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

-	-	A	G	C	T
-	0	-5	-10	-15	-20
A	-5	5	0	-5	-10
C	-10	0	1	5	0
G	-15	-5	5	0	1
T	-20	-10	0	1	5

b) One solution

```
Alignment: score=0
x  GTTCAG
y  G---AG
```

GTTCAG

G---AG

-	-	G	T	T	C	A	G
-	0	-5	-10	-15	-20	-25	-30
G	-5	5	0	-5	-10	-15	-20
A	-10	0	1	-4	-9	-5	-10
G	-15	-5	-4	-3	-8	-10	0

Exercise 2

a) Two solutions:

```
Alignment 1: score=3
x  ATCGT
y  A-CA-
```

ATCGT

A-CA-

-	-	A	T	C	G	T
-	0	-4	-8	-12	-16	-20
A	-4	7	3	-1	-5	-9
C	-8	3	4	10	6	2
A	-12	-1	0	6	7	3

```
Alignment 2: score=3
x  ATCGT
y  A-C-A
```

ATCGT

A-C-A

-	-	A	T	C	G	T
-	0	-4	-8	-12	-16	-20
A	-4	7	3	-1	-5	-9
C	-8	3	4	10	6	2
A	-12	-1	0	6	7	3

b) One solution

```
Alignment: score=13
x  GCATT
y  G—TT
```

GCATT

G--TT

-	-	G	C	A	T	T
-	0	-4	-8	-12	-16	-20
G	-4	7	3	-1	-5	-9
T	-8	3	4	0	6	2
T	-12	-1	0	1	7	13

Exercise 3

a) One solution

```
Alignment: score=15
x  GGTCTCA
y  GG-C-CA
```

GGTCTCA

GG-C-CA

-	-	A	G	G	T	C	T	C	A
-	0	0	0	0	0	0	0	0	0
G	0	0	5	5	0	0	0	0	0
G	0	0	5	10	5	0	0	0	0
C	0	0	0	5	6	10	5	5	0
C	0	0	0	0	1	11	6	10	5
A	0	5	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	0	0	0	0	0	0
C	0	0	5	5	0	5	5	0	0	5
C	0	0	5	10	5	5	10	5	0	5
C	0	0	5	10	6	10	10	6	1	5
C	0	0	5	10	6	11	15	10	5	6