Timeline of AI

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1 The winters and summers of AI

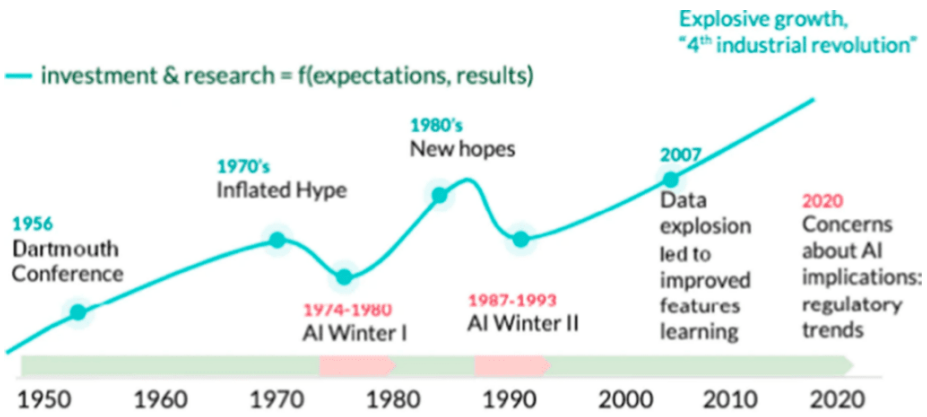

Figure 1: Timeline of AI

The Dartmouth workshop, 1956 The Dartmouth workshop in 1956 is often considered the start of modern AI research. Of course, the idea of human created consciousness or smart artifacts or robots is older than that; i.e. the Turing Test is from 1936, or the story of Talos from mythology. The workshop took place at Dartmouth College in Hanover, New Hampshire, United States. Among the attendees were: John McCarthy (organizer), Marvin Minsky, Nathaniel Rochester, and Claude Shannon (proposed workshop, father of information age); and other attendees. The workshop lasted six to eight weeks and can be understood as a long brainstorming session, in total 20 people attended but not all attended for the full duration of the workshop.

McCarthy: "We will concentrate on the problem of devising a way of programming a calculator to form concepts and to form generalizations. This of course is subject to change when the group gets together."

> *The Proposal states:* We propose that a 2-month, 10-man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer.

Before the workshop people spoke about different names when referring to AI research: Thinking Machines, Cybernetics, Automata Theory, and Complex Information Processing. Afterwards, people started calling it "Artificial Intelligence".

> **See:** "https://en.wikipedia.org/wiki/Dartmouth_workshop"

Inflated Hype, 1965 - 1974

- Reasoning as Search: Algorithms that solve problems in a step by step way. Giving the analogy of reasoning as searching through a maze.
- Neural Networks: McCulloch and Pitts paper (1944) leads to the perceptron (1957-1962) which develops into early neural networks.
- Natural Language: Language is important for an AI to communicate. In this time semantic nets were developed which formalize the language around classification i.e. "bird" "is-a" "animal".
- Micro-Worlds: Inspired by science researchers make micro-worlds where circumstances are controlled. These are then used to test an AI system on a set of tasks.
- Automata: First full-scale "intelligent" humanoid robot build in japan called WABOT. It has a limb control system that allows it to walk with its limbs, but also grab and transport items. Also it was able to communicate.

AI Winter 1, 1974 - 1980 With AI winter is meant the end of funding. In this time the funding for AI diminished due to lack of progress. Mostly development ran into multiple problems:

- **Limited computer power**: Limits on memory and processing speed limit the results and usefullness of AI systems.
- **Intractability and the combinatorial explosion**: When systems were tested on "simple" settings they were able to solve them. But researchers

found out that scaling up these tests to real world settings lead to unacceptable increases in complexity and therefore computation time.

- **Common-sense knowledge and reasoning**: Researchers discover the need for Big-Data to solve problems like vision and natural language.
- **Moravec's paradox**: Solving mathematics problems is easy for computers but recognizing faces is very difficult.
- **The frame and qualification problems**: Boundaries of logic were reached, this lead to creation of new logics like: non-monotonic logics and modal logics.

New Hopes, 1980 - 1987 Expert systems! Today also referred to as GOFAI short for Good Old Fashioned AI. Which is the programming of the knowledge of an expert into a software system. Languages like XML lend themselves well for this. A simple example can be understood as a flow chart where there are choice points which are questions and each multiple choice answer leads to a new question. This eventually leads to a classification based on the expert knowledge formalized in the system. These systems also lead to new funding.

Revival of neural networks/Connectionism through the Hopfield networks and also backpropagation was developed by Geoffrey Hinton and David Rumelhart. These allow the conitnuation of exploring artificial neural networks.

AI Winter 2, 1987 - 1993 Budget cuts occurred mostly due to not met expectations.

Researchers developed the idea of embodied reasoning, meaning the machine needs to be in a body and in the environment in order for it to have a chance at showing intelligence.

Agent Paradigm, 1993-2007 During this period, the agent centred paradigm took off and AI research was more about what an agent is and how to formalize it, but also interaction of groups of agents was studied.

Furthermore in this period, research in probabilistic reasoning increased, for example research on causality and decision theory using probabilities.

Also better algorithms were developed, for example in search engines.

Data Explosion, 2007 - 2018 This period is highlighted with the arrival of big data, i.e. the ability to store large amounts of data and the availability of large amounts of data due to increased online activity. This together with increasing computational power lead to the successes of Machine Learning/Deep Learning. Today, most notably ChatGPT, is the prime example of this.

AI-Act, 2018 - 2023 Due to increased improvements of AI systems, the EU started developing the AI-Act. The development of the AI-Act however was over-taken by developments and ChatGPT was released before regulations were in place. The question remains: "How to regulate AI?"

2 Pillars of AI

As the previous section shows the AI research develops along multiple categories. Often what the categories that are distinguished are:

- Input, perception, language
- Knowledge representation and reasoning
- Learning, adaptivity
- Interaction, human-computer or human-robot
- Legal, social and ethical context
- The interaction of these elements.

Here learning does not necessarily equate to what we now call machine learning. Learning here means the ability of intelligent beings to learn, unlearn and refine skills. This is not necessarily the same as what we know as the approach machine learning, one could call it m-learning.

3 Symbolic Sub-Symbolic Dichotomy

A last point that is found in AI research is a supposed dichotomy between symbolic and connectionist approaches. Many researchers that do work on connectionist approaches believe that connectionism is the way forward maybe even towards Artificial General Intelligence. While many researchers that work on symbolic approaches tend to believe that the symoblic method is the way to this goal. This results in some friction between the approaches that can be perceived when working in the area. There are also many other researchers, probably most, that have a more mixed perception of this. Either they do not see a strict distinction or they think a hybrid approach is optimal.

References

[1] John McCarthy. Programs with common sense, 1959.

[2] P Russel Norvig and S Artificial Intelligence. A modern approach. *Prentice Hall Upper Saddle River, NJ, USA: Rani, M., Nayak, R., & Vyas, OP (2015). An ontology-based adaptive personalized e-learning system, assisted by software agents on cloud storage. Knowledge-Based Systems*, 90:33–48, 2002.