QUESTION 1 (30 poeng)

Answer he following questions with True or False

1. An agent that senses only partial information about the state cannot be perfectly rational. (True or False?)
    a. ANSWER: False. Perfect rationality refers to the ability to make good decisions given the sensor information received.
2. Every agent is rational in an unobservable environment.
    a. ANSWER: False. Some actions are stupid—and the agent may know this if it has a model of the environment—even if one cannot perceive the environment state.

3. “Strikking av en sokk involves a fully observable, deterministic, sequential, static, continuous, single agent miljø.
    a. Answer: T
4. “Bidding in auction” involves a fully observable, strategic, sequential, static, discrete, multi-agent.
    a. Answer: T

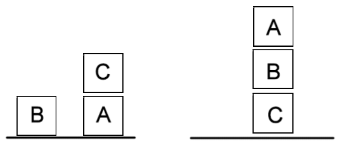
5. The Turing test evaluates a computer system’s ability to act rationally. Answer: FALSE
6. A stochastic environment is one in which the next state is completely determined by the agent’s action.
    a. Answer: FALSE
7. An advantage of Hill Climbing search is that it requires minimal memory.
    a. TRUE
8. A danger of depth-first search is that it may not terminate if the search space is infinite, even if a finite solution exists.
    a. TRUE
9. The knowledge, i.e, the content of the knowledge base determines the system ’ s performance while representation of knowledge determines its competence.
    a. FALSE, the opposite
10. Principal of rationality (due to Allen Newell) maintains that the agent chooses actions in order to achieve its goal using the knowledge it has the knowledge it might gather.
    a. FALSE, only the knowledge it has.
11. This is procedural knowledge about two cities in Norway: bigger (Oslo, Trondheim)
    a. FALSE, declarative
12. An advantage of declarative knowledge is the storage economy, that is, representation of declarative knowledge needs less memory than procedural knowledge.
    a. FALSE: storage economy means that the same declarative knowledeg can be used in different ways.
13. The prodction rules in a Rule-based system is represented in the ” working memory”.
    a. FALSE. They represent this model in the rule base, not in the working memory

14. Assume a rule-based system for classification of fruits. Assume also that the system is currently at time t2 and it uses a refractory conflict resolution strategy. The system will fire the rule R5 at t2.

Step	Applicable Rules	Chosen Rule	Derived Facts
T1	R2, R5		R2
T2	R2, R5		R5

   a. True – tries to avoid loops

15. Consider a block world problem where the goal is On(A,B), On(B,C), and the precondition is On(C,A), On(B,Table), On(A,Table), Clear(C), Clear(B), Block(A), Block(B), Block(C). See the figure below:

   i. 

Suppose a planner that, given subgoals $G_1,...,G_n$, solves each subgoal consecutively (i.e., first one goal, and then the next one,…). If we use such a planner to solve the planning problem above and solve the goals in the given order (i.e., On(A,B), On(B,C)) the planning will obtain an optimal plan.

   b. ANSWER: FALSE: We will get into a deadlock if make a subgoal assumption. For if we try to achieve first On(A,B) efficiently then we will have do MoveToTable(C) and MoveToBlock(A,B) which does not work. Similarly, if we try to accomplish first the goal On(B,C) we will have to do one simple action: MoveToBlock(B,C) and ew are stuck again.

QUESTION 2 - oversettelse til FOPL (20)

a) Translate the following sentences in English to sentences in first order predicate logic

   1. All the existing kinds of birds can fly
      $\forall x Bird(x) \rightarrow Fly(x)$
   2. Some existing kinds of birds can fly
      $\exists x Bird(x) \wedge Fly(x)$
   3. At least two existing kinds of birds can fly
      $\exists x \exists y \neg(x = y) \wedge Bird(x) \wedge Bird(y) \wedge Fly(x) \wedge Fly(y)$
   4. All existing kinds of birds can fly, except two.
      $\exists x \exists y Bird(x) \wedge Bird(y) \wedge \neg(x = y) \wedge \neg Fly(x) \neg Fly(y) \wedge (\forall z Bird(z) \wedge \neg(y = z) \wedge \neg(x = z) \rightarrow Fly(z))$
   5. All birds that are not penguins fly
      $\forall x \; [bird(x) \wedge \neg p(x)) \rightarrow fly(x)]$

or
∀x [*bird*(*x*) → [¬*p*(*x*)) → *f ly*(*x*)]]

6. There are no green Martians.
¬(∃x green(x) ∧ Martian(x))
or
∀x (¬green(x) ∨ ¬Martian(x))
7. Everything painted by Picasso is valuable.
∀x (painting(x) ∧ paintedBy(x, Picasso) → valuable(x))
8. Not all people have a cell phone.
∃p (person(p) ∧ ¬hasCellPhone(p))
9. Everyone who owns a violin knows someone that likes music written by Mozart.
∀x person(x) ∧ owns(x, violin) → (∃y person(y) ∧ knows(x, y) ∧ likesMozartM usic(y))
10. Every students at NTNU knows someone who likes dogs.
∀x studentAt(x, NTNU) → (∃y person(y) ∧ knows(x, y) ∧ likesDogs(y))

QUESTION 3

a) The figure below displays the use of model checking to test whether the following is a **valid** logical expression (using the formal definition of logical validity):

$$\{(A \Rightarrow B) \Rightarrow C\} \Rightarrow \{(C \land A) \Rightarrow B\}$$

A	B	C	$A \Rightarrow B$	$(A \Rightarrow B) \Rightarrow C$	$(C \land A)$	$(C \land A) \Rightarrow B$
0	0	0	1	0	0	1
0	0	1	1	1	0	1
0	1	0			0	
0	1	1			0	
1	0	0	0	1	0	
1	0	1	0	1	1	
1	1	0	1		0	1
1	1	1	1		1	1

Fill in all missing cells of the table with a 1 (True) or 0 (False).
Next, based on the completed table, tell whether or not the expression is valid.

Answer:

Here is the answer, with the newly filled-in values in parentheses. The two starred boxes indicate that the expression is NOT valid.

$$\{(A \Rightarrow B) \Rightarrow C\} \Rightarrow \{(C \wedge A) \Rightarrow B\}$$

A	B	C	$A \Rightarrow B$	$(A \Rightarrow B) \Rightarrow C$	$(C \wedge A)$	$(C \wedge A) \Rightarrow B$
0	0	0	1	0	0	1
0	0	1	1	1	0	1
0	1	0	(1)	(0)	0	(1)
0	1	1	(1)	(1)	0	(1)
1	0	0	0	1	0	(1)
1	0	1	0	1 **	1	(0) **
1	1	0	1	(0)	0	1
1	1	1	1	(1)	1	1

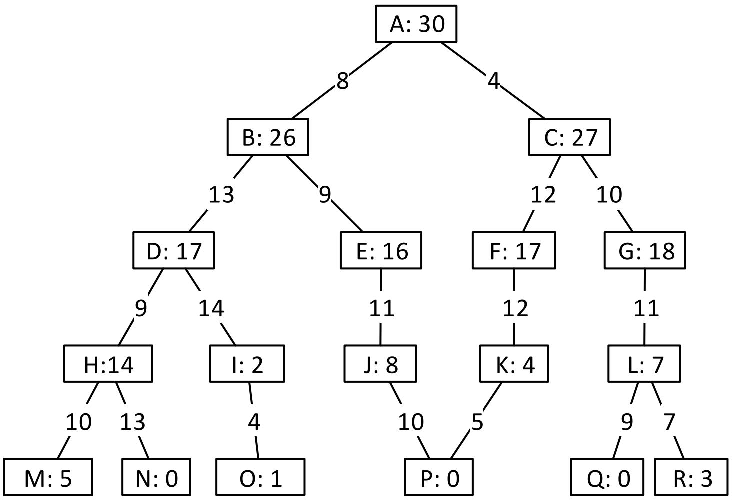
b) Answer the following question with True or False:

1. It is possible to remove the following two primitives from FOPL and still be able to represent all of the same expressions as in standard FOPL: OR and FORALL. Answer = T.
2. In a formal logic, the following expression is false: All 3-headed unicorns in Norway have purple tails. Answer = False (It's a true statement since the antecedent is never true – but correct me if I'm wrong ☺
3. Resolution is an effective (though not necessarily optimal) method for converting logical expressions into horn clauses. Answer = False

4. It is always easier to solve logic problems using backward chaining than forward chaining. Answer = False
5. One of the main benefits of FOPL compared to the vast majority of programming languages is the clean separation between the knowledge and the inference machinery. Answer = True (see page 286, top paragraph).

QUESTION 4

A search graph is shown below. Node A is the initial state and the nodes N, P, and Q are goal states. Each node is labeled with a number corresponding to the value of the heuristic evaluation function for that node, e.g. [A: 30] node with label A has heuristic function value 30.



Answer the following questions:

1. Assuming greedy best-first search strategy, list the nodes in the order that they get expanded. (2 points)
Answer: Answer: A, B, E, J, P
2. Assuming greedy best-first search strategy, list the nodes along the final path between the initial state and the goal state. (2 points)
Answer: A, B, E, J, P
3. Assuming A* search strategy, list the nodes in the order that they get expanded. (8 points)
Answer: A, C, G, L, F, K, P
4. Assuming A* search strategy, list the nodes along the final path between the initial state and the goal state. (2 points)
Answer: A, C, F, K, P
5. Find a node for which heuristic value is not admissible. Explain why it is not admissible.

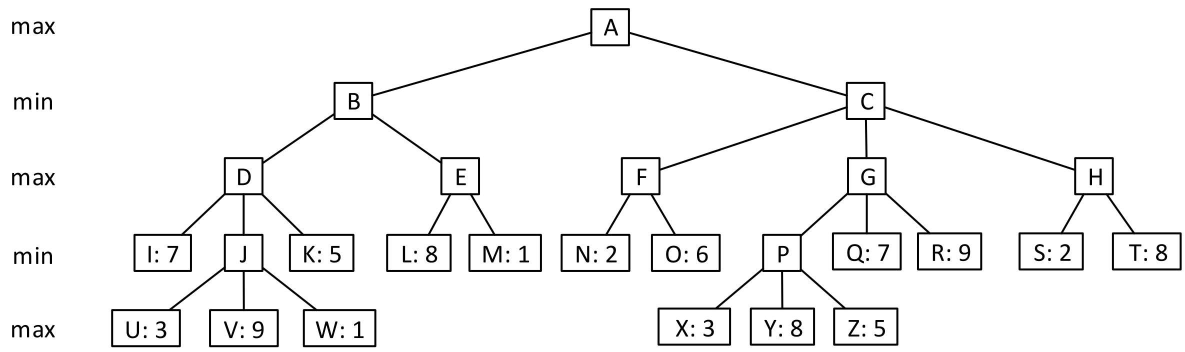
Answer: Node H overestimates the cost to reach the goal node N. (3 points)

6. Find a node for which heuristic value is admissible but not consistent. Explain why it is not consistent. (3 points)
   Answer: Node D is not consistent because h(D) > c(D, I) + h(I)

QUESTION 5

The minimax algorithm

1. What kind of games the minimax algorithm is used for? (2 points)
   Answer: zero-sum games of perfect information (fully observable)
2. Given that the maximum depth of a game tree is *m* with *n* legal moves at each point, what is the time complexity of the minimax algorithm? (2 points)
   Answer: $O(n^m)$
3. Why we may want to use alpha-beta pruning? (2 points)
   Answer: Eliminate part of the game tree from consideration, thus making the search faster
4. Assume the game tree below, in which the evaluation function values are given for the leaf nodes. Assuming an alpha-beta search strategy left to right, which nodes will not be expanded? (9 points)



Answer: G, H, M, P, Q, R, S, T, V, W, X, Y, Z