Mar 28th, 10:00 AM - 10:45 AM

College Mathematics: Placement and Remediation through Data Mining

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College Mathematics

Placement through Data Mining & Remediation through Online Resources

Rachel Manspeaker

Peter Nguyen
About Our Institution
Some Historical and Demographic Information

• Coker College was founded by Major James Coker in 1908 and is located in the heart of the Pee Dee region of South Carolina.

• One of the reasons Coker College was originally founded was to provide a liberal arts education to those who would otherwise not have access to one.
Some Historical and Demographic Information

• As the years passed, Coker has grown in size and extended its reach to those outside the Pee Dee region, but a large number of its students still fit the above description.

• A nontrivial portion of Coker’s student body consists of Pell Grant and 1st generation students.
Data Mining and Placement
Inspiration

• Proper placement into first year mathematics courses is crucial to the immediate and overall success of a Coker student.

• Can we apply data mining techniques designed for analyzing large sets of information to this “small school” problem?

• MAT-399, Data Mining: James Shumpert’s final project was to use data mining techniques on incoming students’ SAT/ACT scores and high school GPA to attempt to predict success in their first college math class.
Classification and Regression Trees (CART)
Student Research- Review of Placement Practices: Summer 2012

• Goals:
  • Further analysis of current placement techniques
  • Analysis of student performance on a pilot placement exam
  • Introduce student researchers to data mining techniques

• Two student researchers: Dylan Bates and Jon Moree
Data Mining Techniques

• Cluster Analysis
  o Looking for similarly acting groups of students based on SAT and GPA data

• Singular Value Decomposition
  o Identifying which placement test questions contributed the most to student variation

• Item Response Theory
  o Compares correct response rates of individual questions to entire placement test scores.
Current Placement Practice: Cluster Analysis
Student Cluster Analysis

- **Cluster 1:** GPA = 3.2, SAT Math = 540, 69 students
  - MAT-101 (36%)   MAT-210 (52%)   • ABC rate: 60%

- **Cluster 2:** GPA = 3.11, SAT Math = 430, 126 students
  - MAT-101 (65%)   MAT-210 (25%)   • ABC rate: 66%

- **Cluster 3:** GPA = 3.68, SAT Math = 470, 96 students
  - MAT101 (51%)   MAT-210 (41%)   • ABC rate: 86%

- **Cluster 4:** GPA = 4.15, SAT Math = 570, 75 students
  - MAT-210 (60%)   MAT-222 and above (32%)   • ABC rate: 88%
• Somewhat obviously, students with very high standardized test scores and GPA’s will pass whatever course they choose to take.

• Traditionally, students are placed into math classes based on their standardized test scores, but GPA is more likely to determine if they will pass.

• Coker needs another predictive measure to more effectively place students into classes that give them their best chance of success.
Coker Math Placement Test

• Pilot placement test developed by Paul Dostert summer 2011.

• Taken online during the summer before freshman year

• Three exams
  o To place out of MAT-100 (remedial Basic Algebra- no credit)
  o To place out of MAT-101 (Algebraic functions)
  o To place into higher level class (Calc 1)
Placement Exam Analysis: Singular Value Decomposition

- Singular Value Decomposition
Placement Exam Analysis: Singular Value Decomposition

• Most of the variation is captured by a dimension composed of all the problems equally (as per usual).

• Problems contributing the most to first SVD dimensions
  o Fractions 3
  o GCD 1

• Problems contributing the least to the first SVD dimensions
  o Solving Equations 3
  o Order of Operations 1
Placement Exam Analysis: Item Response Theory

- Measures the effectiveness of a single question against the entire test.
Placement Exam Analysis: Item Response Theory

- A bad question will not differentiate between high and low scoring students.
Placement Exam Analysis: Item Response Theory

- There should be a variety of grades of steepness to distinguish between different levels of competency.
Placement Exam Analysis: Item Response Theory

- Questions that have the same curves are measuring the same level of proficiency, and therefore are redundant.
Adapting the Placement Exam

• Analysis indicated that students were not as successfully answering questions at the end of the exam, indicating the test should be shortened.

• We excised questions that did not contribute to variability, ones that had redundant IRT profiles for the same topic, and questions that did not distinguish between high and low scoring students.

• This reduced the placement exam from 25 to 13 questions.
Online Remediation
Motivation: Record Enrollment

- Enrollment records at Coker have been set for three consecutive years.

- The increased volume of students precipitated the need for more sections of the institution's two most remedial mathematics courses: MAT-100 and MAT-101.

- The updated placement exam placed a greater percentage of students into MAT-100 than in previous years (25%) as well as MAT-101 (40%).
Motivation: Limited Resources

• Despite the growth in student population, the number of full-time math faculty has remained constant.

• The pool of available qualified adjuncts has been fully utilized.
The Formula

Increased Course Demands
+ Limited Resources
Online Remediation
Our Solution:

Who

Faculty
• Dr. Paul Dostert
• Dr. Rachel Manspeaker
• Dr. Peter Nguyen

Students
• Dylan Bates
• Marie Rogers
Our Solution: How

• The project was essentially broken up into six phases:
  o Reflection
  o Decision
  o Exploration and Research
  o Strategizing
  o Production
  o Launch
Phase 1: Reflection

• What are the primary goals of our project?

• Who do we wish to reach with our project?

• How can we most reasonably achieve our goals and reach our targets with the available resources?
Phase 2: Decision

• We wanted to minimize the enrollment numbers for MAT-100.

• We did *not* want to create an online version of MAT-100.

• We wanted to serve those individuals whose mathematical muscles had atrophied from lack of use.

• We decided that an online “transition course” would be serve to accomplish both of the above goals.
Phase 3: Exploration and Research

- Google Sites (abandoned)
- Blackboard (adopted)
- Respondus (adopted)
- Khan Academy (adopted)
Phase 4: Strategizing

• Allocation of responsibilities

• Expected timetable
Phase 5: Production

• Before constructing our lessons, we created the exams which covered the material we wanted to ensure our MAT-101 students came in with.

• The problems covered on the exam were a mixture of imported problems and originally authored problems.

• After each unit’s exam was created, we created supplementary text-based mini-lessons to cover the material. Within these slides, links to khanacademy.org were provided.
Phase 6: Launch

- Even after diligent testing a few minor errors cropped up, but were easily fixed.

- Our launch deadline achieved and there was enough time for a first round of students to attempt the transition course.

- Advisors were given email notice on the role and structure of the transition course. They were also provided with instructions for how to help their advisees navigate the site.
Our Solution:
What

- The fruits of our labors can be found here.
Some Cautiously Optimistic Results

• To date, 42 total students have enrolled in the transition course.

• 17 students that did not pass the transition course, with only 6 actually failing.

• There is reason to believe that some academically dishonest behaviors are taking place.

• Despite having well-defined rules for placement there are still advisors overriding the placement results.
Some Cautiously Optimistic Results

- Of the 25 that have passed the transition course, nine went on to attempt the exam to place out of MAT-101. Two succeeded in doing so.

- In the Fall semester, 10 of the 25 enrolled in. All of them passed MAT-101 with grades ranging from C to A.

- Currently, there are currently 10 of the 25 students enrolled in. Eight of them are passing two are failing.
Future Work

• Gather feedback on the transition course and modify as appropriate.

• Further data mine to see what aspects of the transition course has the most positive impact.

• Continue to data mine our placement exams to see if our exams still provide meaningful information/placement.

• Apply the techniques used for other courses, not necessarily remedial ones.
Thank you!

Questions? Comments?