CMSC 401 – Fall 2023

Assignment 2
(due Sun 10/8 – 11:59pm)

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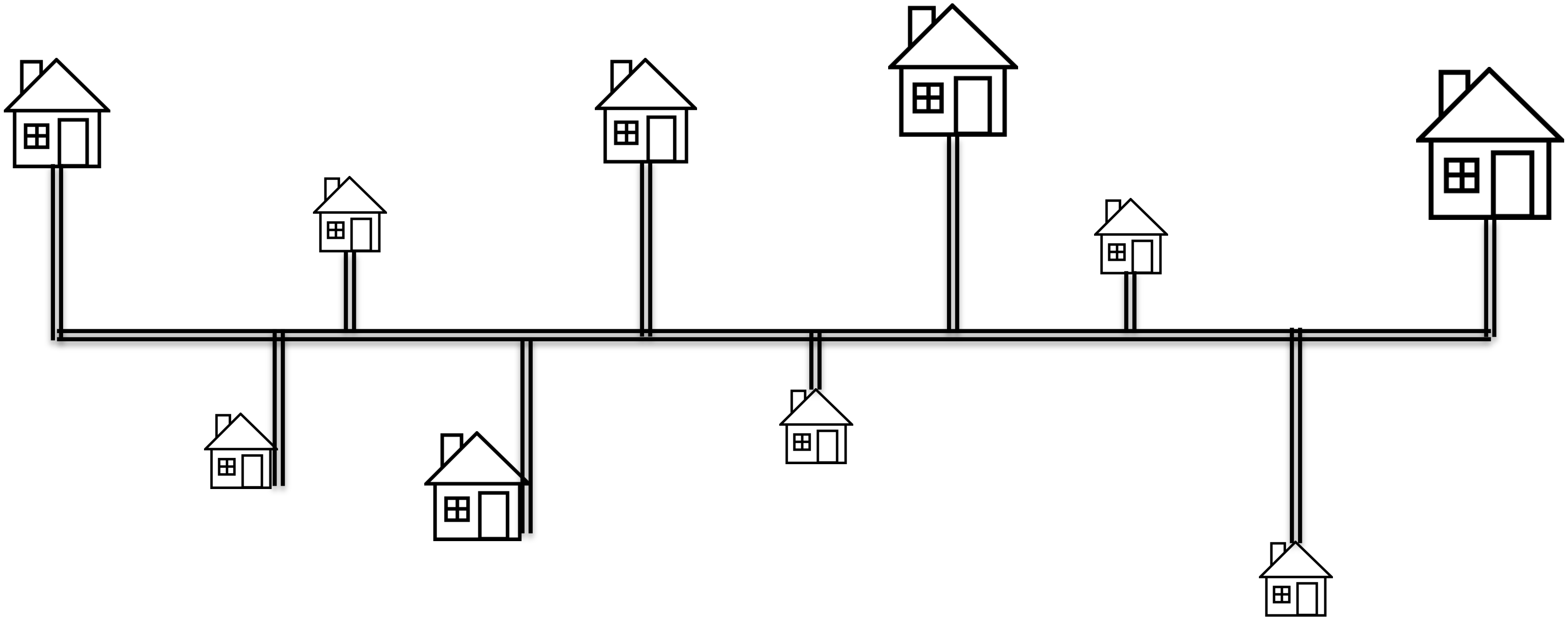
CMSC 401- Algorithm Analysis with Advanced Data Structures

VCU
College of Engineering

Optimal Power Line Location

- Power distribution company is planning to build a main power line from east to west (x-axis) across its distribution area
- The area has n houses of <u>3 different sizes.</u>
- The company wants to connect each house directly to the main power line with smaller power lines in north-south direction (y-axis)



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Optimal Power Line Location

- The cost of each small powerline is proportional to the distance of the house (from its center point) to the main powerline and also the size of the house (larger houses require more power and thus better quality cables etc.).
  - Cost of small powerline = Distance x (Unit price) x (size of house)
  - Unit price = $1
  - Size of house = 1, 2 or 3 (referring to 1000, 2000, 3000 square feet)
- The goal is to estimate the optimal position (on the y-axis) of the main powerline, so that the total cost of small power lines is the minimum.

Assignment 2

Write a program CMSC401_A2.java that

- takes as input
  - in the first line, the number of houses n, n>=2, n<1,000,000
  - in each consecutive line (from 2nd to (n+1)-th line), the y-coordinate of one house's center point (integers in the range 0 to 1,000,000,000) and the size of the house (1, 2 or 3)
- returns as output
  - **a single number:** the y-coordinate where the main power line should be built
  - just one number, no comments, prompts etc.

- Use standard I/O to read input (System.in, System.out) and write the result
- Make sure the program compiles

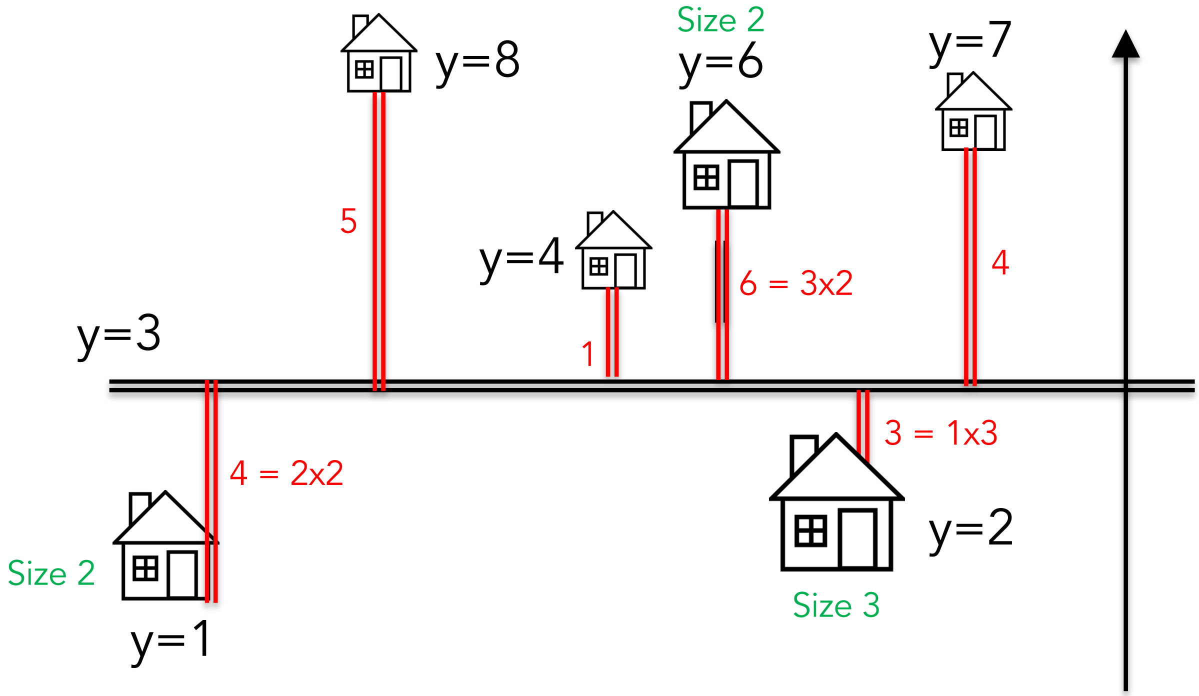
Example

Input

```
6
1 2
8 1
4 1
6 2
2 3
7 1
```

Output

```
3
```



Total cost of smaller power lines: $23

This is the minimum possible cost (when main powerline placed at y=3).

There might be other optimal results (y=2 and y=4 in this example) with the same minimum.

The main powerline may go through a house (under it)

Hints

- Start with the case where the size of all houses is 1.
- Work over examples towards the solution.
- Consider the y-coordinates of houses (their center points) as an array of size n.
- Design a divide & conquer algorithm like quicksort
  - Use recursive approach with an appropriate ***Partition-like*** method
- Look for asymptotically the fastest method
  - Your solution **should** have linear time O(n) complexity on average.
  - **Slower methods will get max 2 out of 10** even if it is correct.
- There may be several correct solutions (i.e., y coordinate of the main powerline), return one of them (all get full credit).
- Taking average or weighted average of y coordinates of houses will not work!
  - Ex: 5 houses (same size) at y locations: 1, 1, 1, 1, 11. Average of locations is 3, but optimal location is 1.

Submission

- Date due: Sun, Oct 8th, 11:59 pm

- Submission through Canvas
  - Just submit the single Java source code file CMSC401_A2.java
    - **No need to zip. Don't worry about "-1", "-2" added to your file by Canvas for new versions.**
    - The file should have *your name* in a comment in the first line
    - Remember: in Java, class name should match the file name, and is case sensitive

- Please do NOT create your own packages
- Use standard I/O to read input (System.in, System.out) and output
- Make sure the **program compiles and WORKS!**
- Late submissions are accepted up to 2 days only with penalties!