


CS533

Modeling and Performance
Evaluation of Network and
Computer Systems

The Art of Data
Presentation


(Chapters 10 and 11)



Introduction


It's not what you say, but how you say it. – A. Putt

- An analysis whose results cannot be understood is as good as one that is never performed.
- General techniques
 - Line charts, bar charts, pie charts, histograms
- Some specific techniques
 - Gantt charts, Kiviatt graphs ...
- A picture is worth a thousand words
 - Plus, easier to look at, more interesting



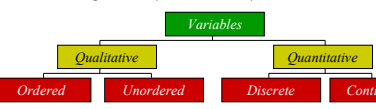
Outline


- Types of Variables
- Guidelines
- Common Mistakes
- Pictorial Games
- Special Purpose Charts
- Decision Maker's Games
- Ratio Games



Types of Variables


- Qualitative (Categorical) variables
 - Have states or subclasses
 - Can be ordered or unordered
 - Ex: PC, minicomputer, supercomputer → ordered
 - Ex: scientific, engineering, educational → unordered
- Quantitative variables
 - Numeric levels
 - Discrete or continuous
 - Ex: number of processors, disk blocks, etc. is discrete
 - Ex: weight of a portable computer is continuous





Outline

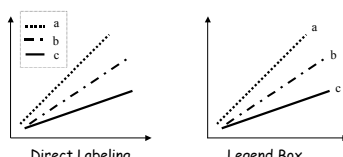
- Types of Variables
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Guidelines for Good Graphs (1 of 5)


- Again, "art" not "rules". Learn with experience. Recognize good/bad when see it.
- Require minimum effort from reader
 - Perhaps most important metric
 - Given two, can pick one that takes less reader effort

Ex:



Direct Labeling

Legend Box



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Guidelines for Good Graphs (2 of 5)

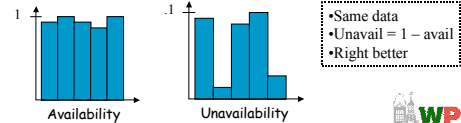
- Maximize information
 - Make self-sufficient
 - Key words in place of symbols
 - Ex: "PIII, 850 MHz" and not "System A"
 - Ex: "Daily CPU Usage" not "CPU Usage"
 - Axis labels as informative as possible
 - Ex: "Response Time in seconds" not "Response Time"
 - Can help by using captions, too
 - Ex: "Transaction response time in seconds versus offered load in transactions per second."

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Guidelines for Good Graphs (3 of 5)

- Minimize ink
 - Maximize information-to-ink ratio
 - Too much unnecessary ink makes chart cluttered, hard to read
 - Ex: no gridlines unless needed to help read
 - Chart that gives easier-to-read for same data is preferred



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Guidelines for Good Graphs (4 of 5)

- Use commonly accepted practices
 - Present what people expect
 - Ex: origin at (0,0)
 - Ex: independent (cause) on x-axis, dependent (effect) on y-axis
 - Ex: x-axis scale is linear
 - Ex: increase left to right, bottom to top
 - Ex: scale divisions equal
- Departures are permitted, but require extra effort from reader so use sparingly

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Guidelines for Good Graphs (5 of 5)

- Avoid ambiguity
 - Show coordinate axes
 - Show origin
 - Identify individual curves and bars
 - Do not plot multiple variables on same chart

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Guidelines for Good Graphs (Summary)

- Checklist in Jain, Box 10.1, p. 143
- The more "yes" answers, the better
 - But, again, may consciously decide not to follow these guidelines if better without them
- In practice, takes several trials before arriving at "best" graph
- Want to present the message the most: accurately, simply, concisely, logically

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Common Mistakes (1 of 6)

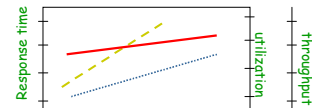
- Presenting too many alternatives on one chart
- Guidelines
 - More than 5 to 7 messages is too many
 - (Maybe related to the limit of human short-term memory?)
 - Line chart with 6 curves or less
 - Column chart with 10 bars
 - Pie chart with 8 components
 - Each cell in histogram should have 5+ values



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Common Mistakes (2 of 6)

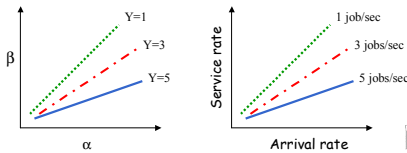
- Presenting many y-variables on a single chart
 - Better to make separate graphs
 - Plotting many y-variables saves space, but better to requires reader to figure out relationship
 - Space constraints for journal/conf!



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Common Mistakes (3 of 6)

- Using symbols in place of text
- More difficult to read symbols than text
- Reader must flip through report to see symbol mapping to text
 - Even if "save" writers time, really "wastes" it since reader is likely to skip!



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Common Mistakes (4 of 6)

- Placing extraneous information on the chart
 - Goal is to convey particular message, so extra information is distracting
 - Ex: using gridlines only when exact values are expected to be read
 - Ex: "per-system" data when average data is only part of message required



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Common Mistakes (5 of 6)

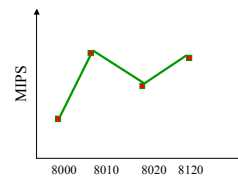
- Selecting scale ranges improperly
 - Most are prepared by automatic programs (excel, gnuplot) with built-in rules
 - Give good first-guess
 - But
 - May include outlying data points, shrinking body
 - May have endpoints hard to read since on axis
 - May place too many (or too few) ticks
 - In practice, almost always over-ride scale values



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Common Mistakes (6 of 6)

- Using a Line Chart instead of Column Chart
 - Lines joining successive points signify that they can be approximately interpolated
 - If don't have meaning, should not use line chart



- No linear relationship between processor types!
- Instead, use column chart



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Pictorial Games

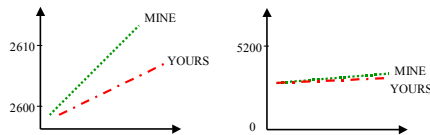
- Can deceive as easily as can convey meaning
- Note, not always a question of bad practice but should be aware of techniques when reading performance evaluation

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Non-Zero Origins to Emphasize (1 of 2)

- Normally, both axes meet at origin
- By moving and scaling, can magnify (or reduce!) difference



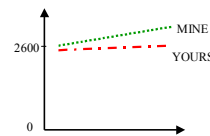
Which graph is better?

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Non-Zero Origins to Emphasize (2 of 2)

- Choose scale so that vertical height of highest point is at least $\frac{3}{4}$ of the horizontal offset of right-most point
 - Three-quarters rule
- (And represent origin as 0,0)

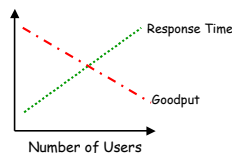


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Using Double-Whammy Graph

- Two curves can have twice as much impact
 - But if two metrics are related, knowing one predicts other ... so use one!

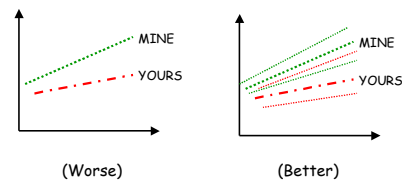


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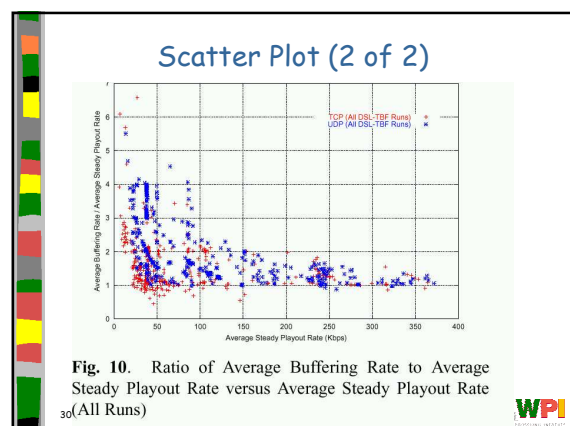
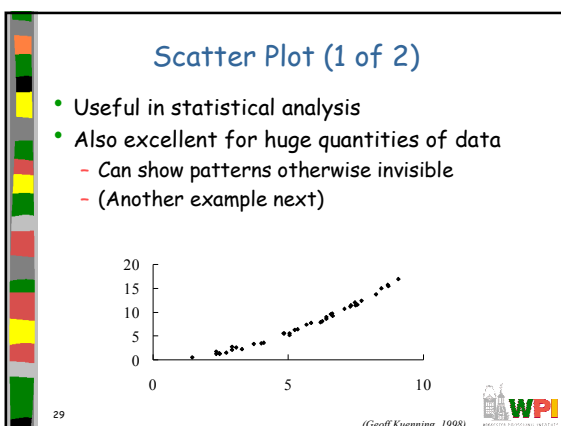
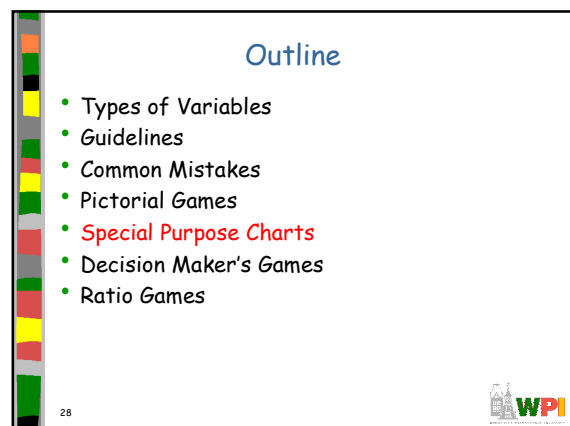
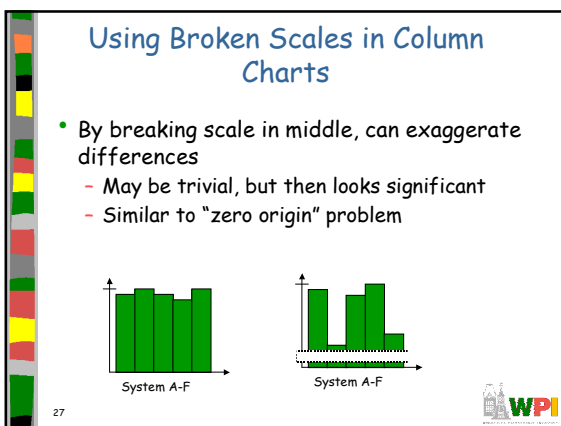
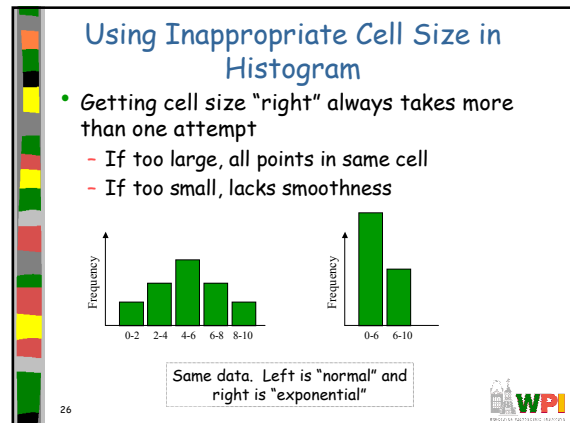
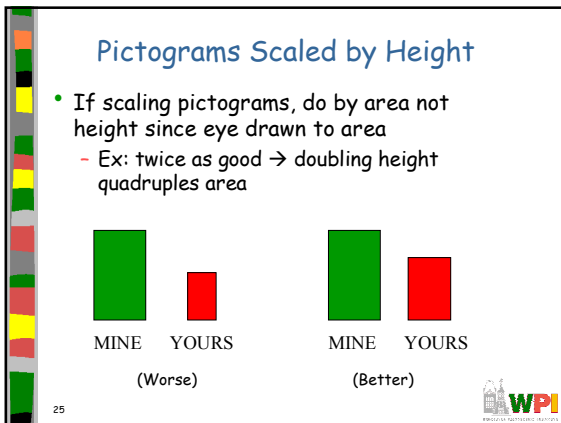
Plotting Quantities without Confidence Intervals

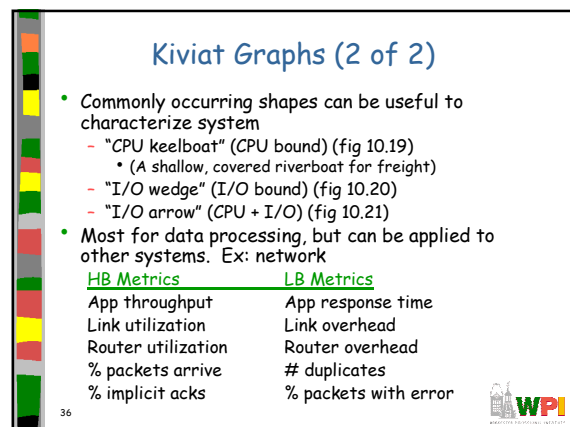
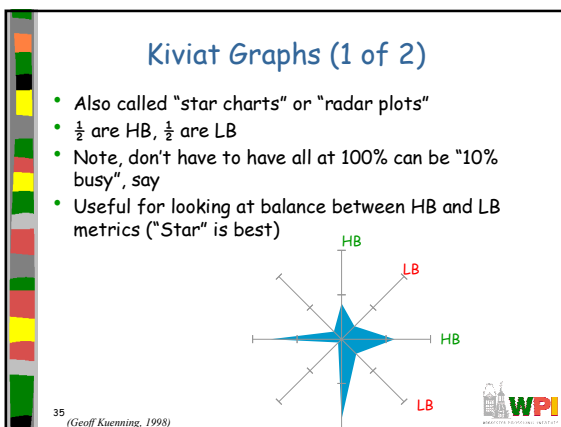
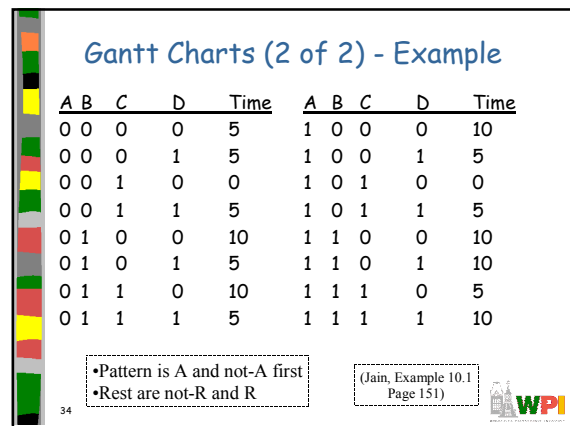
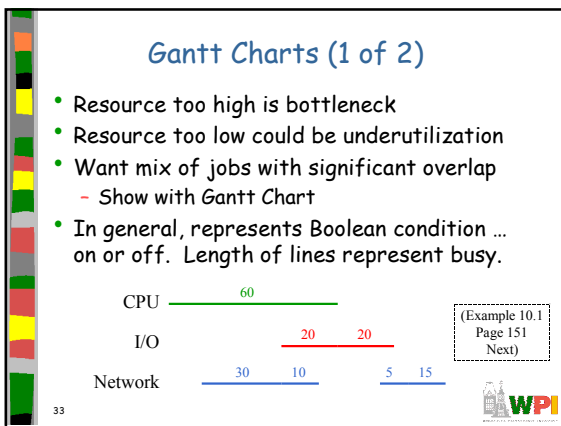
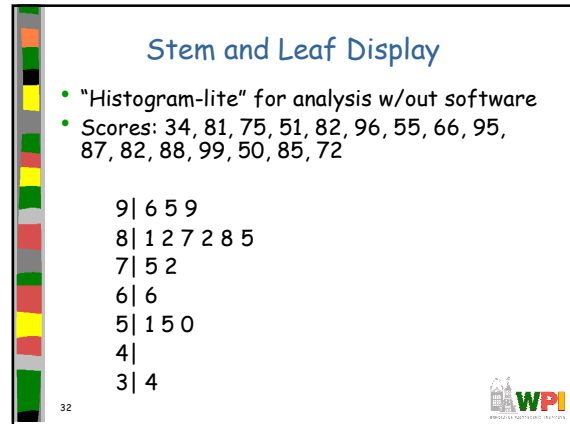
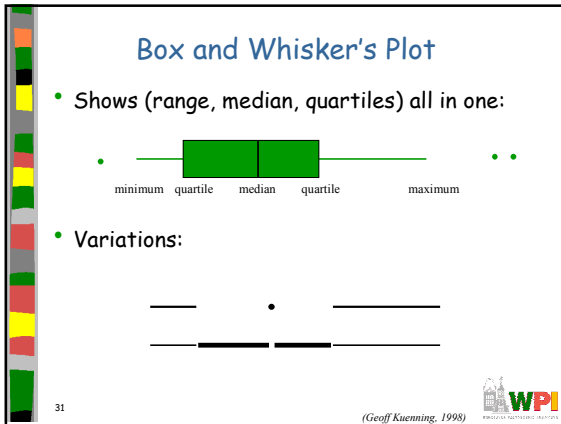
- When random quantification, representing mean (or median) alone (or single data point!) not enough



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Decision Maker's Games

- Even if perf analysis is correctly done, may not convince decision makers (boss, conference referees, thesis advisor...)
 - Box 10.2, p. 162 has list of reasons
- Most common:
 - 1) "More analysis." This is always true. Does not mean analysis done is not valuable.
 - 2) "Alternate workload". Since based on past, can always be questioned as good future workload
- Lead to endless discussion ("rat holes"). Can "head off" criticism by stating this.

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Ratio Games (Ch 11)

If you can't convince them, confuse them. – Truman's Law

- A common way to play games with competitors
- Two ratios with different bases cannot be compared or averaged
 - Doing so is called "ratio game"
- Knowledge of "ratio games" will help protect ourselves, avoid doing

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Games with Base System

- Beware!
 - Normalize each system's performance for each workload by system A and average ratios
 - Normalize each system's performance for each workload by system B and average ratios

System	Work-load 1	Work-load 2	Average
A	20	10	15
B	10	20	15

System	Work-load 1	Work-load 2	Average
A	2	0.5	1.25
B	1	1	1

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Games with Ratio Metrics

- Choose a metric that is ratio of two other metrics. Power = $\text{thrput}/\text{respTime}$

Network	Thrput	RespTime	Power
A	10	2	5
B	4	1	4

- Suggests that A is better.
- But maybe it should be:

$$\text{power} = \text{thrput}/\text{respTime}^2$$

$$\rightarrow \text{Power}_A = 2.5, \text{Power}_B = 4$$

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Games with Relative Performance

- Metric may be specified but can still get ratio game if two are on different machines
- MFLOPS, System X-Y, accelerators A-B

Alternative	Without	With	Ratio
A on X	2	4	2.00
B on Y	3	5	1.66

(Base systems are different)

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Games with Percentages (1 of 2)

- Percentages are really ratios, but disguised
 - So can play games

Test	A Runs	A Passes	A %	B Runs	B Passes	B %
1	300	60	20	32	8	25
2	50	2	4	500	40	8
Total	350	62	18	532	48	9

- A is worse under both tests
 - but it looks better in Total!

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Games with Percentages (2 of 2)

- Percentages
 - Have bigger psychological impact
 - * 1000% sounds bigger than 10-fold
 - Are great when both original and final performance are lousy
 - * Ex: payment was \$40 per week, is now \$80
- When used, base should be initial, not final value
 - Ex: Price was \$400, now \$100
 - * Drop of 400%! But that makes no sense

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Strategies for Winning Ratio Game (1 of 2)

- (Again, don't do these, just be aware of them so no-one does them to you)
- If one system is better by all measures, a ratio game won't (usually) work
 - Although, remember percent-passes example!
 - And selecting the base also lets you change the magnitude of the difference
- If each system wins on some measures, ratio games might be possible
 - May have to try all bases

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Strategies for Winning Ratio Game (2 of 2)

System	Work-load 1	Work-load 2	Base B	Base A
A	20	10	1.25	1
B	10	20	1	1.25

- For LB metrics, use your system as the base
 - Ex: response time
- For HB metrics, use the other system as a base
 - Ex: throughput
- If possible, adjust lengths of benchmarks
 - Run longer when your system performs best
 - Run short when your system is worst
 - This gives greater weight to your strengths

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Extra Credit for Next Class

- Bring in one either notoriously bad or exceptionally good example of data presentation
 - The bad ones may be more fun
- From proceedings, technical documentation, newspaper ...
- Make copies before class or send to me and I'll make copies
- We'll discuss why good/bad

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