Predicting Successful Graduation from Performance in Mathematics Courses

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Student Success Prediction from Performance in Mathematics Classes

Our Data and the Question: Mathematics courses taken and outcome predicts successful graduation.

Our reduced data set: No individual grades, just

- Above C-
- Satisfactory/Pass
- C- or Below

What can be predicted now?

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- Created an analog of GPA

EDA

	Cleaned Dataset	Original Dataset
Total Students	9,181	13,065
Total Courses	28	110
Graduation Rate	49%	58%

EDA

	Math Major Courses	General Courses Only	Full Dataset
Total Students	1,245	7,936	9,181
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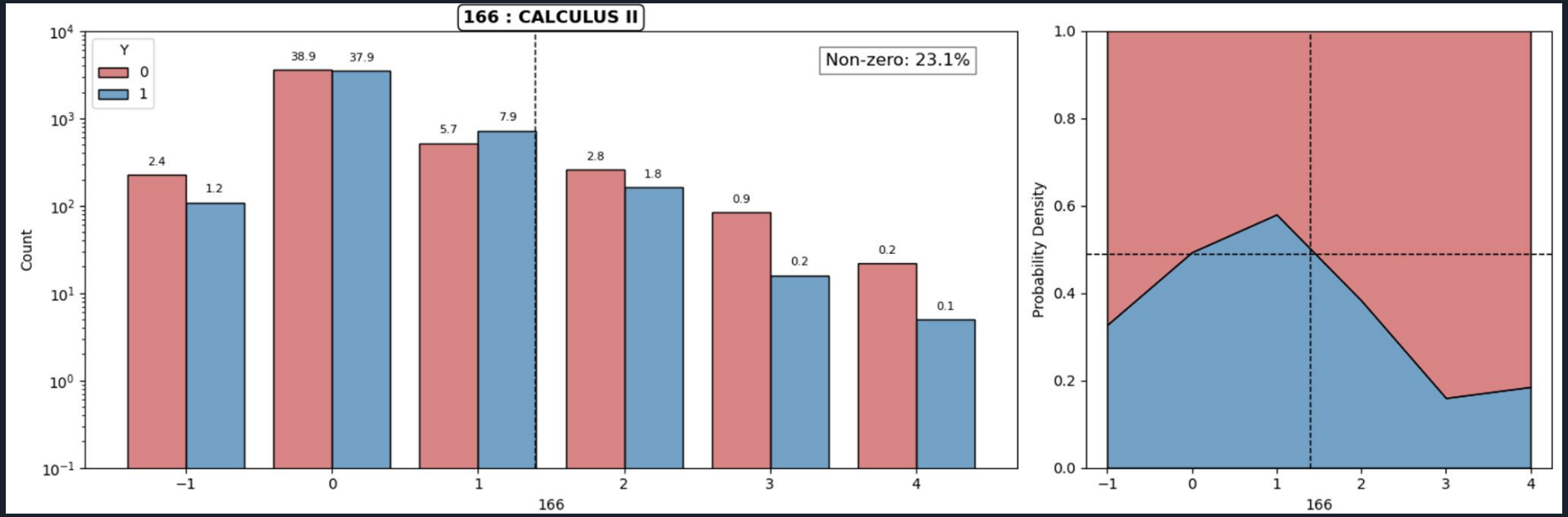
CONCLUSION: Taking at least 1 math major course may improve odds of graduating!

EDA



Weighted performance: 0 if student did not take the course -1 if student took the course and received less than a C

1-4 if student received a C or above in year 1-4, respectively

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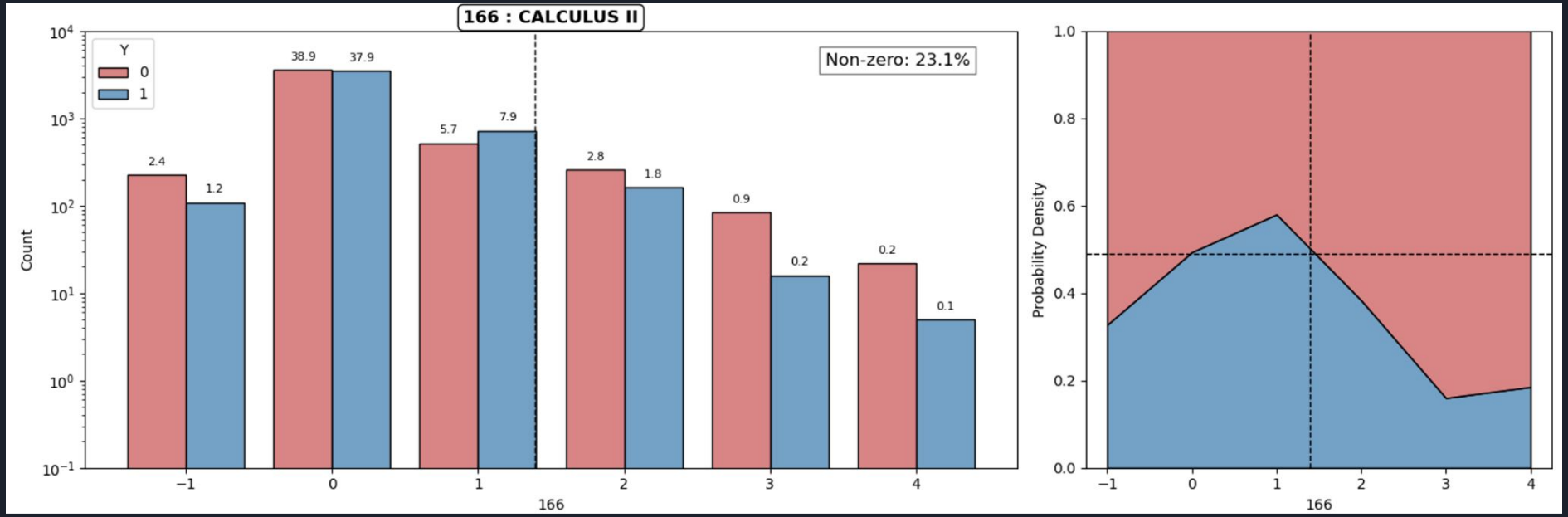

CONCLUSION: the earlier a math major course can be taken, the more likely the student is to succeed

Feature engineering

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- Question: Is taking more math courses in college correlated with graduating on time?
- Measuring “math performance” in college to account for passing time:
  - Performance in semester n:

    SEM_n_cdf = #(math courses passed in sem <=n) - #(math courses failed in sem <=n)
  - E.g. Alice passes 2 courses in 1st sem, fails one in 2nd sem, and takes no more math. Then

    SEM_1_cdf = 2,

    SEM_n_cdf = 1, for all n>1

- Expectation: Greater math performance implies greater odds of graduating in 4 years.

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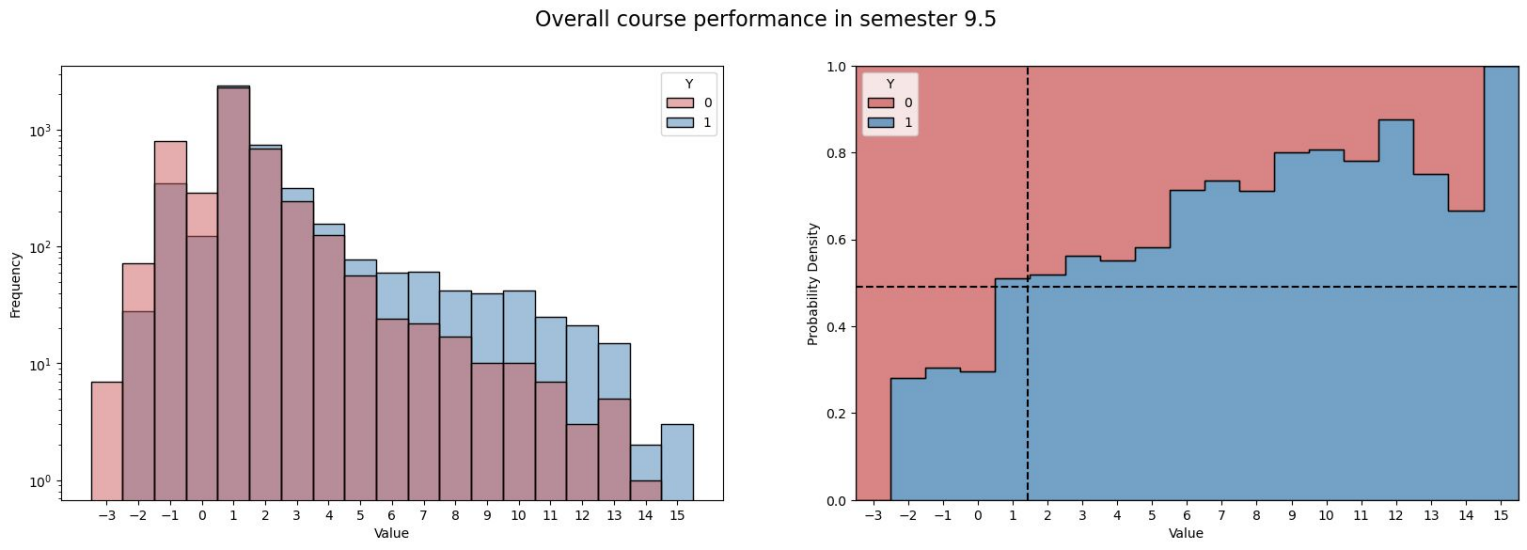

Uncanny connection:

- Performance < Mean performance
- Performance = Mean performance
- Performance > Mean performance

Probability of grad < Mean prob of grad
Probability of grad = Mean prob of grad
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  - Custom Stacked Classifier

Modeling Results

Model	CV Accuracy	Test Accuracy	Accuracy Change
Logistic	63.08	62.44	-1.01
SVC	64.86	64.53	-0.5
XGBoost	66.5	65.7	-1.19
Stacked	69.47s	65.78s	-5.27

Feature Importance

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- XGBoost preferred individual courses
  - Top 3 courses: Introduction to Probability, Preparation for Calculus, and Calculus II

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  - Unavoidable prediction error comes from groups of students
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  - Computed a (highly non-sharp) lower bound for Bayes Error Rate = **25.3**%!
  - Equivalently, upper bound on accuracy = **74.7**%!

- Conclusion: *The predictive power of our dataset was limited from the start!*

Future directions

- Despite the limited nature and sparsity of our dataset, we found some interesting correlations between math courses and successful graduation.

- Expect: with sufficiently large and robust data, can predict graduation with much higher probability.
  (*With great data comes great predictability!*)

- In particular, we believe that the math performance indicators can be further refined to increase predictive power.

- Long-term application: help departments develop tools to identify and support students at risk of dropping out.

Acknowledgements

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