Fast and Rigorous Assignment Algorithm Multiple Preference and Calculation

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Abstract

The goal of paper is to develop an algorithm that evaluates students then places them depending on their desired choices according to dependant preferences. The developed algorithm is also used to implement software. The success and accuracy of the software as well as the algorithm are tested by applying it to ability test at Beykent University. This ability test is repeated several times in order to fill all available places at Fine Art Faculty departments in every academic year. It has been shown that this algorithm is very fast and rigorous after application of 2008-2009 and 2009-20010 academic years.

Key Words: Assignment algorithm, student placement, ability test

1. Introduction

As a result of improved and developed technologies, new definitions and concepts such as information society and information technology are brought into our life. Recently most of the practical problems can be done on computer, but it is very difficult to accomplish without computers. One of the practical problems is assignment problem faced in different forms.

Classroom allocation problem is commonly faced assignment problem that researcher tried to solve in the literature [1-4]. At the beginning of each teaching semester, several thousand students at the same time desire to attend different courses. Each course has preferences in terms of the lecturer, classify of the classroom, the location, available equipment, popularity of the lecture, essentiality, etc. A central system must make a fair assignment according to the preferences, then satisfy them as much as possible.

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Another assignment case studied by the authors is student replacement with couples [5]. In [5] the student replacement problem is determined by a set of position types, the number of available positions of each types, and the students' strict preferences over position types.

Instances of the allocation problem arise in house allocation scenarios [6,7]. Such situations are common in such counties where there are large number of government owned flats or houses [8].

Assignment problem is not limited to house or class allocation. Miao [9] introduced adaptive assignment organisation to improve learning capability of young learners. The proposed model in [9] provided students with an electronic assignment book. A core component of this book was a personal software agent that monitors the learners' progress.

The targeted assignment problem is OSYS (Student Selection and Placement Examination) type placement. Every year, more than one million students attend this exam to be placed to one of the university departments. Students are taken several types of questions that have different weightings. Student also choose desired universities as well as departments according to their marks that are calculated by using number of correct answers of each type of question with weighting. This system is used in Turkey since 1974. Assignment need to be done in correct way but for large number of students this process is really so hard without an algorithm or software system. This paper introduces a fast and rigorous algorithm that evaluates students and places them depending on multiple grade system. This developed project has been tested with success and accuracy of results in the 2008-2009 and 2009-2010 academic years at the University of Beykent.

2. Student Assignment Algorithm

In assignment problem, there are students, their grades and selections. They are placed according to their desired choice in bound of capacity of the selected unit. Students must not placed more than one desired unit as well as the place where they are not chosen. Every selection has its own grade according to exam. In order to analyse the algorithm we need to have units, their capacity and students. Let's assume we have units and their capacity as given in Table 1. As shown in Table 1, there are 4 units and 26 available places.

Table 1. List of units

Unit No	Unit Name	Capacity
U1	Computer Engineering	5
U2	Medical	7
U3	Economy	6
U4	English Literature	8

There are list of students given in Table 2 and their selections with grades given in Table 3. 26, which is total capacity, of the 36 students need to assign to the units according to their selections and selection's grades.

Table 2. List of students

No	Name	No	Name	No	Name
S1	Ali	S13	Zeki	S25	İlknur
S2	Mehmet	S14	Musa	S26	Esra
S3	Can	S15	İsa	S27	Deniz
S4	Ayşe	S16	Emine	S28	Oğuz
S5	Fatma	S17	Sibel	S29	Hasan
S6	Hakan	S18	Semih	S30	Sezen
S7	Elif	S19	Gülben	S31	Türkan
S8	Ahmet	S20	Selda	S32	Tülay
S9	Ümit	S21	Arda	S33	Yavuz
S10	Sevgi	S22	Gökhan	S34	Osman
S11	Gözde	S23	Hakkı	S35	Fatih
S12	Handan	S24	Ceyda	S36	Yasemin

Table 3. The selections and points of students

No	I. Selection / Point	II. Selec. / Point	III. Selec. / Point	IV. Selec. / Point
S1	U1 / 90	U2 / 94	U3 / 99	U4 / 98
S2	U3 / 93	U2 / 95	U1 / 93	U4 / 97
S3	U4 / 100	U3 / 97	U2 / 93	U1 / 91
S4	U2 / 98	U1 / 92		
S5	U1 / 97	U2 / 92	U4 /96	U3 / 100
S6	U2 /97	U3 /94	U4 / 95	U1 / 94
S7	U4 / 99	U3 /95		
S8	U4 / 92	U2 / 96	U1 / 96	U3 / 98
S9	U3 / 92	U4 / 90	U2 /91	
S10	U2 / 99	U3 / 96	U4 / 94	U1 / 95
S11	U3 / 91	U4 / 93		
S12	U2 / 100	U4 / 91		
S13	U1 / 76			

S14	U2 / 70			
S15	U3 /89	U4 / 88	U1 / 77	
S16	U3 /88	U2 / 77	U1/70	
S17	U4 / 86	U2 / 78	U1 / 75	U3 / 85
S18	U3 / 84	U4 / 89	U2 /76	U1 / 74
S19	U2 / 71	U3 / 86		
S20	U1 / 72			
S21	U2 /73	U1 / 71		
S22	U4 / 87	U1 / 79		
S23	U3 / 80			
S24	U2 / 79			
S25	U1 / 67			
S26	U3/68			
S27	U1/65			
S28	U2 /69			
S29	U4 / 79			
S30	U3 / 66			
S31	U2 / 68			
S32	U2 / 66			
S33	U4 / 78			
S34	U1/55	U3/65	U4 / 76	
S35	U3 / 67			
S36	U2 / 65			

The assignment algorithm is run by repeating 3 nested steps. There are 2 control flags which are called active and placed flags in the algorithm. The meanings of the stages according to flags are given below:

- Active = 1 and Placed = 0 : All selections's flags are in this position for initial. This status means that the selection can be be used in assignment loop to place. We call this status as Status I.

- Active = 0 and Placed = 1 : Selection is placed and it wont be used in fortcoming assignment loop anymore. Let's call this status as Status II.
- Active = 0 and Placed = 0 : Selection is not be placed and it wont be used in assignment loop anymore. This status is called as Status III.

STEP I: Each unit orders its own selections that are in Status I by descending order of calculated points. Then each unit places the top selections according their vacant capacity or in other words make placed selection's active flag as 0 and placed flag as 1. As a result of this step Computer Engineer placed 5, Medical 7, Economy 6 and English Literature 8 selections respectively. The placement can be seen in Table 4.

Table 4. Appliying of Step I

Computer Eng.			Medical			Economy			Eng. Literature		
No	**Selection No**	**Point**	**No**	**Selection No**	**Point**	**No**	**Selection No**	**Point**	**No**	**Selection No**	**Point**
S5	1	97	S12	1	100	S5	4	100	S3	1	100
S8	3	96	S10	1	99	S1	3	99	S7	1	99
S10	4	95	S4	1	98	S8	4	98	S1	4	98
S6	4	94	S6	1	97	S3	2	97	S2	4	97
S2	3	93	S8	2	96	S10	2	96	S5	3	96
S4	2	92	S2	2	95	S7	2	95	S6	3	95
S3	4	91	S1	2	94	S6	2	94	S10	3	94
S1	1	90	S3	3	93	S2	1	93	S11	2	93
S22	2	79	S5	2	92	S9	1	92	S8	1	92
S15	3	77	S9	3	91	S11	1	91	S12	2	91
S13	1	76	S24	1	79	S15	1	89	S9	2	90
S17	3	75	S17	2	78	S16	1	88	S18	2	89
S18	4	74	S16	2	77	S19	2	86	S15	2	88
S20	1	72	S18	3	76	S17	4	85	S22	1	87
S21	2	71	S21	1	73	S18	1	84	S17	1	86
S16	3	70	S19	1	71	S23	1	80	S29	1	79
S25	1	67	S14	1	70	S26	1	68	S33	1	78
S27	1	65	S28	1	69	S35	1	67	S34	3	76
S34	1	55	S31	1	68	S30	1	66			
			S32	1	66	S34	2	65			
			S36	1	65						

Status I

Status II

STEP II: In the first step, the algorithm does not control that students might be placed more than one selection. In this step, we control the placed students if they are placed more than one selection. For this step, as see in Table 5, algorithm orders all placed selections for each placed student. There are 11 different students are placed after Step I for the first iteration. For instance S1 is placed for his 3 of 4 selections or S4 is placed for his 1 of 2 selections. There must be no more than one placed selection for any students. So we must apply Step 2 to Table 5 to passive those selections.

Table 5. Ordered selection of selected students

S1		S2		S3		S4		S5		S6		S7		S8		S10		S11		S12	
Unit	Selec.	Unit	Selec.	Unit	Selec.	Unit	Selec.	Unit	Selec.	Unit	Selec.	Unit	Selec.	Unit	Selec.	Unit	Selec.	Unit	Selec.	Unit	Selec.
u2	2	U2	2	U4	1	U2	1	U1	1	U2	1	U4	1	U2	2	U2	1	U4	2	U2	1
u3	3	U1	3	U3	2	U1	2	U2	2	U4	3	U3	2	U1	3	U3	2	U3	1	U4	2
u4	4	U4	4	U2	3	-	-	U4	3	U1	4	-	-	U3	4	U4	3	-	-	-	-
u1	1	U3	1	U1	4	-	-	U3	4	U3	2	-	-	U4	1	U1	4	-	-	-	-

Status I
Status II

If students are placed more than one selection then algorithm turns placed selections to passive, other words make then Status III except for minimum number of placed selections. If a student is placed in his first choice, then other selections of that student are set to Status III. That means that this student is already placed for certain. As seen in Table 5, students with S3, S4, S5, S6, S7, S10 and S12 numbers are placed in their exact choices. So all of those students' selections except for their first choices are set to Status III. However, students S1, S2, S8 and S11 are not placed to their first selections so algorithm set placed selections to passive or in another words set them to Status III except for the minimum order of the placed selections. After applying Step II result can be seen in Table 6. As seen in Table 6 students who placed in their first selection have no more active selection although students who are not placed to their first selections can still have.

Table 6. After applying Step II

S1		S2		S3		S4		S5		S6		S7		S8		S10		S11		S12	
Unit	Selec.	Unit	Selec.	Unit	Selec.	Unit	Selec.	Unit	Selec.	Unit	Selec.	Unit	Selec.	Unit	Selec.	Unit	Selec.	Unit	Selec.	Unit	Selec.
u2	2	U2	2	U4	1	U2	1	U1	1	U2	1	U4	1	U2	2	U2	1	U4	2	U2	1
u3	3	U1	3	U3	2	U1	2	U2	2	U4	3	U3	2	U1	3	U3	2	U3	1	U4	2
u4	4	U4	4	U2	3	-	-	U4	3	U1	4	-	-	U3	4	U4	3	-	-	-	-
u1	1	U3	1	U1	4	-	-	U3	4	U3	2	-	-	U4	1	U1	4	-	-	-	-

Status I
Status II
Status III

After applying Step II to Table 4, we have the result in Table 7.

Table 7. Step II –Iteration I

Computer Eng.			Medical			Economy			Eng. Literature		
No	Selection No	Point	No	Selection No	Point	No	Selection No	Point	No	Selection No	Point
S5	1	97	S12	1	100	S5	4	100	S3	1	100
S8	3	96	S10	1	99	S1	3	99	S7	1	99
S10	4	95	S4	1	98	S8	4	98	S1	4	98
S6	4	94	S6	1	97	S3	2	97	S2	4	97
S2	3	93	S8	2	96	S10	2	96	S5	3	96
S4	2	92	S2	2	95	S7	2	95	S6	3	95
S3	4	91	S1	2	94	S6	2	94	S10	3	94
S1	1	90	S3	3	93	S2	1	93	S11	2	93
S22	2	79	S5	2	92	S9	1	92	S8	1	92
S15	3	77	S9	3	91	S11	1	91	S12	2	91
S13	1	76	S24	1	79	S15	1	89	S9	2	90
S17	3	75	S17	2	78	S16	1	88	S18	2	89
S18	4	74	S16	2	77	S19	2	86	S15	2	88
S20	1	72	S18	3	76	S17	4	85	S22	1	87
S21	2	71	S21	1	73	S18	1	84	S17	1	86
S16	3	70	S19	1	71	S23	1	80	S29	1	79
S25	1	67	S14	1	70	S26	1	68	S33	1	78
S27	1	65	S28	1	69	S35	1	67	S34	3	76
S34	1	55	S31	1	68	S30	1	66			
			S32	1	66	S34	2	65			
			S36	1	65						

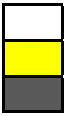
Status I
Status II
Status III

STEP III: This step is for controlling, if there are any free capacity in units and any selection in Status I for those units that have free capacity. If this control is return true then algorithm start with Step I again for new iteration. These steps follow each others until there is no free capacity or no more selection in Status I for unit that has free capacity. After 6 iterations, the result can be displayed as seen in Table 8. As seen, there is no more free capacity or no more active selections (Status I) belongs to units that have free capacity. So the control returns false and the algorithm break itself from placement loop.

After second iteration (applying of Step I-II) we have next result as seen in Table 8;

Table 8 : Result of second iteration

Computer Eng.			Medical			Economy			Eng. Literature		
No	Selection No	Point	No	Selection No	Point	No	Selection No	Point	No	Selection No	Point
S5	1	97	S12	1	100	S5	4	100	S3	1	100
S8	3	96	S10	1	99	S1	3	99	S7	1	99
S10	4	95	S4	1	98	S8	4	98	S1	4	98
S6	4	94	S6	1	97	S3	2	97	S2	4	97
S2	3	93	S8	2	96	S10	2	96	S5	3	96
S4	2	92	S2	2	95	S7	2	95	S6	3	95
S3	4	91	S1	2	94	S6	2	94	S10	3	94
S1	1	90	S3	3	93	S2	1	93	S11	2	93
S22	2	79	S5	2	92	S9	1	92	S8	1	92
S15	3	77	S9	3	91	S11	1	91	S12	2	91
S13	1	76	S24	1	79	S15	1	89	S9	2	90
S17	3	75	S17	2	78	S16	1	88	S18	2	89
S18	4	74	S16	2	77	S19	2	86	S15	2	88
S20	1	72	S18	3	76	S17	4	85	S22	1	87
S21	2	71	S21	1	73	S18	1	84	S17	1	86
S16	3	70	S19	1	71	S23	1	80	S29	1	79
S25	1	67	S14	1	70	S26	1	68	S33	1	78
S27	1	65	S28	1	69	S35	1	67	S34	3	76
S34	1	55	S31	1	68	S30	1	66			
			S32	1	66	S34	2	65			
			S36	1	65						



Status I
Status II
Status III

After 4 iterations we have final result as seen in Table 9.

Table 9. Final Iteration - Result

Computer Eng.			Medical			Economy			Eng. Literature		
No	Selection No	Point	No	Selection No	Point	No	Selection No	Point	No	Selection No	Point
S5	1	97	S12	1	100	S5	4	100	S3	1	100
S8	3	96	S10	1	99	S1	3	99	S7	1	99
S10	4	95	S4	1	98	S8	4	98	S1	4	98
S6	4	94	S6	1	97	S3	2	97	S2	4	97
S2	3	93	S8	2	96	S10	2	96	S5	3	96
S4	2	92	S2	2	95	S7	2	95	S6	3	95
S3	4	91	S1	2	94	S6	2	94	S10	3	94
S1	1	90	S3	3	93	S2	1	93	S11	2	93
S22	2	79	S5	2	92	S9	1	92	S8	1	92
S15	3	77	S9	3	91	S11	1	91	S12	2	91
S13	1	76	S24	1	79	S15	1	89	S9	2	90
S17	3	75	S17	2	78	S16	1	88	S18	2	89
S18	4	74	S16	2	77	S19	2	86	S15	2	88
S20	1	72	S18	3	76	S17	4	85	S22	1	87
S21	2	71	S21	1	73	S18	1	84	S17	1	86
S16	3	70	S19	1	71	S23	1	80	S29	1	79
S25	1	67	S14	1	70	S26	1	68	S33	1	78
S27	1	65	S28	1	69	S35	1	67	S34	3	76
S34	1	55	S31	1	68	S30	1	66			
			S32	1	66	S34	2	65			
			S36	1	65						

Status I
Status II
Status III

As a result of these steps, placement status of students can be seen in Table 10 and point of students who placed depending on units can be seen in Table 11.

Table 10. Placement status of students

No	Name	No	Name	No	Name
S1	Ali	S13	Zeki	S25	İlknur
S2	Mehmet	S14	Musa	S26	Esra
S3	Can	S15	İsa	S27	Deniz
S4	Ayşe	S16	Emine	S28	Oğuz
S5	Fatma	S17	Sibel	S29	Hasan
S6	Hakan	S18	Semih	S30	Sezen
S7	Elif	S19	Gülben	S31	Türkan
S8	Ahmet	S20	Selda	S32	Tülay
S9	Ümit	S21	Arda	S33	Yavuz
S10	Sevgi	S22	GSkhan	S34	Osman
S11	GSzde	S23	Hakkı	S35	Fatih
S12	Handan	S24	Ceyda	S36	Yasemin

Not Placed

Placed

Table 11. Placed students according to units

Computer Eng.			Medical			Economy			Eng. Literature		
Name	Order	Point	Name	Order	Point	Name	Order	Point	Name	Order	Point
Fatma	1	95	Handan	1	100	Mehmet	1	93	Can	1	100
Ali	1	90	Sevgi	2	99	Ümit	1	92	Elif	1	99
Zeki	1	76	Ayşe	1	98	Gözde	1	91	Ahmet	1	92
Selda	1	72	Hakan	1	97	İsa	1	89	Gökhan	1	87
İlknur	1	67	Ceyda	1	79	Emine	1	88	Sibel	1	86
			Arda	1	73	Semih	1	84	Hasan	1	79
			Gülben	1	71				Yavuz	1	78
									Osman	3	76

The Algorism's flow chart can be seen in Figure 1. At first step, algorithm runs a control function which returns 1 or 0 before starting to loop. If control function returns 1 at initial which means that there is at least a unit that has active selections and there is still free capacity for that unit. In the loop, it gets list of empty capacities of units **(EC)**. For each unit in EC that has free capacity we select active selections of the unit by ordering points from max to min **(US)**. In a new loop, place the selections in **US** until all the free capacity are filled. After doing this for all units, now we apply Step II. The list of placed students is taken (**ST**). In the loop, for placed student, all selections of which their order bigger than minimum order of placed selection set passive.

3. Conclusion

In this contribution, new student assignment system has been developed. In this paper introduced novel algorithm that evaluates students and place them depending on multiple grade system. This implemented software was used with success and accuracy of results in the 2008-2009 and 2009-2010 academic years at the University of Beykent.

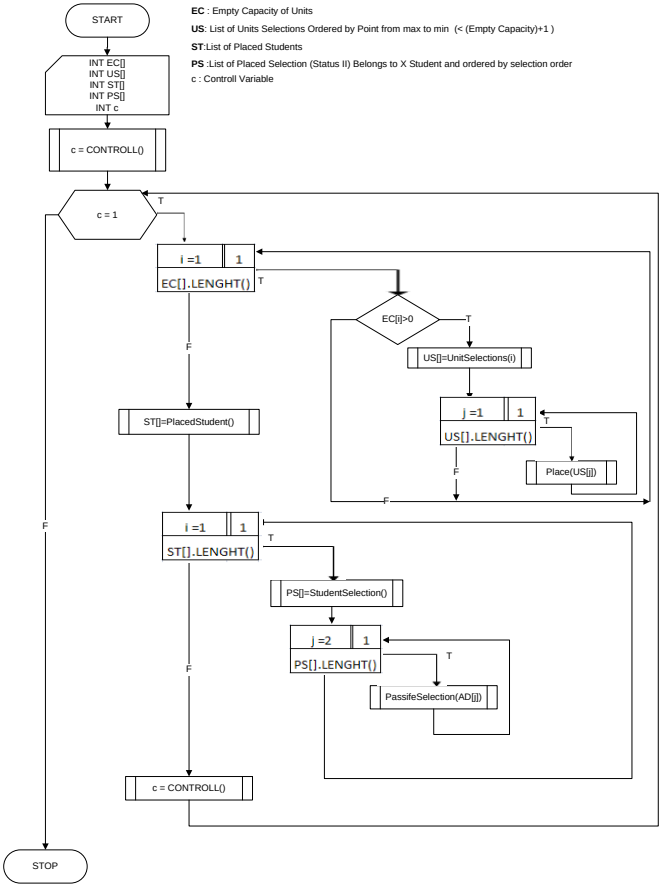


Figure 1. The flow chart of algoritm

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