Algorithms in Comparative Genomics

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https://gi.cebitec.uni-bielefeld.de/teaching/2024summer/cg

Exercise sheet 1, 12.04.2024

Exercise 1 (Algorithm for breakpoint distance) (5 pts)

Devise a linear time algorithm for computing the breakpoint distance $d_{BP}(\mathbb{A}, \mathbb{B})$, where $\mathbb{A}$ and $\mathbb{B}$ are a pair of canonical genomes and can contain multiple linear or circular chromosomes.

Exercise 2 (Number of String representations) (4 pts)

1. Write down all string representations for the following singular genomes.
   - $\mathbb{A} = \{\ [1\,\bar{2}\,3]\ \ [4\,5]\ \}$
   - $\mathbb{B} = \{\ [\bar{1}\,\bar{3}\,2]\ \ (4\,5)\ \}$
   - $\mathbb{C} = \{\ [\bar{2}\,3\,1]\ (4)\ \}$
2. Develop a general formula for the number of string representations of singular genomes

Exercise 3 (Breakpoint distance) (3 pts)
Give the breakpoint distance for all parings of the below genomes.

$\mathbb{A} = \{\ [1\,2\,3]\ \ [4\,5]\ \}$

$\mathbb{B} = \{\ [1\,\bar{2}\,3\,4\,5]\ \}$

$\mathbb{C} = \{\ [1\,3\,2]\ (4\,5)\ \}$

Exercise 4 (Sorting Permutations) (5 pts & Cookies for the entire class)

Problem 1 *Given a linear chromosome* $[s]$ *with* s *a signed permutation on* $\mathbb{N}$*, find the minimum number of operations needed to transform* $[s]$ *into the sorted chromosome* $[1\,2\,3\,...]$ *using the following operations:*

- *GNI: Exchange two elements, i.e.* $...a...b... \rightarrow ...b...a...$,
- *IGI: Exchange two elements and invert their signs, i.e.* $...a...b... \rightarrow ...\bar{b}...\bar{a}...$,
- *SGN: Change the sign of a single element, i.e.* $...a... \rightarrow ...\bar{a}...$.

Note that the three operations can be used in any order and multiplicity.