**Assignment 407: DP String Alignment**

Last Modified: 30 March 2022

This assignment is due to be completed and submitted by noon Thursday, 7 April.

**Dynamic Programming String Alignment**

[Here](https://borax.truman.edu/310/407/template.cpp) is a program that for dynamic programming string alignment. Your assignment is to write the opt and traceback functions based on the discussion in class. The opt function must be recursive.

The program uses [this matrix class](https://borax.truman.edu/310/407/matrix.h). You must not modify the Matrix class or the main function in any way.

Once the memo is filled in by calling the opt function, write a traceback function that uses the memo table and prints the optimal string alignment. You can implement this function iteratively (which I think is easier) or recursively, whichever you prefer. If there are multiple optimal alignments, you only need to print one. Use a hyphen to show a gap.

A run of your program should look like this:

$ ./program thesequences thatsequence 5 -4 -2

match: 5

mismatch: -4

gap: -2

The optimal alignment score between thesequences and thatsequence is 42

The completed memo table:

t h a t s e q u e n c e

0 1 2 3 4 5 6 7 8 9 10 11 12

+ --- --- --- --- --- --- --- --- --- --- --- --- ---

0 | 0 -2 -4 -6 -8 -10 -12 -14 -16 -18 -20 -22 -24

t 1 | -2 5 3 1 -1 -3 -5 -7 -9 -11 -13 -15 -17

h 2 | -4 3 10 8 6 4 2 0 -2 -4 -6 -8 -10

e 3 | -6 1 8 6 4 2 9 7 5 3 1 -1 -3

s 4 | -8 -1 6 4 2 9 7 5 3 1 -1 -3 -5

e 5 | -10 -3 4 2 0 7 14 12 10 8 6 4 2

q 6 | -12 -5 2 0 -2 5 12 19 17 15 13 11 9

u 7 | -14 -7 0 -2 -4 3 10 17 24 22 20 18 16

e 8 | -16 -9 -2 -4 -6 1 8 15 22 29 27 25 23

n 9 | -18 -11 -4 -6 -8 -1 6 13 20 27 34 32 30

c 10 | -20 -13 -6 -8 -10 -3 4 11 18 25 32 39 37

e 11 | -22 -15 -8 -10 -12 -5 2 9 16 23 30 37 44

s 12 | -24 -17 -10 -12 -14 -7 0 7 14 21 28 35 42

The aligned strings:

th--esequences

that-sequence-

**Notes**

Be careful to use the correct data types. The entries of the matrix, and the match bonus, mismatch penalty, and gap penalty, are ints. The indices of the matrix are size\_ts.

Pay particular attention to the style guide with respect to operator and expression formatting. Also remember that objects are never passed by value, only by reference or constant reference.

**Submission**

By the due date and time, submit the C++ source code of the complete program to the [homework submission](https://borax.truman.edu/310/submit.php) page.