

Balancing the Economy

A Multi-Agent Approach

Assignment 6 - Project proposal

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Bachelor thesis

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Introduction

In the current economic system all but too often the only resources limiting our possibilities to improve life quality are our constructed economical resources.

In the open letter issued by the Future of Life Institute (Tallinn, Tegmark, 2015), eradication of poverty is stated as “not unfathomable”. The authors of this letter, and many economists, computer and AI scientist with them, asks to focus AI research on, among others, maximising economic benefits while mitigating social adverse impact. This bachelor thesis will contribute to the later, mitigating social impact, by modelling and experimenting on an economic system with that goal at its core. The model will be further inspired by the societal design of the venus project by Jacque Fresco.

After a life long of studying natural and social sciences alike, futurologist Jacque Fresco came to believe all of the current human population could lead a fulfilling and abundant life with the resources we have got. If only we would design our economic system and use our technical skill to work for us instead of in favor of a few and against the many.

As stated by the Future of Life Institute people’s jobs are and should constantly be offsetted by automation. In this way we can maximise economic potential with AI on the one hand and free people of doing boring repetitive jobs on the other hand. In contrast to those positive effects of automation, it leads to instability in the availability of jobs and consequently in purchasing power of people as well. With automation we could, at some point, reach abundance, but under the current market conditions abundance is not something to strive for as it does not generate profit. When people lack purchasing power the AI optimised production outputs can not be sold.

Lack of purchases made is closely related to lack of purchasing power, but is hardly ever an indicator for the absence of needs to fulfill. The research her proposed aims to investigate the assumptions needed in an economic system in order for it to fulfill everyone’s demands including the demands of those without purchasing power in the current system. Because we probably could if we wanted to and our economic resources might not even be the limiting factor for that.

Research question

The ultimate question would be: if we now the resource availability and the amount of people we have to share them with, how can we then optimise everyone’s quality of life with their fare share of resources?

Or in fear of totalitarianism and one a more practical note, lack of comprehensive knowledge and adequate centralised computing power: how can we design the economic system in such a way that the economic interactions between all agents result in an optimal resource allocation for all agents.

For research purposes this question is restated as follows:

What are the minimal assumptions needed for a simulated economical system, which allocates available resources to fulfill the needs of all agents fairly and directly?

Literature review

Multi agent system (MAS) is the term used in the AI discipline for research on autonomous interacting agents. AI research on MAS is characterised by the methodological and functional design of such systems. Research is done on how agents can be implemented, made intelligent, can communicate, can collaborate, how beliefs, desires and intentions (BDI) of agents can be represented etc (Schumacher, 2001). The proposed research will draw extensively from these developed techniques (starting from Macal, 2014). The research can be predominantly described as a “can it be applied to” type of research but by proving this it can add to the knowledge of reaching a desirable distribution in systems where traditional value models can not be used.

Multi agent resource allocation (MARA)

A lot of research done on MARA is still the allocation of resources to agents with different demands and preferences by a centralised system. When the number of demands and agents scales up, the allocation can no longer be done by a centralised system. For decentralising resource allocations among large numbers of agents MARA research is pointed in the direction of commodity markets existing in the economy today predominantly using the technique of “continuous double auctions” (Chevalleyre, Dunne, Endriss,.. 2006). A double auction is one where both buyers and sellers propose a price, an auctioneer then determines the price after which all buyers who have indicated to buy at that price or higher and all sellers indicating to sell at that price or lower, buy and sell (Parsons, 2006). In a continuous auction this procedure is somewhat modified to accommodate the time components resulting in discriminatory pricing. This model however, is not suitable to the case of this project in which the task is to surpass direct exchange in favor of needs and gifts. There for asking for a fulfillment of the highest need by giving instead of selling to the “highest” bidder. Research done on MARA systems so far has focused on a different task than the type of MARA this research has set to achieve, either by centralising the decisions or by using money instead of need for resources based value. There can be drawn from the MARA research done into the fairness of allocations.

Agent based model (ABM) or agent based computational economics (ACE) are terms used for social scientific research. In the social sciences often systems comprised of individual, autonomous, interacting “agents” are studied. The social sciences makes use of models and simulations mimicking this behavior to gain insight in and explain the collective behavior of interacting agents. In the last decade agent based simulations have become an established tool within economic research to test behavioral hypotheses and gain insight in market functioning (Dawid, 2013). Gaining insight in current market function is not however the aim of the proposed research. The proposed research can be better described as market design. The research done by LeBaron and Tesfatsion (2008) can be referenced for thoughts on scale and robustness of economic models based on agents.

Agent based market design

(Marks, 2005) Market design with agents is done in either economics or computer science to fulfill a policy market wish in a specific sector in which a market has not established

itself historically eg. the magnetic spectrum, energy, CO2, etc. Agent based models are used when the envisioned market can not be molded into classical economic optimisation theories. This is always done to fit into the current economic system. The proposed research seeks to redesign current market systems for the better.

Method and Approach

Optimisation: available resources -> fulfil highest demand

Priority Feature: Demand does not explode

A multi agent simulation will be implemented in JAVA within the RePast framework. First the model start up phase will be used to set up all the basic economic interactions between the different agents. This will be the modeling of the environment and of all possible interactions agents can have with their environment and with other agents. The goal is the have the model running as fast as possible after which details can be filled in and assumptions can be taken out. Once those interactions are in place, decision tools and policies for the agents will be implemented to optimise their actions. During the modeling a lot of economics and AI related issues to consider will be encountered and dealt with including but not limited to additional literature study. Along the way all design choices will be carefully monitored, reported and evaluated. Once the agents and their interactions with a randomised environment are in place, experiments will be conducted as to which agent properties influence the systems behavior in the desired direction. The reporting on design choices, based on feasibility and literature review in each step, together with the experimental results will make up the final thesis.

Evaluation

The model will be evaluated based on its capabilities to fulfill word demands from a book with the letter resources. in this way there is a known optimal allocation and it is an accessible way of getting test data. See figure 1 for example output graphs.

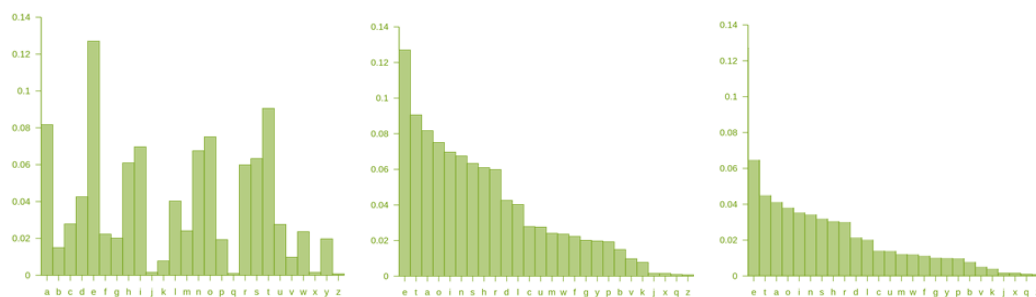


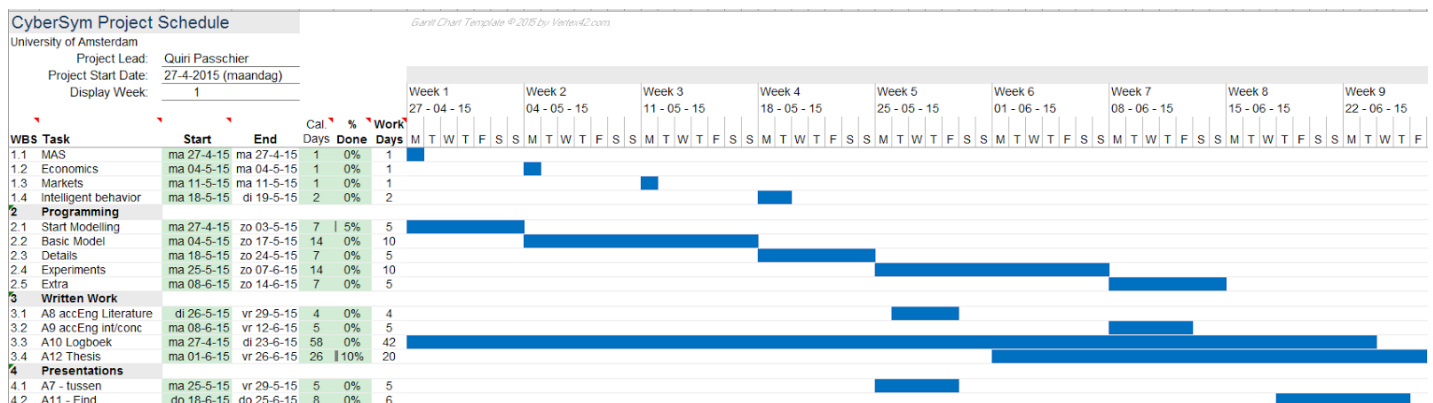
figure 1: a) Letter distribution in the english language. b) Letter distribution sorted by the highest demand. c) A possible stage of the model, The highest demand is fulfilled the most.

In evaluating the model it is set to minimise average waiting time to get a demand fulfilled and, connected, maximise number of demands fulfilled. Those variables can be easily measured and therefore optimised and used as evaluation numbers.

To find the bare minimum requirement for equilibrium evaluation will be done from the beginning on a simple but working model, more features will be added. In this process unrealistic assumptions will be taken out, but idealistic assumptions may have to be put in to keep the balance. A starting question will be: can it work with two agents?

It has to possibility to start from the current economic system and try to improve from there has to be established. It is expected if agents were to be modeled to die when their needs are not fulfilled agents will typically live longer in the new system.

Plan



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