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# What is Artificial Intelligence?

— Summer Springboard —

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<https://golb.us/summerspringboardai/>

— All code is on my webserver —

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# Dr. Peter B. Golbus (he/him/his)

- Lecturer in Computer Science at Boston University
- I earned my Ph.D. from Northeastern University in 2014 studying the meta-evaluation of search engines
- I worked at Wayfair for the next six years as a data scientist
  - Major projects:
    - B2B order scoring model
    - Personalized product recommendations
      - Counterfactual evaluation
        - Easy: Would we recommend what they clicked on
        - Hard: Would they have clicked on what we would have recommended
      - Low level platform for developing / high level platform for consuming recs
- Spent the next two years at CVS before returning to academia last year
- My research interest is in algorithmic fairness
  - Detecting and removing bias from datasets using Hierarchical Bayesian Inference

# Weird things about me

- I'm mildly face-blind
  - There are some people I can't tell apart
  - If you get a dramatic haircut, I won't recognize you
  - It tends to be worst with Chinese faces
- My background is in meta-evaluation
  - I'm not interested in solving problems, I'm interested in telling you that you didn't solve yours
  - I think the best way to explain what these things *are* is not in terms of how they do what they do, but rather what they are trying to achieve and the ways in which they succeed and fail
  - I encourage you to be *skeptical* of your data and results. *Especially* your data
- Unlike most data scientists, I have at times had to fake being an engineer
  - That means I know exactly what we do wrong
  - I have no choice but to do it anyway...
  - Have fun listening to me rant about it
  - 😂



–Takashi Murakami

They are screaming in horror at the  
superflatness of modern life

# Project and Pair Programming

- In this class, you will do a deep learning project using a standard data science tech stack
- There is a limit to how complicated the project can be because of resource and time constraints
- We'll start working on it as soon as we can but models can take days to train
  - if not weeks
  - if not months
- Hopefully this will set you up so you can do a more sophisticated version after the class ends
- Projects will be done in pairs, with one person typing, or “driving”, and the other person giving advice, or “navigating”
- Pair programming is a real thing. This sounds terrible, but I've done it and it really does work. Two can plan better than one and a second set of eyes can spot typos as they're happening
- The next slide has a few companies that incorporate it in at least some of their workflows



**vimeo**

**STASH**



**GRUBHUB**



<https://www.coscreen.co/blog/what-you-can-learn-from-how-successful-companies-use-pair-programming>

# I use ChatGPT / CodeWhisperer. A lot

- I use chatgpt to
  - Start things I know how to fix / finish
  - Learn new things
  - Autocomplete at the level of slides / paragraphs
- I don't use chatgpt to do things I don't know how to do
- Chatgpt is wrong a lot of the time
  - A lot of the time
- If you ask it to do something impossible, it will write code that looks like it will do it
- If it seems too good to be true, it's not true / There Ain't No Such Thing As A Free Lunch (TANSTAAFL)
- Caveat emptor
- If all you learn to do is prompt engineer, how will you pass a job interview?
- It's also, in my non-professional opinion, blatantly illegal. Enjoy it while it lasts



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# What is Artificial Intelligence?

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# Agents interact with the world around them

An agent can

- Sense the world around it: sensors (optional)
- Effect the world around it: effectors

In order for an agent to affect the world, it has to decide if, when and how to do so

- Examples:
  - A washing machine
    - has an internal clock
    - that tells it when to change cycles
  - An automatic transmission
    - senses the RPM of the engine
    - changes gears to keep it within a certain threshold

# More examples

- chatGPT
  - Reads keyboard input
  - Updates the contents of the web page
- A machine learning algorithm
  - Reads in data
  - Outputs a trained model
- A non-paramaterized script that, e.g. is kicked off daily to rotate log files
  - No sensors, just effectors
- A fire
  - No sensors, just effectors
- You
- An amoeba

# How I am choosing to define intelligence

- An agent is “intelligent” if it has effectors and makes decisions
- I think that includes all of our examples with exception of fire and the non-parameterized script
- What do you think?

# I am choosing *not* to define artificial

- I'm honestly not sure how I would...
- What do you think?

# AI is a relatively new area of research

1. True
2. False

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There were originally two research questions in Computer Science

1. The difficult problem for serious people
2. The trivially easy problem not worth paying attention to

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  - Artificial intelligence, which will of course be trivial once we manage to turn the thing on



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  - Artificial intelligence, which will of course be trivial once we manage to turn the thing on
    - The original attempt at Computer Vision was assigned to an undergrad as a summer project
    - He did not pull it off

## Artificial Intelligence, Machine Learning and Deep Learning are synonyms

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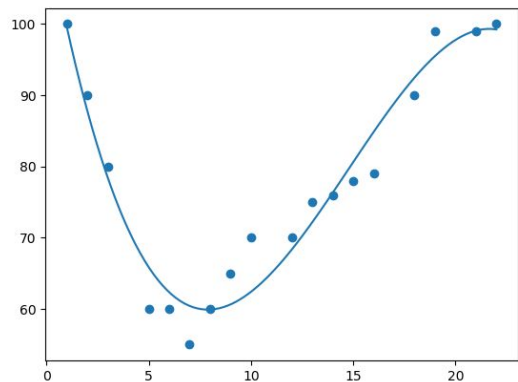
1. True
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- Artificial Intelligence is the field of formalizing real world problems and searching (efficiently) for a good enough solution

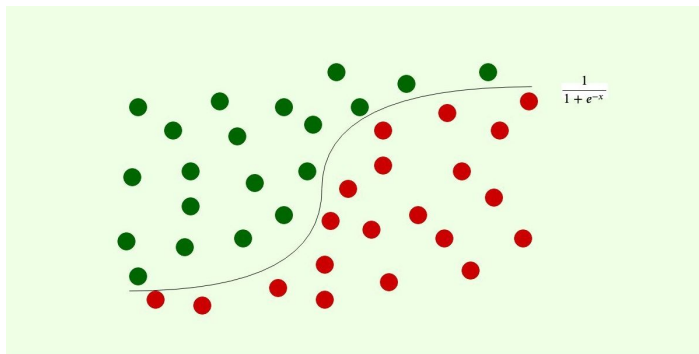
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- Machine Learning is the subfield of searching for the “best” line through a set of points



[Python Machine Learning Polynomial Regression \(w3schools.com\)](https://www.w3schools.com/python/machine_learning_polynomial_regression.php)



[Logistic regression and Keras for classification » AI Geek Programmer](#)



**SUMMER**  
SPRINGBOARD  
Look Inward. Go Upward

## Artificial Intelligence, Machine Learning and Deep Learning are synonyms

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- Artificial Intelligence is the field of formalizing real world problems and searching (efficiently) for a good enough solution
- Machine Learning is the subfield of searching for the “best” line through a set of points
- Deep Learning is a machine learning algorithm for finding that line efficiently

**Machine learning is one of the newest approaches to AI**

1. True
2. False



# Machine learning is one of the newest approaches to AI

1. True
2. False

- The usage of the term “Artificial Intelligence” dates to a workshop in 1956
- The first two machine learning algorithms were implemented in 1958 and 1959 on an IBM 704
- The one from 1959 played checkers. The other...



## Deep learning is one of the newest approaches to ML

1. True
2. False

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- Before being recently rebranded, deep learning models were known as Neural Networks
- The math goes back to 1943
- The program in 1958 implemented a perceptron, which is the Minimum Viable Product (MVP) neural net

# AI *works* all of a sudden. Why?

1. Revolutions in software
2. Revolutions in hardware

# AI works all of a sudden. Why?

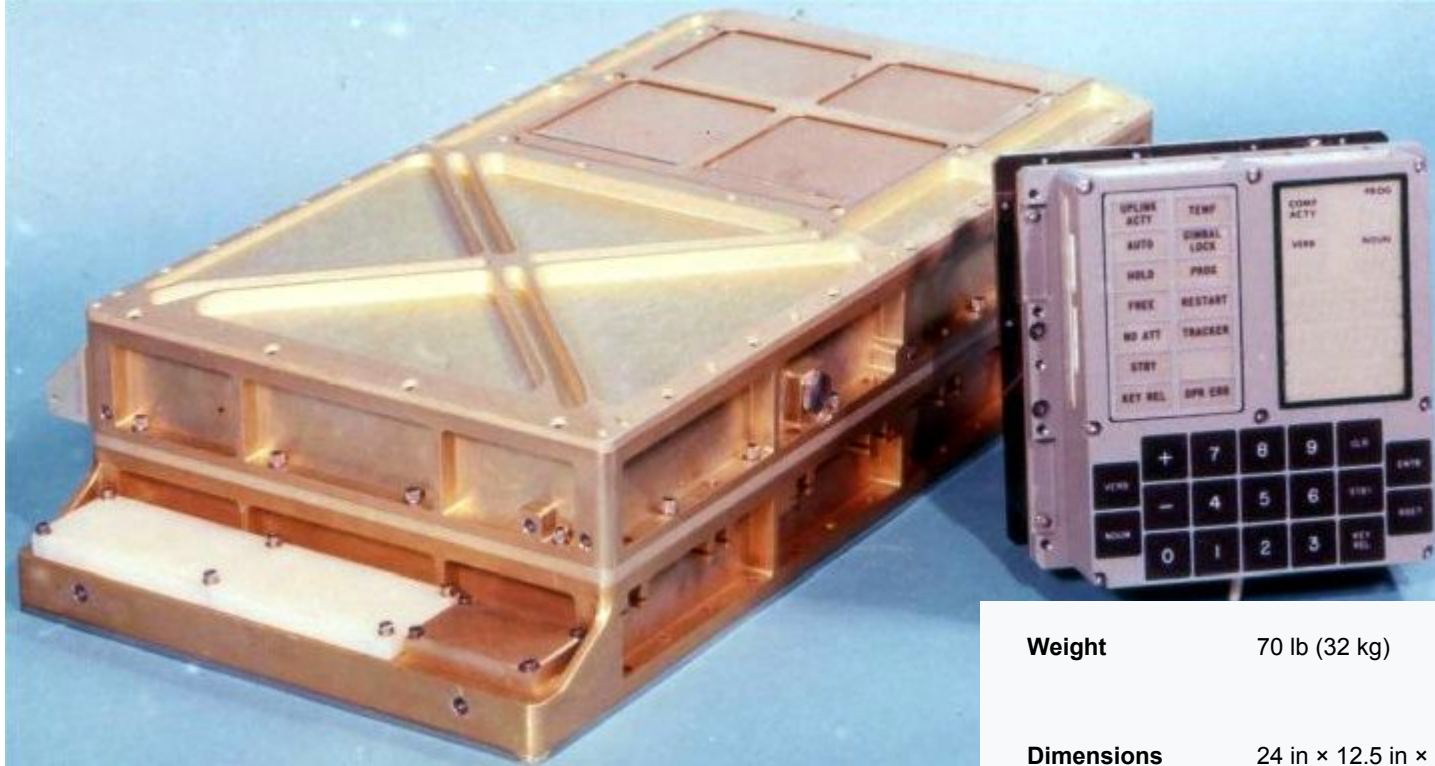
1. Revolutions in software
2. Revolutions in hardware

- The US post office has been using neural nets to read zip codes since the 90s
- In the meantime...

**Computers got fast**

# Apollo Guidance Computer-1966

## 2.048 MHz



**Weight** 70 lb (32 kg)

**Dimensions** 24 in × 12.5 in × 6.5 in (61 cm × 32 cm × 17 cm)

# Apple IIgs-1986

## 2.8 MHz



**Dimensions: 4.6" H x 11.2" W x 13.7" D**  
**Weight: 8.72 lbs.**



# iPhone-2007

## 412 MHz



### Dimensions

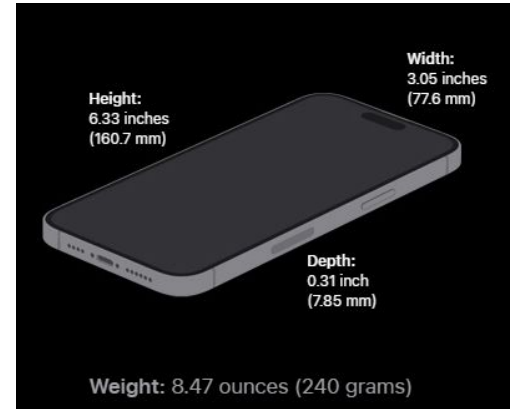
115 mm (4.5 in) H  
61 mm (2.4 in) W  
11.6 mm (0.46 in) D

### Mass

135 g (4.8 oz)

# iPhone 14 Pro Max

## 3.46 GHz



# How fast?

- The first CPU could run 60,000 instructions per second
- Your computer's CPU can do on the order of several thousand million instructions per second
- The world record holder can do 360 trillion instructions per second
- Another computer claims to do 1 quadrillion instructions per second (although it can't run the official benchmark)

# Not to mention GPUs

- Graphical Processing Units are more limited in what they can do efficiently
- Since they don't need to do as much stuff, they are smaller and therefore more cores can be crammed onto a single board
- GPUs can be 100x faster than CPUs!
- One of the things they can do efficiently is deep learning

**And data gets *big***

# How big?

“Perhaps the best way to conceive of something as inconceivable as the size of the Internet is to follow the lead of Russel Seitz. He took estimates for size and traffic of the entire Internet, and used this with the weight of the energy used to move a byte of information around. Although minuscule individually, over trillions and trillions of bytes it slowly added up. How large is the Internet? According to Russel Seitz: two ounces (~57 grams).”

[How Big is the Internet? \(with pictures\) \(easytechjunkie.com\)](#) – 2023

- One photon (so 1 bit?) weighs  $\sim 10^{-57}$  g

**And computation *scales***

# Scaling

- Networks can scale *up*
  - Buy better machines
- Networks can scale *out*
  - Use more machines
- From pets to cattle
  - Originally, you would have like 12 machines each named after a Muppet
  - Now you have 100s of machines named
    - `business_function.XXX.environment.data_center`



# How big are networks?

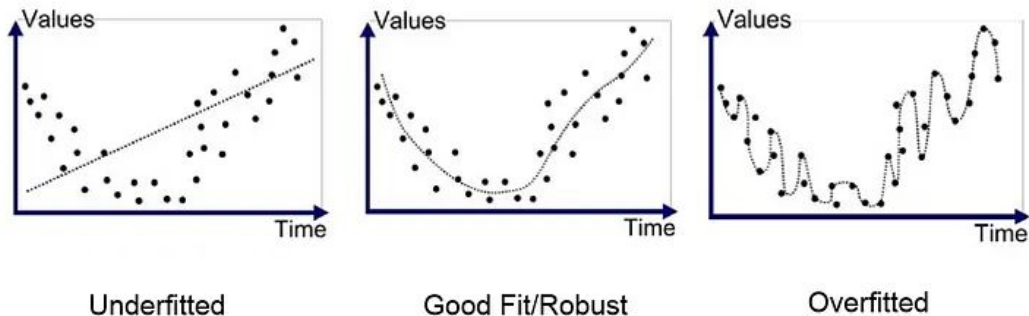
- The Pixar “render farm” that rendered Monster’s University consisted of 24,000 cores across 2,000 computers
- It took two years to render

# We know why deep learning works

1. True
2. False

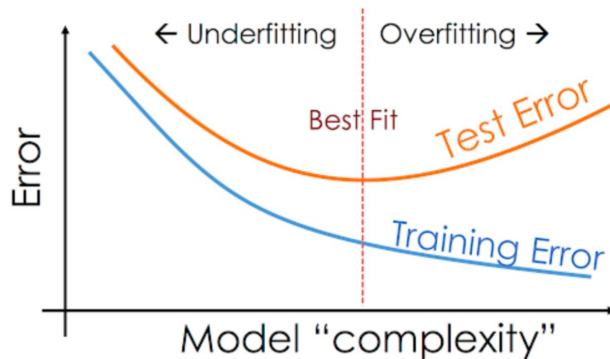
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[Machine Learning: How to Prevent Overfitting | by Ken Hoffman | The Startup | Medium](#)

GPT 4 has a trillion parameters.  
Why doesn't this happen?



[Overfitting & Underfitting in Machine Learning - Data Analytics \(vitalflux.com\)](#)

# Agenda

- Classical AI
- Classical machine learning
- ~~Data lies~~ Exploratory data analysis
- Deep learning
- Computer vision
- Natural language processing
- Bayesian learning (if time)
- Emerging trends, ethics and you