Week 1, video 1

Intro to EDM
Why EDM now?
Which tools to use in class
Big Data in Education
In this MOOC, you’ll learn methods used for exploring big data in education
Two communities

- **International Educational Data Mining Society**
  - First event: EDM workshop in 2005 (at AAAI)
  - First conference: EDM2008
  - Publishing JEDM since 2009

- **Society for Learning Analytics Research**
  - First conference: LAK2011
  - Journal of Learning Analytics (founded 2012)
Two communities

- Joint goal of exploring the “big data” now available on learners and learning

- To promote
  - New scientific discoveries & to advance learning sciences
  - Better assessment of learners along multiple dimensions
    - Social, cognitive, emotional, meta-cognitive, etc.
    - Individual, group, institutional, etc.
  - Better real-time support for learners
EDM/LA is...

- “... escalating the speed of research on many problems in education.”
- “Not only can you look at unique learning trajectories of individuals, but the sophistication of the models of learning goes up enormously.”

Arthur Graesser, Editor, Journal of Educational Psychology
EDM/LA is...

- "... great."

- Me
Despite the area’s newness, we’ve learned a few things about key problems

This course is about methods that have been found to be useful for those problems by EDM/LAK researchers
Where do methods come from?

- Some of the methods would be familiar to someone with a background in Data Mining or Machine Learning.
- Some of the methods would be familiar to someone with a background in Psychometrics or traditional Statistics.
- You don’t have to have either of these backgrounds to get something out of the course.
  - Pick and choose what you find most useful.
A few words for data miners

- You’ll find that there are some current trends in data mining that aren’t represented
- Some of those haven’t gotten here yet
- Some of those haven’t been very useful yet
- I’ll be focusing on the methods of broadest usefulness, not coolest newestness
A word of note

- Just because a method is more recent or produces more complex models does not mean it’s better.

- With complex real-world data, more complex approaches tend to over-fit more to the noise in the data or the biases in the training sample.

(Hand, 2006, Classifier Technology and the Illusion of Progress)
What makes data “big”? 

  - Volume
    - How much total data?
  - Velocity
    - How fast is data coming in? (and how fast do you have to handle it?)
  - Variety
    - Incompatible formats, non-aligned data structures, inconsistent data semantics
Is educational data big?

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Not that big?

- But the name of the course is big data in education!
Not that big?

- Big data in education is big
  - Big by comparison to most classical education research
  - Big compared to common data sets in many domains

- But it’s not human genome project or google big
That differences in $r^2$ of 0.0019 routinely come up as statistically significant (Wang, Heffernan, & Beck, 2011; Wang & Heffernan, 2013)
I will talk about statistical significance

- Sometimes
- But it will not be a focus of the class
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- But it will not be a focus of the class

- Also: statisticians note, terminology is sometimes conflicting between stats and data mining/machine learning
  - I’ll highlight particularly annoying cases where they emerge
Types of EDM/LA method
(Baker & Siemens, 2014; building off of Baker & Yacef, 2009)

- Prediction
  - Classification
  - Regression
  - Latent Knowledge Estimation

- Structure Discovery
  - Clustering
  - Factor Analysis
  - Domain Structure Discovery
  - Network Analysis

- Relationship mining
  - Association rule mining
  - Correlation mining
  - Sequential pattern mining
  - Causal data mining

- Distillation of data for human judgment
- Discovery with models
Prediction

- Develop a model which can infer a single aspect of the data (predicted variable) from some combination of other aspects of the data (predictor variables)

- Which students are off-task?
- Which students will fail the class?
Structure Discovery

- Find structure and patterns in the data that emerge “naturally”

- No specific target or predictor variable
Relationship Mining

- Discover relationships between variables in a data set with many variables
Discovery with Models

- Pre-existing model (developed with EDM prediction methods... or clustering... or knowledge engineering)

- Applied to data and used as a component in another analysis
Why now?

- Why didn’t EDM emerge in the early 1980s, like bioinformatics?
A lot of reasons

- One of the key ones: not enough data
  - In the 1980s, collecting educational data was highly resource-intensive and difficult to scale
  - Much of the data that was easily collectible was purely summative in nature
  - Getting data on learning processes and learner behaviors, in field settings, required methods like
    - Quantitative field observations
    - Video recordings
    - Think-Aloud studies
  - None of which scale easily
Fast-forward to today

- Lots of standardized exams
  - Still summative in nature
- But lots of students now use internet-based educational software in class
  - Can be used to get at learning processes and learner behaviors
  - At a fine-grained scale (can log behavior at a second by second level)
  - Data acquisition is very scalable
- And there are these things called MOOCs which you may have heard of....
PSLC DataShop

(Koedinger et al, 2008, 2010)

- World’s leading public repository for educational software interaction data
- >250,000 hours of students using educational software
- >30 million student actions, responses & annotations
  - Actions: entering an equation, manipulating a vector, typing a phrase, requesting help
  - Responses: error feedback, strategic hints
  - Annotations: correctness, time, skill/concept
Tools

- There are a bunch of tools you can use in this class.
  - **RapidMiner** is one tool you will need to learn in this course
    - Accessible to non-programmers
    - A large proportion of the power of Python or R
  - There is a walkthrough with instructions for getting started
Closing thoughts

- EDM/LAK methods emerging for big data in education
- In this class, you’ll learn the key methods and how to use them for
  - Promoting scientific discovery
  - Driving intervention and improvements in educational software and systems
- Strengths & weaknesses of methods for different applications
- Is your analysis trustworthy? Is it applicable?