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Single Day Event

The Evolving Landscape of Data Visualization in Oncology: A Focus on Graphical Insights

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Disclaimer

- The views and opinions expressed in this presentation are those of the speakers and do not reflect opinions of any other person or organization.

Outline

- **Significance and Complexity of Oncology plots**
- **Evolving landscape in Graphical space**
- **SwimLane Plot -** Programming insights using GTL

  Use case application - Synthetic data
- **Forest Plot -** Programming insights using GTL

  Use case application - Synthetic data
- **Data Visualization using R packages**
- **Conclusion and Outlook**

SIGNIFICANCE AND COMPLEXITY OF ONCOLOGY PLOTS

While SAS offers powerful capabilities for generating statistical graphics, significant challenges remain in effectively and efficiently reporting key oncology plots, such as swimmer and forest plots

Pragmatic Challenges

Nature of layouts and increased scope of demanding customization extensively

Intricate Endpoints & Interpretation

Array of endpoints such as BOR, Treatment effects, Duration of response, requires careful interpretation; correlation does not equal causation

Complexity

Can be overwhelming with large datasets if not well-organized,

Standardization

Lack of standardization in plot design can hinder comparison across studies

EVOLVING LANDSCAPE IN GRAPHICAL SPACE

Graphical landscape has been evolving over the years to enhance the aesthetics of visuals and address the challenges of reporting the plots to support clinical decision-making and advance cancer research

01

Features Robust Dynamic Layouts

Capable of creating multiple displays with precise control over layout

02

Customization & Flexibility

Structured syntax and layering capability for informative visualization

03

Consistency and Reuse

Facilitates the reuse of graphical design, saving time on graph production

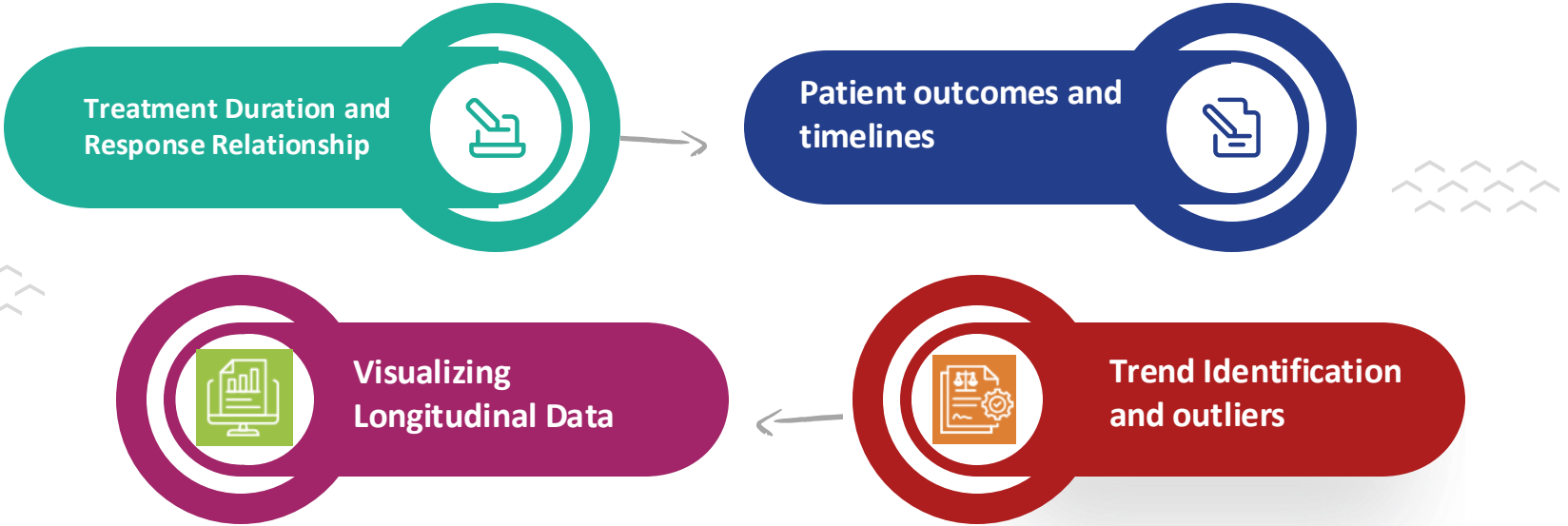
04

Comprehensive style features

Style determine overall look and feel of graphics, can be applied consistenly across various outputs

Early Forms → **Modern Enhancements** → **Future Trends**

SwimLane Plot in Oncology- Programming insights using GTL

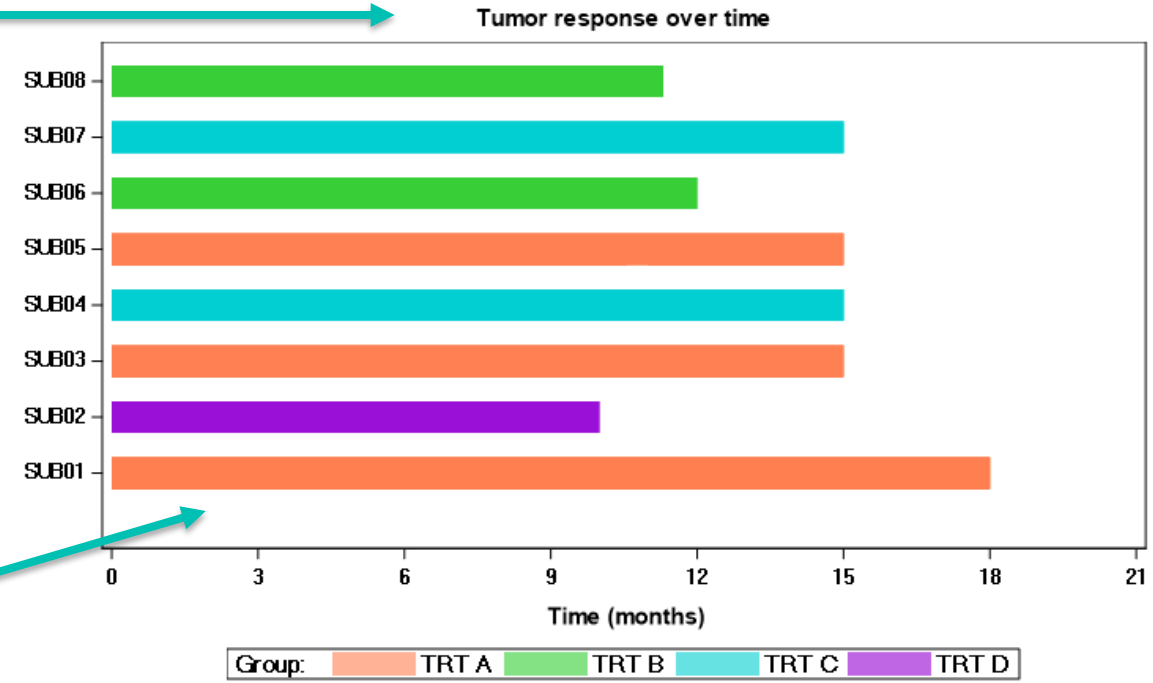


Let’s touch base on the building blocks of the plots and connect the dots to visualise the results

Use case application - Synthetic data

Develop the layout sketch

```
Proc TEMPLATE;
define STATGRAPH swimmer/store=work.swimmer;
BEGINGRAPH /BORDER=False;

 ENTRYTITLE "Tumor response over time" ;
LAYOUT OVERLAY/

 YAXISOPTS =(DISPLAY=(LABEL TICKS
  TICKVALUES)
  TICKVALUEATTRS=(weight=bold COLOR=BLACK)
  LINEAROPTS=(tickvaluepriority=true
  tickdisplaylist=("SUB01"  "SUB02" etc)

 XAXISOPTS=(OFFSETMIN=0.01
  OFFSETMAX=0.01 LABEL="Time (months)"
   LINEAROPTS=(VIEWMIN=0 VIEWMAX=21
  TICKVALUESEQUENCE=(START=0 END=21
  INCREMENT=3)));

/* draw swimmer lane bars*/

 VECTORPLOT X=TIME Y=ORD_NEW
  /GROUP=groupattributes name = "attributes"
   DATATRANSPARENCY=0.4

/*Treatment legend*/

 DISCRETELEGEND "attributes" / TITLE="Group:" BORDER=1 ACROSS=4 LOCATION=outside
ENDLAYOUT;
ENDGRAPH;
```

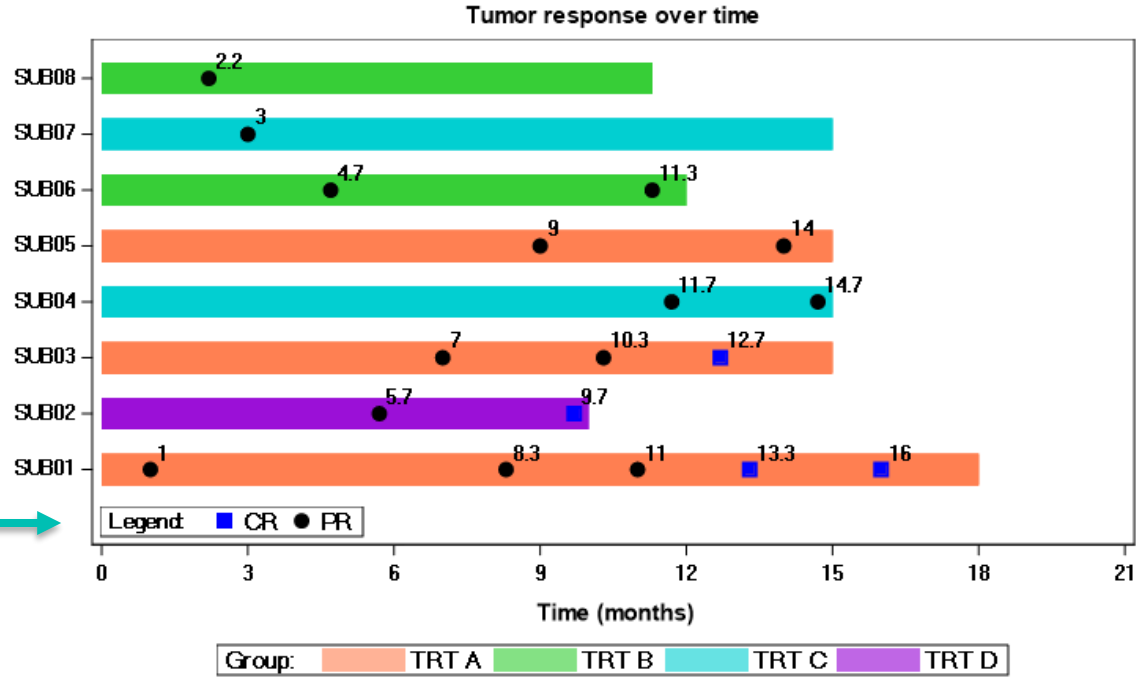


* This graph is for illustration purpose only

Use case application - Synthetic data

Map the responses – CR, PR

```
LAYOUT OVERLAY/

……With previous inherited codes……

 SCATTERPLOT X=CR Y=ORD_NEW/datalabel=CR
  name="CR" LEGENDLABEL="CR"
  MARKERATTRS=(SYMBOL=SquareFilled
  color=blue);

 SCATTERPLOT X=PR Y=ORD_NEW/datalabel=PR
  name="PR" LEGENDLABEL="PR"
  MARKERATTRS=(SYMBOL=CircleFilled);

/*Symbols legend*/

DISCRETELEGEND "CR" "PR" TITLE="Legend
 BORDER=1 ACROSS=2 LOCATION=inside
 HALIGN=LEFT  VALIGN=BOTTOM;

ENDLAYOUT;
```

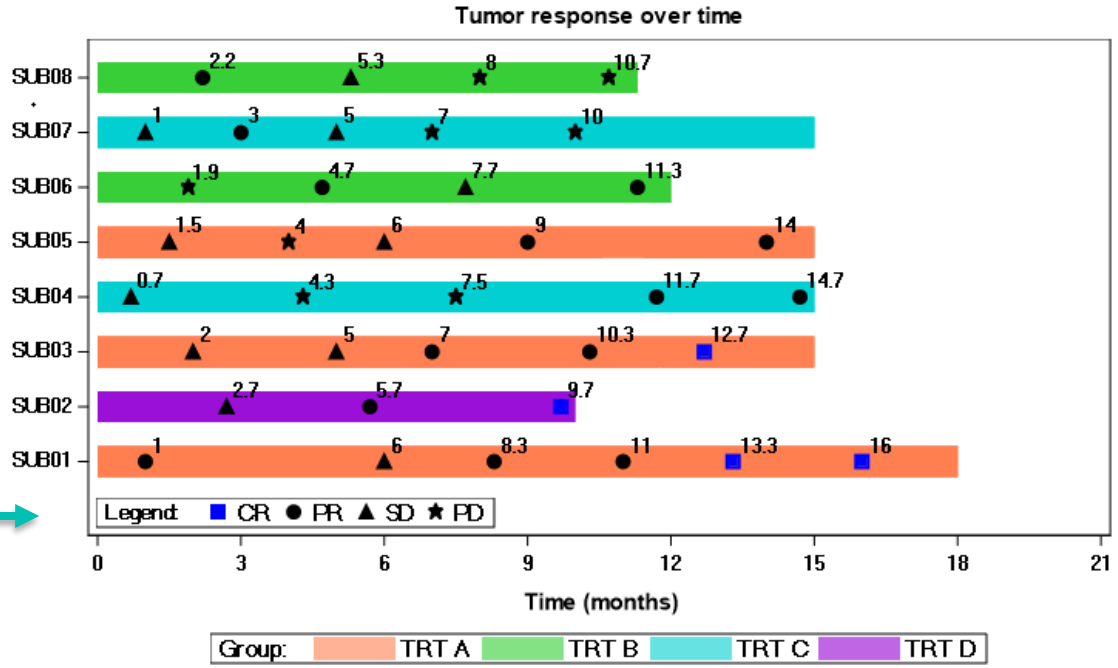


* This graph is for illustration purpose only

Use case application - Synthetic data

Map the responses – SD, PD

```
LAYOUT OVERLAY/

……With previous inherited codes……

 SCATTERPLOT X=SD Y=ORD_NEW/datalabel=SD
  name="SD" LEGENDLABEL="SD"
  MARKERATTRS=(SYMBOL=TriangleFilled);

 SCATTERPLOT X=PD Y=ORD_NEW/datalabel=PD
  name="PD" LEGENDLABEL="PD"
  MARKERATTRS=(SYMBOL=StarFilled);

/*Symbols legend*/

DISCRETELEGEND "CR" "PR" "SD" "PD"
 TITLE="Legend BORDER=1 ACROSS=4
 LOCATION=inside HALIGN=LEFT  VALIGN=BOTTOM

ENDLAYOUT;
```

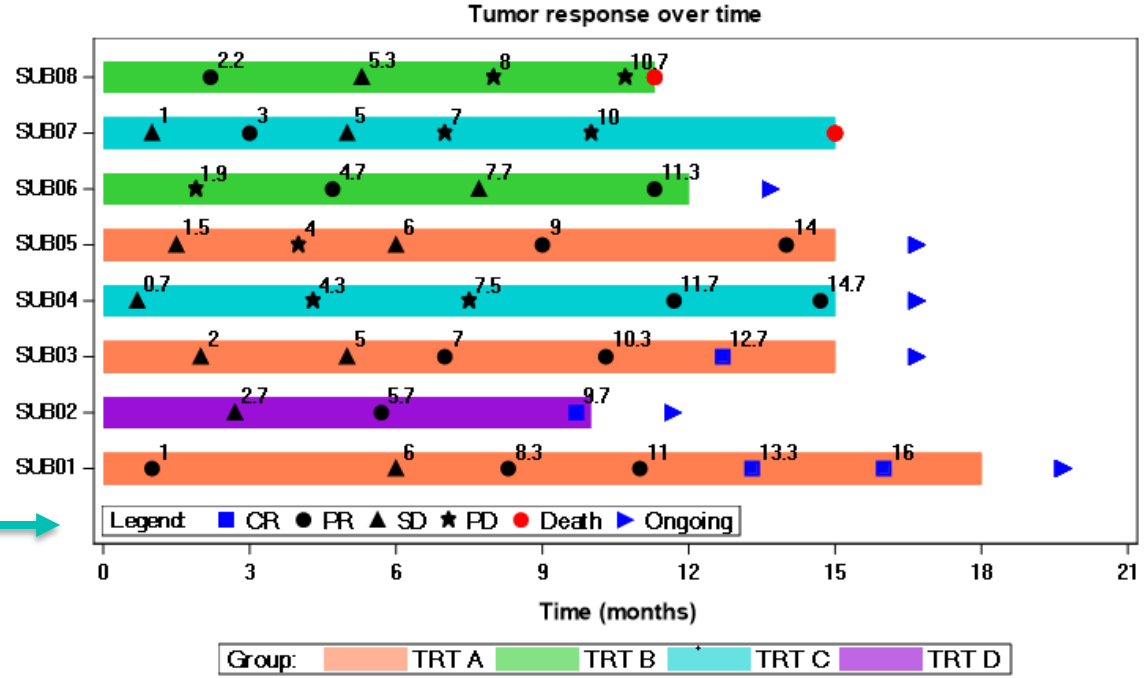


* This graph is for illustration purpose only

Use case application - Synthetic data

Subject Status – Death, Ongoing

```
LAYOUT OVERLAY/

……With previous inherited codes……

 SCATTERPLOT X=DTH Y=ORD_NEW/
        name="Death“  LEGENDLABEL="Death”
           MARKERATTRS=(SYMBOL=CircleFilled
         color=blue);

 SCATTERPLOT X=ONG Y=ORD_NEW/
      name=" Ongoing " LEGENDLABEL="Ongoing"
    MARKERATTRS=(SYMBOL=TriangleRightFilled
         color=blue);

/*Symbols legend*/

DISCRETELEGEND “CR” ”PR” “SD" “PD” “Death”
  “Ongoing” TITLE="Legend BORDER=1 ACROSS=6
 LOCATION=inside HALIGN=LEFT
VALIGN=BOTTOM;

ENDLAYOUT;
```

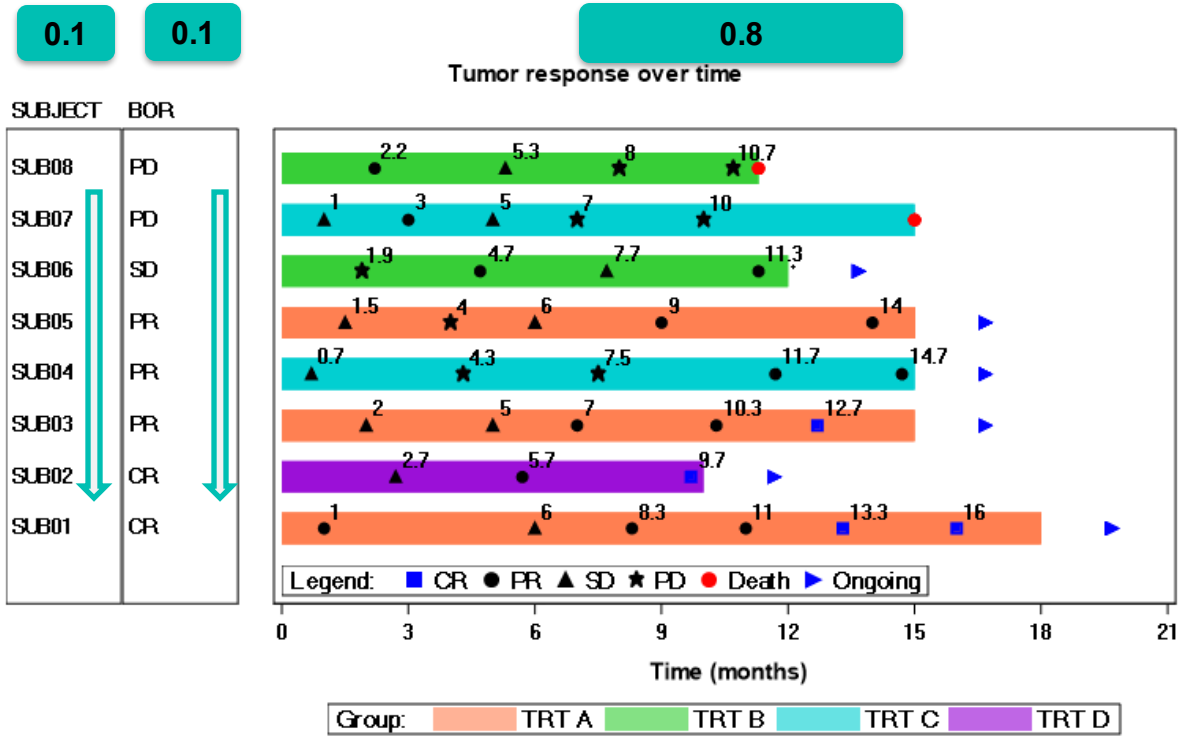


* This graph is for illustration purpose only

Use case application - Synthetic data

Best Response along with timelines

```
LAYOUT LATTICE/ COLUMNS=3
columnweights=(0.1 0.1 0.8) ;
 LAYOUT OVERLAY/

……With previous inherited codes……

/***** SUBJECT COLUMN *****/

 LAYOUT OVERLAY /
  AxisTable Value=subject Y=ORD_NEW/
 title="SUBJECT" display=(values)
ENDLAYOUT;

/***** BOR COLUMN *****/

 LAYOUT OVERLAY /
  AxisTable Value=BOR Y=ORD_NEW/
  title="BOR"  display=(values);
 ENDLAYOUT;

 ENDLAYOUT;
ENDLAYOUT;
```

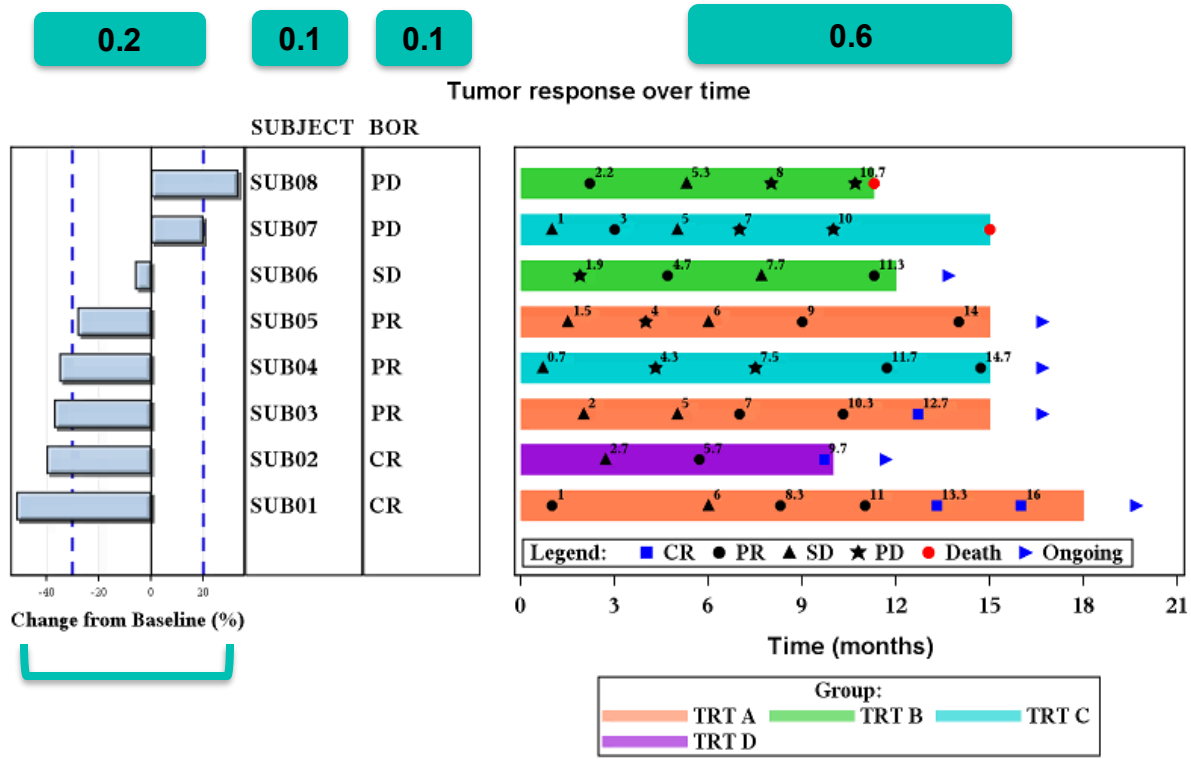


* This graph is for illustration purpose only

Use case application - Synthetic data

Waterfall with Swimmer plot

```
LAYOUT LATTICE/ COLUMNS=4
columnweights=(0.2 0.1 0.1 0.6)
columngutter=0;

……With previous inherited codes……

/***** CHG COLUMN *****/

 LAYOUT OVERLAY /
  yaxisopts=(display=none)
  xaxisopts=(label='Change from Baseline(%)'
            walldisplay=(outline);

 BANDPLOT Y=ORD_NEW limitupper=20
   limitlower=-30 / extend=true
  display=(outline);

 BARCHARTPARM CATEGORY=ORD_NEW
     RESPONSE=CHANGE
   / barwidth=0.6 orient=horizontal;

ENDLAYOUT;
ENDLAYOUT;
```



* This graph is for illustration purpose only

Forest Plot in Oncology - Programming insights using GTL

Vital analytical tool in oncology, aiding in the synthesis of research findings and supporting evidence-based clinical and regulatory decision-making

Meta-Analysis

Essential for aggregating results from multiple trials to determine the overall effect of a treatment

Supporting Regulatory Decisions

Regulatory bodies may use as part of the evidence considered when approving new cancer drugs or therapies

Evaluating Treatment Efficacy

Assist Oncologists to visually assess outcomes

Identifying Heterogeneity

Examine the variability in treatment results across studies and refined subgroup analyses

Risk-Benefit Analysis

illustrate both beneficial and adverse effects of a cancer therapy.

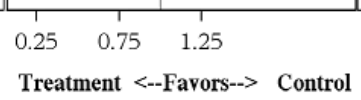
Use case application - Synthetic data

```
LAYOUT LATTICE/ COLUMNS=5
columnweights=(0.15 0.13 0.13 0.27 0.22);

   /*--Column headers--*/

  SIDEBAR / align=top;
     LAYOUT LATTICE/  ROWS=2 COLUMNS=5
     columnweights=(0.15 0.13 0.13 0.27 0.22);

   Entry halign=center " ";
   Entry halign=center "Treatment";
   Entry textattrs=(size=10pt weight=bold)
    halign=center "Control";
   Entry textattrs=(size=10pt weight=bold)
   halign=center  "HZ ratio graph";
    "Subgroup";
   "n / N";
   "n / N";
   " ";
   "HZ ratio (95%CI)";
 ENDLAYOUT;
ENDSIDEBAR;
```

0.15 | 0.13 | 0.13 | 0.27 | 0.22

Forest Plot: Subgroup analysis of treatment effects or meta-analysis results

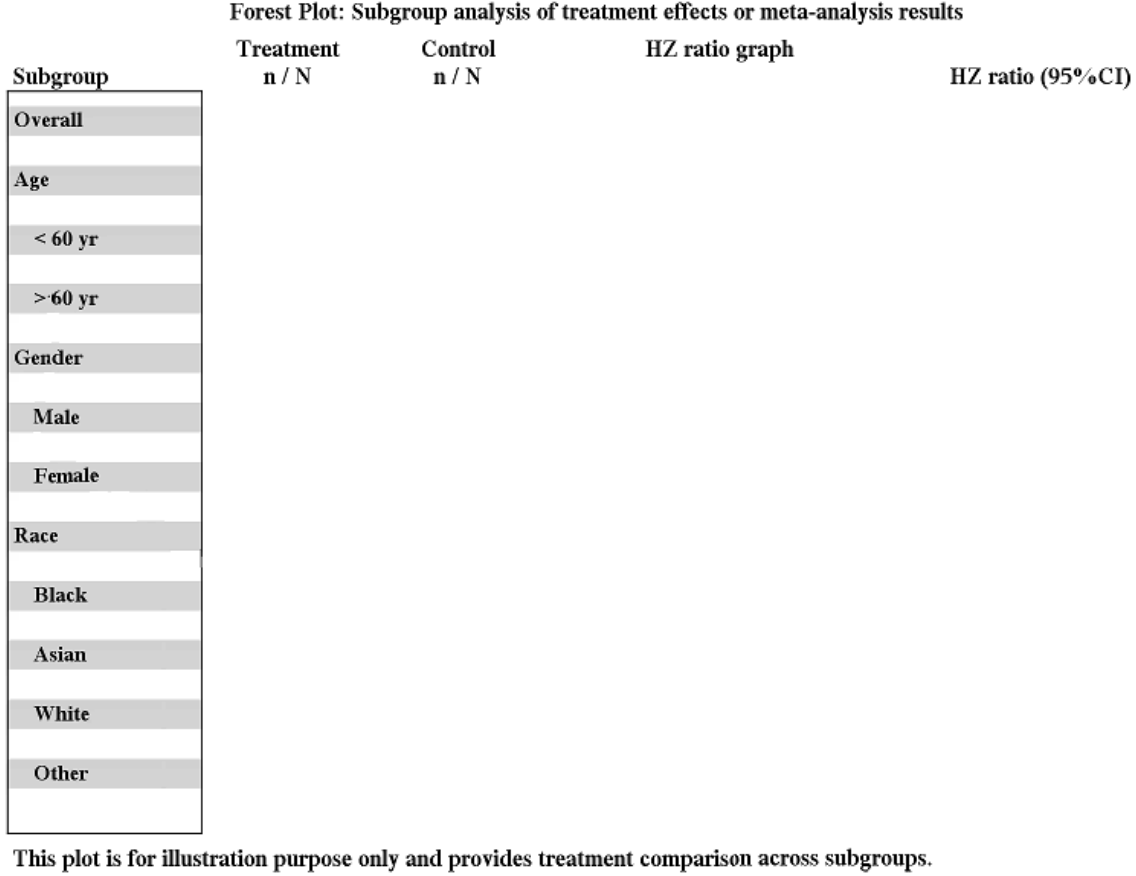
Subgroup	Treatment n / N	Control n / N	HZ ratio graph	HZ ratio (95%CI)
Overall	323/4850	422/4880		0.77 (0.612;0.841)
Age				
< 60 yr	203/3451	236/3470		0.865 (0.587;0.877)
> 60 yr	120/1399	186/1410		0.65 (0.551;0.934)
Gender				
Male	117/1836	154/1758		0.727 (0.551;0.935)
Female	206/3014	268/3122		0.796 (0.588;0.876)
Race				
Black	58/751	107/1103		0.796 (0.493;1.045)
Asian	90/1619	105/1488		0.788 (0.531;0.969)
White	55/790	125/1384		0.771 (0.489;1.053)
Other	120/1690	85/905		0.756 (0.55;0.936)



This plot is for illustration purpose only and provides treatment comparison across subgroups.

Use case application - Synthetic data

```
/*-- First column reports Subgroup --*/

LAYOUT OVERLAY/ walldisplay=(outline)
  xaxisopts=(reverse=true  display=none )
  yaxisopts=(reverse=true display=none
        tickvalueattrs=(weight=bold)  );

   REFERENCELINE Y=ORD/
         lineattrs=(thickness=_thk       color=_color);
   AXISTABLE  Y=ORD value=order
                    /display=(values)
    valueattrs=(size=9pt weight=bold)
        indentweight=indent textgroup=type;
ENDLAYOUT;
```



Use case application - Synthetic data

```
/*--Second column report n / N for Treatment-*/

LAYOUT OVERLAY /  walldisplay=(outline)
          halign=center
   yaxisopts=(reverse=true display=none)
        walldisplay=(outline);
REFERENCELINE Y=ORD /
           lineattrs=(thickness=_thk
            color=_color);
AXISTABLE Y=ORD value=cnt1/display=(values)
      valueattrs=(size=9pt weight=bold);
ENDLAYOUT;


    /*--Third column report n / N for Control*/

LAYOUT OVERLAY /  walldisplay=(outline)
       halign=center
      yaxisopts=(reverse=true display=none)
        walldisplay=(outline);
REFERENCELINE Y=ORD /
                lineattrs=(thickness=_thk
               color=_color);
AXISTABLE Y=ORD value=cnt2/display=(values)
      valueattrs=(size=9pt weight=bold);
ENDLAYOUT;
```

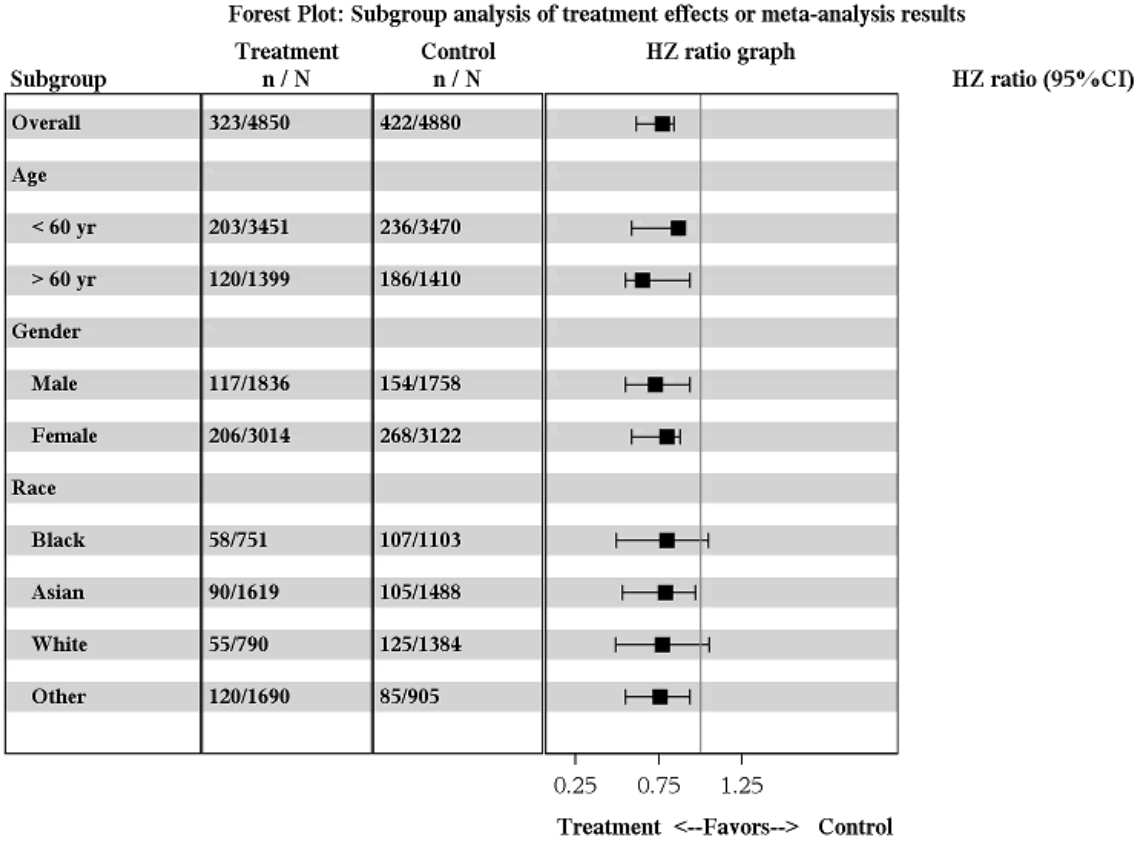
Forest Plot: Subgroup analysis of treatment effects or meta-analysis results

Subgroup	Treatment n / N	Control n / N	HZ ratio graph	HZ ratio (95%CI)
Overall	323/4850	422/4880		
Age				
< 60 yr	203/3451	236/3470		
> 60 yr	120/1399	186/1410		
Gender				
Male	117/1836	154/1758		
Female	206/3014	268/3122		
Race				
Black	58/751	107/1103		
Asian	90/1619	105/1488		
White	55/790	125/1384		
Other	120/1690	85/905		

This plot is for illustration purpose only and provides treatment comparison across subgroups.

Use case application - Synthetic data

```
/*--Fourth column draws HZ ratio plot*/

LAYOUT OVERLAY /  walldisplay=(outline)
 xaxisopts=(label=' Treatment <--Favors-->  Control'
type=linear linearopts=( viewmin=0.25 viewmax=1.25
 tickvaluelist=(0.25 0.5 0.75 1 1.25 ))

 REFERENCELINE Y=ORD /
                    lineattrs=(thickness=_thk
                                    color=_color);
 SCATTERPLOT Y=ORD X=MEAN/
              xerrorlower=low xerrorupper=high
          markerattrs=(symbol=squarefilled size=10) ;
      referenceline x=1;
ENDLAYOUT;
```



This plot is for illustration purpose only and provides treatment comparison across subgroups.

Use case application - Synthetic data

```
/*-- Fifth column reports HZ ratio with 95% CI --*/

LAYOUT OVERLAY / walldisplay=(outline)
  xaxisopts=(reverse=true  display=none )
  yaxisopts=(reverse=true display=none
        tickvalueattrs=(weight=bold)  );

 REFERENCELINE Y=ORD /
              lineattrs=(thickness=_thk
                   color=_color);
 AXISTABLE Y=ORD value=hzratio /display=(values
    valueattrs=(size=9pt weight=bold)
        indentweight=indent textgroup=type;
endlayout;
```

Forest Plot: Subgroup analysis of treatment effects or meta-analysis results

Subgroup	Treatment n / N	Control n / N	HZ ratio graph	HZ ratio (95%CI)
Overall	323/4850	422/4880		0.77 (0.612;0.841)
Age				
< 60 yr	203/3451	236/3470		0.865 (0.587;0.877)
> 60 yr	120/1399	186/1410		0.65 (0.551;0.934)
Gender				
Male	117/1836	154/1758		0.727 (0.551;0.935)
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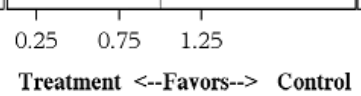
White	55/790	125/1384		0.771 (0.489;1.053)
Other	120/1690	85/905		0.756 (0.55;0.936)



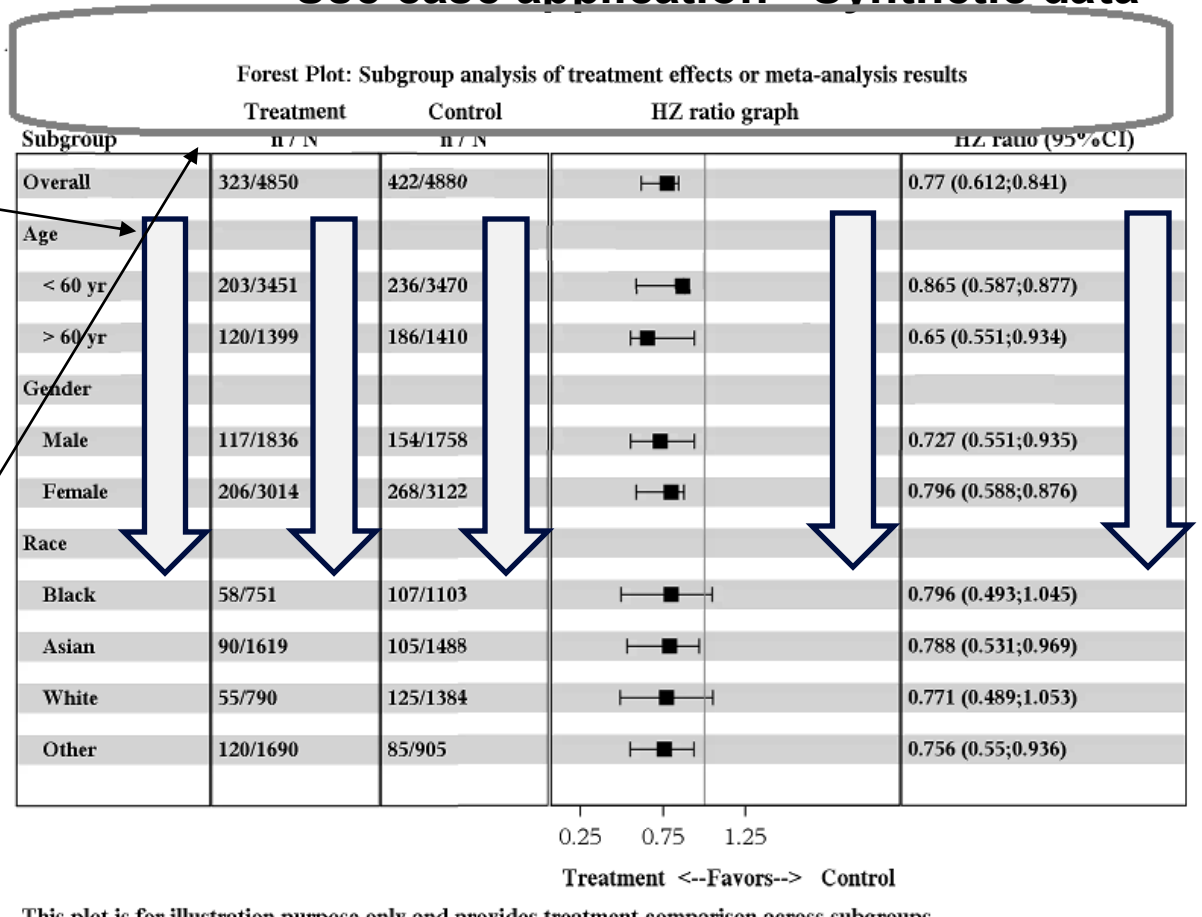
This plot is for illustration purpose only and provides treatment comparison across subgroups.

Use case application - Synthetic data

Layout Lattice

Axistable

ENTRY* TITLE and Footnote statements



Data Visualization using R packages

Versatile platform for statistical computing and data analysis

Standardization

Easy to install and reusable by users.

Community-driven

Large R community contributes to numerous R packages

Greater flexibility and customization

Aesthetics and appealing graphics

Rich ecosystem of packages

CRAN hosts huge packages extending R's functionalities in diverse areas

Data Visualization

Packages like ggplot2, lattice, plotly assists in creating interactive graphics

Platform Independent

Compatible across various computing environments

R packages | Use case application - Synthetic data

Packages in R

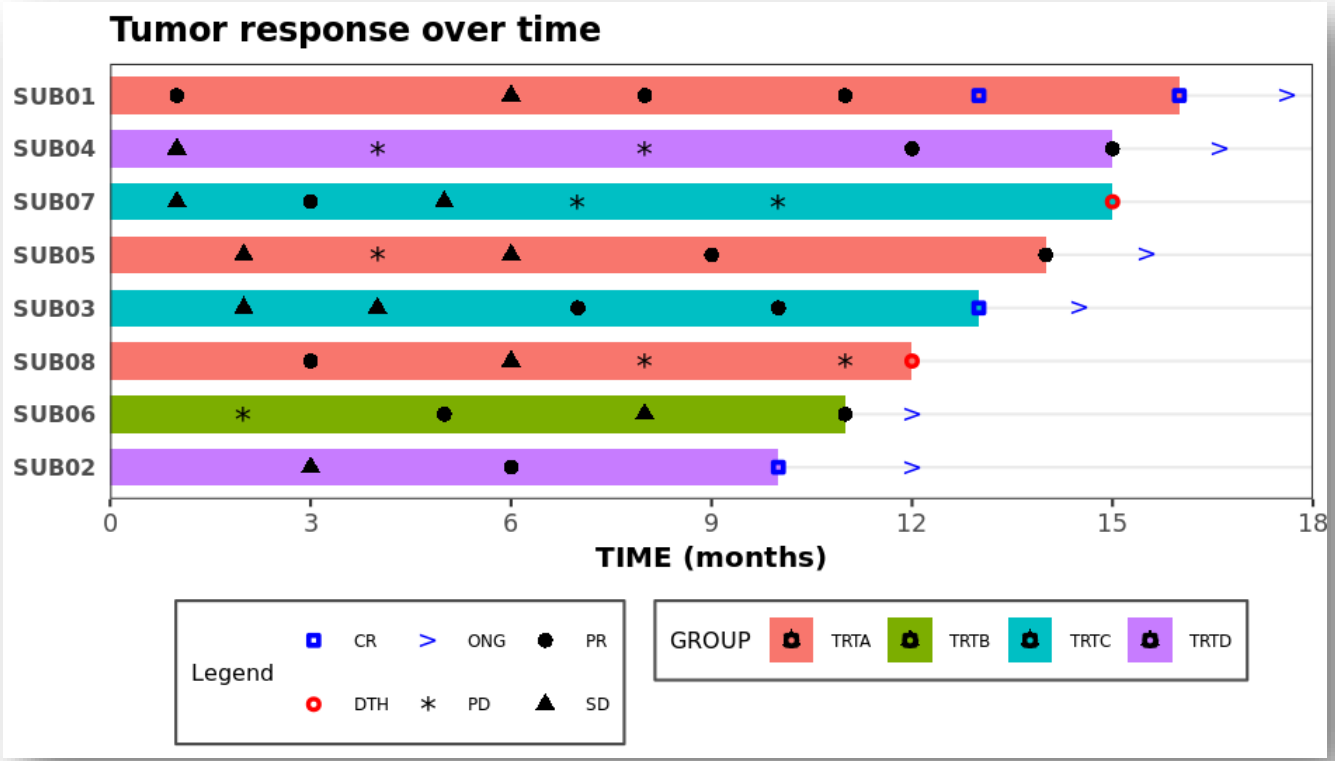
Draws Bar

```
library(tidyverse)
library(Rmarkdown)
library(readxl)

file_path <- "Synth_swim_sample.xlsx"
swimmer_plt <- read_excel(file_path, sheet = 1)

ggplot(aes(y=subjid, x=time, fill = group)) +
  geom_bar(stat="identity") +

  geom_point(aes(x=SD, col="SD"),
             size=1.0, stroke=1.5, shape=17) +
  geom_point(aes(x=PD, col="PD"), size=2.3,
             stroke=1.5, shape=42) +
  geom_point(aes(x=PR, col="PR"), size=1.0,
             stroke=1.5, shape=16) +
  geom_point(aes(x=CR, col="CR"),
             size=0.5, stroke=1.3, shape=22) +
  geom_point(aes(x=ONG, col="CR"),
             size=2.3, stroke=1.3, shape=62) +
      theme_bw() +
  geom_point(aes(x=DTH, col="DTH"),
             size=1.0, stroke=1.3, shape=21) +
      theme_bw() +
```



Scatter Plot

Use case application - Synthetic data

```
labs(x="TIME (months)", y=" ",title="Tumor response over time") +
    scale_x_continuous(limits=c(0, 18), expand=c(0,0)) + # remove extra white
    space

    axis.title.y = element_text(angle = 90, vjust=.5, size=0, face="bold"),
    axis.title.x = element_text(size=10, face="bold", vjust=0.5),
    axis.text.y = element_text(size=6, hjust=1.5),
    axis.ticks.y = element_blank(),

    legend.direction ="horizontal",
    legend.direction ="horizontal",
    legend.position = "bottom",
    legend.title = element_text(colour="black", size=8, face=8),
    legend.text = element_text(colour="black", size=6),
    legend.background = element_rect(size=0.5, linetype="solid", colour ="gray30"),

    panel.grid.major.x = element_blank() )
```

Axis statements

Legend

Aesthetics of graphs

SUMMARY/CONCLUSION

- The strong features of GTL provide extensive applications in data analysis
- Engaging with graphical data is an exciting and exhilarating experience. It's essential to grasp the fundamentals and comprehend the workflow to effectively utilize its applications and interpret the results
- R has become a dominant force in the analytics field, thanks to its impressive packages and applications. Don't hesitate any longer to start exploring its capabilities
- In this ever-changing landscape, data visualization plays pivotal role in providing high-level insights of trial objectives and help make impactful decision to get the medicine faster

Q&A

Thank you !!

The Global Healthcare Data Science Community

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