**ECS129**

**Examples of Sequence Alignments Using Dynamic Programming**

In all the example below:

* Fill in the matrix
* Write one of the alignments with optimal score

**Example 1:**

***Match: +2; Mismatch 0; Gap 0***

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **G** | **A** | **T** | **T** | **A** | **G** | **C** |
| **A** | 0 | 2 | 0 | 0 | 2 | 0 | 0 |
| **T** | 0 | 0 | 4 | 4 | 2 | 2 | 2 |
| **T** | 0 | 0 | 4 | 6 | 4 | 4 | 4 |
| **A** | 0 | 2 | 2 | 4 | 8 | 6 | 6 |
| **C** | 0 | 0 | 2 | 4 | 6 | 8 | 10 |

Only one alignment:

G A T T A G C

A T T A - C

**Example 2:**

***Match: +2; Mismatch 0; Gap -2 (no gap cost at the beginning)***

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | G | A | T | T | A | G | C |
| A | 0 | 2 | 0 | 0 | 2 | 0 | 0 |
| T | 0 | 0 | 4 | 2 | 0 | 2 | 0 |
| T | 0 | 0 | 2 | 6 | 2 | 2 | 2 |
| A | 0 | 2 | 0 | 2 | 8 | 4 | 4 |
| C | 0 | 0 | 2 | 2 | 4 | 8 | 8 |

2 possible alignments:

G A T T A G C G A T T A G C

A T T A – C A T T A C

**Example 3**

***Match: +1; Mismatch: 0; Gap: -1 (no gap cost at the beginning)***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | I | N | D | U | S | T | R | Y |
| I | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| N | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| T | 0 | 0 | 2 | 1 | 1 | 2 | 1 | 1 |
| E | 0 | 0 | 1 | 2 | 1 | 1 | 2 | 1 |
| R | 0 | 0 | 1 | 1 | 2 | 1 | 2 | 2 |
| E | 0 | 0 | 1 | 1 | 1 | 2 | 1 | 2 |
| S | 0 | 0 | 1 | 1 | 2 | 1 | 2 | 1 |
| T | 0 | 0 | 1 | 1 | 1 | 3 | 1 | 2 |

I N D U - - S T R Y ; I N D - - U S T R Y ; I N - - D U S T R Y

I N T E R E S T ; I N T E R E S T ; I N T E R E S T

**Example 4**

***Match: +10; Mismatch: -5; Gap: -5 (no gap cost at the beginning)***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | I | N | D | U | S | T | R | Y |
| I | 10 | -5 | -5 | -5 | -5 | -5 | -5 | -5 |
| N | -5 | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| T | -5 | 0 | 15 | 10 | 10 | 25 | 10 | 10 |
| E | -5 | 0 | 10 | 10 | 5 | 5 | 20 | 15 |
| R | -5 | 0 | 10 | 5 | 5 | 0 | 30 | 15 |
| E | -5 | 0 | 10 | 5 | 0 | 0 | 15 | 25 |
| S | -5 | 0 | 10 | 5 | 15 | 0 | 15 | 20 |
| T | -5 | 0 | 10 | 5 | 0 | 25 | 15 | 20 |

*Many more alignments, including the three before:*

I N D U - - S T R Y ; I N D - - U S T R Y ; I N - - D U S T R Y

I N T E R E S T ; I N T E R E S T ; I N T E R E S T

**Example 5:**

***Match: +10; Mismatch: +3; Gap: -8 (no gap cost at the beginning)***

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | G | S | A | Q | V | K | G | H | H | K | K | V |
| G | 10 | 3 | 3 | 3 | 3 | 3 | 10 | 3 | 3 | 3 | 3 | 3 |
| N | 3 | 13 | 6 | 6 | 6 | 6 | 6 | 13 | 6 | 6 | 6 | 6 |
| P | 3 | 6 | 16 | 9 | 9 | 9 | 9 | 9 | 16 | 9 | 9 | 9 |
| K | 3 | 6 | 9 | 19 | 12 | 19 | 12 | 12 | 12 | 26 | 19 | 12 |
| V | 3 | 6 | 9 | 12 | 29 | 15 | 22 | 15 | 15 | 15 | 29 | 29 |
| K | 3 | 6 | 9 | 12 | 15 | 39 | 24 | 25 | 24 | 31 | 31 | 32 |
| A | 3 | 6 | 16 | 12 | 15 | 24 | 42 | 34 | 34 | 34 | 34 | 34 |
| H | 3 | 6 | 9 | 19 | 15 | 24 | 34 | 52 | 44 | 37 | 37 | 37 |
| G | 10 | 6 | 9 | 12 | 22 | 24 | 41 | 37 | 55 | 47 | 47 | 47 |
| K | 3 | 13 | 9 | 12 | 15 | 32 | 34 | 44 | 47 | 65 | 57 | 50 |
| K | 3 | 6 | 16 | 12 | 15 | 31 | 35 | 37 | 47 | 57 | 75 | 60 |
| V | 3 | 6 | 9 | 19 | 22 | 18 | 34 | 38 | 47 | 50 | 60 | 85 |

G S A Q V K G H H K K V

G N P K V K A H G K K V