INF281 Exercise 02

1. **DP table cell update rules**

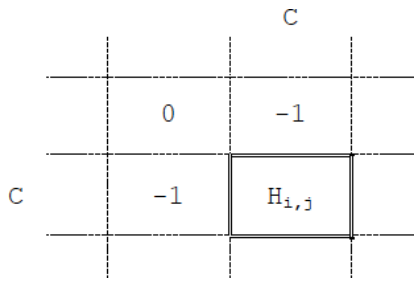
   Dynamic programming (DP) is an algorithm that uses table cells to memorize the sub-solutions of the target solution. DP requires three candidate scores and selects the maximum score among them when updating a cell.

$$
\begin{aligned}
H_{i,j}^{(0)} &= H_{i-1,j} - g && (vertical) \\
H_{i,j}^{(1)} &= H_{i,j-1} - g && (horizontal) \\
H_{i,j}^{(2)} &= H_{i-1,j-1} + R_{a,b} && (diagonal)
\end{aligned}
$$

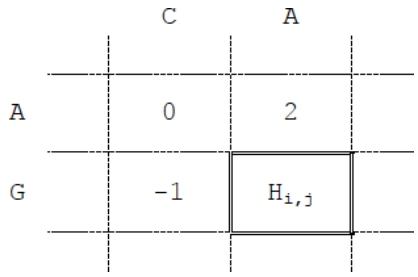
   Use the simple scoring scheme below to calcualte $H_{i,j}$ in Table A and B.

   Scoring scheme:
   $R_{ab} = 1$ for a = b
   $R_{ab} = 0$ for a $\neq$ b
   g = 1

   (a) Table A



   (b) Table B



2. **DP initialization**

Initialization is the first step of the DP procedures.

(a) Initialize the DP table with gap penalty 3.

q\d		C	A	T
C				
A				

3. **DP global alignment**

The score of optimal global alignment is found in the cell of the bottom-right corner after updating all cells.

Scoring scheme:

$R_{ab} = 1$ for a = b
$R_{ab} = 0$ for a $\neq$ b
g = 1

(a) Use the simple scorning scheme and fill the empty cells with appropriate scores.

q\d		C	A	T
	0	-1	-2	-3
C	-1		0	-1
A	-2	0	2	1
G	-3	-1		2
C	-4	-2		1
T	-5	-3	-1	

(b) What is the optimal score of the alignemnt?

4. **DP backtrack**

Backtracking is a process to find the alignment with the optical score. It requires re-calculations of the three candidate scores.

Scoring scheme:
$R_{ab} = 1$ for a = b
$R_{ab} = 0$ for a $\neq$ b
g = 1

(a) Which type of candidate score – vertical, horizontal, or diagonal – is used to update the cell with a double border? Assume that the simple scoring scheme has been used.

- Table 1

		C	A	
A		0	2	
G		-1	1	

- Table 2

		A	T	
C		0	1	
T		-1	1	

(b) Use backtracking to find the optimal global alignment.

q\d		C	A	T
	0	-1	-2	-3
C	-1	1	0	-1
A	-2	0	2	1

	C	G	A	T
C	1	0	0	0
G		1	1	0
A			1	0
T				1

5. **DP with score matrix**

   Use the score matrix below with gap penalty g =1 and answer the following questions.

   (a) Calculate the alignment score.

   - Alignment 1

     ```
     q: ATGCT
     d: CA--T
     ```

   - Alignment 2

     ```
     q: CAGCT
     d: C-A-T
     ```

   (b) Use the simple scorning scheme and fill the empty cells with appropriate scores.

   - Table A

		C
	0	-1
C	-1	$H_{i,j}$

   - Table B

		C	A
	0	2	
A			
G	-1	$H_{i,j}$	

(c) Fill the empty cells with appropriate scores in the DP table. What is the optimal alignment score?

q\d		C	A	T
	0	-1	-2	-3
C	-1		0	-1
A	-2	0	2	1
G	-3	-1		2
C	-4	-2		1
T	-5	-3	-1	

(d) There are two different alignments that give the same optimal score in the solution above. Specify both of them.