

Heaps

a) (2.5 Points). i) (1 Point). Suppose we have the min-heap below (represented as an array) with **distinct** elements, where the values of A and B are unknown. Note that A and B aren't necessarily integers.

{1, A, 3, 5, 9, 11, 13, 10, B}

What can we say about the relationships between the following elements? Put >, <, or ? if the answer is not known.

A > < ? 1

A > < ? 3

B > < ? 10

A > < ? B

Solution:

[Here is a video walkthrough of the solutions.](#)

A > < ? 1

A > < ? 3

B > < ? 10

A > < ? B

ii) (1.5 Points). Note for both parts below, the values of A and B should **not** violate the min-heap properties. Put `-inf` or `inf` if there isn't a lower or upper bound, respectively. If the bound for B depends on the value of A, or vice versa, you may put the variable in the bound, e.g. `A < B`.

Considering **one** `removeMin` call, put **tight** bounds on A and B such that:

- We perform the **maximum** number of swaps.

----- < A < -----

----- < B < -----

- We perform the **minimum** number of swaps.

----- < A < -----

$$\text{-----} < \mathbf{B} < \text{-----}$$

Solution:

Here is a video walkthrough of the solutions.

- We perform the **maximum** number of swaps.

$$1 < \mathbf{A} < 3$$

$$10 < \mathbf{B} < \mathbf{inf}$$

- We perform the **minimum** number of swaps.

$$3 < \mathbf{A} < 5$$

$$5 < \mathbf{B} < 11$$