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 $\rightarrow$ T

Correct Answer A $\rightarrow$ T = 1

1b)

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

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Hint AGATATA $\rightarrow$ ATATATA $\rightarrow$ ...

Correct Answer AGATATA $\rightarrow$ ATATATA $\rightarrow$ TATATATA = 3

1c)

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

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Hint AGTCCT → AGCTCA → ...

Correct Answer AGTCCT → CGTCCT → CGCCCT → 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 → 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 → ACGTTATATAGCCGCGCG → ACGTTATATAGCCGCGC = 4

Exercise 2 - Metric function

Check if the corresponding functions are metric.

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Formulae Note

Definition Metric:

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

2a)

$$w(x,y) = x - y \tag{14}$$

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

Correct Answer Not a metric, violates identity constraint.

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

2b)

$$w(x,y) = |x - y| \tag{15}$$

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Hint You need to check all the properties.

Correct Answer Metric

2c)

$$w(x,y) = x + y \tag{16}$$

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

Correct Answer Not metric, violates symmetry constraint:

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

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