Social Simulation Conference 2021

Book of Abstracts

The numbering of the abstracts corresponds to the numbering in the conference program

Partners:

Key-note presentation: Modelling for Sustainability

Alexis Drogoul

The increasing risks posed by climate change, natural disasters or pandemics require better advance planning of how human communities can adapt to their impacts in a sustainable way. This requires tools capable of taking into account, representing, exploring, but also anticipating the complex interactions that exist between socio-economic and environmental dynamics in multiple scenarios. These tools belong to the world of large-scale computational models of socio-ecosystems, the design of which raises crucial challenges in computer science, AI and software engineering :

- the necessity to support the coupling of knowledge and data coming from different horizons and scientific disciplines;

- the necessity to offer ways to describe (and simulate) the complexity of socio-ecological processes;

- the need to help stakeholders (citizens, businesses, associations, authorities) to participate in the design and evaluation of different adaptation strategies.

It is argued in this speech that agent-based modelling (ABM) provides a capable framework for addressing these challenges. Current research perspectives, illustrated by examples taken from concrete projects in a developing country (Vietnam), will be presented, with the main aim of opening a fruitful discussion about the role of models, and especially agent-based models, in the new, emerging discipline known as Sustainability Science.

Key-note presentation: Dynamics of dominance between the sexes

C. K. Hemelrijk

In social systems of animals their dominance relative to males matter to females for instance when defending themselves against sexual harassment and when competing for food. Females in group-living primates are more easily acknowledged to dominate males in species when both sexes have the same body size (such as in lemurs) than when females are smaller than males. Yet despite their smaller body size, females are often seen to dominate a few males. In the present study, we show that female dominance over males increases due to the self-reinforcing effects of winning and losing fights under certain conditions. First, in computational models, this happens when the aggression of both sexes is fiercer, the fraction of males in the group is higher, males direct to other males aggression that is more intense, males are attracted to females and females are hungrier than males. Second, we confirm these model-based hypotheses in empirical data of macaques, vervet monkeys, capuchin monkeys, lemurs and humans.

Key-note presentation: Agent-Based Modeling: The Right Mathematics for Social Science?

Leigh Tesfatsion

This presentation provides a basic introduction to agent-based modeling in complete agent-based form, characterized by seven specific modeling principles. These principles embody the idea that complete agent-based models are computational laboratories permitting users to explore, in an open-ended manner, how changes in initial conditions for a virtual world affect resulting world outcomes over time. Complete agent-based modeling is thus analogous to biological experimentation with cultures in petri dishes. As computational capabilities continue to develop, this constructive mathematical approach will permit real-world social systems to be modeled with increasing fidelity, with careful co-evolutionary consideration of social interactions, institutional arrangements, and physical constraints. However, it will also require elimination of artificial disciplinary boundaries. Two illustrative examples will be given to illustrate this important point: flood management policy within a watershed populated by farmers; and alignment of customer goals and constraints with grid reliability constraints for an electric power system in a manner that respects customer privacy.

Key-note presentation: Advancing agent-based complex systems science with data science and artificial intelligence

Li An

Nearly all grand challenges besetting humanity can be traced to the actions and interactions of multiple autonomous agents in the corresponding complex systems. To address these challenges, we need to understand decisions and actions of agents, the emerging outcomes, and how such outcomes may feedback and affect the corresponding complex systems. This calls for a new science of Agent-based Complex Systems (ACS) that can handle ACS challenges: ACS science. This talk presents generic features of ACS, summarizes key advances and challenges in agent-based modeling (the primary modeling approach within ACS science), and shows that in addition to domain knowledge, machine learning and data science are contributing greatly to our understanding agents' behavior. To demonstrate the unmatched potential of ACS science, this talk will show two exemplar ABMs that simulate the COVID-19 pandemic and the dynamics of U.S. firms. This talk concludes by a call for further developments of ACS science in the light of data science and artificial intelligence.

Key-note presentation: Towards understanding of the social hysteresis: an agent-based approach

Katarzyna Sznajd-Weron

Hysteresis and tipping points are common features of many complex social and psychological systems. For example, empirical studies suggest that public opinion exhibits both phenomena, which means that it remains seemingly resistant to change (which is related to hysteresis) and then a sudden, abrupt shift of opinion can be observed at the tipping point. In social science, hysteresis is used to explain the inelasticity of change and manifests as a slow response of society to new problems, even if they are recognized by experts. For example, recently it has been argued that hysteresis can occur in the important context of public health and thus may explain several important issues in psychology and sociology of health, such as the recent epidemic of mental illness among undergraduate students or the persistence of the vaccine compliance problem. The term 'hysteresis' has its origins in ancient Greek and is derived from the word meaning 'lagging behind'. Although originally it was used to describe a phenomenon related to magnetism, presently it appears in many fields of natural and social sciences. At first glance, it may seem that the same term means something different in sociology and physics, but the general concept is the same and says that the state of a system depends on its previous state, which indicates the existence of the system's memory. During the talk, I will present the idea of the hysteresis and the tipping point along with some insights from statistical physics that may be particularly useful in social science. Finally, I will show how both phenomena can be modeled and rigorously analyzed within an agent-based approach.

Roundtable: The Future of Experiments in ABM

Bruce Edmonds, Melania Borit

Agent-based simulation can be related to qualitative as well as quantitative data. For example, qualitative input might be used to inform the micro-level specification of agent behaviour in simulations that are then run and compared to aggregate quantitative data. However using qualitative data can seem daunting, partly because there are no established methods for doing this. The goal of this roundtable at SSC2021 is to discuss methods for integrating qualitative and quantitative data in agent-based models, experiences with building social simulations that integrate such evidence, and experience with publishing any aspects of the integrative process.

Roundtable: The Future of Experiments in ABM

Edmund Chattoe-Brown, Nanda Wijermans

The use of behavioural experiments and agent-based modelling is slowly gaining more interest, however the scholars seem to be scattered, without awareness of others having a similar approach. With this roundtable we aim to bring together scholars that (have a keen interest to) combine behavioural experiments and agent-based modelling. It would be good to get an idea of the state of the art: what research domains, what type of experiments, what is the purpose of the models and who are actually involved etc. Together we can explore the potential of writing a JASSS paper on the current state of the art and research agenda for the use of agent-based modelling and experiments.

Roundtable: Increasing Rigour of ABM

Bruce Edmonds

The recent COVID19 has brought the potential of ABM to the forefront, but has also showed up weaknesses. This roundtable discussion will be to discuss collective initiatives to increase rigour - especially where these have a potential to influence decisions that affect people's lives. The focus of this will be "what could we do next" rather than "what is wrong" - we hope that some next steps towards future collective initiatives can be agreed.

1: Theoretical Sampling and Qualitative Empirical Model Validation
Georg Mueller

Systems dynamics models of social processes generally have a formal core of quantitative equations. The temporal dynamics of their output may however be categorized according to qualitative typologies: depending on the model parameters, output variables may fluctuate, steadily increase or decrease, etc. Hence the present paper suggests to explore by computer simulation the relation between parameter values and the associated type of model dynamics. The result may be mapped in a multi-dimensional parameter space. Such maps of model dynamics are useful tools for systematic empirical tests, which are often more rigorous and complete than the usual checks with particular data sets. Like in theoretical sampling in the tradition of qualitative social studies, they guide the investigator to empirical observations, which are of special interest for model validation. Thus, if the mentioned observations and the related qualitative model predictions systematically coincide, the tested model has a high degree of empirical validity. The use of quantitative computer models as pilots through the space of qualitative social dynamics is illustrated by a simulation model of the mobilization for political protest. Depending on the contagiousness of the conflict and the levels of frustration and repression, the model has three possible qualitative outcomes regarding the dynamics of protest mobilization: extinction, stable positive equilibria, and regular/irregular oscillations. The analysis of the model by computer simulation allows to construct samples of particular parameter configurations, which lead to the mentioned mobilization dynamics and thus may serve for empirical model validation.

3: Pay-for-Performance and Emerging Search Behavior: When Exploration Serves to Reduce Alterations
Friederike Wall

Prior research suggests that the fit between task complexity and incentive schemes like pay-for-performance positively affects organizational performance. This study goes a step further and seeks to investigate how different types of pay-for-performance affect subordinates' search behavior for novel solutions to complex decision problems. Based on NK fitness landscapes, the study employs an agent-based simulation with subordinate decision-makers individually adapting their search behavior via reinforcement learning. The results suggest that the emerging search strategy is subtly shaped by the (mis-)fit between task complexity and incentive structure. In particular, the results indicate that search behavior may arise for different "reasons" ranging from fostering new solutions to even preventing alterations.

4: Reputation and punishment sustain cooperation in the Optional Public Goods Game
Simone Righi, Shirsendu Podder and Francesca Pancotto

Cooperative behaviour has been extensively studied, in both evolutionary biology and the social sciences, as a choice between cooperation and defection. However, in many cases, the possibility to not participate or to exit a situation is also available. This type of problem can be studied through the optional public goods game. The introduction of the ``Loner'' strategy, allows players to withdraw from the public goods game, radically changing the dynamics of cooperation in social groups and leading to a never-ending cooperator-defector-loner cycle. While pro-social

punishment has been found to help increase cooperation, anti-social punishment -- where defectors punish cooperators -- causes the downfall of cooperation in both experimental and theoretical studies. In this paper, we extend the theory of the optional public goods game, introducing reputational dynamics in the form of social norms that allow agents to condition both their participation and contribution decisions to the reputation of their peers. We benchmark this setup both with respect to the standard optional public goods game and to the variant where all types of punishment are allowed. We find that a social norm imposing a more moderate reputational penalty for opting out than for defecting, increases cooperation. When, besides reputation, punishment is also possible, the two mechanisms work synergically under all norms that do not punish loners too harshly. Under this latter setup, the high levels of cooperation are sustained by conditional strategies, which largely reduce the use of pro-social punishment and almost completely eliminate anti-social punishment.

5: Developing a stakeholder-centric simulation tool to support integrated mobility planning
Diego Dametto, Gabriela Michelini, Leonard Higi, Tobias Schröder, Daniel Klaperski, Roy Popiolek, Anne Tauch and Antje Michel

Simulation tools aimed at enhancing cross-sectoral cooperation can support the much-needed transition from a traditional transport planning approach (based on predictions and traffic flow assessments) towards more integrated and participatory urban mobility planning. This shift entails not only broader appraisal of urban dynamics, but also transformations in the mobility policy framework, capitalizing on new developments in urban modelling. In this paper, we argue that participatory social simulation can be used to solve these emerging challenges in mobility planning. Our study aims to identify the functionalities that such a tool should have to support practitioners in the integrated mobility planning process. Drawing on a transdisciplinary case study situated in the city of Potsdam, Germany, we address through interviews and workshops stakeholders' needs and expectations and present the requirements of an actionable tool for practitioners. As a result, we present in this paper three main challenges for participatory, simulation-based transport planning, which include: 1) enhancement of the visioning process by testing stakeholders' ideas under different scenarios and conditions to visualise complex urban relationships 2) promotion of collective exchange as means to support stakeholder communication; and 3) increasing credibility by engaging stakeholders with model development from an early stage. We discuss how our participatory modelling approach helps us to better understand the gaps in the knowledge of the planning process and present the coming steps of the project.

6: Efficient Redistribution of Scarce Resources Favours Hierarchies
Rob M. A. Nelissen, Ivet Andres Munoz, David Cristobal Munoz, Mark R. Kramer and Gert Jan Hofstede

Common views identify resource abundance as the cause for the emergence of hierarchy in societies. We investigated if hierarchy may also thrive as a mechanism of redistributing scarce and variable resources, mimicking conditions of ancestral, hunter-gatherer societies. To that end, we built an agent-based model in which we compared the relative success of a comprehensive range of redistribution strategies, derived from relational models theory [1] and explored how well populations of agents that adopt different rules for sharing resources thrive under different

levels of resource availability, reflecting scarcer vs. more abundant environments. Our results show that under most levels of resource availability, a population of agents that redistribute pooled resources according to individual differences in rank among the agents (i.e., reflecting an "Authority Ranking" model), was more sustainable than populations that adopted equal- and need-based sharing rules, as well as agents that did not share resources. Our results suggest that the dominant manifestation of hierarchical organization in society does not require surplus and may derive from its effectiveness in dealing with scarce resources at the group-level.

7: The psychometric house-of-mirrors: the effect of measurement distortions on agent-based models
Dino Carpentras and Michael Quayle

Agent-based models often rely on parameters and variables representing abstract constructs, such as opinions, happiness, and stubbornness, to name a few. While this allows us to straightforwardly model agents, it also introduces a serious problem of measurement if we want to link models to real data. Indeed, psychometrics constructs can be measured in many ways. For example, a concept like "trust in vaccines" may be measured by using a single question, by averaging several questions, by measuring response time in specific tasks, etc. The possibilities are virtually endless and many of them are equally valid according to usual psychometric practice. Another major problem is that in contrast to physics, where different measurement scales have linear relationships to each other (e.g. meters and feet), psychometric measurements of a construct on different scales have no defined relationship. This situation can be visualized as a hall of mirrors, where each curved surface (representing a specific measurement) provides a different distorted image of the same object. y testing the effect of distortions on agent-based models, we find that they may completely alter the model's dynamics and predictions. For example, by using the Deffuant model, we were able to make two completely opposite predictions using different scales on the same topic (i.e. trust in science) for the same people, at the same time point. We conclude by discussing several possibilities for solving or avoiding this problem. We caution that these measurement issues should be considered when seeding models with, or comparing results to, psychometric data.

8: Building An Opinion Dynamics Model From Experimental Data
Dino Carpentras, Paul J Maher, Caoimhe O'Reilly and Michael Quayle

Opinion dynamics models have huge potential for untangling social problems like anthropogenic climate change. Unfortunately, to date most models have little or no empirical validation. In the present study participants report-ed their opinions before and after social interaction using response options "agree" to "disagree" and opinion strength 1 to 10. We synthesized the opinion from these two answers as numerical values from -1 to 1 in steps of 0.1. The social interaction entailed showing the participant their interaction partner's agreement value on the same topic, but not their certainty. Since we have no proof that influence dynamics is independent of topic (e.g. influence may be stronger on the topic of immigration than on abortion), we selected 6 novel topics and confirmed that the observed dynamics were comparable. From the analysis of the data, we observed a very weak, but statistically significant influence between participants. We also noticed three important effects. (1) Asking people their opinion is sufficient to produce opinion shift and thus influence opinion dynamics, at least on novel topics. (2) About 4% of the

time people flipped their opinion, while preserving their certainty level. (3) People with extreme opinions exhibited much less change than people having neutral opinions. We also built an opinion dynamics model based on the three mentioned phenomena. This model was able to produce realistic results (i.e. similar to real-world data) such as polarization from unpolarized states and strong diversity.

9: Whose Law? Social Movement Influence on International Law Making: An Agent-based Perspective
Katharina Luckner

The influence of social movements and civil society engagement on international policy and law making is only poorly understood, as there seems to be a disconnect between the local and regional nature of most social movements and the global nature of international law. Recently, however, global social movements have become increasingly important, addressing international law makers and organizations. It is important for legal scholars and activists alike to understand how such movements can impact the international law making process. We build on established models of social movement catalysts and opinion dynamics, but introduce a novel element of normative change to develop an agent-based model for our investigation of theoretically developed mechanisms of social movement influence on international law making.

10: An Introduction to HANS Solver - Julia powered toolbox for heterogeneous agents static equlibrium agents static equilibrium models with discrete choice and incomplete markets
Mateusz Szetela

HANS Solver is a toolbox for solving heterogeneous agents static equilibrium models with discrete choice. It provides framework in which economic model can be defined and later solved on a grid. It uses adjusted value function iteration to account for noncontinuity regarding discrete choice. The toolbox has proper algorithms installed, with different computational modes. This makes implementation and modification of model simpler and faster as a only model definition needs to be written or updated.

11: On the Role of Incentives in Evolutionary Approaches to Organizational Design
Stephan Leitner

This paper introduces a model of a stylized organization that is comprised of several departments that autonomously allocate tasks. To do so, the departments either take short-sighted decisions that immediately maximize their utility or take long-sighted decisions that aim at minimizing the interdependencies between tasks. The organization guides the departments' behavior by either an individualistic, a balanced, or an altruistic linear incentive scheme. Even if tasks are perfectly decomposable, altruistic incentive schemes are preferred over individualistic incentive schemes since they substantially increase the organization's performance. Interestingly, if altruistic incentive schemes are effective, short-sighted decisions appear favorable since they do not only increase performance in the short run but also result in significantly higher performances in the long run.

12: Agent-based model of pedestrian movements in the build environment
Michal Dziecielski and Marcin Wozniak

Pedestrian transportation is becoming increasingly important in modern cities. In this paper, we develop an agent-based model to simulate pedestrian traffic in a city. The real residential area represented by GIS data was used in simulations. A gradient method with an additional parameter related to the distance between the agent and the target was used. In the first step, we visualized the trajectories of agents' movement and analyzed routes' lengths and time needed to reach the destination by agents. In the second step, sensitivity analysis was performed. Morris screening results show that the impact of all parameters is significant and highly diversified. We also detected non-linear dependencies between model inputs. The study shows that for high values of distance amplification parameter, agents took the shortest path and arrived at the destination in the shortest time. When the parameter had lower values, the agents reached the destination in a longer time, covering a longer route. Therefore, we managed to extract and simulate different walking strategies e.g. leisure walk or rush to the target.

13: Shrinking housing's size: Using agent-based modelling to explore measures for a reduction of floor area per capita
Anna Pagani, Francesco Ballestrazzi and Claudia R. Binder

In the ambition to shrink the environmental footprint of housing, reducing dwellings' size is key. There is agreement among scholars on the measures that should be taken to achieve this goal, however their effectiveness and effects have not been sufficiently investigated. In this paper, we explore and compare the outcomes of measures for reducing housing size and thereby shrinking housing's environmental footprint. We use ReMoTe-S, an empirical agent-based model that simulates the residential mobility of tenants renting from three housing providers in Switzerland. Our simulations show that an increase in floor area per capita is predominantly the consequence of a discrepancy between housing demand and supply. More specifically, on the demand-side, findings indicate that enabling multigenerational households and thus larger groups of occupants to form is the most successful measure, while helping relocating tenants to more easily find households to join by enlarging the number of groups they can visit is the least effective. On the supply-side, we observe that increasing the diversity of dwellings sizes leads to an important reduction in sqm/tenant where occupancy rules most strongly restrict the minimum number of occupants per dwelling. With regard to these rules, our findings display a moderate reduction of individual space consumption when preventing households whose children have moved out to under-occupy their dwelling. We conclude that efforts from both the housing demand- and supply-side are needed to achieve a reduction in floor space per capita, which will entail wide societal and environmental benefits.

14: Simulating social reality
Martin Neumann

This submission presents reflections on how social simulation assists in revealing a social level of reality on the different dimensions of the macro- meso- and micro level. By concentrating on social organizing the submission shows how these levels are intertwined. In the submission three example models will be discussed. A model of the emergence of the state on the macro level, a

model of the escalation of ethno-nationalist radicalization on the meso level, and a model of conflict resolution in a criminal group on the micro level.

15: Exploring the role of leadership in artifacts-enabled formation of routines: An agent-based model
Dehua Gao, Yumei Yang and Jiangfeng Ni

Organizational routines are at the core in capturing how organizations accomplish their tasks. This paper concerns the complicated triple-relations among three essential elements including individual actors, actions, and arti-facts as well, and explored the formation dynamics of routines at the com-munity level from a 'bottom-up' way. By simultaneously considering two distinct contexts, namely, (1) the influence of leader-follower interactions depicted by the leader-member exchange (LMX) theory, and (2) exploitive/explorative activities regarding artifacts, we proposed a conceptual framework to formalize the internal structure and processes underpinning the formation dynamics of organizational routines. We then designed an agent-based model and portrayed several key mechanisms including leader-follower interactions, imitative activities between individual agents, as well as these agents' exploitative/explorative activities regarding artifacts. Our results show potential contributions of using the agent-based modeling (ABM) methodology in routine dynamics to gain insights into the micro-macro link and bring out advanced understandings in routine dynamics research.

16: Cruising Drivers' Response to Changes in Parking Prices in a Serious Game
Sharon Geva and Eran Ben-Elia

Scarcity of on-street parking in cities centers is a known factor motivating drivers to cruise. Cruising is associated with negative externalities, such as congestion, accidents, fuel waste and air pollution. To reduce cruising, understanding drivers' behavior is necessary. We used the PARKGAME serious game to test and model drivers' cruising preferences. Eighty-three players participated in an experiment under two scenarios, differing in the on-street parking prices. Pricing was spatially designed as "price rings", decreasing when receding from the desired destination point. We analyzed search time, parking distance, parking location choice and searching patterns, and show that such a pricing policy may reduce substantially the cruising problem, motivating drivers to park –earlier and further away from the destination or in the lot.

17: Effects of limited and heterogeneous memory in hidden-action situations
Patrick Reinwald, Stephan Leitner and Friederike Wall

Limited memory of decision-makers is often neglected in economic models, although it is reasonable to assume that it significantly influences the models' outcomes. The hidden-action model introduced by Holmström also includes this assumption. In delegation relationships between a principal and an agent, this model provides the optimal sharing rule for the outcome that optimizes both parties' utilities. This paper introduces an agent-based model of the hidden-action problem that includes limitations in the cognitive capacity of contracting parties. Our analysis mainly focuses on the sensitivity of the principal's and the agent's utilities to the relaxed assumptions. The results indicate that the agent's utility drops with limitations in the principal's cognitive capacity. Also, we find that the agent's cognitive capacity limitations affect neither his

nor the principal's utility. Thus, the agent bears all adverse effects resulting from limitations in cognitive capacity.

18: Facing the election prediction problem with agent-based models using particle filtering
Ernesto Carrella

We want to revisit the problem of prediction in complex and wicked systems as described in Polhill et al. (2021) and propose a practical way forward, using election predictions as an applied challenge to solve (as suggested in Polhill 2018). Our task is to produce conditional predictions and continuously update them as more data comes in using agent-based models to weigh the information of each data stream. This preserves the two main advantages of using models versus extrapolating from data alone: (i) use the model to contextualize data, (ii) use the model to simulate policy shocks and control. Structured this way, the "problem of prediction" mentioned above has already a solution: the agent-based modeling literature on data assimilation(Ward, Evans, and Malleson 2016). Data assimilation has so far been restricted to pedestrian flow and other geographical agent-based models. The literature however has matured to the point where only a trivial amount of work is necessary to generalize particle filtering to any agent-based model. We propose to do so here.

19: Agent based model for establishing and maintaining social relationships by heterogeneous actors
Katarzyna Growiec, Beata Łopaciuk-Gonczaryk and Bogumił Kamiński

We propose a complex agent-based simulation model aimed for the investigation of mutual relationships between diverse attributes of actors and evolution of social networks. Special focus is both on psychological traits of actors (need for cognitive closure, self-esteem, agency and communion) as well as on dynamics of social interactions, including the social processes of selection and influence. We diversify between kin and non kin ties; and between three social circles, from the most close to the most distant: support clique, sympathy group, and Dunbar circle and connect them with different mechanisms. We are going to calibrate the model to empirical data collected within the original survey on a representative sample for Poland. We believe that our model can act as a building block or point of reference for economic models. This will be helpful for incorporation of the socio-psychological background in which agents are heterogeneous and interact with each other. Their choices are based not only on their own attributes, but also on the current network structure and attributes and choices of their network neighbors. We will test e.g. the hypothesis that the mutual relation between self-esteem and degree in a social network leads to the effect called "rich get richer".

20: The Problem with Bullying: Lessons Learned from Modelling Marginalization with Diverse Stakeholders
Themis Dimitra Xanthopoulou, Andreas Prinz and F. Leron Shults

While building a simulation model to gain insights on bullying interventions, we encountered challenging issues that forced us to reconsider our modelling content. In this paper, we describe these issues and suggest ways to address them. We learned lessons about the need for quality assurance and a more demanding construction process when building models that aim to support

decision-making. One of the challenges we faced is that experts do not agree about how to define and use the term bullying, which is constantly expanding and evolving. Before we can model 'bullying' we need a shared understanding of its meaning. Otherwise, insights from the model could be misinterpreted and lead to misleading conclusions. We propose to solve these challenges by identifying which concrete bullying behaviors to target, and by focusing on simulation models for interventions addressing those behaviors.

21: Exposure to Traffic-related Air Pollution(Non-exhaust Emission) in Central Seoul using an Agent-based Framework
Hyesop Shin and Mike Bithell

Non-exhaust emission (NEE) from brake and tyre wear cause deleterious effects on human health, but the relationship with mobility has not been thoroughly examined. We construct an in silico agent-based traffic simulator for Central Seoul to illustrate the coupled problems of emissions, behaviour, and the estimated exposure to PM10 (particles less than 10 microns in size) for groups of drivers and subway commuters. The results show that significant extra particulates relative to the background exist along roadways where NEEs contributed some 40% of the roadside PM10. In terms of health risk, 88% of resident drivers had an acute health effect in late March but that kind of emergence rarely happened. By contrast, subway commuters' health risk peaked at a maximum of 30% with frequent oscillations whenever the air pollution episodes occurred. This was due to a wide range of commute times. However, the estimates of health effects depend strongly on how impact and recovery from exposure are parameterised. A 90% vehicle restriction scenario reduced PM10 by 18-24%, and reduced the resident driver's risk by a factor of 2, but not effective for subway commuters as the group generally walked through background areas rather than along major roadways. Using an agent-based traffic simulator in a health context can give insights into how exposure and health outcomes can depend on the time of exposure and the mode of transport. Also, this method tests policy scenarios (also known as 'what-if' scenarios) to envisage potential air quality improvement and less health damage.

22: Decisions, decisions… the complex issue of representing human behavior in social-ecological systems
Beatrice Christa Nöldeke, Etti Winter, Elisée Bahati Ntawuhiganayo and Ulrike Grote

Despite their various benefits, adoption of agroforestry systems by small-scale farmers remains relatively low. Understanding low adoption rates to implement appropriate interventions requires comprehension of farmers' decision-making. To explore adoption behavior, agent-based models (ABMS) provide a suitable tool because they can explicitly represent individual decision-making. However, a variety of different approaches exist to explain human decisions. Simulation outcomes and derived policy recommendations depend on how individual decision making is represented in the ABM. Thus, choosing a theory to represent adoption decisions in simulation models requires careful consideration. The present study aims at comparing several relevant behavioral theories to investigate farmers' decision to adopt biodiversity-enhancing agroforestry systems. Thereby, the model compares the Theory of Planned Behavior with perfect rationality (utility maximization), bounded rationality, and a probabilistic approach. An ABM is adjusted to a case study in rural Rwanda. The simulated agroforestry system combines potatoes with two biodiversity-enhancing trees, namely Podocarpus falcatus and Vernonia amygdalina. Simulation

outcomes include the rate of adopters, generated income, and the area under agroforestry. The simulation model provides insights into the suitability of the various behavioral theories to simulate farmers' decision to adopt agroforestry.

23: Autonomous group formation of heterogeneous agents in complex task environments
Dario Blanco Fernandez, Stephan Leitner and Alexandra Rausch

Since individuals cannot solve complex tasks by themselves due to their limited capabilities, group formation is necessary to solve these tasks. By self-organizing into groups, individuals with different capabilities can overcome their limitations. In addition, individuals and groups often change over time: The individuals that form the group will learn new ways to solve the task, while groups might adapt their composition in response to the current needs of the task. The latter is driven by the differing characteristics of the individuals, as some of them might be better adapted at a particular point in time but do not participate in the group. By self-organizing, groups can absorb these individuals within their ranks, so they have the best-adapted members. However, there is a lack of consensus in the literature on whether changing a group's composition over time is beneficial or detrimental to task performance. Moreover, previous research has often assumed that agents are homogeneous. We implement an agent-based model adapted from the NK-framework using agents with heterogeneous capabilities, which includes an individual learning mechanism with an exogenous probability and a second-price auction mechanism for group self-organization. Heterogeneity in the agents' capabilities ensures that groups have an incentive to self-organize and change their composition over time. Our results suggest that group self-organization can improve task performance depending on task complexity and how prominent is individual learning.

24: Pandemic dynamics determinants in multi-layered urban transportation networks
Mahsa Kazeminooreddinvand, Nykyta Polituchyi, Paweł Prałat, Kinga Siuta and Przemysław Szufel

In the event of a pandemic, a policy regulator may take several actions, or policy designs, in order to minimize and to control the number of people being affected. The development of the epidemic depends on various factors, including the intensity and frequency of social contacts, contagiousness of a particular virus strain, and the level of protection applied during those contacts. In particular, these may take place in the urban space of a large city. We consider two dimensions of complexity: a multilayered network (where layers represent different types of commute, namely, footwalk, individual cars, buses and metro) combined with the existence of virus strains characterized by different contagiousness levels. In the project funded by the NSERC Alliance grant, we have developed a multi-agent simulation framework in which we model a two-variant virus spread in a complex multilayered network including a real-world urban public transportation system. The involved participants are heterogeneous in terms of, e.g., their home/work locations and routes they take to move between the two. The results show that decisions, and hence the epidemic's scale, are heavily impacted by the network itself due to the graph routing process and infection schemes differing within it. The proposed approach and simulation model has been illustrated on real world data of Toronto. The simulation results show that there is a an optimal point of operational frequency for a transportation system that minimizes the negative effect.

25: SESAMSIM: understanding dynamics in tropical agro-forestry
Paulina Rosero Anazco, Margaret Githinji, Mark R. Kramer and Gertjan Hofstede

The paper introduces SESAMSIM, an agent-based model with aims at two levels. Content-wise, it aims to aid understanding of the dynamics of land use in tropical agroforestry, in the interest of sustainability. Methodologically, it introduces artificial sociality of its agents according to the status-power theory of relations by Theodore Kemper. The main axiom here is that farmers try to do what will make them look good to their most important reference groups, and to avoid doing what would subject them to the power of their most feared reference groups. Reference groups include family, ancestors, peers, NGOs, traders, possibly others. SESAMSIM gets its empirical grounding from two case studies, one in tropical Ecuador, one in more arid Kenya. At the time of writing, field studies are in progress in both places. The article presents the ideas behind SESAMSIM, its design, its grounding and current state.

26: The Large-Scale, Systematic and Iterated Comparison of Agent-Based Policy Models
Bruce Edmonds, Edmund Chattoe-Brown and Mike Bithell

Vital to the increased rigour (and hence reliability) of Agent-based model-ling are various kinds of model comparison. The reproduction of simulations is an essential check that models are as they are described. Here we argue that we need to go further and carry out large-scale, systematic and persistent model comparison – where different models of the same phenomena are compared against standardised data sets and each other. Lessons for this programme can be gained from the Model Intercomparison Projects (MIP) in the Climate Community and elsewhere. The benefits, lessons and particular difficulties of implementing a similar project in social simulation are discussed, before sketching what such a project might look like. It is time we got our act together!

27: Social Identity and Management Control: A Social Simulation Perspective
Friederike Wall

This short note outlines, in general lines, the contribution of social simulation to a so far undeveloped field in management control: the systematic analysis of the interrelation between social identity and decision-making behavior of man-agers. For this, some research questions are derived.

28: Simulating Human Movement in a National-Scale Individual-Based Model of Malaria in Burkina Faso
Robert Zupko, Tran Dang Nguyen and Maciej Boni

Malaria due to the Plasmodium falciparum parasite remains a threat to human health despite eradication efforts and the development of anti-malarial treatments, such as artemisinin-based combination therapies. Human movement and migration have been linked to the propagation of malaria on national scales, highlighting the need for the incorporation of human movement in modeling efforts. Individual-based models have been used to study how anti-malarial resistance evolves and spreads in response to drug policy changes; however, as the spatial scale of the model increases, the challenges associated with modeling of movement also increase. In this

paper we discuss the development, calibration, and validation of a movement model in the context of a national-scale, spatial, individual-based model used to study the evolution of drug resistance in the malaria parasite.

29: Young Liberals? An Agent-Based Model of Opinion Shifts among Cohorts
Ivan Puga-Gonzalez and F. Leron Shults

This paper presents the findings of an agent-based model of the shift toward liberal opinions over time within contemporary European populations. Empirical findings and theoretical reflection on this sort of shift suggest that cohort effects, and especially changes in the opinions of teenagers, are a primary driver of liberalization at the population level. We outline the core features and dynamics of the model and report on several optimization experiments that clarify the conditions under which – and the mechanisms by which – opinions become more liberal as agents interact with one another within and across cohorts.

30: Exploring energy security of Dutch urban energy com-munities: an exploratory agent-based modelling approach
Javanshir Fouladvand, Deline Verkerk, Igor Nikolic and Amineh Ghorbani

Local energy systems commonly referred to as energy communities are gaining momentum in the context of the energy transition. Given the distributed and collective action nature of energy communities, the security of these local energy systems is more than just security of supply and related to issues such as affordability and acceptability of energy to members of the community. We build an agent-based model of community energy systems to explore their security challenges. The security dimensions we consider are availability, affordability, accessibility and acceptability, which are referred to as the 4As. The results confirmed that there is always a trade-off between all the four dimensions and that although it is difficult to achieve a high energy security performance it is feasible. Results also showed that among factors influencing energy security, the investment of the community plays the biggest role.

31: The Dynamics of Follower Networks and Spread of Opinion in a Twitter Agent Based Model
Stephen Dipple and Kathleen Carley

The opinions of a population has a wide array of implications from the relative benign opinion of a favorite color, to the extremely consequential decision on who should lead a country. The spread of opinions has changed drastically over the last decade, from newspapers and mail which had taken days or weeks to deliver, to Twitter an almost instantaneous transfer of information between any two users on the platform. This work's focus is on modeling the spread of opinions in an environment like Twitter using an agent based model. In addition, the structure of Twitter's follower network, which greatly influences what information a user sees is also modeled and analyzed.

32: Quantum Leaper: A Methodology Journey From a Model in NetLogo to a Game in Unity
Timo Szczepanska, Andreas Angourakis, Shawn Graham and Melania Borit

Combining Games and Agent-Based Models (ABMs) in a single research design (i.e. GAM design) shows potential for investigating complex past, present, or future social phenomena. Games offer engaging environments generating insights into social dynamics, perceptions, and behaviours, while ABMs support the analysis of complexity. We present a general methodology for a GAM design type in which the ABM and the Game are intertwined in one application. We distil this methodology from the process of designing and developing Quantum Leaper, a proof-of-concept video game made in Unity software and based on the NetLogo implementation of the well known ``Artificial Anasazi'' ABM.

33: Evaluation of COVID-19 infection prevention measures compatible with local economy
Hideyuki Nagai and Setsuya Kurahashi

This study simulates the infection spread process of 2019 novel coronavirus diseases (COVID-19) in a tourism location by agent-based model and evaluates the effects of multiple infection prevention measures. In this model, a continuous influx of tourists brings about an infection spread among regional residents living in daily life there. The experiments' results showed that there are certain effects from measures to reduce human-to-human contact, but the effects are limited. On the other hand, we confirmed that regular PCR testing for tourism business employees and an active epidemiological investigation is effective.

34: A Case Study of Agent-Based Models for Evolutionary Game Theory
Jacobus Smit and Edward Plumb

Evolutionary game theory is a mathematical toolkit to analyse the interactions that an individual agent has in a population and how the composition of strategies in this population evolves over time. While it can provide neat solutions to simple problems, in more complicated situations where assumptions such as infinite population size may be relaxed, deriving analytic solutions can be intractable. In this short paper, we present a game with complex interactions and examine how an agent-based model may be used as a heuristic technique to find evolutionarily stable states.

36: Articial Benchmark for Community Detection algorithm for simulation of social networks
Bogumił Kamiński, Pawel Pralat, François Théberge and Tomasz Olczak

Most of the current complex networks that are of interest to practitioners possess a certain community structure that plays an important role in under-standing the properties of these networks. For instance, a closely connected social communities exhibit faster rate of transmission of information in comparison to loosely connected communities. Moreover, many machine learning algorithms and tools that are developed for complex networks try to take advantage of the existence of communities to improve their performance or speed. As a result, there are many competing algorithms for detecting communities in large networks. Unfortunately, these algorithms are often quite sensitive and so they cannot be fine-tuned for a given, but a constantly changing, real-world network at hand. It is therefore important to test these algorithms for various scenarios that can only be done using synthetic graphs that have

built-in community structure, power law degree distribution, and other typical properties observed in complex networks. The standard and extensively used method for generating artificial networks is the LFR graph generator. Unfortunately, this model has some scalability limitations and it is challenging to analyze it theoretically. Finally, the mixing parameter μ, the main parameter of the model guiding the strength of the communities, has a non-obvious interpretation and so can lead to unnaturally defined networks. In this paper, we provide an alternative random graph model with community structure and power law distribution for both degrees and community sizes, the Artificial Benchmark for Community Detection (ABCD graph). The model generates graphs with similar properties as the LFR one, and its main parameter ξ can be tuned to mimic its counterpart in the LFR model, the mixing parameter μ. We show that the new model solves the three issues identified above and more. In particular, we test the speed of our algorithm and do a number of experiments comparing basic properties of both ABCD and LFR. The conclusion is that these models produce graphs with comparable properties but ABCD is fast, simple, and can be easily tuned to allow the us-er to make a smooth transition between the two extremes: pure (independent) communities and random graph with no community structure.

37: Simulating Delay in Seeking Treatment for Stroke due to COVID-19 Concerns with a Hybrid Agent-Based and Equation-Based Model
Elizabeth Hunter, Bryony McGarry and John Kelleher

COVID-19 has caused tremendous strain on healthcare systems worldwide. At the same time, concern within the population over this strain and the chances of becoming infected has potentially reduced the likelihood of people seeking medical treatment for other health events. Stroke is a medical emergency and swift treatment can make a large difference in patient outcomes. Understanding how concern over the COVID-19 pandemic might impact the time delay in seeking treatment after a stroke can be important in understanding both the long term cost implications and how to target individuals during another pandemic scenario to remind them of the importance of seeking treatment immediately. We present a hybrid agent-based and equation-based model to simulate the delay in seeking treatment for stroke due to concerns over COVID-19 and show that even small changes in behaviour impact the average delay in seeking treatment for the population. This delay could potentially impact the outcomes for stroke patients and future healthcare costs to support them. We find that introducing control measures and having multiple smaller peaks of the pandemic results in less delay in seeking treatment compared to a scenario with one large peak.

38: How task complexity affects group performance and motivation: the comparison between self-organising and top-down task allocation
Shaoni Wang, Kees Zoethout and Wander Jager

This article is aiming at studying the impact of task complexity on group performance, aligning on the comparison between the bottom-up (self-organising) and top-down (competence-based) allocation. The complex social interactions between individuals, the dynamic cooperation network, the interaction of task components, and group performance are difficult to explore with traditional organisational behaviour research methods. In this paper, we use an ABM with implementations of theories on task motivation and negotiation to explore the dynamic

interaction of task complexity and group performance. The simulation experimental results show that: 1) the team satisfaction is higher when under the self-organising allocation, and team performance time is lower under this condition in the long term; 2) when the task variety is larger, the team performance increases or decreases more rapidly under both bottom-up and top-down allocation strategies.

39: WATERING: An Agent-based Model of Community Water Governance
Kavin Narasimhan, Nigel Gilbert, Corinna Elsenbroich, Roshan Adhikari, Emmanuel Obuobie, Samuel Guug, Nathan Forsythe and Sarah Redicker

This paper presents a proof-of-concept agent-based model called WATERING to unpack the complex interplay of factors in community-based water governance in Sub-Saharan Africa (SSA). Agriculture is the dominant economic sector in SSA, and efforts are ongoing to expand irrigation through decentralised water management, despite some less successful or failed projects. One such effort is establishing Water User Associations (WUAs) to manage water resources within communities served by an irrigation scheme. WATERING seeks to understand and explain the impact of WUA's decisions on regulated and opportunistic water use within communities. Preliminary simulation results suggest that water allocation and water sharing decisions made by WUA, and water users' behavioural response to these decisions, have an impact on how much water is used for competing purposes. The model also provides quantified evidence of the impact of unregulated opportunistic water use on the performance of irrigation schemes – a less explored issue for community-based water governance in SSA. WATERING could serve as a testbed to explore how different water management policies might affect water use, productivity and welfare within communities.

40: Institutional Emergence: A study on French Business Schools
Siavash Farahbakhsh and Davide Secchi

Despite the existing rich literature, understanding institutional change in terms of emergence is still under-theorized. In particular, how micro-level factors are connected to meso- or macro-level patterns still requires a more fine grained understanding. From this perspective, our study aims to investigate how the characteristics of the agents (micro) contribute to the evolution of an institutional environment and its emerging patterns (macro). In doing so, we rely on the case of the emergence and evolution of Business Schools in France's higher education sector. We identify two main phases in the institutional evolution of our case: (1) establishment of écoles de commerce (named business school later) mostly by chambres de commerce across France, and (2) adoption of international accreditation standards starting from 1997. While developing a history-friendly calibrated agent-based model, we show the role of different factors including economic resources, risk-taking, trend, internationalization costs, dynamic capability.

45: Understanding Evaluation Mechanisms of Online Community-based Information and Knowledge
Chenlong Wang and Pablo Lucas

Online question and answer platforms have been flourishing. Yet the quality of answers in these systems is neither guaranteed nor obviously apparent. This is as the online community evaluates the quality of specific answers by voting mechanisms, which is a community-based approach to evaluation akin to the wisdom of crowds. Votes given by individuals in a community have to be aggregated so that it can represent the collective outcome to its users. This can also serve as a source of social influence, a known factor that can influence the wisdom of the crowd effectiveness. This paper is focused then on utilising an agent-based model approach to test the reliability of the collective evaluation mechanism within an online question and answer platform. The discussion include the following findings: (1) users driven by community fame and different levels of user conformity can undermine the overall collective evaluation mechanism; (2) the evaluation mechanism is moderately robust regarding the proportion of experts in the group; and (3) inequality among platform users in terms of access to information plays an important role in the evaluation mechanism itself.

46: Local Reputation, Local Selection and the Leading Eight Norms
Shirsendu Podder, Simone Righi and Karoly Takacs

Humans are capable of solving cooperation problems following social norms. Social norms dictate appropriate behaviour and judgement on others in response to their previous actions and reputation. Recently, the so-called leading eight norms have been identified from many potential social norms that can sustain cooperation through a reputation-based indirect reciprocity mechanism. Despite indirect reciprocity being claimed to extend direct reciprocity in larger populations where direct experiences cannot be accumulated, the success of social norms have been analysed in models with global information and evolution. This study is the first to analyse the leading eight norms with local information and evolution. We find that the leading eight are robust against selfish players within most scenarios and can maintain a high level of cooperation also with local information and evolution. In fact, local evolution sustains cooperation under a wider set of conditions than global evolution, while local reputation does not hinder cooperation compared to global reputation. Four of the leading eight norms that do not reward justified defection offer better chances for cooperation with quick evolution, reputation with noise, larger networks, and when unconditional defectors enter the population.

47: On the dynamics of relative prices and the relationship with inflation: an empirical approach
Emiliano Alvarez, Juan Gabriel Brida and Pablo Mones

This paper introduces a minimum dominant price set to represent structure and evolution of relative prices in the economy. Due to the dynamic nature of the links between prices, the construction of a dynamic synthetic index is also proposed, and its properties and its components are studied. The empirical results allows to identify the most important nodes in the price network of the Uruguayan economy. With this set of prices, a synthetic index was generated that allows making more correlated projections with the original index and with less error than

indices of the same size used as benchmarks. The scope of these improvements in projections in the context of complex networks and their consequences in the design of anti-inflation policies are discussed. Food prices are particularly relevant in this minimum price set; this result is discussed in the context of developing economies and globalized industries.

48: Comparison of Viral Information Spreading Strategies in Social Media
Sri Sailesh Meegada and Subu Kandaswamy

Influencing the opinion of people has always been a challenging problem since ages. Businesses and brands thrive on the basis of maintaining their image in people's minds. With the advent of social media, it has been easier than ever to reach people directly, and marketers have been quick to jump on this bandwagon. However, recently this technology is also playing a pivotal role in influencing the opinions and attitude of people, owing to its viral effects. In this paper, we use an Agent Based Model to study the change in peoples' attitude and opinion when treated with different information spreading strategies. We found that in a social network using a single attribute like the number of friends or the betweenness of the individuals, results in comparable performance. We also found that when those attributes such as degree and betweenness are combined with other attributes such as the engagement a user gets on their posts, there is a significant difference in their performance. In addition to this, We also measure the impact of social media platforms trying to maximize their click-through rate by showing content which aligns with the user, and found that it significantly influences the formation of echo chambers.

50: Towards more realism in pedestrian behaviour models First steps and considerations in formalising social identity
Nanda Wijermans and Anne Templeton

Agent-based models of group behaviour often lack evidence-based psycho-logical reasons for the behaviour. Similarly, pedestrian behaviour models focus on modelling physical movement while ignoring the psychological reasons leading to those movements (or other relevant behaviours). To improve realism, we need to be able to reflect behaviour as a consequence of feeling part of a psychological group, so we better understand why collective behaviour occurs under different circumstances. The social identity approach has been recognised as a way of understanding within and between group dynamics, as well as the processes that make an individual act as a group member. However, as promising the social identity approach is, the formalisation is a challenging endeavour since different choices can be made to reflect the core concepts and processes. We therefore in this paper elaborate on a few of these formalisation challenges and the choices we made. To support the formalisation and use of social identity approach and finally for the increased realism in group behaviour models, such as pedestrian models that are so heavily used to manage real-world crowds

51: Explaining and resolving norm-behavior inconsistencies – A theoretical agent-based model
Marlene Batzke and Andreas Ernst

Norm internalization refers to the process integrating normative beliefs into the self and developing personal norms. It is often assumed that once people have internalized a norm, they

behave accordingly. However, empirical research proves this assumption rather implausible and shows inconsistencies in the personal norm-behavior relation. In order to provide a better understanding of personal norm-behavior inconsistencies, we developed an agent-based model that includes a norm internalization process as well as a theory on how personal norms translate into behavior. The internalization process is embedded in a psychological theory of decision-making, containing different types of norms and other motivational factors. That allows investigating the behavioral consequences of internalized norms, explaining norm-behavior inconsistencies and exploring possibilities for their resolution. The agent-based DINO model was implemented within the context of a social dilemma game. The model illustrates how personal injunctive norms become behaviorally effective, while agents are able to develop conflicting personal norms and to behave contrary to their internalized norms. The reasons for norm-behavior inconsistencies are analyzed and different norm-based interventions are tested regarding their efficacy to resolve norm-behavior inconsistencies. The DINO model illustrates the crucial role of not just adopting a normative belief but also of rejecting conflicting ones. The DINO model is able to explain norm-behavior inconsistencies and allows developing approaches on how consistency could be fostered, that may later be tested empirically.

52: Modeling Households' Technology Adoption. A Contribution to the Co-Simulation of a Socio-Technical Multi-Level Energy System
Sebastian Hoffmann and Fabian Adelt

This contribution investigates households' electricity-related technology adoptions (e.g., photovoltaic rooftop systems, electric vehicles or heat pumps) by means of agent-based modeling (ABM). The ABM is based on the authors' previous work on the behavior of social agents (e.g. users or households) in socio-technical infrastructure systems and adapts the Consumat approach to include different complexities of investment decisions in multiple domains (e.g., electricity-related, heating and mobility). Lastly, the presented ABM is part of a larger co-simulation framework that links distributed and modular simulators from social sciences, electrical engineering, computer sciences and innovation research in order to represent a socio-technical energy system with a multi-level architecture. The presentation will give an overview of the household technology adoption model (SimCo-Energy) as well as insights into the conceptual and methodological challenges of linking simulators from different disciplines (e.g., with regard to scenario definitions, time horizons and data sources).

53: How perceived complexity impacts on comfort zones in social decision contexts - Combining gamification and simulation for assessment
Frederick Herget, Benedikt Kleppmann, Petra Ahrweiler, Jan Gruca and Martin Neumann

This paper is about the ambiguous love-hate relationship people have with complexity in social decision contexts: There seems to be a tipping point where increasing complexity seen as an exciting and satisfying way to stop boredom turns to overwhelming and annoying nuisance making people long for simplicity to get back into their comfort zone. People tend to have an intuitive understanding about what constitutes a complex situation. Can we use this intuition to find out more about complexity in a bottom-up approach where a complexity definition would emerge from people's intersubjective understanding and not from a top-down imposition? Is 'too much complexity' or 'not enough complexity' in a specific social decision context just a

subjective feeling individual people might arbitrarily share with others by chance, or are there objective, if not measurable, features underlying the decision situation that agree with people's perceptions and sentiments? The paper combines gamification and simulation to address these questions. By increasing complexity in a gamified social decision situation, empirical data is generated about people's complexity intuitions. The empirical games are then simulated - calibrated by the gamification setting for producing artificial data. The analysis compares the ratings of perceived complexity and satisfaction in empirical games with a set of metrics derived from the simulations. Correlations between participants' ratings and simulation metrics provide interesting insights into the complexity experience of the tipping point: Sentiments about 'too much' or 'not enough' complexity may be related to objective features that enable a bottom-up definition of measurable social complexity.

54: DIPP: Diffusion of Privacy Preferences in Online Social Networks
Albert Mwanjesa, Onuralp Ulusoy and Pinar Yolum

Ensuring the privacy of users is a key component in various computer systems such as online social networks, where users often share content, possibly intended only for a certain audience but not others. The content users choose to share may affect others and may even conflict with their privacy preferences. More interestingly, individuals sharing behavior can change over time, which indicates that privacy preferences of individuals affect others and spread throughout the network. We study the spreading of privacy preferences in online social networks with information diffusion models. Using multi-agent simulations, we show the dynamics of the spread and study the factors (e.g., trust) that influence the spread.

55: On the impact of misvaluation on bilateral trading
Sacha Bourgois-Gironde and Marcin Czupryna

Subjective biases and errors systematically affect market equilibria, whether at the population level or in bilateral trading. Here, we consider the possibility that an agent engaged in bilateral trading is mistaken about her own value of the good she expects to trade. Although it may sound paradoxical that a subjective private valuation is something an agent can be mistaken about, as it is up to her to fix it, we consider the case in which that agent, seller or buyer, consciously or not, given the structure of a market, a type of goods, and a temporary lack of information, may, more or less consciously, state an erroneous valuation. The typical context through which this possibility may arise is in relation with so-called experience goods which are sold while all their intrinsic qualities are still unknown (like, e.g. untasted bottled fine wines). We model that "private misvaluation" phenomenon. The agents can also be mistaken about how their exchange counterparts are themselves mistaken. Formally, they attribute a certain margin of error to the other agent which can differ from the actual way that other agent misvalues the concerned good. We model different attitudes with which the agents proceed these unexpected signals and the extent to which they revise their beliefs. We analyse and simulate the consequences of first-order and second-order private misvaluation on market equilibria and bubbles, and notably focus on the context where the second-order expectations about the other agent's misvaluation are not met.

56: From the lab to the model: Exploring the dynamics of a social norm of honesty in a participative budgeting setting
Matthias Meyer and Jannick Plähn

Experimental research in accounting shows that firms can increase honesty, which is crucial in participative budgeting, by activating a social norm of honesty. Still, initial high levels of honesty may quickly erode because managers use examples of dishonest behavior to justify their dishonest reporting behavior. Thus, we investigate under which circumstances an activated social norm of honesty stabilizes in a participative budgeting setting. Primarily, our study investigates whether peer pressure (i.e., being observed by and ex-posed to social sanctions of other peers) can stabilize a social norm of honesty. Therefore, we use a sequential combination of laboratory experiments with agent-based modeling to build on their complementary methodological advantages. First, we conduct an experiment to investigate how peer pres-sure affects managers' reporting behavior. Second, we replicate the agent-based social norm model by Bicchieri and Funcke (2018). Third, we adapt the model to our participative budgeting setting, integrate the threat of so-cial sanctions by peers, and use the data from our experiment for empirical input validation.

57: Toward Capturing the Underlying Offensive Mechanisms of Social Manipulation: A Data Model Approach
Amir Ebrahimi Fard and Clara Maathuis

The dramatic growth of social media platforms has offered unprecedented opportunities for large-scale Information Operations. Although charming from the offensive perspective, social manipulation would be extremely concerning for the public as it might influence political, economic, and social well-being. Hence it is of the utmost importance to counter this growing threat. Among the existing solutions, they mainly adopt a passive approach which is reactive and after-the-fact. Besides, they focus on the impacts, rather than the functional mechanisms leading to the formation of manipulation campaigns. This article aims to tackle the above-mentioned problems by proposing a data-model that can capture the underlying mechanisms of the social manipulation operations. This model takes a proactive stance against social manipulation and provides us with an opportunity of developing preemptive measures. To implement this approach, an ontology model is developed in an iterative procedure. The model is evaluated through experts' opinion and exemplification on two notoriously famous social manipulation campaigns. The model developed in this study may influence the predominant approach to counter manipulation campaigns in social media and puts forward a new path toward dealing with this problem.

58: Consumer Participation in Demand Response Programs: Development of a Consumat-based Toy Model
Judith Schwarzer and Dominik Engel

Modeling of the smart grid architecture and its subsystems is a basic requirement for the success of these new technologies to address climate change effects. For a comprehensive research especially on effects of demand response systems, the integration of consumers' decisions and interactions is essential. To model consumer participation in demand response programs this

paper introduces an agent-based approach using the Consumat framework. The implementation in NetLogo provides high scalability and flexibility concerning input parameters and can easily interact with other simulation frameworks. It also forms a possible basis for an overall demand response consumer model. As a so-called toy model, simple correlations in this socio-technical scenario can already be explored.

59: Balancing the Vicious Circle of Organizational Resistance to Change: An Agent-Based Approach

Orsolya R. Szabó and Davide Secchi

Leading change management processes in organizations has become the reality of many companies amid the global COVID-19 pandemic (Amis and Greenwood, 2021; Lozano and Barreiro-Gen, 2021). This is driven either by involuntary changes to the aim of business or by the need to continue to keep productivity while adapting to new working circumstances (Gonçalves et al., 2021). In short, the pandemic has generated newfound challenges to cope with dynamic, uncertain change. In this context, understanding individual and group behavioral factors that generate resistance to change (RTC) (Dent and Goldberg, 1999; Ford and Ford, 2008; Reed et al., 2020) through their complex and sensitive structural interdependencies becomes extremely important. Among other considerations, it is important because RTC greatly influences the outcome of any change management initiative, significantly affecting their success (Thomas and Hardy, 2011; Thomas, Sargent and Hardy, 2011). In order to shed some light on the mechanisms that affect the factors leading to success of management-driven change initiatives, this paper presents an agent-based computational simulation model (ABM) with a focus on team dynamics.

61: Support local empowerment using various modeling approaches and model purposes: a practical and theoretical point of view

Kevin Chapuis, Marie-Paule Bonnet, Neriane Da Hora, Christophe Le Page, Jôine Cariele Evangelista-Vale and Gustavo Melo

Theoretical trends in agent-based modeling (ABM) draw sharp lines that usually limit the expressiveness of models to fit their methodological box: KISS puts emphasis on parsimonious and tractable model for systematic simulation analysis, KIDS focuses on the use of data for model specification and simulation validation, while KILT highlights the involvement of stakeholders to build representative model and turn simulation into a learning tool. In this proposal, we stress the benefit to break the lines and reinstate the various agent-based model purposes, focuses and supports in the particular context of designing transformative ABM. The proposed perspective to burst methodological boxes is based on the creation of models to mix social actors and issues based on sub-models supporting a variety of theoretical approaches. To back this methodological claim, we detailed a 10 years-long modeling effort to represent and support community based management of renewable resources in the wetlands of the lower Amazon, in the Para state of Brazil.

64: COMMONSIM   A commons-grounded multi-sector agent-based   political economic utopia

Ernest Aigner, Lena Gerdes, Stefan Meretz, Hanno Pahl, Annette Schlemm, Manuel Scholz-Wäckerle, Jens Schröter and Simon Sutterlütti

The presented agent-based model translates a commons-grounded multi-sector political economic utopia into a social computational simulation. The theoretical utopia serves as a novel and radical vision aiming to upscale the idea of the com-mons, by following the critique of political economy as well as streams of critical theory and critical psychology. The main thought experiment to be analysed and tested eventually, is about negating the core institutions of capitalist development, such as the money form of capital, the state and the market. An ex ante mediation and coordination of needs is suggested to replace the capitalist ex poste mediation via markets. Needs are conceptualized twofold, there are sensual-vital and productive needs. They build the foundational characteristics for the presented com-plex agents who actively contribute to commons that are producing and providing life means and care means in a multi-sector input-output framework. The social structure of the provisioning process is complemented by a diverse group culture that is influencing an array of matching processes in the model. The political stability and feasibility of the social, ecological and economic reproduction in this commons-grounded utopia shall get tested with this model on large scale.

65: Surrogate agent-based models via gradient boosting tree, a preliminary analysis

Francesco Mattioli and Mario Paolucci

In this paper, we explore the use of gradient boosting trees to predict the outputs of an agent-based model over time. A method to speed up training by running simulations with a low computational cost is also proposed. Models with a very heterogeneous setup degrade the quality of the predictions.

66: Conspiracy network in Facebook pages during pandemic outbreak: An Agent Based Model of misleading information in an echo chamber

Vanessa Russo, Federico Cecconi, Eugenia Polizzi di Sorrentino, Mario Paolucci, Giulia Andrighetto and Mara Maretti

The research aims to build a simulation model capable of describing and analyzing the birth of a disinformation bubble within the Facebook Social Network. The objective of the research is based on the hypothesis that certain contents in the digital space have characteristics that make them desirable from Facebook pages and consequently by users' followers. In line with the research hypothesis, the simulation model has two outputs: one descriptive and one experimental. In the descriptive phase, the adherence of the model to the results detected empirically through Social Network Analysis was verified, while in the experimental phase the networks that emerge as the components of the model scenario vary, namely: (a) the probability that a page is selected in the process that creates a link between the page and the article; (b) the probability that an article is selected in the pool of articles is calculated based on the properties of the article. The preliminary results of the experimentation focus on the role of the issues of the articles in the formation of the page-articles network.

67: Using MBTI agents to simulate human behavior in a work context
Luiz Braz and Jaime Sichman

The use of agent-based simulations to study human behavior has provided a significant advance in a better understanding of the impact of the human factor in different contexts, including work. In this sense, instruments such as the Myers-Briggs Type Indicator (MBTI), which allows categorizing different individuals' personality types following their characteristics and behavioral preferences, can provide a significant advance in these studies. In this work, we intend to explore MBTI to simulate different psychological types described in the theory, in order to evolve the comprehension of human factors in organizations.

68: SEM2Agent - A Scheme for the Use of Structural Equation Model Data in Agent-Based Models
Laura Burbach, Lilian Kojan, Ziefle Martina and André Calero Valdez

As the interest in the use of agent-based models (ABMs) is increasing in the social sciences, so is the need for a standardized way to design, document and communicate about ABMs grounded in empirical research. This paper explores the use of structural equation model (SEM) data as a foundation for the design of agent-based models. Utilizing existing protocols for standardized creation of agent-based models like the ODD protocol, we introduce the SEM2Agent translation scheme, which provides guidance on designing agent-based models grounded in structural equation models in a standardized way. We then demonstrate the translation scheme and design two structural equation-based agent-based models exemplary. Our findings are that structural equation models can provide an excellent basis for some components of agent-based models, whereas other components such as the emergent and interactive aspect of the agent-based model have to be modeled independently from the structural equation model.

70: Inequality in the COVID-19 Pandemic and the Containment Measures: An Agent-based Exploration
Patrick Mellacher

I use the integrated economic-epidemiological agent-based model COVID-Town to explore the heterogeneous impact of the COVID-19 pandemic on different groups of people under varying policy scenarios.

73: Exploring Coevolutionary Dynamics of Competitive Arms-Races Between Infinitely Diverse Heterogenous Adaptive Automated Trading Agents
Nik Alexandrov, Dave Cliff and Charlie Figuero

We report on a series of experiments in which we study the coevolutionary ``arms-race" dynamics among groups of agents that engage in adaptive automated trading in an accurate model of contemporary financial markets. At any one time, every trader in the market is trying to make as much profit as possible given the current distribution of different other trading strategies that it finds itself pitched against in the market; but the distribution of trading strategies and their observable behaviors is constantly changing, and changes in any one trader are driven to some extent by the changes in all the others. Prior studies of coevolutionary dynamics in markets have

concentrated on systems where traders can choose one of a small number of fixed pure strategies, and can change their choice occasionally, thereby giving a market with a discrete phase-space, made up of a finite set of possible system states. Here we present first results from two independent sets of experiments, where we use minimal-intelligence trading-agents but in which the space of possible strategies is continuous and hence infinite. Our work reveals that by taking only a small step in the direction of increased realism we move immediately into high-dimensional phase-spaces, which then present difficulties in visualising and understanding the coevolutionary dynamics unfolding within the system. We conclude that further research is required to establish better analytic tools for monitoring activity and progress in co-adapting markets. We have released relevant Python code as open-source on GitHub, to enable others to continue this work.

74: A bibliometric survey of macroeconomic topics in ABM
Emiliano Alvarez, Juan Gabriel Brida and Silvia London

In recent decades, the analysis of economies and their different sectors has intensified through simulations based on agent-based models (ABM). This is especially relevant for macroeconomics, since these methodologies allow us to analyze macroeconomic phenomena from actions and the interaction between individuals. In this presentation, a bibliometric analysis of ABMs in macroeconomics is briefly shown from the information gathered in the databases of the Web of Science (WOS) and Scopus. The main results of this work show that ABMs have analyzed a wide spectrum of the most relevant topics in macroeconomics. There is a greater emphasis on credit crisis and financial instability, explained by the possibilities of this type of implementation to simulate network effects. These works are concentrated in a few research centers, mainly in Europe. In recent years, the agenda of topics to be addressed has grown, as well as the possibilities of a multidisciplinary agenda.

77: Momentum selection, distance decay and the fate of linguistic innovations
Henri Kauhanen

We use agent-based simulations to explore how linguistic changes resulting from momentum-driven utterance selection depend on the spatial decay of social interaction. Having calibrated the latter from large-scale data on human mobility, the simulation results suggest that increasing distance decay makes momentum-based changes more rather than less likely. The possible reasons for this inverse relationship are briefly discussed.

78: PANDORA - an Agent-Based-Model to analyze acceptance of (energy) policies, applied to policies targeting the German heating sector
Alexandra Pröpper and Friedrich Krebs

The common approach to evaluate policy instruments and their impacts is by using simulation or optimization models that project developments given the specific policy scenario. Those models typically assume a certain energy policy is enforced, and then examine its effects on different agents, the economy, and the environment. Human decision-making is usually simulated on the level of market-acceptance. The process of whether policies are accepted by the public often remains implicit within the model design. A better understanding of the public acceptance process

would not only improve policy scenarios, but also show what aspects of policies correspond with the society for a better policy design. In this paper, we present our modeling framework for the Agent-based model PANDORA (Policy AcceptaNce, Diffusion of Opinions and Relations among Actors) that illustrates the process of acceptance among a network of actors in face of an introduced policy measure. Individuals of the artificial population perceive information on a policy measure from the media or institutional actors. The model accounts for the interaction of socio-demographic and socio-psychologic factors on an individual's level, as well as factors related to policy perception, that are endogenously influenced by media and institutional actors.

79: Exploring the effect of external influences on model parameterization
Gary Polhill, Keith Matthews, Jiaqi Ge, Alison Heppenstall and Nick Malleson

We report on a study with an updated version of a previously published model of beef and dairy farms in Scotland. The updated model adds a simple incentive scheme as an `external influence' on the model's behaviour. Using Monte Carlo sampling of the parameter space of the model, we examine the effects these influences have on the model's calibration parameter distributions, and on the ontological factors influencing the `disappearing middle' empirical qualitative observation: that the numbers of small and large sized farms are increasing, whilst those of medium-sized farms are in decline.

80: Supporting the use of agent-based simulation models by non-modeller urban planners and architects
Liu Yang, Yuan Zhu and Koen van Dam

Simulation models can support urban planners and architects in evaluating their work against various metrics, making them a valuable tool in the design as well as stakeholder engagement. However, these simulation models are typically not implemented by the users, leading to questions around validation, incorporation of domain knowledge, explanation of the outcomes, and incorrect applications. This paper discusses the use of a simplified agent-based simulation model of the behaviour of citizens that was made to be understandable and, with some training, adjustable by non-modellers. This model was applied to a case study at Southeast University in China where MSc students were able to compare their plans for an urban area incorporating transit-oriented design and simulate how a synthetic population would use their proposed layout, both at the macro (neighbourhood) and micro (block) scale. Initial findings suggest that this approach allowed the non-modellers to get a better understanding of the role of simulation models in their work, raise new questions related to the justification of their work, and encouraged them to learn more about coding and model development. The experience also allowed them to ask better questions and better specify their requirements for simulation models that could support their work, in addition to being able to better explain the weaknesses of the approach and understand the possible impact of model simplifications. Overall, this work gave a first indication of how social simulation can be incorporated effectively in teaching non-modellers from design disciplines.

81: CINCH: Agent-Based Modelling of Physical Distancing in Hospital Staff Facilities Using the COM-B Behaviour Change Framework
Nick Gotts, Jared Wilson-Aggarwal, Elise Crayton, Carly Meyer and Ed Manley

The paper presents CINCH (Covid-19 INfection Control in Hospitals), a prototype model of physical distancing for infection control among staff in a Central London hospital during the Covid-19 pandemic. Information from hospital sources indicates that virus transmission to staff within the hospital has occurred mainly in communal staff areas, where staff often did not wear PPE or maintain recommended physical distancing. The model incorporates aspects of the COMB Behaviour Change Framework developed at University College London Centre for Behaviour Change, and is aimed at informing decisions about behavioural interventions in hospital and other workplace settings during this and possible future outbreaks of highly contagious diseases.

82: Towards Efficient Context-Sensitive Deliberation
Maarten Jensen, Harko Verhagen, Lois Vanhée and Frank Dignum

When developing social simulations we almost always have to consider the trade-off between many simple agents and few complex agents. However, using agents that can adapt their deliberation methods to the situation at hand can provide a solution. The technique allows for many agents that can perform complex deliberation if needed but generally use simpler less computationally intensive deliberation. The dynamic deliberation is based on the Contextual Action Framework for Computational Agents which interacts with the decision context. We use the smoking ban model as a running example and as basis for our proof of concept implementation that indicates how this dynamic model can move from complex to simple deliberations based on the context.

83: Better representing the diffusion of innovation through the theory of planned behavior and formal argumentation
Loic Sadou, Stephane Couture, Rallou Thomopoulos and Patrick Taillandier

Agent-based simulation has long been used to study the dynamics of adoption and diffusion of innovations. However, the vast majority of these works are limited to an abstract and simplified representation of this process, which does not allow to explain the reasons for the change of opinion of an agent. In order to go further in the explanation of these changes, we present a generic model based on the theory of planned behavior and on formal argumentation. Each agent has the possibility to exchange arguments with another and to build its opinion on an innovation from the set of arguments it knows. An application of the model is proposed to study the adoption of communicating water meters by farmers on the Louts river (South-West of France).

84: Improving speed of models for improved real-world decision-making
Jason Thompson, Haifeng Zhao, Sachith Seneviratne and Rohan Byrne

In 2020, the rapid expansion of the COVID-19 global health crises meant that the speed of model development and analysis was critical to ensuring the right results were placed in

decision-makers' hands as quickly as possible. For researchers in computational social science who may operate outside computer science faculties, making the leap between models built in platforms such as Netlogo and deployed on individual workstations vs high-performance computing (HPC) clusters can be great. Here, we present a set of generic tem-plates that can be used and adapted by computational social science researchers who have access to HPC clusters but require additional support for deploying their models on this infrastructure. We show the improvements in model speed that can be gained through this process and discuss the practical importance of improving model speed for policy and decision-making in the real world.

85: Open, Contingent, Adaptive and Reactive Resilience – using ABM and other tools to facilitate our collective survival in an uncertain world
Bruce Edmonds and Vahid Yazdanpanah

This work puts forward a particular perspective on achieving resilience in the face of deep uncertainty in complex systems. In principle, various forms of uncertainty — as lacking knowledge about the behaviour of the system and its involved agents — makes traditional planning ineffective. This calls for resilient systems that are able to adapt their behaviour and achieve their design goals, or simply survive, in view of unexpected shocks. In response, in this work, we distinguish different types of situations in which different strategies to maintain effectiveness and resilience play a role and propose requirements for the design and delivery of Open, Contingent, Adaptive and Reactive Resilience (OCARR) in the case of deep uncertainty.

86: Exploring cross-scalar interactions in innovation processes in agricultural social-ecological systems
Udita Sanga and Maja Schlueter

In this paper, we develop an empirically-driven agent-based model, Ag-Innovation, to (i) expand the conceptualization of innovations as a complex adaptive process operating across scales within social-ecological systems (ii) explore and compare the effects of two alternate mechanisms of innovation development and diffusion (exogenous, linear and endogenous, non-linear) on emergent properties of food and income distribution among farmers (iii) assess the range of conditions under which these two alternate mechanisms would be effective in improving farmer resilience under the context of a changing environment. The model explores the role of social learning and knowledge sharing within the actors in an agricultural innovation system in influencing farmer well-being and resilience. The paper serves as a thinking-tool to assess the effectiveness of exogenous foreign-aid driven innovation development juxtaposed with social innovations driven by endogenous actors and collective action.

87: Exploring regional agglomeration dynamics in face of climate-driven hazards: insights from an agent-based computational economic model
Alessandro Taberna, Tatiana Filatova, Andrea Roventini and Francesco Lamperti

By 2050 about 80% of the world's population is expected to live in cities. Cities offer spatial economic advantages that create agglomeration forces and innovation that foster concentration of economic activities, but for historic reasons cluster along coasts and rivers that are prone to

climate-driven flooding. To explore tradeoffs between agglomeration economies and the changing face of hazards we present an evolutionary economics model with heterogeneous agents. Our simulation results show that the model replicates the self-reinforcing and path-dependent agglomeration process common in economic geography. The likelihood and speed of such agglomeration strongly depend on the transport cost and magnitude of climate-driven shocks. In particular, shocks of different size have non-linear impact on output growth and spatial distribution of economic
activities.

89: Explaining Polarization by Coupling Dynamics of Opinions and Behaviors Under Conformity: A case study of face mask wearing during the COVID-19 pandemic
Tanzhe Tang, Amineh Ghorbani and Caspar Chorus

With the growing trend of polarization in public opinions and behaviors, especially during crises such as global pandemics and political unrests, polarization has become one of the most mysterious and eye-catching puzzles for sociologists. As Robert Axelrod questioned more than two decades ago, "if people tend to become more alike in their beliefs, attitudes, and behaviors when they interact, why do not all such differences eventually disappear?" [1]. The seemingly obvious incompatibility between conformity ("people tend to become more alike") and polarization ("not all such differences eventually disappear") has been echoed by several strands of opinion dynamics models, including models of negative influence [2], bounded confidence [3, 4], and persuasive arguments [5]. Despite their success in explaining polarization in opinions, disproportionately little attention has been given to behaviors. There is rarely any counterpart of the well-designed and sophisticated opinion dynamics models that can explain why people behave differently even under strong conformity to social norms. Meanwhile, opinions and behaviors are a pair of interacting concepts, hence analyzing opinions without behaviors is not sufficient to explain real-life opinion polarization. To explain polarization of both opinions and behaviors under conformity, we propose an agent-based modeling framework that couples dynamics of opinions and behaviors by integrating conformity theories/ models [6, 7, 8], action-opinion inference [9], and opinion dynamics [2-5].

91: How do value prioritization of nations relate to shared strategies for combatting the pandemic? An ABM approach
Molood Ale Ebrahim Dehkordi, Anna Melnyk, Amineh Ghorbani and Paulien Herder

The disruption caused by the COVID-19 global pandemic has significantly challenged societal structures and existing institutions [1], i.e., systems of rules and enforcement mechanisms that govern human behavior and interaction [2]. From the perspective of welfare economics and the capability approach [3], this crisis deprived societal well-being by threatening citizens' essential freedoms to pursue a good life [4]. The urge to secure the well-being of citizens invoked nation-states to deal with numerous dilemmatic situations where vital decisions need to be made in these uncertain situations. The well-being can be defined are in terms of granting essential "doing and being" like an opportunity to be healthy, employed and mobile by providing equal access to the healthcare services, job market and unrestricted mobility. It is a government's role to set institutions that would support citizens' well-being. Governing the global pandemic, while at the same time being ill-informed about the risks involved, has resulted in heterogeneous

institutional responses [5]. Conditioned in an un-certain situation [6], nation-states opted for different pathways in containing and resolving the health crisis. This paper suggests that national value systems play an important role in nation-states decisions. By referring to social psychologist Schwartz [7], we conceptualize values as "deeply rooted, abstract motivations that guide, justify or explain attitudes, norms, opinions and actions", and an analysis of which "can provide predictive and explanatory power" and "reflect [a] major social change in societies and across nations". Hence, the goal of this paper is to explore the potential relationship between changing value prioritization, induced by the global COVID-19 pandemic, and any institutional changes that occur during the pandemic. Agent-based modeling (ABM) is a powerful tool to deal with complexity and ambiguity of complex social systems (such as value systems of the societies in the time of crises) where modeling multiple factors and parameters under differ-ent conditions is needed [8, 9]. For modeling complex decision making processes, based on real data, it is beneficial to increase the degree of intelligence and learning in ABM, which has also been encouraged and highlighted in the literature [10-13]. Machine Learning (ML) techniques can provide a great potential to bring higher degrees of intelligence and learning into the models. ML allows for the development of more precise and reality-based models and provides better means for handling data [14]. In this work, we bring together computational capacities of ABM and ML techniques to explore the reprioritization of values and institutional changes during an abrupt event. We represent countries as agents whose decisions toward what strategy to implement to control disease spread are based on relevant country specifications. We use Schwartz Value Survey [7], ACAPS dataset on the COVID-19 government measures and EU COVID-19 datasets to inform our model.

92: Social Identity in Agent-based Models: A Systematic Review
Geeske Scholz, Nanda Wijermans, Rocco Paolillo, Torsten Masson, Martin Neumann, Émile Chappin, Anne Templeton and Geo Kocheril

Building agent-based models that represent human behavior in its social and environmental context is a challenge. The Social Identity Approach (SIA) from social psychology reflects a promising potential, as it describes how people behave while being part of a group, how groups interact and how these interactions and 'appropriate group behaviors' can change over time. While SIA is increasingly used in social simulation, a systematic review of SIA formalizations in agent-based models is so far missing. Comparing different SIA formalizations is important, as even slightly different interpretations, and thus, formalizations, of a theory might result in different model outcomes. In this ex-tended abstract, we present our impressions from a systematic review of the current state of SIA models. Our results show a diversity of application areas and formalizations of (parts of) SIA, from very abstract and simple to elaborate and detailed cognitive models.

93: Purposes of and Principles for ABM's in Policy Development: A Proposal
Alexander Melchior, Frank Dignum and Pinar Yolum

We propose three additional ABM purposes and a set of principles to effectively influence policy development processes. The purposes focus on the value of the modelling process of a model in a policy development. This differs from them usual focus on the purpose of a simulation. The

proposal is based on requirements for the ABM process in a policy development context and a case study.

94: Resource Distribution in Supply & Demand Systems
Laurin Hagemann

We want to compare two economic models by simulating their coexistence. A model of free markets and a distributed system based on peer-to-peer communication of supply and demand values. We model humans interacting with their municipality (defined by distance) based on a predefined societal contract. Individuals can break the contract under certain conditions and they can choose one economic model over the other, if it gains approval above a threshold in their municipality. Approval is modelled as a combination of perceived outcome and cultural belief. We hope to find convergences or game theoretical equilibriums towards one or the other system. We will be able to show causality between the results and the model's parameters. The model will be publicly available to be expanded upon, to be corrected, and most importantly to compare more complex systems against each other with different initial states.

95: Dynamics of Wealth Inequality in Simple Artificial Societies
John Stevenson

A simple generative model of a foraging society generates significant wealth inequalities from identical agents on an equal opportunity landscape. These inequalities arise in both equilibrium and non-equilibrium regimes with some societies essentially never reaching equilibrium. Reproduction costs mitigate inequality beyond their affect on intrinsic growth rate. The highest levels of inequality are found during non-equilibrium regimes. Inequality in dynamic regimes is driven by factors different than those driving steady state inequality.

96: Modelling social innovation with empirical calibrated models using HUMAT
Patrycja Antosz, Wander Jager and Loes Bouman

Computer simulations of human societies require an architecture capable of linking perception, motivations, decision-making and communication. HUMAT is an architecture capable of both formalising drivers and simulating processes underlying social dynamics that was developed for the purpose of a H2020 SMARTEES project to model ten cases of social innovations diffusion in European cities. The article demonstrates a replication of a real-life case of Groningen, The Netherlands, where an important park at the heart of the city for cars was closed for through car traffic as a result of a referendum. The simulation mimics the process of attitude formation, information exchange and casting the vote among 1994 Groningen residents.

98: Documenting Data Use in a Model of Pandemic "Emotional Contagion" Using the Rigour and Transparency Reporting Standard (RAT-RS)
Patrycja Antosz, Justin Lane, Ivan Puga-Gonzalez, Roger Normann and Leron Shults

This paper utilizes the recently developed Rigour and Transparency Reporting Standard as a framework for describing aspects of the use of data in an agent-based modelling (ABM) EmotiCon project studying emotional contagion during the COVID-19 pandemic. After briefly

summarizing the role of the ABM in the wider EmotiCon project, we outline how we intend to utilize qualitative data from a natural language processing analysis of Twitter data and quantitative data from a nationally representative survey in model building. The presentation during the SSC 2021 will elaborate on the out-come of implementing the idea.

101: CAFCA in a Pandemic
Corinna Elsenbroich and Harko Verhagen

This paper explores how different motivations for behaviours can be conceptualised and supported by data. We use the conceptual framework CAFCA [3] to distinguish motivations and use an UK Office for National Statistics (ONS) survey during the Covid-19 pandemic as an empirical foundation for this differentiation. We conclude the differentiation is important to keep in mind if ones goal is to develop high veracity agent-based models

102: Understanding complexities in small-scale fisheries: Combining stories and simulations
Emilie Lindkvist, Tim Daw, Elizabeth Drury O'Neill, Rosemarie Mwaipopo, Andrew Wamukota and Maja Schlüter

Communities around the Western Indian Ocean are adopting periodic octopus closures as an innovative way to improve livelihoods, economic and environmental sustainability in small-scale fishing communities. Important factors such as information, bylaws, and other design rules are well known however little is known about how these factors interact or how they play out over the short and long term, affecting men, women and other groups in the communities differently. We use an agent-based model combined with participatory fieldwork to identify interactions and outcomes within and across social groups, and at the community level over short- and long timescales.

104: An Evidence-Driven Model of Voting and Party Competition
Ruth Meyer, Martin Dolezal, Marco Fölsch and Reinhard Heinisch

In this paper we report on the development of an agent-based model (ABM) simulating the behaviour of voters and the positioning of political parties in Austria. The aim is to create what-if scenarios taking into account contextual changes, such as political crises as well as changes in parties' policy positions and voters' attitudes. Drawing on data from the Austrian National Election Study (AUTNES) and the Chapel Hill Expert Survey (CHES), we are able to map both demand- and supply-side characteristics. We present first results of the simulation analysis of applied strategies of voters and parties. This way, we are able to create first what-if scenarios that show how results of elections would change, if voters applied different strategies when deciding which par-ty to vote for. In developing a simulation for the case of Austria as a refer-ence model, we lay the foundation for more universal applications of ABM in political science.

105: An agent-based model to operationalize actor responsibilities and distributive justice in a stylized social system
Aashis Joshi, Emile Chappin and Neelke Doorn

As resilience and justice are acknowledged as crucial determinants of effective and fair climate adaptation action, it is desirable to know which patterns of societal conditions and actor responsibilities are favourable to resilient and just adaptation outcomes for differentially vulnerable and capable actors. Here we present early-stage results from an agent-based model of a stylized social system in which we represent a generic process by which individuals with unequal resource access capacities attempt to fulfil an essential need by interacting with social-environmental systems. To address unequal outcomes among actors with differential capacities to obtain this need, we introduce a set of actor responsibilities derived from distributive justice principles as agent behaviour rules. Preliminary results indicate that some configurations of actor responsibilities and allocation of societal resources fare better than others in helping achieve states of well-being that indicate resilience and social justice. We end by outlining some next steps for the research.

107: On running massive scale agent based simulation of a virtual city using Julia language
Przemyslaw Szufel

The advent of smart connected vehicles is changing the how the transportation networks operate in modern cities. The availability of constant data exchange technologies --- vehicle-to-vehicle (V2V) as well as vehicle-to-infrastructure (V2I) models and the technologies for autonomous vehicles are being developed at a rapid pace. This technological shift brings new ways of transport network optimization - both for commuter traffic as well as for transportation system in general. One of the major challenges in this new emerging environment is to model behavior of participants of such system in order to (1) identify the optimal tolling policies for road access (mechanism design); (2) optimize the transportation network structure and (3) optimize location of other infrastructure that depends on traffic workflows. A transportation grid in such simulations is usually represented as a directed, weighted spatial graph with each vertex representing an intersection. In many cases understanding the dynamics of such model requires running of simulations in 1:1 scale which in turn results in hugely complex computational models possibly having millions of agents. In this paper a sample approach with general guidelines for construction of such massive scale simulations is presented.

108: A methodology to develop agent-based models for policy design in socio-technical systems based on qualitative inquiry
Vittorio Nespeca, Tina Comes and Frances Brazier

Agent-based models for policy design need to be grounded in empirical data. While many agent-based models rely on quantitative data such as surveys, much empirical research in the social sciences is based on qualitative research methods such as interviews or observations that are hard to translate into a set of quantitative rules, leading to a gap in the phenomena that ABM can explain. As such, there is a lack of a clear methodology to systematically develop agent-based models for policy design on the basis of qualitative empirical research. In this paper, a two-stage methodology is proposed that takes an exploratory approach to the development of agent-based models in socio-technical systems based on qualitative data. First, a conceptual framework centered on a particular policy design problem is developed based on empirical insights from one or more case studies. Second, the framework is used to guide the development of an agent-based

model. This step is sensitive to the purpose of the model, which can be theoretical or empirical. The proposed methodology is illustrated by an example application for disaster information management in Jakarta (Indonesia), resulting in an empirical descriptive agent-based model for the Marunda community.

109: Modelling co-constructed scenarios of district heat network adoption in Aberdeen
Doug Salt and Gary Polhill

We describe the ACHSIUM model of district heating network adoption in Aberdeen using the ODD protocol, and illustrate its use with an exploration of three scenarios that have been co-constructed with the model's stakeholders.

110: A hybrid agent-based model to simulate and re-think post-COVID-19 use processes in educational facilities
Davide Simeone, Silvia Ventura Mastrolembo, Sara Comai and Angelo Luigi Camillo Ciribini

The paper presents the development and application of a hybrid multi-agent system to simulate people's behavior in educational facilities, to support decisions and strategies related to the post-COVID-19 scenarios. Complex use phenomena as the ones occurring in schools and educational facilities, required mixed, hybrid simulation models where the agent-based component, usually con-trolling single users/bots, is combined with a process-driven engine that ensures correspondence of the users' behaviors to the general scenario. In our case, hybridization includes also the direct interaction of the intended users through a virtual reality 3D game, to further increase accuracy and adherence to the reality of the simulated phenomena. This paper also presents the application of the simulation model to a real case study, a school in Italy, where use processes have been simulated and currently under assessment during the school opening.

112: The effects of incentives, social norms, and employees' values on work performance
Michael Roos, Jessica Reale and Frederik Banning

This paper presents a theoretical agent-based model that treats monetary incentives, motivational factors and endogenous social norms as joint determinants of work effort and the resulting company performance. We use the model to answer the question of how incentives set by different remuneration systems affect shirking and cooperative behaviour in different organisational cultures, when agents are heterogeneous in their personal values. We compare the effects of a uniform payment scheme with identical salaries for all employees, an individual reward scheme with personal performance-related incentives and a collective reward scheme, in which incentives depend on group performance. A company's management can partly influence the organisational culture, e.g. by monitoring employees, but culture also evolves endogenously by employees' perception of what constitutes normal behaviour. The paper fills a gap in the research literature, since the influence of corporate culture and remuneration are usually treated in separate strands of the literature.

113: Automation-induced Reshoring - An Agent-based Model of the German Manufacturing Industry

Laura Merz and Juan C. Rocha

Industry 4.0 stands for the rise of innovative technologies, including industrial robots. Wider applicability of robotic automation and higher efficiency of production processes alter strategic relocation decisions. Automation is shown to drive the phenomenon of reshoring, thereby shifting global economic realities. As a consequence of this development, competitive la-bour cost advantages, formerly motivating industrial manufacturing firms to offshore production, become less relevant. Environmental regulations increasingly affect globalised supply chains and might also become a decisive factor for relocation decisions. Here, we explore reshoring from an agent-based perspective with the German manufacturing industry as a case study. The developed model allows the analysis of reshoring in the light of heterogeneous assets in terms of automation, capital, knowledge, and political environment. Thereby, we offer a nuanced perspective on automation-induced reshoring by shifting the focus from dominant economic reasoning for location strategies towards integrating environmental and social aspects as well. Simultaneously, popular debate is driven by increased environmental awareness and the proclaimed fear of robots killing jobs. In view of reshoring shaping the political agenda, interest in the phenomenon has recently been fuelled by the rise of populism and protectionism claiming to "bring jobs back home".