All quiz rules from the course syllabus are in effect for the real quiz, in addition to what follows.

If you have questions about the test, please ask *on Piazza* as a **private** post, viewable only by you and the instructors. The instructors will make an announcement if something needs to be said to the entire class.

You may use anything from lecture, discussion, or homework without proof or citation.

This quiz is to be individual effort. Students are permitted to use notes, electronics, and bring textbooks. The work you submit for each quiz is expected to be produced by *you, alone and solely for this assessment.* You may not reuse or repurpose anything you wrote at another time. However, despite being allowed notes and electronics, you may *not* seek out the answer to a question in any way, nor may you communicate with anyone during the exam, *for any reason*, with the exception of asking a question on Piazza *set as instructors-only for visibility.*

You will have a base of 40 minutes for this quiz, plus an additional ten minutes to enter your answers to the answer form. Please be careful when you enter your answers, as this will very likely be graded by a computer program and not a human. If you have a special circumstance, such as through DSC, compute your time using a base time as a 50-minute quiz.

As this is the sample quiz, you may complete this any way you would like, and are not obligated to submit anything. However, I encourage you to allocate time as if this were the real quiz, as that will provide you some feedback about your preparation.

Lastly, be advised that at the real quiz, there may be an errata thread pinned at the top of Piazza. Please check for that at about 30 minutes into the real quiz.

Fill-in form questions

If this were the real quiz, you would fill in your answers to this on a Google Form, similar to many questions on previous quizzes.

Longest Common Subsequence

Suppose we are computing the LCS of two strings, using the algorithm from class. We find the following table, although I have omitted the letters from the word that would be printed across the top.

	0	0	0	0	0	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0	0	0	0	0	0
S	0	0	0	1	1	1	1	1	1	1	1	1
T	0	0	0	1	2	2	2	2	2	2	2	2
A	0	1	1	1	2	2	3	3	3	3	3	3
B	0	1	2	2	2	2	3	3	3	3	3	3
L	0	1	2	2	2	2	3	3	3	3	3	3
I	0	1	2	2	2	2	3	3	3	4	4	4
S	0	1	2	3	3	3	3	3	3	4	4	4
H	0	1	2	3	3	3	3	3	3	4	4	4
M	0	1	2	3	3	3	3	3	3	4	4	4
E	0	1	2	3	3	3	3	3	3	4	4	4
N	0	1	2	3	3	3	3	3	3	4	4	5
T	0	1	2	3	4	4	4	4	4	4	4	5

1. What is the first letter of "ESTABLISHMENT" that appears anywhere in the word it is being compared to? For example, if 'E' appears in the word that would be printed across the top, write 'E.'

2. What is the last letter of the word that would appear across the top?

Edit Distance

For the next few questions, suppose I am computing edit distance using the algorithm from lecture. However, this time I have omitted both strings from the chart and have instead written the string via indices.

Recall that the iterative code is as follows. EditDistance($X_{1\ldots n}$, $Y_{1\ldots m}$)

for $j \leftarrow 0 \ldots m$ **do**
  Edit[0, j] $\leftarrow j$
for $i \leftarrow 1 \ldots n$ **do**
  Edit[$i, 0$] $\leftarrow i$
  for $j \leftarrow 1 \ldots m$ **do**
    ins $\leftarrow 1+$ Edit[$i, j-1$]
    del $\leftarrow 1+$ Edit[$i-1, j$]
    sub $\leftarrow$ Edit[$i-1, j-1$] + $(X_i \neq Y_j)$
    Edit[i, j] $\leftarrow$ min(ins, del, sub)

Recall that, despite how that code is written, if $X[i] == Y[j]$, we do not consider that to be a "substitution" despite the variable that would be chosen. We call that situation a "match."

		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}
	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Y_1	1	1	2	3	4	5	5	6	7	8	9	10	11	12
Y_2	2	1	2	3	4	5	6	6	7	8	9	10	11	12
Y_3	3	2	2	3	4	5	6	7	7	8	9	10	11	12
Y_4	4	3	3	3	4	5	6	6	7	8	9	10	11	12
Y_5	5	4	4	4	4	4	5	6	7	8	9	10	11	12
Y_6	6	5	5	5	5	5	5	6	6	7	8	9	10	11
Y_7	7	6	6	6	6	6	6	6	7	7	8	9	10	11
Y_8	8	7	7	7	7	7	7	6	7	8	8	9	10	11
Y_9	9	8	8	8	8	8	8	7	7	8	9	8	9	10
Y_{10}	10	9	9	9	9	9	9	8	8	8	9	9	9	10
Y_{11}	11	10	9	10	10	10	10	9	9	8	9	10	9	10

3. $X_1 == Y_1$?
4. $X_1 == Y_2$?
5. $X_{13} == Y_{11}$?
6. $X_{12} == Y_{11}$?
7. When computing Edit Distance between $X_{1\ldots 9}$ and $Y_{1\ldots 7}$, was the chosen operation a substitution, a match, or an insertion/deletion?

Optimal Binary Search Trees

8. Consider the following table, which is the output from running the optimal binary search tree algorithm for some nine-key input. In each entry, the value printed in the upper half of the cell is OPT$[i, j]$, the cost of the optimal binary search tree consisting of keys $i \ldots j$. The value printed in the lower half of the cell is the value of roots$[i, j]$.

   Suppose we have computed the following using the algorithm for the optimal binary search tree. However, we accidentally forgot to record OPT$[1, n]$. What is the missing value for that spot? It is the only one omitted in the following table.

	k_1	k_2	k_3	k_4	k_5	k_6	k_7
k_1	0.17 1	0.41 1	0.8 2	1.29 3	1.87 4	2.17 4	 4
k_2		0.12 2	0.41 3	0.83 3	1.31 4	1.61 4	1.73 4
k_3			0.17 3	0.55 4	0.95 4	1.25 4	1.37 4
k_4				0.21 4	0.61 4	0.82 5	0.91 5
k_5					0.2 5	0.4 5	0.49 5
k_6						0.1 6	0.16 6
k_7							0.03 7

9. Consider the following output for the Optimal BST algorithm, but with a different input from the previous problem. Unfortunately this time, I forgot to write down the root values! What is the root of the overall tree? That is, what should be in roots$[1, n]$?

	k_1	k_2	k_3	k_4	k_5
k_1	0.43	0.61	1.06	1.51	2.06
k_2		0.09	0.36	0.66	1.08
k_3			0.18	0.48	0.81
k_4				0.15	0.45
k_5					0.15

Free Response (5 points)

On the real quiz, you would solve this problem, scan your solution (if it isn't already digital), upload your solution to GradeScope, and tag the question.

As a new professor, Shindler needs to set up his lab. However, nothing is free, and Shindler has to pay quarterly rent for the building where he keeps his office. Shindler plans to be at UCI for n quarters (for a hopefully large value of n). Each quarter, he has the option to keep his lab in Donald Bren Hall or in Engineering Hall. If he keeps his lab in Donald Bren Hall during quarter i, he has to pay $\$d_i$. If he keeps his lab in Engineering Hall that quarter, he has to pay $\$e_i$. If he is in one building during quarter i and the other during quarter $i+1$, he has to pay $\$M$ to move offices.

For example, suppose $n = 4$ and $M = 10$, with the following costs:

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Bren	1	3	20	20
Engineering	50	20	2	4

In this case, the optimal solution would be to stay in Bren Hall for the first two quarters and then move to Engineering Hall for the next two quarters.

Give a dynamic programming solution to this problem; (1) write out the base case and recurrence expressions; (2) give an English specification of the underlying recursive sub-problems and (3) analyze the running time for the iterative version, explaining any important implementation details. You do not need to actually write out the iterative version.

Hint: You will either have two $1 \times n$ *tables or one* $2 \times n$ *table.*

If your entire response to this question is "I do not know," you will get 2 points out of 5 instead. Note that it is possible to earn fewer than 2 points for a bad response to this question. The same option will exist on the real quiz.