Parallel Programming

PROBLEM

STEPS

Initialization
→ Matrix Filling
→ Trace Back

SMITH WATERMAN

NEGATIVE VALUES

BECOMES



SMITH WATERMAN

NEGATIVE VALUES

BECOMES

Rewards and Penalties

Match
1
Mismatch
-1
-2

| | Α | Т | G | C | T |
|---|---|-----|---|---|---|
| | | | | | |
| Α | | 7 | | | |
| G | | | | 6 | |
| С | | 0.0 | | | - |
| Т | | | | | |

Seq 1 ATGCT

| | | Α | T | G | С | T |
|---|---|---|------|---|---|---|
| | 0 | | | | | |
| Α | | | 2 | | | |
| G | | | | | 9 | |
| С | | | E2 + | | | |
| Т | | | | | | |

Seq 1 ATGCT

| | | Α | T | G | С | T |
|---|---|----|---|---|---|------|
| | 0 | -2 | | | | |
| Α | | | 2 | | | |
| G | | | | | 8 | |
| С | | | 0 | 1 | | |
| T | | | | | | 1010 |

Seq 1 ATGCT

| | | Α | T | G | C | T |
|---|---|----|-----|---|---|---|
| | 0 | -2 | -4 | | | |
| Α | | | 2 | | | |
| G | | | | | 6 | |
| С | | | Die | | | |
| Т | | | | | | |

Seq 1 ATGCT

| | | Α | Т | G | C | T |
|---|---|----|----|-------|------|-----|
| | 0 | -2 | -4 | -6 | -8 | -10 |
| Α | | | 2 | | | |
| G | | | | | 6- | |
| С | | | Di | | , ,, | - |
| Т | | | | 9 2 6 | | |

Seq 1 ATGCT

| | | Α | T | G | C | L |
|---|----|----|----|------|----|-----|
| | 0 | -2 | -4 | -6 | -8 | -10 |
| Α | -2 | | | | | |
| G | -4 | | | | 6 | |
| С | -6 | | 0 | | | |
| Т | -8 | | | -013 | | |

Seq 1 ATGCT

| | | Α | T | G | С | Т |
|---|----|-----|----|----|----|-----|
| | 0 | -2 | -4 | -6 | -8 | -10 |
| Α | -2 | 1 | | | | |
| G | -4 | -((| | | | |
| C | -6 | | | | | |
| 7 | -8 | 0 | | | | |

Negative

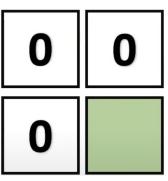


0

| | | Α | Т | G | С | Т |
|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | 1 | | | | |
| G | 0 | | | | |) |
| C | 0 | | | | | |
| Т | 0 | | | | | |

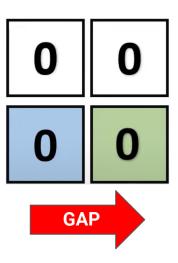
MATRIX FILLING

| | | Α | Т | G | С | T |
|---|---|---|-----|-----|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | | | -(| | |
| G | 0 | | | | 1 | |
| С | 0 | | | | | |
| Т | 0 | | 315 | IIN | FO | RM |



MATRIX FILLING

| | | Α | Т | G | С | T |
|---|---|---|-----|----|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | | | -(| | |
| G | 0 | | | | | |
| С | 0 | | | | | |
| Т | 0 | | 316 | IN | FO | RM |

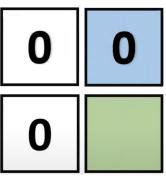


MATRIX FILLING

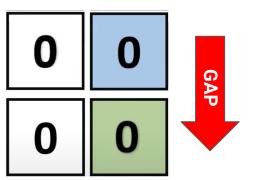
| | | Α | Т | G | С | T |
|---|---|---|-----|---------------|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | | | \mathcal{H} | | |
| G | 0 | | | | 1 | |
| С | 0 | | | | | |
| Т | 0 | | 316 | IIN | FO | RM |

0 0 -2

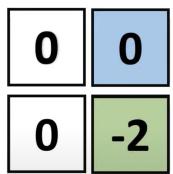
| | | Α | Т | G | C | Ð |
|---|---|---|-----|-----|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | | | -(| | |
| G | 0 | | | | | |
| С | 0 | | | | | |
| Т | 0 | | 316 | NIN | FO | RM |



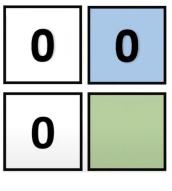
| | | Α | Т | G | С | F |
|---|---|---|-----|---------------|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | | | \mathcal{H} | | |
| G | 0 | | | | | |
| С | 0 | | | | | |
| Т | 0 | | 316 | IN | FO | RM |



| | | Α | Т | G | С | F |
|---|---|---|-----|---------------|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | | | \mathcal{H} | | |
| G | 0 | | | | | |
| С | 0 | | | | | |
| Т | 0 | | 316 | IN | FO | RM |

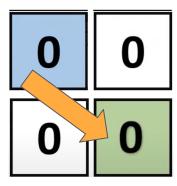


| | | Α | Т | G | С | T |
|---|---|---|-----|---------------|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | | | \mathcal{H} | | |
| G | 0 | | | | | |
| С | 0 | | | | | |
| Т | 0 | | 316 | N | FO | RM |



-2 -2

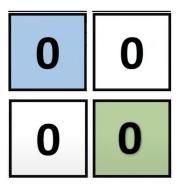
| | | Α | Т | G | С | T |
|---|---|---|-----|-----|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | | | | | |
| G | 0 | | | | 1 | |
| С | 0 | | | | | |
| Т | 0 | | 316 | NIN | FO | RM |



-2 -2

A = A MATCH

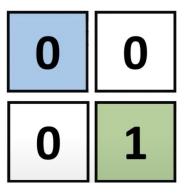
| | | Α | Т | G | С | T |
|---|---|---|-----|----|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | | | -(| | |
| G | 0 | | | | 1 | |
| С | 0 | | | | | |
| Т | 0 | | 316 | ΙΝ | FO | RM |



-2 -2

A = A MATCH

| | | Α | Т | G | С | T |
|---|---|---|-----|-----|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | | | -(| | |
| G | 0 | | | | 1 | |
| С | 0 | | | | | |
| Т | 0 | | 316 | IIN | FD | RM |



-2 | -2

| | | Α | Т | G | С | Ð |
|---|---|---|-----|---------------|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | | | \mathcal{H} | | |
| G | 0 | | | | | |
| С | 0 | | | - | | |
| Т | 0 | | 316 | NIN | FO | RM |

Negative



0

-2

-2

1

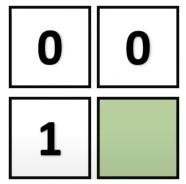
| | | Α | Т | G | U | б |
|---|---|---|-----|---------------|---|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | | | \mathcal{H} | | |
| G | 0 | | | | 1 | |
| С | 0 | | | | | |
| Т | 0 | | 316 | IIN | F | RM |

0 0 1

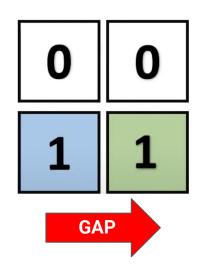
| | | Α | Т | G | С | Ð |
|---|---|---|-----|---------------|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | | | \mathcal{H} | | |
| G | 0 | | | | | |
| С | 0 | | | | | |
| Т | 0 | | 316 | IIN | FO | RM |

| | | Α | Т | G | С | F |
|---|---|---|-----|------|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | 1 | |)—((| | |
| G | 0 | | | | | |
| С | 0 | | | | | |
| Т | 0 | | 310 | HN | ED | RM |

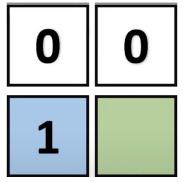
| | | Α | Т | G | С | H |
|---|---|---|-----|-----|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | 1 | | -(| | |
| G | 0 | | | | | |
| С | 0 | | | | | |
| Т | 0 | | 310 | IIN | ED | RM |



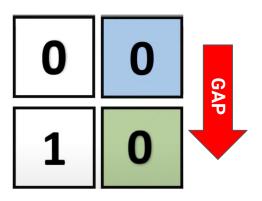
| | | Α | Т | G | С | T |
|---|---|---|-----|-----|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | 1 | | -((| | |
| G | 0 | | 1 | | | |
| С | 0 | | | | - | |
| Т | 0 | | 310 | IIN | FO | RM |



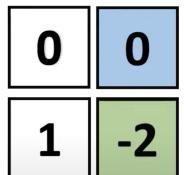
| | | Α | Т | G | С | H |
|---|---|---|-----|---------------|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | 1 | | \mathcal{H} | | |
| G | 0 | | | | | 3 |
| С | 0 | | | | | |
| Т | 0 | | 310 | IIN | FO | RM |



| | | Α | Т | G | С | T |
|---|---|---|-----|---------------|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | 1 | | \mathcal{H} | | |
| G | 0 | | | | | 3 |
| С | 0 | | | /// | | |
| Т | 0 | | 310 | IIN | ED | RM |

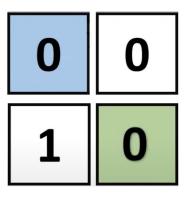


| | | Α | Т | G | C | H |
|---|---|---|-----|---------------|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | 1 | | \mathcal{H} | | |
| G | 0 | | | | | |
| С | 0 | | | - | - | |
| Т | 0 | | 310 | IIN | ED | RM |



A # T MISMATCH

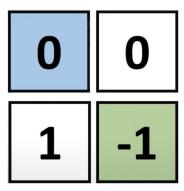
| | | Α | Т | G | С | T |
|---|---|---|-----|---------------|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | 1 | | \mathcal{H} | |)) |
| G | 0 | | | | | |
| С | 0 | | | | | |
| Т | 0 | | 310 | IIN | RO | RM |



-1 -2

A ≠ T MISMATCH

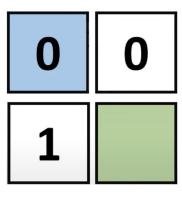
| | | Α | Т | G | С | T |
|---|---|---|----|------|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | 1 | |)-((| | |
| G | 0 | | 1 | | | |
| С | 0 | | | | | |
| Т | 0 | | Вц | IIN | ED | RM |



-1 -2

A # T MISMATCH

| | | Α | Т | G | С | T |
|---|---|---|-----|---------------|----|----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | 1 | | \mathcal{H} | |)) |
| G | 0 | | | | | |
| С | 0 | | | | | |
| Т | 0 | | 310 | IIN | RO | RM |



-1 -2 -1

| | | Α | Т | G | С | |
|---|---|---|-----|---------------|----|-----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | 1 | | \mathcal{H} | | |
| G | 0 | | | | | -5% |
| С | 0 | | | | | |
| Т | 0 | | 310 | MI | RO | RM |

0 0

| | | Α | Т | G | С | |
|---|---|---|-----|---------------|----|-----|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | 1 | | \mathcal{H} | | |
| G | 0 | | | | | -5% |
| С | 0 | | | | | |
| Т | 0 | | 310 | MI | RO | RM |

0 0

| | | Α | T | G | С | Т |
|---|---|--|----|----|-----|---|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | 1 | 0 | | | |
| G | 0 | A. Commission of the Commissio | | | | |
| С | 0 | 0 | | | | |
| Б | 0 | VE | DR | MA | FIC | A |

| | | Α | T | G | С | Т |
|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | 1 | 0 | 0 | 0 | 0 |
| G | 0 | 0 | 0 | 1 | 0 | 0 |
| С | 0 | 0 | 0 | 0 | 2 | 0 |
| Б | 0 | 0 | 0 | 0 | 0 | 3 |

TRACE BACK

Strat from Highest Value

An arrow for a base

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
|----|---|---|---|------------|---|---|---|
| 0_ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 2 | 0 | 1 ~ | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Proceed towards Zeros

Multiple local alignment possible

| | | Α | Т | G | С | Т |
|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | 1 | 0 | 0 | 0 | 0 |
| G | 0 | 0 | 0 | 1 | 0 | 0 |
| С | 0 | 0 | 0 | 0 | 2 | 0 |
| Т | 0 | 0 | 0 | 0 | 0 | 3 |

| | | Α | Т | G | С | Т |
|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | 1 | 0 | 0 | 0 | 0 |
| G | 0 | 0 | 0 | 1 | 0 | 0 |
| С | 0 | 0 | 0 | 0 | 2 | 0 |
| Т | 0 | 0 | 0 | 0 | 0 | 3 |

| | | Α | Т | G | С | Т |
|---|---|---|---|---|---|---|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | 1 | 0 | 0 | 0 | 0 |
| G | 0 | 0 | 0 | 1 | 0 | 0 |
| С | 0 | 0 | 0 | 0 | 2 | 0 |
| Т | 0 | 0 | 0 | 0 | 0 | 3 |

CT

| | | Α | Т | G | С | Т |
|---|---|---|---|----|---|---|
| | 0 | 0 | 0 | 0 | 0 | 0 |
| Α | 0 | 1 | 0 | 0 | 0 | 0 |
| G | 0 | 0 | 0 | 1_ | 0 | 0 |
| С | 0 | 0 | 0 | 0 | 2 | 0 |
| Т | 0 | 0 | 0 | 0 | 0 | 3 |

GCT

GCT

Locally Aligned Sequences

```
Sequence 1 ATGCT | | | | Sequence 2 AGCT
```

THANKS FOR YOUR ATTENTION!!!

190103190 - Bektursyn Azamat 190103157 - Merekeyev Raiymbek