Thus, for any nondeterministic Turing machine $M$ that runs in some polynomial time $p(n)$, we can devise an algorithm that takes an input $w$ of length $n$ and produces $E_{M,w}$. The running time is $O(p^2(n))$ on a multitape deterministic Turing machine and ...

WTF, man. I just wanted to learn how to program video games.
Instructor (me)

James Parker
Shepherd Laboratories 391
(not really in office)

Primary contact:
jparker@cs.umn.edu
Teaching Assistants

Arvind Renganathan,
Ivan Radkevich
Textbook

Artificial Intelligence
A Modern Approach, Russel and Norvig,
4th edition
Class website

www.cs.umn.edu/academics/classes
Or google “umn.edu csci class”

Syllabus, schedule, slides, homework posting
## CSci 4511W: Artificial Intelligence

### Schedule

This is an approximate schedule. It will be updated as the class progresses.

<table>
<thead>
<tr>
<th>Week</th>
<th>Week Of</th>
<th>Topics</th>
<th>Lecture Materials</th>
<th>ReadingsExams</th>
<th>Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jan. 20</td>
<td>Introduction: HI!</td>
<td>1/22</td>
<td>Ch. 1-2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Jan. 27</td>
<td>Agents, Problem Solving and Search</td>
<td></td>
<td>Ch. 2-3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Feb. 3</td>
<td>Search</td>
<td></td>
<td>Ch. 3-4</td>
<td>HW 1, Monday Feb. 3 at 11:55 P.M.</td>
</tr>
<tr>
<td>4</td>
<td>Feb. 10</td>
<td>Search and Heuristics</td>
<td></td>
<td>Ch. 4</td>
<td>Writing 1, Monday Feb. 10 at 11:55 P.M.</td>
</tr>
<tr>
<td>5</td>
<td>Feb. 17</td>
<td>Local Search and Game Playing</td>
<td></td>
<td>Ch. 5</td>
<td>HW 2, Monday Feb. 17 at 11:55 P.M.</td>
</tr>
<tr>
<td>6</td>
<td>Feb. 24</td>
<td>Game Playing</td>
<td></td>
<td>Ch. 5</td>
<td>Midterm 1, Monday Feb. 24</td>
</tr>
<tr>
<td>7</td>
<td>March 2</td>
<td>Game Theory</td>
<td></td>
<td>Ch. 17.5</td>
<td>Writing 2, Monday March 2 at 11:55 P.M.</td>
</tr>
<tr>
<td></td>
<td>March 9</td>
<td>Spring Break</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>March 16</td>
<td>Constraint Satisfaction</td>
<td></td>
<td>Ch. 6</td>
<td>HW 3, Monday March 16 at 11:55 P.M.</td>
</tr>
<tr>
<td>9</td>
<td>March 23</td>
<td>Propositional Logic</td>
<td></td>
<td>Ch. 8</td>
<td>Writing 3, Monday March 23 at 11:55 P.M.</td>
</tr>
<tr>
<td>10</td>
<td>March 30</td>
<td>First Order Logic</td>
<td></td>
<td>Ch. 9</td>
<td>HW 4, Tuesday Monday March 30 at 11:55 P.M.</td>
</tr>
<tr>
<td>11</td>
<td>April 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Class website**
Class websites: recap

Public CS website:
post HW, slides, schedule, office hours

Canvas: grades (discussion?)

Gradescope: HW submission, feedback for HW & tests (rubric)
Don't like my slides? =(

http://aima.eecs.berkeley.edu/slides-pdf/

Acting humanly: The Turing test

Turing (1950) “Computing machinery and intelligence”:
◊ “Can machines think?” → “Can machines behave intelligently?”
◊ Operational test for intelligent behavior: the Imitation Game

◊ Predicted that by 2000, a machine might have a 30% chance of fooling a lay person for 5 minutes
◊ Anticipated all major arguments against AI in following 50 years
◊ Suggested major components of AI: knowledge, reasoning, language understanding, learning

Problem: Turing test is not reproducible, constructive, or amenable to mathematical analysis
Prerequisites

1. Competent programmer and understand big-O

2. Understanding of data structures (graphs and trees)

3. Basic knowledge of formal logic (truth tables, boolean ops)
30% Homework (-15% per day late)
20% Writing assignments (-15% pdl)
15% Project
10% Midterm (Tuesday Oct. 14)
10% Midterm 2 (Tuesday Nov. 16)
15% Final (Thursday Dec. 16)
Homework

Homework and written assignments are individual assessments (unless explicitly stated otherwise)

Please ensure the work you turn in is your own
The writing assignments will use Latex (down with docx!)

The first few will be reviews of related topics and the last couple will tie into the project.

These can be resubmitted within two weeks of being returned for another regrade (once) for a maximum of +20
Exams

All exams are open book/notes (most people think they are hard)

You can use an electronic device if you want on exams, but no:
- phones
- internet
- running code (ish)
Exams

For now the exams are planned to be in-class for the whole period.

However, this is subject to change if things get unsafe.
# Syllabus

<table>
<thead>
<tr>
<th>Grading scale:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>93% A</td>
<td>77% C+</td>
</tr>
<tr>
<td>90% A-</td>
<td>73% C</td>
</tr>
<tr>
<td>87% B+</td>
<td>70% C-</td>
</tr>
<tr>
<td>83% B</td>
<td>67% D+</td>
</tr>
<tr>
<td>80% B-</td>
<td>60% D</td>
</tr>
<tr>
<td></td>
<td>Below F</td>
</tr>
</tbody>
</table>
Schedule

Week 1-4, Ch 1-4 - Intro & Search
Week 5-6, Ch 5, 17.5 - Game playing
Week 7-11, Ch 6-9 - Logic
Week 12-14, Ch 10, 12 - Planning
Week 15 - Special topics

There will be one assignment (or exam) every week (first assignment due Sept. 21)
The project will be a large part of the class and should be about 10-12 pages and include:

- Title, authors, abstract
- Introduction & problem description (1-2 pg)
- Literature review (2-3 pages)
- Description of your approach (2-3 pages)
- Analysis of results (1-2 pages)
- Conclusion and summary
- Bibliography
You may work on the project with partner, but we will expect higher quality of work.

If you form a group, you must also submit a the specific contributions of each member.

The project should reflect about 50 hours of work per person (including reading, programming and writing).
You pick the project, but must use knowledge representation (something interesting)

Some ideas:
- AI for a game (3D tic-tac-toe, board games...)
- Spam filter (naive Bayes probability)
- Use A* to plan paths around Minneapolis
- Agent behavior in a system (evacuation or disaster rescue)
- Planning (snail-mail delivery, TSP)
Project

Mario?
https://www.youtube.com/watch?v=qv6UVOQ0F44
CAN’T WE JUST USE ARTIFICIAL INTELLIGENCE TO MANAGE OUR SALES FUNNEL FOR US?

I FOUND FOUR PLACES THAT SELL FUNNEL CAKES FAIRLY CLOSE TO YOU.
Agent/robot

Let’s start by defining what we mean by artificial (i.e. robot)

For our purpose, a robot/agent:
- Perceives the environment
- Pursues a goal (and knows it)
- Can manipulate/affect environment
Agent/robot

Is this a robot?

.... How about this?
Intelligence

What is intelligence?
What is intelligence?
- No convenient definition

What is rational?
Intelligence

What is intelligence?
- No convenient definition

What is rational?
- Acts on knowledge to achieve “best outcome”
Rationality

Thus a rational agent acts to achieve the best outcome or goal (or best in expectation with uncertainty).

A limitedly rational agent makes the best choice with limited computation (also called “online algorithms”).
Rationality

Often times, fully exploring all the options is too costly (takes forever)

Chess: $10^{47}$ states (tree about $10^{123}$)
Go: $10^{171}$ states (tree about $10^{360}$)

At 1 million states per second...

Chess: $10^{109}$ years
Go: $10^{346}$ years
Turing Test

For a long time, the Turing Test was a supposed indication of intelligence. A person would question two entities and have to determine which one is the computer and human. This is not very popular anymore.
Turing Test

To pass the Turing Test, a computer needs the following:
- Natural language processing (as the test is written and not verbal)
- Knowledge representation (storage)
- Reasoning (logical conclusions)
- Machine Learning (extrapolation)
Turing Test

Jeopardy!

https://www.youtube.com/watch?v=WFR3I0m_xhE
Simple computers have been built for hundreds of years.

For artificial intelligence to mature, it needed to borrow from other fields:
   - Math - logic and proofs
   - Statistics - probability
   - Economics - utility
AI

Self driving cars

Speech recognition

Game playing

Logistics

Spam filter
AI - Chess

Spring 1997 - Deep(er) Blue   (CMU / IBM)
AI - Go

Spring 2016 - AlphaGo (Google)
December 2017 - AlphaZero
AI - Dota2

August 2017 - OpenAI (Elon Musk)

https://www.youtube.com/watch?v=l92J1UvHf6M&feature=youtu.be
AlphaStar – Jan. 2019

Starcraft2

https://www.youtube.com/watch?v=cUTMhmVh1qs