National University of Computer and Emerging Sciences, Lahore Campus

Course:	Artificial Intelligence	Course Code:	CS401
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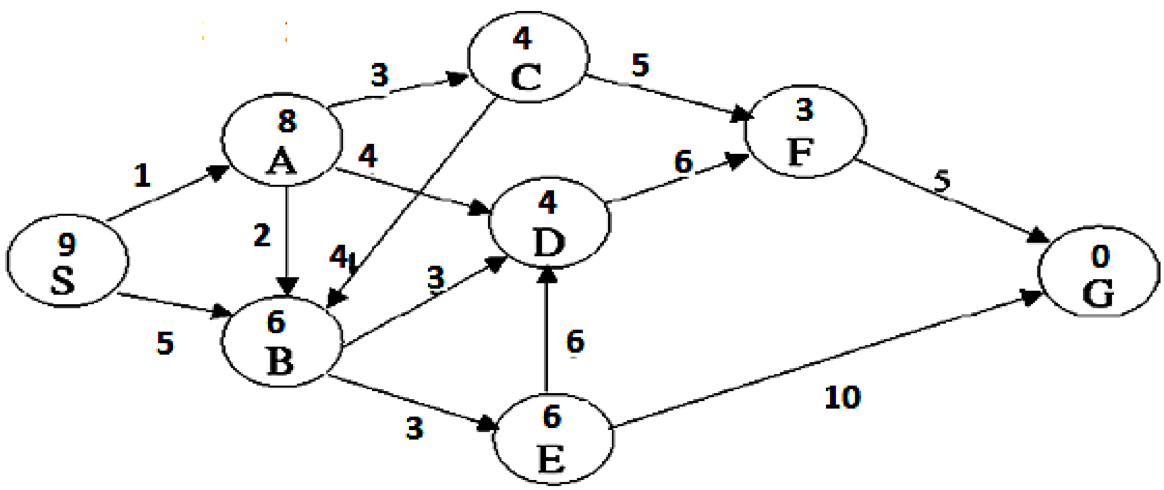
Paper Date:	28-02-2018	Weight	15%
Section:	D, E	Page(s):	6
Exam:	Mid I	Reg. No	

Name: ___________________________________**Registration No**_______________________

Instruction/Notes:
Please read questions carefully, give reason/show all working for all questions
Answer all questions are on this question paper
Rough sheets can be used and attached at the end only if necessary.

Problem 1. Consider the search space shown in the figure below. In this problem the start state is **S**, and the goal state is **G**. The transition costs are next to the edges, and the heuristic estimate are given inside the nodes. Assume ties are always broken by choosing the state which comes first alphabetically



Part a) **[2 + 3 Points]**

i) Is the heuristic function admissible? (Give Reason)

ii) Is the heuristic function consistent? (Give Reason)

Part b) What is the order of states expanded and the path found by A* graph search algorithm when used on this problem? Also specify the nodes in the fringe/frontier/Queue when the goal is found. **[3 + 2 + 1 Points]**

Problem 2:

An intelligent but greedy automated agent/program is trying to solve the famous 0-1 knapsack problem. In this problem the agent has a set of items to choose from with each item having a **weight** the agent has to carry if it picks that item, and a **value** the agent will gain by picking up the item**.** The agent has the capicity to carry only a **MAX_WEIGHT** while his job is to select a subset of items that **it can carry** such that the **total value gained** by the agent is by picking up the subset of items is maximum.

The agent has been programmed by a slected team of students from a famous University (FAST) situated in the city of Lahore. The team programmed the agent such that it uses hill-climbing strategy to solve such optimization problems.

To represent state of the agent, while it is creating a plan to make a selection from a set of **n** items, the team used an array of size **n** with an index corresponding to one of the item in the set. Each index in the state array contains wither a 0 or a 1 where 0 at any index means that the agent will not pick the corresponding item and a 1 means the agent will pick the corresponding item.

Further, to generate successors of a state a very simple successor function is used that works by selecting an index and if the corresponding item is not already in the list of items to be picked it added it into the list by placing a 1 at the corresponding arry index.

Part a) If the ste of items contains 100 items **[1 + 1 + 3 Points]**

i. What is the size of search space the agent has to search from? (Justify)

ii. How many successors a state can have at max? (Justify)

iii. What will be a suitable evaluation function to carry out the hill-climbing search?

Part b) Now suppose that the set of items contain only **4** items. The weights of items and their value is given in the following table.

Item ID	**A**	**B**	**C**	**D**
Item Weight	**0.8 kg**	**0.7 kg**	**2 kg**	**3 kg**
Item Value	**Rs. 80**	**Rs. 70**	**Rs. 200**	**Rs. 320**

Table 1: Item Weights and Value

If the maximum capacity of the agent is **3.5 kg**. then what will be final solution found be the agent (Show Complete Working)

i) If starts in the following state **[2 Points]**

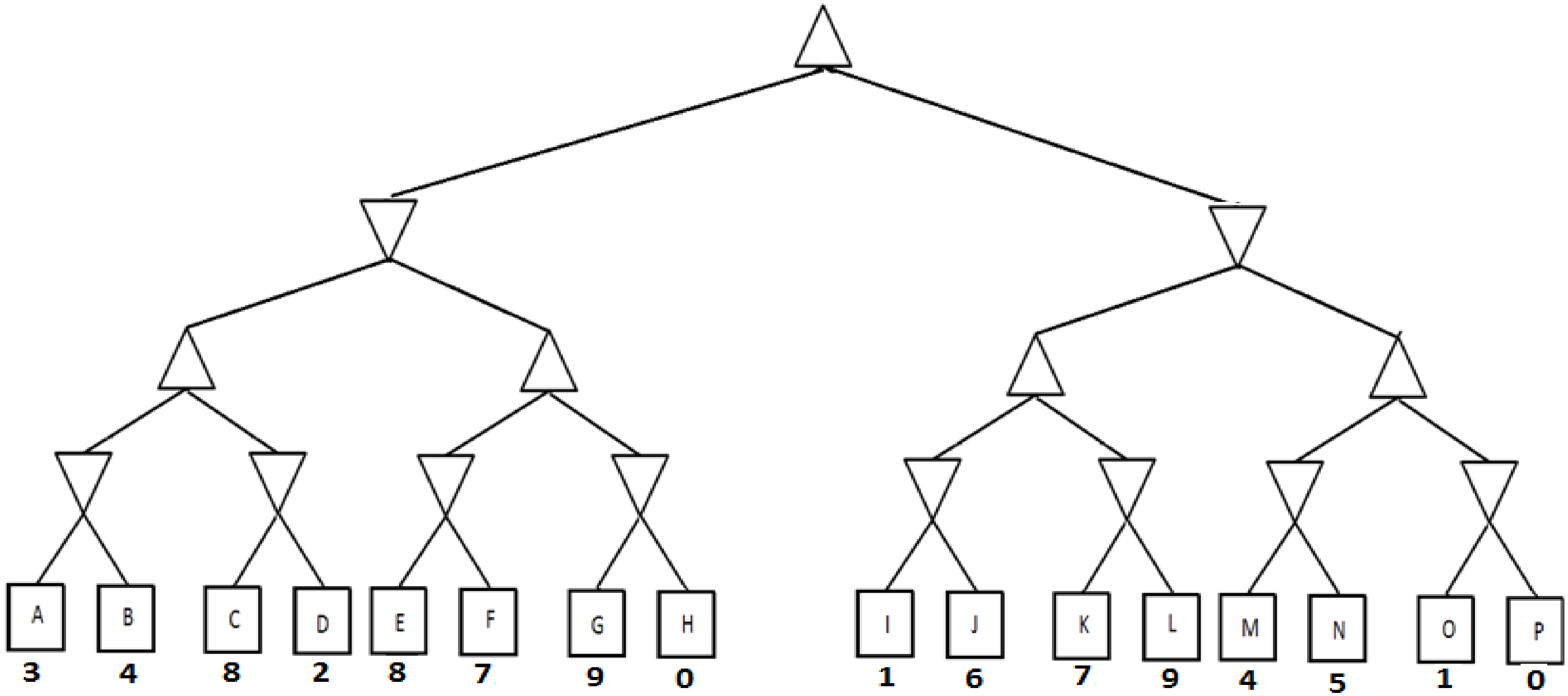
Initial State	**0**	**0**	**0**	**0**

ii) If starts in the following state **[3 Points]**

Initial State	**0**	**1**	**0**	**0**

Problem 3

Figure on the following page shows a game tree of a hypothetical game. To find the best move of **MAX** (denoted by upwards pointing triangle) at the root, this game tree is to be searched using **minimax with α-β pruning**. Assume that the minimax search has been implemented such that the child/successors of any node are traversed from left to right order.



Part a) If value of each leaf node (specified as a square) is as given on the figure then compute the value of each intermediate node that will be assigned by minimax with prunning. On the figure also mark all branches that will be pruned by **α-β** prunning strategy and specify the corresponding values of **α and β** at the time of prunning **[5 + 5 Points]**

Bonus Part

Now assue that the values of the leaf nodes are not known and you are free to specify these values. Determin values of the nodes such that **maximun number of branch will be pruned** if minimax with **α-β pruning** is used to search the tree and children of a node are processesed from left to right. Also specify on the figure the branches that will be pruned. **[5 Points]**