Algorithms in Comparative Genomics

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https://gi.cebitec.uni-bielefeld.de/teaching/2023summer/cg

Exercise sheet 9, 9.6.2023

Exercise 1 (Singular DCJ-indel model) (12 pts)

Consider the following singular genomes:

$$\mathbb{A} = [\,a_1\ 4\ 1\,]\ [\,a_2\ 6\ a_3\ 3\ a_4\ 2\ a_5\ 5\,]\ [\,a_6\ a_7\ 7\ 8\ a_8\ \bar{9}\,]\ [\,a_9\,] \quad \text{and}$$

$$\mathbb{B} = [\,b_1\ 1\ b_2\ 2\ b_3\ 3\ b_4\ 4\ b_5\,]\ [\,5\ b_6\ 6\,]\ [\,b_7\ 7\ 8\ b_8\ 9\,]\ (\,b_9\ b_{10}\,)$$

1. Give the sets of genes $\mathcal{G}_\star$, $\mathcal{A}$ and $\mathcal{B}$ and construct the relational graph $RG(\mathbb{A}, \mathbb{B})$.
2. For each component C of the relational graph $RG(\mathbb{A}, \mathbb{B})$:
   (a) Give the type of C (cycle, singleton, $\mathbb{AB}$-path, $\mathbb{AA}$-path or $\mathbb{BB}$-path).
   (b) Give the number of runs $\Lambda(C)$ and the run-type of C (ε, $\mathcal{A}$, $\mathcal{B}$, $\mathcal{AB}$ or $\mathcal{BA}$);
   (c) Compute the minimum number of indels $\lambda(C)$ that are necessary for sorting C separately.
3. Find all chains of deducting recombinations and compute the DCJ-indel distance $d_{\text{DCJ}}^{\text{ID}}(\mathbb{A}, \mathbb{B})$.

Exercise 2 (Deducting path recombinations) (6 pts)

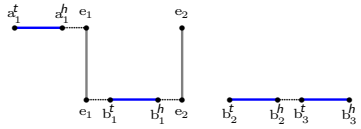
For each of the following deducting path recombinations, draw the cuts and the resultants of the given types with the joins, so that the given $\Delta_{\text{DCJ}}^{\lambda}$ is achieved. (Recall that both cuts must be done in the same genome and each cut either breaks an adjacency or is next to a telomere.)

1. Example: $\Delta_{\text{DCJ}}^{\lambda} = -1$

$\mathbb{AA}_{\mathcal{AB}} + \mathbb{BB}_{\mathcal{A}} \Rightarrow \mathbb{AB}_{\varepsilon} + \mathbb{AB}_{\mathcal{BA}}$

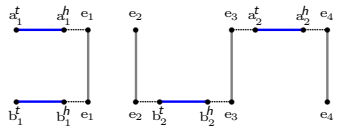
2. $\Delta_{\text{DCJ}}^{\lambda} = -1$

$\mathbb{AA}_{\mathcal{AB}} + \mathbb{BB}_{\mathcal{B}} \Rightarrow \mathbb{AB}_{\varepsilon} + \mathbb{AB}_{\mathcal{AB}}$



3. $\Delta_{\text{DCJ}}^{\lambda} = -1$

$\mathbb{AB}_{\mathcal{AB}} + \mathbb{AB}_{\mathcal{BA}} \Rightarrow \mathbb{AB}_{\mathcal{A}} + \mathbb{AB}_{\mathcal{B}}$



4. $\Delta_{\text{DCJ}}^{\lambda} = -2$

$\mathbb{AA}_{\mathcal{AB}} + \mathbb{BB}_{\mathcal{AB}} \Rightarrow \mathbb{AB}_{\mathcal{A}} + \mathbb{AB}_{\mathcal{B}}$