San José State University
Department of Computer Engineering

CMPE 180-92
Data Structures and Algorithms in C++
Fall 2017

Instructor: Ron Mak

Assignment #1

Assigned: Thursday, August 24
Due: Thursday, August 31 at 5:30 PM
CodeCheck: http://codecheck.it/codecheck/files/17082218369vfzb082gwl1ggr02jbdp0cn6
Canvas: Assignment 1. Watering Plans
Points: 100

Watering plans

This assignment will give you practice using control statements and nested loops to implement some programming logic. Your program will simulate two different watering plans for your garden and determine which plan is better.

At the above CodeCheck URL, complete the program **WateringPlans.cpp** in CodeCheck's edit box, and then press the "Submit" button. CodeCheck will compile and run your program, and compare your output to a master report. You can type into CodeCheck's edit box directly, or you can first edit and test your program in the Eclipse or NetBeans IDE, and then cut and paste it into CodeCheck.

Choose descriptive variable names. Include meaningful comments in your code, but don't over-comment. Include your name in a comment at the top of your program. Follow the coding style (formatting, braces, indentation, etc.) of the Savitch textbook.

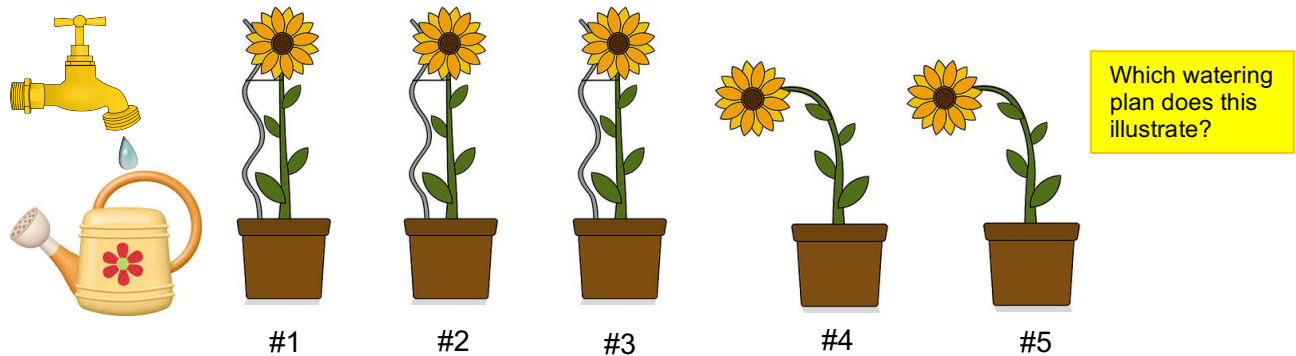The course syllabus describes how to set up your programming environment.

Academic integrity

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?

#1   #2   #3   #4   #5

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 <u>completely</u> 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.

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

etc.

Submission into Canvas

When you're satisfied with your program in CodeCheck, click the "Download" link at the very bottom of the Report screen to download a signed zip file of your solution. Submit this zip file into Canvas. You can submit as many times as you want until the deadline, and the number of submissions will not affect your score. Only your last submission will be graded.

Note: Input file `counts.txt` has already been uploaded into CodeCheck.

Submit the signed zip file from CodeCheck into Canvas:
Assignment 1. Watering Plans.

Note: You must submit the signed zip file that you download from CodeCheck, or your submission will not be graded. Do not rename the zip file.

Rubric

Your program will be graded according to these criteria:

Criteria	Maximum points
Good output (as determined by CodeCheck)	**45**
• Correct output values.	• 30
• Correct output format.	• 15
Good program design	**40**
• Good use of control statements.	• 20
• Good use of nested loops.	• 20
Good program style	**15**
• Descriptive variable names.	• 5
• Meaningful comments.	• 5
• Follows the coding style (formatting, braces, indentation, etc.) of the Savitch textbook.	• 5

File presidents.in

```
George Washington ( 1732 - 1799 ) Federalist 1789 - 1797
John Adams ( 1735 - 1826 ) Federalist 1797 - 1801
Thomas Jefferson ( 1743 - 1826 ) Democratic-Republican 1801 - 1809
James Madison ( 1751 - 1836 ) Democratic-Republican 1809 - 1817
James Monroe ( 1758 - 1831 ) Democratic-Republican 1817 - 1825
John Quincy Adams ( 1767 - 1848 ) Democratic-Republican 1825 - 1829
Andrew Jackson ( 1767 - 1845 ) Democrat 1829 - 1837
Martin van Buren ( 1782 - 1862 ) Democrat 1837 - 1841
William H. Harrison ( 1773 - 1841 ) Whig 1841
John Tyler ( 1790 - 1862 ) Whig 1841 - 1845
James K. Polk ( 1795 - 1849 ) Democrat 1845 - 1849
Zachary Taylor ( 1784 - 1850 ) Whig 1849 - 1850
Millard Fillmore ( 1800 - 1874 ) Whig 1850 - 1853
Franklin Pierce ( 1804 - 1869 ) Democrat 1853 - 1857
James Buchanan ( 1791 - 1868 ) Democrat 1857 - 1861
Abraham Lincoln ( 1809 - 1865 ) Republican 1861 - 1865
Andrew Johnson ( 1808 - 1875 ) National-Union 1865 - 1869
Ulysses S. Grant ( 1822 - 1885 ) Republican 1869 - 1877
Rutherford Hayes ( 1822 - 1893 ) Republican 1877 - 1881
James Garfield ( 1831 - 1881 ) Republican 1881
Chester Arthur ( 1829 - 1886 ) Republican 1881 - 1885
Grover Cleveland ( 1837 - 1908 ) Democrat 1885 - 1889
Benjamin Harrison ( 1833 - 1901 ) Republican 1889 - 1893
Grover Cleveland ( 1837 - 1908 ) Democrat 1893 - 1897
William McKinley ( 1843 - 1901 ) Republican 1897 - 1901
Theodore Roosevelt ( 1858 - 1919 ) Republican 1901 - 1909
William Taft ( 1857 - 1930 ) Republican 1909 - 1913
Woodrow Wilson ( 1856 - 1924 ) Democrat 1913 - 1921
Warren Harding ( 1865 - 1923 ) Republican 1921 - 1923
Calvin Coolidge ( 1872 - 1933 ) Republican 1923 - 1929
Herbert C. Hoover ( 1874 - 1964 ) Republican 1929 - 1933
Franklin Delano Roosevelt ( 1882 - 1945 ) Democrat 1933 - 1945
Harry S Truman ( 1884 - 1972 ) Democrat 1945 - 1953
Dwight David Eisenhower ( 1890 - 1969 ) Republican 1953 - 1961
John Fitzgerald Kennedy ( 1917 - 1963 ) Democrat 1961 - 1963
Lyndon Baines Johnson ( 1908 - 1973 ) Democrat 1963 - 1969
Richard Milhous Nixon ( 1913 - 1994 ) Republican 1969 - 1974
Gerald R. Ford ( 1913 - 2006 ) Republican 1974 - 1977
James Earl Carter ( 1924 ) Democrat 1977 - 1981
Ronald Wilson Reagan ( 1911 - 2004 ) Republican 1981 - 1989
George H. W. Bush ( 1924 ) Republican 1989 - 1993
William Jefferson Clinton ( 1946 ) Democrat 1993 - 2001
George W. Bush ( 1946 ) Republican 2001 - 2009
Barack Obama ( 1961 ) Democrat 2009 - 2017
.
```

Expected output

Codecheck will compare your program's output against this report. Print using the **<<** output insertion operator. Configure **cout** to print the average age at the end of the report with one decimal place. Do not use the C-style **printf** function.

```
First name  Middle name Last name   Born Died  Age  Start End   Party
----------  ----------- ---------   ---- ----  ---  ----- ----  -----
George                  Washington  1732 1799   67   1789 1797  Federalist
John                    Adams       1735 1826   91   1797 1801  Federalist
Thomas                  Jefferson   1743 1826   83   1801 1809  Democratic-Republican
James                   Madison     1751 1836   85   1809 1817  Democratic-Republican
James                   Monroe      1758 1831   73   1817 1825  Democratic-Republican
John        Quincy      Adams       1767 1848   81   1825 1829  Democratic-Republican
Andrew                  Jackson     1767 1845   78   1829 1837  Democrat
Martin                  van Buren   1782 1862   80   1837 1841  Democrat
William     H.          Harrison    1773 1841   68   1841 1841  Whig
John                    Tyler       1790 1862   72   1841 1845  Whig
James       K.          Polk        1795 1849   54   1845 1849  Democrat
Zachary                 Taylor      1784 1850   66   1849 1850  Whig
Millard                 Fillmore    1800 1874   74   1850 1853  Whig
Franklin                Pierce      1804 1869   65   1853 1857  Democrat
James                   Buchanan    1791 1868   77   1857 1861  Democrat
Abraham                 Lincoln     1809 1865   56   1861 1865  Republican
Andrew                  Johnson     1808 1875   67   1865 1869  National-Union
Ulysses     S.          Grant       1822 1885   63   1869 1877  Republican
Rutherford              Hayes       1822 1893   71   1877 1881  Republican
James                   Garfield    1831 1881   50   1881 1881  Republican
Chester                 Arthur      1829 1886   57   1881 1885  Republican
Grover                  Cleveland   1837 1908   71   1885 1889  Democrat
Benjamin                Harrison    1833 1901   68   1889 1893  Republican
Grover                  Cleveland   1837 1908   71   1893 1897  Democrat
William                 McKinley    1843 1901   58   1897 1901  Republican
Theodore                Roosevelt   1858 1919   61   1901 1909  Republican
William                 Taft        1857 1930   73   1909 1913  Republican
Woodrow                 Wilson      1856 1924   68   1913 1921  Democrat
Warren                  Harding     1865 1923   58   1921 1923  Republican
Calvin                  Coolidge    1872 1933   61   1923 1929  Republican
Herbert     C.          Hoover      1874 1964   90   1929 1933  Republican
Franklin    Delano      Roosevelt   1882 1945   63   1933 1945  Democrat
Harry       S           Truman      1884 1972   88   1945 1953  Democrat
Dwight      David       Eisenhower  1890 1969   79   1953 1961  Republican
John        Fitzgerald  Kennedy     1917 1963   46   1961 1963  Democrat
Lyndon      Baines      Johnson     1908 1973   65   1963 1969  Democrat
Richard     Milhous     Nixon       1913 1994   81   1969 1974  Republican
Gerald      R.          Ford        1913 2006   93   1974 1977  Republican
James       Earl        Carter      1924                1977 1981  Democrat
Ronald      Wilson      Reagan      1911 2004   93   1981 1989  Republican
George      H. W.       Bush        1924                1989 1993  Republican
William     Jefferson   Clinton     1946                1993 2001  Democrat
George      W.          Bush        1946                2001 2009  Republican
Barack                  Obama       1961                2009 2017  Democrat

Average age at death = 70.9
```