Meta-ABS
Recursive Agent-Based Simulation

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Abstract

In this paper we ask what influence recursive Agent-Based Simulation has on the dynamics of a simulation. We investigate the famous Schelling Segregation and implement our agents with the ability to anticipate their actions by recursively running simulations. Based on the outcomes of the recursions they are then able to determine whether their move increases their utility in the future or not. We investigate the dynamics of the MetaABS implementation and compare it to the movement-strategy of the original model. We hypothesize that in the case of a deterministic future this approach allows the agents to increase their utility as a group but we hypothesize that this is not the case when the future is non-deterministic as the power to predict is simply lost in this case. Also we show that alone by looking at the implementation we can raise interesting philosophical questions about agents, anticipation, information, determinism. The main contribution of this paper is the introduction of recursive agent-based simulation, a completely new method in ABS, which we termed MetaABS.

1 Introduction

The 'meaning' of MetaABS is not really clear: how can it be interpreted? It is not so much about the dynamics but more on the philosophical questions it raises. But also we wanted to check if the same happens as in the recursive simulation paper [1] : deterministic vs. non-deterministic AND one-agent recursion or all-agents recursion
we are spanning up 3 dimensions: recursion-depth, replications, and time-steps
the agent who is initiating the recursion can be seen as 'knowing' that it is running inside a simulation, but the other agents are not able to distinguish between them running on the base level of the simulation or on a recursive level
We implemented our Meta-ABS in Haskell using the functional reactive programming paradigm following the Yampa library. We believe that pure functional programming is especially suited to implement Meta-ABS due to its lack of implicit side-effects and copying of data. The code is available freely under TODO: until now the whole things is implemented in functionalReactiveABS, when project and paper is finished, copy the code-base to metaABS and insert link

2 Background

2.1 Schelling Segregation

2.2 Extension to Schelling Segregation: movement strategies

3 Meta ABS

Informally, Meta-ABS can be understood as giving the agents the ability to project the outcome of their actions in the future. They are able to halt time and 'play through' an arbitrary number of actions, compare their outcome and then to unhalt time and continue with a specifically chosen action e.g. the best performing or in which they haven't died.

3.1 Formal description

explain the level two levels of recursion

3.2 Interpretation

TODO: how can be Meta ABS be interpreted?

4 Results

4.1 Non-optimizing movement

TODO: first show the dynamics of a difficult but solvable problem e.g. 51x51, 0.75 density, 0.5 similarity. TODO: cannot solve high density with high similarity: utility stays low

4.2 Global optimizing movement

TODO: show that global optimizing movement with can solve extremely difficult cases: 51x51, 0.9 density, 0.9 similarity. actually it doesnt mean it can really solve it but that it can increase the total utility dramatically compared to non-optimizing movement

4.3 Future optimizing movement

TODO: MetaABS - can it solve the difficult case which global optimizing can solve? - is it faster than global optimizing?

5 Conclusion and further research

References

[1] Gilmer, Jr., J. B., and Sullivan, F. J. Recursive Simulation to Aid Models of Decision Making. In *Proceedings of the 32Nd Conference on Winter Simulation* (San Diego, CA, USA, 2000), WSC '00, Society for Computer Simulation International, pp. 958–963.