# Josephus Problem

In a children's game, boys and girls sit in a circle and number off. Every Nth person must leave the circle. Whoever's left at the end is the winner. For a given *N* and *count*, can you predict the position of the winner?

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Michael | Hannah | Jacob | Ruth | Matthew |
|  |  |  |  |  |
| Matthew | Michael | Hannah | Jacob |  |
|  |  |  |  |  |
| Matthew | Michael | Hannah |  |  |
|  |  |  |  |  |
| Michael | Hannah |  |  |  |
|  |  |  |  |  |
| Michael |  |  |  |  |

For *N* = 5 and *count* = 4:

Starting position 1 is the winner.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Michael | Hannah | Jacob | Ruth | Matthew |
|  |  |  |  |  |
| Jacob | Ruth | Matthew | Michael |  |
|  |  |  |  |  |
| Matthew | Michael | Jacob |  |  |
|  |  |  |  |  |
| Jacob | Matthew |  |  |  |
|  |  |  |  |  |
| Jacob |  |  |  |  |

For *N* = 5 and *count* = 2:

Starting position 3 is the winner.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Michael | Hannah | Jacob | Ruth | Matthew |
|  |  |  |  |  |
| Hannah | Jacob | Ruth | Matthew |  |
|  |  |  |  |  |
| Jacob | Ruth | Matthew |  |  |
|  |  |  |  |  |
| Ruth | Matthew |  |  |  |
|  |  |  |  |  |
| Matthew |  |  |  |  |

For *N* = 5 and *count* = 1:

Starting position 5 is the winner.

# 

# The trick is to figure out where to stand so as to be the last person left standing.

# Historical note

# This problem gets its name from Flavius Josephus. In the 1st century AD, Josephus was a leader of a Jewish rebellion against Rome, was trapped in a cave, and somehow, amazingly, was the one who survived the circle of suicide. He then switched sides, advised the Roman armies and emperor, and ended up writing several books about it all.

# The Circular Singly-linked List

p

*Fig. 1*

In a circular linked list, all nodes are linked in a continuous circle, without using null. Because it is circular, there is no natural "first" or "last" node. Let us think about making a circular linked list storing B-C-D-E-F. The first impulse  
 of most people is to make "first" point to "B", as shown in *Fig. 1*. In that case,

1. What is the Big-O of the print command?\_\_\_\_

2. What is the Big-O to insert an "A" before the "B"? \_\_\_\_\_

3. What is the Big-O to insert a "G" after the "F"? \_\_\_\_\_

p

*Fig.2*

Now let's consider this arrangement of the nodes as shown in *Fig. 2*:

4. What is the Big-O of the print command?\_\_\_\_

5. What is the Big-O to insert an "A" before the "B"? \_\_\_\_\_

6. What is the Big-O to insert a "G" after the "F"? \_\_\_\_\_

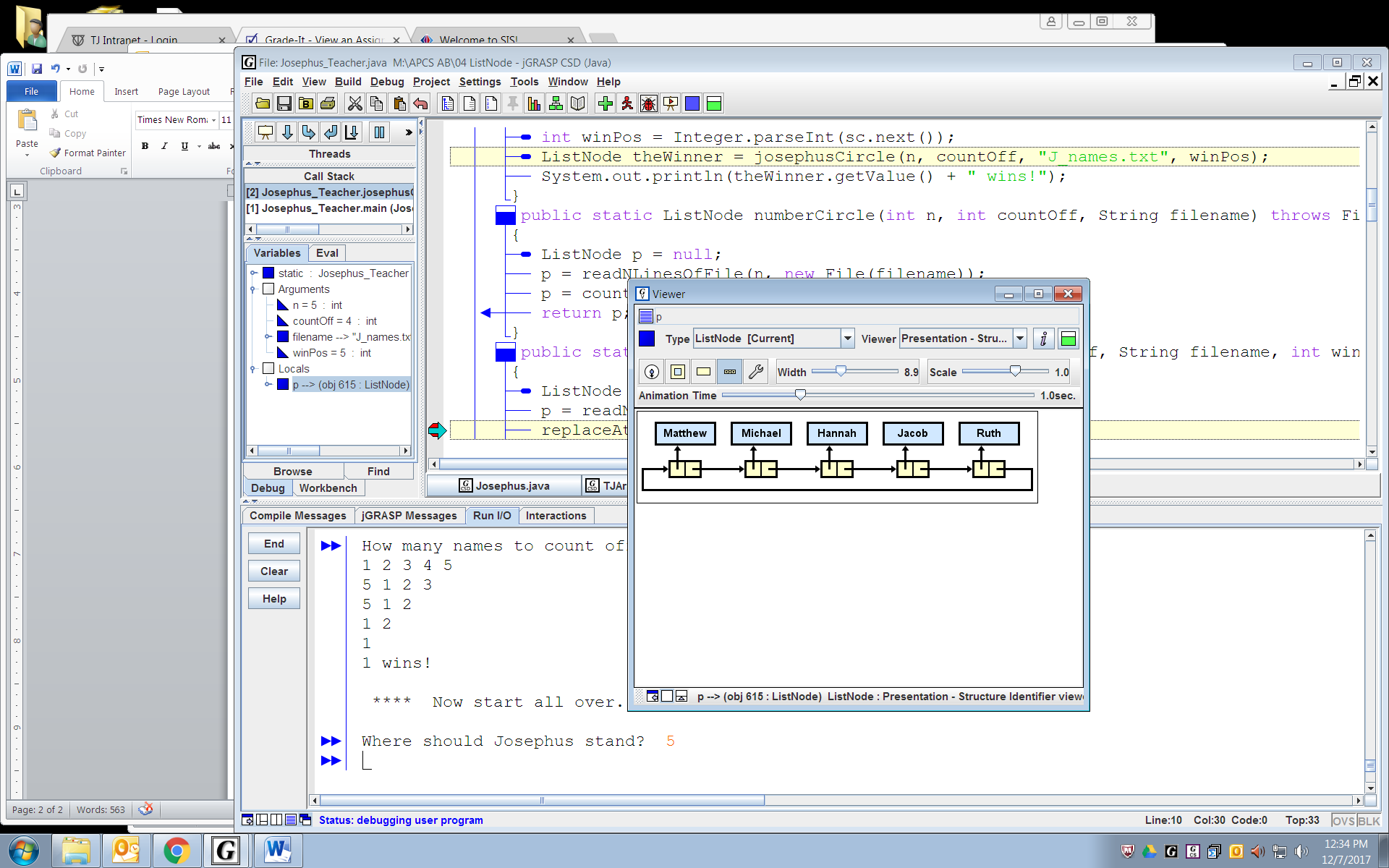
Consequently, you will program your circular linked list as shown in *Fig. 2*.

# Josephus Lab Assignment

Implement the Josephus game with a circular linked list.   
After prompting for N=5 and count, and reading   
integers, your data structure will look like:

p

The pointer *p* just keeps moving around the circle. Move it the appropriate count times, delete that node, and print the list. Stop counting off when one number is left, which is the position of the winner. Easy!



After reading the names Michael, Hannah, Jacob, Ruth and Matthew,   
your data structure should look like:

p

This time through, the program replaces the name at the winning position with "Josephus", so that Josephus will always win.

We will divide this program into two days. The first day, write the print and insert methods and enough of the driver to test both. How will you write print to start with "Michael", and if there is no null in the circle?

*Case 1:*

*Case 2:*

The insert method should insert one (1) node, taking care to keep the list circular. The insert method has two cases. Draw them here:

***Sample run:*** *For full credit format the output exactly as shown below.*

How many names (2-20)? 4  
How many names to count off each time? 5  
1 2 3 4  
2 3 4  
4 2  
2  
2 wins!  
  
 \*\*\*\* Now start all over. \*\*\*\*   
  
Where should Josephus stand? 2  
Michael Josephus Jacob Ruth  
Josephus Jacob Ruth  
Ruth Josephus  
Josephus  
Josephus wins!