

Model United Nations MUN Simulation Software

Joumana Samir Moodad
Department of Electrical and Computer Engineering
Lebanese American University (LAU)
36 Byblos, Lebanon
joumana.moodad@lau.edu

Abstract - This paper describes the Model United Nations (MUN) Simulation Software which is an automated software tool dedicated to the Lebanese American University (LAU) – MUN organizing committee members. The software is used in the Global Classrooms International Model UN Conferences for Middle Schools and High Schools that will take place at the Grand Hyatt and the UN Headquarters in New York City on March 31 – April 2, 2016 and May 12 – May 14, 2016 respectively [1]. It allows LAU-MUN organizing committee members to more effectively organize and process the data needed to launch MUN simulation exercises and conferences, including school/country data storage, organization, and automated preference matching using optimization solutions based on the transportation problem.

I. INTRODUCTION

Model United Nations is an internationally known simulation model of the UN and its agencies. Global Classrooms is the United Nations Association of the United States of America's (UNA-USA) flagship education program, a program of the United Nations Foundation. Through this program, students of middle schools and high schools explore current world issues, improve their skills, and acquire necessary attitudes for active citizenship. Over the past decade, Global Classrooms has worked in 24 major cities around the world, and has engaged more than 25,000 students and teachers annually [2]. The LAU MUN High School program was first launched in 2005-2006. For the past 10 years, more than 1,000,000 hours of teaching peace building and diplomacy were offered to a total of 16,000 Middle School and High School students from around 174 schools throughout Lebanon and from selected schools in the Arab world [3].

A. Challenges

When organizing an MUN exercise, organizing committee members are faced with many data processing challenges, mainly: i) acquiring information regarding participant schools from all around the world, in a timely and organized manner, ii) storing and organizing school information, including: each school's preferences (in terms of the countries – and/or committees - to be delegated) as well as the number of prospective participants, iii) matching school preferences with available countries (committees) profiles in order to assign each school one or more countries, and/or vice versa. The existing solution used by the organizing committee to handle the mentioned challenges consisted of a bunch of disconnected

manual and semi-automated processes, which induced various problems/bottlenecks. For instance, information was acquired through the use of Google documents filled using a primitive Web interface, without any linguistic pre-processing or data cleansing. This produced data full of typos, mistakes, and sometimes ambiguities (e.g., school names or country names written differently). Concerning data storage and organization, it was typically handled in spreadsheets which are disregarded at the end of each simulation exercise, making way for the upcoming one. As for school/country matching and preferences, the task was conducted manually by organizers, which required considerable manual effort and consumed a huge amount of time.

B. Objectives

The goal is to provide a fully automated software-based solution which addresses the three main limitations mentioned above: i) designing a dedicated Web interface, using the sophisticated technology in linguistic pre-processing techniques to clean the data prior to storage, ii) designing a dedicated database structure, handled via a light weight Web-based DBMS (Database Management System) in order to properly store normalized data, iii) allowing to keep track of: not only the current data concerning the current simulation exercise, but rather of historic data regarding previous exercises, allowing advanced applications such as temporal querying (querying the past) and data mining functionality (e.g., discovering and analyzing school preference/country selection patterns), iv) implementing an automated solution to perform school/country matching, adapting existing assignment and/or transportation problem algorithms to handle the specific data at hand.

In the remainder of the paper, we first describe the context of the project (Section II) and its requirements (functional and non-functional in Section III), then we present the proposal (Section IV) including implementation details (Section V), as well as preliminary experimental evaluation (Section VI), before wrapping up with future improvements (Section VII).

II. CONTEXT

The simulation programs have different conditions and requirements. The software is meant to operate on the following programs: Model United Nations (MUN), Global

Classrooms International Model UN (GCI MUN), and Model Arab League (MAL).

A. *Model United Nations Conferences (MUN) & Global Classrooms International Model UN Conferences (GCI MUN)*

In each conference, schools are assigned countries to represent them. The rules and regulations for country assignments: i) the world is divided into 5 regions, ii) each school has to rank these regions from 1 to 5, iii) then, a school needs to choose 2 countries/region and rank them as priority 1 and priority 2, iv) a school has to provide the total number of students that they are applying.

Based on the data provided by each school, the organizers of the conference start by: i) First Come First Serve Basis Rule: the school that registers first will be considered first (through checking the timestamp), ii) Regional Preference Rule: the region that has the highest rank (rank of 1) is first considered, and the region that has the lowest rank (rank of 5) is least considered, iii) Country Preference per Region Rule: the country that has the highest priority (priority #1) in the region is first considered, if the conditions are not satisfied, the second country within the same region (priority #2) is then considered, iv) Delegation Size Match Rule: the number of students applying per school should be matching with the number of representatives of the country it will represent.

One of the main conditions in MUN and GCI MUN is that countries cannot be assigned twice; a country should be assigned to one and only one school. A school should also get only one country.

B. *Model Arab League (MAL)*

The MAL conferences follow the same procedure of MUN and GCI MUN conferences, however with some minor differences in the assignments conditions.

In MAL, a country can be assigned several times to several schools. In other words, a country that has been assigned previously and still lacks a certain number of representatives, can be assigned a second time to a different school than the one it has been assigned before. Similarly, a school can be assigned several countries. For instance, if a school has been assigned to one country which requires lesser number of representatives than the number of students applying, the school can be assigned a second (third, fourth, etc.) country.

Moreover, MAL conferences differ from MUN and GCI MUN conferences in the way schools provide their priorities. In MAL, there is no concept of regions; in other words, a school directly provides ten countries prioritized from the highest to the lowest instead of ranking five regions and choosing two countries within a region.

III. REQUIREMENTS

This section specifies the functional and non-functional requirements of the software. This is done through establishing the services that the users require from the system, in addition to the constraints under which the system operates.

A. *Functional Requirements*

a. *School Application Interface*

Functional requirements are specified in terms of both user and system requirements. One of the requirements which are common to all types of conferences is to have an application interface that is sent to schools to collect data from them and store this data in a database.

b. *MUN and GCI MUN Application Interface*

This interface is to be used by the MUN and GCI MUN organizers to do the school-country assignments. The interface should have as input fields: i) An excel sheet of all applying schools and their regional and country priorities, ii) An excel sheet of all schools with their corresponding number of applying students, iii) An excel sheet of all countries and their corresponding number or representatives, iv) location of the output country-assignment sheets (output excel sheet of first phase where regional and country priorities are considered, and output excel sheet of second phase where only matching size conditions are considered), v) list of all remaining countries not yet assigned, vi) list of all assigned countries, vii) list of remaining schools that couldn't be assigned due to exceptional constraints (Appendix – Fig.4).

c. *MAL Application Interface*

This interface is to be used by the MAL organizers to do the school-country assignments. These assignments are specified in an output excel sheet and have several criteria. The interface should contain input fields for: i) input excel sheet of all applying schools and their country priorities, ii) input excel sheet of all schools with their corresponding number of students, iii) input excel sheet of all countries with their corresponding number of representatives, iv) location of the output excel sheet of the school-country assignments, v) threshold for schools: input from user specifying the minimum number of extra students needed for the school to be assigned a second country, vi) threshold for countries: input from user specifying the maximum number of vacant places allowed for a country to stay functioning/represented, vii) maximum number of countries per school: input from user specifying the maximum number of countries that can be assigned to a school, viii) maximum number of schools per country: input from user specifying the maximum number of schools a country can be assigned to, ix) list of all assigned countries, x) list of all unassigned countries, xi) list of countries which are not totally filled; they still have vacant places above the countries threshold, and thus, can be assigned to other schools (Appendix – Fig. 5).

B. *Non-Functional Requirements*

The non-functional requirements in our design fall under product and organizational requirements.

a. *Product Requirements*

When designing the software, we should consider the space and time requirements. The execution time of the application

should be in the order of seconds. Regarding the efficiency and performance requirements, it should be able to deliver the maximum amount of information using a certain limited number of inputs. In addition, the software should be reliable in terms of country-school assignments and can have a margin error of 1/100 schools. Another important requirement which we should consider is the usability of the application; it should provide the necessary data through a user-friendly interface that can be easily used by users of different backgrounds. Last but not least, since the data is to be stored in a database system and since all the computations and results are based on this data, we need to make sure that our system complies with the security requirements.

b. Organizational Requirements

The organizational/external requirements include interoperability requirements. Since the software is to be used on different platforms and systems (MUN, GCI MUN and MAL offices), we should ensure that it can operate on any system that has Java Runtime Environment.

IV. PROPOSAL

To solve the school-country assignment problem, we referred to the Transportation and Assignment Algorithms. We first identified the different basic feasible solutions which include North West Corner Rule, Minimum Cost Method, and Penalty Cost Method (Vogel’s Approximation Method). Then, we looked at the optimal solutions which include Stepping Stone Method and MODI (Modified Distribution Method) or U-V Method.

After doing several simulations based on the different transportation algorithms, we decided to use the Minimum Cost Method which yielded the lowest costs and best matching of schools-countries [5-11].

The transportation problem (TP) is concerned with shipping a commodity between a set of sources (e.g. manufacturers) and a set of destinations (e.g. retailers/warehouses). Each source has a capacity dictating the amount it supplies. Each destination has a demand dictating the amount it receives (Appendix – Fig.2). In a balanced system, the total number of demand at all destinations is equal to the total amount of supply at all sources. The purpose of this algorithm is to determine the amounts to be shipped between each source and destination with a minimal cost while meeting demand and supply conditions [4].

Table 1: Cost Matrix of a Balanced Transportation Problem

Factories	W1	W2	W3	Supply
F1	6	8	4	14
F2	4	9	3	12
F3	1	2	6	5
Demand	6	10	15	31

Our school-country assignment problem can be mapped to a transportation problem where schools are suppliers and countries are demands (Appendix – Fig.3). The costs for filling the school-country matrix are based on the regional and country preferences provided by the schools.

A. Calculating the Costs – Basic Solution

Since filling the cost matrix is based on the preferences provided by each school, we have to compute the preferences. To do so, and since regions have higher priorities than countries, we used the following method:

“Rank of Region” followed by “Rank of Country/Region”

Example: **51** means it is the region with rank 5 and the country with rank 1 within this region.

Below is the table of preferences/cost mappings.

Table 2: Preference/Cost Mapping

Region Rank	Country Rank/Region
1	1
	2
2	1
	2
3	1
	2
4	1
	2
5	1
	2

Preferences are associated with costs. They are inversely proportional to each other; the higher the preferences, the lower the costs. For instance, the lowest value in this table is **11**, and it refers to region with rank 1 and country with priority 1 within this region → Best preference is mapped to lowest cost. Similarly, the highest value in this table is **52**, and it refers to region with rank 5 and country with priority 2 within this region → Worst preference is mapped to highest cost. For the countries that are not chosen by a school as preferences, they will be assigned very large costs “Infinite” or “Inf” values in the corresponding row of the school.

B. Calculating the Costs – Extensible Solution

This solution is more flexible in terms of setting up and changing the priority of each factor. We can add at any time as many factors as required. It is based on a weighted summation. Each factor is associated a certain cost and weight. The values of the costs are normalized. Currently, we can consider three factors: i) RC: Region Choice, ii) CC: Country Choice, iii) SM: Students Matching Size. The weighted sum is then given by:

$$\sum W_j * Cost(Feature)_j = W(RC) * Cost(RC) + W(CC) * Cost(CC) + W(SM) * Cost(SM)$$

such that $\sum W_j = 1$ and $(W_1, W_2, \dots, W_n) \geq 0$

V. IMPLEMENTATION

In this section, we will discuss the Minimum Cost Method and how it was applied to the school-country assignment problem. This being said, we will study the two solutions developed: Excel sheet based solution and database solution.

A. Minimum Cost Method Implementation

The minimum cost method is a basic feasible solution which takes into account the cost variables of a problem; this makes it more preferred than the North-West Corner Method and other methods. It consists of a cost matrix which has suppliers in its rows and demands in its columns. In our problem, the suppliers are the schools, and the demands are the countries. The last row of the matrix is filled with the value **1**, and the last column of the matrix is also filled with the value **1**. If a school/supplier has a value 1 in its last column, this means that this school has not yet been given any country. If a country/demand has a value of 1 in its last row, this means that the country is not yet assigned to any school. These values are not representing the actual numbers of students of a school and representatives of a country; they are used to flag the fulfillment of a school and the availability of a country. Please note that, what we discussed so far applies to a balanced transportation system. A balanced transportation system is when the total number of suppliers is equal to the total number of demands [13]. If the system was unstable, then we need to add a dummy column or a dummy row (based on which of the total number of suppliers or total number of demands is lower).

a. From Unbalanced to Balanced System: Dummy Row

If the total number of suppliers is lesser than the total number of demands, in other word, if the total summation of **ones** in the last column is lesser than the total summation of **ones** in the last row, we need to add a dummy row that will have in its last column the difference of these two summations. This way, we recover for the deficiency in the number of suppliers by adding dummy suppliers/dummy schools which can supply as many demands based on previously calculated difference. In our problem, the dummy schools are added because not all countries need to be assigned to schools (most of the cases, the list of countries worldwide exceeds the number of schools who apply); thus, these dummy schools will not be considered.

b. From Unbalanced to Balanced System: Dummy Column

If the total number of suppliers is greater than the total number of demands, in other word, if the total summation of **ones** in the last column is greater than the total summation of **ones** in the last row, we need to add a dummy column that will have in its last row the difference of these two summations. This way, we recover for the deficiency in the number of demands by adding dummy demands/dummy countries. In our problem, the dummy countries are added when there are no more countries (all countries have been assigned) and still there are schools not assigned any countries yet. These schools are then assigned dummy countries which do not exist. This

case is rare; to have more schools than the total number of countries worldwide.

c. Steps and Procedure

After setting up the structure of the matrix and making sure the transportation system is balanced, we can proceed with the algorithm [12].

The first step to do is to find the cell with the minimum unit cost in the entire matrix. If there is a tie, we break it arbitrarily. In our case, the tie will not be broken arbitrarily, but we will take the first occurrence of the minimum unit cost because time is considered in our design.

The second step is to cross out the column and row which correspond to the minimum cost unit cell after checking if the supply and demand conditions are satisfied. In other words, we need to check whether the school still have students and whether the country to be assigned still have vacant places for representatives. In our design, the school should have in its last column a value greater than or equal to **1**, and the country should have in its last row a value greater than or equal to **1**. If this condition was not met, we will need to restart the process and find the next minimum unit cost cell.

After doing the assignment of the row and column corresponding to the minimum cost unit cell, we need to take them out from the matrix and update their corresponding supply and demand values. To take them out of the matrix, we replace the values of the cells in this column and row by large values, “infinite” values, so that they will not be chosen anymore when looking for the minimum cost unit cell. Then, we update the supply and demand through subtracting **1** from each of them.

This process is repeated until all rows and columns are assigned. To keep track of the assignments, when doing them, we can replace the value of the cell corresponding to the assigned row and assigned column by a certain fixed constant unused value. This way, when we want to get the assignments after we finish the run of the algorithm, we can search for this specific value and match the rows and columns to get the assignments.

d. Simplified Version of the Minimum Cost Method

The Minimum Cost Algorithm that was discussed in the previous section does not consider the timestamp criteria. It does the assignments after checking the whole matrix for the minimum cost unit; however, in some cases, this will not achieve the correct assignments. Let us consider the following scenario: School X chose a country A with a cost C_1 at a timestamp T_1 ; school Y chose the same country B with a cost $C_2 < C_1$ at a timestamp $T_2 > T_1$. Based on the Minimum Cost Algorithm, Country A should be given to school Y since it has a lesser cost than school X, but if we consider the time condition which has higher priority in our design, Country A **might** be assigned to school Y if school X was assigned another country which it chose with higher priority. The simplified version of the algorithm that is used in our transportation problem is to search row by row for the

minimum cost unit cell, and assign the schools sequentially; this will ensure that a school which comes first has higher probability of being assigned countries from its list of preferred countries than a school which comes last.

B. Excel Sheet Based Solution

This solution is based on providing the input and getting the results through Excel sheets. The desktop application is developed using Eclipse IDE and using Java and JavaFX programming languages. For all types of conferences, we need as input three excel sheets which will be processed differently.

a. MUN and GCI MUN Excel Sheets

The excel sheets needed to run the application as mentioned in section III, part A., include the sheet of applying schools and their country preferences. Please refer to the appendix, Table 3, to see an example of the input excel sheet of all schools applying for the GCI MUN Conference. Once the excel sheets are entered, we read the data and store it in files.

We process the input excel sheet of the schools to get an excel sheet with a list of ten countries listed from the highest to the lowest priority instead of having five regions ranked from 1 to 5 and two countries in each region.

After converting the excel sheet, we apply the Simplified Version of the Minimum Cost Algorithm. We get an output excel sheet with the preliminary school-country assignments. This is the output of the first iteration. If there are schools that were not assigned because we could not find for them countries from their preferred list which have same number of representatives as their number of students, they will be the input of the next iteration. In this new phase, we no longer consider the country preferences of a school, but we only consider the matching size criteria. In this second phase, we use the Minimum Cost Algorithm as well; however, this is the original version (not simplified version) of the algorithm since the time factor (which school applies first) is no longer considered. To create the structure of the new cost matrix, we take the remaining schools that need to be assigned countries and place them in rows; we take the remaining countries (countries that have not been assigned in the first phase) from the total list of countries and place them in columns. To fill the costs inside this matrix, we calculate the difference between each column (number of representatives per country) and each row (number of students per school):

$$\rightarrow \text{Difference} = \text{Representatives}_{\text{Country}} - \text{Students}_{\text{School}}$$

If this difference is **zero**, we place a 0 in the corresponding cell; if it is positive, we place it itself in the cell; otherwise, we place a very large value in the cell to prevent the assignment of the specified country to the school (since it is not allowed to assign a country which has lesser number of representatives than the school's students).

After running the algorithm and getting the assignments of this second phase, we can provide the users with list of countries that are still not assigned to any school; in addition,

we can provide the list of countries that have been assigned so far; and most importantly, we need to provide the list of schools that did not find any country with number of representatives less than or equal to its number of students. These schools will be assigned manually by the user (exceptions handled by the user's decision).

b. MAL Excel Sheets

The procedure for the MAL is similar to the MUN and GCI MUN, with slight changes:

i) The input excel sheet is already given as a list of ten countries (no region ranking).

ii) We can have several countries assigned to the same school (the maximum number of countries assigned per school is specified by the user); similarly, we can have several schools representing the same country (the maximum number of schools representing a country is specified by the user).

iii) The outputs of the first iteration are the preliminary country-school assignments, list of countries that are assigned but still have vacant places for representatives, list of schools that still have students not represented.

iv) The second phase consists of having recursive calls until all schools are completely assigned if the school threshold specified by the user is 1. For instance, if this threshold was 3, a school will not be assigned another country unless it has more than 3 students not represented. Similarly, we have a threshold for the countries; for example, if the country threshold is 5, then a country having lesser than 5 remaining representatives cannot be assigned to a second school.

v) The iterations in the second phase follow the Minimum Cost Algorithm as well; defining the structure and calculating the differences are done in the same way as MUN and GCI MUN; but, in this case, we fill in all cells the absolute value of the differences.

C. Database Solution

The database solution consists of creating a database that will contain all the data entered by the schools through the school application interface, and the control data entered by the MUN, GCI MUN, and MAL organizers (Appendix – Fig.1). Thus, other than the school interface, we need to have another interface for the database dedicated to the organizers. Through this DB, we can extract the input excel sheets that were provided as inputs previously. This way, the organizers can either run the software using external sheets or run it with a button that extracts directly the data regarding the countries and schools from the database. Using this solution not only allows for efficient and better security, but also it can be used for data mining, statistics and visualization techniques.

VI. TESTING

The testing procedure consists of checking if the functional and non-functional requirements of the system are met or not. To do so, we ran a multiple tests and we provided some of the results in the appendix section.

Table 4 in the appendix provides the school-country assignments of the first phase when running the GCI MUN application. The first two columns of this table represent the name and number of students of a school, and the next two columns represent the name and number of representatives of the country that is assigned to a school; the last column represents the difference between the number of students and number of representatives. In the first phase, the difference in all rows is zero since all schools got countries with exactly matching numbers. However, if we look at table 5 which represents the results of the second phase, we can see that some rows have negative values since in worst case scenarios, schools are assigned to countries which have larger number of representatives than their number of students.

If we look at table 6 which represents some of the school-country assignments of the MAL conference, we can notice that the table has a different structure than tables 4 and 5. The first five columns represent the same entities as before; but, the new added columns represent the additional countries that are assigned for the schools which still have remaining students. The number of these columns differs each and every time we run the software since they are added recursively, based on the need of the schools, and the maximum allowed number of countries per school. We can notice that, starting from column 6, we have the notation “country A/x” which indicates that after assigning country A, the school still has x students to be represented. The value of x is obtained by subtracting the number of representatives of country A from the previous value of remaining students. Please note that, for example, in the fifth column and fifteenth row, we have a value of -3 which means that country **Ghana** still has three places for it to be represented completely. If the country threshold is lesser than three, we disregard it; otherwise, we can assign Ghana to another school.

VII. CONCLUSION

United Nations (MUN) is an international simulation program in which students, known as delegates, represent countries from all over the world, do research, formulate positions, and conduct debates regarding regional and global issues. Through this academic competition, students get to participate in simulated UN diplomatic exercises, allowing them to acquire many skills including performing information research, public speaking, debating, critical thinking, team work, writing formal memos, and acquiring leadership skills. One of the upcoming MUN program initiatives is titled *Global Classrooms LAU MUN for Middle Schools*, co-organized with the Lebanese American University (LAU), and which is going to take place in New York in March 2016.

The Model United Nations Simulation Software allows helping organizing committee members to organize and process the data needed to launch MUN simulation exercises and conferences. It is used to come up with school-country assignments for different types of conferences: MUN, GCI MUN and MAL conferences, using adapted transportation

problem algorithms, namely the Minimum Cost optimization method. Each type of conference (e.g., middle schools, or high schools) has its own rules and requirements, with different interfaces and algorithmic designs. Two solutions for data acquisition have been suggested: External Excel sheets and internal imports from a database. The improvements we are aiming to do on the software include developing a mobile application for schools registration, and analyzing the data in the database over the years through visualization and data mining techniques.

ACKNOWLEDGMENT

This project was designed and developed in the context of my *Capstone* (Final Year Project) course, supervised by Dr. Joe Tekli, Assistant Professor in the ECE department, LAU. I would also like to thank Mr. Elie Samia, Assistant Vice President for Outreach and Civic Engagement (OCE) in LAU, as well as Ms. Ghina Harb with OCE and Mr. Alexander El Khawaja with GCIMS Model UN for their continuous support in developing this project.

REFERENCES

- [1] Marković, M. (2015, October 6). 2016 global classrooms international model united nations conferences. Retrieved from [//www.munplanet.com/articles/global-classrooms-lebanese-american-university/2016-global-classrooms-international-model-united-nations-conferences-q-and-a](http://www.munplanet.com/articles/global-classrooms-lebanese-american-university/2016-global-classrooms-international-model-united-nations-conferences-q-and-a)
- [2] (n.d.).Retrieved March 20, 2016, from https://en.wikipedia.org/wiki/Model_United_Nations..
- [3] Global Classrooms International Model UN Conferences. (2016). Retrieved March 20, 2016, from <http://www.gclaumun.org/GCI/gci.html>.
- [4] Maddah. (2005, December 20). the transportation problem (1). Retrieved from http://staff.aub.edu.lb/~bm05/ENMG500/Set_7_TP_a.pdf.
- [5] Shafaat, A., & Goyal, S. K. (1988). Resolution of Degeneracy in Transportation Problems. *Palgrave Macmillan Journals*, 39(4), 411-413. Retrieved from <http://www.jstor.org/stable/2582121>.
- [6] Hung, M. S., ROM, W. O., & Warren, A. D. (1986). Degeneracy in transportation problems. *Discrete Applied Mathematics*, 13, 223-237. Retrieved from <http://www.sciencedirect.com/science/journal/0166218X/13>.
- [7] The Assignment Problem and the Hungarian Method. (n.d.). Retrieved March 21, 2016, from http://www.math.harvard.edu/archive/20_spring_05/handouts/assignment_overheads.pdf.
- [8] Carnegie mellon university, G.A., A.S., M.D. (2007). The Dynamic Hungarian Algorithm for the Assignment Problem with Changing Costs. Retrieved 21 March, 2016, from https://www.ri.cmu.edu/publication_view.html?pub_id=5805.
- [9] The Transportation and Assignment Problems. (2008). *College of Management, NCTU*. Retrieved March 21, 2016, from <http://ocw.nctu.edu.tw/upload/classbfs121001503719748.pdf>.
- [10] Linear Programming Notes VIII – The Transportation Problem - University of California, San Diego. (n.d.). Retrieved March 21, 2016, from <http://econweb.ucsd.edu/~jsobel/172aw02/notes8.pdf>.
- [11] Winston, W. L., Venkataramanan, M., & Goldberg, J. B. (2003). *Introduction to mathematical programming: Operations research* (4th ed., Vol. 1). Place of publication not identified: Duxbury.
- [12] Transportation Problems. (n.d.). Retrieved March 21, 2016, from <http://personal.maths.surrey.ac.uk/st/J.F/chapter7.pdf>.
- [13] Balance An Unbalanced Transportation Problem By A Heuristic approach. (n.d.). Retrieved March 21, 2016, from http://www.academia.edu/6732317/Balance_An_Unbalanced_Transportation_Problem_By_A_Heuristic_approach.

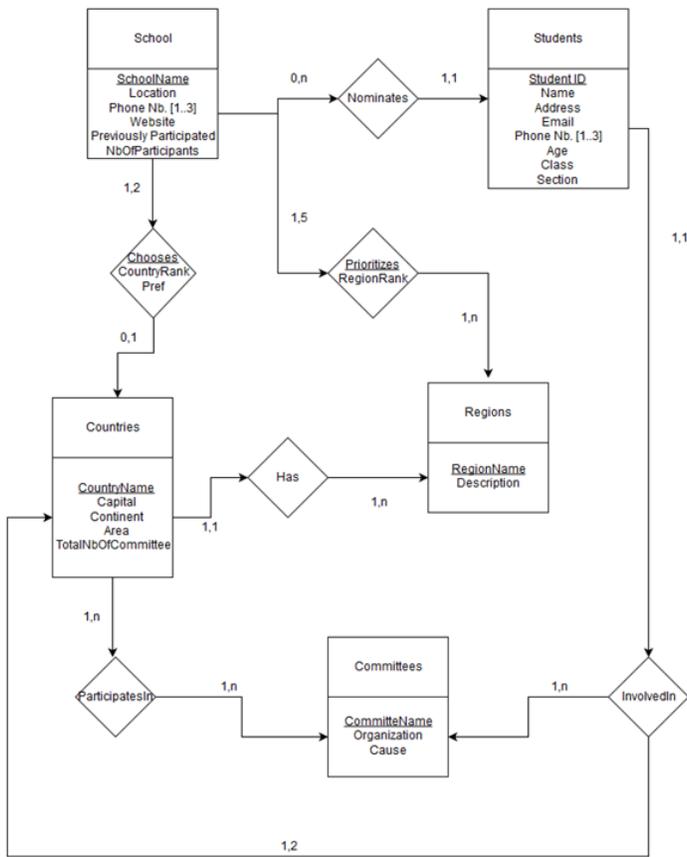


Figure1: Database Conceptual Data Model – Schema Level - Entity Relationship Diagram

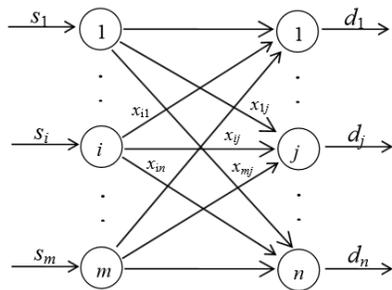


Figure 2: TP Network Representation

School / Country	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	...
School A	Inf	52	42	51	32	Inf	31	41	22	12	11	21	
School B													
School C													
...													

Figure 3: Example of a School-Country Matrix



Figure 4: GCI MUN Application Interface

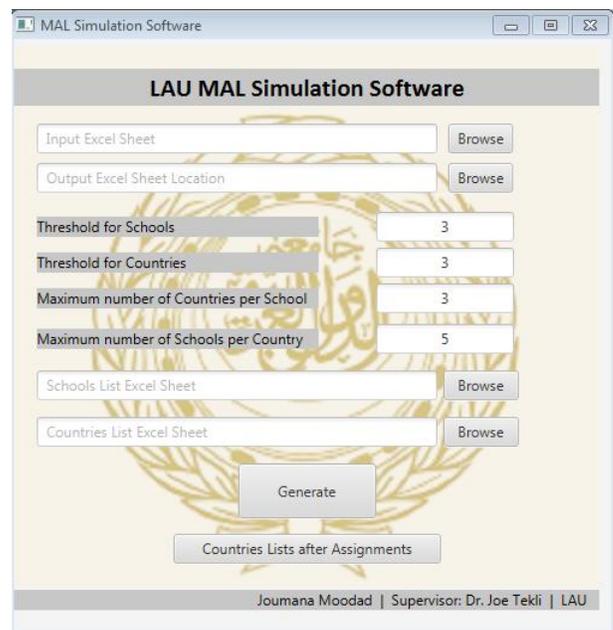


Figure 5: MAL Application Interface

Table 3: Example of Input Excel Sheet for a GCI MUN Conference

1	Official School Name	What	Region 1: Africa	Region 2:	Region 3	Region 4:	Region 5:	First Priority in Africa	Second Priority in Africa	First Pric	Second	First P	Second	First P	Second	First P	Second	Priority in West
2	School A	16	4	2	1	5	3	Kenya	Nigeria	India	China	Russia	Czech R	Brazil	Mexico	Sweder	Germany	
3	School B	12	2	1	5	3	4	Mali	Cape Verde	United Ar	Oman	Russia	Russian	Jamaic	Saint Kitt	Malta	San Marino	
4	School C	16	5	2	4	3	1	Kenya	Egypt	Japan	China	Czech	Poland	Brazil	Mexico	Denmar	Germany	
5	School D	16	5	2	4	3	1	South Africa	Egypt	China	Iran (Isl	Russia	Czech R	Brazil	Venezuel	United K	Germany	
6	School E	16	5	2	4	3	1	South Africa	Nigeria	Republic o	India	Czech	Croatia	Brazil	Mexico	German	Sweden	
7	School F	12	2	1	5	4	3	Mali	Togo	United Ar	Mongoli	Bosnia	Bosnia a	Saint K	Jamaica	San Mar	Malta	
8	School G	15	4	3	2	1	5	Guinea	Tunisia	Lebanon	Jordan	Ukraine	Romania	Argent	Chile	Luxemb	New Zealand	
9	School H	15	5	3	4	1	2	Gabon	Guinea	Qatar	Lebanon	Ukraine	Romania	Argent	Chile	Luxemb	New Zealand	
10	School I	14	5	4	1	3	2	Seychelles	Burkina Faso	Thailand	Philippin	Estonia	Slovakia	Costa R	Dominic	Iceland	Iceland	
11	School K	9	4	3	2	1	5	Lesotho	Lesotho	Kyrgyzste	Kyrgyzst	Lithuan	Lithuania	Nicarag	Nicaragi	Russian	Russian Federation	
12	School L	16	4	3	2	5	1	South Africa	Morocco	India	Iran (Isl	Russia	Czech R	Mexico	Colombi	United K	Germany	
13	School M	15	3	1	2	5	4	Tunisia	Rwanda	Saudi Ara	Jordan	Ukraine	Serbia	Argent	Chile	Luxemb	New Zealand	
14	School N	16	5	2	4	3	1	South Africa	Cameroon	China	Japan	Poland	Bulgaria	Brazil	Mexico	German	France	
15	School O	13	2	1	4	5	3	Ethiopia	Libyan Arab Jamahiriya	Kuwait	Indones	Hungar	Hungary	Trinidad	Guatem	Ireland	Ireland	
16	School P	15	5	4	1	3	2	Mozambique	Tunisia	Qatar	Jordan	Armeni	Ukraine	Chile	Argentini	Luxemb	New Zealand	
17	School Q	12	5	1	2	4	3	Guinea-Bissau	Togo	United Ar	Maldiv	Bosnia	Bosnia a	Jamaic	Barbado	Malta	San Marino	

Note: Please note that due to privacy requirements, the actual names of schools are not disclosed.

Table 4: Part of the Output Excel Sheet for School-Country Assignments (First Phase) – GCI MUN Conference

1	Name of the School	# of Students	Country Assigned #1	RepresentativesPerCountry	(-) Deficiency (in Nb. of Country Representatives) (+) Surplus (in Nb. of School Students) 0: Satisfied
2	SABIS® International School - Adma	16	Russian Federation	16	0
3	Beirut Evangelical School For Girls And Boys - Rabieh	12	United Arab Emirates	12	0
4	Collège Des Saints-Cœurs Kfarhab-Ghazir	16	Denmark	16	0
5	College Notre Dame De Lourdes - Jbeil	16	United Kingdom of Great Britain and Northern Ireland	16	0
6	College Des Saints Coeurs Ain Najm	16	Germany	16	0
7	West Hill College	15	Argentina	15	0
8	Collège De La Sainte Famille Française - Jounieh	14	Estonia	14	0
9	Al-Manar Modern School	9	Nicaragua	9	0
10	College Notre Dame De Nazareth	16	Czech Republic	16	0
11	Collège Protestant Français	15	Saudi Arabia	15	0
12	Makassed Islamic High School	16	France	16	0
13	Collège Notre Dame De Louaizé	13	Kuwait	13	0
14	Central College	15	Armenia	15	0
15	Collège Saint Joseph Antoura	12	Maldives	12	0
16	Rawdah High School	16	United States of America	16	0
17	Baysour Official Secondary School	11	Singapore	11	0

Table 5: Part of the Output Excel Sheet for School-Country Assignments (Second Phase) – GCI MUN Conference

1	Name of the School	# of Students	Country Assigned #1	RepresentativesPerCountry	(-) Deficiency (in Nb. of Country Representatives) (+) Surplus (in Nb. of School Students) 0: Satisfied
2	Beirut Al Horj Public School	16	Benin	16	0
3	College Du Sacre Coeur-Gemmayze	16	Botswana	16	0
4	Collège De La Salle - Kfaryachit, Zgharta	14	Burkina Faso	14	0
5	Antonine Sisters School - Jamhour	13	Burundi	13	0
6	The International School Of Choueifat	16	Cameroon	16	0
7	Komayel Official School	8	Sao Tome and Principe	8	0
8	Christian Teaching Institute CTI	16	Chad	16	0
9	Daughters Of Charity School Ashrafieh	16	Congo (Republic of the)	16	0
10	Ecole Sainte Rita	13	Djibouti	13	0
11	SSCC Bouchrieh	8	Tajikistan	8	0
12	Eastwood College Mansourieh	2	Micronesia (Federated States of)	2	0
13	Lebanese American School Las	12	Cape Verde	12	0
14	Batroun Official Secondary School	6	Namibia	6	0
15	Maroun Abboud Official Secondary School	15	Mozambique	15	0
16	Notre Dame De Moussaitbeh	6	Saint Vincent and the Grenadines	8	-2
17	Saint Sauveur College	8	Guyana	8	0
18	International College	16	Côte d'Ivoire	16	0
19	The National Evangelical School - Kab Elias	6	Timor Leste	10	-4
20	Cedars Cultural School	10	Solomon Islands	10	0
21	Al Imam Hasan High School	3	Kiribati	3	0

Table 6: Part of the Output Excel Sheet for School-Country Assignments – MAL Conference

1	Name of the School	# of Students	Country Assigned #1	RepresentativesPerCountry	(-) Deficiency (in Nb. of Country Representatives) (+) Surplus (in Nb. of School Students) 0: Satisfied	Country Assigned #2	Country Assigned #3
2	SABIS® International School - Adma	10	China	10	0		
3	Wellspring Learning Community	10	India	10	0		
4	Saint Joseph School-Cornet Chahwan	10	Germany	10	0		
5	Bishmazzine High School	10	Netherlands	10	0		
6	Bourj International College	10	Russian Federation	10	0		
7	Houssam Eddine Henri High School	10	Estonia	10	0		
8	Universal College Aley	10	Brazil	10	0		
9	International Learning Community	10	Ethiopia	10	0		
10	Tripoli Evangelical School For Boys And Girls	10	United States of America	10	0		
11	Armenian Evangelical Torosian School	6	Ukraine	6	0		
12	Beirut Modern School	10	Algeria	10	0		
13	Antonine Sisters School - Mar Elias Ghazir	10	Australia	10	0		
14	Brummana High School	100	Japan	10	90		
15	Beirut Evangelical School For Girls And Boys - Rabieh	7	Ghana	10	-3		
16	Phoenix International School	10	Venezuela (Bolivarian Republic of)	10	0		
17	College Notre Dame De Lourdes - Jbeil	10	France	10	0		
18	Jesus & Mary School	10	Spain	10	0		
19	Daughters Of Charity School Dar En Nour	10	Colombia	10	0		
20	German International School Beirut	6	Central African Republic	6	0		
21	College Saint Joseph Minara	4	Italy	4	0		
22	Collège Mariste Champville	6	South Africa	6	0		
23	Students' Paradise Secondary School	6	Egypt	6	0		
24	Collège Notre Dame De Balamand	50	Canada	6	41		
25	Adma International School	6	Switzerland	6	0		
26	College Du Sacre Coeur-Gemmayze	10	Argentina	6	4		
27	The International School Of Choueifat	6	Russia	6	0		