AI midterm test, 2017. 11. 27. **NAME:**
TOTAL POINTS:60 (minimum to pass: 24) **NEPTUN ID:**

1) Define and explain the concept of effective branching factor (relation to branching factor, maximum branching factor in a tree, quality of a heuristic function). Estimate the effective branching factor for the search tree in Fig.1. (the goal state is the node 12, in bold)!

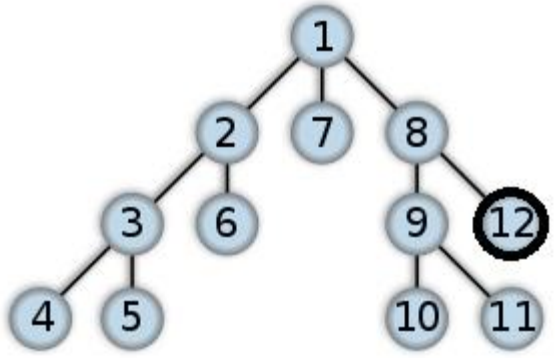


Fig.1. Search tree with the goal node in bold found by the search.

(15 points)

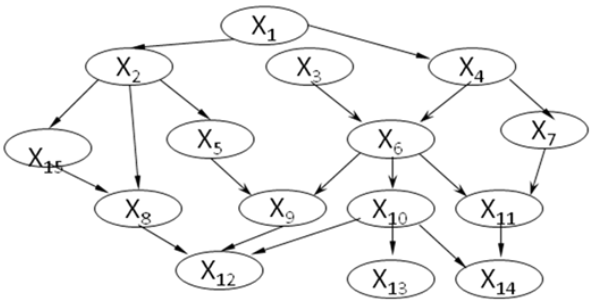
2) There is a contest with three players, Adam (A), Betty (B) and Chris (C), in which the result is a single complete ordering/ranking of the players (a permutation of A, B,C). We assume that there are no ties/draws, ranking is complete and transitivity holds, which constraints are formalized in a knowledge base KB. Let the propositions P_{AB}, P_{AC}, P_{BC} denote the following relations of the result $A \prec B$, $A \prec C$, $B \prec C$ ($X \prec Y$ denotes that X precedes/has a better position than Y in the result of the contest). We do not know the complete order of the three players, but we have the following statements also in the knowledge base KB:

- A claims (SA): C is not the first.
- B claims (SB): I'm not the last.
- C claims (SC): A is not the second.

a) Define the statements SA, SB, SC using the propositions P_{AB}, P_{AC}, P_{BC}.
b) Convert them to conjunctive normal form (CNF).
c) Prove with resolution that the knowledge base KB entails P_{BC}, ($KB \models P_{BC}$), that is that B has a better position than C („$B \prec C$").
d) Prove with truth-table that the knowledge base KB entails P_{BC}, ($KB \models P_{BC}$), that is that B has a better position than C („$B \prec C$").

(15 points)

3) Assuming binary variables answer the following questions.
   a) What is the number of parameters of a multinomial distribution for the joint distribution $P(X_1,..., X_{15})$
   b) Give an estimate for the number of parameters in this Bayesian network using
      i) multinomial local models,
      ii) noisy-OR local models.
   c) Give the product representation of the joint distribution defined by this Bayesian network.
   d) What is the Markov Blanket/Boundary of variable X_6? What is the general definition of Markov Boundary and what is its significance in diagnostics?



(15 points)

4) Use the following attributes and observations in the next questions:

CaseID.	Small	White	Barking	PopularDog
X1	Yes	Yes	Yes	Yes
X2	Yes	Yes	No	Yes
X3	No	No	Yes	Yes
X4	No	No	No	No
X5	No	Yes	No	No
X6	Yes	No	No	Yes

   a) Define a decision tree exactly representing the functional dependency of PopularDog (as an outcome variable) from the other variables (from Small, White, and Barking variables as inputs/attributes).
   b) Define a Boolean expression for PopularDog using these input variables.
   c) What is the cardinality of decision trees (as logical functions) over *n* ternary (3-valued) attributes?
   d) What is the definition of information gain in an information theoretic decision tree learning algorithm? Give the equations for selecting the root node.

(15 points)