Annual Conference of
The Netherlands Platform of Complex Systems
4 April 2019 at Utrecht University

Conference Materials

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2 Registration/Conference and Route description

Registration of the Conference starts at 9.30 am in the Hall on the first floor of the **Minnaert Building** (Leuvenlaan 4, 3584 CE Utrecht).

There will be a reception desk in the Hall for registration and enquiry.

The **Conference** takes place at **Victor J. Koningsberger Building** ,Budapestlaan 4a-b, Utrecht (which is connected to the Minnaert Building) and the Minnaert Building

The Conference kicks off at 10.00 am in Lecture Hall COSMOS (Viktor Koningsberger building).

The parallel tracks take place in:

Social Sciences, Lecture Hall COSMOS (Victor J. Koningsberger building)
Natural Sciences, Lecture Hall ATLAS (Viktor J. Koningsberger building)
Applied topics, Lecture Hall 2.02 (Minnaert building)

3 Route description

How to Reach the Venue:

1. Coming by car

If you plan to reach the venue by car, you are recommended to park at the Padualaan parking-area (capacity 419 spaces) which is located opposite to the Minnaert Building (where the registration of the Conference takes place). The parking rate is €0.50 per 33 minutes (the first half hour is free of charge, a later departure results in paying the first 30 minutes too), Monday to Friday, 07:00 - 18:00, unless indicated otherwise. The maximum daily charge is € 7.00 (also applicable if you lose your entry ticket). For information about other parking-areas on the campus, please refer to this link.

2. Coming by public transportation

Utrecht University (De Uithof) is served by a total of 21 bus lines, for details please visit the website. From Utrecht Central Station, you can take bus line 12 to reach Utrecht University (De Uithof) directly. Get off at the bus stop 'Padualaan'. It takes only a few minutes to walk to the venue of the Conference. Here is the map of Utrecht University (De Uithof).

4 Abstracts of keynote lectures

4.1 Professor Han van der Maas (University of Amsterdam / Institute for Advanced Study)

Complex systems approach to psychology

The human mind, rooted in a network of billions of neurons with thousands of connections each and embedded in multiple other complex (social) networks is the ultimate complex system. It is a big challenge to study this system. In the 25 years, we explored the use of different models and techniques originated in the natural sciences.
We developed methods and new statistical techniques to study phase transitions in psychological processes. A second line concerns network modeling as alternative for the dominant approach in psychology of latent variable modeling. Our newest work focuses on the integration of these two lines as particular types of networks models (Ising models) entail phase transitions. Applications mainly concern learning, addiction, and attitude change.

4.2 Professor Phil Hodgkin (Walter+Eliza Hall Institute of Medical Research)

How determinism and probability combine to control the complex immune response

A series of qualitative immune models developed 40-50 years ago successfully explained the broad, overarching principles of immune responses that protect us from infections. However, these approaches are proving inadequate to explain the complexity of systems level immune responses revealed with modern technology. In particular such models fail to predict the remarkable number of new cell types created following infection and how many different cell communication signals can be integrated by individual cells to change their behaviour. Recent experiments examining isolated cell responses under controlled conditions, combined with modelling methods, help place immune theory on a firm quantitative foundation to resolve these difficulties. The results of this approach suggest the immune system has evolved strategies to balance stochastic processes and deterministic causation at multiple levels of scale (molecular, cellular and whole system) to ensure successful protection against infectious diseases.

5 Abstracts of parallel sessions

5.1 Social Sciences

5.1.1 Denny Borsboom (University of Amsterdam)

The Network Theory of Psychopathology: Mental Disorders as Complex Systems

In recent years, the *network approach to psychopathology* has been advanced as an alternative way of conceptualizing mental disorders. In this approach, mental disorders arise from direct interactions between symptoms. Although the network approach has led to many novel methodologies and substantive applications over the last decade, it has only recently been fully articulated as a scientific theory of mental disorders. In the present talk, I present this theory, by postulating a limited set of theoretical principles regarding the structure and dynamics of symptom networks. These principles naturally lead to a comprehensive model of psychopathology, encompassing novel definitions of concepts such as mental health, mental disorders, resilience, vulnerability, and liability. In addition, network theory has direct implications for how to understand diagnosis and treatment, and suggests a clear agenda for future research in psychiatry and associated disciplines.

5.1.2 Charlotte Hemelrijk (University of Groningen)

Dynamics of dominance relations of female versus males in promates

In a social system of animals the inter-sexual dominance hierarchy is important. In group-living primates females are often supposed to be subordinate to males, because they are usually smaller than males. This ignores the working of the self-reinforcing effect of winning and losing fights, the winner-loser effect, implying that after losing a fight the loser is more likely to lose again and after winning, the winner is more likely to win again.

In a theoretical study of it, we show that when aggression is fierce rather than mild, some males sink low in rank due to the severity of injuries received; over these females become dominant; when the proportion of males in a group is higher, females dominate more males. We confirm the generality of this phenomenon in macaques, vervet monkeys and capuchin monkeys and in humans.

Showing the generalizability of these processes, we urge future empirical studies of inter-sexual dominance of all kinds of animals to take sex-ratio and fierceness of aggression into account.

5.1.3 Marieke Schreuder (University of Groningen)

Does psychopathology behave as a complex system? A new apporach for personalized health care

Introduction: Clinically, it is highly relevant to be able to foresee sudden rises in psychopathology. However, person-specific symptom transitions are extremely difficult to predict. Complex system theory offers a novel possibility to estimate the likelihood of such transitions and expects the presence of rising early warning signals (EWS) in anticipation of sudden symptom transitions. We aimed to replicate a first study[1] that revealed empirical support for this and, second, we translated this idea to personalized models.

Methods: Adolescent participants were recruited via the East Flanders Twin register. This novel sample consisted of 239 participants with SCL-90 baseline and follow-up measures. At baseline they underwent experience sampling (ESM). ESM is a valid method to monitor real-life momentary emotions. We examined whether higher levels of EWS in these emotion patterns were associated with larger increases in symptoms at follow-up. Second, a set of ESM case-studies were conducted in patients tapering their antidepressant medication. These were followed for > 4 months with >5 measurements per day to capture possible sudden transitions in symptoms and the precise period before those transitions. Here, we could directly test whether within-person increases in EWS closely precede sudden symptom transitions.

Results: We replicated the results of the first group-level study. The level of EWS in ESM items on depressed mood states was associated with follow-up increases in symptom severity (down: $B=0.10$, $p<0.001$; listless: $B=0.09$, $p<0.001$). Furthermore, in the individual time-series cases, rising EWS were observed in anticipation of sudden transitions.

Conclusions: The current studies supported the hypothesis that critical transitions in psychopathology can be foreseen by observing changes in EWS. This suggests that psychopathology behaves as a complex system, which may have major implications for personalized health care in the field of psychiatry.

[1] Leemput, Wichers et al. Proc Natl Acad Sci USA 111(1):87–92.

5.1.4 Paul Duijn (University of Amsterdam)

Detecting and disrupting crimnal networks: A data-driven approach

Criminal networks were often pictured by law enforcement professionals and policy makers as hierarchical organisations, such as the mafia. This image led to many exhausting criminal investigations aimed at the kingpin leaders at the presumed summit of criminal enterprises. However, the effects of such interventions on the overall organisational structures remained uncertain. In recent years more data have become available for research on the complexity behind criminal cooperation, evolving towards a data-driven approach in the study of organised crime. In this talk I will demonstrate how data-driven methods such as social network analysis, crime scripting and computational modelling helped us unravel the complex social dynamic behind these opaque networks and how we utilize computer simulations to understand the effects of different intervention strategies.

5.2 Natural Sciences

5.2.1 Wouter Peters (Wageningen University & Research)

Interactions between the carbon cycle and climate from local to global scales

The global carbon cycle encompasses the exchange of carbon dioxide (CO_2) between its major reservoirs: the ocean, the land biosphere, and the atmosphere. CO_2 exchange takes place over many different time scales, and can be forced by many different factors: variations in solar activity, internal climate variability, or human influences such as deforestation and fossil fuel burning. CO_2, as major greenhouse forcing gas, predominantly exchanges between the land-surface and atmosphere through vegetation, and plants actively regulate their energy, water, and CO_2 balance in response to environmental conditions. This can be the opening and closing of stomata (small pores in the leaf surface) to optimize photosynthesis and minimize water-loss, but it can also be increased growth of roots in the soil to tap into new ground water during prolonged droughts. Each of these responses in turn affects the environment itself, for example by reducing cloud cover when plant evaporation stops. The complexity of such interactions between vegetation and its environment gives rise to large uncertainties in weather predictions, and in climate projections, and thus form a field of very active research. In this presentation I will show examples of key research questions and the strategies employed to gather new observational and numerical insights in this field. Interestingly, these strategies are now also finding their way into the upcoming societal and scientific challenge to independently verify the reduction of fossil fuel emissions by countries, cities, and sectors of industry, which I will illustrate.

5.2.2 Guido de Kroon (Delft University of Technology)

Insect-inspired artificial intelligence: simple solutions to complex problems?

Tiny, light-weight flying robots hold a great potential for a variety of indoor applications. They are inherently safe for humans, can navigate even in narrow spaces, while still capturing the information necessary for the application such as warehouse stock tracking or search-and-rescue. For such applications, the tiny drones will have to fly completely by themselves. This is very challenging, since they are very restricted in terms of sensing, processing power, and memory. I will present the research we performed at TU Delft to achieve fully autonomous flight of tiny flying robots, and will explain how their artificial intelligence is inspired by natural organisms, finding simple solutions to complex problems.

5.2.3 Barbara Bakker (University of Groningen)

Living on the edge: complexity in metabolic disease

Patients with inherited diseases in the oxidation of fat run a high risk of a sudden decrease of blood glucose levels. Most of the time, however, their metabolism functions well. It is only partly clear how energetic challenges lead to this life-threatening condition. Moreover, patients with identical genetic defects may have very different disease outcomes. To understand how the complexity in the underlying network enhances the risk of metabolic failure, we constructed a computational model of fat oxidation in the liver and validated it experimentally. The model consists of differential equations describing how liver metabolites are interconverted by enzymes. A key property of the model is the competition between multiple metabolites for the same enzymes in the network. We found that this gives rise to a high sensitivity to small perturbations, a dramatic decrease of fat oxidation rate, and potential bistability. In the seminar I will show how genetic defects may bring the network in a dangerous state and which metabolic adaptations may protect patients.

5.2.4 Nelly Litvak (University of Twente)

Web ranking and centrality in large scale-free networks

One of Google's crucial innovations was the PageRank algorithm, designed to solve a profound problem: in which order should we arrange web search results for the user? The idea behind PageRank is that a page is important when many important pages link to it. PageRank has been used in many applications beyond web search, from combatting web spam to finding the most endangered biological species. This is because PageRank in fact solves the broader problem of network centrality. For example, in social networks, centrality defines most central and influential people. In real-world networks, such as social networks and the World Wide Web, centrality is greatly affected by the so-called `scale-free property'. The scale-free property means that there is a notable fraction of hubs, which have a huge number of connections. We will discuss the mathematical relations between scale-free property and network centrality, including the state-of-the-art, as well as open problems.

5.3 Applied topics on the added value of complexity in governance, energy, logistics and health

5.3.1 Sacha Epskamp (University of Amsterdam/Institute for Advanced Study)

Complexity in clinical practice: how can network models be used to aid therapists?

A surge of recent research has conceptualized human behavior as a complex system of interacting psychological, biological, and sociological components. This complex systems approach has grown especially prominent in the study of mental health, in which mental illnesses are seen as emergent behavior in a complex interplay of symptoms and external forces. For example, concentration problems may lead to stress at work, leading in turn to more concentration problems. Smartphone applications now make possible the gathering of intensive repeated measures (time-series data) of individual people's moods and attitudes, and recent technical advances allow for the estimation of probabilistic graphical models (networks) on such rich datasets. This presentation will discuss the potency of time-series data in psychological complexity research. I will discuss how network models may be estimated from time-series data of individual clinical patients, and how these may further be used to form personalized treatment plans.

5.3.2 Jacco Spek (TNO)

A methodological approach for development and deplayment of data sharing in complex organizational supply and logistics networks

Each manufacturer, supplier, and retailer has its own chain of collaborating stakeholders to meet their customer demands. Many perspectives can be taken like food safety, security, and sustainability, which may each lead to separate solutions that are not necessarily interoperable with each other. Data can only be shared within the context of those solutions and only with extra effort, and thus costs, across these solutions. To address this solution, this paper proposes a methodological approach for specification of data that can be shared with rapid deployment by for instance a blockchain based - or a peer-to-peer infrastructure. The methodological approach is based on basic informatics principles like the Turing machine and ontologies.

5.3.3 Koen Kok (Eindhoven University of technology, and ECN part of TNO)

Complexity in Electrical Power Systems Control and Coordination

The Western-world electricity systems are among the most complex systems engineered by man and consist of multiple layered networks: physical electricity network (cables, wires, transformers, etc.), business network (consumers, energy suppliers, traders, etc.) and the data networks interconnecting these layers. This complexity is further increasing due to the transition to sustainability, which comes with a strong decentralization of electricity generation (e.g. roof-top solar panels) and a strong increase of generation uncertainty due to weather dependencies (wind, solar). This presentation will address research results regarding the use of distributed software technology (multi-agent systems, market-based control) to trigger desired emergent behavior in large groups of electricity producing and consuming devices and installations. Key results of this work have been field-deployed, made open-source and commercialized.
The current research challenge in this area is to realize self-managing characteristics of the future intelligent electricity network, and the stakeholder ecosystem around it, adapting to unpredictable changes and events while hiding intrinsic complexity to operators and users will be addressed.

5.3.4 Roland Kupers (Institute for Advanced Study/Roland Kupers Consult)

Complexity and Climate Policy

Many solutions to the climate crisis assume that there is a governance agent independent of the system who can implement the recommended policy measures. One of the reasons climate policy has been largely ineffective is that the governance agents should be seen as part of the system, and co-dependent on its actors and interests. An alternative perspective is to view climate actions as emergent processes from inside the system, and not as top-down actions from outside the system. In an upcoming book from Harvard University Press, the author describes how climate policy might be conducted from a complex systems perspective.

6 Poster abstracts

6.1 Applied topics on the added value of complexity in governance, energy, logistics and health

Poster number: 1

Pitch: yes

Presenter: Mark Dekker (Utrecht University)

Title: Predicting transitions across macroscopic states for railway systems

Abstract:

Railways are classic instances of complex socio-technical systems, whose defining characteristic is that they exist and function by integrating (continuous-time) interactions among technical components and human elements. Typically, unlike physical systems, there are no governing laws for describing their dynamics. Based purely on micro-unit data, here we present a data-driven framework to analyze macro-dynamics in such systems, leading us to the identification of specific states and prediction of transitions across them. It consists of three steps, which we elucidate using data from the Dutch railways. First, we form a dimensionally reduced phase-space by extracting a few relevant components, wherein relevance is proxied by dominance in terms of explained variance, as well as by persistence in time. Secondly, we apply a clustering algorithm to the reduced phase-space, resulting in the revelation of states of the system. Specifically, we identify "rest" and "disrupted" states, for which the system operations deviates respectively little and strongly from the planned timetable. Third, we define an early-warning metric based on the probability of transitions across states, predict whether the system is likely to transit from one state to another within a given time-frame and evaluate the performance of this metric using the Peirce skill score. Interestingly, using case studies, we demonstrate that the framework is able to predict large-scale disruptions up to 90 minutes beforehand with significant skill, demonstrating, for the railway companies, its potential to better track the evolution of large-scale disruptions in their networks. We discuss that the applicability of the three-step framework stretches to other systems as well (i.e., not only socio-technical ones) wherein real-time monitoring can help to prevent macro-scale state transitions, albeit the methods chosen to execute each step may depend on specific system-details."

Poster number: 2

Pitch: yes

Presenter: Rico Mockel (Maastricht University)

Title: Self-organization among autonomous agents in complex seaports (SWARMPORT)

Abstract:

Modern seaports are complex systems formed by a range of service provides (e.g. for positioning, piloting, mooring, bunkering, and fuelling) who collaborate and partially compete to support the turnaround process of ships. Being embedded in the world economy and under competition with other ports, transport by land and air, a well-organized chain of nautical services within the seaport is essential to remain successful in the national and international competition. The performance of this service chain depends on the dynamic nature of the demand for services (volume and size of ships), on external circumstances (e.g. weather), the capabilities of individual agents within the chain as well as on the collaboration between them. Performance within the complex system can be enhanced in different ways, including through process agreements, information exchange, and regulation. The development of strategies to increase performance can benefit from quantitative models that support the evaluation of possible strategies. Due to the complexity of the system of services and their interactions, it is not a trivial task to create such models. In a consortium of TU Delft, Maastricht University, TNO, the harbour of Rotterdam and its port authority and its service providers, we mobilize knowledge from complexity science, multi-agent systems, machine learning, economics, and logistics to develop such models as well as tools for modelling, analysing, and synthesizing complex self-organizing systems.

The aim of our collaboration is threefold:

1. To improve our understanding of the self-organizational properties of the chain of nautical handling processes.

2. To develop valid and practicable methods for modelling and analysing port operational processes, implementing agent-based modelling from a self-organizational, complex system perspective.

3. To design strategies based on self-organizational properties of port processes to increase the resilience, reliability and flexibility of services of individual actors and of the aggregate service chain.

Poster number: 3

Pitch: yes

Presenter: Sharon Ong (Tilburg University)

Title: Spatiotemporal Analysis of Collective Bacteria Forming Biofilms

Abstract:

Bacteria are predominately found in biofilms, communities of microorganisms bound to a surface. Biofilms can form on many surfaces such as plastic, metal, glass, soil particles, wood, tissue and food products. They can cause corrosion on certain materials, harbor pathogens and contaminate water and food. A crucial property of biofilms is the existence of an extracellular protective matrix, which provides a certain degree of protection and homeostasis to the bacteria within (Stoodley, 1999). It is difficult to eradicate biofilms due to this protective layer.

The first step of biofilm formation; how individual bacteria organize themselves to form biofilms is not well understood. To study early biofilm formation, time-lapse microscopy images of biofilm-forming bacteria are acquired. We are developing high-throughput tools to automatically track individual bacteria and detect unique bacteria behaviors.

Poster number: 4

Pitch: yes

Presenter: Martin Atzmueller and Cicek Guven (Tilburg University)

Title: A Multi-Perspective View on Model-Based Exceptional Link Analysis on Complex Interaction Networks

Abstract:

The detection of anomalies and exceptional patterns in the context of link analysis on complex interaction networks is a prominent research direction in complexity and network science. Applications include, e.g., fraud detection in online social networks, discovering events or unusual topics in heterogeneous network data, or identifying specific interesting or outstanding behavior, for example, considering influential or "central" actors. Taking an abstract view, an anomaly can be considered as a pattern that does not conform to some notion of the expected, normal behavior.

A straightforward general anomaly detection approach first defines a range covering the expected behavior, and then identifies any observation in the data that does not belong to this range as an anomaly. However, there is usually no clear formalization of the "normal behavior". In addition, the notion of an anomaly includes other factors compared to a mere outlier which is typically defined by statistical criteria. The concept of an anomaly typically captures more complex criteria, including semantics, (user) expectations and complex data-driven structures. Thus, it is difficult to formalize anomalies with a complex structure, e.g., relating to a group structure instead of considering isolated points. Therefore, such complex (collective) anomaly patterns are often not detected if the individual contained points seem normal and only their interaction causes an anomaly. In addition, the complexity of anomaly detection is further enhanced by multi-relational and multi-dimensional data.

This poster presents model-based approaches and methods for addressing and formalizing these issues in the context of complex interaction networks, and exemplifies promising directions for its implementation.

We basically distinguish between approaches that require an explicit formalization, i. e., theory-based, knowledge-based and preference-based modeling, and those that rely on data-driven and structure-driven criteria, i. e., behavior-based and structure-based modeling. Then, we specifically consider exceptional pattern mining and link prediction. Exceptional pattern mining can be applied, e.g., for subgroup discovery and community detection. The typical focus of link prediction targets the dynamics and mechanisms in the creation of links between nodes in complex networks. Then, the goal is to learn a model for predicting the links accurately. However, such a model can also be applied for identifying anomalous links. For the sketched model-based approaches, we exemplify theory-based models (e.g., exploiting homophily), knowledge-based models (e.g., utilizing logical formalisms such as answer set programming), preference-based models (using user preferences/expectations), as well as behavior-based and structure-based models (utilizing data-driven interestingness functions and structural/topological network criteria).

Poster number: 5

Pitch: yes

Presenter: Matt Vert (TU Delft)

Title: Complex sociotechnical systems resilience

Abstract:

Complex sociotechnical systems (CSTS) resilience is an emergent phenomenon. It is produced by a set of dynamical mechanisms such situation awarness, sensemaking, decision-making, monitoring, coordination, learning, and by means of adaptations, in order to handle unplanned and unexpected adverse events that may disturb the system. The poster shows a framework to explain CSTS resilience that is possible to formalize as a future work in order to quantify the relationships between system's adaptation and its level of performance. The core of the framework is the articulation adaptation/adaptive capacity, and the presence of humans as intelligent entities able to understand their environment and to make decision to handle efficiently adversity.

Poster number: 6

Pitch: yes

Presenter: Jan van derKamp (Health Systems Innovations)

Title: The Health System Quartet

Abstract:

In society, the question arises how a transition can be reached towards sustainability, with resources that can be made use of, without using them up. This question is also relevant for healthcare. At present, healthcare systems mainly deliver cure and care services that are used up. The question is: how intrinsic health building and healing capacities can counterbalance the overuse of the healthcare system.

The natural healing ability of human beings is underexposed. It is of a different order than modern medical interventions. It builds on implicit learning capacity and affects the agility of resilience, defensibility and healing.

In the intervention tradition, one wants to know what is wrong and how to fix it. This approach has been very successful. While this may be true, in itself it hardly provides the necessary means for health behavior improvement. Behavior change develops on emo-tional rewarding and a friendly lure forward or nudging (Kahneman, Thaler).

A positive appreciation of human behavior deserves more attention. Basically, humans are competent to rule their lives, including their health. Through their essential involvement, they are natural partners in health. In this view, people are no longer consumers of health care ser-vices but are seen as co-producers of their own health. This development thrives on the in-formation and social media revolution. Empowering competence is a positive goal for better health.

The health care system's Cure and Care focus can cooperate with people's agency to Deal with their biological and mental dynamics to Heal. The interactions of Cure, Care, Deal and Heal are at the heart of the Health Systems Quartet, a framework to form a simple basis for the complex transdisciplinary approaches to achieve "health". It opens a new perspectives for sustainable health policy, health system organization and health practices.

6.2 Natural Sciences

Poster number: 7

Pitch: no

Presenter: Mehdi Habibi (Wageningen University)

Title: Complex relaxation dynamics and mechanical memory of crumpled sheets

Abstract:

Crumpled sheets show slow mechanical relaxation and long lasting memory of previous mechanical states. By using uniaxial, compression tests, the role of friction and ductility on the stress relaxation dynamics of crumpled systems is investigated. We find a material dependent relaxation constant that can be tuned by changing ductility and adhesive properties of the sheet. After a two-step **compression protocol, nonmonotonic aging is reported for polymeric,** elastomeric and metal sheets, with relaxation dynamics that are dependent on the material's properties. These findings can contribute to tailoring and programming of crumpled metamaterials to get desirable mechanical properties.

Poster number: 8

Pitch: yes

Presenter: Arpit Swain (Utrecht University)

Title: Homeostatic regulation of memory T cells

Abstract:

The consensus among Immunologists is that homeostatic proliferation is responsible for the long-term maintenance of memory T cells. The levels of Interleukins IL-7 and 15 have been convincingly shown to keep the memory T cell population regulated through homeostatic proliferation. However, the inability of the very first immunological memory to fill the entire memory pool despite high levels of homeostatic cytokines in several clean mice studies offers puzzling questions into the working of homeostatic proliferation. In this study, we investigate the changes in the memory T cell pool, due to homeostatic proliferation, with additions of subsequent memory populations.

Poster number: 9

Pitch: yes

Presenter: Loes Crielaard (Amsterdam UMC, Location AMC)

Title: Systems thinking and body weight perception: Modelling interactions between the individual and the collective

Abstract:

Aim: Shifts in obesity prevalence cause individuals to re-evaluate their weight with reference to the average weight in their socio-cultural group as opposed to a fixed standard. We therefore hypothesise that diversity regarding the social norms of obesity exists among different socio-cultural groups, reflecting their variation in obesity prevalence. This stems from an intricate web of interactions between different elements â€“ individual- and group-level body weight, individual and collective body weight perception, ethnicity and sex â€“, which can be perceived as a complex system. We analyse this system using system dynamics (SD) modelling in order to identify the relative impact of individual- versus group-level interventions.

Methods: Individual and collective ideal body image variables are embedded in a conceptual causal loop diagram (CLD) and subsequently in functioning SD models (SDMs). These SDMs simulate the dynamics of weight for six socio-cultural groups (Dutch, Moroccan and South-Asian Surinamese men and women) in Amsterdam, where we focus on the feedback loops that drive the re-evaluation of individual perceptions regarding body weight based on obesity prevalence.

The SDMs are created using a structured methodology to construct operational SDMs from cross-sectional data, building upon the exploitation of qualitative expert knowledge as outlined in a CLD. Our work therefore highlights the value of integrating qualitative knowledge into quantitative SD modelling and clarifies which assumptions are necessary. Developing methodologies like this to generate pseudo time-series data from cross-sectional data â€“ which are often available but fail to provide us with dynamic insights â€“ may also be imperative in fields beyond public health.

Results: We aim to present our results in April.

Outlook: SD modelling enables simulation of the system's behaviour in different scenarios, such as individual- versus group-level interventions, and may clarify why concentrating on the individual often does not achieve its anticipated impact. Hereby, it can support evidence-informed policy making.

Poster number: 10

Pitch: yes

Presenter: Elodie Blouzard (Utrecht University)

Title: Modellisation of Trypasonoma Cruzi spread, the parasite responsible for chagas disease, in different environments

Abstract:

With 10,000 attributable deaths each year, chagas disease is a widespread but neglected disease. In the last decades, it expanded outside its natural area of occurrence, Latin America, to the 5 continents due to tourism and migration. However, Latin America is the only place where the disease is endemic so far. Its transmission is very complex due to its multiple hosts and reservoirs and the way they change depending on space and time. That is why finding a way to model the spread is a challenge. The main aim is to uncover the mechanisms and the parameters behind it. Indeed, the complex dynamic between chagas disease, its vector Triatominae spp. And its hosts, T.cruzi the parasite and its reservoirs needs to be better understand to hamper the spread in endemic areas. To do so, a novel method is used, ecomultiplex networks. They consist of multi-layered networks, each layer describing one means of transmission here. In chagas disease's case, there are two layers, trophic and vectorial, that correspond to oral and vectorial transmission, the two main ways of getting infected. Although, there are no result, yet. This new model includes humans in the transmission process and uses a One Health approach to better understand the interdependent relationship between humans, animals (wild and domestic) and the environment. The results should help understanding how human's settings (villages or larger cities) influence the spread and its speed. The ultimate goal of the model will be to foresee how changes in the environment such as a fluctuation in species' composition affect the spread in animals and humans.

Poster number: 11

Pitch: no

Presenter: Erik van Haeringen (University of Groningen)

Title: Mechanisms Underlying the Formation of Dominance Hierarchies: A Comparison

Abstract:

What mechanisms underlie the linearity of dominance hierarchies is still debated. Linearity is often attributed to cognitively sophisticated processes, such as transitive inference, individual recognition and eavesdropping. A cognitively more simple alternative explanation, shown by a computational model, DomWorld, is the winner-loser effect. It implies that after winning the winner is more likely to win again, and the loser more likely to lose again. In the complete model, DomWorld, individuals are grouping in space, they are more likely to attack when they think they will win and outcomes of fights are self-reinforcing.

Recently, however, an article doubted this conclusion based on observations in groups of hens, but it left out both the spatial component of interactions and risk-sensitivity of attacks in the model. The authors concluded that hens are aware of the group hierarchy and strive towards a hierarchy being linear.

The present study tests whether all hierarchical patterns described for hens can be found in DomWorld after all, when at least the complete model is examined. For this the hierarchical development is tracked and a network analysis of triad motifs is performed in DomWorld and compared to the published results on groups of hens.

We show that when one model parameter, representing the intensity of aggression, was set to match the high linearity typical of groups of hens, many patterns of hierarchy development emerged in DomWorld that were similar to those reported in hens.

Thus, this study demonstrates that strongly linear hierarchies can emerge as a consequence of the socio-spatial structure that arises from risk-sensitive dominance interactions reinforced by winner-loser effects. Winner-loser effects thus offer a cognitively parsimonious explanation underlying hierarchy formation that is linear.

Poster number: 12

Pitch: yes

Presenter: Lauren Seex (University of Groningen)

Title: Undecided fights and social systems of lemurs

Abstract:

In primates two types of dominance hierarchies are distinguished, a despotic dominance style (which is strongly differentiated) and an egalitarian dominance style (which is weakly differentiated). A computational model, DomWorld, in which animals merely group and compete, has shown that differences between despotic and egalitarian species of macaques can be reproduced by changing merely intensity of aggression. Only when aggression is intense, as in despotic societies of macaque, are some females able to dominate some males that have been wounded by other males. However, in lemurs, a radiation of primates from Madagascar where females are dominant over males, intensity of aggression is similar across species even though both types of society are present. Instead, they differ in the proportion of "undecided fights". These are agonistic interactions for which there is no clear winner. It is unknown, however, how undecided fights affect the dominance hierarchy. Here we examine in three species of lemur whether undecided fights may influence the dominance style. Data were collected by focal observation in Madagascar of Eulemur rufifrons (6 groups, 468 hrs), Propithecus verreauxi (10 groups, 1,395 hrs) and Lemur catta (5 groups, 754.5 hrs). Our results show that fights were undecided when opponents had similar dominance rank. They were most common in Eulemur rufifrons (40%), an egalitarian species with weak female dominance over males, occurred at intermediate frequency in Propithecus verreauxi (20%) with moderate female dominance and were least common in Lemur catta (5%), a despotic species with strong female dominance. This shows that a high number of undecided fights may prevent the dominance hierarchy from differentiating, leading to unclear dominance relations which may prevent females from consistently dominating males. Our research highlights the need of involving both decided and undecided conflicts when investigating dominance relations and social styles in primates.

Poster number: 13

Pitch: no

Presenter: Jian Gao (University of Groningen)

Title: Synchronization and oscillatory states in second-order oscillator networks

Abstract:

Synchronization of coupled dynamical units has been recognized in the past 50 years as one of the most important phenomena in nature. Several mathematical models are used to understand this fascinating phenomenon. Among them, coupled oscillators are one of the most popular models, such as the Kuramoto oscillator, and the second-order oscillator. While the dynamics of each oscillator is simple, the collective synchronization phenomena of coupled oscillators are quite rich. In this poster, we propose a new theoretical framework to explore the synchronization process of second-order oscillators and compare it with Kuramoto oscillators. We show that compared with a single Kuramoto oscillator which has only one stable fixed point, the second-order oscillator has a stable fixed point and a stable limit cycle. The difference in the dynamics of each unit changes the collective synchronization processes of the system of coupled units. The effective phase shift from the stable limit cycle changes the continuous synchronization processes to abrupt ones. The bi-stability of second-order oscillators contributes the hysteresis of synchronization processes, and the nonlinear boundary of bi-stable regions weakens the effect of synchronized clusters on the others, introducing the secondary synchronized clusters. Our method gives both the intuitive understandings and precise estimations of the synchronization processes, such as the number of synchronized oscillators, and the smallest coupling strength for the appearance of synchronized clusters.

6.3 Social Sciences

Poster number: 14

Pitch: yes

Presenter: Koen van der Zwet (University of Amsterdam/IAS)

Title: An Agent-Based Model for Emergent Opponent Behavior

Abstract:

Organized crime, insurgency and terrorist organizations have a large and undermining impact on societies. This highlights the urgency to better understand the complex dynamics of these individuals and organizations in order to timely detect critical social phase transitions that form a risk for society. In this paper we introduce a new multi-level modelling approach that integrates insights from complex systems, criminology, psychology, and organizational studies with agent-based modelling. We use a bottom-up approach to model the active and adaptive reactions by individuals to the society, the economic situation and law enforcement activity. This approach enables analyzing the behavioral transitions of individuals and associated micro processes, and the emergent networks and organizations influenced by events at meso- and macro-level. At a meso-level it provides an experimentation analysis modelling platform of the development of opponent organization subject to the competitive characteristics of the environment and possible interventions by law enforcement. While our model is theoretically founded on findings in literature and empirical validation is still work in progress, our current model already enables a better understanding of the mechanism leading to social transitions at the macro-level. The potential of this approach is illustrated with computational results.

Poster number: 15

Pitch: yes

Presenter: Dirk Bruin (VUB/ECCO)

Title: A Memetic View on the Firm

Abstract:

I am a PhD candidate at the Vrije Universiteit Brussels, more specifically he Evolution, Cognition and Complexity group ECCO, see ecco.vub.ac.be. My research is supervised by Dr Heylighen and Dr Lenartowicz. You will also find more about me via LinkedIn, dirkpbruin, and on my website magrathea-tlc.nl. The research concerns the development of a theory to explain what a firm (a company) is by answering these questions: how is it conceived, how does it cease to exist, and what are the firm's "substance" and behavior? Its final objective is to provide instruments to better explain their behavior.

The theorizing is based on a process ontology: processes not objects are at its core. Major elements of the theory are memetics, micro-sociology and enactment, social systems, theoretical ecology (autopoiesis), and chemical organization theory. A body of widespread ideas (memes) originating from Western culture, namely the market system and belief in progress are conjugated with this theory. The firm is inn this way modeled as a complex of coherent memes co-evolving with other bodies of culture in society.

Some of the insights are that firms as autopoietic systems are autonomous, instead of instruments of people. This outcome bears consequences for the relation between the different roles of persons vis-a-vis firms, and those firms. Its operational requirement to perpetuate its existence drives a firmâ€™s actions, and not so much the actions of the people associated with them. This is consequential for the effects that can be expected of (human) interventions into the operations of a firm.

These outcomes are relevant for a range of scientific disciplines such as the life sciences, political and business sciences. But perhaps more importantly they are relevant for people associated with firms, virtually everyone on Earth. Access to these ideas enables them to re-establish their relations to the firms they deal with. And just because the beliefs of people in a wider sphere are at the basis of the kind of firms that we have at this time, a contribution can be made to a more sustainable future.

Poster number: 16

Pitch: yes

Presenter: Anna Kuranova (University of Groningen)

Title: A dynamic systems perspective on mental health: the speed of affect recovery from daily unpleasant events as an indicator of psychological resilience

Abstract:

Introduction: Complex dynamic systems theory states that a slower recovery from small perturbations indicates the loss of resilience of the system. There is growing evidence that psychiatric disorders behave like complex dynamic systems, and the increase in the number of symptoms represents the loss of resilience. This study is the first to test whether the speed of recovery of affect states from small daily life perturbations predicts changes in psychopathological symptoms over one year in a group of adolescents at increased risk.

Methods: We used data from 157 adolescents from the TWINSSCAN study. The course of psychopathology was operationalized as the yearly change in the Symptom Checklist-90 sumscore. Two groups were defined: one with stable and one with increasing symptom levels. Time-series data on their daily affect and daily stressors were collected at baseline.

We modeled the effect of daily unpleasant events on negative and positive affect for six consecutive hours (at four time points each 90 minutes starting from contemporaneous associations) to examine at which time point the impact of the events is no longer detectable.

Results: At 90 minutes there was a marginally significant (p=0.52) difference between groups in the effect of unpleasant events on negative affect. Stratified by group, in the Increase group the effect of unpleasant events on both negative and positive affect was still detectable 90 minutes after the events, whereas in the Stable group it was not the case.

Conclusion: Adolescents with future increase in psychopathology recovered slower from daily perturbations than their peers who remained stable. These findings suggest that mental health may behave according to the laws of a complex dynamic system. Future research needs to examine whether these dynamic indicators of systems resilience may prove valuable for personalized risk assessment in this field.

Poster number: 17

Pitch: yes

Presenter: Travis Wiltshire (Tilburg University)

Title: Phase Transition Identification Methods in Nominal and Continuous Time Series

Abstract:

Psychology has a long history of theorized phases and stages characterizing psychological phenomena including, for example, distinct periods of cognitive development, skill acquisition, problem solving, emotions following certain life events, and how relationships form and develop. Fields such as physics and ecology have increasingly focused on how certain systems transition from one phase to another including developing methods for detecting such transitions. Generally, dynamical systems theory predicts that as a system moves toward a transition it exhibits increased complexity up to a peak point, following which, it will become less complex. With the increasing incorporation of dynamical systems theory and methods into psychological investigations, we capitalize on these advances to present an accessible introduction for psychologists to evaluate both if, and when, psychological phenomena exhibit phase transitions. Toward this end, we present a detailed discussion of the issues involved in applying and evaluating a variety of methods for detecting phase transitions in nominal and continuous time series. Specifically, this includes determining an appropriate rolling window size, selecting an appropriate complexity measure for certain data types, and selecting an appropriate method for peak detection. We provide examples using simulated data from a well-known system exhibiting a phase transition, categorical communication sequences, daily ratings of affect, and heart rate data. Given the pervasiveness of phase transitions in living and nonliving systems, we expect the study of phase transitions will have broad appeal to many psychological scientists.

Poster number: 18

Pitch: yes

Presenter: Fred Hasselman (School of Pedagogical and Educational Sciences, Radboud University Nijmegen)

Title: A Characteristic Destabilization Profile In Parent-Child Interactions Associated With Treatment Efficacy For Aggressive Children

Abstract:

This study examined profiles of change in repeated parent-child interactions (60 dyads) over the course of a 12-week treatment period for childhood aggression. The aim was to detect "flags" or "fingerprints" associated with non-equilibrium phase transitions of complex dynamical systems in the second-to-second behavioural interactions of child and caregiver during treatment. In particular, we asked whether the occurrence of a period of destabilization marked by an increase in entropy (disorder) of the observed temporal evolution of dyadic states was associated with positive treatment outcomes. Estimates of the entropy in 6 therapy sessions were obtained for each dyad by conducting categorical Recurrence Quantification Analysis (RQA) on the time series of observed child-caregiver interactions. A Latent Class Growth Analysis (LCGA), with no restrictions on the pattern of change was used to evaluate whether the 60 dyads could be grouped into distinct clusters based on the patterns of change in the entropy values across therapy sessions. The analysis revealed 2 latent classes of growth curves should be distinguished: One with a peak in entropy around session 2, the other in which entropy remained relatively constant across sessions. The predicted LCGA class was cross-tabulated with the outcome of an improver / non-improver judgement for each dyad, based on a post treatment assessment by a clinician (using the Child and Adolescent Functional Assessment Scale). We conclude that the presence (or absence) of a period of destabilization is essential for predicting treatment efficacy.

Poster number: 19

Pitch: yes

Presenter: Adriana Correia (Utrecht University)

Title: Nash Equilibria in the Response Strategy of Correlated Games

Abstract:

In nature and society, problems that arise when different interests are difficult to reconcile are modeled in game theory. While most applications assume that the players make decisions based only on the payoff matrix, a more detailed modeling is necessary if we also want to consider the influence of correlations on the decisions of the players. We therefore extend here the existing framework of correlated strategies by giving the players the freedom to respond to the instructions of the correlation device by probabilistically following or not following its suggestions. This creates a new type of games that we call "correlated games". The associated response strategies that can solve these games turn out to have a rich structure of Nash equilibria that goes beyond the correlated equilibrium and pure or mixed-strategy solutions and also gives better payoffs in certain cases. We here determine these Nash equilibria for all possible correlated Snowdrift games and we find these solutions to be describable by Ising models in thermal equilibrium. We believe that our approach paves the way to a study of correlations in games that uncovers the existence of interesting underlying interaction mechanisms, without compromising the independence of the players.

Poster number: 20

Pitch: yes

Presenter: Merlijn Olthof (Behavioural Science Institute, Radboud Universiteit Nijmegen)

Title: Critical Fluctuations as an Early-Warning Signal for Sudden Gains and Losses in Patients receiving Psychotherapy for Mood Disorders

Abstract:

While sudden gains and losses (large shifts in symptom severity) in patients receiving psychotherapy appear abrupt and hence may seem unexpected, hypotheses from complex systems theories suggest that sudden gains and losses reflect order transitions that are actually preceded by certain early-warning signals. We tested whether increased levels of complexity in daily self-ratings of the therapeutic process (indicative for critical fluctuations) could serve as a predictive early-warning signal for sudden gains and losses. Data was collected from 328 patients receiving psychotherapy for mood disorders who completed daily self-ratings about their therapeutic process using the therapy process questionnaire (TPQ). Sudden gains and losses were classified from the "problem intensity" scale of the TPQ. The other items of the TPQ were used to compute the evolution of complexity over time for each patient, using a moving window analysis. Increased levels of complexity predicted an increased probability for sudden gains and losses in a 4-day predictive window. These results show that critical fluctuations in daily self-ratings can be used as early-warning signals for real-time prediction of sudden gains and losses in clinical practice. Detecting critical fluctuations in psychotherapy is relevant because these fluctuations signify sensitive periods in which patients may be more susceptible to the effects of psychological intervention.

Authors: Merlijn Olthof, Fred Hasselman, Guido Strunk, Marieke van Rooij, Benjamin Aas, Marieke Helmich, Gunter Schiepek & Anna Lichtwarck-Aschoff

Poster number: 21

Pitch: no

Presenter: Justin Timmer (Hanze University)

Title: Viewing myself as a complex dynamic system using 4 years of self-tracking data

Abstract:

The past four years I was part of a movement called "The Quantified Self" and have tracked my life using data for diverse purposes. Each day I measure about 40 variables in a holistic manner using a morning-, work, and evening quantitative diary, which contains variables like happiness, stress, work hours, context, and social interaction. Furthermore, through apps and wearables I measure my body and behaviour passively through variables like heart rate, steps, sleep duration, and phone use. I performed several experiments, performed several analyses, and wrote multiple blog articles. Over time, I started to notice the evolution and entropy of my system, the importance of stable patterns, questioned causality, and discovered fractals, without being aware of complexity science. When I learned about this area of science, I could consolidate my view with according analyses, visualizations and graphs of my personal database. While viewing myself as a complex dynamic system, I have developed a personal model with key concepts that guide me through my daily life.