Thus, for any nondeterministic Turing machine M that runs in some polynomial time \( p(n) \), we can devise an algorithm that takes an input \( \omega \) of length \( n \) and produces \( E_M(\omega) \). The running time is \( O(p^2(n)) \) on a multitape deterministic Turing machine and...
James Parker
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Teaching Assistants

Myat Mo,
Ojas Bhavani Narayanann,
Robert Giaquinto,
Shreyasi Pal,
Yan Luo
Textbook

Artificial Intelligence
A Modern Approach,
Russel and Norvig,
3rd edition
Class website

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

Syllabus, schedule, other goodies

Canvas page will have grades and homework submission
### 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>Readings/Exams</th>
<th>Due</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Sept. 4</td>
<td>Introduction: AI</td>
<td>Ch. 1-2</td>
<td>HW 1, Wednesday Sept. 19 at 11:00 P.M.</td>
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<tr>
<td>2</td>
<td>Sept. 10</td>
<td>Agents, Problem Solving and Search</td>
<td>Ch. 2-3</td>
<td>Writing 1, Wednesday Sept. 26 at 11:00 P.M.</td>
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<td>3</td>
<td>Sept. 17</td>
<td>Search and Heuristics</td>
<td>Ch. 3-4</td>
<td>HW 2, Wednesday Oct. 3 at 11:00 P.M.</td>
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<tr>
<td>4</td>
<td>Sept. 24</td>
<td>Other search heuristics</td>
<td>Ch. 4</td>
<td>Writing 2, Wednesday Oct. 17 at 11:00 P.M.</td>
<td></td>
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<tr>
<td>5</td>
<td>Oct. 1</td>
<td>Game playing</td>
<td>Ch. 5</td>
<td>Midterm 1, Tuesday Oct. 18</td>
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<td>6</td>
<td>Oct. 8</td>
<td>Game playing</td>
<td>Ch. 17.5</td>
<td>HW 3, Wednesday Oct. 24 at 11:00 P.M.</td>
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<tr>
<td>7</td>
<td>Oct. 15</td>
<td>Constraint satisfaction</td>
<td>Ch. 6</td>
<td>Writing 3, Wednesday Oct. 31 at 11:00 P.M.</td>
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<tr>
<td>8</td>
<td>Oct. 22</td>
<td>Propositional logic</td>
<td>Ch. 7</td>
<td>HW 4, Wednesday Nov. 7 at 11:00 P.M.</td>
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<td>9</td>
<td>Oct. 29</td>
<td>First-order logic</td>
<td>Ch. 8</td>
<td>Midterm 2, Tuesday Nov. 13</td>
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<tr>
<td>10</td>
<td>Nov. 5</td>
<td>Inference in logic</td>
<td>Ch. 9</td>
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<td>11</td>
<td>Nov. 12</td>
<td></td>
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</tbody>
</table>
Don't like my slides? (tough)

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)
Syllabus

30% Homework (-15% per day late)
20% Writing assignments (-15% pdf)
15% Project
10% Midterm (Tuesday Oct. 8)
10% Midterm 2 (Tuesday Nov. 12)
15% Final (Sec 001: 12/17 @ 4pm
        Sec 002: 12/19 @ 8am)
3% Extra credit in-class activities
Syllabus

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

Please ensure the work you turn in is your own
Syllabus

Grading scale:
93% A
90% A-
87% B+
83% B
80% B-

77% C+
73% C
70% C-
67% D+
60% D
Below F
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 Sep. 17)
Writing assignments

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)
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 report documenting 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
Syllabus

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

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

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

https://www.youtube.com/watch?v=WFR3lOm_xhE
Agent/robot

The formal definition of a robot is not very useful either.

For our purpose, a robot/agent:
- Perceives the environment
- Adapts to changes
- Pursues a goal
Agent/robot

Is this a robot?

.... How about this?
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).
Agent/robot

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
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

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