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Enhancement of Gale-Shapley algorithm with imbalanced sets for hiring and job finding applications

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ABSTRACT

In this paper, we discuss a modification to the Gale Shapley algorithm in this study. We concentrated on how the modified algorithm would operate if the data sets for men and women were not equal. We showed how to measure the average energies of men and women with equal and unequal sets, how the new design of the algorithm will benefit both parties by duplicating sets of data to fill the unequal sets of data, resulting in an equal set of pairings, and how to measure the average energies of men and women of the new algorithm in this paper. Having stated that, each couple will have a stable partner and/or will be queued to the algorithm's suggested stable partner.

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1. INTRODUCTION

Gale and Shapley addressed a problem of applying to college applicants who can only meet a specific quota. There are n males and n women in each neighborhood. According to his or her choices for a marriage mate, each individual rates those of the opposing sex. We're looking for an acceptable approach to marrying all the community's members. If there are men and women who are not married but prefer each other to their actual partners, a group of marriages is considered unstable. If stable matches exist, it must be established which one is favored, therefore a stable assignment is considered optimum if every applicant is at least as well off as under any other stable assignment [1]-[4]. With the stable marriage problem, Gale and Shapley used a mathematical approach, discarding reality-based applications and even doubting whether the stable marriage algorithm contributed to the initial admissions problem at all [1]-[3]. The stable marriage algorithm is being used to solve a variety of problems in computer programming, including industry-related problems. One of which is a performance-based stable matching for employees. This stable matching using the stable marriage algorithm provided optimal pairing results for the employees [5]-[9].

A variety of systems [10], [11], industry-related problems [12]-[14], and economical problems [15] uses the stable marriage algorithm. Although useful, the application of the algorithm still has its lapses depending on specific requirements. The researchers aim to provide an enhancement to the algorithm in terms of job-seeking applications. One, the algorithm was necessarily designed to fit a mathematical scenario that does not resemble anything in real life [1], [2], [8], [16]. And, if the essential parameters are altered, it can pose certain usability issues, one of which is that little is known about how the structure of stable results is affected

by its features [17], [18]. Secondly, if one member of a set is removed, causing an imbalanced number of members in the sets, the algorithm shows a significant shift from advantageous to disadvantageous. [19]-[22].

The goal of this paper is to improve an altered Gale-Shapley Algorithm that can optimally provide stable matches with imbalanced sets. This involves researching ways to measure instability of unequal sets and developing additional or alternative steps in the algorithm optimized for the proposed goal. The paper aims to further enhance the algorithm based on the proposed enhancement and does not aim to provide any mathematical improvements nor compare with other similar problems [23], [24] unless new discoveries can be made.

2. RESEARCH METHOD

Men and women will be used to exemplify a situation where one side of the pair is unequal to the other side of the pair. The following formulae will be used to calculate men's and women's average energies, which may be used to determine one feature of the Gale-Shapley algorithm that causes instability [17], [18]. These formulae can be used to show that uneven sets can still affect one of the Gale-Shapley algorithm's properties.

2.1. Average energies of men and women where number of men and women are equal

In (1) gives a method for calculating the average energy of men. In (2) gives a method for calculating the average energy of women. These equations are used when the number of men and women is equal and are used as the stable standard in this study [19].

$$e_m = \log(N) \tag{1}$$

e_m–Average Energy of Men
N–Number of Men

$$e_w = N/log(N) \tag{2}$$

e_w–Average Energy of Women

2.2. Average energies of men and women where number of men is greater than women

In (3) is used to calculate the average energy of men. In (4) is used to calculate the average energy of women. These equations are used when the number of men is greater than the number of women [19].

$$e_m = \frac{M}{N} ln \frac{M}{M-N} \tag{3}$$

e_m–Average Energy of Men
N–Number of Men
M–Number of Women

$$e_w = \frac{N}{e_m} + \frac{M-N}{M} \tag{4}$$

e_w–Average Energy of Women

2.3. Average energies of men and women where number of women is greater than men

In (5) is used to calculate the average energy of men. In (6) is used to calculate the average energy of women. These equations are used when the number of women is greater than the number of men [19].

$$e_w = \frac{N}{M} ln \frac{N}{N-M} \tag{5}$$

e_w–Average energy of women
N–Number of men
M–Number of women

$$e_m = \frac{e_w}{N} \frac{1-(1-\left(\frac{e_w}{N}\right))^M}{(\frac{e_w}{N})^2} + \left(1 - \left(\frac{e_w}{N}\right)\right)^M \tag{6}$$

e_m–Average energy of men

3. RESULTS AND DISCUSSION

The researchers investigated a method for determining the instability of unequal sets by measuring the average energies of men and women in the three different equality and inequality cases (equal men and women, number of men is greater than number of women, and number of women is greater than number of men) and came up with the results shown [19], [25] in Figure 1.

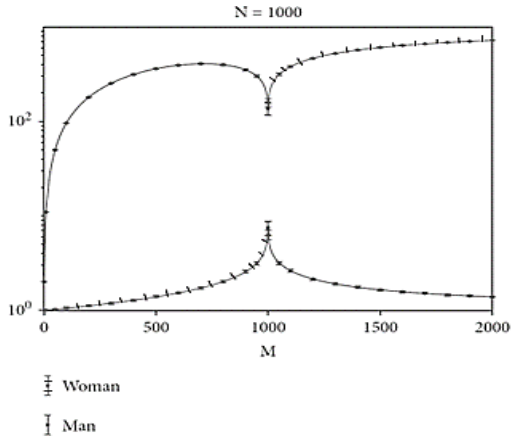

Figure 1. N males and M women's average energy vs. the number of women M, where N is set to 1,000. Averaging over 100 realizations yields the result

The number of men is fixated to 1,000 and the number of women M vary from 1 to 2,000. The graph in Figure 1 demonstrates that men's average energy levels rise in the beginning and nearly saturate when M hits 700. It's worth noting that when M is close to 1, the average energy is low. It can be used to explain a variety of social phenomena. When there are too few women (M near to 1), most men in the matching process end up single. However, as sociologist Veenhoven [26] points out, happiness "results from comparison," hence a low overall happiness level is not unexpected.

When M approaches 1,000; both men and women's energies shift dramatically. In this location, men's energy levels plummet, whilst women's energy levels skyrocket. The energy of the active side and the passive side switch places. As M rises, men's energy falls; in contrast, women's energy rises, which is normal given that more women fight for a limited number of males. The use of these formulas determines the different energy of men and women when there are unequal number of men and women that are to be paired with each other. This situation can also be applied to job finding applications where there could be more applicants than available jobs or vice versa.

4. CONCLUSION

The Gale-Shapley Algorithm can further be studied by exploring its different characteristics and in this study's case, the number of participants is explored. This exploration led to the discovery of the Average energies of men and women. These averages and how they are constructed can be used to determine the different instabilities that inequalities will produce, as well as how well future developments of the Gale-Shapley Algorithm in terms of how it handles inequality can be measured. Furthermore, future research might focus on the development of the Gale-Shapley algorithm, with the goal of determining how to restore the average energies of men and women, for job finding applications, by adjusting the Algorithm or the information presented.

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