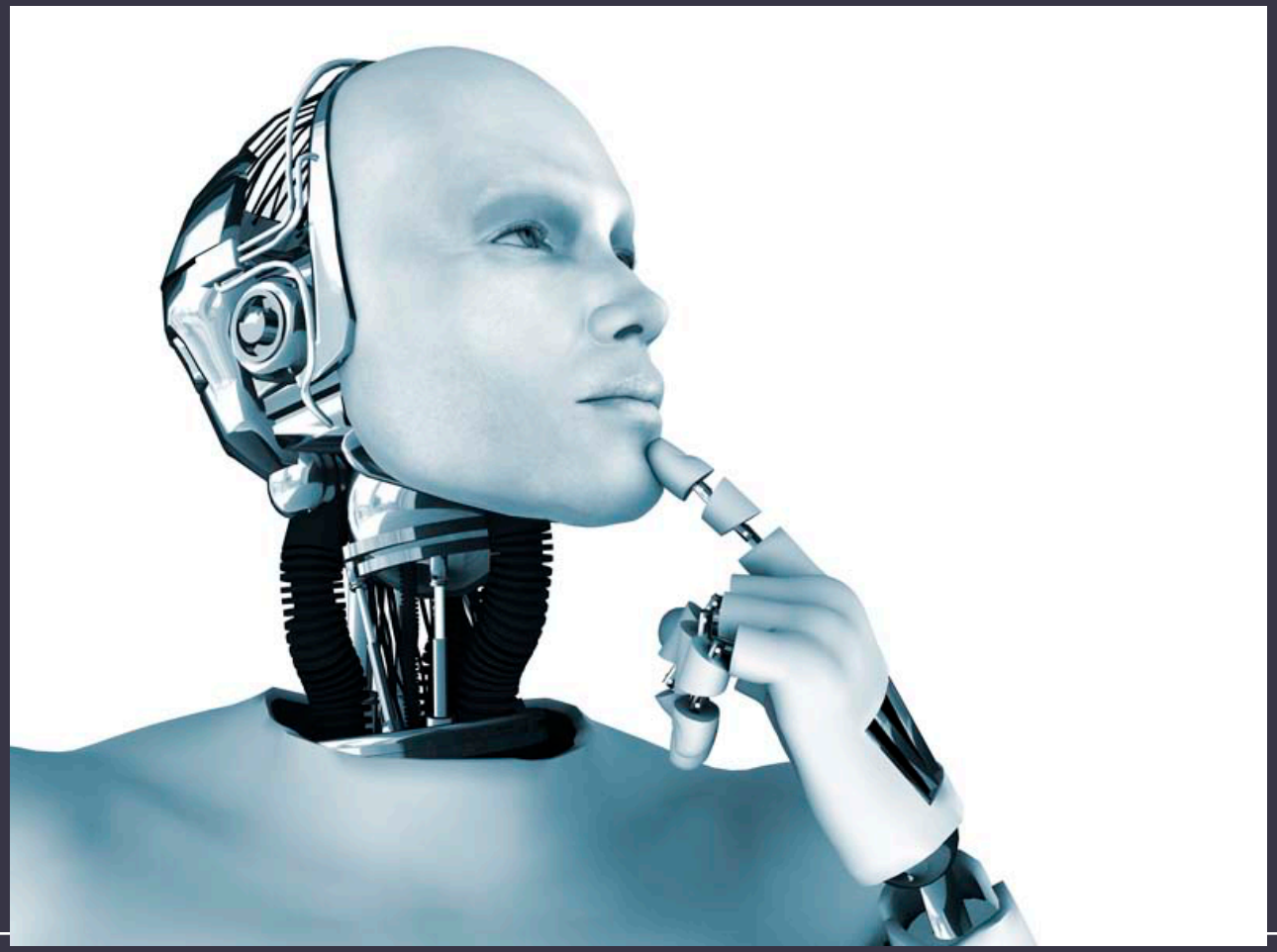
MACHINE COGNITION

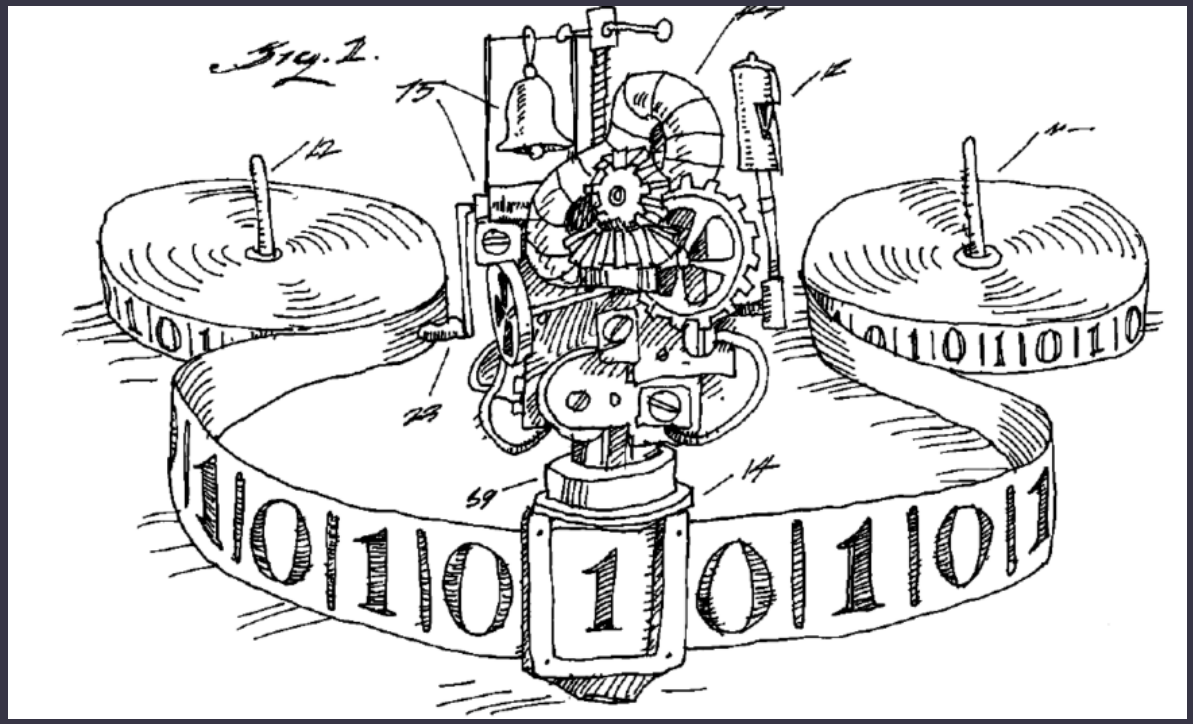
PSY435

Can computers think like us?



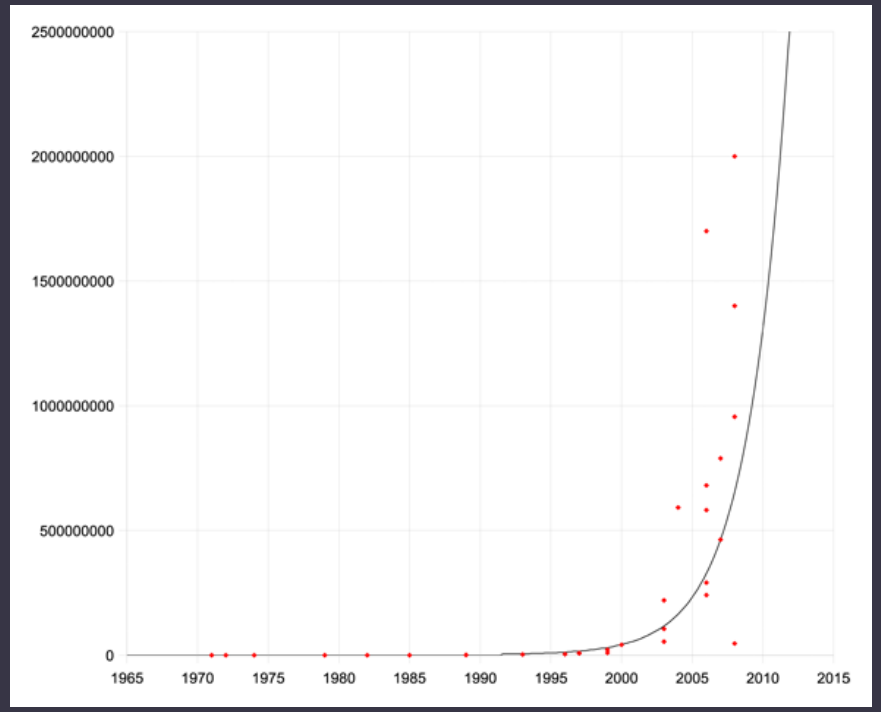
Turing Machine (1940s)

- Computers were originally designed with the human brain in mind.
- The first prototype of a general purpose computer was the Turing machine.
- It has a central processing unit, and a memory store.
- Kind of like working memory and LTM?



Moore's Law

- Computer processing power doubles every year.
- We've come a long way since the Turing machine…



Deep Blue (1990s)

- https://www.youtube.com/watch?v=NJarxpYyoFI
- First computer to win chess match against reining world champion in 1996.
- Uses "brute force."
- Skills required?
  - Symbol manipulation
  - Outcome processing

Brute Force

- A trial and error method, where all possible combinations are attempted.
- In chess this means every possible move is considered.
- For something like object recognition, this simply doesn't work, as there are too many possibilities.
- Example: Guessing a password

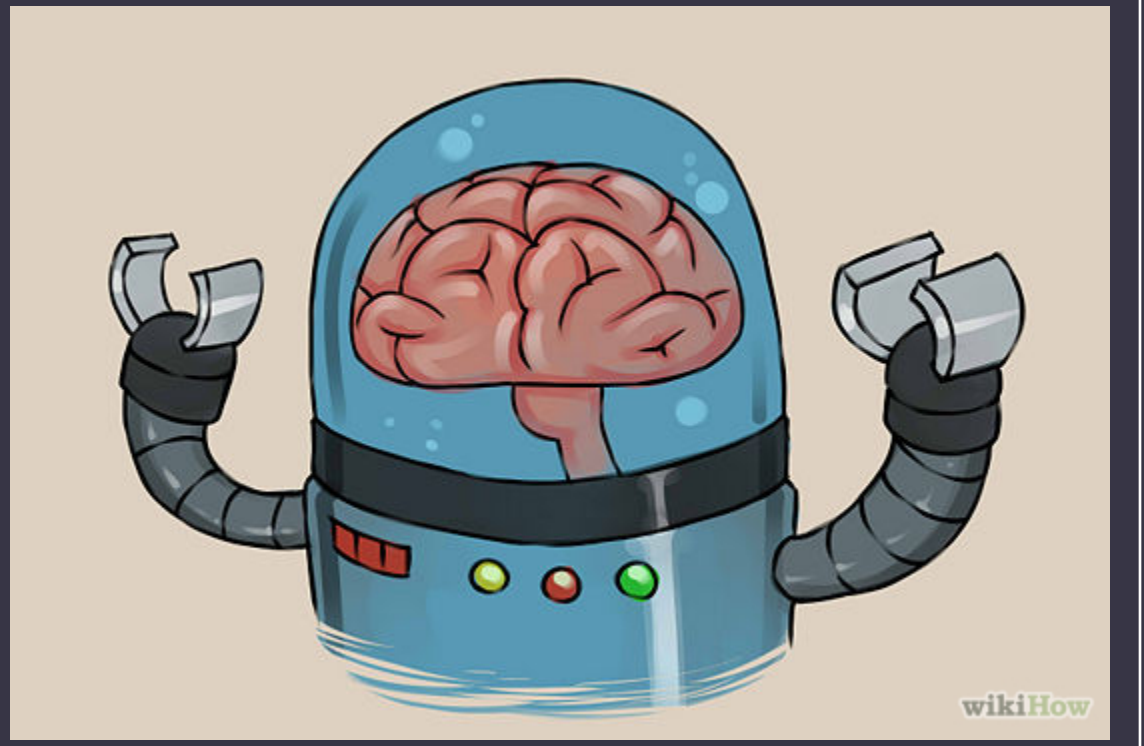
Chess is rule based, what about tasks without fixed rules?

Watson (2010s)

- https://www.youtube.com/watch?v=P18EdAKuC1U
- In February 2011 won Jeopardy game against world champions.
- Skills required?
  - Language comprehension
  - Semantic understanding

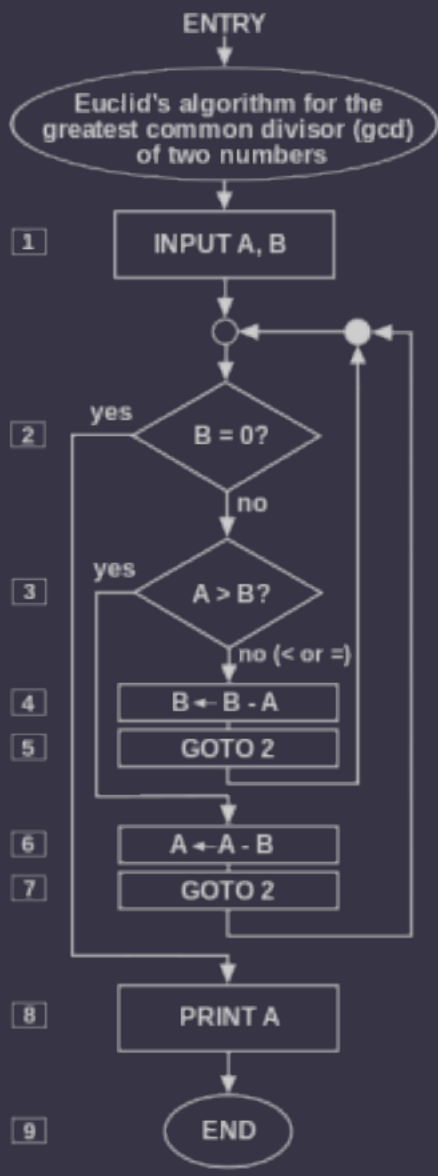
Two ways computers “think”

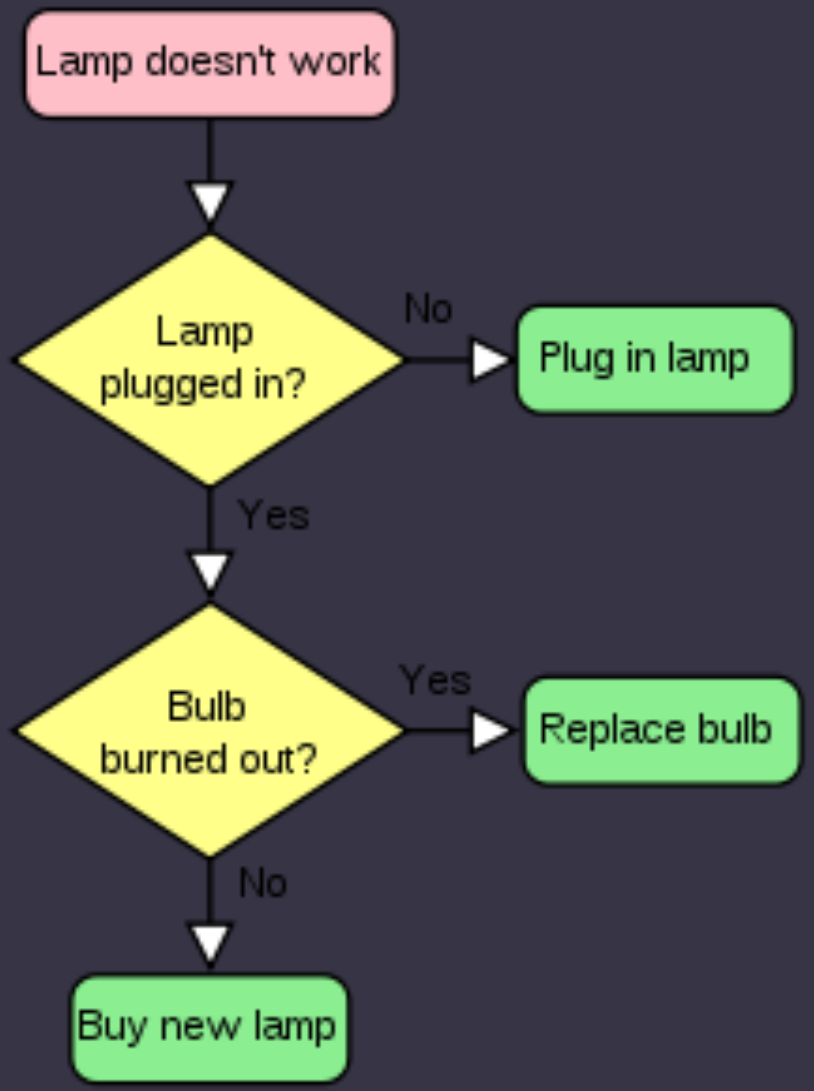
- Algorithm (Deep Blue)
- Neural Network (Watson)



Algorithms

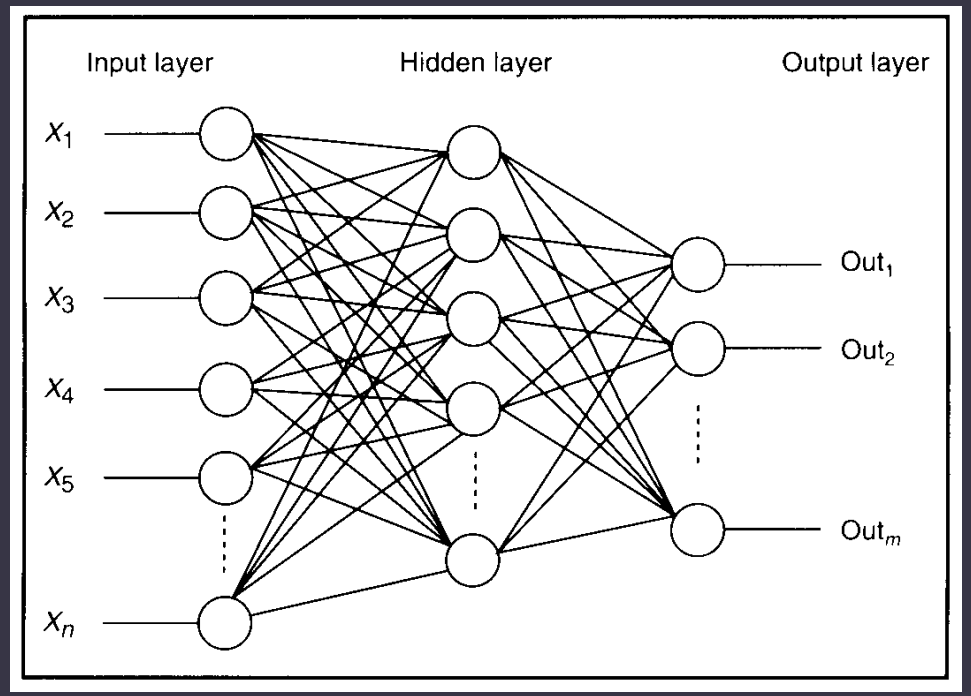
- A self-contained step-by-step set of operations to be performed
- Processed linearly

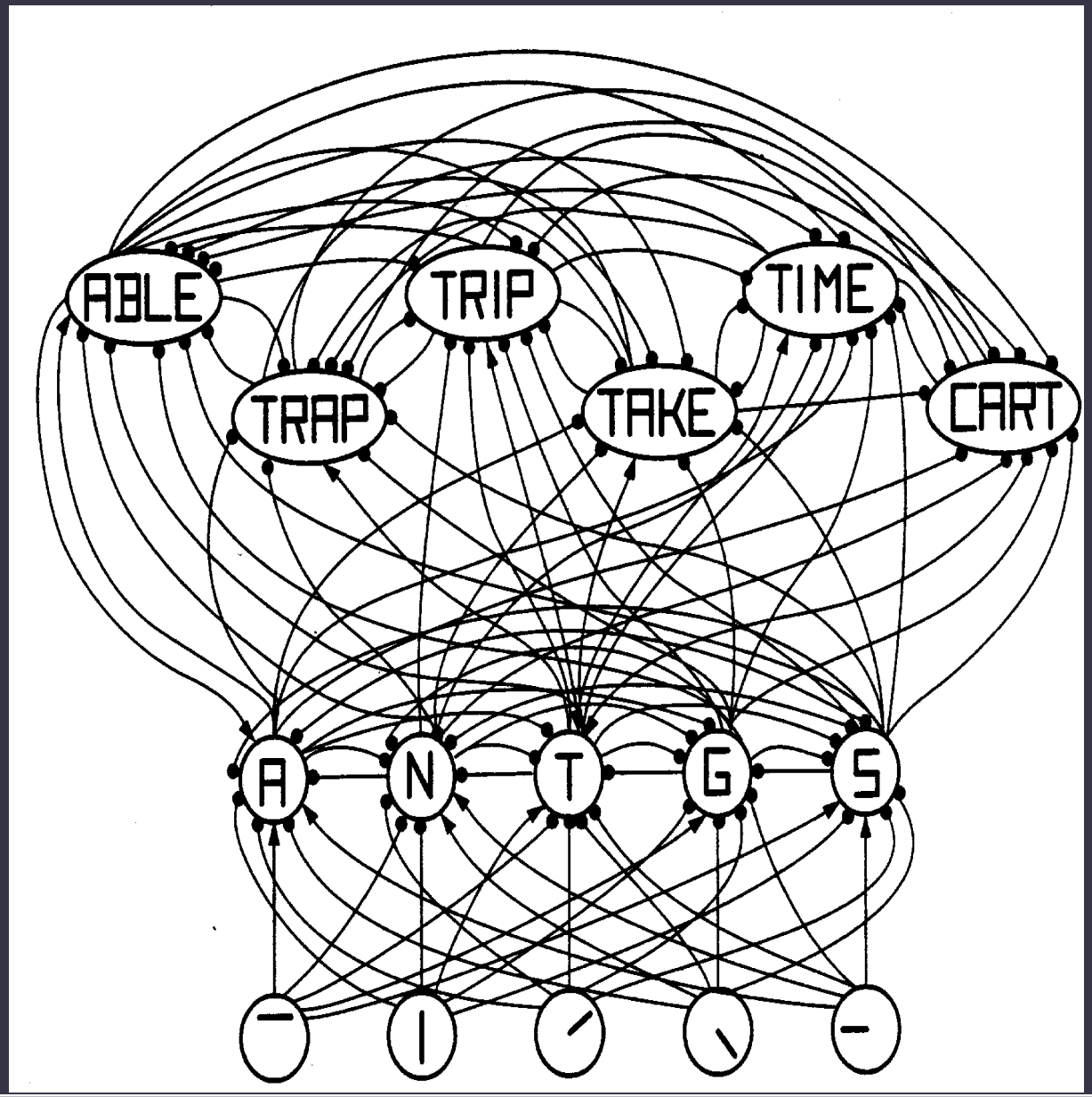



Lamp doesn't work
Lamp plugged in?
No
Plug in lamp
Yes
Bulb burned out?
Yes
Replace bulb
No
Buy new lamp

Neural Networks

- Software applications that are used to simulate the behavior of artificial or biological neural networks
- Processed simultaneously




ABLE
TRIP
TIME
TRAP
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CART
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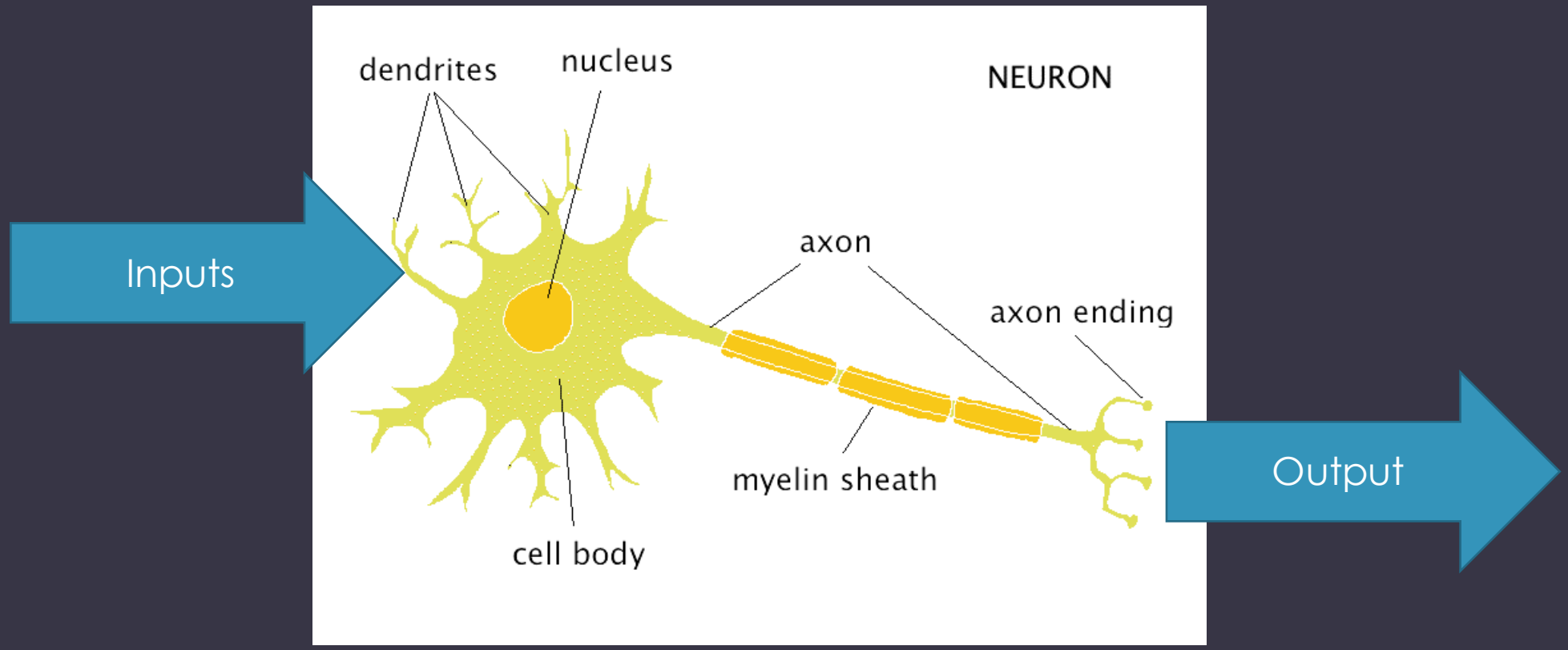
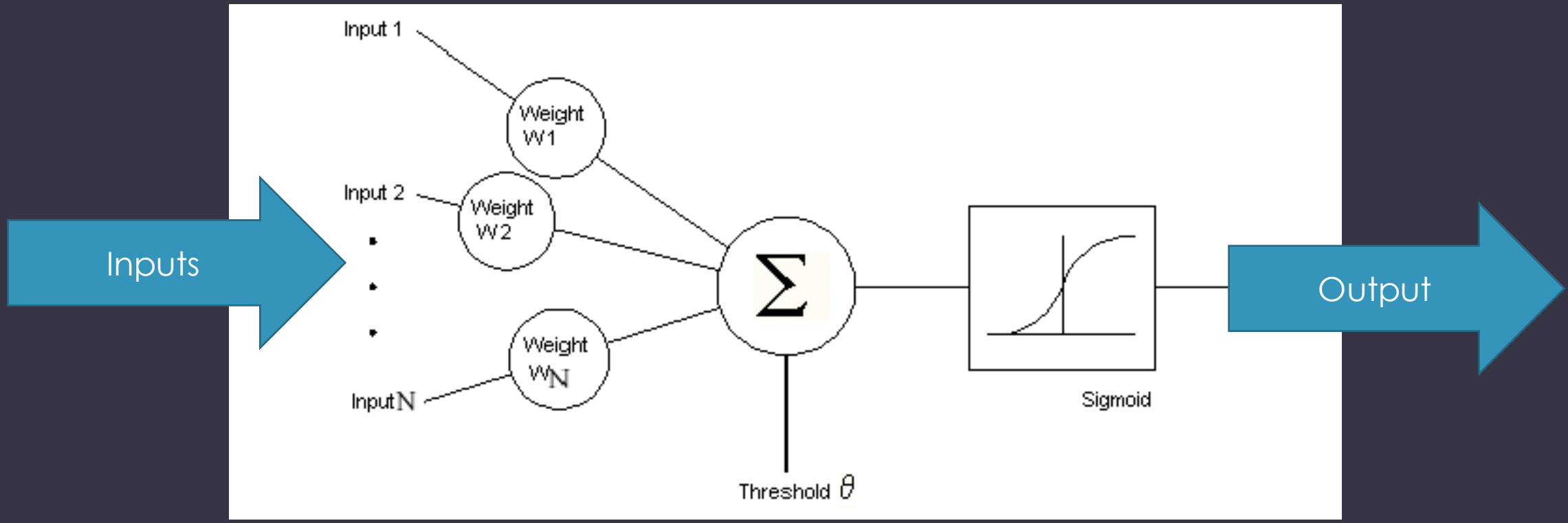
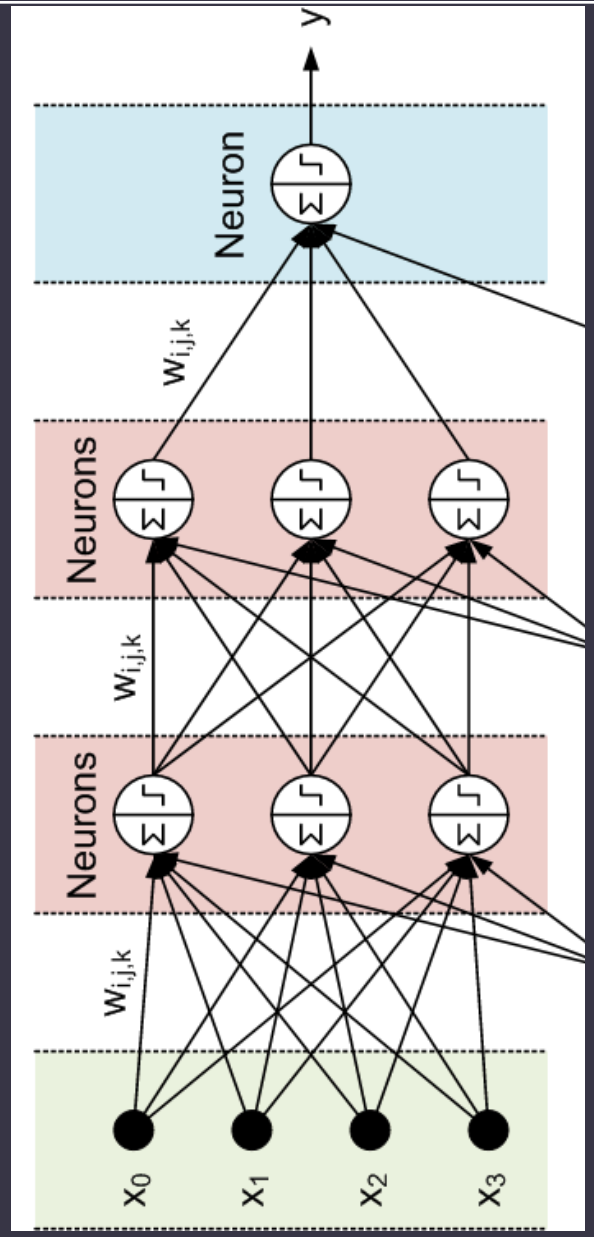
G
S

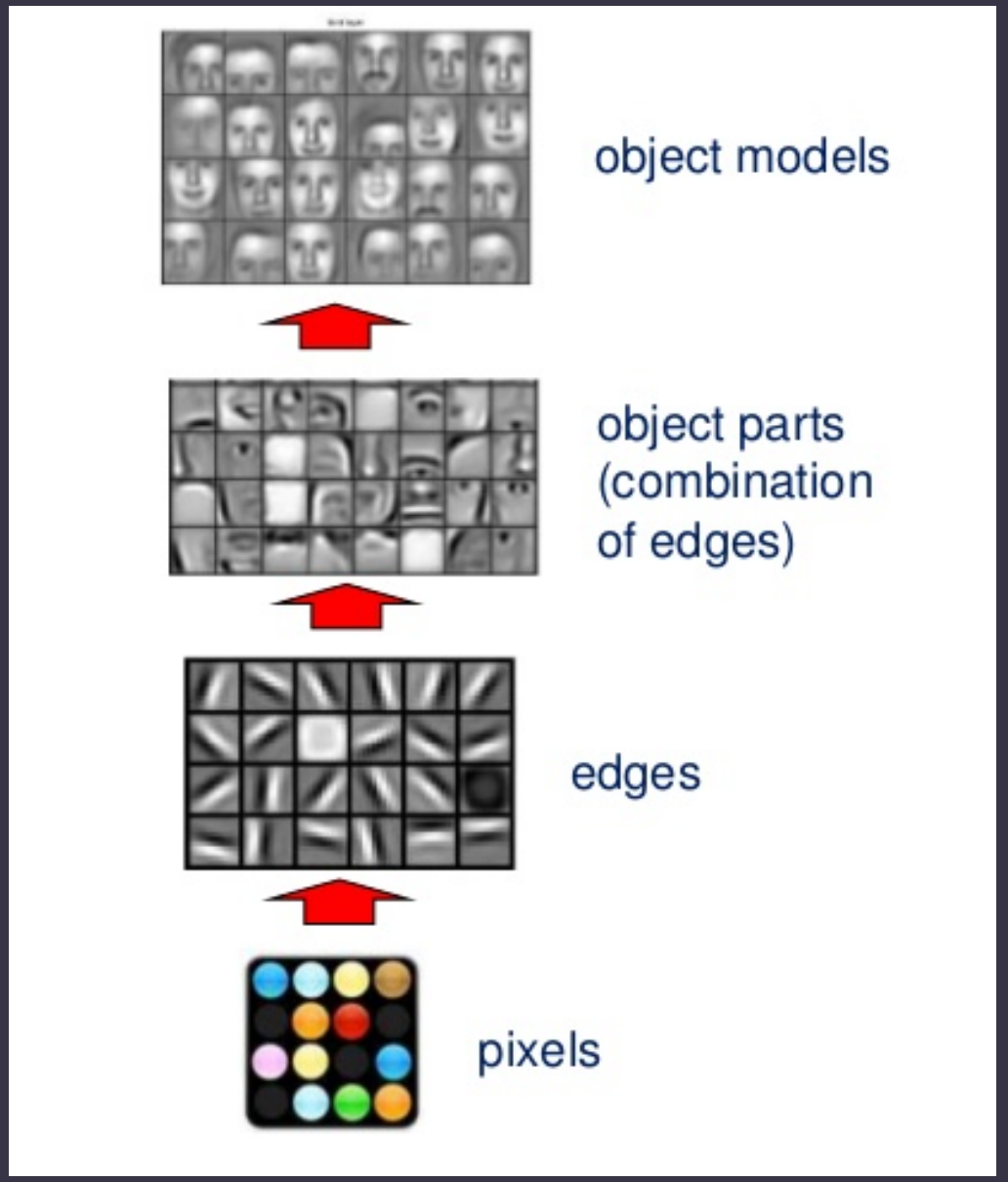
Basic Human Neuron



Basic Computer "Neuron"




y
Neuron
$w_{i,j,k}$
Neurons
$w_{i,j,k}$
Neurons
$w_{i,j,k}$
x_0
x_1
x_2
x_3


object models
object parts
(combination
of edges)
edges
pixels

Neural Networks need training

- For Watson, thousands of articles, books, magazines, journals, etc, were given as training input, with a fixed output.
- All this input adjusts the weights between neurons.
- Adjusting the weights allows a neural network to learn.

How do computers recognize things?

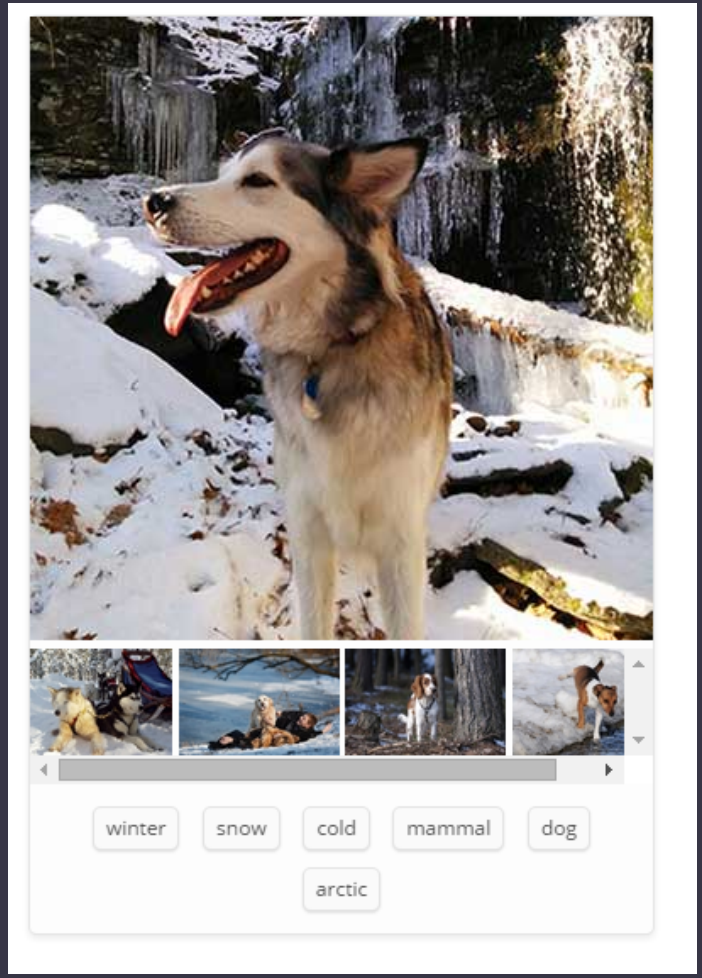
- Neural networks are used for recognition of things in the world, like images, language, music.
- Bottom-up and top-down information interact to produce what the network thinks image is.
- Google, Apple, and others also use this for language recognition.

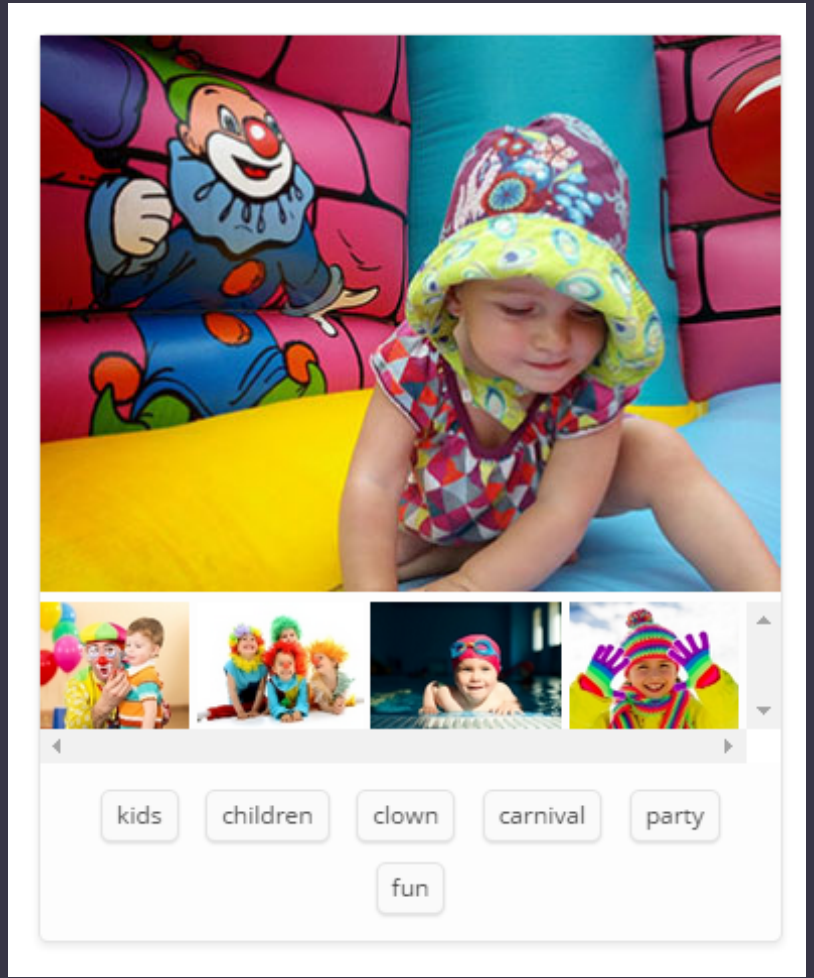
- https://www.google.com/

Speech recognition systems

Image Recognition Systems

- http://www.clarifai.com/





Picture Time!

Predicted Tags

portrait people group

women singer adult

fun girl men music

Are computer neural networks as good at object recognition as our humans ones?

Where neural networks go wrong…

Predicted Tags

fine art | people | seat | furniture | painting | girl | group | chair | print | child

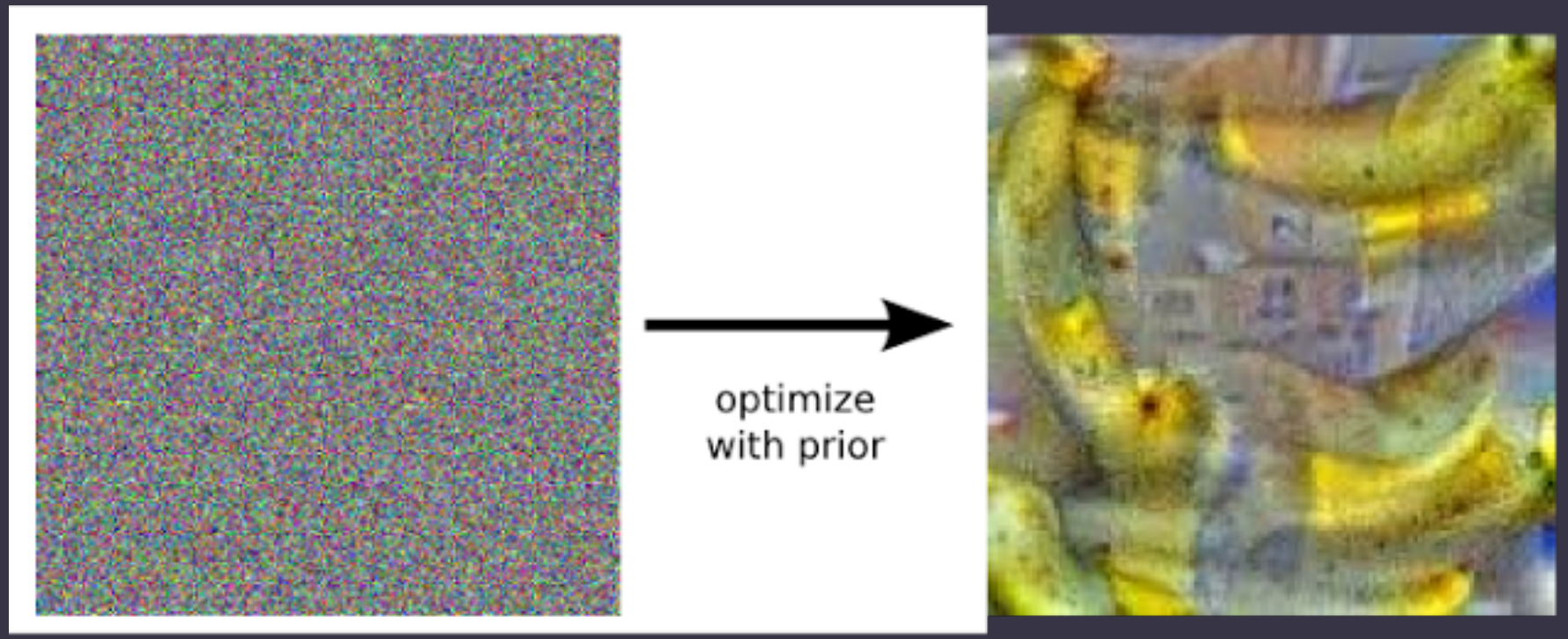
Issues with current computer neural networks

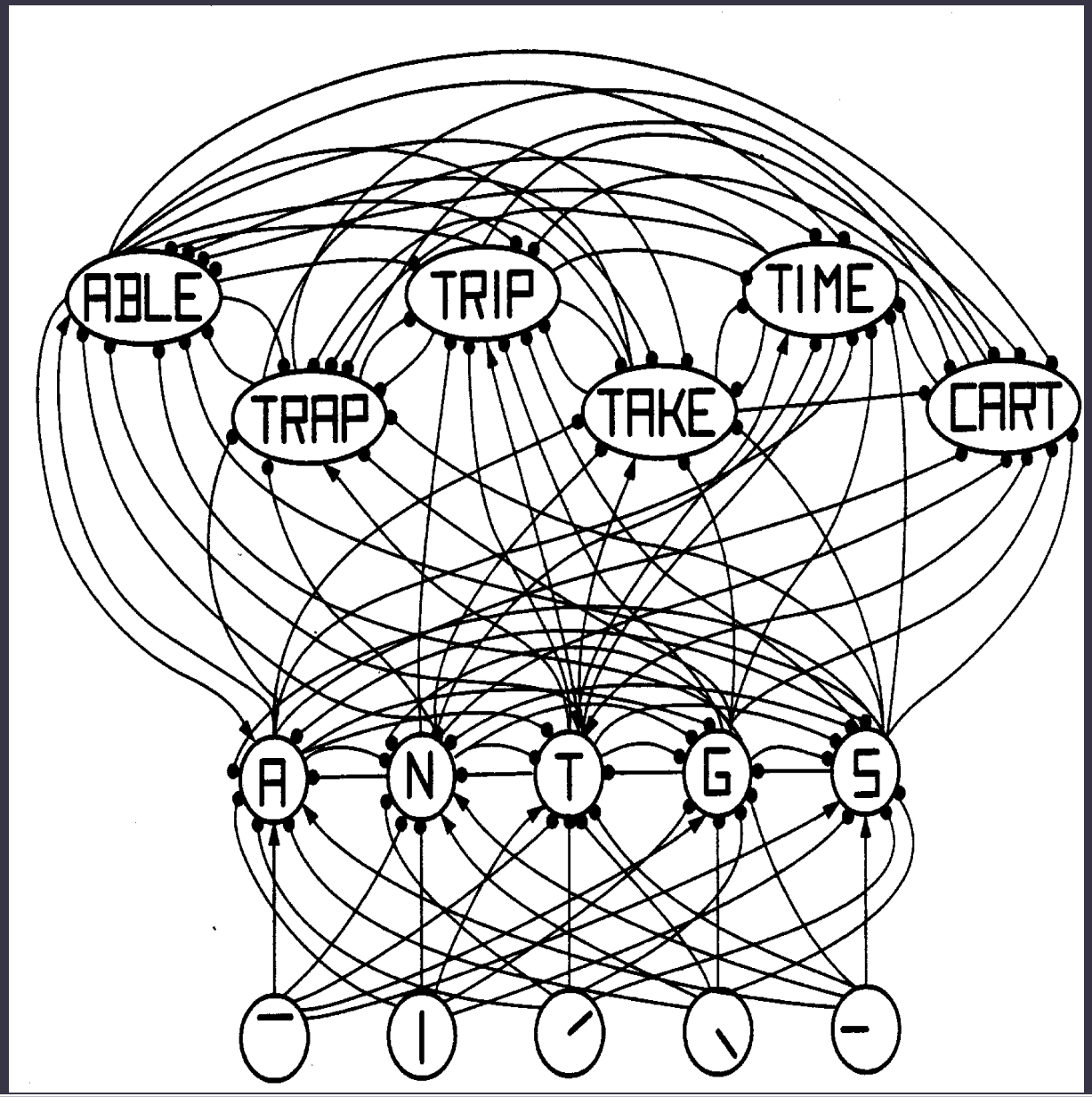
- Difficulty making Gestalt distinctions like figure/ground.
- Unusual objects within scenes are less likely to be detected.
- Action in scenes less likely to be recognized.

What do computers hallucinate?

Close your eyes and imagine a banana…

We can ask trained neural networks to imagine objects.




ABLE
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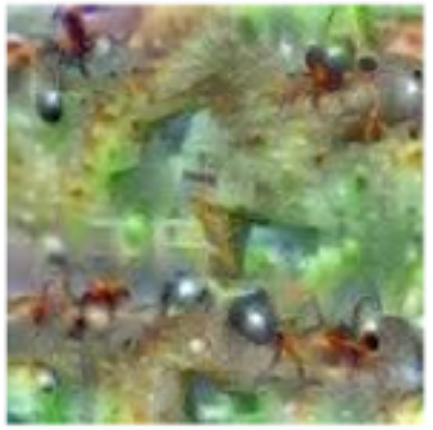
Hartebeest

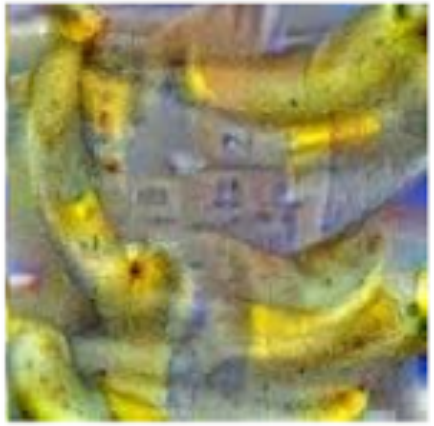
Measuring Cup



Ant

Starfish

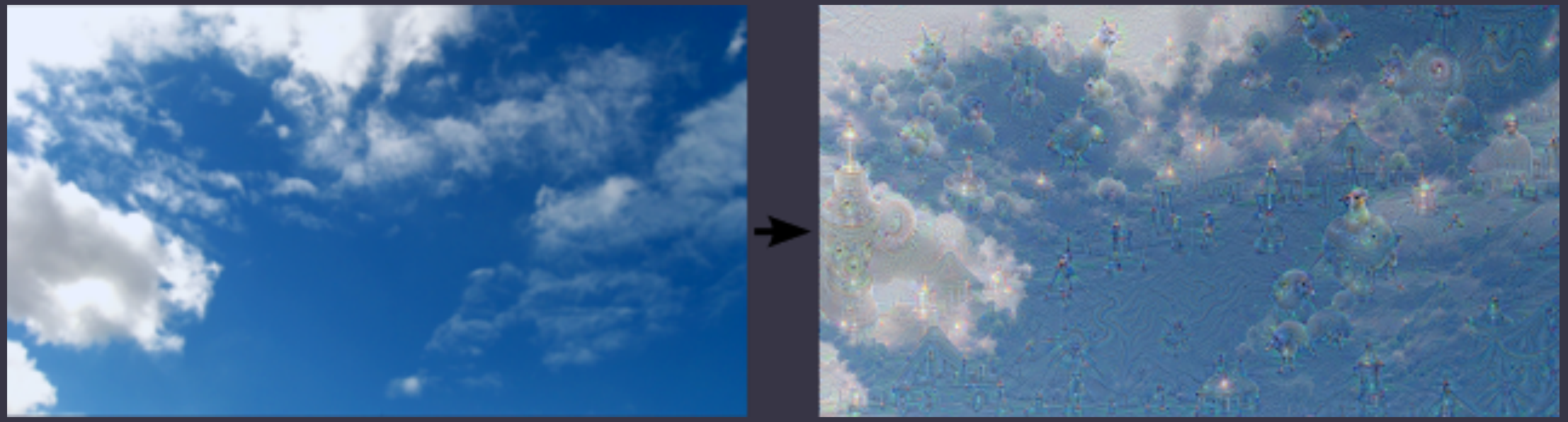
Anemone Fish

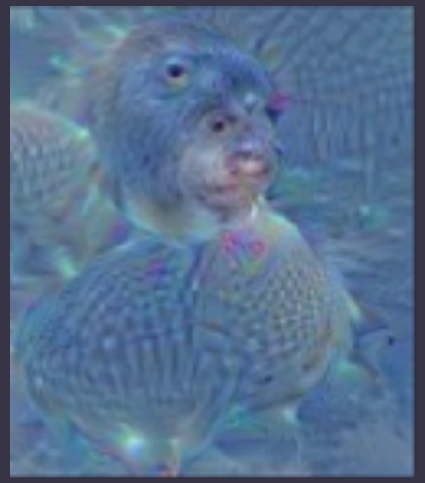


Banana

Parachute

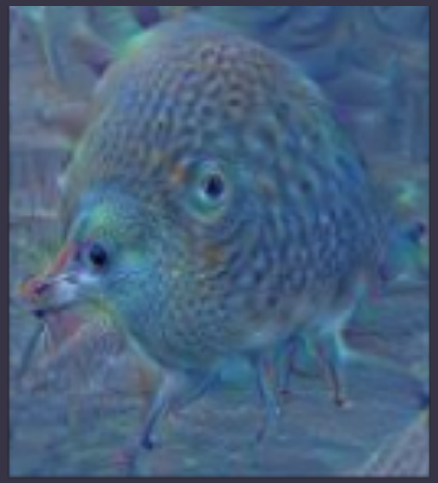
Screw





"Admiral Dog!"

"The Pig-Snail"



"The Camel-Bird"

"The Dog-Fish"

https://dreamscopeapp.com/

http://googleresearch.blogspot.co.uk/2015/06/inceptionism-going-deeper-into-neural.html

https://www.reddit.com/r/deepdream/