

## HW assignment #5

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1. Consider the unsigned permutation  $\pi = 6\ 8\ 2\ 5\ 4\ 1\ 7\ 3$ .
  - (a) How many breakpoints does it have? List them.
  - (b) Plot its breakpoint graph  $G(\pi)$  (for unsigned permutations).
  - (c) Try to find the maximal cycle decomposition of  $G(\pi)$ .
  - (d) Apply the Kececioglu-Sankoff 2-approximation algorithm to sort  $\pi$ .
  - (e) Use the GRIMM server (Tesler) <http://www.cs.ucsd.edu/groups/bioinformatics/GRIMM/> to find  $d(\pi)$ .
  - (f) Use GRIMM to find  $d(\pi)$  assuming the reversals are signed (or that  $\pi$  is a signed permutation that happens to be positive).
2. Complete the proofs of:
  - (a) Claim 3
  - (b) Claim 5
3. As defined in class, *oriented pairs* (Bergeron 01) is a pair of consecutive integers  $(\pi_j, \pi_{j+1})$  with opposite signs. It has a naturally associated *oriented reversal* that creates a strip out of the pair. Note that for signed permutations  $5\ 4\ 3$  and  $-3\ -4\ -5$  are *not* strips.
  - (a) Give an example of a permutation that has no oriented pairs.
  - (b) What are the possible oriented reversals for a given oriented pair?
  - (c) Consider the breakpoint graph associate with the signed  $\pi$ . The slide entitled “Oriented pairs and the bp graph” identifies oriented pairs with a gray edge. Show that the oriented reversal corresponds to cutting the black edges between the red and light blue circles.
  - (d) Show that each oriented reversal reduces the number of cycles by 1 (Claim 6).