University of El Oued
Department of Computer science

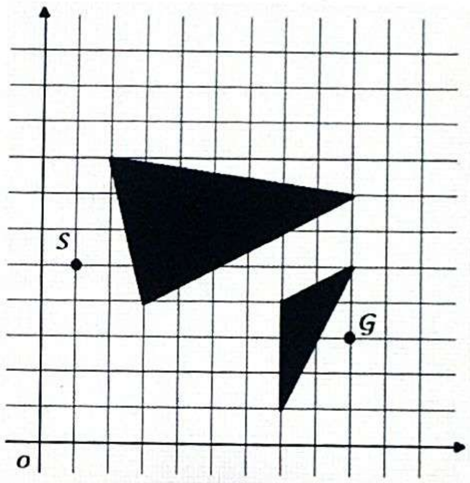
Duration: 1 hour
Level: Master 1

Principles and Approaches of AI

Exam

Exercise 1: *(10 pts)*

Consider the problem of finding the shortest path for a robot using *Hill-Climbing* between two points on a plane that has convex polygonal obstacles (see the figure).



- The origin O is at coordinates (0, 0). The start state is at (1, 5). The goal is at (9, 3).
- The heuristic for *hill-climbing* algorithm is the Euclidean Distance between the position of the agent and the goal.
- The agent (robot) can move from a point to another horizontally or vertically and perceive the obstacle only one position away.

1. Characterize the task environment of the agent in terms of the following properties: ***Observable, Deterministic, Static, Continuous, Agents. (2.5 pts)***
   The task environment ***is partially observable, deterministic, static, discrete and single agent.***
2. Suppose the state space consists of all positions (x, y) in the plane. How many states exist? How many paths are there to the goal?
   If we consider all (X, Y) points, then there are an infinite number of states, and of paths. (2pts)
3. Give the optimal succession of points' coordination between ***S*** and ***G*** using the ***hill-climbing*** algorithm.
   There is no optimal path, the hill-climbing algorithm will reach a local maximum after 7 moves which are (2, 5), (2, 4), (2, 3), (3, 3), (4, 3), (5, 3), (6, 3) and gets stuck in (6, 3) where h=3 and both its nearest neighbor their h= 3.16. (4pts)
4. Is the agent rational? ***Explain.***
   The agent is not rational, the hill-climbing algorithm can reach a local maximum in different scenarios which will prevent the agent from achieving its final goal, hence, compromising its performance measure. (1.5 pts)

Exercise 2: *(10 pts)*

You have the following data to consider:

Example	Size	Colour	Species	Class
A	P	R	X	Pure
B	P	R	X	Pure
C	G	R	X	Pure
D	G	B	Y	Pure
E	G	B	X	NPure
F	G	B	X	NPure
G	P	R	Y	NPure

H	P	B	X	NPure

a) Which attribute should you choose as the root of a decision tree between **Colour** and **Size**? ***(3pts)***

$$Remainder_{Color} = \frac{4}{8}\left(-\frac{3}{4}\log_2\frac{3}{4} - \frac{1}{4}\log_2\frac{1}{4}\right) + \frac{4}{8}\left(-\frac{1}{4}\log_2\frac{1}{4} - \frac{3}{4}\log_2\frac{3}{4}\right) \cong 0.8113$$

$$Remainder_{Size} = \frac{4}{8}\left(-\frac{2}{4}\log_2\frac{2}{4} - \frac{2}{4}\log_2\frac{2}{4}\right) + \frac{4}{8}\left(-\frac{2}{4}\log_2\frac{2}{4} - \frac{2}{4}\log_2\frac{2}{4}\right) \cong 1$$

Choose ***Color*** for first split since it minimizes the remaining information needed to classify all examples.

b) Build the decision tree, figure this out by looking at the data without explicitly computing the information gain of the rest of the attributes **(explain)**. ***(4pts)***

You can notice that the ***attribute specie*** *is accurately decisive:*

When **colour** equal to **R:** **3 specie = X => class = Pure**
1 specie = Y => class = NPure

When **colour** equal to **B:** **3 specie = X => class = NPure**
1 specie = Y => class = Pure

3pts