Artificial Intelligence

Assignment 4

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1 Uninformed and Informed Search   (10 Points)

The following figure shows the complete search tree of a search problem. The start node is node A, all target nodes are marked with a square. The number next to each edge is its cost. A heuristic indicating the estimated distance to the closest target is shown in parentheses next to each node.
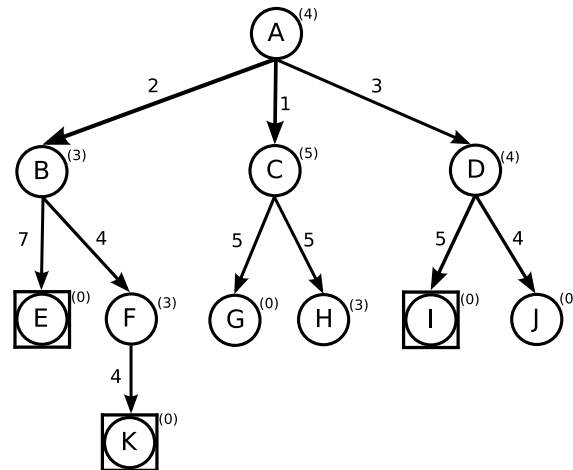
For each of the following search strategies, write down (in order) which nodes are visited:

- Breadth first search

- Depth first search

- Iterative deepening with increment 1 (mark where the depth limit increases)

- A*. If two nodes with the same value are present in the frontier, the one which was added to the frontier first will be selected. Provide the f value for all nodes taken from the frontier.

- A*, but the heuristic for D is 8 instead of 4.

Which solution is optimal? Why does one of the A*-variants not find it?

2 STRIPS   (20 Points)

In a rather unorthodox experiment, Prof. Dr. Darksome created raptors which become more intelligent when they drink alcohol. However, as expected by everyone who has ever seen Jurassic Park, two raptors, *hans* and *klaus*, managed to free themselves. The professor is currently hiding in a small closet. The door of the closet d_1 is currently closed. However, if a raptor is drunk, he is intelligent enough to open a door. The goal of the two raptors is to open the door. *hans* is at position a, *klaus* at position b. Both are standing on the floor, making their height *normal*. A bottle of whisky, *talisker*, is on a shelf at at position c—the bottle therefore has a height of *high*. The door to the closet d_1 is at position d. When raptors drink alcohol, they will drink the entire bottle and then drop it. Therefore, we're ignoring the actual drinking in our formalization. However, a raptor becomes drunk if he drinks alcohol. To reach the shelf, *hans* and *klaus* must work together. If one of them bows down, the other one can jump on his back, thereby reaching the bottle on the shelf.

The following predicates are given:

- **raptor(X)**: X is a raptor.

- **whisky(X)**: X is a whisky.

- **door(D)** D is a door.

- **open(X)**: X is open.

- **closed(X)**: X is closed.

- **drunk(X)**: X is drunk.

- **height(X,Y)**: X has height Y (either *normal*, *low* or *high*).

- **pos(X,Y)**: X is at position Y (either a, b, c or d).

- **free(X)**: Raptor X is free, if no other raptor is standing on his shoulders.

- **on(X,Y)**: Raptor X is standing on raptor Y's shoulders.

Your tasks are:

1. Write down the initial STRIPS data base and the goal state.

2. Describe the following actions in STRIPS notation. Please note that some preconditions or effects of actions necessary to achieve a consistent formalization may have been left implicit.

   - **move**$(R, X_{\text{old}}, X_{\text{new}})$: Raptor R moves from position X_{old} to position X_{new}. This is only possible if he has a height of *normal*.

   - **openDoor**(R, D): Raptor R opens the door D. The raptor must be drunk and at the same position as the door.

- **drink**(R, W): Raptor R drinks whisky W. This is only possible if the raptor and the whisky are at the same positions and have the same heights.

- **bowDown**(R): Raptor R bows down to prepare for some other raptor jumping on his back. For this, the raptor must have a height of *normal*. As a result, the new height is *low*.

- **straightenUp**(R): A raptor R can straighten up if his height is *low* and he has no other raptor standing on his shoulders. As a result, the raptor has a height of *normal*.

- **climbOn**(R_1, R_2): Raptor R_1 climbs upon raptor R_2. For this, both must be at the same position. Additionally, R_2 must have a height of *low* and no other raptor may be standing on his shoulders. R_1 must have a height of *normal*. As a result, R_1 is standing on R_2 and now has a height of *high*.

- **climbDown**(R_1, R_2) Raptor R_1 climbs down from raptor R_2. For this, he must be on the other raptor. Afterwards R_1 has a height of *normal* again.

Important hints

- Always include all names of all group members that helped solving the excercises **on your PDF**. Only those will receive points for solving the excercises.

- By handing in this sheet, you confirm that you solved these excercises yourself. If the situation occurs that two groups have identical solutions, both groups will get zero points.

- Your SVN-Repositories can be accessed via

    <https://svn.uni-koblenz.de/mhorbach/ai23/[yourGroupName]>

  You can use the subfolder `workspace` to share data among your group; this folder's content will not be graded. Submit your solution in the subfolder `solutions` with speaking name such as `assignment4.pdf`. You tutor will upload their notes in the subfolder `comments`.

  Note that you do not have access to the repository's base directory.

- **Format:** All solutions must be contained in PDF documents (including source code). Additionally, source code must be provided as plain files that are readable via a standard text editor.

- Please make sure that all your programs can be run without errors. Comments on your souce code will be in the annotated PDF that we create during excercise corrections.

- Do not use any mutated vowels or special characters in your source code. Also, do not use those or spaces in file names.