

Graphs made easy using SAS Graph Template Language

Manohar Modem, Cytel

Bhavana Bommisetty, Vita Data Sciences

INTRODUCTION

- Traditional SAS/GRAPH procedures
Eg: PROC GPLOT
- Graph Template Language (GTL)
- Statistical Graphics (SG) procedures
Eg: PROC SGPLOT, SGPANEL
- Why GTL ?
- Provided data and code

GTL topics

1. Types of Annotation.
2. Methods to create/modify attributes of GTL elements.
3. Dynamic variables
4. Single and Multi-cell graphs.
5. Usage of appropriate options for various elements

GTL Procedures

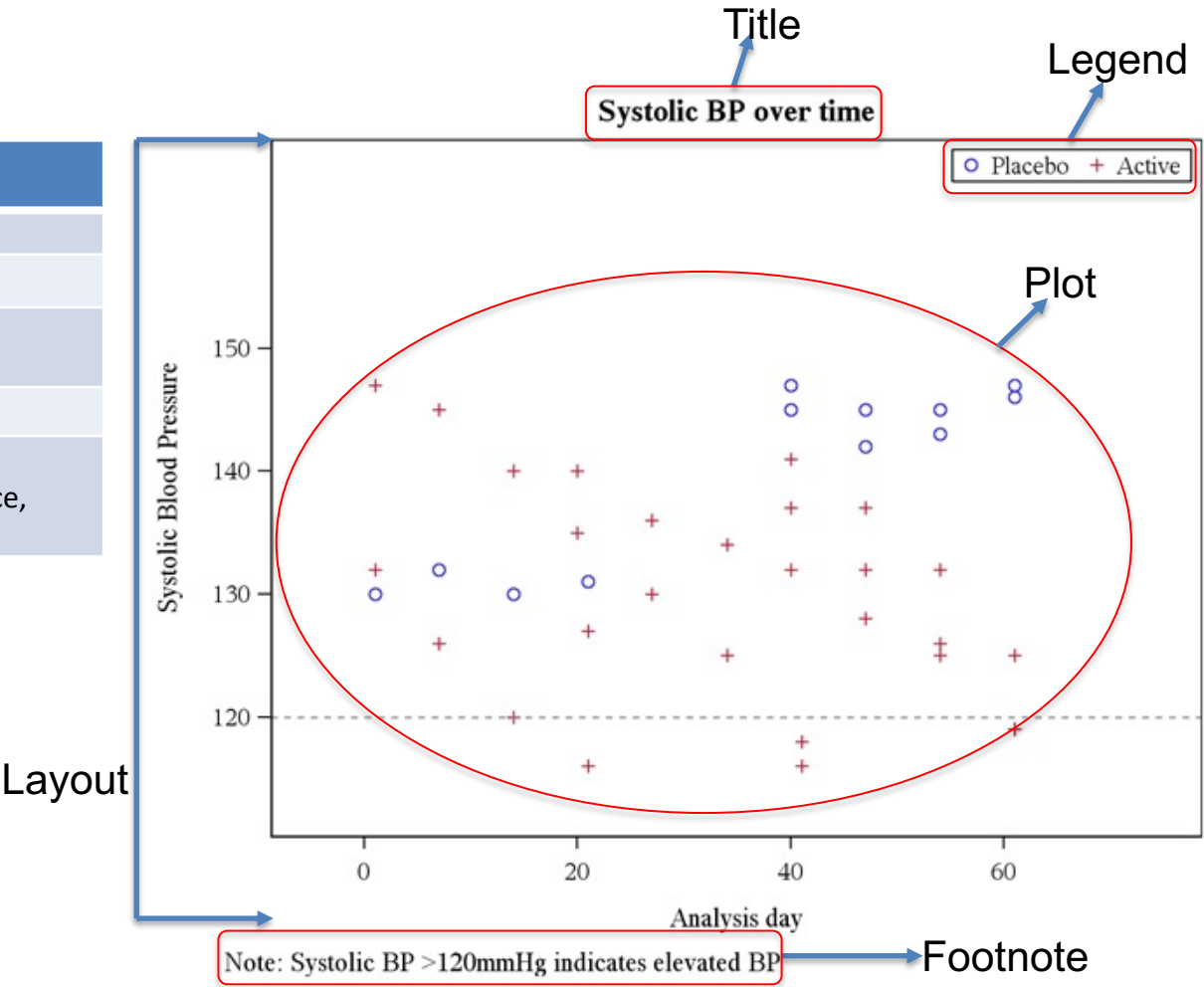
1. Proc template
2. Proc sgrender

```
proc template;  
  define statgraph template-name;  
    begingraph;  
      GTL statement 1;  
      GTL statement 2;  
      .....  
    endgraph;  
  end;  
run;  
  
proc sgrender data= template=/template-name;  
run;
```

GTL code

Common graph elements and GTL statements

	Element	GTL statement
1	Title	Entrytitle
2	Footnote	Entryfoonote
3	Plot	Depends on the graph. Eg: scatterplot
4	Legend	Discretelegend
5	Layout	Single cell: Layout overlay Multi cell: Layout datalattice, Layout datapanel



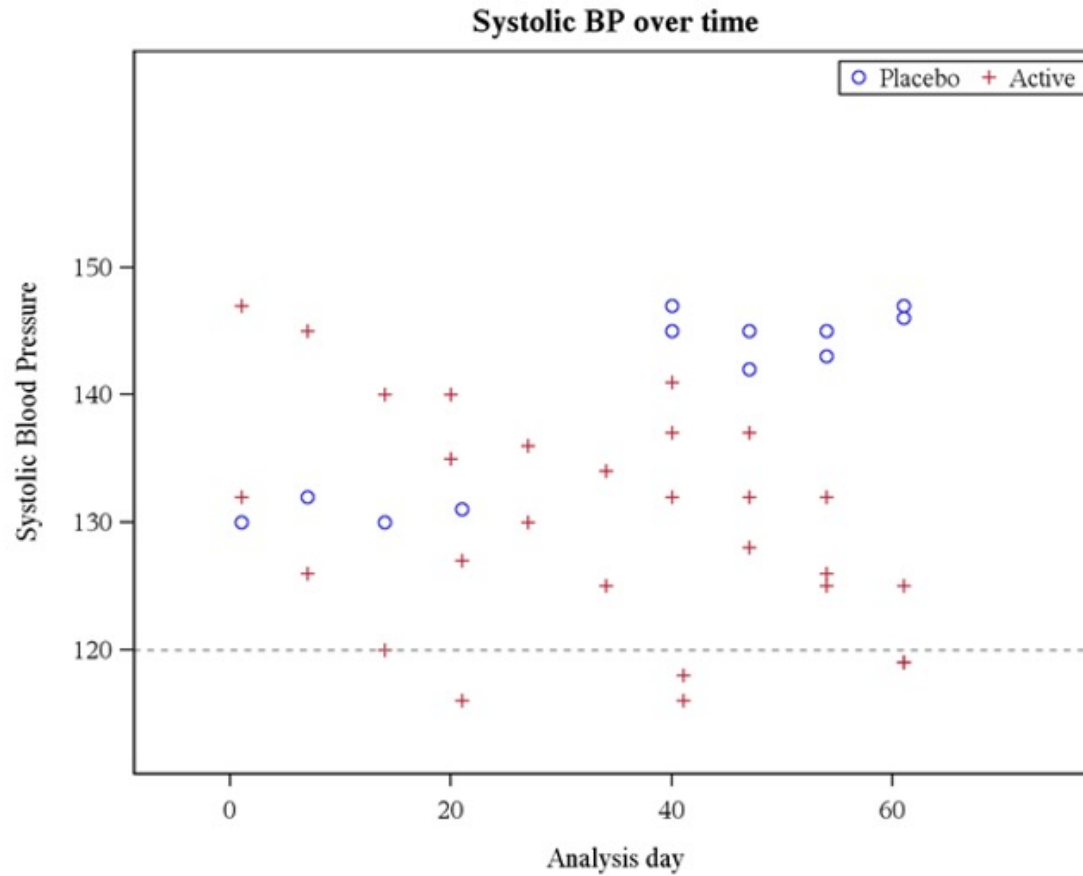
Proc template

```
proc template;  
  define statgraph template-name;  
    begingraph;  
      entrytitle;  
      entryfootnote;  
      layout overlay/xaxisopts yaxisopts;  
        scatterplot x=xvar y=yvar name='scat'; /*plot statement*/  
        discretelegend 'scat' /location= inside;  
      endlayout;  
    endgraph;  
  end;  
run;
```

	Element	GTL statement
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1. Scatter plot

Plot with duration on x-axis and systolic blood pressure on y-axis.



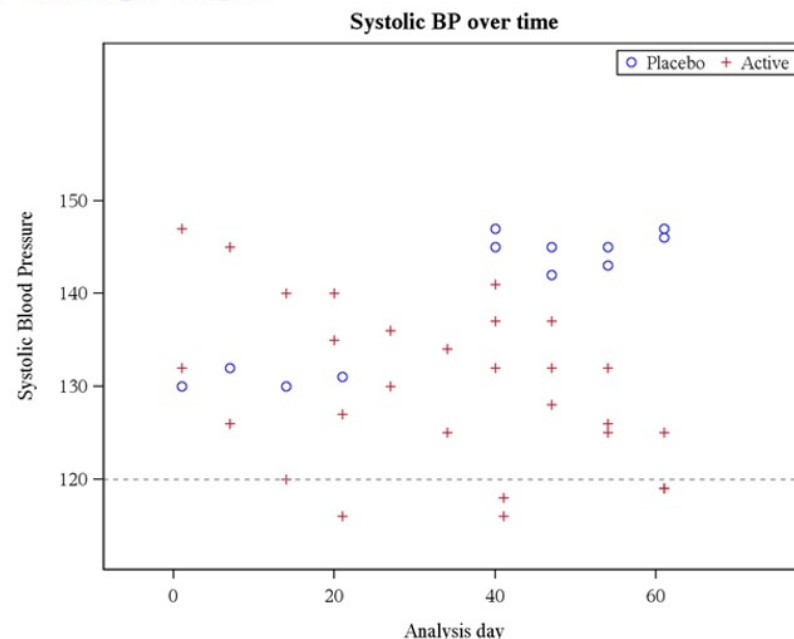
Note: Systolic BP >120mmHg indicates elevated BP

1. Scatter plot (continued)

```
proc template;  
  define statgraph scat;  
    begingraph;  
      entrytitle "Systolic BP over time" ;  
      entryfootnote halign=left "Note: Systolic BP >120mmHg indicates  
        elevated BP";  
      layout overlay/ xaxisopts=(offsetmin=0.1 offsetmax=0.2)  
        yaxisopts=(offsetmin=0.1 offsetmax=0.3);  
      scatterplot x=ady y=systolic/group= trtn name= 'treatment';  
      referenceline y=120 / lineattrs=(pattern=shortdash ) ;  
      discretelegend 'treatment' / location= inside halign=right  
        valign=top border=yes;  
    endlayout;  
  endgraph;  
end;  
run;
```

```
options orientation=landscape ;  
ods listing close;  
ODS RTF FILE="pathname/scatter..rtf" ;  
ods graphics on/reset=all height=5.5in width=6.5in  
  imagename="scatter" imagefmt=png noborder ;
```

```
proc sgrender data=heart2 template=scat;  
  format trtn trt.;  
run;  
ods _all_ close;  
ods listing;
```



Title and Footnotes

- Multiple titles or footnotes

Eg: `entrytitle "Systolic BP";`
`entrytitle "over time";`

- Attributes: alignment, text size and text weight.

Eg: `entrytitle textattrs=(size=12pt weight=normal) halight = center 'Systolic BP over time';`

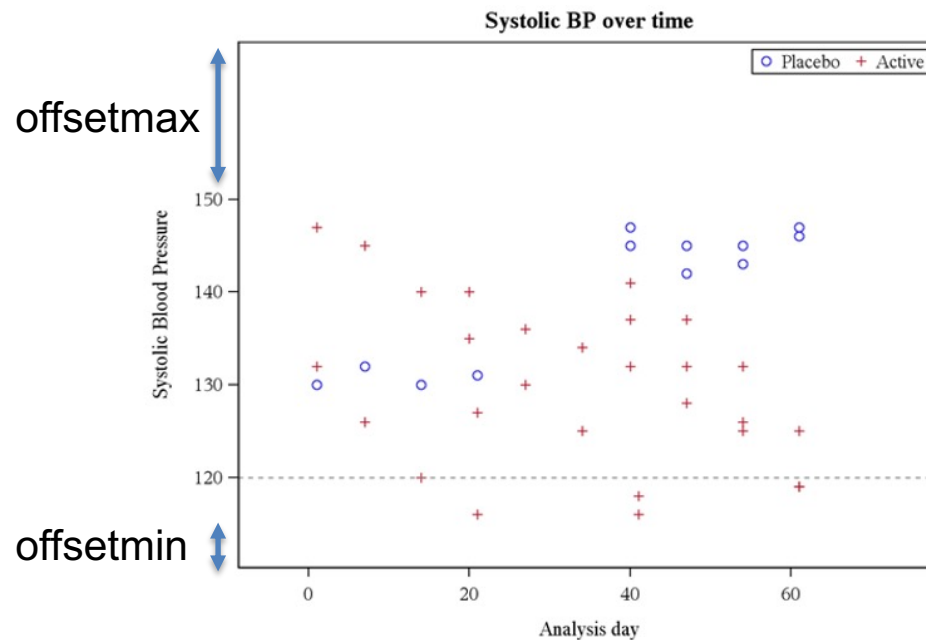
HALIGN	CENTER LEFT RIGHT
textattrs	SIZE WEIGHT COLOR

Layout

- Single celled graph - 'layout overlay'

```
layout overlay/ xaxisopts=(offsetmin=0.1 offsetmax=0.2)  
                yaxisopts=(offsetmin=0.1 offsetmax=0.3);
```

- X-axis and Y-axis 'xaxisopts' and 'yaxisopts'.
- OFFSETMIN : gaps at the beginning of the x-axis or y-axis
- OFFSETMAX : gaps at the end of the x-axis or y-axis



Note: Systolic BP >120mmHg indicates elevated BP

Legend

```
discretelegend 'treatment' / location= inside  halign=right  
    valign=top border=yes;
```

LOCATION	OUTSIDE INSIDE
HALIGN	CENTER LEFT RIGHT
VALIGN	CENTER TOP BOTTOM
ACROSS	specifies the number of legend entries that are placed horizontally before the next row begins
BORDER	TRUE FALSE

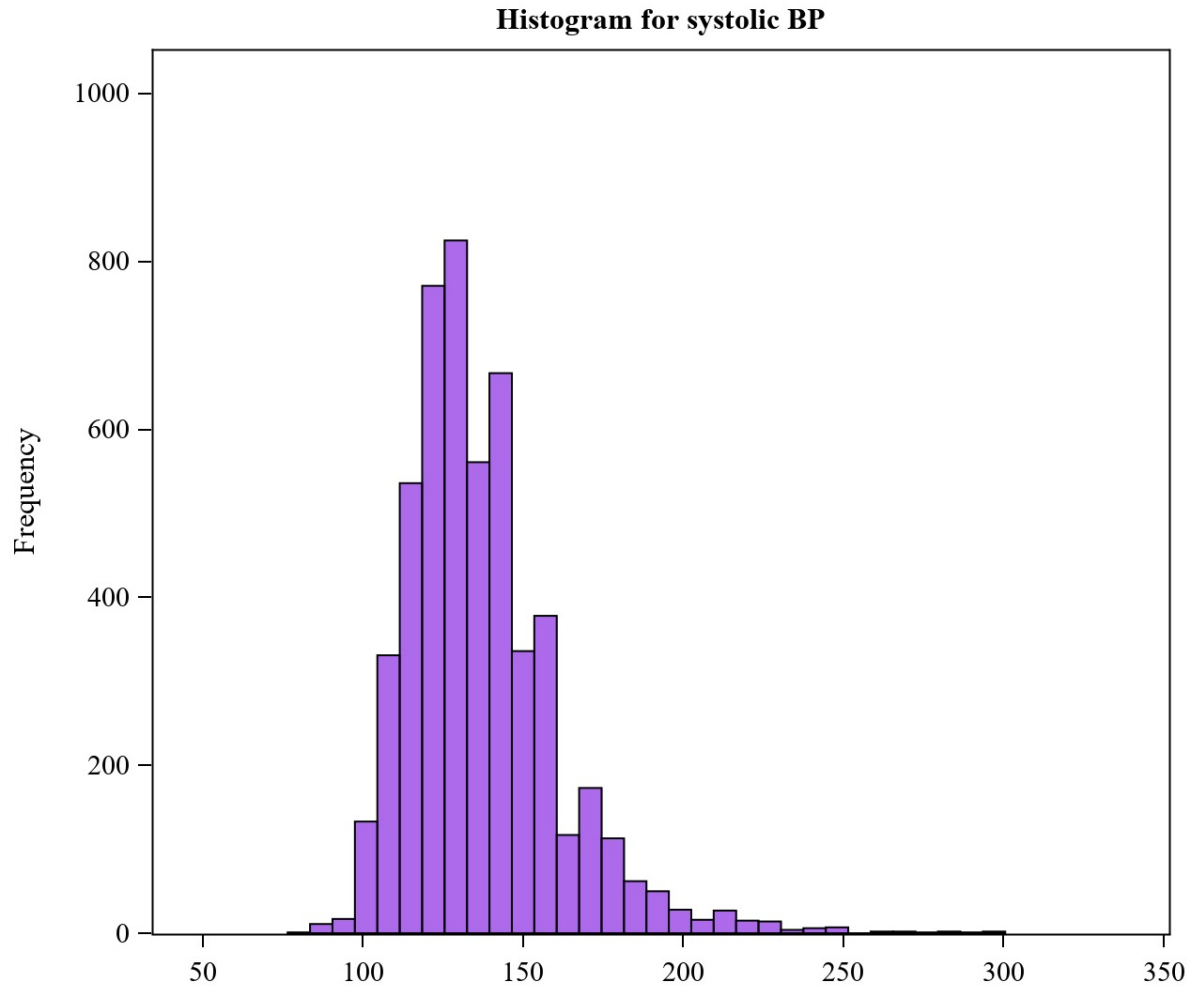
ODS

```
ODS RTF FILE="pathname/scatter..rtf" ;  
ods graphics on/reset=all height=5.5in width=6.5in  
    imagename="scatter" imagefmt=png noborder ;
```

RESET	change the values for these options back to their defaults
WIDTH	width of the graph
HEIGHT	height of the graph
IMAGENAME	Filename of the graph
IMAGEFMT	Type of the image eg: png, jpeg
NOBORDER	Removes the border around the graph

2. Histogram

Frequency distribution plot with systolic BP on x-axis and frequency on y-axis.



2. Histogram (continued)

Layout

Axis type	Option	Data type
Linear	LINEAROPTS	Numeric
Discrete	DISCRETEOPTS	Discrete Eg: Male, Female
Log	LOGOPTS	Logarithmic
Time	TIMEOPTS	SAS time, SAS date, or SAS datetime

Display: controls axis features - LABEL, LINE, TICKS, and TICKVALUES

Option	
DISPLAY= NONE	specifies that no axis features are displayed
DISPLAY= ALL	displays all 4 features
display= (ticks tickvalues)	select what we want

```
layout overlay/ xaxisopts=(offsetmin=0.05 linearopts=(viewmin=50 viewmax=350)
                    display= (ticks tickvalues))
Yaxisopts=(offsetmax=0.05 linearopts=(viewmin=0 viewmax=1000)
            label= "Frequency" display= (ticks tickvalues label));
```

2. Histogram (continued)

Plot

Option	
Scale	specifies whether the y-axis displays the frequency counts, percentages or proportions. Default one is percentages
Nbins	Specifies the number of bins.
binwidth	Specifies the width of each bin. If both 'nbins' and 'binwidth' are used, 'binwidth' options will be ignored.

```
histogram systolic/ scale=count binwidth= 7
```

ODS

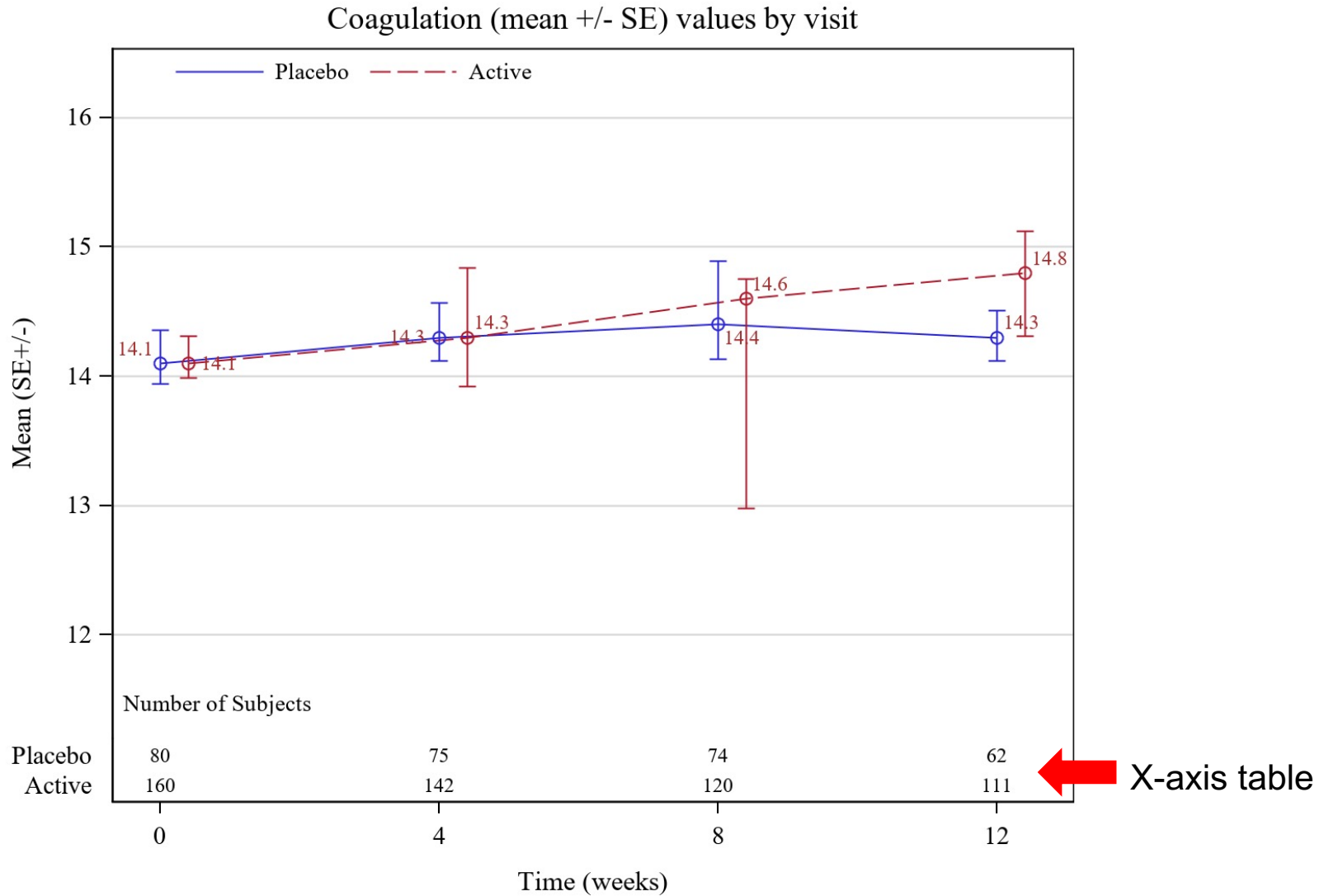
Default template store: sashelp.tmplmst.

ERROR: Template 'xxx' was unable to write to template store!"

```
ods path show;  
ods path work.testtemp(update) sashelp.tmplmst(read);
```

```
proc template;  
  define statgraph histogram/store=work.testtemp;  
    beginingraph;
```

3. Line plot with error bars



3. Line plot with error bars (continued)

Layout

1. Ways to provide tick values.

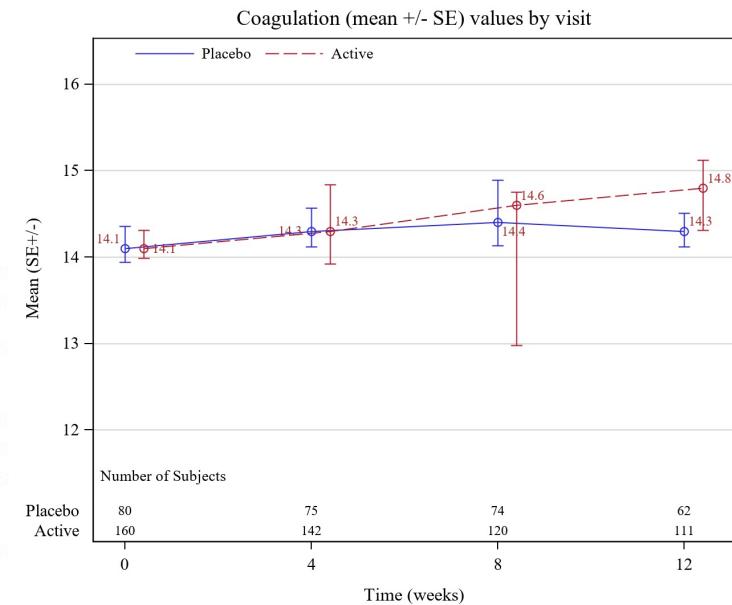
TICKVALUELIST	Specifies the order of the tick values for a linear axis as list.
TICKVALUEROTATION	Specifies how the tick values are rotated on the X and X2 axes.
TICKVALUESEQUENCE	Specifies the tick values for a linear axis by start, end, and increment.
VIEWMAX	Specifies the maximum data value to include in the display.
VIEWMIN	Specifies the minimum data value to include in the display.
TICKVALUEPRIORITY	Specifies whether an axis tick specification can extend the axis data range.

Eg1: tickvaluepriority=true TICKVALUESEQUENCE=(START=12 END=16 INCREMENT=1)

Eg2: tickvaluepriority=true TICKVALUELIST=(12 13 14 15 16)

2. Grid display

```
layout overlay/ xaxisopts=(offsetmin=0.05 offsetmax=0.05
    linearopts=(tickvaluelist= (0 4 8 12)) label= 'Time (weeks)')
yaxisopts=(griddisplay=on gridattrs=(thickness= 0.1 color=lightgrey)
    linearopts=(tickvaluepriority=true
        TICKVALUESEQUENCE=(START=12 END=16 INCREMENT=1))
    offsetmin=0.15 offsetmax=0.1 label='Mean (SE+/-)');
```



3. Line plot with error bars (continued)

Plot

- Seriesplot
- Scatter plot with error bars
 - datalabel

```
scatterplot x=avisitn2 y=mean/ group=treatn yerrorlower= minus_se yerrorupper=plus_se  
datalabel= mean datalabelattrs=(color=brown);
```

Input dataset

	param	treatc	treatn	avisitn	avisit	mean	plus_se	minus_se	nsubj
1	Prothrombin	Placebo	0	0	Week_0	14.1	14.36	13.94	80
2	Prothrombin	Placebo	0	4	Week_4	14.3	14.57	14.12	75
3	Prothrombin	Placebo	0	8	Week_8	14.4	14.89	14.13	74
4	Prothrombin	Placebo	0	12	Week_12	14.3	14.51	14.12	62

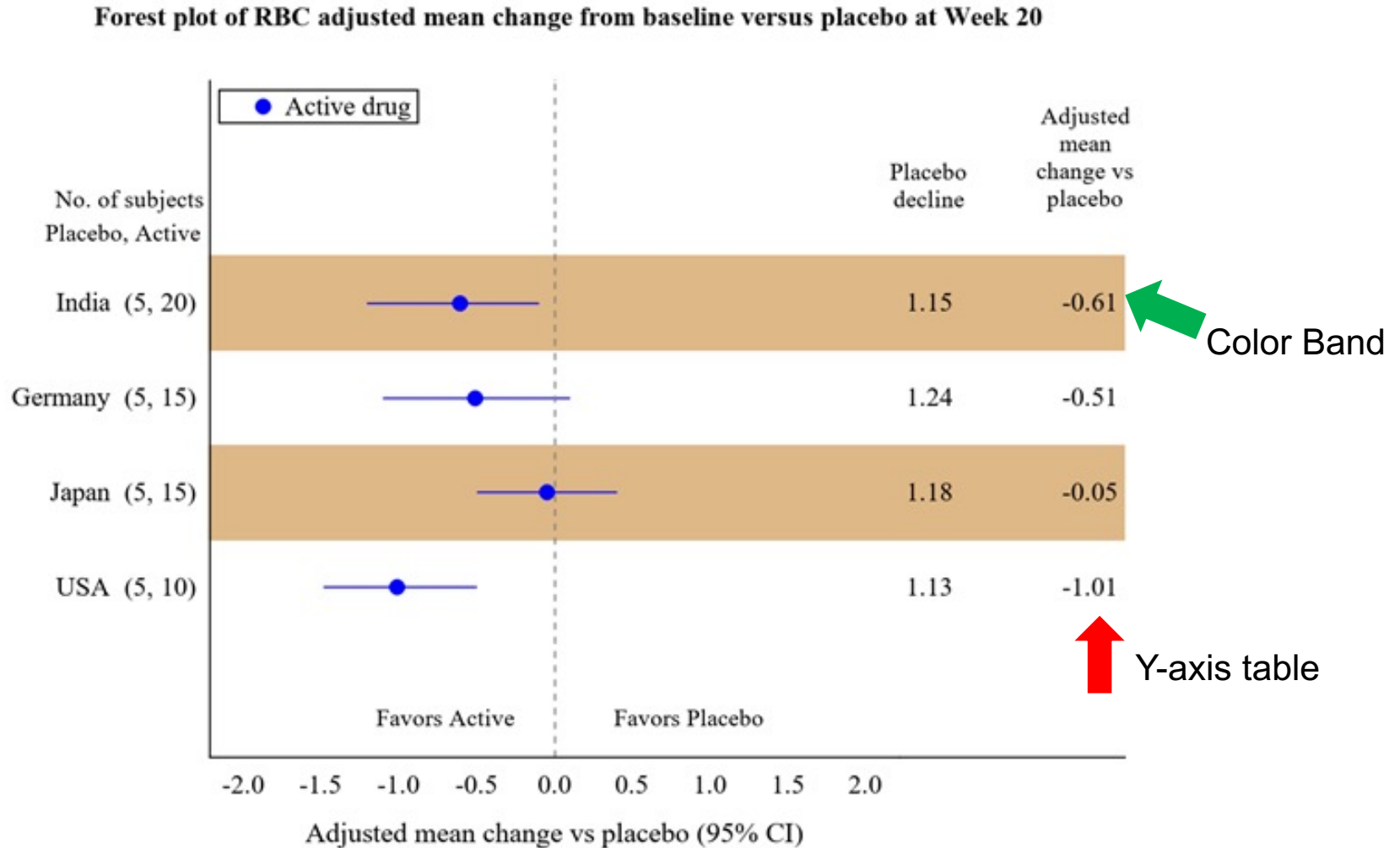
Axis table

- No. of subjects – X/X2/Y/Y2 axis.
- innermargin block - within a cell.

```
innermargin/align=bottom pad=0.8;  
axistable x=avisitn value=nsubj / class=treatn;  
endinnermargin;
```

4. Forest plot

Displays estimated results to find the effectiveness of the drug.



4. Forest plot (continued)

Input dataset for plot

	start	COUNTRY_N	LCL	UCL	PDECL	DF_AMEAN	LABEL
1	1	1	-1.486	-0.5	1.13	-1.01	USA (5, 10)
2	2	2	-0.5	0.4	1.18	-0.05	Japan (5, 15)
3	3	3	-1.105	0.1	1.24	-0.51	Germany (5, 15)
4	4	4	-1.205	-0.1	1.15	-0.61	India (5, 20)

Axis table

On Y-axis

Layout

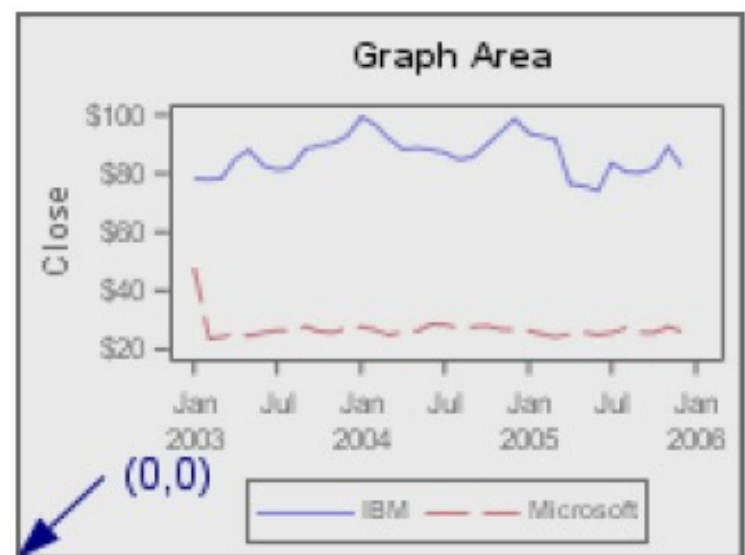
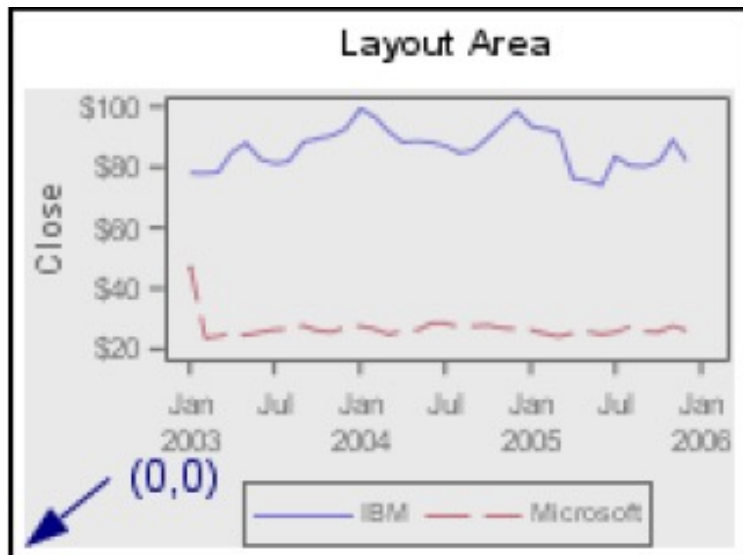
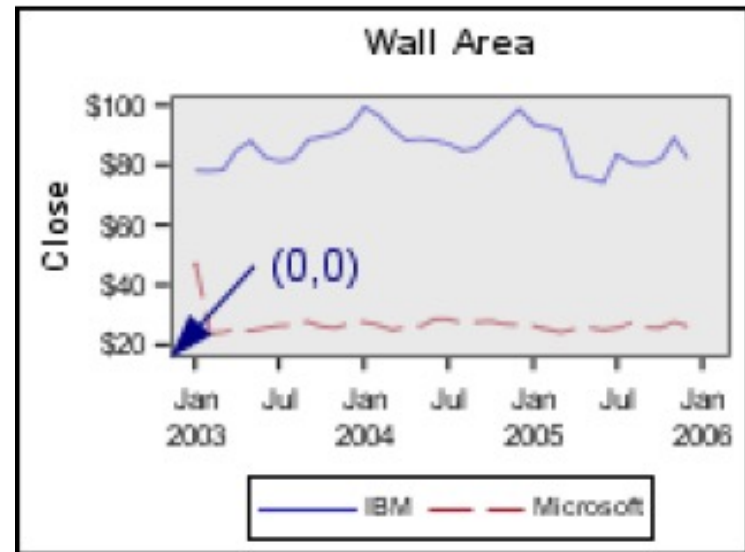
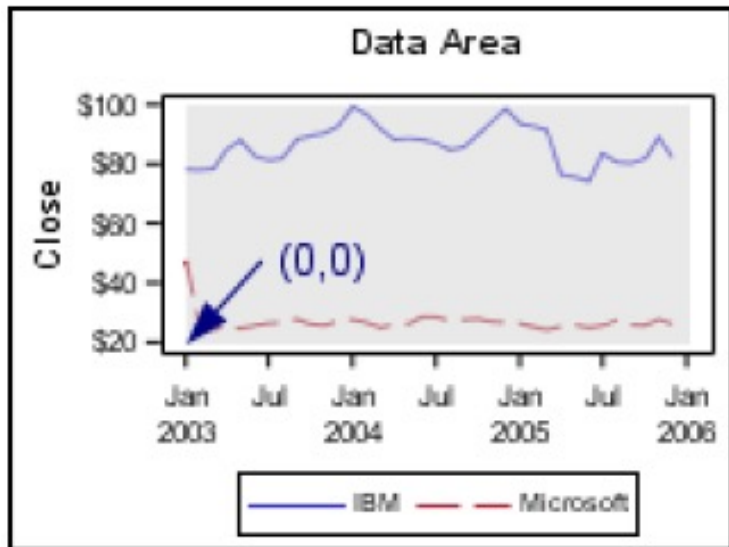
1. Cell wall

```
layout overlay /walldisplay=none
                xaxisopts=(display=(label tickvalues line))
                yaxisopts=(display=(tickvalues line)) ;
```

2. Color bands

```
yaxisopts=(discreteopts=(colorbands=even COLORBANDSATTRS=(color=burlywood))) ;
```

Annotation drawing spaces



Steps for Annotation

1. What you want to create. Eg: text, shape
2. Drawing spaces for x and y coordinates. Eg: x1space= datavalue y1space=graphpercent
3. Providing coordinates. Eg: x1, y1

Types of Annotation

1. **Draw statements** Eg: Drawtext, Drawline, Drawrectangle

```
drawtext textattrs=( size=9pt) "Favors Active" /anchor=bottomleft width=18 widthunit=percent  
xspace=wallpercent yspace=wallpercent x=18 y=3.5 justify=center ;
```

2. **SGANNO macros**

- %sganno: compiles

```
data anno;  
%sgtext(label="Placebo",x1=15,y1=4,drawspace="DATAVALUE");  
%sgtext(label="Active",x1=5,y1=4,drawspace="DATAVALUE");  
run;
```
- %sganno_help:

- purpose of these macros
- possible values of macro-variables.

Eg: %sganno_help(sgtext)

- %SGTEXT, %SGLINE, %SGOVAL

Types of Annotation (continued)

3. Dataset driven

- Function, label, x1, y1, x1space, y1space, width, color etc.,

Eg:

	function	x1space	y1space	textsize	textcolor	width	widthunit	justify	STRATUM	label	desc	x1	y1
1	text	graphpercent	graphpercent	8	black	20	percent	left	Placebo	0.000	Estimated proportion at Week 26	32	76
2	text	graphpercent	graphpercent	8	black	20	percent	left	Placebo	0.071 (0.010, 0.409)	Estimated proportion at Week 50	50.5	76
3	text	graphpercent	graphpercent	8	black	20	percent	left	Placebo	0.071 (0.010, 0.409)	Estimated proportion at Week 78	68.5	76

a. Create annotate dataset

b.

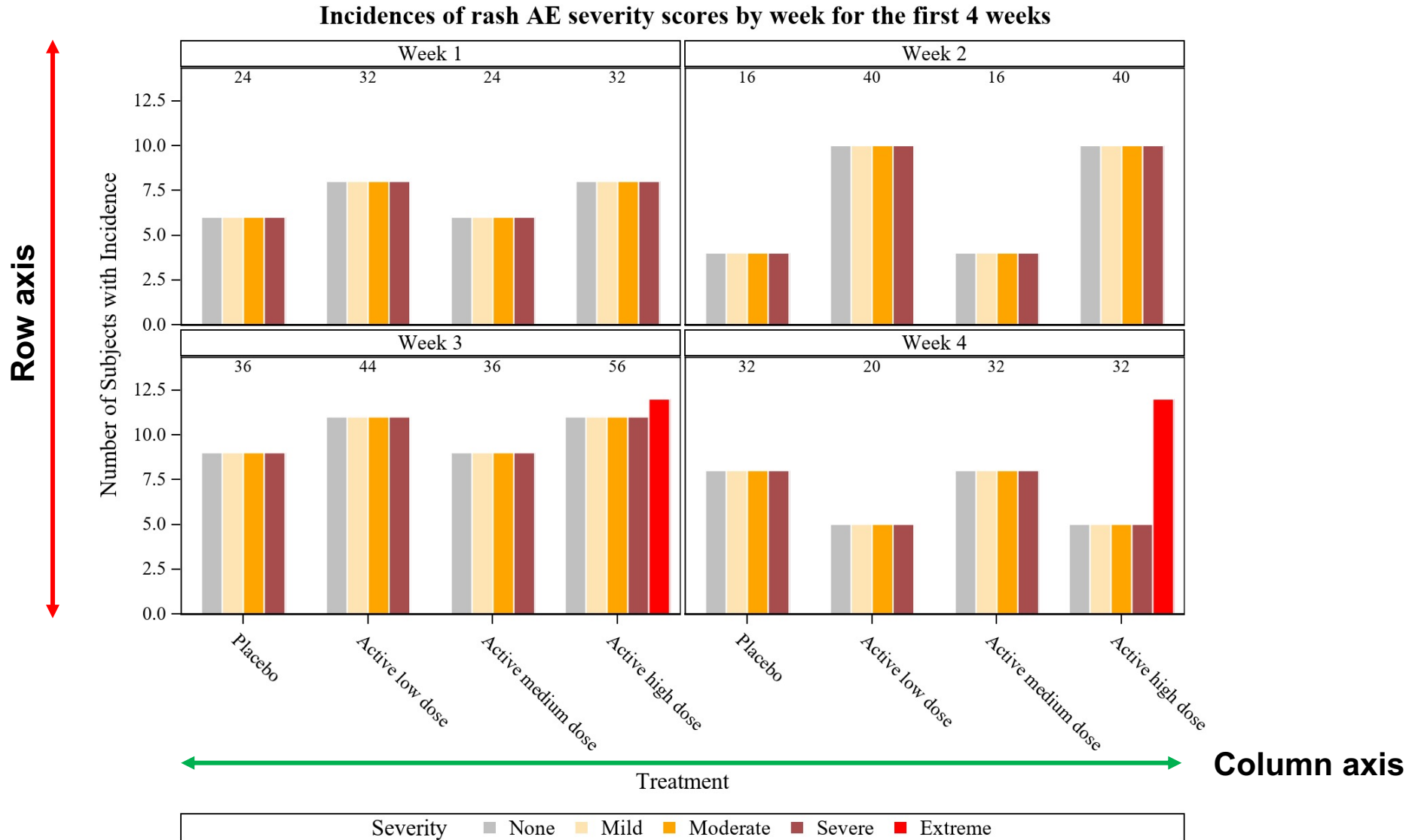
```
proc template;  
  define statgraph km;  
    begingraph;  
      GTL statements  
      .....;  
      annotate;  
    endgraph;  
  end;  
run;
```

c.

```
proc sgrender data=surv_risk3 template=km2 sganno=anno;  
run;
```

5. Panel Bar Chart

AE's |Treatment| Severity| Visit



5. Panel Bar Chart (continued)

Layout

Multicell graph: 2 columns & 2 rows

- Layout datapanel
- Layout prototype

```
layout datapanel classvars=(avisitn)/  
    columns=2 columngutter=2  
    columnaxisopts=(label = "Treatment")  
    rowaxisopts=(label = "Number of Subjects with Incidence ");  
layout prototype;  
    barchart x=trt y=nsubj2/ group=max_sev_map;  
endlayout;  
sidebar ;  
    discretelegend 'bar'/ title= "Severity";  
Endsidebar;  
endlayout;
```

Axes

- Columnaxis – x-axis for all cells
- Rowaxis – y-axis for all cells

Legend

- Sidebar: It spans the legend across the cells

Plot Attributes

1. Discreteattrmap

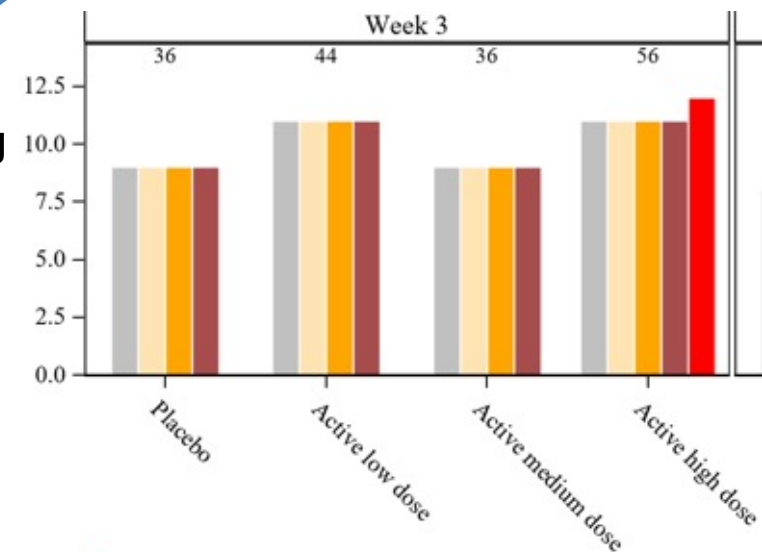
- Creates attribute map for grouping variable values
- 4 types of attributes – lineattrs, markerattrs, textattrs and fillattrs
- Begingraph – endgraph block.

```
discreteattrmap name='Sev';  
  value 'None' / fillattrs= (color=grey transparency=0.5) lineattrs=(color=white);  
  value 'Mild' / fillattrs= (color= Orange transparency=0.7) lineattrs=(color=white);  
  value 'Moderate' / fillattrs= (color= Orange transparency=0) lineattrs=(color=white);  
  value 'Severe' / fillattrs= (color= maroon transparency=0.3) lineattrs=(color=white);  
  value 'Extreme' / fillattrs= (color= red transparency=0) lineattrs=(color=white);  
enddiscreteattrmap;  
discreteattrvar attrvar=max_sev_map var=aesev attrmap='Sev';
```

Formatted grouping
variable

Grouping
variable

Map for grouping
variable



Plot Attributes (continued)

2. Custom style

- Each ODS destination has a default style.
- List of available styles

```
proc template;  
  list styles;  
run;
```

- Provides all style elements in styles.default

```
proc template;  
  source styles.default;  
run;
```

- Create custom style:
 - Use available styles
 - New style from scratch.

Custom style

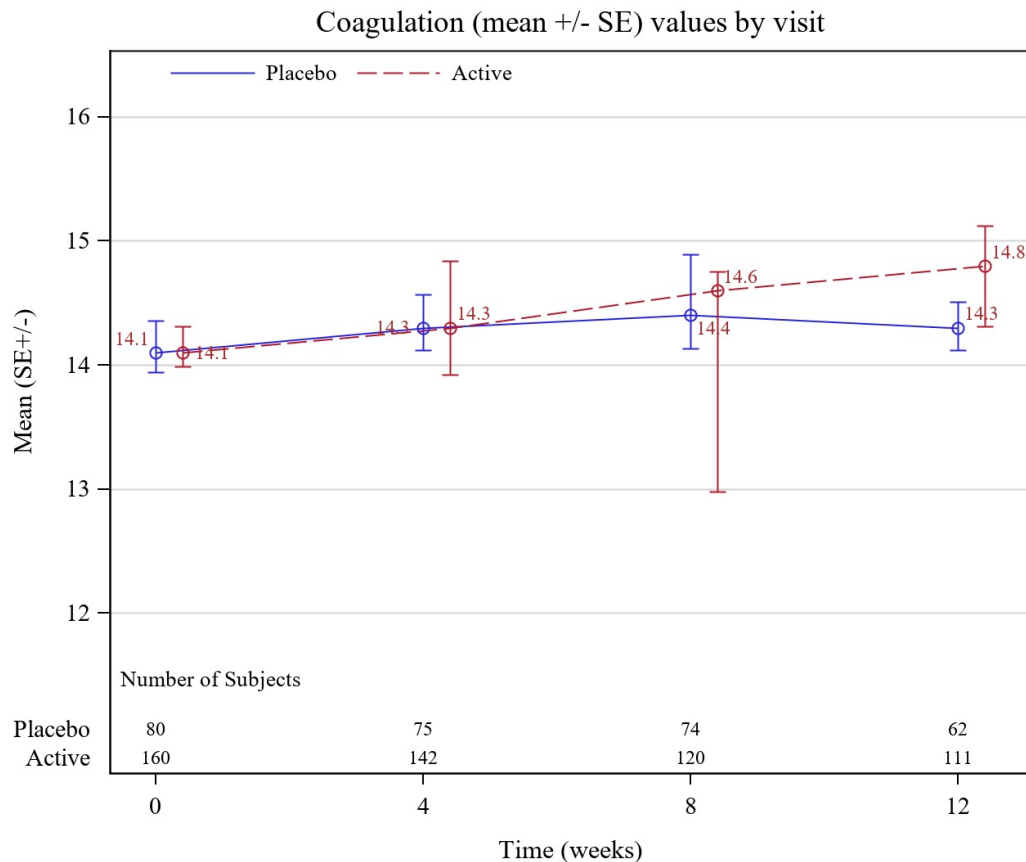
```
proc template;  
  define style mystyle;  
    parent=Styles.Default;  
    style GraphData1 from GraphData1 /  
      markersymbol = "triangle";  
    style GraphData2 from GraphData2 /  
      markersymbol = "square";  
  end;  
run;  
  
ods rtf file="&gpathname\panel_bar_plot.rtf" style=mystyle ;
```

Plot Attributes (continued)

3. Plot level

- Update attributes at plot level
- Provides same symbol for all the values of grouping variable.

```
scatterplot x=avisitn y=mean/ group=trtn markerattrs=(symbol= circle);
```



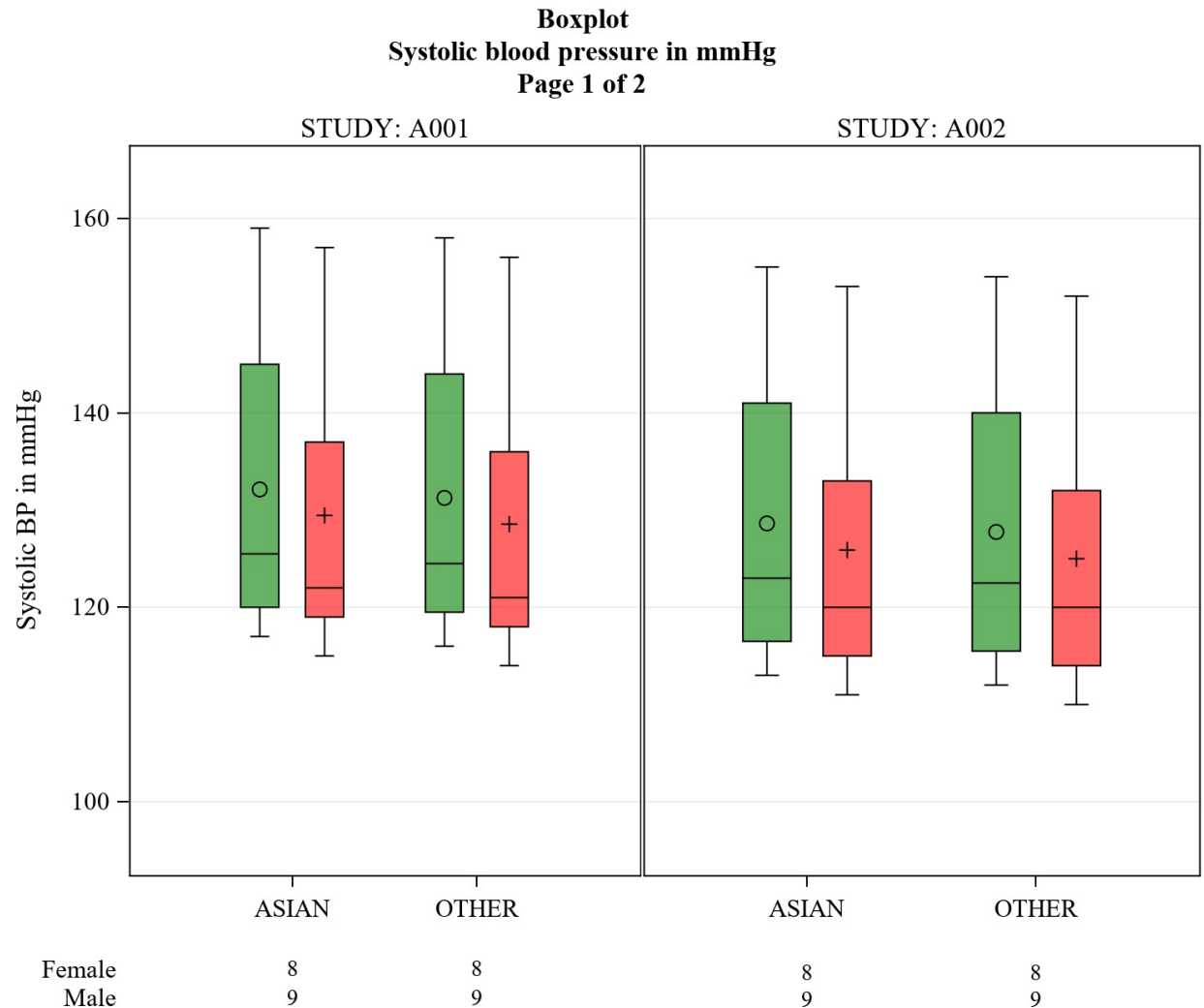
6. Custom Panel Bar plot

Systolic BP | Study | Race | Sex

Multicell graph:

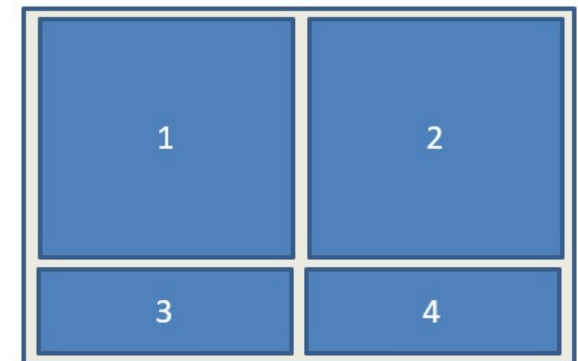
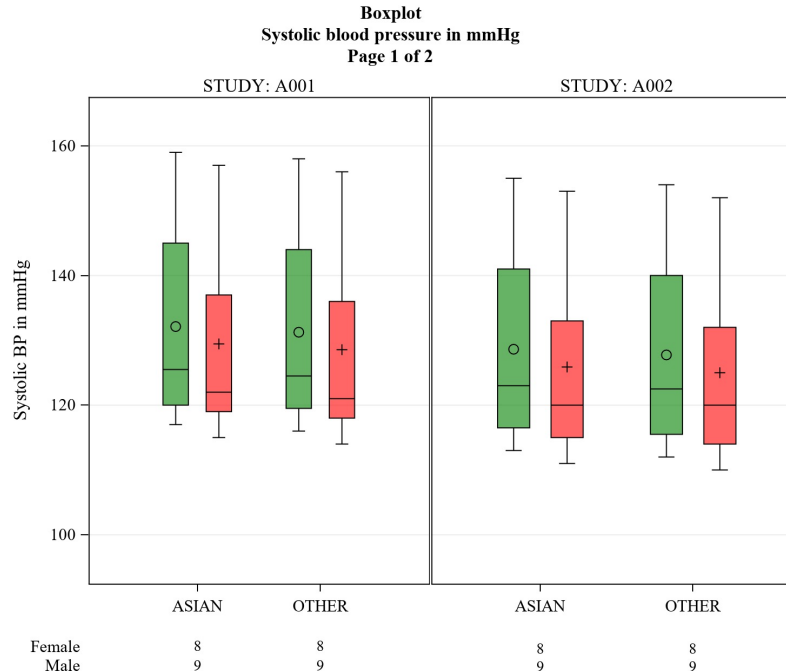
2 columns & 2 rows

- Layout lattice
- Layout overlay (4)



6. Custom Panel Bar plot (continued)

```
layout lattice / columns=2 rows=2 rowweights= (0.9 0.1) columnweights=(0.5 0.5);  
  layout overlay ; /*1st cell plot*/  
    boxplot ;  
  endlayout;  
  layout overlay ; /*2nd cell plot*/  
    boxplot ;  
  endlayout;  
  Layout Overlay / walldisplay=none; /*3rd cell plot*/  
    AxisTable ;  
  endlayout;  
  Layout Overlay / walldisplay=none; /*4th cell plot*/  
    AxisTable ;  
  endlayout;  
endlayout;
```



Dynamic Variables

Flexible code

```
proc template;  
  define statgraph box_panel;  
    dynamic _ylabel _ticks ;  
    beginngraph;  
  
    rowaxes;  
      rowaxis / label=_ylabel type=linear  
               linearopts=(tickvaluelist=_ticks tickvaluepriority=true) ;  
      rowaxis / display=none ;  
    endrowaxes;  
  
proc sgrender data=boxd5 template=box_panel;  
  dynamic _ylabel= "Systolic BP in mmHg"  
           _ticks="100 120 140 160 " ;  
run;
```

Declare - Compile

Define - Execute

References

MATANGE, S. (2019). GETTING STARTED WITH THE GRAPH TEMPLATE LANGUAGE IN SAS: Examples, tips, and techniques for ... creating custom graphs. SAS Institute.

SAS Institute Inc. 2016. SAS® 9.4 Graph Template Language: User's Guide, Fifth Edition. Cary, NC: SAS Institute Inc.

Unicode® character name index. (n.d.). Retrieved March 26, 2021, from <http://www.unicode.org/charts/charindex.html>

Thank You!