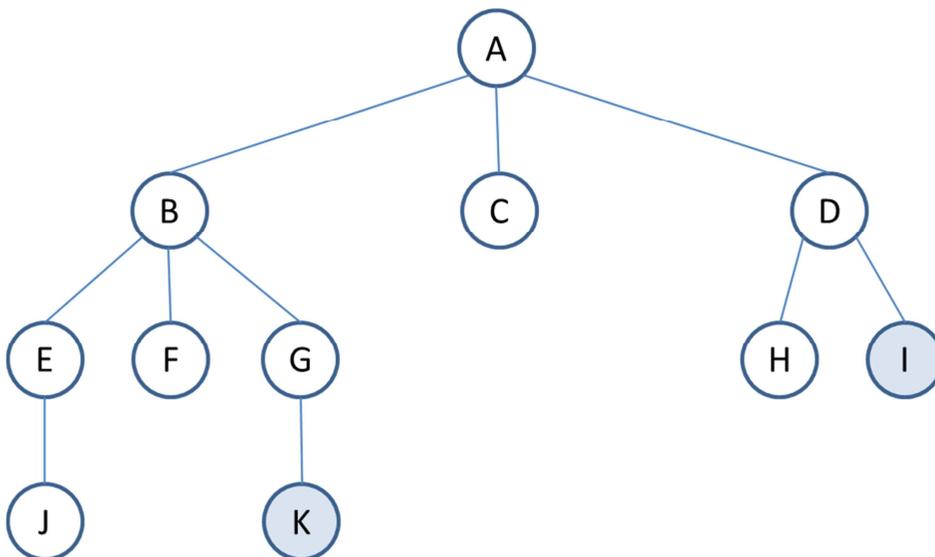Technische Universität München

Exercises for the Lecture

Techniques in Artificial Intelligence

7.12.2012 - Sheet1

1) Search

Consider the following search graph

Assume that all direct connections between nodes have costs of 10 units. Start node is A, goal nodes are K and I.

a) Write down the nodes in order visited for different search strategies:

Depth-first search: _____

Breadth-first search: _____

Iterative deepening: _____

b) Write down the nodes in the order visited for the A* algorithm using the following heuristic:

	A	B	C	D	E	F	G	H	I	J	K
h(.)	3	5	80	35	5	20	10	30	0	0	0

In case of equal values, the node to expand is chosen by **reverse** alphabetical order.

Give all intermediate steps and the values for g(n), h(n) and f(n). Explain why a node has been chosen.

c) Is the solution found optimal? Explain.

d) Is the given heuristic admissible? If not, how can it be made admissible?

e) Is the given heuristic consistent? Explain.

f) Is the following statement true: "If h is an admissible heuristic, then h(n) = 0 for all goal nodes n". Explain.

2) Normal form in first-order logic

Transform the following sentences into the Conjunctive Normal Form (CNF) for first-order logic:

(a) $(\exists x (p(x,y))) \rightarrow (\exists x (q(x,x)))$

(b) $\forall x (\forall y \exists z (r(x,y,z)) \wedge \exists z \forall y (\neg r(x,y,z)))$

3) Resolution in First-Order Logic

Show that the following sets of clauses are **unsatisfiable** using resolution for first-order logic.

$$F = \{\{\neg p(y), q(x), r(x, f(x))\},$$
$$\{\neg p(y), q(x), s(f(x))\},$$
$$\{t(a)\},$$
$$\{p(a)\},$$
$$\{\neg r(a, y), t(y)\},$$
$$\{\neg t(x), \neg q(x)\},$$
$$\{\neg t(x), \neg s(x)\}\}$$

$$F = \{\{p(x, a, x)\},$$
$$\{p(x, s(y), s(z)), \neg p(x, y, z)\},$$
$$\{\neg p(s(s(s(a))), s(s(a)), u)\}\}$$

$$F = \{\{q(x), q(s(x))\},$$
$$\{\neg q(x), \neg q(s(s(x)))\}\}$$