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| The Gale-shapley algorithm  The above photo is the photo of David Gale. He is the one that came up with this famous algorithm. | Abstract  During old times code was a piece of instruction that a computers used to analyze data. However, the Gale- Shapley algorithm was able to revolutionize that by including preference based systems that are completely self-reinforcing  Naol Legesse |

**What is this algorithm about?**

* The gale-Shapley algorithm is mainly focused on using preferences of parties to create self-reinforcing systems. One of the many fields that we can see this is in job hiring openings or during college admissions.
* Each and every institution has its own preference of who it want to higher or who it wants to admit. The gale-Shapley algorithm provides a stable matching in which all the given parties are satisfied at a given time as the matching is stable for a given group of participants at a time.
* In order to understand this we need to define what stable matching:
* Let’s take gale Shapley algorithm that helps provide a set of male and female participants with a stable copulation. A matching is stable if :

1. If it is perfect (perfect matching: a matching with the property that each member of *the male set* and each member of *women set* appears in *exactly* one pair in the stable matching set)
2. If there is no stability. That is every partner likes or prefers the partner it finally has after stable matching has been conducted in a way that doesn’t disrupt the stability.

* You may ask how does this algorithm provide a stable matching? The answer will come as follows.
* The function uses **man optimality** and **female pessimality** which help and insure the achievement of a stable matching. Men optimality refers to the fact that the men propose in decreasing order of preference, which insure that a man will be rejected.
* Female pessimality refers to the fact the a woman gets the worst valid partner. A valid partner is a valid paring that occurs between a male and a female before the final optimal state is achieved.
* Look at this gif for more information. <https://commons.wikimedia.org/wiki/File:Gale-Shapley.gif>

**What does the pseudo code for this function look like?**

A screenshot of a cell phone

Description automatically generated

* The while loop insures that the algorithm runs until a stable matching is reached. We pair the woman with a man if he is free. We next compare if the woman is paired up with a man so that we can make new arrangements for her based on her needs. If all is good our result will be a stable matched result.

**Description of the experiment**

* The demo code was more or less close to the final one as a stable match was a final result for both. However the final code seems to be more powerful as it take small amount of time( in milliseconds) for sample sizes that are really huge. I created a main function that takes command line arguments for the sample size input that drives the final code to run as a whole.
* The final code summarizes the running time of the code with specific sample sizes. I t also shows how the gale-Shapley algorithm can be implemented and used to make stable matches.
* The final code runs flawlessly for sample sizes up to 11 thousand which is really amazing when we think about how long it would take if this was done manually.

**Conclusion**

* From the gun plot results which will be shown below, the code runs on big o of n2 time which is consistent with the required time complexity. The graph is an upward parabola that closely resembles the graph of x2.
* The empirical results more or less resemble the predicted outcome, the discrepancy comes from the way the code was written, which wasn’t that huge.
* As the theory states the final matching will be stable and all and every individual will end up satisfied with the outcome.