Exercises – Algorithms for Genome Rearrangement

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http://wiki.techfak.uni-bielefeld.de/gi/Teaching/2014summer/gr

Exercise List 2 — 14.04.2014

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Exercise 1 **(2 Points)**

Consider the permutation $\pi = (\ 2\ \ 4\ \ 1\ \ 3\ )$.

(a) Sort π with unsigned reversals, drawing the BP graph and a cycle decomposition at each step, also indicating wich reversal edges you chose and whether the edges are directed or undirected.

(b) Is your solution optimal? Why?

Exercise 2 **(2 Points)**

A *transposition* is a rearrangement operation where two consecutive blocks of elements are swapped. For instance, in the permutation $\pi = (\ 1\ \ 2\ \ 3\ \ 4\ \ 5\ \ 6\ )$ we can apply a transposition swapping blocks $(2\ \ 3)$ and $(4\ \ 5)$, resulting in the permutation $\sigma = (\ 1\ \ 4\ \ 5\ \ 2\ \ 3\ \ 6\ )$.

(a) In the permutation graph G_π, which edges are removed and which are created, to transform G_π into G_σ?

(b) In the general case, which edges are changed in a transposition? For instance, how can we tranform $\pi = (\ \cdots\ x_{i-1}\ \ x_i\ \cdots\ x_{j-1}\ \ x_j\ \cdots\ x_k\ \ x_{k+1}\ \cdots\ )$, swapping blocks $(x_i \cdots x_{j-1})$ and $(x_j \cdots x_k)$, resulting in the permutation $\sigma = (\ \cdots\ x_{i-1}\ \ x_j\ \cdots\ x_k\ \ x_i\ \cdots\ x_{j-1}\ \ x_{k+1}\ \cdots\ )$?

Exercise 3 **(2 Points)**

Multichromosomal genomes can also be represented by graphs. For instance, a genome with the chromosomes $(\ 1\ \ 2\ \ 3\ \ 4\ )$ and $(\ 5\ \ 6\ \ 7\ \ 8\ )$ is represented by the graph

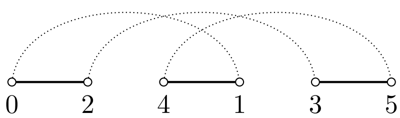
(in the multichromosomal case we can avoid the auxiliary elements 0 and $n+1$). A *translocation* is a multichromosomal rearrangement operation where the ends of two linear chromosomes are swapped. For instance, the genome above can be transformed into $(\ 1\ \ 2\ \ 7\ \ 8\ )$ and $(\ 5\ \ 6\ \ 3\ \ 4\ )$ with one translocation.

(a) In the translocation above, which edges are removed and which are created?

(b) Can you give a general formula for the edges that are changed in a translocation, similarly to the previous exercise?

Exercise 4 **(3 Points)**

Consider the following cycle in a BP graph decomposition of a permutation $\pi = (\ 2\ \ 4\ \ 1\ \ 3\ )$.



All the black edges in this graph are directed, which means that there is no reversal defined by two edges that can break this cycle in two. But, if we generalize the idea of a reversal as "removing two edges and creating two new ones", there is a way of applying a rearrangement operation that breaks this cycle in two.

(a) Find a rearrangement operation (in terms of two edges removed/two edges created) that breaks the above cycle in two.

(b) What is the effect of this operation in the permutation graph? Is this still a genome with one chromosome?