ENGLISH (Oppgaver på bokmål starter på side 8, og nynorsk på side 15)

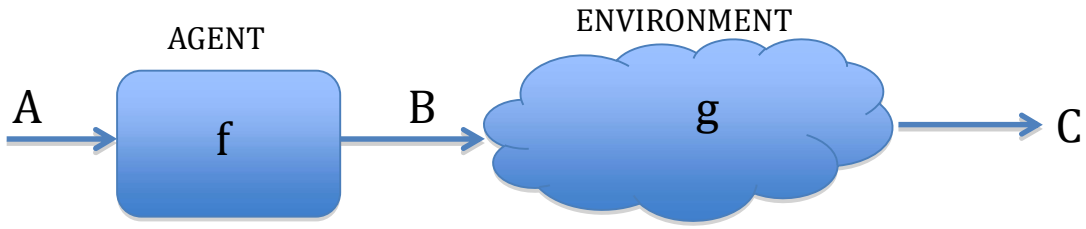
All problems have equal weight, i.e., 10 points.

Problem 1

Answer the following sentences with True or False. *A* is a special case where you should choose between *a* and *b*. For some of the sentences you are explicitly asked to explain your answer.

A. Which one of these does a rule-based agent system (like the one on a classical expert system) have in its *agent function*? a)contention scheduling algorithm b) conflict resolution algorithm? Answer with *a* or *b*.
B. In a rule based system, when there are more than one rules that match the current situation and when the agent wants to explore a new/different (than the one in focus last time) hypothesis, the agent prefers the rule that has in its left side (of the a→ b) elements that are most recently updated in the working memory of the agent. Is this statement True or False? If false, describe why – very briefly.
C. The first phase of GraphPlan can be used as a heuristic function for forward search in the following way: Given a state s and goal g, run the graph-construction phases of GraphPlan until all the components are present and not mutex in the last layer. Let n be the number of action layers in the graph. We can let n be the heuristic value for s. This an admissible heuristic. True or false?
D. Density is an extrinsic property of olive oil. True or false?
E. Frame-based representation is mainly a declarative representation. True or false?
F. Spreading activation and inheritance are main mechanisms of inference in rule-based systems. True or False?
G. Turing test measures the utility of an agent. True or false?
H. In a rule based system, backward chaining works best when the rules have complex consequent structures. True or False?
I. N-gram character model is a natural language model. True or False?
J. *Sufficient* and *necessary* conditions are inference rules for sound reasoning. True or False?

Problem 2



The above figure illustrates an agent system. The two main components (depicted as a square and a cloud shape respectively in the figure) are the agent and the environment modules.

A. In the agent terminology what is the generic/abstract names of each of A, B and C in the figure?
B. What is the ***f*** and the ***g*** function called in the agent terminology? What role does each play in an agent system?
C. Is there a relationship between A and C? Explain your answer – very briefly.

D. Assume now that the "AGENT" in the system is purely reactive.
    a. Draw a figure illustrating how the agent makes its decisions, i.e., illustrate what it takes into consideration and what type of decision(s) it takes?
    b. Can a purely reactive agent predict the consequences of its action in the environment? If the answers is "yes", explain how, and if it is "no" explain why not
E. Assume now that the agent is a goal-based agent and its current task is to achieve a certain goal in the block world ENVIRONMENT . For example, ON(X ,Y); move (X ,Table) etc, .
    a. Draw a figure illustrating how the agent makes its decisions, i.e., what it takes into consideration and how it does deliberate (think)?.
    b. Can a goal-based agent predict the consequences of its action in the environment? If the answers is "yes", explain how, and if it is "no" explain why not.

Problem 3

Choose suitable predicates and translate the following sentences into first order predicate logic:

A. Cats are animals.
B. Pusur is a cat.
C. Every dog owner is an animal lover.
D. No animal lover kills an animal.
E. Either Ole or Pusur kills Fido
F. All soccer players either play with Rosenborg, or they are world-class players, or both.
G. All soccer players either play with Rosenborg, or they are world-class players, but not both.

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Problem 4

Given a set of logical sentences and a set of models for which sentences can be true or false.

A. What does it mean that a sentence is 'valid'?
B. What does it mean that a sentence is 'satisfiable'?

C. Determine, for example by using a truth table, whether the following sentence is 'satisfiable':

$$(A \Leftrightarrow B) \wedge (\neg A \vee B)$$

Justify your answer.

D. What does it mean that an inference rule is 'sound'?

E. Prove whether the following inference rule is sound or not:

$$\frac{P \Rightarrow Q,\ Q}{P}$$

P	***Q***	***P*** $\Rightarrow$ ***Q***
T	T	T
T	F	F
F	T	T
F	F	T

Problem 5

A. What is a state space? List the most important components of a state space, and describe the role of each component.

B. Explain the meaning of the following two concepts:

- Heuristic
- Heuristic search

C. Given the evaluation function for heuristic search in the form f(n) = g(n) + h(n). What do the terms mean?

C. Define the A* algorithm

Problem 6

A. True or False?: Greedy Best-First search using the heuristic h(n) = 0 for all states n, is guaranteed to find an optimal solution.

B. True or False?: If h1 and h2 are both admissible heuristics, it is always preferable to use the heuristic h3(n) = max(h1(n), h2(n)) over the heuristic h4(n) = min(h1(n), h2(n)).

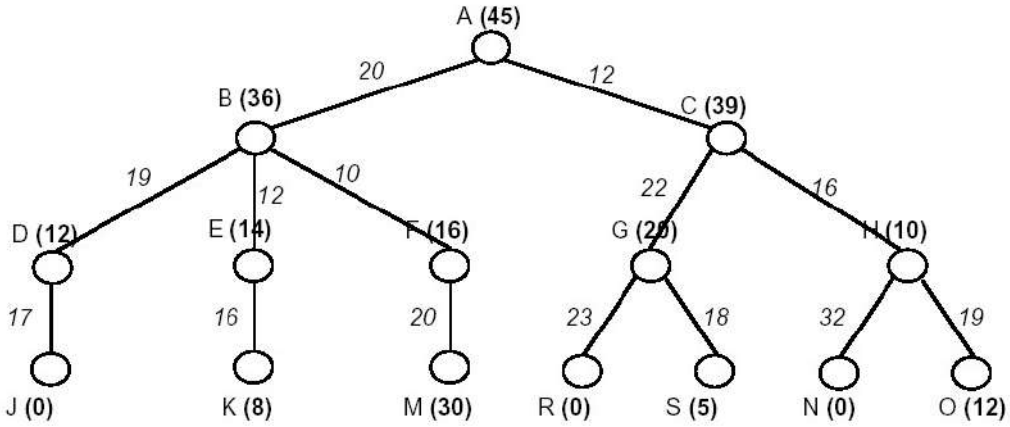
C. True or False?: If h1 is an admissible heuristic and h2 is not an admissible heuristic, (h1 + h2)/2 must be an admissible heuristic.

D. Greedy Best-First search using h(n) = −depth(n) corresponds to which search method?

E. Say we have a search space that has a large branching factor at most nodes, there may be infinitely long paths in the search space, we have no heuristic function, and all arcs have cost 1. What search method would be good to use in this situation and why?

Problem 7

A search tree is shown below. Node A is the initial state and the nodes J, R, og N are goal states. Each node is market (in parenthesis behind the letter) with a number corresponding to the value of the heuristic evaluation function for that node. For example: G(20).



For each of the following search strategies A and B,

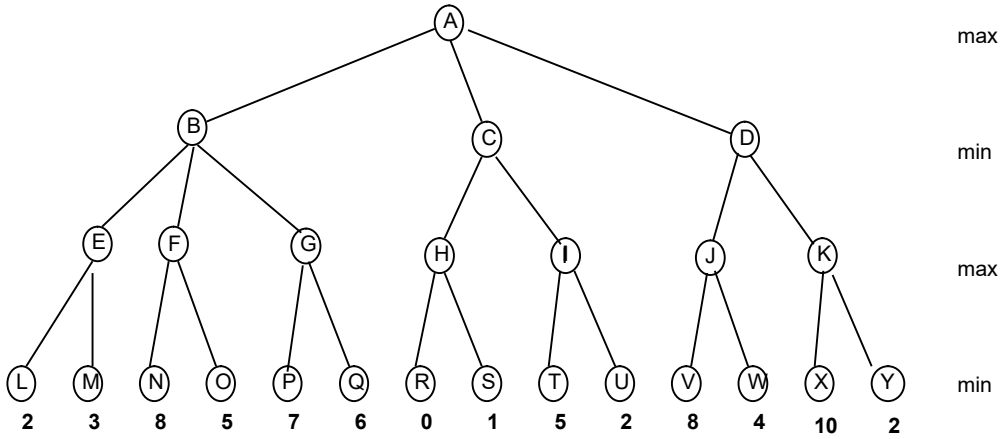
- list the nodes in the order that they get expanded
- list the nodes along the final path between the initial state and the goal state:

A. Hill climbing

B. A* search

Problem 8

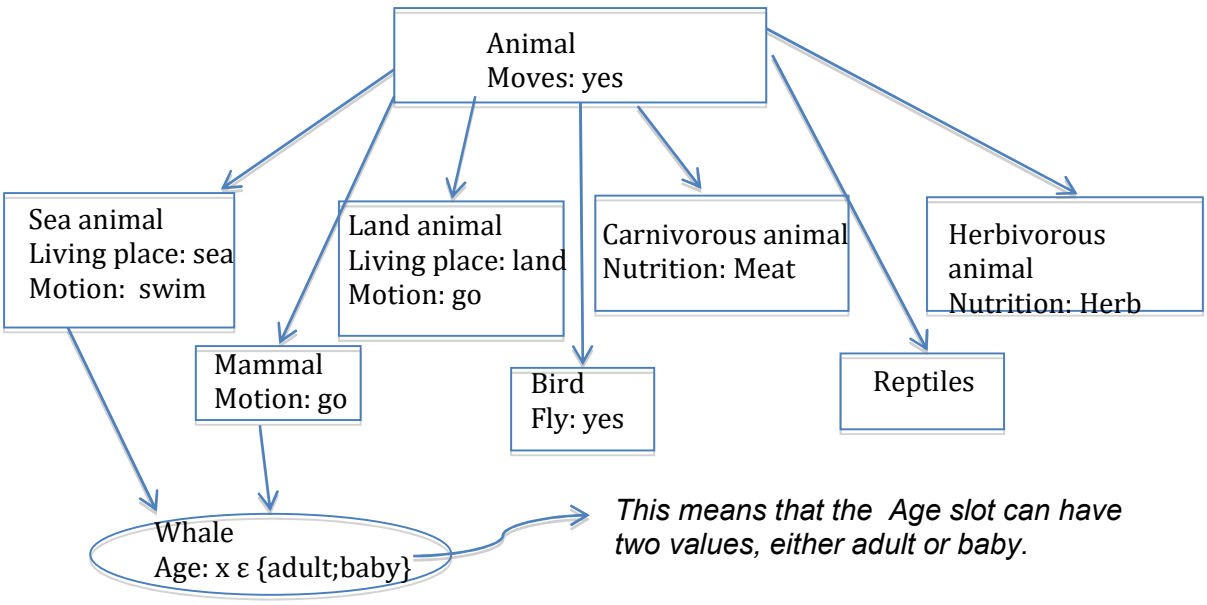
Given the game tree below, in which the evaluation function values are given for the leaf nodes. Assume an alpha-beta search strategy, left to right.



Which nodes will not be expaned? Which move will max choose in state A?

Problem 9

A. What does a partition of a category mean? Give an example.
B. Does the **animal** category in the figure below have a partition? If so, write it down; write all partitions of **animal** if there are more than one.
C. We want the system to be able to answer the question " How many kg does a particular whale (i.e., my-whale) eat each day?". How would you update the knowledge base of the agent in order for it to give the correct answer to such a question? In your solution, the system shall have the knowledge that baby whales eat 5 kg food each day while adult whales eat 20 kg. A constraint is that the new knowledge base shall NOT have two additional frames for "baby whale" and "adult whale". ".



Problem 10

This problem is about planning and consists of two independent questions (A and B).

A. Suppose you are implementing a planning mechanism for the block-world applications. **Result** is a function which, given action ***a*** and environmental state ***s***, computes the the state of the environment after execution of ***a***. Assume you have the following two alternatives to define **Result**:

Result1 (s, a) = ([s $\cup$ [Add(a)] - Del(a))
Result2 (s, a) = ([s $\cup$ Del(a)]- Add(a))

where ***Del*** and ***Add*** correspond to what becomes True and False, respectively, as the result of action ***a***.

Would a choice between adopting Result1 or Result2 make a difference on the planning result? Choose one of these 3 options: a) No difference between Result1 and Result2, b) Result1 is the correct function, c) Result2 is the correct function.

Motivate your answer by considering the following PDDL for a blocks-world problem:

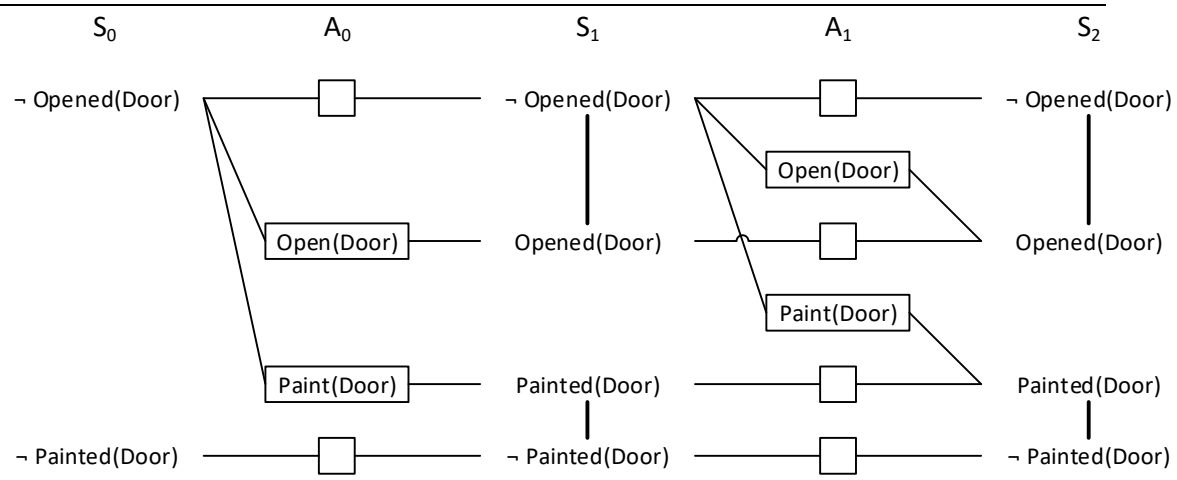
Action MoveToTable(b, x)
PRECOND: On(b, x) $\wedge$ Clear(b) $\wedge$ Block(b) $\wedge$ (b $\neq$x)
EFFECT: On(b,Table) $\wedge$ Clear(x) $\wedge \neg$ On(b, x)

Notice that in the PDDL snippet above, **Add** and **Del** are not separated but are put together as **EFFECT**.
Explain your answer briefly.

B. For the following planning problem

Init(¬Opened(Door) $\wedge$¬Painted(Door))
Goal(Opened(Door) $\wedge$ Painted(Door))
Action(Open(Door)
    Precond: ¬Opened(Door)
    Effect: Opened(Door))
Action(Paint(Door)
    Precond: ¬Opened(Door)
    Effect: Painted(Door)

we have the following planning graph where some mutex links are missing:



Find the missing mutex links between state literals and between actions on all levels.

Write down the list of missing mutex links for each level (both state and action levels). For each mutex link, provide an explanation of why they are mutex. Your answer will look like, for example:

S1:

¬Opened(Door), Opened(Door) – one negates the other
¬Painted(Door), Painted(Door) – one negates the other

S2:

¬Opened(Door), Opened(Door) – one negates the other
¬Painted(Door), Painted(Door) – one negates the other

You do not need to draw the graph, just list the pairs of the state literals and the actions that have mutex relations between them, with an explanation for each pair as shown in the example above.

END OF QUESTIONS
GOOD LUCK!