sas innovate 2026

A Map to Success with Data Visualization Using ODS Statistical Graphics

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Agenda

- General Syntax
- Stacked Bar Chart
  - SG Procedures
  - GTL (PROC TEMPLATE)
- Map of New England States
  - SG Procedure
  - GTL (PROC TEMPLATE)
- Side-by-Side of Plots in GTL
  - GRIDDED Layout
  - LATTICE Layout
- Conclusion

General Syntax

SGPLOT

```
proc sgplot </options>;
   styleattrs </options>;

   plot statements
run;
```

HBAR
VBAR
POLYGON

Two-Step Process

Per Matange (Getting Started with Graph Template Language, 2013, p. 11)

1. First, you need to define the structure of the graph using the STATGRAPH template. In the creation of the template, no graph is actually produced.

2. Secondly, you need to associate the data in order to render the template which will produce the graph.

Step 1 – PROC TEMPLATE – General Syntax

```
proc template;
  define statgraph templatename;
    begingraph / <options>;
      layout type / <options>;

        … GTL SAS code …

      endlayout;
    endgraph;
  end;
run;
```

Begin Template Definition

Begin Graph Specifications

Specify Layout Type

Specify Plot Type(s) and Other GTL Statements

End Layout Specification

End Graph Specifications

End Template Definition

Step 2 – PROC GRENDER – General Syntax

- Produce the Graph

```
proc sgrender data = datasetname
              template = templatename;
   <optional SAS  statements>;
run;
```

Specify Input Data

Associate Template

OVERLAY and GRIDDED General Syntax

```
layout type </options>;

   GTL-statement(s);

   <innermargin </options>;
     block-plot or axis-table statements;
   innermargin;>

endlayout;
```

OVERLAY and PROTOTYPE Only

LATTICE General Syntax

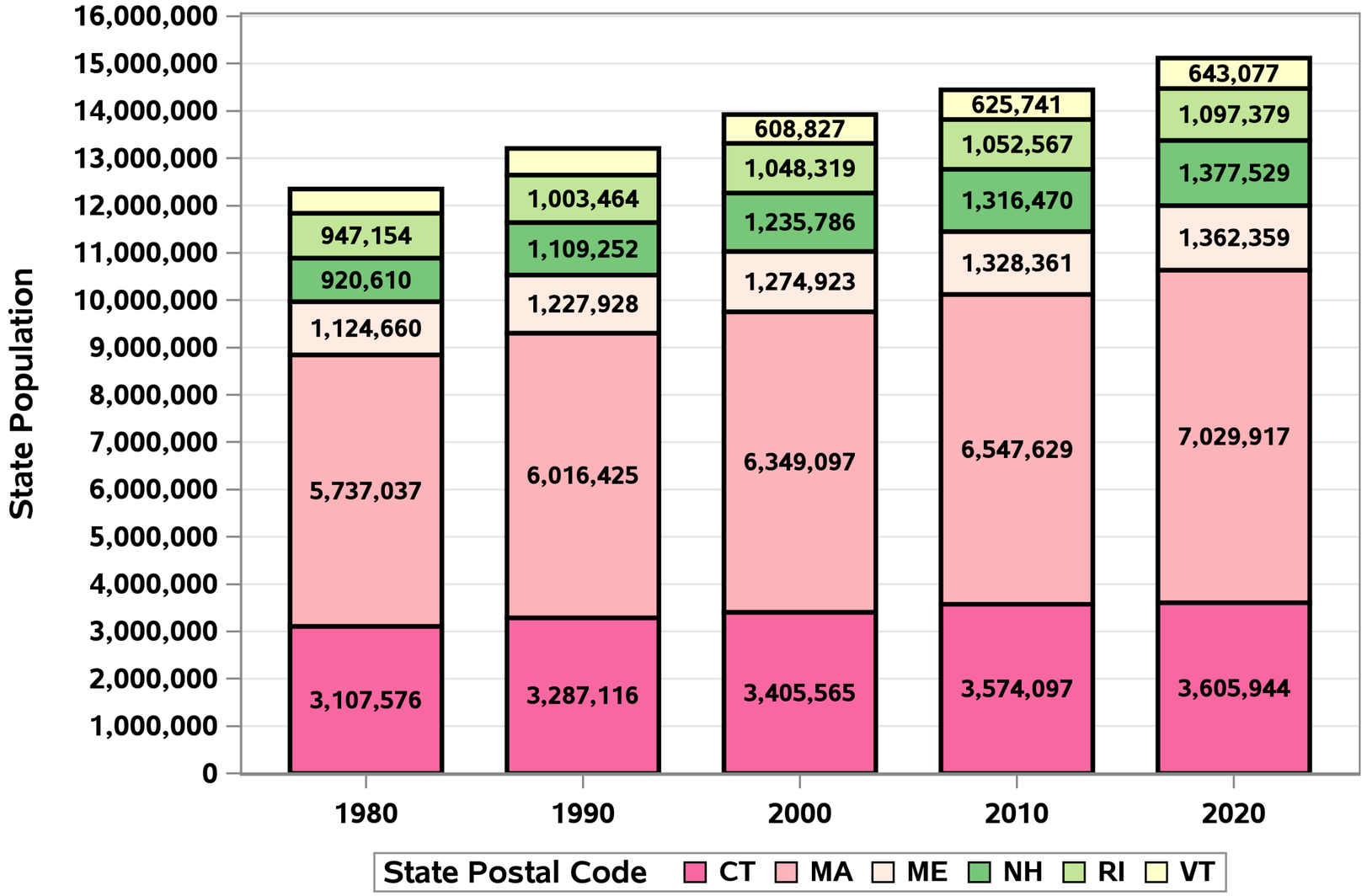
```
layout LATTICE </options>;
   …
   <columnaxes </options>;
      columnaxis/axis-option(s);
      …
   endcolumnaxes;>
   <column2axes </options>;
      columnaxis/axis-option(s);
      …
   endcolumn2axes;>
   <rowaxes </options>;
      rowaxis/axis-option(s);
      …
   endrowaxes;>
   …
```

```
   …
   <row2axes </options>;
      rowaxis / axis-option(s);
      …
   endrow2axes;>
   <columnheaders;
      GTL-statement(s);
   endcolumnheaders;>
   <rowheaders;
      GTL-statement(s);
   endrowheaders;>
   <sidebar </options>;
      GTL-statement(s);
   endsidebar;>
endlayout;
```

Stacked Bar Chart

SG Procedures

PROC SGPLOT Stacked Bar Charts



Sample Data for Bar Chart

STATENAME	STATECODE	DIVISION	REGION	POPULATION	YEAR
Connecticut	CT	New England	Northeast	3,107,576	1980
…					
Connecticut	CT	New England	Northeast	3,605,944	2020
Maine	ME	New England	Northeast	1,124,660	1980
…					
Maine	ME	New England	Northeast	1,362,359	2020
Massachusetts	MA	New England	Northeast	5,737,037	1980
…					
Massachusetts	MA	New England	Northeast	7,029,917	2020
New Hampshire	NH	New England	Northeast	920,610	1980
…					
New Hampshire	NH	New England	Northeast	1,377,529	2020
Rhode Island	RI	New England	Northeast	947,154	1980
…					
Rhode Island	RI	New England	Northeast	1,097,379	2020
Vermont	VT	New England	Northeast	511,456	1980
…					
Vermont	VT	New England	Northeast	643,077	2020

BAR CHART – Stacked

```
proc sgplot data = popln_eng;
     format POPULATION comma13.;
     styleattrs datacolors = (&sixcolors.);
     vbar YEAR / response = POPULATION
                 group = STATECODE
          seglabel
          seglabelattrs = (size = 8 weight = bold)
          barwidth = 0.7
          outlineattrs = (color = black thickness = 2pt);
          ...
```

DATACOLORS can be used to specify a specific color scheme

GROUP is used to group the data

Indicate the width of each bar as ratio to max width

Display segment labels and specify attributes associated with label

BAR CHART – Stacked

```
      . . .
      xaxis display = (nolabel)
            valueattrs = (weight = bold);
      yaxis values = (0 to 16000000 by 1000000)
            valueattrs = (weight = bold)
            label = 'State Population'
            labelattrs = (weight = bold)
            grid offsetmin = 0;
      keylegend / valueattrs = (weight = bold)
                  title = "State Postal Code"
                  titleattrs = (weight = bold);
run;
```

YAXIS and XAXIS statements allows you to specify axes attributes

KEYLEGEND allows for control of how the legend is displayed

For horizontal bar chart use HBAR and switch X and Y axes

Creating Templates

Building on What We Know

PROC TEMPLATE – General Syntax

```
proc template;
 define statgraph templatename;
    begingraph / <options>;
       layout type / <options>;

             … GTL SAS code …


       endlayout;
    endgraph;
 end;
run;
```

TMPLOUT Option

```
proc sgplot data = input-data-set
              TMPLOUT = "filename";

    … PLOT STATEMENTS …

run;
```

Writes the GTL code for the graph to a file

Saving Custom TEMPLATE

```
ods path
      ADAM.TEMPLAT (update)
      SASUSER.TEMPLAT (read)
      SASHELP.TMPLMST (read);
```

Stacked Bar Chart

GTL (PROC TEMPLATE)

BAR CHART

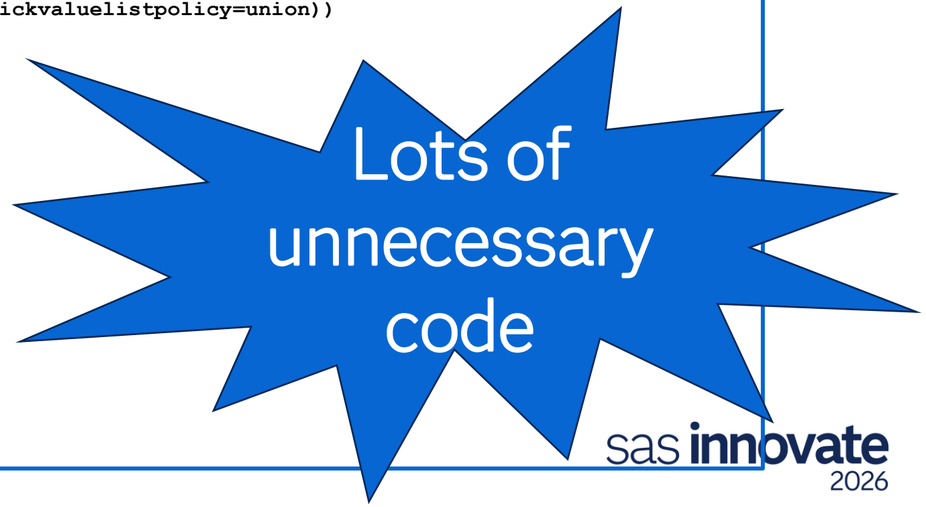
PROC TEMPLATE Produced from TMPLOUT on SGPLOT

```
proc template;
define statgraph sgplot;
dynamic _NEGATIVE_;
dynamic _ticklist_;
begingraph / collation=binary dataColors=( CXF768A1 CXFBB4B9 CXFEEBE2 CX78C679 CXC2E699 CXFFFFCC );
EntryTitle "Stacked Bar Chart - Produced with SGPLOT" /;
layout overlay / xaxisopts=( display=( ticks tickvalues line ) TickValueAttrs=( Weight=bold) type=discrete discreteopts=(
TickValueFitPolicy=SplitRotate tickValueList=_ticklist_ ) ) y2axisopts=(labelFitPolicy=Split) yaxisopts=( Label="State Population"
labelFitPolicy=Split offsetmin=0 LabelAttrs=( Weight=bold) TickValueAttrs=( Weight=bold) type=auto linearopts=( tickvaluelist=( 0
1000000 2000000 3000000 4000000 5000000 6000000 7000000 8000000 9000000 10000000 11000000 12000000 13000000 14000000 15000000 16000000
) viewmin=0 viewmax=16000000 ) griddisplay=on ) x2axisopts=(type=Discrete discreteOpts=(tickValueList=_ticklist_
tickvaluefitpolicy=SplitRotate tickValueListPolicy=Union)) y2axisopts=(labelFitPolicy=Split);
   BarChartParm X='YEAR'n Y='_Sum1_POPULATION_'n / primary=true Group='STATECODE'n OutLineAttrs=( Color=CX000000 Thickness=2pt)
SegmentLabelType=auto SegmentLabelAttrs=( Size=8 Weight=bold ) barwidth=0.7 LegendLabel="POPULATION (Sum)" NAME="VBAR";
   DiscreteLegend "VBAR" / Location=Outside Title="State Postal Code" TitleAttrs=( Weight=bold) ValueAttrs=( Weight=bold);
endlayout;
endgraph;
end;
run;
```

BAR CHART

PROC TEMPLATE Produced from TMPLOUT on SGPLOT

```
proc template;
   define statgraph sgplot;
   dynamic _NEGATIVE_;
   dynamic _ticklist_;
      begingraph / collation=binary
                   datacolors=( CXF768A1 CXFBB4B9 CXFEEBE2 CX78C679 CXC2E699 CXFFFFCC );
         entrytitle "Stacked Bar Chart - Produced with SGPLOT" /;
         layout overlay / xaxisopts=(display=(ticks tickvalues line)
                                     tickvalueattrs=(weight=bold)
                                     type=discrete
                                     discreteopts=( tickvaluefitpolicy=splitrotate tickvaluelist=_ticklist_ ) )
                          y2axisopts=(labelfitpolicy=split)
                          yaxisopts=(label="State Population" labelfitpolicy=split offsetmin=0 labelattrs=(weight=bold)
                                     tickvalueattrs=(weight=bold)
                                     type=auto
                                     linearopts=(tickvaluelist=(0 1000000 2000000 3000000 4000000 5000000 6000000 7000000 8000000
                                                                9000000 10000000 11000000 12000000 13000000 14000000 15000000 16000000)
                                                 viewmin=0 viewmax=16000000 ) griddisplay=on)
                          x2axisopts=(type=discrete
                                      discreteopts=(tickvaluelist=_ticklist_ tickvaluefitpolicy=splitrotate tickvaluelistpolicy=union))
                          y2axisopts=(labelfitpolicy=split);
            barchartparm x='YEAR'n Y='_Sum1_POPULATION_'n /
                         primary=true
                         group='STATECODE'n outlineattrs=(color=CX000000 thickness=2pt)
                         segmentlabeltype=auto segmentlabelattrs=( size=8 weight=bold)
                         barwidth=0.7 name="VBAR"
                         legendlabel="POPULATION (Sum)";
            discretelegend "VBAR" / location=outside
                                    title="State Postal Code"
                                    titleattrs=(weight=bold) valueattrs=( weight=bold);
         endlayout;
      endgraph;
   end;
run;
```



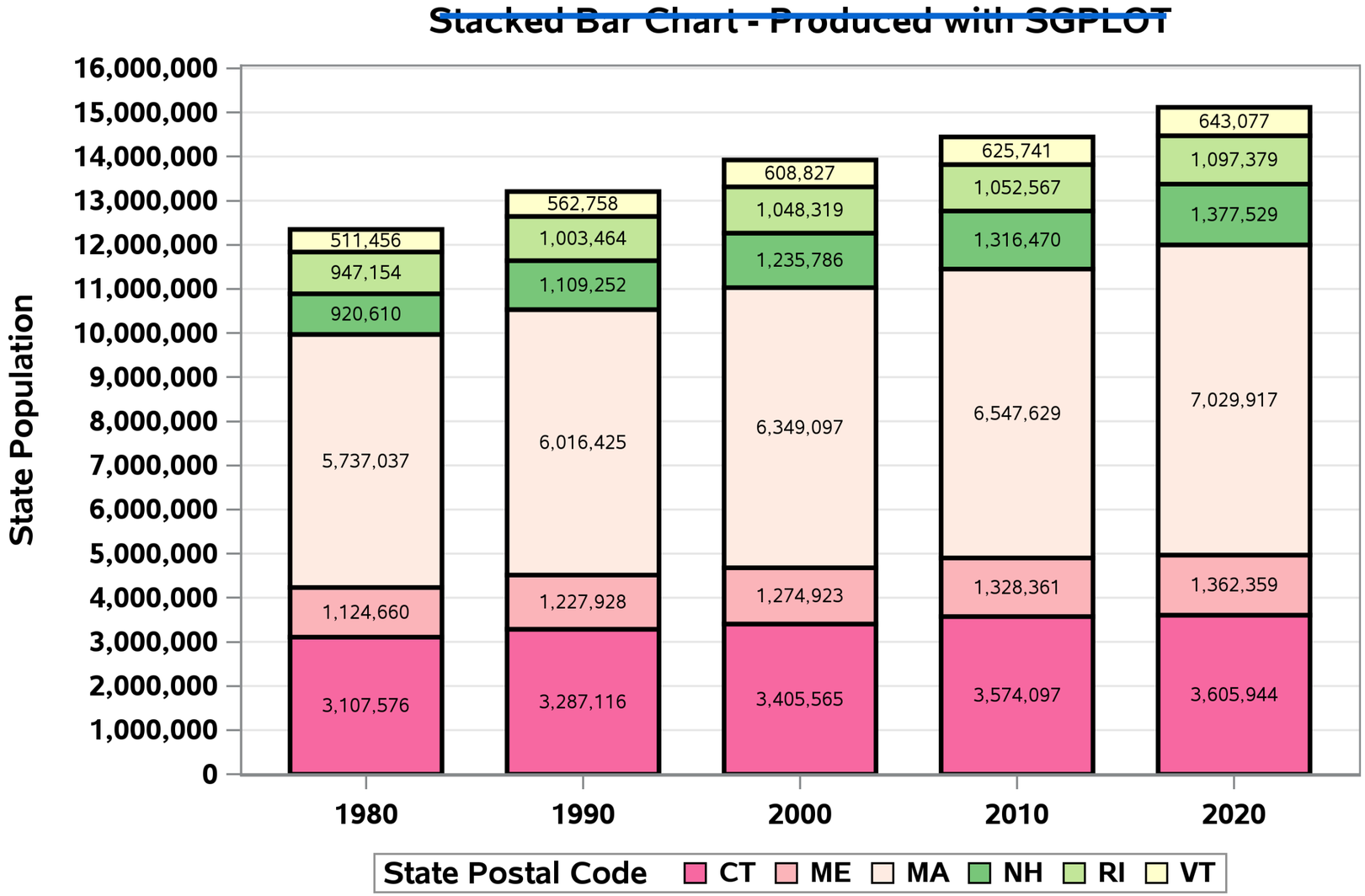
BAR CHART

GTL with ENTRYTITLE

```
proc template;
   define statgraph ne_bar_ttl;
      begingraph / datacolors = (&sixcolors);
         entrytitle "Stacked Bar Chart - Produced with SGPLOT" /;
         layout overlay /
             xaxisopts = (display = (ticks tickvalues line)
                          labelattrs = (weight = bold) tickvalueattrs = (weight = bold))
             yaxisopts = (label = "State Population" labelattrs = (weight = bold) offsetmin = 0
                          tickvalueattrs = (weight = bold)
                          linearopts = (tickvaluesequence = (start = 0 end = 16000000 increment = 1000000)
                                        viewmin = 0 viewmax = 16000000)
                          griddisplay = on);
            barchart x = year y = population / group = STATECODE barwidth = 0.7
                          outlineattrs = (color = CX000000 thickness = 2pt)
                          segmentlabel = true segmentlabelformat = comma15. segmentlabelattrs = (size = 6)
                          name = "VBAR";
            discretelegend "VBAR" / location = outside
                          title = "State Postal Code" titleattrs = (weight = bold)
                                  valueattrs = (weight = bold);
         endlayout;
      endgraph;
   end;
run;
```

BOX PLOT

GTL with ENTRYTITLE



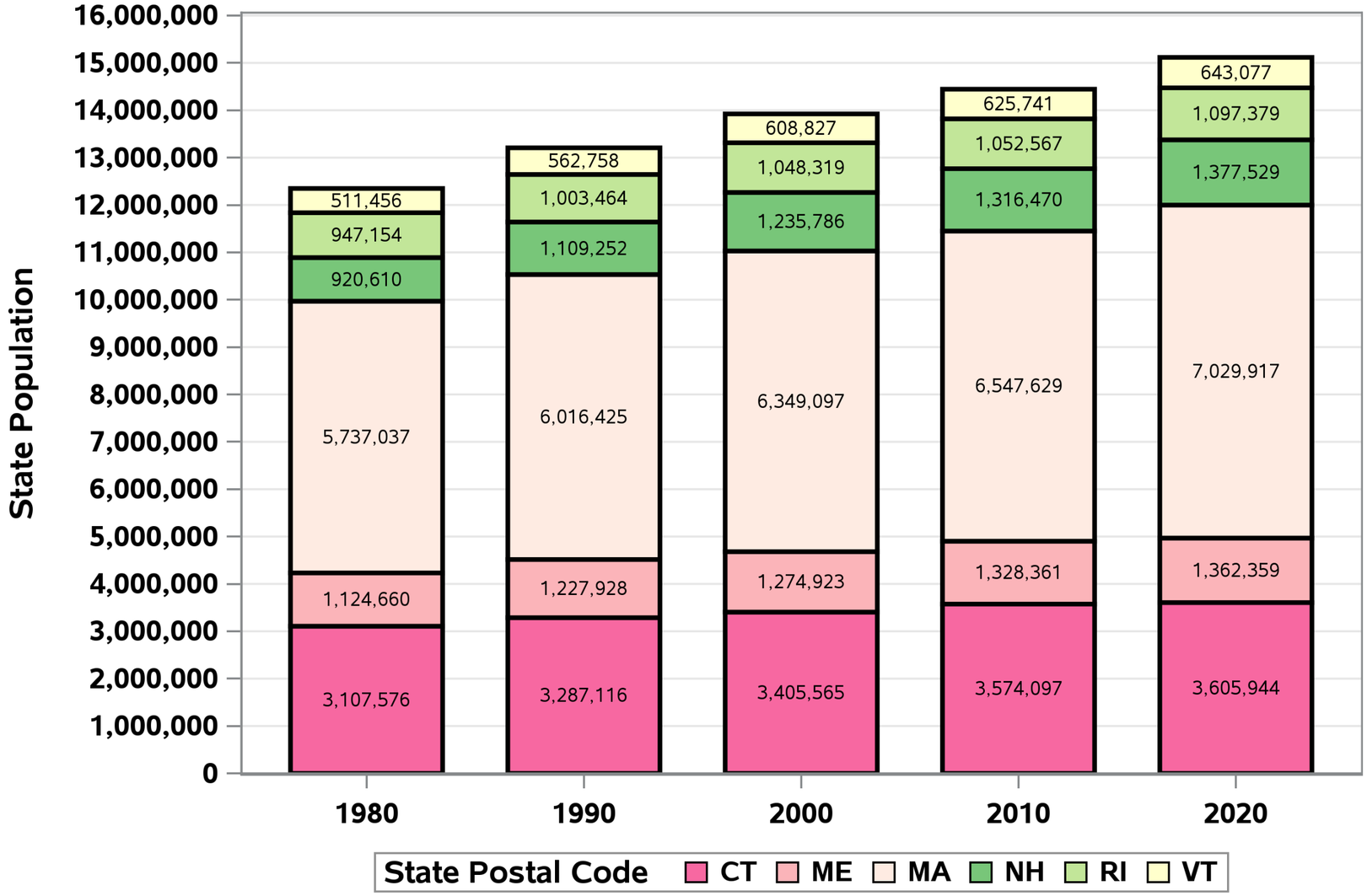
BAR CHART

GTL without ENTRYTITLE

```
proc template;
   define statgraph ne_bar_ttl;
      begingraph / datacolors = (&sixcolors);
         entrytitle "Stacked Bar Chart - Produced with SGPLOT" /;
         layout overlay /
             xaxisopts = (display = (ticks tickvalues line)
                          labelattrs = (weight = bold) tickvalueattrs = (weight = bold))
             yaxisopts = (label = "State Population" labelattrs = (weight = bold) offsetmin = 0
                          tickvalueattrs = (weight = bold)
                          linearopts = (tickvaluesequence = (start = 0 end = 16000000 increment = 1000000)
                                        viewmin = 0 viewmax = 16000000)
                          griddisplay = on);
            barchart x = year y = population / group = STATECODE barwidth = 0.7
                          outlineattrs = (color = CX000000 thickness = 2pt)
                          segmentlabel = true segmentlabelformat = comma15. segmentlabelattrs = (size = 6)
                          name = "VBAR";
            discretelegend "VBAR" / location = outside
                          title = "State Postal Code" titleattrs = (weight = bold)
                                  valueattrs = (weight = bold);
         endlayout;
      endgraph;
   end;
run;
```

BAR CHART

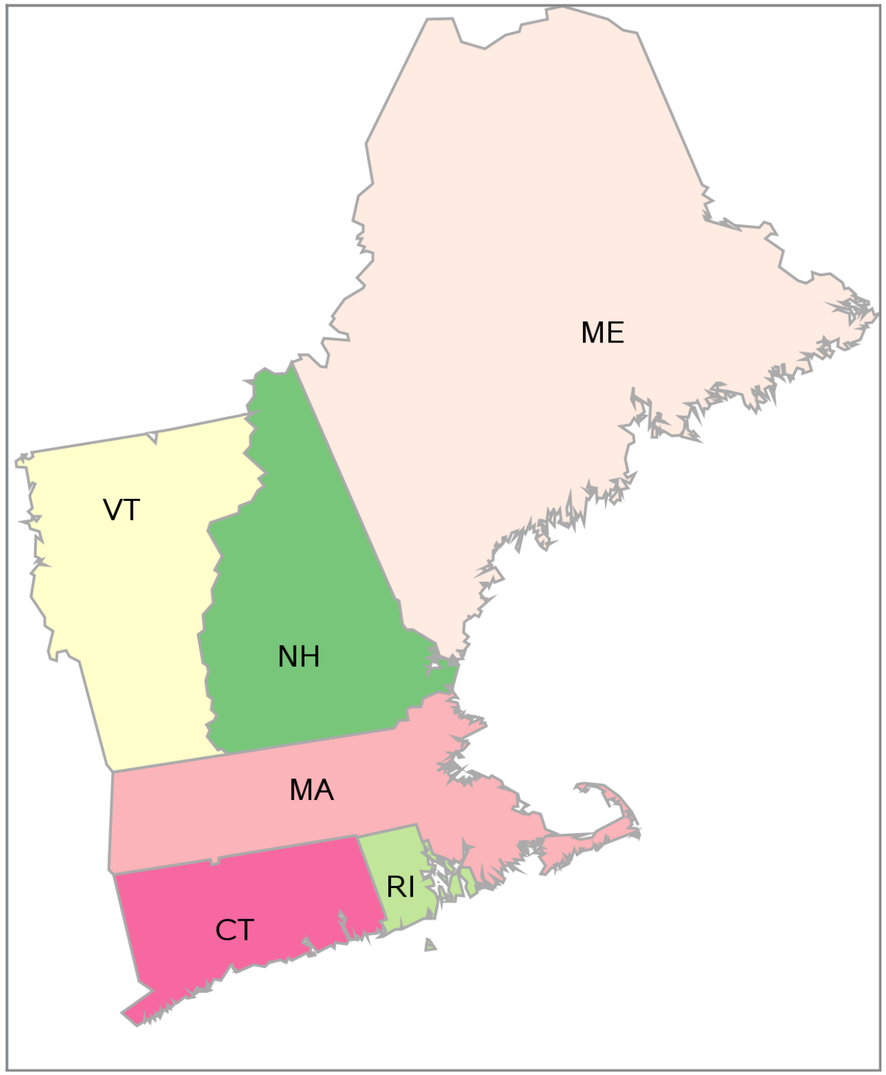
GTL without ENTRYTITLE



Map of New England States

SG Procedures

Map of New England States



Population Change in 2020

0.9 **2.6** **2.8** **4.3** **4.6** **7.4**

Sample Data for Polygon Plot

MAPID	LAT	LONG	STATE	STATECODE	STATENAME	CHANGE_2020	DIVISION	REGION	XCEN	YCEN	LABEL
US-09	.	.	.			.			0.297336	0.115669	CT
US-25	.	.	.			.			0.304032	0.132749	MA
US-23	.	.	.			.			0.329596	0.188531	ME
US-33	.	.	.			.			0.302927	0.149041	NH
US-44	.	.	.			.			0.311886	0.120933	RI
US-50	.	.	.			.			0.287356	0.166911	VT
US-09-1	0.29513	0.12434	9	CT	Connecticut	0.9	New England	Northeast	.	.	
...											
US-09-1	0.28661	0.12251	9	CT	Connecticut	0.9	New England	Northeast	.	.	
US-25-1	0.31606	0.14456	25	MA	Massachusetts	7.4	New England	Northeast	.	.	
...											y
US-25-2	0.32756	0.13358	25	MA	Massachusetts	7.4	New England	Northeast	.	.	
US-23-1	0.31642	0.22689	23	ME	Maine	2.6	New England	Northeast	.	.	
...											
US-23-1	0.31418	0.22684	23	ME	Maine	2.6	New England	Northeast	.	.	
US-33-1	0.30226	0.18493	33	NH	New Hampshire	4.6	New England	Northeast	.	.	
...											
US-33-1	0.3018	0.18362	33	NH	New Hampshire	4.6	New England	Northeast	.	.	
US-44-1	0.31318	0.12859	44	RI	Rhode Island	4.3	New England	Northeast	.	.	
...											
US-44-9	0.31494	0.12257	44	RI	Rhode Island	4.3	New England	Northeast	.	.	
US-50-1	0.28953	0.17625	50	VT	Vermont	2.8	New England	Northeast	.	.	
...											
US-50-1	0.27943	0.17396	50	VT	Vermont	2.8	New England	Northeast	.	.	

POLYGON PLOT

```
proc sgplot data = NE_MAP;
    xaxis offsetmin = 0.01 offsetmax = 0 display = none;
    yaxis offsetmin = 0.01 offsetmax = 0 display = none;

    polygon x = LAT y = LONG id = MAPID / group = CHANGE_2020
          fill outline lineattrs = (color = grayaa);
    styleattrs datacolors = (&sixcolors);

    scatter x = XCEN y = YCEN / markerchar = LABEL;

    keylegend / position = bottom location = outside across = 6 noborder
                sortorder = ascending
                valueattrs = (weight = bold) titleattrs = (weight = bold)
                title = 'Population Change in 2020' exclude = ('.' 'YCEN');
run;
```

OFFSET indicates how much space to adjust from the axes to the min/max value

Indicates nothing is to be displayed on the axes

GROUP is used to group the data

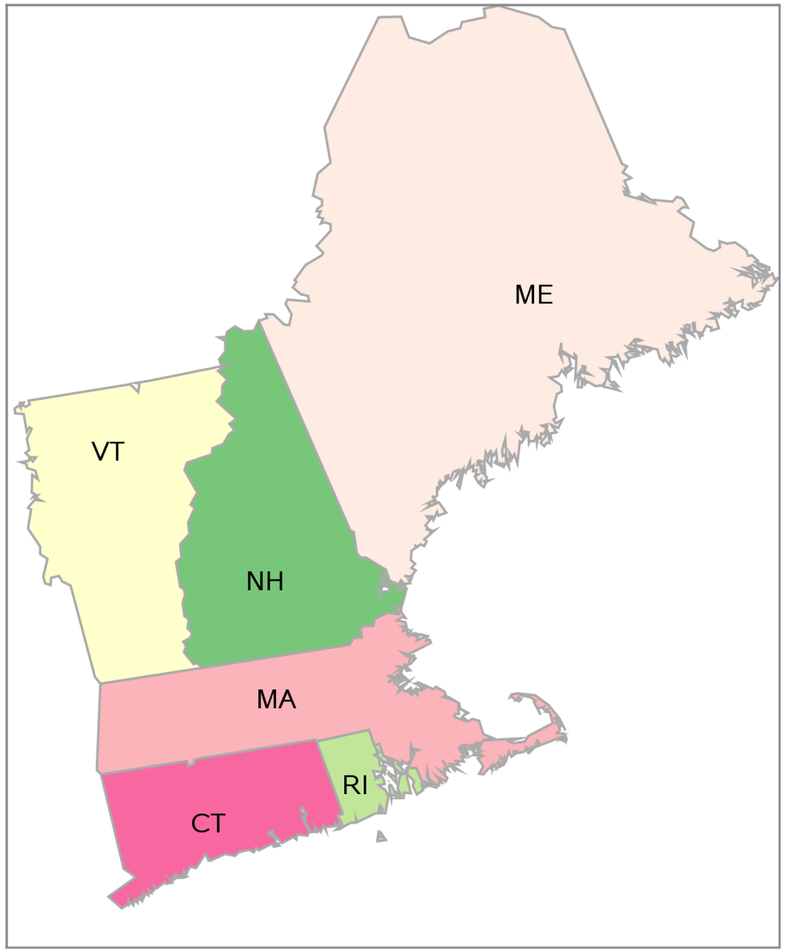
SCATTER statement creates the state label

Control position, location and how to display legend items

Indicates the order in which the legend items appear

Indicates which values are to be excluded from the legend

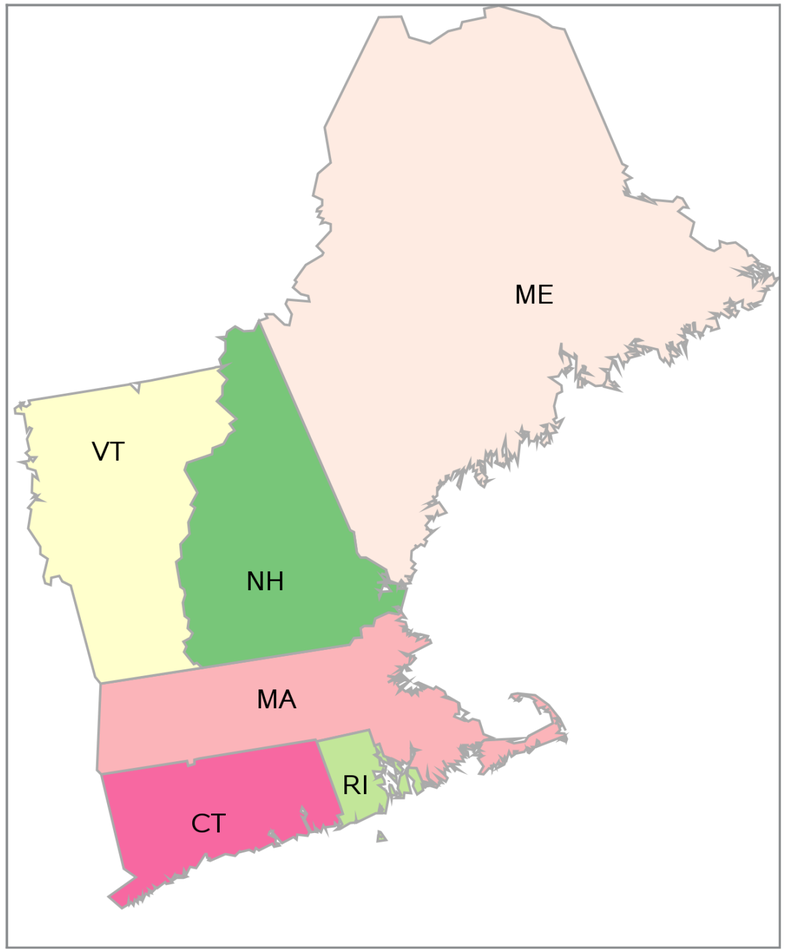
Legend SORTORDER



Population Change in 2020

0.9 7.4 2.6 4.6 4.3 2.8

Default SORTORDER



Population Change in 2020

0.9 2.6 2.8 4.3 4.6 7.4

SORTORDER = ASCENDING

Map of New England States

GTL (PROC TEMPLATE)

POLYGON PLOT

```
proc template;
   define statgraph sgplot;
      begingraph / collation=binary dataColors=( CXF768A1 CXFBB4B9 CXFEEBE2 CX78C679 CXC2E699 CXFFFFCC );
         EntryTitle "Map of New England Stats - Produced with SGPLOT" /;
         layout overlay / x2axisopts=(labelFitPolicy=Split)
                          xaxisopts=( display=none labelFitPolicy=Split offsetmin=0.01 offsetmax=0 type=linear )
                          yaxisopts=( display=none offsetmin=0.01 offsetmax=0 type=linear )
                          x2axisopts=(labelFitPolicy=Split);
            PolygonPlot X='LAT'n Y='LONG'n ID='MAPID'n / Group='CHANGE_2020'n
                              OutLineAttrs=( Color=CXAAAAAA) Display=( Outline Fill )
                              LegendLabel="Projected Latitude: Albers" NAME="POLYGON";
            ScatterPlot X='XCEN'n Y='YCEN'n / subpixel=off primary=true
                              MarkerCharacter='LABEL'n LegendLabel="YCEN" NAME="SCATTER";
            DiscreteLegend "POLYGON" "SCATTER" / Location=Outside across=6 valign=bottom
                              Title="Population Change in 2020" TitleAttrs=( Weight=bold)
                              ValueAttrs=( Weight=bold) Exclude=( "." "YCEN")
                              sortorder=ascendingFormatted Border=false;
         endlayout;
      endgraph;
   end;
run;
```

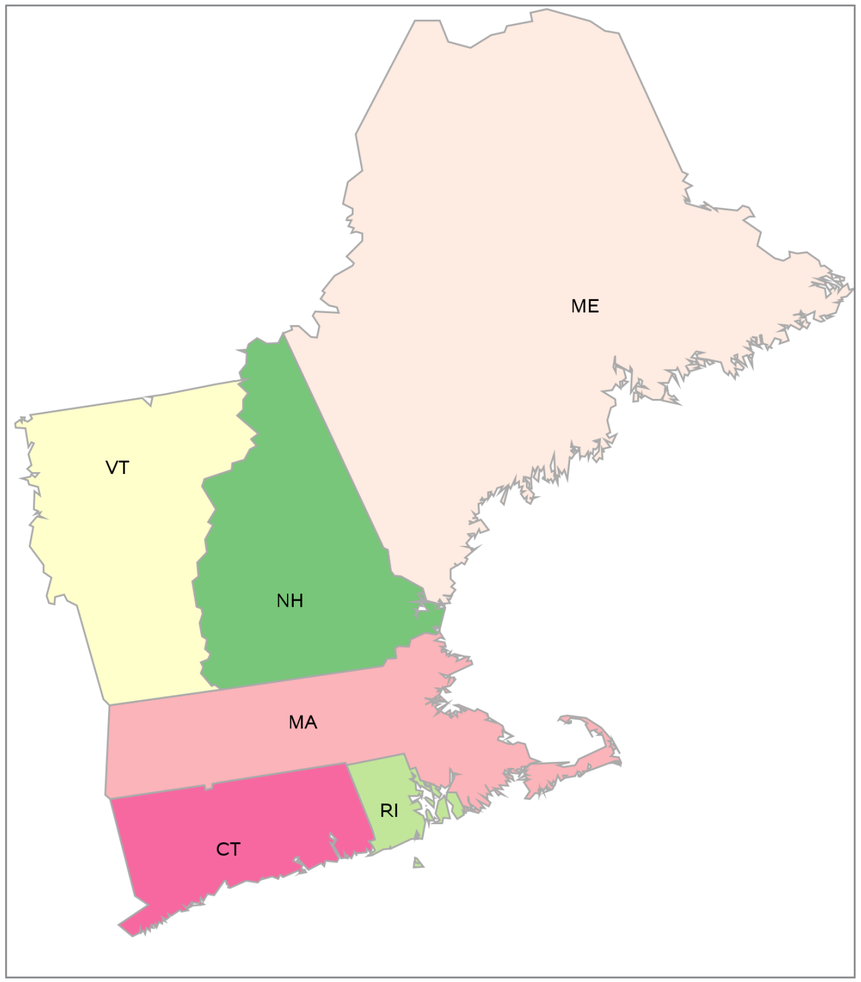
POLYGON PLOT

```
proc template;
   define statgraph ne_poly;
      begingraph / datacolors = (&sixcolors);
         layout overlay / xaxisopts = (display = none offsetmin = 0.01 offsetmax = 0)
                          yaxisopts = (display = none offsetmin = 0.01 offsetmax = 0);
            polygonplot x = LAT y = LONG id = MAPID / group = CHANGE_2020
                                                     outlineattrs = (color = CXAAAAAA)
                                                     display = (outline fill)
                                                     name = "polygonplot";

            scatterplot x = XCEN y = YCEN / markercharacter = LABEL;

            discretelegend "polygonplot" / location = outside across = 6 valign = bottom
                                           sortorder = ascendingformatted
                                           title = "Population Change in 2020"
                                           titleattrs = (weight = bold)
                                           valueattrs = (weight = bold)
                                           exclude = ("." "YCEN")
                                           border = false;
         endlayout;
      endgraph;
   end;
run;
```

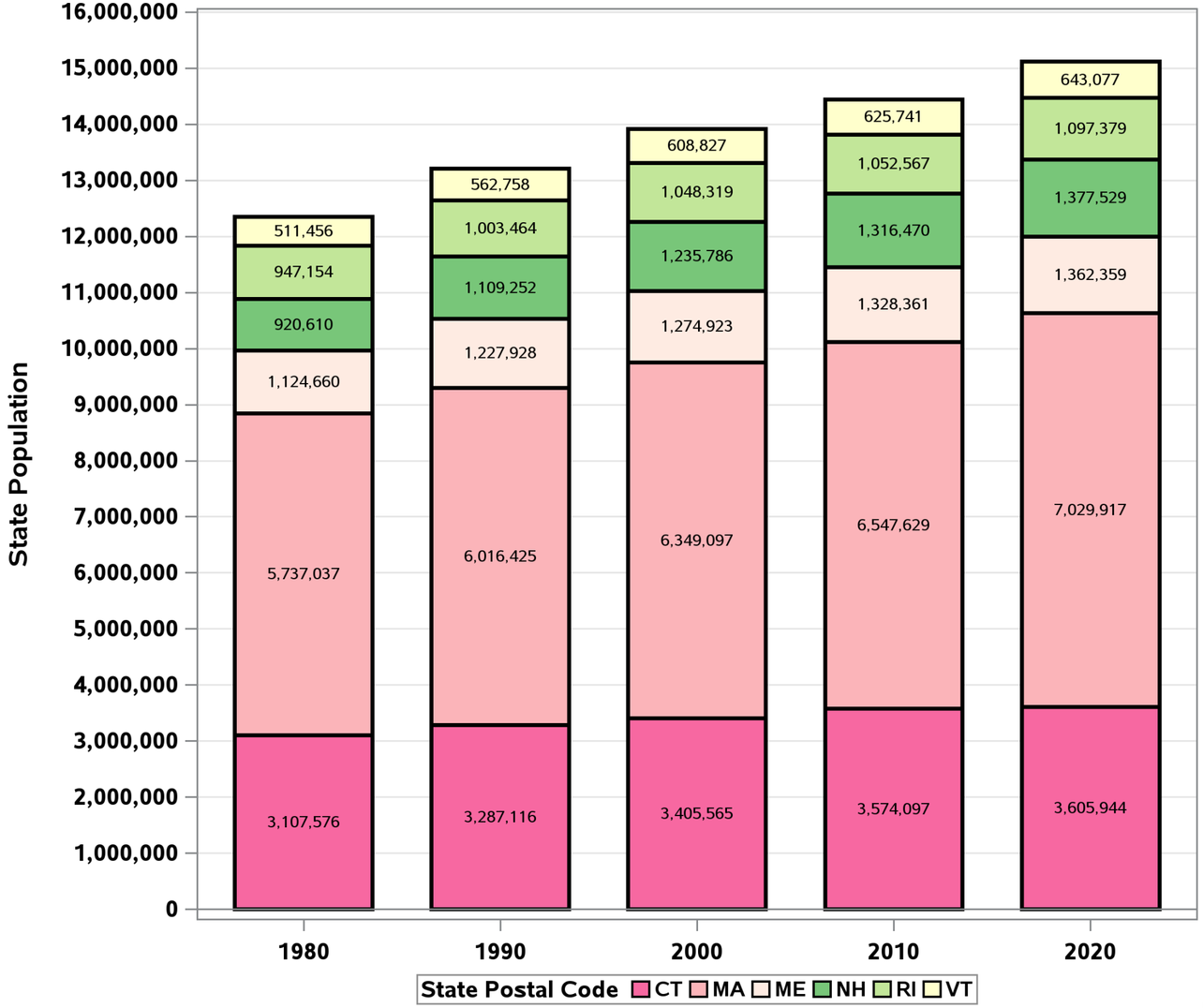
Side-by-Side Plots

Our End Goal

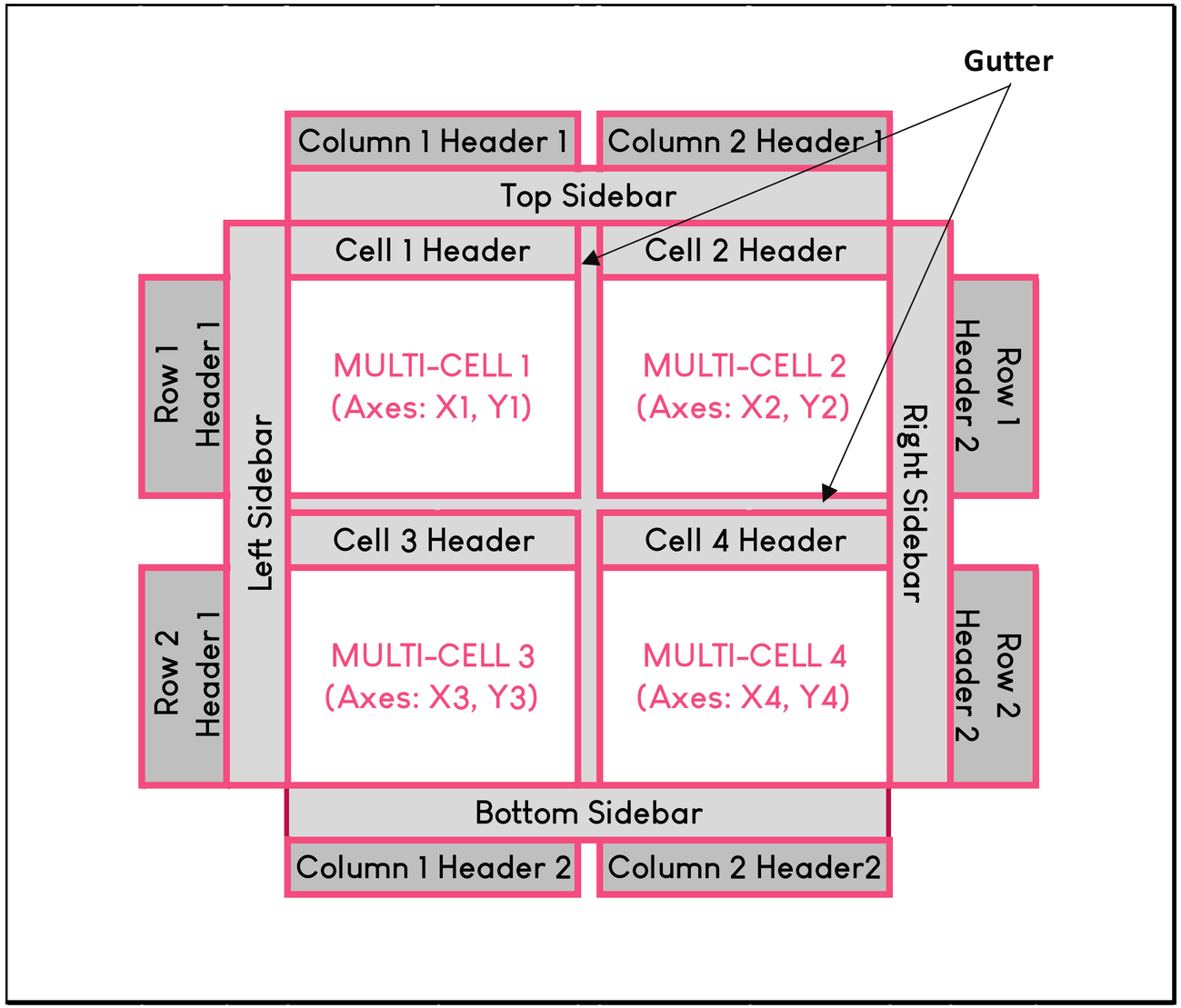
Side by Side Plots



Population Change in 2020 0.9 2.6 2.8 4.3 4.6 7.4



Getting Caught in the Gutter



Sample Data for Side-by-Side Plots

MAPID	LAT	LONG	STATECODE	CHANGE_2020	XCEN	YCEN	LABEL	YEAR	POPULATION
US-09					0.297336	0.115669	CT		
US-25					0.304032	0.132749	MA		
US-23					0.329596	0.188531	ME		
US-33					0.302927	0.149041	NH		
US-44					0.311886	0.120933	RI		
US-50					0.287356	0.166911	VT		
US-09-01	0.29513	0.12434	CT	0.9					
US-09-01	0.29525	0.12367	CT	0.9					
...									
			VT					2010	625,741
			VT					2020	643,077

Side by Side Plots - GRIDDED

```
proc template;
   define statgraph sbysgrid;
      begingraph;
         layout gridded / columns = 2 rows = 1;
            /** create the right side of the graph **/
            layout overlay / << axes options >>;
               << POLYGON STATEMENT >>
               << SCATTER PLOT STATEMENT >>
               << DISCRETELEGEND STATEMENT >>
            endlayout; /** overlay for left side **/
            /* create the right side of the graph */
            layout overlay / << axes options >>;
               << BARCHAT STATEMENT >>
               << DISCRETELEGEND STATEMENT >>
            endlayout; /** overlay for right side **/
         endlayout; /** end of GRIDDED layout **/
      endgraph;
   end;
run;
```

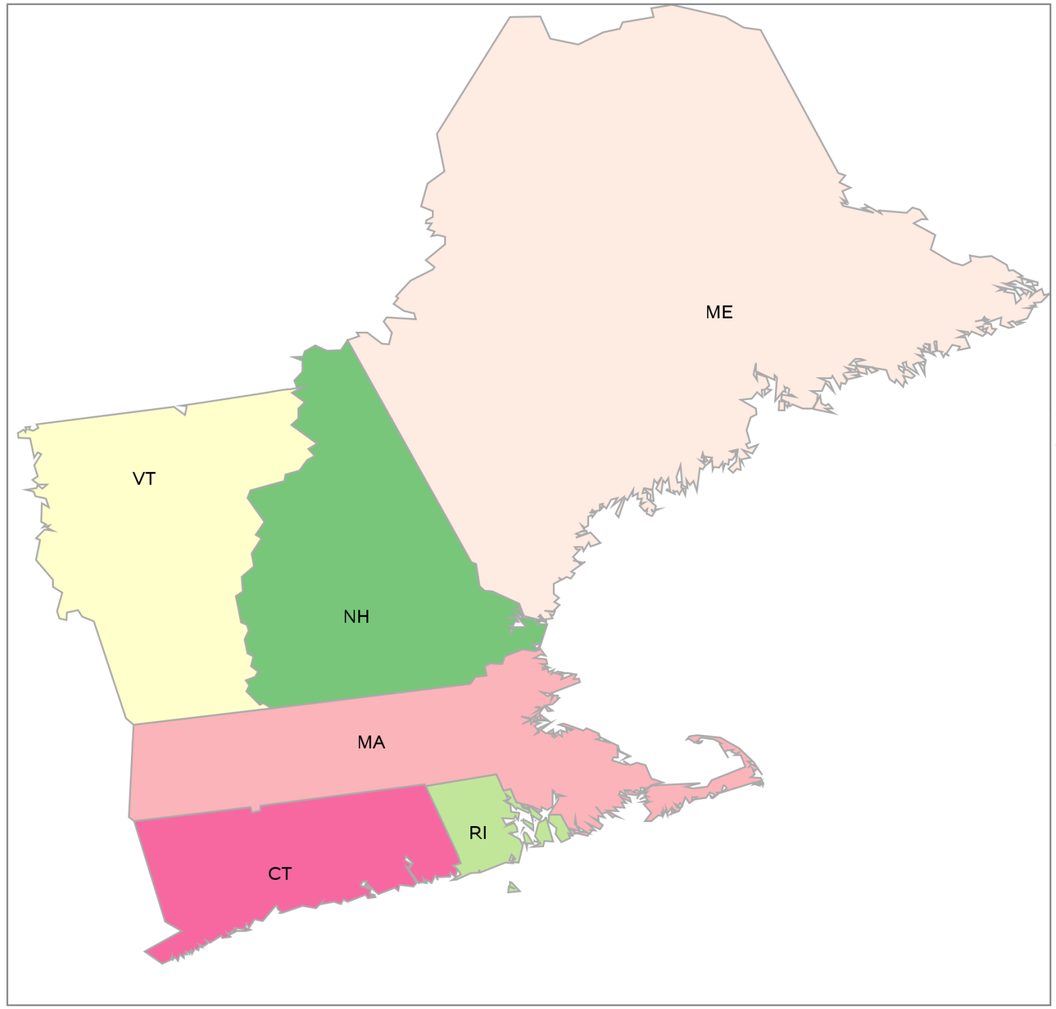
GRIDDED need to specify number of columns and rows

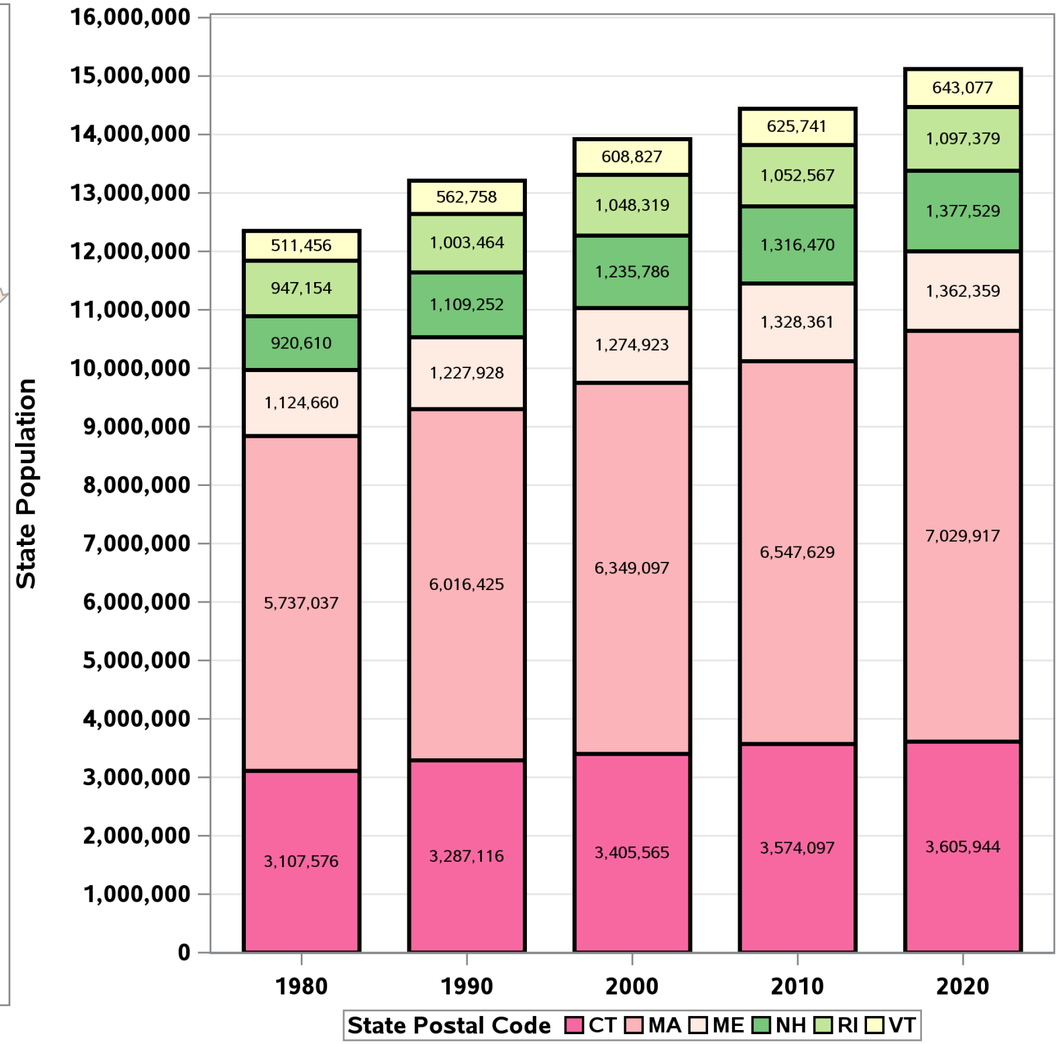
Same code used to produce the polygon plot in GTL

Same code used to produce the stacked bar chart in GTL

Side by Side Plots

GRIDDED Layout





Side by Side Plots - LATTICE

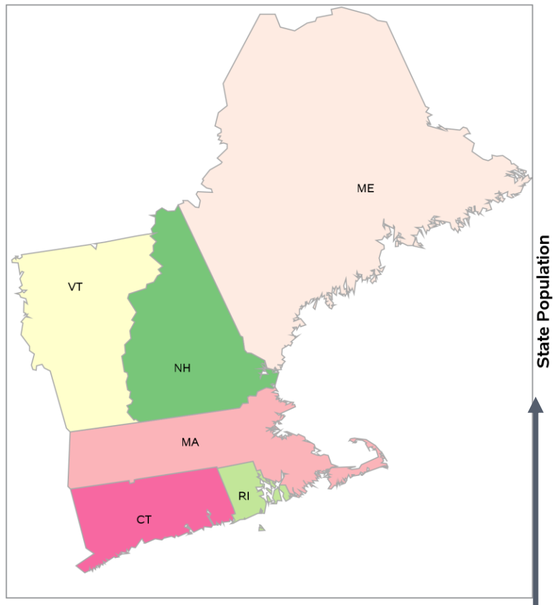
```
proc template;
   define statgraph sbyslat;
      begingraph;
         layout lattice / columns = 2 rows = 1
                columnweights = (0.4 0.60)
                columngutter = 50;
            /** create the right side of the graph **/
            layout overlay / << axes options >>;
               << POLYGON STATEMENT >>
               << SCATTER PLOT STATEMENT >>
               << DISCRETELEGEND STATEMENT >>
            endlayout; /** overlay for left side **/
            /* create the right side of the graph */
            layout overlay / << axes options >>;
               << BARCHAT STATEMENT >>
               << DISCRETELEGEND STATEMENT >>
            endlayout; /** overlay for right side **/
         endlayout; /** end of LATTICE layout **/
      endgraph;
   end;
run;
```

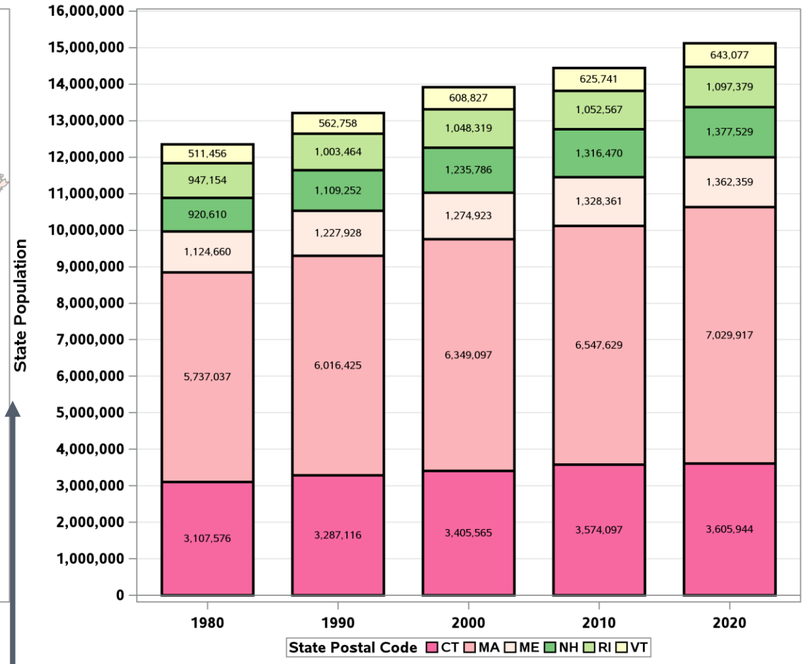
LATTICE requires you to specify column and/or row weights

COLUMNGUTTER and ROWGUTTER allows us to add spaces between the cells

Side by Side Plots

LATTICE Layout

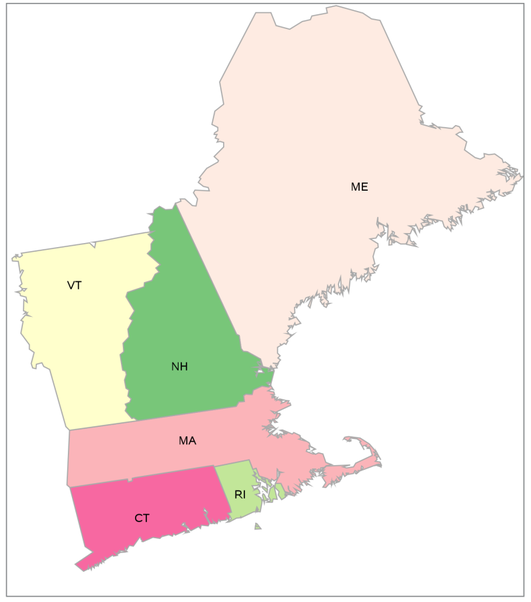




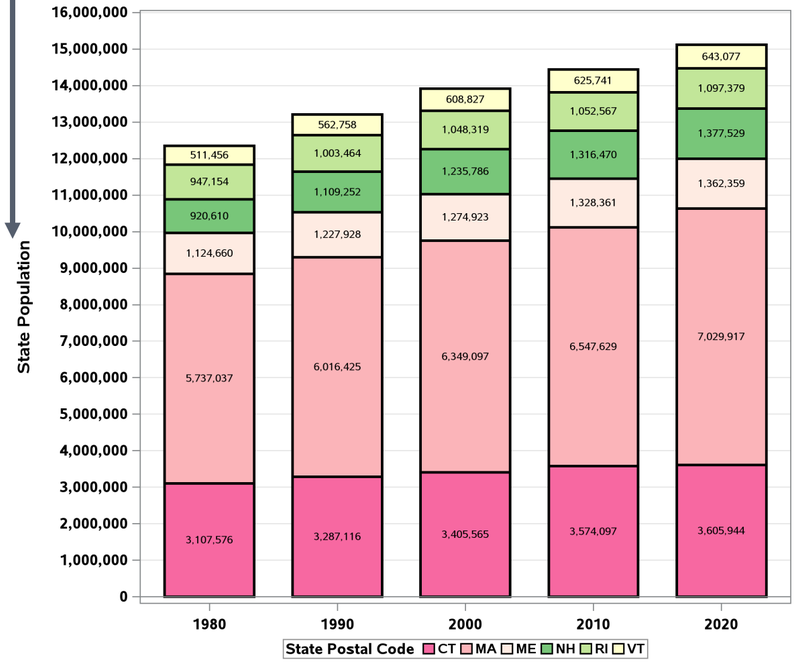
Population Change in 2020 0.9 2.6 2.8 4.3 4.6 7.4

Gutter Space of 0

Gutter Space of 50



Population Change in 2020 0.9 2.6 2.8 4.3 4.6 7.4



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Conclusion

Conclusion

- Start with what you know
  - Use TMPLOUT on SG procedures
- Build each component separately
- Piece all components together and modify as necessary

Producing Graphs does not have to be a daunting task

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