Visualization
Learning Curves
Visualization

- Displaying information in a meaningful fashion
Visualization Should…
(Tufte, 1983)

- Show the data
- Induce the viewer to think about the substance
- Avoid distorting what the data have to say
- Make large data sets coherent
- Encourage the eye to compare different pieces of data
- Reveal the data at several levels
- (And other stuff too)
Visualization

- A big area
- Worthy of a course in its own right
- Rather than discussing standard visualizations
- I’ll discuss a few visualizations that are particularly important with educational data
Learning Curves

- One of the most important visualizations in education

- Briefly discussed in Week 4

- I’ll go into more depth today
The Classic Learning Curve
Assumptions

- The student is practicing the same skill several times in (approximately) the same fashion
- Completing a physics problem set
- Reading the same word in several stories
- Learning to complete an assembly line procedure
  - Early application! (Crossman, 1959)
Assumptions

- Similar methods and considerations apply to situations where the student is recalling the same knowledge several times
Assumptions

- We have some way to measure student performance over time
  - Speed or accuracy
Learning LISP programming in the LISP Tutor (Corbett & Anderson, 1995)

![Graph showing the relationship between error rate and opportunity to apply a rule. The x-axis represents the opportunity to apply a rule in terms of required exercises, while the y-axis represents the error rate. The graph shows a decreasing trend as the opportunity to apply a rule increases.]
Learning in Cognitive Tutor Geometry (Ritter et al., 2007)
A certain characteristic pattern
Power Law of Learning*

- Performance (both speed and accuracy) improves with a power function

* -- May actually be an exponential function rather than a power function (Heathcote, Brown, & Mewhort, 2000)
Called Power Law

- Because speed and accuracy both follow a power curve

- Radical improvement at first which slows over time towards an asymptote

- Passing the asymptote usually involves developing entirely new strategy
Passing the Asymptote

- Famous example: Fosbury Flop

  - [http://www.youtube.com/watch?v=Id4W6VA0uLc](http://www.youtube.com/watch?v=Id4W6VA0uLc)
Power Law of Learning proven to apply across many domains

- **Simple domains**
  - Pressing correct button on stimulus

- **Complex problem-solving domains**
  - Math
  - Programming

- **Real-world domains**
  - Cigar-making in factories (Crossman, 1959)
Real-world data

- Are rarely perfectly smooth...

- (At least not without hundreds of students or more)
Example from a minute ago
Making inference from learning curves
Making inference from learning curves

- Via visual inspection of the curve form
“Normal learning”
No learning going on
What might this graph mean?
Insert Pause-Continue Quiz Here
Student has already learned skill for the most part
What might this graph mean?
Insert Pause-Continue Quiz Here
Student learned a new strategy and “broke through” the asymptote
What might this graph mean?
Insert Pause-Continue Quiz Here4
Two skills treated as the same skill (Corbett & Anderson, 1995)
Uses

- To understand how (and whether) a skill is being learned across students
Uses

- To study and refine item-skill mappings in educational software

- As discussed in week 4, Pittsburgh Science of Learning Center DataShop (Koedinger et al., 2010) is a common tool for doing this
Next lecture

- Moment-by-Moment Learning Graphs