questions_overview

1. Introduction (source)

1. From Robots to autonomous agents

1. What are the types of robots according to their usage?
    - Industrial and work robots
    - Domestic or household robots
    - Medical robots
    - Personal assistant robots
    - Military and police robots
    - Entertainment and pet robots
    - Research robots
2. What are the types of robots according to their locomotion and kinematics?
    - Stationary robots and robotic arms
    - Mobile robots with wheels
    - Mobile robots with legs
    - Swimming robots.
    - Flying robots.
    - Swarm robots
3. What is the definition of an autonomous agent?
   An autonomous agent is a computer system that is capable of independent (autonomous) actions on behalf of its user or owner. They:
    - *are situated* within an *environment*,
    - sense the environment, they are situaded in,
    - *act upon* their environment over time **in pursuit of their own agenda**
4. Give some examples of autonomous agents
    - source
        - autonomous robots,
        - program agents,
        - virtual assistants,
        - artificial life agents,
        - computer viruses and worms.

2. Artificial perception

1. What is artificial perception?

- Artificial perception is *a computerised imitation of natural perception*, which is *the process of recognising and interpreting sensory stimuli.*

2. What is the relation between artificial perception, cognition and recognition
    - **Perception** is the basis for **cognition**, since we need to perceive our surroundings to form *relevant concepts* about it. While **recognition** is the process of *applying already perceived relations* onto a new set of events. (source)
3. How is artificial visual perception performed by computer image analysis?
    - Artificial visual perception, by computer analysis is performed by algorithms, that *analyse and partition the image* into sub-segments or *regions* that represent some meaningfull entities and identify their mutual relations.
4. How is artificial sound perception performed by computer sound analysis?
    - Artificial sound perception by computer sound analysis is performed by algorithms, that *analise and partition the sound* into *sub-segments* that represent some meaningful entities, and identify their mutual relations
5. Why is dealing with spoken language so important in the field of developing artificial intelligence?
    - Dealing with spoken language is of *special importance* in the field of developing artificial intelligence, since *spoken language represents a foundation of fuman reasoning and intelligence*

3. Artificial intelligence

1. What is intelligence
    - Intelligence is *the ability to effectively solve problems in a creative way that is not pre-programmed*. Or the ability to *take over and adapt the ways that other solve problems for their own needs*.
2. What determines intelligent behaviour?
    - Intelligent behavior includes:
        - *Perceiving and interacting* with the environment.
        - *Learning and understanding from experience*.
        - *Reasoning* to solve problems.
        - Applying knowledge in *new situations*.
        - *Communicating and understanding natural language*.
        - *Demonstrating creativity, curiosity, and ingenuity*.
3. Define artificial intelligence
    - Artificial Intelligence refers to *the development of systems or machines* that can perform tasks typically *requiring human intelligence.* These tasks may include reasoning, learning, problem-solving, perception, and understanding natural language.
4. What is the difference between strong and weak AI?

- While **strong AI** focuses on the development of machines that *fully achieve or exceed the human intellectual and cognitive abilities*, **weak AI** focuses on the development of the machines that *can solve specific complex problems* that *does not require the full range of human mental and cognitive abilities*

5. What are the goals of AI?
    - The field of AI has various goals, which inclode:
        - The development of a system that think and/or _act as a human being
        - The development of a system that think and/or _act rationally.
        - The development of AI systems is currently more *detdicated to developing systems that* **think and/or act artionally**
6. What are the sub-fields of AI?
    - The sub-fields of AI are divided in accordance to 2 criteria, *based on content* and *based on research field*. They also get divided in accordance to *their field of application* but this is outside the scope of this question.
    - **Based on content:**
        - *Artificial perception*
        - *Natural language processing*
        - *Machine learning*
        - *Robotics and multi-agent systems*
        - *Knowledge representation and reasoning*,
        - *Planning, problem solving, automatic design*
        - ⋮
    - **Based on research field:**
        - *Combinatorial search*
        - *Expert systems*
        - *Pattern recognition*
        - *Soft computing*
        - *Ambient intelligence and smart environments*
        - ⋮
7. What are the applications of AI?
    - AI is used in various fields, including:
        - *Medicine*: Diagnostic tools, robotic surgeries.
        - *Robotics*: Industrial automation, autonomous vehicles.
        - *Education*: Intelligent tutoring systems.
        - *Entertainment*: Game AI, content generation.
        - *Law*: Legal research and analysis.
        - *Military*: Autonomous systems for surveillance and strategy.
        - *Commerce*: Personalized recommendations, fraud detection.
        - *Space Exploration*: Autonomous rovers and systems.

8. What are the possible consequences of the development of the AI?
    - AI research could have a lot of consequences with potential *societal and ethical* impacts:
        - It could yield an **Artilect**, or a *successor to the human species*
        - If AI were to represent a new species, the question of *what rights and freedoms* it should have
        - The *uniqueness* of these systems comes to mind
        - Potential *security concerns* of this technology being used for malicious purposes, like *military or surveilance* applications.
        - There is also *an ecological debate* going on about the sustainability of current AI systems.

4. Soft computing

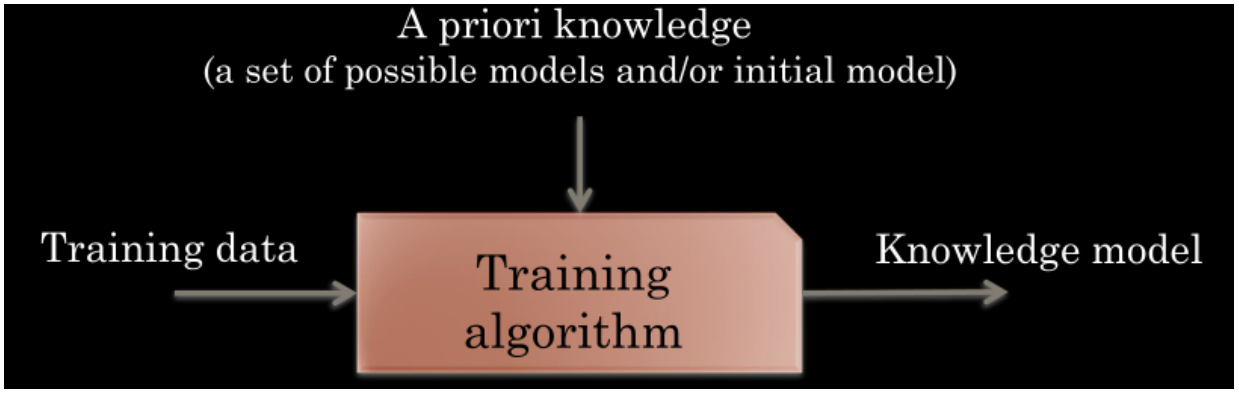
1. What is Soft Computing?
    - Soft computing covers a wider field of computational methods modelling and *solving problems that are too complex* for classical mathematical modelling. Unlike hard (conventional) computing, the *soft computing is tolerant to imprecision, uncertainty, partial truths, and approximation*, which is *inspired by the human way of reasoning* and decision-making.
2. What are the aims of Soft Computing?
    - It aims to *solve problems that are too complex* for classical mathematical modelling.
3. What computing paradigms are covered by Soft Computing?
    - The paradigms covered by *soft computing include:*
        - *Fuzzy logic*, that deals with imprecise and vague real-world knowledge, mimickiking human reasoning.
        - *Neural computing*, made to mimic the biological neural system, is used for pattern recognition and data classification
        - *Evolutionary computing* employs trial and error problem-solving approaches, utilising a population approach to extract the optimal "skillset" to complete a problem
        - *Probabilistic computing* incorporates probability models, to handle uncertainty in complex systems

5. Machine learning

1. What is machine learning?
    - Machine learning is *a branch of artificial intelligence* research, based on *modelling environment from data* and related to the field of *pattern recognition and data mining*.
2. What are the types of natural learning?

- There are various types of natural learning, including:
  - Learning with *imprinting* (unchangeable knowledge)
  - Learning through *conditioning* (Pavlov)
  - *Probabilistic (Bayesian) learning*
  - Learning with *memorizing*
  - Learning by *trial and error*
  - *Immitation learning*
  - Learning with *understanding and insight*

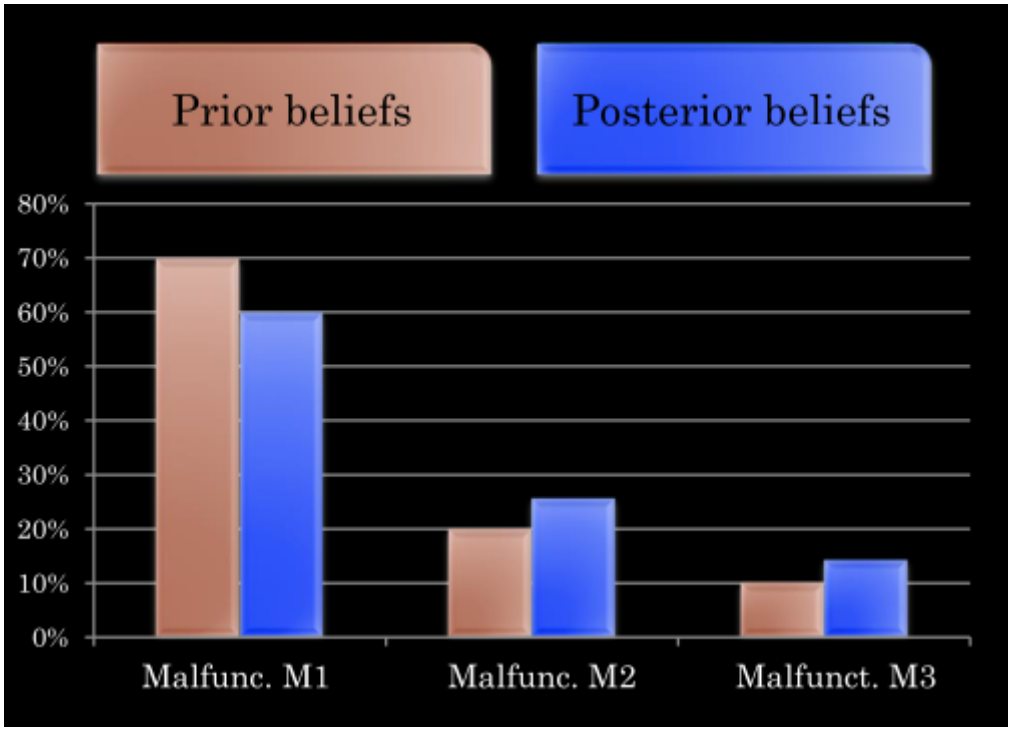
3. What are the basic principles of machine learning?
   - The basic principles of machine learning are:
   - Training data
   - A priori knowledge
   - Training algorithm
   - Execution algorithm
   - Knowledge model



4. What are the main machine learning methods?
   - The main methods of machine learning are:
     - *Supervised Learning:* Learning with labeled data for tasks like classification or regression.
     - *Unsupervised Learning:* Discovering patterns in unlabeled data, such as clustering.
     - Semi-supervised Learning: Combining labeled and unlabeled data.
     - Reinforcement Learning: Learning by maximizing rewards and minimizing penalties.
     - Transfer Learning: Adapting knowledge from one task to improve another.

5. Give an example of machine learning with Bayesian reasoning
   - In Bayesian inference, the a priori knowledge is modelled as a *prior belief* (trust, uncertainty) and is often called prior . In accordance to the *Bayesian theorem*, the belief mode is *adjusted according to the likelyhood of the obtained data.*
   - Let's set an **example** of using Bayesian inference in machinelearning. A technician *needs to diagnose a car* that presents with *unusual sounds.* His *prior beliefs* are, that 70% of car engines with such noises *had a malfunction* of type 1, while 20% had a malfunction of type 2, and 10% a malfunction of type 3. The technician performs *a*

measurement of the engine vibrations and *analises them* with a special diagnostic tool. The diagnostic tool states, that 60% of engines with a type 1 malfunction present with these vibrations, but so do 90% of cars with a type 2 malfunction and 100% of cars with a type 3 malfunction. The technician **combines** the probabilities of his own *prior knowledge* and the probabilities from the *diagnostic software* and makes an educated guess on the type of malfunction. He also **adjusts his prior beliefs** to the *combined probabilities*.



2. Ambient intelligent systems

1. What a shift of paradigm do we make with the transition from Artificial Intelligence to Ambient Intelligence?
    - While the field of artificial intelligence is very *techno-centric* as it deals with specific technical problems, ambient intelligence is supposed to be very unobtrusive and ubiquitous, making it *human-centric*.
2. What do we mean by "ubiquitous/disappearing computer"?
    - It means that the interaction between humans and computers has *surpassed the prevalent desktop work*, making using the computer *ubiquitous*, since we don't have to think about how we use it.
3. What is the vision of AmI?
    - The vision of ambiental machine learning is a system, supported by *netowrked information communication technologies*, embedded in everyday objects, which:
        - *recognises* human presence
        - *adapts* to the needs of the user
        - *engages in intelligent* interactions using speech and gestures
        - provides *relaxed* and unobtrusive experiences
        - *integrates* multiple environments into a seamless user experience

4. What is the use-value of AmI?
    - *Improvement* of citizens' safety
    - *New opportunities* for work, learning and entertainment
    - New forms of health and social care
    - Tackling *environmental problems*
    - Improvement of the *public service*
    - Modernization of the *social model*
    - Support for *democratic political process*
5. What are the main types of the AmI components?
    - Aml systems feature 2 main kinds of components, *ambient* and *intelligent* ones. Ambient components are mainly used to interact directly with the user, while intelligent components handle the intelligent processes that *facilitate the intelligent behaviour of said system*
6. What are the concerns in the development of AmI?
    - There are various concerns, social, political and cultural, about the use of ambiental intelligence. which exist due to:
        - The potential *loss of privacy*
        - The *concentration of excessive power* in individual organizations.
        - The possibility of the development of *excessively individualized and fragmented society* in which individuals in their hyperreal world will *no longer distinguish between the real and the virtual*.
        - There is also the concern of *unclear accountability* in decision-making processes

3. Intelligent problem solving

1. General problem-solving

1. What usually characterizes a problem?
    - A problem is characterized by *a set of goals*, *a set of objects* and their *relations as well as a set of operations* on objects that are *poorly defined and may evolve during problem solving*.
2. What kinds of problems are considered in the field of AI?
    - There are multiple types of problems:
        - *Deterministic and Fully Observable* (Single-State Problems), where the agent is *fully aware of the current state* and the solution is a sequence of operations.
        - *Non-Observable* (Conformant Problems), where the agent has *no information about the current state* and the solution is a sequence of operations deduced without sensing.

- *Nondeterministic and Partially Observable* (Contingency Problems) In these problems, *percepts provide partial information* and the solution is a tree or a contingent plan.
- *Exploration Problems* involve *discovering and learning* about an unknown state space.

3. What are typical examples of problem solving?
    - The typical examples of problem solving are:
        - Assembling products in industrial production (deterministic)
        - Defining the optimum layout of the building blocks of integrated systems. (non-deterministic)
        - Determining the optimal paths with visiting points in space.
        - Rearranging (putting in order) an environment into a final desired state.
        - Making a series of moves that leads to a victory in a game.
        - Proving theorems in mathematics and logics
4. How is a problem formally defined?
    - A formal definition of a problem requires the following:
        - Defining a state space that contains all the possible configurations of the relevant objects that are part of the problem.
        - Specifying one or more initial states that describes possible situations from which the problem-solving process may start.
        - Specifying one or more final states that describes all the possible situations that are considered to be acceptable solutions to the problems
        - Defining a set of rules that describe all the possible actions (operations) on the problem state space, and usually their costs as well.
5. How are problems solved by search?
    - Search is a *fundamental method* to solve problems that are *not solvable with more simple direct methods*. It provides a framework into which more simple direct methods for *solving sub-problems* can be embedded.
    - The problem is solved by *using the rules and actions* in combination with an appropriate strategy of *traversing/moving through the problem space until a path from an initial state to the final state is found.*
6. What are examples of single-state problems?
    - SIngle state problems are separated into 2 categories , based on the solution:
        - The problems for which _the solution is a description of the path from the initial to the final state
        - Assembling industrial products,
        - Finding an optimal route on maps,
        - Assembling a puzzle picture,
        - The problem of the *Tower of Hanoi* ,
        - The *Water Jugs problem* etc.

- The problems for which *the solution is only a description of the final state*, like:
  - Finding an optimal layout of elements (integrated circuits etc),
  - Defining the optimal time schedule for different parties,
  - A game of n-queens puzzle,
  - The Sudoku game etc.

7. How a directed graph is converted into a tree?
   - A directed graph is converted to a tree by *duplicating nodes and breaking cyclic paths*, if they exist
8. What search strategies are used to search problem trees?

- There are a number of proposed search strategies, such as
  - Breadth-first search
  - Depth-first search
  - Uniform-cost search
  - Depth-limited search
  - Iterative deepening search
  - Informed search with the use of a heuristic function

9. How are search strategies evaluated?
   - Strategies are evaluated using the following criteria:
     - *Completeness*: Does it always find a solution, if it exists?
     - *Time complexity*: The number of nodes generated/expanded.
     - *Space complexity*: The number of nodes holds in memory.
     - *Optimality*: Does it always find a least-cost solution?

2. Solving problems by decomposing them into sub-problems

1. In what ways is the decomposition of a problem to sub-problems usually presented?
   - The decomposition of the problem into sub-problems is *represented by an AND/OR tree*.
   - The *leaves* of the AND/OR trees *are basic sub-problems that are trivial to solve*.
2. What do the nodes represent in an AND/OR tree?
   - Different types of nodes represent different things:
     - *Leaves* represent the lowest level problems, that are *trivial to solve*
     - *Intermediate nodes* represent sub-problems, *derived from combining simpler solutions*
     - *The root node* represents the *final solution of the entire problem*
3. What constitutes a solution to the problem that is decomposed to sub-problems?
   - The decomposed problem is solved by *solving its basic problems in accordance with the final problem solving plan*.

- This *solves the sub-problems in the intermediate nodes* of the AND/OR tree all the way up to the root of the tree, which represents the solution of the entire problem.

4. How many solutions are contained in the tree with only the AND nodes?
   - If an AND/OR tree contains *only AND nodes* then there is *only one possible solution to the problem*, otherwise, there are several.
   - The solution of the problem is *no longer a path, but each subtree of the AND/OR tree containing only the AND nodes*.
5. Describe how the Hanoi Tower problem can be solved by decomposing it into sub-problems.
   - In the given example, the decomposition of a given (intermediate) problem to its *three more simple sub-problems* is always carried out in the same way that can be described as follows:
     - Move the (n-1)-disk tower from *the given initial rod to the given spare rod*.
     - Move the last n-th largest disk *from the given initial rod to the given target rod* (trivial / basic sub-problem).
     - Move the (n-1)-disk tower *from the given spare rod to the given target rod* (which now has the largest disc).
   - If on the given initial rod is only one disk then just move it to the target rod (trivial / basic sub-problem).
6. How production rules can be represented by an AND/OR tree?
   - **AND Trees**: All conditions must be met for the conclusion to hold.
   - **OR Trees**: At least one condition suffices for the conclusion.