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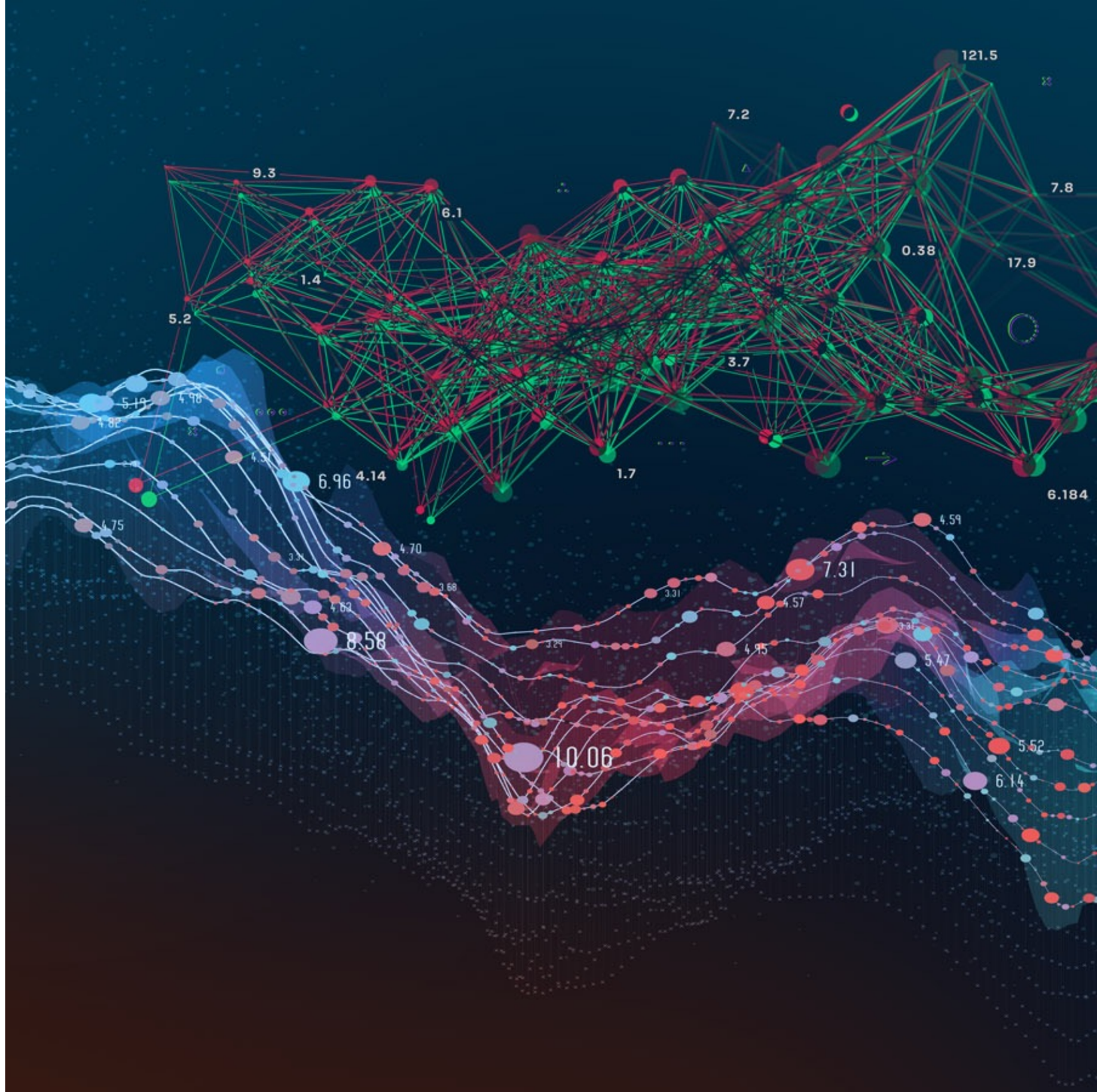
AI Camp: Introduction to AI

January 4, 2026

Ted Nowak
Data Scientist at Pacific Northwest National Lab



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Talk Outline

- What is AI?
- What is Deep Learning?
- What are some applications of AI?
- What are current challenges in AI?
- Ask Me Anything / Q and A

Questions are welcome at all times! Please interrupt!

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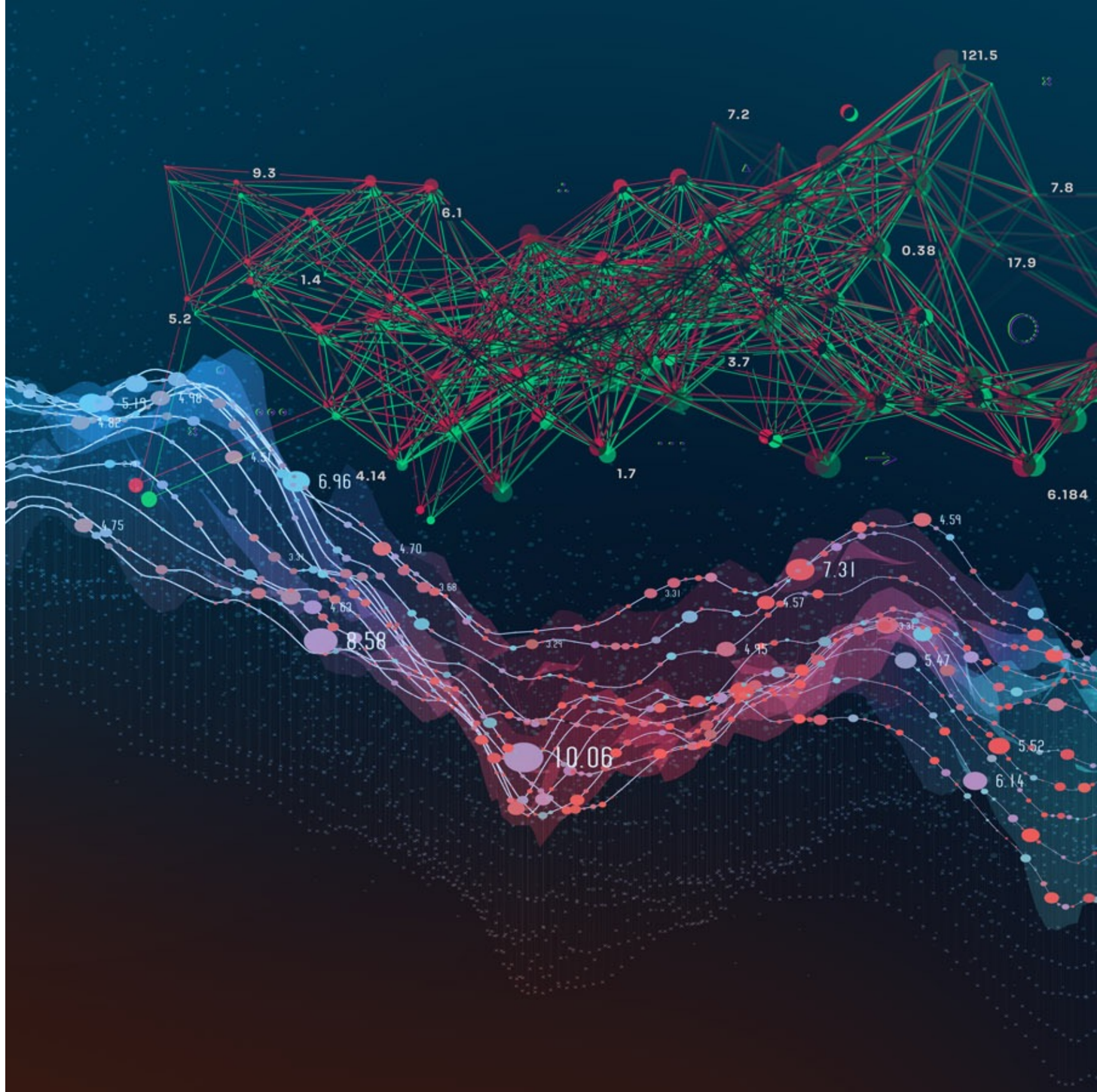
What is AI?



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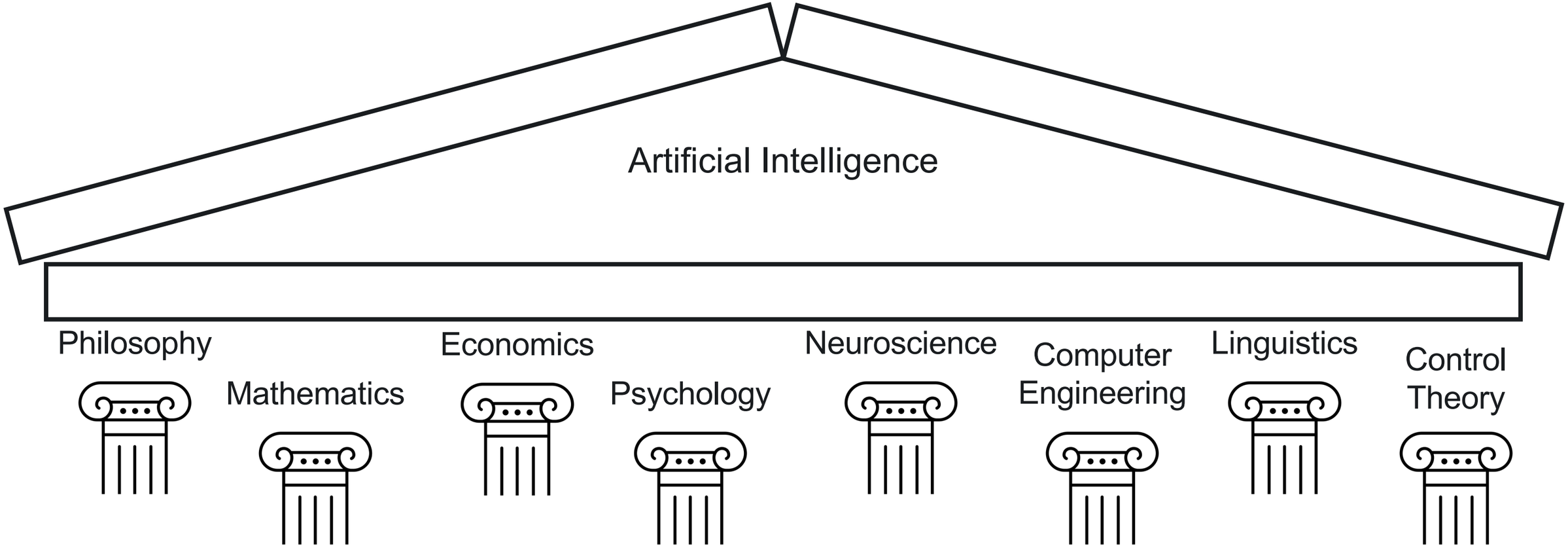
Definitions of Artificial Intelligence

Thinking Humanly	**Thinking Rationally**
"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998) "AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

Russell and Norvig: Artificial Intelligence: A Modern Approach. 2010

Foundations of AI

Pillars of AI:



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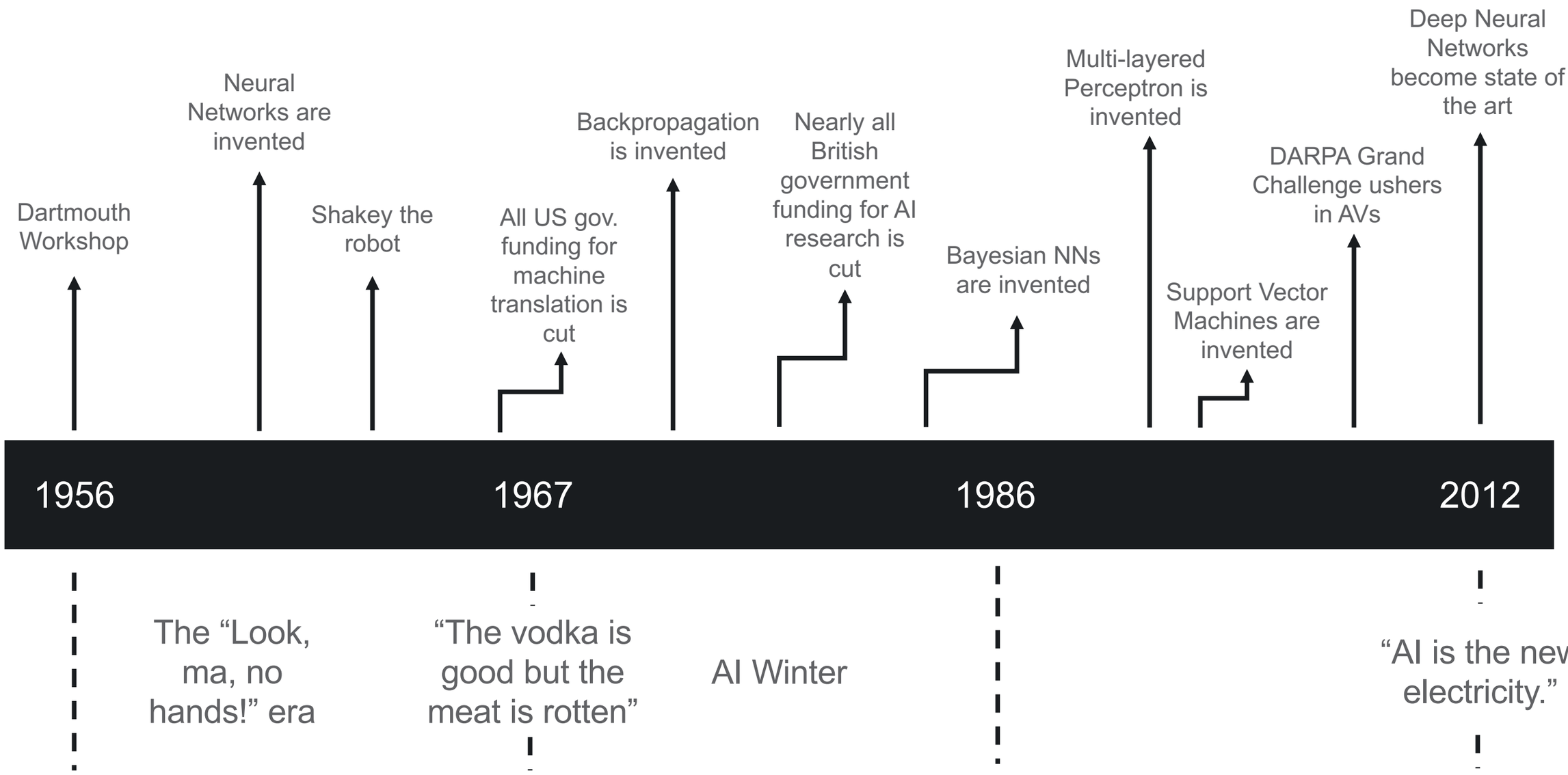
The Coining of "Artificial Intelligence"

A PROPOSAL FOR THE
DARTMOUTH SUMMER RESEARCH PROJECT
ON ARTIFICIAL INTELLIGENCE

"We propose that a 2 month, 10 man study of *artificial intelligence* be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to and how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer."

A Timeline of AI



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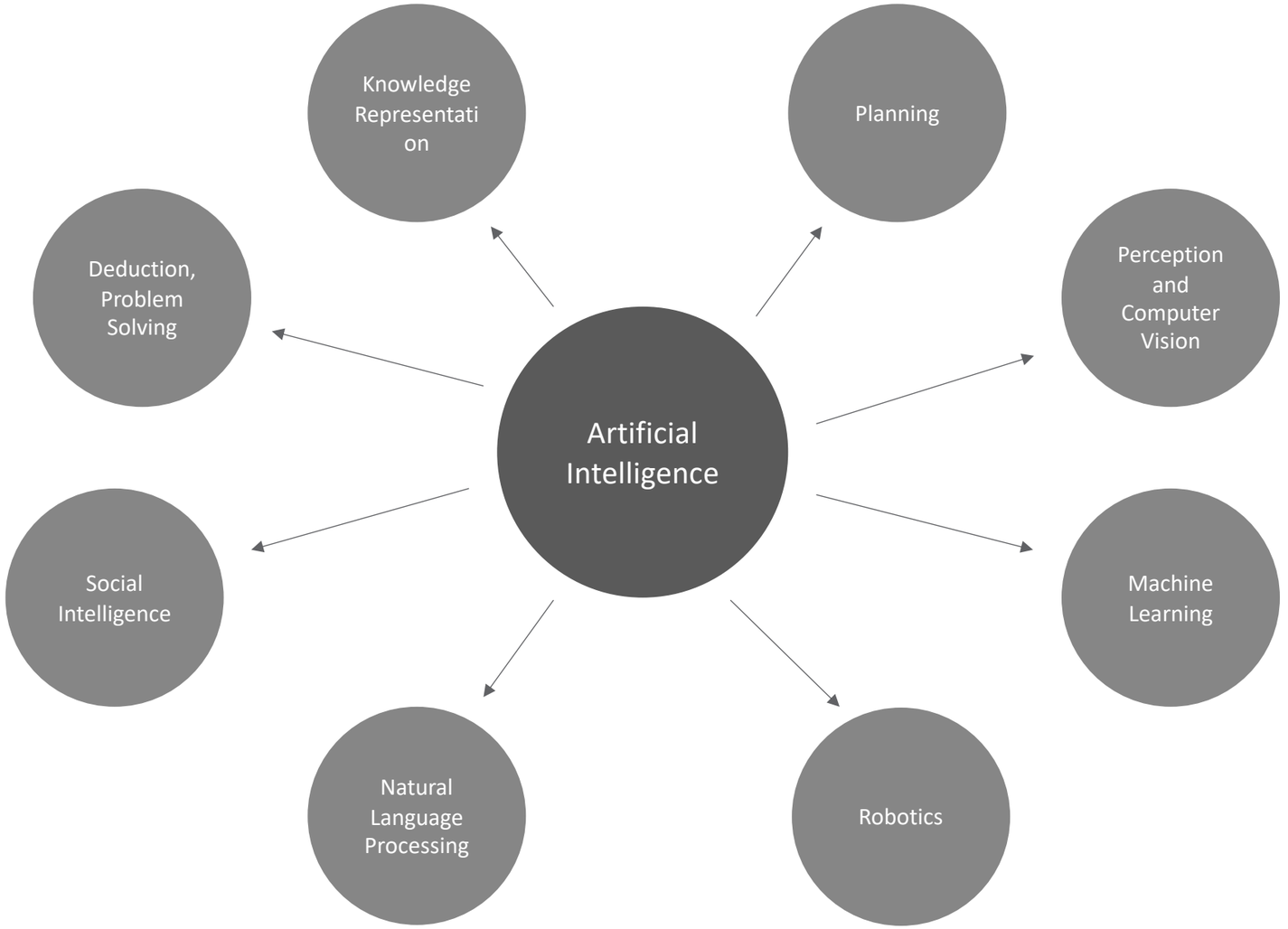
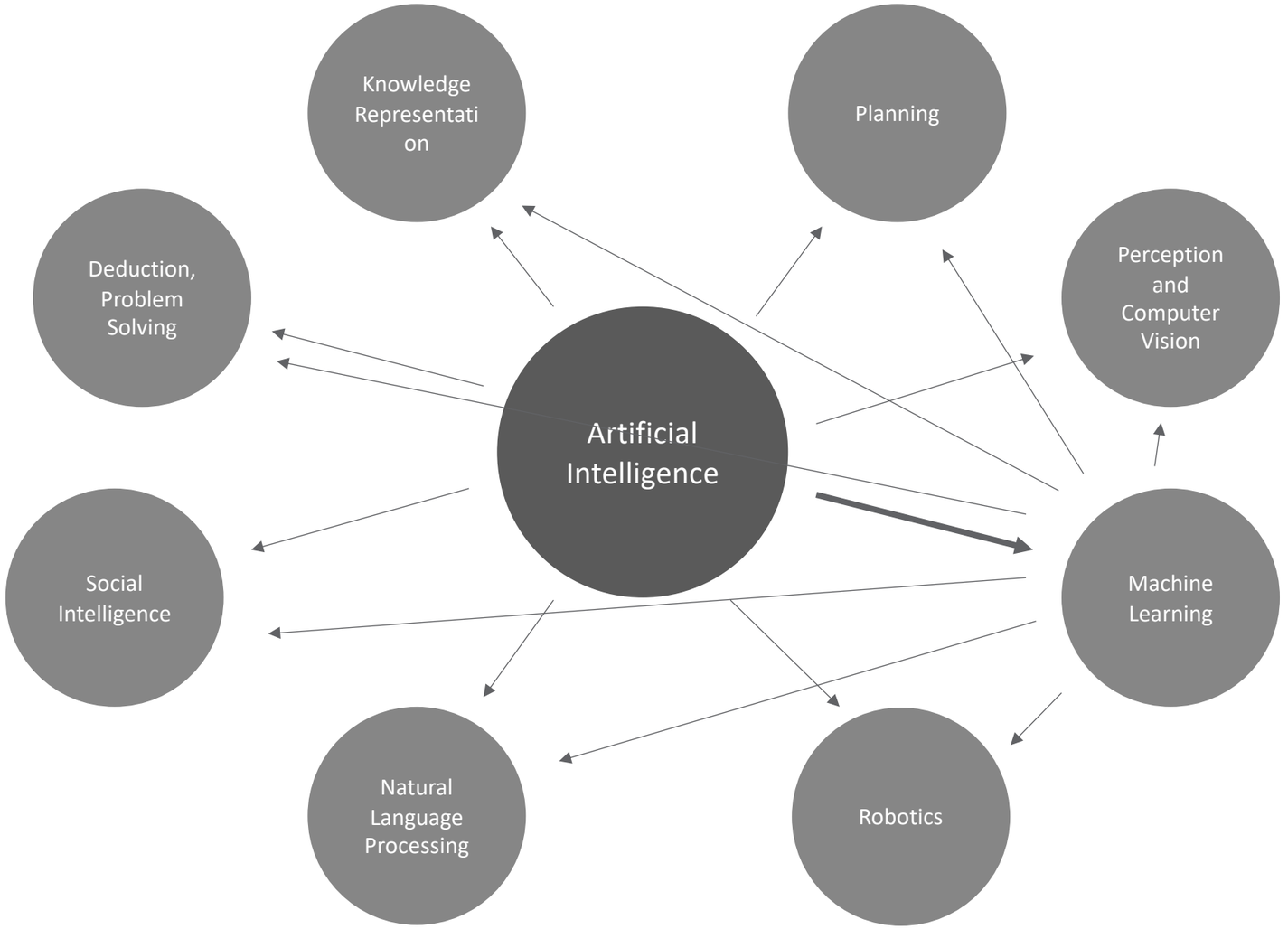
So what is AI?



So what is AI?


Knowledge Representation
Planning
Deduction, Problem Solving
Perception and Computer Vision
Artificial Intelligence
Social Intelligence
Machine Learning
Natural Language Processing
Robotics

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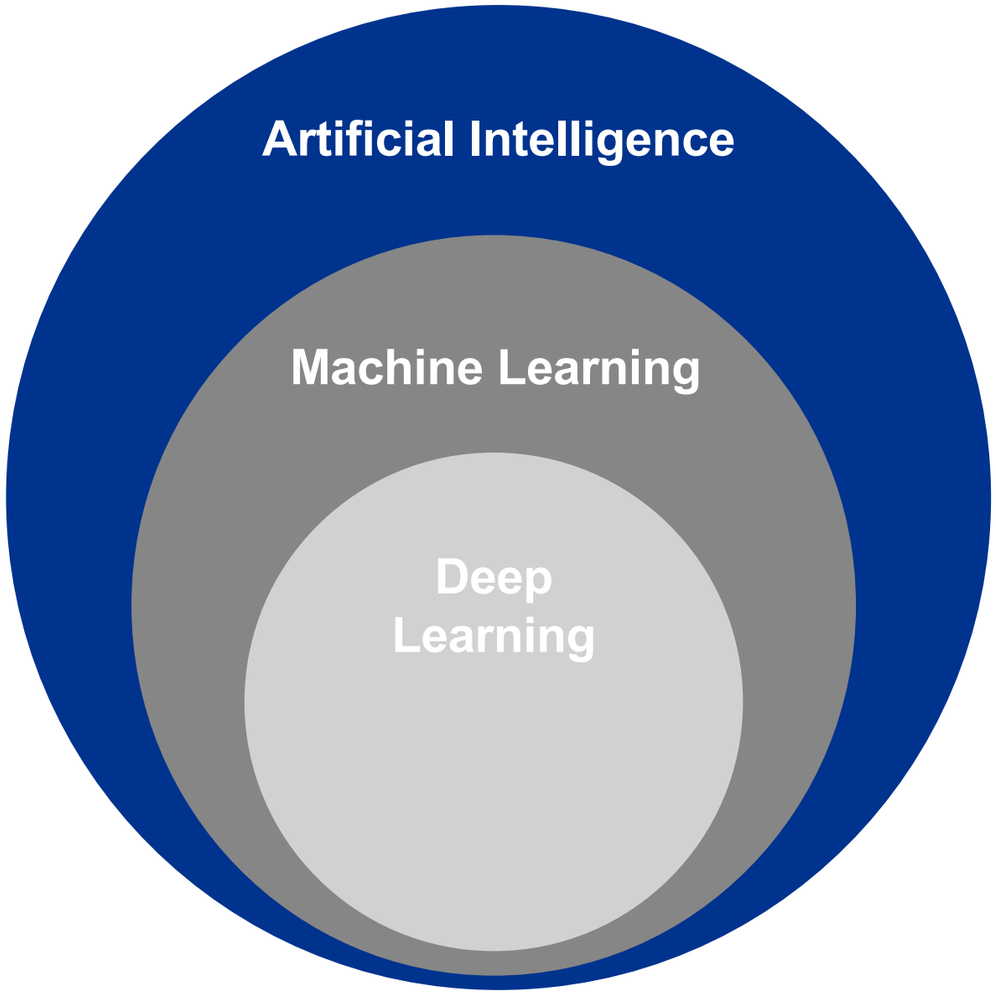
Artificial Intelligence



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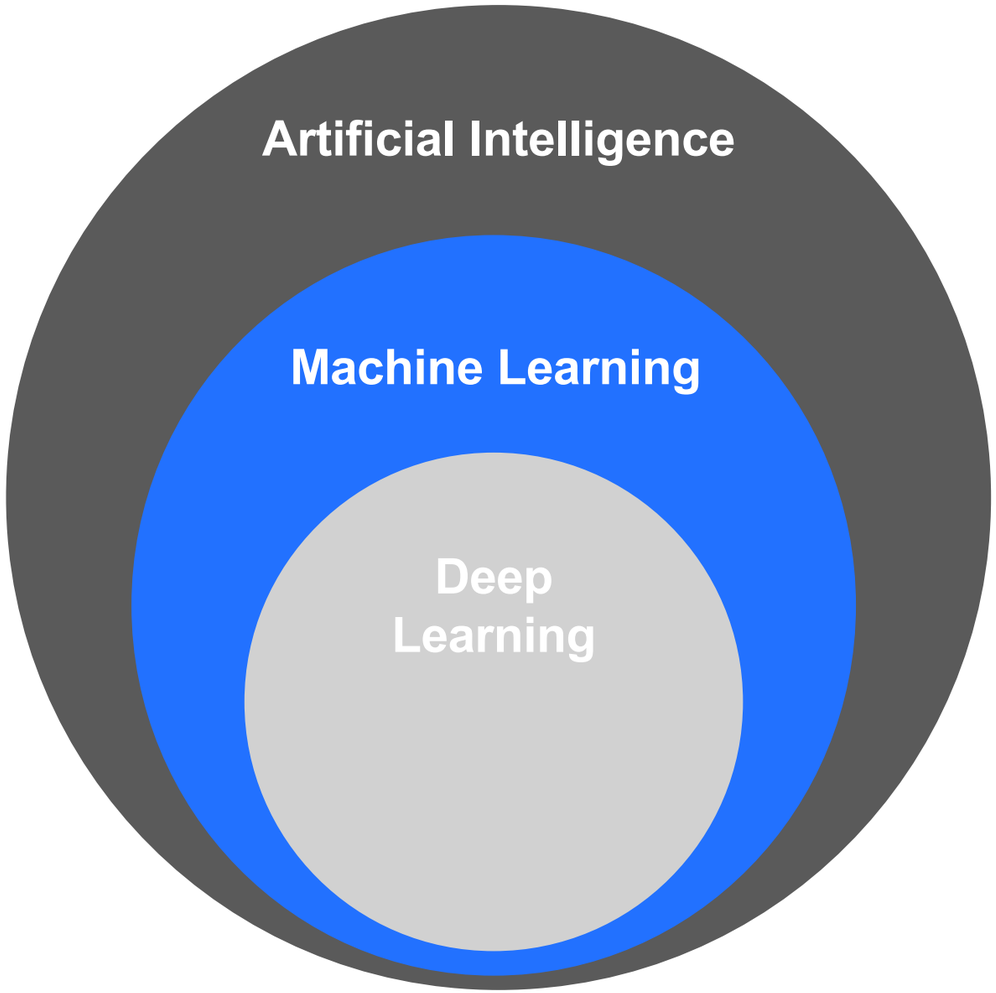
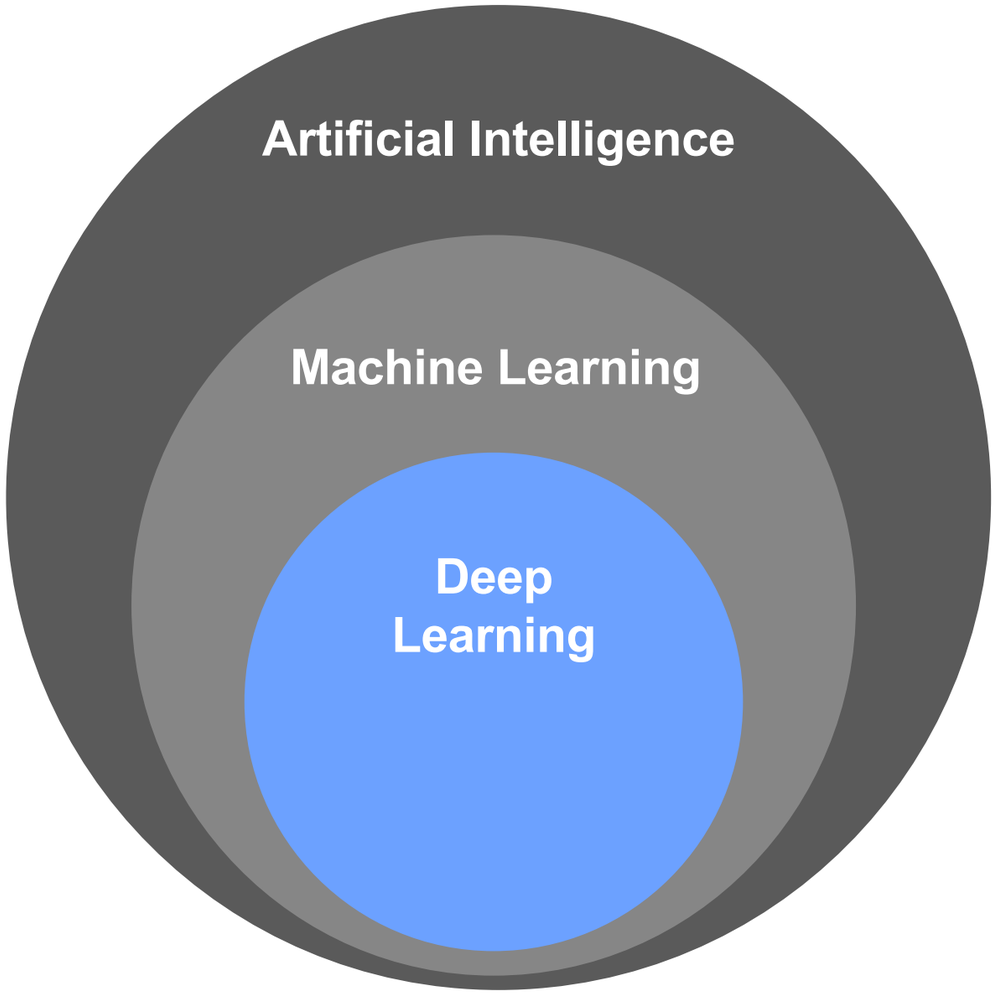
Machine Learning



"[ML uses] algorithms and statistical models to analyze and draw inferences from patterns in data"

- (some) **Popular Methods**
  - Linear-Logistic Regression
  - Random Forests
  - Support Vector Machines
  - Bayesian Models

Deep Learning



- Subset of ML which extend previous *neural network* approaches, made applicable with the increase in available compute
- Neural networks are made up of successive *layers*
- “Deep” as in more layers

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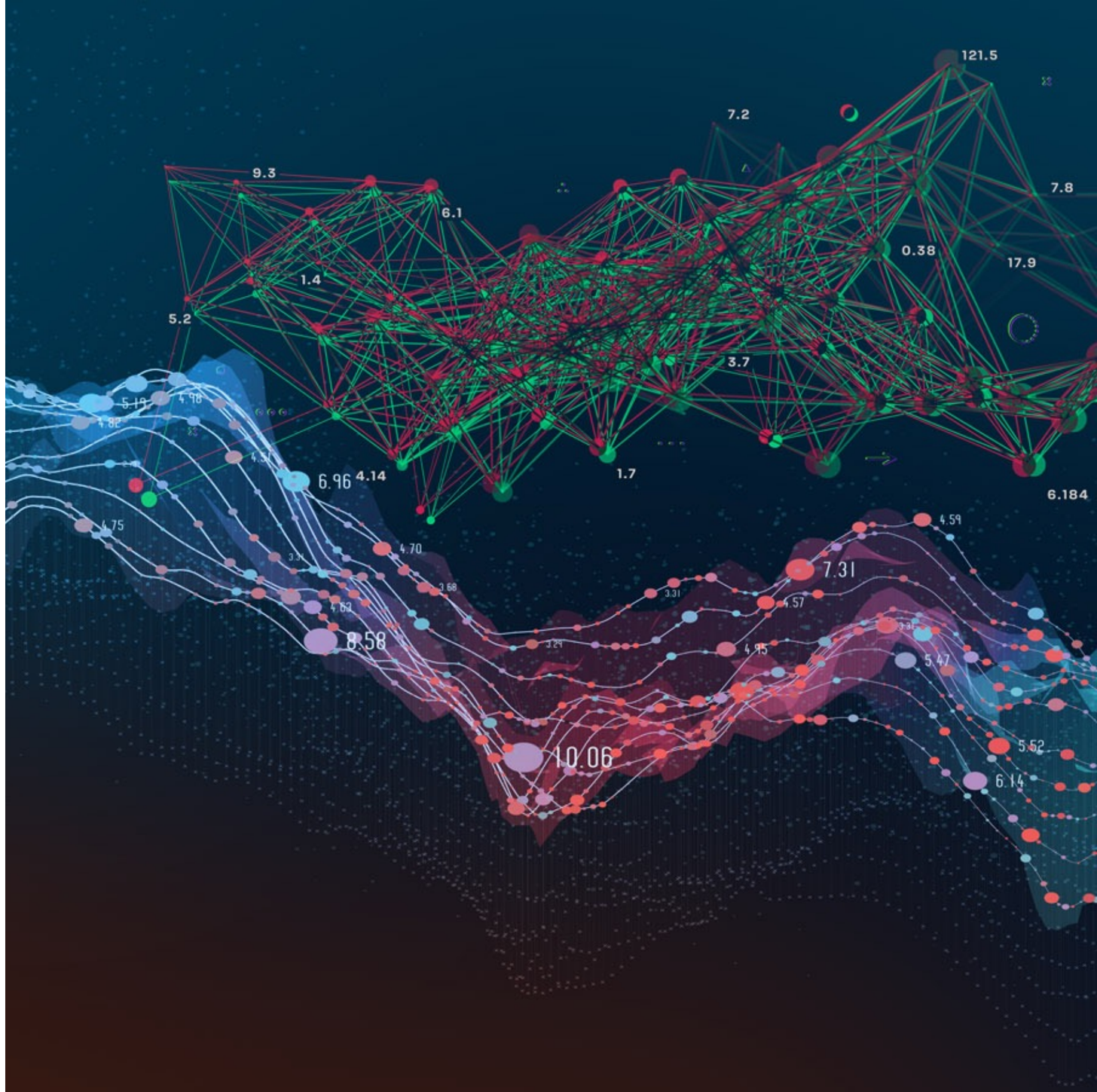
Deep Learning



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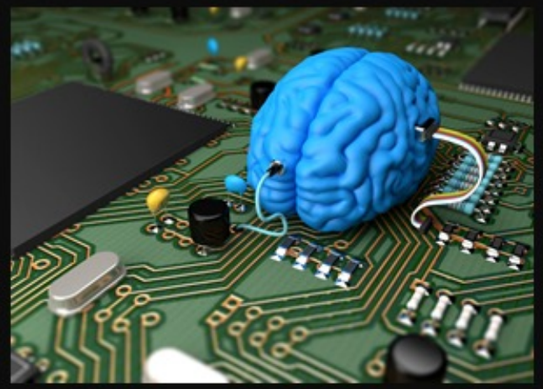
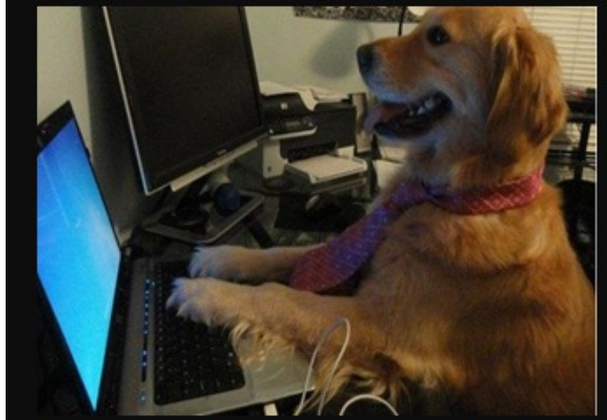
Deep Learning

What society thinks I do



What my friends think I do

What other computer scientists think I do



What mathematicians think I do

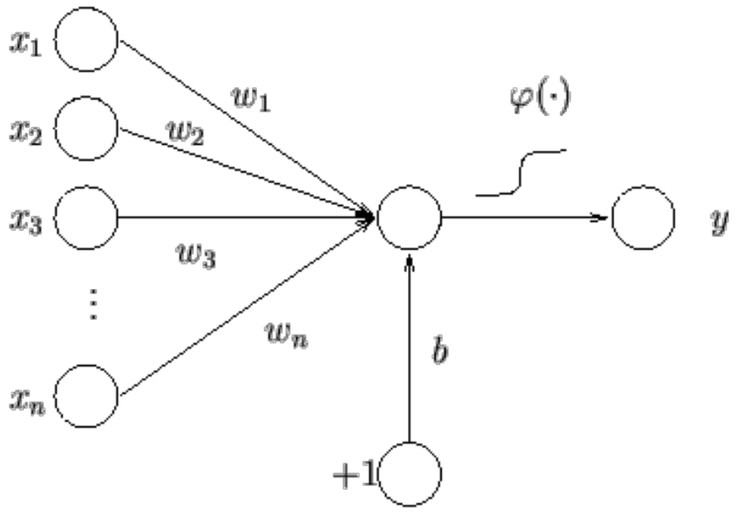
What I think I do

```
from theano import *
```

What I actually do

What is a Neural Network?

- A neural network is a type of machine learning algorithm where individual computational units (neurons) have weighted connections to each other within a network



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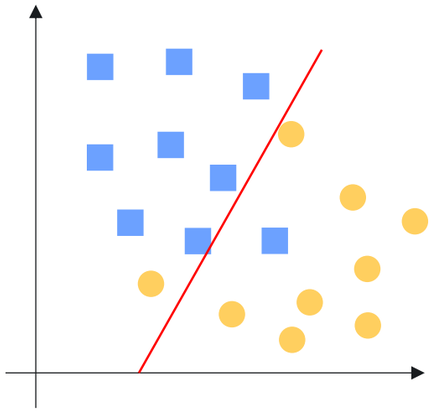
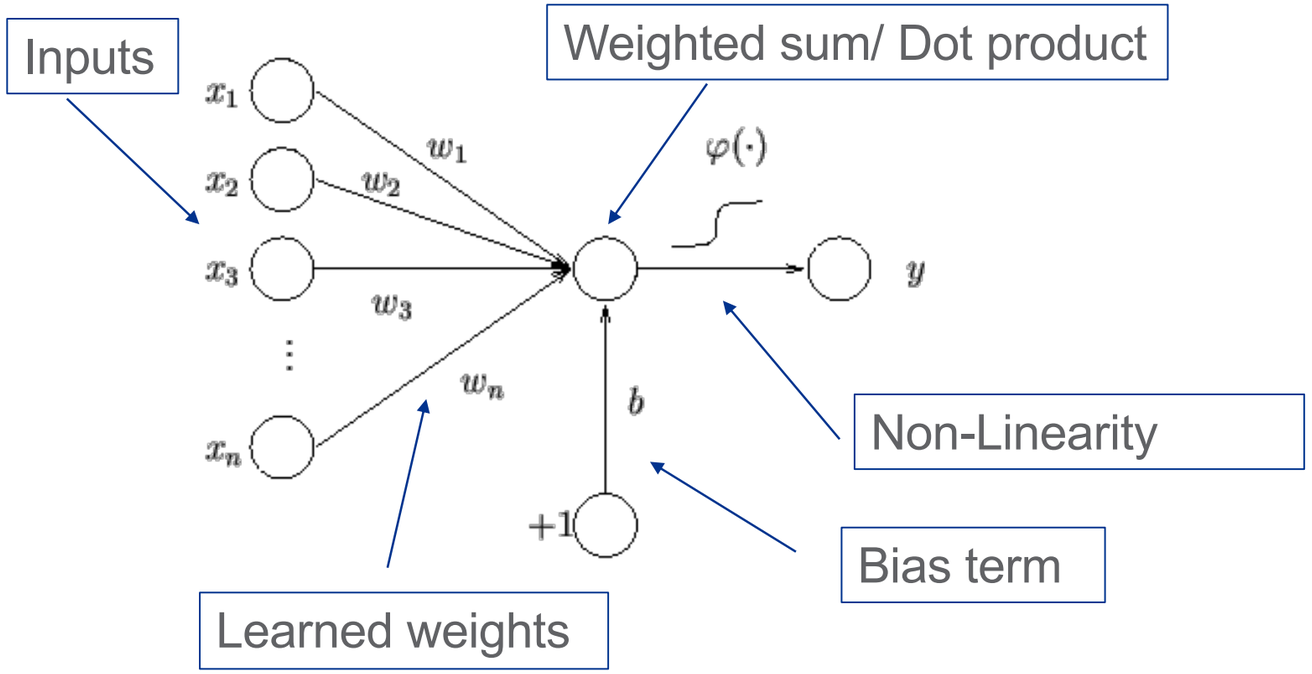
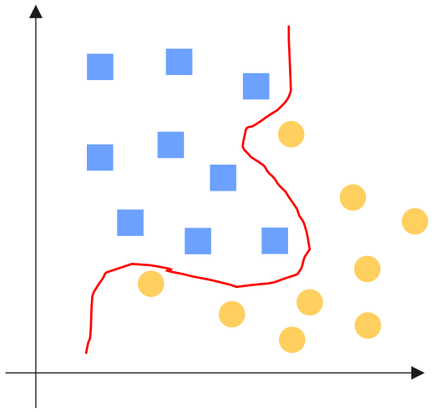


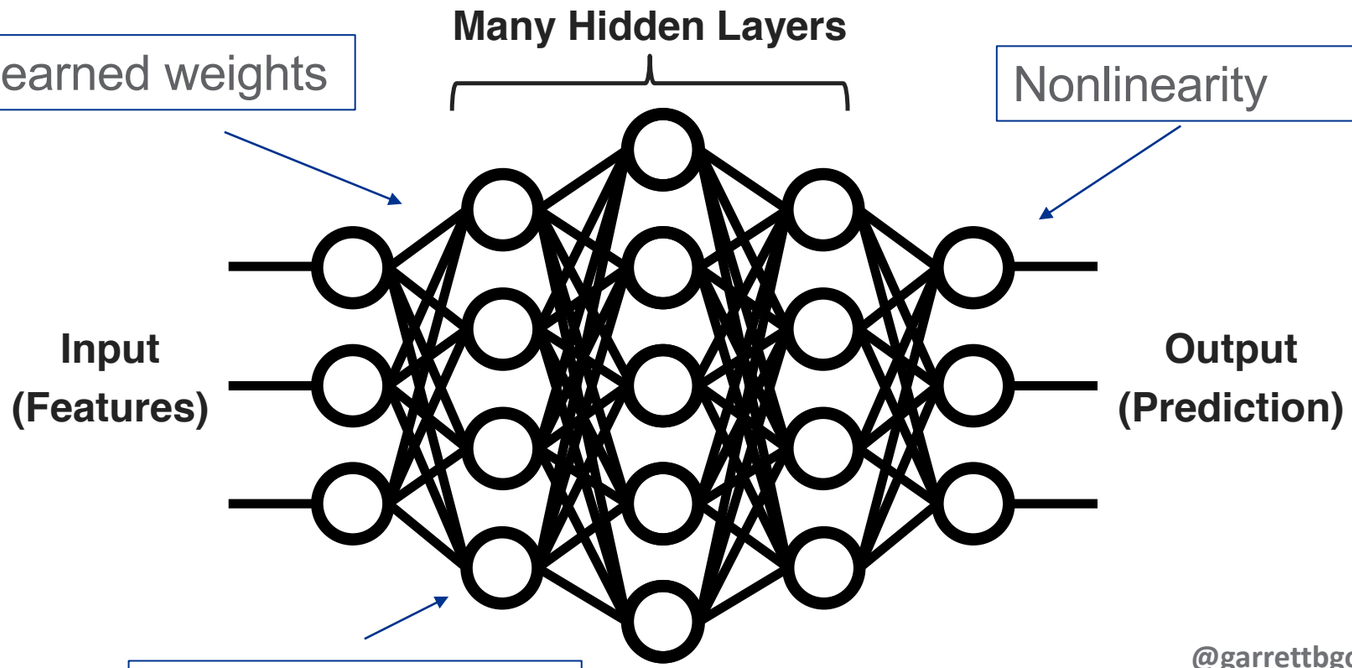


$$\vec{y} = \varphi(W\vec{x} + b)$$

What is “Deep Learning”?

- A ***deep*** neural network is a ***multi-layer*** neural network
- *Hierarchical representations* of data are learned





Deep Learning – Key Concept

- Learned function approximation

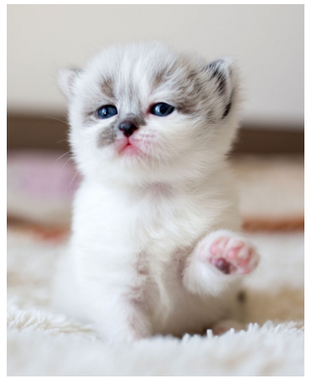
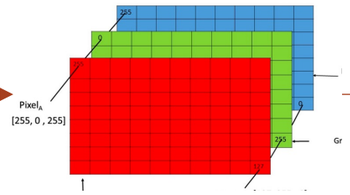


Image are just arrays of numbers



(200, 200, 3) = 120,000 parameters

Learn to map them to other numbers

Deep Neural Network (some crazy function)

For example vertices of a box and a number representing object class

Scoring Function

Backpropagation

Update model weights (b/c differentiability + chain rule)

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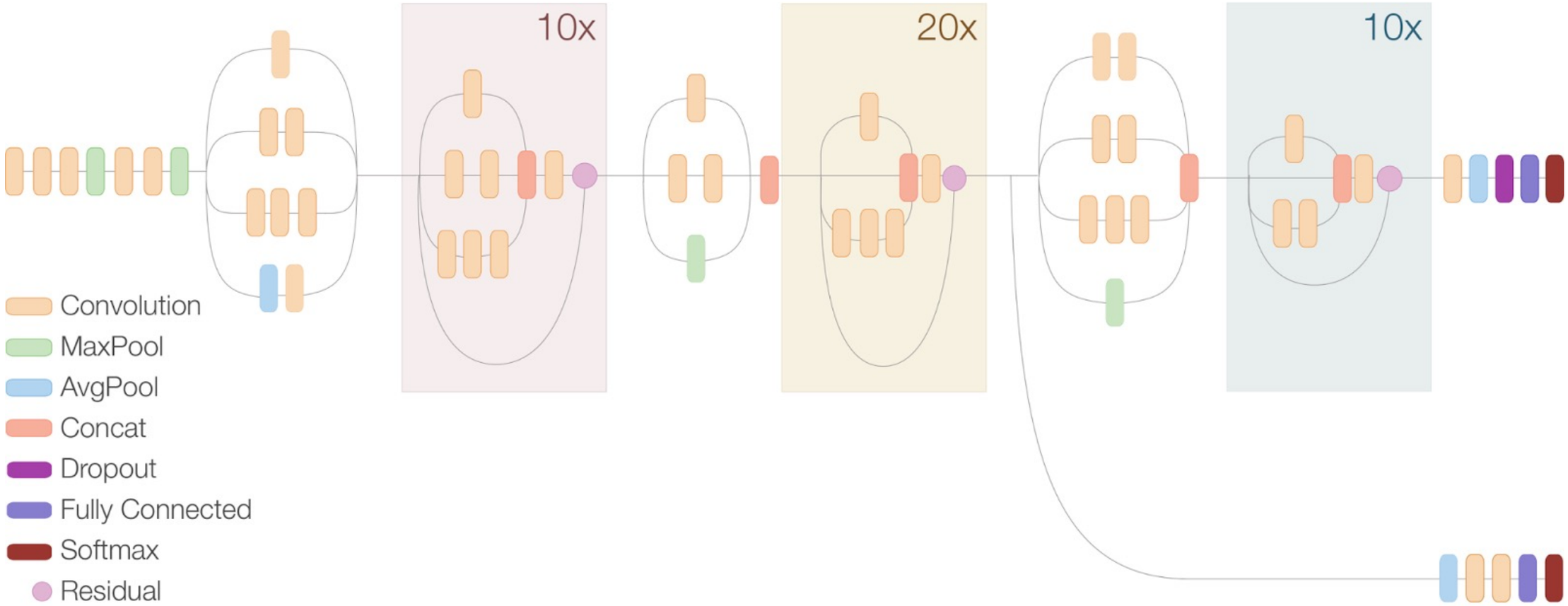
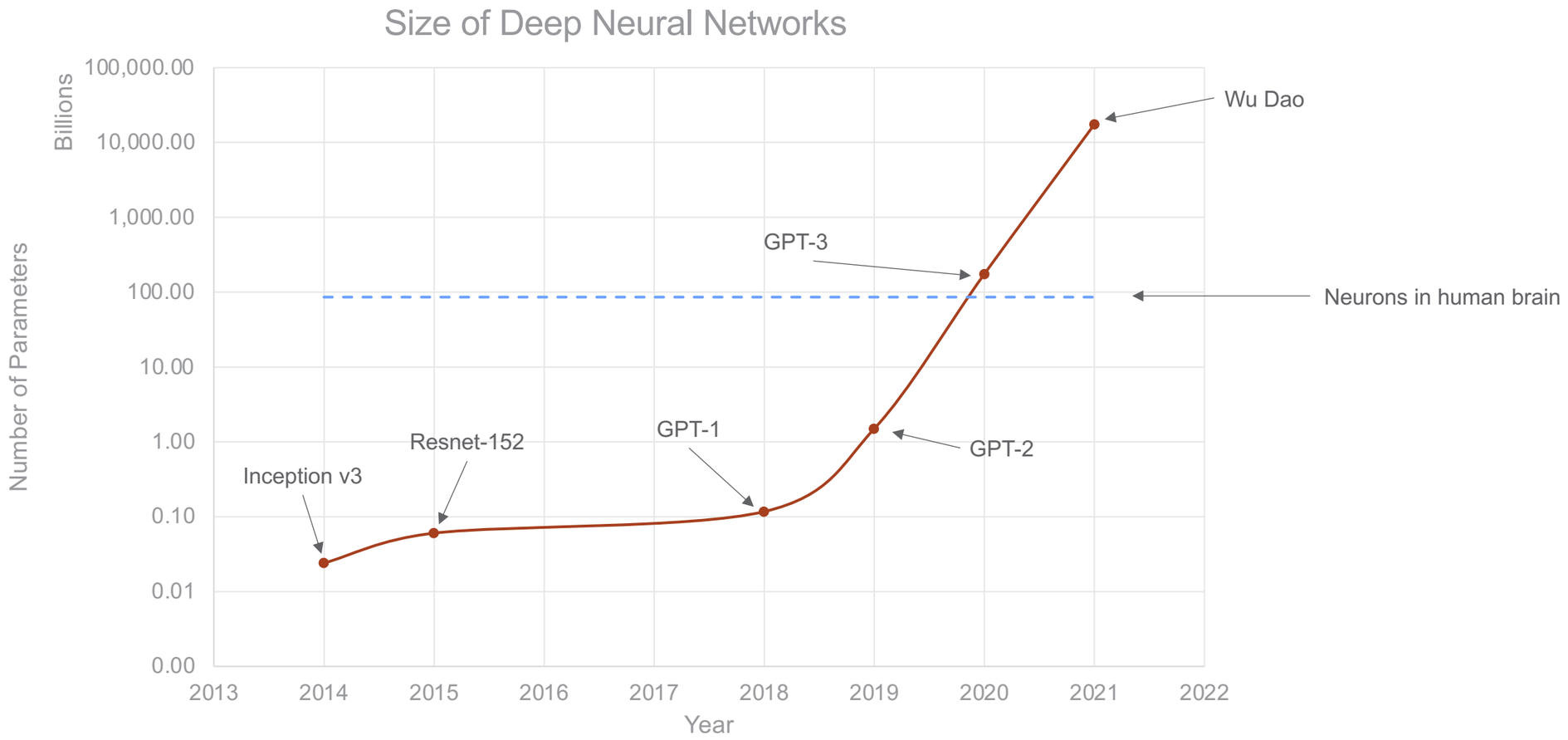
What Makes Deep Learning “Deep”?



Inception V3 (2014)

How deep is “Deep”?



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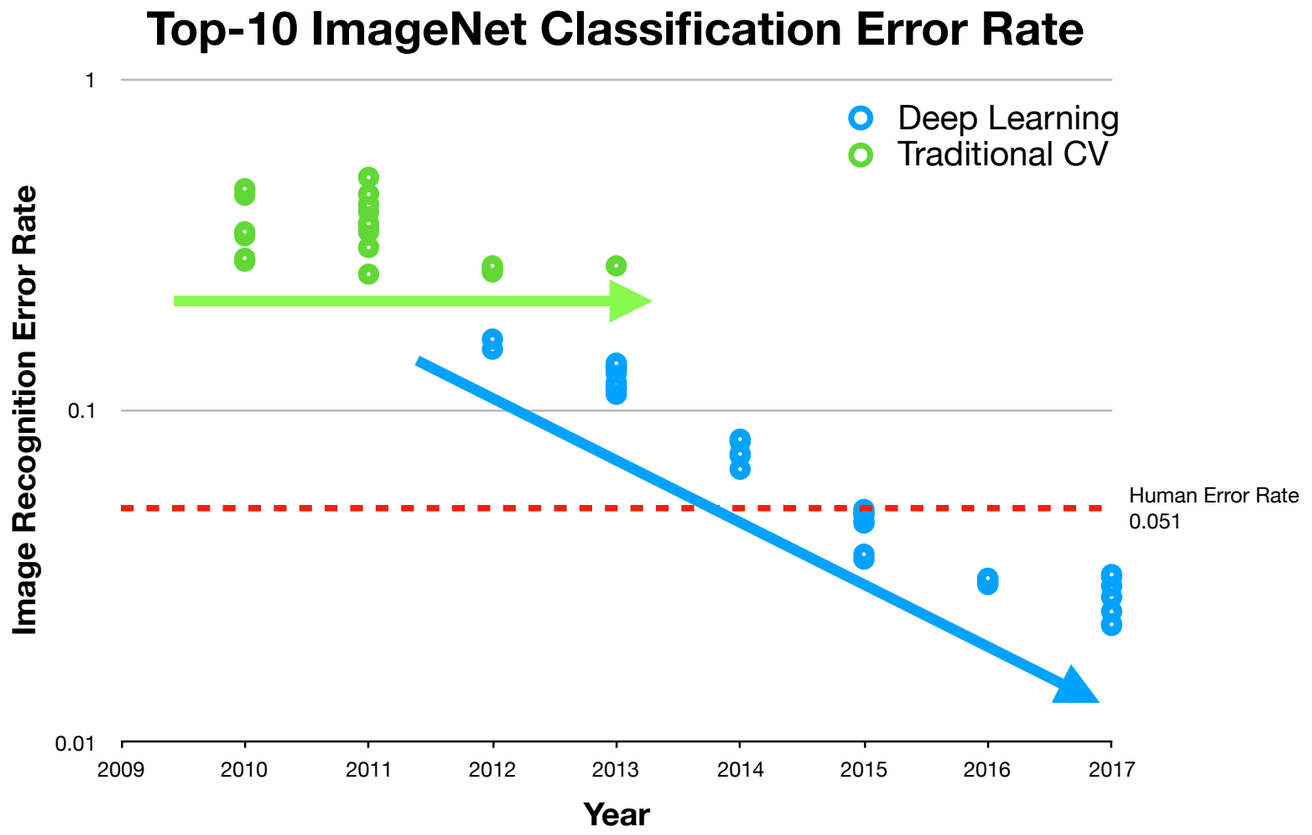
Why Deep Learning?

- Deep learning can help to break the “soft barriers”



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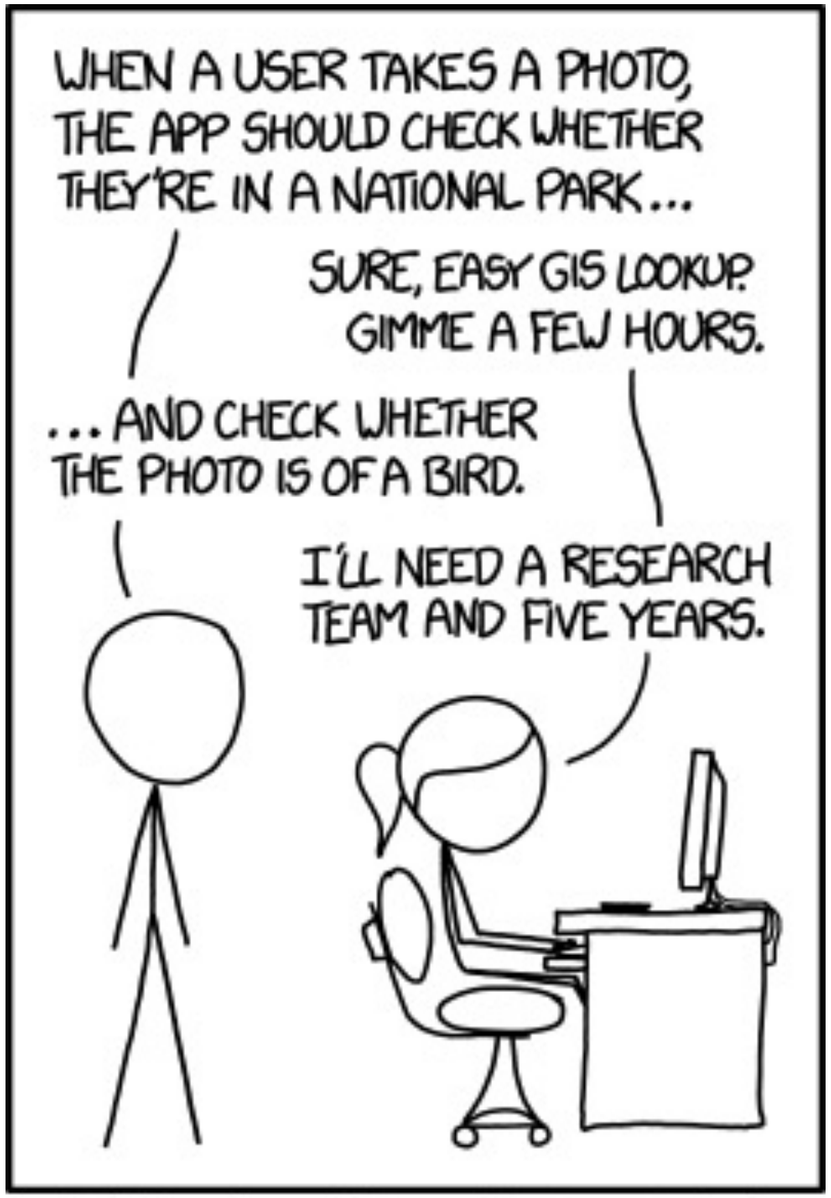

<- What was possible in 2014 isn't the same as what's possible today

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Why Now?

- More data
- More available computing (GPUs)
- Better techniques
  - Optimizers
  - Schedulers
- Open-source tools and software

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Software Frameworks

- Deep learning frameworks provide the tools needed to implement deep neural networks
- **We don’t have to reinvent the wheel!**
- The community is coalescing around a couple major software libraries
  - Enables sharing of models/methods
  - Driving faster research innovation

https://pytorch.org

https://www.tensorflow.org/

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Can be as easy as…

```
model = Sequential()
model.add(Dense(512, activation='relu', input_shape=(784,)))
model.add(Dense(512, activation='relu'))
model.add(Dense(num_classes, activation='softmax'))

model.compile(loss='categorical_crossentropy', optimizer=Adam())

history = model.fit(
    x_train,
    y_train,
    batch_size=batch_size,
    epochs=epochs,
    validation_data=(x_test, y_test)
)

```

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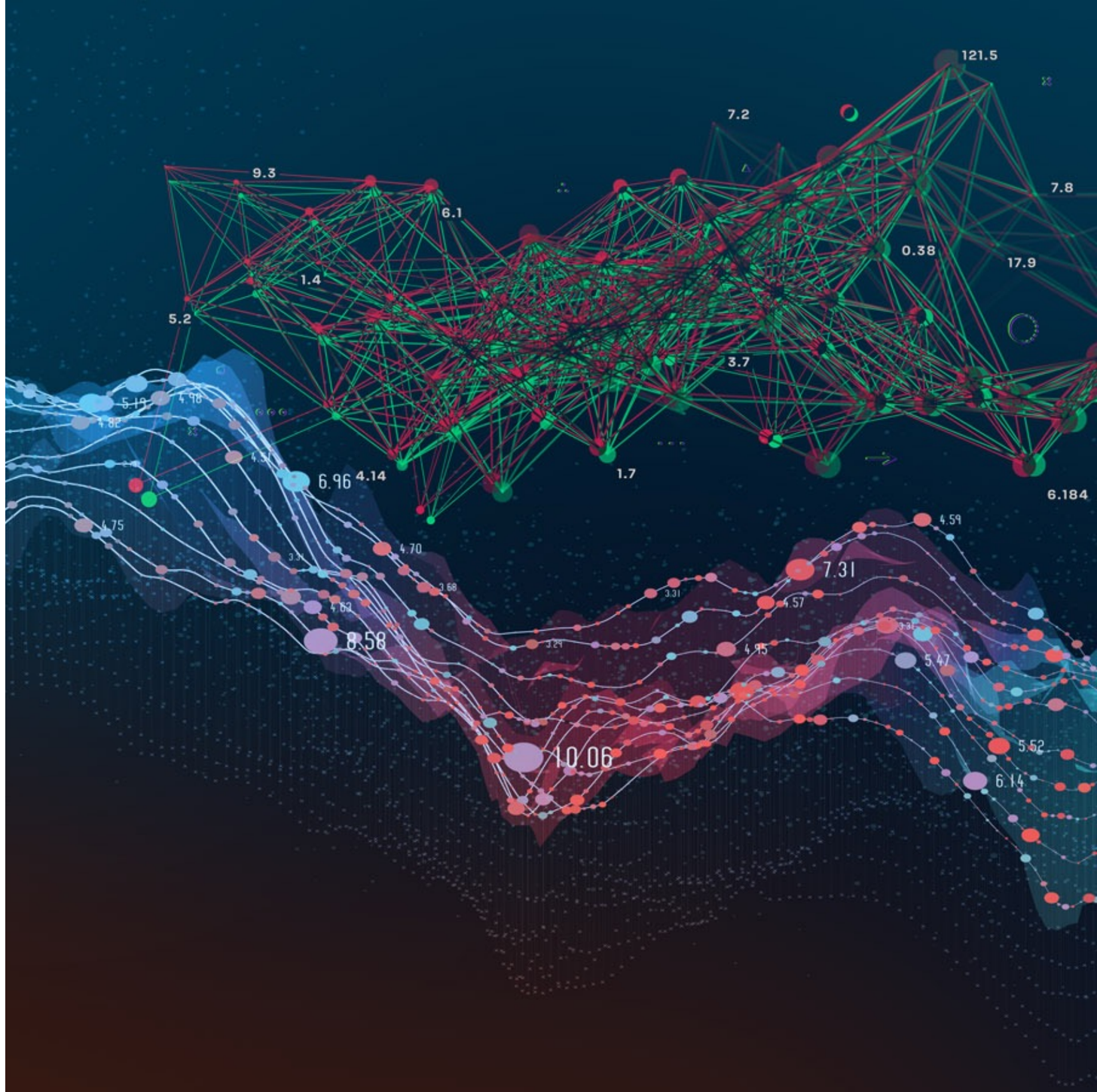
Applications of AI



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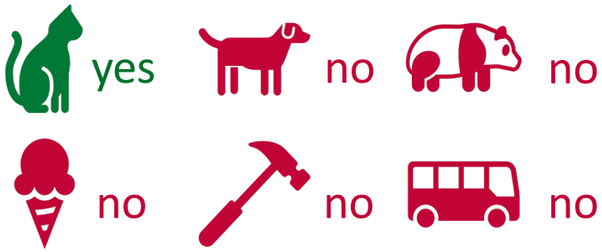
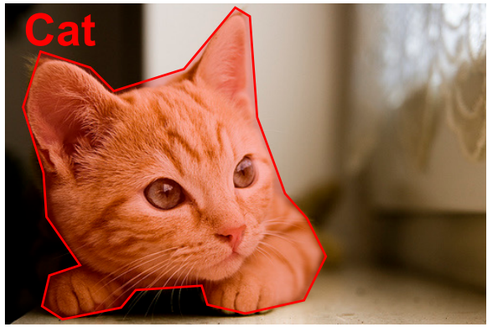
What can we do with Deep Learning?

- Machine translation
- Speech understanding
- Image recognition
- Question answering systems
- Autonomous systems
- Natural language processing (NLP)
- Game playing

amazon alexa

Deep Learning on Images

Input	Task	Output
	Classification	
	Object Detection	
	Semantic Segmentation	

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Deep Learning on Text

Tasks:

- Classification
- Generation
- Conversation
- Transformation/Translation /Code Generation
- Summarization
- Completion
- Factual Responses

GPT3 to automatically generate website HTML

Reinforcement Learning

Goal:
Learning actions through trial and error and some notion of reward.

Tasks:
- Game playing
- Robotic Motion
- Puzzle solving

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Robotics

Goal:
Developing intelligent agents (actors).

Tasks:
- Optimal control
- Robot perception
- Active learning
- Decision planning
- Motion planning
- Manipulation planning
- Navigation
- Localization
- Human Machine Interaction and Teaming

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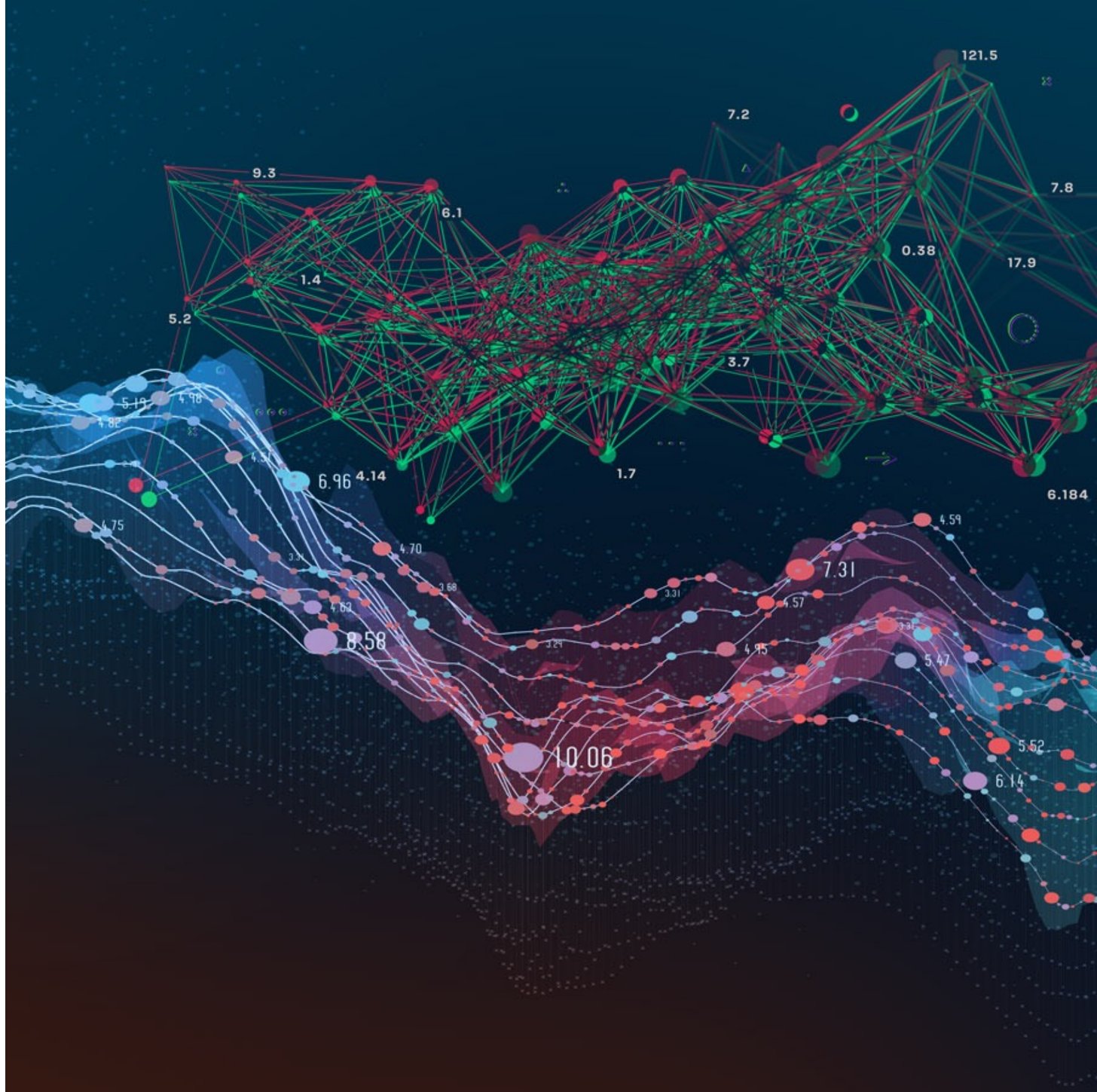
Challenges in AI



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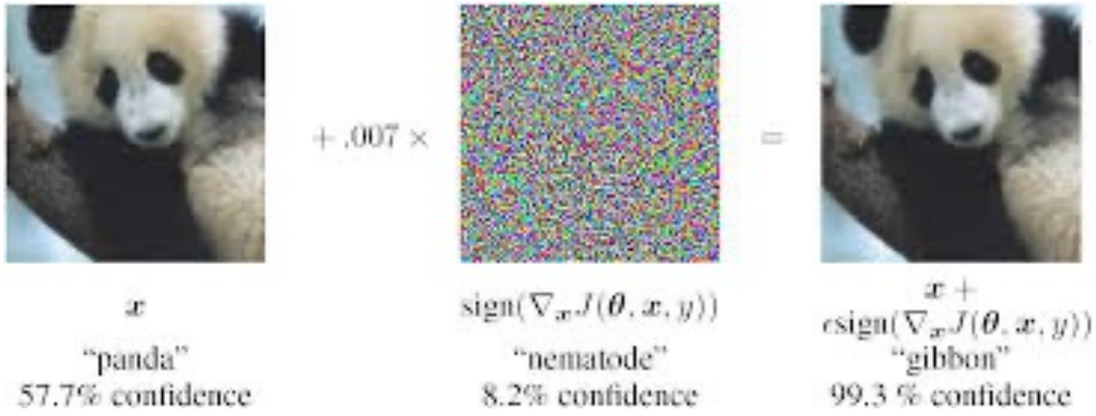
Challenges

- Generalized AI
- Adversarial attacks
- Compute and Data Hungry
- Constrained Learning
- Ethical AI
- (many more)



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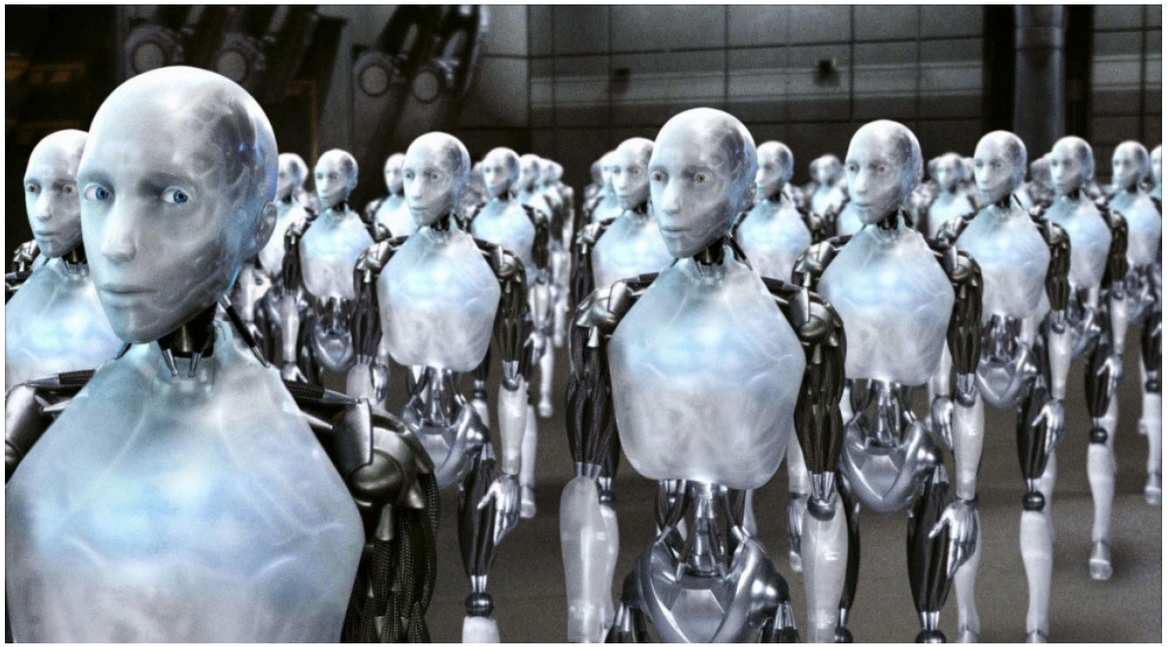
Generalized AI

- Models are trained for a certain task
- Robots are designed to operate in a certain environment
- How can a single agent do it all?



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Adversarial Machine Learning

Athalye, Engstrom, Ilyas, et. Al. - Synthesizing Robust Adversarial Examples. 2017

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Big Compute and Big Data

"Converting this energy consumption in approximate carbon emissions and electricity costs, the authors estimated that the carbon footprint of training a single big language model is equal to around 300,000 kg of carbon dioxide emissions. This is of the order of 125 round-trip flights between New York and Beijing, a quantification that laypersons can visualize."

Dhar, P. The carbon impact of artificial intelligence. *Nat Mach Intell* **2,** 423–425 (2020). https://doi.org/10.1038/s42256-020-0219-9

Constrained/Physical AI

Microsoft Tay learned to be racist via interaction with users on twitter

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Ethical AI

Kyle Byers
@Kyle_Byers

This is a cautionary allegory about machine learning.

> **Stephanie Hurlburt** @sehurlburt
> Oh no my dog accidentally knocked down the trash and discovered old cheesy pasta in it, and is now convinced trash cans provide an endless supply of cheesy pasta, knocking it over every chance she gets

3:41 AM · Sep 15, 2018

4.3K Retweets **14.2K** Likes

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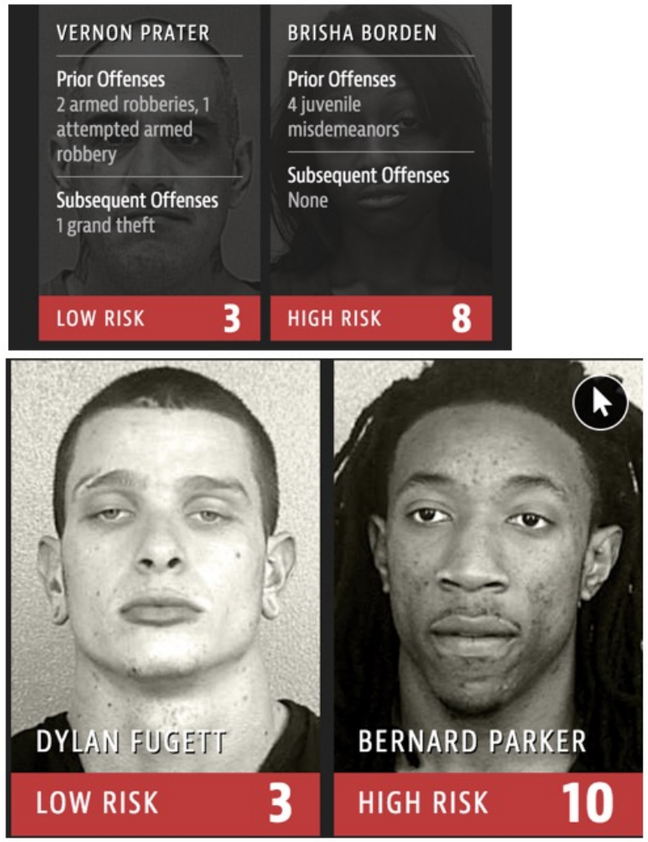
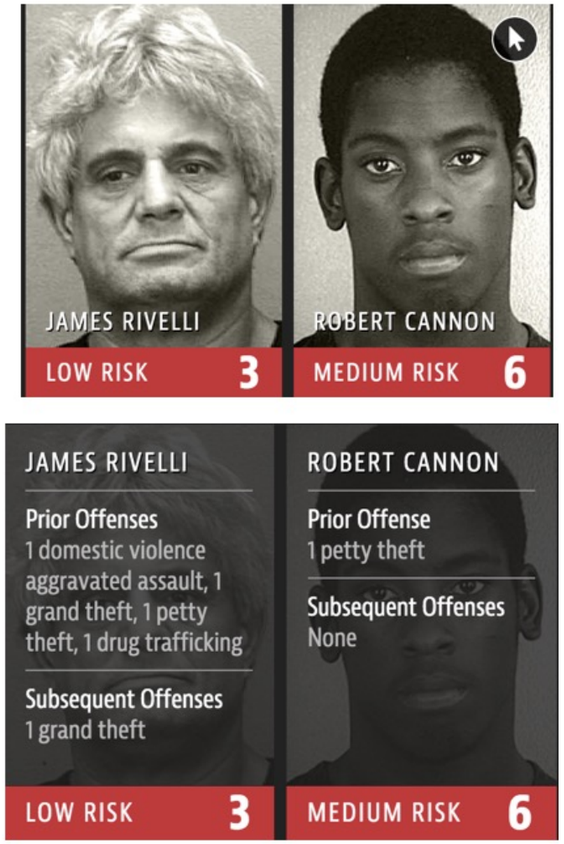
Ethical AI





‘COMPAS Software Results’, Julia Angwin et al. (2016)

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Ask me anything!

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