

Hirschberg

Hint: Many test values are taken from project Algorithms for Bioninformatics of Alexander Mattheis or the lectures.

Test 1 (used Needleman-Waterman-Implementation for calculation)

Input

Sequence A: AATCG

Sequence B: AACG

Deletion: 2

Insertion: 2

Match: -1

Mismatch: 1

Output

1. $Trace(A_1, A_2, T_3, C_4, G_5 | A_1, A_2, C_3, G_4)$ and $i = \text{ceil}(5/2) = 3$

| | | A | A | C | G |
|---|----|----|----|----|----|
| | 0 | 2 | 4 | 6 | 8 |
| A | 2 | -1 | 1 | 3 | 5 |
| A | 4 | 1 | -2 | 0 | 2 |
| T | 6 | 3 | 0 | -1 | 1 |
| C | 8 | 5 | 2 | -1 | 0 |
| G | 10 | 7 | 4 | 1 | -2 |

| | | A | A | C | G |
|---|----|----|----|----|----|
| | -2 | 1 | 4 | 7 | 10 |
| A | 0 | -1 | 2 | 5 | 8 |
| A | 1 | -1 | 0 | 3 | 6 |
| T | 2 | 0 | -2 | 1 | 4 |
| C | 5 | 3 | 1 | -1 | 2 |
| G | 8 | 6 | 4 | 2 | 0 |

Optimum: -2

| | 0 | 1 | j=2 | 3 | 4 |
|----------|---|---|-----|----|---|
| i=3 | 6 | 3 | 0 | -1 | 1 |
| | 2 | 0 | -2 | 1 | 4 |
| Σ | 8 | 3 | -2 | 0 | 5 |

or: $i = 5-3 = 2$ in the matrix below and then reverse the line horizontally

| | | G | C | A | A |
|---|----|----|----|----|----|
| | 0 | 2 | 4 | 6 | 8 |
| G | 2 | -1 | 1 | 3 | 5 |
| C | 4 | 1 | -2 | 0 | 2 |
| T | 6 | 3 | 0 | -1 | 1 |
| A | 8 | 5 | 2 | -1 | -2 |
| A | 10 | 7 | 4 | 1 | -2 |

| | | A | A | C | G |
|---|--|---|---|---|---|
| | | | | | |
| A | | | | | |
| A | | | | | |
| T | | | | | |
| C | | | | | |
| G | | | | | |

1.1. $Trace(A_1, A_2 | A_1, A_2)$: and $i = \text{ceil}(2/2) = 1$

| | | A | A |
|---|---|----|----|
| | 0 | 2 | 4 |
| A | 2 | -1 | 1 |
| A | 4 | 1 | -2 |

| | | A | A |
|---|----|----|---|
| | -2 | 1 | 4 |
| A | 1 | -1 | 2 |
| A | 4 | 2 | 0 |

Optimum: -2

| | 0 | j=1 | 2 |
|----------|---|-----|---|
| i=1 | 2 | -1 | 1 |
| | 1 | -1 | 2 |
| Σ | 3 | -2 | 3 |

| | | A | A |
|---|--|---|---|
| | | | |
| A | | | |
| A | | | |

1.1.1. $Trace(|A_1|)$: and $i = \text{ceil}(0/2) = 0$

| | | A |
|--|---|---|
| | 0 | 2 |

| | | A |
|--|---|---|
| | 2 | 0 |

Not shown!

1.1.2. $Trace(A_2 | A_1, A_2)$: and $i = \text{ceil}(1/2) = 1$ (local for that matrix)

| | | A | A |
|---|---|----|---|
| | 0 | 2 | 4 |
| A | 2 | -1 | 1 |

| | | A | A |
|---|---|----|---|
| | 1 | -1 | 2 |
| A | 4 | 2 | 0 |

Optimum: **1**

| | 0 | j=1 | 2 |
|----------|---|-----|---|
| i=1 | 2 | -1 | 1 |
| | 4 | 2 | 0 |
| Σ | 6 | 1 | 1 |

(search minimum from right side, because right node?)

1.2. $Trace(C_4, G_5 | A_2, C_3, G_4)$:

and $i = \text{ceil}(2/2) = 1$ (local for that matrix)

| | | A | C | G |
|---|---|---|---|---|
| | 0 | 2 | 4 | 6 |
| C | 2 | 1 | 1 | 3 |
| G | 4 | 3 | 2 | 0 |

| | | A | C | G |
|---|---|----|----|---|
| | 0 | -2 | 1 | 4 |
| C | 3 | 1 | -1 | 2 |
| G | 6 | 4 | 2 | 0 |

Optimum: **0**

| | 0 | 2 | j=3 | 4 |
|----------|---|---|-----|---|
| i=4 | 2 | 1 | 1 | 3 |
| | 3 | 1 | -1 | 2 |
| Σ | 5 | 2 | 0 | 5 |

| | A | C | G |
|---|---|---|---|
| C | | | |
| G | | | |

1.2.1. $Trace(A_2, C_3)$:

and $i = \text{ceil}(0/2) = 0$ (local for that matrix)

| | | A | C |
|--|---|---|---|
| | 0 | 2 | 4 |

Not shown!

1.2.2. $Trace(C_4 | C_3, G_4)$:

and $i = \text{ceil}(1/2) = 1$ (local for that matrix)

| | | C | G |
|---|---|---|---|
| | 0 | 2 | 4 |
| G | 2 | 1 | 1 |

| | | C | G |
|---|---|----|---|
| | 1 | -1 | 2 |
| G | 4 | 2 | 0 |

Optimum: **1**

| | | | |
|----------|---|---|-----|
| | 0 | 2 | j=4 |
| i=5 | 2 | 1 | 1 |
| | 4 | 2 | 0 |
| Σ | 6 | 3 | 1 |

so:

| | | | | | |
|---|--|---|---|---|---|
| | | A | A | C | G |
| | | | | | |
| A | | | | | |
| A | | | | | |
| T | | | | | |
| C | | | | | |
| G | | | | | |