COMP 150:
Basics of Computer Organization
Week 05, Lecture 08

Agenda

1. Let's Talk About AI
    a. What is it?
    b. What is it *not?*
2. History
3. Machine Learning: Major Problems
    a. Structured
    b. Unstructured
    c. Games
    d. Feature set
    e. Natural Language Processing
    f. Image recognition
4. Neural Networks and Deep Learning
5. GPT
6. GPUs - Why?
7. Where do we go from here?

What is AI?

- Britannica: “artificial intelligence (AI), the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings.”
- Wikipedia: “Artificial intelligence (AI) is the capability of computational systems to perform tasks typically associated with human intelligence, such as learning, reasoning, problem-solving, perception, and decision-making.”
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AI - What it *is*, what it *isn't*

Is:

- Algorithms
- Code
- Data (computer memory)
- Tools to automate tasks
- Pattern recognition
- Repetition (in full or part)
- Contextualization

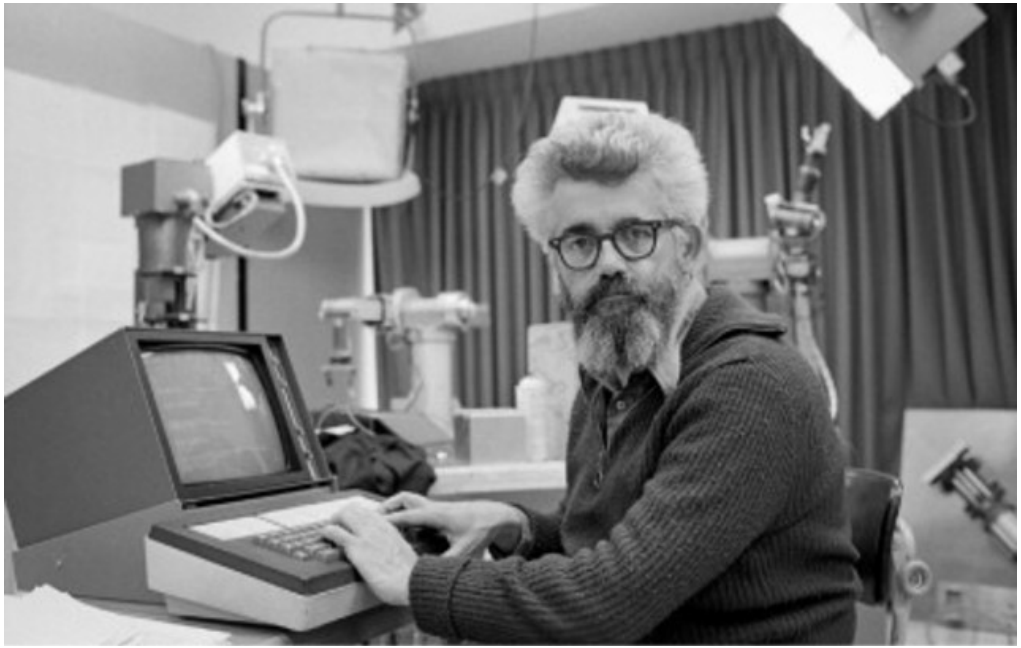
Is *not*:

- Thinking
- Creative (nothing is new!)
- Intuitive
- Novel
- *Recent*

History of Artificial Intelligence

John McCarthy

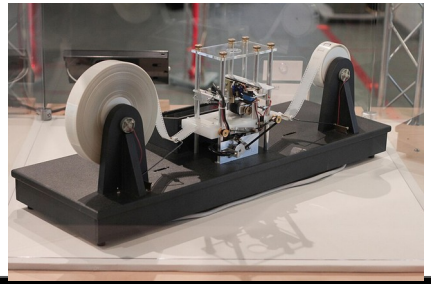
- Mathematician and computer scientist
- Coined the term “artificial intelligence”
  - 1955, summer project
- Also built LISP, a language
- His definition of AI?
  - Human logic made mathematical



History of Artificial Intelligence

Alan Turing

- Mathematician and computer scientist
- Turing machine
  - Can implement any number of steps to do any algorithm
  - We still use “turing complete” to describe languages
- Turing Test
  - Is it a computer, or is it a human?
  - Ultimate test of AI
- His definition of AI?
  - Human interaction made universal



History of Artificial Intelligence

Machine Learning

- Nuts-and-bolts
  - Models = the algorithm
  - Training = teaching
- “How can we teach a computer to do a task?”
- Different branches approach different types of tasks
  - Supervised (a human trains the model)
  - Unsupervised (a human points a model at a lot of data)
  - Reinforcement (a human provides correctness feedback)

Machine Learning Examples

- Game theory (1970s)
  - Samuel: Checkers, 1952
  - Menace: Tic Tac Toe, 1963
  - Deep Blue: Chess, 1997
  - Watson: Jeopardy, 2011
  - AlphaGo: Go, 2016
  - Libratus: Poker, 2017
- Feature selection
  - Lots of data - do we need all of it?
- NLP - Natural Language Processing
  - What does this sentence mean?
  - Translation
- Image recognition
  - How many stoplights in this photo?
  - Is this a bird or not a bird?

How does machine learning work?

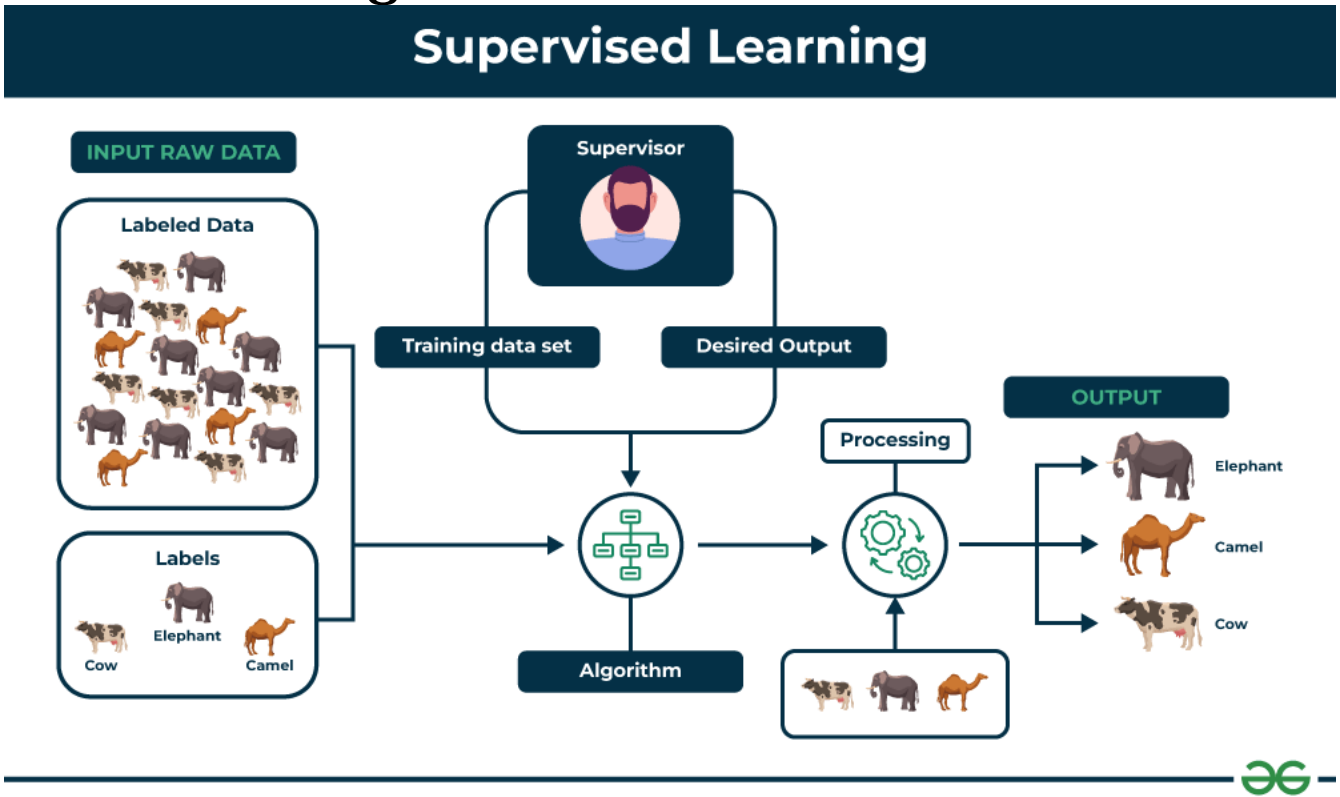
It depends!

- Problem
- Data
- Type (supervised, unsupervised, reinforcement)

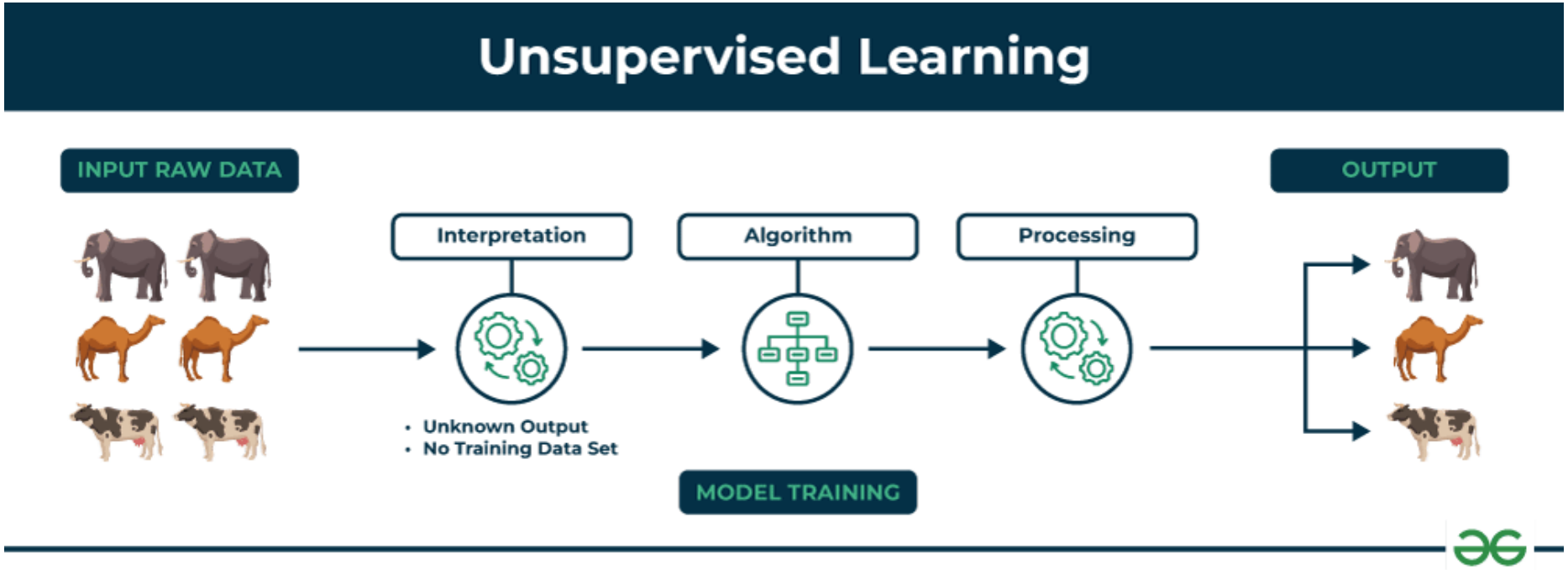
In general:

- Provide data
- Run the data through an algorithm
  - The algorithm stores information (“remembers”)
- Query the algorithm
  - “Does this image contain a bird?”
- Update the algorithm’s knowledge

Supervised Learning

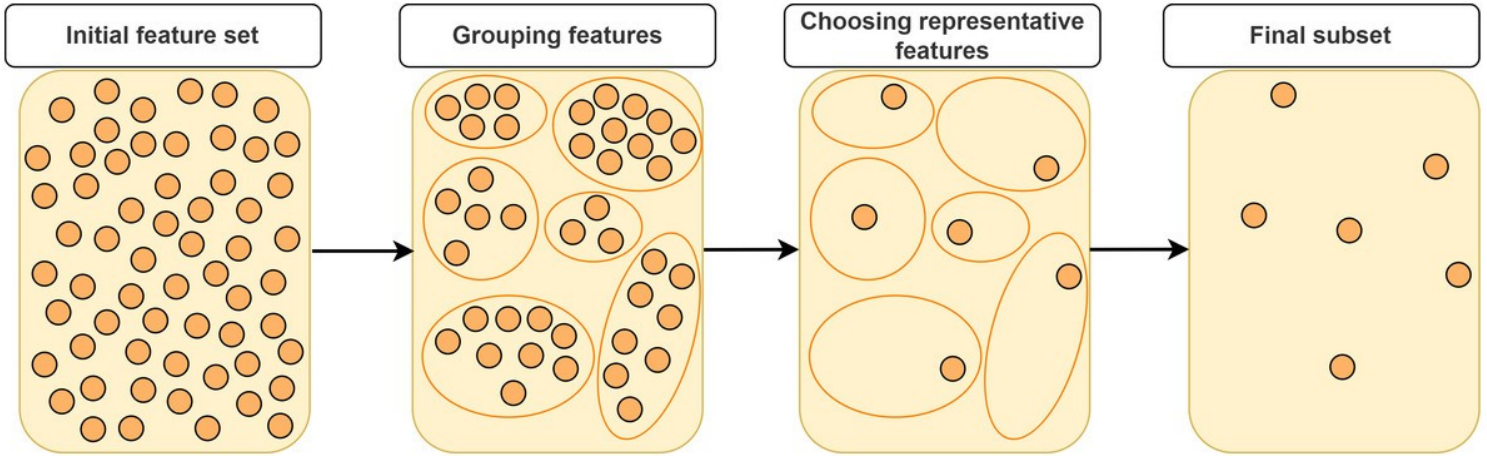


Unsupervised Learning



Feature Reduction

- Data is large
- Choose representative subset



Natural Language Processing

- Take words and turn them into their meaning
- Chat bots
- Translation
- Contextualization
- Easy to do - hard to do well!

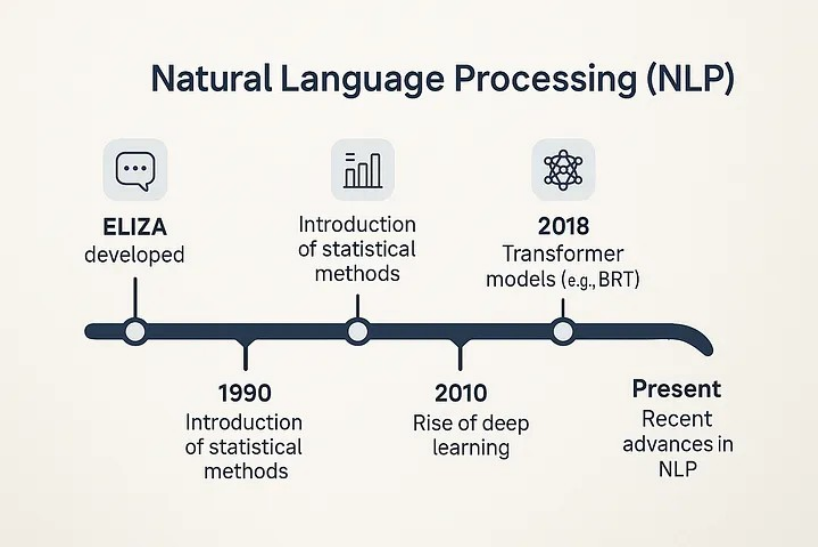
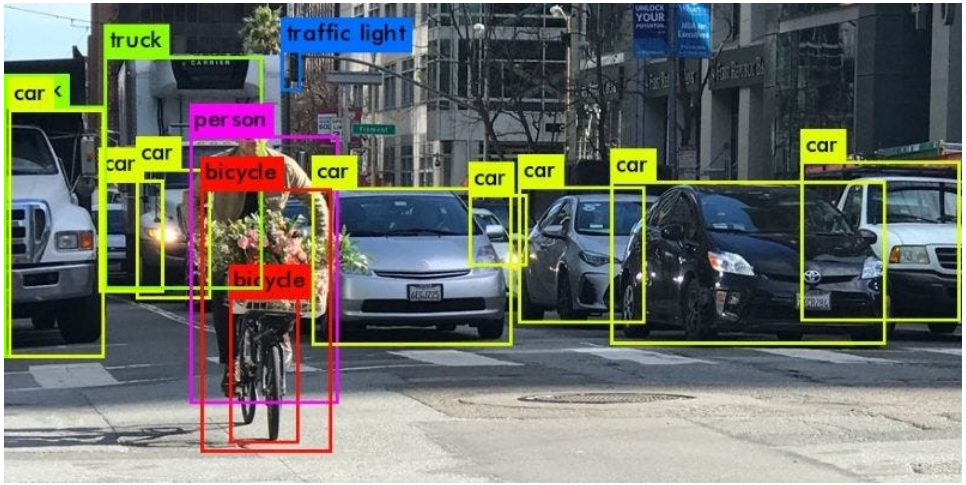


Image Recognition

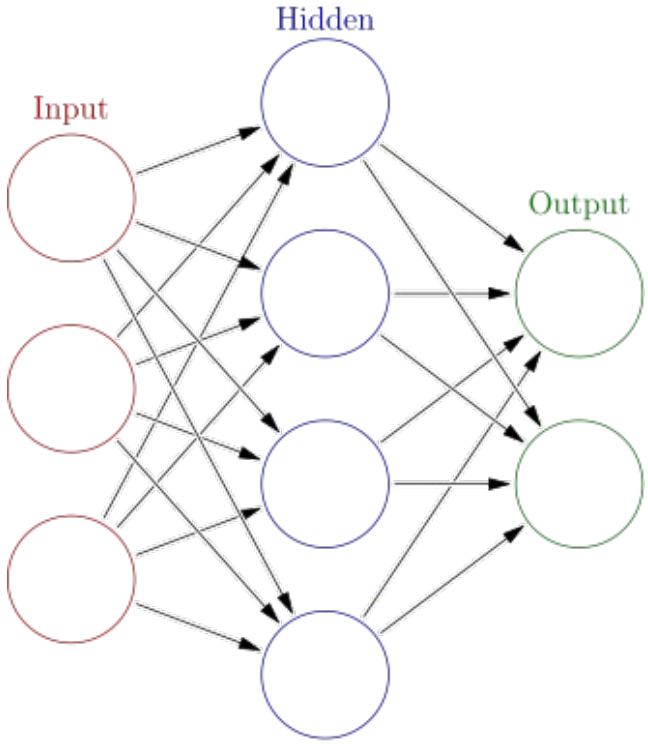
- Extremely difficult
- Started in the 70s
- Wasn't solved until **2011**



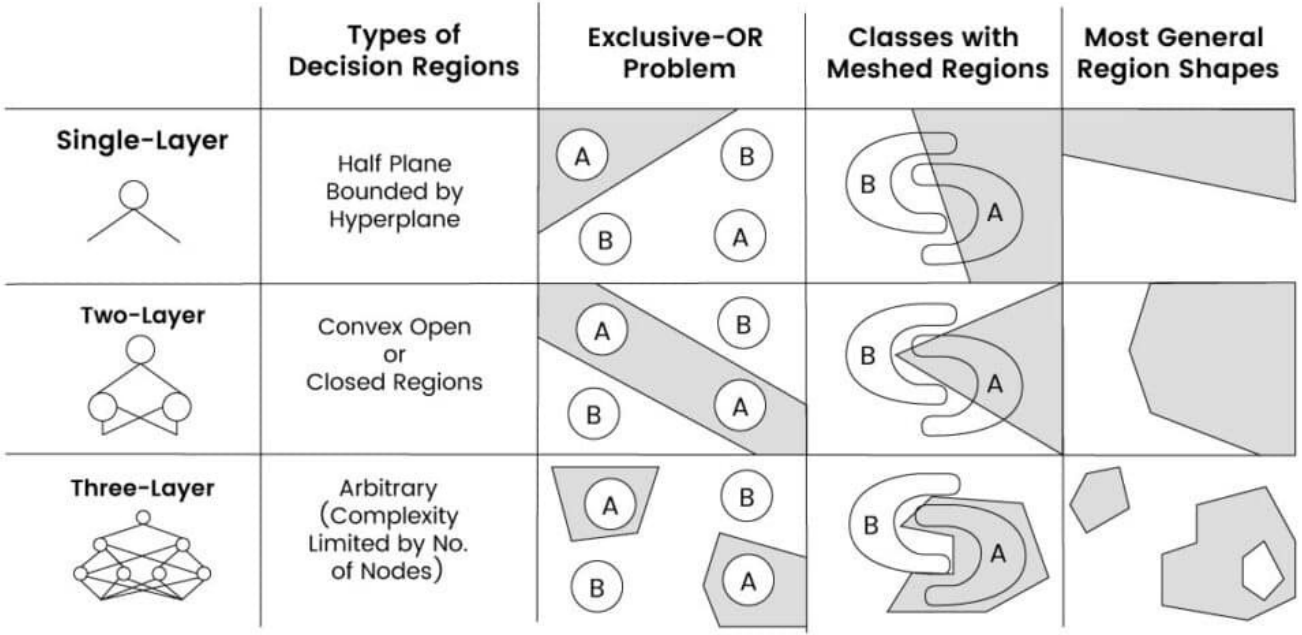
Neural Networks

- Linear algebra solver
- Can be used for any number of tasks
- Similar setup to the human brain
  - Connect decisions one to the next
  - Similar to neurons
- Incredibly simple - but we need a *lot*

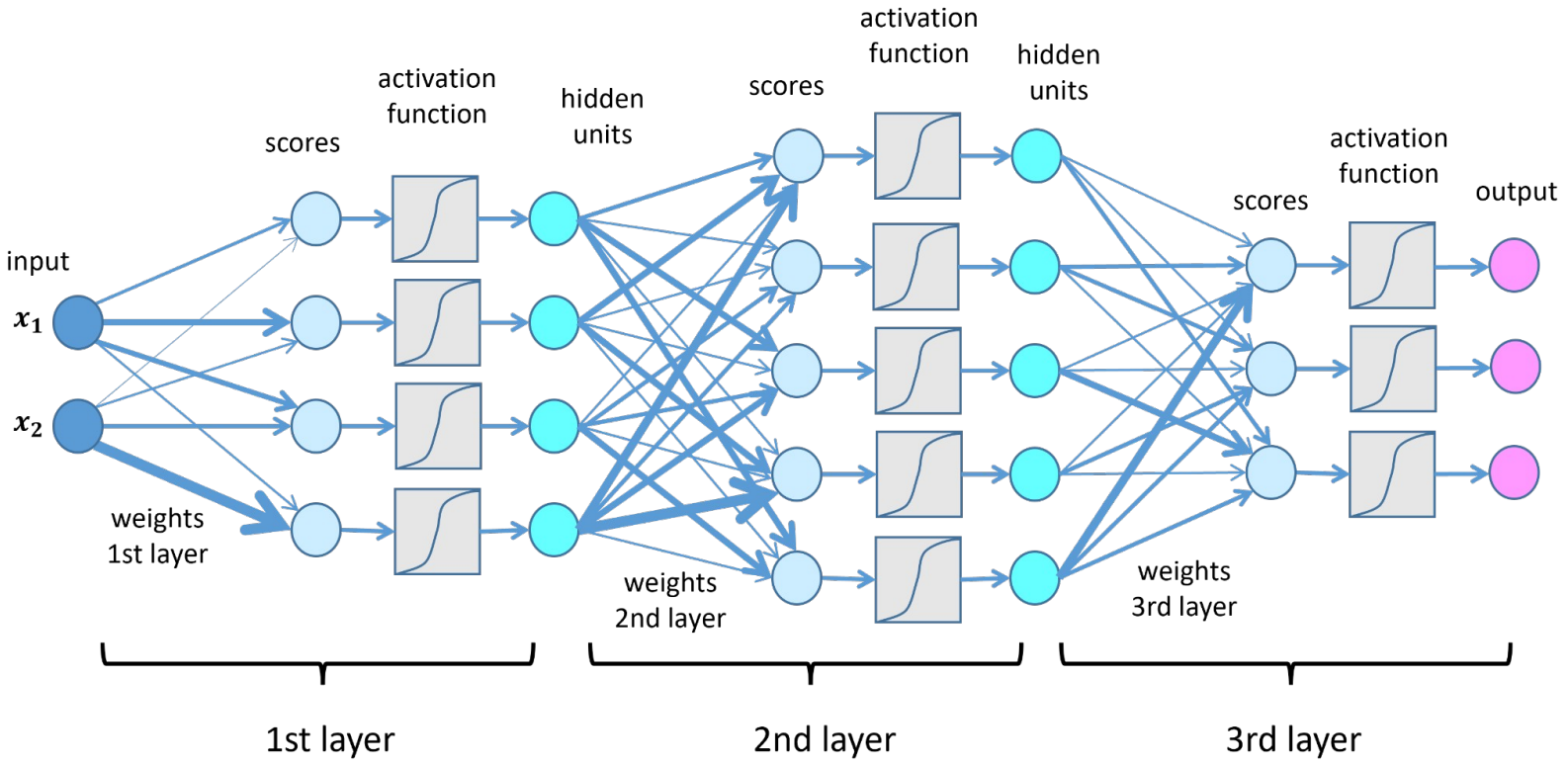
Deep learning: when we have a lot!



Neural Networks

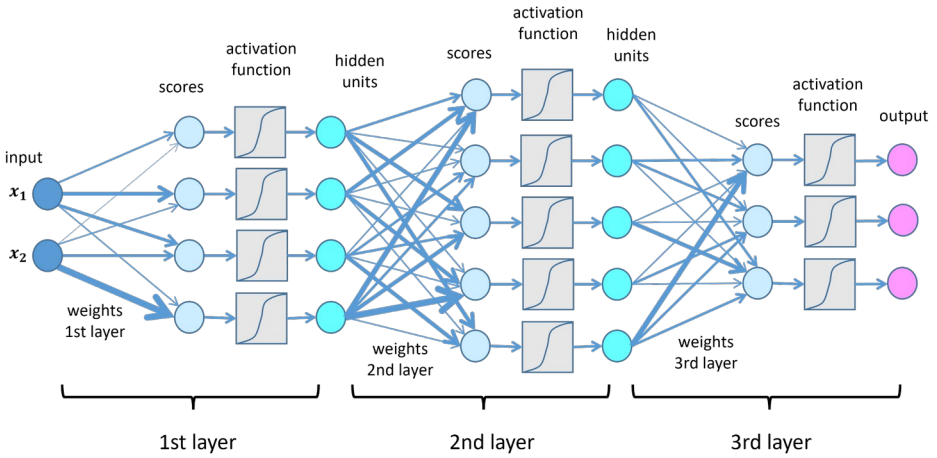


Neural Networks



GPUs and Machine Learning

- Architecture is well-suited to ML!
- Most modern ML uses networks
- Repetition and simultaneous use means lots of the same math



GPT

Generative Pre-Trained Transformer

- Text prediction
- Trained on the internet (not kidding)
- Transformers
  - Hold context
  - Look at the context and decide what's important
  - Use the importance to adjust weights in math

They are, in the end, text generators.