Machine Learning, Artificial Intelligence, and Natural Language Processing

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Introduction







► A gentle introduction to

- 1. Machine Learning (ML), Artificial Intelligence (AI), and
- 2. Natural Language Processing (NLP)
- Open the black box of "Generative Pre-trained Transformers"
- ▶ Five online 90-minute meetings: 3/26, 4/2, 4/9, 4/16, and 4/23.



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ChatGPT is a chatbot based on generative pre-trained transformer (GPT) technology.





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- GPTs are a family of large language models (LLMs) based on a transformer deep learning architecture.





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- GPTs are a family of large language models (LLMs) based on a transformer deep learning architecture.
- It uses NLP and generative machine learning to craft dialogue that resembles human conversation.



Introduction to the course What is ChatGPT?

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Introduction to the course What is ChatGPT?



- ▶ There are many Large Language Models (LLM) out there ...
- ► Some examples:
 - * Claude, BERT, RoBERTa, FinBERT, CoPilot, LLaMA, DeepSeek,
- To understand the "magic" behind the models we need to learn some basics of ML and NLP.



LLMs, prompts, and prompt engineering



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► What is a prompt?

* It is a natural language instruction that tells an AI model what to do.



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 - * It is the practice of designing and refining prompts to get the desired output from an AI model.
 - * It is akin to offering a blueprint for the AI, directing it towards the precise result you envisage.



A Lecture 1: Introduction to ML and AI models

- A Lecture 2: The basics of NLP
- A Lecture 3: Neural Networks
- A Lecture 4: Word embedding and attention mechanism

A Lecture 5: Neural Networks and LLMs – Transformers



Introduction





Machine Learning, Artificial Intelligence, and Natural Language Processing Lots of buzzwords... What is the meaning?

Artificial Intelligence (AI) versus Machine Learning (ML)

- Al refers to the general ability of computers to emulate human thought and perform tasks in real-world environments.
- ML refers to the technologies (math) and algorithms that enable systems to identify patterns, make decisions, and *improve* themselves through experience and data.
- Machine learning is a pathway to artificial intelligence.



Machine Learning, Artificial Intelligence, and Natural Language Processing Lots of buzzwords... What is the meaning?

Natural Language Processing (NLP)

- NLP is a discipline that intersects computer science, linguistics, and artificial intelligence.
- NLP focuses on how computers comprehend, interpret, and handle human languages.
- It can involve things such as interpreting the semantic meaning of a language, translating between human languages, or recognizing patterns in human languages.
- It uses statistical methods, machine learning, and text mining.



Machine Learning, Artificial Intelligence, and Natural Language Processing Lots of buzzwords...





Machine Learning and Artificial Intelligence

AI and ML significantly influence our everyday activities...





► AI/ML methodologies have existed for quite some time...



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So, why have they gained such attention only recently?



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- So, why have they gained such attention only recently?
 - improved fuel: huge amounts of data



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- advances in computational power and new methods/algorithms



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 - improved fuel: huge amounts of data
 - **
- advances in computational power and new methods/algorithms
- 倡
- the ability of process text data (and audio, images, ...)



We can find data everywhere...





















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Data come in very different formats...

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From Data to Decisions







Big Data

Machine Learning/Al

Decisions



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Machine learning is the field of study that gives computers the ability to learn without being explicitly programmed.

Arthur L. Samuel, Al pioneer, 1959

The original sentence:

Programming computers to learn from experience should eventually eliminate the need for much of this detailed programming effort.

A.L. Samuel (1959). Some studies in machine learning using the game of checkers. **IBM Journal of Research and Development**, 3.3, 210–229.



What is Machine Learning? Definitions out there...

Machine Learning is the science of getting computers to learn and act like humans do, and improve their learning over time in autonomous fashion, by feeding them data and information in the form of observations and real-world interactions.

https://emerj.com/ai-glossary-terms/what-is-machine-learning/



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Machine Learning at its most basic is the practice of using algorithms to parse data, learn from it, and then make a determination or prediction about something in the world.

https://blogs.nvidia.com/blog/2016/07/29/whats-difference-artificial-intelligence-machine-learning-deep-learning-ai/



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Machine learning algorithms can figure out how to perform important tasks by generalizing from examples.

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The field of Machine Learning seeks to answer the question "How can we build computer systems that automatically improve with experience, and what are the fundamental laws that govern all learning processes?"

http://www.cs.cmu.edu/ tom/pubs/MachineLearning.pdf



Let's ask the machine..

+* GPT-4

what is machine learning?



Machine learning (ML) is a subfield of artificial intelligence (AI) that focuses on building systems that can learn from data. Rather than being explicitly programmed to perform a certain task, these systems are trained using large amounts of data and algorithms that give them the ability to learn how to perform the task.





What is Machine Learning? Traditional Programming



What is Machine Learning? ML Programming

Machine Learning is the field of study that gives computers the ability to learn without being explicitly programmed A.L. Samuel (1959)







What is Machine Learning? ML Programming: "Harry Potter's approach"



Machine Learning is the field of study that gives computers the ability to learn without being explicitly programmed A.L. Samuel (1959)

Outputs





\bigcirc

What is Machine Learning? ML Programming: a more realistic approach



Programmer Create a code based a mathematical/statistical model

Defined by an expert.





What is Machine Learning? An Example

Is this a valid email address: marcelom@illinois.edu?



Machine Learning



Input: (Big) data on valid/invalid email addresses

Y/N	Address
0	john@williams
1	xyz@greatcompany.com
0	mister.paul@GOT†.rxs

Computer: Statistical model where Y/N = f (input | parameters)

Output: Estimated probability of valid email

▶ Well, what do we want to learn/do?



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What is Machine Learning (ML)? My view

Automated computer algorithms/methods + statistical models to "learn" (discover) hidden patterns from data.



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- Automated computer algorithms/methods + statistical models to "learn" (discover) hidden patterns from data.
- Interpretation/explanation of the model/method is now an essential component of Machine Learning solutions.



What is Machine Learning (ML)? My view

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Ingredient List

Data + empirical question (what we want to learn) +

(Statistical) Model + loss function

+ optimization algorithms + evaluation/intepretation tools



Machine Learning Models/Methods

Different types of ML models/methods



Source: https://www.datasciencecentral.com/profiles/blogs/types-of-machine-learning-algorithms-in-one-picture

Evolution of ML Models/Methods



Evolution of ML Models/Methods





ML model previously trained with structured (tabular) data

▶ The ML model produces new outputs based on new data



Evolution of ML Models/Methods

Second Generation - The art of transforming text and images into numbers



- ML model previously trained with unstructured data (text, images, audio, ...)
- ▶ The ML model produces new outputs based on new data



Third Generation



ML model previously trained with structured/unstructured data

► The ML model produces new outputs "upon request"





Machine Learning with Structured Data



Structured (numerical) data Usually commonly available







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Large Scale Forecasting (macro, sales, etc...)

> Credit Models and Fraud Detection

Portfolio Choices and Investment Decisions

Marketing Strategies

Pricing



Machine Learning with Unstructured Data



The Age of AI and the Future Ahead...



Large Language Models Summarize Topic allocation Sentiment Analysis



Image Processing Tools



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Products



News/Social Media Based Leading Indicators Sentiment Analysis Topic Models



Image processing Revisiting technical analysis Information from graphs



Document processing Information from firms' reports Social media scrapping Central Bank communication



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What's next? See you next class...





