Using Learning Analytics to Coach Students to “Electrifying” Careers in Engineering

Exploring Learning Analytics Project
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What is Engineering?

• What is Engineering?
• What is Electrical Engineering?
• Take a minute and visualize what engineers do, and specifically electrical engineers
• Many students only picture this guy
• Don’t know what EE is, even after declaring!
Areas in Electrical Engineering

Circuits and Solid State Electronics

Computers

Electromagnetics and Optics

Control, Signals and Systems
How Do We Recruit/Advise/Mentor?

• How/who should we recruit to EE?
• What are common traits of successful EEs?
• How can we best advise our students?
• What can we learn from our students and alumni?
• Data and analytics should help!
  – Student academic records, past 10 years
  – Focus groups with current students
  – Surveys of students, alumni
  – Scrape data on alumni from LinkedIn
Model For Recommendations

Student Input

Academic record  |  Interests  |  Activities

Correlation, Predictive Models (Transfer function)

Prediction of success  |  Match interests and skills

Recommendations (output)

Area of study, courses  |  Careers, grad school  |  Extracurriculars
Analytics on Graduates (past 10 yrs)

- Start with graduating GPA as metric for success
- Examine correlations with course performance, gender, subdiscipline in EE

\[ r = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \bar{X})^2} \sqrt{\sum_{i=1}^{n}(Y_i - \bar{Y})^2}} \]
Some Examples of “Grade Penalty”

- EECS 280 (programming): grade penalty (grade-GPA < 1:1 line)
- Major Design: higher grades across the board
- No obvious differences among gender
- What is statistically significant?

![EECS 280 Graph](image1)

EECS 280

CC = 0.65814

![EECS 438 Graph](image2)

EECS 438

CC = 0.29531
Some Examples of “Grade Penalty”

• EECS 280 (programming): grade penalty (grade-GPA < 1:1 line)
• Major Design: higher grades across the board
• No obvious differences among gender
• What is statistically significant?

<table>
<thead>
<tr>
<th>Required</th>
<th>Major Design</th>
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<tbody>
<tr>
<td>2.2</td>
<td>3.8</td>
</tr>
<tr>
<td>2.4</td>
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<tr>
<td>2.6</td>
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<tr>
<td>2.8</td>
<td>3.2</td>
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<tr>
<td>3.0</td>
<td>3.0</td>
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</tbody>
</table>

Average Grade (2002-2013)
Comparison of Correlation

- Early required courses have strong correlation
- Weaker correlations for major design (typically high grades for all students)
- Weaker correlations for EECS 280 and 401 (turn out to have grade penalty!)
Relative Performance in Courses

- Compare performance in course relative to graduating GPA (Grade – GPA)
- Does a student generally perform better or worse in particular courses?
- Are there correlations with choice of major design?
Analyzing Differences Between Groups

• Use analysis of variance (ANOVA) to determine statistical significance
• Scheffe post-hoc analysis
• Cases where significance (p-value) < 0.05
  – EECS 215: Other MDE vs EECS MDE
  – EECS 216: Signals/systems vs EM/optics
  – EECS 230: Other MDE vs EECS MDE
  – EECS 280: Computers vs EM/optics, Circuits/SS
  – EECS 320: Circuits/SS vs all

(MDE = Major Design Experience)
• Lower relative performance in EECS 215 (circuits) and 230 (electromagnetics)
• Exception: Comparison to EM/Optics in EECS 215
• **Students choosing MDE outside EECS did worse in required courses (215 and 230) than other students**
Signals/Systems “math heavy”, did they do better in required signals/systems courses?

• Not necessarily! (high significance not observed)
Students choosing Computers MDE generally received higher grades in computer programming (EECS 280)

Students choosing circuits/solid state generally received higher grades in semiconductor devices (EECS 320)
Some required courses serve as predictors for choice of subdiscipline

- EECS 280: computers
- EECS 320: solid state and circuits
- EECS 215 and 230: all ECE

Some do not!
- EECS 216 and 401: signals and systems

Need data beyond grades
How are Major and Subfield Chosen?

• Get information from surveys
• First gather key feedback through focus groups
  – Undeclared EE
  – Recent declares (EECS 215, 216 students)
  – Juniors
  – Seniors in MDE courses
• Designing a good survey is important!
Determine how students make academic decisions

- Freshmen, sophomores, juniors, seniors
- Role of a good instructor cannot be overemphasized
  - A single professor can affect the course trajectory of students
- Job prospects dictate decisions
  - EE careers perceived to require graduate school
  - Computer Science positions are in large demand for B.S graduates

Use this information to help tailor surveys to improve program development
Surveys must be:
- Valid: are we measuring what we think we are measuring?
- Reliable: do we obtain the same results over time?

Exit survey includes:
- Demographics, choice of major, quality of program, extracurricular activities, post-graduation plans
- Quality of instruction and influences

Rolling out to 2014 graduates (fill out for senior audit!)

Plan to design/issue another survey to all current CoE students

Surveys based on past work:

Plans for the Survey Data

• Examine regression models for several dependent variables
• Where do we see strong correlations, high confidence?

\[ y_i = \beta_1 x_{i1} + \ldots + \beta_p x_{ip} + \varepsilon_i, \quad i = 1,\ldots,n \]

**Dependent variables**
- Choice of sub-discipline
- Job placement
- Grad/professional school acceptance
- Confidence to succeed in future
- Overall satisfaction with program
- Graduating GPA

**Predictor variables**
- Age
- Gender
- Parental education
- Prior awareness of engineering
- Student societies
- Student projects
- Internships and co-ops
- Research
- Awards and scholarships

(With advice from CSCAR, of course!)
Conclusions

• Strong correlations observed between required courses and graduating GPA (predictor, or is “a good student a good student”?)

• Improved relative performance in required courses appears to correlate with choice of design project, but only certain subfields

• Survey information expected to help identify how EE and EE subfields chosen by students, and where to target recruiting and advising

• Big challenge: connection with alumni!
Thanks to the Learning Analytics Fellows and Exploring Learning Analytics program for support of this project, and to Center for Statistical Consultation and Research for advice in statistical analysis.