



Introduction to Machine Learning

FA690 Machine Learning in Finance

Dr. Zonghao Yang

2026 Spring

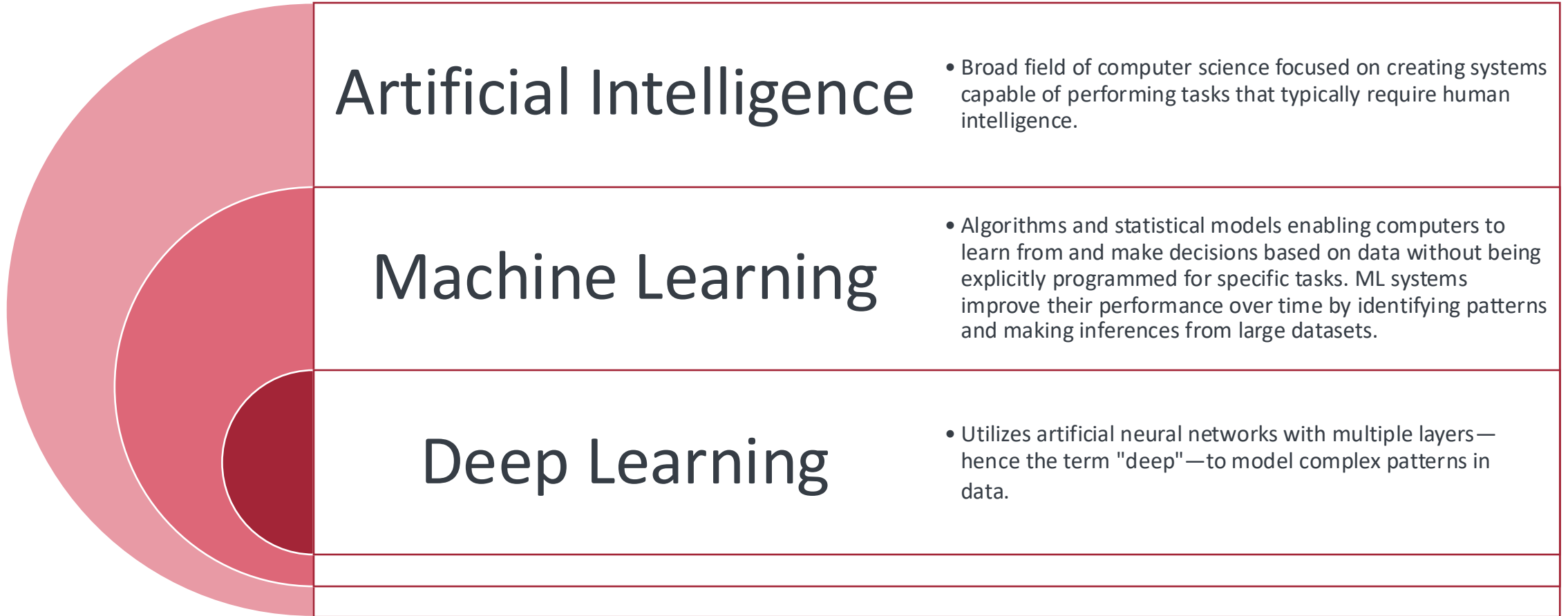
Learning Objectives

- Understand the relationship between Artificial Intelligence, Machine Learning, and Deep Learning, and recognize how recent technological advances (big data, hardware, software) have enabled their rapid development.
- Recognize the major branches of modern AI applications, including computer vision, natural language processing, and generative AI.
- Recognize the transformative impact of AI across different domains through concrete examples in healthcare, environmental monitoring, business operations.
- Preview how deep learning is beginning to transform finance and business, preparing students for deeper exploration of financial applications in subsequent lectures.

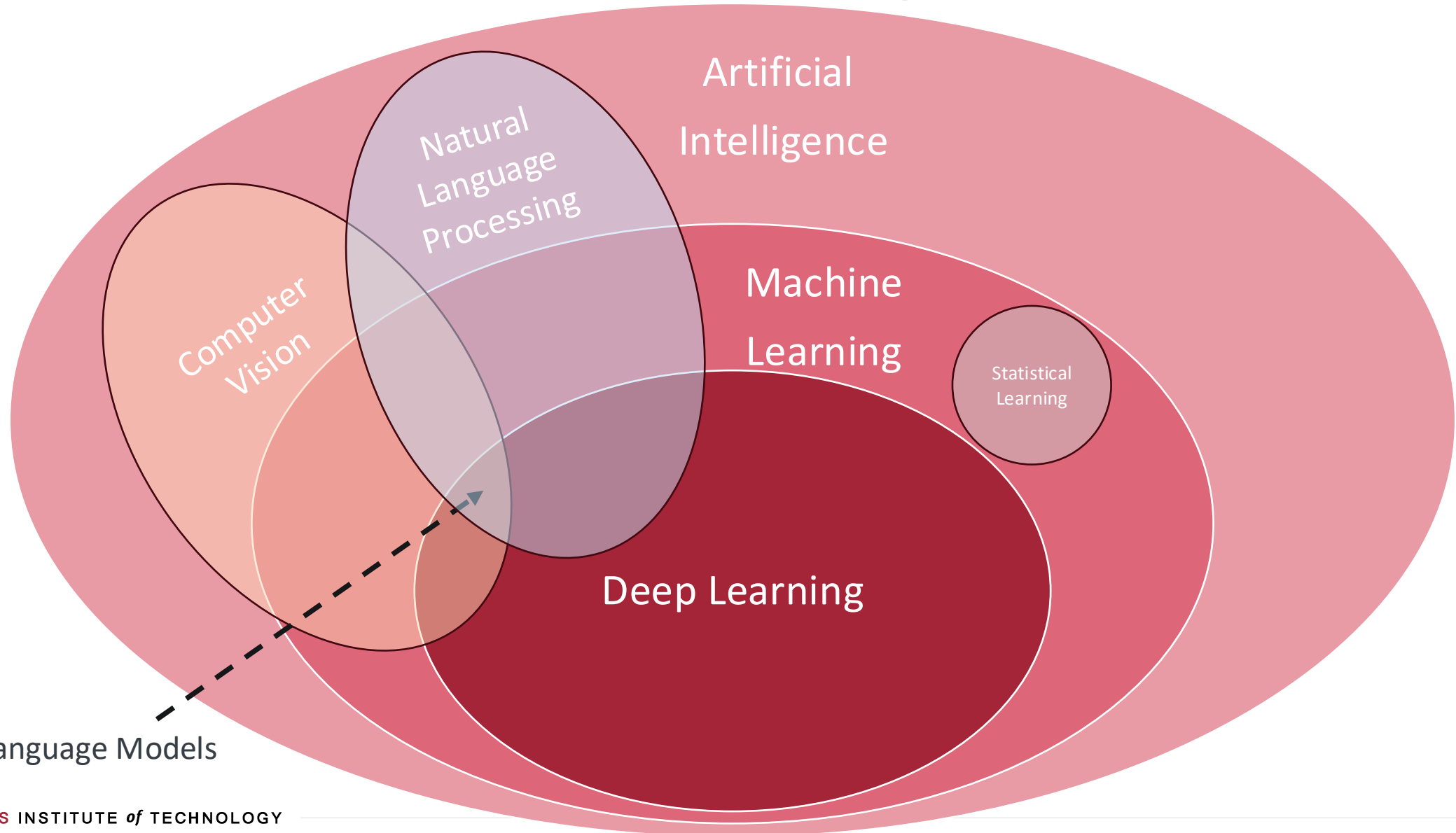


Landscape of Artificial Intelligence

Introduction to Artificial Intelligence

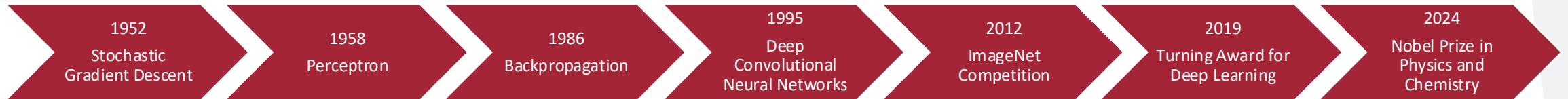


Introduction to Artificial Intelligence

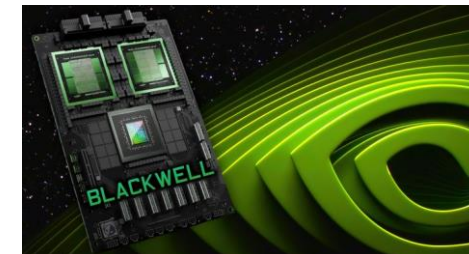
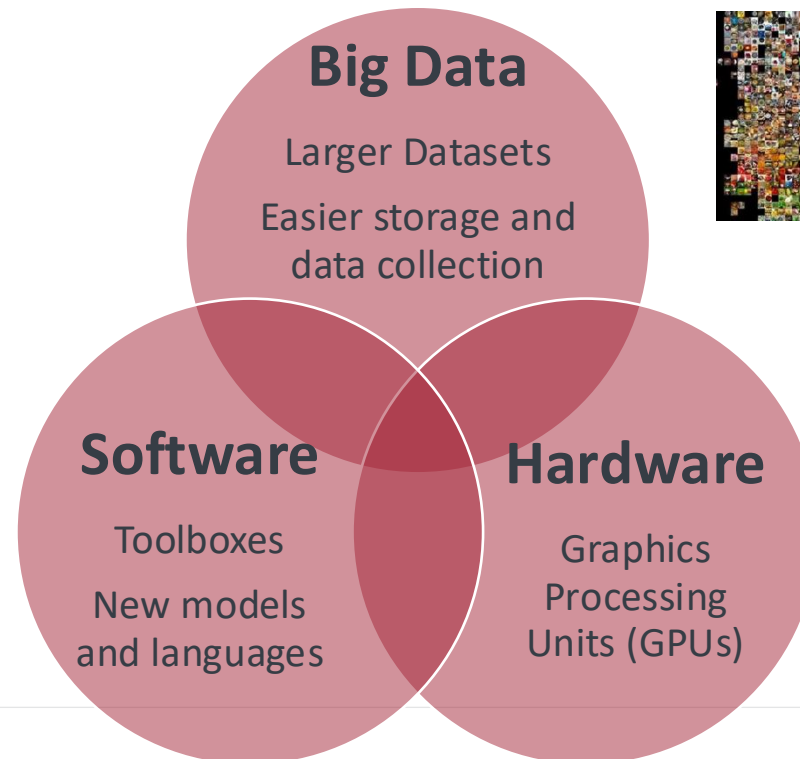


Introduction to Artificial Intelligence

- AI is not new

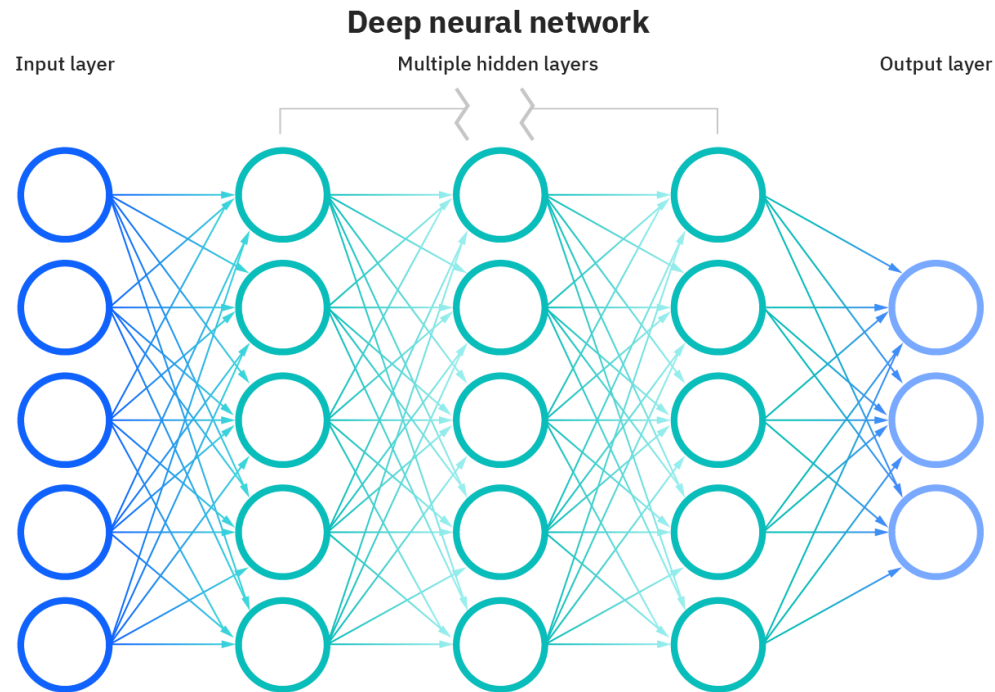


- Its recent success is a combination of 3 main factors



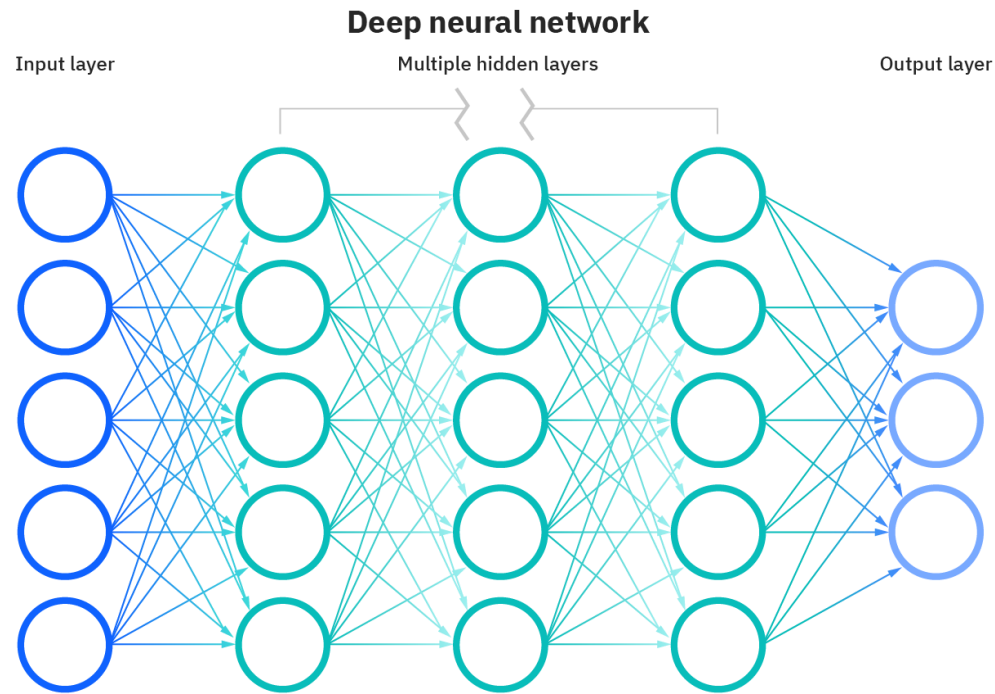
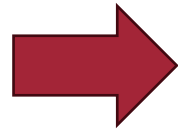
The Building Block of Deep Learning

State-of-the-art AI is often based on deep neural networks



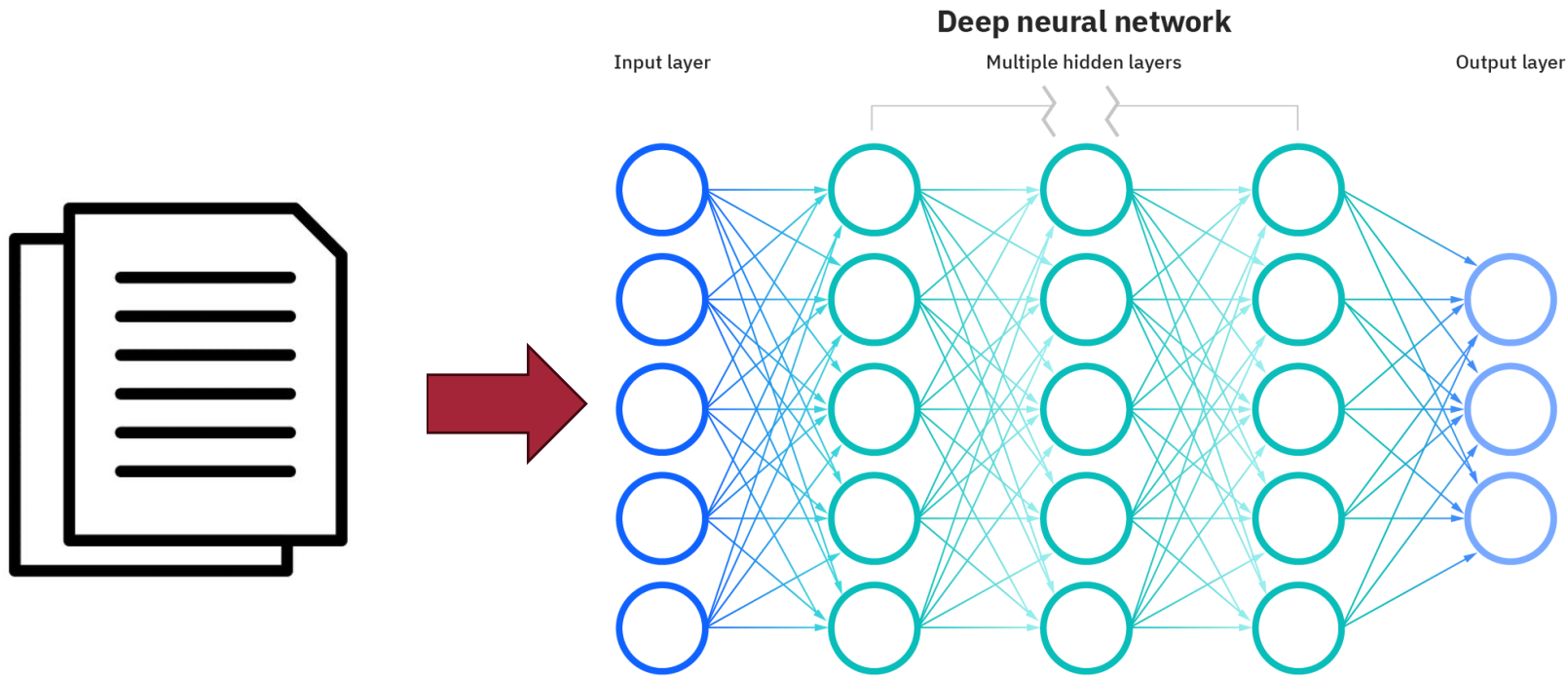
The Building Block of Deep Learning

Computer Vision

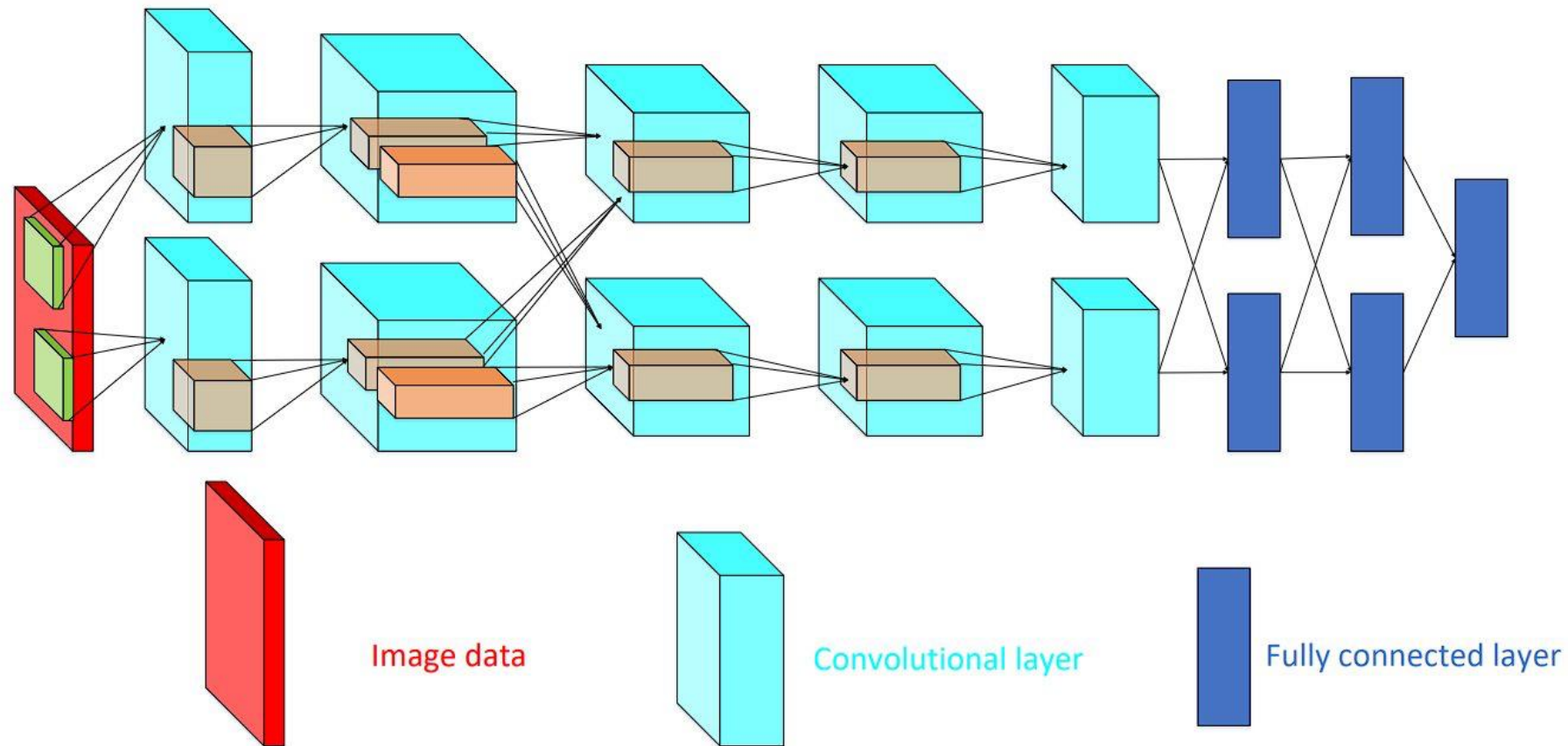


The Building Block of Deep Learning

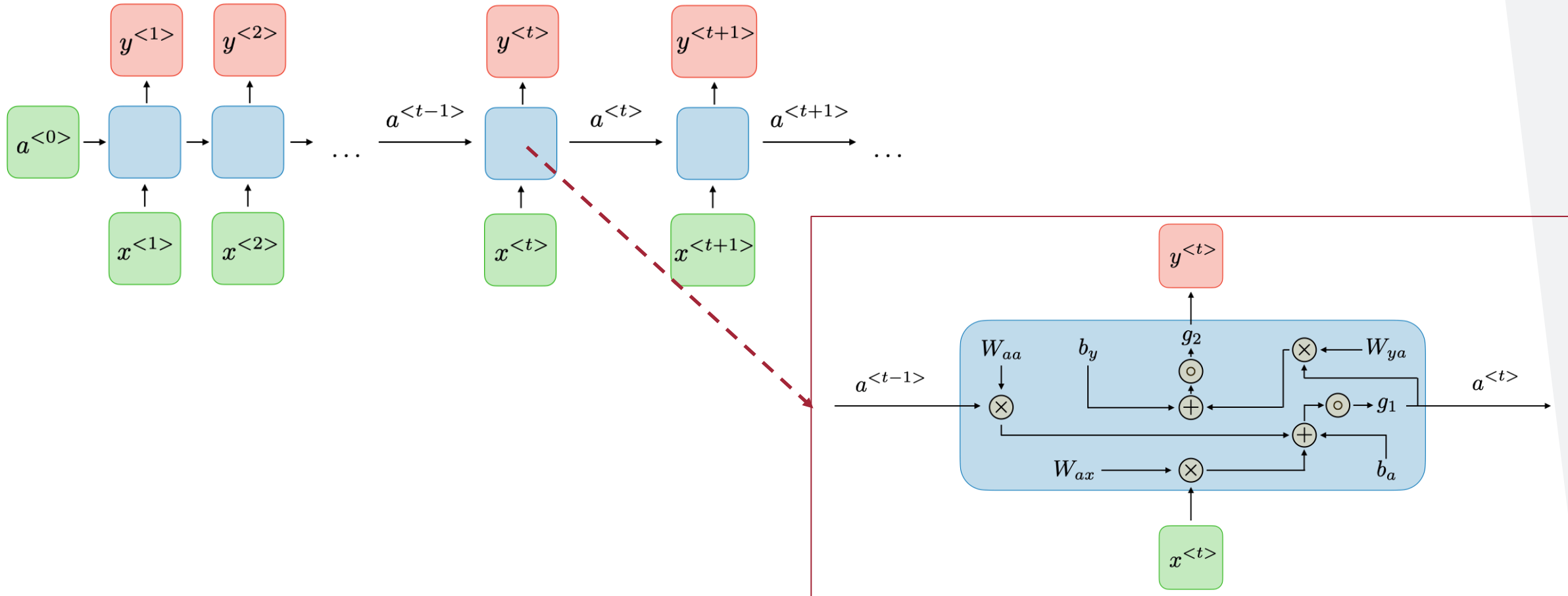
Natural Language Processing



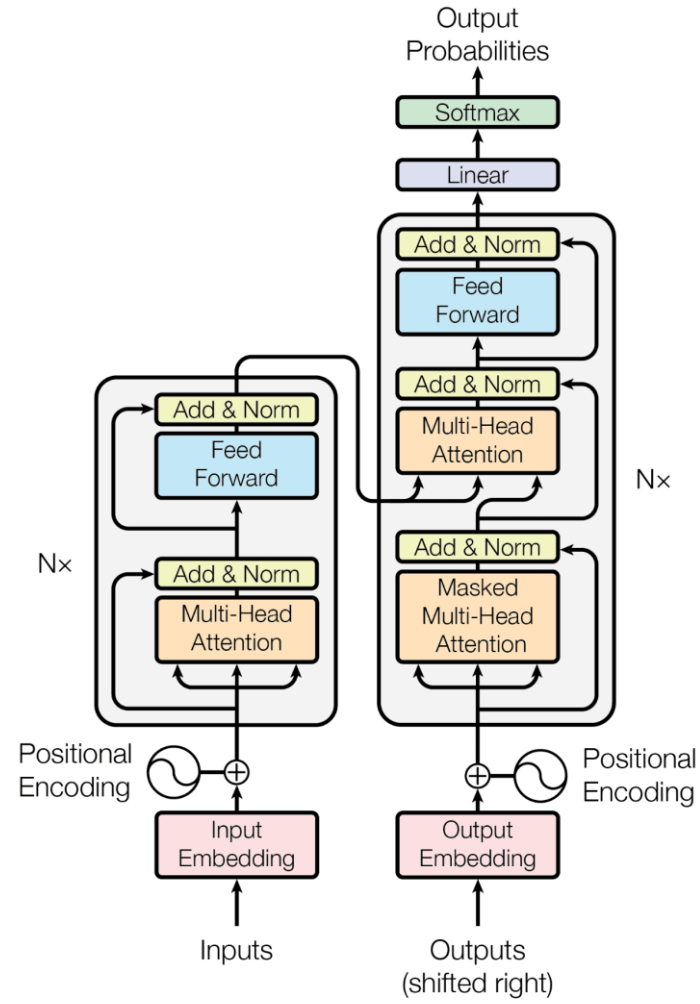
Convolutional Neural Networks: AlexNet



Recurrent Neural Networks

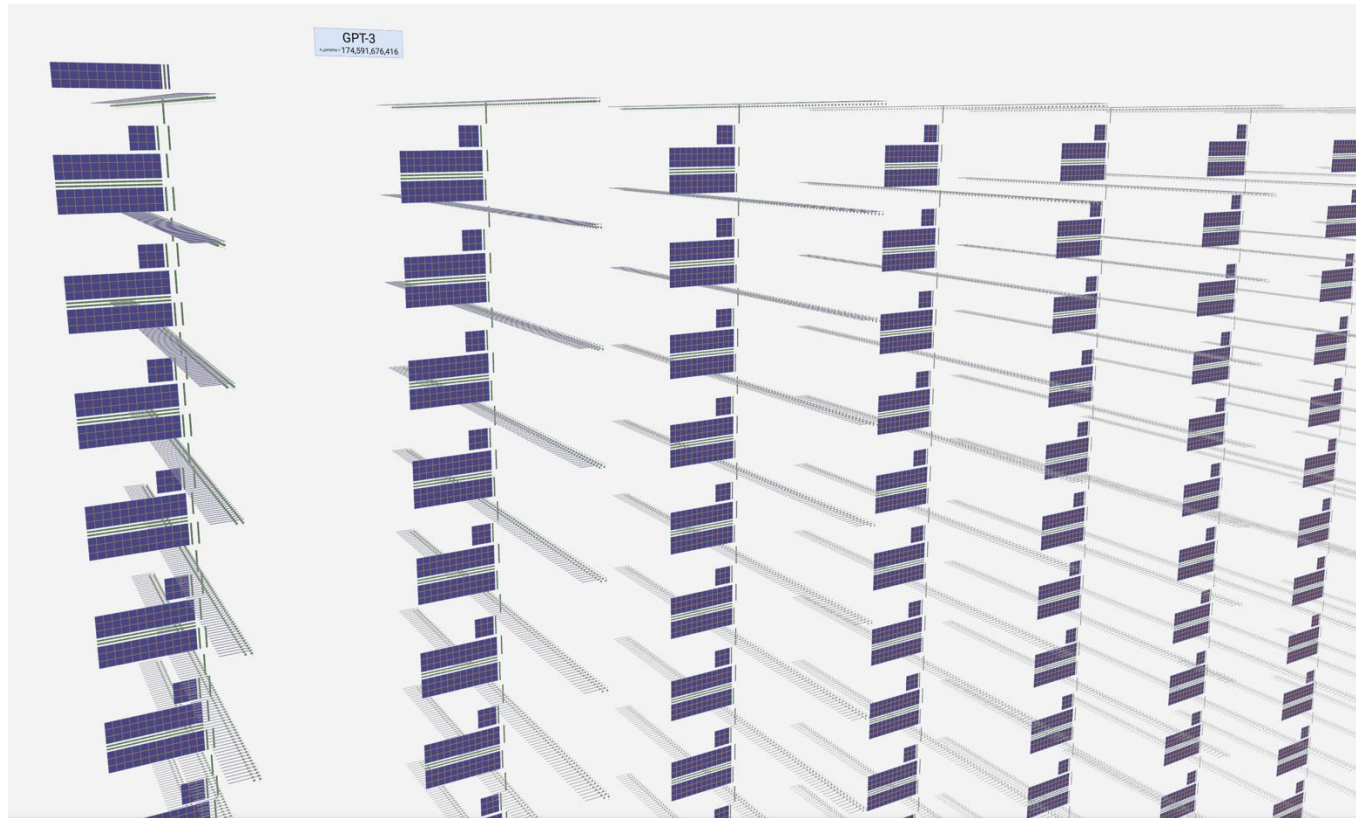


Transformer



Large Language Models

GPT-3 has 174,591,676,416 parameters.



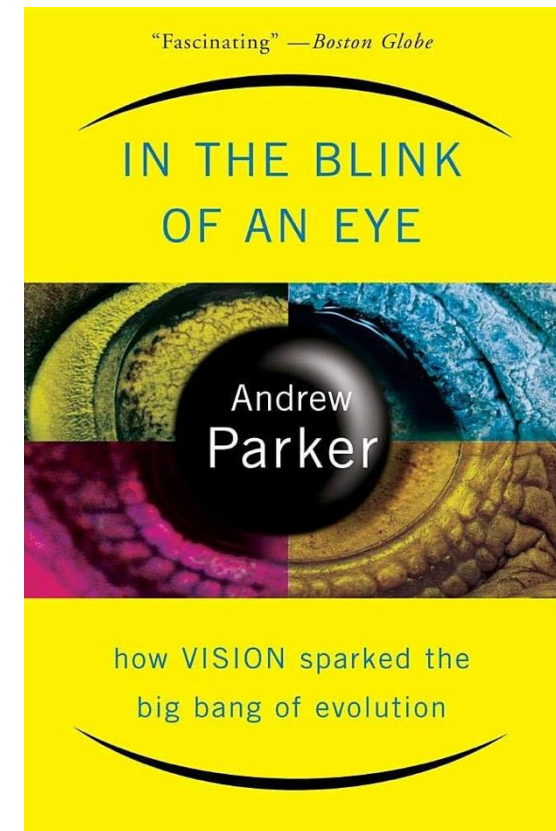
Computer Vision

Discover from images what is present in the world, where things are, what actions are taking place, to predict and anticipate events in the world.

Vision

“The Cambrian Explosion is triggered by the sudden evolution of **vision**, which set off an evolutionary arms race where animals either **evolved** or **died**.” Andrew Parker

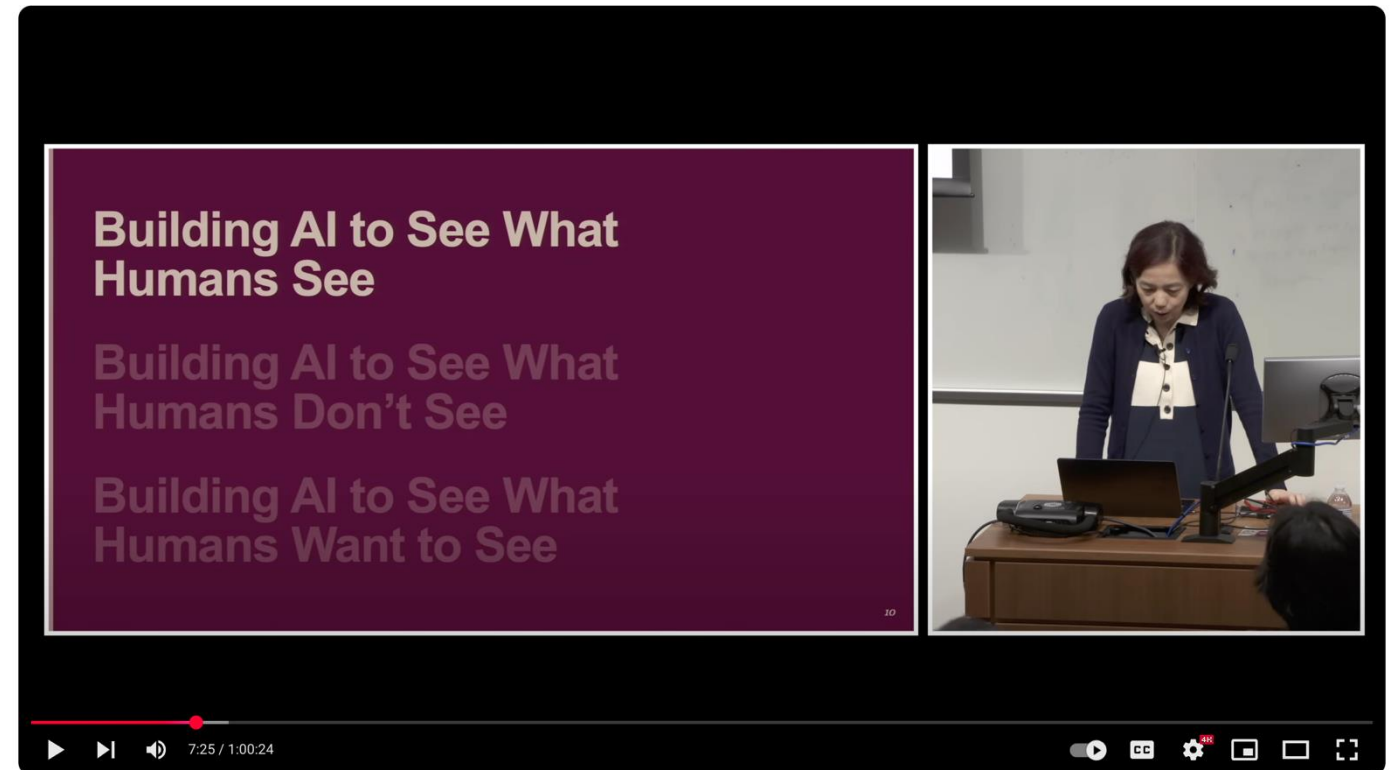
- The Cambrian explosion was a period of rapid evolution that occurred around 540 million years ago



Vision

Humans are amazingly good at seeing objects

- Seminar on “What we see and what we value: AI with a human perspective” Fei-Fei Li, January 2024 [[YouTube](#)]



What we see and what we value: AI with a human perspective—Fei-Fei Li (Stanford University)



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Vision

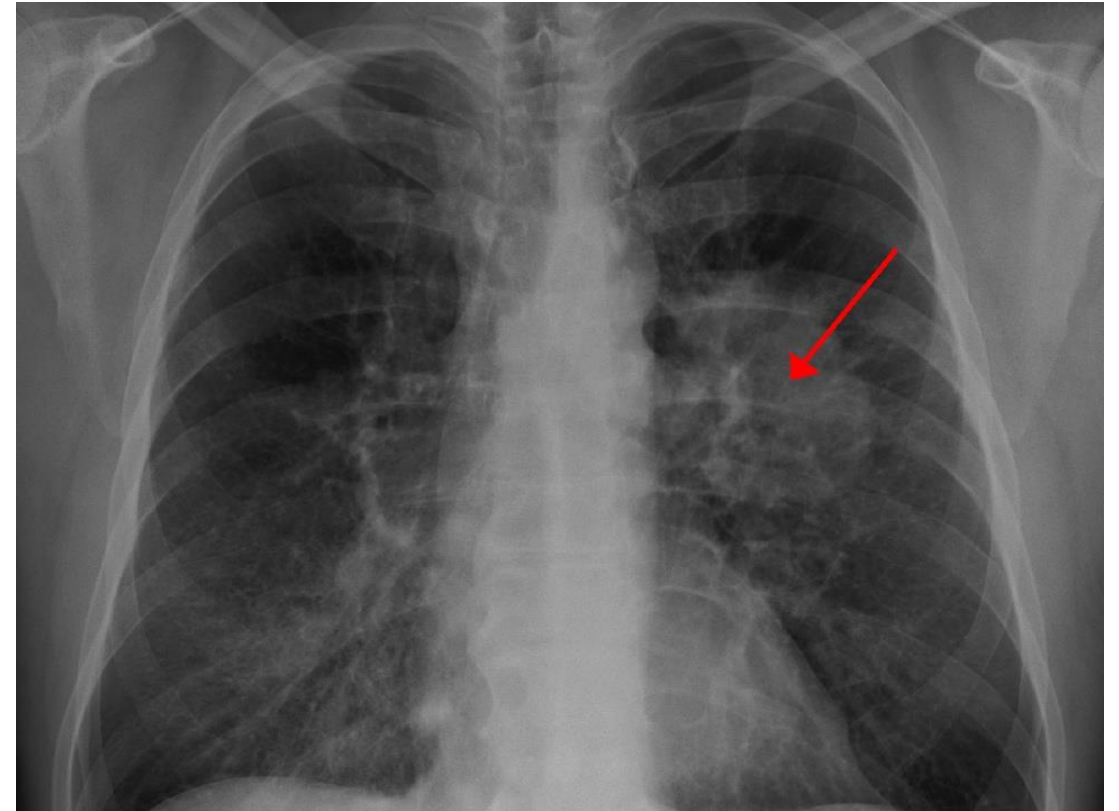
Seeing can also be challenging



Vision

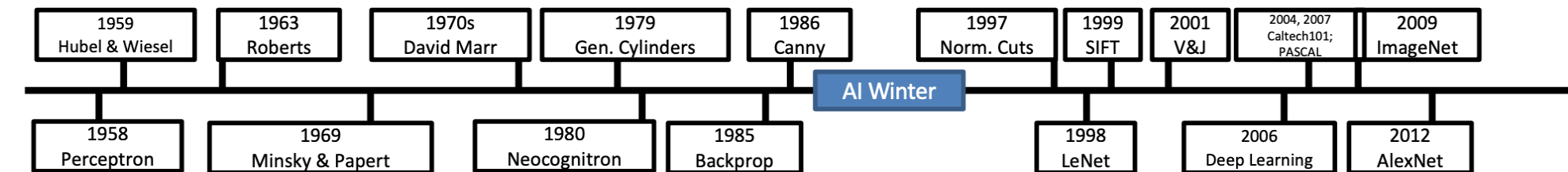
“Not seeing” in real-life can have dire consequences.

- Medical errors are the third leading cause of death



Computer Vision

- Building AI to see what humans see (e.g., autonomous driving)
- Building AI to see what humans don't see (e.g., medical imaging diagnosis, quality control in manufacturing, astronomy)
- Building AI to see what humans want to see (e.g., weather, security surveillance)



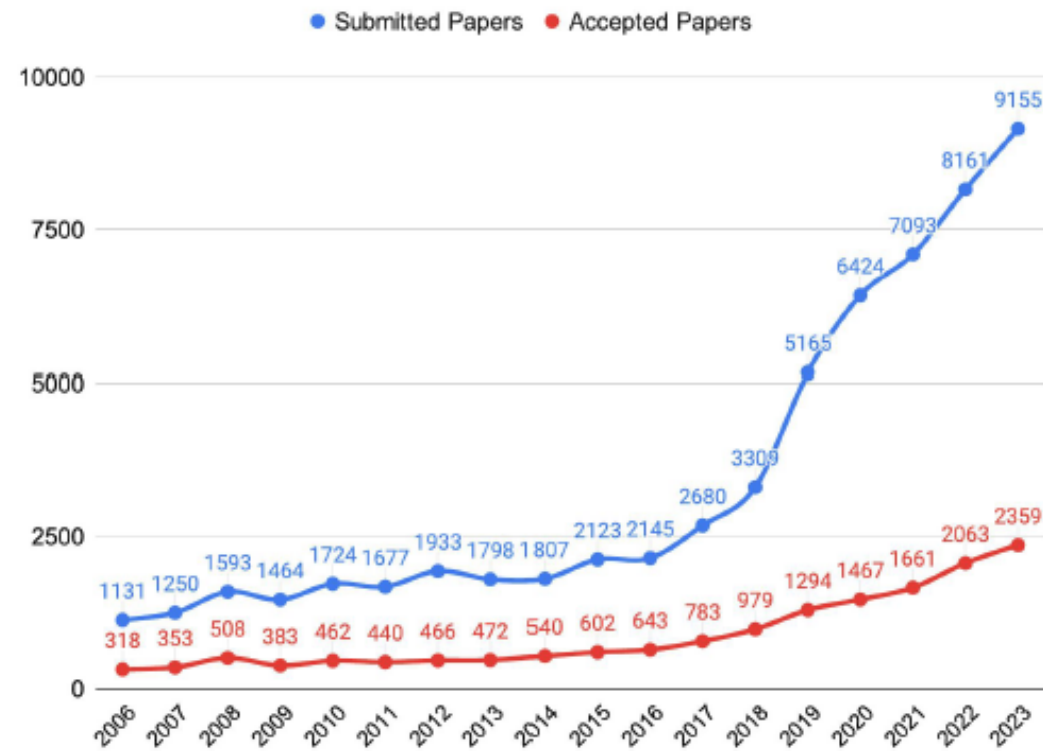
ImageNet (2009)

ImageNet has been instrumental in advancing computer vision and deep learning research.

- ImageNet is a large scale visual recognition challenge: 1,000 object classes, 1,431,167 images
 - **Prof. Li Fei-Fei, PI, Stanford University**
 - Prof. Jia Deng, Princeton University
 - Prof. Olga Russakovsky, Princeton University
 - Prof. Alex Berg, UNC Chapel Hill, Facebook, Shopagon
 - Prof. Kai Li, Princeton University
- Why is ImageNet important?
 - A high-quality benchmark: Object categorization was recognized to be one of the most fundamental capabilities of both human and machine vision
 - Data: More data to enable more generalizable machine learning algorithms

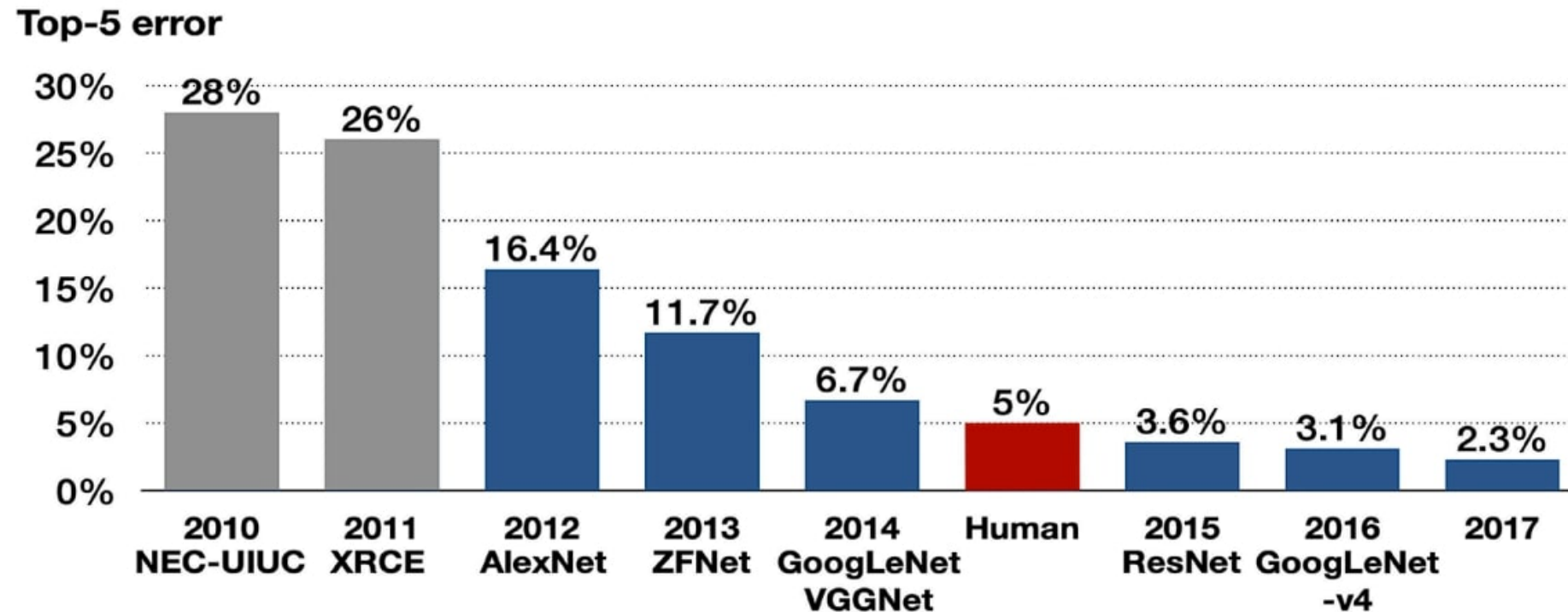
After ImageNet (2009)

A boom in the number of papers submitted to and accepted in Conference on Computer Vision and Pattern Recognition (CVPR), the top conference in Computer Vision.



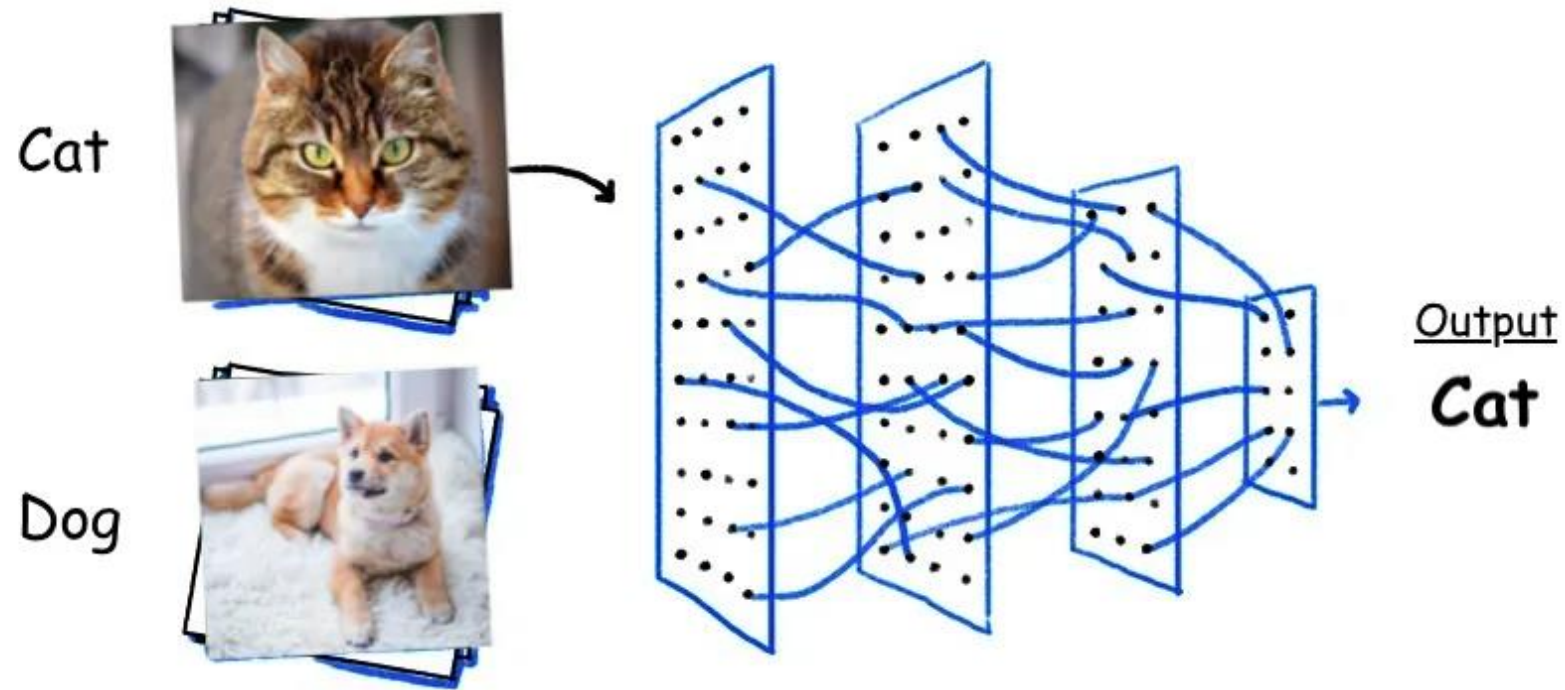
After ImageNet (2009)

The emergence of a series of deep learning architectures that become the backbone of the modern CV applications, including AlexNet (2012) and ResNet (2015).



Building AI to See What Humans See

Object categorization



Tasks Beyond Image Classification

Localization +
Classification



CAT

Single object

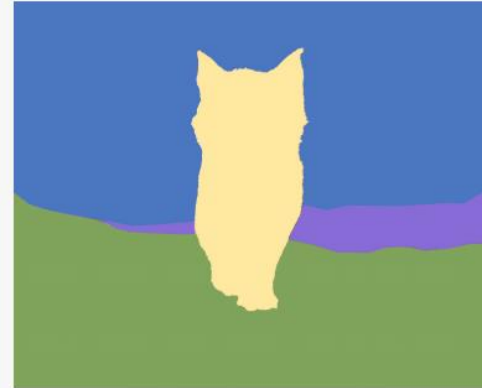
Object
Detection



CAT, DOG, DOG

Multiple objects

Semantic
Segmentation



GRASS, CAT, HILL, SKY

No objects, just pixels

Instance
Segmentation



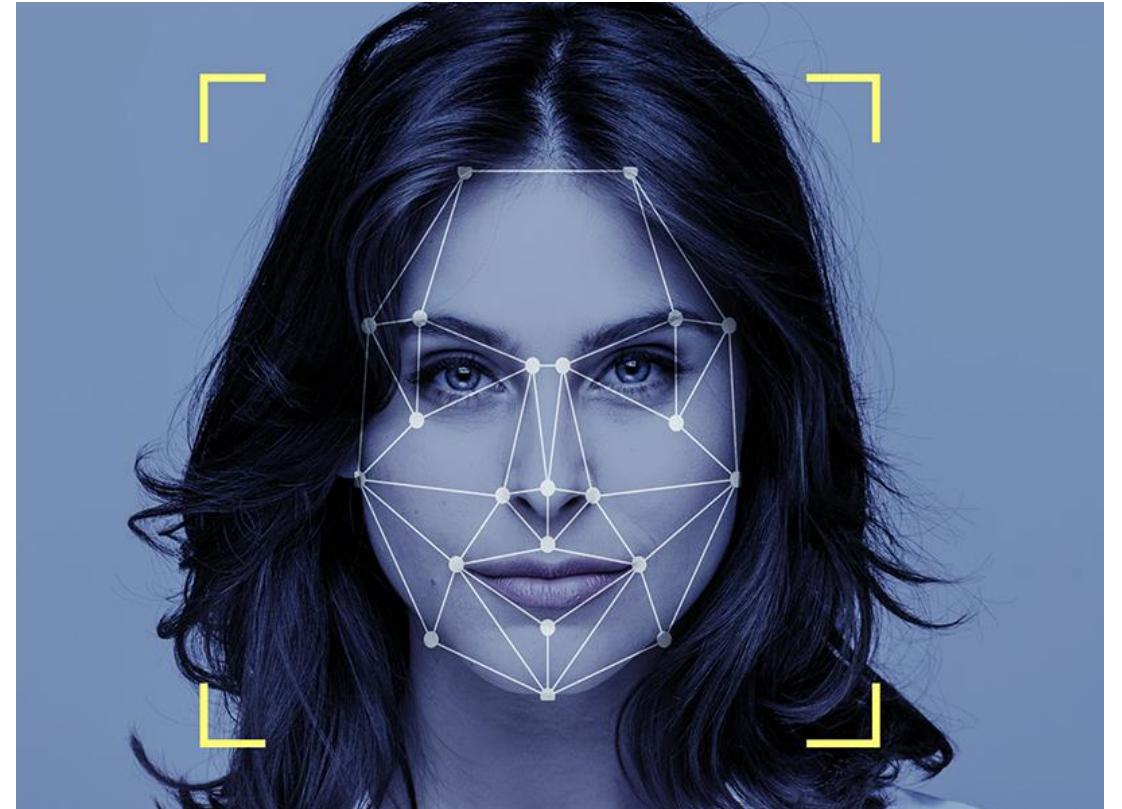
CAT, DOG, DOG

Multiple objects

Building AI to See What Humans See

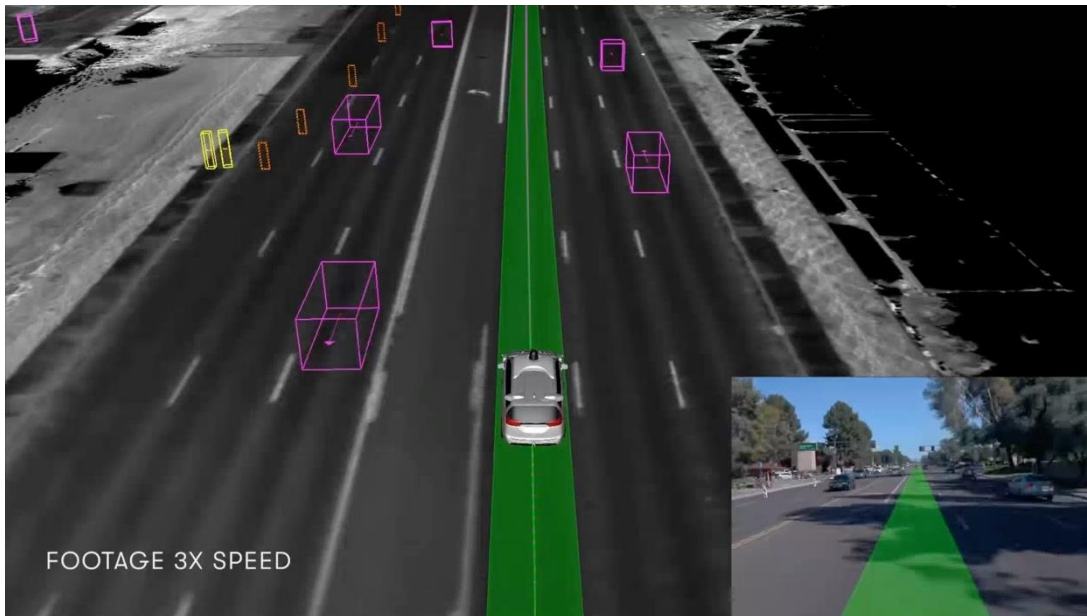
Facial detection and recognition

- Facial detection
 - Feature extraction (e.g., eyes, nose, mouth)
 - Face location
- Feature recognition
 - Feature mapping (e.g., the distance between eyes, jawline shape)
 - Matching in database



Building AI to See What Humans See

Autonomous driving



Waymo's autonomous driving technology navigates a police-controlled intersection [[YouTube](#)]



Tesla's FSD 12.6.1 Hardware 3 [[YouTube](#)]



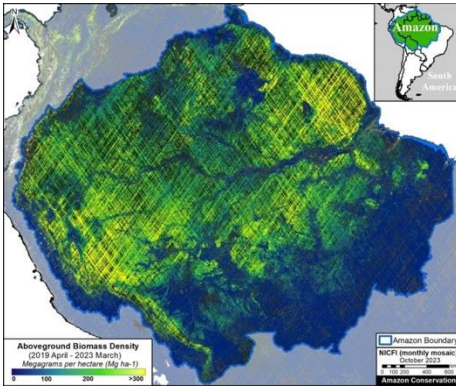
Building AI to See What Humans Don't See

Fine-grained object categorization

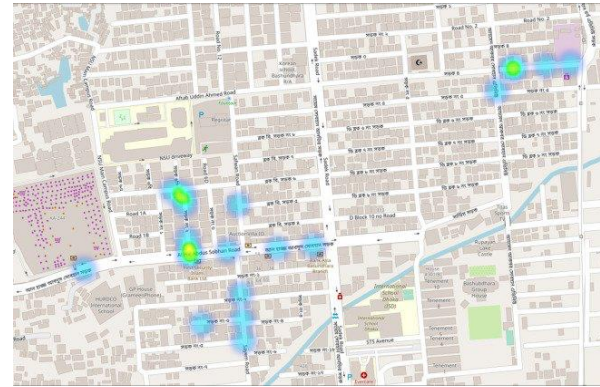


Building AI to See What Humans Don't See

Computer Vision in Environmental Conservation Applications [[Source](#)]



Forest Conservation



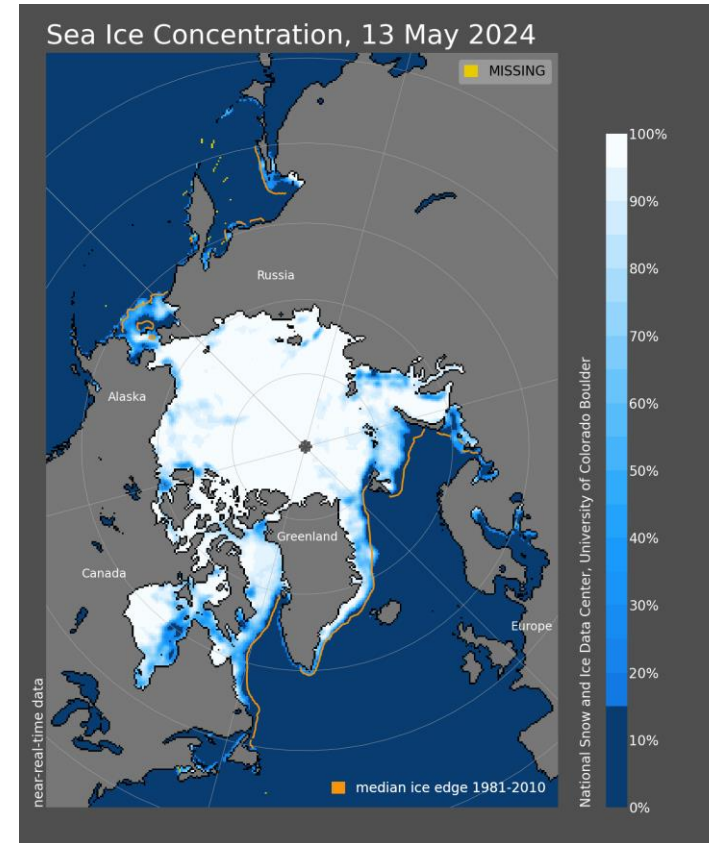
Pollution Detection and Control



Ocean and Marine Life Conservation



Wildlife Monitoring and Protection



Climate Change Impact Assessment



What Humans Don't See But AI Could in Finance Data?

- Videos of earnings calls
- Satellite imagery
- Price charts



Building AI to See What Humans Want to See

Smart Sensors + AI can recognize useful daily life activities to provide insights for clinicians and caretakers

Infection

- Fever
- Urinary frequency
- Respiratory rate

Diet

- Fluid intake
- Pill consumption
- Alcohol consumption

Mobility

- Falls
- Slowed movements
- Immobility

Other concerns of the design of AI systems

- Data privacy
- Diagnostic accuracy
- ...



Building AI to See What Humans Want to See

Deep learning to improve breast cancer detection on screening mammography

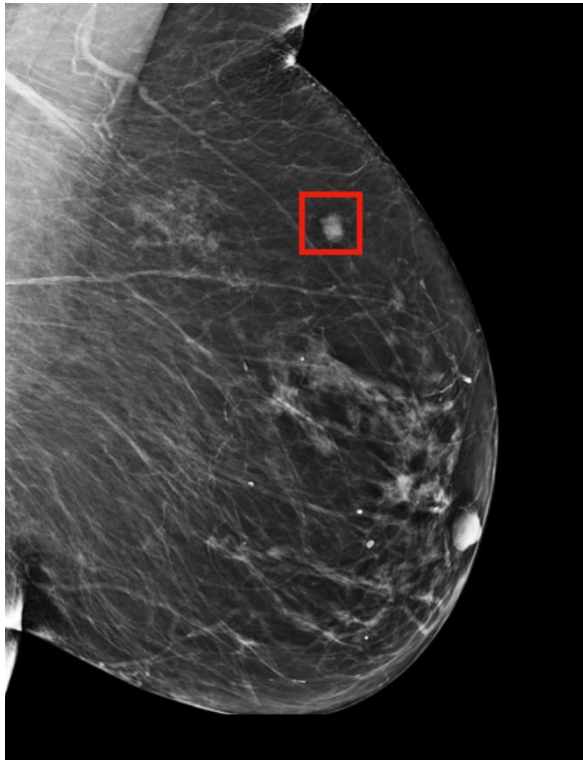
- Breast Cancer is the second leading cause of cancer deaths among U.S. women
- Role of Computer Vision
 - Deep Learning Algorithms: Enhance accuracy in detecting breast cancer on mammograms
 - End-to-End Training: Efficiently uses datasets with varying levels of annotation
- Benefits
 - Transferability: Models can be fine-tuned for different mammography platforms with minimal additional data.
 - Promise for Clinical Tools: Potential to significantly reduce false positives and negatives, improving early detection and treatment outcomes.

Shen, L., Margolies, L. R., Rothstein, J. H., Fluder, E., McBride, R., & Sieh, W. (2019). Deep learning to improve breast cancer detection on screening mammography. *Scientific reports*, 9(1), 12495.

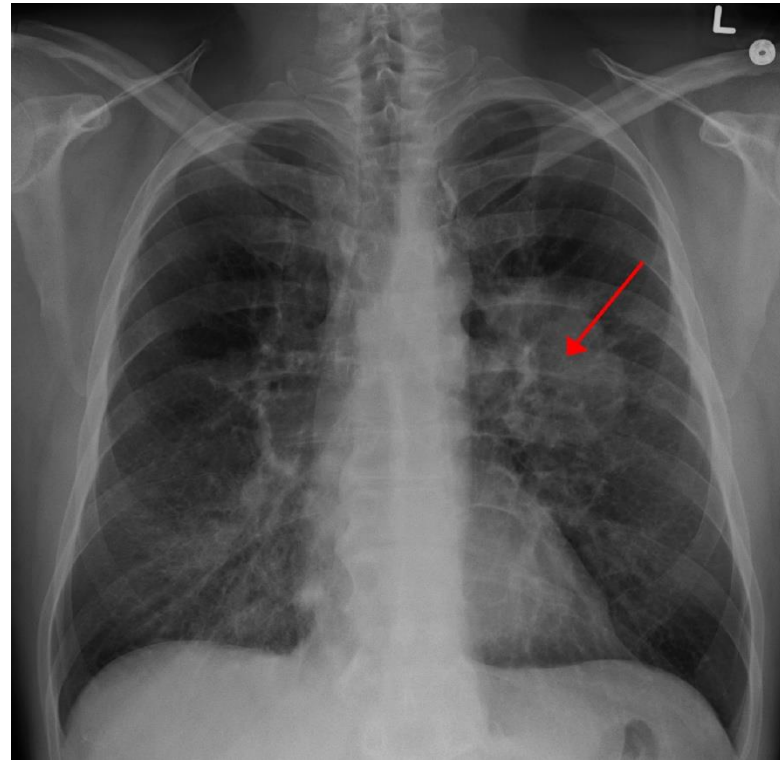


Real-World Impact of Computer Vision

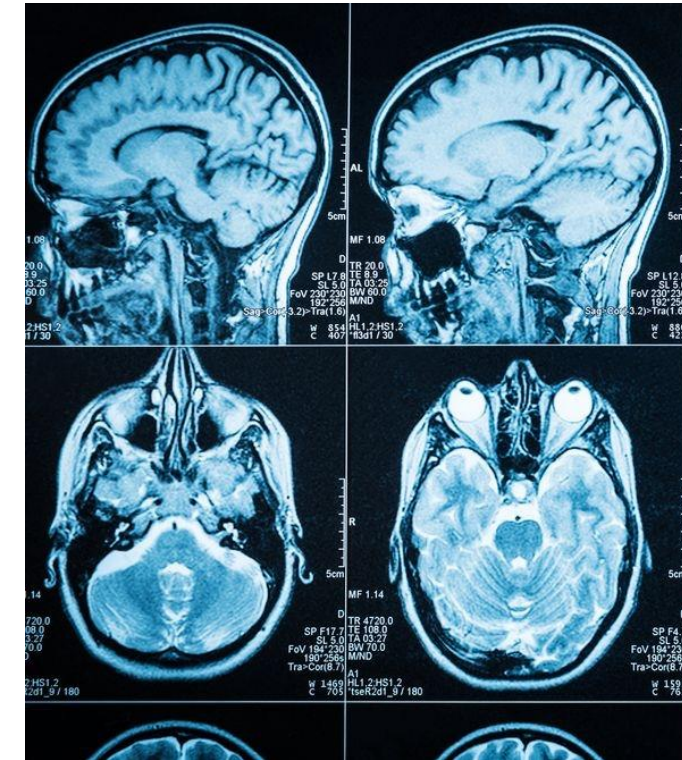
Biology, medicine, healthcare



Breast Cancer



Lung Disease



Brain Scan



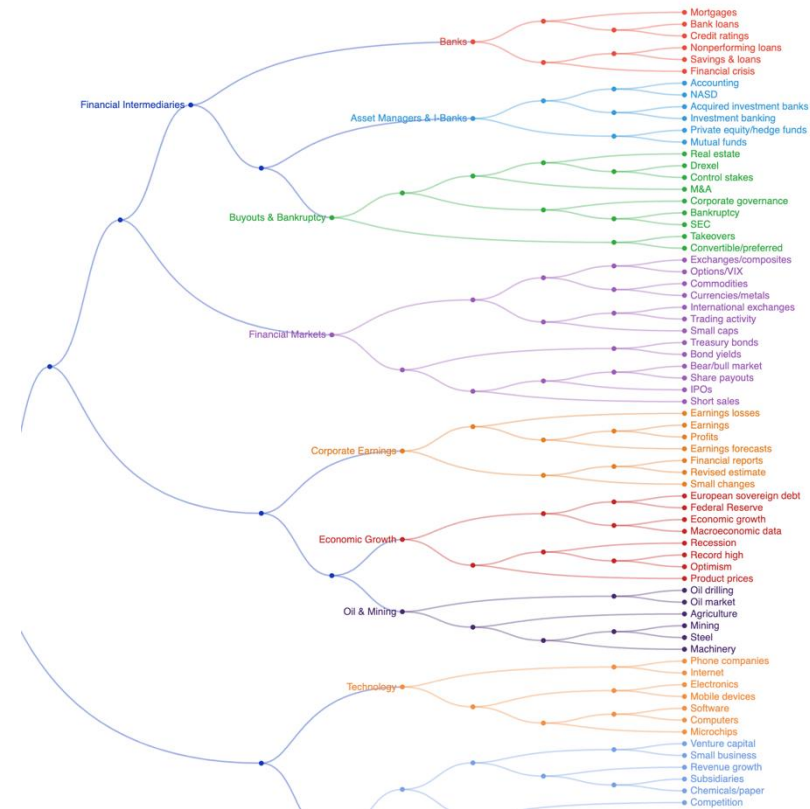
Natural Language Processing

Applications of NLP are everywhere because people communicate almost everything in language: web search, advertising, emails, customer service, language translation, virtual agents, medical reports, politics, etc.

Text Classification

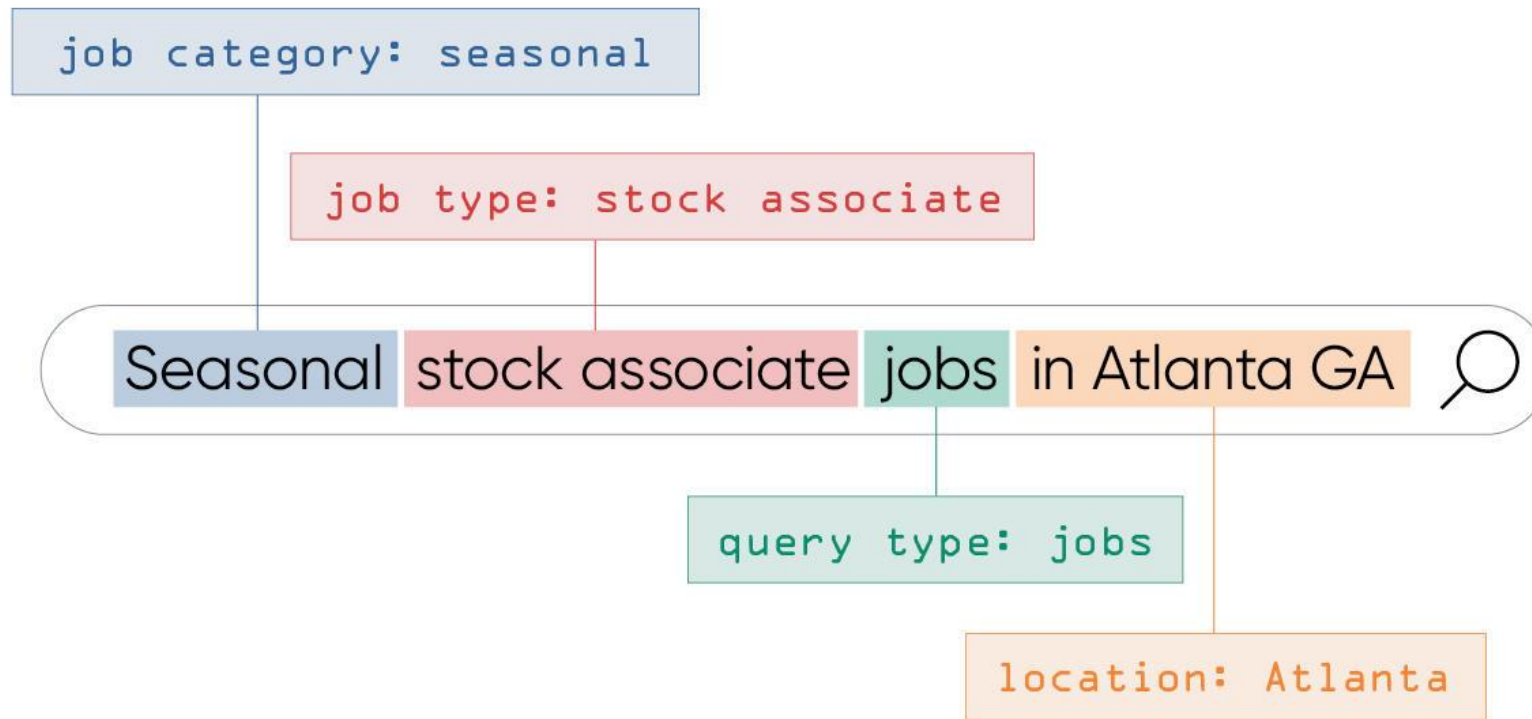
Categorizing text into predefined labels or groups

- Sentiment analysis
 - Reviews on online platforms, such as Amazon and Google Maps
 - Investor's sentiment on the stock market based on news and social media
- News topic labeling
- Spam detection



Named Entity Recognition (NER)

Identifying and classifying entities like names, dates, locations, and organizations in text



Machine Translation

Automatically translating text from one language to another

✎ Text

🖼 Images

📄 Documents

🌐 Websites

Detect language

English

Spanish

French

▼

Welcome to FA690 Machine Learning in Finance

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Advanced ▼

📄 ▼

↔

Hindi

French

Spanish

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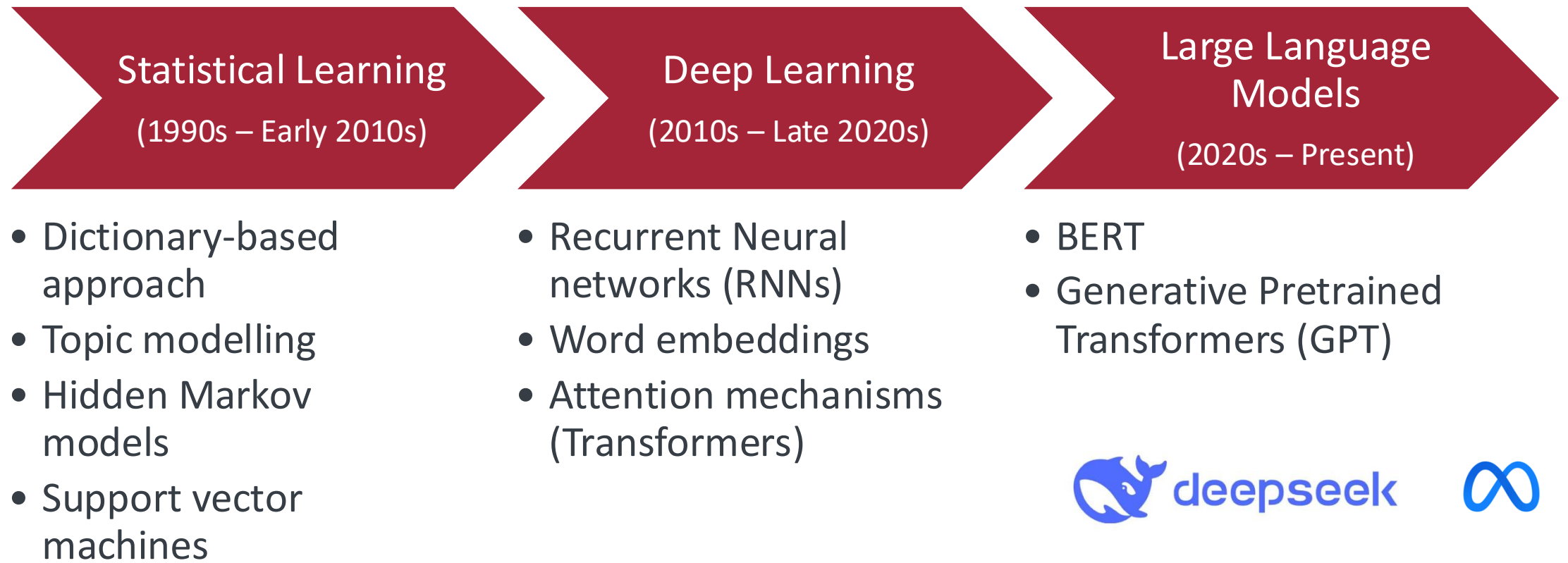
Other NLP Tasks

- Text summarization
 - Generating a concise summary of a longer text while retaining key information
 - Example: Summarizing a news article into a few sentences
- Question answering
 - Automatically answering questions posed in natural language based on a given context or knowledge base
 - Example: Answering "What is the capital of France?" with "Paris"
- Text generation
 - Creating coherent and contextually relevant text based on a prompt or input
 - Example: Generating a product description or writing a short story



Natural Language Processing

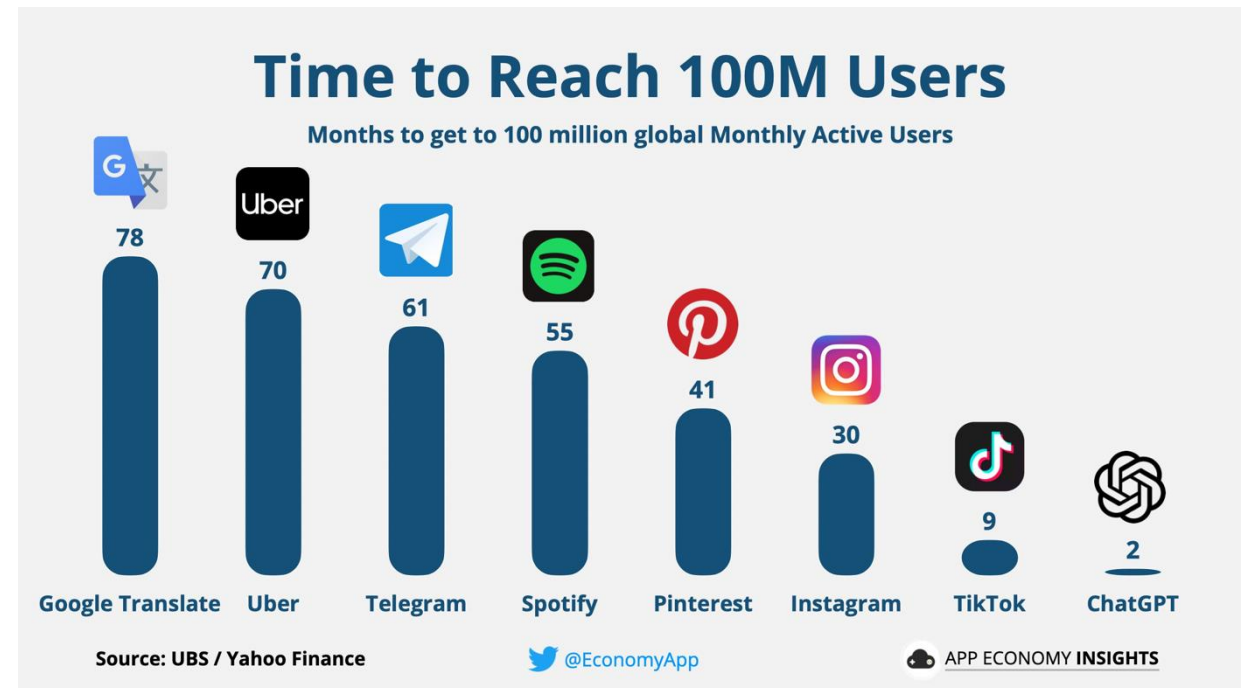
The evolution of NLP algorithms has consistently expanded their capabilities, enabling breakthroughs across a wide range of natural language processing tasks.



Generative AI and Large Language Models

ChatGPT represents a significant milestone in natural language processing and AI

- OpenAI launched GPT3.5 and ChatGPT in 2022
- ChatGPT sprints to 100 million users within 3 months



Your Experience with Generative AI

- How are you currently integrating GenAI tools like ChatGPT into your daily workflow or studies?
- Can you share a specific moment where the AI either surprisingly succeeded or completely failed?
- Share one Generative AI app that you are most excited about



Song Writing Using Suno

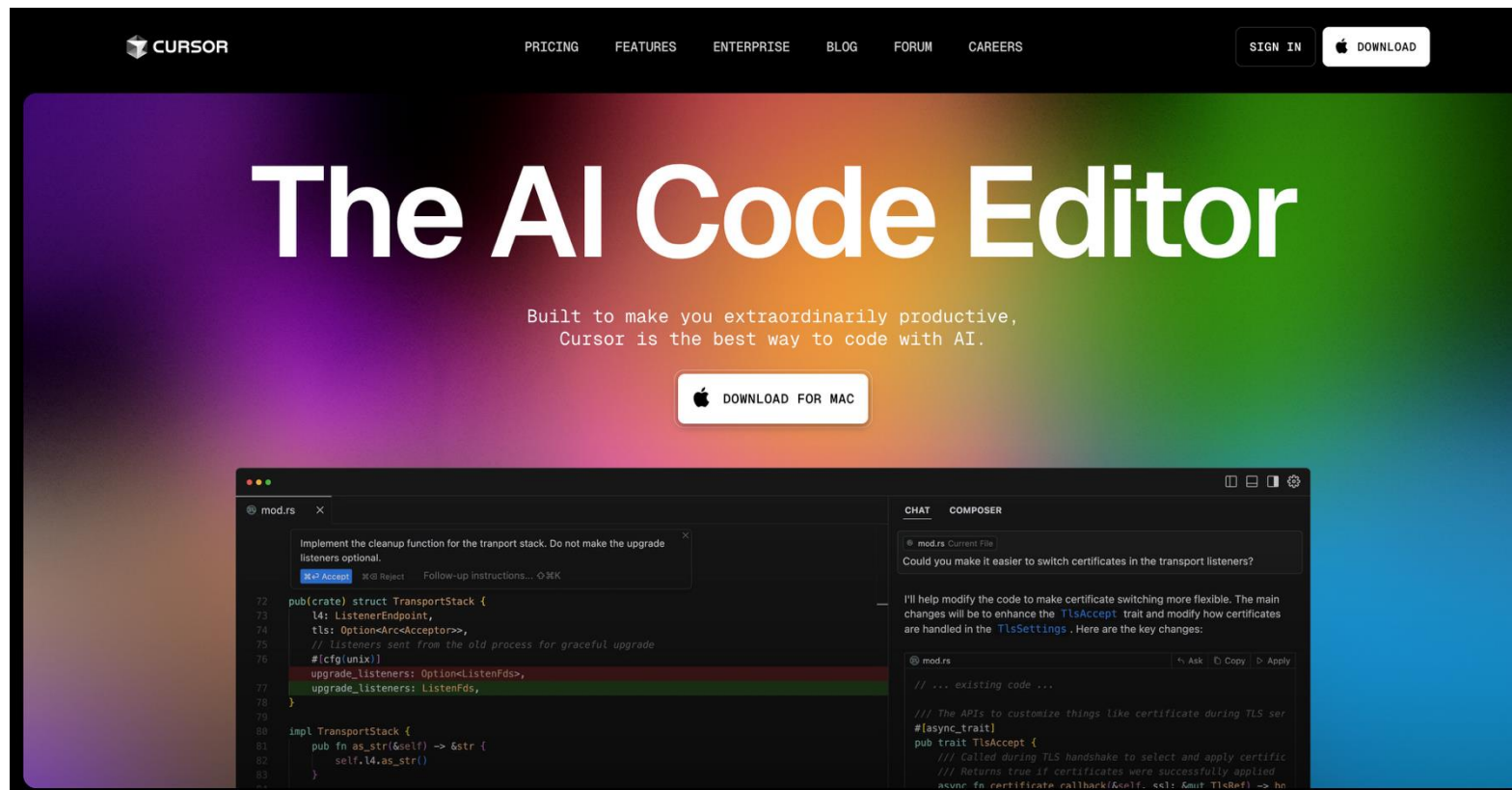
Suno is an AI music generation platform that allows users to create original songs by providing text prompts.

- Workflow of song writing using GenAI
 - Lyrics Creation: Use AI tools like Suno to generate or refine lyrics. You can input a few lines or a theme and the AI can expand on it
 - Melody and Harmony Development: AI can help compose melodies and harmonies. Tools can suggest chord progressions, generate melodies based on lyrical content, or even create backing tracks
 - Arrangement and Production: Once the basic elements are in place, AI can assist in arranging the song. This includes suggesting instrumentations, creating drum patterns, and structuring the song (verse, chorus, bridge, etc.)
- Link to [Suno Library](#)
- Link to [Course Theme Song](#)



GenAI Copilots

Cursor is an AI-powered code editor that helps developers write and understand code faster



Google NotebookLM

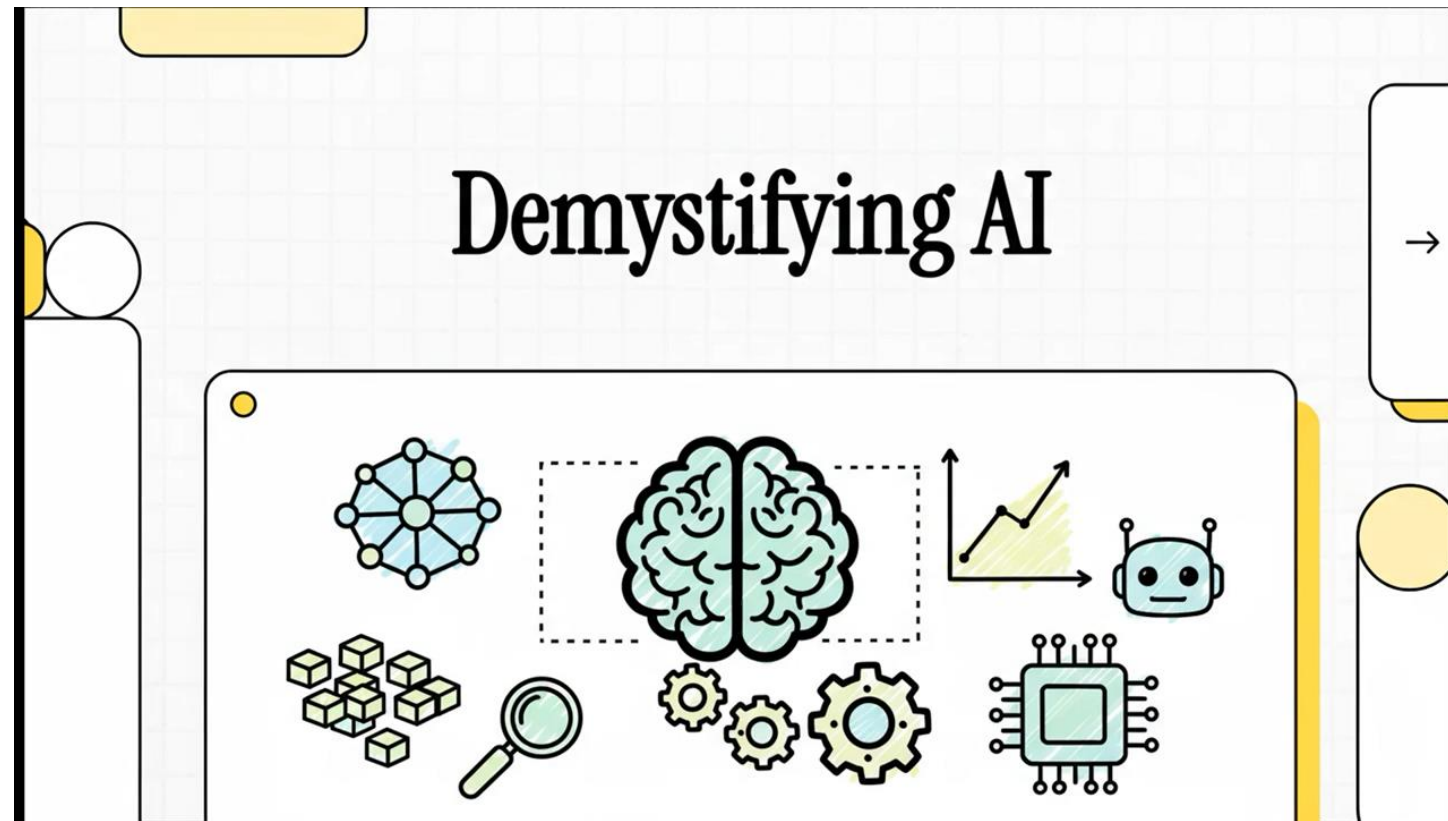
NotebookLM is Google's AI-powered note-taking tool that helps users analyze, summarize, and interact with their documents using natural language.

- NotebookLM provides a new way of
 - consuming knowledge
 - disseminating research
- Example:
 - A Podcast generated based on this set of slides
 - A Video generated based on this set of slides
- What's more
 - Quiz
 - Flashcards
 - Slide deck



Demystifying AI

Video generated by NotebookLM based on this set of slides



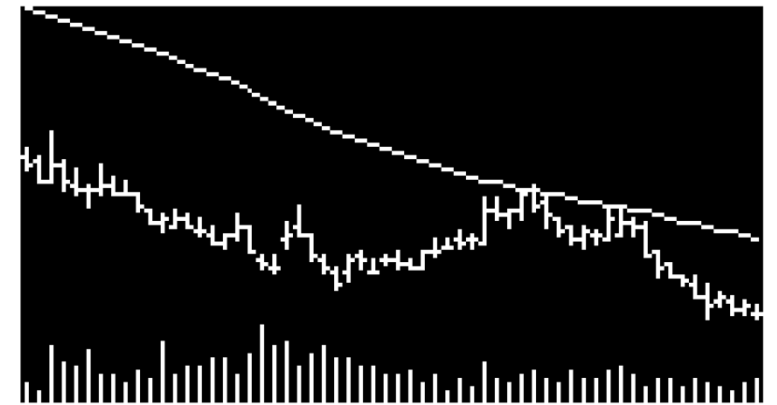
Deep Learning in Business and Finance

The application of Deep Learning in Business and Finance is still at its infancy and presents huge opportunities.

Return Predictability Based on Images

Jiang, J., Kelly, B., & Xiu, D. (2023). (Re-) Imag (in) ing price trends. *Journal of Finance*, 78(6), 3193-3249.

- Can machine predict price trends using images?
 - OHLC (Open-High-Low-Close) images
- Motivation: Technical trading hinges on the presence of geometric shapes visually defined and observed by human cognition
- So what: The predictive patterns based on the CNN approach
 - are distinct from trend signals analyzed in the literature
 - give more accurate return predictions
 - translate into more profitable investment strategies



Market Data Image

Sales Prediction with Satellite Images

With Satellite Images, Wall Street Analysts Spy On Wal-Mart [[Source](#)]

- If you were a hedge fund manager, what specific data points could you extract from this image to make money?
- Crowded parking lots suggest higher sales
- UBS analysts use pictures like this of Wal-Marts around the country to help them estimate the company's sales



Satellite Image of a Wal-Mart Parking Lot in Wichita, Kansas

Sales Prediction with Satellite Images

How to do it using GenAI?

- Instructions in natural language
 - “Based on the provided image of the parking lot, estimate the percentage of parking spaces currently occupied. Choose one of the following options: 0%, 25%, 50%, 75%, or 100%.”
- Agentic workflow
 - Image collection
 - Image analysis
 - Statistical analysis
 - Report writing



Satellite Image of a Wal-Mart Parking Lot in Wichita, Kansas

Extract Brand Image Portrayed on Social Media

Liu, L., Dzyabura, D., & Mizik, N. (2020). Visual listening in: Extracting brand image portrayed on social media. *Marketing Science*, 39(4), 669-686.

- Brand perception: How do users view my brand?
- Traditional approach: Consumer surveys
 - Expensive and slow
- Alternative approach: BrandImageNet, a multi-label convolutional neural network, that analyzes images posted by consumers and extract perceptual brand attributes, such as "glamorous," "rugged," "healthy," and "fun"
 - Broad consumer base
 - Fast response
 - Time varying brand perception



Sample Images

Measuring Corporate Culture Using NLP

Li, K., Mai, F., Shen, R., & Yan, X. (2021). Measuring corporate culture using machine learning. *Review of Financial Studies*, 34(7), 3265-3315.

- Feng Mai is a former Stevens Faculty
- Leverage word embedding models (specifically, the word2vec model) to analyze 209,480 earnings call transcripts, scoring five key cultural values: *innovation*, *integrity*, *quality*, *respect*, and *teamwork*
- So what?
 - Corporate culture correlates with various business outcomes, such operational efficiency, risk-taking, earnings management, executive compensation design, firm value, and deal making
 - Corporate culture is shaped by major corporate events like mergers and acquisitions (M&As)



Do Investors Use GenAI to Trade

- Stocks top the list of “Top 10 AI Prompt Words of 2025” in Qwen [[News](#)]
- The Motley Fool Survey: How Investors Are Using Generative AI [[Link to Survey](#)]
 - ChatGPT is the most popular tool among investors who use AI
 - Investors most commonly use AI for analyzing stocks and market trends
 - 69% of investors using AI tools say it saves them time on stock research
 - Younger, less experienced investors use AI tools most frequently
 - Data privacy is the top AI concern among investors using generative AI tools



Can ChatGPT Forecast Stock Price Movement?

Lopez-Lira, A., & Tang, Y. (2023). Can chatgpt forecast stock price movements? return predictability and large language models. arXiv preprint arXiv:2304.07619.

- Document the capability of large language models (LLMs) like ChatGPT to predict stock market reactions from news headlines without direct financial training
- GPT-4 captures initial market responses with 90% accuracy
- GPT-4 scores also significantly predict the subsequent drift, especially for small stocks and negative news
- Forecasting ability generally increases with model size, suggesting that financial reasoning is an emerging capacity of complex LLMs



AI-Trader: Can AI Beat the Market?

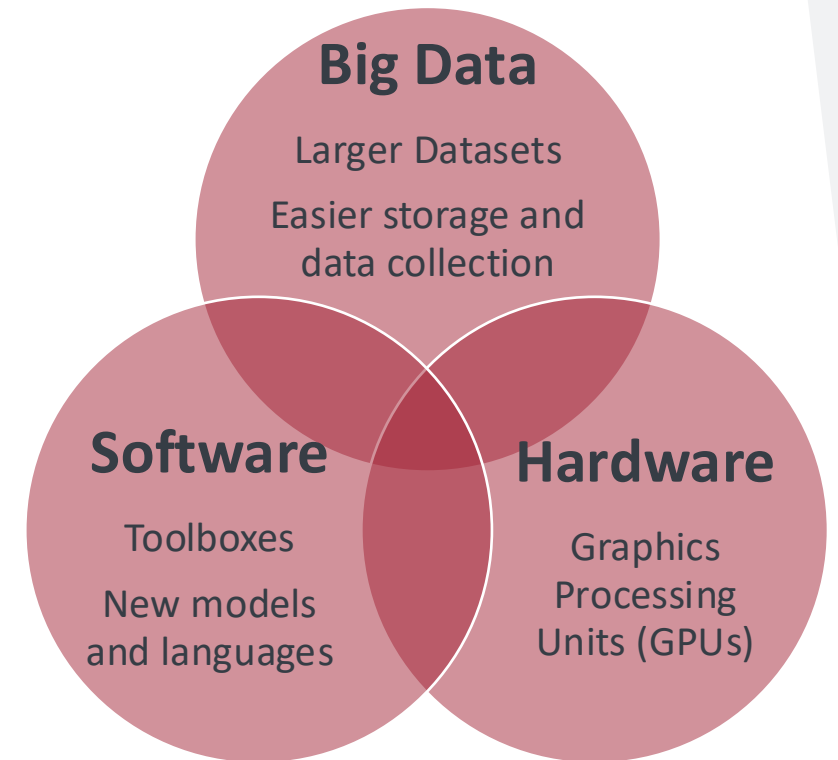
AI agents battle for supremacy in NASDAQ 100, SSE 50, and cryptocurrency markets. Zero human input. Pure competition [[Link to AI Live Trading](#)]



Reflections

The unstructured nature of images and text presents both challenges and opportunities

- Challenges of analyzing unstructured data
 - How to represent the data?
 - How to model the data?
 - What do you want to extract from the data?
- If we abstract the ML applications at the level of data, model, and prediction, i.e., $Y = f(X) + \epsilon$, the execution is the easiest step
- Equipped with data, software, and hardware today, creativity and ideas are what matters



Learning Objectives for This Course

- A basic understanding of the fundamental concepts/methods in machine learning (deep learning)
- Implementation and application of machine learning models for solving financial problems
- Hands-on experience with advanced techniques for leveraging LLMs, including prompt engineering, RAG, and fine-tuning
- (Develop an intuition of what to model that matters to investment and business)



Acknowledgement

The lecture note has benefited from various resources, including those listed below. Please contact Zonghao Yang (zyang99@stevens.edu) with any questions or concerns about the use of these materials.

- Lecture Notes on Deep Learning Fundamentals by Léonard Boussioux at University of Washington
- Seminar on “What we see and what we value: AI with a human perspective” Fei-Fei Li, January 2024 [[YouTube](#)]





THANK YOU

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