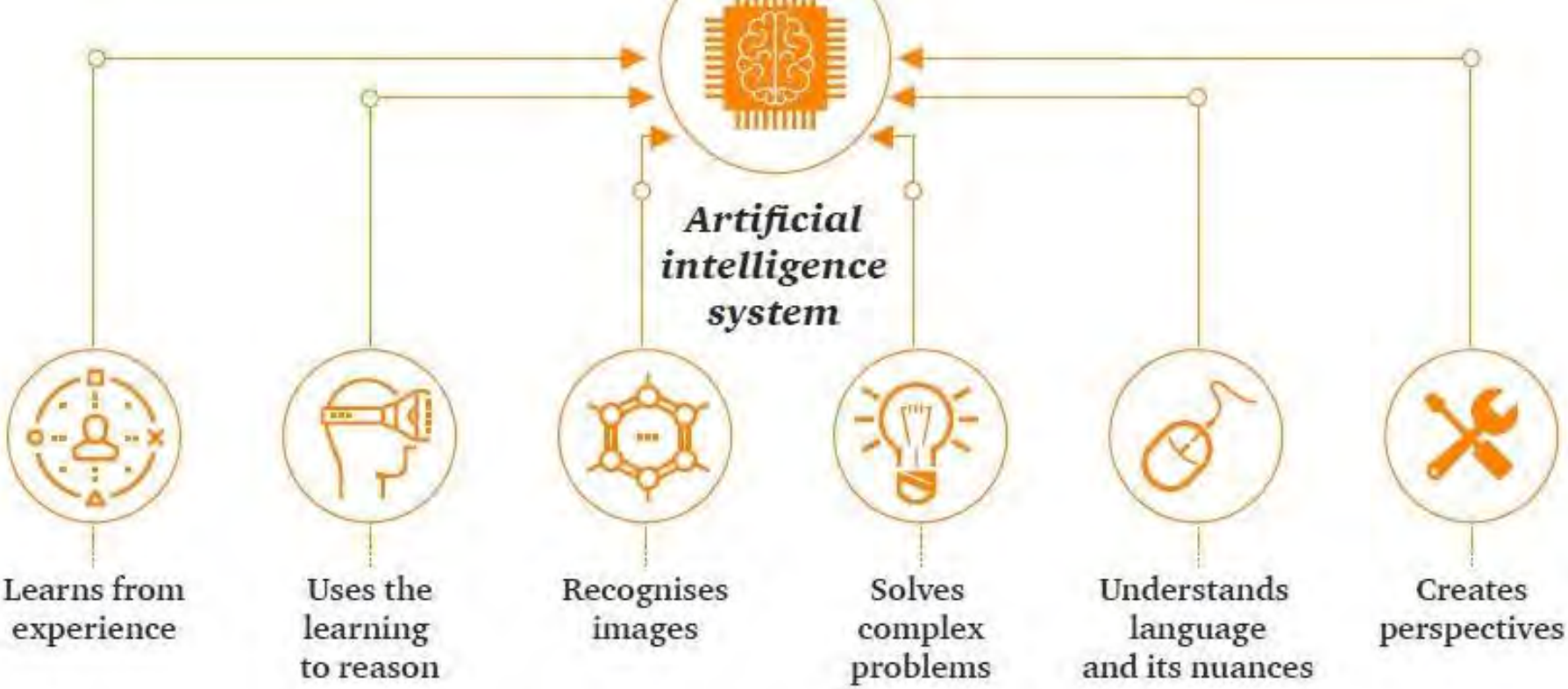
AN INTRODUCTION TO ARTIFICIAL INTELLIGENCE

COMPILED BY HOWIE BAUM

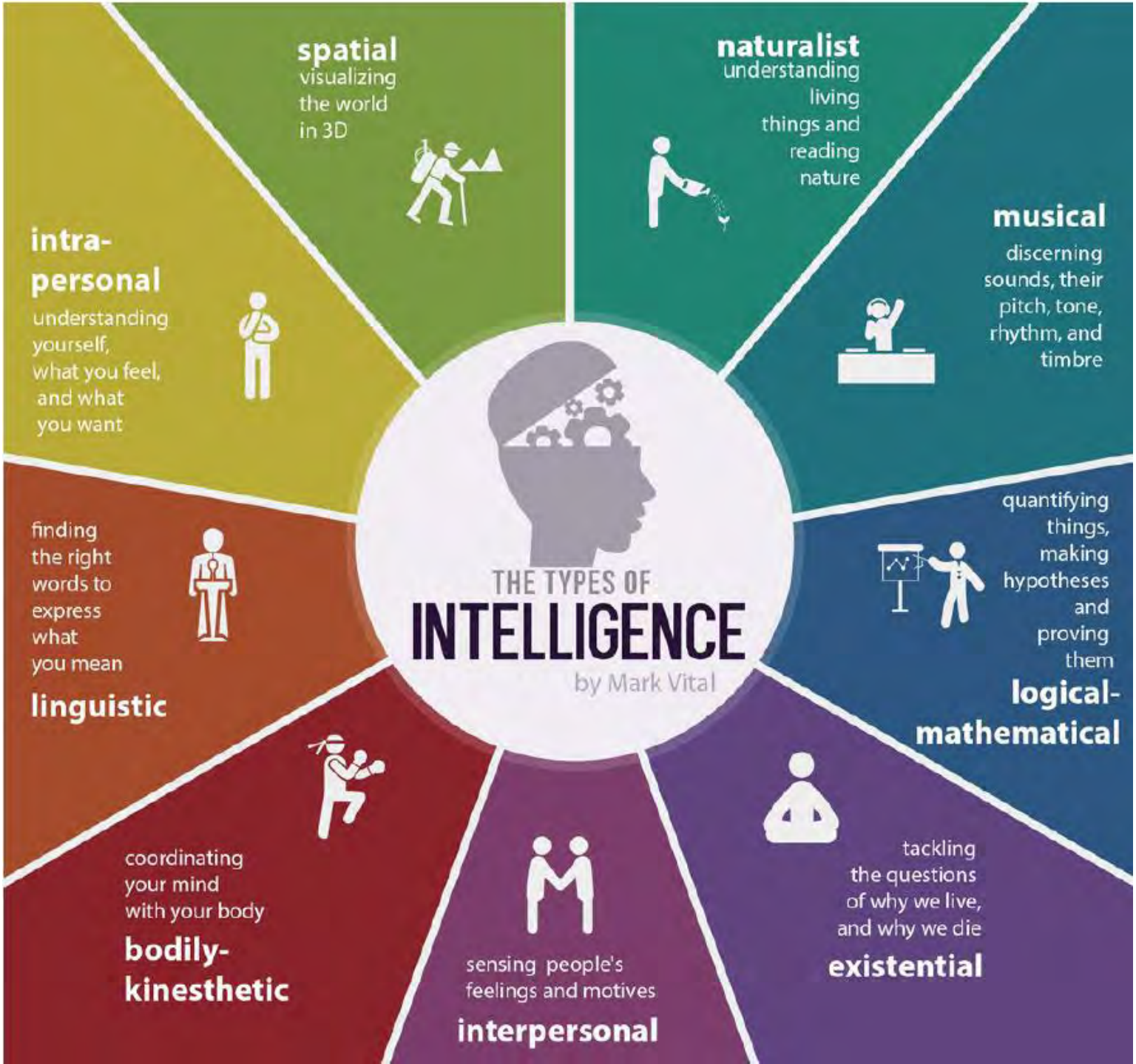


- **Artificial intelligence** (**AI**), sometimes called **machine intelligence**, is intelligence demonstrated by machines, in contrast to the **natural intelligence** displayed by humans and other animals, such as "learning" and "problem solving. .

- **In computer science AI research is defined as the study of "intelligent agents": any device that perceives its environment and takes actions that maximize its chance of successfully achieving its goals.**

HOW ARE HUMANS INTELLIGENT ?

- Learning
- Reasoning
- Problem Solving and Creativity
- Social Behavior
- Experiencing our Environment with our senses:
  - Hearing
  - Sight
  - Touch
  - Taste
  - Smelling


spatial
visualizing the world in 3D
naturalist
understanding living things and reading nature
musical
discerning sounds, their pitch, tone, rhythm, and timbre
intra-personal
understanding yourself, what you feel, and what you want
THE TYPES OF
INTELLIGENCE
by Mark Vital
finding the right words to express what you mean
linguistic
quantifying things, making hypotheses and proving them
logical-mathematical
coordinating your mind with your body
bodily-kinesthetic
sensing people's feelings and motives
interpersonal
tackling the questions of why we live, and why we die
existential

Ways that People Think and Learn About Things

- If you have a problem, think of a past situation where you solved a similar problem.
- If you take an action, anticipate what might happen next.
- If you fail at something, imagine how you might have done things differently.
- If you observe an event, try to infer what prior event might have caused it.
- If you see an object, wonder if anyone owns it.
- If someone does something, ask yourself what the person's purpose was in doing that.

Artificial intelligence (AI) - The study of computer systems that attempt to model and apply the intelligence of the human mind.

For example, writing a program to pick out objects in a picture:

This is what Humans do best

Can you list the items in this picture ?

A computer might have trouble identifying the cat there.

FIGURE 13.1 A computer might have trouble identifying the cat in this picture

This is what Computers do best

Can you count the distribution of letters in a book?

Add a thousand 4-digit numbers?

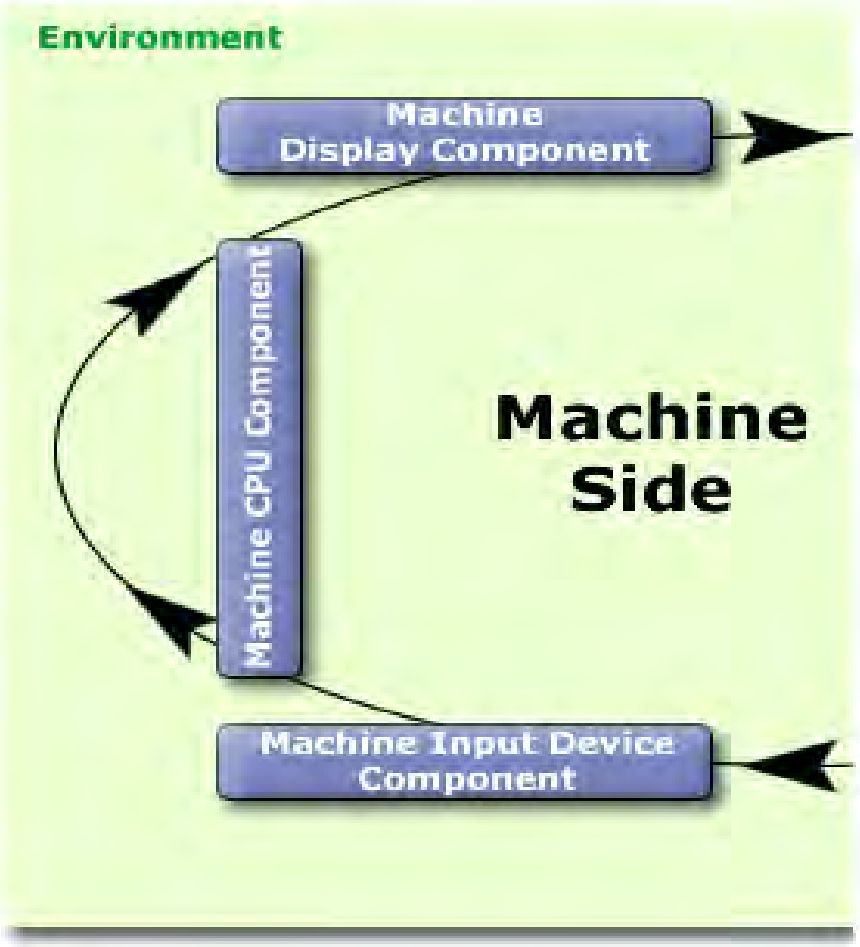
Match finger prints?

Search a list of a million values for duplicates?

When we compare Humans to Machines, it is important to note that a Machine can be a car, a Smart Phone, a Digital Television, etc.

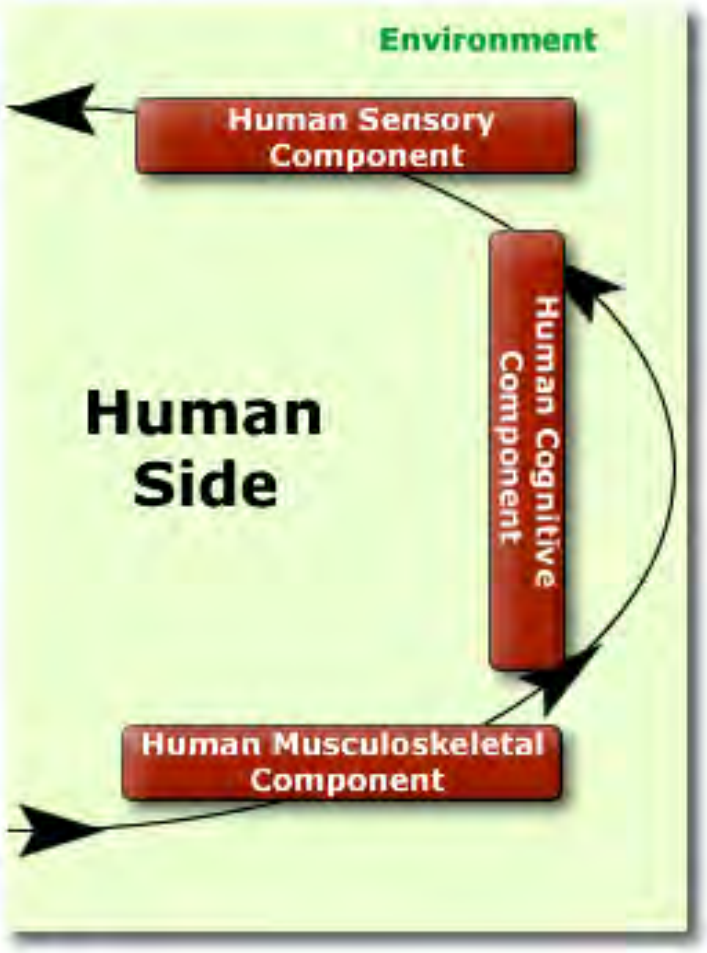
Machines are Better Than Humans in:

- Alertness
- Speed and Power
- Sensor Detection Outside Human Range
- Routine Work
- Computation
- Short-term Memory Storage
- Simultaneous Activities

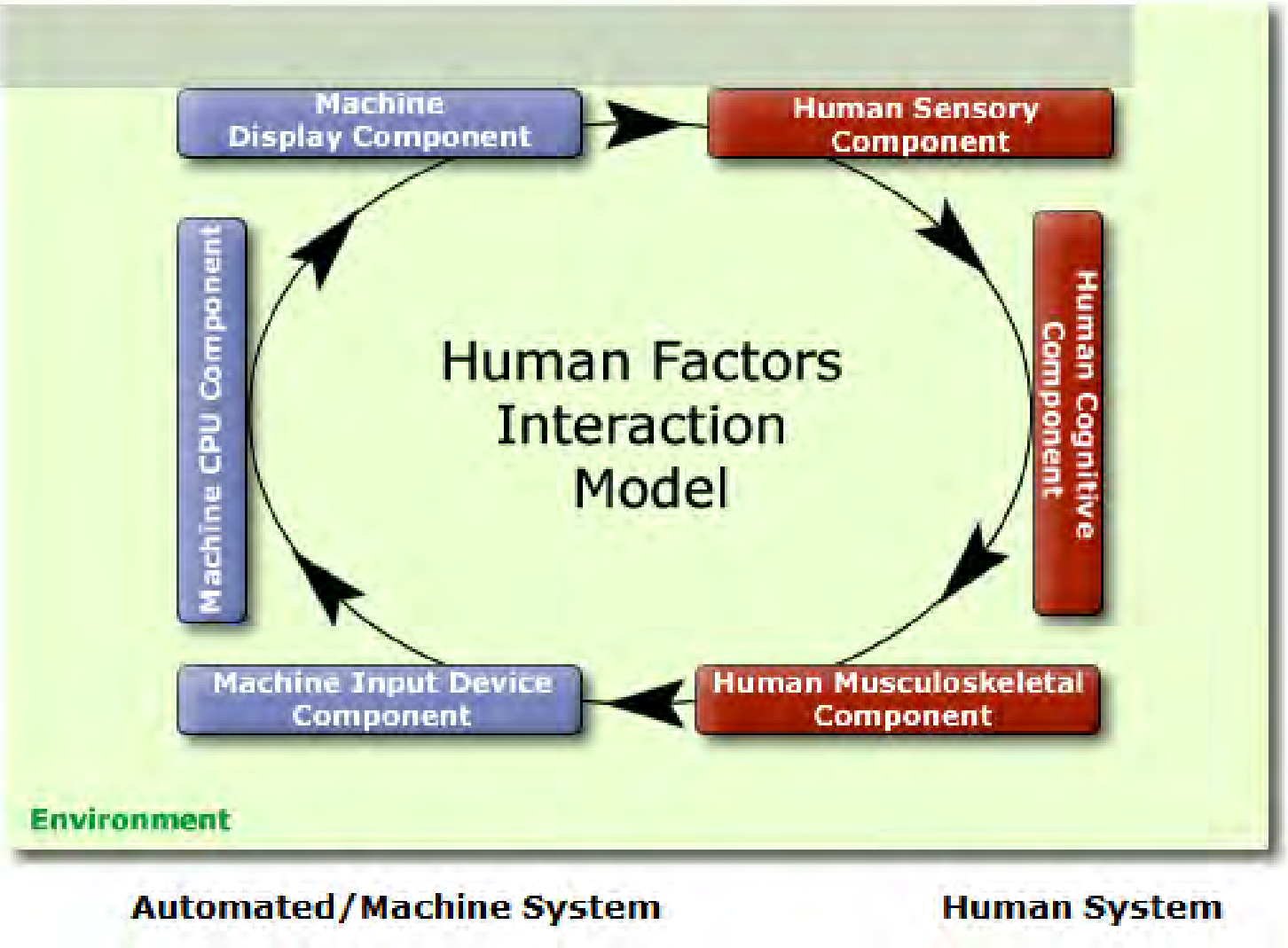


Humans are Better than Machines in:

- Sensory Functions
- Perceptual Abilities
  - Stimulus Generalization
  - Abstract Concepts
- Flexibility
  - Ability to Improvise
- Judgment
- Selective Recall
- Inductive Reasoning



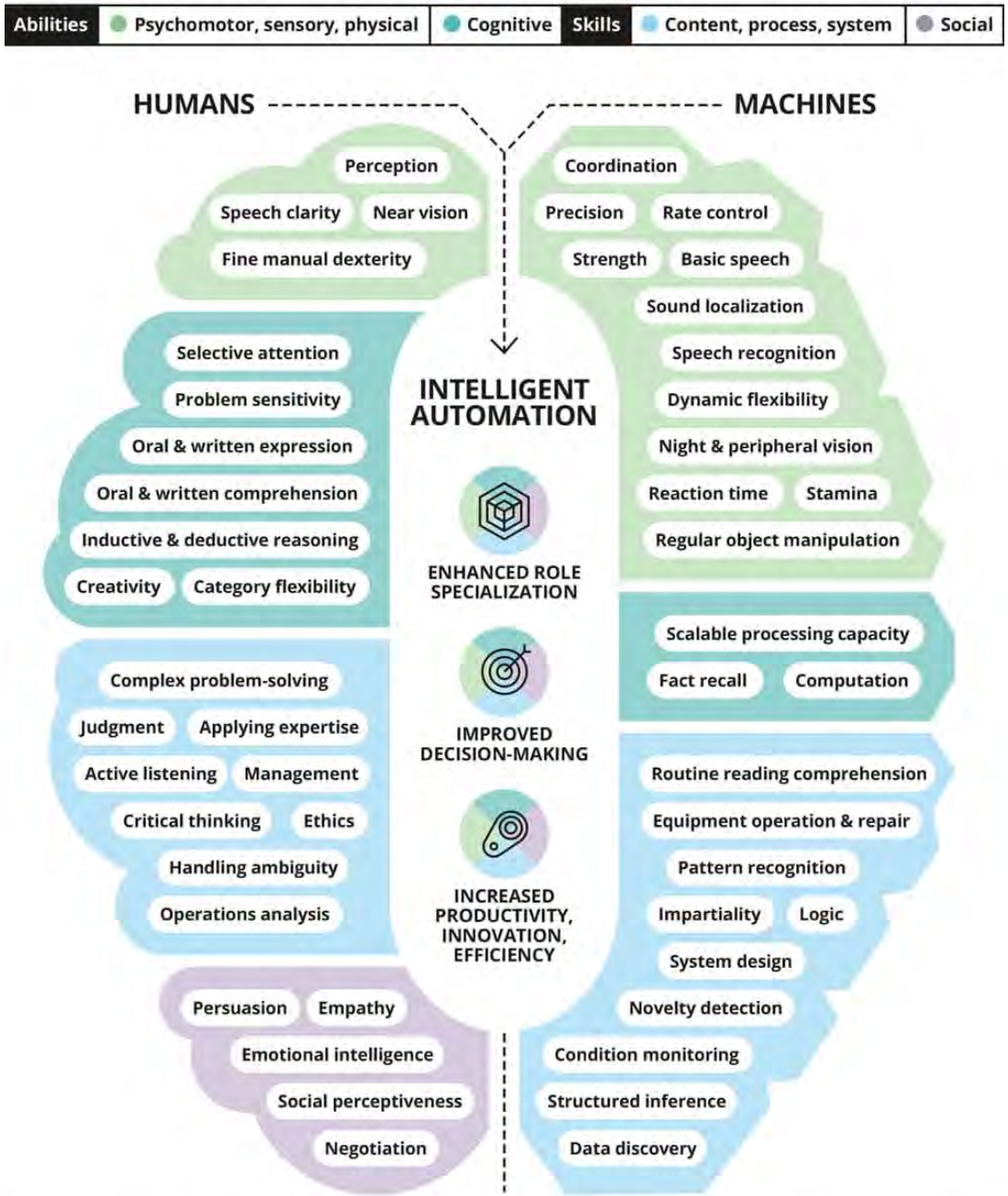
The illustration below illustrates a typical information flow between the "human" and "machine" components of a system. For a properly designed system, its important to know the capabilities and flexibilities of both.



https://www.hf.faa.gov/webtraining/HFModel/HFInterModel/overview.htm

Figure 1. A new mind-set for the no-collar workforce

Humans and machines can develop a symbiotic relationship, each with specialized skills and abilities, in a unified workforce that delivers multifaceted benefits to the business.



KEY RESEARCH AREAS IN AI

- **Problem solving, planning, and search --- generic problem solving architecture based on ideas from cognitive science (game playing, robotics).**
- **Knowledge Representation – to store and manipulate information (logical and probabilistic representations)**
- **Automated reasoning / Inference – to use the stored information to answer questions and draw new conclusions**
- **Machine Learning – intelligence from data; to adapt to new circumstances and to detect and extrapolate patterns**
- **Natural Language Processing – to communicate with the machine**
- **Computer Vision --- processing visual information**
- **Robotics --- Autonomy, manipulation, full integration of AI capabilities**

From SIRI and Alexa, to self-driving cars, artificial intelligence (AI) is progressing rapidly.

While science fiction often portrays AI as robots with human-like characteristics, AI can encompass anything from Google's search algorithms, to IBM's Watson, to autonomous weapons.

Artificial intelligence today is properly known as narrow AI (or weak AI), in that it is designed to perform a narrow task such as only facial recognition, or only internet searches, or only driving a car).

However, the long-term goal of many researchers is to create general AI (AGI or strong AI).

While narrow AI may outperform humans at whatever its specific task is, like playing chess or solving equations, AGI would outperform humans at nearly every thinking task.

We've been waiting for such a time as this....

AI is not necessarily smarter than a human, but is able to think differently and process LARGE amounts of data.
- Kevin Kelley (Wired)

1

LOW Cost Chips

Cheap computer chips, particularly developed for gaming has resulted in Graphics Processing Units (GPUs)
Lowered the cost to explore and enable AI

2

LARGE Scale Neural Networks

Neural networks are now working in large scale.
Increased the ability for Deep Learning

3

LIMITLESS Training Sets

Training sets are now able to be created or enable in large, large numbers, thanks to the neural networks.
Reduced the time to train and refine, and Increased the scale of deployment of these data sets..

The potential benefits from self-learning computer chips are limitless as these types of devices can learn to perform the most complex thinking tasks, such as interpreting critical cardiac rhythms, detecting anomalies to prevent cyber-hacking and composing music.

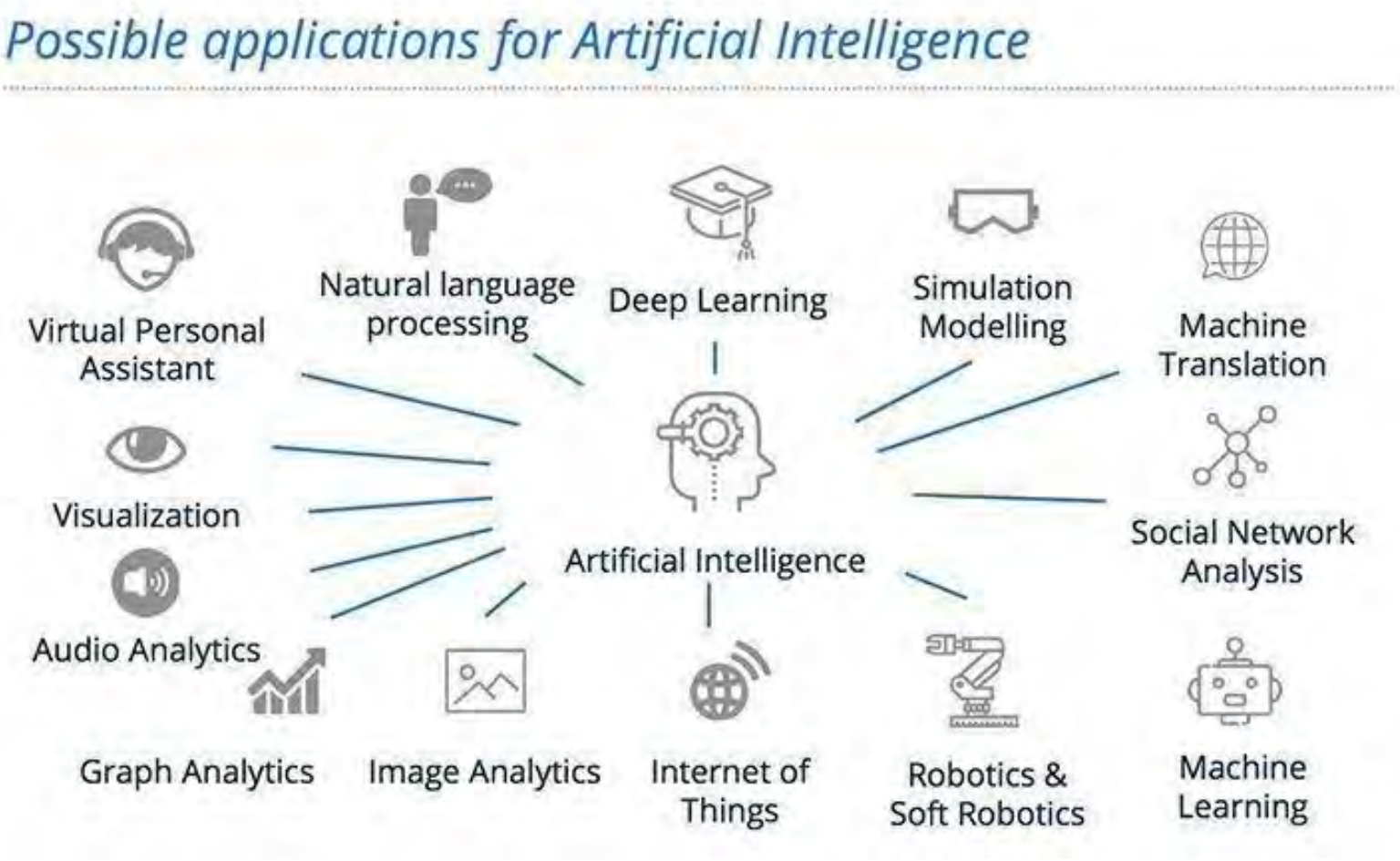
This is a new one made by the Intel company and many other companies are making special AI chips too.

AUTOMATONS – ARE THESE DEVICES INTELLIGENT ?

https://www.youtube.com/watch?v=C7oSFNKIlaM (2.22 min)

Artificial Intelligence (AI) has entered our daily lives like never before and we are yet to unravel the many other ways in which it could flourish.

All of the tech giants such as Microsoft, Uber, Google, Facebook, Apple, Amazon, Oracle, Intel, IBM or Twitter are competing in the race to lead the market and acquire the most innovative and promising AI businesses.



A.I. TIMELINE

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

Five Skills of AI

(AI) is similar to our perception of human intelligence – this isn't built on a single element, it's a combination of senses, experiences, and knowledge.
– Christopher Stancombe

Listen/Talk

The ability to listen, read, talk, write and respond to users of the IA solution. The aim here is for technology to ensure that the interaction feels intuitive and the customer is happy. Examples in this space include chatbots and voicebots.

Act

This area uses technology to take action. We are used to the concept of Robots working on an assembly line and now they are moving into the office. Examples include resetting a password and placing a customer order.

Think

This is the ability to detect patterns and recognise trends. It applies algorithms to knowledge to determine appropriate action or predict future consequences.

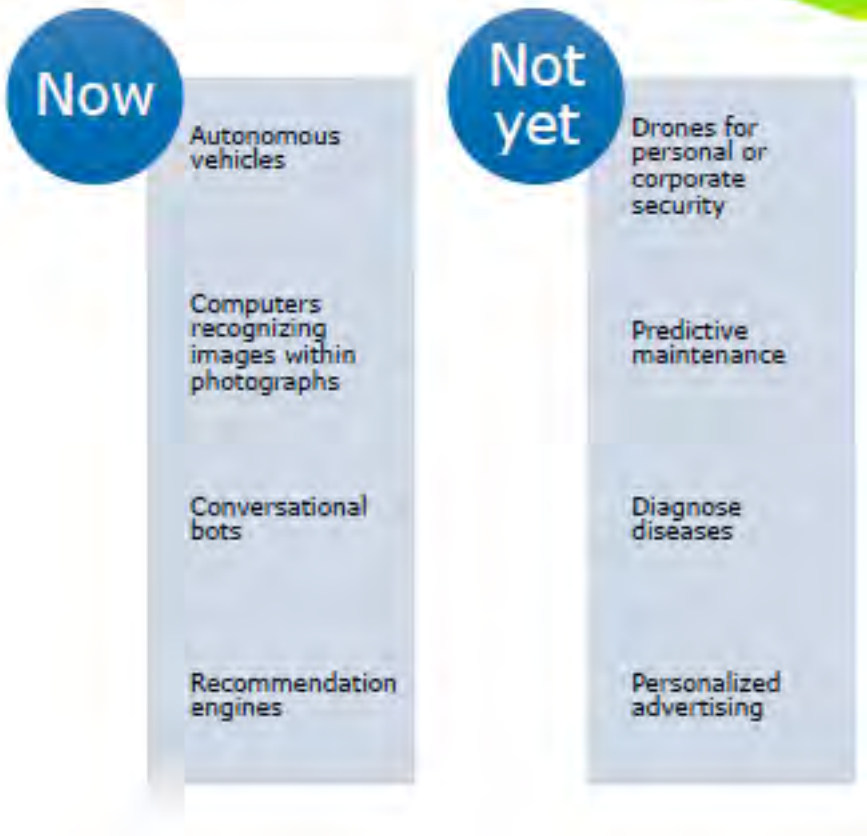
Watch

Here technology is used to watch and record key business data. It is used to create knowledge. This would include CCTV and IoT sensors.

Remember

This is about being able to store and find information effectively using components like databases and search engines. This is probably the least developed area within corporations, but examples include Wikipedia and employee's hard drives.

Designing for the Now and the Not Yet



Google announced their **Duplex** system, a new technology for conducting natural conversations to carry out "real world" tasks over the phone.

The technology is directed towards completing specific tasks, such as scheduling certain types of appointments.

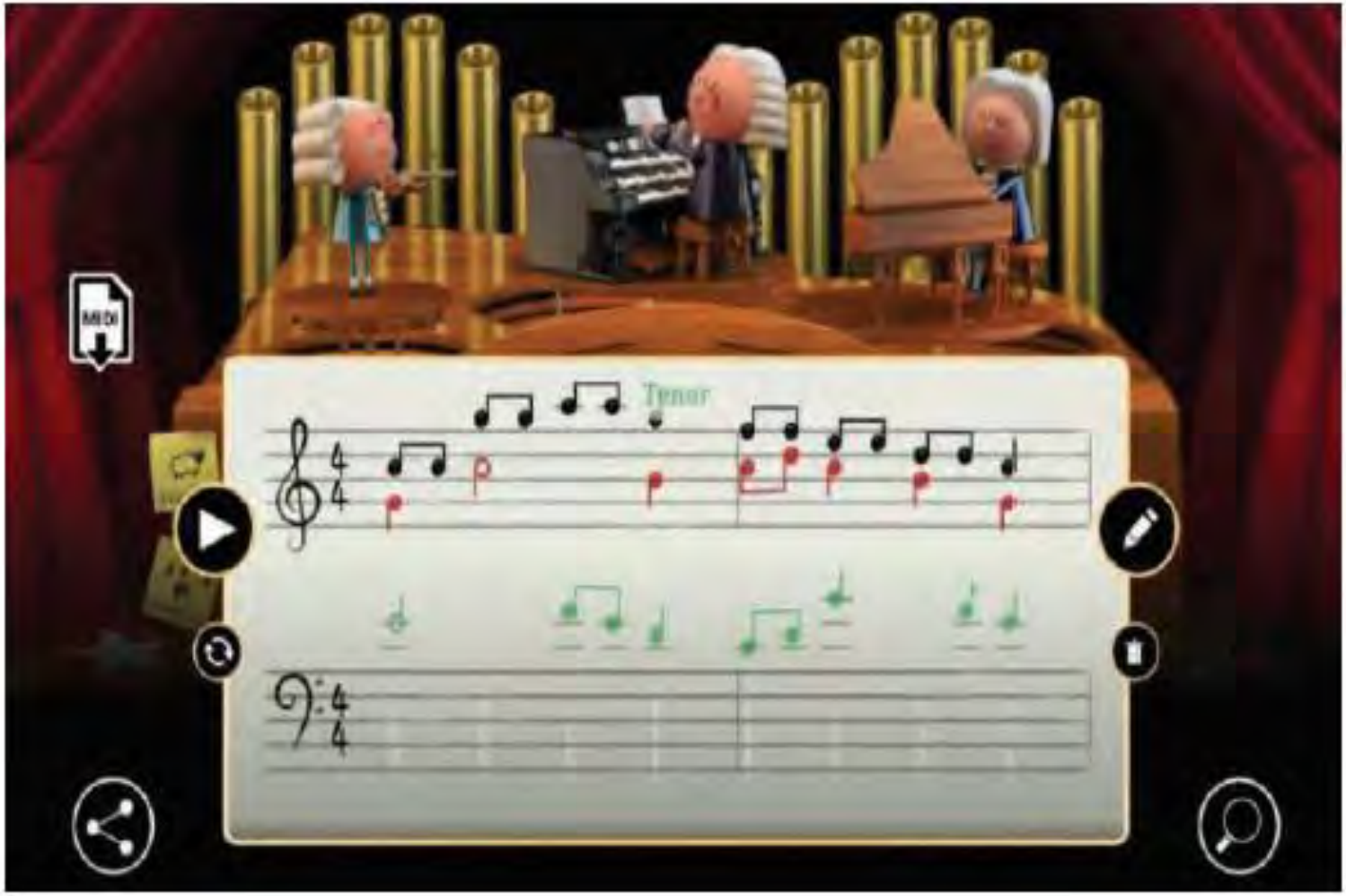
For such tasks, the system makes the conversational experience as natural as possible, allowing people to speak normally, like they would to another person, without having to adapt to a machine.

https://www.youtube.com/watch?v=GoXp1leA5Qc

Neural network tracks treatment of brain tumors on MRI

Physicians and scientists in Germany have developed an artificial neural network that's capable of interpreting brain MRI scans to tell neuroradiologists how brain tumors are responding to chemotherapy and radiation therapy, according to a study published in *The Lancet Oncology*.

Be Bach in the first AI-powered Google Doodle



https://www.youtube.com/watch?v=gsUV0mGEGaY

Machine learning is making pesto even more delicious

Researchers at MIT have used AI to improve the flavor of basil. It's part of a trend that is seeing artificial intelligence revolutionize farming

GENERATIVE ADVERSARIAL NETWORKS

Two neural networks trying to outsmart each other are getting very good at creating realistic images.

Can you identify which of these images are fake?

The answer is all of the above.

Each of these highly realistic images were created by generative adversarial networks, or GANs.

GAN, a concept introduced by Google researcher Ian Goodfellow in 2014, taps into the idea of "AI versus AI."

There are two neural networks: the generator, which comes up with a fake image (say a dog for instance), and a discriminator, which compares the result to real-world images and gives feedback to the generator on how close it is to replicating a realistic image.

Researchers at CMU used GANs for “face-to-face” translation in this iteration of “deepfake” videos. In the deepfake example below, John Oliver turns into Stephen Colbert:

Source: http://www.cs.cmu.edu/~aayushb/Recycle-GAN/

Art auction house Christie's sold its first ever GAN-generated painting for a whopping $432,500.

Portrait of Edmond Belamy, 2018, created by GAN (Generative Adversarial Network). Sold for $432,500 on 25 October at Christie's in New York. Image © Obvious

And in a more recent paper on GANs, Nvidia researchers used a "style-based generator" to create hyper-realistic images.

Source: https://arxiv.org/pdf/1812.04948.pdf

The Turing Test

Turing test

A test to determine whether a computer has achieved intelligence

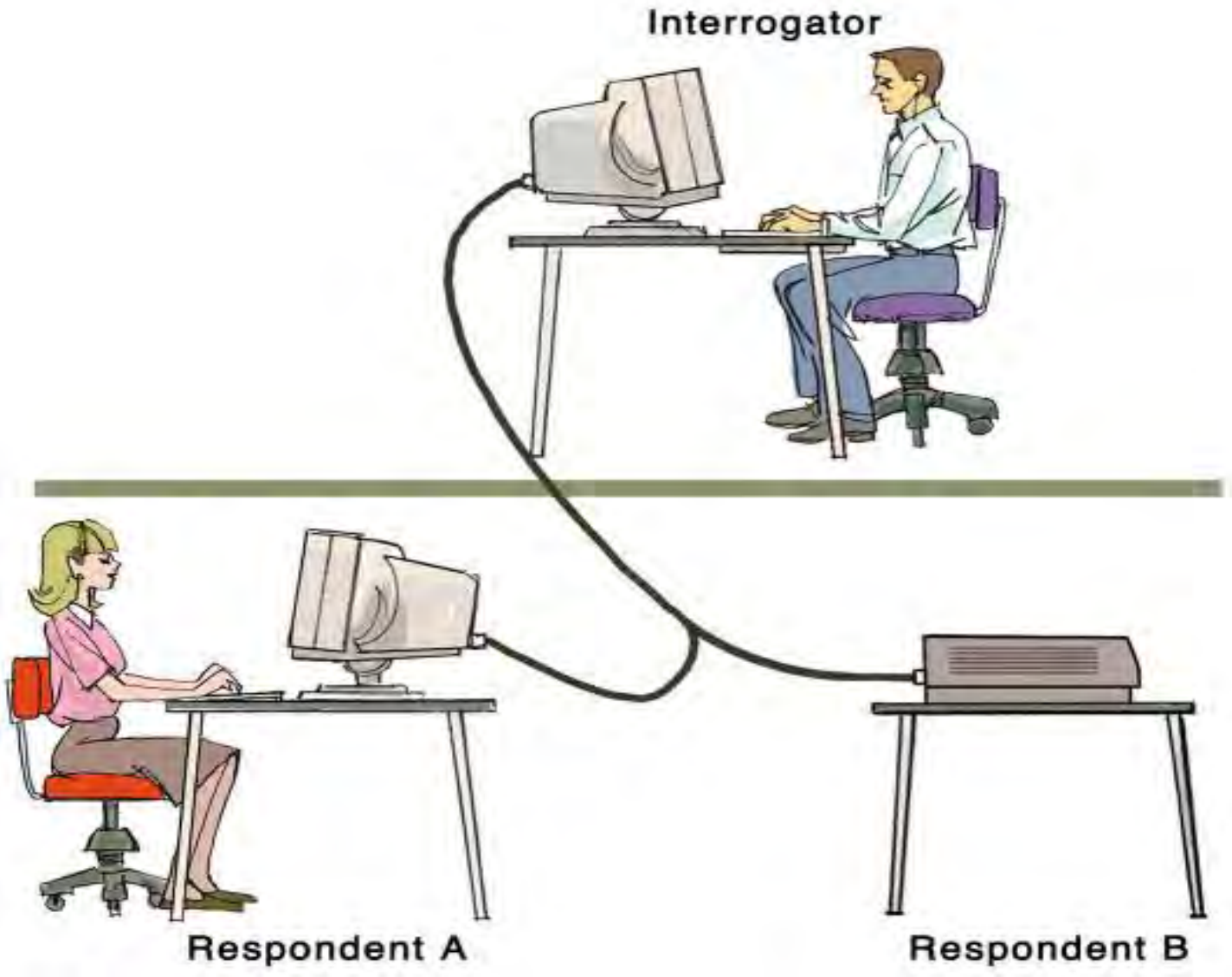
Alan Turing

An English mathematician who wrote a landmark paper in 1950 that asked the question: *Can machines think?*

He proposed a test to answer the question "How will we know when we have succeeded?"

He said that a machine passes the test when it successfully generates responses appropriate enough to convince the evaluator that it is human.

In the Turing test, the interrogator must determine which respondent is the computer and which is the human.



THE LOEBNER PRIZE FOR COMPLETING THE TURING TEST

The Loebner Prize is an annual competition in artificial intelligence that awards prizes to the computer programs considered by the judges to be the most human-like, using the Turing Test computer and person arrangement.

The contest was launched in 1990 by Hugh Loebner and there are bronze, silver, and gold coin prizes, plus money.

•So far, there have only been winners of the **bronze** medal and a $4,000 award.

Silver – a one-time-only prize plus $25,000 offered for the first program that judges cannot distinguish from a real human.

Gold plus $100,000 for the first program that judges cannot distinguish from a real human in a Turing test that includes deciphering and understanding text, visual, and auditory input.

Once this is achieved, the annual competition will end.

.

Loebner Prize Gold Medal

(Solid 18 carat, not*gold-plated* like the Olympic "*Gold*" medals)

KNOWLEDGE REPRESENTATION

- We need to create a logical view of the data, based on how we want to process it
- Natural language is very descriptive, but does not lend itself to efficient processing.

What are the different ways that we can represent knowledge so it can be reviewed by an Artificial Intelligence computer program ?

1) **Expert Learning Systems**

2) **Semantic Networks** - A knowledge representation technique that focuses on the relationships and word descriptions of objects. A graph is used to represent a semantic network or net

3) **Decision or Search tree**

4) **Neural networks** – creating a computer version of the neurons of the brain and how they work

1) Expert Learning Systems

- **Expert Learning Systems** were commercially the first and most successful domain in Artificial Intelligence.
  - Somewhat out of favor today
  - These programs mimic the experts in whatever field is being studied.

Auto mechanic	Telephone networking
Cardiologist	Delivery routing
Organic compounds	Professional auditor
Mineral prospecting	Manufacturing
Infectious diseases	Pulmonary function
Diagnostic internal medicine	Weather forecasting
computer configuration	Battlefield tactician
Engineering structural analysis	Space-station life support
Audiologist	Civil law

- **Rule-based or Expert systems** - Knowledge bases consisting of hundreds or thousands of rules of the form:
- **IF (condition) THEN (action).**

  - Use rules to store knowledge ("rule-based").
  - The rules are usually gathered from experts in the field being represented ("expert system").
  - Most widely used knowledge model in the commercial world.

IF (it is raining AND you must go outside)
THEN (put on your raincoat)

- Rules can fire off a chain of other rules

IF (raincoat is on)
THEN (you will not get wet)

Expert Systems

Gardener Expert System Example

Expert Systems

Named abbreviations that represent conclusions:

- NONE—apply no treatment at this time
- TURF—apply a turf-building treatment
- WEED—apply a weed-killing treatment
- BUG—apply a bug-killing treatment
- FEED—apply a basic fertilizer treatment
- WEED & FEED—apply a weed-killing and fertilizer combination treatment

Expert Systems

Variables that are needed to represent the state of the lawn

- BARE—the lawn has large, bare areas
- SPARSE—the lawn is generally thin
- WEEDS—the lawn contains many weeds
- BUGS—the lawn shows evidence of bugs

Expert Systems

Data that is available:

- LAST—the date of the last lawn treatment
- CURRENT—current date
- SEASON—the current season

Now we can formulate some rules for our gardening expert system

Rules take the form of *if-then* statements

Expert Systems

Some rules

- if (THE CURRENT DAY – LAST DAY IS LESS THAN 30) then NONE
- if (SEASON = winter) then not BUGS
- if (BARE) then TURF
- if (SPARSE and not WEEDS) then FEED
- if (BUGS and not SPARSE) then BUG
- if (WEEDS and not SPARSE) then WEED
- if (WEEDS and SPARSE) then WEED & FEED

Expert Systems

An execution of our inference engine

- **System**: Does the lawn have large, bare areas?
- **User**: No

- **System**: Does the lawn show evidence of bugs?
- **User**: No

- **System**: Is the lawn generally thin?
- **User**: Yes

- **System**: Does the lawn contain significant weeds?
- **User**: Yes

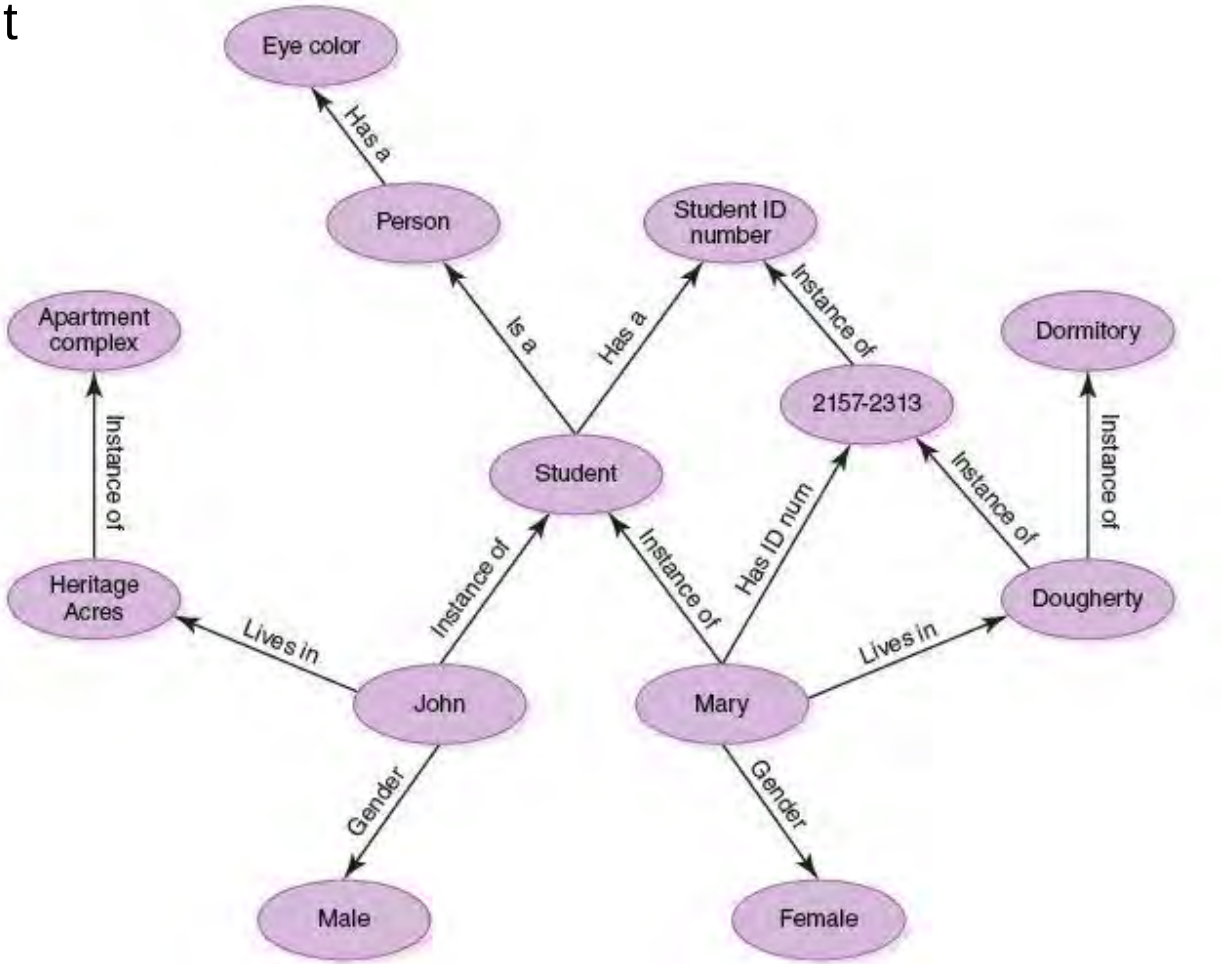
- **System**: You should apply a weed-killing and fertilizer combination treatment.

2) Semantic (word description) Networks

Semantic network

A knowledge representation technique that focuses on the relationships between objects

A directed graph or word chart is used to represent a semantic network or net

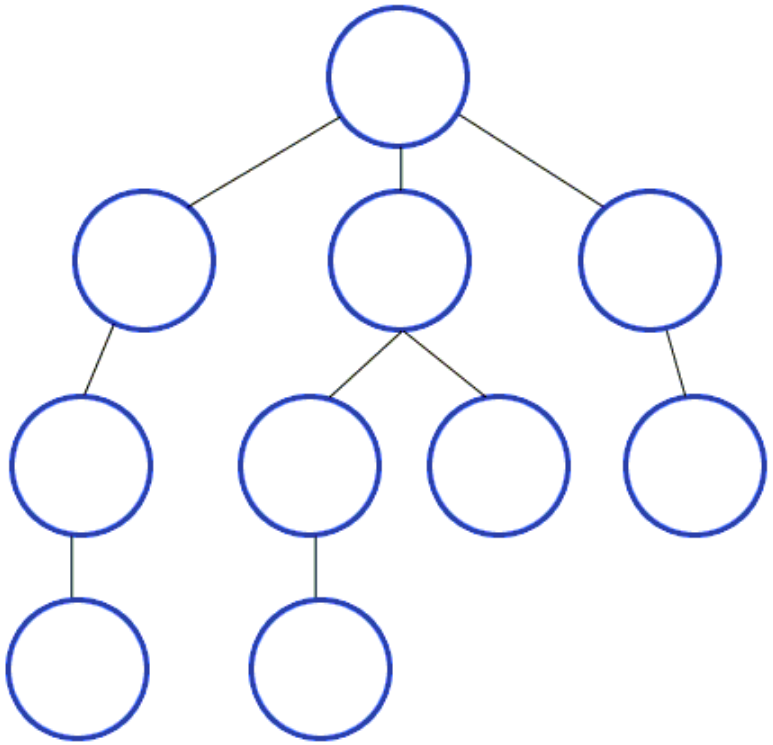


3) Search Trees

AI often revolves around the use of algorithms.

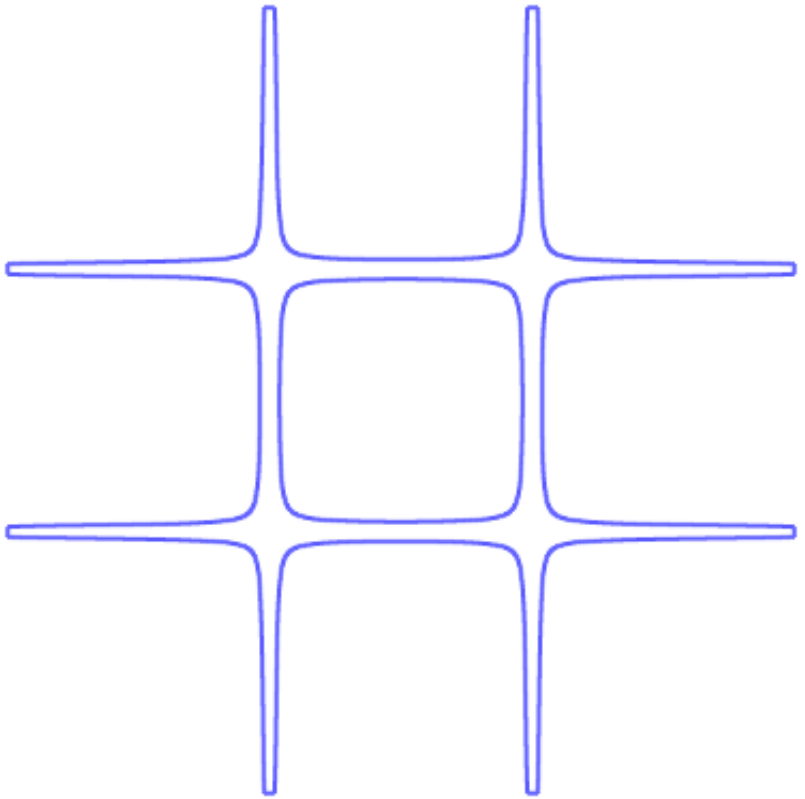
An algorithm is a set of instructions that a mechanical computer can execute.

A complex algorithm is often built on top of another, simpler, one and a common way to visualize it is with a tree design.



A simple example of an algorithm is the following recommendations for optimal play at tic-tac-toe:

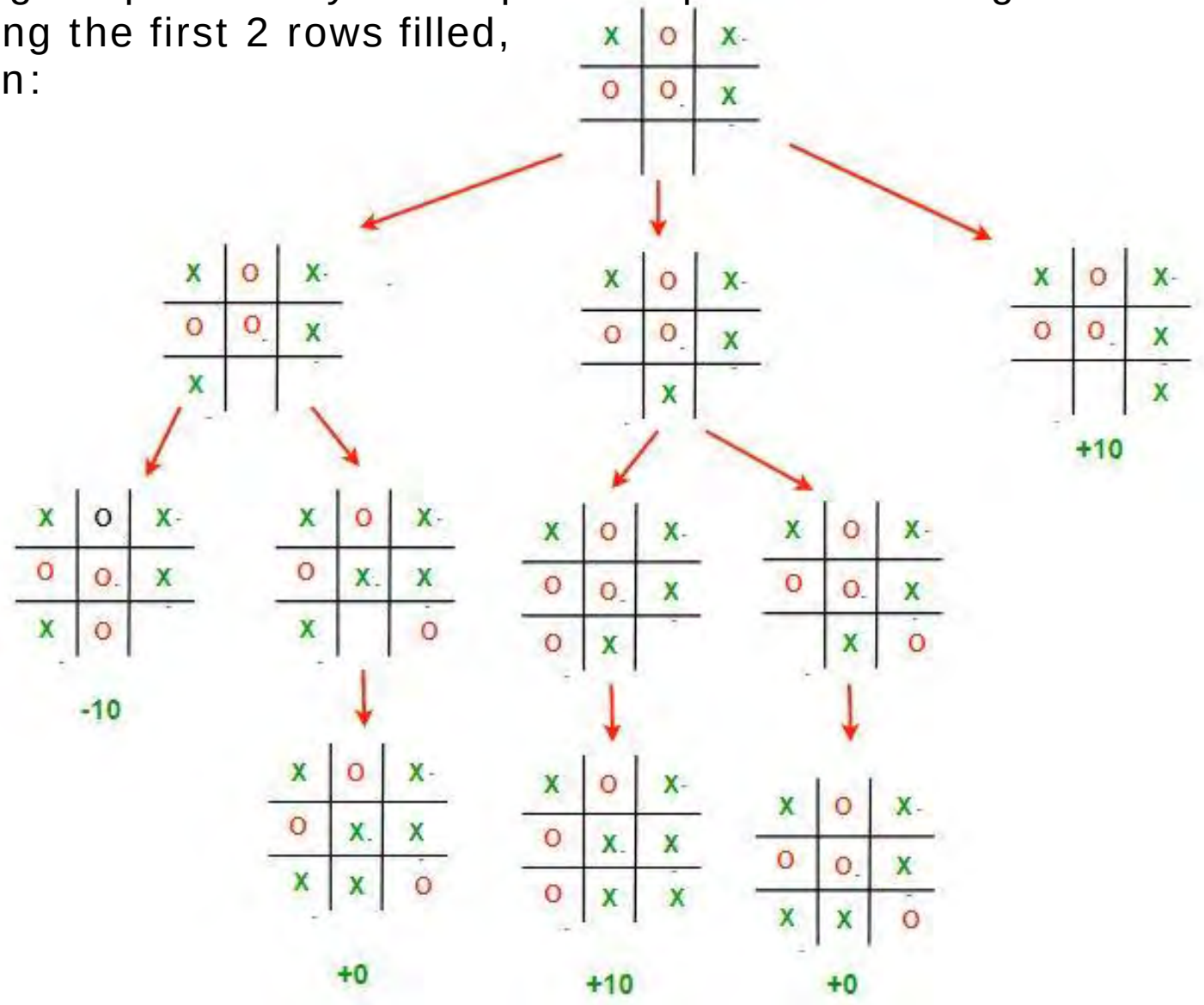
- If someone has a "threat" (that is, two in a row), take the remaining square. Otherwise,
- If a move "forks" to create two threats at once, play that move. Otherwise,
- Take the center square if it is free. Otherwise,
- If your opponent has played in a corner, take the opposite corner. Otherwise,
- Take an empty corner if one exists. Otherwise,
- Take any empty square.



benice equation

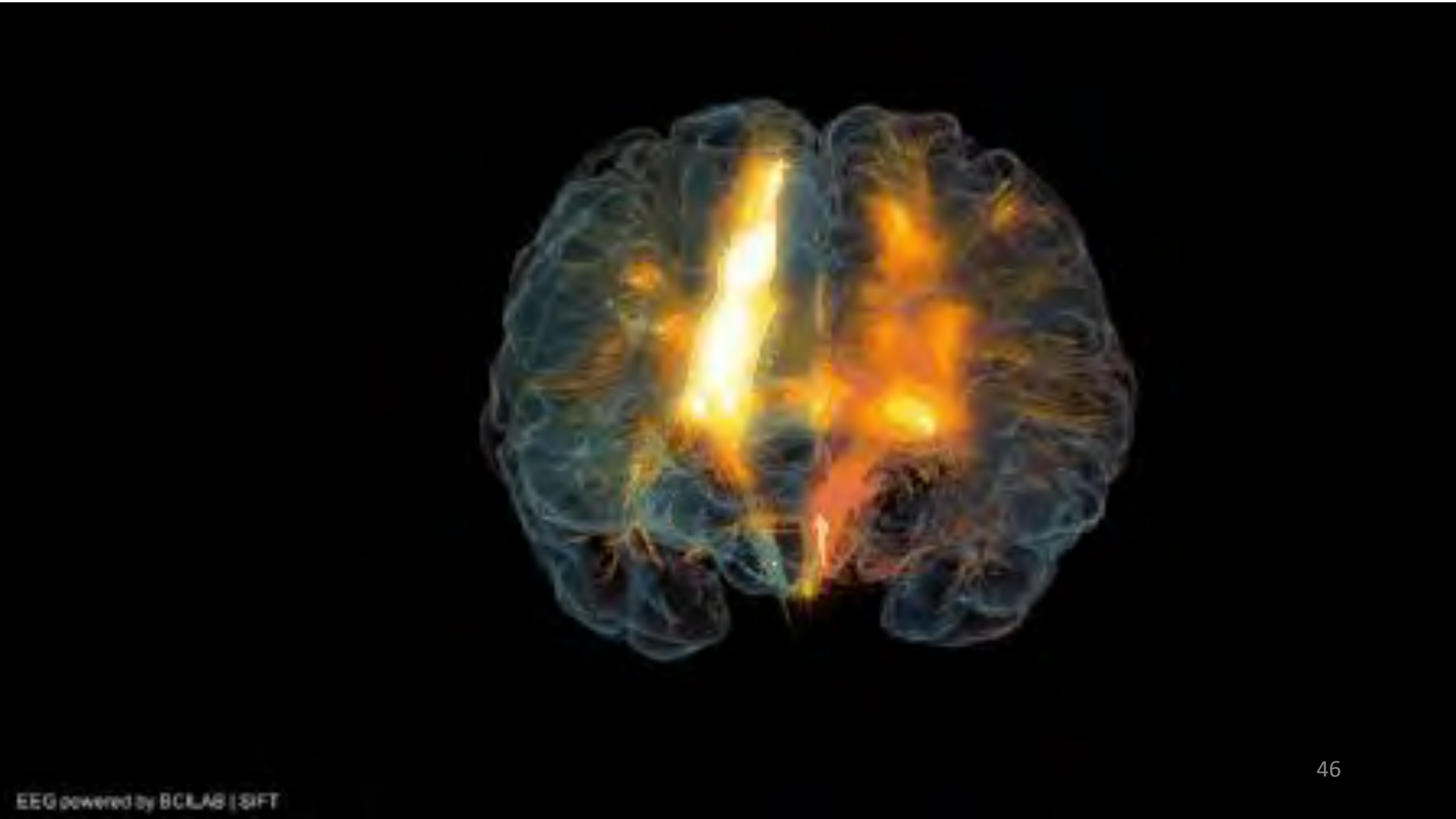
An example is a Search tree for playing the game Tic-Tac-Toe, as shown below.

This image depicts many of the possible paths that the game can take from the having the first 2 rows filled,
as shown:

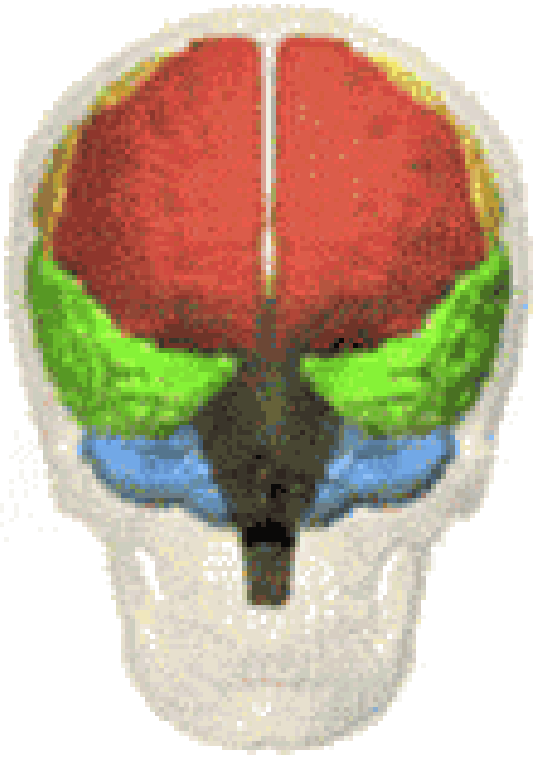


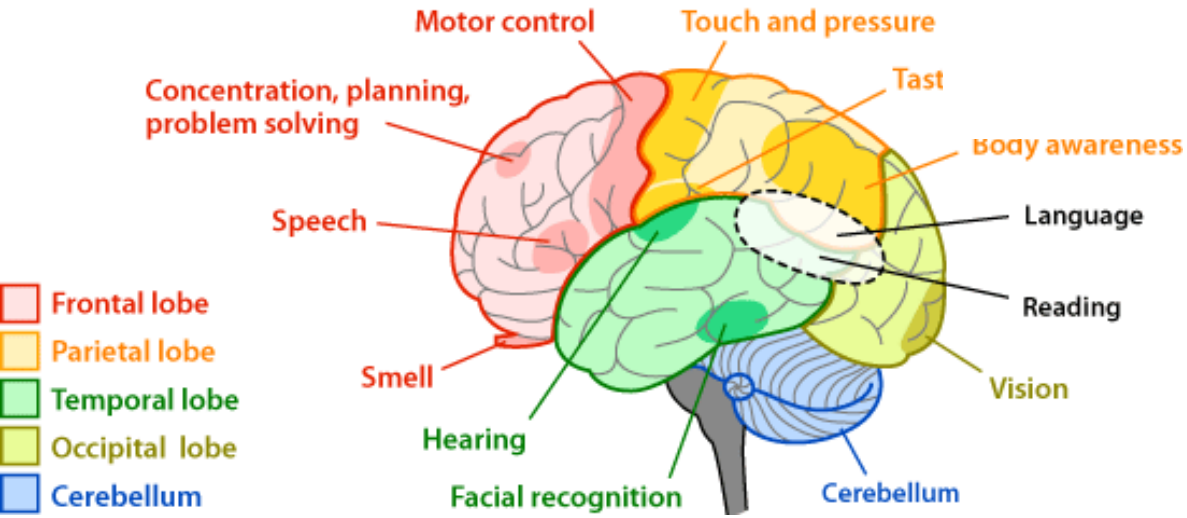
THE HUMAN BRAIN AND NEURONS IN IT

A REVIEW BEFORE THE DISCUSSION ABOUT 4) NEURAL NETS



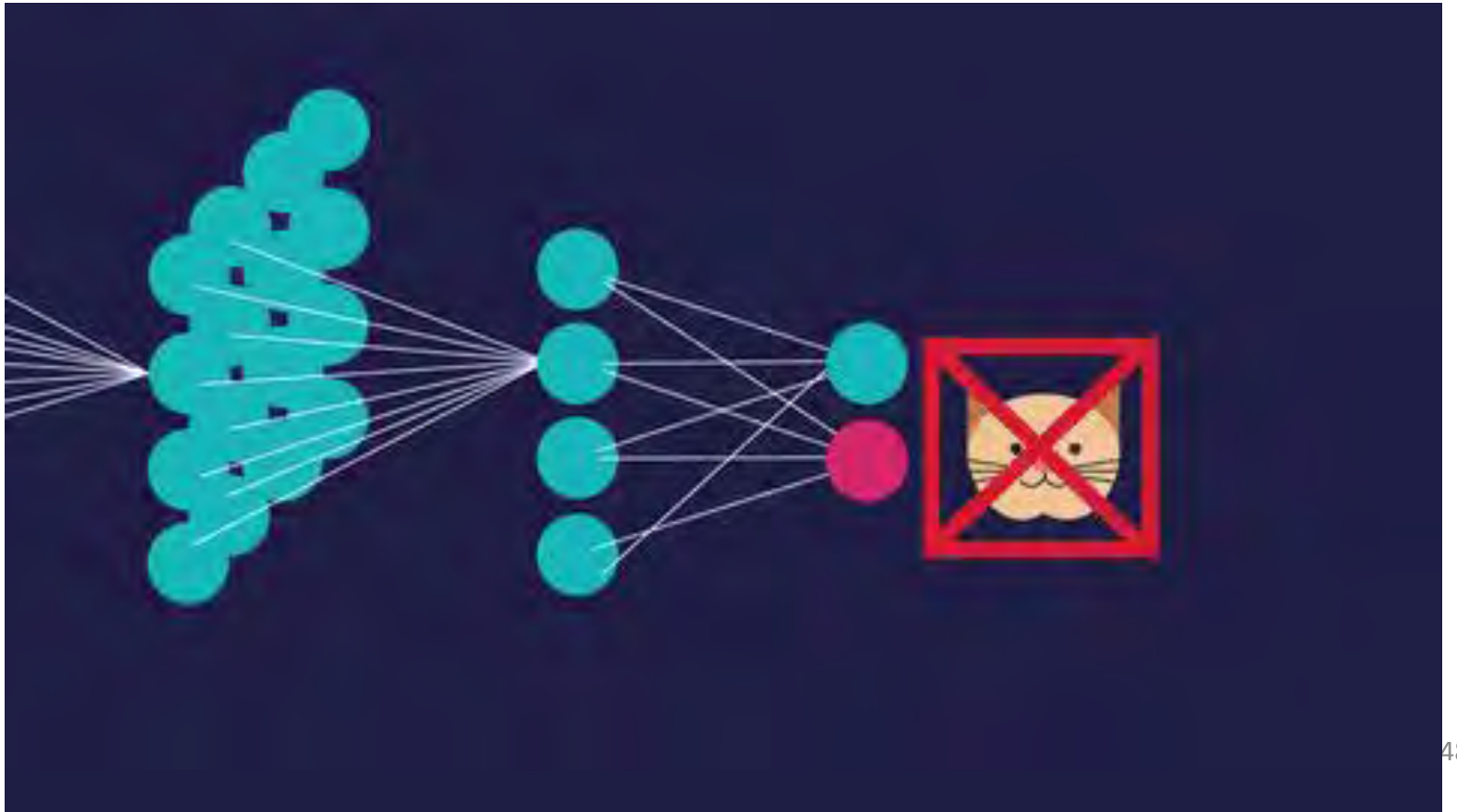
THE BRAIN IS DIVIDED INTO 4 LOBES AND THE CEREBELLUM WHICH IS LOCATED AT THE BOTTOM, BACK AREA





AI technology called machine learning today, is great at helping for taking good photos, translating languages, recognizing your friends on Facebook, delivering search results, screening out spam and many other chores.

It usually uses an approach called neural networks that works something like a human brain, not a sequence of IF THIS, THEN steps as in traditional computing.

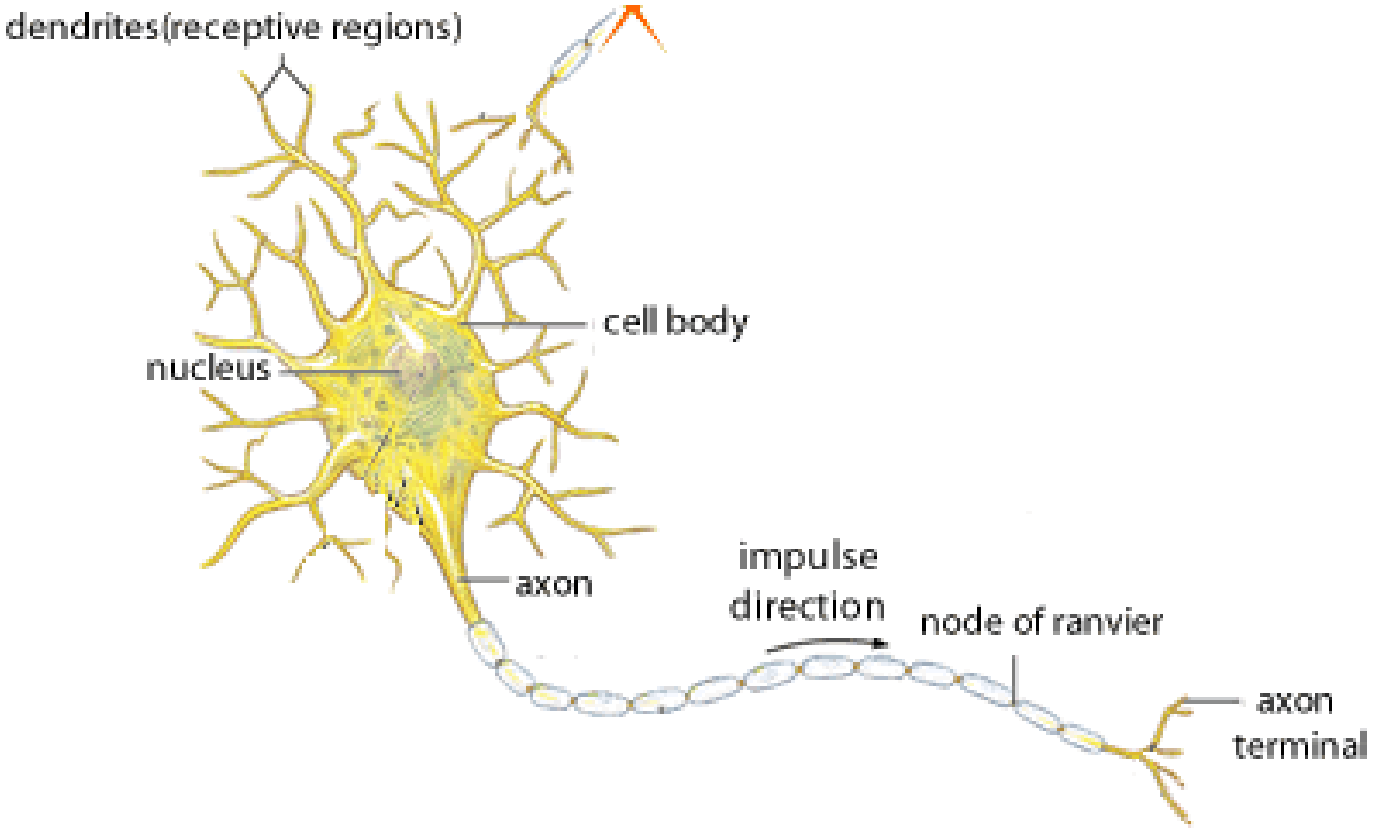


TYPES AND FUNCTION OF NEURONS

Neurons are essential for every action that our body and brain carry out.

It is the complexity of neuronal networks that gives us our personalities and our consciousness.

They make up around 10 percent of the brain; the rest consists of glial cells and other cells that support and nourish the neurons.

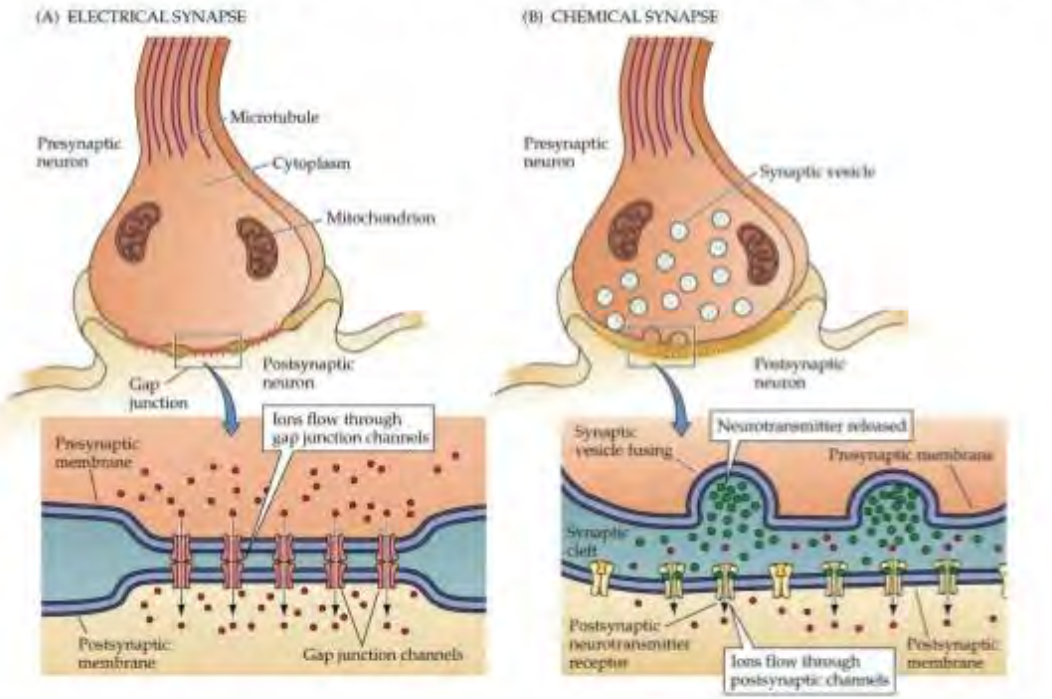


There are around 86 billion neurons in the brain. To reach this huge target, a developing fetus must create around 250,000 neurons per minute !

Each neuron is connected to at least 10,000 others – giving well over 1,000 trillion connections (1 quadrillion connections).

They all connect at a junction called a synapse, which can be electrical or a higher percentage of them are chemical.

Electrical vs. Chemical Synapses



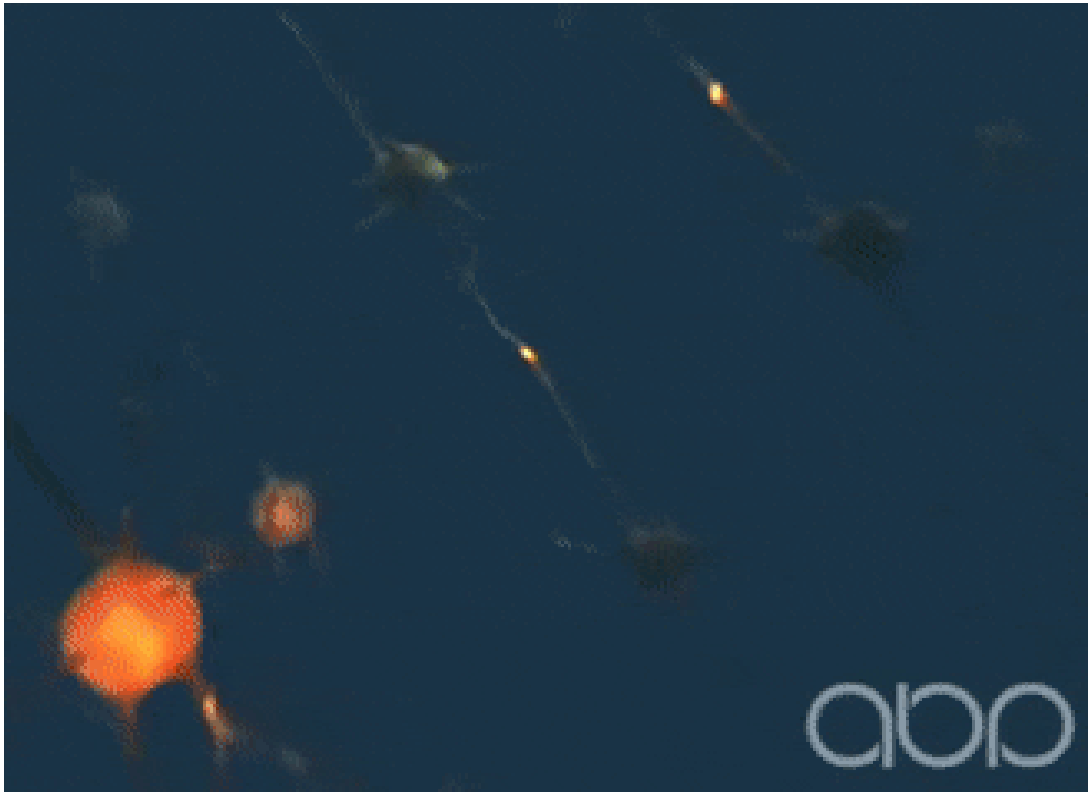
NEUROSCIENCE, Fourth Edition, Figure 5.1

Incoming signals to the neuron can be either **excitatory** – which means they tend to make the neuron **fire** (generate an electrical impulse) – or **inhibitory** – which means that they tend to keep the neuron from firing.

A single neuron may have more than one set of dendrites, and may receive many thousands of input signals.

Whether or not a neuron is excited into firing an impulse depends on the sum of all of the excitatory and inhibitory signals it receives.

If the neuron does end up firing, the nerve impulse is conducted down the axon.

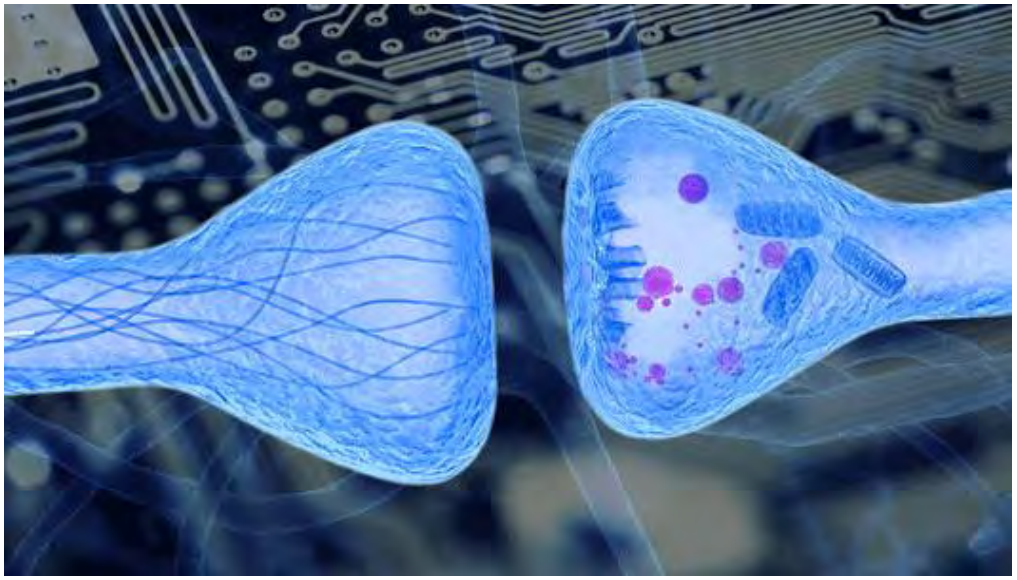


How synapses work - Neurons are connected to each other at a location called a Synapse, so that they can communicate messages

Amazingly, where each cell connects with the other one, <u>NONE</u> of these cells ever touch each other !!

The signal that is carried from the first nerve fiber to the next one is transmitted by an electrical signal or a chemical one, up to a speed of 268 miles per hour !

There is new evidence that both types closely interact with each other and that the transmission of a nerve signal is both **chemical *and* electrical,** which is actually required for normal brain development and function.



https://www.youtube.com/watch?v=mItV4rC57kM&t=10s

If you don’t use a foreign language you learned years ago or mathematics, the neurons used for those things will move the synapses away from each other so they can do other things that you are learning to do. This is called Synaptic Pruning.

4) Artificial Neural Network (ANN)

A computer representation of knowledge that attempts to mimic the neural networks of the human brain

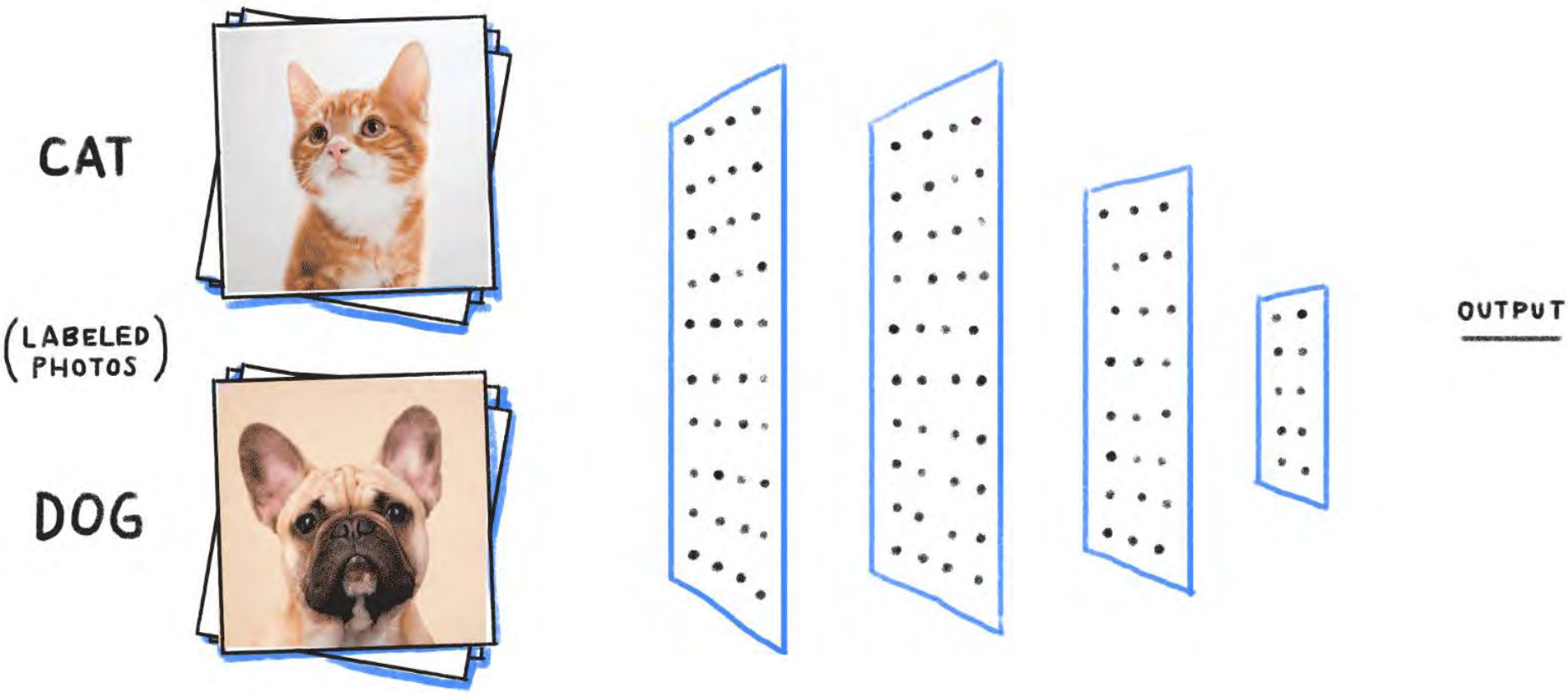
Yes, but what is a human neural network?

Neural networks, or neural nets, were inspired by the architecture of neurons in the human brain.

A simple "neuron" *N* accepts input from multiple other neurons, each of which, when activated (or "fired"), cast a weighted "vote" for or against whether neuron *N* should itself activate.

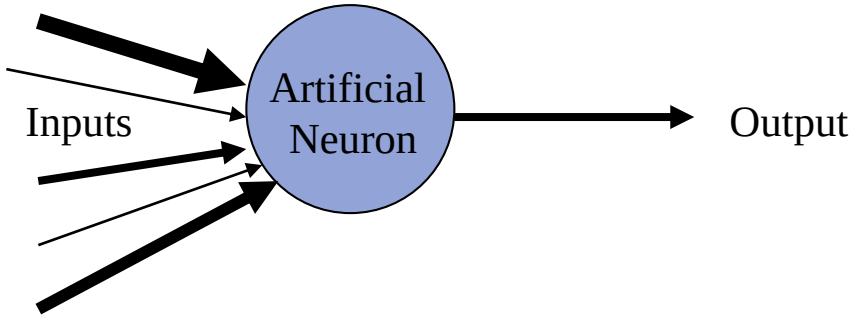
An ANN is based on a collection of connected units or nodes called artificial neurons, which loosely model the neurons in a biological brain.

Each connection, like the synapses in a biological brain, can transmit a signal from one artificial neuron to another. An artificial neuron that receives a signal can process it and then signal additional artificial neurons connected to it.



ARTIFICIAL NEURAL NETWORK

- **Artificial neurons**: Commonly called processing elements, are modeled after real neurons of humans and other animals.
  - Has many inputs and one output.
  - The inputs are signals that are strengthened or weakened (weighted).
  - If the sum of all the signals is strong enough, the neuron will put out a signal to the next neuron output of a 1.



Artificial Neural Networks

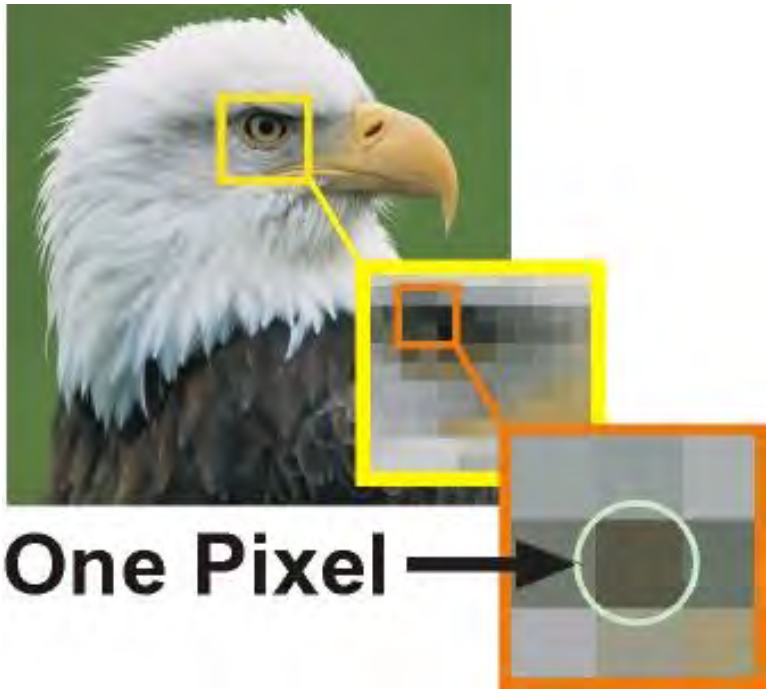
Training

The process of adjusting the weights and threshold values in a neural net

How does this all work?

Train a neural net to recognize An eagle in a picture.

Given one output value per pixel, train network to produce an output value of 1 for every pixel that contributes to the eagle and 0 for every one that doesn't.



DeepMind is a subsidiary of **Google** that focuses on the development of **artificial intelligence** and deep reinforcement machine learning.

The deep reinforcement learning of its **AI** algorithms has been used in both research and applied contexts

DeepMind is built around the framework of neural networks and uses a method called deep-reinforced-learning.

This means that the A.I can learn from it's experiences and become more efficient at whatever it **does**.

The A.I is general-purpose meaning that it's NOT pre-programmed for a specific task from the go.

https://www.youtube.com/watch?v=gn4nRCC9TwQ

Agents

- **An agent is anything that can be viewed as a device that can perceive its environment through sensors and act upon that environment through actuators.**

- **Human agent:** eyes, ears, and other organs for sensors; hands, legs, mouth, and other body parts for actuators

- **Robotic agent**: cameras and infrared range finders for sensors

- Various motors for actuators

- **Rational Agent:**
- For each possible sequence, a rational agent should select an action that is expected to maximize its performance measure, given the evidence provided by the perception sequence and whatever built-in knowledge the agent has.

Why "meaning" is the central concept of AI

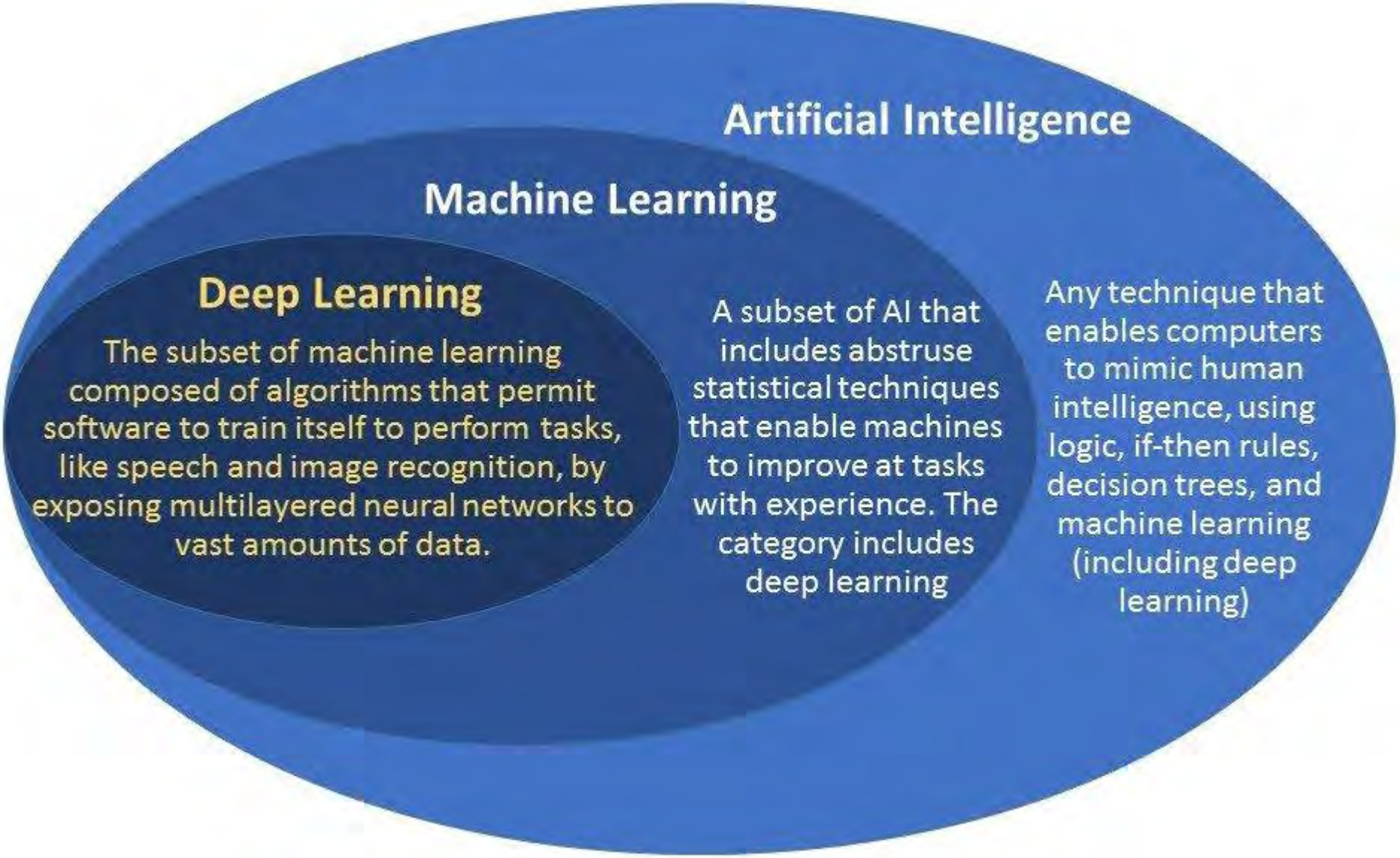
- For an agent to be "intelligent", it must be able to understand the meaning of information.

- Information is acquired / delivered / conveyed in messages which are phrased in a selected representation language.

- There are two sides in information exchange: the source (text, image, person, program, etc.) and the receiver (person or an AI agent). They must speak the same "language" for the information to be exchanged in a meaningful way.

- The receiver must have the ability to interpret the information correctly according to the intended by the source meaning or semantics of it.

MEANING = SEMANTICS


Artificial Intelligence
Any technique that enables computers to mimic human intelligence, using logic, if-then rules, decision trees, and machine learning (including deep learning)
Machine Learning
A subset of AI that includes abstruse statistical techniques that enable machines to improve at tasks with experience. The category includes deep learning
Deep Learning
The subset of machine learning composed of algorithms that permit software to train itself to perform tasks, like speech and image recognition, by exposing multilayered neural networks to vast amounts of data.

Machine Learning

The phrase 'machine learning' dates back to the middle of the last century where Arthur Samuel in 1959 defined machine learning as "the ability to learn without being explicitly programmed."

Machine learning is a type of AI that helps a computer's ability to learn and essentially teach itself to evolve as it becomes exposed to new and ever-changing data.

For example, Facebook's news feed uses machine learning in an effort to personalize each individual's feed based on what they like.

DRONE CHASSIS DESIGN USING MACHINE LEARNING

https://www.youtube.com/watch?v=odHC-gxJhG4

Deep Learning

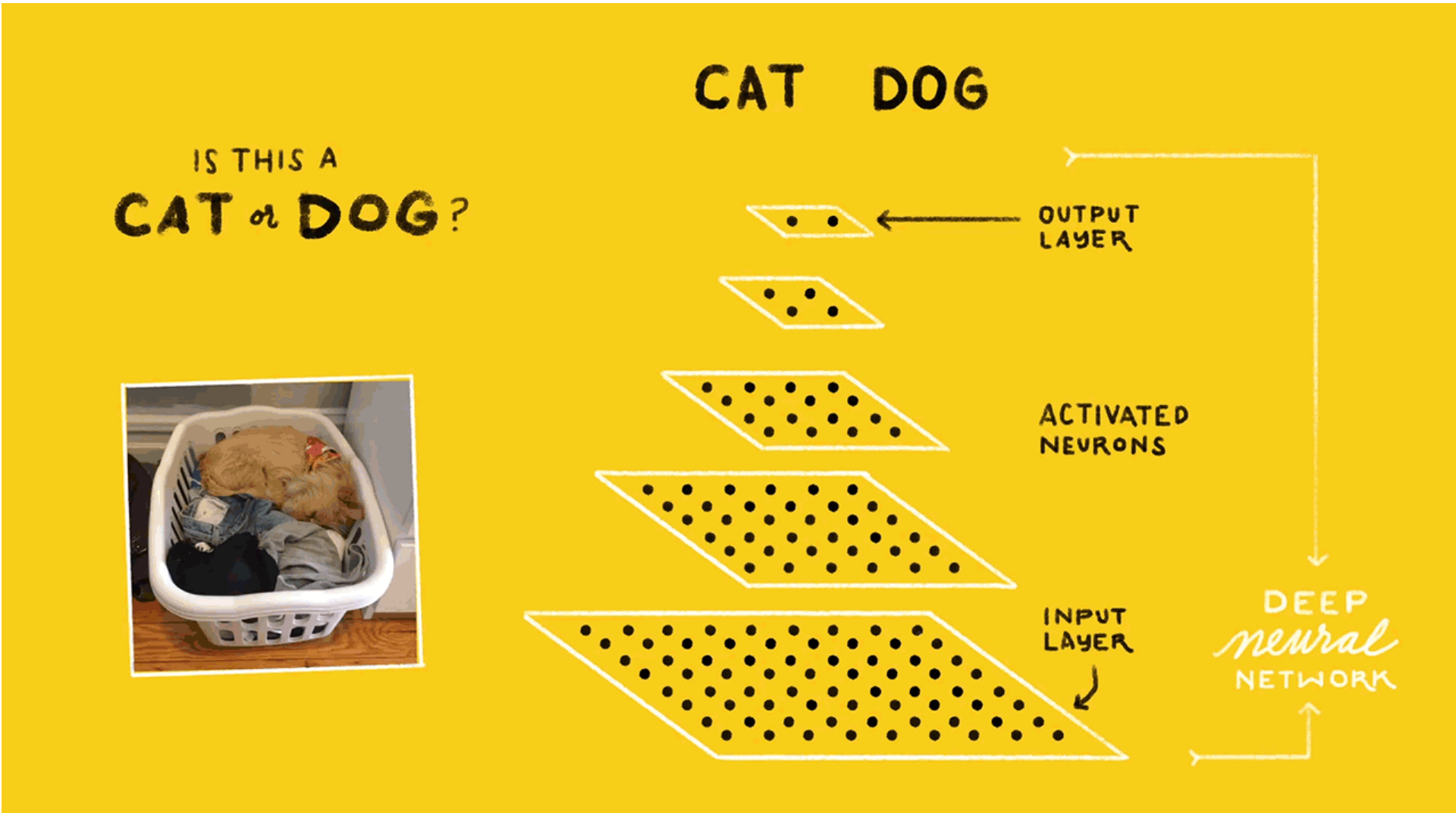
Deep Learning is a new area of machine learning research, which has been introduced with the objective of moving machine learning closer to artificial intelligence.

It relates to study of 'deep neural networks' in the human brain and, under this perspective, the deep learning tries to emulate the functions of inner layers of the human brain, creating knowledge from multiple layers of information processing.

Since the deep learning technology is modelled after the human brain, each time new data is poured in, its capabilities get better.

Deep artificial neural networks are a set of algorithms reaching new levels of accuracy for many important problems, such as image recognition, sound recognition, recommender systems, etc.

For example, a deep learning algorithm could be trained to ‘learn’ how a dog looks like. It would take an enormous dataset of images for it to understand the minor details that distinguish a dog from a wolf or a fox.




TRANSITORY
NECESSARY
EXPERIMENTAL
THREATENING
High
Low
INDUSTRY ADOPTION
Low
MARKET STRENGTH
High
Open source frameworks
Facial recognition
Conversational agents
Predictive maintenance
Edge computing
Cyber threat hunting
Medical imaging & diagnostics
E-commerce search
Synthetic training data
Drug discovery
Back office automation
Crop monitoring
Language translation
Anti-counterfeit
Check-out free retail
Autonomous navigation
Advanced healthcare biometrics
Auto claims processing
Reinforcement learning
Clinical trial enrollment
Network optimization
Next-gen prosthetics
GANs
Federated learning
Capsule Networks
Application: Computer vision
Application: Natural language processing/synthesis
Application: Predictive intelligence
Architecture
Infrastructure

CONCERNS ABOUT AI TAKING OVER THE WORLD

The computer that wins at games of Chess or Go, is analyzing data for patterns. It has no idea it's playing Go as opposed to golf, or what would happen if more than half of a Go board was pushed beyond the edge of a table.

When you ask Amazon's Alexa to reserve you a table at a restaurant you name, its voice recognition system, made very accurate by machine learning, saves you the time of entering a request in Open Table's reservation system.

But Alexa doesn't know what a restaurant is or what eating is.

If you asked it to book you a table for two at 6 p.m. at the Mayo Clinic, it would try.


DIGITALISATION
"Creating better humans will always be more important than creating smarter machines".
Garry Kasparov, former world chess champion and author of "Deep Thinking", opened the OECD conference "Artificial Intelligence: Intelligent Machines, Smart Policies" on 26 October 2017.

My AI

Reads facial expressions

Detects emotion

Responds to voice, touch, gestures

Listens....sometimes

Very good at specific tasks

Constantly learning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Thanks for the weather forecast, Alexa.
Whatever.
Wayno® & 4 Pirro.
6.9.18
ARTIFICIAL INDIFFERENCE


BRACE YOURSELVES
ARTIFICIAL INTELLIGENCE IS COMING
memegenerator.net

THE END