Today’s outline

• What’s in CS540
• Course logistics
• Software
Part I: Course overview
Classify Images


ImageNet Large Scale Visual Recognition Challenge results

In the competition’s first year teams had varying success. Every team got at least 25% wrong.

In 2012, the team to first use deep learning was the only team to get their error rate below 25%.

The following year nearly every team got 25% or fewer wrong.

In 2017, 29 of 38 teams got less than 5% wrong.
Detect and Segment Objects

https://github.com/matterport/Mask_RCNN
Style Transfer

https://github.com/StacyYang/MXNet-Gluon-Style-Transfer
Generative Modeling

4.5 years of face generation
Machine Translation


Google Expands Neural Networks for Language Translation

The new system can translate whole sentences at a time, rather than just phrases.
Text Synthesis

Content: Two dogs play by a tree.

Style: happily, love

Two dogs in love play happily by a tree.

Li et al, NACCL, 2018
me: why is carbon dioxide highly sought after?

ChatGPT: In recent years, CO2 has also become highly sought after as a potential source of renewable energy. When burned, CO2 releases a large amount of heat, which can be harnessed to generate electricity. It can also be used to power fuel cells, which are a type of clean energy technology that converts chemical energy into electricity.
OpenAI ChatGPT (in 2022):

me: which molecules are produce when burning co2?

ChatGPT: When carbon dioxide (CO2) is burned, it reacts with oxygen in the air to produce carbon monoxide (CO) and water (H2O). The chemical reaction for this process can be written as: CO2 + O2 -> CO + H2O

The exact products of the combustion of CO2 depend on the conditions under which it is burned, such as the temperature, oxygen concentration, and presence of other chemicals. However, in general, CO and H2O are the primary products of the burning of CO2.
me: why is salt highly sought after in the desalination process?

ChatGPT: Salt, or sodium chloride, is highly sought after in the desalination process because it is a readily available and relatively inexpensive compound that can be used to remove dissolved salts from seawater. Desalination is a process that is used to produce fresh water from seawater, and it is often necessary in areas where there is a shortage of fresh water.

Salt is used in the desalination process because it has a unique chemical property that allows it to readily dissolve in water. When seawater is mixed with salt, the salt ions will dissolve and become evenly distributed throughout the water. This creates a solution that has a higher concentration of salt ions than the seawater.

The higher concentration of salt ions in the solution makes it possible to use a process called reverse osmosis to remove the dissolved salts from the seawater. In reverse osmosis, the salty solution is forced through a membrane that only allows water molecules to pass through, effectively separating the salt from the water. The resulting water is fresh and drinkable, and the salt can be recovered and used again in the desalination process.

Overall, salt is highly sought after in the desalination process because it is a key component in the reverse osmosis process, which is the most commonly used method for removing dissolved salts from seawater.
Will AI kill me?
Improbable

- Sentient AI  
  7 + 8 = 15. True or false?
  False. The sum of 7 and 8 is 15.
but...

- Sentient AI ✗
- Dual use ✓

Spearphishing powered by AI

![Diagram showing a conversation between 'Your loved one' and a scammer, using voice cloning to sound convincing. The conversation includes phrases like 'in car accident', 'been robbed', 'lost wallet', and 'send gift card, wire transfer'.]

[Artificial Imposters—Cybercriminals Turn to AI Voice Cloning for a New Breed of Scam. Bunn, 2023]
Will AI take my job?
The more AI helps your job, the higher the replacement risk

[GPTs are GPTs: An Early Look at the Labor Market Impact Potential of Large Language Models. Eloundou et al. 2023]
Will AI help my job?
It’s a Trap!
Yes!

- Key UW-Madison AI courses (many more):
  - Computer Sciences 540 Introduction to Artificial Intelligence
  - Computer Sciences 760 Machine Learning
GPT, large language model, generative AI, deep learning…

Oh my!
AI Venn diagram

Artificial Intelligence
Artificial Intelligence

AI Venn diagram

Artificial Intelligence

Machine learning
Artificial Intelligence

Machine learning

Natural language processing
AI Venn diagram

Artificial Intelligence

- Machine learning
- Natural language processing
- Computer vision
Artificial Intelligence

- Machine learning
- Natural language processing
- Computer vision
- Robotics
AI Venn diagram

Artificial Intelligence

- Machine learning
- Deep learning with Artificial neural networks
  - Transformer (ANN structure)
- Natural language processing
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- Robotics
AI Venn diagram

Artificial Intelligence

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Large Language Model
Artificial Intelligence

Robotics

Computer vision

Natural language processing

Deep learning with Artificial neural networks

Transformer (ANN structure)

Large Language Model

GPT

AI Venn diagram
Artificial Intelligence

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Generative AI
UW-Madison conducts world-class AI research*

- Computer Sciences
- ECE
- Statistics
- ISyE
- Math
- iSchool
- Almost all other departments on AI applications
- Data Science Institute, Data Science Hub

* CSRankings.org #14 world-wide on machine learning, as of Sept 2023
Artificial Intelligence is not Magic

They rely on **fundamental** techniques in:

- Algorithms
- Mathematics
- Logic
- Probability and Statistics
- Optimization
What you can learn from CS540?

• Foundational tools in **Machine Learning** and **Artificial Intelligence**: Linear algebra, Probability, Logic, and elements of Statistics.

• Core techniques in **Natural Language Processing (NLP)**, including bag-of-words, tf-idf, n-Gram Models, and Smoothing.

• Basics of **Machine Learning**: supervised learning vs. unsupervised learning

• **Neural Networks and Deep Learning**: Network Architecture, Training, Backpropagation, Stochastic Gradient Descent.

• Fundamentals of **Game Theory**.

• **Search and Reinforcement Learning**

• **Artificial Intelligence** and **Machine Learning** in Real-World settings and the Ethics of Artificial Intelligence.
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• Search and Reinforcement Learning

• Artificial Intelligence and Machine Learning in Real-World settings and the Ethics of Artificial Intelligence.

TL;DR Lots of useful stuff, theory and practice in AI
What you can learn from CS540?


<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
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<tbody>
<tr>
<td>Tuesday, Jan 26</td>
<td>Welcome and Introduction to Python</td>
</tr>
<tr>
<td>Thursday, Jan 28</td>
<td>Probability</td>
</tr>
<tr>
<td>Tuesday, Feb 2</td>
<td>Linear Algebra and PCA</td>
</tr>
<tr>
<td>Thursday, Feb 4</td>
<td>Statistics and Math Review</td>
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<tr>
<td>Tuesday, Feb 9</td>
<td>Introduction to Logic</td>
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<td>Thursday, Feb 11</td>
<td>Natural Language Processing</td>
</tr>
<tr>
<td>Tuesday, Feb 13</td>
<td>Machine Learning: Introduction</td>
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<td>Thursday, Feb 18</td>
<td>Machine Learning: Unsupervised Learning I</td>
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<td>Tuesday, Feb 23</td>
<td>Machine Learning: Unsupervised Learning II</td>
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<tr>
<td>Thursday, Feb 25</td>
<td>Machine Learning: Linear regression</td>
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<td>Tuesday, March 2</td>
<td>Machine Learning: K - Nearest Neighbors</td>
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<td>Machine Learning: Perceptron</td>
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Foundations
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**Machine learning**
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<td>Tuesday, March 16</td>
<td>Machine Learning: Neural Network III</td>
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<tr>
<td>Thursday, March 18</td>
<td>Machine Learning: Deep Learning I</td>
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<td>Thursday, March 25</td>
<td>Machine Learning: Deep Learning III</td>
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<tr>
<td>Tuesday, March 30</td>
<td>Machine Learning: Deep Learning and Neural Network's Summary</td>
</tr>
<tr>
<td>Thursday, April 1</td>
<td>Game - Part I</td>
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<tr>
<td>Tuesday, April 8</td>
<td>Game - Part II</td>
</tr>
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<td>Tuesday, April 20</td>
<td>Introduction to Reinforcement Learning</td>
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**Deep Learning**

- **ResNet**
- **DenseNet**

*: Channel-wise concatenation*
What you can learn from CS540?
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<td>Game - Part II</td>
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<td>Search I: Uniformed search</td>
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<tr>
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<td>Search II: Informed search</td>
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<td>Genetic Algorithms</td>
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Game, search and Reinforcement Learning
What you can learn from CS540?

### What you can learn from CS540:

- **Real-world AI (new!)**
  - Artificial Intelligence in the Real World
  - Ethics of Artificial Intelligence

#### Training Data

- Food Image Classifier

#### Course Schedule:

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Part II: Course Logistics
Where to find everything?

- **Canvas** - *Pointer to everything*
  - grades, other private materials *that should not be shared*
- **Course website** - public materials
  - Slides, schedule, policies
- **Piazza**
  - [https://piazza.com/wisc/fall2023/cs540](https://piazza.com/wisc/fall2023/cs540)
  - Discussion, questions, announcements
Textbook

Instruction Team
(See course webpage)

Merged across 3 sections:

• Teaching Assistants (TAs): hold office hours, grade your homework
• Peer Mentors: hold office hours
Office Hours

• Available on the course website

• All office hours are merged across sections, you can go to anyone

• Use TA and Peer Mentor hours for detailed-level questions (e.g. coding related), and use professor office hours for conceptual level questions
Grading scheme

• **Midterm Exam**: 15% (around Nov 1, evening)

• **Final Exam**: 15% (TBA)

• **Homework Assignments**: 70% (10 HWs)

  **TWO** lowest homework scores are dropped from the final homework average calculation. This is for emergency, sickness, etc.

  Homework is always due 9am on the specified date.
  (Late submissions will not be accepted.)

  More details to come (submission, grading, etc)
Integrity

Just don’t cheat at all. You’ll be caught. It’s not worth it.

You are encouraged to discuss with your peers, the TA or the instructors ideas, approaches and techniques broadly. However, all examinations, programming assignments, and written homeworks must be written up individually. For example, code for programming assignments must not be developed in groups, nor should code be shared. Make sure you work through all problems yourself, and that your final write-up is your own. If you feel your peer discussions are too deep for comfort, declare it in the homework solution: “I discussed with X,Y,Z the following specific ideas: A, B, C; therefore our solutions may have similarities on D, E, F...”.

You may use books or legit online resources to help solve homework problems, but you must always credit all such sources in your writeup and you must never copy material verbatim.

We are aware that certain websites host previous years’ CS540 homework assignments and solutions against the wish of instructors. Do not be tempted to use them: the solutions may contain “poisonous berries” previous instructors planted intentionally to catch cheating. If we catch you copy such solutions, you automatically fail.

Do not bother to obfuscate plagiarism (e.g. change variable names, code style, etc.) One application of AI is to develop sophisticated plagiarism detection techniques!

Cheating and plagiarism will be dealt with in accordance with University procedures (see the UW-Madison Academic Misconduct Rules and Procedures)
Quiz

1. Where can I find all the 540 stuff, if I didn’t write down the URL?

2. I feel sick, should I still show up to class?

3. I can’t finish my homework because I was traveling, I was sick, my dog ate it, etc. Can I ask for an extension?

4. Can I do homework with a group?
Answers

1. Where can I find all the 540 stuff, if I didn’t write down the URL? Your Canvas has the main link.

2. I feel sick, should I still show up to class? No. Study materials online. After you have recovered, come to office hours to discuss the materials that you missed.

3. I can’t finish my homework because I was traveling, I was sick, my dog ate it, etc. Can I ask for an extension? No. But we discard 2 lowest hw scores.

4. Can I do homework with a group? Yes (and encouraged) for high level discussions. No for exact solutions.
Part III: Software
Tools

• Python
  • Everyone is using it in machine learning & data science
  • Conda package manager (for simplicity)

• Jupyter Notebook
  • So much easier to keep track of your experiments
  • Obviously you should put longer code into modules
A Crash Course in Python

1. Why are we doing this in Python?
2. Where do I write Python code? How do I run it?
   a. Online
   b. Offline
3. What are the big differences between Java and Python
Colab

• Go to colab.research.google.com
• Activate the GPU supported runtime (this is a K80 or T4 GPU)
ML loves matrices and vectors
### Access Elements

**An element: [1, 2]**

```
0   1   2   3
0   1   2   3
1   5   6   7   8
2   9  10  11  12
3  13  14  15  16
```

**A row: [1, :]**

```
0   1   2   3
0   1   2   3
1   5   6   7   8
2   9  10  11  12
3  13  14  15  16
```

**A column: [:, 2]**

```
0   1   2   3
0   1   2   3
0   1   2   3
1   2   3   4
2   5   6   7   8
3   9  10  11  12
```

57
Coming up: Probability and Linear Algebra Review

\[ C = AB \text{ where } C_{ik} = \sum_j A_{ij} B_{jk} \]
Recap

- What’s in CS540
- Course logistics
- Software
Thanks!