Charles University in Prague
Faculty of Mathematics and Physics

BACHELOR THESIS

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Komunikace a paměť pro plausibilní agenty
Communication and memory in plausible agents

Department of Theoretical Computer Science and Mathematical Logic

Supervisor: Mgr. Ondřej Sýkora

Study programme: General Computer Science

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Na tomto místě mohou být napsána případná poděkování (vedoucímu práce, konzultantovi, tomu, kdo půjčil software, literaturu, poskytl data apod.).

Prohlašuji, že jsem svou bakalářskou práci napsal(a) samostatně a výhradně s použitím citovaných pramenů. Souhlasím se zapůjčováním práce a jejím zveřejňováním.

V Praze dne Jméno Příjmení

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Abstrakt: V předložené práci studujeme ... Uvede se abstrakt v rozsahu 80 až 200 slov. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut sit amet sem. Mauris nec turpis ac sem mollis pretium. Suspendisse neque massa, suscipit id, dictum in, porta at, quam. Nunc suscipit, pede vel elementum pretium, nisl urna sodales velit, sit amet auctor elit quam id tellus. Nullam sollicitudin. Donec hendrerit. Aliquam ac nibh. Vivamus mi. Sed felis. Proin pretium elit in neque. Pellentesque at turpis. Maecenas convallis. Vestibulum id lectus. Fusce dictum augue ut nibh. Etiam non urna nec mi mattis volutpat. Curabitur in tortor at magna nonummy gravida. Mauris turpis quam, volutpat quis, porttitor ut, condimentum sit amet, felis.

Klíčová slova: klíčová slova (3 až 5)

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Abstract: In the present work we study ... Uvede se anglický abstrakt v rozsahu 80 až 200 slov. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut sit amet sem. Mauris nec turpis ac sem mollis pretium. Suspendisse neque massa, suscipit id, dictum in, porta at, quam. Nunc suscipit, pede vel elementum pretium, nisl urna sodales velit, sit amet auctor elit quam id tellus. Nullam sollicitudin. Donec hendrerit. Aliquam ac nibh. Vivamus mi. Sed felis. Proin pretium elit in neque. Pellentesque at turpis. Maecenas convallis. Vestibulum id lectus. Fusce dictum augue ut nibh. Etiam non urna nec mi mattis volutpat. Curabitur in tortor at magna nonummy gravida. Mauris turpis quam, volutpat quis, porttitor ut, condimentum sit amet, felis.

Keywords: klíčová slova (3 až 5) v angličtině

Chapter 1

Introduction

[What I deal with] In modern society the amount of information is far behind what one can remember or even process. If we understand that, we realize how important is to be able to communicate in a group. The decision making in groups and teams is a topic covered by several papers. [citation required] Supposing we have limited capacity of memory, we have to distribute the knowledge amongst people around us and communicate with each other so as to gather facts which we currently need to make the decision.

Our decisions are either explicitly or implicitly based on our needs or drives - former term might be rather connected with human behavior, latter term is used for plausible agents. As in microeconomics we can use an utility as a measure of relative satisfaction [1] and see how one manages fulfilling their needs. While attaining the goals we use a knowledge which we store in our memory and which we update regularly. With infinite memory we wouldn't have any problems to store all information and use it when required; however, we don't have such memory - our memory is limited.

What I mean by saying "not to have enough space in our memory" is one is not able to remember everything. Certain pieces of information are fading away as time goes or as one is learning new facts. I want to observer if and how an intensive communication can substitute insufficient memory space with the condition of constant level of utility.

[Why it is important] Why?

[How I am going to solve it] I want to demonstrate that there is a relation between amount of communication and needed space in memory and that the relation is different in various situations and environments. I will create a multi-agent system with several environments where agents will communicate at a basic level of sharing information about food locations. Hunger is going to be their drive and their motivation to move around the environment in search for food.

[Structure of the work] Later.

Chapter 2

Related work

2.1 Agents

There are several ways where to start explaining what or who the agent is. Apart from systems of agents used in philosophy or sociology, we can see a first modern use of agency and agents in economy where economists have substited the human with a simpler agent. They intended to simplify their economic models to be able to actually simulate something. Buyers and sellers are typical examples of agents used in simplified market model in microeconomics (see []). In this context agents are entities in the model which can act based on situation in the model.

For area of artificial intelligence we can use the definition of an agent which can be found in [7]. It cannot be more simple:

Definition 1 Agent *is just something that acts.*

Of course it is as general as it could be and for my purposes it is too simple, so I will use another definition which meets better the context of my work.

Definition 2 Agent *is something that senses the environment and affects it using its actuators.*

Having that defined we continue to specific kinds of agent

A rational agent refers back to economics where we can find a definition of rational behaviour. Even though it is rather a hypothetical model, as people are usually irrational in their decisions from the economics perspective, their is yet nice definition whereby a rational agent acts as if balancing costs against benefits to arrive at action that maximizes personal advantage (Milton Friedman (1953), Essays in Positive Economics).

A plausible agent

A narrative agent

2.2 Spatial resource-bounded memory

[4]

Chapter 3

Used algorithms

In previous chapter you have been familiarized with several kinds of agents, how they can be used and also what a spatial memory is. I have briefly prepaired you for the next chapters, where I will explain my contribution to this area. This chapter is going to cover the used algorithms and computational methods I have studied and implemented in my work.

The first subsection disserts on the implementations of agents' memory and in detail describes fundamental parts. Both the Growing Neural Gas and the Quad..blah are used as memory storages to handle spatial information about the environment with bounded resources.

3.1 Growing Neural Gas

3.1.1 Topology learning

Having an enormous spatial data about an environment it is computationaly demanding to process them when for example we want to navigate in the environment. A topology learning or recognition can help us to create a representation such as topological map which can be viewed as a graph and which makes reasoning in that environment much easier. Rather complex understanding of topology in an indoor space using Bayesian programming has been shown in [8]. It goes much farther than I need to.

Based on competitive Hebbian learning (CHL) method [6] and Neural Gas (NG) [5] Bern Fritzke suggested earlier mentioned Growing Neural Gas [3], an unsupervised learning method for finding a topological structure which reflects the topology of the data distribution. Although the combination of both CHL and NG is an effective method for topology learning, there are some flaws in practical application as it requires an initial setup of number of nodes/centers that are used. This fact prevents the method from adequately describing the topology, when a different number of nodes would work better.

As Fritzke described the algorithm uses a set of nodes and edges that connects the nodes. A simplified describtion of algorithm in context of two-dimensional space follows:

1. Add two nodes at random position onto canvas
2. Generate input signal based on the data distribution (its probability density)
3. Find the nearest node n_1 and second nearest node n_2 to the signal
4. Increment the age of all edges leading from node n_2
5. Moved node n_1 and its topological neighbors towards the signal (according to parametres $epsilon_{winner}$ and $epsilon_{neighbour}$)
6. Remove all edges with an age larger than a_{max}
7. Generate new nodes
8. Go to 1.

For the purpose of this work I want to use this algorithm to learn a topology of dynamically changing data availability. In following subsection I am going to introduce you to the experimenting with this algorithm.

3.1.2 Experiments on dynamic data

3.2 Quad

The idea for this data structure representing resource-bounded memory is based on [1]. What differs in my work from their observed environment is agents in my simulation act in a homogeneous space which cannot be differentiated in a way the mentioned simulation does. To solve this issue I have found inspiration in Quad-tree structures [2] which are used, among others, for storaging more dimensional objects.

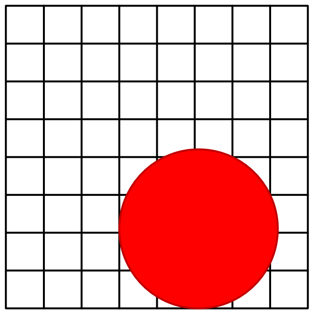

Figure 3.1: Example of a circle in two-dimensional space

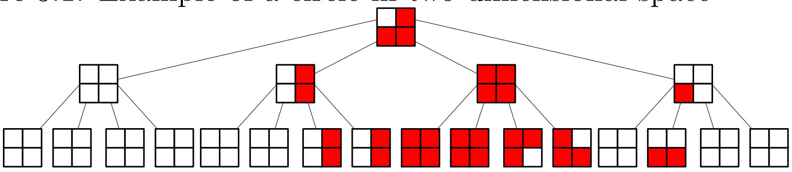

Figure 3.2: Quadtree structure of 3.1

Definition 3 *The* **quadtree** *is a tree structure where each node has exaclty four children.*

In 3.1 and 3.1 you can se an example how is a two-dimensional object such as a circle is stored in quadtree.

Similary I will use this structure to keep spatial information about the environment in the simulation.

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