POLITECNICO MILANO 1863

ENVIRONMENTAL INTELLIGENCE LAB

Thesis title

Analyzing the stability of cooperative climate policies in the RICE50++ agent-based integrated assessment model

Short description

Every year diplomats of most countries meet at the Conference Of the Parties (COP) to discuss future strategies to mitigate climate change and reduce its impacts through adaptation. Climate agreements can be mathematically formalized as strategic games where heterogeneous agents try to maximize their own benefits, by taking decisions within a shared environment that affects each other.

Game Theory has thus been widely adopted to investigate the cooperative stability of climate coalitions [3]; however, these approaches are computationally intensive and are usually limited as they consider a small number of actors or introduce other simplifying assumptions. As a partial solution, game-theoretical approaches are sometimes substituted with agent-based models to examine the potential development of cooperation between actors or study cooperative stability [4].

We are interested in investigating the stability of the cooperative policies that result from the coupling of the EMODPS algorithm [5] with the RICE50++ model [6], a cost-benefit integrated assessment model with 57 autonomous agents. To this aim, we will test an alternative computational approach to examine agents' defection from cooperative solutions and their robustness to advance insightful policy design [7].

In particular, we expect the student to carry out the following activities:

1. Literature review: reviewing the state of the art for modelling climate change policy agreements under a game-theoretical and multi-agent perspective.
2. Run defection analysis for the agents and for hypothetical coalitions to assess the agents most likely to defect.
3. Assess the robustness of the defecting agents' newly found climate policies.
4. Include information from the defection analysis to improve the stability of the cooperative climate policies in the RICE50++.

Relevant courses and knowledge: Natural Resources Management / Advanced Environmental Systems Analysis

Number of Students: 1 or 2

Requisites*:* The student should be comfortable with data handling and programming skills (preferably C++ and Python, Matlab).

References

(1) Madani, K., 2013. Modeling international climate change negotiations more responsibly: Can highly simplified game theory models provide reliable policy insights?. Ecological Economics, 90, pp.68-76.

(2) Barfuss, W., Donges, J.F., Vasconcelos, V.V., Kurths, J. and Levin, S.A., 2020. Caring for the future can turn tragedy into comedy for long-term collective action under risk of collapse. Proceedings of the National Academy of Sciences, 117(23), pp.12915-12922.

(3) Lessmann, K., Kornek, U., Bosetti, V., Dellink, R., Emmerling, J., Eyckmans, J., Nagashima, M., Weikard, H.P. and Yang, Z., 2015. The stability and effectiveness of climate coalitions. Environmental and Resource Economics, 62(4), pp.811-836.
(4) Karatayev, V.A., Vasconcelos, V.V., Lafuite, A.S., Levin, S.A., Bauch, C.T. and Anand, M., 2021. A well-timed shift from local to global agreements accelerates climate change mitigation. Nature communications, 12(1), pp.1-7.
(5) Giuliani, M., Quinn, J.D., Herman, J.D., Castelletti, A. and Reed, P.M., 2017. Scalable multiobjective control for large-scale water resources systems under uncertainty. IEEE Transactions on Control Systems Technology, 26(4), pp.1492-1499.
(6) Gazzotti, P., Emmerling, J., Marangoni, G., Castelletti, A., Wijst, K.I.V.D., Hof, A. and Tavoni, M., 2021. Persistent inequality in economically optimal climate policies. Nature communications, 12(1), pp.1-10.
(7) Gold, D.F., Reed, P.M., Gorelick, D. and Characklis, G.W., 2021. Power and Pathways: Exploring robustness, cooperative stability and power relationships in regional infrastructure investment and water supply management portfolio pathways. Earth's Future, p.e2021EF002472.