

Meta-ABS

Recursive Agent-Based Simulation

Jonathan THALER

March 21, 2017

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 thing 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

2.1.1 Movement strategies

We distinguish between two movement-strategies: local and global.

2.1.2 Optimizing behaviour

We distinguish between multiple optimization-strategies: 1. none at all: agent just move depending on their movement-strategy to another place if they are not happy on the current one - they don't care

how the target place is in the present or in the future, they will decide again in the next time-step

2. optimizing in the present: agent pick a free place depending on their movement-strategy and move to it if it satisfies the condition 3. optimizing in the future: agent pick a free place depending on their movement-strategy and move to it if it satisfies the condition in the future 4. optimizing in the present & future: agent pick a free place depending on their movement-strategy and move to it if it satisfies the condition now and in the future - note that we can distinguish between conditions now and in the future: they may be the same or they may differ

we introduce the condition: either it makes them happy or it just increases their utility but ultimately does not make them completely happy

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?

how can we justify the ability of the agents to do that? real persons lack the information and the computational power to forecast such a complex problem.

4 Results

4.1 Experiment Setup

Setup: 50x50, 0.8 density, 0.8 similarity, torus-world, 50/50 red/green distribution, local movement-radius

5

Dynamics: - global happiness over time - happiness-change between steps

4.2 Future optimizing

a fraction pf agents is predicting: see what influence it has

- deterministic future vs. non-deterministic future questions: - 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.