1. **Give three examples of expert systems:**

Chess solving system, taxation systems and MYCIN.

MYCIN is a rule-based expert system that is used to diagnose bacterial infections of the blood. It does so by asking questions and using backward-chaining through a rule base of about 500 rules, to then determine and recommend effective drug prescriptions.

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Speech recognition, loan advising and mathlab

1. **Describe common knowledge representations.**

Rules, Meta-rules, O-A-V, Logic, Frames, Semantic network, Ontologies.

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**Semantic nets (semantic network) is** a knowledge base which represents the semantic relations between the different concepts in a network. Googles search engine is an example. It is presented as a graph made up of nodes and edges where the nodes represent objects and the edges the relationships between the nodes, they also have a direction.One can create systems that can reason about the data within a certain domain.

**Inheritance**, is a type of relationship by allowing subclasses inherit the properties of its superclass. For example Fido is a subclass of dog and dog is a subclass of mammals. Dog will inherit properties of mammal and Fido will inherit properties of dog and mammal.

**Frames**, is a structure used in both semantic nets and inheritance. The objects in semantic nets is a frame which has one or more slots and slot values that describes the relationship between frames. For example the frame Fido has a slot “is a” with a slotvalue “dog”.

1. **What is O-A-V and how is it related to MYCIN?**

O-A-V stands for Object – Attribute – Value and was used in the MYCIN system in this type of manner: (Ball, Color, Red) (Bob, Age, 22) But maybe with slightly more advanced medical terms. Either way, this way MYCIN could store only data that was relevant, and could leave knowledge that was missing empty. Instead of filling a large matrix or the likes with info,.

1. **What are the four key features of an expert system, list and explain them?**

* Expertise, which implies that the system must possess expert knowledge to make decisions as an expert of the field would.
* Symbolic reasoning implies that knowledge must be represented symbolically, and decision be made using symbolic reasoning rather than mathematical calculation. (Backward and forward chaining).
* Deep Knowledge implies that the system needs a certain level of knowledge. The knowledge needs to be at the level of an expert of the field.
* Self-knowledge is something that the system needs to examine its own reasoning and motivate how it came to a certain conclusion. The system must have the ability to learn from its mistakes and success.

1. **What are the main knowledge types? Explain them.**

* Procedural is knowledge about how to do something. It describes itself, procedural information describes how to execute a procedure. The procedural knowledge is therefore often related to rules, if x then do y else do z. It explains how the system should execute things.
* Declarative knowledge are concepts, objects and facts. This is a descriptive type of knowledge which describes what kind of facts about a field that is known.

1. **Explain forward chaining.**

Forward chaining is a technique used to gather information and then infer whatever that can be inferred. Forward chaining is facts/data-driven for example suppose we have A, B, C D, E facts in our database.

We have the following rules:

Rule 1 : Y & D -> Z

Rule 2 : X & B & E -> Y

Rule 3 : A -> X

Rule 4 : C -> L

Rule 5 : L & M -> N

In the first round we can see that we have A and C which gives us X and L. In the second round we can apply rule 2 since we have X and we can infer Y. In the third round we can infer Z because of Y. Rule 5 will be ignored since we don't have any facts on M. The downside to this approach is that we end up calling many actions that are unrelated. For example suppose we need Z but we end up calling rule 4 “C -> L” which is unrelated to rule 1.

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Forward chaining is an inference technique that starts with the data. The rules are first applied to the available data and the result is used to see if the goal was produced from this data.

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In a system where we have data and a decision (goal). Forward chaining refers to the

method of using data to reach the decision.

1. **Explain backwards chaining and give an example.**Backwards chaining starts with facts being entered into a system and the system then using the facts to try and prove a hypothesis. If there are missing facts the system could use forward chaining which is the opposite of backward where you start with a hypothesis and work through the facts for it to help ask relevant questions for the user. Example: You know strawberries are red and small, and you know tomatoes are red and large. You then know the user has a red object so you ask if the object is small and then can come to a conclusion.
2. **What is an expert system?**

An expert system is a computer based system that tries to emulate an human expert at a specific domain. They are primarily designed to solve complex problem by reasoning through bodies of knowledge typically represented as if-then rules. One of the most important characteristic of an expert system is the quality of performance. The conclusion it reaches must be accurate. The second most important characteristic is the speed in which it reaches the conclusion. A real human expert typically uses rule of thumb or heuristics. Hence an expert system emulates this approach to cut down the search area and computation to reach a quicker and more accurate solution.

1. **What is the main purpose of Expert Systems?**

The main purpose of Expert Systems is to replicate knowledge and skills of human experts in a particular area, and then to use this knowledge to solve similar problems without human experts participation. In short, expert systems should be able to help a novice to make the same decision and draw the same conclusion that an actual expert would make or possibly exceed.

1. **What is the difference between knowledge based systems and expert systems?**

A Knowledge Based system is essentially an expert system but they use two different domains of data. A knowledge system generally works with information which currently is available, which may or may not be valid. On the other hand, an expert system works with reliable information which is known to be correct.

1. **Give 4 useful tools which can help with prototyping knowledge presentations.**

Graphic maps can be used to easier understand how the structure is represented. These are cognitive map, inference network, decision tree and charts.

1. **What are the limitations of expert systems?**

* They can only handle specific domain compared to a human expert which can handle more domains.
* They don’t have common sense or emotions to be aware of the situation.
* Expert systems can’t learn for themselves and needs to manually receive new data.
* It can be difficult to extract all information needed from human experts, there may be facts that are known but the methods to derive the facts may not the as easy to represent in a knowledge based system.
* Can’t exchange knowledge base, only few thousand of rules.
* Expert systems can only be used for the knowledge-base they were built with, they can only be used in specific circumstances. They also do not know what they are used for or when they cannot be used, they can’t tell the user if the provided problem isn’t what the expert system was built to solve. They can also not “know” how their solution fits into the big picture, a larger context.

1. **What are the limitations of knowledge-based systems?**

They take a lot of time to build and their decisions aren’t always as good as you would need them to be. They cannot use common sense or intuition and can also not find unorthodox solutions (outside the box).

1. **What is Knowledge Representation?**

Knowledge representation is about how you are going to save knowledge. If the machine is going to use knowledge, we will need a way to store it. Depending on what kind of knowledge we wish to store, different structures may be suited. For example, in a rule-based knowledge base where A and B are true, knowledge representation can be: IF A AND B THEN C. The knowledge of C is represented through the rule including A and B.

1. **What is a cognitive map?**

A mental representation/map of one’s environment, which can be represented as graphs or fuzzy cognitive maps in expert systems.

1. **What are some areas where expert systems have been commercially applied?**

*Finance:* insurance evaluation, credit analysis, tax planning, financial report analysis etc.

*Data processing:* system planning, equipment selection equipment maintenance etc.

1. **Explain the concept of Tacit knowledge.**

Tacit knowledge is considered to be a specific kind of knowledge that is considered to be difficult to express or pass on to other people. Typical example of tacit knowledge is the ability to cycle bikes. It is not fully known how we keep balance, but we do know that. Furthermore, the opposite of tacit knowledge is called explicit knowledge.

1. **What is an expert system shell?**

An expert system shell is an expert system with the knowledge removed. (Negnevitsky)Hence, everything that the user needs to do is to add certain knowledge to it, in the form of the rules, and also add specific data which is required to solve a problem.Hence, many expert system nowadays can be made by just one person filling in the data on the computer into the shell, that is, a team of 5 people, as mentioned in the general description above, is not required.

1. **What is Fuzzy logic, and can we make a fuzzy expert system?**

Fuzzy logic is considered to be a method of reasoning that bears resemblance to human reasoning, that is, it does not require that each decision needs to have a definitive value yes or no, but can also be something in between. It is based on “degrees of truth”. A fuzzy expert system can be implemented by using fuzzy logic and rules(instead of Boolean rules) to reason about data.

1. **Explain what a frame means, and how the frames are related in frame based system.**

Frame is a certain data structure which has specific information about a concept or object. Furthermore, every frame has its name and set of attributes. Furthermore, there are 3 types of relations in frame-based system: generalization, aggregation and association. Generalization represents a-kind-of relation between superclass and subclass. Aggregation represents a-part-of relationship where multiple components are associated in a superclass representing the whole. Association represents semantic relation between different classes which are, otherwise, independent.

1. **Explain structural and meta knowledge**

Structural knowledge shows how and in which way things work, and what is the relation between those things. On the other hand, meta-knowledge is considered to be knowledge about knowledge, and the concept of meta-knowledge is specifically useful when we need to decide which knowledge should be used in order to solve the problem

1. **Where does the real problem solving power lie?**

In domain dependent real world knowledge. Not in algorithms or smart reasoning techniques.

1. **What does the domain expert(SME) do and why is this person important?**

It is an person with special knowledge or skills in a specific area or domain, that is not the software domain. One example is an accountant that is an expert in the domain accountancy. This role is important, because in order to build a Knowledge base, the domain expert needs to provide the knowledge engineer with expert information.

1. **What components form the knowledge base?**

Heuristics, rules, objects, attributes, hypothesis, relationships, definitions, events, processes, facts.

1. **Name the three subsystems in an expert system and what they do.**

An Expert System traditionally consists of three parts, the User Interface, the database and the inference engine. There could be more parts of course, but these are the most basic.

The **User Interface** allows the user to communicate with the expert system and thereby seek a solution to a problem.   
The **Knowledge Base** contains the rules and reasoning of the Expert System, this is where the IF-THEN information is stored as well as Heuristics and the likes. The **Inference Engine** links together the Knowledge Base and the Database, to allow for transfer of information between the two. The Inference Engine can then pass along the reasoning from the Expert System. When the user asks the expert system a question, the inference engine is meant to search through the knowledge base using the users query to provide a useful conclusion that can be returned to the user as an answer

1. **Explain what Heuristics is.**

Is also called “Rules of thumb”. It can be used when not all facts are known but we still can reach a conclusion. Ex:

When this liquid is red

And the connection rod is hot

Then, the engine is broken.

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Heuristic knowledge can be explained as knowledge that helps with drawing conclusions when there is faulty or missing information, this information is often gained through experience much like human intuition.

Best first and A\* algorithms can be given as an example for heuristic search. Also travelling salesman, which is about shortest possible route, and virus scanning are examples of heuristics.

1. **What is a Decision Trees?**

Composite of nodes and links, the nodes represent decisions and links represents a value for each decision. Traverse the tree to reach a solution. They help map out the decision-making process.

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A decision tree is a presentation of a problems search space. Nodes are decision that needs to be made and links are the decision chosen. It becomes a tree since decisions often lead to new decisions that have to be made. Traversing the tree gives the solution.

1. **What is the knowledge acquisition problem?**

Process of converting human knowledge into computable rules and facts.

1. **What are the advantages of expert systems?**

The main advantage of an expert system is its consistency meaning that it will make the same decision for same situations because the knowledge is programmed into the system. It can also store a lot of data and knowledge. Another benefit is that the system is always available and can be used accessed by multiple users at the same time.

1. **What is an ontology?**

Ontology is the teaching of what exists and what it means to exist. How reality may ether be unambiguous or if everything is a fabrication of our senses. In computer science ontology is a representation of the knowledge from different concepts and the relationship between those concepts (within a domain). Ontology is used to describe and reason about different properties in each area. It also defines a common vocabulary.

1. **Explain the terms Knowledge- elicitation/acquisition/transfer.**

Knowledge is a collection of data, information and experience about the particular task.

Knowledge elicitation: Collect, interpret and analyze the knowledge of experts. (Interviews, books etc.)

Knowledge acquisition: Elicitation plus structuring and organizing the result. (Often in terms of rules)

Knowledge transfer: Acquisition plus an end user using the system (The knowledge has been transferred to another person).

1. **What are typical problems at the knowledge elicitation and how can they be approached?**

One problem could be that the expert gives controversial answers. In this case, asking other experts in this domain will be helpful. If different experts give different solving strategies for the same problem, confronting each of the experts with the contradicting strategies may result in aligned answers.

1. **Explain the difference between Cognitive maps and Inference networks.** Cognitive maps shows the relations between objects and concepts. Shows objects in a hierarchical graph where child objects have a link to their parent. Nodes have attributes/properties. Similar to Frames.   
   Inference networks shows the rules of a system, children are premises and links are relations (AND/OR). So, both can show the objects and their properties, but they are presented in different ways.
2. **What are production rules in Expert Systems?**

Production rules are ways the system can determine a possible solution to a certain input data. If we take the earlier example of MYCIN, that was a system that accepted a bunch of data and then compared it to certain rules to determine a diagnosis. Some examples for simpler diseases could be If HEADACHE then COLD, BRAIN TUMOR, POOR EYESIGHT If HAS\_GLASSES then COLD, BRAIN TUMOR This way, the system can remove the diagnoses that are no longer possible.

1. **One knowledge representation, perhaps the most common, is production rules. Three problems that can arise are subsumed rules, circular rules and conflicting rules. Describe them and how you can solve them.**

(conceptually) One rule can be subsumed by another if it is included in it. Handle it with meta-rules, so that the subsumed rules condition is a premise in the rule which subsumed it. Ex: R1: A && B => X R2: A && B && C => Y With meta-rule: MR2: R1 && C => Y Circular rules are (meta)rules which are independent of each other forming a cycle. They are avoided by not forming cycles, use some graph algorithm if too complex. Ex: R1: A && B => X R2: R1 && R3 => Y R3: R2 && C => Z Conflicting rules are rules which create a conflict and thus gives conflicting conclusions. Avoid conflicting rules by being consistent. Ex: R1: A && B => X R2: A && B => !X.

1. **Name some advantage with Knowledge-based systems.**

Since the system is built upon explicitly represented knowledge, it is capable of explain its reasoning with full precision, unlike humans. By presenting the rules with which it drew its conclusion it can present combinations of reasoning which might have been previously unknown and unthought of.

1. **Explain what Knowledge extraction is.**

Knowledge extraction is the creation of knowledge from structured (relational databases, XML) and unstructured (text, documents, images) sources.

1. **Can an Expert System replace a human expert?**

Expert systems, when limited in their area of expertise, can perform exceptionally well. But they are only as good as the data loaded to it, e.g. IBM's famous Watson. Implicit knowledge, like tacit knowledge, cannot be applied by a computer. This leads to several problems, when the expert system reaches its predefined database boundaries. E.g. an expert system used in an surgery-robot, how will the robot behave if it encounters a new situation which is not covered by the predefined data?

1. **Explain why knowledge based systems generally are considered to scale badly.**

The very core of a knowledge based system is the facts and ruled stored in the knowledge base, the acquisition of these facts and rules for any individual domain is often very costly which causes the expansion of the system in general to be very costly.

1. **List three types of knowledge based systems.**

Expert systems, CASE-based systems and Linked systems.

1. **What is a knowledge-based system?**

Knowledge-based system (KBS) is a broad term that refers to many different kinds of systems. A KBS uses a knowledge base to store “knowledge” (how to use the database) which is represented for example via logic, ontologies and Meta-rules. Inference engine is another important subsystem of a KBS. While the knowledge base represents facts within the domain, the inference engine represents conditions and is used to draw conclusions for the content of the knowledge base.

1. **Explain the disadvantages of an expert system compared to a human expert.**

An expert system is better in looking at facts but a human has several advantages. The most important advantages are that a human has intuition and has an overview. A system doesn't know what it is doing and it can only rely on the facts and rules that are implemented.

1. **Describe an appropriate way to develop a knowledge based system-**

The most important part of an knowledge based system is the database. Especially if you use an knowledge based shell the most important part is collecting data and building a knowledge base. Therefore it is useful to form a team of engineers for knowledge based system and experts for the specific domain. Also using different types of charts can be useful to show the structure of the knowledge. In developing the program an agile attempt should be used. For example it can be a good idea to test the prototype, edit the knowledge base,test it again and so on.

1. **Explain how does a DSS differ from an expert system?**

A decision support system (DSS) require extended interaction with decision makers for the system to be effective whereas an expert system tries to mimic the knowledge of experts in their domain and require less involvement of end users.

1. **Explain the KR scheme Frame and some of its advantages.**

The frame scheme is an object-oriented data structure. Each frame consists of a set of slot -value pairs where the slot describes what kind of information is stored in the value. Frames can also be connected in a way where one frame is a subset of another frame and it then inherit properties from its parent frame that then can be changed if needed. One of the advantages of frames is their flexibility as it can easily deal with exceptions by adding newslot - value pairs to a given frame.

1. **Explain what a knowledge graph is and mention some benefits?**

A knowledge graph is a knowledge base which represent data in the vertices in a graph. Example if we have a nod for machine, it's subnodes/neighbors can be car, airplane or boat for example. This is an effective way to store data that is related to each other and this data structure is used by google.   
The program can look at a vertices neighbors to be able to predict what the user wants or simply just find related information.

1. **If you were to design a system that could guess what person you are thinking of using only yes and no questions, what system would you choose.**

A Knowledge-based system is clearly the better choice here. The Knowledge-base would need to contain a huge amount of information about almost every possible person in existence.

1. **What kind of system is Eliza?**

Eliza is a very simple Expert system that is identifying the minimal context with the highest ranked keyword.

1. **Discuss which of the two systems that has the highest probability of causing a large impact in the future.**

I think that if there is a breakthrough in knowledge acquisition then the Knowledge-based systems will be of great use since a large database is easily created.

1. **What inference method starts with a list of goals and works backwards from the consequent to the antecedent to see if any data supports any of these consequents?**

Backward chaining or backward reasoning**.**