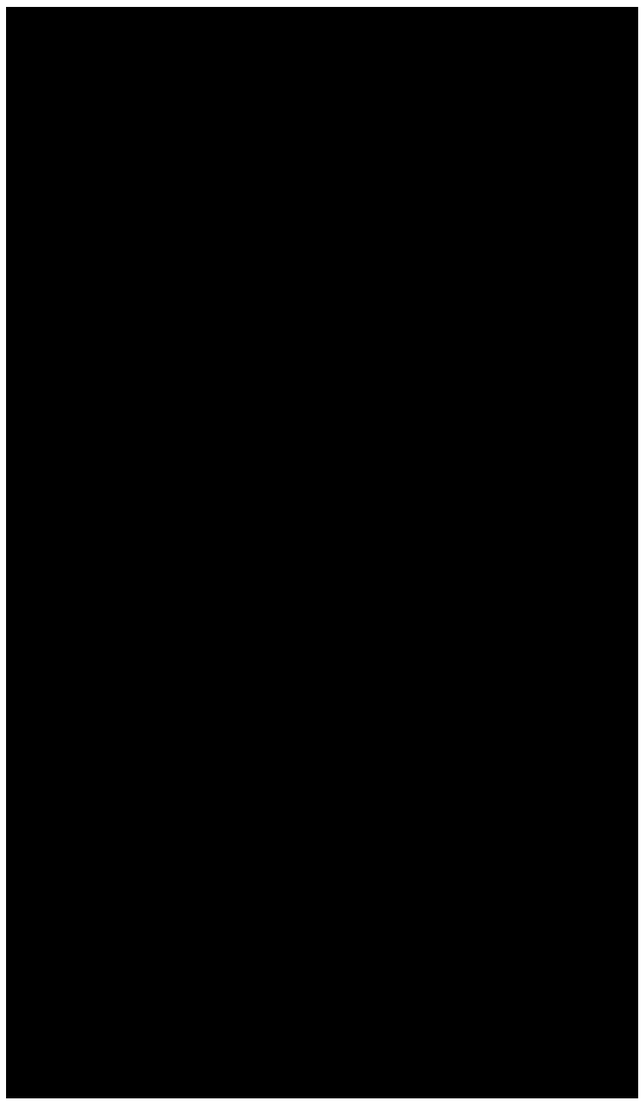
Sample Style Guide:

Dashboard Design, Data Visualizations, and Human Factors Principles



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December 7, 2022

WELCOME DESIGNERS & DEVELOPERS

This document is meant to act as a standard for designing dashboards. In addition, best practices for data visualization and dashboard creation are included. The style guidelines are recommendations based on best practices in user experience.

SECTIONS

03 APPLICATION OF CONTENT

This section outlines recommended use and application of this document.

06 COLORS

This section outlines recommended use of colors and provides specific examples of their application.

13 CONTRAST RATIO

This section describes the proper use of contrast, particularly for users with visual deficits.

14 ACCESSIBILITY

This section focuses on the importance of accessibility in design.

16 TYPOGRAPHY

This section details the usage of font and font sizes.

24 LAYOUT

This section denotes how to design a consistent experience.

27 DATA VISUALIZATIONS

This section covers the use of different data visualizations, when to use them, and how to style them.

APPLICATION OF CONTENT

THIS DOCUMENT SHOULD BE USED AS A REFERENCE WHEN CREATING OR MODIFYING DATA VISUALIZATIONS AND DASHBOARDS.

- New data visualizations and dashboards should align with the suggestions and principles presented in this document.

- Aligning with all suggestions and principles can be challenging and therefore, the most relevant or impactful suggestions should be prioritized.

- Always seek user feedback and modify visualizations and dashboards as appropriate.

- Ensure that all new or modified visualizes align with the current style and patterns of existing visuals in the dashboards.

APPLICATION OF CONTENT

HUMAN-CENTERED DESIGN PRINCIPLES ARE CRITICAL TO THE DESIGN PROCESS.

Human-centered design principles are empirically derived from studies of users' perception, cognition, and motor capabilities.

Incorporating these principles helps designers create designs of higher quality earlier in the design process.

The utilization of these principles reduces the rework and redesign time needed.

Factors to Consider:

- Data are not objective.
- People have biases when interpreting data.
- People apply heuristics, or mental shortcuts, when interpreting data.
- Usability is key to a products usefulness and effectiveness.
- The interpretation of data is subjective and context dependent.
- Level of data literacy can vary greatly among individuals.
- Visualizations can impact decision-making.

APPLICATION OF CONTENT

QUESTIONS TO CONSIDER BEFORE AND AFTER CREATING DATA VISUALIZATIONS

DATA

- How can the graph support the decisions that need to be made by the users?
- What are the interesting aspects of the data (e.g., outliers or trends)?
- How many variables need to be displayed in a single graph?
- How should the data be displayed (e.g., over time or in groups)?
- How many data points are there for each variable?
- How large is your data?
- Is showing the uncertainty in the data important for the users' decision making?

USERS

- Will the visualization be helpful or address the user's needs?
- Are the visualizations easy to interpret and understand?
- Are the visualizations appropriate for the user?
- Do you have the best visualization for the interpretation of the data?
- Have you allowed the user to access more information when necessary?

GRAPHS

- Are the visualizations an appropriate and accurate representation of the data?
- Does the visualization emphasize or highlight important information?
- Do the visualizations include all relevant information like labels?
- Are the visualizations as simple as possible?
- Have best practices for the specific visualization been followed?

COLORS

GLOBAL COLORS

These colors define the foundational color palette for the dashboard.

WHITE

USE

- Graph backgrounds
- Text for dark colors (will be noted)

CODE

HEX: #FFFFFF

RGB: (255, 255, 255)

LIGHT GRAY

USE

- Page background

CODE

HEX: #F2F4F8

RGB: (242, 244, 248)

BLACK

USE

- All text (unless otherwise noted)

CODE

HEX: #000000

RGB: (0, 0, 0)

COLORS

EXECUTIVE DASHBOARDS

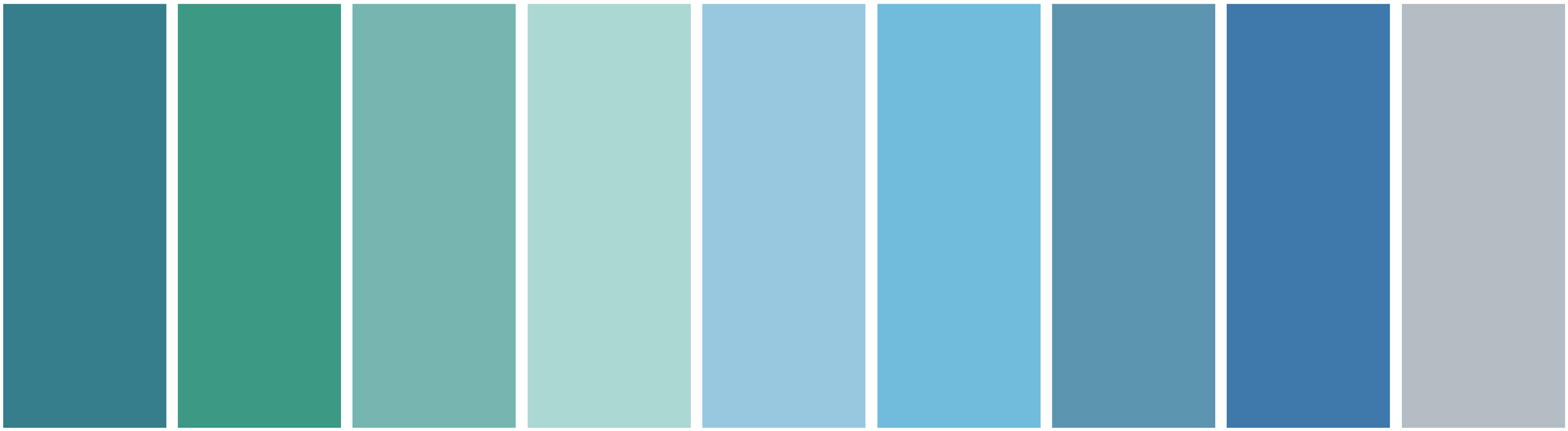
These colors define the foundational color palette for visualizations. All colors should use black text for proper contrast for low vision users.

PAOLO VERONESE GREEN
HEX: #3C9A84 RGB:
(60, 154, 132)

POWDER BLUE
HEX: #ADD8D4 RGB:
(173, 216, 212)

DARK SKY BLUE
HEX: #71BCDD RGB:
(113, 188, 221)

STEEL BLUE
HEX: #3F79AB RGB:
(63, 121, 171)



METALLIC SEAWEED
HEX: #367F8C RGB:
(54, 127, 140)

GREEN SHEEN
HEX: #76B7B2
RGB: (118, 183, 178)

LIGHT CORNFLOWER BLUE
HEX: #97C9E0
RGB: (151, 201,
224)

BLUE GREEN
HEX: #5D96AF RGB:
(93, 150, 175)

SILVER SAND
HEX: #B4BDC4 RGB:
(180, 189, 196)

GUIDANCE

- Use different shades of blue or green to indicate varying magnitudes of data and different data points.
- Darker colors should be used to indicate a greater value in data, while lighter colors should be used for lower values.
- Use the different shades at designer discretion depending on surrounding items and contrast requirements.
- Certain colors are hard for colorblind individuals to distinguish, so always provide a secondary indicator of value such as a hover over or symbol.
- The use of gray (i.e. Silver Sand) should be reserved to indicate a null or N/A value.

COLORS

HUMAN CAPITAL DASHBOARDS

These colors are specific to the Human Capital Dashboard. Each color has a specific use denoted in the legend of the dashboard.

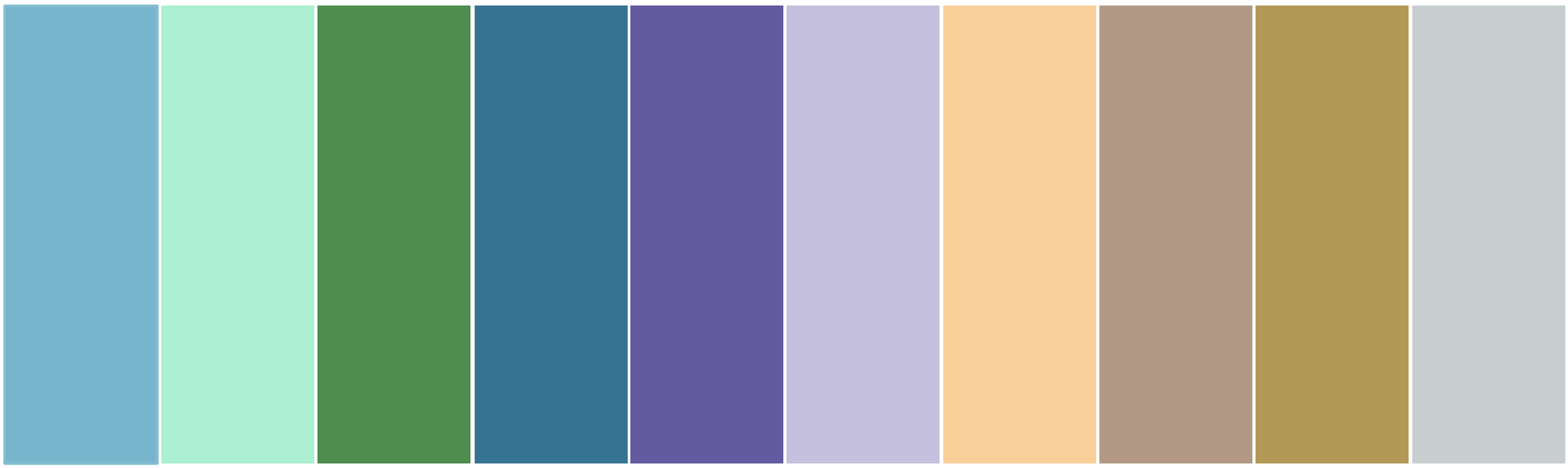
HEX: #84BDD2
RGB: ()

HEX: # 4E8D4E
RGB: ()

HEX: #635AA0
RGB: ()

HEX: #F9D099
RGB: ()

HEX: # B29955
RGB: ()



HEX: #AAF0D1
RGB: ()

HEX: # 367392
RGB: ()

HEX: #C5C0DD
RGB: ()

HEX: #B29985
RGB: ()

HEX: #C8CDD0
RGB: ()

GUIDANCE

- Use different shades of blue or green to indicate varying magnitudes of data and different data points.
- The blues and greens on the left should be used to indicate a greater value in data, while the colors on the right should be used for lower values.
- Use the different shades at designer discretion depending on surrounding items and contrast requirements.
- Certain colors are hard for colorblind individuals to distinguish, so always provide a secondary indicator of value such as a hover over or symbol.
- The use of gray should be reserved to indicate a null or N/A value.

COLORS

FINANCIALS DASHBOARDS

These colors may be used to call attention to values, typically in a table. However, the dark red color may be used to call attention to pie charts whose funds are expiring. The meaning for each color is the same as the previous slide.

HEX:
#A9DFBF

RGB:
(169,223,191)

HEX:
#FBEFCD

RGB:
(251,239,205)

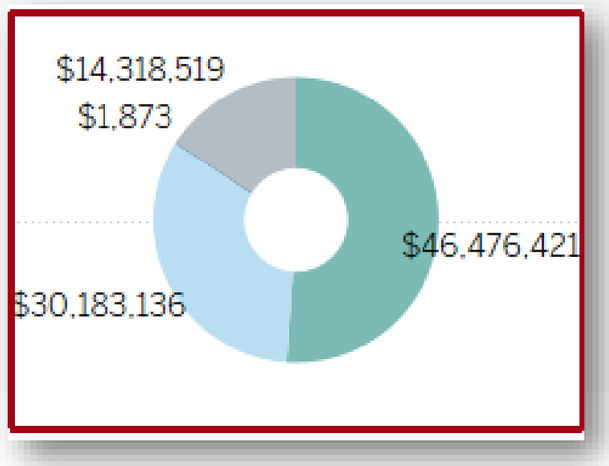
HEX:
#F5B7B1

RGB:
(245,183,177)

HEX:
#8B2323

RGB:
(139,35,35)

Obligations to Date ($)	Expenditures to Date ($)	Unobligated from Appropriated	Variance from Spend Plan	Obligated to Date (%)	Execution Goal
$4,929,139	$4,869,383	$95,559,861	($2,099,799)	4.91%	16.67%
$15,362,262	$3,997,959	$8,191,738	($1,101,747)	65.22%	91.67%
$46,903	$30,006	$50,399,097	($1,837,097)	0.09%	15.00%
$61,950,634	$35,914,459	$366	($366)	100.00%	91.67%
$126,356,914	$32,895,733	$7,591,086	($656,738)	94.33%	81.67%
$73,466	$51,398	$139,109,534	$42,616	0.05%	13.33%
$76,661,431	$32,148,294	$14,318,519	$1,873	84.26%	91.67%
$41,827,155	$2,345,839	$27,033,931	($9,000)	60.74%	81.67%
$0	$0	$55,304,000	($33,334)	0.00%	13.33%
$55,260,504	$33,356,876	$11,706,760	($298,701)	82.52%	91.67%
$33,043,895	$4,594,743	$31,008,279	($4,041,881)	51.59%	84.08%
$41,484	$26,810	$82,473,516	$28,393	0.05%	13.38%
$415,553,787	**$150,231,500**	**$522,696,687**	**($10,005,781)**	**44.29%**	**53.71%**



COLORS

VISUALIZATIONS - EXTENDED

These colors should be leveraged when there are 8+ distinct options or the visualization requires additional differentiation.

BLACK TEXT

HEX: #3B9A13 RGB: (59, 154, 19)	HEX: #59A14F RGB: (89, 161, 79)	HEX: #A4DE02 RGB: (164, 222, 2)	HEX: #ACDF87 RGB: (172, 223, 135)
HEX: #367F8C RGB: (54, 127, 140)	HEX: #3C9A84 RGB: (60, 154, 132)	HEX: #76B7B2 RGB: (118, 183, 178)	HEX: #ADD8D4 RGB: (173, 216, 212)
HEX: #97C9E0 RGB: (151, 201, 224)	HEX: #71BCDD RGB: (113, 188, 221)	HEX:#508BAD RGB: (80, 139, 173)	HEX: #3F79AB RGB: (63, 121, 171)
HEX: #A184FA RGB: (161, 132, 250)	HEX: #D6CAFF RGB: (214, 202, 255)	HEX: #8376AF RGB: (131, 118, 175)	HEX: #A062C1 RGB: (160, 98, 193)
HEX: #F28E2B RGB: (242, 142, 43)	HEX: #BAB0AC RGB: (186, 176, 172)		

WHITE TEXT

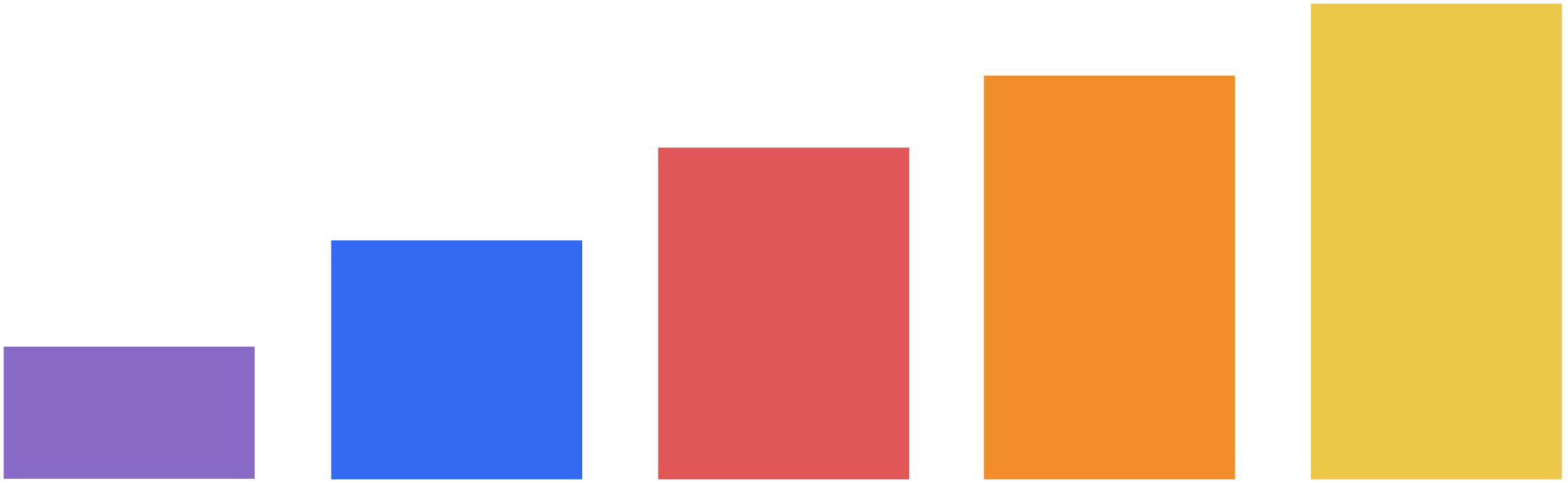
HEX: #194B2A RGB: (25, 75, 42)	HEX: #27744B RGB: (39, 116, 75)
HEX: #062E60 RGB: (6, 46, 96)	HEX: #3E42B2 RGB: (62, 66, 178)
HEX: #510AFF RGB: (81, 10, 255)	HEX: #4704A1 RGB: (71, 4, 161)
HEX: #7827D7 RGB: (120, 39, 215)	HEX: #8D009F RGB: (141, 0, 159)

COLORS

CLEARANCE LEVELS

These colors are standard designations for clearance levels. They should be used when clearances need to be designated in an illustration. All colors should use black text for proper contrast for low vision users.

LOWEST ⟷ HIGHEST

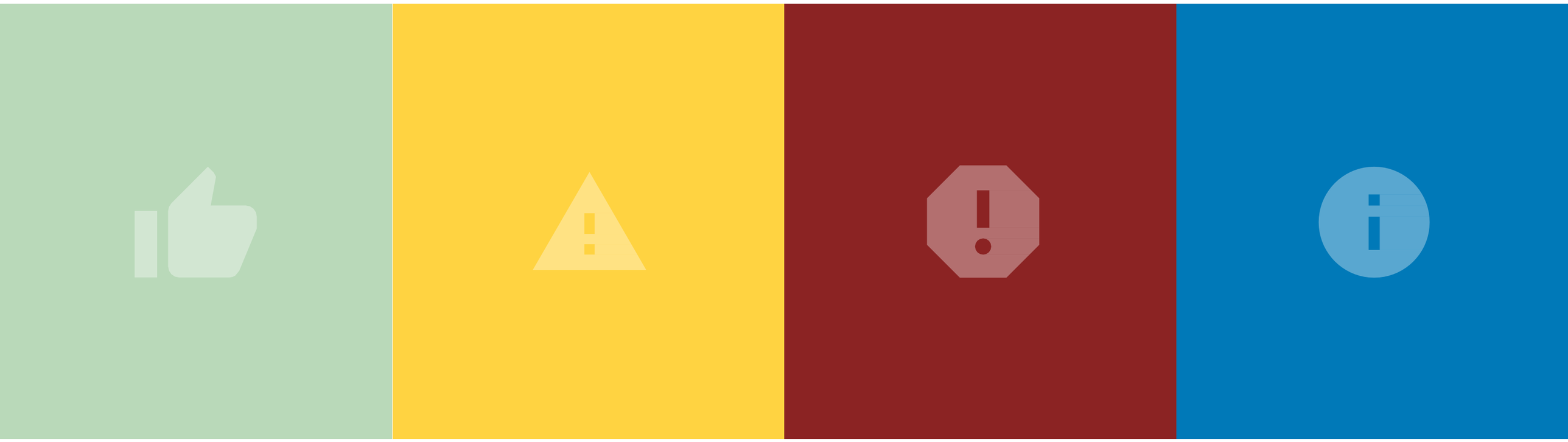


CONTROLLED	CONFIDENTIAL	SECRET	TOP SECRET	TOP SECRET (SCI)
HEX: #8A6BC7 RGB: (138, 107, 199)	HEX: #326BF1 RGB: (50, 107, 241)	HEX: #E15759 RGB: (225, 87, 89)	HEX: #F28E2B RGB: (242, 142, 43)	HEX: #EDC948 RGB: (237, 201, 72)

COLORS

RESTRICTED COLORS

The use of these colors should be restricted to convey specific information, referenced under “Use,” and are recognized as web design standards. These colors should not be used for text, since they do not provide sufficient contrast for all users.



GREEN

USE

- Good
- Low
- On-Time

CODE

HEX: #BAD9BA RGB: (186,217,186)

ORANGE/YELLOW

USE

- Caution
- Medium
- Not Started

CODE

HEX: #FFD342
RGB: (255,211,66)

RED

USE

- Warning
- Bad
- High
- Late/Past-Due

CODE

HEX: #8B2323
RGB: (139,35,35)

BRIGHT BLUE

USE

- Information
- Clickable Elements/Links

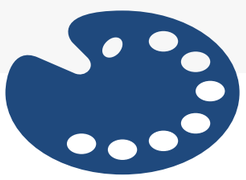
CODE

HEX: #007AB8
RGB: (0,122,184)

COLORS

DESIGN BEST PRACTICES FOR COLOR

- Use as few unique colors as possible. Five colors or less is standard.
- Consistently use each color in the same context across dashboards (e.g., one item is always the same color). This will apply meaning to the chosen colors. Provide redundant cues such as mouse-over pop-up windows for users with visual deficiencies.
- Graphs can be grouped using color or grouping can be used to simplify charts with lots of colors.
- Utilize intuitive colors . Adhere to the suggested color palette (slide 10) but iterate on future versions as users provide feedback.
- Use a single, attention-grabbing color for buttons or links. Consistently use this color across the dashboard to guide users.
- Use contrast in dashboard layouts to ensure that elements are visible. Contrast ensures that individuals with visual deficits can also easily interpret the dashboard or graph.



CONTRAST RATIO

IDEAL CONTRAST RATIOS FOR VISIBILITY

- Contrast allows users greater visibility of text and differentiating colors in visualizations.
- Web Content Accessibility Guidelines (WCAG) defines WCAG AA as the standard.
- The AAA designation has greater contrast than AA and A has lower contrast (do not use for regular text).
- Text font, font size, font color, font weight, and background color must be considered when deciding on contrast ratio.

WCAG AAA	7:1 contrast ratio minimum	Not always necessary to use but most ideal.
WCAG AA	4.5:1 contrast ratio minimum	Use this as the standard for all text/backgrounds.
WCAG A	3:1 contrast ratio minimum	This is the bare minimum for contrast ratio and should be avoided in favor of greater contrast.

ACCESSIBILITY

SECTION 508 WAS ADDED TO THE REHABILITATION ACT OF 1973 IN 1998 AND GIVES MINIMUM GUIDELINES FOR CONTRAST.

- Visibility and readability for those with visual impairments, including those who are colorblind, is a primary concern.

- To ensure these individuals are accommodated, the Web Content Accessibility Guidelines 2.1 State for background and text contrast:

- Section 1.4.3 Contrast (Minimum):
  For body, subtext, or general copy, the goal is a contrast ratio of 4.5:1
  For headers or larger text, (Font size 18 pt or 14 pt bold), the goal is a contrast ratio of approximately 3:1

- When adding new colors, helpful tools to ensure contrast levels are: https://webaim.org/resources/contrastchecker/ or https://adasitecompliance.com/ada-color-contrast-checker/

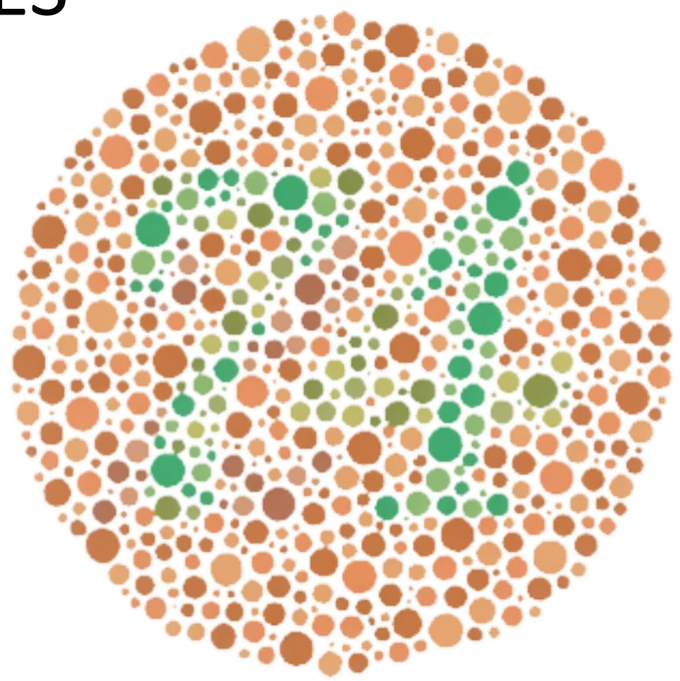
- This section requires that “federal agencies make their electronic information and technology (EIT) accessible to people with disabilities”.

ACCESSIBILITY

A WORD ON SPECIAL USER CASES

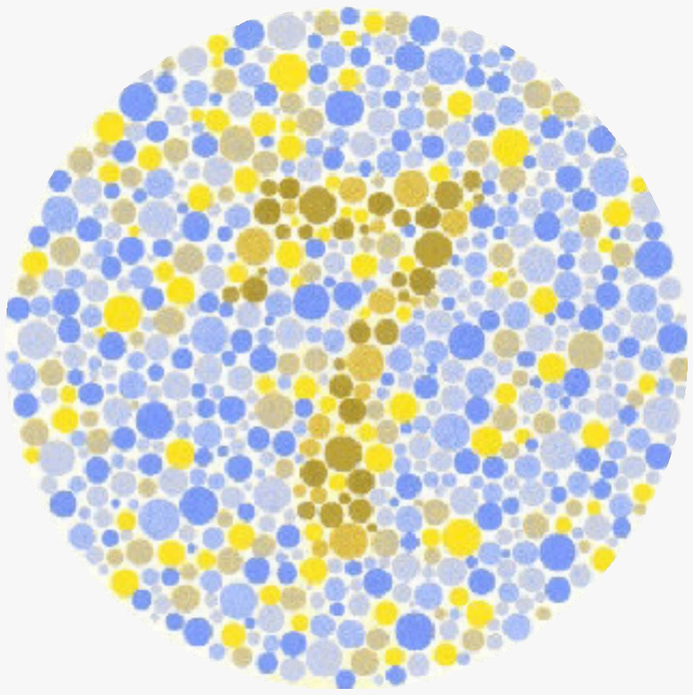
- Many users have visual deficiencies such as color deficits, cataracts, and glaucoma, among others.

- Red-green color blindness is the most common form of color blindness. These users cannot tell the difference between shades of red and green.



A red-green color deficient individual cannot see the green "74" in the circle.

A blue-yellow color deficient individual cannot see the yellow “7” in the circle



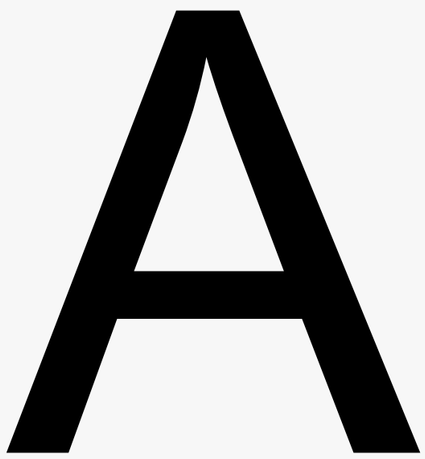
- Blue-yellow color blindness is another common (but rarer) form of color blindness. These users cannot tell the difference between shades of blue and yellow.

- Visual issues are one component of accessibility issues users may face. For example, users may lack fine motor skills so clicking on small icons can be challenging. Cognitive impairments like dyslexia are also common.

TYPOGRAPHY

FONT

Benton Sans Book is the font used throughout these dashboards. This includes, but is not limited to, all titles, headers, labels, icons, and navigation.



ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
1234567890

TYPOGRAPHY

TYPE HIERARCHY

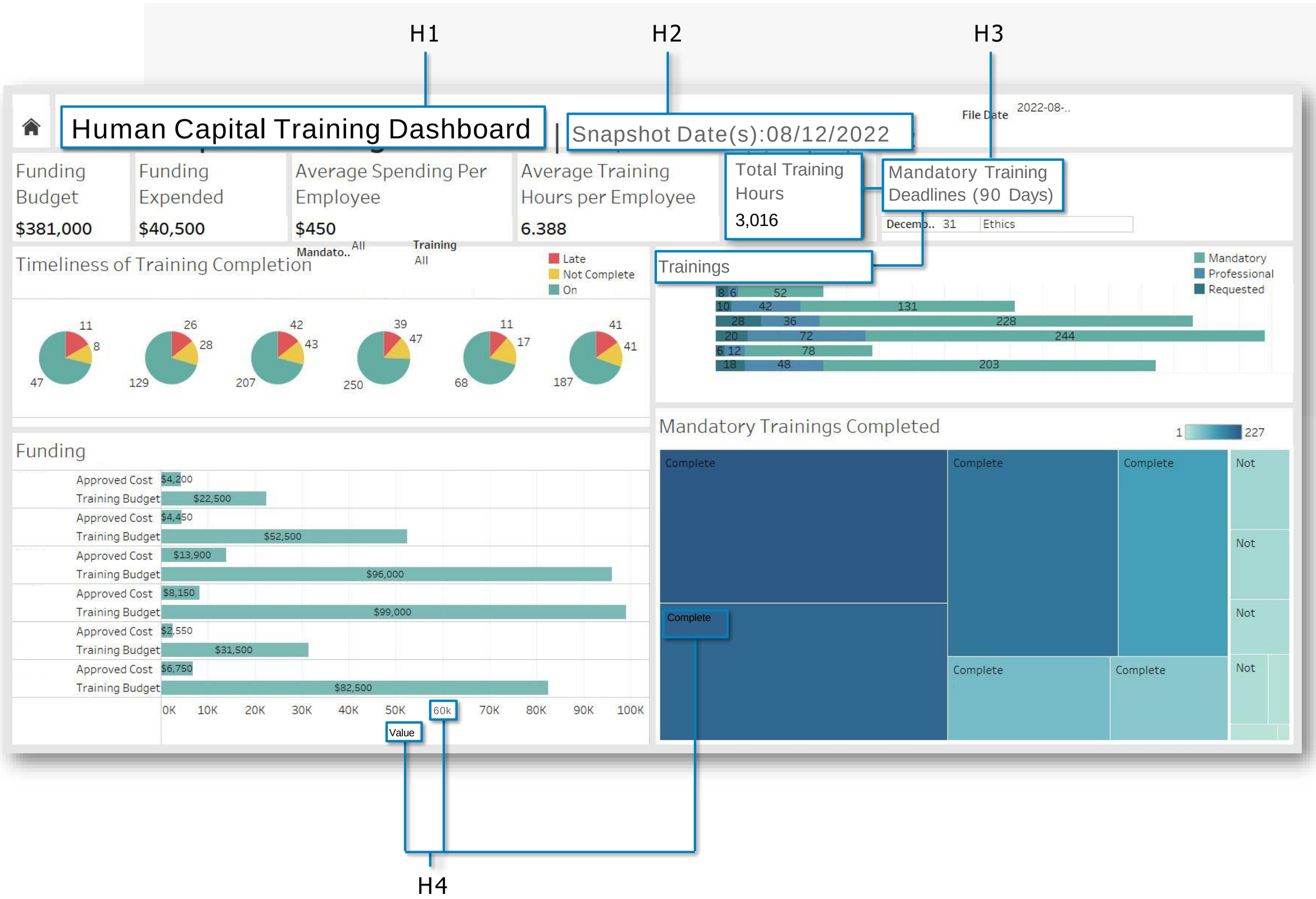
Text hierarchy is important to convey information and provide order for data.
Font sizes are listed in Tableau sizes.

Page Title H1	Font Size: 24 | Font Weight: Bold | Usage: Page Title
Subheading H2	Font Size: 20 | Font Weight: Regular | Usage: Data Date
Titles H3	Font Size: 15 | Font Weight: Regular | Usage: Graph Titles
Content H4	Font Size: 9 | Font Weight: Regular | Usage: Graph Text, Axis, Legends

TYPOGRAPHY

EXAMPLES

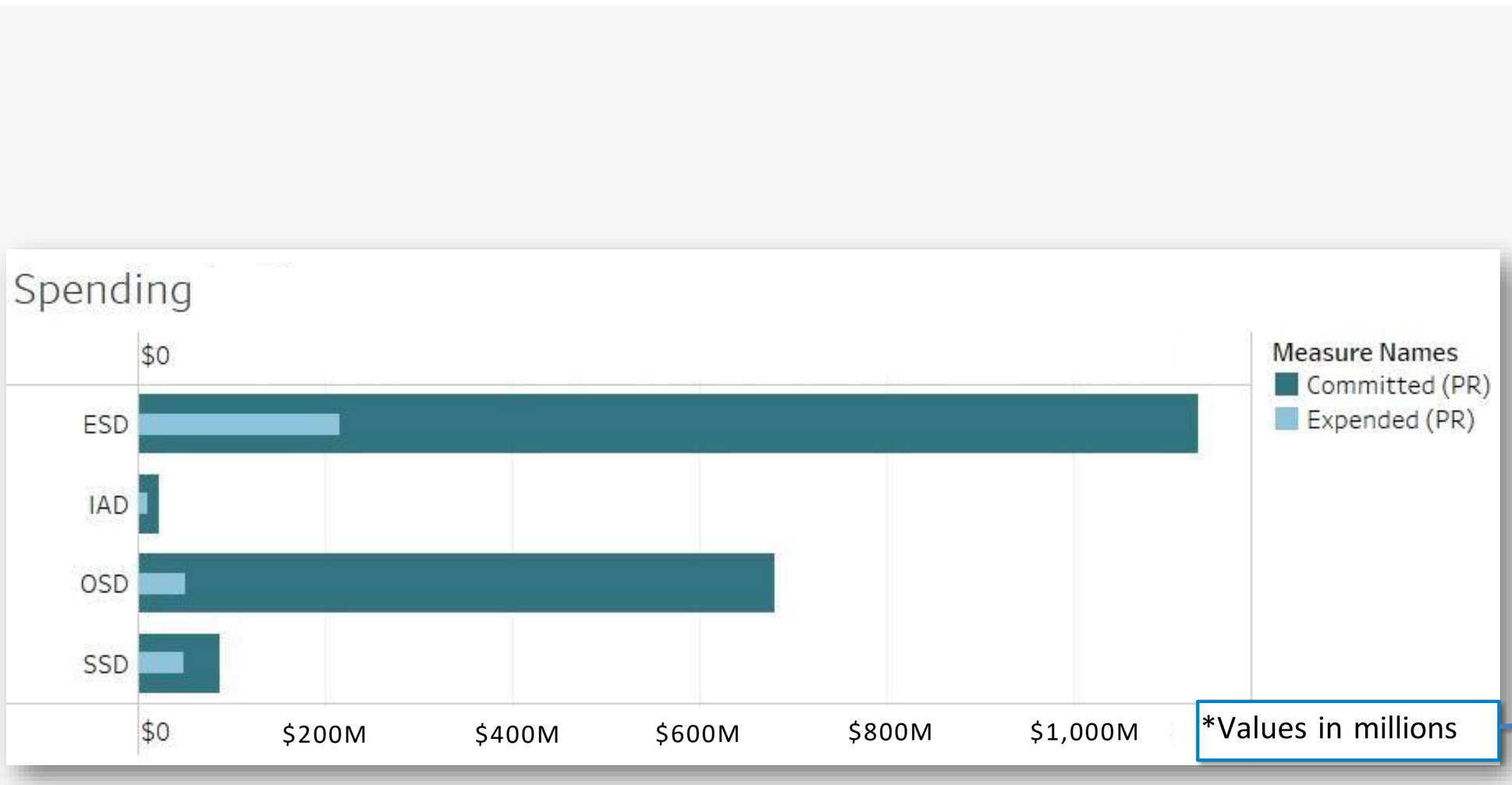
Below are examples of how this hierarchy is used in practice.



TYPOGRAPHY

NUMERICAL VALUES

- Use a lower case k to indicate thousands (e.g., 1k).
- Use a capital M to indicate millions (e.g., 1M).
- Use a capital B to indicate billions (e.g., 1B).



Value label

TYPOGRAPHY

NUMERICAL VALUES

When leveraging numerical data, these best practices ensure users are not confused or overwhelmed when reviewing large amounts of data:

DECIMALS

- Only round to a whole number if no additional meaning is conveyed in keeping decimals.
- Decimals should not exceed 2 points; it is important to use only as many decimal points as necessary to convey meaning in the data.

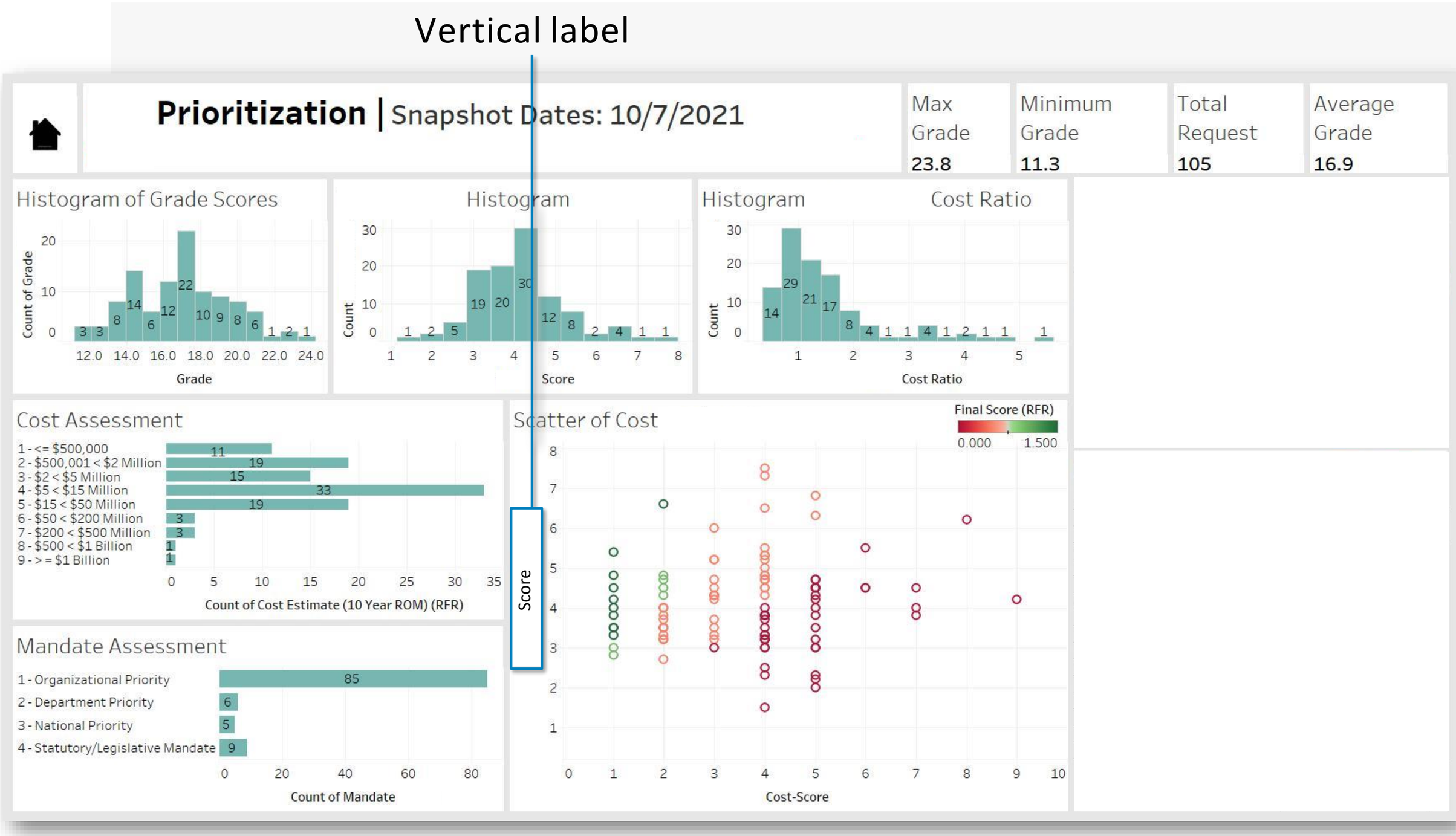
YEARS

- Use 4-digits when displaying years (e.g., 2022 or FY22).
- When 4-digits are not possible, a second interaction should be available to display complete information (e.g., hover over or drill down).

TYPOGRAPHY

USE OF HORIZONTAL VS VERTICAL TEXT

- All dashboards utilize horizontal text by default.
- Vertical text is only used for y-axis labels.



TYPOGRAPHY

USE OF POSITION TITLES VS SERIES

- Display position titles with series number for all visuals.

Series displayed on the left

organized by award number

Remaining Funds by Award Number

Award Number (CLM)	External Doc Ref Num ..	Day of Line POP Start ..	Day of Line POP End ..	Days Since PoP Start (CLM)	Sum of Fun
2		Null	Null	Null	$22,969
3		Null	Null	Null	$18,163
4		Null	Null	Null	$389
5		Null	Null	Null	$10,200
7		Null	Null	Null	$371,797
8		Null	Null	Null	$103,515
9	Null	Null	Null	Null	$59
10	Null	Null	Null	Null	$1,884
12	Null	Null	Null	Null	$30
13	Null	Null	Null	Null	$36
15	Null	Null	Null	Null	$89
16		Null	Null	Null	$176

TYPOGRAPHY

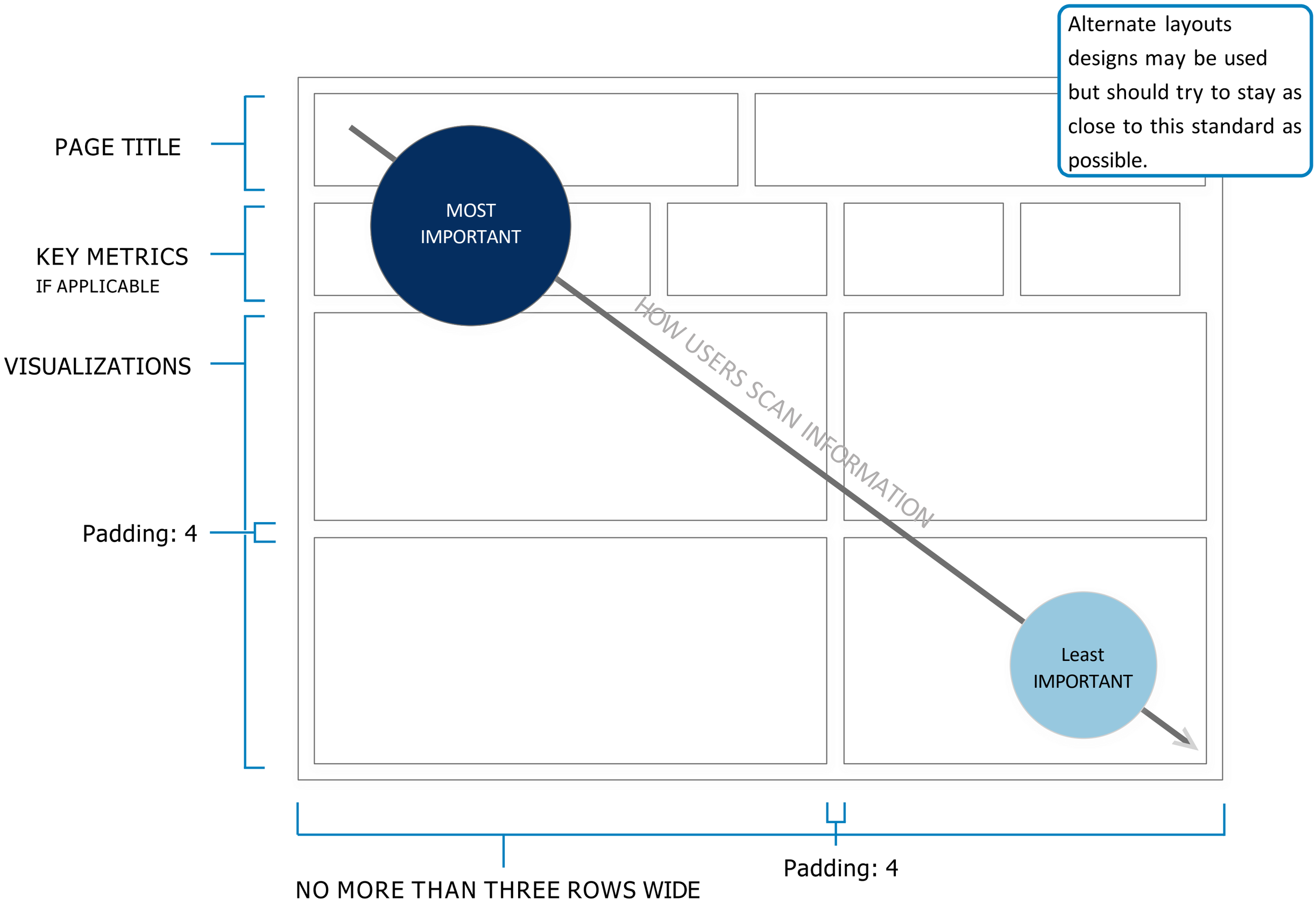
DESIGN BEST PRACTICES FOR TYPOGRAPHY

- As with most design considerations, consistency is key for typography as your audience should be able to anticipate how the design is laid out for each dashboard.
- The same font typeface should be used throughout the dashboard design (*see Slide 15). If a different typeface must be used, ensure that font is only used in a specific context consistently throughout the dashboards.
- Consistently use the same font size for headings, subheadings, titles, and content across dashboards (*see Slide 16).
- Align with previously mentioned contrast suggestions. Whenever possible, use black text with a white background or white text with a black background for greater contrast and legibility.
- Use a clean typeface as it will be more legible (e.g., Calibri, Arial, etc.).
- Avoid use of font decoration (e.g., bolding, underlining, italicizing, etc.) unless to emphasize specific content.

LAYOUT

DASHBOARD LAYOUT

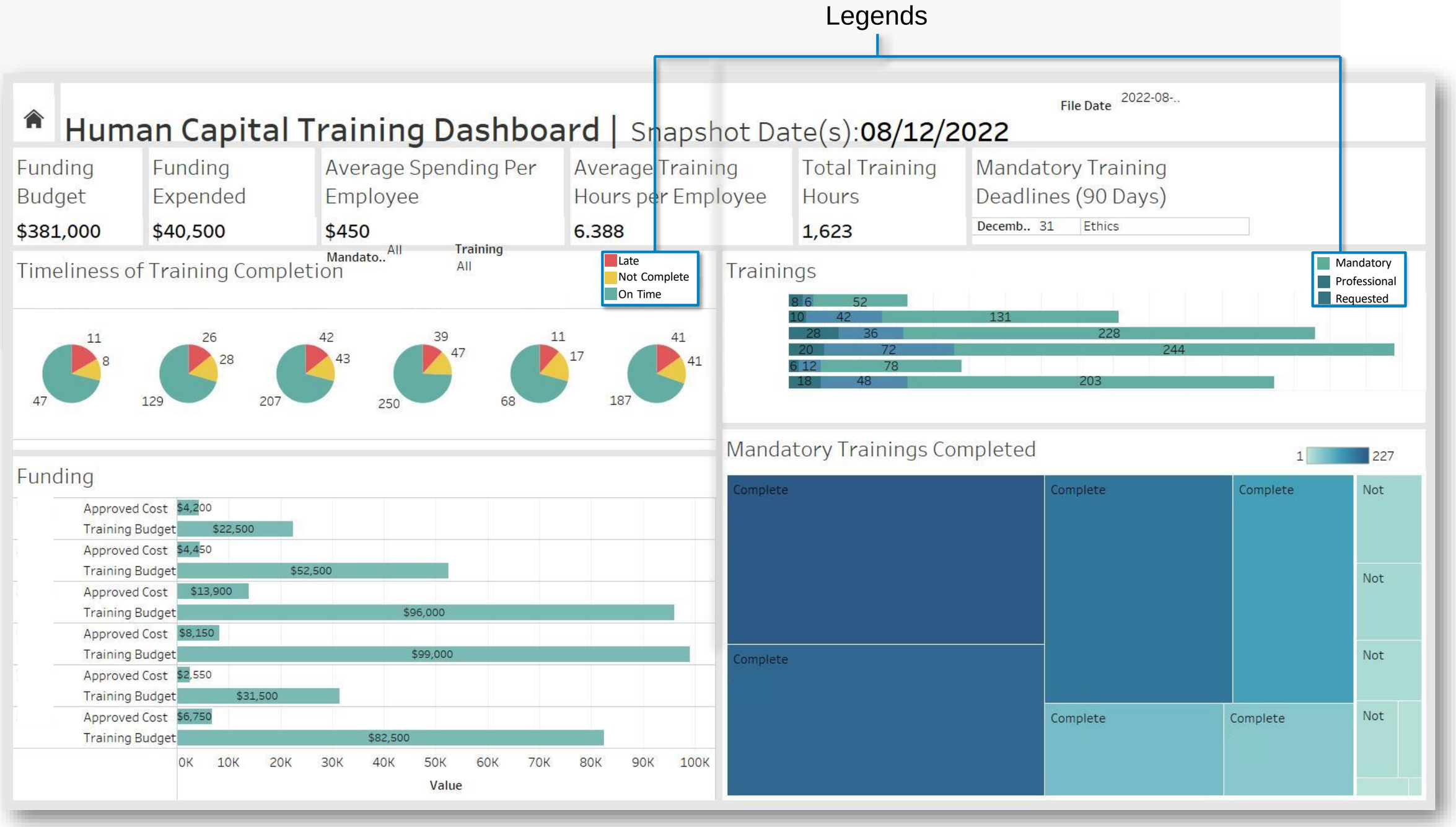
- These layout guidelines ensure the most important information is viewed first. Place summary and/or key metric data at the top with supporting information below.



LAYOUT

LEGENDS

- One legend per color set per dashboard should be used.
- Format legends as floaters and select a placement location that does not obstruct other visualization information.
- Place at the top right of individual visualizations or dashboard if referring to all visualizations.



LAYOUT

DESIGN BEST PRACTICES FOR LAYOUT

- Create a visual hierarchy of information. Users read from left to right, so it is beneficial to have the most pertinent information in the top left corner. The least important items should be at the bottom right of the dashboard.
- Use the same layout structure for every dashboard as consistently as possible (*see Slide 23 for suggested layout).
- Keep the layout simple without trying to include too much information. A maximum of 4 visualizations per dashboard is preferrable.
- Visual navigation of the dashboards should be natural and supported by legends, headers, pop-up text from mouse-over, and other relevant information. Make it obvious to the user what they are looking at and support their ability to find what they are looking for.
- Ensure the dashboard page is responsive and is compatible on different standard displays. Be aware as to how users will be viewing the information. For example, accounting for a phone-sized display will most likely be unnecessary for the sake of these dashboards.
- When possible, use whitespace to break up information.
- Provide options for navigation and viewing but only as necessary. Too many options can quickly become confusing for users.
- Consider user feedback and implement changes to dashboards, as necessary.

DATA VISUALIZATIONS

Visualizations translate information into a visual context to enable users to better understand data and pull insights. The main goal is to enable decision making by making it easy to identify patterns, trends, and outliers.

TYPES OF VISUALIZATIONS

28 BAR CHART

30 HISTOGRAM

32 SCATTERPLOT

34 MULTI-BARRED CHART

36 DONUT AND PIE CHART

38 TREE MAP AND PACKED BUBBLE CHART

40 GEOGRAPHICAL MAP

42 LINE GRAPH

44 BOX AND WHISKER PLOT

46 TABLE

48 SAND CHART

DATA VISUALIZATIONS

BAR CHART

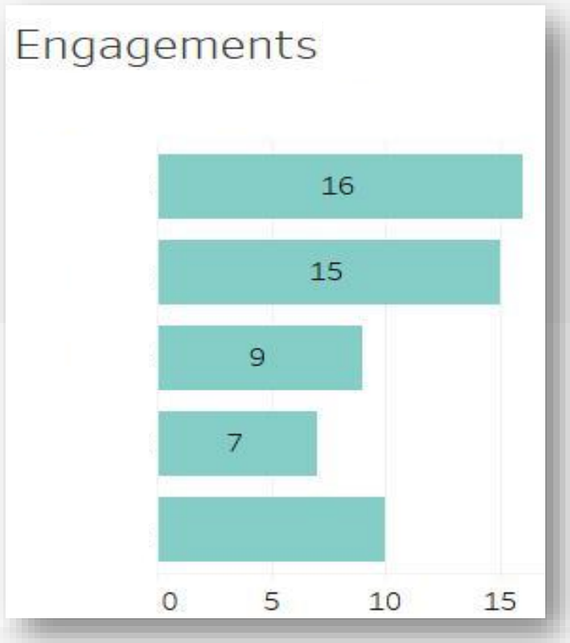
- Bar charts depict data with rectangular bars corresponding to the values they represent.
- Present data horizontally or vertically depending on the space available and number of values.
- Use a horizontal bar chart for nominal values, categorical values, and long numbers.
- Use a vertical bar chart for ordinal and sequential values.

Value Labels: Display values inside their respective bars.

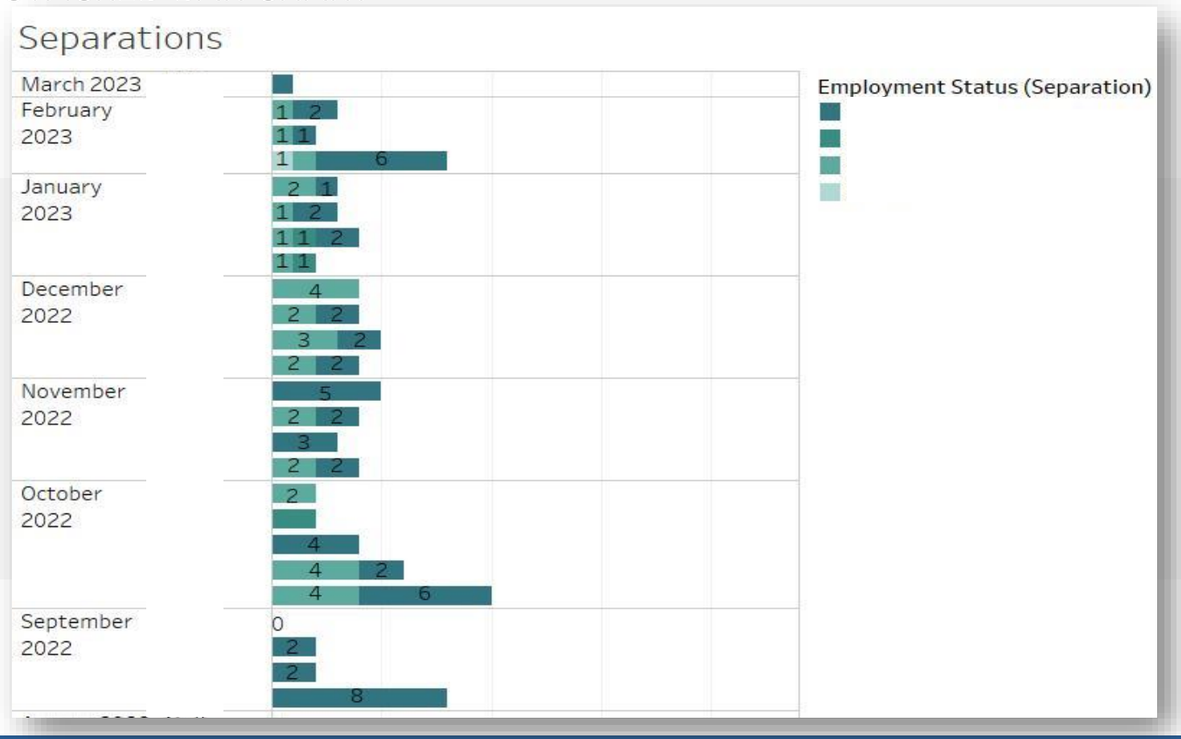
SINGLE SERIES BAR CHART

Used for direct comparison among distinct categories.

SINGLE SERIES BAR CHART



STACKED BAR CHART



STACKED BAR CHART

Used when the total matters as much as the categories.

COLUMN OR BAR CHARTS CAN BE USED TO COMPARE VALUES OR SEE THE DISTRIBUTION OF DATA ACROSS GROUPS.

WHEN TO USE

- Categorical variables/visual summary of categories. With ordinal or sequential values, use vertical bar charts and horizontal bar charts for nominal or categorical values.

- Viewers want to know actual values while being able to compare the data. Stacked bar charts can be used when the total maters as much as the category composition.

- See the distribution of variables across categories or changes in a variable over time.

DESIGN

- Minimalist style design to prioritize the data (e.g., limit the grid lines or backgrounds).
- Arrange bars in an intuitive order (e.g., numbered stages appear in numerical order).
- Do not use 3-D bars.
- Label the count above or within each bar
- Axes should always start at zero.
- Include title, axes labels, and source of the data.
- Group bars when possible.
- Use consistent bar widths; the space between the bars should be half the width of the bars.
- Bars should be solid colors (i.e., do not use patterns).

WHEN NOT TO USE

- Do not use if the range of values is important or if the data are not normally distributed.

ALTERNATIVES

- A grouped bar chart can used to compare categories in sets. Stacked bar charts can also show comparisons between sets but are more difficult for people to compare. Alternatives to using a bar chart include a stacked row chart, a waffle chart, and bubble row chart.

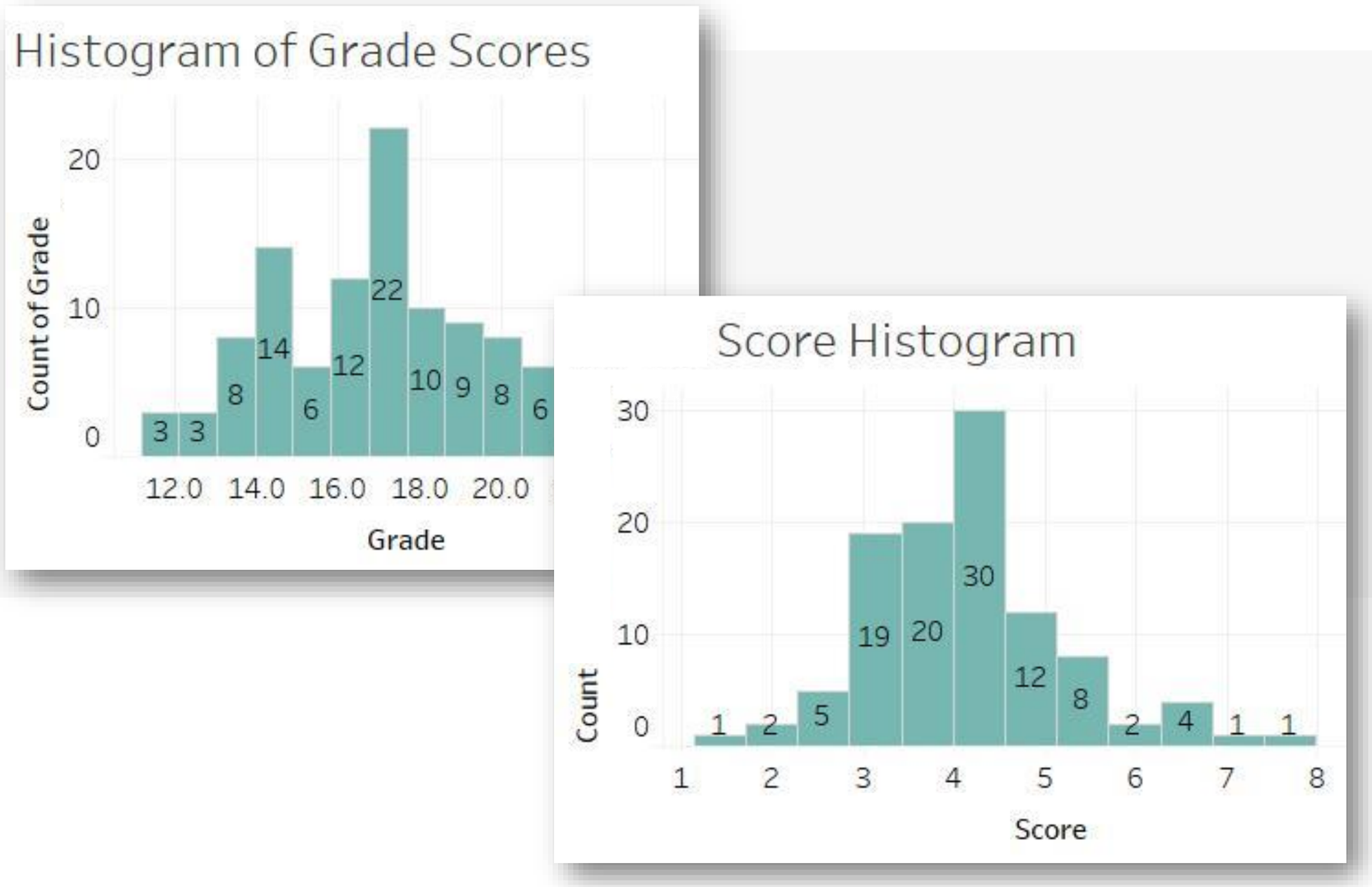
DIFFERENT TYPES OF VISUALIZATIONS FALL INTO ONE OF FOUR CATEGORIES

HISTOGRAM

- Histograms show data using rectangular bars corresponding to the values they represent.
- Unlike bar charts, histograms have no space between the bars.
- Histograms can only be used with consistent, normally distributed data.
- Use histograms to summarize discrete or continuous data that are measured on an interval scale.

Value Labels: Display values inside their respective bars.

HISTOGRAM



HISTOGRAM CAN BE USED TO DISPLAY THE DISTRIBUTION OF A VARIABLE OVER A CONTINUOUS RANGE.

WHEN TO USE

- Visualizing patterns in data distribution quickly and easily.
- Histograms and bar charts are different. Bar charts are based on height and represent discrete categories while histograms are based on area and represent a distribution over a continuous variable.
- Comparing the distributions of different variables or variables at different time points.

DESIGN

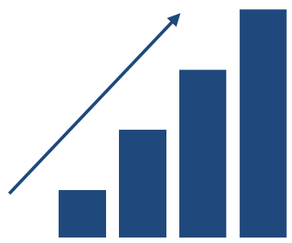
- Pick a minimalist style design to prioritize the data (e.g., limit the grid lines/backgrounds when possible).
- Bars should be solid colors, not use patterns. Transparency can be used when comparing variables.
- Use an appropriate and interpretable bar size and ensure consistency in bar size.
- No spaces between the bars.
- Axes should always start at zero.
- Include title, axes labels, and source of the data.
- A smoothed line can be used over the bars to better highlight the shape of the distribution.

WHEN NOT TO USE

- Do not use a histogram if you want to prioritize the number over the distribution shape or if the measured variable is not continuous.

ALTERNATIVES

- Alternatives to using a histogram can include a density chart or a violin plot.



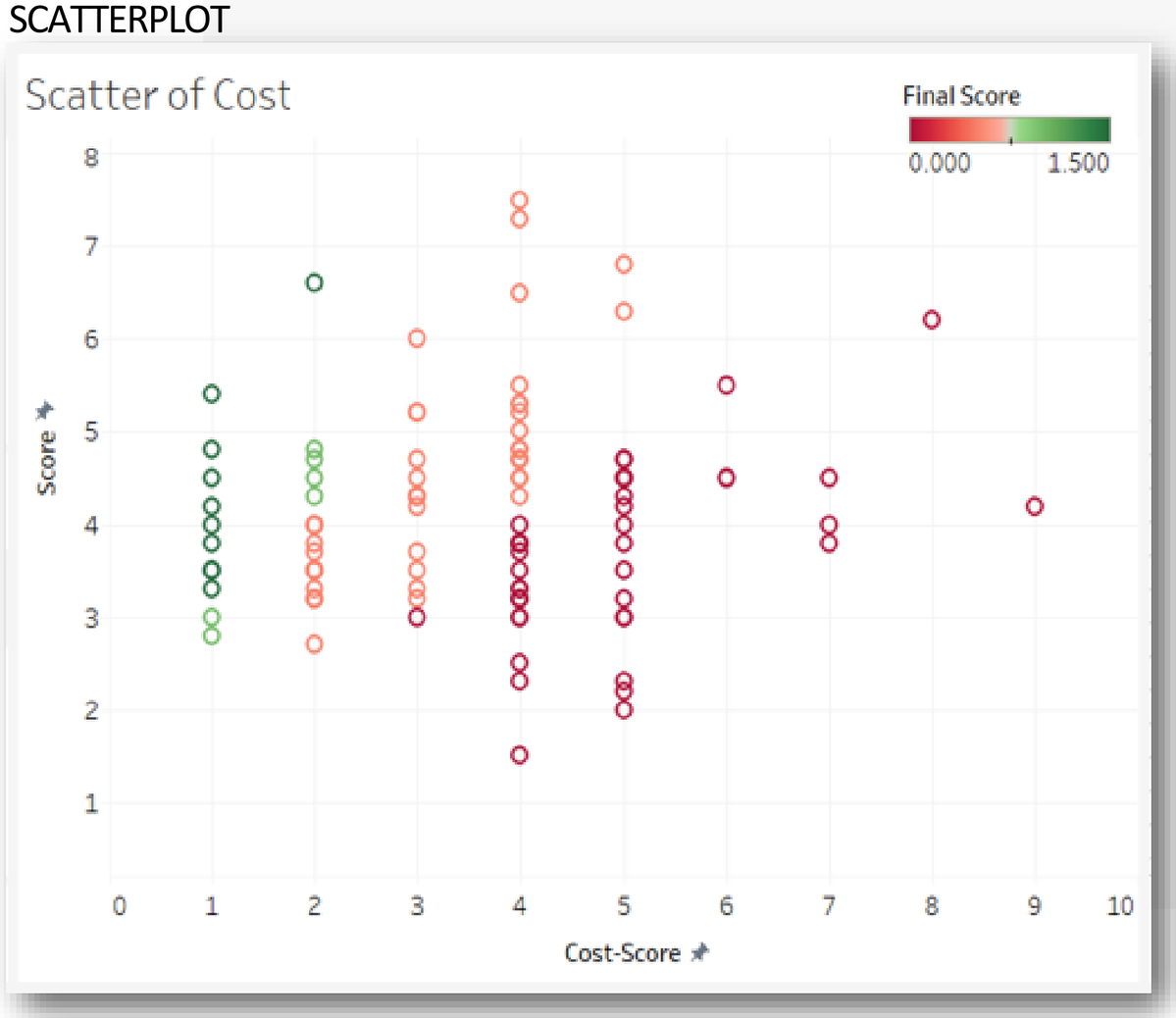
DATA VISUALIZATIONS

SCATTERPLOT

- Scatterplots represent data points using dots.
- Dot position indicates a value for an individual data point.
- Scatterplots show the relationship between two variables.
- When hovering over a dot, you should be able to see the exact value.
- Dot color can represent a third variable.

Value Labels: Display values along the X and Y axes.

SCATTERPLOT



DATA VISUALIZATIONS

THE RELATIONSHIP BETWEEN TWO VARIABLES CAN BE SHOWN WITH SCATTERPLOTS.

WHEN TO USE

- Use as an easy way to display relationships between variables, identify clusters, or highlight outliers.
- Use to highlight linear and non-linear patterns as well as data maximum and minimums.
- It is best when both variables are continuous, but one can be discrete.

DESIGN

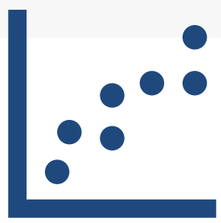
- Color, shape, and bubble size (area) can be used to represent more variables.
- Pick a minimalist style design to prioritize the data (e.g., limit the grid lines or backgrounds).
- Trend lines can make the relationship clearer but limit the number of lines.
- Axes should always start at zero.
- Include title, axes labels, and source of the data.
- Including formation on correlation strength can be helpful.
- Be careful that the viewer does not mistake correlation for causation.
- A regression line can be used to highlight the relationship between the variables or to make a prediction.

WHEN NOT TO USE

- Reconsider using a scatter plot if the data is unrelated, if the two variables have no discernable relationship, or if the data is too large (i.e., cluttered plot).

ALTERNATIVES

- Alternatives to using a scatter plot include a 2-D binning graph (large data), a heat map, or possibly a violin graph.



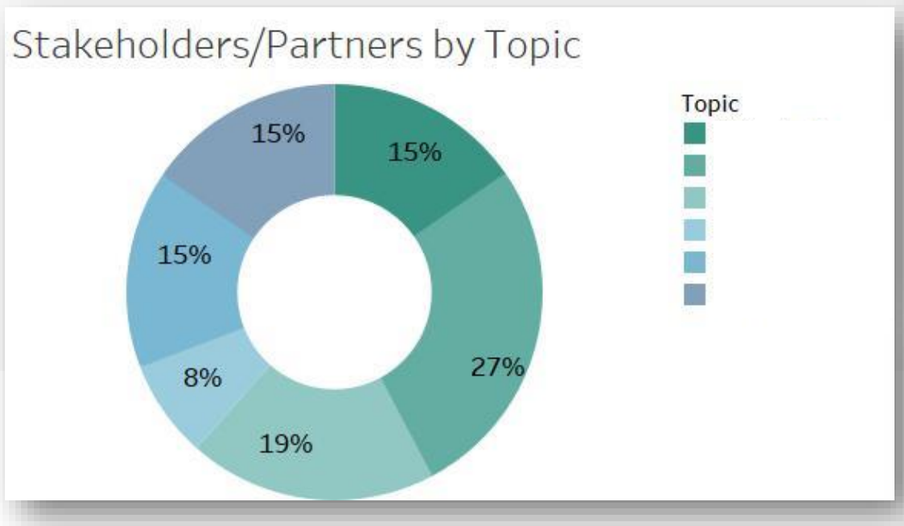
DATA VISUALIZATIONS

DONUT & PIE CHART

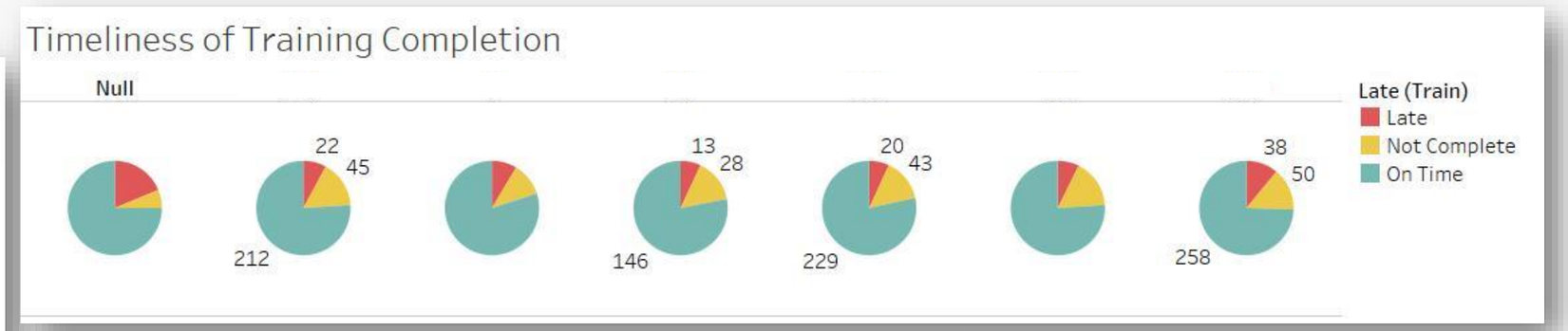
- Use circular charts to visualize data proportions.
- Use pie charts to compare a piece to the whole.
- Use donut charts to compare many categories as related to the whole.
- If displaying more than 7 data points, use a tree map or bar graph.
- A red box around a pie or donut chart may be used to convey a message (e.g. expiration, etc.)

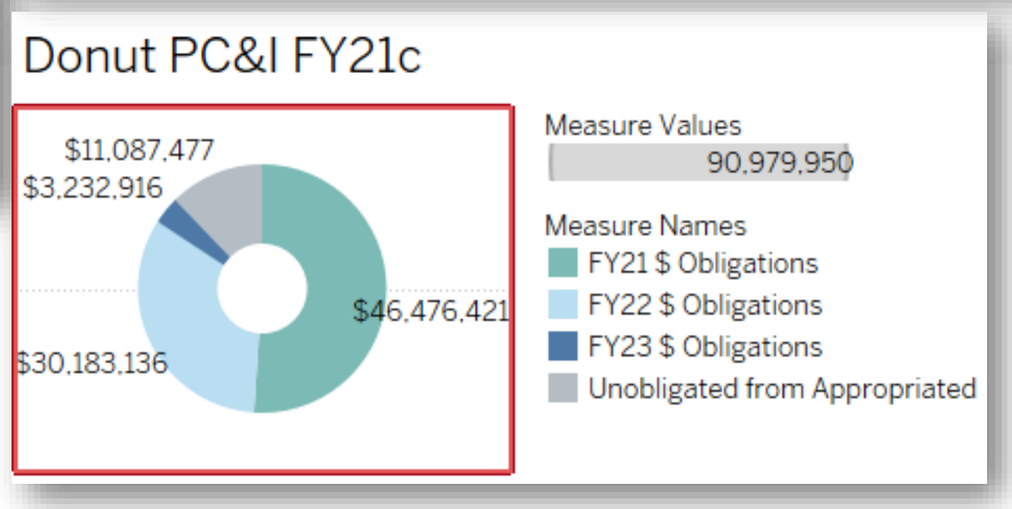
Value Labels: Display values or percentages inside or around the edge of the respective slice. Percentages are preferred for this type of visualization; however, if space is available, providing both values and percentages is useful.

DONUT CHART



PIE CHART





PIE CHARTS CAN SHOW PROPORTIONS OF A WHOLE BUT HAVE FALLEN OUT OF FAVOR.

WHEN TO USE

- Use to quickly show proportions of a whole and are best for percentages or proportions rather than exact numbers.

- Easy for audiences to understand because they are visually simpler than other types of graphs.

DESIGN

- Limit the number of slices to less than five, ideally three.
- Slices should be solid in color (i.e., no patterns).
- Slices should be labeled with category and number in the chart, not in a legend.
- Do not use a 3-D pie chart.
- Make sure all slices add up to 100%.

WHEN NOT TO USE

- Pie charts should not be used if there are many categories or if you want to compare across multiple sets.

- Reconsider using a pie chart if all the slices are similar in proportion with only small differences.

ALTERNATIVES

- Pie charts have fallen out of favor because people have difficulty estimating proportion based on angles, especially when there are more than three slices.

- Donut charts are becoming more popular because it is easier to label the segments. Alternatives to using a pie chart can include tree maps, waffle charts, and percentage bar charts.

DATA VISUALIZATIONS

TREE MAP & PACKED BUBBLE CHART

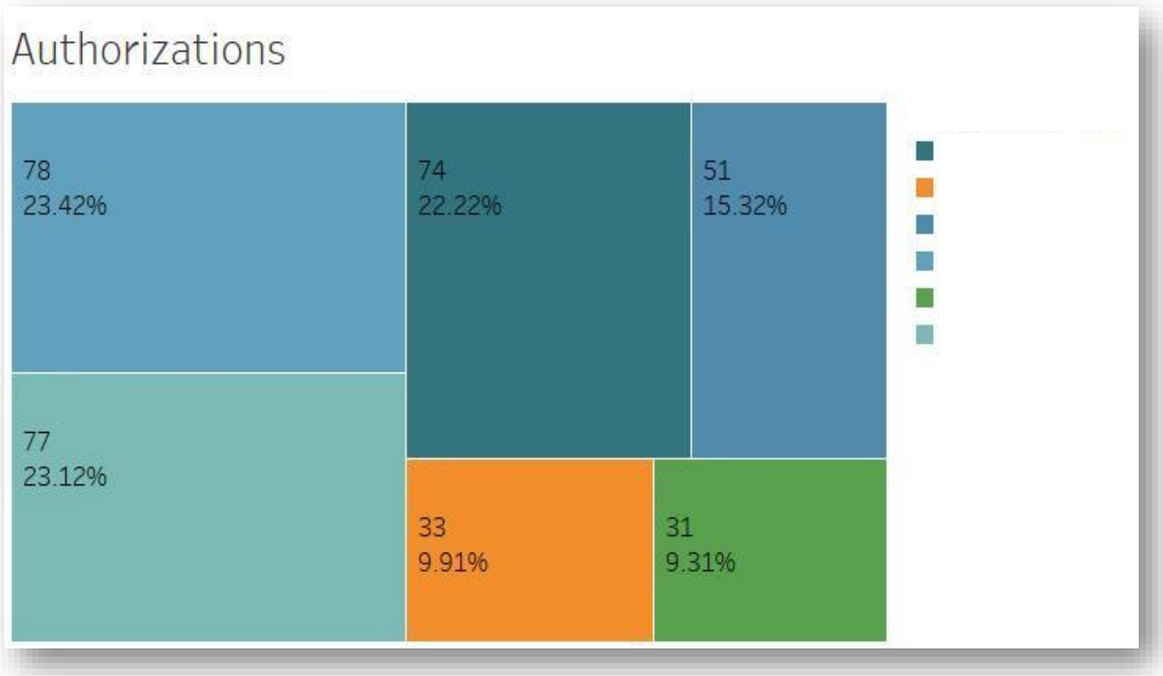
- Tree maps and packed bubble charts display the proportionate value of each data point as an alternative to pie and donut charts.

Value Labels: Values are displayed in respective "slices".

TREE MAP

Rectangles are used to convey relative scale of data points. Percentages are desired, but values are encouraged if there is space and they add meaning.

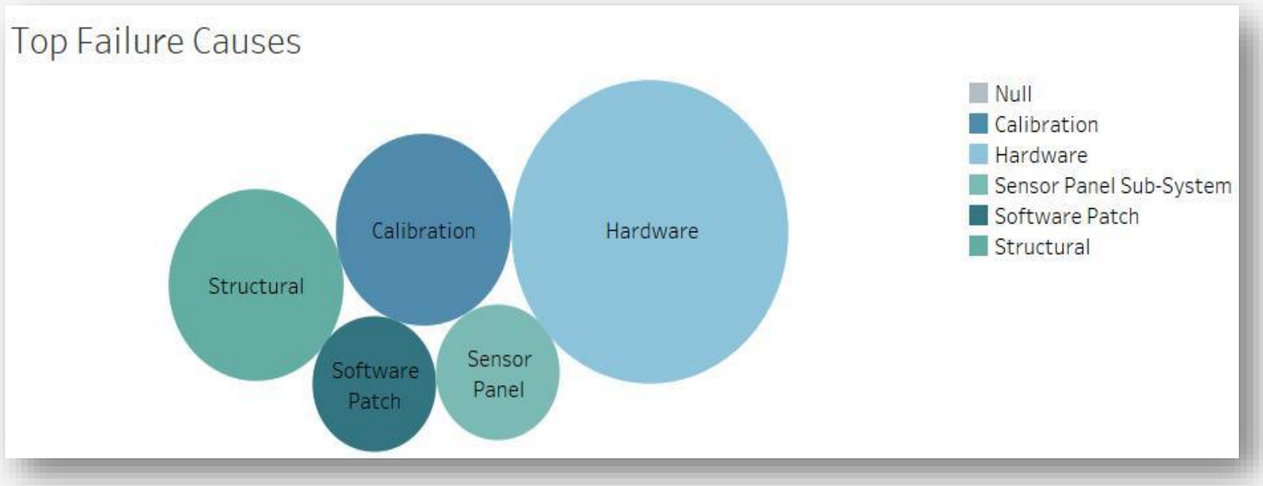
TREE MAP



PACKED BUBBLE CHART

Circles are used to convey relative scale of data points. Numerical values or categories are recommended labels.

PACKED BUBBLE CHART



OTHER TYPES OF PROPORTION CHARTS INCLUDE A TREE MAP, BUBBLE CHART, OR WAFFLE CHART

WHEN TO USE

- Use for percentages or proportions rather than exact numbers.
- Use to easily display complex data and can be used when there are many different categories
- These charts are still easy to read while also being visually interesting and informative for the audience.

DESIGN

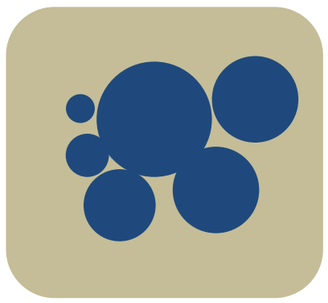
- Make sure the visual has the lowest number of categories feasible.
- Proportions should be solid in color (i.e., no patterns) and easily distinguishable.
- Proportions should be labeled with category and number in the chart, not in a legend.
- Proportion size should be based on area to not distort the data.
- Make sure all proportions add up to 100%.
- If hierarchy of the data is important, consider using a tree map or sunburst chart.

WHEN NOT TO USE

- Reconsider using a proportion chart if you are interested in exact numbers or if it is important to display zero or negative values.

ALTERNATIVES

- The type of proportion chart utilized should align with the type of data and the purpose of the visualization. Each type has its own advantages and disadvantages.



DATA VISUALIZATIONS

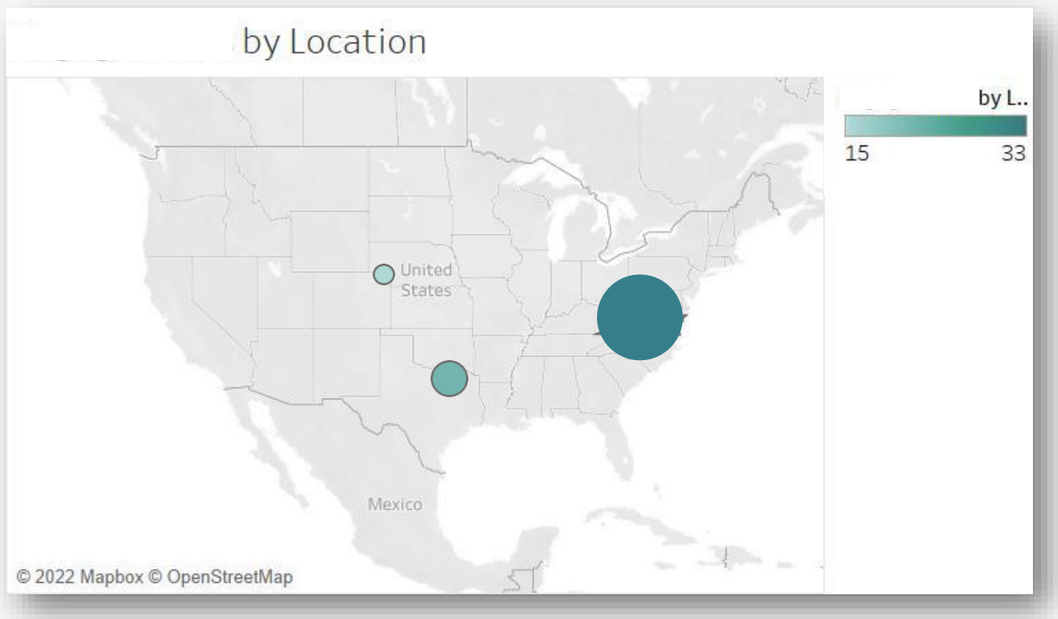
GEOGRAPHICAL MAP

- Geographical maps show location (e.g. states in United States) with colors or bubbles to indicate the location and magnitude of the data.

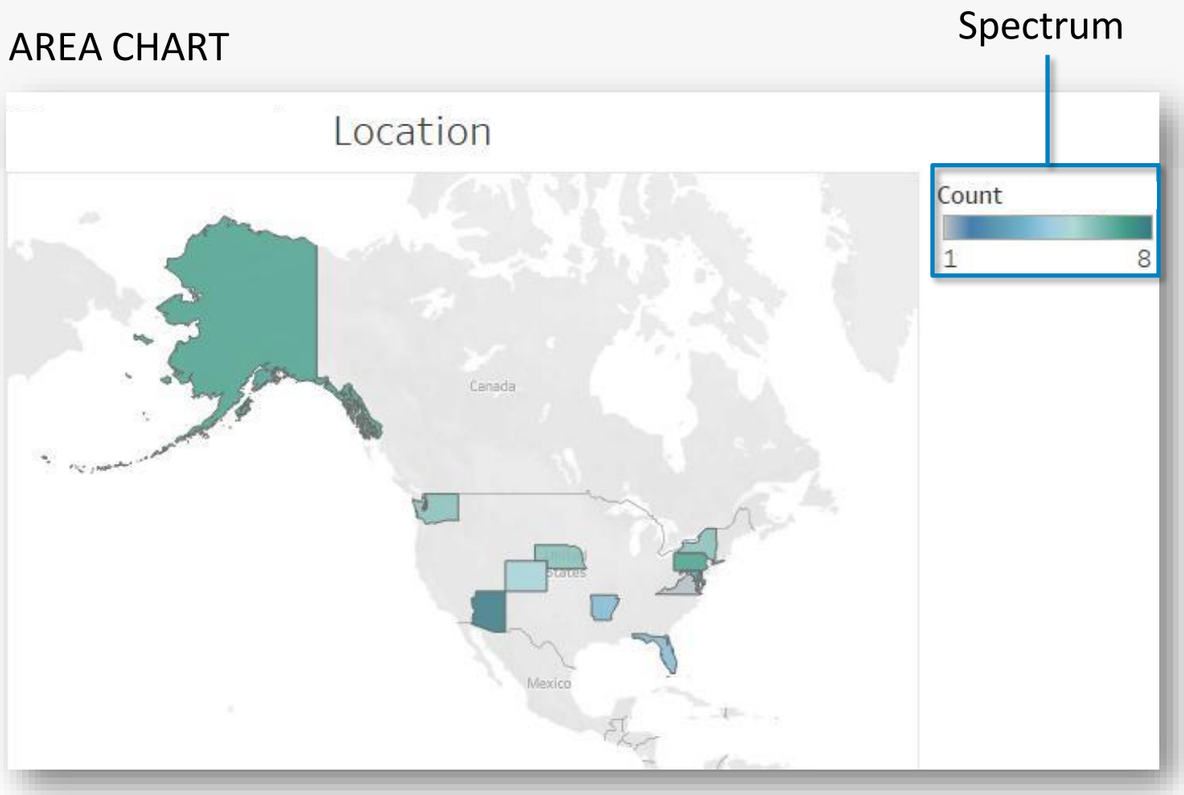
BUBBLE CHART

Bubble charts rely on marker size to convey values. Larger markers and darker colors signify greater values.

BUBBLE CHART



AREA CHART



Spectrum

AREA CHART

Area charts shade the entire geographic location to relay information. The colors are determined by discrete categories or a spectrum – the darker the color, the higher the value.

GEOGRAPHICAL MAPS CAN SHOW THE LOCATION AND MAGNITUDE OF VALUES

WHEN TO USE

- Use when geographical context is required, or data is associated with a population or specific area.
- Use for data that is different for each geographical region.
- Use when the magnitude of a value must be displayed in a specific region.

DESIGN

- Use a color over a specified region to indicate the association between a value and its location.
- Values should be determined by circle area, not circle diameter.
- Clearly label the map for users unfamiliar with the location.
- A darker color signifies a greater magnitude of a value.
- Include a color spectrum or legend to clarifying color meaning.
- Circles can also be used to show a value’s magnitude.

WHEN NOT TO USE

- Do not use geographical maps if the data is not related to locations.
- Reconsider using geographical maps if showing large amounts of variable data.

ALTERNATIVES

- A bar chart with regions labeled in the axes can also be used.

DATA VISUALIZATIONS

LINE GRAPHS

- Line graphs display historical data over time.

Value Labels: Only use labels when critical statistics require specific attention.

Time Markers: If used, time markers should contrast in color and pattern to ensure sufficient differentiation.

LINE GRAPH

LINE CHARTS CAN EASILY SHOW CHANGES TRENDS IN DATA.

WHEN TO USE

- Use to show trends or movements of a value over time, especially when the data is large.
- Use to compare multiple variables over time (recommended less than four variables).
- Since the emphasis of a line chart is on the flow of the data, it is best if both variables are continuous.

DESIGN

- Pick a minimalist style design to prioritize the data (e.g., limit the grid lines when possible).
- Use solid lines to represent the data (i.e., no dashes), preferably with data points.
- Limit the number of lines to 4-5 maximum and use contrasting colors to represent each line.
- Time should run left to right on the x-axis.
- Intervals should be equal on the axes.
- Use an appropriate range on the y-axis to highlight changes in the values. Start the axis at zero if it does not hide trends in data.
- Reconsider a line chart if the lines have significant overlap.
- Be careful that smoothing the line does not distort the data.

WHEN NOT TO USE

- Line charts should not be used if you want to compare different categories at one point (e.g., one time point) or if you have a sparse dataset.

ALTERNATIVES

- A line chart is different than a scatter plot with a regression line. Alternatives to using a line chart can include area charts (or stacked area charts), spark lines or small multiples, or a highlight table.

DATA VISUALIZATIONS

TABLE

- Use tables to display data that needs to be quickly parsed and scanned.
- Alternate rows with the background color (*noted below).

TABLE

Programs

Failure ..	Cost (..	Schedul..	Perform..	Fundin..	Committed..	Expende..	End (PR)	Expiration Dat..	
Sensor ..	Green	Green	Green	Green	Null	$14,880,..	10/1/2027	9/30/2029	
Null	Null	Null	Null	Null	Null	Null	Null	Null	
Null	Green	Yellow	Green	Green	$10,701,055	$8,760,8..	3/31/2021	3/31/2023	
Null	Green	Green	Green	Green	$134,860,0..	Null	10/1/2025	10/1/2027	
Softwa..	Green	Green	Green	Green	$59,415,237	$29,311,..	5/1/2024	5/1/2026	
Null	Green	Green	Green	Green	$55,499,357	$25,799,..	5/1/2024	5/1/2026	
Null	Null	Null	Null	Null	Null	Null	Null	Null	
Null	Null	Null	Null	Null	Null	Null	Null	Null	
Null	Green	Red	Green	Green	$1,925,356	$949,129	8/1/2022	7/31/2024	
Null	Green	Green	Green	Green	$10,468,513	$0	10/1/2024	10/1/2026	
Null	Null	Null	Null	Null	Null	Null	Null	Null	
Null	Null	Null	Null	Null	Null	Null	Null	Null	
Null	Green	Green	Green	Green	$2,570,520	$2,488,1..	8/24/2022	8/23/2024	
Structu..	Null	Null	Null	Null	Null	Null	Null	Null	
Hardw..	Green	Green	Green	Green	$2,086,177	$0	10/1/2023	9/30/2025	
Null	Green	Green	Green	Green	$1,650,000	$317,000	10/1/2026	9/30/2028	
Null	Yellow	Yellow	Green	Green	$8,097,000	$1,440,0..	6/1/2024	6/1/2026	
Null	Null	Null	Null	Null	Null	Null	Null	Null	
Null	Green	Green	Yellow	Green	$89,892,083	$20,728,..	9/1/2033	9/1/2035	
Null	Green	Green	Green	Green	$136,192,8..	$19,857,..	7/1/2022	6/30/2024	
Null	Green	Green	Green	Green	$6,457,431	$2,907,9..	1/1/2022	1/1/2024	
Null	Green	Green	Green	Green	Null	Null	Null	Null	
Calibra..	Null	Null	Null	Null	Null	Null	Null	Null	
Hardw..	Green	Green	Green	Green	Null	Null	Null	Null	
Hardw..	Green	Green	Green	Green	Null	Null	1/1/2018	1/1/2020	
Structu..	Null	Null	Null	Null	Null	Null	Null	Null	
Null	Green	Green	Green	Green	$2,093,000	$209,300	1/1/2017	1/1/2019	
Null	Green	Green	Green	Green	$50,007,064	$6,597,6..	8/1/2022	7/31/2024	
Null	Green	Green	Green	Green	$4,840,000	$4,350,5..	8/1/2021	8/1/2023	
Null	Green	Green	Green	Green	$32,500,000	$0	10/1/2026	9/30/2028	
Null	Green	Green	Green	Green	$372,760,4..	$310,000	3/2/2026	3/1/2028	

Expiration Status
- <1 Mos
- <1 Yr
- <6 Mos
- >1 Yr

STRIPE COLOR

HEX: #F5F5F5 RGB: (245, 245, 245)

DATA VISUALIZATIONS

TABLES CAN BE GREAT FOR SUMMARIZING DATASETS AND OFFERING AN OVERVIEW OF IMPORTANT NUMBERS.

WHEN TO USE

- Use when you are prioritizing exact values over the shape of the data.
- Use to present small datasets that may not contain enough data for robust graphical interpretations.
- Use to consolidate information that is difficult to include in a graph like variables with many different units.

DESIGN

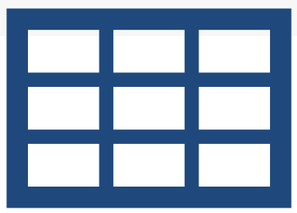
- Pick a minimalist style design to prioritize the data (e.g., limit the distraction of the grid lines).
- Use color sparingly.
- Use visual cues to highlight important information (e.g., shading cells with totals).
- Include reasonable spacing in each cell (i.e., have white space).
- Include column headers and fix them so they are visible when scrolling.
- Be consistent in your formatting (e.g., decimal spaces or units).

WHEN NOT TO USE

- Reconsider using a table if you are interested in the shape of the data or the relationships between variables.

ALTERNATIVES

- A pivot table or a pivot chart can be used to group data into categories. Alternatives to using a table can include a Sankey Diagram or a stacked text chart.



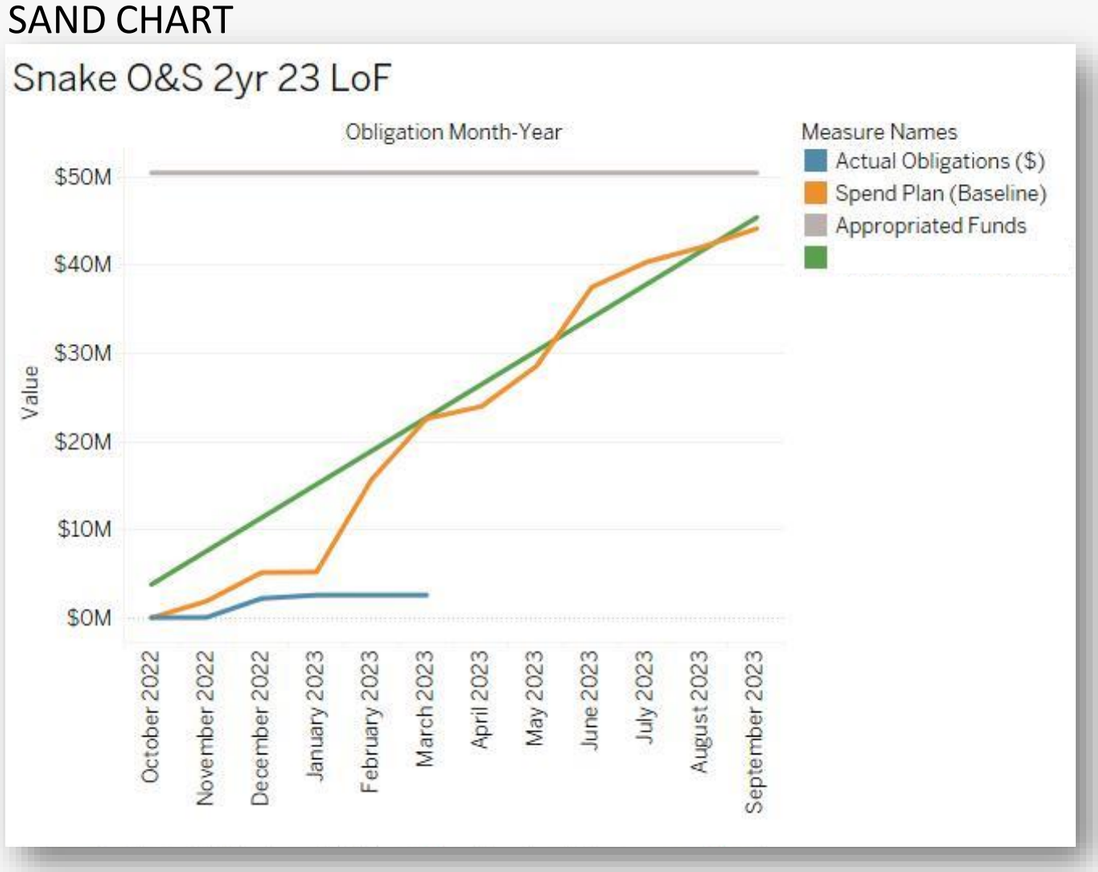
DATA VISUALIZATIONS

SAND CHART

- Sand charts use different colors to compare values and display the magnitude of a trend over time.

- Colors should follow color recommendations.

Value Labels: Label columns with values vertically.



SAND CHARTS ARE GOOD FOR COMPARING DIFFERENT VALUES OVER TIME

WHEN TO USE

- Sand charts are effectively line charts with bars added to show values over time.
- Used for time series data and may or may not be normalized.
- Can also be used to compare groups or show how a whole is divided into component parts.

DESIGN

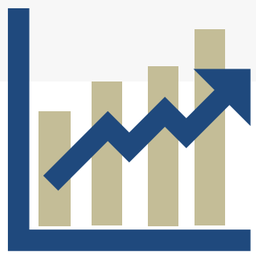
- Use a bars to show data at each time interval.
- Another variable may be displayed inside a larger bar to compare the values
- Use a brightly colored line to indicate a target value or average over time.

WHEN NOT TO USE

- Reconsider using a sand chart if you have many overlapping variables to be displayed in the bars.
- Instead, break up into multiple sand charts or bar charts.

ALTERNATIVES

- A bar chart or line graph can also be used to display data over time intervals



APPENDIX

APPENDIX

This section provides additional information and resources regarding design and human factors principles.

CONTENT

51 CONSOLIDATED HUMAN FACTORS PRINCIPLES

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APPENDIX

CONSOLIDATED HUMAN FACTORS PRINCIPLES

While each set of principles has an individual focus, they are often used in combination to improve data visualization and dashboard design

- GESTALT PRINCIPLES
  Focus on human perception and explains how visual elements are perceived.

- TUFTE'S RECOMMENDATIONS
  Focus on graphical excellence and explains best practices for data visualization development.

- NIELSON'S USABILITY HEURISTICS
  Focus on improving the usability of human-computer interfaces.

- NORMANS'S PRINCIPLES OF DESIGN
  Focus on improving human interaction with designed products.

- FITT'S LAW
  Used to estimate how long it will take and individual to select a target.

- HICK'S LAW
  Used to estimate the relationship between the number of stimuli and a user's response time.

APPENDIX

TUFTE'S RECOMMENDATIONS FOR GRAPHICAL EXCELLENCE

1. SHOW THE DATA WITH GRAPHICAL INTEGRITY
   Good graphs tell an accurate story about the data.

2. HELP THE VIEWER FOCUS ON SUBSTANCE
   Each graph should have a clear purpose.

3. AVOID DISTORTING DATA
   Lie factor = size of the effect shown in the graph / size of the effect in the data.

4. MAXIMIZE THE RATIO OF DATA TO SPACE
   Data Density of a Graphic = Number of Entries in Data Matrix / Area of the Graphic

5. MAKE LARGE DATASETS COHERENT
   The graph should clearly display key factors and insights.

6. ENCOURAGE COMPARISONS
   Many design choices can encourage comparisons like the appropriate use of color.

7. DISPLAY DATA AT VARIOUS LEVELS OF DETAIL
   Modern tools for data visualization can easily allow for drill-down functionalities.

8. APPROPRIATELY SERVE A CLEAR PURPOSE
   Is the graph for description, exploration, tabulation, or decoration?

9. INTEGRATE STATISTICAL AND LANGUAGE DESCRIPTIONS OF DATA
   All descriptions of the data should align and support the same interpretation.

APPENDIX

TUFTE'S RECOMMENDATIONS FOR GRAPHICAL EXCELLENCE

Tufte's Principles define graphical excellence and provide guidelines for graphical integrity and graphical redesign.

GRAPHICAL EXCELLENCE

- Well-designed display of interesting data consisting of substance, statistics, and design.
- Complex ideas are communicated accurately and simply with clarity, precision, and efficiency.
- Leads the viewer to have the greatest number of ideas with the least ink in the smallest space.

GRAPHICAL INTEGRITY

- Representations of numbers should match their true proportions.
- Labels should be clear, detailed, and thorough.
- Graphs should only vary due to variations in the data, not design.
- Use well-known, accurate, and descriptive units.
- The number of represented dimensions should be the same as the number of dimensions in the data.
- Graphs should accurately represent the context of the data.

GRAPHICAL REDESIGN

- Prioritize showing the data. The data should drive the graphical design.
- Maximize the data-ink ratio (maximize the amount of data in each graph).
- Erase non-data-ink (limit the amount of ink devoted to aspects that are not the data).
- Erase redundant data-ink (limit repetitiveness within each graph).
- Revise and edit. Design is a cyclic and iterative process.
- Data-Ink Ratio = data-ink / the graphic's total ink = 1 – the proportion of the graphic that can be erased without loss of data-information

For more information: Tufte, E. R. (1983). *Visual Display of Quantitative Data*. Cheshire, CT: Graphics Press.
Or https://thedoublethink.com/tuftes-principles-for-visualizing-quantitative-information/

APPENDIX

TUFTE'S RECOMMENDATIONS FOR GRAPHICAL EXCELLENCE

Tufte also offers suggestions on aesthetic and technique for data visualizations.

1. GRAPHICAL ELEGANCE
   Elegance is a result of simplistic design and complex data.

2. HIGH-DENSITY GRAPHS
   The data in each graph should be appropriately maximized.

3. UTILIZE SMALL MULTIPLES
   Small versions of the same graph can be used to represent complex or high dimensional data.

4. AVOID CHART-JUNK
   Limit the unnecessary use of graphical or design effects like texture and grids.

5. UTILIZE ALIGNING MODALITIES
   Use words, numbers, and graphics together to tell the story of the data.

6. SIZING CONSISTENCY
   Designs and graphics should utilize balance, proportion, and a relevant scale.

7. APPROPRIATE SIMPLIFICATION
   Data should be displayed at an accessible complexity that accurately represents the data.

8. INCORPORATE A NARRATIVE
   The data, graphics, and design should tell the story of the data.

9. CLEAR PROFESSIONALISM
   The final product should reflect professional quality and be produced with care.

For more information: Tufte, E. R. (1983). *Visual Display of Quantitative Data*. Cheshire, CT: Graphics Press.
Or https://thedoublethink.com/tuftes-principles-for-visualizing-quantitative-information/

APPENDIX

ADDITIONAL GUIDELINES

Some additional guidelines can contribute to the improved usability and aesthetic of an interface (not a comprehensive list)

ALIGNMENT
- Elements in a design should be aligned with one or more elements on natural positions.
- Alignment can help guide users through a design and increase the perceived aesthetic of the design.
- **Example Impact:**
- When there are multiple graphs, designers should consider a grid design.

SYMMETRY
- Design should utilize reflectional, rotational, and translational symmetry.
- Symmetry adds a perception of balance, harmony, stability and beauty to a design.
- **Example Impact:**
- Graphs can be placed to support symmetry across a dashboard.

ORIENTATION SENSITIVITY
- An individual can visually process certain line orientations more quickly and easily than others.
- An individual can better process line orientation differences if they are more than 30 degrees. It is also easier to judge line orientation if the line is closely anchored to a horizontal or vertical line.
- **Example Impact:**
- If the graph requires distinguishing line orientation be conscious of its placement and angle.

For more information: Lidwell, W., Holden, K., & Butler, J. (2010). *Universal Principles of Design*. Beverly, MA: Rockport Publishers.

APPENDIX

ADDITIONAL GUIDELINES

CHUNKING

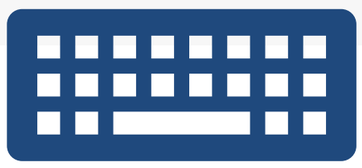
- Chunking should be used when users are required to recall and retain information. It is accepted that people can retain 4 ± 1 units.
- Chunking may be necessary due to the limits of short-term memory.
- **Example Impact:**
- Large strings of numbers are hard to remember but can be remembered more easily if chunked.

PROGRESSIVE DISCLOSURE

- Information should be separated in layers with only pertinent layers being presented at a time. The user should also be able to request additional information easily.
- This reduces clutter in the design and helps prevent the user from becoming overwhelmed.
- **Example Impact:**
- Only details of the data specifically relating to a particular graph are shown at a time.

PERFORMANCE VS PREFERENCE

- The design that is optimal for performance is not necessarily the preferred design.
- Designers must balance performance and preference based on the importance of performance versus preference.
- **Example Impact:**
- People may prefer familiar data formats even if it is not the most effective presentation.



For more information: Lidwell, W., Holden, K., & Butler, J. (2010). *Universal Principles of Design*. Beverly, MA: Rockport Publishers.

APPENDIX

NIELSEN'S 10

1. VISIBILITY OF SYSTEM STATUS
- Keep the user informed of what is happening with appropriate feedback.
- Feedback should be giving in a reasonable amount of time.
- **Example Impact:** Clearly titling graphs and dashboards can help the user orient.

2. MATCH THE SYSTEM TO THE REAL WORLD
- Designs should align with concepts familiar to the user.
- Designs should include language, concepts, icons, and images familiar to the user.
- **Example Impact:** Discipline-specific jargon can be used to communicate clearly to groups of professionals.

3. USER CONTROL AND FREEDOM
- Designs should allow the user to control the system and provide options to backout or undo an action.
- A lack of control can cause users to get stuck and experience frustration.
- **Example Impact:** Including back, undo, and cancel options can help the user navigate.

4. CONSISTENCY AND STANDARDS
- Designs should follow platform and industry conventions.
- Consistency across platforms can aligns with users' expectations and can reduce users' cognitive load and frustration.
- **Example Impact:** Using icons that are common in similar platforms can help the user navigate dashboards and understand graphs.

5. ERROR PREVENTION
- Good designs prevent error and provide important error messages.
- Designs should manage slips (unconscious errors) and mistakes (conscious errors).
- **Example Impact:** Warning your users can help prevent them from making errors.

For more information: Nielsen, J. (1994). Heuristic evaluation. In Nielsen, J., and Mack, R.L. (Eds.), Usability Inspection Methods, John Wiley & Sons, New York, NY.
Or https://www.nngroup.com/articles/ten-usability-heuristics/

APPENDIX

NIELSEN'S 10

6. RECOGNITION RATHER THAN RECALL
- Designs should limit the amount of information that users have to remember.
- Necessary information should be easily available.
- **Example Impact:** Including labels can remind users of important information.

7. FLEXIBILITY AND EFFICIENCY OF USE
- Designs should allow for users to tailor common actions.
- Designs should be flexible enough to allow for novice and expert users.
- **Example Impact:** Providing options for personalization or customizations can improve the experience of users.

8. AESTHETICS AND MINIMALIST DESIGN
- Designs should be focused on essentials and limit clutter.
- Content and features should support the goals of the user.
- **Example Impact:** Removing unnecessary information or design elements can prevent the user from getting distracted.

9. HELP USERS RECOGNIZE, DIAGNOSE, AND RECOVER FROM ERRORS
- Errors should precisely explain the problem in plain language and suggest a solution.
- Designs should make sure that error notifications grab users' attention.
- **Example Impact:** Error messages can pop up in the middle of the screen to grab users' attention.

10. HELP AND DOCUMENTATION
- If designs require additional documentation, it should be easily accessible and clear.
- Extra documentation should be focused on the task, have concrete steps, and concise.
- **Example Impact:** Necessary documentation could should be easy to access or search for.

For more information: Nielsen, J. (1994). Heuristic evaluation. In Nielsen, J., and Mack, R.L. (Eds.), Usability Inspection Methods, John Wiley & Sons, New York, NY.
Or https://www.nngroup.com/articles/ten-usability-heuristics/

APPENDIX

NORMAN'S PRINCIPLES OF DESIGN

These principles can inform better interaction between users and products.

AFFORDANCES
- Designs should have appropriate affordances to make the use of the product intuitive.
- An affordance is the relationship between how an item looks and how it is used.
- **Example Impact:** Using designs with clear buttons can help the user navigate the product easily.

CONSISTENCY
- The design should be consistent throughout the users' complete experience.
- Consistency helps users recognize patterns and prevents them from experiencing frustration.
- **Example Impact:** All graphs should be similarly labeled so users know where to search for important information.

MAPPING
- Designs should have controls that closely match their effect.
- Mapping should be as natural and intuitive as possible.
- **Example Impact:** Using a vertical scroll bar can indicate where the user is on the page and indicate that the page moves down.

CONSTRAINTS
- Constraints should be used to restrict forms of user interaction to simply the interface and guide the user.
- Limitless options or possibilities can cause the user to be confused and overwhelmed.
- **Example Impact:** Limiting the buttons that allow the user to navigate a design can make it easier to navigate the system.

For more information: Norman, Don. (1989). *The design of everyday things.* Doubleday, New York, NY.
Or https://sites.google.com/site/thedesignofeverydaythings/

APPENDIX

NORMAN’S PRINCIPLES OF DESIGN

FEEDBACK

- Designs should incorporate frequent feedback that explains the action that has been taken and the consequence.
- Feedback can take many forms including visual, audio, and tactile.
- **Example Impact:** Changing the color of a clicked button can tell users that the action has been completed.

VISIBILITY

- Designs should clearly display all the users' options and how to access them.
- This is particularly challenging for viewing interfaces on small screens or mobile devices.
- **Example Impact:** Hiding information in a menu bar can cause users to have difficulty finding it.

CONCEPTUAL MODELING

- Designs should display all the information needed for the user to create an accurate conceptual model of the system.
- It is important that users know how to control the system.
- **Example Impact:** New icons or acronyms that are not defined may cause the user to form an inaccurate conceptual model.

For more information: Norman, Don. (1989). *The design of everyday things*. Doubleday, New York, NY.
Or https://sites.google.com/site/thedesignofeverydaythings/

APPENDIX

GESTALT PRINCIPLES

These principles are commonly used to improve UX design and can inform data visualization.

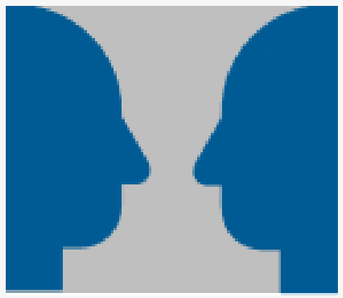
SIMILARITY

- Objects that share similarity are automatically grouped together.
- Common groupings are by size, color, or shape.
- **Example Impact:** Data for the same variable should be consistently one color so it's grouped together by the viewer.

CONTINUITY

- An individual's eye will follow the smoothest path regardless of what is drawn.
- Placing items in a series will help guide the user.
- **Example Impact:** Displaying data that drills down in a series can help the user to see the data in the appropriate order.

CLOSURE



- An individual's brain will fill in missing parts of an image to create a whole.
- Closure is often used in logo design (e.g., WWF).
- **Example Impact:** Displaying a partial or cutoff image can encourage the user to scroll to complete the whole.

PROXIMITY

- An individual's brain will group objects with proximity together.
- Overlap is the strongest proximity. Space between objects can indicate separation.
- **Example Impact:** Putting space between unrelated graphs can help the user to separate them.

FIGURE/GROUND

- An individual's brain will distinguish between foreground and background objects.
- Larger areas are typically considered the background and smaller ones the figure.
- **Example Impact:** Contrast can be used to distinguish important focal points.

APPENDIX

GESTALT PRINCIPLES

SYMMETRY AND ORDER

- An individual's brain will interpret complex or ambiguous shapes in the simplest manner possible.
- Objects that are symmetrical will be perceived as a group.
- **Example Impact:** Symmetry can be used in a design to indicate grouping to the viewer.

COMMON FATE

- An individual's brain will interpret objects moving in the same direction as a group.
- Objects only need to appear to be in motion for this principle to apply.
- **Example Impact:** When drilling down to more detailed data, motion can be used to indicate relevance.

FOCAL POINT

- An individual's attention will be first captured by elements that visually stand out.
- Color, size, shape, asymmetry, and figure/ground can be used to make an item visually stand out.
- **Example Impact:** Important information can be designed to visually stand out to draw a viewer's attention.

CONNECTEDNESS

- An individual will group items that are visually connected.
- Visually connecting items can indicate which items work together.
- **Example Impact:** Visually connecting data/graphs coming from the same source can help the viewer group these items.

COMMON REGION

- An individual will group items enclosed in the same region.
- The items do not have to be visually connected for this principle to apply.
- **Example Impact:** Grouping graphs on different topics in regions can help the viewer to understand which graphs are related.