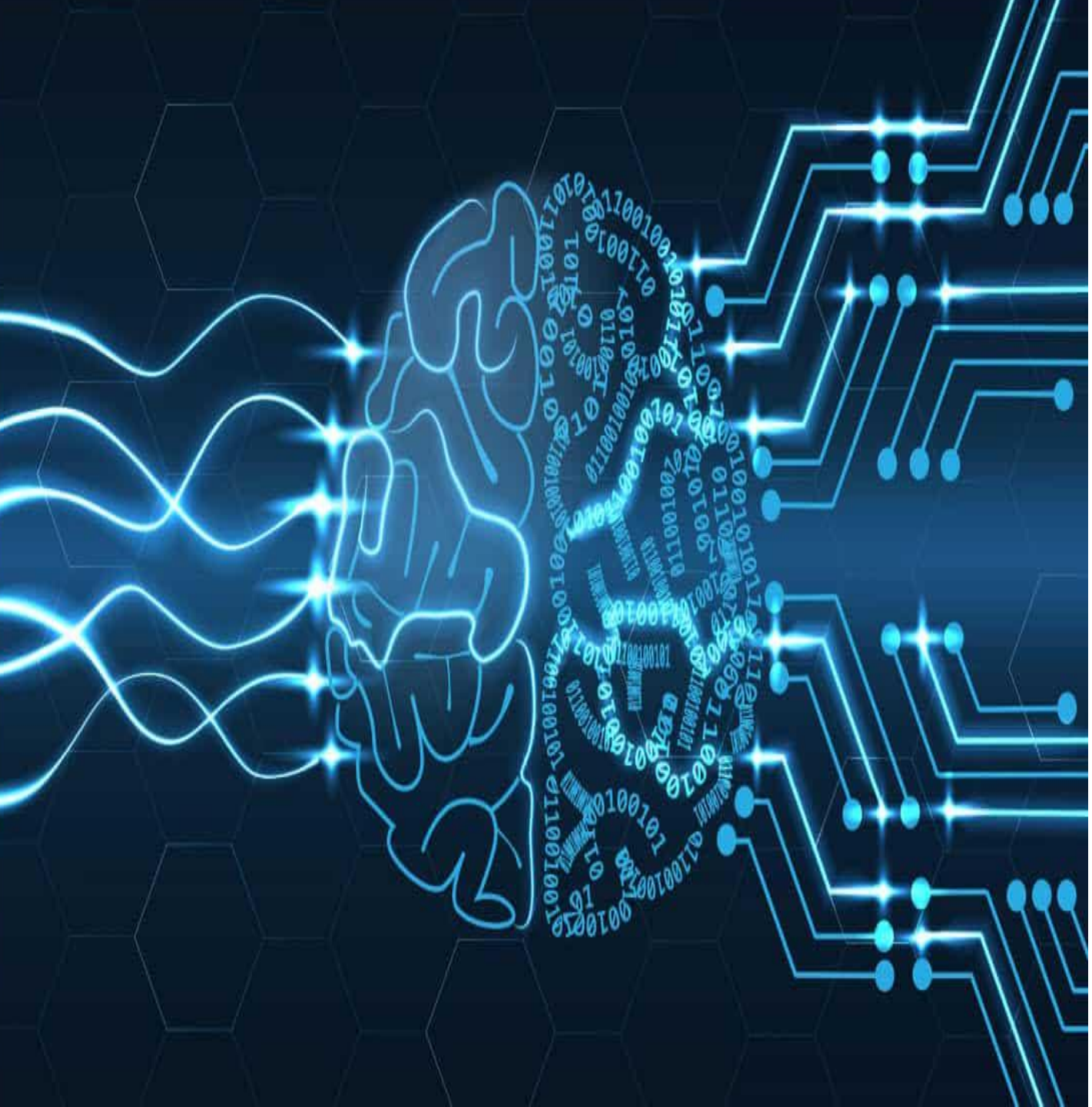


Business Applications in Artificial Intelligence

Taylor, E. (2024)

Decision & Game Theory:

The course "Decision and Game Theory" aims to familiarise students with a formal decision-making theory under risk and uncertainty and in strategic setups. Students will learn how to model risky and uncertain alternatives.

Business Applications in AI:

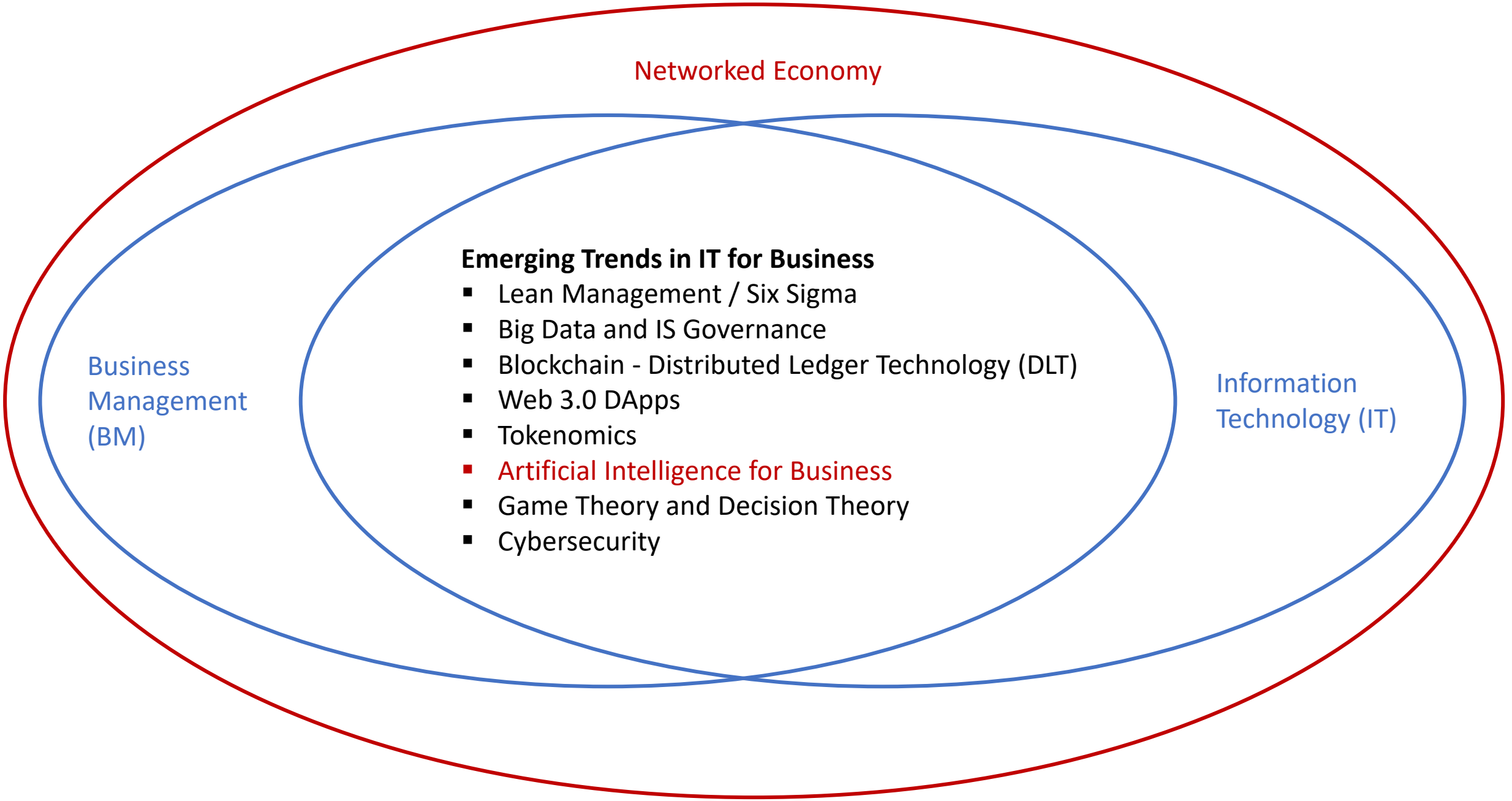
AI is transforming the way we do business. In 2020 alone, investment in AI companies quadrupled to $40 billion worldwide against the $10 billion invested in 2015. Advertising, healthcare, insurance, HR, and education - AI and big data radically transform how we do business. Or does it? In this class, we will explore the promises of AI, its potential, the craze it generated, and the truth about how it is (or is not) transforming businesses. We will also dive into AI's potential and discuss its impact in future years. We will also discuss the ethical implications of AI. One of the promises of AI is to achieve goals faster and more reliable. But what about fairness, accuracy, and precision? We will explore the concept of algorithmic biases and discuss how to minimise the negative impacts of AI to harness the best of its power. The class will be based on interviews from leaders in the field and concrete cases from the video game industry, fashion, education, music, fraud detection, and HR.

Introduction to Artificial Intelligence:

This course presents the strategic value of artificial intelligence (AI) on digital content's supply and demand sides. It includes an illustration of how AI-based tools enable viral content production and personalised consumption and delivery. The course compares the approaches of companies, research organisations, and different countries to AI, generating important distinctions in terms of implementation and innovation. Other concepts are discussed, such as the internationalisation of digital platforms, the control of illegal content on the web and the possibility of filtering content through AI and human intervention.

Big Data and IT systems governance

Big Data & IT Systems Governance encompasses a set of practices, processes, and policies to ensure that an organisation's IT systems effectively support its strategic goals, are secure, compliant with regulations, and operate efficiently. The course is designed to equip students with the knowledge and skills to manage, oversee, and optimise an organisation's IT infrastructure and systems. It explores the intersection of technology, business strategy, Big Data use and compliance to ensure that IT resources are aligned with organisational objectives.


Networked Economy
Business Management (BM)
Information Technology (IT)
Emerging Trends in IT for Business
Lean Management / Six Sigma
Big Data and IS Governance
Blockchain - Distributed Ledger Technology (DLT)
Web 3.0 DApps
Tokenomics
Artificial Intelligence for Business
Game Theory and Decision Theory
Cybersecurity

Course info

3 ECTS – 24 hours – 18h classes + 6h eLearning

Learning outcomes

- Understanding the basic concepts of AI and its applications in business
- Identifying the benefits and challenges of implementing AI in various industries
- Analyzing the impact of AI on business operations, strategy, and decision-making
- Developing skills to communicate effectively about AI-related projects
- Learning how to avoid pitfalls associated with AI adoption and implementation

Practical course

4 assignments: 50% team work – 50% individual

Evaluation criteria:

Participation – Contribution – Problem solving – Critical thinking – Creativity

Course content

Session I – Game Theory, Decision Theory & Serious Games

- 25% exam: individual written (eLearning)

Session II – Use cases of Artificial Intelligence in Business – Sectoral analysis

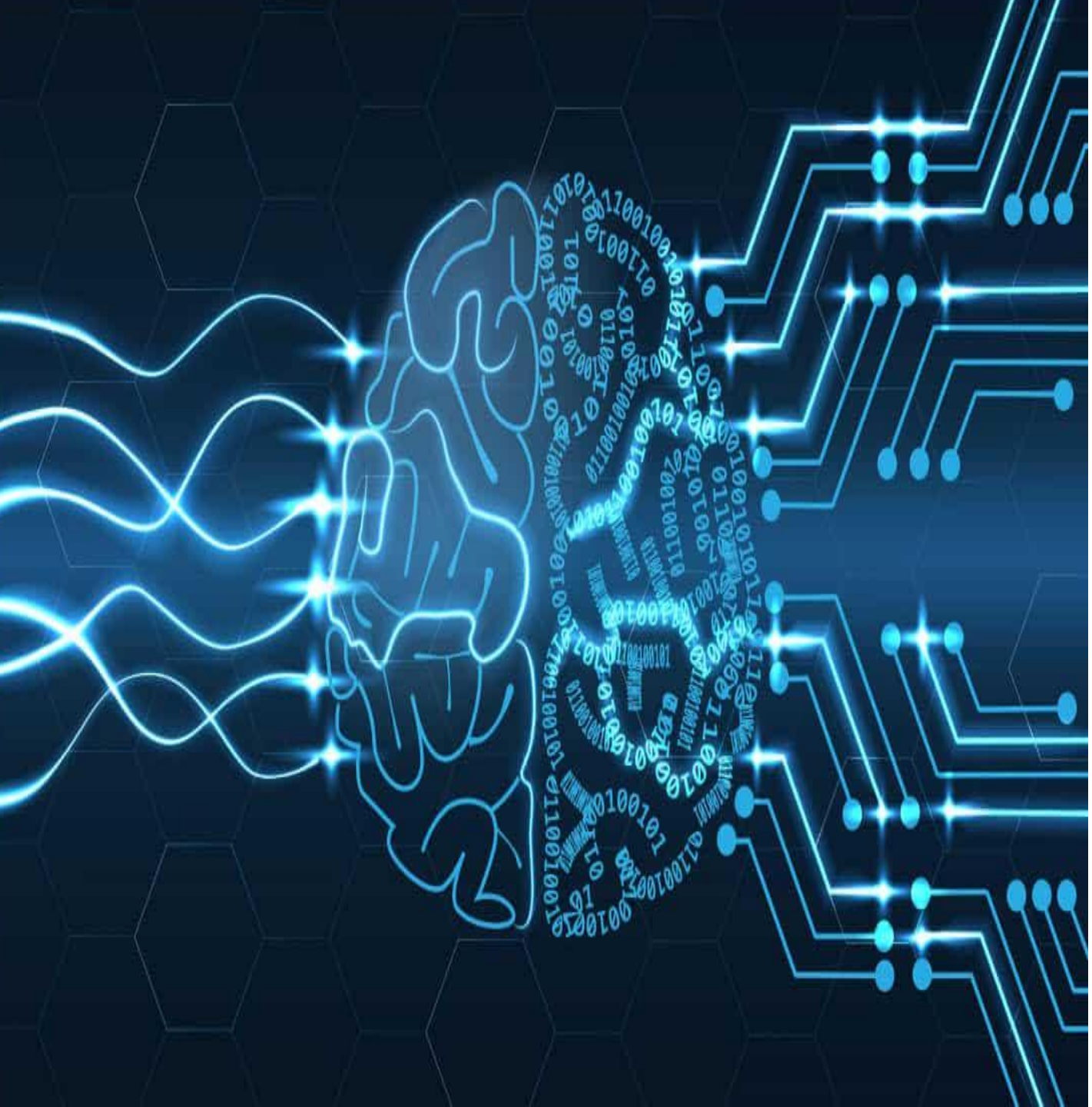
- 25% cc: team written/oral

Session III – Big Tech and the pursuit of AI dominance – Enterprise strategies

- 25% cc: team written/oral

Session IV – Ethical issues in AI applications for Business – Benefits & Risks

- 25% exam: individual oral (eLearning)



Business Applications in AI

Part I
Game Theory, Decision Theory & Serious Games

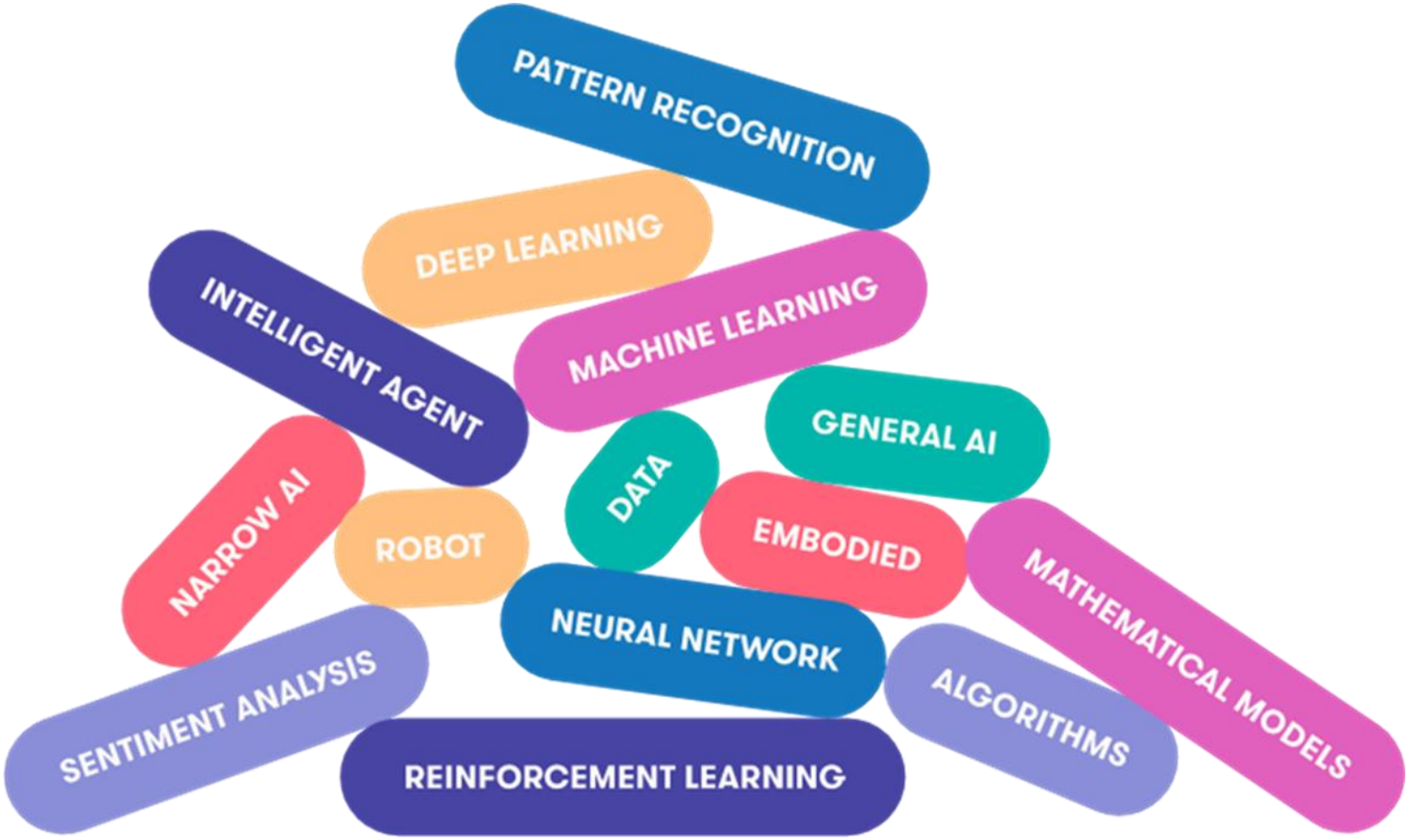
Agenda

1. Introduction to Artificial Intelligence
   - Definition of Artificial Intelligence
   - History & philosophy. The Turing Test and the Chinese Room
2. Game Theory & Problem Solving (Decision Trees)
   - TicTac Toe, Row Boat, Towers of Hanoi, MiniMax, Chess…
   - **Implementation: GPS – optimal route from A-Z**

   (The Travelling Salesman Problem)
3. Decision Theory
   - E.g. The Prisoners' Dilemma, The Byzantine Generals' Problem…
4. Serious Games
   - E.g. The Evolution of Trust, Oiligargy, The Uber Game, The Good-The Bad-and the Accountant …
5. Assignment: Impact of serious games for business

Introduction to Artificial Intelligence

What is (Artificial) Intelligence?



Useful definition by properties that are characteristic to (A)I

- **Reasoning**

The ability to choose the most appropriate algorithm, among a set of algorithms, to use in a particular context and solve a problem

- **Autonomy**

The ability to perform tasks in complex environments without constant guidance by a user

- **Adaptivity**

The ability to improve performance by learning from experience (self-correction aspect)

It has been long understood that **learning** is a key element of intelligence.
This holds both for natural intelligence – we all get smarter by learning – and artificial intelligence

Related fields to AI

- *Computer science*

Computer science is the study of computation, information, and automation.

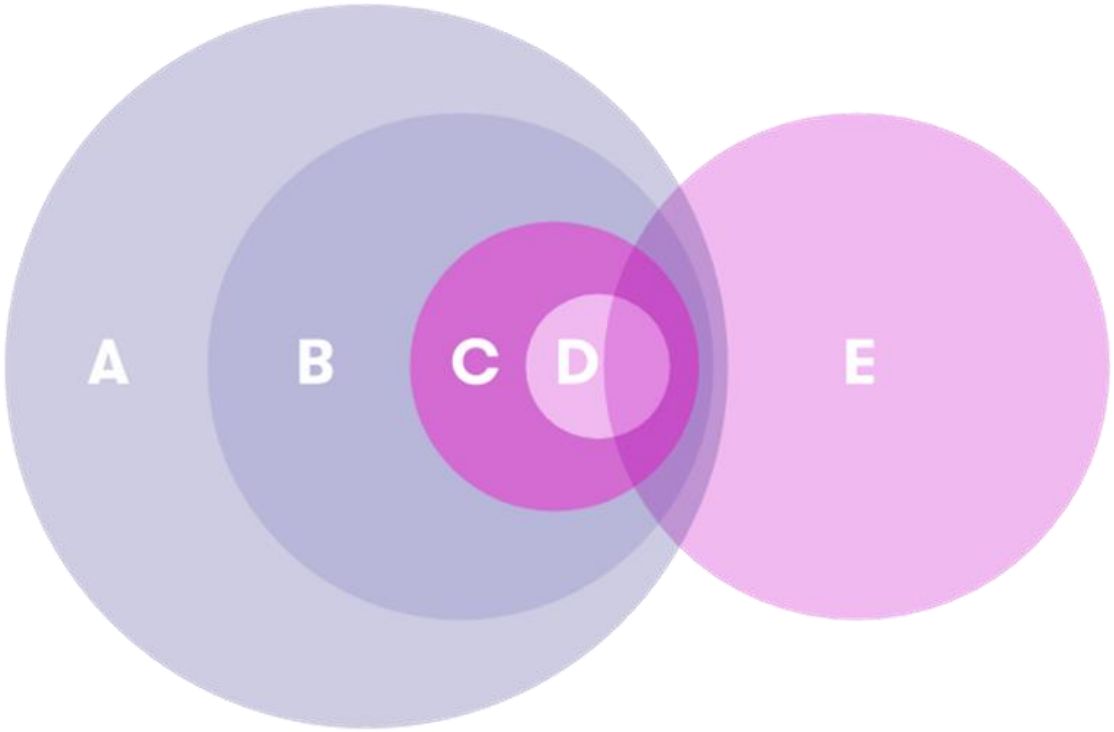
- *Data science*

Is a recent umbrella term that includes machine learning, deep learning and statistics, certain aspects of computer science including algorithms, data storage, and web application development.

- *Robotics*

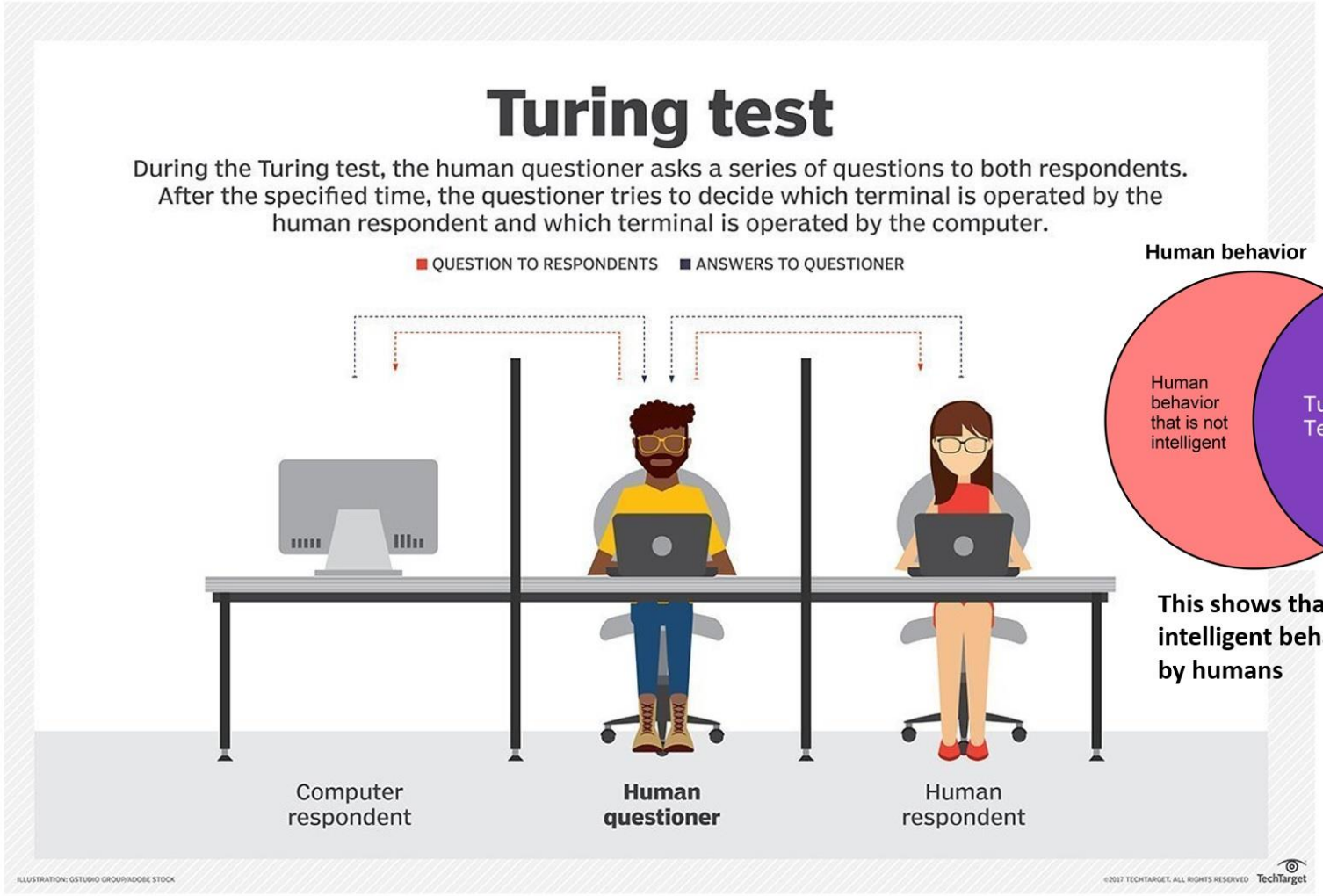
It means building and programming robots so that they can operate in complex, real-world scenarios. In a way, robotics is the ultimate challenge of AI since it requires a combination of virtually all areas of AI.

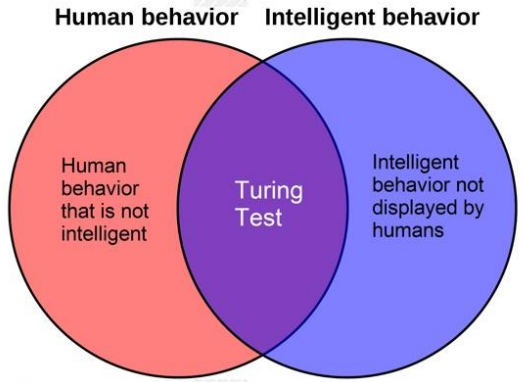
Taxonomy



A. Computer Science
B. Artificial Intelligence
C. Machine Learning
D. Deep Learning
E. Data science

Philosophy of Artificial Intelligence



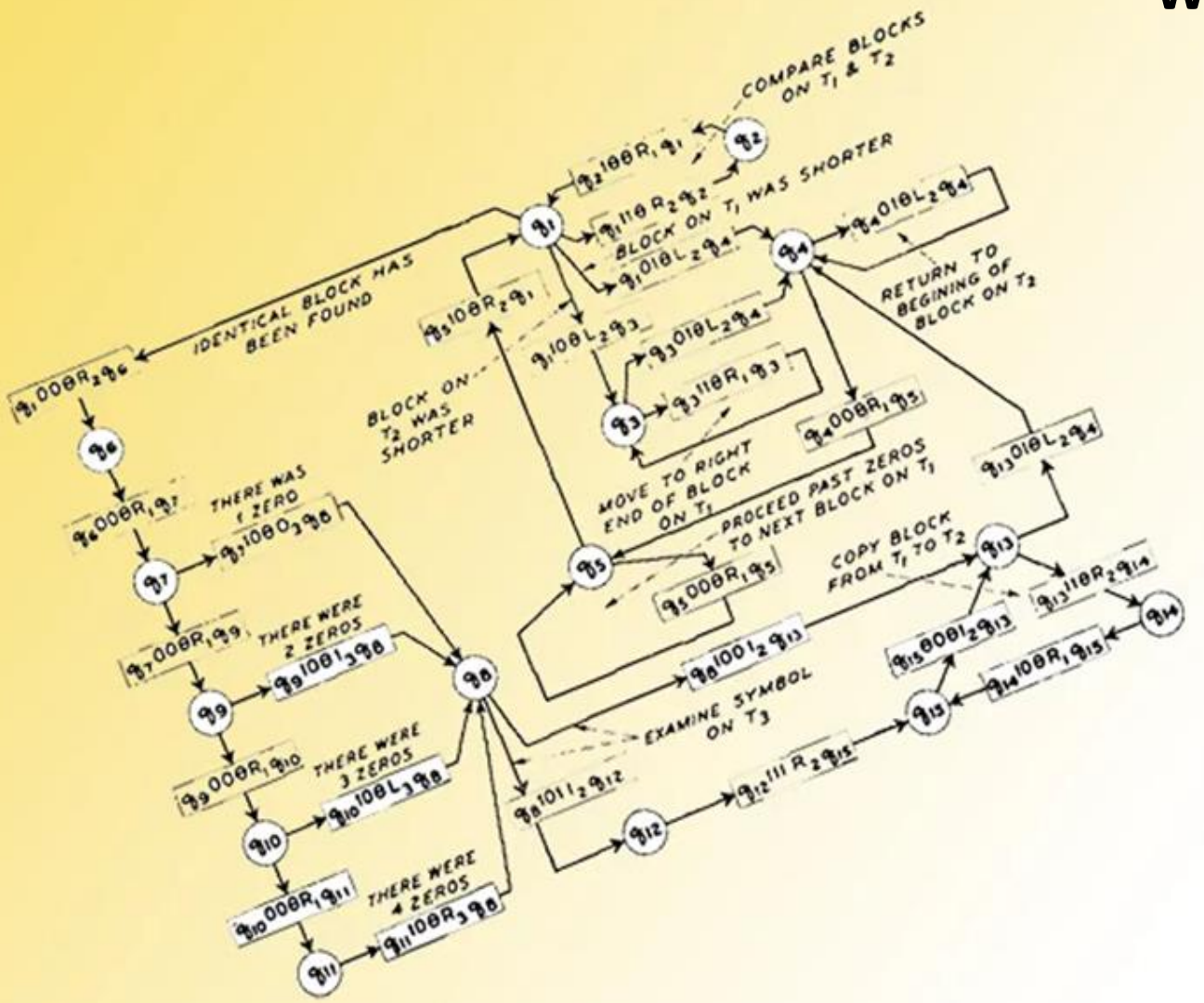


This shows that not all possible intelligent behavior can be shown by humans

The illustrations here have been derived from the following sources -

Turing test – What is the Turing Test? - Definition from Whatis.com (techtarget.com)
Venn Diagram – Artificial intelligence: Will computers pass the Turing test by 2029? Does it matter? - Science in the News (harvard.edu)

Who is Alan Turing?




会! 流利地
Yes! fluently

Solving problems with Artificial Intelligence

- Turing, father of computer programming (1950): *“If a computer is indistinguishable from a human in a general natural language conversation, then it must have reached human-level intelligence.”*
- McCarthy, father of AI *(1955)*: *“Intelligence is intelligence even if the system that implements it is just a computer that mechanically follows a program.”*
- Searle (1980): *“Even if a machine behaves in an intelligent manner, for example, by passing the Turing test, it doesn’t follow that it is intelligent or that it has a “mind” (conscious) in the way that a human has.”*
- **McCarthy *(1997)*: *“Intelligence is the computational part of the ability to achieve goals”*** → **Narrow and Weak AI**

What matters in practice? Key terminology

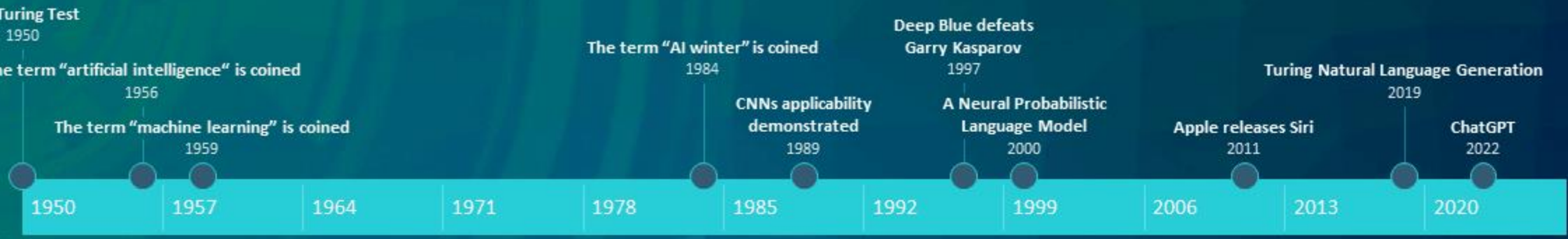
- **General vs Narrow AI**

Narrow AI refers to AI that handles one task. General AI, or Artificial General Intelligence (AGI) refers to a machine that can handle any intellectual task. All the AI methods we use today +-fall under narrow AI, with general AI being in the realm of science fiction.

- **Strong vs Weak AI**

A related dichotomy is “strong” and “weak” AI. This boils down to the above philosophical distinction between being intelligent (Turing) and acting intelligently (Searle). Strong AI would amount to a “mind” that is genuinely intelligent and self-conscious. Weak AI is what we actually have, namely systems that exhibit intelligent behaviors despite being “mere“ computers.

History of Artificial Intelligence (AI) timeline



1950-1979

- SNARC, 1951
- ELIZA and Shakey, 1966
- Samuel Checkers-Playing Program, 1952
- Artificial Intelligence: A General Survey, 1973
- The Logic Theorist, 1956
- The General Problem Solver, 1957
- The first AI winter begins, 1974

1980-2009

- Symbolics Lisp machines commercialized, 1980
- Fifth Generation Computer Systems, 1982
- Large-Scale Deep Unsupervised Learning, 2009
- Bayesian networks causal analysis, 1985
- A Statistical Approach to Language Translation, 1988

2010-2014

- Watson wins on Jeopardy!, 2011
- Googles's deep neural network project, 2012
- China's Tianhe-2 fastest system, 2013
- Facebook introduces DeepFace, 2014

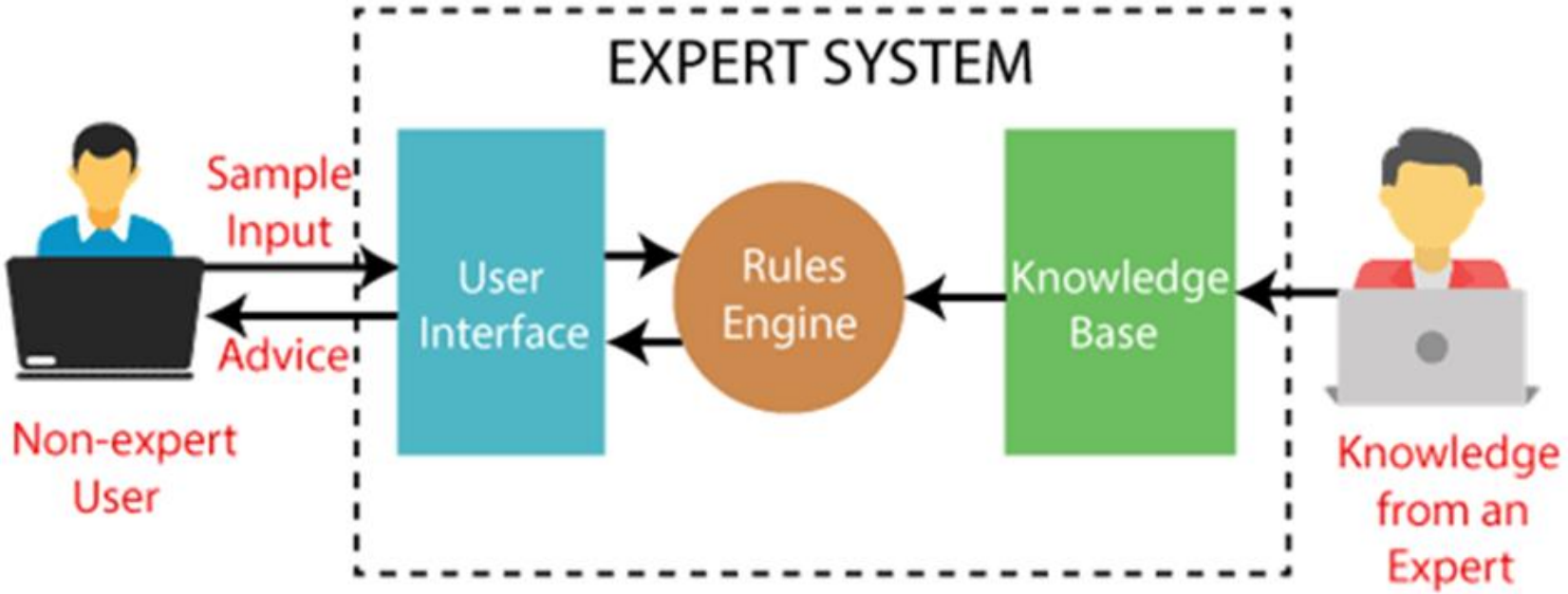
2015-2019

- AlphaGo wins at Go, 2016
- Sophia: the first robot with citizenship, 2017
- Google introduces the Transformer, 2017
- Cimon, GPT, Lovot, 2018

2020-2025

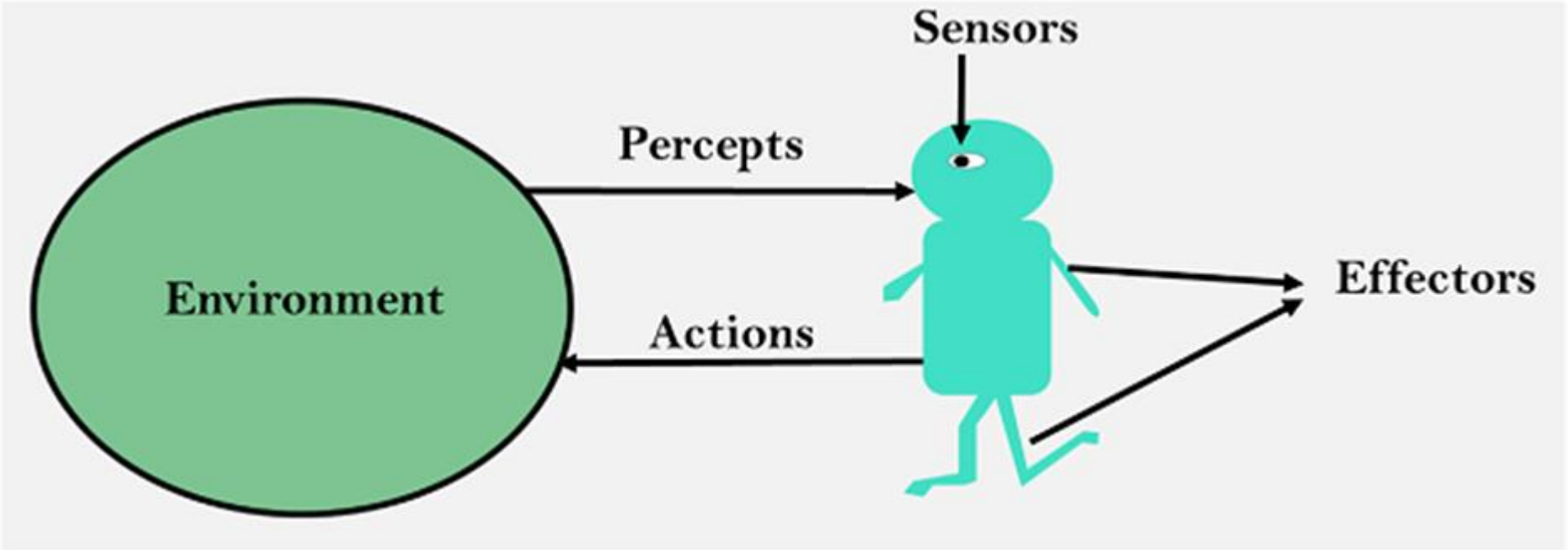
- Curial GPT-3 LLM, 2020
- Dall-E, 2021
- GPT-4, 2023

Expert Systems

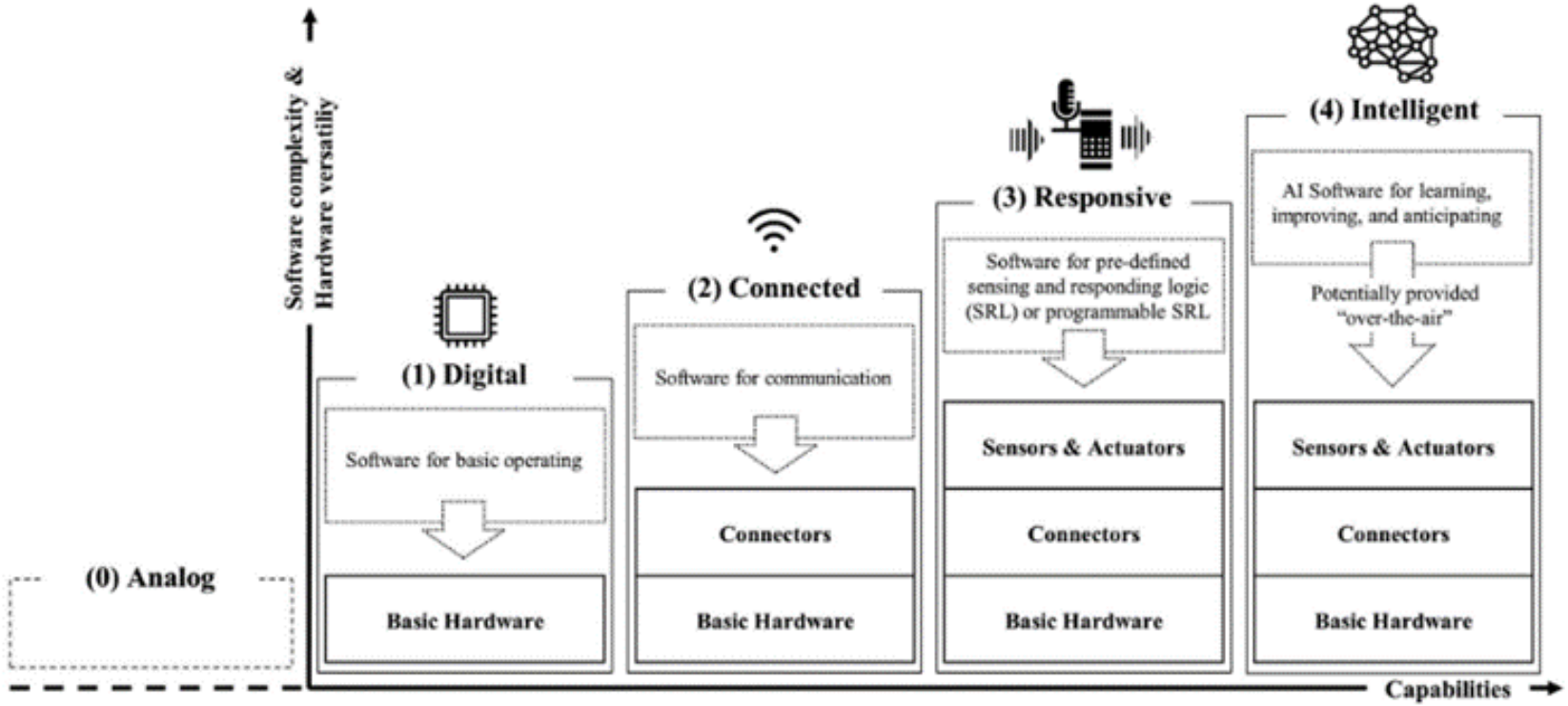


Expert system is a part of AI and a computer program that is used to solve complex problems, and to give the decision-making ability like humans with the help of **a knowledge base, an inference engine (forward/backward chaining), and a user interface.**

Expert Systems

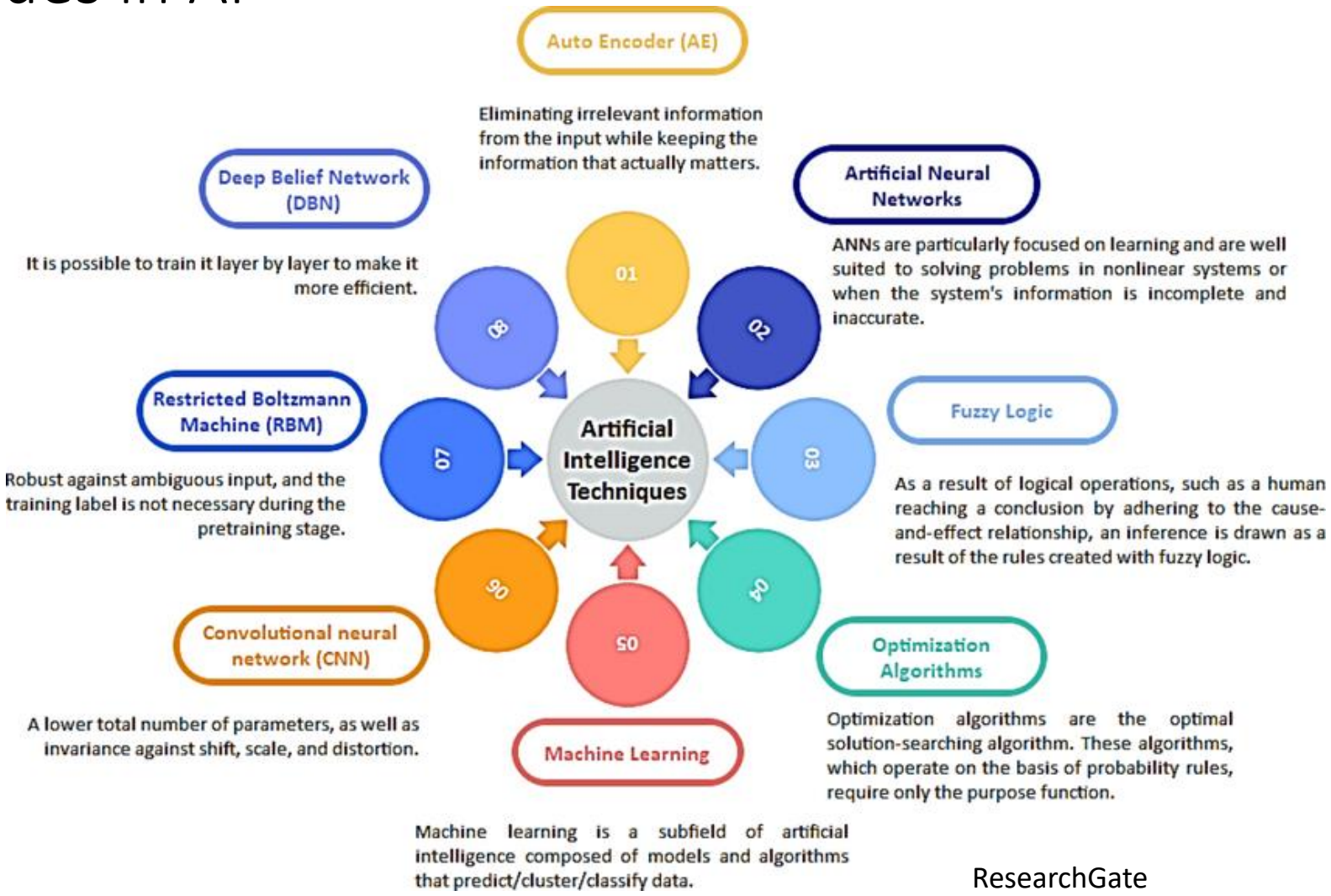


- An problem-solving agent perceives and acts upon the environment using **sensors and actuators**. With sensors, it senses the surrounding, and with actuators, it acts on it.
- An intelligent agent improves its performance with **learning algorithms**.



	(1) Digital	(2) Connected	(3) Responsive	(4) Intelligent
Capability-based definition criteria	• IT Equipped • Data Storage • Data Processing & Analysis • Data Provision & Transmission	+ • Unique Identification • Networking & Connectivity • Communication & Information Exchange • Interaction & Cooperation	+ • Sensing • Real-Time Context-Awareness • Reactivity & Adaptability • Automated Actuation • Functionality & Customization	+ • Reasoning & Decision-Making • Autonomy & Self-Management • Proactivity
Example functions & services	• Predefined input and output operations (e.g., digital camera) • Basic settings (e.g., radio station or alarm setting on a hi-fi system) • Entering, storing and displaying of information (e.g., Apple iPod first generation)	• Tracking services (e.g., Smart Meter) • Dispersed functionality (e.g., Samsung Hue Lighting System) • Remote control and monitoring (e.g., wireless printer) • Infotainment services (e.g., Audi connect)	• IFTTT routines (e.g., Amazon Echo) • Rule-based skills and actions (e.g., Google Home actions) • Reactive functions (e.g., car lane assist) • Deterministic automated actions (e.g., Amazon Dash Shelf) • Location- & Data-based services or navigation tasks (e.g., route optimization) • Performance tracking (e.g., Apple Watch)	• Complex context-based services (e.g., NEST Learning Thermostat) • Proactive services (e.g., anticipatory services in the AI:CON car) • Complex learning-based and self-organizing autonomous actions (e.g., driverless vehicles)

Techniques in AI



ResearchGate

Types of AI

The emergence of artificial superintelligence will change humanity, but it's not happening soon. Here are the types of AI leading up to that new reality.

Reactive AI

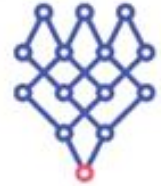
- Good for simple classification and pattern recognition tasks
- Great for scenarios where all parameters are known; can beat humans because it can make calculations much faster
- Incapable of dealing with scenarios including imperfect information or requiring historical understanding

Limited memory

- Can handle complex classification tasks
- Able to use historical data to make predictions
- Capable of complex tasks such as self-driving cars, but still vulnerable to outliers or adversarial examples
- This is the current state of AI, and some say we have hit a wall

Theory of mind

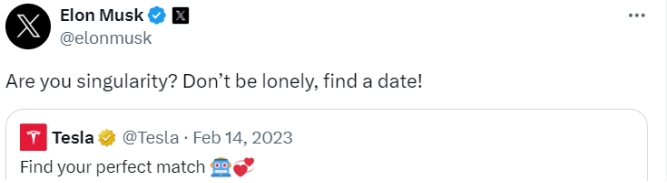
- Able to understand human motives and reasoning; can deliver personal experience to everyone based on their motives and needs
- Able to learn with fewer examples because it understands motive and intent
- Considered the next milestone for AI's evolution

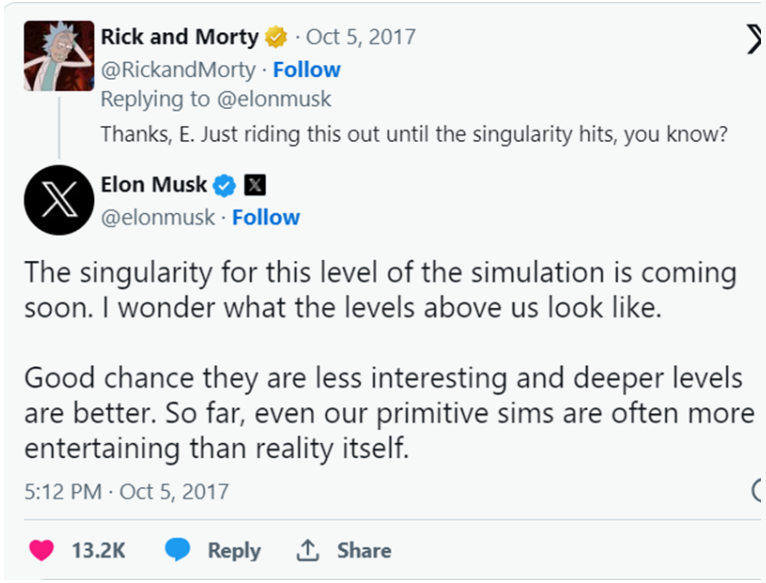


Self-aware

- Human-level intelligence that can bypass our intelligence, too
- Considered a long-shot goal

Point of Singularity





What does Elon Musk say about singularity?

The singularity also means that tech progress is so rapid that it would exceed the ability of humans to control, predict and understand it. Musk believes that there is still time to act so as not to cross this boundary, which is supposed to impact the future of human civilization. Mar 4, 2023

Components of AI

Applications

- Image recognition
- Speech recognition
- Chatbots
- Natural language generation
- Sentiment analysis

Types of models

- Deep learning
- Machine learning
- Neural networks

Software/hardware for training and running models

- GPUs
- Parallel processing tools (like Spark)
- Cloud data storage and compute platforms

Programming languages for building models

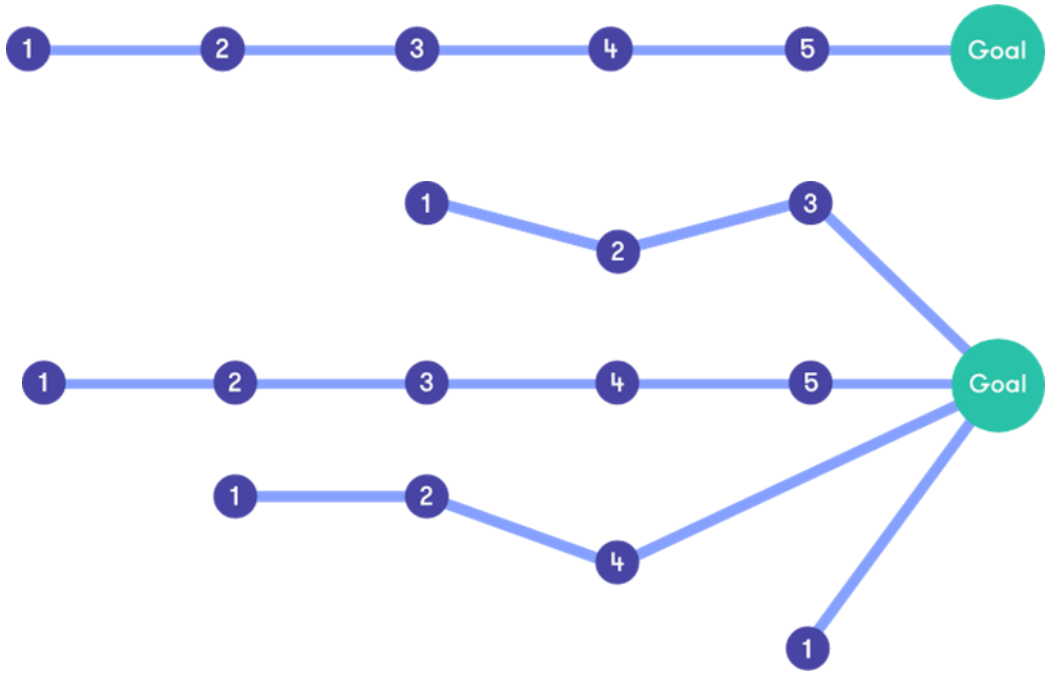
- Python
- TensorFlow
- Java
- C

ILLUSTRATION: SORBETTO/GETTY IMAGES

Problem Solving & Game Theory

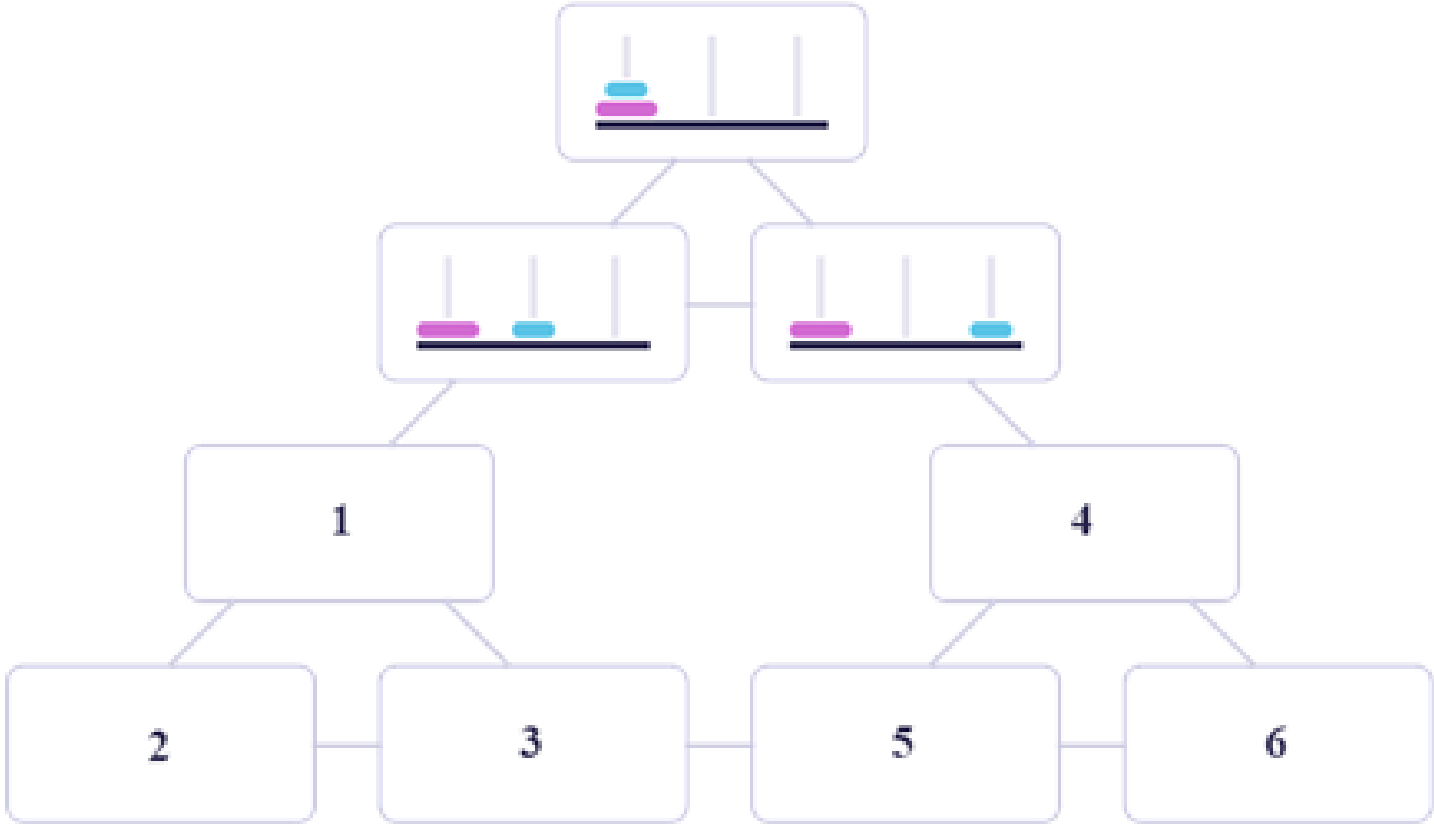
The Travelling Salesman's problem

- Playing chess
- Looking for a restaurant (GPS)



The Rowboat Puzzle

The Towers of Hanoi



A

B

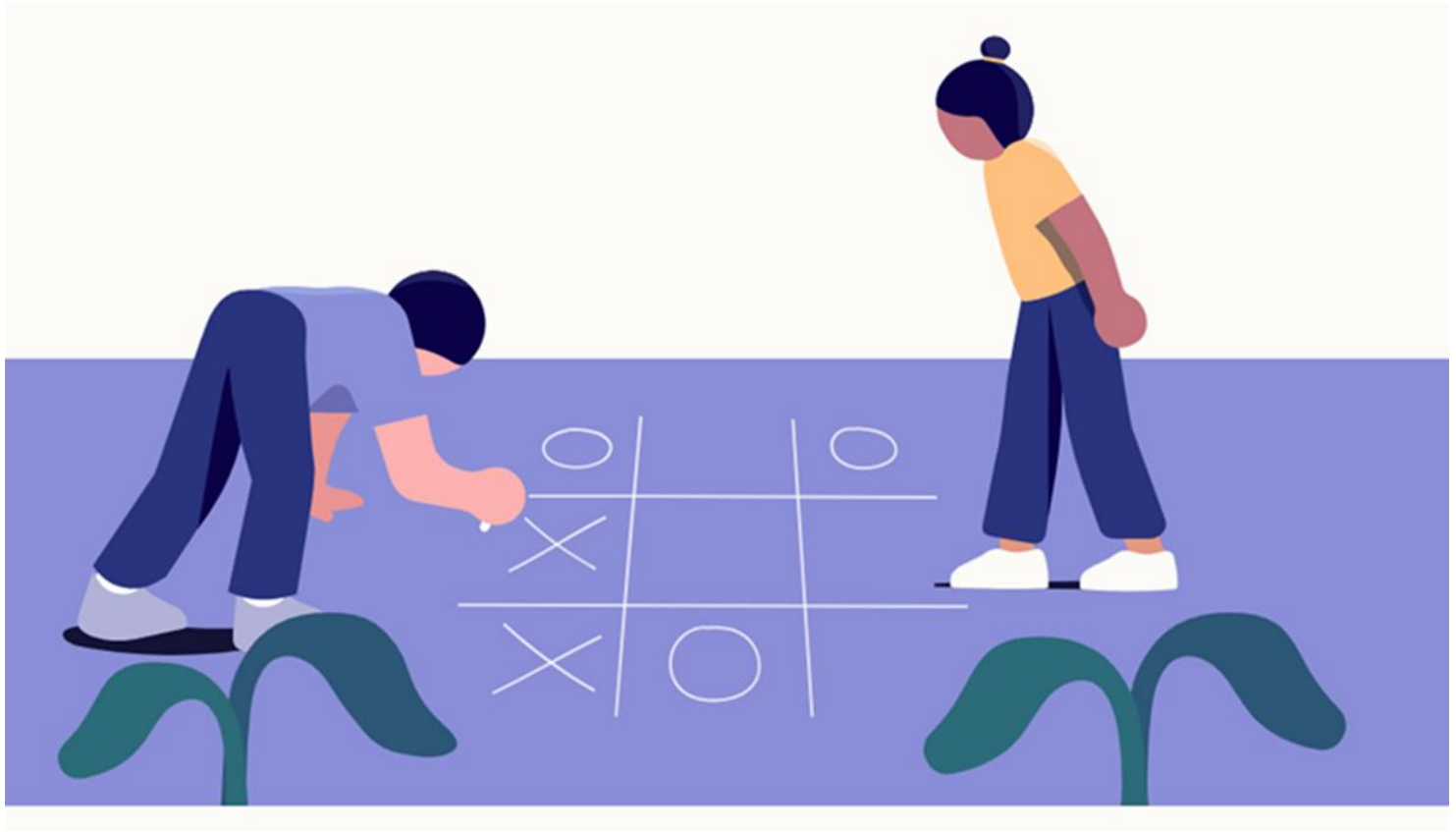
C

D

E

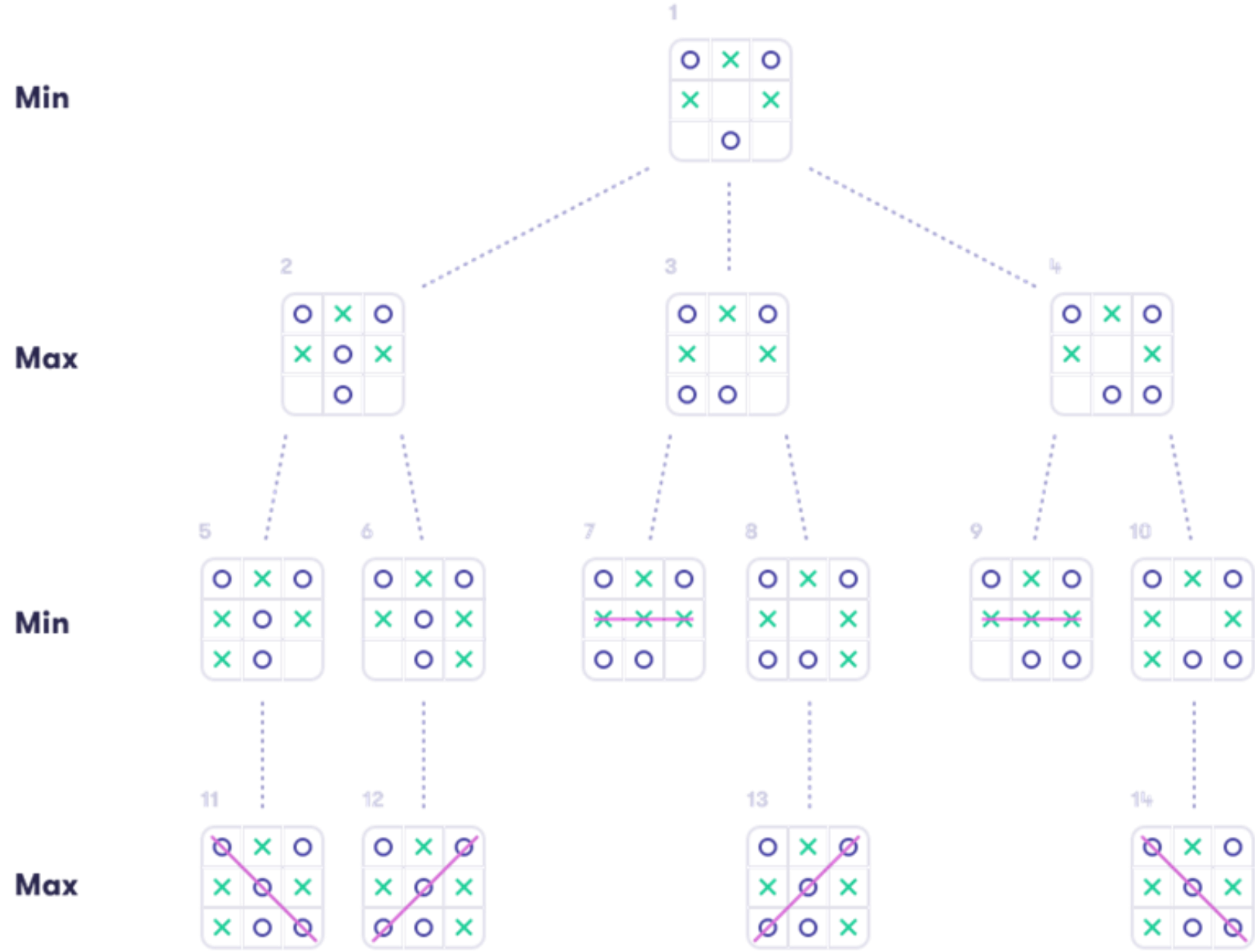
F

Tic Tac Toe



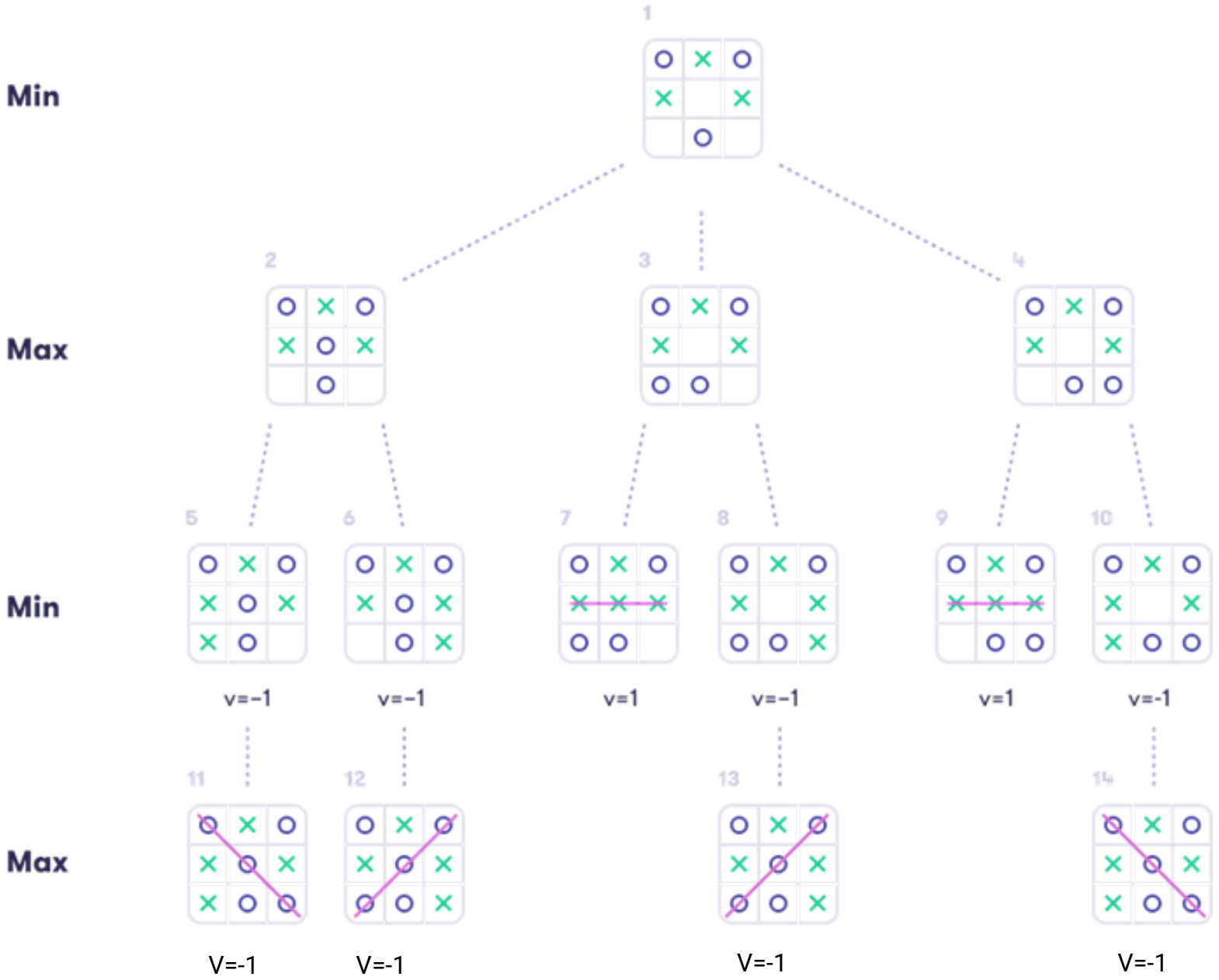
Game Tree 1

- Min to play (o)
- Max to play (x)
- …



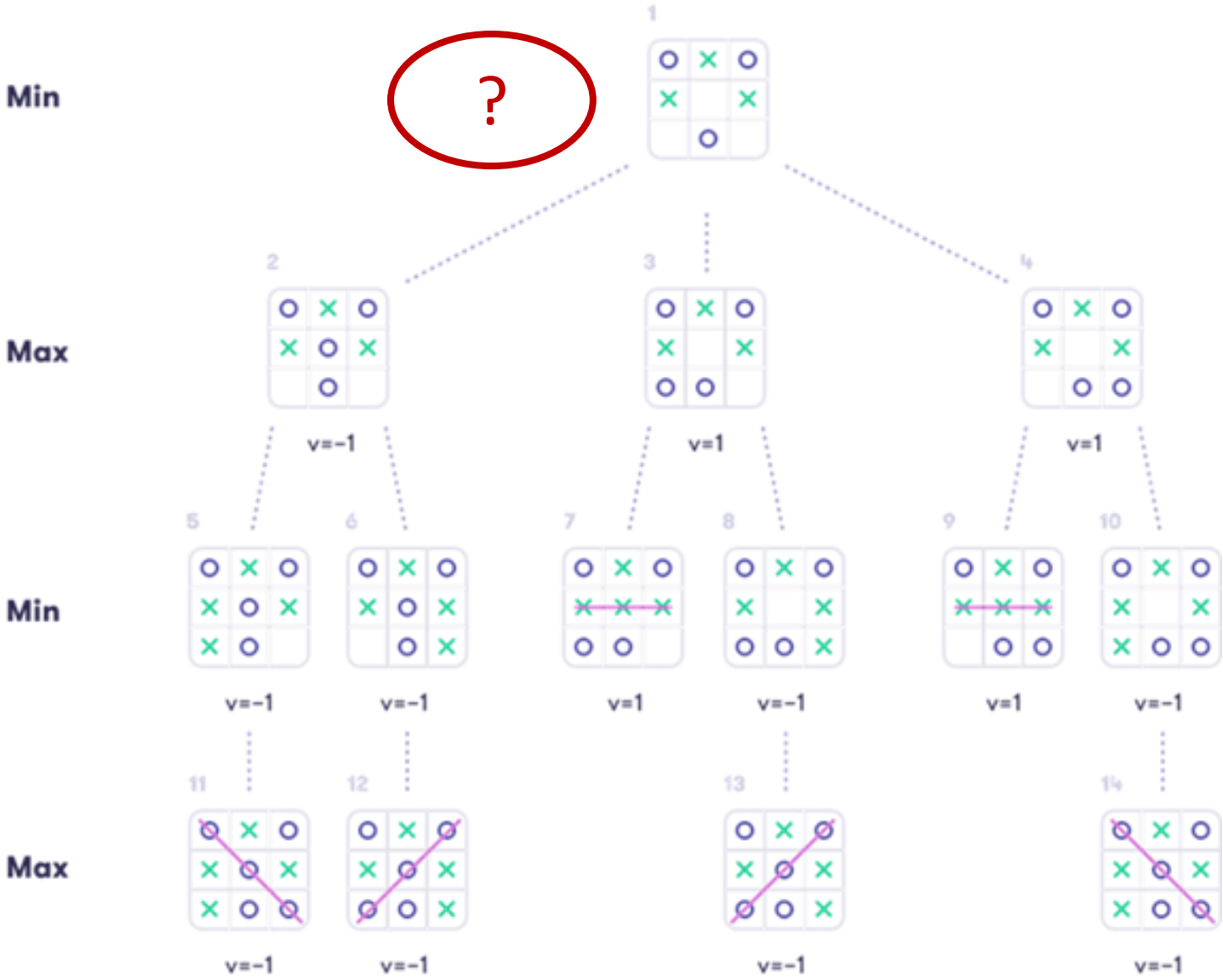
Game Tree 2

Possible outcomes
-1 = Min (o) wins
+1 = Max (x) wins
0 = draw (no one wins)

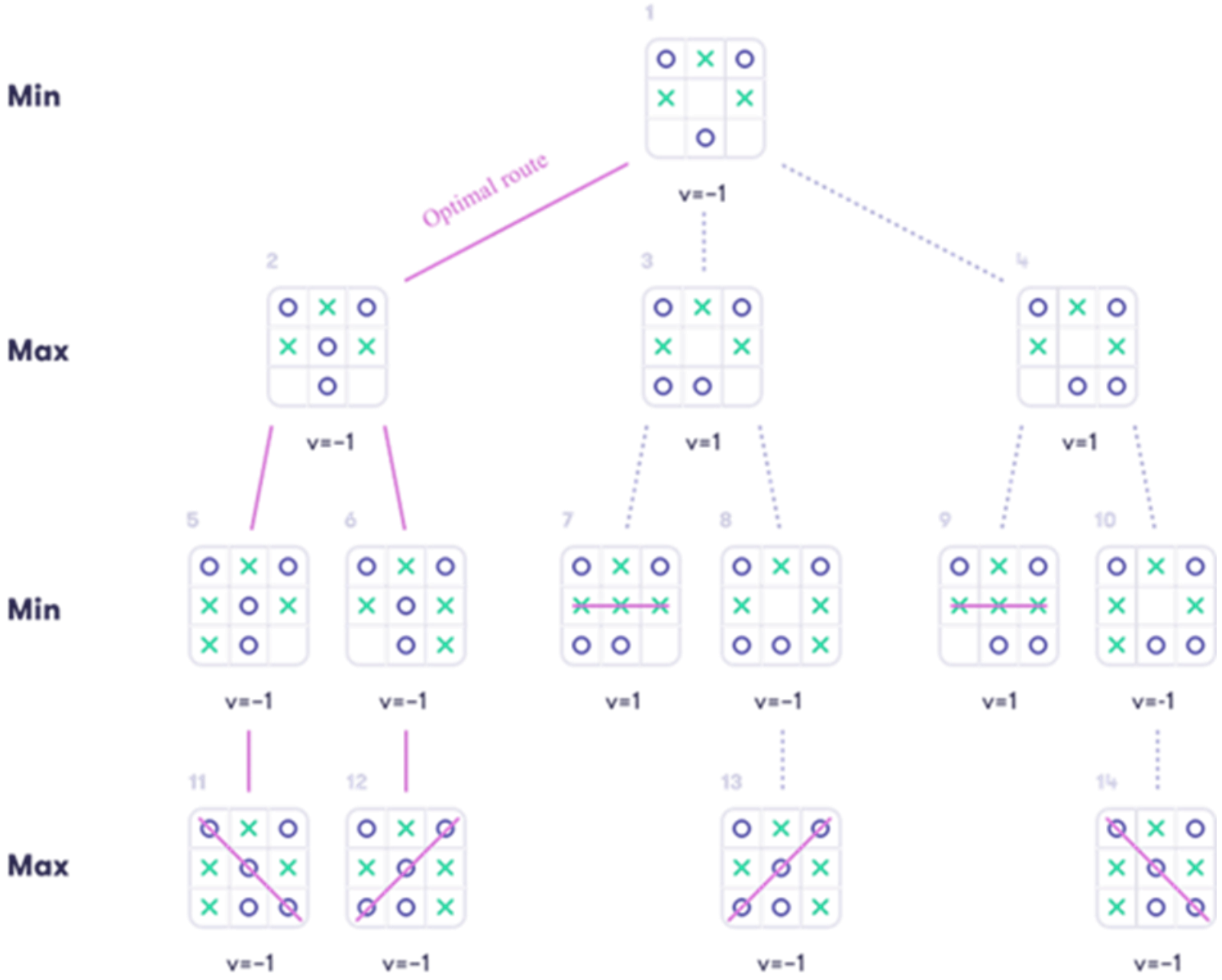


Game Tree 3

Who wins?
Max +1, Min -1
or is it a draw 0?

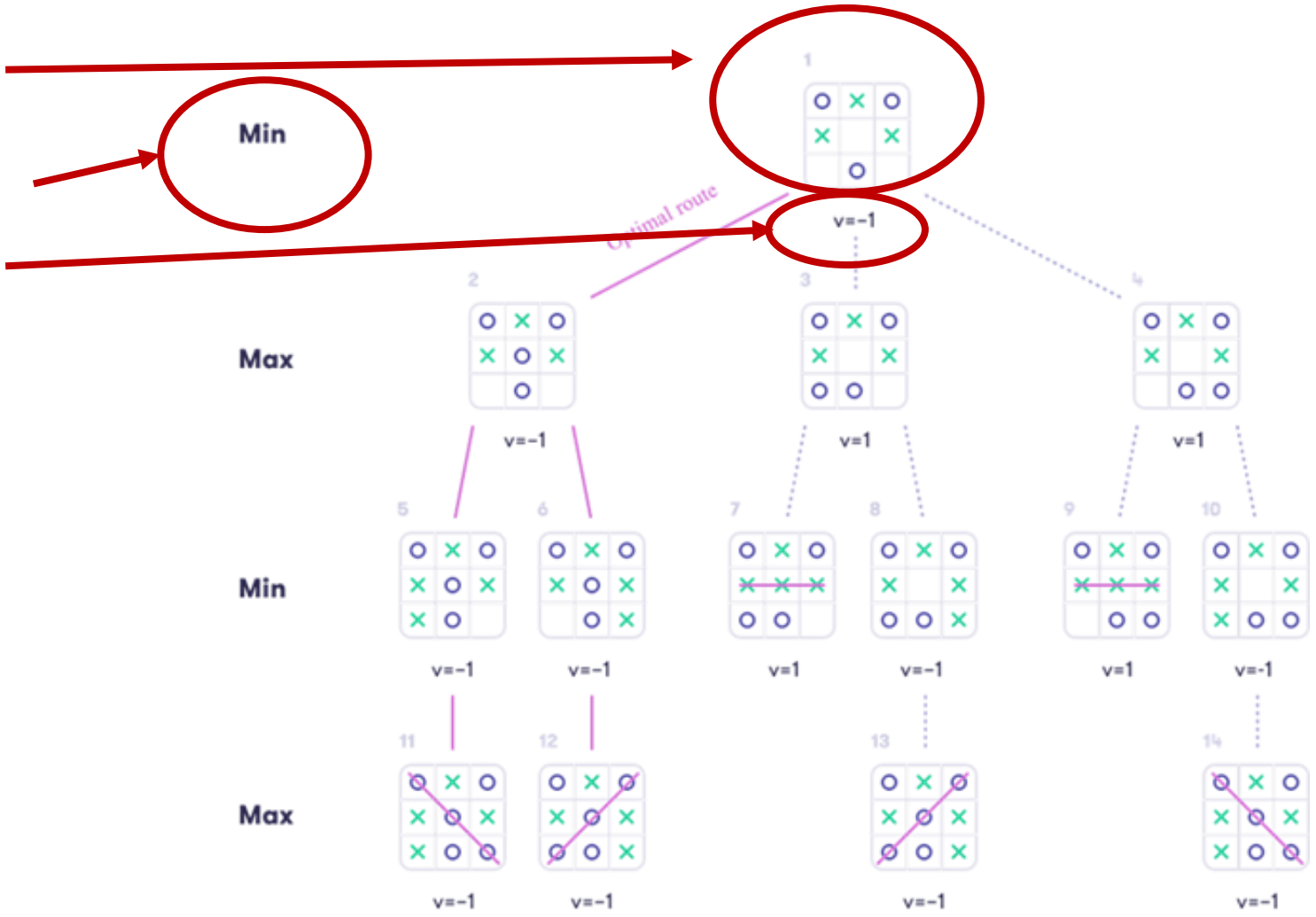


Game Tree 4


Min
Max
Min
Max
Optimal route
1
v=-1
2
3
4
v=-1
v=1
v=1
5
6
7
8
9
10
v=-1
v=-1
v=1
v=-1
v=1
v=-1
11
12
13
14
v=-1
v=-1
v=-1
v=-1

The MiniMax algorithm – The Optimal route

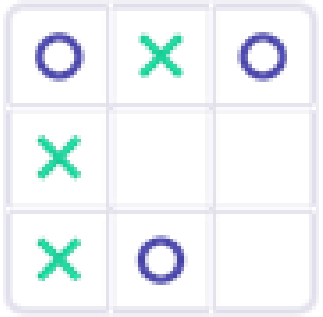
- State of the game
- Who's turn is it to play?
- Value of the game (-1)



Your turn…

Complete the MiniMax Game Tree, add the values -1, 0, and 1 for each step at each level and draw the final optimal route to solve the problem. It is Min's turn to play. Who wins the game??? Optimal route?

Min



Problem Solving & Game Theory

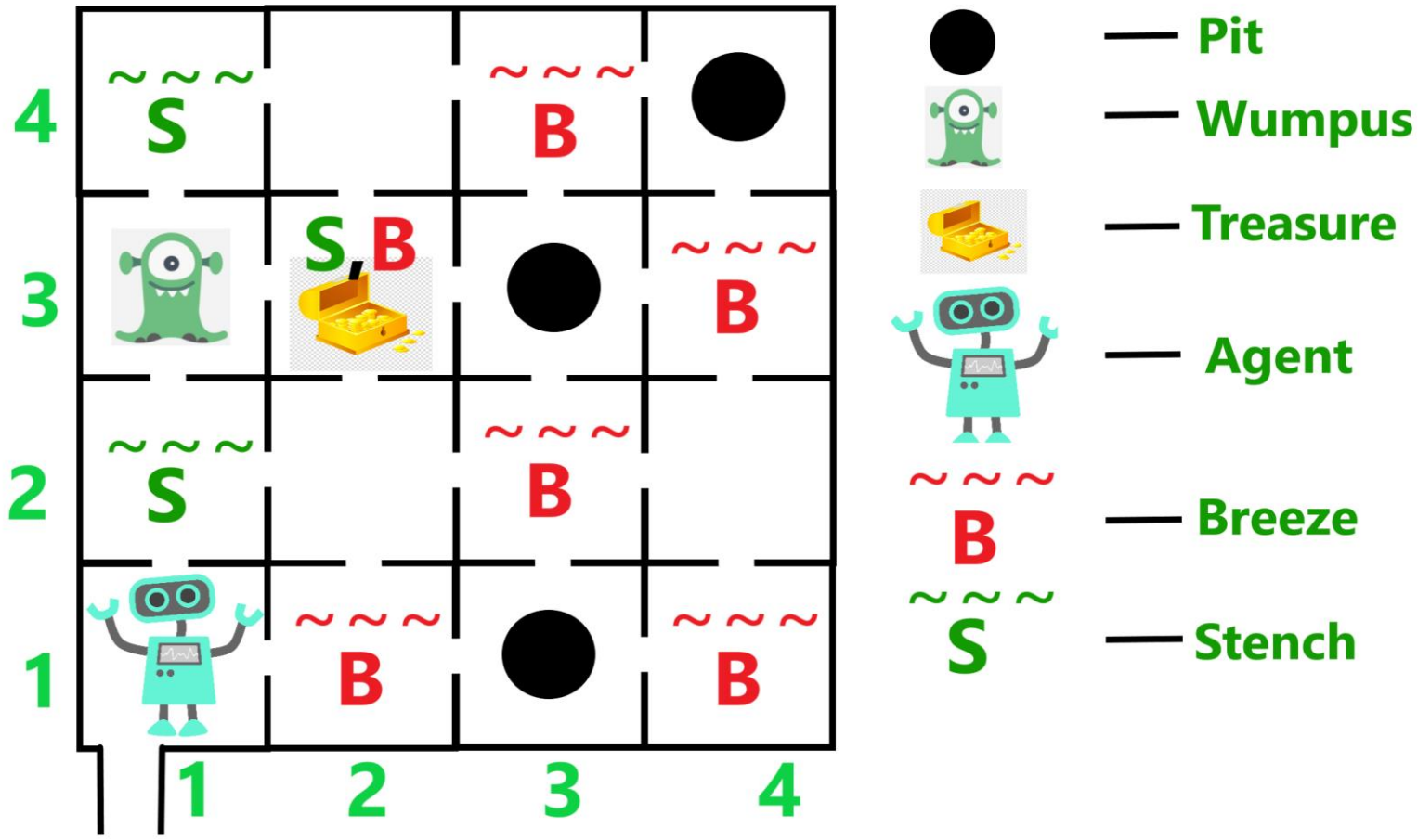
Chess

Massive game tree!!! Heuristic evaluation function

- Board position (state)
- Who's in play?
- Number of pieces
- Value of pieces
- Dominance in the centre
- Defensive or offensive strategy?

https://lichess.org/analysis

Wumpus World Problem (cf. escape room)



Task environment (PEAS)

- Performance measures
- Environment
- Sensors
- Actuators

Decision Theory

How can game theory improve strategic decision-making?

- **Game theory is the study of how people or groups make decisions in situations where their actions affect each other (interaction).**
- Overall, game theory provides a powerful framework for understanding and analyzing strategic decision-making in a wide range of situations. By modelling the behavior of individuals and groups, it can help us better understand the dynamics of complex systems and make more informed decisions.
- It can help managers understand the incentives, strategies, and outcomes of different scenarios, and design policies that promote cooperation, efficiency, and fairness. E.g.

1. The Prisoners' Dilemma
2. The Byzantine Generals' Problem

The Prisoners' Dilemma

- Two members of a criminal gang A and B are arrested and imprisoned. Each prisoner is in **solitary confinement** with no means of speaking to or exchanging messages with the other. The police admit they don't have enough evidence to convict the pair on the principal charge. They plan to sentence both to a year in prison on a lesser charge.
- Simultaneously, the police offer each prisoner a **Faustian bargain**. If he testifies against his partner, he will go free while the partner will get three years in prison on the main charge. If both prisoners testify against each other, both will be sentenced to two years in jail.
- The goal of both parties will be to **maximize gain and minimize loss (MiniMax algorithm), under uncertainty (stats/mats)**.

The Prisoners' Dilemma

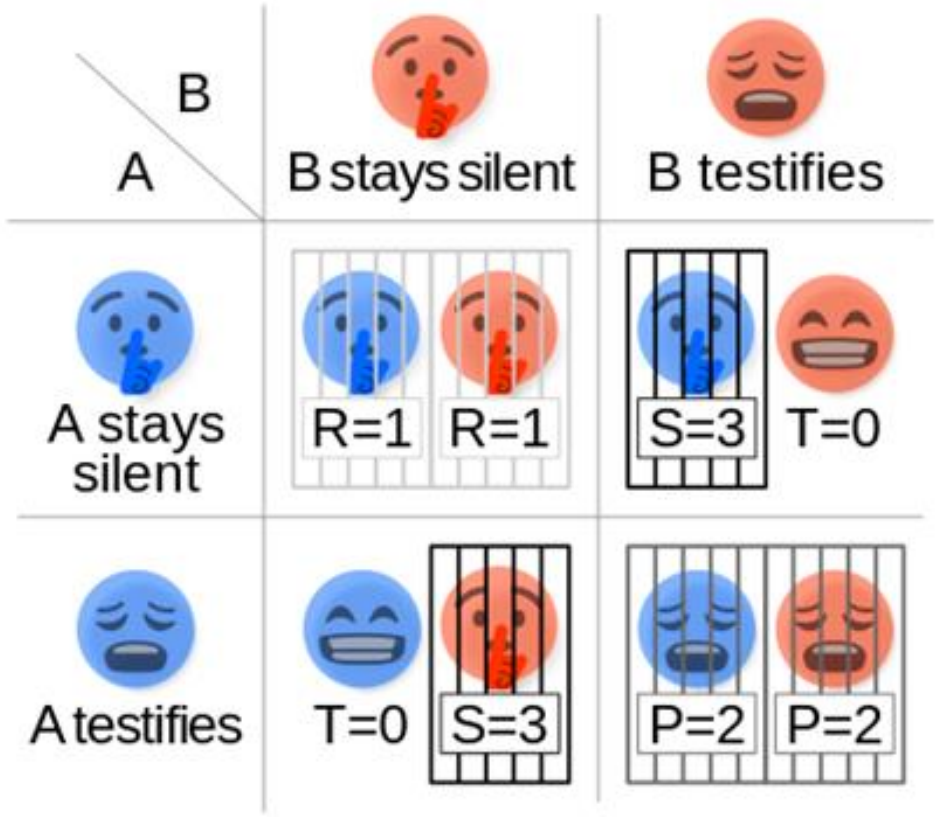
This leads to four different possible outcomes for prisoners A and B:

1. If A and B both remain silent, they will each serve one year in prison.

2. If A testifies against B but B remains silent, A will be set free while B serves three years in prison.

3. If A remains silent but B testifies against A, A will serve three years in prison and B will be set free.

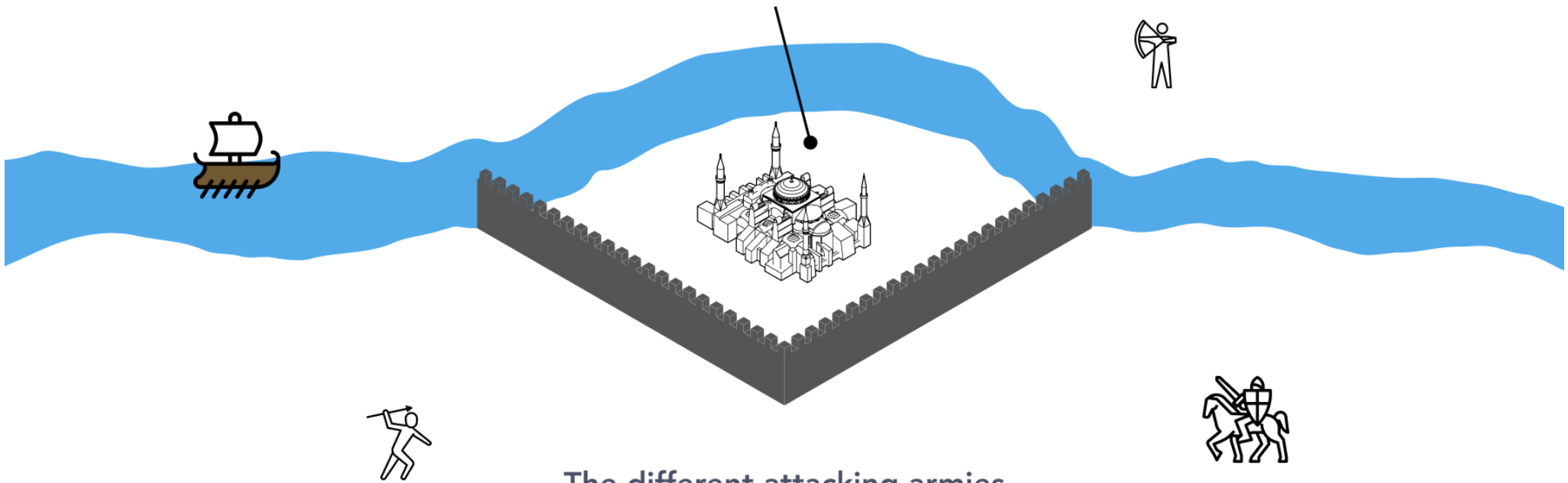
4. If A and B testify against each other, they will each serve two years.



The Byzantine Generals Problem

A game theory problem: How do decentralized parties arrive at consensus without a trusted central party?

The defender can intercept communication between attackers and send false messages.



The different attacking armies only win if they all attack at the same time, but they have no secure communications.

The Byzantine Generals' Problem

- The Byzantine Generals Problem is a game theory problem, which describes the difficulty decentralized parties have in arriving at **consensus** without relying on a "trusted" central party.
- If all generals attack at the same time, they will win, but if they attack at different times, they will lose. The generals have no secure communication channels with one another because any messages they send or receive may have been intercepted or deceptively sent by Byzantium's defenders.
- Centralized systems do not solve the Byzantine Generals problem, which requires that **truth be established trustlessly**. Rather, they sacrifice trustlessness for efficiency and choose not to face the problem at all. However, centralized systems are vulnerable to corruption by the central authority.
- Bitcoin was the first realized solution to the Byzantine Generals' Problem with respect to money. Its **Byzantine fault tolerance (BFT) algorithm** is based on the concept of a **consensus mechanism** (PoW).

Strategic games

Examples

- Chess

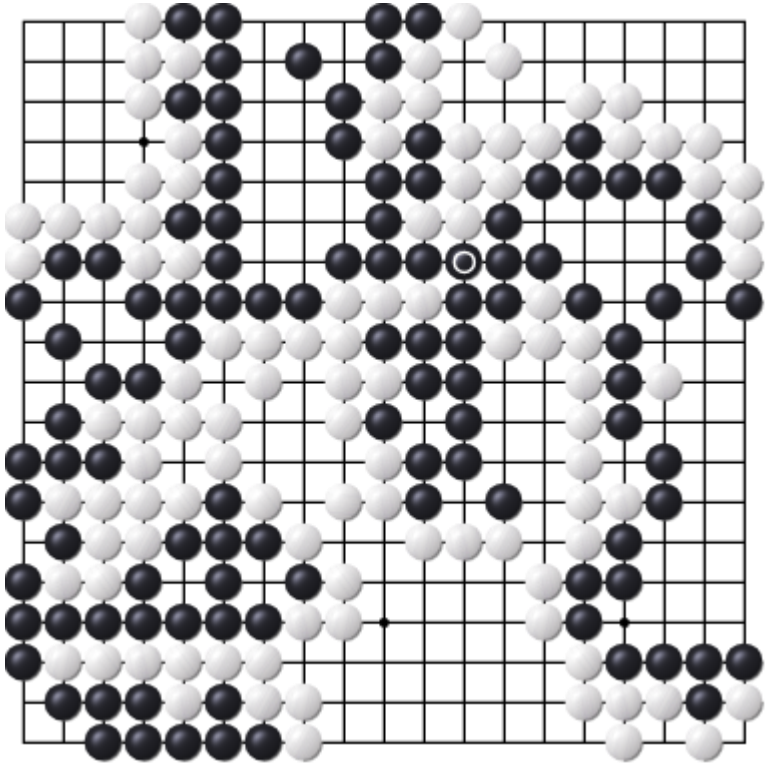
https://lichess.org/analysis

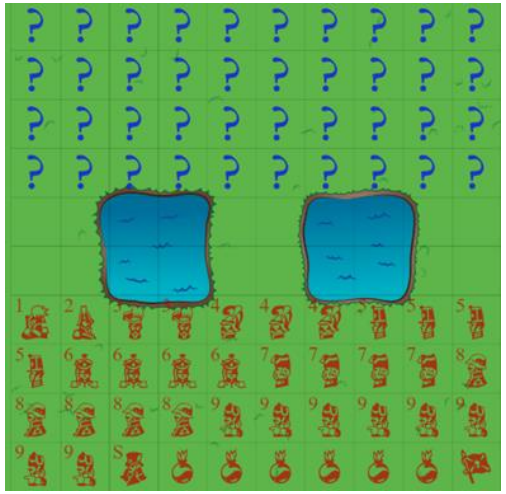
- GO

https://online-go.com/

- Stratego

https://www.stratego.io/





Serious Games

Examples

- The Evolution of Trust

https://ncase.me/trust/

- Oiligargy

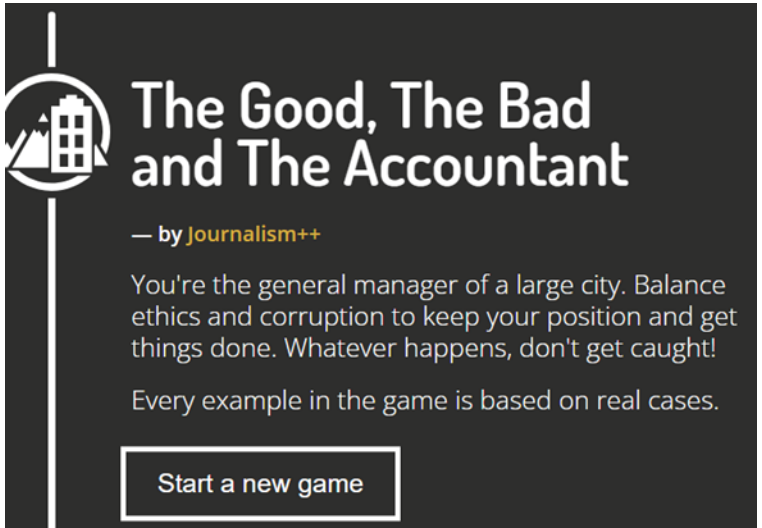
https://www.crazygames.com/game/oiligarchy

- The Uber Game

https://ig.ft.com/uber-game/

- The Good, The Bad and The Accountant

https://jplusplus.github.io/the-accountant/#/



How do firms use game theory in decision making?

- Game theory has a wide application in economics. An example is two firms in a **duopolistic market** competing for profits. In this case, each firm attempts to counter the strategies of their competitor to maximize profits. For example, firms may use game theory to determine the optimal price to set for their products, taking into account the possible reactions of their competitors.
- Game theory can also be used to study the **behavior of consumers** in markets, such as auctions or bargaining situations.
- Game theory can be used to **analyze negotiation and bargaining situations**, such as salary negotiations, business deals, or diplomatic discussions.
- By understanding the underlying strategic dynamics, individuals/companies can make better-informed decisions and improve their chances of reaching a favourable outcome.

Assignment 1 – Serious Games

- Play the 4 proposed games individually (eLearning)
- Explain your strategies and outcomes
- Describe the contribution of these different Serious Games to business and/or personal life.
- Also suggest 1 other serious game, and explain why.
- Upload your findings in a document in the dropbox Part I
- Deadline is 28/09 12:00
- Evaluation 25% exam