Program Structures & Algorithms

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Assignment No. 3

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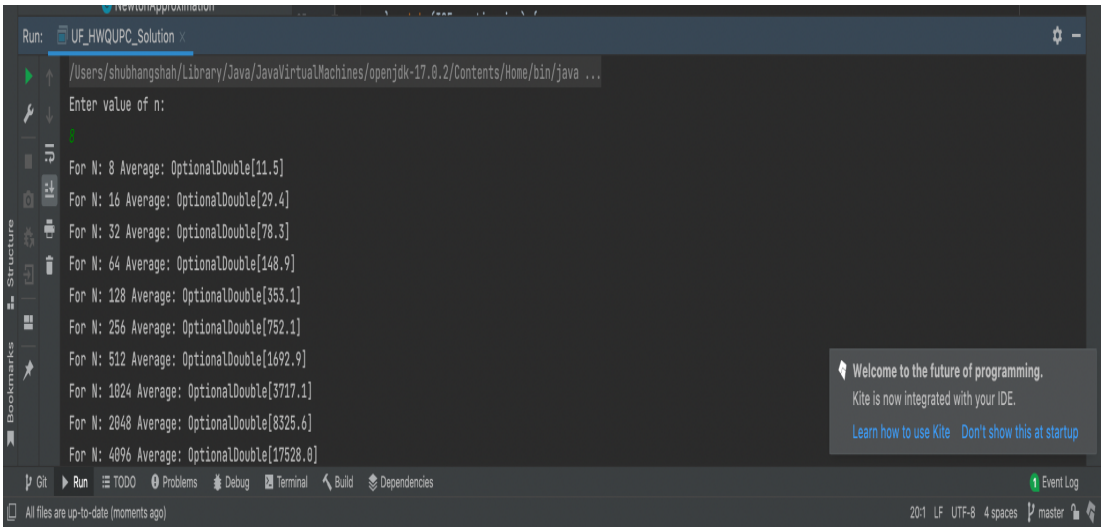
- **Task**
  - Implement below methods in UF_HWQUPC.java
    - find(int p)
    - mergeComponents(int p)
    - doPathCompression(int i)
  - Develop a UF ("union-find") client that takes an integer value n from the command line to determine the number of "sites."
    - Generate random pairs of integers 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.
  - Determine the relationship between the number of objects (n) and the number of pairs (m)
- **Output screenshot**
  - Evidence to show number of outputs by taking n from input

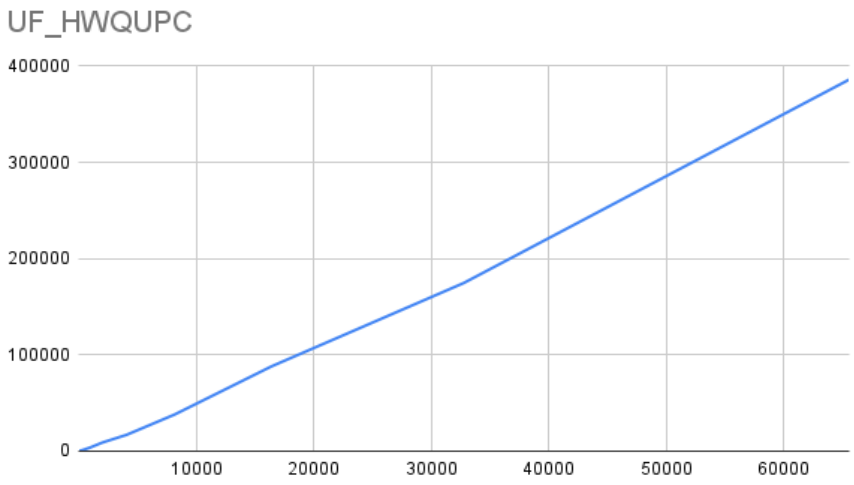


- **Relationship Conclusion**
  - A standard plot graph i.e. N vs M (number of pairs) was plotted based on observations and conclusions:
    - The graph is **linearithmic graph** and hence the relationship between N and M (number of pairs) is **linear**
    -

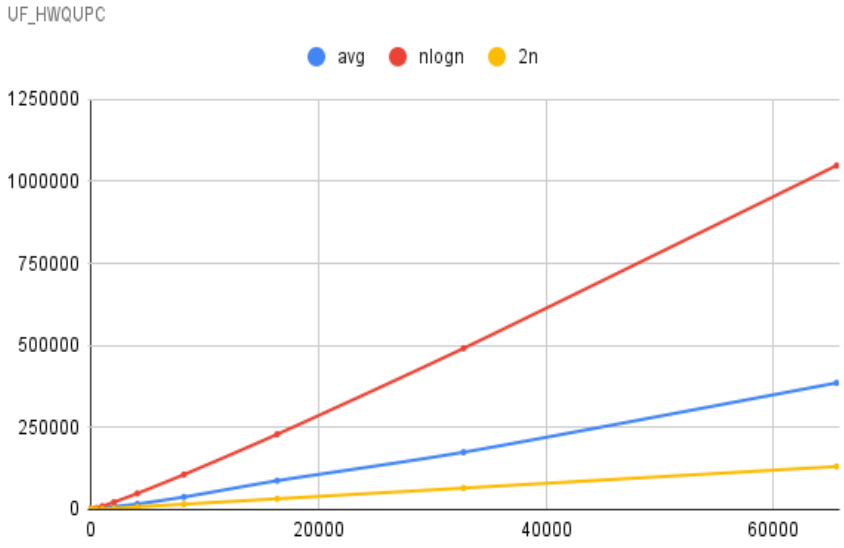
n	avg
8	13.1
16	32.5
32	72.2
64	180
128	350.3
256	823.1
512	1738.5
1024	3897.5
2048	8984.2
4096	16952
8192	38138.6
16384	87898.8
32768	174720.4
65536	386036.3

    - Based on the graph and benchmarks, the relation we can see that as N doubles, M (number of pairs) is also close to doubles.
    - To get the relationship for N and M, let's do some calculations
      - For N = 256 (2^8),
        - $log_2(823.1) = 9.68 \sim 8 + 2$
      - For N = 8192 (2^{13}),
        - $log_2(38138.6) = 15.21 \sim 13 + 2$
    - Hence the relationship can be derived as,
      - $C * Nlog(N)$

- **Evidence / Graph**
    - Graphical representation of N vs pairs relationship



    - Graphical representation of N vs pairs relationship with NlogN and 2N



- **Unit tests result**
    - UF_HWQUPC_Test.java