

Some factors influencing students' academic performance in the Integrated Master in Mechanical Engineering (MIEM) at FEUP

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Introduction

In Portugal, admission to public higher education (PHE) is subject to *numerus clausus*, fixed annually for each cycle of studies (CS). For each institution/CS pair, applicants are ordered by their application mark, ApM . The weight $k \in [0, 1]$, the national exams which are compulsory to calculate the component S in formula, and the minimum marks required for ApM and E are decided by the PHE institution/CS pair. For Mechanical Engineering (ME) CS, all Portuguese Universities require the national exams of "Mathematics A" and "Physics and Chemistry", which marks are $M, PQ \in [0, 200]$, respectively. In the last years the students' ApM for ME in the Faculty of Engineering, University of Porto (FEUP) have been the highest among all national ME CS (Fig. 1, 2016/2017).

$$E = 0.5 (M + PQ)$$

$$ApM = k.S + (1-k).E$$

S - Achievements at secondary school for a period of three years
 E - National exams mark

The present work studies possible correlations between the ApM of 150 ME students admitted in 2016/2017 and their performance over their next 5 years stay at FEUP. Six variables are analysed: *Application Mark*, *1st Year Mark*, *Weighted 1st Year Mark* (mark = 1st Year Mark x (10 - n° failed courses)), *5th Year Mark*, *Weighted 5th Year Mark* (mark = 5th Year Mark x (10 - n° failed courses)), and *Conclusion Mark*. The study considers the whole sample, as well as students divided in 8 groups. Fig. 2 depicts their distribution according to gender, (Male/Female), type of high school they came from, (Public/Private), location of the high school, (Away/Home, meaning not in/in the metropolitan area of Porto) and ME rank in the application list of options, (Option 1/Option 2-6). It can be seen that the students enrolled in ME are predominantly male. Most come from public schools and live in the metropolitan area of Porto. Despite the majority choose ME in first option, there is a considerable portion who prefer other CS.

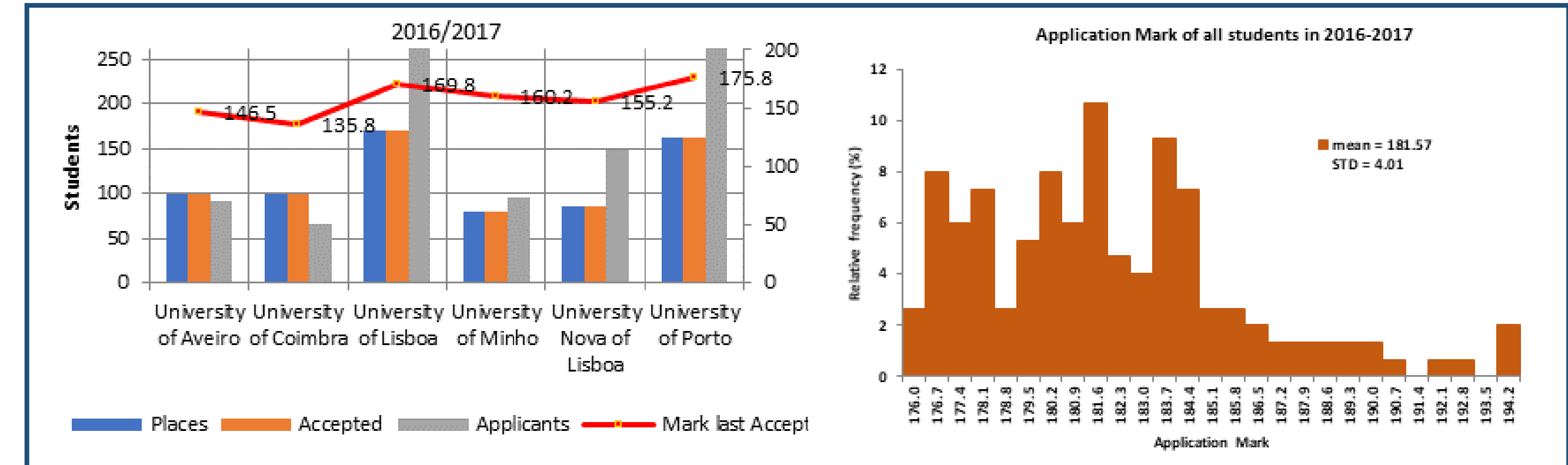


Fig. 1. Left: The *numerus clausus*, students accepted and applicants for the 6 institutions that offer ME; Right: the distributions of ApM for all ME students admitted in ME at FEUP in 2016-2017.

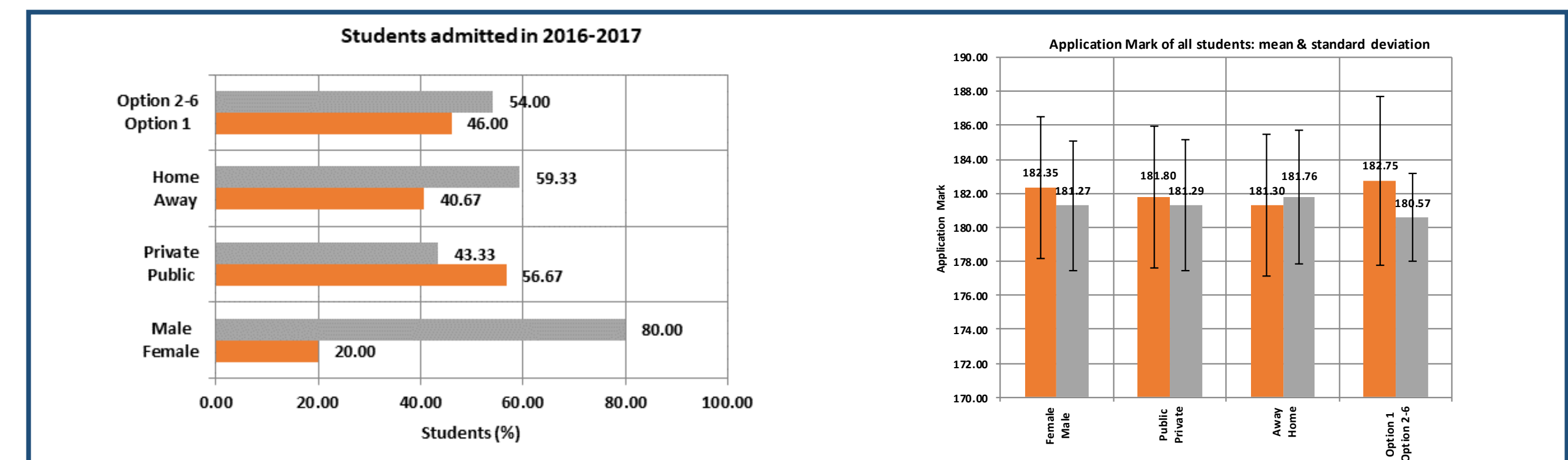


Fig. 2. Left: Students admitted in 2016-2017 divided in 8 groups; Right: Application mark of all students – mean and standard deviation.

Results and Discussion

1. Academic performance at the end of first year

Figs. 3-4 and 5-6 present the *1st Year Mark* and *Weighted 1st Year Mark* results of the 150 ME students. Per group, the patterns are similar, with the exception of the group Away/Home that changed slightly. However, in value the marks at the end of first year decreased about 50 points out of 200. The histograms changed considerably, meaning that the one of the *1st Year Mark* is now more similar to a Gaussian distribution, while the one of the *1st Year Weighted Mark* shifted to the right, reflecting the courses failure rate.

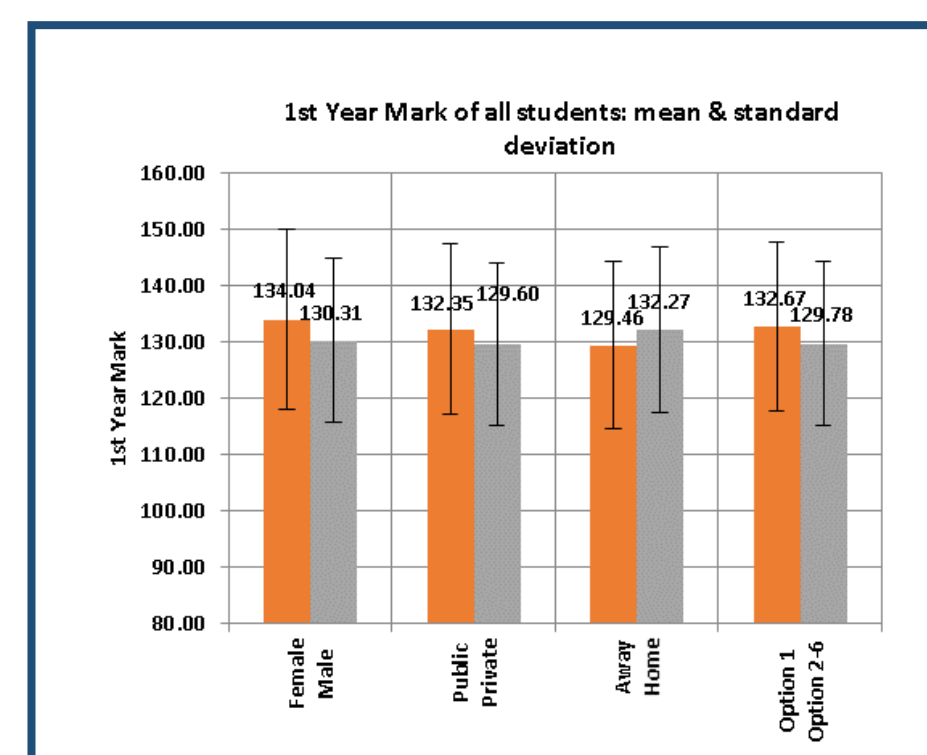


Fig. 3. *1st Year Mark* of all 150 students.

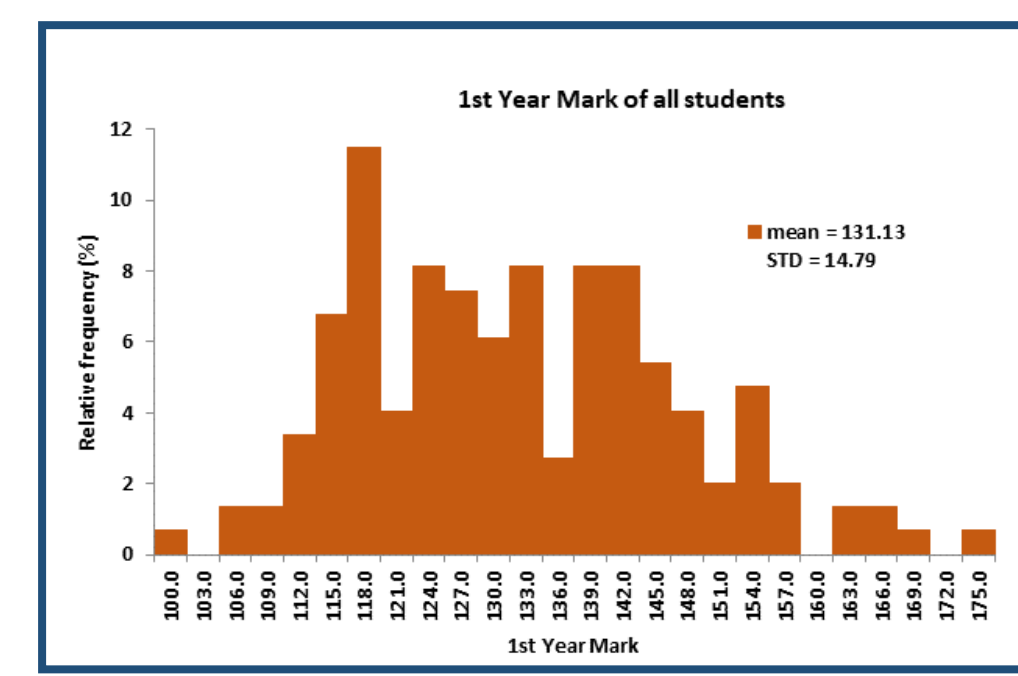


Fig. 4. Histogram of *1st Year Mark* of all 150 students.

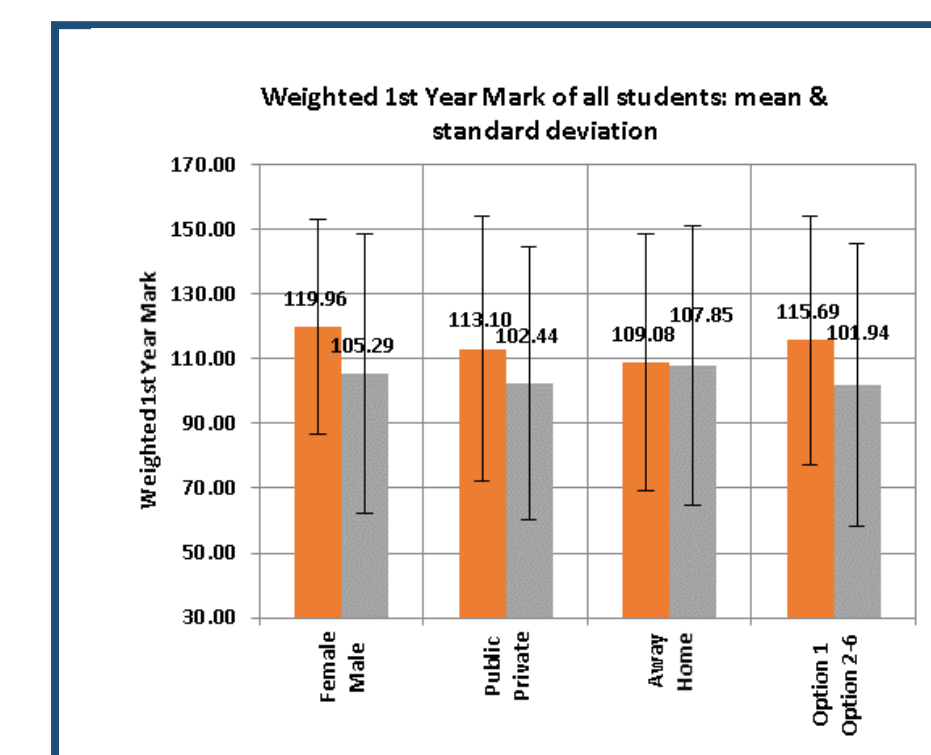


Fig. 5. *Weighted 1st Year Mark* of all 150 students.

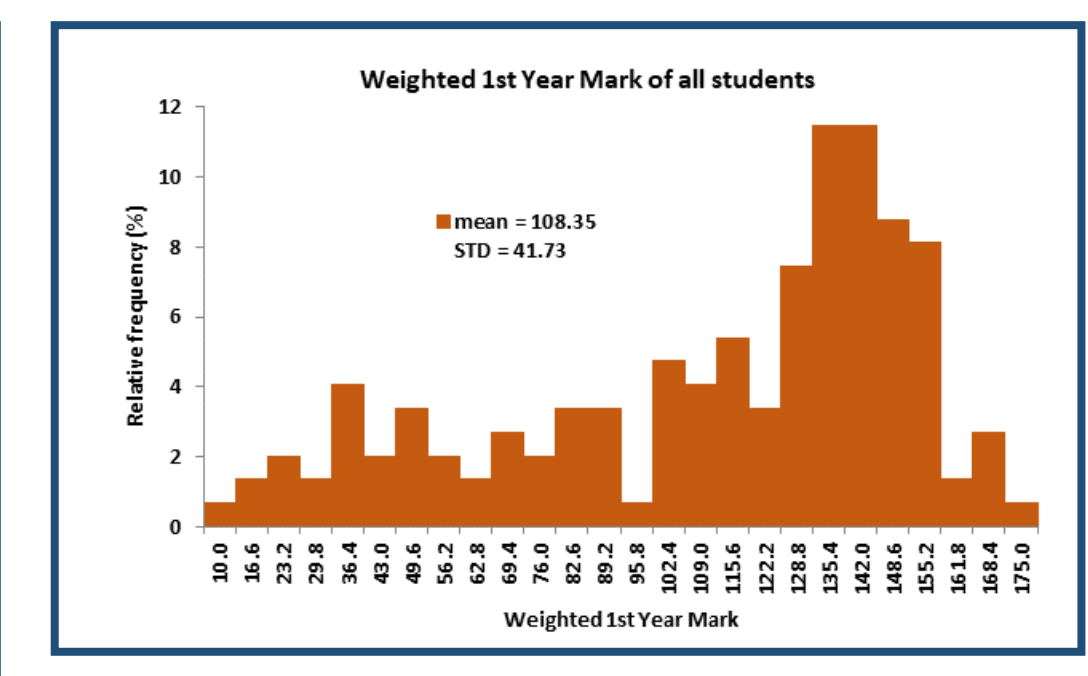


Fig. 6. Histogram of *Weighted 1st Year Mark* all 150 students.

2. Academic performance at the end of fifth year (students not concluding in 5 years)

Figs. 7-10 depict the *5th Year Mark* and *Weighted 5th Year Mark* results of the 73 out of 150 students not concluding the CS in five years. The histogram of the *Weighted 5th Year Mark* presents an interesting bi-modal distribution. However, any possible patterns embedded in the data are unclear, demanding a deeper analysis.

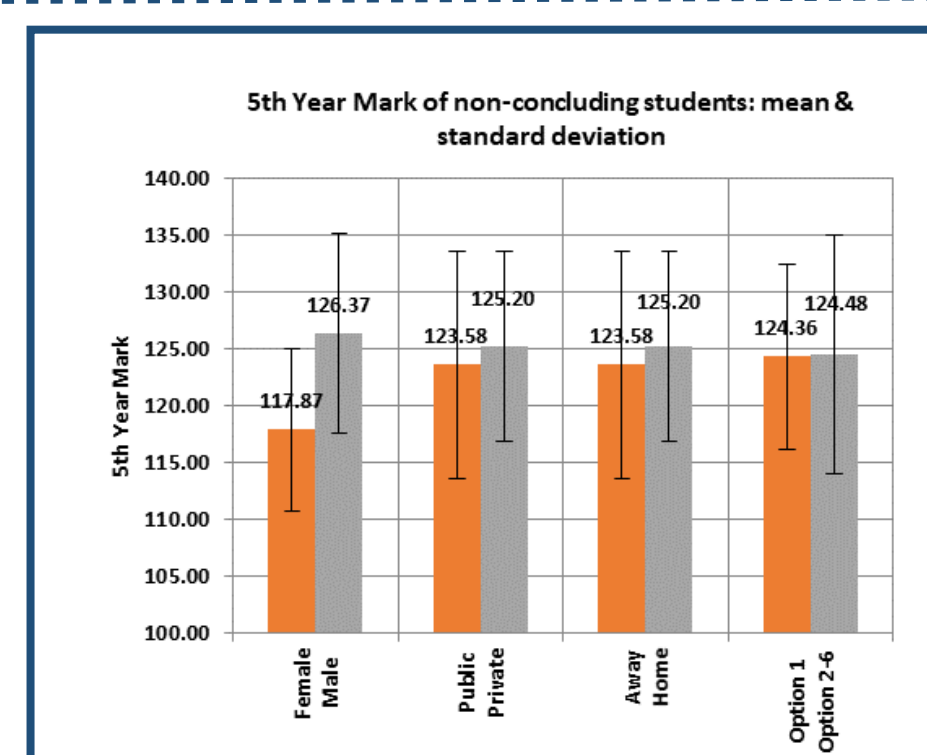


Fig. 7. *5th Year Mark* of 73 students not concluding in 5 years.

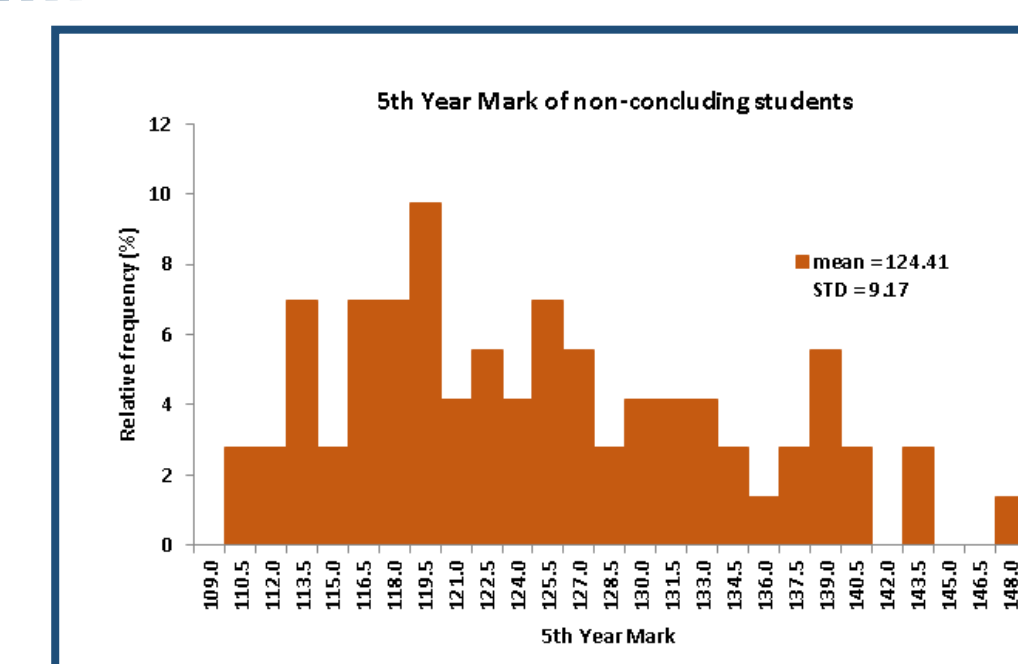


Fig. 8. Histogram of *5th Year Mark* of 73 non-concluding students

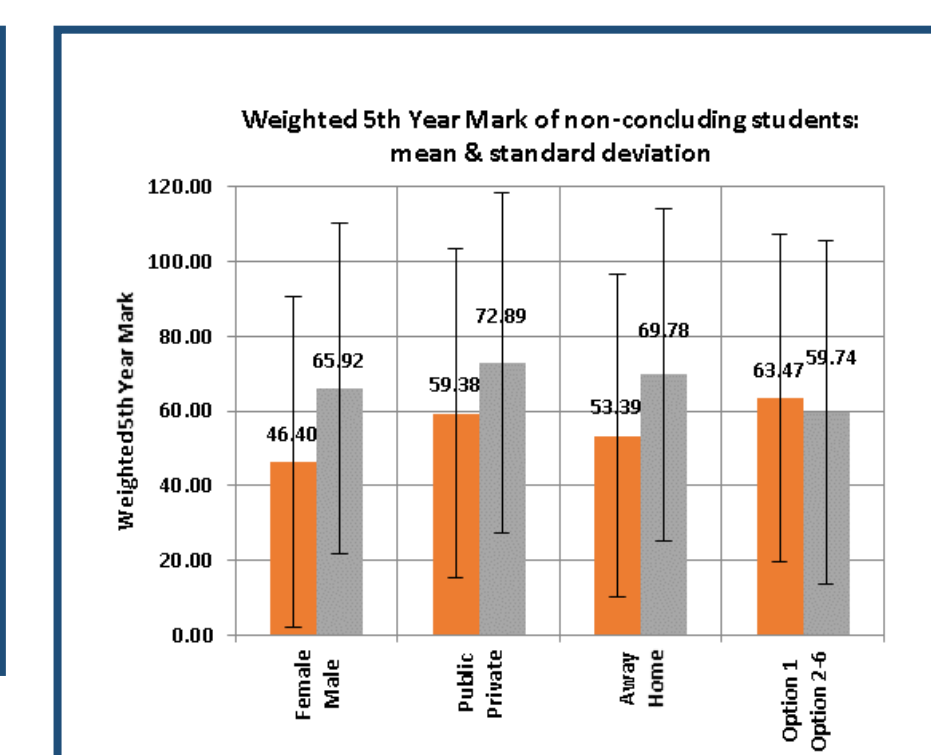


Fig. 9. *Weighted 5th Year Mark* of 73 students not concluding in 5 years.

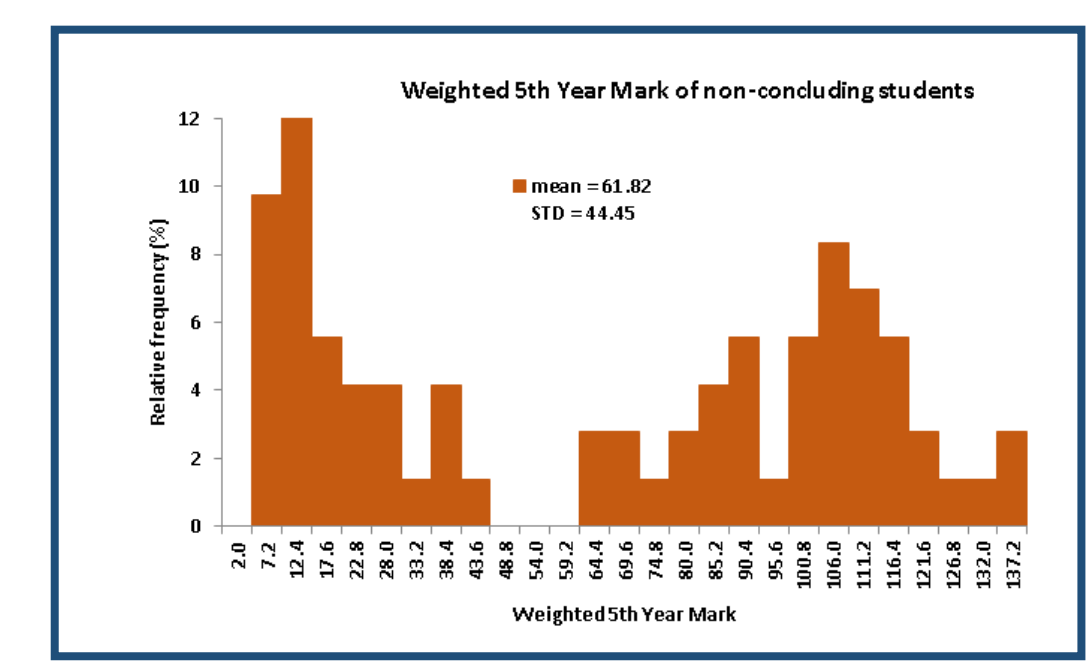


Fig. 10. Histogram of *Weighted 5th Year Mark* of 73 students not concluding in 5 years.

3. Academic performance at conclusion after 5 years

A total of 77 out of 150 students concluded the CS in 5 years. Fig. 11 shows better performance of those who are female, come from public schools, live away from Porto, and choose ME in first option.

Figs. 12-13 represent the *Conclusion Mark* of the 77 students, per group, and the distribution of the *Conclusion Mark* of all 77 students.

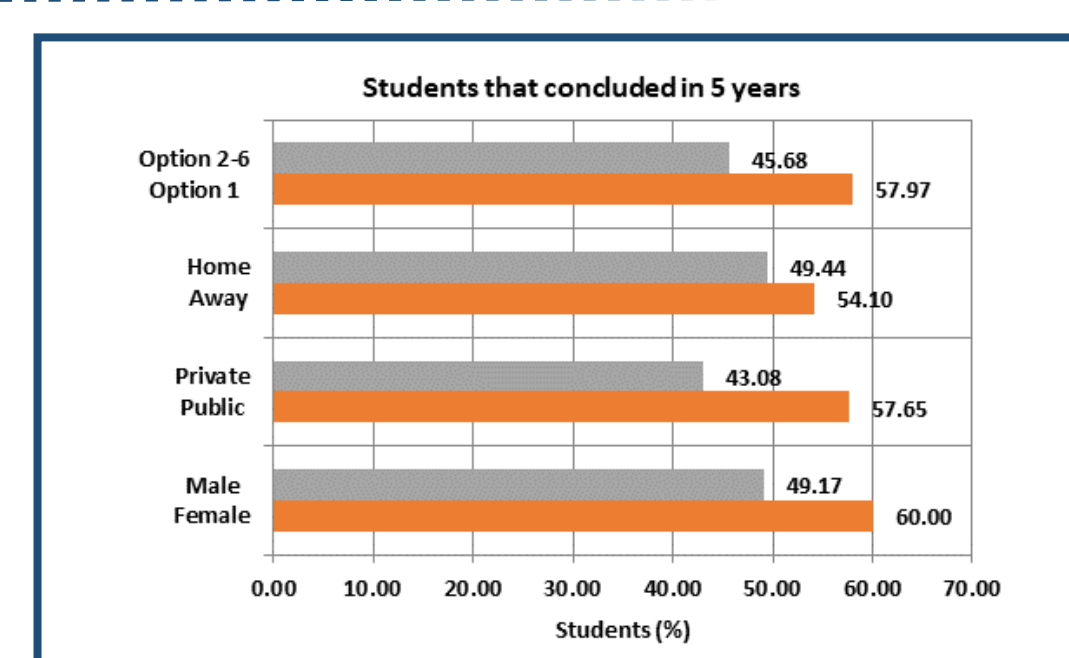


Fig. 11. Students that concluded the CE in 5 years.

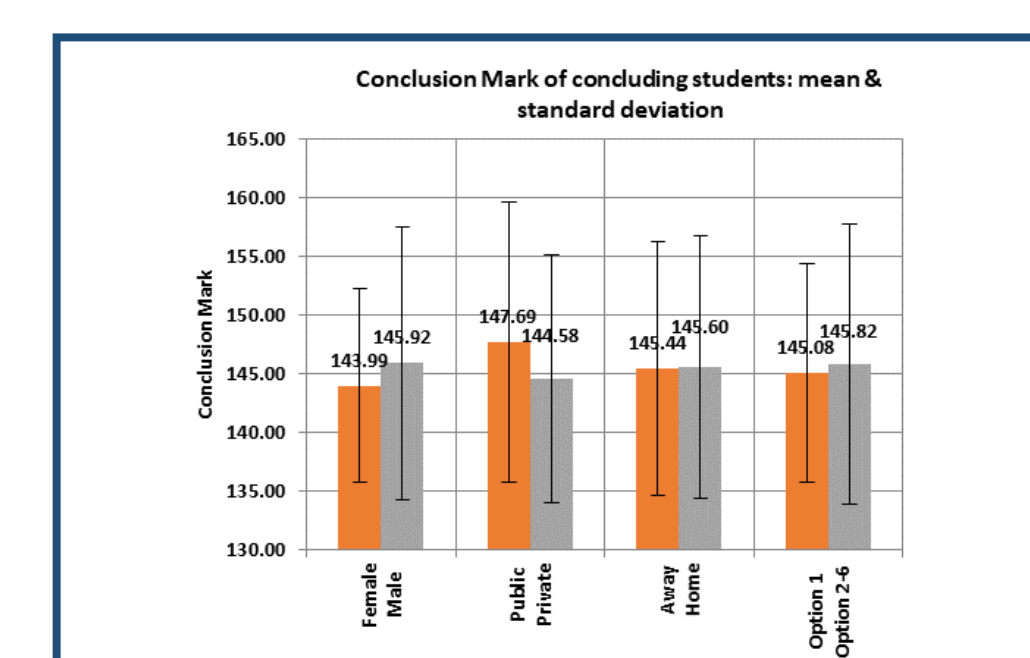


Fig. 12. *Conclusion Mark* of 77 students that concluded in 5 years.

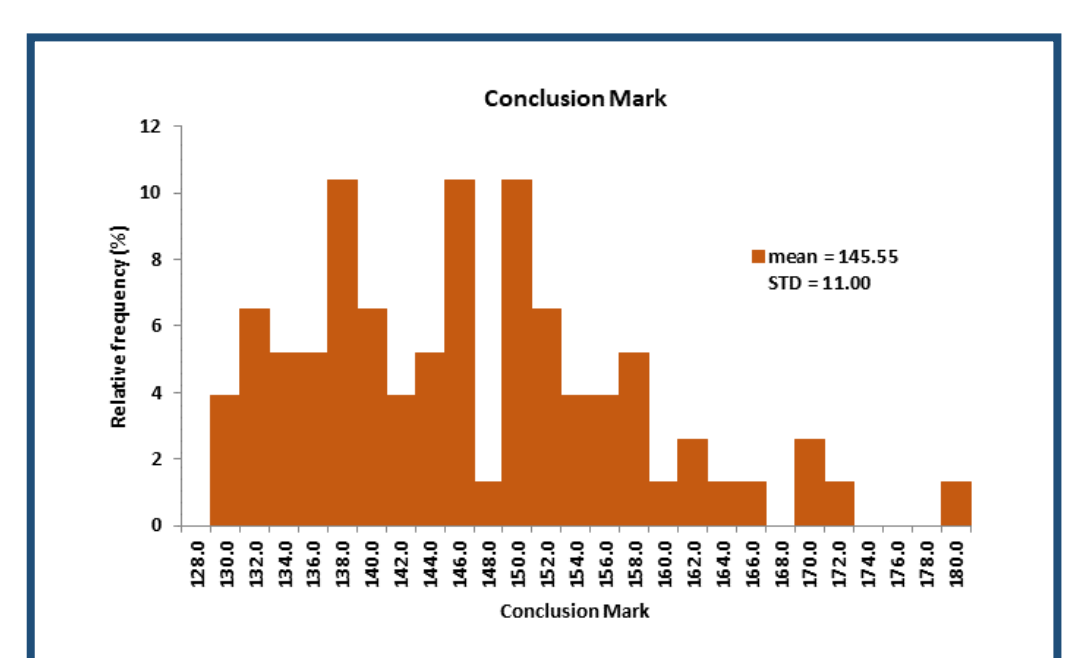


Fig. 13. Histogram of *Conclusion Mark* of 77 students that concluded in 5 years.

4. Correlation analysis

Seeking for possible correlations in the data, the Pearson correlation between all combinations of the six variables: *Application Mark*, *1st Year Mark*, *Weighted 1st Year Mark*, *5th Year Mark*, *Weighted 5th Year Mark*, and *Conclusion Mark* is performed. Fig. 14 depicts the results when considering all 150 students. Higher correlation values of interest are marked in bold larger font.

A pattern is unveiled, in which 3 pairs of variables have correlation and the Pearson correlation values have a tendency.

The observed pattern is consistent when analysing each group of students, as illustrated in Fig. 15.

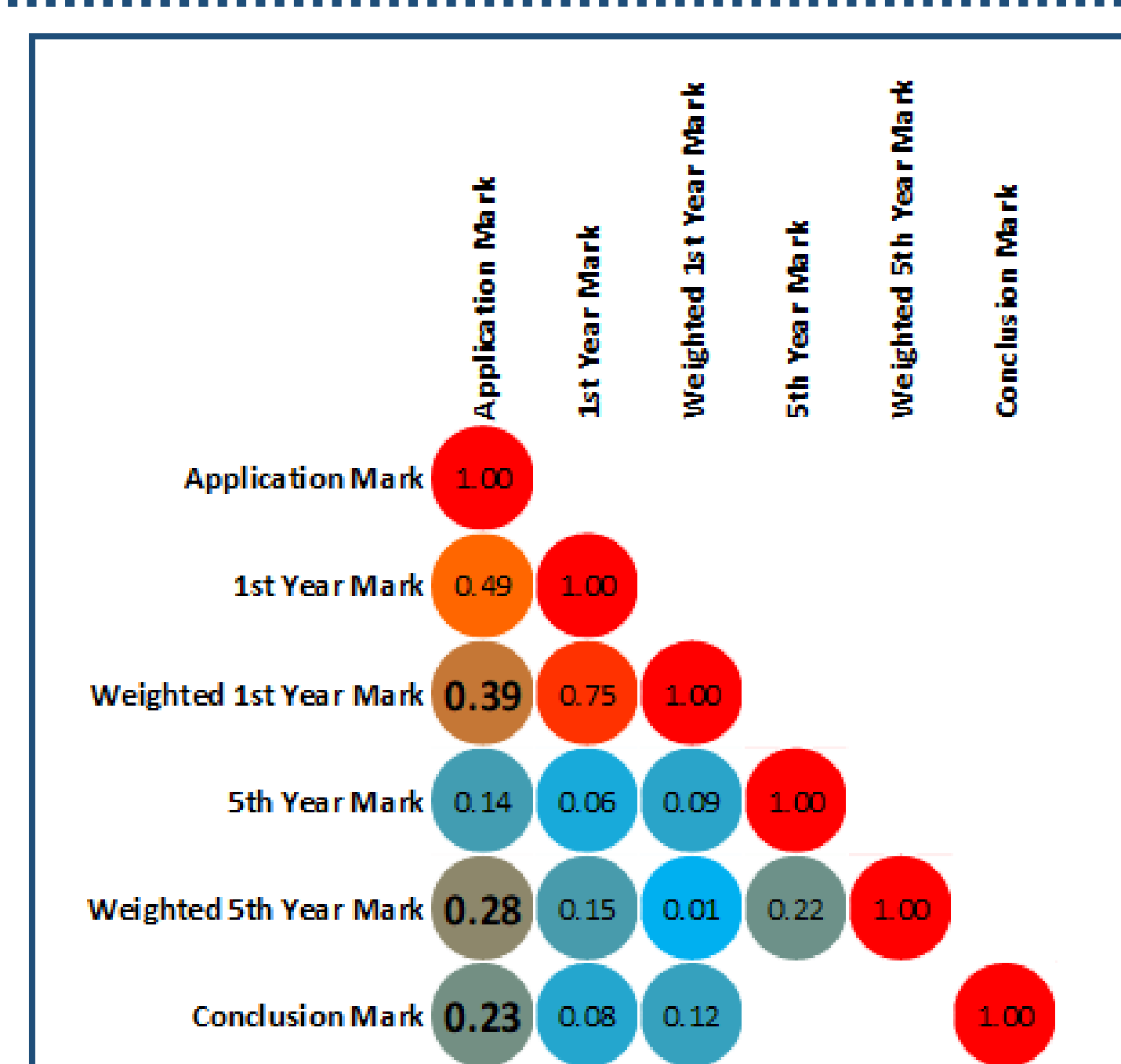


Fig. 14. Correlations for the whole sample of 150 students admitted in 2016-2017.

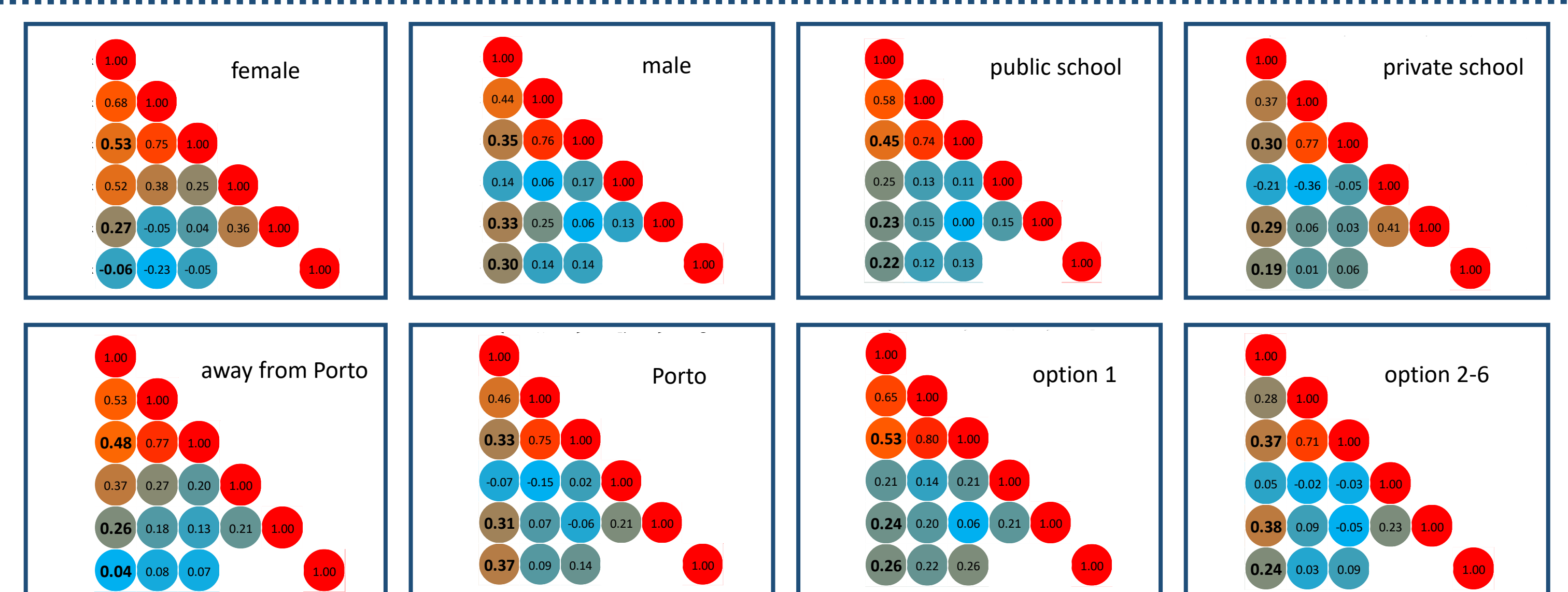


Fig. 15. Correlations for the 150 students admitted in 2016-2017, divided per group.

Conclusions

- There are some correlations between the 3 pairs of variables: {*Application Mark* vs. *Weighted 1st Year Mark*}, {*Application Mark* vs. *Weighted 5th Year Mark*}, and {*Application Mark* vs. *Conclusion Mark*};
- The values of those correlations decrease: for 1st pair is higher; then for 2nd pair; finally for 3rd pair. This is visible when considering the whole sample of students simultaneously (Fig. 14), and verified when the students are considered organized in categories (male, female, public, private, away, home, option 1, option 2-6) (Fig. 15);
- The pattern means that "the memory of the *Application Mark* is progressively lost as time passes". In other words, students with higher (lower) *Application Mark* tend to perform better (worse) in their first year. But, as time passes, the students' performance evolves (getting better or worse) and, at the end of the 5th year in FEUP (no matter they concluded the CE or not), the students' performance is practically unrelated with their *Application Mark*.