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**Program Structures & Algorithms Fall 2021**

**Assignment No. 03**

**Task:**

- Implemented height-weighted Quick Union with Path Compression and check that all the unit tests pass
- Using the implementation of UF\_HWQUPC, determined the number of connection pairs for the given number of objects ( $n$ )
- Determined the relationship between the number of objects ( $n$ ) and the number of connection pairs ( $m$ ) generated.

**Relationship Conclusion:**

After performing a series of experiments by passing different values of  $n$  (1000,2000,3000,4000,5000), it is evident that the number of pairs generated ( $m$ ) is related to ( $n$ ) as

$$m \approx \left(\frac{1}{2}\right) n \cdot \ln(n)$$

**Findings:**

Number of Objects ( $n$ )	Pairs Generated ( $m$ )	value of $\left(\frac{1}{2}\right)n \cdot \ln(n)$
1000	3739	3453
2000	7604	7600
3000	11855	12009
4000	18901	17588
5000	23236	21292

For the given number of objects (n) - [1000], the number of pairs generated are [3739]

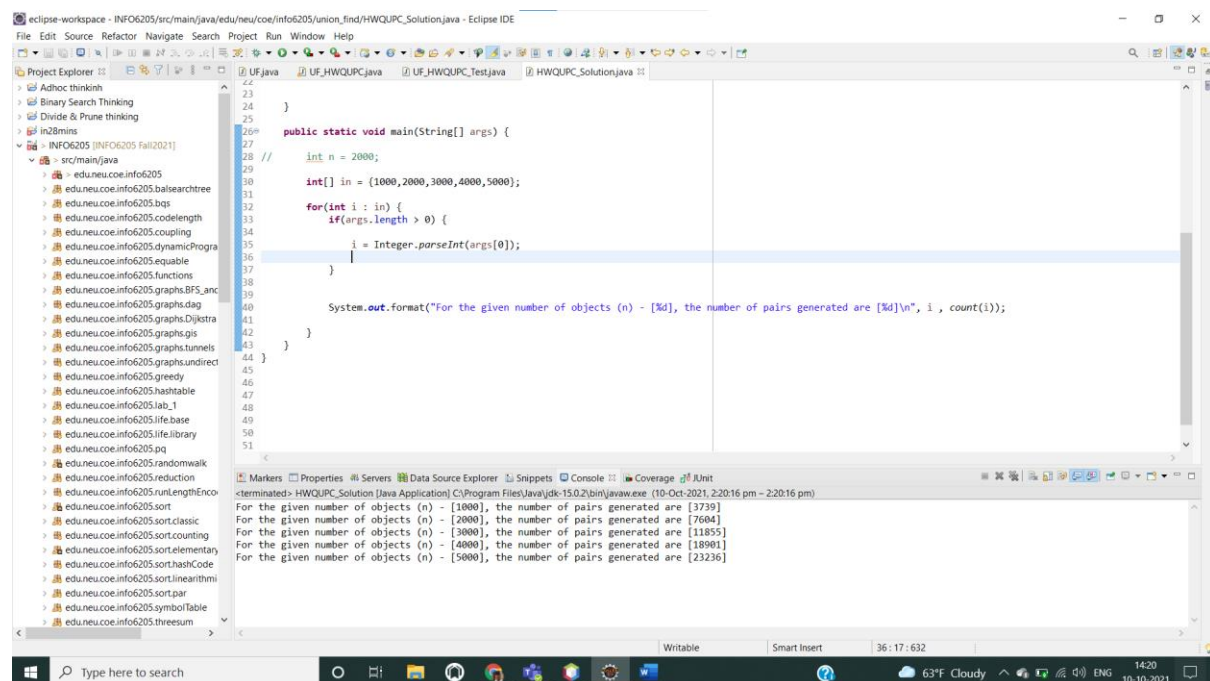
For the given number of objects (n) - [2000], the number of pairs generated are [7604]

For the given number of objects (n) - [3000], the number of pairs generated are [11855]

For the given number of objects (n) - [4000], the number of pairs generated are [18901]

For the given number of objects (n) - [5000], the number of pairs generated are [23236]

## Output Screenshot:



The screenshot shows the Eclipse IDE interface. The left sidebar displays a project explorer with a tree structure of files and folders. The main editor window shows a Java file named `HWQUPC_Solution.java` with the following code:

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The output console at the bottom shows the following results:

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<terminated> HWQUPC_Solution [Java Application] C:\Program Files\Java\jdk-15.0.2\bin\javaw.exe (10-Oct-2021, 2:20:16 pm - 2:20:16 pm)  
For the given number of objects (n) - [1000], the number of pairs generated are [3739]  
For the given number of objects (n) - [2000], the number of pairs generated are [7604]  
For the given number of objects (n) - [3000], the number of pairs generated are [11855]  
For the given number of objects (n) - [4000], the number of pairs generated are [18901]  
For the given number of objects (n) - [5000], the number of pairs generated are [23236]
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For the given number of objects (n) - [1000], the number of pairs generated are [3739]

For the given number of objects (n) - [2000], the number of pairs generated are [7604]

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For the given number of objects (n) - [4000], the number of pairs generated are [18901]

For the given number of objects (n) - [5000], the number of pairs generated are [23236]

The graph displays two data series: 'Connection pairs(m)' (blue line) and the theoretical formula  $(1/2) \cdot n \cdot \log n$  (orange line). The x-axis represents the 'Number of nodes (n)' from 1000 to 5000, and the y-axis represents 'Connection pairs' from 0 to 25000. The blue line shows the actual connection pairs, which are slightly lower than the theoretical formula represented by the orange line.

Number of nodes (n)	Connection pairs(m)	$(1/2) \cdot n \cdot \log n$
1000	3500	3500
2000	7500	7500
3000	11500	11500
4000	17500	19000
5000	21500	23500

[illegible]