

Due: Friday, November 18, 8AM EST

This assignment is worth 15% of final grade. If you have no idea how to answer a question (or part of a question), you will receive 20% of the credit for that question (or subquestion) by stating “I do not know how to answer this question”. If your answer makes no sense, you will not receive any credit. Any answer that shows some understanding of the question will receive some credit.

1. (20 points)

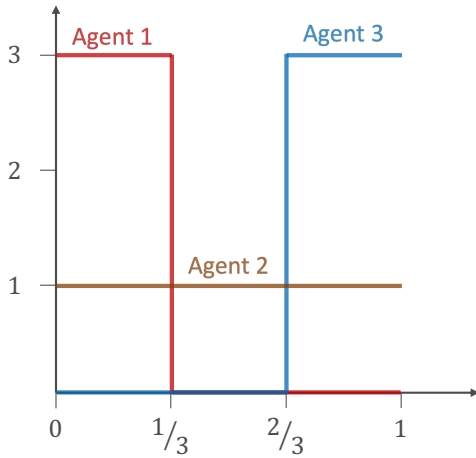
Note: This question is based on your own experience with a search engine. Everyone should be able to obtain full credit but you do have to articulate your answers clearly.

We want you to create two different search experiences, for each of which you will create a record of your search experience as will be explained. In all examples do not search for something that would be considered personal. And make your two information needs significantly different. For example, do not try “What was John Wayne’s first movie” and then “What was Jane Fonda’s first movie”.

Here are the details:

Create an “information need” for which you believe that the desired information exists in a single document but where you are not sure how to create an appropriate query. Create an initial query and detail your search experience. Namely, record that query, the time you issued the query, the titles of the 10 highest ranked documents. (Ignore sponsored documents). If only $k < 10$ documents are returned then just record those. State whether or not you obtained the desired information. If the desired information was obtained then indicate the rank of the relevant document. If you didn’t find the desired information, refine your query and try searching again using your refined query. Try explaining as best you can how your thinking led to the refined query. Indicate if you were successful or not in your refined search and if successful what was the rank of the relevant document. Wait one day and repeat the same search for your information need using the same initial query. Now just indicate whether or not you obtained the same set of the 10 (or less) highest ranked documents. If the two lists of highest ranked documents are not the same, explain why you think the lists are different.

- Value density functions



- Agent 1 wants $[0, 1/3]$ uniformly and does not want anything else
- Agent 2 wants the entire cake uniformly
- Agent 3 wants $[2/3, 1]$ uniformly and does not want anything else

2. (10 points)

Consider the example of cake-cutting on slide 7 (also shown above) of Nisarg Shah's presentation. Find an allocation that is equitable and envy-free. Briefly argue why your allocation is envy-free and equitable. That is, determine allocations A_1, A_2, A_3 such that $v_1(A_1) = v_2(A_2) = v_3(A_3)$. Explain how you determined those allocations.

3. Assume $P \neq NP$. It is a proven fact that the 3-colouring problem is NP -complete. That is, the language $\mathcal{L} = \{ \langle G \rangle \mid G = (V, E) \text{ is 3-colourable} \}$ is an NP complete language. Given our assumption, which of the following languages are decidable in polynomial time. Explain your answer.

- (5 points)

$$\mathcal{L}_1 = \{ \langle G' \rangle \mid G' = (V', E') \text{ is 100-colourable} \}$$

- (5 points)

$$\mathcal{L}_2 = \{ \langle G' \rangle \mid G' = (V', E') \text{ is } k\text{-colourable when } k = |V'| - 1 \}.$$

Hint: Every graph $G' = (V', E')$ is k -colourable when $k = |V'|$.

- (5 points)

$$\mathcal{L}_3 = \{ \langle G' \rangle \mid G' = (V', E') \text{ is } k\text{-colourable when } k = |V'|/2 \text{ and } |V'| \text{ is an even positive integer} \}.$$