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Follow My Lead: Designing Accessible Reports by Example Using SAS® Visual Analytics

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ABSTRACT

Your Legal, IT, or Communications department said that your reports must be accessible to people with disabilities. They might have used terms like "Section 508" or "WCAG". Now what? This paper leads you down the path to creating accessible reports by using SAS® Visual Analytics. It includes examples of what to do—and what not to do—to make your reports accessible. It provides information about which types of objects to use and how to use them in order to maximize the accessibility of your reports. You can use the information in this paper to create accessible reports, comply with your organization's accessibility requirements, and enable people with disabilities to benefit from the information that you publish.

INTRODUCTION

Many organizations, whether public or private, must comply with accessibility laws and policies. If you work in such an organization, you might have been asked whether your SAS Visual Analytics reports comply with accessibility standards. You might wonder what these standards are, and how do you comply with them?

Fortunately, you can craft your SAS Visual Analytics reports to comply with the most commonly used technical standard for digital accessibility, which is the *Web Content Accessibility Guidelines*, version 2.0. Also known as WCAG 2.0, this standard is used widely in industry, educational organizations, and governments worldwide. It has these three levels of conformance:

- Level A: basic accessibility features
- Level AA: generally accessible to people with a variety of different abilities (this is the most commonly used level)
- Level AAA: enhanced accessibility

Many national and provincial accessibility laws incorporate WCAG 2.0 AA as their technical standard. For example, both Section 508 in the United States and the Accessibility for Ontarians with Disabilities Act in Ontario, Canada, incorporate WCAG 2.0 AA. Using the information in this paper, you can design SAS Visual Analytics reports that comply with WCAG 2.0 level AA. These are the most important factors that determine compliance:

- The choices you make when authoring a report, such as which types of report objects to use
- The viewer application used to view your report

SAS Visual Analytics 8.3 comes with these four viewer applications:

- SAS Report Viewer: the HTML5 web-based viewer application
- SAS Visual Analytics App for iOS: the native iOS viewer
- SAS Visual Analytics App for Android: the native Android viewer
- SAS Visual Analytics App for Windows: the native Windows 10 viewer

As of the publication date of this paper, SAS Visual Analytics App for iOS has the highest level of accessibility. This is partly due to the iOS operating system itself having a high level of accessibility. iOS devices include an excellent built-in screen reader called VoiceOver. The VoiceOver screen reader, available on iPhones and iPads, is widely used by people who have visual impairments or blindness. SAS Visual Analytics App for iOS has powerful accessibility features, including sonification, which is the ability to present data using sound. For more information about the accessibility features of SAS Visual Analytics App for iOS, see the document *SAS Visual Analytics App 8.35 for iOS: Accessibility Features*.

This paper uses the recommendations in the document *Creating Accessible Reports Using SAS® Visual Analytics 7.4*. While those recommendations cover SAS Visual Analytics version 7.4, this paper is based on SAS Visual Analytics version 8.3.1 and SAS Visual Analytics App for iOS version 8.35. The information described in this paper also generally applies to SAS Visual Analytics 7.4 and later when used with the latest version of SAS Visual Analytics App for iOS.

To comply with WCAG 2.0 AA, follow the recommendations in the document above, along with the suggestions and examples in this paper, and inform the consumers of your reports that SAS Visual Analytics App for iOS offers the most accessible viewing experience.

PREPARATION

Much of the work of creating a report comes in the preparation. Choosing your primary message, identifying your audience, and thoroughly understanding your data are all important steps. This paper covers these topics only to the extent necessary to walk you through the process of creating an accessible report. For more detailed information about these topics, see the 2017 SAS Global Forum paper *Data Can Be Beautiful: Crafting a Compelling Story with SAS® Visual Analytics*. (See the References section of this paper.)

This paper discusses an example report about crime in the town of Cary, North Carolina, where SAS Institute is headquartered. The main objective of the report is to share facts about the town – specifically about crime in the town, though other supporting facts, like population, are included. Most of the data comes from the town itself and requires only minor cleanup. (See the References section of this paper.) The report includes ten years of data, from 2009 to 2018. The report uses these data items:

Category:

- Area: geographic area names, for example, "Walnut Plaza"
- Crime Category: general crime categories, for example, "Larceny"
- Crime Type: specific crime categories, for example, "Larceny – Shoplifting"
- Date: the date the incident began, in MMDDYYYY format, for example, "01/15/2009"
- Day of Week: the day of the week, for example, "Tuesday"
- Larceny + Burglary: a custom category that categorizes crimes as Larceny, Burglary, or Other
- Month: the calendar month, for example, "February"

Geography:

- Location: the latitude and longitude coordinates of the incident

Measure:

- Crimes: the number of police incidents

Aggregated Measure:

- Frequency Percent

The general public is the intended audience for this report. This is a large and diverse audience that includes people with disabilities.

The report tells the story of crime in the town of Cary. Its purpose is to answer several high-level questions:

- How frequently do various types of crimes occur?
- What are the long-term patterns or trends in the crime rate?
- Do certain crimes occur more often on particular days of the week?
- Where do crimes occur?

The report is broken into five sections: an introduction and one section for each of the questions above.

1. Intro: basic facts about the town (such as population, cost of living, and median income) along with a table of contents
2. Crime Types: the most prevalent types of crime along with a sidebar about larceny
3. Long-Term Trends: crimes over the 10-year period of the data, plus a repeating seasonal pattern
4. Day of Week: crimes by day of week, plus a weekly pattern
5. Geographic Area: crimes by area within the town, including locations plotted on a map

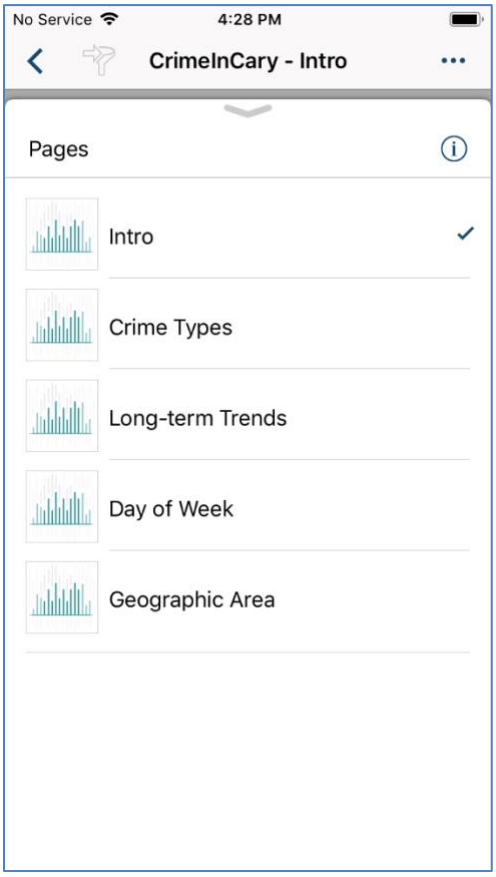

Figure 1: Pages in the Crime in Cary Example Report

OBJECTS

The set of objects you use to build your report greatly affects its accessibility. Choose objects that the paper *Creating Accessible Reports Using SAS® Visual Analytics 7.4* identifies as being accessible, and then use those objects in accessible ways as described here.

The example report uses a variety of objects:

- List Table

- Bar Chart
- Geo Map
- Line Chart
- Pie Chart
- Time Series plot
- Drop-down list
- Standard Container
- Text

The accessibility of each of these objects, with the exception of Standard Container, is described in *Creating Accessible Reports Using SAS® Visual Analytics 7.4*. Using a Standard Container generally does not affect report accessibility. In addition, the Drop-down List object is fully compliant with WCAG 2.0 AA.

TEXT

The Intro page of the example report makes heavy use of text objects – in fact, those are the only objects in the page.

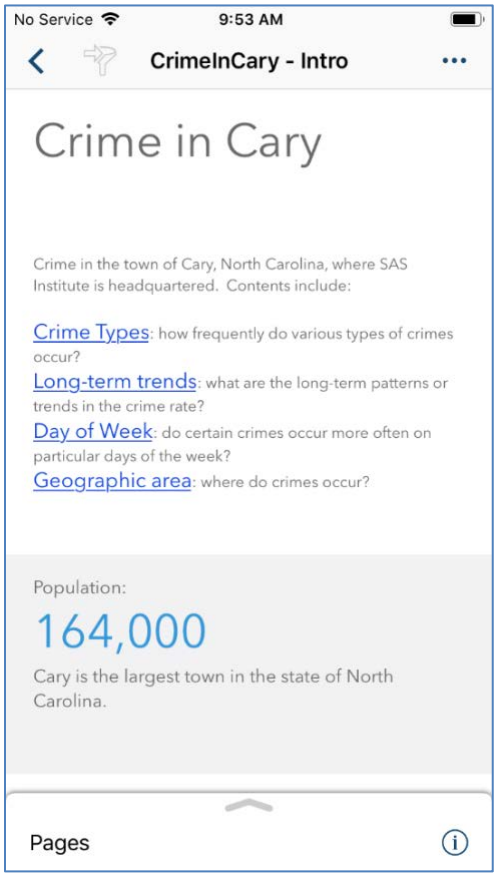

Figure 2: Intro Page of the Crime in Cary Report

By default, text objects comply with WCAG 2.0 AA. Users with disabilities can generally use and understand text objects. However, it's still possible to introduce accessibility problems that can cause the object not to meet WCAG 2.0 AA. An example is selecting a background

color that has insufficient contrast with foreground text. Compare the two objects in Figures 3 and 4 – one of them passes minimum contrast requirements and one does not.

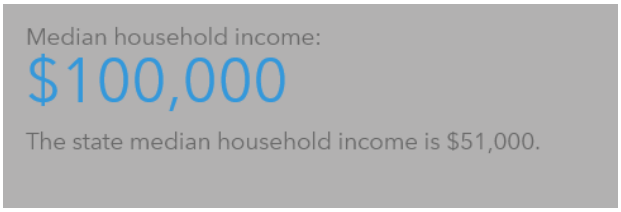

Figure 3: Text With Poor Contrast

Figure 4: Text With Sufficient Contrast

Use default colors to create objects that generally have sufficient contrast. Although SAS Visual Analytics App for iOS includes a theme override feature that allows users to override the colors and styles in your report with a high contrast theme, not all users will be aware of, or want to use, this option. It is best to choose colors that pass the WCAG guidelines for minimum contrast. For more information, see *Contrast (Minimum)*, WCAG Success Criterion 1.4.3.

You could also introduce formatting that conveys meaning in a way that is not accessible. Colors used in text objects cannot be perceived by users of the VoiceOver screen reader, and people with color deficient vision might not be able to perceive the colors either. However, this is generally not a problem if you follow these guidelines:

- Your use of color is decorative – that is, color is not used to convey meaning.
- You use both color and something else that is accessible to convey the same meaning.

For example, in the text object in Figure 5, color is used decoratively. You do not need the color to understand all of the information presented.

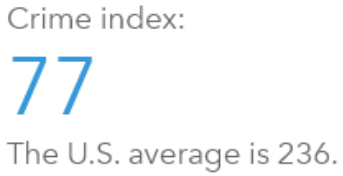

Figure 5: Color Used Decoratively in a Text Object

Instead of using the decorative color in Figure 5, suppose you decided to color the Cary crime index value green if it is below the U.S. average or red if it's above the U.S. average, as shown in Figure 6.

Figure 6: Color Used to Convey Meaning in a Text Object

This use of color to convey meaning prevents people with visual impairments that affect perception of color or contrast from understanding the data in the object. It also prevents your report from complying with WCAG 2.0 AA. Because color is the only way to tell whether the Cary crime index is above or below the U.S. average, people with such visual impairments might not be able to perceive this information.

BAR CHART

The main objects in both the Crime Types and Day of Week pages of the example report are bar charts. The Crime Types page uses a horizontal bar chart showing the most common crimes by type. The Day of Week page uses a vertical bar chart showing the number of crimes by day of week.

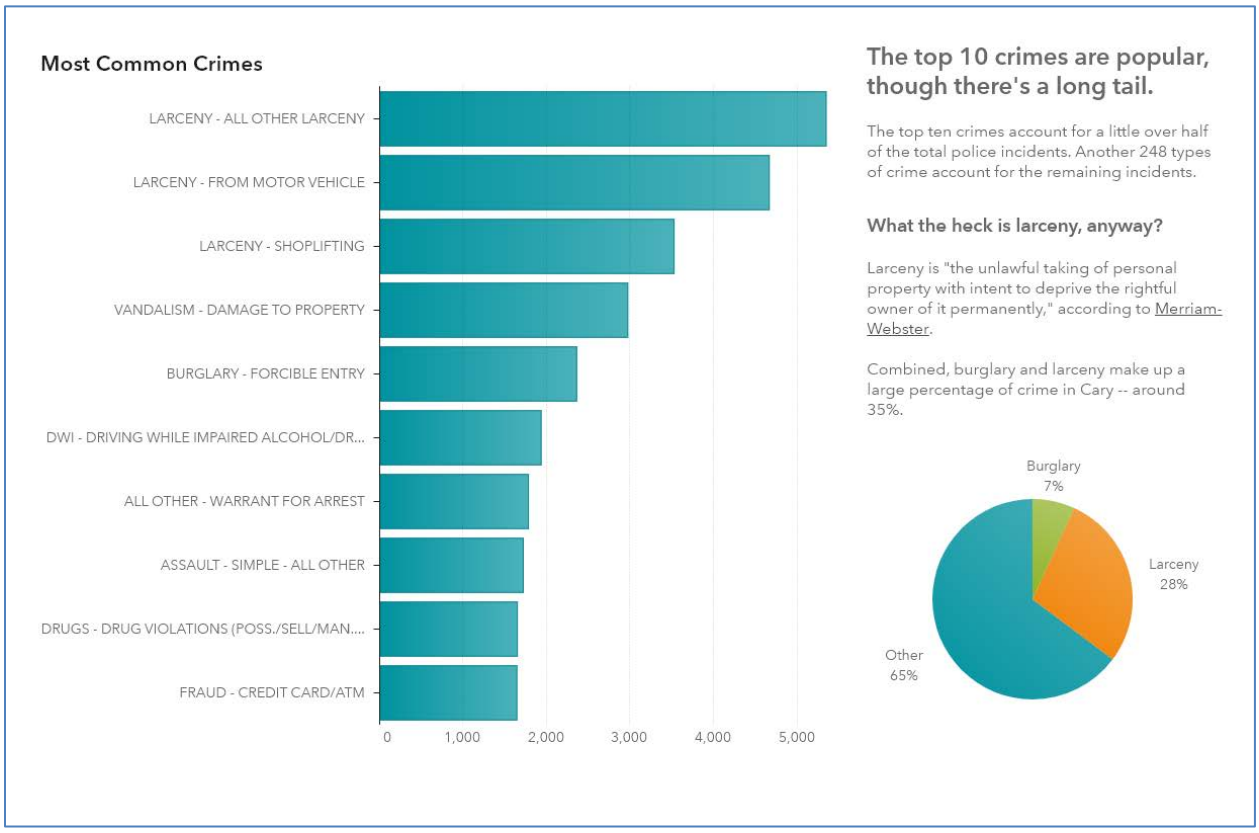

Figure 7: Crime Types Page, Bar Chart of the Most Common Crimes

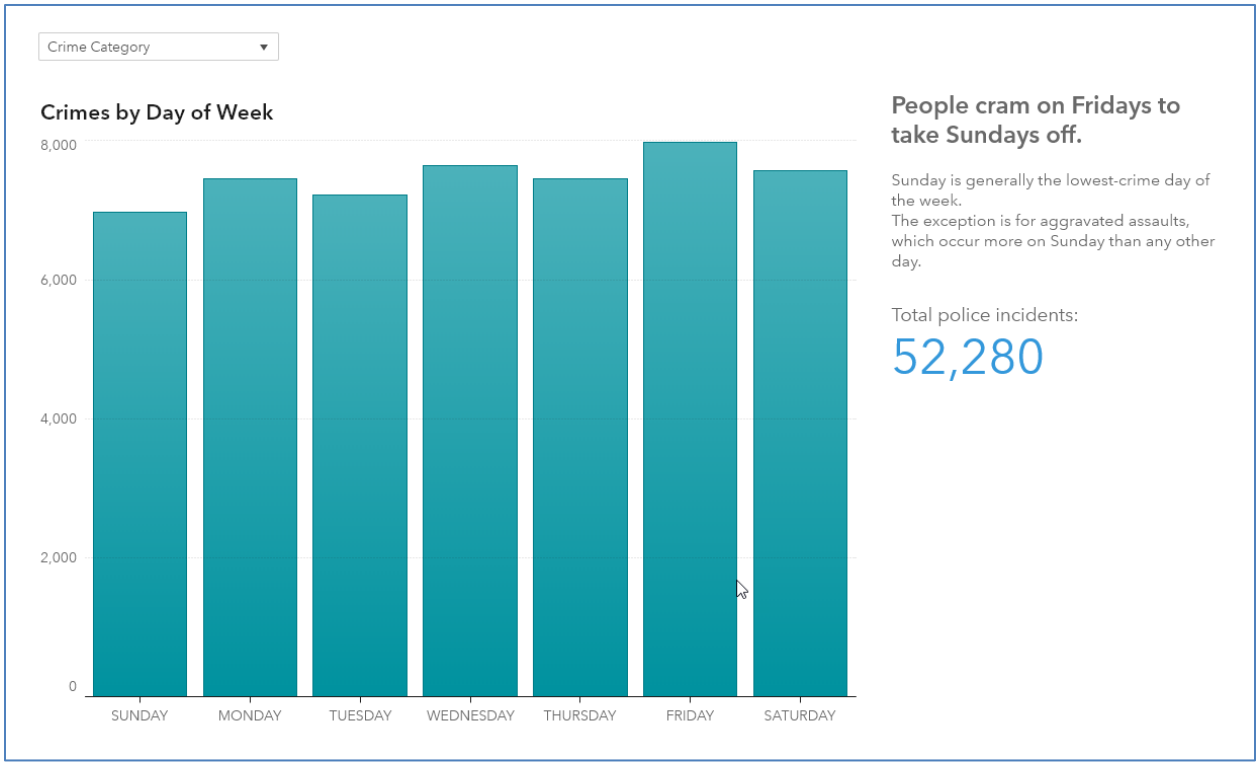

Figure 8: Day of Week Page, Bar Chart of Crimes by Day of Week

While bar charts comply with WCAG 2.0 AA by default, it's important to avoid using them in ways that cause them not to comply. Both of the bar charts in Figure 7 and 8 use a single measure and they both avoid grouping. That's good, because as of the publication date of this paper, including multiple measures or grouping in a SAS Visual Analytics bar chart prevents it from complying with WCAG 2.0 AA. Charts with these features would be non-compliant because SAS Visual Analytics distinguishes groups and measures from one another using color alone, rather than using color in addition to another feature such as a fill pattern.

One way to work around this issue is to use filtering instead of grouping. Suppose that you wanted to show the prevalence of crimes by day of week, grouped by crime category, as in Figure 9.

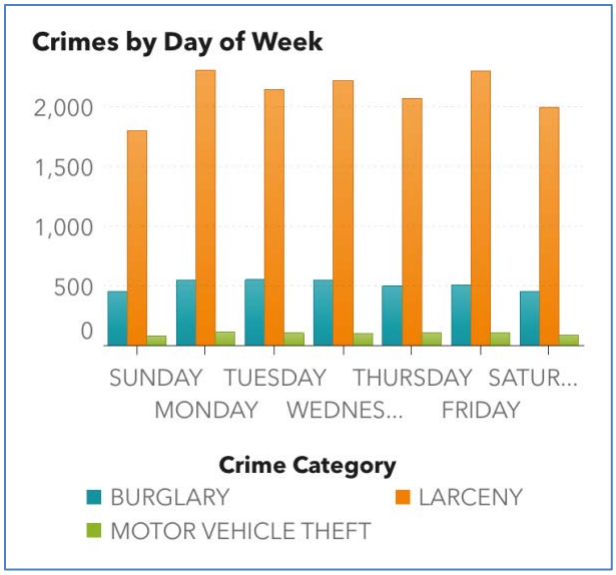

Figure 9: Grouped Bar Chart Using Only Color to Distinguish Groups

This chart can be difficult or impossible for someone with color deficient vision to understand, because the chart uses only color to distinguish one group from another. Instead, you could show a non-grouped bar chart, and let the person viewing your report choose the crime category using a filter, as in Figure 10.

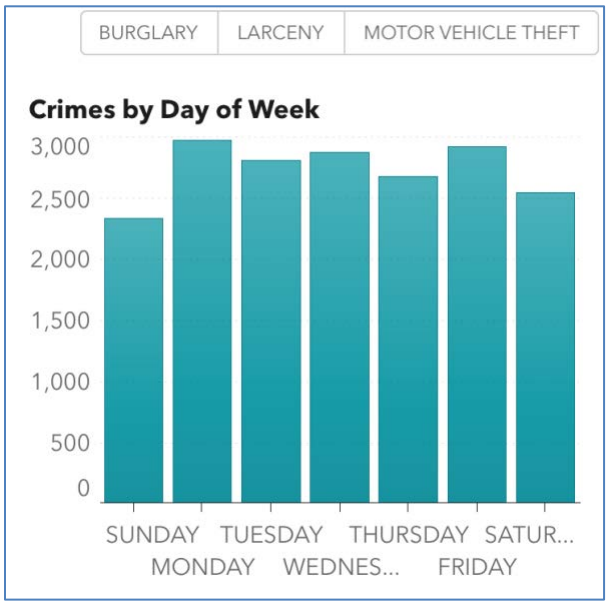

Figure 10: Bar Chart Using a Filter Instead of Grouping

While this technique might not work perfectly for all types of data, it's effective in many situations to avoid the problem of using color alone to distinguish between groups. In a future release of SAS Visual Analytics, SAS plans to introduce fill patterns for bar charts that include groups or multiple measures.

PIE CHART

Pie charts can be used in ways that comply with WCAG 2.0 AA. In general, pie charts are best used under these criteria:

- You want to emphasize the relationship between the size of a slice and the size of the whole pie.
- You have a very small number of slices (no more than three). (Gabrielle)

For example, Figure 11 illustrates appropriate data to show in a pie chart.

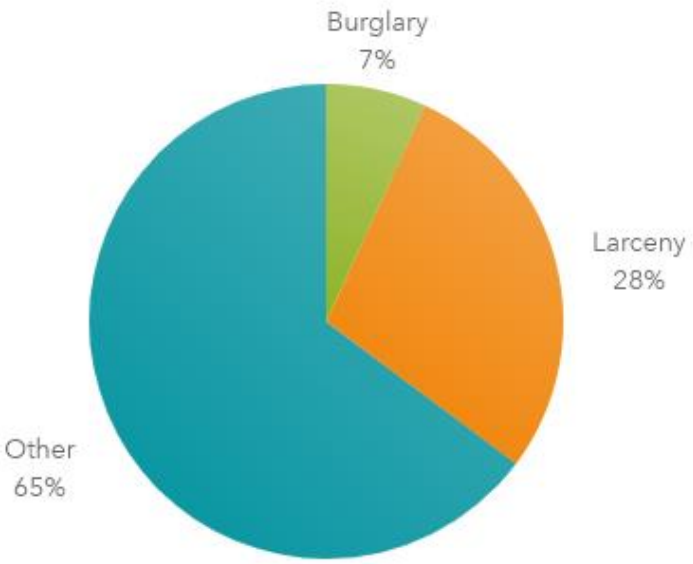

Figure 11: Pie Chart Using Color and Other Factors to Convey Meaning

While this pie chart uses color to convey meaning, it does not use color alone. To illustrate this point, try to understand the black-and-white version of the pie chart in Figure 12 (which can look quite a lot like the color version in Figure 11, if you've printed this paper on a black-and-white printer).

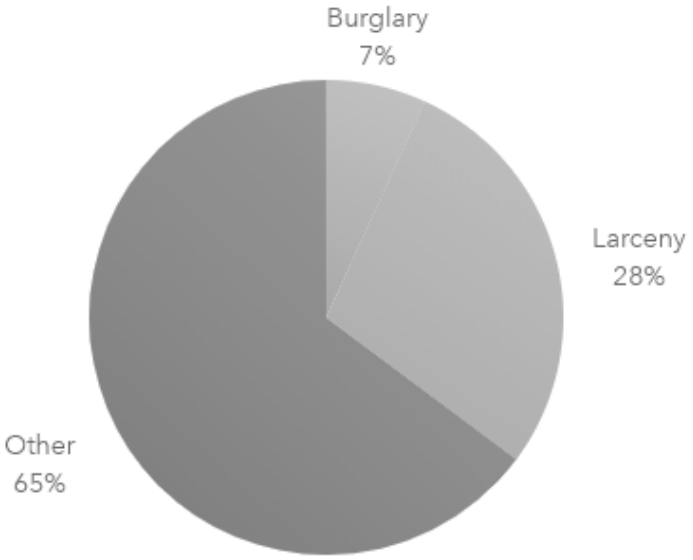

Figure 12: Pie Chart Still Understandable Without Color

You'll probably have no trouble understanding the pie chart in Figure 12, even though it's in black-and-white. In fact, you don't even need to be able to see the slices to glean the information from this pie chart, because the categories and their values are printed in the labels, which are sufficient on their own.

To make a pie chart comply with WCAG 2.0 AA, enable the Category labels and Actual values options. and set Data label location to Outside, in the pie chart object's properties.

TIME SERIES PLOT AND LINE CHART

The Long-Term Trends section of the example report uses both Time Series Plot objects and Line Chart objects. These two types of objects are very similar when it comes to accessibility, so this paper addresses them together. Both the Time Series Plot and Line Chart comply with WCAG 2.0 AA as used in the example report, and these objects are generally good choices for accessibility. However, as with most objects, it's possible to use these objects in ways that don't comply.

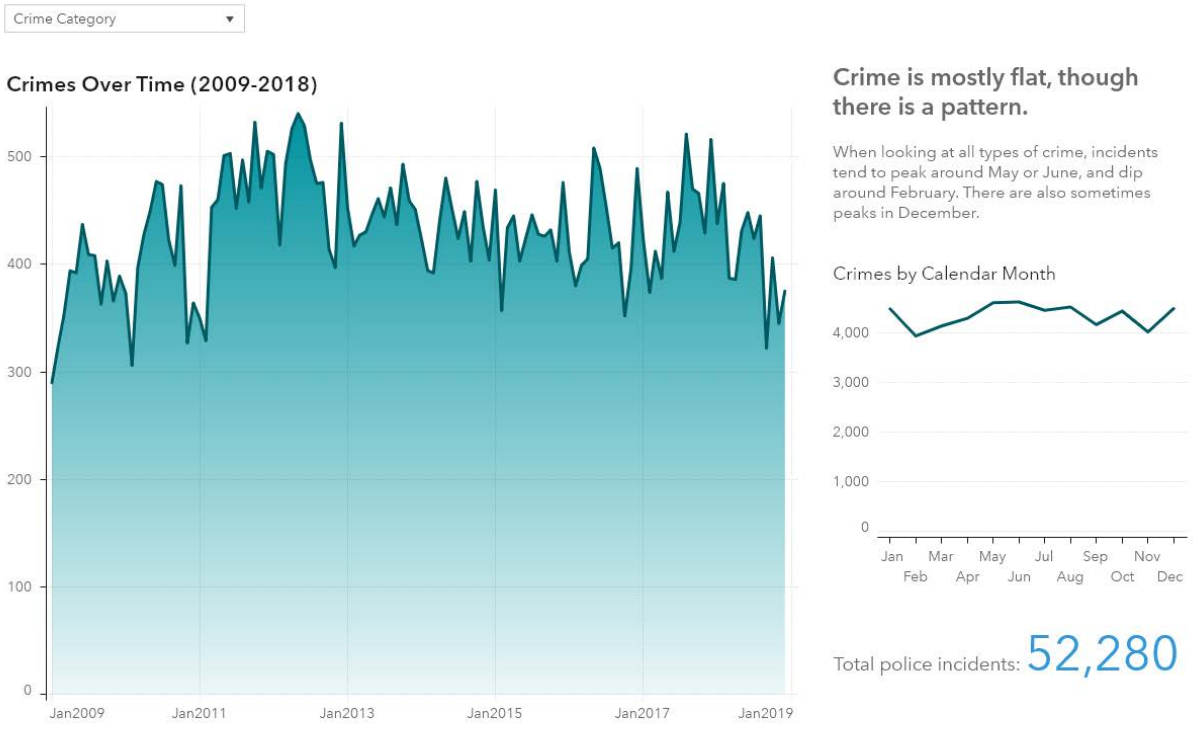

Figure 13: The Long-term Trends Page

As with bar charts, it's important to avoid using only color to convey meaning in line charts and time series plots. This matters when you are using one of these objects to display multiple measures, or when you're using grouping. Luckily, with both line charts and time series plots, there's an easy option to bring grouped charts or charts with multiple measures into compliance. Compare the three charts in Figures 14, 15, and 16.

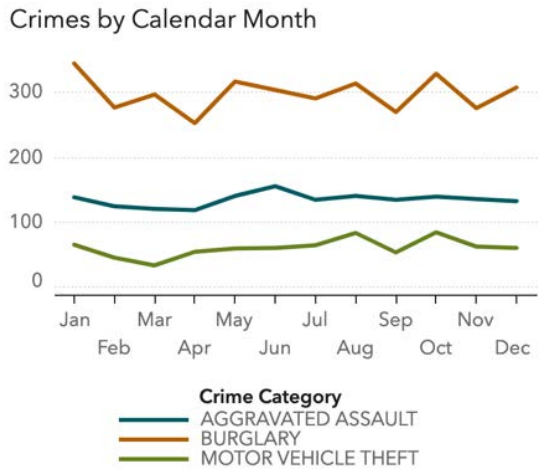

Figure 14: Chart Using Only Color to Distinguish Lines

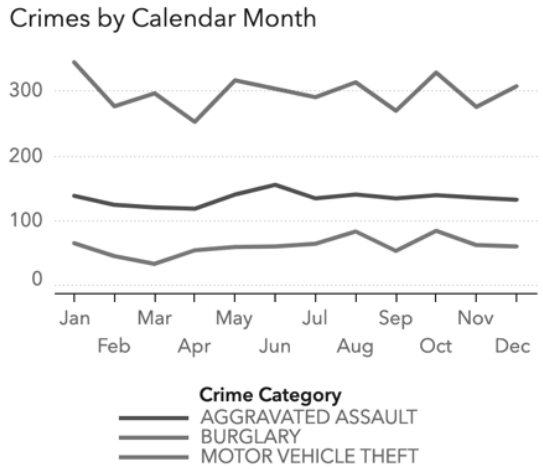

Figure 15: Chart From Figure 14, Without Color

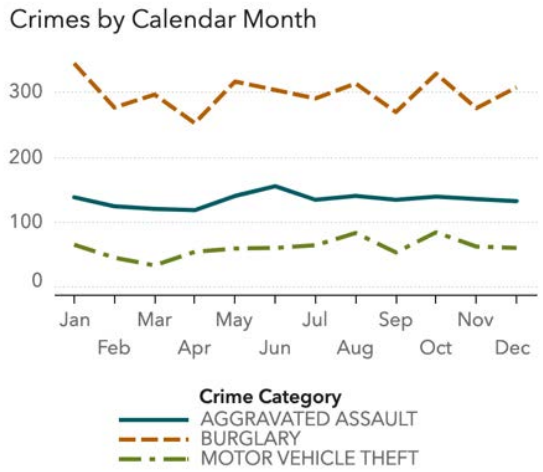

Figure 16: Chart from Figure 14, Using Both Color and Line Pattern to Distinguish Lines

Figure 14 shows a time series chart using color alone to convey meaning. Each line in the chart is color coded, and you must be able to perceive color to distinguish one line from another.

Figure 15 shows the same chart in gray scale. This is what the image looks like without any color. Note that it's essentially impossible to distinguish one line from another. This figure simulates the experience of someone with no color perception.

Figure 16 shows the same chart with both color and line patterns used to distinguish one line from another. This is the best of both worlds. People with good color perception can still use color to distinguish one line from another, while people with color deficient vision can still tell one line from another by using the pattern. As a bonus, we've also improved the usability of the chart for anyone who prints it on a black-and-white printer.

To achieve this effect of using both color and line pattern in line charts and time series charts, set the report-level option Data element style rotation to Rotate all attributes. Note that this option applies to SAS Visual Analytics 8.3 and later. SAS Visual Analytics 7.4 and later uses object-level options to achieve similar effects.

GEO MAP

The central object in the Geographic Area section of the example report is a Geo Map object. Geo maps are complex objects with many accessibility considerations. While it is possible to use geo maps in ways that are compliant with WCAG 2.0 AA, doing so limits the functionality of the geo maps. For example, as of the writing of this paper, any geo map that shows a background image, including the geo map used in the example report, does not comply with WCAG 2.0 AA. A reason for this non-compliance is insufficient contrast between various elements of the background (such as insufficient contrast of the text for place names against their background colors). There can be other reasons that geo maps are not compliant. Geo maps do not respect some accessibility settings such as dynamic text (increased text size) on iOS or the use of a high contrast report theme.

However, it is still possible to use geo maps in your report and maintain overall compliance for the report by presenting the same information in another type of object that is accessible. You can do this because WCAG 2.0 allows for inaccessible content if there is an accessible alternative representation of the same content.

The Geographic Area page of the example report shows information about the geographic distribution of police incidents in two forms: a geo map and a list table. The information in the list table essentially duplicates the information in the geo map. This is useful not only to people with disabilities, who might have an easier time accessing the information in list table form, but to people without disabilities as well. It allows everyone to answer questions such as, "which neighborhoods have the greatest number of crimes?"

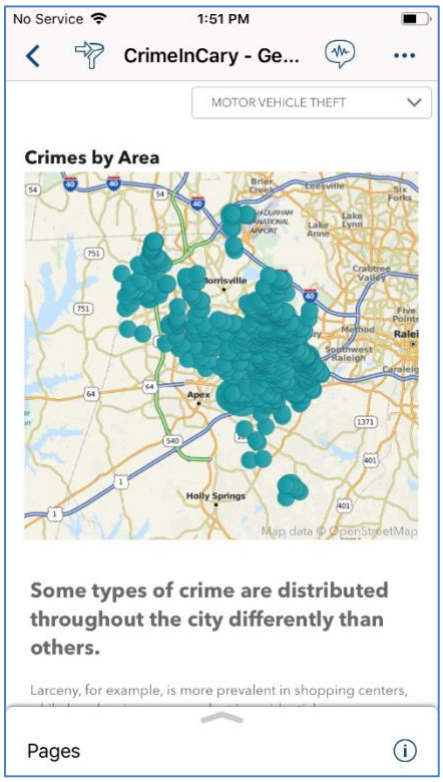

Figure 17: Crimes by Area Geo Map

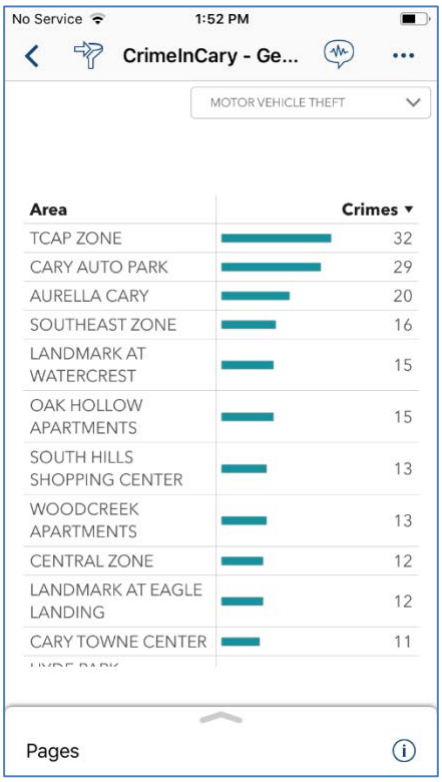

Figure 18: Crimes by Area List Table

LIST TABLE

List tables comply with WCAG 2.0 AA. Other than avoiding certain options mentioned in the Universal Considerations section of this paper, there is nothing that you need to do to ensure that list tables remain compliant. In fact, list tables are a useful way to present information in an alternative, accessible form when you want to use an object that has accessibility issues, as in the geo map example shown above. You can use this same technique of duplicating information in a list table when you want to use other object types that are less accessible.

ACCESSIBILITY OF OTHER TYPES OF OBJECTS

The types of objects mentioned in this paper include excellent integrated accessibility such that you generally do not need to represent the same data in another more accessible form. If you create reports that include types of objects not mentioned in this paper or in the document *Creating Accessible Reports Using SAS® Visual Analytics 7.4*, you should consider those objects to be inaccessible. In this case, you should also include their content in another, more accessible form, such as a list table.

In future releases of SAS Visual Analytics, SAS plans to expand the set of known-accessible objects and publish updated guidance about creating accessible reports.

UNIVERSAL CONSIDERATIONS

OBJECT NAMES OR TITLES

Give every object in your report either a meaningful visible title, or a meaningful object name. This is important because screen reader users rely on object names and titles to identify objects. As of the publication of this paper, VoiceOver identifies report objects in these ways:

- If there is a visible title for the object, VoiceOver announces the title.
- If there is no visible title for the object, VoiceOver announces the object name.

Meaningful names should convey the purpose of the object and the data that it presents. The names do not need to include the object type, because VoiceOver communicates the object type to screen reader users. The example report includes visible titles for most graph objects, such as Most Common Crimes and Crimes by Calendar Month. Objects that don't include a visible title include a meaningful object name.

SENSORY CHARACTERISTICS IN TEXT

Avoid using sensory characteristics such as shape, size, color, or position, as the sole identifying information in descriptive or instructional text within your report. Screen reader users and others might not have access to these characteristics. For example, suppose you included this description of a chart in a Text object (as illustrated in Figure 19):

"As you can see from the green line marked with dots and long dashes, some types of crime dip in the colder months of January, February and especially March."

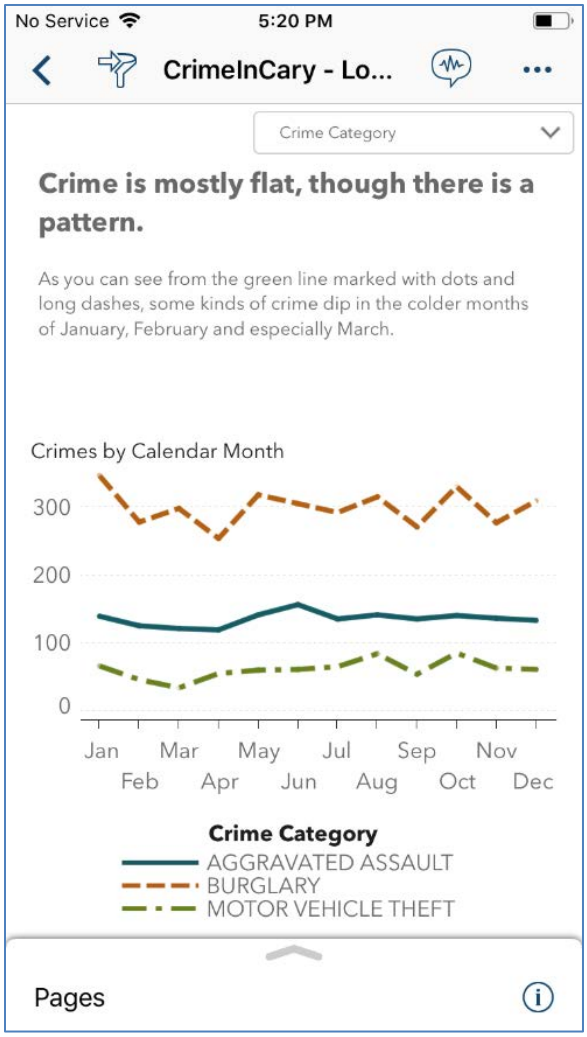

Figure 19: Sensory Characteristics Used in a Problematic Way

Even though people with color deficient vision can understand this description, it still presents a problem for screen reader users, who can only tell that a line called Motor Vehicle Theft exists. They cannot tell that the line is green, or that it is formed with dots and longer dashes. A better description would simply use the name of the line, or more generally, use the name of the element or object being referred to. It's okay to include sensory characteristics along with more accessible identifying information. For example, you can include text such as these examples:

- "As you can see in the Crimes Over Time chart on the left…"
- "…in the Motor Vehicle Theft line, shown in green, you'll notice a dip in March."

In both descriptions, the sensory characteristic supplements non-sensory identifying information.

INTERACTIONS

As of the publication of this paper, SAS Visual Analytics App for iOS does not supply information to VoiceOver users about interactions between objects. This can make it difficult for VoiceOver users to discover interactions such as filtering and linking. To work around this limitation, you can use a Text object to note and explain interactions between objects in

your reports. For example, the Geographic Area section of the example report includes a list table that filters a geo map. The instructions in the text object include a note indicating that you can select an area listed in the table in order to see police incidents in that area on the map.

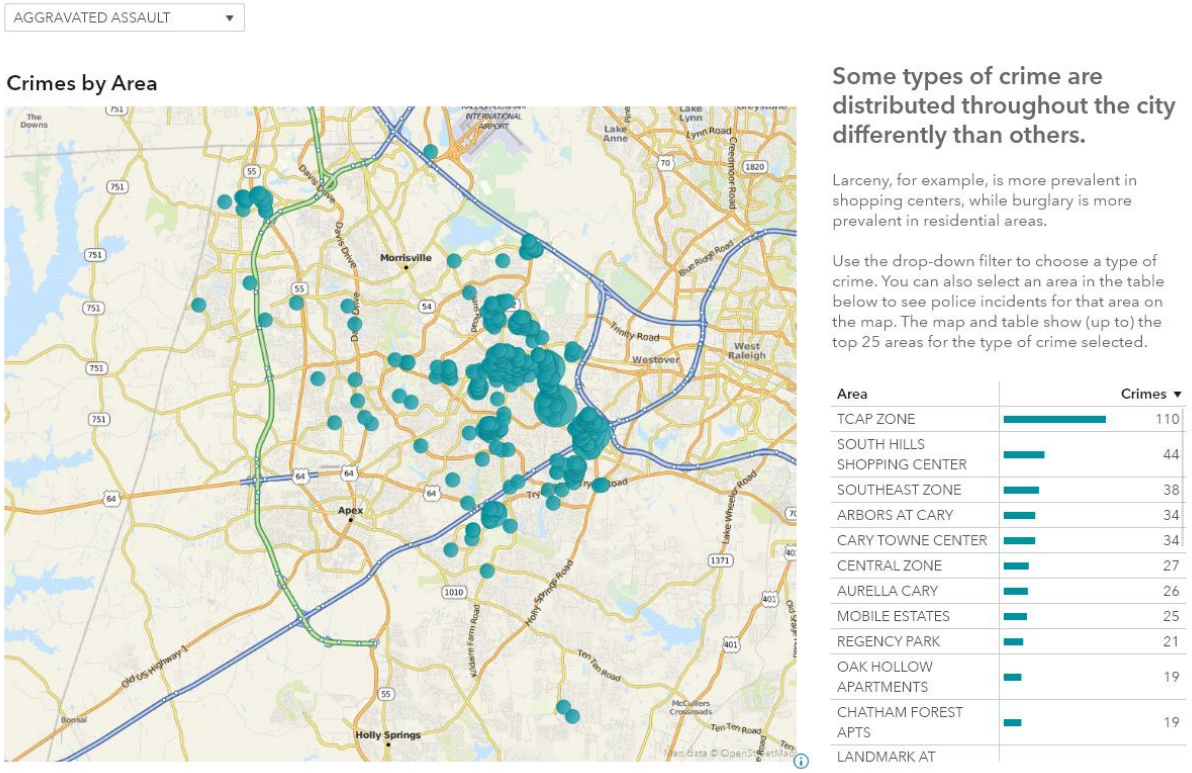

Figure 20: Text Instructions Identify Filtering Relationship Between the List Table and Geo Map

You should also avoid complex chains of interactions that are difficult to explain in order to make your reports easier for everyone to use, regardless of their ability.

DATA ELEMENT STYLE ROTATION

As mentioned in the section on Time Series Plots and Line Charts, to increase accessibility you should turn on the Data Element Style Rotation report-level option. This option causes certain chart types, including line charts, time series plots, scatter plots, and needle plots, to use either line pattern or point shapes to distinguish one group or measure from another. In the future, SAS plans to expand this option to cover more chart types.

AVOID FEATURES THAT DON'T COMPLY WITH WCAG 2.0 AA

As of the publication of this paper, these features do not comply with WCAG 2.0 AA and should be avoided:

- Display rules
- Brushing
- Overview axes
- Lattice columns and lattice rows
- Animation

- Reference lines

If you need to use one or more of these features, consider that section of your report to be inaccessible. Include the same information in a more accessible form elsewhere within your report.

CONCLUSION

By following the examples and suggestions in this paper, you can make your reports comply with WCAG 2.0 AA, which is the most widely used technical standard for digital accessibility. Complying with this standard not only helps your organization meet its legal or policy requirements, but also allows people with disabilities to access your reports. Compliance also makes your reports easier for everyone to use and understand, regardless of their abilities.

SAS is actively improving the accessibility of SAS Visual Analytics. The information in this paper is current as of the publication date. For the most up-to-date information on the accessibility of SAS Visual Analytics, see *Creating Accessible Reports Using SAS® Visual Analytics 7.4*. SAS also plans to publish a similar document for other recent versions of SAS Visual Analytics.

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RECOMMENDED READING

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