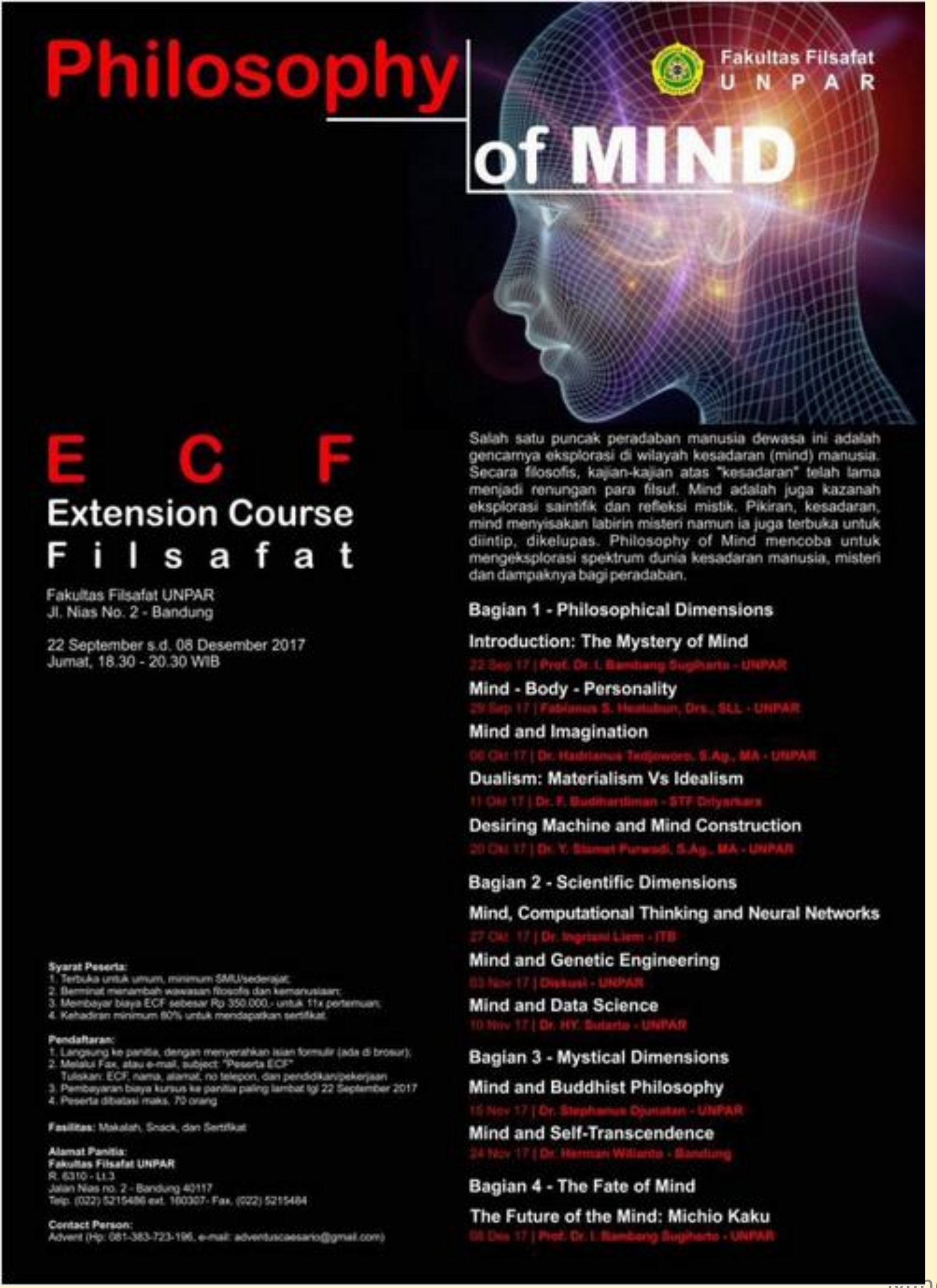

Mind, Computational Thinking & Neural Network

Inggriani

Penceramah Tamu Tanggal 27 Oktober 2017

Presentation Summary

- Brain, Mind and Thinking – Society of MInd
- Thinking - consciousness
- Neural Network and Artificial Neural Network
- Computational Thinking

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The Society of Mind

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The Minsky Arm, developed by Marvin Minsky in the late 1960s through the early 1970s, uses a camera and computer to build with blocks. Working on the arm served as inspiration for his later work on the human mind. (Photo courtesy of gastev on Flickr. CC-BY.)

Instructor(s)
Prof. Marvin Minsky

MIT Course Number
6.868J

As Taught In
Fall 2011

Level
Graduate

CITE THIS COURSE

Introduction to the course

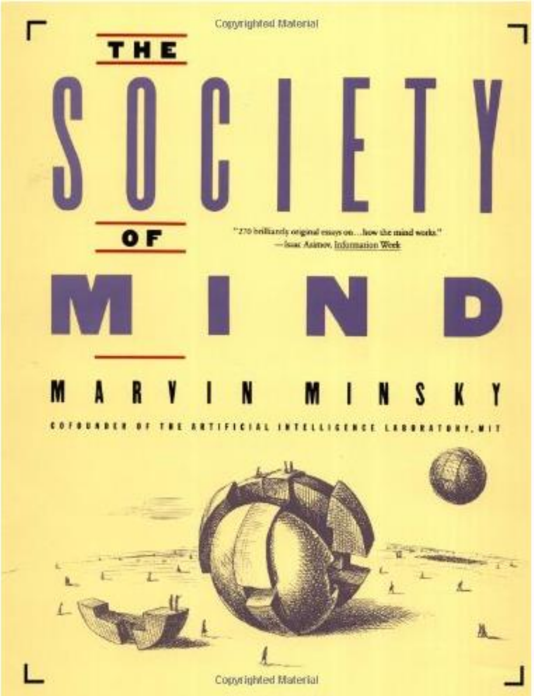
- This course is an introduction to the theory that tries to explain how minds are made from collections of simpler processes.
- It treats such aspects of thinking as vision, language, learning, reasoning, memory, consciousness, ideals, emotions, and personality.
- It incorporates ideas from psychology, artificial intelligence, and computer science to resolve theoretical issues such as wholes vs. parts, structural vs. functional descriptions, declarative vs. procedural representations, symbolic vs. connectionist models, and logical vs. common-sense theories of learning.

Society of Mind

- Nature of mind
  - A core tenet of Minsky's philosophy is that "**minds are what brains do**". The society of mind theory views the human mind and any other naturally evolved cognitive systems as a vast society of individually simple processes known as agents. These processes are the fundamental thinking entities from which minds are built, and together produce the many abilities we attribute to minds. The great power in viewing a mind as a society of agents, as opposed to the consequence of some basic principle or some simple formal system, is that different agents can be based on different types of processes with different purposes, ways of representing knowledge, and methods for producing results.
- This idea is perhaps best summarized by the following quote:
  - What magical trick makes us intelligent? The trick is that there is no trick. The power of intelligence stems from our vast diversity, not from any single, perfect principle. — Marvin Minsky, The Society of Mind, p. 308

Society of Mind by Marvin Minsky

- Marvin Minsky -- one of the fathers of computer science and cofounder of the Artificial Intelligence Laboratory at MIT -- gives a revolutionary answer to the age-old question: "How does the mind work?" Minsky brilliantly portrays the mind as a "society" of tiny components that are themselves mindless. Mirroring his theory, Minsky boldly casts *The Society of Mind* as an intellectual puzzle whose pieces are assembled along the way. Each chapter -- on a self-contained page -- corresponds to a piece in the puzzle. As the pages turn, a unified theory of the mind emerges, like a mosaic. Ingenious, amusing, and easy to read, *The Society of Mind* is an adventure in imagination.



Society of Mind

The functions performed by the brain are the products of the work of thousands of different, specialized sub-systems, the intricate product of hundreds of millions of years of biological evolution.

We cannot hope to understand such an organization by emulating the techniques of those particle physicists who search for the simplest possible unifying conceptions.

Constructing a mind is simply a different kind of problem—of how to synthesize organizational systems that can support a large enough diversity of different schemes, yet enable them to work together to exploit one another's abilities.

What are the simplest agents?

- **K-lines** : the most common agent in the Society of Mind theory. The purpose of a K-line is simply to turn on a particular set of agents, and because agents have many interconnections, activating a K-line can cause a cascade of effects within a mind
- **Nemes.** Nemes invoke **representations of things**, and are mostly produced by learning from experience.
  - *Micronemes* provide 'global' contextual signals to agencies all across the brain.
  - *Polynemes* invoke partial states within multiple agencies, where each agency is concerned with representing some different aspect of a thing.
- **Nomes : control** how representations are manipulated.
  - Isonomes signal to different agencies to perform the same uniform type of cognitive operation.
  - Pronomes are isonomes that control the use of short-term memory representations.
  - Paranomes are sets of pronomes linked to each other so that assignments or changes made by one pronome to some representation produce corresponding assignments or changes by the other pronomes to related representations.

How can we combine agents to build larger agencies?

- **Frames.**
  - Frames are a form of knowledge representation concerned with representing a thing and all the other things or properties that relate to it in certain particular ways, which are attached to the 'slots' of the frame.
- **Frame-arrays.**
  - We can describe a thing richly by using not just one frame, but rather a collection of frames where each frame describes the thing from some particular perspective or point of view.
- **Transframes.**
  - Transframes are a central form of knowledge representation in the Society of Mind theory
  - **Other types of frames.**
    - In addition to transframes, Minsky describes several other types of frames, including story-frames that represent structured collections of related events, and picture-frames that represent the spatial layout of objects within scenes. Presumably these are only a few of the many types of frames that are required to represent and organize the world as well as cognitive processes themselves.

How can agents solve problems?

- While Minsky argues that there **no single method** that societies of agents use to solve problems, he does suggest **several ways one might build or organize problem solving agencies**
- **Difference-Engines.** What does it mean to 'solve' a problem? Solving a problem can be regarded as reducing or eliminating the important differences between the current state and some desired goal state. Minsky proposes a simple machine called a *difference-engine* that embodies this problem solving strategy.
- **Censors and Suppressors.** No method of problem solving or reasoning will always work, especially when it comes to ordinary, commonsense reasoning.
- **A-brains and B-brains.** Some types of unproductive mental activity are not specific to any particular method, such as 'looping' or 'meandering', which might occur in any problem solving method that engages in search. Minsky introduces the notion of the 'B-brain' whose job is not so much to think about the outside world, but rather to think about the world inside the mind (the 'A-brain'), so as to be able to notice these kinds of errors and correct them.

How do agents communicate with each other?

- **K-lines.** The simplest method of communication is for an agent to just arouse some other sets of agents. An agent can turn on a polyneme to arouse agents that think about some particular object, event, or situation;
- **Connection lines.** Many agents are not directly connected to each other but rather communicate via 'connection lines', buses or bundles of wires that transmit signals to other agents attached to the bus. These wires can be thought of as simple agents in themselves, and while they are initially meaningless, over time the individual wires begin to take on local significance, that is, they come to acquire dependable and repeatable 'meanings'.
- **Internal language.** For agencies that need to communicate more complex, structured descriptions of things, as in a system of linked frames, Minsky proposes a more elaborate communication mechanism in [14], modeled after his 're-duplication' theory of how people communicate with each other through natural language.
- **Paranomes.** Perhaps the most common method of communication in the Society of Mind is actually for there to be *no active communication* at all. Instead, agents often find that the information they need is already available when they need it.
- **Ambiguity.** While this is not so much a communication mechanism in and of itself, an important consideration in how agents communicate in a Society of Mind is that precise communication may be unnecessary, and in fact, may be impossible, between different agents

The growth of mental societies [1]

- **Protospecialists.** In an infant mind, the first functional large-scale agencies are *protospecialists* — highly evolved agencies that produce behaviors providing initial solutions to problems like locomotion, obtaining food and water, staying warm, defending yourself from predators, and so forth. While these initial protospecialists are fairly unskilled, over time their performance may improve by exploiting agencies that develop later.
- **Predestined learning.** Related to the notion of a protospecialist is the idea that complex behaviors need not be fully pre-specified nor fully learned, and instead can result from a mixture of more partial such influences.
- **Types of learning.** Minsky describes several important forms of learning: accumulating, uniframing, transframing, and reformulating.
    - *Accumulating* is the simplest form of learning, where you simply remember each example or experience as a separate case.
    - *Uniframing* amounts to finding a general description that subsumes multiple examples.
    - *Transframing* is forming an analogy or some other form of bridge between two representations.
    - *Reformulation* amounts not to acquiring fundamentally new knowledge per se, but finding new ways to describe existing knowledge.

The growth of mental societies [2]

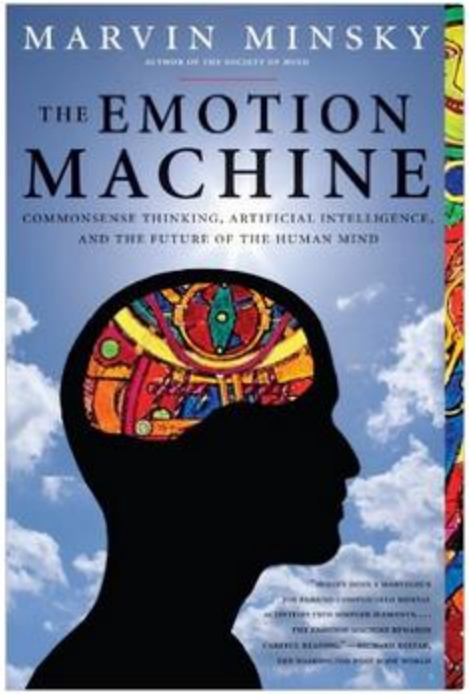
- **Learning from attachment figures.** A very important type of learning is concerned with the question of how we learn our goals in the first place. This form of learning is not so much about how to acquire the specific representations and processes needed to achieve some goal, but rather how to learn when a particular goal should be adopted and how it should be prioritized relative to our other goals.
- **Learning mental managers.** As a mind grows up, it acquires not only increasingly sophisticated models of its environment, but also builds increasingly sophisticated cognitive processes for making use of those models—knowledge about *when* and *how* to use knowledge. As we accumulate our mental societies of agents, we build 'mental managers' to regulate them, processes for delegating, controlling, repairing, and selecting more specific knowledge and problem solving techniques.
- **Developmental stages.** Ultimately, nothing as complex as a mind can be built in a single stage of construction.

Reference

- https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-868j-the-society-of-mind-fall-2011/index.htm
- http://www.jfsowa.com/ikl/Singh03.htm

Emotional Machine

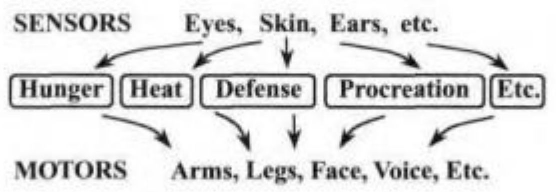
By Marvin Minsky


MARVIN MINSKY
THE EMOTION MACHINE
COMMONSENSE THINKING, ARTIFICIAL INTELLIGENCE, AND THE FUTURE OF THE HUMAN MIND

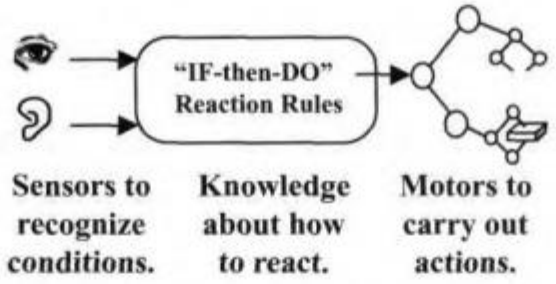
The Emotion Machine

- In this mind-expanding book, scientific pioneer Marvin Minsky continues his groundbreaking research, offering a fascinating **new model for how our minds work**. He argues persuasively that **emotions, intuitions, and feelings are not distinct things, but different ways of thinking**.
- By examining these different forms of mind activity, Minsky says, we can explain why our thought sometimes takes the form of carefully reasoned analysis and at other times turns to emotion.
  He shows how our minds progress from simple, instinctive kinds of thought to more complex forms, such as consciousness or self-awareness.
  And he argues that because we tend to see our thinking as fragmented, we fail to appreciate what powerful thinkers we really are.
  Indeed, says Minsky, **if thinking can be understood as the step-by-step process** that it is, then we can build machines -- artificial intelligences -- that not only can assist with our thinking by thinking as we do but have the potential to be as conscious as we are.

Your Self sees the world by using your senses. Then it stores what it learns in your memory. It originates all your desires and goals—and then solves all your problems for you, by exploiting your "intelligence."

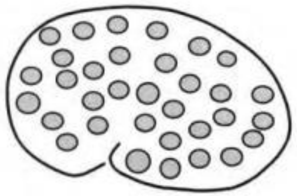


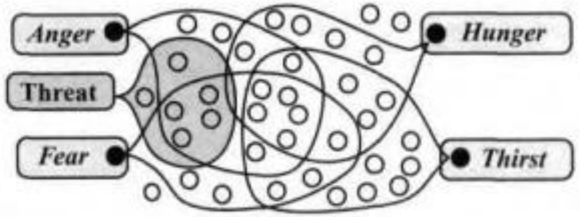
A SELF CONTROLLING ITS PERSON'S MIND

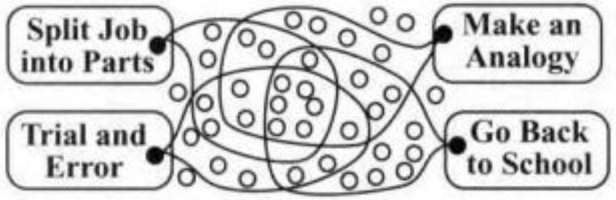


Mind is a cloud of resources

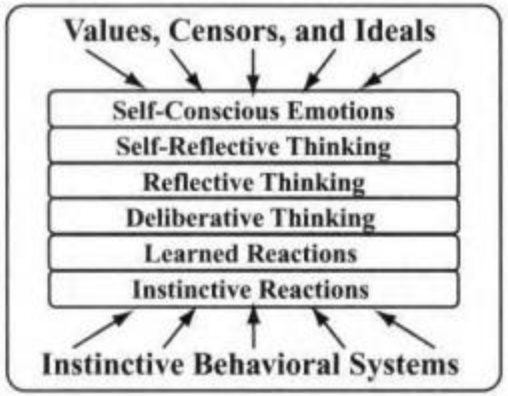
will begin by portraying a typical brain as containing a great many parts that we'll call "resources."

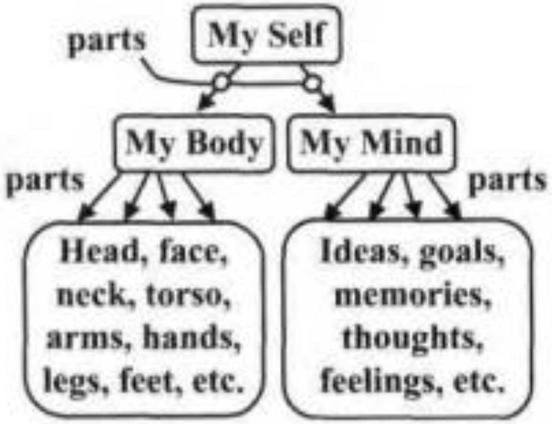




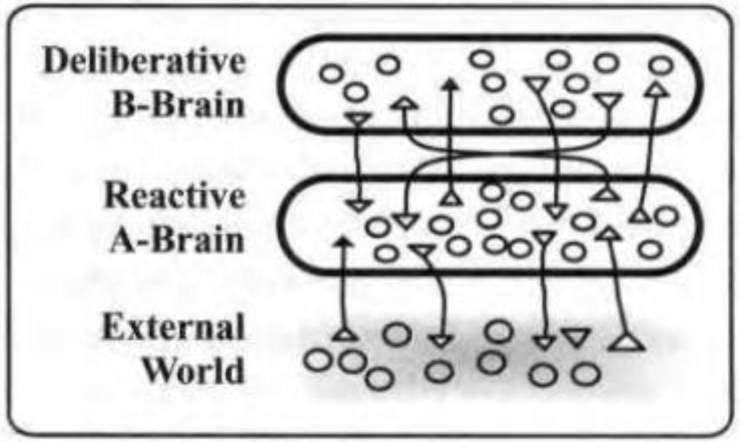


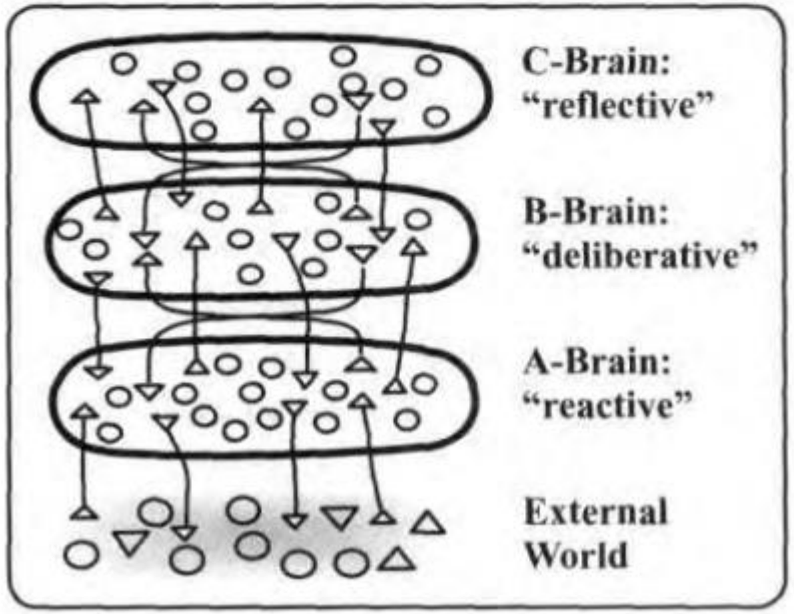
A simple model of a person's Self might consist of just a few parts connected like those shown below. However, each person eventually builds more complex Self-models that represent ideas about, for example, one's social relationships, physical skills, and economic attitudes. So Chapter 9 will argue that when you say "Self," you are referring not to a single representation but to an extensive network of different models that represent different aspects of yourself.

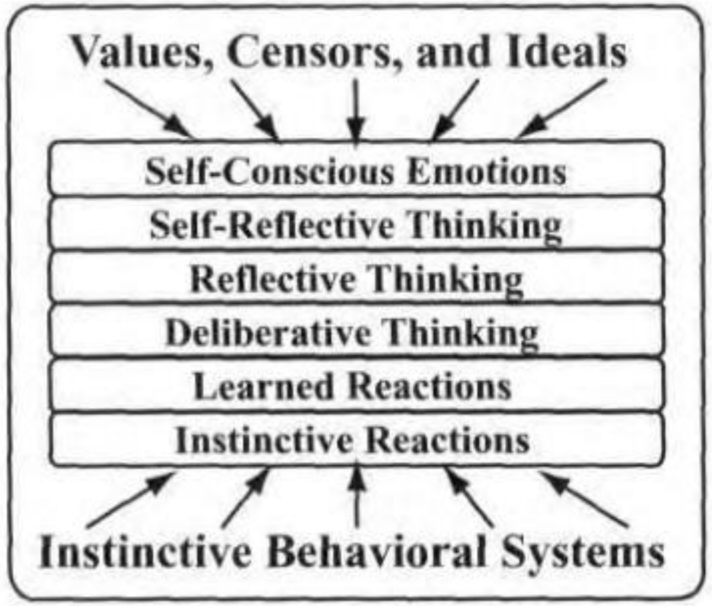




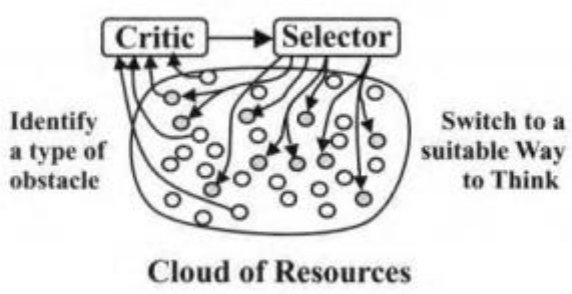
Consciousness



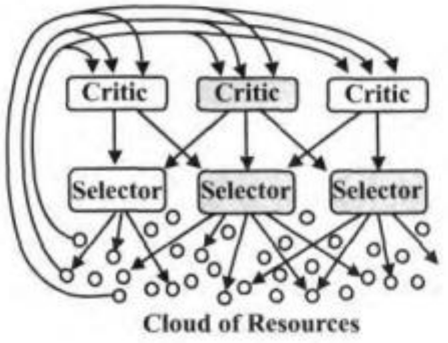




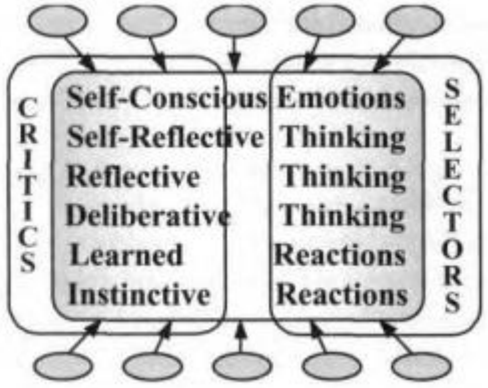
Thinking



Critic
Selector
Identify a type of obstacle
Switch to a suitable Way to Think
Cloud of Resources



Critic
Critic
Critic
Selector
Selector
Selector
Cloud of Resources



CRITICS
Self-Conscious
Self-Reflective
Reflective
Deliberative
Learned
Instinctive
Emotions
Thinking
Thinking
Thinking
Reactions
Reactions
SELECTORS

Two extreme ways to think

- **Knowing how**. The best way to solve a problem is to already know away to solve it. However, we may not be able to retrieve that knowledge — and often we don't even know that we have it.
- **Searching Extensively**. When one has no better alternative, one could try to search through all possible chains of actions. But that method is not often practical because such searches grow exponentially.

Ways to Think between two extrems

- **Reasoning by Analogy**. When a problem reminds you of one that you solved in the past, you may be able to adapt that case to the present situation—if you have good ways to tell which similarities are most relevant.
- **Dividing and Conquering**. If you can't solve a problem all at once, then break it down into smaller parts. For example ,every difference we recognize may suggest a separate sub-problem to solve.
- **Reformulating**. Find a different representation that highlights more Relevant information. We often do this by making a verbal description—and then "understanding“ it in some different way!
- **Planning**. Consider the set of sub goals you want to achieve and Examine how they affect each other. Then, with those constraints in mind, propose an efficient sequence for achieving them .

Other techniques that work by first solving a different problem

- **Simplifying**. Often a good way to solve a difficult problem is first to solve a simpler version that ignores some features of that problem. Then any such solution may serve as a sequence of stepping-stones for solving the original problem.
- **Elevating**. If you are bogged down into many details, describe the situation in more general terms. But if your description seems too vague, switch to one that is more concrete.
- **Changing the subject**. Whatever you are working on now, if you get discouraged enough, you can always abandon it and simply switch to a different task.

Some more reflective Ways to Think :

- **Wishful thinking**. Imagine having unlimited time and all the resources that you might want. If you still can't envision solving the problem, then you should reformulate it.
- **Self-reflection**. Instead of further pursuing a problem, ask what makes that problem seem hard, or what you might be doing wrong. This can suggest some better techniques—or ,instead , better ways to spend your time .
- **Impersonation**. When your own ideas seem inadequate ,imagine someone better at this ,and try to do what that person would do. Myself, I do this frequently, by imitating imprimers and teachers. We also use many other Ways to Think.

Other ways to think

- **Logical Contradiction**. Try to prove that your problem can not be solved, and then look for a flaw in that argument.
- **Logical Reasoning**. We often try to make chains of deductions. However, this can lead to wrong conclusions when our assumptions turn out to be unsound.
- **External Representation**s. If you find that you're losing track of details, you can resort to keeping records and notes, or drawing suitable diagrams.
- **Imagination**. One can avoid taking physical risks if one can predict "What would happen if“ by simulating possible actions inside the mental models that one has built.
- Of course, if you are not completely alone, you can try to exploit your social resources.
  - **Cry for help**. You can behave in ways that may arouse your companions 'sympathies.
  - **Ask for help**. If your status is high enough, you can persuade or command some one else to help—or even offer to pay them .

Thus…

- Everyone has many ways to think , and the following section will discuss how your **Critics choose which ones** to use.
- However, everyone always has one“ last resort"—namely, simply to give up and quit!
- **Resignation**. Whenever you find yourself totally stuck, you can shut down the resources you‘ reusing now and relax, lie back, drop out, and stop. Then the "rest of your mind “ may find an alternative—or conclude that you don't have to do this at all

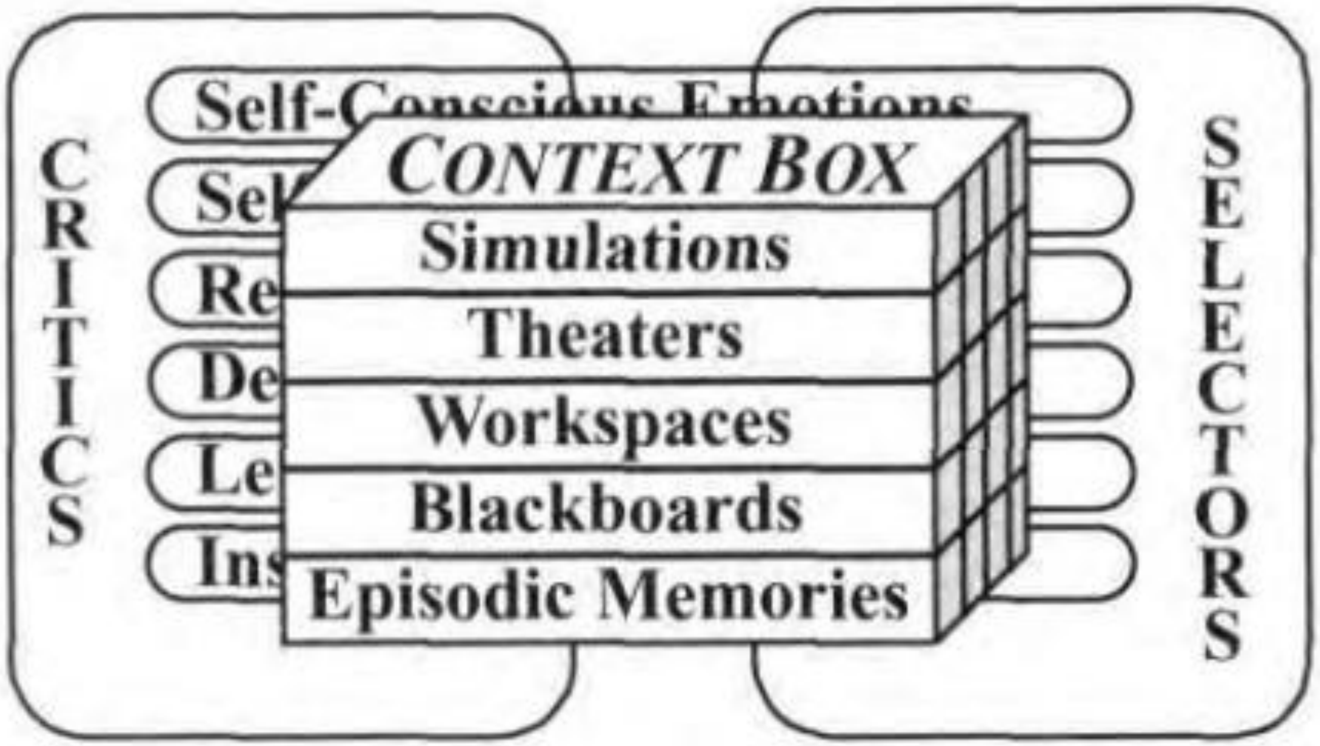
Critics

- **Learned Reactive Critics**. A typical infant will simply cry when exposed to high levels of noise — but later a child may learn to react by moving to a quieter place. And eventually we learn to deal with obstacles by using "deliberative" thinking about them.
- **Deliberative Critics**. When our first attempt fails to solve a problem, we can often discover alternatives, by thinking about what might have gone wrong.
- **Reflective Critics**. When you try to solve problems by trial and error, you use your critics as "diagnosticians" — either to verify that you're making progress or to suggest alternative ways to proceed.
- **Self-Reflective Critics**. When you can't control the resources you need, or try to achieve too many goals at once, then you may start to criticize yourself
- **Self-Conscious Critics**. Some assessments may even affect one's current image of oneself, and this can affect one's over all state

Poincaré's Unconscious Processes

- *Joan has been thinking about her report for days but has not invented a good enough plan. Discouraged, she sets those thoughts aside...but then an idea "occurs" to her.*

- Poincaré concluded that when making his discoveries, he must have used activities that typically worked in four stages like these:
  - **Preparation**: activate resources to deal with this particular type of problem
  - **Incubation**: generate many potential solutions
  - **Revelation**: recognize a promising one
  - **Evaluation**: verify that it actually works

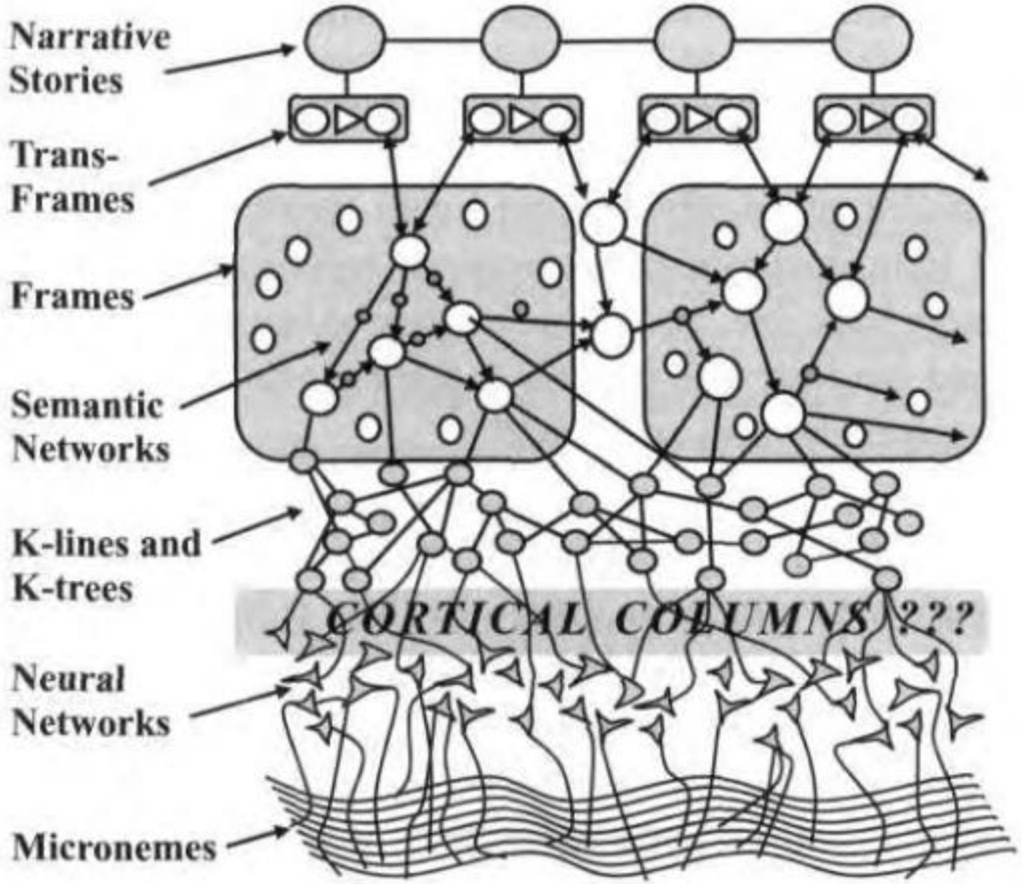

CRITICS
CONTEXT BOX
Simulations
Theaters
Workspaces
Blackboards
Episodic Memories
SELECTORS

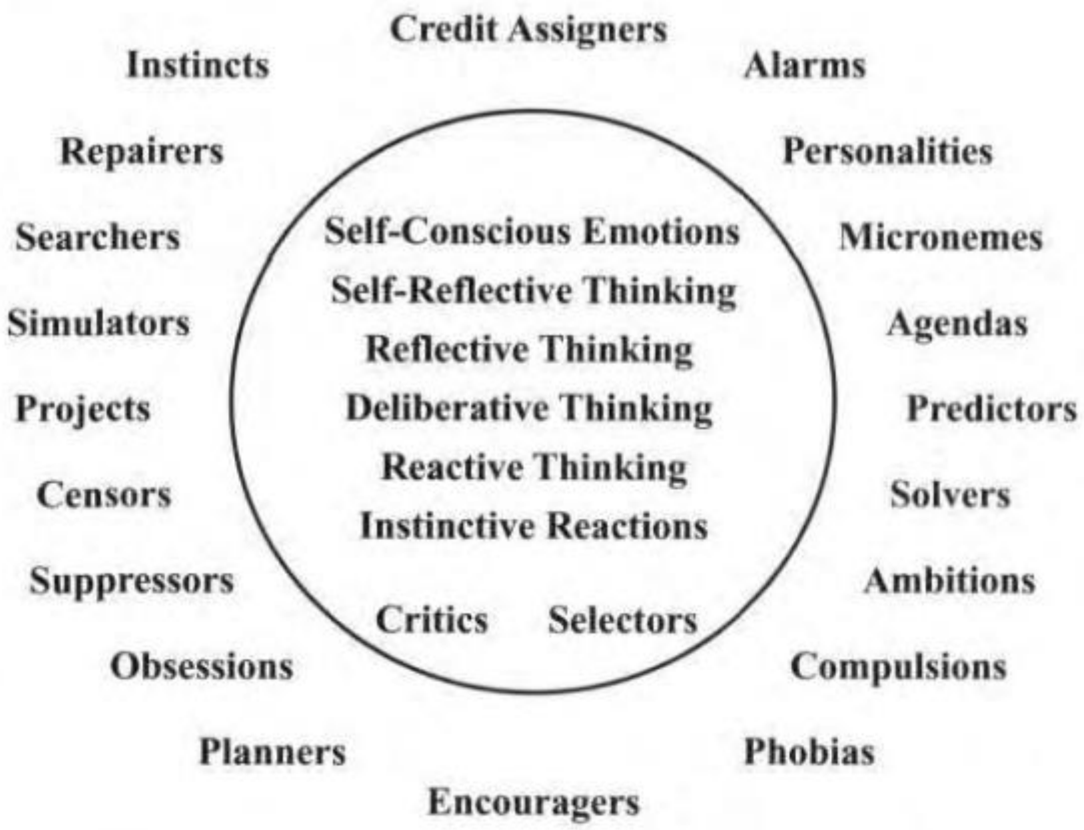
RESOURCEFULNESS

- We are born with many kinds of resources.
- We learn from our Imprimers and friends.
- We also learn what we ought not to do.
- We can reflect upon what we are thinking about.
- We can predict the effects of imagined actions.
- We use huge stores of common sense knowledge.
- We can switch among different Ways to Think.

Additional features that make human minds so versatile:

- We can see things from many points of view.
- We have ways to rapidly switch among these.
- We have developed special ways to learn very quickly.
- We learn efficient ways to retrieve relevant knowledge.
- We keep extending the range of our Ways to Think.
- We have many different ways to represent things .
- We develop good ways to organize these representations


Narrative Stories
Trans-Frames
Frames
Semantic Networks
K-lines and K-trees
CORTICAL COLUMNS ???
Neural Networks
Micronemes

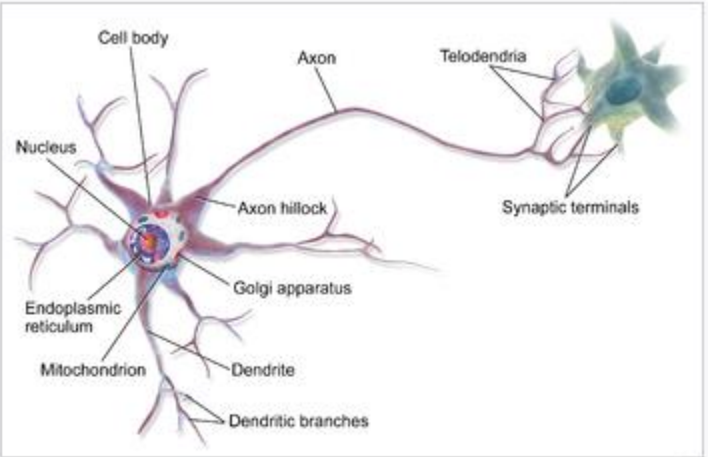


Is a Mind Like a Human Community?

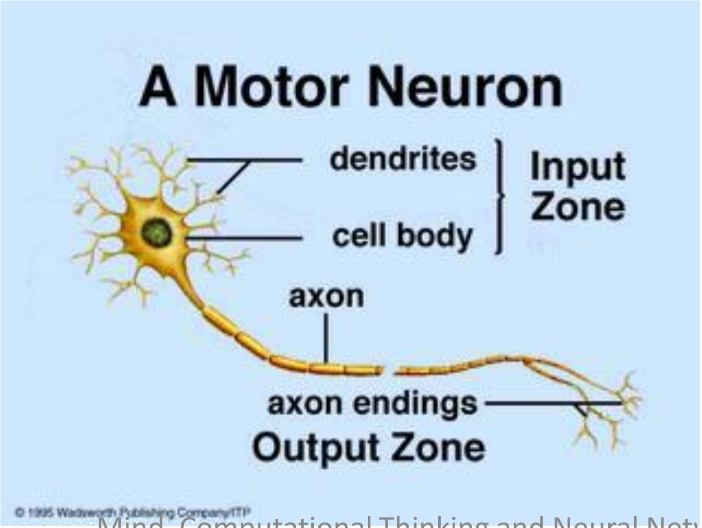
Neural Network and ANN

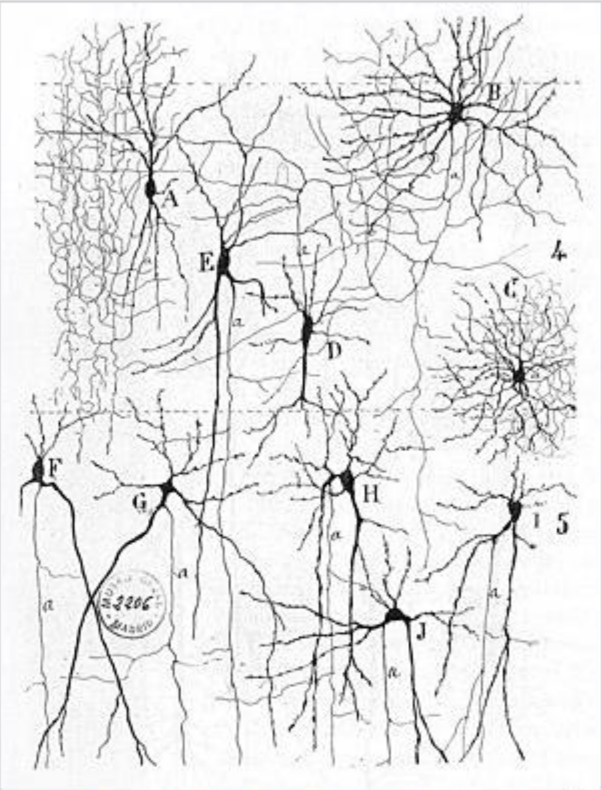
- An Artificial **Neural Network** (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system.

- **Neurons and Synapses**
    - The basic computational unit in the nervous system is the nerve cell,
    - or **neuron**. A neuron has: Dendrites (inputs) ,Cell body ,Axon (output)
- A neuron receives input from other neurons (typically many thousands). Inputs sum (approximately). Once input exceeds a critical level, the neuron discharges a **spike** - an electrical pulse that travels from the body, down the axon, to the next neuron(s) (or other receptors). This spiking event is also called **depolarization**, and is followed by a **refractory period**, during which the neuron is unable to fire.
- The axon endings (Output Zone) almost touch the dendrites or cell body of the next neuron. Transmission of an electrical signal from one neuron to the next is effected by **neurotransmittors**, chemicals which are released from the first neuron and which bind to receptors in the second. This link is called a **synapse**. The extent to which the signal from one neuron is passed on to the next depends on many factors, e.g. the amount of neurotransmittor available, the number and arrangement of receptors, amount of neurotransmittor reabsorbed, etc

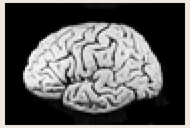
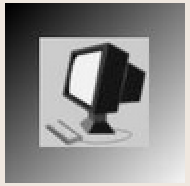


Anatomy of a multipolar neuron




From "Texture of the Nervous System of Man and the Vertebrates" by Santiago Ramón y Cajal. The figure illustrates the diversity of neuronal morphologies in the auditory cortex.

The Brain as an Information Processing System https://nic.schraudolph.org/teach/NNcourse/brain.html

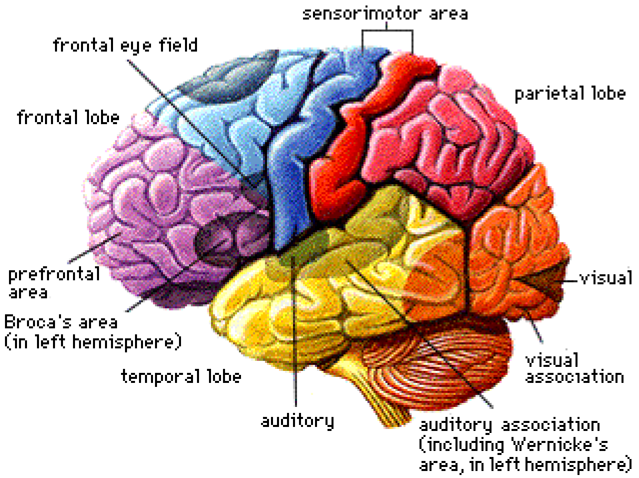
	processing elements	element size	energy use	processing speed	style of computation	fault tolerant	learns	intelligent, conscious
	10^{14} synapses	10^{-6} m	30 W	100 Hz	parallel, distributed	yes	yes	usually
	10^{8} transistors	10^{-6} m	30 W (CPU)	10^{9} Hz	serial, centralized	no	a little	not (yet)

Despite of being built with very slow hardware, the brain has quite remarkable capabilities:

- its performance tends to degrade gracefully under partial damage. In contrast, most programs and engineered systems are brittle: if you remove some arbitrary parts, very likely the whole will cease to function.
- it can learn (reorganize itself) from experience.
- this means that partial recovery from damage is possible if healthy units can learn to take over the functions previously carried out by the damaged areas.
- it performs massively parallel computations extremely efficiently. For example, complex visual perception occurs within less than 100 ms, that is, 10 processing steps!
- it supports our intelligence and self-awareness. (Nobody knows yet how this occurs.)

As a discipline of Artificial Intelligence, Neural Networks attempt to bring computers a little closer to the brain's capabilities by imitating certain aspects of information processing in the brain, in a highly simplified way.

Neural Networks in the Brain

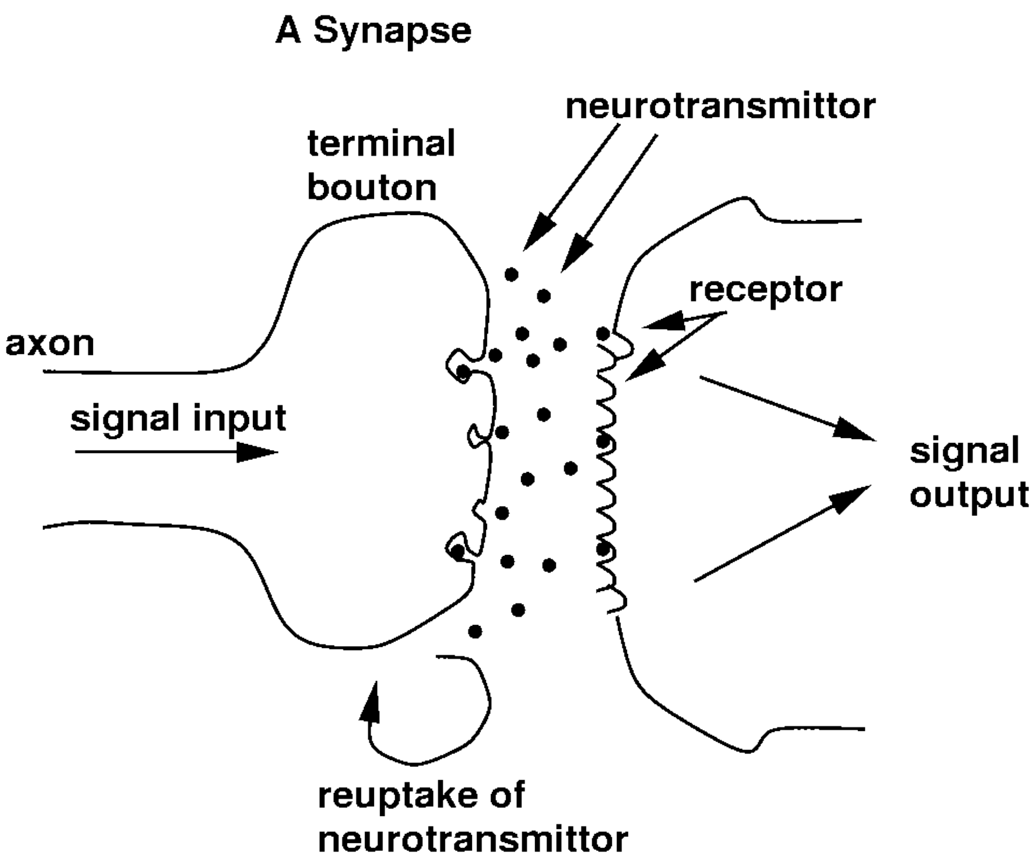


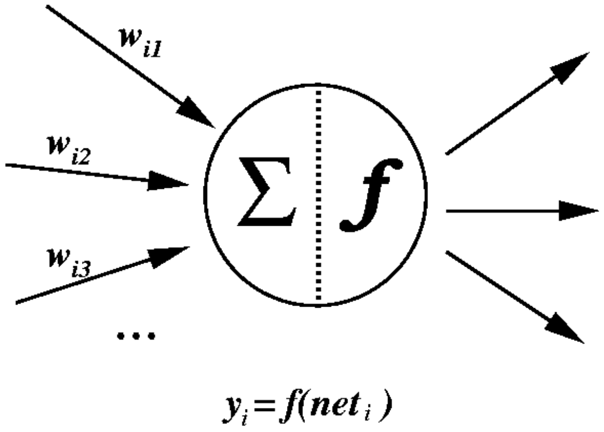
- The brain is not homogeneous. At the largest anatomical scale, we distinguish **cortex**, **midbrain**, **brainstem**, and **cerebellum**. Each of these can be hierarchically subdivided into many **regions**, and **areas** within each region, either according to the anatomical structure of the neural networks within it, or according to the function performed by them.
- The overall pattern of **projections** (bundles of neural connections) between areas is extremely complex, and only partially known. The best mapped (and largest) system in the human brain is the visual system, where the first 10 or 11 processing stages have been identified. We distinguish **feedforward** projections that go from earlier processing stages (near the sensory input) to later ones (near the motor output), from **feedback** connections that go in the opposite direction.
- In addition to these long-range connections, neurons also link up with many thousands of their neighbours. In this way they form very dense, complex local networks:

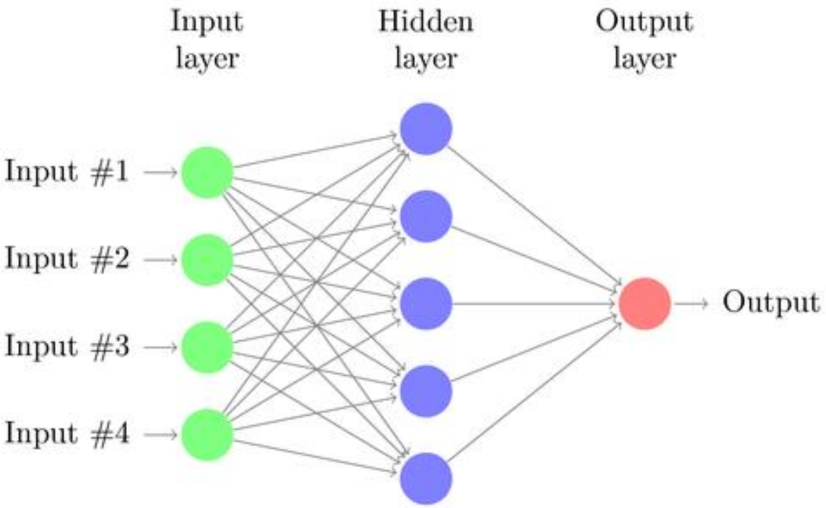
Synaptic Learning

- Brains learn. Of course. From what we know of neuronal structures, one way brains learn is by altering the strengths of connections between neurons, and by adding or deleting connections between neurons. Furthermore, they learn "on-line", based on experience, and typically without the benefit of a benevolent teacher.
- The efficacy of a synapse can change as a result of experience, providing both memory and learning through long-term potentiation. One way this happens is through release of more neurotransmitter. Many other changes may also be involved.
- Long-term Potentiation:
  - An enduring (>1 hour) increase in synaptic efficacy that results from high-frequency stimulation of an afferent (input) pathway

https://nic.schraudolph.org/teach/NNcourse/intro.html







https://hackernoon.com/overview-of-artificial-neural-networks-and-its-applications-2525c1addff7

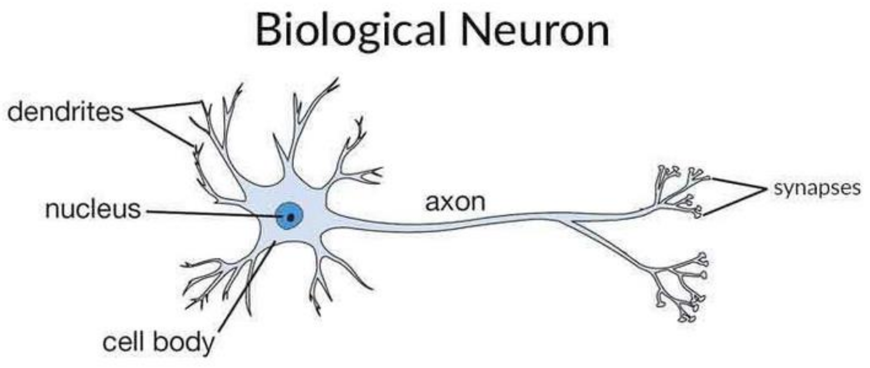
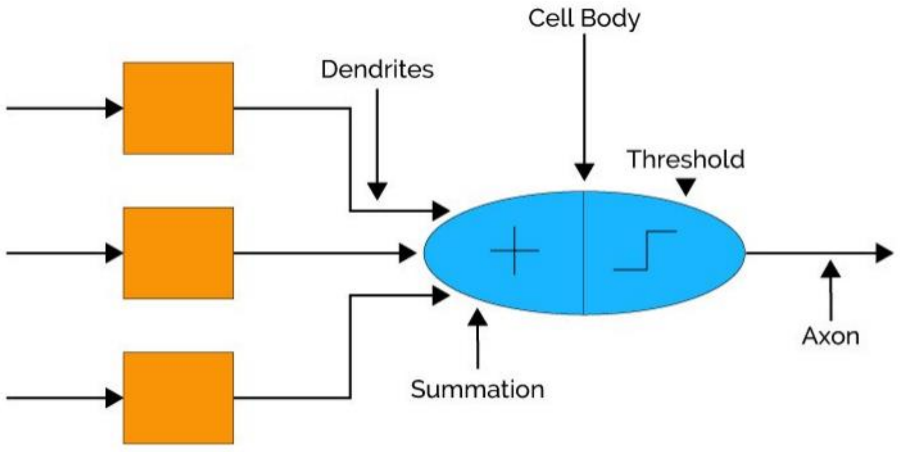
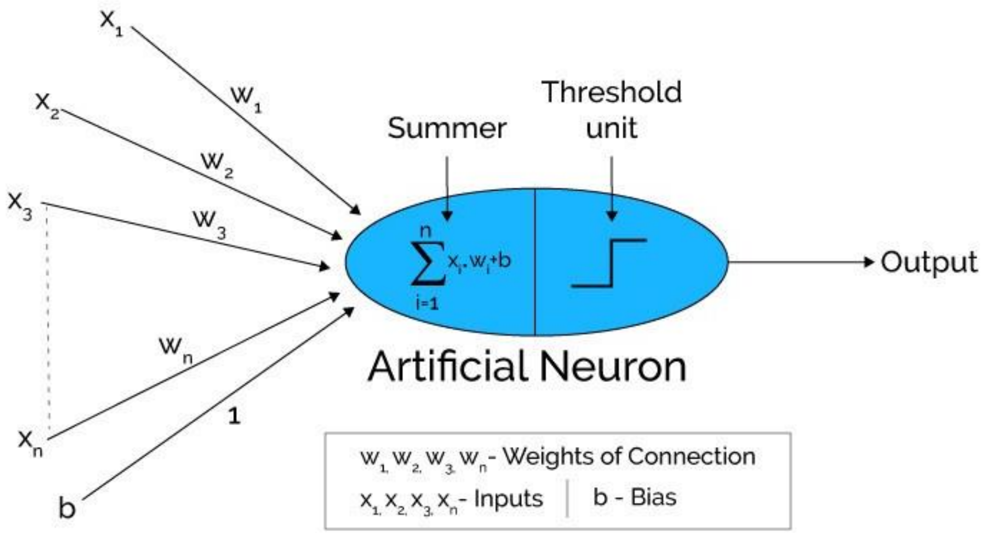
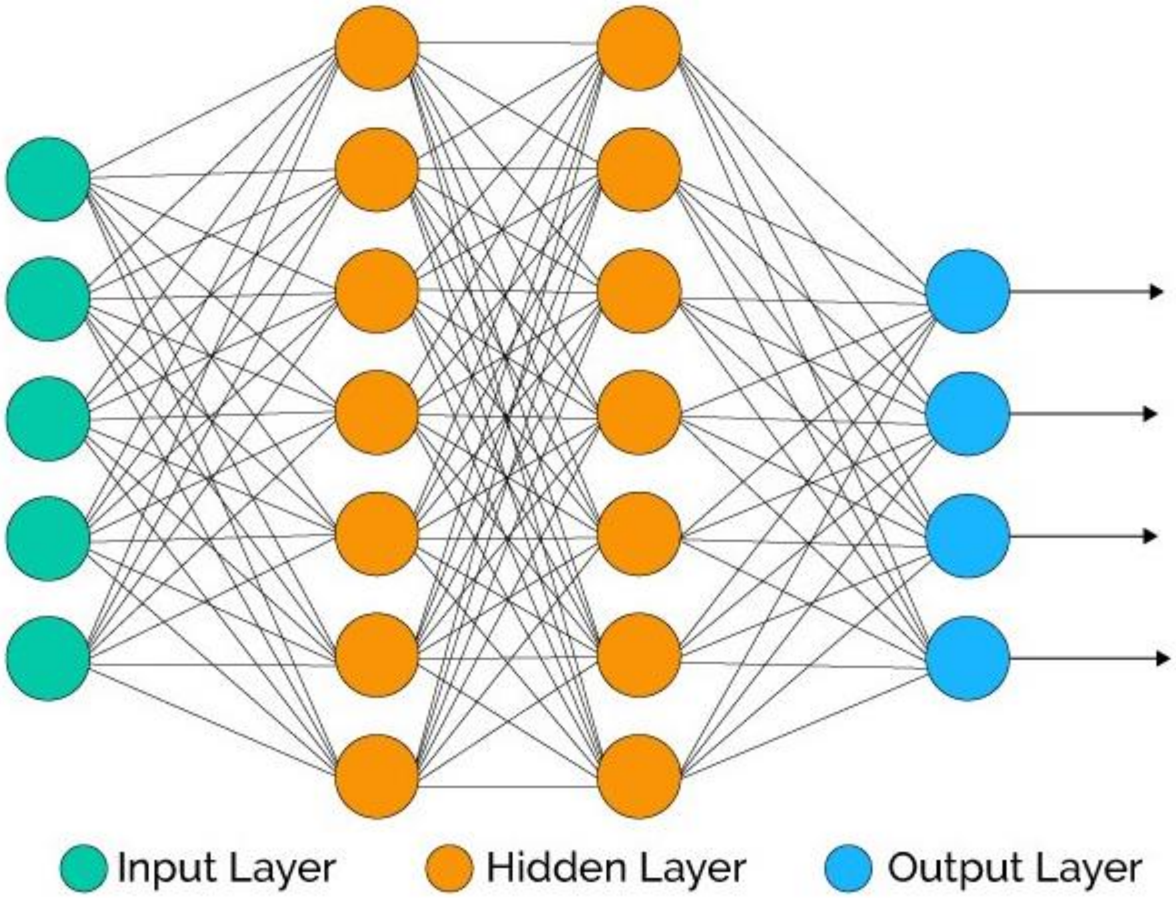


Image Source—cs231n.github.io

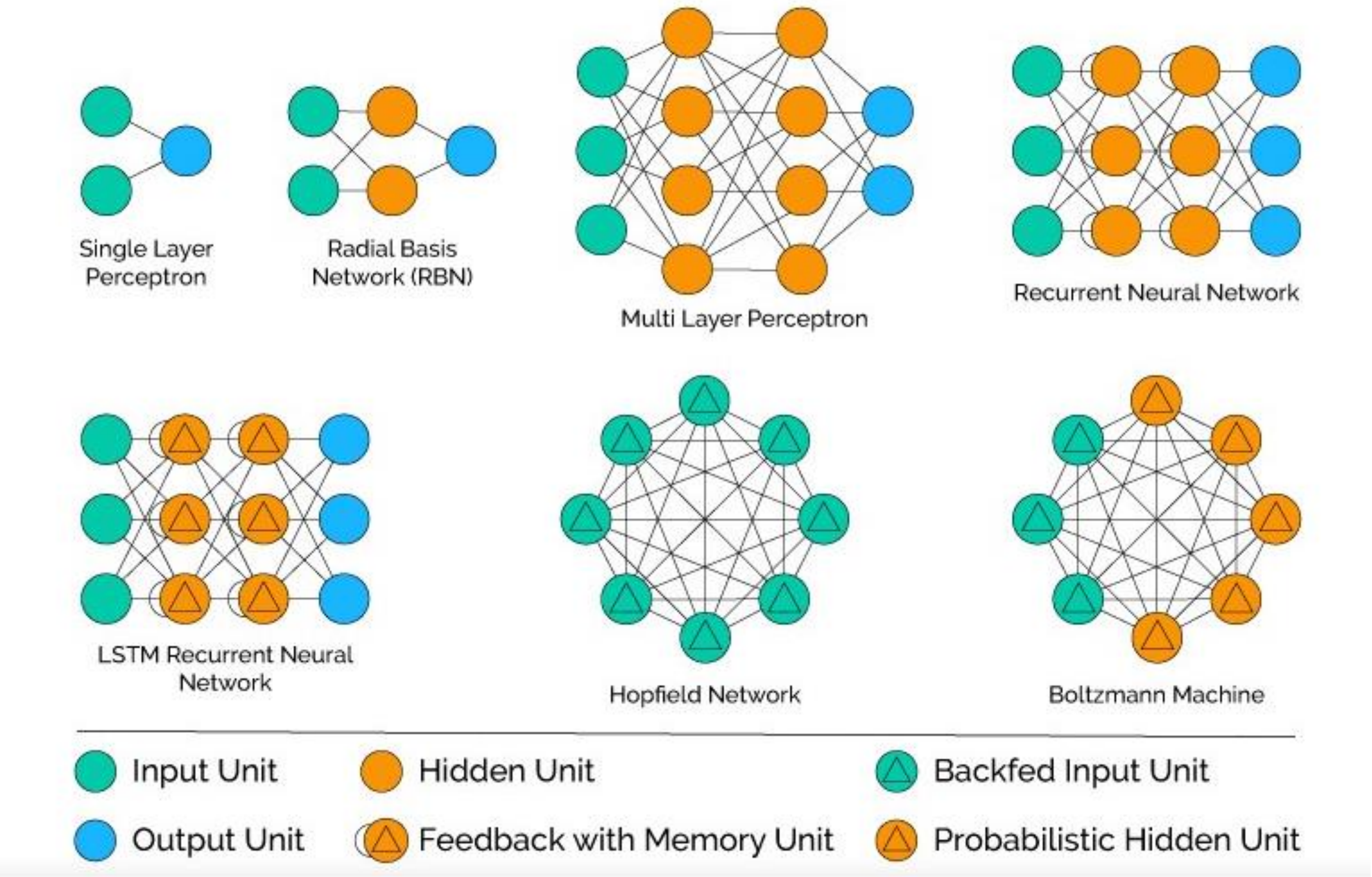


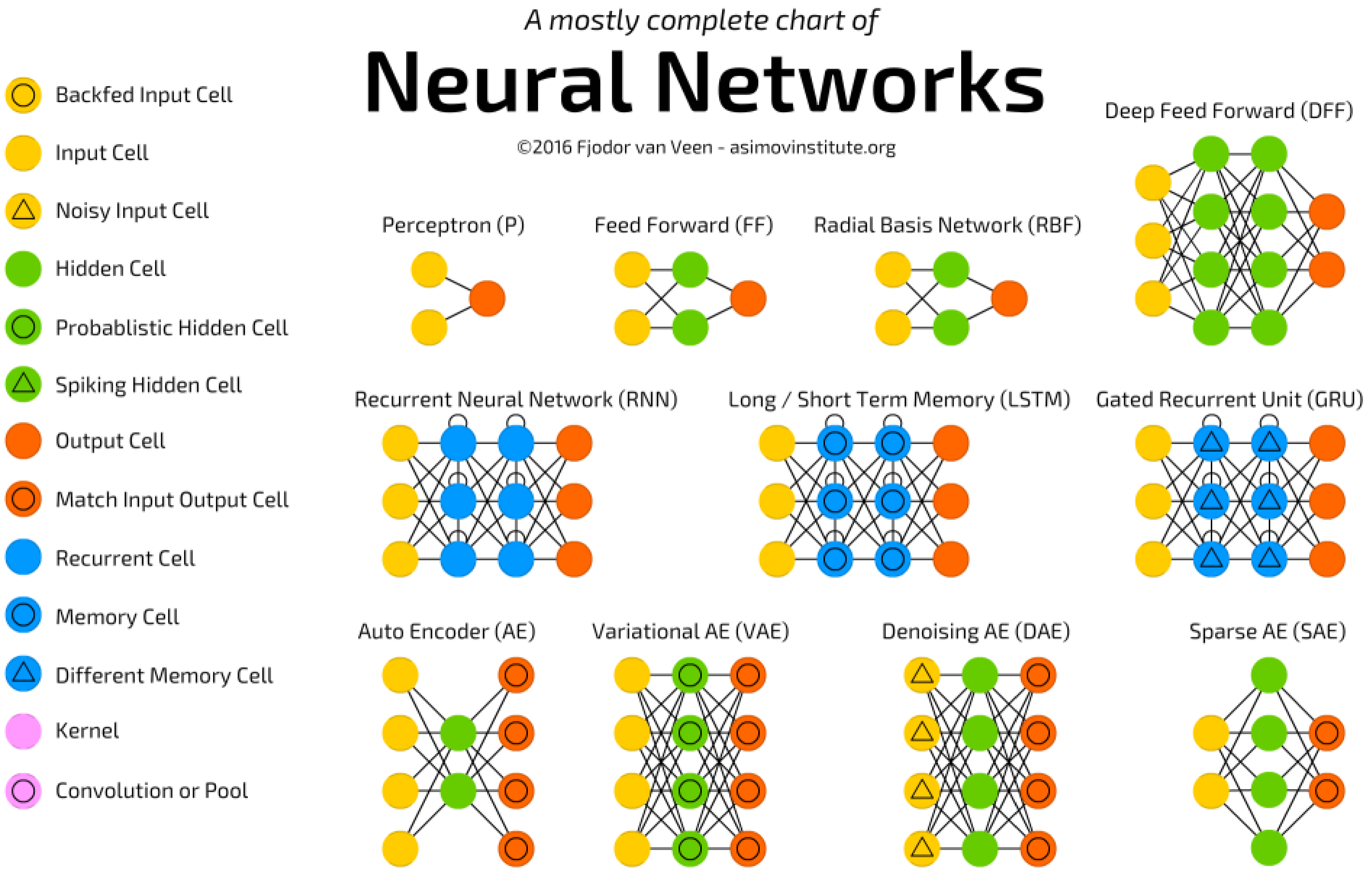
	
Biological neurons or nerve cells	Silicon transistors
200 billion neurons, 32 trillion interconnections.	1 billion bytes RAM, trillion of bytes on disk.
Neuron size: 10-6 m.	Single transistor size: 10-9m.
Energy consumption: 6-10 joules per operation per sec.	Energy consumption: 10-16 joules per operation per second.
Learning capability	Programming capability

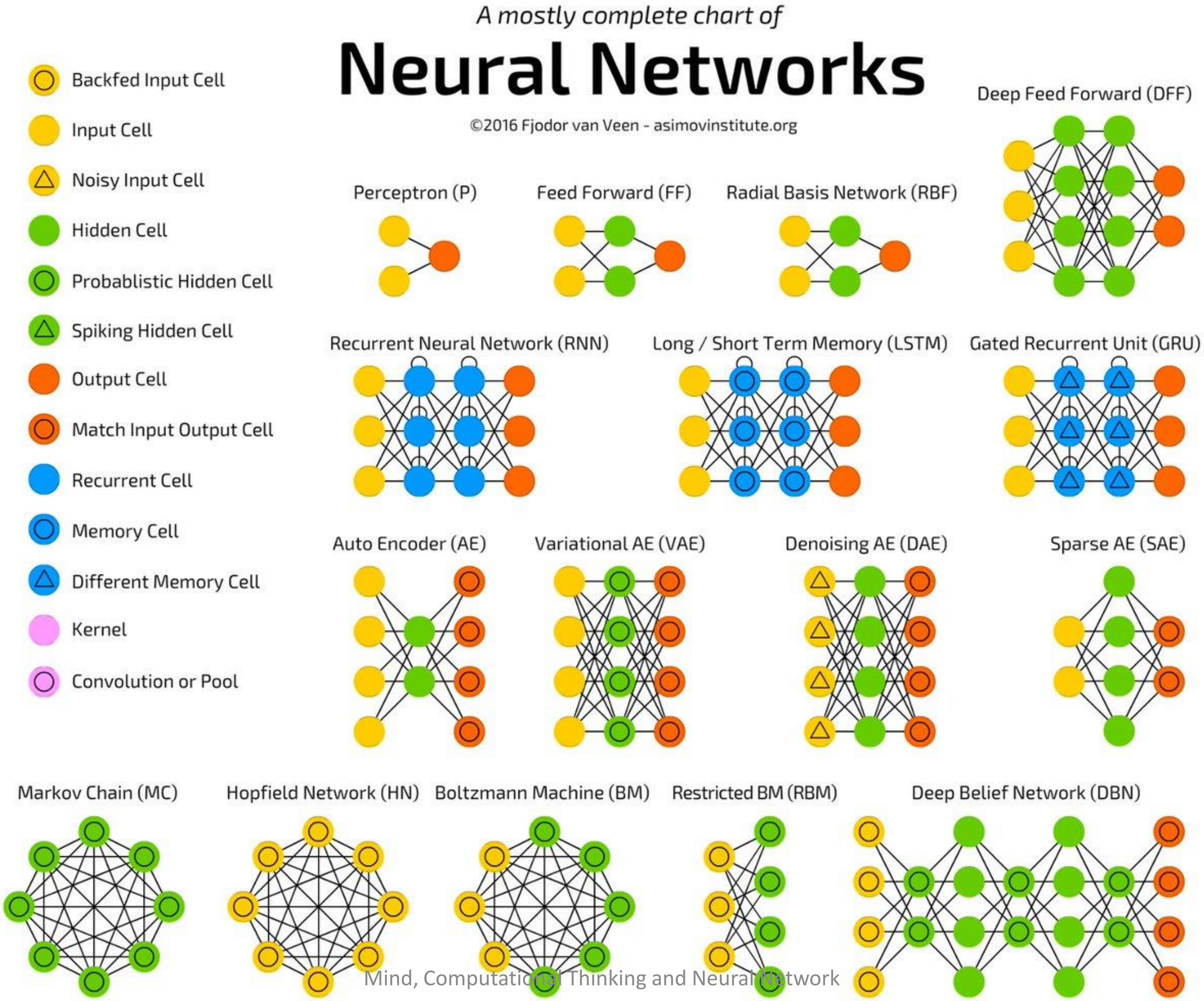



Input Layer
Hidden Layer
Output Layer

Popular Neural Network Architectures




A mostly complete chart of
Neural Networks
©2016 Fjodor van Veen - asimovinstitute.org
Backfed Input Cell
Input Cell
Noisy Input Cell
Hidden Cell
Probablistic Hidden Cell
Spiking Hidden Cell
Output Cell
Match Input Output Cell
Recurrent Cell
Memory Cell
Different Memory Cell
Kernel
Convolution or Pool
Perceptron (P)
Feed Forward (FF)
Radial Basis Network (RBF)
Deep Feed Forward (DFF)
Recurrent Neural Network (RNN)
Long / Short Term Memory (LSTM)
Gated Recurrent Unit (GRU)
Auto Encoder (AE)
Variational AE (VAE)
Denoising AE (DAE)
Sparse AE (SAE)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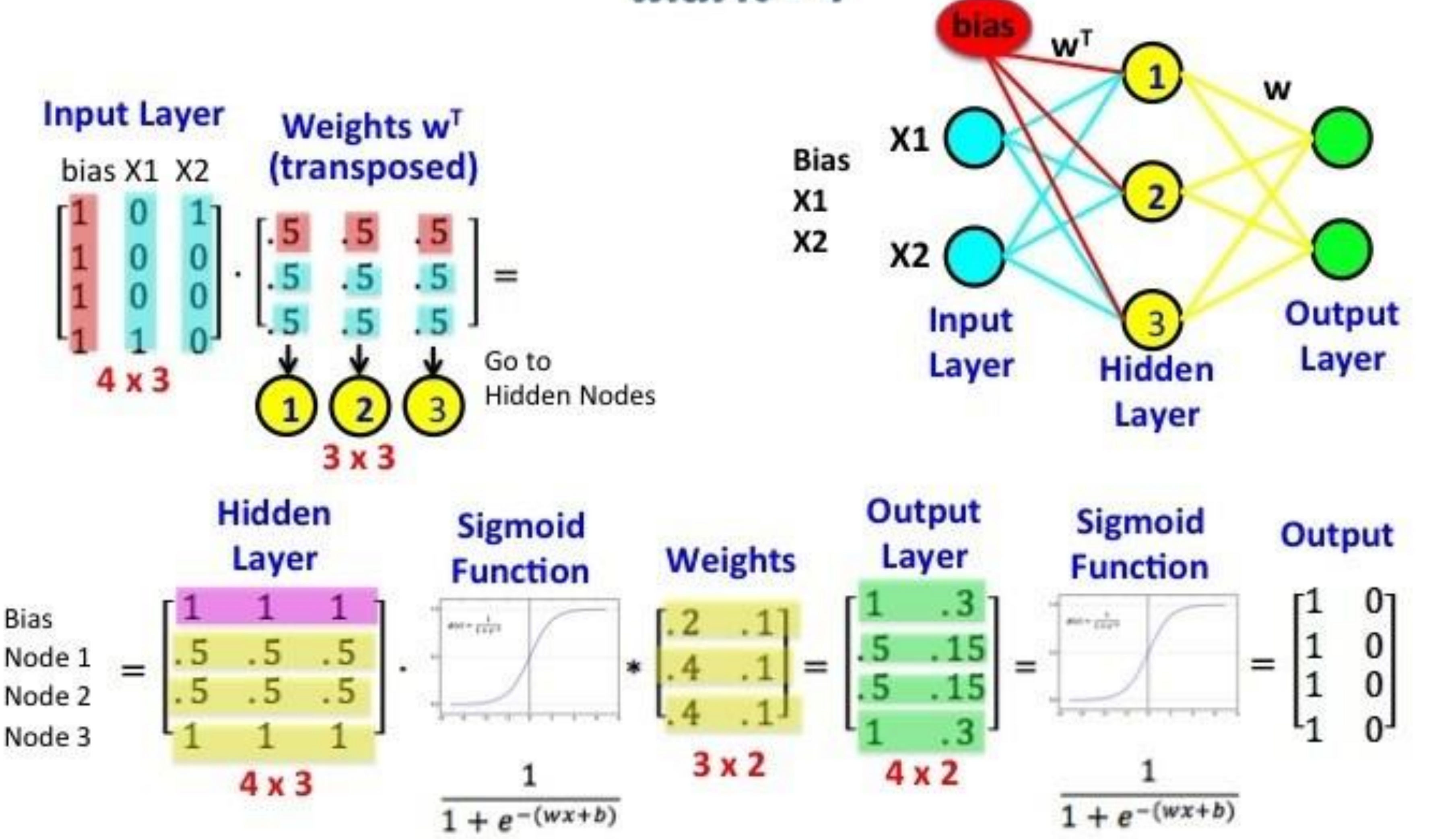
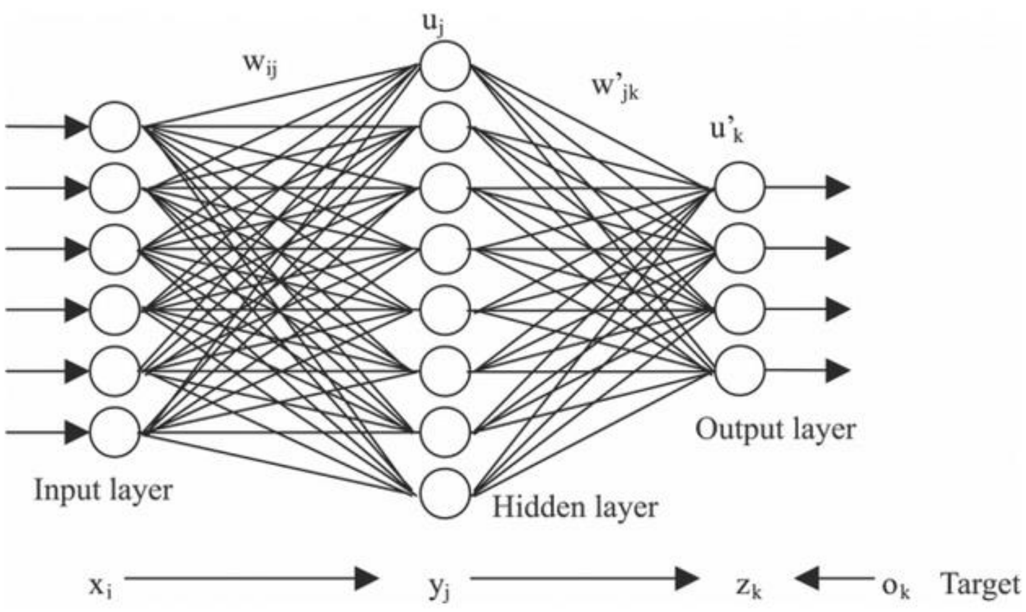
Variational AE (VAE)
Denoising AE (DAE)
Sparse AE (SAE)
Markov Chain (MC)
Hopfield Network (HN)
Boltzmann Machine (BM)
Restricted BM (RBM)
Deep Belief Network (DBN)

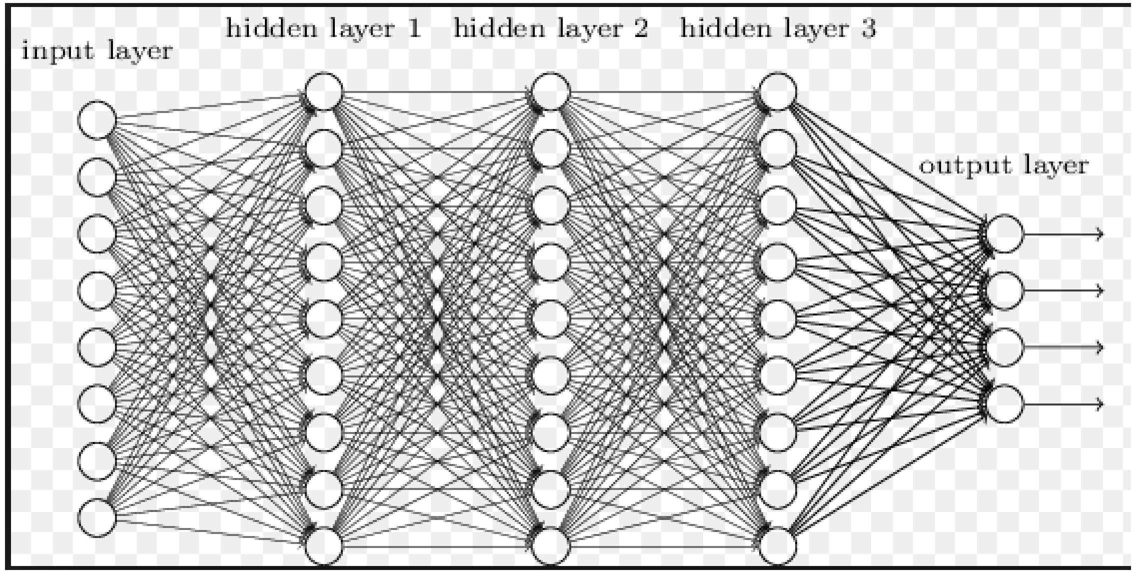
Neural Networks

Color Guided Matrix Multiplication for a Binary Classification Task with N = 4

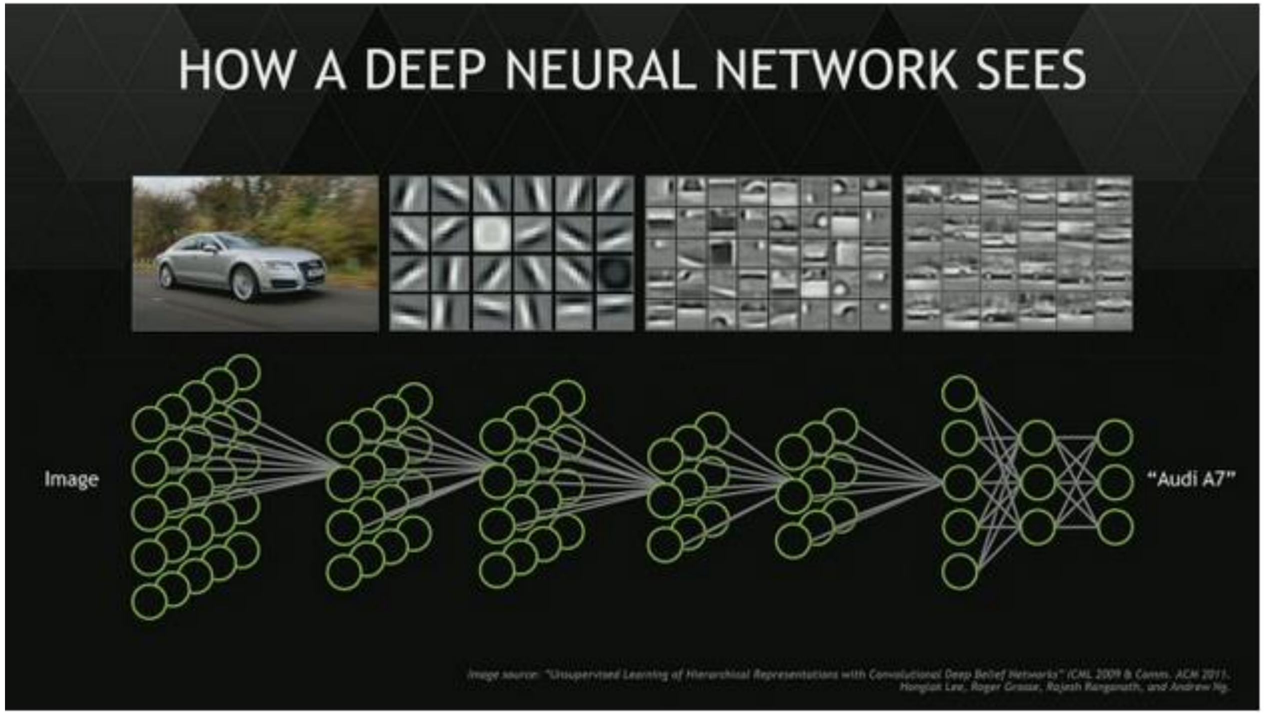




u_j
w_{ij}
w'_{jk}
u'_k
Output layer
Input layer
Hidden layer
x_i
y_j
z_k
o_k
Target



input layer
hidden layer 1
hidden layer 2
hidden layer 3
output layer



HOW A DEEP NEURAL NETWORK SEES
Image
"Audi A7"

Computational Thinking

(Fokus Presentasi)

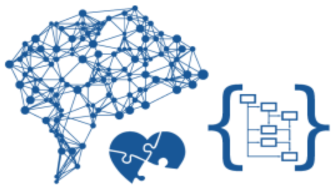
Top 10 skills

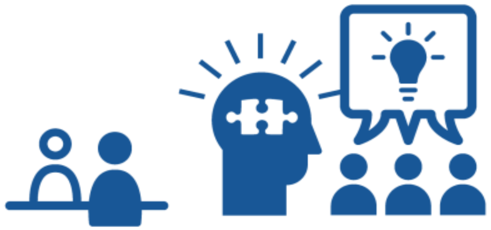
in 2020

1. Complex Problem Solving
2. Critical Thinking
3. Creativity
4. People Management
5. Coordinating with Others
6. Emotional Intelligence
7. Judgment and Decision Making
8. Service Orientation
9. Negotiation
10. Cognitive Flexibility

in 2015

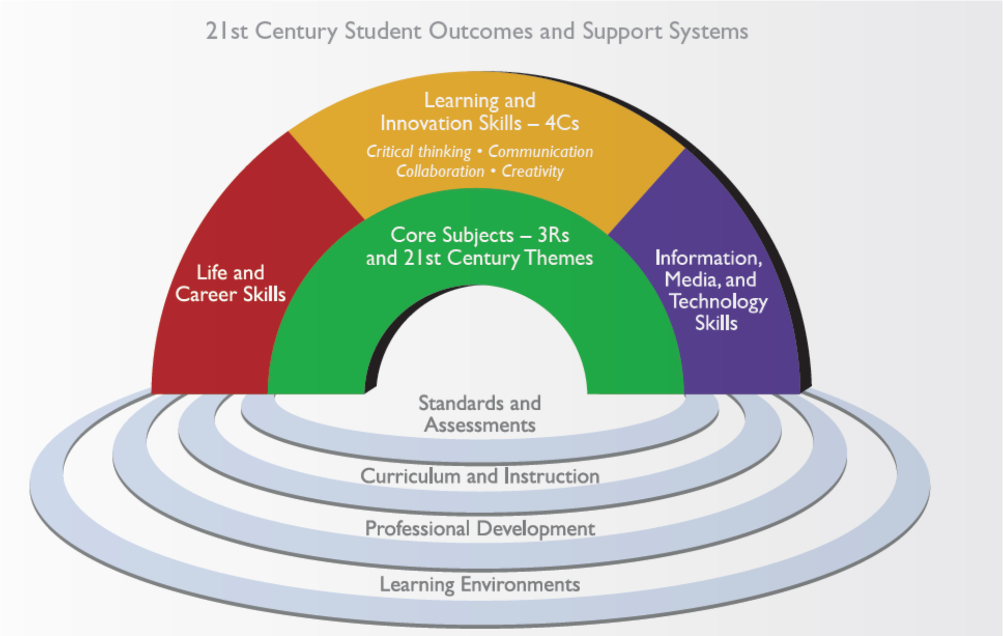
1. Complex Problem Solving
2. Coordinating with Others
3. People Management
4. Critical Thinking
5. Negotiation
6. Quality Control
7. Service Orientation
8. Judgment and Decision Making
9. Active Listening
10. Creativity





Source: Future of Jobs Report, World Economic Forum

21st century learning http://www.p21.org/



Four Cs of 21st century learning:
Collaboration.
Communication.
Critical thinking.
Creativity.

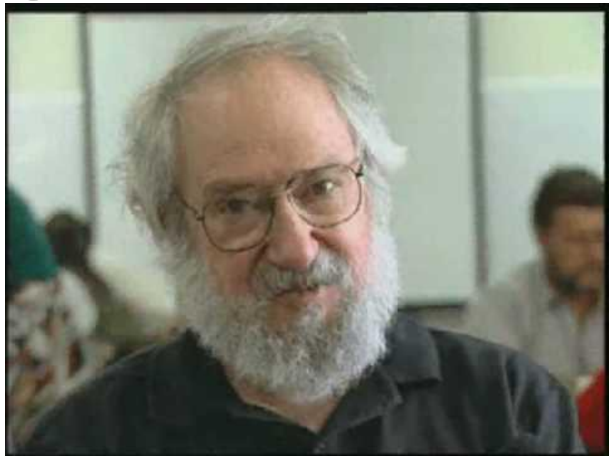
SCAN Fundamental Skills

Basic Skills: *reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

Thinking Skills: *thinks creatively, makes decisions, solves problems, visualizes, knows how to learn, and reasons*

Personal Qualities: *displays responsibility, self-esteem, sociability, self-management, and integrity and honesty*

Computational Thinking



- Originally used by Seymour Papert, MIT, in Mindstorms: Children, computers, and powerful ideas, Basic Books Inc. 1980.

- Popularized by Jeanette M. Wing (2006) Computational Thinking. *Communications of the ACM,* 49(3), 33-35.

http://research-srv.microsoft.com/en-us/um/redmond/events/asiafacsum2012/day1/Jeannette_Wing.pdf

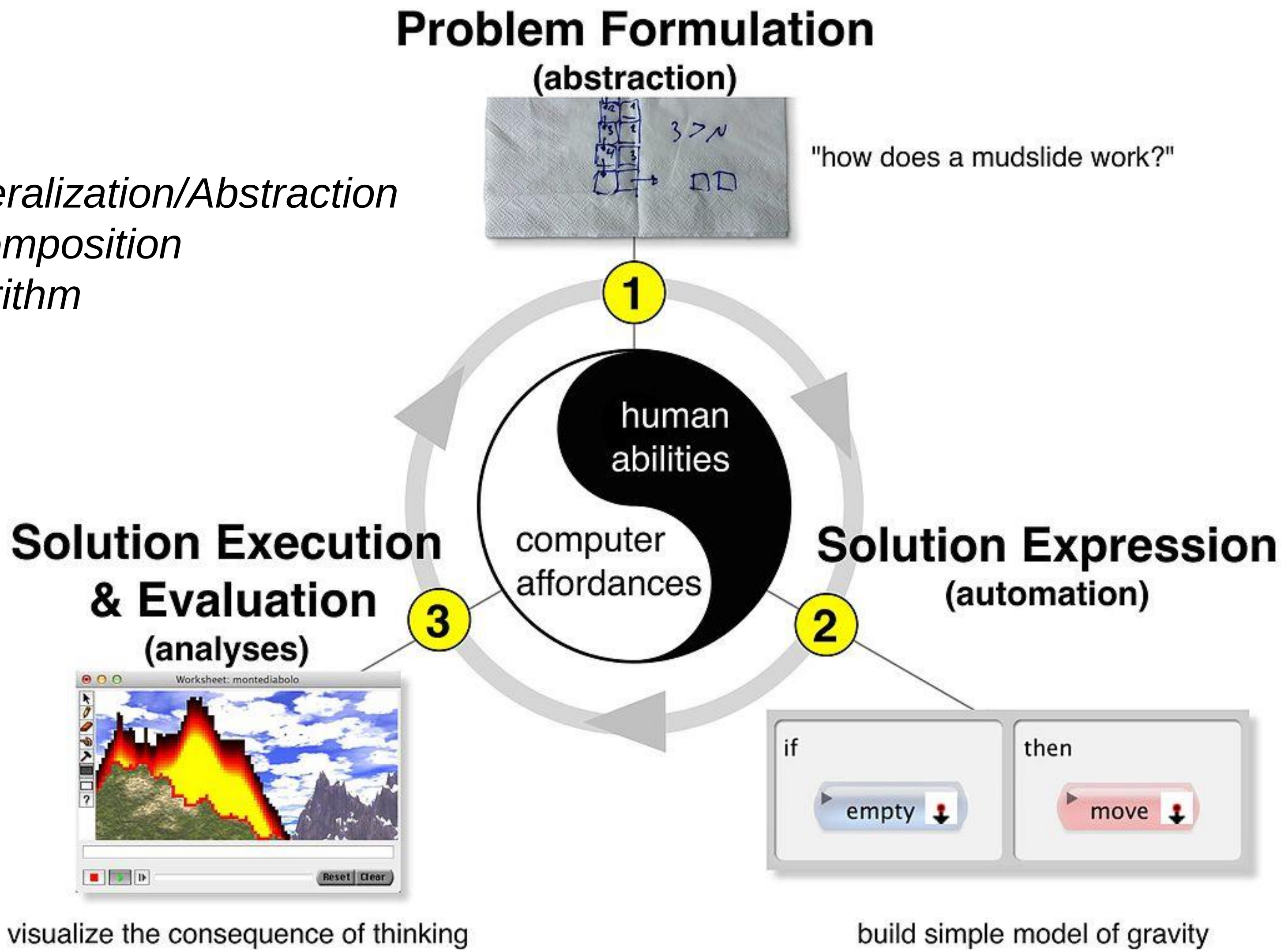
Computational Thinking

"Computational Thinking is the thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively carried out by an information-processing agent.“

Jeanette M. Wing
Carnegie Mellon University

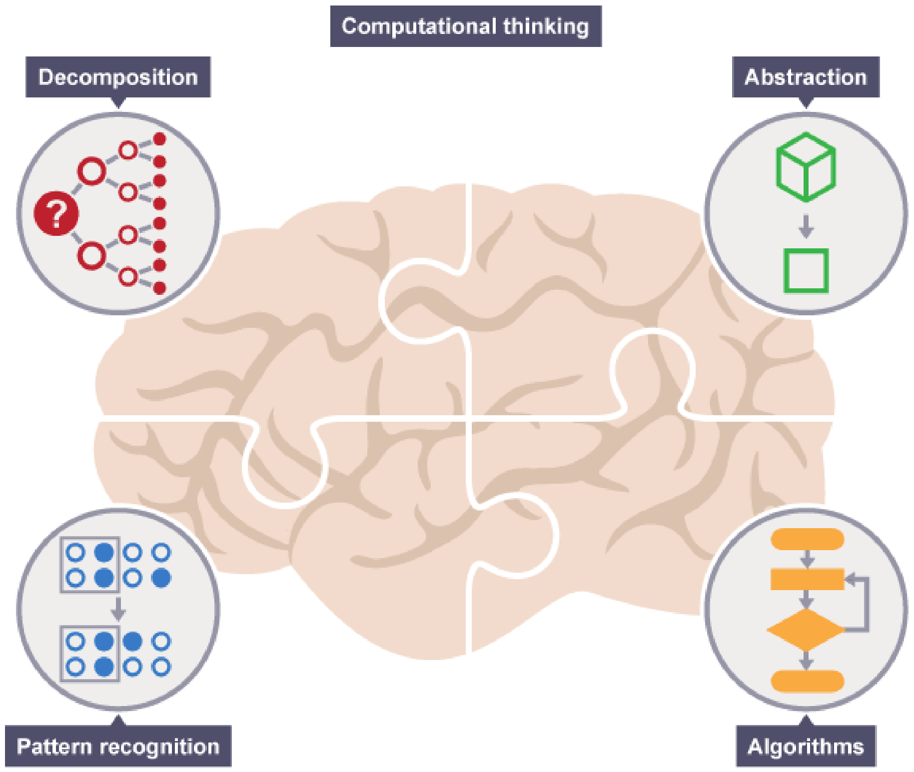
J. Cuny, L. Snyder, and J. M. Wing. Demystifying Computational Thinking for Non-Computer Scientists, 2010 https://en.wikipedia.org/wiki/Computational_thinking

Generalization/Abstraction
Decomposition
Algorithm



Computational Thinking

http://www.bbc.co.uk/education/topics/z7tp34j



Four key techniques (cornerstones) to CT:

decomposition - breaking down a complex problem or system into smaller, more manageable parts

pattern recognition – looking for similarities among and within problems

abstraction – focusing on the important information only, ignoring irrelevant detail

algorithms - developing a step-by-step solution to the problem, or the rules to follow to solve the problem

Computational Thinking: Operational definition for K-12 education

Computational thinking (CT) is a problem-solving process that includes (but is not limited to) the following characteristics:

- **Formulating** problems in a way that enables us to use a computer and other tools to help solve them
- Logically **organizing** and **analyzing** data
- **Representing** data through abstractions such as models and simulations
- **Automating** solutions through algorithmic thinking (a series of ordered steps)
- **Identifying**, **analyzing**, and **implementing** possible solutions with the goal of achieving the most efficient and effective combination of steps and resources
- **Generalizing** and **transferring** this problem solving process to a wide variety of problems

ISTE and CSTA, 2011

CT in UK

Logic
predicting & analysing
Algorithms
making steps & rules
Decomposition
breaking down into parts
Patterns
spotting & using similarities
Abstraction
removing unnecessary detail
Evaluation
making judgement
Concepts
The Computational Thinker: Concepts & Approaches
Tinkering
experimenting & playing
Creating
designing & making
Debugging
finding & fixing errors
Persevering
keeping going
Collaborating
working together
Approaches
Barefoot Computing
COMPUTING AT SCHOOL
www.barefootcas.org.uk
© Crown copyright 2014 (OGL)
Barefoot would like to acknowledge the work of Julia Briggs and the eLIM team at Somerset County Council for their contribution to this poster.

CT Concept, Capability	Informatics
Data collection	Find a data source for a problem area
Data analysis	Write a program to do basic statistical calculations on a set of data
Data representation	Use data structures such as array, linked list, stack, queue, graph, hash table
Problem decomposition	Define objects and methods; define main and functions
Abstraction	Use procedures to encapsulate a set of often repeated commands that perform a function; use conditionals, loops, recursion,
Algorithms & procedures	Study classic algorithms; implement an algorithm for a problem area
Automation	Run programs
Parallelization	Threading, pipelining, dividing up data or task in such a way to be processed in parallel
Simulation	Algorithm animation, parameter sweeping

Bebras

International Challenge on Informatics and Computational Thinking

Valentina Dagienė
Vilnius University, Lithuania

Bebras

Participants

6 age groups:

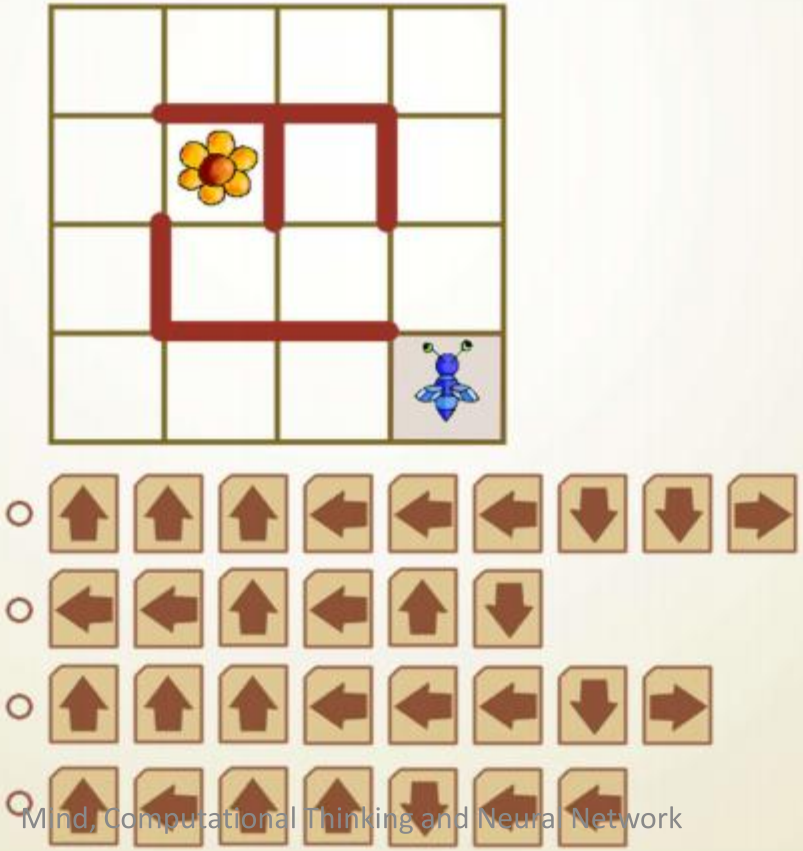
- I age 5-8
- II age 8-10
- III age 10-13
- IV age 13-15
- V age 15-17
- VI age 17-19

Age group			Primary		Benjamin		Cadet		Junior		Senior		
Grades	1	2	3	4	5	6	7	8	9	10	11	12	13

Learning by contests grounds on **attractive tasks**

Example: The Bee

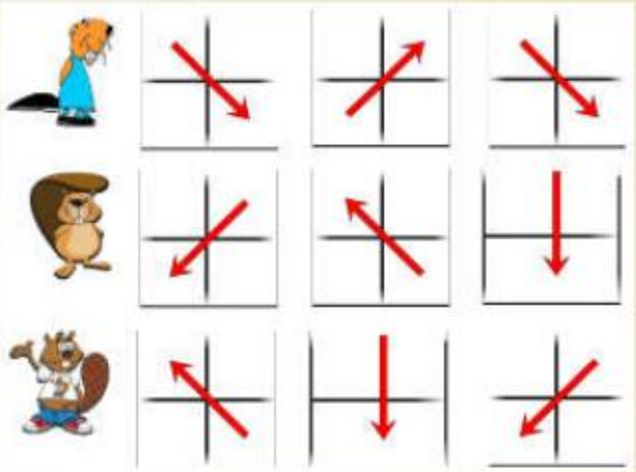
One of the four programs below will lead the bee to the flower.
Which one is it? Note that the bee cannot fly over the red barriers.

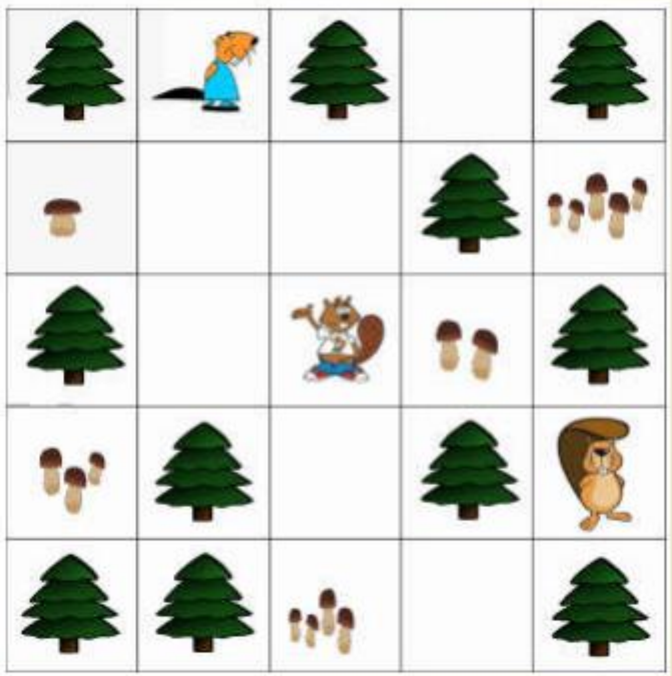


Mushrooms

Three beavers are standing in a forest. Each wants to go where there are mushrooms. Arrows in the picture to the right show the directions the beavers will walk.

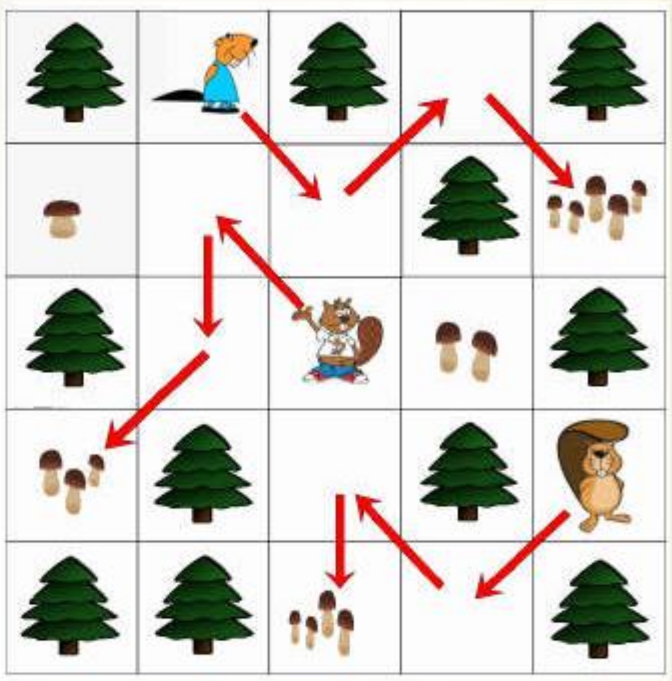
Where do the beavers end up?





Answer and Explanation:

Answer:



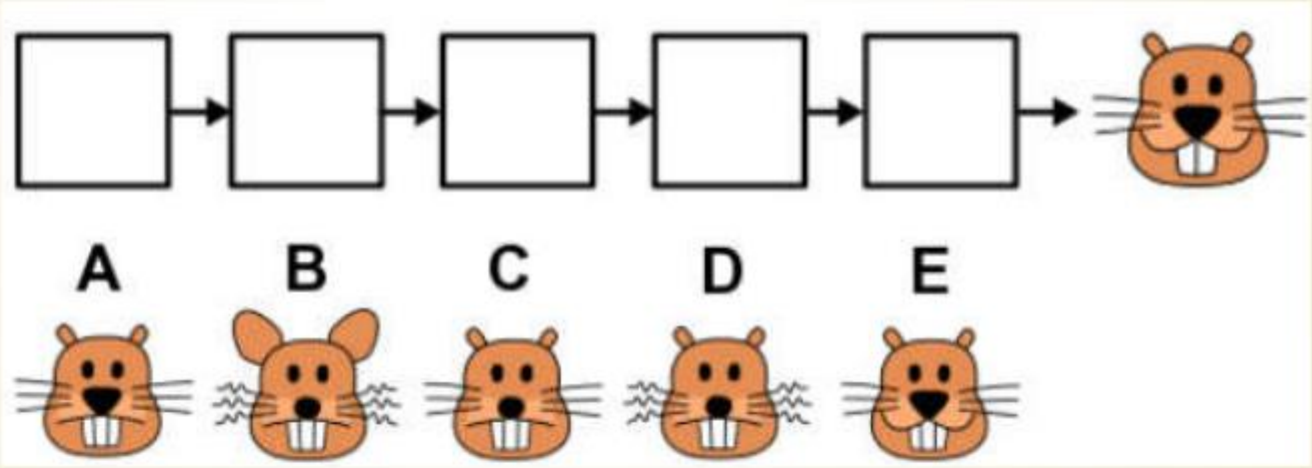
It's Computational Thinking:

Skills - ***Algorithmic Thinking***

Simple sets of instructions called algorithms can help us solve problems. It is sometimes easier to do this with pictures and arrows than with words.

Animation

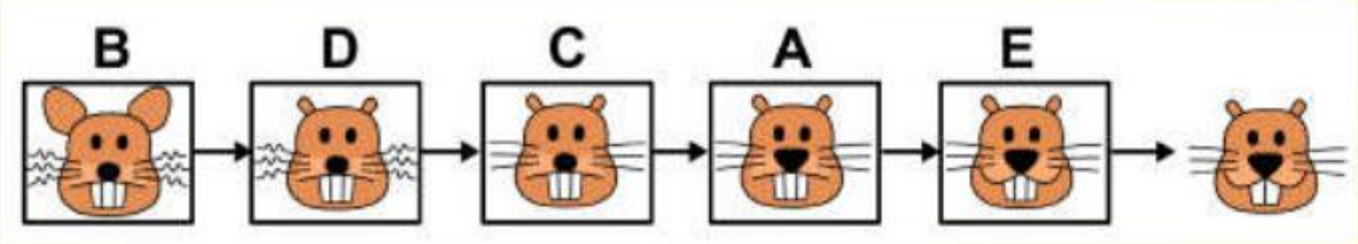
Taro is planning an animation of a face that is made from a sequence of pictures. To make the animation run smoothly, only one feature of the face should change from one picture to the next. Unfortunately, the pictures got mixed up. Now Taro must find the correct order again. Luckily, he knows which picture is last.



Put the pictures in the correct order by dragging them onto the squares.

Answer and Explanation:

Answer:



It's Computational Thinking:

*Skills - **Abstraction**, **Decomposition**, **Generalisation***

- In order to find the differences between the pictures, you have to find about about the essential attributes of the faces first. The list of attributes and their possible values is:

ears: small, large; **mouth**: plain, smile; **nose**: small, large

number of teeth: 2, 3; **whiskers**: curly, straight

Face A can now be described as:

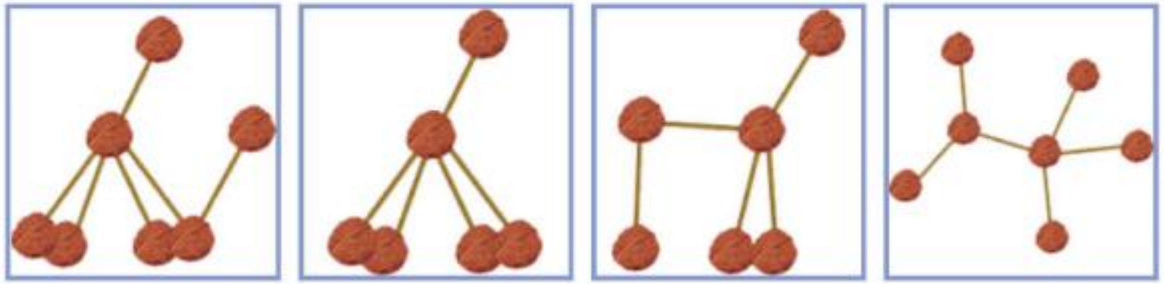
(**ears**: small; **mouth**: plain; **nose**: large; **number of teeth**: 3; **whiskers**: straight)

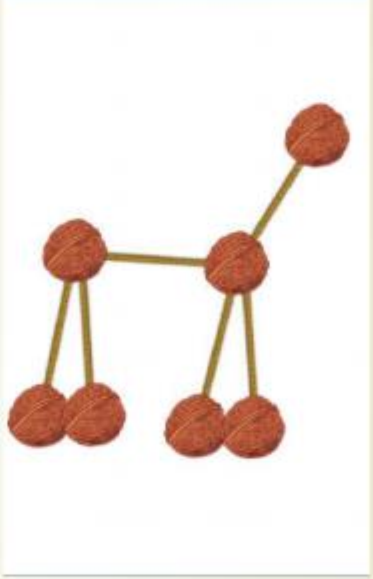
In computing, it is very usual to model things from the real world as "objects" that have attributes and values.

Abstraction – Walnut animal

Question:

Which of the following figures can be bent back to make the figure of the dog again?



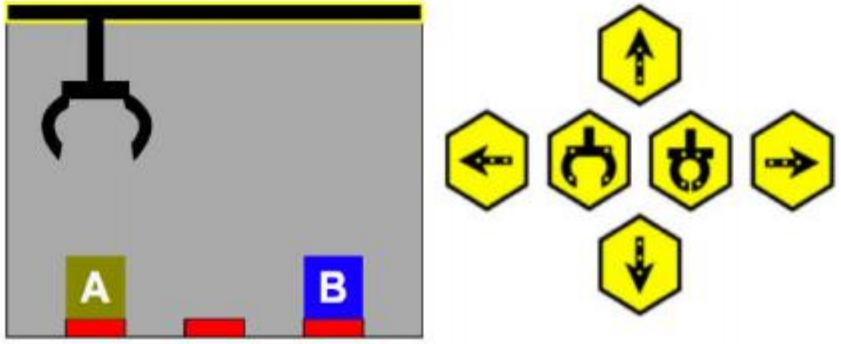


Abstraction means hiding unnecessary details in order to solve the problem.

Algorithmic thinking – Crane operating

The crane in the port of Lodgedam has six different input commands:

left
right
up
down
grab
let go



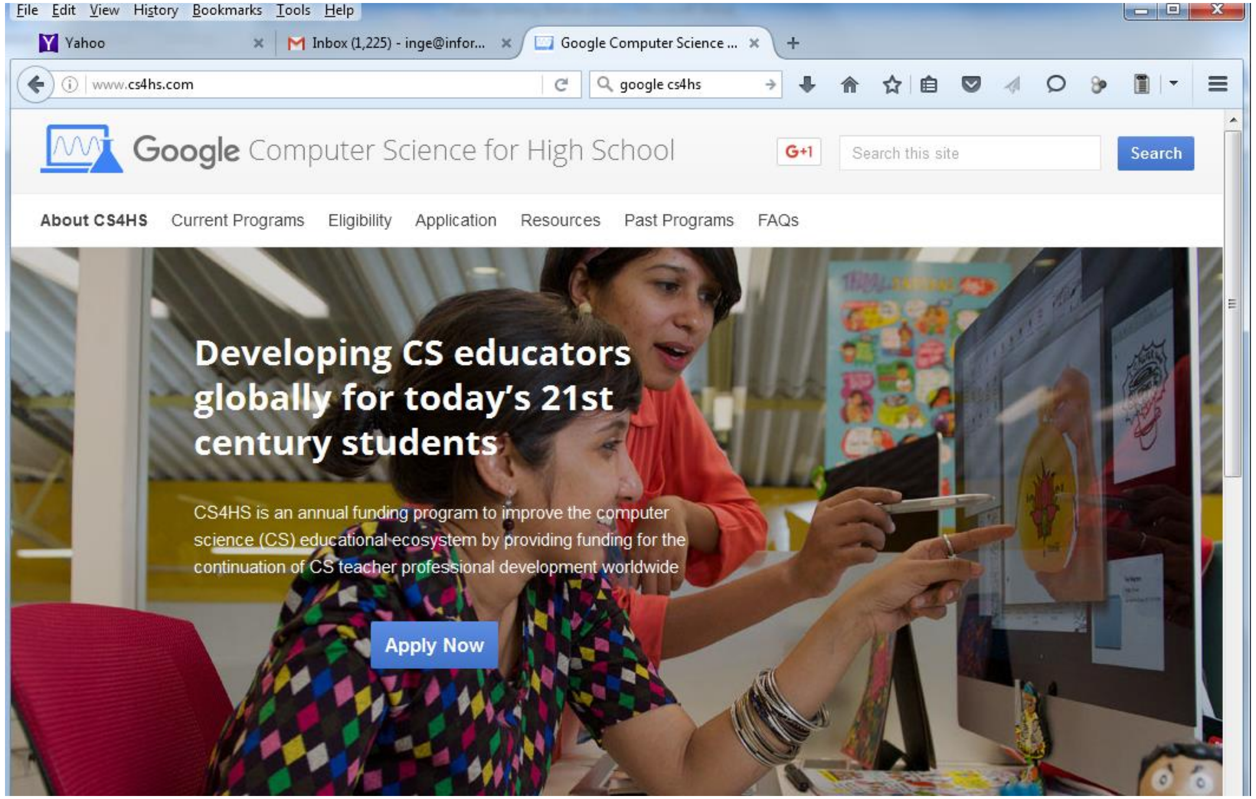
Crate A is in the left position, crate B is in the position on the right.

Question:

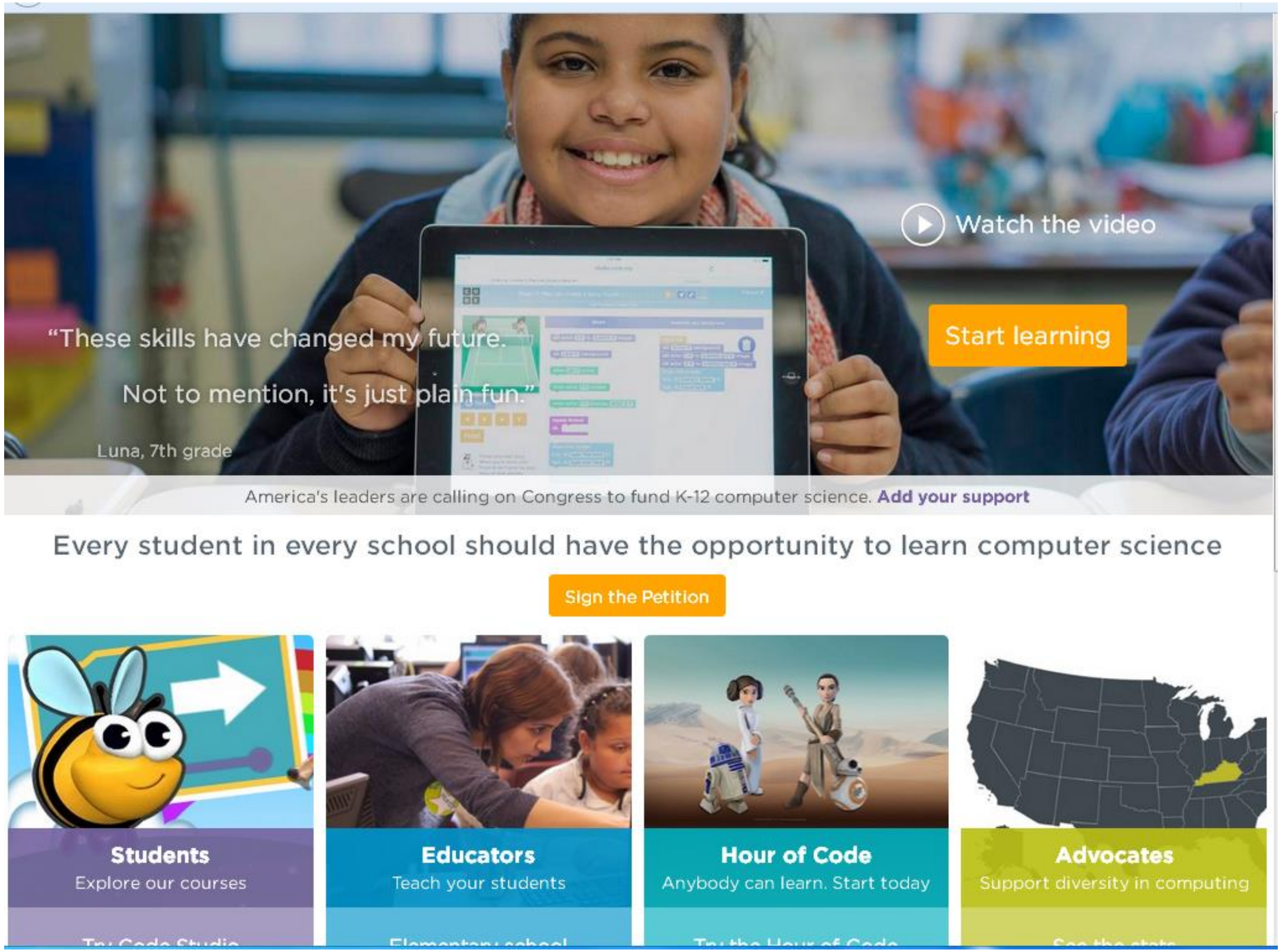
Using the command buttons, swap the position of the two crates.

To solve the problem, the student needs to execute a sequence of instructions – ie an algorithm

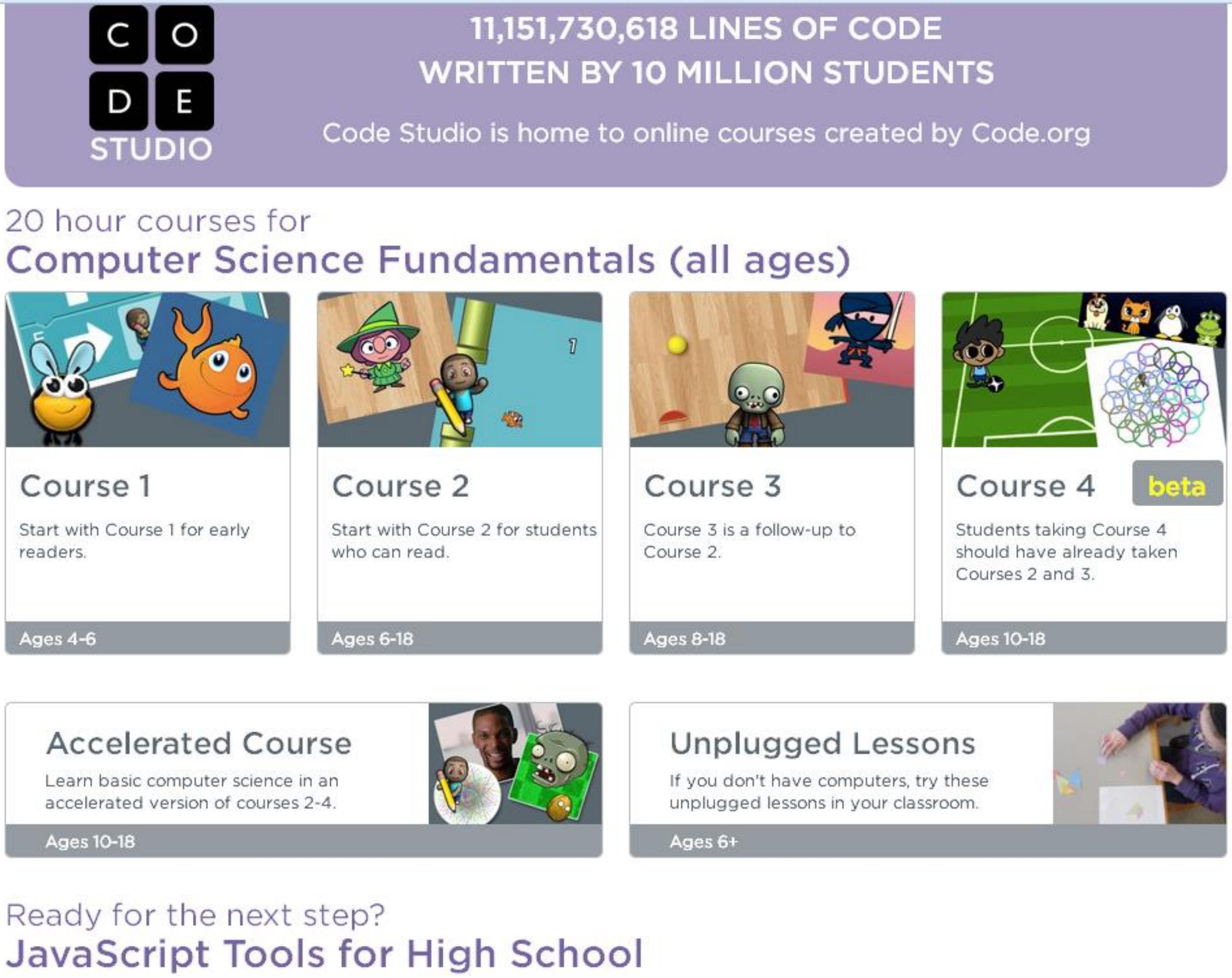
Google support for Computational thinking



https://www.google.com/edu/resources/programs/exploring-computational-thinking/
https://computationalthinkingcourse.withgoogle.com/course?use_last_location=true



https://code.org/



https://code.org/

Terimakasih

https://olympia.id
Latihan Bebras

http://bebras.or.id
Bebras Indonesia