1st Year Report

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Abstract

1 Part I: Basic Research

How can ABS/M be done in pure functional programming Haskell? Is it convenient? Are there special benefits / disadvantages to it?
- start with suitability of haskel / pure functional paradigm as implementation for ABS: take the programming paradigm paper for that. - extend section on Haskell with implementation details (no direct method/function call, parallelism, concurrency) - add special section on STM because its a killer-feature for concurrent ABS in Haskell - section on update-strategies following my submitted paper - EDSL for Functional Reactive ABS/M - model checking and reasoning by quickcheck: [3], [10]

2 Part II: Fields of Application

Applying the methods to ACE and / or Social Simulation. Need a short description of the fields and the usage of ABS/M there.
- section on ACE with special emphasis on simulated economies (ACE Trading World): gowdo equlibrium prices form? - section on Social Simulations with special emphasis on SugarScape: how do societies form? Also includes markets and trading - maybe this model is enough - my new idea: extend SugarScape with a metaphysical model of death and rebirth with karma

3 ACE

[13] gives a broad overview of agent-based computational economics (ACE), gives the four primary objectives of it and discusses advantages and disadvantages. She introduces a model called *ACE Trading World* in which she shows how an artificial economy can be implemented without the *Walrasian Auctioneer* but just by agents and their interactions. She gives a detailed mathematical

specification in the appendix of the paper which should allow others to implement the simulation.
MY INTERESTS: - Artificial agent-based economies: [13], [8], [9], [6], [1] - Artificial agent-based markets: [11], [4] - Agent-Based Market Design: [12], [2] negotiation: cant call methods on each other but how can we implement negotiation in a pure functional way?
- Qualitative Modelling - EDSL for qualitative, descriptive modelling instead of quantitative

4 Social Simulation

The SugarScape model [5] is one of the most influential models of agent-based simulation in the social sciences

4.1 SugarScape

The book heavily promotes object-oriented programming (note that in 1996 oop was still in its infancy and not yet very well understood by the mainstream software-engineering industry). We ask how it can be done using pure functional programming paradigm and what the benefits and limits are. We hypothesize that our solution will be shorter (original reported 20.000 LOC), can make use of EDSL thus making it much more expressive, can utilize QuickCheck for a completely new dimension of model-checking and debugging and allows a very natural implementation of MetaABS (see Part III) due to its recursive and declarative nature.

5 Part III: Phd Research

Describe the idea, motivation and research questions of the method I want to research

5.1 Research Questions

5.1.1 Main

How can Agent-Based Simulation be done using pure functional programming and what are the benefits and disadvantages of it? this is the main thread of my PhD, everything needs to be connected to this

How?

Benefits?

Disadvantages?

6 Meta Agent-Based Simulation

- TODO: i have only the idea but am lacking a theory or hypothesis for its use - meta need a kind of decision error measure to distinguish between various meta-simulations. also we need a mechanism to sample the decision space =¿ it can be considered to be an optimization technique.

6.1 Overview

6.1.1 Idea

Give each Agent the ability to run the simulation locally from its point of view do anticipate its actions and change them in the future thus introducing a meta-level in the simulation, from which the method derives its name.

6.1.2 Problems

- Definition of a recursive, declarative description of the Model.
- Perfect information about other agents is not realistic and runs counter to agent-based simulation (especially in social sciences) thus an Agent needs to be able to have local, noisy representations of the other agents.
- Local representation of other agents could be captured by Hidden Markov Models: observe what other agents do but have hidden interpretation of their internal state - these internal state-representations can be different between the local and the global version whereas the agent learns to represent the global version as best as possible locally.
- Infinite regress is theoretically possible but not on computers, we need to terminate at some point

6.1.3 Interpretation

It can be regarded as a Model of Free Will in ABS, which allows learning in an ABS environment in a new way - look on the section of interpretation.

6.1.4 Application

hypothesis: allows to model social and psychological phenomena like free will. Mostly in social sciences, maybe also in economics. Investigate SugarScape, PrisonersDilemma and ACE Trading World
TODO: question: what is the meaning of an entity running simulations? it strongly depends on the context: in ACE it may be search for optimization behaviour, in Social Simulation it may be interpreted as a kind of free will

6.1.5 Research Questions

1. How does deep regression influence the dynamics of a system? Hypothesis: TODO
2. How do the dynamics of a system change when using perfect information or learning local information? Hypothesis: TODO
3. Is a hidden markov model suitable for the local learning? Hypothesis: TODO
4. How can MetaABS best be implemented? Hypothesis: implementing a MetaABS EDSL in a pure functional language like Haskell, should be best suited due to its inherent recursive, declarative nature, which should allow a direct mapping of features of this paradigm to the specification of the meta-model

- functional programming perfect. standard toolkits (anylogic, netlogo, repast) are not capable of doing this - extend my existing EDSL for functional reactive agent-based simulation & modelling (FrABS/M) with recursive functionality

6.1.6 Related Research

TODO: [7] cite paper of recursive simulation: [ ] military simulation, [ ] not explicitly abs, [ ] implemented in c++, [ ] deterministic models seem to benefit significantly from using recursions of the simulation for the decision making process. when using stochastic models this benefit seems to be lost

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