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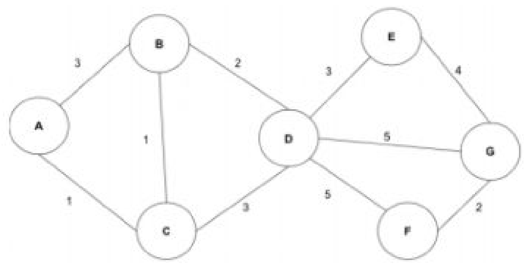
1. Search [11%]

With each algorithm below, Show the final path returned (and the cost if necessary) for the graph search in the Figure. (When breaking ties, use alphabetic order).

1) Depth First Search
2) Breadth First Search
3) Uniform Cost Search



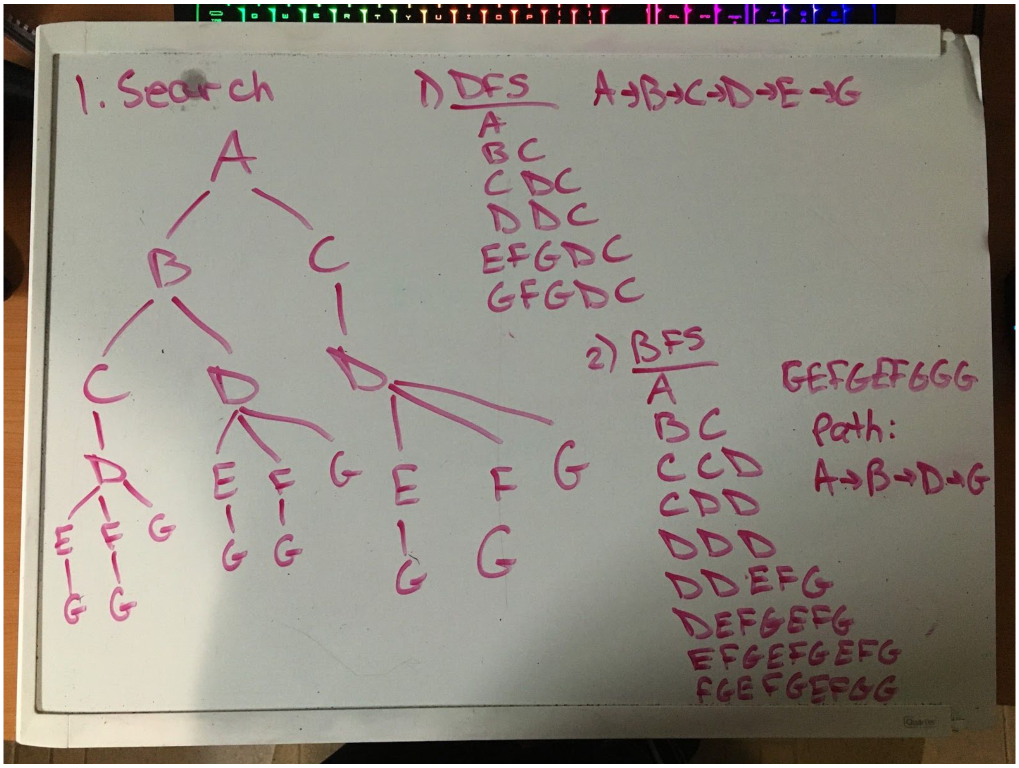
Consider two heuristics h1, h2 below.

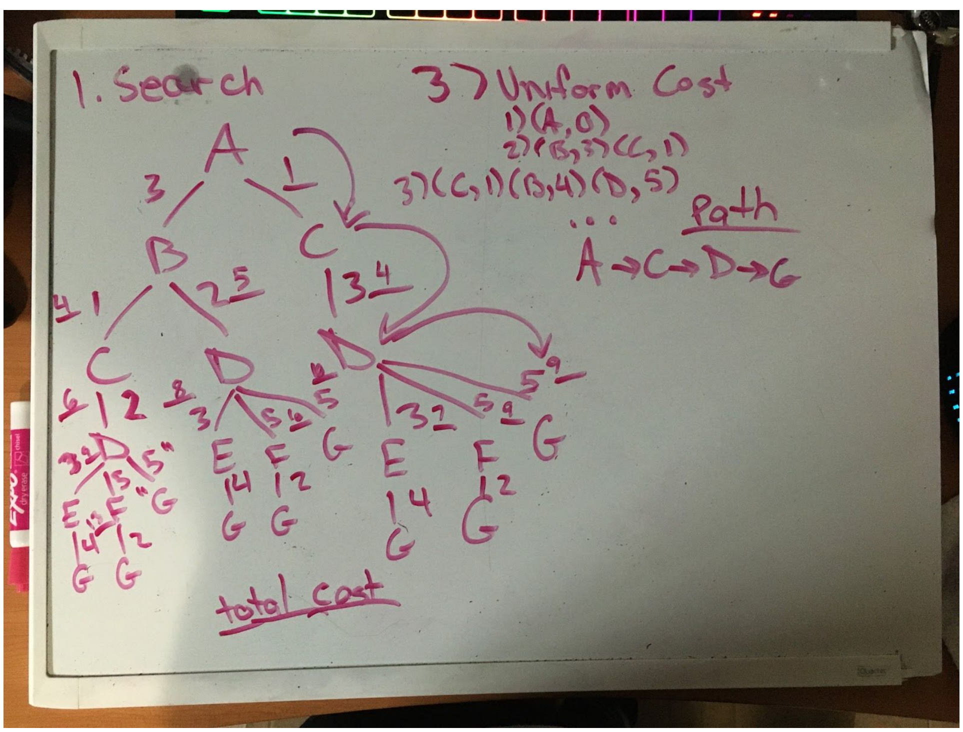
Node	A	B	C	D	E	F	G
h1	9	10	9	8	5	4.5	0
h2	10	9	8	5	3	2	0

The table above indicates the estimated cost to goal (h value) foreach of the heuristics for each node in the search graph.

1) Are these two heuristics are consistent and/or admissible, explain your answer?
2) Using A* with the consistent heuristics above.
3) Using greedy best first search with the heuristic **h1**.

I know I forget the A->C->B path, but this should not change any of the answers
since BFS would look at first horizontal level occurrence of goal which is the same as the A->B->C->D path
DFS could take the A->C->B->D->E->G path, but since I wrote the A->B->C->D->E->G path first in the diagram it would look at the leftmost answer first
Uniform cost would have not change in answer as A->C->B->D has the same cost as A->C->D


1. Search
1) DFS
A→B→C→D→E→G
A
BC
CDC
DDC
EFGDC
GFGDC
2) BFS
A
BC
CCD
CDD
DDD
DDEFG
DEFGEFG
EFGEFGEFG
FGEFGEFGG
GEFGEFGGG
Path:
A→B→D→G


1. Search
3) Uniform Cost
1)(A,0)
2)(B,3)(C,1)
3)(C,1)(B,4)(D,5)
...
Path
A→C→D→G
total cost

1.1)
h1 is not admissible and not consistent
B has a value of 10 while actual lowest cost is 7 so it overestimated
h1 also overestimated F to G actual cost was 2 and h1 evaluated 4.5

h2 is not admissible and not consistent
B has value of 9 while actual lowest cost is 7 so it overestimated
h2 also overestimated step B to D, because if D is 5 and B is 9 it implies the cost of B to D is 4, while actual cost is 2

1.2)
using h2

(A, 0+10)
(C,10) (B,13)
(D,9) (B,11)(B,13)
(G,9)(E,10)(B,11)(F,11)(B,13)
Path: A->C->D->G

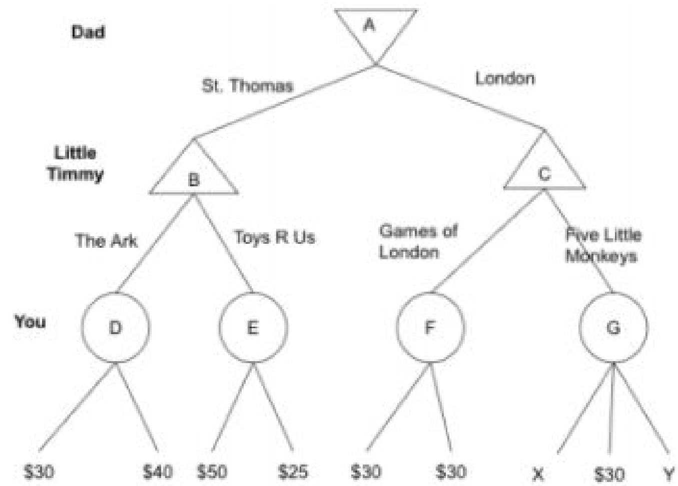
1.3)

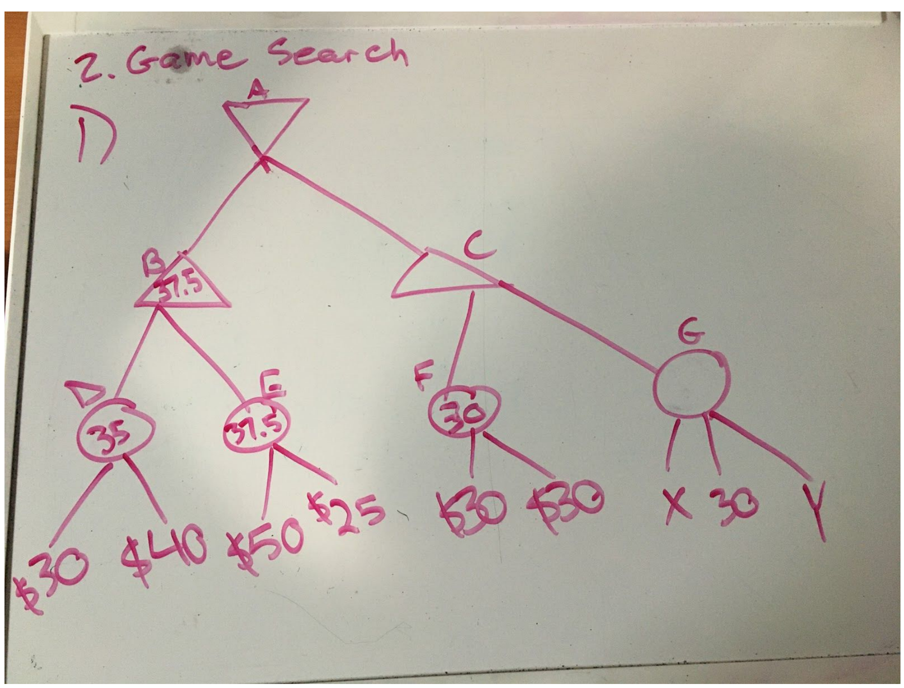
(A, 0 + 9)
(C,10)(B,13)
(D,11)(B,12)(B,13)
(G,9)(B,12)(E,12)(B,13)(F,13.5)
Path: A->C->D->G

2. Game Search [6%]

Your little brother Timmy has a birthday and he was promised a toy. However, Timmy has been misbehaving lately and Dad thinks he deserves the **least** expensive present. Timmy, of course, wants the **most** expensive toy. Dad will pick the city from which to buy the toy, Timmy will pick the store and you get to pick the toy itself. You don't want to take sides so you decide to pick a toy at **random**. All prices (including X and Y) are assumed to be nonnegative.

1) Fill in the values of all the nodes that don't depend on X or Y.
2) What values of X will make Dad pick Emeryville regardless of the price of Y?
3) We know that Y is at most \$25. What values of X will result in a toy from Games of Berkeley regardless of the exact price of Y?





2)
C will have to be greater than 37.5 and therefore G has to be greater than 37.5
(X+30)/3 > 37.5

If X > 82.5 then the price of Y does not matter

3)
G will have to be less than 30
(X+25+30)/3 < 30

If X < 35 then the exact price of Y does not matter

3. Probability and Byers Rule [4%]

To evaluate a new test for detecting COVID-19, the doctor told you that overall the disease is about 9 in 1,000 people. The test finds positive among 90% of those with the disease (true positive) and 15% of those without (false positive).

1) What is the chance now that someone really has the disease with one positive test?
2) What is the chance of having the disease if after the first positive test, the second independent test is negative?

3) 1) $P(d) = 0.009$

$P(+|d) = 0.90 \quad P(+|\sim d) = 0.15$

$P(-|d) = 0.85 \quad P(-|\sim d) = 0.10$

$$P(d|+) = \frac{P(d)P(+|d)}{P(d)P(+|d) + P(\sim d)P(+|\sim d)}$$

$$= \frac{(0.009)(0.90)}{(0.009)(0.90) + (0.991)(0.15)}$$

$$= 0.052 \qquad P(0.052, 0.948)$$

3) $P(d) = 0.009$

2)

$P(+|d) = 0.90$ $\quad$ $P(+|\sim d) = 0.15$

$P(-|d) = 0.85$ $\quad$ $P(-|\sim d) = 0.10$

$$P(+-|d) = \frac{P(-|d)P(d|+)}{P(-|d)P(d|+) + P(-|\sim d)(\sim P(d|+))}$$

$$= \frac{(0.85)(0.052)}{(0.85)(0.052) + (0.10)(0.948)}$$

$= 0.318$ $\quad$ $P(0.318, 0.682)$

4. Classifiers [14%]

Given the training data in the below table.

Home Owner	Job Experience (1-5)	Defaulted
No	2	Yes
Yes	1	Yes
No	4	Yes
No	4	No
Yes	3	No

Given ***Bob (HomeOwner=Yes, Job Experience = 4)***

1) Using Naive Bayes Classifier to predict if Bob *will be defaulted or not*
2) Build a Decision Tree Classifier to predict Bob
3) Build a KNN Classifier (k = 3) to predict Bob
4) Run k-Means (with k = 2) on the whole training data using all attributes (Home Owner, Job Experience, and Defaulted) to see what two clusters would be produced. You only need to run the algorithm with 2 iterations
5) What are the main differences between supervised learning and unsupervised learning, and what are their roles in real-world applications?

4.1)

	Home owner	Job exp 1	Job exp 2	Job exp 3	Job exp 4
$\sim D$	$\frac{1}{2}$			$\frac{1}{2}$	$\frac{1}{2}$
D	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$		$\frac{1}{3}$

bob = (Yes, 4)

P(~default | Bob)

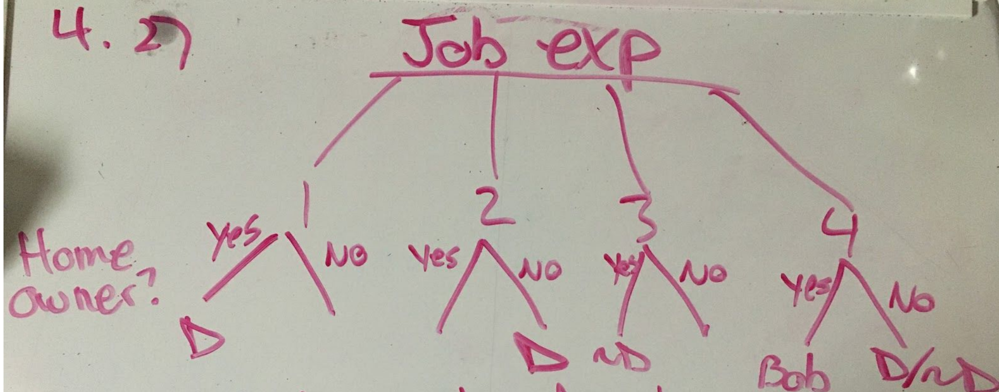
$$\left(\frac{1}{2}\right)\left(\frac{1}{2}\right) = \frac{1}{4} = 0.25$$

P(default | Bob)

$$\left(\frac{1}{3}\right)\left(\frac{1}{3}\right) = \frac{1}{9} = 0.11$$

more likely not default

4.2)



Not enough information to decide default or not

4. 3)

HO	JE	diff to Bob squared	
N	2	$(1+2)^2$	9
Y	3	$(0+3)^2$	9
N	4	$(1+0)^2$	1
N	4	$(1+0)^2$	1
Y	3	$(1+1)^2$	4

KNN closest 3

$\frac{2}{3}$ no defaults

so Bob more likely not to default

4. 4)

Cluster 1 → N (row 1)

Cluster 2 → Y (row 5)

HO	JE	sq Diff 1	sq diff 2	Next Cluster
N	2			
Y	1	$(1+1)^2$	$(0+2)^2$	4 = 4 ?
N	4	$(0+2)^2$	$(1+1)^2$	4 = 4 ?
N	4	$(0+2)^2$	$(1+1)^2$	4 = 4 ?
Y	3			
Bob		$(1+2)^2$	$(0+1)^2$	9 > 1 ∴ cluster 2

Cluster 2 is a no default

∴ Bob more likely not to default

4.5)
Supervised learning is when the database gives you the classification (labeled) and groups new and old entries based on that classification, for example like in this question the table gives us which people have defaulted on their loans and we performed probability practices (question 4.1) to estimate whether Bob will default his loan or not.

Unsupervised learning is when the database does not give the classification, so it will be up to the algorithm to hopefully and successfully put data into clusters with the correct classification. A real-world example would be digit recognition from human penmanship.