form of *computer-aided thought experiment*. This approach to modelling can also be related to Cartwright's (1999: 50) concept of a *nomological machine*: "a fixed (enough) arrangement of components, or factors, with stable (enough) capacities that in the right sort of stable (enough) environment will, with repeated operation, give rise to the kind of regular behavior that we represent in our scientific laws". In this terminology, models thus constitute a type of artificial condition, a nomological machine that enables us to see the real manifestation of a capacity or a mechanism in a strict regularity.

But the support of the computer is not merely that of convenience. On the contrary, it may in fact be essential in those cases when we are dealing with

nonlinear causal mechanisms that may have counter-intuitive consequences. In these cases it is for cognitive reasons impossible to mentally abstract and analyze these mechanisms, simply because they may form chains of causation that are too long for our unaided cognition to be able to follow. While technologically unaided abstraction might be possible when we are dealing with linear mechanisms or very simple mechanisms, as soon as we are concerned with multiple causal factors impacting each other it becomes much more difficult. Thus, in these cases we might need models to enhance our abstractions, thus enabling us to untangle emergent, counter-intuitive causal mechanisms.

For an example, let us return to Schelling's segregation model. Due to the nonlinear and counter-intuitive mechanisms at play in processes of social segregation, it would indeed be very difficult — if not impossible — to untangle and systematically analyze these mechanisms using only unaided mental abstraction. It is very hard to imagine how one could manage to assume away the complexity of social segregation and in the mind temporarily abstract or individuate a number of factors that form a causal chain or a mass dynamic that leads to this emergent pattern. This task is of course further aggravated by the fact that, as a result of biological evolution, the human mind has a very limited capacity to keep track of more than just a few objects in the working memory at the same time, making this task even cognitively impossible (Miller, 1956; Read, 2008).

Consequently, if one were to take seriously the critique against experiments in the social realm and follow the argument of e.g. Bhaskar, Collier and Sayer to its logical conclusion, it appears that the strength of abstraction in their view (compared to experiments) actually lies in the inadequacy of our cognition, which abstraction ultimately rests upon, to successfully hold off contingency/competing mechanisms. If we assume that our unaided mind actually *would* be capable of dealing with mass dynamics and *would* allow us to successfully isolate certain mechanisms and study their effect shielded from the impact of countervailing mechanisms; what would then be the difference from isolating the mechanisms in an artificially closed system?

As I have touched upon above, the effect and outcome of causal mechanisms in experimental settings such as computer simulations can never be directly translated to open systems. Simulations cannot be used as a basis for prediction of real-world dynamics since mechanisms do not automatically yield empirical regularities in open systems. Of course, these difficulties of prediction in social systems do not arise because the causal explanations are incomplete, but because the working of the mechanisms depends upon the constantly changing form of contingent relations in open systems (Sayer, 1992: 106). This is also why it is useful to distinguish between *laws* and *tendencies*, where the former is restricted to the luxury of closed systems where we may find general laws

that lead to empirical regularities, while the latter term emphasizes that open systems seldom exhibit such regularities since the effect of the mechanisms ultimately depends upon countervailing mechanisms. Therefore, as Bhaskar (1989: 16) famously puts it, "causal laws must be analyzed as tendencies, which may be possessed unexercised and exercised unrealized, just as they may of course be realized unperceived (or undetected) by anyone". This implicates that generative mechanisms are *transfactual*; mechanisms can be valid despite not being evident in each empirical instance, i.e. they may exist despite not being realized in their pure form. This provides us with another way of thinking of simulations. They explore and simulate hypothesized general mechanisms, shielded from any potential countervailing mechanism in an isolated environment. Whether these mechanisms are then empirically manifested or generate a certain effect in reality is a matter for empirical investigation to conclude[31].

This has important implications. First, it implies that the knowledge we may generate from models is a form of *non-predictive explanation*. Sayer (1992: 131-132) illustrates this type of explanation by using an example from geology: since we know the necessary conditions for oil to be formed, we may conclude where we are likely to find oil, but we cannot fully predict where it actually is. This is not due to any inadequacy or deficiency in the knowledge regarding the mechanisms at play that produce oil, but simply the fact that we do not have full empirical knowledge about the complex and contingent context these mechanisms are active in. Consequently, this emphasizes that we must have a continuous and

31 In relation to this, Bhaskar (1989) distinguishes between three ontological domains. The domain of the *real*, which refers to the objects, their structures and causal powers. At this level lie generative/causal mechanisms that are generally not observable, but we may know them through their effects. But since most mechanisms tend to operate in open systems, they are rarely, if ever, actualized as regular sequences or constant conjunctions of events. These objects and mechanisms are intransitive to humans, which is just a fancy way of saying that they exist and operate independently, regardless of whether or not anyone observes or experiences them. The domain of the *actual* refers to the events that are caused by these generative mechanisms and is a subset of the real. This includes e.g. events, phenomena and happenings, whether or not these are observed. Finally, the *empirical* domain is a subset of both the real and the actual, and refers to what is experienced or observed. The point in distinguishing these realms is that causal mechanisms can operate in the real but without producing any actual events or empirical regularities, since other countervailing mechanisms operating in open systems may intervene and prevent the appearance of an event. Experiments, and arguably computer simulations, thus create a closed system that isolates causal mechanism from other mechanism, which enables to study their causal effects.

iterative dialogue between abstract models of causal mechanisms and their potential manifestation in concrete, empirical phenomena. Models need to be connected to the empirical phenomena under study, which can be performed either by operationalizing central aspects of a theory and investigating whether these assumptions yield the expected outcomes[32], or by exploring hypotheses derived inductively from empirical studies. When used in this way, I argue that simulations offer a bridge between mathematical rigor and the flexibility of narratives.

The fact that we cannot assess the actual effect of certain mechanisms in open systems of course applies to all types of mechanisms, no matter whether the method used to derive them is performed with or without computational aid. This is simply a matter of not conflating the artificially closed system and open social systems, which is equivalent to not confusing the *abstract* and the *concrete* (Bhaskar, 1993; Bhaskar, 1978). The problem when making the abstraction the real is that the real then becomes simple, and the messy complex reality is ignored or even denied (Byrne and Uprichard, 2012)[33].

To conclude, the criticism against experiments that has been raised by scholars such as Bhaskar, Colliers and Sayer appears somewhat misguided. The problem lies not in any inadequacy or inherent deficiency in the logic of the method itself, but is rather an erroneous generalized critique of the method based on how it is commonly applied and interpreted. Thus, we should be careful to neither reject nor naively praise simulations, but acknowledge that they should be used cautiously and as a complement; as yet another valuable tool in a set of analytical repertoires which is indeed useful, perhaps even necessary, to deal with the complexities of the social world. In this sense, models may facilitate the

32 In this way, models thus enable a way, in Byrne and Callaghan's (2014) words, to "build emergent futures" or create "narratives of the future", by providing a basis for saying what will happen if the rules describing the agent behavior are correct representations of the causal power of interactions among agents. This is of course particularly valuable in cases when it may be hard to access real-world empirical data.

33 A highly important issue here is not to confuse method and ontology and always be aware of its limitations. No matter if our model only focuses on micro-emergence or also incorporates some sort of downward causation (i.e. that the macro-pattern that emerges "acts back" and has an impact on the lower-level), we must be aware that the limits of our models can be reached at any time. For example, economic models may to some degree describe aspects of economic systems in stable times, but have very little to say about sudden market crises, as these are often outside the scope of the model.

illumination of an aspect of the social world that other methods cannot. In the case of wicked systems, computer simulations may be useful as a tool for explanation and understanding. They provide crutches to our cognition by helping to build a better intuition for complex dynamics. But just as crutches cannot walk on their own, models need to be incorporated in narrative explanations like small but vital pieces of a puzzle. In this sense, models and simulations provide a key function as a way to zoom in on emergence and *demystify* or *narrativize mass dynamics* (Lane et al., 2009).

This is essentially the approach we take in Paper III: *Modelling free social spaces and the diffusion of social mobilization*. In this paper we develop a network model to investigate how the structural properties of free social spaces impact the diffusion of collective mobilization. This approach enables us to explore complex non-linear dynamics that would otherwise be very difficult to investigate using traditional empirical methods or narrative explanations based solely on our unaided intuition. It provides a clear example of how we may use simple micro-emergence models to deal with mass dynamics in wicked systems and systematically develop small causal theories about non-linear mechanisms. In the paper, we also show how these small causal theories can be integrated into broader theoretical frameworks and narrative explanations that also account for mechanisms on higher levels, and thereby contribute to answering previously largely unanswered issues in the field.

A challenging task for the future is to further develop ways of integrating narrative approaches and multi-level theorizing with formal models. As I will argue now, such an integrating endeavor is even more urgent today due to the arrival of digital data. This development has created new, unique possibilities by opening the door for empirical social scientific studies of emergence and complexity, but also poses new wicked challenges that need to be addressed. This further actualizes the importance of what I have argued for here, namely to develop integrating approaching to deal with social complexity.

7

Digital Data - opening the gates to complexity?

Revolutions in science have often been preceded by revolutions in measurement.

Sinan Aral

If we are to move towards a complexity-informed sociology, such an endeavor necessarily has to go all the way, and not contribute by simply adding yet another layer to the sociological pile of vaguely applied theoretical concepts. Rather, such an approach needs to be firmly grounded in sociological practices. After all, doing science involves doing research, and a complexity-informed sociology needs an empirical foundation in order to avoid the impending risk of only broadening the existing gap between sociological theory and empirical practice (Layder, 1998). Clearly, a key factor behind this schism has been the lack of suitable data. For example, most longitudinal data sets generally tend to lack relational and interaction-based data, and thus tend to tell us more about the attributes of the entities involved than the relationship between them, which is, as we have seen, problematic when we are dealing with emergence and complexity. This may have contributed, as Bail (2014) has argued, to the fact that while sociology has indeed generated numerous theoretical insights and well-developed concepts with great promise for the understanding of cultural and social change, we have often lacked the means to make such concepts operational.

However, the explosive growth of available digital data during the last decades has started to radically change the landscape for sociological theory and practice. Internet and social media such as Twitter, Internet forums and Facebook offer unique access to high-quality relational and interactional social data of a quality and quantity not previously imaginable, opening up new possibilities

to study complex social dynamics in detail as they unfold. For instance, this allows us to analyze wide-scale discursive changes, the evolution of meaning structures *in situ* (Bail, 2014) and the study of entire communities over time, tracing key actors, networks, groups and their interactions. This type of longitudinal and relational data would of course have been a dream for Tarde, enabling him to study in practice how social patterns unfold from micro-level interactions.

But digital data, or "big data", is unique in more ways than simply its size. Most conventional data sets used in social studies are generally designed according to our means to study the data. For instance, surveys are usually designed to collect data that is compatible with certain methods, while omitting other data. Similarly, conventional qualitative studies are generally restricted to certain (rather limited) aspects of reality. Of course, both these data sources can be combined into large-scale databases, which can then be studied using a combination of quantitative and qualitative methods. Nonetheless, this data is designed for social inquiry: what data is selected and collected simply depends on the accessible means of analysis, much like constructing screws that fit the screwdriver. The structuring of census data and the associated methods imply — like any scientific methodology — implicit presumptions regarding the system under study; the system is decomposed and compartmentalized to be made palatable for scientific consumption (Törnberg and Törnberg, 2016a).

The same does not hold for digital data. Digital data is messy; it does not respect our well-elaborated scientific means to approach it. It is a by-product that comes entangled and embedded in a social context and it is made up of traces of ongoing social processes, rather than something directly produced for scientific consumption. The structure of the data thus shows traces of the ongoing social process, rather than being delivered in predefined containers hiding the true complexity of reality. However, this does not mean this data speaks for itself. As Kitchin (2014: 5) argues, "[Big] Data are not simply natural and essential elements that are abstracted from the world in neutral and objective ways and can be accepted at face value; data are created within a complex assemblage that actively shapes its constitution". It is a biased sample rather than a realistic representation, and the process of analyzing it and identifying patterns does not occur in a scientific vacuum. Rather, it is inevitably shaped, both by the process through which it is generated (e.g. technical solutions and assumptions embedded in our tools and technical platforms) and when we approach it as scientists. We always make important decisions regarding how we clean data, construct corpus, assemble, structure (e.g. lemmatization) and analyze it; all of which involves important assumptions. Thus, in "cleaning the data", we also make it "algorithm ready" (Gillespie, 2014: 171).

DIGITAL DATA- OPENING THE GATES TO COMPLEXITY?

As I have argued, the social world is composed of intersecting complex systems with causal powers running in all direction between and within those systems. Digital data at least nudges at the gate of this type of complexity by not providing clear cuts between what we want to study and its context. In a sense, we now have data reminiscent of the complexity of the social reality. Digital data hence potentially reframes the research process and reassesses key questions about the constitution of knowledge and how we should engage with information. It does this by revealing the underlying scaffold of social complexity in a way that makes it impossible to ignore (we further develop this argument elsewhere; see Törnberg and Törnberg, 2016a). So, digital data provides us with access to aspects of the social world that traditional scientific data has to a large extent excluded, and this of course opens unique opportunities to explore previously unexplored issues.

Consequently, digital data practically manifests the two types of complexity that we have discussed here. Firstly, it is clearly characterized by micro-emergence and enables us to get detailed empirical data on an individual level, which permits us to trace and investigate the formation of structures and social patterns from underlying relations; for instance, how norms, behavior and ideas diffuse throughout networks and how they change during these processes. But at the same time the medium itself undergoes constant technological and social changes at a never-before seen rate. Online technologies develop in a feedback process between social practices and technological affordances, resulting in highly unpredictable innovation cascades, in what Lane et al. (2009) have referred to as *exaptive bootstrapping*. This means that social practices, norms and social institutions are constantly changing as the medium itself is transforming. While these dynamics are of course not unique to digital technology, it has undergone a phase transition in the speed of change. This means that digital data is also intrinsically connected to the second type of complexity that we have discussed here: ontological uncertainty and wickedness.

What is special about digital data is that it not only permits, but calls for integrating approaches that can deal with both of these types of complexity. While computational tools are clearly necessary to explore emergence and various complexity-related dynamics, the necessary assumptions of such formal methodology are at the same time undermined by the constant ontological changes of these systems. Therefore, we need to be mindful of their epistemological limitations, conscious of the ontological nature of the system under study, and draw upon social theory to frame the research and make sense of the findings. This includes keeping in mind that research is not neutral or objective just because it employs automatic tools or uses large data sets, as there are plenty of subjective choices both in the design of the analytical tools, data selection, and

interpretations of their output, allowing ideas and intentions of researchers to affect the framing of the results in various subtle ways (Haraway, 2013; Rose, 1997). It calls for research that is reflexive and open, acknowledging the limitations of the approaches and producing nuanced and contextualized accounts and conclusions, which not only combines various formal analytic methods, but is also possibly supplemented with small data studies that provide additional insights and contribute social context. In other words, we need a question-driven and methodologically pluralist approach within an epistemological framing that enables social scientists to draw insights that are situated and reflexive, while allowing the exploration of opportunities and benefits of vast new data.

In Paper IV, we address these issues by developing a methodological synergy between Critical Discourse Analysis and Topic Modeling, a new type of statistical model using hierarchical probabilistic modeling developed in computer science (Blei et al., 2003). By categorizing and thereby enabling us to find potentially interesting patterns in large amounts of unstructured textual data, these tools can contribute a form of content map, helping us to find and explore complexity-related dynamics. This approach allows us to bridge qualitative "deep" analysis and close reading, with powerful computational methods. These methodological techniques also make it possible to explore discursive changes over time. For instance, in a related paper that is not included in this thesis, we explore how discursive representations of Muslims and Islam in social media change between the years 2000 and 2013, and how Muslims are portrayed as a homogeneous outgroup that is embroiled in conflict, violence and extremism; characteristics that are described as emanating from Islam as a religion (for a graphical illustration, see Figure 5 in Attachments). These results also indicate how social media may serve as a form of "online amplifier" that reflects and reinforces existing discourses in traditional media, which is likely to result in even stronger polarizing effects on public discourses (Törnberg and Törnberg, 2016b).

8
Conclusion

In conclusion, I have argued that the social world consists of multiple, intersected layers of agents, entities, processes, structures and powers that gives it a laminated character; it is simultaneously and jointly influenced and governed by causal forces at all levels. Social causation is thus generally conjunctural, and social events are often the product of a range of different emergent causes. This gives social systems a wicked character; they are nebulous systems with multi-level characteristics, thus effectively depriving us from any fixed laws or simple answers. Not only do we have causal powers running from the bottom up as the case in merely complex systems, but wicked systems also exert emergent downward causal force back onto constituting levels, and emerging structures contribute by conditioning the very actions of individuals that also comprise them. In other words, micro-emergence is merely a subset of the causation that characterizes social systems.

Furthermore, the separation between system and structure is essential in order to clarify the unique contribution of a complex system approach to sociology, and to illustrate that such an approach is not necessarily in conflict or at odds with existing perspectives that rest upon a realist ontology, but can contribute important insights and practical methods that the prevailing approaches cannot. This provides a response to the first set of research questions that concern how to characterize the complexity of social systems, and whether this differs from other types of complexity.

Relating to the second set of research questions that concern the implications of this for any epistemological and methodological inquiry, I have argued

that this ontologically driven reconsideration of the nature of the social world and the Humean conception of causality[34] has seriously called into question the positivist variable-centered methodology that prevails in large parts of the social sciences. The wicked nature of social systems provides a fundamental and insurmountable obstacle to reductionism.

But fortunately, there is no rest for the wicked: while the open nature of most social systems means that there is no universal method that is capable of dealing with social phenomena in their entirety, we may combine different methods to cast light on different aspects of them. This calls for *critical method pluralism* (Danermark et al., 1997), or what Bunge (1973) refers to as *integrated pluralism*, in other words to combine methods that share a common meta-theoretical foundation and some basic ontological assumptions concerning the nature of reality. Of course, such an integrated approach also includes employing conventional quantitative methods and mathematical models based on linearity. These methods can indeed have great value, as long as they are employed with awareness and a qualitative understanding of their limitations. They are useful within certain boundaries but problematic — if not directly misleading — when employed beyond these boundaries[35].

While a method-pluralist approach is indeed often necessary, I have argued that narrative or processual explanations through case studies provides an important foundation for a complexity-informed sociology, advocating more local

34 Hume has defined a cause as "an object precedent and contiguous to another…where all the objects resembling the former are placed in relations to precedency and contiguity to those objects that resemble the latter" (Hume, 1978:170 quoted in Kurki, 2008: 35). While there are of course different interpretations of Hume, I believe that this perspective can be viewed as a precursor to the empiricist theory of causality, according to which causation is only seen as empirical regularities among observable events. Clearly, this is in sharp contrast with the generative theory of causality that is associated with the realist approach, which shifts focus from law-like regularities of observable events to "the real properties, structures and generative mechanisms that underlie the actualization of events and their empirical observations" (Kurki 2008: 166).

35 For instance, while statistical analysis may have a limited explanatory value, it is often essential for descriptive purposes and useful when embedded in case research. As Harvey and Reed (1996: 297) argue: "If the actual mathematical models of deterministic chaos and the concrete findings of the physical sciences have limited value in their direct application to the social sciences, they can still provide a rich heuristic base from which social scientists can work". Thus, correlation, as a statistical relationship between variables, is not explanation, but rather provides the beginning of an explanatory process rather than its conclusion.

universal knowledge claims and a sensitivity to deep causality. Additionally, this approach is compatible with multi-level theorizing which is essential to deal with the multi-level nature of the social world. As Jepperson and Meyer (2011) have pointed out, it does appear strange that while large parts of the contemporary physical sciences have actually undergone a robust development towards such multi-level theorizing, thus displacing previous doctrinal atomism, the social sciences, on the other hand, have recently seen a return to micro-reductionist explanations. Particularly in an Anglo-American context, a constitutive individualism has re-emerged with the intention of "bringing the individual back in", hence driving the cult of individualism to heights that Durkheim would never have imagined.

Although such micro-level focus is clearly not without its merits, what is needed is a research strategy that is not limited to this, but that focuses on identifying the emergent properties of the system in question; describes and studies it as its own level; investigates same-level relations; and tries to relate levels by employing both micro- and macro-level explanations. We need to combine different abstractions on different levels, and these should be developed so that they do not contradict each other. In this way, we can enable an understanding of social systems based on a constructive circularity of the explanation of the whole by the parts, and the parts by the whole, in which these two types of explanations become complementary; associating them without losing their continuous and opposing characteristics (Morin, 1992).

Whereas these issues were conceptually and theoretically elaborated in Paper I, Paper II and Paper III together illustrate how such a constructive circularity of explanations can be achieved in practice. In the latter study, we develop an agent-based model that focuses particularly on micro-emergence. As I have argued, this type of formal model plays an important role in extending the cognitive range of theorizing and investigating certain aspects of wicked systems. Wicked systems tend to leave traces of mass dynamics that we can pick up, and then use formal models to untangle and closely examine. In this way, while models may not be objective representations of the system in question, they do provide a valuable tool to help us to develop small causal theories that enable us to link certain lower-level mechanisms to higher-level outcomes, and can therefore prove helpful to explain key dynamics in concrete social phenomena. In this particular study, the model contributed important insights on how micro-level interactions lead to emergent network structural effects that may have an impact on the diffusion of social mobilization.

While it is indeed true that these models do make assumptions of closure that in general do not hold for this type of system, we should remember that this is in fact a general problem, since "all theorising in science involves abstrac-

tions (or isolations) that involve some partial or temporary closure in the theory" (Hodgson, 2006: 3). This means that models are still necessary, even if they make assumptions of closure that do not hold for the system in general. But this also emphasizes that models need to be embedded and incorporated into broader and narrative-based theoretical frameworks, both to avoid the fallacy of naturalism and confuse methodology and ontology, but also to help decide what aspects or which mechanisms of a certain social phenomenon the model should investigate[36], and to facilitate the integration of the results of the models into broader theoretical frameworks.

In Paper II, I take the first steps towards developing a theoretical synthetic framework to approach radical societal changes driven by social movements. This theoretical framework is based on a complexity-sensitive terminology, which facilitates the integration of formal models into the framework. In this way, the (tentative) conclusions and the small causal theory developed in Paper III can be directly embedded into this broader framework that also incorporates other forms of emergent causation, such as the causal powers of broader social processes, higher-level entities and social structures. This enables a form of multi-level theorizing that opens the possibility to analyze how micro and macro conspire, and study the co-evolution of mechanisms and processes between and within different levels, which I view as absolutely essential in order to understand societal change[37] [38].

Paper IV then contributes to this, and also relates to the third set of research questions, by developing a methodological synergy that helps us to further ground such a research strategy in empirical research by using the growing access to high-quality relational and interactional digital data.

My intention in this introductory chapter has been to go beyond the individual studies that comprise this thesis and show their common theoretical and

36 This is indeed an open issue when it comes to modeling: how do we decide what aspects or causal mechanisms the model should investigate? However, this is of course a general problem when constructing any kind of model, whether qualitative or quantitative.

37 This does not imply that we will be able to make exact predictions of such societal processes. As we have seen, such endeavor is generally not possible due to the predisposition towards chaotic behavior that is inherent in most complex social systems. But it is important to note that the inability to predict is no failure of the theory; it only implies that social theory in this sense is closer to evolutionary biology than physics.

38 Notably, this approach also appears to coincide with what Castellani (2014) has claimed is the future for complexity research: case-based modeling and multi-level complex systems.

methodological foundation — and thereby also illustrate their joint contribution. In this manner, the introduction has contributed by recontextualizing the individual papers, and thus shedding light on how these different methodological approaches are in fact not incompatible paradigms, but complementary perspectives that share important meta-theoretical/ontological assumptions and are all vital parts of a method pluralist approach. However, like any comprehensive overview, this introductory chapter is by necessity rather broad and merely touches on these complex issues, rather than providing the deep and thorough examination that they surely crave. Therefore, I want to emphasize that my aim here has been to sort out, elaborate and refine these issues, and that this introductory chapter should therefore be read as a starting point, opening up leads and paths for further exploration, rather than providing any finite conclusion.

As we have seen, while multi-level causation and conjunctural emergence do require us in certain circumstances to adopt a holist strategy and assume emergence; micro-emergent dynamics on the other hand, which often contribute to shaping social systems, require a more individualist bottom-up approach. When employed unreflexively and as independent research projects, both holist and individualist approaches are indeed problematic. But when based in a critical realist ontology and informed by a complexity science perspective, I have shown how these approaches can be fruitfully combined in a way that gives credits to both approaches. Thus, they are not only commensurable, but can in fact be mutually informing and complementary, at both the theoretical and the practical levels.

Consequently, the approach to social complexity I propose here enables a way of reconciling the individualist methodology of, for example, mainstream complexity science and analytical sociology with the structuralist emergentism of critical realism. This position captures parts of the analytical sociology position, but is embedded within and grounded upon a critical realist ontology that acknowledges the social as an emergent reality with its own specific powers and properties. It also makes a contribution to the critical realist camp by enabling us to systematically explore emergent processes. While structures and agents are often rightly claimed to belong to different strata of social reality and should therefore not be reduced one to the other (see e.g. Archer, 1996: 679), we must also be careful not to overemphasize the stratification and differentiation of the social world. Emergent properties do not form sealed compartments that separate strata from each other. In certain circumstances we can indeed derive a higher level (or at least aspects thereof) from the working of a lower level. In this way, complexity science furnishes what critical realism lacks by contributing both conceptual and technical means to study the emergent interplay between human action and social structure.

9
Epilogue: Tarde and Durkheim revisited

Social life, just like the ritual, moves in a circle … On the one hand, the individual gets from society the best part of himself … But on the other hand, society exists and lives only in and through individuals … society cannot do without individuals any more than these can do without society.

Émile Durkheim

To conclude, let us finally return to where we started—in the classical and fierce debate between Tarde and Durkheim, but this time through the lenses of the concepts and terminology introduced in this thesis.

It is hard to avoid being struck by the similarities between the mainstream complexity approach and Tarde's dream for a borderless sociology, capable of studying emergence from the bottom up, and where a yawn, suicides or a desire for the newest iPhone can spread contagiously throughout a population and give rise to collective patterns. Tarde stretched the boundaries for where social systems begin, and where they transcend into natural systems, comparing for instance ant societies with human societies since both can be explained according to the principle of "individual initiative followed by imitation" (de Tarde, 1903). Similarly, he viewed repetitions as self-spreading contagions, and uses the example of how waves are formed as a stone is dropped in water as a model for how fashion trends are multiplied and diffused in society. In this way, Tarde focused on the small and seemingly insignificant imitations and repetitions and how these are spread from person to person, through newspapers and telegraphs, like microscopic but contagious wildfires that through their vibrations give rise to what we call society. In his view, structures are not, they become, and the task for sociology should not be confined to merely assuming emergence, but to study it as an ongoing process.

Durkheim's vision for a foundational sociology on the other hand, firmly distinguished from adjacent disciplines, was formulated in critique of micro-reductionism. While he could certainly be criticized for certain substantialist tendencies, his fundamental argument was that social and mental phenomena are not decomposable systems. As he states in *Sociology and Philosophy:* "If we concede that ideas can be decomposed into parts, we should have to admit further that to each of the parts corresponds a particular neural element … Such a geography of the brain belongs to the world of the novelette rather than to that of science" (Durkheim, [1898] 1953: 12). The consequence thereof is that "reductionist analysis is inappropriate because the combinations of elements are changed by their associations" (ibid. p. 11).

Although Durkheim himself did not use the term *emergence*, his concepts of *sui generis*, *synthesis* and *associations* clearly accomplished the same function, namely to explain how a social level of analysis can result from individual actions, and yet take on a seemingly independent existence (Sawyer, 2002: 237). Tarde, however, saw this distinction between the individual and the social as a "chimerical conception", arguing that Durkheim represented two incompatible ontological positions when he claimed that society emerges from individuals in interaction, yet is external and autonomous to individuals and exerts causal power over those individuals[39] (Durkheim, [1893] 1984). This ostensible contradiction is even apparent within the same volume, as Durkheim states in *The Rules of Sociological Method* that: "Society is not a mere sum of individuals" (p.103), while less than a hundred pages earlier he had argued that "Social things are actualized only through men; they are a product of human activity" (p. 17).

While this position is often represented as a fundamental dilemma, it appears less problematic if we approach the relation between individuals and the social in terms of emergence. Using this terminology, there is no surprise that a whole is different than simply the additive combination of its components. Social facts can thus be defined as an emergent totality of forces, and that such totality may have social constraints in relation to its components is no stranger than that the density of a social network is likely to increase the pace of diffusion, an argument Tarde would likely have appreciated. Social constraint can thus be understood in terms of *downward causation*; it is a form of constraint that

39 Later, Giddens (1977), Alexander (1982) and Lukes (1973) have also criticized Durkheim on similar, and as I argue erroneous, grounds.

is simultaneously undergoing processes of emergence. Social facts constrain individuals, but at the same time they emerge from the actions and interactions of those very same individuals. Following this line of argument, social facts emerge from the association of individuals, but nonetheless exhibit unique qualities since the combining elements are changed by their associations and are thus not reducible to utilitarian atomism and the individualistic reductionist approaches. The whole is different from its components, and in the same way as biology does not suffice to fully understand psychological phenomena, the social requires its own approach.

In this way, both Tarde and Durkheim "avant la lettre" outlined the foundations for a complexity-oriented sociology, although in radically different versions of such inquiry. While they did not ascribe the label to themselves, both can be described as emergentist theorists, despite reaching fundamentally different conclusions on how to study social phenomena. While Tarde's perspective resembles a mainstream complexity approach, Durkheim's theory of emergence represents a non-reductionist perspective.

However, returning to this conflict in the light of the conclusions drawn in this thesis and the distinction made between complex systems and wicked systems, these perspectives should not be understood as necessarily competitive. There is no fundamental opposition between them; in fact they are not only commensurable but mutually informing and methodologically complementary. Interestingly, at some level Durkheim seems to have opened up for this possibility himself as he states that science and access to novel types of methods might eventually be capable of reductionist explanations of some social facts. "If this exteriority should prove to be only apparent, the advance of science will bring the disillusionment and we shall see our conception of social phenomena change" (Durkheim, [1895] 1964: 28).

Perhaps the development of digital data and novel computational techniques provides such a "novel method" that may take us one step closer towards a realization of Tarde's empirical program: enabling us to trace in detail the processes when new concepts and ideas are invented, how they are imitated and how they diffuse like a contagious disease throughout user-based networks, get connected with other ideas, and eventually may lead to the emergence of what Durkheim is often claimed to treat as merely segmented macro-structures.

In the end, the question of whether or not a particular social system can be fully explained in terms of the constituent individuals and their interactions, or whether we need to acknowledge causality to higher-level entities and social structures, is an empirical issue. I think that complexity science can indeed prove highly useful here, providing us with both conceptual and practical tools to illustrate the value of both Tarde and Durkheim and help us to understand

when and *why* a Tardenean micro-emergence approach is sufficient, and when the wickedness of social systems requires a more holistic approach. In other words, although a meeting between the holism of Durkheim and the individualism of Tarde may be "sheer madness", as Guillaume de Tarde claimed in the quote initiating this thesis, complexity science at least gives a method to the madness.

10
Appendix: The four papers

In this section I will present brief summaries of the four studies this thesis is based upon, reported in the appended papers. By employing different approaches to social complexity, the individual papers in the thesis contribute to the different fields they are situated in. In this way, they provides a tangible, "hands-on" illustration of how complexity science can contribute to both sociological theory and methodological practice. By discussing, refining and elaborating on various theories and notions, the introductory chapter has provided a recontextualization of these papers that imbues them with a different meaning by allowing us to see them as different approaches to wicked systems. In a sense, adding the introductory chapter to the four studies can be seen as a type of *creative abduction*; to introduce a new typology that attempts to reveal new relations and meanings that are not otherwise given or explicit. In other words; *to see something as something else* (this "meta-purpose" is also included in table 2). This research process—resulting from the oscillation between the parts and the whole, between the individual articles and my overall approach to social complexity—has gradually emerged in parallel to the more linear work related to the individual studies. Table 2 provides a comprehensive overview of the studies that may be useful while reading the main results.

	Main purpose	Meta-purpose	Theoretical engagement	Material& method	Key results
1	Explain the lack of breakthrough of complexity science within social science. Distinguish between different types of complexity	What distinguishes complex social systems? Can they be approached in similar ways as other complex systems?	*Mainstream complexity* (e.g. Holland, 2006; Johnson, 2009) *General complexity* and *complex realism* (Byrne and Callaghan, 2014; Morin, 2007; Simon, 1962)	Conceptual study	Distinguishes *complex*, *complicated* and *wicked systems* and discusses how these can be approached
2	Combine Transition Studies and social movement theory to understand radical societal transitions	Integrate complexity thinking into theoretical frameworks; employ process-based, multi-level approach to societal change.	*Transition Studies* (de Haan and Rotmans, 2011; Geels, 2002; Seyfang and Longhurst, 2013) *Free social spaces* (Evans, 1979; Polletta, 1999)	Narrative explanations, typological theorizing, case study	Develops a theoretical synthesis. Highlights the role of free social spaces in societal transitions
3	Investigate the network structural effects of free social spaces on diffusion of social mobilization	Illustrate how formal modeling can investigate micro-emergent dynamics.	*Free social spaces* (Evans, 1979; Polletta, 1999) *Diffusion of Social mobilization & Collective action* (Centola and Macy, 2007; Givan et al., 2010; Olson, 1971)	Formal model, computer simulation. Focuses primarily on two mechanisms: *political bias* and *clusterness*	Clusterness has positive effects on diffusion of social mobilization. Positive synergistic relation between bias and clusterness, up to certain levels.
4	Investigate connections between anti-feminism and Islamophobia in a web forum. Combine topic modeling and critical discourse analysis (CDA)	Enable empirical studies of social complexity by developing an integrated methodological approach	*CDA* (van Dijk, 2008; van Leeuwen, 2009), and *discursive fields*(Snow, 2004; Steinberg, 1999) *Online hate & Islamophobia*(Correa and Sureka, 2013)	Topic modeling and Critical Discourse Analysis. Corpus= 50 million posts from Flashback.org	Identifies topics that connect anti-feminist and Islamophobic discourses. Provides a methodological synergy to study digital data

Table 2. Overview of the four papers.

Paper I
Societal systems – complex or worse?

Authors: The article was originally based on Anton Törnberg and Petter Törnberg's master's thesis, but was thoroughly rewritten and recontextualized in close collaboration with Claes Andersson (Published in Futures, 2014).

The first paper is a theoretical and conceptual study. Since this study has been more thoroughly discussed above, I will only briefly summarize the main approach taken in the study and the ensuing results.

The article starts with the ostensible dilemma that while complexity science undeniably has made huge progress within broad spectra of the natural sciences, corresponding success in the study of societal systems in their full complexity seems to have been much more limited. In a sense, applied within the social sciences, complexity science seems to be stuck in a state of being perpetually promising, but has nonetheless so far failed to deliver beyond the application of simple models, and often rather vaguely applied terminology.

This article contributes by critically engaging the notion of complexity and introduces a theoretical tool/model and heuristics that enable us to distinguish between different types of complexity, and allow us to chart the relation between problems, systems and methods. In other words, we use this heuristic to map different types of complexity, and analyze which approaches work for different types of systems. A major benefit of our conceptualization in this study is that it removes the otherwise forceful prior notion that social systems should be understandable by extending the toolbox of mainstream complexity science. Instead, we introduce the notion of *wicked systems* to describe social systems, and argue that this constitutes a different type of complexity that requires fundamentally different methodological and theoretical approaches than the type of complexity that is typically found within natural systems. In this sense, this article can be read as a critique of naturalism, but targeting primarily a mainstream audience and formulated in the rather formalist language of complex system theorists.

Paper II

Combining transition studies and social movement theory: conceptualizing radical societal change as a social innovation

Author: Anton Törnberg (submitted manuscript).

This study starts by identifying two central characteristics or features of social movements that have arguably not been properly accounted for in contemporary social movement literature, namely [i] abrupt and rapid social mobilizations that lead to [ii] the construction of radically novel and innovative political processes and structures. There are arguably three main reasons for this lack of understanding of explosive mobilizations and movement-driven radical societal transitions.

Firstly, radical societal transitions are not very common as empirical phenomena, which has created serious limitations for the possibilities of any systematic investigation. Secondly, established theories and methods in the field have in general significant difficulties in dealing with complex dynamics such as emergence and non-linearity. Thirdly, there is a prevailing lacuna in the literature concerning the connection between informal or small-scale forms of resistance and large-scale, organized mobilizations. In fact, these are often treated as analytically separate phenomena.

This paper takes a novel approach to these issues by arguing that a potentially fruitful way forward is to combine social movement literature and particularly the notion of *free social spaces*, with transition studies — an interdisciplinary field that focuses on large scale socio-technical transitions. The strength and potential of the latter lies in the fact that these theoretical frameworks build upon complexity-thinking, and focus on *how* and *when* novel technical innovations that are fostered in niches manage to break through and radically change the overall socio-technical system. In this sense, the connection between small-scale processes within niches and large-scale transitions is well established within this field.

This theoretical approach is empirically illustrated in a case study that focuses on the APPO movement in Mexico. The empirical material for the case study was collected during a fieldtrip to Oaxaca in 2015, and consists of a number of interviews with activists in the movement. This is complemented with secondary sources.

A key insight emerging from this study is that for bottom-up societal transitions to be possible, radical social movements need to proactively develop concrete alternatives to existing societal structures. Free social spaces play a crucial function here, by providing shielding, nurturing and empowering functions and

thus serving as a space where new, radical social innovations may grow. A key strength of the theoretical approach developed in this paper is that it enables us to address central questions such as when radical social innovations manage to break through and change the overall system, and when they are channeled, domesticated and stifled of their transformative potential and incorporated as institutional reforms.

The transition studies frameworks that are employed in this study can be regarded as a development of the *diffusion of innovation* perspective (Coleman et al., 1966; Rogers, [1962] 2010; Strang and Soule, 1998), which also forms the basis for the model employed in paper III. While the perspective in paper II focuses primarily on diffusion processes from the bottom up, the transition studies frameworks such as the Multi-Level Perspective also incorporate multi-level theorizing and provide a more elaborated and extended account of the context that surrounds and sets up the structural condition for such diffusion processes to occur. In this sense, these two studies are directly compatible. The broader transition studies frameworks thus function as encompassing frameworks that can incorporate diffusion models. This is also facilitated by the fact that these frameworks build upon complexity thinking which, besides being central to understanding complex system dynamics, also facilitates the employment and incorporation of computer simulations. This has in fact been done within other fields, such as socio-technical innovation.

Paper III
Modelling free social spaces and the diffusion of mobilization

Authors: Anton Törnberg and Petter Törnberg. The article was written jointly by the two authors concerning the overall research design, the operationalization of theoretical assumptions and the analysis and discussion. PT was main responsible for the technical part that concerns the construction and calibration of the model, while AT was main responsible for the theoretical section. (Published in Social Movement Studies, 2017).

This study focuses on the notion of free social spaces in the context of social movements. While there is extensive literature that focus on the internal dynamics within such spaces, and how they contribute in the development of e.g. collective identities and oppositional cultures in social movements, less is known when it comes to what role they play in relation to the diffusion of collective mobilizations.

In this study, we address this issue by investigating the emergent network structural effects of free social spaces on the diffusion of mobilization. Based on

the literature, we extract two main mechanisms or functions that are often attributed to free social spaces: [i] they tend to be biased or politically deviant in relation to mainstream society, and [ii] they tend to be more densely clustered, characterized by high internal interconnectivity. By developing a formal computational network model, we investigate whether, how and to what extent these mechanisms affect the diffusion of social movements.

The main results from the simulations show that the network structure that characterizes free social spaces indeed seems relevant to take into account when studying what role such spaces play in social mobilizations. Up to certain levels, clusterness in itself tends to have a positive impact on diffusion of social mobilization. Additionally, up to certain levels, there is also a positive synergistic relation between bias and the presence of a cluster. This indicates that for free social spaces that are not radically deviant from mainstream society, clusterness has a positive impact on diffusion. However, if these spaces are too radical, they would benefit from focusing on building more external connections than internal. These are emergent system dynamics that would indeed be very difficult to predict or analyze using other types of methods. This clearly illustrates the potentials of further integrating formal modelling as yet an important tool in the repertoires of methods available for social movement scholars. This is in fact also one of the reasons why we tried to present the model and its findings in a narrative manner, motivating the assumptions made in the model and illustrating the results in close relation to real-world social movement dynamics, thus trying to render it more accessible for scholars not previously familiar with this type of methodology.

However, as we also stress in the article, it is essential to acknowledge that these are preliminary findings that cannot be directly translated and used for real-world prediction. In the real world, the working of these mechanisms is dependent upon contingent relations in open systems, and their impact thus hinge upon any potential countervailing mechanisms.

An interesting prospect with simulation models is that they permit the scholar to investigate emergent futures or, in Byrne and Callaghan's (2014) words, create "narratives of the future". While conventional quantitative methods are in a sense stuck in the present due to their general reliance on empirical data, simulations enable researchers to go beyond the hegemonic present by providing a basis for investigating *what-if scenarios*: to investigate situations where we, for some reason, do not have access to real-world empirical data. This may be either due to difficulties to collect empirical data within certain fields, or when experimental methods are disqualified due to ethical reasons.

Paper IV

Combining CDA and Topic Modeling: analyzing discursive connections between Islamophobia and anti-feminism on an online forum

Authors: Anton Törnberg and Petter Törnberg. AT and PT jointly conceived the study and its basic design. AT is the main author, performed the analysis and drafted the manuscript. PT was responsible for the technical aspects, concerning building the database and performing and calibrating the LDA. (Published in Discourse & Society, 2016.)

The fourth study focuses on how discourses around Muslims, Islam and feminism are constructed in a large Internet forum, and how these discourses are interrelated and connected, both discursively and through engaged users. This topic is situated within the broader issue of net hatred, which has attracted special interest in recent years. The corpus consists of about 50 million posts that were scraped from Flashback.org, the largest Internet forum in Sweden.

The basic motif behind the article is the explosive growth of social media and social networking sites in recent decades. These sites are becoming increasingly important platforms for social interaction, but are also significant sources for the (re)production of discourses in society, central in framing issues and events and thus shaping people's perception of reality and political issues. As an illustrative fact, Flashback has in fact more unique visitors per week than Sweden's two leading daily press newspapers, even after adding the number of their paper edition subscribers[40].

While this clearly motivates the need for further empirical inquiry, a central problem has for long been the methodological challenges associated with the huge quantities and unstructured nature of social media data. This has made it difficult to approach these pressing issues, using either traditional qualitative methods for text analysis, or conventional quantitative methods. The crux of the matter is simply that even relatively small data sets are often very difficult to

40 This is intended to serve as a loose approximation, since getting accurate and trustworthy figures on website statistics is close to impossible. The numbers for the two largest daily newspapers (Dagens Nyheter and Svenska Dagbladet) come from the KIA-index, a website that measures media impact. For offline editions, we rely on the Orvesto Konsument Index. As Flashback is not included by KIA, we are forced to rely on the figures that Flashback has provided themselves.

approach, as it is hard to delineate, select and confine materials from millions of texts, posts or tweets.

This prompts novel approaches that combine the ability of content analytical approaches to explore, categorize, structure and visualize the more manifest aspects and meanings of a textual corpus, with the sensitivity of qualitative and hermeneutic approaches to complexities of meaning, subtleties of expression, complex layeredness; aspects that may not always be easily found on the surface of texts. Aiming to bridge the gap between these different types of text analysis, this article develops a methodological synergy by combining Critical Discourse Analysis (CDA) and Topic Modeling, a type of statistical model for the automated categorization of large quantities of texts that has been developed in computer science. We also complement this with tools from Social Network Analysis (SNA) in order to visualize how various topics and discursive fields are connected to each other through the active users in the forum.

Topic modeling is basically a set of methods and algorithms that uncover the latent thematic structure in document collections by revealing recurring clusters of concurrent words. In this sense, topic modeling enables us to categorize and visualize themes, or topics, that arise inductively from texts. The algorithm that is currently the most widely used for topic modeling, and also the algorithm we apply in this paper, is Latent Dirichlet Allocation (LDA) (Blei et al., 2003). While there are certain affinities with cluster analysis — and both techniques can indeed be used for data mining — there are also differences, primarily in the technical procedure and how the techniques are conventionally employed.

The basic logic behind topic modeling is that a document about a certain topic is more likely to contain words associated with that particular topic. For instance, if a document is about mammals, it is more likely to include words like "cat", "elephant" and "blue whale" than a document about, say, philosophy. Correspondingly, it is less likely than the latter to contain words like "Kant" or "epistemic fallacy". Simply put, topic modeling is basically an algorithmic operationalization of this simple logic, and defines a topic as a list of words with different assigned probabilities and attempts to find the set of topics that best capture the documents.

The algorithms that LDA uses are based on Bayesian statistical theory (Gelman et al., 2014), where the topics and the per-document topic proportions are seen as latent variables in a hierarchical probabilistic model. The conditional distribution of those variables is approximated, given an observed collection of documents. When applied to the documents in a corpus, inference produces a set of topics and, for each document, an estimate of its topic proportions and to

which topic each observed word is assigned. For a more technical description of LDA, see Blei (2012); Blei et al. (2003).

Using this methodological approach, we identify a number of topics that seem to connect anti-feminist and Islamophobic discourses in the forum, for instance in discussions that focus on religious private schools, family and gender roles, and the claimed overrepresentation of Muslims in violent assaults against women. Additionally, we identify a common discourse that pervades all these various topics and that asserts a claimed inherent oppression of women within Islam, and what is described as a contradiction among feminists and the political left to be both in favor of gender equality, and at the same time pro-Islam and positive toward Muslim immigration.

Through this empirical analysis, we also illustrate how topic modeling can serve as an important complement to discourse analysis, allowing us to inductively explore large quantities of unstructured textual data. In this way, this methodological synergy is useful by combining a valuable overview and structure, with sensitivity for linguistic nuances and more latent symbolic meanings. But we also emphasize the importance of a critical awareness when using automated text analysis, and not to over-emphasize the automated part of this. CDA countervails this by affording a more elaborated and transparent perspective to hermeneutic interpretation processes.

In more general terms, this article also aims to provide a methodological solution that enables researchers to approach the vast and growing archive of texts that constitute social media. This is essential, not only to allow for a critical investigation of the construction of discursive power in society, but also since social media offers a unique entrance into the everyday discourses and the otherwise often impenetrable world of kitchen-table discussions — a world that has previously been beyond the reach of both traditional media and social analysis.

There are a number of ethical considerations that are unique to online research and that need to be accounted for. Since the size and magnitude of the Internet forum that is investigated in paper IV precludes the use of informed permission from the users, the first and major issue therefore concerns how this type of data should be approached, and whether public posts and discussions on these forums can be used without the permission of their authors.

In this respect I follow the suggested ethical guidelines of Reilly and Trevisan (2016) for research on social media, which are informed both by organizations such as the British Psychological Society, but also by the specific sociopolitical context in which data are collected and analyzed. This means that rather than developing general rules, data collection and presentation strategies should be made on a case-by-case basis, with researchers reflecting upon any potential harm that might be inflicted on unaware participations through the use of their

data. Hence, different ethical considerations may be relevant depending on the specific social media platform analyzed. While Twitter, for instance, is explicitly designed as a public forum, other platforms such as private blogs provide different functions.

First of all, and in line with existing research in the field (Burkell et al., 2014; Reilly and Trevisan, 2016; Sveningsson Elm, 2009), I consider the social media forum investigated in paper IV as a form of "public space". The discussions and threads on this forum are all open to the general public and do not require any registration to access. Administrators and users constantly remind each other about the visibility of posts, indicating that discussants are well aware that their comments are likely to be scrutinized by a range of external actors such as police, media, researchers and by those with opposing views. This is also supported by previous research that indicates that most people see such online social spaces as "loci of public display rather than private revelation" (Burkell et al., 2014).

While the focus in this study lies on discursive patterns on a macro-level and individuals are not relevant here, I nonetheless consider the privacy and integrity of the users as essential and have carried out a number of additional measures to ensure their anonymity. The usernames in the forums are generally pseudonyms, with very few, if any, exceptions. This means that it is in general not possible to identify specific individuals. To further ensure the users' privacy, we have removed all Personally Identifiable Information (PII) such as usernames, age or gender, which could lead to the identification of specific users. The results of the data analysis are primarily illustrated as "topics" (lists of concurrent words), which are generated by the underlying algorithm and cannot be traced back to their original authors. Furthermore, the extracted quotes are all translated from Swedish into English, which makes it more difficult to track them back to specific users.

Svensk sammanfattning

Många sociala fenomen som intresserar oss samhällsvetare präglas av icke-linjära dynamiker, där små faktorer kan få stora - och ibland oväntade - konsekvenser. Ett exempel på detta är den så kallade arabiska våren, då den arbetslösa akademikern Mohammed Bouazizi tände eld på sig själv som protestaktion, vilket kom att bli den utlösande gnista som initierade en våg av uppror som under flera månader skakade Arabvärlden. På samma sätt kan internationella banker kollapsa över en natt som följd av komplexa kaskader i belåningsnätverk, och sjukdomar kan snabbt spridas från en avgränsad by till att utgöra en samhällshotande pandemi. Liknande spridningsdynamiker tycks återfinnas även inom social media, där symboler och ”memes” kan få global spridning och nå miljoner människor inom endast några få timmar.

Denna typ av komplexa och icke-linjära dynamiker och processer utgör en central utmaning för samhällsvetenskapliga teorier och metoder. Linjära modeller och statistiska variabelbaserade metoder är sällan till stor hjälp för att förstå *emergenta* dynamiker; då en helhet har egenskaper som skiljer sig från dess enskilda delar, som exempelvis vatten vars egenskaper är väsensskilda från syre och väte. Även traditionella kvalitativa metoder är problematiska eftersom icke-linjära fenomen ofta är kontra-intuitiva och består av långa kausala kedjor och processer som kan vara svåra att följa och förstå utan tekniska hjälpmedel.

Det faktum att många av dessa dynamiker är generella och återfinns inom en mängd discipliner och vetenskapliga fält - från fågelflockar och myrkolonier till partikelinteraktioner inom fysik, cellbiologi och inte minst klimatet - väcker intressanta frågor. Kan vi som samhällsvetare använda samma metoder och perspektiv som används inom naturvetenskap för att studera komplexa system? Kan datorsimulationer, som har visat sig effektiva för att undersöka dynamiken hos fågelflockar, även vara användbart inom sociologi för att studera hur kollektiva sociala mönster och strukturer växer fram underifrån, från individernas interaktioner? Eller särskiljer sig sociala system från andra typer av komplexa system då dess komponenter - människor - är reflexiva varelser som tolkar och aktivt förändrar sina handlingar utifrån framväxande strukturer?

Dessa frågor relaterar till ett grundläggande problem som varit centralt inom sociologi från första början, nämligen spänningen mellan *individualism* och *holism*. Det vill säga; bör sociologer fokusera på de sociala strukturer som styr och betingar mänskligt agerande och formar en slags helhet som inte kan reduceras till individerna och deras interaktioner? Eller bör vi snarare anta ett individualistiskt perspektiv och studera hur det sociala växer fram ur människors handlingar och interaktioner?

Denna avhandling tar avstamp i dessa frågor och undersöker vad det interdisciplinära fältet *komplexitetsvetenskap* kan bidra till sociologi, både teoretiskt och metodologiskt.

Avhandlingen består av fyra artiklar samt en introducerande kappa. Artiklarna utgår från olika forskningsfält och tillämpar olika teorier och metoder för att studera komplexitet inom sociala fenomen. Den introducerande kappan utgörs av en vetenskapsteoretisk diskussion som re-kontextualiserar dessa studier för att påvisa att de olika approacherna som används i artiklarna är kompatibla och kan kombineras. På detta sätt ger kappan en ”nybeskrivning” av de enskilda artiklarna; en ny tolkningsram som ger en ytterligare innebörd åt artiklarna genom att explicitgöra relationer och sammanhang som annars inte är givna eller uppenbara.

Sammanfattningsvis så lägger den första artikeln grunden för den teoretiska ingången i avhandlingen. Den andra artikeln utvecklar ett process-baserat teoretiskt ramverk som är baserat på komplexitetstänkande och som undersöker samspelet mellan kausala processer på olika nivåer för att förstå samhälleliga förändringsprocesser. Den tredje artikeln använder datorsimulationer i form av agent-baserade modeller för att undersöka vilka effekter nätverksstrukturer har för spridningsprocesser. Eftersom det teoretiska ramverket i artikel två bygger på komplexitetsteori, så kan resultaten från den tredje artikeln direkt inkorporeras i detta ramverk, som dock även tar hänsyn till mer kontextuella och strukturella förutsättningar för spridningsprocesser. Utgångspunkten i den fjärde och sista artikeln är att digital data öppnar upp nya, unika möjligheter för att praktiskt kunna studera komplexitetsrelaterade dynamiker i sociala processer. För att kunna studera detta så utvecklar denna artikel en metodologisk kombination av kritisk diskursanalys och avancerade, kvantitativa metoder från datavetenskap.

Artikel I

Den första artikeln är teoretisk och konceptuell och kan sägas utveckla den teoretiska ingången till komplexitet som ligger till grund för hela avhandlingen. Medan komplexitetsvetenskap har haft en stark inverkan inom breda skikt av de naturvetenskapliga disciplinerna så har motsvarande utveckling inom samhällsvetenskaperna varit mer modest. Denna artikel bidrar till diskussionen genom att kritiskt närma sig begreppet komplexitet och introducerar en teoretisk modell som särskiljer mellan olika typer av system. Artikeln tar sin utgångspunkt i uppdelningen mellan *komplicerade system* och *komplexa system*. Dessa skilda typer av system präglas av olika dynamiker och förutsätter olika analysmetoder för att kunna studeras. Komplicerade system kan förstås och analyseras genom att fokusera på dess beståndsdelar, såsom en motor som helt kan förstås genom att dissekeras till sina underliggande delar. Komplexa system, såsom fiskstim och

fågelflockar, är dock generellt icke-linjära och kräver ett fokus snarare på *interaktionerna* mellan dess delar. Komplexa system studeras vanligtvis med hjälp av datorsimulationer som modellerar hur interaktioner mellan delarna i dessa system kan leda till kollektiva mönster.

Artikeln bidrar genom att introducera begreppet *wicked systems* som beskriver den kategori av system som många sociala system faller inom. Wicked systems är en emergent kombination av det komplicerade och det komplexa: de är komplexa i bemärkelsen att de präglas av komplexitetsrelaterad dynamiker såsom självorganisering, men de är samtidigt komplicerade i bemärkelsen att de är hierarkiska och innehåller flera nivåer.

Wicked systems är öppna system, vilket innebär att de är svåra att avgränsa och studera isolerat från sin omgivning. Beståndsdelarna i dessa system, människor, är reflexiva varelser med en unik förmåga att tolka och förstå verkligheten, samt agera utifrån dessa tolkningar. Människor kan således inte enkelt operationaliseras till regelföljande agenter, vilket man ofta gör när man studerar enklare komplexa system. Som en konsekvens av detta så präglas wicked systems inte bara av emergenta processer nedifrån-och-upp, utan även av processer uppifrån-och-ner, då sociala strukturer påverkar människors handlingar och beteenden. Detta innebär att wicked systems varken kan reduceras till sina beståndsdelar eller relationen mellan dem, utan handlar snarare om nivåer, processer och strukturer på flera olika nivåer som konstant interagerar och samevolverar.

I artikeln kategoriserar vi olika typer av komplexitet och diskuterar vilka analytiska perspektiv som fungerar för olika typer av system. En central slutsats är att wicked systems förutsätter andra metodologiska approacher än andra typer av komplexa system. Medan datasimulationer och modeller kan vara användbara för att studera *aspekter* av wicked systems, som exempelvis för att förstå ickelinjära dynamiker som *tröskeleffekter* och *kaskader*, så behövs även mer narrativa och process-baserade förklaringsmodeller som är mer flexibla och kan ta hänsyn till kausala processer på flera nivåer. Sammanfattningsvis kan denna artikel således läsas som en kritik mot naturalism och idén att sociala och naturliga system kan förstås och studeras på likvärdigt sätt.

Artikel II

Den andra artikeln fokuserar på sociala rörelser och social förändring. Mer specifikt så undersöks de samhälleliga transitionsprocesser som är drivna av politisk mobilisering, det vill säga de fall då sociala rörelser driver fram dramatiska samhällsomvandlingar och bygger nya sociala och politiska strukturer som radikalt skiljer sig från de tidigare etablerade politiska institutionerna. Det finns ett flertal exempel på denna typ av sociala revolutionsprocesser genom historien.

Den Franska revolutionen 1789 och den Ryska revolutionen 1917 är klassiska exempel. Det finns även mindre fall såsom Zapatistupproret i Chiapas i Mexiko 1994, och inom den så kallade arabiska våren, då en våg av uppror i visa fall ledde till uppbyggnaden av nya, mer eller mindre demokratiska regimer.

Forskning om sociala rörelser har generellt svårt att hantera denna typ av radikala förändringsprocesser. De sker ofta snabbt och oväntat och enskilda protester kan i vissa fall övergå till storskaliga massmobiliseringar inom loppet av några få dagar. En begränsning inom befintlig forskning är att det finns relativt få historiska fall att studera, vilket försvårar en systematisk jämförelse. En annan viktig faktor är att social rörelseteori ofta har svårt att hantera komplexitet, vilket gör att det blir såväl konceptuellt som metodologiskt svårt att studera icke-linjära dynamiker. Slutligen finns det en teoretisk lucka inom rörelseforskning när det gäller kopplingen mellan småskaliga och informella former av motstånd, och storskaliga, organiserade mobiliseringar. I litteraturen så hanteras dessa ofta som analytiskt särskiljda fenomen.

Syftet med denna artikel är föra samman teorier och koncept från *transition studies* och social rörelseforskning. Transition studies utgörs av en uppsättning teoretiska ramverk som undersöker innovationsdynamik och förändringsprocesser inom teknik. Fokus ligger på *när* och *under vilka omständigheter* nya, radikala tekniska innovationer som utvecklas inom skyddade *nischer* lyckas slå igenom och ersätta etablerade tekniker i samhället. Utgångspunkten i denna artikel är att innovationsdynamikerna när det gäller tekniska och sociala innovationer är snarlika. Detta ligger till grund för en teoretisk syntes som praktiskt illustreras genom en fallstudie av APPO-rörelsen i Mexiko, vilket utgör ett intressant fall av en gräsrotsdriven samhällsförändring.

Sammanfattningsvis så illustrerar artikeln hur denna teoretiska syntes möjliggör att studera viktiga frågor som när radikala sociala innovationer lyckas slå igenom och förändra samhället nedifrån och upp, och när de kanaliseras och berövas sin revolutionära potential och istället inkorporeras som institutionella reformer. En preliminär slutsats från artikeln är att radikala samhälleliga omvandlingar förutsätter *konstruktivt motstånd,* det vill säga att sociala rörelser proaktivt behöver bygga upp konkreta alternativ till rådande strukturer och processer samt att *fria sociala utrymmen* är centrala i dessa processer.

Artikel III

I den tredje artikeln undersöks betydelsen av *fria sociala utrymmen* eller *autonoma rum* för politisk mobilisering. Det finns en mängd historiska exempel på olika typer av skyddade, autonoma rum som varit centrala inom sociala rörelser och politisk mobilisering, såsom kyrkor för svarta under medborgarrättsrörelsens

USA, arbetarklasscaféer under 1800-talets franska revolutioner, separatistiska kvinnogrupper och studentföreningar.

Denna typ av fria utrymmen är relativt välstuderade inom rörelseforskningen och de utgör ofta ett viktigt skydd från såväl dominerande ideologier och diskurser i samhället som från politisk repression. Det är således välkänt att dessa utrymmen ofta bidrar till allt från ledarskapsträning, till utvecklingen av kollektiv identitet och oppositionella motkulturer inom rörelser. Det är dock mindre känt vilken roll de spelar när det gäller spridning av kollektiv mobilisering.

Denna artikel tar således ett nytt perspektiv på dessa frågor och undersöker vilken roll nätverksstrukturen hos fria sociala utrymmen spelar för spridningsprocesser i samhället i stort. Artikeln fokuserar på två centrala mekanismer eller funktioner hos dessa utrymmen som ofta betonas inom rörelseforskning. För det första tenderar de att vara *politiskt avvikande* i relation till omgivande samhälle, och för det andra kan de sägas utgöra ett slags *kluster* som tenderar att vara mer sammankopplade internt än i relation till omgivande nätverk.

Baserat på främst dessa två mekanismer så utvecklar artikeln en agentbaserad datorsimulation för att studera hur dessa mekanismer samspelar, och i vilken utsträckning de påverkar spridningsprocesser. På detta sätt undersöker vi relationen mellan öppenhet och slutenhet inom sociala utrymmen. Med andra ord; hur öppna respektive slutna bör dessa rum vara för att på ett så effektivt sätt som möjligt kunna sprida idéer och praktiker till omgivande samhälle, men samtidigt utgöra ett skydd mot repression och politiska fiender?

Huvudresultatet från simulationerna antyder att nätverksstrukturen hos fria sociala utrymmen kan fylla en viktig funktion för spridning av politisk mobilisering. Upp till vissa nivåer så har graden av klusterhet (proportionen av interna relationer i relation till externa) en positiv effekt på diffusionsprocesser, och likaså tycks det finnas en positiv synergistisk relation mellan politisk avvikande och existensen av ett kluster. Detta antyder att så länge de fria sociala utrymmena inte är alltför radikala eller avvikande i relation till det omgivande samhället, så har klusterhet en positiv effekt på spridningsprocesser. Dock; om dessa rum är alltför radikala så tjänar de generellt på att minska andelen interna relationer och istället satsa på att bygga externa relationer.

Resultaten från denna studie påvisar även hur datorsimulationer och formella modeller kan vara praktiskt användbara inom social rörelseteori för att på ett systematiskt sätt kunna abstrahera och studera specifika mekanismer och icke-linjära dynamiker i detalj, något som skulle vara mycket svåra med andra metoder. Det är dock viktigt att poängtera att resultaten från modellen är preliminära och kan inte användas i direkt prediktiva syften. Den sociala verkligheten myllrar och kryllar, den är nivårik, öppen och komplex, och är i sin helhet sammansatt av en mängd kausala krafter och mekanismer som på olika vis påverkar

det faktiska utfallet av en specifik mekanism. Detta innebär att specifika mekanismer ofta samverkar med en mängd andra processer och mekanismer vilket kan förstärka, försvaga och eliminera dess effekter. Precis som för de flesta typer av experiment bör man således vara försiktig med att generalisera resultaten bortom den slutna experimentsituationen.

Artikel IV

Den fjärde artikeln undersöker konstruktionen av diskurser om muslimer, islam och feminism på ett stort internetforum, och hur dessa diskurser är sammankopplade. Materialet till studien utgörs av drygt 50 miljoner inlägg som har hämtats från Flashback.org, ett av Sveriges största Internetforum.

En viktig bakgrund till artikeln är den närmast explosiva utvecklingen av social media under de senaste två årtiondena. Social media har således kommit att fylla en allt viktigare funktion som plattform för social interaktion, men också som en central källa för (re)produktion av samhälleliga diskurser. Forskning inom området har dock länge begränsats av de metodologiska problem som ofta är associerade till att hantera stora textmängder. Både traditionella kvalitativa och kvantitativa metoder för textanalys har således ofta svårt när det gäller att avgränsa och selektera material som innehåller miljontals texter, inlägg eller tweets.

För att kunna studera det empiriska materialet i denna studie så utvecklar vi en metodologisk kombination av *kritisk diskursanalys* och *topic modeling*, en typ av statistisk modell som utvecklats inom datavetenskap för att automatiskt och induktivt kategorisera stora mängder text. Topic modeling identifierar latenta, tematiska strukturer i texter och producerar utifrån detta ”topics”; kluster eller listor med ord som ofta förekommer tillsammans. Detta är således en användbar metod för att på ett induktivt sätt kategorisera och identifiera olika ämnen som återfinns inom textdokument. Denna approach kombinerar vi med *social nätverksanalys* för att kunna visualisera hur olika ämnen och diskurser är sammankopplade genom användare på forumet.

I analysen av materialet framkommer ett antal topics som tycks innehålla och koppla samman anti-feministiska och islamofobiska diskurser. Detta gäller främst diskussioner om religiösa friskolor, familjer och genusroller, samt den påstådda överrepresentationen av muslimer när det gäller sexuella övergrepp mot kvinnor. I analysen identifieras även en underliggande diskurs som tycks prägla samtliga dessa topics. Denna diskurs kretsar kring vad som beskrivs som en inneboende tendens till kvinnoförtryck inom Islam, samt vad som beskrivs som en ”självmotsägelse” bland feminister och inom den politiska vänstern som påstås både förespråka jämställdhet, men samtidigt har en positiv attityd till muslimsk invandring.

Sammanfattningsvis illustrerar denna empiriska analys hur topic modeling utgör ett värdefullt komplement till diskursanalys och andra typer av kvalitativ textanalys. Denna metodologiska syntes möjliggör således både att på ett kvantitativt vis utforska, kategorisera och ge en överblick till stora mängder text, men ger samtidigt utrymme för en mer kvalitativ analys av lingvistiska nyanser och texters mer subtila, symboliska och ofta implicita uttryck.

Slutsatser

Slutsatsen i avhandlingen är att många sociala system inte bara är komplexa, utan kan kategoriseras som *wicked systems*; de är öppna system som inte enkelt kan avgränsas och reduceras. De kännetecknas av såväl emergenta dynamiker nedifrån-och-upp, men även av kausala processer i alla riktningar då framväxande strukturer och system har nedåtverkande kausala krafter. Detta innebär att både *holistiska* och *individualistiska* approacher uppfyller viktiga funktioner för att studera dessa system, men som enskilda forskningsstrategier är de otillräckliga då de endast fokuserar på vissa typer av kausalitet. Konsekvensen av detta är att sociala fenomen generellt förutsätter en metod-pluralistisk ansats där olika perspektiv och metoder kan belysa olika aspekter av den sociala verkligheten och de fenomen som studeras.

Datorsimulationer och liknande individualistiska strategier kan således vara användbara som verktyg för att undersöka aspekter av sociala fenomen, närmare bestämt hur individers myllrande interaktioner kan ge upphov till icke-linjära dynamier och emergenta mönster på makro-nivå. Men dessa metoder behöver ofta kompletteras med teoretiska ramverk som utifrån ett mer holistiskt perspektiv även tar hänsyn till sociala strukturer och system och dess kausala krafter. Artikel 2 och 3 utgör praktiska exempel på en mer holistisk respektive individualistisk ansats, och den introducerande kappan illustrerar hur dessa kan kombineras.

Sammanfattningsvis så utvecklar avhandlingen ett perspektiv på social komplexitet som inkluderar delar av den analytiska sociologins perspektiv, men inom ramen av en kritisk realistisk position som erkänner den kausala kraft och inverkan som utövas av sociala system och strukturer. Detta perspektiv ger även ett bidrag till kritisk realism genom att påvisa hur ett komplexitetsteoretiskt perspektiv kan erbjuda både konceptuella och tekniska verktyg för att kunna studera det emergenta samspelet mellan sociala strukturer och mänsklig handling.

Attachments

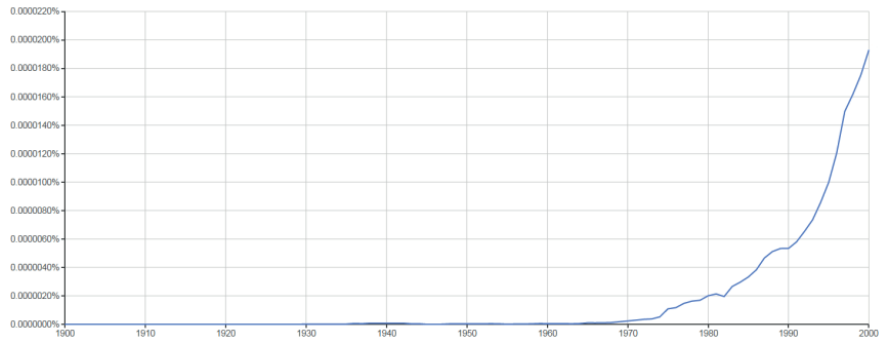

Figure 4. This graph illustrates the development over time of the terms complexity science and complexity theory. Source: Google N-gram.

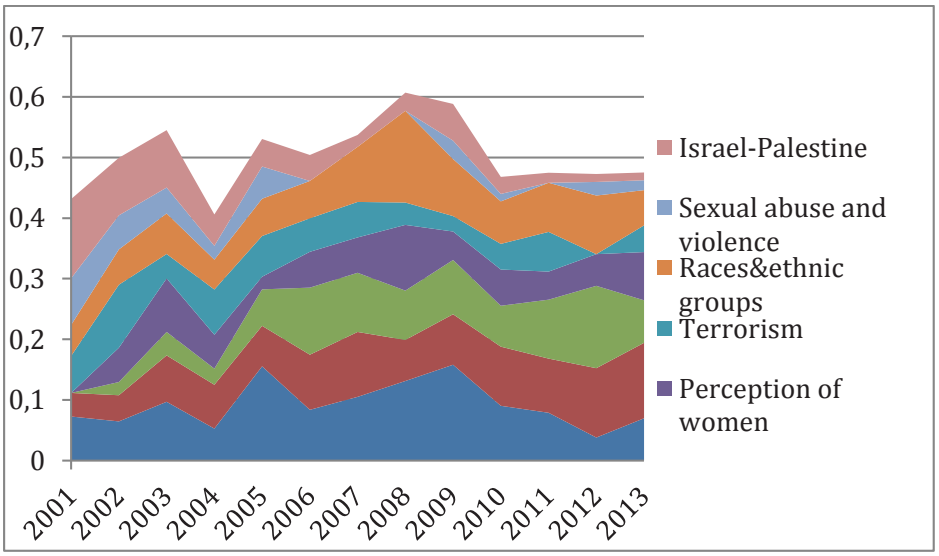

Figure 5. This area graph plots the development over time for the continuous topic categories. The graph shows the proportional size of the topic categories in relation to all other topics in the same year and is calculated by adding the strength value of all topics within each topic category/year.

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