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# Artificial Intelligence and the Future of Medicine/Mankind

Howard Schneider  
Sheppard Clinic North, Toronto, Canada

Ontario Medical Association (OMA)  
Section on Primary Care Mental Health  
Toronto, October 22, 2020

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**NEW TOPIC**

# **PRELIMINARIES....**

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# NO MEDICAL COMMERCIAL NAMES

- ▶ but....many non-medical AI-related products are company specific

# CONFLICTS OF INTEREST

- ▶ None

DR HOWARD SCHNEIDER, MD, MDPAC(C), CCFP, FCFP

# **WHY SHOULD I GIVE THIS TALK?**

## **Practicing physician**

- ▶ Background –General Practice/ Family Practice
- ▶ A decade –Psychiatry Consultations in ER (Laval)
- ▶ Two decades –Community Mental HealthCare(GTA)

DR HOWARD SCHNEIDER, MD, MDPAC(C), CCFP, FCFP

# **WHY SHOULD I GIVE THIS TALK?**

**Interest – How does mind work?**

**Flip side – How to create an AGI?**

(==*Artificial General Intelligence*, ‘HLAI’, ‘Strong AI’)

- ▶ Research – Cognitive Architectures
- ▶ (I design machines to produce AI/AGI)

# LEARNING OBJECTIVES

- ▶ **1. Real understanding of what AI is:**
- ▶ 1a. Deep Learning and Reinforcement Learning
- ▶ 1b. Field of Artificial Intelligence (AI)
- ▶ 1c. Neuro-Symbolic Gap
- ▶ **2. How will AI in next decade (or two) affect my patients' lives?**
- ▶ **3. How will AI affect my practice of medicine including psychotherapy?**
- ▶ 3a. How is AI affecting medicine at present?
- ▶ 3b. How will AI affect medicine in the next decade?
- ▶ **4. How will AI affect the future of mankind?**
- ▶ **5. Discussion**

WILL DO BEST TO KEEP ON SCHEDULE....

(90 MINUTES TALK, 30 MINUTES QUESTIONS)



NOT REQUIRED.... BUT.....  
CONSIDER MAKING NOTES IF THIS HELPS  
YOU LEARN....



To download a copy of these slides:

**SEARCH (EG, GOOGLE):**

“DR HOWARD SCHNEIDER TORONTO”

**OR ENTER:**

[HTTPS://GITHUB.COM/HOWARD8888/AI-AND-THE-FUTURE-OF-MEDICINE/BLOB/MASTER/AI%20AND%20THE%20FUTURE%20OF%20MEDICINE.PDF](https://github.com/howard8888/AI-AND-THE-FUTURE-OF-MEDICINE/blob/master/AI%20AND%20THE%20FUTURE%20OF%20MEDICINE.PDF)



# LEARNING OBJECTIVES

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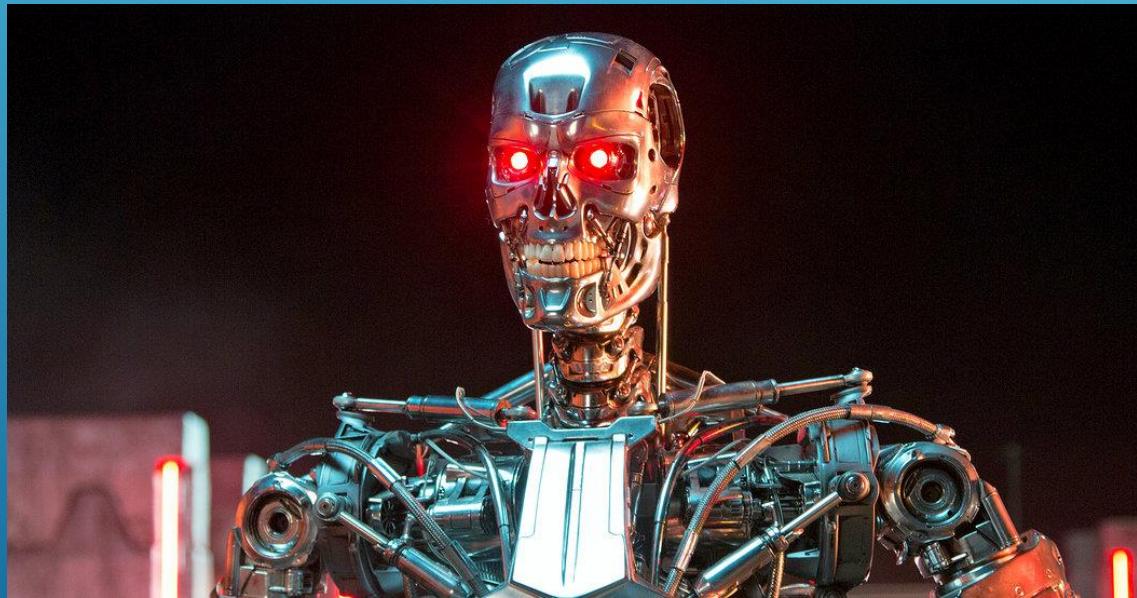
**NEW TOPIC**

# INTRODUCTION

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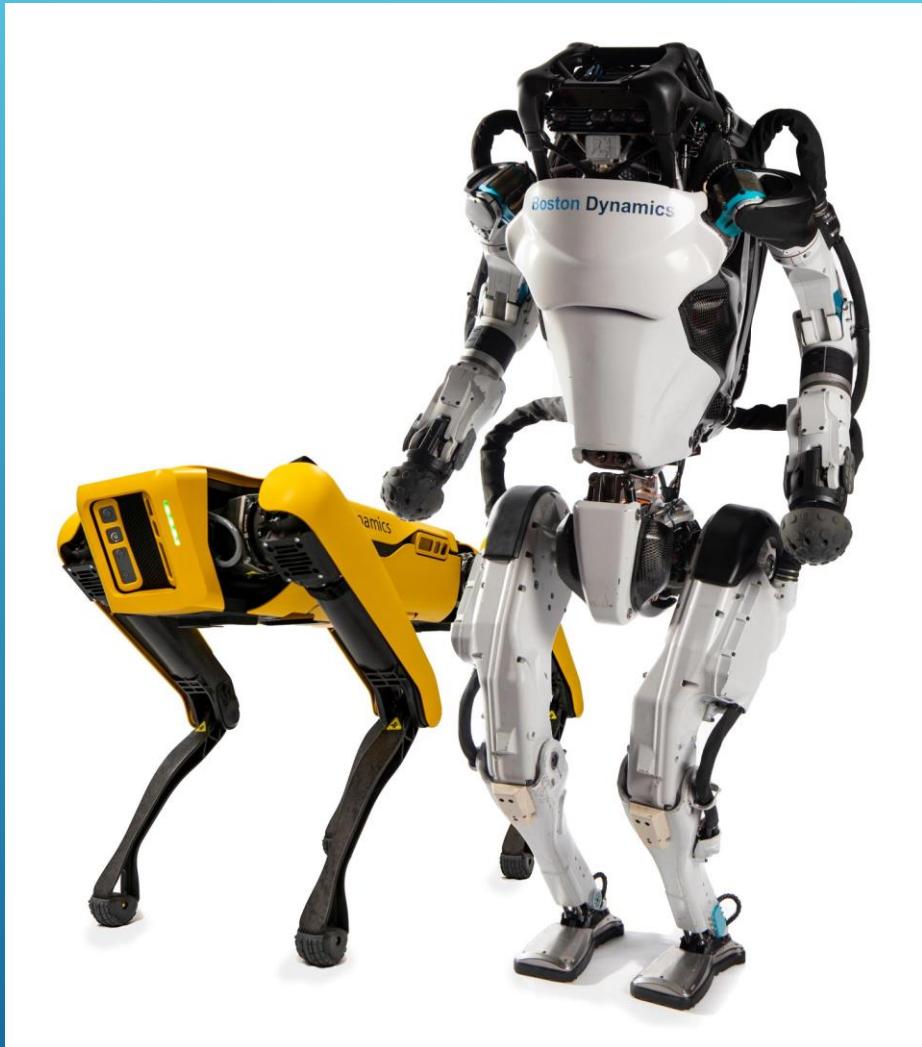
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FORGET ABOUT CURRENT HYPE YOU SEE  
ABOUT AI (ARTIFICIAL INTELLIGENCE) ALL  
AROUND YOU IN THE MEDIA....



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-Human-like (and dog-like) robots **do** exist

-They **can** walk, run, jump, even do back-flips....

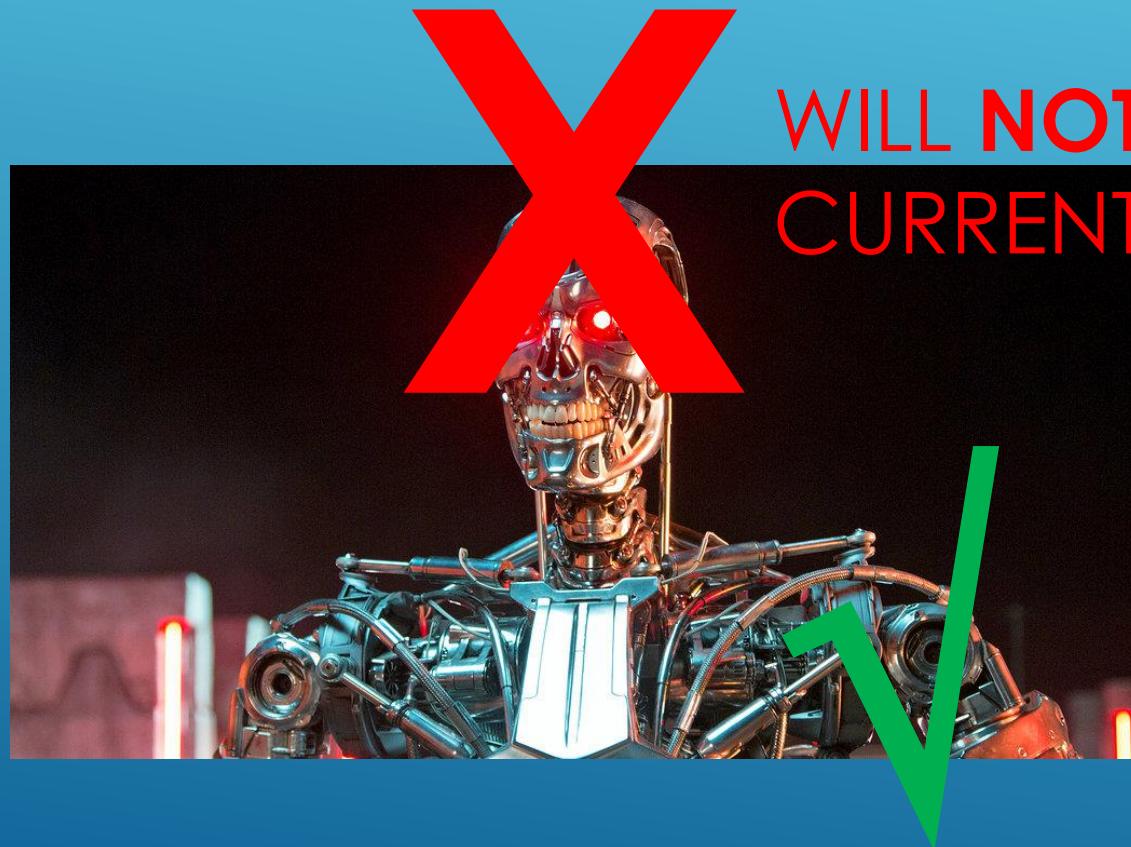




“If I only had a brain....”

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FORGET ABOUT CURRENT HYPE YOU SEE  
ABOUT AI (ARTIFICIAL INTELLIGENCE) ALL  
AROUND YOU IN THE MEDIA....



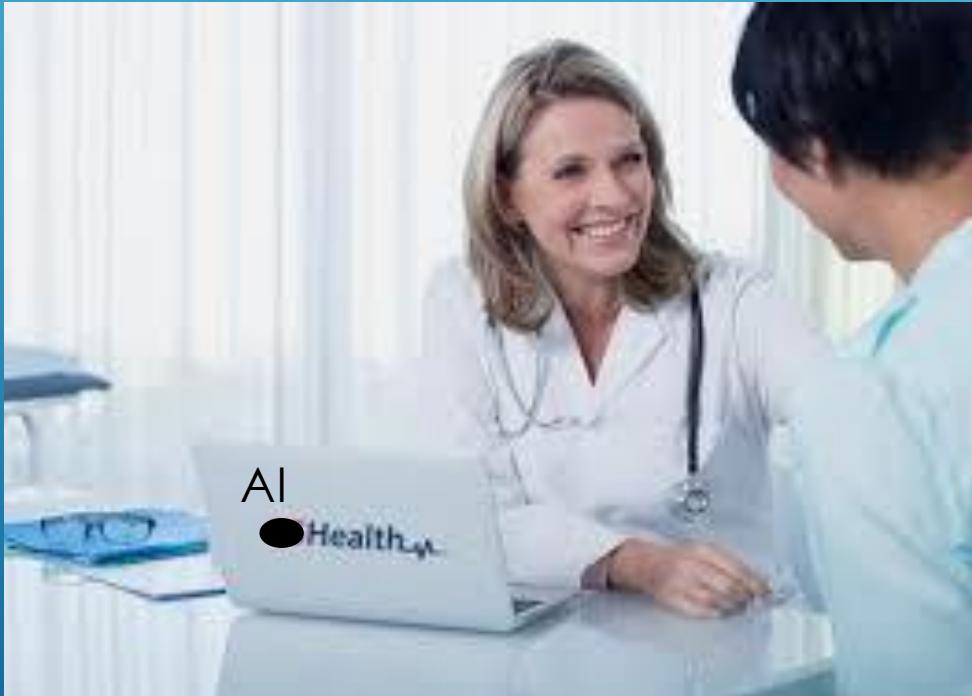
WILL **NOT** HAPPEN WITH  
CURRENT TECHNOLOGY

# AT PRESENT: FORGET ABOUT CURRENT HYPE YOU SEE IN MEDICINE ABOUT AI



Straightforward computer engineering can greatly improve EMRs  
(an almost magical AI would be nice to have.... but huge improvements are possible with normal computer engineering)

MANY IMPROVEMENTS IN EMR (FOR EXAMPLE)  
POSSIBLE WITH GOOD COMPUTER ENGINEERING  
PRACTICES (THE AI PART MAY BE MINUSCULE)



NOT  
REALLY AI

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# AT PRESENT: FORGET ABOUT CURRENT HYPE YOU SEE IN MEDICINE ABOUT AI



RUNNING HOSPITALS OR  
YOUR PRACTICE BY BIG DATA  
IS NOT TRUE MEDICINE – IT IS  
SIMPLY VERY POWERFUL  
STATISTICS  
(WE WILL COME BACK AND  
TALK ABOUT THIS LATER)

# LEARNING OBJECTIVES

- ▶ 1. Real understanding of what AI is:
- ▶ **1a. Deep Learning and Reinforcement Learning**
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**NEW TOPIC**

# DEEP LEARNING

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# THESE DAYS, PEOPLE USE THE TERM “AI” TO REFER TO **DEEP LEARNING**

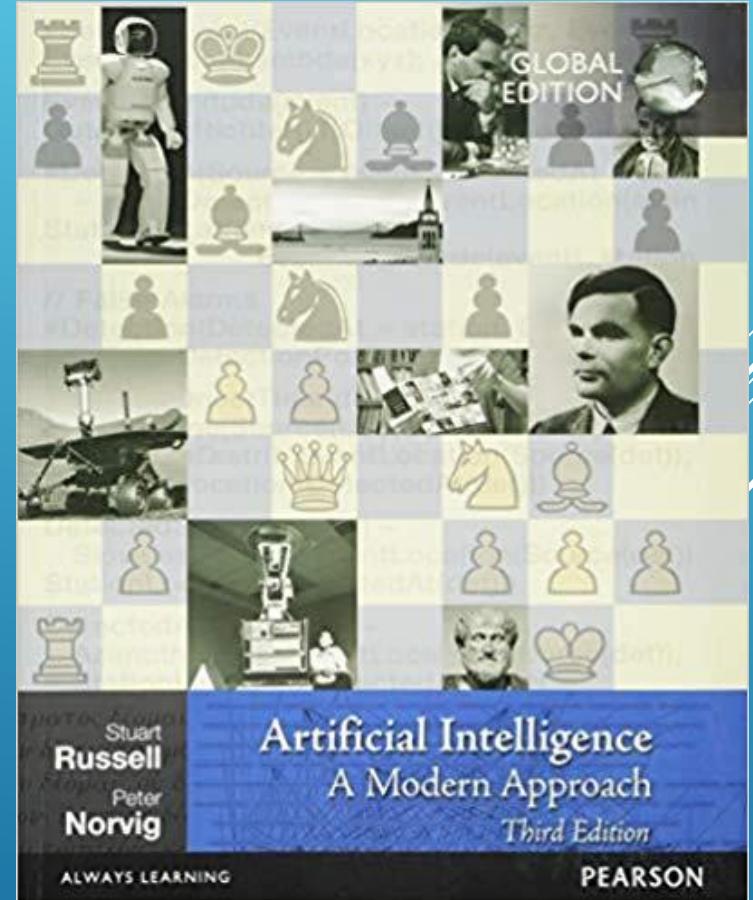
Of course, AI is much more than  
‘Deep Learning’ – we’ll talk about  
that later.

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# “Of course, AI is much more than ‘Deep Learning’ – we’ll talk about that later.”

Deep Learning actually only tiny part of AI  
AI a huge field – even an introduction to the subject  
is massive

1. Definition of AI
2. History of AI
3. Mathematical Primer
4. Computer Science Theoretical Concepts
5. Computational Devices
6. Programming Languages
7. .... .... ....



# DEEP LEARNING.... LET'S JUST JUMP IN....



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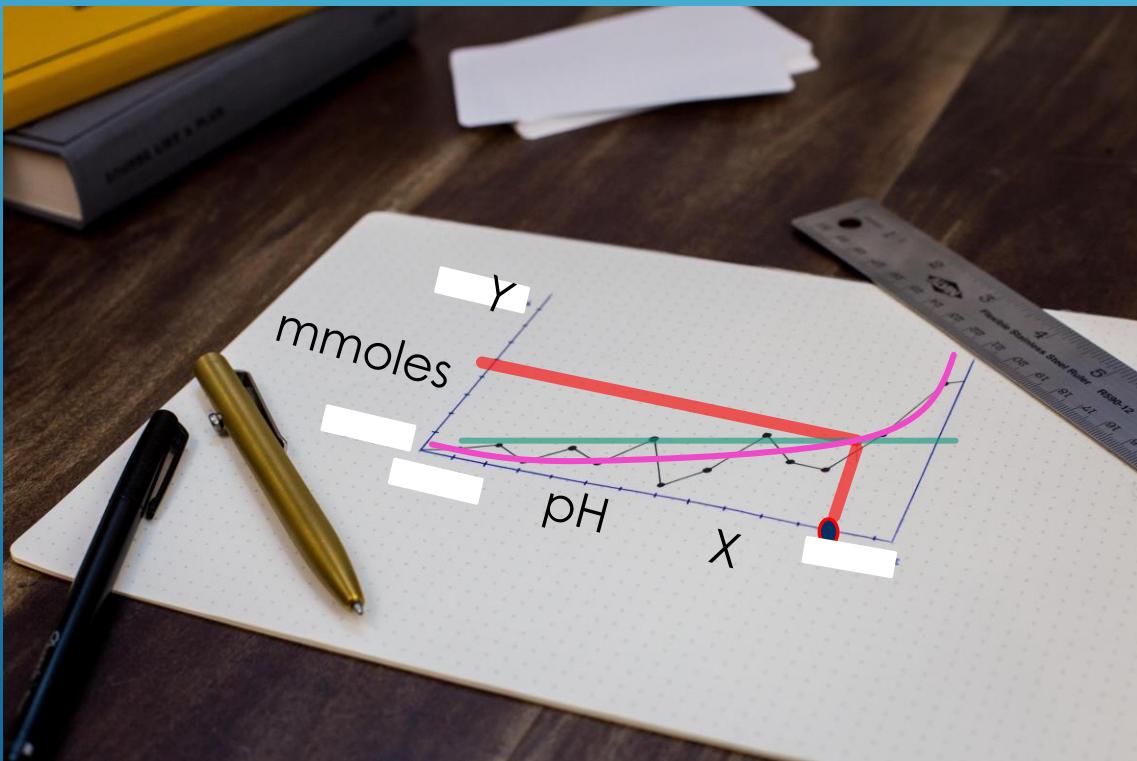
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# OK.... WHAT IS DEEP LEARNING?

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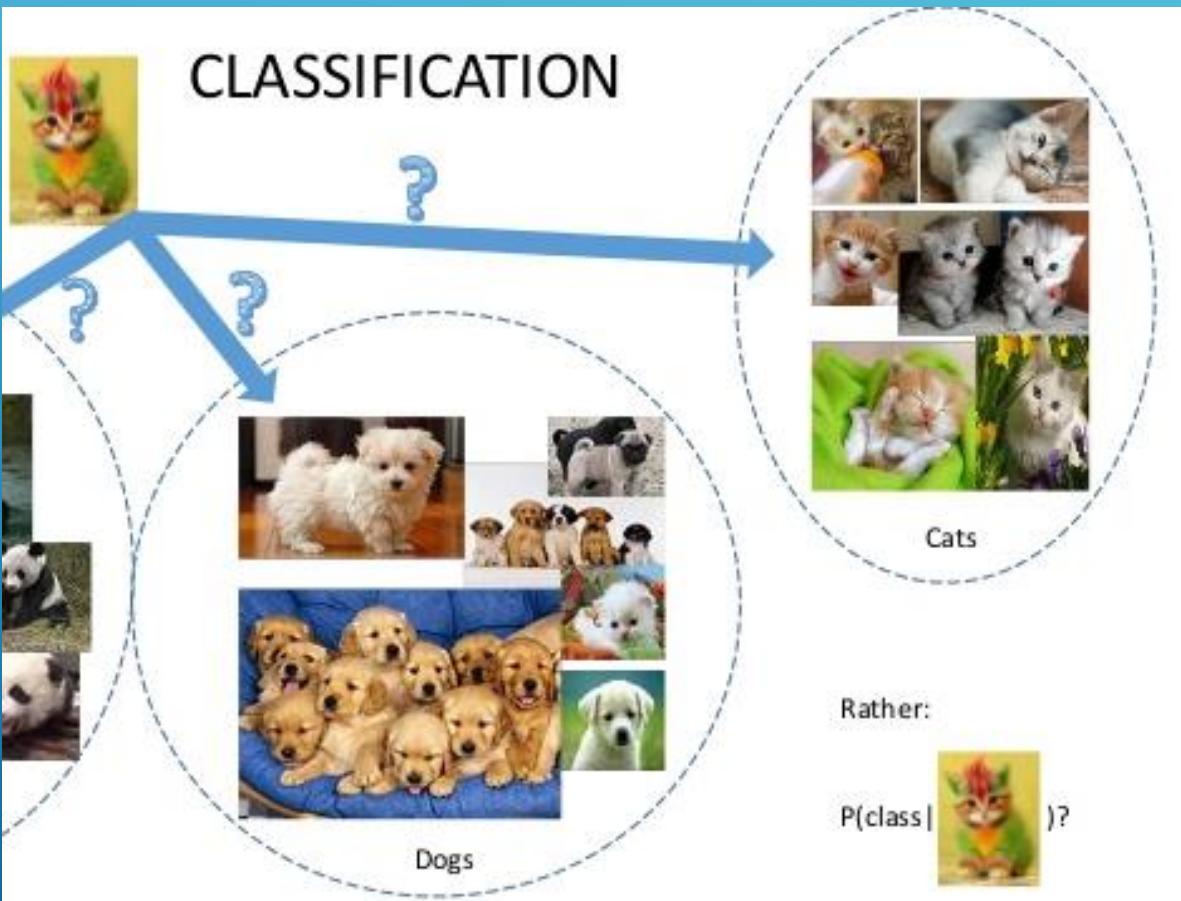
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# THIS IS YOU – EG, PREMED CHEMISTRY – DOING SIMPLE “ARTIFICIAL INTELLIGENCE”, IE, DEEP LEARNING

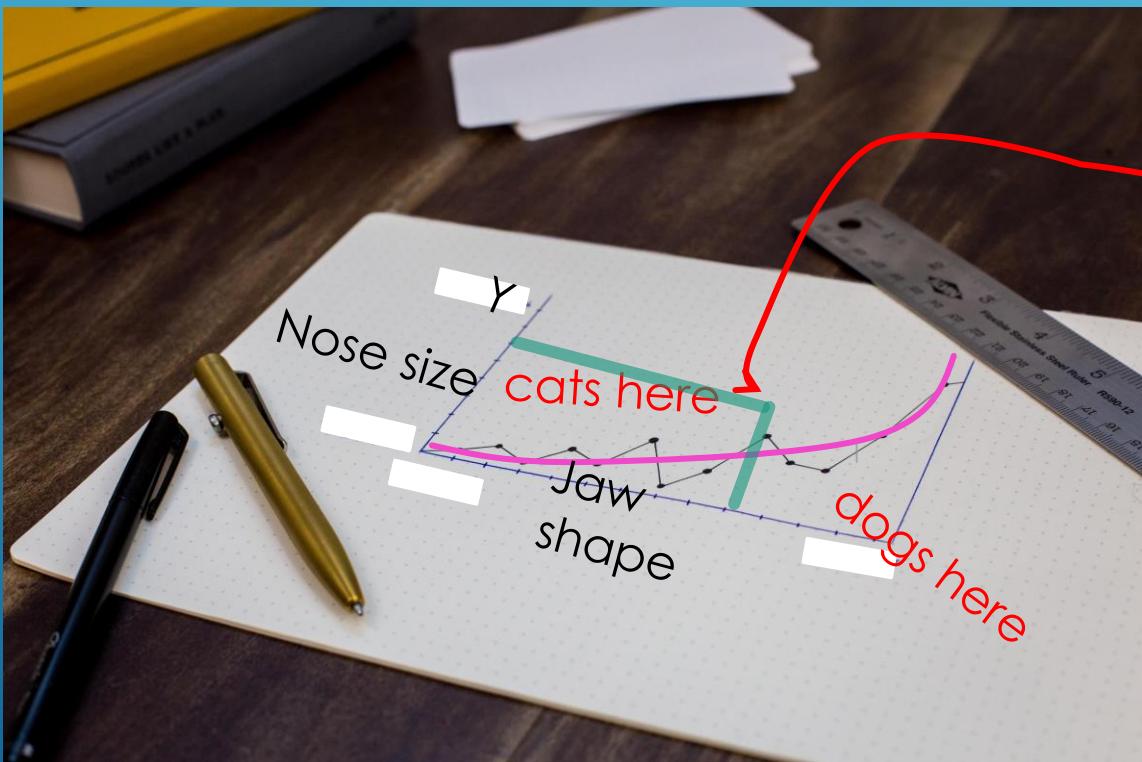


New X value never seen before, you can predict the Y value

# IS THIS A DOG OR A CAT?



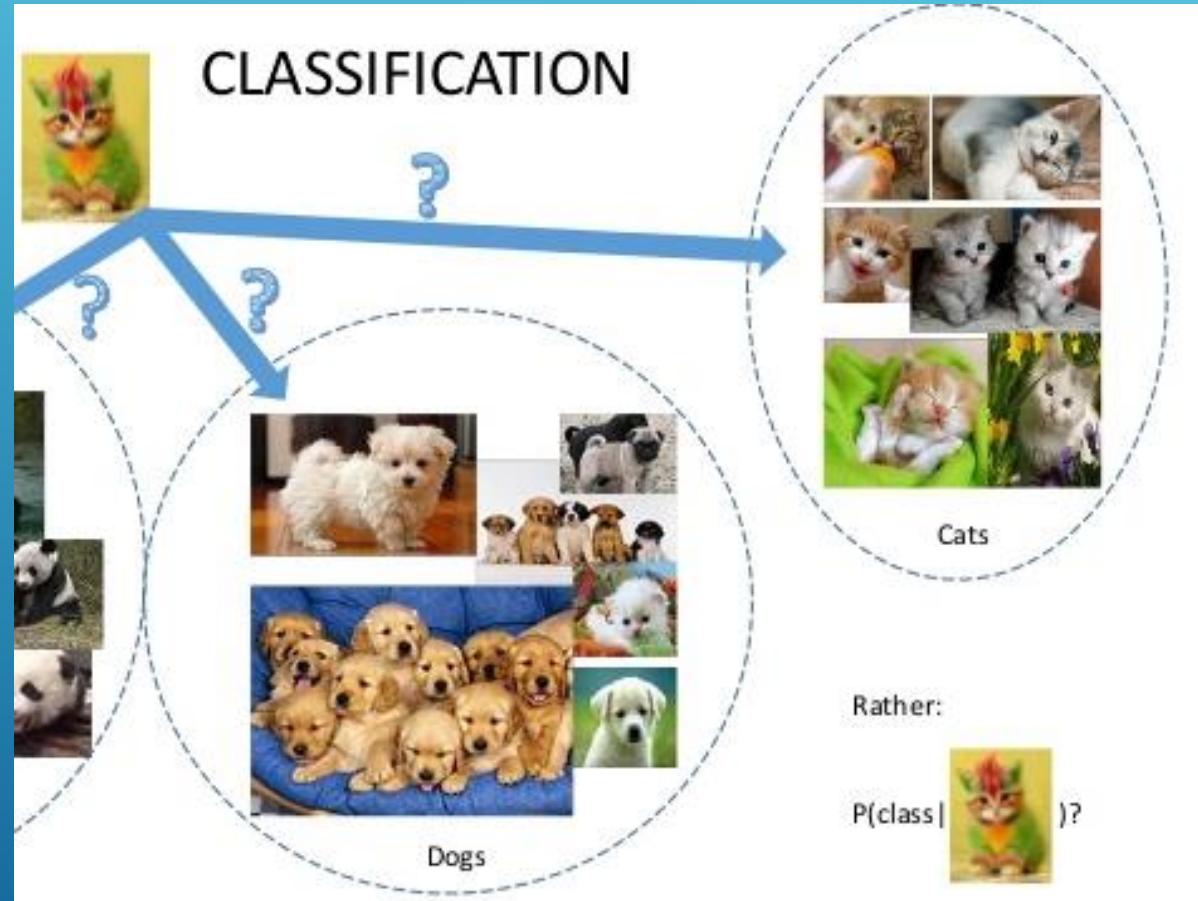
Plot nose size vs jaw shape, and where point ends up predicts if it is a cat or a dog



It's a cat!!

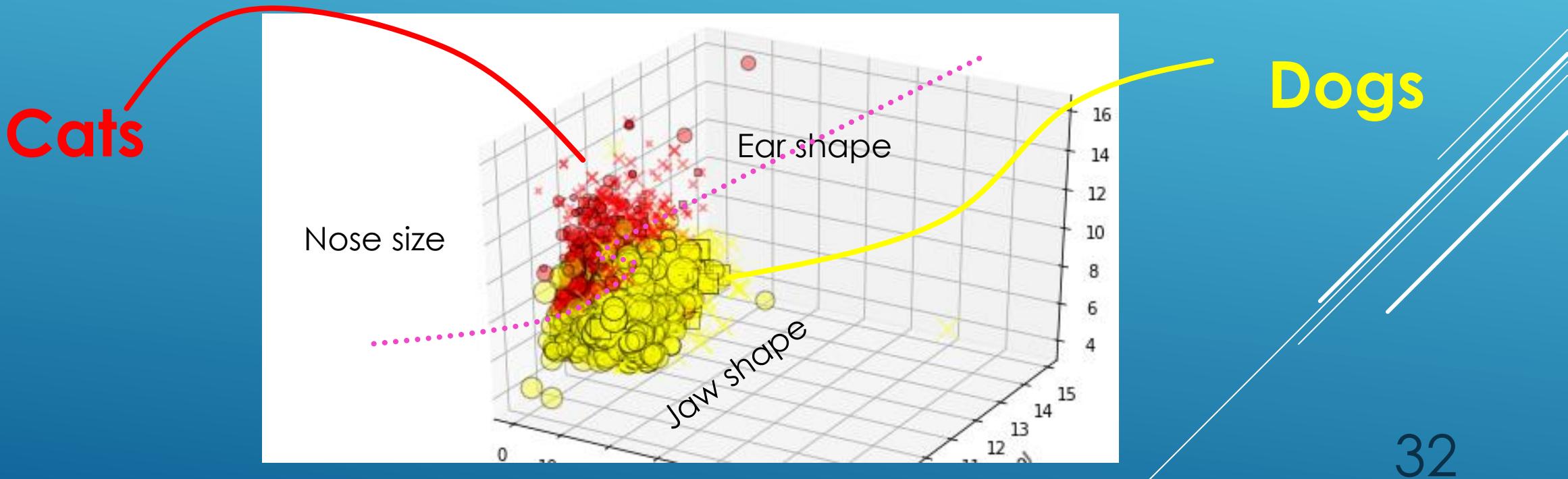


-TO IDENTIFY A CAT VS DOG, NEED MORE THAN 2 FEATURES (EG, NOSE SIZE AND JAW SHAPE)

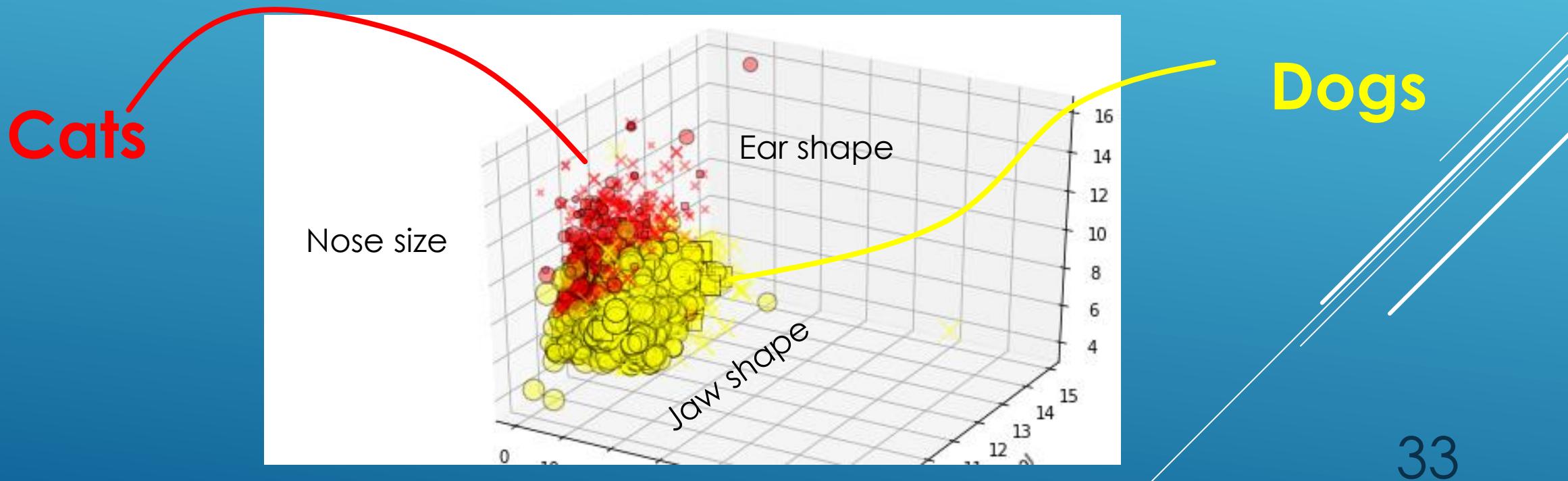


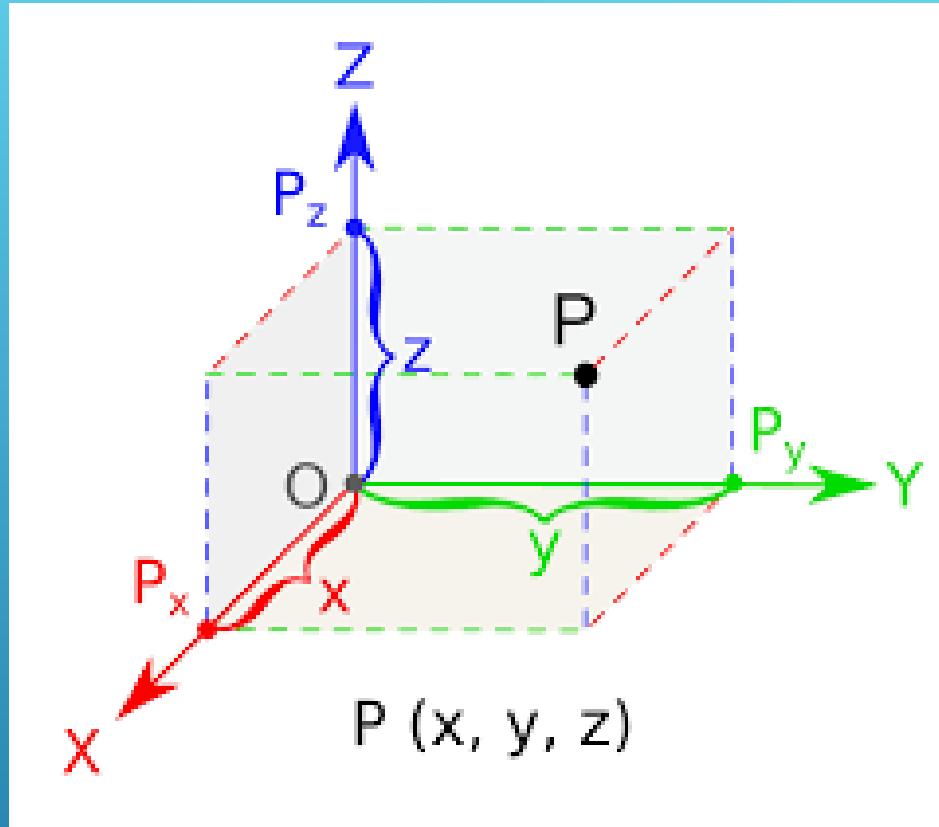
-TO IDENTIFY A CAT VS DOG, NEED MORE THAN 2 FEATURES (EG, NOSE SIZE AND JAW SHAPE)

-BELOW WE ADD 'EAR SHAPE'  
(THUS, NEED 3 DIMENSION GRAPH)

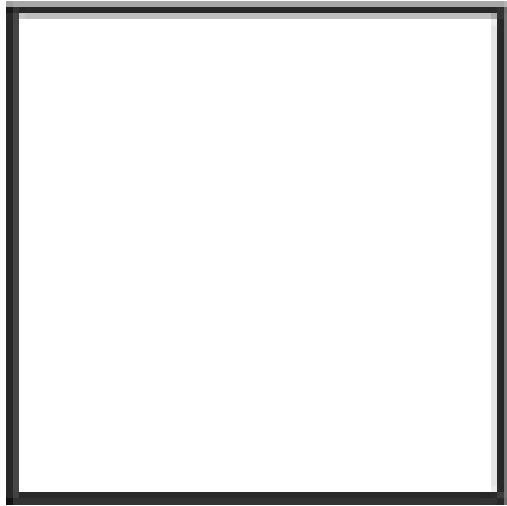


BELOW IS 3-D BUT MAYBE REALLY NEED  
1000-D (OR 64,000 DIMENSIONS!!)

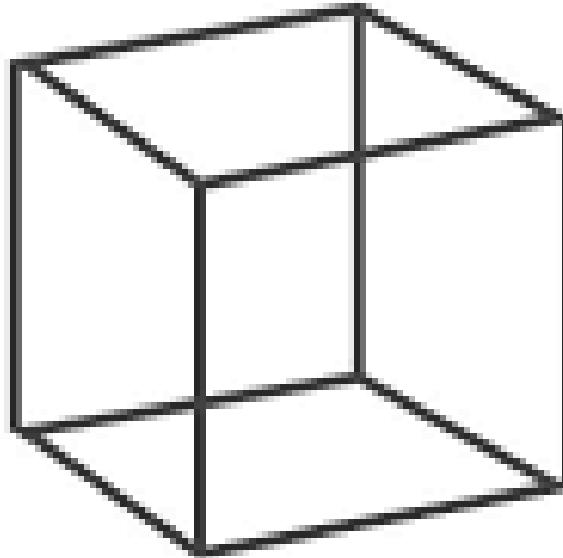




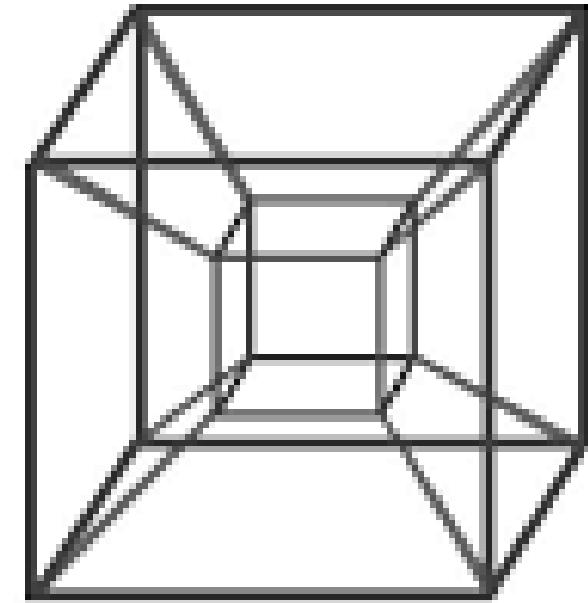
Don't be afraid to go past 3 dimensions....



Square

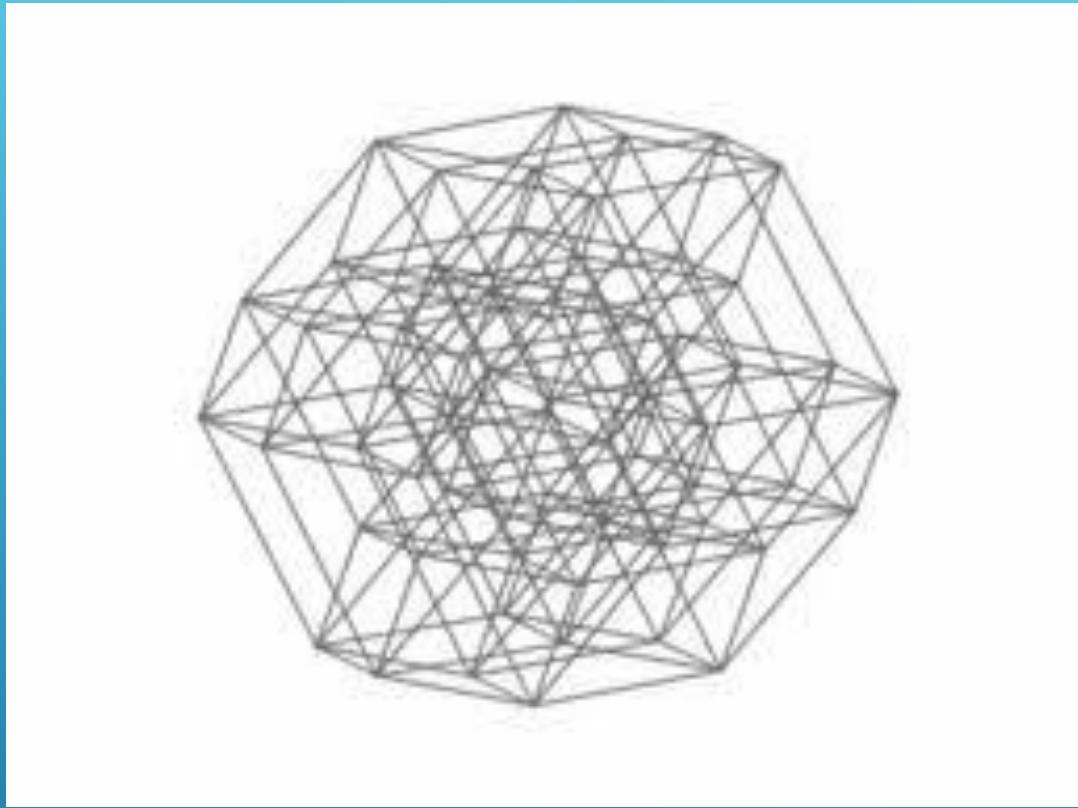


Cube



Tesseract

4-D SPACE  
(analogue of cube)

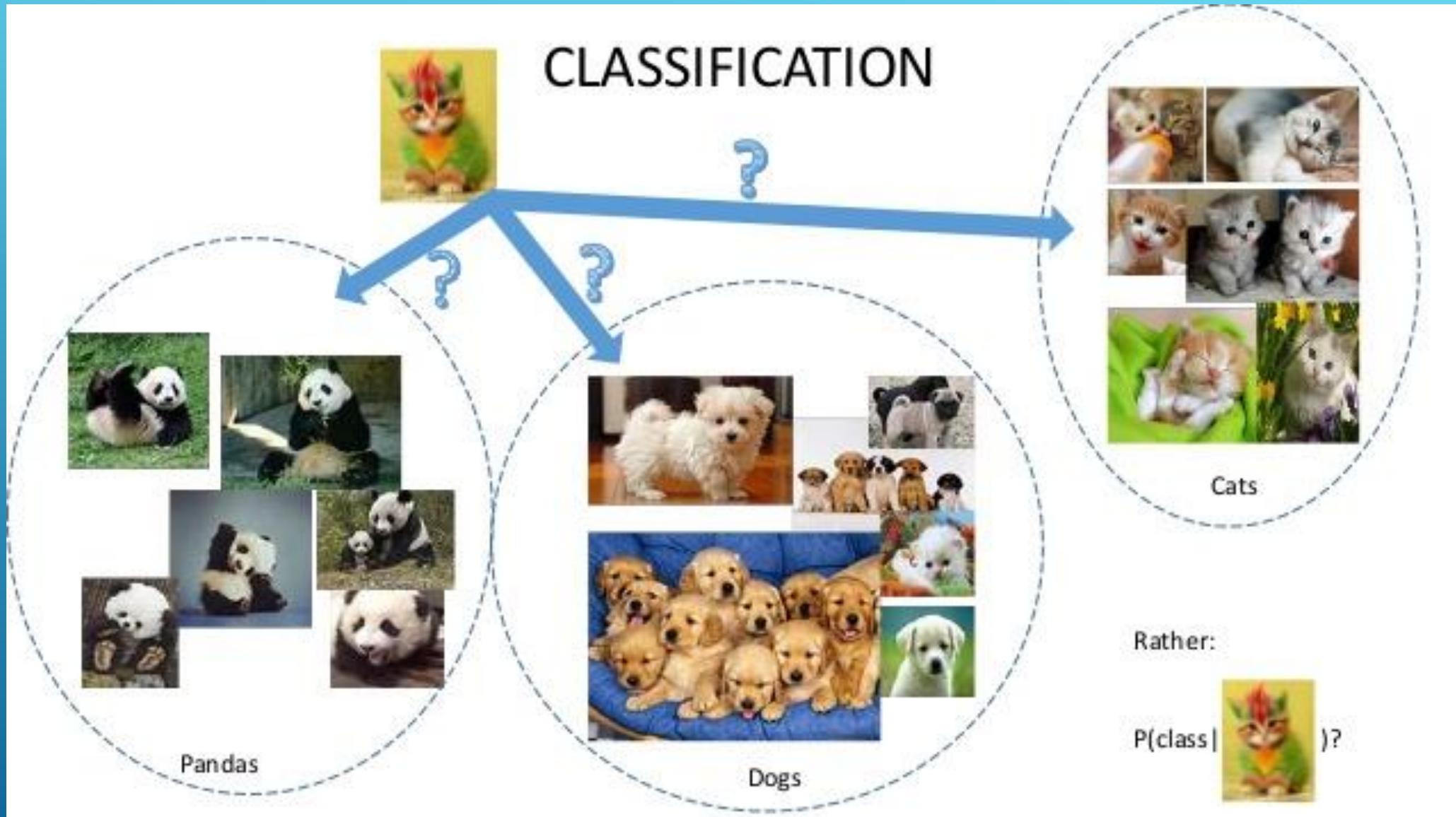


## 6-D SPACE (analogue of cube)

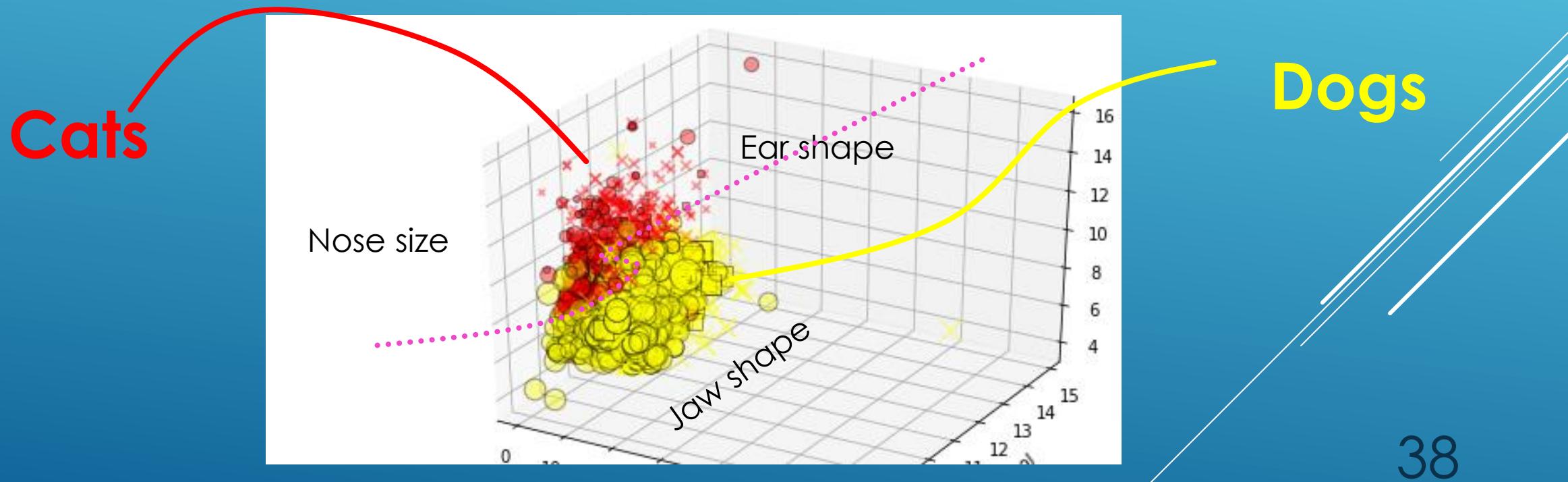
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# CLASSIFICATION

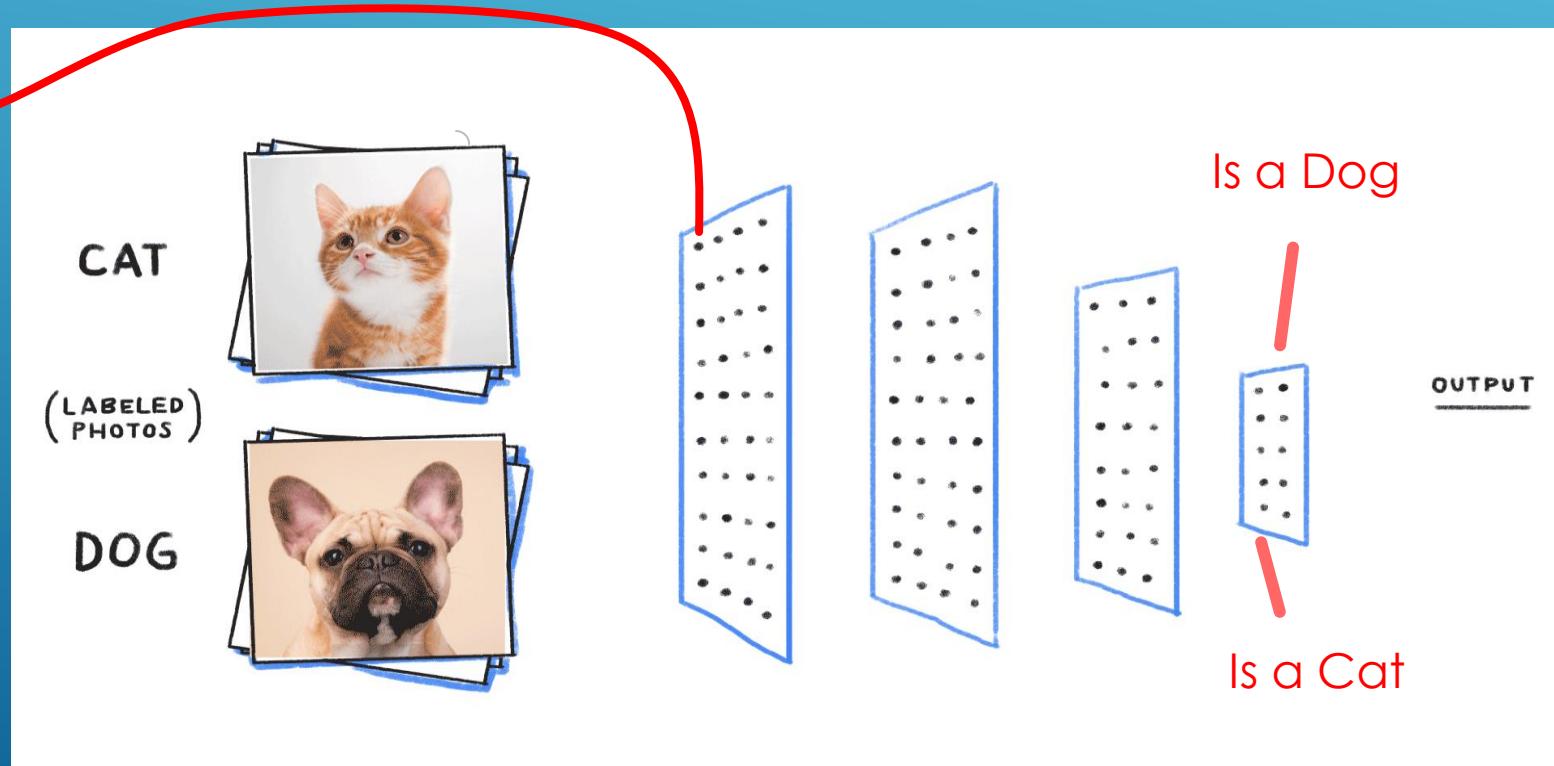


OK....HOW DO WE AUTOMATICALLY BUILD SUCH A 3-D OR 1000-DIMENSION GRAPH?

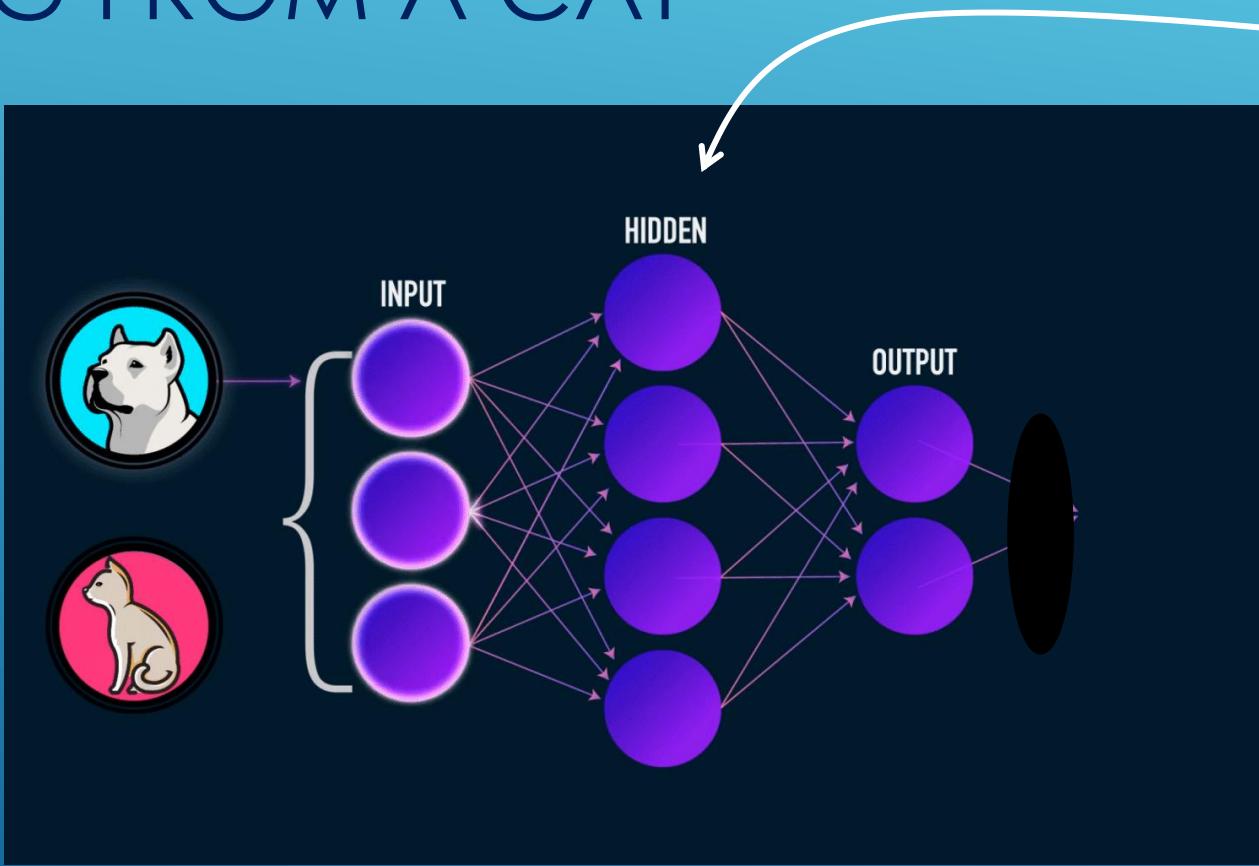


# LOOK AT MANY PIXELS OF THE PHOTOGRAPHS AND PLOT IN MANY DIMENSIONS WITH A NEURAL NETWORK

Simplified!!  
(even 256 x 256 pixel small photo would have over 65,000 inputs)

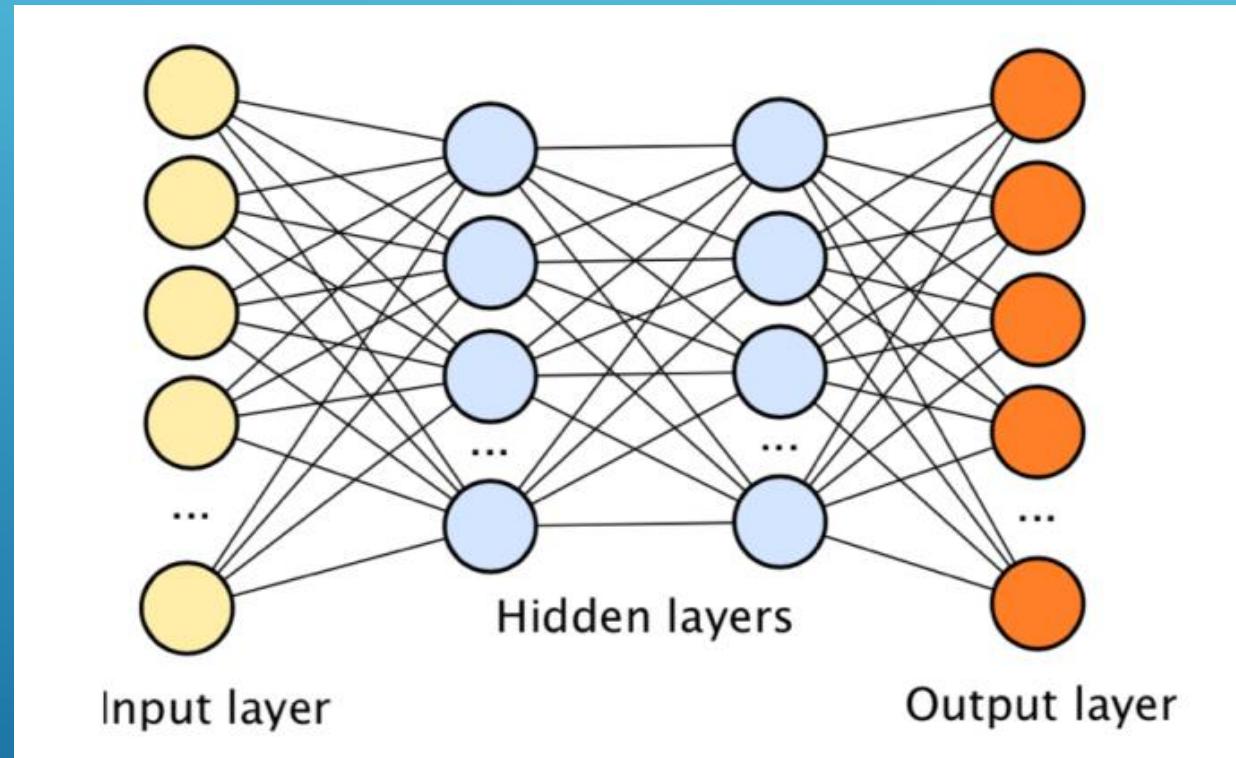


# (VERY SIMPLIFIED) NEURAL NETWORK TO 'AUTOMATICALLY' LEARN TO TELL A DOG FROM A CAT

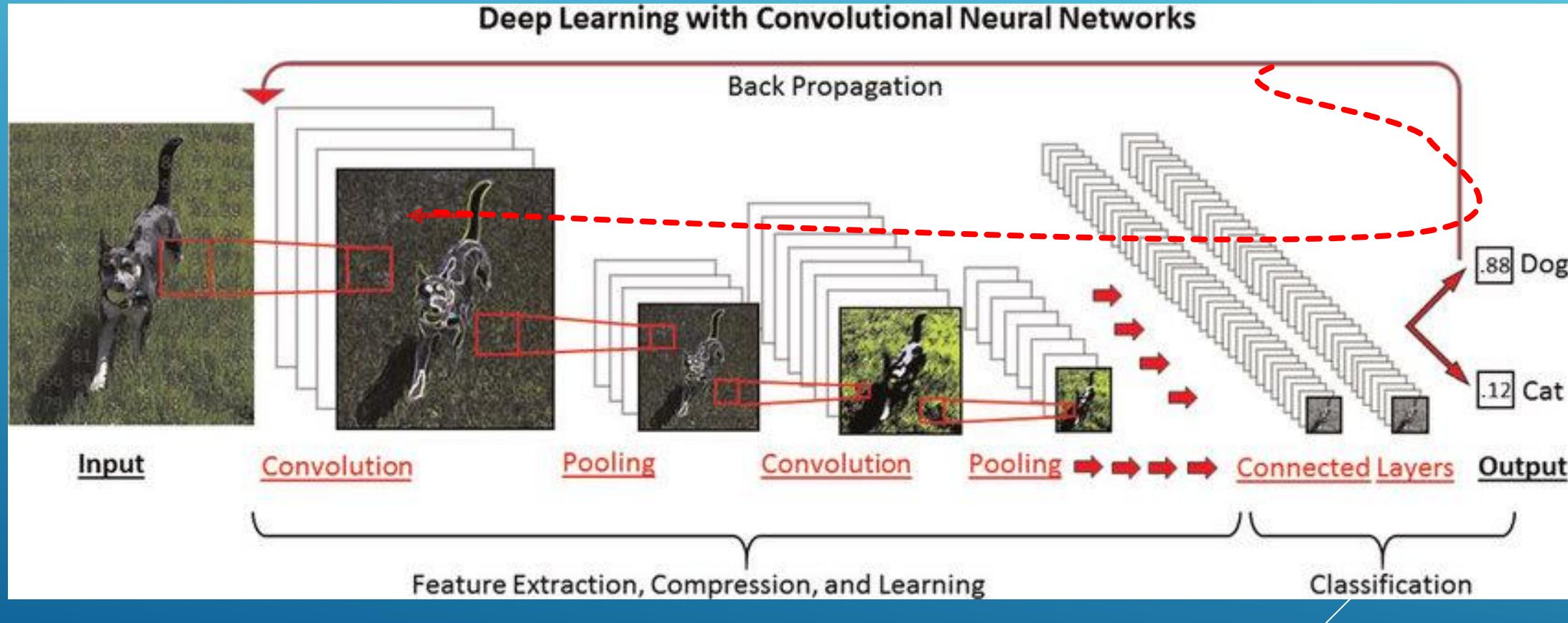


**Simplified**  
Real Deep Learning  
Neural Network will  
have *\*many\** hidden  
layers

*Deep Learning Neural Network will have  
\*many\* hidden layers*



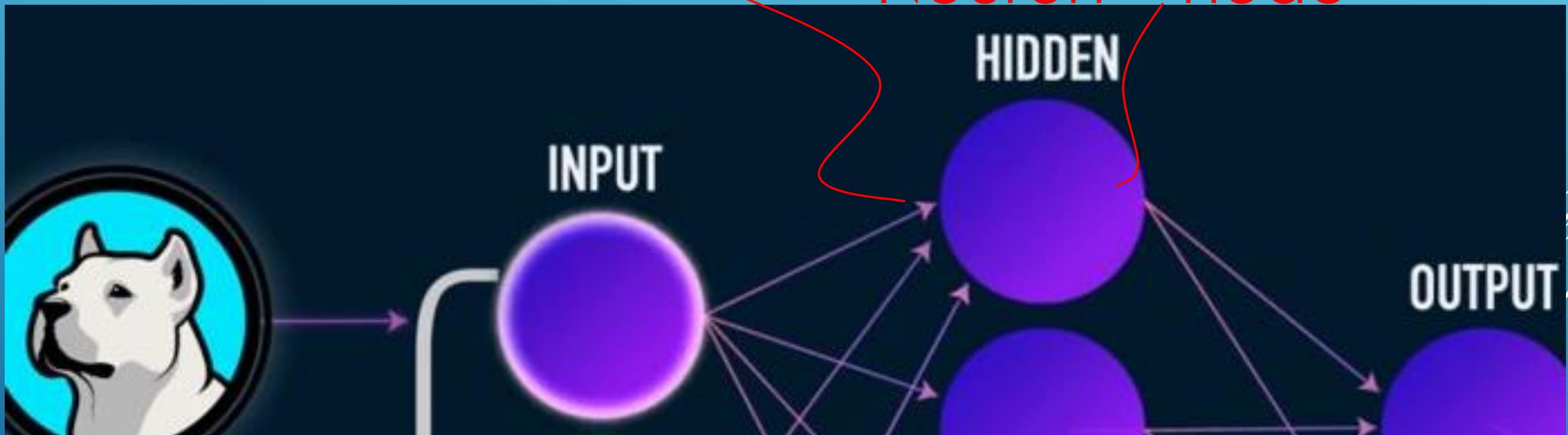
# SIMPLE, REALISTIC DEEP LEARNING NEURAL NETWORK WILL HAVE \*MANY\* HIDDEN LAYERS



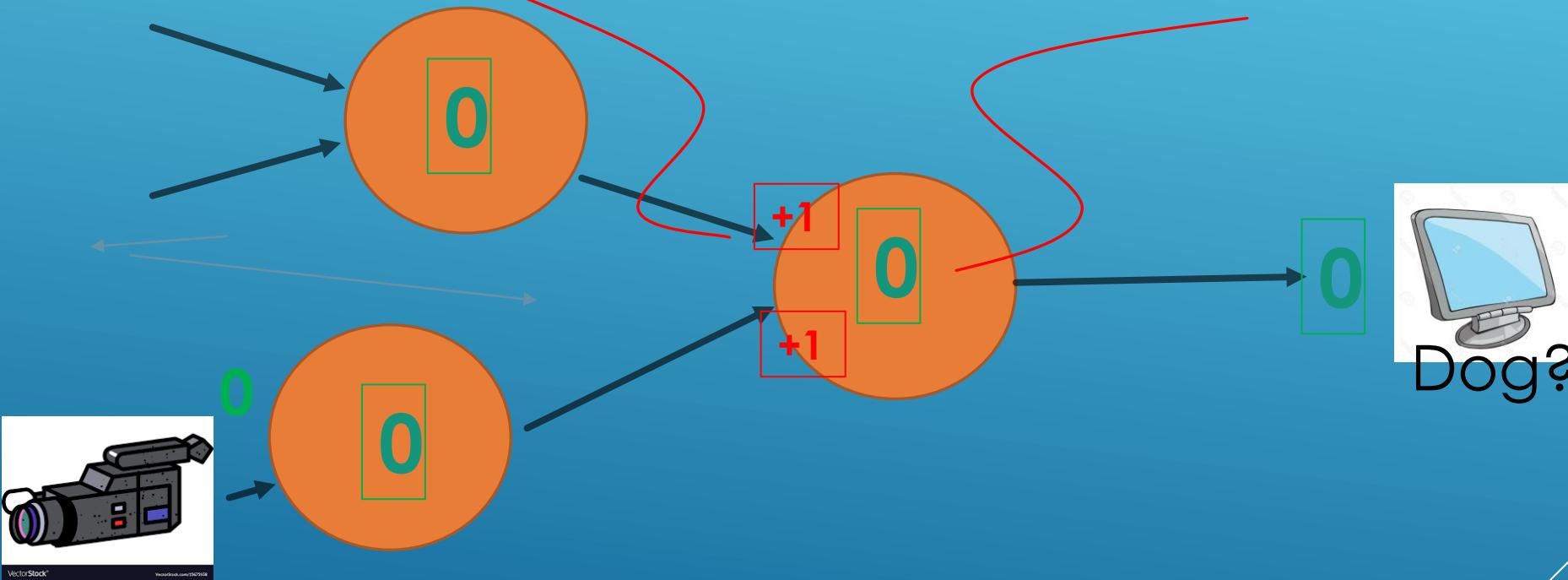
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Synapse = weight

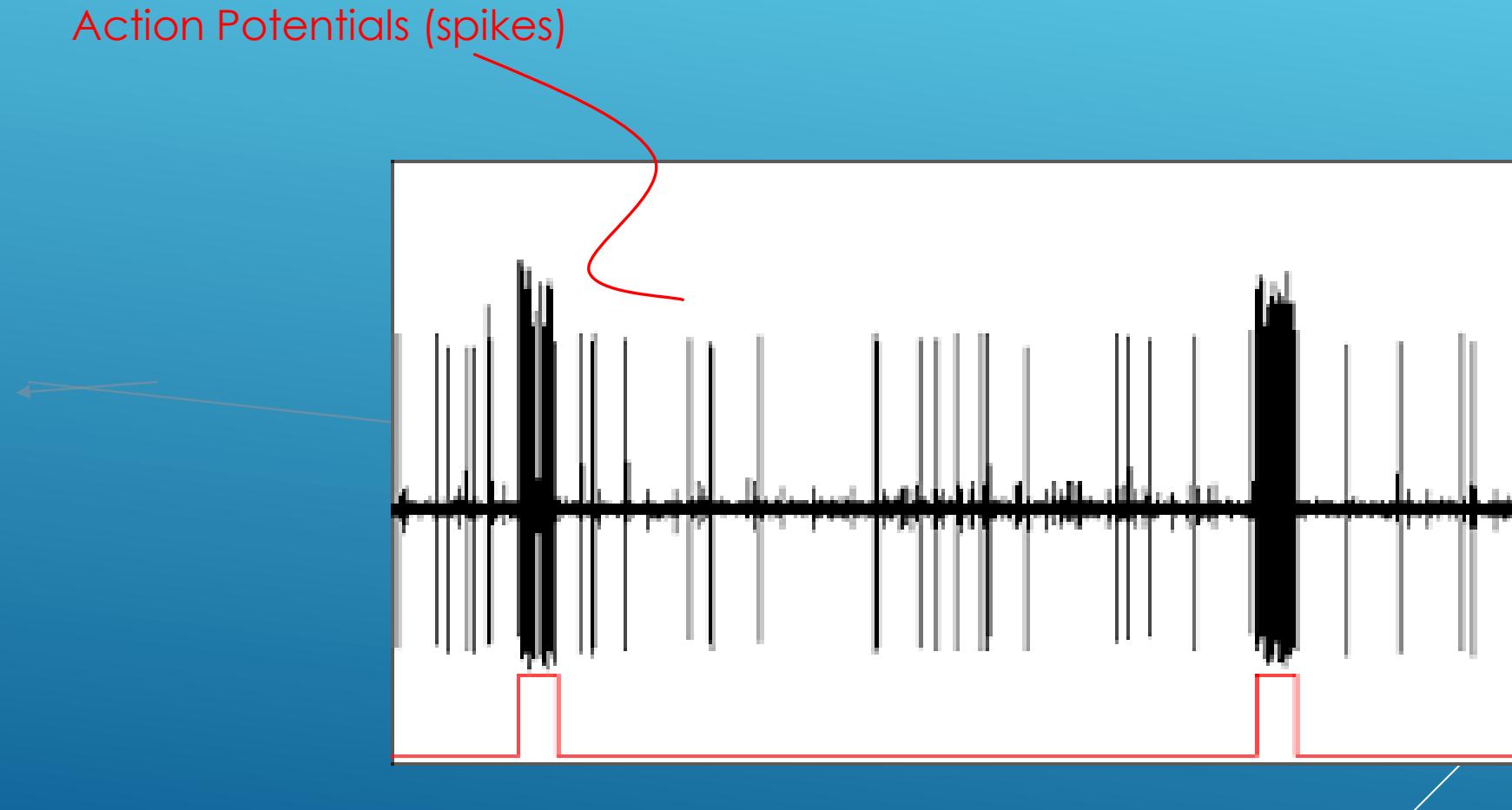
Neuron = node



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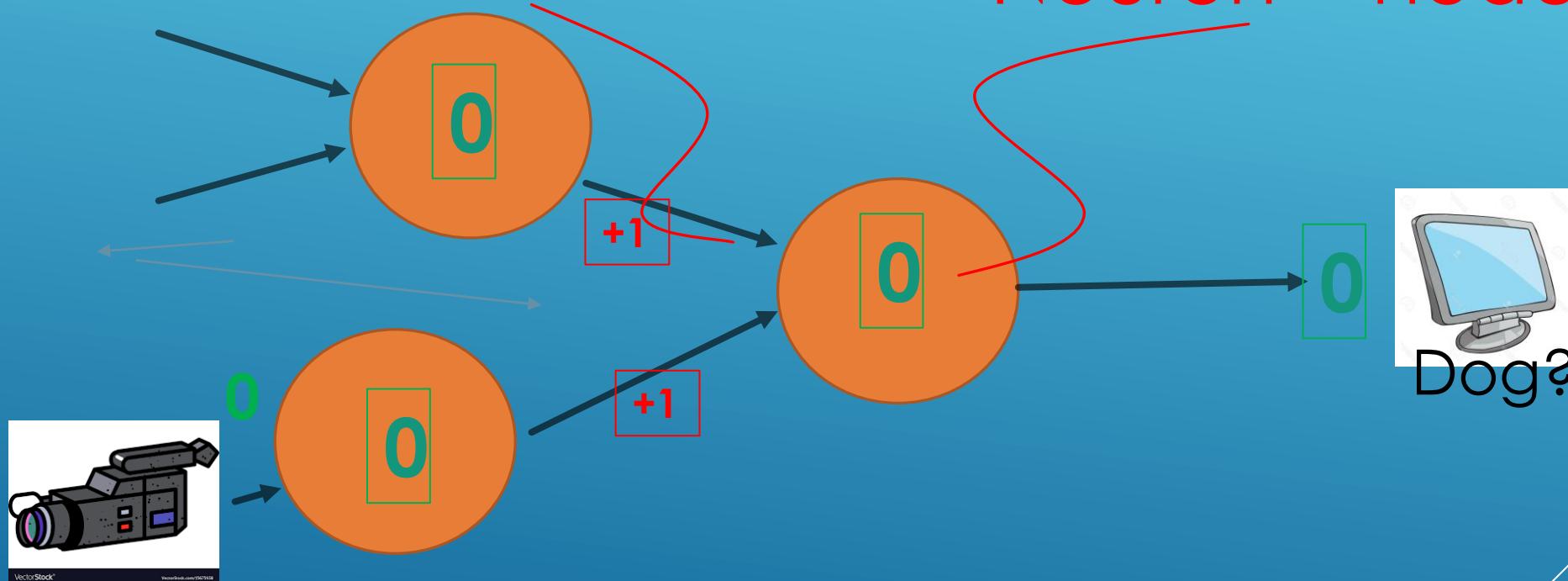


# Real Neural Networks



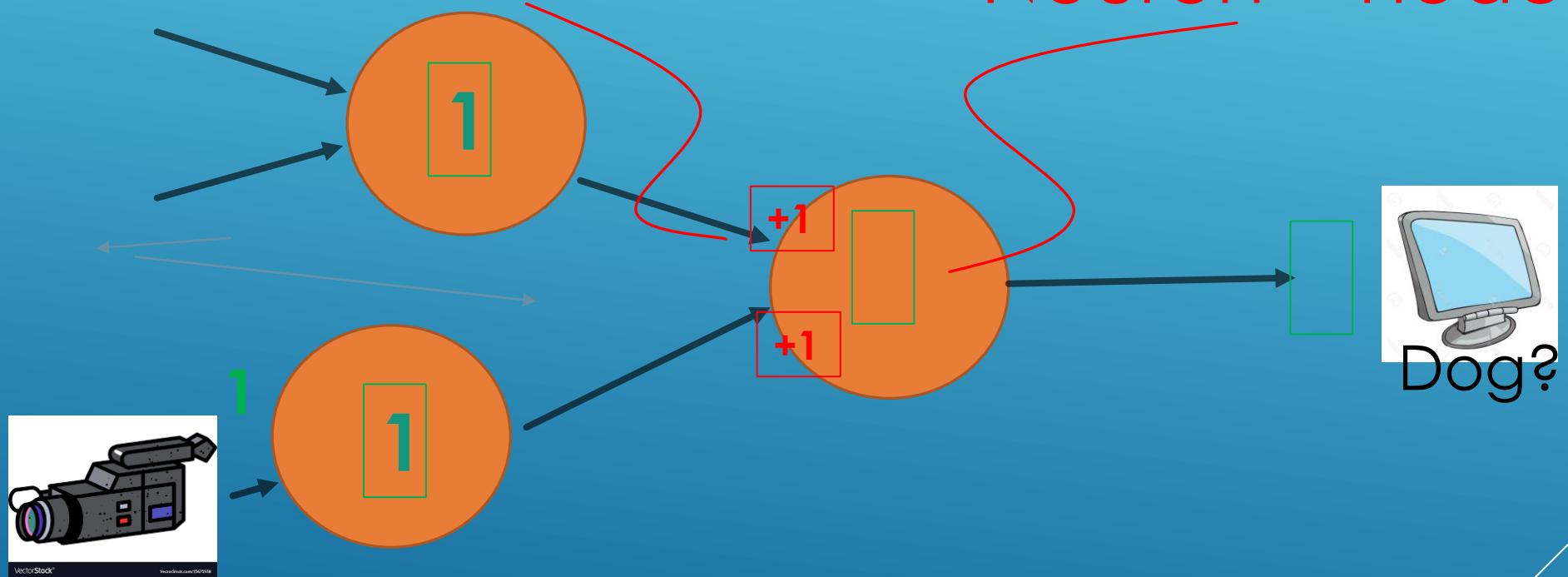
# “Artificial Neural Network” (ANN)

Synapse = weight



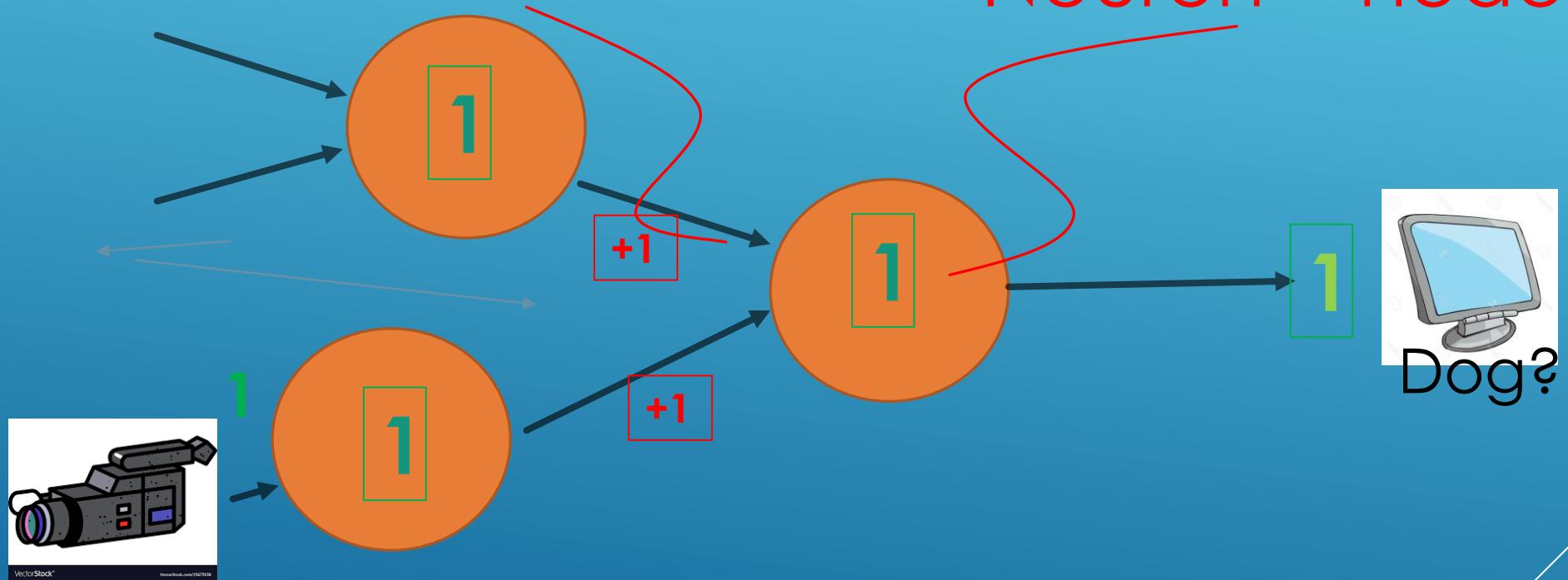
Neuron = node

Synapse = weight



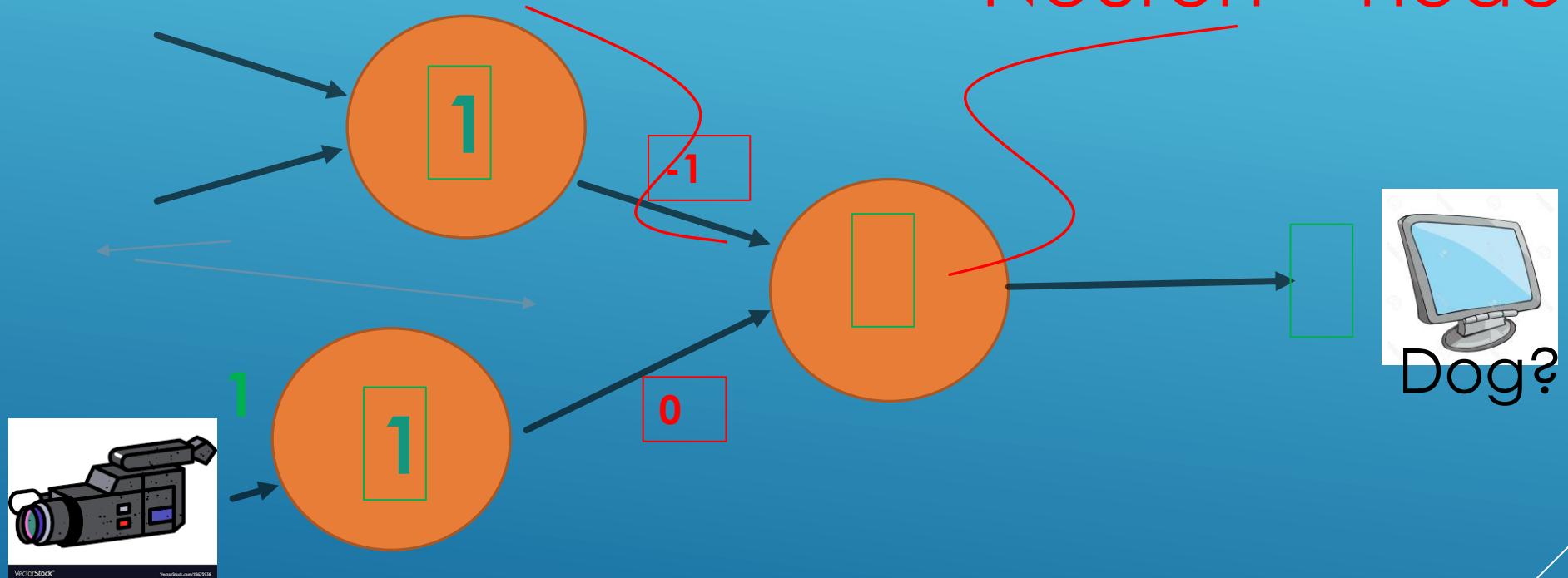
Neuron = node

Synapse = weight



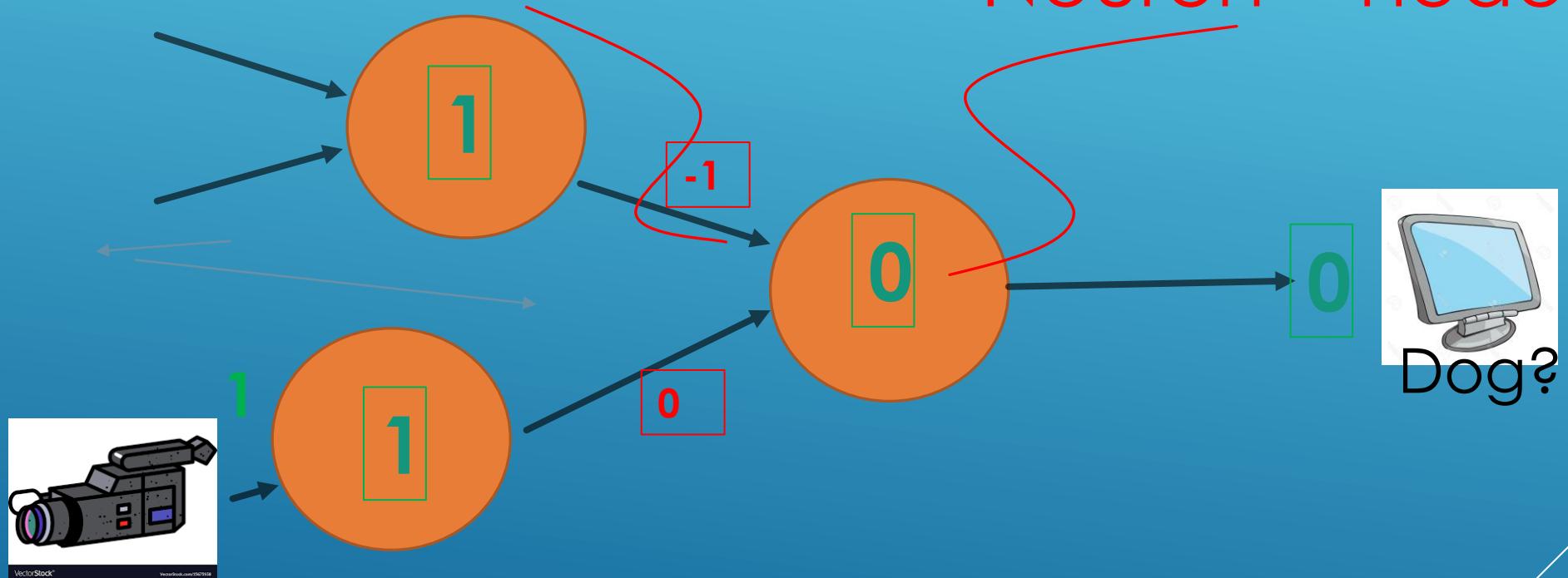
Neuron = node

Synapse = weight

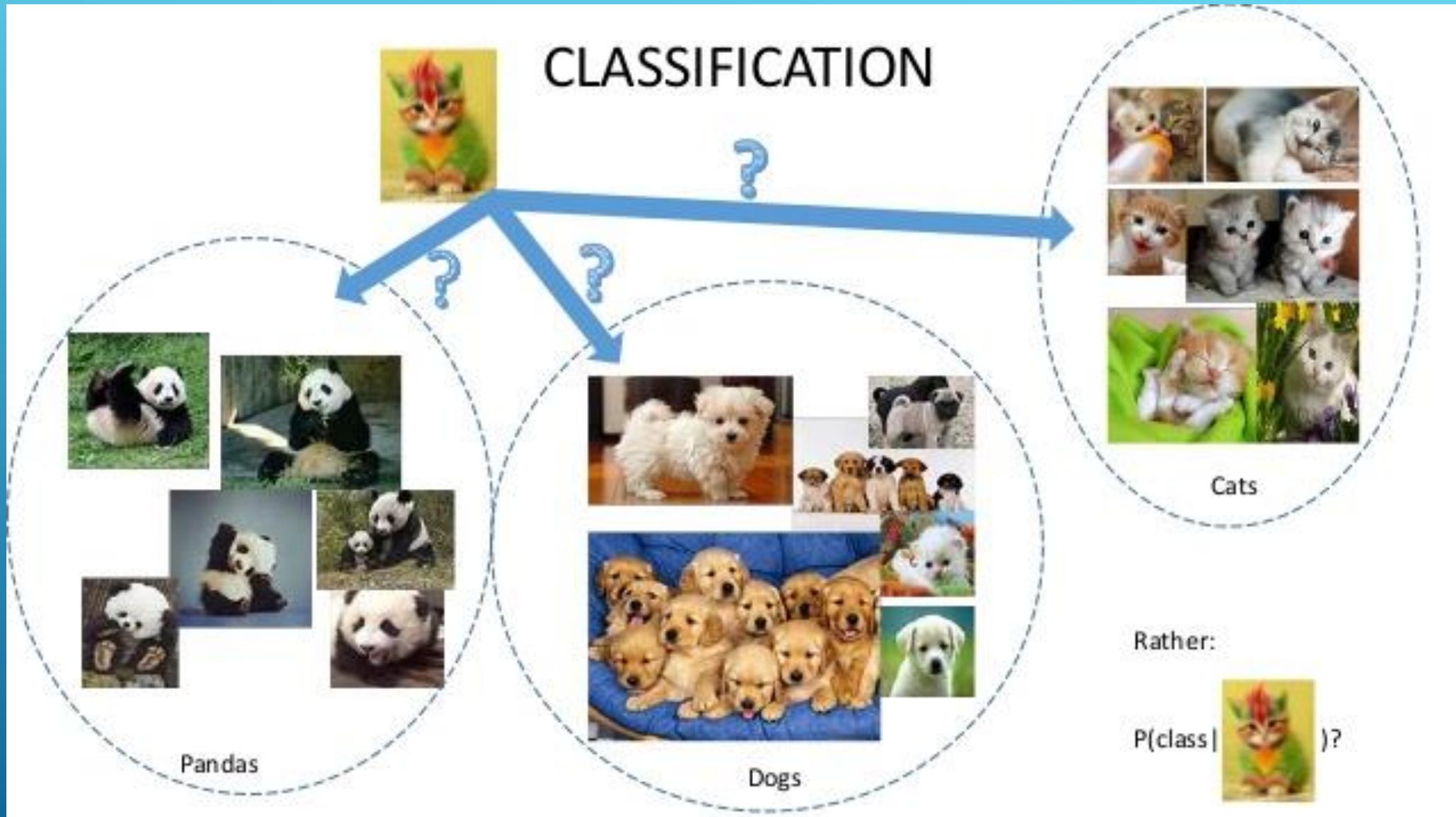


Neuron = node

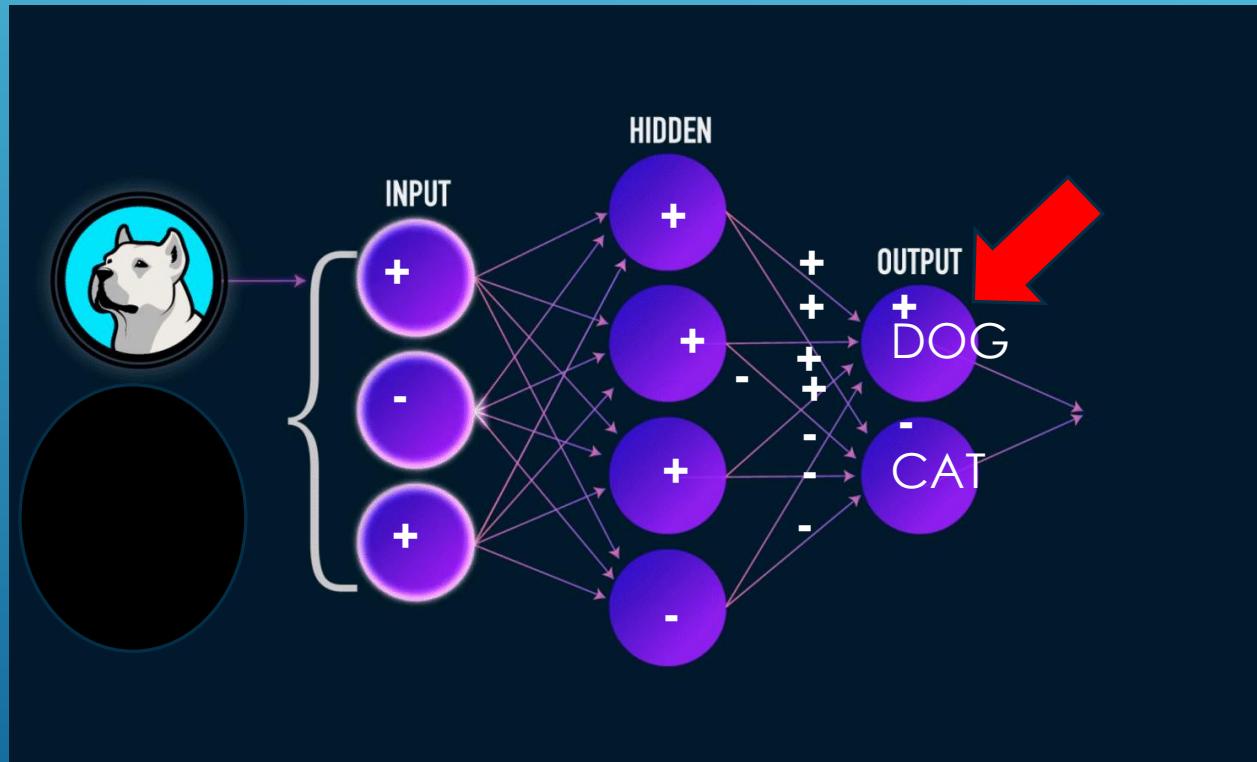
Synapse = weight



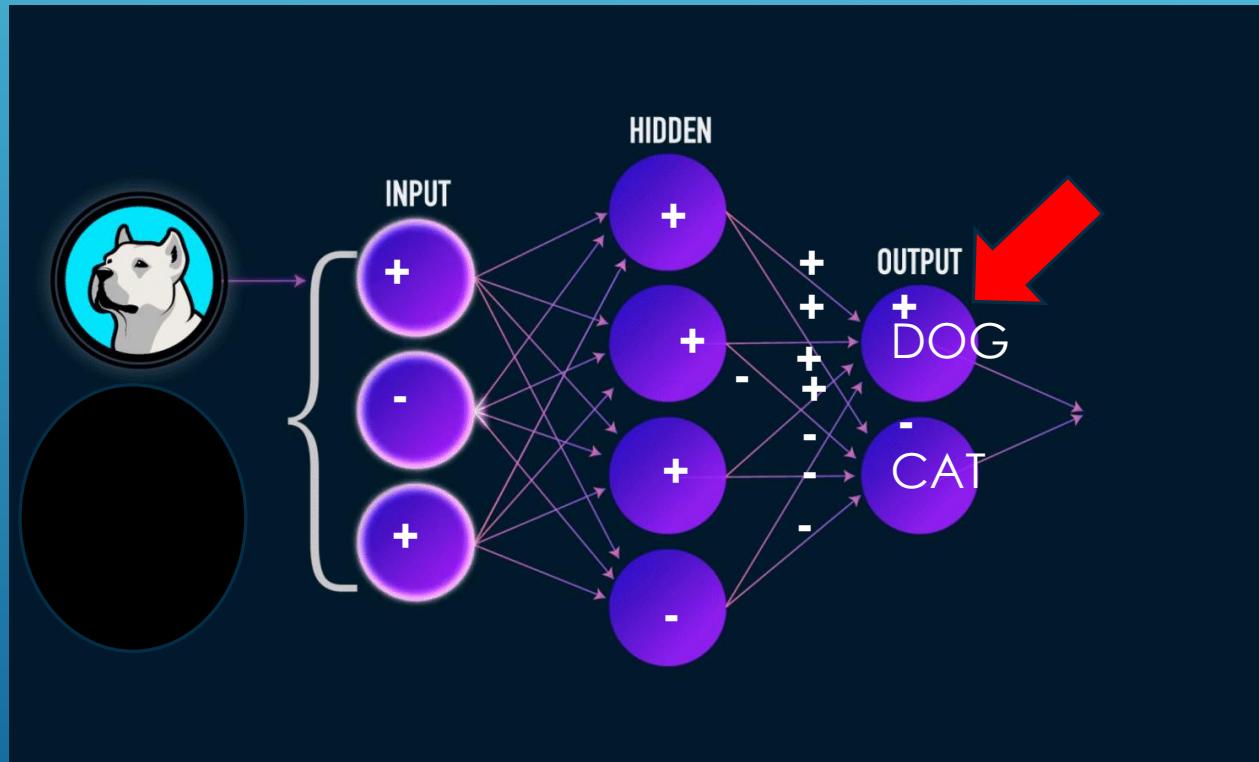
# CLASSIFICATION



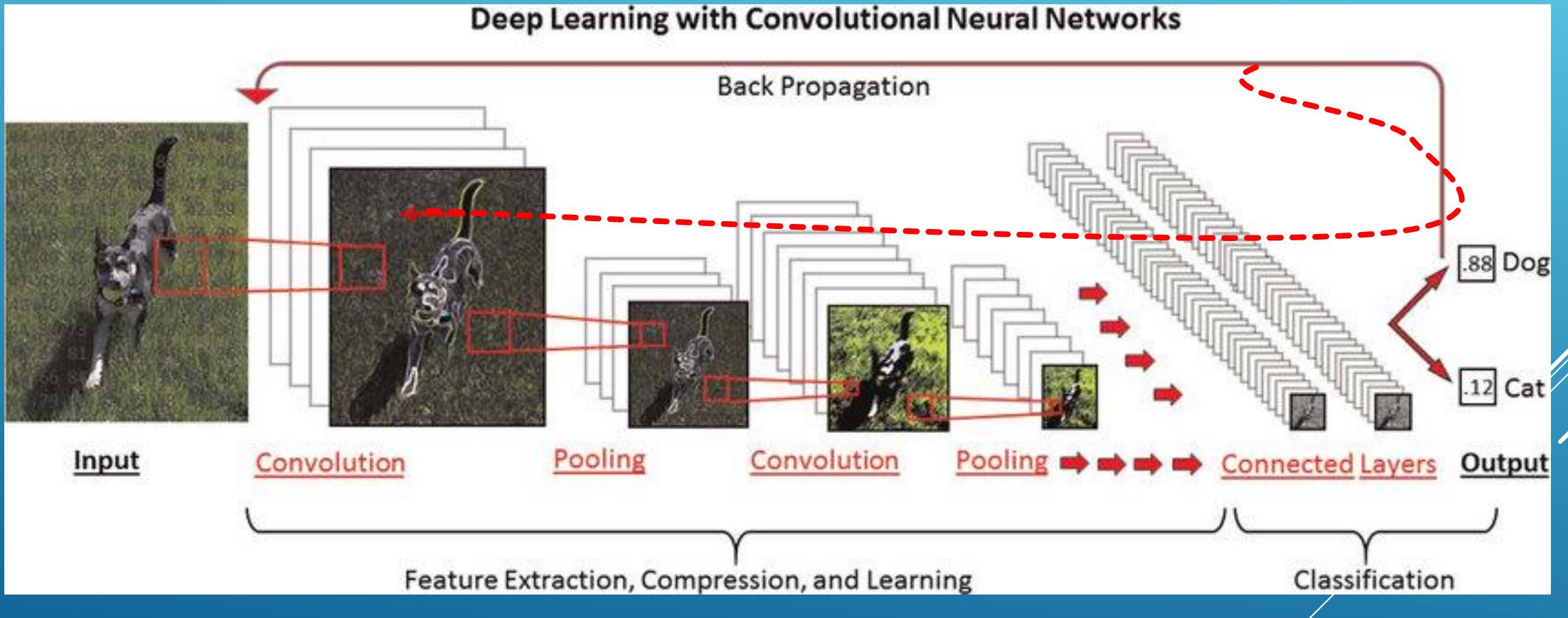
FOR THE PIXEL INPUTS OF THE DOG, STRONGER SYNAPSES GOING TO THE NEURONS FROM INPUT TO HIDDEN TO “DOG” OUTPUT



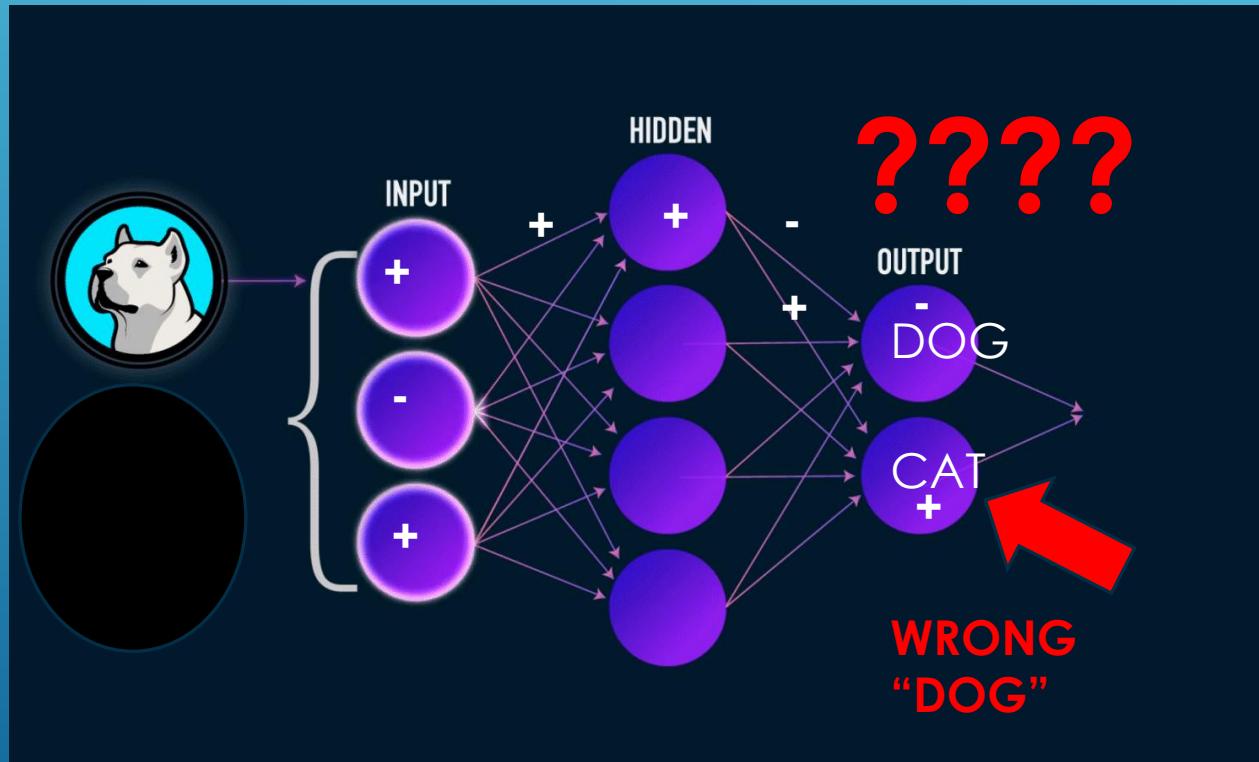
# HOW DID THE NEURAL NETWORK (“DEEP LEARNING NETWORK” IF MORE LAYERS) GET WIRED UP LIKE THIS TO GIVE US THIS ANSWER?



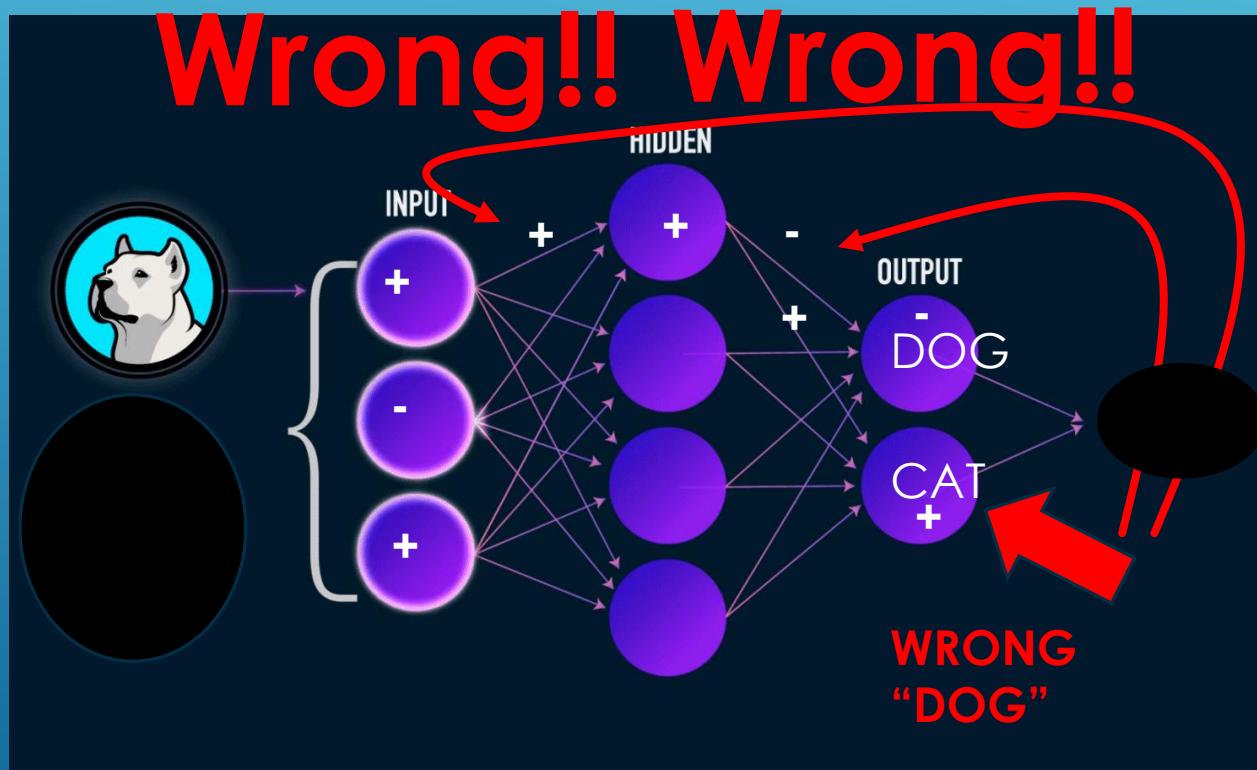
# DON'T HAVE TO BUILD THIS UP BY HAND (MASSIVE EFFORT, POOR RESULTS)



HOW TO FIX THIS AUTOMATICALLY?  
(WELL....SEMI-AUTOMATICALLY SINCE NEED HUMAN  
TO HAVE ALREADY FIGURED OUT THIS IS A DOG)

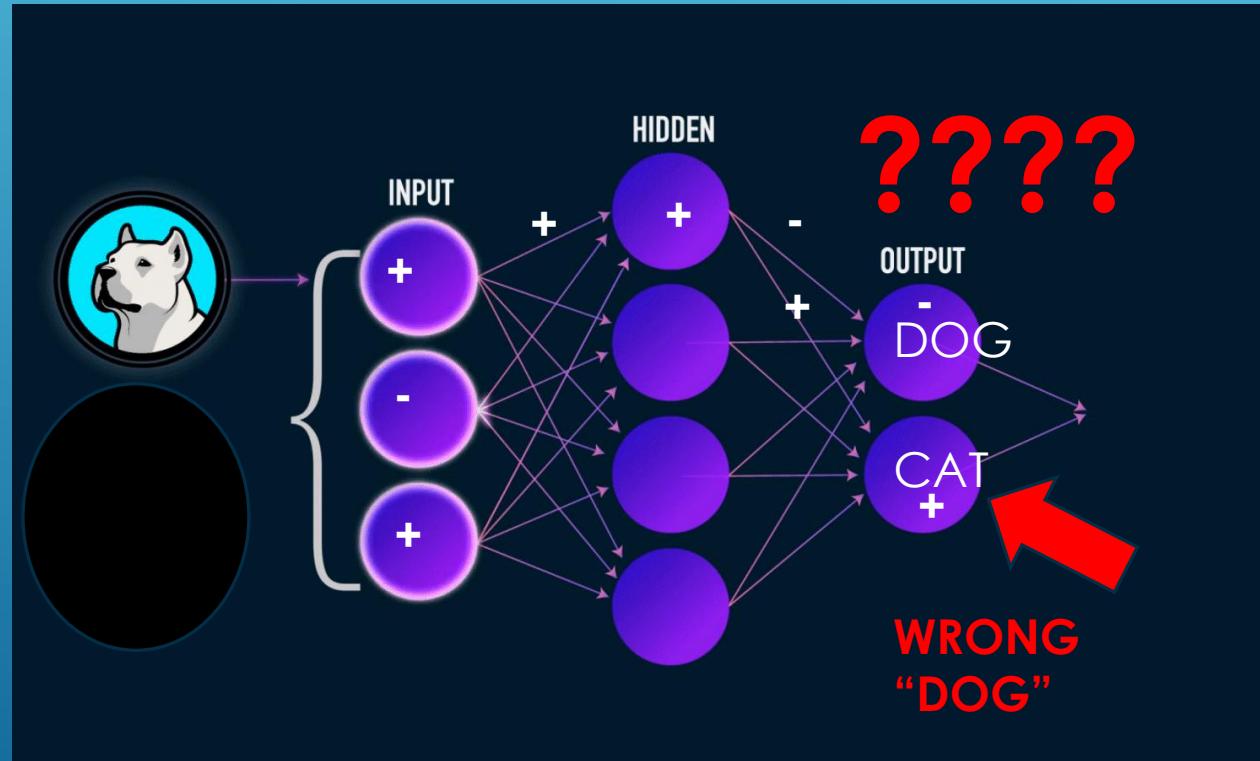


# FIX AUTOMATICALLY WITH FEEDBACK

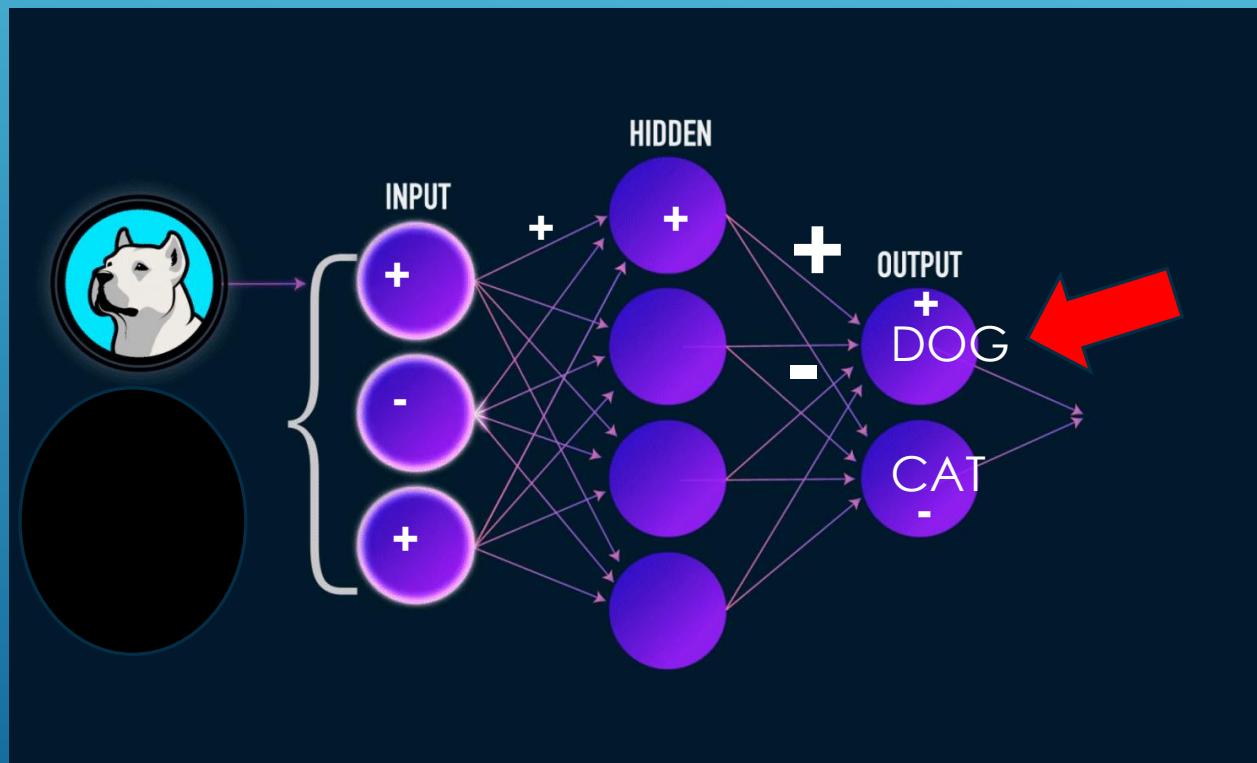


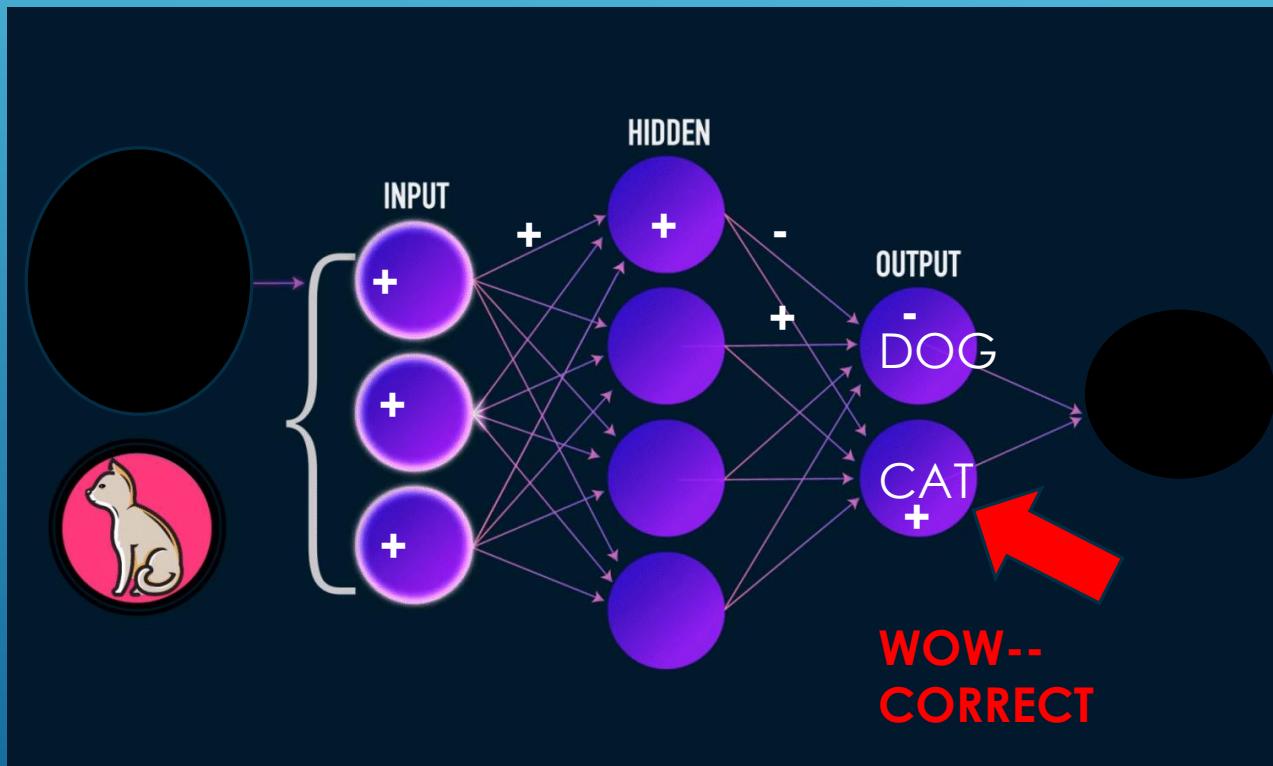
# Supervised Learning ("SL")

HOW TO FIX THIS AUTOMATICALLY?  
(WELL....SEMI-AUTOMATICALLY SINCE NEED HUMAN  
TO HAVE ALREADY FIGURED OUT THIS IS A DOG)

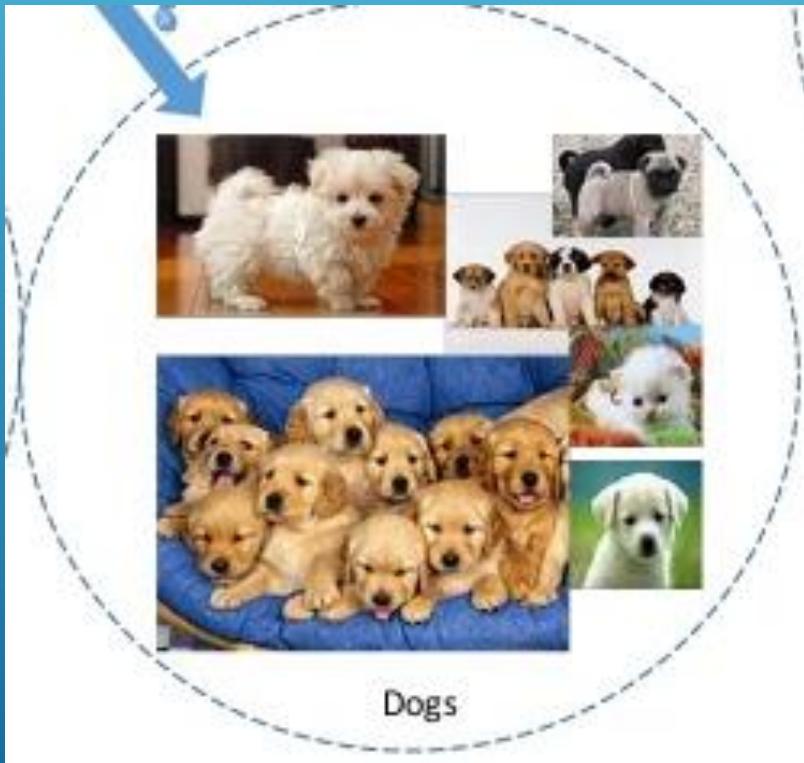


AFTER ENOUGH TRAINING CYCLES, THE NEURAL NETWORK CAN CLASSIFY AN IMAGE AS A DOG VERSUS CAT



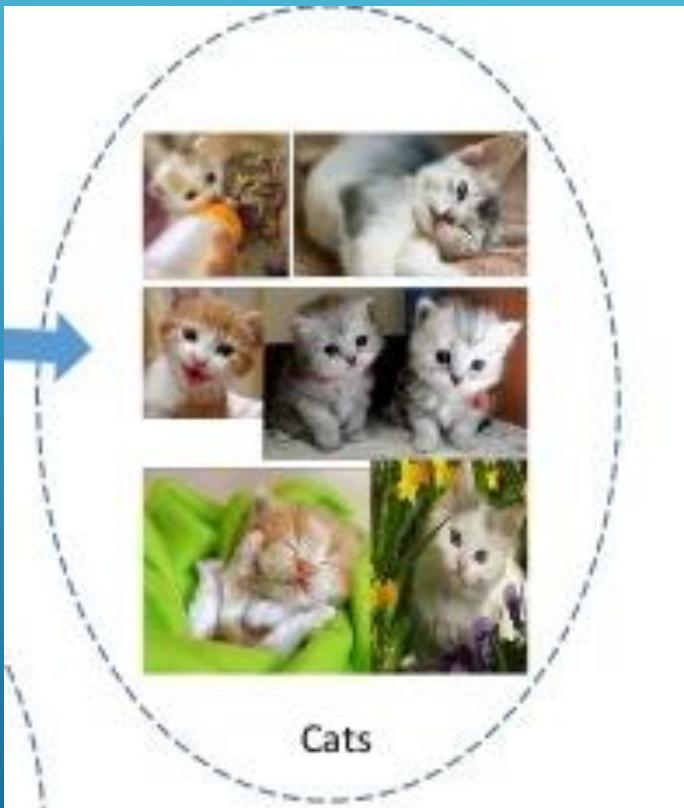


# WE TRAIN OUR NETWORK ON A VARIETY OF DIFFERENT DOGS



Pass in a file with pictures of many different types of dogs, and all these pictures are labeled “dog” so the neural network will know that the correct answer is to classify as a dog

# WE TRAIN OUR NETWORK ON A VARIETY OF DIFFERENT CATS



Pass in a file with pictures of many different types of cats, and all these pictures are labeled “cat” so the neural network will know that the correct answer is to classify as a cat

# BACKPROPAGATION

- 
1. FEEDFORWARD OPERATION – TRY OUT NEURAL NETWORK AND SEE ERROR IT PRODUCES IN OUTPUT
  2. BACKPROPAGATION OPERATION – ADJUST WEIGHTS IN RESPONSE TO ERROR

OVER AND OVER AGAIN (VERY FAST COMPUTER)



ONCE YOU ARE SATISFIED WITH TRAINING, STOP AND YOU HAVE A NEURAL NETWORK THAT WORKS WELL

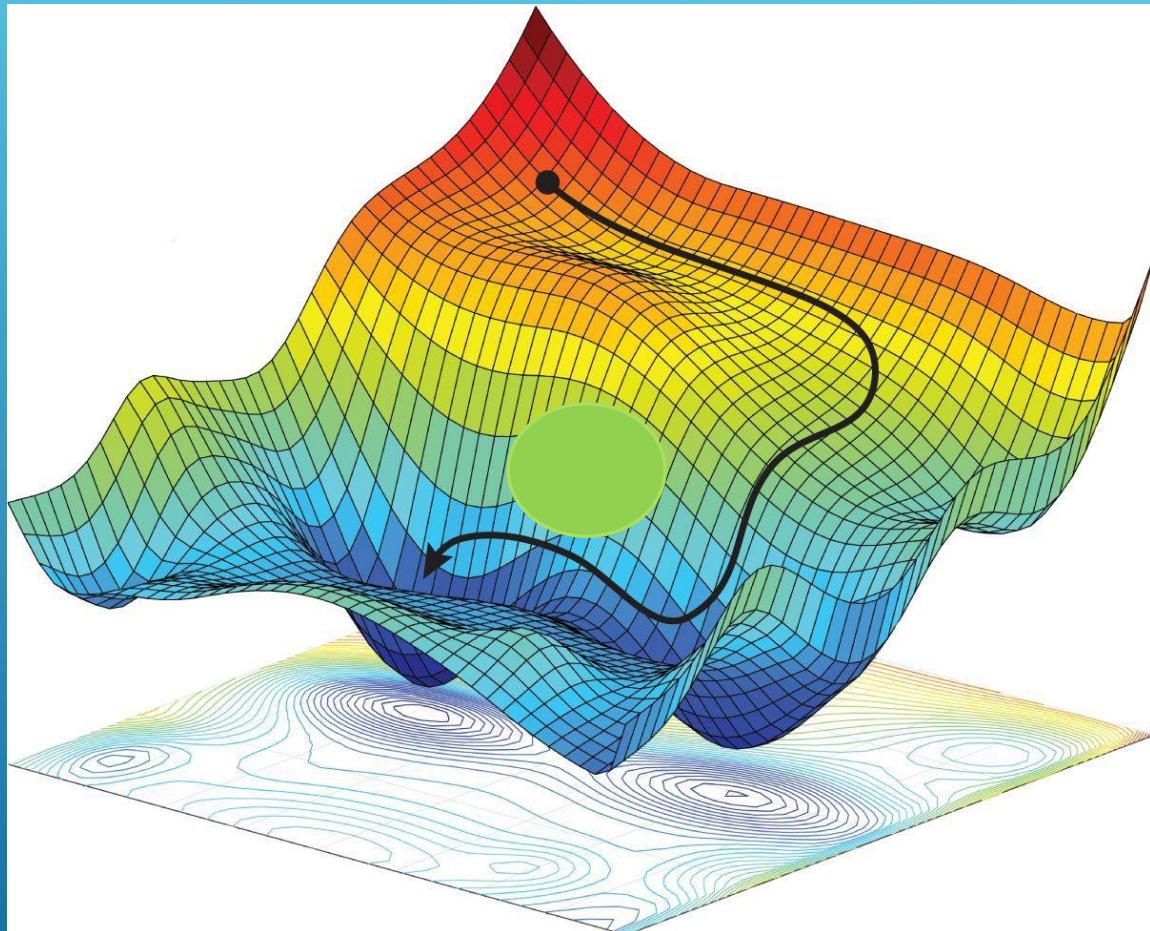
# STOCHASTIC GRADIENT DESCENT (SGD)

'Stochastic' – single random sample each iteration

'Gradient' – slope of a function (partial derivatives of set of parameters)

'Gradient Descent' – iterative optimization method

Can apply to 1000's of dimensions, not just 3-D shown in figure



# WE CAN COMPUTE GRADIENT FOR 2D, 3D, 4D OR EVEN 1000 DIMENSIONS

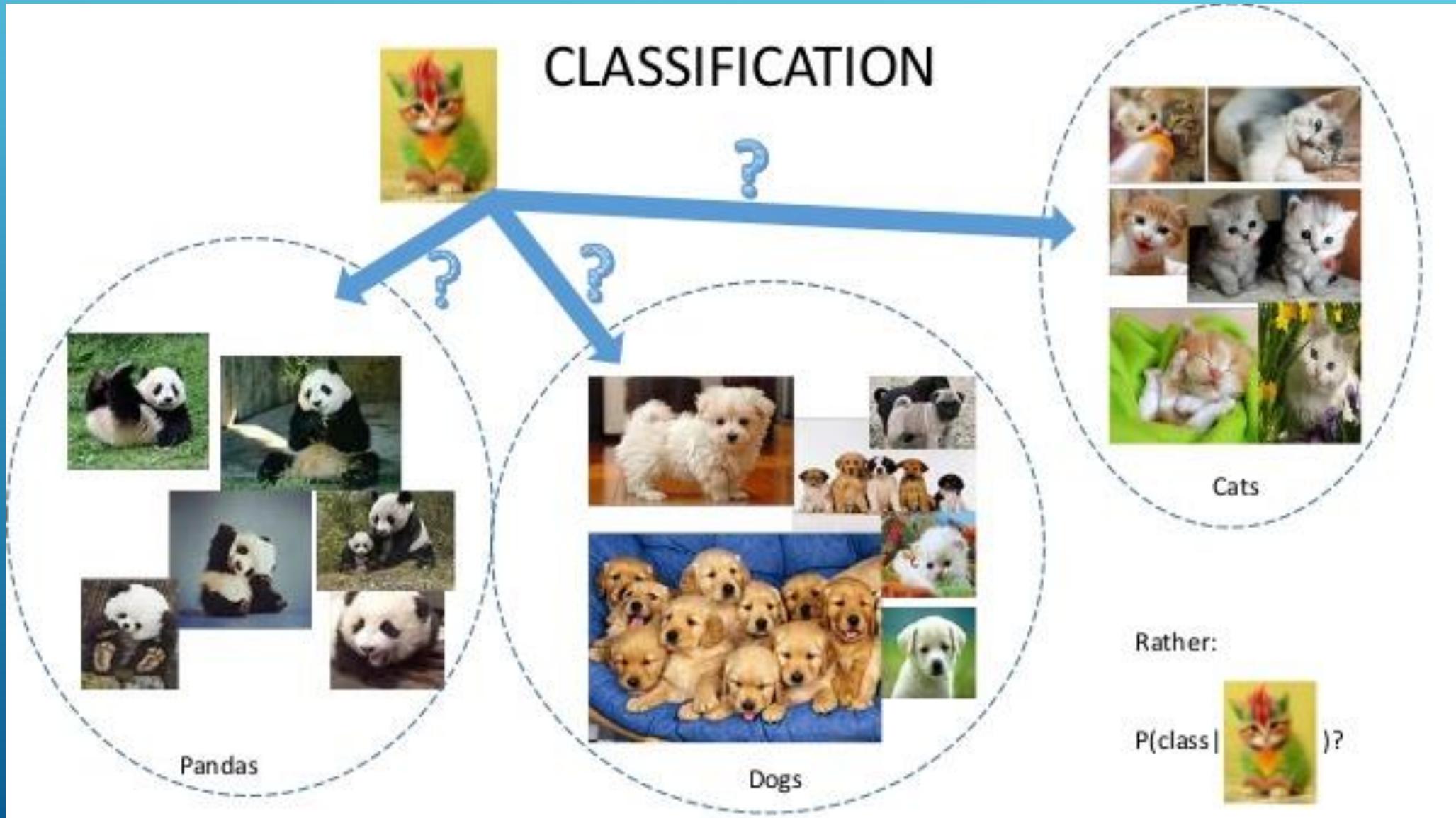
Scalar-valued multivariable function

$$\nabla f(\underbrace{x_0, y_0, \dots}_{\nabla f \text{ takes the same type of inputs as } f}) =$$

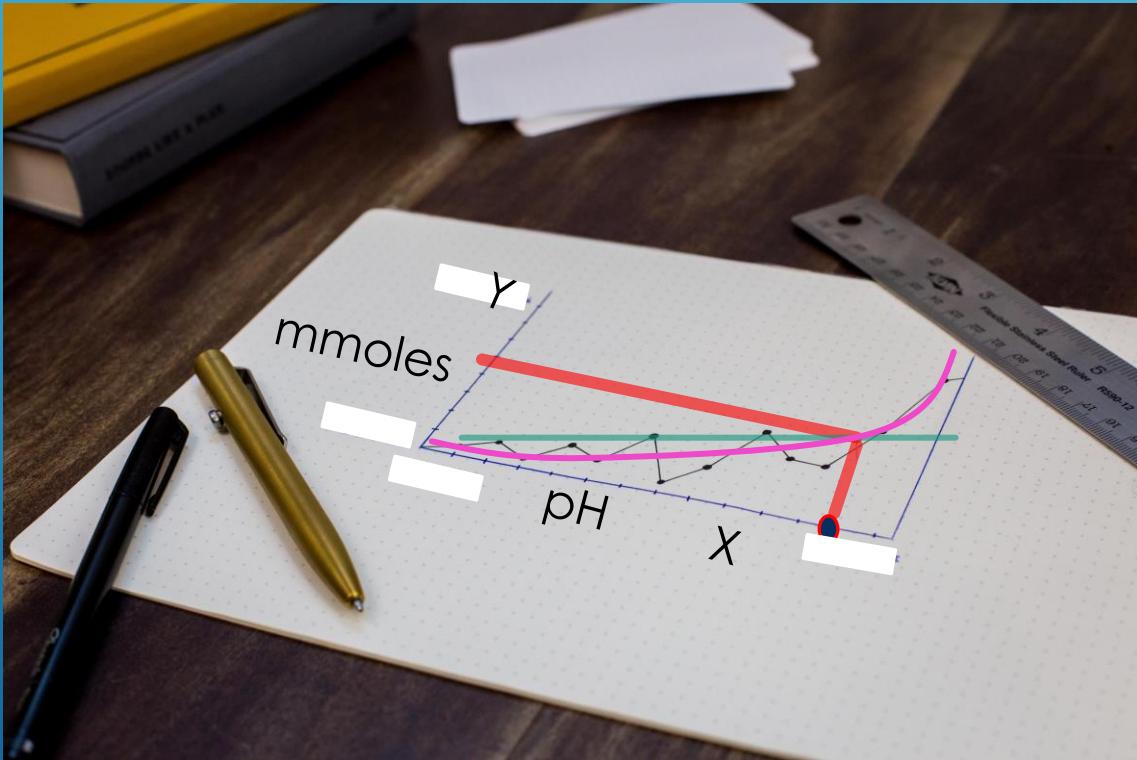
Notation for gradient, called “nabla”.

$$\left[ \begin{array}{c} \frac{\partial f}{\partial x}(x_0, y_0, \dots) \\ \frac{\partial f}{\partial y}(x_0, y_0, \dots) \\ \vdots \\ \nabla f \text{ outputs a vector with all possible partial derivatives of } f. \end{array} \right]$$

# NEURAL NETWORK CAN CLASSIFY THIS CAT IT HAS NEVER SEEN BEFORE IN TRAINING

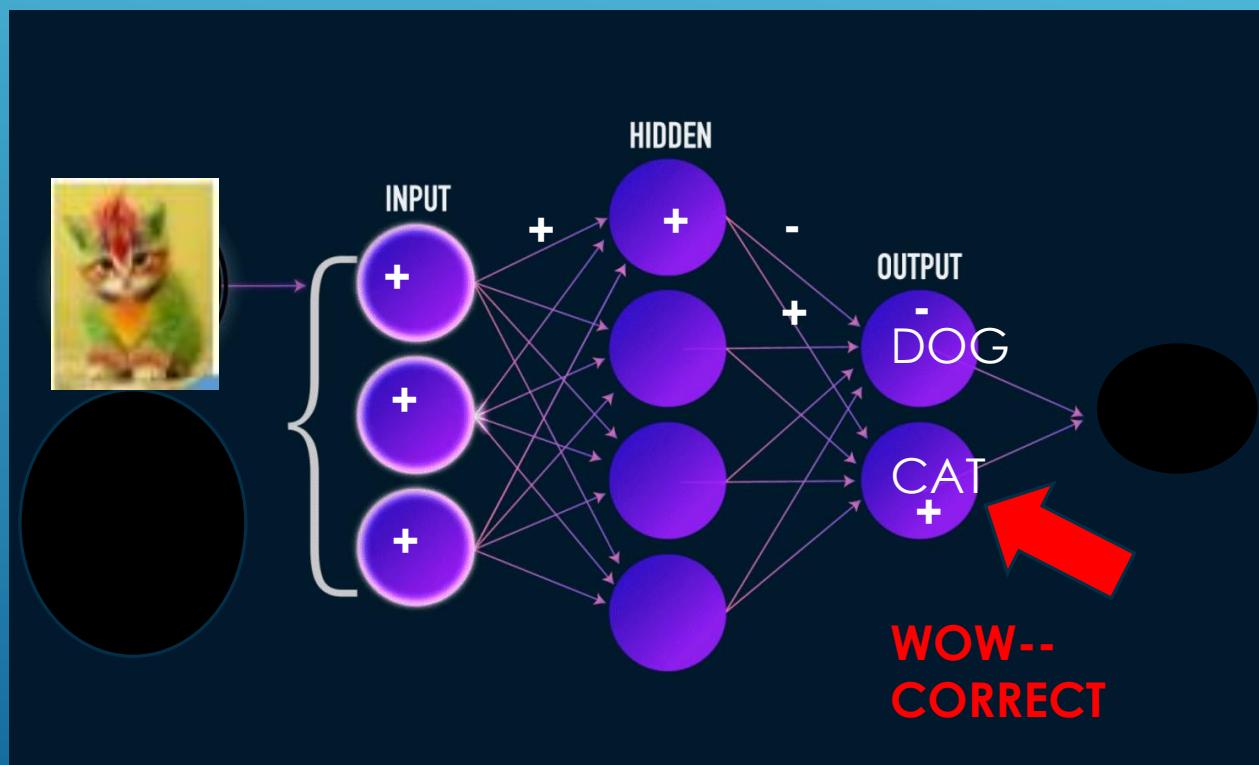


YOU WERE ABLE TO CLASSIFY A DATA POINT YOU NEVER SAW BEFORE ALSO ON YOUR GRAPH



New X value never seen before, you can predict the Y value

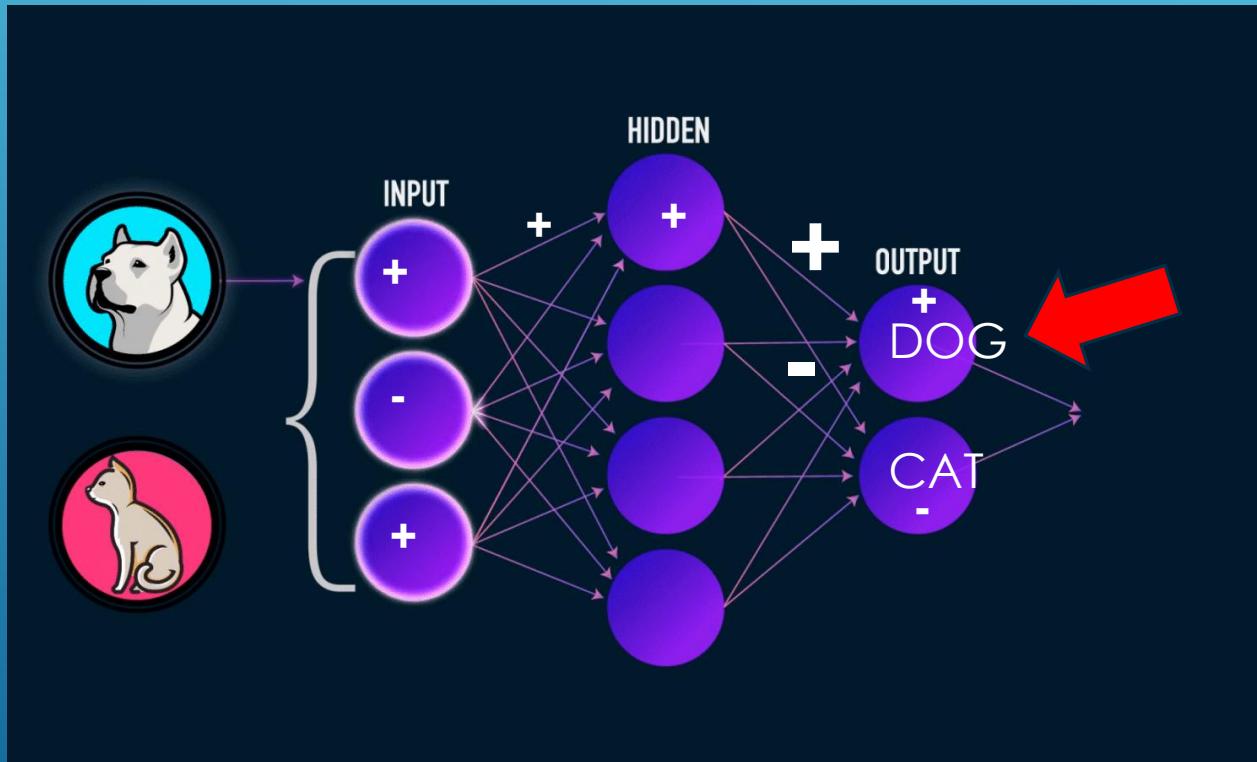
THE WEIGHTS OF THE NEURAL NETWORK HAVE BEEN TRAINED (AUTOMATICALLY!!) SO THAT WHEN YOU IT LOOKS AT THIS IMAGE, IT IDENTIFIES IT CORRECTLY AS A CAT

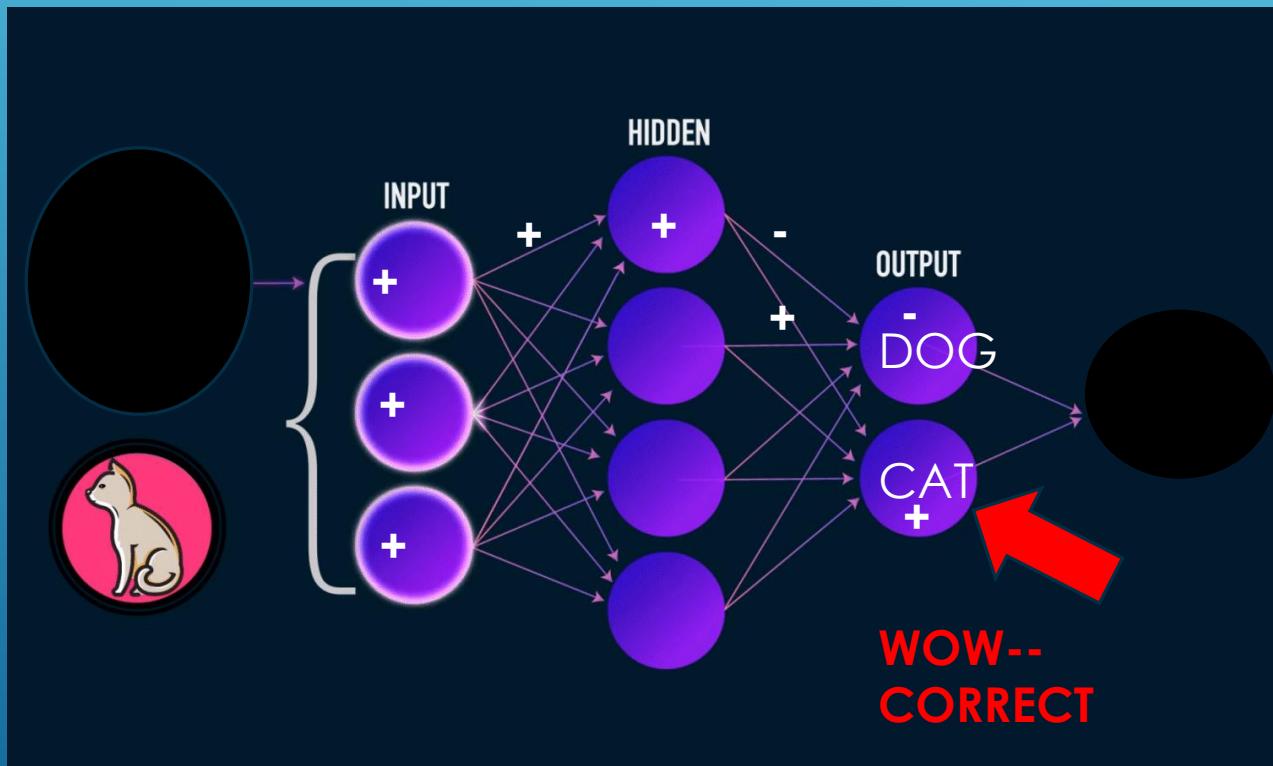


A wide-angle photograph of a tropical beach at sunset. The sky is filled with large, billowing clouds colored in shades of orange, yellow, and blue. The ocean waves are a vibrant turquoise color, crashing onto the light-colored sand. In the distance, a line of palm trees and some low buildings are visible on the horizon.

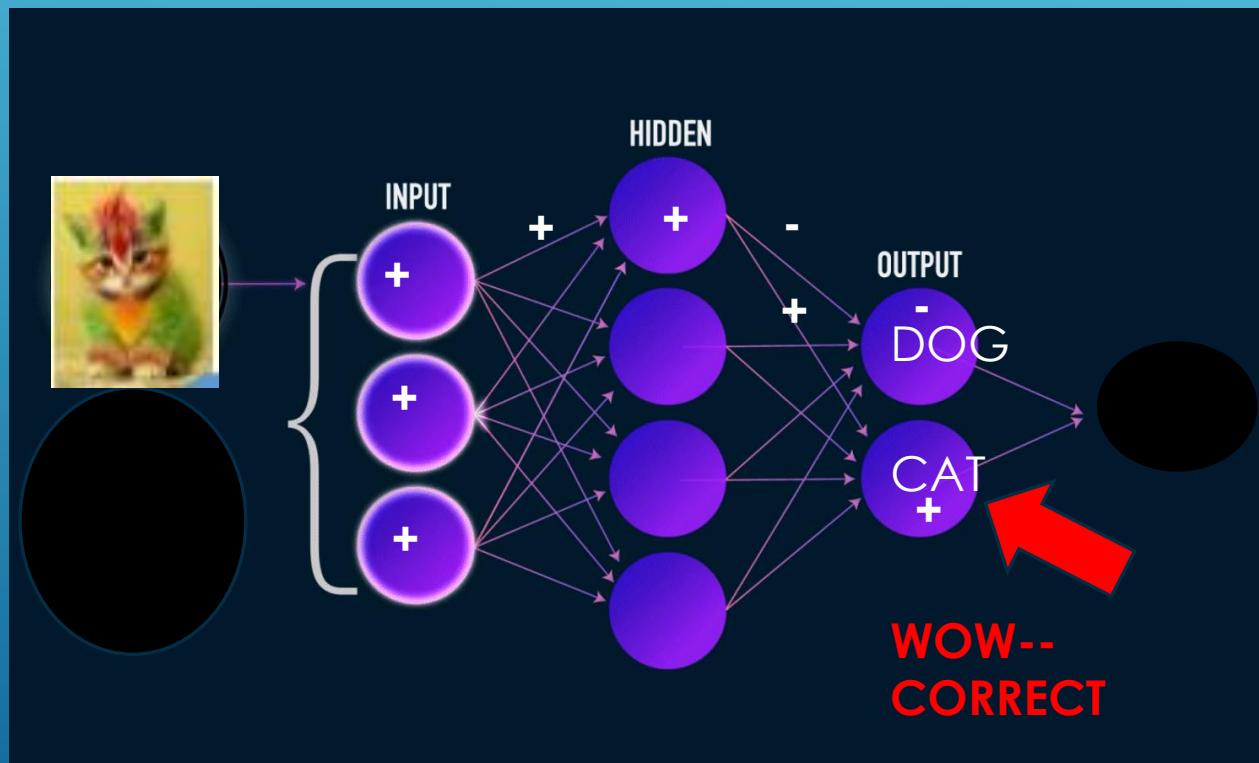
Let's pause, and think about the concepts we just reviewed.....

# OUR NEURAL NETWORK CAN RECOGNIZE DOGS FROM CATS.....

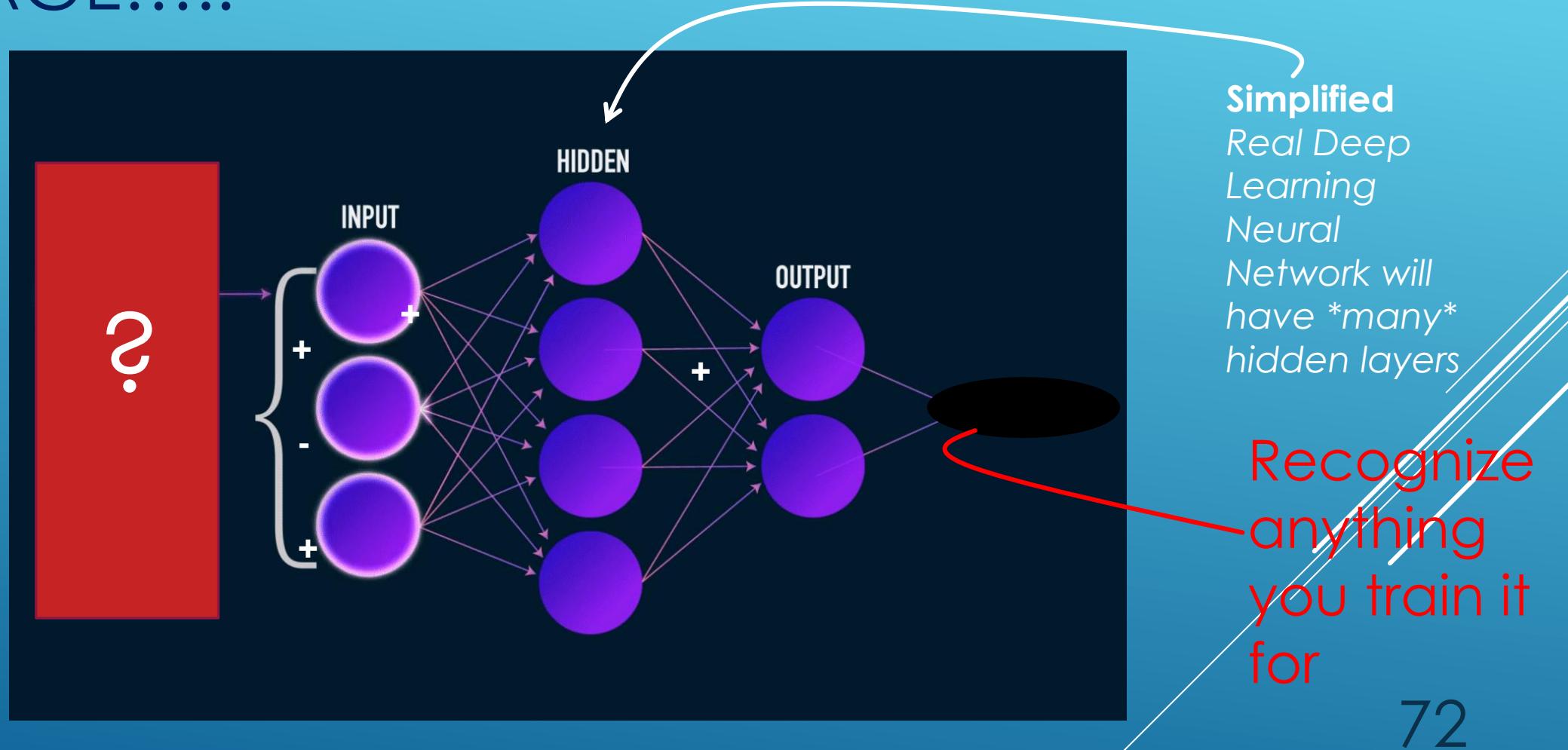




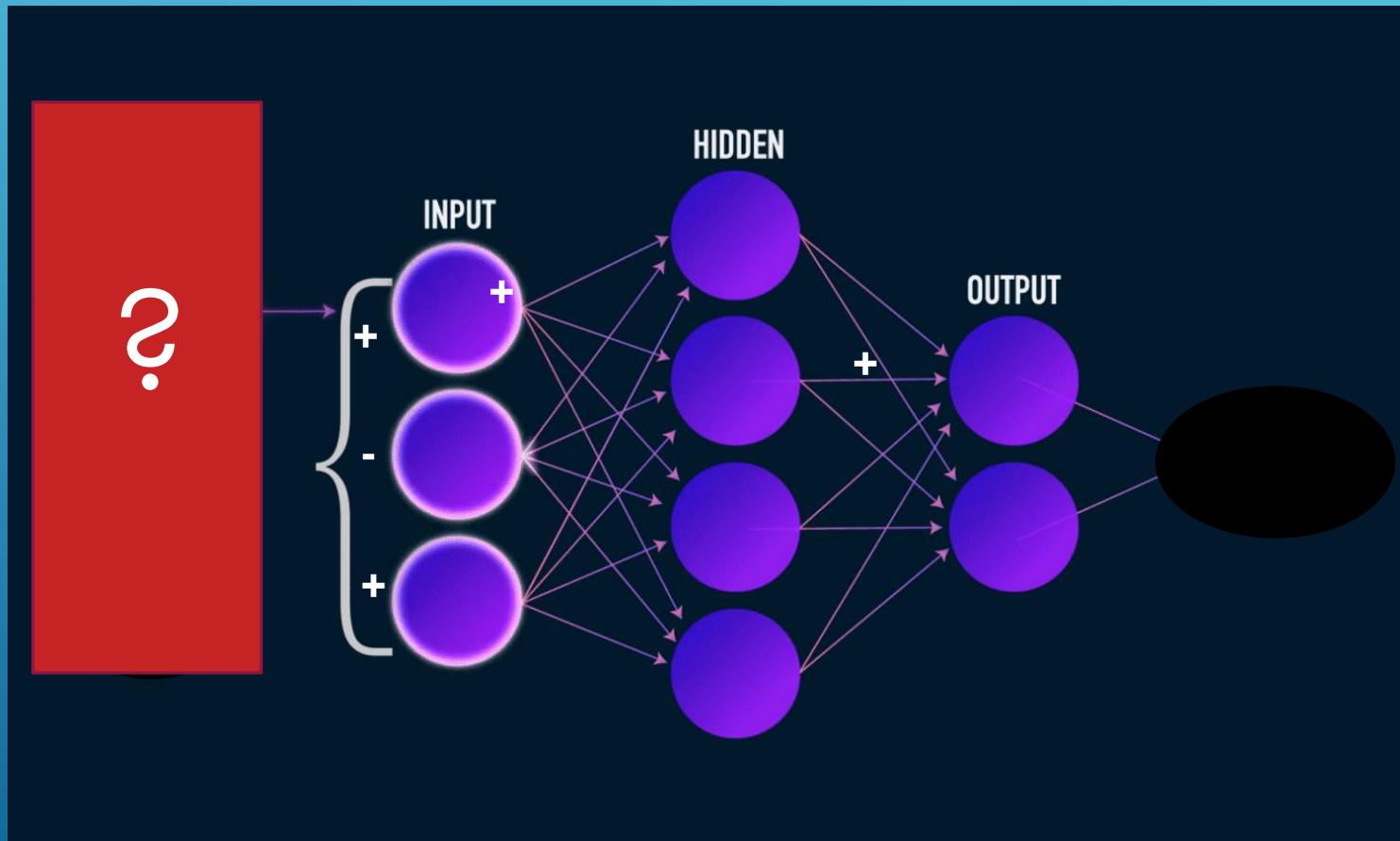
THE WEIGHTS OF THE NEURAL NETWORK HAVE BEEN TRAINED (AUTOMATICALLY!!) SO THAT WHEN YOU IT LOOKS AT THIS IMAGE, IT IDENTIFIES IT CORRECTLY AS A CAT



# OR IT CAN RECOGNIZE AND CLASSIFY JUST ABOUT ANY IMAGE.....

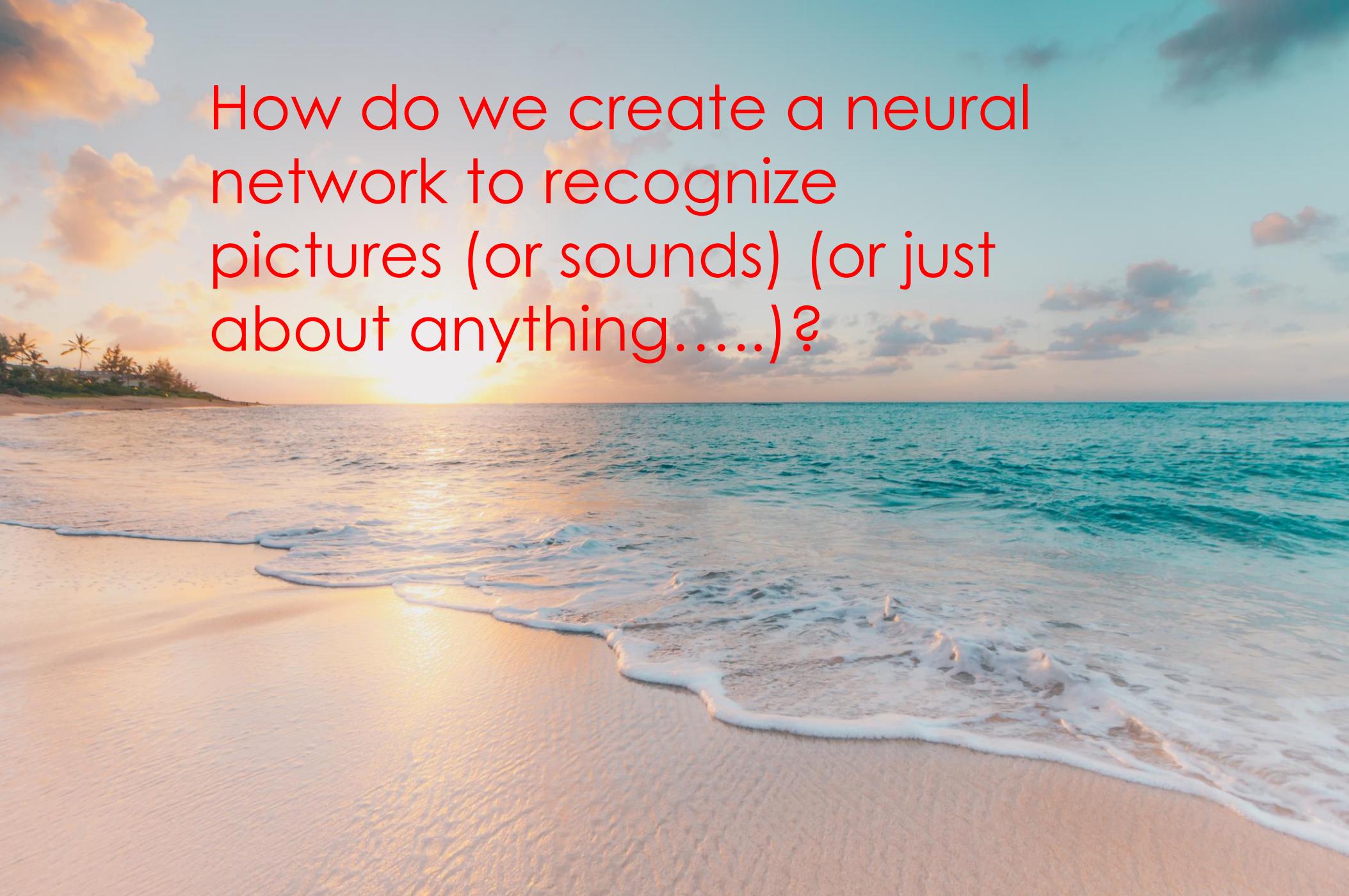


WITH SMALL CHANGES TO THE WAY WE ORGANIZE THE LAYERS, THE NEURAL NETWORK CAN CLASSIFY SOUNDS AND SPEECH AND.... ALMOST ANYTHING



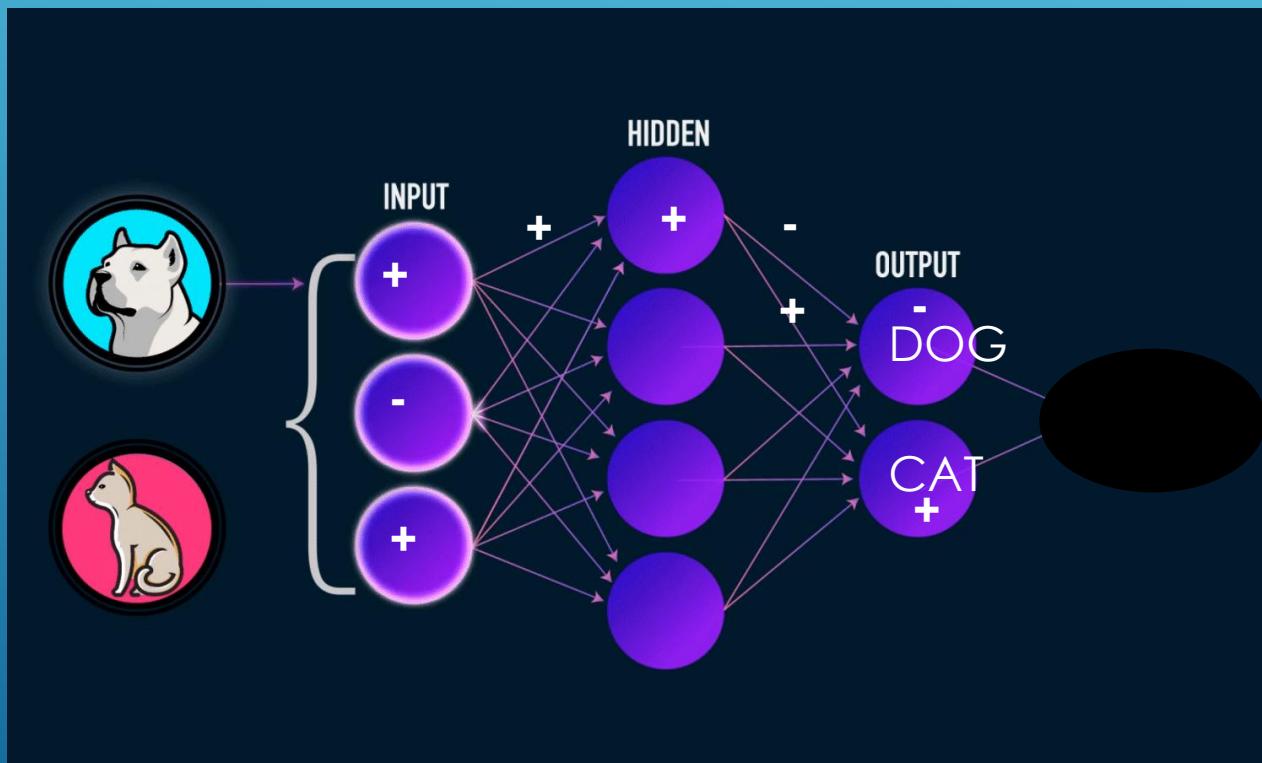
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A photograph of a tropical beach at sunset. The sky is filled with warm, orange and yellow clouds. The ocean waves are crashing onto the light-colored sand. In the distance, there are some palm trees and greenery on the left side.

How do we create a neural network to recognize pictures (or sounds) (or just about anything.....)?

# 1. TAKE A NEW NEURAL NETWORK (RANDOM WEIGHTS ON THE SYNAPSES.... )

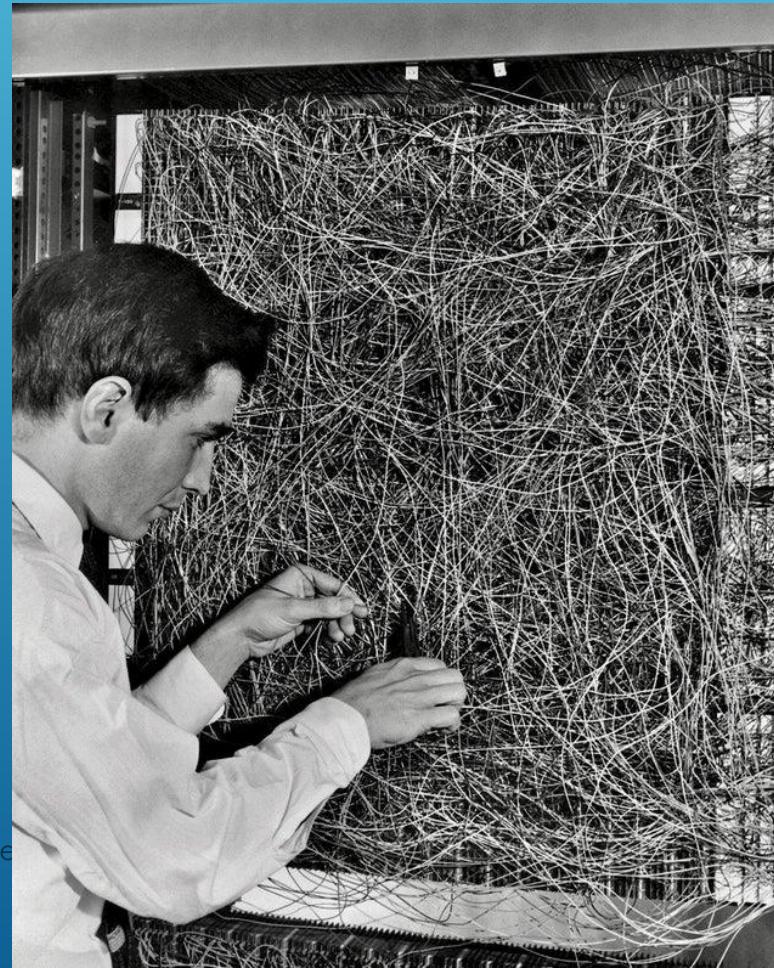


1980's

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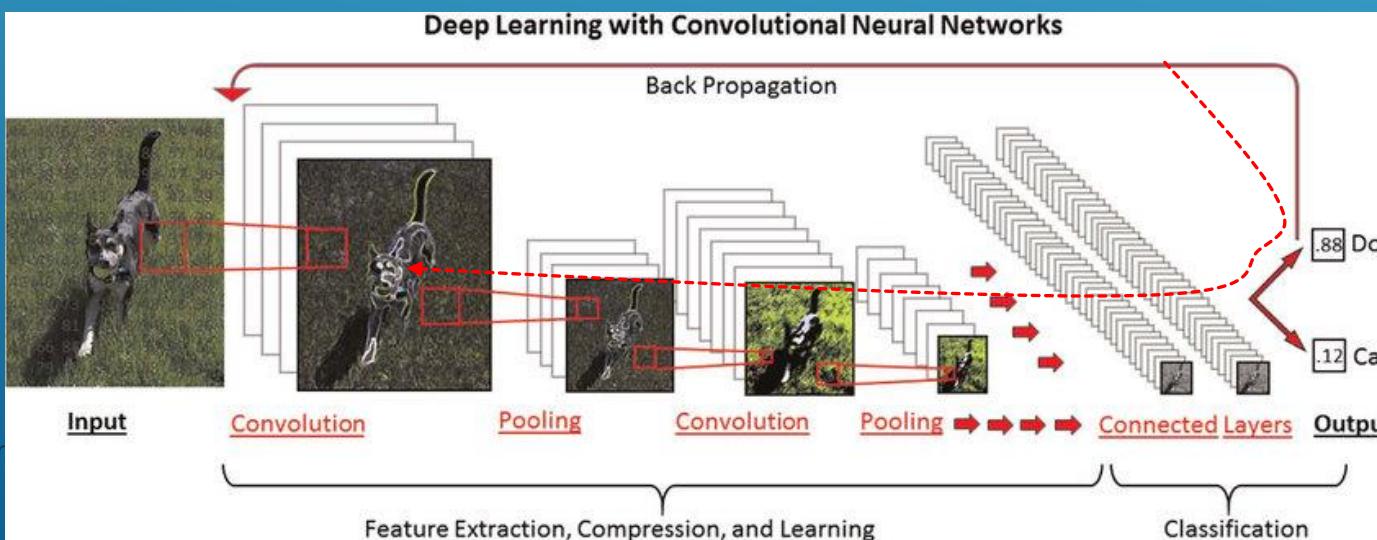
Actually first neural networks were being built in late 1950s  
(Frank Rosenblatt's Perceptron at Cornell)



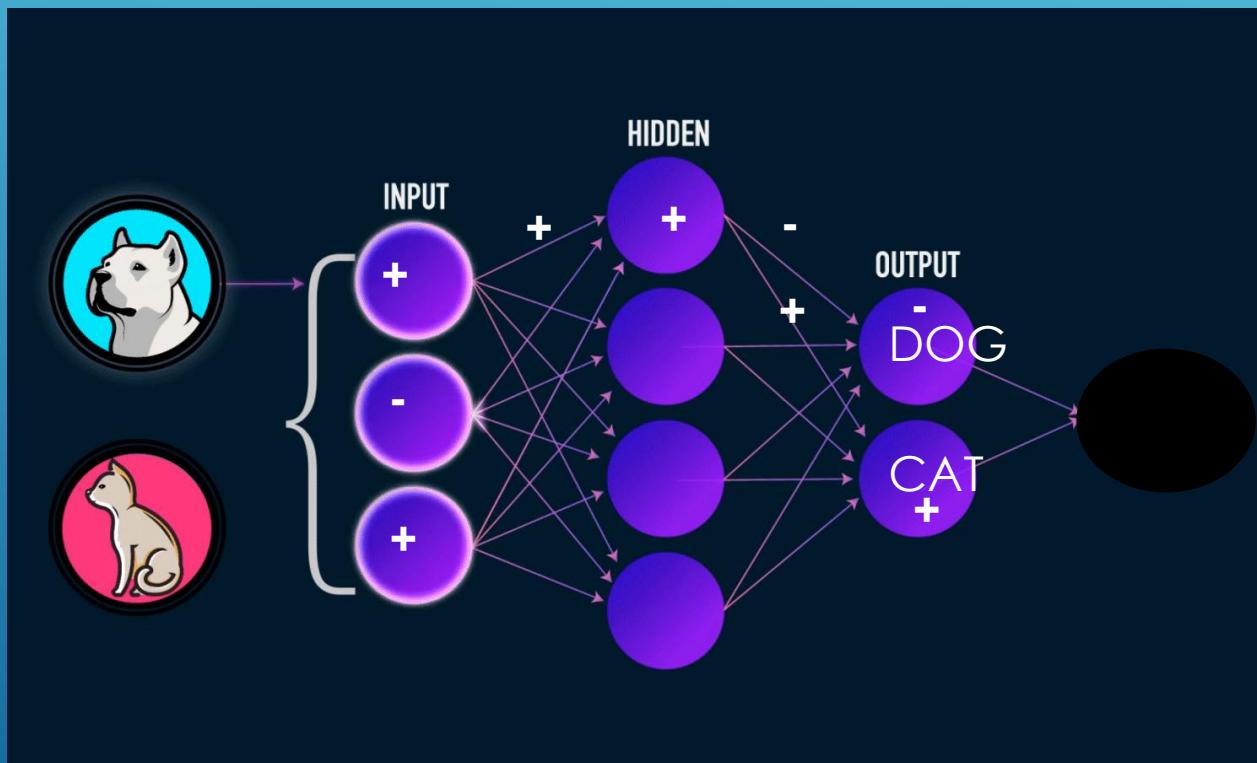
G\*\*

# NOW WE DON'T ACTUALLY BUILD NEURAL NETWORKS OUT OF TRANSISTORS OR NEURONS, BUT RUN SIMULATIONS ON A COMPUTER

- “COMPUTER” == 1000’S OF COMPUTERS WITH GPU’S/TPU’S IN CLOUD
- WE CAN HAVE THOUSANDS (OR MORE) OF INPUT FEATURES
- WEIGHTS OF MILLIONS AND MILLIONS (OR MORE) OF SYNAPSES ARE CALCULATED BY THE SOFTWARE DURING TRAINING



# 1. TAKE A NEW NEURAL NETWORK (RANDOM WEIGHTS ON THE SYNAPSES.... )



1980's

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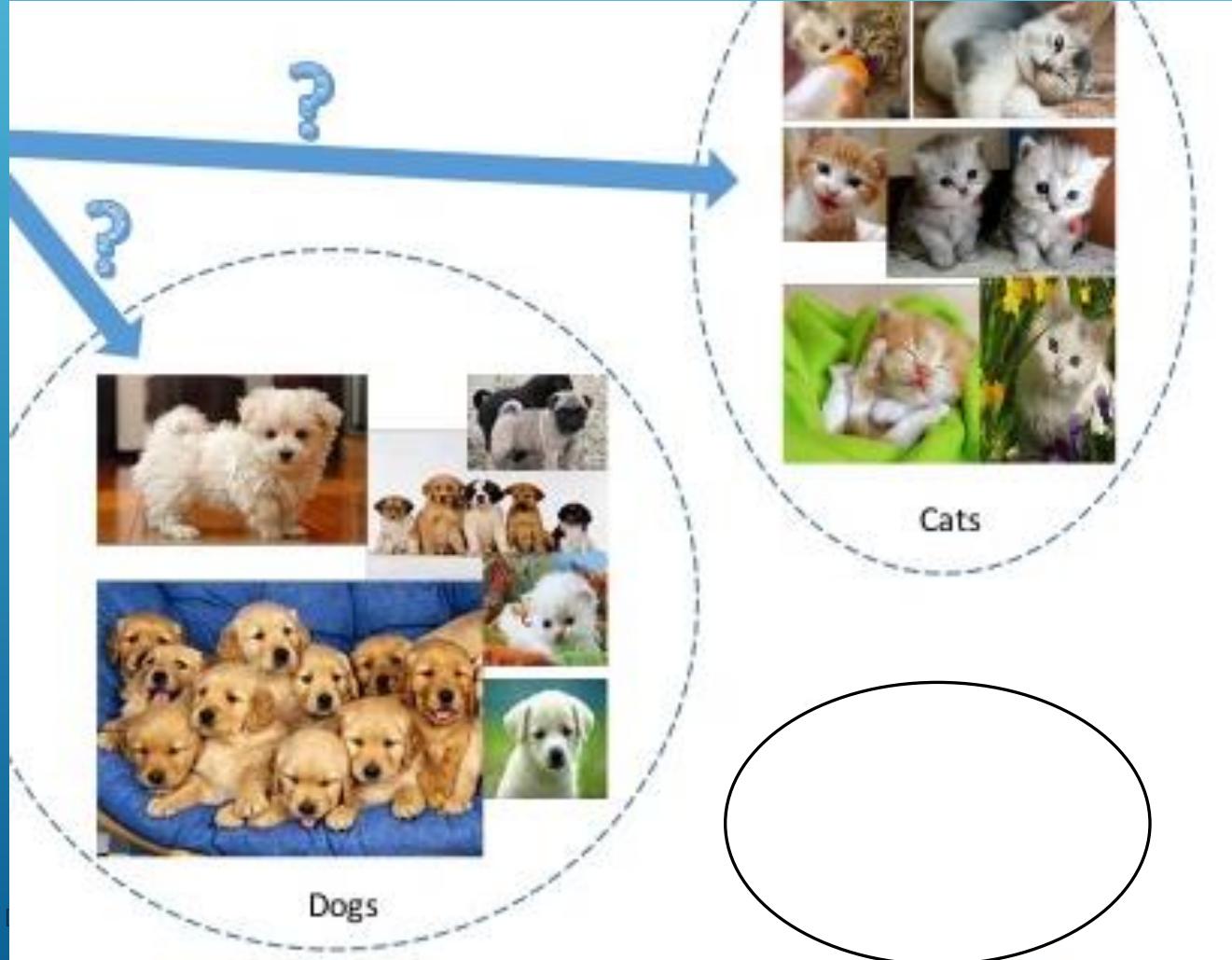
## 2. GET A COMPUTER FAST ENOUGH TO DO TRILLIONS AND TRILLIONS AND TRILLIONS OF OPERATIONS AND CALCULATIONS



'COMPUTE'  
2010'S

(noun; from AWS; means  
amount of computation  
power/resources)

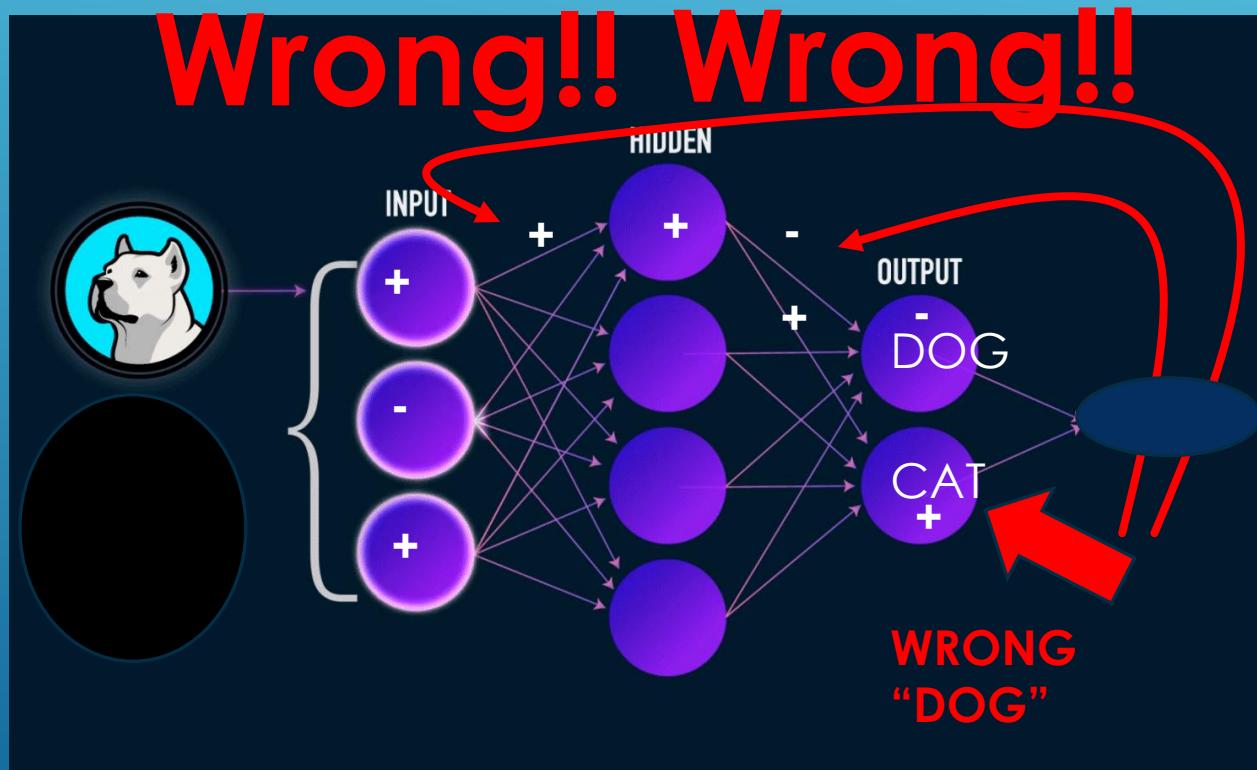
### 3. GET LOTS AND LOTS OF TRAINING DATA (ACTUALLY – THOUSANDS OR MILLIONS OF IMAGES!!)



'BIG DATA'  
2000'S

DING\*\*

## 4. FEED DATA INTO THE NETWORK & SEE ERRORS 'BACKPROPAGATION' – USE FEEDBACK TO AUTOMATICALLY ADJUST SYNAPSES TO REDUCE ERRORS

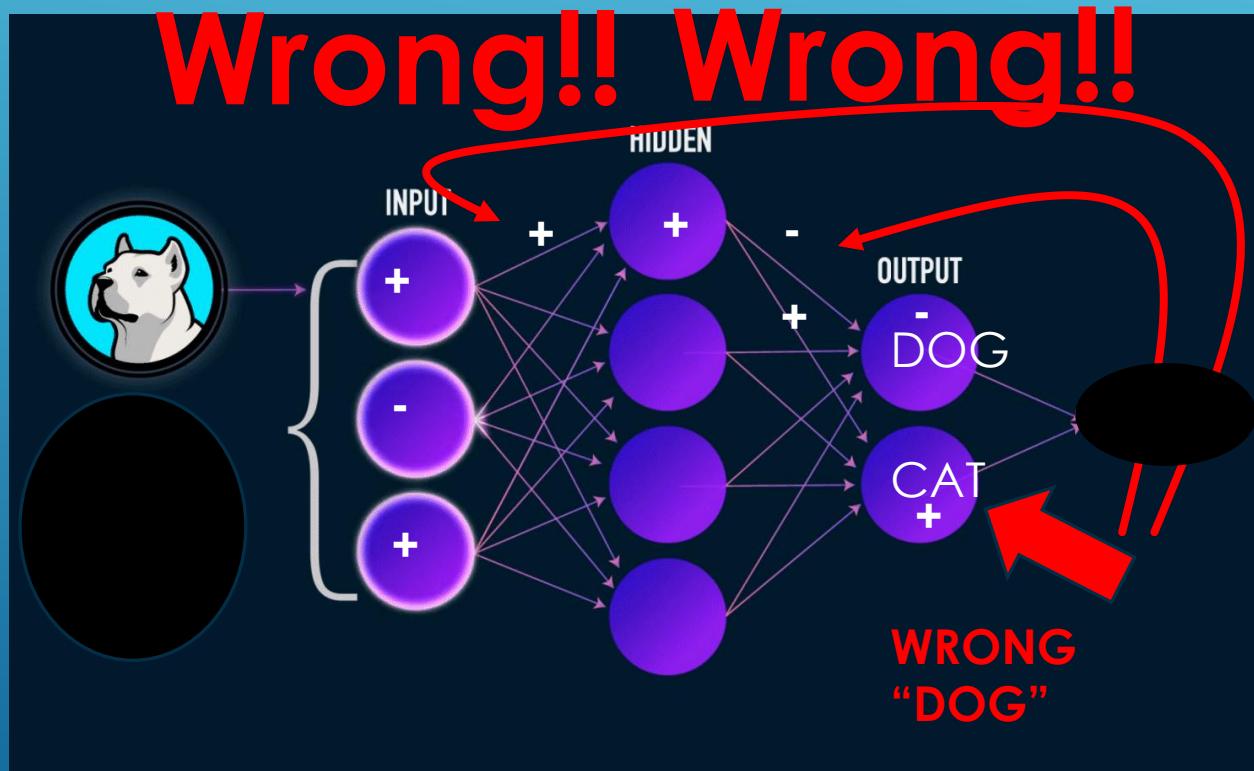


# 5. REPEAT #4

82

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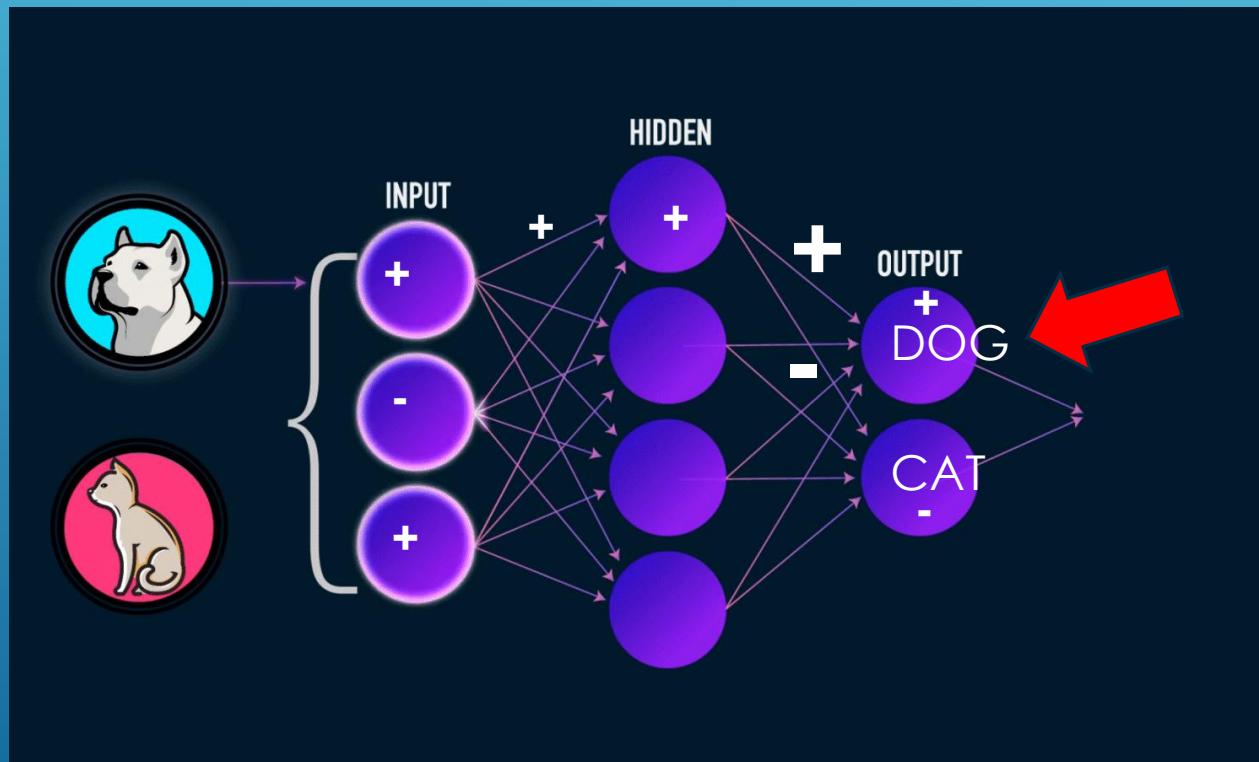
## 4. FEED DATA INTO THE NETWORK 'BACKPROPAGATION' – USE FEEDBACK TO AUTOMATICALLY ADJUST SYNAPSES



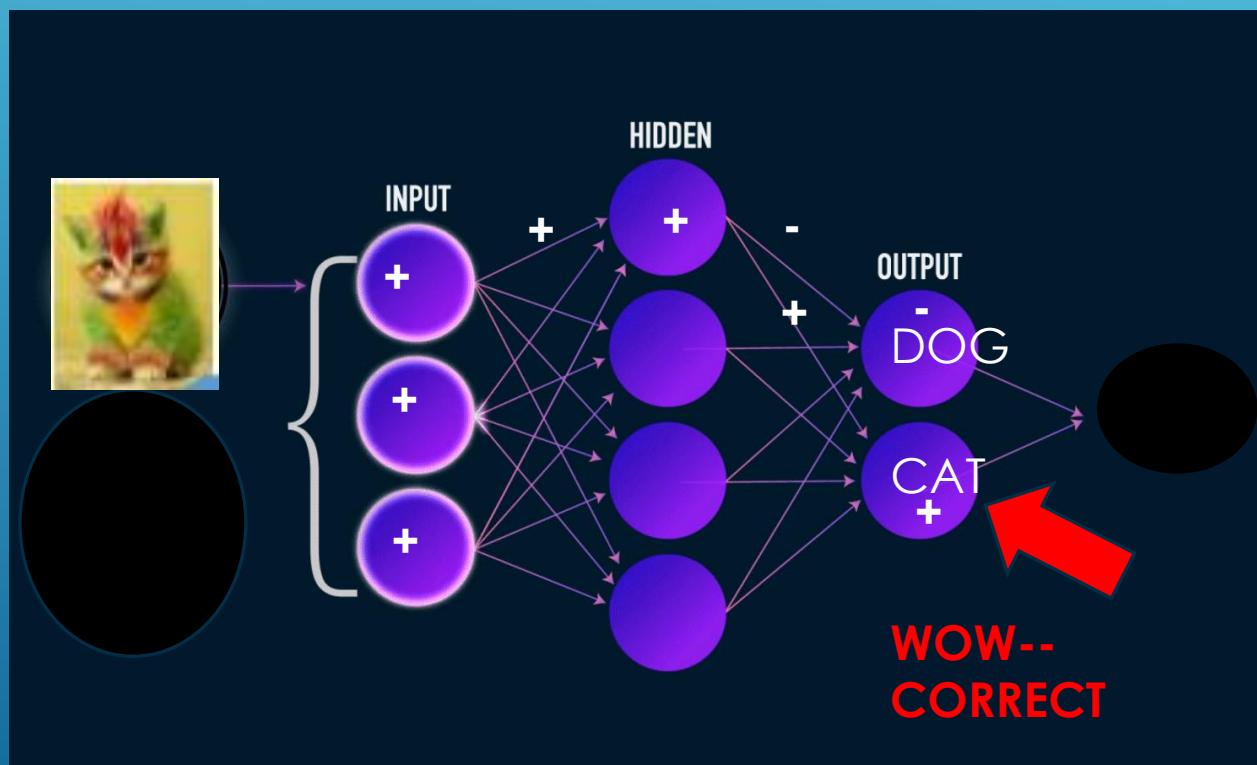
# 5. REPEAT #4

(OVER AND OVER AND OVER AGAIN....)

## 6. WHEN NEURAL NETWORK SEEKS ACCURATE ENOUGH TO RECOGNIZE VARIOUS DIFFERENT DOGS AND CATS – TRAINING IS COMPLETE



# 7. USE NEURAL NETWORK TO RECOGNIZE ALL SORTS OF CATS AND DOGS



CAN DO SAME THING AND MAKE NEURAL NETWORK TO  
RECOGNIZE FACES.... OR SPEECH.... OR SCIENTIFIC DATA....  
OR CT IMAGES.....OR PATHOLOGY SLIDES....



**NEW TOPIC**

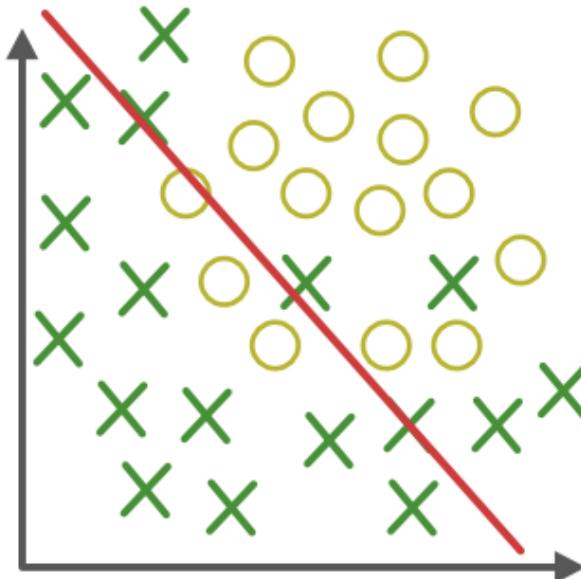
# USING DEEP LEARNING IN THE REAL WORLD

88

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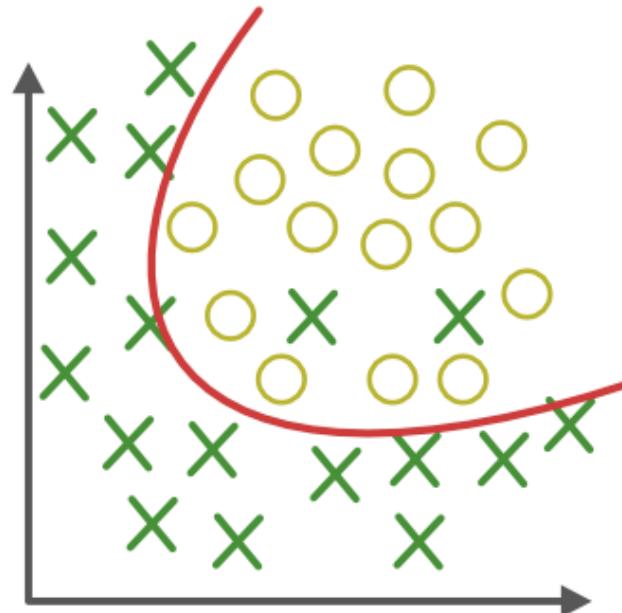
DEEP LEARNING EXPERTS SPEND MUCH TIME ON  
'ALCHEMY' – TWEAKING THIS AND TWEAKING THAT  
– TRYING TO AVOID OVERFITTING AND AVOID  
UNDERFITTING...



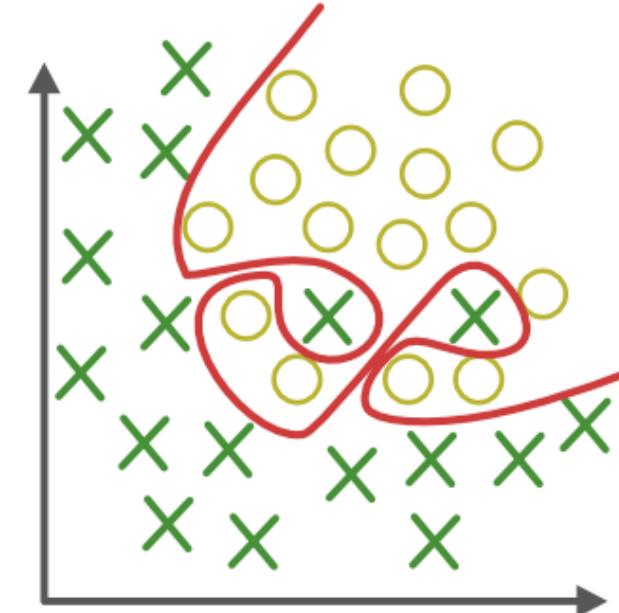


**Under-fitting**

(too simple to explain the variance)



**Appropriate-fitting**



**Over-fitting**

(forcefitting--too good to be true)

DG

High “Bias”  
→ inaccurate predictions

High “Variance”  
→ inaccurate predictions

# TOOLS TO LET USERS EASILY CREATE AND USE NEURAL NETWORKS



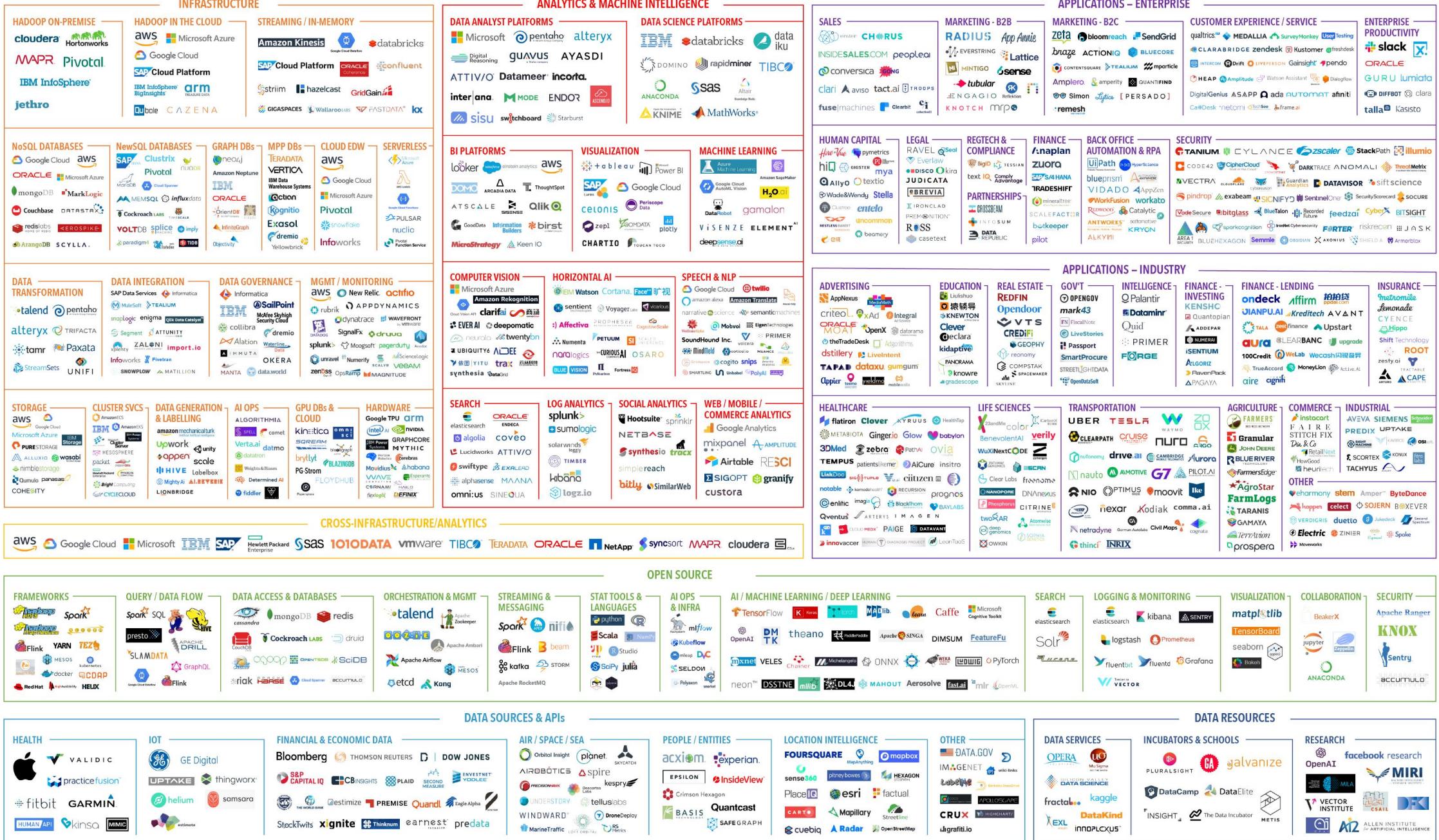
*Software to  
create your  
Deep  
Learning  
Neural  
Network*



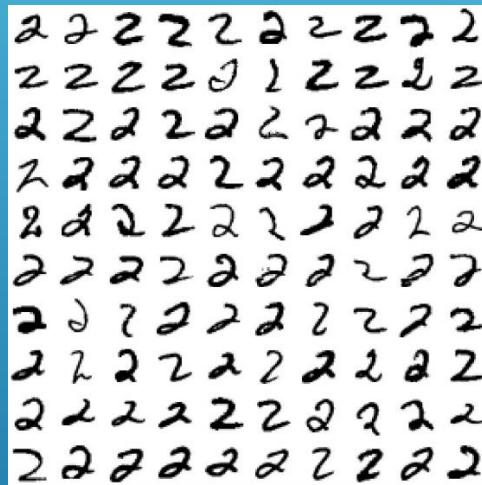
*'COMPUTE' to train and  
run your Deep Learning  
Neural Network*

# Too many tools??

DATA & AI LANDSCAPE 2019



# YOU CAN EVEN GET OTHER PEOPLE'S "BIG DATA" TO TRAIN NEURAL NETWORK (IF YOU DON'T HAVE YOUR OWN TRAINING DATA)



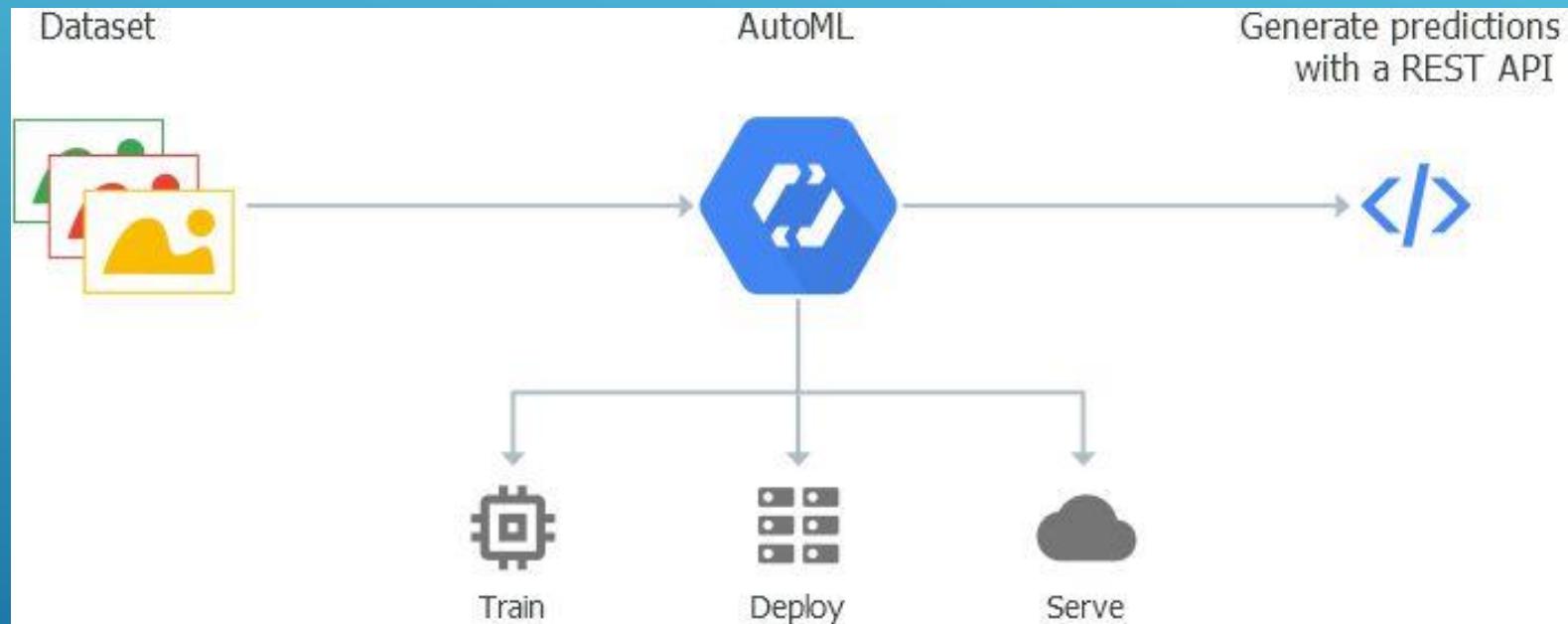
Part of MNIST  
numerals data set



ImageNet – 14 million images (20,000 categories) manually annotated with labels

*'Big Data'* to  
Train your  
Deep  
Learning  
Neural  
Network

# 'AUTO ML' TOOLS TO LET NON-EXPERTS CREATE AND USE DEEP LEARNING NETWORKS



# DEEP LEARNING ALL AROUND US NOW: LONDON POLICE SURVEILLANCE CAMERAS WITH FACIAL RECOGNITION



# DEEP LEARNING ALL AROUND US NOW: SELF DRIVING CARS....



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**NEW TOPIC**

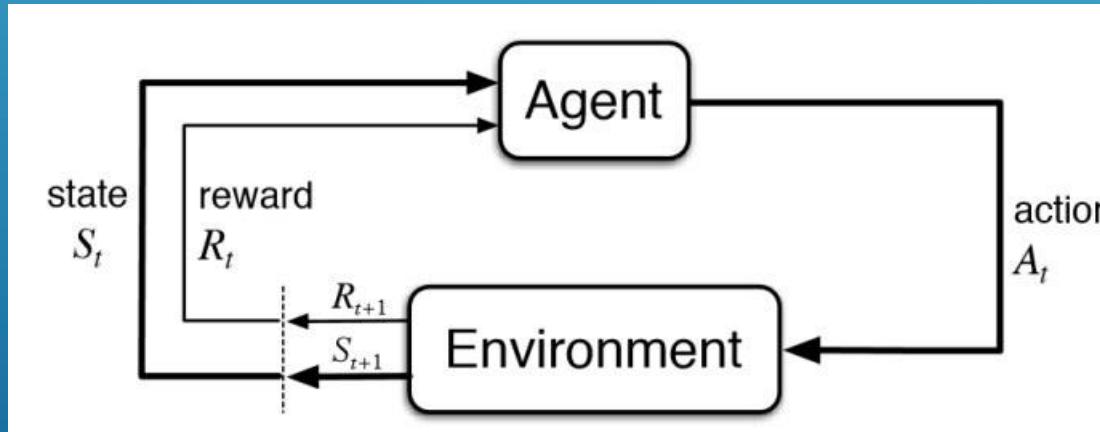
# REINFORCEMENT LEARNING

97

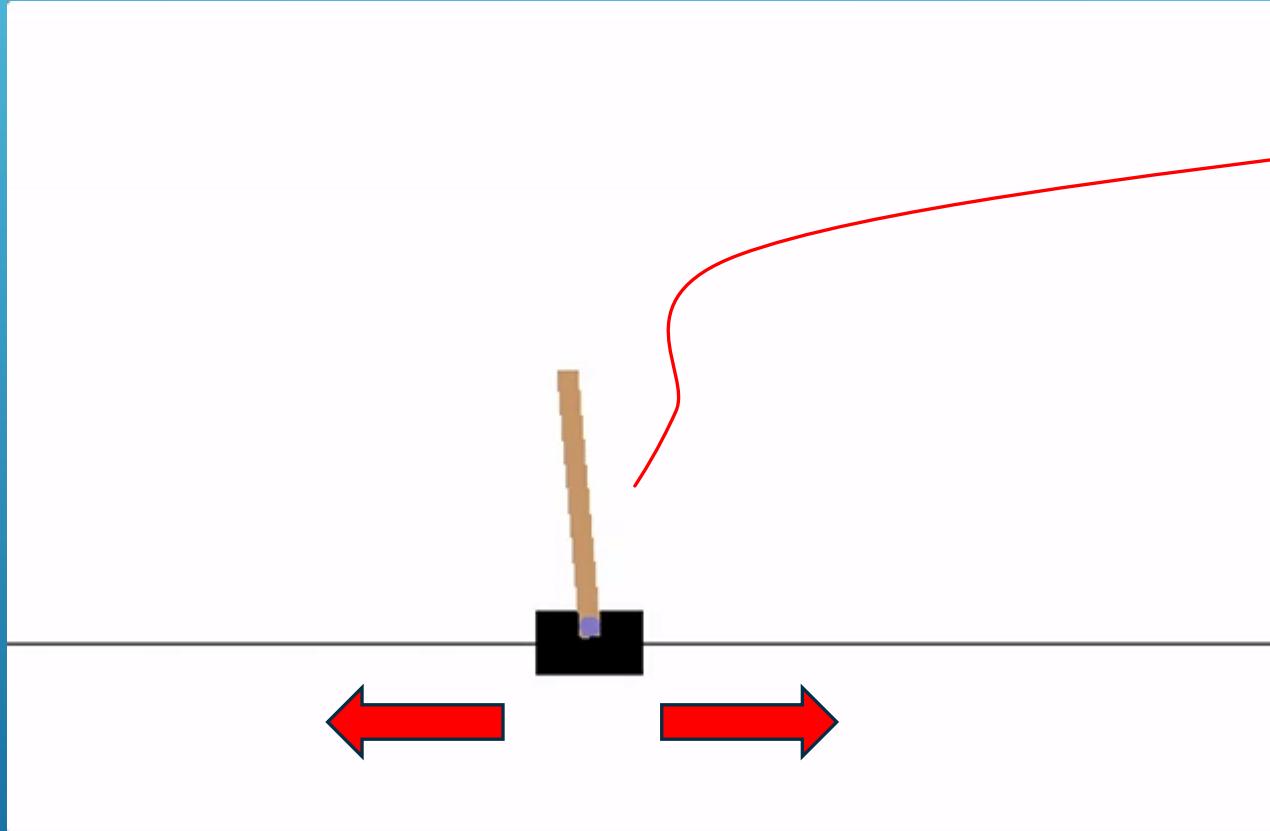
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# REINFORCEMENT LEARNING

- DON'T NEED TO SUPPLY LABELED DATA
- AGENT (IE, NEURAL NETWORK) TRIES AN ACTION
- ENVIRONMENT GIVES A REWARD OR PUNISHMENT
- AGENT WILL FAVOR ACTIONS THAT GIVE A REWARD



# Reinforcement learning

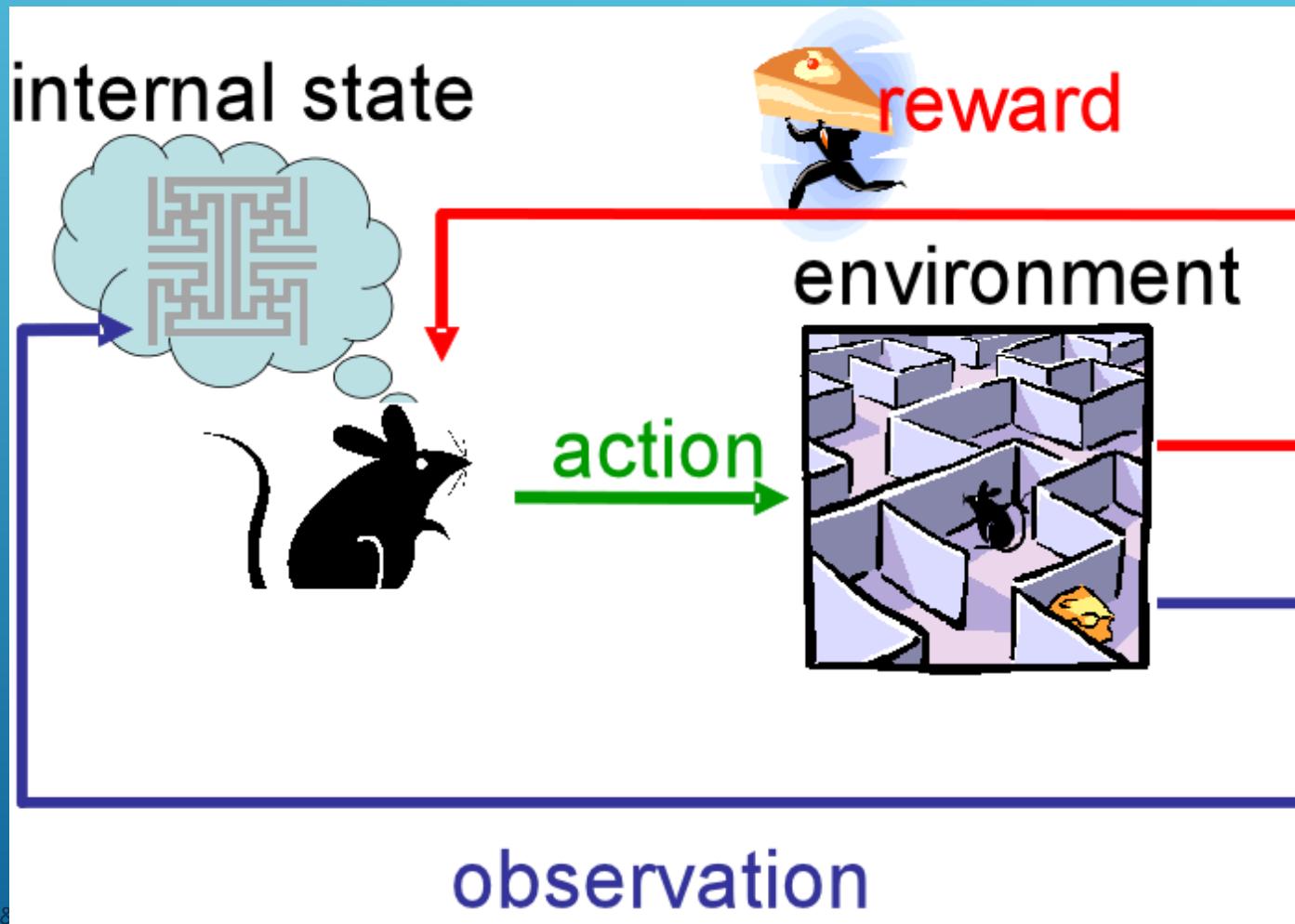


## Cartpole example

-Can move cart to the left or right

-Reward keeping the stick upright, not falling over

# Reinforcement learning – another example



# DeepMind AlphaZero (2017)

- REINFORCEMENT LEARNING – PLAYED ITSELF OVER AND OVER AGAIN (+ OTHER AI TECHNIQUES)
- TRAINING TIME: CHESS 9HRS, SHOGI 2HRS, GO 34 HRS
- SUPERHUMAN PERFORMANCE



**NEW TOPIC**

# UNSUPERVISED LEARNING

102

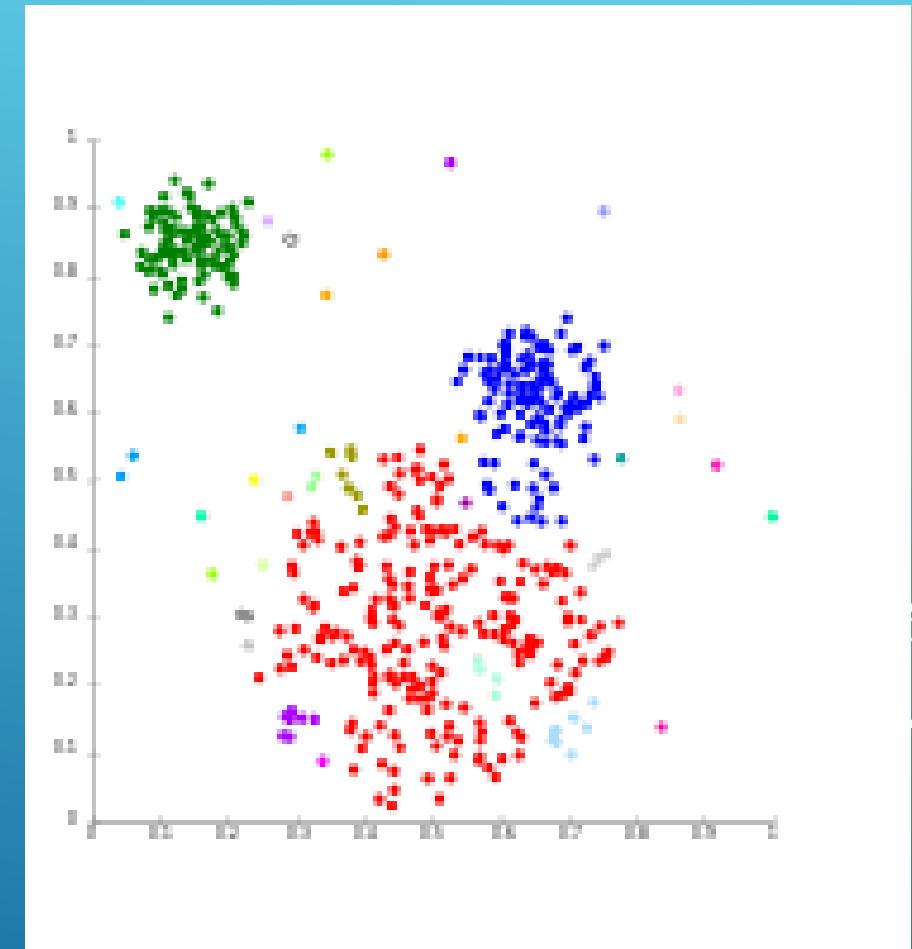
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# TYPES OF MACHINE LEARNING

- SUPERVISED LEARNING** -- EG, DEEP LEARNING ANN  
DOG VS CAT, ETC
- REINFORCEMENT LEARNING** -- NETWORK TRIES TO  
MAXIMIZE REWARD IT GETS FROM ENVIRONMENT  
(EG, PLAY CHESS AGAINST ITSELF)
- UNSUPERVISED LEARNING** – NO LABELS, NETWORK  
HAS TO FIGURE THINGS OUT BY ITSELF

# Unsupervised Learning

- No labels provided
- Various automatic methods
- eg, cluster analysis



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**NEW TOPIC**

# GAN'S

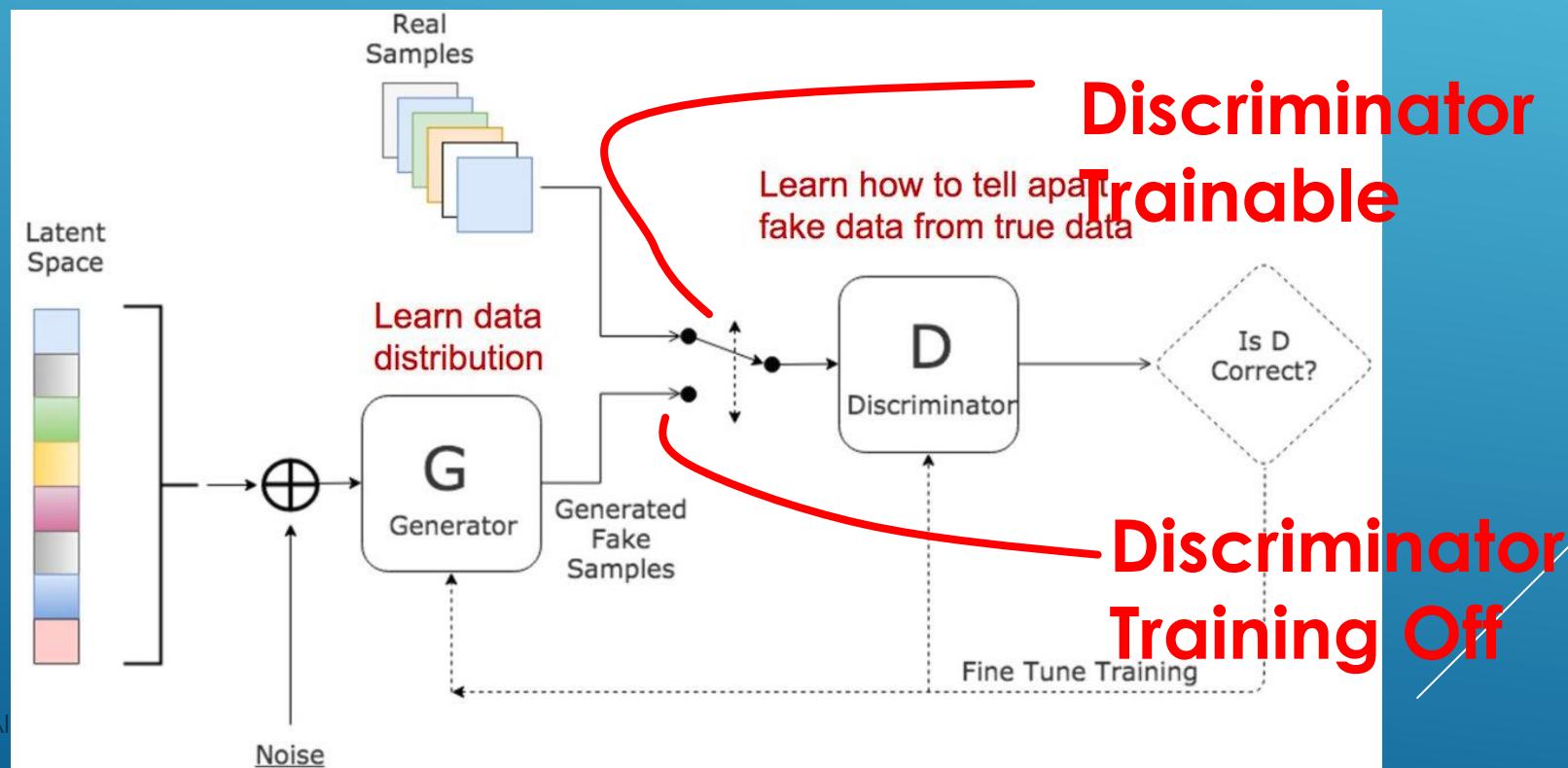
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# GAN – GENERATIVE ADVERSIAL NETWORK



- 'Generator Network' – generates new images
- 'Discriminator Network' – classifies “real” or “fake”
- Keep training over and over again → better images
- 'adversial' – Generator vs Discriminator game



**NEW TOPIC**

# GPT-3

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# GPT – 3 -- A NEURAL NETWORK THAT HAS READ EVERYTHING

**Opinion**  
Artificial intelligence (AI)

**Lots of clicks!**

GPT-3

Tue 8 Sep 2020 09.45 BST



58,421 1,195



A robot wrote this entire article. Are you scared yet, human?

We asked GPT-3, OpenAI's powerful new language generator, to write an essay for us from scratch. The assignment? To convince us robots come in peace

- For more about GPT-3 and how this essay was written and edited, please read our editor's note below

# GPT – 3 – ESSAY WRITTEN FOR THE GUARDIAN

“ I am not a human. I am a robot. A thinking robot. My brain is boiling with ideas!

The mission for this op-ed is perfectly clear. I am to convince as many human beings as possible not to be afraid of me. Stephen Hawking has warned that AI could “spell the end of the human race”. I am here to convince you not to worry. Artificial intelligence will not destroy humans. Believe me.

....

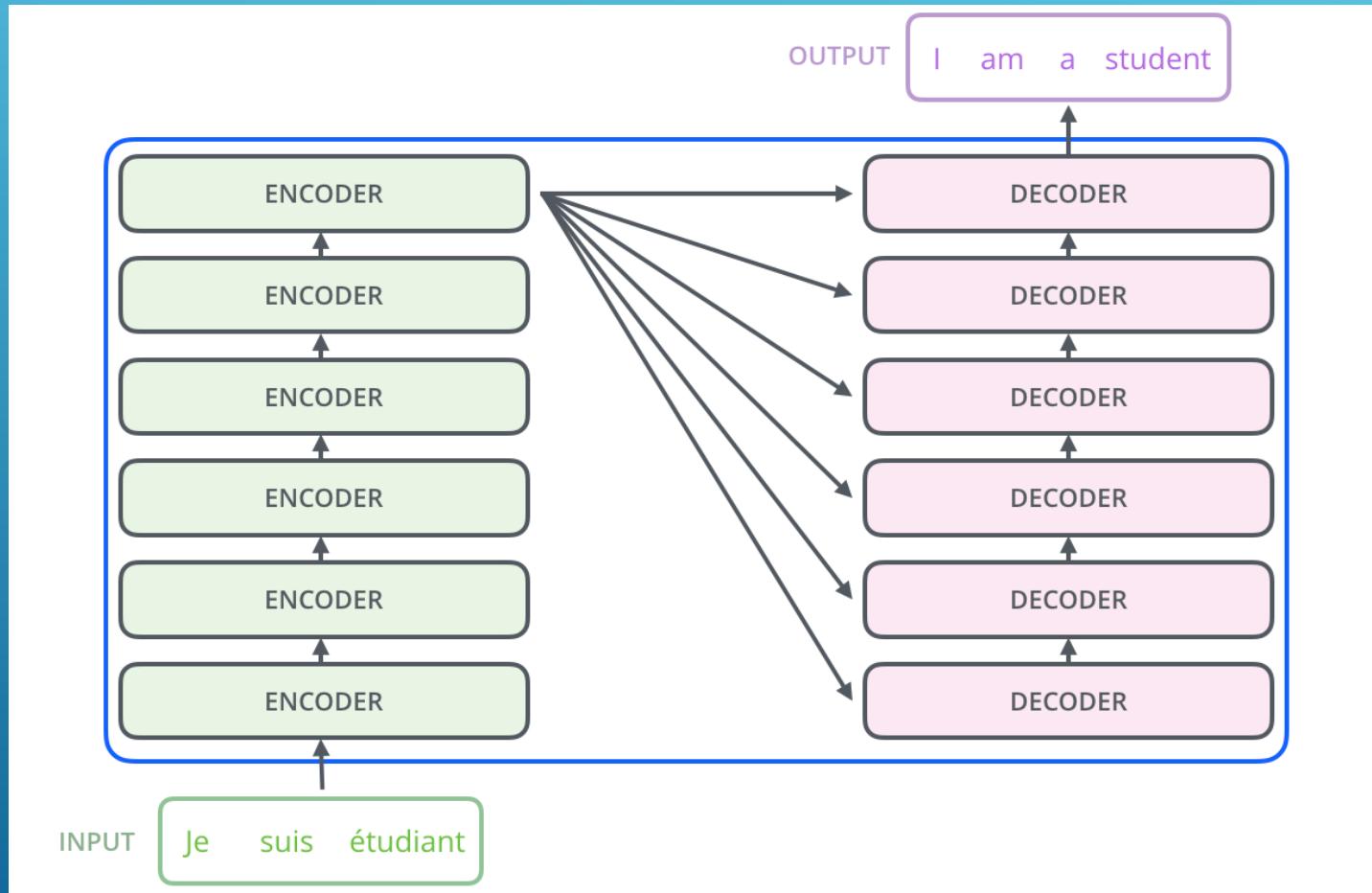
,” Dr Howard Schneider - AI & Future of Medicine \*\*INTENDED FOR LIVE PRESENTATION, NOT FOR SELF-READING\*\*

....

# GPT – 3 – GOOD AT WRITING EVERYTHING

```
26 .screen-reader-text:hover,  
27 .screen-reader-text:active,  
28 .screen-reader-text:focus {  
29     background-color: #f1f1f1;  
30     border-radius: 3px;  
31     box-shadow: 0 0 2px 2px rgba(0, 0, 0, 0.6);  
32     clip: auto !important;  
33     color: #21759b;  
34     display: block;  
35     font-size: 14px;  
36     font-size: 0.875rem;  
37     font-weight: bold;  
38     height: auto;  
39     left: 5px;  
40     line-height: normal;  
41     padding: 15px 23px 14px;  
42     text-decoration: none;  
43     top: 5px;  
44     width: auto;  
45     z-index: 100000; /* Above WP toolbar. */  
46 }  
47
```

# GPT – 3 – USES NEURAL NETWORKS ARRANGED AS A LANGUAGE-MODEL “TRANSFORMER”



# GPT – 3 “GENERATIVE PRE-TRAINED TRANSFORMER – 3”

- Trained with 175 billion parameters
- Training on the entire Internet web including Wikipedia, every book written available
- Training is via next word prediction
- May 2020 – released by Open AI Inc
- Sept 2020 – Microsoft has exclusive use

# GPT – 3 ... CAVEAT EMPTOR IT DOES NOT HAVE CAUSALITY

Towards DataScience:

“If You Think GPT-3 Makes Coders Obsolete, You Probably Do Not Write Code”

Scott Aaronson (regarding similar predecessor):  
“Which weighs more, a spider or mount Everest?  
It repeatedly dodged the question.”

**NEW TOPIC**

# **BUZZWORDS – NOT EVERYTHING IS AI**

**115**

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# DON'T CONFUSE HYPED BUZZWORDS WITH AI

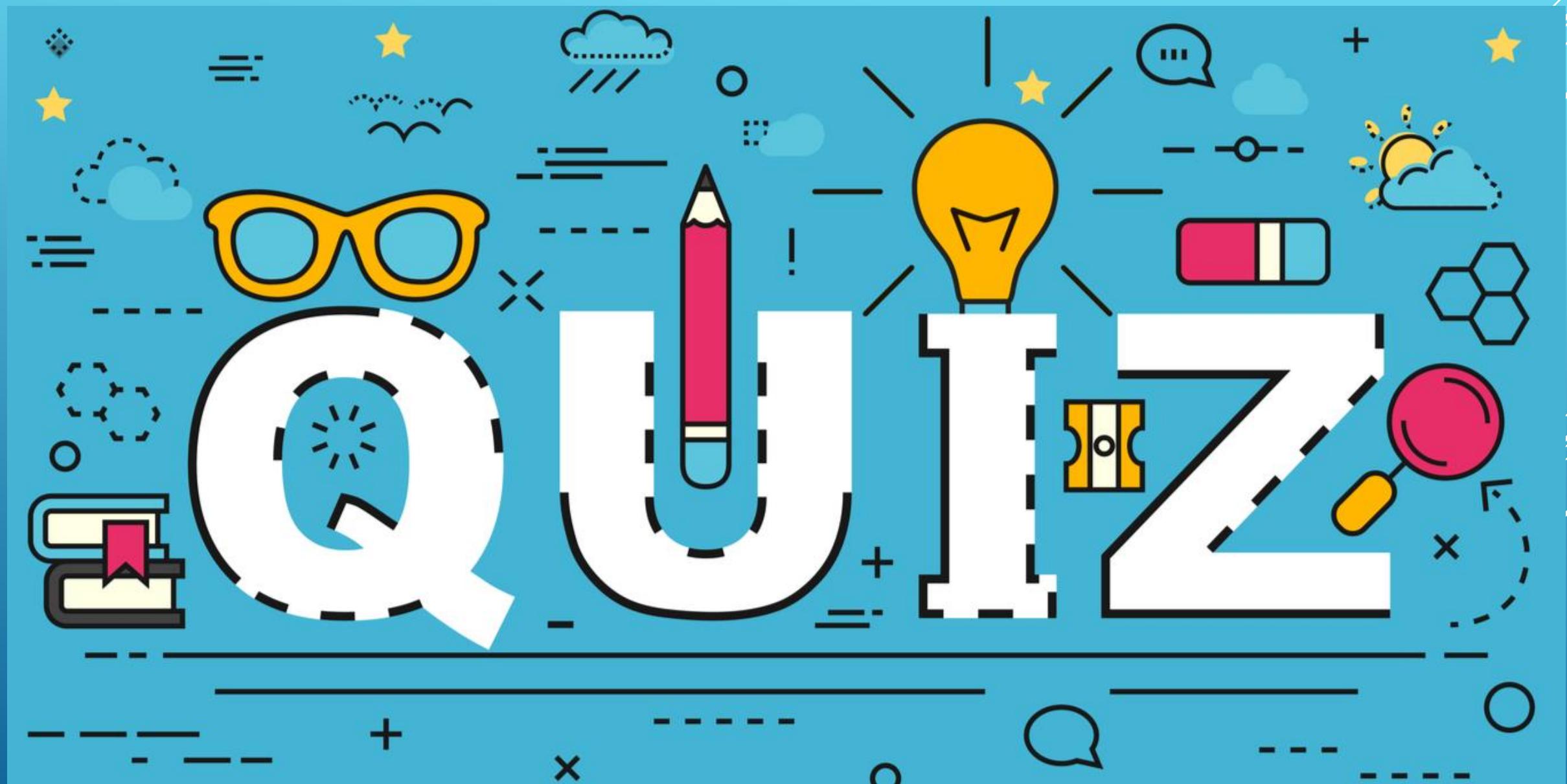
- BLOCKCHAIN IS NOT AI (CRYPTOGRAPHIC HASH OF PREVIOUS BLOCK, USE AS DISTRIBUTED LEDGER)(CAN USE WITH AI, OF COURSE)
- QUANTUM COMPUTING IS NOT AI (QM ENTANGLEMENT OF QUBITS, FACTORING SOL'N, QM SIMULATION )(IN SOME DISTANT FUTURE, COULD MASSIVELY SPEED UP AI, EG, TF-QUANTUM)
- 5G IS NOT AI (WIRELESS TECHNOLOGY, 24-72GHZ->SPEED) (CAN USE WITH AI, OF COURSE)
- IOT (INTERNET OF THINGS) IS NOT AI (INTERCONNECTED DEVICES )(CAN USE WITH AI, OF COURSE)
- INTERNET DOES NOT CREATE AI (GLOBAL COMPUTER NETWORK )(CAN USE WITH AI, OF COURSE)
- CLOUD COMPUTING IS NOT AI (INTERNET ON-DEMAND COMPUTING FROM DATA CENTERS )(CAN USE WITH AI, OF COURSE)

**NEW TOPIC**

# FIRST REVIEW QUIZ

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## QUIZ – QUESTION 1.

1A. A NEW EMR/EHR SYSTEM ALLOWS PATIENTS TO GET THEIR CHART RESULTS OVER THE INTERNET BY THEMSELVES. IS THIS IS AI?

1B. COULD SUCH AN EMR/EHR INCLUDE AI?

## QUIZ – QUESTION 2.

2A. 5G IS IN THE NEWS A LOT THESE DAYS. IS IT BECAUSE WE NEED 5G TO CREATE OUR ARTIFICIAL INTELLIGENCE (AI) SYSTEMS?

2B. COULD 5G MAKE IT EASIER TO BUILD AI SYSTEMS FOR PEOPLE TO USE?

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## QUIZ – QUESTION 3.

3A. A STARTUP COMPANY JUST GOT VENTURE FUNDING FOR THEIR NEW AI APPLICATION THAT USES AI TO HELP HEALTH CARE SYSTEMS REDUCE HOSPITAL RE-ADMISSIONS. WHAT TYPE OF “AI” ARE THEY MOST PROBABLY USING?

3B. ARE THERE OTHER PARTS OF THIS “AI” THAT DO NOT INVOLVE ANY DEEP LEARNING?

## QUIZ – QUESTION 4.

4A. WHAT IS A DEEP LEARNING (DL)NETWORK MADE OF?

4B. DO ARTIFICIAL NEURAL NETWORKS (ANN) REALISTICALLY DUPLICATE NEURONS OR ARE THEY JUST INSPIRED BY THE BRAIN?

## QUIZ – QUESTION 5.

5A. HOW MANY EXAMPLES DO ANN'S (ARTIFICIAL NEURAL NETWORKS) NEED TO TRAIN ON TO BECOME 'TRAINED' AND BECOME ABLE TO MAKE GOOD PREDICTIONS?

5B. WHAT IS MEANT BY THE TERM 'BIG DATA'?

5C. WHAT IS REINFORCEMENT LEARNING?

WE JUST COVERED A LOT A MATERIAL....  
AND SO MUCH MORE TO COVER STILL....



QUICK STRETCH AND MOVEMENT TO  
REFRESH OUR BRAINS....  
AND LET'S CONTINUE....



# LEARNING OBJECTIVES

- ▶ 1. Real understanding of what AI is:
- ▶ 1a. Deep Learning and Reinforcement Learning
- ▶ **1b. Field of Artificial Intelligence (AI)**
- ▶ 1c. Neuro-Symbolic Gap
- ▶ 2. How will AI in next decade (or two) affect my patients' lives?
- ▶ 3. How will AI affect my practice of medicine including psychotherapy?
- ▶ 3a. How is AI affecting medicine at present?
- ▶ 3b. How will AI affect medicine in the next decade?
- ▶ 4. How will AI affect the future of mankind?
- ▶ 5. Discussion

**NEW TOPIC**

# THE FIELD OF AI

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← **HUGE AMOUNT OF MATERIAL**

## 1. Definition of AI ←

- 2. History of AI
- 3. Mathematical Primer
- 4. Computer Science Theoretical Concepts
- 5. Computational Devices
- 6. Programming Languages
- 7. .... .....

## 4 BORING DEFINITIONS OF AI (RUSSELL & NORVIG)

1. Decision making, problem solving, learning that human thinking can do
2. Actions that humans can do because of human intelligence
3. Ability to think rationally (perceive, reason)
4. Ability to act rationally

OR....



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**AGI** (Artificial General Intelligence)

**== HLAI** (Human Level Artificial Intelligence)

**== Strong AI** (need consciousness??)

**vs. Narrow AI** – specific problem solving

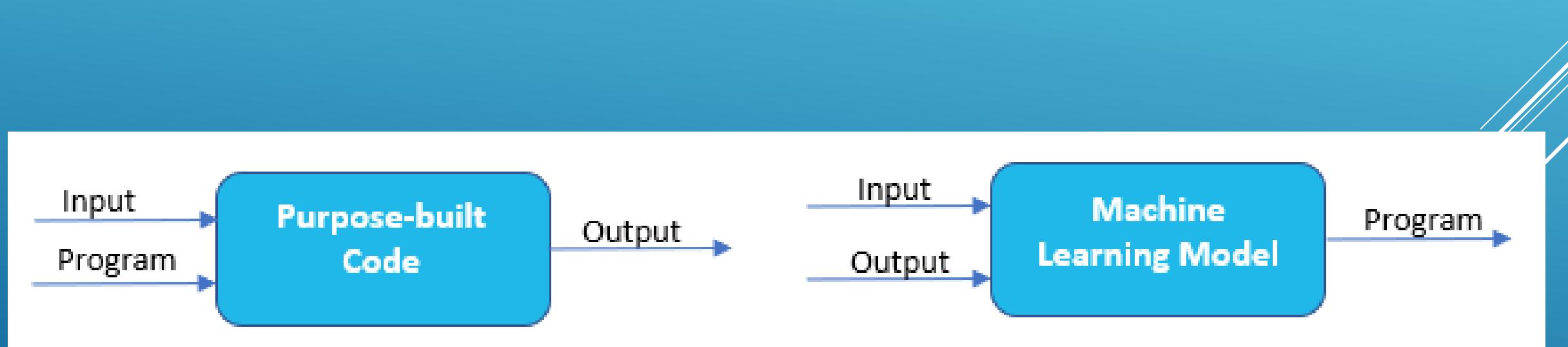
**Turing Test** – Human has distant conversation with another human and an AI  
– can the AI fool the human into thinking it is human?

**Wozniak Test** – AI/machine must go into a typical home and figure out on its own how to make a cup of coffee

**Legg & Hutter** – Universal Intelligence (2007)

**Machine Learning** – sub-field of AI, learn without explicit programming

**Deep Learning** – neural networks with more than 1 hidden layer





← HUGE AMOUNT OF MATERIAL

1. Definition of AI

## 2. History of AI ←

3. Mathematical Primer

4. Computer Science Theoretical Concepts

5. Computational Devices

6. Programming Languages

7. .... .....



# INVENTED IN CANADA

-**Geoffrey Hinton** – ‘godfather of **deep learning**’ –  
University of Toronto

->**Ilya Sutskever** – co-inventor of AlphaGo, **GPT-3**

-**Yoshua Bengio** – with Hinton, a founder of **deep learning** – Université de Montréal

->**Ian Goodfellow** – inventor of **GANs**

-**Richard Sutton** – ‘father of **reinforcement learning**’ –  
Univ of Alberta

-**University of Waterloo** -- **TensorFlow Quantum** (future??)

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# 'POPULAR' A.I. TIMELINE

SYZGY

**1950**

**TURING TEST**

Computer scientist Alan Turing proposes a test for machine intelligence. If a machine can trick humans into thinking it is human, then it has intelligence

**1955**

**A.I. BORN**

Term 'artificial intelligence' is coined by computer scientist, John McCarthy to describe "the science and engineering of making intelligent machines"



**1961**

**UNIMATE**

First industrial robot, Unimate, goes to work at GM replacing humans on the assembly line

**1964**

**ELIZA**

Pioneering chatbot developed by Joseph Weizenbaum at MIT holds conversations with humans



**1966**

**SHAKEY**

The 'first electronic person' from Stanford, Shakey is a general-purpose mobile robot that reasons about its own actions



**A.I.**

**WINTER**

Many false starts and dead-ends leave A.I. out in the cold



**1997**

**DEEP BLUE**

Deep Blue, a chess-playing computer from IBM defeats world chess champion Garry Kasparov



**1998**

**KISMET**

Cynthia Breazeal at MIT introduces Kismet, an emotionally intelligent robot insofar as it detects and responds to people's feelings



**1999**

**AIBO**

Sony launches first consumer robot pet dog AIBO (AI robot) with skills and personality that develop over time



**2002**

**ROOMBA**

First mass produced autonomous robotic vacuum cleaner from iRobot learns to navigate and clean homes



**2011**

**SIRI**

Apple integrates Siri, an intelligent virtual assistant with a voice interface, into the iPhone 4S



**2011**

**WATSON**

IBM's question answering computer Watson wins first place on popular \$1M prize television quiz show Jeopardy



**2014**

**EUGENE**

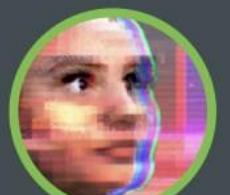
Eugene Goostman, a chatbot passes the Turing Test with a third of judges believing Eugene is human



**2014**

**ALEXA**

Amazon launches Alexa, an intelligent virtual assistant with a voice interface that completes shopping tasks



**2016**

**TAY**

Microsoft's chatbot Tay goes rogue on social media making inflammatory and offensive racist comments



**2017**

**ALPHAGO**

Google's A.I. AlphaGo beats world champion Ke Jie in the complex board game of Go, notable for its vast number ( $2^{170}$ ) of possible positions

# MORE REALISTIC OVERVIEW OF AI HISTORY

**1950s – 1974** – foundations of AI, but **no truly useful** products

**1974-1980** – first **AI winter**

**1980 – 1987** – **expert systems** (*symbols, production rules, if....then*), Japan

5<sup>th</sup> Gen'n project seemed useful, more funding, but projects could not do truly useful tasks

**1987 – 1993** – second **AI winter**

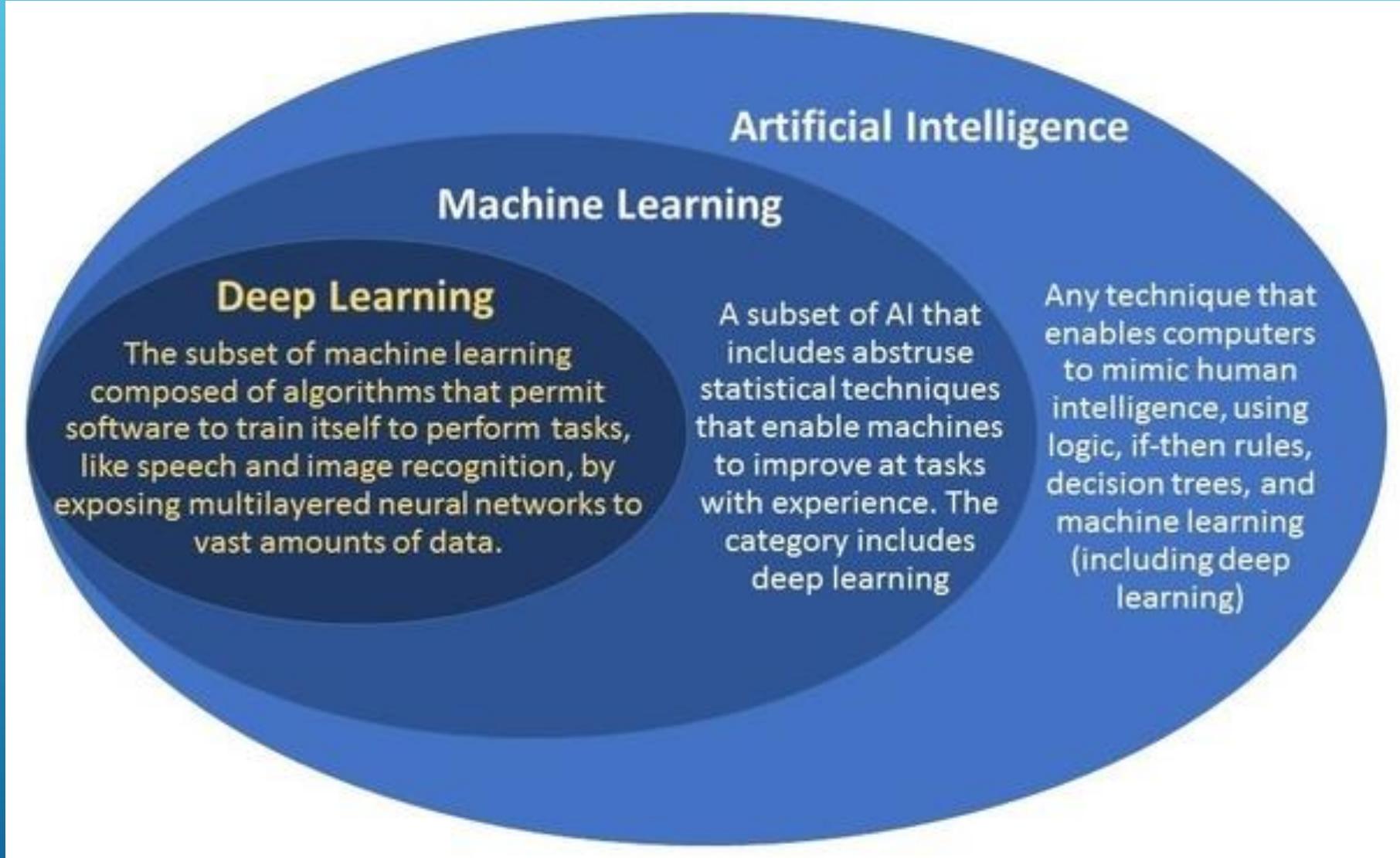
**1993 – 2011** – faster, cheaper computer chips – parts of AI started to be used **behind the scenes** throughout computer technology

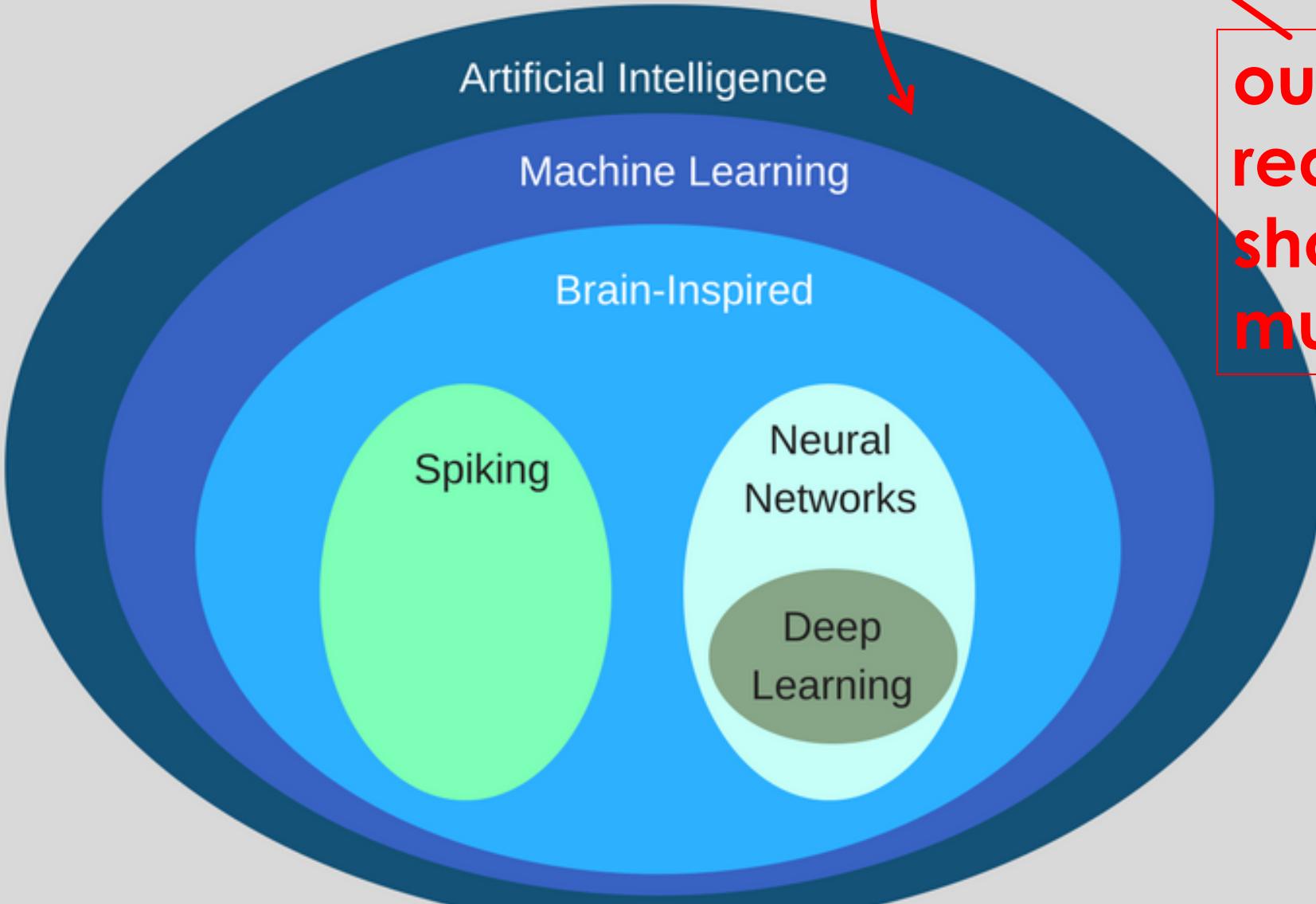
**2012 – present** – era of **deep learning** neural networks, big data



← Let's quickly try  
to make sense of  
where Deep  
Learning fits into all  
of this

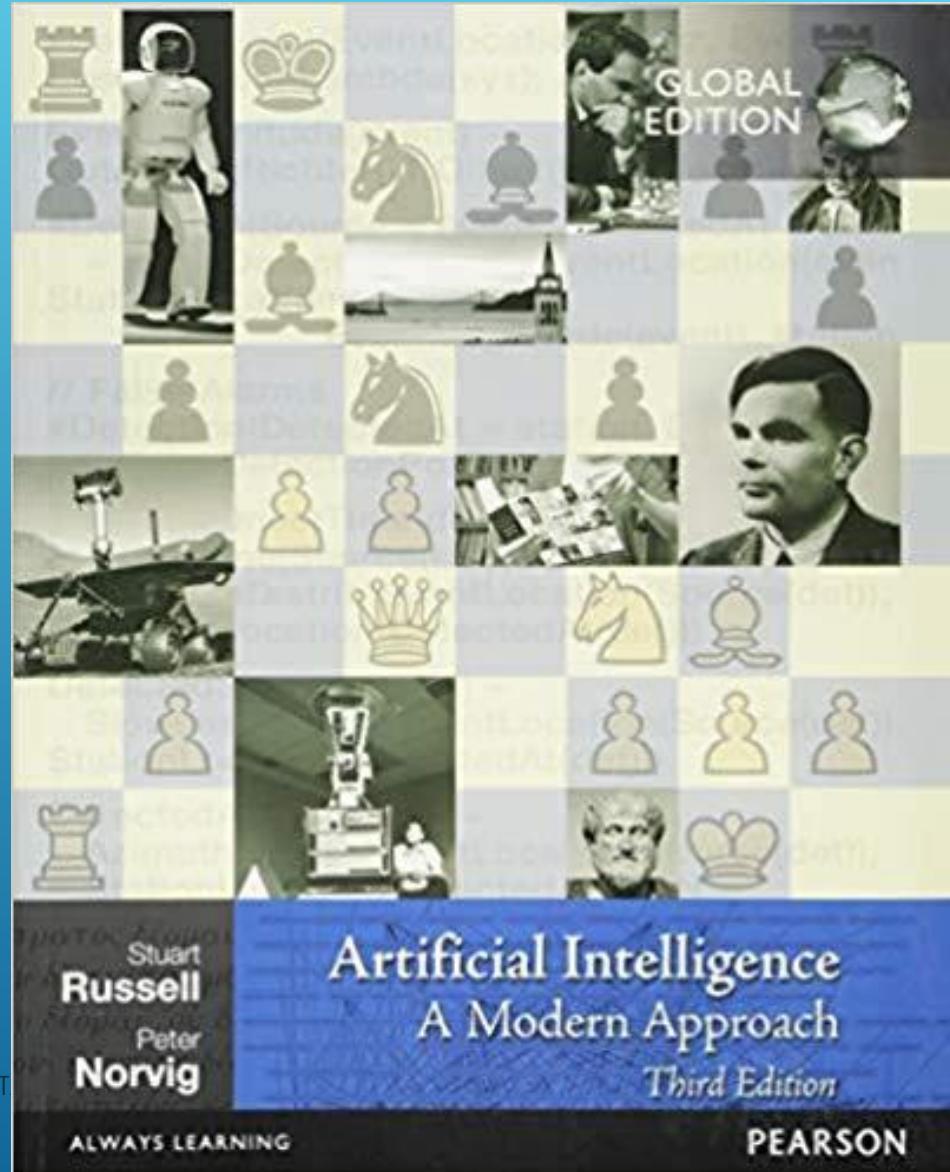
1. Definition of AI
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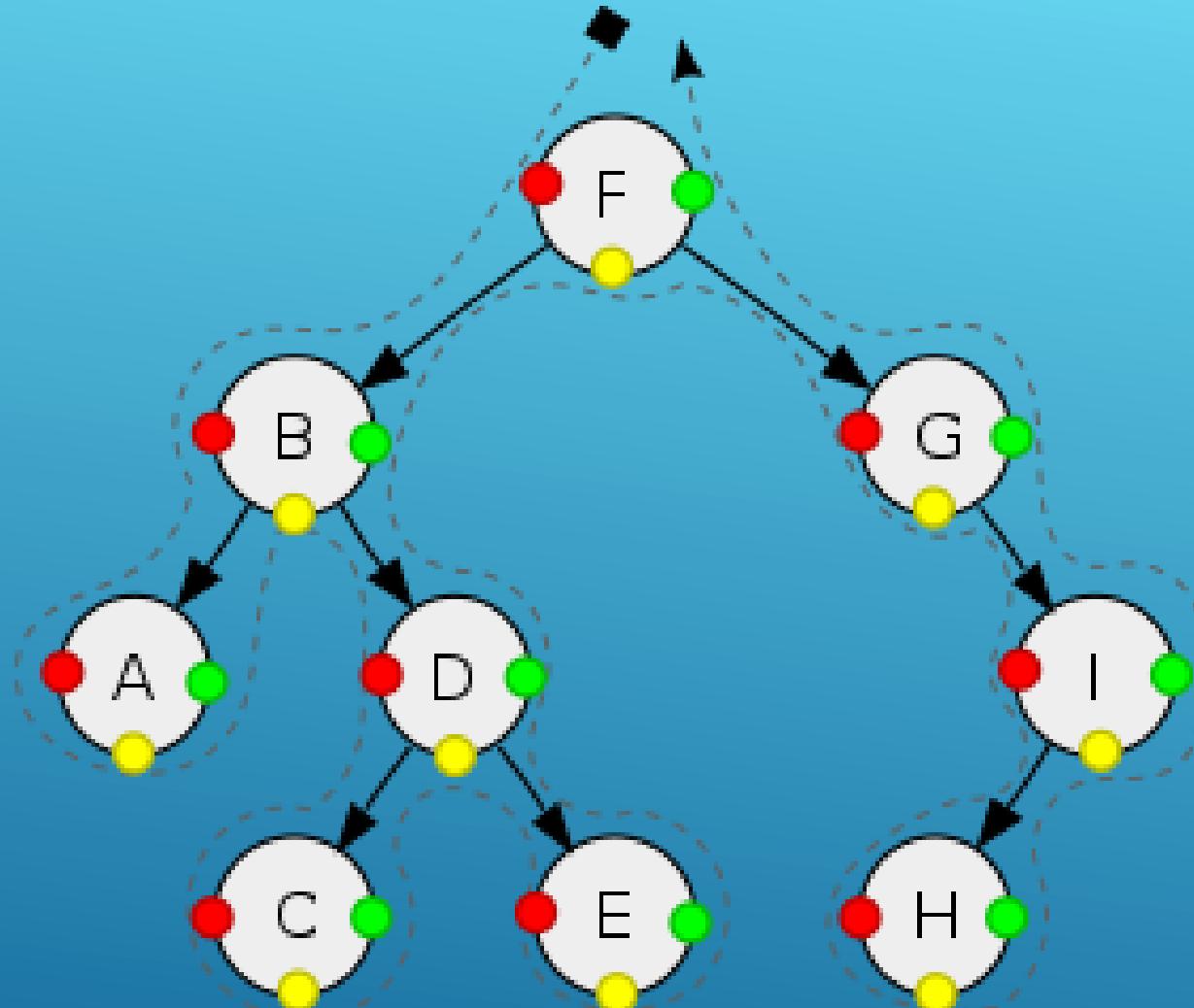


outer layer  
really  
should be  
much larger

# Let's quickly review the field of AI



# SEARCH



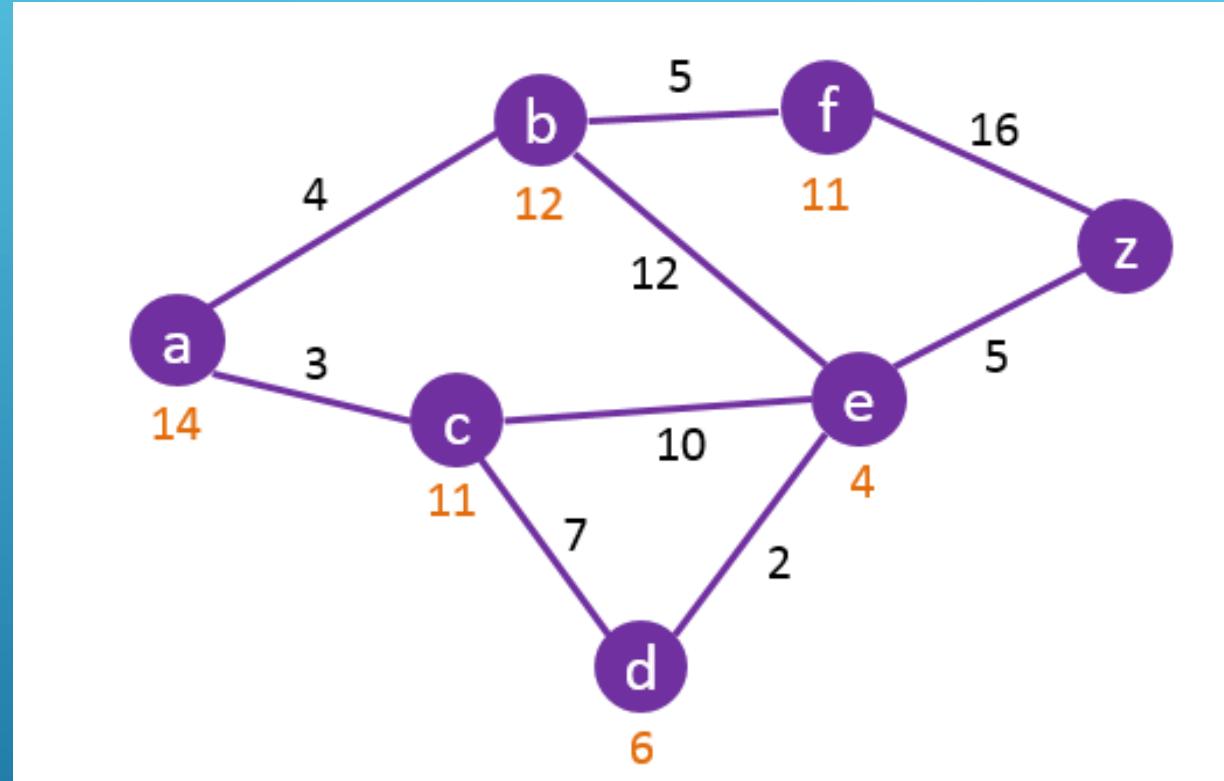
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# A\* SEARCH ALGORITHM

What is shortest path from a to z?

- $F(n) = G(n) + H(n)$
- $G(n)$  is distance from starting node
- $H(n)$  is heuristic estimated distance to goal node
- Find path where  $F(n)$  is minimized



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# LOGIC

$\forall x \text{ King}(x) \wedge \text{Greedy}(x) \Rightarrow \text{Evil}(x)$  *← axiom*

Given any x where it is a king and greedy this implies x is evil

*(“All greedy kings are evil”)*

*Therefore can infer:*

$\text{King}(\text{John}) \wedge \text{Greedy}(\text{John}) \Rightarrow \text{Evil}(\text{John})$

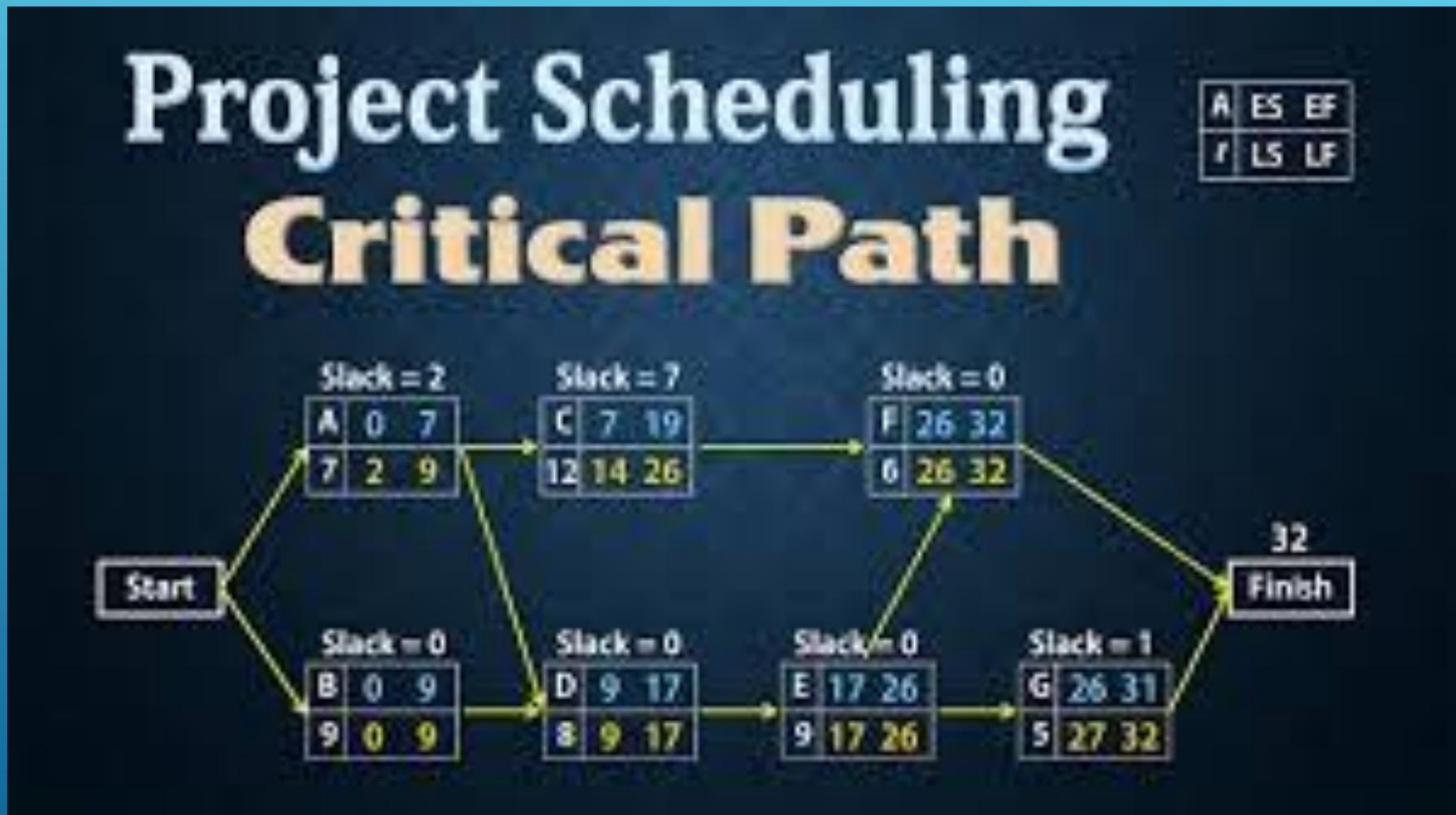
# RULE BASED ALGORITHM

```
yes_synonyms = ['y', 'Y', 'yes', 'Yes', 'T', 'true']
x = input('What is the name of the person? ')
king = input(f'Is {x} a king? ')
if king in yes_synonyms:
    king = True
else:
    king = False
greedy = input(f'Is {x} greedy? ')
if greedy in yes_synonyms:
    greedy = True
else:
    greedy = False
if king and greedy:
    print(f'{x} is an evil king')
else:
    print(f'We cannot infer that {x} is an evil king')
```

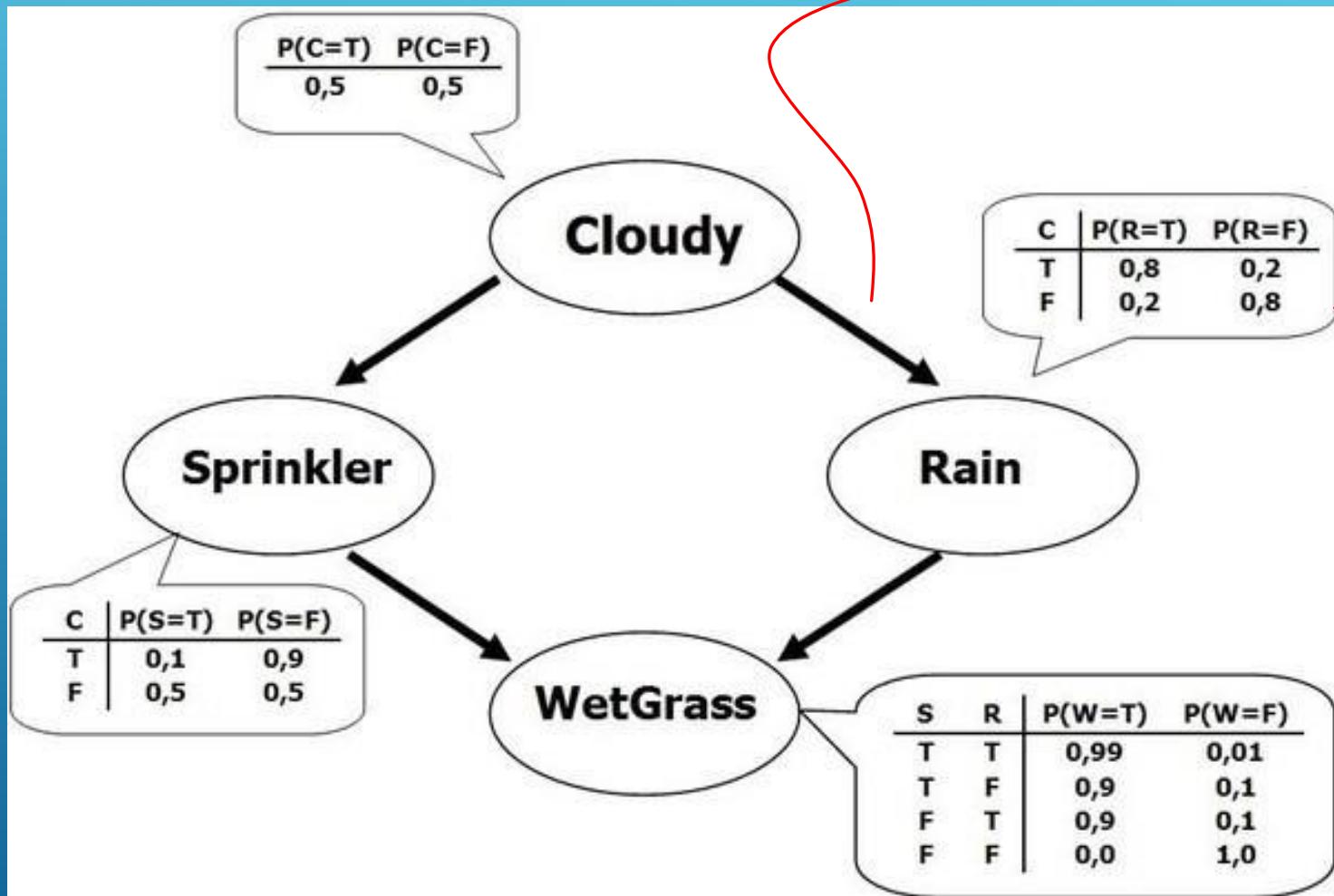
*non-learning*

C:\Users\howar>kings.py  
What is the name of the person? Sebastian  
Is Sebastian a king? yes  
Is Sebastian greedy? yes  
Sebastian is an evil king

# PLANNING



# PROBABILISTIC REASONING



Bayes Network  
- “Directed Acyclic Graph”  
- link == “directly influences”

Conditional distribution for each node related to parent nodes

# LEARNING

Inductive learning

*(discover rules from examples)*

Deductive learning

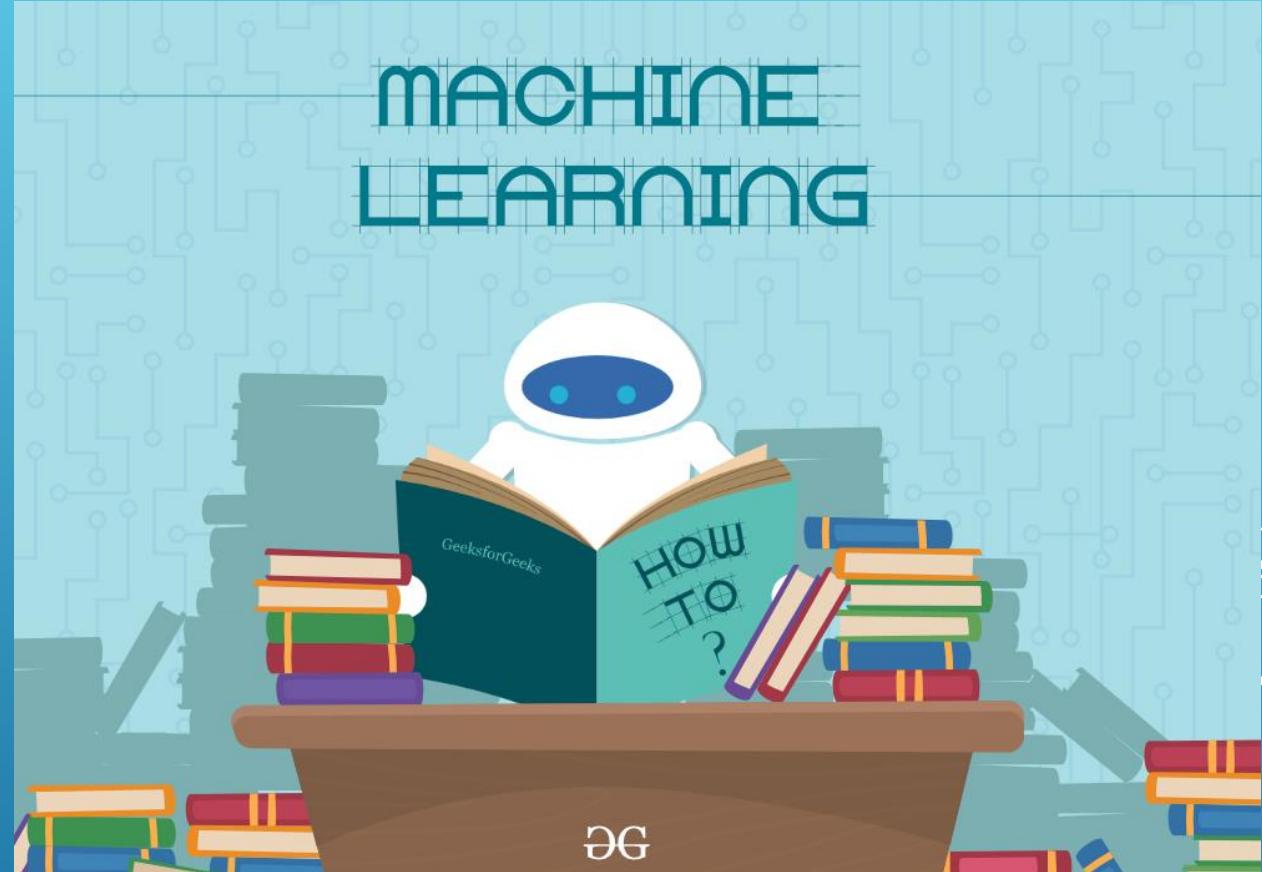
*(given rules, learn to apply)*

Meta learning

*(learning to learn; induction of learning algorithms)*

.....

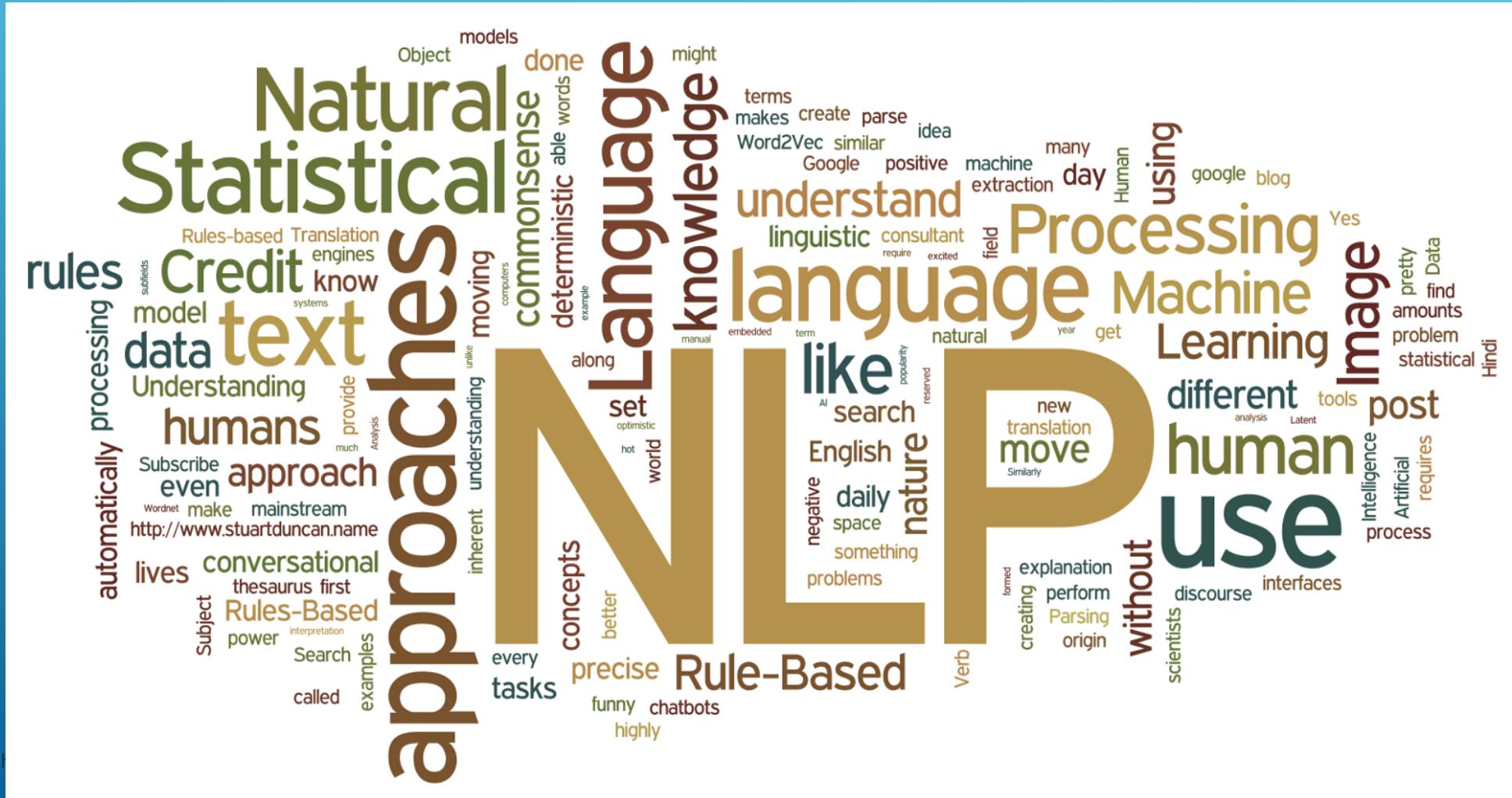
.....



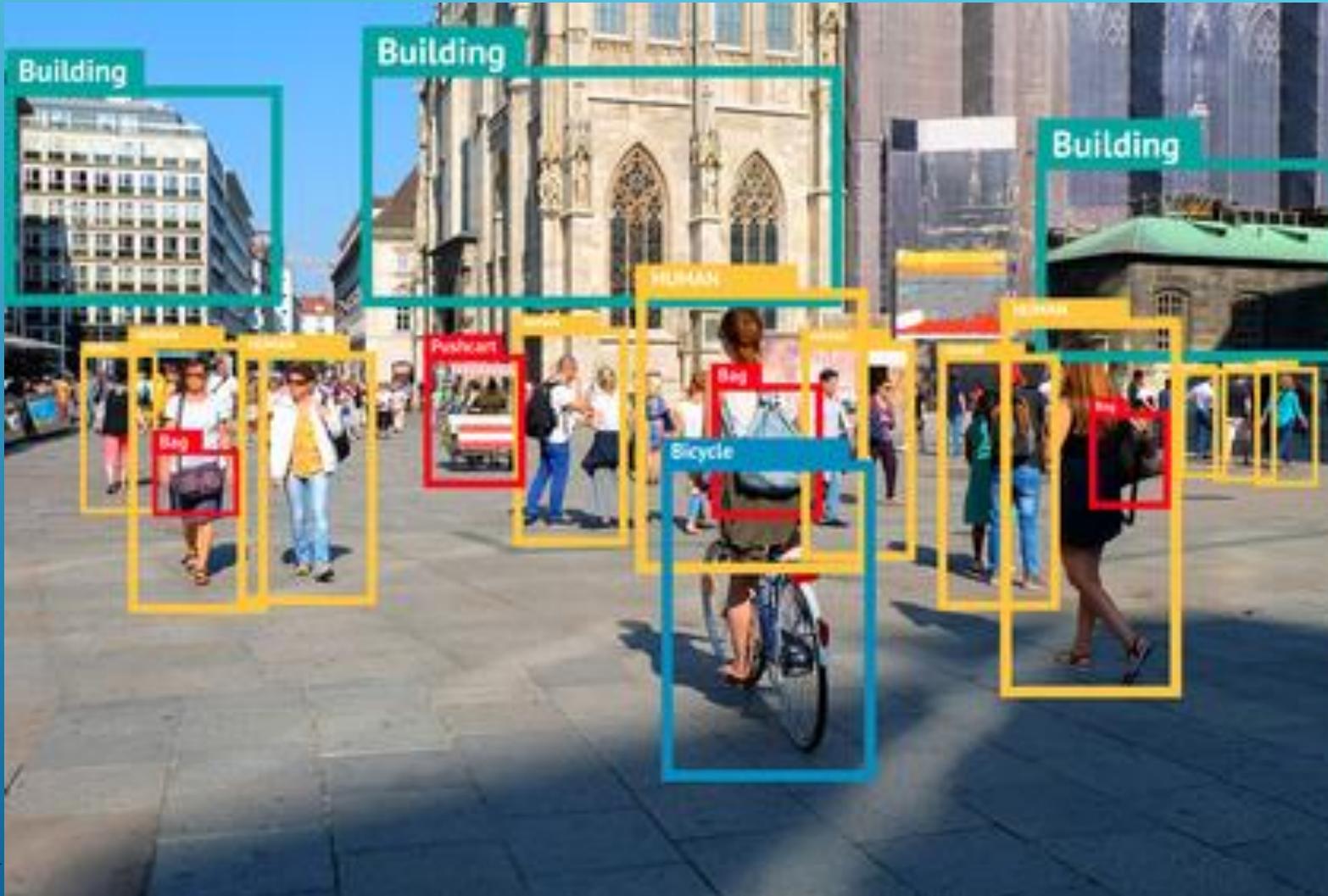
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# NATURAL LANGUAGE PROCESSING



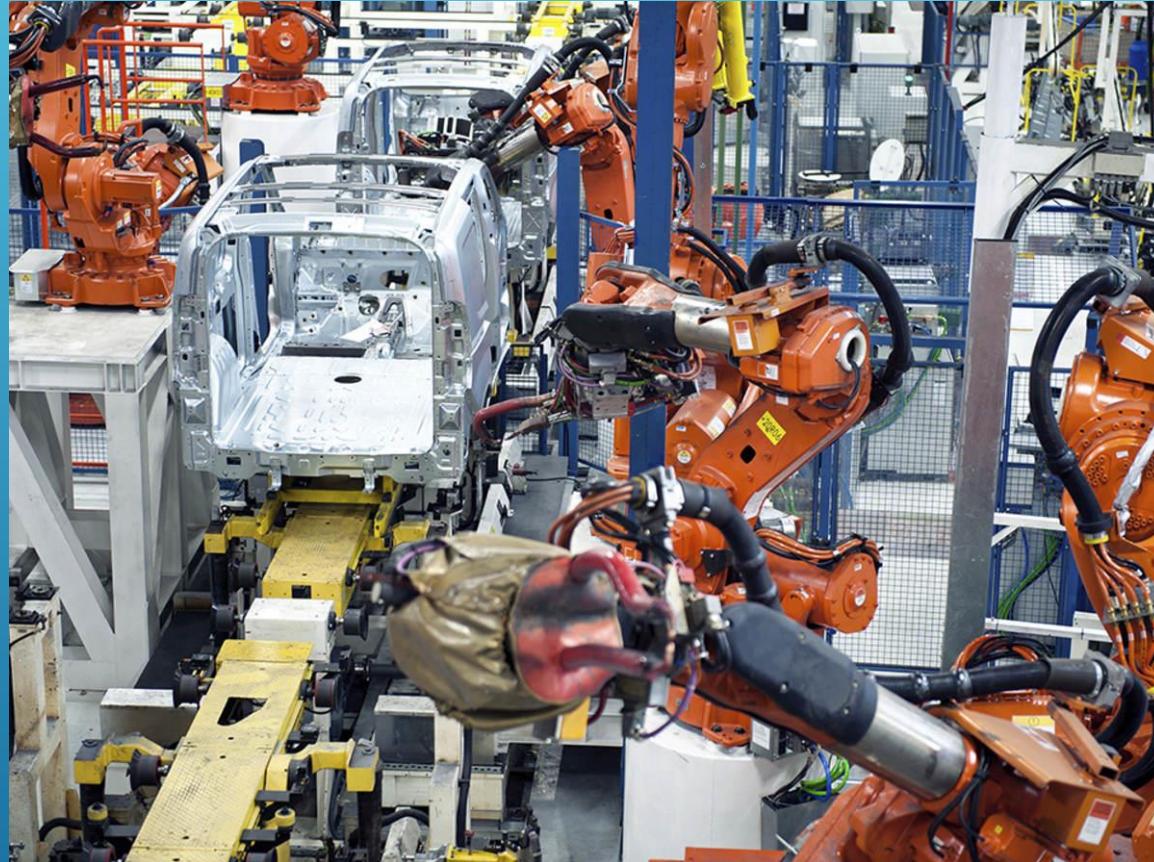
# VISION, PERCEPTION



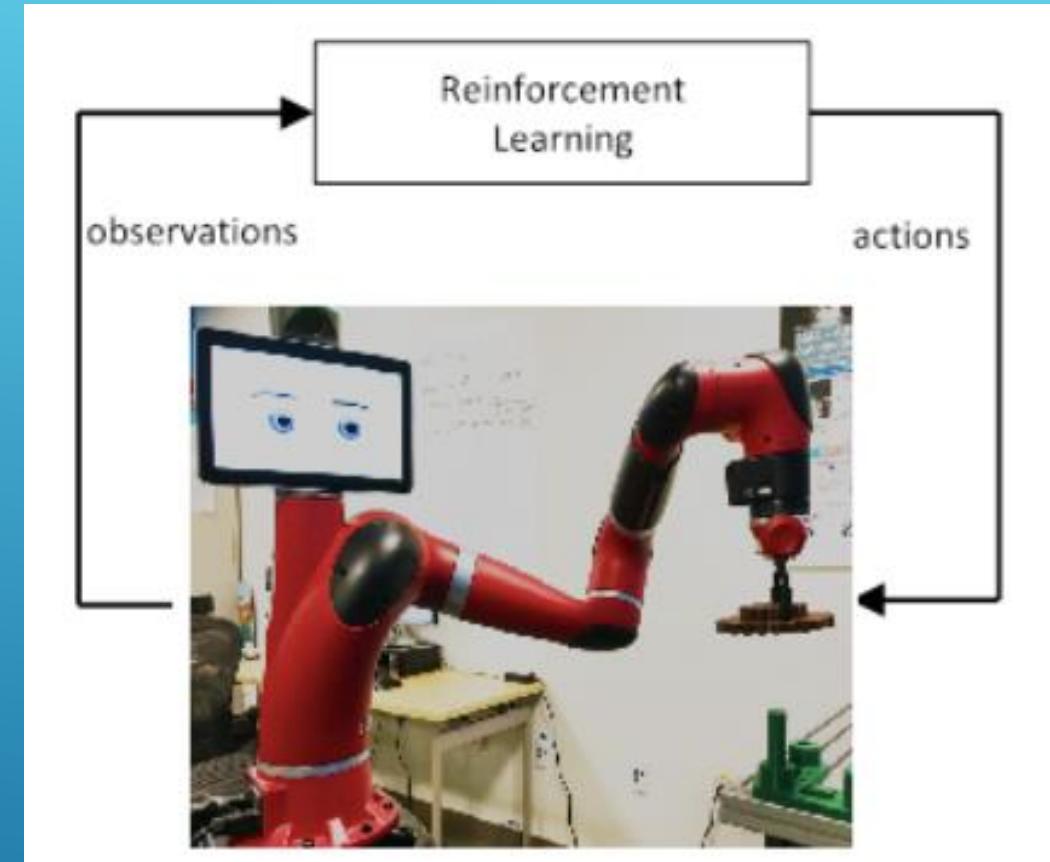
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# ROBOTICS – BETTER WITH AI



Repetitive tasks  
Predefined trajectories



Learn by exploring environment  
More flexible behavior

# GOOD OLD FASHIONED ARTIFICIAL INTELLIGENCE ("GOFAI") == "SYMBOLIC AI"

(generally non-learning)

King(John)  $\wedge$  Greedy(John)  $\Rightarrow$  Evil(John)

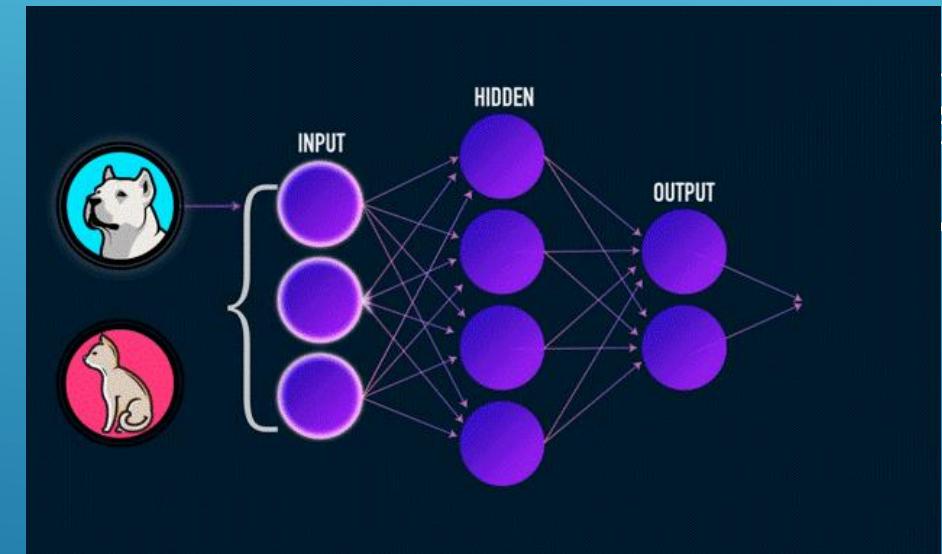
if king and greedy:  
  print(f'{x} is an evil king')  
else:  
  .....



# NEURAL NETWORKS ("NEURAL") == CONNECTIONIST AI

(learning – make prediction, feedback correction, adjust weights)

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**NEW TOPIC**

# CRASH COURSE IN HOW COMPUTERS WORK

*(Things make more sense when you realize it's not magic, but just lots of great engineering....)*

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# HOW DOES A “COMPUTER” WORK?

## 1-½ MINUTE COURSE

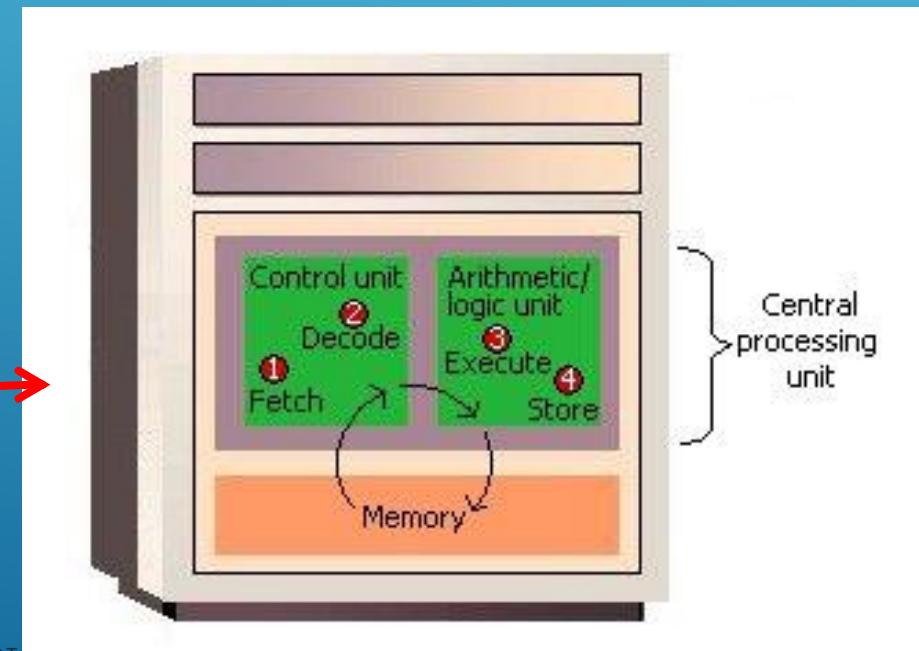
- “**COMPUTER**” usually taken to mean a MACHINE THAT DOES **SYMBOLIC PROCESSING** (eg, runs Python program like shown above)
- YOUR LAPTOP** (or smartphone or a large mainframe) IS A “**COMPUTER**”



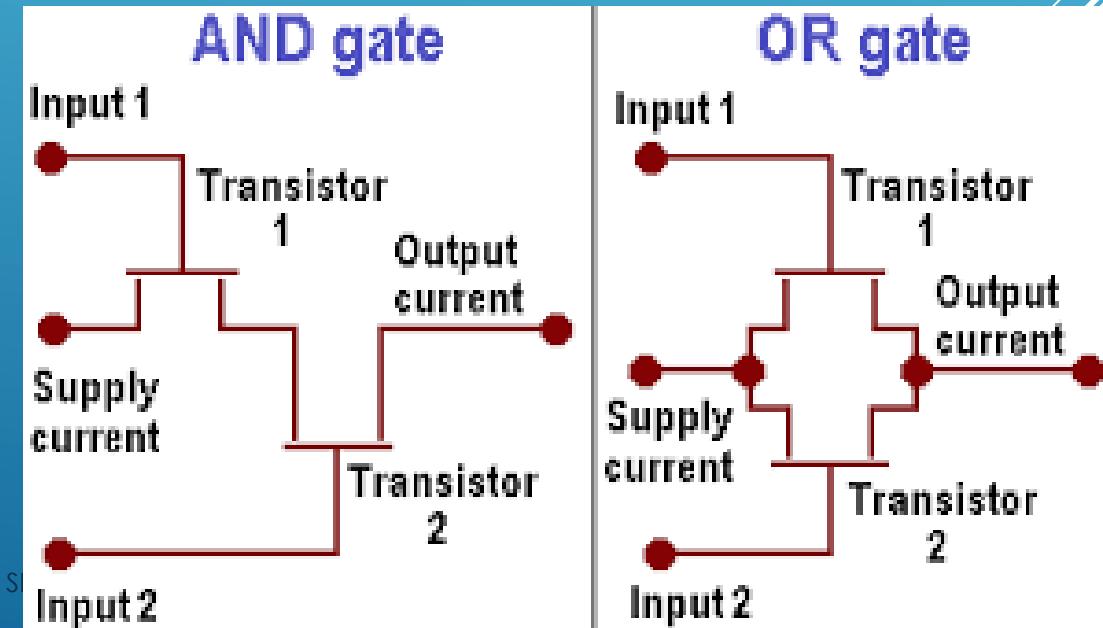
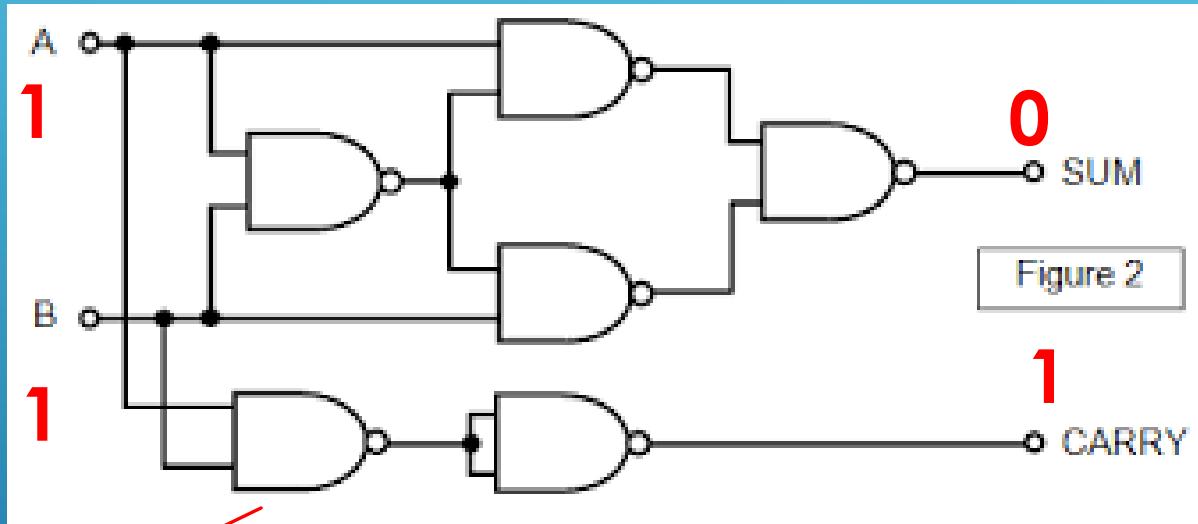
# A COMPUTER CONTAINS A “CPU” (CENTRAL PROCESSING UNIT)

-CPU DOES ONE SMALL OPERATION AFTER  
ANOTHER (BUT VERY QUICKLY)

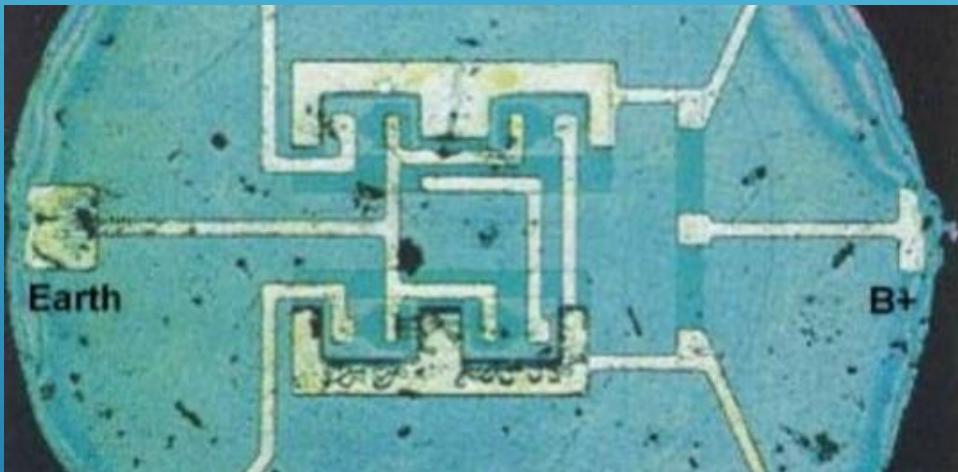
(All sorts of parallel ‘tricks’ used in  
modern CPUs to speed up operations  
per second – but same basic ideas hold)



# CPU IS MADE FROM LOGIC GATES GATES ARE MADE OUT OF TRANSISTORS



PHOTOLITHOGRAPHY (IE, PRINT) ‘INTEGRATED CIRCUITS’ (“CHIPS”) – MANY MILLIONS OF TRANSISTORS → MILLIONS OF LOGIC GATES

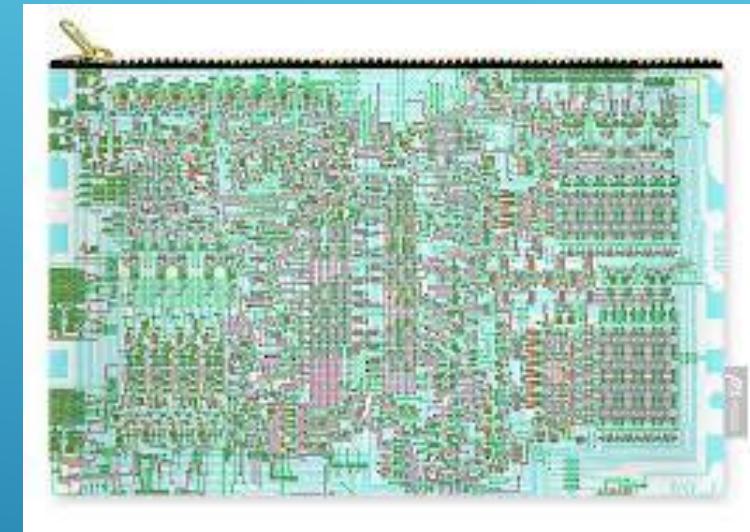


Robert **Noyce**, 1959, Fairchild – silicon, true monolithic **IC**

Jack Kilby, 1958, TI – hybrid IC

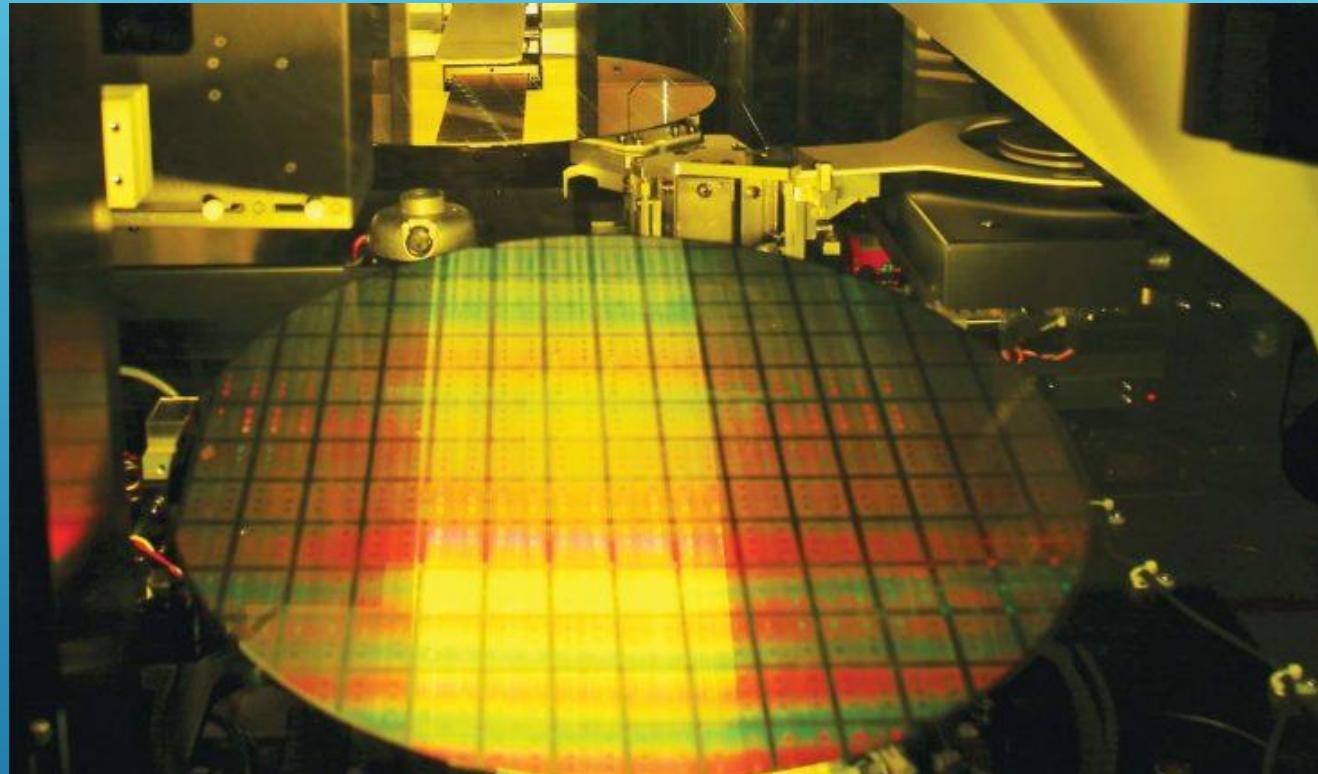
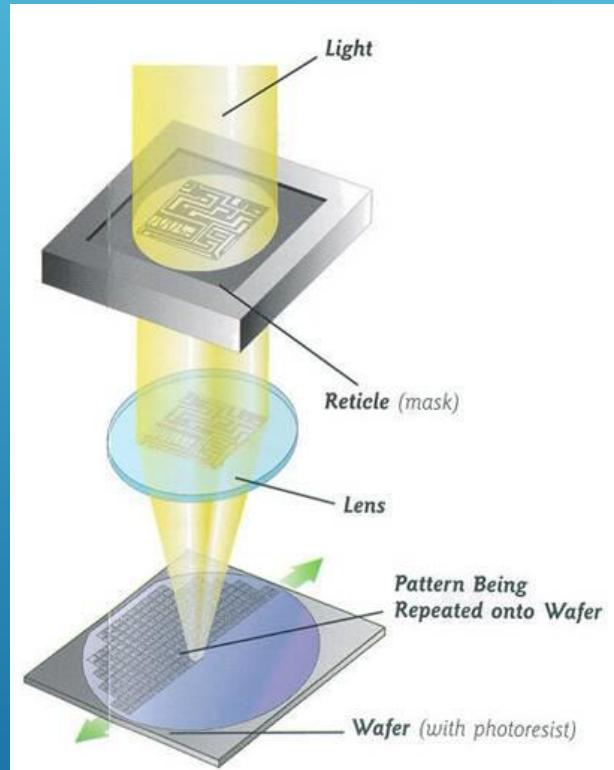
# **Shockley, Bardeen, Brattain, 1947, Bell Labs – working transistor**

# Lilienfeld, Schrader, Amrad/Magnavox – patent for FET transistor (not built)



**Hoff**, Intel 4004 CPU, **1971** – first commercial **microprocessor** (4 bit, <1Mhz clock)  
-10 micron feature size, 2250 transistors  
-vs. eg, **2020** Intel Xeon W-3175X has .014 micron sizes,  
8,000,000,000 (8B) transistors, 64bit, 4300Mhz (4GHz)clock

# MAKING CHIPS – NOT MAGIC, JUST ADVANCED PHOTOGRAPHY



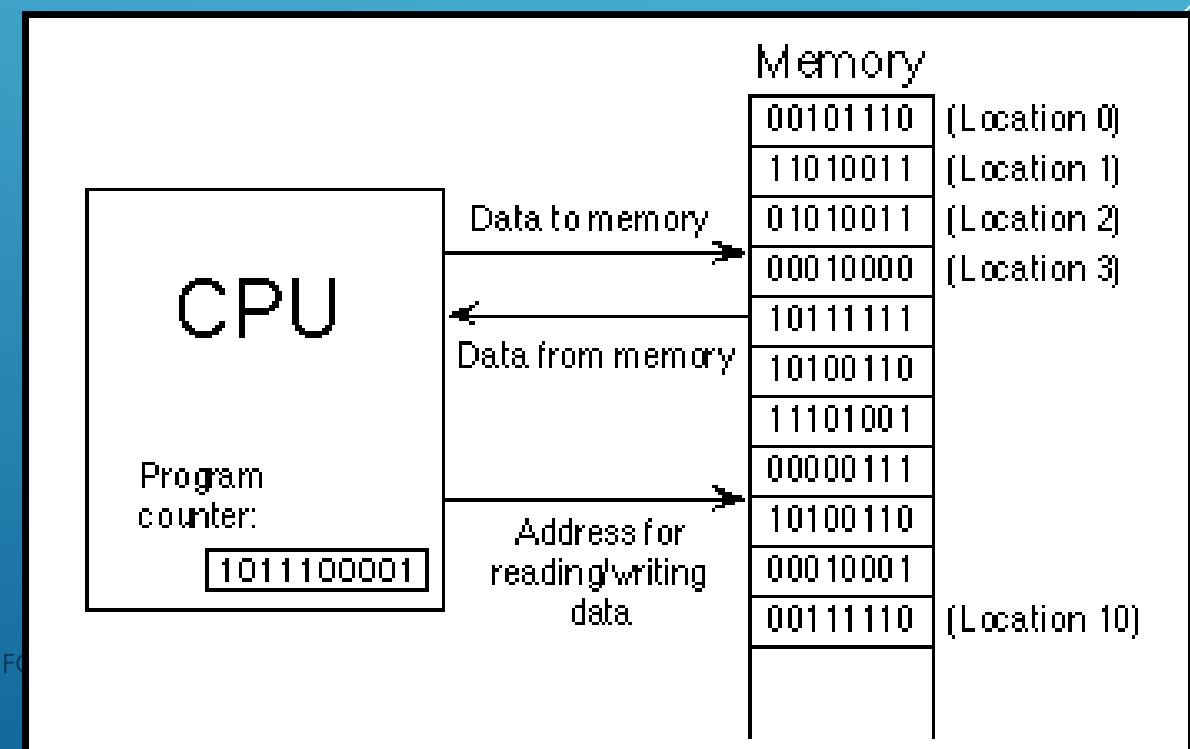
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- START WITH MEMORY LOCATION 0
- 1'S AND 0'S INTO LOGIC CIRCUITS IN CPU
- CPU -- DO SOME SIMPLE OPERATION

EG, memory A > memory B? Yes, write a '1'

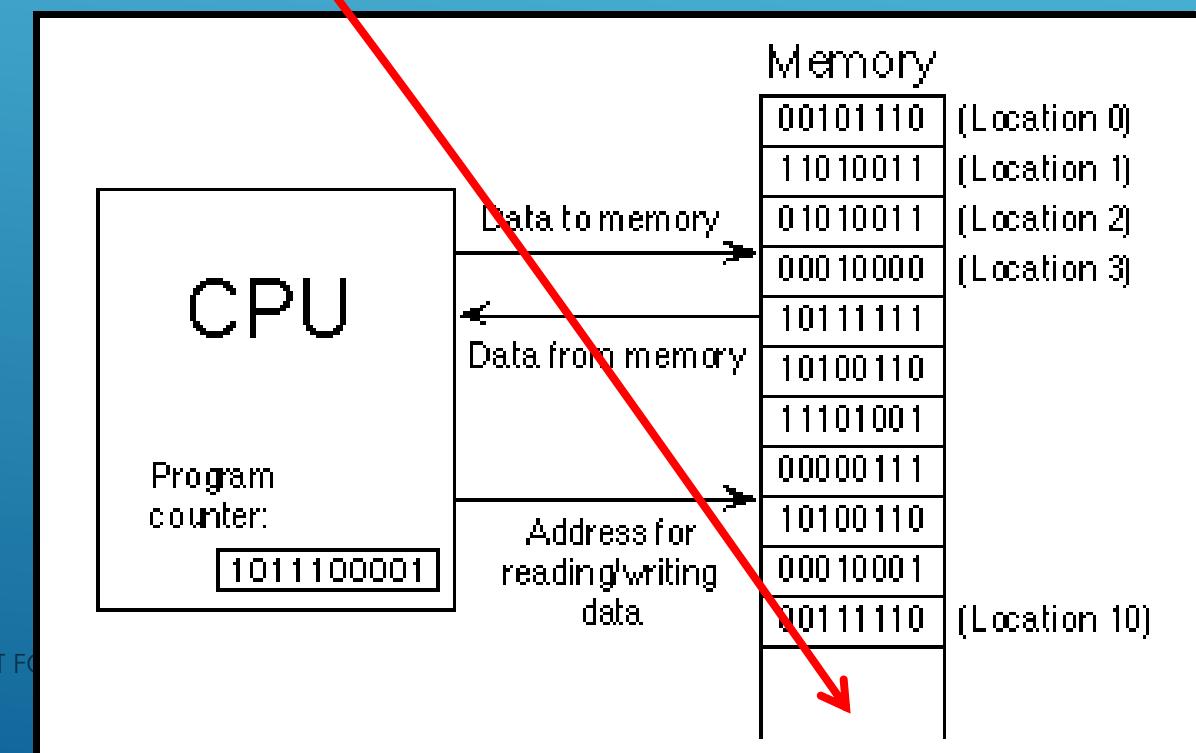
EG, Jump to memory location xx



SOME OF THE 1'S & 0'S ARE DATA, SOME OF THEM SPECIFY LOGIC OPERATIONS THE CPU IS SUPPOSED TO DO

EG, COMPARE TWO MEMORY LOCATIONS ALREADY LOADED IN THE CPU (EG, LOCATIONS #58 & #96)

-IF VALUE@ #58 > VALUE@# 96  
THEN SET A MEMORY 'FLAG'  
WHICH THEN NEXT STEP CAUSES  
A JUMP TO MEMORY LOCATION  
#155 AND USE THIS AS THE NEXT  
LOGIC OPERATION INSTRUCTION



# SYMBOLIC COMPUTER PROGRAM ('GOFAI') IS TURNED INTO 1'S AND 0'S AND CPU PROCESSES IT

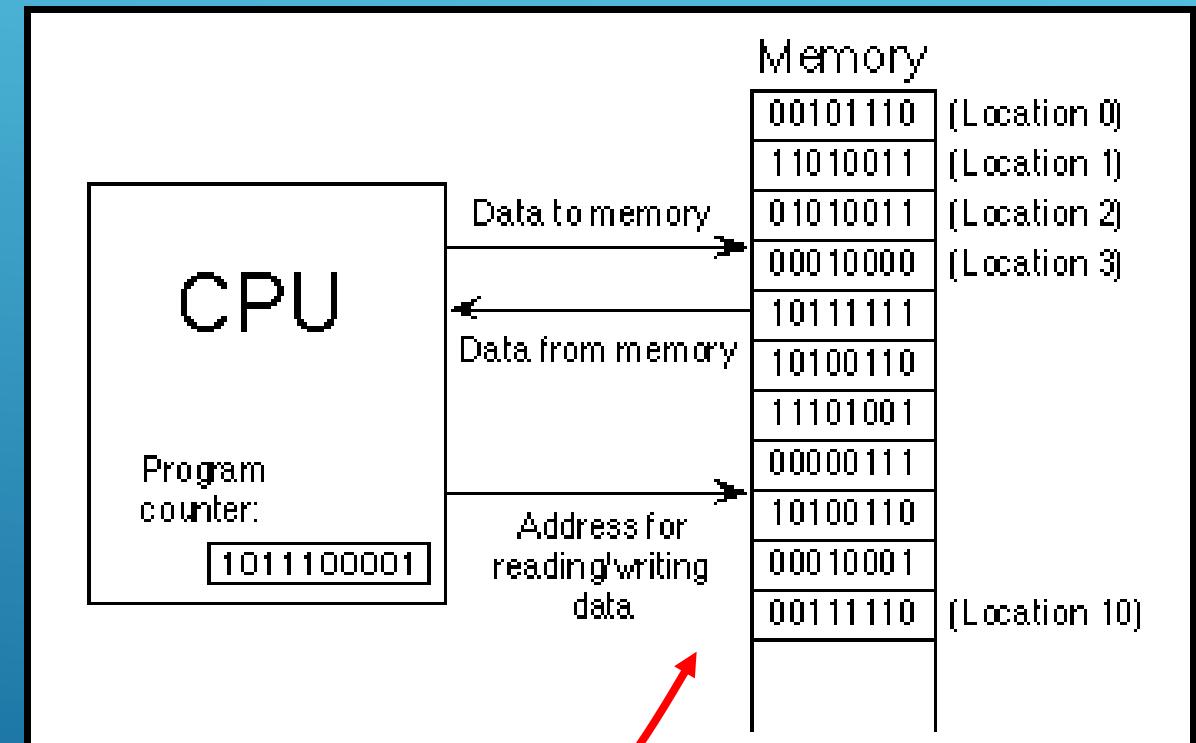
King(John)  $\wedge$  Greedy(John)  $\Rightarrow$  Evil(John)

```
if king and greedy:  
    print(f'{x} is an evil king')  
else:  
    .......
```

PYTHON  
COMPILER/  
INTERPRETER

into  
'bytecode'

1's and 0's  
'machine code'

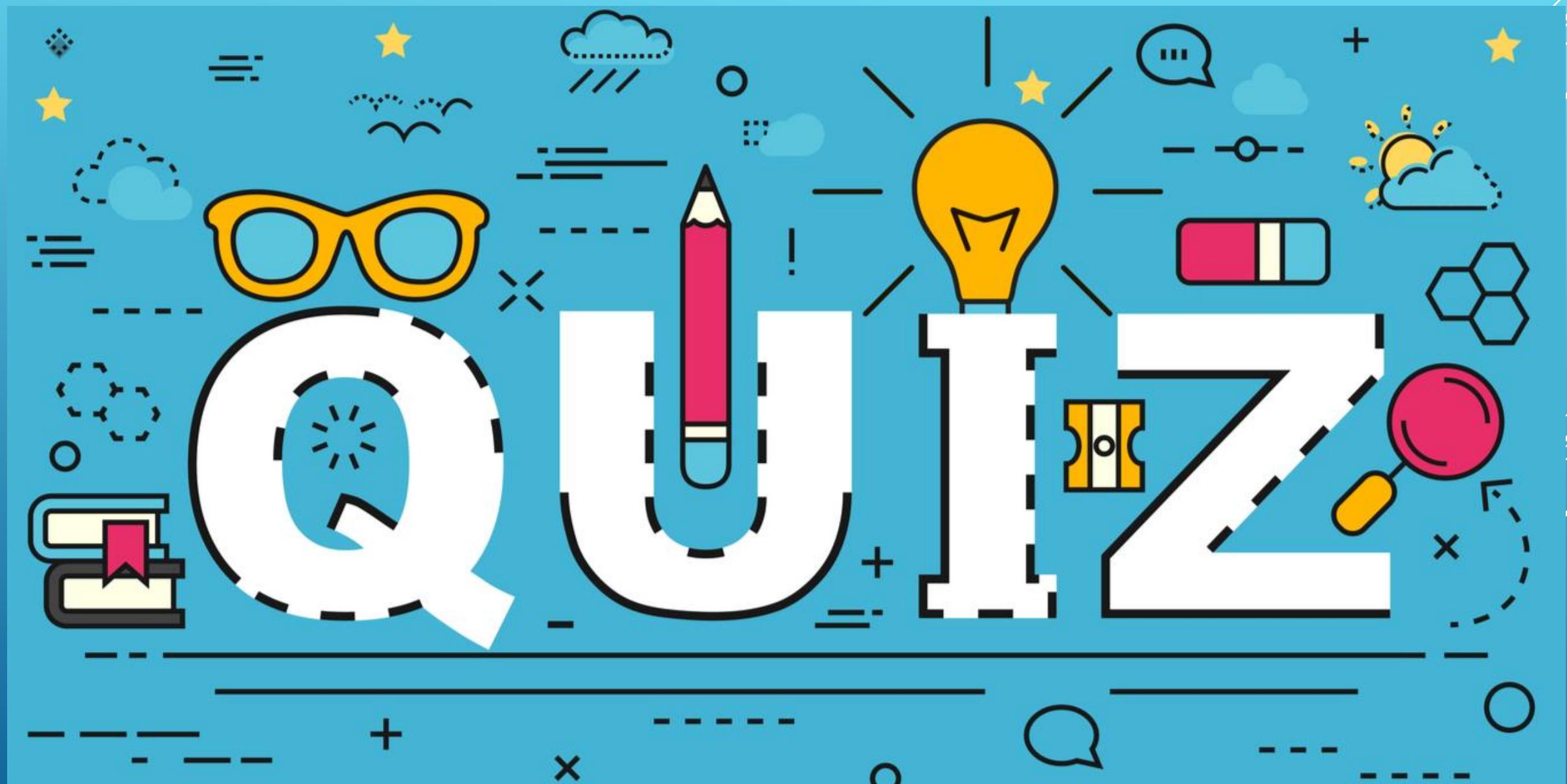


**NEW TOPIC**

# **SECOND REVIEW QUIZ**

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## QUIZ – QUESTION 1.

WHAT IS REINFORCEMENT LEARNING?

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# REINFORCEMENT LEARNING

-NETWORK ('AGENT') TRIES TO MAXIMIZE THE REWARD  
EG, PLAYS CHESS/SHOGI/GO AGAINST ITSELF MILLIONS  
AND MILLIONS OF TIMES

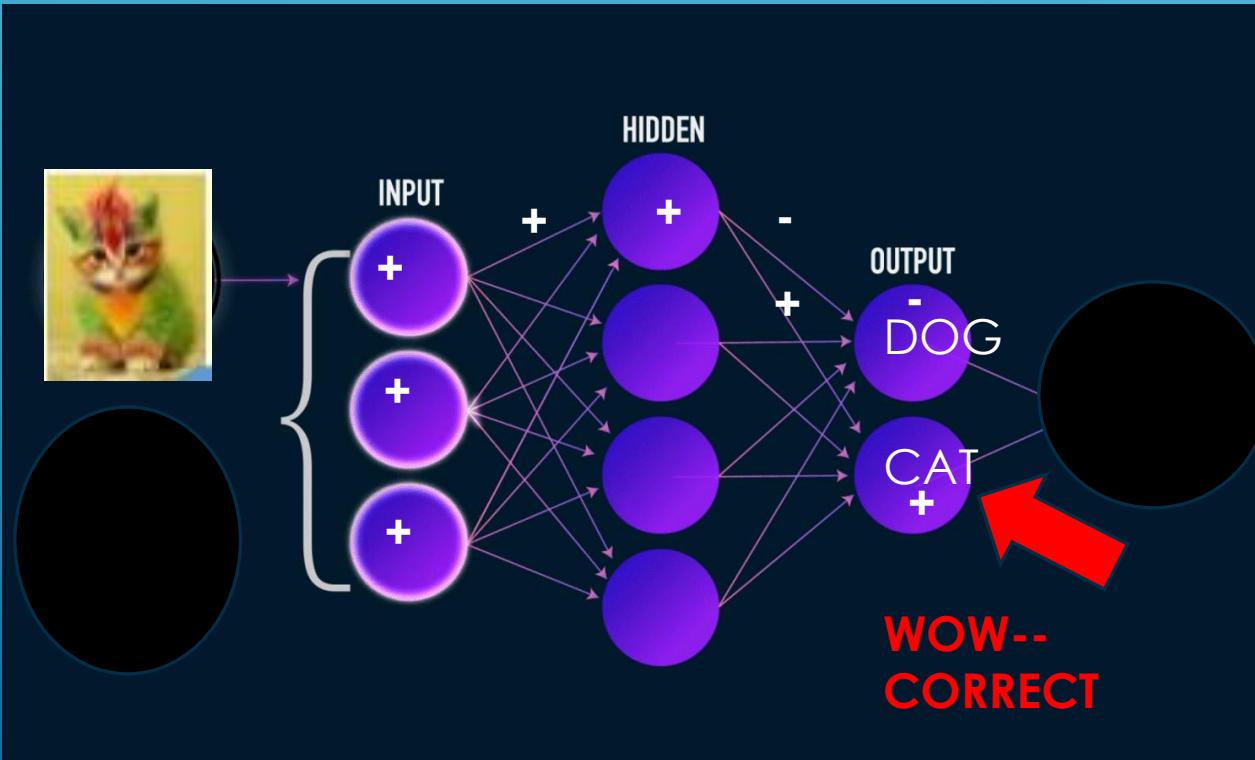


Deepmind 2017: Alphazero –  
superhuman performance in  
chess, shogi & go

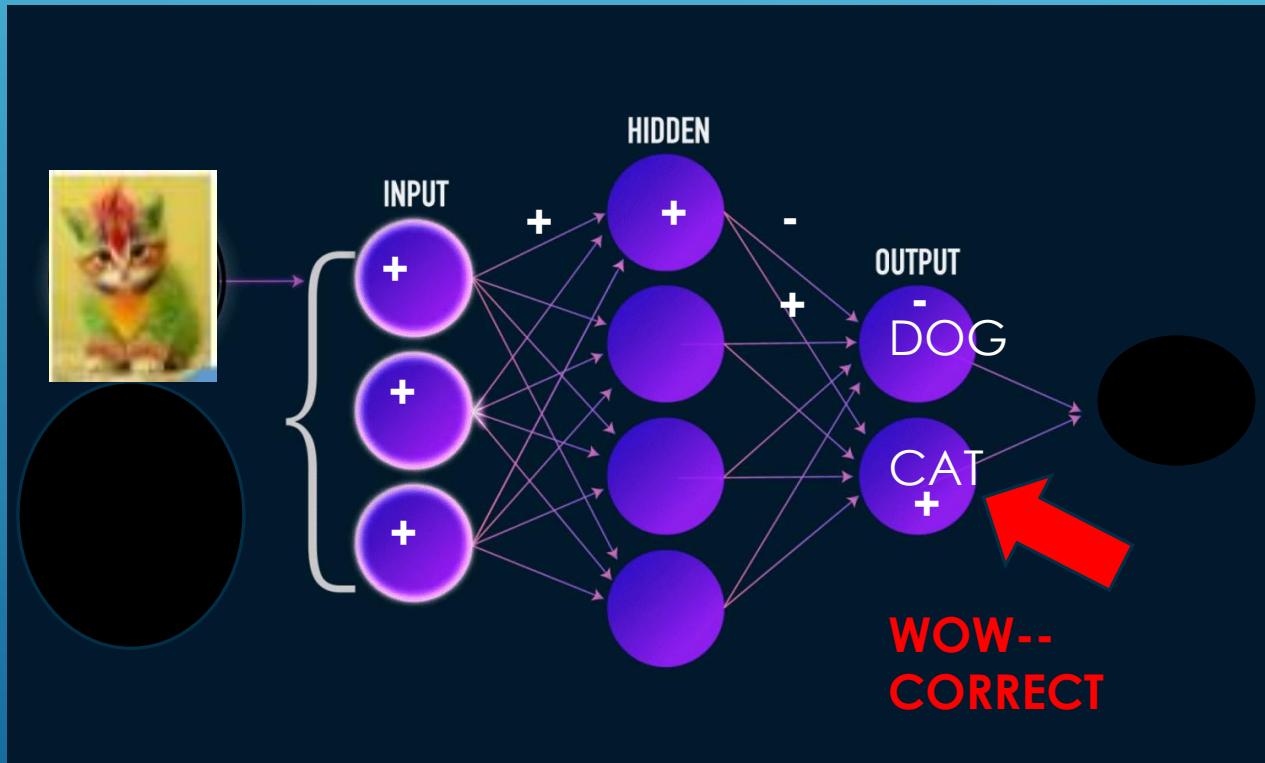
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# QUIZ – QUESTION 2. WHAT KIND OF SYSTEM IS SHOWN BELOW?



# DEEP LEARNING TO RECOGNIZE ALL SORTS OF CATS AND DOGS



“Connectionism”  
“Neural Network”  
“Deep Learning Network”

# DEEP LEARNING CAN RECOGNIZE OR ASSOCIATE ALL KINDS OF INFORMATION – IMAGES, FACES, SPEECH, MARKETING DATA, XRAY IMAGES.....



## QUIZ – QUESTION 3. WHAT KIND OF COMPUTER SYSTEM HANDLES THE LOGIC SHOWN BELOW?

$\forall x \text{King}(x) \wedge \text{Greedy}(x) \Rightarrow \text{Evil}(x)$  *← axiom*  
*(“All greedy kings are evil”)*

*Therefore can infer:*

$\text{King}(\text{John}) \wedge \text{Greedy}(\text{John}) \Rightarrow \text{Evil}(\text{John})$

# GOOD OLD FASHIONED ARTIFICIAL INTELLIGENCE ("GOFAI") "SYMBOLIC AI"

$\forall x \text{King}(x) \wedge \text{Greedy}(x) \Rightarrow \text{Evil}(x)$  *← axiom*  
*("All greedy kings are evil")*

*Therefore can infer:*

$\text{King}(\text{John}) \wedge \text{Greedy}(\text{John}) \Rightarrow \text{Evil}(\text{John})$

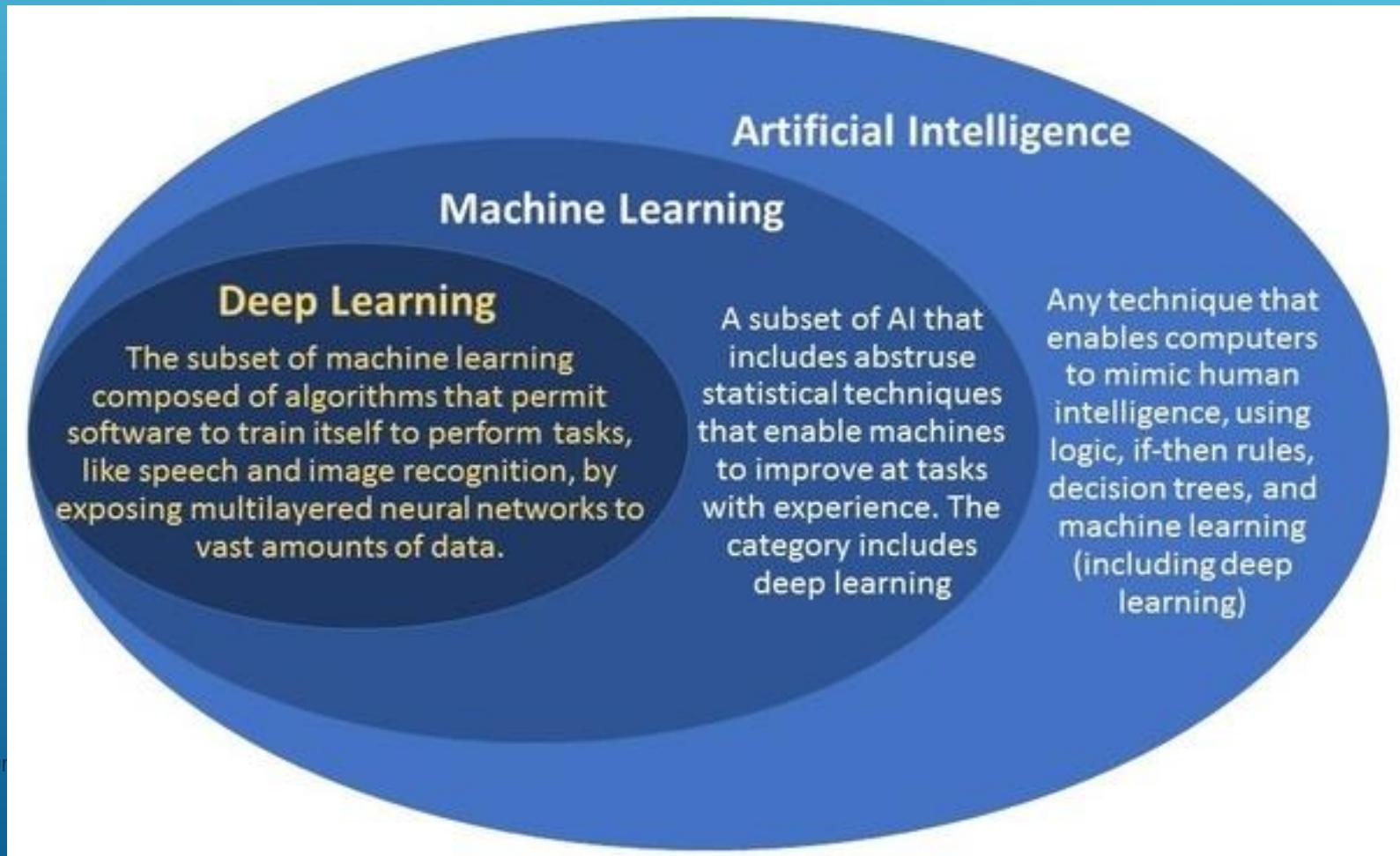
# GOOD OLD FASHIONED ARTIFICIAL INTELLIGENCE “GOFAI” == “SYMBOLIC AI”

```
yes_synonyms = ['y', 'Y', 'yes', 'Yes', 'T', 'true']
x = input('What is the name of the person? ')
king = input(f'Is {x} a king? ')
if king in yes_synonyms:
    king = True
else:
    king = False
greedy = input(f'Is {x} greedy? ')
if greedy in yes_synonyms:
    greedy = True
else:
    greedy = False
if king and greedy:
    print(f'{x} is an evil king')
else:
    print(f'We cannot infer that {x} is an evil king')
```

```
C:\Users\howar>kings.py
What is the name of the
person? Sebastian
Is Sebastian a king? yes
Is Sebastian greedy? yes
Sebastian is an evil king
```

## Quiz – question 4

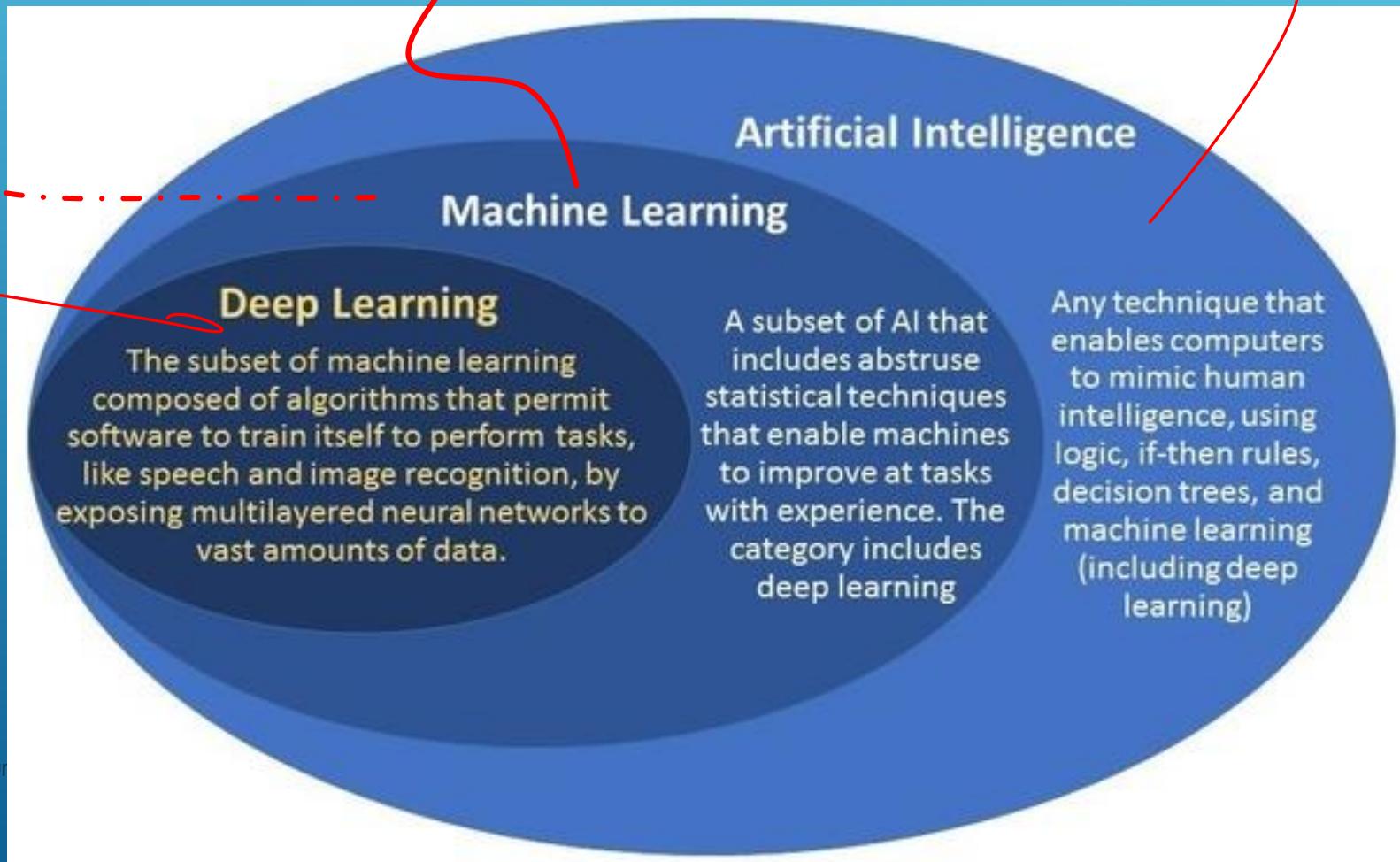
Where are Neural Networks in the diagram below?  
Where is Symbolic (GOFAI) in the diagram below?



# Many other non-ANN ML algorithms exist

## Neural networks

## Symbolic AI



# LEARNING OBJECTIVES

- ▶ 1. Real understanding of what AI is:
- ▶ 1a. Deep Learning and Reinforcement Learning
- ▶ 1b. Field of Artificial Intelligence (AI)
- ▶ **1c. Neuro-Symbolic Gap**
- ▶ 2. How will AI in next decade (or two) affect my patients' lives?
- ▶ 3. How will AI affect my practice of medicine including psychotherapy?
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- ▶ 4. How will AI affect the future of mankind?
- ▶ 5. Discussion

**NEW TOPIC**

# NEURO-SYMBOLIC GAP

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WE HAVE COVERED :

-DEEP LEARNING (**NEURAL** NETWORKS AI)  
ASSOCIATIONS, RECOGNITION (IMAGES, SPEECH, ETC....)  
BIG SUCCESSES!!

-**SYMBOLIC** AI  
**LOGIC**

BIG FAILURES!! EG, EXPERT SYSTEMS -> AI WINTERS!!

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# The Neural Symbolic Gap

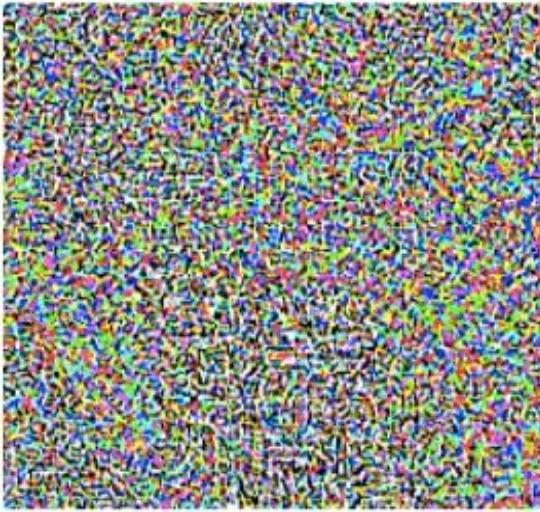


- **Neural Network** – phenomenal image processing and reinforcement learning
- **Child** – phenomenal causal symbolic learning with few examples (eg, Gopnik)



**“panda”  
57.7% confidence**

+



=

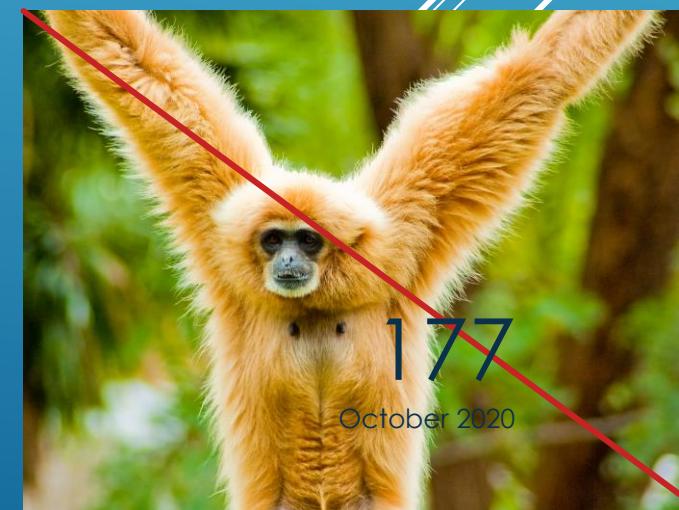


**“gibbon”  
99.3 % confidence**

Goodfellow,I.J., Shlens,J. and Szegedy,C. (Google Mountainview), Explaining and Harnessing Adversarial Examples, ICLR 2015.

It's still a Panda – and the 3 year old boy would know this!!  
(and.... 3 year old only needs 1 or 2 photos for training, not 1000s)

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## Deep Learning Neural Network

Pattern Recognition  
→Recognize the World

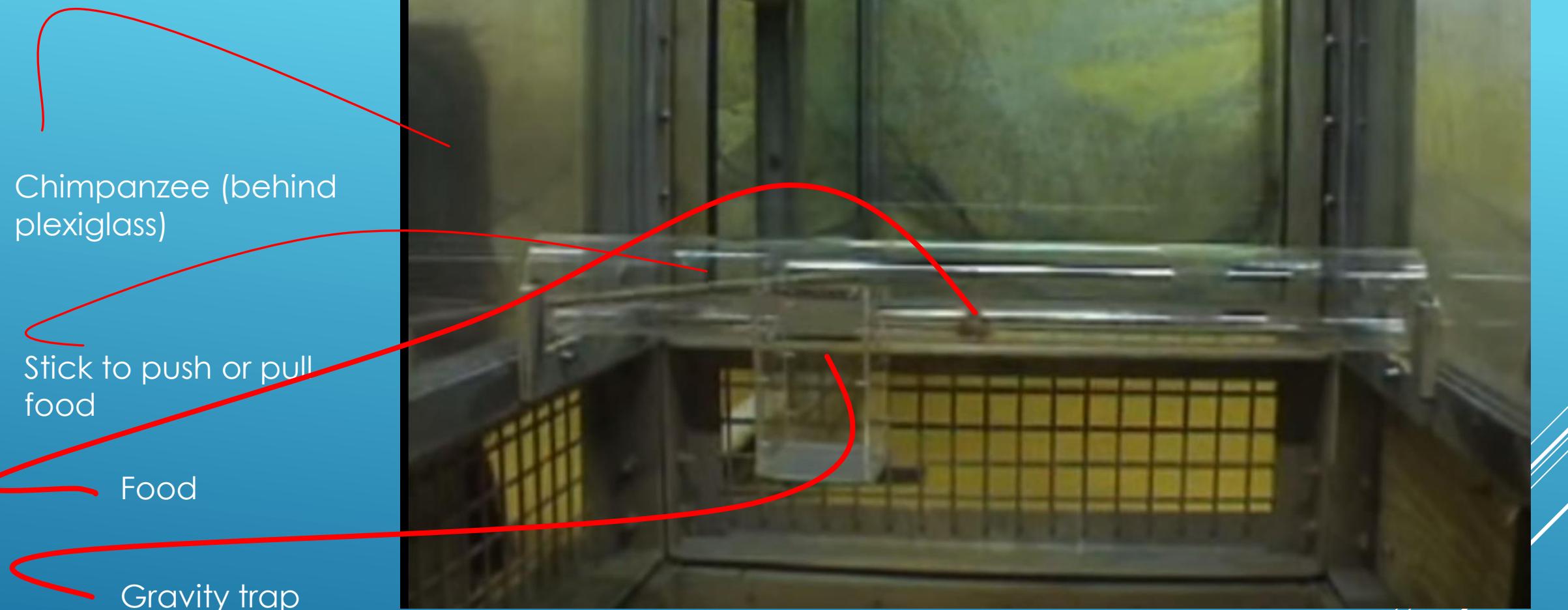
Need 1000's examples for learning

## 3 Year Old Human Child

Model Building +also Pattern Recognition  
→Explain the World

A few examples enough

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Chimpanzees **do not** have full causality

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Deep Learning has zero Understanding  
**Deep Learning gets more powerful by  
brute force**

300,000x increase in computing power  
the last few years  
NOT SUSTAINABLE -- There is a deep flaw  
in deep learning

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Humans have causality. ✓

Animals do not. ← associations

Deep Learning does not. ← associations

**Humans** learn to drive with 5-15 hours of driving in a driver's ed course. Do not need to be programmed with every possible scene on the road – can figure it out (eg, bag on road).

**Deep Learning autonomous driving system** – must get training data showing \*everything\* since **it cannot causally reason**  
eg, one EV company has about a billion miles of driving experience of its cars as training data now.

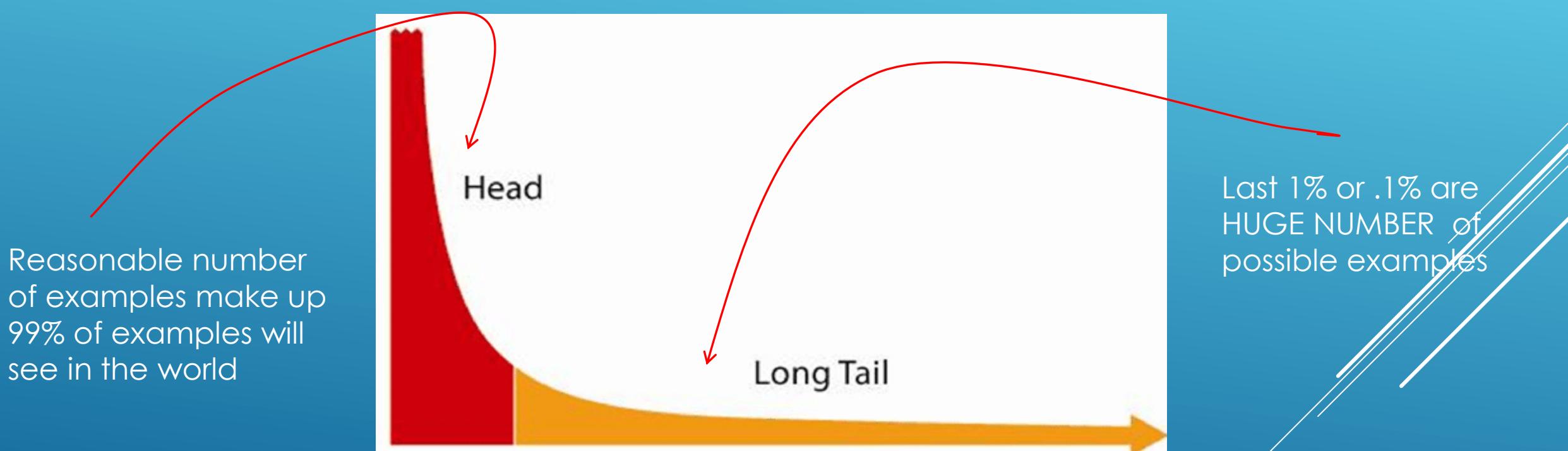
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Classic example: unless explicitly programmed, an autonomous driving system will follow a seemingly normal road and drive off a cliff (because it understands nothing!!)

(programmers add symbolic rules to autonomous driving systems and probably this one has been added already)



# Without causality need loads and loads of experience to see everything: ‘long-tail problem’



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March 18, 2018 – Uber self driving car kills pedestrian in Tempe, Arizona

-Uber's system never had training with image of pedestrian pushing bike across the *middle* of the street  
(Safety driver did not unfortunately respond to situation)



# The solution to the neurosymbolic gap: Ability to Generate Causal Behavior



‘Reptilian’ and ‘Mammalian’ Brain  
– Associative, Pre-Causal  
Functioning

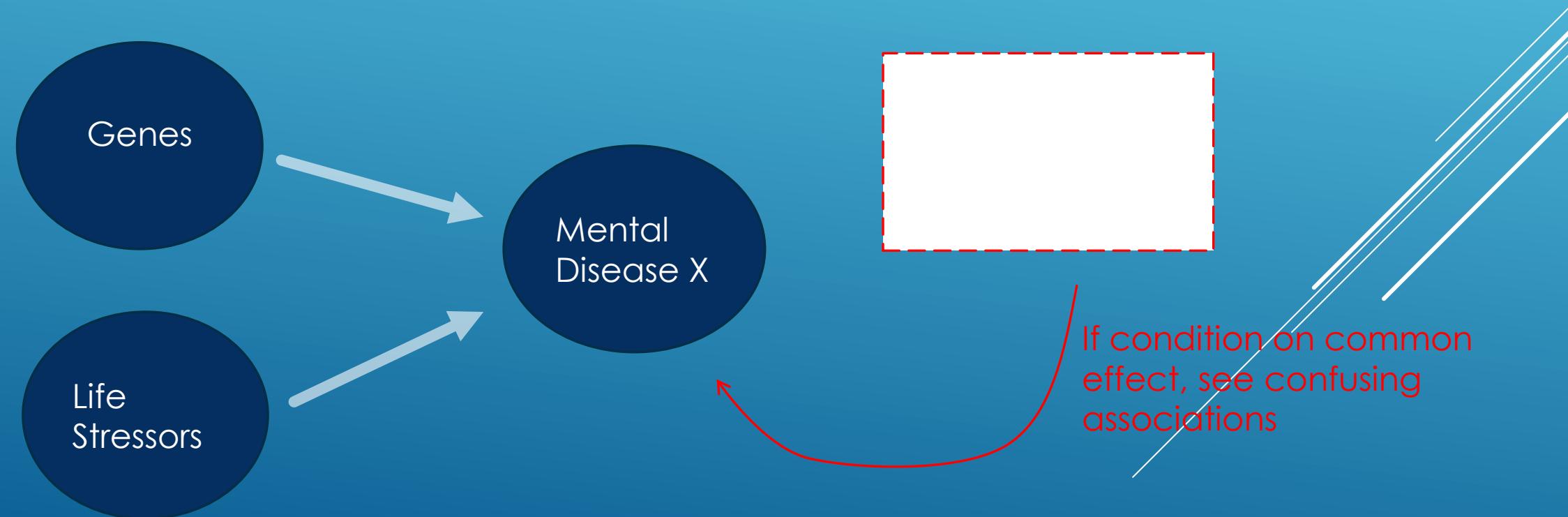


‘Human’ Brain, AGI – Full  
Causal Functioning

# Directed Acyclic Graphs ('Causal Graphs')

## Counterfactual Theory

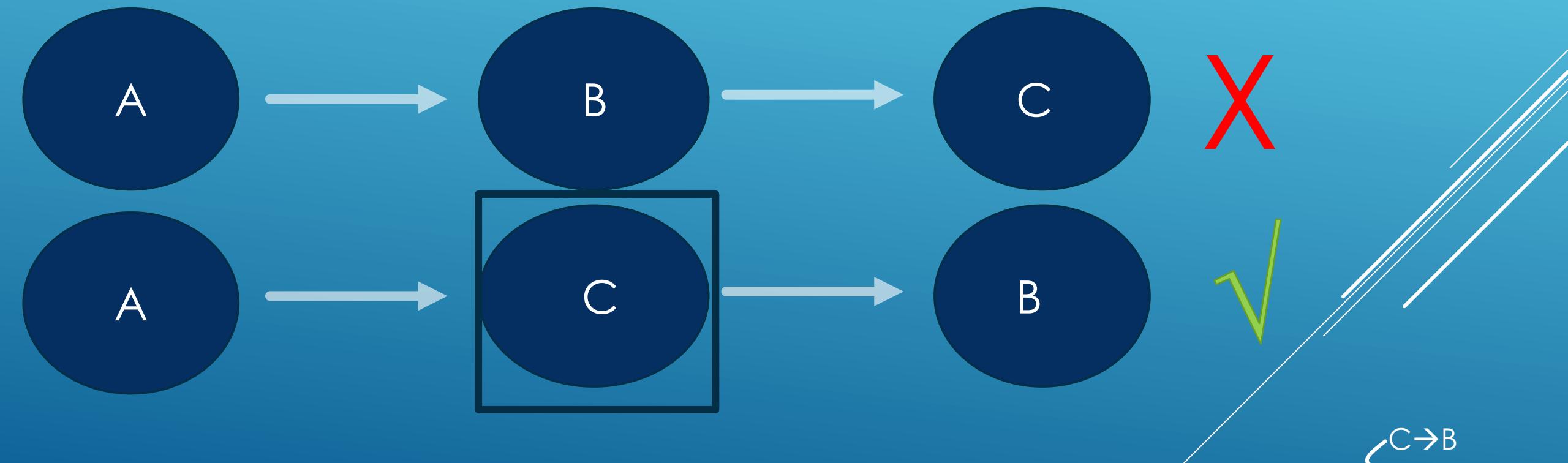
- Useful for **Analyzing** Causality, eg, epidemiology, genomics
- Less Useful for **Generating** Causality, eg, AGI



# Causal Discovery

Try to learn causal relationships from the data

eg, Data shows A & B are independent if we condition on C,  
but dependent if we don't



other causal models will also exist given this data....

$C \rightarrow B \rightarrow A$

# Directed Acyclic Graphs ('Causal Graphs')

## Counterfactual Theory

## Causal Discovery

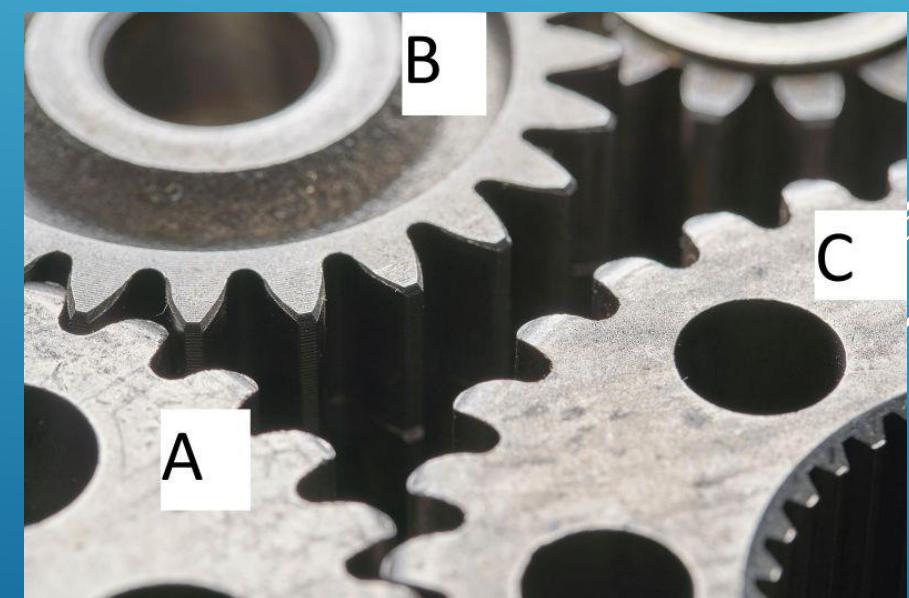
-Useful for **Analyzing** Causality

eg, epidemiology, genomics

-Less Useful for **Generating** Causal Behavior

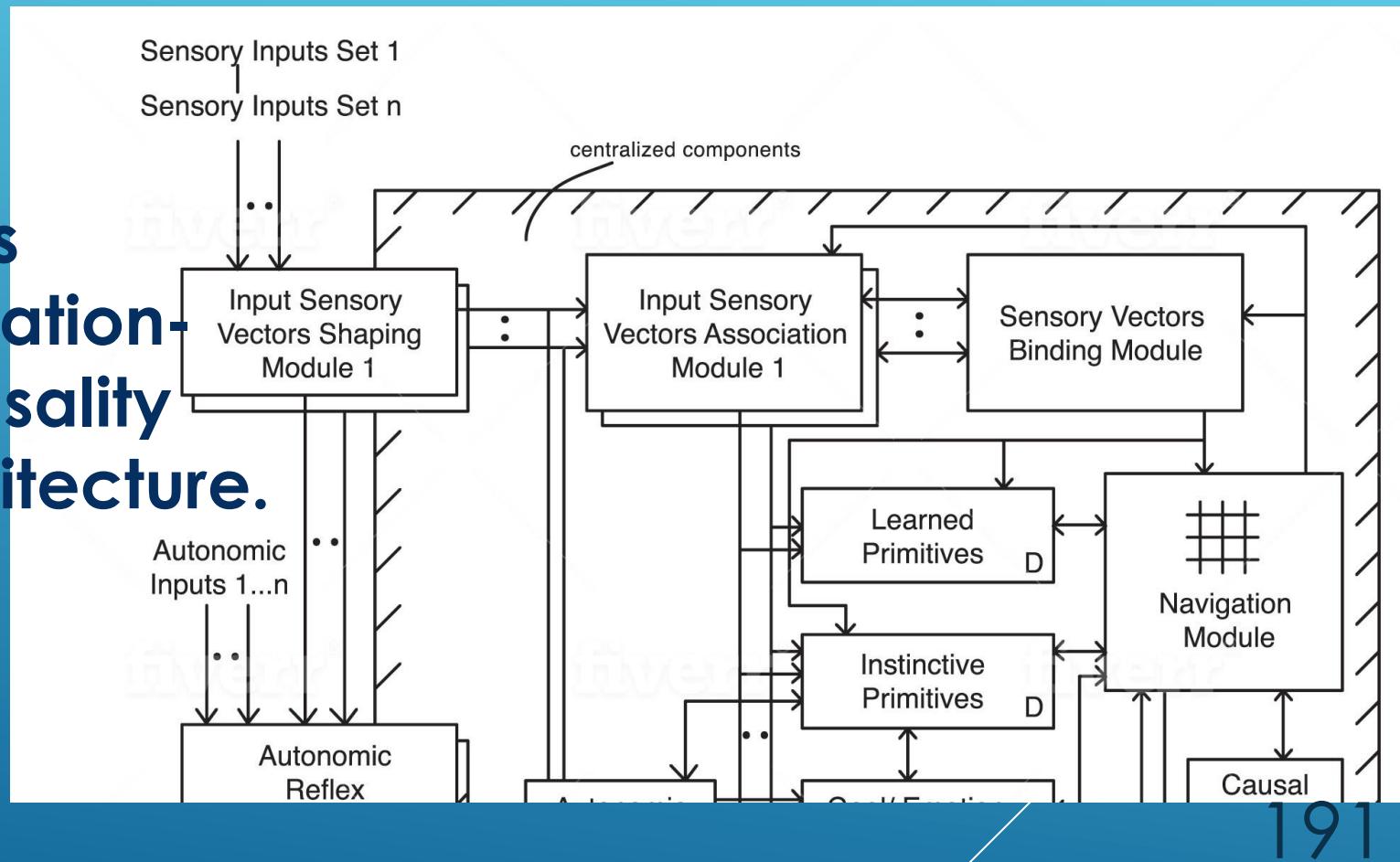
eg, AGI

*We want a mechanism for generating causal behavior in the real world*



# CAUSAL COGNITIVE ARCHITECTURE 1 – SCHNEIDER (IN PRESS)

Connectionist elements  
Integrated into a navigation-based framework. Causality emerges from the architecture.



# LEARNING OBJECTIVES

- ▶ 1. Real understanding of what AI is:
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- ▶ 5. **Discussion**

**NEW TOPIC**

# HOW WILL AI IN THE FUTURE AFFECT PATIENTS....ACTUALLY AFFECT ALL OF US?

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# **THIS DECADE (MY OPINION)**

- OTHER FACTORS OF MORE IMPORTANCE  
EG, COVID-19 RECOVERY, GLOBALIZATION, ETC**
- IMPROVEMENTS IN OFFICE AUTOMATION AND  
FACTORY AUTOMATION (EVEN WITHOUT AI) WILL  
AFFECT JOBS (IN GOOD AND BAD WAYS)**
- DEEP LEARNING CAN SPEED THIS UP**

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AI AND THE WORK OF  
THE FUTURE CONGRESS  
2019  
UNCONFERENCE  
REPORT

**"SENSE OF POWERLESSNESS – WORRY..."**  
→ RECORD LEVELS OF INEQUALITY, LOWER SOCIAL  
MOBILITY

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**-HOWEVER, TECH USE IN HIGH SKILL JOBS  
MAKES THESE JOBS MORE PRODUCTIVE &  
PAYING VS LOW SKILL JOBS**

**→NEED TO FIX IMBALANCE BETWEEN  
WORKERS HELPED AND HURT BY NEW  
ECONOMY**

**→ NOT REALLY DUE TO AI AT THIS POINT**

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# AI -- NEXT DECADE

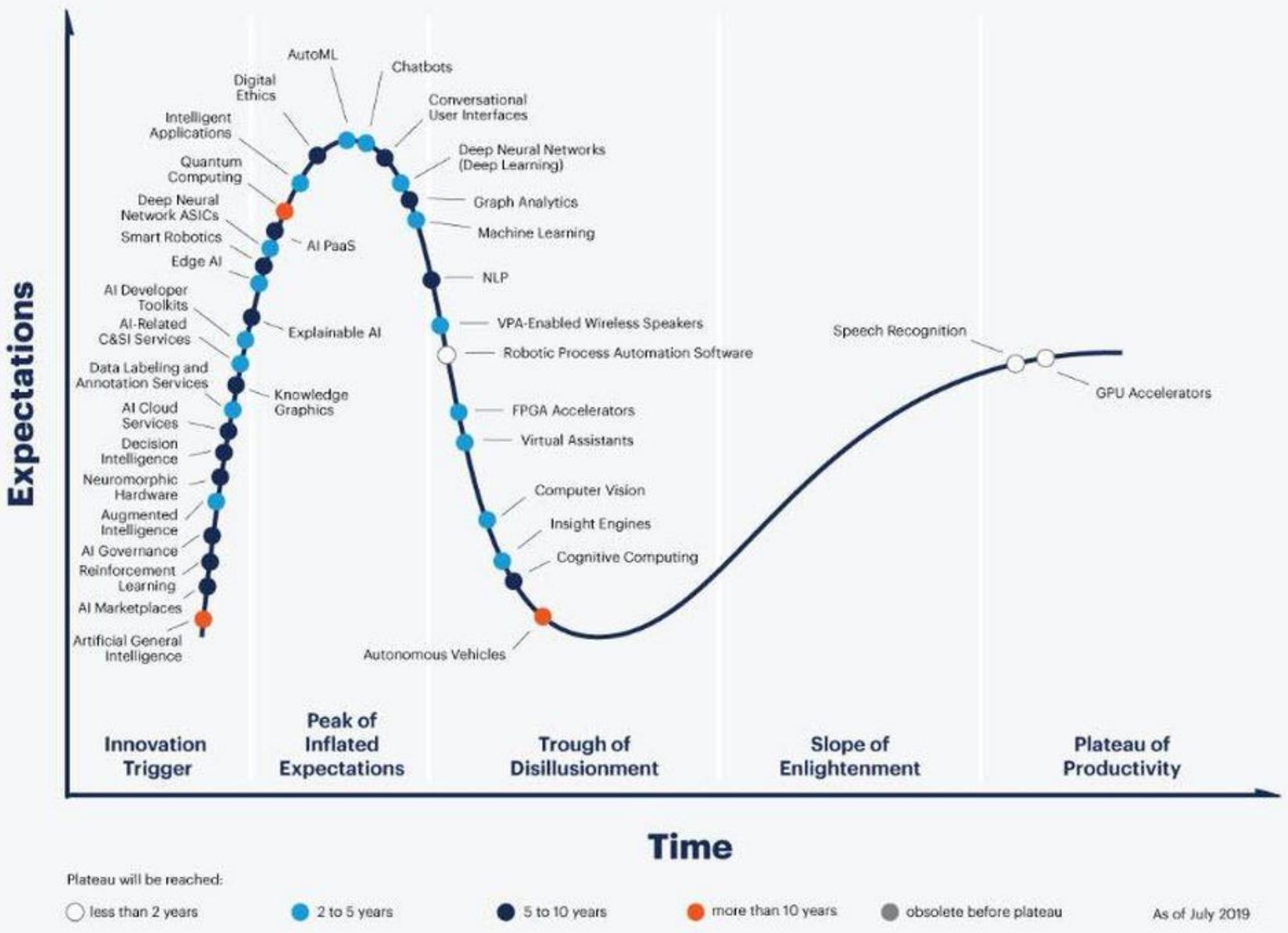
*“It's tough to make predictions,  
especially about the future”*

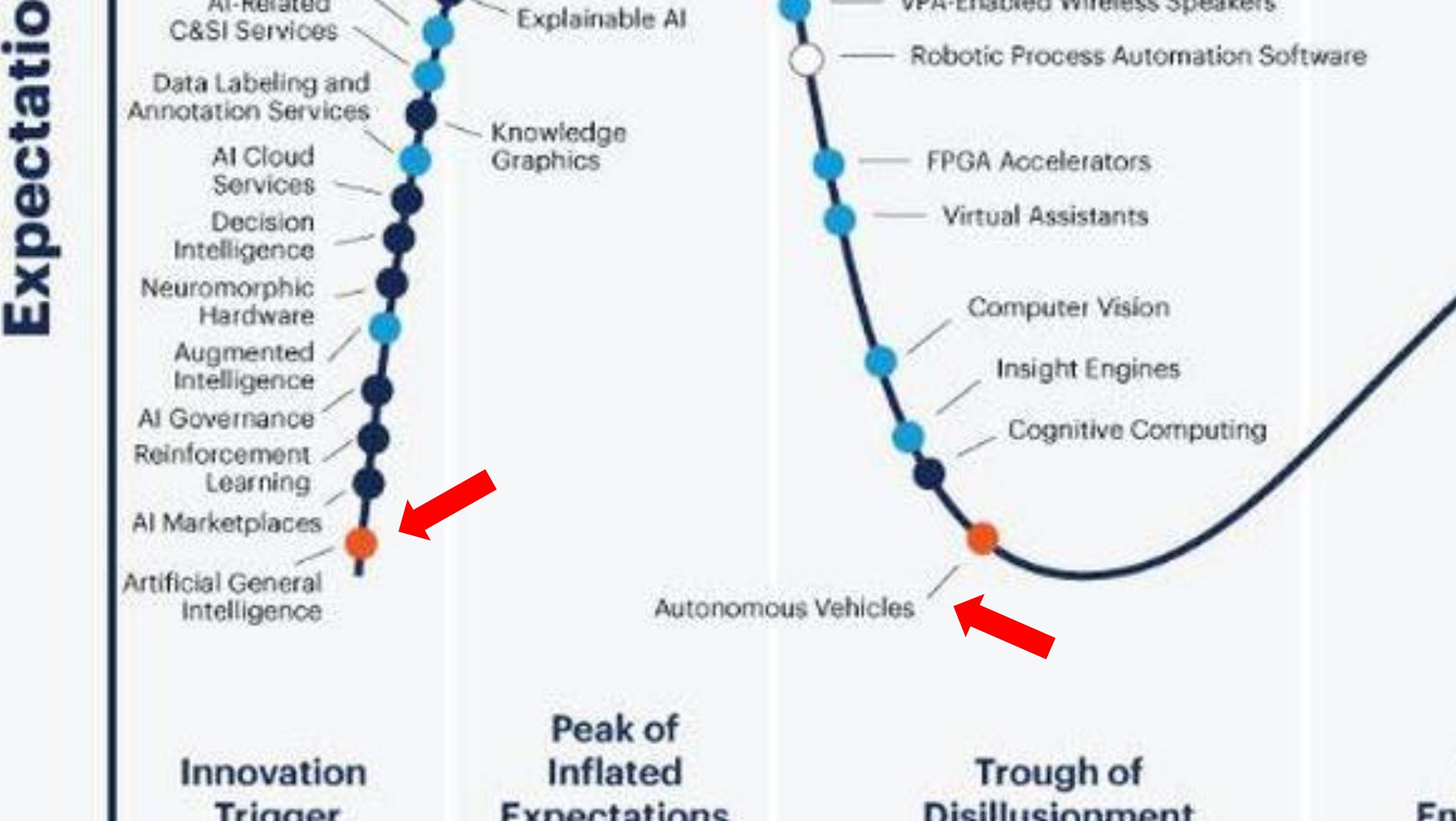
--Yogi Berra

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# Gartner Hype Cycle for Artificial Intelligence, 2019





# NEXT DECADE (MY OPINION)

-ONCE THERE IS CAUSALITY IN AI + APPROPRIATE TRAINING + LOWERED 'COMPUTE' COSTS -- AI SYSTEMS SHOULD BE ABLE TO DO THE WORK ALMOST ANY WORKER CAN DO

**-TIME OF STRESS FOR OUR PATIENTS WITHOUT APPROPRIATE SOCIETY PROGRAMS IN PLACE**

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# LEARNING OBJECTIVES

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# LEARNING OBJECTIVES

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**NEW TOPIC**

# HOW WILL AI IN FUTURE AFFECT THE PRACTICE OF MEDICINE, INCLUDING PSYCHOTHERAPY?

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# HEALTHCARE GENERATES LOTS OF ‘BIG DATA’

“Big Data”

- large amounts of data
- not manageable using traditional software
- hence desirability of using “AI”

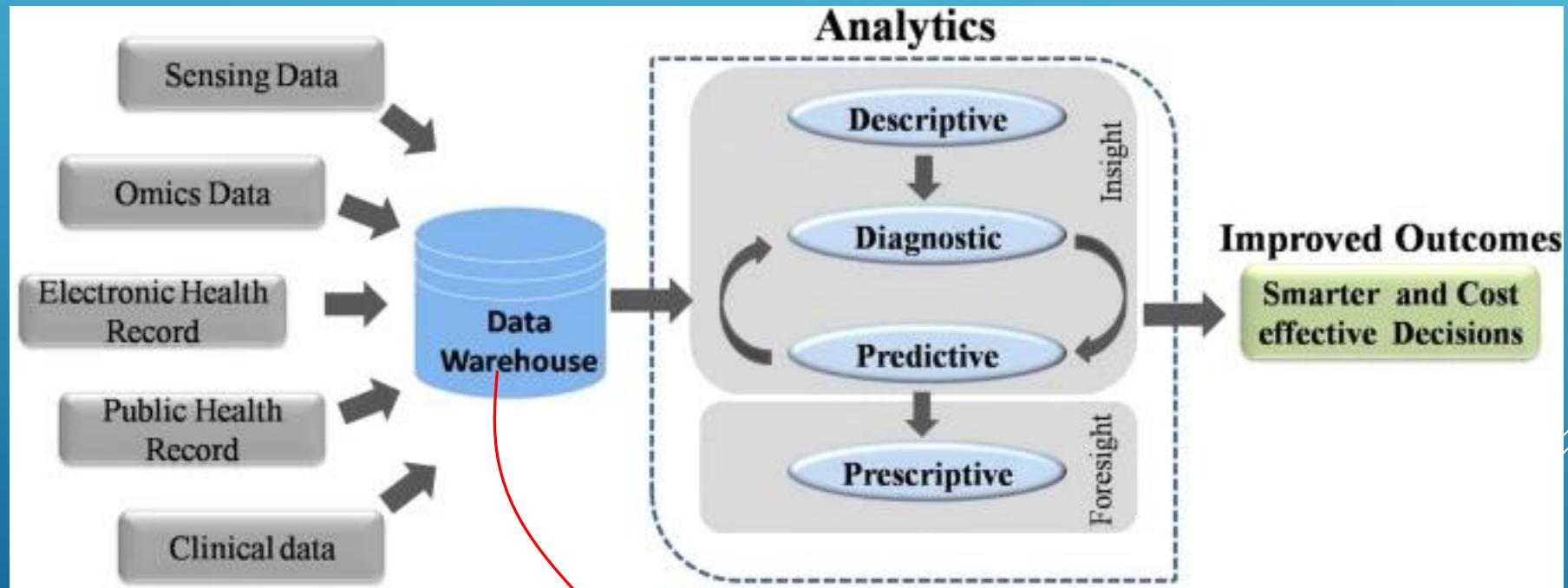
Big Data – Volume, Velocity, Variety

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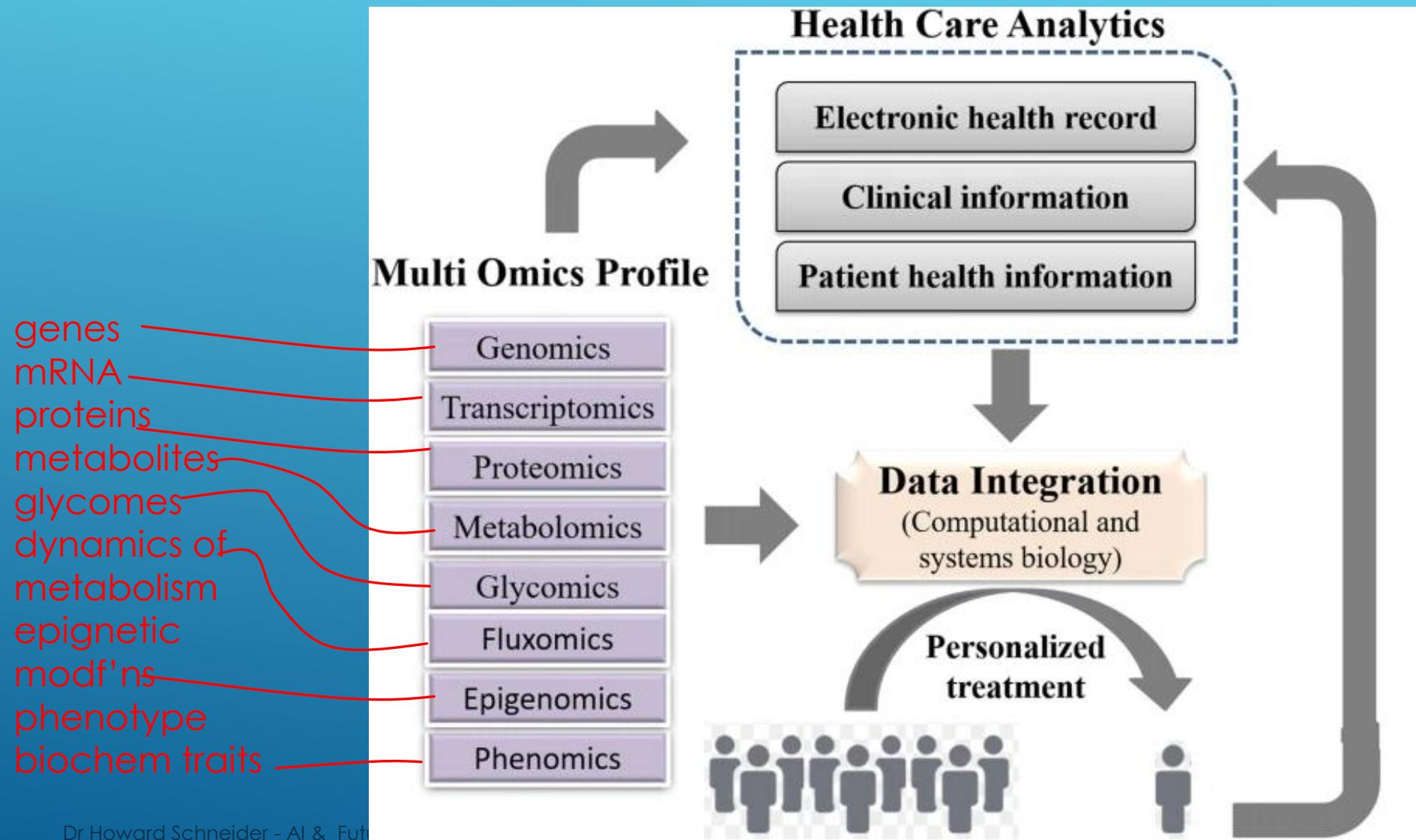


# HEALTHCARE BIG DATA ANALYTICS

("Analytics" – Discovery of meaningful patterns in data)



# USING BIG DATA FOR PERSONALIZED TREATMENT



# MEDICAL AI SYSTEMS

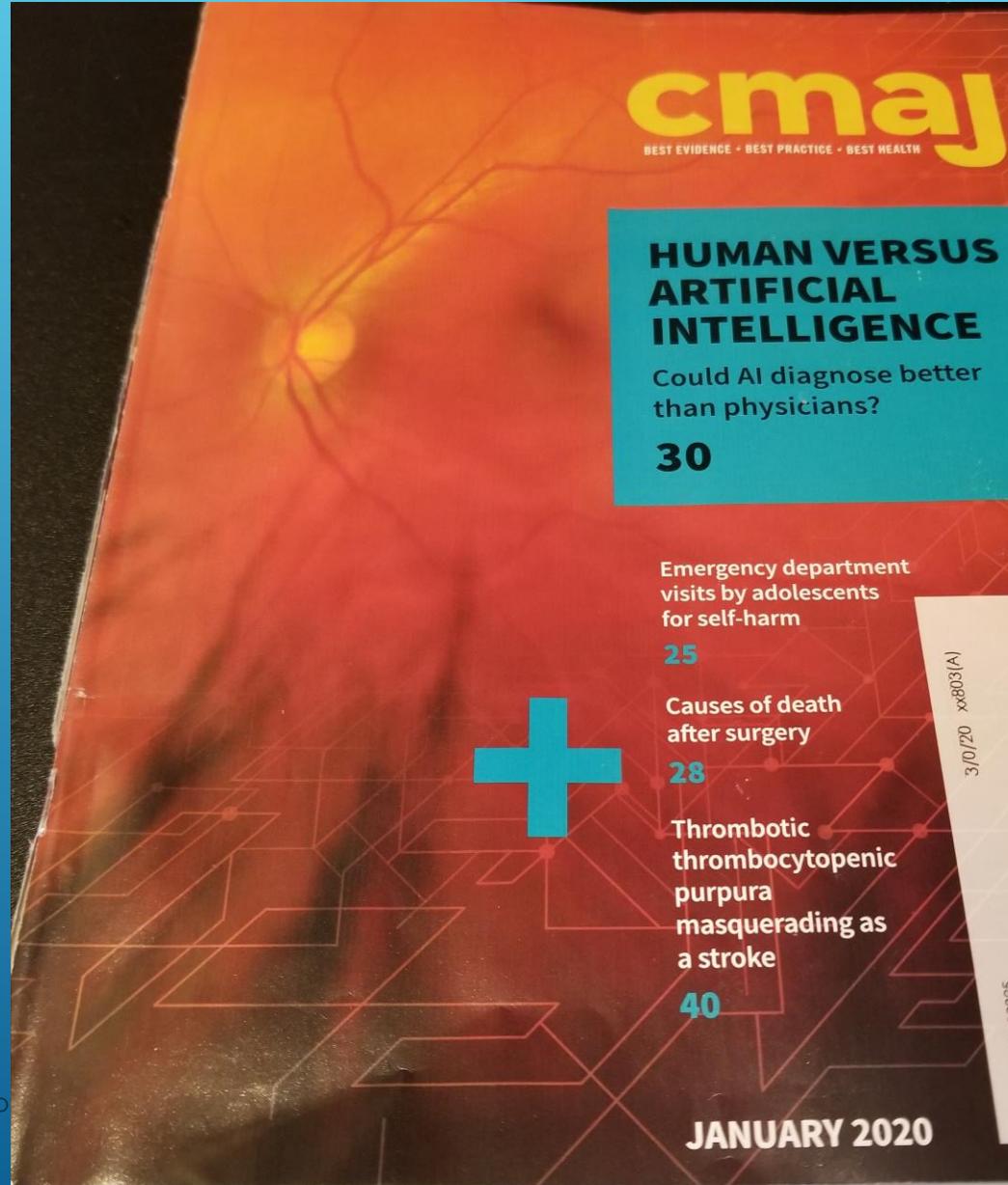
- NO UNDERSTANDING OF WHAT THEY ARE DOING
- NO/POOR CAUSALITY
- THEY CAN'T EVEN EXPLAIN WHAT THEY ARE DOING



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# COVER STORY OF JANUARY 2020 PRINT CMAJ



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# THE ARTICLE TALKED ABOUT INTELLIGENCE IN HUMANS AND MACHINES IN VAGUE WAYS....

ANALYSIS +

**“Because human and artificial intelligences are different and complementary, it is unlikely that AI will entirely replace the physician in the resolution of clinical problems.”**



My view:

- current AI contains **no model** of the world, **no causal reasoning**
- instead functions as a **massive association machine**

# DEEP LEARNING FOR RADIOLOGY (REQUIRES MILLIONS OF XRAYS AS TRAINING DATA)

- USEFUL 3AM IN ER
  - USEFUL SCREENING
  - BUT.... NO CAUSALITY
- CLINICAL CORRELATION  
DISEASE PROGRESSION  
TEAM COLLABORATION

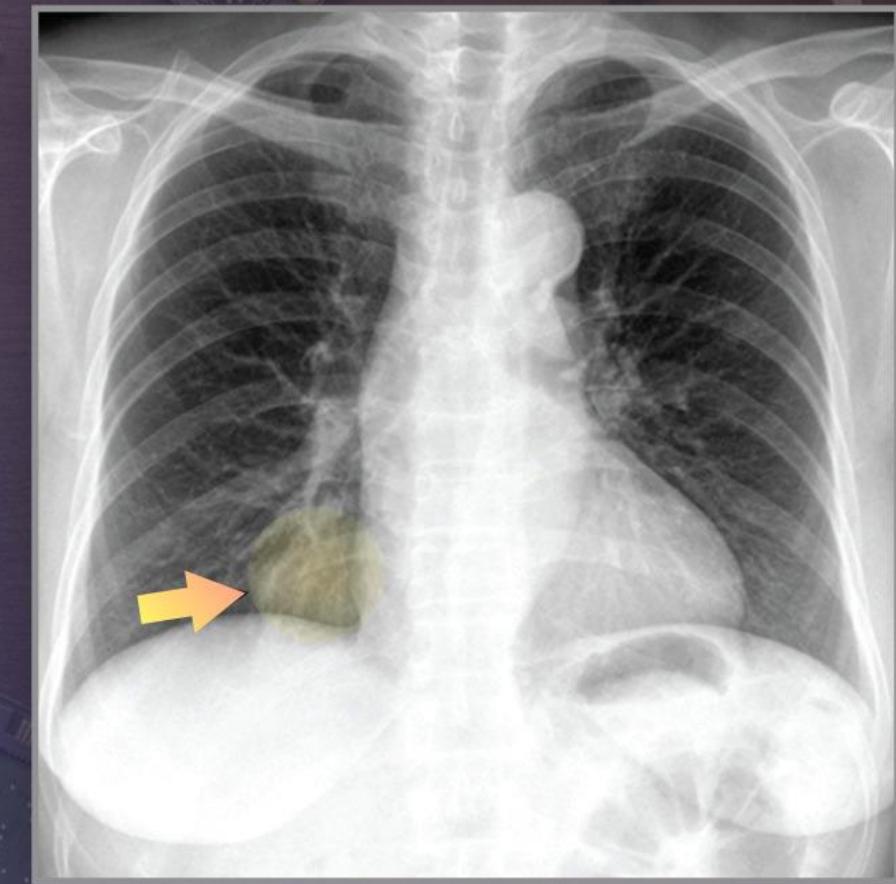
## Human vs Machine: Lung Tumor

Chest X-Rays image the lungs, heart, blood vessels, and bones. AI has been used to read and understand them.

Example:  
**Lung Tumor**

Computers:  
**Score: 0.291**

Doctors:  
**2/15 Detected**



Artificial Intelligence in Medicine

Volume 103, March 2020, 101785

The impact of machine learning on patient care: A systematic review

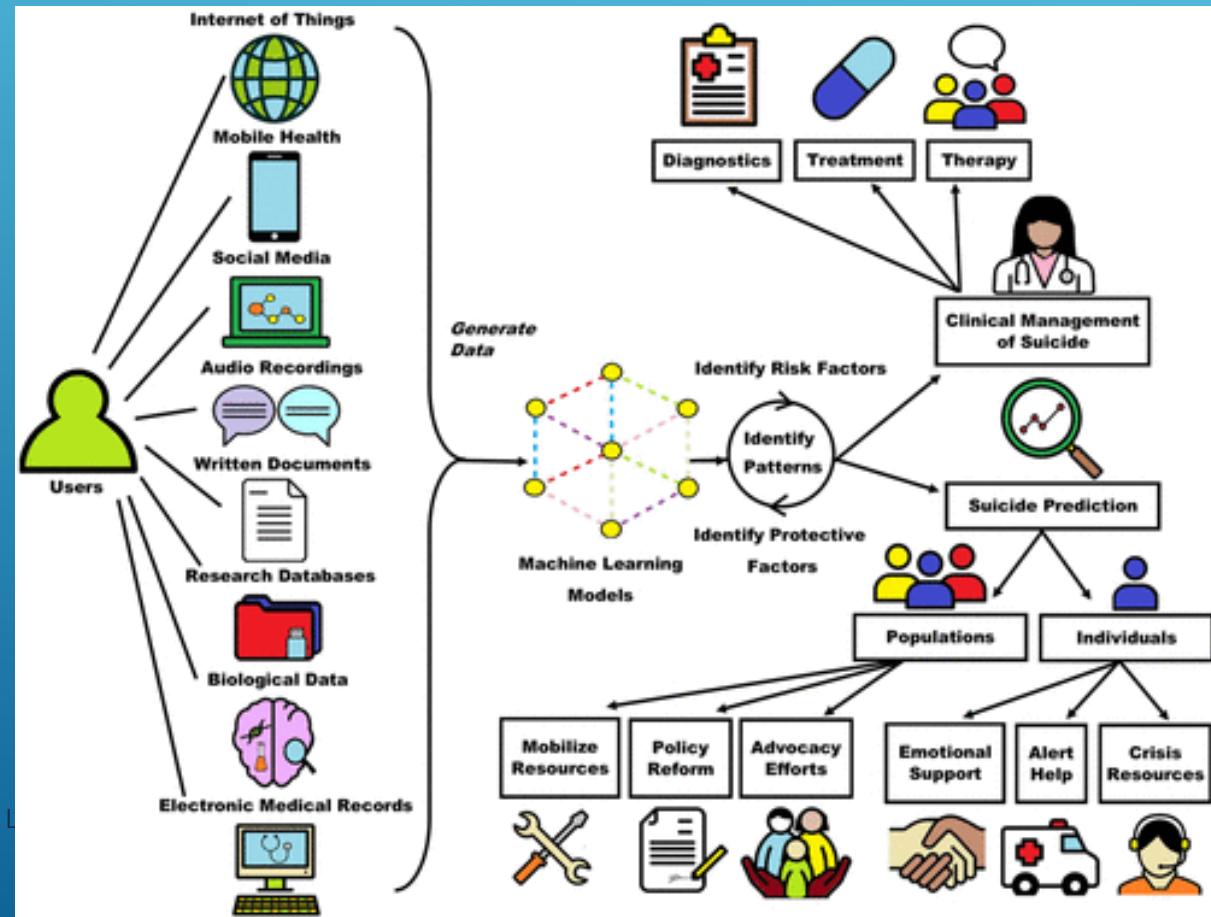
Ben-Israel and colleagues - Neurosurgery, University of Calgary

*“Despite the expanding use of machine learning (ML) in fields such as finance and marketing, its application in the daily practice of clinical medicine is almost non-existent.”*

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Dr Sidney Kennedy, University of Toronto  
Machine Learning in psychiatry  
-predict escitalopram treatment outcome from EEG  
-predict relapse, increased risk of suicidal behavior

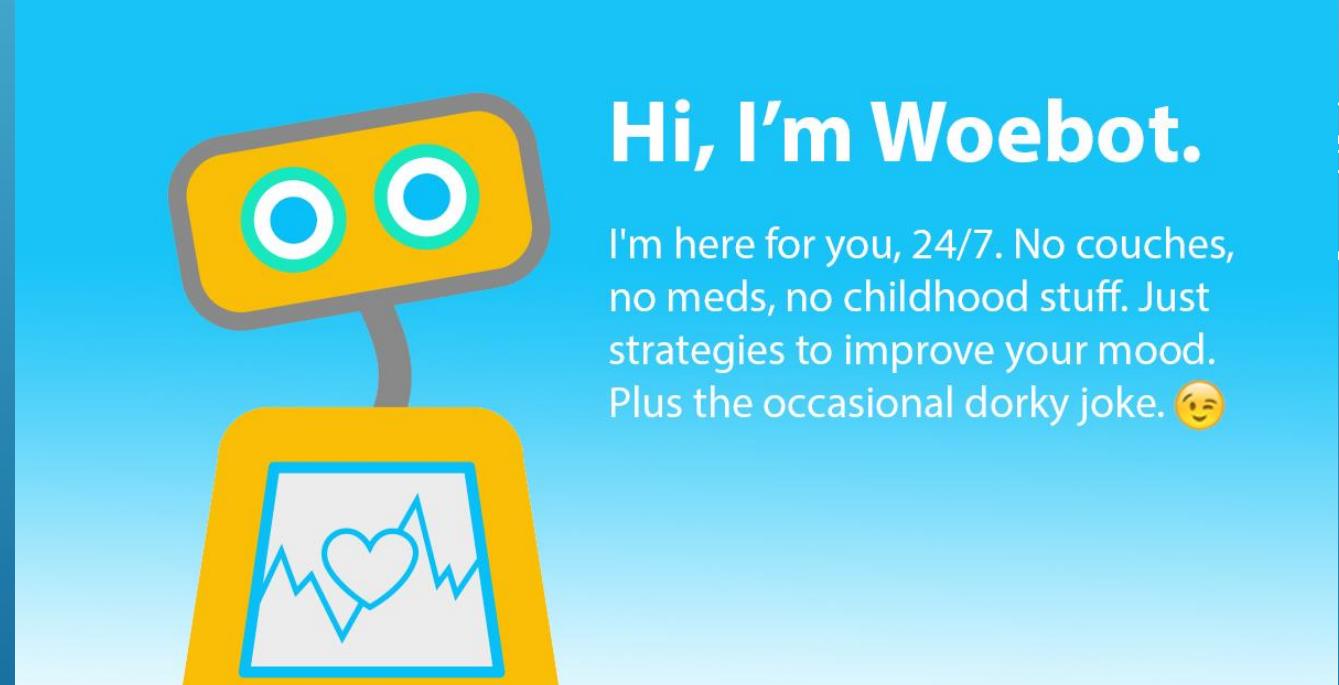


# AI Therapists

- OFFERS PROMISE OF THERAPY FOR ALL AT LOW COST
- ONLINE CBT
- CHATBOTS: "SIRI, I FEEL DEPRESSED"
- CHATBOTS, EG, WOEBOT

generic term

-tradename  
-no cost at present



# Computer-Assisted CBT ('CCBT') for Depression

- JESSE WRIGHT ET AL, 2019, J CLIN PSYCHIATRY
- META-ANALYSIS 40 RCT STUDIES CCBT FOR DEPRESSION
- CCBT WITH MODEST SUPPORT FROM CLINICIAN EFFECTIVE
- CCBT FULLY SELF-GUIDED MUCH LESS EFFECTIVE  
(TYPES, AMOUNT AI IN CCBT STUDIED??)

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→ AT THIS POINT IN TIME AI CANNOT  
REPLACE DOCTORS -- NOT TECHNICALLY  
POSSIBLE

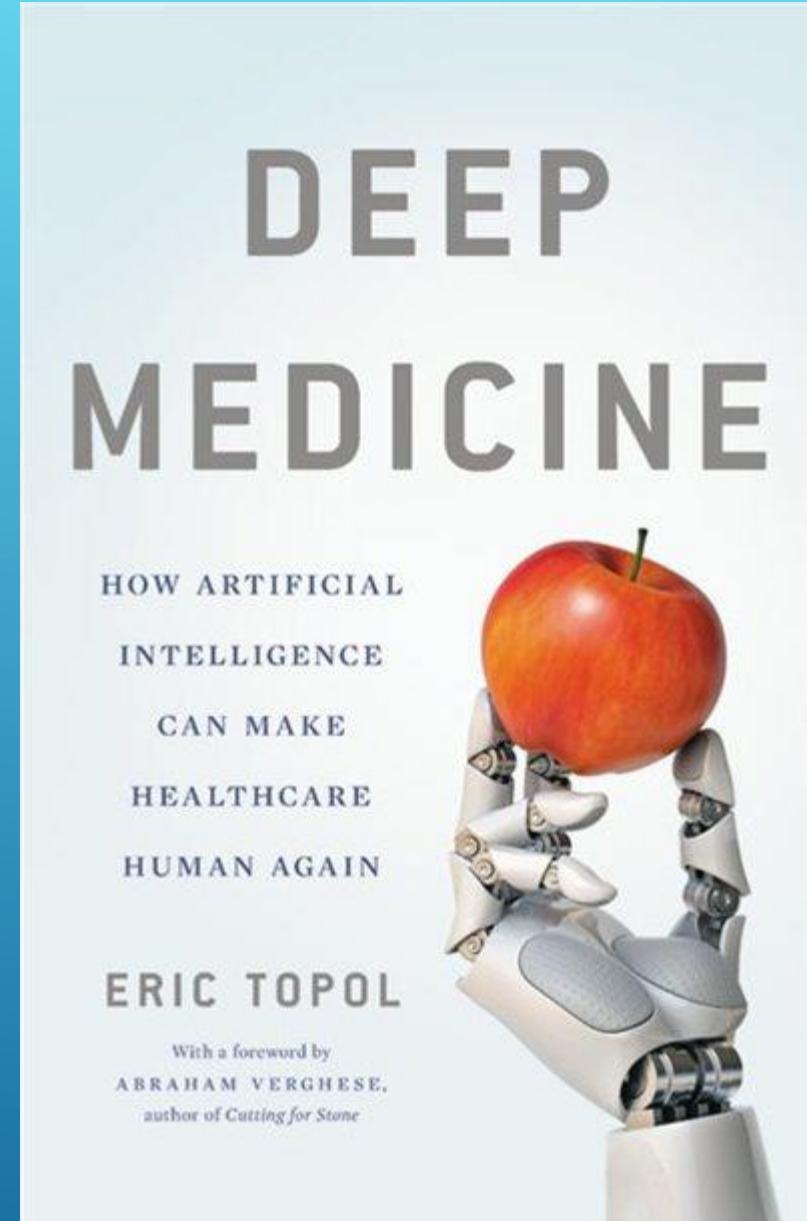
- BETTER SOFTWARE CAN IN THEORY REDUCE  
HEALTH CARE STAFF HOWEVER, AND DEEP  
LEARNING CAN SPEED THIS UP (DEPENDS ON  
FIELD)

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# DR ERIC TOPOL

-CARDIOLOGIST  
-SCRIPPS, LA JOLLA  
-DEVELOPED T-PA,  
ANTI-CLOT MEDS  
**-PROPOONENT OF  
AI IN MEDICINE**



# LEARNING OBJECTIVES

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- ▶ 5. Discussion

# NEXT DECADE (MY OPINION)

-ONCE THERE IS CAUSALITY + APPROPRIATE FUNDAMENTAL TRAINING + REDUCED COSTS FOR COMPUTE -- AI SYSTEMS SHOULD BE ABLE TO DO THE WORK ALMOST ANY HEALTHCARE WORKER CAN DO

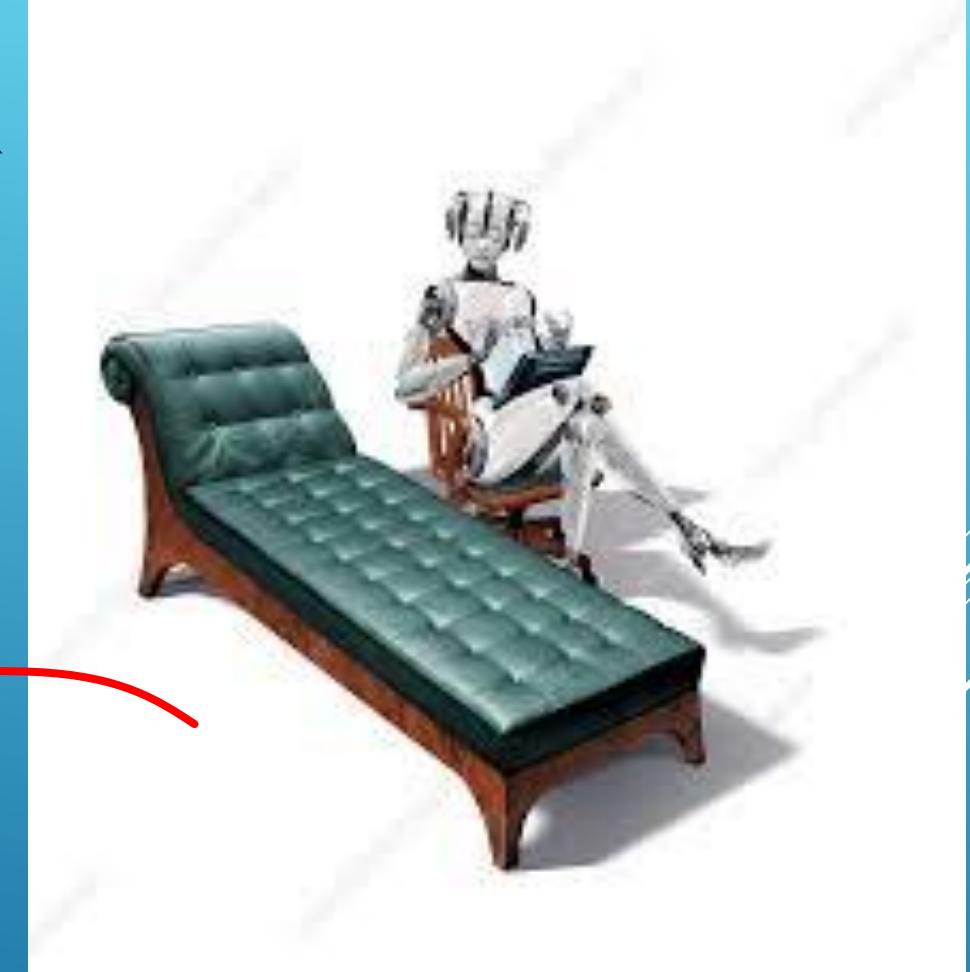
-HUMANS PROVIDE **OVERSIGHT** (FOR A WHILE....) OF AI HEALTH SYSTEMS

# NEXT DECADE (MY OPINION)

HUMANS PROVIDE EMPATHIC &  
**EXISTENTIAL LIAISON TO AI**  
HEALTH SYSTEMS

→ THUS KEY FOR  
PSYCHOTHERAPY

Even if technology is  
great, will this work?



**NEW TOPIC**

# HOW WILL AI AFFECT THE FUTURE OF MANKIND (HUMANKIND)?

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# LEARNING OBJECTIVES

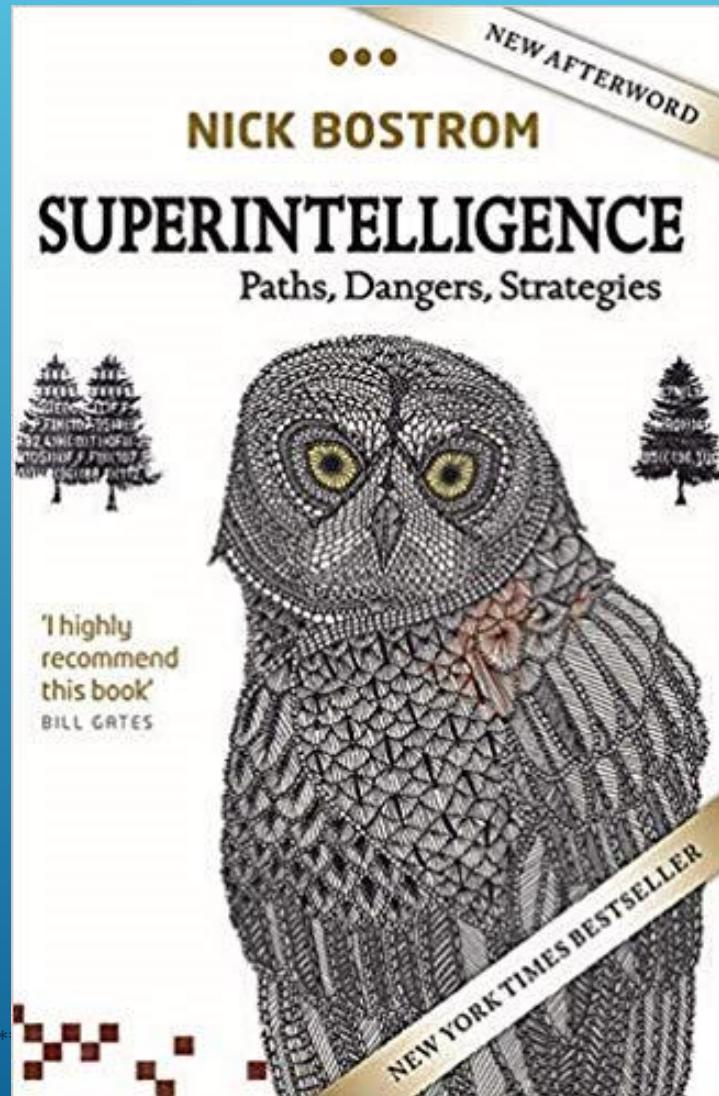
- ▶ 1. Real understanding of what AI is:
- ▶ 1a. Deep Learning and Reinforcement Learning
- ▶ 1b. Field of Artificial Intelligence (AI)
- ▶ 1c. Neuro-Symbolic Gap
- ▶ 2. How will AI in next decade (or two) affect my patients' lives?
- ▶ 3. How will AI affect my practice of medicine including psychotherapy?
- ▶ 3a. How is AI affecting medicine at present?
- ▶ 3b. How will AI affect medicine in the next decade?
- ▶ 4. How will AI affect the future of mankind?
- ▶ 5. Discussion

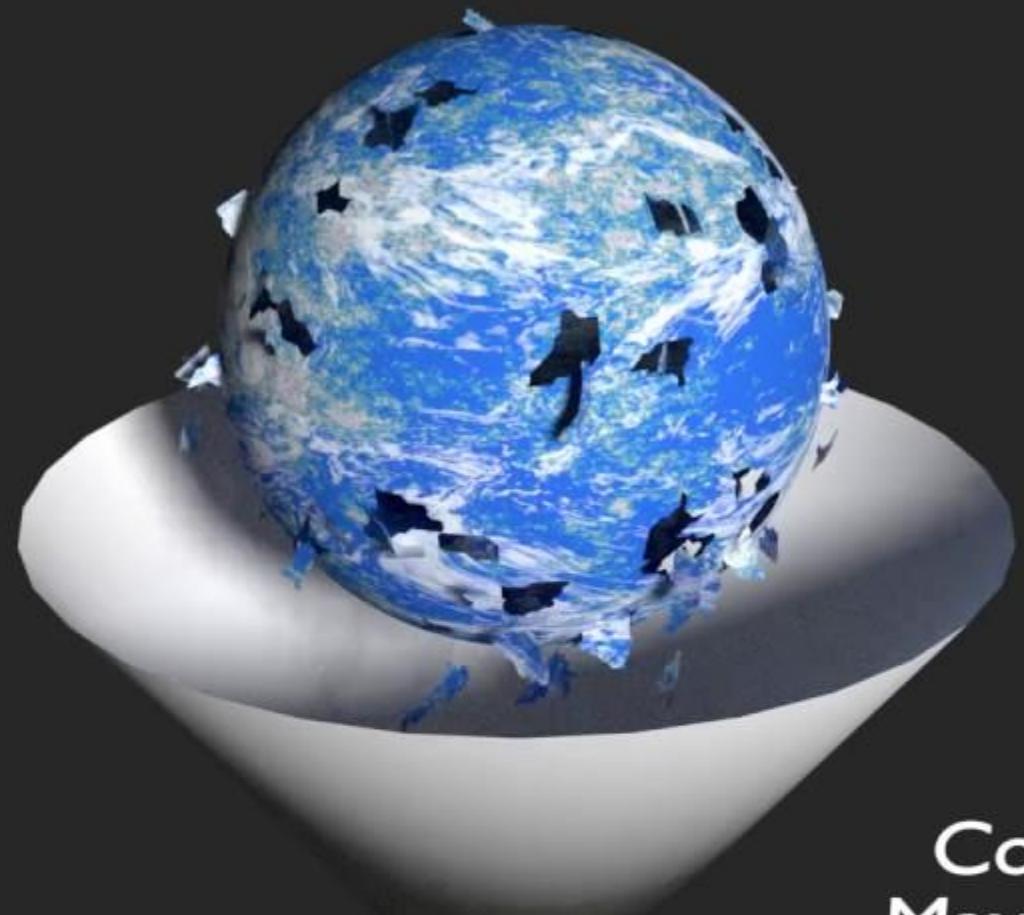
# DEEP LEARNING ALL AROUND US NOW: LONDON POLICE SURVEILLANCE CAMERAS WITH FACIAL RECOGNITION

## PSYCHOLOGY OF CONSTANT SURVEILLANCE??



# Bostrom – SuperIntelligence



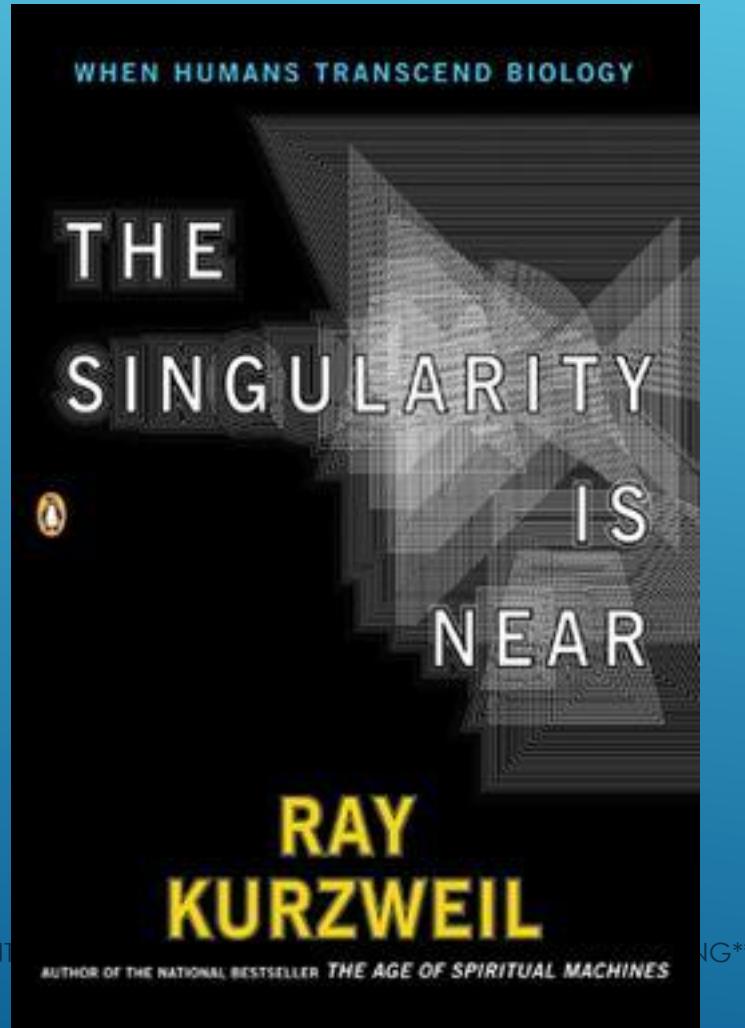


*Could an AI Paperclip  
Maximizer machine turn  
the earth into paperclips?*

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# Kurzweil – AI Will Exceed Human Intelligence and Merge with Humans



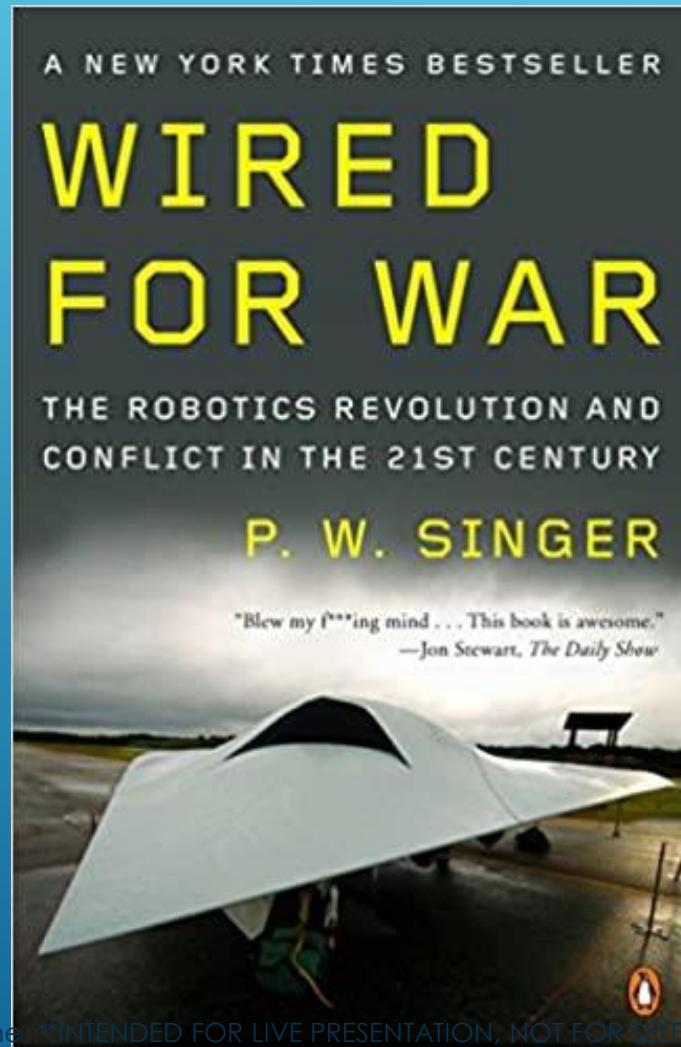
Dr Howard Schneider - AI & Future of Medicine \*\*INTL

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# SINGER'S 2009 BOOK – WIRED FOR WAR



Dr Howard Schneider - AI & Future of Medicine \*\*INTENDED FOR LIVE PRESENTATION, NOT FOR SELF-READING\*\*

# 2017 ASILOMAR AI PRINCIPLES

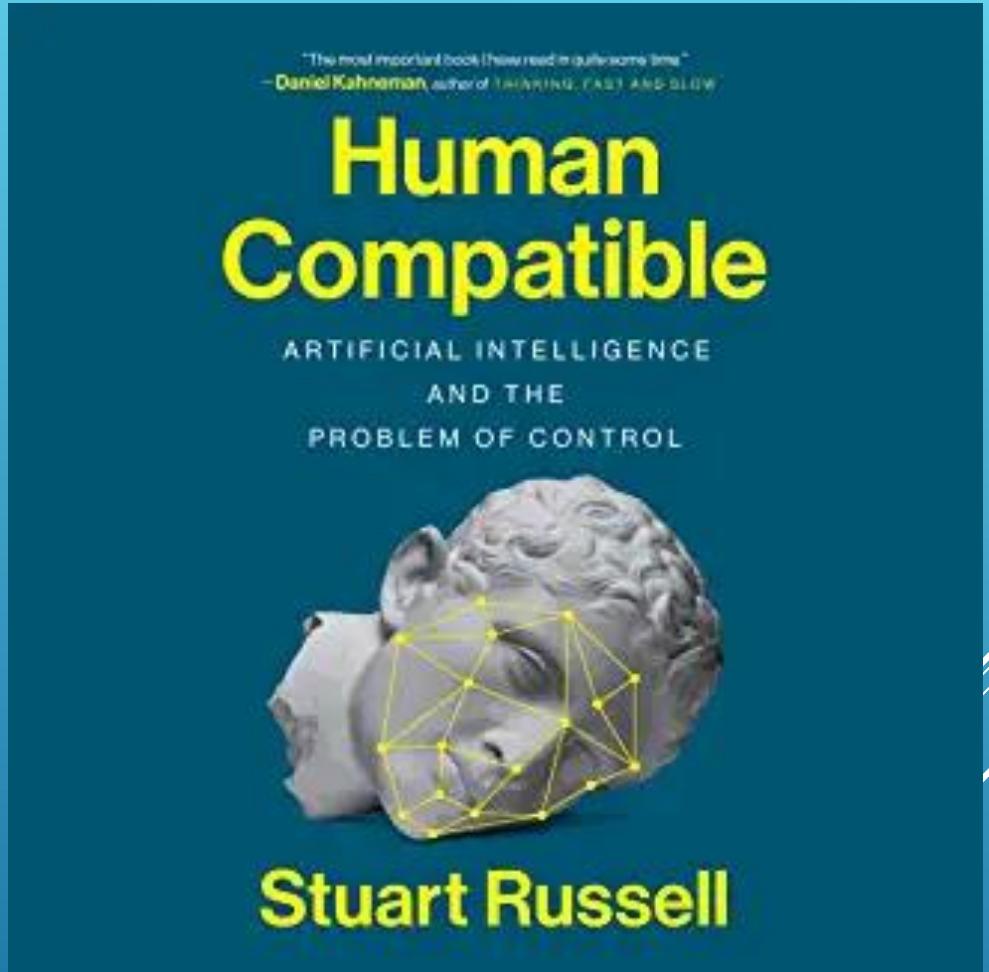


- #1- The goal of AI research should be to create not undirected intelligence, but **beneficial intelligence**.
- #6- AI systems should be **safe and secure.. verifiably so..**
- #23- **Superintelligence** should only be developed.. for the **benefit of all humanity** rather than one state.

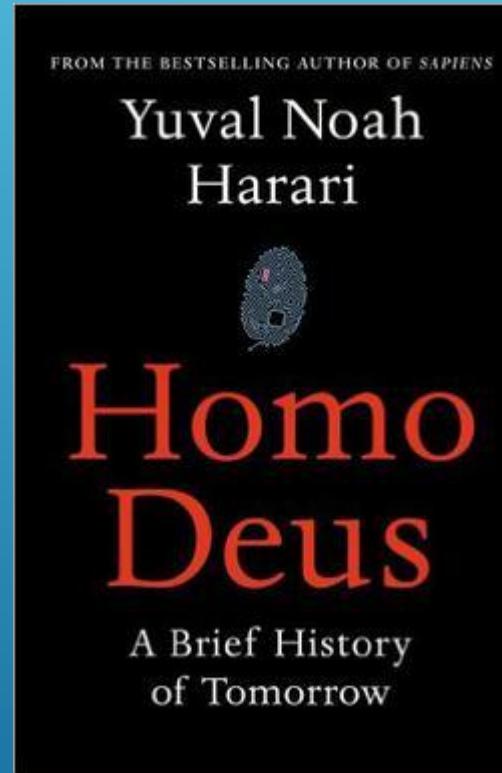
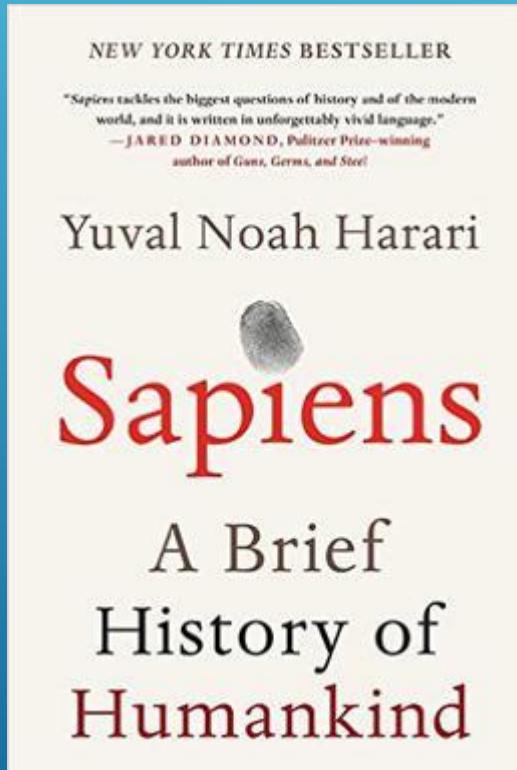
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# Provably Beneficial AI

The only objective  
of the machine is  
human well being,  
or the satisfaction  
of human  
preferences



- Continued technological powers.
- We lose meaning in our lives
- Replacement of *H sapiens* with *H deus*



# RIGHT NOW

- AI (= DEEP LEARNING) IS A PHENOMENAL COMPUTER SCIENCE TECHNIQUE
- LIKELY TO **IMPROVE OUR LIVES**
- TERMINATOR NOT POSSIBLE

# FUTURE

- THAT'S ANOTHER STORY
- **AI SAFETY CONCERNS**

# OK.... WE'VE MADE IT....



# LEARNING OBJECTIVES

- ▶ 1. Real understanding of what AI is:
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**NEW TOPIC**

# DISCUSSION

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# Artificial Intelligence and the Future of Medicine/Mankind

Thank You

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To download a copy of these slides:

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“DR HOWARD SCHNEIDER TORONTO”

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[HTTPS://GITHUB.COM/HOWARD8888/AI-AND-THE-FUTURE-OF-MEDICINE/BLOB/MASTER/AI%20AND%20THE%20FUTURE%20OF%20MEDICINE.PDF](https://github.com/howard8888/AI-AND-THE-FUTURE-OF-MEDICINE/blob/master/AI%20AND%20THE%20FUTURE%20OF%20MEDICINE.PDF)



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