

Due: Friday, November 17, 9AM EST but might possibly extend to Monday, November 20

NOTE possible change of due date!

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 and perhaps Chat-GPT.

Everyone should be able to obtain full credit on this question but you do have to articulate your answers clearly.

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. Do not search for something that would be considered personal or embarrassing. Create an initial query for a search engine. This could be just a few keywords or it could be a longer sentence. You need to detail your search experience. Namely, state the exact query, the time you issued the query, and 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(s) of the relevant document(s). 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(s) of the relevant document(s). Wait one day and repeat the same search for your information need using your initial or refined query. 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.

2. (10 points) From what you have learned from our discussion of complexity theory and from Professor Srinivasan’s discussion of zero knowledge proofs (ZKP), explain why any language $L \in NP$ has a ZKP. You can use any information in my slides or in Professor Srinivasan’s slides.

3. In each of these questions, you are asked to describe a polynomial time transformation.

(a) (5 points) Show that $3SAT \leq_{trans}^{poly} \text{exact } 4SAT$

Note: That is, show how to polynomial time transform a formula F with at most 3 literals per clause to a formula F' with exactly 4 literals per clause so that F is satisfiable if and only if F' is satisfiable.

(b) (5 points) Show the $3\text{Colouring} \leq_{trans}^{poly} 4\text{Colouring}$

Note: It is helpful to note that a 4-Clique is 4-colourable but not 3-colourable. A clique on k nodes is a graph with k nodes v_1, v_2, \dots, v_k such that there is an edge (v_i, v_j) for all $i \neq j$.