# Program Structures & Algorithms
# Spring 2022
# Assignment No. 3 (WQUPC)

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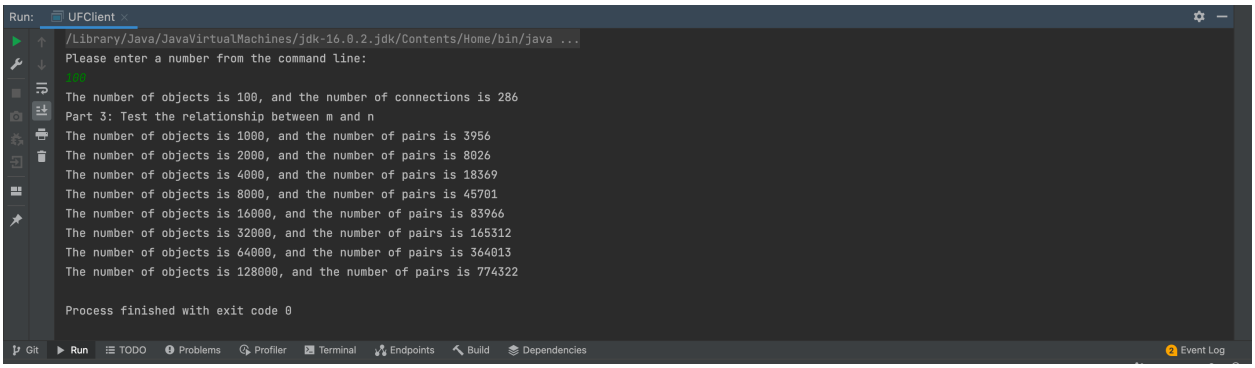
- **Task**
  1. Two classes implemented.
     - UF_HWQUPC.java (Step 1 implementation)
     - UFClient.java (Step 2 implementation)
  2. Completed the UF_HWQUPC.java file which had below methods implemented.
     - find()
     - mergeComponents()
     - doPathCompression()
  3. Develop a UF ("union-find") client that takes an integer value n from the command line to determine the number of sites.
     - Generate random pairs of integers between 0 and n-1, calling connected() to determine if they are connected and union() if not. Loop until all sites are connected then print the number of connections generated
     - Package your program as a static method count() that takes n as the argument and returns the number of connections
     - A main() that takes n from the command line, calls count() and prints the returned value

- **Output screenshot**

Evidence of running UFClient.java



- **Relationship Conclusion**

From the above observations we came to following conclusion: Both the lines are approximately same. We can derive the relationship between m and n as below:

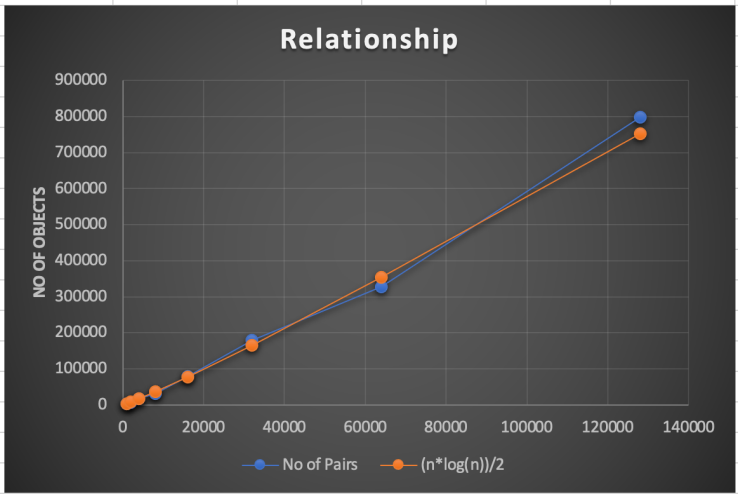
**m = C (n * log(n)) or ½ (n * log(n)) (considering Path Compression)**

- **Evidence / Graph**

Run main program in UFClient.java. We can input the number from command line to test the count method. We can run more n values and make their values bigger using doubling method, each with 10 times to test the relationship between m and n. We mapped the 2 outputs using above method. First passed the input from command line as 100 and then passed the input from command line as 200. Output of both was mapped in a graphical format. Output and graphical representation is as below. I will be also uploading excel file of this analysis. Please check that.

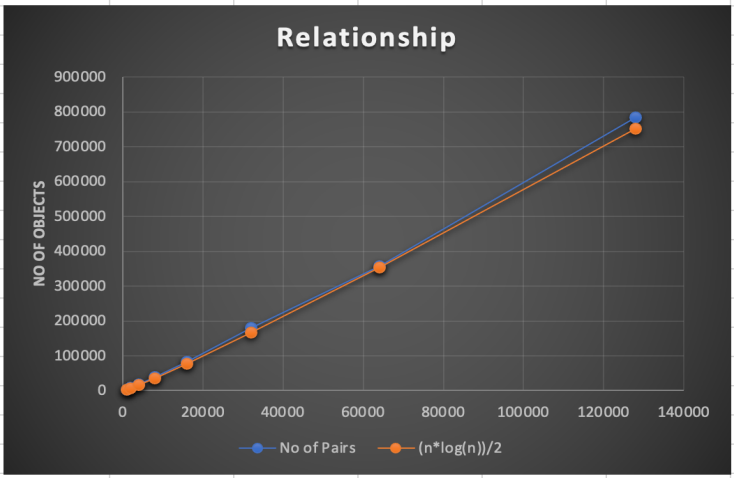
Input: 100

| No of Objects | No of Pairs | (n*log(n))/2 |
|---|---|---|
| 1000 | 3313 | 3454 |
| 2000 | 7388 | 7601 |
| 4000 | 16942 | 16588 |
| 8000 | 31395 | 35949 |
| 16000 | 78319 | 77443 |
| 32000 | 179520 | 165976 |
| 64000 | 327425 | 354132 |
| 128000 | 798428 | 752626 |




Input: 200

| No of Objects | No of Pairs | (n*log(n))/2 |
|---|---|---|
| 1000 | 3739 | 3454 |
| 2000 | 8076 | 7601 |
| 4000 | 18002 | 16588 |
| 8000 | 39392 | 35949 |
| 16000 | 83276 | 77443 |
| 32000 | 179854 | 165976 |
| 64000 | 357956 | 354132 |
| 128000 | 783778 | 752626 |



- # Unit tests result

The below output is test case output for UF_HWQUPC.


The below output is test case output for WQUPCTest.