CMPUT 652—Probability Models for Artificial Intelligence

Project

Fall 2003
Department of Computing Science
University of Alberta

Due: with instructor, *Monday, December 15*
Worth: 50% of final grade
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The goal of this project is to get you to tackle a probabilistic artificial intelligence problem of your own choosing. This requires you first to identify an interesting task that you would like a computer to perform. Note that it might be hard work to think about what you are really interested in, but it is crucial for the project remain open ended and in your hands. It is up to *you* to pick a problem you would like to solve, and then discover what it would really take to tackle it successfully. (You might try visiting the library, surfing the web, or even just thinking for a bit to get some ideas.) The intent of the project is to get you to start off with something interesting and ambitious (i.e. a system that you think would be really neat to build), and through the course of the project learn about the research that is going on in an interesting sub-area of probabilistic artificial intelligence, and also (more importantly) how to take a general idea and hone it down to a concrete and doable task. Along the way it is hoped that you will learn useful things, like:

- How to take a poorly defined problem and turn it into a concrete proposal (and then a concrete implementation and test).
- What is involved in solving the specific problem you are interested in, how hard it is to actually succeed.
- How partial progress can be sensibly made on difficult problems (or perhaps how not).
- How to read the research literature to find the ideas and techniques that might be relevant to your needs.

Experience in these areas will help you in whatever direction you follow in your professional career. In the end, however, the project is just a chance to learn more about some sub-area of probabilistic artificial intelligence that you might be most interested in, as well as create a potentially interesting system.

The basic types of projects in this course are:

1. *Empirical investigation of an application problem.*
2. *Experimental investigation of a technique (or techniques) in an abstract setting.*
3. *Theoretical investigation of a technique or problem.*

Marking

Your final project report should clearly articulate the *rationale* behind your project, in addition to simply reporting what you did and the results that were achieved. Below is a rough idea of the things that I will be looking for when grading the project reports. Note that this scheme is not intended to be a binding contract for exactly how I will mark the final project! It is only meant to give you guidance on the elements that I will typically be looking for. The specific marking scheme will be adapted to the different types of projects that are submitted (e.g., applied versus theoretical).

Background

- **Problem** (5%): As clearly as possible, describe the general problem you are working on, and explain the specific refinements and special cases that you addressed.
- **Literature survey** (5%): Briefly survey the existing work that has been done on your problem, as well as the existing work that has been done on the approach(es) you are considering. You should cite about 10-15 relevant references. Your survey need not be exhaustive, but you should try to cover the most important prior work if you can.

Methods

- **Approach** (5%): As clearly as possible, describe the approach(es) that you applied to the problem, and clearly specify the final system(s) that were implemented.
- **Rationale** (5%): Explain why you implemented the systems that you did. Specifically, explain the simplifications you made along the way, and why you made these particular choices (and not others). (For example, you might detail other approaches that could be applied to the problem and explain why these were not pursued.)

Plan

The most important (and most difficult) part of any research project is figuring out how to evaluate the results. You should state concrete goals for your project. In particular, you should identify at least three concrete hypotheses that you think would be interesting to test with your implemented system, and outline a specific plan for experiments that you would need to conduct in order to test each of these hypotheses. Testing these hypotheses should be stated as the concrete goals for your project.

Note: You should *not* phrase your project goals as "our technique will achieve great performance at task X". Rather, you should phrase your goals as tests of specific hypotheses whose outcome would be interesting no matter what happened (so that your project would succeed however the tests turned out). For example, rather than simply claiming "our technique will work great", it is better to formulate and test a hypothesis that would teach all of us something useful about the technique and problem, like: technique *blah* is robust to certain kinds of noise or perturbations in the problem (or perhaps not), or technique *blah* scales up feasibly in the size of problem X (or not), or technique *blah* is inherently limited in the ultimate performance capabilities it can achieve on problem X because of *blah blah* about the problem (or not), *etc.* This requires a little more thought than perhaps you are used to in planning a project.

- **Hypotheses** (6%): Clearly state the main questions that you investigated in this project. *These should be identified before you run the experiments!* Ideally, these should be interesting questions whose answer is not obvious beforehand, but the answer would be interesting no matter how the experiments turned out.
- **Experimental design** (7%): Once you have settled on some good questions, it is important to figure out how to answer them. For each main question, describe a series of experiments that is designed to answer the question. Explain the difficulties faced in designing these tests and explain why your experiments will overcome these difficulties to yield a definitive answer.

Experiments

- **Results** (5%): As clearly as possible, describe the results you obtained with your tests. Use plots, graphs, and tables, if necessary. Make sure it is easy to understand what happened.
- **Critical evaluation** (7%): In the end it is important to critically evaluate the results of the experiments. Did the experimental results answer the questions? If so, then what were the answers? If not, then why did the results fail to yield definitive answers? Is it then possible to formulate a new experimental strategy?

  Note that it is important to demonstrate critical thought in this part of your assessment. You will be graded more on the strength of your reasoning rather then how the tests actually turned out. For example, it is perfectly acceptable if you did not achieve definitive answers to your questions, so long as you can recognize this, explain why it happened, and suggest additional tests that might yield more definitive results.

Conclusion

- **Lessons learned** (5%): What specific things did you learn from doing this project? Did you learn anything about the problem itself, the approaches you tried, or the experiments you conducted? If there are any good ideas you came up with in the end but did not have time to pursue, this would be a good place to mention them.