Graduate Applications Evaluation

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Thanks for your interest in our research group at York University. We are looking for motivated students with a strong background in theoretical computer science to work with us on various research projects in the areas of Online Algorithms, Prediction and Fairness in Artificial Intelligence, Data Compression, and Approximation Algorithms. You must have a degree in Computer Science, Computer Engineering, or other related fields (if you have completed core CS courses). Additionally, Ph.D. applicants are expected to have at least one paper published in peer-reviewed international workshops, conferences, or journals. To join our lab, you will need to take the following steps:

1. Read and understand the two questions posted on the next page. Solving these questions will increase your chance of a successful evaluation. You are expected to write the answers without consulting others. You must typeset your answers in LaTeX and compile them into a pdf document. Use the LaTeX template in https://www.eecs.yorku.ca/~kamalis/Graduate-Applications-2022.tex (add your own name as the author). Contact Dr. Kamali if you have any concerns about these questions. In case you found the questions difficult, you are welcome to send your partial answers (or the answer to only one problem).

2. Send your answers (in a single pdf document), together with your CV and transcripts (and your published papers, if any), to kamalis@yorku.ca. Include “[resolute prospective student]” in your email subject to indicate you have read this document. Please attach your CV and transcript even if you had sent them in an earlier email. You can send your email any time in Fall 2022.

3. Your application will be evaluated based on the quality of your submitted solutions, the GPA, the schools you graduated from (or will be graduating from), and your research experience (which is particularly important for Ph.D. applicants). Note that even if correct, sending the answers does not guarantee a successful evaluation. You will be contacted for a short interview on Skype or Zoom if you are among the top applicants.

4. In case of a successful evaluation, you will be advised to apply, and Dr. Kamali will support your application. Note that a separate committee will evaluate your graduate application before you get an admission letter from the university. support from Dr. Kamali does not guarantee admission.
Questions:

1. Suppose you want to buy an old painting from an antique shop. You have discovered that the painting is of infinite value and are willing to pay any amount to own it. The seller has already received multiple offers to sell the painting. The highest offer has been made by Mr. Adversary, who is willing to pay $x$ CAD for the painting. The seller does not reveal $x$, but you know that $x$ is a positive integer (again, you don’t know any bound for $x$). The seller makes a deal with you: you can make any number of efforts to buy the painting. At your $i$’th effort, you send a particular price $y_i$ CAD to the seller’s bank account. The seller will not return the money, but if $y_i \geq x$, you will own the painting (and do not need to send more money); otherwise, when $y_i < x$, you will need to try again.

What should be your strategy in buying the painting so that you pay the smallest total sum relative to $x$? Note that if you spend a significant amount on the first day, it might be that $x = 1$, in which case you have wasted too much money relative to $x$. On the other hand, if you are too conservative in your efforts, you might spend too much money on failed efforts.

**Answer:** Put your answer here. Be as specific and detailed as you can be. If you came up with an algorithm, please include a description of the algorithm in English words (no need for pseudocode). Investigate how much the total sum your algorithm pays compares with $x$ in the worst case.

2. Suppose that you find Mr. Adversary and intend to identify the value of $x$ that he has offered for the painting. For that, you ask binary questions about $x$. Each binary question $q_i$ is in the form: “is $x \leq b_i$” for some $b_i$ that you define. Suppose that you know Mr. Adversary correctly answers all questions except for up to 2 questions that might be answered incorrectly. Provide a solution that ensures you identify $x$ with as few queries as possible. You might assume that the algorithm can ask the same query multiple times.

**Answer:** Put your answer here. Be as specific and detailed as you can be. If you came up with an algorithm, please include a description of the algorithm in English words (no need for pseudocode). Investigate how many queries your algorithm asks in the worst case.