Multi-dimensional stable matching (special case)

1-Ahmed Hameedshakir[1], 2-Sarmad Hamza Ali[2]andShaker RazaqAbdul kareem[3]

[1]College of Nursing
AlMuthanna University
Amajic-1984@mu.edu.iq

[2]computer center
AlMuthanna University
sarmad@mu.edu.iq

[3]college of education for pure sciences
AlMuthanna University
Shakirmuthana@mu.edu.iq

ABSTRACT.

In this research, The Stable Matching is taken into another dimension, the SMP in general is the problem of finding stable matching between two groups for example room mates or marriage, our work is to find another dimension of matching which is between Man and Woman and their child.

Keywords: Stable Matching, two-sided stable matching, multi-sided stable matching, Gale and Shalepy Solution

DOI Number: 10.14704/nq.2022.20.5.NQ22521 **NeuroQuantology 2022; 20(5):1308-1313**

1. Introduction.

Stable Marriage Problem in the past decade 60 years ago, Gale and Shapley (1962) validated the existence of Stable Matching Marriage (two-sided stable matching).

But what is Stable Matching?
Assume that each Mail, We Call it later in the research a Man has an order of Preference for the Females, referred as WOMEN

2.

MEN	Order of Preference
Anatole	c , b , d , a
Barnabe	b , a , c , d
Camille	b , d , a , c
Dominique	c , a , d , b

And each WOMEN has an order, who she likes the most, of preference, for the MEN

WOMEN	Order of Preference
Antoinette	A , B , D , C
Brigitte	C , A , D , B
cunegonde	C , B , D , A
donatienne	B , A , C , D

A matching is unstable if a MAN A and a WOMEN a, NOT married to each other, mutually likes each other to their mate.
A matching is stable if this case does NOT happen.

3. Multi – Sided stable matching
Now the problem is getting bigger to one-to-many and many-to-many, which called (three-sided stable matching).
In order to try to solve this kind of problem we need three (disjoined) finite set M, W and C, A Family is a triple (w , c , m) ∈ W *X* C *X* M .
A matching is subset μ ⊂ W *X* C *X* M whose projections onto M, W and C are injective.
Given a matching μ and WOMEN w , we donate by μ(w) the unique pair (c,m)
of Corse μ and MEN m , we donate by μ(m) the unique pair (c,w)
And μ and Children CH, we donate by μ(CH) the unique pair (w,m).
in case no such pair exists, we will donate μ(w) = * .

First case:-
μ(m) = (w,CH)

MEN	Order of Preference
A	{a x CH1 , a x CH3 , a x CH2 , a x CH4},{ b x CH2 , b x CH3 , b x CH4 , b x CH2}, {c x CH2 , c x CH1 , c x CH4 , c x CH3},{ d x CH4 , d x CH2 , d x CH3 , d x CH1}
B	{a x CH4 , a x CH3 , a x CH2 , a x CH1},{ b x CH2 , b x CH3 , b x CH1 , b x CH4}, {c x CH2 , c x CH1 , c x CH4 , c x CH3},{ d x CH1 , d x CH2 , d x CH3 , d x CH4}
C	{a x CH4 , a x CH3 , a x CH2 , a x CH1},{ b x CH2 , b x CH3 , b x CH4, b x CH2}, {c x CH2 , c x CH1 , c x CH4 , c x CH3},{ d x CH4 , d x CH2 , d x CH3 , d x CH1}
D	{a x CH1 , a x CH3 , a x CH2 , a x CH4},{ b x CH2 , b x CH1 , b x CH3 , b x CH4}, {c x CH2 , c x CH3 , c x CH1 , c x CH4},{ d x CH3 , d x CH2 , d x CH3 , d x CH1}

Second case:-
μ(W) = (m,CH)

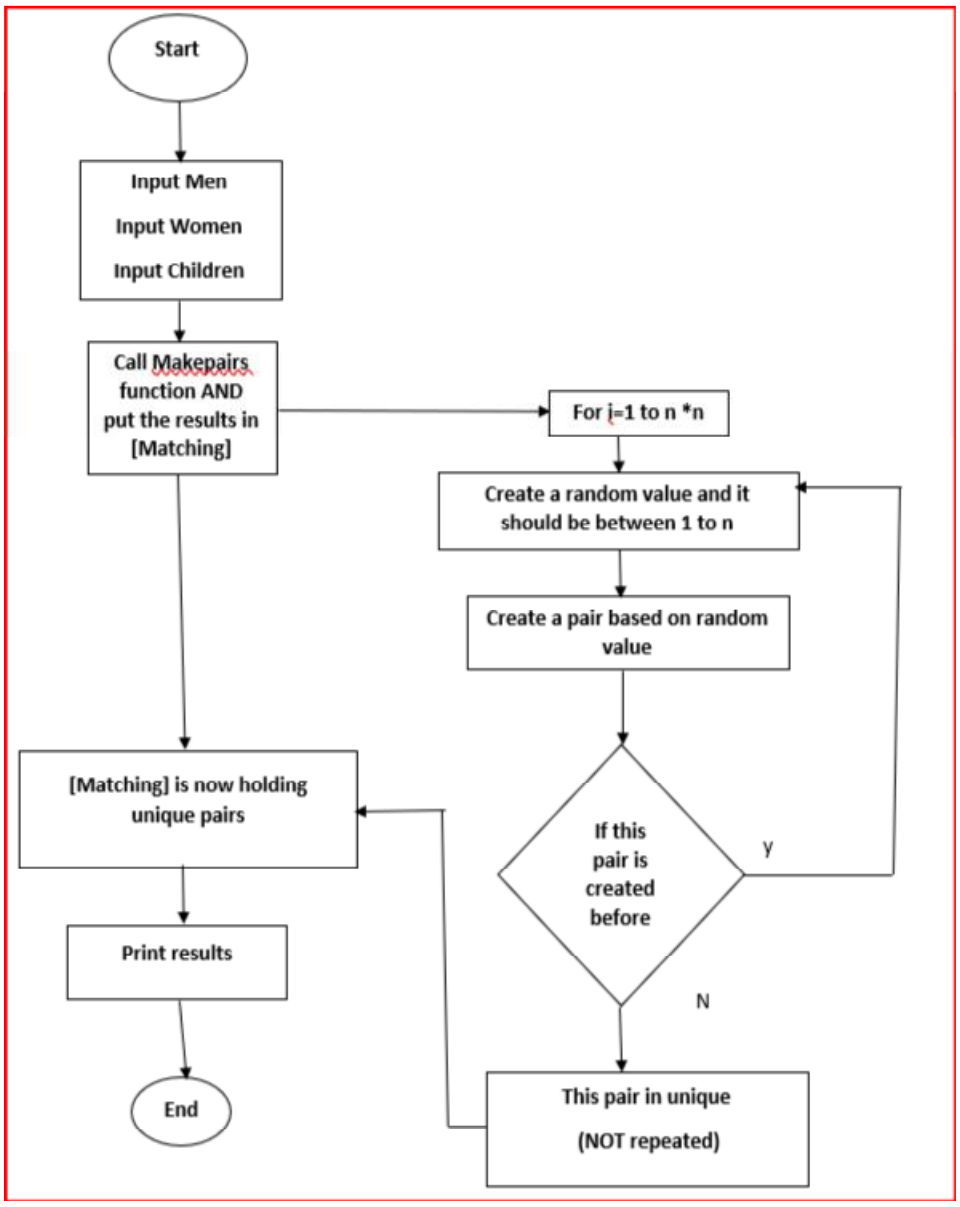
Women	Order of Preference
a	{A x CH1 , A x CH3 , A x CH2 , A x CH4},{ B x CH2 , B x CH3 , B x CH4 , B x CH2}, { C x CH2 , C x CH1 , C x CH4 , C x CH3},{ d x CH4 , d x CH2 , d x CH3 , d x CH1}
b	{A x CH4 , A x CH3 , A x CH2 , A x CH1},{ B x CH2 , B x CH3 , B x CH1 , B x CH4}, { C x CH2 , C x CH1 , C x CH4 , C x CH3},{ d x CH1 , d x CH2 , d x CH3 , d x CH4}
c	{A x CH4 , A x CH3 , A x CH2 , A x CH1},{ B x CH2 , B x CH3 , B x CH4, B x CH2}, { C x CH2 , C x CH1 , C x CH4 , C x CH3},{ d x CH4 , d x CH2 , d x CH3 , d x CH1}
d	{A x CH1 , A x CH3 , A x CH2 , A x CH4},{ B x CH2 , B x CH1 , B x CH3 , B x CH4}, { C x CH2 , C x CH3 , C x CH1 , C x CH4},{ d x CH3 , d x CH2 , d x CH3 , d x CH1}

Third case:-

μ(W) = (m,w)

Women	Order of Preference
CH1	{A x a, A x c, A x b , A x d},{ B x b , B x c , B x d , B x b}, { C x b , C x a , C x d , C x c},{ d x d , d x b , d x c , d x a}
CH2	{ A x d , A x c , A x b , A x a},{ B x b , B x c , B x a , B x d}, { C x b , C x a , C x d , C x c},{ d x a , d x b , d x c , d x d}
CH3	{ A x d , A x c , A x b , A x a},{ B x b , B x c , B x d, B x b}, { C x b , C x a , C x d , C x c},{ d x d , d x b , d x c , d x a}
CH4	{A x a , A x c , A x b , A x d},{ B x b , B x a , B x c , B x d}, { C x b , C x c , C x a , C x d},{ d x c , d x b , d x c , d x a}

4. Algorithm working Program



5. Results

As we see the output of the program is three matrixes, because we take an example of 4 men, 4 women and 4 Children the result is n^2 that's mean 16 pairs , so every line is a 16 pairs of all possible pairs can be exist , noticing that every pairs isn't repeated.

6. Conclusions.

Analyzing Results

As we see in the first image is the input matrixes , and the 16 possible pairs that considered to be the first step of multi-sided stable matching, the pairs are μ(m) = (w,CH) that mean all the possible pairs between WOMEN and CHILDREN

μ(w) = (M,CH) that mean all the possible pairs between MAN and CHILDREN

μ(CH) = (w,M) that mean all the possible pairs between WOMEN and MAN.

Acknowledgment. This work is partially supported by The authors also gratefully acknowledge the helpful comments and

suggestions of the reviewers, which have improved the presentation.

REFERENCES

[1] D . E Knuth . The Art of Computer Programing . V. 1 Fundamental Algorithms Reading ,Mass.:Addison-Wesley, 1968.

[2] V . I. Danilov . Existence of Stable Matching in some three-sided system . Central Economical Mathematical Institute ,Nakhimovskiipr . 47 , Moscow 117418 , Russia , Page 145 to page 148.

[3] Дональд Э. Кнут ,Устойчивыепаросочетания и другиекомбинаторыезадачи , превод с английского О . А .Кашиной ,подредакцией Э. Ю . Лернера.

[4] Biró, P. (2017). Applications of matching models under preferences.

[5] Mordig, M., Della Vecchia, R., Cesa-Bianchi, N., &Schölkopf, B. (2021). Two-Sided Matching Markets in the ELLIS 2020 PhD Program. arXiv preprint arXiv:2101.12080.

[6] Pycia, M., &Yenmez, M. B. (2021). Matching with externalities. University of Zurich, Department of Economics, Working Paper, (392).

[7] Doerner, J., Evans, D., &Shelat, A. (2016, October). Secure stable matching at scale. In Proceedings of the 2016 ACM SIGSAC Conference on Computer and Communications Security (pp. 1602-1613).

[8] Mohd, S. B. R. (2015). A Study on Multi-Agent Systems for Stable Matching.

[9] Brilliantova, A., & Hosseini, H. (2022). Fair Stable Matching Meets Correlated Preferences. arXiv preprint arXiv:2201.12484.

[10] Shi, R., Li, Z., Tang, Z., & Wang, D. (2022). Mechanism and Algorithm for Stable Trading Matching between Coal Mining and Power Generation Companies in China. Applied Sciences, 12(8), 3919.

[11] Fenoaltea, E. M., Baybusinov, I. B., Zhao, J., Zhou, L., & Zhang, Y. C. (2021). The Stable Marriage Problem: An interdisciplinary review from the physicist's perspective. Physics Reports, 917, 1-79.

[12] Aziz, H., Biró, P., Fleiner, T., Gaspers, S., De Haan, R., Mattei, N., &Rastegari, B. (2022). Stable matching with uncertain pairwise preferences. Theoretical Computer Science.

[13] Perrault, A., Drummond, J., & Bacchus, F. (2016, May). Strategy-proofness in the stable matching problem with couples. In Proceedings of the 2016 International Conference on Autonomous Agents & Multiagent Systems (pp. 132-140).

[14] Aziz, H., Biró, P., Gaspers, S., Haan, R. D., Mattei, N., &Rastegari, B. (2016, September). Stable matching with uncertain linear preferences. In International Symposium on Algorithmic Game Theory (pp. 195-206). Springer, Berlin, Heidelberg.

[15] Arkin, E. M., Bae, S. W., Efrat, A., Okamoto, K., Mitchell, J. S., &Polishchuk, V. (2009). Geometric stable roommates. Information Processing Letters, 109(4), 219-224.

[16] Wu, J. (2016, May). Stable matching beyond bipartite graphs. In 2016 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW) (pp. 480-488). IEEE.

[17] FA: Hersh F. Mahmood, HooshangDabbagh, Azad A. Mohammed, Comparative study on using chemical and natural admixtures (grape and mulberry extracts) for concrete, Case Studies in Construction Materials, Volume 15, 2021,

[18] Kumar, S. (2022). A quest for sustainium (sustainability Premium): review of sustainable bonds. Academy of Accounting and Financial Studies Journal, Vol. 26, no.2, pp. 1-18

*e*ISSN 1303-5150

[19] Allugunti, V.R. (2019). Diabetes Kaggle Dataset Adequacy Scrutiny using Factor Exploration and Correlation. International Journal of Recent Technology and Engineering, Volume-8, Issue-1S4, pp 1105-1110.

[20] De Clercq, S., Schockaert, S., De Cock, M., &Nowé, A. (2016). Solving stable matching problems using answer set programming. Theory and Practice of Logic Programming, 16(3), 247-268.

[21] Aziz, H., Biró, P., Gaspers, S., de Haan, R., Mattei, N., &Rastegari, B. (2020). Stable matching with uncertain linear preferences. Algorithmica, 82(5), 1410-1433.

[22] Wu, J. (2016, May). Stable matching beyond bipartite graphs. In 2016 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW) (pp. 480-488). IEEE.

[23] Aziz, H., Biró, P., Gaspers, S., de Haan, R., Mattei, N., &Rastegari, B. (2020). Stable matching with uncertain linear preferences. Algorithmica, 82(5), 1410-1433.

[24] Wu, M., Li, K., Kwong, S., Zhou, Y., & Zhang, Q. (2017). Matching-based selection with incomplete lists for decomposition multiobjective optimization. IEEE Transactions on Evolutionary Computation, 21(4), 554-568.

*e*ISSN 1303-5150