Exercises on sequence alignment

MVE510, 2019

Exercises

Exercise 1

Use the Needleman-Wunsch algorithm with a scoring matrix $S(a, b) = \begin{cases} 5, & a = b \\ -4, & a \neq b \end{cases}$ and a linear gap penalty with d = -5 to find the optimal global alignments and their corresponding alignment scores for

- a) x=AGCT with y=ACGT
- b) x=GTTCAG and y=GAG

Exercise 2

Use the Needleman-Wunsch algorithm with a scoring matrix $S(a, b) = \begin{cases} 7, & a = b \\ -3, & a \neq b \end{cases}$ and a linear gap penalty with d = -4 to find the optimal global alignments and their corresponding alignment scores for

- a) x=ATCGT with y=ACA
- b) x=GCATT and y=GTT

Exercise 3

Use the Smith-Waterman algorithm with a scoring matrix $S(a,b) = \begin{cases} 5, & a=b \\ -4, & a \neq b \end{cases}$ and a linear gap penalty d=-5 to find the optimal local alignments and their corresponding alignment scores for

- a) x=AGGTCTCA with y=GGCCA
- b) x=GCCGCCGGC and y=CCCC

Solutions

Exercise 1

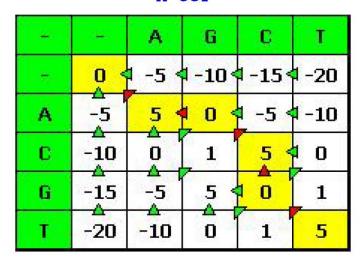
a) One solution:

Alignment: score=5

x AGC-T y A-CGT

AGC-T

A-CGT



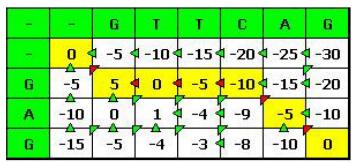
b) One solution

Alignment: score=0

x GTTCAG y G---AG

GTTCAG

G---AG



Exercise 2

a) Two solutions:

Alignment 1: score=3

x ATCGT
y A-CA-

ATCGT

A-CA-

2	12	Α	T	С	G	T
-	0 <	1 -4 •	-8 <	-12	-16	-20
A	-4	7 :	13 <	-1 <	1 -5 <	1 -9
С	-8	3	4	10	6 <	1 2
Α	-12	-1	ō	6	7	3

Alignment 2: score=3

x ATCGT y A-C-A

ATCGT

A-C-A

ω.	Δ.	Α	Ţ	C	G	T
-	0 <	1 -4 <	1 -8 <	-12	1-16 4	-20
A	-4	7 5	13	-1 <	1 -5 <	1 -9
C	-8	3	4	10	6 4	1 2
Α	-12	-1	o	6	7 -	3

b) One solution

Alignment: score=13

x GCATT y G—TT

GCATT

G--TT

2	320	G	C	Α	T	T
-	0 <	1 -4 <	1 -8 <	1-12	-16	-20
G	-4	7 -	3 4	-1 <	-5 <	1 -9
T	-8	3	4 4	0	6	2
T	-12	-1	O	1	7	13

Exercise 3

a) One solution

Alignment: score=15

x GGTCTCA y GG-C-CA

GGTCTCA

GG-C-CA

-	-	Α	G	G	T	С	T	C	Α
-	0 <	1 0 <	0	0 <	0	0	0 4	0 <	1 0
G	0	0	5	5 <	1 0	0	0	0	0
G	O	0	5	10	5	₫ 0	0	0	0
С	Ō	0	ō	5	6	10	5	5 <	1 0
С	Ō	0	0	ō	1	11	6	10 <	5
A	0	5 <	1 0	0	0	6	7	5	15

b) One solution

Alignment: score=15

x CCGCC y CC-CC CCGCC CC-CC

-	-	G	C	C	G	C	C	G	G	C
	0 <	0 <	0	0 <	10	0 4	104	0 <	10	1 0
C	Ō	0	5	5 <	0	5	5 <	0	0	5
C	Ö	0	5	10	5	5	10 <	5 5	0	5
С	Ö	0	5	10	6	10	10	6	1	5
С	o	0	5	10	6	11	15 <	10 <	15	6