Stable Pairing Methods

Example of the SPM and SKM programmes at Corvinus University of Budapest

Donát Kim
Doris Tuanh Nguyen
March, 2014

Consultant:

Dániel Havran
Faculty of Finance, senior lecturer
# Contents

Abstract........................................................................................................................................... 3

1 Introduction ...................................................................................................................................... 3

2 Literature of the stable matching models ...................................................................................... 5

   2.1 The Gale-Shapley Algorithm ................................................................................................. 6

3 Advanced Level Study Programmes .............................................................................................. 8

4 The recent admission method ........................................................................................................ 9

   4.1 The programmes in numbers ............................................................................................... 9

   4.2 The questionnaire .................................................................................................................. 13

5 Criteria for admission test .............................................................................................................. 15

   5.1 Current admission test ........................................................................................................... 17

6 Our model ........................................................................................................................................ 19

   6.1 Input parameters .................................................................................................................... 19

   6.2 The method ............................................................................................................................. 21

   6.3 Measurement .......................................................................................................................... 21

   6.4 Simulation ................................................................................................................................ 22

   6.5 Our results .............................................................................................................................. 22

   6.6 The proposal ........................................................................................................................... 24

7 Extensions ........................................................................................................................................ 25

   7.1 Different assumptions on students’ preferences .................................................................... 25

   7.2 Preferences determined by other factors ............................................................................... 26

   7.3 Student types .......................................................................................................................... 26

8 Summary .......................................................................................................................................... 27

References .......................................................................................................................................... 28

Appendix ............................................................................................................................................ 30

   I. Questions for teachers: ............................................................................................................. 30

   II Questions for students: ............................................................................................................. 31

   III Measuring the change in places ............................................................................................. 36
Abstract

There is a crucial point to find an appropriate practice of admission for institutions in higher education. In this study we focus on a certain case, the entrance tests of the elective advanced level courses at Corvinus University of Budapest. The so-called IMP programme is a frame for extra studies which consists of advanced finance and advanced economic study programmes. The entry process selects students for more different levels and types of programmes for this study frame. Our example of the student and track matching process helps us to reveal the most common aspects which should be considered in preliminary examinations and in case of applications for admissions. The essay describes the aims and the application practice of the programme in order to provide a common ground for the discussion. We investigate the efficiency of the current testing method in two particular points of view. At first, because of an asymmetric information situation, the program management has to measure the competences of the applying students and their preferences about the programme. We analyse the predictive power of the entry scores. Secondly, we consider the process which matches the students with particular types of the programmes. Using simulation techniques, we apply some matching algorithms (based on Gale and Shapley algorithm) to analyse the stability and welfare effects of the process and to formulate our recommendations.

1 Introduction

This study outlines the critical parts of an admission test in higher education. Our aim is to highlight the problems that might occur in such a situation and find possible solutions. To do so, first we have to understand the current stance, with all the connections and the influence of the acts.

The first question is why it is needed to have admission tests. There are more answers for that. Universities and colleges want to select the right students for their study programmes. Additionally, they want to make this selection period short and effective. Most of the times, the mentioned institutions only have scarce resources. So their goal is to find a way to achieve good result with less effort.

These tests also provide a transparent system for admission, so that both teachers, both students could know what the expectations are. This makes it possible for students to prepare,
and for teachers to select fast. Teachers will have a best practice to use, a standard solution for the selection.

We also tested whether we could improve the adaptation of the stable matching algorithm of Gale and Shapley (The American Mathematical monthly, 1962) and get better results than the current one. However, to use their method, some corrections are needed to be done, as there are behavioural distorts in the preferences. To do so, we tested the hypothesis of telling the students their test results would make them choose wiser. To decide if it is better, we also have to determine what reasonable expectations a teacher or a student can have related to an entrance method. To do that, we asked both parties and set up a criteria list.

The entrance test should measure two aspects most importantly. One is the willingness of students to learn in the given area. The other is their competences to complete these studies. Both of these is needed for a student to be selected, as the programmes want members, who can finish the module and get a good average mark from their courses.

Our study starts with a brief summary of the related literature, to illustrate the importance and the actuality of the issue. Then we introduce our example, the way the concerned programmes and the related admission work currently. After that we present our model with all its assumptions, methods and results. Having done that raised new questions, which give a ground for further extensions, but answering these is not part of our essay.

We found out, that our hypothesis was proper, the extra information really made it possible to find a more optimal solution for students and the programmes, too. We believe that our results besides helping to improve this particular setting may offer solutions in other similar problems as well.
2 Literature of the stable matching models

After David Gale and Lloyd Shapley published their new algorithm in 1962 a new chapter was established in the literature of the stable matching problem (SMP). From the 70’s the interest in the subject still not reduced. In the following section our goals are not only to introduce the history of SMP literature, rather to present some of the main issues and questions of the area through the contemporary studies.

The main users of Stable Matching Model are those professionals who are responsible for drawing up the selection procedures especially for university entrance. In the “A survey of international practice in university admissions testing” study Edwards, Coates and Friedman [2012] summarised “how admissions tests are used in different higher education systems around the world” They categorized the countries in three groups. The first one is where the general admissions test is run by the government or a government body and it is the only measure for university admission. In the second group the admission test plays a dominant role in the determination, but it is not the only criteria (e.g. the secondary school result mattered). Finally in the third group the countries universities can choose the admissions test, there is no centralized test. They found that centralized admissions tests can bring advantages due to predictability, but they put a great amount of pressure on candidates to succeed. However, it can be offset by the outcomes with school results like in group two.

Even though we focused on Gale-Shapley algorithm there are many different stable matching models. Much research has been conducted about the reveal differences. For instance Pais, Pinter and Vesztég [2011] study focused on the difference between Gale-Shapley mechanism, the Boston mechanism and top trading cycles mechanism (TTC mechanism). In the paper they analysed the recruitment of the teachers at schools. They were interested in different models outcomes stability, the efficiency levels and agents truth telling under different information levels. They found that having more information about others’ preference reduce the chance to demonstrate their true preferences. Comparing the three models they recognized TTC mechanism is clearly better in terms of efficiency and stability than Boston mechanism or Gale-Shapley, since TTC is less sensitive to the information. These are the same result as Pais and Pintér [2008] presented for the school choice model, but it differs in intensity.

Selim and Salem [2010] study is another instance that insufficient information could cause different output. They compared the Egyptian education matching system with Gale-Shapley
algorithm. In the Egyptian education matching mechanism after the students get to know their scores they have to express their preferences before they know anything about the minimum admission scores for each college at each category. The college bases their minimum admission scores on the demand of the students. In Gale-Shapley the college has to announce its preferences before knowing students preferences. All students, whose points are equal to or higher than their preferred college minimum points, are guaranteed the admission. Against the Gale-Shapley mechanism the Egyptian is neither Pareto efficient nor strategy proof, but it is fair as Gale-Shapley mechanism as well.

It is not incidental that students take the first bid or universities make the first offer. From Viriyakattiyaporn [2007] study a student-optimal stable mechanism and a college-optimal stable mechanism was compared. He found out that student-optimal stable mechanism still makes it a dominant strategy for every student demonstrated their true preferences, the college-optimal stable mechanism is far from being certain that telling the true preferences will be the dominant strategy. So the student-optimal stable mechanism has less objectionable properties, than college-optimal properties they conclude that student-optimal mechanism is more preferable.

In the remainder of our essay we seek to answer about these outcomes, to face also with the SPM and SPM-IMP programme, and depending on that fact what would be the best recording system.

2.1 The Gale-Shapley Algorithm

Our model based on the best-known method, the Gale-Shapley mechanism. The Gale-Shapley algorithm became well-known not undeservedly. Owing to the model novelty and penetrating power in 2012 The Prize in Economic Science by Sveriges Riksbank was awarded to Lloyd Shapley and Alvin Roth "for the theory of stable allocations and the practice of market design" (RSAS[2012]). In the list of the “Nobel-Prize” explanatory memorandum Gale-Shapley algorithm take the first place.

Originally in 1962 David Gale and Lloyd Shapley proved that, that any equal number women and men can be matched, while respecting their individual preferences, and additionally make all the marriage stable. They used marriage just as an illustrative example. The Gale-Shapley algorithm real-world relevance started in early 1980’s when Alvin Roth published a study about the market of the newly graduated and job-seekers doctors in the USA, which was a
very similar allocation problem. After that the Gale-Shapley algorithm occupied an important place – not just in theory – but became the basis for worldwide recruitment procedures, although some other methods performed better on some issues.

In our model each student reports their preferences over the programme, and each programme reports its preferences over the students. Thenceforward each student makes a bid to the first ranked school according to his preferences. Each school keeps the best ranked student according to his preference until positions have elapsed, while denied the worst ranked student in the level of oversubscription. Those students who had been disapproved in the previous round make a bid to the next school according to their preference. The school compares the emerging students with the previous round charged student portfolio, and the worst ranked students are denied in the level of oversubscription, whereas the remaining student are kept on hold. This process continues until all slots are recharged or all students are consumed.

One of the most common criticisms about the Gale-Shapley algorithm is that one of the participants does not enter their real preference, could achieve a better result for them. Pais and Pintér (2008) revealed that the amount of information has a negative effect on participants telling their true preferences under Gale-Shapley mechanism.
3 Advanced Level Study Programmes

This section, presents the three advanced level track in Finance and Economics at Corvinus University of Budapest, which are relevant for this study. These are the examples, where we test the efficiency and the effectiveness of entrance test methods.

At the base level, there is SPM, which acronym stands for Advanced Studying Programme in Finance and Mathematics programme. Its aim is to provide students in the Faculty of Business Administration or Economics an opportunity to get a deep knowledge in this area. That is to say, this programme was created for those, who want to have a career in finance and a competitive advantage by being familiar with the quantitative methods (CUB [2013]).

To reach this goal, the financial theories, the necessary mathematical and statistical tools are taught, while evolving a financial perspective, too. For those students, who want to learn more, SPM-IMP offers a more intensive track to study Economics. Even though its basis is the SPM programme, it has extra classes. The courses IMP (Intensive Methodological Programmes) provide development in the advanced methodological way of thinking. It is also stronger in the economic field. However, one who only applies for SPM still has a chance to take up some of the mandatory courses of SPM-IMP (CUB [2013]).

And last but not least, there is also SKM-IMP. It is similar to SPM-IMP, nevertheless, its focus is economics instead of finance. In practice it means that subjects like micro- and macroeconomics are more emphatic. Another difference is that only students in the Faculty of Economics can apply to SKM-IMP. Also, on the contrary to SPM, SKM-IMP did not form a separate programme; it remained in the frame of IMP (SKMD [2013]).

To graduate, all the mandatory courses of the programme that the students have admission to have to be done. If they accomplish it, they get a certification. This also means that if someone only applied for SPM, but done all the courses of SPM-IMP, will not receive a
certification of completing IMP. On the other hand, one applied for SPM-IMP can get a certification of SPM without having all the courses of IMP done as well.

Not getting a certification not necessarily means a failure at the programme. The reason is that they can still profit from each and every course they applied to. Not to mention, they get the possibility to be a member of a cohesive community. Nonetheless, in this essay, to make it easier to define, only students completing all the compulsory courses are considered as ones successfully having done the programme.

In our definition the others are dropped out. They failed to finish the programme and/or left it earlier. To emphasis, it is not always a defeat, and it also does not mean that these students were selected falsely for the programme. We do not want to judge or downgrade students by putting them into this category. We just need this, because there are no better objective signals for success.

4 The recent admission method

No solutions can be found before defining the problem and analysing the initial situation. To examine what the problem is, we choose to method for exploration. At first we did an empirical analysis about the correlation between admission points and grades of the students. Secondly, we collected and evaluated student and teacher feedbacks to figure out how efficient the current admission method is. This second part is also important, because we are trying to test behavioural and psychological effects as well, so the subjective information are just as conducive as the quantitative ones.

4.1 The programmes in numbers

We analysed the historical data to find out whether there are indicators for the students future performance. This performance can be defined with the average of the marks they get for the courses they took, or the probability of finishing the program they applied to. Our database – which was requested from Dániel Havran – is based on information from the 2008/09 academic year to 2012/13 academic year including 268 students. Yet it should be stated, that we only have full information from two grades, in total, full data were obtained from 116 students. The entrance test was introduced in the academic year 2009/10, so there weren’t any admission points earlier. Who started in 2010 just finished the program at the end of 2013.
1. speardsheet - The programmes in numbers

<table>
<thead>
<tr>
<th>Started SPM and finished it</th>
<th>Numbers</th>
<th>Entrance point</th>
<th>Average</th>
<th>Average of the first-year math mark</th>
<th>Average of first-year microeconomic mark</th>
<th>Men-women rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Started IMP and finished it</td>
<td>40</td>
<td>6,96</td>
<td>4,28</td>
<td>3,75</td>
<td>4,15</td>
<td>21 male 19 female</td>
</tr>
<tr>
<td>Started SPM and finished IMP</td>
<td>3</td>
<td>5 (1 student)</td>
<td>4,08</td>
<td>4</td>
<td>-</td>
<td>2 male 1 female</td>
</tr>
<tr>
<td>Started IMP and finished SPM</td>
<td>19</td>
<td>5,78</td>
<td>3,85</td>
<td>3,53</td>
<td>4</td>
<td>11 male 8 female</td>
</tr>
<tr>
<td>Started SPM and leaved it</td>
<td>27</td>
<td>3,79</td>
<td>2,78</td>
<td>2,36</td>
<td>-</td>
<td>11 male 3 female</td>
</tr>
<tr>
<td>Started IMP and leaved it</td>
<td>26</td>
<td>4,17</td>
<td>2,51</td>
<td>2,32</td>
<td>2,13 (16 student)</td>
<td>17 male 9 female</td>
</tr>
<tr>
<td>SPM student</td>
<td>50</td>
<td>4,17</td>
<td>3,29</td>
<td>2,62</td>
<td>3 (5 student)</td>
<td>23 male 27 female</td>
</tr>
<tr>
<td>IMP student</td>
<td>89</td>
<td>6,01</td>
<td>3,46</td>
<td>3,25</td>
<td>3,25</td>
<td>64 male 25 female</td>
</tr>
</tbody>
</table>

Over the five years there were 174 students, who have started the SPM-IMP programme, and 94 students, who have started SPM, but only 47 SPM and 43 SPM-IMP students had finished them. (From 2008 to 2010 there were 103 SPM-IMP and 60 SPM starters.) It is common that some of the student start SPM-IMP and finish only the SPM part (19 students), but it is unusual that someone starts SPM and finishes the IMP part too.

As expected the successfully graduated students get the highest points from the entrance test and the programme leavers have the fewest point. The students’ average and the marks of the first-year classes from the programme are also very similar. Those students who will leave the programme generally have more confusing mathematics knowledge and they perform worse in the first semester as well. We could recognize that IMP students not just have more entrance test points than SPM students, but they get better marks too, since they have more course than SPM students. The entrance points and average of those who are currently in the programme are between leavers and alumnus, as it was suspected.
From the programmes subjects the lowest average was in mathematic I. course (3.06) and the highest average was in mathematic IV. course (4.61). In addition, the distribution of mathematic I course marks are the most similar to bell-shaped curve despite the fact that it has the smallest standard deviation (1.04). The average of the average of the student is 3.44, but the standard deviant is almost equal (1).

A more sophisticated approach to examine this question is to use linear regression. For the purpose we choose Eviews7 statistical program, and least squares estimated regressions as models. We tested many variations, chose different explanatory and dependent variables. In the next session we are only focusing on the main results.

In one of the models we set up, students’ test score, microeconomic mark and mathematic mark are the explanatory variables. The output data is what indicates the finishing of the course. There were many factors included in the model. Nevertheless, not all of these were statistically significant, including gender and faculty.

2 spreadsheet - Connection between test results and finishing the programme

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-0.598239</td>
<td>0.403591</td>
<td>-1.482292</td>
<td>0.1383</td>
</tr>
<tr>
<td>Admission test result</td>
<td>0.273738</td>
<td>0.076034</td>
<td>3.600188</td>
<td>0.0003</td>
</tr>
<tr>
<td>McFadden R- squared</td>
<td>0.136889</td>
<td>Mean dependent var</td>
<td>0.798165</td>
<td></td>
</tr>
<tr>
<td>Prob(LR statistic)</td>
<td>0.000107</td>
<td>S.D. dependent var</td>
<td>0.403224</td>
<td></td>
</tr>
</tbody>
</table>

According to this result (spreadsheet number 2) 13.7 per cent of the variance in students’ finish success (in terms of their score points) can be explained by the significant predictors above. The relationship between score points and chance to finish the programme was less strong for SPM students and was stronger for SPM-IMP students. We add mathematic I mark as an explanatory variable too, since from the reports it is proved to be good forecaster for the success of students’ accomplishment.
### 3 spreadsheet - Connection between admission test results, Mathematics mark and finishing

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-3.449333</td>
<td>1.140250</td>
<td>-3.025067</td>
<td>0.0025</td>
</tr>
<tr>
<td>Admission test result</td>
<td>0.369726</td>
<td>0.155486</td>
<td>2.377878</td>
<td>0.0174</td>
</tr>
<tr>
<td>Mathematics 1</td>
<td>1.093216</td>
<td>0.386217</td>
<td>2.830574</td>
<td>0.0046</td>
</tr>
<tr>
<td>McFaddan R-squared</td>
<td>0.227389</td>
<td>Mean dependent var</td>
<td>0.798165</td>
<td></td>
</tr>
<tr>
<td>Prob(LR statistic)</td>
<td>0.000004</td>
<td>S.D. dependent var</td>
<td>0.403224</td>
<td></td>
</tr>
</tbody>
</table>

In this model (spreadsheet number 3\text{Hiba! A hivatkozási forrás nem található.}) 22.7 per cent of the variance in finishing chance can be explained by the significant predictors. We run a model when students’ average is the output. Presumably who has better average predictably is more likely to finish the programme. In this favour we have more data and could show the performance, and plot them on a scatter matrix to see the positive correlation between them.

#### 2. figure Relation between the admission test point and average

![Scatter matrix showing relation between admission test point and average](scatter_matrix.png)
4 spreadsheet - Connection between admission test result and average

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>2.617224</td>
<td>0.155947</td>
<td>16.78282</td>
<td>0.0000</td>
</tr>
<tr>
<td>Admission test result</td>
<td>0.167096</td>
<td>0.026242</td>
<td>6.367559</td>
<td>0.0000</td>
</tr>
<tr>
<td>R- squared</td>
<td>0.159287</td>
<td>Mean dependent var</td>
<td>3.539218</td>
<td></td>
</tr>
<tr>
<td>Prob(F-statistic)</td>
<td>0.000000</td>
<td>S.D. dependent var</td>
<td>0.926079</td>
<td></td>
</tr>
</tbody>
</table>

Despite the data seemingly co-movement (figure number 2) we could see this regression analysis (spreadsheet number 4) implies that only 15.93 per cent of the average of the subject in the programme of a student can be explained by the score they got at the admission test. To sum up the statistic, we can figure out that entrance test result is significant, but it can’t forecast accurately that who will perform well during the programme. In the model the taken mathematic knowledge, that the test can measure, is less than fifth of the explanatory variables.

As a conclusion, the points they get in the current entrance test can only forecast a little part of success. Success as we defined in this case can be measured by the average mark they get, or by completing all the mandatory subjects. As these are not random mass phenomenon, we cannot simulate performance for models that we set up. So we cannot run the same statistics for our simulated data. That is the reason why we are focusing on the possible weaknesses of the admission’s method.

4.2 The questionnaire

It would be difficult to give a comprehensive picture of the programme and its recording system without knowing the students reviews. To get to know their opinion the most workable way was to convey them a questionnaire. Altogether 115 students have filled it out. The number of students and alumni in total is 270. In the test three categories distinguished: currently the programme participants (73 of them), alumni who completed the programme (31 of members) and students who left the programme (11 of them). We summarized the key data in the following spreadsheet (spreadsheet number 5).
An unexpected result is that leavers’ entry points are higher than current students’ entry points. This means that the test could not filter well that who will leave the program or who will remain. Although it does not mean that the test was inadequate. For instance the motivation of the students could change during the time or they might have better options. The statistical part also shows that entry points are significantly higher for students who will successfully complete the program. The result of the questionnaire might defer due to the insufficient information. It can mean that students were not given the correct information, or the result distorted because of the sampling. (E.g. those leavers answered the questions that were more active and leaved SPM programme for personal reasons).

Both teachers and most of the students agree that – properly to its name – to complete the advanced level modules, more time and energy is needed compared to the basic education. (Száz and Havran [2014]) In the questionnaire there is no big difference between the averages and the estimated difficulties. The entire three groups thought the programme will be quite hard and their expectations fell. Yet, there is a significant difference among contentment. Those who left the program were less satisfied, usually mentioned that they had to study unnecessary things for their future career as a reason for leaving the programme. A returning resentment was that the programme should be more organized and the university should recognize the extra work more.

In our point of view, it can be interpreted as the effect of lack of information causes. When these unsatisfied students applied, they were uninformed about the subjects they would have to deal with. They might also have not been motivated enough to get extra knowledge by

---

### 5 spreadsheet - Questionnaire

<table>
<thead>
<tr>
<th></th>
<th>average entrance point</th>
<th>how difficult they thought the program would be before they started it</th>
<th>how difficult they think the program is now</th>
<th>average of their study marks</th>
<th>satisfaction level</th>
<th>would they recommend it to a friend?</th>
</tr>
</thead>
<tbody>
<tr>
<td>current students</td>
<td>5.26</td>
<td>7.25</td>
<td>7.6</td>
<td>4.01</td>
<td>7.48</td>
<td>yes (95%)</td>
</tr>
<tr>
<td>alumnus</td>
<td>-</td>
<td>7.30</td>
<td>same/bit more difficult than they thought</td>
<td>-</td>
<td>-</td>
<td>yes (100%)</td>
</tr>
<tr>
<td>leavers</td>
<td>6.36</td>
<td>7.64</td>
<td>7.54</td>
<td>3.9</td>
<td>5.73</td>
<td>yes (55%)</td>
</tr>
</tbody>
</table>
investing extra work in it. Acknowledgement of the university could have been an incentive for them to keep on working.

Teachers’ opinion about this issue is that although students do not know exactly what they apply for, they are aware of the fact that this programme means that they have to learn more and that it is connected to Mathematics. They already have an idea of what Mathematics is, so this part should not be a big surprise. They apply because they expect the basic education in this field to be not enough for their future career, and they want to signal their willingness to learn more (Száz and Havran [2014]).

On the other hand, beside the dissatisfaction, students mostly appreciated the plus knowledge the modules provided and the better learning opportunities. As a result of the small group, students had classes with almost the same people. This made it easier for a small intimate community to be formed, which they really enjoyed. To summarize, it seems from the questionnaire that the decision is more important than the differences in ability.

As another counterpoise, teachers state that students from these programmes are much better in attitude and in knowledge too: both those who are still learning, and those who have finished any of these. This means that the teachers work and the incentive community helped the students to improve. And also the testing method used at the admission cannot be completely inappropriate. We do not have to make radical changes, only little improvements.

5 Criteria for admission test

Before really testing any algorithms, we have to define our aims. First of all, we want to have the right students at the right place. To find out who we can call a ‘right student’, we made an interview with János Száz, who is the academic director of the SPM programme, and Dániel Havran the managing director. They both agreed that those, who want to have a Masters degree in this field or later on a carrier, should take part in advanced level modules. However, they also have to have certain competences, mostly logical and analytical skills. Besides that, another important factor is their interest. If they are not willing to learn more, or this programme will not be able to help them to improve, even if they have the competences.

Now that we know, who we call a right student, let’s take a look at the ideal numbers for each programmes. Although both teachers want to give the opportunity to all the competent students, the capacity constraints give a limit. These constraints come from the size of the
groups, which are optimal for a pedagogical intent and the number of teachers. For the IMP programme the maximum is 60 people, which includes the SPM-IMP and the SKM-IMP participants. The experiences understate that the optimal is to provide 45 places of these 60 for SPM-IMP members, and the rest goes for SKM-IMP. For SPM a limit of 30 was proved to be optimal. We are using the same numbers in our model as well.

To build up our model, we first need to specify our expectations. We want to find a method that is effective and efficient all at once. People often mix up these two expressions, so we find it important to define their meanings. To do that, we used Random House Webster’s College Dictionary as a basis.

We call something effective, if it produces the desired effect. In this situation, our method would be effective, if we could reach all the students, who might be interested and competent for the programmes. This is not exactly what the method can have a big influence on, as students apply mostly because of the programme and the entrance test is not usually an aspect. The effect the process may cause is deterring students from applying, if it is too difficult or complicated to effectuate.

Comparing to this, efficiency is almost totally dependent on the selection method. Efficiency means getting a certain result with minimal effort. That is to say, in this case we want to select the right students in an easy way. We do not want to commit alpha error and accept students who do not meet the criteria. Type II error is to be avoided as well: we do not want to reject the ‘right students’. Minimal effort can mean short time period for the selection, or as less work from teachers as possible (e.g. tests that are easy to correct).

After defining what we want, we also have to find a way to measure it. In our case there is a test, which is created to measure the competences of the students. Questioning the content of these exercises is not part of our study. Another property that we had to measure is the willingness of the students to learn more during their ensuing few years. Attending at the test and applying for the courses after getting admission to a programme can be a good signal for this.

Furthermore, as we already mentioned, performance cannot be simulated, so we will consider a method operating, if the students’ and the programmes’ preferences meet. Students might not get in the programme they wanted (more), or a programme might not get the student with
the highest points, but neither side could get into a better situation without making someone’s status worse. So our aim is to reach a stable, Pareto-optimal state.

5.1 Current admission test

To get an admission to any of the programmes mentioned, students have to apply for a test, which is held before starting their first week at the University. This is a written exam, where students have to solve 10 problems in mathematics. It tests their capability mostly and also some of their skills. The emphasis is on their logic instead of what they have learnt before. They also have to declare their choice between the programmes before getting to know their points.

On the same day, after a few hours, the results are announced. The maximum they can get is 10 points. If the point is above a certain level, they are offered to join IMP. If someone really wants to get in IMP, but did not get a needed result, still has a chance to have an oral discussion. The same goes for those, whose points are too low, but still want to join SPM. This part is more like a small conversation, to get to know the level of their motivation. They can only be considered, if the number of the admitted students is not significantly over the limit, which is 15 people for SKM-IMP, 45 for SPM-IMP and 30 for SPM. This significance level can be permitted, as some of the admitted ones may leave and the capacity constraints are loose, too.

Once they are accepted, they only have to take up the courses in the electronic system of the University, called Neptun, to start the programme. Missing this equals to unregistering the programme and has no other consequences. Later on, there is still an opportunity to leave the programme, but there might be some complications with the acceptance of some subjects, such as Mathematics and Microeconomics. This can also cause a slip in the time of education by making plus one more semester necessary.

In the followings we will not consider SKM-IMP as an option, as only those who study at Faculty of Economics can take up its module. (And when we say IMP, we mean SPM-IMP.) Our questionnaire also proved that most of the ones from this Faculty, who applied to any of the programmes, are attending SKM-IMP. Those who wanted to take part in this programme but could not achieve enough points for admission may still study at SPM, but we do not want to separate them from any other applicants of SPM. The reason is that it cannot be called a substitute programme, as one of the main focus is different (studies in finance cannot replace
the ones in economy). There are the ones who could get into SKM-IMP, but wanted to learn in the frame of SPM or SPM instead. For them we could say SKM-IMP is not an option, so they are not needed to be treated separately either.

In the current model, the preferences in the point of view of the programme are defined as, the higher one’s points are, the more chance this person has to be accepted. They will be offered IMP, and after that students can choose whether they accept it, so we can say it is the programme optimal version of the Gale-Shapley algorithm. This means that no programme could change any of its students to one with higher points, who wants to take part in it.

It would be a student optimal version, if they were divided into groups by their preferences in the first round. So everyone could apply for the programme closest to their favourite. After that the programmes decide who they want to accept conditionally and who they reject permanently. Students, who did not get an admission, yet, may apply to the other ones, and programmes will choose which applicants to keep. After this round everyone has found their place, and no students could take up a better programme than they already have.

There could be a situation where they get to know their points and want to change their choices. In our questionnaire 18 students out of 115 claimed that the points they got defined the choice they made. This leads us to the main problem, we are focusing on. Gale-Shapley method cannot be applied efficiently in this situation, since the preferences are not clear, and in our model we are making corrections so that we get to know the effects.
6 Our model

6.1 Input parameters

Declaring the preferences can be hard. Mostly for freshmen students, who do not have the knowledge yet to decide what they really want. We asked the ones accomplished their chosen module and only 47% claimed that they were aware of what they applied for. Because of this uncertainty of the students, we introduce a simplification in our model. We suppose that they give themselves a score ($\hat{y}$), according to what they think of their abilities and this determines the choice they make. If their abilities can be measured by a number theta, on a zero to ten scales, they give themselves a point appropriate for the expected value of their real competences:

$$\hat{y}_i = E[x_i|\Theta] + c_i,$$

where $c$ is a constant. This is the bias students make when it comes to self-evaluation. This number can vary in according to their personality. In our model we will assume there are three types of students. For one type $c$ is always zero, for the other $c>0$, and for the last group $c<0$.

Besides this there is the test result ($y$) they get.

$$y_i = E[x_i|\Theta] + \epsilon,$$

where $\epsilon$ is the error: a random member with the expected value of zero. The standard deviation of $\epsilon$ can be calculated from our regression between the averages and the test results. If the value of this error is positive for some students, they might had a lucky day, and wrote a better tests than they really could, if we only look at their competences. With the same logic, if it is negative for some students, that could be interpret as a result of a bad day, or any other external factors.

It is also a psychological fact that people in general are not always good at evaluating competences, especially at the case of self-recognition. (Dunning, Johnson, Ehrlinge and, Kruge 2003) In this study we assume that there are three types of students: the overconfident ones, the defeatists and the realists. Our definition will be very simple. If someone’s $c>0$, we call this person overconfident, as this student thinks that he or she is better, than he or she really is. For a realist students their own rating would match the reality, so in their case $c=0$. And lastly if a student’s $c<0$, we define the person as a defeatist. To make it close to reality, we used the results of the questionnaire to estimate their proportion.
The preferences are determined by the points they gave themselves. They will choose IMP, if this point is higher than the point limit they expect (L). Otherwise they will favour SPM. It also implicates that we assume that the only difference between the two programmes is that IMP is harder, but the same people are interested in both. And all students want to choose the programme that is the most suitable for them and the points reflect it.

For starters, let us take a look at a method, where students have to declare their preferences first. After that they compare it with their real performance to match the students with the programmes, where the real performance reflects the programme’s preferences. It is exciting to compare the results of this process with the one, where students’ preferences are determined by their real points, too. In practice, this second version means that applicants only have to declare where they want to go, after they announced their results in public. It is obvious that in this situation the preferences of both sides will be the same, and it will be optimal in any point of view. 45+30=75 students with the highest points will get in. The students with 45 highest points will be the members of IMP, and the remaining 30 will join SPM.

To make the comparison, we normally distributed random variables for the value of theta, as the distribution of older test results were close to normal. We used the empirical mean and standard deviation to get similar points. The numbers higher than ten were replaced with ten, as we thought if someone could achieve more than ten points, this person would still just get ten on the test. The same is true for the negative numbers, they are replaced with zero. The software that enabled us to simulate these points was MS Excel with its built-in functions.

The next step was deciding the value of \( c \). As we could not measure this, we tried to place values from one to four in this variable. We stopped at four because we think that it is not really realistic for people to be that wrong about their ratings.

An epsilon was also needed to generate the test results. We chose to apply normal distribution again, as most of the similar phenomenon follows this distribution. The mean and the standard deviation of this variable were explained before, so we have all data to use MS Excel’s function to simulate these numbers.

Getting to the preferences, L is missing from the model. We assume that since everyone could hear all the results, they can estimate the value of L, and this is the same for everyone:
\(E[L]=L\). Or we can also say that teachers tell all students the value of \(L\), it will lead to the same result.

### 6.2 The method

All student have an internal rating \((\hat{y})\), what they think of themselves. As we stated, this determines their preferences: if \(\hat{y} \geq L\), they will apply for IMP, if \(\hat{y} < L\), they only choose SPM. Obviously their second choice will be the other programme. We paired the students and the programmes in student and in programme optimal version, too.

Let’s see the programme optimal situation first. In this method, we sort the students by their real points \((y)\), starting with the highest to the lowest. After that we use a filter, and only look at those who have IMP as their preferred programme. The first 45 are selected, they got in. The next step is filtering those, who chose SPM at first place and the first 30 are accepted.

If we imagine the student optimal version, we filter first, and sort the points after. A student has the same points for both programmes, so in this situation it does not matter which party’s preference we start with. It will give the same results and will be optimal for both. So only testing from one side is enough.

The hypothesis we want to test is whether telling the students their results would help their decision to become more consistent with their real competences \((\Theta)\). In this case they choose preferences almost the same way as before. The difference is that they use \(y\) instead of \(\hat{y}\). And the results were already discussed.

### 6.3 Measurement

We compared the results to test whether students can choose wiser by letting them know their results, providing extra information for them. Two indicators were selected to measure if it is recommended to tell them their results.

The first one was the average of the differences in the average of the SPM-IMP members’ points. This might sound difficult at first, but it is pretty simple. We took the students, who were accepted to SPM-IMP in one of the method and calculated an average of their points. We did the same for the ones in the other method, too. Then we compared these numbers and calculated their difference. We had many simulations, with newly generated input data and did the same for all the results. When we got many numbers for the differences, we computed their average.
The other indicator is the cumulated change in the ranking. When we compared the results, there were students, who did not get in the programme they wanted to, but with the new algorithm, they did. For example he was the 32\textsuperscript{th} student for SPM in the first method, and 28\textsuperscript{th} in the second one. It means that his improvement in situation is 32-28=4 places. For each scenario we cumulated these numbers for those whose acceptance changed. Then we calculated an average for the cumulated value.

6.4 Simulation

As we mentioned, we wanted to test more scenarios. First, we wrote some subroutines. One of them helped us do the pairing; we selected the students for SPM-IMP and SPM. From the output data the average scores for each programme was easy to calculate with the built-in function. The change in the situation was a little bit harder; so we wrote our own algorithm for that (which can be found in the Appendix). After these steps, one scenario was simulated. To have more scenarios, we used another subroutine that used this one, as well. We run this test for fifty times and calculated an average from the indicators.

6.5 Our results

In the test we had more variations depending on the value of the constant $c$, which determines the internal ratings of the students. We are going to present the results for the basic model (where $c$ is either -1, 0, or 1 depending on the students’ personality) first, then give a conclusion about what happens if we change our assumptions on students self-evaluation. We used this value for $c$, to test whether a small bias like this could make a big difference in the result. Later on we used higher values as well to compare the results.

6.5.1 The results of the basic model

The average of the SPM-IMP members’ scores was higher with the second method for all the scenarios. Obviously, this means that the average was higher, too. The interpretation of this from the programme’s point of view is that telling plus information to the students is much more efficient. They accept the ones with higher points, which mean the result is closer to their preferences. The same could be said from the students’ perspective, if we accept the presupposition that the points reflect all the factors that could influence their choice.

The mean of the average points of the SPM members was lower when students got extra information about their rating. Nonetheless, the difference was only 0.17 points, which is
quite low compared to 0.41 points difference in SPM-IMP. In this case, in some scenarios the point was lower with the first method, yet in some scenarios it was the other way round.

The results are not really surprising: the ones with higher points got into IMP with the second algorithm. They probably were in SPM before, and as they got into IMP, they increased the average score of that programme, and decreased SPM’s. Yet, the scores of SPM did not necessarily drop, because the ones who were in IMP before, but could not fit in anymore because of pulling up the average by new members.

The cumulated change in the freshly accepted students’ situation is always 0 points for IMP. It was expected, as we defined their preferences this way. Because if they think that their competences are not enough, they will not prefer that one. In this aspect, they are rational. They know the acceptance point limit and the distortion in their self-evaluation is quite low. So the results of the two situations are close to each other.

For SPM the result is different. They do not have information about the acceptance limit for SPM, so everyone who does not favour IMP chooses SPM. There will be students, who want to get in, and only the new method enables this. In our test, this was true for 32% of the outcomes. The maximum cumulated value was 25 places, and the average for all the tested scenarios was 2.68. This means remarkable improvements can be obtained by informing the students before making them decide which programme they want to apply to. Not only because there were ones, who could deserve to get in to SPM, but could not with the standard version, but also because many students changed their preferences (almost 20%), which means they could choose a programme that is more suitable for their abilities.

All in all, providing extra information for students can lead us to a more optimal solution. This matching is better for both programmes and fairer for students, too. Every stakeholder of this issue can be more satisfied with the results, then with the algorithm before.

### 6.5.2 Different student self-evaluation

If we increase the value of $c$ constant – so we make the students’ internal rating more distorted – than the results are more interesting. The differences in the IMP averages get bigger as the $c$ increases, except for the version where the bias is really high. The numbers can be seen in spreadsheet numbers. On the other hand, for SPM difference of the averages vary from 0.08 points to 0.17 points. The cumulated change is still 0 points at IMP, and at SPM the values change the opposite way compared to $c$. Not only the maximum value of the cumulated
improvement, but also the number of cases where this phenomenon can be found is decreasing (last column of the spreadsheet). These two effects make the average lower, too.

1 spreadsheet - Comparing results

<table>
<thead>
<tr>
<th></th>
<th>IMP average (points)</th>
<th>difference (points)</th>
<th>SPM average (points)</th>
<th>difference (points)</th>
<th>cumulated change in places</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>basic</td>
<td>new</td>
<td>basic</td>
<td>new</td>
<td>IMP</td>
</tr>
<tr>
<td>1</td>
<td>8,39</td>
<td>8,80</td>
<td>7,27</td>
<td>7,10</td>
<td>- 0,17</td>
</tr>
<tr>
<td>2</td>
<td>8,16</td>
<td>8,83</td>
<td>7,24</td>
<td>7,15</td>
<td>- 0,09</td>
</tr>
<tr>
<td>3</td>
<td>8,08</td>
<td>8,85</td>
<td>7,23</td>
<td>7,12</td>
<td>- 0,11</td>
</tr>
<tr>
<td>4</td>
<td>8,11</td>
<td>8,85</td>
<td>7,23</td>
<td>7,14</td>
<td>- 0,08</td>
</tr>
</tbody>
</table>

As a conclusion, if we look at the average of the averages, the extra information makes the matching more optimal. The same can be said for the cumulated improvements, although it might not be obvious at first sight. We could only measure this improvement at students, who did not change their preferences and could get in a programme that they were not accepted in before. If the difference between their points and their prior rating is differing more, the probability of their changing preferences is increasing, too. So the number of those, who did not change their preferences but could get into a better position, must be lower than before.

6.6 The proposal

As we have seen when students have more information regarding to the admission their choice will be much more efficient. If they are aware of their performance they could accept the programme which is closer to their knowledge. In our view if they have to express their preferences after they get to know their points, (which means they also get information about programmes’ preferences too,) both the programmes and the students faced with a favourable result. We have not seen any fact that would make it worth not telling their true preferences, because of the additional information.

It is worth considering to only finalizing the programme selection in the second semester. The programmes’ schedules based on the first years’ microeconomics and mathematics marks. In
this case the students also should apply for the intensive courses in the first semester, but they should only decide after the semester end whether they would like to be part of the further program. The system would be more permeable therefore students who decide not practicing in the programme, and only wish to pursue their studies in normal could more easily continue their studies. In this case, we believe that more students would begin the program, since there were fewer liabilities associated. And even if it is not convenient for them, they could continue their normal study. Furthermore, a half-year course reflects the students’ performances better, which can be achieved on the basis of a better pairing. From the students questionnaire the remarks were similar too. On the other hand, from the programmes’ point of view, it needs a lot more effort, than a simple test. The question is whether the programme is willing to make this step for better results, or the improvement would not worth the extra effort.

7 Extensions

Although we could handle a problem of the admission test, there are further extensions possible. We can modify our model to make it more sophisticated and closer to the real life. Namely these are making the expected point limit more realistic by modifying $E[L]$, or redefine the way students determine their preferences.

7.1 Different assumptions on students’ preferences

The way they announce the points can have different effects on the students’ preferences. This issue is important when they only need to declare their willingness after getting to know their points. If the results are announce as they are now, everyone gets to know the others points. Students will get know the programmes’ preferences, and from that the possible point limits. So students might know how good their performance was compared to the others and choose a programme considering that.

The other variation is notifying them in private. Each and every student only knows their own points, and only this plus information will correct their prior notions. They will not have a broad picture of the performances that day, which also means – compared to the other version – they can only estimate the preferences of the programmes’.

In a simulation we could use the real L and add a random error factor to it, just as we did before at the real results. However, the standard deviation cannot be that high at this time.
Since we have no data for this, we might experiment with different standard deviation values that might seem reasonable.

7.2 Preferences determined by other factors

In our basic model, we deterred as if all the students were rational and the test result would gave a better approximation for their competences, than their prior self-rating. However, there might be a situation, when the test result gives an unrealistic number (e.g. the student had luck or a bad day). Furthermore, a student may be really clever and can still want to join only SPM for any other reasons.

We can handle this problem by applying the basic method on the determination of the preferences with a little change. This change can be performed by building in a certain percentage \( p \) into the model. This number is representing the probability of a student to act like we expected, assuming that the student is rational. This also means that there is a \( (1-p) \) probability for them to act completely opposite than we would think. Using the results of the survey, the value of \( p \) is somewhere around 75%.

7.3 Student types

We categorized the students into three groups to reflect the behavioural bias. In the model, to make it simpler, we used a constant \( c \) value to define one’s internal rating. Yet, this could also be a random variable, different for every people.

To estimate its distribution, the mean and the variance for each type of people, more tests or questionnaires would be needed. Probably we should ask some students to write a test with mathematical problems, like the one at the admission test. Before they hand it in, they should guess their result – and we should find a way to make them tell the truth about what they think of themselves. Then if we correct their tests, we get a database that we can use to estimate \( c \).

Probably it is not a big surprise if we say that there will not be a crowd standing in line to do this, and those who are willing to fill out these test might not be the kind of people, who would apply for the programme. The easiest way to get a database to estimate \( c \) would be in practice: asking them to write their valuation when they are writing the admission test.
8 Summary

In this essay we focused on the entrance test of facultative advanced level courses at Corvinus University of Budapest. Emerged within the data although entrance test points are highly significant, it could explain only a small percentage of the successful completion of the programme. One reason could be that the candidates have similarly high skills – since it is difficult to get in to the Corvinus University – and self-motivation and perseverance matter more prominently but the test cannot measure these factors. The questionnaires also showed that lack of motivation plays a greater role than the lack of knowledge. If students have to be settled after completing the subjects in the first semester presumably could lead to better pairings. We made a model in which the role of information was pointed out. Two programmes were chosen, SPM and SPM-IMP. We made an assumption before that all students would like to become the member of the programme, which is more suitable for their skills. From the programmes’ perspective, we assumed that students with higher points would like to be added to the SPM-IMP programme. In the first case they give themselves a score, according to what they think of their abilities and tell them the inclusion of the points, this determines the choice they make. In the second case after the test writing students shall know their points and the entrance points, this affects the decision they make. We found that average of the SPM-IMP members’ scores was higher in each case. The interpretation is that telling plus information to the students about their performance is more efficient. The results are consistent with known relevant studies.
References


Appendix

I. Questions for teachers:

Mikor nevezné oktatói szempontból sikeresnek a programot?
(As a teacher, when would you call the programme successful?)

Melyek azok a tárgyak amelyek a programok alapját képezik, melyek elvégezése esetén sikeresnek tekinthetjük a diák teljesítményét?
(Which are the basic subjects of the programmes that have to be done for a student to graduate?)

Tanárként milyen preferenciáik vannak a felvételivel kapcsolatban?
(What kind of preferences do you have according to the admission method?)

Mennyi lenne az ideális létszám az egyes programokra?
(How many students would be ideal to be accepted for each programme?)

Ha többen jelentkeznek, egy bizonyos teljesítményszint elérése az elsődleges szempont, vagy az elérhető kapacitás?
(If more students apply, are their performance more important, or the capacity constraints in making decision about their admission?)

Melyik fontosabb cél a kiválasztásnál: a későbbi lemorzsolódás minimalizálása, vagy hogy minél többen vegyék fel?
(Which goal is more important in selecting students: to lessen the number of drop outs, or to accept as much students as possible?)

Tudomása szerint, akik otthagyják a programot annak inkább magánéleti vagy teljesítménylebi okai vannak?
(As far as you know, for those who leave the programme, is the reason of dropping out connected to their performance or rather personal issues?)

Becslése szerint mennyivel több energiabefeketetés a program elvégzése a diákok számára?
(How much extra work do you think it is for students to complete the programme?)

Mi a véleménye, miért jelentkeznek a diákok a programokra?
(In your opinion, why do students apply for these programmes?)

Véleménye szerint fel tudják-e mérni a diákok mire jelentkeznek?
(Do you think that students are aware of what they apply for?)

Hogyan vette észre...
...jobban motiváltak-e,
...jobb-e a teljesítmény,
...jobb eredmények születnek-e a programot végzők körében?
(How have you experienced: are the ones doing the programme...
... more motivated,
... performing better,
... achieving better results?)
II. Questions for students:

1. Részt veszel a Corvinus SPM/SPM-IMP/SKM-IMP programjain? (Are you a member of any of the following programmes of CUB: SPM/SPM-IMP/SKM-IMP?)
   1.1. Igen. (Yes.)
   1.2. Nem, abbahagytam. (No, I left it.)
   1.3. Már elvégeztem az SPM/SPM-IMP/SKM-et. (I have already done SPM/SPM-IMP/SKM.)

2. Melyik programban veszel/vettél részt? (Which programme are/were you a member of?)
   2.1. SPM
   2.2. SPM-IMP
   2.3. SKM-IMP

Questions for those who are participants of the programme:

1. Milyen szakos vagy? (Which sector do you study?)
   1.1. pénzügy-számvitel (finance and accounting)
   1.2. gazdálkodás és menedzsment (business and management)
   1.3. alkalmazott közgazdaságtan (applied economics)
   1.4. kereskedelem és marketing (commerce and marketing)
   1.5. nemzetközi gazdálkodás (International business)
   1.6. közszolgálati (public service)
   1.7. turizmus-vendéglátás (tourism and catering)

2. Mióta veszel részt az SPM/SKM-IMP/SPM-IMP programban? (Since when are you taking part in the SPM/SKM-IMP/SPM-IMP programme?)

3. Mi alapján választottad a programot? (Why did you choose the programme?)
   3.1. A felvételi pontszám miatt (Because of the admission test results.)
   3.2. A felvételre döntöttek a számomra referenciaszemélyek. (At the admissions the ones who were reference for me made the same decision.)
   3.3. A felvételi előtt is ezt a programot szemeltettem (I chose it before the admissions.)

4. Egytől tízes skálán milyen nehéznek gondoltad felvételizéskor a programot? (From a one to ten scale how hard did you think the programme is at the admissions? 1-easiest; 10-hardest)

5. Mi volt az elsődleges motivációd, hogy felvedd a programot? (What was your prior motivation to apply to the programme?)
   5.1. Reputáció. (Reputation.)
   5.2. Jobb karrier lehetőség. (Better career opportunities.)
   5.3. Intellektuális kihívás. (Intellectual challenge.)
   5.4. Közösség tagjává válni. (Be part of a community.)
   5.5. Környezeted ajánlotta. (My environment recommended it.)
   5.6. Egyéb (Other.)
6. Milyen felvételi pontot értél el a teszten? (keresztülhez)
   (How many points did you get on the test? (rounded))

7. Tudásod és teherbírásod alapján megfelelő csoportba kerültél? (Compared to your knowledge and carrying capacity, did you get to the appropriate group?)
   7.1. Igen (Yes.)
   7.2. Nem, teherbírásomhoz mértén könnyebb csoportba kerültem (No, it is easier.)
   7.3. Nem, teherbírásomhoz mérten nehezebb csoportba kerültem. (No, it is harder.)

8. Corvinusos tanulmányaid átlaga (kumulált átlag)?
   (The cumulated average of your studies at Corvinus?)

9. Egytől tízével milyen nehéznek tartod jelenleg a programot?
   (From a one to ten scale, how hard do you think the programme is?)

10. Melyik kurzus elvégzése volt a legnehezebb számodra?
    (Which course was the hardest for you?)

11. Eddige tanulmányaid alapján mennyire vagy elégedett a programmal?
    (According to your studies so far, how satisfied are you with the programme?)

12. Érzésed szerint jelentős tudástöbblettel rendelkezel a képzésből kimaradó diákokhoz viszonyítva?
    (As far as you know, do you have a significant extra knowledge compared to the ones, who are not taking part in the programme?)

13. Mit tartasz a program legnagyobb előnyének?
    (Which is the biggest advantage of the programme?)

14. Mit tartasz a program legnagyobb hátrányának?
    (Which is the biggest disadvantage of the programme?)

15. Ajánlanád a programot ismerőseidnek?
    (Would you recommend the programme to your acquaintances?)

16. Egyéb megjegyzés:
    (Other comments: )
Questions for those who have left them programme

1. Egytől tízes skálán milyen nehéznek gondoltad felvételizéskor a programot? (1- legkönnyebb; 10-legnehezebb)
   (From a one to ten scale how hard did you think the programme is at the admissions? 1- easiest; 10-hardest)

2. Mi volt az elsődleges motivációd, hogy felvedd a programot? (What was your prior motivation to apply to the programme?)
   2.1. Reputáció. (Reputation.)
   2.2. Jobb karrier lehetőség. (Better career opportunities.)
   2.3. Intellektuális kihívás. (Intellectual challenge.)
   2.4. Közösség tagjává válni. (Be part of a community.)
   2.5. Környezeted ajánlotta. (My environment recommended it.)
   2.6. Egyéb (Other.)

3. Mi alapján választottad a programot? (Why did you choose the programme?)
   3.1. A felvételi pontszám miatt (Because of the admission test results.)
   3.2. A felvételi pontokat írja döntőt a számmomra referenciaiszemélyek.
   (At the admissions the ones who were reference for me made the same decision.)
   3.3. A felvételi előtt is ezt a programot szemelted ki (I chose it before the admissions.)
   3.4. Egyetlen program indult. (There was only one programme.)

4. Milyen felvételi pontot értél el a program tesztjén? (kererekítve)
   (How many points did you get on the test? (rounded))

5. Egytől tízes skálán milyen nehéznek tartottad a programot, mikor ott hagytad?
   (From a one to ten scale how hard did you find the programme, when you left it?)

6. Program feladásával a Corvinus egyetemet is otthagytad?
   (Have you also left the University, when you left the programme?)

7. Egytől-tízes skálán, mennyire voltál elégedett a programmal?
   (From a one to ten scale how satisfied were you with the programme?)

8. Milyen ok miatt hagytad ott a programot?
   (Why did you left the programme?)

9. Döntéshed ellenére hasznosnak tartod a programot?
   (Despite your decision, did you find the programme useful?)

10. Ajánlanád a programot ismerőseidnek?
    (Would you recommend the programme to your acquaintances?)

11. Egyéb megjegyzés:
    (Other comments: )
Questions for those who finished the programme

1. Hány félév alatt végezted el?  
   (How many semesters did it take for you to complete the programme?)

2. A program előnyt jelentett-e későbbi tanulmányaid/ munkád folyamán?  
   (Did the programme provide an advantage in your further studies/career?)

3. Mi volt az elsődleges motívációd, hogy felvedd a programot?  
   (What was your prior motivation to apply to the programme?)
   3.1. Reputáció.  (Reputation.)
   3.2. Jobb karrier lehetőség.  (Better career opportunities.)
   3.3. Intellektuális kihívás.  (Intellectual challenge.)
   3.4. Közösség tagjává válni.  (Be part of a community.)
   3.5. Környezeted ajánlotta.  (My environment recommended it.)
   3.6. Egyéb  (Other.)

4. Egytől tízes skálán milyen nehéznek gondoltad felvételizéskor a programot?  
   (From a one to ten scale how hard did you think the programme is at the admissions? 1- 
   easiest; 10-hardest)

5. Mi alapján választottad a programot?  
   (Why did you choose the programme?)
   5.1. A felvételi pontszám miatt  (Because of the admission test results.)
   5.2. A felvételi részletes vizsgálattal dolgoztak a személy, aki megjelentetett  
        a felvételi adatokon.  (At the admissions the ones who were reference for me made the same decision.)
   5.3. A felvételi előtt is ezt a programot szemelted ki.  (I chose it before the admissions.)
   5.4. Egyetlen program indult.  (There was only one programme.)

6. Elgondolásodhoz mérten a program nehezebbnek, vagy könnyebbnek bizonyult?  
   (Compared to your expectations, is the programme harder or easier?)
   6.1. Meglehetősen könnyebbnek.  (Much easier.)
   6.2. Könnyebbnek.  (Easier.)
   6.3. Erre számítottam  (Same as I expected.)
   6.4. Nehezebben  (Harder.)
   6.5. Meglehetősen nehezebben.  (Much harder.)

7. Tudásod és teherbírással alapján megfelelő csoportba kerültél?  (Compared to your 
   knowledge and carrying capacity, did you get to the appropriate group?)
   7.1. Igen.  (Yes.)
   7.2. Nem, kerülhettem volna magasabb elvárásokat támasztó csoportba.  
        (No, it was easier.)
   7.3. Nem, alacsonyabb elvárásokat támasztó csoport ideálisabb lett volna.  
        (No, it was harder.)
8. Szerinted a felvételi teszt az SPM/SPM-IMP/SMK-IMP csoportokhoz megfelelő képet adott tudásodról?
(Do you think the admission test reflected your knowledge?)
8.1. Nem volt felvételi teszt. (There was no admission test.)
8.2. Igen. (Yes.)
8.3. Nem, tudásomhoz mértén magasabb pontot kaptam. (No, I got more points.)
8.4. Nem, tudásomhoz mértén kisebb pontot kaptam. (No, I got less points.)

9. Mit éreztél a program erősségének? (What do you think is the programme’s strength?)

10. Mit éreztél a program gyengeségének?
(What do you think is the programme’s weakness?)

11. Mely tárgyakat tartottad nélkülözhetőnek a képzésből?
(Which subjects did you find dispensable?)

12. Mely tárgyakat hiányoltad a képzésből?
(Which subjects did you miss from the programme?)

13. Volt-e holtpont a képzés során, amikor úgy érezted otthagynád a programot?
(Was there a deadlock, when you felt you would leave the programme?)

14. Melyik félévben érezted, hogy elhagynád a programot?
(In which year did you feel you would leave the programme?)

15. Mely tárgy okozott nehézséget?
(Which subject caused you difficulties?)

16. Mi segített átbillenni ezen a holtponton?
(What helped you get by this deadlock?)

17. Ajánlanád ismerőseidnek a programot?
(Would you recommend the programme to your acquaintances?)

18. Egyéb megjegyzés:
(Other comments: )

You can find the questionnaire in the following link:

https://docs.google.com/forms/d/1k_8IN7a3CaZH_yvCBdjmrUUFUQiGgJqpDqHuAJ2q-mI/viewform
III. Measuring the change in places

Option Base 1

Function improve(ID1, ID2, L)

n = ID1.Count
m = ID2.Count
k = 0

For i = 1 To n
    For j = 1 To m
        If ID1(i) = ID2(j) And ID1(i) > 0 Then
            k = k + i - j + L
        End If
    Next j
Next i

improve = k

End Function