CS 147: Computer Systems Performance Analysis
Specifics of Graphical Presentation
Overview

Specific Things to Do
- Give Information the Reader Needs
- Limit Complexity and Confusion
- Have a Point
- Show Statistics Graphically
- Don’t Always Use Graphics
- Discuss It in the Text

Principles of Esthetics
- Use Appropriate Format and Design
- Use Words, Numbers, Drawings Together
- Reflect Balance, Proportion, Relevant Scale
- Keep Detail and Complexity Accessible
- Have a Story About the Data
- Do a Professional Job of Drawing
- Avoid Decoration and Chartjunk
Give Information the Reader Needs

- Show informative axes
  - Use axes to indicate range
- Label things fully and intelligently
- Highlight important points on the graph
Giving Information the Reader Needs

Specific Things to Do

Give Information the Reader Needs

Example of a bar chart showing data distribution across categories.
Giving Information the Reader Needs

Sales in Millions

<table>
<thead>
<tr>
<th></th>
<th>East</th>
<th>West</th>
<th>North</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Qtr</td>
<td>20</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>2nd Qtr</td>
<td>80</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>3rd Qtr</td>
<td>100</td>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td>4th Qtr</td>
<td>40</td>
<td>20</td>
<td>0</td>
</tr>
</tbody>
</table>

Microsoft Contract Signed

1st Qtr 2015-06-15
Limit Complexity and Confusion

- Not too many curves
- Single scale for all curves
- No “extra” curves
- No pointless decoration (“ducks”)
Specific Things to Do
Limit Complexity and Confusion

Limiting Complexity and Confusion

CS147

2015-06-15
Specific Things to Do
Limit Complexity and Confusion

1st Qtr 2nd Qtr 3rd Qtr 4th Qtr

Millions of Dollars

Japan Europe Mexico

2015-06-15
Have a Point

- Graphs should add information not otherwise available to reader
- Don’t plot data just because you collected it
- Know what you’re trying to show, and make sure the graph shows it
Having a Point

- Sales were up 15% this quarter:
Specific Things to Do

Having a Point

User Time of Copy Benchmarks (Seconds)

- cp
- rcp

1 Replica 2 Replicas 3 Replicas 4 Replicas

0.00
0.25
0.50
0.75
1.00

2015-06-15
CS147
Having a Point

Specific Things to Do

- Throughput (Mbits/sec) vs. Latency (ms)
- Modem
- Ethernet
- ATM
- Satellite

- CS147
- 2015-06-15
Show Statistics Graphically

- Put bars in a reasonable order
  - Geographical
  - Best to worst
  - Even alphabetic
- Make bar widths reflect interval widths
  - Hard to do with most graphing software
- Show confidence intervals on the graph
  - Examples will be shown later
Specific Things to Do

Don’t Always Use Graphics

- Tables are best for small sets of numbers
  - Tufte says 20 or fewer
- Also best for certain arrangements of data
  - E.g., 10 graphs of 3 points each
- Sometimes a simple sentence will do
- Always ask whether the chart is the best way to present the information
  - And whether it brings out your message
Specific Things to Do

Don’t Always Use Graphics

Text Would Have Been Better
Discuss It in the Text

- Figures should be self-explanatory
  - Many people scan papers, just look at graphs
  - Good graphs build interest, “hook” readers
  - Caption should help that process
- But text should highlight and aid figures
  - Tell readers when to look at figures
  - Point out what figure is telling them
  - Expand on what figure has to say
  - Put figures near text so it’s easy to find
Principles of Esthetics

Esthetics

- Not everyone is an artist
  - But figures should be visually pleasing
- Elegance is found in
  - Simplicity of design
  - Complexity of data
Don’t automatically draw a graph
  ► Mentioned before

Choose graphical format carefully

Sometimes “text graphic” works best
  ► Use text placement to communicate numbers
  ► Very close to being a table
Using Text as a Graphic

A year ago, eight forecasters were asked for their predictions on some key economic indicators. Here’s how the forecasts stack up against the probable 1978 results (shown in the black panel).

<table>
<thead>
<tr>
<th>Indicator</th>
<th>CEA</th>
<th>DR</th>
<th>NABE</th>
<th>WEF</th>
<th>CBO</th>
<th>CB</th>
<th>IBM</th>
<th>NABE</th>
<th>IBM</th>
<th>WEF</th>
</tr>
</thead>
<tbody>
<tr>
<td>GNP</td>
<td>+3.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IPG</td>
<td>+5.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPI</td>
<td>+7.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+13.3</td>
</tr>
<tr>
<td>Unempl</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+6.0</td>
</tr>
</tbody>
</table>

From Tukey, via Tufte, heights of some volcanos:

0|9 = 900 feet
1|97719630
2|99987766654422211009850
3|876655412099551426
4|999844331929433361107
5|976666655442210097731
6|898665441077761065
7|9885431100652108073
8|653322122937
9|77655421000493
0|984433165212

Stem-and-leaf displays:
heights of 218 volcanos, unit 100 feet
11|4963201631
12|45421164
13|47830
14|00
15|676
16|52
17|92
18|5
19|3 = 19,300 feet
19|39730
Choosing a Graphical Format

- Many options, more being invented all the time
  - Examples will be given later
  - See Jain for some commonly useful ones
  - Tufte shows ways to get creative

- Choose a format that reflects your data
  - Or that helps you analyze it yourself
Put graphics near or in text that discusses them
  - Even if you have to murder your word processor
Integrate text into graphics
Tufte: “Data graphics are paragraphs about data and should be treated as such”
Much of this boils down to “artistic sense”

Make sure things are big enough to read
  - Tiny type is OK only for young people!

Keep lines thin
  - But use heavier lines to indicate important information

Keep horizontal larger than vertical
  - About 50% larger works well
Remarks:

**Principles of Esthetics**

Reflect Balance, Proportion, Relevant Scale

**Poor Balance and Proportion**

- Sales in the North and West districts were steady through all quarters.
- East sales varied widely, significantly outperforming the other districts in the third quarter.
Better Proportion

- Sales in the North and West districts were steady through all quarters
- East sales varied widely, significantly outperforming the other districts in the third quarter
Make your graphics friendly:
- Avoid abbreviations and encodings
- Run words left-to-right
- Explain data with little messages
- Label graphics, don’t use elaborate shadings and a complex legend
- Avoid red/green distinctions
- Use clean, serif fonts in mixed case
An Unfriendly Graph
Note almost no growth in compile/remove times.
Note slower growth in compile and remove times.
May be difficult in technical papers
But think about why you are drawing graph
Example:
  Performance is controlled by network speed
  But it tops out at high end
  And that’s because we hit a CPU bottleneck
Showing a Story About the Data

Transactions per Second

Network Bandwidth (Mbps)

CPU bottleneck reached
Do a Professional Job of Drawing

- This is easy with modern tools
  - But take the time to do it right
- Align things carefully
- Check final version in format you will use
  - I.e., print Postscript one last time before submission
  - Or look at your slides on projection screen
    - Preferably in presentation room
    - Color balance varies by projector
Avoid Decoration and Chartjunk

- Powerpoint, etc. make chartjunk easy
- Avoid clip art, automatic backgrounds, etc.
- Remember: data is the story
  - Statistics aren’t boring
  - Uninterested readers aren’t drawn by cartoons
  - Interested readers are distracted
- Does removing it change message?
  - If not, leave it out
Examples of Chartjunk

- Borders and Fills Galore
- Pointless Fake 3-D Effects
- Unintentional Heavy or Double Lines
- In or out?
- Vibration
- Filled “Walls”
- Unintentional Gridlines!
- Serif Font with Thin & Thick Lines
- Filled “Floor”
- Filled Labels
- Clip Art