

General Visualization Principles

Concept and Examples

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On behalf of the
FDA-Industry-Academia
Safety Graphics Working Group
(General Principles Subteam)

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Agenda

- Motivation
- Framework
- Catalog of clinical questions and associated graphs
- General Principles
 - Graph Navigator, Glossary, Do's and Don'ts
- Conclusions

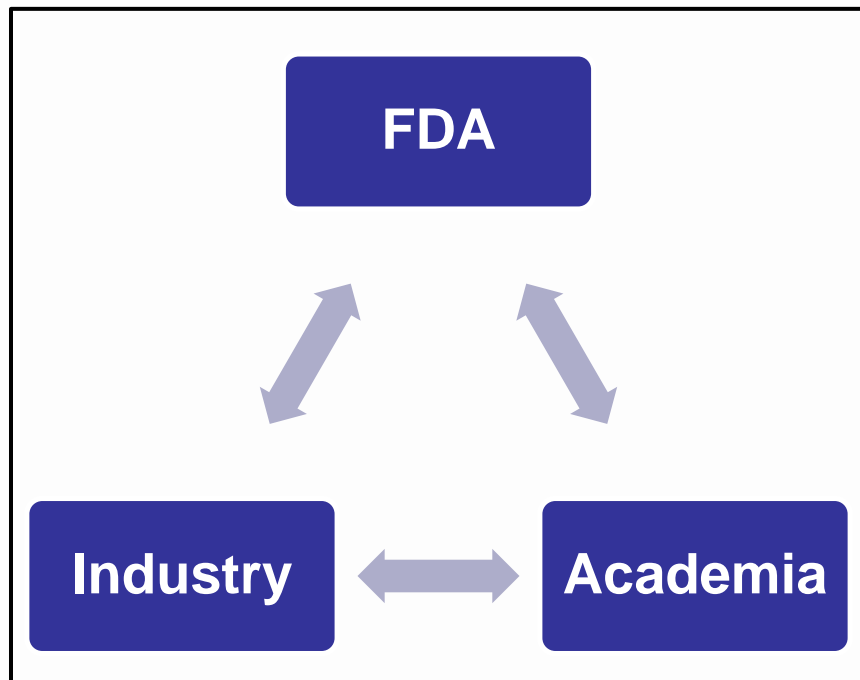
Motivation

- Graphical visualisation of a product's safety and efficacy data should be
 - More used (internal review, reports for submission)
 - When used,

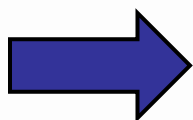
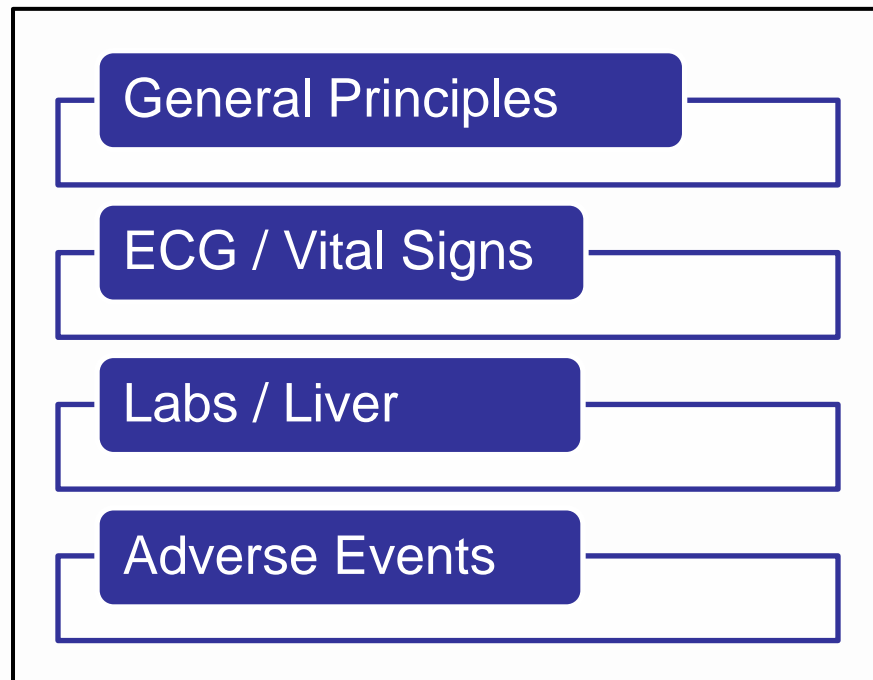
The choice of graph and its detailed design should allow a quick decode of the information
- ⇒ foster use of graphics (enablers, guidance)

Framework

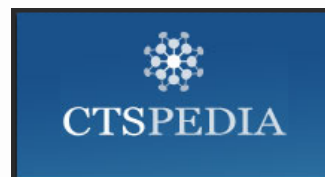
Joint Collaboration



Themes / Subteams

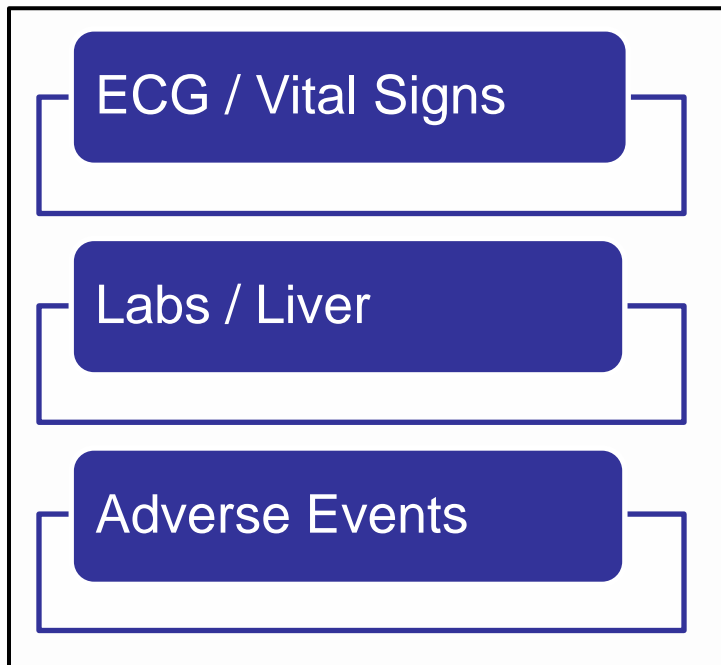


<http://www.ctspedia.org>



Catalog of clinical questions and associated graphs

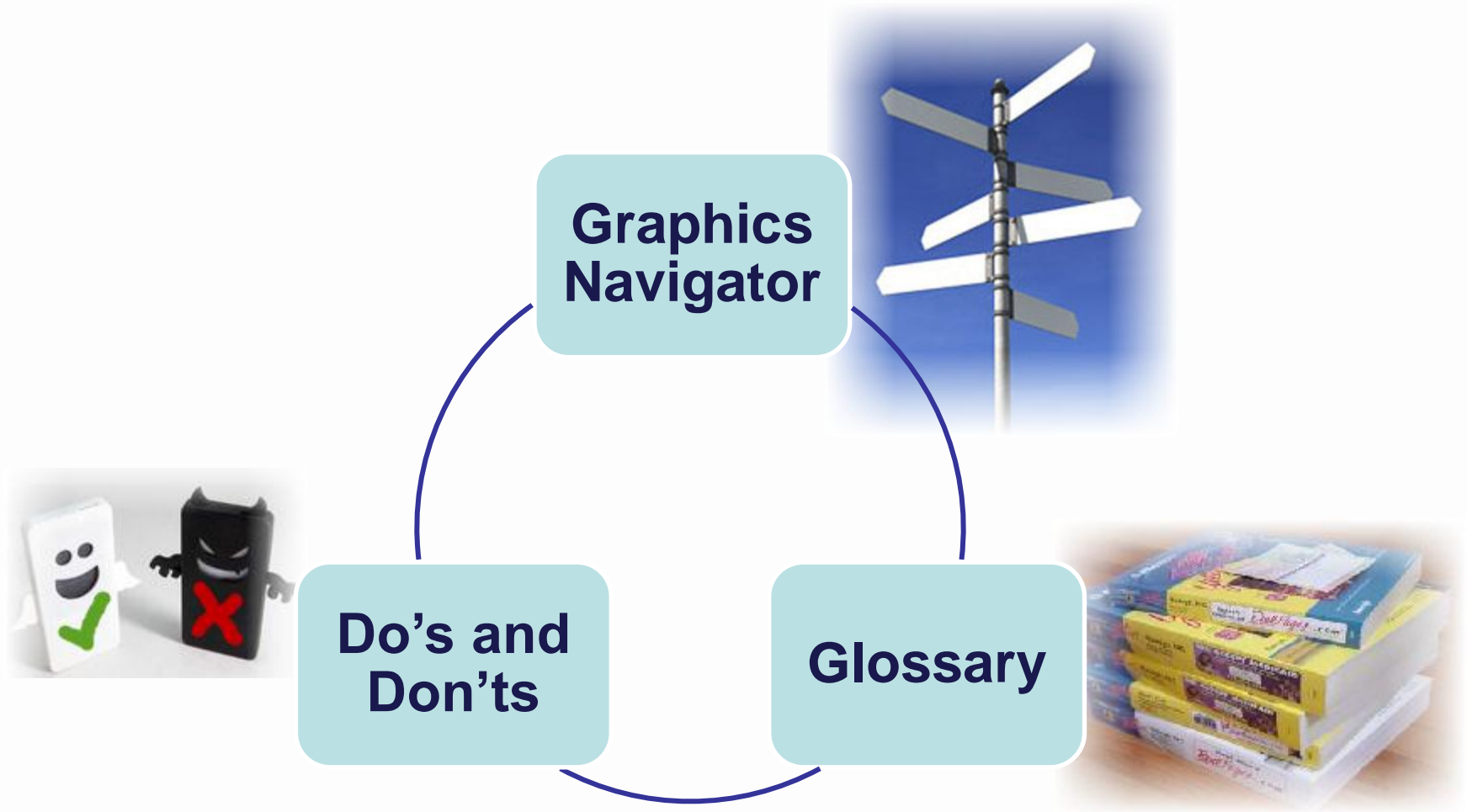
Themes/ Subteams



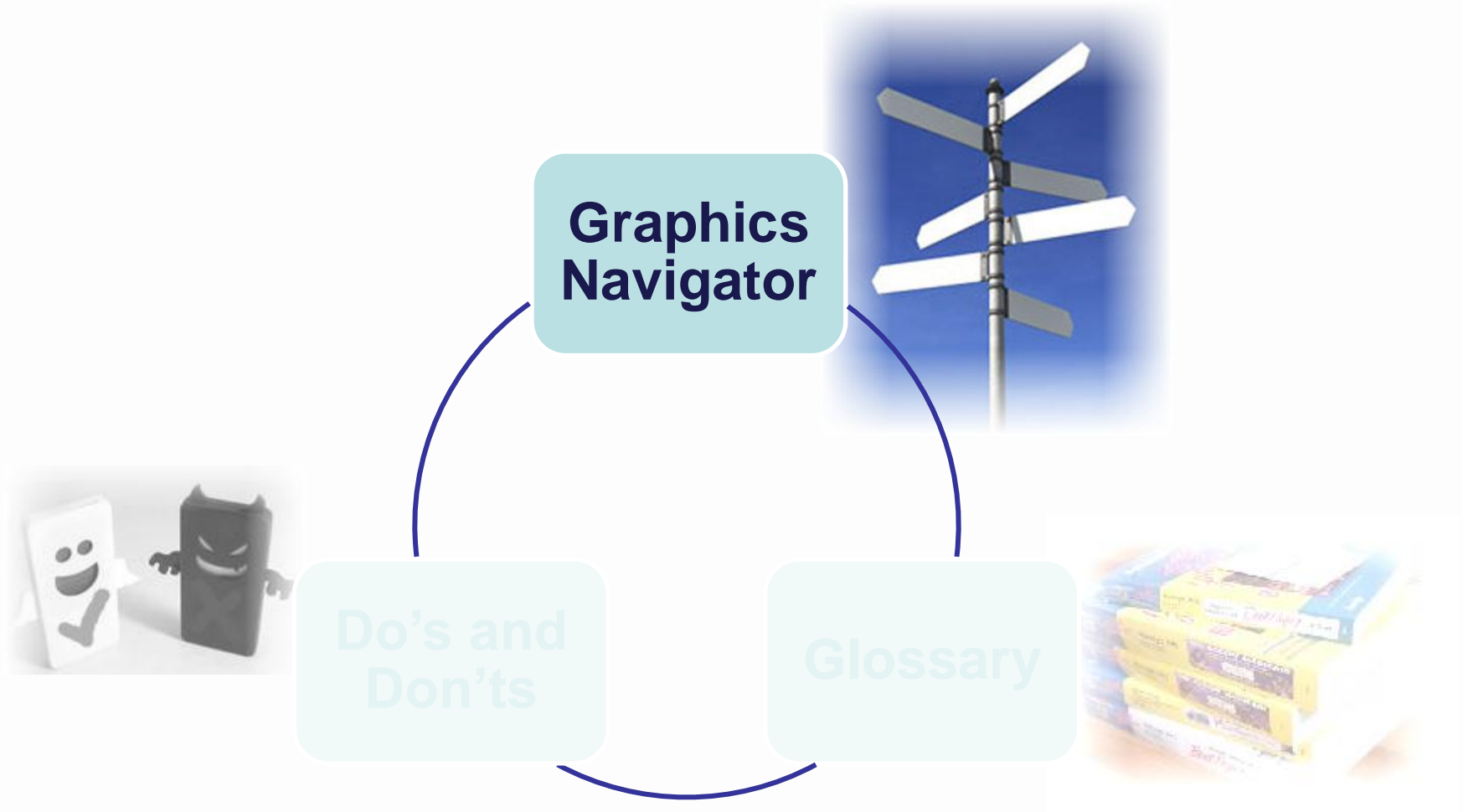
Catalog Entries

- Required Fields
 - **Illustration**,
 - Title, Description,
 - Background [**clin.question**],
 - Use (reporting / exploratory),
 - Keywords
 - Author,
 - Software used, **Code**,
- Optional Fields
 - References, Data
- Categorization
 - **Graph Type** (bar, box, dot plot ...)

General Principles



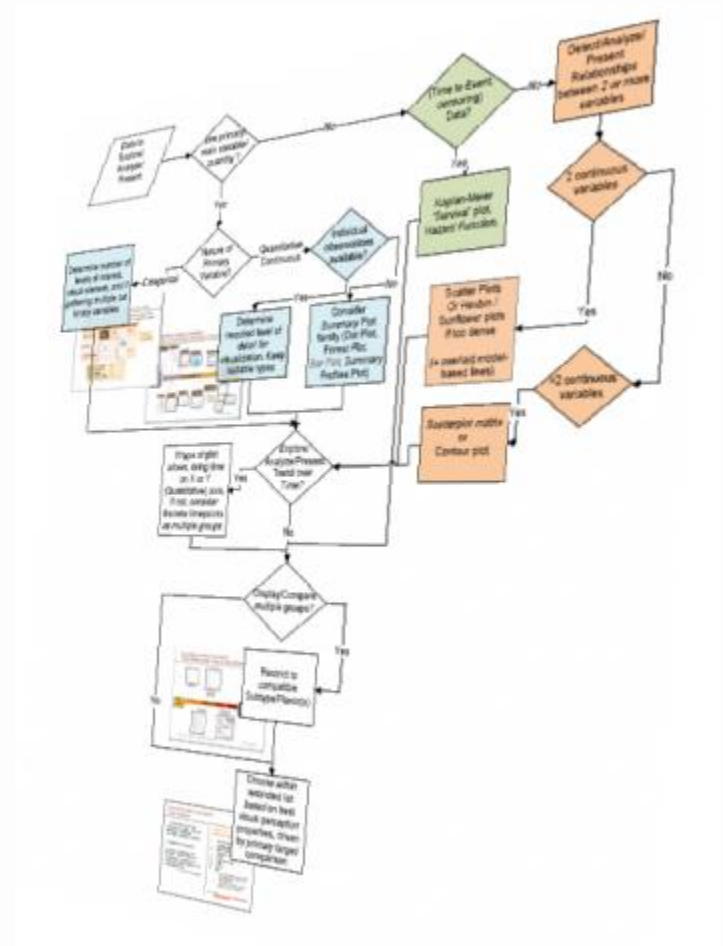
General Principles



Graphics Navigator - Main Flow Diagram

■ Main drivers

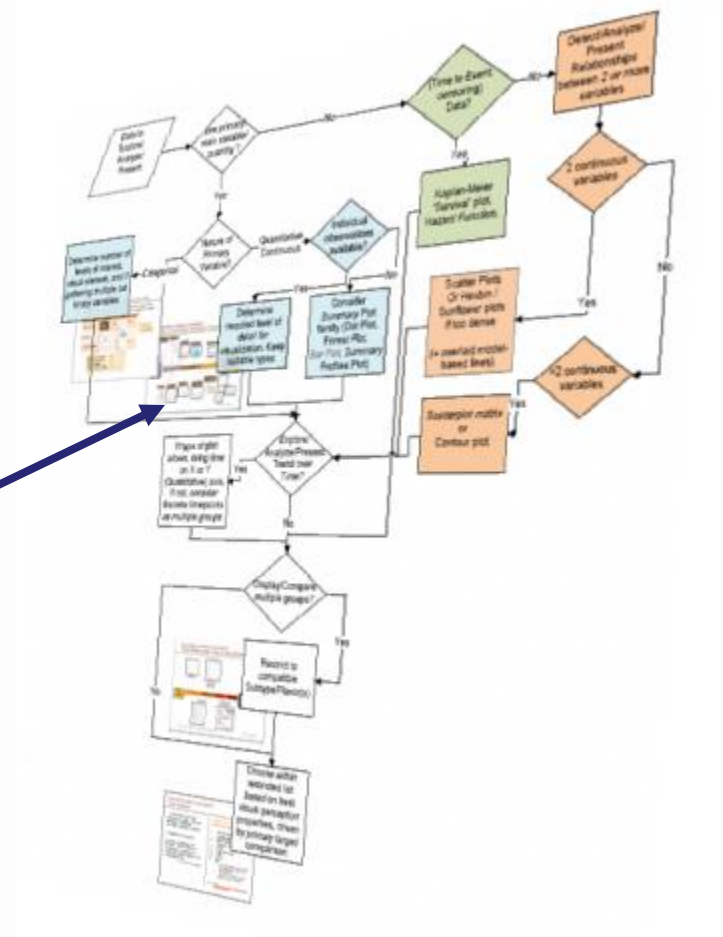
- Type (categ., quant.) of variables
- Number of Variables
- Number of levels of categorical variables
- Level of detail needed for the distribution (quant.),
- Visual Perception Criteria



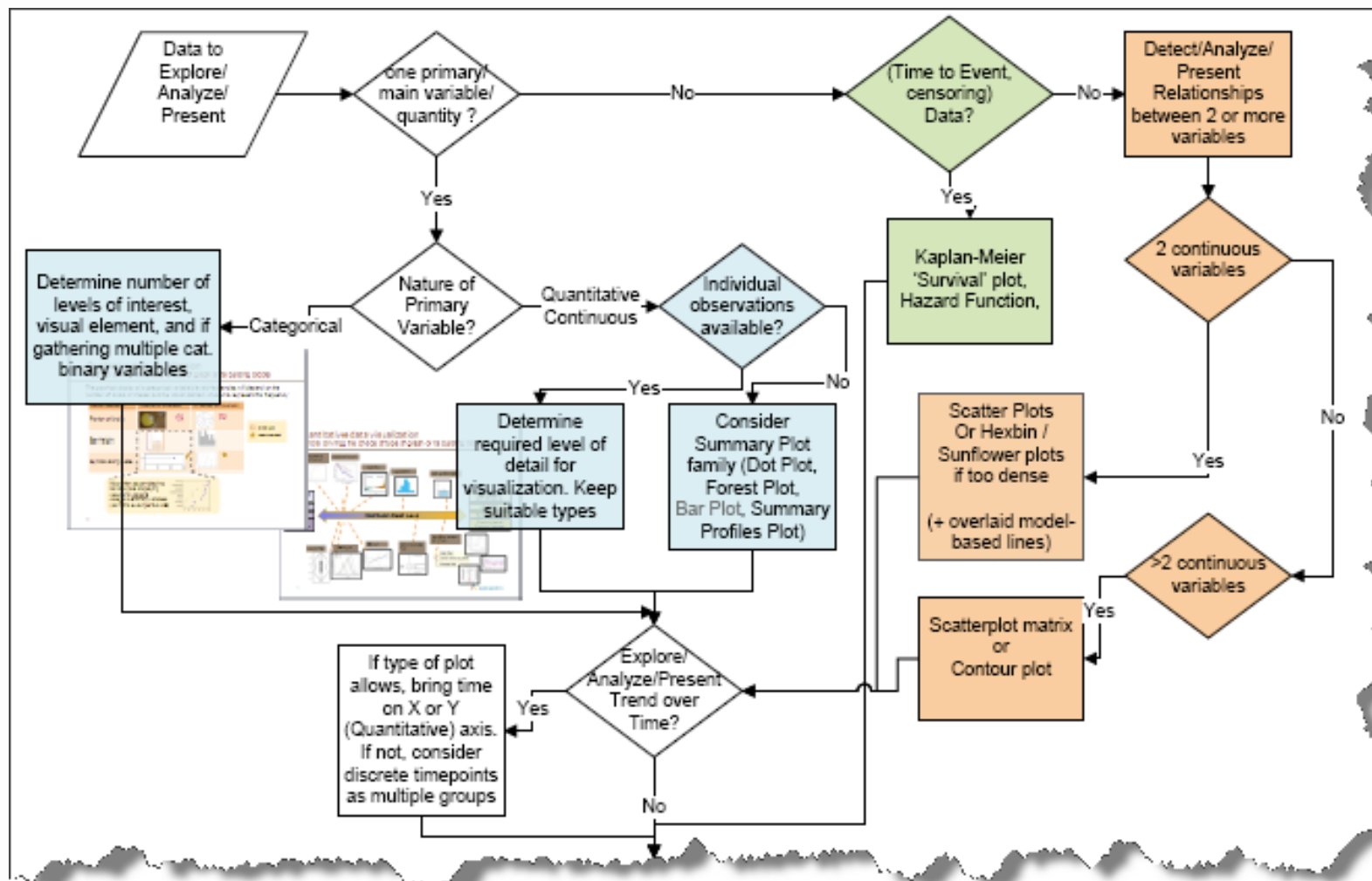
Graphics Navigator - Main Flow Diagram

■ Main drivers

- Type (categ., quant.) of variables
- Number of Variables
- Number of levels of categorical variables
- **Level of detail needed for the distribution (quant.),**
- Visual Perception Criteria

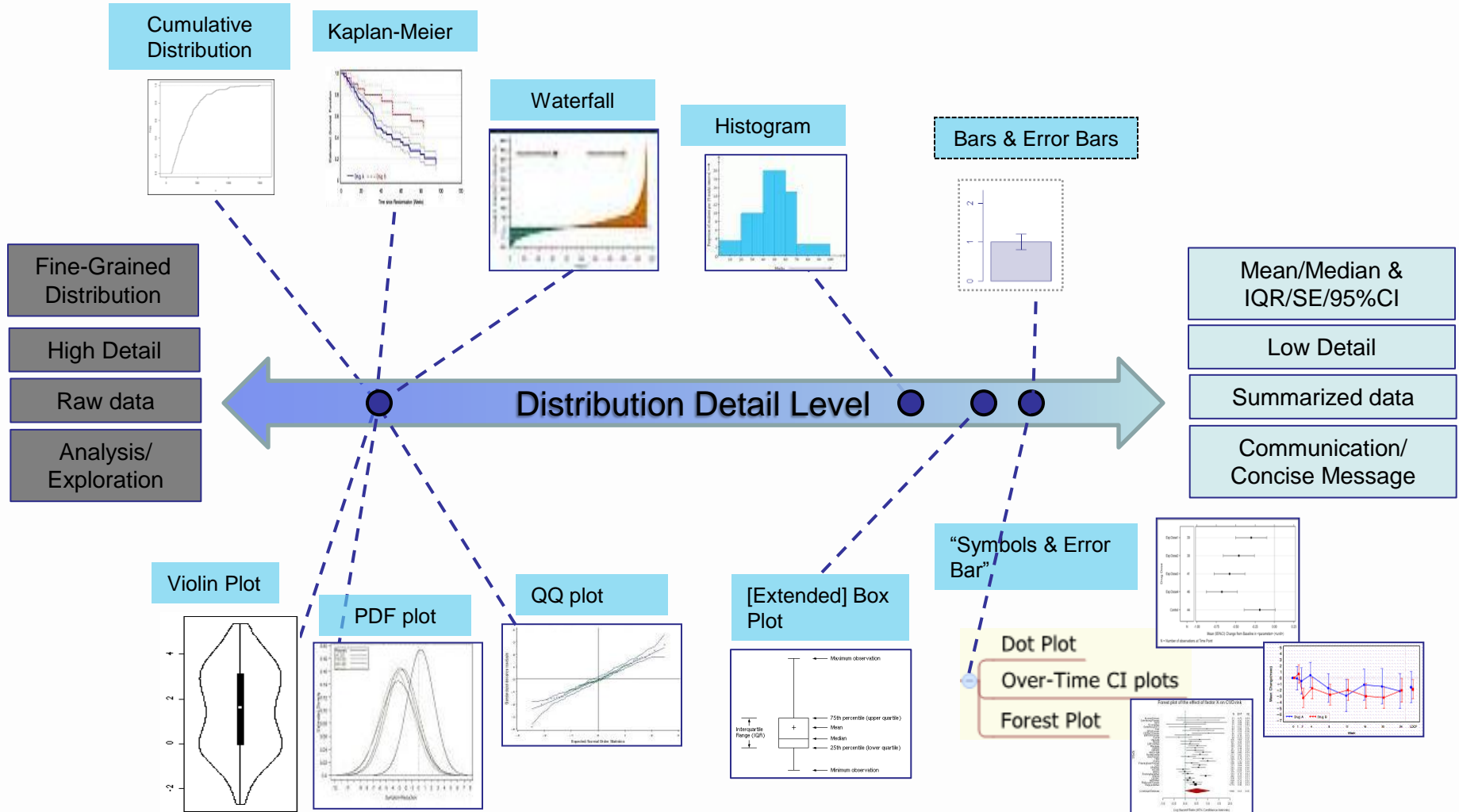


Graphics Navigator - Main Flow Diagram



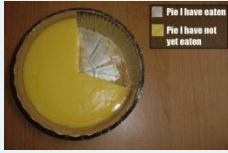

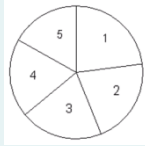

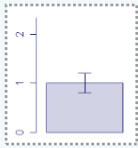
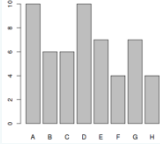
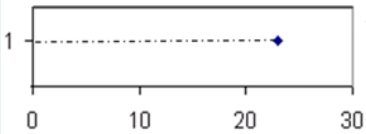

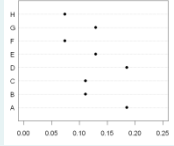

Graphics Navigator– Navigator Slide 1


Drivers of graph type/building blocks (1 quant. var)




Graphics Navigator – Navigator Slide 2

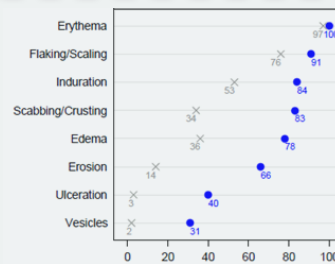
Drivers of graph type /building blocks (1 main categ. var)

Visual Element	1 Level of interest	>1 Level of interest
Portion of circle	 	 
Bar Height		
Symbol along scale	 	 

 : avoid use

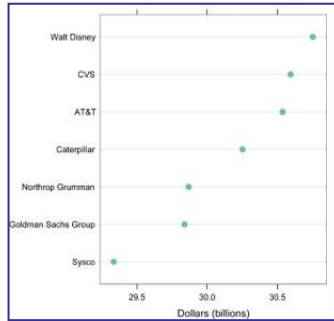
 : recommended

Most often assembled into bar/dot plots displaying results for **several** categorical binary variables (as in this example for 8 AEs)

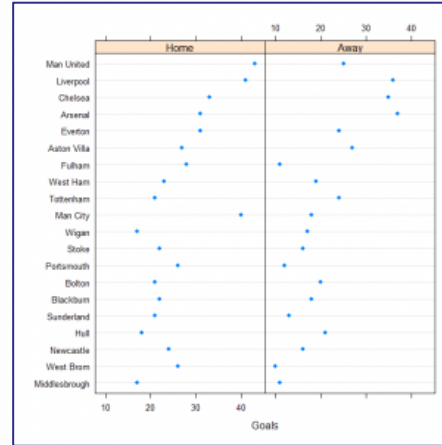


Graphics Navigator – Navigator slide 3

Drivers of Graph Subtype choice



Simple



Multipanel
of simple

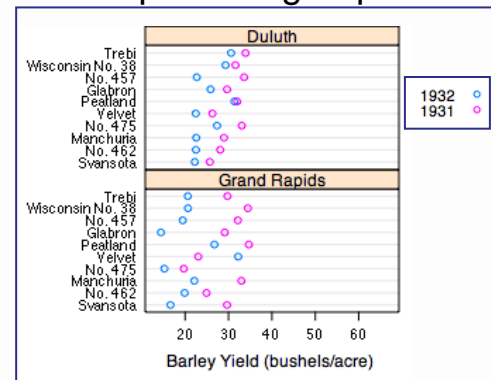
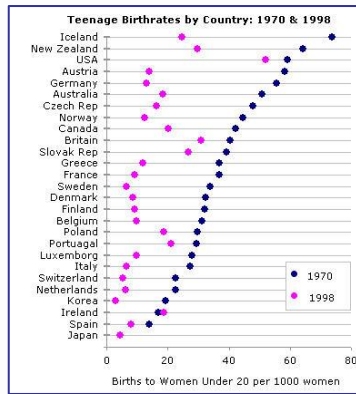
0 or 1
grouping
Variable

Graph Subtype/Flavor

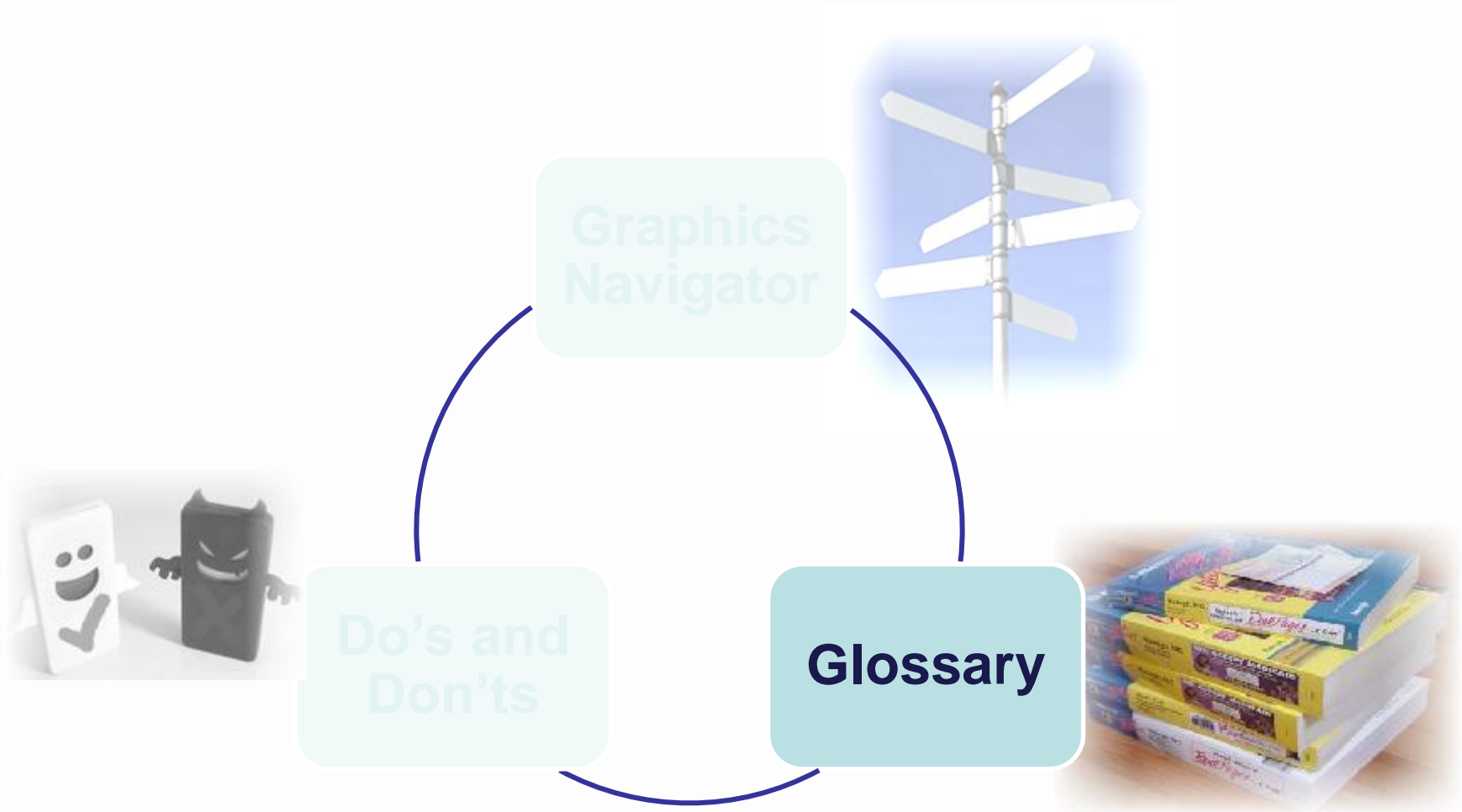
Grouped

Multipanel of grouped

Multiple grouping
Variables
(e.g., age category
x gender
x treatment group)



General Principles



Glossary

- Graph Types

- Histogram, Violin, Box plot ...

➡ Description, typical use,
Illustration(s), sample code, limitations

- Graph Subtypes

- Simple, Grouped, Multipanel

- Graph Terms

- Shift, Jitter, axis frame,
- Major, minor tick marking, tick mark mirroring ...

Glossary

CTSPedia Snapshot – Graph Type

Histograms

Last updated by Richard Forshee on September 17, 2010

Type of data: continuous

Type of analysis: univariate

Description and purpose:

Histograms are used to represent the distribution of individual observations into bins (mouseover to see number of observations in each bin). Rectangles in a histogram represent the frequency, percentage, or density of observations in each bin. By convention, the rectangles in a histogram touch.

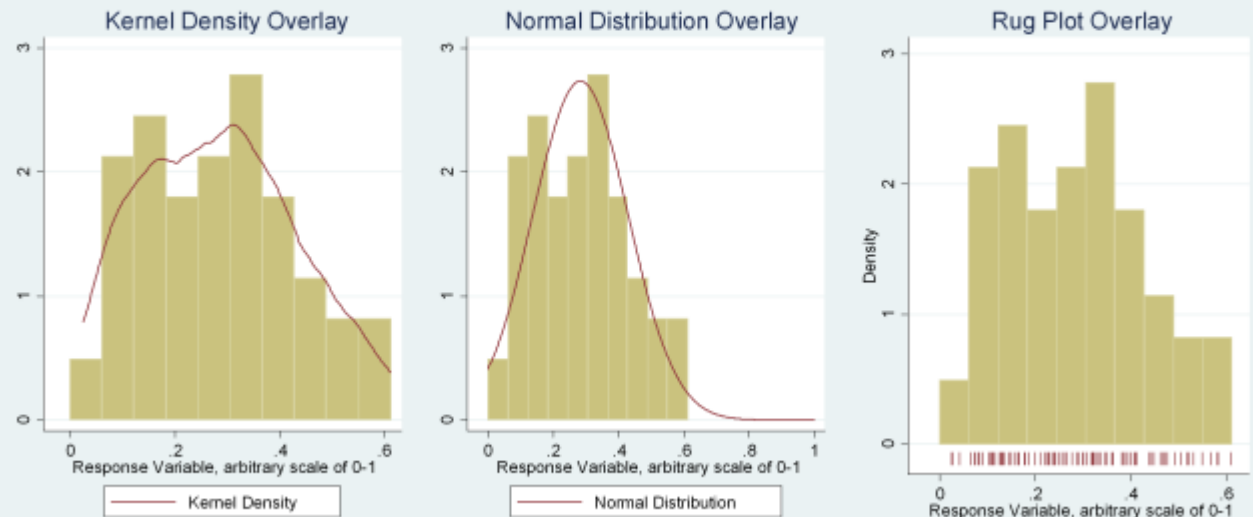
Histograms are distinct from bar charts (link). Bar charts have gaps between rectangles in a bar chart do not touch.

Examples:

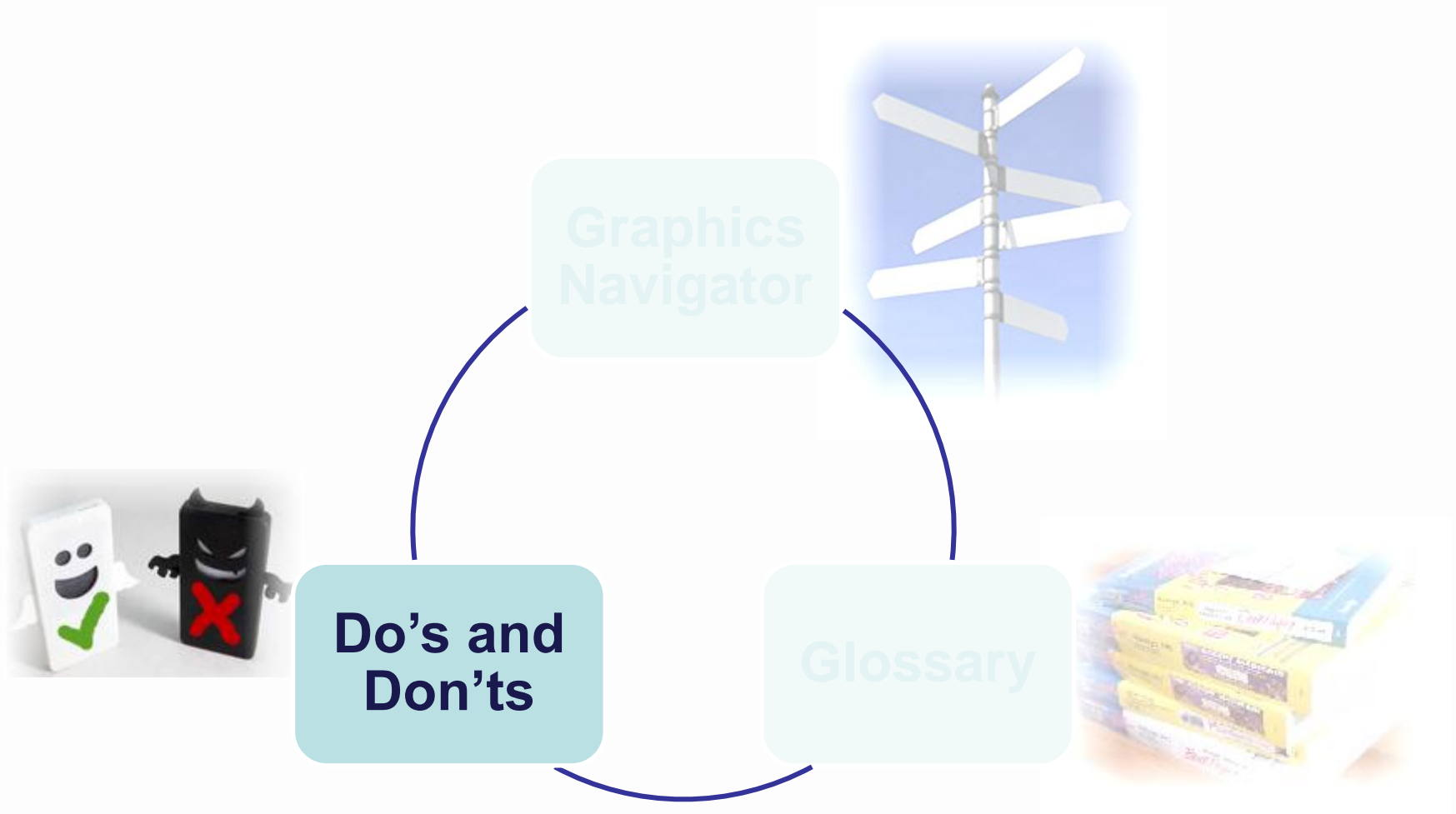
All examples use 100 data points that were randomly generated from a Beta(2,5) distribution. Beta(2,5) is a skewed distribution that is bounded between 0 and 1.

Histograms with Kernel Density, Normal Distribution, and Rug Plot Overlays

Randomly generated data, Beta(2,5) distribution, n=100



General Principles

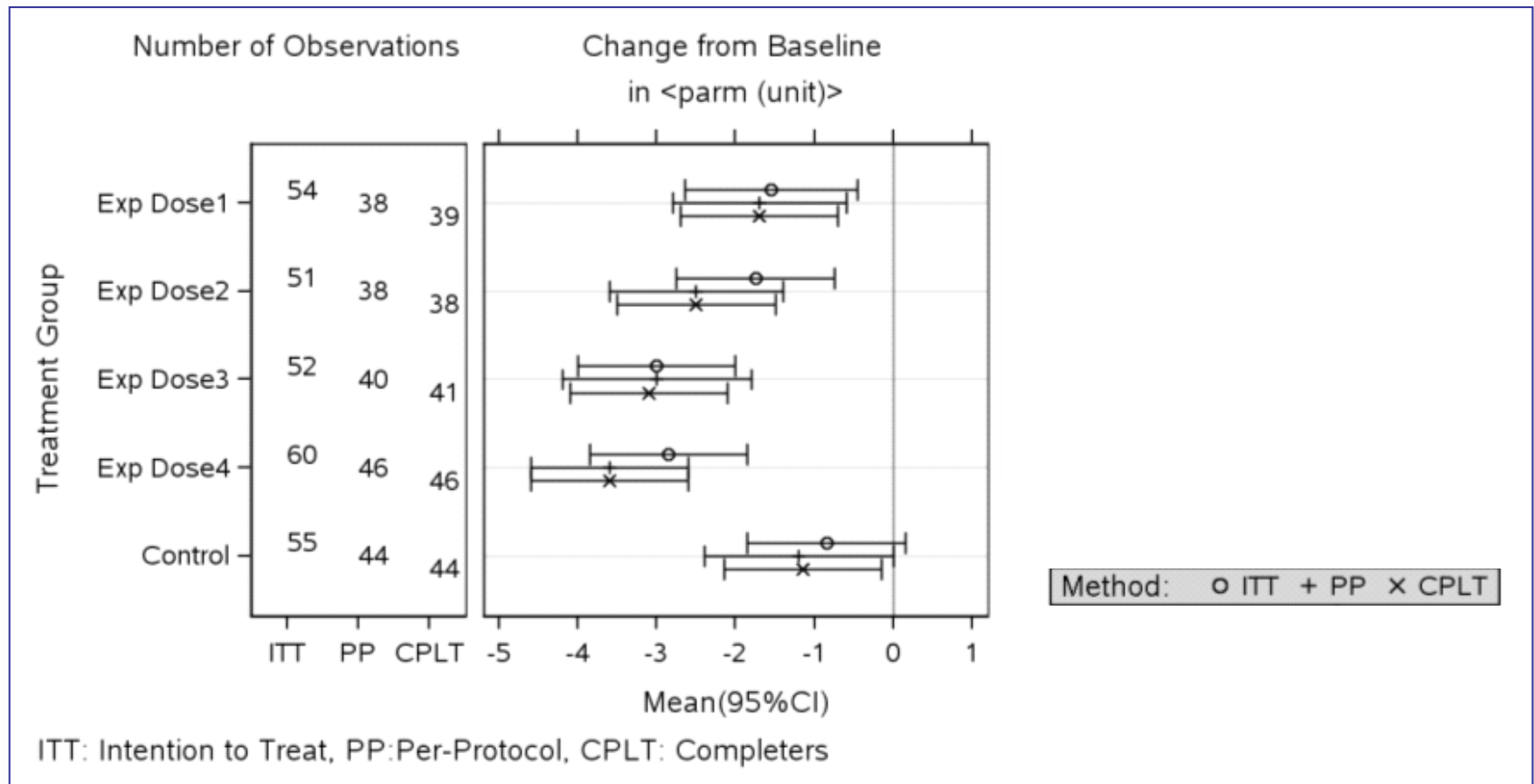


Do's and don'ts

- Display the quantity of interest
- Provide visual anchors
- Bring closer items the reader needs to compare
- Maximize the data-to-ink ratio
- Use quantitative scales ... for quantitative variables
- Don't use unnecessary dimensions
- Avoid using stacked bar plots
- Bring different components of the answer together

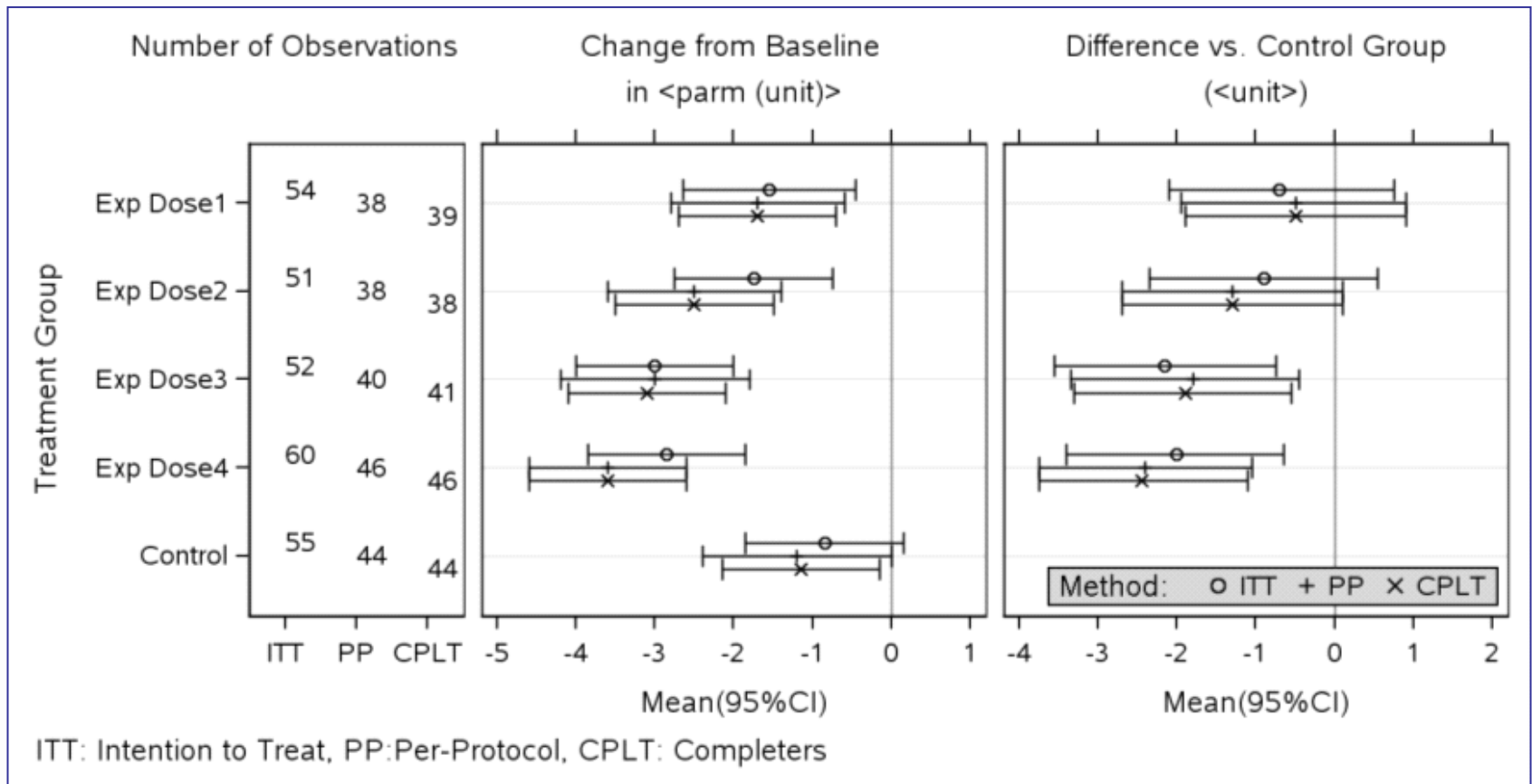
Do's and don'ts - Display the quantity of interest

- *Don't assume the reader can 'visually subtract' displayed quantities*



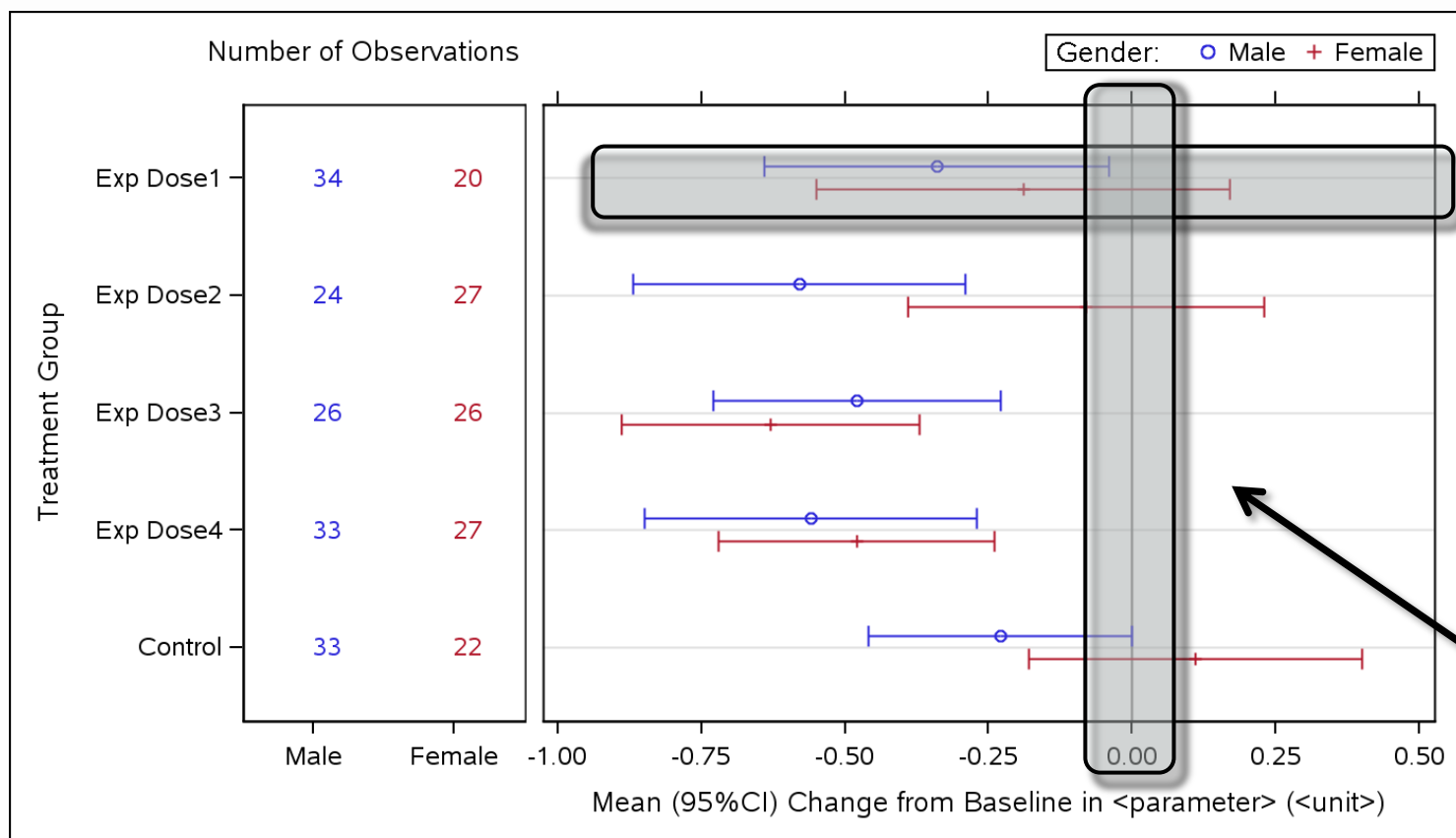
Do's and don'ts - Display the quantity of interest

- *Don't assume the reader can 'visually subtract' displayed quantities*



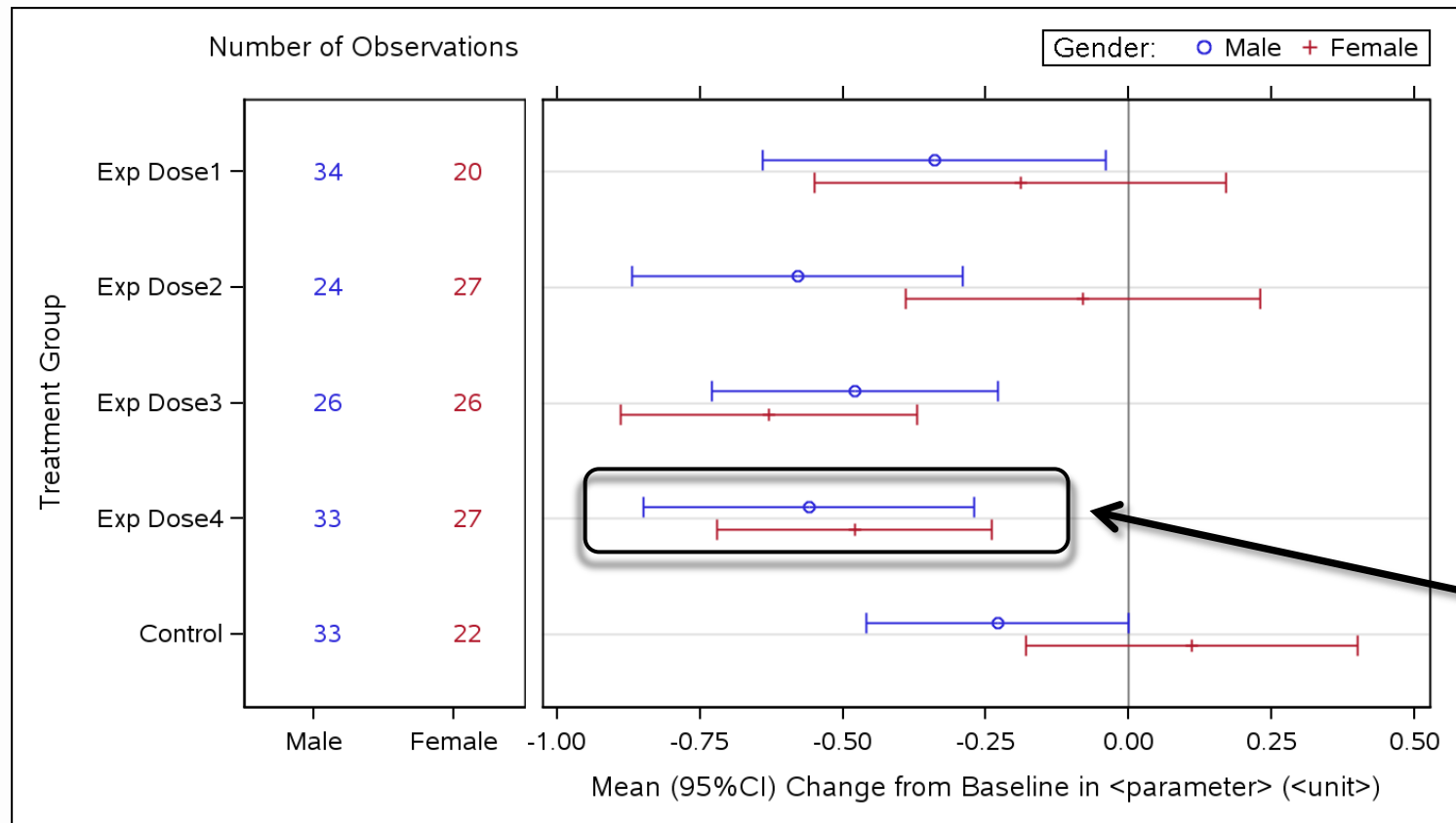
Do's and don'ts - Provide visual anchors

- Use meaningful reference lines, mirror tick mark onto right and upper axes, regression lines / curves, smoothed curves



Do's and don'ts - Bring closer items the reader needs to compare

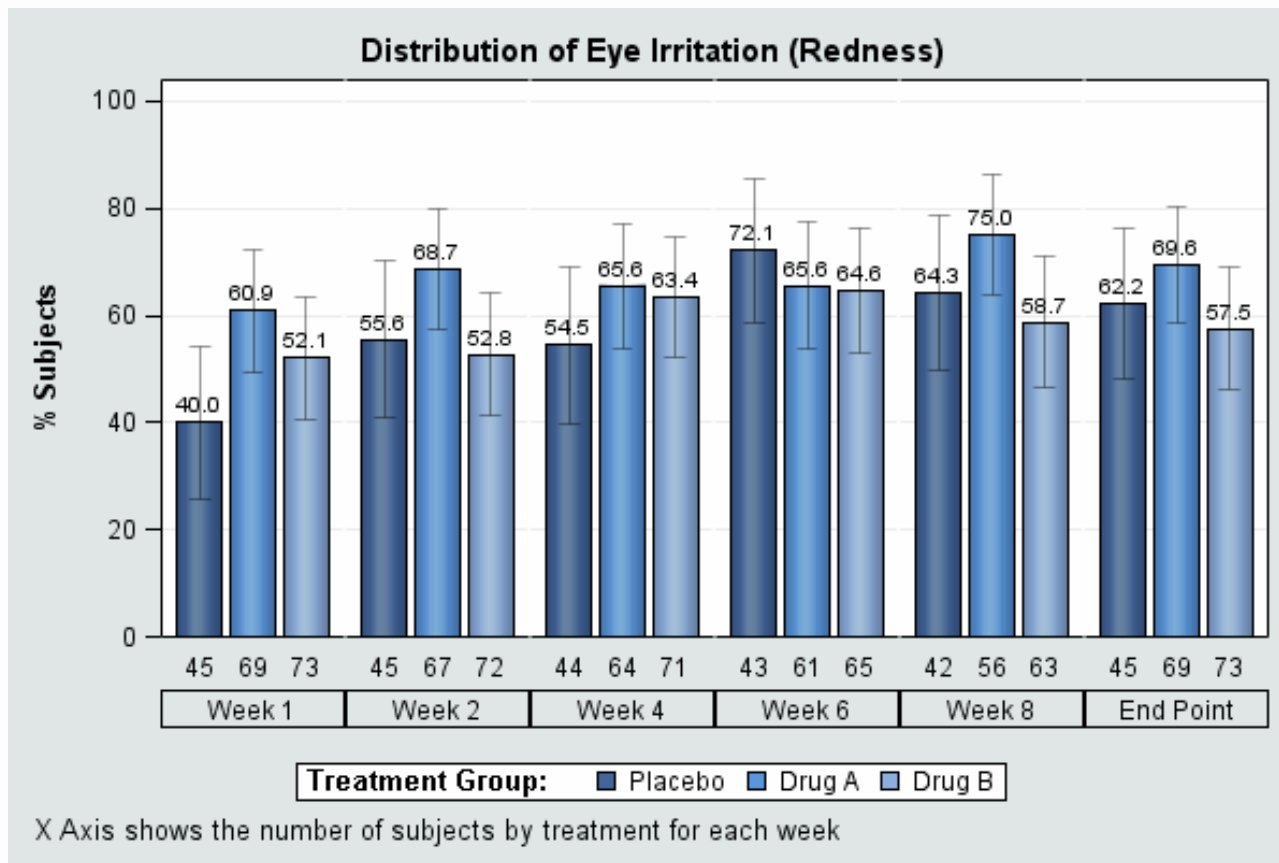
Dose-Response relationship ? Consistent across subgroups?



Do's and don'ts - Maximize the data-to-ink ratio

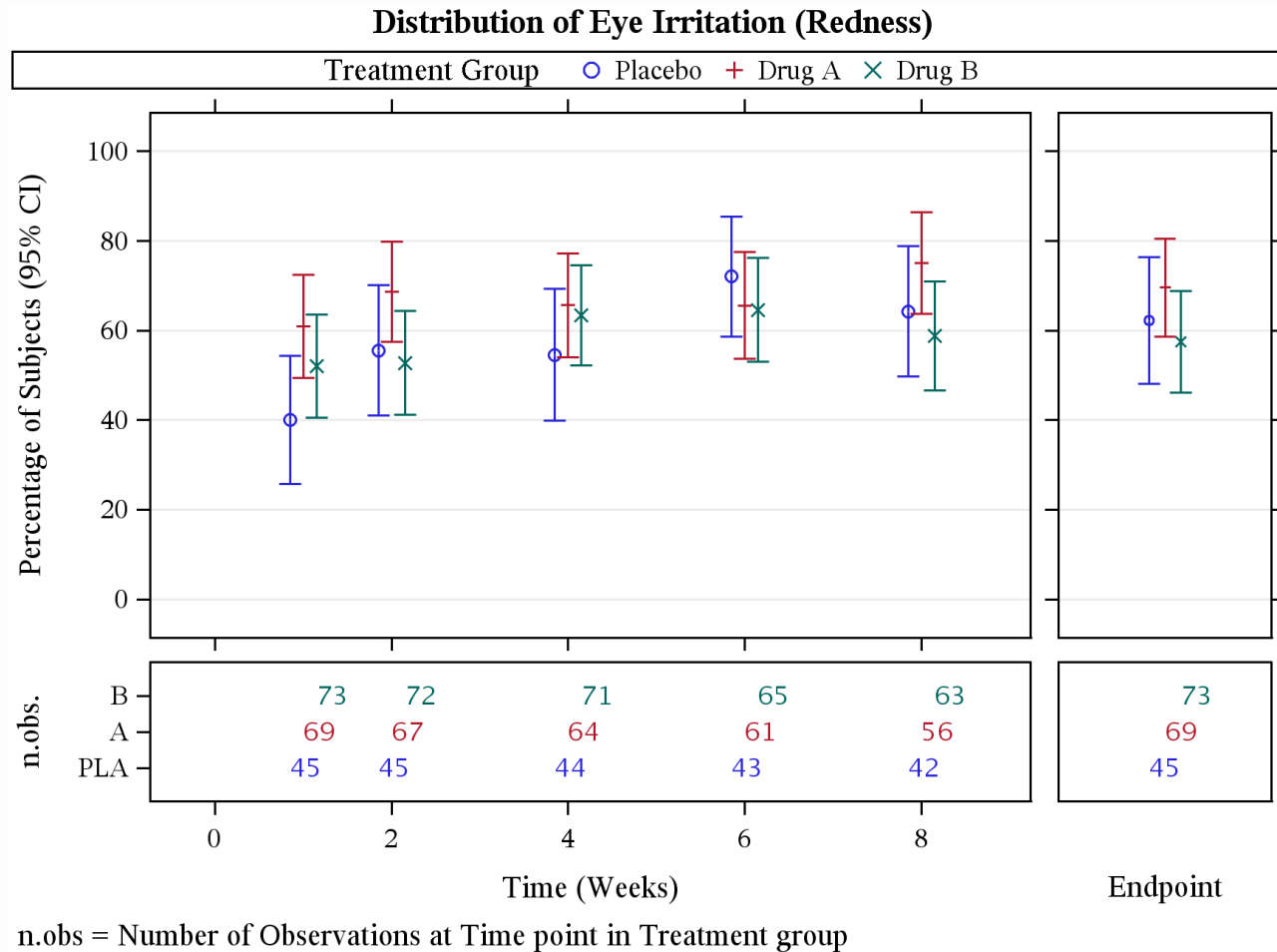
Use quantitative scales ... for quantitative variables

Lot of ink' version ... Categorical scale ...



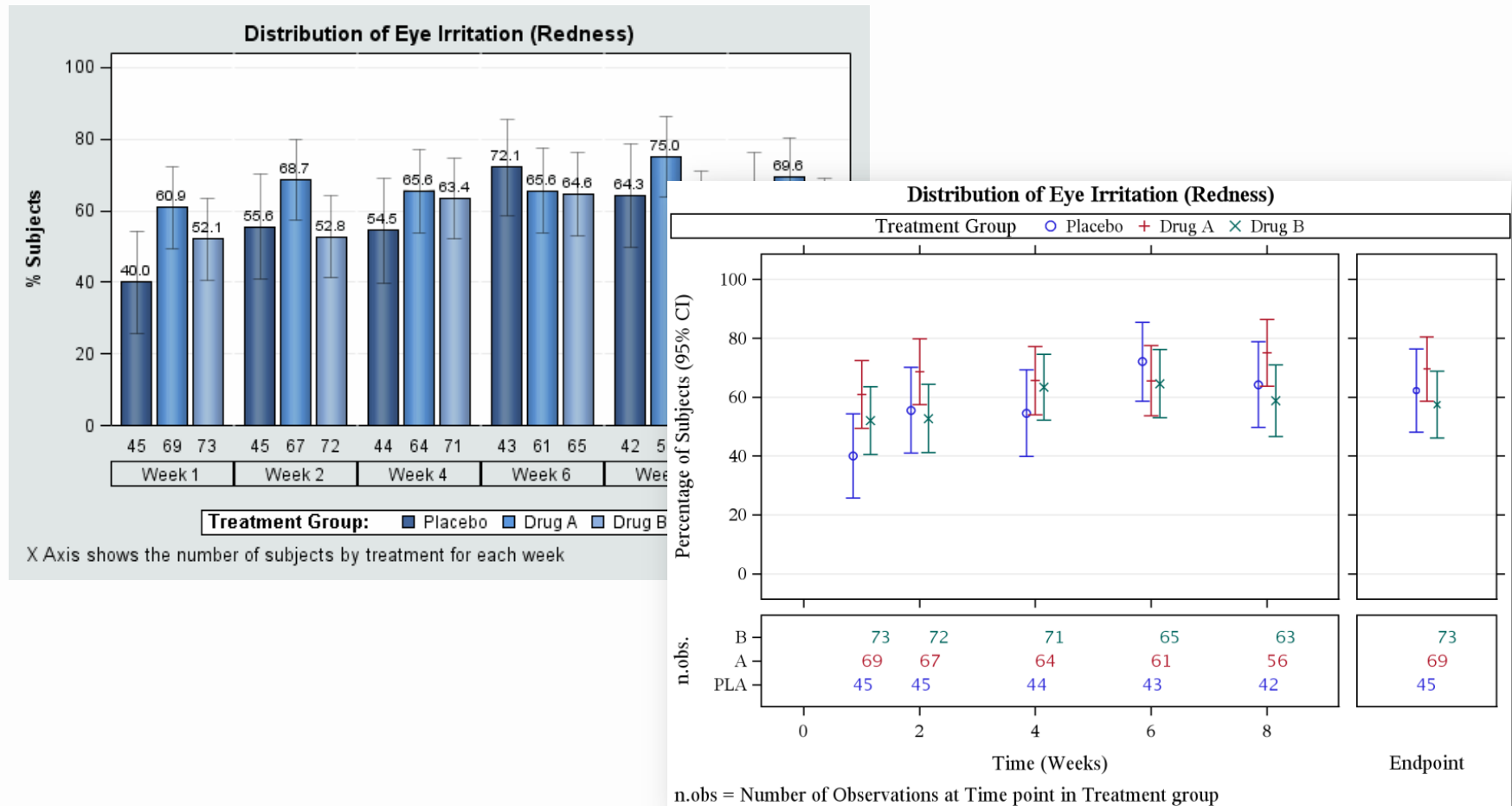
Do's and don'ts - Maximize the data-to-ink ratio

Use quantitative scales ... for quantitative variables



Do's and don'ts - Maximize the data-to-ink ratio

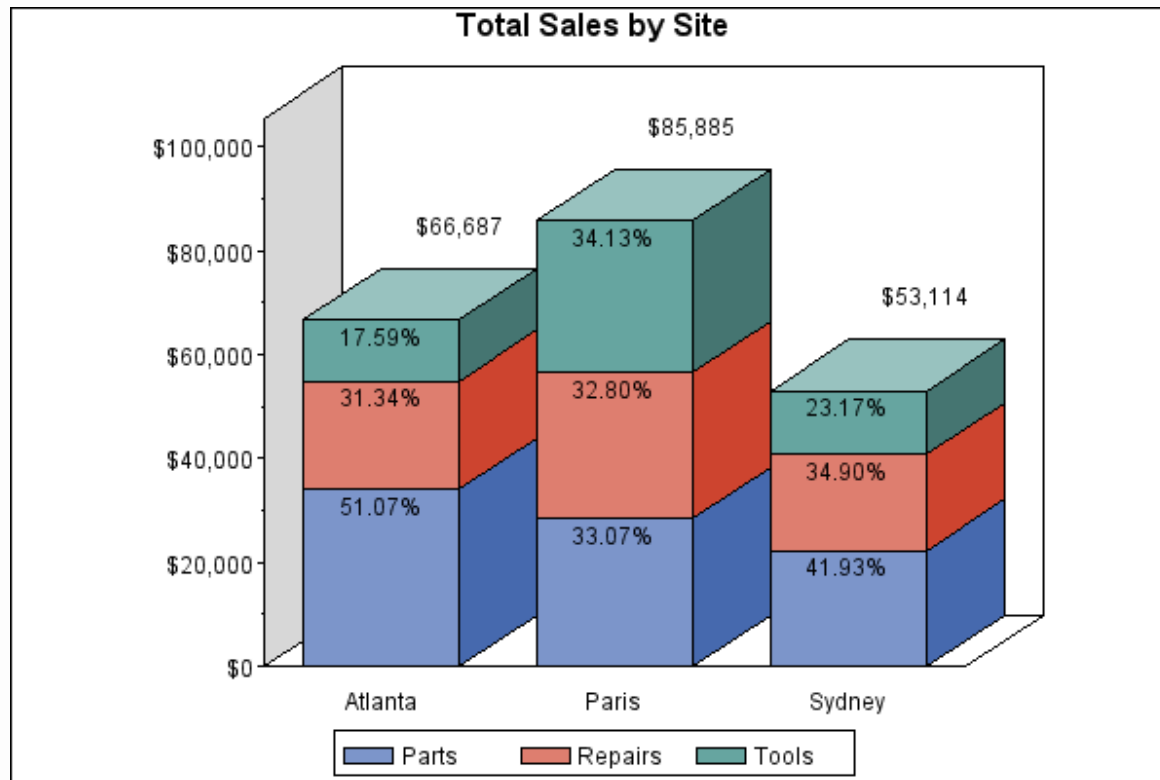
Use quantitative scales ... for quantitative variables



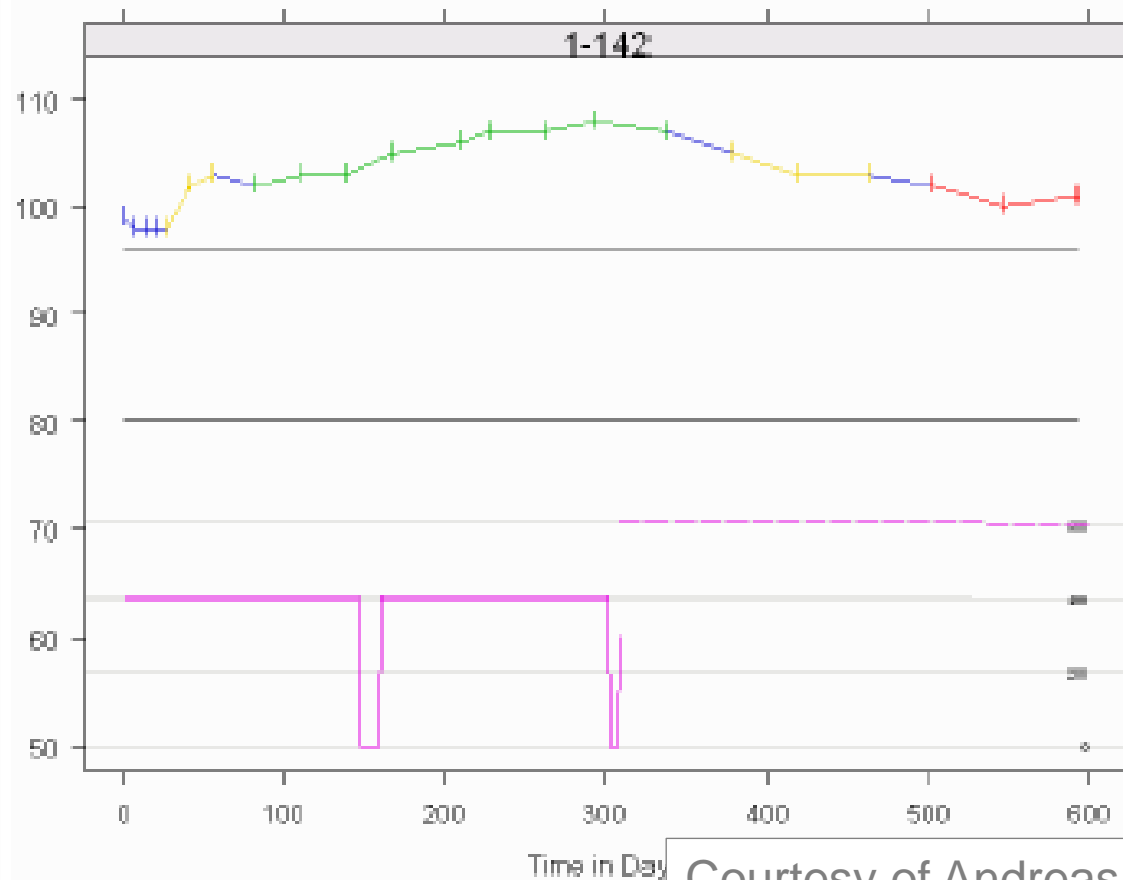
Do's and don'ts - Maximize the data-to-ink ratio

Don't use unnecessary dimensions

Avoid stacked bar plots

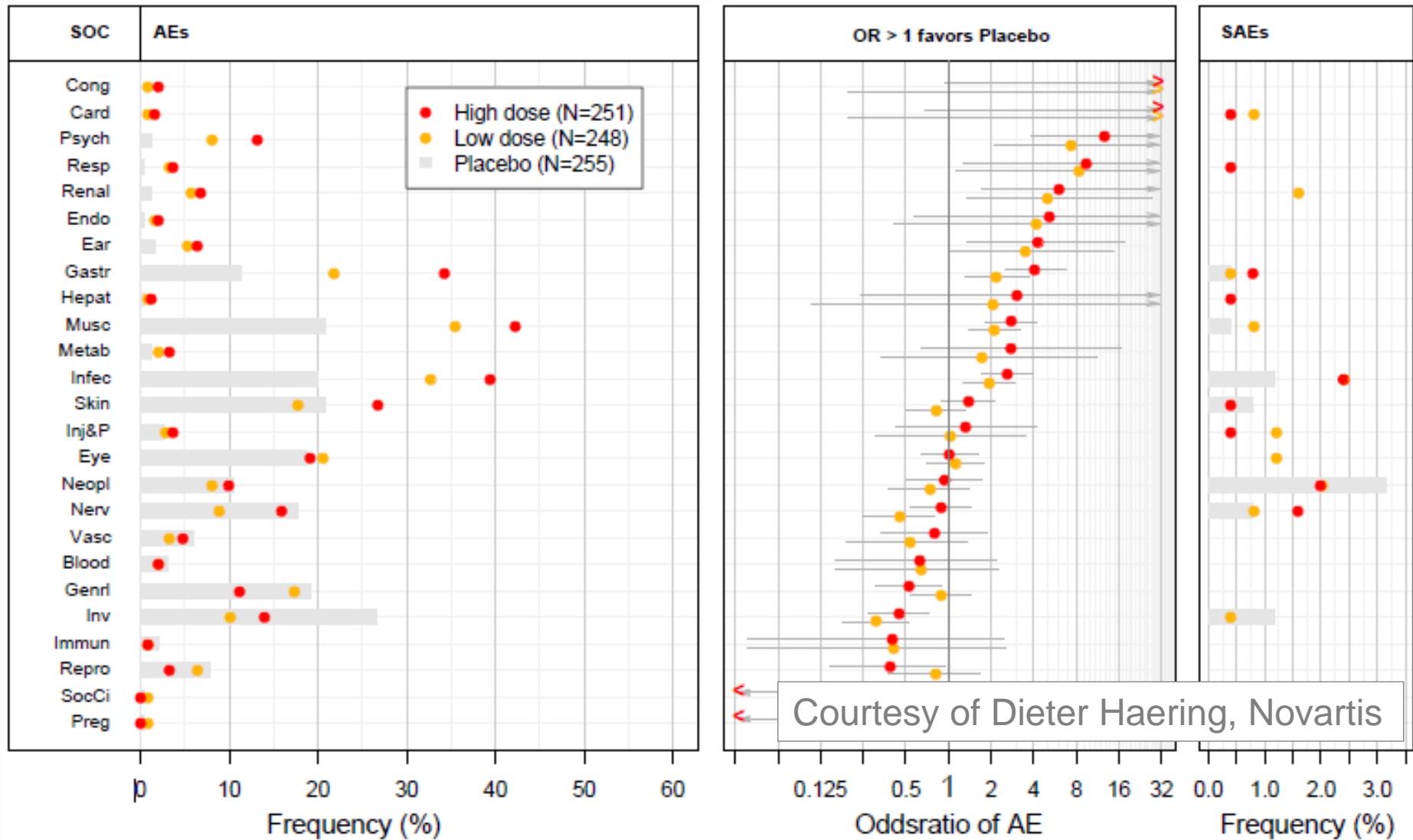


Do's and don'ts - Bring different components of the answer together (dashboard view)

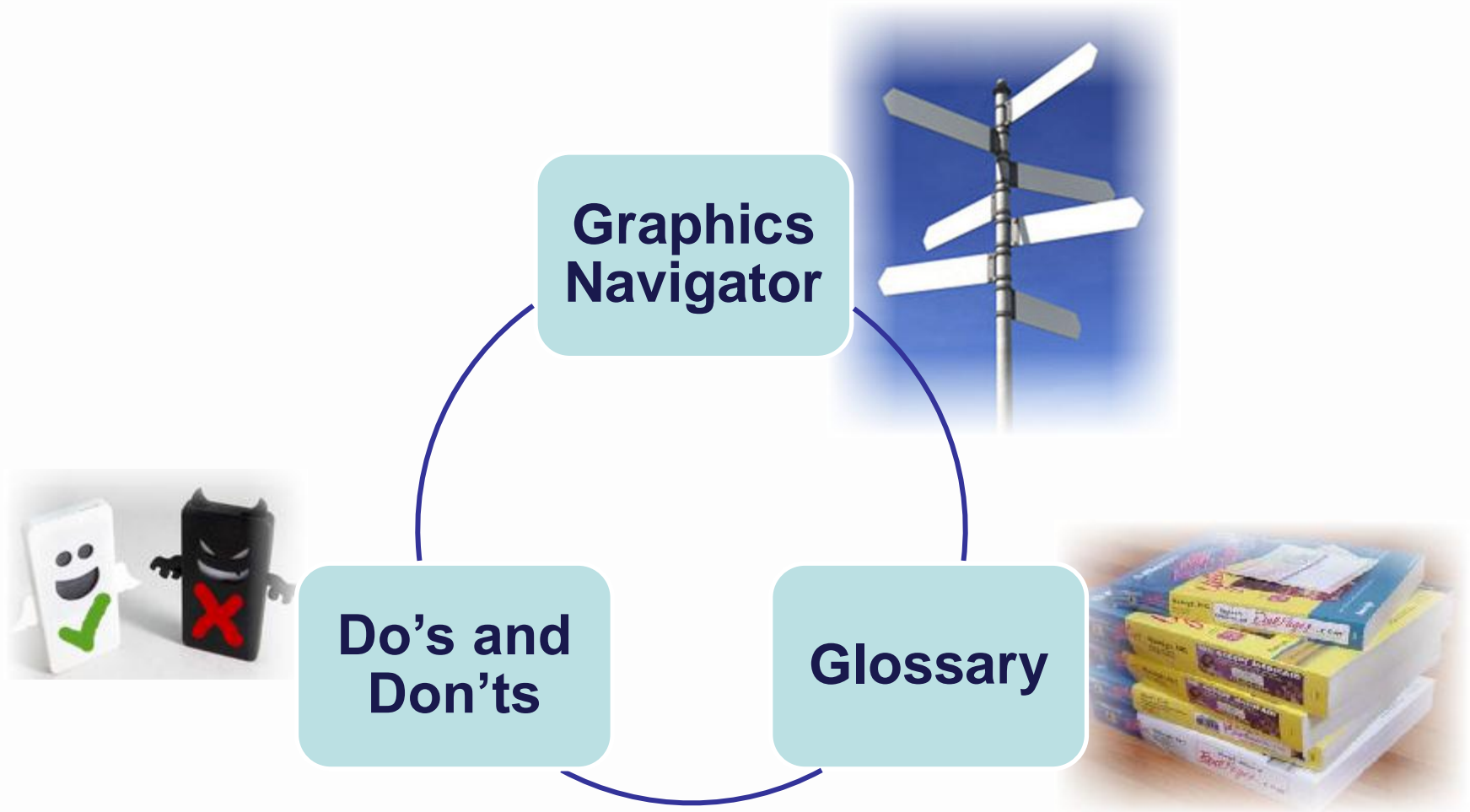


Courtesy of Andreas Krause, Actelion

Do's and don't's – another dashboard view



General Principles



Conclusions

- Use more graphical visualization to support messages
- Make reader's life easier in decoding the information
- Share experience through the CTSpedia graphical catalog



<http://www.ctspedia.org>

Special Thanks

The members of the FDA/Industry/Academia Working Group

- **Regulatory:** George Rochester, Bruce Weaver, Stephine Keeton, Janelle Charles, Chuck Cooper, Suzanne Demko, Robert Fiorentino, [Richard Forshee](#), Eric Frimpong, Ted Guo, Pravin Jadjav, Leslie Kenna, Joyce Korvick, Antonio Paredes, [Matt Soukup](#), Je Summers, Mark Walderhaug, Yaning Wang, [Markus Yap](#), Hao Zhu, Catherine Njue
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- **Academia:** [Frank Harrell](#), [Mary Banach](#)

References and Useful Links

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- Michael Friendly's Gallery of Data Visualization - The Best and Worst of Statistical Graphics
<http://www.math.yorku.ca/SCS/Gallery/>
- Robert Allison's SAS/Graph Examples - <http://robslink.com/SAS/Home.htm>
<http://stat-computing.org/events/2010-jsm> - Use of Graphics in Clinical Trials
- Frank Harell's Tutorial: Statistical Presentation Graphics
<http://biostat.mc.vanderbilt.edu/twiki/pub/Main/StatGraphCourse/graphscourse.pdf>

Backup Slides

Graphics Navigator – Navigator Slide 4

Visual Perception

“When a graph is constructed, information is *encoded*. The *visual decoding* of this encoded information is *graphical perception*.

The decoding is the vital link ...

No matter how ingenious the encoding ... and no matter how technologically impressive the production, a graph is a failure if the visual decoding fails.”

William Cleveland, The Elements of Graphing Data

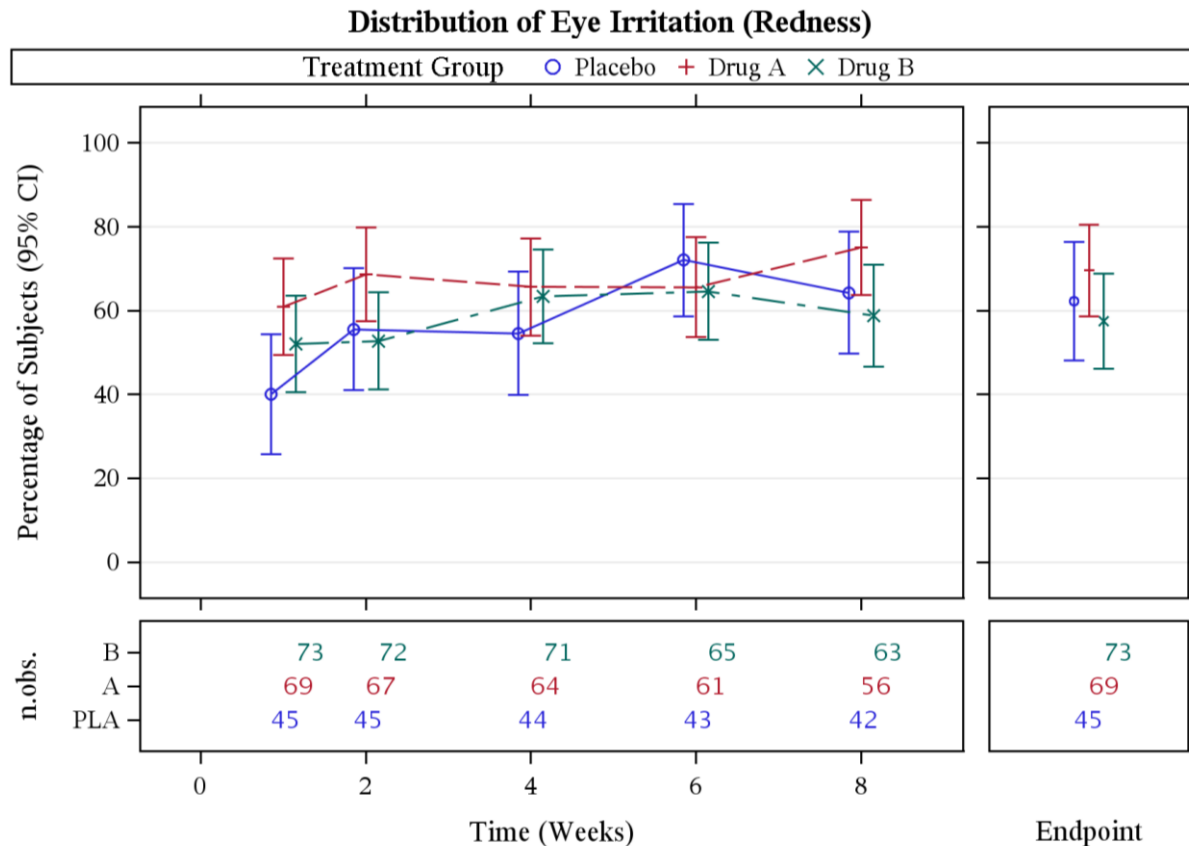
Hierarchy of human graphical perception abilities

1. Position along a common scale (most accurate)
2. Position along identical nonaligned scales
3. Length
4. Angle and slope
5. Area
6. Volume
7. Color
 1. Hue (red, green, blue, etc) can give good discrimination but poor ordering
 2. Saturation (pale/deep) can be useful if order is important

Source: W.S. Cleveland - Elements of Graphing Data

Do's and don'ts

- Another variation with connecting lines



n.obs = Number of Observations at Time point in Treatment group