Exercise sheet 2: Edit operations and alignments

Exercise 1 - Levenshtein Distance

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

1a)

$$S_1 = A \tag{1}$$
$$S_2 = T \tag{2}$$

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Hint   A → T

Correct Answer   A → T = 1

1b)

$$S_1 = AGATATA \tag{3}$$
$$S_2 = TATATATA \tag{4}$$

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Hint   AGATATA → ATATATA → ...

Correct Answer   AGATATA → ATATATA → TATATATA = 2

1c)

$$S_1 = AGTCCT \tag{5}$$
$$S_2 = CGCTCA \tag{6}$$

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Hint   AGTCCT → AGCTCA → . . .

Correct Answer   AGTCCT → CGTCCT → CGCCCT → CGCTCT → CGCTCA = 4

1d)

$$S_1 = TGCATAT \tag{7}$$
$$S_2 = ATCCGAT \tag{8}$$

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Hint   TGCATAT → AGCATAT → . . .

Correct Answer   TGCATAT → AGCATAT → ATCATAT → ATCAGAT → ATCCGAT = 4

1e)

$$S_1 = ACGTATATAGCCCCGCG \tag{9}$$
$$S_2 = ACGTTATATAGCCGCGC \tag{10}$$

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Hint   You need to use all the possible operations

ACGTATATAGCCCCGCG → ACGTTATATAGCCCCGCG → . . .

Correct Answer   ACGTATATAGCCCCGCG → ACGTTATATAGCCCCGCG → ACGTTATATAGC-CGCGCG → ACGTTATATAGCCGCGC = 3

Exercise 2 - Metric function

Check if the corresponding functions are metric.

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Formulae Note

Definition Metric:

$$w(x, y) = 0 \leftrightarrow x = y \qquad \text{(identity)} \qquad (11)$$
$$w(x, y) = w(y, x) \qquad \text{(symmetric)} \qquad (12)$$
$$w(x, z) \leq w(x, y) + w(y, z) \qquad \text{(triangle inequality)} \qquad (13)$$

2a)

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

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

Correct Answer   Not a metric, violates symmetry constraint.

$$x = 1y = 2x - y = 1 - 2 = -1 \neq 1 = 2 - 1 = y - x$$

2b)

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

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Hint   You need to check all the properties.

Correct Answer   Metric

2c)

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

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

Correct Answer   Not metric, violates identity constraint:

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

2d)

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

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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.