

**LECTURER: Nghia Duong-Trung**

# **ARTIFICIAL INTELLIGENCE**

## WHO I AM

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- Current Employer: The German Research Center for Artificial Intelligence (DFKI GmbH)
  - Senior Researcher/Project Lead
- Current Employer: IU International University of Applied Sciences
  - Academic Teacher
- PostDoc (2020-2022) in Machine Learning at Technische Universität Berlin, Germany
- PhD (2014-2017) in Machine Learning at The Information Systems and Machine Learning Lab (ISMLL), University of Hildesheim, Germany
- MSc (2009-2011) in Software Engineering at Heilbronn University, Germany
- Profile: <https://sites.google.com/isml.de/duongtrungnghia/>

## INTRODUCTION TO ARTIFICIAL INTELLIGENCE\_DLBDSEAIS01

- Course book: Artificial Intelligence\_DLBDSEAIS01, provided by IU, myStudies
- Reading list provided by IU, myStudies
- The amount of slides content is based on the course book.
- Additional teaching materials:

<https://github.com/duongtrung/IU-ArtificialIntelligenceCourse>

## TOPIC OUTLINE

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**History of AI**

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**Modern AI Systems**

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**Reinforcement Learning**

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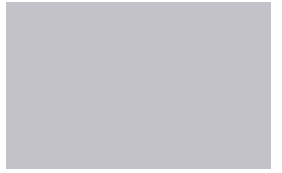
**Natural Language Processing – Part 1**

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**Natural Language Processing – Part 2**

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**Computer Vision**



UNIT 1

# HISTORY OF AI

## STUDY GOALS

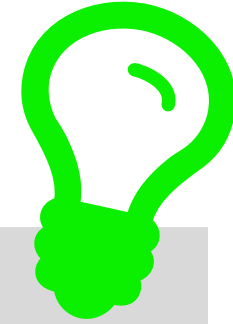


- What is Artificial Intelligence (AI)?
- Developments of AI as a scientific discipline
- The AI winters
- Basics of expert systems
- Advances of AI



1. How did AI develop as a scientific discipline?
2. What are the main reasons for AI winters?
3. How does an expert system work?
4. What does the Gartner hype cycle curve reflect?

## WHAT IS ARTIFICIAL INTELLIGENCE?



“The science and engineering  
of making intelligent machines,  
especially intelligent computer programs.”



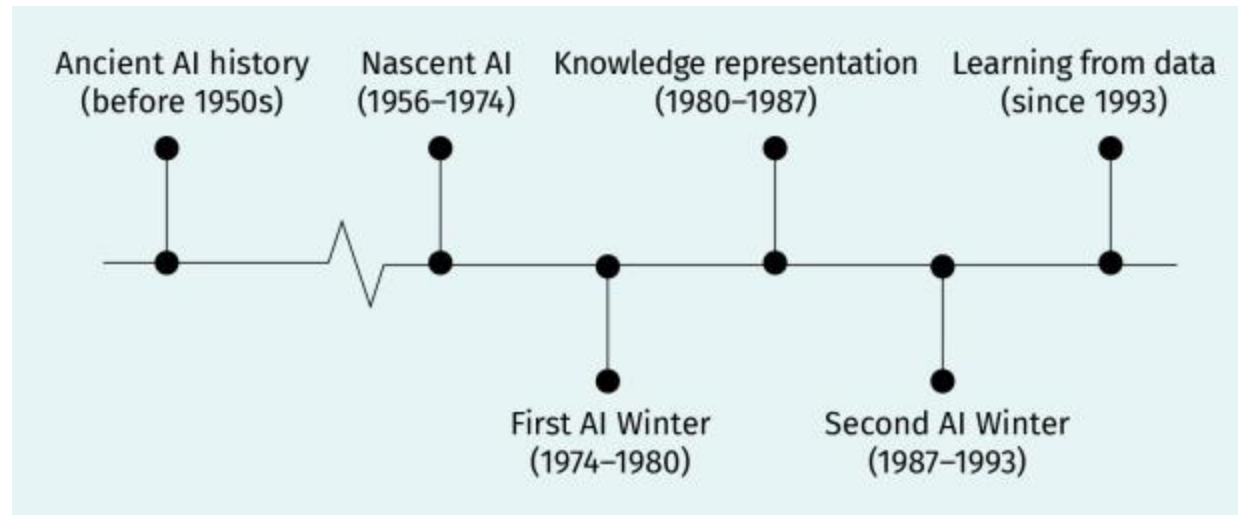
## WHAT IS ARTIFICIAL INTELLIGENCE?

The two words *artificial* and *intelligence* were first put together on August 31, 1955, when professor John McCarthy from Dartmouth College, together with M.L Minsky from Harvard University, N. Rochester from IBM, and C. E. Shannon from Bell Telephone Laboratories, asked the Rockefeller Foundation to fund a summer of research on artificial intelligence

“*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. . . . 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.*”

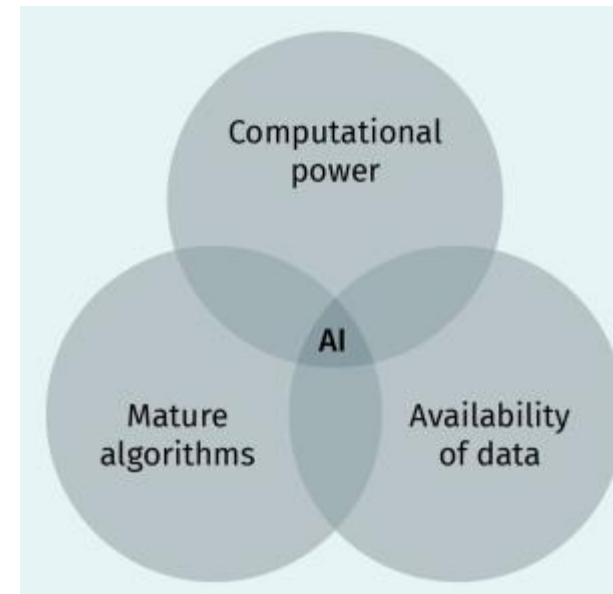
## HISTORICAL DEVELOPMENT OF AI

- Historical views of artificial intelligence often start in the 1950s when it was first applied in computer science
- The first considerations about AI range back to 350 BCE
  - Aristotle, Greek Philosopher (384–322 BCE)
  - Leonardo da Vinci, Italian Polymath (1452–1519)
  - René Descartes, French Philosopher (1596–1650)
  - Thomas Hobbes, British Philosopher (1588–1679)
  - David Hume, Scottish Philosopher (1711–1776)



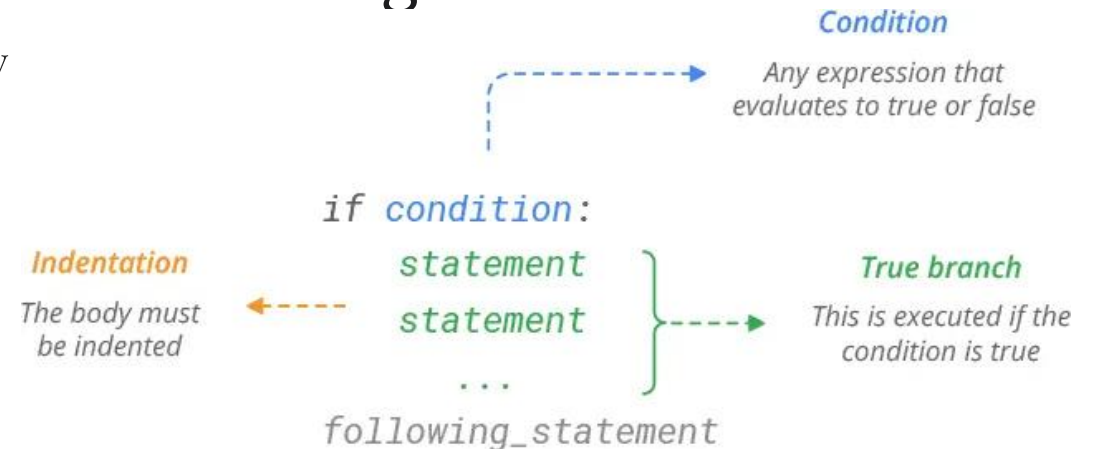
## AI WINTER

- It was coined by AI researchers to describe periods when interest, research activities, and funding of AI projects significantly decreased (Crevier, 1993)
- Downturns like this are usually based on exaggerated expectations towards the capabilities of new technologies that cannot be realistically met.
- The First AI Winter (1974–1980)
- The Second AI Winter (1987–1993)
- There are several conditions that can cause AI winters. The three most important requirements for the success of artificial intelligence are
  - algorithms and experience with them,
  - computing capacity, and
  - the availability of data.



## NARROW VS GENERAL AI

- **Narrow AI:**
  - Solving a single, well defined task
  - It can be broad (recognizing objects from pictures) or extremely specific (predicting which customers who bought product A are more likely to purchase product B as well)
- **General AI:**
  - Tackling every kind of task it's presented. This is similar to an extremely resourceful human, and you can think of it as the robot from The Terminator
  - still far away, researchers don't know when we'll finally get it.
- **The engine of the AI revolution: machine learning**
  - ML is the field of study that gives computers the ability learn without being explicitly programmed

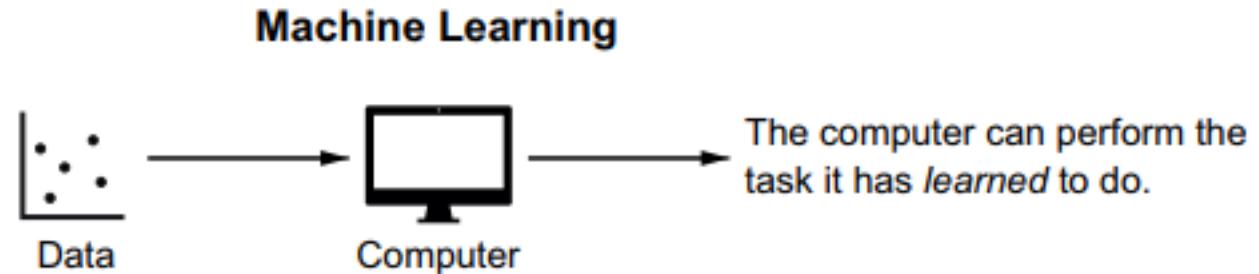
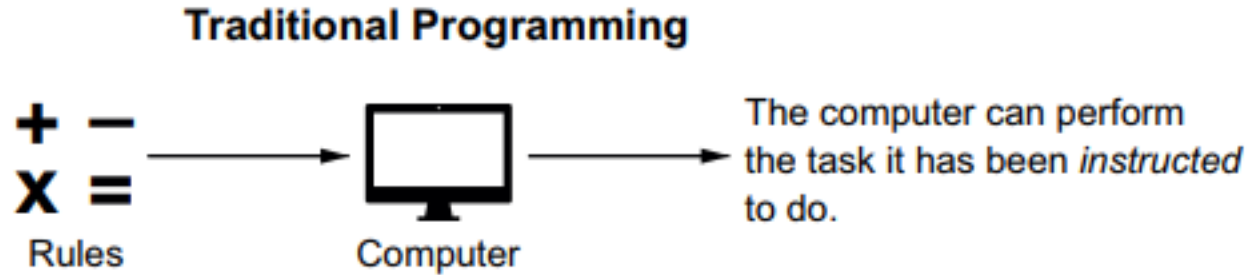


## WHAT IS MACHINE LEARNING?

- Explicitly programming a computer means defining the rules and instructions it must follow to perform a specific task
  - This is what software engineers do when they write software that handles your everyday tasks
- Unfortunately, things are not always explicit
  - Can you explain the process you make to recognize a cat vs a dog?
  - Can you list all the English grammar rules you apply as you talk?
  - If you can't precisely explain how you do something, there's no chance that you can instruct a computer to do it.

## WHAT IS MACHINE LEARNING?


- From rules to data
- ML couldn't possibly have Blossomed before the 2000s
  - Learning from data doesn't for free, and computers need Fast processors to perform This task
- Availability of data and cheap computing power created the perfect environment for ML to bloom



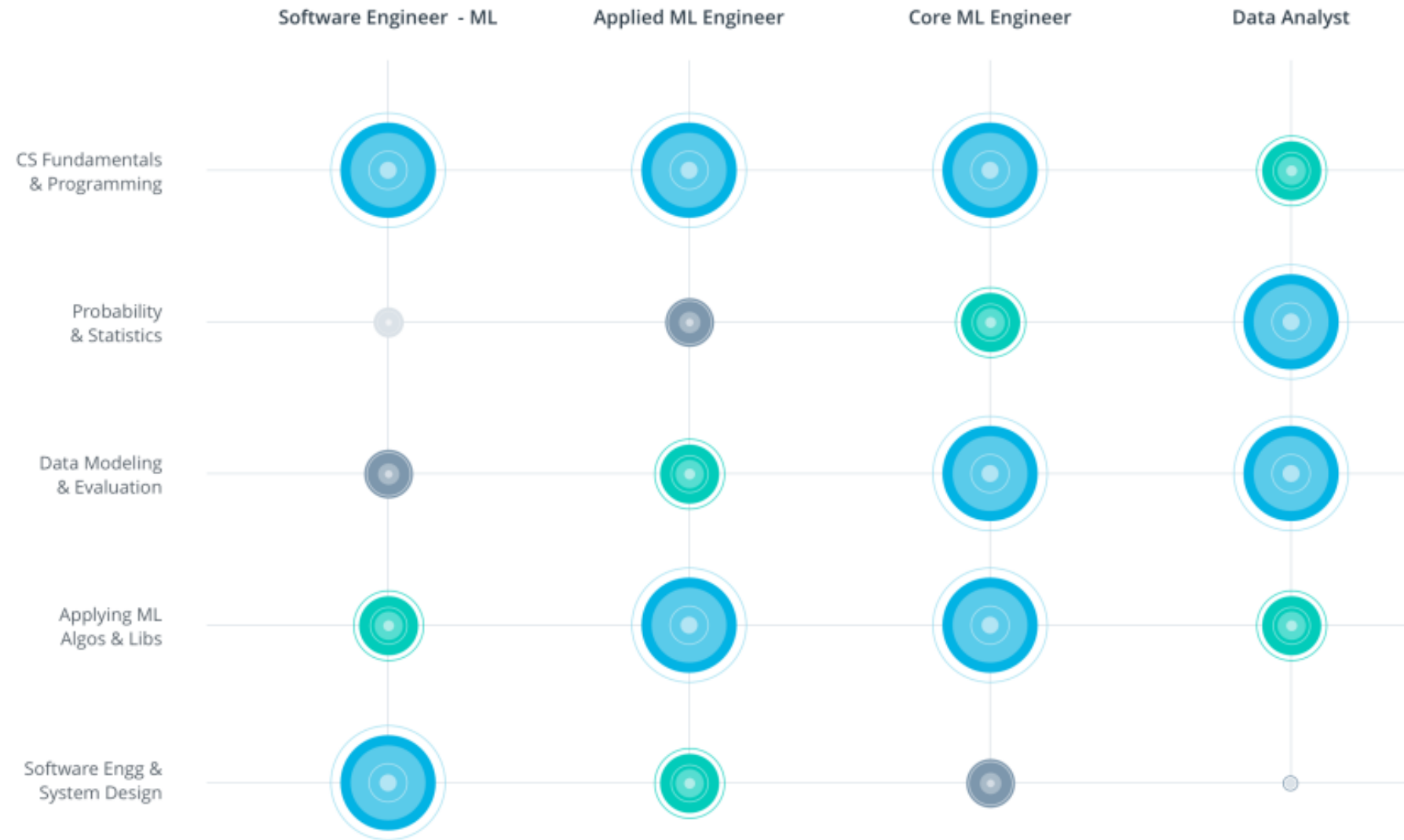
## WHAT IS ARTIFICIAL INTELLIGENCE, AFTER ALL?

- Software that solves a problem without explicit human instruction
- The definition focuses on the outcome of the technology rather than the specific techniques used to build it
- It's almost equivalent to what we said about ML?
  - Learning is an intelligent trait, while ML is just a tool. It is the tool behind 99% of the successful applications we happen to call AI today.

## THE MAIN DIFFERENCES BETWEEN AI AND DATA SCIENCE?

- Automates tasks or predicts future events based on data
  - Is commonly used “live”: it continuously elaborates news data and produces answers
  - It commonly has the form of software
- 
- Produces insights based on data
  - Is commonly “one-off”: it produces some insights that inform decisions
  - It commonly has the form of a presentation or report



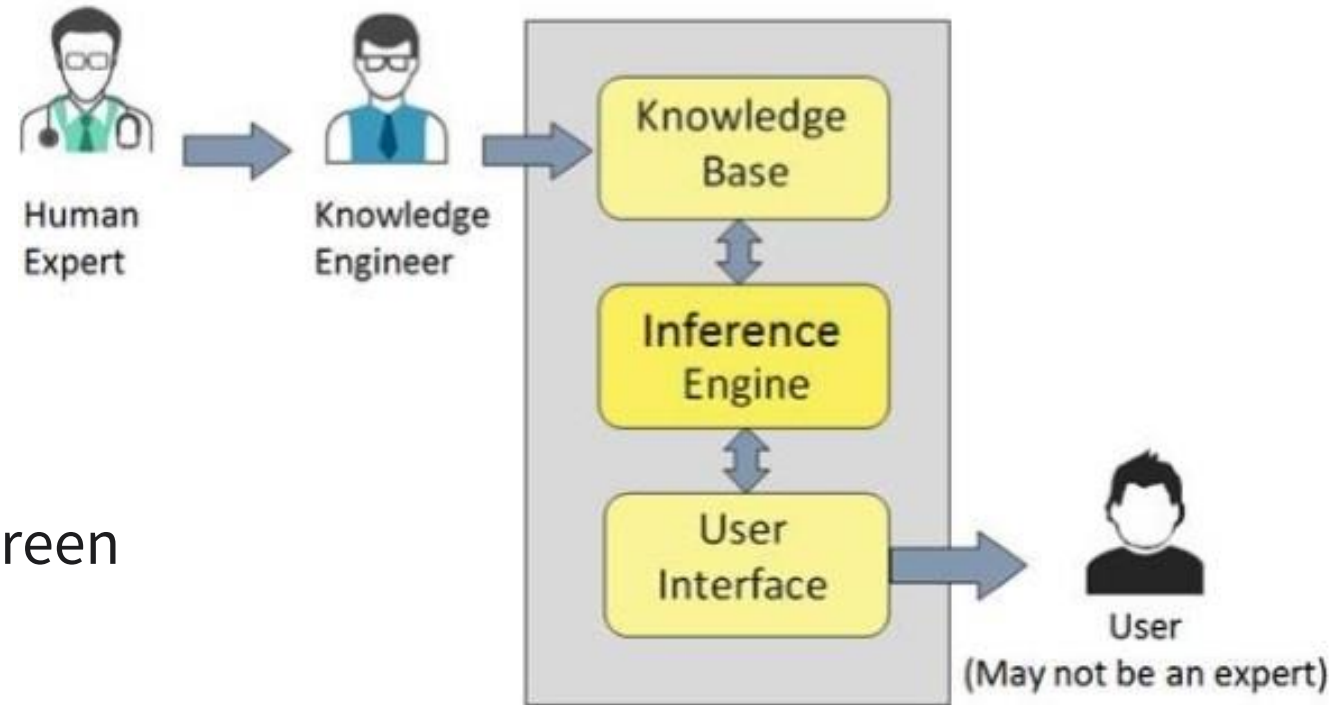


## DEFINITIONS OF EXPERT SYSTEMS

- An expert system is a computer system that simulates the decision-making ability of a human expert. Expert systems are designed to solve complex problems by reasoning about knowledge like an expert.
- Case-based systems store examples of concrete problems together with a successful solution
- Rule-based systems represent the knowledge base in the form of facts and if-A-then-Btype rules that describe relations between facts
- An expert system is a computer system that performs a task that would otherwise be performed by a human expert.

## BASIC COMPONENTS OF EXPERT SYSTEMS

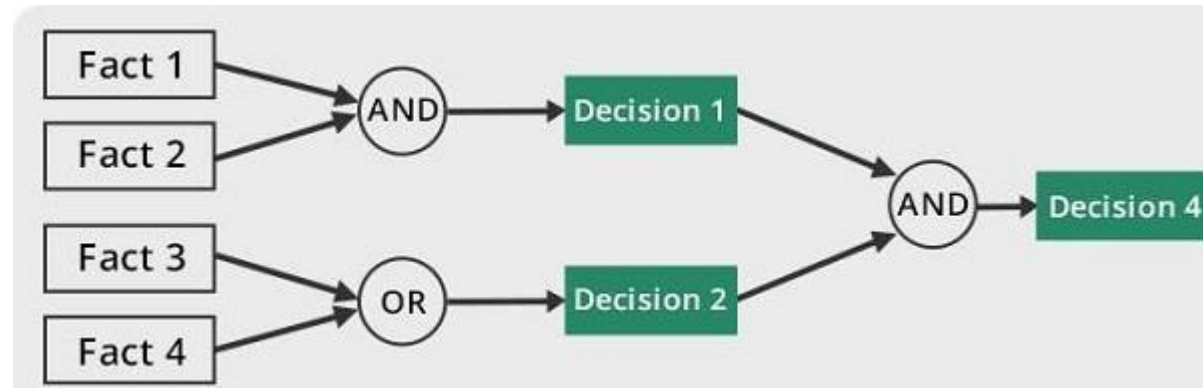
- Knowledge base
  - Data is collection of facts, experience
  - factual and heuristic knowledge
  - The form of IF-ELSE rules
- Inference engine
  - Forward and backward chaining
- User interface
  - Natural language displayed on the screen
  - Verbal narrations via speaker



## BASIC COMPONENTS OF EXPERT SYSTEMS

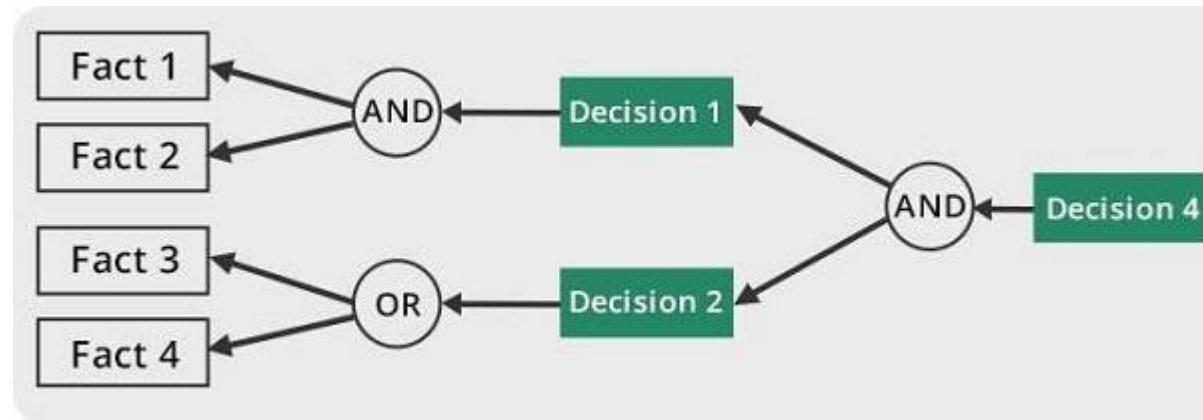
### - Forward chaining

- To answer the question „what can happen next?“
- Follows the chain of conditions, derivations and finally deduces the outcome



### - Backward chaining

- To answer the question „why this happened?“
- Finds out which conditions could have happened in the past for the current result

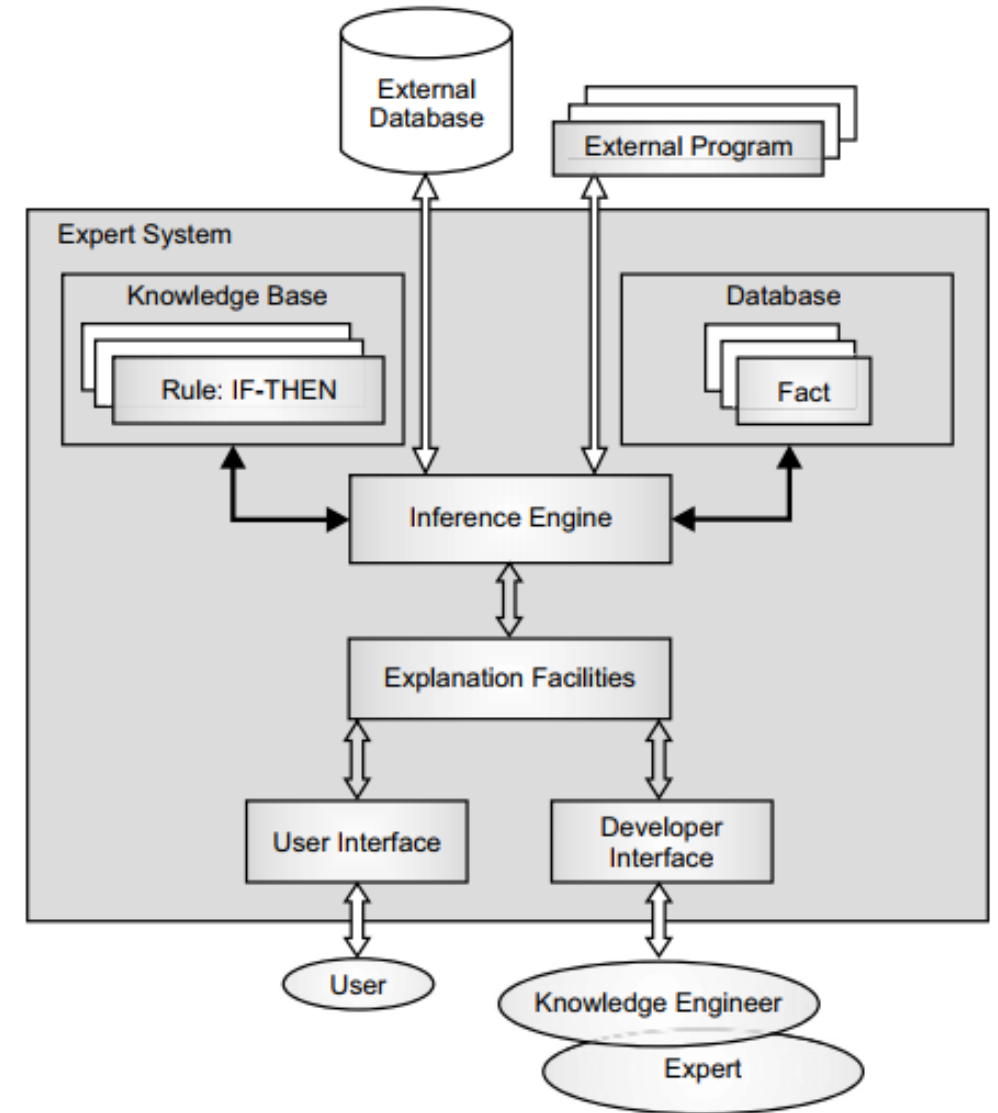


## ADVANCED COMPONENTS OF EXPERT SYSTEMS

Krishnamoorthy, C. S., & Rajeev, S. (2018). *Artificial Intelligence and Expert Systems for Artificial Intelligence Engineers*. CRC press.

Gupta, I., & Nagpal, G. (2020). *Artificial Intelligence and Expert Systems*. Mercury Learning and Information.

In short: expert system = knowledge base + inference engine

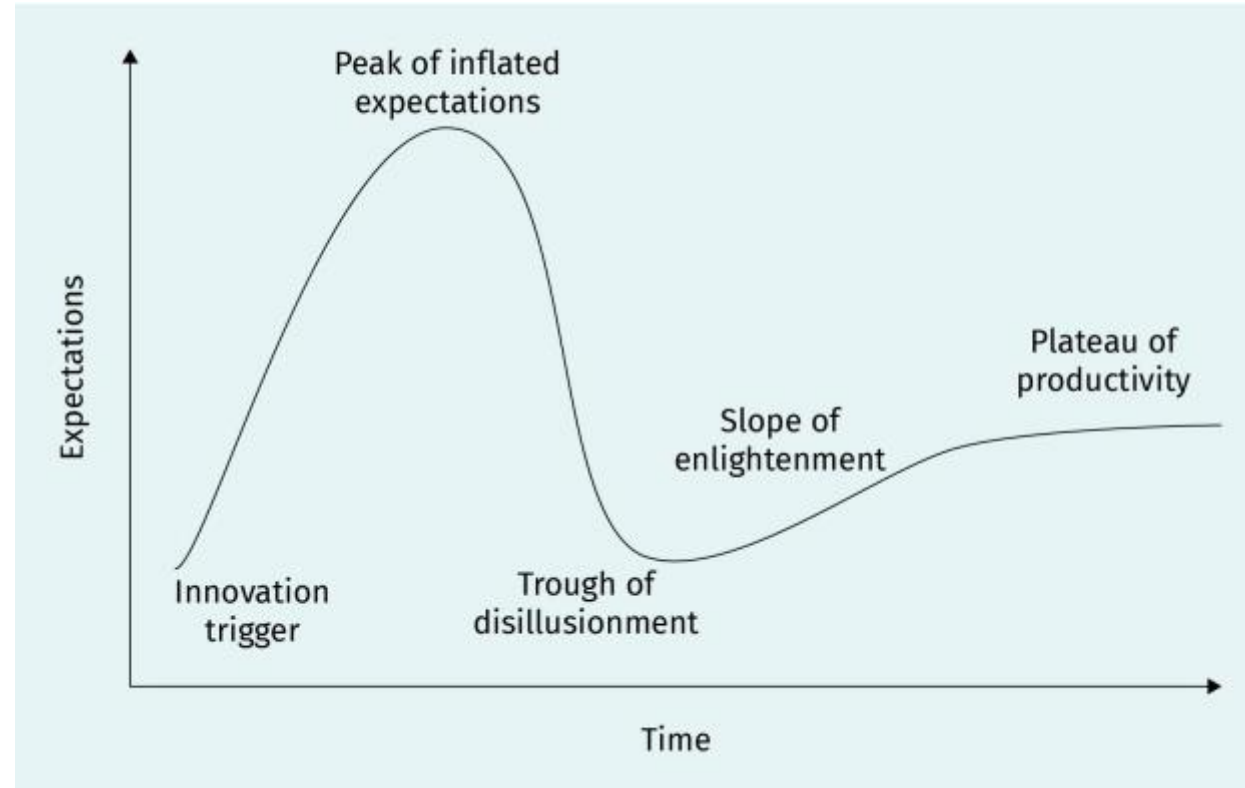


## FEATURES OF GOOD EXPERT SYSTEMS

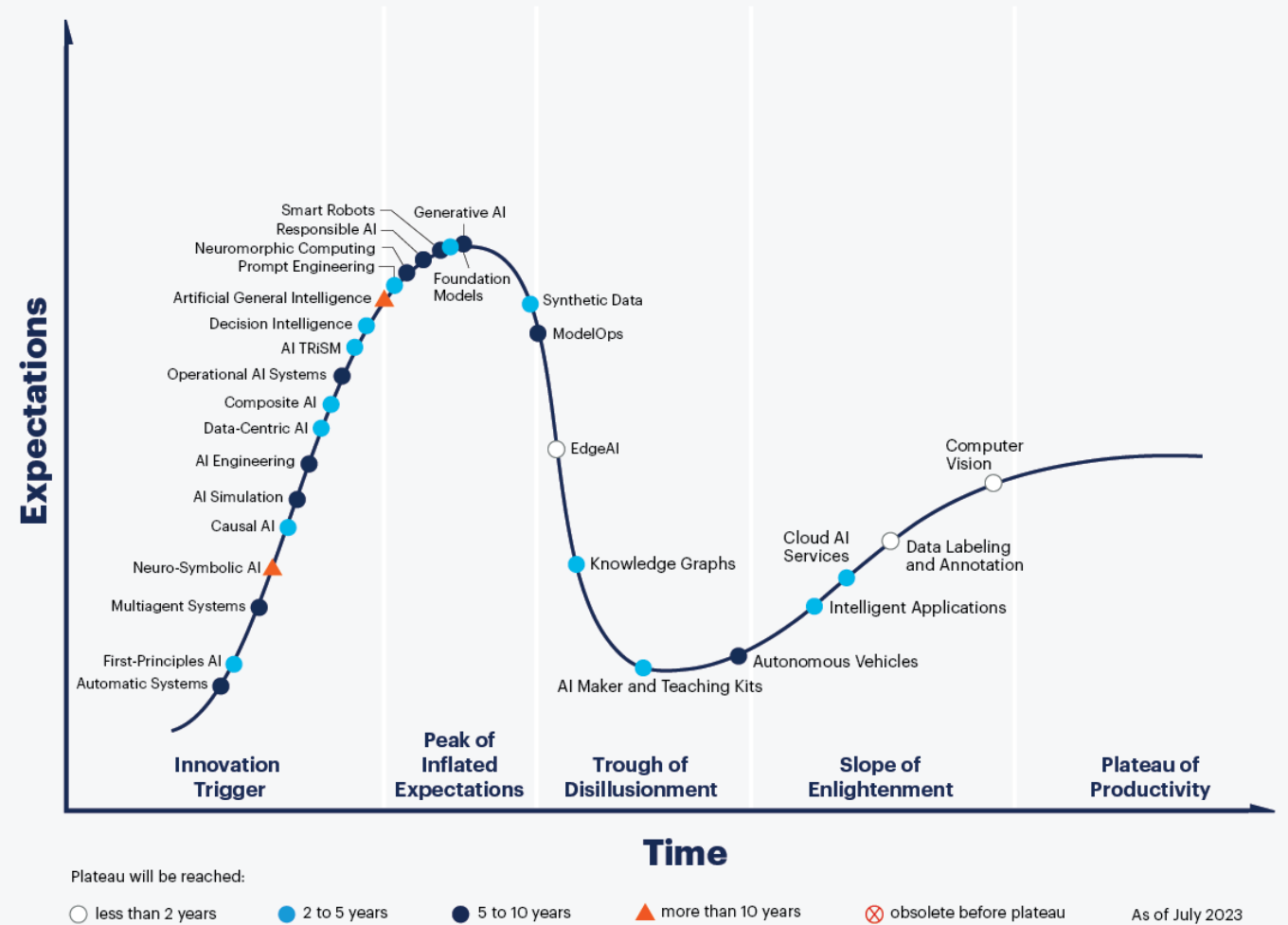
- Useful: meet a specific need
- Usable: even a novice computer user finds them easy to use
- Educational: an expert system may be used by non-experts who can then increase their own expertise by using it
- Able to explain the given advice: explain the reasoning process
- Able to learn new knowledge: ask questions to gain additional knowledge
- Exhibit a high performance: high quality output -> satisfy users
- Make timely decisions: able to produce decisions on time

## THE GARTNER HYPE CYCLE CURVE

<https://www.gartner.com/en/research/methodologies/gartner-hype-cycle>



# Hype Cycle for Artificial Intelligence, 2023



gartner.com

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Gartner®





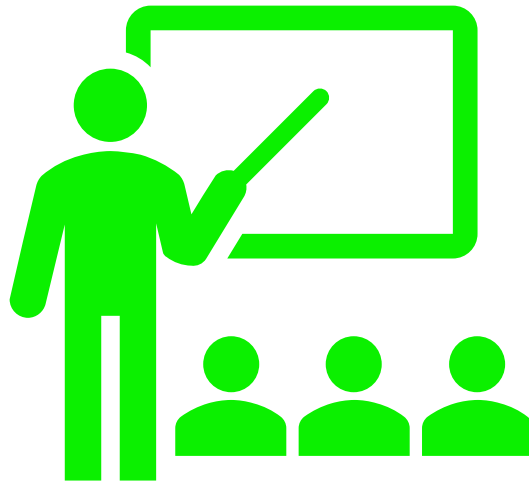
- AI is the science of making intelligent machines.
- Early considerations about AI date back to the ancient Greek history.
- Nowadays, AI is an important component of computer science.
- Expert systems emulate decision making by using domain-specific knowledge of an expert.
- The Gartner hype cycle curve evaluates the potential of new technologies.

**SESSION 1**

# **TRANSFER TASK**

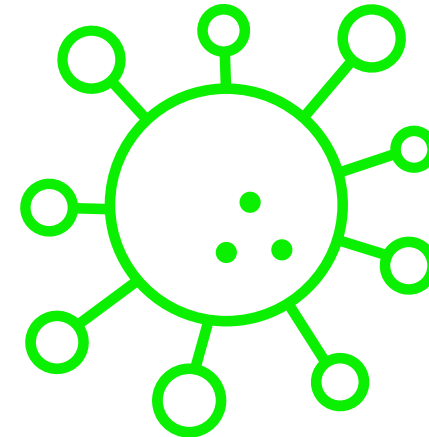
## TRANSFER TASK

1. Describe how artificial intelligence can affect the future of learning.



## TRANSFER TASKS

2. Outline how the knowledge base for an expert system to detect COVID-19 could look like.



3. How would you assign the following technologies on the hype cycle curve?

- Chatbots
- Smart robots
- Deep learning
- Autonomous vehicles
- Artificial general intelligence

How long do you think it will take until the plateau of productivity is reached?

**TRANSFER TASK**  
**PRESENTATION OF THE RESULTS**

Please present your  
results.

The results will be  
discussed in plenary.





1. Which event was key for the recent history of AI?
2. For which group of end users are expert systems developed?
3. What proportion of AI systems have already reached the plateau of productivity at the Gartner hype cycle?

## LIST OF SOURCES

McCarthy, J. (2007). *What is Artificial Intelligence?* Stanford University. <http://jmc.stanford.edu/articles/whatisai/whatisai.pdf>



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