Final Year Project Report

Full Unit - Interim Report

Resourceful Robots

Cougar Tasker

A report submitted in part fulfilment of the degree of

MSci (Hons) in Computer Science (Artificial Intelligence)

Supervisor: Dr. Anand Subramoney

Department of Computer Science
Royal Holloway, University of London

November 2, 2023

Declaration

This report has been prepared on the basis of my own work. Where other published and unpublished source materials have been used, these have been acknowledged.

Word Count:

Student Name: Cougar Tasker

Date of Submission:

Signature:

Table of Contents

Abstract

This document serves as a layout and formatting template for your project report. It does not tell you how to write it, or what it should contain. It explains how it should be formatted and typeset. Please refer to your project booklet for information about report sizes, contents and rules.

NOTE: in your report, you should replace this with an appropriate Abstract for your project report.

Project Specification

Your project specification goes here.

Chapter 1: **Introduction**

The project report is a very important part of your project and its preparation and presentation should be of extremely high quality. Remember that a significant portion of the marks for your project are awarded for this report.

The format of the final report is fixed by the template of this document and the Department of Computer Science suggests its usage.

While this may sound like a rather prescriptive approach to report writing, it is introduced for the following reasons:

1. The template allows students to focus on the critical task of producing clear and concise content, instead of being distracted by font settings and paragraph spacing.
2. By providing a comprehensive template the Department benefits from a consistent and professional look to its internal project reports.

The remainder of this document briefly outlines the main components and their usage.

A **final project report** is approximately 15,000 words and must include a word count. It is acceptable to have other material in appendixes. Your **interim report** for the December Review meeting, even if it is a collection of reports, should have a total word count of about 5,000 words. This should summarise the work you have done so far, with sections on the theory you have learnt and the code that you have written.

Also remember that any details of report content and submission rules, as well as other deliverables, are defined in the project booklet

1.1 How to use this template

The simplest way to get started with your report is to save a copy of this document. First change the values for the initial document definitions such as `studentname` and `reportyear` to match your details. Delete the unneeded sections and start adding your own sections using the styles provided. Before submission, remember to fill in the Declaration section fields.

Chapter 2: **Markov Decision Processes**

Markov Decision Processes (MDP) provide a mathematical formalisation of problems that involve decision-making. Markov Decision Processes provide the foundation that reinforcement learning (RL) is built upon. This is because MDPs distil the fundamental parts of decision-making allowing RL techniques that are built upon MDPs to generalise to learning in the real world and across different domains such as finance and robotics.

As a formal mathematical framework, MDPs allow us to derive and prove statements about our RL methods built upon them. An important example of this is that we can prove that Q-learning (an RL technique explained in chapter 4) will converge to the true Q-values as long as each Action-State pair is visited infinitely often. [1]. Furthermore, MDPs allow us to reason about problems with uncertainty allowing RL agents to account for randomness in their environment.

The standardisation of decision-making problems as MDPs allows for a uniform definition of optimality with the value functions. this gives a basis for assessing the performance of RL algorithms. Fascinating like-for-like comparisons for different RL approaches.

2.1 Markov Property

The Markov property is that the future state of a Markov system only depends on the current state of the system. In other words, if we have a system that follows the Markov property then the history preceding the current configuration of the system will not influence the following state, all of the information about the system is encoded in the system's current state.

The Markov property put formally:

- S_t represents the state at some time t,
- c is the current time, and S_c is the current state

then the Markov property would hold if and only if:

$$P(S_{c+1} \mid S_c,\ S_{c-1},\ \ldots,\ S_0) = P(S_{c+1} \mid S_c)$$

This definition demonstrates how the Markov property can hold in non-deterministic, stochastic processes.

2.2 Markov chains

Markov Chains model a sequence of events.

2.3 Extending Markov Chains

Chapter 3: **Policy and value function**

Report on notions of policy and value function;

3.1 optimal policy/value function via the Bellman equation

3.2 Finding optimal policies by iteration

3.2.1 Value iteration

3.2.2 Policy iteration

Chapter 4: **Q-learning**

Chapter 5: **Page Layout & Size**

The page size and margins have been set in this document. These should not be changed or adjusted.

In addition, page headers and footers have been included. They will be automatically filled in, so do not attempt to change their contents.

Chapter 6: **Headings**

Your report will be structured as a collection of numbered sections at different levels of detail. For example, the heading to this section is a first-level heading and has been defined with a particular set of font and spacing characteristics. At the start of a new section, you need to select the appropriate LaTeX command, `\chapter` in this case.

6.1 Second Level Headings

Second level headings, like this one, are created by using the command `\section`.

6.1.1 Third Level Headings

The heading for this subsection is a third level heading, which is obtained by using command `\subsection`. In general, it is unlikely that fourth of fifth level headings will be required in your final report. Indeed it is more likely that if you do find yourself needing them, then your document structure is probably not ideal. So, try to stick to these three levels.

6.2 A Word on Numbering

You will notice that the main section headings in this document are all numbered in a hierarchical fashion. You don't have to worry about the numbering. It is all automatic as it has been built into the heading styles. Each time you create a new heading by selecting the appropriate style, the correct number will be assigned.

Chapter 7: **Presentation Issues**

7.1 Figures, Charts and Tables

Most final reports will contain a mixture of figures and charts along with the main body of text. The figure caption should appear directly after the figure as seen in Figure 7.1 whereas a table caption should appear directly above the table. Figures, charts and tables should always be centered horizontally.

Figure 7.1: Logo of RHUL.

7.2 Source Code

If you wish to print a short excerpt of your source code, ensure that you are using a fixed-width sans-serif font such as the Courier font. By using the `verbatim` environment your code will be properly indented and will appear as follows:

```
static public void main(String[] args) {
  try  {
    UIManager.setLookAndFeel(UIManager.getSystemLookAndFeelClassName());
  }
  catch(Exception e) {
    e.printStackTrace();
  }
  new WelcomeApp();
}
```

Chapter 8: **References**

Use one consistent system for citing works in the body of your report. Several such systems are in common use in textbooks and in conference and journal papers. Ensure that any works you cite are listed in the references section, and vice versa.

Chapter 9: **Project Information and Rules**

The details about how your project will be assessed, as well as the rules you must follow for this final project report, are detailed in the project booklet.

You must read that document and strictly follow it.

Bibliography

[1] C. J. Watkins and P. Dayan, "Q-learning," *Machine learning*, vol. 8, pp. 279–292, 1992.