

# Artificial Intelligence

## Unit-1

**Introduction:** The Foundation of AI, The History of AI, The State of art. **Intelligent agents:** Agent and Environments, Good Behavior, Nature of Environments, Structure of Agents.

# Artificial Intelligence

Creating an intelligent machine which can behave like a human, think like a human and able to take decisions like a human.

## Definition of AI

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**“Intelligence: The ability to learn and solve problems”**

Webster's Dictionary.

**“Artificial intelligence (AI) is the intelligence exhibited by machines or software’**

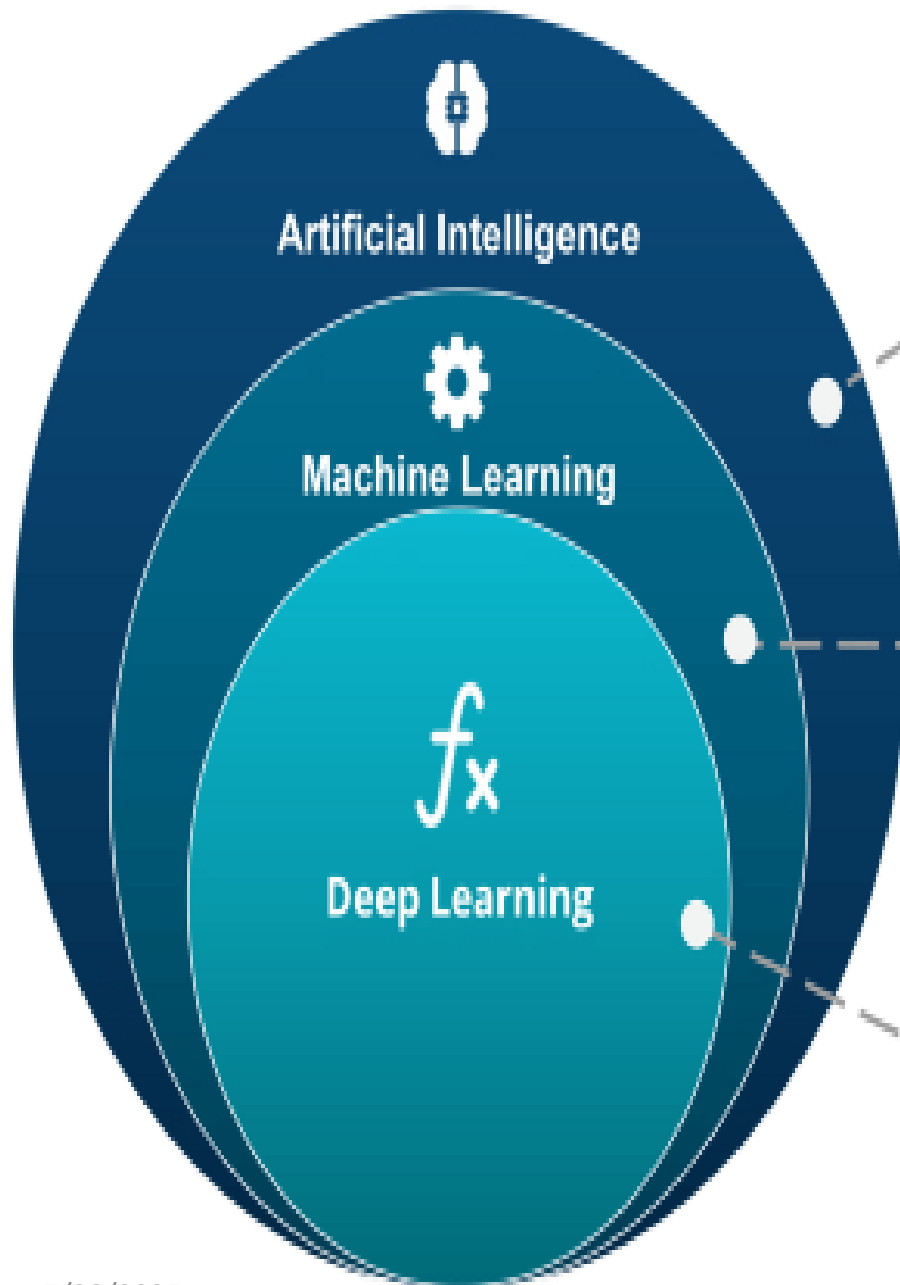
Wikipedia.

**“The science and engineering of making intelligent machines”**

McCarthy.

**“The study and design of intelligent agents, where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success.”**

Russel and Norvig AI book.



## ARTIFICIAL INTELLIGENCE

A technique which enables machines to mimic human behaviour

## MACHINE LEARNING

Subset of AI technique which use statistical methods to enable machines to improve with experience

## DEEP LEARNING

Subset of ML which make the computation of multi-layer neural network feasible

# Why AI

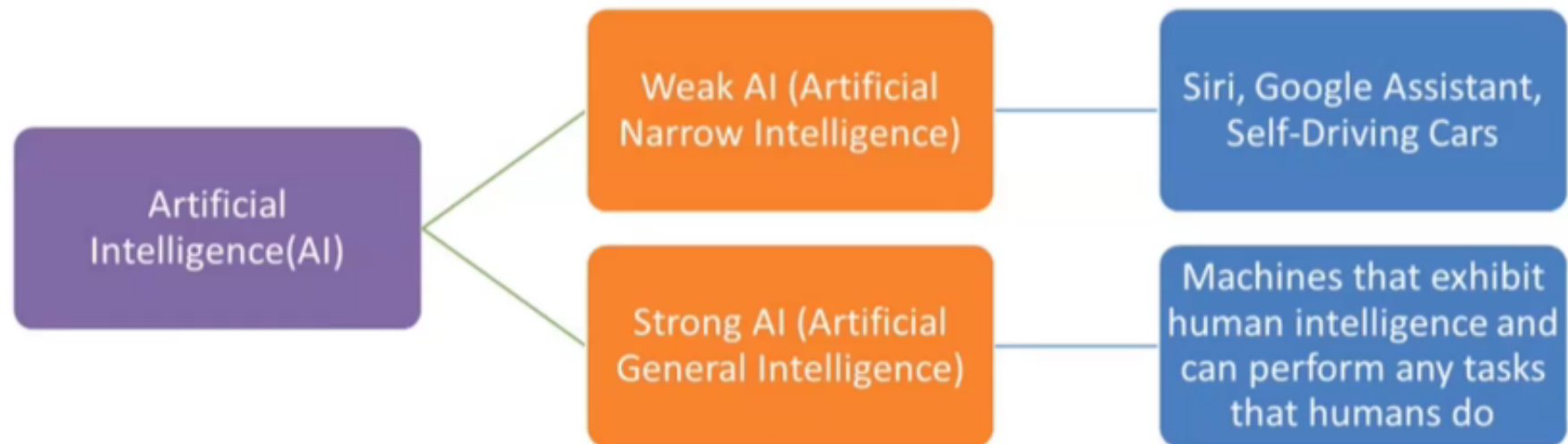
**“Just as the Industrial Revolution freed up a lot of humanity from physical drudgery, I think AI has the potential to free up humanity from a lot of the mental drudgery.”**

Andrew Ng.

# Basic Computer capabilities to be acted as Human

1. **Natural language processing:** To communicate successfully in a human language
2. **Knowledge representation:** To store what it knows or hears
3. **Automated reasoning** to answer questions and to draw new conclusions
4. **Machine learning:** To adapt to new circumstances and to detect and extrapolate patterns.
5. **Computer vision and speech recognition:** To process the world
6. **Robotics:** To understand the environment and move about.

# Introduction to Artificial Intelligence



# Introduction to AI

Rational= mathematics+engineering

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

# What is AI

## Thinking humanly: cognitive approach



Requires to determine how humans think!

1960's "cognitive revolution".

Requires scientific theories of internal activities of the brain

- What level of abstraction? "Knowledge" or "circuits"?
- How to validate?

**Today, Cognitive Science and Artificial Intelligence are distinct disciplines.** Study of how the mind works



# Thinking rationally: The "laws of thought" approach

- **Right thinking.** (impossible to deny the reasoning process/logics)
- The Greek philosopher Aristotle was one of the first to attempt to reasoning in logic that involves drawing a conclusion from two premises.  
**(Syllogism)**

- |   |   |
|---|---|
| 1. <b>Major Premise:</b> A general statement or universal truth.            | • <b>Major Premise:</b> All humans are mortal.      |
| 2. <b>Minor Premise:</b> A specific statement related to the major premise. | • <b>Minor Premise:</b> Socrates is a human.        |
| 3. <b>Conclusion:</b> The logical result derived from the two premises.     | • <b>Conclusion:</b> Therefore, Socrates is mortal. |

The two main obstacles to using formal logical notation for computational reasoning are:

**1.Expressing Informal Knowledge:** It is challenging to convert informal knowledge into formal logical terms, especially when that knowledge is uncertain.

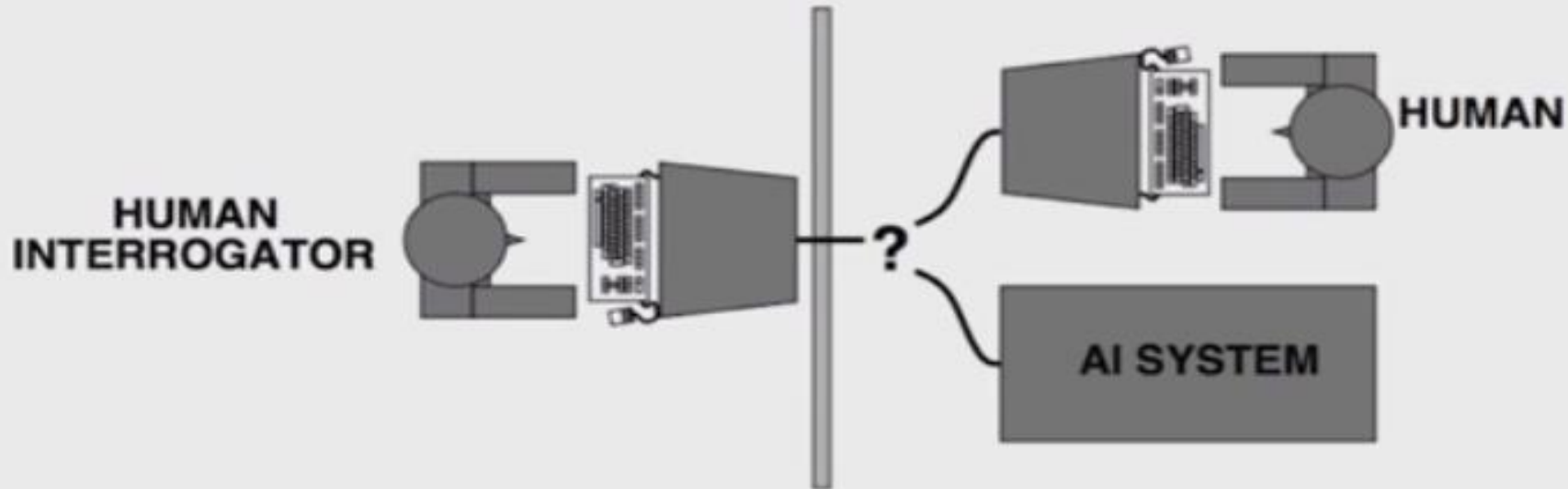
**2.Practical Problem Solving:** There is a significant difference between solving problems theoretically ("in principle") and actually implementing solutions in practice.

# What is AI?

## ② Acting humanly:

*machines do  
things...*

- **Turing test (Alan Turing 1950):** A computer passes the test of intelligence, if it can fool a human interrogator.



- **Major components of AI:** knowledge, reasoning, language, understanding, learning.

# What is AI?

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**Acting humanly:**



# What is AI?

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## ④ Acting rationally:

- The right thing: that which is expected to maximize goal achievement, given the available information.
- A **rational agent** is one that acts so as to achieve the best outcome, or when there is uncertainty, the best expected outcome.
- Aristotle (Nicomachean Ethics):  
*“Every art and every inquiry, and similarly every action and pursuit, is thought to aim at some good.”*

# Applications of AI

Handwriting recognition (check, zipcode)





# Applications of AI

## Speech recognition

- Virtual assistants: Siri (Apple), Echo (Amazon), Google Now, Cortana (Microsoft).
- “They” helps get things done: send an email, make an appointment, find a restaurant, tell you the weather and more.
- Leverage deep neural networks to handle **speech recognition** and **natural language understanding**.



# Applications of AI

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## Machine translation

- Historical motivation: translate Russian to English.
- First systems using **mechanical translation** (one-to-one correspondence) failed!
- “Out of sight, out of mind”  $\Rightarrow$  “Invisible, imbecile”.

# Applications of AI

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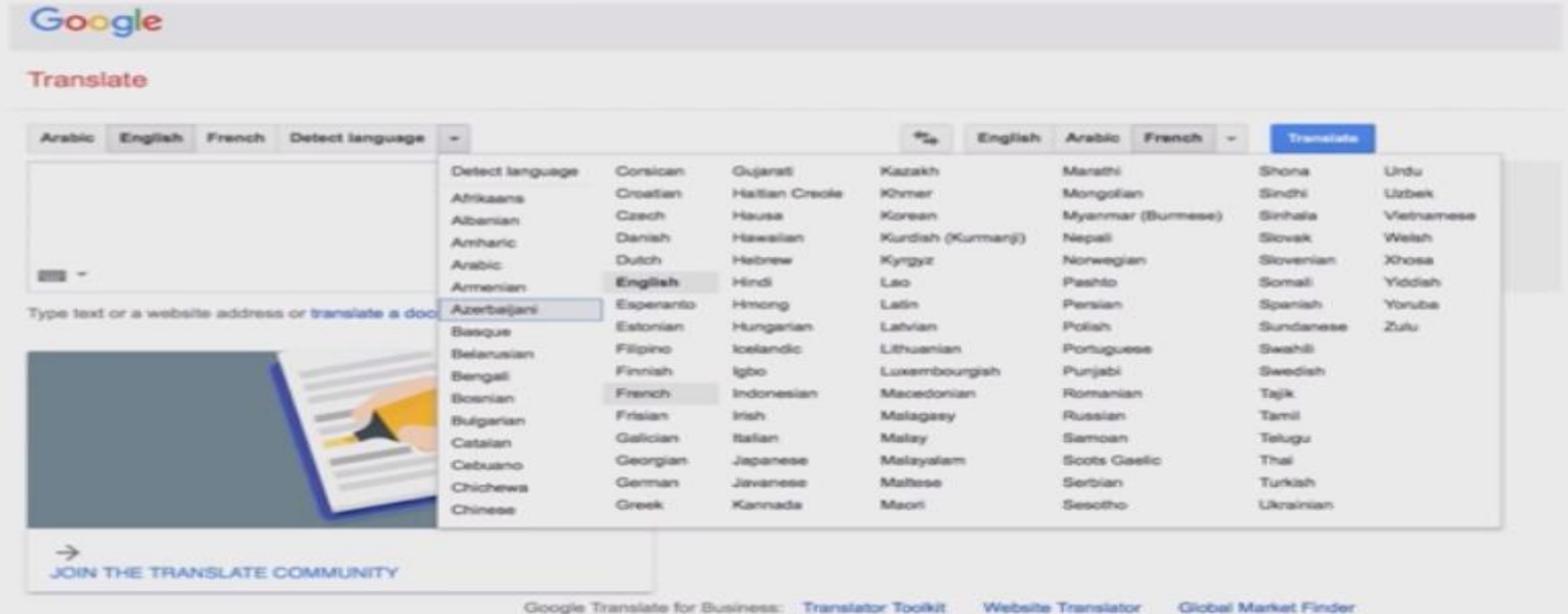
## Machine translation

- MT has gone through ups and downs.
- Today, **Statistical Machine Translation** leverages the vast amounts of **available translated corpuses**.
- While there is room for improvement, machine translation has made significant progress.



# Applications of AI

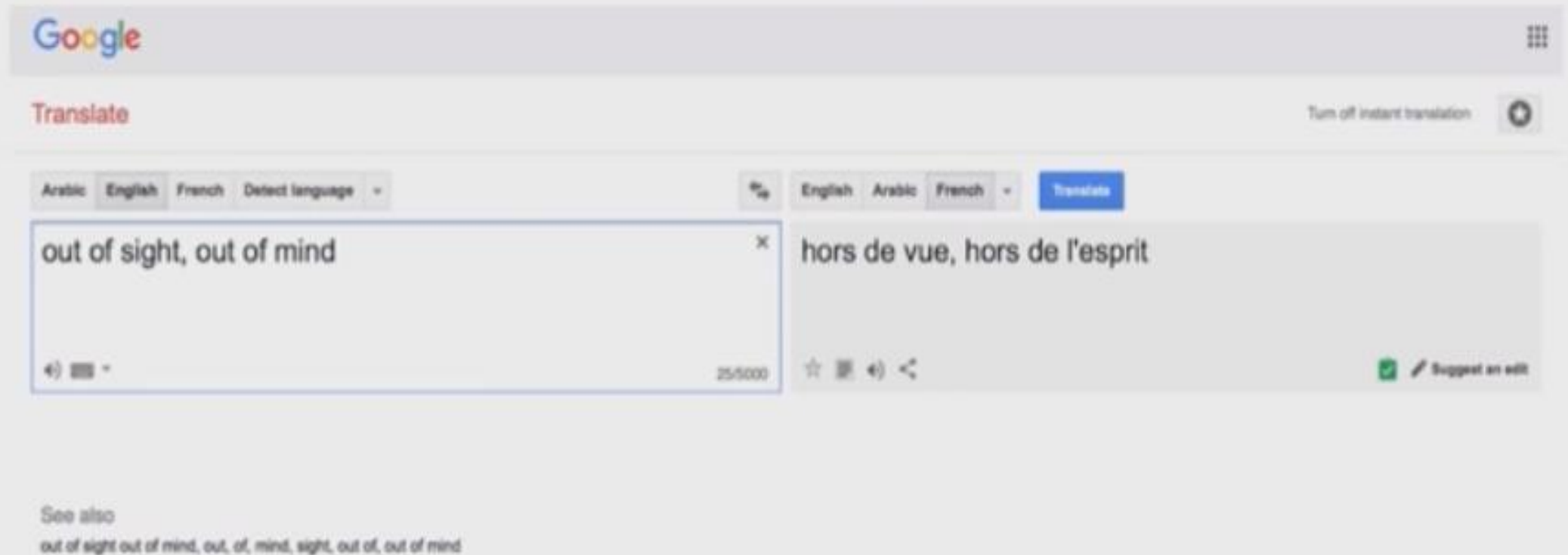
## Machine translation



100+ languages

# Applications of AI

## Machine translation



The screenshot shows the Google Translate interface. At the top, the Google logo is on the left and a grid icon is on the right. Below the logo, the word "Translate" is on the left and "Turn off instant translation" with a circular arrow icon is on the right. The main interface has two language selection bars. The left bar shows "Arabic", "English", "French", and "Detect language" with a dropdown arrow. The right bar shows "English", "Arabic", "French", and a dropdown arrow, with a blue "Translate" button to its right. The input text box on the left contains "out of sight, out of mind" and has a character count of "25/5000". The output text box on the right contains the French translation "hors de vue, hors de l'esprit". Below the output box, there are icons for star, dictionary, voice, and share, along with a "Suggest an edit" link. At the bottom left, there is a "See also" section with the text "out of sight out of mind, out, of, mind, sight, out of, out of mind".

Google

Translate

Turn off instant translation

Arabic English French Detect language

English Arabic French Translate

out of sight, out of mind

hors de vue, hors de l'esprit

See also

out of sight out of mind, out, of, mind, sight, out of, out of mind

# Applications of AI

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Robotics: Awesome robots today! NAO, ASIMO, and more!



Credit: By Momotarou2012, via Wikimedia Commons.

# Applications of AI

## Recommendation systems (collaborative filtering)

amazon

Shop by Department

Search

Kids Dance Wii U

Video Games

Just Dance Kids 2014 - Nintendo Wii U

Wii U Remote™ Required

JUST DANCE KIDS 2014

Learn More

Price: **\$19.99** & FREE Shipping on orders over \$25. Details

Free from \$19.99 (33%)

In Stock.

Ship from and sold by Amazon.com. Gift-wrap available.

Want it Thursday, Nov. 20? Order within 25 hrs 59 mins and choose One-Day Shipping at checkout. [Details](#)

Platform: Nintendo Wii U

Nintendo Wii U

- 32 Brand-New Dances led by real kids
- Dance Shoulder Mode: Use the Wii U controller to make your entire family dance to silly dance moves during any
- Kids can create custom playlists for endless fun
- Play with up to 5 Players

22 more from \$19.99

Customers Who Bought This Item Also Bought

Product	Price
SNES Party with Wii U Microphone	\$15.99
Wii U Microphone	\$6.98
Barbie Dreamhouse Party - Nintendo Wii U	\$39.96
Wii Party U	\$39.99
Just Dance 2014 - Nintendo Wii U	\$35.21
Just Dance 4 - Nintendo Wii U	\$17.89
ESPN Sports Connection - Nintendo Wii U	\$19.23

# Applications of AI

## Email

**Gmail -** 1-50 of 2,006

**COMPOSE**

**Inbox (1,886)**

- Starred
- Important
- Sent Mail
- Drafts (1)
- Circles
- Less -
- Chats
- All Mail
- Spam (15)**
- Trash

From	Subject	Time
Lumosity.com - Challenge Your Brain	Challenge your brain with Lumosity, the personal trainer designed by neuroscientists.	
Groupon Getaways	NYC   Dominican Republic   Niagara Falls   Turkey   O	
WebMD	Goat Cheese Grits With Fresh Corn - Daily Bite Tue	
1-800-FLOWERS.COM	Free Shipping Today & Tomorrow! - Send a smile, L	
The Body Shop	Buy 3 Get 3 or Buy 2 Get 2 FREE All Bath & Body - Mega Moisture, Mini Price, S	9:35 am
WebMD	Have you logged your food and fitness today? - Food & Fitness Planner Dear fi	9:26 am
Century 21 Dept Store	Say Spaaaaa! 50% Off Setai Pampering Package + More V-Day Gifts - This Just	7:06 am
Banana Republic	35% off starts right now! - 35% off ends 1/22. Online only. Can't see the images ir	5:04 am

This ad is based on emails from your mailbox and information from your Google account. [Ads Settings](#) puts you in control of the ads you see.



# Applications of AI

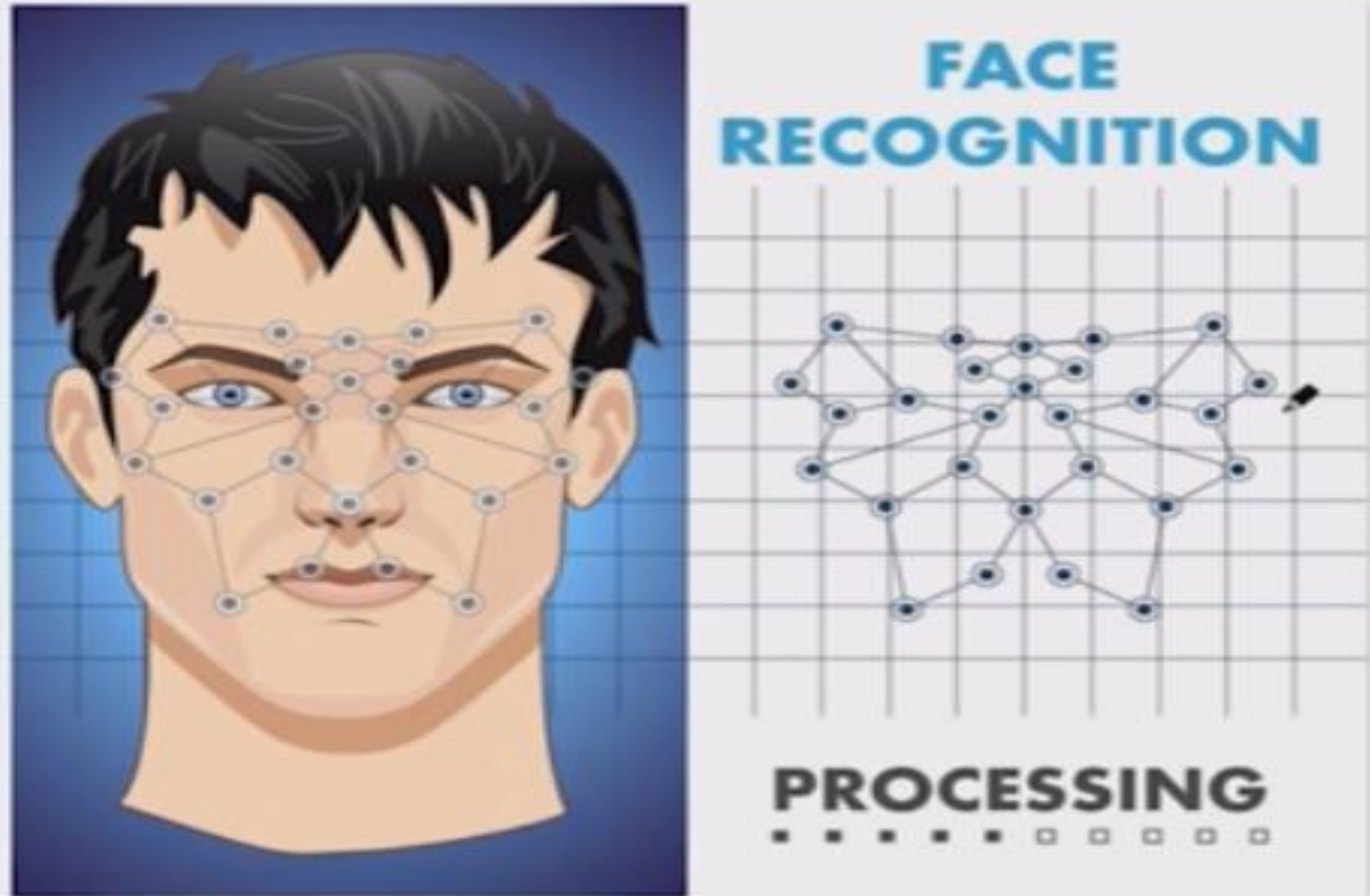
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## Face detection



**Viola-Jones method.**

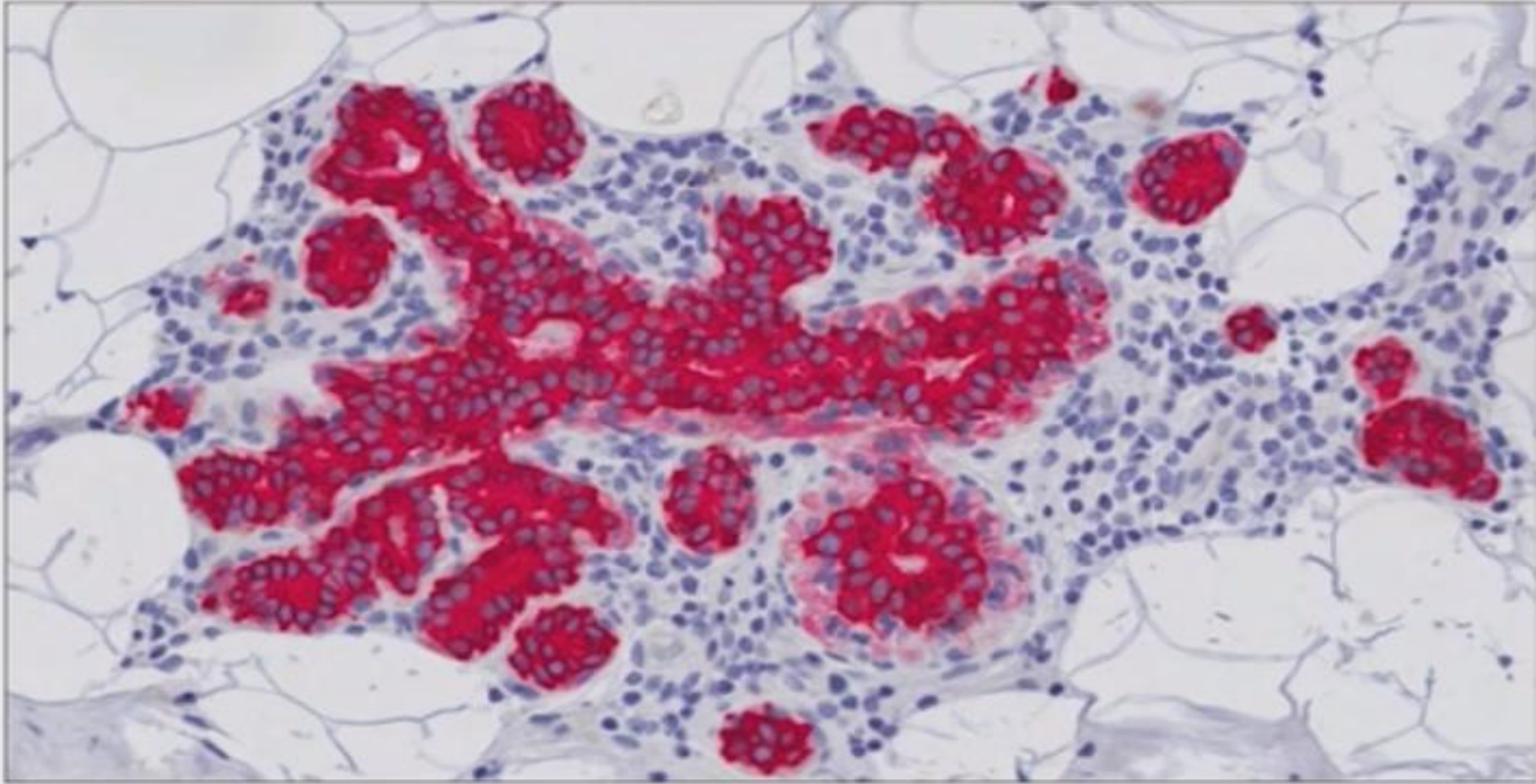
# Face recognition



# Applications of AI

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## Detection of breast cancer in mammography images





# Chess (1997): Kasparov vs. IBM Deep Blue



(Left) Copyright 2007, S.M.S.I., Inc. - Owen Williams, The Kasparov Agency, via Wikimedia Commons (Right) By James the photographer, via Wikimedia Commons

**Powerful search algorithms!**

# Jeopardy! (2011): Humans vs. IBM Watson



By Rosemaryetoufee (Own work), via Wikimedia Commons

**Natural Language Understanding and information extraction!**

# Autonomous driving



By User Spaceape on en.wikipedia, via Wikimedia Commons

- DARPA Grand Challenge
  - 2005: 132 miles
  - 2007: Urban challenge
  - 2009: Google self-driving car

# Applications

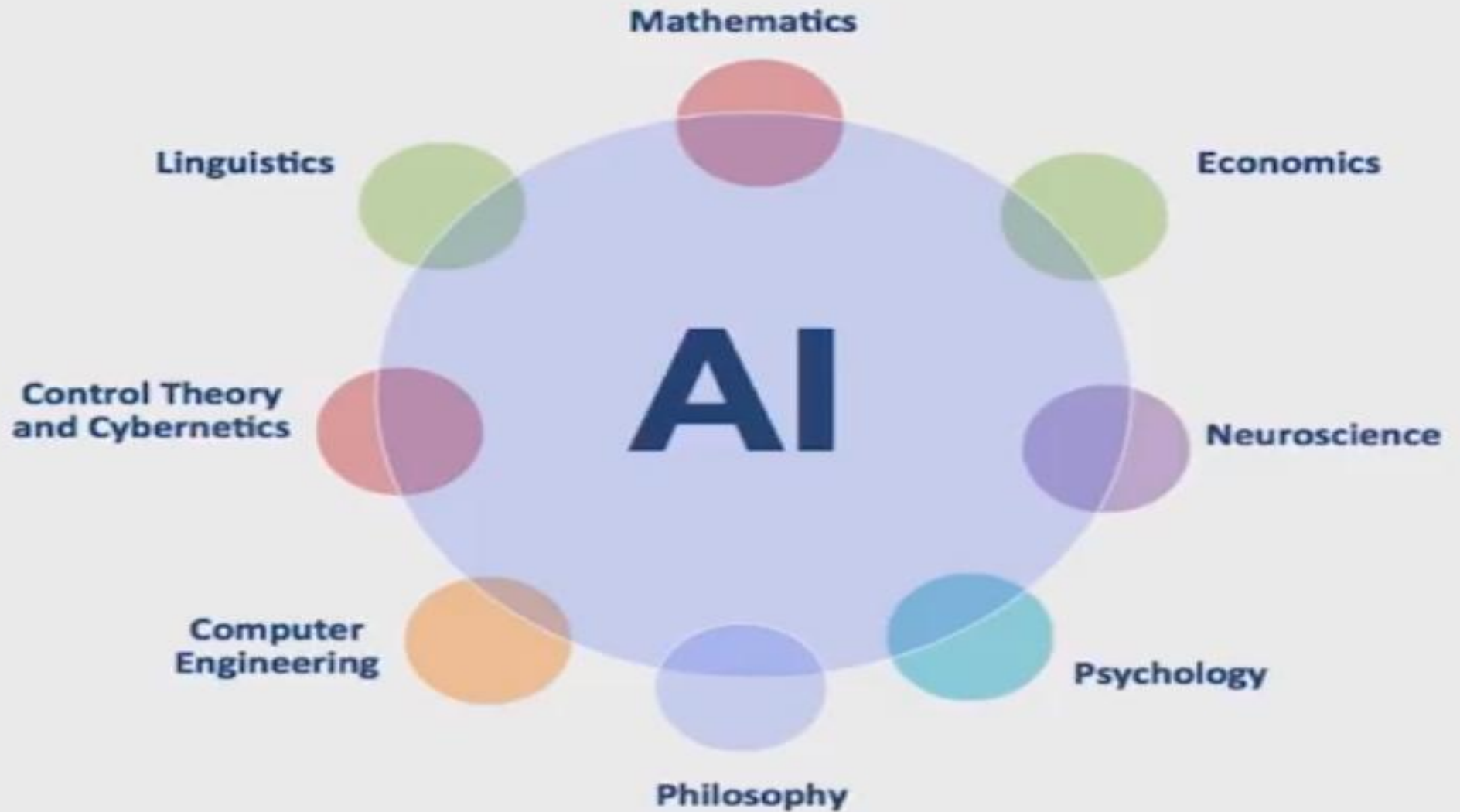
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- **Natural Language Processing (NLP):** concerned with the interactions between computers and human languages.
- **Vision/perception:** concerned with image processing and building computer vision agents. Goals: information extraction for tasks such as manipulation, navigation, and object recognition.
- **Robotics:** concerned with intelligent agents that manipulate the physical world. Different aspects: planning of robot motion, vision and object recognition.



# Foundation of AI

(Disciplines that contributed to AI)



# Foundation of AI

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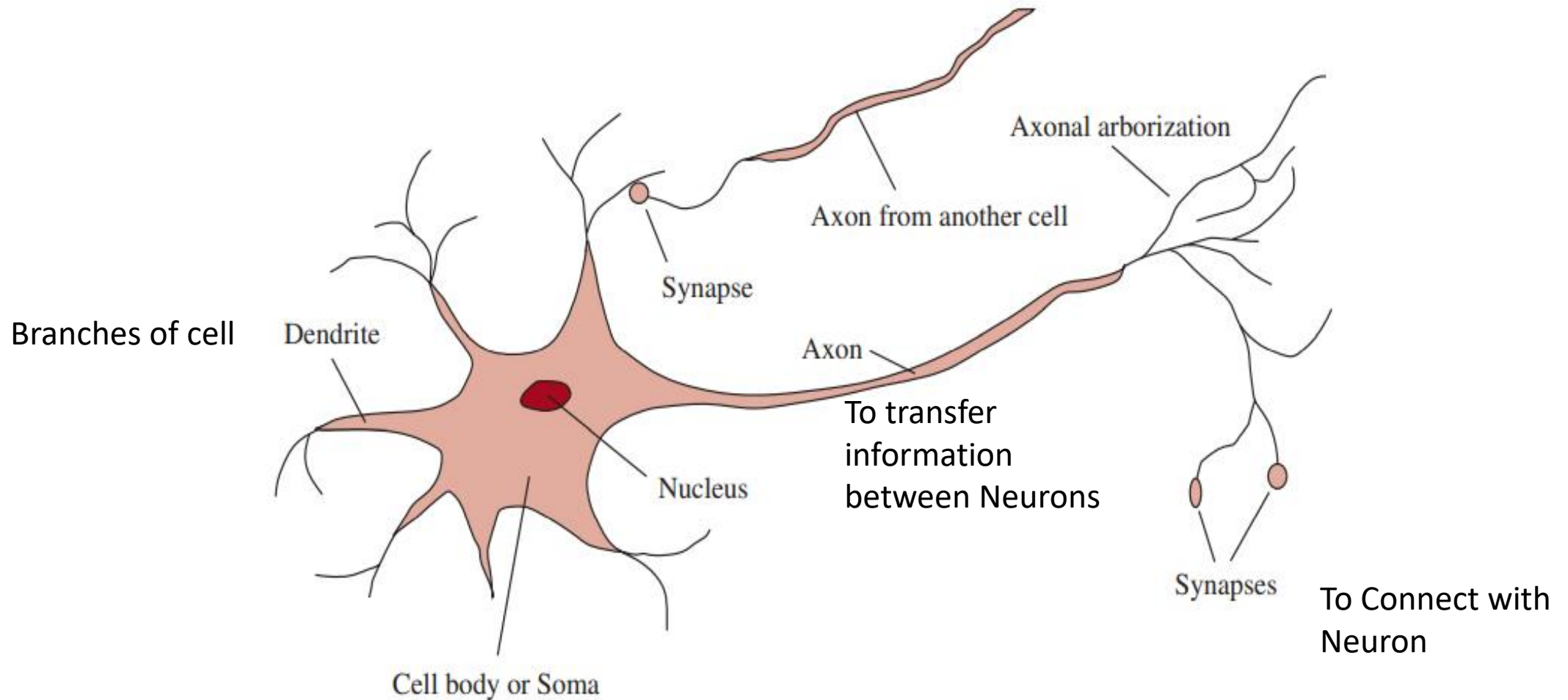
- **Philosophy** Basic foundation, usage of formal rules to draw conclusions
  - Logic, methods of reasoning. Knowledge and mind(brain)
  - Mind as physical system that operates as a set of rules.
  - Foundations of learning, language, rationality.
- **Mathematics** Logic, Probability, computation
  - Logic: Formal representation and proof.
  - Computation, algorithms.
  - Probability.
- **Economics** Low Investing and maximizing utility
  - Formal theory of rational decisions.
  - Combined decision theory and probability theory for decision making under uncertainty.
  - Game theory.
  - Markov decision processes. How agent behaves in diff. situations to achieve goal

# Foundation of AI

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- **Neuroscience** Study of Human brain and nervous system
  - Study of brain functioning.
  - How brains and computers are (dis)similar.
- **Psychology** Cognitive science
  - How do we think and act?
  - Cognitive psychology perceives the brain as an information processing machine.
  - Led to the development of the field *cognitive science*: how could computer models be used to study *language, memory, and thinking* from a psychological perspective.
- **Computer engineering** Super computers, GPUs, Quantum computers
  - Cares about how to build powerful machines to make AI possible. Super computers, Quantum computers
  - E.g., Self-driving cars are possible today thanks to advances in computer engineering.

# Biological Neuron





# Foundation of AI

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System interactions

- **Control theory and cybernetics** System analyse, define, debug and fix errors by itself
  - Design simple optimal agents receiving feedback from the environment.
  - Modern control theory design systems that maximize an objective function over time. Self controlling machines
- **Linguistics** Speech to text and text to speech
  - How are language and thinking related.
  - Modern linguistics + AI = Computational linguistics (Natural language processing).



Can  
Machine  
Think?

## Birth of AI

1952-1956

In the 1940s and 50s, a handful of scientists from a variety of fields (mathematics, psychology, engineering, economics and political science) began to discuss the possibility of creating an artificial brain.

## Symbolic AI

- The programs developed in the years after the Dartmouth Workshop were,
- Computers were solving algebra word problems, proving theorems in geometry and learning to speak English.

1956-1974

Knowledge revolution,

## Boom

- Rise of Expert Systems
- The Knowledge Revolution
- The Money Return

1980-1987

Tech and data limitations reduced

1974-1980

## AI Winter

- Limited Computer Power
- There are many problems that can probably only be solved in exponential time
- Can still only handle trivial versions of the problems.
- The end of funding

No significant developments recorded

1987-1993

## Bust : 2nd AI Winter

The collapse was due to the failure of commercial vendors to develop a wide variety of workable solutions. As dozens of companies failed, the perception was that the technology was not viable

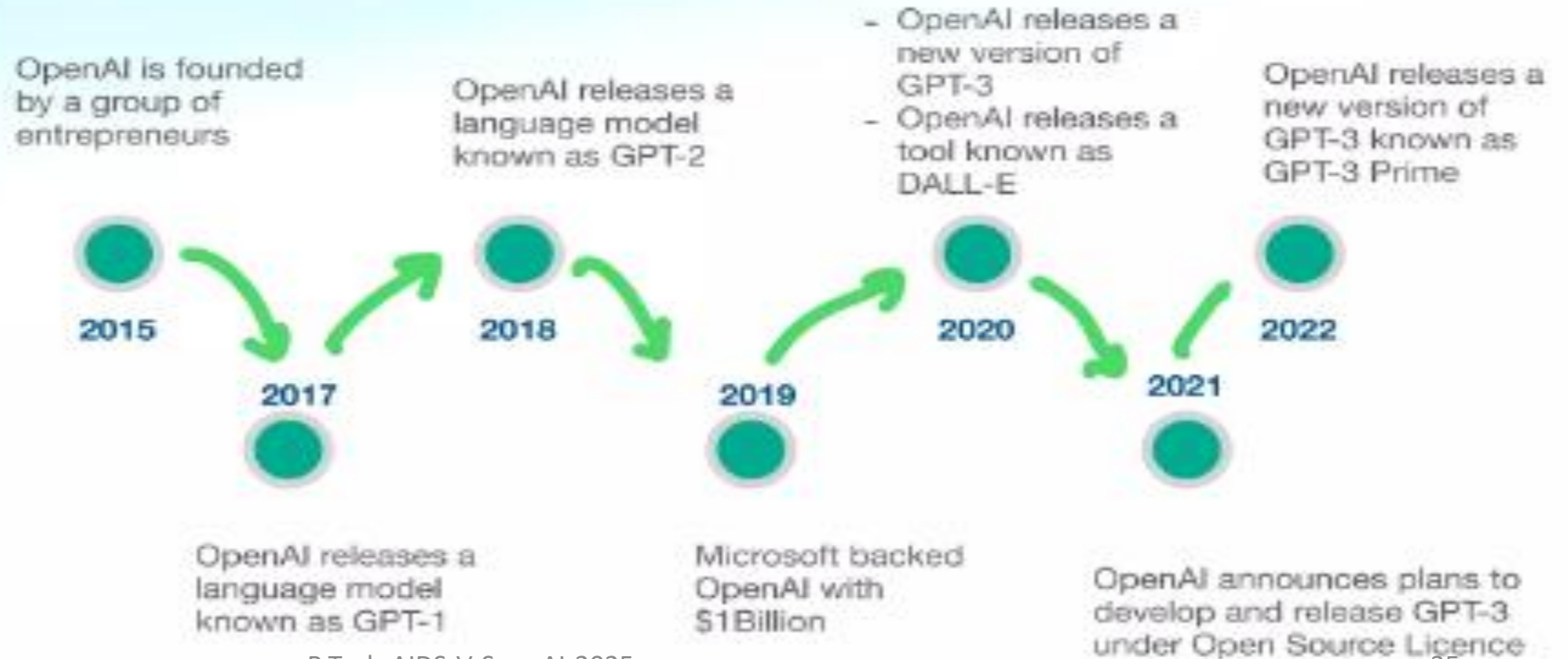
## AI Renaissance

- AI was both more cautious and more successful than it had ever been.
- Deep Blue became the first computer chess-playing system

1993-2011

## Deep learning, big data and artificial general intelligence (AGI)

2011- Present

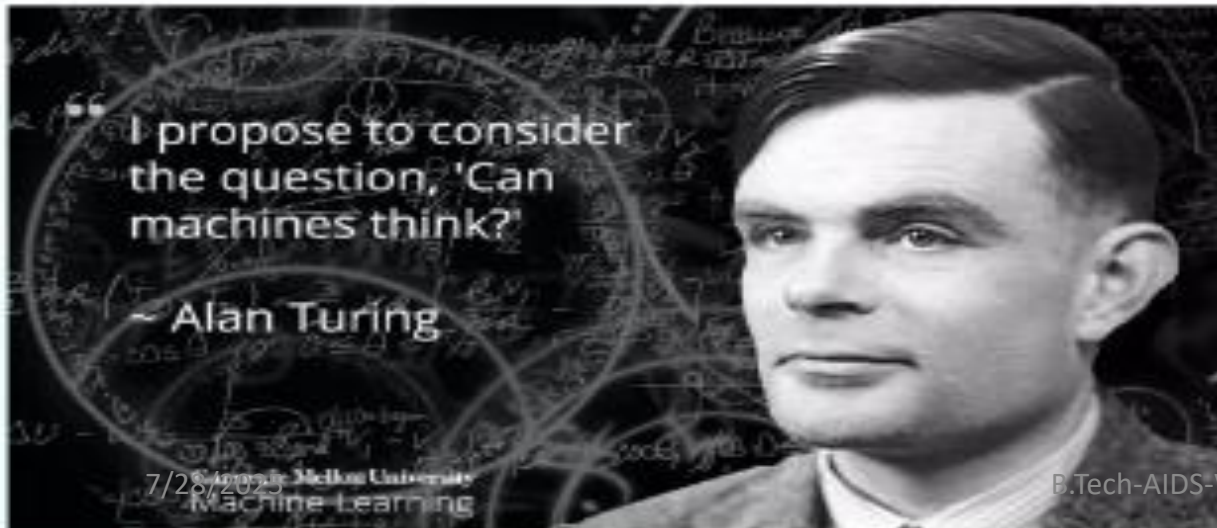




# 1950 - Alan Turing

## Can Machine Think?

1950: Alan Turing publishes "Computing Machinery and Intelligence" which proposes the Turing Test, a method for determining whether a machine can exhibit intelligent behaviour equivalent to, or indistinguishable from, that of a human.



### Computing Machinery and Intelligence

A. M. Turing

1950

#### 1 The Imitation Game

I propose to consider the question, "Can machines think?" This should begin with definitions of the meaning of the terms "machine" and "think." The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words "machine" and "think" are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, "Can machines think?" is to be sought in a statistical survey such as a Gallup poll. But this is absurd. Instead of attempting such a definition I shall replace the question by another, which is closely related to it and is expressed in relatively unambiguous words.

<https://web.itd.ac.in/~sumeet/Turing50.pdf>

Alan Turing: Turing test

# 1956 - John McCarthy



Dartmouth Conference: Coined the term AI

## Birth of AI

1956: John McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude Shannon organize the **Dartmouth Conference**, which is considered to be the birth of AI as a field. The conference defines the goals of AI research and lays the groundwork for the development of early AI systems.

### 1956 Dartmouth Conference: The Founding Fathers of AI



John McCarthy



Marvin Minsky



Claude Shannon



Ray Solomonoff



Alan Newell



Herbert Simon



Arthur Samuel



Oliver Selfridge



Nathaniel Rochester



Trenchard More





# 1958 - John McCarthy

## Lisp - Designed for AI

1958: John McCarthy invents Lisp, a programming language designed specifically for AI research.

Expression based language, dynamic typing, supports many data types.



### Recursive Functions of Symbolic Expressions and Their Computation by Machine, Part I

John McCarthy, Massachusetts Institute of Technology, Cambridge, Mass. \*

April 1960

#### 1 Introduction

A programming system called LISP (for LISP Processor) has been developed for the IBM 704 computer by the Artificial Intelligence group at M.I.T. The system was designed to facilitate experiments with a proposed system called the Advice Taker, whereby a machine could be instructed to handle declarative as well as imperative sentences and could exhibit "common sense" in carrying out its instructions. The original proposal [1] for the Advice Taker was made in November 1958. The main requirement was a programming system for manipulating expressions representing formalized declarative and imperative sentences so that the Advice Taker system could make deductions.

<http://www-formal.stanford.edu/jmc/recursive.pdf>



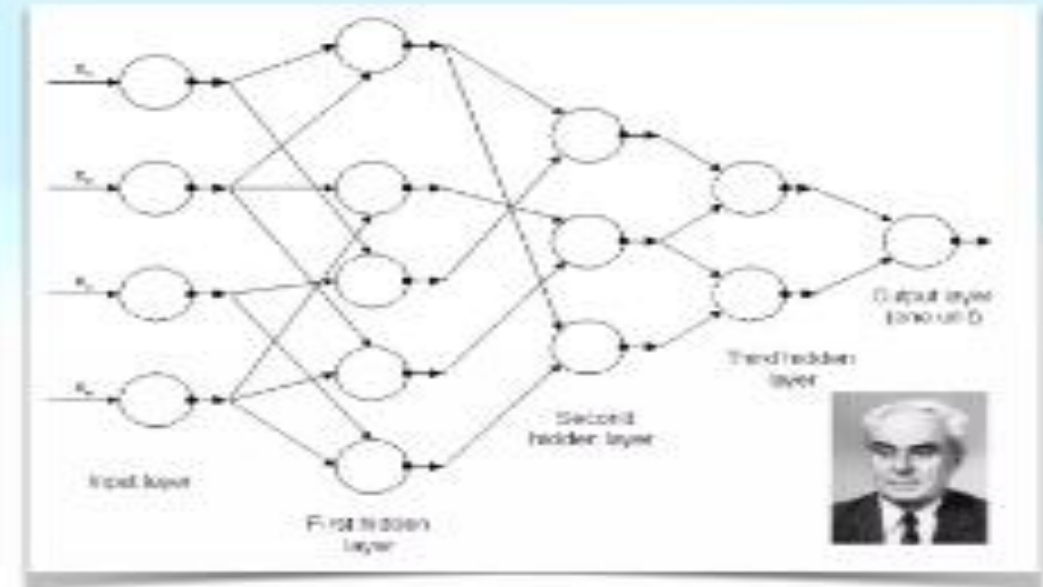
**1965 - Anatolii Gershman, Alexey Ivakhnenko, Valentin Lapa**

## Deep Learning - Multi Layered Perceptron

**1965 : The Group Method of Data Handling (GMDH)** is a data-driven approach to modeling that is based on a multi-layered architecture of interconnected polynomial models.

A multi-layer perceptron (MLP) is a type of artificial neural network (ANN) that is composed of multiple layers of interconnected nodes, or "neurons". MLPs are typically used for supervised learning tasks, such as classification and regression.

Ivakhnenko is often considered as the father of **deep learning**.



# Chess (1997): Kasparov vs. IBM Deep Blue



(Left) Copyright 2007, S.M.S.I., Inc. - Owen Williams, The Kasparov Agency, via Wikimedia Commons (Right) By James the photographer, via Wikimedia Commons

**Powerful search algorithms!**



## 2009



**2014:** Facebook creates its AI research division, and Google acquires DeepMind, an AI company that later develops the AlphaGo system that beats the world champion in the game of Go.

**2016:** Google's AlphaGo defeats world champion Lee Sedol in a five-game match.

**2018:** The development of deep learning algorithms for natural language processing leads to significant improvements in machine translation and other language-based AI applications.



against the legendary Lee Seokol

Colin Bates (c.bates@cam.ac.uk) is a Lecturer in the Department of Psychology, University of Cambridge, 184A, 185A, 187, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998,



Google will buy London-based artificial-intelligence company DeepMind. The information reports that the acquisition price was more than \$500 million, and that Facebook was once in talks to buy the startup late last year. DeepMind confirmed the acquisition to us, but wouldn't elaborate what terms.

<https://techcrunch.com/2014/01/26/google-deadming/>

- The **emergence of intelligent agents** like in the **Year 1997: IBM Deep Blue** beats world chess champion, Gary Kasparov, and became the first computer to beat a world chess champion.
- **Year 2002:** for the first time, AI entered the home in the form of **Roomba, a vacuum cleaner.**
- **Year 2006:** AI came in the Business world. Companies like Facebook, Twitter, and Netflix also started using AI.
- **Year 2011: IBM's Watson won jeopardy,** Google now, Chatbot "Eugene Goostman" won a competition in the famous "Turing test." etc.
- Year 2017: **Google Brain** introduced **Transformers** in NLP to process text.

# GPT stands for Generative Pre-training Transformer.

## 2015-2022 - Open API & ChatGPT3

### Large Language Model

Transformers to LLMs

2015: OpenAI is founded by a group of entrepreneurs - Elon Musk, Sam Altman, Reid Hoffman etc - they pledged \$1Billion

2017: OpenAI releases GPT-1

2018: OpenAI releases GPT-2

2019: Microsoft backed OpenAI with \$1Billion

2020: OpenAI releases a new version of GPT-3

2020: OpenAI releases a tool known as DALL-E

2021: OpenAI announces plans to develop and release GPT-3 under an open-source license.

2022: OpenAI releases GPT-3 Prime

115M  
GPT1

1.5B  
GPT2

175B  
GPT3

~ In Trillion  
GPT-4

#### Significance of Number of Params

These are tuneable variables that the model has learned during the training process.

More params means more flexibility in the model's ability to generate diverse and coherent text output.

# The State of art

- **Robotic Vehicles**

## STANLEY's Achievement:

- **In 2005, STANLEY, a driverless robotic car**, completed the DARPA Grand Challenge, traveling 132 miles through the Mojave Desert at 22 mph.
- STANLEY is a Volkswagen Touareg equipped with cameras, radar, and laser rangefinders for environmental sensing, along with onboard software for steering, braking, and acceleration control.

## CMU's Boss: (Carnegie Mellon University)

- **In 2006, robotic vehicle, Boss, won the Urban Challenge.** Boss successfully navigated through traffic in a closed Air Force base, adhering to traffic rules and avoiding pedestrians and other vehicles.
- **Machine Translation:** A computer program automatically **translates from Arabic to English.**
- **Speech Recognition : United Airlines** used a automated speech recognition and dialog management system to book flights.

# The State of art

- **Autonomous Planning and Scheduling**
  - **NASA's Remote Agent program** was the first onboard autonomous planning system, **controlling spacecraft operations** a hundred million miles from Earth.
  - The successor to the Remote Agent program, **MAPGEN**, is responsible for **planning daily operations for NASA's Mars Exploration Rovers**.
  - **MEXAR2 conducted mission planning** for the European Space Agency's Mars Express mission in 2008, **encompassing both logistics and scientific planning**
- **Game Playing**
  - **IBM's Deep Blue** was the first computer program to **defeat a world chess champion**, Garry Kasparov, in an exhibition match.
  - Newsweek referred to the match as "The brain's last stand," reflecting the significance of this event in the context of human versus machine intelligence. IBM's stock value increased by \$18 billion.



- **Spam Fighting**
  - **Learning algorithms classify over a billion messages daily as spam**, significantly reducing the time recipients spend deleting unwanted emails.
  - Spammers continuously update their tactics, making it challenging for static programmed approaches to effectively combat spam.
- **Logistics planning:**
  - During the Persian Gulf crisis of 1991, **U.S. forces deployed a Dynamic Analysis and Replanning Tool, DART** (Cross and Walker, 1994), to do automated logistics planning and scheduling for transportation.
  - This involved up to 50,000 vehicles, cargo, and people at a time, and had to account for starting points, destinations. routes, and conflict resolution among all parameters. The AI planning techniques generated in hours a plan that would have taken weeks with older methods.
- **Robotics:**
  - **The iRobot Corporation has sold over two million Roomba robotic vacuum cleaners** for home use.
  - **PackBot**, where it is used **to handle hazardous materials**, clear explosives, and **identify the location of snipers.** (For Iraq and Afghanistan)

# State-of-the-art applications

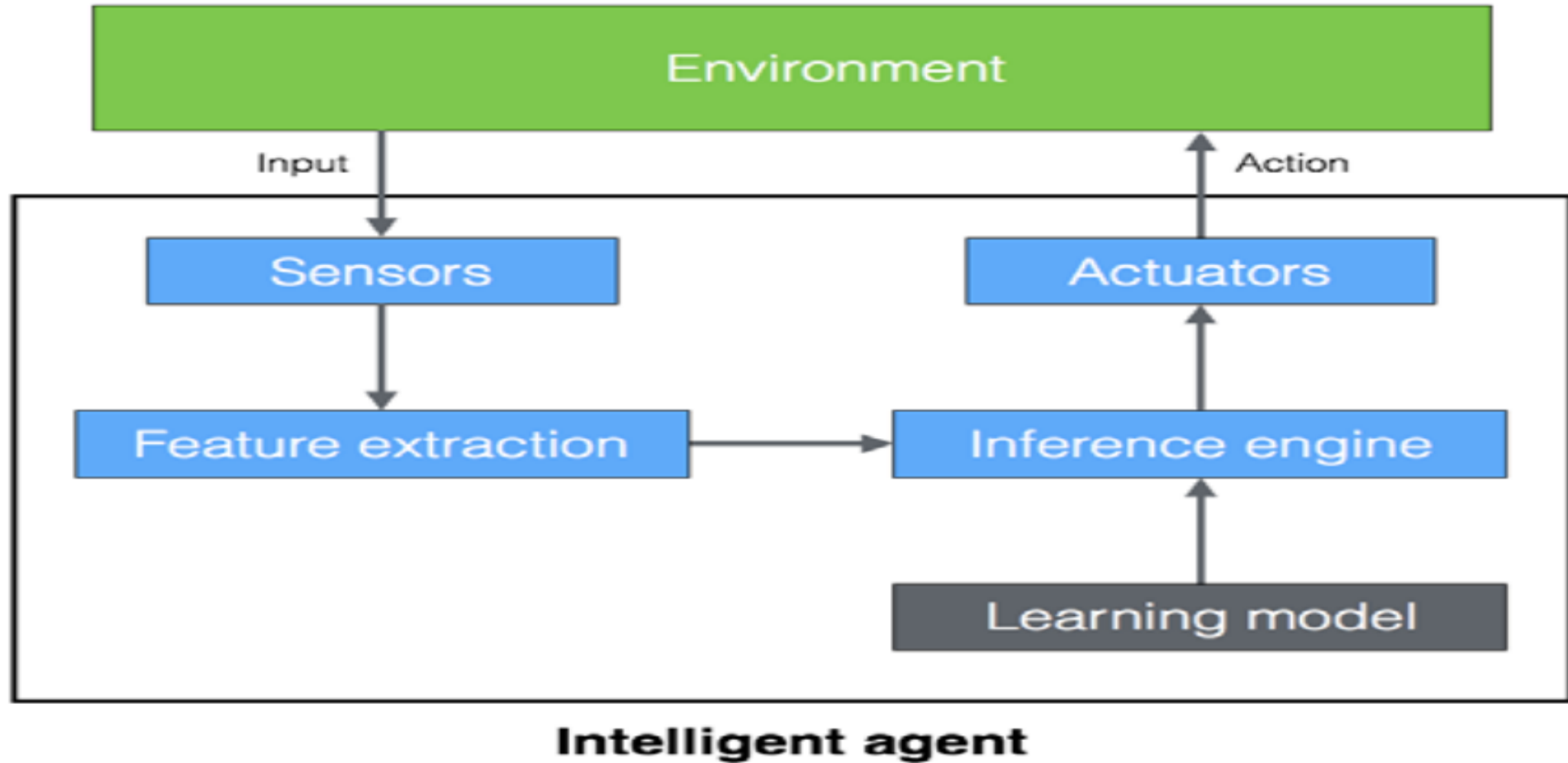
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- Speech recognition
- Autonomous planning and scheduling
- Financial forecasting
- Game playing, video games
- Spam fighting
- Logistics planning
- Robotics (household, surgery, navigation)
- Machine translation
- Information extraction
- VLSI layout
- Automatic assembly
- Sentiment analysis
- Fraud detection
- Recommendation systems
- Web search engines
- Autonomous cars
- Energy optimization
- Question answering systems
- Social network analysis
- Medical diagnosis, imaging
- Route finding
- Traveling salesperson
- Protein design
- Document summarization
- Transportation/scheduling
- Computer animation

1. Rational intelligent agents
2. Search agents (uninformed search, informed search)
3. Adversarial search/games
4. Machine Learning (ML)
5. Constraint satisfaction problems (CSPs)
6. Logic (propositional logic, first order logic)
7. Markov Decision Processes (MDPs) and Reinforcement Learning (RL)
8. Application to Natural language Processing (NLP)
9. Application to vision and robotics

An artificial intelligence (AI) agent refers to a system or program that is capable of autonomously performing tasks on behalf of a user

# Agent



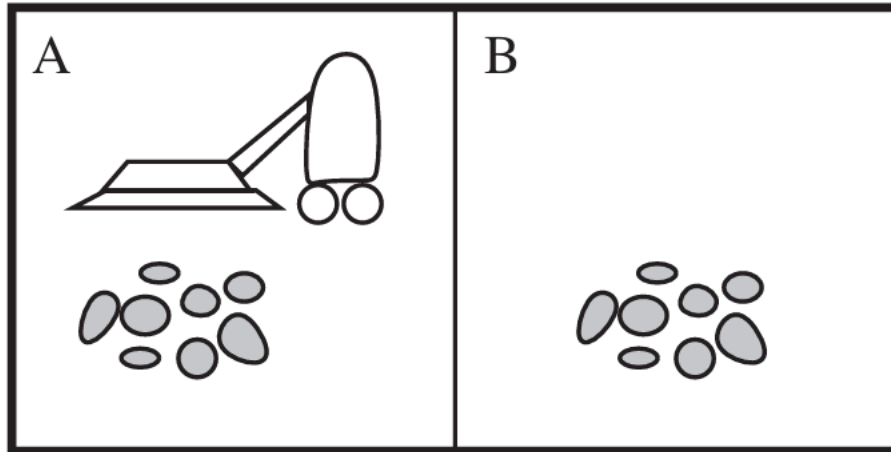
# Agents and Environments

- An **agent** is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators.
- **Percept**: agent's perceptual inputs at any given instant.
- **Percept Sequence**: complete history of everything the agent has ever perceived.
- An agent's choice of action at any given instant can depend on its built-in knowledge and on the entire percept sequence observed to date, but not on anything it hasn't perceived.
- **Agent's behavior**: is described by the agent function.
- **Agent function**: is an abstract mathematical description
- **Agent program**: is a concrete implementation, running within some physical system.



## Example: Vacuum-cleaner world

- Perception: Clean or Dirty? where it is in?
- Actions: Move left, Move right, suck, do nothing



Percept Sequence	Action
[A, Clean]	Right
[A, Dirty]	Suck
[B, Clean]	Left
[B, Dirty]	Suck
[A, Clean], [A, Clean]	Right
[A, Clean], [A, Dirty]	Suck
...	.....

**Agent = architecture + program**

Architecture :device with sensors and actuators  
(e.g., A robotic car, a camera, a PC)

# Good Behavior: The concept of Rationality

- A **rational agent** is **one that does the right thing**—conceptually speaking, every entry in the table for the agent function is filled out correctly.
- **Need of performance measure:** A performance measure is an objective criterion for **success of an agent's behavior**.
- **Example:** Performance measure of a vacuum cleaner agent could be amount of dirt cleaned up, amount of time taken, amount of electricity consumed, amount of noise generated, etc.

## Rationality:

- The **performance measure** that **defines degree of success**. (no. of squares it has taken for clean-up)
- Everything that the agent has perceived so far. We will call this complete perceptual history the percept sequence.
- What the agent knows about the environment. (Priori(Unknown Location))
- The actions that the agent can perform. (Left, Right, and Suck)

- **Rationality** is about making the best decisions possible given the agent's current information and capabilities.
- **Omniscience** means having unlimited, all-knowing intelligence and awareness.
- Rational agent not only to gather information but also to **learn** as much as possible from what it perceives.
- To the extent that an agent relies on the prior knowledge of its designer rather than on its own percepts, we say that the agent lacks **autonomy**.
- A rational agent should be **autonomous**—it should learn what it can to compensate for partial or incorrect prior knowledge.

# The Nature of Environments

- **Task environments**, which are essentially the “**problems**” to which **rational agents** are the “**solutions**.”
- For an agent (Vacuum cleaner), we had to specify the performance measure, the environment, and the agent’s actuators and sensors. This is called **Task environment**.
- Acronymically, we call this the **PEAS (Performance, Environment, Actuators, Sensors)**

Agent Type	Performance Measure	Environment	Actuators	Sensors
Taxi driver	Safe, fast, legal, comfortable trip, maximize profits	Roads, other traffic, pedestrians, customers	Steering, accelerator, brake, signal, horn, display	Cameras, sonar, speedometer, GPS, odometer, accelerometer, engine sensors, keyboard

**Figure 2.4** PEAS description of the task environment for an automated taxi.



Agent Type	Performance Measure	Environment	Actuators	Sensors
Medical diagnosis system	Healthy patient, reduced costs	Patient, hospital, staff	Display of questions, tests, diagnoses, treatments, referrals	Keyboard entry of symptoms, findings, patient's answers
Satellite image analysis system	Correct image categorization	Downlink from orbiting satellite	Display of scene categorization	Color pixel arrays
Part-picking robot	Percentage of parts in correct bins	Conveyor belt with parts; bins	Jointed arm and hand	Camera, joint angle sensors
Refinery controller	Purity, yield, safety	Refinery, operators	Valves, pumps, heaters, displays	Temperature, pressure, chemical sensors
Interactive English tutor	Student's score on test	Set of students, testing agency	Display of exercises, suggestions, corrections	Keyboard entry

**More examples of agent types and their PEAS descriptions**

**Softbots: Software-based Intelligent Agents**, are a type of artificial agent that exists and operates solely in a digital, software-based environment.

### Properties of task environments:

- **Fully observable vs. partially observable:** If an agent's sensors give it access to the complete state of the environment, unobservable sometimes. (Chess Vs Poker)
- **Single agent vs. multiagent:** Single agent operates independently, multiagent involves multiple autonomous agents interacting with each other. (crossword puzzle vs chess)
- **Deterministic vs. stochastic:** if the next state is completely determined by the current state and the agent's action, stochastic if the next state is determined probabilistically. (Tic-tac-toe vs. Weather forecasting)
- **Episodic vs. sequential:** if the agent's experience is divided into discrete, independent episodes, sequential if the agent's experience is a continual sequence of states, actions. (Medical diagnosis vs. Robot navigating a maze)

- **Static vs. dynamic:** if the environment does not change while the agent is deliberating, dynamic if the environment changes independently of the agent. (Pieces puzzle solving Vs. Online shopping)
- **Discrete vs. continuous:** The environment has a finite no.of distinct states and actions, continuous has infinite no.of distinct states and actions (Chess vs taxi driving)
- **Known vs. unknown:** The agent has complete knowledge of the environment, including the possible states, actions, transition model, and reward function. Otherwise, unknown. (Monopoly Vs. Self driving car navigating in new city)

- It is quite possible for a known environment to be partially observable—for example, in solitaire card games, I know the rules but am still unable to see the cards that have not yet been turned over.
- Conversely, an unknown environment can be fully observable—in a new video game, the screen may show the entire game state but I still don't know what the buttons do until I try them.

Task Environment	Observable	Agents	Deterministic	Episodic	Static	Discrete
Crossword puzzle	Fully	Single	Deterministic	Sequential	Static	Discrete
Chess with a clock	Fully	Multi	Deterministic	Sequential	Semi	Discrete
Poker	Partially	Multi	Stochastic	Sequential	Static	Discrete
Backgammon	Fully	Multi	Stochastic	Sequential	Static	Discrete
Taxi driving	Partially	Multi	Stochastic	Sequential	Dynamic	Continuous
Medical diagnosis	Partially	Single	Stochastic	Sequential	Dynamic	Continuous
Image analysis	Fully	Single	Deterministic	Episodic	Semi	Continuous
Part-picking robot	Partially	Single	Stochastic	Episodic	Dynamic	Continuous
Refinery controller	Partially	Single	Stochastic	Sequential	Dynamic	Continuous
Interactive English tutor	Partially	Multi	Stochastic	Sequential	Dynamic	Discrete

**Figure 2.6** Examples of task environments and their characteristics.



# Structure of Agents

- The job of AI is to design an agent program that implements the **agent function**.
- **Agent program** is an implementation of an agent function.
- An **Agent function** is a map from the percept sequence(history of all that an agent has perceived till date) to an action.  $a = F(p)$
- **Agent = architecture + program**
- **Architecture:** A device with sensors and actuators (e.g., A robotic car, a camera, a PC)

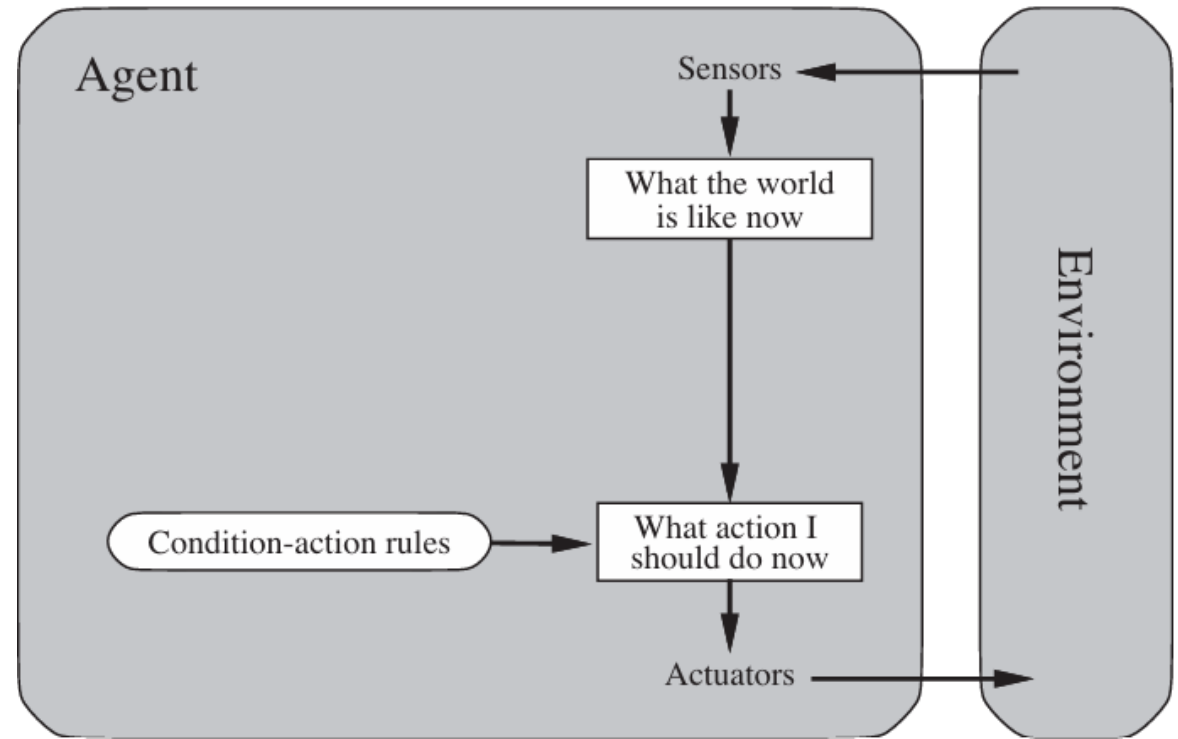
# Types of agents

Agents can be grouped into four classes based on their degree of perceived intelligence and capability :

1. **Simple Reflex Agents** (select actions based solely on the current percept)
2. **Model-Based Reflex Agents** (maintain an internal state to handle partially observable environments)
3. **Goal-Based Agents** (make decisions to minimize the distance from a defined goal)
4. **Utility-Based Agents** (optimize actions to maximize satisfaction or utility)
5. **Learning Agents** (improve over time by learning from past experiences)
6. **Problem Solving Agents** (use algorithms and search strategies to find solutions to specific problems)

# 1. Simple reflex Agents

- Simple reflex agents ignore the rest of the percept history and act only on the basis of the **current percept**.
- The agent function is based on the **condition-action rule**.
- If the condition is true, then the action is taken, else not.
- This agent function only **succeeds** when the environment is **fully observable**.
- The Simple reflex agent does not consider any part of percepts history during their decision and action process.



Ex: Turning on AC if temp is greater than 45 degrees.

**function** SIMPLE-REFLEX-AGENT(*percept*) **returns** an action  
**persistent:** *rules*, a set of condition–action rules

*state*  $\leftarrow$  INTERPRET-INPUT(*percept*)  
*rule*  $\leftarrow$  RULE-MATCH(*state*, *rules*)  
*action*  $\leftarrow$  *rule*.ACTION  
**return** *action*

**A simple reflex agent.** It acts according to a rule whose condition matches the current state, as defined by the percept.

**function** REFLEX-VACUUM-AGENT(*[location, status]*) **returns** an action

**if** *status* = *Dirty* **then return** *Suck*  
**else if** *location* = *A* **then return** *Right*  
**else if** *location* = *B* **then return** *Left*

Percepts : Dirty, Clean

**Example:** A basic thermostat that turns the heating system on or off based solely on the current temperature reading, following a simple rule (e.g., if the temperature is below a certain threshold, turn on the heat).

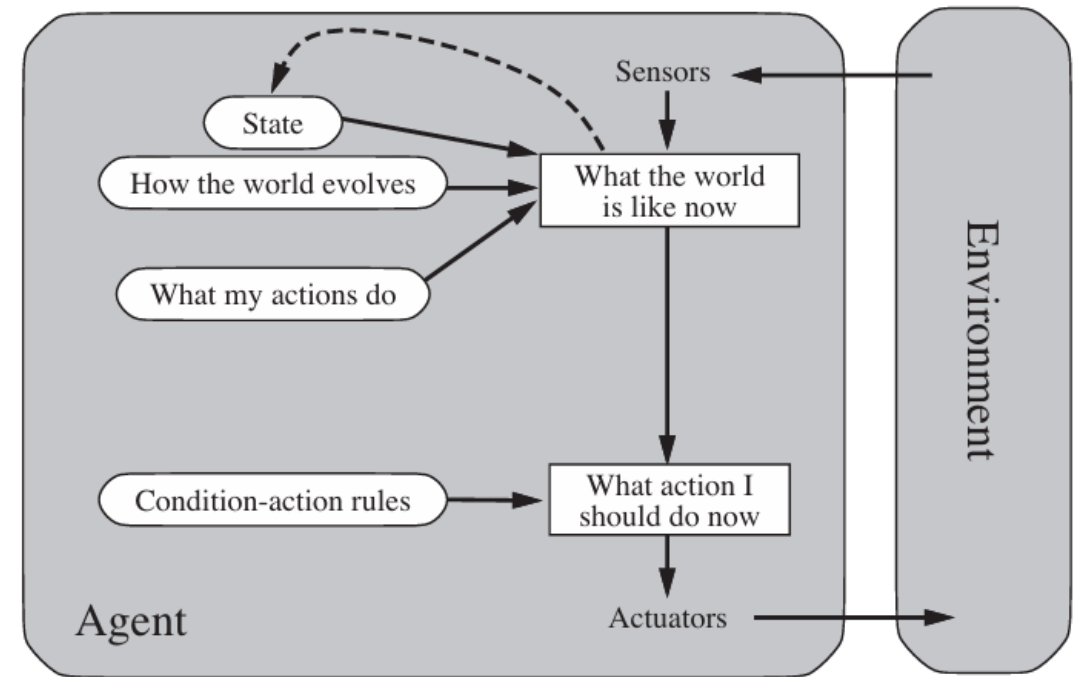


## 2. Model-based reflex Agents

- The Model-based agent can work in a **partially observable environment**, and track the part of the world it can't see now.
- **Internal State:** It is a representation of the current state based on percept history.
- **Model:** It is knowledge about "how things happen in the world," so it is called a Model-based agent.
- These agents have the model, "which is knowledge of the world" and based on the model they perform actions.

**Updating the agent state requires information about:**

- How the world evolves
- How the agent's action affects the world.



**function** MODEL-BASED-REFLEX-AGENT(*percept*) **returns** an action

**persistent:** *state*, the agent's current conception of the world state

*model*, a description of how the next state depends on current state and action

*rules*, a set of condition–action rules

*action*, the most recent action, initially none

*state*  $\leftarrow$  UPDATE-STATE(*state*, *action*, *percept*, *model*)

*rule*  $\leftarrow$  RULE-MATCH(*state*, *rules*)

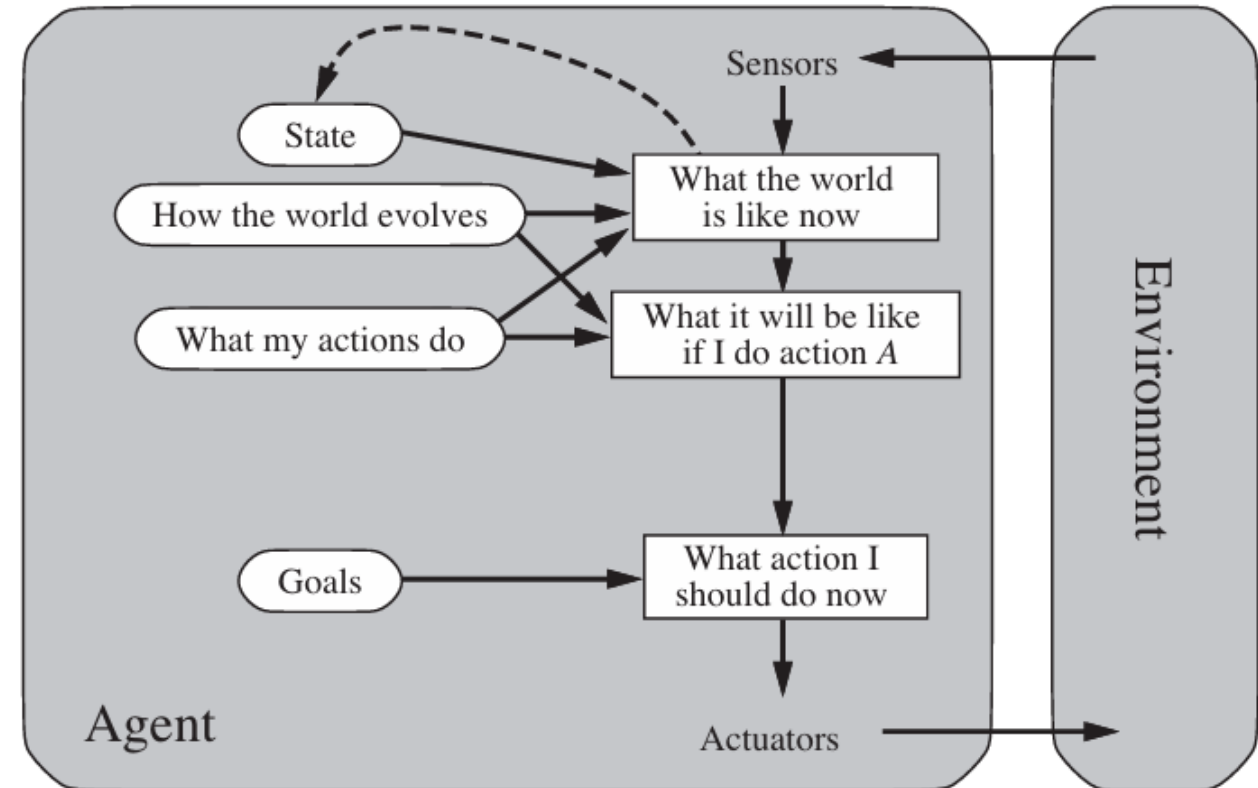
*action*  $\leftarrow$  *rule*.ACTION

**return** *action*

An automated vacuum cleaner that keeps track of the areas it has already cleaned (internal state) and adjusts its cleaning path based on previously mapped areas to ensure complete coverage of a room.

# 3.Goal-based Agents

- A **goal-based agent** has an agenda.
- It operates based on a goal in front of it and makes decisions based on how best to reach that goal.
- A goal-based agent operates as a **search and planning** function, meaning it targets the goal ahead and finds the right action in order to reach it.
- It makes an agent proactive.
- These agents may have to consider a long sequence of possible actions before deciding whether the goal is achieved or not.
- **Example: Travel route to destination (Google Maps)**

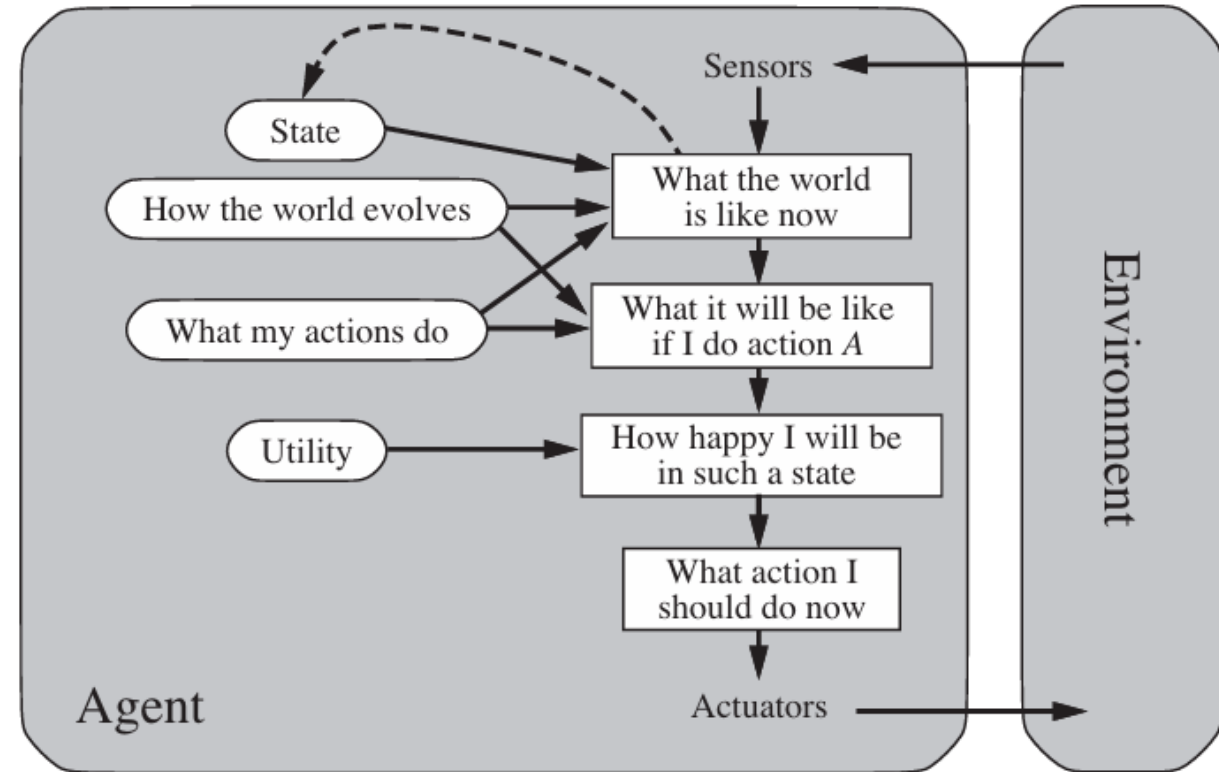


# Goal Based agent(Ex: Gplus robot At Alibaba)



# 4. Utility-based Agents

- A utility-based agent is an agent that acts based not only on what the goal is, but the best way to reach that goal.
- The Utility-based agent is useful when there are multiple possible alternatives, and an agent has to choose in order to perform the best action.
- The term utility can be used to describe how "happy" the agent is.
- The utility function maps each state to a real number to check how efficiently each action achieves the goals.

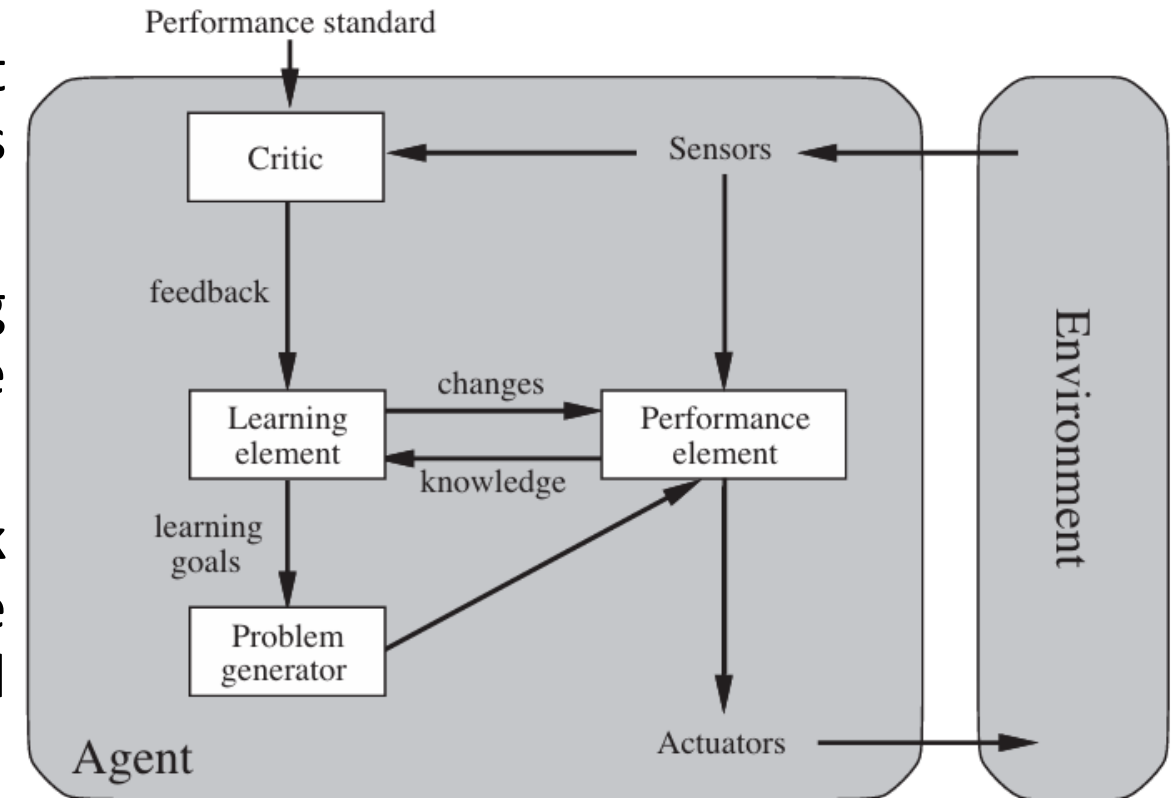


**Example: re-routing a GPS**



# 5. Learning Agents

- A learning agent in AI is the type of agent that **can learn from its past experiences** or it has learning capabilities.
- **Learning element:** It is responsible for making **improvements** by learning from the environment.
- **Critic:** The learning element takes **feedback** from critics which describes how well the agent is doing with respect to a fixed performance standard.
- **Performance element:** It is responsible for selecting external **action**
- **Problem Generator:** This component is responsible for **suggesting actions** that will lead to new and informative experiences.



**Ex: A recommendation system on streaming platforms (like Netflix)**