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September 13-18, 2021 – “Distributed” Remote Mode

Agent-based models and social interactions

17 September 2021

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Organizers:

Agent-based models and social interactions

Stephan Leitner

Paolo Pellizzari

Friederike Wall

Reputation and punishment sustain cooperation in the Optional Public Goods Game

Shirsendu Podder
Dpt. of Computer Science
University College London
Gower Street 66-72, WC1E 6EA London, UK
`shirsendu.podder.17@ucl.ac.uk`

Simone Righi
Dpt. of Economics
Ca'Foscari University of Venice
Fondamenta S. Giobbe, 873, 30121 Venezia, Italy
`simone.righi@unive.it`

Francesca Pancotto
Dpt. of Communication and Economics
University of Modena and Reggio Emilia
Viale Antonio Allegri, 9, 42121 Reggio Emilia, Italy
`francesca.pancotto@unimore.it`

Extended abstract ¹

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 (OPGG). 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

¹Special session: ABM SI.

Corresponding author: Simone Righi, `simone.righi@unive.it`.

Speaker: Simone Righi, `simone.righi@unive.it`

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 with an Agent-based model, 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 eliminate anti-social punishment.

Our contribution sheds light on the surprising success of reputation in a world under the contemporaneous threat of exploitation and of anti-social punishment. Finally, our results contribute to identifying the conditions that allow effective collective action in the presence of the possibility to opt-out of interactions.

Keywords

Agent-Based model; Evolution of Cooperation; Reputation; punishment; Optional Public Goods Game.

Fair Division of Goods in the Shadow of Market Values

Marco Dall'Aglio
Department of Economics and Finance,
Luiss University
mdallaglio@luiss.it

Extended abstract ¹

Inheritance, divorces or liquidations of companies require common assets to be divided among the entitled parties. Legal methods usually consider the market value of goods, while fair division theory takes into account the parties' preferences expressed as utilities. I combine the two practices to define a procedure that optimally allocates divisible goods with market values to people with preferences. To keep the number of split items to a minimum, we suggest a procedure that does not deliver bundles of exact equal (or proportional) monetary value, but one in which the differences in that value are explained in terms of satisfaction per monetary share as perceived by the agents.

The full paper is available at <https://arxiv.org/abs/1910.01615v2> **Key-**

words

Group Decision and Negotiation, Fair Division, Divisible Goods, Private Law.

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¹

Speaker:[Marco Dall'Aglio mdallaglio@luiss.it].

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An Agent-based model of informed and misinformed trading with learning by imitation

Gerotto Luca, Pellizzari Paolo and Tolotti Marco
Catholic University of Milan (GL) and Ca' Foscari University, Venice
paolop@unive.it

Extended abstract ¹

We consider a model of a financial market a là Grossmann and Stiglitz, where three types of boundedly rational agents can either trade buying a costly normal signal θ on the future return, $D + \theta_t + \epsilon_t$; alternatively, they can trade assuming that some fake news ζ_t is informative when indeed it's not, see [1], as $\zeta_t \perp \epsilon_t \perp \theta_t, \forall t$. Agents can choose not to use any signal and stay uninformed. Minimal learning capabilities are introduced in the model: intuitively, every T periods, agents change behaviour when they see that other strategies happen to have produced higher revenues. This copycat learning mechanism is augmented with tiny rates of random mutations. We retrieve some of the findings of the original Grossmann and Stiglitz model and obtain several novel and sharp results.

First, we obtain an equilibrium, where the probability to gain more than other strategies is the same as the one of getting less, for all types. We named this peculiar situation, in which no agent has the incentive "in probability" to switch to another type, a "median equilibrium". In the special case with only two types, we provide a semi-analytical expression for the equilibrium fractions.

Second, through numerical simulations of an agent-based model, we show that the extinction of misinformed agents is obtained only when $T \rightarrow \infty$ and mutation vanishes. In other words, the presence of misinformed traders is pervasive and robust.

Third, even when the misinformed agents asymptotically fade away, their decay is extremely slow when T takes low values, i.e., agents (quite) often revise their strategy regarding which information to consider (if at all). Hence,

¹Pellizzari Paolo. Cluster: Agent-based models and social interactions

trading based on fake news is likely to be observed often. This nicely agrees with the informal observation that agents often are myopic and do not allow themselves a long span of time T to gather data and critically gauge the quality of the available news, see [2].

Keywords

Agent-based models; Financial markets with information; Median equilibrium; Bounded rationality; Fake news.

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New results about probabilistic strategies for the iterated prisoner's dilemma

Mathieu Philippe

CRIStAL Lab, UMR 9189 CNRS, University of Lille, France
philippe.mathieu@univ-lille.fr

Delahaye Jean-Paul

CRIStAL Lab, UMR 9189 CNRS, University of Lille, France
jean-paul.delahaye@univ-lille.fr

Extended abstract ¹

Computational game theory or algorithmic game theory is a discipline that allows the formal study of the behavior of interacting agents. Unlike practical MAS applications, it is in this formal framework much easier to design behavioral strategies and to provide tools to evaluate them. It is therefore a very useful research area for the MAS community since it allows the design of tools adaptable to practical situations. Since its description by R. Axelrod et W. Hamilton in 1981 [1] the iterated prisoner's dilemma (IPD) has been the subject of a large number of studies and publications [4]. Particularly, many works and articles about probabilistic strategies for the prisoner's dilemma have already been realised. In this line of thought, Press & Dyson 2012 article [2, 3] has lead to renewed interest in the subject. In this presentation, with the help of a systematic study of probabilistic memory-one strategies, we show that there is a basic criterion to configure and anticipate their success. This criterion, identified through the study of large homogeneous sets of strategies, is then compared to other similar criteria. Our experimental method has allowed us to discover new strategies that are efficient not only in probabilistic environments, but also in more general, probabilistic or non-probabilistic environments [5]. We test the robustness of our results

¹Special session: Agent-based models and social interactions

Corresponding author: Philippe Mathieu, philippe.mathieu@univ-lille.fr

Speaker: Philippe Mathieu, philippe.mathieu@univ-lille.fr

by various methods and compare the new strategies obtained with the best strategies currently known.

Keywords

Iterated prisoner's dilemma, probabilistic strategies, Simulation, Agents' strategies, Evolutionary game theory, Behaviour

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Shall Fiscal Policies be Centralized in a Monetary Union?

A Dynamic Game Approach

Reinhard Neck

Department of Economics, Alpen-Adria Universität Klagenfurt, Austria

Reinhard.neck@aau.at

Dmitri Blueschke

Department of Economics, Alpen-Adria Universität Klagenfurt, Austria

Dmitri.blueschke@aau.at

Extended Abstract ¹

In this paper we present an application of the dynamic tracking games framework to a monetary union. We use a small stylized nonlinear two-country macroeconomic model of a monetary union for analysing the interactions between fiscal (governments) and monetary (common central bank) policy makers, assuming different objective functions of these decision makers. Using the OPTGAME algorithm we calculate solutions for two game strategies: one cooperative (Pareto optimal) and one non-cooperative game type (the Nash game for the feedback information pattern). Applying the OPTGAME algorithm to the MUMOD2 model [1], we show how the policy makers react upon demand shocks according to these solution concepts. To this end we introduce two sequences of shocks on the monetary union. The first sequence of shocks aims at describing the dynamics in a monetary union in a situation similar to the economic crisis (2007-2010), the sovereign debt crisis (2010-2013) and the current Covid crisis in Europe. The second sequence of shocks serves to discuss macroeconomic policy strategies for these shocks. In particular, we investigate the welfare consequences of two scenarios: decentralized fiscal policies by independent governments (the present situation), both under a non-cooperative and a cooperative mood of play, and a centralized fiscal policy under different assumptions about the joint objective function corresponding to different weights for the governments in the bargaining process assumed to precede the design of the common fiscal policy. We show the crucial importance of these weights (and hence of the regulations contained in the fiscal constitution of the union) for the results of the outcome in terms of sustainability of fiscal policies and main objective variables of the policy makers.

Keywords

Numerical methods; dynamic games; monetary union; fiscal policy centralization vs. decentralization.

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¹ Special session: ABM-SI

Corresponding author: Reinhard Neck, Reinhard.neck@aau.at

Speaker: Reinhard Neck, Reinhard.neck@aau.at

Macroprudential policy analysis via an agent-based model of the real estate sector

Gennaro Catapano
Financial stability Directorate, Bank of Italy,
Gennaro.Catapano@bancaditalia.it

Francesco Franceschi
Financial stability Directorate, Bank of Italy,
Francesco.Franceschi@bancaditalia.it

Extended abstract ¹

Housing markets are crucial in most economies: the value of the global real estate stock is the highest of any other asset class. This is particularly true for the Italian economy, given their importance for households, banks and the construction sector. Furthermore, as the financial crisis of 2007-2009 has shown, housing and mortgage sectors are critically important for financial stability.

In our work we extend and calibrate, with Italian data, the Agent Based Model (ABM) of the real estate and mortgage sectors described in [1]. We do so in order to study the effects of the introduction of borrower-based macroprudential measures.

Calibrating a large-scale ABM is still a challenging endeavor (see for example [2]): there is a plethora of methodologies available but little guidance in their choice; it is computationally very costly, even when using model surrogates. In order to overcome, at least partially, these difficulties, we design and employ a novel calibration procedure that is built on a multivariate moment-based measure and a set of three search algorithms: the Halton low discrepancy series; a metamodel built using a random forest classifier; a simple genetic algorithm.

¹Special session: ABM-SI.

Corresponding author: Gennaro Catapano, Gennaro.Catapano@bancaditalia.it.
Speaker: Gennaro Catapano, Gennaro.Catapano@bancaditalia.it.

With the calibrated and validated model we evaluate the effects of three hypothetical macroprudential policies, applicable to newly issued mortgages: an 80% loan-to-value cap; a 30% cap on the loan service to income ratio; a combination of both policies. We find that these policy interventions tend to slow-down the credit and housing cycles and reduce the probability of defaults on mortgages. However, these effects are very small over a five years horizon. This result is consistent with the view that the Italian household sector is already financially sound. Finally, we find that restrictive policies induce a shift in demand toward lower quality dwellings. Due to household heterogeneity, this effect is stronger for market segments with a higher concentration of constrained households.

Keywords

Agent based model; Housing market; Macroprudential policy

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Interactions Between Individual Learning and Group Adaptation: An Agent-Based Modeling Approach

Dario Blanco-Fernandez
Digital Age Research Centre D!ARC,
University of Klagenfurt, Austria
`dario.blanco@aau.at`

Stephan Leitner and Alexandra Rausch
Department of Control and Strategic Management,
University of Klagenfurt, Austria,
`stephan.leitner@aau.at`, `alexandra.rausch@aau.at`

Extended abstract ¹

Organizations have often been studied unidimensionally: Researchers have focused on either the individual, the team or the organizational level [1]. Consequently, research that considers how the different levels interact is not extensive. We aim to contribute to the literature by employing a multidimensional approach that considers two different levels: The individual and the team. Following [2], we implement a multilevel design that considers the emergence of macro-level effects coming from micro-level behaviour to address a problem with practical relevance.

Our focus lies in complex tasks solved by groups of human decision-makers, and we study how the interactions between individual learning and group adaptation affect task performance. We implement an agent-based model based on the NK-framework [3]. In this setting, a population of agents with heterogeneous capabilities is modeled. These heterogeneous capabilities imply that agents differ in (i) the subtask they can solve and (ii) the solutions to this subtask they know. Agents are endowed with learning capabilities as they discover new solutions to the subtask over time. Since the agents' capabilities are limited, they need to form a group to solve the complex task.

¹Speaker: Dario Blanco-Fernandez, `dario.blanco@aau.at`

We allow agents to change the group's composition periodically, which we identify as the process of group adaptation. By changing how often agents learn and groups adapt, we mirror an organization that promotes a specific multidimensional policy. We measure the effects on task performance of applying a specific policy mix of individual learning and group adaptation. Our results suggest that task complexity plays a moderating role between the two policy variables. In particular, more complex tasks are associated with underproportional interactions between the policy variables. Promoting excessively individual learning and group adaptation can result in decreases in performance.

Keywords

Agent-based modeling; Complex task; Adaptation; Learning.

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Interacting non-linear reinforced stochastic processes: synchronization or no-synchronization

Irene Crimaldi

IMT School for Advanced Studies Lucca,
Piazza San Ponziano 6, 55100 Lucca, Italy,
`irene.crimaldi@imtlucca.it`

Pierre-Yves Louis

Université Bourgogne Franche-Comté, AgroSup Dijon
Dijon, 1 esplanade Erasme, 21000, Dijon, France
`pierre-yves.louis@math.cnrs.fr`

Ida G. Minelli

Università degli Studi dell'Aquila,
Via Vetoio (Coppito 1), 67100 L'Aquila, Italy,
`idagermana.minelli@univaq.it`

Extended abstract ¹

(at most 2000 characters - spaces included)

Rich get richer rule comforts previously often chosen actions. What is happening to the evolution of individual inclinations to choose an action when agents do interact? Interaction tends to homogenize while each individual dynamics tends to reinforce its own position. Interacting stochastic systems of reinforced processes were recently considered in many papers (see for instance [1, 2, 3, 5]), where the asymptotic behavior was proven to exhibit a.s. synchronization. In this talk, we present models and results from [4] where, even if interaction among agents is present, absence of synchronization may happen due to the choice of an individual non-linear reinforcement. We show how these systems can naturally be considered as models for coordination games, technological or opinion dynamics.

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Corresponding author: Pierre-Yves LOUIS, `pierre-yves.louis@math.cnrs.fr`

Speaker: Pierre-Yves LOUIS, `pierre-yves.louis@math.cnrs.fr`

Keywords

Interacting agents; Reinforced stochastic process; Non-linear Pólya urn; Reinforcement learning; Game theory

References

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Research under the microscope: A Simulation of the scientific the research process

Daniel Kurzawe
Research and Development Department,
State and University Library
University of Göttingen, Germany
kurzawe@sub.uni-goettingen.de

30.08.2021

Extended abstract ¹

I present a multi-agent simulation of the scientific research process (SRP). Members of the research community are represented as social agents and interact in a dynamic environment. In the simulation, different views on the SRP are interconnected.

As a complex and dynamic entity with many methodical, economic, linguistic, physical and social challenges, the SRP, is studied by many dedicated research disciplines. Their research subjects range from the theoretical structure of theories [1] to the interplay of the actors in research [2].

The simulation shows the interplay of three methodologically different layers: (1) a theory layer, (2) a social layer (3) and a society layer. Students, Researchers and Research Funders are the actors in this scenario and are represented as autonomous social agents. A set of actions, beliefs and abilities enable the agents to perform their actions. Several actions and action types are implemented which allow the agents to develop theories (analogue to Kuhns Theory life cycle [3]) and build theory networks. Examples of such actions are the observation of events happening in the simulated world, the publication of articles, the contribution to reviews or the application for research funds.

¹Special session: ABM-SI.
Speaker: Daniel Kurzawe, kontakt@daniel-kurzawe.de.

Agents conduct their actions in an interactive and dynamic world, which they can observe [4]. This world is represented in a frame consisting of a limited 2-d space $D = \langle x, y \rangle$ with a discrete and limited time T and a list of laws and events. A pattern of events through space and time form complex *event shapes* which determines laws and transform the world from t_i to t_{i+1} .

The application of the simulation is shown in experiments, which show aspects of the SRP. Examples are different strategies of research funding or the impact of open access publishing vs. traditional publishing methods. This social simulation is written in a custom simulation environment and implemented in SWI-Prolog [5].

Keywords

Social Simulation; Research Process; Philosophy of Science; Research Networks

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Local Environmental Quality and Heterogeneity in an OLG Agent-Based Model with Spatial Externalities

Andrea Caravaggio
Department of Economics,
University of Foggia
andrea.caravaggio@unifg.it

Mauro Sodini
Department of Law,
University of Napoli Federico II,
mauro.sodini@unina.it

Extended abstract ¹

Most of the theoretical contributions on the relationship between economy and environment assumes the environment as a good distributed homogeneously among the agents. The aim of this work is to weaken this hypothesis and to consider that the environment can have a local character even if conditioned through externalities by the choices made at global level. In particular, adapting the classical framework introduced in John and Pecchenino (1994) to analyze the dynamic relationship between environment and economic process, in this paper we propose an OLG agent-based model where each agent perceives its own level of environmental quality determined by her own decisions, and by the decisions of those living around her. What emerges is that, despite the attention devoted to local environmental aspects, the network externalities (determined through the scheme of Moore neighborhoods) play a fundamental role in defining environmental dynamics and they may induce the emergence of cyclical dynamics. The occurrence of oscillations in the local environmental quality is partially mitigated by the

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Speaker:[Andrea Caravaggio, andrea.caravaggio@unifg.it]. The abstract is submitted for the parallel session **Agent-based models and social interactions**.

presence of heterogeneity in individuals' preferences. Finally, when a centralized planner is introduced, the dynamics converge to stationary values regardless the assumption on heterogeneity of agents.

Keywords

Agent-Based Models; Overlapping Generations; Local Environment; Network Externalities.

References

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On the Effect of Social Norms on Performance in Teams with Distributed Decision Makers

Ravshanbek Khodzhimatov
Digital Age Research Center,
University of Klagenfurt
ravshanbek.khodzhimatov@aau.at

Stephan Leitner and Friederike Wall
Department for Management Control and Strategic Management,
University of Klagenfurt,
stephan.leitner@aau.at, friederike.wall@aau.at

Extended abstract¹

Social norms are rules and standards of expected behavior that emerge in societies as a result of information exchange between agents [3]. This paper studies the effects of emergent social norms on the performance of teams. We use the *NK*-framework [1, 2] to build an agent-based model, in which agents work on a set of interdependent tasks and exchange information regarding their past behavior with their peers. Social norms emerge from these interactions. We find that social norms come at a cost for the overall performance, unless tasks assigned to the team members are highly correlated, and the effect is stronger when agents share information regarding more tasks, but is unchanged when agents communicate with more peers. Finally, we find that the established finding that the team-based incentive schemes improve performance for highly complex tasks still holds in presence of social norms.

Keywords

agent-based models; *NK*-framework; social interactions; social norms.

¹Speaker: Ravshanbek Khodzhimatov

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