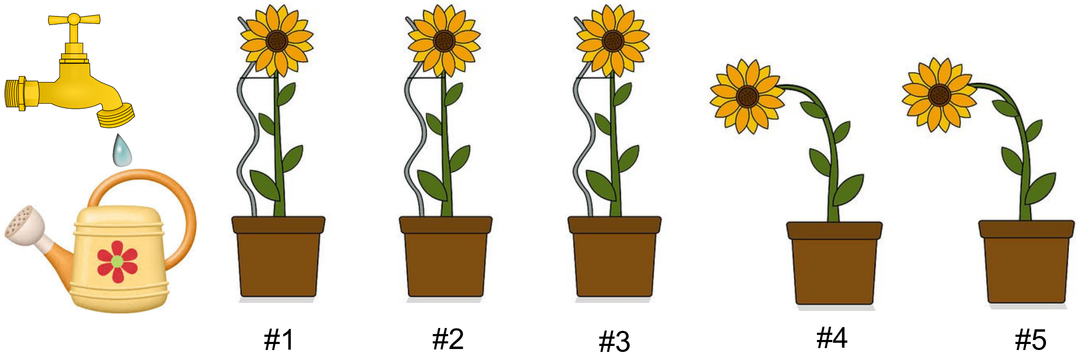
How to water your garden

You have a simple garden with *N* plants in a straight row, and a faucet at one end:



Which watering plan does this illustrate?

At the faucet, you fill a watering can completely with water and then walk to water your plants one at a time. When the can becomes empty, you walk back to the faucet to refill it. After you've watered the last plant, you walk back to the faucet with an empty or partially filled can. Leaving the faucet, watering plants, and returning to the faucet constitute one trip.

To keep things simple, assume that the watering can holds three units of water, and each plant requires one unit of water. Each plant is one step away from the next plant, and the faucet is one step from the first plant. The plant next to the faucet is labeled #1, the next plant is labeled #2, etc.

You have two different plans to accomplish each trip.

Watering Plan Near: After filling the watering can at the faucet, you always walk to the nearest unwatered plant and proceed to water each unwatered plant as you walk away from the faucet. When the can becomes empty, you walk back to the faucet with the empty can to refill it completely for another trip. After you've watered the last unwatered plant, you walk back to the faucet with the can, which can be empty or partially filled.

For example, you have five plants. On the first trip, you walk to plant #1 and water it, you water #2 and #3, and then you walk back to the faucet with an empty can. On your second trip, you walk to plant #4 and water it and #5, and then walk back to the faucet with one unit of water remaining in the can.

Watering Plan Far: After filling the watering can at the faucet, you always walk to the farthest unwatered plant and proceed to water each unwatered plant as you walk back towards the faucet. When the can becomes empty, you walk back to the faucet with the empty can to refill it completely for another trip. After you've watered the last unwatered plant, you walk back to the faucet with the can, which can be empty or partially filled.

For example, you have five plants. On the first trip, you walk to plant #5 and water it, you water #4 and #3, and then you walk back to the faucet with an empty can. On your second trip, you walk to plant #2 and water it and #1, and then you walk back to the faucet with one unit of water remaining in the can.

In each plan, you always fill the can completely before each trip.

Which plan is better? For each plan, you can count the total number of steps required to water all the plants. But a better measure is the total amount of weight you had to carry, measured in “step-units”. If you walk 3 steps to a plant with a full can (3 units), that’s 9 step units. Water the plant (now the can contains 2 units) and step to the next plant, which adds 2 step-units, for a cumulative total of 11 step-units. Which watering plan results in fewer total step-units?

Before you write the program to give you some answers, which plan does your intuition tell you is better?

The simulations

Write a C++ program that does a series of simulations. Each simulation involves *N* plants, where *N* is an integer greater than 0 read from an input file. The input file contains several different values for *N* separated by spaces, and the last value is 0 as the end-of-data sentinel. As mentioned above, your program should assume the watering can holds three units of water, each plant requires one unit, and there is one step from the faucet to plant #1 and one step from one plant to the next. Always fill the can completely at the start of each trip.

For each value of *N* that your program reads, it should first simulate Watering Plan Near and then Watering Plan Far. During each simulation, your program should print which plant is being watered, how many steps have accumulated up to that point, how much water is in the can, and how many step-units have accumulated. Show walks back to the faucet.

After simulating both watering plans for a given value of *N*, your program should print which plan was better based on the total number of step-units.

Your program should not require any functions other than the main function. We’ll discuss programmer-defined functions next week.

What do your simulations tell you? Can you explain the results? Is there a pattern?

Sample input file `counts.txt`

```
5 6 7 0
```

Expected output for the sample input file

```
==========================
 Plan Near with 5 plants
==========================

Where      Cum. steps  Water amt.  Cum. step-units
---------  ----------  ----------  ---------------
Plant  1        1          3               3
Plant  2        2          2               5
Plant  3        3          1               6
FAUCET          6          0               6
Plant  4       10          3              18
Plant  5       11          2              20
FAUCET         16          1              25

Plan Near: Total steps = 16, total step-units = 25

=========================
 Plan Far with 5 plants
=========================

Where      Cum. steps  Water amt.  Cum. step-units
---------  ----------  ----------  ---------------
Plant  5        5          3              15
Plant  4        6          2              17
Plant  3        7          1              18
FAUCET         10          0              18
Plant  2       12          3              24
Plant  1       13          2              26
FAUCET         14          1              27

Plan Far: Total steps = 14, total step-units = 27

*** With 5 plants, Plan Near is better with 2 fewer step-units.

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 Plan Near with 6 plants
==========================
```

etc.