

Exercise sheet 2: Edit operations and alignments

Exercise 1 - Levenshtein Distance

Compute the minimal Levenshtein edit distance for the following pairs of sequences.

1a)

$$S_1 = A \tag{1}$$

$$S_2 = T \tag{2}$$

Hide

Hint $A \rightarrow T$

Correct Answer $A \rightarrow T = 1$

1b)

$$S_1 = AGATATA \tag{3}$$

$$S_2 = TATATATA \tag{4}$$

Hide

Hint $AGATATA \rightarrow ATATATA \rightarrow \dots$

Correct Answer $AGATATA \rightarrow ATATATA \rightarrow TATATATA = 2$

1c)

$$S_1 = AGTCCT \tag{5}$$

$$S_2 = CGCTCA \tag{6}$$

Hide

Hint AGTCCT \rightarrow AGCTCA $\rightarrow \dots$

Correct Answer AGTCCT \rightarrow CGTCCT \rightarrow CGCCCT \rightarrow CGCTCA = 3

1d)

$$S_1 = TGCATAT \quad (7)$$

$$S_2 = ATCCGAT \quad (8)$$

Hide

Hint TGCATAT \rightarrow AGCATAT $\rightarrow \dots$

Correct Answer TGCATAT \rightarrow AGCATAT \rightarrow ATCATAT \rightarrow ATCCGAT = 3

1e)

$$S_1 = ACGTATATAGCCCCGCG \quad (9)$$

$$S_2 = ACGTTATATAGCCGCGC \quad (10)$$

Hide

Hint You need to use all the possible operations

ACGTATATAGCCCCGCG \rightarrow ACGTTATATAGCCCCGCG $\rightarrow \dots$

Correct Answer ACGTATATAGCCCCGCG \rightarrow ACGTTATATAGCCCCGCG \rightarrow ACGTTATATAGCCGCGC \rightarrow ACGTTATATAGCCGCGC = 3

Exercise 2 - Metric function

Check if the corresponding functions are metric.

Hide

Formulae Note

Definition Metric:

$$w(x, y) = 0 \leftrightarrow x = y \quad (\text{identity}) \quad (11)$$

$$w(x, y) = w(y, x) \quad (\text{symmetric}) \quad (12)$$

$$w(x, z) \leq w(x, y) + w(y, z) \quad (\text{triangle inequality}) \quad (13)$$

2a)

$$w(x, y) = x - y \quad (14)$$

Hide

Hint What if $x = 1$ and $y = 2$?

Correct Answer Not a metric, violates symmetry constraint.

$$x = 1, y = 2 \Rightarrow w(x, y) = 1 - 2 = -1 \neq 1 - 2 = w(y, x)$$

2b)

$$w(x, y) = |x - y| \quad (15)$$

Hide

Hint You need to check all the properties.

Correct Answer Metric

2c)

$$w(x, y) = x + y \quad (16)$$

Hide

Hint What if $x = 1$ and $y = 1$?

Correct Answer Not metric, violates identity constraint:

$$x = y = 1 \Rightarrow x + y = x + x = 2 \neq 0$$

2d)

$$w(x, y) = \begin{cases} 1 & \text{if } x \neq y \\ 0 & \text{else} \end{cases} \quad (17)$$

Hide

Hint You need to check all the properties.

Correct Answer Metric

Exercise 3 - Programming assignment

Programming assignments are available via Github Classroom and contain automatic tests.

We recommend doing these assignments since they will help you to further understand this topic.

Access the Github Classroom link: [Programming Assignment: Sheet 02](#).
