King Saud University

College of Computer and Information Sciences
Computer Science Department

76	Course Code: CSC 361	Course Title: ARTIFICIAL INTELLIGENCE
	Type of Exam: Midterm Exam	Semester: 2nd Semester 2022/2023
	Date: 11-January-2023	Time: 6:00-7:30 PM (**90** minutes)
Student Name & ID:	[redacted]	
Student Section No.		
Instructor Name:		

Instructions:

• Do not use pencil	• Total marks:100

PART 1: Theory (20 Points) 16

1	2	3	4	5	6	7	8	9	10
c	b	b	b	b	a	d	d	d	c

1)	PEAS description includes: **a)** People **b)** Events **c)** Actuators **d)** Single agents
2)	A search strategy is complete if and only if: **a)** All solutions can be found **b)** It always finds a solution when a solution exists **c)** It always finds a solution **d)** It does not find a solution if solution does not exist
3)	Problem formulation includes determinaltion of all the following **EXCEPT**: **a)** Initial state **b)** Objective function **c)** Goal test function **d)** Successor function
4)	AI became an industry starting of: **a)** 1970 **b)** 1980 **c)** 1990 **d)** 2000
5)	Which is **NOT** considered an AI applications: **a)** Computer vision **b)** Robotic arm **c)** Speech recognition **d)** Remotly controlled car
6)	Cognitive Science is linked to which AI approach? **a)** Thinking humanly **b)** Acting rationally **c)** Acting Humanly **d)** Thinking rationally
7)	Irrefutable reasoning process is linked to which AI approach? **a)** Thinking humanly **b)** Acting rationally **c)** Acting Humanly **d)** Thinking rationally
8)	The notion of desirability is captured by performance measure that evaluates any given sequence of percepts of: **a)** Percepts state **b)** Environment states **c)** Agent states **d)** All answers are correct
9)	Rationality depends on: **a)** Criterion of success **b)** Prior knowledge of the environment **c)** Possible actions **d)** All answers are correct
10)	Which can be considered as performance measure for Autonomous Taxi: **a)** GPS **b)** Cameras **c)** Profit **d)** Horn

PART 2: Problem solving (15 Points) 4

In the magic square problem, the objective is to arrange numbers from 1 to $\mathbf{n}^2$, such that the sum of each line of $\mathbf{n}$ numbers (vertical, horizontal, or diagonal) is constant $\mathbf{c}$. Every number should be used once. The figure beside shows an example when n=3, with one possible solution. Assume state is represented by a 2-D array. At each step x, one new number is inserted in square x. Answer the following in terms of $\mathbf{n}$.

$\Longrightarrow$

2	7	6
9	5	1
4	3	8

a) What is the size of the state space? $n^2!$ ✗

b) What is the maximum branching factor? ~~x~~ n^2 ✓ 4

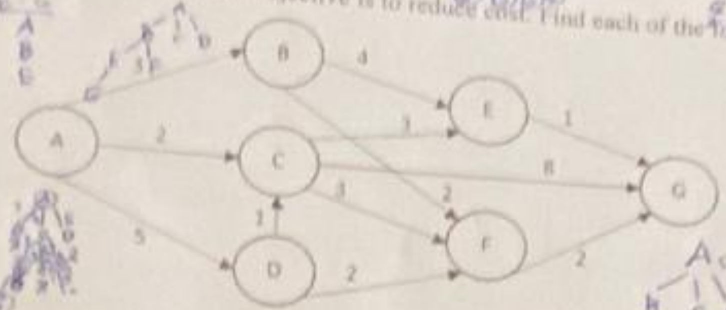
c) Write the goal test function:

```
                                    return solution or false
goal test function {
  if(state is complete)
~~insert~~  return solution
  else{
  <-insert num random
      check if it is Right
      goal test function( );

}
```

✗

PART 3: Blind/Informed search (30 Points) 30

Consider the given graph, the objective is to reduce cost. Find each of the following:

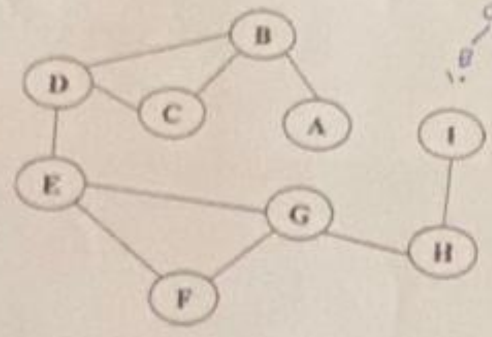


State	h
A	5
B	4
C	3
D	2
E	1
F	2
G	0

	Strategy	Solution path	Order of node expansion
a)	BFS	A C G	A B C D E F E F
b)	UCS	A C E G	A C B D E F E C
c)	DFS	A B E G	A B E
d)	IDS	A C G	A B E
e)	Greedy	A D F G	A D F
f)	A*	A C E G	A C E

Part 4: Local search (15 Points) 13

A state graph is given, along with two candidate heuristics (objective functions) shown in the table.



State	h1
A	12
B	10
C	15
D	16
E	8
F	3
G	11
H	9
I	13

1. Starting at node D, using hill climbing algorithm and heuristic h_1 (to be minimized), what is the (local) optimal state that will be found. F
2. Starting at node C, using hill climbing algorithm and heuristic h_1 (to be minimized), what is the (local) optimal state that will be found. B
3. Explain how simulated annealing can help improve the search when it starts at C. Clarify at what state and how its decision making differs from that of hill climbing here.

one of the advantages of simulated annealing is that you ~~can~~ may choose bad moves in order to reach the best solution from (C) you can go to (D) as a bad move with probability and after that it will move until reaching (F)

3

Part 5: CSP (20 Points) 13

An airport has one runway for international flights and one runway for domestic flights. We need to schedule the landing and taking off of <u>three</u> departing flights F1, F2 and F3, and two arriving flights F4 and F5. There are <u>four</u> time slots for each runway S1 to S4, each time slot can be used either for one airplane landing or one airplane take off. The schedule must adhere to the following constraints:

Constraints:

u 1. F1, F2, and F3 are international flights.
u 2. F5 and F4 are domestic flights.
3. Some passengers will transfer from F4 to F3, so F4 must land before F3 takes off.
4. F1 must land before S3.
5. F4 must land after S2.
6. F2 must land in S2.

D, R   S1, S4
(r, S)

If the problem is formulated using the variables: V = {F1, F2, F3, F4, F5}:

A. What are the domains of the variables before considering the constraints?

~~$D_{F_1} = \{S_1, S_2\}$ $D_{F_2} = \{S_2\}$ $D_{F_3} =$~~

$D = \{S_1, S_2, S_3, S_4\}$ for all the variable 3

B. Express the constraints in mathematical and/or logical terms. Specify whether each constraint is unary or binary. if = international flights   df = domestic flights

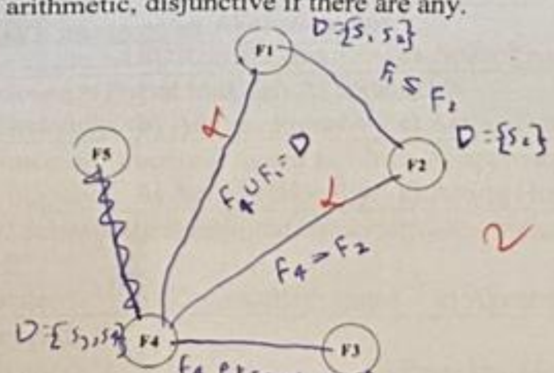
1, $F_1 = if$, $F_2 = if$, $F_3 = if$ | 2 $F_4 = df$ $F_5 = df$ 3

3- $F_4 \rightarrow F_3$ s.t $F_{4_S} < F_{3_S}$ | 4- $F_1 = \{S_1, S_2\} < S_3$ | 5- $F_4 = S_3$ or $F_4 = S_4$

$F_1 = S_1$ or $F_1 = S_2$ 6- $F_2 = S_2$

1, 2, 4, 5, 6 are unary and 3 is binary

C. Complete the following constraint graph by drawing the edges and labeling each edge using the words: precedence, arithmetic, disjunctive if there are any.



D. Reduce the domains, if possible, by enforcing unary constraints then rewrite the changed domains only.

$F_2 = S_2$

$F_1 = \{S_1\}$ $F_2 = \{S_2\}$ $F_3 = \{S_4\}$ $F_4 = \{S_3\}$

5

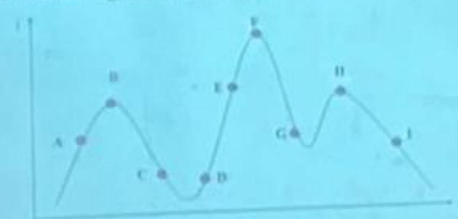
ns.ksu.edu.sa/bbcswebdav/pid-6204513-dt-content-rid-110080463_1/courses/CSC361_11453_1_442/AK.pdf

```
function goal-test(state B) as Boolean
/* check for each column */
for j=1 to n
    s=0
    For i=1 to n
     s+=B[i,j]
    End for /* i */
    If s <> c then return false
End for /* j */

/* check for each row */
for j=1 to n
    s=0
    For i=1 to n
     s+=B[j,i]
    End for /* i */
    If s <> c then return false
End for /* j */

/* check for diagonal 1*/
    s=0
    For i=1 to n
     s+=B[i,i]
    End for /* i */
    If s <> c then return false

/* check for diagonal 2*/
    s=0
    For i=1 to n
     s+=B[i,n-i+1]
    End for /* i */
    If s <> c then return false
/* reaching this step implies we are in a goal state */
```

	Strategy	Solution path	Order of node expansion
a)	BFS	ACG	ABCDEFEF
b)	UCS	ACEG	ACBDEFFC
c)	DFS	ABEG	ABE
d)	IDS	ACG	AABC
e)	Greedy	ADFG	ADF
f)	A*	ACEG	ACE

PART 4:

Simulated annealing starts at C and reaches B like greedy algorithm, however, unlike greedy which will get stuck there, simulated annealing allows for bad move to a state with worse objective function (higher h1) such as D and hence escaping the local optima, then from D the algorithm reaches F.



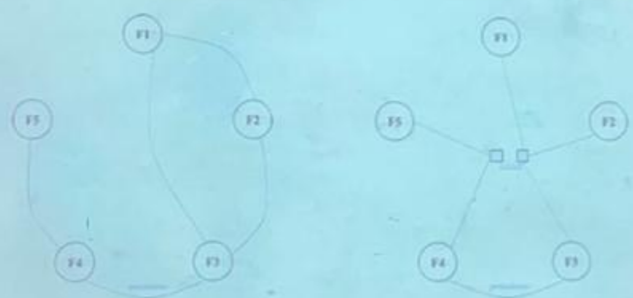
PART 5:

A.

$Di = \{(r,s) : r \in \{IR, DR\}, s \in \{s1, s2, s3, s4, s5\}\}$

8. Alldiff(F4.second, F5.second)

C.



D-

Changed

D1 = {(IR, s1), (IR, s2)}

D2 = {(IR, s2)}

D4 = {(DR, s3), (DR, s4)}

Unchanged