Accessible Charts:
Extending AChart

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Abstract

This report elaborates on extensions to the AChart suite, comprising AChart Creator and AChart Interpreter, made by Group 1 of the Information Visualisation course of 2021. These changes also include proposals for new SVG annotation roles and structures. For a better understanding of the domain also a short summary of the ARIA standard with all the rules, roles and properties, as well as different annotation types is given. Lastly, this report gives a deeper insight into how charts are turned into accessible charts by using AChart Creator and AChart Interpreter.

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Chapter 1

Web Accessibility

Web accessibility, also sometimes known as “web a11y” (“11” represents the eleven characters between the starting “a” and the ending “y”), describes the conglomerate of efforts to make the web accessible for people with disabilities, like blindness and color-blindness. This includes web content ranging from web user interfaces through infographics to text. However, not only people with disabilities benefit from web a11y. The target group ranges from elderly people, through people using a slow internet connection to people simply using mobile devices. Access to information and communication technologies is defined as a human right by the United Nations and web a11y is even required by law in many situations [W3C 2021a]. To achieve a more accessible web, different standards emerged.

The web browser maintains two parallel internal data structures: the DOM Tree and the Accessibility Tree. In fact, the Accessibility Tree is a subset of the flattened DOM Tree. This subset is used to track user interface objects of the web browser and the objects of the current document. Accessible objects are created in the Accessibility Tree for every DOM element that can be handled by an assistive technology.

The Accessibility Tree can be inspected using a web browser’s development tools. In Google Chrome, for example, it can be viewed by right-clicking on a web page and then selecting Inspect. In this window, where all the inspection areas are open, you can select Accessibility, which can be found in the lower inspection section right next to Properties. The result is shown in Figure 1.1.

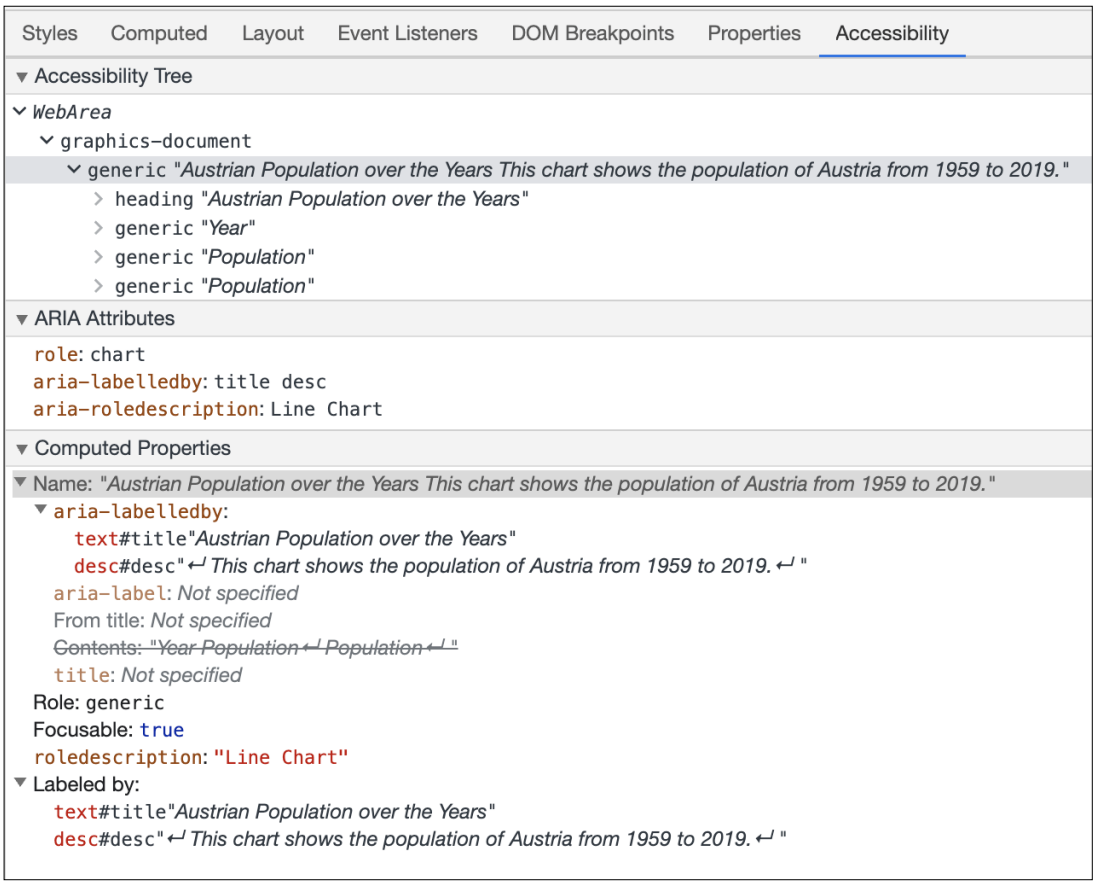

Figure 1.1: Google Chrome showing the Accessibility Tree, ARIA Attributes, and Computed Properties. [Screenshot captured by Markus Stradner using Google Chrome.]

Chapter 2

WAI and ARIA

Accessible Rich Internet Applications (ARIA) [W3C 2021c] emerged from the Web Accessibility Initiative (WAI) [W3C 2021b] of the World Wide Web Consortium (W3C) [W3C 2021a]. ARIA consists of a set of rules, roles, and properties, and provides semantics, especially for dynamic content. As some parts of websites are not usable for some people who, for example, rely on screen readers, WAI-ARIA provides the developers with tools to make web content accessible for people with disabilities.

2.1 WAI

The Web Accessibility Initiative is part of the W3C (World Wide Web Consortium). It develops different standards to improve the accessibility of the World Wide Web (WWW) for people with disabilities. Such standards are for example the Web Content Accessibility Guidelines (WCAG) [W3C 2021b].

2.2 ARIA Rules

When working with the ARIA standard, a few rules [Suman Damera 2021] have to be followed:

1. Always use native HTML, unless there is no other way to make elements accessible.
2. Do not change the semantics of native HTML. Use the `<button>` element instad of `<span role="button">`.
3. Make aria-controls keyboard accessible, with the help of `tabindex="0"`.
4. Never use `role="presentation"` or `aria-hidden="true"` on focusable elements. It might be confusing if a plain face is focused.
5. Always use accessible names by using the `<label>` element or `aria-labels="Search"`.

All mentioned elements and attributes are part of the standard HTML or SVG markup.

2.3 ARIA Properties

ARIA defines different properties to annotate web content for accessibility. All ARIA properties are denoted by the prefix `aria-`. These properties are used to add further information to an element. There exist many different ARIA properties, in this survey only the most important are described in detail:

- `aria-label`: `aria-label` is used to label an element with a short name or a value. This can be used to give an accessible name to the element. Listing 2.1 shows an example how to use `aria-label` on a button for sending a mail.

```
<button aria-label="Send" type="submit">Send</button>
```

Listing 2.1: An example of using `aria-label`.

```
<div id="SendID">Send</div>
<button aria-labelledby="SendID" type="submit">Send</button>
```

Listing 2.2: An example of using `aria-labelledby`.

- `aria-labelledby`: `aria-labelledby` is similar to `aria-label` but gives an alternative way of labelling an element. `aria-labelledby` uses the ID of another element. For example it can use a text element with a label and refer to it by the ID. Listing 2.2 shows the same example as above but with `aria-labelledby`. It is also possible to combine more labels. This can be helpful to reuse labels. One use case can be seen in Listing 2.3. In the example, the screen reader would read the first button as "Send Mail" and the second button as "Send Direct Message". Notice the "Send" label was reused in both buttons.

- `aria-describedby`: `aria-describedby` property is used similar to `aria-labelledby`. The difference is that with `aria-describedby` one can give the element a longer more detailed description. This is especially important when the `aria-label` or `aria-labelledby` property does not give a detailed enough description of the element. Listing 2.4 shows a use case of `aria-describedby`, where the screen reader would read the more detailed description of the button given by the `aria-describedby` property.

- `aria-valuemin/aria-valuemax`: `aria-valuemin` and `aria-valuemax` properties are used to give a description to range elements, like sliders. This is important to give information of the maximum and the minimum of the slider. `aria-valuenow` can be used as the default value of the slider. Listing 2.5 shows a use case of these properties. The screen reader would give the information of the minimum value of the slider, in this case, 0, the maximum value of the slider, in this case, 100, and the current value of the slider, in this case, 10.

- `aria-roledescription`: `aria-roledescription` can be used to give a natural language description for the role of an element. Sometimes the role of an element is not very meaningful and in this case one can change this with the `aria-roledescription` property. Listing 2.6 shows a use case of `aria-roledescription`. The screen reader would understand that the element is a button and with the `aria-roledescription` it tells the user that it is an attachment button (for example attaching a file to a mail).

- `aria-hidden`: The `aria-hidden` property is used to hide an element and all its children from the Accessibility Tree and therefor hide the elements from the screen reader. This is especially useful for purely decorative elements on a webpage. It can be also used for repeated text or offscreen/collapsed content on the screen like menus. Listing 2.7 shows a use case of the property, where the screen reader would not read the text.

2.4 ARIA Roles

The ARIA properties described until now can be used for both HTML and SVG. The ARIA Graphics Module, which defines all the properties and roles to make SVGs more accessible. The properties defined in the ARIA Graphics Module [W3C 2018] are the same as those discussed in Section 2.3. For example,

```
<div id="SendID">Send</div>
<div id="MailID">Mail</div>
<button aria-labelledby="SendID MailID"
  type="submit">Send Mail</button>
<div id="MessageID">Direct Message</div>
<button aria-labelledby="SendID MessageID"
  type="submit">Send Direct Message</button>
```

Listing 2.3: An example of combining `aria-labelledby` properties.

```
<div id="SendID">Send</div>
<div id="MailID">Mail</div>
<div id="SendMailDescriptionID">Sending the text as mail</div>
<button aria-labelledby="SendID MailID" aria-describedby="SendMailDescriptionID"
  type="submit">Send Mail</button>
<div id="MessageID">Message</div>
<div id="SendMessageDescriptionID">Sending the text as a direct message</div>
<button aria-labelledby="SendID MessageID" aria-describedby="
    SendMessageDescriptionID"
  type="submit">Send Direct Message</button>
```

Listing 2.4: An example of using `aria-describedby`.

```
<div class ="slidecontainer">
  <input type ="range" aria-valuemin="0" aria-valuemax="100" aria-valuenow="10">
</div>
```

Listing 2.5: An example of using `aria-valuemin`, `aria-valuemax`, and `aria-valuenow`.

```
<div role="button" tabindex="0" aria-roledescription="attachment button">
  attach file
</div>
<button aria-roledescription="attachment button">attach file</button>
```

Listing 2.6: An example of using `aria-roledescription`.

```
<p aria-hidden="true">
  This text would not be read by the screen reader.
</p>
```

Listing 2.7: An example of using `aria-hidden`.

```
<svg xmlns ="https://www.w3.org/2000/svg" viewBox="0 0 200 100" role="graphics-
    document">
```

Listing 2.8: An example of using `graphics-document`.

```
<g role="graphics-object" aria-label="x-axis">
  <line x1="0" y1="0" x2="900" y2="0" stroke="black" stroke-width="3"/>

  <line x1="114" x2="114" y1="-15" y2="15" stroke="black" stroke-width="2"/>
  <text x="114" y="20" transform="rotate(-45, 114, 20)" font-size="20"
    text-anchor="end">2014</text>
  ...
</g>
```

Listing 2.9: An example of using `graphics-object`.

the `aria-label` property can be added to define the value of a data point in an SVG chart or to define what is seen on the x and the y-axis. In this survey, only the three most important SVG-specific roles are described:

- `graphics-document`: Is used to define that the next part of the document conveys its meaning through visual appearance. In this case it is used to define that the SVG is a document which conveys its meaning through a chart and is accessible. This can be seen in Listing 2.8.
- `graphics-object`: Is a subsection of the `graphics-document` and is used for sub elements in the SVG. It is used inside the SVG `g` grouping element. Every `graphics-object` can contain more `graphics-object`. It can be used to define that the x or y-axis is a graphics object. `graphics-object` can be seen in Listing 2.9. In the example, an x-axis is defined. The role `graphics-object` is set for the x-axis. Inside line elements are defined which are used as the x-axis marks and text elements which are used as the label.
- `graphics-symbol`: Is again a subsection of the `graphics-object` role and can be used to define graphical symbols such as icons. It is part of a larger structure such as a chart. The usage is seen in Listing 2.10. In the example, a symbol is defined which is a simple arrow for the x-axis from the example before. In the x-axis declaration where the arrow is used the `graphics-symbol` role is added.

```
<symbol id="arrow" viewBox="0 0 50 50">
  <polygon points="25,0 50,50 0,50" fill="black" />
</symbol>

...

<g transform="translate(160, 800)" font-family="Verdana">
  <use href="#arrow" role="graphics-symbol" x="910" y="-5" width="10" height="10"
    transform="rotate(90 910,-5)"></use>
  <line x1="0" y1="0" x2="900" y2="0" stroke="black" stroke-width="3"/>

  <line x1="114" x2="114" y1="-15" y2="15" stroke="black" stroke-width="2"/>
  <text x="114" y="20" transform="rotate(-45, 114, 20)" font-size="20"
    text-anchor="end">2014</text>
  ...
</g>
```

Listing 2.10: An example of using `graphics-symbol`.

Chapter 3

Annotated SVG Charts

As discussed in Sections 2.3 and 2.4, SVGs can be annotated with ARIA roles and properties. In this section, a deeper look into the annotation of SVGs and how to accomplish such annotated SVGs is given. There are three different ways to annotate SVGs:

- *Manual annotation*: Simply annotate SVGs by hand. An already existing SVG file can be used and then all the necessary roles and properties get added. Or the SVG itself can be created from scratch and all the necessary roles and properties get added. This approach can be quite tedious when more complex SVG charts get created.
- *Semi-automatic annotation*: Already existing programs like AChart can be used. This is categorized as semi-automatic annotation, since it adds all the necessary annotations, but there is no deeper control of how the final chart will look without modifying the predefined "recipes" for each chart type. In AChart there are recipes for a pie chart, a bar chart, and a line chart (more information about AChart in Section 4.1). If a different chart is needed, the manual annotation process has to be used, or a new recipe has to be written in TypeScript.
- *Automatic annotation*: The final way to create annotated SVGs is to use a vector graphics editor which can add annotations. For example, such an editor is Glimpse [Kasprzyk et al. 2021].

Overall, it can be differentiated between *simply* annotated SVG charts and *richly* annotated SVG charts. Simply annotated SVG charts contain all the roles and properties seen until now and defined in ARIA. However, there are also proposals for properties and custom classes for annotating SVG charts which create more detailed annotations. These SVG charts are called richly annotated SVG charts. More about richly annotated SVG charts is given in Section 3.2.

3.1 Simply Annotated SVG Charts

First, a deeper look into simply annotated SVGs is given. A simply annotated SVG chart makes use of the standard WAI ARIA roles and properties. Figure 3.1 shows the structure of a simply annotated SVG chart. The dark blue parts contain the visible parts of the chart, like the heading, the bars, and the axes. The purple circles with the numbers are the tab indices. They define the order in which elements are read by the screen reader. In this case, first, the title is read out, then the more detailed description, then the x-axis label, and finally the values of the bars. Th red and grey parts of the chart can be focused by the screen reader. However, the grey parts are not visible on the chart, they are only provided for the screen reader to read out.

In Figure 3.2 such a simply annotated SVG is given. For non-blind people, the SVG looks like any other. When a deeper look at the source code of the SVG is given it is indeed a simply annotated SVG, as can be seen in Listing 3.1). It contains the standard ARIA roles and properties, like `aria-label`, `aria-labelledby`, and so forth.

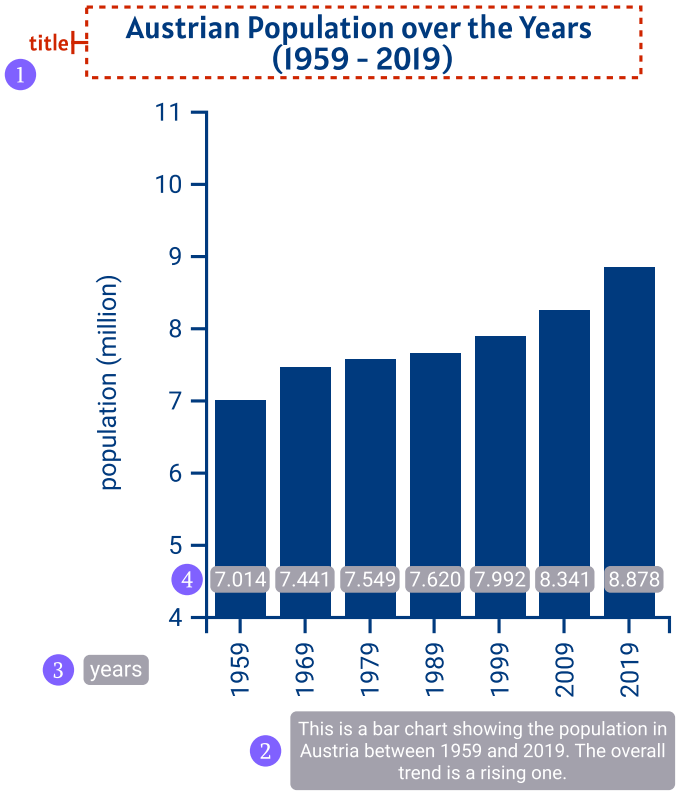

Figure 3.1: The structure of a simply annotated SVG chart. [Drawn by Markus Stradner, inspired by the illustrations of a barchart from Fizz Studio (`https://fizz.studio/wp-content/uploads/2018/04/barchart.png`).]

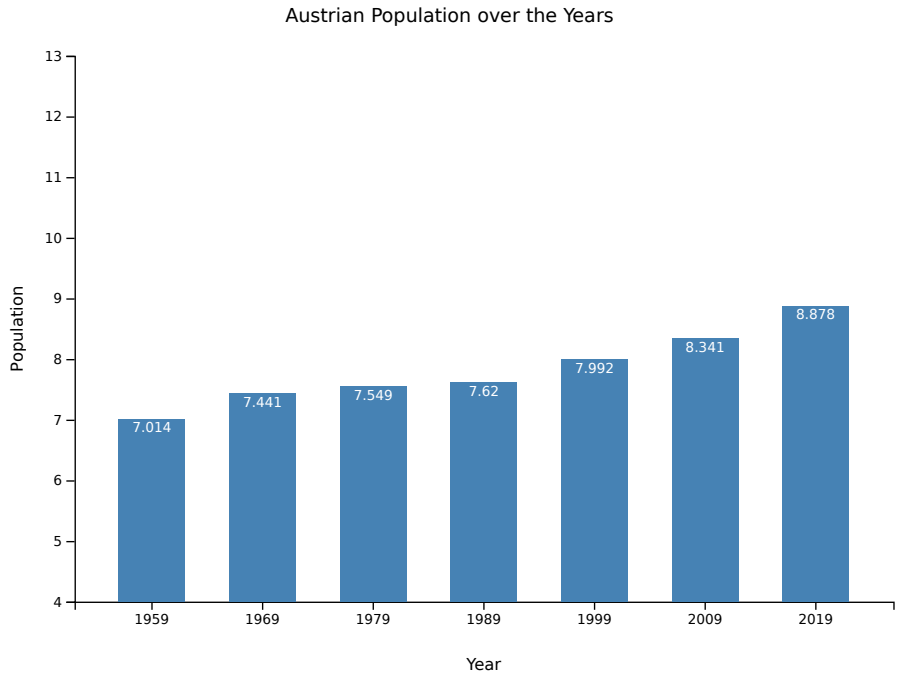

Figure 3.2: An example of a simply annotated SVG chart. It contains a bar chart showing the Austrian population from 1959 to 2019. On the y axis is the population in millions and on the x axis are the years. [Created by Alexander Perko with AChart.]

```svg
<svg viewBox="0 0 750 600" version="1.1" xmlns="http://www.w3.org/2000/svg"
  xmlns:xlink="http://www.w3.org/1999/xlink" role="graphics-document">
  <style type="text/css">
    .bar {fill: steelblue; }
  </style>
  <rect id="backdrop" width="750" height="600" fill="#fff"></rect>
  <g id="ChartRoot" tabindex="0" transform="translate(100,100)"
    aria-labelledby="title desc" aria-charttype="bar" aria-roledescription="Bar
        Chart">
    <desc id="desc">
      A bar chart showing the population in Austria between 1959 and 2019.
      The overall trend is rising.
    </desc>
    <rect width="600" height="400" fill="none"></rect>
    <text id="title" text-anchor="middle" font-size="14" x="275" y="-25">
      Austrian Population over the Years
    </text>
    <g id="xScale" aria-axistype="category" aria-roledescription="x-Axis"
      aria-labelledby="x-title" tabindex="0" transform="translate(0,400)"
      fill="none" font-size="10" font-family="sans-serif" text-anchor="middle">
      <text y="50" x="300" text-anchor="middle" fill="black"
        font-size="12" id="x-title">Years</text>
      <path class="domain" stroke="currentColor" d="M0.5,6V0.5H600.5V6"></path>
      <g class="tick" opacity="1" transform="translate(56.757,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em" id="x1">1959</text>
      </g>
      ...
    </g>
    <g id="yScale" aria-roledescription="y-Axis" tabindex="0" aria-valuemin="4"
       aria-valuemax="13" aria-labelledby="y-title" fill="none" font-size="10"
       font-family="sans-serif" text-anchor="end">
      <text transform="rotate(-90)" y="-38" x="-200" text-anchor="middle"
        fill="black" id="y-title" font-size="12">Population</text>
      <path class="domain" stroke="currentColor" d="M-6,400.5H0.5V0.5H-6"></path>
      <g class="tick" opacity="1" transform="translate(0,400.5)">
        <line stroke="currentColor" x2="-6"></line>
        <text fill="currentColor" x="-9" dy="0.32em" id="y1">4</text>
      </g>
      ...
    </g>
    <g id="dataarea" tabindex="0">
      <title>
        Population
      </title>
      <g tabindex="0" transform="translate(32.432,266.044)"  aria-labelledby="x1">
        <rect class="bar" width="48.649" height="133.956"></rect>
        <text x="24.325" y="10" text-anchor="middle" font-size="10"
          fill="white" id="value1">7.014</text>
      </g>
      ...
    </g>
  </g>
</svg>
```

Listing 3.1: The source code of the simply annotated SVG chart. It contains standard ARIA roles and properties, like `aria-label` and `aria-labelledby`.

3.2 Richly Annotated SVGs

Richly annotated SVG charts contain more detailed descriptions and information about the chart. Numerous tools and libraries help with creating richly annotated SVG charts. However, each tool and library takes its own approach and standards still have to emerge:

- Describler [Doug Schepers 2021]: Describler used standard ARIA roles and properties for SVG charts, as well as introducing a custom taxonomy for additional rich annotations.
- AChart [Andrews and Kopel 2021a; Andrews and Kopel 2021b]: AChart builds upon Describler's roles and propeties for rich annotation of SVG charts.
- W3C (Bellamy-Royds) [Bellamy-Royds 2021]: Amelia Bellany-Royds proposed standard ARIA roles and properties for rich annotations. Until now, they have not been added to the standard ARIA roles and properties.
- Highcharts [Highcharts 2020]: Highcharts also adds standard ARIA roles and properties and defines a custom taxonomy for rich annotations.
- Semiotic [Meeks and Lu 2021]: Semiotic handles annotations the same as Highcharts by adding the standard ARIA roles and properties and defining a custom taxonomy for rich annotations.
- amCharts [amCharts 2021]: amCharts uses standard ARIA roles and properties as well as menu elements for rich annotations. Due to this, it is not as versatile and feature-rich as the other libraries.
- FusionCharts [FusionCharts 2021]: FusionCharts uses standard ARIA roles and properties and defines a custom taxonomy for rich annotations.

All of these tools and libraries define different ways of richly annotating SVG charts. The most promising concepts from the different proposals and taxonomies are summarised in Table 3.1. In particular:

- Data Point: A declaration of a data point. This is probably the most promising concept. It is used to define a data point in a chart as a data point. From these data point values, the screen reader or the chart interpreter can then calculate additional information like the mean of the data or a trend line.
- Collection of Data Points: Used to add different data points to a collection of data points. This is very useful if a chart shows more than one group of data points, since the screen reader can then differentiate between them and therefore calculate the additional information for each group of data separately.
- Legend: Used to define a legend for the chart. The goal is that the information is received from the data itself without creating all the labels by hand. This is very useful when the data changes.
- Legend Item: Part of the legend and used to define which items are in the legend.
- Axis: Used to define an axis. Again, without the need to define all the labels for the screen reader.
- Axis Label: Part of an axis and used to read out the label of the axis.

A richly annotated SVG chart contains all the standard roles and properties and additional non-standard properties, which are used to encode more of the semantics of the chart inside the SVG code. These additional properties are defined differently within the different tools and libraries (see Table 3.1). Figure 3.3 shows how such a richly annotated SVG is structured. The dark blue parts indicate the visible parts of the chart, like the heading, the bars, and the axes. The purple circles with numbers are the tab indices. They define the order in which elements are read by the screen reader. In this case, first, the title is read out, then the more detailed description, then the x-axis, the y-axis, and finally the values of the bars. The red and grey parts can be focused by the screen reader. However, the grey parts are not actually

Meaning	Describler / AChart	W3C (Bellamy-Royds)	Highcharts	Semiotic	amCharts	FusionCharts
Data Point	`datapoint`	`graphics-dataunit` / `aria-datavalues`	`highcharts-point`		`menuitem`	
Collection of Data Points	`dataset`	`graphics-dataline` / `aria-datavaluearray`	`highcharts-line-series`	`lines` / `pieces`	`menu`	`raphael-group-N-plot-group`
Legend	`legend`	`graphics-legend`	`highcharts-legend`			`raphael-group-N-legend`
Legend Item	`legenditem`		`highcharts-legend-item`			
Axis	`xaxis` / `yaxis`	`graphics-axis`	`highcharts-axis` / `highcharts-xaxis` / `highcharts-yaxis`	`axis`		`raphael-group-N-dataset-axis-name`
Axis Label	`axislabel`		`highcharts-axis-labels`	`axis-label`		`raphael-group-N-dataset-axis`

Table 3.1: Proposals for rich annotations in various systems. N denotes a variable number.

visible in the chart, they are only provided for the screen reader to read out. The orange parts indicate the rich annotations for the x and y-axis. The green part indicates supplementary information which is created by the screen reader from the encoded data points.

A richly annotated SVG chart does not look different for sighted people. The richly annotated SVG looks the same as the simply annotated SVG when displayed as a graphic, just like in Figure 3.2. Looking deeper into the SVG source code, shown in Listing 3.2, reveals the difference. It contains standard ARIA roles and properties, like `aria-label` and `aria-labelledby`, but also rich annotations like `datapoint`, `dataset` and `xaxis` (as proposed by Describler and AChart).

```
<svg viewBox="0 0 750 600" version="1.1" xmlns="http://www.w3.org/2000/svg"
   xmlns:xlink="http://www.w3.org/1999/xlink" role="graphics-document">
  <style type="text/css">
    .bar {fill: steelblue; }
  </style>
  <rect id="backdrop" width="750" height="600" fill="#fff"></rect>
  <g id="ChartRoot" role="chart" tabindex="0" transform="translate(100,100)"
    aria-labelledby="title desc" aria-charttype="bar"
    aria-roledescription="Bar Chart">
    <desc id="desc">This is a bar chart showing the population in Austria
      between 1959 and 2019. The overall trend is a rising one.</desc>
    <rect role="chartarea" width="600" height="400" fill="none"></rect>
    <text id="title" role="heading" text-anchor="middle"
      font-size="14" x="275" y="-25">Austrian Population over the Years</text>
    <g id="xScale" role="xaxis" aria-axistype="category"
      aria-roledescription="x-Axis" aria-labelledby="x-title" tabindex="0"
      transform="translate(0,400)" fill="none"
      font-size="10" font-family="sans-serif" text-anchor="middle">
      <text y="50" x="300" text-anchor="middle" fill="black"
        font-size="12" role="heading" id="x-title">Years</text>
      <path class="domain" stroke="currentColor" d="M0.5,6V0.5H600.5V6"></path>
      <g class="tick" opacity="1" transform="translate(56.757,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em"
          role="axislabel" id="x1">1959</text>
      ...
    </g>
    <g id="yScale" role="yaxis" aria-roledescription="y-Axis" tabindex="0"
      aria-valuemin="4" aria-valuemax="13" aria-labelledby="y-title" fill="none"
      font-size="10" font-family="sans-serif" text-anchor="end">
      <text transform="rotate(-90)" y="-38" x="-200" text-anchor="middle"
        fill="black" role="heading" id="y-title" font-size="12">Population</text>
      <path class="domain" stroke="currentColor" d="M-6,400.5H0.5V0.5H-6"></path>
      <g class="tick" opacity="1" transform="translate(0,400.5)">
        <line stroke="currentColor" x2="-6"></line>
        <text fill="currentColor" x="-9" dy="0.32em"
          role="axislabel" id="y1">4</text>
      </g>
      ...
    </g>
    <g id="dataarea" role="dataset" tabindex="0">
      <title>Population</title>
      <g tabindex="0" transform="translate(32.432,266.044)"
        role="datapoint" aria-labelledby="x1">
        <rect class="bar" width="48.649" height="133.956"></rect>
        <text x="24.325" y="10" text-anchor="middle" font-size="10"
          fill="white" role="datavalue" id="value1">7.014</text>
      </g>
      ...
    </g>
  </g>
</svg>
```

Listing 3.2: The source code of the richly annotated SVG chart. It contains standard ARIA roles and properties, like `aria-label`, `aria-labelledby` etc., and also some custom roles such as `datapoint`, `dataset` and `xaxis`. The rich annotations are used as proposed by Describler and AChart.

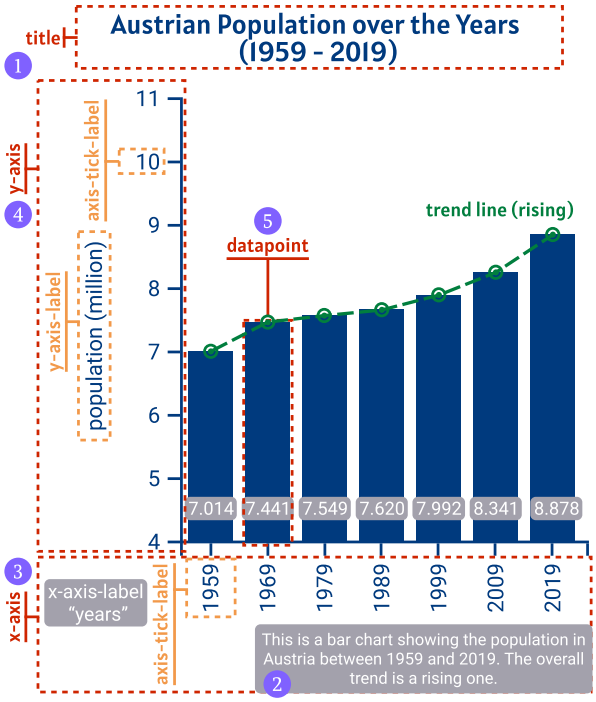

Figure 3.3: The elements of a richly annotated SVG chart encode more of its semantics. [Drawn by Markus Stradner, inspired by the illustration of a bar chart from Fizz Studio (`https://fizz.studio/wp-content/uploads/2018/04/barchart.png`).]

Chapter 4

AChart

The tool developed by Keith Andrews and Christopher Kopel is split up in a creator, which works as a generator of annotated SVGs, and an interpreter where the annotated charts are introduced to the users.

Screen readers, in general, are very important for blind people, because the audio description from the computer screen, more detailed, menu elements, graphics and web-content, is the primary way, next to braille displays and keyboards, how to understand the interface and interact with the computer.

4.1 AChart Creator

AChart Creator is a command-line tool for creating annotated SVG graphics from a CSV source. It is developed by Keith Andrews and Christopher Kopel [Andrews and Kopel 2021a], is freely available and open source. Tabular data stored in CSV format can be opened and transformed into simple SVG charts. There are three "recipes" available to choose from: bar chart, line chart, and pie chart. Optionally, a title, a description, and labels for the x-axis and y-axis can be added. Everything from source-file and output-file, over chart type to additional information has to be added as a parameter when invoking the program. SVG files created by the program contain rich information like, for instance, data points and their corresponding values. The program is easy to use, given basic knowledge in handling the command-line. AChart Creator is limited to the three pre-defined chart-types and cannot annotate already existing SVG charts. Making new chart types or modifying the existing chart types requires programming in TypeScript.

An exemplary use of AChart Creator to create a line chart can be seen in Figure 4.1, alongside the input CSV file. The generated output chart can be seen in Figure 4.2. An excerpt of its SVG source code showing a data point group can be seen in Figure 4.3. To see AChart Creator in action, view the showcase video on YouTube (`https://youtu.be/tc9Z5zbMBLA`).

4.2 AChart Interpreter

AChart Interpreter is a web application developed by Keith Andrews and Christopher Kopel [Andrews and Kopel 2021b] for reading out and navigating through annotated SVG files. It was inspired by Doug Schepers' Describler [Doug Schepers 2021]. The software is freely available and is open source. It can be downloaded from GitHub to run it locally either as a standalone Electron App or as a server on localhost. There is also a hosted version available on github.io (`https://tugraz-isds.github.io/achart-interpreter/`). As there are some difficulties when opening files from disk, Google Chrome (or Mozilla Firefox) is (are) recommended to access AChart Interpreter.

AChart Interpreter's main screen consists of two panels: a Graphic Panel on the left-hand side and a Text Panel on the right-hand side. The software is built from the ground up to be accessible, which is why it is fully navigable through the keyboard and reads out aloud every text element (including menu items)

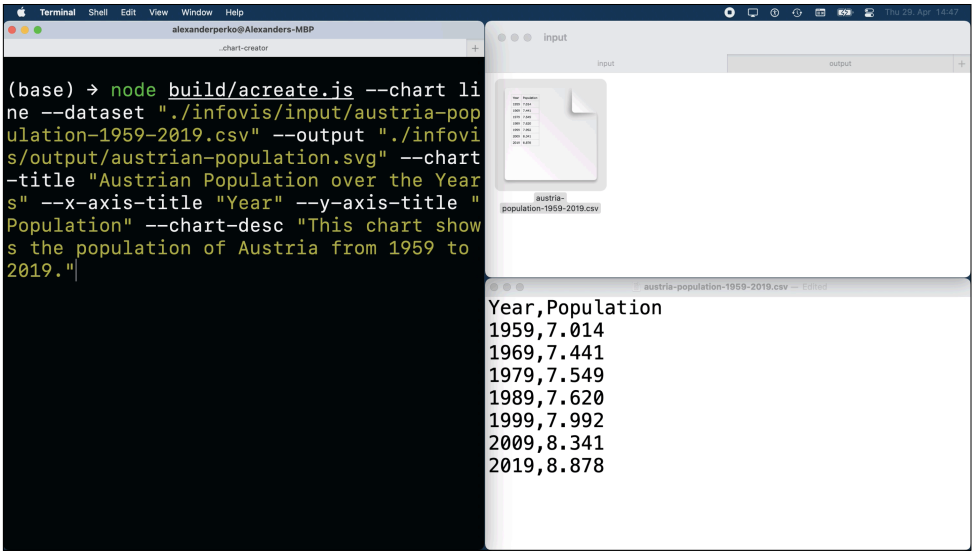

Figure 4.1: AChart Creator: A command line to create a line and the corresponding input CSV file. [Screenshot captured by Alexander Perko.]

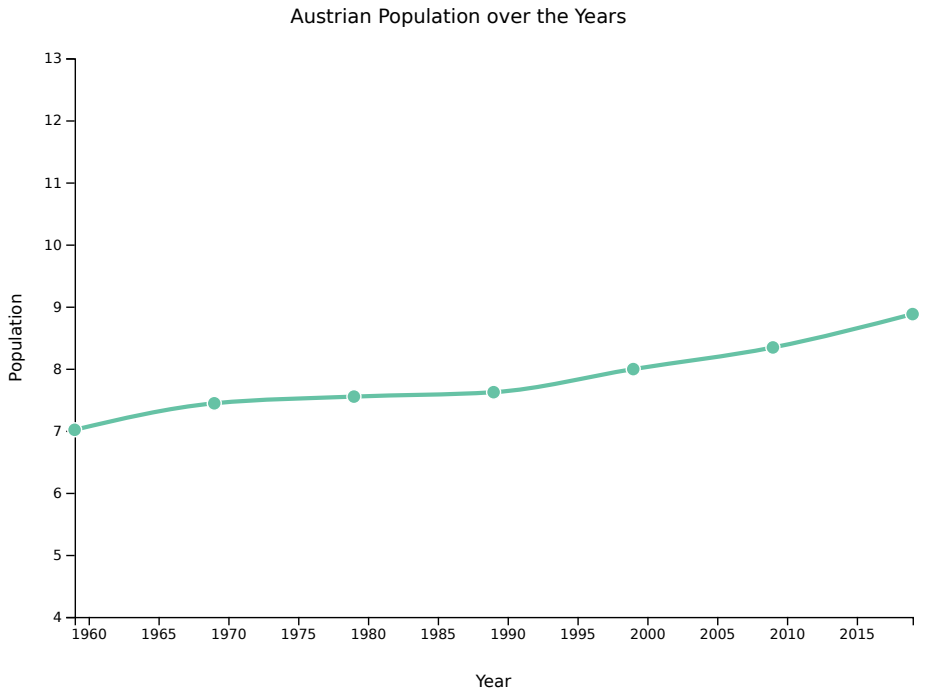

Figure 4.2: AChart Creator: The resulting richly annotated line chart. [Created as SVG by Alexander Perko with AChart Creator.]

```
<g tabindex="0" role="datapoint" aria-labelledby="name1-1">
  <title role="heading" id="name1-1">
    1959
  </title>
  <circle class="dot" cx="0" cy="266.044" r="5" fill="#66c2a5"></circle>
  <title role="datavalue" id="value1-1">
    7.014
  </title>
</g>
```

Figure 4.3: AChart Creator: Part of the richly annotated SVG code for a line chart. See A.4 for the full listing of the SVG output code. [Screenshot captured by Alexander Perko.]

on screen. The audio description feature can be turned off completely or used in tandem with a screen reader, which-for there are different modes to optimize AChart Interpreter's keyboard shortcuts. Richly annotated SVG charts can be loaded from disk through the file chooser in the main menu. Moreover, there are multiple sample SVG files to choose from. The main menu may be collapsed behind a menu button depending on the screen size. Once opened, an annotated SVG chart is displayed in the synchronised split screen, as can be seen in Figure 4.4. As the user navigates through the elements of a chart, the accompanying annotations are read out aloud.

When the chart at hand was richly annotated with AChart Creator, for example, AChart Interpreter can access special properties like data points and their values and hence navigate through data series or even sort data points in a different order based on their value. In addition, it can jump between data points of different data series to directly compare them, if there are multiple data series in the chart. Another useful feature is the Statistics Window, which shows additional information about the data, such as the highest and lowest values, as well as the mean or the range, as can be seen in Figure 4.5. This aims to give the user a better understanding of the data and simulates the "first glance" at the chart experienced by sighted people. For better illustration of the usage of AChart Interpreter consider viewing the showcase video on YouTube (`https://youtu.be/NLKqTTnKLII`).

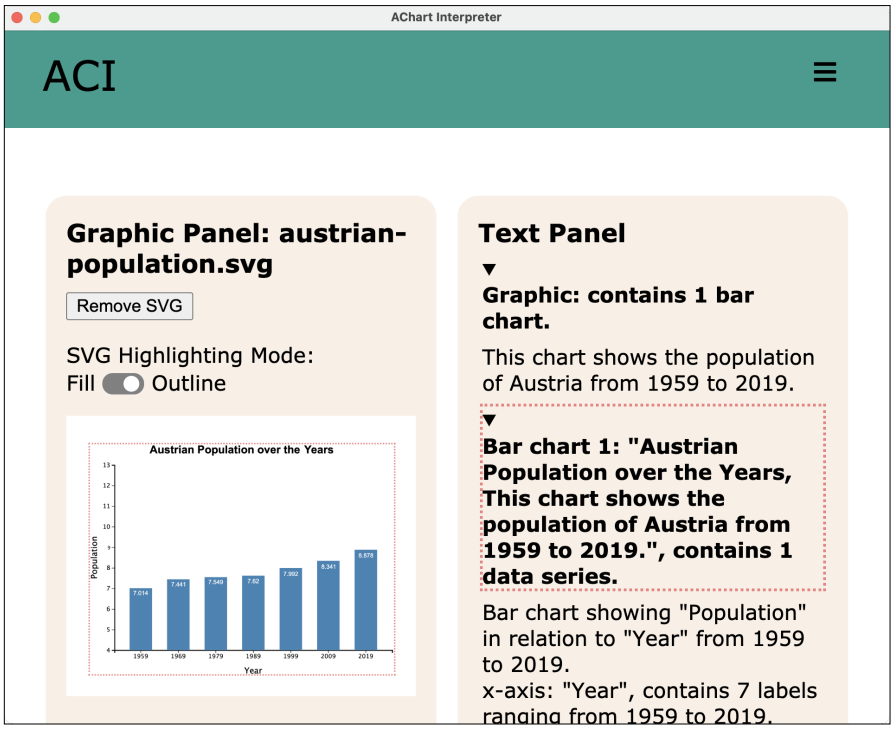

Figure 4.4: AChart Interpreter: Navigating through a richly annotated SVG chart. See A.5 for the full listing of the input file. [Screenshot captured by Alexander Perko.]

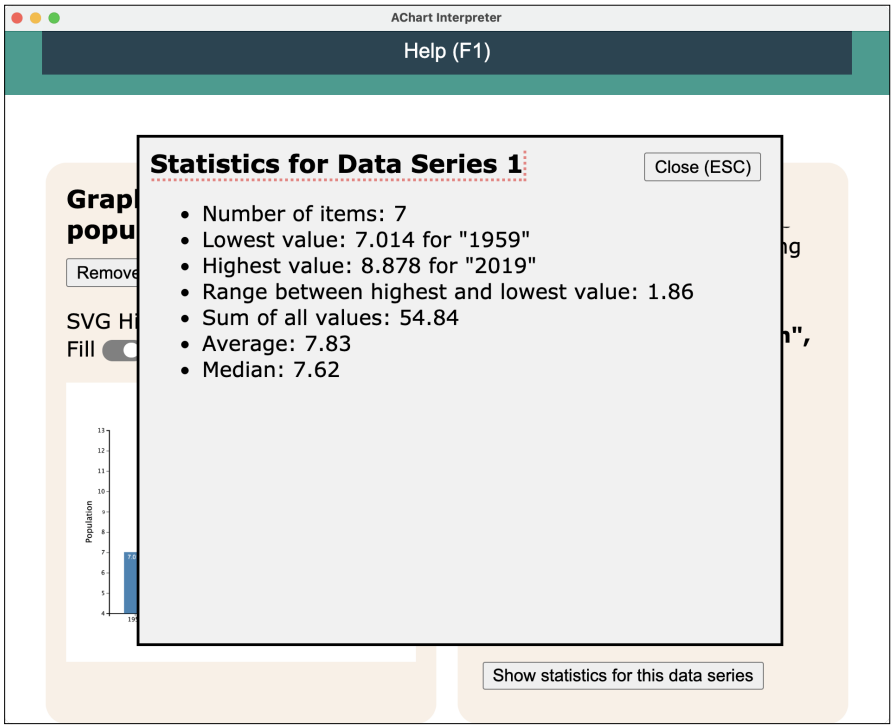

Figure 4.5: AChart Interpreter: Statistics window. [Screenshot captured by Alexander Perko.]

Chapter 5

AChart Extensions

This chapter proposes new roles for SVG annotation and showcases these additional markup elements and structures by extending the AChart suite. The main goal was to extend the SVG annotation to work with multidimensional data and groups of data points. For this purpose, support for creating and interpreting four new chart types was added to AChart, namely: stacked bar charts, grouped bar charts, scatter plots, and parallel coordinates.

For the sake of consistency and backwards compatibility, we built upon the existing markup structures and the commands used by previous versions of AChart Creator. Table 5.1 shows the additional and modified command-line options and parameters introduced to AChart Creator.

A new role, `datagroup`, was introduced to group data points together and is added as an additional layer between the `dataset` and the `datapoint` elements. The role `datapoint` was extended to be able to hold multiple `datavalue` elements, in order to capture multidimensionality. These can be seen in Table 5.2

Finally, the property `aria-charttype` was modified to include the four new chart types, as can be seen in Table 5.3. The following sections describe the four new chart types added to the AChart suite, from the dual perspectives of creation (AChart Creator) and Interpretation (AChart Interpreter).

5.1 Stacked Bar Charts

The first chart type added is the stacked bar chart. Stacked bar charts are an extension of standard bar charts, where individual bars are aggregated from component values. Compared to a standard bar chart, every bar is subdivided into sub-bars stacked on top of each other.

5.1.1 Creation

The user can create a stacked bar chart with the command shown in Listing 5.1. Here, the Election data from Listing A.2 is used as an input file. This creates the stacked bar chart shown in Figure 5.1. The subdivided bars contain the percentages of seats of the different political parties for each of Austria's federal states.

Data groups encode another layer of meaning and can be used intentionally by the author. In the particular case, shown in Figure 5.1 data groups represent a data point's affiliation to one of Austria's federal states. The data points show the seats per political party in each federal parliament in percent. Another possible grouping could have been made per party, for instance. The grouping can be changed explicitly to either be made by columns or by rows via the optional parameter `-aria-datagroup`. Depending on the data set, this change may result in a benefit for a blind person and does not affect the visual representation of the plot. Listing A.6 shows (part of) the generated SVG source code with the newly added property `datagroup`. The grouping is done by federal state.

Command	Parameter	Description
`--chart**`	`bar-grouped*`	Creates a grouped bar chart.
	`bar-stacked*`	Creates a stacked bar chart.
	`scatter*`	Creates a scatter plot.
	`parallel-coordinates*`	Creates a parallel coordinates chart.
`--columns*`	`"col1 col2 ... colN"*`	Choose the columns which should be grouped. Works with column name or index or both. Chooses x1, x2, size and colour for scatter. Last column index chooses the colour index for parallel coordinates when also colours parameter is given.
`--colours*`	`"colour1 colour2 ... colourN"*`	Set colour of groups. Works with colour names, hex codes, rgb and rgba.
`--colors*`	`"color1 color2 ... colorN"*`	
`--rotate-x-labels*`	`[ROTATION]`	Set the rotation of x/y labels by `ROTATION`. If `ROTATION` is omitted, the default value is set to 45°.
`--rotate-y-labels*`	`[ROTATION]`	
`--aria-datagroup*`	`DIMENSION`	Chooses by which dimension the data is grouped. Can be rows or columns. When creating scatter it can be column name or index by which the data is grouped.

Table 5.1: Commands and parameters added to AChart Creator. One asterisk (*) indicates a new command or parameter added by us. Two asterisks (**) indicate a command already present in AChart Creator.

Role	Element	Ancestor	Content	Description
`datagroup*`	`<g>`	`dataset**`	`datapoint**`	Group of data points. All data points come from the same column/group.

Table 5.2: Roles added to AChart. One asterisk (*) indicates a new role added by us. Two asterisks (**) indicate a role already present in AChart.

Property	Object	Value	Description
`aria-charttype*`	chart root	`bar**` / `pie**` / `line**` / `bar-grouped*` / `bar-stacked*` / `scatter*` / `parallel-coordinates*`	Type of chart.

Table 5.3: Properties added to AChart. One asterisk (*) indicates a new property added by us. Two asterisks (**) indicate a property already present in AChart.

```
acreate --chart bar-stacked --dataset .\data\nrw2019.csv --chart-title "Seats of
    Political Parties in Austria" --chart-desc "Seats of Political Parties in
    Austria per Federal state" --x-axis-title "Federal States" --y-axis-title "
    Number of  Seats in percent" --colours "#63C3D0 #CE000C #0056A2 #88B626 #E84188
    #DCDCDC" --rotate-x-labels
```

Listing 5.1: An example of using the `acreate` command to create a stacked bar chart with the Election dataset from Listing A.2.

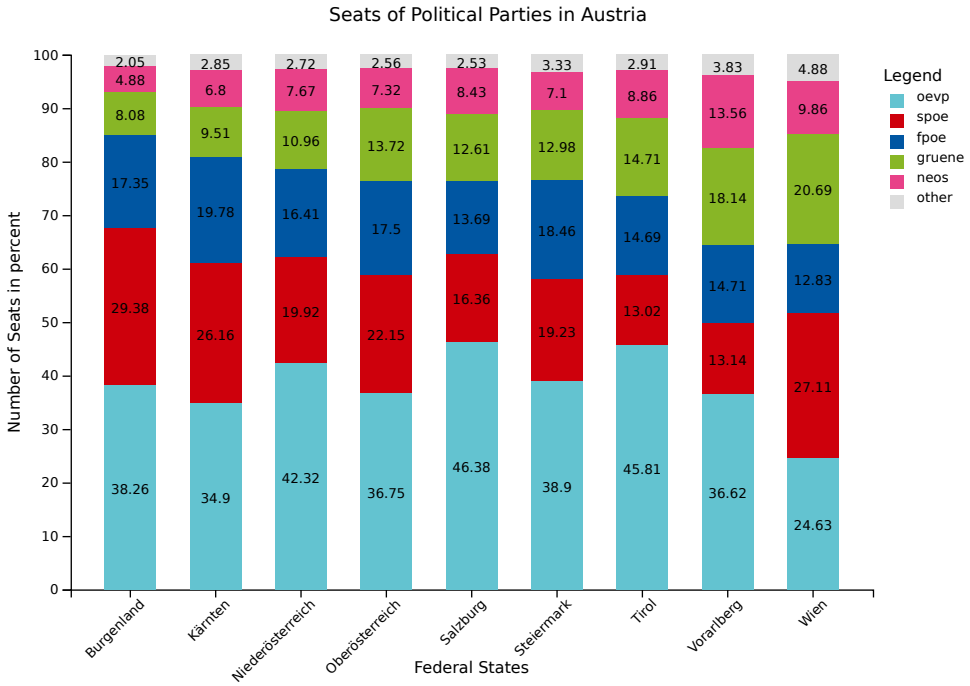

Figure 5.1: Stacked bar chart created with AChart Creator using the command in Listing 5.1. The dataset is shown in Listing A.2. [Screenshot captured by Moritz Erlacher using AChart Creator.]

5.1.2 Interpretation

Figure 5.2 shows the stacked bar chart opened in AChart Interpreter. In the Text Panel on the right hand side, several data groups are listed. Those data groups are themselves part of a dataset. In case data groups are present, data points are shown as being part of those groups rather than the parent dataset, since such groupings are intentionally made by the author of the chart to encode another layer of meaning.

Each data group has an individual Statistics Window, which can be invoked via the corresponding button. This Statistics Window is functionally identical to the one for datasets already present in previous versions of AChart Interpreter with two exceptions. The title of the current data group (or dataset) is now shown and multidimensionality is now supported.

Another addition made regarding data groups can be heard while navigating through data points with the arrow keys or by clicking on a data point in the Graphic Panel. To better understand the context of a data point, its affiliation to a data group is read out when jumping between groups by pressing either the left or the right arrow key or by clicking on a data point directly. For jumps through data points within the same group by pressing the up or down arrow keys, this is not done for every point.

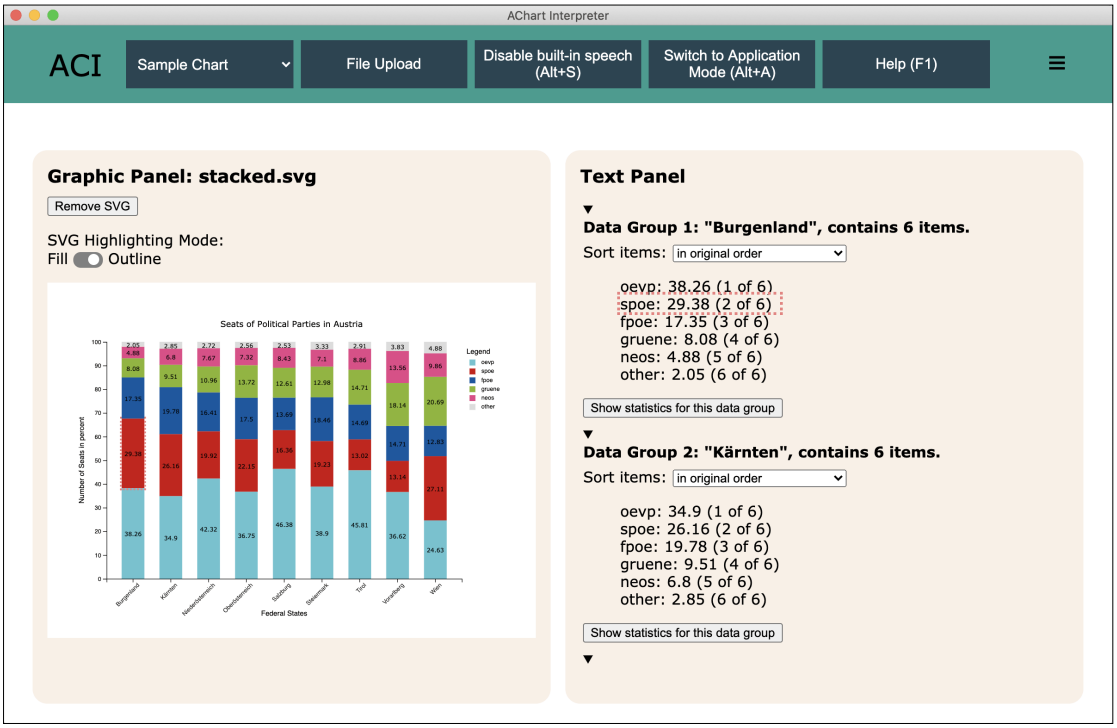

Figure 5.2: Stacked bar chart opened in AChart Interpreter. The full chart can be seen in Figure 5.1 [Screenshot captured by Lisa Habich using AChart Interpreter.]

```
1 acreate--chart bar-grouped --dataset .\data\nrw2019.csv --chart-title "Seats of
    Political Parties in Austria" --chart-desc "Seats of Political Parties in
    Austria per Federal state" --x-axis-title "Federal States" --y-axis-title "
    Number of  Seats in percent" --colours "#63C3D0 #CE000C #0056A2 #88B626 #E84188
    #DCDCDC" --rotate-x-labels
```

Listing 5.2: An example of using the `acreate` command to create a grouped bar chart with the Election dataset from Listing A.2.

5.2 Grouped Bar Charts

Grouped bar charts are an extension of standard bar charts, which display values for sub-categories together in groups.

5.2.1 Creation

The user can create a grouped bar chart with the command shown in Listing 5.2. Here, the Election data from Listing A.2 is used as input. This creates a grouped bar chart as seen in Figure 5.3. Each bar contains the proportion of seats of the different political parties in Austria in each federal state. Listing A.7 shows (part of) the generated SVG source code with the newly added property `datagroup`. The grouping is done by federal state.

5.2.2 Interpretation

Figure 5.4 shows the grouped bar chart opened in AChart Interpreter. The comments regarding stacked bar charts in Section 5.1.2 apply analogously to grouped bar charts.

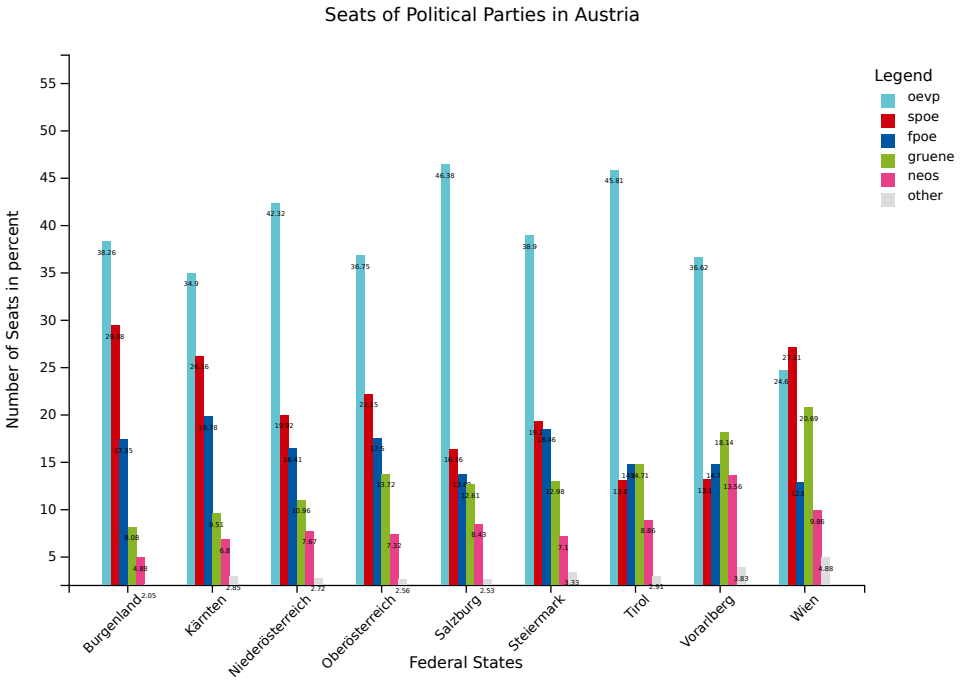

Figure 5.3: Grouped bar chart created with AChart Creator using the command in Listing 5.2. The dataset in Listing A.2 was used an input. [Screenshot captured by Moritz Erlacher using AChart Creator.]

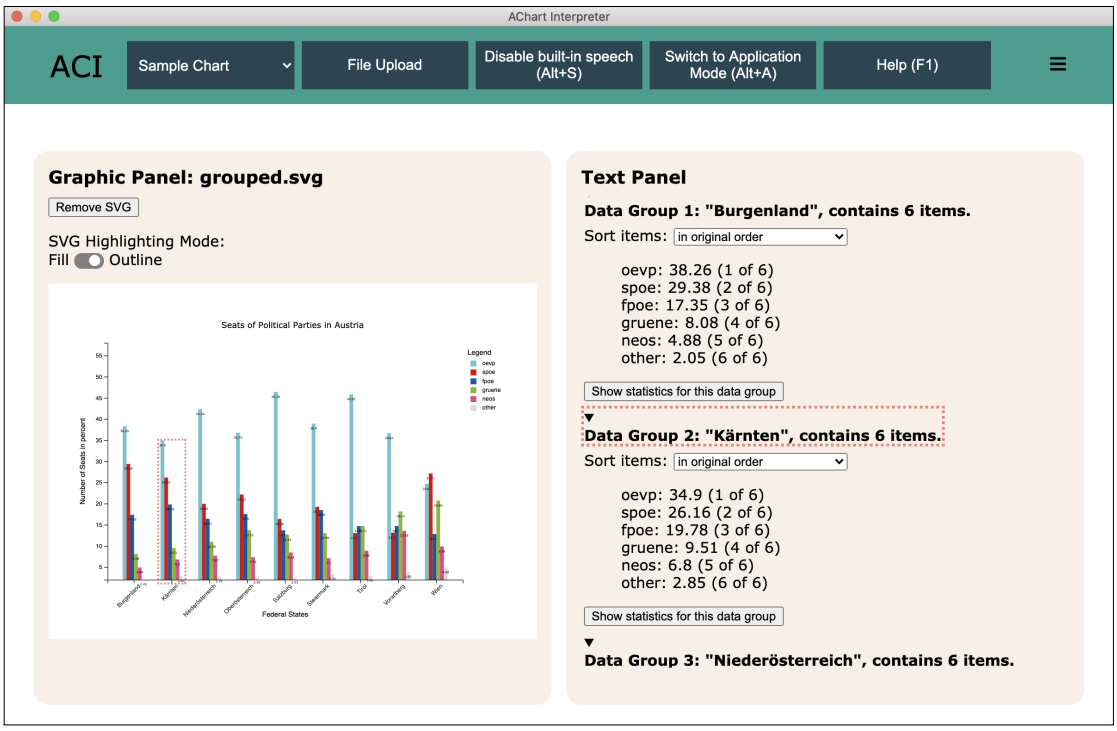

Figure 5.4: Grouped bar chart opened in AChart Interpreter. The full chart can be seen in Figure 5.3. [Screenshot captured by Lisa Habich using AChart Interpreter.]

```
acreate --chart scatter --dataset .\data\iris.csv --chart-title "Iris Flower Dataset
    " --chart-desc "Sepal length and width plotted as Scatter Plot. Colour is mapped
     to species and size is mapped to petal length" --x-axis-title "sepal length" --
    y-axis-title "sepal width" --columns "sepal_length sepal_width petal_length
    species" --aria-datagroup "species"
```

Listing 5.3: An example of using the `acreate` command to create a scatter plot with the Iris dataset from Listing A.3.

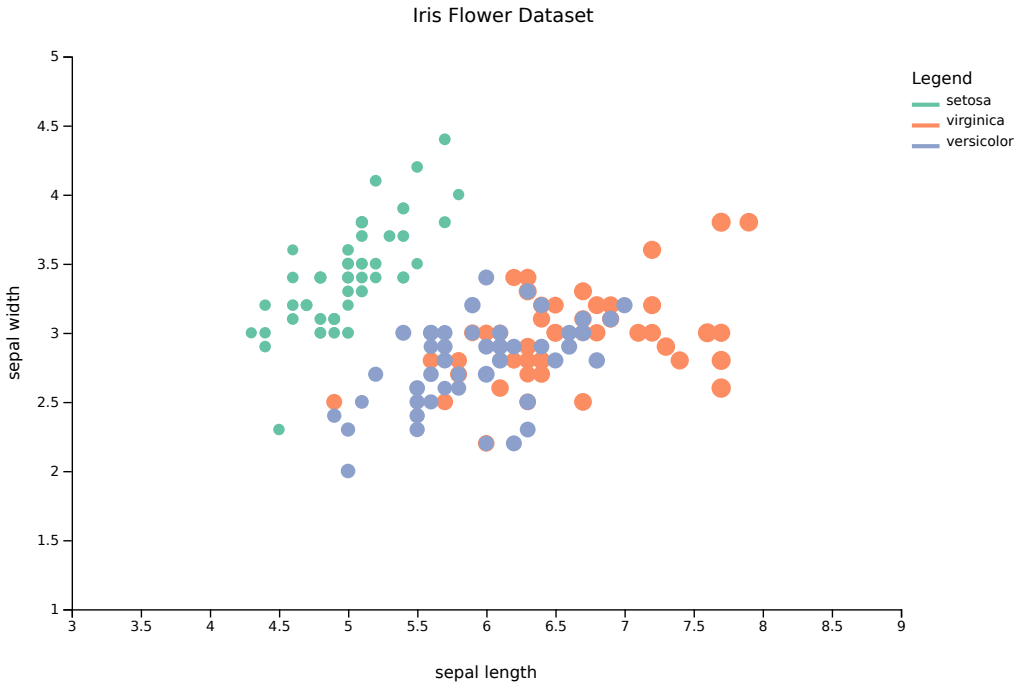

Figure 5.5: Scatter plot created with AChart Creator using the command in Listing 5.3. The dataset is shown in Listing A.3. [Screenshot captured by Moritz Erlacher using AChart Creator.]

5.3 Scatter Plots

A scatter plot is a multidimensional data representation, which depicts a data point by two dimensions (in this work, scatter plots are always projected onto a two-dimensional plain). More dimensions given by additional columns in the input file can be encoded by size, colour, or shape of the individual glyphs used to represent data points.

5.3.1 Creation

The user can create a scatter plot with the command seen in Listing 5.3. Here, the Iris data from Listing A.3 is used as input. Note that command-line option `--aria-datagroup` is used to group the data by flower species. This creates the scatter plot shown in Figure 5.5. The position of Each point is defined by sepal length on the x dimension and sepal width on the y dimension. The glyph size is determined by the petal length and its colour by the species.

Listing A.8 shows (part of) the generated SVG source code with the newly added property `datagroup`. The grouping is done by flower species. Also note that every `datapoint` consists of two `datavalues`, one for the first dimension and one for the second dimension. The colour and size are encoded in the `circle`

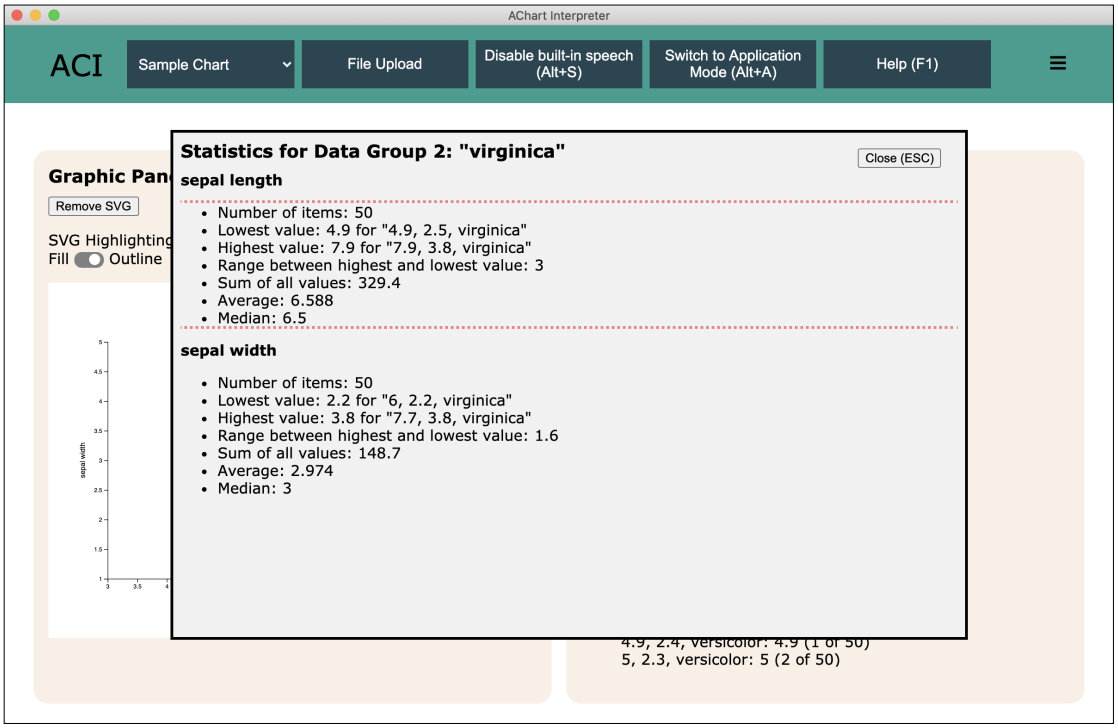

Figure 5.6: Scatter plot opened in AChart Interpreter. The full chart can be seen in Figure 5.5. [Screenshot captured by Lisa Habich using AChart Interpreter.]

element.

5.3.2 Interpretation

Figure 5.6 shows the scatter plot opened in AChart Interpreter. Everything regarding data groups described in Section 5.1.2 applies analogously to this chart type. In addition, multiple dimensions are now displayed in each Statistics Window, one for each numerical dimension encoded with a `datavalue`-role within the SVG markup.

5.4 Parallel Coordinates

A parallel coordinates chart incorporates one vertical axis for each dimension of the dataset. Each (multidimensional) data point is represented as a polyline, with one value on each vertical axis.

5.4.1 Creation

The user can create a parallel coordinates chart with the command shown in Listing 5.4. Here, the Iris data from Listing A.3 is used as input. The command-line option `--aria-datagroup` is used to group the data by the flower species. Furthermore, species is given in the `columns` argument as the last parameter to indicate groups for colouring. The colours themselves are defined with the `--colours` option. This creates the parallel coordinates chart shown in Figure 5.7. Each polyline represents a data point (record) from the dataset. The colouring is done by the species dimension.

Listing A.9 shows (part of) the generated SVG source code with the newly added property `datagroup`. The grouping is done by flower species. Note that every `datapoint` consists of four `datavalues` and there are four y axes.

```
acreate --chart parallel-coordinates --dataset .\data\iris.csv --chart-title "Iris
    Flower Dataset" --chart-desc "Iris Flower Dataset plotted as parallel
    coordinates. Colour is mapped to species" --colours "#03FC8C #03D7FC #FCA503" --
    rotate-x-labels --columns "sepal_length sepal_width petal_length petal_width
    species" --aria-datagroup "species"
```

Listing 5.4: An example of using the `acreate` command to create a parallel coordinates chart with the Iris dataset from Listing A.3.

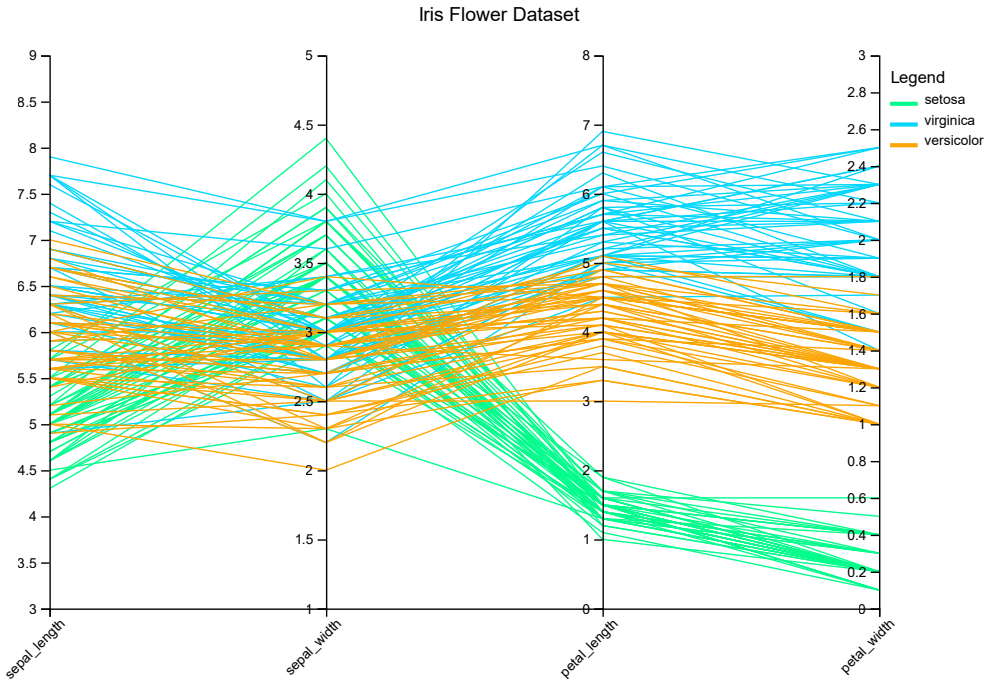

Figure 5.7: Parallel coordinates chart created with AChart Creator using the command in Listing 5.4. The dataset in Listing A.3 is used as input. [Screenshot captured by Moritz Erlacher using AChart Creator.]

5.4.2 Interpretation

Figure 5.8 shows the Statistics Window of a parallel coordinates chart in AChart Interpreter. Statistics are displayed for each dimension in the dataset, encoded with a `datavalue` element within the SVG markup. Everything regarding data groups described in Section 5.1.2 applies analogously to this chart type.

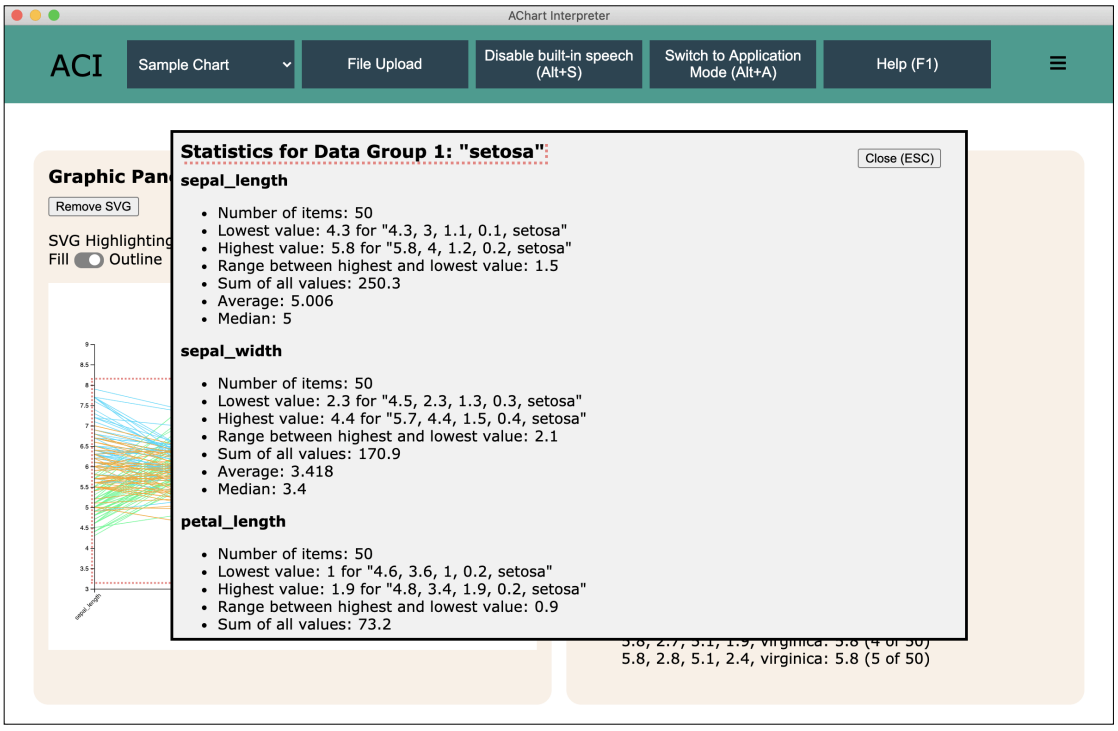

Figure 5.8: Parallel coordinates chart opened in AChart Interpreter. The full chart can be seen in Figure 5.7. [Screenshot captured by Lisa Habich using AChart Interpreter.]

Appendix A

Additional Listings

This appendix provides additional listings of input CSV files and output SVG files for AChart Creator.

A.1 Input CSV Population

Listing A.1 shows tabular data in CSV format about the population of Austria from 1959 to 2019 in 10-year increments, which was distilled from official Austrian statistics [SA 2021]. It is used as input for AChart Creator.

A.2 Input CSV National Elections 2019

Listing A.2 shows tabular data in CSV format about the Austrian General Election in 2019. The entries are the percentage of votes gained by each party.

A.3 Input CSV Iris Flower Dataset

Listing A.3 shows class iris flowers dataset in CSV format [UCI 2021]. Each ot the 150 records represents a flower with 4 numerical dimensions: `sepal_length`, `sepal_width`, `petal_length`, and `petal_width`. In addition, each record is labelled as belonging to one of three classes of iris species: `setosa`, `versicolor`, or `virginica`, with 50 examples of each class.

```
Year,Population
1959,7.014
1969,7.441
1979,7.549
1989,7.620
1999,7.992
2009,8.341
2019,8.878
```

Listing A.1: Tabular data in CSV format used as input for AChart Creator. The data shows the population of Austria from 1959 to 2019 in 10-year increments.

```
Name             ,oevp  ,spoe  ,fpoe  ,gruene ,neos ,other
Burgenland       ,38.26 ,29.38 ,17.35 ,8.08   ,4.88 ,2.05
Kärnten          ,34.90 ,26.16 ,19.78 ,9.51   ,6.80 ,2.85
Niederösterreich ,42.32 ,19.92 ,16.41 ,10.96  ,7.67 ,2.72
Oberösterreich   ,36.75 ,22.15 ,17.50 ,13.72  ,7.32 ,2.56
Salzburg         ,46.38 ,16.36 ,13.69 ,12.61  ,8.43 ,2.53
Steiermark       ,38.90 ,19.23 ,18.46 ,12.98  ,7.10 ,3.33
Tirol            ,45.81 ,13.02 ,14.69 ,14.71  ,8.86 ,2.91
Vorarlberg       ,36.62 ,13.14 ,14.71 ,18.14  ,13.56 ,3.83
Wien             ,24.63 ,27.11 ,12.83 ,20.69  ,9.86 ,4.88
```

Listing A.2: Tabular data in CSV format used as input for AChart Creator. The data shows the results of the Austria General Election in 2019. The entries are the percentage of votes gained by each party.

A.4 Output SVG Line Chart

Listing A.4 shows the SVG source code of a line chart generated by AChart Creator from the Austrian population dataset shown in Listing A.1.

A.5 Output SVG Bar Chart

Listing A.5 shows the SVG source code of a bar chart generated by AChart Creator from the Austrian population dataset shown in Listing A.1.

A.6 Output SVG Stacked Bar Chart

Listing A.6 shows part of the SVG source code of a stacked bar chart generated by AChart Creator from the Austrian Election dataset shown in Listing A.2.

A.7 Output SVG Grouped Bar Chart

Listing A.7 shows part of the SVG source code of a grouped bar chart generated by AChart Creator from the Austrian Election dataset shown in Listing A.2.

A.8 Output SVG Scatter Plot

Listing A.8 shows part of the SVG source code of a scatter plot generated by AChart Creator from the Iris dataset shown in Listing A.3.

A.9 Output SVG Parallel Coordinates

Listing A.9 shows part of the SVG source code of a parallel coordinates plot generated by AChart Creator from the Iris dataset shown in Listing A.3.

```
sepal_length,sepal_width,petal_length,petal_width,species
5.1,3.5,1.4,0.2,setosa
4.9,3.0,1.4,0.2,setosa
4.7,3.2,1.3,0.2,setosa
4.6,3.1,1.5,0.2,setosa
5.0,3.6,1.4,0.2,setosa
5.4,3.9,1.7,0.4,setosa
4.6,3.4,1.4,0.3,setosa
5.0,3.4,1.5,0.2,setosa
4.4,2.9,1.4,0.2,setosa
4.9,3.1,1.5,0.1,setosa
5.4,3.7,1.5,0.2,setosa
4.8,3.4,1.6,0.2,setosa
4.8,3.0,1.4,0.1,setosa
4.3,3.0,1.1,0.1,setosa
5.8,4.0,1.2,0.2,setosa
5.7,4.4,1.5,0.4,setosa
5.4,3.9,1.3,0.4,setosa
5.1,3.5,1.4,0.3,setosa
5.7,3.8,1.7,0.3,setosa
5.1,3.8,1.5,0.3,setosa
5.4,3.4,1.7,0.2,setosa
5.1,3.7,1.5,0.4,setosa
4.6,3.6,1.0,0.2,setosa
5.1,3.3,1.7,0.5,setosa
4.8,3.4,1.9,0.2,setosa
5.0,3.0,1.6,0.2,setosa
5.0,3.4,1.6,0.4,setosa
5.2,3.5,1.5,0.2,setosa
5.2,3.4,1.4,0.2,setosa
4.7,3.2,1.6,0.2,setosa
4.8,3.1,1.6,0.2,setosa
5.4,3.4,1.5,0.4,setosa
5.2,4.1,1.5,0.1,setosa
5.5,4.2,1.4,0.2,setosa
4.9,3.1,1.5,0.1,setosa
5.0,3.2,1.2,0.2,setosa
5.5,3.5,1.3,0.2,setosa
4.9,3.1,1.5,0.1,setosa
4.4,3.0,1.3,0.2,setosa
5.1,3.4,1.5,0.2,setosa
5.0,3.5,1.3,0.3,setosa
4.5,2.3,1.3,0.3,setosa
4.4,3.2,1.3,0.2,setosa
5.0,3.5,1.6,0.6,setosa
5.1,3.8,1.9,0.4,setosa
4.8,3.0,1.4,0.3,setosa
5.1,3.8,1.6,0.2,setosa
4.6,3.2,1.4,0.2,setosa
5.3,3.7,1.5,0.2,setosa
```

Listing A.3: The classic iris flowers dataset in CSV format.

```
5.0,3.3,1.4,0.2,setosa
7.0,3.2,4.7,1.4,versicolor
6.4,3.2,4.5,1.5,versicolor
6.9,3.1,4.9,1.5,versicolor
5.5,2.3,4.0,1.3,versicolor
6.5,2.8,4.6,1.5,versicolor
5.7,2.8,4.5,1.3,versicolor
6.3,3.3,4.7,1.6,versicolor
4.9,2.4,3.3,1.0,versicolor
6.6,2.9,4.6,1.3,versicolor
5.2,2.7,3.9,1.4,versicolor
5.0,2.0,3.5,1.0,versicolor
5.9,3.0,4.2,1.5,versicolor
6.0,2.2,4.0,1.0,versicolor
6.1,2.9,4.7,1.4,versicolor
5.6,2.9,3.6,1.3,versicolor
6.7,3.1,4.4,1.4,versicolor
5.6,3.0,4.5,1.5,versicolor
5.8,2.7,4.1,1.0,versicolor
6.2,2.2,4.5,1.5,versicolor
5.6,2.5,3.9,1.1,versicolor
5.9,3.2,4.8,1.8,versicolor
6.1,2.8,4.0,1.3,versicolor
6.3,2.5,4.9,1.5,versicolor
6.1,2.8,4.7,1.2,versicolor
6.4,2.9,4.3,1.3,versicolor
6.6,3.0,4.4,1.4,versicolor
6.8,2.8,4.8,1.4,versicolor
6.7,3.0,5.0,1.7,versicolor
6.0,2.9,4.5,1.5,versicolor
5.7,2.6,3.5,1.0,versicolor
5.5,2.4,3.8,1.1,versicolor
5.5,2.4,3.7,1.0,versicolor
5.8,2.7,3.9,1.2,versicolor
6.0,2.7,5.1,1.6,versicolor
5.4,3.0,4.5,1.5,versicolor
6.0,3.4,4.5,1.6,versicolor
6.7,3.1,4.7,1.5,versicolor
6.3,2.3,4.4,1.3,versicolor
5.6,3.0,4.1,1.3,versicolor
5.5,2.5,4.0,1.3,versicolor
5.5,2.6,4.4,1.2,versicolor
6.1,3.0,4.6,1.4,versicolor
5.8,2.6,4.0,1.2,versicolor
5.0,2.3,3.3,1.0,versicolor
5.6,2.7,4.2,1.3,versicolor
5.7,3.0,4.2,1.2,versicolor
5.7,2.9,4.2,1.3,versicolor
6.2,2.9,4.3,1.3,versicolor
5.1,2.5,3.0,1.1,versicolor
```

Listing A.3 (cont.)**:** The classic iris flowers dataset in CSV format.

```
5.7,2.8,4.1,1.3,versicolor
6.3,3.3,6.0,2.5,virginica
5.8,2.7,5.1,1.9,virginica
7.1,3.0,5.9,2.1,virginica
6.3,2.9,5.6,1.8,virginica
6.5,3.0,5.8,2.2,virginica
7.6,3.0,6.6,2.1,virginica
4.9,2.5,4.5,1.7,virginica
7.3,2.9,6.3,1.8,virginica
6.7,2.5,5.8,1.8,virginica
7.2,3.6,6.1,2.5,virginica
6.5,3.2,5.1,2.0,virginica
6.4,2.7,5.3,1.9,virginica
6.8,3.0,5.5,2.1,virginica
5.7,2.5,5.0,2.0,virginica
5.8,2.8,5.1,2.4,virginica
6.4,3.2,5.3,2.3,virginica
6.5,3.0,5.5,1.8,virginica
7.7,3.8,6.7,2.2,virginica
7.7,2.6,6.9,2.3,virginica
6.0,2.2,5.0,1.5,virginica
6.9,3.2,5.7,2.3,virginica
5.6,2.8,4.9,2.0,virginica
7.7,2.8,6.7,2.0,virginica
6.3,2.7,4.9,1.8,virginica
6.7,3.3,5.7,2.1,virginica
7.2,3.2,6.0,1.8,virginica
6.2,2.8,4.8,1.8,virginica
6.1,3.0,4.9,1.8,virginica
6.4,2.8,5.6,2.1,virginica
7.2,3.0,5.8,1.6,virginica
7.4,2.8,6.1,1.9,virginica
7.9,3.8,6.4,2.0,virginica
6.4,2.8,5.6,2.2,virginica
6.3,2.8,5.1,1.5,virginica
6.1,2.6,5.6,1.4,virginica
7.7,3.0,6.1,2.3,virginica
6.3,3.4,5.6,2.4,virginica
6.4,3.1,5.5,1.8,virginica
6.0,3.0,4.8,1.8,virginica
6.9,3.1,5.4,2.1,virginica
6.7,3.1,5.6,2.4,virginica
6.9,3.1,5.1,2.3,virginica
5.8,2.7,5.1,1.9,virginica
6.8,3.2,5.9,2.3,virginica
6.7,3.3,5.7,2.5,virginica
6.7,3.0,5.2,2.3,virginica
6.3,2.5,5.0,1.9,virginica
6.5,3.0,5.2,2.0,virginica
6.2,3.4,5.4,2.3,virginica
5.9,3.0,5.1,1.8,virginica
```

Listing A.3 (cont.)**:** The classic iris flowers dataset in CSV format.

```
<svg viewBox="0 0 750 600" version="1.1" xmlns="http://www.w3.org/2000/svg" xmlns:
    xlink="http://www.w3.org/1999/xlink" role="graphics-document">
  <style type="text/css">
    .line {
        fill: none;
        stroke-width: 3;
    }
    .overlay {
        fill: none;
        pointer-events: all;
    }

    /* Style the dots by assigning a fill and stroke */
    .dot {
        stroke: #fff;
    }

    .focus circle {
        fill: none;
        stroke: steelblue;
    }
  </style>
  <rect id="backdrop" width="750" height="600" fill="#fff"></rect>
  <g id="ChartRoot" role="chart" tabindex="0" transform="translate(100,100)" aria-
      labelledby="title desc" aria-charttype="line" aria-roledescription="Line Chart
      ">
    <desc id="desc">
      This chart shows the population of Austria from 1959 to 2019.
    </desc>
    <rect role="chartarea" width="600" height="400" fill="none"></rect>
    <text id="title" role="heading" text-anchor="middle" font-size="14" x="275" y="
        -25">
      Austrian Population over the Years
    </text>
    <g id="xScale" role="xaxis" aria-roledescription="x-Axis" aria-axistype="" aria-
        labelledby="x-title" tabindex="0" aria-valuemin="1959" aria-valuemax="2019"
        transform="translate(0,400)" fill="none" font-size="10" font-family="sans-
        serif" text-anchor="middle">
      <text y="50" x="300" text-anchor="middle" fill="black" font-size="12" role="
          heading" id="x-title">
        Year
      </text>
      <path class="domain" stroke="currentColor" d="M0.5,6V0.5H600.5V6"></path>
      <g class="tick" opacity="1" transform="translate(10.5,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" id="x1">
          1960
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(60.5,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" id="x2">
          1965
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(110.5,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" id="x3">
```

Listing A.4: The SVG source code of a line chart generated by AChart Creator from the Austrian population dataset shown in Listing A.1.

```
          1970
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(160.5,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" id="x4">
          1975
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(210.5,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" id="x5">
          1980
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(260.5,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" id="x6">
          1985
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(310.5,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" id="x7">
          1990
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(360.5,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em">
          1995
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(410.5,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em">
          2000
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(460.5,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em">
          2005
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(510.5,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em">
          2010
        </text>
      </g>
```

Listing A.4 (cont.)**:** The SVG source code of a line chart generated by AChart Creator.

```
      </g>
      <g class="tick" opacity="1" transform="translate(560.5,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em">
          2015
        </text>
      </g>
    </g>
    <g id="yScale" role="yaxis" aria-roledescription="y-Axis" tabindex="0" aria-
        valuemin="4" aria-valuemax="13" aria-labelledby="y-title" fill="none" font-
        size="10" font-family="sans-serif" text-anchor="end">
      <text transform="rotate(-90)" y="-38" x="-200" text-anchor="middle" fill="
          black" font-size="12" role="heading" id="y-title">
        Population
      </text>
      <path class="domain" stroke="currentColor" d="M-6,400.5H0.5V0.5H-6"></path>
      <g class="tick" opacity="1" transform="translate(0,400.5)">
        <line stroke="currentColor" x2="-6"></line>
        <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y4">
          4
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(0,356.056)">
        <line stroke="currentColor" x2="-6"></line>
        <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y5">
          5
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(0,311.611)">
        <line stroke="currentColor" x2="-6"></line>
        <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y6">
          6
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(0,267.167)">
        <line stroke="currentColor" x2="-6"></line>
        <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y7">
          7
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(0,222.722)">
        <line stroke="currentColor" x2="-6"></line>
        <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y8">
          8
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(0,178.278)">
        <line stroke="currentColor" x2="-6"></line>
        <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y9">
          9
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(0,133.833)">
```

Listing A.4 (cont.)**:** The SVG source code of a line chart generated by AChart Creator.

```
151         <line stroke="currentColor" x2="-6"></line>
152         <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y10">
153           10
154         </text>
155       </g>
156       <g class="tick" opacity="1" transform="translate(0,89.389)">
157         <line stroke="currentColor" x2="-6"></line>
158         <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y11">
159           11
160         </text>
161       </g>
162       <g class="tick" opacity="1" transform="translate(0,44.944)">
163         <line stroke="currentColor" x2="-6"></line>
164         <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y12">
165           12
166         </text>
167       </g>
168       <g class="tick" opacity="1" transform="translate(0,0.5)">
169         <line stroke="currentColor" x2="-6"></line>
170         <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y13">
171           13
172         </text>
173       </g>
174     </g>
175     <g id="dataarea1" role="dataset" aria-roledescription="Data Series" tabindex="0"
          aria-labelledby="dataset-title1">
176       <title role="heading" id="dataset-title1">
177         Population
178       </title>
179       <path class="line" d="M0,266.044C33.333,258.156,66.667,250.267,100,247.067C133
            .333,243.867,166.667,243.593,200,242.267C233
            .333,240.941,266.667,241.215,300,239.111C333
            .333,237.007,366.667,227.919,400,222.578C433
            .333,217.237,466.667,213.63,500,207.067C533
            .333,200.504,566.667,191.852,600,183.2" stroke="#66c2a5"></path>
180       <g tabindex="0" role="datapoint" aria-labelledby="name1-1">
181         <title role="heading" id="name1-1">
182           1959
183         </title>
184         <circle class="dot" cx="0" cy="266.044" r="5" fill="#66c2a5"></circle>
185         <title role="datavalue" id="value1-1">
186           7.014
187         </title>
188       </g>
189       <g tabindex="0" role="datapoint" aria-labelledby="name1-2">
190         <title role="heading" id="name1-2">
191           1969
192         </title>
193         <circle class="dot" cx="100" cy="247.067" r="5" fill="#66c2a5"></circle>
194         <title role="datavalue" id="value1-2">
195           7.441
196         </title>
197       </g>
198       <g tabindex="0" role="datapoint" aria-labelledby="name1-3">
199         <title role="heading" id="name1-3">
200           1979
201         </title>
```

Listing A.4 (cont.)**:** The SVG source code of a line chart generated by AChart Creator.

```
        </title>
        <circle class="dot" cx="200" cy="242.267" r="5" fill="#66c2a5"></circle>
        <title role="datavalue" id="value1-3">
          7.549
        </title>
      </g>
      <g tabindex="0" role="datapoint" aria-labelledby="name1-4">
        <title role="heading" id="name1-4">
          1989
        </title>
        <circle class="dot" cx="300" cy="239.111" r="5" fill="#66c2a5"></circle>
        <title role="datavalue" id="value1-4">
          7.62
        </title>
      </g>
      <g tabindex="0" role="datapoint" aria-labelledby="name1-5">
        <title role="heading" id="name1-5">
          1999
        </title>
        <circle class="dot" cx="400" cy="222.578" r="5" fill="#66c2a5"></circle>
        <title role="datavalue" id="value1-5">
          7.992
        </title>
      </g>
      <g tabindex="0" role="datapoint" aria-labelledby="name1-6">
        <title role="heading" id="name1-6">
          2009
        </title>
        <circle class="dot" cx="500" cy="207.067" r="5" fill="#66c2a5"></circle>
        <title role="datavalue" id="value1-6">
          8.341
        </title>
      </g>
      <g tabindex="0" role="datapoint" aria-labelledby="name1-7">
        <title role="heading" id="name1-7">
          2019
        </title>
        <circle class="dot" cx="600" cy="183.2" r="5" fill="#66c2a5"></circle>
        <title role="datavalue" id="value1-7">
          8.878
        </title>
      </g>
    </g>
  </g>
</svg>
```

Listing A.4 (cont.)**:** The SVG source code of a line chart generated by AChart Creator.

```
<svg viewBox="0 0 750 600" version="1.1" xmlns="http://www.w3.org/2000/svg" xmlns:
    xlink="http://www.w3.org/1999/xlink" role="graphics-document">
  <style type="text/css">
    .bar {fill: steelblue; }
  </style>
  <rect id="backdrop" width="750" height="600" fill="#fff"></rect>
  <g id="ChartRoot" role="chart" tabindex="0" transform="translate(100,100)" aria-
      labelledby="title desc" aria-charttype="bar" aria-roledescription="Bar Chart">
    <desc id="desc">
      This chart shows the population of Austria from 1959 to 2019.
    </desc>
    <rect role="chartarea" width="600" height="400" fill="none"></rect>
    <text id="title" role="heading" text-anchor="middle" font-size="14" x="275" y="
        -25">
      Austrian Population over the Years
    </text>
    <g id="xScale" role="xaxis" aria-axistype="category" aria-roledescription="x-
        Axis" aria-labelledby="x-title" tabindex="0" transform="translate(0,400)"
        fill="none" font-size="10" font-family="sans-serif" text-anchor="middle">
      <text y="50" x="300" text-anchor="middle" fill="black" font-size="12" role="
          heading" id="x-title">
        Year
      </text>
      <path class="domain" stroke="currentColor" d="M0.5,6V0.5H600.5V6"></path>
      <g class="tick" opacity="1" transform="translate(56.757,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" id="x1">
          1959
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(137.838,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" id="x2">
          1969
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(218.919,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" id="x3">
          1979
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(300,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" id="x4">
          1989
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(381.081,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" id="x5">
          1999
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(462.162,0)">
        <line stroke="currentColor" y2="6"></line>
```

Listing A.5: The SVG source code of a bar chart generated by AChart Creator from the Austrian population dataset shown in Listing A.1.

```
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" id="x6">
          2009
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(543.243,0)">
        <line stroke="currentColor" y2="6"></line>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" id="x7">
          2019
        </text>
      </g>
    </g>
    <g id="yScale" role="yaxis" aria-roledescription="y-Axis" tabindex="0" aria-
        valuemin="4" aria-valuemax="13" aria-labelledby="y-title" fill="none" font-
        size="10" font-family="sans-serif" text-anchor="end">
      <text transform="rotate(-90)" y="-38" x="-200" text-anchor="middle" fill="
          black" role="heading" id="y-title" font-size="12">
        Population
      </text>
      <path class="domain" stroke="currentColor" d="M-6,400.5H0.5V0.5H-6"></path>
      <g class="tick" opacity="1" transform="translate(0,400.5)">
        <line stroke="currentColor" x2="-6"></line>
        <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y1">
          4
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(0,356.056)">
        <line stroke="currentColor" x2="-6"></line>
        <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y2">
          5
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(0,311.611)">
        <line stroke="currentColor" x2="-6"></line>
        <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y3">
          6
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(0,267.167)">
        <line stroke="currentColor" x2="-6"></line>
        <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y4">
          7
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(0,222.722)">
        <line stroke="currentColor" x2="-6"></line>
        <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y5">
          8
        </text>
      </g>
      <g class="tick" opacity="1" transform="translate(0,178.278)">
        <line stroke="currentColor" x2="-6"></line>
        <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y6">
          9
        </text>
```

Listing A.5 (cont.)**:** The SVG source code of a bar chart generated by AChart Creator.

```
101         </text>
102       </g>
103       <g class="tick" opacity="1" transform="translate(0,133.833)">
104         <line stroke="currentColor" x2="-6"></line>
105         <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y7">
106           10
107         </text>
108       </g>
109       <g class="tick" opacity="1" transform="translate(0,89.389)">
110         <line stroke="currentColor" x2="-6"></line>
111         <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y8">
112           11
113         </text>
114       </g>
115       <g class="tick" opacity="1" transform="translate(0,44.944)">
116         <line stroke="currentColor" x2="-6"></line>
117         <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y9">
118           12
119         </text>
120       </g>
121       <g class="tick" opacity="1" transform="translate(0,0.5)">
122         <line stroke="currentColor" x2="-6"></line>
123         <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y10">
124           13
125         </text>
126       </g>
127     </g>
128     <g id="dataarea" role="dataset" tabindex="0">
129       <title>
130         Population
131       </title>
132       <g tabindex="0" transform="translate(32.432,266.044)" role="datapoint" aria-
            labelledby="x1">
133         <rect class="bar" width="48.649" height="133.956"></rect>
134         <text x="24.325" y="10" text-anchor="middle" font-size="10" fill="white"
              role="datavalue" id="value1">
135           7.014
136         </text>
137       </g>
138       <g tabindex="0" transform="translate(113.514,247.067)" role="datapoint" aria-
            labelledby="x2">
139         <rect class="bar" width="48.649" height="152.933"></rect>
140         <text x="24.325" y="10" text-anchor="middle" font-size="10" fill="white"
              role="datavalue" id="value2">
141           7.441
142         </text>
143       </g>
144       <g tabindex="0" transform="translate(194.595,242.267)" role="datapoint" aria-
            labelledby="x3">
145         <rect class="bar" width="48.649" height="157.733"></rect>
146         <text x="24.325" y="10" text-anchor="middle" font-size="10" fill="white"
              role="datavalue" id="value3">
147           7.549
148         </text>
149       </g>
150       <g tabindex="0" transform="translate(275.676,239.111)" role="datapoint" aria-
            labelledby="x4">
```

Listing A.5 (cont.)**:** The SVG source code of a bar chart generated by AChart Creator.

```
151         <rect class="bar" width="48.649" height="160.889"></rect>
152         <text x="24.325" y="10" text-anchor="middle" font-size="10" fill="white"
                role="datavalue" id="value4">
153           7.62
154         </text>
155       </g>
156       <g tabindex="0" transform="translate(356.757,222.578)" role="datapoint" aria-
            labelledby="x5">
157         <rect class="bar" width="48.649" height="177.422"></rect>
158         <text x="24.325" y="10" text-anchor="middle" font-size="10" fill="white"
                role="datavalue" id="value5">
159           7.992
160         </text>
161       </g>
162       <g tabindex="0" transform="translate(437.838,207.067)" role="datapoint" aria-
            labelledby="x6">
163         <rect class="bar" width="48.649" height="192.933"></rect>
164         <text x="24.325" y="10" text-anchor="middle" font-size="10" fill="white"
                role="datavalue" id="value6">
165           8.341
166         </text>
167       </g>
168       <g tabindex="0" transform="translate(518.919,183.2)" role="datapoint" aria-
            labelledby="x7">
169         <rect class="bar" width="48.649" height="216.8"></rect>
170         <text x="24.325" y="10" text-anchor="middle" font-size="10" fill="white"
                role="datavalue" id="value7">
171           8.878
172         </text>
173       </g>
174     </g>
175   </g>
176 </svg>
```

Listing A.5 (cont.)**:** The SVG source code of a bar chart generated by AChart Creator.

```
<svg xmlns="http://www.w3.org/2000/svg" xmlns:xlink="http://www.w3.org/1999/xlink"
    version="1.1" viewBox="0 0 825 600" role="graphics-document">
  <rect id="backdrop" width="825" height="600" fill="#fff"/>
  <g id="ChartRoot" role="chart" tabindex="0" transform="translate(100,100)" aria-
      labelledby="title desc" aria-charttype="bar-stacked" aria-roledescription="
      Stacked Bar Chart">
    <desc id="desc">Seats of Political Parties in Austria per Federal state</desc>
    <rect role="chartarea" width="600" height="400" fill="none"/>
    <text id="title" role="heading" text-anchor="middle" font-size="14" x="312.5" y=
        "-25">Seats of Political Parties in Austria</text>
    <g id="xScale" role="xaxis" aria-axistype="category" aria-roledescription="x-
        Axis" aria-labelledby="x-title" tabindex="0" transform="translate(0,400)"
        fill="none" font-size="10" font-family="sans-serif" text-anchor="middle">
      <text y="62.5" x="300" text-anchor="middle" fill="black" font-size="12" role="
          heading" id="x-title">Federal States</text>
      <path class="domain" stroke="currentColor" d="M0.5,6V0.5H600.5V6"/>
      <g class="tick" opacity="1" transform="translate(44.681,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x1">Burgenland</text>
      </g>
      <g class="tick" opacity="1" transform="translate(108.511,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x2">Kärnten</text>
      </g>
      <g class="tick" opacity="1" transform="translate(172.34,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x3">Niederösterreich</text>
      </g>
      <g class="tick" opacity="1" transform="translate(236.17,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x4">Oberösterreich</text>
      </g>
      <g class="tick" opacity="1" transform="translate(300,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x5">Salzburg</text>
      </g>
      <g class="tick" opacity="1" transform="translate(363.83,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x6">Steiermark</text>
      </g>
      <g class="tick" opacity="1" transform="translate(427.66,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x7">Tirol</text>
      </g>
      <g class="tick" opacity="1" transform="translate(491.489,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x8">Vorarlberg</text>
      </g>
```

Listing A.6: Part of the SVG source code of a stacked bar chart generated by AChart Creator from the Austrian Election dataset shown in Listing A.2.

```
42        <g class="tick" opacity="1" transform="translate(555.319,0)">
43          <line stroke="currentColor" y2="6"/>
44          <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
                anchor: end;" transform="rotate(-45)" id="x9">Wien</text>
45        </g>
46      </g>
47      <g id="yScale" role="yaxis" aria-roledescription="y-Axis" tabindex="0" aria-
            valuemin="0" aria-valuemax="100" aria-labelledby="y-title" fill="none" font-
            size="10" font-family="sans-serif" text-anchor="end">
48        <text transform="rotate(-90)" y="-38" x="-200" text-anchor="middle" fill="
              black" role="heading" id="y-title" font-size="12">Number of  Seats in
              percent</text>
49        <path class="domain" stroke="currentColor" d="M-6,400.5H0.5V0.5H-6"/>
50        <g class="tick" opacity="1" transform="translate(0,400.5)">
51          <line stroke="currentColor" x2="-6"/>
52          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y1">0</text>
53        </g>
54        <g class="tick" opacity="1" transform="translate(0,360.5)">
55          <line stroke="currentColor" x2="-6"/>
56          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y2">10</text>
57        </g>
58        <g class="tick" opacity="1" transform="translate(0,320.5)">
59          <line stroke="currentColor" x2="-6"/>
60          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y3">20</text>
61        </g>
62        <g class="tick" opacity="1" transform="translate(0,280.5)">
63          <line stroke="currentColor" x2="-6"/>
64          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y4">30</text>
65        </g>
66        <g class="tick" opacity="1" transform="translate(0,240.5)">
67          <line stroke="currentColor" x2="-6"/>
68          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y5">40</text>
69        </g>
70        <g class="tick" opacity="1" transform="translate(0,200.5)">
71          <line stroke="currentColor" x2="-6"/>
72          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y6">50</text>
73        </g>
74        <g class="tick" opacity="1" transform="translate(0,160.5)">
75          <line stroke="currentColor" x2="-6"/>
76          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y7">60</text>
77        </g>
78        <g class="tick" opacity="1" transform="translate(0,120.5)">
79          <line stroke="currentColor" x2="-6"/>
80          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y8">70</text>
81        </g>
82        <g class="tick" opacity="1" transform="translate(0,80.5)">
83          <line stroke="currentColor" x2="-6"/>
84          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y9">80</text>
85        </g>
```

Listing A.6 (cont.)**:** Part of the SVG source code of a stacked bar chart generated by AChart Creator.

```
86        <g class="tick" opacity="1" transform="translate(0,40.5)">
87          <line stroke="currentColor" x2="-6"/>
88          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y10">90</text>
89        </g>
90        <g class="tick" opacity="1" transform="translate(0,0.5)">
91          <line stroke="currentColor" x2="-6"/>
92          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y11">100</text>
93        </g>
94      </g>
95      <g id="dataset" role="dataset" tabindex="0" aria-labelledby="dataset-title">
96        <title role="heading" id="dataset-title">Seats of Political Parties in Austria
              </title>
97        <g id="datagroup-1" role="datagroup" tabindex="0" aria-labelledby="datagroup-
              title-1">
98          <title role="heading" id="datagroup-title-1">Burgenland</title>
99          <g tabindex="0" transform="translate(25.532,246.96)" role="datapoint" aria-
                labelledby="legenditem1">
100           <rect fill="#63C3D0" width="38.298" height="153.04"/>
101           <text x="19.149" y="81.52" text-anchor="middle" font-size="10" fill="black
                  " role="datavalue" id="value1-1">38.26</text>
102         </g>
103         <g tabindex="0" transform="translate(25.532,129.44)" role="datapoint" aria-
                labelledby="legenditem2">
104           <rect fill="#CE000C" width="38.298" height="117.52"/>
105           <text x="19.149" y="63.76" text-anchor="middle" font-size="10" fill="black
                  " role="datavalue" id="value1-2">29.38</text>
106         </g>
107         ...
108       </g>
109       <g id="datagroup-2" role="datagroup" tabindex="0" aria-labelledby="datagroup-
              title-2">
110         <title role="heading" id="datagroup-title-2">Kärnten</title>
111         <g tabindex="0" transform="translate(89.362,260.4)" role="datapoint" aria-
                labelledby="legenditem1">
112           <rect fill="#63C3D0" width="38.298" height="139.6"/>
113           <text x="19.149" y="74.8" text-anchor="middle" font-size="10" fill="black"
                    role="datavalue" id="value2-1">34.9</text>
114         </g>
115         ...
116       </g>
117       ...
118     </g>
119     <g role="legend" aria-roledescription="Legend" font-size="10" font-family="sans-
          serif" text-anchor="start" tabindex="0" aria-labelledby="legend-title"
          transform="translate(608, 20)">
120       <text role="heading" font-size="12" id="legend-title">Legend</text>
121       <g role="legenditem" id="legenditem1" transform="translate(0,15)" tabindex="0"
            >
122         <rect x="5" y="-5" width="10" height="10" fill="#63C3D0"/>
123         <text x="25" alignment-baseline="middle">oevp</text>
124       </g>
```

Listing A.6 (cont.)**:** Part of the SVG source code of a stacked bar chart generated by AChart Creator.

```
125       <g role="legenditem" id="legenditem2" transform="translate(0,30)" tabindex="0"
              >
126         <rect x="5" y="-5" width="10" height="10" fill="#CE000C"/>
127         <text x="25" alignment-baseline="middle">spoe</text>
128       </g>
129       <g role="legenditem" id="legenditem3" transform="translate(0,45)" tabindex="0"
              >
130         <rect x="5" y="-5" width="10" height="10" fill="#0056A2"/>
131         <text x="25" alignment-baseline="middle">fpoe</text>
132       </g>
133       <g role="legenditem" id="legenditem4" transform="translate(0,60)" tabindex="0"
              >
134         <rect x="5" y="-5" width="10" height="10" fill="#88B626"/>
135         <text x="25" alignment-baseline="middle">gruene</text>
136       </g>
137       <g role="legenditem" id="legenditem5" transform="translate(0,75)" tabindex="0"
              >
138         <rect x="5" y="-5" width="10" height="10" fill="#E84188"/>
139         <text x="25" alignment-baseline="middle">neos</text>
140       </g>
141       <g role="legenditem" id="legenditem6" transform="translate(0,90)" tabindex="0"
              >
142         <rect x="5" y="-5" width="10" height="10" fill="#DCDCDC"/>
143         <text x="25" alignment-baseline="middle">other</text>
144       </g>
145     </g>
146   </g>
147 </svg>
```

Listing A.6 (cont.)**:** Part of the SVG source code of a stacked bar chart generated by AChart Creator.

```
<svg xmlns="http://www.w3.org/2000/svg" xmlns:xlink="http://www.w3.org/1999/xlink"
    version="1.1" viewBox="0 0 825 600" role="graphics-document">
  <rect id="backdrop" width="825" height="600" fill="#fff"/>
  <g id="ChartRoot" role="chart" tabindex="0" transform="translate(100,100)" aria-
      labelledby="title desc" aria-charttype="bar-grouped" aria-roledescription="
      Grouped Bar Chart">
    <desc id="desc">Seats of Political Parties in Austria per Federal state</desc>
    <rect role="chartarea" width="600" height="400" fill="none"/>
    <text id="title" role="heading" text-anchor="middle" font-size="14" x="312.5" y=
        "-25">Seats of Political Parties in Austria</text>
    <g id="xScale" role="xaxis" aria-axistype="category" aria-roledescription="x-
        Axis" aria-labelledby="x-title" tabindex="0" transform="translate(0,400)"
        fill="none" font-size="10" font-family="sans-serif" text-anchor="middle">
      <text y="62.5" x="300" text-anchor="middle" fill="black" font-size="12" role="
          heading" id="x-title">Federal States</text>
      <path class="domain" stroke="currentColor" d="M0.5,6V0.5H600.5V6"/>
      <g class="tick" opacity="1" transform="translate(44.681,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x1">Burgenland</text>
      </g>
      <g class="tick" opacity="1" transform="translate(108.511,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x2">Kärnten</text>
      </g>
      <g class="tick" opacity="1" transform="translate(172.34,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x3">Niederösterreich</text>
      </g>
      <g class="tick" opacity="1" transform="translate(236.17,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x4">Oberösterreich</text>
      </g>
      <g class="tick" opacity="1" transform="translate(300,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x5">Salzburg</text>
      </g>
      <g class="tick" opacity="1" transform="translate(363.83,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x6">Steiermark</text>
      </g>
      <g class="tick" opacity="1" transform="translate(427.66,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x7">Tirol</text>
      </g>
      <g class="tick" opacity="1" transform="translate(491.489,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x8">Vorarlberg</text>
      </g>
```

Listing A.7: Part of the SVG source code of a grouped bar chart generated by AChart Creator from the Austrian Election dataset shown in Listing A.2.

```
42        <g class="tick" opacity="1" transform="translate(555.319,0)">
43          <line stroke="currentColor" y2="6"/>
44          <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
                anchor: end;" transform="rotate(-45)" id="x9">Wien</text>
45        </g>
46      </g>
47      <g id="yScale" role="yaxis" aria-roledescription="y-Axis" tabindex="0" aria-
            valuemin="2" aria-valuemax="58" aria-labelledby="y-title" fill="none" font-
            size="10" font-family="sans-serif" text-anchor="end">
48        <text transform="rotate(-90)" y="-38" x="-200" text-anchor="middle" fill="
              black" role="heading" id="y-title" font-size="12">Number of  Seats in
              percent</text>
49        <path class="domain" stroke="currentColor" d="M-6,400.5H0.5V0.5H-6"/>
50        <g class="tick" opacity="1" transform="translate(0,379.071)">
51          <line stroke="currentColor" x2="-6"/>
52          <text fill="currentColor" x="-9" dy="0.32em" style="text-anchor: end;"
                transform="rotate(0)" id="y1">5</text>
53        </g>
54        <g class="tick" opacity="1" transform="translate(0,343.357)">
55          <line stroke="currentColor" x2="-6"/>
56          <text fill="currentColor" x="-9" dy="0.32em" style="text-anchor: end;"
                transform="rotate(0)" id="y2">10</text>
57        </g>
58        <g class="tick" opacity="1" transform="translate(0,307.643)">
59          <line stroke="currentColor" x2="-6"/>
60          <text fill="currentColor" x="-9" dy="0.32em" style="text-anchor: end;"
                transform="rotate(0)" id="y3">15</text>
61        </g>
62        <g class="tick" opacity="1" transform="translate(0,271.929)">
63          <line stroke="currentColor" x2="-6"/>
64          <text fill="currentColor" x="-9" dy="0.32em" style="text-anchor: end;"
                transform="rotate(0)" id="y4">20</text>
65        </g>
66        <g class="tick" opacity="1" transform="translate(0,236.214)">
67          <line stroke="currentColor" x2="-6"/>
68          <text fill="currentColor" x="-9" dy="0.32em" style="text-anchor: end;"
                transform="rotate(0)" id="y5">25</text>
69        </g>
70        <g class="tick" opacity="1" transform="translate(0,200.5)">
71          <line stroke="currentColor" x2="-6"/>
72          <text fill="currentColor" x="-9" dy="0.32em" style="text-anchor: end;"
                transform="rotate(0)" id="y6">30</text>
73        </g>
74        <g class="tick" opacity="1" transform="translate(0,164.786)">
75          <line stroke="currentColor" x2="-6"/>
76          <text fill="currentColor" x="-9" dy="0.32em" style="text-anchor: end;"
                transform="rotate(0)" id="y7">35</text>
77        </g>
78        <g class="tick" opacity="1" transform="translate(0,129.071)">
79          <line stroke="currentColor" x2="-6"/>
80          <text fill="currentColor" x="-9" dy="0.32em" style="text-anchor: end;"
                transform="rotate(0)" id="y8">40</text>
81        </g>
82        <g class="tick" opacity="1" transform="translate(0,93.357)">
83          <line stroke="currentColor" x2="-6"/>
84          <text fill="currentColor" x="-9" dy="0.32em" style="text-anchor: end;"
                transform="rotate(0)" id="y9">45</text>
85        </g>
```

Listing A.7 (cont.)**:** Part of the SVG source code of a grouped bar chart generated by AChart Creator.

```
86        <g class="tick" opacity="1" transform="translate(0,57.643)">
87          <line stroke="currentColor" x2="-6"/>
88          <text fill="currentColor" x="-9" dy="0.32em" style="text-anchor: end;"
                transform="rotate(0)" id="y10">50</text>
89        </g>
90        <g class="tick" opacity="1" transform="translate(0,21.929)">
91          <line stroke="currentColor" x2="-6"/>
92          <text fill="currentColor" x="-9" dy="0.32em" style="text-anchor: end;"
                transform="rotate(0)" id="y11">55</text>
93        </g>
94      </g>
95      <g id="dataset" role="dataset" tabindex="0" aria-labelledby="dataset-title">
96        <title role="heading" id="dataset-title">Seats of Political Parties in Austria
              </title>
97        <g id="datagroup-1" role="datagroup" tabindex="0" aria-labelledby="datagroup-
              title-1">
98          <title role="heading" id="datagroup-title-1">Burgenland</title>
99          <g tabindex="0" transform="translate(25.532,141)" role="datapoint" aria-
                labelledby="legenditem1">
100           <rect fill="#63C3D0" width="6.383" height="259"/>
101           <text x="3.192" y="10" text-anchor="middle" font-size="5" fill="black"
                  role="datavalue" id="value1-1">38.26</text>
102         </g>
103         <g tabindex="0" transform="translate(31.915,204.429)" role="datapoint" aria-
                labelledby="legenditem2">
104           <rect fill="#CE000C" width="6.383" height="195.571"/>
105           <text x="3.192" y="10" text-anchor="middle" font-size="5" fill="black"
                  role="datavalue" id="value1-2">29.38</text>
106         </g>
107         <g tabindex="0" transform="translate(38.298,290.357)" role="datapoint" aria-
                labelledby="legenditem3">
108           <rect fill="#0056A2" width="6.383" height="109.643"/>
109           <text x="3.192" y="10" text-anchor="middle" font-size="5" fill="black"
                  role="datavalue" id="value1-3">17.35</text>
110         </g>
111         ...
112       </g>
113       <g id="datagroup-2" role="datagroup" tabindex="0" aria-labelledby="datagroup-
              title-2">
114         <title role="heading" id="datagroup-title-2">Kärnten</title>
115         <g tabindex="0" transform="translate(89.362,165)" role="datapoint" aria-
                labelledby="legenditem1">
116           <rect fill="#63C3D0" width="6.383" height="235"/>
117           <text x="3.192" y="10" text-anchor="middle" font-size="5" fill="black"
                  role="datavalue" id="value2-1">34.9</text>
118         </g>
119         <g tabindex="0" transform="translate(95.745,227.429)" role="datapoint" aria-
                labelledby="legenditem2">
120           <rect fill="#CE000C" width="6.383" height="172.571"/>
121           <text x="3.192" y="10" text-anchor="middle" font-size="5" fill="black"
                  role="datavalue" id="value2-2">26.16</text>
122         </g>
123         ...
124       </g>
```

Listing A.7 (cont.)**:** Part of the SVG source code of a grouped bar chart generated by AChart Creator.

```
      ...
    </g>
    <g role="legend" aria-roledescription="Legend" font-size="10" font-family="sans-
        serif" text-anchor="start" tabindex="0" aria-labelledby="legend-title"
        transform="translate(608, 20)">
      <text role="heading" font-size="12" id="legend-title">Legend</text>
      <g role="legenditem" id="legenditem1" transform="translate(0,15)" tabindex="0"
          >
        <rect x="5" y="-5" width="10" height="10" fill="#63C3D0"/>
        <text x="25" alignment-baseline="middle">oevp</text>
      </g>
      <g role="legenditem" id="legenditem2" transform="translate(0,30)" tabindex="0"
          >
        <rect x="5" y="-5" width="10" height="10" fill="#CE000C"/>
        <text x="25" alignment-baseline="middle">spoe</text>
      </g>
      <g role="legenditem" id="legenditem3" transform="translate(0,45)" tabindex="0"
          >
        <rect x="5" y="-5" width="10" height="10" fill="#0056A2"/>
        <text x="25" alignment-baseline="middle">fpoe</text>
      </g>
      <g role="legenditem" id="legenditem4" transform="translate(0,60)" tabindex="0"
          >
        <rect x="5" y="-5" width="10" height="10" fill="#88B626"/>
        <text x="25" alignment-baseline="middle">gruene</text>
      </g>
      <g role="legenditem" id="legenditem5" transform="translate(0,75)" tabindex="0"
          >
        <rect x="5" y="-5" width="10" height="10" fill="#E84188"/>
        <text x="25" alignment-baseline="middle">neos</text>
      </g>
      <g role="legenditem" id="legenditem6" transform="translate(0,90)" tabindex="0"
          >
        <rect x="5" y="-5" width="10" height="10" fill="#DCDCDC"/>
        <text x="25" alignment-baseline="middle">other</text>
      </g>
    </g>
  </g>
</svg>
```

Listing A.7 (cont.)**:** Part of the SVG source code of a grouped bar chart generated by AChart Creator.

```
<svg xmlns="http://www.w3.org/2000/svg" xmlns:xlink="http://www.w3.org/1999/xlink"
    version="1.1" viewBox="0 0 825 600" role="graphics-document">
  <rect id="backdrop" width="825" height="600" fill="#fff"/>
  <g id="ChartRoot" role="chart" tabindex="0" transform="translate(100,100)" aria-
      labelledby="title desc" aria-charttype="scatter" aria-roledescription="Scatter
       Plot">
    <desc id="desc">Sepal length and width plotted as Scatter Plot. Colour is
        mapped to species and size is  mapped to petal length</desc>
    <rect role="chartarea" width="600" height="400" fill="none"/>
    <text id="title" role="heading" text-anchor="middle" font-size="14" x="312.5" y=
        "-25">Iris Flower Dataset</text>
    <g id="xScale" role="xaxis" aria-roledescription="x-Axis" aria-axistype="" aria-
        labelledby="x-title" tabindex="0" aria-valuemin="3" aria-valuemax="9"
        transform="translate(0,400)" fill="none" font-size="10" font-family="sans-
        serif" text-anchor="middle">
      <text y="50" x="300" text-anchor="middle" fill="black" font-size="12" role="
          heading" id="x-title">sepal length</text>
      <path class="domain" stroke="currentColor" d="M0.5,6V0.5H600.5V6"/>
      <g class="tick" opacity="1" transform="translate(0.5,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: middle;" transform="rotate(0)" id="x1">3</text>
      </g>
      <g class="tick" opacity="1" transform="translate(50.5,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: middle;" transform="rotate(0)" id="x2">3.5</text>
      </g>
      <g class="tick" opacity="1" transform="translate(100.5,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: middle;" transform="rotate(0)" id="x3">4</text>
      </g>
      <g class="tick" opacity="1" transform="translate(150.5,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: middle;" transform="rotate(0)" id="x4">4.5</text>
      </g>
      <g class="tick" opacity="1" transform="translate(200.5,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: middle;" transform="rotate(0)" id="x5">5</text>
      </g>
      <g class="tick" opacity="1" transform="translate(250.5,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: middle;" transform="rotate(0)" id="x6">5.5</text>
      </g>
      <g class="tick" opacity="1" transform="translate(300.5,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: middle;" transform="rotate(0)" id="x7">6</text>
      </g>
      <g class="tick" opacity="1" transform="translate(350.5,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: middle;" transform="rotate(0)" id="x8">6.5</text>
      </g>
```

Listing A.8: Part of the SVG source code of a scatter plot generated by AChart Creator from the Iris dataset shown in Listing A.3.

```
42        <g class="tick" opacity="1" transform="translate(400.5,0)">
43          <line stroke="currentColor" y2="6"/>
44          <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
                anchor: middle;" transform="rotate(0)" id="x9">7</text>
45        </g>
46        <g class="tick" opacity="1" transform="translate(450.5,0)">
47          <line stroke="currentColor" y2="6"/>
48          <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
                anchor: middle;" transform="rotate(0)" id="x10">7.5</text>
49        </g>
50        <g class="tick" opacity="1" transform="translate(500.5,0)">
51          <line stroke="currentColor" y2="6"/>
52          <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
                anchor: middle;" transform="rotate(0)" id="x11">8</text>
53        </g>
54        <g class="tick" opacity="1" transform="translate(550.5,0)">
55          <line stroke="currentColor" y2="6"/>
56          <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
                anchor: middle;" transform="rotate(0)" id="x12">8.5</text>
57        </g>
58        <g class="tick" opacity="1" transform="translate(600.5,0)">
59          <line stroke="currentColor" y2="6"/>
60          <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
                anchor: middle;" transform="rotate(0)" id="x13">9</text>
61        </g>
62      </g>
63      <g id="yScale" role="yaxis" aria-roledescription="y-Axis" tabindex="0" aria-
            valuemin="1" aria-valuemax="5" aria-labelledby="y-title" fill="none" font-
            size="10" font-family="sans-serif" text-anchor="end">
64        <text transform="rotate(-90)" y="-38" x="-200" text-anchor="middle" fill="
              black" font-size="12" role="heading" id="y-title">sepal width</text>
65        <path class="domain" stroke="currentColor" d="M-6,0.5H0.5V400.5H-6"/>
66        <g class="tick" opacity="1" transform="translate(0,0.5)">
67          <line stroke="currentColor" x2="-6"/>
68          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y5">5</text>
69        </g>
70        <g class="tick" opacity="1" transform="translate(0,50.5)">
71          <line stroke="currentColor" x2="-6"/>
72          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y4.5">4.5</text>
73        </g>
74        <g class="tick" opacity="1" transform="translate(0,100.5)">
75          <line stroke="currentColor" x2="-6"/>
76          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y4">4</text>
77        </g>
78        <g class="tick" opacity="1" transform="translate(0,150.5)">
79          <line stroke="currentColor" x2="-6"/>
80          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y3.5">3.5</text>
81        </g>
82        <g class="tick" opacity="1" transform="translate(0,200.5)">
83          <line stroke="currentColor" x2="-6"/>
84          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y3">3</text>
85        </g>
```

Listing A.8 (cont.)**:** Part of the SVG source code of a scatter plot generated by AChart Creator.

```
86        <g class="tick" opacity="1" transform="translate(0,250.5)">
87          <line stroke="currentColor" x2="-6"/>
88          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y2.5">2.5</text>
89        </g>
90        <g class="tick" opacity="1" transform="translate(0,300.5)">
91          <line stroke="currentColor" x2="-6"/>
92          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y2">2</text>
93        </g>
94        <g class="tick" opacity="1" transform="translate(0,350.5)">
95          <line stroke="currentColor" x2="-6"/>
96          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y1.5">1.5</text>
97        </g>
98        <g class="tick" opacity="1" transform="translate(0,400.5)">
99          <line stroke="currentColor" x2="-6"/>
100         <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" style="text-
                anchor: end;" transform="rotate(0)" id="y1">1</text>
101       </g>
102     </g>
103     <g id="dataarea" role="dataset" aria-roledescription="Data Series">
104       <g id="datagroup-1" role="datagroup" tabindex="0" aria-labelledby="datagroup-
              title-1">
105         <title role="heading" id="datagroup-title-1">setosa</title>
106         <g tabindex="0" role="datapoint" aria-labelledby="x1-1-1 x2-1-1 legenditem1"
                >
107           <title>x1: 4.3, x2: 3, size: 1.1, class: setosa</title>
108           <desc role="datavalue" id="x1-1-1" aria-labelledby="xScale">4.3</desc>
109           <desc role="datavalue" aria-labelledby="yScale" id="x2-1-1">3</desc>
110           <circle class="dot" cx="130" cy="200" r="4.0508474576271185" fill="#66c2a5
                "/>
111         </g>
112         <g tabindex="0" role="datapoint" aria-labelledby="x1-1-2 x2-1-2 legenditem1"
                >
113           <title>x1: 4.4, x2: 3.2, size: 1.3, class: setosa</title>
114           <desc role="datavalue" id="x1-1-2" aria-labelledby="xScale">4.4</desc>
115           <desc role="datavalue" aria-labelledby="yScale" id="x2-1-2">3.2</desc>
116           <circle class="dot" cx="140" cy="180" r="4.1525423728813555" fill="#66c2a5
                "/>
117         </g>
118         <g tabindex="0" role="datapoint" aria-labelledby="x1-1-3 x2-1-3 legenditem1"
                >
119           <title>x1: 4.4, x2: 3, size: 1.3, class: setosa</title>
120           <desc role="datavalue" id="x1-1-3" aria-labelledby="xScale">4.4</desc>
121           <desc role="datavalue" aria-labelledby="yScale" id="x2-1-3">3</desc>
122           <circle class="dot" cx="140" cy="200" r="4.1525423728813555" fill="#66c2a5
                "/>
123         </g>
124         ...
```

Listing A.8 (cont.)**:** Part of the SVG source code of a scatter plot generated by AChart Creator.

```
125       </g>
126       <g id="datagroup-2" role="datagroup" tabindex="0" aria-labelledby="datagroup-
              title-2">
127         <title role="heading" id="datagroup-title-2">virginica</title>
128         <g tabindex="0" role="datapoint" aria-labelledby="x1-2-1 x2-2-1 legenditem2"
                >
129           <title>x1: 4.9, x2: 2.5, size: 4.5, class: virginica</title>
130           <desc role="datavalue" id="x1-2-1" aria-labelledby="xScale">4.9</desc>
131           <desc role="datavalue" aria-labelledby="yScale" id="x2-2-1">2.5</desc>
132           <circle class="dot" cx="190" cy="250" r="5.779661016949152" fill="#fc8d62"
                  />
133         </g>
134         ...
135       </g>
136       <g id="datagroup-3" role="datagroup" tabindex="0" aria-labelledby="datagroup-
              title-3">
137         <title role="heading" id="datagroup-title-3">versicolor</title>
138         <g tabindex="0" role="datapoint" aria-labelledby="x1-3-1 x2-3-1 legenditem3"
                >
139           <title>x1: 4.9, x2: 2.4, size: 3.3, class: versicolor</title>
140           <desc role="datavalue" id="x1-3-1" aria-labelledby="xScale">4.9</desc>
141           <desc role="datavalue" aria-labelledby="yScale" id="x2-3-1">2.4</desc>
142           <circle class="dot" cx="190" cy="260" r="5.169491525423728" fill="#8da0cb"
                  />
143         </g>
144         ...
145       </g>
146     </g>
147     <g role="legend" aria-roledescription="Legend" font-size="10" font-family="sans-
          serif" text-anchor="start" tabindex="0" aria-labelledby="legend-title"
          transform="translate(608, 20)">
148       <text role="heading" font-size="12" id="legend-title">Legend</text>
149       <g role="legenditem" id="legenditem1" transform="translate(0,15)" tabindex="0"
              >
150         <line x2="20" style="stroke-width: 3;" stroke="#66c2a5"/>
151         <text x="25" alignment-baseline="middle">setosa</text>
152       </g>
153       <g role="legenditem" id="legenditem2" transform="translate(0,30)" tabindex="0"
              >
154         <line x2="20" style="stroke-width: 3;" stroke="#fc8d62"/>
155         <text x="25" alignment-baseline="middle">virginica</text>
156       </g>
157       <g role="legenditem" id="legenditem3" transform="translate(0,45)" tabindex="0"
              >
158         <line x2="20" style="stroke-width: 3;" stroke="#8da0cb"/>
159         <text x="25" alignment-baseline="middle">versicolor</text>
160       </g>
161     </g>
162   </g>
163 </svg>
```

Listing A.8 (cont.)**:** Part of the SVG source code of a scatter plot generated by AChart Creator.

```
<svg xmlns="http://www.w3.org/2000/svg" xmlns:xlink="http://www.w3.org/1999/xlink"
    version="1.1" viewBox="0 0 800 600" role="graphics-document">
  <rect id="backdrop" width="800" height="600" fill="#fff"/>
  <g id="ChartRoot" role="chart" tabindex="0" transform="translate(75,100)" aria-
      labelledby="title desc" aria-charttype="parallel-coordinates" aria-
      roledescription="Parallel Coordinates Plot">
    <desc id="desc">Iris Flower Dataset plotted as parallel coordinates. Colour is
        mapped to species</desc>
    <rect role="chartarea" width="600" height="400" fill="none"/>
    <text id="title" role="heading" text-anchor="middle" font-size="14" x="325" y="
        -25">Iris Flower Dataset</text>
    <g id="xScale" role="xaxis" aria-roledescription="x-Axis" aria-axistype="" aria-
        labelledby="x-title" tabindex="0" aria-valuemin="4.3" aria-valuemax="7.9"
        transform="translate(0,400)" fill="none" font-size="10" font-family="sans-
        serif" text-anchor="middle">
      <text y="50" x="300" text-anchor="middle" fill="black" font-size="12" role="
          heading" id="x-title"/>
      <path class="domain" stroke="currentColor" d="M0.5,6V0.5H600.5V6"/>
      <g class="tick" opacity="1" transform="translate(0.5,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x1">sepal_length</text>
      </g>
      <g class="tick" opacity="1" transform="translate(200.5,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x2">sepal_width</text>
      </g>
      <g class="tick" opacity="1" transform="translate(400.5,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x3">petal_length</text>
      </g>
      <g class="tick" opacity="1" transform="translate(600.5,0)">
        <line stroke="currentColor" y2="6"/>
        <text fill="currentColor" y="9" dy="0.71em" role="axislabel" style="text-
            anchor: end;" transform="rotate(-45)" id="x4">petal_width</text>
      </g>
    </g>
    <g id="dataarea" role="dataset" aria-roledescription="Data Series">
      <g id="datagroup-1" role="datagroup" tabindex="0" aria-labelledby="datagroup-
          title-1">
        <title role="heading" id="datagroup-title-1">setosa</title>
        <g tabindex="0" role="datapoint" aria-labelledby="datavalue1-1-1 datavalue1
            -1-2 datavalue1-1-3 datavalue1-1-4 legenditem1">
          <path class="line" stroke-width="1" fill="None" d="M0,313.333L200,200L400
              ,345L600,386.667" stroke="#03FC8C"/>
          <title>sepal_length: 4.3 sepal_width: 3 petal_length: 1.1 petal_width: 0.1
               </title>
          <desc role="datavalue" id="datavalue1-1-1" aria-labelledby="yScale1">4.3</
              desc>
          <desc role="datavalue" id="datavalue1-1-2" aria-labelledby="yScale2">3</
              desc>
          <desc role="datavalue" id="datavalue1-1-3" aria-labelledby="yScale3">1.1</
              desc>
          <desc role="datavalue" id="datavalue1-1-4" aria-labelledby="yScale4">0.1</
              desc>
        </g>
```

Listing A.9: Part of the SVG source code of a parallel coordinates plot generated by AChart Creator from the Iris dataset shown in Listing A.3.

```
38          <g tabindex="0" role="datapoint" aria-labelledby="datavalue1-2-1 datavalue1
                -2-2 datavalue1-2-3 datavalue1-2-4 legenditem1">
39            <path class="line" stroke-width="1" fill="None" d="M0,306.667L200,180L400
                ,335L600,373.333" stroke="#03FC8C"/>
40            <title>sepal_length: 4.4 sepal_width: 3.2 petal_length: 1.3 petal_width:
                0.2 </title>
41            <desc role="datavalue" id="datavalue1-2-1" aria-labelledby="yScale1">4.4</
                desc>
42            <desc role="datavalue" id="datavalue1-2-2" aria-labelledby="yScale2">3.2</
                desc>
43            <desc role="datavalue" id="datavalue1-2-3" aria-labelledby="yScale3">1.3</
                desc>
44            <desc role="datavalue" id="datavalue1-2-4" aria-labelledby="yScale4">0.2</
                desc>
45          </g>
46          <g tabindex="0" role="datapoint" aria-labelledby="datavalue1-3-1 datavalue1
                -3-2 datavalue1-3-3 datavalue1-3-4 legenditem1">
47            <path class="line" stroke-width="1" fill="None" d="M0,306.667L200,200L400
                ,335L600,373.333" stroke="#03FC8C"/>
48            <title>sepal_length: 4.4 sepal_width: 3 petal_length: 1.3 petal_width: 0.2
                 </title>
49            <desc role="datavalue" id="datavalue1-3-1" aria-labelledby="yScale1">4.4</
                desc>
50            <desc role="datavalue" id="datavalue1-3-2" aria-labelledby="yScale2">3</
                desc>
51            <desc role="datavalue" id="datavalue1-3-3" aria-labelledby="yScale3">1.3</
                desc>
52            <desc role="datavalue" id="datavalue1-3-4" aria-labelledby="yScale4">0.2</
                desc>
53          </g>
54          <g tabindex="0" role="datapoint" aria-labelledby="datavalue1-4-1 datavalue1
                -4-2 datavalue1-4-3 datavalue1-4-4 legenditem1">
55            <path class="line" stroke-width="1" fill="None" d="M0,306.667L200,210L400
                ,330L600,373.333" stroke="#03FC8C"/>
56            <title>sepal_length: 4.4 sepal_width: 2.9 petal_length: 1.4 petal_width:
                0.2 </title>
57            <desc role="datavalue" id="datavalue1-4-1" aria-labelledby="yScale1">4.4</
                desc>
58            <desc role="datavalue" id="datavalue1-4-2" aria-labelledby="yScale2">2.9</
                desc>
59            <desc role="datavalue" id="datavalue1-4-3" aria-labelledby="yScale3">1.4</
                desc>
60            <desc role="datavalue" id="datavalue1-4-4" aria-labelledby="yScale4">0.2</
                desc>
61          </g>
62          ...
63        </g>
```

Listing A.9 (cont.)**:** Part of the SVG source code of a parallel coordinates plot generated by AChart Creator.

```
64        <g id="datagroup-2" role="datagroup" tabindex="0" aria-labelledby="datagroup-
              title-2">
65          <title role="heading" id="datagroup-title-2">virginica</title>
66          <g tabindex="0" role="datapoint" aria-labelledby="datavalue2-1-1 datavalue2
                -1-2 datavalue2-1-3 datavalue2-1-4 legenditem1">
67            <path class="line" stroke-width="1" fill="None" d="M0,273.333L200,250L400
                  ,175L600,173.333" stroke="#03D7FC"/>
68            <title>sepal_length: 4.9 sepal_width: 2.5 petal_length: 4.5 petal_width:
                  1.7 </title>
69            <desc role="datavalue" id="datavalue2-1-1" aria-labelledby="yScale1">4.9</
                  desc>
70            <desc role="datavalue" id="datavalue2-1-2" aria-labelledby="yScale2">2.5</
                  desc>
71            <desc role="datavalue" id="datavalue2-1-3" aria-labelledby="yScale3">4.5</
                  desc>
72            <desc role="datavalue" id="datavalue2-1-4" aria-labelledby="yScale4">1.7</
                  desc>
73          </g>
74          ...
75        </g>
76        ...
77      </g>
78      <g role="legend" aria-roledescription="Legend" font-size="10" font-family="sans-
            serif" text-anchor="start" tabindex="0" aria-labelledby="legend-title"
            transform="translate(608, 20)">
79        <text role="heading" font-size="12" id="legend-title">Legend</text>
80        <g role="legenditem" id="legenditem1" transform="translate(0,15)" tabindex="0"
              >
81          <line x2="20" style="stroke-width: 3;" stroke="#03FC8C"/>
82          <text x="25" alignment-baseline="middle">setosa</text>
83        </g>
84        <g role="legenditem" id="legenditem2" transform="translate(0,30)" tabindex="0"
              >
85          <line x2="20" style="stroke-width: 3;" stroke="#03D7FC"/>
86          <text x="25" alignment-baseline="middle">virginica</text>
87        </g>
88        <g role="legenditem" id="legenditem3" transform="translate(0,45)" tabindex="0"
              >
89          <line x2="20" style="stroke-width: 3;" stroke="#FCA503"/>
90          <text x="25" alignment-baseline="middle">versicolor</text>
91        </g>
92      </g>
93      <g id="yScale1" role="yaxis" aria-roledescription="y-Axis" tabindex="0" aria-
            valuemin="3" aria-valuemax="9" transform="translate(0,0)" fill="none" font-
            size="10" font-family="sans-serif" text-anchor="end">
94        <desc role="heading">sepal_length</desc>
95        <path class="domain" stroke="currentColor" d="M-6,400.5H0.5V0.5H-6"/>
96        <g class="tick" opacity="1" transform="translate(0,400.5)">
97          <line stroke="currentColor" x2="-6"/>
98          <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y1-3">3</
                text>
99        </g>
```

Listing A.9 (cont.)**:** Part of the SVG source code of a parallel coordinates plot generated by AChart Creator.

```
100       <g class="tick" opacity="1" transform="translate(0,367.167)">
101         <line stroke="currentColor" x2="-6"/>
102         <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y1-3.5"
                >3.5</text>
103       </g>
104       <g class="tick" opacity="1" transform="translate(0,333.833)">
105         <line stroke="currentColor" x2="-6"/>
106         <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y1-4">4</
                text>
107       </g>
108       ...
109     </g>
110     <g id="yScale2" role="yaxis" aria-roledescription="y-Axis" tabindex="0" aria-
          valuemin="1" aria-valuemax="5" transform="translate(200,0)" fill="none" font
          -size="10" font-family="sans-serif" text-anchor="end">
111       <desc role="heading">sepal_width</desc>
112       <path class="domain" stroke="currentColor" d="M-6,400.5H0.5V0.5H-6"/>
113       <g class="tick" opacity="1" transform="translate(0,400.5)">
114         <line stroke="currentColor" x2="-6"/>
115         <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y2-1">1</
                text>
116       </g>
117       ...
118     </g>
119     <g id="yScale3" role="yaxis" aria-roledescription="y-Axis" tabindex="0" aria-
          valuemin="0" aria-valuemax="8" transform="translate(400,0)" fill="none" font
          -size="10" font-family="sans-serif" text-anchor="end">
120       <desc role="heading">petal_length</desc>
121       <path class="domain" stroke="currentColor" d="M-6,400.5H0.5V0.5H-6"/>
122       <g class="tick" opacity="1" transform="translate(0,400.5)">
123         <line stroke="currentColor" x2="-6"/>
124         <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y3-0">0</
                text>
125       </g>
126       ...
127     </g>
128     <g id="yScale4" role="yaxis" aria-roledescription="y-Axis" tabindex="0" aria-
          valuemin="0" aria-valuemax="3" transform="translate(600,0)" fill="none" font
          -size="10" font-family="sans-serif" text-anchor="end">
129       <desc role="heading">petal_width</desc>
130       <path class="domain" stroke="currentColor" d="M-6,400.5H0.5V0.5H-6"/>
131       <g class="tick" opacity="1" transform="translate(0,400.5)">
132         <line stroke="currentColor" x2="-6"/>
133         <text fill="currentColor" x="-9" dy="0.32em" role="axislabel" id="y4-0">0</
                text>
134       </g>
135       ...
136     </g>
137   </g>
138 </svg>
```

Listing A.9 (cont.)**:** Part of the SVG source code of a parallel coordinates plot generated by AChart Creator.

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