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Analysis of the Pass/Fail Results of the Pharmacist National Examination

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Abstract

In this poster, using the MEXT's national survey and the topic analysis of the Faculty of Pharmacy at Hokuriku University as reference, IR data were used to identify variables related to the success or failure of the national examinations.

Keywords: Pharmaceutical Education in Japan, National Examination, IR, Machine Learning, Random Forest

1 Introduction

In Japan, there are only four professional occupations that require graduation from a professional undergraduate colleges and passing a national examination: doctors, dentists, veterinarians, and pharmacists. However, an expert panel of the Ministry of Health, Labor, and Welfare (MHLW) predicted an excess of up to 126,000 pharmacists by 2045. The reason for this is the increasing number of pharmaceutical colleges. Before the start of six-year education in Japanese pharmaceutical colleges in 2006, the student population capacity was 8,200 in 2002. In 2020, however, that number increased by about 1.4 times to 11,600. The number of colleges increased from 46 in 2002 to 79 in 2021. As a result, 41 colleges have been experiencing a shortage of capacity. The expert panel of the MHLW pointed out that the number of universities with low filling rates and low applicants/students ratios may further increase due to the declining population. Meanwhile, The Ministry of Education, Culture, Sports, Science and Technology (MEXT) conducted hearings with universities with low filling rate, and for the first time disclosed the dropout rates for all colleges.

The IR office of Hokuriku university conducted a topic analysis of the current state of its pharmaceutical college. This paper extends that analysis and uses a random forest method to predict student success on the national pharmacist examination.

2 The National Survey

The MEXT has published the dropout rates, passing rates for the national pharmacist exam, and 6-year graduation rates of all pharmaceutical colleges in Japan. Only the Faculty of Pharmacy has such detailed information available to the public from the MEXT. Table I shows statistics on the average of private universities' pharmaceutical colleges and Hokuriku University's faculty of Pharmacy.

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Table 1: Statistics of the students who enrooled in 2015

Statistics	***Hokuriku University***	***Average of Private Colleges***
# of Enrollment Students	151	193
# of Students in 5th year in 2019	81	143
Graduation Rate in 2021	53.0%	64.5%
# of Passed the National Exam	65	112
% of Passed the National Exam	43.0%	55.6%
% of Dropout Rate	29.1%	15.3%

As shown in Table 1, the straight graduation and national exam pass rates for pharmacy students are quite severe compared to other faculties. The advancement rate, graduation rate, pass rate, and dropout rate of Hokuriku University Faculty of Pharmacy are below the average of private universities. Therefore, Hokuriku University is working to improve its teaching methods and learning environments.

Figure 1 shows the relationship between the national exam pass rate for 2015 enrollment students and the entrance exam capacity multiplier for 2021 entrants, based on a survey conducted over time by the MEXT. There is a positive correlation between two numbers.

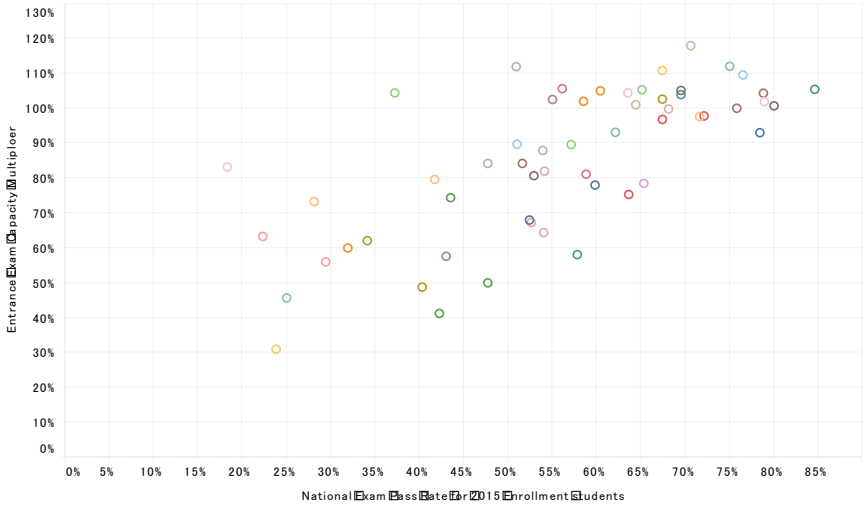
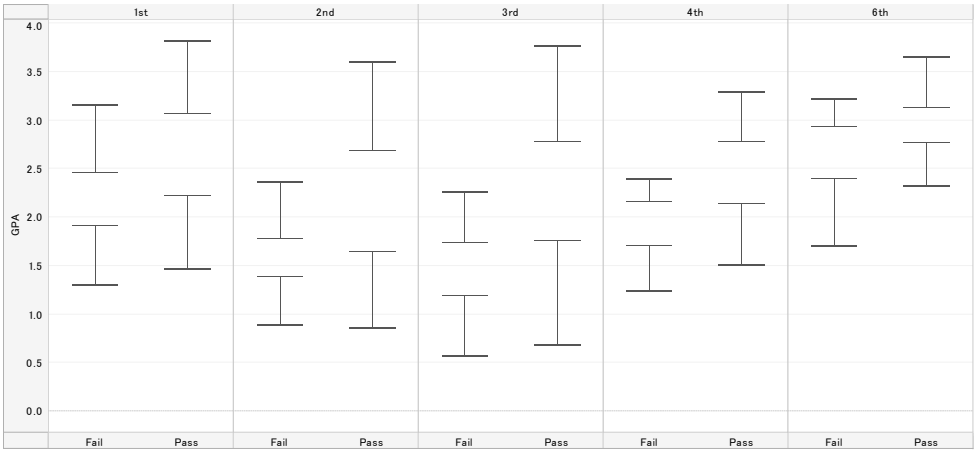


Figure 1: Pass Rate and Admission Multiplier by University

3 Topic Analysis by the IR Office

Hokuriku University Faculty of Pharmacy enrolled 151 students in 2015, 81 of whom took the national exam in 2021, and 65 passed. The pass rate was 43% as shown in Table 1.

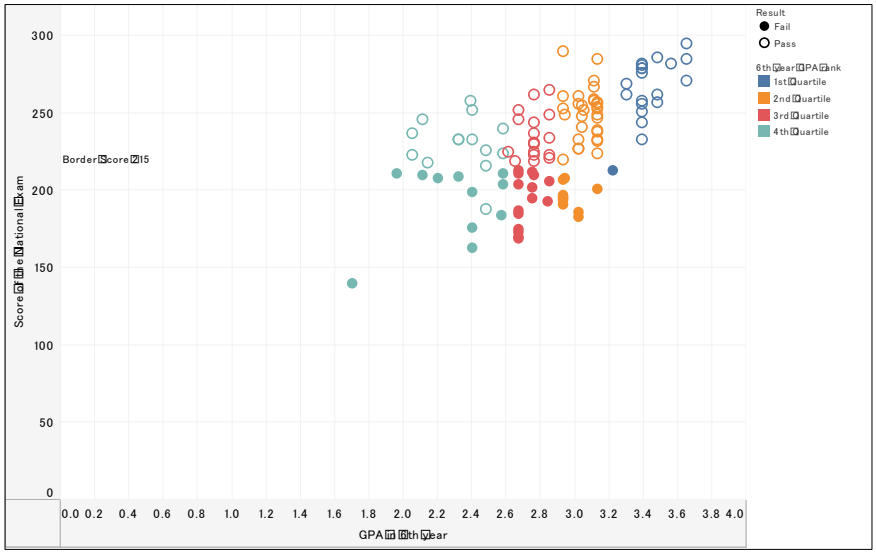
The IR office conducted several analyses of national exam pass/fail and GPA. Figure 2 shows the distribution of GPA both passed and failed students. That is largest in the third year, but it is clear that most of the distribution of failed students overlaps the lower part of the distribution of passed students.



IR Office, Hokuriku University

Figure 2: Distributions of Annual GPA of Passed (Blue) and Failed (Orange)

In Figure 3, GPA is color-coded by quartile in the scatterplot of sixth-year GPA and 2022 national exam scores. This figure shows that there are few students in the 1st quartile of GPA students, but for the 2nd, 3rd and 4th quartile of students, there are some who pass and some who fail even with the same GPA.



IR Office, Hokuriku University

Figure 3: Scatter Plot of the GPA in 6th-year and the Score of the National Exam

4 Analysis of Random Forest Method

A machine learning analysis (Random Forest, RF) was conducted on students who entered the Faculty of Pharmacy at the Hokuriku University in 2015, with the objective variable being the Boolean type of passing or failing the pharmacist national exam in 2022. Predictor variables were gender, type of enrollments, placement test scores at the time of admission, and semester GPA in years 1st, 2ed, 3rd, 4th and the first semester of year 6th. GPA was put into each model cumulatively per semester. Calculations were performed using Exploratory 6.9.5. A summary of the calculation is presented in Table II, which very accurately predicted the pass/fail.

Table 2: Summary of Random Forest

	2015S	2015F	2016S	2016F	2017S	2017F	2018S	2018F	2020S
Accuracy	0.86	0.9	0.9	0.91	0.94	0.9	0.88	0.9	0.93
AUC	0.88	0.92	0.94	0.92	0.94	0.95	0.95	0.95	0.95

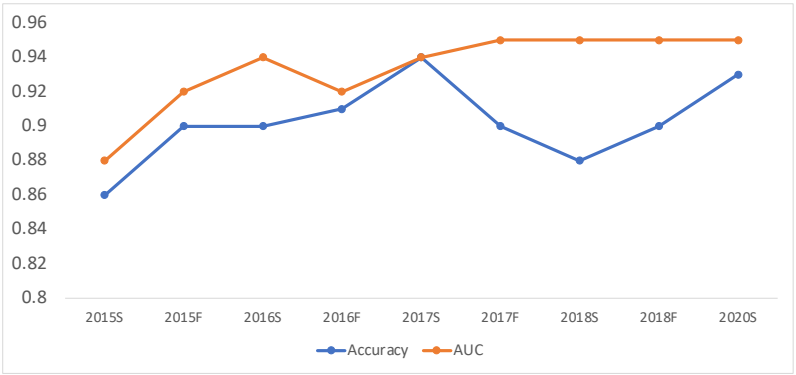


Figure 3: Scatter Plot of the GPA in 6th-year and the Score of the National Exam

Table 2 shows the Accuracy and AUC for each model that cumulatively added each semester's GPA to the predictor variables. All models show high predictive accuracy, but Figure 4 shows that adding GPA up to the first semester of the junior year to the predictor variables is sufficient to obtain satisfactory results. This high predictive accuracy is due to the fact that the GPA is a reflection of the academic performance of individual students. In the final model of 2020s, Boruta is used to identify variable importance and in which semester GPA is more important in predicting national exam pass/fail. Boruta was repeated 40 times, and the P-value threshold was set at 0.05.

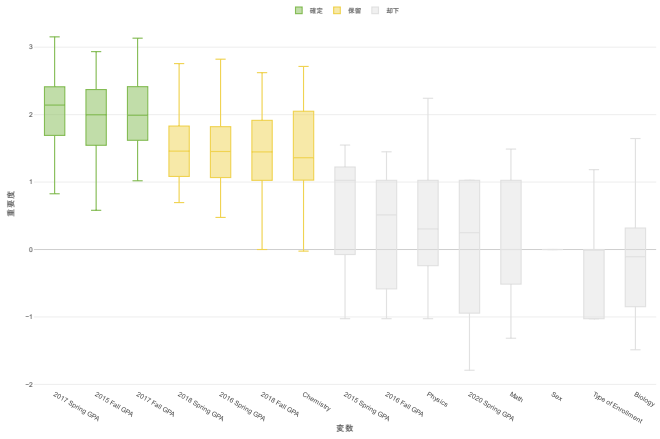


Figure 3: Variable Importance by Boruta

The results showed that GPA was significantly more important in the spring and fall semesters of 2017 and in the fall semester of 2015.

Acknowledgment

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References

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