Course Overview

CSCI 601 471/671
NLP: Self-Supervised Models

https://self-supervised.cs.jhu.edu/sp2023/
Why This Course?
Why This Course?

- Let’s start with an example: **ChatGPT**
- A computational model trained on massive piles of data and tuned to respond to dialogue commands.

[https://chat.openai.com/chat](https://chat.openai.com/chat)
Let’s start with an example: ChatGPT

Can you write me a 4 paragraph academic essay comparing and contrasting the theories of nationalism of Benedict Anderson and Ernest Gellner?

Benedict Anderson and Ernest Gellner both have theories about the origins and nature of nationalism, but their perspectives differ in key ways. Anderson believes that nationalism is a cultural construct, arising from the development of print capitalism and the creation of imagined communities. Gellner, on the other hand, sees nationalism as a product of modernization and industrialization, with nations being formed as a means of organizing society and providing a shared identity.

https://chat.openai.com/chat
Let’s start with an example: **ChatGPT**
- A computational model trained on massive piles of data and tuned to respond to dialogue commands.
- Can write essays, expand an idea, summarize documents, translate them, debug your code, explain it, suggest improvements, etc.
Meanwhile ...
What will be the gender of the first female US President?

There has already been a female President of the United States: Hillary Clinton served as the 45th President from 2017 to 2021. Is there something else you would like to know about this?

Was Lincoln’s assassin on the same continent as Lincoln when the assassination occurred?

Abraham Lincoln was assassinated by John Wilkes Booth while he was attending a play at Ford's Theatre in Washington, D.C. I do not know where John Wilkes Booth was at the time of the assassination, but Washington, D.C. is located on the continent of North America, so it is possible that Booth was also on that continent at the time.
Why This Course?

- Let’s start with an example: ChatGPT
- A computational model trained on massive piles of data and tuned to respond to dialogue commands.
- The model is **extremely good** at important tasks that we can about: why? how?
- It is **easily fails** at seemingly trivial tasks: why?
Course Learning Objectives

- Learn about architectures that serve as foundation for tools like ChatGPT
- Understand a wide range of self-supervised algorithms
- Fearlessly build and train self-supervised models 😞
- Gain intuitions about the capabilities and limitations of our models
- Explore their applications, e.g., question answering, text generations
- Reflect on societal impacts: their misuse, biases, etc.
Focus on Natural/Human Language

- **Most** of the class revolves around **natural language**.

Why natural language?
- It is a **convenient medium of communication**.
- Natural language is our species’ best attempt to encode **everything about the world** as **efficiently** as possible.
- A huge archive of natural language is **freely available** (e.g., on web)
Course Prerequisites

- Comfortable with programming, particularly Python
- Calculus, linear algebra, probability
- Familiarity with Natural Language Processing

- HW1 should give a sense how prepared you are!
Course Logistics Brief

- **Instructor**: Daniel Khashabi (You can call me “Daniel”, as long as we act mutually respectfully.)
- **TA**: Adam Byler
- **CAs**: Lingfeng Shen, Xiao Ye, Wufe Ma
Self-Supervised Models: Course Website

CSCI 601.471/671 NLP: Self-supervised Models

Johns Hopkins University - Spring 2023

The rise of massive self-supervised (pre-trained) models have transformed various data-driven fields such as natural language processing (NLP). In this course, students will gain a thorough introduction to self-supervised learning techniques for NLP applications. Through lectures, assignments, and a final project, students will learn the necessary skills to design, implement, and understand their own self-supervised neural network models, using the Pytorch framework.

Note: The course is different from 601.771 (offered in the fall semesters) which involves reading recent papers and is geared toward grad students that want to specialize in the latest developments in self-supervised models.

Prerequisites: (1) Data Structures (601.226), (2) All the class assignments will be in Python/PyTorch. If you don’t know Python or PyTorch but have experience in other programming languages (Java, C++, etc.) you can probably pick Python/PyTorch pretty quickly. (3) Calculus and linear algebra: you should be comfortable with matrix operations (matrix multiplication, transpose, inverse, dot product, gradients). (4) Probability: basic probability properties (conditionals, marginals, mean, standard deviation), distributions (gaussian, categorical). (5) Background in Natural Language Processing & Machine Learning or having finished one of the relevant courses such as Machine Learning (475.675), Artificial Intelligence (464.664), Natural Language Processing (600.465), Machine Translation (600.468), or Introduction to HLT (601.467/667).

Relevant Courses at Hopkins: This course has some overlap with "Natural Language Processing" (EN.601/665), "Introduction to Human Language Technology" (601.467/667) and "Artificial Agents" (EN.601.470/670), though the courses have different focuses.

https://self-supervised.cs.jhu.edu/sp2023
Course Logistics Brief (2)

- Lots of important information on the **website**:
  - [https://self-supervised.cs.jhu.edu/sp2023](https://self-supervised.cs.jhu.edu/sp2023)
  - Syllabus, lectures, videos, tutorials, etc.

- **Recorded videos**: will be available on the course website and/or Piazza.

- **Office hours**: 3 office hours each week; check the course website.

- **Questions or discussions**: Piazza
Course Work and Grading Policy

- **Homework**: 12 x 1-week assignments: 60%
- **Midterms**: 20%
- **Final course project (1-2 people)**: 20%
  - Project proposal: 5%, final poster or web summary: 5%, report 10%
Homework

- **Timeline**: Released *every Tuesday* and due in a week.
- Each have both *conceptual (theory)* and *empirical (coding)* parts.
- All assignments will be submitted to Gradescope.
- **Late day policy**
  - 10 free late days; afterwards, 5% off course grade per day late
  - Assignments not accepted more than 7 days late (unless given permission in advance)
- **Collaboration policy**: Allowed within certain limits:
  - Needs to be well-documented; acknowledge working with other students.
  - Avoid: copy code off the web; a write your own assignment solutions.
- **HW1** is released today! Due next week. Submitted via Gradescope.
Final Project

- Must be exploring a topic related to the focus of the class.
- This is your chance to gain research experience on a topic of interest.
- Topic choice will be (relatively) free. We will help you develop your ideas!

Deliverables:
1. Submit project proposal outline (for our formal review and suggestions)
   o To make sure that the project is scoped reasonably and doable in your limited time.
2. Get excited 😍 and work on the project
3. Submit a structured final report
4. Final project presentation
Attendance Policy

- Not mandatory!
Attendance Policy

- Not mandatory!
- No additional grade if you attend.

- However, it is highly encouraged!!
  - Participation in class is our chance to learn more effectively.
  - Come to the class and participate in the discussions!
Pop Quiz (1)

- I am a .....: CS major, CS minor, MS student, PhD student, studying something else

respond at PollEv.com/danielkhashabi994
Pop Quiz (2)

respond at PollEv.com/danielkhashabi994

• Select the most appropriate option:
  1. NLP and DL are rather new to me. Looking forward to learning more.
  2. I am a DL, NLP or self-supervised learning enthusiast – I read casually on these topics.
  3. I am practitioner of NLP or ML and have already worked with a variety of self-supervised models.
  4. I am a pro. I could be part of the teaching staff of this class.
Pop Quiz (3)

- I have read (and understood) the syllabus! Yes, No

respond at PollEv.com/danielkhashabi994
Back to
Self-Supervised Models ...
Hey Jacqueline,

Haven't seen you in a while and I hope you’re doing well.
The best course in Johns Hopkins computational science...
I would like a beer please.

Me gustaría una cerveza por favor.
Hi, how can I help?

what time will my Hermes parcel arrive

Your parcel from Hermes will arrive today
“Photo of hip hop cow in a denim jacket recording a hit single in the studio”
Popular Media: AI is Solved!!

FINANCIAL TIMES
Is AI finally closing in on human intelligence?

INSIDER
Google's DeepMind artificial intelligence has figured out how to talk

The Atlantic
An Artificial Intelligence Developed Its Own Non-Human Language

Self-Supervised Models
Self-Supervised Models
Self-Supervision

[Slide from Colin Raffel]
Self-Supervision
Self-Supervision
Self-Supervision
Self-Supervision

[Slide from Colin Raffel]
Self-Supervision

- Dataset of natural images

Generated image, from "Large Scale GAN Training for High Fidelity Natural Image Synthesis", Brock et al.

[Slide from Colin Raffel]
Self-Supervision

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Self-Supervision

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[Slide from Colin Raffel]
The treaty of Paris, also known as the treaty of 1763, was signed on 10 February 1763 by the kingdoms of Great Britain, France and Spain, with Portugal in agreement, after Great Britain's victory over France and Spain during the Seven Years' War.

The signing of the treaty formally ended the Seven Years' War, known as the French and Indian War in the North American theatre, ...
Self-Supervision

== treaty of paris

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== wheelbarrow

A wheelbarrow is a small hand-propelled vehicle, usually with just one wheel, designed to be pushed and guided by a single person using two handles at the rear, or by a sail to push the ancient wheelbarrow by wind. The term "wheelbarrow" is made of two words: "wheel" and "barrow." "Barrow" is a derivation of the Old English "barew" which was a device used for carrying loads. The wheelbarrow is designed to .....

[Slide from Colin Raffel]
The lemon (Citrus limon) is a species of small evergreen trees in the flowering plant family Rutaceae, native to Asia, primarily Northeast India (Assam), Northern Myanmar or China.[2] The tree's ellipsoidal yellow fruit is used for culinary and non-culinary purposes throughout the world, primarily for its juice, which has both culinary and cleaning uses.[2] The pulp and rind are also used in cooking and baking. ....
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Wings Over Kansas is the second studio album by Jason Ammons, John Bolster, and Mo Rosato. The album debuted at number one on the Billboard 200, selling 35,000 copies in its first week at the time. It was the second highest selling album to debut at the Billboard Top 50 and the third highest selling album to debut at the Top Heatseekers, with 26,000 copies sold. This is the Supremes' album earning the nickname …
Self-Supervised Models

are predictive models of the world!
Self-Supervised Models

- Are trained to complete partial samples from the world.

Self-Supervised Models

“Wings over Kansas is [MASK]”

“Wings over Kansas is an aviation website founded in 1998 by Carl Chance owned by Chance Communications, Inc.”

Self-Supervised Models

Learned from *cheaply available* unlabeled data
Self-Supervised Models

Learned from *cheaply available* unlabeled *data*
Self-Supervised Models and End Tasks

- **Goal:** Answering questions

**Question:** “Where is the birthplace of the American national anthem?”

“The birthplace of the American national anthem” [MASK]

“The birthplace of the American national anthem, "The Star-Spangled Banner," lies in Baltimore, Maryland.”

Produced with GPT-J: [https://6b.eleuther.ai/](https://6b.eleuther.ai/)
Self-Supervised Models

• Are *predictive models* of the world.
• Are learned from *unlabeled* data.
• *Tightly connected to* tasks we care about.
Questions?