Multi-agent systems

Course project description, 2016

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1 Introduction

This document describes the project assignment for the course on multi-agent systems. The objectives of this project are for students to get hands-on experience with developing multi-agent systems and with conducting scientific experiments in this domain.

2 Context

Route planning and task allocation are two problems that are faced when controlling a fleet of autonomous guided vehicles (AGVs) (Vis, 2006). Route planning concerns finding a route for a vehicle such that the vehicle arrives in time for the task to be performed while avoiding collisions and deadlocks. Task allocation concerns the assignment of vehicles to tasks. Other problems that are often faced with AGVs are battery management and failure management. For example, an AGV battery often needs to be charged or replaced at a specific location in a warehouse. This charging facility is capacitated and therefore imposes additional constraints on the AGVs actions. Failure management consists of handling AGV failures that require manual intervention, other AGVs need to route around a failed AGV to avoid getting stuck for the duration of a failure. Tasks that need to be performed are often the transportation of goods. Requests for transportation often arrive dynamically, a request consists of a pickup location, pickup time window, delivery location and delivery time window. A time window is defined by a begin time indicating the earliest start of servicing and an end time indicating the latest start of servicing. The goal of the fleet of AGVs is to service all requests as *efficient* as possible, where efficiency is defined by an objective function which depends on the specific problem.

3 Objectives

- Develop a multi-agent system for a problem in the logistics domain.
- Evaluate the behavior of the MAS.

The problem must consist of at least two of the following (combined) subproblems:

- Route planning
- Task allocation
- Additional constraints, such as batteries (power constraints) and failures

The approach that you define to solve the problem must be one of the following:

- Delegate MAS
- Contract-net protocol, combined/enhanced with negotiation or advanced dynamic contract-net
- ACO and gradient field
- Partial order causal link (POCL) planning
- Another technology, e.g, learning techniques such as neural networks, genetic programming, etc. combined with any of the techniques studied in this course. This has to be approved by the didactical team before you start working on it.

Groups start with defining exactly their own AGV problem, it is wise to choose a problem for which RinSim has built-in support to avoid implementation overhead. In particular, you need to be very precise in the problem definition and assumptions, and in the objectives.

4 Deliverables

- A detailed, technical report, approximately 10 pages, using the following outline:
  1. Introduction
     (a) objectives (more detailed than described above)
     (b) hypotheses
  2. Theory
  3. Multi-agent system design
     (a) design
     (b) comparison with existing MAS from literature
  4. Experiments
     (a) setup
     (b) results
     (c) analysis

5. Conclusion

- Implementation (a zip file containing all source code)

The theory section must be an in depth theoretical discussion of the chosen approach (approximately 3 pages).

5 Practical information

In this project, groups of two students implement and study multi-agent system solutions. Please find your partner as soon as possible, if you cannot find a partner, please use the Toledo forum or email Rinde van Lon.

For help with defining your objectives, hypotheses and experiment setup please refer to chapter 6 of the handbook by Schut (2007) on Toledo.

In April we will organize a feedback session where each team has the possibility to discuss their project. You will have a time slot of 5 minutes to present your project to the didactical team, followed by 10 minutes of discussion. During this meeting we expect you to present what you want to achieve/know, and how you plan to achieve your goals. From the report outline this covers: your objectives, hypotheses, MAS design idea (high level) and experiment setup. The time and place will be announced via Toledo.

The final submission deadline for the report is

Friday, June 3, 16h59.

Additionally, each group will give a presentation showing their work. The presentation and written report will be evaluated on the knowledge and insight that is displayed in the MAS domain.

RinSim is developed to be easy to use and the website provides installation instructions and examples to get started. Further, the code is open source and heavily documented and tested. If you have general questions about the simulator you can also ask them on `http://StackOverflow.com`, make sure you mention RinSim explicitly as this will trigger an email alert to us (we will try to answer your questions as soon as possible). In case you find a bug it is appreciated if you report this via GitHub's issues system. If you do this, please provide a detailed explanation (with code if possible) of how to reproduce the bug. If you find a bug and fix it (via a pull request) this *will* have a positive effect on your grade.

References

Schut, M. (2007). Scientific handbook for simulation of collection intelligence.

Vis, I. F. (2006). Survey of research in the design and control of automated guided vehicle systems. *European Journal of Operational Research*, 170(3):677–709.