Introduction to Visual Analytics

Week 1 Lecture 1
IAT 355
Lyn Bartram
Introductions

- Instructor
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- Visualization
  - Information visualization
  - Perception, attention and visual representations
  - Visualization for sustainable living/Ambient visualization
  - Motion and Animation visual techniques
  - And generally interactive visual systems
Introductions: Ankit

• He will introduce himself
What is visualisation?

- [geek] branches of computer graphics and user interface design that are concerned with presenting data to users by means of images
  - A tool or method for generating images from complex multidimensional data fed into a computational processor

- [psychologist] The formation of mental visual images
  - The act or process of interpreting in visual terms

- [designer] The process of putting into visual form
  - The art of assigning representational “codes” and techniques to data attributes and conveying meaning
  - The practice of assembling images
What is visual analytics?

• the science of **analytical reasoning** supported by highly interactive visual interfaces
• the science of combining interactive visual interfaces with automatic algorithms to support analytical reasoning and build synergies between humans and computers
  - Data mining
  - Visualization
  - Cognition
  - Information retrieval

• Highly complex, sometimes incomplete data
• AND HUGE AMOUNTS OF IT!
Why do we care?
Why?

• We are in a new era of human history:
• Since 1994 we have witnessed an information explosion
  ■ Everyone can get all of the data that’s out there
    • News, sports, financial, purchases, etc...

• What do we do with it?
Kegs of data

• Between 1 and 2 exabytes of unique data produced per year
  ▪ 10000000000000000000 (10^{18}) bytes
  ▪ 800 meg for every person (2003)
  ▪ Printed documents only .003% of total
    Lyman and Varian, 2000
    Cal-Berkeley, Info Mgmt & Systems
    www.sims.berkeley.edu/how-much-info
  ▪ 90 trillion emails sent on the Internet in 2009
Unlike Before…

• Used to be (15 years ago), you had to go to a library
  - read the info, put it on some sort of storage device, take notes, run a specialized program
  - On a computer 1000 times slower than today

• Now:
  - How do we make sense of the data?
  - How do we harness this data in decision making processes?
  - How do we avoid being overwhelmed?
The only reasonable solution

• Computing + Human Vision
  ■ Highest bandwidth sense
  ■ Fast, parallel
  ■ Pattern recognition
  ■ Extends memory and cognitive capacity
  ■ Many People think visually
Visualizations make data into information

Causes of Mortality in the Army in the East
April, 1854 to March 1855

- Non-Battle
- Battle

From: F. Nightingale, "Notes on Matters Affecting the Health, Efficiency and Hospital Administration of the British Army", 1858
At first glance: the Cain 9-9-9 tax proposal

![Chart showing tax impact relative to current policy, 2013.](chart.png)
But really …. 

• A different picture tells a very different story
The sensemaking loop of visual analysis

**Figure 2.** Notional model of sensemaking loop for intelligence analysis derived from CTA.
Two Levels of Design

• 2 Levels of Designing things:
  ▪ WHAT
  ▪ HOW
WHAT

• What is WHAT?
  ■ The first design task is to figure out WHAT to design
    • Talk to stakeholders,
    • Dream up a great idea, etc
    • Refine an existing design
HOW

• What is HOW?
  ▪ As one becomes more clear about WHAT, You can start to figure out HOW to design/build it.
  ▪ HOW follows WHAT
    • (Although they may co-evolve as you learn more about the problem)

• What we do at SIAT is WHAT and HOW
• This class touches on both
Questions:

1. Which state has the highest income?
2. Is there a relationship between income and education?
3. Are there any outliers?
Spotfire: Visualize the data

1. [Circle 1]
2. [Circle 2]
3. [Circle 3]
Visualization

• It’s tempting to think that Visualization is about pictures
• Really, it’s a tool to help you think about a problem and learn something
  ▪ A cognitive process helped by pictures
  ▪ “The purpose of visualization is insight, not pictures”
    • Fred Brooks, quoting Claude Shannon
  ▪ Insight: discovery, decision making, explanation
Visual thinking

• Visuals help us think
  ▪ Provide a frame of reference, a temporary storage area

• External cognition
  ▪ Role of external world in thinking and reason
Information

• What is “information”?
  ▪ Items, entities, things which do not have a direct physical correspondence
  ▪ Notion of abstractness of the entities is important too
  ▪ Examples: baseball statistics, stock trends, connections between criminals, car attributes...
  ▪ Data that have been abstracted and placed into meaningful form
What is “Visualization”?  

• The use of computer-supported, interactive visual representations of data to amplify cognition.  [Card, Mackinlay Shneiderman ‘98]

• DISCOVERY, EXPLORATION, INVESTIGATION

• COMMUNICATION, EXPLANATION
Scientific visualization

- the visual display of spatial data associated with scientific processes (e.g., bonding of molecules)

- deals with data that has a natural geometric structure (e.g., chemical data or wind flows)
Information visualization

• visual metaphors for non-inherently spatial data such as the exploration of text-based document databases.
  ▪ More abstract
• Assign structure and position to information that has none

• Text
• Statistics
• Finance/Business
• Internet
• Software
Visual analytics

• analytical reasoning supported by the interactive visual interface

• Intersection of visualization with data analysis

• Biology

• National security
SciVis vs InfoVis

- With SciVis: you have the geometry already
- With InfoVis: Must create a mapping from Information to geometry
  - Map info to 2D or 3D space
  - Give the info a visual representation

- Both: Enable interaction with the visual data
Using vision to think

- Comprehend huge amounts of data
- Emergent properties and relations
- Detect problems and inconsistencies in data
- Facilitates understanding of large- and small-scale features of the data
- Facilitates hypothesis formation: the forming of new questions and insights
Visualization goals: not quite there
So what is visualization again? (take 2)

Visual thinking involves:

• Constructing visual queries on displays
• Visual search strategies through eye movements and attention to relevant patterns
• Visual notification and attention “redirection” to new patterns and events
• Well structured balance of elements and tasks
IAT 355 Course information
What you will do in this course

• Design, Build, Use, Critique Visualizations

• Develop an understanding of tools, techniques and methods for approaching visual analytics problems

• Become familiar with some of the programming resources for making visualizations
Topics

- Visualization Tools, techniques and Programming
  - Computer Graphics
- Information Visualization
  - Representation
  - Presentation
  - Interaction
- Visual Thinking: Perception, Cognition and Information Sense-Making
Assessment

- 4 Assignments (10% each, 40%)
  - Analysis
  - Making \( (\text{programming}) \)
- In-class exercises and participation: 10%
- Small Project (25%): programming or analysis
- Final Exam (25%)

- You must get 50% in each to pass the course
Course Information

- Course website:

- Updates, schedule, policies and all information are kept current on this site. Check it!
  - List of resources and articles

- Canvas submission and discussion site
Logistics

- Lectures
- Tues, Wed, Thurs 5:30 PM – 6:20 PM SUR 2740
  - At least one will be hands-on, “workshop” session
  - 2 lectures
  - Assignments are due Fri night at 11:59 PM

- Optional drop-in session SUR 3100
  - Vote for Tue or Th 6:30- 7:20 PM

- Office hours by appointment
Course policies

• Attendance

• Use of technology

• Conduct

• Plagiarism and academic honesty

• Late penalties (10% day for 2 days, 20% after)
Expected Audience

- People in 3rd year
- Some experience with design
- Some experience with building software

I DON'T KNOW HOW COMPUTATIONALLY FLUENT YOU ARE:
- Please fill out this very short survey on programming experience: it will help me better tailor the class to your needs.
- https://websurvey.sfu.ca/cgi-bin/WebObjects/WebSurvey.woa/wa/survey?99382727
How to find me

Lyn Bartram Office (not really very good)

• 778 782 7439
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• HVI Lab (best place to physically find me)
• 778 782 8009
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• drlynb (skype)