Svelte and Sapper IN ACTION

R. Mark Volkmann

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R. MARK VOLKMANN

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preface

I have been a professional software developer for 37 years and a web developer for around 10 years. My projects have used many technologies and frameworks, including raw DOM manipulation, jQuery, Ruby, Angular 1, React, Polymer, Angular 2+, Vue, Svelte, and probably some I have forgotten.

I place a high value on developer productivity. Unnecessary complexity really works against this. While I find many things to love about Svelte and Sapper, the main driver for me is their simplicity compared to other web development approaches. I know from my experience of using other frameworks that I am far more productive when using Svelte and Sapper.

My first exposure to Svelte came from watching a talk titled "Rethinking Reactivity" by the creator of Svelte, Rich Harris. It is a very compelling talk and definitely appealed to my desire to reduce the complexity of web development. That led me to dig in further, write a long article about Svelte, give talks at user groups, and expand to giving talks at conferences. The next logical step was to write this book!

The book covers nearly every topic related to Svelte and Sapper, and some that are only tangentially related. After reading this, you should be well-poised to use these tools in your next web development project.

acknowledgments

Many authors thank their spouses for the patience they showed during the writing process. The experience of writing this book has made clear to me the sacrifices involved. My wife Tami generously gave me lots of encouragement and time to complete this project. Thank you so much Tami for helping me to achieve the goal of finally writing a book!

Thanks to my Manning development editor, Jennifer Stout, who provided just the right amount of corrections, suggestions, encouragement, and compliments to keep me going. Seeing comments like "I love this!" mixed in with comments like "You need to explain why someone would want to do this" made the writing process so much more bearable.

Thanks to Manning technical editor Alain Couniot who continually pointed out when I wasn't being clear or was short on providing compelling examples. He also made sure I mentioned TypeScript wherever possible. The book is much better because of his feedback!

Thanks to Manning technical reviewer Erik Vullings. He tried many things in the example code that never crossed my mind to try and suggested many improvements in the text. His thoroughness was greatly appreciated!

Thanks to Peer Reynders, a volunteer MEAP reviewer who went through all the code examples with a fine-tooth comb and pointed out many ways I could improve it.

Thanks to reviewers who added their own takes on ways to improve the book: Adail Retamal, Amit Lamba, Clive Harber, Damian Esteban, David Cabrero Souto, David Paccoud, Dennis Reil, Gerd Klevesaat, Gustavo Filipe Ramos Gomes, Jonathan Cook,

Kelum Senanayake, Konstantinos Leimonis, Matteo Gildone, Potito Coluccelli, Robert Walsh, Rodney Weis, Sander Zegveld, Sergio Arbeo, and Tanya Wilke. More eyes and more opinions definitely helped!

Thanks to Charles Sharp of Object Computing, Inc. He has been the most frequent editor of all my previous writings. Charles donated large amounts of time over past 10 plus years to making me a better writer . . . Oxford comma and all!

Thanks to Eldon Ahrold of Object Computing, Inc. for reviewing the chapter on Svelte Native. Eldon is a very experienced mobile and web developer, and I'm lucky to be able to bounce ideas off of him.

Finally, thanks to Dr. Ebrahim Moshiri who hired me into Object Computing, Inc. 24 years ago. He provided me with an environment that encourages continual learning and I've never stopped. I most likely would not have been in a position to write this book if it wasn't for the career he gave me.

about this book

Who should read this book

Svelte and Sapper in Action is for web developers who want to increase their productivity. Maybe you have a nagging suspicion that there must be an easier way to develop web applications. Good news—there is, and you will learn about it here!

Through numerous code examples, you will learn how to use Svelte and Sapper to implement many common features of web applications.

The book assumes that readers have a basic familiarity with HTML, CSS, and JavaScript:

- On the topic of HTML, readers should be familiar with elements like html, head, link, style, script, body, div, span, p, ol, ul, li, input, textarea, and select.
- On the topic of CSS, readers should understand the syntax of CSS rules, the CSS meaning of "cascade," basic CSS selectors (including element names, class names, ids, descendants, and children), commonly used CSS properties (including color, font-family, font-size, font-style, and font-weight), and the CSS box model (content, padding, border, and margin).
- On the topic of JavaScript, readers should know about variables, strings, arrays, objects, functions, classes, Promises, destructuring, the spread operator, exports, and imports.

I am easy to find online, should you have questions about anything in the book. My hope is that by the time you make it through this book, you will be convinced that there is something special about Svelte and Sapper. These are technologies that deserve a shot at being used in your next project.

How this book is organized: A roadmap

This book is divided into 4 parts containing a total of 21 chapters.

Part 1 introduces Svelte and Sapper.

- Chapter 1 explains why these approaches to web development deserve your attention. It concludes with a brief introduction to Svelte Native, a comparison of Svelte to other popular web frameworks, and a description of the tools you will need to get started.
- Chapter 2 walks you through building your first Svelte applications using an online tool (called the "REPL"). Apps built this way can be saved, shared with others, and exported to continue development locally. Then the steps for developing Svelte apps locally are described.

Part 2 dives deep into Svelte, providing thorough coverage along with lots of example code.

- Chapter 3 teaches you how to build Svelte components. This includes the logic, markup, and styling. Then it covers managing component state, using reactive statements, and using module context. Finally, an example of developing and using a custom component is presented.
- Chapter 4 covers Svelte block structures that wrap conditional logic, iteration, and promise handling around markup, which is typically HTML. Conditional logic is implemented using `{#if}`, iteration is implemented using `{#each}`, and promise handling is implemented using `{#await}`.
- Chapter 5 explores several options for communicating between components. These include using props, two-way binding, slots, events, and context.
- Chapter 6 describes the use of stores to share state between components. There are four kinds of stores: writable, readable, derived, and custom. Then techniques for using stores with JavaScript classes and persisting store data are described.
- Chapter 7 shows various approaches to interacting with the DOM in Svelte components. This includes inserting HTML, using "actions" to gain access to DOM elements, and using the `tick` function to manually modify the DOM after Svelte updates it. Finally, approaches to implementing dialog boxes and drag-and-drop are presented.
- Chapter 8 reviews the provided lifecycle functions that enable registering functions to be called at key points in the lifecycle of components. These include onMount, beforeUpdate, afterUpdate, and onDestroy. Finally, an approach to implementing custom lifecycle functions based on the provided lifecycle functions is presented.

- Chapter 9 demonstrates three approaches to adding page routing in Svelte applications: manual routing, hash routing, and using the page.js library. A shopping app is developed to demonstrate each of these options. Another popular approach is to use Sapper. Sapper routing is discussed in chapter 16.
- Chapter 10 explores the extensive support for animation that is built into Svelte. The packages svelte/animate, svelte/motion, and svelte/transition are described in detail. Two approaches to animating moving items between two lists are presented. One uses a combination of the `fade` transition and the `flip` animation. Another uses the `crossfade` transition. Finally, the creation of custom animations and using transition events is discussed.
- Chapter 11 shows several approaches to debugging issues in Svelte applications. These include using the `@debug` tag, reactive statements with `console` methods, and the svelte-devtools browser extension.
- Chapter 12 demonstrates various approaches to testing Svelte applications. Unit tests are implemented with Jest and svelte-testing-library. End-to-end tests are implemented with Cypress. Some accessibility checking is provided by the Svelte compiler. Additional accessibility testing is performed with Lighthouse, axe, and WAVE. Finally, Storybook is used to demonstrate and manually test components.
- Chapter 13 explores a few options for deploying Svelte applications. These include manual deployment to an HTTP server, using Netlify, using Vercel Now, and using Docker.
- Chapter 14 covers additional topics related to Svelte. These include form validation, using CSS libraries, using "special elements," creating Svelte component libraries, and generating web components from Svelte components.

Part 3 explores Sapper in depth. Sapper builds on Svelte to add many features.

- Chapter 15 walks through building your first Sapper application. The shopping app developed in chapter 9 is recreated using Sapper.
- Chapter 16 explores many aspects of Sapper. First, the default file structure of Sapper applications is explained. Then several Sapper features are described, including page routes, page layouts, preloading, prefetching, and code splitting.
- Chapter 17 explores Sapper server routes. These enable implementing API services in the same project as the client side of a web app. An example of implementing create, retrieve, update, delete (CRUD) services is presented.
- Chapter 18 shows how Sapper apps can be "exported" to generate static sites. This can be desirable for apps where it is possible to generate the HTML for every page at build time. An example of such an app is implemented, containing pages related to the rock/paper/scissors game, and dogs in my family.
- Chapter 19 describes how Sapper apps support offline operation using a service worker. Many caching strategies are described. Details about the default Sapper service worker are provided, as are descriptions of the service worker events

`install`, `activate`, and `fetch`. An approach to enabling the use of HTTPS in the Sapper server is presented. Finally, techniques to verify the offline behavior of a Sapper app are shared.

Part 4 goes beyond Svelte and Sapper.

- Chapter 20 explores preprocessing source files to add support for alternative syntaxes. Popular options include Sass, TypeScript, and Markdown. Examples of using each of these are provided.
- Chapter 21 provides an introduction to Svelte Native. This combines Svelte and NativeScript to build mobile applications for Android and iOS. Two online REPL apps will get you started building Svelte Native apps without installing any software on your computer. The provided components for display, forms, actions, dialogs, layout, and navigation are described, and details about styling Svelte Native components are provided. An example app that demonstrates most of these is implemented. Finally, the NativeScript UI add-on library is described, and an example app using one of its components, `RadSideDrawer`, is presented.

The learning doesn't stop after the last chapter! The seven appendixes contain important information.

- Appendix A provides links to many resources related to Svelte, Sapper, Svelte Native, and more.
- Appendix B describes how to use the Fetch API to invoke REST services.
- Appendix C describes the basics of using the MongoDB database, which is used in chapter 17.
- Appendix D describes how to configure and use ESLint to check for issues in your Svelte and Sapper apps.
- Appendix E describes how to configure and use Prettier to format the code in Svelte and Sapper apps.
- Appendix F describes how to use several VS Code extensions when editing Svelte and Sapper apps with VS Code.
- Appendix G describes how to use Snowpack to build Svelte applications. Snowpack implements a more efficient way to build web applications than the approach typically used by module bundlers such as Webpack, Rollup, and Parcel.

Throughout the book we'll develop a Travel Packing application. Most chapters add features to the app based on the topics they cover.

Readers who are new to Svelte should read chapters 1 through 8 before skipping to any of the later chapters. These cover the core principles of Svelte. Readers with previous Svelte experience can skip to chapters of interest.

About the code

Much of the code in the book can be found in the author's GitHub repositories at https://github.com/mvolkmann. In particular, see https://github.com/mvolkmann/svelte-and-sapper-in-action and https://github.com/mvolkmann/svelte-native-components.

To run the code, you will need to install a recent version of Node.js. If you do not already have this installed, browse to https://nodejs.org/ and click either the LTS or Current button to download it.

This book contains many examples of source code both in numbered listings and in line with normal text. In both cases, source code is formatted in a `fixed-width font like this` to separate it from ordinary text. Sometimes code is also **`in bold`** to highlight code that has changed from previous steps in the chapter, such as when a new feature adds to an existing line of code.

In many cases, the original source code has been reformatted; we've added line breaks and reworked indentation to accommodate the available page space in the book. In rare cases, even this was not enough, and listings include line-continuation markers (➥). Additionally, comments in the source code have often been removed from the listings when the code is described in the text. Code annotations accompany many of the listings, highlighting important concepts.

liveBook discussion forum

Purchase of *Svelte and Sapper in Action* includes free access to a private web forum run by Manning Publications where you can make comments about the book, ask technical questions, and receive help from the author and from other users. To access the forum, go to https://livebook.manning.com/#!/book/svelte-and-sapper-in-action/ discussion. You can also learn more about Manning's forums and the rules of conduct at https://livebook.manning.com/#!/discussion.

Manning's commitment to our readers is to provide a venue where a meaningful dialogue between individual readers and between readers and the author can take place. It is not a commitment to any specific amount of participation on the part of the author, whose contribution to the forum remains voluntary (and unpaid). We suggest you try asking the author some challenging questions lest his interest stray! The forum and the archives of previous discussions will be accessible from the publisher's website as long as the book is in print.

Other online resources

Appendix A lists a large number of online resources. Most of these are directly related to Svelte and Sapper, but some cover topics applicable to all varieties of web development.

about the author

R. Mark Volkmann is a partner at Object Computing, Inc. (OCI) in St. Louis, where he has provided software consulting and training since 1996. As a consultant, Mark has assisted many companies with JavaScript, Node.js, Svelte, React, Vue, Angular, and more. Mark has created and taught many courses on topics including React, Vue, AngularJS, Node.js, jQuery, JavaScript, HTML5, CSS3, Ruby, Java, and XML. He is a frequent presenter at St. Louis-area user groups. He has presented at many conferences, including Nordic.js, Jfokus, NDC Oslo, Strange Loop, MidwestJS, No Fluff Just Stuff, and XML DevCon. Mark frequently writes articles on various software development topics. These can be found at https://objectcomputing.com/resources/publications/mark-volkmann.

In his spare time, Mark likes to run. To date he has run 49 marathons in 39 states.

about the cover illustration

The figure on the cover of *Svelte and Sapper in Action* is captioned “femme Corfiote,” or a woman from the island of Corfu, in Greece. The illustration is taken from a collection of dress costumes from various countries by Jacques Grasset de Saint-Sauveur (1757–1810), titled *Costumes de Différents Pays*, published in France in 1797. Each illustration is finely drawn and colored by hand. The rich variety of Grasset de Saint-Sauveur’s collection reminds us vividly of how culturally apart the world’s towns and regions were just 200 years ago. Isolated from each other, people spoke different dialects and languages. In the streets or in the countryside, it was easy to identify where they lived and what their trade or station in life was just by their dress.

The way we dress has changed since then and the diversity by region, so rich at the time, has faded away. It is now hard to tell apart the inhabitants of different continents, let alone different towns, regions, or countries. Perhaps we have traded cultural diversity for a more varied personal life—certainly for a more varied and fast-paced technological life.

At a time when it is hard to tell one computer book from another, Manning celebrates the inventiveness and initiative of the computer business with book covers based on the rich diversity of regional life of two centuries ago, brought back to life by Grasset de Saint-Sauveur’s pictures.

Part 1

Getting Started

Welcome to *Svelte and Sapper in Action*! We'll start here by learning why these approaches to web development deserve your attention, then we'll learn about Svelte Native, compare Svelte to other popular web frameworks, and delve into the tools you'll need to get started. We're also going to build our first Svelte application with an online tool called the REPL. Apps built this way can be saved, shared with others, and exported to continue development locally.

1 Meet the players

This chapter covers

- Svelte
- Sapper
- Svelte Native

Svelte (https://svelte.dev/) is a tool for building JavaScript-based web applications. It is an alternative to web frameworks like React, Vue, and Angular. Like them, Svelte focuses on defining user-interface (UI) components and their interactions. Each UI component is an independent, potentially reusable part of a larger user interface that can be independently designed and implemented.

Svelte has many benefits over other web frameworks:

- Apps produced using Svelte require less code than most frameworks to implement the equivalent functionality.
- Svelte produces smaller bundle sizes, which results in decreased browser load times.
- Svelte greatly simplifies state management, both within and across components. (State management includes organizing the data that drives an app and responding to changes in the data.)

Sapper (https://sapper.svelte.dev/) is a framework built on top of Svelte for creating more advanced web applications. It adds many features over Svelte, including page routing, server-side rendering, code splitting, and static site generation. But web applications that do not need these features, or that wish to implement them in a different way, can opt to use Svelte by itself.

Svelte Native (https://svelte-native.technology/) also builds on Svelte. It integrates the use of NativeScript for building Android and iOS mobile applications.

> **NOTE** Throughout this book when referring to various options for creating web applications, I will refer to them as "frameworks," even though some use the term "library."

1.1 Introducing Svelte

Do we really need another tool for building web applications?

Putting in the effort to learn yet another approach is only worthwhile if it brings significant benefits. Perhaps it could require writing less code to achieve the same outcome. Maybe it could do less actual work at runtime to accomplish the same result. Or perhaps it could result in fewer total bytes needing to be downloaded to browsers.

Check, check, and check! Svelte delivers on all of these goals and more.

Like other frameworks, Svelte can be used to build entire web applications. Svelte components can be used in a single application or can be defined in a library that is shared by multiple applications. It can also be used to create custom elements (web components) that are usable in web apps implemented with other frameworks or with no framework at all.

Rich Harris, who formerly worked at *The Guardian* and is currently at *The New York Times*, developed Svelte starting in 2016. He previously created the Ractive web framework (https://ractive.js.org/), which is used at *The Guardian* and inspired parts of Vue. He also created the Rollup module bundler, which is an alternative to Webpack and Parcel.

The word *svelte* means slender, which describes both the syntax of Svelte and the bundle sizes it produces.

1.1.1 Why Svelte?

Svelte has many advantages over existing web frameworks. The most significant of these are summarized in the following sections.

SVELTE IS A COMPILER

Other popular web frameworks include large runtime libraries to support all their features. But Svelte is not a runtime library. It is a web application compiler implemented in TypeScript.

> **NOTE** A compiler is software that translates code in one programming language to another. Typically this is from a high-level language (such as Go or Java) to a lower-level language (such as machine code or bytecode).

> **NOTE** TypeScript is an open source programming language that is a superset of JavaScript; its programs are compiled to JavaScript. TypeScript adds many features above JavaScript, the most significant of which is the ability to define the types of variables and functions. TypeScript is developed and maintained by Microsoft.

Svelte UI components are defined in `.svelte` files. These can contain a combination of JavaScript, CSS, and HTML. For example, a component could contain HTML elements for a login form, CSS to style it, and JavaScript to pass the data entered to an authentication service when the Login button is clicked.

The Svelte compiler compiles `.svelte` files to JavaScript and CSS. This has many benefits, one being that new features can be added to Svelte without bloating the bundle size of deployed applications. The compiler only includes code for the features of Svelte that are actually used.

SVELTE PRODUCES SMALL BUNDLES

Svelte apps have significantly smaller bundle sizes than equivalent apps created with other web frameworks. This means that Svelte apps can be downloaded to browsers more quickly.

> **NOTE** In the context of web applications, *bundles* are JavaScript files that are created by combining, optimizing, and minimizing all the JavaScript code needed by an application.

In large part, Svelte achieves smaller bundle sizes by including only the required framework code instead of an entire framework library. For example, the Todo app presented in chapter 2 has a bundle size that is 13% of the size of an equivalent React app. Links to Svelte, React, and Vue versions of this app can be found in chapter 2.

> **NOTE** All of these web frameworks incorporate some amount of "tree shaking" to eliminate unused code. But Svelte retains far less framework code. For example, React apps must ship code that produces virtual DOM representations and finds differences between them. The use of virtual DOMs is described later.

FreeCodeCamp's comparison of frameworks, "A RealWorld Comparison of Front-End Frameworks with Benchmarks (2019 update)," catalogs statistics on building a real world web application using many web frameworks (http://mng.bz/8pxz). In this case, the app used in the comparison is a social blogging site called "Conduit," similar to Medium.com.

The reported gzipped app size for some popular framework choices include

- Angular + ngrx: 134 KB
- React + Redux: 193 KB
- Vue: 41.8 KB
- Svelte: 9.7 KB

Clearly Svelte shines on this metric.

Svelte requires less code

Svelte requires less code to implement the same functionality. The reported number of lines of code from these same benchmarks are

- Angular + ngrx: 4,210
- React + Redux: 2,050
- Vue: 2,076
- Svelte: 1,116

This is significant for multiple reasons. Having less code to read means there is less code to understand. It also means there are fewer places for bugs to hide.

Svelte provides reactivity without using a virtual DOM

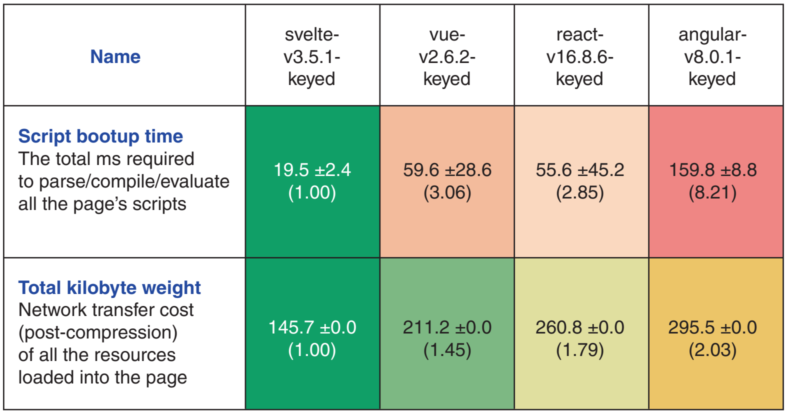
Some web frameworks, including React and Vue, use a virtual Document Object Model (DOM) to optimize updating the real DOM in response to data changes. When component state changes, the framework builds a new version of the DOM in memory and then compares it to the previous version. Only the differences are applied to the real DOM. Although this is faster than updating everything in the real DOM, it does take time to build a virtual DOM and compare it to the previous one.

Reactivity is the ability to update the DOM in response to application and component state changes. Svelte provides reactivity by tracking changes to top-level component variables (not scoped inside functions) that affect what components render. It updates only the affected parts of the DOM rather than re-rendering the entire component. This allows Svelte to do less work than many frameworks to keep the DOM in sync with application state.

Svelte is fast

Check out Stefan Krause's benchmarks at https://krausest.github.io/js-framework-benchmark/current.html. The app used in these tests renders a table with 4 columns and 1,000 rows. On this page you can select the frameworks to be compared and see side-by-side statistics. For example, select "angular-v8.0.1-keyed," "react-v16.8.6-keyed," "svelte-v3.5.1-keyed," and "vue-v2.6.2-keyed." This returns the results for application startup time shown in figure 1.1. These results demonstrate that Svelte is quite fast compared to other options.

> **NOTE** The term *keyed* in these selections means the code creates an association between data and DOM elements. When the data changes, the associated DOM element is updated. Adding and removing array elements causes DOM elements to be added and removed. The test results in figure 1.1 are from "keyed" implementations because that is more representative of what apps typically use to make updating of existing DOM elements more efficient.



Name	svelte-v3.5.1-keyed	vue-v2.6.2-keyed	react-v16.8.6-keyed	angular-v8.0.1-keyed
Script bootup time The total ms required to parse/compile/evaluate all the page's scripts	19.5 ±2.4 (1.00)	59.6 ±28.6 (3.06)	55.6 ±45.2 (2.85)	159.8 ±8.8 (8.21)
Total kilobyte weight Network transfer cost (post-compression) of all the resources loaded into the page	145.7 ±0.0 (1.00)	211.2 ±0.0 (1.45)	260.8 ±0.0 (1.79)	295.5 ±0.0 (2.03)

Figure 1.1 Benchmark boot-up time and download time

Svelte requires less memory

Using less memory is a significant benefit when web applications are run on older computers or mobile devices, which tend to have less available memory for running applications.

The benchmark site used in the previous section reports the comparison for memory usage shown in figure 1.2. These results demonstrate that Svelte apps typically use less memory than other options.

Svelte components do not use a JavaScript container

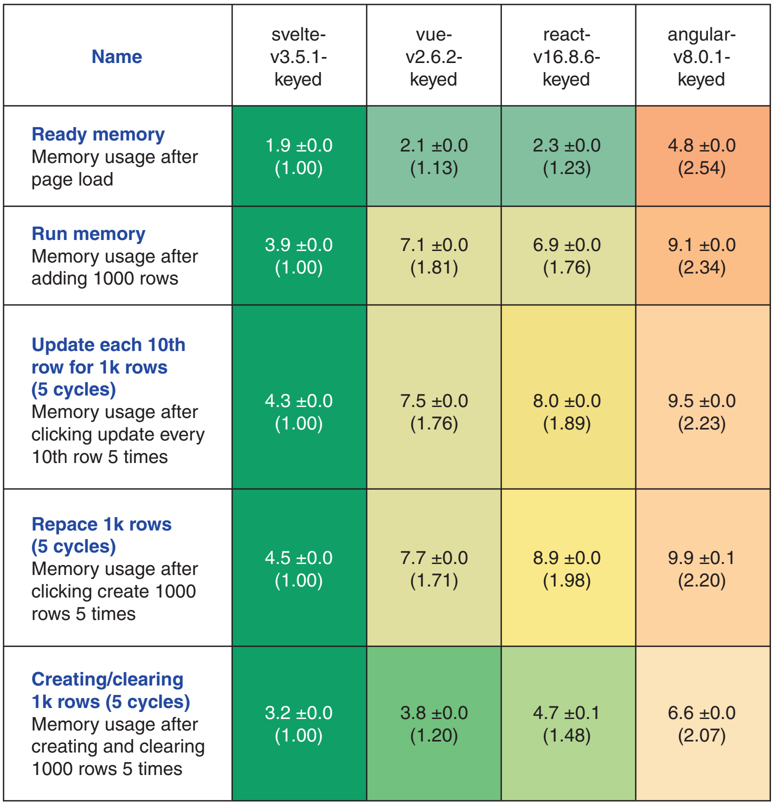
`.svelte` files do not define any kind of JavaScript container for the component. Instead, a component is defined by a combination of a `script` element, HTML to render, and a `style` element.

This approach is simpler than that used by most other web frameworks. Fewer lines of code are required to define a component, and there are fewer JavaScript concepts to think about. For example, Angular components are defined by a class, React components are defined by a function or a class, Vue 2 components are defined by an object literal, and Vue 3 components are defined by functions.

Svelte styling is scoped

By default, the CSS specified in each Svelte component only applies to that component. This means that CSS rules defined in a `.svelte` file do not accidentally "leak out" and affect the styling of other components.

Styles are treated differently in other frameworks. In Angular, styles specified in the `styles` property of a component are also scoped to the component by default. In Vue, styles are only scoped to components if they are specified inside a `style` element with the `scoped` attribute. React does not provide support for scoping styles to components, which is one reason why CSS-in-JS solutions are popular in React applications. There is little appeal for these CSS-in-JS solutions in Svelte.



Name	svelte-v3.5.1-keyed	vue-v2.6.2-keyed	react-v16.8.6-keyed	angular-v8.0.1-keyed
Ready memory Memory usage after page load	1.9 ±0.0 (1.00)	2.1 ±0.0 (1.13)	2.3 ±0.0 (1.23)	4.8 ±0.0 (2.54)
Run memory Memory usage after adding 1000 rows	3.9 ±0.0 (1.00)	7.1 ±0.0 (1.81)	6.9 ±0.0 (1.76)	9.1 ±0.0 (2.34)
Update each 10th row for 1k rows (5 cycles) Memory usage after clicking update every 10th row 5 times	4.3 ±0.0 (1.00)	7.5 ±0.0 (1.76)	8.0 ±0.0 (1.89)	9.5 ±0.0 (2.23)
Repace 1k rows (5 cycles) Memory usage after clicking create 1000 rows 5 times	4.5 ±0.0 (1.00)	7.7 ±0.0 (1.71)	8.9 ±0.0 (1.98)	9.9 ±0.1 (2.20)
Creating/clearing 1k rows (5 cycles) Memory usage after creating and clearing 1000 rows 5 times	3.2 ±0.0 (1.00)	3.8 ±0.0 (1.20)	4.7 ±0.1 (1.48)	6.6 ±0.0 (2.07)

Figure 1.2 Benchmark memory utilization in MBs

SVELTE PROVIDES A PLACE FOR GLOBAL STYLES

Svelte provides a clear place to specify global styles that can affect any component. This is in the file `public/global.css`.

SVELTE SIMPLIFIES STATE MANAGEMENT

Management of application and component state is much easier in Svelte compared to other frameworks. Contributing features include context, stores, and module context, each of which will be covered in detail later.

SVELTE SUPPORTS TWO-WAY DATA BINDINGS

Svelte makes it easy to bind the value of a form control to a component variable. Form controls include `input`, `textarea`, and `select` elements. Top-level variables in `.svelte` files represent the state of a component.

When the value of a bound variable changes, the values of associated form controls are automatically updated. When the user changes the value of a bound form control, the value of the associated variable is automatically updated.

Svelte makes animation easy

Svelte has built-in support for a variety of animations. Adding animation to an application is surprisingly simple. This encourages the use of more animation, which can result in a better user experience.

Examples of such animations in a Todo app include causing new todo items to fade into view and deleted todo items to fade out of view. If todo items are maintained in categorized lists, animation can be used to smoothly move an item out of its current category and into a new category.

Svelte encourages accessibility

Svelte provides runtime warnings for accessibility issues. For example, `img` elements that have no `alt` attribute are flagged. This makes it more likely that Svelte applications will be usable by users that require special ways of interacting with web browsers.

1.1.2 Rethinking reactivity

In the context of web applications, *reactivity* is the ability of the DOM to be updated automatically in response to changes in data (a.k.a. state). This can be compared to spreadsheets. A change to the value of one cell can cause the values displayed in other cells to change. This happens when a cell's value is based on the values of other cells using a formula.

Svelte makes implementing reactivity easier than other frameworks. It supports a unique way of managing the state of a component that relies on watching top-level variables (explained in section 3.9). It also simplifies the ways in which state can be shared across components.

HTML DOM

The HTML DOM provides an in-memory representation of a web page. It is composed of a tree of JavaScript objects that represent nodes. There is a JavaScript object that represents the entire `Document`, and it has references to other DOM objects that represent elements on the page. DOM objects have methods that can be called to get information about a node, add child nodes, register event listeners, and more. Modifying the DOM changes what the browser displays.

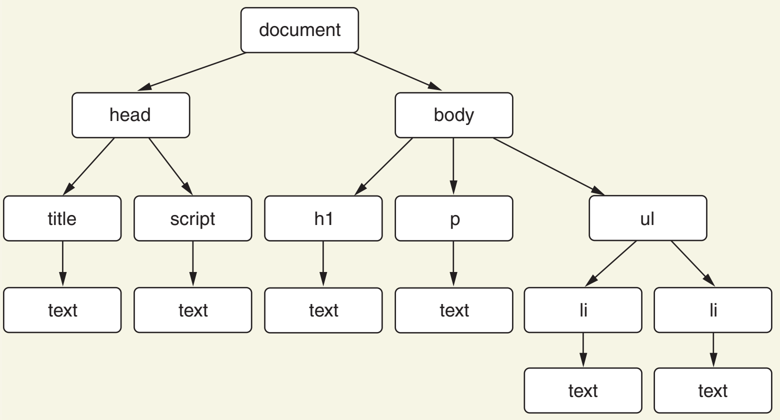
Here is a sample HTML document:

```
<!DOCTYPE html>
<html>
  <head>
    <title>My Page</title>
  </head>
  <script>
    // For exploring the DOM from the DevTools console ...
    window.onload = () => console.dir(document);
  </script>
  <body>
    <h1>My Page</h1>
```

(continued)

```
    <p>I like these colors:</p>
    <ul>
      <li>yellow</li>
      <li>orange</li>
    </ul>
  </body>
</html>
```

The following figure illustrates the DOM nodes created by a web browser that represent the HTML document in memory.



DOM nodes

The "Rethinking Reactivity" conference talk given by Rich Harris on multiple occasions clearly describes the concerns that motivated the creation of Svelte (www.youtube.com/watch?v=gJ2P6hGwcgo). The top 10 points in this talk all correlate to features implemented in Svelte:

1. Implement real "reactive programming" as seen in spreadsheets. When a value changes, other values can update in response.
2. Avoid use of a virtual DOM. Rich says, "As engineers we should be offended by all that inefficiency."
3. Write less code. It's better for developers and better for performance. Rich says, "There's only one reliable way to speed up your code, and that is to get rid of it."
4. Provide warnings for accessibility issues.
5. Scope styles to components so they don't leak out and affect each other.
6. Identify unused CSS rules so they can be removed.
7. Make it easy to add transitions and animations, using CSS for performance.
8. Allow framework features to be added without bloating the bundle size of apps that don't use them.

9 Use Sapper (a wrapper around Svelte) to add page routing, code splitting, server-side rendering, and more.

10 Use Svelte Native for mobile apps. This is an alternative to React Native.

1.1.3 Current issues in Svelte

Using Svelte is appropriate for nearly any web application. However, there are issues you should consider that may cause some developers to prefer other frameworks.

Svelte is implemented in TypeScript, but until July 21, 2020 it did not support using TypeScript to define components out of the box. This could be achieved with a little configuration and added tooling. But now, opting into the use of TypeScript is much easier. See https://svelte.dev/blog/svelte-and-typescript for details.

> **NOTE** Chapter 20 discusses using svelte-preprocessor to support using TypeScript in `.svelte` files. The official TypeScript support added in July, 2020 uses this. Chapter 20 also touches on using the command-line tool svelte-check to check for errors in `.svelte` files, including TypeScript errors. Appendix F discusses using the VS Code extension Svelte for VS Code, which uses the Svelte Language Server to report errors in opened `.svelte` files, including TypeScript errors.

Svelte is not a particularly good option for web applications that must run in Internet Explorer. Polyfills are required to run Svelte apps in Internet Explorer 11 (see https://github.com/sveltejs/svelte/issues/2621 and https://mvolkmann.github.io/blog/topics/#/blog/svelte/supporting-ie11/). Svelte apps are unlikely to run in versions of Internet Explorer before version 11. Fortunately, it is no longer a requirement for most web applications to run in Internet Explorer.

Some web frameworks (such as React and Vue) make it easy to generate the content for different parts of a component in separate functions within a component definition. Contrast this with the approach used by Svelte, where all the HTML for a component is specified outside its JavaScript code. A downside of the Svelte approach is that dividing the HTML to be rendered into separately managed chunks requires defining additional components in separate `.svelte` files. However, since these files contain almost no boilerplate code, creating a new component is easy.

Web frameworks that predate Svelte have had many years for their supporting libraries to be created. One example is collections of pre-built components. Fewer of these libraries currently exist for Svelte, but the number is growing.

Consider whether the benefits of Svelte outweigh the limitations described here. I'm confident that after a little experience with Svelte, you will conclude, as I have, that they do!

1.1.4 How does Svelte work?

Figure 1.3 shows the role of the Svelte compiler. User-interface (UI) components are implemented in `.svelte` files. These can contain JavaScript code (in a `script` element), CSS (in a `style` element), and HTML to be rendered.

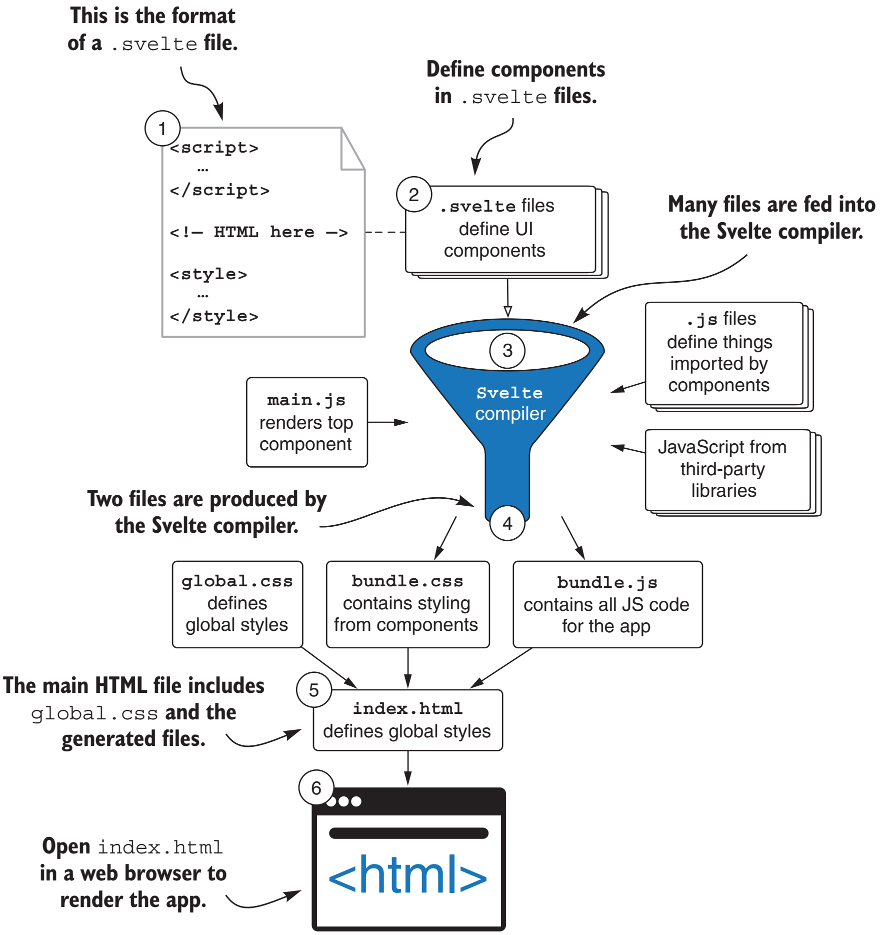

This is the format of a .svelte file.
Define components in .svelte files.
1
<script>
…
</script>
<!– HTML here –>
<style>
…
</style>
2
.svelte files define UI components
Many files are fed into the Svelte compiler.
3
Svelte compiler
.js files define things imported by components
main.js renders top component
JavaScript from third-party libraries
Two files are produced by the Svelte compiler.
4
global.css defines global styles
bundle.css contains styling from components
bundle.js contains all JS code for the app
The main HTML file includes global.css and the generated files.
5
index.html defines global styles
6
Open index.html in a web browser to render the app.
<html>

Figure 1.3 Flow of files into and out of the Svelte compiler

.svelte files can import other .svelte files to use as child components. For example, a TodoList component that represents an entire Todo application can import and use a Todo component that represents a single todo item, perhaps with a checkbox, the text of the item, and a Delete button.

.svelte files can also import things such as functions from .js files and from third-party libraries (typically obtained from npm). For example, functions from the popular Lodash library can be imported and used in a Svelte app.

The Svelte compiler compiles all of this into a single bundle.js file and a single bundle.css file. These contain only the JavaScript code and CSS rules that are used in the application. Only the parts of the Svelte library that are needed are included in bundle.js.

Styling that can affect any component is placed in the `global.css` file. The main HTML file, `index.html`, includes `global.css` and the bundle files produced by the Svelte compiler. This HTML file is loaded into a web browser to run the application.

The Svelte compiler also generates `bundle.css.map` and `bundle.js.map` files, which support mapping from the generated code to original source lines. These are used by debuggers, such as those built into browsers.

1.1.5 Does Svelte disappear?

In most web frameworks, the code that is delivered to web browsers to run an application includes code written by the developers and a framework library. If the framework implements a large number of features, the code to support those features is often delivered even if only a subset of the features is actually used.

Some say that Svelte "disappears" once an app is built. This refers to not including a Svelte library in the bundle produced by the Svelte compiler. But some Svelte library code is included.

The Svelte library is mostly defined by JavaScript files in the `node_modules/svelte` directory. The main functions are defined in `internal.js`, which is currently around 1,400 lines of code. Other library files are used for specific features, including `easing.js`, `motion.js`, `register.js`, `store.js`, and `transition.js`.

As you will see later, Svelte applications are compiled by running the `npm run dev` or `npm run build` commands. These produce files in the `public` directory, including `bundle.js` and `bundle.css`. Svelte library functions that are used by the app are copied to the top of `bundle.js`. For small to medium size apps (such as a Todo app), this amounts to around 500 lines of code.

The Svelte library code doesn't disappear, but it is very small compared to other web frameworks.

1.2 Introducing Sapper

Sapper is a framework that builds on Svelte. It includes all of Svelte and adds many features that are not included in Svelte by default. These features can be added to Svelte applications, but it is easier to use Sapper and automatically gain them.

The name *Sapper* has two meanings. First, it is a contraction of "Svelte app maker." Second, the English word *sapper* is defined as "a soldier responsible for tasks such as building and repairing roads and bridges, laying and clearing mines, etc." In a sense, this is what Sapper does for Svelte.

Like Svelte, Sapper was created and is maintained by Rich Harris along with many other contributors.

1.2.1 Why consider Sapper?

Each of the following features are added by Sapper. We'll look at them in detail in later chapters.

- *Sapper provides page routing.* Page routing associates URLs with "pages" in an app and defines how navigation between pages is described in markup. Sapper page routing is entirely defined by directory and file naming conventions. This makes it easier to understand and implement than approaches that require calling library functions to configure routing.
- *Sapper supports page layouts.* Page layouts define a common layout for sets of pages within an app. For example, many pages might contain common `header`, `footer`, and `nav` sections. Page layouts remove the need to repeat these common sections on each page that requires them.
- *Sapper provides server-side rendering (SSR), which generates the HTML for visited pages on the server instead of in the browser.* This can provide a better user experience, because the JavaScript for the page does not have to be downloaded before the page is rendered. It can also result in better search engine optimization (SEO). Sapper SSR does this automatically for the first page visited within a session.
- *Sapper supports server routes.* Server routes provide an easy way to implement Node-based API services in the same project as the client-side web application. This is convenient for developers who wish to work on the full stack of an application rather than only the frontend. Using this feature is optional. The API/REST services used by Svelte and Sapper apps can be implemented with any technology stack.

REST

REST stands for *representational state transfer*, and it is described in Roy Fielding's PhD dissertation from 2000. It is an architectural style, not a standard or API.

These are the main ideas behind REST:

1. A software component requests a "resource" from a service by supplying a resource identifier and a desired media type. A resource identifier can be a URL, and a request can be made using Ajax (https://developer.mozilla.org/en-US/docs/Web/Guide/AJAX).
2. A "representation" of the resource is returned. This is a sequence of bytes, and metadata to describe it. For example, it can be JSON, name/value pairs in HTTP headers, an image, etc. A representation can contain identifiers of other resources.
3. Obtaining this representation causes the software component to "transfer" to a new "state."

In common usage, REST uses HTTP requests and responses. The HTTP verbs `POST`, `GET`, `PUT`, and `DELETE` are mapped to the "CRUD" operations *create*, *retrieve*, *update*, and *delete* respectively.

- *Sapper supports code splitting.* Code splitting allows the JavaScript required for each page of the application to be downloaded only when a page is visited for the first time. This is much more efficient than downloading all the code for the entire application when the first page is visited.
- *Sapper supports prefetching.* Prefetching provides faster page loads by anticipating the next page a user will visit based on mouse hovers. This can be configured on each page link. The first time a user hovers over such a page link, Sapper will begin downloading the JavaScript required by the page. It can also initiate calls to API services that gather data required by the page.
- *Sapper supports static site generation.* Static site generation (or exporting) crawls a Svelte web application at build time and generates the HTML that each page renders. This results in highly efficient websites because each page is, in a sense, prerendered.

  Sites created this way are not required to be entirely static. They can still include JavaScript code and take advantage of Svelte reactivity for updating the DOM.
- *Sapper supports offline usage.* Sapper web applications use a service worker in order to remain usable, perhaps in a limited sense, when network connectivity is lost. This is done by caching certain files and responses so that cached versions are used when there is no connection to the internet.
- *Sapper supports end-to-end testing.* Sapper apps come with support for using Cypress to implement tests that walk through an application in the way a user would, performing tasks like logging in, navigating to various pages, entering text, and clicking buttons.

1.2.2 How does Sapper work?

The "pages" of a Sapper app are defined in `.svelte` files that reside in the `src/routes` directory. The components used by these pages are defined in `.svelte` files that reside in the `src/components` directory. Navigation between pages is implemented with plain HTML anchor elements (`<a>`) that specify a page name in their `href` attribute.

By default, Sapper apps are served by the Polka server library. This is a Node-based library that has nearly the same API as Express, but Polka is more efficient in terms of performance and size. If desired, Sapper apps can easily be modified to use Express instead.

As you saw earlier, the Svelte compiler generates `bundle.js` and `bundle.css` files that contain all the JavaScript and CSS for the entire application. Sapper is different. It generates separate `.js` and `.css` files for each page of the application. These are placed in the `__sapper__/build/client` directory. On each page load, only the JavaScript and CSS needed for that page are downloaded.

1.2.3 When should Sapper be used?

Using Sapper instead of straight Svelte is as easy as creating a project with a different initial set of directories and files. These sets of files can be created with the `npx` command, as you will see later.

All of the features described in the previous section are available by default in Sapper applications. No additional libraries are required.

Using Sapper instead of Svelte is recommended any time an app needs one or more of the features provided by Sapper, and when developers approve of the way Sapper has implemented them. For example, developers who prefer an alternative way of describing page routes might opt to use Svelte, where they can choose a routing strategy. For most apps, the approaches used by Sapper are acceptable.

1.2.4 When should Sapper not be used?

At the time of writing, Sapper had not yet reached version 1.0.0. This means that its features are still subject to breaking changes. Developers who are concerned about this may want to wait until Sapper is more mature before using it in production applications.

However, the features provided by Sapper are so valuable and well-implemented that it may be better to use it in its current state than attempt to duplicate these features in a Svelte app. After all, it is likely that you already use many npm packages that are not yet tagged as version 1 or above.

1.3 Introducing Svelte Native

NativeScript (https://nativescript.org/) is a framework for creating mobile applications that run on Android and iOS devices. It was created and is maintained by Telerik, which was acquired by Progress Software in 2014.

NativeScript applications are built using XML syntax (with custom elements), CSS, and JavaScript. They can be written without using any web framework, or they can use Angular, React, Svelte, or Vue.

NativeScript applications use native components rather than web views. In this sense, NativeScript is similar to React Native. Plugins allow access to all native device APIs.

Svelte Native (https://svelte-native.technology/) builds on top of NativeScript to enable developers to build mobile applications using Svelte. It provides a thin layer over the NativeScript API, which will make it easy to ensure compatibility with future NativeScript versions.

Chapter 21 will provide an introduction to writing Svelte Native applications.

1.4 How does Svelte compare with other web frameworks?

Svelte differs from other currently popular web frameworks in several ways. Let's examine some of them.

1.4.1 Angular

Angular apps require developers to write more code to accomplish the same tasks. Svelte code is more, well, … svelte.

Angular concepts appeal to Java and C# developers who are accustomed to writing lots of classes and using dependency injection.

Angular apps typically use "effects" and libraries like RxJS and ngrx/store. These increase the time required to become proficient in Angular.

1.4.2 React

React components use JSX (short for JavaScript XML) to describe what should be rendered. JSX is an extension to JavaScript syntax that looks like HTML. React converts this to function calls that produce DOM nodes. Although JSX is very similar to HTML, there are differences. Some developers dislike JSX because they do not like mixing it into their JavaScript code. While Svelte components define their JavaScript, CSS, and HTML in the same file, they are specified in distinct sections of the file.

React uses a virtual DOM. Issues with this were described earlier.

The number of concepts that must be grasped to be proficient in React continues to grow. For example, hooks are a big topic, and there are many others to learn. There are multiple ways to deal with state, including `this.setState`, the `useState` hook, Redux, and many more. On the horizon we have Suspense and Concurrent Mode. Svelte is much easier to learn.

1.4.3 Vue

Vue 2 components are described with object literals. These describe many things about a component, including the props it accepts, computed properties (based on others), data used (component state), watch functions (to react to state changes), and methods (such as event handling). Code in Vue 2 components make frequent use of the `this` keyword, and some developers feel this makes the code more difficult to understand. It also makes the code more verbose. Vue 3 components are described with functions. In addition, Vue uses a virtual DOM, and the issues with this were described earlier.

But with Svelte components, all of these things are defined using plain JavaScript variables and functions with the help of reactive statements (described in the next chapter).

1.5 What tools are needed to get started?

This book assumes that you understand the fundamentals of using HTML, CSS, and JavaScript in the context of implementing web applications. You should be familiar with basic HTML (including form elements), CSS syntax (including the box model), and JavaScript syntax (including some features added in ECMAScript 2015 and beyond).

Getting started with Svelte and Sapper only requires that you have a recent version of Node.js installed. An installer can be downloaded from https://nodejs.org/.

> **NOTE** As it states on the main Node.js website (https://nodejs.org/), “Node.js is a JavaScript runtime built on Chrome’s V8 JavaScript engine.” Node.js enables you to build many kinds of applications using JavaScript. These include network applications such as HTTP servers and tooling such as code linters, code formatters, and even the Svelte compiler.

Installing Node.js provides the commands `node`, `npm`, and `npx`:

- The `node` command is used to start the local servers that are needed to test an app and to run other development tasks, such as linting, code formatting, and running tests.
- The `npm` command is used to install the libraries used by a project.
- The `npx` command is used to create new Svelte and Sapper projects.

> **NOTE** Although it’s not yet ready for production use, another Svelte-related tool to consider is svelte-gl (https://github.com/sveltejs/gl). This library is similar to three.js (https://threejs.org/), but it’s tailored for use in Svelte. It takes as input a 3D scene graph description and outputs WebGL code to render it. You can see a demo at http://mng.bz/lG02.

Prepare to be amazed at how easy web development can be, compared to the approaches you currently use!

Summary

- Svelte is a tool for building web applications that is an alternative to currently popular web frameworks like React, Vue, and Angular.
- Svelte is a web application compiler, not a library.
- Svelte has many features that make it an attractive option, such as writing less code, producing smaller bundles (which improves startup times), and simplifying state management.
- Sapper builds on Svelte, adding more features like page routing, server-side rendering, code splitting, and static site generation.
- Svelte Native uses the features of Svelte to provide an alternative to React Native for building Android and iOS mobile applications.

2 Your first Svelte app

This chapter covers

- Using the Svelte REPL
- Developing a Svelte app outside the REPL
- Developing a simple Todo app

In this chapter, you will learn everything you need to know to experiment with Svelte without having to download or install anything. This will be accomplished using a web-based REPL tool.

REPL stands for *read, evaluate, print, loop*. A REPL *reads* the code you enter, *evaluates* it (possibly compiling and reporting errors), *prints* the result of the code, and *loops* to allow for repeating this process. There are REPLs for many programming languages and web frameworks.

The REPL is a perfect gateway to developing larger apps locally, outside of the REPL, using common programming editors such as VS Code. This chapter will cover how to download REPL apps for further local development and how to create an app from scratch without using the REPL.

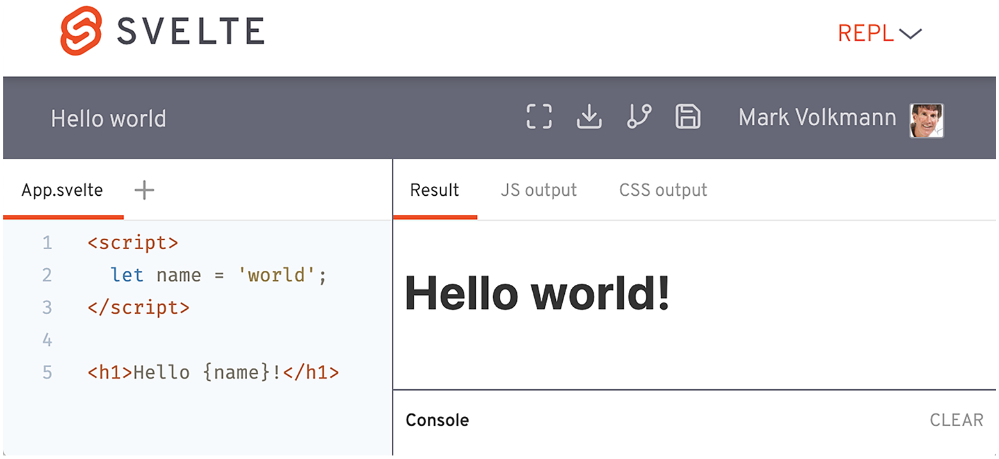
By the end of the chapter, you will be ready to start developing your own Svelte applications.

2.1 The Svelte REPL

Svelte provides a browser-based REPL that supports defining Svelte components, seeing their rendered output, and more. Using the REPL is the easiest way to experiment with Svelte. Your first Svelte application is just a click away!

To get started, browse to the main Svelte website at https://svelte.dev/. Then click the REPL link near the upper-right corner of the page.

Code for a Hello World app is provided by default, as shown in figure 2.1. You can modify this code to experiment with the various features of Svelte.



```
<script>
  let name = 'world';
</script>

<h1>Hello {name}!</h1>
```

Hello world!

Figure 2.1 The initial REPL screen

Experimenting is just one use of the REPL. Another is creating an ever-growing collection of examples you can draw from as you learn about Svelte. I highly encourage you to take advantage of this feature.

2.1.1 Using the Svelte REPL

Initially, the only file provided in the REPL is `App.svelte`. This file can import other files defined in additional tabs within the REPL (not in separate browser tabs).

To add more `.svelte` or `.js` files, click the plus button (+) to the right of the existing file tabs, and give the new file a name. By default, newly created files have a `.svelte` extension, but this can be changed to `.js` by typing `.js` at the end of the filename.

> **NOTE** The REPL error “Failed to construct 'URL': Invalid base URL” typically means that a file created in the REPL is missing its file extension and couldn’t be imported.

To delete a file, click its tab and then click the "X" that appears to the right of the filename.

The right side of the REPL page contains three tabs:

- *Result*—The Result tab shows the rendered output of `App.svelte`. When this tab is selected, the lower-right corner of the REPL shows output from calls to `console` methods, such as `console.log`.
- *JS Output*—The JS Output tab shows the JavaScript code generated for the app by the Svelte compiler.
- *CSS Output*—The CSS Output tab shows the minimized CSS generated for the app by the Svelte compiler. Unused CSS selectors are not included. All selectors include generated CSS class names that scope the CSS to the component. We will discuss how these names are generated later.

The top bar in the REPL (see figure 2.2) contains links to many Svelte resources including a tutorial, the API docs, examples, the Svelte blog, the Svelte FAQ, the main page for Sapper, the Discord chat, and the Svelte GitHub repo.

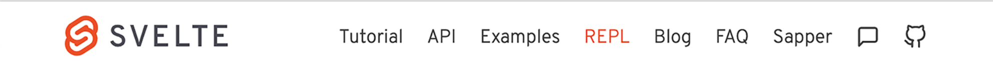


Figure 2.2 The Svelte website header

To hide this bar and gain more editing room, click the full-screen editor icon, which looks like a dashed square (see figure 2.3).

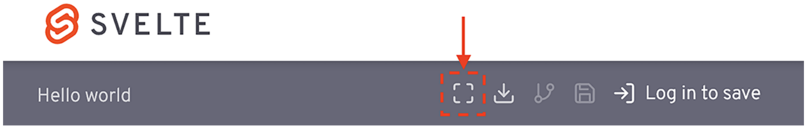


Figure 2.3 The REPL full screen button

After you click it, this icon will change to an "X" (see figure 2.4). Click it to restore the top bar.

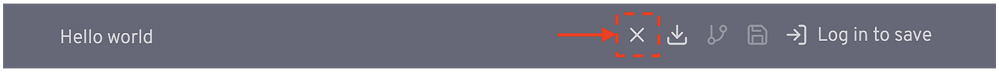


Figure 2.4 The REPL exit full screen button

There is currently no option in the REPL to format `.svelte` files. Perhaps an option to do this using Prettier will be added in the future.

> **NOTE** Prettier (https://prettier.io) is a very popular tool for formatting code from many languages, including JavaScript, HTML, CSS, and more.

To reset the REPL to its starting point, which is a basic Hello World app, click the REPL link in the header (see figure 2.5).

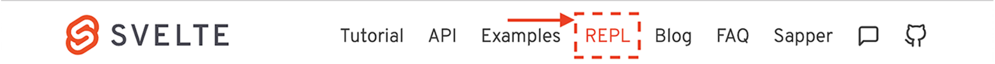


Figure 2.5 The REPL reset button

2.1.2 Your first REPL app

Using only what you have learned so far, let's create a simple app and begin learning about some features of Svelte.

The provided Hello World app always says hello to "world." Let's change this so it can say hello to anybody. Add the following HTML before the `h1` element:

```
<label for="name">Name</label>
<input id="name" value={name}>
```

> **NOTE** The `input` HTML element is an example of an *empty element*, which means it cannot have child nodes. When empty elements are used in Svelte components, they do not need to be terminated with `/>`. However, if Prettier is used to format the code, it will change empty elements so they're terminated this way. This is why some code examples in this book show terminated empty elements.

Now we can enter a name, but it doesn't change the greeting. We need to add event handling so the value of the `name` variable is updated when the user types in the input. We can do this using an inline arrow function or a reference to a function defined in the `script` element. Change the `input` to the following:

```
<input
  id="name"
  on:input={event => name = event.target.value}
  value={name}
>
```

This works, but it's a bit verbose. We can do better using the Svelte `bind` directive. You will see many uses of the `bind` directive later, but one use is to bind the value of a form element to a variable. This causes the form element to display the current value of the variable. If a user changes the value of the form element, the variable will be updated to match.

Change the `input` element to match the following:

```
<input id="name" bind:value={name}>
```

Oh my, that's nice! And if the variable name is `value` instead of `name`, it can be shortened as follows:

```
<input id="name" bind:value>
```

This isn't very stylish, though. Let's add styling to change the color of the greeting. Add the following at the bottom of the file, after the HTML.

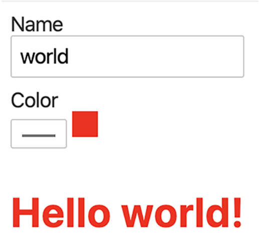
```
<style>
  h1 {
    color: red;
  }
</style>
```

Great! Now the greeting is red.

Let's allow the user to select a color. We will do this by adding an `input` element with a `type` of `color`. This uses the native color picker to select a color. It appears as a rectangle containing a horizontal line in figure 2.6. Clicking it opens a Color Picker dialog.

Top-level variables in the `script` element of a component define the state of the component. For example, the state of the component below includes the `color` and `name` variables.

Here is the full code for this version of `App.svelte`.



Name

world

Color

Hello world!

Figure 2.6 A REPL app with color input

Listing 2.1 A REPL app with color input

```
<script>
  let color = 'red';
  let name = 'world';
</script>

<label for="name">Name</label>
<input id="name" bind:value={name}>

<label for="color">Color</label>
<input id="color" type="color" bind:value={color}>
<div style="background-color: {color}" class="swatch" />

<h1 style="color: {color}">Hello {name}!</h1>

<style>
  .swatch {
    display: inline-block;
    height: 20px;
    width: 20px;
  }
</style>
```

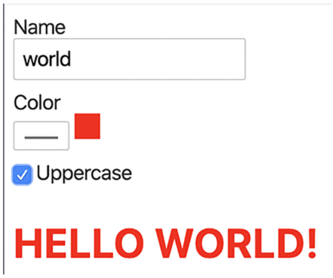
Let's allow the user to toggle a checkbox to change the case of the greeting. Add the following inside the script element, at the bottom:

```
let upper = false;
$: greeting = `Hello ${name}!`;
$: casedGreeting = upper ? greeting.toUpperCase() : greeting;
```

What does $: mean? It's called a *reactive statement*. Reactive statements are re-executed any time the value of a variable they reference changes. Reactive statements that assign a value to a variable are also called *reactive declarations*. They are covered in more detail in chapter 3.

In the preceding code above we calculate a new value for greeting any time the value of name changes. Then we calculate a new value for casedGreeting any time the value of upper or greeting changes. This is incredibly convenient!

Now we just need a way to change the value of upper when a checkbox is toggled, and to render the value of casedGreeting. Add the following code before the h1 element to render the checkbox, as shown in figure 2.7.



Name
world
Color
☑ Uppercase

HELLO WORLD!

Figure 2.7 A REPL app with an Uppercase checkbox

```
<label>
  <input type="checkbox" bind:checked={upper}>
  Uppercase
</label>
```

Change the h1 element to the following:

```
<h1 style="color: {color}">{casedGreeting}</h1>
```

So far we have implemented everything in a single .svelte file named App.svelte. Let's move beyond this by defining a second component.

Click the plus button (+) to the right of the App.svelte tab in the REPL. Enter Clock for the name of the component, as shown in figure 2.8. Component names and their source file names should use camel case, starting with an uppercase letter.

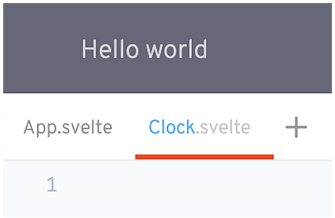


Figure 2.8 REPL app with Clock tab

We want this component to display the current time in hh:mm:ss format.

Start by adding only the following in Clock.svelte:

```
<div>
  I will be a clock.
</div>
```

Back in App.svelte, add the following inside the script element, at the top:

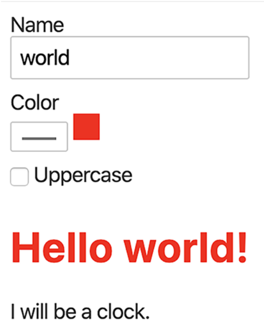
```
import Clock from './Clock.svelte';
```

Add the following at the bottom of the HTML in `App.svelte`:

```
<Clock />
```

> **NOTE** The space before the slash in `<Clock />` is not required, but many developers, and the Prettier code formatter, prefer to include it.

You will now see "I will be a clock." at the bottom of the rendered output (see figure 2.9).



Name

world

Color

🟥

☐ Uppercase

Hello world!

I will be a clock.

Figure 2.9 A REPL app with "I will be a clock."

Props allow data to be passed into components (they will be discussed in detail in chapter 5). Svelte uses the `export` keyword to define a prop that a component accepts. In a `.js` file, `export` makes a value visible outside that file and able to be imported. When you use `export` in a component, other components that use this component can pass in a value.

Change `Clock.svelte` so it contains the following. In this component, `color` is a prop with a default value.

```
<script>
  export let color = 'blue';
  let hhmmss = '';
  setInterval(() => {
    hhmmss = new Date().toLocaleTimeString();
  }, 1000);
</script>

<span style="color: {color}">{hhmmss}</span>
```

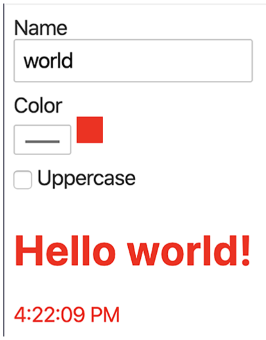
This defines the color prop.

This is executed once every second.

Modify `App.svelte` to pass a `color` prop to the `Clock` component. The following line demonstrates a shorthand syntax that is equivalent to `<Clock color={color} />`.

```
<Clock {color} />
```

We now have a functioning clock component, as shown in figure 2.10.



Name

world

Color

🟥

☐ Uppercase

Hello world!

4:22:09 PM

Figure 2.10 A REPL app with a clock

This gives you a taste of some of what you can do in Svelte. We will dive deeper in the chapters that follow.

If you are familiar with other web frameworks, now is a good time to pause and think about what code you would need to write to implement this in those frameworks. Is it longer? Is it more complicated?

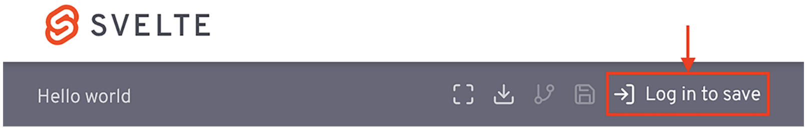


Figure 2.11 The REPL Log In to Save button

2.1.3 Saving REPL apps

To save apps created in the REPL so they can be recalled in the future, click the Log In to Save button in the upper right (see figure 2.11). This will open the browser window shown in figure 2.12.

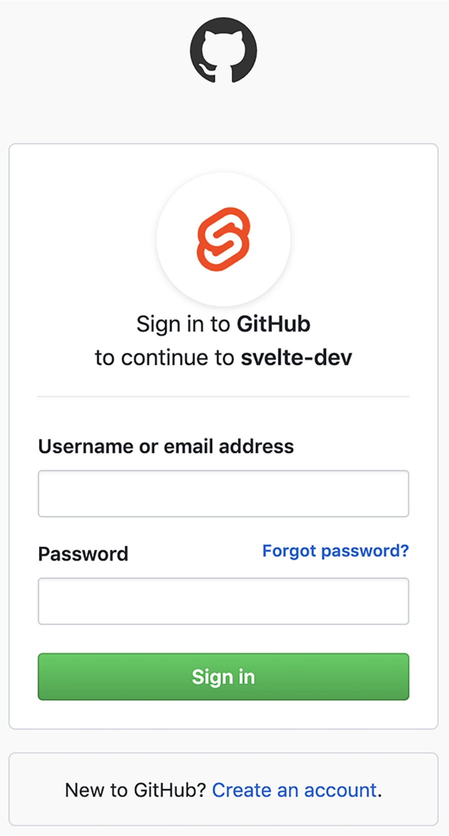
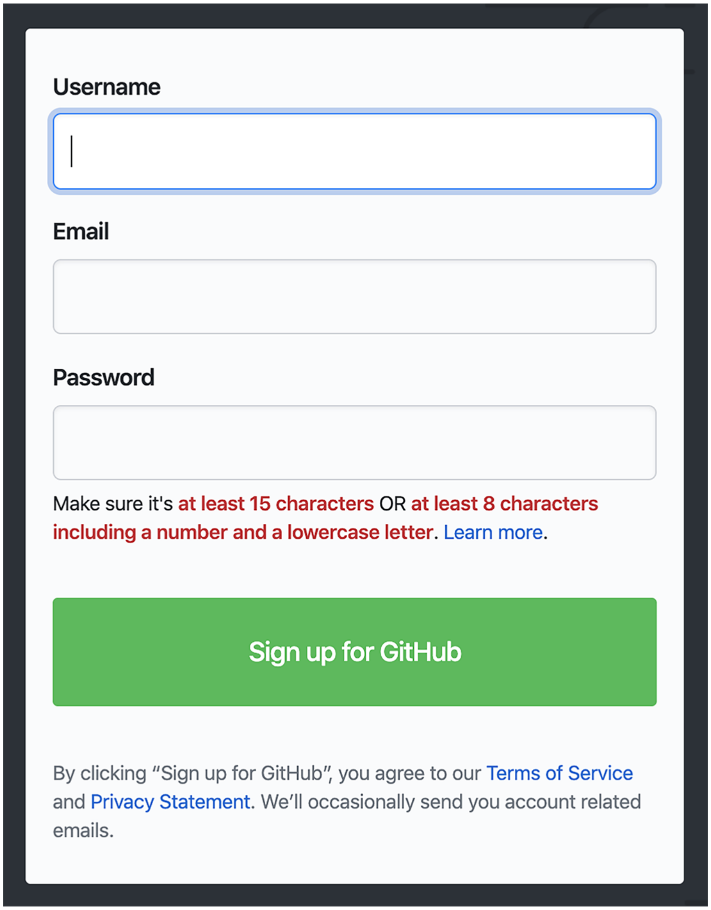

Sign in to GitHub
to continue to svelte-dev
Username or email address
Password
Forgot password?
Sign in
New to GitHub? Create an account.

Figure 2.12 The GitHub Sign In page

Enter your GitHub username and password, and click the Sign In button.

If you do not already have a GitHub account, browse to https://github.com/ and click the large, green Sign Up for GitHub button (see figure 2.13). After signing into GitHub, you will be returned to the REPL.



Username

|

Email

Password

Make sure it's at least 15 characters OR at least 8 characters including a number and a lowercase letter. Learn more.

Sign up for GitHub

By clicking "Sign up for GitHub", you agree to our Terms of Service and Privacy Statement. We'll occasionally send you account related emails.

Figure 2.13 The GitHub Sign Up page

To save your current app, enter a name for it on the left side of the gray bar at the top, and click the floppy disk icon (see figure 2.14). Pressing Ctrl-S (or Cmd-S on macOS) also saves the app.

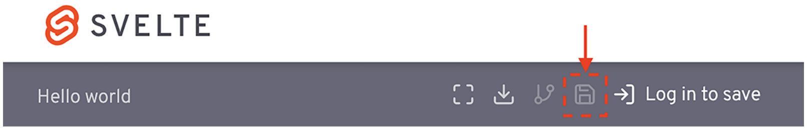


Figure 2.14 The REPL save button

To load a previously saved app, hover over your username at the upper-right of the page, and click Your Saved Apps (see figure 2.15).

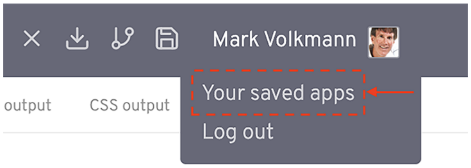


Figure 2.15 The REPL Your Saved Apps menu option

This will display a list of saved app names. Click one to load it.

To make a copy of your current app so it can be modified without changing the current version, click the fork button (see figure 2.16).

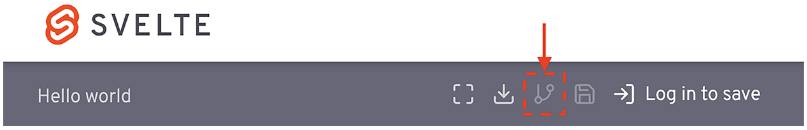


Figure 2.16 The REPL fork button

Currently it is not possible to delete saved REPL apps, but this feature has been requested (see https://github.com/sveltejs/svelte/issues/3457). Until it is added, consider renaming REPL apps you no longer need to something like "delete me."

2.1.4 Sharing REPL apps

To share a REPL app with other developers, copy its URL from the browser address bar. Then provide it to others via chat, text message, or email. They will be able to modify the REPL app and save the changes as their own app, but they cannot modify your version of the app.

Sharing REPL apps is great for asking questions in the Svelte Discord chat. Post a question along with a REPL URL that demonstrates something you would like to share.

2.1.5 REPL URLs

The URL of every REPL app ends with a query parameter named `version` that specifies the version of Svelte being used. It defaults to the newest version, but you can change this to test the REPL app with a different version of Svelte.

This is particularly useful if you suspect a bug has been introduced in Svelte. You can try the REPL app in several versions and determine if its behavior changes.

2.1.6 Exporting REPL apps

At some point in the development of an app in the REPL, you may want to break out of the REPL. There are many reasons to do this:

- To avoid the limitations of the REPL described in section 2.1.8
- To manage the app in a source control system such as Git
- To use a build system (such as npm scripts) for tasks such as building the app for deployment and running unit or end-to-end tests
- To get automatic code formatting, perhaps with Prettier
- To get code completion (a.k.a. IntelliSense), perhaps with VS Code

To download the current app so you can continue developing it locally, click the download button (see figure 2.17). This downloads a zip file whose name defaults to svelte-app.zip.

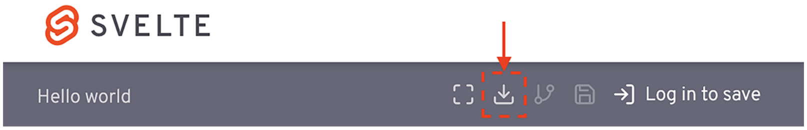


Figure 2.17 The REPL download button

Follow these steps to run the app locally:

1. If Node.js is not already installed, install it from https://nodejs.org. This installs the `node`, `npm`, and `npx` commands.
2. Unzip the downloaded zip file.
3. `cd` to the directory it creates.
4. Enter `npm install`.
5. Enter `npm run dev` to run the app in development mode.

Running Svelte apps outside of the REPL in this way will be covered in more detail later.

2.1.7 Using npm packages

REPL apps can import functions and other values from npm packages. For example, to use the `capitalize` function from the lodash package, first import it:

```
import capitalize from 'lodash/capitalize';
```

You can then call this function with `capitalize(*someString*)`.

Alternatively, the entire library can be imported.

```
import _ from 'lodash';
```

NOTE An underscore is a valid variable name in JavaScript. It is commonly used as the name of the variable that holds the Lodash library because an underscore looks like a "low dash."

With this kind of import, you can call the `capitalize` function with `_.capitalize(someString)`.

The REPL obtains npm package code from https://unpkg.com, which is a content delivery network (CDN) for all the packages in npm. To import a specific version of an npm package, follow the name with `@` followed by the version. For example,

```
import _ from 'lodash@4.16.6'
```

2.1.8 REPL limitations

The Svelte REPL is great, but it does have some limitations. It cannot do these things:

- Delete a selected saved project.
- Sort saved projects by name or date.
- Filter the list of saved projects based on text in a project name or text found in one of the files.
- Edit the provided files `src/main.js` and `public/global.css`. Global styles can be defined in a REPL app by defining them in the `style` element within `App.svelte`, enclosing them in the syntax `:global(body) { … }`. This syntax is described in chapter 3.

2.1.9 CodeSandbox

CodeSandbox provides an alternative to the Svelte REPL for building Svelte applications without downloading or installing anything. This is an online version of the VS Code editor.

To use it, browse to https://codesandbox.io. No signup is required. To save your work, sign in with your GitHub account.

To create a Svelte project, click the + Create Sandbox button. Under Official Templates, select Svelte.

To enable Vim keybindings, select File > Preferences > CodeSandbox Settings > Editor and toggle Enable VIM Extension to on.

Apps developed in CodeSandbox can be deployed to Vercel Now or Netlify by clicking the left navigation button containing a rocket icon, and then clicking the Deploy to Vercel or the Deploy to Netlify button. This will take a couple of minutes to complete. For Vercel Now, click the supplied link to visit the new app. For Netlify, click the Visit button to visit the new app, and click the Claim button to add the app to your Netlify dashboard.

NOTE Deploying Svelte apps using Netlify and Vercel Now is covered in more detail in chapter 13. The ZEIT company was renamed to Vercel in April 2020.

CodeSandbox supports a Live mode where you can live-edit the files of an application collaboratively with others.

2.2 Working outside the REPL

There are two common ways to create a Svelte application that can be developed and run outside the REPL.

You have already seen the first option. An app created in the REPL can be downloaded as a zip file, and unzipping this provides all the files you need to get started. It is not necessary to enter any code in the REPL. It is sufficient to download the example Hello World app that the REPL provides, and modify the code from that starting point.

The second option is to use the `npx` tool that is installed with Node.js to execute the `degit` command. Rich Harris, the creator of Svelte, created `degit` to simplify project scaffolding. Think of the "de" prefix in the name as meaning "out of." It simply downloads a Git repository that contains a predefined directory structure, including starting files. By default, it downloads the master branch.

It is helpful to use a powerful code editor when working outside the REPL. Although any code editor or IDE can be used, VS Code is recommended. Details on using VS Code to develop Svelte and Sapper apps, including the use of specific extensions, is provided in appendix F.

2.2.1 Starting with npx degit

Let's walk through the steps for creating and running a Svelte application using the `degit` command.

1. Enter `npx degit sveltejs/template` *`app-name`*.

   In this case, `sveltejs` is the organization, and `template` is the name of a repository owned by that organization.

   The second argument is the name of the subdirectory to create, and it is also the name of the application.

   This repository uses the Rollup module bundler (https://rollupjs.org). The provided `rollup.config.js` file uses `rollup-plugin-terser` which uses the terser library. This minimizes the resulting JavaScript bundle when building for production using `npm run build`.

   Webpack (https://webpack.js.org/) is a module bundler that is an alternative to Rollup. If there are specific Webpack plugins you would like to use, enter the following to create a Svelte project that uses Webpack for module bundling instead of Rollup: `npx degit sveltejs/template-webpack` *`app-name`*

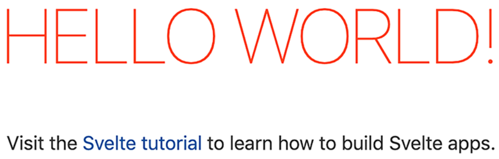
   Parcel (https://parceljs.org/) is another module bundler that is an alternative to Rollup. Currently there is no official support for Parcel in Svelte, but unofficial support is available at https://github.com/DeMoorJasper/parcel-plugin-svelte.

2. Enter `cd` *`app-name`*.
3. Enter `npm install` to install all the required dependencies from npm. To use TypeScript instead of JavaScript, enter node `scripts/setupTypeScript.js`. This will modify the project to use TypeScript and delete the `scripts` directory.
4. Enter `npm run dev` to run the app in development mode.

   This starts a local HTTP server. It also provides live reload, which rebuilds the app and refreshes it in the browser if any source files used by the app are modified using any editor.

   An alternative way to run the app is to enter `npm run build` followed by `npm start`. This omits live reload. The `build` step is required to create the bundle files that `npm start` expects to exist in the public directory.
5. Browse to localhost:5000, which renders the page shown in figure 2.18.

   Note that the default Webpack configuration uses port 8080 instead of 5000.



HELLO WORLD!

Visit the Svelte tutorial to learn how to build Svelte apps.

Figure 2.18 The sveltejs/ template Hello World app

Module bundlers

A JavaScript module bundler combines the JavaScript code (and sometimes other assets) needed by an application into a single JavaScript file. This includes JavaScript library dependencies such as those from npm (https://npmjs.com). It can also remove code that is not used and minimize the remaining code. All of this reduces the time required to download a JavaScript-based app to a web browser.

There are several popular JavaScript module bundlers, the most popular of which are Webpack, Rollup, and Parcel. Rollup was created by Rich Harris, the creator of Svelte.

Regardless of whether the app is built by entering `npm run dev` or `npm run build`, the following files will be created in the public directory:

- `bundle.css`
- `bundle.css.map`
- `bundle.js`
- `bundle.js.map`

The `.map` files support debugging the app. They map the generated code to the code you wrote so you can view and step through the code in a debugger.

Now you are ready to start modifying the app. If the browser doesn't render the expected output after you save your changes, check for compilation errors in the terminal window where the server is running. The Svelte compiler is unable to parse some syntax errors (such as unbalanced braces) and a message describing the issue may appear there. These error messages cannot be displayed in the browser because Svelte doesn't produce a new version of the app if there are syntax errors. For this reason, it is recommended that you keep the window where `npm run dev` is running in view.

TIP Sometimes `npm run dev` is able to start the server despite warning messages being output. These may scroll off the screen, but you can scroll backwards in the window where `npm run dev` is running to see them.

TIP If you are not seeing the results of your latest code changes, it could be because you ran `npm start` instead of `npm run dev`. The former command runs the code that was compiled the last time you ran `npm run build` or `npm run dev`. It's easy to make this mistake because in many other web frameworks `npm start` is the command that runs the app locally in dev mode with live reload.

2.2.2 Provided package.json

A peek at the `package.json` file reveals two things.

The first is that Svelte uses Rollup by default for module bundling, as seen in all the references to `rollup` in the `devDependencies`. If desired, you can change this to use Webpack or Parcel.

The second is that Svelte apps have only one required runtime dependency, `sirv-cli`, which provides the local HTTP server used by the `npm start` command. To see this, look at the values of `dependencies` and `devDependencies` in `package.json`. No other runtime dependencies are required because all the code needed by Svelte apps is included in the `bundle.js` file that the Svelte compiler produces.

2.2.3 Important files

The most important starting files in a Svelte app are `public/index.html`, `src/main.js`, and `src/App.svelte`. All of these can be modified to suit the needs of the application being developed.

These files use tabs for indentation, but feel free to change these to spaces if tabs aren't your cup of tea. As you will see later, Prettier can do this for you, changing all indentation to use either spaces or tabs.

The `public/index.html` file contains the following:

Listing 2.2 The `public/index.html` file

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="utf8" />
    <meta name="viewport" content="width=device-width,initial-scale=1" />
    <title>Svelte app</title>
    <link rel="icon" type="image/png" href="/favicon.png" />
    <link rel="stylesheet" href="/global.css" />
    <link rel="stylesheet" href="/build/bundle.css" />

    <script defer src="/build/bundle.js"></script>
  </head>
  <body>
  </body>
</html>
```

Note that this includes two CSS files and one JavaScript file. The `global.css` file holds CSS that can affect any component. The `bundle.css` file is generated from the CSS in each component `.svelte` file. The `bundle.js` file is generated from the JavaScript and HTML in each component `.svelte` file and any other JavaScript code the components use.

The `src/main.js` file contains the following:

Listing 2.3 The `src/main.js` file

```
import App from './App.svelte';

const app = new App({
  target: document.body,
  props: {
    name: 'world'
  }
});

export default app;
```

This renders the `App` component. The `target` property specifies where the component should be rendered. For most apps this is the body of the document.

This code passes the `name` prop to the `App` component. Typically the topmost component does not need props, and the `props` property seen here can be deleted. This is because any data that is hardcoded in `main.js` can alternatively be hardcoded in `App.svelte` instead of passing it in through props.

The `src/main.js` file is expected to make the instance of the topmost component, `App` in this case, be the default export.

The `src/App.svelte` file contains the following:

Listing 2.4 The `src/App.svelte` file

```
<script>
  export let name;
</script>

<main>
  <h1>Hello {name}!</h1>
  <p>
    Visit the <a href="https://svelte.dev/tutorial">Svelte tutorial</a>
    to learn how to build Svelte apps.
  </p>
</main>

<style>
  main {
    text-align: center;
    padding: 1em;
    max-width: 240px;
    margin: 0 auto;
  }

  h1 {
    color: #ff3e00;
    text-transform: uppercase;
    font-size: 4em;
    font-weight: 100;
  }

  @media (min-width: 640px) {
    main {
      max-width: none;
    }
  }
</style>
```

All `.svelte` files can contain a `script` element, arbitrary HTML, and a `style` element. Each section is optional. The order of these sections is not important, but the most common order is `script` first, HTML second, and `style` last. This places the parts that interact next to each other. Variables and functions in the `script` element are typically used by the HTML, and the HTML is styled by the CSS, but the `style` element is rarely affected by code in the `script` element. To use TypeScript instead of JavaScript inside a `script` element, change the opening tag to `<script lang="ts">`.

The `export` keyword before the `name` variable at the top of the `script` element indicates it is a prop. Prop values can be set in other components that use this component. This is a case where the Svelte compiler treats valid JavaScript syntax (the `export` keyword) in a special way. Another such case is the syntax `$:` for reactive statements, which you learned about earlier.

Curly braces are used to output or render the value of a JavaScript expression, in this case just the variable `name`. This is referred to as *interpolation*. As you will see later, curly braces are also used for dynamic attribute values.

At this point you are free to modify the provided files and add more, just like we did earlier in the REPL.

2.2.4 Your first non-REPL app

Let's build a Svelte app that calculates monthly loan payments given a loan amount, annual interest rate, and number of years. Users should be able to change any of the inputs and see the newly calculated monthly payment. We can build this in just 28 lines of code. The details of the calculation are not important. Focus on the layout of the code and the use of reactive declarations.

Follow along with these steps:

1. Enter `npx degit sveltejs/template loan`.
2. Enter `cd loan`.
3. Enter `npm install`.
4. Edit `src/App.svelte` and change it to match the code in listing 2.5.
5. Enter `npm run dev`.
6. Browse to localhost:5000.
7. Try changing any of the inputs and verify that the monthly payment is updated.

Listing 2.5 Loan calculator app in `src/App.svelte`

```
<script>
  let interestRate = 3;
  let loanAmount = 200000;
  let years = 30;
  const MONTHS_PER_YEAR = 12;

  $: months = years * MONTHS_PER_YEAR;
  $: monthlyInterestRate = interestRate / 100 / MONTHS_PER_YEAR;
  $: numerator = loanAmount * monthlyInterestRate;
  $: denominator = 1 - (1 + monthlyInterestRate) ** -months;
  $: payment =
    !loanAmount || !years ? 0 :
    interestRate ? numerator / denominator :
    loanAmount / months;
</script>

<label for="loan">Loan Amount</label>
<input id="loan" type="number" bind:value={loanAmount}>

<label for="interest">Interest Rate</label>
<input id="interest" type="number" bind:value={interestRate}>

<label for="years">Years</label>
<input id="years" type="number" bind:value={years}>

<div>
  Monthly Payment: ${payment.toFixed(2)}
</div>
```

When an input type is "number," bind coerces the value of the variable, in this case loanAmount, to a number.

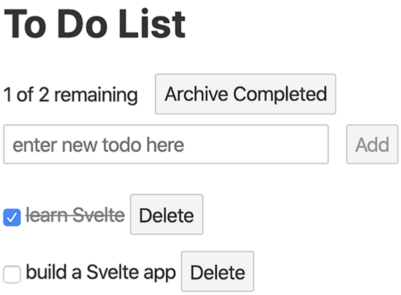
Note the use of reactive declarations in the preceding code. When the value of `interestRate`, `loanAmount`, or `years` changes, the value of `payment` is recomputed and displayed in the `div` element at the bottom.

It's not fancy. There is no styling. But it works and demonstrates the ease with which useful web apps can be created with Svelte.

2.3 Bonus app

Let's implement the famous Todo app in Svelte, as shown in figure 2.19. I have implemented this app in Svelte, React, and Vue, and you can find my implementations here:

- https://github.com/mvolkmann/svelte-todo
- https://github.com/mvolkmann/react-todo
- https://github.com/mvolkmann/vue-todo



To Do List

1 of 2 remaining

☑ ~~learn Svelte~~

□ build a Svelte app

Figure 2.19 Todo app

With this app, users can

- Add todos
- Check todos to mark them as completed
- Uncheck todos to mark them as not completed
- Archive the completed todos
- Delete todos
- See the number of todos that have been completed and the total number of todos

We will implement this with two Svelte components named `Todo` and `TodoList`.

To create your own version of this app, begin by entering `npx degit sveltejs/template todo`.

The `Todo` component renders a list item (`<li>`) for a single todo item. It contains a checkbox, the text of the todo, and a Delete button. This component doesn't know what to do when the checkbox is toggled. It also doesn't know what to do when the Delete button is clicked. It just dispatches events that are received by the `TodoList` component.

The `TodoList` component is the topmost component in the app. It renders a list of todos inside an unordered list (`<ul>`). It also listens for events from the `Todo` components and takes the appropriate actions.

This simple implementation does not actually persist todos to a storage location such as a database when they are archived. It just deletes them.

Listing 2.6 shows the code for the `Todo` component. We will cover event dispatching in more detail in chapter 5. When todos are added or deleted, the built-in `fade` transition is used so they gradually appear and disappear.

Listing 2.6 Todo component in src/Todo.svelte

```
<script>
  import {createEventDispatcher} from 'svelte';
  import {fade} from 'svelte/transition';
  const dispatch = createEventDispatcher();

  export let todo;
</script>

<li transition:fade>
  <input
    type="checkbox"
    checked={todo.done}
    on:change={() => dispatch('toggleDone')} />
  <span class={'done-' + todo.done}>{todo.text}</span>
  <button on:click={() => dispatch('delete')}>Delete</button>
</li>

<style>
  .done-true {
    color: gray;
    text-decoration: line-through;
  }

  li {
    margin-top: 5px;
  }
</style>
```

This creates a dispatch function that is used to dispatch an event.

TodoList passes an object describing a todo as a prop.

This dispatches a custom event named toggleDone, for which parent components can listen.

This dispatches a custom event named delete, for which parent components can listen.

The todo text will have a CSS class of done-true or done-false. We do not need any special styling for done-false.

Next is the code for the `TodoList` component.

Listing 2.7 TodoList component in src/TodoList.svelte

```
<script>
  import Todo from './Todo.svelte';

  let lastId = 0;

  const createTodo = (text, done = false) => ({id: ++lastId, text, done});

  let todoText = '';

  let todos = [
    createTodo('learn Svelte', true),
    createTodo('build a Svelte app')
  ];

  $: uncompletedCount = todos.filter(t => !t.done).length;

  $: status = `${uncompletedCount} of ${todos.length} remaining`;

  function addTodo() {
    todos = todos.concat(createTodo(todoText));
```

This is a function that creates a todo object.

The app starts with two todos already created.

This is recomputed when the todos array changes.

This is recomputed when the todos array or uncompletedCount changes.

```
    todoText = ''; // clears the input
  }

  function archiveCompleted() {
    todos = todos.filter(t => !t.done);
  }

  function deleteTodo(todoId) {
    todos = todos.filter(t => t.id !== todoId);
  }

  function toggleDone(todo) {
    const {id} = todo;
    todos = todos.map(t => (t.id === id ? {...t, done: !t.done} : t));
  }
</script>

<div>
  <h1>To Do List</h1>
  <div>
    {status}
    <button on:click={archiveCompleted}>Archive Completed</button>
  </div>
  <form on:submit|preventDefault>
    <input
      size="30"
      placeholder="enter new todo here"
      bind:value={todoText} />
    <button disabled={!todoText} on:click={addTodo}>Add</button>
  </form>
  <ul>
    {#each todos as todo}
      <Todo
        {todo}
        on:delete={() => deleteTodo(todo.id)}
        on:toggleDone={() => toggleDone(todo)} />
    {/each}
  </ul>
</div>

<style>
  button {
    margin-left: 10px;
  }

  ul {
    list-style: none; /* removes bullets */
    margin-left: 0;
    padding-left: 0;
  }
</style>
```

This keeps only the todos that are not done.

This deletes the todo with a given ID.

When we use a form, pressing the return key while focus is in the input activates the Add button, calling the addTodo function. But we don't want to POST the form data. The preventDefault modifier prevents that.

This is the Svelte syntax for iterating over an array.

The Add button is disabled if no text has been entered in the input.

We listen for delete and toggleDone events here.

The `main.js` file is modified to render a `TodoList` component instead of the default `App` component.

Listing 2.8 Todo app `src/main.js` file

```
import TodoList from './TodoList.svelte';

const app = new TodoList({target: document.body});

export default app;
```

The following steps will build and run this app:

1. Enter `npm install`.
2. Enter `npm run dev`.
3. Browse to localhost:5000.

That's it! We now have a functioning Todo app implemented with a very small amount of code. It demonstrates many of the Svelte concepts we have covered up to this point.

Hopefully what you have seen so far is enough to convince you that there is something special about Svelte. It has a minimal syntax that makes implementing web applications very easy compared to the alternatives.

Svelte has many more features that we will cover in the following chapters. Along the way we will build a web application that serves as a travel-packing checklist. In the next chapter we will dive deeper into defining Svelte components.

Summary

- Svelte provides an online REPL that makes it easy to experiment with Svelte without downloading or installing anything. It can even save apps so they can be recalled later for further study, or it can download them so development can continue outside of the REPL.
- Svelte components are described by files with a `.svelte` extension that can contain JavaScript, HTML, and CSS.
- Svelte provides a template for generating a starting point for new apps that run outside the REPL.
- Creating a Svelte application outside the REPL only requires a few extra steps.

Part 2

Deeper into Svelte

This part of the book dives deep into Svelte, providing thorough coverage along with lots of example code as we build and manage Svelte components. We'll cover Svelte block structures that wrap conditional logic, iteration, and promise handling around markup, component communication, the use of "stores" to share state between components, lifecycle functions, page routing, animation, debugging, and testing. This part of the book will close out with some options for deploying Svelte applications and additional Svelte-related topics, such as form validation, libraries, and "special elements."

3 Creating components

This chapter covers

- Creating Svelte components
- Styling Svelte components
- Implementing logic in Svelte components
- Defining and updating state in Svelte components

In this chapter we will delve deeper into defining components by creating `.svelte` files. These files specify the JavaScript that implements state and logic, the HTML to be rendered, and the CSS that will style them.

Components are the fundamental building blocks of web applications in most frameworks. Components are composed of closely related portions of a user interface. They can encapsulate data that is specific to their part of the UI, often referred as *state*. They split a UI into potentially reusable parts.

Some components represent entire pages while others are used within pages. For example, a page that displays a shopping list can be implemented by a `ShoppingList` component, and it can render each item in the list using an `Item` component.

Components accept data passed to them from other components using *props*. These have a syntax similar to HTML attributes, but their values can be any JavaScript type.

The state of a component is the data that is unique to each component instance. The logic of a component is defined by a set of functions that specify its behavior and include event handling.

Styling can be global, potentially affecting all components. More often it is scoped, so it only affects the component in which it is defined. CSS preprocessors such as Sass can be used to gain additional styling functionality.

Reactive statements allow code to be re-executed any time the value of a variable they use changes. Often these statements change the value of a state variable, which causes parts of the component UI to be updated.

Module context can be used to define things that are shared between all instances of a component. For example, it can define variables that hold data to be shared.

By the end of the chapter, you'll be able to create components that can be used in any Svelte app.

3.1 Content of .svelte files

Svelte components are defined by the content of a file, not by a JavaScript container in the file, such as a class, function, or object literal. Creating a Svelte component is as easy as creating a file with a `.svelte` extension that follows some basic rules. These files belong in or below the src directory of an app.

`.svelte` files can contain at most one `<script context="module">` element, one `script` element, one `style` element, and any number of HTML elements that can appear in a `body` element. Each of these are optional, and these elements can appear in any order. This means that something as simple as the following is a valid Svelte component:

```
<div>Hello Svelte!</div>
```

Other currently popular web frameworks require more code than this to define a component.

Most `.svelte` files have the following structure:

```
<script>
  // Scoped JavaScript goes here.
</script>

<!-- HTML to render goes here. -->

<style>
  /* Scoped CSS rules go here. */
</style>
```

Note the different forms of comment syntax that can be used in each section.

JavaScript constructs defined in the `script` element are scoped to this component, meaning they are not visible in other components. Likewise, the CSS rules defined in the `style` element are scoped to this component. In both cases, the benefit is that code in one component cannot accidentally affect other components, which simplifies debugging.

3.2 Component markup

As you saw in the previous chapter, the syntax used to refer to and render a Svelte component matches the syntax of HTML elements. For example, a `Hello` component can be used like this:

```
<Hello name="World" />
```

Instances of Svelte components can be passed props and children. The preceding example has a `name` prop, but no children. Props are used to pass data to components. Children provide content to components. Components can then decide when and where to render the children. The children can be text, HTML elements, and other Svelte components.

> **NOTE** In terms of syntax, *props* look just like HTML attributes, but there is a difference. Attributes are specified on HTML elements, whereas props become the properties on JavaScript objects that represent DOM elements, which are in-memory representations of HTML elements.

A prop value can be a literal value of any type (Boolean, number, string, object, array, or function) or the value of a JavaScript expression. When the value is a string, it is enclosed in single or double quotes. Otherwise the value is enclosed in curly braces. These curly braces can optionally be surrounded by quotes to satisfy syntax highlighters.

Here are some examples of props on a Svelte component named `Person`:

```
<Person
  fullName="Jane Programmer"
  developer={true}
  ball={{name: 'baseball', grams: 149, new: false}}
  favoriteColors={['yellow', 'orange']}
  age={calculateAge(person)}
  onBirthday={celebrate}      <—— celebrate is a function.
/>
```

When the value of a prop on an HTML element is `null` or `undefined`, it is not added to the DOM. For example, in `<img alt={description} src={imageUrl}>` if the `description` variable is `null` or `undefined`, the `img` element will not have an `alt` attribute.

We can define the Person component component in a file named `src/Person.svelte` as follows:

```
<script>
  export let age;
  export let ball;
  export let developer;
  export let favoriteColors;
  export let fullName;
  export let onBirthday;
</script>
```

```
<div>
  {fullName} is {age} years old and
  {developer ? 'is' : 'is not'} a developer.
</div>
<div>
  They like the colors {favoriteColors.join(' and ')}.
</div>
<div>
  They like to throw {ball.new ? 'a new' : 'an old'} {ball.name}
  that weighs {ball.grams} grams.
</div>
<button on:click={onBirthday}>It's my birthday!</button>
```

String values can use interpolation to compute values based on JavaScript expressions. Expressions in a string surrounded by curly braces are replaced by their corresponding values. For example,

```
<Person fullName="{lastName}, {firstName} {middleName[0]}." />
```

A shorthand syntax can be used when a prop value is held in a variable with the same name as the prop. For example, if there is a variable named `fullName`, the following are equivalent:

```
<Person fullName={fullName} />
<Person {fullName} />
```

The JavaScript spread operator (`...`) can be used to insert multiple props if they are in an object where the keys are prop names and the values are the prop values. For example, suppose we want to render an `input` element that allows the user to enter a number from 0 to 10. If we have some of the needed `input` attributes in a JavaScript object, we can spread the properties of the object into an HTML `input` element as follows:

```
<script>
  let score = 0;
  const scoreAttrs = {
    type: 'number',
    max: 10,
    min: 0
 };
</script>

<input {...scoreAttrs} bind:value={score}>
```

This uses the bind directive you saw in chapter 2. Recall that this binds the value of a form element to a variable.

If we didn't use the spread operator, we would have to write one of the following:

```
<input type="number" min="0" max="10" bind:value={score}>

<input
  type={scoreAttrs.type}
  min={scoreAttrs.min}
  max={scoreAttrs.max}
  bind:value={score}>
```

DOM properties

Some DOM properties get their initial value from an HTML attribute. Some of these DOM properties can be modified, but their corresponding attribute value never changes. For example, consider the following HTML, which uses JavaScript but not Svelte. The initial value displayed in the `input` is “initial”. If a user changes the value to “new” by typing in the `input` and clicks the Log button, this will write values from the `input` to the DevTools console. The DOM property `value` will be “new”, but the HTML attribute `value` will still be “initial”.

```
<html>
  <head>
    <script>
      function log() {
        const input = document.querySelector('input');
        console.log('DOM prop value =', input.value);
        console.log('HTML attr value =',
          input.getAttribute('value'));
      }
    </script>
  </head>
  <body>
    <label>
      Name
      <input value="initial">
    </label>
    <button onclick="log()">Log</button>
  </body>
</html>
```

Some HTML attributes do not have a corresponding DOM property. An example is the HTML attribute `colspan` used on `td` elements in a `table`.

Some DOM properties do not have a corresponding HTML attribute, such as the DOM property `textContent`.

All these technicalities aside, we never speak of Svelte components as having *attributes*. They have *props*.

3.3 Component names

Svelte component definitions do not specify a component name. There is no class name, function name, or property value that specifies the name of the component like in other frameworks. Instead, a name is associated when a `.svelte` file is imported.

Components can import other components inside their `script` element:

```
import Other from './Other.svelte';
```

Imported components can be used in the HTML section of the component that imports them:

```
<Other />
```

Component names must start with an uppercase letter, and names consisting of multiple words are in typically camel cased. Lowercase names are reserved for predefined elements like those provided by HTML and SVG.

It is common for component names to match the name of their source file, but this is not required. For example,

```
import AnyNameIWant from './some-name.svelte';

import SameName from './SameName.svelte';
```

Somewhat confusing and doesn't follow conventions

Very clear

3.4 Component styles

One way to apply styling to an HTML element of a component is to add a `class` attribute for which a CSS rule has been defined inside the `style` element of a component.

Any number of CSS classes can be associated with an HTML element. Suppose we want to use the classes `holiday` and `sale`. Here is one approach:

```
<div class="holiday sale">large red wagon</div>
```

A CSS class can be conditionally added to an HTML element in several ways, each allowing the associated styling to only be applied when a certain condition is met.

The following example renders a message that only has the CSS class `error` if the value of the `status` variable is greater than or equal to 400.

```
<script>
  let status = 200;
  let message = 'This is a message.';
</script>

<label>
  Status
  <input type="number" bind:value={status}>
</label>
<div class:error={status >= 400}>{message}</div>

<style>
  .error {
    color: red;
    font-weight: bold;
  }
</style>
```

This allows the user to change the value of status.

This conditionally adds the "error" CSS class.

Conditionally used

An alternative way to conditionally apply the `error` class is as follows:

```
<div class={status >= 400 ? 'error' : ''}>{message}</div>
```

The empty string used for the class name when the status is less than 400 can, of course, be replaced by some other CSS class name.

Another approach is to use a Boolean variable with the same name. We can set it by adding the following reactive declaration to the previous `script` element:

```
$: error = status >= 400;
```

The syntax `$:`, as seen in chapter 2, marks a *reactive statement*. The important thing to know about reactive statements now is that they are re-executed when the value of any variable they reference changes. In this case, any time the value of `status` changes, the value of `error` will be recomputed. More detail on reactive statements is provided in section 3.10.

With the value of `error` in place, the `div` that uses it can be changed to the following:

```
<div class:error>{message}</div>
```

Svelte automatically excludes unused CSS rules from the generated CSS. These are rules that do not match any HTML element that can be rendered by the component. The Svelte compiler outputs warning messages that identify unused CSS rules.

3.5 CSS specificity

CSS specificity determines the precedence of conflicting CSS rules. This concept is not unique to Svelte, but understanding it will be important in the section that follows.

For example, consider the following HTML:

```
<div class="parent">
  I am the parent.
  <div id="me" class="child" style="color: red">
    I am the child.
  </div>
</div>
```

The following CSS rules set the color of the text "I am the child." to different values. The color used depends on the specificity of the selectors. Scores represented by a list of four numbers are explained after this example.

```
#me {
  color: orange;
}
```

score is 0,1,0,0.

```
.parent > .child {
  color: yellow;
}
```

score is 0,0,2,0.

```
.parent .child {
  color: green;
}
```

This has the same specificity as the rule before: 0,0,2,0. The last one wins.

```
.child {
  color: blue;
}
```

score is 0,0,1,0.

```
.parent {
  color: purple;
}
```

This has the same specificity as the rule before: 0,0,1,0. It applies the color purple to the element with the class "parent", but the previous rule applies the color blue to the element with the class "child".

The precedence order of these rules happens to be the order in which they are listed here. Using a `style` attribute on the inner `div` has the highest specificity.

There is a formula for computing the specificity score of any CSS rule that results in a list of four numbers. Considering the four numbers from left to right,

- The first is 1 for inline styles and 0 otherwise.
- The second is the number of `id` values in the selector.
- The third is the number of class names in the selector.
- The fourth is the number of element name references in the selector.

The selector with the highest combined number, obtained by removing the commas and treating it as a single 4-digit number, wins. For example, treat a score of 1,2,3,4 as 1234.

This means that inline styling specified with a `style` attribute on an HTML element always wins. After this, `id` attributes are more important than class names, which are more important than element names.

It also means that the order in which `id` values, class names, and element names appear in a selector does not affect its specificity calculation.

Here are some examples of applying this scoring:

- The CSS selector `.parent > #me` has a score of 0,1,1,0.
- The CSS selector `.parent #me` has the same score.
- The CSS selector `.parent .child` has a score of 0,0,2,0 and so has a lower score than selectors that use an `id`.

For more details on CSS specificity, see "Specifics on CSS Specificity" on the CSS-Tricks site: https://css-tricks.com/specifics-on-css-specificity/.

3.6 Scoped vs. global styles

Global styles are desirable when consistent styling needs to be applied across all components in an app. For example, all buttons can be styled to have a blue background with white text, no border, and rounded corners.

Scoped styles are desirable for styling the elements within a component and not affecting elements in other components. For example, a `table` element rendered by a component can be styled so rows are separated by a gray border line, but columns have no border line between them. If this styling is scoped, `table` elements rendered by other components can choose to use different borders.

As mentioned earlier, the CSS rules specified in a Svelte component `style` element are automatically scoped to the component and do not affect other components.

Style scoping is achieved by adding the same generated CSS class name, `svelte-`*`hash`*, to each rendered element of the component that is potentially affected by these CSS rules. The hash is generated from the content of the `style` element. The same value is used for all generated CSS rules of the component.

For example, suppose we define the following component in the `src/Pony.svelte` file:

```
<h1>Pony for sale</h1>
<p class="description">2 year old Shetland pony</p>

<style>
  h1 {
    color: pink;
  }
  .description {
    font-style: italic;
  }
</style>
```

The generated `public/build/bundle.css` file will contain CSS rules like the following, but all on the same line:

```
h1.svelte-uq2khz{color:pink}
.description.svelte-uq2khz{font-style:italic}
```

Note how the CSS selectors for `h1` and `.description` both specify an additional CSS class whose name starts with `svelte-` and ends with the same hash value.

It would be rare for multiple components to have the same set of CSS rules in the same order in their `style` elements. If this occurs, those components will use the same hash value. This is not an issue, but it does result in duplicate CSS rules inside the combined `build/bundle.css` file produced by the Svelte compiler.

There are two ways to specify global styles. One way is to define them in the `public/global.css` file. This file is included by `public/index.html` by default. Another way is to use the `:global(`*`selector`*`)` modifier inside the `style` element of a component. This syntax is borrowed from that of CSS Modules (https://github.com/css-modules/css-modules).

An advantage of placing global styles in the `public/global.css` file instead of scattering them across component source files using the `:global(`*`selector`*`)` syntax is that it gives developers a single place to go to discover the global styles.

CSS properties specified in global styles only take effect in a component if that component does not also specify values for the same CSS properties in its `style` element.

For example, suppose we want all `h1` elements to be red unless this is overridden in specific components. We can add the following in `public/global.css`:

```
h1 {
  color: red;
}
```

We can also specify this in the `style` element of any component with the following:

```
:global(h1) {
  color: red;
}
```

If we also use `h1` as a CSS selector inside a component, it will compile to a selector with a scoping class that has the syntax `h1.svelte-`*`hash`*. The `:global(h1)` selector compiles to the selector h1 with no scoping. So the :global modifier just prevents the addition of a scoping CSS class.

CSS properties specified using the :global modifier override those for the same CSS selector in public/global.css.

The :global modifier can also be used to override styles in descendant components. This relies on creating CSS rules with selectors that have higher specificity than rules in descendant components.

For example, suppose we have the following component that sets the color of h1 elements to red.

Listing 3.1 A child component defined in src/Child.svelte

```
<h1>Hello from Child</h1>

<style>
  h1 {
    color: red;
  }
</style>
```

Listing 3.2 shows a component that uses the Child component. It overrides the CSS color property for h1 elements inside any element with a CSS class of override.

Listing 3.2 A parent component defined in src/Parent.svelte

```
<script>
  import Child from './Child.svelte';
</script>

<div class='override'>
  <Child />
</div>

<style>
  .override :global(h1) {
    color: blue;
  }
</style>
```

The CSS generated from Child.svelte is

```
h1.svelte-bt9zrl{color:red}
```

The CSS generated from Parent.svelte is

```
.override.svelte-ul8eid h1{color:blue}
```

This CSS selector takes precedence because it has higher specificity than the CSS selector from Child.svelte. The h1 color becomes blue instead of red.

When :global is used, it must appear at the beginning or end of a CSS selector list, not in the middle. For example, the following is not allowed:

```
.user :global(.address) .city { ... }
```

Typically :global is used at the end of a selector list to override styling in an ancestor component rather than at the beginning to specify truly global styling.

A list of CSS selectors can be passed to :global:

```
.user :global(.address .city) { ... }
```

3.7 Using CSS preprocessors

The module bundler used by Svelte can be configured to support using a CSS preprocessor. A CSS preprocessor reads custom styling syntax that supports features not found in standard CSS and converts it to standard CSS. Chapter 20 provides details on configuring these.

One popular CSS preprocessor is Sass (https://sass-lang.com/), which is discussed in more detail in chapter 20. It enables the use of variables, nested rules, mixins, and Sass functions. Once Sass is configured, components can opt into using Sass by adding a lang attribute to their style element as follows:

```
<style lang="scss">
```

3.8 Component logic

The logic of components is defined in two ways. The first is with plain JavaScript functions defined inside their script element. The second is using block structures in the component HTML. These block structures are covered in chapter 4.

Many developers find using plain functions easier to understand than using methods of a class or object. Plain functions remove the need to understand the meaning of the JavaScript this variable.

As an example of using a plain function in a Svelte component, the following component re-implements the loan-payment calculator shown in section 2.2.4 to perform the calculation in the function calculatePayment. It also adds a Reset button that resets the values of all the inputs using the reset function.

Listing 3.3 Loan payment calculator

```
<script>
  const MONTHS_PER_YEAR = 12;
  let interestRate, loanAmount, years;

  function calculatePayment(loanAmount, interestRate, years) {
    if (!loanAmount || !years) return 0;
    const months = years * MONTHS_PER_YEAR;
    if (!interestRate) return loanAmount / months;
    const monthlyInterestRate = interestRate / 100 / MONTHS_PER_YEAR;
    const numerator = loanAmount * monthlyInterestRate;
    const denominator = 1 - (1 + monthlyInterestRate) ** -months;
    return numerator / denominator;
  }

  function reset() {
    interestRate = 3;
    loanAmount = 200000;
    years = 30;
  }

  reset();

  $: payment = calculatePayment(loanAmount, interestRate, years);
</script>

<label for="loan">Loan Amount</label>
<input id="loan" type="number" bind:value={loanAmount}>

<label for="interest">Interest Rate</label>
<input id="interest" type="number" bind:value={interestRate}>

<label for="years">Years</label>
<input id="years" type="number" bind:value={years}>

<div>
  Monthly Payment: ${payment.toFixed(2)}
</div>

<button on:click={reset}>Reset</button>
```

This recalculates the payment if any of the arguments to calculatePayment change.

You may be wondering why we need to pass the arguments `loanAmount`, `interestRate`, and `years` to the `calculatePayment` function. These are also the names of variables that are in the scope of the `calculatePayment` function. Passing the values as arguments lets Svelte know that it needs to call the function again any time those values change.

If we merely used the following, Svelte would never recalculate the `payment` value.

```
$: payment = calculatePayment();
```

3.9 Component state

Top-level variables declared in the `script` element of a component are treated as the *state* of the component if they are referenced in HTML interpolations. They are top-level in the sense that they are not local to any function. Recall that interpolations are JavaScript expressions inside curly braces.

Changes to these variables cause interpolations that use them to be reevaluated. If their values change, the associated parts of the DOM are updated.

```
<script>
  let count = 0;
  const increment = () => count++;
</script>
```

```
<div>count = {count}</div>
<button on:click={increment}>+</button>
```

Clicking the "+" button causes the increment function to be called. That updates the value of the top-level variable count. Because count is used in an interpolation inside the div element, that part of the DOM is updated.

A new value must be assigned with = to trigger this behavior (or alternative operators such as += and ++). Pushing new elements onto an array does not create a new array and doesn't assign a new value to the variable. The following approaches for updating an array do work:

```
myArr = myArr.concat(newValue);

myArr = [...myArr, newValue];

myArr.push(newValue);
myArr = myArr;
```

The last approach shows that Svelte looks for the assignment of a new value, even if it is just assigning the variable to itself.

From a performance perspective, using push is preferred because, unlike using the concat method or the spread operator, it does not create a new array.

3.10 Reactive statements

Beginning a JavaScript statement with a name followed by a colon creates a *labeled statement*. Labeled statements can be used as targets of break and continue statements, which can break out of a loop and resume execution at a specified statement. Labeled statements are a feature of JavaScript that is almost never used in practice.

When a label is added to a top-level statement (not nested inside a function or block) and the name is a dollar sign, Svelte treats it as a *reactive statement*.

Interestingly it is not an error in JavaScript to use the same label name for more than one statement in the same scope. This means that we can have more than one reactive statement using the label name $.

This is another example of the Svelte compiler treating valid JavaScript syntax in a special way. Earlier you saw that Svelte treats the export keyword specially to define the props that a component accepts.

Reactive statements are repeated when the value of any variable referenced by the statement changes. This is somewhat like "computed properties" in the Vue framework.

When a reactive statement is an assignment, it is called a *reactive declaration*. In the following examples, the first is a reactive declaration and the second is a reactive statement.

```
$: average = total / count;

$: console.log('count =', count);
```

The value of average is computed initially and recomputed if the value of total or count changes.

The value of count is output in the DevTools console when this statement is first executed and again every time it changes. This is great for debugging!

When `$:` precedes an assignment to an undeclared variable, as in the previous assignment to `average`, Svelte inserts a `let` for the variable ahead of the reactive statement. It doesn't allow the `let` keyword to be added after `$:` because doing that is not valid in JavaScript. For example, this is not valid:

```
$: let average = total / count;
```

`$:` can also be applied to a block in order to re-execute all the statements in the block when any variables they reference change.

Consider a set of reactive declarations such as the following:

```
$: isTeen = 13 <= age && age < 20;
$: upperName = name.toUpperCase();
```

These can be replaced by a reactive block, but the code becomes more verbose due to the need to declare all the variables outside the block.

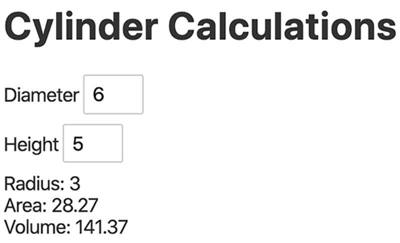
```
let isTeen, upperName;
$: {
  isTeen = 13 <= age && age < 20;
  upperName = name.toUpperCase();
}
```

`$:` can also be applied to multiline statements such as `if` statements.

```
$: if (someCondition) {
  // body statements
}
```

The preceding example executes if any variables referenced in the condition or the body change. If the condition includes calls to functions, they will be called if any references in the body have changed. Of course, the body only executes if the condition evaluates to true.

Reactive declarations are executed in topological order. This means evaluations of variables that are used in the calculations of other reactive declarations are executed first. For example, in the app shown in figure 3.1 and listing 3.4, the reactive declarations are executed in the reverse order in which they are listed.



Cylinder Calculations

Diameter 6

Height 5

Radius: 3
Area: 28.27
Volume: 141.37

Figure 3.1 Cylinder volume calculator

Listing 3.4 Cylinder volume calculator

```
<script>
  let diameter = 1;
  let height = 1;

  $: volume = area * height;
```

This expression depends on the values of area and height.

```
  $: area = Math.PI * radius ** 2;

  $: radius = diameter / 2;
</script>

<h1>Cylinder Calculations</h1>
<label>
  Diameter
  <input type="number" bind:value={diameter}>
</label>
<label>
  Height
  <input type="number" bind:value={height}>
</label>
<label>Radius: {radius}</label>
<label>Area: {area.toFixed(2)}</label>
<label>Volume: {volume.toFixed(2)}</label>

<style>
  input {
    width: 50px;
  }
</style>
```

This expression depends on the value of radius.

This expression depends on the value of diameter.

Dependencies between the variables in listing 3.4 are shown in figure 3.2.

Consider ordering reactive declarations in the order in which they will be executed to make reading and understanding the code a bit easier. In this case, the order would be `radius`, `area`, and `volume`. The opposite order was used in listing 3.4 to emphasize that Svelte handles these correctly regardless of their order.

Svelte is able to detect reactive declarations that are circular in nature and flag them as an error. For example, the following code will trigger the error "Cyclical dependency detected."

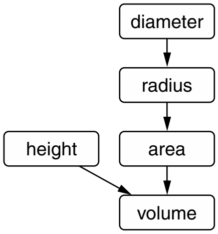


Figure 3.2 Dependencies between variables

```
$: a = b + 1;
$: b = a + 1;
```

3.11 Module context

Svelte supports a custom `script` element attribute that indicates the code it contains is in the *module context*. Think of this as like the distinction between instance and class (static) variables and methods in a JavaScript class.

```
<script context="module">
  ...
</script>
```

When a `script` element doesn't specify its context, it is *instance context*. One of each kind of `script` element, module and instance context, can appear in a component source file.

The module context can declare variables and define functions that are accessible in the instance context of all instances of the component. This allows the sharing of data between all instances. However, module context variables are *not reactive*, so components will not update when their values change. Instance context variables and functions are not accessible in the module context.

To run JavaScript code in a component source file only once instead of once for each component instance created, include the code in module context.

Note that it is not necessary to move functions that don't access component state to the module context because (from the Svelte API docs) "Svelte will hoist any functions that don't depend on local state out of the component definition."

However, one reason to put functions in module context is so they can be exported and called from outside the source file. Note that `.svelte` files cannot specify a default `export`—they always define a component, and that component automatically becomes the default `export`.

The following listing shows an example of a component definition that also exports a function from its module context.

Listing 3.5 Using module context in `src/Demo.svelte`

```
<script context="module">
  export function add(n1, n2) {
    return n1 + n2;
  }
</script>

<script>
  <!-- Component JavaScript goes here. -->
</script>

<!-- Component HTML goes here. -->

<style>
  /* Component CSS goes here. */
</style>
```

Another component can use the exported `add` function as follows.

Listing 3.6 Using an exported function

```
<script>
  import {onMount} from 'svelte';
  import {add} from './Demo.svelte';

  onMount(() => {
    const sum = add(1, 3);
    console.log('home.svelte onMount: sum =', sum);
  });
</script>
```

Although this works, it is more common to define and export utility functions like this in a `.js` file instead of a `.svelte` file.

Perhaps the most common use of module context is to define preload functions that are used to load data needed by a component in a Sapper app. You will learn about these in chapter 16.

3.12 Building a custom component

Many web apps use select elements to allow a user to select from a set of options. The options are specified using nested option elements. Each option can specify the text to display, and optionally the value to use if a user selects it. When no value is specified, the text becomes the value.

We can create a custom Svelte component that simplifies using select elements. Like the Todo component in chapter 2, this Select component dispatches a custom event named select for which parent components can listen. It does this by calling the dispatch function, which is obtained by calling the provided createEventDispatcher function.

Listing 3.7 Select component in src/Select.svelte

```
<script>
  import {createEventDispatcher} from 'svelte';
  const dispatch = createEventDispatcher();
  export let options;

  const getLabel = option =>
    typeof option === 'object' ? option.label : option;

  const getValue = option =>
    typeof option === 'object' ?
      option.value || option.label :
      option;
</script>

<select on:change={event => dispatch('select', event.target.value)}>
  {#each options as option}
    <option value={getValue(option)}>{getLabel(option)}</option>
  {/each}
</select>
```

Options are passed in through this prop. They are represented by an array of strings or objects. When objects are used, they can have label and value properties. If no value is provided, the label is used for the value.

When an option is selected, a "select" event is dispatched with the selected value as the value of the event.

This is Svelte syntax for iterating over an array.

The following listing shows a component that uses the Select component.

Listing 3.8 App that uses Select component in src/App.svelte

```
<script>
  import Select from './Select.svelte';

  const options = [
    '',
    'Red',
    {label: 'Green'},
    {label: 'Blue', value: 'b'}
  ];
```

This represents nothing being selected.

Options can be just strings.

When the value is an object, having a value property is optional.

This object value specifies both a label and a value for the option.

```
  let selected;

  const handleSelect = event => selected = event.detail;
</script>

<Select options={options} on:select={handleSelect} />

{#if selected}
  <div>You selected {selected}.</div>
{/if}
```

The second argument to the dispatch function in Select.svelte is the value of the selected option, which is available here as event.detail.

3.13 Building the Travel Packing app

Let's use what we have learned so far to begin building the Travel Packing app described earlier. The finished code can be found at http://mng.bz/wBdO.

In the end, we want to allow users to do the following:

- Create an account (though we won't really implement this)
- Log in and log out
- Create, edit, and delete categories for checklist items
- Create, edit, and delete checklist items
- Check and uncheck items
- See all checklist items, only checked items, and only unchecked items
- See a progress bar that shows the percentage packed in each category
- Clear all checked items in preparation for the next trip

To create the starting files for the app, `cd` to the directory where you would like to create the app and enter `npx degit sveltejs/template travel-packing`.

Next, create the `src/Login.svelte` file. The Login component will consist of an `input` for username, an `input` for password, a Login `button`, and a Sign Up `button`. The buttons won't do anything yet. We're just focusing on the presentation aspects.

The CSS for the `Login` component uses flexbox for layout. If you are new to flexbox, check out "Flexbox Froggy" (https://flexboxfroggy.com) or the free video course from Wes Bos (https://flexbox.io/).

Here is the code for the `Login` component.

Listing 3.9 `Login` component in `src/Login.svelte`

```
<script>
  let password = '';
  let username = '';

  const login = () => alert('You pressed Login.');
  const signup = () => alert('You pressed Signup.');
</script>

<section>
  <form on:submit|preventDefault={login}>
    <label>
      Username
```

The preventDefault modifier prevents form submission.

```
      <input required bind:value={username}>
    </label>
    <label>
      Password
      <input type="password" required bind:value={password}>
    </label>
    <div class="buttons">
      <button>Login</button>
      <button type="button" on:click={signup}>Sign Up</button>
    </div>
  </form>
</section>

<style>
  .buttons {
    display: flex;
    justify-content: space-between;

    font-size: 1.5rem;
    margin-top: 1rem;
  }

  form {
    display: inline-block;
  }

  input {
    display: block;
    margin-top: 0.3rem;
  }

  label {
    color: white;
    display: block;
    font-size: 1.5rem;
    margin-top: 0.5rem;
  }
</style>
```

The default type of button element is "submit". We only want the form to have one submit button, so this button is explicitly given a type of "button".

Note that the Login button does not have an `on:click` attribute. Clicking the button or pressing the Enter key while focus is in either input triggers a call to the `login` function because that is specified in the `on:submit` prop of the `form` element, and the Login button has a default type of `submit`.

Import the `Login` component in `src/App.svelte` by replacing the content of its `script` element with the following:

```
import Login from './Login.svelte';
```

Render the `Login` component in `App.svelte` by replacing the content of its `main` element with the following:

```
<h1 class="hero">Travel Packing Checklist</h1>
  <Login />
```

The CSS for the App component uses CSS variables and flexbox. If you are new to CSS variables, check out the "Using CSS custom properties (variables)" page on Mozilla Developer Network (MDN) at http://mng.bz/qM8A.

Replace the style element in App.svelte with the following.

Listing 3.10 The style element in App.svelte

```
<style>
  :global(body) {
    background-color: cornflowerblue;
  }

  .hero {
    --height: 7rem;

    background-color: orange;
    color: white;
    font-size: 4rem;
    height: var(--height);
    line-height: var(--height);
    margin: 0 0 3rem 0;
    text-align: center;
    vertical-align: middle;
    width: 100vw;
  }

  main {
    color: white;
    display: flex;
    flex-direction: column;
    justify-content: flex-start;
    align-items: center;
  }
</style>
```

This defines a CSS variable.

This uses a CSS variable.

Modify the styling for the body element in public/global.css.

Listing 3.11 Change to body styling in public/global.css

```
body {
  padding: 0; /* was 8px */
  ... keep other properties ...
}
```

By default, Firefox displays a red box shadow around required inputs that have no value. To prevent this, add the following in public/global.css.

Listing 3.12 Styling of invalid inputs in public/global.css

```
/* This prevents Firefox from displaying a red box shadow
  around required inputs that have no value. */
input:invalid {
  box-shadow: none;
}
```

Run the app by entering `npm install` followed by `npm run dev` and browsing localhost:5000. You should see the results shown in figure 3.3.

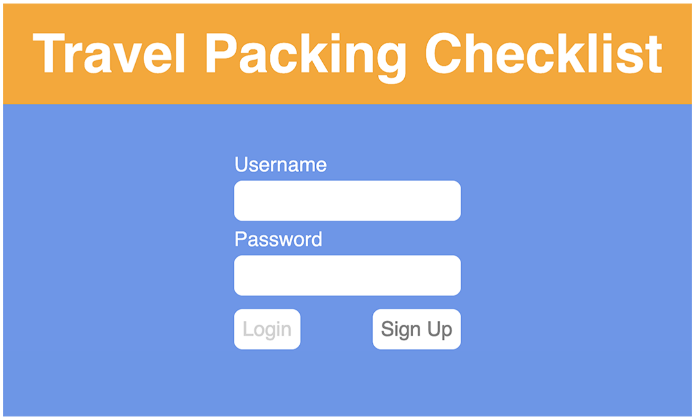


Figure 3.3 Travel Packing login

We have covered the basics of defining Svelte components, including defining what they render, styling the rendered HTML, and defining and updating component state.

In the next chapter, you will learn how to add conditional logic, iteration, and promise handling in the HTML portion of Svelte components.

Summary

- Svelte component definitions have a simple, recognizable syntax that consists of HTML elements. A `script` element holds the logic, a `style` element contains the CSS styles, and the rest is the HTML markup.
- A common way to pass data to components is through props.
- A Svelte component can import and render other Svelte components.
- CSS styling specified in a Svelte component is scoped to that component by default.
- Logic for Svelte components is implemented with plain JavaScript functions.
- Top-level variables in a Svelte component represent its state.
- Reactive statements start with `$:` and are repeated any time the value of a variable they reference changes.
- Module context is used to declare variables and define functions that are shared by all instances of the component, like static properties in many programming languages.

4 Block structures

This chapter covers

- Conditional logic in HTML with `#if`
- Iteration in HTML with `#each`
- Waiting on promises in HTML with `#await`

There are three common approaches to adding conditional and iteration logic in the markup of various web frameworks. React uses JSX (JavaScript XML) where logic is implemented by JavaScript code in curly braces (https://reactjs.org/docs/introducing-jsx.html). Angular and Vue support framework-specific attributes for logic. For example, Angular supports `ngIf` and `ngFor`, while Vue supports `v-if` and `v-for`. Svelte supports a Mustache-like (https://mustache.github.io/) custom syntax that wraps HTML and the components to render.

There are only three kinds of block structures in Svelte:

- `if` is used to specify conditional logic that determines whether something should be rendered.
- `each` is used to iterate over a collection of data, rendering something for each piece of data.
- `await` waits for a promise to resolve and renders something using that data.

Each of these defines blocks of HTML to render. They begin with {#*name*}, end with {/*name*}, and can contain {:*name*} intermediate markers. The # character indicates a block opening tag. The / character indicates a block ending tag. The : character indicates a block continuation tag. Read on to learn how to use these block structures.

4.1 Conditional logic with {#if}

Conditional logic in the HTML section of a Svelte component begins with {#if *condition*}, where the condition is any valid JavaScript expression. The end is marked with {/if}. The markup to be conditionally rendered goes between these. Other block tags that can be included between these are {:else if *condition*} and {:else}.

For example, we can render an assessment of a color as follows:

```
{#if color === 'yellow'}
  <div>Nice color!</div>
{:else if color === 'orange'}
  <div>That's okay too.</div>
{:else}
  <div>Questionable choice.</div>
{/if}
```

While this syntax may seem odd at first, it does have the benefit of being able to conditionally render multiple elements without specifying a common parent element.

The Angular/Vue approach of adding special attributes to elements requires specifying a common parent element in order to render multiple elements. In Angular this can be the special <ng-container> element, which does not produce a corresponding DOM element, as in the following listing.

Listing 4.1 Conditional logic in Angular using `ng-container`

```
<ng-container *ngIf="isMorning">
  <h1>Good Morning!</h1>
  <p>There is a lot on your plate today.</p>
</ng-container>
```

In Vue the common parent element can be a div element, but that element will appear in the rendered output, as in the following listing.

Listing 4.2 Conditional logic in Vue using a `div`

```
<div v-if="isMorning">
  <h1>Good Morning!</h1>
  <p>There is a lot on your plate today.</p>
</div>
```

React requires a common parent element or a React-specific “fragment.” Fragments do not produce a corresponding DOM element.

Listing 4.3 Conditional logic in React using a fragment

```
{isMorning && (
  <>
    <h1>Good Morning!</h1>
    <p>There is a lot on your plate today.</p>
  </>
)}
```

Svelte does not require any wrapping element to conditionally render multiple elements. Its block syntax is used instead.

Listing 4.4 Conditional logic in Svelte

```
{#if isMorning}
  <h1>Good Morning!</h1>
  <p>There is a lot on your plate today.</p>
{/if}
```

4.2 Iteration with {#each}

Iteration in HTML begins with `{#each array as item}`. The end is marked with `{/each}`. The markup to be rendered for each item goes between these.

The expression that follows `#each` can be any JavaScript expression that results in an array or array-like object. This includes literal values, variables, and function calls.

Optionally `{:else}` can be used before `{/each}`. Content after `{:else}` is rendered when the array is empty.

For example, suppose the variable `colors` is set to `['red', 'green', 'blue']`. The following example outputs each color on a separate line using the color.

```
{#each colors as color}
  <div style="color: {color}">{color}</div>
{/each}
```

The next example outputs each color on a separate line preceded by its 1-based position followed by a parenthesis:

```
{#each colors as color, index}
  <div>{index + 1}) {color}</div>
{/each}
```

The following example uses destructuring to get specific properties of the objects in the array `people`:

```
{#each people as {name, age}}
  <div>{name} is {age} years old.</div>
{:else}
  <div>There are no people.</div>
{/each}
```

Another option is to iterate over the keys and values of an object using `Object.entries` as follows:

```
<script>
  const person = {
    color: 'yellow',
    name: 'Mark',
    spouse: {
      color: 'blue',
      name: 'Tami'
    }
  };
</script>

{#each Object.entries(person) as [key, value]}
  <div>found key "{key}" with value {JSON.stringify(value)}</div>
{/each}
```

This renders the following:

```
found key "color" with value "yellow"
found key "name" with value "Mark"
found key "spouse" with value {"color":"blue","name":"Tami"}
```

If the items in an array will be added, removed, or modified after they are initially rendered, a unique identifier should be supplied for each element. Svelte refers to this as a "keyed each block," and it allows Svelte to optimize updating the DOM. It is similar to the need for the `key` prop in React and Vue.

In Svelte, the unique identifier is supplied as part of the `#each` syntax, not as a prop. In the following example, the unique identifier for each person is their `id` property.

```
{#each people as person (person.id)}
  <div>{person.name} is {person.age} years old.</div>
{/each}
```

To iterate a given number of times rather than over all the elements in an array, you can create an array with that number of elements. For example,

```
{#each Array(rows) as _, index}
  <div>line #{index + 1}</div>
{/each}
```

Array(rows) creates an array of length rows where all the elements are undefined.

4.3 Promises with {#await}

Svelte provides a block structure to wait for promises to resolve or reject. It can render different output based on whether the promise is still pending, has resolved, or has rejected.

For example, suppose we have a `getDogs` function that calls an API service, perhaps using the Fetch API, to retrieve a list of dog descriptions. Calling an API service is an asynchronous operation, so a JavaScript `Promise` object is returned. It will resolve to an array of objects that describe dogs. Each has a `name` and `breed` property.

NOTE Using the Fetch API is described in appendix B.

Any variable name can be used after `:then` and `:catch` to receive the resolved or rejected value.

```
{#await getDogs()}
  <div>Waiting for dogs ...</div>
{:then dogs}
  {#each dogs as dog}
    <div>{dog.name} is a {dog.breed}.</div>
  {/each}
{:catch error}
  <div class="error">Error: {error.message}</div>
{/await}
```

The next example omits the markup to be rendered while waiting for the `Promise` to resolve. The `:catch` portion can also be omitted, but it's typically best to render something to let the user know if the promise was rejected.

```
{#await getDogs() then dogs}
  {#each dogs as dog}
    <div>{dog.name} is a {dog.breed}.</div>
  {/each}
{:catch error}
  <div class="error">Error: {error.message}</div>
{/await}
```

If a component needs to trigger re-evaluating data from a promise, you can store the promise in a top-level variable, use that variable after `#await` (eg., `{#await myPromise}`), and modify the variable in a function.

Let's demonstrate this using a publicly available API service that returns images of a given dog breed (see figure 4.1). Copy this code to a REPL and try it!

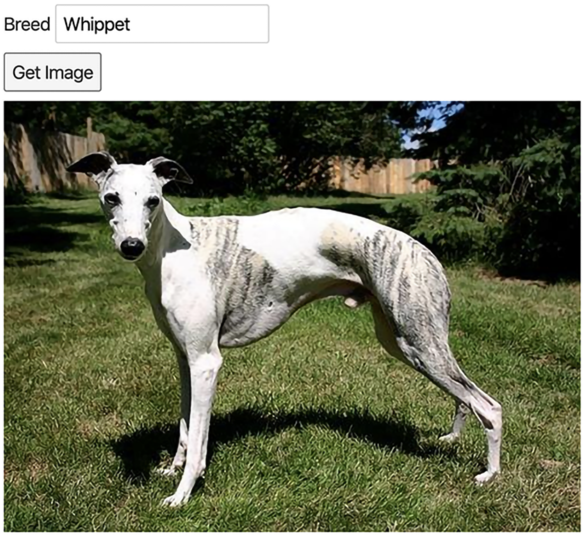

Breed Whippet

Figure 4.1 Dog breed image app

Listing 4.5 Dog breed image app

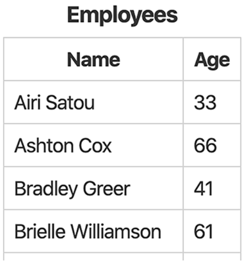
```
<script>
  let breed = 'Whippet';

  async function getDogs() {
    const url =
      'https://dog.ceo/api/breed/' +
      `${breed.toLowerCase()}/images/random/1`;
    const res = await fetch(url);
    if (!res.ok || res.status === 404) return [];
    const json = await res.json();
    return json.message;
  }

  let dogsPromise = getDogs();
</script>

<label>
  Breed
  <input bind:value={breed}>
</label>
<button on:click={() => dogsPromise = getDogs()}>
  Get Image
</button>

{#await dogsPromise}
  <div>Waiting for dogs ...</div>
{:then imageUrls}
  {#each imageUrls as url}
    <div><img alt="dog" src={url}></div>
  {:else}
    <div>Not found</div>
  {/each}
{:catch error}
  <div>Error: {error.message}</div>
{/await}
```

A Whippet is a dog breed.

This returns a promise.

Changing the value of dogsPromise causes the #await to be evaluated again.

Listing 4.6 shows one more example of using `#await` that uses a publicly available API service intended for demonstration purposes, and the results are shown in figure 4.2. The service returns a JSON object containing two properties, `status` and `data`. The `status` property is set to the string "success" when the call is successful. The `data` property holds an array of objects describing employees at a company.



Employees

Name	Age
Airi Satou	33
Ashton Cox	66
Bradley Greer	41
Brielle Williamson	61

Figure 4.2 Employee table

Listing 4.6 Component that renders the employee table

```
<script>
  let employees = [];
  let message;
```

This sorts the employees on their name, first before last.

```
  async function getEmployees() {
    const res = await fetch(
      'http://dummy.restapiexample.com/api/v1/employees');
    const json = await res.json();
    if (json.status === 'success') {
      return json.data.sort(
        (e1, e2) => e1.employee_name.localeCompare(e2.employee_name));
    } else {
      throw new Error(json.status);
    }
  }
</script>

{#await getEmployees()}
  <div>Loading employees ...</div>
{:then employees}
  <table>
    <caption>Employees</caption>
    <tr><th>Name</th><th>Age</th></tr>
    {#each employees as employee}
      <tr>
        <td>{employee.employee_name}</td>
        <td>{employee.employee_age}</td>
      </tr>
    {/each}
  </table>
{:catch message}
  <div class="error">Failed to retrieve employees: {message}</div>
{/await}

<style>
  caption {
    font-size: 1rem;
    font-weight: bold;
    margin-bottom: 0.5rem;
  }
  .error {
    color: red;
  }
  table {
    border-collapse: collapse;
  }
  td, th {
    border: solid lightgray 1px;
    padding: 0.5rem;
  }
</style>
```

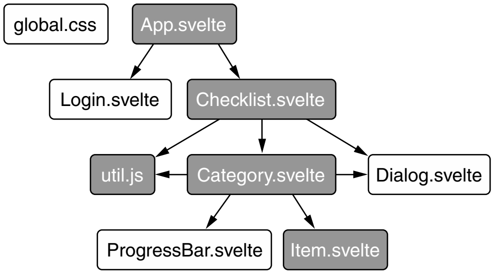
4.4 Building the Travel Packing app

Let's apply what you have learned about Svelte block structures to the Travel Packing app. The finished code can be found at http://mng.bz/vxBM.

We need to walk through a lot of code here, but it should all be understandable given what you have learned so far. This will set the stage for adding more features to the app in subsequent chapters.

The Item component uses #if to render the item name in an HTML input when in editing mode and in an HTML span otherwise. The Category component does the same for its name. It also uses #each to iterate over the items in a category. The Checklist component uses #each to iterate over the categories in a checklist.

Eventually we will create all the files shown in figure 4.3. The arrows point to files that are imported by a given file.



Shaded files are presented in this chapter.

Figure 4.3 Travel Packing app source files

4.4.1 *Item component*

First we need a component to represent an item to be packed. Items belong to a category, and categories have an ID. The Item component takes one prop, item, whose value is an object. An item object has the properties id (string), name (string), and packed (Boolean).

An item is represented by an li element that contains three children:

- The first child of the li is a checkbox that indicates whether the item has been packed. Clicking this toggles the packed property of the item object.
- The second child of the li is either a span element containing the name of the item or an input element that is used to edit the name. To edit the name of an item, the user clicks the text. This changes the value of the Boolean editing to true, which causes an input element to be rendered instead of a span. The editing Boolean is changed back to false when the user moves focus out of the input or presses the Enter key.
- The third child of the li is a button containing a trash can icon. In the future, clicking this will delete the item, but this is not implemented yet.

When an item is packed, its name is displayed in gray and with line-through, as shown in figure 4.4.

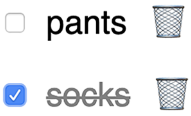


Figure 4.4 Item components

Listing 4.7 Item component defined in src/Item.svelte

```
<script>
  import {blurOnKey} from './util';
  export let item;

  let editing = false;
</script>

<li>
  <input type="checkbox" bind:checked={item.packed}>
  {#if editing}
    <input
      autofocus
      bind:value={item.name}
      on:blur={() => (editing = false)}
      on:keydown={blurOnKey}
      type="text" />
  {:else}
    <span class="packed-{item.packed}" on:click={() => (editing = true)}>
      {item.name}
    </span>
  {/if}
  <button class="icon">&#x1F5D1;</button>
</li>

<style>
  button {
    background-color: transparent;
    border: none;
  }

  input[type='checkbox'] {
    --size: 24px;
    height: var(--size);
    width: var(--size);
  }

  input[type='text'] {
    border: solid lightgray 1px;
  }

  li {
    display: flex;
    align-items: center;
  }

  .packed-true {
    color: gray;
    text-decoration: line-through;
  }

  span {
    margin: 0 10px;
  }
</style>
```

This is a CSS variable.

4.4.2 *Utility functions*

Some components use functions defined in `util.js`, shown in listing 4.8.

The `getGuid` function returns a unique ID. This is used to assign IDs to items to be packed. It requires the `uuid` npm package, which you can install by entering `npm install uuid`.

The `sortOnName` function is used to sort items within a category in a case-insensitive way.

Listing 4.8 Utility functions defined in `src/util.js`

```
import {v4 as uuidv4} from 'uuid';

export function getGuid() {
  return uuidv4();
}

export function blurOnKey(event) {
  const {code} = event;
  if (code === 'Enter' || code === 'Escape' || code === 'Tab') {
    event.target.blur();
  }
}

export function sortOnName(array) {
  array.sort((el1, el2) =>
    el1.name.toLowerCase().localeCompare(el2.name.toLowerCase())
  );
  return array;
}
```

4.4.3 *Category component*

Next we need a component to represent a category of items, such as “Clothing.” The `Category` component renders the following (see figure 4.5):

- The name of the category
- The number of items in the category remaining to be packed
- The total number of items in the category
- A trash can icon for deleting the category

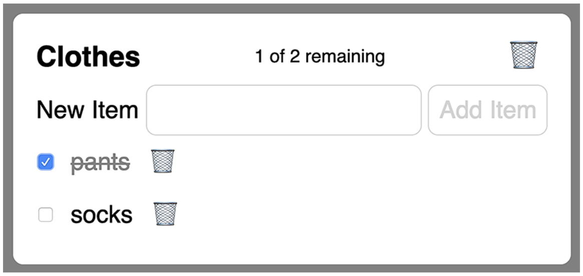


Figure 4.5 `Category` **component**

- An `input` for entering the name of a new item to be added to the category
- A `button` to click to add a new item
- A list of `Item` components, one for each item in the category

A category object has the properties `id` (string), `name` (string), and `items` (array of item objects).

The `Category` component takes three props: `categories` (array of category objects), `category` (object), and `show` (string). The `categories` prop is used to determine whether an item to be added already exists in another category. The `category` prop describes the category being rendered. The `show` prop is a string with a value of `all`, `packed`, or `unpacked`. It indicates which of the items should be displayed.

Clicking the name of the category changes it to an `input` so it can be edited. Moving focus out of the `input` or pressing the Enter key finalizes the change.

Listing 4.9 `Category` component defined in `src/Category.svelte`

```
<script>
  import Item from './Item.svelte';
  import {getGuid, blurOnKey, sortOnName} from './util';

  export let categories;
  export let category;
  export let show;

  let editing = false;
  let itemName = '';
  let items = [];
  let message = '';

  $: items = Object.values(category.items);
  $: remaining = items.filter(item => !item.packed).length;
  $: total = items.length;
  $: status = `${remaining} of ${total} remaining`;
  $: itemsToShow = sortOnName(items.filter(i => shouldShow(show, i)));

  function addItem() {
    const duplicate = Object.values(categories).some(cat =>
      Object.values(cat.items).some(item => item.name === itemName)
    );
    if (duplicate) {
      message = `The item "${itemName}" already exists.`;
      alert(message);
      return;
    }

    const {items} = category;
    const id = getGuid();
    items[id] = {id, name: itemName, packed: false};
    category.items = items;
    itemName = '';
  }
```

This will be replaced by a dialog in chapter 7.

This clears the input.

```
  function shouldShow(show, item) {
    return (
      show === 'all' ||
      (show === 'packed' && item.packed) ||
      (show === 'unpacked' && !item.packed)
    );
  }
</script>

<section>
  <h3>
    {#if editing}
      <input
        bind:value={category.name}
        on:blur={() => (editing = false)}
        on:keypress={blurOnKey} />
    {:else}
      <span on:click={() => (editing = true)}>{category.name}</span>
    {/if}
    <span class="status">{status}</span>
    <button class="icon">&#x1F5D1;</button>
  </h3>

  <form on:submit|preventDefault={addItem}>
    <label>
      New Item
      <input bind:value={itemName}>
    </label>
    <button disabled={!itemName}>Add Item</button>
  </form>

  <ul>
    {#each itemsToShow as item (item.id)}
      <!-- This bind causes the category object to update
        when the item packed value is toggled. -->
      <Item bind:item />
    {:else}
      <div>This category does not contain any items yet.</div>
    {/each}
  </ul>
</section>

<style>
  button,
  input {
    border: solid lightgray 1px;
  }

  button.icon {
    border: none;
  }

  h3 {
    display: flex;
```

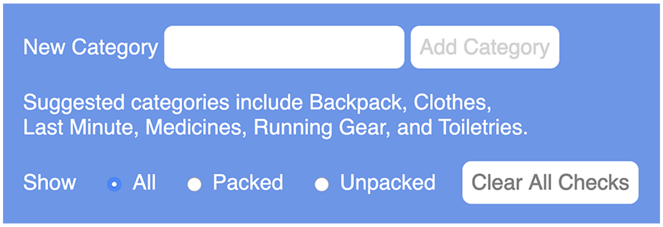
This is equivalent to <Item bind:item={item} />.

```
    justify-content: space-between;
    align-items: center;

    margin: 0;
  }

  section {
    --padding: 10px;

    background-color: white;
    border: solid transparent 3px;
    border-radius: var(--padding);
    color: black;
    display: inline-block;
    margin: var(--padding);
    padding: calc(var(--padding) * 2);
    padding-top: var(--padding);
    vertical-align: top;
  }

  .status {
    font-size: 18px;
    font-weight: normal;
    margin: 0 15px;
  }

  ul {
    list-style: none;
    margin: 0;
    padding-left: 0;
  }
</style>
```

4.4.4 Checklist component

Now we need a component to render all the categories. The `Checklist` component renders the following (see figure 4.6):

- An `input` for entering the name of a new category
- A `button` to click that adds the new category
- A list of suggested category names
- A set of radio buttons that determine whether to show all items, only those that have been packed, or only those that still need to be packed (unpacked items)



Suggested categories include Backpack, Clothes, Last Minute, Medicines, Running Gear, and Toiletries.

Figure 4.6 `Checklist` **component**

- A button to click that clears all the item checkboxes, which is useful when starting to pack for a new trip
- One Category component for each existing category

The Checklist component does not take any props.

Listing 4.10 Checklist component defined in src/Checklist.svelte

```
<script>
  import Category from './Category.svelte';
  import {getGuid, sortOnName} from './util';

  let categoryArray = [];
  let categories = {};
  let categoryName;
  let message = '';
  let show = 'all';

  $: categoryArray = sortOnName(Object.values(categories));

  function addCategory() {
    const duplicate = Object.values(categories).some(
      cat => cat.name === categoryName
    );
    if (duplicate) {
      message = `The category "${categoryName}" already exists.`;
      alert(message);
      return;
    }

    const id = getGuid();
    categories[id] = {id, name: categoryName, items: {}};
    categories = categories;
    categoryName = '';
  }

  function clearAllChecks() {
    for (const category of Object.values(categories)) {
      for (const item of Object.values(category.items)) {
        item.packed = false;
      }
    }
    categories = categories;
  }
</script>

<section>
  <header>
    <form on:submit|preventDefault={addCategory}>
      <label>
        New Category
        <input bind:value={categoryName}>
      </label>
      <button disabled={!categoryName}>Add Category</button>
```

This will be replaced by a dialog in chapter 7.

This triggers an update.

This clears the input.

Consider adding a confirmation here to avoid accidentally clearing all the checks.

```
      <button class="logout-btn">
        Log Out
      </button>
    </form>
    <p>
      Suggested categories include Backpack, Clothes,
      <br />
      Last Minute, Medicines, Running Gear, and Toiletries.
    </p>

    <div class="radios">
      <label>Show</label>
      <label>
        <input name="show" type="radio" value="all" bind:group={show}>
        All
      </label>
      <label>
        <input name="show" type="radio" value="packed" bind:group={show}>
        Packed
      </label>
      <label>
        <input name="show" type="radio" value="unpacked" bind:group={show}>
        Unpacked
      </label>

      <button class="clear" on:click={clearAllChecks}>Clear All Checks</button>
    </div>
  </header>

  <div class="categories">
    {#each categoryArray as category (category.id)}
      <Category bind:category {categories} {show} />
    {/each}
  </div>
</section>

<style>
  .categories {
    display: inline-flex;
    flex-wrap: wrap;
    justify-content: center;
  }

  .clear {
    margin-left: 30px;
  }

  input[type='radio'] {
    --size: 24px;
    height: var(--size);
    width: var(--size);
    margin-left: 10px;
  }

  .logout-btn {
    position: absolute;
```

There are accessibility issues here that will be fixed in chapter 12.

Using bind:group with a set of related radio buttons makes the value a single string.

```
    right: 20px;
    top: 20px;
  }

  .radios {
    display: flex;
    align-items: center;
  }

  .radios > label:not(:first-of-type) {
    display: inline-flex;
    align-items: center;

    margin-left: 1em;
  }

  .radios > label > input {
    margin-bottom: -3px;
    margin-right: 5px;
  }

  section {
    display: flex;
    flex-direction: column;
    align-items: center;

    font-size: 24px;
    margin-top: 1em;
  }
</style>
```

4.4.5 App component

For now we will render this component in the App component instead of the Login component created in the previous chapter. Later we will add logic to render only one of them at a time, depending on the state of the app.

Modify App.svelte:

1. Comment out the import of the Login component at the top of the script element.
2. Import the Checklist component at the top of the script element.

   ```
   import Checklist from './Checklist.svelte';
   ```

3. In the HTML section, comment out <Login /> and add <Checklist />.

To specify global styling for the app that can affect any component, replace the contents of public/global.css with the following:

Listing 4.11 Global CSS defined in public/global.css

```
body {
  font-family: sans-serif;
  height: 100vh;
```

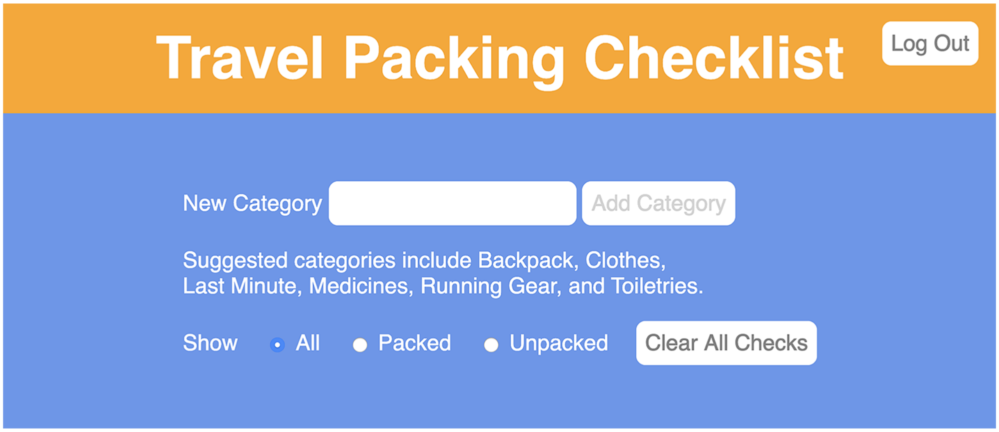
```
  margin: 0;
  padding: 0;
}

button:not(:disabled),
input:not(:disabled) {
  cursor: pointer;
}

button:disabled {
  color: lightgray;
}

button.icon {
  background-color: transparent;
  border: none;
  margin-bottom: 0;
}

input:disabled {
  color: #ccc;
}

label {
  display: inline-block;
}

input,
button,
select,
textarea {
  --padding: 10px;

  border-radius: var(--padding);
  border: none;
  box-sizing: border-box;
  color: gray;
  font-family: inherit;
  font-size: inherit;
  margin: 0;
  padding: var(--padding);
}
```

4.4.6 Try it

Run the app by entering `npm run dev` and browsing to localhost:5000. You should now see the page shown in figure 4.7.

Try adding some categories and adding items in each category. Click category and item names to modify them. Check some items to mark them as packed. Click the Show radio buttons to switch between showing all items, only packed items, or only unpacked items.

Clicking the trash can icons will not delete categories and items just yet. We will implement those in chapter 5, and you will also learn about all the ways in which Svelte components can share data.



Suggested categories include Backpack, Clothes,
Last Minute, Medicines, Running Gear, and Toiletries.

Figure 4.7 Travel Packing app

Summary

- Svelte component HTML uses Mustache-inspired syntax for specifying conditional logic, iteration, and promise handling.
- Conditional logic is specified using the syntax `{#if` *`condition`*`}`.
- Iteration is specified using the syntax `{#each` *`collection`* `as` *`element`*`}`.
- Promise handling is specified using the syntax `{#await` *`promise`*`}`.

5

Component communication

This chapter covers

- Passing data into components using props
- Getting data out of components by binding to props
- Using slots to supply content to be rendered
- Dispatching events to notify parent elements
- Using context to pass data to descendant components

Components in non-trivial Svelte applications need to communicate with each other. For example, suppose we have a component that allows a user to enter their mailing address. It can render inputs for street, city, state, and postal code. It also contains logic to verify that the postal code matches the city. Another component that displays a map may want to know when the data in our mailing address component has been changed so it can display the location of the new address.

There are many ways for Svelte components to communicate. Table 5.1 summarizes the available options. It uses the terms “parent,” “child,” “descendant,” and “ancestor” to refer to the relationships between components in the component hierarchy.

Table 5.1 Component communication options

Need	Solution
Parent passes data to child	Props
Parent passes HTML and components to child	Slots
Child notifies parent, optionally including data	Events
Ancestor makes data available to descendants	Context
Component shares data between all instances	Module context
Any component subscribes to data	Stores

Parent components directly render child components in their HTML sections. Ancestor components can be one or more levels removed from their descendant components. For example, if a `Bank` component renders an `Account` component, which renders a `Transaction` component, the `Bank` component is an ancestor of the `Transaction` component, and the `Transaction` component is a descendant of the `Bank` component.

Module context was discussed in chapter 3, and stores will be discussed in chapter 6. This chapter explains how to use all the other options and provides examples. It will conclude with adding component communication to the Travel Packing app.

5.1 Component communication options

There are six ways to share data between Svelte components.

1. *Props* pass data from parent components to child components, and optionally back to the parent using `bind`.
2. *Slots* pass content from parent components to child components so children can decide whether and where to render it.
3. *Events* are used to notify a parent component that something has happened in a child component, and they optionally include data in the event object that is passed to the parent.
4. *Contexts* allow ancestor components to make data available to descendant components without explicitly passing it to all the layers in between.
5. *Module context* stores data in component modules and makes it available to all instances of the component.
6. *Stores* store data outside components and can make it available to any of them.

5.2 Props

Components can accept input through props. Their values are specified as attributes on component elements. For example, a parent component can use a `Hello` component as follows.

Listing 5.1 Component that uses the `Hello` component

```
<script>
  import Hello from './Hello.svelte';
</script>

<Hello name="Mark" />
```

In this case, the value of the `name` prop is a literal string.

5.2.1 *Props go in with export*

The `Hello` component defined in `src/Hello.svelte` can be implemented as follows.

Listing 5.2 `Hello` component

```
<script>
  export let name = 'World';
</script>

<div>
  Hello, {name}!
</div>
```

Props are declared in the `script` element of a component with the `export` keyword. This uses valid JavaScript syntax, the `export` keyword, in a Svelte-specific way.

The `let` keyword must be used instead of `const` to declare props, because parent components can change the value.

Assigning default values to props is optional. In the preceding example, the `name` prop is given a default value of `'World'`. Props with no default value are required, meaning that parent components must specify them. When required props are not provided or unexpected props are provided and the app is run in dev mode (not production), warning messages are displayed in the DevTools console, and missing props have a value of `undefined`. However, the app still runs. The same is true in production mode, but the warning messages are omitted.

Prop values that are non-string literals or JavaScript expressions must be surrounded by curly braces instead of quotes. These can evaluate to any kind of JavaScript value, including objects, arrays, and functions.

The following listing shows examples of specifying non-string values for a prop.

Listing 5.3 Prop examples

```
myProp={false}
myProp={7}
myProp={{name: 'baseball', grams: 149, new: false}}
myProp={['red', 'green', 'blue']}
myProp={myCallbackFunction}
myProp={text => text.toUpperCase()}
```

An extra pair of braces is needed to pass an object literal.

This passes a reference to a named function as a prop value.

This passes an anonymous function as a prop value.

The braces around a prop value can optionally be surrounded with quotes:

```
myProp="{{name: 'baseball'}}"
```

Some editors and syntax highlighters prefer this, but the Svelte compiler does not require quotes.

The value of Boolean props can be inferred from the absence of the prop, or its presence without specifying a value, as will be demonstrated in listing 5.5. The `StopLight` component renders a red or green circle. The `on` prop value is used to determine the color. When the prop is omitted, its value defaults to `false`. When the prop name is specified without a value, its value is inferred to be `true`.

Listing 5.4 `StopLight` component in `src/StopLight.svelte`

```
<script>
  export let on = false;
  $: color = on ? 'green' : 'red';
</script>

<div style="background-color: {color}">
  {color}
</div>

<style>
  div {
    border-radius: 25px;
    color: white;
    height: 50px;
    line-height: 50px;
    margin-bottom: 10px;
    text-align: center;
    width: 50px;
  }
</style>
```

Specify a default value if the prop can be omitted.

The `App` component in listing 5.5 renders three `Stoplight` components. The instance with no `on` prop uses a value of `false`, so it renders a red circle. The instance with an `on` prop that has no value uses a value of `true`, so it renders a green circle. The instance with an `on` prop that specifies a value uses that value, so it renders either a red or green circle. Clicking the Toggle button toggles the color of the last circle (see figure 5.1).

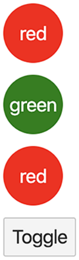


Figure 5.1 App that uses the `StopLight` component

Listing 5.5 App that uses the `StopLight` component

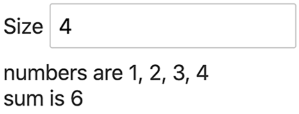
```
<script>
  import StopLight from './StopLight.svelte';
  let go = false;
</script>
```

```
<StopLight />
<StopLight on />
<StopLight on={go} />
<button on:click={() => go = !go}>Toggle</button>
```

5.2.2 Reacting to prop changes

When a parent component passes new prop values to a child component, interpolations (expressions in curly braces) in the HTML of the child component are automatically re-evaluated. However, the same is not true when the prop is used inside the `script` tag of the child component, unless reactive statements are used.

The following examples in listings 5.6 and 5.7 makes this clear. The `Sum` component is passed an array of numbers. It renders the numbers and their sum. Figure 5.2 shows an incorrect sum after Size is changed from 3 to 4.



Size 4

numbers are 1, 2, 3, 4
sum is 6

Figure 5.2 An incorrect sum caused by not using a reactive statement

Listing 5.6 `Sum` component in `.src/Sum.svelte`

```
<script>
  export let numbers;
  //const sum = numbers.reduce((acc, n) => acc + n);
  $: sum = numbers.reduce((acc, n) => acc + n);
</script>

<div>numbers are {numbers.join(', ')}</div><div>sum is {sum}</div>
```

This computes the sum of the numbers in the numbers array. Without a reactive statement, the sum is only computed once. If a parent component modifies the numbers prop, the sum will not be recomputed.

Using a reactive statement fixes this.

Listing 5.7 App that uses the `Sum` component

```
<script>
  import Sum from './Sum.svelte';
  let size = 3;
  $: numbers = Array(size).fill().map((_, i) => i + 1);
</script>

<label>
  Size
  <input type="number" bind:value={size}>
</label>

<Sum numbers={numbers} />
```

This creates an array of numbers from 1 to size. For example, when size is 3, numbers is [1, 2, 3].

When a new value for size is entered, this passes a new numbers array to the Sum component.

5.2.3 Prop types

Svelte does not provide a mechanism for defining the types of props. Providing the wrong kind of value for a prop can result in a runtime error. For example, a component might expect the value of a certain prop to be a `Date` object, and an error could occur if a string is passed instead.

TypeScript can be used to define the types of props and catch errors in passing props to components at compile time. If TypeScript is not used, prop types can be checked at run time.

We can use the same library that is used by React for prop type checking (see "prop-types" in npm). Listing 5.8 shows an example of using the prop-types library. `LabeledCheckboxes` is a component that accepts four props:

- The `className` prop is an optional string CSS class name.
- The `label` prop is a string to be displayed in front of a list of checkboxes.
- The `list` prop is an array of objects that have a `label` property and an optional `value` property.
- The `selected` prop is an array of strings that indicates which checkboxes are currently checked.

Listing 5.8 `LabeledCheckboxes` component in `src/LabeledCheckboxes.svelte`

```
<script>
  import PropTypes from 'prop-types/prop-types';
  const {arrayOf, checkPropTypes, shape, string} = PropTypes;

  const propTypes = {
    className: string,
    label: string.isRequired,
    list: arrayOf(shape({
      label: string.isRequired,
      value: string
    })).isRequired,
    selected: arrayOf(string).isRequired
  }
  checkPropTypes(propTypes, $$props, 'prop', 'LabeledCheckboxes');

  ... implementation omitted ...
</script>
... implementation omitted ...
```

$$props is an undocumented Svelte variable that is subject to change. Its value is an object where the keys are prop names and the values are their values.

If any parent component passes an invalid prop to this component or omits any required props, these errors are reported in the DevTools console.

5.2.4 Directives

Directives are special props that are written as a directive name followed by a colon and sometimes a value. Brief descriptions of the directives are provided here. Each is described in more detail later.

- The `bind` directive binds a prop value to a variable. See the next section.
- The `class` directive toggles the presence of a CSS class based on the truthiness of a variable. See section 3.4.
- The `on` directive registers an event listener. See section 5.4.1.

- The `use` directive specifies a function that will be passed the DOM element that is created for the element to which this directive is attached. See section 7.2.
- The directives `animate`, `transition`, `in`, and `out` support animations. See chapter 10.

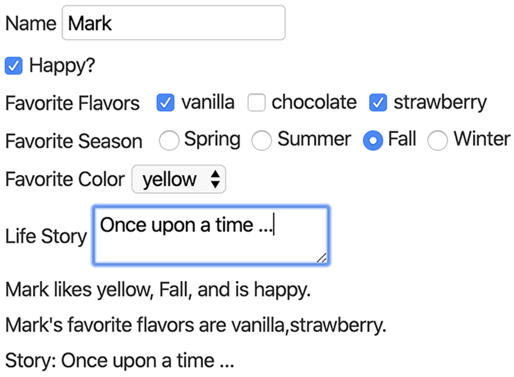
Svelte does not support creating custom directives. A benefit of this is that developers only have to learn about a relatively small set of them. Reading the code of existing applications never requires learning about custom directives.

5.2.5 The bind directive on form elements

The value of the form elements `input`, `textarea`, and `select` can be bound to a variable using the `bind` directive. When a form element uses this, it renders the value of the variable. If a user changes the form element's value, the bound variable is updated to match. This simulates two-way data binding and is much easier than explicitly listening for a specific event, extracting the new value from the event, and explicitly updating a variable.

The Svelte compiler generates the necessary event-handling code to keep the form element and variable in sync. For `input` elements with the type `number` or `range`, using the `bind` directive automatically coerces values from strings to numbers.

The following HTML form, implemented in a single Svelte component, uses the `bind` directive with a variety of form element types. The result is shown in figure 5.3.



Name Mark

☑ Happy?

Favorite Flavors ☑ vanilla ☐ chocolate ☑ strawberry

Favorite Season ○ Spring ○ Summer ● Fall ○ Winter

Favorite Color yellow

Life Story Once upon a time ...

Mark likes yellow, Fall, and is happy.

Mark's favorite flavors are vanilla,strawberry.

Story: Once upon a time ...

Figure 5.3 App demonstrating the use of `bind`

Listing 5.9 App demonstrating the use of `bind`

```
<script>
  const colors =
    ['red', 'orange', 'yellow', 'green', 'blue', 'purple'];
  const flavors = ['vanilla', 'chocolate', 'strawberry'];
  const seasons = ['Spring', 'Summer', 'Fall', 'Winter'];
  let favoriteColor = '';
  let favoriteFlavors = [];
  let favoriteSeason = '';
  let happy = true;
  let name = '';
  let story = '';
</script>

<div class="form">
  <div>
    <label>Name</label>
    <input type="text" bind:value={name}>
  </div>
  <div>
    <label>
      <input type="checkbox" bind:checked={happy}>
      Happy?
    </label>
  </div>
  <div>
    <label>Favorite Flavors</label>
    {#each flavors as flavor}
    <label class="indent">
      <input type="checkbox" value={flavor} bind:group={favoriteFlavors}>
      {flavor}
    </label>
    {/each}
  </div>
  <div>
    <label>Favorite Season</label>
    {#each seasons as season}
    <label class="indent">
      <input type="radio" value={season} bind:group={favoriteSeason}>
      {season}
    </label>
    {/each}
  </div>
  <div>
    <label>
      Favorite Color
      <select bind:value={favoriteColor}>
        <option />
        {#each colors as color}
        <option>{color}</option>
        {/each}
      </select>
    </label>
  </div>
  <div>
    <label>
      Life Story
      <textarea bind:value={story} />
    </label>
  </div>

  {#if name}
    <div>
      {name} likes {favoriteColor}, {favoriteSeason},
```

For checkboxes, bind to the checked property rather than the value.

Using bind:group with a set of related checkboxes makes the value an array of strings.

Using bind:group with a set of related radio buttons makes the value a single string.

To change a select to a scrollable list that allows selecting multiple options, add the multiple attribute.

option elements can also have a value attribute, and its value can be a string, number, or object.

This part just reports the variable values set by binds, but only if name has a value.

```
      and is {happy ? 'happy' : 'unhappy'}.
    </div>
    <div>{name}'s favorite flavors are {favoriteFlavors}.</div>
    <div>Story: {story}</div>
  {/if}
</div>

<style>
  div {
    margin-bottom: 10px;
  }

  .indent {
    margin-left: 10px;
  }

  input,
  select,
  textarea {
    border: solid lightgray 1px;
    border-radius: 4px;
    margin: 0;
    padding: 4px;
  }

  input[type='checkbox'],
  input[type='radio'] {
    margin: 0 5px 0 0;
  }

  label {
    display: inline-flex;
    align-items: center;
  }

  select,
  textarea {
    margin-left: 5px;
  }
</style>
```

In addition to binding to primitive variables, form elements can bind to object properties. User input then causes those objects to be mutated.

5.2.6 bind:this

Another form of the `bind` directive is `bind:this={`*`variable`*`}`. When used on an HTML element, this sets the variable specified as its value to a reference to the corresponding DOM element. This opens the door to arbitrary DOM manipulations. For example, it can be used to move focus into an `input` element. This is used in section 7.4, and there are also examples in chapter 8.

When bind:this={*variable*} is used on a component, it sets the variable specified as its value to a reference to a SvelteComponentDev object. This represents an instance of the component.

> **NOTE** Most uses of bind:this are on HTML elements, not Svelte components. While the following example is interesting, it is somewhat contrived and just serves to demonstrate this rarely used feature.

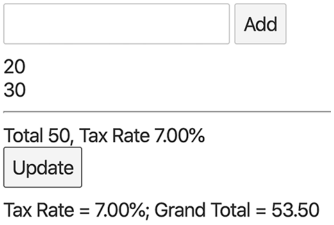
For example, suppose we have a Tally component that allows the user to enter a series of prices (listing 5.10). It displays each price, sums them, and displays the total and the tax rate to apply.

Components that render a Tally component may want to access the tax rate and ask for the grand total, which includes tax. The Tally component can export the tax rate constant and a function that can be called to get the grand total.

Listing 5.10 Tally component in src/Tally.svelte

```
<script>
  export const taxRate = 0.07;

  let price;
  let prices = [];

  $: total = prices.reduce((acc, n) => acc + n, 0);

  function add() {
    prices.push(price);
    prices = prices;        ◁ This triggers an update of the price list.
    price = '';             ◁ This clears the input.
  }

  export const getGrandTotal = () => total * (1 + taxRate);
</script>

<input type="number" bind:value={price} />
<button on:click={add}>Add</button>
{#each prices as price}
  <div>{price}</div>
{/each}
<hr>
<label>Total {total}, Tax Rate {(taxRate * 100).toFixed(2)}%</label>
```

An app that uses the Tally component is shown in figure 5.4 and listing 5.11.



20
30

Total 50, Tax Rate 7.00%

Tax Rate = 7.00%; Grand Total = 53.50

Figure 5.4 App that uses Tally component

Listing 5.11 App that uses `Tally` component

```
<script>
  import Tally from './Tally.svelte'

  let tally, taxRate = 0, grandTotal = 0;

  function update() {
    taxRate = tally.taxRate;
    grandTotal = tally.getGrandTotal();
  }
</script>

<Tally bind:this={tally} />

<button on:click={update}>Update</button>
<div>
  Tax Rate = {(taxRate * 100).toFixed(2)}%;
  Grand Total = {grandTotal.toFixed(2)}
</div>
```

This component does not react to changes in the properties of the Tally instance. We must explicitly ask for the new grand total.

This gets a reference to the SvelteComponentDev object that represents a Tally component instance.

The built-in properties of `SvelteComponentDev` objects have names that begin with `$`, which indicates they are private properties that are subject to change. If the `script` element of the component that is the target of the `bind` exports values, they become properties of this object. This is not a commonly used feature, but it is good to be aware of its existence.

5.2.7 Props go out with bind

Svelte can bind a child component prop to a variable in a parent component. This allows child components to change values of a parent component's variables. This is handy when a child component computes a value that parent components need. For example, listing 5.12 shows a `Parent` component, and listing 5.13 shows the `Child`.

Listing 5.12 `Parent` component in `src/Parent.svelte`

```
<script>
  import Child from './Child.svelte';
  let pValue = 1;
</script>

<Child bind:cValue={pValue} />
<div>pValue = {pValue}</div>
```

Listing 5.13 `Child` component in `src/Child.svelte`

```
<script>
  export let cValue;
  const double = () => (cValue *= 2);
</script>

<button on:click={double}>Double</button>
<div>cValue = {cValue}</div>
```

When the button in the Child component is clicked, cValue is doubled. That becomes the new value of pValue, because it is bound to cValue.

If the name of the variable in the parent component matches the name of the prop, the bind expression can be shortened. For example, these are equivalent:

```
<Child bind:cValue={cValue} />
<Child bind:cValue />
```

Child components can also use reactive declarations to modify the value of a prop. If the parent component uses bind with that prop, it will also be updated.

For example, we can add the following lines in Child.svelte:

```
export let triple;

$: triple = cValue * 3;
```

To make use of the new triple prop, we can modify Parent.svelte as follows.

Listing 5.14 Parent component in src/Parent.svelte

```
<script>
  import Child from './Child.svelte';
  let pValue = 1;
  let triple;
</script>

<Child bind:cValue={pValue} bind:triple />
<div>pValue = {pValue}</div>
<div>triple = {triple}</div>
```

Let's implement a color-picker component that takes advantage of the bind directive. It uses sliders to select values for red, green, and blue, and it displays a swatch of the selected color below the sliders, as shown in figure 5.5.

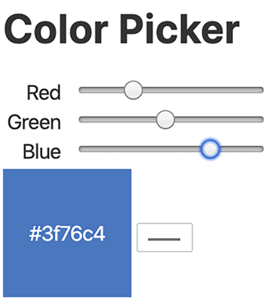


Figure 5.5 ColorPicker component

First, we need to define a ColorSlider component that can be used to select a value between 0 and 255.

Listing 5.15 ColorSlider component in src/ColorSlider.svelte

```
<script>
  export let name;
  export let value;
</script>

<div>
  <label for="slider">{name}</label>
  <input id="slider" type="range" min="0" max="255" bind:value>
</div>

<style>
  label {
    display: inline-block;
    margin-right: 10px;
    text-align: right;
    width: 45px;
  }
</style>
```

Next, we'll use the ColorSlider component in a ColorPicker component to select values for red, green, and blue, and obtain a hex value for a color that combines these. Note how this uses the bind directive to bind variables in ColorPicker to the value prop in a ColorSlider. When the user changes any slider, the corresponding bound variable in ColorPicker is updated.

Listing 5.16 ColorPicker component in src/ColorPicker.svelte

```
<script>
  import ColorSlider from './ColorSlider.svelte';
  export let hex;
  let red = 0;
  let green = 0;
  let blue = 0;

  function getHex(number) {
    const hex = number.toString(16);
    return hex.length === 1 ? '0' + hex : hex;
  }

  $: hex = '#' + getHex(red) + getHex(green) + getHex(blue);
</script>

<ColorSlider name="Red" bind:value={red} />
<ColorSlider name="Green" bind:value={green} />
<ColorSlider name="Blue" bind:value={blue} />
```

Finally, we'll use the ColorPicker component in an app to demonstrate its usage.

Listing 5.17 App that uses the `ColorPicker` component

```
<script>
  import ColorPicker from './ColorPicker.svelte';
  let hex = '000000';
</script>

<h1>Color Picker</h1>
<ColorPicker bind:hex />
<div class="swatch" style="background-color: {hex}">
  {hex}
</div>

<input type="color" bind:value={hex}>

<style>
  .swatch {
    color: white;
    display: inline-block;
    height: 100px;
    line-height: 100px;
    text-align: center;
    width: 100px;
  }
</style>
```

In modern browsers, clicking an input with a type of "color" will open a native color picker. This provides an alternative way to select a color. Note that when this is used, the sliders are not updated to match.

Note how the `ColorPicker` instance in the app uses the `bind` directive to obtain the hex value of the selected color.

There are special bind values for obtaining the size of an element. The size of an element, including padding, border, and scrollbars (if any), can be obtained from `offsetWidth` and `offsetHeight`. The size of an element including padding, but excluding everything else, can be obtained from `clientWidth` and `clientHeight`. To obtain these values, declare variables to hold them and bind them to these properties, as in the following listing.

Listing 5.18 Using element size bindings

```
<script>
  let clientH, clientW, offsetH, offsetW;
</script>

<div
  bind:clientHeight={clientH}
  bind:clientWidth={clientW}
  bind:offsetHeight={offsetH}
  bind:offsetWidth={offsetW}
>
  How big am I?
</div>
```

The client size of elements with the CSS property `display` set to “inline” will be reported as 0.

These values are read-only. Changing the bound variable values does not change the size of the element.

5.3 Slots

Components can allow content to be passed to them as child elements. For example, a custom `Envelope` component can accept child elements that represent a return address, a stamp, and a mailing address. It can then render all of these in the standard layout of an envelope.

The ability of a component to accept child elements is supported by *slots*. The component can decide whether and how to render each slot. Note that whitespace is included in the passed content.

The receiving component can mark the spot where all slot content is to be rendered with `<slot />`. This is called the *default slot.*

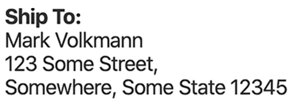
> **NOTE** The `slot` element was added to HTML to support Web Components. Slots are not unique to Svelte. For more about Web components, see the introduction at WebComponents.org (www.webcomponents.org/introduction) and *Web Components in Action* by Ben Farrell (Manning, 2019).

A `slot` element can also provide default content to render when parent elements do not provide content for the slot. For example,

```
<slot>Thanks for nothing!</slot>
```

Named slots allow parent components to provide multiple sets of content that the receiving component can render. The parent component identifies these with a `slot` attribute on an HTML element, not a custom component. The order of the elements with a `slot` attribute in the parent component does not matter. The child component defines where they will be rendered by using `slot` elements that have a matching `name` attribute.

Figure 5.6 shows the results of a parent component that targets multiple named slots in the child component `ShippingLabel`. Their names are “address” and “name”.



Ship To:
Mark Volkmann
123 Some Street,
Somewhere, Some State 12345

Figure 5.6 Named slots

Listing 5.19 Using the `ShippingLabel` component

```
<ShippingLabel>
  <div slot="address">
    123 Some Street,<br />
    Somewhere, Some State 12345
  </div>
  <div slot="name">Mark Volkmann</div>
</ShippingLabel>
```

Listing 5.20 `ShippingLabel` component in `src/ShippingLabel.svelte`

```
<div>
  <label>Ship To:</label>
  <slot name="name">unknown</slot>
  <slot name="address" />
</div>

<style>
  label {
    display: block;
    font-weight: bold;
  }
</style>
```

This slot has default content of "unknown".

This slot does not have default content.

If a parent component targets more than one slot with the same name, the content of all of them is used in that child component slot. For example, if we add `<div slot="address">duplicate</div>` as a new child in the `ShippingLabel` element in `App.svelte`, then "duplicate" will be rendered along with the previously specified address.

5.4 Events

Svelte components can listen for DOM events and custom events. Event handling is specified with the `on:`*`event-name`* directive. Note that `on` is followed by a colon and an event name. Its value is a function to be invoked when the event is dispatched. The event name can be the name of a DOM event or a custom event. An event object is passed to the given function.

Here's an example:

```
<button on:click={handleClick}>Press Me</button>

<button on:click={event => clicked = event.target}>
  Press Me
</button>
```

The handleClick function must be defined in the script section.

This demonstrates inline event handling using an anonymous function. It just sets the variable clicked to the DOM element for the button.

Multiple event-handling functions can be specified for the same event, and each will be invoked when the event is dispatched. For example,

```
<button on:click={doOneThing} on:click={doAnother}>
  Press Me
</button>
```

5.4.1 Event dispatching

Components can dispatch events by creating and using an event dispatcher. For example,

```
<script>
  import {createEventDispatcher} from 'svelte';
  const dispatch = createEventDispatcher();

  function sendEvent() {
    dispatch('someEventName', optionalData);
  }
</script>
```

This must be called when the component is instantiated, not conditionally or later (inside a function).

The data associated with the event can be a primitive or an object.

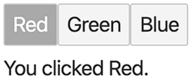
These events only go to the parent component. They do not automatically bubble farther up the component hierarchy.

Parent components use the on directive to listen for events from child components. For example, if the parent component defines the `handleEvent` function, it can register that function to be invoked when a child component dispatches an event with a given name.

```
<Child on:someEventName={handleEvent} />
```

The event-handling function (`handleEvent` in this case) is passed an event object. This object has a `detail` property that is set to the data passed as the second argument to the `dispatch` function. Any additional arguments passed to `dispatch` are ignored.

To demonstrate this, we will create a `Buttons` component (listing 5.21) that renders several buttons and dispatches an event to let the parent component know which one was clicked (see figure 5.7).



You clicked Red.

Figure 5.7 `Buttons` **component**

Listing 5.21 `Buttons` **component in** `src/Buttons.svelte`

```
<script>
  import {createEventDispatcher} from 'svelte';
  const dispatch = createEventDispatcher();
  export let labels;
  export let value;
</script>

{#each labels as label}
  <button
    class:selected={label === value}
    on:click={() => dispatch('select', label)}
  >
    {label}
  </button>
{/each}

<style>
  .selected {
    background-color: darkgray;
    color: white;
  }
</style>
```

Parent components pass in an array of button labels.

Parent components pass in the currently selected label, if any.

Parent components listen for a select event that provides the label that was selected.

The following listing shows a component that uses the `Buttons` component.

Listing 5.22 App that uses the `Buttons` component

```
<script>
  import Buttons from './Buttons.svelte';
  let colors = ['Red', 'Green', 'Blue'];
  let color = '';
  const handleSelect = event => color = event.detail;
</script>

<Buttons labels={colors} value={color} on:select={handleSelect} />
{#if color}
  <div>You clicked {color}.</div>
{/if}
```

5.4.2 Event forwarding

Omitting the event handling function from an `on` directive is shorthand to forward events up to the parent component. For example, suppose part of the component hierarchy is A > B > C, and C emits a `demo` event. B can forward it up to A with `<C on:demo />`. Note that in this case the `on` directive has no value.

This approach can also be used to forward DOM events.

5.4.3 Event modifiers

The `on` directive can specify any number of event modifiers with vertical bars preceding modifier names. For example,

```
<button on:click|once|preventDefault={handleClick}>
  Press Me
</button>
```

These are the supported modifiers:

- `capture`—This causes the handler function to only be invoked in the capture phase, not the default bubbling phase. Typically it is not necessary to understand this distinction.

NOTE The capture and bubbling event-handling phases are described on the Mozilla Developer Network (MDN) "Introduction to events" page at http://mng.bz/XPB6. Search for "Event bubbling and capture."

- `once`—This removes the handler after the first occurrence of the event.
- `passive`—This can improve scrolling performance. You can learn more on the MDN page for `EventTarget.addEventListener()` at http://mng.bz/yyPq.
- `preventDefault`—This prevents the default action for a DOM event from occurring. For example, it can stop a form submission from occurring. This is by far the most commonly used event modifier.
- `stopPropagation`—This prevents subsequent handlers in the capture/bubbling flow from being invoked as a result of a DOM event being dispatched.

5.5 Context

Context provides an alternative to using props and stores for making data in a component available in other components (stores are covered in chapter 6).

Suppose we have components A, B, and C. Component A renders component B, and component B renders component C. We want to define data in A and make it available in C. One way is to pass the data as props from A to B and do the same from B to C. But as the component hierarchy grows deeper, using props to pass data down to descendant components becomes tedious.

Context provides an easier way to do this. Data can be added to a context in an ancestor component like A and be accessed in a descendant component like C. In fact, context data can only be accessed in descendant components. Like with props, changes made to context values are not propagated upward.

To define a context in a component, import the setContext function and call it, supplying a context key and a value. The setContext function must be called when the component is instantiated, not conditionally or later (inside a function). For example,

```
import {setContext} from 'svelte';

setContext('favorites', {color: 'yellow', number: 19});
```

To use context in a descendant component, import the getContext function and call it, supplying a context key. This gets the context value from the closest ancestor component that has defined a context with that key. Like setContext, the getContext function must be called when the component is instantiated, not conditionally or later (inside a function).

```
import {getContext} from 'svelte';

const favorites = getContext('favorites');
```

Context keys can be any kind of value, not just strings. Context values can be any kind of value including functions and objects with methods that can be called by descendant components.

The following three component definitions illustrate the scenario described earlier, where A renders B, B renders C, and A wishes to define data that is available in C.

Listing 5.23 A component in src/A.svelte

```
<script>
  import {setContext} from 'svelte';
  import B from './B.svelte';
  setContext('favorites', {color: 'yellow', number: 19});
</script>

<div>
  This is in A.
  <B />
</div>
```

Listing 5.24 `B` component in `src/B.svelte`

```
<script>
  import C from './C.svelte';
</script>

<div>
  This is in B.
  <C />
</div>
```

Listing 5.25 `C` component in `src/C.svelte`

```
<script>
  import {getContext} from 'svelte';
  const {color, number} = getContext('favorites');
</script>

<div>
  This is in C.
  <div>favorite color is {color}</div>
  <div>favorite number is {number}</div>
</div>
```

This renders the following:

```
This is in A.
This is in B.
This is in C.
favorite color is yellow
favorite number is 19
```

If a component that has created context calls `setContext` again with the same key but a different value, descendant components will not receive updates. They only see what is available during component initialization.

Unlike props and stores, context is not reactive. This limits the usefulness of context to situations where the data an ancestor component wants to make available to descendant components is known before runtime or can be computed before the ancestor is rendered. When this is not the case, stores are a better option for sharing data, because they are reactive.

5.6 Building the Travel Packing app

Let's apply what you have learned about component communication to the Travel Packing app. The finished code can be found at http://mng.bz/Mdzn.

The code in chapter 4 already passes props to components. It also uses the `bind` directive on many elements.

We now want to implement the following abilities:

- Delete an item from a category
- Delete a category from a checklist

- Log in before viewing the checklist
- Log out, returning to the login page
- Persist data to localStorage

All of the preceding functionality is triggered by dispatching custom events. The Category component will dispatch persist and delete events. The Checklist component will dispatch logout events. The Item component will dispatch delete events. The Login component will dispatch login events.

Persisting to localStorage means that the data is saved across sessions. We can close the browser tab, open a new one, browse the app again, and restore the data. We can even close the browser or restart the computer and still restore the data. However, a downside of persisting data to localStorage is that it is only available in one browser on one computer.

Let's implement the ability to delete items and categories. In Item.svelte, do the following:

1. Inside the script element add

   ```
   import {createEventDispatcher} from 'svelte';
   ```

2. Create the dispatch function with

   ```
   const dispatch = createEventDispatcher();
   ```

3. Change the trash can button (with class icon) to dispatch a delete event when it is clicked. The Category component will listen for this.

   ```
   <button class="icon" on:click={() => dispatch('delete')}>&#x1F5D1;</button>
   ```

In Category.svelte, do the following:

1. Inside the script element, add

   ```
   import {createEventDispatcher} from 'svelte';
   ```

2. Create the dispatch function with

   ```
   const dispatch = createEventDispatcher();
   ```

3. Add the following deleteItem function.

   ```
   function deleteItem(item) {
     delete category.items[item.id];
     category = category;
   }
   ```

   This triggers an update.

4. Add the following on directive to the Item component instance to delete a given item when a delete event is received:

   ```
   <Item bind:item on:delete={() => deleteItem(item)} />
   ```

5. Change the trash can button (with class icon) to dispatch a delete event when it is clicked. The Checklist component will listen for this.

```
<button class="icon" on:click={() => dispatch('delete')}>
  &#x1F5D1;
</button>
```

In Checklist.svelte, do the following:

1. Inside the script element, add

```
import {createEventDispatcher} from 'svelte';
```

2. Create the dispatch function with

```
const dispatch = createEventDispatcher();
```

3. Add the following deleteCategory function.

```
function deleteCategory(category) {
  delete categories[category.id];
  categories = categories;
}
```

Later we will ask for confirmation before deleting.

4. Add the following on directive to the Category component instance to delete a given category when a delete event is received:

```
on:delete={() => deleteCategory(category)}
```

With these changes, we can now click the trash can icons to delete items in a category and delete entire categories.

Now let's tackle login and logout. We want the app to begin by displaying the Login component. For now we will accept any username and password. After the Login button is pressed, we want to remove the Login component and instead display the Checklist component.

In App.svelte, do the following:

1. Uncomment the import of the Login component.
2. Add a page variable that is set to the component that should be rendered, and set it to Login:

```
let page = Login;
```

3. Replace <Checklist /> with the following. The instances of the Login and Checklist components here each listen for an event that tells App.svelte to render the other component.

```
{#if page === Login}
  <Login on:login={() => (page = Checklist)} />
{:else}
  <Checklist on:logout={() => (page = Login)} />
{/if}
```

In `Login.svelte`, do the following:

1. Inside the `script` element add

   ```
   import {createEventDispatcher} from 'svelte';
   ```

2. Create the `dispatch` function with

   ```
   const dispatch = createEventDispatcher();
   ```

3. Change the `login` function definition to

   ```
   const login = () => dispatch('login');
   ```

In `Checklist.svelte`, do the following:

1. Add the following `on` directive to the Log Out button:

   ```
   on:click={() => dispatch('logout')}>
   ```

With these changes made, you can log in and log out.

Now let's tackle persisting the data to `localStorage`. We want to persist the `categories` variable in the `Checklist` component whenever an item or category is modified in any way.

In `Checklist.svelte`, do the following:

1. Add the following code at the bottom of the `script` element:

   ```
   restore();

   $: if (categories) persist();

   function persist() {
     localStorage.setItem('travel-packing', JSON.stringify(categories));
   }

   function restore() {
     const text = localStorage.getItem('travel-packing');
     if (text && text !== '{}') {
       categories = JSON.parse(text);
     }
   }
   ```

   We must do this before the first call to persist.

   This persists the categories in localStorage any time they change.

2. Add an `on` directive to the `Category` element:

   ```
   on:persist={persist}
   ```

In `Category.svelte`, do the following:

1. Add the following line at end of the `addItem` and `deleteItem` functions:

   ```
   dispatch('persist');
   ```

With these changes made, you can now create categories, add items to them, refresh the browser, and not lose the data. You will have to log in again, but the data is retained.

In the next chapter you will learn how to use *stores* to share data between components regardless of their relationship in the component hierarchy.

Summary

- Parent components can pass data into child components using props.
- Parent components can receive updates from child components by using the `bind` directive on props.
- Parent components can provide content to be rendered by child components using slots.
- Child components can dispatch events that are handled by parent components.

6 Stores

This chapter covers

- Defining writable, readable, derived, and custom stores
- Using stores to share data between components
- Using stores in conjunction with JavaScript classes
- Persisting stores

This chapter focuses on using *stores* to share data between components, regardless of their relationship in the component hierarchy. Stores provide an alternative to using props or context. They hold application state outside any component. Each store holds a single JavaScript value, but the value can be an array or an object, which of course can hold many values.

Svelte supports several kinds of stores.

- *Writable stores* allow components to change their data.
- *Readable stores* do not allow components to change their data because the store itself can change its own data.
- *Derived stores* compute their value from other stores.
- *Custom stores* can do any of these things and often provide a custom API for controlling their use.

Every store has a subscribe method that returns a function you can call to unsubscribe.

The built-in support for stores is so useful that there is really no need for state management libraries. Such libraries are commonly used with other frameworks. For example, Angular has @ngrx/store, React has Redux, and Vue has Vuex.

6.1 Writable stores

To create a writable store, call the writable function, which is defined in the svelte/store package. Pass an initial value and optionally a function that initializes the store. The use of such a function is described later.

In addition to the subscribe method, writable stores have the following methods:

- set(*newValue*)

  This sets a new value for the store.
- update(*fn*)

  This updates the store value based on its current value. *fn* is a function that is passed the current value and returns the new value. For example, the following would double the value of a store that holds a number:

  ```
  myStore.update(n => n * 2);
  ```

Here is an example of defining a writable store using just an initial value. Its purpose is to hold a collection of objects that describe dogs.

Listing 6.1 Writable store with an initial value

```
import {writable} from 'svelte/store';

export const dogStore = writable([]);
```

The initial value is an empty array.

Recall that declaring a variable that holds a reference to an object as const does not prevent modifying the object properties. The same is true for stores. Declaring a variable that holds a reference to a store does not prevent the store value from being modified.

We can also pass a function to the writable function that determines the initial value. This function is passed a set function that it calls to set the store value. For example, the function can call an API service and pass the value returned to the set function.

This way of initializing a store is lazy in that the function is not called until the first component subscribes to the store. It is called every time the subscriber count goes from 0 to 1, which can occur more than once.

The function passed to the writable function must return a “stop” function. This is called every time the subscriber count goes from 1 to 0. Any necessary cleanup can be performed here. Typically this is not needed, and the function does nothing.

The following example calls an API service to obtain an array of objects describing dogs. This becomes the value of the store.

Listing 6.2 Writable store that sets its value asynchronously

```
import {writable} from 'svelte/store';

export const dogStore = writable([], async set => {
  const res = await fetch('/dogs');
  const dogs = await res.json();
  set(dogs);
  return () => {};
});
```

The initial value is an empty array.

This uses the Fetch API, which is built into modern browsers.

This is the "stop" function.

Using a $ prefix on a store name utilizes "auto-subscription," which is explained in section 6.4.

The bind directive can be used to bind the value of a form element to a writable store. In the following example, someStore holds a string value that is used as the value of the input and is updated when the user changes the value of the input.

```
<input bind:value={$someStore}>
```

Components that use a writable store can call the set and update methods on the store to modify it.

6.2 Readable stores

To create a readable store, call the readable function, which is defined in the svelte/store package. As with writable stores, readable is passed an initial value and optionally a function that takes a set function.

Here is the example shown in listing 6.2, but this time it creates a readable store instead of a writable one.

Listing 6.3 Readable store example

```
import {readable} from 'svelte/store';

export const dogStore = readable([], set => {
  const res = await fetch('/dogs');
  const dogs = await res.json();
  set(dogs);
  return () => {};
});
```

The set function can use setInterval to continuously change the value of the store. For example, the readable store in the following listing provides numbers starting from 0 in increments of 10. The value changes every second.

Listing 6.4 Readable store that updates its value periodically

```
import {readable} from 'svelte/store';

let value = 0;
export const tensStore = readable(
  value,        ◁——————  initial value
  set => {
    const token = setInterval(() => {
      value += 10;
      set(value);
    }, 1000);
    return () => clearInterval(token);
  }
);
```

Components that use a readable store cannot set or update it. This does not mean that readable stores are immutable, just that only they can change their own value.

6.3 Where to define stores

For stores that should be available to any component, you should define and export them in a file like `src/stores.js` and import the stores from that file wherever they're needed.

For stores that should only be available to descendants of a given component, define them in that component and pass them to descendants using props or context.

6.4 Using stores

To begin using a store, you can gain access to it in one of these ways:

- Import it from a `.js` file (for global stores).
- Accept it as a prop.
- Get it from a context.

There are two ways to get the value from a store:

- Call the `subscribe` method of the store (this is somewhat verbose).
- Use the auto-subscription shorthand (this is usually preferred).

Listing 6.5 shows an example of using the `subscribe` method to access the value of `dogStore`. The function passed to the `subscribe` method of the store is called initially and again every time the value changes. Here we just assign the value to the component variable `dogs` so it can be used in the HTML.

Listing 6.5 Store subscription example

```
<script>
  import {onDestroy} from 'svelte';
  import {dogStore} from './stores';
  let dogs;
  const unsubscribe = dogStore.subscribe(value => (dogs = value));
  onDestroy(unsubscribe);
</script>
```

Now we can use `dogs` in the HTML section.

We can simplify this code by using auto-subscription. All variables whose names begin with $ must be stores. Components automatically subscribe to stores when they're first used, and they automatically unsubscribe when the component is destroyed. When using auto-subscription, you only need to import the store as follows. It is not necessary to subscribe to or unsubscribe from the store.

```
<script>
  import {dogStore} from './stores';
</script>
```

Now we can use `$dogStore` in the HTML section. Clearly, less code is required when using auto-subscription.

The `svelte/store` package also exports a `get` function that takes a store and returns its current value. This can be used in both `.svelte` and `.js` files. For example, to get the current value of the store in the variable `myStore`, call `get(myStore)`.

> **NOTE** The `get` function is somewhat inefficient. Behind the scenes it subscribes to the store, gets its value, unsubscribes from the store, and returns the value. Avoid calling this function frequently.

There are three ways to change the value of a writable store from inside a `.svelte` file. You have already seen the `set` and `update` methods. The value can also be directly assigned using a `$` prefix on the store name:

```
$dogStore = [{breed: 'Whippet', name: 'Dasher'}];
```

Only `.svelte` files can use auto-subscription. Files with a `.js` extension must use the `set` or `update` method to change the value of a writable store.

Listing 6.6 uses the `tensStore` readable store (defined in listing 6.4) with auto-subscription. This component is automatically updated every time a new value is provided by the store. Each second a new value is displayed: 0, 10, 20, and so on.

Listing 6.6 App that uses `tensStore`

```
<script>
  import {tensStore} from './stores';
</script>

<div>{$tensStore}</div>
```

Let's create an app that manages a collection of dogs. For now the app will just hold objects representing dogs in memory. Later we will modify it to persist the dogs so they are not lost if the browser is refreshed.

We'll begin by defining a writable store to store objects that describe dogs. It will hold an object where the keys are dog IDs and the values are dog objects. Dog objects have `id`, `name`, `breed`, and `size` properties.

Listing 6.7 Creation of the `dogStore` in `src/stores.js`

```
import {writable} from 'svelte/store';

export const dogStore = writable({});
```

We want the ability to view, add, modify, and delete dogs. All components that subscribe to the store will see the changes.

Now we'll define the topmost component, `App`. It uses the `DogList` and `DogForm` components, which are defined in listings 6.9 and 6.10. The `App` component decides which one to render based on the value of `mode`, which can be `list`, `create`, or `update`. When `mode` is `list`, it displays the `DogList` component. Otherwise it displays the `DogForm` component.

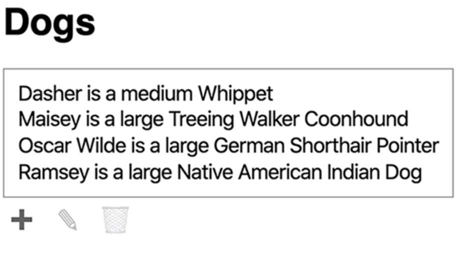
The `App` component listens for two custom events. The `mode` event signals that the value of `mode` should be changed. The `select` event signals that a dog has been selected in the `DogList` component. The selected dog can then be edited.

Listing 6.8 App that uses the `DogForm` and `DogList` components

```
<script>
  import DogForm from './DogForm.svelte';
  import DogList from './DogList.svelte';

  let dog = {};
  let mode = 'list';

  function changeMode(event) {
    mode = event.detail;
    if (mode === 'create') dog = {};
  }

  const selectDog = event => (dog = event.detail);
</script>

<h1>Dogs</h1>
{#if mode === 'list'}
  <DogList on:mode={changeMode} on:select={selectDog} />
{:else}
  <DogForm {dog} {mode} on:mode={changeMode} />
{/if}
```

Other modes are "create" and "update".

The `DogList` component displays the list of dogs, sorted on their names. It also provides buttons that can be clicked to act on the list (see figure 6.1). To add a dog, click the "+" button. To edit a dog, select one in the list and click the pencil button. To delete dogs, select them in the list and click the trash can button.



Dogs

Dasher is a medium Whippet
Maisey is a large Treeing Walker Coonhound
Oscar Wilde is a large German Shorthair Pointer
Ramsey is a large Native American Indian Dog

Figure 6.1 `DogList` component

Listing 6.9 DogList component in src/DogList.svelte

```
<script>
  import {createEventDispatcher} from 'svelte';
  import {dogStore} from './stores';
  import {sortOnName} from './util';

  const dispatch = createEventDispatcher();

  $: dogs = sortOnName(Object.values($dogStore));

  let selectedDogs = [];

  function deleteSelected() {
    const ids = selectedDogs.map(dog => dog.id);
    dogStore.update(dogMap => {
      for (const id of ids) {
        delete dogMap[id];
      }
      return dogMap;
    });
    selectedDogs = [];
  }

  const dogToString = dog => dog.name + ' is a ' + dog.size + ' ' + dog.breed
     ;

  function onSelect(event) {
    const {selectedOptions} = event.target;
    selectedDogs = Array.from(selectedOptions).map(
      option => $dogStore[option.value]
    );
    dispatch('select', selectedDogs[0]);
  }
</script>

{#if dogs.length}
  <select multiple on:change={onSelect}>
    {#each dogs as dog (dog.id)}
      <option value={dog.id}>{dogToString(dog)}</option>
    {/each}
  </select>
{:else}
  <h3>No dogs have been added yet.</h3>
{/if}

<div class="buttons">
  <button on:click={() => dispatch('mode', 'create')}>
    <span aria-label="plus" role="img">&#x2795;</span>
  </button>
  <button
    disabled={selectedDogs.length === 0}
    on:click={() => dispatch('mode', 'update')}>
    <span aria-label="pencil" role="img">&#x270E;</span>
  </button>
```

The value of each option is a dog id.

Remember the first of the selected dogs. This is the one that can be edited.

Clicking the edit (pencil) button is disabled if no dog is selected.

```
  <button disabled={selectedDogs.length === 0} on:click={deleteSelected}>
    <span aria-label="trash can" role="img">&#x1F5D1;</span>
  </button>
</div>

<style>
  button {
    background-color: transparent;
    border: none;
    font-size: 24px;
  }

  option {
    font-size: 18px;
  }

  select {
    padding: 10px;
  }
</style>
```

Clicking the delete (trash can) button is disabled if no dog is selected.

The DogForm component displays a form that is used to enter data for a new dog or modify an existing dog (see figure 6.2).

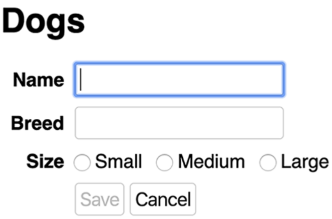


Figure 6.2 DogForm component

Listing 6.10 DogForm component in src/DogForm.svelte

```
<script>
  import {createEventDispatcher} from 'svelte';
  import {dogStore} from './stores';
  import {getGuid} from './util';

  const dispatch = createEventDispatcher();
  export let dog;
  export let mode;

  let {name, breed, size} = dog;
  $: canSave = name && breed && size;

  function save() {
    const id = dog.id || getGuid();
    dogStore.update(dogMap => {
      dogMap[id] = {id, name, breed, size};
      return dogMap;
    });
    dispatch('mode', 'list');
  }
</script>
```

After saving, display the list.

```
<form on:submit|preventDefault={save}>
  <div>
    <label for="name">Name</label>
    <input autofocus id="name" bind:value={name}>
  </div>
  <div>
    <label for="breed">Breed</label>
    <input id="breed" bind:value={breed}>
  </div>
  <div>
    <label>Size</label>
    <span class="radios">
      <label>
        <input type="radio" value="small" bind:group={size}>
        Small
      </label>
      <label>
        <input type="radio" value="medium" bind:group={size}>
        Medium
      </label>
      <label>
        <input type="radio" value="large" bind:group={size}>
        Large
      </label>
    </span>
  </div>
  <div>
    <label />
    <button disabled={!canSave}>{mode === 'create' ? 'Save' : 'Update'}</button>
    <button type="button" on:click={() => dispatch('mode', 'list')}>
      Cancel
    </button>
  </div>
</form>

<style>
  div {
    display: flex;
    align-items: center;
    margin-bottom: 10px;
  }

  input {
    border: solid lightgray 1px;
    border-radius: 4px;
    font-size: 18px;
    margin: 0;
    padding: 4px;
  }

  input[type='radio'] {
    height: 16px;
  }

  label {
    display: inline-block;
    font-size: 18px;
    font-weight: bold;
    margin-right: 10px;
    text-align: right;
    width: 60px;
  }

  .radios > label {
    font-weight: normal;
    width: auto;
  }
</style>
```

The `util.js` file in listing 6.11 defines a couple of utility functions. The first generates a unique ID that is used as the ID of a dog. It uses the npm package “uuid,” which must be installed by entering `npm install uuid`. The second function sorts an array of objects on their `name` properties.

Listing 6.11 Utility functions in `src/util.js`

```
import {v4 as uuidv4} from 'uuid';

export const getGuid = () => uuidv4();

export function sortOnName(array) {
  array.sort((el1, el2) =>
    el1.name.toLowerCase().localeCompare(el2.name.toLowerCase())
  );
  return array;
}
```

The following `global.css` file in the `public` directory defines CSS rules that can affect any component. We want all buttons in the app to have common default styling.

Listing 6.12 Global CSS rules in `public/global.css`

```
body {
  font-family: sans-serif;
}

button {
  border: solid lightgray 1px;
  border-radius: 4px;
  font-size: 18px;
  margin-right: 5px;
  padding: 4px;
}
```

That’s it. We now have a working Svelte app that performs the common CRUD operations on a collection of dogs.

6.5 Derived stores

Derived stores derive their value from one or more other stores. To define one, import the derived function from the svelte/store package and call it.

The derived function takes two arguments. The first is the source stores. It can be a single store or an array of them. The second is a function that is passed that single store or array of stores. This function is called again each time the value of any of the source stores changes. It returns the new value of the derived store.

For example, we can create a derived store that holds only the large dogs in dogStore. The value of this store is an array of dog objects.

Listing 6.13 Derived store defined in src/stores.js

```
import {derived} from 'svelte/store';

export const bigDogsStore = derived(dogStore, store =>
  Object.values(store).filter(dog => dog.size === 'large')
);
```

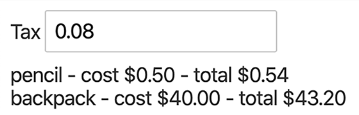
The preceding derived store is based on only one other store. The next example uses two stores named itemsStore and taxStore. itemsStore holds an array of objects that have name and cost properties. taxStore holds a number that is the sales tax percentage. We can create a derived store that uses these stores to hold an array of objects similar to those in itemsStore, but that adds a total property. The total of each item is computed by multiplying its cost by one plus the tax percentage.

Here is the definition of these three stores.

Listing 6.14 Stores defined in src/stores.js

```
import {derived, writable} from 'svelte/store';

const items = [
  {name: 'pencil', cost: 0.5},
  {name: 'backpack', cost: 40}
];
export const itemsStore = writable(items);

export const taxStore = writable(0.08);

export const itemsWithTaxStore = derived(
  [itemsStore, taxStore],
  ([$itemsStore, $taxStore]) => {
    const tax = 1 + $taxStore;
    return $itemsStore.map(item => ({...item, total: item.cost * tax}));
  }
);
```

Listing 6.15 shows a component that allows the value of taxStore to be modified. It displays the name, cost, and total for each item in itemsStore (see figure 6.3). The itemsWithTaxStore is updated any time the value of itemsStore or taxStore changes. Note that we haven't provided a way to change itemStore here.



Tax 0.08

pencil - cost $0.50 - total $0.54
backpack - cost $40.00 - total $43.20

Figure 6.3 Derived store example

Listing 6.15 App that uses stores in `src/App.svelte`

```
<script>
  import {itemsWithTaxStore, taxStore} from './stores';
</script>

<label>
  Tax
  <input type="number" bind:value={$taxStore}>
</label>

{#each $itemsWithTaxStore as item}
  <div>
    {item.name} - cost ${item.cost.toFixed(2)} -
      total ${item.total.toFixed(2)}
  </div>
{/each}
```

6.6 Custom stores

We can also create custom stores. These can control the ways in which the code that uses them can modify the store. This is in contrast to a writable store, where the value can be changed to anything by using the set and update methods.

One use of a custom store is to provide methods that are more restrictive than set and update. These can allow only specific values or specific kinds of changes. The following count store example does this.

Another use of a custom store is to encapsulate access to API services that create, retrieve, update, and delete objects held by the store. It can expose methods that make the API calls and validate the data used to create and update the store.

The only requirement on a custom store is that it be an object with a properly implemented subscribe method. This means that the subscribe method accepts a function as its argument and returns another function that unsubscribes from the store. The subscribe method must call the function passed to it immediately and every time the store value changes, passing the function the current value of the store.

As an alternative, subscribe methods can return an object that has an unsubscribe method instead of an unsubscribe function.

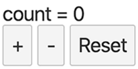
Typically custom stores are created from a writable store that already has a proper subscribe method.

In the following example, count is a custom store. Unlike writable stores, it does not expose set and update methods. Instead it exposes increment, decrement, and reset methods. Users of this store can only update its value by calling those methods.

Listing 6.16 count store defined in count-store.js

```
import {writable} from 'svelte/store';

const {subscribe, set, update} = writable(0);

export const count = {
  subscribe,
  increment: () => update(n => n + 1),
  decrement: () => update(n => n - 1),
  reset: () => set(0)
};
```

The following listing shows an example of using this custom store (see figure 6.4).



count = 0

Figure 6.4 App using the count store

Listing 6.17 App using the count store in src/App.svelte

```
<script>
  import {count} from './count-store';
</script>

<div>count = {$count}</div>
<button on:click={() => count.increment()}>+</button>
<button on:click={() => count.decrement()}>-</button>
<button on:click={() => count.reset()}>Reset</button>
```

6.7 Using stores with classes

Stores can hold instances of custom JavaScript classes. If those classes define methods that modify the properties of an instance, calling them will not notify the store that a change has been made, and subscribers to the store will not be notified.

This is no different than storing any object in a store. The only ways to trigger an update to all the subscribers are to call the set and update methods on the store or directly set the store value using the $ prefix syntax.

Fixing this is easy. In the following two listings we have the classes Point and Line. A point is defined by *x* and *y* coordinates. A line is defined by start and end Point objects. Both points and lines can be translated by given delta *x* (dx) and delta *y* (dy) values.

Listing 6.18 Point class defined in src/point.js

```
export default class Point {
  constructor(x, y) {
    this.x = x;
    this.y = y;
  }
  toString() {
    return `(${this.x}, ${this.y})`;
  }

  translate(dx, dy) {
    this.x += dx;
    this.y += dy;
  }
}
```

Listing 6.19 `Line` class defined in `src/line.js`

```
import Point from './point';

export default class Line {
  constructor(start, end) {
    this.start = start;
    this.end = end;
  }

  toString() {
    return `line from ${this.start.toString()} to ${this.end.toString()}`;
  }

  translate(dx, dy) {
    this.start.translate(dx, dy);
    this.end.translate(dx, dy);
  }
}
```

To demonstrate holding instances of custom classes in stores, we can define stores in `stores.js`. Any component that needs these stores can import them.

Listing 6.20 Stores defined in `src/stores.js`

```
import {writable} from 'svelte/store';
import Line from './line';
import Point from './point';

export const pointStore = writable(new Point(0, 0));

export const lineStore =
  writable(new Line(new Point(0, 0), new Point(0, 0)));
```

The following listing shows a Svelte component that uses these stores.

Listing 6.21 App using the `Point` class and stores in `src/App.svelte`

```
<script>
  import Point from './point';
  import {lineStore, pointStore} from './stores';

  let point = new Point(1, 2);
```

This point is local to this component and is not in a store.

```
  function translate() {
    const dx = 2;
    const dy = 3;

    point.translate(dx, dy);
    point = point;

    pointStore.update(point => {
      point.translate(dx, dy);
      return point;
    });

    lineStore.update(line => {
      line.translate(dx, dy);
      return line;
    });
  }
</script>

<h1>local point = ({point.x}, {point.y})</h1>
<h1>point store = {$pointStore.toString()}</h1>
<h1>line store = {$lineStore.toString()}</h1>

<button on:click={translate}>Translate</button>
```

This translates the local Point, the Point in pointStore, and the Line in lineStore each by the same amount.

This assignment is necessary to let Svelte know there has been a change.

The main takeaway is that instance methods can be used to update objects in stores, but the updates must be performed inside the function passed to the store's `update` method. In addition, those functions must return the updated object.

The calls to `update` can be simplified as follows if the `translate` methods in the `Point` and `Line` classes are modified to return `this`.

```
pointStore.update(point => point.translate(3, 4));

lineStore.update(line => line.translate(dx, dy));
```

Another approach is to use custom stores instead of classes to represent points and lines. This moves all the logic into these stores and out of the code that uses them. For example, we can define the following custom stores for points and lines.

Listing 6.22 Stores defined in `src/stores.js`

```
import {get, writable} from 'svelte/store';

export function pointStore(x, y) {
  const store = writable({x, y});
  const {subscribe, update} = store;
  let cache = {x, y};
  return {
    subscribe,
    toString() {
      return `(${cache.x}, ${cache.y})`;
    },
    translate(dx, dy) {
      update(({x, y}) => {
        cache = {x: x + dx, y: y + dy};
        return cache;
      });
    }
  };
}

export function lineStore(start, end) {
  const store = writable({start, end});
  const {subscribe, update} = store;
  return {
    subscribe,
    translate(dx, dy) {
      update(({start, end}) => {
        start.translate(dx, dy);
        end.translate(dx, dy);
        return {start, end};
      });
    }
  };
}
```

These stores can be used as in the following listing.

Listing 6.23 App using stores in `src/App.svelte`

```
<script>
  import Point from './point';
  import {lineStore, pointStore} from './stores';
  let point = pointStore(1, 2);
  let line = lineStore(new Point(0, 0), new Point(2, 3));

  function translate() {
    const dx = 2;
    const dy = 3;

    point.translate(dx, dy);
    line.translate(dx, dy);
  }
</script>

<h1>point = ({$point.x}, {$point.y})</h1>
<h1>line = {$line.start.toString()}, {$line.end.toString()}</h1>

<button on:click={translate}>Translate</button>
```

It may seem that we could use the `toString` method in the object returned by the `pointStore` function to render its value. However, Svelte will not detect that there has been a change simply from the following:

```
<h1>point = {$point.toString()}</h1>
```

We can fix this by adding the following lines inside the `script` element,

```
let pointString = '';
point.subscribe(() => pointString = point.toString());
```

and rendering it with the following:

```
<h1>point = {pointString}</h1>
```

A similar approach can be used to add a `toString` method to `lineStore` and use it to render the current value of the store.

6.8 Persisting stores

If a user refreshes the browser, the code that creates stores is run again. This causes them to revert to their initial values.

It is possible to implement custom stores that persist any changes to `sessionStorage` and restore their values from `sessionStorage` on refresh.

NOTE The REPL is sandboxed and cannot use `localStorage` or `sessionStorage`.

The following example of a generic writable store does this. Using it is nearly the same as using the provided `writable` function. The only difference is that it needs a `sessionStorage` key string.

Listing 6.24 Creating writable, persistent stores in `src/store-util.js`

```
import {writable} from 'svelte/store';

function persist(key, value) {
  sessionStorage.setItem(key, JSON.stringify(value));
}

export function writableSession(key, initialValue) {
  const sessionValue = JSON.parse(sessionStorage.getItem(key));
  if (!sessionValue) persist(key, initialValue);

  const store = writable(sessionValue || initialValue);
  store.subscribe(value => persist(key, value));
  return store;
}
```

Only save initialValue in sessionStorage if it does not already contain a value.

Create a writable store using either the value in sessionStorage or the provided initial value.

This persists any changes to the store to sessionStorage.

The following listing creates an instance of this kind of store.

Listing 6.25 Writable, persistent store of numbers in `src/stores.js`

```
import {writableSession} from './store-util';

export const numbers = writableSession('numbers', [1, 2, 3]);
```

Any number of components can import the `numbers` store and call its `set` and `update` methods to change the value. All changes are saved in `sessionStorage` and restored from there if a user refreshes the browser.

6.9 Building the Travel Packing app

The Travel Packing app doesn't need stores because there is no data that needs to be shared between multiple components. In chapter 17 on Sapper server routes, you will see how to call API services to persist the data in a database.

In the next chapter you will learn several ways to interact with the DOM, in addition to the DOM manipulation performed by Svelte.

Summary

- Svelte stores provide an easy way to share data between components regardless of their relationship in the component hierarchy.
- Writable stores allow components to change their data.
- Readable stores do not.
- Derived stores compute their value from other stores.
- Custom stores can do any of these things and often provide a custom API for controlling their use.
- Stores can hold instances of custom JavaScript classes.
- Stores can persist their data in a number of ways. For example, `sessionStorage` can be used so data is not lost if the user refreshes the browser.

7 DOM interactions

This chapter covers

- Inserting HTML from string variables
- Avoiding cross-site scripting attacks from untrusted HTML
- Using "actions" to run code when an element is added to the DOM
- Using the `tick` function to modify the DOM after Svelte updates
- Implementing a dialog component
- Implementing drag and drop

Sometimes Svelte applications need to tap into DOM functionality that is not directly supported by Svelte. Examples include

- Moving focus to an input where the user is expected to enter data
- Setting the cursor position and selected text inside an `input`
- Calling methods on a `dialog` element
- Allowing users to drag particular elements onto others

All of these require going beyond simply writing the HTML to be rendered inside a Svelte component definition. Svelte supports this by providing access to the DOM elements it creates. Component code can modify the properties of these DOM elements and call methods on them. This chapter presents several such scenarios.

7.1 Inserting HTML

Typically Svelte components render HTML by directly specifying HTML elements in `.svelte` files. However, sometimes it is convenient to obtain the HTML as a string from a source outside the component definition. Let's explore a scenario where this is useful.

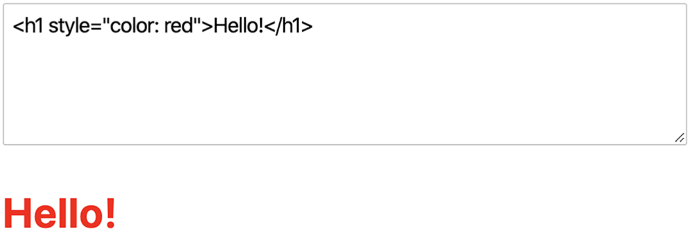
A content management system (CMS) typically allows users to save assets such as text and images that will be used in web applications. The CMS can allow users to enter HTML into a `textarea`. This HTML can be stored as a string in a database. Web applications can call API services to query the CMS and obtain assets to render.

If the CMS is implemented in Svelte, it can use the `@html` syntax shown next to present the user with a preview of how the HTML they enter will be rendered. If consuming applications are written in Svelte, they can use the same mechanism to render the HTML.

To render a JavaScript expression whose value is an HTML string, use the following syntax:

```
{@html expression}
```

In the following example, the user can enter any HTML in the `textarea`, and it will be rendered below it, as shown in figure 7.1.



<h1 style="color: red">Hello!</h1>

Hello!

Figure 7.1 Rendering user-entered HTML

Listing 7.1 App that renders HTML entered in a `textarea`

```
<script>
  let markup = '<h1 style="color: red">Hello!</h1>';
</script>
```

This is the initial value of the textarea.

```
<textarea bind:value={markup} rows={5} />
{@html markup}

<style>
  textarea {
    width: 95vw;
  }
</style>
```

In order to avoid cross-site scripting, HTML that comes from untrusted sources (such as the `textarea` in listing 7.1) should be sanitized. There are many open source libraries that remove potentially dangerous HTML from strings. One is sanitize-html, at https://github.com/apostrophecms/sanitize-html.

To use sanitize-html in a Svelte app:

1. Install it by entering `npm install sanitize-html`.
2. Import the `sanitizeHtml` function where needed.

By default `sanitizeHtml` keeps only the following elements: `a`, `b`, `blockquote`, `br`, `caption`, `code`, `div`, `em`, `h3`, `h4`, `h5`, `h6`, `hr`, `i`, `iframeli`, `nl`, `ol`, `p`, `pre`, `strike`, `strong`, `table`, `tbody`, `td`, `th`, `thead`, `tr`, and `ul`. All other elements are removed. Note that one of the elements removed is `script`.

The retained elements can have any attributes, except the `a` element, which can only have `href`, `name`, and `target` attributes.

By default, `img` elements are removed, but `sanitizeHtml` can be configured to retain them. It can also be configured to specify which `img` attributes are allowed. It will remove all other `img` attributes, such as `onerror` and `onload` that can run JavaScript code. See the `SANITIZE_OPTIONS` constant in listing 7.2.

`@html` inserts markup by setting the DOM property `innerHTML`. The HTML5 spec says "script elements inserted using `innerHTML` do not execute when they are inserted." So if the HTML is not sanitized and `script` elements are retained, they will not be executed. However, it's still advisable to remove `script` elements so someone inspecting the elements on the page won't assume they were executed.

Here is an example of using `@html` along with the `sanitizeHtml` function to render HTML from a string.

Listing 7.2 Using `@html` with `sanitizeHtml`

```
<script>
  import sanitizeHtml from 'sanitize-html';

  const SAFE = true;

  const SANITIZE_OPTIONS = {
    allowedTags: [...sanitizeHtml.defaults.allowedTags, 'img'],
    allowedAttributes: {img: ['alt', 'src']}
  };
```

Set this to false to see what is rendered when no HTML sanitizing is performed.

This adds 'img' to the list of elements that are allowed by default.

```
  function buildScript(content) {
    const s = 'script';
    return `<${s}>${content}</${s}>`;
  }

  function sanitize(markup) {
    return SAFE ? sanitizeHtml(markup, SANITIZE_OPTIONS) : markup;
  }

  const markup1 = buildScript('console.log("pwned by script")');

  const markup2 = '<img alt="star" src="star.png" />';

  const markup3 = '<img alt="star" src="star.png" ' +
    'onload="console.log(\'pwned by onload\')" />';

  const markup4 = '<img alt="missing" src="missing.png" ' +
    'onerror="console.log(\'pwned by onerror\')" />';

  const markups = [markup1, markup2, markup3, markup4];
</script>

<h1>Check the console.</h1>
{#each markups as markup}
  {@html sanitize(markup)}
{/each}
```

We have to create script elements in this way so the Svelte parser doesn't interpret them.

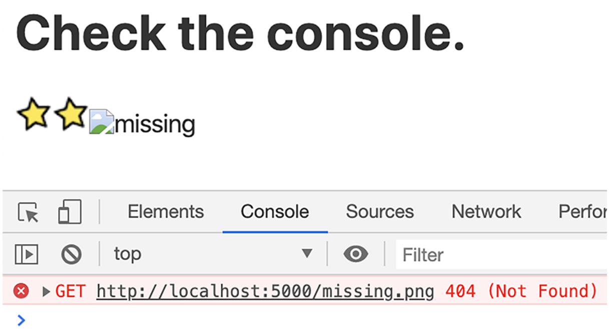
The script created here will not be executed even if sanitizeHtml is not used to remove it. (If you're not familiar with the term "pwned," see https://en.wikipedia.org/wiki/Pwn.)

With the specified options, sanitizeHtml will keep this. The star.png file can be obtained from http://mng.bz/XPBv in the public directory.

With the specified options, sanitizeHtml will keep this but remove the onload attribute.

With the specified options, sanitizeHtml will keep this but remove the onerror attribute. It will appear as a broken image because missing.png does not exist.

The HTML will be sanitized if the constant SAFE is set to true. When this is the case, the following HTML is rendered in the body. Note that the script element is removed, and the onerror and onload attributes are removed from the img elements. This means that output from their console.log calls will not appear in the DevTools console. The only thing that will appear in the DevTools console is a 404 error for the missing.png file, which is expected (see figure 7.2).



Check the console.

missing

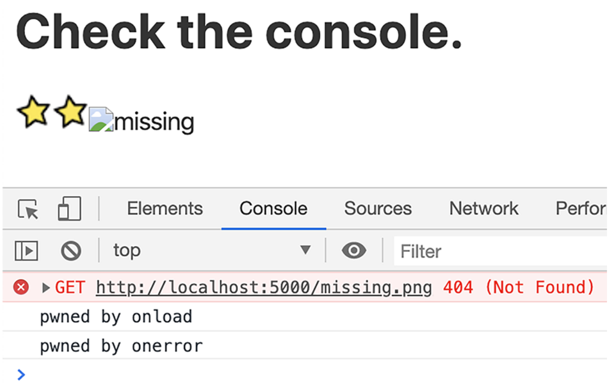
```
GET http://localhost:5000/missing.png 404 (Not Found)
```

Figure 7.2 Sanitized output in the browser

```
<h1>Check the console.</h1>
<img alt="star" src="star.png">
<img alt="star" src="star.png">
<img alt="missing" src="missing.png">
```

If the `SAFE` constant is changed to `false`, the HTML will not be sanitized and the following HTML is rendered in the `body` (see figure 7.3). In this case, the `script` will not execute, but the JavaScript passed to `onload` and `onerror` will execute and write to the DevTools console.

```
<h1>Check the console.</h1>
<script>console.log("pwned by script")</script>
<img alt="star" src="star.png">
<img alt="star" src="star.png" onload="console.log('pwned by onload')">
<img alt="missing" src="missing.png" onerror="console.log('pwned by onerror')">
```



Check the console.

missing

```
GET http://localhost:5000/missing.png 404 (Not Found)
pwned by onload
pwned by onerror
>
```

Figure 7.3 Unsanitized output in the browser

7.2 Actions

Actions register a function to be called when a specific element in a component is added to the DOM. This is useful in cases where an application needs to modify a property of a DOM element or call a method on a DOM element after it has been added to the DOM.

> **NOTE** Actions are somewhat related to the `onMount` lifecycle function (described in chapter 8), which registers a function to call when each instance of a component is added to the DOM.

Actions are specified on elements with the `use` directive, which has the syntax `use:`*`fnName`*`={`*`args`*`}`. The registered function is passed the DOM element and the arguments, if any. Omit `={`*`args`*`}` if no arguments other than the element are needed.

For example, the following code moves the focus to an `input` element after it is added to the DOM by calling the `focus` function:

```
<script>
  let name = '';
  const focus = element => element.focus();
</script>

<input bind:value={name} use:focus>
```

Action functions can optionally return an object, with `update` and `destroy` properties that are functions. The `update` function is called every time an argument value changes. Of course, this doesn't apply if there are no arguments. The `destroy` function is called when the element is removed from the DOM. Returning such an object from an action function is not common.

7.3 The tick function

Component state is invalidated by changing the values of top-level component variables. This causes Svelte to update the parts of the DOM that rely on the modified variables, and in doing so, some properties of the previously rendered DOM elements can be lost. In some cases we need a way to restore them.

From the Svelte documentation, "When you invalidate component state in Svelte, it doesn't update the DOM immediately. Instead, it waits until the next microtask to see if there are any other changes that need to be applied, including in other components. Doing so avoids unnecessary work and allows the browser to batch things more effectively."

Also from the Svelte documentation, the `tick` function "returns a promise that resolves as soon as any pending state changes have been applied to the DOM (or immediately, if there are no pending state changes)."

The `tick` function can be used to make additional state changes after DOM updates have been applied using the following pattern.

```
<script>
  import {tick} from 'svelte';
  ...

  await tick();

  ...
</script>
```

Make some state changes here.

Wait for previously batched state changes to be applied to the DOM.

Make more state changes here, after the DOM updates.

Calling `tick()` is rarely required, but let's walk through an example where it is needed.

Suppose we want to implement a masked input. Often this is an input where digits must be entered with particular delimiter characters at specific positions. For example, a phone number can be entered in the format `(123)456-7890`.

Let's create a `MaskedInput` component that takes a mask and a value as props (shown in listing 7.3). The mask is a string that contains `9` characters where digits are allowed. All other mask characters are the literal characters that must be added at specific locations. The mask for the preceding phone number format is `(999)999-9999`.

This is used as the `input` `placeholder` attribute, which is displayed until the user begins entering a value.

We want to add the appropriate delimiters in the `input` as the user is typing. But when Svelte updates the value of the `input`, the cursor position within the input is lost. To address this, we can follow these steps:

1. Capture the current cursor position before updating the value.
2. Update the value with the proper delimiter characters.
3. Wait for the DOM to finish updating, using the `tick` function.
4. Restore the cursor position.

Listing 7.3 `MaskedInput` component in `src/MaskedInput.svelte`

```
<script>
  import {tick} from 'svelte';
  export let mask;
  export let value;

  function getDigits(value) {
    let newValue = '';
    for (const char of value) {
      if (char >= '0' && char <= '9')  newValue += char;
    }
    return newValue;
  }

  function maskValue(digits) {
    const {length} = digits;
    if (length === 0) return '';

    let value = '';
    let index = 0;
    for (const char of mask) {
      if (char === '9') {
        const nextChar = digits[index++];
        if (!nextChar) break;
        value += nextChar;
      } else if (index < length) {
        value += char;
      }
    }
    return value;
  }

  function handleKeydown(event) {
    if (event.key !== 'Backspace') return;

    const {target} = event;
    let {selectionStart, selectionEnd} = target;

    setTimeout(async () => {
      value = maskValue(getDigits(target.value));
```

This creates a string containing only the digits in the value.

This creates a string by placing digits into the mask. For example, if the digits are “1234567” and we are using our phone number mask, this returns “(123)456-7”.

This block adds a digit from digits.

This adds a mask character.

This only handles the backspace (delete) key.

This captures the current cursor position.

Using setTimeout gives time for the backspace key to be processed.

This changes the value rendered by the input element.

```
      await tick();

      if (selectionStart === selectionEnd) selectionStart--;
      target.setSelectionRange(selectionStart, selectionStart);
    });
  }

  function handleKeypress(event) {
    setTimeout(async () => {
      const {target} = event;
      let {selectionStart} = target;

      value = maskValue(getDigits(target.value));

      await tick();

      if (selectionStart === value.length - 1) selectionStart++;

      const maskChar = mask[selectionStart - 1];
      if (maskChar !== '9') selectionStart++;

      target.setSelectionRange(selectionStart, selectionStart);
    });
  }
</script>

<input
  maxlength={mask.length}
  on:keydown={handleKeydown}
  on:keypress={handleKeypress}
  placeholder={mask}
  bind:value={value}
/>
```

This waits for Svelte to update the DOM.

After the DOM is updated by Svelte, this restores the insert cursor position.

This handles keys that are printable characters, like digits.

Using setTimeout gives time for the keypress to be processed.

This captures the current cursor position.

This changes the value rendered by the input element.

This waits for Svelte to update the DOM.

If we are at the end of the input, this moves selectionStart ahead one.

If a mask character was just inserted, this moves selectionStart ahead one.

This restores the insert cursor position.

The following listing shows an example of using the `MaskedInput` component.

Listing 7.4 App that uses the `MaskedInput` component

```
<script>
  import MaskedInput from './MaskedInput.svelte';
  let phone = '';
</script>

<label>
  Phone
  <MaskedInput
    mask="(999)999-9999"
    bind:value={phone}
  />
</label>
<div>
  phone = {phone}
</div>
```

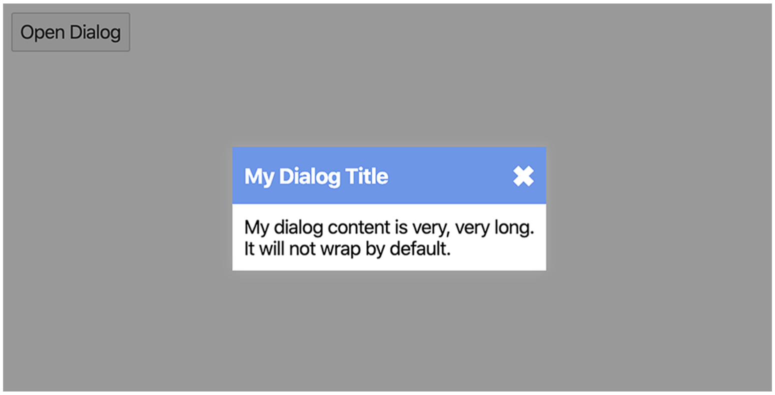
NOTE Listening for keypress events is deprecated but still supported (see http://mng.bz/6QKA). The proposed alternative is to listen for beforeinput events. However, at the time of writing those are not supported by Firefox. Another way of implementing a masked input that does not rely on keypress events can be found at http://mng.bz/oPyp.

Calling await tick() can also be useful in test code to wait for a change to be processed before testing for the effect.

7.4 Implementing a dialog component

Some applications use dialogs to present important information that users must acknowledge before continuing, or to prompt for input that must be provided before continuing. Dialogs are often *modal*, which means users cannot interact with elements outside the dialog until the dialog is dismissed. To indicate this, a *backdrop* is displayed behind the dialog and above all the other content. The backdrop blocks interaction with content outside the dialog. It typically has some opacity that shades the other content but still allows it to be visible.

In figure 7.4, a dialog is displayed when the user clicks the Open Dialog button.



My dialog content is very, very long.
It will not wrap by default.

Figure 7.4 A dialog example

Typically dialog components are implemented using a div element with a z-index that is higher than anything else on the page. Absolute positioning is used to position the div in the center of the page.

An alternative is to use the dialog element defined in the HTML specification. This makes using dialogs much easier. Unfortunately, browser support for the dialog element is still incomplete. At the time of writing, the only popular browsers that support it are Chrome and Edge.

However, a good polyfill is available in npm. It allows you to use the dialog element in other browsers, such as Firefox and Safari. See dialog-polyfill at www.npmjs.com/package/dialog-polyfill. To install it, enter npm install dialog-polyfill.

Let's implement a Svelte Dialog component that uses the dialog element and this polyfill. This component can have an icon, a title, a close "X," and any content. It is initially closed.

Parent components obtain a reference to the dialog element by including the bind:dialog prop, where dialog is a variable in the parent component.

To open the dialog as modal, call dialog.showModal(). This prevents interaction with elements outside the dialog.

To open the dialog as non-modal, call dialog.show(). This allows interaction with elements outside the dialog.

To close the dialog programmatically, call dialog.close(). Parent components can listen for the dialog being closed by the user by including the on:close={handleClose} prop, where handleClose is a function in the parent component.

The following listing shows a component that uses the Dialog component. This code can be found at https://github.com/mvolkmann/svelte-dialog.

Listing 7.5 App that uses the Dialog component

```
<script>
  import Dialog from './Dialog.svelte';
  let dialog;
</script>

<div>
  <button on:click={() => dialog.showModal()}>Open Dialog</button>
</div>

<Dialog title="Test Dialog" bind:dialog>
  My dialog content is very, very long.<br>
  It will not wrap by default.
</Dialog>
```

Here is the implementation of the Dialog component.

Listing 7.6 Dialog component in src/Dialog.svelte

This is a Boolean that determines whether a close "X" should be displayed.

```
<script>
  import dialogPolyfill from 'dialog-polyfill';
  import {createEventDispatcher, onMount} from 'svelte';

  export let canClose = true;
  export let className = '';
  export let dialog = null;
  export let icon = undefined;
  export let title;
```

This is an optional CSS class name to be added to the dialog element.

Parent components can use bind:dialog to get a reference so they can call show(), showModal(), and close() on it.

This is the title text to display in the dialog header.

This is an optional icon to render in the header before the title.

```
  const dispatch = createEventDispatcher();

  $: classNames = 'dialog' + (className ? ' ' + className : '');

  onMount(() => dialogPolyfill.registerDialog(dialog));

  function close() {
    dispatch('close');
    dialog.close();
  }
</script>

<dialog bind:this={dialog} class={classNames}>
  <header>
    {#if icon}{icon}{/if}
    <div class="title">{title}</div>
    {#if canClose}
      <button class="close-btn" on:click={close}>
        &#x2716;
      </button>
    {/if}
  </header>
  <main>
    <slot />
  </main>
</dialog>

<style>
  .body {
    padding: 10px;
  }

  .close-btn {
    background-color: transparent;
    border: none;
    color: white;
    cursor: pointer;
    font-size: 24px;
    outline: none;
    margin: 0;
    padding: 0;
  }

  dialog {

    position: fixed;
    top: 50%;
    transform: translate(0, -50%);

    border: none;
    box-shadow: 0 0 10px darkgray;
    padding: 0;
  }
```

onMount is a lifecycle function that is described in chapter 8. This is called when the component has been added to the DOM.

Parent components can optionally listen for this event.

This sets the dialog variable to a reference to the DOM element.

This is a Unicode "heavy multiplication X."

There is an accessibility issue here that will be fixed in chapter 12.

This is where the children of the Dialog component appear.

These properties center the dialog in the browser window.

```
  header {
    display: flex;
    justify-content: space-between;
    align-items: center;

    background-color: cornflowerblue;
    box-sizing: border-box;
    color: white;
    font-weight: bold;
    padding: 10px;
    width: 100%;
  }

  main {
    padding: 10px;
  }

  .title {
    flex-grow: 1;
    font-size: 18px;
    margin-right: 10px;
  }

  dialog::backdrop,
  :global(dialog + .backdrop) {
    background: rgba(0, 0, 0, 0.4);
  }
</style>
```

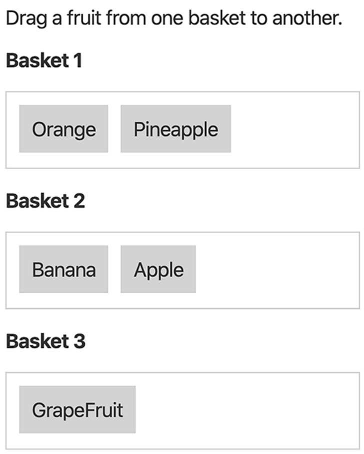
We need to define styling for the .backdrop element that is not scoped to this component, because in the polyfill that element is not nested in the root element of this component. See http://mng.bz/nPX2 for more on the ::backdrop pseudo element.

This is a transparent shade of gray.

7.5 Drag and drop

Implementing drag and drop in a Svelte app is easy. There is nothing Svelte-specific required. It can be implemented with the HTML Drag and Drop API documented on MDN at http://mng.bz/4Azj.

Let's implement a simple app that allows users to drag the names of fruits between baskets (see figure 7.5). This was inspired by an example found on the Svelte site at http://mng.bz/Qyev. The following listing presents a simpler version.



Drag a fruit from one basket to another.

Figure 7.5 Fruit drag and drop

Listing 7.7 App that demonstrates drag and drop

```
<script>
  let baskets = [
    {
      'name': 'Basket 1',
      'items': ['Orange', 'Pineapple']
    },
    {
      'name': 'Basket 2',
      'items': ['Banana', 'Apple']
    },
    {
      'name': 'Basket 3',
      'items': ['GrapeFruit']
    }
  ];

  let hoveringOverBasket;
```

This is used to highlight the basket over which an item is hovering during a drag operation.

```
  function dragStart(event, basketIndex, itemIndex) {
```

The data we want to make available when the element is dropped is the index of the item being dragged and the index of the basket from which it is leaving.

```
    const data = {basketIndex, itemIndex};
    event.dataTransfer.setData('text/plain', JSON.stringify(data));
  }

  function drop(event, basketIndex) {
    const json = event.dataTransfer.getData("text/plain");
    const data = JSON.parse(json);

    const [item] = baskets[data.basketIndex].items.splice(data.itemIndex, 1);
```

This removes the item from one basket. The splice method returns an array of the deleted elements, just one in this case.

```
    baskets[basketIndex].items.push(item);
```

This adds the item to the drop target basket.

```
    baskets = baskets;

    hoveringOverBasket = null;
  }
</script>

<p>Drag a fruit from one basket to another.</p>

{#each baskets as basket, basketIndex}
  <b>{basket.name}</b>
  <ul
    class:hovering={hoveringOverBasket === basket.name}
    on:dragenter={() => hoveringOverBasket = basket.name}
    on:dragleave={() => hoveringOverBasket = null}
    on:drop|preventDefault={event => drop(event, basketIndex)}
    on:dragover|preventDefault
  >
    {#each basket.items as item, itemIndex}
      <li
        draggable="true"
        on:dragstart={event => dragStart(event, basketIndex, itemIndex)}
      >
        {item}
      </li>
    {/each}
  </ul>
{/each}

<style>
  .hovering {
    border-color: orange;
  }
  li {
    background-color: lightgray;
    cursor: pointer;
    display: inline-block;
    margin-right: 10px;
    padding: 10px;
  }
  li:hover {
    background: orange;
    color: white;
  }
  ul {
    border: solid lightgray 1px;
    height: 40px; /* needed when empty */
    padding: 10px;
  }
</style>
```

For even more functionality, such as making components resizable, see the open source svelte-moveable Svelte component from Younkue Choi at http://mng.bz/vxY4.

7.6 Building the Travel Packing app

Let's apply what you have learned about dialogs to the Travel Packing app. The finished code can be found at http://mng.bz/XPKa.

First, configure use of the dialog polyfill as shown in listing 7.6. Copy the file `src/Dialog.svelte` from https://github.com/mvolkmann/svelte-dialog and place it in the `src` directory. We will use it to warn users if they attempt to create a category that already exists, add an item that already exists, or delete a category that is not empty.

In `Category.svelte`, do the following:

1. Add the following import:

   ```
   import Dialog from './Dialog.svelte';
   ```

2. Add the following variable declaration that will hold a reference to the DOM dialog:

   ```
   let dialog = null;
   ```

3. In the `addItem` function, change `alert(message);` to `dialog.showModal();`.
4. At the bottom of the HTML `section` element, add the following:

   ```
   <Dialog title="Category" bind:dialog>
     <div>{message}</div>
   </Dialog>
   ```

In Checklist.svelte, do the following:

1. Add the following import:

   ```
   import Dialog from './Dialog.svelte';
   ```

2. Add the following variable declaration, which will hold a reference to the DOM dialog:

   ```
   let dialog = null;
   ```

3. In the addCategory function, change alert(message); to dialog.showModal();.
4. Add the following code at the beginning of the deleteCategory function to prevent deleting a category that still contains items:

   ```
   if (Object.values(category.items).length) {
     message = 'This category is not empty.';
     dialog.showModal();
     return;
   }
   ```

5. At the bottom of the HTML section element, add the following:

   ```
   <Dialog title="Checklist" bind:dialog>
     <div>{message}</div>
   </Dialog>
   ```

With this code in place, try to create a new category that already exists, and try to add an item that already exists to a category. In both cases you will see a dialog that says it already exists, and nothing will be added.

Try to delete a category that contains one or more items. You will see a dialog that says the category is not empty, and the category will not be deleted.

Now let's apply what we have learned about drag and drop in the Travel Packing app. We want to allow users to drag items from one category to another.

In Item.svelte, do the following:

1. Add a categoryId prop so each Item knows its current category:

   ```
   export let categoryId;
   ```

2. Add a dnd prop that will receive an object that has drag and drop methods:

   ```
   export let dnd;
   ```

3. Add the following props to the span element inside the li element:

   ```
   draggable="true"
   on:dragstart={event => dnd.drag(event, categoryId, item.id)}
   ```

In `Category.svelte`, do the following:

1. Add a `dnd` prop that will receive an object that has `drag` and `drop` methods:

   ```
   export let dnd;
   ```

2. Declare a `hovering` variable that will be set to `true` if we are currently dragging an `Item` over it, and `false` otherwise:

   ```
   let hovering = false;
   ```

3. Add the following attributes to the `section` element:

   ```
   class:hover={hovering}
   on:dragenter={() => (hovering = true)}
   on:dragleave={event => {

     const {localName} = event.target;
     if (localName === 'section') hovering = false;
   }}
   on:drop|preventDefault={event => {
     dnd.drop(event, category.id);
     hovering = false;
   }}
   ondragover|preventDefault
   ```

   This only sets hovering to false when leaving the root element or the category.

4. Add the `categoryId` prop to the `Item` component instance so each `Item` knows the category to which it currently belongs:

   ```
   categoryId={category.id}
   ```

5. Forward the `dnd` prop as a prop to the `Item` component:

   ```
   {dnd}
   ```

6. Add styling for the `hover` class inside the `style` element:

   ```
   .hover {
     border-color: orange;
   }
   ```

In `Checklist.svelte`, do the following:

1. Define the `dragAndDrop` variable, which is an object that has the methods `drag` and `drop`:

   ```
   let dragAndDrop = {
     drag(event, categoryId, itemId) {
       const data = {categoryId, itemId};
       event.dataTransfer.setData('text/plain', JSON.stringify(data));
     },
     drop(event, categoryId) {
       const json = event.dataTransfer.getData('text/plain');
       const data = JSON.parse(json);
   ```

```
    const category = categories[data.categoryId];
    const item = category.items[data.itemId];
    delete category.items[data.itemId];

    categories[categoryId].items[data.itemId] = item;

    categories = categories;
  }
};
```

This removes the item from one category.

This adds the item to another category.

This triggers an update.

2 Add the `dnd` prop to the `Category` instance:

```
dnd={dragAndDrop}
```

With these changes in place, try dragging items from one category to another. Note how the border of a category changes to orange when you are hovering over it.

In the next chapter you will learn about Svelte "lifecycle" functions.

Summary

- Svelte components can render a string of HTML using the syntax `{@html markup}`.
- Depending on the source of the HTML string, it may be advisable to sanitize it.
- Svelte actions provide a way to run a given function when a specific element is added to the DOM.
- The Svelte `tick` function provides a way to wait for Svelte to finish updating the DOM before proceeding to the next line of code. This can be used to restore parts of the DOM state that existed before the updates.
- A Svelte `Dialog` component can be implemented using the HTML `dialog` element.
- Svelte components can implement drag and drop operations using the HTML Drag and Drop API.

8 Lifecycle functions

This chapters covers

- `onMount` to run code when a component is added to the DOM
- `beforeUpdate` to run code before every component update
- `afterUpdate` to run code after every component update
- `onDestroy` to run code when a component is removed from the DOM

In some applications there are actions that need to be performed when a component is added to or removed from the DOM. There are also situations where actions need to be performed before or after a component is updated. Svelte supports this by allowing the registration of functions to be invoked when four specific events occur in the lifecycle of a component instance:

- When it is mounted (added to the DOM)
- Before it is updated
- After it is updated
- When it is destroyed (removed from the DOM)

A component is "updated" if any of its props change or any of its state variables change. Recall that state variables are top-level variables in a component that are used in its HTML.

8.1 Setup

To register functions for these events, import the provided lifecycle functions from the `svelte` package:

```
import {afterUpdate, beforeUpdate, onDestroy, onMount} from 'svelte';
```

Call these functions, passing them a function to be called when the event occurs. They must be called during component initialization. This means they cannot be called conditionally or be called in a function that is not invoked before each component instance is mounted.

Listings 8.1 and 8.2 show examples of using each of these events. Enter the code in these listings into a REPL, and open the DevTools console (or expand the Console pane in the REPL). Click the Show checkbox and the Demo button to see when each of the lifecycle functions is called.

Listing 8.1 `Demo` component that uses all the lifecycle functions

```
<script>
  import {onMount, beforeUpdate, afterUpdate, onDestroy} from 'svelte';

  let color = 'red';

  function toggleColor() {
    color = color === 'red' ? 'blue' : 'red';
  }

  onMount(() => console.log('mounted'));
  beforeUpdate(() => console.log('before update'));
  afterUpdate(() => console.log('after update'));
  onDestroy(() => console.log('destroyed'));
</script>

<button on:click={toggleColor} style="color: {color}">
  Demo
</button>
```

Changing the color triggers the beforeUpdate function, updates the color of the button, and triggers the afterUpdate function.

Listing 8.2 App that uses the `Demo` component

```
<script>
  import Demo from './Demo.svelte';
  let show = false;
</script>

<label>
  <input type="checkbox" bind:checked={show}>
  Show
```

This determines whether the Demo component should be rendered. Changing it causes the Demo component to be mounted and unmounted. The beforeUpdate function is called before the onMount function, and the afterUpdate function is called after the onMount function.

```
</label>
{#if show}
  <Demo />
{/if}
```

The lifecycle functions can be called any number of times. For example, if `onMount` is called three times, passing it three functions, all of them will be called when the component is mounted, in the order in which they were registered.

Note that functions passed to `beforeUpdate` are called before functions passed to `onMount`. This happens because component props and state are evaluated before a component is added to the DOM.

8.2 The onMount lifecycle function

The most commonly used lifecycle function is `onMount`.

One use is to anticipate where a user is most likely to want to enter data in a form that is rendered by a component. An `onMount` function can move focus to that input when the component is first rendered. The following section shows an example of this.

Another use is to retrieve data needed by a component from API services. For example, a component that displays information about employees at a company can use an `onMount` function to obtain the data and store it in a top-level variable so it can be rendered. Section 8.2.2 shows an example of this.

8.2.1 Moving focus

Here's an example that moves the focus so the user is immediately ready to enter their name without having to click in the `input` or press the Tab key.

> **NOTE** Consider the impact on accessibility when moving focus. This can cause screen readers to skip over content before the input.

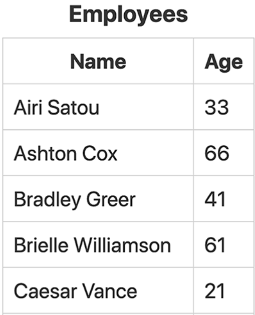
```
<script>
  import {onMount} from 'svelte';
  let name = '';
  let nameInput;
  onMount(() => nameInput.focus());
</script>

<input bind:this={nameInput} bind:value={name}>
```

The `bind:this` directive sets a variable to a reference to a DOM element. In the preceding example, the variable `nameInput` is set to the DOM element of the HTML `input`. This is used in the function passed to `onMount` to move the focus to the `input`.

Recall that in section 7.2 you saw an even easier way to move the focus—by using an action.

8.2.2 Retrieving data from an API service

Here is an example that retrieves data about employees at a company from an API service when the component is mounted. This is the same API service described in section 4.3. The array of employee objects returned is sorted by their names (first name before last name) and stored in a top-level variable. The component renders the employee data in a table (see figure 8.1).



Employees

Name	Age
Airi Satou	33
Ashton Cox	66
Bradley Greer	41
Brielle Williamson	61
Caesar Vance	21

Figure 8.1 Employee table

Listing 8.3 App that uses `onMount` to fetch data

```
<script>
  import {onMount} from 'svelte';

  let employees = [];
  let message;

  onMount(async () => {
    const res = await fetch(
      'http://dummy.restapiexample.com/api/v1/employees');
    const json = await res.json();
    if (json.status === 'success') {
      employees = json.data.sort(
        (e1, e2) => e1.employee_name.localeCompare(e2.employee_name));
      message = '';
    } else {
      employees = [];
      message = json.status;
    }
  });
</script>

<table>
  <caption>Employees </caption>
  <tr><th>Name</th><th>Age</th></tr>
  {#each employees as employee}
    <tr>
      <td>{employee.employee_name}</td>
      <td>{employee.employee_age}</td>
    </tr>
  {/each}
</table>
{#if message}
  <div class="error">Failed to retrieve employees: {message}</div>
{/if}

<style>
  caption {
    font-size: 18px;
```

For details on using the browser-provided Fetch API, see appendix B.

This sorts the employees on their name, first before last.

```
    font-weight: bold;
    margin-bottom: 0.5rem;
  }
  .error {
    color: red;
  }
  table {
    border-collapse: collapse;
  }
  td, th {
    border: solid lightgray 1px;
    padding: 0.5rem;
  }
</style>
```

8.3 The onDestroy lifecycle function

To register a function to be called when a component is removed from the DOM, pass the function to `onDestroy`. This is typically used for cleanup operations, such as clearing timers (created with `setTimeout`) or intervals (created with `setInterval`). It can also be used to unsubscribe from stores where auto-subscribe (`$` syntax) is not used.

For example, suppose we want to cycle through a set of colors for some text, changing the color every half second. Here is a Svelte component that does this.

Listing 8.4 `ColorCycle` component in `src/ColorCycle.svelte`

```
<script>
  import {onDestroy, onMount} from 'svelte';
  export let text;
  const colors = ['red', 'orange', 'yellow', 'green', 'blue', 'purple'];
  let colorIndex = 0;
  let token;

  onMount(() => {
    token = setInterval(() => {
      colorIndex = (colorIndex + 1) % colors.length;
    }, 500);
  });

  onDestroy(() => {
    console.log('ColorCycle destroyed');
    clearInterval(token);
  });
</script>

<h1 style="color: {colors[colorIndex]}">{text}</h1>
```

The following app component uses the `ColorCycle` component. It provides a way to remove the `ColorCycle` component from the DOM and add a new instance.

Listing 8.5 App that uses the `ColorCycle` component

```
<script>
  import ColorCycle from './ColorCycle.svelte';
  let show = true;
</script>

<button on:click={() => show = !show}>Toggle</button>

{#if show}
  <ColorCycle text="Some Title" />
{/if}
```

An alternative to using `onDestroy` is to return a function from the function registered with `onMount`. This function will be called when the component is removed from the DOM.

> **NOTE** This approach is a bit like the `useEffect` hook in React, but it differs in that functions passed to `useEffect` are run on both mount and updates.

Here is the `ColorCycle` component implemented with this approach.

Listing 8.6 `ColorCycle` component with `onMount` returning a function

```
<script>
  import {onMount} from 'svelte';
  export let text;

  const colors = ['red', 'orange', 'yellow', 'green', 'blue', 'purple'];
  let colorIndex = 0;

  onMount(() => {
    const token = setInterval(() => {
      colorIndex = (colorIndex + 1) % colors.length;
    }, 500);
    return () => clearInterval(token);
  });
</script>

<h1 style="color: {colors[colorIndex]}">{text}</h1>
```

One advantage of this approach is that the `token` variable can be scoped to the function passed to `onMount` instead of being a top-level variable in the component. This visually groups the setup and cleanup code, making it easier to follow.

8.4 The beforeUpdate lifecycle function

To register a function to be called before each component update, pass the function to `beforeUpdate`. The `beforeUpdate` function is rarely used.

One reason to use it is to capture part of the DOM state before it is updated by Svelte so those values can be restored after the update using the `afterUpdate` function.

For example, the cursor position in an input can be captured and restored after its value is changed.

The following component does this when the UPPER button is clicked. This changes the value of the input to be all uppercase. Figures 8.2 and 8.3 show the component before and after the UPPER button is clicked. The cursor position, including the range of characters selected, is restored after the change.

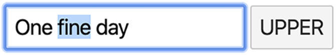

One fine day

Figure 8.2 Before clicking UPPER with "fine" selected

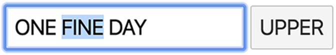

ONE FINE DAY

Figure 8.3 After clicking UPPER with "FINE" still selected

Listing 8.7 App that uses `beforeUpdate` and `afterUpdate`

```
<script>
  import {afterUpdate, beforeUpdate} from 'svelte';

  let input, name, selectionEnd, selectionStart;

  beforeUpdate(() => {
    if (input) ({selectionStart, selectionEnd} = input);
  })

  afterUpdate(() => {
    input.setSelectionRange(selectionStart, selectionEnd);
    input.focus();
  });
</script>

<input bind:this={input} bind:value={name}>
<button on:click={() => name = name.toUpperCase()}>UPPER</button>
```

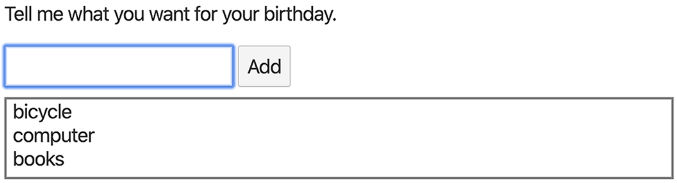
This uses destructuring to get two properties from the DOM input object.

Recall that bind:this captures the associated DOM element.

8.5 The afterUpdate lifecycle function

To register a function to be called after each component update, pass the function to `afterUpdate`. This is typically used to perform additional DOM updates after Svelte has updated the DOM.

The previous example already used `afterUpdate`, but used it in conjunction with `beforeUpdate`. The following Svelte app provides another example. It allows the user to enter items they want for their birthday. The list displays at most three items, and new items are added at the end (see figure 8.4). After each item is added, we want to automatically scroll to the bottom so the most recently added items are visible.


Tell me what you want for your birthday.

bicycle
computer
books

Figure 8.4 Birthday list

The function passed to `afterUpdate` scrolls the list to the bottom.

Listing 8.8 App that uses `afterUpdate`

```
<script>
  import {afterUpdate} from 'svelte';
  let input;
  let item = '';
  let items = [];
  let list;

  afterUpdate(() => list.scrollTo(0, list.scrollHeight));

  function addItem() {
    items.push(item);
    items = items;
    item = '';
    input.focus();
  }
</script>

<style>
  .list {
    border: solid gray 2px;
    height: 52px;
    overflow-y: scroll;
    padding: 5px;
  }
</style>

<p>Tell me what you want for your birthday.</p>

<form on:submit|preventDefault>
  <input bind:this={input} bind:value={item}>
  <button on:click={addItem}>Add</button>
</form>

<div class="list" bind:this={list}>
  {#each items as item}
    <div>{item}</div>
  {/each}
</div>
```

This function has access to item, which is a state variable.

This triggers an update.

This clears the input.

This prepares the user for entering another item.

This is enough height to display three items.

8.6 Using helper functions

Lifecycle functions can be called from helper functions whose purpose is to implement lifecycle functionality that can be shared between multiple components. These helper functions are best defined in separate `.js` files, which allows them to be imported and used by more than one component. This is similar to defining custom React hooks.

It is recommended that you name these helper functions starting with "on", similar to how React hook names start with "use".

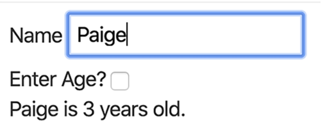
For example, we can implement lifecycle helper functions that move the focus to the current first `input` and log when a component is mounted.

Listing 8.9 Helper functions defined in `src/helper.js`

```
import {onMount} from 'svelte';

export function onMountFocus() {
  onMount(() => {
    const input = document.querySelector('input');
    input.focus();
  });
}

export function onMountLog(name) {
  onMount(() => console.log(name, 'mounted'));
}
```

This finds the first input element.

Let's create two components that use these helper functions. The `NameEntry` component allows the user to enter the name of a person (figure 8.5 and listing 8.10). The `AgeEntry` component allows their age to be entered (figure 8.6 and listing 8.11). These components use both of the helper functions defined in listing 8.9.

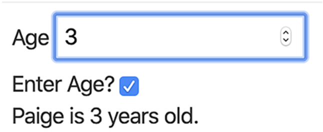


Name Paige

Enter Age? ☐

Paige is 3 years old.

Figure 8.5 `NameEntry` component



Age 3

Enter Age? ☑

Paige is 3 years old.

Figure 8.6 `AgeEntry` component

The component that renders `NameEntry` and `AgeEntry` toggles between showing one or the other based on the value of a checkbox with the label "Enter Age?" (see listing 8.12).

Listing 8.10 `NameEntry` component in `src/NameEntry.svelte`

```
<script>
  import {onMountFocus, onMountLog} from './helper';
  export let name;
  onMountLog('NameEntry');
  onMountFocus();
</script>

<label>
  Name
  <input bind:value={name}>
</label>
```

Listing 8.11 `AgeEntry` component in `src/AgeEntry.svelte`

```
<script>
  import {onMountFocus, onMountLog} from './helper';
  export let age;
  onMountLog('AgeEntry');
  onMountFocus();
</script>

<label>
  Age
  <input type="number" min="0" bind:value={age}>
</label>
```

The following listing shows a component that renders `AgeEntry` or `NameEntry`.

Listing 8.12 App that uses `AgeEntry` and `NameEntry`

```
<script>
  import {onMountLog} from './helper';
  import AgeEntry from './AgeEntry.svelte';
  import NameEntry from './NameEntry.svelte';

  let age = 0;
  let enterAge = false;
  let name = '';
  onMountLog('App');
</script>

{#if enterAge}
  <AgeEntry bind:age />        ◁ This uses bind to get age from AgeEntry.
{:else}
  <NameEntry bind:name />      ◁ This uses bind to get name from NameEntry.
{/if}

<label>
  Enter Age?
  <input type="checkbox" bind:checked={enterAge}>
</label>

<div>{name} is {age} years old.</div>
```

8.7 Building the Travel Packing app

The only place where the Travel Packing app needs to use a lifecycle function is in `Dialog.svelte`. This registers the dialog polyfill with each `dialog` instance after it is mounted. (The `Dialog` component and uses of it were added to the Travel Packing app in chapter 7.)

The dialog polyfill was registered with the following line of code:

```
onMount(() => dialogPolyfill.registerDialog(dialog));
```

The `dialog` variable was set using `bind:this` with code like the following:

```
<Dialog title="some-title" bind:dialog>
```

In the next chapter you will learn how to implement routing between the “pages” of an app.

Summary

- Components can register functions to be called at specific points in their lifecycle.
- The `onMount` function registers a function to be called when each component instance is added to the DOM.
- The `onDestroy` function registers a function to be called when each component instance is removed from the DOM.
- The `beforeUpdate` function registers a function to be called before each component instance is updated due to receiving a new prop value or having a state change.
- The `afterUpdate` function registers a function to be called after each component instance is updated due to receiving a new prop value or having a state change.
- The functions passed to lifecycle functions can be defined outside component source files in plain JavaScript files. This allows them to be shared by multiple components and by other JavaScript functions.

9 Client-side routing

This chapter covers

- “Manual” routing
- Hash routing
- Using the page.js library for routing
- Other routing options

Client-side routing is the ability to navigate between the pages of a web application. There are many things that can trigger a route change:

- The user clicks a link or button.
- The application programmatically changes the route based on the current state of the app.
- The user manually modifies the URL in the browser’s address bar.

Sapper, which builds on Svelte, provides a routing solution that is generally easier to use than adding routing to a Svelte app. This approach will be covered in chapters 15 and 16.

If you do not wish to use the other features that Sapper provides, or you wish to use a different routing approach, there are many ways to implement routing in a Svelte application. Several open source libraries support routing in Svelte. Another option is to use *hash routing*, which takes advantage of the hash portion of URLs and doesn't require installing a library. The easiest approach, however, is to simply choose a "page" component to render in the topmost component. We'll call this the "manual" approach.

We will start by exploring the manual approach before moving on to hash routing and using the page.js library. Then we will look at how to implement hash routing and routing with page.js in the Travel Packing app.

9.1 Manual routing

The downsides of the manual approach are that the browser's back button cannot be used to return to a previous "page," and the URL in the browser's address bar does not change when the "page" changes. However, for many applications these features are not necessary. This might be the case if the app begins every session on the same starting page, and users do not need to bookmark pages within the app.

The basic recipe for this approach is as follows:

1. Import all the components that represent pages in the topmost component, typically named `App`.
2. Create an object in `App` that maps page names to page components, perhaps named `pageMap`.
3. Add a variable in `App` that is set to the name of the current page.
4. Set up event handling to change this variable.
5. Use the special element `<svelte:component … />` (described more in chapter 14) to render the current page.

Let's use this approach to implement a simple shopping app. The code for this app can be found at http://mng.bz/jgq8.

The app has three page components named `Shop`, `Cart`, and `Ship`. Navigation between the pages is performed by clicking buttons at the top. The button for the `Cart` page contains a shopping cart emoji and the number of unique items in the cart, not considering their quantities. The Shop and Ship buttons just contain text labels.

All the page components share access to a writable store named `cartStore` that stores an array of items in the cart. This is defined in `stores.js` and starts as an empty array.

Listing 9.1 Defining `cartStore` in `src/stores.js`

```
import {writable} from 'svelte/store';

export const cartStore = writable([]);
```

The items available for purchase and their prices are defined in `items.js`.

Listing 9.2 Defining store items in `src/items.js`

```
export default [
  {description: 'socks', price: 7.0},
  {description: 'boots', price: 99.0},
  {description: 'gloves', price: 15.0},
  {description: 'hat', price: 10.0},
  {description: 'scarf', price: 20.0}
];
```

The `NavButton` component is used to allow users to navigate between the pages of the app. Three instances of this component are used in the `App` component.

Listing 9.3 `NavButton` component in `src/NavButton.svelte`

```
<script>
  export let name;
  export let pageName;
</script>

<button
  class:active={pageName === name}
  on:click={() => pageName = name}
>
  <slot />
</button>

<style>
  button {
    --space: 0.5rem;
    background-color: white;
    border-radius: var(--space);
    height: 38px;
    margin-right: var(--space);
    padding: var(--space);
  }

  .active {
    background-color: yellow;
  }
</style>
```

This is the name associated with this button.

This is the name of the currently selected page. The parent component, App, will bind to this prop to receive an update when the button is clicked.

The `App` component is where we implement manual routing. It provides buttons that can be clicked to navigate to the three pages of the app. One page component at a time is rendered.

Listing 9.4 App that uses the `NavButton` component

```
<script>
  import {cartStore} from './stores';

  import NavButton from './NavButton.svelte';
  import Cart from './Cart.svelte';
  import Ship from './Ship.svelte';
  import Shop from './Shop.svelte';
```

These are the page components.

```
  const pageMap = {
    cart: Cart,
    ship: Ship,
    shop: Shop
  }

  let pageName = 'shop';
</script>
```

This holds the name of the current page to be rendered.

```
<nav>
  <NavButton bind:pageName name='shop'>Shop</NavButton>
  <NavButton bind:pageName name='cart'>
    &#x1F6D2; {$cartStore.length}
  </NavButton>
  <NavButton bind:pageName name='ship'>Ship</NavButton>
</nav>
```

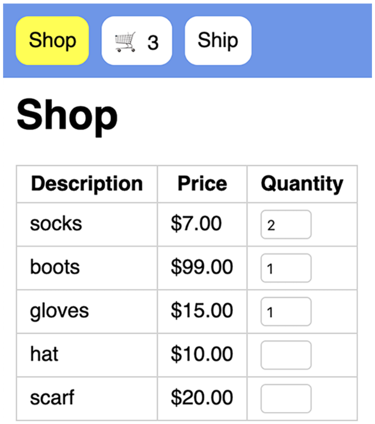
The Unicode character here is a shopping cart.

```
<main>
  <svelte:component this={pageMap[pageName]} />
</main>
```

This is a special Svelte element that renders a given component.

```
<style>
  main {
    padding: 10px;
  }

  nav {
    display: flex;
    align-items: center;
    background-color: cornflowerblue;
    padding: 10px;
  }
</style>
```

The Shop page allows the user to add items to be purchased to their cart simply by changing the quantity of an item to a number other than 0 (see figure 9.1). Deleting the quantity or setting it to 0 removes the item from the cart.



Shop

Description	Price	Quantity
socks	$7.00	2
boots	$99.00	1
gloves	$15.00	1
hat	$10.00	
scarf	$20.00	

Figure 9.1 `Shop` **component**

Listing 9.5 `Shop` **component in** `src/Shop.svelte`

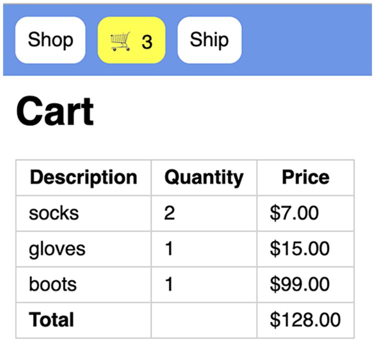
```
<script>
  import items from './items';
  import {cartStore} from './stores';

  function changeQuantity(event, item) {
    const newQuantity = Number(event.target.value);
```

```
      cartStore.update(items => {
        // If the new quantity is not zero and the old quantity is zero ...
        if (newQuantity && !item.quantity) {
          items.push(item);
         // If the new quantity is zero and the old quantity is not zero ...
       } else if (newQuantity === 0 && item.quantity) {
          const {description} = item;
          items = items.filter(i => i.description !== description);
        }

        item.quantity = newQuantity;

        return items;
      });
    }
  </script>

  <h1>Shop</h1>

  <table>
    <thead>
      <tr>
        <th>Description</th>
        <th>Price</th>
        <th>Quantity</th>
      </tr>
    </thead>
    <tbody>
      {#each items as item}
        <tr>
          <td>{item.description}</td>
          <td>${item.price.toFixed(2)}</td>
          <td>
            <input
              type="number"
              min="0"
              on:input={e => changeQuantity(e, item)}
              value={item.quantity}
            >
          </td>
        </tr>
      {/each}
    </tbody>
  </table>

  <style>
    input {
      width: 60px
    }
  </style>
```

This adds the item to the cart.

This removes the item from the cart.

The Cart page merely displays the cart contents and the total price of the items in the cart (see figure 9.2).



Cart

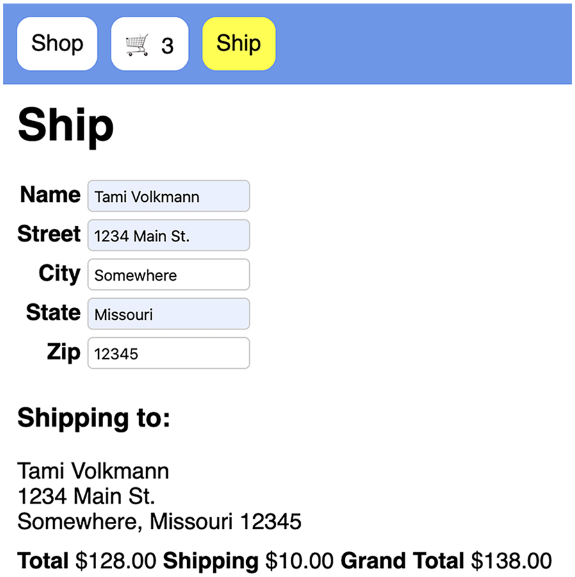
Description	Quantity	Price
socks	2	$7.00
gloves	1	$15.00
boots	1	$99.00
Total		$128.00

Figure 9.2 Cart component

Listing 9.6 `Cart` component in `src/Cart.svelte`

```
<script>
  import {cartStore} from './stores';

  let total =
    $cartStore.reduce((acc, item) => acc + item.price * item.quantity, 0);
</script>

<h1>Cart</h1>

{#if $cartStore.length === 0}
  <div>empty</div>
{:else}
  <table>
    <thead>
      <tr>
        <th>Description</th>
        <th>Quantity</th>
        <th>Price</th>
      </tr>
    </thead>
    <tbody>
      {#each $cartStore as item}
        <tr>
          <td>{item.description}</td>
          <td>{item.quantity}</td>
          <td>${item.price.toFixed(2)}</td>
        </tr>
      {/each}
    </tbody>
    <tfoot>
      <tr>
        <td colspan="2"><label>Total</label></td>
        <td></td>
        <td>${total.toFixed(2)}</td>
      </tr>
    </tfoot>
  </table>
{/if}
```

The `Ship` page allows the user to enter their name and shipping address. It also displays the total before shipping, the shipping cost, and the grand total (see figure 9.3).



Ship

Name Tami Volkmann
Street 1234 Main St.
City Somewhere
State Missouri
Zip 12345

Shipping to:

Tami Volkmann
1234 Main St.
Somewhere, Missouri 12345

Total $128.00 **Shipping** $10.00 **Grand Total** $138.00

Figure 9.3 `Ship` **component**

Listing 9.7 `Ship` **component in** `src/Ship.svelte`

```
<script>
  import {cartStore} from './stores';

  let total = $cartStore.reduce(
    (acc, item) => acc + item.price * item.quantity, 0);

  let city = '';
  let name = '';
  let state = '';
  let street = '';
  let zip = '';

  $: shipping = total === 0 ? 0 : total < 10 ? 2 : total < 30 ? 6 : 10;

  const format = cost => '$' + cost.toFixed(2);
</script>

<h1>Ship</h1>

<form on:submit|preventDefault>
  <label>
    Name
    <input bind:value={name}>
  </label>
  <label>
    Street
    <input bind:value={street}>
  </label>
```

This computes the shipping cost based on the total cost of the items.

This function formats a cost with a dollar sign and two decimal places.

```
  <label>
    City
    <input bind:value={city}>
  </label>
  <label>
    State
    <input bind:value={state}>
  </label>
  <label>
    Zip
    <input bind:value={zip}>
  </label>
</form>

<h3>Shipping to:</h3>
<div>{name}</div>
<div>{street}</div>
<div>{city ? city + ',' : ''} {state} {zip}</div>

<div class="totals">
  <label>Total</label> {format(total)}
  <label>Shipping</label> {format(shipping)}
  <label>Grand Total</label> {format(total + shipping)}
</div>

<style>
  form {
    display: inline-block;
  }

  form > label {
    display: block;
    margin-bottom: 5px;
    text-align: right;
    width: 100%;
  }

  .totals {
    margin-top: 10px;
  }
</style>
```

Styling that can affect any component is placed in the `public/global.css` file.

Listing 9.8 Global CSS in `public/global.css`

```
body {
  font-family: sans-serif;
  margin: 0;
}

h1 {
  margin-top: 0;
}
```

```
input {
  border: solid lightgray 1px;
  border-radius: 4px;
  padding: 4px;
}

label {
  font-weight: bold;
}

table {
  border-collapse: collapse;
}

td,
th {
  border: solid lightgray 1px;
  padding: 5px 10px;
}
```

As you can see, very little of this code is specific to routing. In this example, only the topmost component, `App`, is aware of routing. The remaining components are just plain Svelte components.

9.2 Hash routing

An advantage of hash routing over manual routing is that the URL in the browser's address bar changes when the user navigates to a different page.

The browser's `Window` object dispatches a `hashchange` event when the portion of the URL after `#` changes. These events provide a simple way to implement client-side routing. All that is required is to

1. Listen for `hashchange` events.
2. Change the component rendered based on the hash value.
3. Navigate to URLs with different hash values to switch pages.

NOTE Some people dislike the aesthetics of using hash values in URLs to differentiate between the pages of an app.

Let's implement the same Svelte shopping app as before, but using hash routing. The code for this app can be found at http://mng.bz/WPWl.

Users can manually change the URL in the browser's address bar to change the page that is rendered. This means it is possible to have a hash value in the URL that does not map to one of the pages of the app. When this occurs, the `NotFound` component, defined in the following listing, is rendered.

Listing 9.9 `NotFound` component in `src/NotFound.svelte`

```
<h1>Page Not Found.</h1>
```

The App component is where we will implement hash routing. This is similar to the App component for manual routing in listing 9.4, but it uses anchor elements instead of the NavButton component to allow users to navigate between the pages. Only the App.svelte file needs to change. The other source files do not require any changes.

Listing 9.10 The shopping app

```
<script>
  import {cartStore} from './stores';


  import Cart from './Cart.svelte';
  import NotFound from './NotFound.svelte';
  import Ship from './Ship.svelte';
  import Shop from './Shop.svelte';

  let component;

  const hashMap = {
    '#cart': Cart,
    '#ship': Ship,
    '#shop': Shop
  };

  function hashChange() {
    component = hashMap[location.hash] || NotFound;
  }
</script>

<svelte:window on:hashchange={hashChange} />

<nav>
  <a href="/#shop" class:active={component === Shop}>Shop</a>
  <a href="/#cart" class:active={component === Cart} class="icon">
    &#x1F6D2; {$cartStore.length}
  </a>
  <a href="/#ship" class:active={component === Ship}>Ship</a>
</nav>

<main>
  <svelte:component this={component} />
</main>

<style>
  :root {
    --space: 0.5rem;
  }

  a {
    background-color: white;
    border-radius: var(--space);
    margin-right: var(--space);
    padding: var(--space);
```

These are the page components.

This holds the page component to be rendered.

This function is called when the hash value in the URL changes.

This is a special Svelte element that supports adding event listeners on the window object without having to write code to remove them when the component is removed from the DOM (destroyed).

This is a special Svelte element that renders a given component.

This defines a global CSS variable that any CSS rule can use.

```
    text-decoration: none;
  }

  a.active {
    background-color: yellow;
  }

  .icon {
    padding-bottom: 6px;
    padding-top: 6px;
  }

  main {
    padding: var(--space);
  }

  nav {
    display: flex;
    align-items: center;
    background-color: cornflowerblue;
    padding: var(--space);
  }
</style>
```

As with manual routing, very little of this code is specific to routing. Only the topmost component is aware of the use of hash routing.

9.3 Using the page.js library

When using page.js, the URL in the browser's address bar changes if the user navigates to a different page, as it does with hash routing. An advantage of using page.js over hash routing is that page URLs do not use the hash portion. Some people prefer the look of non-hash URLs.

Page.js isn't specific to Svelte. It bills itself as a "Tiny ~1200 byte Express-inspired client-side router" (https://visionmedia.github.io/page.js). To install page.js, enter `npm install page`.

If any of the page URLs will use query parameters as a way of passing data, you should also install query-string by entering `npm install query-string`.

Let's implement the same Svelte app as before, but using page.js instead of hash routing. As in the previous routing approaches, the pages in the app are implemented as plain Svelte components. Only the `App.svelte` file needs to change. The other source files do not require any changes. The code for this app can be found at http://mng.bz/8p5w.

NOTE Page.js relies on the browser History API, and the Svelte REPL does not support using this. Therefore, this code will not work in the REPL. The following error will be displayed: "Failed to execute 'replaceState' on 'History': A history state object with URL 'https://svelte.dev/srcdoc' cannot be created in a document with origin 'null' and URL 'about:srcdoc'."

Listing 9.11 App using page.js

```
<script>
  import page from 'page';
  import {cartStore} from './stores';


  import Cart from './Cart.svelte';
  import NotFound from './NotFound.svelte';
  import Ship from './Ship.svelte';
  import Shop from './Shop.svelte';

  let component;

  page.redirect('/', '/shop');
  page('/cart', () => (component = Cart));
  page('/ship', () => (component = Ship));
  page('/shop', () => (component = Shop));

  page('*', () => (component = NotFound));

  page.start();
</script>

<nav>
  <a href="/shop" class:active={component === Shop}>Shop</a>
  <a class="icon" href="/cart" class:active={component === Cart}>
    &#x1F6D2; {$cartStore.length}
  </a>
  <a href="/ship" class:active={component === Ship}>Ship</a>
</nav>

<main>
  <svelte:component this={component} />
</main>

<style>
  /* styles for this component are the same as before */
</style>
```

These are the page components.

This holds the page component to be rendered.

Since this is the last registered path and it matches everything, it will be invoked for any path not already handled. If the first parameter, '*', is omitted, it will do the same thing.

This is a special Svelte element that renders a given component.

It is typical for Svelte apps to be created using the GitHub repository sveltejs/template as a starting point. This uses the sirv server application (www.npmjs.com/package/sirv) to serve static assets of the web app for local testing. Other server applications are typically used in production.

By default, the sirv app only supports HTTP requests that match files found in the `public` directory. If your web app routing solution uses URLs that deviate from this, such as the URLs used by the page library, those URLs will not work. To fix this, modify `package.json` and change the `start` script to the following:

```
"start": "sirv public --single"
```

With these changes in place, the app should operate as before. However, the URLs for the pages will end with a slash and a path part rather than a hash. Manually changing the URL to end with something other than `/shop`, `/cart`, or `/ship` will cause the `NotFound` page to be displayed.

9.4 Using path and query parameters with page.js

Now that you have seen the basic usage of page.js, let's look at how path and query parameters can be passed to a route. We don't need this capability in our shopping app, but other apps might use this to pass data to the new page component to be rendered. For example, a page that renders information about an upcoming concert might need a unique ID for the concert in order to fetch data about it.

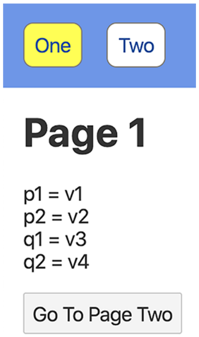
Path and query parameters

As a refresher on the difference between path and query parameters, consider the following URL: https://mycompany.com/myapp/v1/v2?q1=v3&q2=v4

The app represented by this URL is at the domain "mycompany.com" with a path of "myapp". The URL contains two path parameters with the values "v1" and "v2". It also contains two query parameters named "q1" and "q2". The value of "q1" is "v3" and the value of "q2" is "v4".

Let's demonstrate using path and query parameters in a simple app that only has two pages named `Page1` and `Page2`.

The `Page1` component accepts four props, two of which will come from path parameters and two of which will come from query parameters. This page simply renders the values of these parameters to show that they were received. It also renders a button that navigates to the second page when clicked (see figure 9.4). This demonstrates programmatic navigation that is not triggered by a user clicking a link.



Page 1

p1 = v1
p2 = v2
q1 = v3
q2 = v4

Figure 9.4 `Page1` **component**

Listing 9.12 `Page1` **component in** `src/Page1.svelte`

```
<script>
  import page from 'page';

  export let p1; // required
  export let p2 = undefined; // optional
  export let q1; // required
  export let q2 = undefined; // optional
  console.log('Page1 $$props =', $$props);
</script>

<h1>Page 1</h1>
<div>p1 = {p1}</div>
<div>p2 = {p2}</div>
<div>q1 = {q1}</div>
<div>q2 = {q2}</div>

<button on:click={() => page.show('/two')}>
  Go To Page Two
</button>

<style>
  button {
    margin-top: 1rem;
  }
</style>
```

This shows that we can access all the props in a single object. $$props is an undocumented variable that is subject to change.

This demonstrates programmatic navigation.

The Page2 component doesn't use any props (see figure 9.5). Its only purpose in this example is to show that we can navigate between multiple pages.

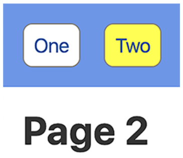


Figure 9.5 Page2 component

Listing 9.13 Page2 component in src/Page2.svelte

```
<h1>Page 2</h1>
```

The following listing shows the topmost component, which configures page routing.

Listing 9.14 App that uses the Page1 and Page2 components

```
<script>
  import page from 'page';
  import qs from 'query-string';

  import Page1 from './Page1.svelte';
  import Page2 from './Page2.svelte';

  let component;

  let props = {};

  function parseQueryString(context, next) {
    context.query = qs.parse(context.querystring);
    props = {};
    next();
  }

  page('*', parseQueryString);

  page('/', context => {
    component = Page1;
```

This holds the page component to be rendered.

This holds all the props to be passed to the page component.

This is a middleware function that parses query strings and puts the result back on the context object.

This clears the previous value.

This allows the next middleware to run.

This causes the parseQueryString middleware to run on every path. If the first parameter '*' is omitted, it will do the same thing.

This is the root path for the app.

```
    props = {p1: 'alpha', q1: 'beta'};
  });

  page('/one/:p1/:p2?', context => {
    component = Page1;
    const {params, query} = context;
    props = {...params, ...query};
  });

  page('/two', () => component = Page2);

  page.start();
</script>

<nav>
  <a
    class:active={component === Page1}
    href="/one/v1/v2?q1=v3&q2=v4"
  >
    One
  </a>
  <a class:active={component === Page2} href="/two">Two</a>
</nav>

<main>
  <svelte:component this={component} {...props} />
</main>

<style>

  :global(body) {
    padding: 0;
  }
  :global(h1) {
    margin-top: 0;
  }

  a {
    --padding: 0.5rem;
    background-color: white;
    border: solid gray 1px;
    border-radius: var(--padding);
    display: inline-block;
    margin-right: 1rem;
    padding: var(--padding);
    text-decoration: none;
  }

  .active {
    background-color: yellow;
  }

  main {
    padding: 1rem;
  }
```

This path requires the path parameter, p1, and accepts the optional path parameter, p2, indicated by following its name with a question mark. The associated component, Page1, also uses the query parameters q1 and q2, but there isn't a way to state in the path whether these are required or optional.

The path and query parameters are passed as props to the component to be rendered in <svelte:component> later.

This path doesn't use any path or query parameters.

Note how this link uses different path and query parameters than the previous "/" path, which sets p1 to "alpha" and q1 to "beta".

This is a special Svelte element that renders a given component.

These global CSS rules could instead be specified in public/global.css. This demonstrates an alternative way to define global styles.

```
  nav {
    background-color: cornflowerblue;
    padding: 1rem;
  }
</style>
```

Clearly, supporting URL paths that accept path and query parameters is a bit more complicated, but not overly so. The page.js library has additional features not demonstrated here. See https://visionmedia.github.io/page.js/ for more details.

Other routing libraries

There are also open source routing libraries that are specific to Svelte. These are some to consider:

- *navaid*—https://github.com/lukeed/navaid
- *Routify*—https://routify.dev/
- *svelte-routing*—https://github.com/EmilTholin/svelte-routing
- *svelte-spa-router*—https://github.com/ItalyPaleAle/svelte-spa-router

9.5 Building the Travel Packing app

Let's apply what you have learned about routing to the Travel Packing app. The finished code can be found at http://mng.bz/NKW1.

Currently the `App` component decides whether to render the `Login` component or the `Checklist` component. But the URL in the browser's address bar does not change.

Let's first use hash routing to treat these components as pages and give them unique URLs. The version you will find in GitHub uses page.js, not hash routing, but here are the steps to use hash routing.

First, copy the `NotFound.svelte` file shown in listing 9.9 into the `src` directory. Then in `App.svelte`, do the following:

1. Import the `NotFound` component with this line:

   ```
   import NotFound from './NotFound.svelte';
   ```

2. Replace the line `let page = Login;` with the following:

   ```
   const hashMap = {
     '#login': Login,
     '#checklist': Checklist
   };

   let component = Login;

   const hashChange = () => (component = hashMap[location.hash] || NotFound);
   ```

3. Add the following at the beginning of the HTML section:

   ```
   <svelte:window on:hashchange={hashChange} />
   ```

4 Replace the `{#if}` block that decides which component to render with the following:

```
<svelte:component
  this={component}
  on:login={() => (location.href = '/#checklist')}
  on:logout={() => (location.href = '/#login')}
/>
```

As you can see, only a small amount of code is needed to get client-side routing.

With these changes in place, the app should function as before. However, now the URL changes when the page switches between `Login` and `Checklist`. You can also switch pages by manually changing the hash portion of the URL. If an unsupported hash value is used, the `NotFound` component is rendered.

Now let's change the app to use page.js instead of hash routing. Install the library by entering `npm install page` in the top project directory.

In `App.svelte`, do the following:

1 Add an `import` for the page.js library at the top of the `script` element.

```
import page from 'page';
```

2 Remove the `hashMap` variable declaration.

3 Remove the `hashChange` function definition.

4 Add the following at the bottom of the `script` element:

```
page.redirect('/', '/login');
page('/login', () => (component = Login));
page('/checklist', () => (component = Checklist));
page('*', () => (component = NotFound));
page.start();
```

5 Remove the `<svelte:window>` element at the top of the HTML section.

6 Change the `<svelte:component>` element to match the following:

```
<svelte:component
  this={component}
  on:login={() => page.show('/checklist')}
  on:logout={() => page.show('/login')} />
```

7 Change the `start` script in `package.json` to include the `--single` option.

With these changes in place, the app should function as before. However, now the URL for each page no longer contains a hash.

We haven't implemented login authentication. If we did, we could prevent navigation to the `Checklist` page unless a valid username and password were entered.

In the next chapter you will learn how to implement animations in Svelte components.

Summary

- Client-side routing is the ability to navigate between pages of a web application.
- Svelte does not support this out of the box, but there are many ways to add routing in a Svelte app.
- A popular option is to use Sapper, which has a built-in routing solution.
- Manual routing, hash routing, and the page.js library are easy-to-use options for implementing routing in a Svelte app.
- Several additional open source libraries also add routing to Svelte apps.

10 Animation

This chapter covers

- Easing functions used by animations
- The `svelte/animate` package
- The `svelte/motion` package
- The `svelte/transition` package
- Creating custom transitions
- Transition events

Adding animation to a web application can make it more enticing to users and can make some operations more intuitive. There are libraries for many web frameworks that add animation support, but in Svelte this is a built-in feature.

Svelte provides many `transition` directive values and functions that make it easy to add CSS-based animation to elements. The fact that they are CSS-based rather than JavaScript-based means they do not block the main thread, which is good for performance. This chapter describes each of the provided animations and concludes with showing how custom transitions can be implemented.

Svelte supports two kinds of animations: adding/removing an element, and changing a value.

When elements are added to or removed from the DOM, animation allows a special effect to occur over a given number of milliseconds. For example, added elements can fade in, and removed elements can slide out of the browser window. This is more visually appealing than abruptly adding or removing an element.

Animated value changes enable a variable's value to gradually change from its current value to a new value over a given number of milliseconds. When the variable is part of the state of a component, the DOM is updated for each intermediate value. For example, the value of a given bar in a bar chart can be changed from a value of 0 to a value of 10 over a duration of 500 milliseconds. Rather than the bar jumping from a height of 0 to, say, 300 pixels, it gradually increases, resulting in an animated change.

Let's get started in our journey through Svelte animations. Each of the following sections will focus on an important animation topic or package provided by Svelte.

10.1 Easing functions

Animations can proceed at varying rates over their duration. This is specified with easing functions. Each animation has a default easing function that can be overridden with the `easing` option.

The `svelte/easing` package currently defines 11 easing functions. Custom easing functions can also be defined. They are simply functions that take a number between 0 and 1 and return a number in that same range.

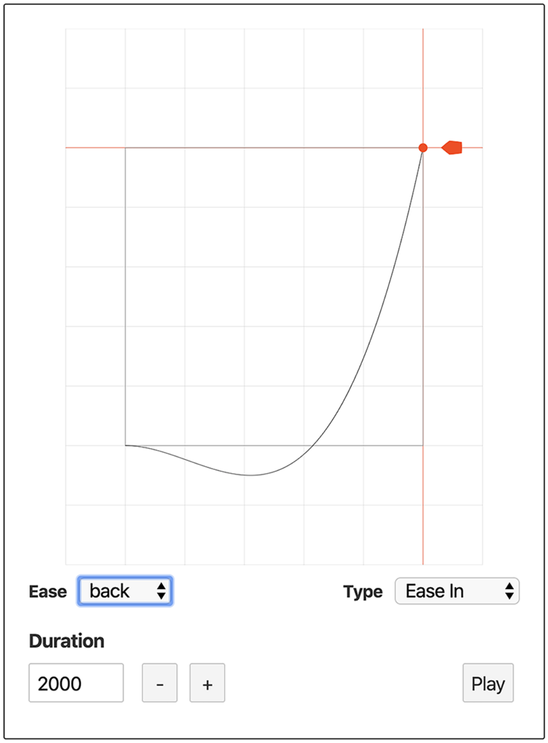
A great way to learn about the provided easing functions is to browse the Ease Visualizer at https://svelte.dev/examples#easing (see figure 10.1). After selecting an Ease and a Type (Ease In, Ease Out, or Ease In Out), it displays a curve that describes its effect and animates the movement through the duration.

The `linear` easing function is the most basic. It provides a smooth, constant rate of animation. The easing functions `sine`, `quad`, `cubic`, `quart`, `quint`, `expo`, and `circ` are all simple curves with only minor differences in their acceleration in the middle of an animation. The most extreme of these is `expo`.

The easing functions `back`, `elastic`, and `bounce` are more interesting because they move forward and backward. `bounce` changes direction seven times, and `elastic` changes direction five times. `back` changes direction only once and so is the least bouncy.

The actual names of all of these easing functions end with `In`, `Out`, or `InOut`. For example, `bounceIn`, `bounceOut`, and `bounceInOut`.

Easings ending in `In` are applied when components are added to the DOM. Easings ending in `Out` are applied when components are removed from the DOM. Easings ending in `InOut` are applied for both.


Ease: back

Type: Ease In

Duration: 2000

Figure 10.1 The Ease Visualizer

10.2 The svelte/animate package

The `svelte/animate` package provides the `flip` function, which stands for *first, last, invert, play*. It doesn't actually flip anything. Instead, it determines the new position of an element and animates changes to its *x* and *y* values from the old to the new position. A common use is to animate the changing location of items in a list.

In the following example, the Add button adds a new number to a list of numbers that are each displayed in buttons (see figure 10.2). New numbers are added to the beginning of the list so that each one must move to make room. Clicking a number button removes it, causing all the buttons after it to slide toward the beginning of the list to close up the vacated space. The list can be toggled between horizontal and vertical, and this change is also animated (see figure 10.3).

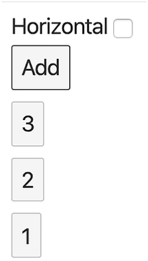

Horizontal ☐

Figure 10.2 `flip` animations in vertical orientation

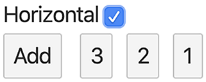

Horizontal ☑

Figure 10.3 `flip` animations in horizontal orientation

Copy this code to the Svelte REPL and try it.

Listing 10.1 `flip` animation demo

```
<script>
  import {flip} from 'svelte/animate';

  let horizontal = false;
  let next = 1;
  let list = [];

  function addItem() {
    list = [next++, ...list];
  }

  function removeItem(number) {
    list = list.filter(n => n !== number);
  }

  const options = {duration: 500};
</script>

<label>
  Horizontal
  <input type="checkbox" bind:checked={horizontal}>
</label>

<button on:click={addItem}>Add</button>

{#each list as n (n)}
  <div animate:flip={options} class="container" class:horizontal>
    <button on:click={() => removeItem(n)}>{n}</button>
  </div>
{/each}

<style>
  .container {
    width: fit-content;
  }

  .horizontal {
    display: inline-block;
    margin-left: 10px;
  }
</style>
```

This adds the next number to the beginning of the list.

This is a keyed each block.

The flip animation is specified here.

Animating between the vertical and horizontal layout of the buttons only works well if the container knows its width, so this line is critical for proper animation.

Toggling the Horizontal checkbox before the animation completes cancels the in-progress animations and starts new animations that cause the elements to return to their previous locations.

The `animate` directive that's used to request a `flip` animation in listing 10.1 must be applied to an HTML element. Applying it to a custom component has no effect.

The flip animation supports several options:

- delay specifies how long to wait in milliseconds before beginning the animation. It defaults to 0.
- duration specifies how long it should take in milliseconds to complete the animation. The value can also be a function that takes the distance to move in pixels and returns the duration to use. It defaults to the function d => Math.sqrt(d) * 120.
- easing is an easing function that defaults to cubicOut. Many more easing functions can be imported from the svelte/easing package.

Here is an example of specifying options for the flip animation:

```
<script>
  import {bounceInOut} from 'svelte/easing';
</script>
...
<div animate:flip={{delay: 200, duration: 1000, easing: bounceInOut}}>
```

10.3 The svelte/motion package

The svelte/motion package provides the spring and tweened functions. These create writable stores whose values animate from old to new values. As with all writable stores, the stored value can be changed by calling the store's set and update methods. The set method is passed a new value. The update method is passed a function that computes the new value based on the current value.

Typically these functions are used to interpolate between two numbers. However, they can also be used to interpolate between multiple numbers held in two arrays or between two objects that have the same shape and only have number values in their primitive properties (properties whose values are not objects).

For example, the spring and tweened functions are useful for rendering changes in a pie chart. When the value changes from say 10% to 90%, we might want the pie chart to animate showing many values in between. Rather than changing immediately, the value changes smoothly.

The spring and tweened functions both take an initial value and an options object. Supported options include delay, duration, easing, and interpolate. The first three have the same meaning as previously described for the flip function. The interpolate function is used to interpolate between values that aren't numbers or dates and is discussed a little later in this section.

Let's implement an SVG-based pie chart component that displays a given percentage value (see figure 10.4). As you learned in geometry class, 0 degrees corresponds to 3 o'clock on a clock face, and angles increase counterclockwise from there. It does not use animation, but components

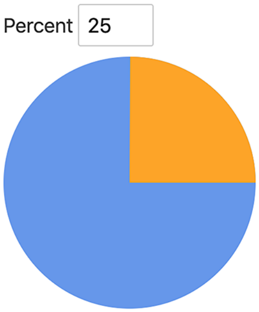


Figure 10.4 A pie chart component

that use it can animate its value. For details on creating pie charts with SVG, see Kasey Bonifacio's "How to Create an SVG Pie Chart": https://seesparkbox.com/foundry/how_to_code_an_SVG_pie_chart.

Listing 10.2 `Pie` component in `src/Pie.svelte`

```
<script>
  export let size = 200;
  export let percent = 0;
  export let bgColor = 'cornflowerblue';
  export let fgColor = 'orange';

  $: viewBox = `0 0 ${size} ${size}`;

  $: radius = size / 2;
  $: halfCircumference = Math.PI * radius;
  $: pieSize = halfCircumference * (percent / 100);
  $: dashArray = `0 ${halfCircumference - pieSize} ${pieSize}`;
</script>

<svg width={size} height={size} {viewBox}>
  <circle r={radius} cx={radius} cy={radius} fill={bgColor} />
  <circle
    r={radius / 2}
    cx={radius}
    cy={radius}
    fill={bgColor}
    stroke={fgColor}
    stroke-width={radius}
    stroke-dasharray={dashArray}
  />
</svg>
```

This renders the background circle.

This renders a pie wedge whose size is a percentage of the circle.

The following component renders a number `input` and a `Pie` component using that value. It uses the `tweened` function to animate the value.

Listing 10.3 App that uses `Pie` component

```
<script>
  import {tweened} from 'svelte/motion';
  import Pie from './Pie.svelte';

  let percent = 0;
  const store = tweened(0, {duration: 1000});
  $: store.set(percent || 0);
</script>

<label>
  Percent
  <input type="number" min="0" max="100" bind:value={percent}>
</label>
<Pie size={200} percent={$store} />
```

This updates the store every time the value of percent changes. If the input is empty, percent will be undefined, but we want the store to always contain a number.

Copy these files to the REPL and try it!

The spring function is similar to the tweened function, but it uses stiffness, damping, and precision parameters to give a spring-like effect to the animations. It does not use the duration parameter.

The previous pie chart example can be changed to use spring animation by simply replacing the call to tweened with a call to spring. For example, this makes it quite springy:

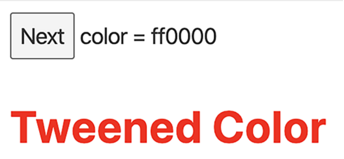
```
const store = spring(0, {stiffness: 0.3, damping: 0.3});
```

Make this change in the REPL, and also change the import of tweened to spring to try it!

One of the options accepted by the spring and tweened functions is an interpolate function. It supports interpolating between values that are *not* numbers, dates, arrays of them, or objects whose properties only have number or date values.

An interpolate function takes starting and ending values. It returns another function that takes a number between 0 and 1 and returns a value of the same type as the starting and ending values that is “between” them.

For example, we can use an interpolate function to tween over hex color values in the format “rrggbb”. When changing from one color to another, such as red to green, we want to pass through colors that are in a sense between them (see figure 10.5 and listing 10.4).



Next color = ff0000

Tweened Color

Figure 10.5 App that demonstrates using tweened

Listing 10.4 App that demonstrates using tweened

```
<script>
  import {tweened} from 'svelte/motion';

  let colorIndex = 0;
  const colors = ['ff0000', '00ff00', '0000ff']; // red, green, blue

  // This converts a decimal number to a two-character hex number.
  const decimalToHex = decimal =>
    Math.round(decimal).toString(16).padStart(2, '0');

  // This cycles through the indexes of the colors array.
  const goToNextColor = () => colorIndex = (colorIndex + 1) % colors.length;

  // This extracts two hex characters from an "rrggbb" color string
  // and returns the value as a number between 0 and 255.
  const getColor = (hex, index) =>
    parseInt(hex.substring(index, index + 2), 16);

  // This gets an array of red, green, and blue values in
  // the range 0 to 255 from an "rrggbb" hex color string.
  const getRGBs = hex =>
    [getColor(hex, 0), getColor(hex, 2), getColor(hex, 4)];

  // This computes a value that is t% of the way from
  // start to start + delta where t is a number between 0 and 1.
  const scaledValue = (start, delta, t) => start + delta * t;

  // This is an interpolate function used by the tweened function.
  function rgbInterpolate(fromColor, toColor) {
    const [fromRed, fromGreen, fromBlue] = getRGBs(fromColor);
    const [toRed, toGreen, toBlue] = getRGBs(toColor);
    const deltaRed = toRed - fromRed;
    const deltaGreen = toGreen - fromGreen;
    const deltaBlue = toBlue - fromBlue;

    return t => {
      const red = scaledValue(fromRed, deltaRed, t);
      const green = scaledValue(fromGreen, deltaGreen, t);
      const blue = scaledValue(fromBlue, deltaBlue, t);
      return decimalToHex(red) + decimalToHex(green) + decimalToHex(blue);
    };
  }

  // Create a tweened store that holds an "rrggbb" hex color.
  const color = tweened(
    colors[colorIndex],
    {duration: 1000, interpolate: rgbInterpolate}
  );

  // Trigger tweening if colorIndex changes.
  $: color.set(colors[colorIndex]);
</script>

<button on:click={goToNextColor}>Next</button>
<span>color = {$color}</span>
<h1 style="color: #{$color}">Tweened Color</h1>
```

This returns a function.

The color of this h1 changes when the Next button is clicked.

Copy this file to the REPL and try it!

10.4 The svelte/transition package

The svelte/transition package provides the crossfade function and the transition directive values blur, draw, fade, fly, scale, and slide.

These are specified using the directives in, out, and transition. An in effect is applied when an element is added to the DOM. An out effect is applied when an element is removed from the DOM. A transition effect is applied in both cases.

Like the animate directive, the in, out, and transition directives must be applied to an HTML element. Applying them to a custom component has no effect.

We will begin by looking at each of the provided transitions and their options. Then we will look at an example that demonstrates all of them, side by side, for comparison.

The fade transition animates a change in opacity between 0 and the current opacity value, which is typically 1. It goes from 0 to the current opacity when an element is added to the DOM, and from the current opacity to 0 when an element is removed from the DOM. It accepts the options delay and duration. The delay option is the number of milliseconds to wait before starting the transition. The duration option is the number of milliseconds over which the transition should occur.

The blur transition is like fade, but it also animates an amount of blur in pixels. In addition to the delay and duration options, it accepts the easing, opacity, and amount options. The easing option is an easing function described earlier in section 10.1. The opacity option specifies the starting opacity value. This defaults to 0, which is typically the desired value. The amount option specifies the size of the blur in pixels and defaults to 5.

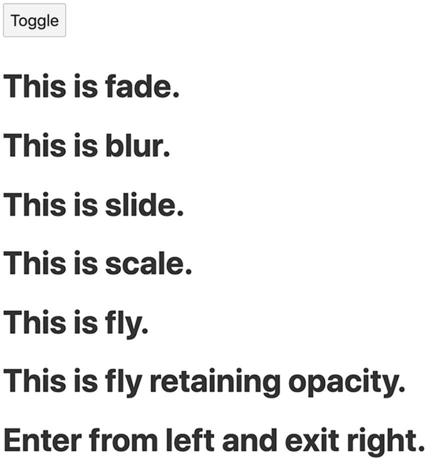
The slide transition is like a window shade. It animates hiding and showing an element by gradually changing its height. When hiding an element, it is removed from the DOM after the height reaches 0. Elements below it in the normal DOM flow will move up to occupy the vacated space. It accepts delay, duration, and easing options.

The scale transition animates the size and opacity of an element. It accepts delay, duration, easing, start, and opacity options. The start option specifies the smallest scale to use before the element is removed. It defaults to 0, which is typically the desired value.

The fly transition animates the *x* and *y* location of an element. It accepts delay, duration, easing, opacity, x, and y options. The x and y options can be set to negative values to slide the element off the left and top sides of the page. By default, it also animates opacity to 0, but this can be changed by specifying the opacity option. To slide an element off the screen without changing its opacity during the slide, set this to 1.

The draw transition animates the stroke of an SVG element. It accepts delay, duration, easing, and speed options. The speed option is an alternate way to specify the duration, computed based on the SVG path length using length / speed.

The following example (figure 10.6 and listing 10.5) demonstrates each of these transitions. Copy the following code to the REPL to try it. Click the Toggle button to toggle between hiding and showing each of the h1 elements, which triggers their transitions. Focus your eyes on one element at a time to get a clear understanding of the effect of a particular transition.



This is fade.

This is blur.

This is slide.

This is scale.

This is fly.

This is fly retaining opacity.

Enter from left and exit right.

Figure 10.6 Transitions demo app

Listing 10.5 Transitions demo app

```
<script>
  import {linear} from 'svelte/easing';
  import {blur, fade, fly, scale, slide} from 'svelte/transition';
  let show = true;
  let options = {duration: 1000, easing: linear};
</script>

<button on:click={() => show = !show}>
  Toggle
</button>
{#if show}
  <h1 transition:fade={options}>This is fade.</h1>
  <h1 transition:blur={options}>This is blur.</h1>
  <h1 transition:slide={{...options, x: -150}}>This is slide.</h1>
  <h1 transition:scale={options}>This is scale.</h1>
  <h1 transition:fly={{...options, x: -150}}>This is fly.</h1>
  <h1 transition:fly={{...options, opacity: 1, x: -400}}>
    This is fly retaining opacity.
  </h1>
  <h1
    in:fly={{...options, opacity: 1, x: -400}}
    out:fly={{...options, opacity: 1, x: 500}}
  >
    Enter from left and exit right.
  </h1>
{/if}
```

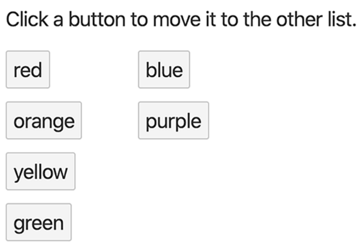
Setting the easing function to linear makes it more obvious that all the animations are happening simultaneously.

Only transitions specified with the `transition` directive can be canceled. Canceling a transition means the element returns to its previous state of either being in the DOM or not being in the DOM. Transitions specified using the `in` and `out` directives cannot be canceled. This makes sense because, for example, it would be odd to stop the addition of an element with a `blur` transition partway through, and to remove the element using a `fly` transition.

10.5 The fade transition and flip animation

The following example moves buttons between left and right lists as each button is clicked (see figure 10.7). It uses the `fade` transition, so the clicked button fades out of its current list and fades into its new list. It also uses the `flip` animation so buttons below the button being moved slide up to fill the vacated space.

We will implement this using two components to avoid duplicating code. The following listing shows the `ButtonList` component that is used for both the left and right lists.



Click a button to move it to the other list.

Figure 10.7 Moving buttons with `fade` and `flip`

Listing 10.6 `ButtonList` component in `src/ButtonList.svelte`

```
<script>
  import {flip} from 'svelte/animate';
  import {fade} from 'svelte/transition';

  export let list;
  export let moveFn;

  const options = {duration: 1000};
</script>

<div class="list">
  {#each list as item (item)}
    <button
      class="item"
      on:click={moveFn}
      animate:flip={options}
      transition:fade={options}>
      {item}
    </button>
  {/each}
</div>

<style>
  .item {
    display: block;
    margin-bottom: 10px;
    padding: 5px;
  }

  .list {
    display: inline-block;
    vertical-align: top;
    width: 100px;
  }
</style>
```

This is an array of button text values.

This is a function that moves the clicked button to the other list.

The next listing shows a component that uses two instances of the `ButtonList` component.

Listing 10.7 App that uses the `ButtonList` component

```
<script>
  import ButtonList from './ButtonList.svelte';

  let left = ['red', 'orange', 'yellow', 'green'];
  let right = ['blue', 'purple'];

  function move(event, from, to) {
    const text = event.target.textContent.trim();
    to.push(text);
    return [from.filter(t => t !== text), to];
  }
```

trim is needed because ButtonList includes whitespace in the button text.

This adds the text to the “to” list.

This removes the text from the “from” list.

```
  function moveLeft(event) {
    [right, left] = move(event, right, left);
  }

  function moveRight(event) {
    [left, right] = move(event, left, right);
  }
</script>

<p>Click a button to move it to the other list.</p>
<ButtonList list={left} moveFn={moveRight} />
<ButtonList list={right} moveFn={moveLeft} />
```

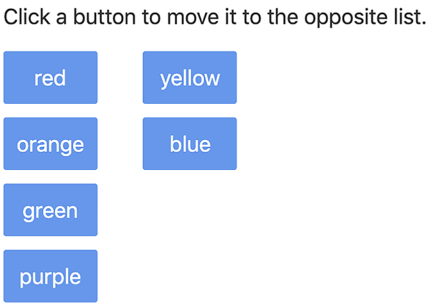
New values must be assigned to left and right to trigger updates.

Copy these files to the REPL and try it!

10.6 The crossfade transition

The `crossfade` transition creates `send` and `receive` transitions. These are used to coordinate the movement of an element from one parent to another. This is also referred to as a *deferred transition* (see https://svelte.dev/tutorial/deferred-transitions).

One example of using `crossfade` is to move items between lists (see figure 10.8). An item is sent out of one list and received into another. The `send` transition defers to see if the element is being `received` in the other location. Then it animates a transition of the element from its current location to its new location. This provides a much nicer visual effect than what we achieved earlier using the `fade` transition.



Click a button to move it to the opposite list.

Figure 10.8 `crossfade` **demo app**

The following listing shows an example of using `crossfade`. Like before, this example also uses the `flip` animation so that the remaining list items animate closing up the vacated space.

Listing 10.8 `crossfade` **demo app**

```
<script>
  import {flip} from 'svelte/animate';
  import {crossfade} from 'svelte/transition';
  const [send, receive] = crossfade({});

  let left = ['red', 'orange', 'green', 'purple'];
  let right = ['yellow', 'blue'];

  function move(item, from, to) {
    to.push(item);
    return [from.filter(i => i !== item), to];
  }
```

The crossfade function must be passed an options object, but it can be an empty object to use the defaults.

```
  function moveLeft(item) {
    [right, left] = move(item, right, left);
  }

  function moveRight(item) {
    [left, right] = move(item, left, right);
  }
</script>

<main>
  <p>Click a button to move it to the opposite list.</p>
  <div class="list">
    {#each left as item (item)}
      <button
        animate:flip
        in:receive={{key: item}}
        out:send={{key: item}}
        on:click={() => moveRight(item)}
      >
        {item}
      </button>
    {/each}
  </div>

  <div class="list">
    {#each right as item (item)}
      <button
        animate:flip
        in:receive={{key: item}}
        out:send={{key: item}}
        on:click={() => moveLeft(item)}
      >
        {item}
      </button>
    {/each}
  </div>
</main>

<style>
  button {
    background-color: cornflowerblue;
    border: none;
    color: white;
    padding: 10px;
    margin-bottom: 10px;
    width: 100%;
  }

  .list {
    display: inline-block;
    margin-right: 30px;
    vertical-align: top;
    width: 70px;
  }
</style>
```

Copy this code to the REPL and try it. It’s amazing!

10.7 The draw transition

The `draw` transition animates the stroke of an SVG element.

The example in listing 10.9 draws a house with a single SVG `path` element that uses `transition:draw`. Click the Toggle button to cause the drawing and erasing of the house to be animated (see figure 10.9).

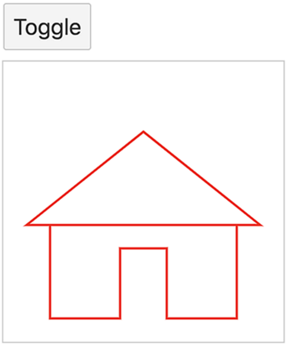


Figure 10.9 `draw` demo app

SVG refresher

Here's a quick SVG refresher:

- The `M` command moves to a given `x` and `y` location.
- The `h` command draws a horizontal line with a given `dx`.
- The `v` command draws a vertical line with a given `dy`.
- The `l` command draws a line with a given `dx` and `dy`.

By default, the origin is the upper-left corner. The SVG `scale` and `translate` functions can be used to flip the coordinate system so the origin is in the lower-left corner.

Listing 10.9 `draw` demo app

```
<script>
  import {draw} from 'svelte/transition';
  const commands =
    'M 2 5 v-4 h3 v3 h2 v-3 h3 v4 h-9 l 5 4 l 5 -4 h-1';
  const max = 12;
  let show = true;
</script>

<div>
  <button on:click={() => show = !show}>
    Toggle
  </button>
</div>

{#if show}
  <svg width={200} height={200} viewBox="0 0 {max} {max}">
    <g transform="translate(0 {max}) scale(1 -1)">
      <path transition:draw={{duration: 1000}}
        d={commands}
        fill="none"
        stroke="red"
```

This draws a house.

This gives a coordinate system that goes from 0 to max on both the x and y axes.

The scale function flips the coordinate system.

```
        stroke-width="0.1px"
      />
    </g>
  </svg>
{/if}

<style>
  svg {
    outline: solid lightgray 1px;
  }
</style>
```

In the coordinate system we have configured, 1px is very wide.

10.8 Custom transitions

Implementing custom transitions is easy. All that is required is to write a function that follows a few basic rules. The function should take two arguments: the DOM node to be transitioned and an options object. Examples of options include

- delay—This is the number of milliseconds to wait before the transition begins.
- duration—This is the number of milliseconds over which the transition should occur.
- easing—This is an easing function that takes a value between 0 and 1 and returns a value in that same range.

Options that are specific to a given transition can also be provided. For example, the fly transition accepts x and y options.

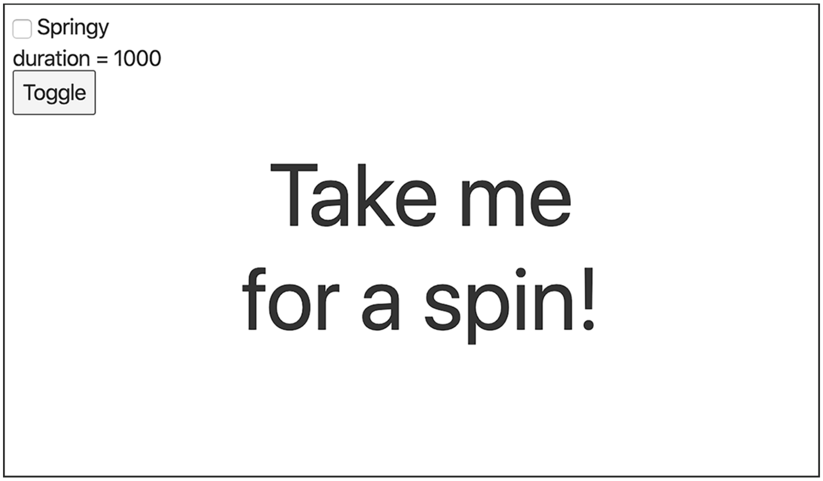
The function must return an object whose properties include the transition options and a css method. The css method must return the appropriate CSS string for the number between 0 and 1 that is returned by calling the easing function. Svelte takes care of honoring the delay and duration options.

The transition options returned can be given default values that are used when options are not passed to the custom function. For example, default values for duration and easing can be provided.

The css method is passed a time value between 0 and 1. It must return a string containing CSS properties to be applied to the DOM node for that time value. Examples of CSS properties that might vary over time include opacity, size, font size, position, rotation, and color.

Listing 10.10 is an example of a custom transition. It animates the scale and rotation of an element to make it appear to spiral down a drain when removed from the DOM. We will apply this to a div element containing the text “Take me for a spin!” sized to wrap to two lines (see figure 10.10). Click the Toggle button to toggle between hiding and showing the div element. Check the “Springy” checkbox to use the backInOut easing function instead of the linear easing function.

Copy this code to the REPL to try it.



□ Springy

duration = 1000

Take me
for a spin!

Figure 10.10 Custom transition app

Listing 10.10 Custom transition app

```
<script>
  import {backInOut, linear} from 'svelte/easing';

  let springy = false;
  $: duration = springy ? 2000 : 1000;
  $: easing = springy ? backInOut : linear;
  $: options = {duration, easing, times: 2};

  let show = true;
  const toggle = () => show = !show;

  function spin(node, options) {
    const {easing, times = 1} = options;
    return {
      ...options,
      css(t) {
        const eased = easing(t);
        const degrees = 360 * times;
        return `transform: scale(${eased}) rotate(${eased * degrees}deg);`;
      }
    };
  }
</script>

<label>
  <input type="checkbox" bind:checked={springy} /> Springy
</label>
<div>duration = {duration}</div>
<button on:click={toggle}>Toggle</button>
```

The value of t passed to the css method varies between 0 and 1 during an "in" transition and between 1 and 0 during an "out" transition.

Recall that easing functions return a value between 0 and 1 inclusive.

This is the degrees through which to spin.

```
{#if show}
  <div class="center" in:spin={options} out:spin={options}>
    <div class="content">Take me for a spin!</div>
  </div>
{/if}

<style>
  .center {
    position: absolute;
    left: 50%;
    top: 50%;
    transform: translate(-50%, -50%);
  }

  .content {

    position: absolute;
    transform: translate(-50%, -50%);

    font-size: 64px;
    text-align: center;
    width: 300px;
  }
</style>
```

The reasons for using in and out instead of transition is explained in the next section.

This has a width and height of 0 and is only used to center the content on the page.

These CSS properties give rotation about the center.

10.9 The transition vs. in and out props

Recall that we can specify separate `in` and `out` transition props instead of specifying a `transition` prop that is used for both the "in" and "out" portions. There is a difference between these approaches even if the same transition is specified for `in` and `out`. When the `transition` prop is used, the same transition options will be used for the "out" portion as the "in" portion even if the options are changed after the "in" portion occurs. To allow option changes made after the "in" portion occurs to be honored by the "out" portion, use the `in` and `out` props instead of the `transition` prop.

In the previous example, the transition options are changed when the "Springy" checkbox is changed. This is why we use `in:spin={options} out:spin={options}` instead of `transition:spin={options}`.

10.10 Transition events

Events are dispatched at specific points in a transition. An `introstart` event is dispatched when an "in" transition begins. An `introend` event is dispatched when an "in" transition ends. An `outrostart` event is dispatched when an "out" transition begins. An `outroend` event is dispatched when an "out" transition ends.

Like with other events, the `on` directive can be used to register a function to be called when these events are dispatched. For example, to run a function when the transition for an element being removed from the DOM completes, use `on:outroend={`*`someFunction`*`}`. These functions can trigger changes to the affected component or to other components. For example, focus can be moved to a particular `input` element after the transition for an element being added to the DOM completes using `on:introend`.

10.11 Building the Travel Packing app

Let's apply what you have learned about animation to the Travel Packing app. The finished code can be found at http://mng.bz/rrlD.

We want to add four animations:

- Animate adding and deleting items in a category so they slide to their new positions.
- Animate adding and deleting categories so they slide to their new positions.
- Animate adding a category so it scales from 0 to full size.
- Animate deleting a category by rotating and scaling it so it appears to spin down a drain.

In `Category.svelte`, do the following:

1. Import the `flip` transition:

```
import {flip} from 'svelte/animate';
```

2. Wrap the `Item` component and the comment that precedes it with the following `div`:

```
<div animate:flip>
  ...
</div>
```

The first animation for adding and deleting items is now complete.

In `Checklist.svelte`, do the following:

1. Import the `flip` transition:

```
import {flip} from 'svelte/animate';
```

2. Declare an `options` constant:

```
const options = {duration: 700};
```

3. Wrap the `Category` component with the following `div`:

```
<div class="wrapper" animate:flip={options}>
  ...
</div>
```

NOTE In Safari, items are not visible while they are being dragged if the `<Category>` in `Checklist.svelte` is wrapped in a `div` element. Removing the `div` fixes it, but then we lose animation of `Category` components.

4. Add the following CSS rules in the `style` element:

   ```
   .animate {
     display: inline-block;
   }

   .wrapper {
     display: inline;
   }
   ```

The second animation for adding and deleting categories is now complete.

In `Category.svelte`, do the following:

1. Import the `linear` easing function and the `scale` transition:

   ```
   import {linear} from 'svelte/easing';
   import {scale} from 'svelte/transition';
   ```

2. Add an `options` constant:

   ```
   const options = {duration: 700, easing: linear};
   ```

3. Add the following attribute to the `section` element that wraps all the HTML for a category:

   ```
   in:scale={options}
   ```

The third animation for scaling new categories from 0 to full size is now complete.

In `Category.svelte`, do the following:

1. Add the `times` property, which specifies the number of times to spin, to the `options` constant to match the following:

   ```
   const options = {duration: 700, easing: linear, times: 2};
   ```

2. Add the custom transition function `spin`, which scales and rotates a given DOM node over the duration of an animation:

   ```
   function spin(node, options) {
     const {easing, times = 1} = options;
     return {
       ...options,
       css(t) {
         const eased = easing(t);
         const degrees = 360 * times;
         return 'transform-origin: 50% 50%; ' +
           `transform: scale(${eased}) ` +
           `rotate(${eased * degrees}deg);`;
       }
     };
   }
   ```

   This is the total degrees through which to spin.

3. Add the following attribute to the section element that wraps all the HTML for a category:

   ```
   out:spin={options}
   ```

The fourth animation for making categories appear to spin down a drain when they are deleted is now complete.

That was really a small amount of code to add in order to gain all those animations! In the next chapter you will learn some tips for debugging Svelte applications.

Summary

- Svelte has great built-in support for CSS-based, rather than JavaScript-based, animation, which means the animation won't block the main thread.
- Easing functions control the rate of change in an animation over its duration. Many easing functions are provided, and custom easing functions can be defined.
- Animation is supported by the provided packages `svelte/easing`, `svelte/animate`, `svelte/transition`, and `svelte/motion`.
- Custom transitions can be easily implemented.

11 Debugging

This chapter covers

- Using the `@debug` tag
- Using reactive statements for debugging
- Using Svelte Devtools

There are three popular ways to debug issues in Svelte applications. The most basic approach to debugging is to add `@debug` tags that pause execution and output variable values.

Another approach is to use reactive statements to output the values of JavaScript expressions any time variables they use change. Both of these use features built into Svelte.

A final approach covered here is to use a browser extension called Svelte Devtools to view the component hierarchy. After selecting a component, its props and state can be viewed and modified.

NOTE Like in all web applications, the `debugger` statement can be added in JavaScript code to pause execution when the statement is reached if DevTools is open.

11.1 The @debug tag

The @debug tag pauses execution (breaks) when given top-level variables change, and it outputs those variables' values in the browser's DevTools console. It is only honored if DevTools is open. The browser debugger can then be used to examine the code and other variables that are in scope.

> **NOTE** Both debugger and the @debug tag can be used when running apps in the REPL, but they only pause execution if DevTools is open.

To use the @debug tag, place it at the top of the HTML section, not inside a script element. For example, the following listing shows a Svelte component that allows the user to enter the radius of a circle and then computes its area. We want to break any time the value of radius or area changes.

Listing 11.1 App that uses @debug

```
<script>
  export let radius = 1;
  $: area = 2 * Math.PI * radius**2;
</script>

{@debug radius, area}
<main>
  <label>
    Circle Radius:
    <input type="number" bind:value={radius}>
  </label>
  <label>
    Circle Area: {area}
  </label>
</main>
```

If the browser's DevTools is not open when the app is run, the @debug tag will have no effect. If DevTools is open, it will pause and display what's shown in figure 11.1. Here we can examine the source code and see the values of all variables that are in scope.

Clicking the Console tab will display what's shown in figure 11.2. Click the play button (blue in Chrome, hollow in Firefox) to resume execution.

Now we can change the value in the Radius input, which will trigger another break and show updated values in the Console tab. The variables being watched can have any kind of value, including an object or array.

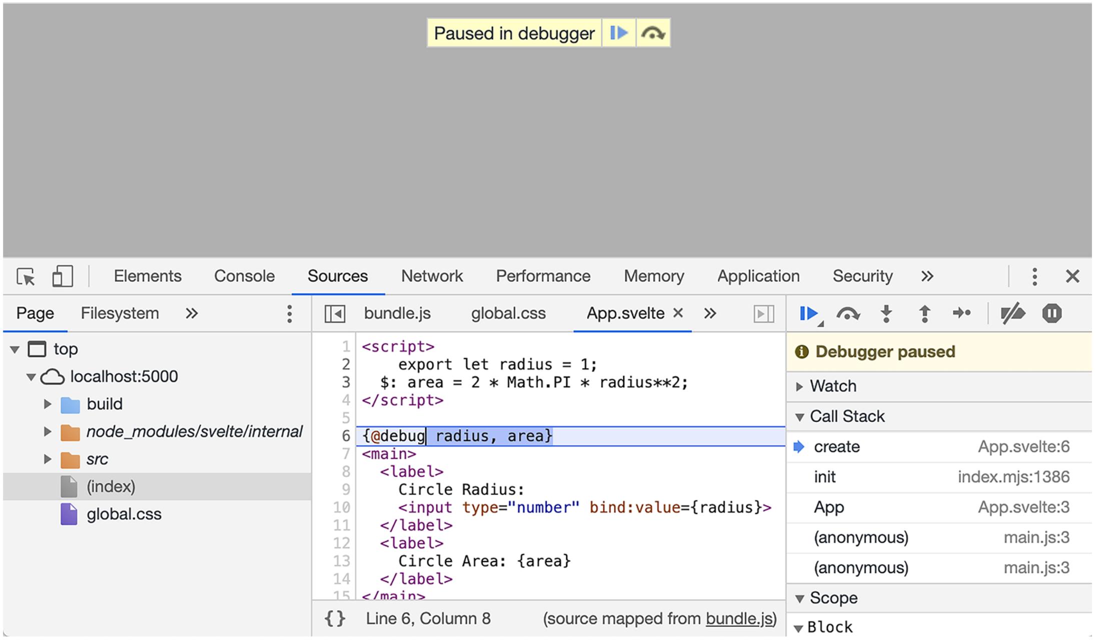
To break when any state in the current component changes, omit the variable names:

```
{@debug}
```

Let's try this in the Travel Packing app. Add the following line at the top of the HTML section in Category.svelte:

```
{@debug status}
```

Start the app by entering npm run dev. Log in to get to the Checklist page.

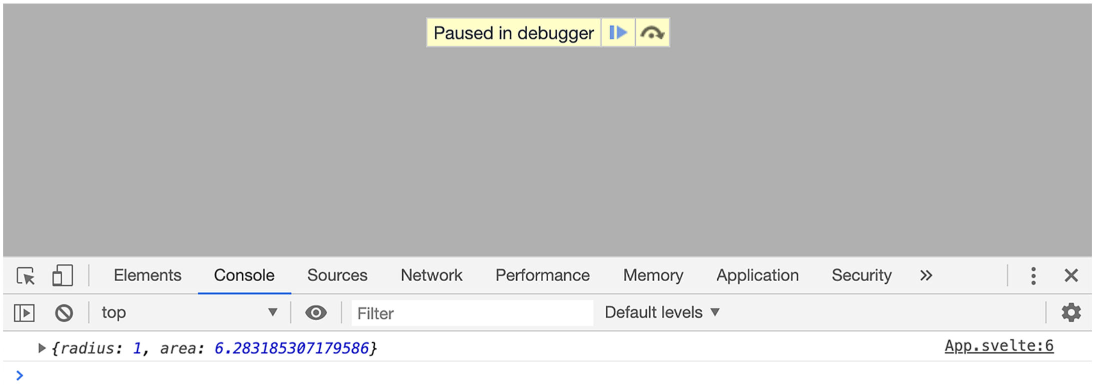


```
<script>
  export let radius = 1;
  $: area = 2 * Math.PI * radius**2;
</script>

{@debug radius, area}
<main>
  <label>
    Circle Radius:
    <input type="number" bind:value={radius}>
  </label>
  <label>
    Circle Area: {area}
  </label>
</main>
```

Line 6, Column 8 (source mapped from bundle.js)

create	App.svelte:6
init	index.mjs:1386
App	App.svelte:3
(anonymous)	main.js:3
(anonymous)	main.js:3

Figure 11.1 Chrome DevTools Sources tab



```
▸{radius: 1, area: 6.283185307179586}                    App.svelte:6
>
```

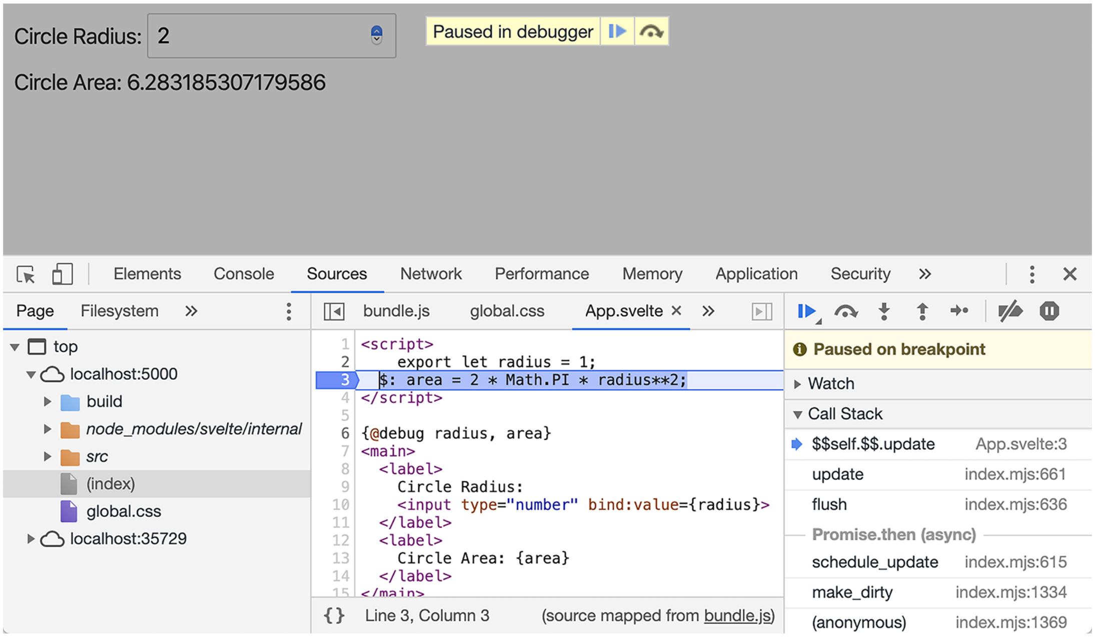
Figure 11.2 Chrome DevTools Console tab

The status variable holds a string that indicates the number of items in the category that have not yet been packed and the total number of items in the category. Any change that affects its value will now cause execution to stop. This includes adding an item, deleting an item, or toggling the checkbox for an item. Try doing these things and verify that the new value of `status` is output in the DevTools Console and that execution is paused.

Note that the `@debug` tag is not useful for determining which line of code caused the state change. By the time execution pauses, the code in question will have already executed, and the debugger will show that it stopped on the line containing `{@debug}`.

To stop at a particular line of code, use the browser debugger to set a breakpoint there. This is done by clicking its line number which toggles a breakpoint. Alternatively, you can add the statement `debugger;` before a line in the JavaScript code.

Back in the circle example, if we set a breakpoint at line 3 and change the value of the radius, execution will pause as shown in figure 11.3.



Circle Radius: 2

Circle Area: 6.283185307179586

Paused in debugger

```
1  <script>
2    export let radius = 1;
3   $: area = 2 * Math.PI * radius**2;
4  </script>
5
6  {@debug radius, area}
7  <main>
8   <label>
9    Circle Radius:
10   <input type="number" bind:value={radius}>
11  </label>
12  <label>
13   Circle Area: {area}
14  </label>
15 </main>
```

Line 3, Column 3 (source mapped from bundle.js)

Paused on breakpoint

```
$$self.$$.update    App.svelte:3
update              index.mjs:661
flush               index.mjs:636
Promise.then (async)
schedule_update     index.mjs:615
make_dirty          index.mjs:1334
(anonymous)         index.mjs:1369
```

Figure 11.3 Chrome DevTools when paused at a breakpoint

11.2 Reactive statements

The `$:` syntax can be used to output the value of variables if any of their values change. You saw this approach in section 3.10. For example, if a component has the top-level variables `date` and `count`, we can log their values whenever they change with the following line:

```
$: console.log('count on date', date, 'is', count);
```

Let's try this in the Travel Packing app. Add the following inside the `script` element of `Item.svelte`:

```
$: if (editing) console.log('editing item', item.name);
```

Start the app by entering `npm run dev`. Log in to get to the Checklist page. Open the browser's DevTools and click the Console tab. Click the text of an item to edit it. Output from the preceding `console.log` call will appear in the DevTools Console.

11.3 Svelte Devtools

Svelte Devtools is a Chrome and Firefox extension for debugging Svelte apps that are running in development mode (`npm run dev`). It was created by Timothy Johnson and can be found here: https://github.com/RedHatter/svelte-devtools.

Svelte Devtools can be installed in Chrome from the Chrome Web Store (https://chrome.google.com/webstore/category/extensions). It can be installed in Firefox from the Firefox Add-ons page (https://addons.mozilla.org/en-US/firefox/).

To use Svelte Devtools, browse a Svelte app, open the browser's DevTools, and click the Svelte tab. A tree representing the hierarchy of the Svelte application is displayed on the left. This contains Svelte components, the HTML elements they render, Svelte blocks (`#if`, `#each`, and `#await`), slots, and text nodes.

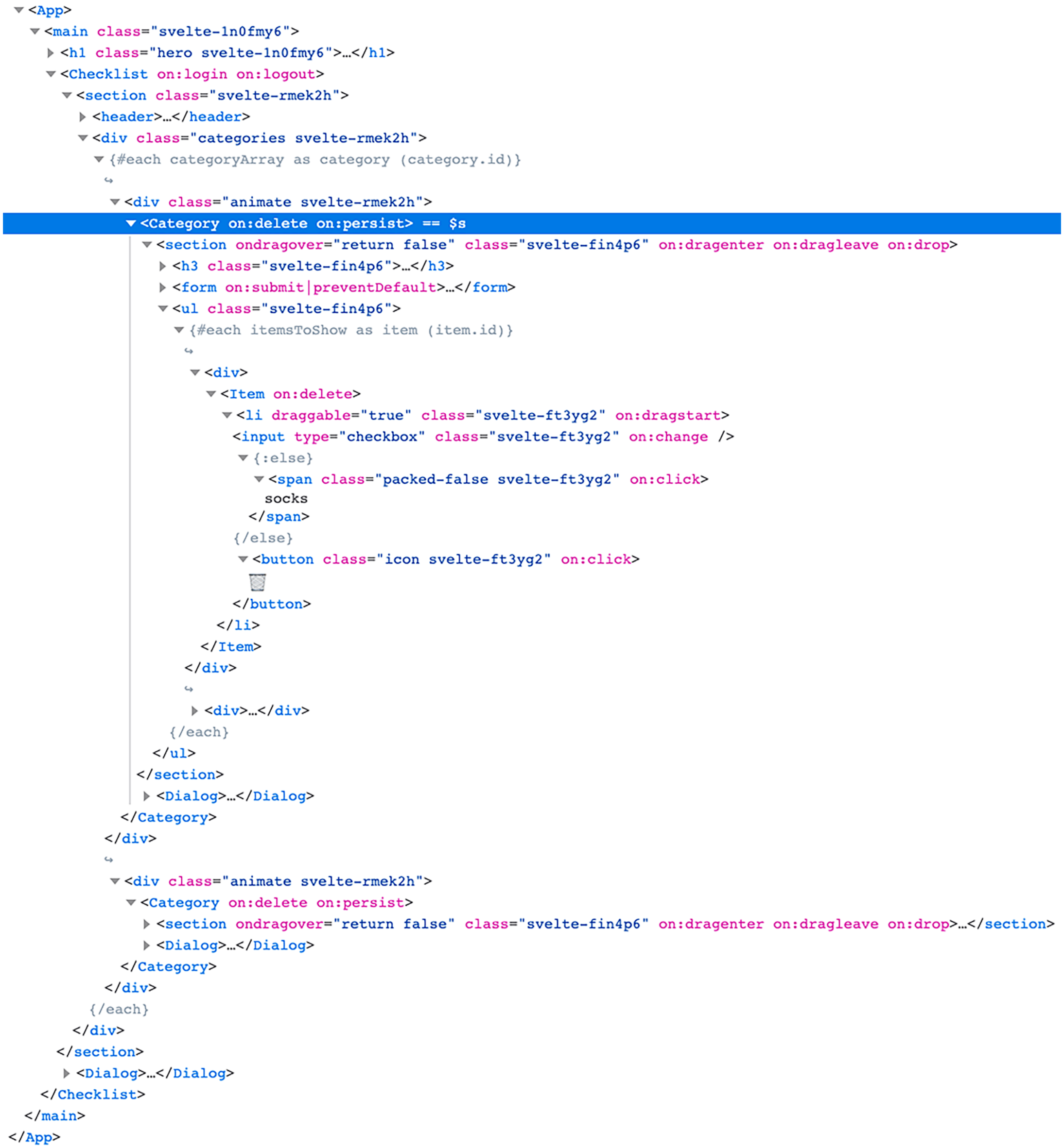
Expand and collapse parts of this tree by clicking the disclosure triangles. Select a Svelte component to examine it. Its attributes, props, and state are displayed on the right. The props and state of the selected component can be modified, and those changes can affect the running application.

Let's try this in the Travel Packing app.

1. Start the app by entering `npm run dev`.
2. Log in to get to the Checklist page.
3. Create the categories "Clothes" and "Toiletries".
4. Add the items "socks" and "shoes" in the "Clothes" category.
5. Add the item "toothbrush" in the "Toiletries" category.
6. Open the browser's DevTools.
7. Click the Svelte tab.
8. Click disclosure triangles on the left side to open parts of the hierarchy to be examined. Click a component on the left side to see its props and state on the right side.

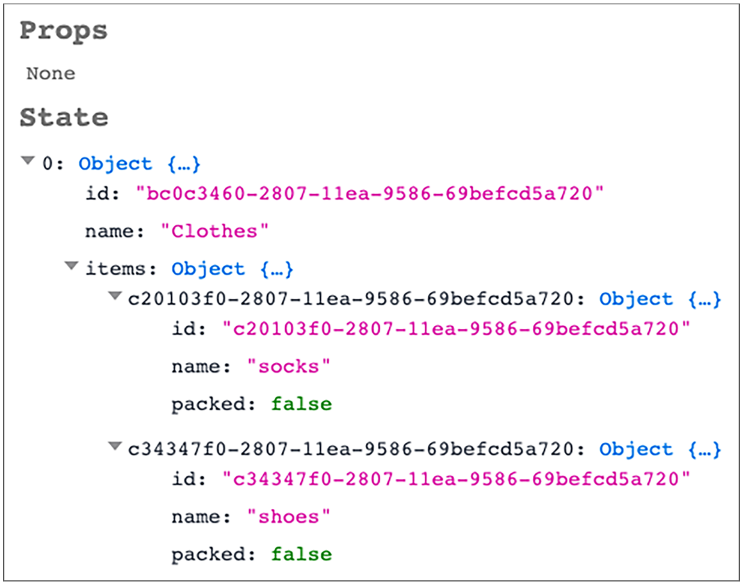
For example, click the `Category` component for "Clothes". Figures 11.4, 11.5, and 11.6 show what you'll see on the left and right sides.

Hover over an element on the left side of the Svelte tab to highlight it in the browser. Right-click a rendered HTML element and select Inspect to see that element in DevTools' Elements tab. Click the Svelte tab again to see the Svelte component that rendered that HTML element.



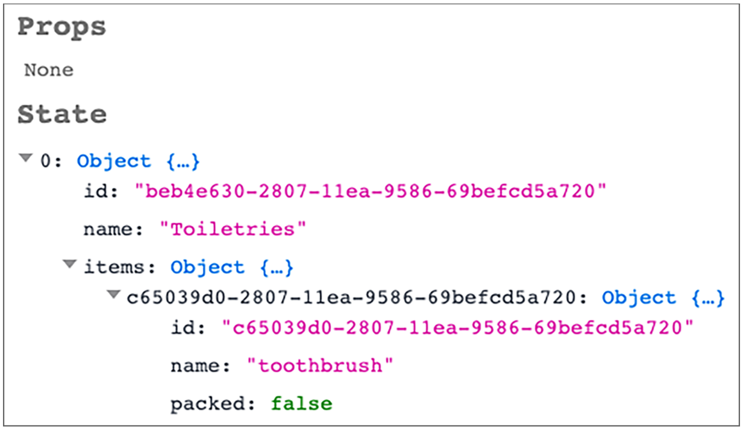
```
▼ <App>
  ▼ <main class="svelte-1n0fmy6">
    ▶ <h1 class="hero svelte-1n0fmy6">…</h1>
    ▼ <Checklist on:login on:logout>
      ▼ <section class="svelte-rmek2h">
        ▶ <header>…</header>
        ▼ <div class="categories svelte-rmek2h">
          ▼ {#each categoryArray as category (category.id)}
              ↪
            ▼ <div class="animate svelte-rmek2h">
              ▼ <Category on:delete on:persist> == $s
                ▼ <section ondragover="return false" class="svelte-fin4p6" on:dragenter on:dragleave on:drop>
                  ▶ <h3 class="svelte-fin4p6">…</h3>
                  ▶ <form on:submit|preventDefault>…</form>
                  ▼ <ul class="svelte-fin4p6">
                    ▼ {#each itemsToShow as item (item.id)}
                        ↪
                      ▼ <div>
                        ▼ <Item on:delete>
                          ▼ <li draggable="true" class="svelte-ft3yg2" on:dragstart>
                              <input type="checkbox" class="svelte-ft3yg2" on:change />
                            ▼ {:else}
                              ▼ <span class="packed-false svelte-ft3yg2" on:click>
                                  socks
                                </span>
                              {/else}
                            ▼ <button class="icon svelte-ft3yg2" on:click>
                                🗑
                              </button>
                            </li>
                          </Item>
                        </div>
                        ↪
                      ▶ <div>…</div>
                    {/each}
                  </ul>
                </section>
                ▶ <Dialog>…</Dialog>
              </Category>
            </div>
              ↪
            ▼ <div class="animate svelte-rmek2h">
              ▼ <Category on:delete on:persist>
                ▶ <section ondragover="return false" class="svelte-fin4p6" on:dragenter on:dragleave on:drop>…</section>
                ▶ <Dialog>…</Dialog>
              </Category>
            </div>
          {/each}
        </div>
      </section>
      ▶ <Dialog>…</Dialog>
    </Checklist>
  </main>
</App>
```

Figure 11.4 Svelte Devtools left side



```
Props
 None
State
▼ 0: Object {…}
      id: "bc0c3460-2807-11ea-9586-69befcd5a720"
      name: "Clothes"
    ▼ items: Object {…}
        ▼ c20103f0-2807-11ea-9586-69befcd5a720: Object {…}
              id: "c20103f0-2807-11ea-9586-69befcd5a720"
              name: "socks"
              packed: false
        ▼ c34347f0-2807-11ea-9586-69befcd5a720: Object {…}
              id: "c34347f0-2807-11ea-9586-69befcd5a720"
              name: "shoes"
              packed: false
```

Figure 11.5 Svelte Devtools right side with Clothing category selected

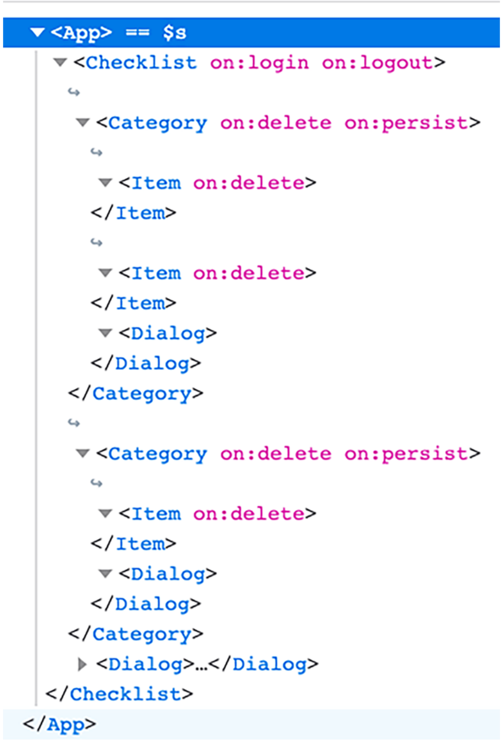


```
Props
 None
State
▼ 0: Object {…}
      id: "beb4e630-2807-11ea-9586-69befcd5a720"
      name: "Toiletries"
    ▼ items: Object {…}
        ▼ c65039d0-2807-11ea-9586-69befcd5a720: Object {…}
              id: "c65039d0-2807-11ea-9586-69befcd5a720"
              name: "toothbrush"
              packed: false
```

Figure 11.6 Svelte Devtools right side with Toiletries category selected

Click the eye icon inside the Svelte tab to select the kinds of things that should be displayed on the left. For example, it can be configured to only show components, not HTML elements, blocks, slots, anchors, or text (see figure 11.7). Anchors, in this context, are special comment nodes that Svelte adds for internal use. There is little reason to want to see them, and that is why they are not shown by default.

In the next chapter you will learn how to test Svelte applications.



```
▼<App> == $s
  ▼<Checklist on:login on:logout>
     ↪
    ▼<Category on:delete on:persist>
       ↪
      ▼<Item on:delete>
      </Item>
       ↪
      ▼<Item on:delete>
      </Item>
      ▼<Dialog>
      </Dialog>
    </Category>
     ↪
    ▼<Category on:delete on:persist>
       ↪
      ▼<Item on:delete>
      </Item>
      ▼<Dialog>
      </Dialog>
    </Category>
    ▶<Dialog>…</Dialog>
  </Checklist>
</App>
```

Figure 11.7 Svelte Devtools left side showing only components

Summary

- The `@debug` tag can be used to pause execution when the values of specific component state variables change, or when any state variables change if none are specified.
- Reactive statements can be used to write to the DevTools console when the values of specific component state variables change.
- Svelte Devtools can be used in Chrome and Firefox to examine the runtime component hierarchy of a Svelte application.

12 Testing

This chapter covers

- Unit tests with Jest
- End-to-end tests with Cypress
- Accessibility tests with the Svelte compiler, Lighthouse, axe, and WAVE
- Demonstrating and debugging Svelte components with Storybook

Now that we've covered most of the features of Svelte, it's time to turn our focus to testing. We want to feel confident that our applications have properly implemented their intended functionality in a way that is accessible to a variety of users and that will remain that way through repeated updates. Three primary kinds of tests to consider are unit, end-to-end, and accessibility.

Unit tests are intended to test a piece of code in isolation from the rest of an application. These are great for testing individual functions and components. We will cover implementing unit tests using the Jest testing framework.

End-to-end tests are intended to test an application in the same way that a user would interact with it. This includes logging in (if the app requires it), navigating to each page within the app (if there are multiple pages), and generally putting the app into each of the states a user would encounter. We will cover implementing end-to-end tests using the Cypress testing framework.

Accessibility tests verify that users with special needs will be able to successfully use the application. Often they focus on supporting users with vision impairments that require more color contrast or the use of screen readers. We will cover implementing accessibility tests using the Svelte compiler, Lighthouse, axe, and WAVE.

Storybook is a tool that catalogs and demonstrates individual components that are used by an app. It works with many web frameworks, including Svelte.

Proper use of the tools described in this chapter can help developers identify issues in their Svelte and Sapper applications. These tools can also help reduce the issues users might encounter when apps are released for production use.

This chapter is a bit longer than previous ones due to the many code examples and screenshots. But it's well worth working through them all to get better at testing Svelte apps, which results in better apps overall!

12.1 Unit tests with Jest

Jest (https://jestjs.io) bills itself as "a delightful JavaScript Testing Framework with a focus on simplicity." It can be used to implement unit tests for many web frameworks, including Svelte.

By default, Jest tests are run in jsdom (https://github.com/jsdom/jsdom), which supports headless execution of DOM-based tests. This enables us to run Jest tests from a command prompt and in continuous integration (CI) environments.

Jest can watch source and test files and automatically rerun the tests if any of these files are modified. This is a convenient feature when debugging test failures.

Jest supports *snapshot tests*. These are simple tests that assert that some output should be the same as it was the last time the test was run. They make implementing many tests much easier, but they require extra diligence in examining test failures.

Jest test suites are defined by functions that are passed to the `describe` function . These functions can

- Declare constants and variables used by all the tests in the suite
- Specify functions to be called
  - Before any of the tests in the suite run (`beforeAll`)
  - After all the tests in the suite have run (`afterAll`)
  - Before each test in the suite runs (`beforeEach`)
  - After each test in the suite runs (`afterEach`)
- Call the `test` function once for each test in the suite, passing it a function that contains the code for the test. Note that `it` is an alias for `test`.

Typically each test suite is defined in a separate file with an extension of `.spec.js`. These files can be colocated with the `.js` and `.svelte` source files they test, or they can be placed in the `__tests__` directory at the same level as the `src` directory.

NOTE Recall that Svelte bundles only include code that is actually used. This means that test code will not be included.

The functions passed to the `test` function can

- Render a Svelte component, optionally providing prop values.
- Find DOM nodes in the rendered output.
- Simulate user interactions by firing events that can trigger DOM updates.
- Make assertions about what should be found in the DOM using the `expect` function.

For details on using the `expect` function and "matchers" that specify what to expect, see the Jest documentation for "Using Matchers" (https://jestjs.io/docs/en/using-matchers). Many examples are provided in this section.

The Svelte Testing Library (https://testing-library.com/docs/svelte-testing-library/intro) can be used in conjunction with Jest to make implementing tests of Svelte components easier. It is built on the DOM Testing Library (https://testing-library.com/docs/dom-testing-library/intro), which provides functions for implementing tests that are not specific to any web framework.

The most important functions provided by the Svelte Testing Library are `render` and `fireEvent`.

The `render` function takes a Svelte component and an object containing props to pass to the component. It returns an object containing a `container` property and query functions that can be called to find nodes in the DOM created by the component. The `container` property value is the topmost DOM element of the rendered component. Tests can find DOM nodes inside this using the DOM methods `querySelector` and `querySelectorAll`.

For details on the query functions returned by the `render` function, see the DOM Testing Library's "Queries" documentation (https://testing-library.com/docs/dom-testing-library/api-queries). Some of the most commonly used query functions are `getByText`, `getByLabelText`, and `getByTestId`.

The `fireEvent` function fires a given event on a specific DOM node. This can trigger a Svelte component to update the DOM. Calls to the `expect` function that follow can verify that the expected DOM updates were made.

To install everything needed to implement unit tests for Svelte components, `cd` to the project directory and enter `npm install -D` *`name`*, where *`name`* is each of the following:

- `@babel/core`
- `@babel/preset-env`
- `@testing-library/svelte`
- `babel-jest`
- `jest`
- `svelte-jester`

Babel compiles modern JavaScript code to JavaScript that runs in current browsers. Configure the use of Babel by creating the following file in the top project directory.

Listing 12.1 Babel configuration in `babel.config.js`

```
module.exports = {
  presets: [
    [
      '@babel/preset-env',
      {
        targets: {
          node: 'current'
        }
      }
    ]
  ]
};
```

This setting avoids the error message "regenerator-runtime not found."

Configure the use of Jest by creating the following file in the top project directory.

Listing 12.2 Jest configuration in `jest.config.js`

```
module.exports = {
  bail: false,
  moduleFileExtensions: ['js', 'svelte'],
  transform: {
    '^.+\\.js$': 'babel-jest',
    '^.+\\.svelte$': 'svelte-jester'
  },
  verbose: true
};
```

This tells Jest not to exit a test suite when one of its tests fails, which allows you to get results for other tests in the suite.

This causes Jest to show the result of each test rather than just a summary of the results for each test suite.

Add the following npm scripts in `package.json`.

```
"test": "jest src",
"test:watch": "npm run test -- --watch"
```

To run the unit tests once, enter `npm test`. To run the unit tests in watch mode so they are automatically rerun when code changes are detected, enter `npm run test:watch`.

12.1.1 Unit tests for the Todo app

Here is a Jest test suite for the `Todo` component shown at the end of chapter 2.

Listing 12.3 Jest test for `Todo` component in `src/Todo.spec.js`

```
import {cleanup, render} from '@testing-library/svelte';

import Todo from './Todo.svelte';

describe('Todo', () => {
  const text = 'buy milk';
  const todo = {text};
  afterEach(cleanup);

  test('should render', () => {
    const {getByText} = render(Todo, {props: {todo}});
    const checkbox = document.querySelector('input[type="checkbox"]');
    expect(checkbox).not.toBeNull(); // found checkbox
    expect(getByText(text)); // found todo text
    expect(getByText('Delete')); // found Delete button
  });
});
```

This unmounts any components mounted in the previously run test.

There is no easy way to test that events are fired when the checkbox state is changed or when the Delete button is clicked. These are covered by tests for the `TodoList` component.

The following listing shows a Jest test suite for the `TodoList` component from the end of chapter 2.

Listing 12.4 Jest test for `TodoList` component in `src/TodoList.spec.js`

```
import {cleanup, fireEvent, render, waitFor} from '@testing-library/svelte';

import TodoList from './TodoList.svelte';

describe('TodoList', () => {
  const PREDEFINED_TODOS = 2;

  afterEach(cleanup);

  function expectTodoCount(count) {
    return waitFor(() => {
      const lis = document.querySelectorAll('li');
      expect(lis.length).toBe(count);
    });
  }

  test('should render', async () => {
    const {getByText} = render(TodoList);
    expect(getByText('To Do List'));
    expect(getByText('1 of 2 remaining'));
    expect(getByText('Archive Completed')); // button
    await expectTodoCount(PREDEFINED_TODOS);
  });

  test('should add a todo', async () => {
    const {getByTestId, getByText} = render(TodoList);

    const input = getByTestId('todo-input');
    const value = 'buy milk';
    fireEvent.input(input, {target: {value}});
    fireEvent.click(getByText('Add'));

    await expectTodoCount(PREDEFINED_TODOS + 1);
    expect(getByText(value));
  });
```

This is the number of todos that are automatically added in the TodoList component.

This is used by many of the test functions below.

This waits for the DOM to be updated; it returns a Promise.

Each Todo component has an li root element.

This requires adding the following attribute to the input element in src/TodoList.svelte: data-testid="todo-input":.

```
  test('should archive completed', async () => {
    const {getByText} = render(TodoList);
    fireEvent.click(getByText('Archive Completed'));
    await expectTodoCount(PREDEFINED_TODOS - 1);
    expect(getByText('1 of 1 remaining'));
  });

  test('should delete a todo', async () => {
    const {getAllByText, getByText} = render(TodoList);
    const text = 'learn Svelte';
    expect(getByText(text));

    const deleteBtns = getAllByText('Delete');
    fireEvent.click(deleteBtns[0]);
    await expectTodoCount(PREDEFINED_TODOS - 1);
  });

  test('should toggle a todo', async () => {
    const {container, getByText} = render(TodoList);
    const checkboxes = container.querySelectorAll('input[type="checkbox"]');

    await fireEvent.click(checkboxes[1]);
    expect(getByText('0 of 2 remaining'));

    await fireEvent.click(checkboxes[0]);
    expect(getByText('1 of 2 remaining'));
  });
});
```

This is the text in the first todo.

This deletes the first todo.

This toggles the second todo.

This toggles the first todo.

12.1.2 Unit tests for the Travel Packing app

Let's add some unit tests in the Travel Packing app. The finished code can be found at http://mng.bz/QyNG.

Change the `button` element in `src/Item.svelte` to include a `data-testid` attribute to make it easier to find this button in a test.

Listing 12.5 Change to `Item` component in `src/Item.svelte`

```
<button class="icon" data-testid="delete"
  on:click={() => dispatch('delete')}>
  &#x1F5D1;
</button>
```

The following listing shows a Jest test suite for the `Item` component.

Listing 12.6 Jest test for `Item` component in `Item.spec.js`

```
import {cleanup, render} from '@testing-library/svelte';

import Item from './Item.svelte';

describe('Item', () => {
  const categoryId = 1;
  const dnd = {};
  const item = {id: 2, name: 'socks', packed: false};

  afterEach(cleanup);

  test('should render', () => {
    const {getByTestId, getByText} = render(Item, {categoryId, dnd, item});
    const checkbox = document.querySelector('input[type="checkbox"]');
    expect(checkbox).not.toBeNull();
    expect(getByText(item.name));
    expect(getByTestId('delete'));
  });
});
```

The Item component requires this prop, but it won't be used in the test, so an empty object suffices.

Tests that the checkbox can be found

Tests that the item name can be found

Tests that the Delete button can be found

The preceding test simply verifies that the `Item` component renders the expected DOM elements. This can also be accomplished using a "snapshot" test. The first time snapshot tests are run, a `__snapshots__` directory is created, and files containing rendered output are saved in this directory. In subsequent runs the rendered output is compared to these files. Any differences are reported as failed tests.

Relying on snapshot tests requires attention to detail on the part of the developers who run them. When tests are run the first time, developers should verify that components are currently rendering correctly. In subsequent test runs, if any tests fail, developers should carefully examine the differences reported and determine whether they are expected based on recent code changes. If they are expected, press the "U" key to update all the snapshot files that differ. Otherwise, fix the errors and rerun the tests.

The following listing shows a snapshot test for the `Item` component. Note how much simpler this is to write than the previous "should render" test.

Listing 12.7 Snapshot test for `Item` component in `Item.spec.js`

```
test('should match snapshot', () => {
  const {container} = render(Item, {categoryId, dnd, item});
  expect(container).toMatchSnapshot();
});
```

Tests for the `Category` component need to be able to find the `input` element that binds to the variable `itemName`. To simplify this, change the `input` element to include a `data-testid` attribute.

Listing 12.8 Adding `data-testid` attribute to `input` in `src/Category.svelte`

```
<input data-testid="item-input" required bind:value={itemName} />
```

The following listing shows a Jest test suite for the `Category` component.

Listing 12.9 Jest tests for `Category` component in `Category.spec.js`

```
import {cleanup, fireEvent, render, waitFor} from '@testing-library/svelte';

import Category from './Category.svelte';

describe('Category', () => {
  let itemCount = 0;

  const category = {id: 1, name: 'Clothes', items: {}};
  const categories = [category];
  const dnd = {};
  const props = {categories, category, dnd, show: 'all'};

  beforeEach(() => {
    category.items = {
      1: {id: 1, name: 'socks', packed: true},
      2: {id: 2, name: 'shoes', packed: false}
    };
    itemCount = Object.keys(category.items).length;
  });

  afterEach(cleanup);

  test('should match snapshot', () => {
    const {container} = render(Category, props);
    expect(container).toMatchSnapshot();
  });

  function expectItemCount(count) {
    return waitFor(() => {
      const lis = document.querySelectorAll('li');
      expect(lis.length).toBe(count);
    });
  }

  test('should render', async () => {
    const {getByText} = render(Category, props);
    expect(getByText('Clothes'));
    expect(getByText('1 of 2 remaining'));
    expect(getByText('New Item'));
    expect(getByText('Add Item'));
    await expectItemCount(itemCount);
  });

  test('should add an item', async () => {
    const {getByTestId, getByText} = render(Category, props);

    const input = getByTestId('item-input');
    const value = 't-shirts';
    fireEvent.input(input, {target: {value}});
    fireEvent.click(getByText('Add Item'));
```

This will be set to the number of items that are added to the category inside the function that is passed to beforeEach.

The Category component requires this prop, but it won't be used in the test, so an empty object suffices.

Each Item component has an li root element.

```
    await expectItemCount(itemCount + 1);
    expect(getByText(value));
  });

  test('should delete an item', async () => {
    const {getAllByTestId} = render(Category, props);

    const deleteBtns = getAllByTestId('delete');
    fireEvent.click(deleteBtns[0]); // deletes first item
    await expectItemCount(itemCount - 1);
  });

  test('should toggle an item', async () => {
    const {container, getByText} = render(Category, props);

    const checkboxes = container.querySelectorAll('input[type="checkbox"]');
    expect(checkboxes.length).toBe(2);

    const [shoesCheckbox, socksCheckbox] = checkboxes;

    expect(socksCheckbox.nextElementSibling.textContent).toBe('socks');
    await fireEvent.click(socksCheckbox);
    expect(getByText('2 of 2 remaining'));

    expect(shoesCheckbox.nextElementSibling.textContent).toBe('shoes');
    await fireEvent.click(shoesCheckbox);
    expect(getByText('1 of 2 remaining'));
  });
});
```

The items are sorted so that “shoes” comes before “socks”.

Now nothing in this category is packed.

Now one item in this category is packed.

When the Jest tests for the Travel Packing app are run, DialogPolyfill, which is used in the custom Dialog component, will not be defined. To account for this, modify the call to onMount in src/Dialog.svelte to match the following:

Listing 12.10 Dialog component onMount in src/Dialog.svelte

```
onMount(() => {
  if (dialogPolyfill) dialogPolyfill.registerDialog(dialog);
});
```

You might be tempted to wrap an if around the call to onMount instead of placing the if inside the function passed to onMount. However, that would not be correct because lifecycle functions cannot be called conditionally.

To temporarily skip running certain test suites, change their describe function to describe.skip. To temporarily skip running certain tests within a suite, change their test function to test.skip. To temporarily run only certain tests in a suite, change their test function to test.only.

We are now ready to run the Jest tests using the npm scripts added earlier in package.json.

When tests fail, output similar to the following will appear in the terminal where the tests ran. This test failure is caused by searching for “SOCKS” instead of “socks”.

Listing 12.11 Failed Jest output

```
FAIL  src/Item.spec.js
  Item
    ✕ should render (32ms)
    ✓ should match snapshot (4ms)

  ● Item › should render

    Unable to find an element with the text: SOCKS.
    This could be because the text is broken up by multiple elements.
    In this case, you can provide a function for your
    text matcher to make your matcher more flexible.

    <body>
      <div>
        <li
          class="svelte-ft3yg2"
          draggable="true"
        >
          <input
            class="svelte-ft3yg2"
            type="checkbox"
          />

          <span
            class="packed-false svelte-ft3yg2"
          >
            socks
          </span>

          <button
            class="icon svelte-ft3yg2"
            data-testid="delete"
          >
            🗑
          </button>
        </li>
      </div>
    </body>

      15 |     const checkbox = document.querySelector('input[type="checkbox"]');
      16 |     expect(checkbox).not.toBeNull(); // found checkbox
    > 17 |     expect(getByText(item.name.toUpperCase())); // found item name
         |            ^
      18 |     expect(getByTestId('delete')); // found delete button
      19 |   });
      20 |

      at getElementError (node_modules/@testing-library/dom/dist/query-
     helpers.js:22:10)
      at node_modules/@testing-library/dom/dist/query-helpers.js:76:13
      at getByText (node_modules/@testing-library/dom/dist/query-
     helpers.js:59:17)
      at Object.<anonymous> (src/Item.spec.js:17:12)
```

```
Test Suites: 1 failed, 1 passed, 2 total
Tests:       1 failed, 6 passed, 7 total
Snapshots:   2 passed, 2 total
Time:        1.964s, estimated 2s
Ran all test suites matching /src/i.

Watch Usage: Press w to show more.
```

When tests are successful, output similar to the following will appear in the terminal where the tests ran.

Listing 12.12 Successful Jest output

```
PASS  src/Item.spec.js
  Item
    ✓ should render (22ms)
    ✓ should match snapshot (5ms)

 PASS  src/Category.spec.js
  Category
    ✓ should match snapshot (48ms)
    ✓ should render (16ms)
    ✓ should add an item (14ms)
    ✓ should delete an item (32ms)
    ✓ should toggle an item (11ms)

Test Suites: 2 passed, 2 total
Tests:       7 passed, 7 total
Snapshots:   2 passed, 2 total
Time:        1.928s, estimated 2s
Ran all test suites matching /src/i.

Watch Usage: Press w to show more.
```

12.2 End-to-end tests with Cypress

Cypress (www.cypress.io/) bills itself as "fast, easy and reliable testing for anything that runs in a browser." It supports end-to-end testing of web applications written using any framework (including Svelte) or even no framework. This means that the tests can exercise the functionality of a web application without focusing on specific components as is done in unit tests.

All the functionality of Cypress is accessed through the global variable cy. Queries to find elements on the page can search by text and CSS selectors. By default they wait 4 seconds for elements to appear.

Suppose a web application renders a button containing the text "Press Me" that when clicked renders the text "Success". The following code finds this button, clicks it, and verifies that "Success" is found.

```
cy.get('button').contains('Press Me').click();
cy.contains('Success');
```

The following code finds an `input` and types text into it. It assumes that the `input` has a `data-testid` attribute that can be used in tests to find it.

```
cy.get('[data-testid=some-id]').type('some text');
```

Cypress tests benefit greatly from you writing and using utility functions that navigate to various application states and make assertions. For example, a function that navigates to the login page, enters a username and password, and clicks the Login button is useful in nearly all tests of a web app that requires logging in. You will see several examples of these kinds of functions shortly, in tests for the Travel Packing app.

To install Cypress in a Svelte app, enter `npm install -D cypress`. Then add the following npm scripts in `package.json`:

```
"cy:open": "cypress open",
"cy:run": "cypress run",
```

This runs Cypress in interactive mode.

This runs Cypress in command-line mode.

To launch the Cypress test tool in interactive mode, enter `npm run cy:open`. The tests are automatically rerun if any source files or test files are modified. This command also creates a `cypress` directory, if it doesn't already exist, containing the following subdirectories:

- `fixtures`—Fixtures can hold data used by tests. The data is typically in `.json` files that are imported into tests. Using fixtures is optional.
- `integration`—Test implementation files (a.k.a. specs) go here, either at the top of this directory or in subdirectories.
- `plugins`—Plugins extend the functionality of Cypress. For examples of Cypress plugins, see https://github.com/bahmutov/cypress-svelte-unit-test. Cypress automatically runs the code in the `index.js` file in this directory before running each spec file. Using plugins is optional.
- `screenshots`—This subdirectory holds screenshots produced by calling `cy.screenshot()`. These are useful when debugging tests.
- `support`—Files in this subdirectory add custom Cypress commands, making them available in tests. Cypress automatically runs the code in the `index.js` file in this directory before running each spec file. Using custom Cypress commands is optional.

These subdirectories are populated with sample files, all of which can be deleted. Create your test files under the `cypress/integration` directory with extensions of `.spec.js`.

12.2.1 End-to-end tests for the Todo app

Here are some end-to-end tests for the Todo application shown at the end of chapter 2.

Listing 12.13 Cypress tests for the `TodoList` component in `cypress/integration/TodoList.spec.js`

```
const baseUrl = 'http://localhost:5000/';

describe('Todo app', () => {
  it('should add todo', () => {
    cy.visit(baseUrl);
    cy.contains('1 of 2 remaining');
    cy.contains('Add')
      .as('addBtn')
      .should('be.disabled');

    const todoText = 'buy milk';
    cy.get('[data-testid=todo-input]')
      .as('todoInput')
      .type(todoText);

    const addBtn = cy.get('@addBtn');
    addBtn.should('not.be.disabled');
    addBtn.click();

    cy.get('@todoInput').should('have.value', '');
    cy.get('@addBtn').should('be.disabled');
    cy.contains(todoText);
    cy.contains('2 of 3 remaining');
  });

  it('should toggle done', () => {
    cy.visit(baseUrl);
    cy.contains('1 of 2 remaining');

    cy.get('input[type=checkbox]')
      .first()
      .as('cb1')
      .click();
    cy.contains('2 of 2 remaining');

    cy.get('@cb1').check();
    cy.contains('1 of 2 remaining');
  });

  it('should delete todo', () => {
    cy.visit(baseUrl);
    cy.contains('1 of 2 remaining');

    const todoText = 'learn Svelte'; // first todo
    cy.contains('ul', todoText);
```

The Add button should be disabled until text is entered.

This saves a reference to found elements for later use.

This enters todo text.

This finds the first checkbox and toggles it.

This toggles the same checkbox again to show that status text returns to its previous value.

```
    cy.contains('Delete').click();
    cy.contains('ul', todoText).should('not.exist');
    cy.contains('1 of 1 remaining');
  });

  it('should archive completed', () => {
    cy.visit(baseUrl);

    const todoText = 'learn Svelte'; // first todo
    cy.contains('ul', todoText);

    cy.contains('Archive Completed').click();
    cy.contains('ul', todoText).should('not.exist');
    cy.contains('1 of 1 remaining');
  });
});
```

This clicks the first Delete button.

This clicks the Archive Completed button.

To run the tests in interactive mode, start the local server with `npm run dev`, enter `npm run cy:open`, and click the Run All Specs button in the upper-right corner of the Cypress tool. This opens a browser window where all the tests are run. When you're finished running the tests, close this browser window and the Cypress tool.

To aid in debugging, add `console.log` calls in the application code. When there are several of these in the code, it is helpful if they identify the source file and function where they are located. For example, `console.log('TodoList.svelte toggleDone: todo =', todo);`. To see their output, open the DevTools Console in the browser window where the tests are running.

To run the tests in command-line mode, start the local server with `npm run dev`, open another terminal, and enter `npm run cy:run`. This outputs test results in the terminal window, records an MP4 video of the test run, and outputs the file path of the video, which is in the `cypress/videos` subdirectory. Double-click the video file to watch it.

12.2.2 End-to-end tests for the Travel Packing app

Let's add end-to-end tests in the Travel Packing app. The finished code can be found at http://mng.bz/eQqQ.

1. Install Cypress by entering `npm install -D cypress`.
2. Add the npm scripts suggested for Cypress in section 12.2.
3. Start the app by entering `npm run dev`.
4. In another terminal, enter `npm run cy:open` to create the `cypress` directory and starting files inside it.
5. Move the `cypress/integration/examples` directory to `cypress/examples` so these example tests don't appear in the Cypress app but can be referred to later for examples.

6. Add a data-testid attribute to the input element that binds to the categoryName variable in src/Checklist.svelte so the input element is easy to find in a test:

   ```
   <input
     data-testid="category-name-input"
     required
     bind:value={categoryName}
   />
   ```

7. Create a travel-packing.spec.js file in the cypress/integration directory containing the code in listing 12.14.

Listing 12.14 Cypress tests for the Travel Packing app in cypress/integration/travel-packing.spec.js

```
const baseUrl = 'http://localhost:5000/';

function login() {
  cy.visit(baseUrl);
  cy.contains('Username')
    .children('input')
    .type('username');
  cy.contains('Password')
    .children('input')
    .type('password');
  cy.get('button')
    .contains('Login')
    .click();
}

function addCategories() {
  login();

  cy.get('[data-testid=category-name-input]')
    .as('nameInput')
    .type('Clothes');
  cy.get('button')
    .contains('Add Category')
    .click();

  cy.get('@nameInput').type('Toiletries{enter}');
}

function addItems() {
  addCategories();

  cy.get('[data-testid=item-input]')
    .first()
    .as('item-input-1')
    .type('socks');
  cy.get('button')
    .contains('Add Item')
```

We must log in before adding categories.

Including “{enter}” in a string passed to the type method simulates a user pressing the Enter key.

We must add categories before adding items.

This finds the input item in the “Clothes” category.

```
      .first()
      .click();
    cy.get('@item-input-1').type('shoes{enter}');
    verifyStatus('Clothes', '2 of 2 remaining');

    cy.get('[data-testid=item-input]')
      .last()
      .type('razor{enter}');
    verifyStatus('Toiletries', '1 of 1 remaining');
  }

  function deleteCategory(categoryName) {
    cy.contains(new RegExp(`^${categoryName}$`))
      .siblings('button')
      .click();
  }

  function deleteItem(itemName) {
    cy.contains(new RegExp(`^${itemName}$`))
      .siblings('button')
      .click();
  }

  function togglePacked(itemName) {
    cy.contains(new RegExp(`^${itemName}$`))
      .siblings('input[type="checkbox"]')
      .click();
  }

  function verifyStatus(categoryName, expectedStatus) {
    cy.contains(new RegExp(`^${categoryName}$`))
      // This is useful to verify that the correct element is found.
      // It draws a red outline around all the matching elements.
      //.then(el => el.css('outline', 'solid red'))
      .siblings('span')
      .contains(expectedStatus);
  }

  describe('Travel Packing app', () => {
    it('should login', login);

    it('should add categories', addCategories);

    it('should add items', addItems);

    it('should toggle packed', () => {
      addItems();
      verifyStatus('Clothes', '2 of 2 remaining');

      togglePacked('shoes');
      verifyStatus('Clothes', '1 of 2 remaining');
```

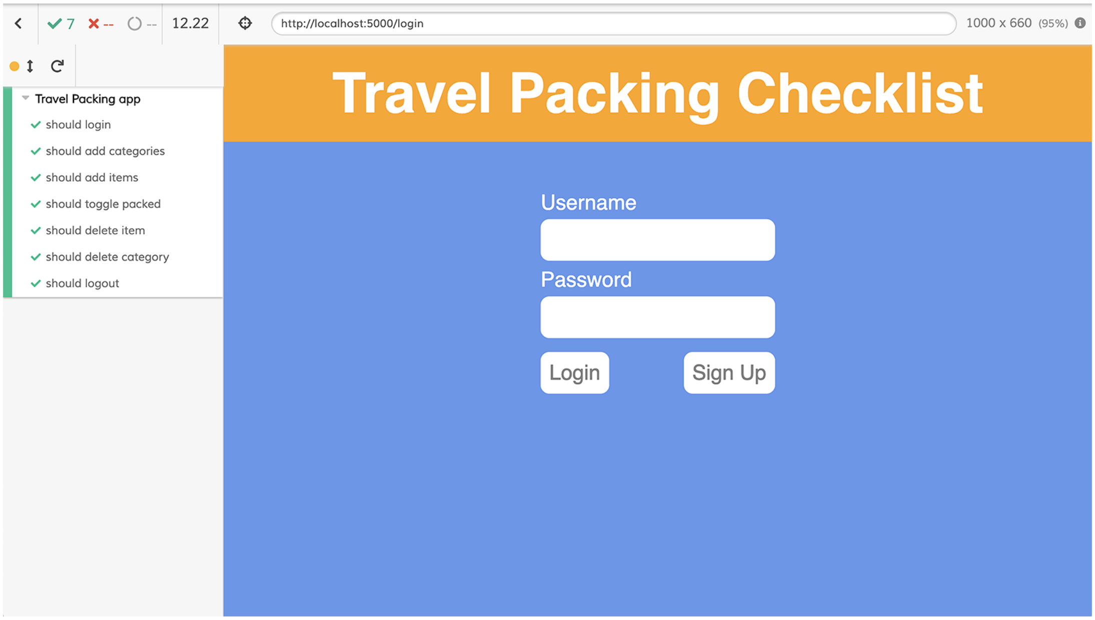
This finds the input item in the "Toiletries" category.

```
    togglePacked('shoes');
    verifyStatus('Clothes', '2 of 2 remaining');
  });

  it('should delete item', () => {
    addItems();
    verifyStatus('Clothes', '2 of 2 remaining');

    deleteItem('shoes');
    verifyStatus('Clothes', '1 of 1 remaining');
  });

  it('should delete category', () => {
    addItems();
    verifyStatus('Toiletries', '1 of 1 remaining');

    deleteItem('razor');
    verifyStatus('Toiletries', '0 of 0 remaining');

    const categoryName = 'Toiletries';
    // Verify that the category exists.
    cy.get('.categories h2 > span').contains(categoryName);
    deleteCategory(categoryName);
    // Verify that the category no longer exists.
    cy.get('.categories h2 > span')
      .contains(categoryName)
      .should('not.exist');
  });

  it('should logout', () => {
    login();
    cy.get('button')
      .contains('Log Out')
      .click();
    cy.contains('Login');
  });
});
```

We must delete all items in a category before the category can be deleted.

To run these end-to-end tests, enter `npm run cy:open`. This renders the results shown in figure 12.1. Note the green check marks next to the successful tests.

To run these end-to-end tests in command-line mode, enter `npm run cy:run`. This outputs listing 12.15 in the terminal window.



Travel Packing app
- ✓ should login
- ✓ should add categories
- ✓ should add items
- ✓ should toggle packed
- ✓ should delete item
- ✓ should delete category
- ✓ should logout

Figure 12.1 Cypress in Chrome

Listing 12.15 Cypress command-line output

```
(Run Starting)

  ┌────────────────────────────────────────────────────────────────────────────┐
  │ Cypress:    3.8.1                                                          │
  │ Browser:    Electron 78 (headless)                                         │
  │ Specs:      1 found (travel-packing.spec.js)                               │
  └────────────────────────────────────────────────────────────────────────────┘

────────────────────────────────────────────────────────────────────────────────

  Running:  travel-packing.spec.js                                       (1 of 1)

  Travel Packing app
    ✓ should login (888ms)
    ✓ should add categories (1196ms)
    ✓ should add items (1846ms)
    ✓ should toggle packed (2057ms)
    ✓ should delete item (1973ms)
    ✓ should delete category (2037ms)
    ✓ should logout (1938ms)

  7 passing (13s)

  (Results)
  ┌────────────────────────────────────────────────────────────────────────────┐
  │ Tests:        7                                                            │
  │ Passing:      7                                                            │
  │ Failing:      0                                                            │
  │ Pending:      0                                                            │
  │ Skipped:      0                                                            │
  │ Screenshots:  0                                                            │
  │ Video:        true                                                         │
  │ Duration:     12 seconds                                                   │
  │ Spec Ran:     travel-packing.spec.js                                       │
  └────────────────────────────────────────────────────────────────────────────┘

  (Video)

  •  Started processing:  Compressing to 32 CRF
  •  Finished processing: /Users/mark/Documents/programming/languages/ (0 seconds)
                          javascript/svelte/book/svelte-and-sapper-in-action/
                          travel-packing-ch11/cypress/videos/
                          travel-packing.spec.js.mp4

================================================================================

  (Run Finished)

       Spec                              Tests  Passing  Failing  Pending  Skipped
  ┌────────────────────────────────────────────────────────────────────────────┐
  │ ✓  travel-packing.spec.js  00:12      7        7        -        -        - │
  └────────────────────────────────────────────────────────────────────────────┘
    ✓  All specs passed!       00:12      7        7        -        -        -
```

12.3 Accessibility tests

There are many tools for detecting web UI accessibility issues, such as the following.

- *Svelte compiler*—The Svelte compiler flags some accessibility issues. These are described in the following section.
- *Lighthouse* (https://developers.google.com/web/tools/lighthouse)—This is a free tool. It is used by Chrome DevTools on the Audits tab and can also be run from a command line or a Node application. Lighthouse audits many aspects of a web app, including performance, progressive web app metrics, accessibility, and search engine optimization (SEO).
- *axe* (www.deque.com/axe/)—This is a free Chrome extension. axe PRO is an enterprise version of axe that identifies even more issues.
- *WAVE* (https://wave.webaim.org/)—This is a free Chrome and Firefox extension. Pope Tech (https://pope.tech/) is an enterprise-level accessibility tool built on WAVE.

These tools can identify different issues, so it is recommended that you use more than one. As you will see below, sometimes it is not desirable to address all the identified issues.

12.3.1 Svelte compiler

The Svelte compiler detects some accessibility issues and outputs warning messages that begin with "A11y:". You will see a list of the messages, along with their codes, in table 12.1. Note that some codes are used for more than one message.

Table 12.1 Svelte accessibility warning codes and messages

Code	Message
a11y-distracting-elements	Avoid <{name}> elements
a11y-structure	<figcaption> must be an immediate child of <figure>
a11y-structure	<figcaption> must be first or last child of <figure>
a11y-aria-attributes	<{name}> should not have aria-* attributes
a11y-unknown-aria-attribute	Unknown aria attribute 'aria-{type}'
a11y-hidden	<{name}> element should not be hidden
a11y-misplaced-role	<{name}> should not have role attribute
a11y-unknown-role	Unknown role '{value}'
a11y-accesskey	Avoid using accesskey
a11y-autofocus	Avoid using autofocus
a11y-misplaced-scope	The scope attribute should only be used with <th> elements
a11y-positive-tabindex	Avoid tabindex values above zero
a11y-invalid-attribute	'{value}' is not a valid {attribute-name} attribute
a11y-missing-attribute	<a> element should have an href attribute
a11y-missing-content	<{name}> element should have child content
a11y-missing-attribute	<{name}> element should have {article} {sequence} attribute

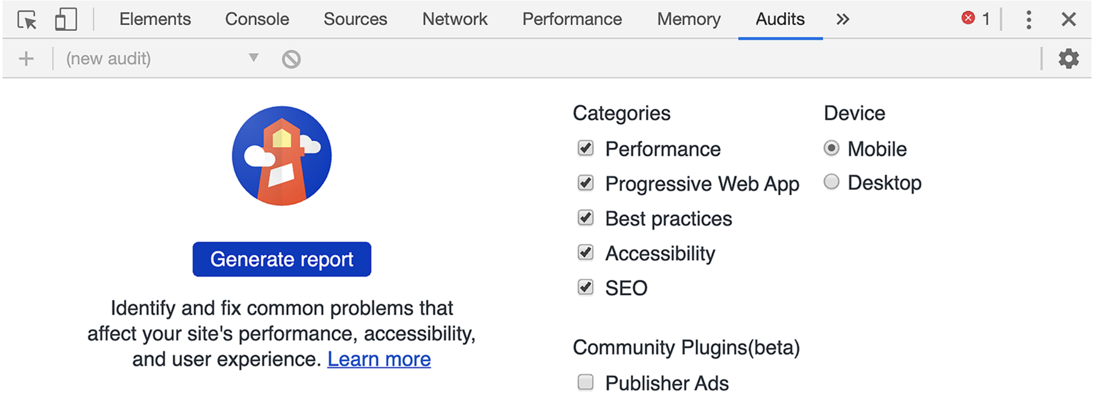
In some cases it may be desirable to suppress certain warnings. To do this, add a special comment above the offending lines. For example, to suppress the warning "Avoid using autofocus," add the following line before all `input` elements that use it:

```
<!-- svelte-ignore a11y-autofocus -->
```

12.3.2 Lighthouse

The easiest way to use Lighthouse to identify accessibility issues is as follows:

1. Open the website to be tested in Chrome.
2. Open the DevTools.
3. Click the Audits tab (see figure 12.2).
4. Verify that the Accessibility checkbox is checked.



Identify and fix common problems that affect your site's performance, accessibility, and user experience. Learn more

Categories

☑ Performance
☑ Progressive Web App
☑ Best practices
☑ Accessibility
☑ SEO

Device

● Mobile
○ Desktop

Community Plugins(beta)

□ Publisher Ads

Figure 12.2 Lighthouse setup in Chrome DevTools

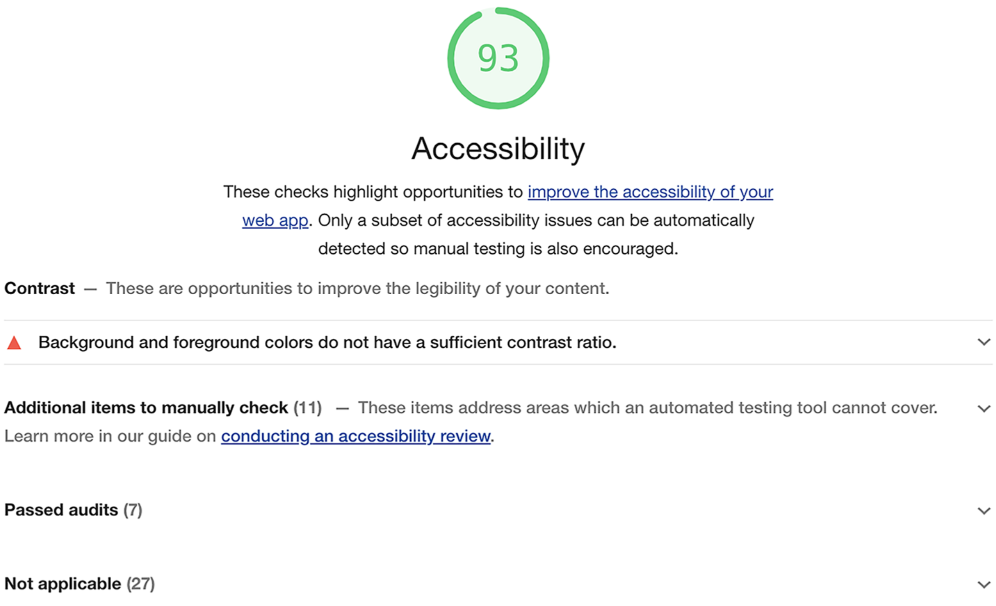
5. Click the Generate Report button.
6. To keep current test results and open a new tab for the next test, press the "+" in the upper-left corner of the Audits tab.
7. Visit another page or state of the site.
8. Click the Generate Report button again.
9. Repeat steps 6 to 8 for each page or state of the site, noting the reported accessibility issues for each.

> **NOTE** The issues have already been fixed in this chapter's version of the Travel Packing app. To see these issues, run Lighthouse on the chapter 11 version.

To rerun tests after code changes, click the Clear All icon (a circle with a diagonal line) and then click the Run Audits button.

Lighthouse reported two issues for the Login page. The color contrast on the Login and Sign Up buttons, gray on white, is insufficient. These can be fixed by changing `gray` to `black` in `public/global.css`.

Lighthouse only reported one issue for the Checklist page of the Travel Packing app after adding a category and an item in it. It was "Background and foreground colors do not have a sufficient contrast ratio," as shown in figures 12.3 and 12.4. The color contrast between the white text and the orange and cornflowerblue backgrounds is not sufficient from an accessibility standpoint. These color contrast issues can be fixed by choosing a color other than orange for `.hero` in `src/App.svelte` and choosing a color other than cornflowerblue for `main` in `src/App.svelte` and `header` in `src/Dialog.svelte`.



93

Accessibility

These checks highlight opportunities to improve the accessibility of your web app. Only a subset of accessibility issues can be automatically detected so manual testing is also encouraged.

Contrast — These are opportunities to improve the legibility of your content.

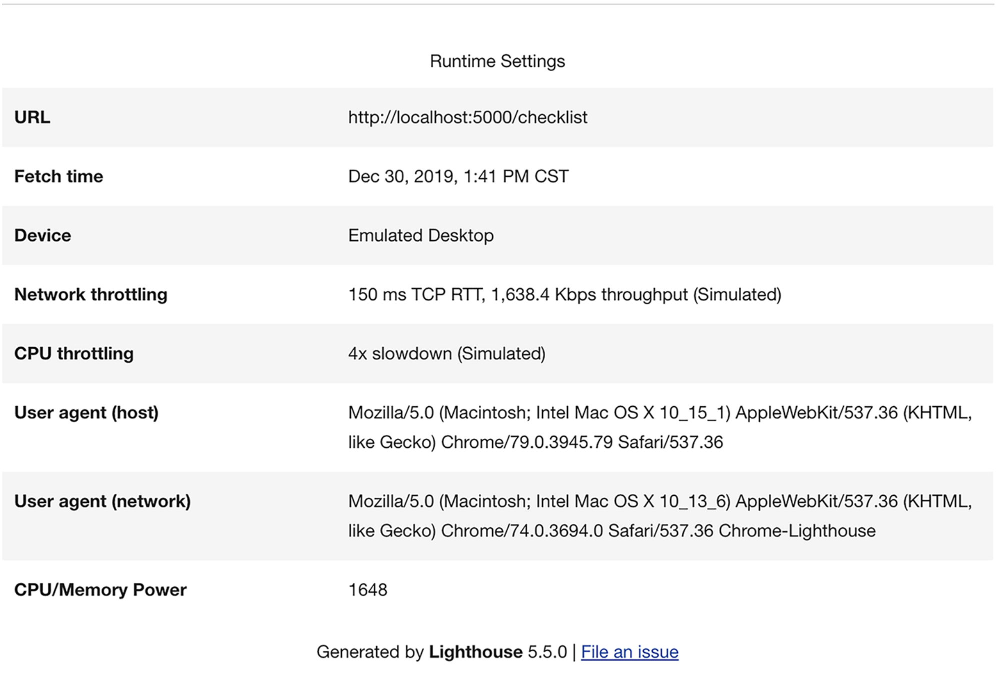
▲ Background and foreground colors do not have a sufficient contrast ratio.

Additional items to manually check (11) — These items address areas which an automated testing tool cannot cover. Learn more in our guide on conducting an accessibility review.

Passed audits (7)

Not applicable (27)

Figure 12.3 Lighthouse results in Chrome DevTools (top of page)



Runtime Settings

URL	http://localhost:5000/checklist
Fetch time	Dec 30, 2019, 1:41 PM CST
Device	Emulated Desktop
Network throttling	150 ms TCP RTT, 1,638.4 Kbps throughput (Simulated)
CPU throttling	4x slowdown (Simulated)
User agent (host)	Mozilla/5.0 (Macintosh; Intel Mac OS X 10_15_1) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/79.0.3945.79 Safari/537.36
User agent (network)	Mozilla/5.0 (Macintosh; Intel Mac OS X 10_13_6) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/74.0.3694.0 Safari/537.36 Chrome-Lighthouse
CPU/Memory Power	1648

Generated by **Lighthouse** 5.5.0 | File an issue

Figure 12.4 Lighthouse results in Chrome DevTools (bottom of page)

One way to discover acceptable colors is to use the Contrast Checker tool at https://webaim.org/resources/contrastchecker/. Current colors can be entered, and a Lightness slider can be moved until the contrast ratio reaches at least 4.5.

To fix the contrast issues reported by Lighthouse, change all uses of the color cornflowerblue (#6495ed) to #3f6fde and all uses of the color orange (#ffa500) to #a3660a. A good way to do this is to assign the new colors to CSS variables and refer to the variables wherever the colors are needed. We can define global CSS variables in `src/App.svelte` using the `:root` syntax, as follows:

```
:root {
  --heading-bg-color: #a3660a;
  --primary-color: #3f6fde;
  ...
}
```

Then we can refer to the CSS variables wherever needed, as follows:

```
background-color: var(--heading-bg-color);

background-color: var(--primary-color);
```

12.3.3 axe

To install axe in Chrome, follow these steps:

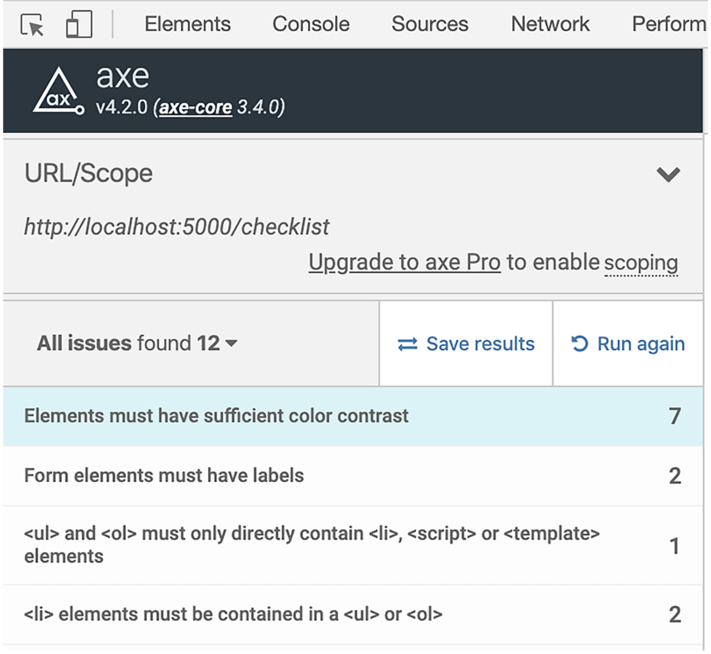
1. Browse to https://www.deque.com/axe/.
2. Click the Download free Chrome extension button.
3. Click the Add to Chrome button.

To run axe on a website, follow these steps:

1. Browse to the website to be tested.
2. Open the browser's DevTools.
3. Click the Axe tab.
4. Click the Analyze button.
5. Click each issue identified in the left nav to see a detailed description on the right.

To navigate between multiple instances of the same issue type, click the "<" and ">" buttons in the upper-right. To see the rendered element associated with the issue, click Highlight. To see the DOM element associated with the issue, click "</> Inspect Node". To rerun the tests after code changes, click Run Again.

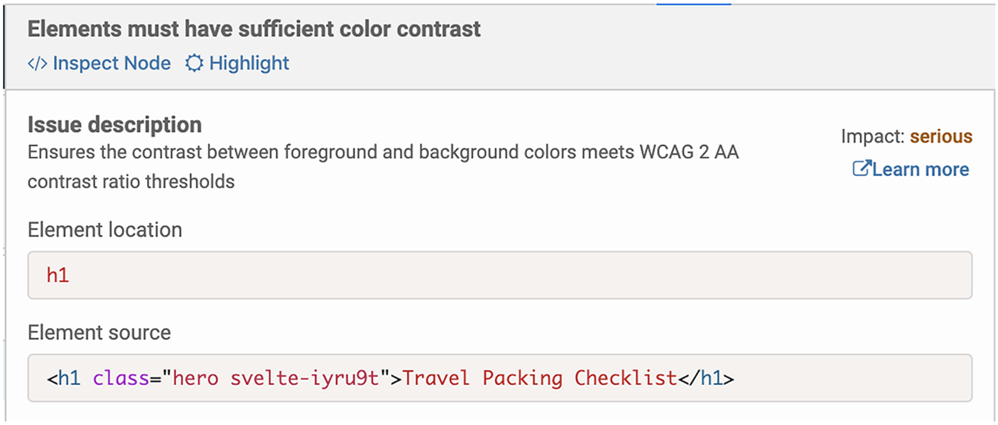
When axe is run on the Checklist page of the Travel Packing app after adding a category and an item in it, you'll see the results shown in figures 12.5, 12.6, and 12.7.



http://localhost:5000/checklist

Elements must have sufficient color contrast	7
Form elements must have labels	2
<ul> and <ol> must only directly contain <li>, <script> or <template> elements	1
<li> elements must be contained in a <ul> or <ol>	2

Figure 12.5 axe results



Elements must have sufficient color contrast

Issue description

Ensures the contrast between foreground and background colors meets WCAG 2 AA contrast ratio thresholds

Impact: serious

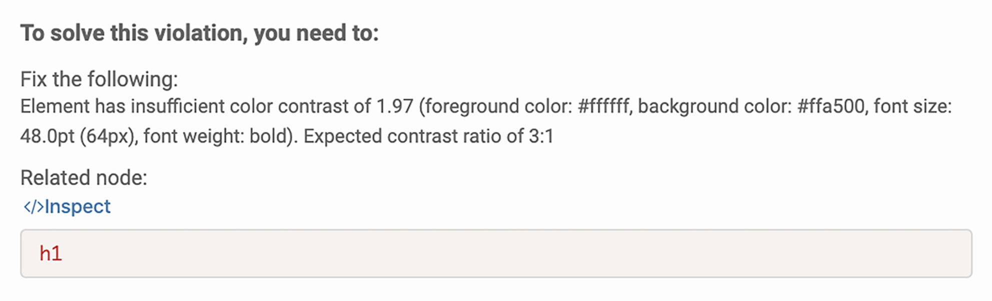
Element location

```
h1
```

Element source

```
<h1 class="hero svelte-iyru9t">Travel Packing Checklist</h1>
```

Figure 12.6 axe detail for an issue



To solve this violation, you need to:

Fix the following:
Element has insufficient color contrast of 1.97 (foreground color: #ffffff, background color: #ffa500, font size: 48.0pt (64px), font weight: bold). Expected contrast ratio of 3:1

Related node:
</>Inspect

```
h1
```

Figure 12.7 axe fix suggestion for an issue

Let's walk through the issues.

- *Elements must have sufficient color contrast*—These are the same color contrast issues that were reported by Lighthouse.
- *Document must have one main landmark*—This is caused by both `App.svelte` and `Dialog.svelte` rendering a `main` element. One fix is to change `Dialog.svelte` to use a `section` element instead of a `main` element.
- *Form elements must have labels*—This is reported for two elements in `src/Item/svelte`. The first is the checkbox `input` for marking an item as packed. The second is the text `input` for editing an item name that is rendered when the name of an item is clicked. Both of these omit a `label`. We don't want to display `label` elements in these cases. One fix is to add an `aria-label` attribute to these `input` elements as follows:

```
<input
  aria-label="Toggle Packed"
  type="checkbox"
  bind:checked={item.packed}
/>
{#if editing}
  <input
    aria-label="Edit Name"
    autofocus
    bind:value={item.name}
    on:blur={() => (editing = false)}
    on:keydown={blurOnKey}
    type="text"
  />
```

- *<ul> and <ol> must only directly contain <li>, <script> or <template> elements*—This issue is in `Category.svelte` where `Item` components that render an `li` element are wrapped in a `div` with the attribute `animate:flip`. We cannot remove the `div` and move this attribute to the `li` in `Item.svelte` because doing so causes the

Svelte error “An element that use the animate directive must be the immediate child of a keyed each block.” So it seems we have to live with this accessibility issue if we want to keep this particular animation.

- *<li> elements must be contained in a <ul> or <ol>*—This identifies the same issue as the previous one.
- *Heading levels should only increase by one*—This issue is caused by using an `h3` for the name of a category when the previous heading is an `h1` in the “hero” at the top of the page. One fix is to change all occurrences of `h3` in `Category.svelte` to `h2`. CSS can be used to reduce the font size of the `h2` elements if desired.

12.3.4 WAVE

To install WAVE in Chrome, follow these steps:

1. Browse to https://wave.webaim.org/.
2. Click the Browser Extensions link.
3. Click the link for the extension for your browser.
4. Click the Add to Chrome button.

To run WAVE on a website, follow these steps:

1. Browse to the website to be tested.
2. Click the WAVE icon (W) to the right of the browser’s address bar.
3. An accessibility report will open on the left side of the page.
4. Click the View Details button.

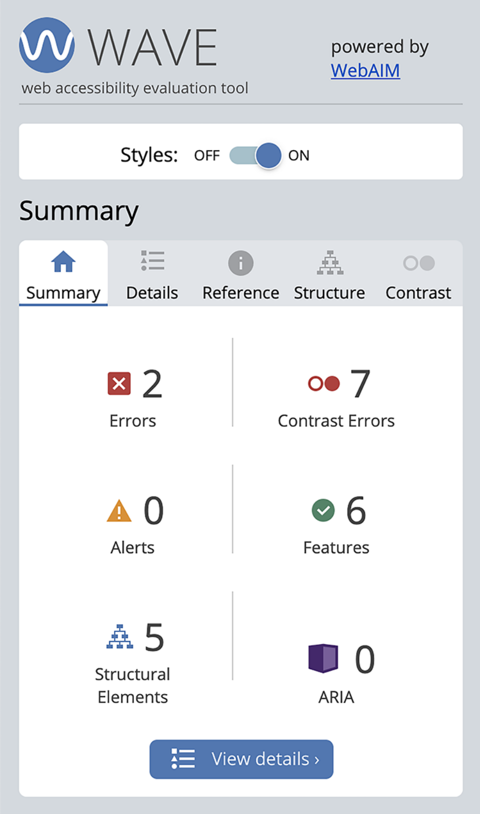
WAVE reports both issues and the good things it finds (such as having `alt` text for images). Click an icon for an issue to scroll to it on the web page.

WAVE reported the issues shown in figures 12.8 and 12.9 for the Checklist page of the Travel Packing app after adding a category and an item in it.

Let’s walk through the issues.

- *Missing form label*—These are the same issues that axe reported as “Form elements must have labels.”
- *Very low contrast*—These are the same color contrast issues that were reported by Lighthouse.
- *Orphaned form label*—This means that a form label is not associated with a form control. It refers to the Show label in `Checklist.svelte`. A fix is shown after the next issue because they are related.
- *Missing fieldset*—This means that a group of checkboxes or radio buttons is not enclosed in a `fieldset` element.

One fix for the last two issues is to edit `Checklist.svelte` and use a `fieldset` element to surround the radio buttons. We want the radio buttons to be laid out in a row. But there is a browser issue where flexbox layout is not honored on `fieldset` elements.



WAVE
web accessibility evaluation tool
powered by WebAIM

Styles: OFF ON

Summary

Summary | Details | Reference | Structure | Contrast

2 Errors

7 Contrast Errors

0 Alerts

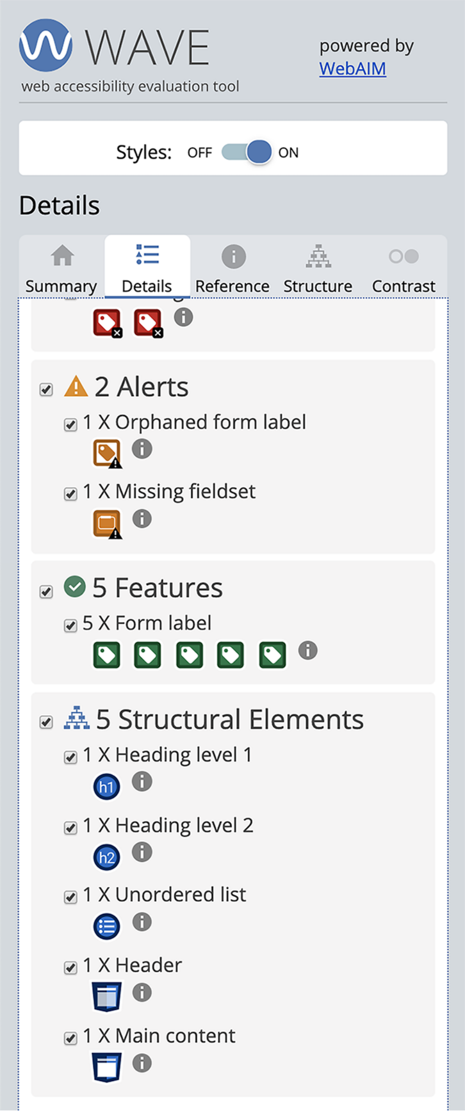
6 Features

5 Structural Elements

0 ARIA

View details ›

Figure 12.8 WAVE summary



WAVE
web accessibility evaluation tool
powered by WebAIM

Styles: OFF ON

Details

Summary | Details | Reference | Structure | Contrast

☑ 2 Alerts
☑ 1 X Orphaned form label
☑ 1 X Missing fieldset

☑ 5 Features
☑ 5 X Form label

☑ 5 Structural Elements
☑ 1 X Heading level 1
☑ 1 X Heading level 2
☑ 1 X Unordered list
☑ 1 X Header
☑ 1 X Main content

Figure 12.9 WAVE detail

A workaround is to wrap all the `fieldset` children in a `div` and apply flexbox layout to that. Here is a replacement for the `<div class="radios">` element that fixes the accessibility issues.

```
<fieldset>
  <div>
    <legend>Show</legend>
    <label>
      <input name="show" type="radio" value="all" bind:group={show} />
      All
    </label>
    <label>
      <input name="show" type="radio" value="packed" bind:group={show} />
      Packed
    </label>
    <label>
      <input name="show" type="radio" value="unpacked" bind:group={show} />
      Unpacked
    </label>
    <button class="clear" on:click={clearAllChecks}>Clear All Checks</button>
  </div>
</fieldset>
```

Replace the CSS rules for `.radios` with the following:

```
fieldset {
  border: none;
  margin: 0;
  padding: 0;
}

fieldset > div {
  display: flex;
  align-items: center;
}

fieldset input {
  margin-left: 1.5rem;
}

fieldset legend {
  padding: 0;
}
```

12.4 Component demos and debugging with Storybook

Storybook (https://storybook.js.org) bills itself as "an open source tool for developing UI components in isolation." It works with many web frameworks including React, Vue, Angular, Svelte, and more.

Storybook displays a list of components in specific states in its left nav (see figure 12.10). Selecting a component or state renders it in the main area of the UI. It also allows interaction with the component in all ways supported by the component. For example, if a `Category` component from the Travel Packing app is rendered, it can be renamed, and items can be added, renamed, marked as packed, and deleted.

Storybook has many uses. One is for showcasing the set of components that have been developed. Another is for testing and debugging components separately from web apps that use them. This is much faster than having to navigate to the use of a particular component in a web app.

Detailed instructions for using Storybook with Svelte components can be found in the Storybook documentation at https://storybook.js.org/docs/guides/guide-svelte/.

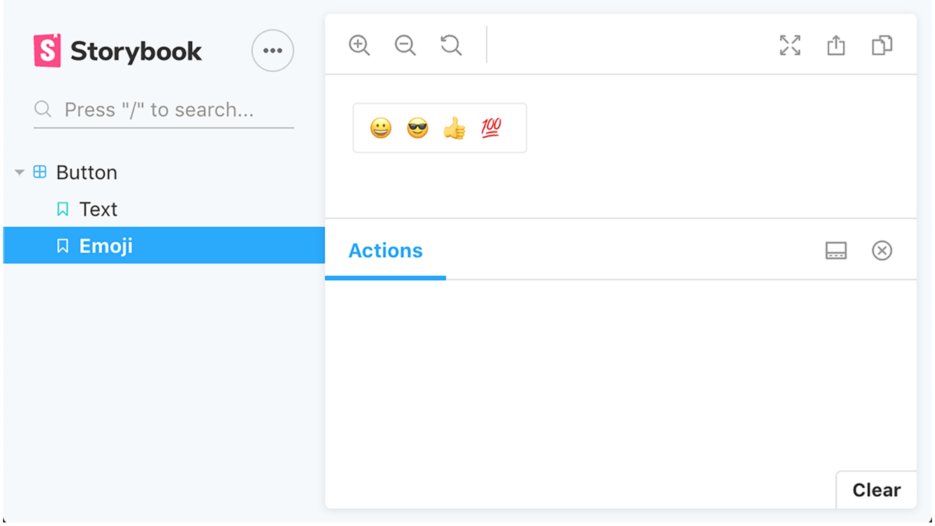


Figure 12.10 Storybook before adding components

To add the use of Storybook to an existing Svelte application, cd to the top application directory and enter the following:

```
npx -p @storybook/cli sb init --type svelte
```

This takes a couple of minutes to complete and results in the following changes:

- It installs all the development dependencies needed by Storybook.
- It adds the following npm scripts in package.json:

  ```
  "storybook": "start-storybook",
  "build-storybook": "build-storybook"
  ```

- It creates the .storybook directory, which contains the addons.js file that registers the use of Storybook actions and links. Actions provide a way to log user interactions, such as a certain button being pressed. Links provide a way to add links in stories that can be clicked to navigate to other stories, as an alternative to clicking a link in the left nav.

  This directory also contains the config.js file that configures the use of Storybook to automatically import all files found in the stories directory whose names end with .stories.js.
- It creates the stories directory, which contains the button.svelte file that defines a simple Svelte component. It also contains the index.stories.js file that registers the Button component with Storybook. These files just provide an example of registering a component with Storybook. Typically source files for

the components being demonstrated are found in the src directory rather than the stories directory.

The supplied Button component dispatches an event when it is clicked. The index.stories.js file listens for the event and calls the action function that it imports from @storybook/addon-actions. Strings passed to the action function are logged at the bottom of the main section of the Storybook UI. The Clear button in the lower-right corner of the Actions area clears the list of logged actions.

To run Storybook locally, enter npm run storybook.

To add components to Storybook, add one .stories.js file for each component in the stories directory. These files should be similar to the provided index.stories.js file.

Each story renders a component in a different state. It is common for a .stories.js file to define multiple stories that render the same component in different states. Each state has a name that is displayed in the left nav below the component name. The two states for the provided Button component are "Text" and "Emoji".

When new .stories.js files are created, refresh the browser where Storybook is running to see them in the left nav. When an existing .stories.js file is modified, Storybook automatically detects the changes and displays the modified story at the bottom of the left nav.

12.4.1 Storybook for Travel Packing app

Let's define Storybook stories for the Travel Packing app components. The finished code can be found at http://mng.bz/pBqz.

The following listing shows stories for the Item component (see figure 12.11).

Listing 12.16 Storybook stories for the Item component in stories/Item.stories.js

```
import {action} from '@storybook/addon-actions';
import Item from '../src/Item.svelte';
import '../public/global.css';

export default {title: 'Item'};

const getOptions = packed => ({
  Component: Item,
  props: {
    categoryId: 1,
    dnd: {},
    item: {id: 2, name: 'socks', packed}
  },
  on: {delete: action('item delete dispatched')}
});

export const unpacked = () => getOptions(false);
export const packed = () => getOptions(true);
```

This applies global styles from the Travel Packing app.

This writes to the Actions area of the Storybook UI to indicate that the action occurred.

Each story is defined by an exported function that returns an object describing the component to be rendered, props to be passed to it, and handling of events dispatched by the component.

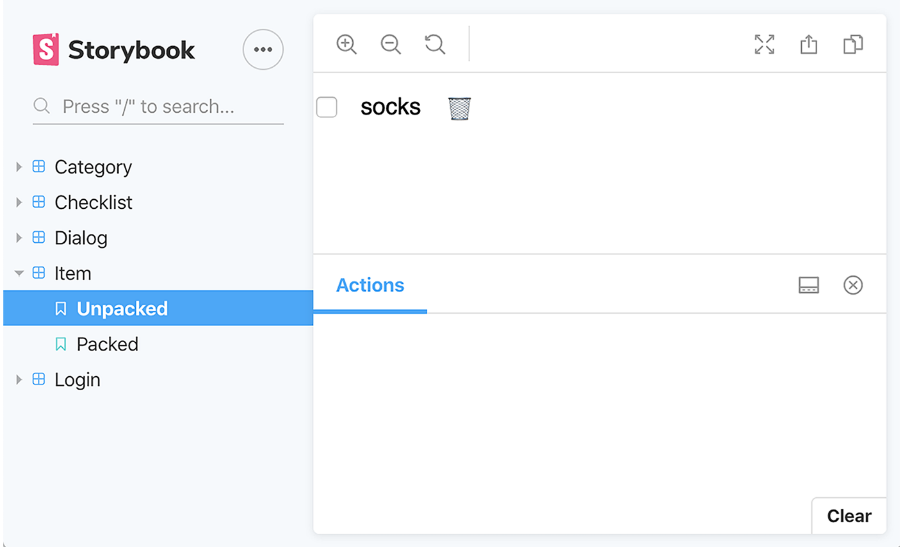


Figure 12.11 `Item` component in Storybook

Now that we have developed stories of our own, we no longer need the provided example files. The files `button.svelte` and `index.stories.js` can be deleted so they no longer appear inside Storybook.

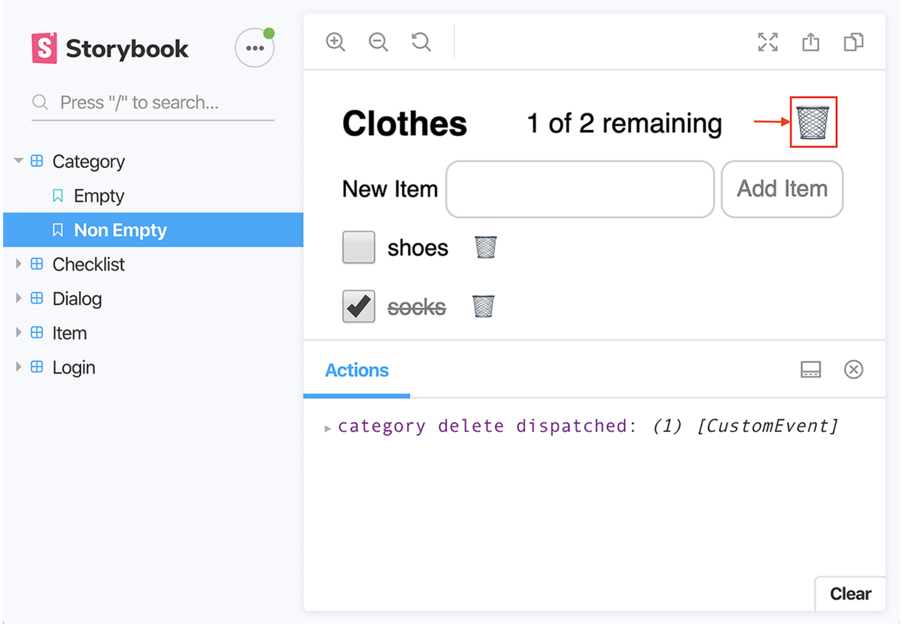
The following listing shows stories for the `Category` component (see figure 12.12).

Listing 12.17 Storybook stories for the `Category` component in `stories/Category.stories.js`

```
import {action} from '@storybook/addon-actions';
import Category from '../src/Category.svelte';
import '../public/global.css';

export default {title: 'Category'};

function getOptions(items) {
  const category = {id: 1, name: 'Clothes', items};
  return {
    Component: Category,
    props: {
      category,
      categories: {[category.id]: category},
      dnd: {},
      show: 'all'
    },
    on: {delete: action('category delete dispatched')}
  };
}
```

This writes to the Actions area of the Storybook UI to indicate that the action occurred.

```
export const empty = () => getOptions({});
export const nonEmpty = () =>
  getOptions({
    1: {id: 1, name: 'socks', packed: true},
    2: {id: 2, name: 'shoes', packed: false}
  });
```



```
▸ category delete dispatched: (1) [CustomEvent]
```

Figure 12.12 `Category` component in Storybook

In the Travel Packing app, the `App` component provides some styling that will be missing in Storybook when we render components not nested in an `App` component. But we can simulate this by defining a `StyleWrapper` component that renders a given component in a `div` with specified styling applied to the `div`. The `StyleWrapper` component is used in a couple of the stories that follow.

Some of the components dispatch events to which their parent component listens. Recall that events only go to parent components. Inserting the `StyleWrapper` component between them breaks the ability of parent components to receive the events. To fix this, the `StyleWrapper` component must forward the events. The events in question are `login` and `logout`, so those are the events that are forwarded.

Listing 12.18 `StyleWrapper` component in `stories/StyleWrapper.svelte`

```
<script>
  export let component;
  export let style;
</script>

<div style={style}>
  <svelte:component this={component} on:login on:logout />
</div>
```

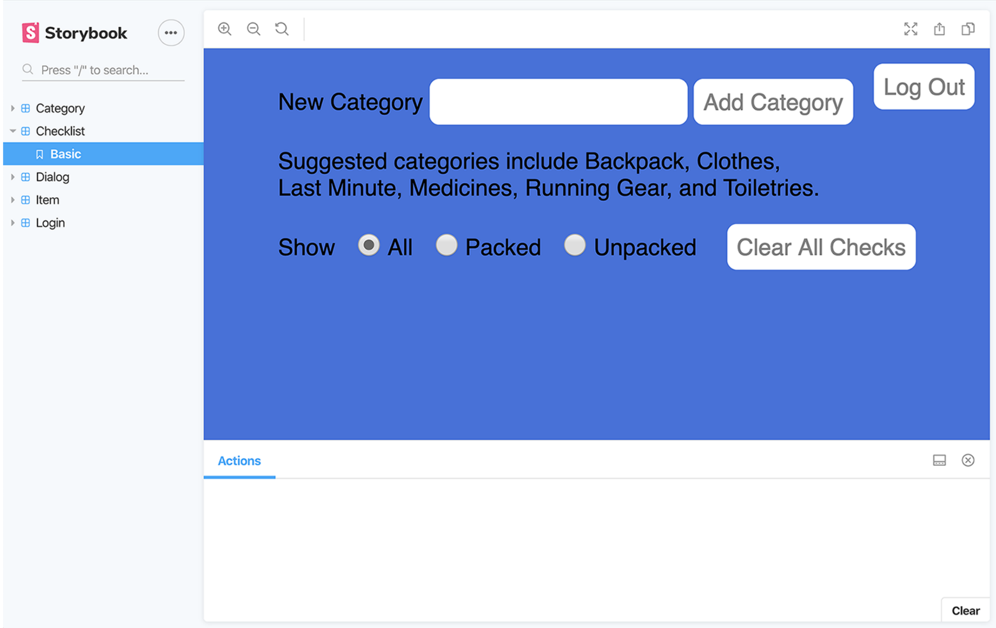
This forwards login and logout events.

The following listing shows stories for the `Checklist` component (see figure 12.13). Each story has a name that is specified by the name of the function that defines it. These should be as descriptive as possible. The stories for the `Item` component were given the names `unpacked` and `packed`. The stories for the `Category` component were given the names `empty` and `nonEmpty`. However, sometimes there is no obvious name, and a generic name such as `basic` is used to indicate that basic use of the component is being demonstrated.

Listing 12.19 Storybook stories for the `Checklist` component in `stories/Checklist.stories.js`

```
import {action} from '@storybook/addon-actions';
import Checklist from '../src/Checklist.svelte';
import StyleWrapper from './StyleWrapper.svelte';
import '../public/global.css';

export default {title: 'Checklist'};

export const basic = () => ({
  Component: StyleWrapper,
  props: {
    component: Checklist,
    style: `
      background-color: cornflowerblue;
      color: white;
      height: 100vh;
      padding: 1rem
    `
  },
  on: {logout: action('logout dispatched')}
});
```

This wraps the component being demonstrated in the StyleWrapper component.



Suggested categories include Backpack, Clothes, Last Minute, Medicines, Running Gear, and Toiletries.

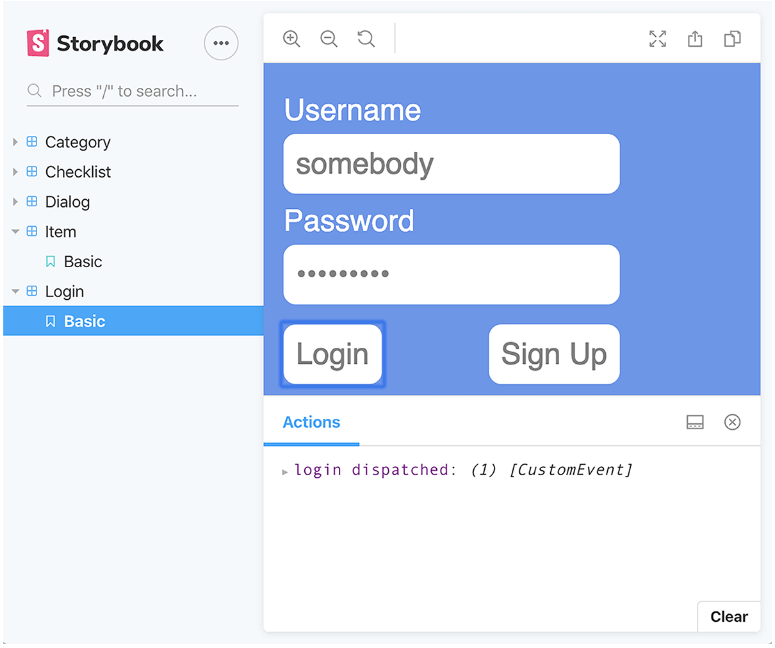
Show ● All ○ Packed ○ Unpacked

Figure 12.13 `Checklist` **component in Storybook**

The following listing shows stories for the `Login` component (see figure 12.14).

Listing 12.20 Storybook stories for the `Login` component in `stories/Login.stories.js`

```
import {action} from '@storybook/addon-actions';
import StyleWrapper from './StyleWrapper.svelte';
import Login from '../src/Login.svelte';
import '../public/global.css';

export default {title: 'Login'};

export const basic = () => ({
  Component: StyleWrapper,
  props: {
    component: Login,
    style: `
      background-color: cornflowerblue;
      height: 100vh;
      padding: 1rem
    `
  },
  on: {login: action('login dispatched')}
});
```



Username

somebody

Password

•••••••••

```
login dispatched: (1) [CustomEvent]
```

Figure 12.14 `Login` component in Storybook

We want to allow Storybook users to configure the title and content of a `Dialog` component. To enable this, we can define the following `DialogWrapper` component that provides inputs for the title and content. This component is only used by Storybook, not the Travel Packing app.

Listing 12.21 `DialogWrapper` component in `stories/DialogWrapper.svelte`

```
<script>
  import Dialog from '../src/Dialog.svelte';
  let content = 'This is some\\nlong content.';
  let dialog;
  let title = 'My Dialog Title';

  $: lines = content.split('\\n');
</script>

<section>
  <label>
    Title
    <input bind:value={title} />
  </label>

  <label>
    Content
```

The content string is split on occurrences of \n, which is the escape sequence for a newline character, to support multiline content.

```
    <textarea bind:value={content} />
    Insert \n to get multi-line content.
  </label>

  <button on:click={() => dialog.showModal()}>Show Dialog</button>

  <Dialog {title} bind:dialog={dialog} on:close={() => dialog.close()}>
    {#each lines as line}
      <div>{line}</div>
    {/each}
  </Dialog>
</section>

<style>
  input, textarea {
    margin: 0 1rem 1rem 1rem;
  }

  label {
    color: white;
    display: flex;
    align-items: flex-start;
  }

  section {
    background-color: cornflowerblue;
    height: 100vh;
    padding: 1rem;
  }
</style>
```

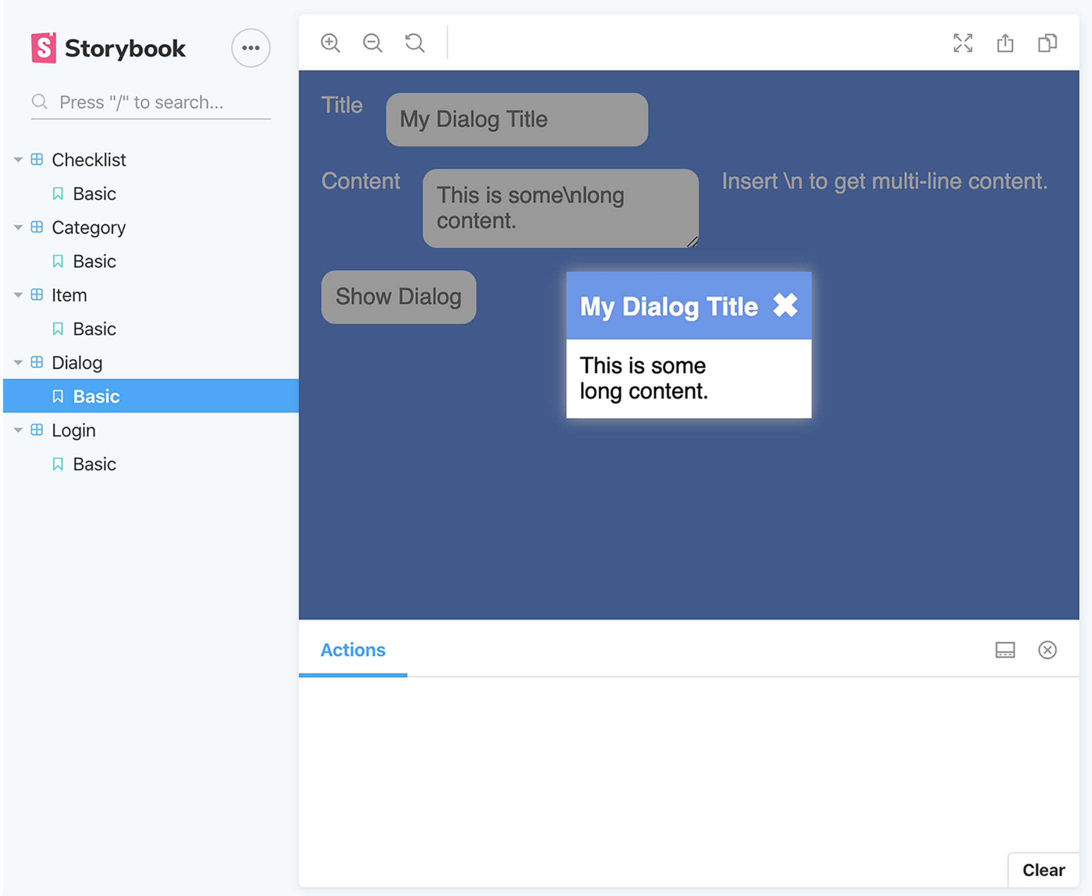
The following listing shows stories for the `Dialog` component (see figure 12.15).

Listing 12.22 Storybook stories for the `Dialog` component in `stories/Dialog.stories.js`

```
import DialogWrapper from './DialogWrapper.svelte';
import '../public/global.css';

export default {title: 'Dialog'};

export const basic = () => ({Component: DialogWrapper});
```

We have now added all the components in the Travel Packing app to Storybook.

It may be desirable to generate and deploy a static version of Storybook, including all the registered components, to allow others to view the components. To generate a static version of Storybook, enter `npm run build-storybook`. This creates the `storybook-static` directory containing all the required HTML and JavaScript files. All required CSS rules are compiled into the JavaScript. This directory can be copied to a web server. To view it locally, simply open the `index.html` file in a web browser.



Title: My Dialog Title

Content: This is some\nlong content.

Insert \n to get multi-line content.

My Dialog Title ✖

This is some
long content.

Figure 12.15 `Dialog` component in Storybook

Storybook provides a quick way to see a list of all the components used by an app and to interact with them. If a bug is discovered in a component, it can be debugged in the context of Storybook, which is easier than debugging in an app that uses it.

In the next chapter you'll see options for deploying Svelte applications.

Summary

- Jest is a good choice for implementing unit tests for Svelte applications, and using the Svelte Testing Library in conjunction with it makes this even easier.
- Cypress is a good choice for implementing end-to-end tests for Svelte applications.
- Lighthouse, axe, and WAVE are good choices for testing the accessibility of Svelte applications. The Svelte compiler also identifies many accessibility issues.
- Storybook is a good tool for demonstrating Svelte components and debugging issues in them.

13 Deploying

This chapter covers

- Deploying to any HTTP server
- Using Netlify
- Using Vercel (formerly ZEIT)
- Using Docker

Writing a Svelte app is lots of fun, and they are easy to run locally. But eventually you'll want to deploy apps to a server that enables others to use them. There are many more deployment options than we will cover here, but we will discuss some popular choices.

Some services, such as Netlify and Vercel, support registering a source repository (such as GitHub, GitLab, or Bitbucket). After you do this, they watch the repository for changes. Every time changes are pushed, they rebuild the web app and serve the resulting files.

13.1 Deploying to any HTTP server

It is easy to deploy a Svelte application to any HTTP server. To demonstrate this, we will use the Node-based Express server. Here are the steps:

1. cd to the top project directory.
2. Enter npm run build to create files in the public/build directory.
3. Create a server directory in the top project directory.
4. cd to the server directory.
5. Enter npm init and answer the questions it asks in order to create a package.json file. Alternatively enter npm init --yes to use the default values instead of having to answer questions.
6. Install Express by entering npm install express.
7. Create a server.js file containing the following:

```
const express = require('express');
const path = require('path');

const app = express();

app.use(express.static(path.resolve(__dirname + '/..', 'public')));

const PORT = 1234;
app.listen(PORT, () => console.log('listening on port', PORT));
```

This specifies that files will be served from the public directory, which is a sibling of the server directory.

Other port numbers can be used.

8. Add the following script in package.json:

```
"start": "node server.js"
```

9. Start the server by entering npm start, still in the server directory.
10. Browse to localhost:1234 (or whatever port you chose) to run the app.

When using a cloud-based server, upload the public directory to its recommended location.

13.2 Using Netlify

Netlify (www.netlify.com) bills itself as an “all-in-one platform for automating modern web projects.”

To get started using Netlify, browse to https://www.netlify.com/, click the Get Started in Seconds button, and sign up. Netlify sites are automatically secured with HTTPS using a “Let’s Encrypt” certificate.

There are two ways to create and deploy sites in Netlify: using the website and working from the command line.

13.2.1 Netlify from the website

When you use Netlify from the website, code for your site must be in a GitHub, GitLab, or Bitbucket repository. Once the repository is associated with your site, pushing changes to it will trigger a new build and deploy.

To create a site and build and deploy it, follow these steps:

1. Browse to https://www.netlify.com/.
2. Log in and enter your email address and password.
3. Click the New Site From Git button in the upper right.
4. Click a button for one of the supported repository services. A dialog will open.
5. Click the Authorize button to grant Netlify access to repositories.
6. Select the account where Netlify should be installed to allow it to host applications in repositories found there.
7. Choose between allowing Netlify to access all repositories or only selected repositories (preferred). If the latter is selected, choose a specific repository.
8. Click the Install button.
9. Enter your password for the repository service.
10. Click a repository name to configure its Netlify options. These include the branch to deploy, the build command to run, and the directory to publish that contains build artifacts. In the case of Svelte and Sapper, the build command should be `npm install; npm run build`. The directory to publish should be `public` for Svelte and `__sapper__/build` for Sapper.
11. If your build process requires environment variables to be set, click the Show Advanced button. For each environment variable needed, click the New Variable button and enter a name and value.
12. Click the Deploy Site button. The message "Site deploy in progress" will appear for a few seconds, and then the URL of the newly deployed application will be displayed. If the build fails, a red link that says "Site deploy failed" will be displayed. Click this to see the error messages.
13. The provided URL is fine for testing, but you will want a better URL for users. To change the URL, click the Site Settings button and the Change Site Name button. Enter a new site name. It must be unique among all domains that end in .netlify.com. For example, you can try changing the site name to "travel-packing".
14. To add a custom domain, click the Domain Settings and Add Custom Domain buttons. Of course, you need to own a domain to do this.
15. To run the app, click its URL link or enter the URL in a browser.

When changes are pushed to the repository, Netlify will automatically rebuild and redeploy the site. This can be seen by browsing the Netlify site and clicking the Deploys tab. There will be a row at the top of the list of deploys that says "Building." If you are already viewing this page, refresh the browser to get an updated list of deploys. To monitor the build progress, click the "Building" row that displays the "Deploy log."

To manually trigger a new deploy, click Deploys near the top of the page, click the Trigger Deploy drop-down, and select Deploy Site. This is useful after making changes to the deploy settings, such as changing the build command.

13.2.2 Netlify from the command line

To install the Netlify CLI for operating on Netlify sites from the command line, follow these steps:

1. Enter `npm install -g netlify-cli`.
2. Enter `netlify login`, which launches a website.
3. Click the Authorize button. This stores an access token in your home directory in the file `.netlify/config.json`. The access token is automatically used by the Netlify CLI commands.

For help on the `netlify` command, enter `netlify help` or just `netlify`.

To create a Netlify site from code in the current directory, enter `netlify init` and answer a few questions. If the current directory is a local source repository, this will associate the site with it, so that pushes will trigger deploys. However, the current directory is not required to be a local source repository.

If the current directory becomes a source repository later, it can be linked to the Netlify site by entering `netlify link`. This is an optional step that causes pushes to automatically trigger a deploy.

To deploy the current directory site using the latest code changes when it is unlinked (not associated with a remote repository), follow these steps:

1. If the dependencies of the site have not yet been installed, enter `npm install`.
2. Build the site locally by entering `npm run build`.
3. Enter `netlify init` to create a Netlify site for this app.
4. Select Yes, Create and Deploy Site Manually.
5. Select a team, likely your own.
6. Optionally enter a site name with no spaces.
7. Enter `netlify deploy --dir build`.
8. Select Create & Configure a New Site.
9. Select a team name, which is typically the one associated with your account.
10. Optionally enter a site name.

This will output a “live draft URL” at which the site can be tested.

You can deploy the site to its production URL by entering `netlify deploy --prod --dir build`. This will output a “live URL” at which users can visit the site.

The same steps can be used to deploy a site that was created through the Netlify website.

To open the web-based Netlify admin UI for the current directory site, enter `netlify open:admin`. To open the current directory site, enter `netlify open:site`.

To delete the Netlify site for the current directory, follow these steps:

1. Enter `netlify open`.
2. Click the Site Settings button.
3. Scroll to the bottom and click the red Delete This Site button.
4. Enter the site name in the input.
5. Click the red Delete button.

For more details on Netlify, see the documentation: https://docs.netlify.com/cli/get-started/.

13.2.3 Netlify plans

At the time of this writing, Netlify has three plans. For details on pricing, see www.netlify.com/pricing/.

- *Starter*—This plan is free. It only supports a single team member. Only one build can run at a time. This plan is great for enabling individual web developers to show their applications to others during development and for hosting applications that do not require advanced features or large amounts of bandwidth. It provides up to 100 GB of bandwidth per month for free, and it charges beyond that.
- *Pro*—This plan adds support for three team members, three concurrent builds, and password-protected sites. Additional team members incur added costs.
- *Business*—This plan adds support for five team members and five concurrent builds. Additional team members incur added costs. It also adds support for single sign-on (SSO), role-based access control (RBAC), full audit logs, 24/7/365 support options, a CDN, and a 99.99% uptime SLA. Pricing is also based on bandwidth usage and total monthly build times.

In addition to hosting web apps, Netlify also hosts serverless functions and FaunaDB, but no other databases.

13.3 Using Vercel

Vercel (https://vercel.com/) bills itself as "the optimal workflow for frontend teams." To get started using Vercel, browse to https://vercel.com/ and click the Start Deploying button. Click the appropriate button to continue with GitHub, GitLab, or Bitbucket. Follow the instructions to finish creating an account.

By default, Vercel projects that are associated with a source repository build and deploy the default branch, which defaults to "master." This can be changed by modifying the default branch in the source repository. Deploying a non-default branch requires custom CI/CD tooling such as GitHub Actions (https://github.com/features/actions).

There are two ways to create and deploy projects in Vercel: using the website and working from the command line.

13.3.1 Vercel from the website

Code for a new site can be created from a template. There are templates for many kinds of projects, including Create React App, Next.js, Gatsby, Vue.js, Nuxt.js, Svelte, Sapper, and more.

Alternatively, code for a new site can be obtained from a GitHub, GitLab, or BitBucket repository. Pushing changes to the repository will trigger a new build and deploy.

To create a project and build and deploy it, follow these steps:

1. Browse to https://vercel.com.
2. Click Login in the upper right and log in to your account.
3. Click the Import Project button.
4. The first time a given repository service is used, Now integration must be installed. For example, for GitHub, click the Install Now for GitHub button.
5. Select a repository account, and enable it for All Repositories or Only Select Repositories (preferred).
6. Click the Install button.
7. Enter your password for the repository service.
8. To use an existing repository, select it and click the Import button.
9. Wait for the initial project build to complete.
10. To run the project, browse to the provided URL, which will have the format `*project-name*.*username*.now.sh`. Alternatively, just click the Visit button.

Now when changes are pushed to the repository, Vercel will automatically build and deploy the project. To customize the build process, modify the npm `build` script in the `package.json` file in the top project directory.

13.3.2 Vercel from the command line

To install the `vercel` command for operating on Vercel projects from the command line, follow these steps:

1. Enter `npm install -g vercel`.
2. Enter `vercel login`.
3. After being prompted, enter your email address.
4. Click the Verify button in the email you receive.

For help on using the `vercel` command, enter `vercel help`.

To create and deploy a Vercel project from the current directory, enter `vercel`. The project does not need to be in a source repository. This is by far the easiest way to deploy a web application.

To list all your deployments, enter `vercel ls`.

To delete a deployment from the command line, `cd` to the top project directory and enter `vercel projects rm *project-name*`.

13.3.3 Vercel tiers

At the time of this writing, Vercel has three tiers. For details on pricing, see https://vercel.com/pricing.

- *Free*—This tier only supports a single user. It also supports use of serverless functions. Only one build can run at a time.
- *Pro*—This tier adds support for 10 team members and concurrent builds. Additional team members incur added costs.
- *Enterprise*—This tier adds an SLA for 99.99% uptime, enterprise support, audit logs, and more.

13.4 Using Docker

Svelte applications can be deployed as Docker images. To create and run a Docker image for a Svelte application locally, follow these steps:

1. Install Docker from https://docs.docker.com/get-docker/.
2. Create a `Dockerfile` file containing the following:

```
FROM node:12-alpine
WORKDIR /usr/src/app
COPY package*.json ./
RUN npm install
COPY . .
EXPOSE 5000
ENV HOST=0.0.0.0
CMD ["npm", "start"]
```

3. Add the following scripts in `package.json`:

```
"docker:build": "docker build -t svelte/app-name .",
"docker:run": "docker run -p 5000:5000 svelte/app-name",
```

4. Enter `npm run docker:build`.
5. Enter `npm run docker:run`.

Details on deploying a Docker image to the cloud are provider-specific. Examples include Amazon Web Services (AWS), Google Cloud Platform (GCP), and Microsoft Azure.

In the next chapter we will explore some advanced features of Svelte.

Summary

- Deploying Svelte apps is easy.
- Using a service like Netlify or Vercel makes it even easier.
- Vercel provides the easiest command-line option, only requiring you to enter the single command `vercel` to create and deploy a new project.

14 Advanced Svelte

This chapter covers

- Form validation
- Using CSS libraries
- Special elements
- Importing JSON files
- Creating component libraries
- Web components

This chapter will wrap up our coverage of Svelte with a collection of relatively unrelated topics. What they have in common is that they may not be needed for basic Svelte applications.

Web applications that require form input from users typically need to validate that input. There are third-party libraries for other web frameworks that assist with this. However, the form validation that is part of HTML is often sufficient and is easy to use. We will look at how to do so in a Svelte application.

CSS libraries generally provide three things. First is a set of common styles that make it easy to produce polished user interfaces. Second is help with page layout and making user interfaces responsive to a variety of screen sizes. Third is a set of reusable UI components. Examples of CSS libraries include Bootstrap, Foundation, and Material UI. We will look at how one of these libraries, Bootstrap, can be used in Svelte applications.

Svelte supports a set of elements whose names begin with `svelte:`. These enable functionality that is needed in a variety of special circumstances, such as rendering a component identified by an expression, listening to DOM window and body events, binding variables to DOM window properties, inserting elements into the document `head` element, and specifying options for the Svelte compiler.

It can be convenient in some applications to import data from JSON files. Svelte does not support this by default, but the module bundler being used can be configured to support it. We will look at how to do this.

It is common to want to develop collections of components that can be reused across multiple Svelte applications. The steps involved in creating component libraries are only slightly different from the steps for creating a Svelte application. You will see how to implement such a library.

The Svelte compiler can generate web components from Svelte components. If you're new to web components, see www.webcomponents.org/ and *Web Components in Action* by Ben Farrell (Manning, 2019). Web components can be used in applications that are built with other frameworks, such as React, Vue, and Angular. They can even be used in applications that do not use a framework. We will create a couple of web components from Svelte components and use them in a React application.

Changes to the Travel Packing app suggested in this chapter can be found at http://mng.bz/YrlA.

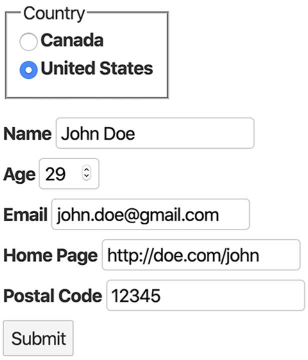
14.1 Form validation

Svelte components can use built-in HTML form validation to validate user inputs. When this is done, the browser provides nice error messages for invalid fields.

A `form` element can contain the form control elements `input`, `textarea`, and `select`. To require users to enter or select a value, add the attribute `required`. The `input` element accepts a `type` attribute that can have many values. Some values such as `email` and `url` provide validation.

When an invalid value is entered in an input, it is given the CSS pseudo-class `:invalid`. Invalid inputs can be styled to indicate this, perhaps by adding a red border.

Figure 14.1 shows an example form that requires a user to enter their name, age, email address, home page URL, and postal code. The required format for postal code changes based on whether they are in the United States or Canada.



Country
○ Canada
● United States

Name John Doe

Age 29

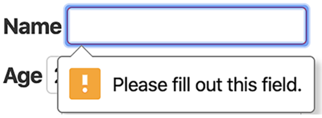
Email john.doe@gmail.com

Home Page http://doe.com/john

Postal Code 12345

Figure 14.1 Form with valid data

Figures 14.2 through 14.8 show the error messages that are displayed if the user omits required data or enters invalid data. These are provided by the browser based on the requirements specified on the input elements.

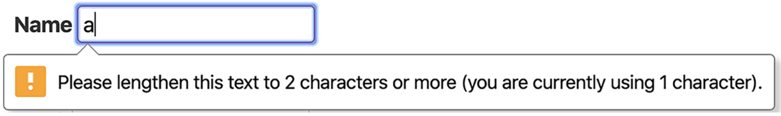


Name

Age

! Please fill out this field.

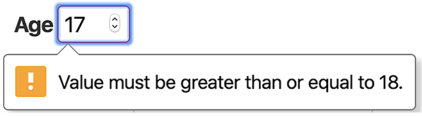
Figure 14.2 Form missing a required field



Name a

! Please lengthen this text to 2 characters or more (you are currently using 1 character).

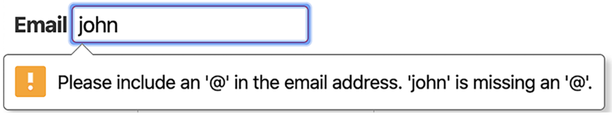
Figure 14.3 Form with invalid name



Age 17

! Value must be greater than or equal to 18.

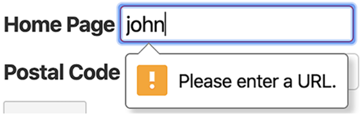
Figure 14.4 Form with invalid age



Email john

! Please include an '@' in the email address. 'john' is missing an '@'.

Figure 14.5 Form with invalid email

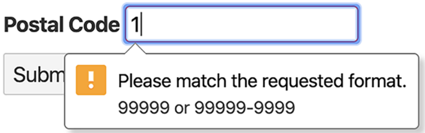


Home Page john

Postal Code

! Please enter a URL.

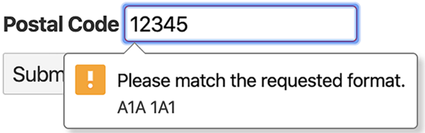
Figure 14.6 Form with invalid home page URL



Postal Code 1

! Please match the requested format.
99999 or 99999-9999

Figure 14.7 Form with invalid US postal code



Postal Code 12345

! Please match the requested format.
A1A 1A1

Figure 14.8 Form with invalid Canadian postal code

The following listing shows a Svelte component that implements the preceding form.

Listing 14.1 App that demonstrates form validation

```
<script>
  const canadaRegExp = '[A-Z][0-9][A-Z] [0-9][A-Z][0-9]';
  const usRegExp = '[0-9]{5}(-[0-9]{4})?';
  const countries = ['Canada', 'United States'];

  let age = 18;
  let email = '';
  let homePage = '';
  let name = '';
  let postalCode = '';
  let postalCodeType = countries[1];

  $: isCanada = postalCodeType === countries[0];
  $: postalCodeExample = isCanada ? 'A1A 1A1' : '99999 or 99999-9999';
  $: postalCodeRegExp = isCanada ? canadaRegExp : usRegExp;

  function submit() {
    alert(`You submitted
      name = ${name}
      age = ${age}
      email = ${email}
      home page = ${homePage}
      postal code = ${postalCode}
    `);
  }
</script>

<form on:submit|preventDefault={submit}>
  <fieldset>
    <legend>Country</legend>
    <div>
      {#each countries as country}
        <label>
        <input
          type="radio"
          name="postalCodeType"
          value={country}
          bind:group={postalCodeType}
        />
        {country}
      </label>
      {/each}
    </div>
  </fieldset>
  <label>
    Name
    <input
      required
      minlength={2}
      maxlength={40}
```

The input pattern attribute does not recognize regular expression character classes like \d.

This allows 5-digit zip codes or the 9-digit ZIP+4 format.

It is customary for the text associated with checkboxes and radio buttons to come after the input element.

```
      placeholder=" "
      bind:value={name}
    />
  </label>
  <label>
    Age
    <input required type="number" min={18} max={105} bind:value={age} />
  </label>
  <label>
    Email
    <input required placeholder=" " type="email" bind:value={email} />
  </label>
  <label>
    Home Page
    <input
      required
      placeholder="http(s)://something"
      type="url"
      bind:value={homePage}
    />
  </label>
  <label>
    Postal Code
    <input
      required
      pattern={postalCodeRegExp}
      placeholder={postalCodeExample}
      title={postalCodeExample}
      bind:value={postalCode}
    />
  </label>
  <button>Submit</button>
</form>

<style>
  fieldset {
    display: inline-block;
    margin-bottom: 1rem;
  }

  input {
    border-color: lightgray;
    border-radius: 4px;
    padding: 4px;
  }

  input:not(:placeholder-shown) {
    border-color: red;
  }

  input:valid {
    border-color: lightgray;
  }
```

This displays example values in a tooltip.

This adds a red border to all inputs where a value has been entered, which is detected by the lack of a placeholder. Of course, this requires all inputs that need this border to have a placeholder attribute, but it can be just a single space.

This adds a lightgray border to all valid inputs, which removes the red border.

```
  label {
    font-weight: bold;
  }
</style>
```

Adding a red border only to `input` elements that contain an invalid value is tricky! The preceding approach, using placeholders, seems to be the easiest.

14.2 Using CSS libraries

As an example of using a CSS library in a Svelte app, let's look at Bootstrap. If Material UI is more your style, Svelte implementations of Material UI-themed components are available on the Svelte Material UI site (https://sveltematerialui.com/).

Bootstrap provides CSS classes that help with page layout and make user interfaces responsive to a variety of screen sizes. Some developers think that these are no longer needed. Layout is well-supported by using CSS flexbox and grid layout. Using CSS media queries in conjunction with these works well. For example, elements that use flexbox can change the value of `flex-direction` between `row` and `column` to switch between laying out elements horizontally and vertically. However, all the CSS classes provided by Bootstrap, including those for its grid system, can be used for layout in Svelte apps.

Bootstrap components can be used in Svelte applications. However, many of them require including jQuery which bloats the bundle size of the app. An alternative is to use the sveltestrap library (https://bestguy.github.io/sveltestrap/), which re-implements nearly all the Bootstrap components as Svelte components These components use Bootstrap CSS classes, but sveltestrap does not include Bootstrap CSS, so that must be downloaded and added with a `link` element.

Bootstrap components typically require the developer to write several nested HTML elements with special CSS classes applied to them. Sveltestrap components are easier to use because they require less markup.

Here are the steps to use sveltestrap in a Svelte application:

1. Enter `npm install bootstrap sveltestrap`.
2. Copy the files `bootstrap.min.css` and `bootstrap.min.css.map` from `node_modules/bootstrap/dist/css` to the `public` directory.
3. Add the following line in `public/index.html` after the other `link` elements:

   ```
   <link rel='stylesheet' href='/bootstrap.min.css'>
   ```

NOTE In order to use Bootstrap styles in a REPL app, all the required files must be imported from a CDN.

Figures 14.9 through 14.12 show an example Svelte app that uses Bootstrap. Listing 14.2 shows the code for the app.

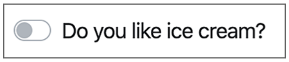
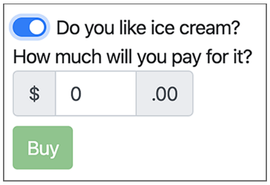
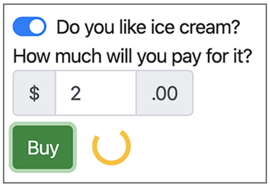


Figure 14.9 Before liking



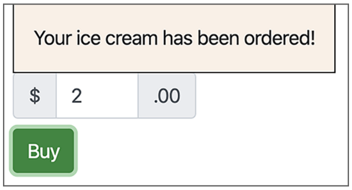
$ 0 .00

Figure 14.10 After liking



$ 2 .00

Figure 14.11 After entering an amount and clicking Buy (shows spinner)


Your ice cream has been ordered!

$ 2 .00

Figure 14.12 Showing toast after order is processed

Listing 14.2 App that demonstrates use of sveltestrap

```
<script>
  import {CustomInput, Spinner} from 'sveltestrap';
  import Toast from './Toast.svelte';

  let amount = 0;
  let like = false;
  let status = '';

  function buy() {
    status = 'buying';
    // Show the toast after 1 second.
    setTimeout(
      () => {
        status = 'bought';
        // Hide the toast after 3 seconds.
        setTimeout(() => status = '', 3000);
      },
      1000);
  }
</script>

<main>
  <CustomInput
    type="switch"
    id="like"
    label="Do you like ice cream?"
    bind:checked={like} />
```

These are Bootstrap components implemented as Svelte components.

Code for this component is shown in listing 14.3.

This is a Bootstrap switch component.

```
  {#if like}
    <label>
      How much will you pay for it?
      <div class="input-group">
        <div class="input-group-prepend">
          <span class="input-group-text">$</span>
        </div>
        <input type="number" class="form-control" min="0" bind:value={amount}>
        <div class="input-group-append">
          <span class="input-group-text">.00</span>
        </div>
      </div>
    </label>
    <div class="btn-row">
      <button class="btn btn-success" disabled={!amount} on:click={buy}>
        Buy
      </button>
      {#if status === 'buying'}
        <div class="spinner-container">
          <Spinner color="warning" />
        </div>
      {/if}
    </div>
  {/if}

  {#if status === 'bought'}
    <Toast>Your ice cream has been ordered!</Toast>
  {/if}
</main>

<style>
  .btn-row {
    display: flex;
    align-items: center;
  }

  button {
    border: none;
  }

  .input-group {
    width: 150px;
  }

  .row > div {
    outline: solid red 1px;
  }

  .spinner-container {
    display: inline-block;
    margin-left: 1rem;
  }
</style>
```

This uses Bootstrap styling to build a fancy input.

This button uses Bootstrap styling.

This is a Bootstrap spinner component.

The following listing shows the code for the `Toast` component. It uses the `fly` transition to animate a toast coming into view and leaving from the top.

Listing 14.3 `Toast` component in `src/Toast.svelte`

```
<script>
  import {fly} from 'svelte/transition';
  let height = 0;
</script>

<div
  class="my-toast"
  bind:clientHeight={height}
  transition:fly={{duration: 1000, opacity: 1, y: -height}}
>
  <slot />
</div>

<style>
  .my-toast {
    display: inline-flex;
    align-items: center;

    background-color: linen;
    border: solid black 1px;
    border-top: none;
    box-sizing: border-box;
    padding: 1rem;
    position: absolute;
    top: 0;
  }
</style>
```

The default value of 0 will be changed by the bind below.

This gets the height of this div.

Bootstrap defines a CSS class named "toast", so I named this "my-toast".

14.3 Special elements

Svelte supports many special elements that have the form `<svelte:`*`name props`*`>`. They are placed in the HTML section of `.svelte` files.

- `<svelte:component this={`*`expression`*`}` *`optionalProps`* `/>`

  This renders the component specified by *`expression`*. If *`expression`* is falsy, it renders nothing. The optional props are passed to the component that is rendered.

  We used this in chapter 9 for manual routing, hash routing, and the page library. For example, when we implemented hash routing, the `pageMap` variable held an object that mapped a page name to a page component. The current page was rendered with the following:

  ```
  <svelte:component this={pageMap[pageName]} />
  ```

  The `App.svelte` file of the Travel Packing app also uses this special element for hash routing.

- `<svelte:self` *`props`* `/>`

  This allows a component to render an instance of itself. It supports recursive components and is needed because a component cannot import itself.

  This special element is rarely needed, but one case where it is used is when a component represents a tree node. For example, a genealogy application that renders a family tree might define a `Person` component. Rendering one of these might also render its children, which are also represented by `Person` components.

- `<svelte:window on:`*`eventName`*`={`*`handler`*`} />`

  This registers a function to be called when a given event is dispatched by the DOM `window` object. One example is the `resize` event. Listening for this event allows an application to change the layout of its components based on the window size. It could even remove certain components when the window becomes small and add them back when it becomes large.

  We used this in chapter 9 to implement hash-based page routing. In that case we listened for the `hashchange` event.

  NOTE When possible, it is better to use CSS media queries to change page layout based on window size. See the MDN web docs for more on using media queries: http://mng.bz/GVMO.

- `<svelte:window bind:`*`propertyName`*`={`*`variable`*`} />`

  This binds a variable to a window property. The supported window properties are `innerHeight`, `innerWidth`, `outerHeight`, `outerWidth`, `scrollX`, `scrollY`, and `online`.

  For example, a component can use the following code to obtain the value of `innerWidth` and change its layout based on the value.

  ```
  <svelte:window bind:innerWidth={windowWidth} />
  ```

  The scroll properties can be modified to trigger scrolling the window. All the other properties are read-only. Here's an example:

  ```
  <script>
    const rows = 100;
    const columns = 150;
    let scrollX;
    let scrollY;
  </script>

  <svelte:window bind:scrollX={scrollX} bind:scrollY={scrollY} />

  <button on:click={() => scrollX += 100}>Right</button>
  <button on:click={() => scrollY += 100}>Down</button>

  <!-- This just creates content that can be scrolled. -->
  {#each Array(rows) as _, index}
  ```

  This iterates a given number of times instead of over an existing array.

```
  <div>{index + 1}{'#'.repeat(columns)}</div>
{/each}
```

NOTE A component can only include one `svelte:window` element. but it can listen to any number of events *and* bind to any number of properties.

- `<svelte:body on:`*`eventName`*`={`*`handler`*`} />`

  This registers a function to be called when a given event is dispatched by the DOM `body` element. Examples include `mouseenter` and `mouseleave`. A component can only include one `svelte:body` element, but it can bind to any number of `body` events.

  For example, this can be used to change the background color of an app when the mouse enters and leaves the browser window:

```
<script>
  let bgColor = 'white';
</script>

<svelte:body
  on:mouseenter={() => bgColor = 'white'}
  on:mouseleave={() => bgColor = 'gray'}
/>
<main style="background-color: {bgColor}">
  ...
</main>
```

- `<svelte:head>`*`elements`*`</svelte:head>`

  This inserts elements in the `head` element of the DOM document. Examples include inserting `link`, `script`, and `title` elements. Including a `title` element changes what is displayed in the browser title bar and in bookmarks.

  For example, for the Travel Packing app we can add the following in the HTML section of `src/Login.svelte`:

```
<svelte:head>
  <title>Login</title>
</svelte:head>
```

Add the following in the HTML section of `.src/Checklist.svelte`:

```
<svelte:head>
  <title>Checklist</title>
</svelte:head>
```

Interpolation can be used in the `title` element content to compute a title, as the following example shows in `src/App.svelte`:

```
<script>
  const days = [
    'Sunday', 'Monday', 'Tuesday', 'Wednesday',
    'Thursday', 'Friday', 'Saturday'
  ];
  const dayName = days[new Date().getDay()];
</script>
<svelte:head>
  <title>Today is {dayName}</title>
</svelte:head>
<!-- More page content goes here. -->
```

If multiple components insert elements into the head that cannot be duplicated, such as the `title` element, the value of the element will be updated by the last one rather than adding multiple elements.

NOTE Using `<svelte:head>` has no impact inside the REPL.

- `<svelte:options` *`option`*`={`*`value`*`} />`

  This is used to specify options for the Svelte compiler. Most applications do not need to set any of these options, but it's important to be aware of them so you can recognize when they are needed.

  This element is placed at the top of a `.svelte` file, before any other elements (not inside the `script` element).

  The following compiler options can be specified:

  – `immutable`—This means props will be treated as immutable, which provides an optimization. The default value is `false`.

    Being *immutable* means parent components will create new objects for all object props rather than modifying properties of existing objects. This allows Svelte to determine whether a prop has changed by comparing object references rather than object properties.

    When this option is set to `true`, if a parent component modifies the object properties of a child component, the child will not detect the change and will not re-render.

    In the Travel Packing app, we can add `<svelte:options immutable={true} />` or the equivalent of `<svelte:options immutable />` at the top of the `Dialog` component source file. We cannot add it to the `Category` component because that takes the prop `categories`, which is an object whose properties are modified in its parent component `Checklist`. We cannot add it to the `Item` component because that takes the prop `item`, which is an object whose `packed` property is modified when the checkbox for an item is toggled. There is no point in adding it to the `Login` or `Checklist` components because those do not take any props.

  – `accessors`—This adds getter and setter methods for the component props. The default is `false`. This option isn't really needed when components are used in a Svelte app because the `bind` directive can be used instead to attach a variable to a prop. It can be useful when Svelte components are compiled to custom elements and those are used in non-Svelte apps. You will learn how to do this in section 14.6.

Having a setter method allows non-Svelte code to modify the value of a component prop after it has been rendered. Having a getter method allows non-Svelte code to obtain the current value of a component prop after it has been rendered.

- `namespace="`*`value`*`"`—This specifies the namespace of the component. One use is for Svelte components that only render SVG. Those can use a namespace of `svg`.
- `tag="`*`value`*`"`—This specifies the name to use when a Svelte component is compiled as a custom element. It allows Svelte components to be used as custom elements in non-Svelte apps. See section 14.6 for examples of using this option.

14.4 Importing JSON files

Svelte applications can import JSON files if the module bundler is configured to support this. By default, Svelte applications use the Rollup module bundler. Here are the steps to configure it:

1. Install the required Rollup plugin by entering `npm install -D @rollup/plugin-json`.
2. Edit `rollup.config.js`.
3. Add `import json from '@rollup/plugin-json';` near the top with the other imports.
4. Add `json()` in the `plugins` array. For example, it should already contain `commonjs()`.

After restarting the Svelte server, you will be able to process code like the following:

```
import myData from './myData.json';
```

14.5 Creating component libraries

Svelte components can be reused by multiple Svelte applications. For example, suppose we implement a component that renders a bar chart. We might want to use it in an application that shows company profits by quarter and also in a separate application that shows changes in utility bills by month.

A good way to achieve Svelte component reuse is to create an npm package that defines the components, install that package in the apps that will use the components, and import them where needed.

To create an npm package that defines Svelte components, follow these steps:

1. Choose a library name that is not already registered in npm.
2. Create a Svelte project for the library by entering the following:

   ```
   npx degit sveltejs/component-template library-name
   ```

3. Enter `cd` *`library-name`*.

4. Create a `.svelte` file for each component in the `src` directory.
5. Delete the provided example file, `src/Component.svelte`.
6. Replace the content of `src/index.js` with a line like the following for each component:

   ```
   export {default as MyComponentName} from './MyComponentName.svelte';
   ```

7. Edit `package.json`.
   - Change the `name` property value to the library name.
   - Add a `version` property such as `"version": "0.1.0",`.
8. Build the component library by entering `npm run build`. This creates a `dist` directory and the files `index.js` and `index.mjs` inside it, which contain all the required Svelte library code and the definitions of all the components. The `index.js` file contains CommonJS definitions. The `index.mjs` file contains ES Module definitions. Svelte applications that use the components will get their definitions from one of these files.
9. Create a GitHub repository for the library.
10. Add the contents of this directory to the GitHub repository.
11. If you're not already logged into npm, enter `npm login`.
12. Every time changes need to be published, bump the version in `package.json` and tag the GitHub repository by entering the following commands:

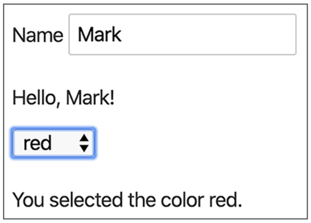
    ```
    npm version patch|minor|major
    git push --tags
    git push
    ```

    Choose one of these options based on the kind of change being made.

13. Publish the library to npm by entering `npm pub`.

To use Svelte components defined in an npm package in a Svelte app, follow these steps:

1. Install the library by entering `npm install` *`library-name`*. For example, `npm install rmv-svelte-components`.
2. Import the components to be used. For example, `import {LabeledInput, Select} from rmv-svelte-components;`
3. Use the components like any other Svelte components. For example, the app in listing 14.9 uses the components `LabeledInput` and `Select` from the `rmv-svelte-component` library (see figure 14.13).



Name Mark

Hello, Mark!

red

You selected the color red.

Figure 14.13 App that uses library components

Listing 14.4 App that uses library components

```
<script>
  import {LabeledInput, Select} from 'rmv-svelte-components';
  let color = '';
  let name = 'Mark';
  let options = ['', 'red', 'green', 'blue'];
</script>

<main>
  <LabeledInput label="Name" bind:value={name} />
  <p>Hello, {name}!</p>
  <Select {options} on:select={event => color = event.detail} />
  <p>You selected the color {color}.</p>
</main>
```

14.6 Web components

The Web Components standard defines the ability to create custom elements. These are custom HTML elements that can be used in web frameworks (such as React, Vue, and Angular) and when using no framework (just JavaScript and the DOM).

Svelte components can be compiled into custom elements. However, there are some limitations to keep in mind:

- The styles for these components are copied to the generated JavaScript code and used as inline styles. This means they cannot be overridden by external CSS rules. For this reason, it is best for such Svelte components to include minimal CSS to maximize the degree to which applications that use them can apply styling.
- In Svelte components that use slots to render child content, `{#if}` and `{#each}` blocks surrounding slots are ignored.
- The `slot` directive `:let` is ignored. This is a rarely used feature.
- Using Svelte-based custom elements in older browsers requires polyfills.

Follow these steps to generate custom elements from a set of Svelte components:

1. Create a new Svelte project with `npx degit sveltejs/template` *`project-name`*.
2. Enter `cd` *`project-name`*.
3. Enter `npm install`.
4. Add `.svelte` files defining components in the `src` directory.

   Here is one example of a basic component, the `Greet` component in `src/Greet.svelte`:

```
<script>
  export let name = 'World';
</script>

<div>Hello, {name}!</div>
```

And here is another, the `Counter` component in `src/Counter.svelte`:

```
<script>
  export let count = 0;
</script>

<div class="counter">
  <button on:click={() => count--}>-</button>
  <span>{count}</span>
  <button on:click={() => count++}>+</button>
</div>

<style>
  button {
    border: solid lightgray 1px;
    border-radius: 4px;
    padding: 10px;
  }

  .counter {
    font-size: 24px;
  }
</style>
```

5 Specify a tag at the top of each component `.svelte` file. Tags must contain at least one hyphen. Typically they consist of a common prefix string followed by a hyphen and an element name. We will use “svelte” for the prefix.

For example, we can add this to `src/Greet.svelte`:

```
<svelte:options tag="svelte-greet" />
```

And we can add this to `src/Counter.svelte`:

```
<svelte:options tag="svelte-counter" />
```

If the tag is `{null}` instead of a string, applications that import the custom element can specify the name of the custom element. This changes the way applications configure the use of custom elements, and is explained below.

6 To verify that the components work as expected, render them in `App.svelte`, as in this example:

```
<script>
  import Counter from './Counter.svelte';
  import Greet from './Greet.svelte';
</script>

<Greet name="Mark" />
<Counter />
```

7 Test the components by entering `npm run dev` and browsing to `localhost:5000`.

8. Create a `custom-elements.js` file that imports the components. For example, if the components are `Counter` and `Greet`, the contents should be as follows:

   ```
   import Counter from './Counter.svelte';
   import Greet from './Greet.svelte';
   export {Counter, Greet};
   ```

9. Copy `rollup.config.js` to `rollup.ce-config.js`.
   - `ce` stands for custom elements, but the actual name is not important.
10. Modify `rollup.ce-config.js`:
    - Change the `input` property value from `'src/main.js'` to `'src/custom-elements.js'`.
    - Change the `format` property of `output` from `iife` to `es`.
    - Add `customElement: true` to the object passed to the `svelte` function in the `plugins` array.
11. Add the following npm script in `package.json`:

    ```
    "custom-elements": "rollup -c rollup.ce-config.js",
    ```

12. Enter `npm run custom-elements`. This generates files in the `public/build` directory that define custom elements for the components.

The following steps show how you can use these custom elements in a new React application:

1. Create a new React application by entering `npx create-react-app` *`app-name`*.
2. Enter `cd` *`app-name`*.
3. Copy the file `public/build/bundle.js` from the Svelte project to the `src` directory of the React application, and rename it `svelte-elements.js`.
4. If using ESLint (and why wouldn't you?), edit `svelte-elements.js` to ignore some ESLint issues:

   ```
   /* eslint-disable eqeqeq, no-self-compare, no-sequences, no-unused-
     expressions */
   ```

5. Edit `src/index.js`.

   If the custom elements used a `{null}` tag, add the following after the existing imports to import JavaScript classes that define the custom elements and assign names to them.

   ```
   import {Counter, Greet} from './svelte-elements';
   customElements.define('svelte-greet', Greet);
   customElements.define('svelte-counter', Counter);
   ```

   If the custom elements each specified a tag name, the preceding code that defines custom elements will already be in the `svelte-elements.js` file. This frees users of the custom elements from needing to do this. In this case, just add the following line after the existing imports to import the custom elements that already have names.

```
import './svelte-elements';
```

NOTE Specifying a `{null}` tag is often preferred because it allows users of the component to choose the name. This matches the way components work in Svelte, where a component is defined by a source file but does not specify the name of the component. When web components are given names, there is the possibility that two component authors might select the same name. This makes it difficult to use both components in the same app.

6. Render the custom elements in React components. For example, the following lines can be added in the JSX of `src/App.js`:

```
<svelte-greet name="Mark" />
<svelte-counter />
```

Empty custom elements

The self-closing versions of the custom elements above only work in the context of JSX. When using them in a setting where JSX is not supported, they must be written as follows:

```
<svelte-greet name="Mark"></svelte-greet>
<svelte-counter></svelte-counter>
```

7. Enter `npm start` to run the React app.
8. Verify that the custom elements render correctly.

NOTE React currently only supports passing primitive values as props to custom elements. Objects and arrays cannot be passed. See the notes on React at https://custom-elements-everywhere.com/. This is a significant limitation. React relies on its own *synthetic events* for representing DOM events. It cannot currently listen for DOM events emitted by custom elements.

A similar approach can be employed to use custom elements in other frameworks such as Vue and Angular.

For another approach to creating custom elements from Svelte components, see the video “How to create a web component in sveltejs” at http://mng.bz/zjqQ.

The command-line tool publish-svelte (or “pelte” for short) at https://github.com/philter87/publish-svelte automates the previous steps to generate custom elements from a set of Svelte components. It compiles and bundles a single Svelte component into a custom element. Then it publishes the custom element to npm for use in applications. The author of publish-svelte plans to enhance it to support publishing multiple Svelte components to a single npm package.

In the next chapter we will begin exploring Sapper, which is a framework built on Svelte that adds many features.

Summary

- Form validation can be added to Svelte apps using features provided by HTML.
- CSS libraries such as Bootstrap, Foundation, and Material UI can be used in Svelte apps.
- Svelte provides special elements to implement features that cannot be implemented in a Svelte app using HTML elements alone.
- Svelte apps can import JSON files if the module bundler is configured to support this.
- It is possible to create libraries of Svelte components that can be reused across multiple applications.
- It is possible to generate custom elements from Svelte components so they can be used in web applications that use any web framework or no framework.

Part 3

Deeper into Sapper

Part 3 explores Sapper, a tool that builds on Svelte to add more features. We'll build our first Sapper application, which will recreate the shopping app we developed earlier in the book, and take a closer look at Sapper's unique features, such as page routes, page layouts, preloading, prefetching, and code splitting. We'll also cover server routes, which enable API service implementation in the same project as the client side of a web app. Sapper apps can be "exported" to generate static sites, which can be desirable when you want to generate the HTML for every page at build time. This part will cover that topic and look at an example app that builds on it, along with service worker caching strategies and events. Finally, we'll look at techniques to verify the offline behavior of a Sapper app.

15 Your first Sapper app

This chapter covers

- Reasons to use Sapper
- Creating a new Sapper app
- Redeveloping the shopping application with Sapper

In this chapter we will review the benefits of using Sapper and walk through developing a Sapper app.

As you learned in chapter 1, Sapper (https://sapper.svelte.dev/) is a framework built on top of Svelte. It is used to create more advanced web applications that take advantage of one or more of the features summarized below.

- *Sapper provides page routing*, which associates URLs with the "pages" in an app and defines how navigation between pages is described in markup. Having a unique URL for each page allows those pages to be bookmarked so users can begin subsequent sessions on different pages.
- *Sapper supports page layouts*, which define a common layout for sets of pages within an app. This can include common areas of a page such as headers, footers, and navigation.

- *Sapper provides server-side rendering* (SSR), which allows the generation of HTML for pages to occur on the server instead of in the browser. This can provide a better user experience for rendering the initial page, because it is typically faster to generate this HTML on the server than to download the JavaScript required to render it in the browser and then do so. JavaScript for rendering subsequent pages can then be downloaded in the background before the user navigates away from the initial page.
- *Sapper supports server routes*, which provide an easy way to implement Node-based API services in the same project as the frontend web application. This allows API services to be implemented in the same programming language that is used to implement the user interface, avoiding a mental switch between languages. Having frontend and backend code in the same project naturally leads toward storing it in the same source repository, which is convenient for developers who maintain both kinds of code.
- *Sapper supports code splitting*, which allows the JavaScript required for each page of the application to be downloaded only when a page is visited for the first time. This reduces the initial load time because it is no longer necessary to download all the code for the app at startup. It also avoids downloading code for pages that are never visited.
- *Sapper supports prefetching*, which provides faster page loads by anticipating the next page a user will visit based on mouse hovers. Page links can be configured so if a user hovers over it, Sapper will begin downloading the code needed to render the page before the user clicks the link. This provides a better user experience because it decreases the time required to render the next page.
- *Sapper supports static site generation* by crawling a Svelte web app at build time and generating the HTML that each page renders. This produces a site where all the pages a user might visit have already been rendered to HTML files. It provides a better user experience because when users visit each page, no server-side or client-side HTML generation is required. Static sites can include JavaScript code that provides dynamic behavior.
- *Sapper supports offline usage* by using a service worker in order for some portions of an application to remain usable when network connectivity is lost. This includes issues with internet providers and cell phone connectivity.
- *Sapper supports end-to-end testing* using Cypress. This enables you to write comprehensive tests that exercise an application in ways that a user would. It can simulate user actions such as typing text into input fields, selecting items from dropdowns, and clicking buttons. Everything needed to implement and run Cypress tests is preconfigured in Sapper projects created using a template described in the next section.

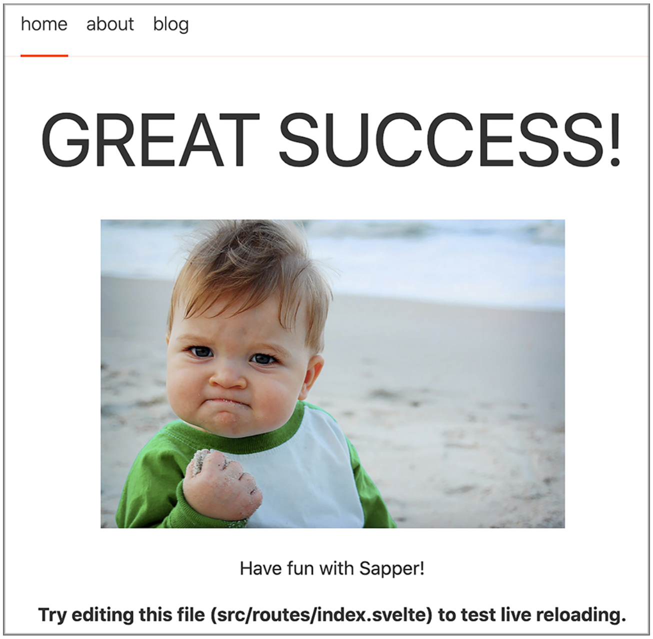
In this chapter we will recreate the shopping application from chapter 9 using Sapper. It will use page routing, page layouts, server-side rendering, and code splitting. This will serve to demonstrate how easy it is to take advantage of some of the features of Sapper.

15.1 Creating a new Sapper app

Let's walk through the steps to create and run a Sapper application. It will have Home, About, and Blog pages, along with a way to navigate between them. The Sapper home page recommends that you start any Sapper application from this beginning point and then customize the pages and their navigation to suit the app you would like to create.

1. If you haven't already, install Node.js from https://nodejs.org.
2. Create the starting directory structure and files for a new application. Choose between using the Rollup or Webpack module bundler. To use Rollup, enter `npx degit sveltejs/sapper-template#rollup` *`app-name`*. To use Webpack, enter `npx degit sveltejs/sapper-template#webpack` *`app-name`*.
3. Enter `cd` *`app-name`*.
4. Enter `npm install`.
5. Enter `npm run dev`. This starts a local HTTP server and provides live reload, unlike `npm start`, which omits live reload. Then browse to localhost:3000.

   The default Sapper app contains three "pages" or "routes" with navigation links at the top. The routes are Home, About, and Blog. Links on the Blog page open sub-pages that render specific blog content. These pages are shown in figures 15.1, 15.2, and 15.3.

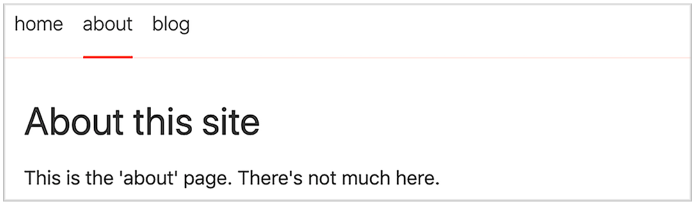


GREAT SUCCESS!

Have fun with Sapper!

Try editing this file (src/routes/index.svelte) to test live reloading.

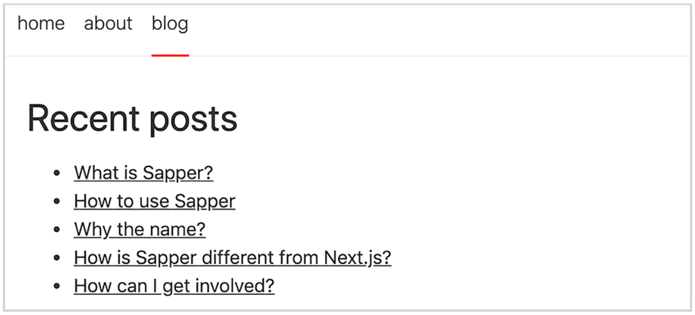
Figure 15.1 Home page



About this site

This is the 'about' page. There's not much here.

Figure 15.2 About page

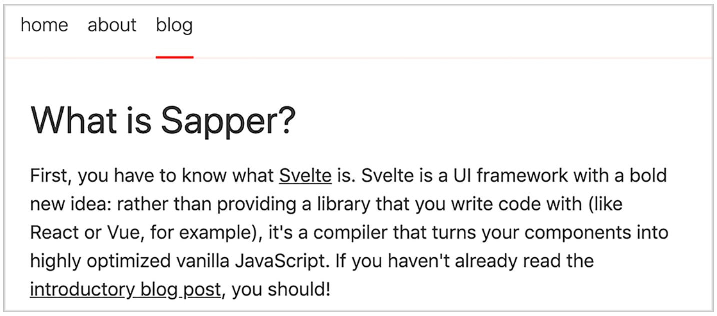


Recent posts

- What is Sapper?
- How to use Sapper
- Why the name?
- How is Sapper different from Next.js?
- How can I get involved?

Figure 15.3 Blog page

The page in figure 15.4 is rendered when the first link on the Blog page is clicked.



What is Sapper?

First, you have to know what Svelte is. Svelte is a UI framework with a bold new idea: rather than providing a library that you write code with (like React or Vue, for example), it's a compiler that turns your components into highly optimized vanilla JavaScript. If you haven't already read the introductory blog post, you should!

Figure 15.4 Blog page for "What is Sapper?"

Now we can begin modifying the app.

15.2 Recreating the shopping app with Sapper

Let's recreate the shopping application from chapter 9 using Sapper. The code for this app can be found at http://mng.bz/NKG1.

This is a simpler app to start with than the Travel Packing app. We will tackle creating a Sapper version of that in chapter 16.

Change the links at the top of the pages to be “Shop”, “Cart”, and “Ship”. To do this, modify `Nav.svelte` and change the `li` elements to match the following.

Listing 15.1 Nav component in `src/components/Nav.svelte`

```
<li>
  <a aria-current={segment === undefined ? 'page' : undefined}
    href=".">Shop</a>
</li>
<li>
  <a aria-current={segment === "cart" ? 'page' : undefined}
    href="cart">Cart</a>
</li>
<li>
  <a aria-current={segment === "ship"? 'page' : undefined}
    href="ship">Ship</a>
</li>
```

NOTE For details on the `aria-current` attribute, see the W3C documentation (www.w3.org/TR/wai-aria-1.1/#aria-current), which says “Indicates the element that represents the current item within a container or set of related elements.”

NOTE Perhaps you don’t want the page links to be at the top of the page, or you want to style them differently. You’ll see how to change them in section 16.2.

Files in the `src/routes` directory represent the pages in the app. These define Svelte components, but the filenames are all lowercase. This is because these names become part of the URLs for visiting the pages, and it is common for URLs to be lowercase.

Make the following changes to files in the `src/routes` directory:

1. Rename `about.svelte` to `cart.svelte`.
2. Modify `cart.svelte` to match the following:

   ```
   <svelte:head>
     <title>Cart</title>
   </svelte:head>

   <h1>Cart</h1>

   <p>This is the 'cart' page.</p>
   ```

3. Copy `cart.svelte` to `ship.svelte`.
4. Modify `ship.svelte` to match the following:

   ```
   <svelte:head>
     <title>Ship</title>
   </svelte:head>
   ```

```
<h1>Ship</h1>

<p>This is the 'ship' page.</p>+
```

5. Delete the `blog` directory in `src/routes`.
6. Modify the bottom of `index.svelte`, which represents the Home page of the app, to match the following:

   ```
   <svelte:head>
     <title>Shop</title>
   </svelte:head>

   <h1>Shop</h1>
   ```

7. Delete the following line in `src/routes/_layout.svelte`:

   ```
   max-width: 56em;
   ```

   Removing this left-justifies the content of each page. Page layouts will be discussed in the next chapter.

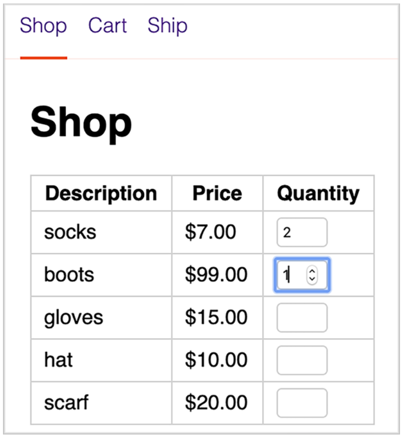
We now have the three pages we need for the shopping app. Assuming the app is still running, click the links at the top to verify that navigating between the pages still works.

Another way to navigate to a page is to manually change the URL in the browser's address bar. Change it to end with `/cart` or `/ship` to switch to those pages. Remove the path at the end to switch to the Shop page, since it is the Home page.

Now let's copy code from chapter 9 to finish implementing the three pages:

1. Copy `public/global.css` from the chapter 9 version of the shopping application to the `static` directory, replacing the existing file. This includes styling for tables.
2. Copy `src/items.js` from chapter 9 to the `src` directory. This defines the items available for sale.
3. Copy `src/stores.js` from chapter 9 to the `src` directory. This defines a writable store that holds items in the cart.
4. Copy the code in `src/Shop.svelte` from chapter 9 into the existing `src/routes/index.svelte` file. The only code currently in `index.svelte` that should be retained is the `<svelte:head>` element, which should be the first element after the `script` element. Change the path for the imports at the top of the `script` element to begin with `..` since those files are in the parent directory of the `routes` directory.
5. Repeat what was done with `src/Shop.svelte` to copy code in `src/Cart.svelte` from chapter 9 into `src/routes/cart.svelte` and to copy code in `src/Ship.svelte` from chapter 9 into `src/routes/ship.svelte`.

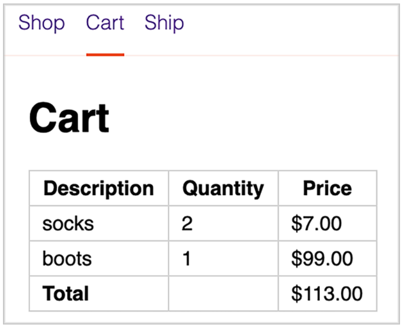
The app should now be operational. Figures 15.5, 15.6, and 15.7 show screenshots of the three pages with some data entered.



Shop

Description	Price	Quantity
socks	$7.00	2
boots	$99.00	1
gloves	$15.00	
hat	$10.00	
scarf	$20.00	

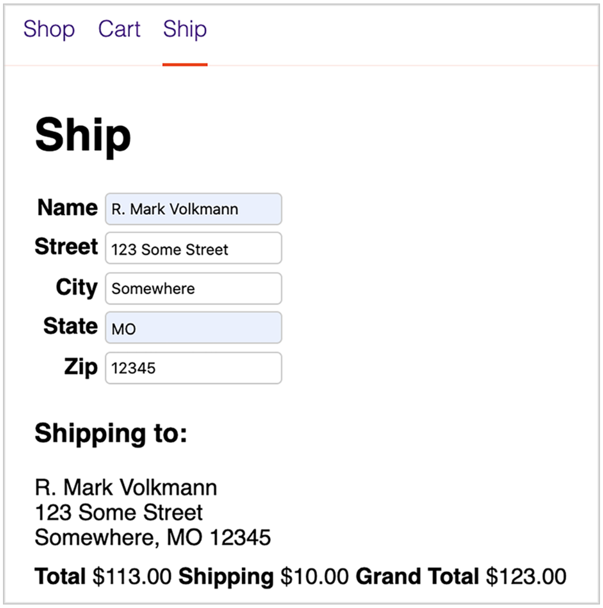
Figure 15.5 Shop page



Cart

Description	Quantity	Price
socks	2	$7.00
boots	1	$99.00
Total		$113.00

Figure 15.6 Cart page



Ship

Name R. Mark Volkmann
Street 123 Some Street
City Somewhere
State MO
Zip 12345

Shipping to:

R. Mark Volkmann
123 Some Street
Somewhere, MO 12345

Total $113.00 **Shipping** $10.00 **Grand Total** $123.00

Figure 15.7 Ship page

What did we gain by using Sapper instead of straight Svelte? We now have simple page routing, server-side rendering, and code splitting.

To see server-side rendering in action, open the DevTools in the browser window where the app is running, click the Network tab, and refresh the browser. There will be a `GET` request to http://localhost:3000/ that returns HTML for the first page, which is the Shop page. The remaining pages are created in the browser by downloaded JavaScript code.

To see code splitting in action within the DevTools Network tab, click the Cart or Ship link at the top of the page. The first time each page is rendered, new files are downloaded with names like `cart.`*`hash`*`.js`, `ship.`*`hash`*`.js`, and `ship.`*`hash`*`.css`. The Cart page does not contain a `style` element, so no `cart.`*`hash`*`.css` is downloaded.

In the next chapter we will dive deeper into Sapper projects and learn about their directory structure, more on routes, page layouts, preloading, prefetching, code splitting, and more.

Summary

- Sapper builds on Svelte to add many features.
- Creating a new Sapper app is as easy as running `npm degit`.
- Pages in a Sapper app are defined by files in the `src/routes` directory.
- Navigation to pages is implemented with HTML anchor elements (`<a>`).
- Sapper automatically provides many benefits.

16 Sapper applications

This chapter covers

- The file structure of Sapper projects
- Page routes
- Page layouts
- Handling errors
- Running on both server and client
- The Fetch API wrapper
- Preloading data needed by pages
- Prefetching for faster page loads
- Code splitting

The previous chapter provided a taste of using Sapper. Now it's time to dig deeper into a series of topics covering its most commonly used features:

- *File structure*—While it is not technically necessary to understand the purpose of every directory and file in a Sapper project, being exposed to this information will give you a better understanding of what Sapper provides and how the pieces fit together. By the time you've finished this chapter, you will feel comfortable navigating a Sapper project.

- *Page routes*—Sapper routes greatly simplify creating apps where users can navigate to multiple pages, like the three pages in the Shopping app from chapter 15.
- *Page layouts*—Page layouts are Svelte components that provide a common layout to a set of pages. A scenario supported by page layouts is when multiple pages in an app have common sections, such as a header, footer, or left nav. We will explore implementing custom page layouts.
- *Error handling*—Things can go wrong when web apps invoke server APIs. Maybe the URL of the service has changed, the service is down, invalid data is passed, a database error occurs, or there is a logic error in the server-side code. These kinds of errors should typically be described on a dedicated, nicely formatted, informative error page. Sapper supports configuring such a page, and you will see how to do this.
- *Client and server code*—When writing Sapper apps, it is important to consider where each piece of JavaScript code will run. It may run only in the browser, only on the server, or in both places. You will learn how to determine this, why it matters, and how to avoid errors from code running in the wrong environment.
- *Preloading and prefetching*—The Sapper concepts of preloading and prefetching coordinate data loading and provide performance benefits. We'll explore when and how to use these features.
- *Code splitting*—Finally, we will dig into the details of code splitting to understand the benefit it brings and its relationship with prefetching.

We have a lot of exciting concepts to learn and material to cover, so let's get to it!

> **NOTE** This chapter uses the term "API service" when referring to any kind of remote service to which a request can be sent from the client side of a web app. This includes REST services.

16.1 Sapper file structure

Sapper apps created from `sveltejs/sapper-template` begin with the directory structure described in this section. Typically most of the files described here do not require modification. Those that do are noted in their descriptions.

Let's take a high-level look at the project structure.

- `__sapper__` directory—This contains the following subdirectories:
  - `build` subdirectory—This is the destination for generated build artifacts. This directory and the files in it are created by entering `npm run build`, if they do not already exist. A simple way to serve the app locally is to enter `npm start` and browse to localhost:3000.
  - `dev` subdirectory—This is the destination for generated, development-mode artifacts. This directory and the files in it are created by entering `npm run dev`, if they do not already exist.

  - `export` subdirectory—This is the destination for files generated by `npm run export`, which generates a static site. Using Sapper in this way is similar to using Gatsby to generate a static site from React components. We will cover this in detail in chapter 18.
- `cypress` directory—This contains directories and files for running end-to-end tests. The Cypress test tool was described in chapter 12. Using Cypress with Sapper apps works in much the same way as it does with Svelte apps.
- `node_modules` directory—This contains dependency package files installed by running `npm install`. All project dependencies are described in `package.json`.
- `src` directory—This contains application code and is where most of your changes will take place.
  - `components` subdirectory—This contains Svelte components that are used in pages of the app.
    - `Nav.svelte`—This file defines nav bar links for navigating to the pages in the app. Modify it to change page navigation.
    - `routes` subdirectory—This contains Svelte components that represent the pages in the app.
    - `client.js`—This file is the starting point of the client-side Sapper app. It is not typically modified.
    - `server.js`—This file configures the server used for server-side routes (API services). It uses Polka (https://github.com/lukeed/polka) by default but can easily be modified to use another library such as Express (https://expressjs.com/) if desired. You will see how in chapter 17. Another reason to modify this file is to configure the use of additional server middleware libraries for special needs, such as body parsing and request logging.

      The environment variable `PORT` can be set to specify the port on which the server should listen for requests. By default it listens on port 3000.

      The server will run in dev mode if the `NODE_ENV` environment variable is set to `development`. Running in dev mode has several effects.
      - It causes the Sapper error page to include a stack trace for errors that have one.
      - It causes the sirv middleware, which is used by Polka to serve static files, to disable file caching and ignore the sirv options `etag`, `immutable`, `maxAge`, and `setHeaders`. The benefit is that code changes will be reflected immediately.
      - It passes a `dev` option to the Rollup Svelte plugin in `rollup.config.js`. The plugin doesn't use this option, but any unsupported options are passed on to the Svelte compiler. Enabling the `dev` option of the Svelte compiler causes it to generate extra code that performs runtime checks and output debugging information.

  - service-worker.js—This file defines the service worker caching strategy to use. This will be covered in chapter 19.
  - template.html—This file contains the HTML template used by the app. It defines the DOM ID sapper that is targeted by client.js. It also includes several files from the static directory described next.
- static directory—This contains static assets such as images. Add images needed by the app here, and delete any provided images that are not needed. It also contains the following files, which are included by template.html described previously.
  - static/global.css defines global styling. Edit this to change or add global styles that can affect any component.
  - static/manifest.json is important for progressive web apps (PWAs), which are described in chapter 19.
  - static/favicon.png is the icon displayed in the browser tab where the app is running.
- cypress.json—This file contains configuration details for Cypress end-to-end tests.
- package.json—This file lists package dependencies. It also defines the npm scripts dev, build, export, start, cy:run, cy:open, and test.
- README.md—This file contains basic documentation on using Sapper. Modify it to provide details on your application.
- rollup.config.js—This file contains configuration details for the Rollup module bundler. Modify this to use preprocessors like Sass and TypeScript.

There is also a directory named node_modules under the src directory. Sapper generates this directory and the files inside it when the commands npm run dev, npm run build, and npm run export are run. Placing files here allows them to be imported using Node resolution rules. Otherwise imports of these files would have to use relative paths.

Here is the content of the src/node_modules directory:

- @sapper directory—This directory and its subdirectories contain files provided or generated by Sapper that should not be modified.
  - app.mjs—This file exports the Sapper API functions, including
    - goto for programmatic navigation.
    - start, which configures event handling for page navigation and is called by client.js, which was described earlier.
  - server.mjs—This file exports the Sapper middleware function that processes HTTP requests sent to the app. It is called by server.js, which was described earlier.
  - service-worker.js—This file exports the following constants used by src/service-worker.js, described earlier.
    - files is an array of static files to be cached by the service worker.

    - shell is an array of files generated by Sapper to be cached by the service worker.
  - internal directory—This contains the following files:
    - App.svelte—This displays the current page, or an error page if there is an error.
    - error.svelte—This is the default error page component that is used if src/routes/_error.svelte is not found. It displays the status code and an error message. It also displays a stack trace if the NODE_ENV environment variable is set to development.
    - layout.svelte—This is the default layout component that is used if src/routes/_layout.svelte is not found. It only contains a <slot> for rendering the current page component.
    - manifest-client.mjs—This provides data about components and routes (pages). It is used by app.mjs, which was described earlier.
    - manifest-server.mjs—This provides data about server routes (see chapter 17) and pages. It is used by server.mjs, which was described earlier.
    - shared.mjs—This currently doesn't seem to provide anything useful. Perhaps it will have some purpose in the future.

That's it! You now know, at least at a high level, the purpose of each directory and file provided by sveltejs/sapper-template.

16.2 Page routes

Think of a *route* as a path to a page, like the Shopping app pages you saw in chapter 15. Each page in a Sapper app is implemented as a Svelte component defined in the src/routes directory. Route names are derived from the names of the .svelte files and directories found there.

The default Sapper app renders a Nav component at the top of every page. The Nav component renders a page navigation link for each page.

It is important to use anchor elements (<a>) for page navigation instead of alternative elements such as buttons. This is because Sapper page navigation requires changing the URL, and clicking anchor elements does this. Also, as you will see in chapter 18, exporting a Sapper app to generate a static site version relies on crawling the anchor elements that are reachable starting from the first page.

We can modify src/components/Nav.svelte to add or remove page navigation anchor elements.

In the default Sapper app, the Nav component renders each anchor element with code like the following:

```
<li>
  <a aria-current={segment === 'about' ? 'page' : undefined} href="about">
    about
  </a>
</li>
```

The href attribute is set to the URL path for the corresponding page. In the case of the home page described by src/routes/index.svelte, the href attribute can be set to "." or "/". Either works.

Sapper passes a segment prop to all layout components. The provided layout defined in routes/_layout.svelte passes this on to the Nav component. The segment prop indicates the current page and can be used to style the anchor element for the current page differently than the others. This is why the anchor element is given the aria-current attribute value of page if it corresponds to the current page. The default Nav component styles the selected nav item with a red underline in the CSS rule for [aria-current]::after.

We can define additional pages by creating components in the src/routes directory. To add navigation links for new pages, add an anchor element in src/components/Nav.svelte for each new page using the same markup as is used for the other anchor elements.

As an example, the path to the page component source file for a route named dogs is src/routes/dogs.svelte or src/routes/dogs/index.svelte. The latter is preferred when a page has associated server routes (see chapter 17). Creating a dogs directory provides a common location for these related files.

Nested directories under the routes directory create pages with additional URL path parts. For example, the file src/routes/baseball/cardinals/roster.svelte defines a page component that is rendered by browsing a URL with the path /baseball/cardinals/roster. This can be useful for grouping related pages.

Files in route directories with names that begin with an underscore are considered helper files and are not interpreted as routes. These typically define and export JavaScript functions that are imported and used by multiple routes.

> **NOTE** A result of these naming conventions is that there can be many source files within an app that have names that are not meaningful on their own (such as index.svelte and _layout.svelte). Some editors support displaying the directory name along with the filename in the tab of each open file. In VS Code, this is enabled by setting the workbench.editor.labelFormat option to a value like short.

16.3 Page layouts

A page layout is a Svelte component that provides a common layout for a set of pages. For example, a page layout can be used to add a common header, footer, and left nav to each rendered page.

The topmost page layout is defined in src/routes/_layout.svelte. This is a special file that Sapper looks for because it defines the layout for all pages.

Layout components can use conditional logic to vary the layout depending on the current app state. For example, suppose the app has a login page that requires a different layout than all the other pages. Typically the login page does not render links to navigate to other pages.

The path to the page being rendered can be determined from a provided store. The package @sapper/app provides a stores function that returns an object containing three stores named page, preloading, and session.

The page store holds an object containing host, path, query, and params properties. The properties host and path are strings. The properties query and params are objects that hold query and path parameters. Pages can use this data to determine what to render.

The prefetching store holds a Boolean that indicates whether the component is currently prefetching data. An example is a page that invokes an API service to obtain data to render. Prefetching will be described in more detail in section 16.8.

The session store holds session data. It is a writable store that is set to undefined by default, meaning there is currently no session data. Placing data here is one way to share data between the pages of an app.

The following layout implementation renders only the page component if the path is "/". This is the case for the login page. For all other paths, it renders a Nav component and a main element that contains a section element that contains the corresponding page component.

Listing 16.1 Topmost page layout in src/routes/_layout.svelte

```
<script>
  import {stores} from '@sapper/app';
  import Nav from '../components/Nav.svelte';

  export let segment;

  const {page} = stores();
</script>

{#if $page.path === '/'}
  <slot />
{:else}
  <Nav {segment} />
  <main>
    <section>
      <slot />
    </section>
  </main>
{/if}

<style>
  main {
    display: flex;
    justify-content: center;

    background-color: linen;
    box-sizing: border-box;
    height: calc(100vh - var(--nav-height));
    padding: 2em;
```

This prop is automatically passed to all layouts.

The CSS variable --nav-height can be defined in static/global.css.

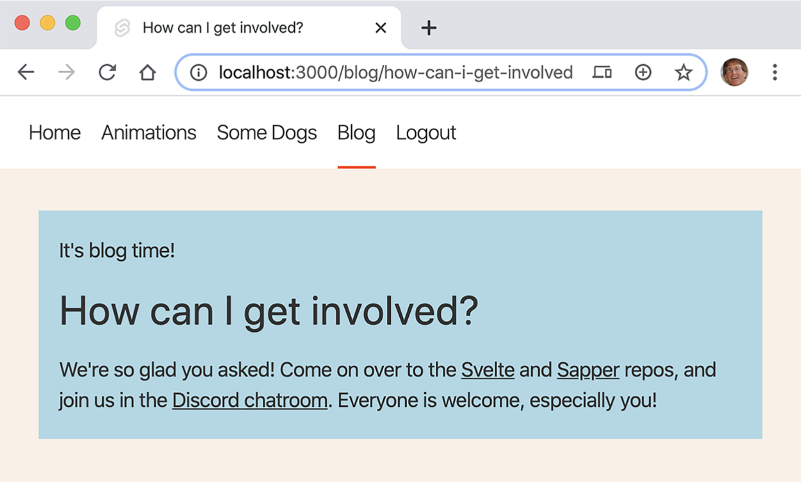
```
    width: 100vw;
  }
</style>
```

Page layouts can be nested. The top page layout defined in `src/routes/_layout.svelte` applies to all pages. Each route subdirectory can define its own `_layout.svelte` file that specifies the layout of its content within the `slot` element of its parent layout.

In the sample Sapper app, we can add the following file in `src/routes/blog` to place the content of each blog entry inside a `div` with a light blue background (see figure 16.1).

Listing 16.2 Blog layout in `src/routes/blog/_layout.svelte`

```
<div>
  <p>It's blog time!</p>
  <slot />
</div>

<style>
  div {
    background-color: lightblue;
    padding: 0.2rem 1rem;
  }
</style>
```



It's blog time!

How can I get involved?

We're so glad you asked! Come on over to the Svelte and Sapper repos, and join us in the Discord chatroom. Everyone is welcome, especially you!

Figure 16.1 Nested layout for blog pages

16.4 Handling errors

When certain kinds of errors occur, the component defined in src/routes/_error.svelte is rendered. These errors include page navigation and server-side errors. For example, this component is rendered if there is an attempt to navigate to an undefined route. We can modify this file to customize the error page.

For example, the following error page handles 404 errors differently than other errors. The path to the page where the error occurred can be determined from a provided store.

Listing 16.3 Error page in src/routes/_error.svelte

```
<script>
  import {stores} from '@sapper/app';
  const {page} = stores();

  export let status;
  export let error;

  const dev = process.env.NODE_ENV === 'development';
</script>

{#if status === 404}
  There is no page mapped to {$page.path}.
{:else}
  <h1>Error: {error.message}</h1>
  <p>status: {status}</p>
  {#if dev && error.stack}
    <pre>{error.stack}</pre>
  {/if}
{/if}
```

A Sapper app defines a single error page. Unlike page layout components, nested directories under src/routes cannot define different error pages that only apply to subsets of the routes.

16.5 Running on both server and client

When the server for a Sapper app is started, the code in the <script context="module"> element of all routes and all components they import is run. This provides a way to perform any necessary setup tasks, such as establishing WebSocket connections. Often a module context only defines a preload function and does not contain any code to be executed immediately.

Sapper apps render the first page visited on the server. The JavaScript code in the script element for this page runs twice: once on the server, and once in the browser. The JavaScript code in the script element of subsequently rendered pages only runs in the browser.

If the code in the script element accesses things that are only available in a browser, such as the window object, sessionStorage, or localStorage, care must be taken to avoid running the code on the server. One way to do this is to place such code in a function that is passed to the `onMount`, `beforeUpdate`, or `afterUpdate` lifecycle functions. These functions are only run in browsers. Another way is to check the value of `process.browser`, which is true when running in a browser.

16.6 Fetch API wrapper

The Fetch API (http://mng.bz/xWqe) defines the global function `fetch` and interfaces for `Body`, `Headers`, `Request`, and `Response` objects. The `fetch` function is commonly used to invoke API services. It is built into browser environments but not Node.js environments.

Recall that the module context is used to define variables and functions that are associated with the module, not with each instance of the component. The module context includes everything defined inside a `<script context="module">` element.

In normal `script` elements, the `fetch` function provided by browsers can be used to call API services. In `<script context="module">` elements, use `this.fetch` instead of `fetch`. This is required to ensure the availability of a `fetch` function when it is invoked on the server, as happens during server-side rendering. An example of using `this.fetch` is presented in the next section.

16.7 Preloading

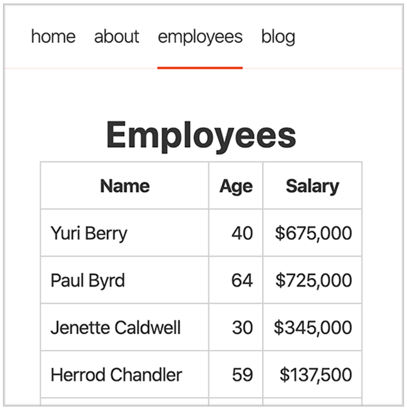
Pages that require data to be fetched from API services before they can be rendered can do so in a `preload` function. This must be defined in the module context (`<script context="module">`) of the page component. The `preload` function has two parameters, typically named `page` and `session`. These values were described earlier in section 16.3.

The `preload` function can call any number of API services to obtain data. It can also obtain data in other ways, such as GraphQL queries, WebSocket connections, and so on. The `preload` function should return an object whose property names are the names of props accepted by the page component and whose property values will become the prop values.

Defining a `preload` function in a component that is not a route has no purpose, because it will never be invoked.

Let's demonstrate this by adding an Employees page to the default Sapper app (see figure 16.2).

Create an `employees.svelte` file in the `routes` directory containing the following content.



Employees

Name	Age	Salary
Yuri Berry	40	$675,000
Paul Byrd	64	$725,000
Jenette Caldwell	30	$345,000
Herrod Chandler	59	$137,500

Figure 16.2 Employees page

Listing 16.4 Employees page in `src/routes/employees.svelte`

```
<script context="module">
  export async function preload(page, session) {
    try {
      const url = 'http://dummy.restapiexample.com/api/v1/employees';
      const res = await this.fetch(url);
      if (res.ok) {
        const result = await res.json();
        const employees = result.data;

        // Sort the employees on their last name, then first name.
        employees.sort((emp1, emp2) => {
          const [first1, last1] = emp1.employee_name.split(' ');
          const [first2, last2] = emp2.employee_name.split(' ');
          const compare = last1.localeCompare(last2);
          return compare ? compare : first1.localeCompare(first2);
        });

        return {employees};
      } else {
        const msg = await res.text();
        this.error(res.statusCode, 'employees preload error: ' + msg);
      }
    } catch (e) {
      this.error(500, 'employees preload error: ' + e.message);
    }
  }
</script>

<script>
  export let employees;

  const formatter = new Intl.NumberFormat('en-US', {
    style: 'currency',
    currency: 'USD',
    minimumFractionDigits: 0
  });
</script>

<svelte:head>
  <title>Employees</title>
</svelte:head>

<table>
  <caption>Employees</caption>
  <tr>
    <th>Name</th>
    <th>Age</th>
    <th>Salary</th>
  </tr>
  {#each employees as employee}
    <tr>
      <td>{employee.employee_name}</td>
      <td class="right">{employee.employee_age}</td>
```

This is a free, public API service that returns fake employee data.

Note the use of this.fetch instead of fetch.

The API service returns a JSON object with a data property whose value is an array of employee objects.

The object returned provides prop values to the component.

Note the way errors are handled.

This formats a number as US currency and only includes cents when they are not zero.

```
      <td class="right">{formatter.format(employee.employee_salary)}</td>
    <tr>
  {/each}
</table>

<style>
  caption {
    font-size: 2rem;
    font-weight: bold;
  }

  table {
    border-collapse: collapse;
  }

  td, th {
    border: solid lightgray 1px;
    padding: 0.5rem;
  }

  .right {
    text-align: right;
  }
</style>
```

Edit routes/_layout.svelte and remove the CSS properties position, max-width, and margin from the rule for main, so the table is left-aligned on the page.

Edit components/Nav.svelte and add a link for the new Employees page by adding the following after the li element for the About page:

```
<li>
  <a [aria-current]={segment === 'employees' ? 'page' : undefined}
    href="employees">
    employees
  </a>
</li>
```

That's it! We now have a component that calls an API service to get the data it needs before it is rendered.

Note that it is not possible to register the same component for multiple route paths because the route path also specifies the path to the component .svelte file.

Consider how the onMount lifecycle function differs from the preload function. onMount can directly set top-level component variables that represent the state of the component. preload returns an object whose properties are supplied to the component as props. It does not have access to the state variables of the component.

16.8 Prefetching

Routes can be configured so the data they require is downloaded when the user simply hovers over their anchor element. This anticipates that the user will click the anchor element and results in faster page loads.

Prefetching is configured by adding the `rel="prefetch"` attribute to the anchor element for a page component. This is under consideration for being added as a standard HTML anchor attribute and value (see http://mng.bz/AAnK).

Prefetching works in conjunction with code splitting. The first time a user hovers over an anchor element that uses prefetch (or taps on it when using a mobile device), the JavaScript required by the page is downloaded and its `preload` function, if any, is called. This occurs before the component is rendered.

Should you opt into prefetching on every page link? It's great for performance! But also consider whether there are any negative consequences to invoking API services for pages that may not actually be visited because the user only hovered over a link and never clicked it. The consequences could include consuming server resources unnecessarily or logging server-side activity that didn't need to occur. It's okay to make a different decision for each page link in the app.

When prefetching is not configured, the `preload` function is called each time the anchor for a route is clicked and it is not the current route.

When prefetching is configured, the `preload` function is called when the user hovers over the anchor for a route. It will not be called again due to a hover unless the user first navigates to another route or hovers over another route that has a `preload` function.

To enable prefetching for the Employees page created in the previous section, edit `components/Nav.svelte` and add `rel="prefetch"` to the anchor element for employees as follows:

Listing 16.5 Nav component changes in `src/components/Nav.svelte`

```
<li>
  <a
    aria-current={segment === 'employees' ? 'page' : ''}
    href="employees"
    rel="prefetch">
    employees
  </a>
</li>
```

To verify that this works as expected, add a `console.log` call inside the `preload` function in `employees.svelte` so you can detect when it is called.

Listing 16.6 Employees page changes in `src/routes/employees.svelte`

```
<script context="module">
  export async function preload(page, session) {
    console.log('employees.svelte preload: entered');
    ...
  }
</script>
```

Now follow these steps:

1. In the browser tab where the app is running, open the DevTools, click the Console tab, and refresh the page.
2. Hover over the Employees link and note that the `preload` function is called.
3. Hover over another link and then back to the Employees link. Note that the `preload` function is not called again.
4. Click another link, such as About.
5. Hover over the Employees link. Note that the `preload` function is called again.

The `rel="prefetch"` attribute cannot be applied to `button` elements. However, anchor elements can be styled to look like buttons, as in the following listing.

Listing 16.7 `Nav` component style changes in `src/components/Nav.svelte`

```
<style>
  a {
    border: solid gray 1px;
    border-radius: 4px;
    padding: 4px;
    text-decoration: none;
  }
</style>
```

16.9 Code splitting

Svelte produces bundles that are much smaller than those produced by other frameworks. But the initial download size can be decreased even further by code splitting. This removes the need to download all the JavaScript for the app when the first page is rendered. Code splitting provides a significant improvement for apps that are run with slow internet connections or on mobile devices. Sapper provides this automatically.

When a browser first loads a Sapper app, only the JavaScript code necessary to render the first page/route is downloaded. The JavaScript for each remaining route is not downloaded until the page is rendered. This typically happens in response to a user clicking on an anchor element that triggers a route change.

For routes whose anchor element includes `rel="prefetch"`, the download of their JavaScript code begins when the user hovers over their anchor element. In the Sapper starter app, this is specified on anchor elements in `src/components/Nav.svelte`. The Blog route uses prefetching, and we added this to the Employees route in the previous section.

Follow these steps using our app with the Employees route to see code splitting in action:

1. Open the DevTools and click the Network tab.
2. Click the Home link to return to the first page.
3. Refresh the browser tab.

4. Note that three files are downloaded:
   - `client.some-hash.js` contains code corresponding to `src/client.js` that bootstraps the Sapper app. No page-specific code is included in this file.
   - `sapper-dev-client.some-hash.js` is only downloaded when running in development mode. It provides a small amount of additional debugging output.
   - `index.some-hash.js` contains code for the Home page.
5. Click the `index.some-hash.js` file in DevTools to see its contents. Note that it contains “Great success!” from the Home page but does not contain “About this site” from the About page.
6. Click the About link in the web app. Note that a file named `about.some-hash.js` is downloaded.
7. Click this file in DevTools to see its contents. Note that it contains “About this site” from the About page, but it does not contain “Great success!” from the Home page.
8. Hover over the Employees link in the web app. Note that a file named `employees.some-hash.js` is downloaded without you clicking the link, because it uses `rel="prefetch"`.
9. Click the Employees link in the web app. Note that no new file is downloaded because the JavaScript for this page has already been downloaded.

Code splitting is a great feature for improving the performance of web applications, and Sapper provides this automatically.

16.10 Building the Travel Packing app

Let’s create a Sapper version of the Travel Packing app. It will have two routes, use a page layout, and take advantage of code splitting. The finished code can be found at http://mng.bz/Z2BO.

This code will not use preloading or prefetching because we do not yet use API services in the app. Those features will be added in chapter 17.

First, create the new Sapper application:

1. `cd` to the directory where you want it to reside.
2. Enter `npx degit sveltejs/sapper-template#rollup sapper-travel-packing`.
3. Enter `cd sapper-travel-packing`.
4. Enter `npm install`.
5. Enter `npm install name` for any packages needed that are not included in `sveltejs/sapper-template`. For the Travel Packing app, this includes `dialog-polyfill` and `uuid`.

Now copy files from the Svelte version of the app to the Sapper version. This is going to seem like a lot of work, but that’s only because we need to modify several things to work with Sapper. Starting an app with Sapper is a more natural path.

1. Copy `public/global.css` to `static/global.css`, replacing the provided version.
2. Delete `static/great-success.png` because it will not be used.
3. Delete supplied page component files that will not be used from the `src/routes` directory. These are `index.svelte`, `about.svelte`, and the `blog` directory.
4. Copy components that represent pages from `src` to `src/routes`. These are `Login.svelte` and `Checklist.svelte`.
5. Rename these `.svelte` files to snake-case. For example, the filename `TwoWords.svelte` should be renamed to `two-words.svelte`. This is preferred because these names will appear in page URLs. Also, rename the Home page source file to `index.svelte`. In this case, this means renaming `Login.svelte` to `index.svelte` and `Checklist.svelte` to `checklist.svelte`.
6. Copy components that do not represent pages from `src` to `src/components`. These include `Category.svelte`, `Dialog.svelte`, `Item.svelte`, and `NotFound.svelte`.
7. Copy `.js` files to the same directory in the new project. For this project, copy `util.js` from the `src` directory in the Svelte app to the `src` directory in the Sapper app.
8. Correct the paths of the imports in the `.svelte` files that were copied to `src/routes`. In this case, change the following in `checklist.svelte`:

   ```
   import Category from '../components/Category.svelte';
   import Dialog from '../components/Dialog.svelte';
   import {getGuid, sortOnName} from '../util';
   ```

   We changed . to ..

   And change the following in `Item.svelte`:

   ```
   import {blurOnKey} from '../util';
   ```

9. Correct the paths of the imports in the `.svelte` files that were copied to `src/components`. In this case, all the changes are in `Category.svelte`:

   ```
   import {getGuid, sortOnName} from '../util';
   ```

10. Modify `src/routes/_layout.svelte`:
    - Delete the `script` element and its contents because nothing there is being used.
    - Remove the `Nav` element.
    - Add the following line before the `slot` element:

      ```
      <h1 class="hero">Travel Packing Checklist</h1>
      ```

    - Replace the `style` element and its contents with those found in the Svelte version of `src/App.svelte`.
11. Delete `src/components/Nav.svelte`, since it is not being used.

12 Modify src/routes/index.svelte to handle the Login button differently:

- Add an import of the goto function.

```
import {goto} from '@sapper/app';
```

- Remove the import of the createEventDispatcher function.
- Remove the dispatch variable.
- Change the login function to the following:

```
const login = () => goto('/checklist');
```

13 Modify src/routes/checklist.svelte:

- At the top, add import {onMount} from 'svelte';.
- Change the call to restore() to onMount(restore) so the restore function is only called in the browser.
- Remove the import of the createEventDispatcher function.
- Remove the dispatch variable.
- Add a let restored = false; variable declaration inside the script element near the other variable declarations.
- Make changes to ensure that code that calls methods on localStorage only happens in the browser, because localStorage is not defined on the server. Recall that functions passed to lifecycle functions are only executed in the browser. In this case, change the persist and restore functions to the following:

```
function persist() {
  if (process.browser && restored) {
    localStorage.setItem('travel-packing', JSON.stringify(categories));
  }
}

function restore() {
  const text = localStorage.getItem('travel-packing');
  if (text && text !== '{}') categories = JSON.parse(text);
  restored = true;
}
```

- Replace the Log Out button with the following:

```
<a class="button logout-btn" href="/">Log Out</a>
```

14 Add the following CSS rule in static/global.css to style anchor elements that should look like buttons:

```
.button {
  background-color: white;
  border-radius: 10px;
  color: gray;
```

```
    padding: 1rem;
    text-decoration: none;
  }
```

15. Modify `src/components/Dialog.svelte`:
    - Remove `import dialogPolyfill from 'dialog-polyfill';` because this runs code that accesses the `window` global variable, which is not available when this code is run on the server side.
    - Change the call to `onMount`, which is only run in the browser, to match the following:

```
onMount(async () => {
  const {default: dialogPolyfill} = await import('dialog-polyfill');
  dialogPolyfill.registerDialog(dialog);
});
```

This uses an asynchronous import.

Now run the app by entering `npm run dev`.

Whew, that was a lot of work! But consider what we have gained. Adding new pages will be much easier now, we gained code splitting and preloading, and we introduced a common page layout. Larger apps benefit greatly from the features that Sapper provides.

In the next chapter you will learn how to implement Node-based API services in Sapper apps.

Summary

- Sapper apps have a well-defined file structure.
- Pages within a Sapper app are defined by files and directories under the `src/routes` directory.
- A Sapper app has a top page layout that applies to all pages.
- Nested routes can define their own layout that supplies the `slot` content in their parent layout.
- A Sapper app has a single error page.
- Sapper apps must avoid running certain JavaScript code on the server side, but doing this is easy.
- The Fetch API wrapper supports using the Fetch API in code that is run on the server, such as `preload` functions.
- Preloading allows pages to load data they need before the page is rendered.
- Prefetching downloads the code and data needed by a page before the user navigates to the page.
- Sapper provides code splitting so the code for a page is not downloaded until the user navigates to the page or hovers over its link (when prefetching is enabled).

17

Sapper server routes

This chapter covers

- Server routes
- Server route source files
- Server route functions
- A create/retrieve/update/delete (CRUD) example
- Switching to Express

Server routes are Node-based API/REST services. Sapper supports implementing these, and it hosts them so the client-side code can send requests to them. It enables collocating server-side code with client-side code in the same project. This is convenient for full-stack developers because it avoids having to maintain multiple source code repositories, one for client-side code and one for server-side code. It also has the benefit of using the same programming language, JavaScript, for all of the code.

> **NOTE** It is possible to host a Svelte app and Node-based API server in the same repository (a monorepo) without using Sapper. However, in that case they would typically be implemented in separate source trees, each with their own `package.json` file. With Sapper, the frontend and backend code are in the same source tree, and the same HTTP server is used to serve frontend assets and respond to API requests.

Server route source files define functions for server-side code that is part of a Sapper application. This code can perform tasks like managing data persistence using a relational database such as PostgreSQL or a NoSQL database such as MongoDB. For example, an app that manages employee data can use API services to create, retrieve, update, and delete this data.

Using server routes to implement server-side functionality is optional. Sapper apps are not restricted to only invoking services that are implemented using server routes. The services used by a Sapper app can be implemented outside the app, using any programming language and any framework.

We will explore how to implement Sapper server routes, including where to place the source files, how to name them, and what functions to implement in these files.

17.1 Server route source files

The source files that define server routes are placed under the src/routes directory. As you saw earlier, this is also where the definitions of Svelte components that correspond to pages in the app reside.

API services are defined in source files with a .js extension containing JavaScript code. There is a convention to use an extension of .json.js to indicate that response bodies contain JSON data.

Each directory below src/routes can contain both a page .svelte file and a server routes .js file. This is useful when a page is the only one that uses the colocated server routes. If a page doesn't use server routes that are only intended for it, its directory can just contain the page .svelte file. If particular server routes are not intended for use by a single page, their directory can only contain server route source files. The bottom line is that there is a lot of flexibility in where page and server routes are defined, as long as they are defined under the src/routes directory.

Sapper has a convention for naming the source files that define server routes. The example code in this chapter assumes the resources are descriptions of dogs, and the page route that will use the services has the name dogs. A particular dog might have the following JSON representation:

```
{
  "id": "5e4984b33c9533dfdf102ac8",
  "breed" : "Whippet",
  "name" : "Dasher"
}
```

Server routes that do not require a path parameter in their URL, such as retrieving all instances of a resource or creating a new resource, are typically defined in src/routes/dogs/index.json.js.

Server routes that do require a path parameter in their URL, such as updating or deleting an existing resource, are typically defined in src/routes/dogs/[id].json.js. The syntax [id] here represents a path parameter, where id is a unique identifier for a resource.

Server routes can only have one path parameter per path part. Having more than one path part is useful when the data exists in a hierarchy. For example, if we wanted to segregate dogs based on the families that own them, we might create a server route source file in `src/routes/families/[familyId]/dogs/[dogId].json.js`. Note that the square brackets are actually part of the directory and file names. We could update the dog with an ID of "d7" that is owned by the family with an ID of "f3" by sending a `PUT` request to `/families/f3/dogs/d7`.

17.2 Server route functions

Server route source files define server route functions. These process HTTP requests and are similar to Express (https://expressjs.com/) middleware functions. Typically they examine a request object and call methods on the response object to provide response data.

Express middleware functions

Express middleware functions are used to process HTTP requests. They are run in the order in which they were registered. Each is passed three arguments: a request object, a response object, and a `next` function. These functions typically perform one of the following actions:

- Modify the request object and call `next`, allowing the next middleware function to process the request.
- Call methods on the response object to provide response data.
- Modify the response object and call `next`, allowing the next middleware function to make additional modifications.

Some middleware functions only handle errors, perhaps logging them. Passing an error description to the `next` function triggers the next (or first) error middleware function to run. Passing nothing to the `next` function triggers the next normal (non-error) middleware function to run.

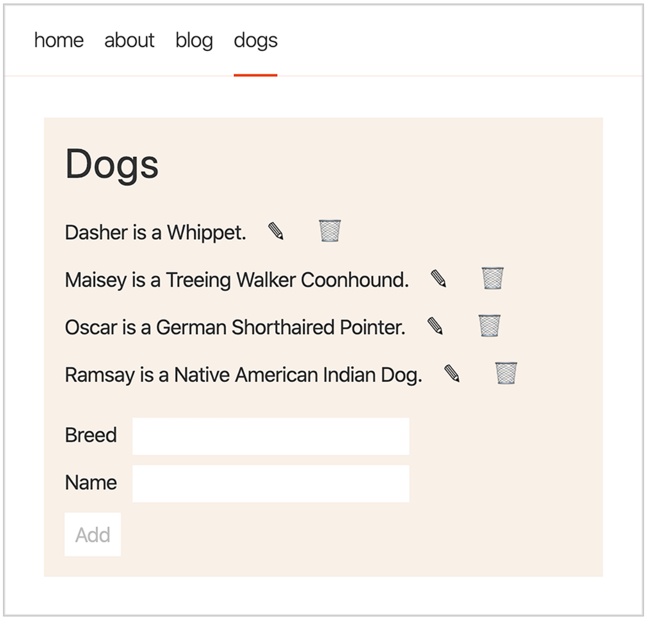
The names of server route functions correspond to HTTP verbs, as you can see in table 17.1.

Table 17.1 CRUD operations

CRUD operation	HTTP verb	Function name
Create	`POST`	`post`
Retrieve	`GET`	`get`
Update	`PUT`	`put`
Delete	`DELETE`	`del`

17.3 A create/retrieve/update/delete (CRUD) example

Let's walk through the steps to implement a page that supports CRUD operations on dogs using a MongoDB database. The code to use a relational database such as PostgreSQL would not be dramatically different. It would just involve substituting SQL in place of MongoDB-specific calls. Figure 17.1 shows a screenshot of what we want to create.



Dogs

Dasher is a Whippet. ✎ 🗑

Maisey is a Treeing Walker Coonhound. ✎ 🗑

Oscar is a German Shorthaired Pointer. ✎ 🗑

Ramsay is a Native American Indian Dog. ✎ 🗑

Figure 17.1 Dogs page

With this UI we can

- See all the dogs that are currently in the database.
- Add a new dog to the database by entering a breed and name and clicking the Add button.
- Modify the breed or name of an existing dog in the database by clicking the pencil icon next to one, modifying the values, and clicking the Modify button. The Add button changes to Modify when a pencil icon is clicked.
- Delete an existing dog from the database by clicking the trash can icon next to one.

Start by creating a new Sapper app with the following commands:

1. `npx degit sveltejs/sapper-template#rollup dog-app`
2. `cd dog-app`
3. `npm install`
4. `npm install body-parser mongodb`

The body-parser library parses HTTP request bodies.

The mongodb library lets us communicate with a MongoDB database. See appendix C for details on installing MongoDB, starting the MongoDB server, and interacting with MongoDB databases from both the MongoDB shell and JavaScript.

By default, server routes are managed by Polka (https://github.com/lukeed/polka). Polka is described as “a micro web server so fast, it’ll make you dance!” It is an alternative to Express and claims to be 33% to 50% faster. Polka supports a nearly identical API and the same middleware functions. It was created by Luke Edwards, who is also a Sapper contributor.

To enable your code to pass HTTP request bodies, make two changes in src/server.js:

1. Add the following require call:

   ```
   import {json} from 'body-parser';
   ```

2. Add the following as the first call chained onto polka():

   ```
   .use(json())
   ```

   The use method registers a middleware function.

Create the directory src/routes/dogs. In this directory, create the following files:

- index.svelte—This defines the component that renders the page shown in figure 17.1.
- index.json.js—This exports middleware functions that get all dogs and create a new dog. These are API services that could be implemented with many frameworks using many programming languages, but you will see how easy it is to define them using Sapper.
- [id].json.js—This exports middleware functions that update or delete an existing dog. These are more API services.
- _helpers.js—This exports a helper function that returns an object for operating on the dogs MongoDB collection.

Listing 17.1 shows the code for the dogs page component. There is a lot of code here, but it should all be understandable, given what you have already learned about Svelte and Sapper.

Listing 17.1 dogs page component in src/routes/dogs/index.svelte

```
<script context="module">
  export async function preload() {
    try {
      const res = await this.fetch('dogs.json');
      if (res.ok) {
        const dogs = await res.json();
```

This function is called before each time this component is rendered in order to get the dog data. Preload functions were described in chapter 16.

This invokes the get middleware function defined in dogs/index.json.js.

```
        const dogMap = dogs.reduce((acc, dog) => {
          acc[dog._id] = dog;
          return acc;
        }, {});

        return {dogMap};
      } else {
        // Handle errors.
        const msg = await res.text();
        this.error(res.statusCode, 'Dogs preload: ' + msg);
      }
    } catch (e) {
      this.error(500, 'Dogs preload error: ' + e.message);
    }
  }
</script>

<script>
  export let dogMap = {};

  let breed = '';
  let breedInput;
  let error = '';
  let id = '';
  let name = '';

  $: saveBtnText = id ? 'Modify' : 'Add';

  $: sortedDogs = Object.values(dogMap).sort((dog1, dog2) =>
    dog1.name.localeCompare(dog2.name)
  );

  function clearState() {
    id = breed = name = '';
    breedInput.focus();
  }

  async function deleteDog(id) {
    try {
      const options = {method: 'DELETE'};
      const res = await fetch(`dogs/${id}.json`, options);
      if (!res.ok) throw new Error('failed to delete dog with id ' + id);
      delete dogMap[id];
      dogMap = dogMap;
      clearState();
    } catch (e) {
      error = e.message;
    }
  }

  function editDog(dog) {
    ({breed, name} = dog);
    id = dog._id;
  }
```

This creates a map of dog IDs to dog objects.

Properties in the object returned here are passed to this component as props, in this case only dogMap.

The previous preload function provides this prop.

If we have a dog ID, we can modify the dog. Otherwise we can add a new dog.

This invokes the del middleware function defined in [id].json.js.

This triggers an update to parts of the UI that use dogMap.

```
  async function saveDog() {
    const dog = {breed, name};
    if (id) dog._id = id;

    try {
      const options = {
        method: id ? 'PUT' : 'POST',
        headers: {'Content-Type': 'application/json'},
        body: JSON.stringify(dog)
      };
      const path = id ? `dogs/${id}.json` : 'dogs.json';
      const res = await fetch(path, options);
      const result = await res.json();

      if (!res.ok) throw new Error(result.error);

      dogMap[result._id] = result;
      dogMap = dogMap;

      clearState();
    } catch (e) {
      error = e.message;
    }
  }
</script>

<svelte:head>
  <title>Dogs</title>
</svelte:head>

<section>
  <h1>Dogs</h1>

  {#if error}
    <div class="error">Error: {error}</div>
  {:else}
    {#each sortedDogs as dog}
      <div class="dog-row">
        {dog.name} is a {dog.breed}.
        <button class="icon-btn" on:click={() => editDog(dog)}>
          <!-- pencil icon -->
          &#x270E;
        </button>
        <button class="icon-btn" on:click={() => deleteDog(dog._id)}>
          <!-- trash can icon -->
          &#x1F5D1;
        </button>
      </div>
    {/each}
  {/if}

  <form>
    <div>
      <label>Breed</label>
      <input bind:this={breedInput} bind:value={breed} />
```

This handles both creating and updating dogs.

If id is set, we are updating a dog. Otherwise we are creating a new dog.

This invokes either the post middleware function defined in index.json.js or the put middleware function defined in [id].json.js.

This triggers an update to parts of the UI that use dogMap.

```
    </div>
    <div>
      <label>Name</label>
      <input bind:value={name} />
    </div>

    <button disabled={!breed || !name} on:click={saveDog} type="button"
      {saveBtnText}
    </button>

    {#if id}
      <button on:click={clearState} type="button">Cancel</button>
    {/if}
  </form>
</section>

<style>
  button {
    border: none;
    font-size: 1rem;
    padding: 0.5rem;
  }

  .dog-row {
    display: flex;
    align-items: center;
  }

  form {
    margin-top: 1rem;
  }

  form > div {
    margin-bottom: 0.5rem;
  }

  .icon-btn {
    background-color: transparent;
    font-size: 18px;
    margin-left: 0.5rem;
  }

  .icon-btn:hover {
    background-color: lightgreen;
  }

  input {
    border: none;
    padding: 0.5rem;
    width: 200px;
  }

  label {
    margin-right: 0.5rem;
  }
  section {
    background-color: linen;
    padding: 1rem;
  }
</style>
```

Now we are ready to turn our attention to the server-side code for this application.

The following listing shows the code for a helper function that is used by functions in other source files to obtain the MongoDB dogs collection.

Listing 17.2 MongoDB helper function in `src/routes/dogs/_helpers.js`

```
const {MongoClient} = require('mongodb');

const url = 'mongodb://127.0.0.1:27017';
const options = {useNewUrlParser: true, useUnifiedTopology: true};
let collection;

export async function getCollection() {
  if (!collection) {
    const client = await MongoClient.connect(url, options);
    const db = client.db('animals');
    collection = await db.collection('dogs');
  }

  return collection;
}
```

MongoDB thinks localhost is a different database instance than 127.0.0.1. The mongo shell uses 127.0.0.1, so we use that to hit the same instance.

These are recommended MongoDB options to avoid deprecation warnings.

This holds the dogs collection, so we only retrieve it once per session.

This gets access to the "animals" MongoDB database. There is no need to call the close method on db (see http://mng.bz/qMqw).

This gets the "dogs" collection from the "animals" database.

The following listing shows the code that implements the server routes for GET and POST requests. These server routes do not require any path parameters. The functions exported here must have the names get and post.

Listing 17.3 `GET` and `POST` server routes in `src/routes/dogs/index.json.js`

```
import {getCollection} from './_helpers';

export async function get(req, res) {
  try {
    const collection = await getCollection();
    const result = await collection.find().toArray();
    res.end(JSON.stringify(result));
  } catch (e) {
    console.error('index.json.js get:', e);
    res.status(500).json({error: e.message});
  }
}

export async function post(req, res) {
  const dog = req.body;
```

This gets all the documents (objects) in the dogs MongoDB collection.

This returns an array of dog objects as JSON.

```
  try {
    const collection = await getCollection();
    const result = await collection.insertOne(dog);
    const [obj] = result.ops;
    res.end(JSON.stringify(obj));
  } catch (e) {
    console.error('index.json.js post:', e);
    res.status(500).json({error: e.message});
  }
}
```

This adds a dog to the dogs MongoDB collection.

This gets the inserted document, which contains all the dog data plus its assigned unique ID.

This returns the dog object to the client as JSON, primarily so it has access to its ID.

The next listing shows the code that implements the server routes for `DELETE` and `PUT` requests. These server routes require one path parameter named `id`. The functions exported here must have the names `del` and `put`.

Listing 17.4 `DELETE` and `PUT` server routes in `src/routes/dogs/[id].json.js`

```
const {ObjectId} = require('mongodb');
import {getCollection} from './_helpers';
```

This function is used to create objects that represent document IDs.

```
export async function del(req, res) {
  const {id} = req.params;
  try {
    const collection = await getCollection();
    const result = await collection.deleteOne({_id: ObjectId(id)});
    if (result.deletedCount === 0) {
      res.status(404).send(`no dog with id ${id} found`);
    } else {
      res.end();
    }
  } catch (e) {
    console.error('[id].json.js del:', e);
    res.status(500).json({error: e.message});
  }
}
```

This gets the ID of the dog to delete from a path parameter.

This attempts to delete the document with a given ID from the dogs collection.

```
export async function put(req, res) {
  const {id} = req.params;
  const replacement = req.body;

  delete replacement._id;
```

This gets the ID of the dog to update from a path parameter.

The object passed to the MongoDB replaceOne method cannot have an _id property, so we remove it.

```
  try {
    const collection = await getCollection();
    const result = await collection.replaceOne(
      {_id: ObjectId(id)},
      replacement
    );
    const [obj] = result.ops;
    obj._id = id;
    res.end(JSON.stringify(obj));
```

This updates a document in the dogs collection identified by its unique ID.

This restores the _id property in the object that will be returned as JSON.

```
  } catch (e) {
    console.error('[id].json.js put:', e);
    res.status(500).json({error: e.message});
  }
}
```

Now we that we have implemented all the necessary server-side functionality, we are ready to add our dogs route to the navigation bar. Add a navigation link for this route by adding the following in the provided Nav component.

Listing 17.5 Change to Nav component in src/components/Nav.svelte

```
<li>
  <a
    rel="prefetch"
    aria-current={segment === 'dogs' ? 'page' : undefined}
    href="dogs"
  >
    dogs
  </a>
</li>
```

The impact of rel="prefetch" was described in chapter 16. It causes the preload function in src/routes/index.svelte to be called as soon as the user hovers over the link for that page in the nav bar. Hovering also triggers downloading the JavaScript required for the Dogs page. Recall that you can see this happening by opening the browser's DevTools and clicking on the Network tab before hovering over the Dogs link.

To run the app, enter npm run dev and browse to localhost:3000.

That's it! We have implemented a new route that supports all the CRUD operations on dogs. Copy this pattern to implement similar functionality for other kinds of data.

17.4 Switching to Express

Sapper applications can easily be modified so that server routes are managed by another Node.js server library such as Express. Here are the steps to switch a Sapper app from using Polka to using Express:

1. Enter npm uninstall polka.
2. Enter npm install express.
3. Edit src/server.js.
   - Remove import polka from 'polka';.
   - Add import express from 'express';.

By default, Sapper uses Sirv to serve static files.

Assuming the preceding changes have been made, here are the additional steps to use Express for serving static files:

1. Enter `npm uninstall sirv`.
2. Edit `src/server.js`.
   - Remove `import sirv from 'sirv';`.
   - Replace `sirv('static', {dev}),` with `express.static('static'),`.
3. Restart the server.

17.5 Building the Travel Packing app

Let's modify the Sapper Travel Packing app created in chapter 16 to use server routes. It will persist the travel-packing checklist in a MongoDB database. The finished code can be found at http://mng.bz/7XN9.

The MongoDB database will be named "travel-packing". It will contain a single collection named `categories`. Each document in this collection will represent a category and all of its items.

Enter the following command to install a few npm packages that perform HTTP request-body parsing, enable the use of MongoDB, and provide an easier way to send HTTP responses:

```
npm install body-parser mongodb @polka/send-type
```

Make the following changes in `src/server.js` for parsing HTTP request bodies:

1. Add the following import:

   ```
   const {json} = require('body-parser');
   ```

2. Add the following as the first call after `polka()`:

   ```
   .use(json())
   ```

Here is a summary of the API services we need to implement:

1. *Create a category*—This is currently implemented in the `addCategory` function of `routes/checklist.svelte`. We will implement this as a `POST` to `/categories` by defining and exporting a `post` function in `src/routes/categories/index.json.js`.
2. *Retrieve all categories*—This is currently implemented in the `restore` function of `routes/checklist.svelte`. We will implement this as a `GET` to `/categories` by defining and exporting a `get` function in `src/routes/categories/index.json.js`.
3. *Delete a category*—This is currently implemented in the `deleteCategory` function of `routes/checklist.svelte`. We will implement this as a `DELETE` to

/categories/{category-id} by defining and exporting a del function in src/routes/categories/[categoryId]/index.json.js. Note that [categoryId] is the actual name of a directory, including the square brackets.

4. *Update a category name*—This is currently implemented in the persist function of routes/checklist.svelte, which is called if any data in the categories object changes. We will implement this as a PUT to /categories/{category-id} by defining and exporting a put function in src/routes/categories/[categoryId]/index.json.js.
5. *Create an item in a category*—This is currently implemented in the addItem function of components/Category.svelte. We will implement this as a POST to /categories/{category-id}/items by defining and exporting a post function in src/routes/categories/[categoryId]/items/index.json.js.
6. *Delete an item from a category*—This is currently implemented in the deleteItem function of components/Category.svelte. We will implement this as a DELETE to /categories/{category-id}/items/{item-id} by defining and exporting a del function in src/routes/categories/[categoryId]/items/[itemId].json.js.
7. *Update an item name or packed status*—This is currently implemented in the persist function of components/Category.svelte, which is called if any data in the categories object changes. We will implement this as a PUT to /categories/{category-id}/items/{item-id} by defining and exporting a put function in src/routes/categories/[categoryId]/items/[itemId].json.js.

Note that we do not need an API service to retrieve all the items in a given category because those are included when a category is retrieved.

The directory structure for the files that implement these API services looks like this:

- src directory
  - routes directory
    - categories directory
      - index.json.js—get and post category
      - [categoryId] directory
        - index.json.js—put and del category
        - items directory
          - index.json.js—post item
          - [itemId].json.js—put and del item

Here are the steps to implement these API services:

1. Create the categories directory under src/routes.
2. Create the following src/routes/categories/_helpers.js file that defines a function for getting the checklist collection from the "travel-packing" MongoDB database. This is nearly identical to the file src/routes/dogs/_helper.js shown in listing 17.2. See the annotations in that code.

```
const {MongoClient} = require('mongodb');

const url = 'mongodb://127.0.0.1:27017';
const options = {useNewUrlParser: true, useUnifiedTopology: true};
let collection;

export async function getCollection() {
  if (!collection) {
    const client = await MongoClient.connect(url, options);
    const db = client.db('travel-packing');
    collection = await db.collection('categories');
  }
  return collection;
}
```

3 Implement the API services to retrieve and create categories in `src/routes/categories/index.json.js`:

```
const send = require('@polka/send-type');
import {getCollection} from './_helpers';

export async function get(req, res) {
  try {
    const collection = await getCollection();
    const result = await collection.find().toArray();
    res.end(JSON.stringify(result));
  } catch (e) {
    console.error('categories/index.json.js get:', e);
    send(res, 500, {error: e});
  }
}

export async function post(req, res) {
  const category = req.body;
  try {
    const collection = await getCollection();
    const result = await collection.insertOne(category);
    const [obj] = result.ops;
    res.end(JSON.stringify(obj));
  } catch (e) {
    console.error('categories/index.json.js post:', e);
    send(res, 500, {error: e});
  }
}
```

Using this send function simplifies returning HTTP responses.

This gets all the categories from the database.

This adds a category to the database.

The object added to the database is returned so the client can get its assigned _id value.

4 Implement the API services to delete and update categories in `src/routes/categories/[categoryId]/index.json.js`:

```
const send = require('@polka/send-type');
const {ObjectId} = require('mongodb');
import {getCollection} from '../_helpers';

export async function del(req, res) {
  const {categoryId} = req.params;
```

This function is used to create objects that represent document IDs.

This deletes a category from the database.

```
  try {
    const collection = await getCollection();
    const result =
      await collection.deleteOne({_id: ObjectId(categoryId)});
    if (result.deletedCount === 0) {
      send(res, 404, `no category with id ${categoryId} found`);
    } else {
      res.end();
    }
  } catch (e) {
    console.error(
      'categories/[categoryId]/index.json.js del:',
      e
    );
    send(res, 500, {error: e});
  }
}
```

This updates a category in the database.

```
export async function put(req, res) {
  const {categoryId} = req.params;
  const replacement = req.body;
```

The object passed to the MongoDB replaceOne method cannot have an _id property.

```
  delete replacement._id;

  try {
    const collection = await getCollection();
    const result = await collection.replaceOne(
      {_id: ObjectId(categoryId)},
      replacement
    );
```

This restores the value of the _id property.

```
    const [obj] = result.ops;
    obj._id = categoryId;
    res.end(JSON.stringify(obj));
  } catch (e) {
    console.error(
      'categories/[categoryId]/index.json.js put:',
      e
    );
    send(res, 500, {error: e});
  }
}
```

5 Implement the API service to create items in a category in `src/routes/categories/[categoryId]/items/index.json.js`:

```
const {ObjectId} = require('mongodb');
const send = require('@polka/send-type');
import {getCollection} from '../../_helpers';
```

This adds an item to a category in the database.

```
export async function post(req, res) {
  const {categoryId} = req.params;
  const item = req.body;
  try {
    const collection = await getCollection();
    const itemPath = `items.${item.id}`;
```

```
      await collection.updateOne(
        {_id: ObjectId(categoryId)},
        {$set: {[itemPath]: item}}
      );
      res.end();
    } catch (e) {
      console.error(
        'categories/[categoryId]/items/index.json.js post:',
        e
      );
      send(res, 500, {error: e});
    }
  }
```

6 Implement the API services to delete and update items in a category in `src/routes/categories/[categoryId]/items/[itemId].json.js`:

```
const {ObjectId} = require('mongodb');
const send = require('@polka/send-type');
import {getCollection} from '../../_helpers';
```

This deletes an item from a category in the database.

```
export async function del(req, res) {
  const {categoryId, itemId} = req.params;
  try {
    const collection = await getCollection();
    const itemPath = `items.${itemId}`;
    const result = await collection.updateOne(
      {_id: ObjectId(categoryId)},
      {$unset: {[itemPath]: ''}}
    );
    if (result.deletedCount === 0) {
      res
        .status(404)
        .send(
          `no item with id ${itemId} found ` +
          `in category with id ${categoryId}`
        );
    } else {
      res.end();
    }
  } catch (e) {
    console.error(
      'categories/[categoryId]/items/[itemId].json.js del:',
      e
    );
    send(res, 500, {error: e});
  }
}
```

This updates an item in a category in the database.

```
export async function put(req, res) {
  const {categoryId} = req.params;
  const item = req.body;

  try {
    const collection = await getCollection();
```

```
      const itemPath = `items.${item.id}`;
      await collection.updateOne(
        {_id: ObjectId(categoryId)},
        {$set: {[itemPath]: item}}
      );
      res.end();
    } catch (e) {
      console.error(
        'categories/[categoryId]/items/[itemId].json.js put:',
        e
      );
      send(res, 500, {error: e});
    }
  }
```

Here are the steps to use these API services in the client-side code of the Sapper app:

1. *Update the* `id` *property of category objects.* The objects returned from the MongoDB database that represent categories contain an `_id` property that holds their unique ID. The current client-side code expects category objects to have an `id` property. Change all these references to `_id`.
2. *Modify* `src/routes/checklist.svelte`. Many changes to this file are required. Calls to the API services implemented above can be found in the `preload`, `drop`, `deleteCategory`, and `saveCategory` functions. Check out `checklist.svelte` (http://mng.bz/mBqr) for details.
3. *Modify* `src/components/Category.svelte`. Many changes to this file are required. Calls to the API services implemented above can be found in the `deleteItem` and `saveItem` functions. Check out `Category.svelte` (http://mng.bz/5a8B) for details.
4. *Modify* `src/components/Item.svelte`. Minor event handling changes to dispatch a `persist` event are needed. Check out `Item.svelte` (http://mng.bz/6QEo) for details.

To try all these changes, follow these steps:

1. Start the MongoDB server.
2. Start the server from a terminal by entering `npm run dev`.
3. Add a few categories.
4. Change a category name by clicking it, modifying the name, and pressing Enter.
5. Delete a category by clicking its trash can icon.
6. Add a few items to a category.
7. Change the name of an item by clicking it, modifying the name, and pressing Enter.
8. Delete an item by clicking its trash can icon.
9. Drag an item from one category to another.
10. Refresh the browser to see that all the categories and items are retained.

With these changes in place, we have transformed the Travel Packing app into one that no longer just saves data in browser `localStorage`, which is tied to a single web browser. It now saves the data in a MongoDB database.

As an exercise, you can modify the app to store the data separately for each user. Currently there is one travel packing checklist that is shared by all users.

In the next chapter you will learn how to create a static site from a Sapper application.

Summary

- Server routes are Node-based API/REST services that enable collocating server-side code with client-side code in the same Sapper project.
- Server route source files are placed under the `src/routes` directory along with the `.svelte` files that define page components. They follow a special naming convention.
- Server route functions are like Express middleware functions. They handle HTTP requests.
- Server routes can implement all the common CRUD operations.
- It is easy to switch from using the Polka server library to using Express, though there is not a strong reason to do so.

18 Exporting static sites with Sapper

This chapter covers

- Exporting Sapper apps to generate static sites
- When to export apps
- An example exported app

Exporting can be desirable for apps where it is possible to generate the HTML for every page at build time.

A common example is a blog site, where users can navigate to specific posts. Authors periodically add blog posts, and the new posts only become available when the site is regenerated. Site generation can be automated so it occurs on a regular basis, such as every night. The site can also be automatically regenerated every time there is a push to its source repository.

Static sites have excellent runtime performance. One reason is that the HTML for each page only has to be downloaded, not generated in the browser or on the server. Another reason is that typically far less JavaScript code is downloaded. In some cases no JavaScript is required, such as for sites that do not require user interaction other than page navigation.

Static sites are also more secure because most or all API interactions occur during site generation, not when users interact with the site. This means there is little to no chance that server hacking can affect the content of the site.

Exporting a Sapper app is somewhat similar to the functionality provided by Gatsby (www.gatsbyjs.org/) for React. In this chapter, we will dive deep into the details of exporting and use it in an example app.

The Travel Packing app is not a candidate for creating a static site because it uses server routes to query and update a MongoDB database. Server routes are not available for use at runtime in exported Sapper apps. Instead we will build a site that does two things: it provides information about the rock-paper-scissors game, and it provides information about selected dog breeds.

18.1 Sapper details

Sapper apps that are not exported only provide server-side rendering for the first page that is visited. All other pages are rendered in the browser.

Exporting a Sapper app generates the HTML for every page at build time. No pages are rendered on the server or in the browser. Sapper does this by recursively crawling the pages of an app starting at the first page, looking for anchor elements (`<a>`), and prerendering every reachable page. This static version of the app can be deployed using any static hosting solution. No Node-based server is required because no JavaScript that is part of the Sapper app is processed on the server.

When a Sapper app is exported, the `preload` functions defined in reachable pages are invoked. If these functions call API services that are implemented outside of the Sapper app (in other words, not implemented by a Sapper server route), the servers that support them must be running.

The `preload` functions are only called during the export, not when users visit the site. The data retrieved in these functions is typically used to render the component defined in the same `.svelte` file. This data will be from a snapshot in time, which is the time that the site was last exported. The responses are written to `.json` files, and when the static site is browsed, these `.json` files are used in place of the API calls. For some types of apps, this is an acceptable limitation, but exporting is certainly not appropriate for all apps.

API calls made outside of `preload` functions can still be made at runtime. However, server routes are not available at runtime in exported apps, so API services that need to be called at runtime cannot be implemented as server routes.

To build a static site from a Sapper app, enter `npm run export`. This generates files in the `__sapper__/build` and `__sapper__/export` directories.

18.2 When to export

Before deciding to export a Sapper app, some questions should be considered.

First, is it possible to determine and generate all the pages required by the site at build time? This is related to requirements on data being up to date. For example, if the site provides a catalog of items for sale, is it acceptable to only show the items that were available at the time the site was last generated? If not, using a normal, unexported Sapper app is better, because it can generate pages when users visit the site.

Second, how long does it take to generate a new version of the site? The need to present up-to-date data might lead to automating site builds, perhaps nightly. But if the data needs to be more current, say within the last hour, you could automatically generate a new site every hour. Whether this is reasonable depends on how long it takes to generate the site. Returning to our catalog example, if there are thousands of items available and we need to generate a separate page for each item, the site generation time and cost of computing resources might make this an unreasonable approach. Using an unexported Sapper app may be a better option.

18.3 Example app

Let's walk through an example of building a static site starting with the Sapper app template. The finished code for this app and all the images it uses can be found at http://mng.bz/oPqd.

It's best to build and test the app as a dynamic site (non-static) before exporting it. This provides live reload after changes, which provides great feedback.

First, create a new Sapper app using the provided template:

1. Enter `npx degit "sveltejs/sapper-template#rollup" my-static-site`.
2. Enter `cd my-static-site`.
3. Enter `npm install`.
4. To test the app as a dynamic site, enter `npm run dev`.
5. Browse to http://localhost:3000.
6. Verify that the app works by clicking each of the navigation links at the top and verifying that the pages render correctly.
7. Stop the server by pressing Ctrl-C.
8. To test the app as a static site, enter `npm run export`.
9. Enter `npx serve __sapper__/export`, as suggested in the output from the previous command.
10. Browse to http://localhost:5000.
11. Verify that the app still works by again clicking each of the navigation links at the top and verifying that the pages render correctly.
12. Stop the server by pressing Ctrl-C.

During the development of a static site, it will be necessary to run the `export` and `serve` commands many times. To simplify this, install a couple of npm packages by entering `npm install -D npm-run-all serve`. Then add the following npm scripts in `package.json`:

```
"serve": "serve __sapper__/export",
"static": "npm-run-all export serve",
```

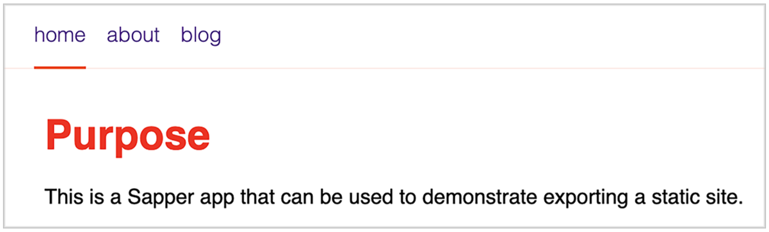
Now both the export and serve scripts can be run by entering the single command npm run static. Browse to http://localhost:5000 to see the result.

Next, let's replace the contents of the home page:

1. Enter npm run dev to start the server so the app can be run as a dynamic site.
2. Browse to http://localhost:3000.
3. Edit src/routes/index.svelte and replace its contents with the following:

```
<svelte:head>
  <title>Home</title>
</svelte:head>

<h1>Purpose</h1>

<p>
  This is a Sapper app that can be used
  to demonstrate exporting a static site.
</p>
```

4. Since we are no longer using the default image, delete the file static/great-success.png.
5. Edit src/routes/_layout.svelte:
   - Delete the max-width and margin CSS properties from the CSS rule for main elements. This will allow page content to be left-aligned.
6. Verify that the Home page shown in figure 18.1 is rendered in the browser.



Purpose

This is a Sapper app that can be used to demonstrate exporting a static site.

Figure 18.1 Home page

Now let's replace the About page with a new RPS page (for "Rock, Paper, Scissors").

1. Create the following files. Note the use of anchor elements to link to other pages.

   First, create src/routes/rps.svelte:

```
<svelte:head>
  <title>Rock Paper Scissors</title>
</svelte:head>

<h1>Rock Paper Scissors</h1>
<p>This is a game for two players.</p>
<p>Meet <a href="./rock">rock!</p>
```

Next, create src/routes/rock.svelte:

```
<svelte:head>
  <title>Rock</title>
</svelte:head>

<h1>Rock</h1>
<img alt="rock" src="./images/rock.jpg" />
<p>I beat <a href="./scissors">scissors</a>.</p>
```

Next, create src/routes/paper.svelte:

```
<svelte:head>
  <title>Paper</title>
</svelte:head>

<h1>Paper</h1>
<img alt="paper" src="./images/paper.jpg" />
<p>I beat <a href="./rock">rock</a>.</p>
```

And next, create src/routes/scissors.svelte:

```
<svelte:head>
  <title>Scissor</title>
</svelte:head>

<h1>Scissors</h1>
<img alt="scissors" src="./images/scissors.jpg" />
<p>I beat <a href="./paper">paper</a>.</p>
```

2. Edit src/components/Nav.svelte and change the second li to match the following:

```
<li>
  <a
    aria-current={segment === "rps" ? 'page' : undefined}
    href='rps'
  >
    RPS
  </a>
</li>
```

3. Capitalize the text for the Home link so it is “Home”, just to be consistent with the “RPS” and “Dogs” links (created later).
4. Add images like those in figures 18.2, 18.3, and 18.4 in the static/images directory.

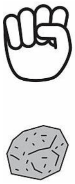


Figure 18.2 static/images/rock.jpg

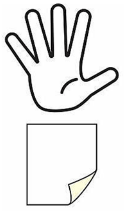
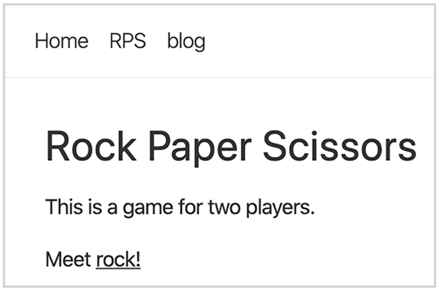


Figure 18.3 static/images/paper.jpg

Figure 18.4 static/images/scissors.jpg

5 Delete the file `src/routes/about.svelte`, since it is no longer being used.
6 In the browser, click the RPS navigation link and verify that the RPS page shown in figure 18.5 is rendered.



Home RPS blog

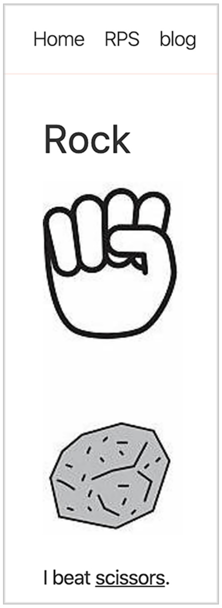
Rock Paper Scissors

This is a game for two players.

Meet rock!

Figure 18.5 RPS page

7 Click the Rock link and verify that the Rock page shown in figure 18.6 is rendered.
8 Click the Scissors link and verify that the Scissors page shown in figure 18.7 is rendered.
9 Click the Paper link and verify that the Paper page shown in figure 18.8 is rendered.
10 Click the Rock link and verify that the Rock page is again rendered.

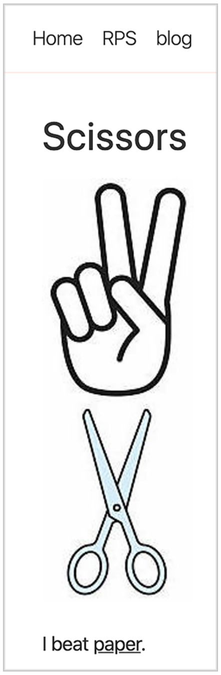


Home RPS blog

Rock

I beat scissors.

Figure 18.6 Rock page

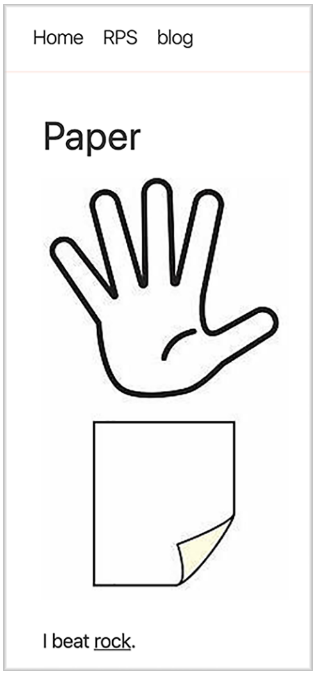


Home RPS blog

Scissors

I beat paper.

Figure 18.7 Scissors page



Home RPS blog

Paper

I beat rock.

Figure 18.8 Paper page

Finally, let’s replace the Blog page with a new Dogs page.

1. Configure Rollup to enable importing JSON files:
   - Enter `npm install -D @rollup/plugin-json`.
   - Edit `rollup.config.js`:
   - Add `import json from '@rollup/plugin-json';` after the existing imports.
   - Add `json()` after `commonjs()` in the `plugins` array for both the `client` and `server` objects. Be sure to add commas where needed after elements in the `plugins` arrays.
2. Create a dogs directory under `src/routes`.
3. Create the following files in the dogs directory.

   First, create `src/routes/dogs/dogs.json`:

```
{
  "Dasher": {
    "name": "Dasher",
    "gender": "male",
    "breed": "Whippet",
    "imageUrl": "./images/whippet.jpg",
    "description": "The sleek, sweet-faced Whippet, ..."
  },
  "Maisey": {
    "name": "Maisey",
    "gender": "female",
    "breed": "Treeing Walker Coonhound",
    "imageUrl": "./images/treeing-walker-coonhound.jpg",
    "description": "A smart, brave, and sensible hunter, ..."
  },
  "Ramsay": {
    "name": "Ramsay",
    "gender": "male",
    "breed": "Native American Indian Dog (NAID)",
    "imageUrl": "./images/native-american-indian-dog.jpg",
    "description": "The NAID is one of friendliest dog breeds. ..."
  },
  "Oscar": {
    "name": "Oscar ",
    "gender": "male",
    "breed": "German Shorthaired Pointer (GSP)",
    "imageUrl": "./images/german-shorthaired-pointer.jpg",
    "description": "Male German Shorthaired Pointers stand between ..."
  }
}
```

Feel free to substitute dogs you know.

The next file, `src/routes/dogs/index.json.js`, implements an API service that retrieves a sorted array of dog names:

This gets the dog names from dogs.json and sorts them.

```
import dogs from './dogs.json';
const names = Object.values(dogs).map(dog => dog.name).sort();
```

```
export function get(req, res) {
  res.end(JSON.stringify(names));
}
```

This implements the GET /dogs API service. Alternatively, we could implement this to get the dog names from a database.

The next file, src/routes/dogs/[name].json.js, implements an API service that retrieves an object that describes the dog with a given name:

```
import dogs from './dogs.json';

export function get(req, res, next) {
  const {name} = req.params;
  const dog = dogs[name];

  if (dog) {
    res.end(JSON.stringify(dog));
  } else {
    const error = {message: `${name} not found`};
    res.statusCode = 404;
    res.end(JSON.stringify(error));
  }
}
```

This implements the GET /dogs/{name} API service. Alternatively, we could implement this to get the dog data from a database.

The next file, src/routes/dogs/index.svelte, implements the Dogs page, which renders an anchor for each dog, styled to look like a button. Clicking a button navigates to the page for that dog.

```
<script context="module">
  export async function preload(page, session) {
    try {
      const res = await this.fetch('dogs.json');
      if (res.ok) {
        const names = await res.json();
        return {names};
      } else {
        const msg = await res.text();
        this.error(res.statusCode, 'error getting dog names: ' + msg);
      }
    } catch (e) {
      this.error(500, 'getDogs error:', e);
    }
  }
</script>

<script>
  // The preload function above makes this available as a prop.
  export let names;
</script>

<svelte:head>
  <title>Dogs</title>
</svelte:head>

<h1>Dogs</h1>
```

This retrieves an array of dog names by invoking an API service.

This supplies the value of the names prop used in the #each block.

```
{#each names as name}
  <div>
    <a rel="prefetch" href="dogs/{name}">{name}</a>
  </div>
{/each}
<div>
  <a rel="prefetch" href="dogs/Spot">Spot</a>
</div>

<style>
  div {
    --padding: 0.5rem;
    box-sizing: border-box;
    height: calc(22px + var(--padding) * 2);
    margin-top: var(--padding);
  }

  div > a {
    border: solid lightgray 2px;
    border-radius: var(--padding);
    padding: var(--padding);
    text-decoration: none;
  }
</style>
```

This is only here to demonstrate what happens when there is a link to a non-existent page.

The next file, `src/routes/dogs/[name].svelte`, implements the page that renders data for a specific dog.

```
<script context="module">
  export async function preload({params}) {
    const {name} = params;
    const res = await this.fetch(`dogs/${name}.json`);
    if (res.ok) {
      const data = await res.json();
      if (res.status === 200) {
        return {dog: data};
      } else {
        this.error(res.status, data.message);
      }
    } else {
      const {message} = await res.json();
      const status = message && message.endsWith('not found') ? 404 : 500;
      this.error(status, 'error getting dog data: ' + message);
    }
  }
</script>

<script>
  import {goto} from '@sapper/app';

  export let dog;

  function back() {
    goto('/dogs');
  }
</script>
```

This retrieves an object describing a dog with a given name by invoking an API.

This supplies the value of the dog prop used in the HTML of this component.

The goto function navigates to a page at a given path.

```
<svelte:head>
  <title>{dog.name}</title>
</svelte:head>

{#if dog.message}
  <h1>{dog.message}</h1>
  <button on:click={back}>Back</button>
{:else}
  <h1>{dog.name} - {dog.breed}</h1>
  <div class="container">
    <div>
      <p>{dog.description}</p>
      <button on:click={back}>Back</button>
    </div>
    <img alt="dog" src={dog.imageUrl} />
  </div>
{/if}

<style>
  .container {
    display: flex;
  }

  img {
    height: 400px;
    margin-left: 1rem;
  }

  p {
    max-width: 300px;
  }
</style>
```

The dog object has a message property when there is an error retrieving data for a given dog name, as is the case with "Spot".

4 Edit `src/components/Nav.svelte` and change the third `li` element to match the following:

```
<li>
  <a
    aria-current={segment === 'dogs' ? 'page' : undefined}
    href='dogs'
  >
    Dogs
  </a>
</li>
```

5 Delete the `src/routes/blog` directory, since it is no longer being used.

6 Add images for each of the dogs in the `static/images` directory. The `dogs.json` file defined earlier in this section specifies that we need the following files:

- `german-shorthaired-pointer.jpg`
- `native-american-indian-dog.jpg`
- `treeing-walker-coonhound.jpg`
- `whippet.jpg`

The Dogs page should now be operational. Click the Dogs navigation link and verify that the page in figure 18.9 is rendered.

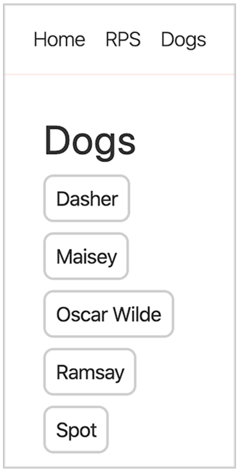
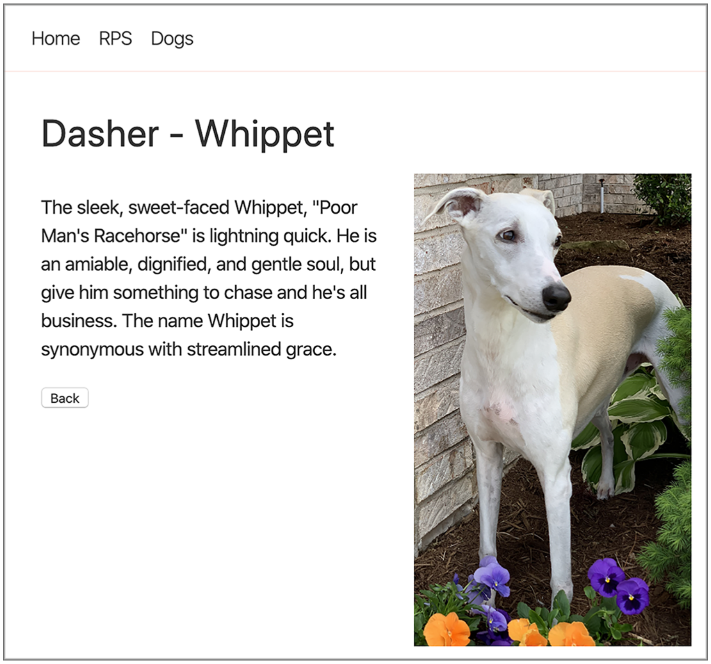


Figure 18.9 Dogs page

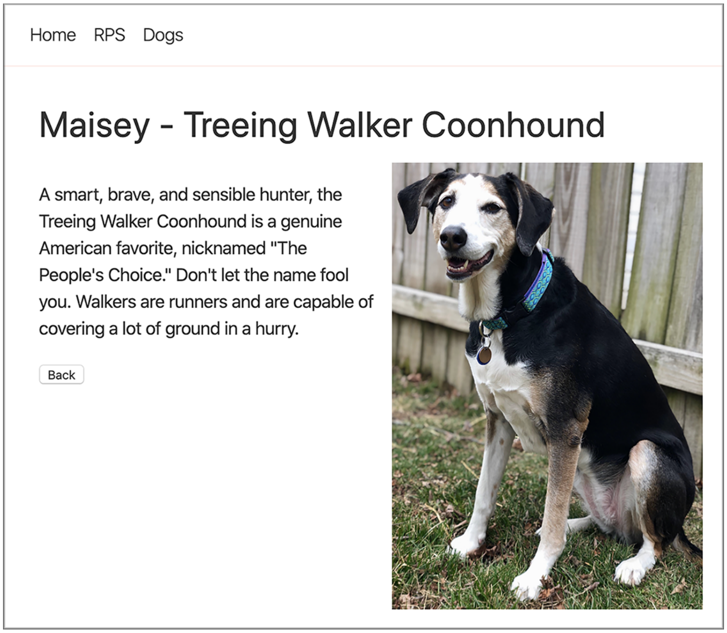
Click each dog name button and verify that the pages shown in figures 18.10 through 18.14 are rendered. After each of these pages is rendered, click the Back button to return to the Dogs page.



Dasher - Whippet

The sleek, sweet-faced Whippet, "Poor Man's Racehorse" is lightning quick. He is an amiable, dignified, and gentle soul, but give him something to chase and he's all business. The name Whippet is synonymous with streamlined grace.

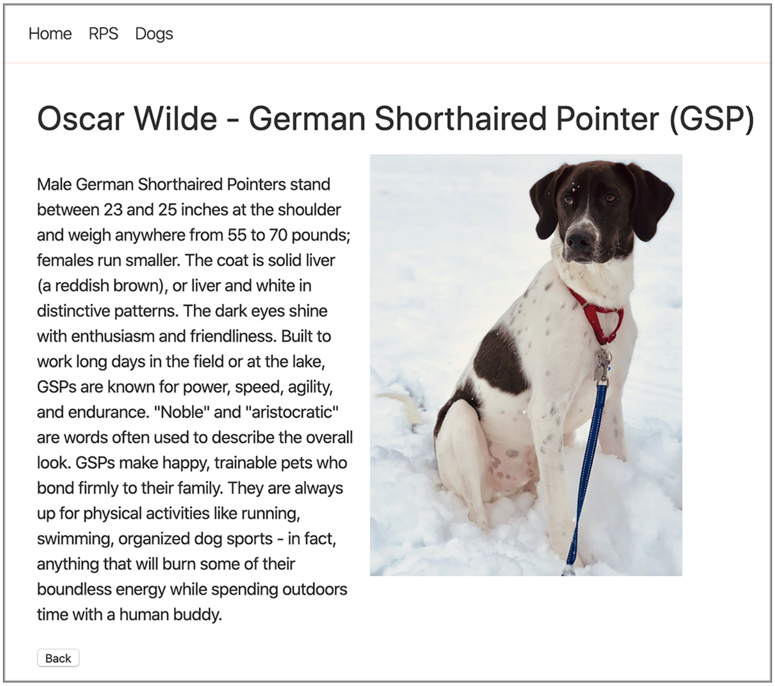
Figure 18.10 Dasher page



Maisey - Treeing Walker Coonhound

A smart, brave, and sensible hunter, the Treeing Walker Coonhound is a genuine American favorite, nicknamed "The People's Choice." Don't let the name fool you. Walkers are runners and are capable of covering a lot of ground in a hurry.

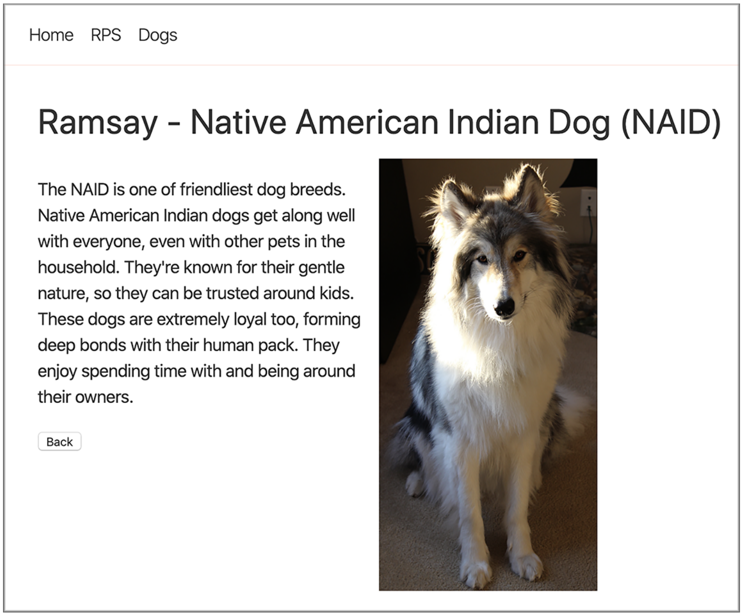
Figure 18.11 Maisey page



Oscar Wilde - German Shorthaired Pointer (GSP)

Male German Shorthaired Pointers stand between 23 and 25 inches at the shoulder and weigh anywhere from 55 to 70 pounds; females run smaller. The coat is solid liver (a reddish brown), or liver and white in distinctive patterns. The dark eyes shine with enthusiasm and friendliness. Built to work long days in the field or at the lake, GSPs are known for power, speed, agility, and endurance. "Noble" and "aristocratic" are words often used to describe the overall look. GSPs make happy, trainable pets who bond firmly to their family. They are always up for physical activities like running, swimming, organized dog sports - in fact, anything that will burn some of their boundless energy while spending outdoors time with a human buddy.

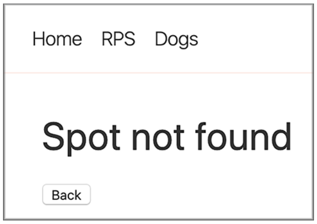
Figure 18.12 Oscar page



Ramsay - Native American Indian Dog (NAID)

The NAID is one of friendliest dog breeds. Native American Indian dogs get along well with everyone, even with other pets in the household. They're known for their gentle nature, so they can be trusted around kids. These dogs are extremely loyal too, forming deep bonds with their human pack. They enjoy spending time with and being around their owners.

Figure 18.13 Ramsay page



Spot not found

Figure 18.14 Spot page

Now that all the pages in the app are working when run as a dynamic (non-static) app, we are ready to export the app, creating a static version.

1. Enter `npm run static`. This will export the site, creating many files under the `__sapper__/export` directory. It will also start a local HTTP server for testing the site.
2. Browse to http://localhost:5000.
3. Verify that the Home, RPS, and Dogs pages all work as before.

NOTE Exporting a Sapper app does not currently perform any image optimization. This is a desired feature that may be added in the future. At the time of writing, it is being discussed in the issue at https://github.com/sveltejs/sapper/issues/172.

In the next chapter you will learn how to make Sapper apps usable, at least in a limited sense, when offline.

Summary

- Sapper apps can be "exported" to generate a static site.
- This is done by crawling all the anchor (`<a>`) elements, starting from the first page.
- API calls in `preload` functions can retrieve data that is used to generate the pages.
- Static sites can be periodically regenerated to include updated data.

19 Sapper offline support

This chapter covers

- Progressive web applications (PWAs)
- Service worker overview
- Caching strategies used by service workers
- Sapper service worker configuration
- Service worker events
- Managing service workers in Chrome
- Enabling the use of HTTPS in the Sapper server
- Verifying offline behavior

Progressive web applications (PWAs) are apps created using browser-supported technologies such as HTML, CSS, and JavaScript. They can run on any platform with a standard web browser, including desktop computers, tablets, and phones. Their primary features are the ability to run when offline, receive push notifications, and interact with device features such as cameras.

> **NOTE** When an app attempts to use device features, users are typically prompted to give permission to the app. For example, an app that uses the camera to identify a food item or diagnose a skin condition would be required to ask for permission to use the camera.

Users must be online the first time they browse a PWA so the files that implement it can be downloaded to the browser. After downloading a PWA, it can optionally be installed. This typically adds an icon to the home screen and allows it to be invoked by tapping or double-clicking an icon instead of explicitly browsing the app URL. It also makes the PWA appear more like a native application because it can run without displaying browser chrome (such as a browser menubar and tabs).

Sapper apps are PWAs by default, enabled through the use of a service worker, which will be described in the next section (see "Using Service Workers" in the MDN docs: http://mng.bz/nPqa). Offline behavior, with some limitations, is provided automatically. Modifications are only required to use a different caching strategy.

Web apps generally must be served over HTTPS in order to use service workers. This is a safety measure aimed at preventing man-in-the-middle attacks, where a substitute service worker could modify network responses. Some browsers can be configured to allow the use of service workers with localhost URLs using HTTP, but this is only for debugging purposes.

In this chapter, we will dive into the details of using service workers with Sapper apps. Then we will apply what we have covered to the Travel Packing app.

19.1 Service worker overview

A service worker is a kind of *web worker*, which means its functionality is defined by a JavaScript source file and it runs in a background thread (see "Using Web Workers" in the MDN docs: http://mng.bz/vxq7). Service workers have many use cases. They can listen for external events, periodically fetch data, and send notifications to their associated web app using push notifications. Their most common use is enabling offline functionality by acting as a proxy between a web app and the network, deciding how to handle each resource request.

Service workers can allow parts of a web application to continue functioning after network connectivity is lost. They do this by returning cached responses when requests for inaccessible resources are received.

Common tasks performed by service workers include

- Creating caches
- Storing resources in caches
- Intercepting network requests and deciding how to respond to them

There is a limit to how much data each application domain can cache and to the total amount of data that can be cached across all domains. The limits differ across web browsers, but they are mostly consistent for Chrome, Edge, and Firefox. The limit for a single domain is 20% of the overall limit. Typically the limits are based on the available space as summarized in table 19.1.

Currently Safari is an outlier in this regard. It limits each application domain to 50 MB of cache storage regardless of available disk space, and it purges this after two weeks of not being used. An alternative is to store data in IndexedDB, which has a

Table 19.1 Cache limits

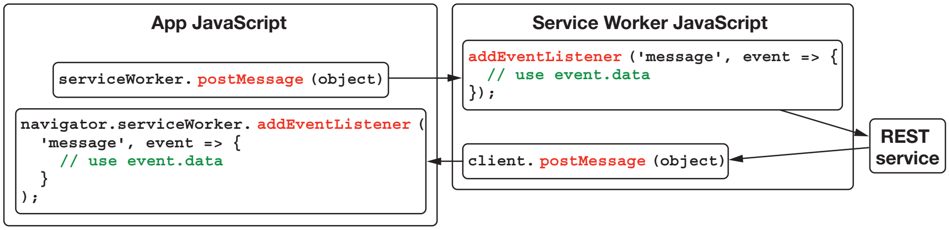
Available space	Total cache limit
Up to 8 GB	50 MB
8 to 32 GB	500 MB
32 to 128 GB	4% of volume size
Over 128 GB	The smaller of 20 GB or 4% of volume size

limit of 500 MB per application domain in Safari (see "Using IndexedDB" in the MDN docs: http://mng.bz/4AWw).

When the total limit has been reached, some browsers remove the least recently used caches to make room for new caches. Currently Chrome and Firefox do this.

Service workers do not have access to the DOM of their associated web application, so they cannot directly change what is rendered in the browser. However, they can communicate with the associated web application via message passing. The Worker postMessage method is used to send a message from a web worker to the associated web app or from the web app to a web worker.

Figure 19.1 illustrates one possible scenario. Here the client app posts a message to the service worker. The service worker uses data in the message to invoke an API service. It then returns data from the API service to the client by posting a message. The client app can use the data it receives to change what is rendered.



```
serviceWorker. postMessage (object)
```

```
navigator.serviceWorker. addEventListener (
  'message', event => {
    // use event.data
  }
);
```

```
addEventListener ('message', event => {
  // use event.data
});
```

```
client. postMessage (object)
```

Figure 19.1 Service worker flow

As stated earlier, web workers run in a background thread. A user can close the browser tab or window where the web application is running, and its web workers can continue executing.

19.2 Caching strategies

Service workers can implement many caching strategies. Different strategies can be used for different kinds of resources being requested. Resources can be files with content such as HTML, CSS, JavaScript, JSON, and image data. Resources can also be the results of API calls.

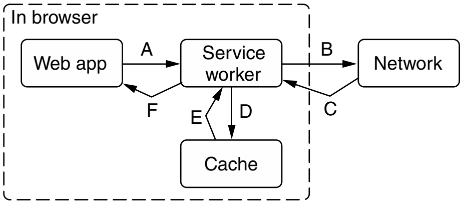


Figure 19.2 Service worker flow

Figure 19.2 is helpful for understanding the differences between these strategies. In all cases, if the requested resource cannot be obtained from the network or the cache, and the service worker cannot generate the resource, a "not found" (404) status is returned.

These are some examples of caching strategies:

- *Network only*—This strategy is applicable when using cached versions of a resource is unacceptable. For example, a banking app might decide it is better to let the user know when they are offline and not show stale data.

  All resource requests are forwarded to the network, and only resources obtained from the network are returned. No caching is used. In figure 19.2 this is represented by the path A-B-C-F.
- *Cache only*—This strategy is applicable for resources that never change or that change very rarely. Examples include a CSS file that defines site styling or an image file for a company logo.

  The service worker is responsible for initially populating the caches and thereafter only returns resources from the caches. Resource requests are never forwarded to the network. In figure 19.2 this is represented by the path A-D-E-F.
- *Network or cache*—This strategy is applicable when having the latest data is preferred, but it is acceptable to use previously fetched data. For example, a site that reports basketball scores prefers to show the latest scores, but showing the last known scores is better than showing no scores.

  Resource requests are first forwarded to the network. If a response is obtained from the network, that is returned. Then cache is updated with the response, so it can be used again later if the same resource is requested while offline. If no response is obtained from the network and a previously cached response is available, that is returned. In figure 19.2 this is represented by the path A-B-C-(D-E)-F where steps D and E are optional.
- *Cache and update*—This strategy is applicable when fast responses are prioritized over having the latest data. It's difficult to think of a case when this strategy might be preferred, but the next strategy augments this to make it more applicable.

  If the requested resource is available in a cache, that is returned. Then the request is forwarded to the network to obtain an up-to-date value. If the network returns a different value, the cache is updated so the next request for the same resource will receive the updated value. This is great for performance but has the downside of potentially using stale data. In figure 19.2 this is represented by the path A-D-E-F-B-C-D.

- *Cache, update, and refresh*—This strategy starts the same way as the "cache and update" strategy, but after new data is received from the network, the UI is triggered to refresh using the new data.

  For example, a theater website might use this approach to quickly display the known shows and ticket availability from the cache. As soon as new data becomes available, it can update this information in the browser.
- *Embedded fallback*—In this strategy, the service worker provides default responses for cases when the resource cannot be obtained from the network or a cache. For example, a service worker that returns photos of specific dogs can return stock images that match the breeds of requested dogs when the requested photos are unavailable. This, of course, assumes that the stock images have already been cached.

  This strategy can be employed as a supplement to the previously described strategies to provide an alternative to returning a "not found" (404) status.

For some web applications it is possible to define a subset of functionality that can be supported for offline use and then only cache resources related to that. For example, in the Travel Packing app we can cache the checklist of items to be packed, along with all the JavaScript and CSS required by the site, making the checklist available for viewing while offline. But we can forego support for changing the checklist in any way.

For some web applications it is acceptable to accumulate transactions when offline and execute them later when online again. For example, suppose a timesheet web app allows users to enter the hours they worked on various projects. If network connectivity is lost, the app can save the hours entered in a cache. When connectivity is restored, it can read data from the cache, make the appropriate API calls to save it on a server, and delete the data from the cache.

This can be challenging to implement due to special cases that must be considered. For example, what should be done in the timesheet app if we are saving hours for a project that has been deleted by someone else after network connectivity was lost for the user that entered the hours? Perhaps the new hours should just be ignored, or perhaps the project should be recreated and the hours should be applied to it. There can be many such cases to consider.

The current state of network connectivity can be determined from the Boolean value of `navigator.onLine`. The best way to access the current value of this variable in a Svelte/Sapper app is to do the following:

```
<script>
  let online = true;
  //...use online in JavaScript code and {#if} blocks ...
</script>

<svelte:window bind:online />
```

online is an alias for window.navigator.onLine.

Another option is to register functions to be called when connectivity changes by listening for offline and online events on the window object. In a Svelte/Sapper app, this is best done as follows, where handleOffline and handleOnline are functions to be invoked:

```
<svelte:window on:offline={handleOffline} on:online={handleOnline} />
```

19.3 Sapper service worker configuration

By default, Sapper apps configure a ServiceWorker in src/service-worker.js. This file can be modified to change the default caching strategy. When debugging this code, it can be useful to write to the DevTools Console using calls like console.log.

The src/service-worker.js file imports four variables defined in the generated file src/node_modules/@sapper/service-worker.js. That file should not be modified. The variables are timestamp, files, shell, and routes.

The timestamp variable is set to the timestamp of the last time the app was built. It is used as part of cache names so that new builds use new caches containing new resources, and old caches can be deleted.

The files variable is set to an array of the names of all the files found in the static directory. This includes the global.css file and media files such as images. It also includes the manifest.json file, which configures how the PWA will appear to users, including names, colors, and icons. When the service worker receives the install event (described in the next section), these files are saved in a cache with a name formed by concatenating "cache" with the value of the timestamp variable.

The shell variable is set to an array of the paths to all the files found in the __sapper__/build/client directory. These files are generated by code splitting each route and contain minimized JavaScript. When the service worker receives the install event (described in the next section), these files are saved in the same cache used for files in the files array.

The routes variable is set to an array of objects with a pattern property whose value is a regular expression that matches the URL of each route in the app. The default service worker configuration does not use this variable. However, the function that handles fetch events (described in the next section) contains a commented-out if statement that uses this variable to determine if the URL being fetched matches any of the app routes. Study this code to determine if uncommenting it might be appropriate for your application.

The Sapper app can be built by entering npm run build, and the server can be started by entering npm start. In this case, changes to the code, such as src/service-worker.js, will not be reflected in the running application unless the app is rebuilt, the server is restarted, and the page is manually refreshed.

Alternatively, if npm run dev is used to build the app and start the server, the server will be restarted when code changes are detected. It is still necessary to manually refresh the page in the browser. This differs from Svelte and Sapper apps that do not use a service worker, in which case the browser is automatically reloaded after code changes.

Until each page is visited, the cache will not contain everything needed to render the page. After a page has been visited once while online, it can be visited again while offline.

The results of API calls made from the `preload` function in a page are cached when the page is visited while online. If visited pages are revisited later while offline, the cached API responses are used. However, if a page that was not visited while online is visited while offline, the error page will be displayed with a 500 error and the message "Failed to fetch."

For apps where it is possible to proactively cache all pages, a better option may be to export the app. This is the case for the default Sapper app.

19.4 Service worker events

Service workers listen for events and act on them.

The first event received is `install`. This is a one-time event. The default Sapper service worker configuration handles this event by doing the following:

1. Open a `cache` whose name is "cache" concatenated with the value of the `timestamp` variable. If this cache does not exist, it is created.
2. Add all the files listed in the `shell` and `files` arrays to the cache. These files are always served from the cache. They are available without a network connection after the app is initially loaded from the network.

The second event received is `activate`. This is also a one-time event. The default Sapper service worker configuration handles this event by deleting any old caches for this app that were created when previous builds of the app were run. This is determined by checking whether their names contain the current value of the `timestamp` variable.

The third event type received is `fetch`. This can be received many times. The caching strategy is implemented here. The default Sapper service worker caching strategy defined in `service-worker.js` evaluates each request using the following steps in this sequence:

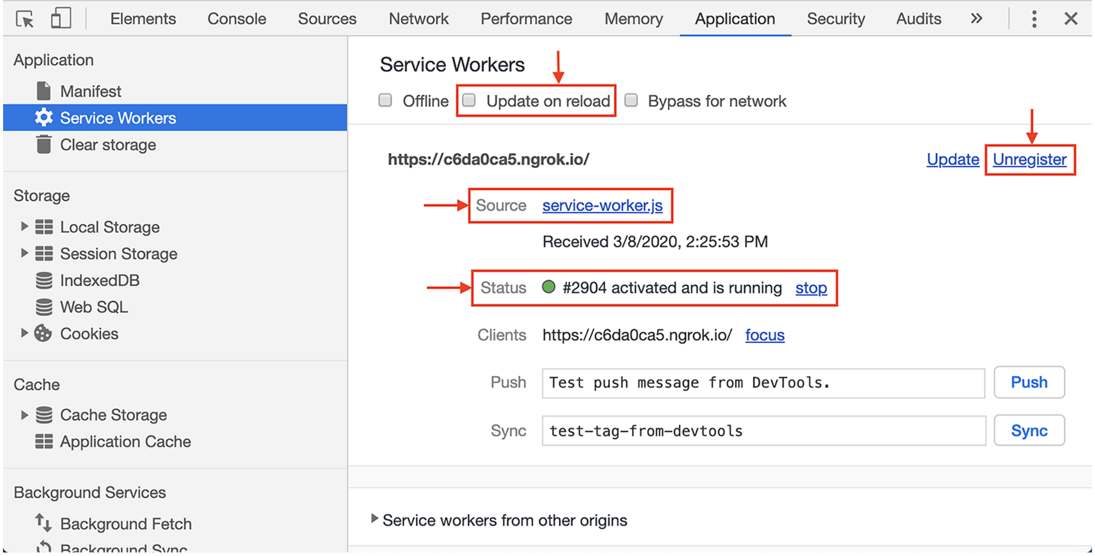
1. Only process `GET` requests.
2. Don't process requests asking for just part of a document, using an HTTP "Range" header (not commonly used).
3. Only process URLs with a protocol beginning with "http". For example, URLs with the "data" protocol are ignored.
4. Serve all static files and bundler-generated assets (such as those from code splitting) from the cache.
5. If the file was not found in the cache and the request has a `cache` property of `only-if-cached`, don't attempt to find the file using the network.
6. Otherwise, attempt to satisfy the request using the network.
7. If found, add the file to the cache and return its contents.
8. If not found and a match for the URL is in the cache, return that content.

This caching strategy means that the results of API service calls are cached. Later, if the same request is made again and the service is offline, the cached value will be returned.

19.5 Managing service workers in Chrome

The Chrome DevTools provide a way to interact with service workers and the caches they create.

To view service workers for the current site, click the DevTools Application tab. Then click Service Workers in the left nav. The main area will display information about each of the service workers for the site (see figure 19.3).



□ Offline □ Update on reload □ Bypass for network

https://c6da0ca5.ngrok.io/

Source service-worker.js

Received 3/8/2020, 2:25:53 PM

Status ● #2904 activated and is running

Clients https://c6da0ca5.ngrok.io/

Push `Test push message from DevTools.`

Sync `test-tag-from-devtools`

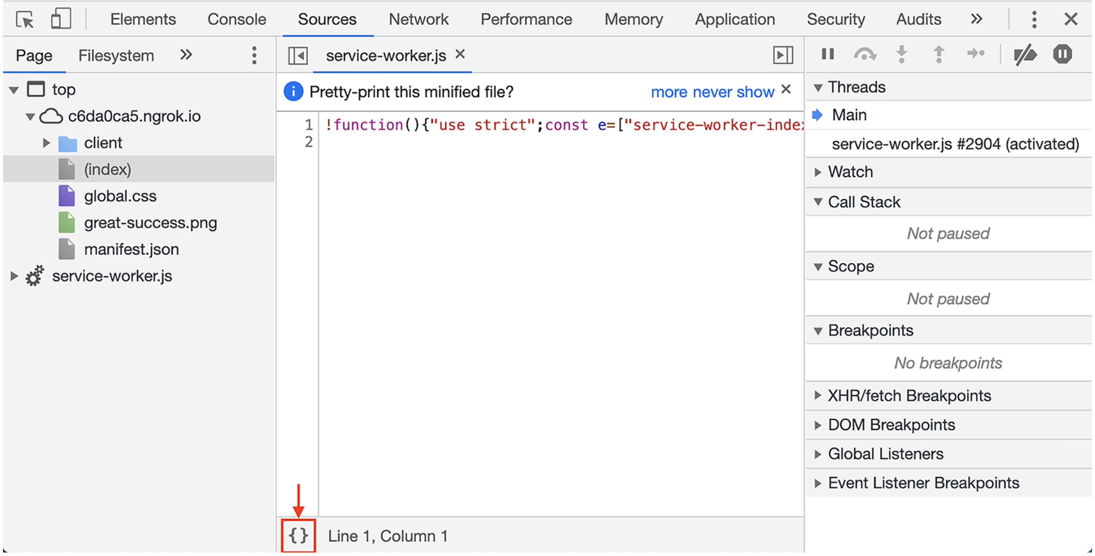
Figure 19.3 Service workers in Chrome DevTools

The status of a service worker is displayed after the Status label. For example, it may say "activated and is running." To stop the service worker, click the Stop link after the status. The Stop link will change to Start, and this can be clicked to restart it.

Unregistering a service worker allows it to run through its lifecycle again one time, when the page is refreshed. This includes processing the `install` and `activate` events again. This is useful for debugging the code that handles those events. To do this, click the Unregister link to the right of a service worker description.

To cause service workers to install and activate again every time the page is reloaded, and without creating a new build, check the Update on Reload check box at the top of the main area, and refresh the page.

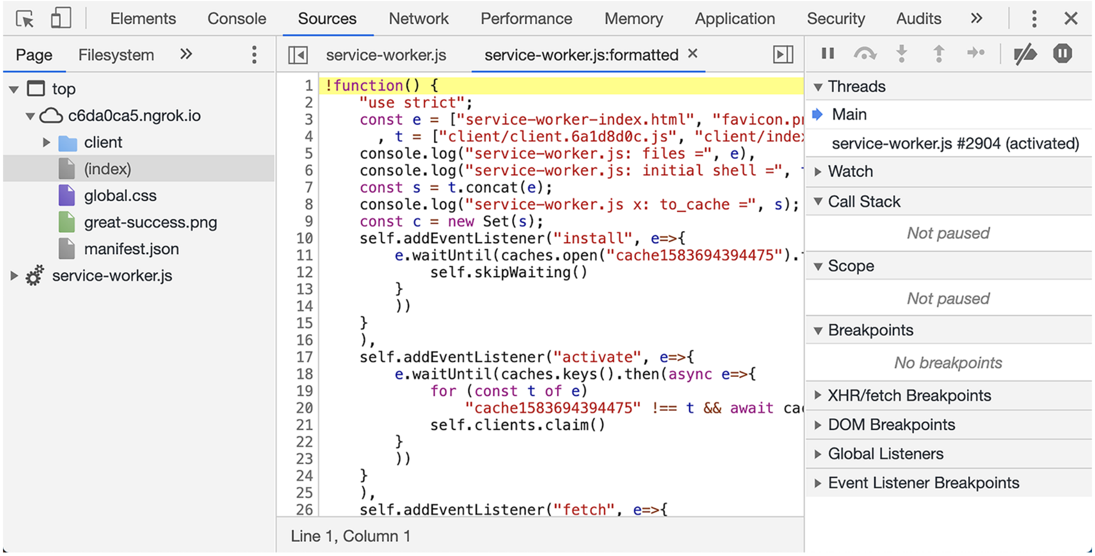
To view the source code for a service worker, click the link after the Source label. This switches to the Sources tab and displays the code. Typically the code will have been minified (see figure 19.4). To see a pretty-printed version of this, as displayed in figure 19.5, click the "{}" shown at the bottom of figure 19.4.



Pretty-print this minified file?

```
!function(){"use strict";const e=["service-worker-inde
```

Figure 19.4 Minimized service worker code in Chrome DevTools

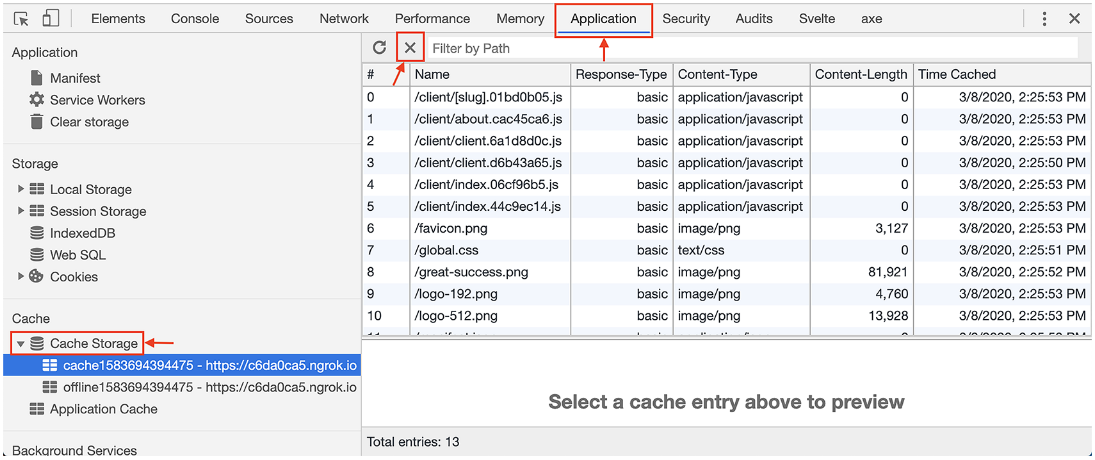


```
!function() {
    "use strict";
    const e = ["service-worker-index.html", "favicon.p
      , t = ["client/client.6a1d8d0c.js", "client/inde
    console.log("service-worker.js: files =", e),
    console.log("service-worker.js: initial shell =",
    const s = t.concat(e);
    console.log("service-worker.js x: to_cache =", s);
    const c = new Set(s);
    self.addEventListener("install", e=>{
        e.waitUntil(caches.open("cache1583694394475").
            self.skipWaiting()
        }
        ))
    }
    ),
    self.addEventListener("activate", e=>{
        e.waitUntil(caches.keys().then(async e=>{
            for (const t of e)
                "cache1583694394475" !== t && await ca
            self.clients.claim()
        }
        ))
    }
    ),
    self.addEventListener("fetch", e=>{
```

Figure 19.5 Pretty-printed service worker code in Chrome DevTools

To see the files that have been cached, click the DevTools Application tab. Then click the disclosure triangle before Cache Storage in the left nav. This will display a list of all the current caches for the site. The caches that Sapper apps create by default have names that begin with "cache" and "offline" and end with a build timestamp.

Click one of these to see a list of the files that it has cached (see figure 19.6). Click a file to see its contents at the bottom of the main area.



#	Name	Response-Type	Content-Type	Content-Length	Time Cached
0	/client/[slug].01bd0b05.js	basic	application/javascript	0	3/8/2020, 2:25:53 PM
1	/client/about.cac45ca6.js	basic	application/javascript	0	3/8/2020, 2:25:53 PM
2	/client/client.6a1d8d0c.js	basic	application/javascript	0	3/8/2020, 2:25:53 PM
3	/client/client.d6b43a65.js	basic	application/javascript	0	3/8/2020, 2:25:50 PM
4	/client/index.06cf96b5.js	basic	application/javascript	0	3/8/2020, 2:25:53 PM
5	/client/index.44c9ec14.js	basic	application/javascript	0	3/8/2020, 2:25:53 PM
6	/favicon.png	basic	image/png	3,127	3/8/2020, 2:25:53 PM
7	/global.css	basic	text/css	0	3/8/2020, 2:25:51 PM
8	/great-success.png	basic	image/png	81,921	3/8/2020, 2:25:52 PM
9	/logo-192.png	basic	image/png	4,760	3/8/2020, 2:25:53 PM
10	/logo-512.png	basic	image/png	13,928	3/8/2020, 2:25:53 PM

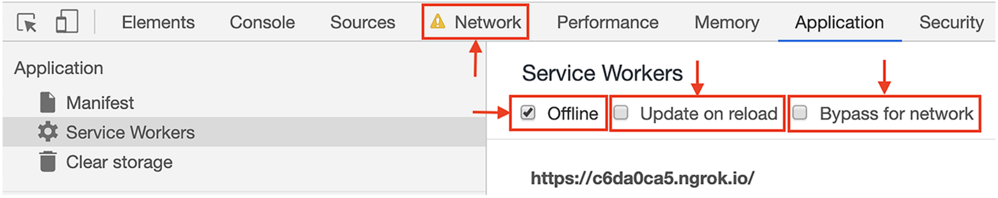
Select a cache entry above to preview

Total entries: 13

Figure 19.6 Cached files in Chrome DevTools

To remove an individual file from a cache, select the file in the main area and press the Delete key or click the "X" above the list of files. To delete an entire cache, right-click a cache name and select Delete.

To simulate being offline, click Service Workers in the left nav and check the Offline check box at the top of the main area (see figure 19.7). This is an alternative to going to the Network tab and changing the Online drop-down to Offline. A warning icon will appear in the Network tab to remind you that you are offline. This is useful for testing the ability of service workers to use cached files.



Service Workers

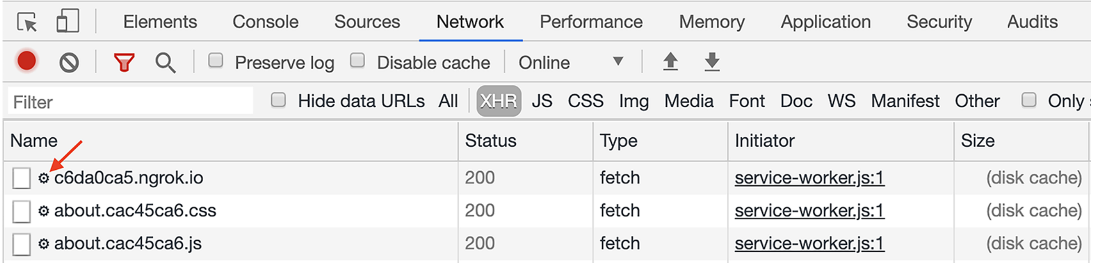
☑ Offline ☐ Update on reload ☐ Bypass for network

https://c6da0ca5.ngrok.io/

Figure 19.7 Simulating being offline in Chrome DevTools

To bypass the use of service workers, causing all requests to go to the network, check the Bypass for Network check box at the top of the main area. This, of course, requires being online.

The list of requested files in the Network tab has a gear icon before each file that was loaded from a cache (see figure 19.8). This is useful for determining whether specific files were served from the network or from a cache.

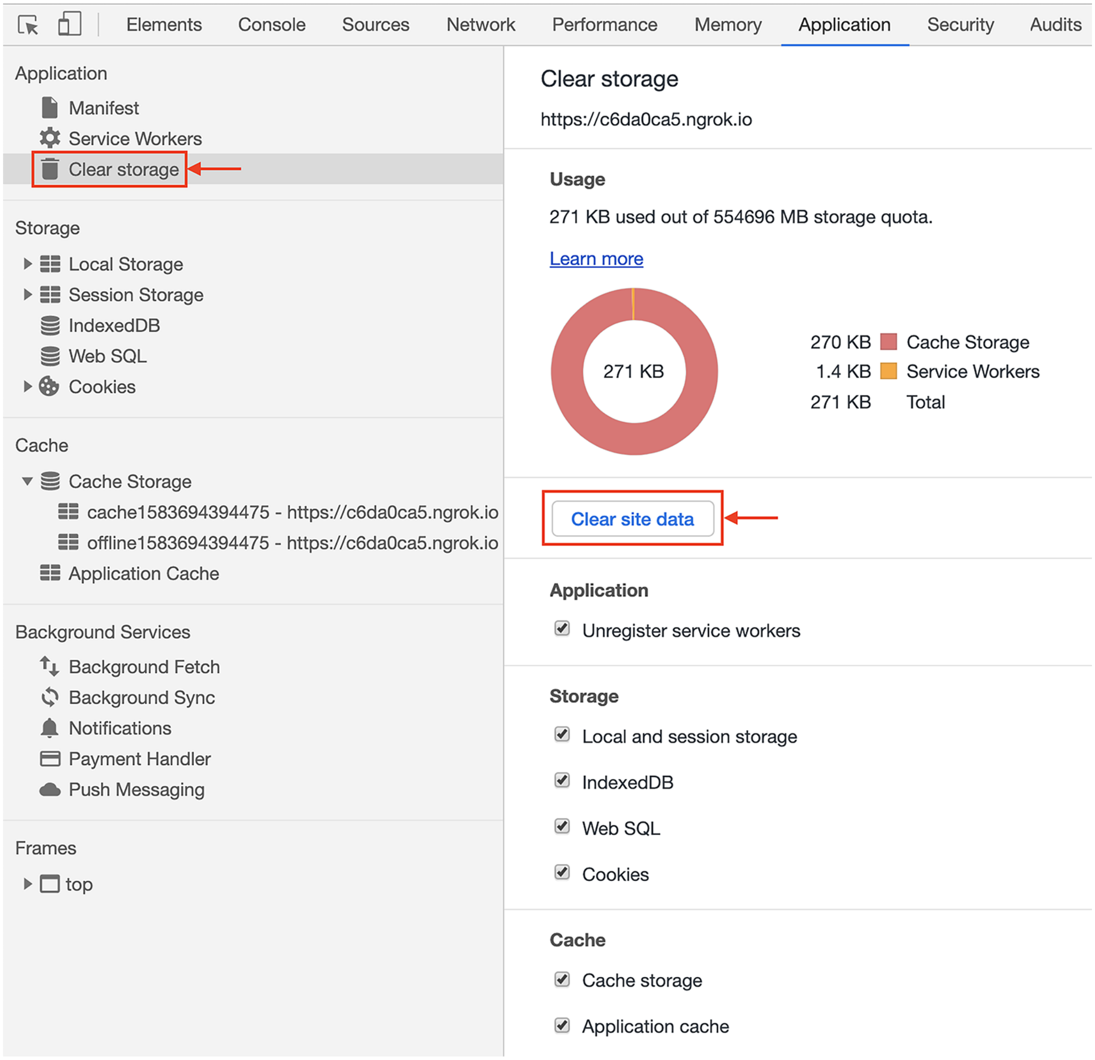


Name	Status	Type	Initiator	Size
□ ⚙ c6da0ca5.ngrok.io	200	fetch	service-worker.js:1	(disk cache)
□ ⚙ about.cac45ca6.css	200	fetch	service-worker.js:1	(disk cache)
□ ⚙ about.cac45ca6.js	200	fetch	service-worker.js:1	(disk cache)

Figure 19.8 Files loaded from cache in Chrome DevTools

To clear many things at once, click the Application tab and click Clear Storage (preceded by a trash can icon) in the left nav (see figure 19.9). This displays a series of check boxes in the main area for categories of things that can be cleared. By default, all the check boxes are checked. This includes Unregister Service Workers and Cache Storage. Click the Clear Site Data button to clear the data associated with every checked category.

A great video covering most of the topics in this section, created by the Chrome team, can be found at http://mng.bz/oPwp. A similar video for Firefox, also from the Chrome team, can be found at http://mng.bz/nPw2.



Clear storage

https://c6da0ca5.ngrok.io

Usage

271 KB used out of 554696 MB storage quota.

270 KB	🟥	Cache Storage
1.4 KB	🟧	Service Workers
271 KB		Total

Application

☑ Unregister service workers

Storage

☑ Local and session storage

☑ IndexedDB

☑ Web SQL

☑ Cookies

Cache

☑ Cache storage

☑ Application cache

Figure 19.9 Clearing storage in Chrome DevTools

19.6 Enabling the use of HTTPS in the Sapper server

By default, Sapper apps use the Polka server library and configure it to use HTTP, not HTTPS. As discussed earlier, service workers must be served over HTTPS for security reasons.

The following steps show one approach to enable serving a Sapper app using HTTPS:

1 Install ngrok at https://ngrok.com/. This is a tool that provides a public URL that tunnels to a local server. Anyone can then browse this URL, but the URL is

only temporary and the number of connections per minute is limited to 40. The benefit we are after is being able to browse a local server using HTTPS. The free version of ngrok is sufficient for this.

2 Create a Sapper app:

– Enter `npx degit sveltejs/sapper-template#rollup` *`app-name`*.

– `cd` to the new *`app-name`* directory.

– Enter `npm install`.

3 If you do not already have suitable SSL key and certificate files, generate temporary, self-signed ones using the `openssl` command and answering the questions it asks. Anything can be entered for Organizational Unit, and `localhost` can be entered for Common Name.

```
openssl req -newkey rsa:2048 -nodes -x509 -days 365 \
  -keyout key.pem \
  -out cert.pem
```

NOTE If you do not already have openssl, you'll need to install it. Windows users can install `openssl` from www.openssl.org. MacOS users can install a newer version of `openssl` using Homebrew (see https://brew.sh/).

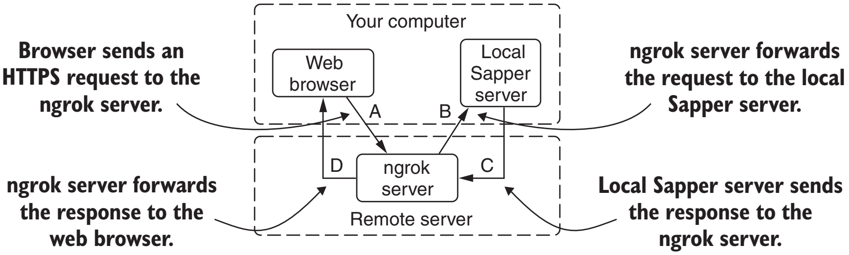
4 Modify `server.js` to use HTTPS by matching the following:

```
const {createServer} = require('https');
const {readFileSync} = require('fs');

import sirv from 'sirv';
import polka from 'polka';
import compression from 'compression';
import * as sapper from '@sapper/server';

const {PORT, NODE_ENV} = process.env;
const dev = NODE_ENV === 'development';

const options = {
  key: readFileSync('key.pem'),
  cert: readFileSync('cert.pem')
};

const {handler} = polka().use(
  compression({threshold: 0}),
  sirv('static', {dev}),
  sapper.middleware()
);

createServer(options, handler).listen(PORT, err => {
  if (err) {
    console.error('error', err);
  } else {
    console.info('listening for HTTPS requests on', PORT);
  }
});
```

The function imported here creates a server that listens for HTTPS requests.

The files referenced here can be created using the openssl command.

5. Build the Sapper app by entering `npm run build`.
6. Start the Sapper server by entering `npm start`. This listens on port 3000 by default.
7. Establish a tunnel by entering `ngrok http https://localhost:3000`.
8. Browse the Forwarding URL output from ngrok that begins with “https:”, not the one that begins with “http:”.



Browser sends an HTTPS request to the ngrok server.

ngrok server forwards the request to the local Sapper server.

ngrok server forwards the response to the web browser.

Local Sapper server sends the response to the ngrok server.

Figure 19.10 Flow of HTTPS requests using ngrok

Issue with running in development mode

If the Sapper server is run in development mode by entering `npm run dev`, the following error message will appear in the DevTools console:

```
Mixed Content: The page at 'https://{some-id}.ngrok.io/' was loaded over
HTTPS, but requested an insecure EventSource endpoint
'http://{some-id}.ngrok.io:10000/__sapper__'.
This request has been blocked; the content must be served over HTTPS.
```

This is why the previous steps use `npm run build` and `npm start`.

19.7 Verifying offline behavior

When developing apps that use service workers for offline behavior, it is important to know how to use tools to verify that they are working correctly. Here are some steps that can be followed to do this using the Chrome DevTools.

1. Browse the app in Chrome.
2. Open the DevTools.
3. Verify that browser caching is not disabled. (When this is disabled, service workers will not cache any downloaded files.)
   - Click the Network tab.
   - Verify that Disable Cache is not checked.
   - Click the vertical ellipsis in the upper right of the DevTools.
   - Select Settings.

   - Scroll to the Network section.
   - Verify that Disable Cache (While DevTools Is Open) is not checked.
4. Browse all the pages of the app so they are cached.
5. View the status of the service worker:
   - Click the Application tab.
   - Click Service Workers in the left nav.
6. View lists of files that have been cached.
   - Expand Cache Storage in the left nav.
   - Click the cache names that begin with "cache" and "offline." Each of these displays a list of cached files.
7. Go offline using one of several options:
   - The easiest option is to ask the browser to simulate being offline. Click the Application tab and check the Offline check box.
   - If you're using Wi-Fi, another option is to turn it off.
   - If you're using a wired connection, another option is to disconnect the Ethernet cable.
8. Now that you are offline, browse all the pages of the app and verify that they render properly.
9. Return to being online.

Another approach to testing the offline behavior of a Sapper app is to export it using the `export` npm script. Recall that this crawls all the pages of the app and generates a static site. After doing this, you can manually test the behavior of the static site.

There are many tools that assist in testing all the pages of a web application. One to consider is BrowserStack at www.browserstack.com.

19.8 Building the Travel Packing app

There are a couple of aspects of the Travel Packing app that make implementing offline use challenging.

The first issue is handling authentication. Of course, we haven't really implemented that yet, but if we had, how would we authenticate a user when they are offline? One option would be to assume it is the same user that authenticated last when they were online on the current computer. This might be acceptable if the app is only used on non-shared devices. Otherwise this is a risky assumption.

The second issue is deciding what to do when the user is offline and wants to make changes. Examples include adding/modifying/deleting categories and items, and checking and unchecking items. One option is to disallow these when offline. The user could still view their travel packing checklist in the state it was in the last time they used the app online.

Another option is to save any change transactions, simulate their effect in the UI, and replay them when the user is back online. As you might imagine, implementing this introduces a fair amount of complexity. Code to do this would have to consider many transactional scenarios. For example, what should happen if a user performs the following steps:

1. Add a category named “Clothing”.
2. Add an item named “socks” to the “Clothing” category.
3. Lose connectivity.
4. Delete the “socks” item, creating a saved transaction.
5. Delete the “Clothing” category, creating a saved transaction.
6. Go to another computer with connectivity.
7. Browse the app and notice that the “Clothing” category and the “socks” item are still there.
8. Rename “Clothing” to “Clothes”.
9. Return to the first computer and restore connectivity.

What should happen now? There are pending transactions to delete the “socks” item and the “Clothing” category, but that category no longer exists because it was renamed.

As you can see, this is a difficult problem to solve and one that the Travel Packing app will avoid for now by making the data read-only while offline. Users can still view their checklists. They just cannot modify them while offline. The finished code can be found at http://mng.bz/vxw4.

Let’s start by making it clear to users when they are offline. We will do this in two ways. First, we will add the text “Offline” to the page title when offline. Second, we will change the background color of the main area from its current shade of blue to gray when offline. We only need to modify `src/routes/_layout.svelte` to achieve both of these.

Listing 19.1 Top layout defined in `src/routes/_layout.svelte`

```
<script>
  let mainElement;
  let online = true;
  $: title = 'Travel Packing Checklist' + (online ? '' : ' Offline');
  $: if (mainElement) {
    mainElement.style.setProperty(
      '--main-bg-color',
      online ? '#3f6fde' : 'gray'
    );
  }
</script>

<svelte:window bind:online />

<main bind:this={mainElement}>
  <h1 class="hero">{title}</h1>
  <slot />
</main>
```

This updates the title every time the value of online changes.

This updates the value of the CSS variable, --main-bg-color, every time the value of online changes.

This causes the online variable to be updated when the value of window.navigator.onLine changes.

This sets the mainElement variable to the DOM element for the main element.

```
<style>
  .hero {
    /* no changes here */
  }

  main {
    --main-bg-color: #3f6fde; /* shade of blue */
    background-color: var(--main-bg-color);
    /* no other changes here */
  }
</style>
```

Next, let's ensure that API calls made while offline are handled gracefully. We won't save the requests and re-execute them when connectivity is restored. We will just ignore them.

Add the following function in src/util.js:

Listing 19.2 fetchPlus function in src/util.js

```
export async function fetchPlus(path, options = {}) {
  if (navigator.onLine) return fetch(path, options);

  alert(`This operation is not available while offline.`);
  return {offline: true};
}
```

We could implement a nicer looking notification than using the alert function. This is left as an exercise.

Replace all client-side calls to the fetch function, not calls to this.fetch in preload functions, with calls to fetchPlus. There are four occurrences in src/routes/checklist.svelte and two occurrences in src/components/Category.svelte. These files already import from util.js. Modify the existing import statement to also import the fetchPlus function.

> **NOTE** To understand why the calls to this.fetch cannot be changed to use the fetchPlus function, see section 16.6.

The response returned by fetchPlus when offline is a JSON object containing the property offline set to true. Check for this immediately after calls to fetchPlus, as follows, and just return if it is true to avoid performing the requested update in the UI.

```
if (res.offline) return;
```

Prevent use of the Clear All Checks button when offline by modifying src/routes/checklist.svelte. Add the following variable inside the script element:

```
let online = true;
```

Add the following at the top of the HTML section to update this variable when connectivity changes:

```
<svelte:window bind:online />
```

Add a `disabled` attribute to the Clear All Checks button as follows:

```
<button class="clear" disabled={!online} on:click={clearAllChecks}>
  Clear All Checks
</button>
```

Prevent the editing of category names when offline by modifying `src/components/Category.svelte`. Add the following variable inside the `script` element:

```
let online = true;
```

Add the following at the top of the HTML section to update this variable when connectivity changes:

```
<svelte:window bind:online />
```

Change the line that renders the category name to the following so the `editing` variable is only set to `true` when online:

```
<span on:click={() => (editing = online)}>{category.name}</span>
```

Prevent the editing of item names when offline by modifying `src/components/Item.svelte`. Add the following variable inside the `script` element:

```
let online = true;
```

Add the following at the top of the HTML section to update this variable when connectivity changes:

```
<svelte:window bind:online />
```

Prevent the toggling of item check boxes by adding a `disabled` attribute to them that is set to `true` when offline, as follows:

```
<input
  aria-label="Toggle Packed"
  type="checkbox"
  disabled={!online}
  bind:checked={item.packed}
  on:change={() => dispatch('persist')} />
```

Change the line that renders the item name to the following so the `editing` variable is only set to `true` when online:

```
<span
  class="packed-{item.packed}"
  draggable="true"
  on:dragstart={event => dnd.drag(event, categoryId, item.id)}
  on:click={() => (editing = online)}>
  {item.name}
</span>
```

When using a tunnel like that provided by ngrok, API calls in `preload` functions will need help knowing the domain that ngrok provides. We have only one case like this in the Travel Packing app. It is the `preload` function in `src/routes/checklist.svelte`.

A solution is to modify it to begin as follows. Note the use of `page.host` in the URL passed to `this.fetch`.

```
export async function preload(page) {
  try {
    const res = await this.fetch(`https://${page.host}/categories.json`);
```

Follow these steps to build and run the app:

1. Open a terminal window.
2. Enter `npm run build`.
3. Enter `npm start`.
4. Open another terminal window.
5. Enter `ngrok http https://localhost:3000`.
6. Run the app by browsing the forwarding URL for https that is output.

Now we can load the app, go offline, and refresh the browser. The page will still display the current travel packing checklist.

In the next chapter you will learn about using preprocessors to support alternate syntaxes for JavaScript, HTML, and CSS.

Summary

- Service workers can act as proxies for network requests, deciding how to fulfill them. This typically involves caching.
- Many caching strategies can be implemented.
- Sapper provides a default service worker that implements a particular caching strategy, but this can be customized.
- Service workers respond to events. The most important of these are `install`, `activate`, and `fetch`.
- The Polka-based server provided by Sapper does not use HTTPS by default, but it can be modified to do so.

Part 4

Beyond Svelte and Sapper

The last part of the book goes beyond Svelte and Sapper to explore preprocessing source files that can add support for alternate syntaxes. Examples include Sass, TypeScript, and Markdown. We'll return to Svelte Native and build mobile applications for Android and iOS. In particular, we'll focus on components for display, forms, actions, dialogs, layout, and navigation, as well as details about styling them, all through an example app that demonstrates how to implement them.

20 Preprocessors

This chapter covers

- Custom preprocessing
- Using svelte-preprocess and its auto-preprocessing mode
- Using Sass instead of CSS
- Using TypeScript instead of JavaScript
- Using Markdown instead of HTML
- Using multiple preprocessors
- Image compression as a preprocessing step

By default, Svelte and Sapper only support using JavaScript, HTML, and CSS. Preprocessors enable the use of alternate syntaxes for these files that can simplify writing the code or provide additional features not otherwise present.

This chapter assumes that if you're interested in adding preprocessing, you will have some familiarity with Sass, TypeScript, and Markdown. You may have also heard of less popular options such as CoffeeScript, Pug, Less, PostCSS, and Stylus, but knowing about those is less important because no examples of using them are shown here.

Svelte apps can optionally configure the use of preprocessors that transform the content of .svelte files before they are passed to the Svelte compiler. This is typically specified in the configuration file for the bundler being used, such as Rollup or Webpack.

Examples of preprocessing include

1. Converting Sass syntax to CSS
2. Compiling TypeScript code to JavaScript
3. Converting Markdown or Pug syntax to HTML
4. Custom search and replace

Many npm packages can be used to implement preprocessing, and some examples are identified in the sections that follow. When multiple preprocessors are configured, they are executed one at a time, with the output of each being used as input for the next.

Internally, Svelte preprocessing is managed by the function svelte.preprocess, documented at https://svelte.dev/docs#svelte_preprocess. This function can be called directly, but it is more common to configure a module bundler to use it, as shown in the next section.

20.1 Custom preprocessing

Let's implement an example of custom preprocessing that changes color: red to color: blue inside style elements. We will accomplish this using the JavaScript String replace method and a regular expression with the global flag as follows:

```
content.replace(/color: red/g, 'color: blue')
```

The value of the content variable will be the content of a style element.

Create a Svelte app by entering npx degit sveltejs/template *app-name*. This uses Rollup as the module bundler. Later you will see how to use Webpack if you prefer.

Edit rollup.config.js to configure the use of the custom preprocessor. This file defines a default export that is an object with several properties, including one named plugins. The value of plugins is an array, and one of the elements in this array is a call to the svelte function. It is passed an object with the properties dev and css (not shown here). Add a preprocess property to this object whose value is an object as shown in the following listing.

Listing 20.1 Rollup configuration in rollup.config.js

```
plugins: [
  svelte({
    ...
    preprocess: {
      style({content}) {
        return {
          code: content.replace(/color: red/g, 'color: blue')
        };
      }
```

This specifies a transformation for code inside style elements.

```
    }
  }),
  ...
]
```

To test this, follow these steps:

1. Enter `npm install`.
2. Edit `src/App.svelte` and change the color for `h1` inside the `style` element to `red`.
3. Enter `npm run dev`.
4. Browse to localhost:5000.
5. Note that "Hello world!" is blue.

The value of the `preprocess` property in the object passed to the `svelte` function is an object where the properties can be `script`, `markup`, and `style`. Each of these is a function that takes an object with `content` and `filename` properties. These functions must return an object, or a promise that resolves to an object, that has a `code` property whose value is a string representing the preprocessing result.

The returned object can also have a `dependencies` property, but this is not frequently used. It is an array of file paths to watch. Changes in these files can trigger reprocessing of the file that depends on them. See the Svelte documentation for `preprocess` for details (https://svelte.dev/docs#svelte_preprocess).

20.1.1 Using Webpack

A Svelte app that uses Webpack as its module bundler can be created by entering `npx degit sveltejs/template-webpack {app-name}`.

To configure the same custom preprocessing shown in the previous section for a Svelte app that uses Webpack, edit the file `webpack.config.js`. This defines a default export that is an object with several properties, including one named `module`. The value of `module` is an object that has a `rules` property. The value of `rules` is an array of objects. These objects have a `test` property that specifies the files to which they apply, and a `use` property that specifies what to do to those files. Add a `preprocess` property to the `options` object for `.svelte` files as shown in the following listing.

Listing 20.2 One of the `rules` objects in `webpack.config.js`

```
{
  test: /\.svelte$/,
  use: {
    loader: 'svelte-loader',
    options: {
      ...
      preprocess: {
        style({content}) {
          return {
            code: content.replace(/color: red/g, 'color: blue')
          };
```

```
            }
          }
        }
      }
    }
```

The value of the `preprocess` property is the same kind of object used by the Rollup `svelte` plugin. Its properties can be `script`, `markup`, and `style` functions.

To test this, follow the same steps as for the Rollup-based app in the preceding section, but browse localhost:8080.

> **NOTE** When using Sapper, configure the desired preprocessing in both the `client` and `server` sections of the bundler configuration file so preprocessing is performed for both server-side and client-side rendered pages.

You have seen how easy adding preprocessing can be. But, of course, you will want to perform more advanced transformations than color substitutions. The preprocessing functions can invoke compilers such as Sass and TypeScript to obtain their `code` result, but doing this is a bit more involved. The svelte-preprocess package described next simplifies this.

20.2 The svelte-preprocess package

The svelte-preprocess package (https://github.com/kaisermann/svelte-preprocess) makes configuring the use of certain preprocessors easier. These include

- Transforming TypeScript and CoffeeScript to JavaScript
- Transforming Pug to HTML
- Transforming Sass, Less, PostCSS, and Stylus to CSS

There are two ways to add the svelte-preprocess package to a Svelte project. When using `npx degit sveltejs/template {`*`project-name`*`}` to start a project, cd to the directory created and enter `node scripts/setupTypeScript.js`. This adds svelte-preprocess to the `devDependencies` in `package.json`. Otherwise it can be installed by entering `npm install -D svelte-preprocess`. Each supported preprocessor to be used requires additional installs.

To configure the use of svelte-preprocess with Rollup, modify `rollup.config.js`. Add the following `import` near the top:

```
import sveltePreprocess from 'svelte-preprocess';
```

Add the following property to the object passed to the `svelte` function in the `plugins` array:

```
preprocess: sveltePreprocess()
```

An options object can be passed to the `sveltePreprocess` function, but one is not required. For details on the supported options, see the documentation for svelte-preprocess: https://github.com/kaisermann/svelte-preprocess#options.

20.2.1 Auto-preprocessing mode

The easiest way to use the svelte-preprocess package is in auto-preprocessing mode. This mode determines the preprocessors to use based on `lang` and `type` attributes on `script`, `style`, and `template` elements in `.svelte` files, such as these:

```
<script lang="ts">

<template lang="pug">

<style lang="scss">
```

Note that alternative HTML syntaxes, such as Pug, must be surrounded by a `template` element in order to specify its language.

20.2.2 External files

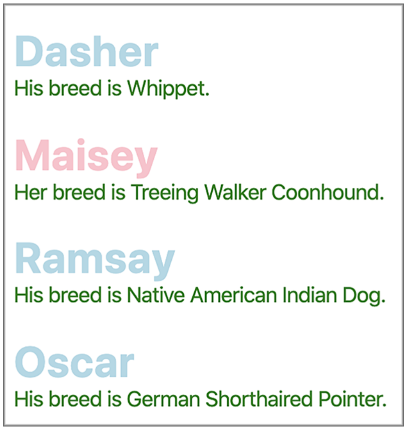
The svelte-preprocess package also adds external file support. To get content from an external file, add `src` attributes whose values are file paths to `script`, `template`, and `style` elements, such as these:

```
<script src="./name.js">

<template src="./name.html">

<style src="./name.css">
```

The language of an external file is determined by its file extension. This allows preprocessing to be performed on its content.

To demonstrate, let's create an app that renders information about dogs, as shown in figure 20.1.

The `Dog` component implemented in the following listing uses JavaScript, HTML, and CSS stored in separate files rather than in the `.svelte` file that defines the component. Any of the elements with `src` attributes could be replaced by the content of the referenced file without changing the component definition.



Dasher

His breed is Whippet.

Maisey

Her breed is Treeing Walker Coonhound.

Ramsay

His breed is Native American Indian Dog.

Oscar

His breed is German Shorthaired Pointer.

Figure 20.1 Dogs UI with external files

Listing 20.3 `src/Dog.svelte` referring to three external files

```
<script src="./Dog.js"></script>

<template src="./Dog.html"></template>

<style src="./Dog.css"></style>
```

The following listing shows the JavaScript used by the Dog component.

Listing 20.4 JavaScript for the Dog component in src/Dog.js

```
export let name;
export let breed;
export let gender;

let color = gender === 'male' ? 'lightblue' : 'pink';
```

The props of this component are name, breed, and gender.

The following listing shows the HTML used by the Dog component.

Listing 20.5 HTML for the Dog component in src/Dog.html

```
<h1 style="color: {color}">{name}</h1>
<div class="breed">{gender === 'male' ? 'His' : 'Her'} breed is {breed}.</div>
```

Next is the CSS used by the Dog component.

Listing 20.6 CSS for the Dog component in src/Dog.css

```
h1 {
  margin-bottom: 0;
}

.breed {
  color: green;
}
```

The following listing shows the topmost component in the app that renders several Dog components.

Listing 20.7 App that uses the Dog component in src/App.svelte

```
<script>
  import Dog from './Dog.svelte';

  const dogs = [
   {name: 'Dasher', gender: 'male', breed: 'Whippet'},
   {name: 'Maisey', gender: 'female', breed: 'Treeing Walker Coonhound'},
   {name: 'Ramsay', gender: 'male', breed: 'Native American Indian Dog'},
   {name: 'Oscar ', gender: 'male', breed: 'German Shorthaired Pointer'}
  ];
</script>

{#each dogs as {name, breed, gender}}
  <Dog {name} {breed} {gender} />
{/each}
```

20.2.3 Global styles

The svelte-preprocess package also provides a new way to specify global styles that is an alternative to the `:global(selector)` syntax you learned about in chapter 3. All CSS placed inside a `<style global>` element becomes global instead of being scoped to the component. Using this feature leads to spreading global styling across component source files. Consider placing global styles in the `global.css` file instead, to avoid this.

This global style feature requires PostCSS. To install it, enter `npm install -D postcss`.

For example, one way to change the background color of the `body` element is to add the following code in the `App` component.

Listing 20.8 Global styles in `src/App.svelte`

```
<style global>
  body {
    background-color: linen;
  }
</style>
```

20.2.4 Using Sass

Sass is a very popular CSS preprocessor. For details on Sass, see https://sass-lang.com/.

To enable Sass support, install the node-sass package by entering `npm install -D node-sass`. All features of Sass will be available, including variables, nested rules, mixins, and Sass functions.

The following listing shows an example of using Sass inside a component. It takes advantage of variables, nested rules, and single-line comments.

Listing 20.9 Using Sass in a `.svelte` file

```
<style lang="scss">
  $color: green;
  $space: 0.7rem;

  form {
    // a nested CSS rule
    input {
      $padding: 4px;
      border-radius: $padding;
      color: $color;
      padding: $padding;
    }

    // another nested CSS rule
    label {
      color: $color;
      margin-right: $space;
    }
  }
</style>
```

NOTE Now that there is widespread support for CSS variables in popular browsers (not including IE), there is little reason to use Sass variables unless you want a more compact syntax for referring to them.

The style element global attribute can be used in conjunction with Sass:

```
<style global lang="scss">
  // define global styles here using Sass syntax.
</style>
```

20.2.5 Using TypeScript

TypeScript is a programming languages that is a superset of JavaScript. Its primary benefit is that it adds types to JavaScript. For details on TypeScript, see www.typescriptlang.org.

There are two ways to enable TypeScript support in a Svelte project. The easiest option is to use `npx degit sveltejs/template {project-name}` to start a project. Then cd to the directory created and enter `node scripts/setupTypeScript.js`. This configures the use of svelte-preprocess and a TypeScript plugin for Rollup. It also installs the svelte-check tool and adds a "validate" script in `package.json` to run it. Finally, it deletes the `setupTypeScript.js` file and also the `scripts` directory if there are no other files in it.

The svelte-check tool (http://mng.bz/4Agj) checks all `.svelte` files in a project and reports many kinds of errors, including TypeScript errors. To run it, enter `npm run validate`.

For existing Svelte applications, the use of TypeScript can be manually configured by following these steps:

1. Install the required npm packages by entering the following:

   ```
   npm install -D @rollup/plugin-typescript svelte-check tslib typescript
   ```

2. Edit `rollup.config.js`:
   - Add the following import near the top:

     ```
     import typescript from '@rollup/plugin-typescript';
     ```

   - Add a call to `typescript()` in the `plugins` array:

     ```
     plugins: [
       svelte({
         ...
         preprocess: sveltePreprocess()
       }),
       typescript(),
       ...
     ]
     ```

3. Edit `package.json` and add the following script:

   ```
   "validate": "svelte-check"
   ```

If using VS Code, also install the Svelte for VS Code extension described in appendix F which catches TypeScript errors in opened `.svelte` files.

Here is a simple example of using TypeScript inside a component:

```
<script lang="ts">
  function add(n1: number, n2: number): number {
    return n1 + n2;
  }

  const sum = add(1, '2');
</script>

<div>sum in ts = {sum}</div>
<div>sum in HTML = {add(1, '2')}</div>
```

The TypeScript compiler will give the following error: "error TS2345: Argument of type "'2'" is not assignable to parameter of type 'number'." However, the code will run, and the value assigned to sum will be 1 concatenated with '2' resulting in '12'. To fix the error, pass the number 2 instead of the string '2'.

The same type error occurs.

Let's see how we can move the `add` function out of the Svelte component and into a separate `.ts` file. This will allow it to be imported by any number of components. TypeScript source files can export any number of values, including functions, classes, and constants.

Listing 20.10 `add` function in `src/math.ts`

```
export function add(n1: number, n2: number): number {
  return n1 + n2;
}
```

This return type can be inferred by the compiler.

We can now modify `src/App.svelte` to match the following:

Listing 20.11 App that uses the `add` function in `src/App.svelte`

```
<script lang="ts">
  import {add} from './math';

  const sum = add(1, '2');
</script>

<div>sum in ts = {sum}</div>
<div>sum in HTML = {add(1, '2')}</div>
```

The TypeScript compiler will report the same error described earlier.

The same type error occurs here.

When using TypeScript, there is a specific way to declare the type of variables that are the target of a reactive declaration: declare the variable being assigned, including its type, before the reactive declaration. Here is an example:

```
let upperName: string;
$: upperName = name.toUpperCase();
```

NOTE Another option to consider for TypeScript support in Svelte is svelte-type-checker (https://github.com/halfnelson/svelte-type-checker). There is a corresponding svelte-type-checker-vscode VS Code extension (https://github.com/halfnelson/svelte-type-checker-vscode).

20.2.6 A VS Code tip

Code editors may flag the use of non-JS syntax inside `script` elements, non-HTML syntax such as Pug, and non-CSS syntax inside `style` elements. For VS Code this can be addressed by creating the `svelte.config.js` file in the root application directory with the following content, and restarting VS Code:

```
const sveltePreprocess = require('svelte-preprocess');

module.exports = {
  preprocess: sveltePreprocess()
};
```

20.3 Using Markdown

Svelte component content can be specified using Markdown instead of HTML. The svelte-preprocessor package does not currently support Markdown, but two libraries that do are svelte-preprocess-markdown and MDsveX. Currently svelte-preprocess-markdown better supports the syntax of `.svelte` files, so only that option is described here.

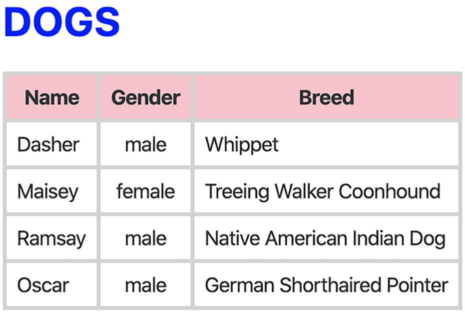
The svelte-preprocess-markdown package can be found at https://alexxnb.github.io/svelte-preprocess-markdown/. It uses the popular "marked" library at https://marked.js.org to process Markdown syntax.

This package supports implementing Svelte components in `.md` files that include Markdown syntax. These files can contain everything that can be present in `.svelte` files, including `script` elements, HTML elements, `style` elements, and the use of other Svelte components.

To style the Markdown, add CSS that targets the HTML elements produced by the Markdown syntax. For example, # creates an `h1` element. For details on the mapping from Markdown syntax to HTML elements, see the "Basic Syntax" section of the Markdown Guide: www.markdownguide.org/basic-syntax.

To demonstrate, let's create an app that renders a table of information about dogs using Markdown syntax (see figure 20.2).

Starting from the default Svelte app, rename `src/App.svelte` to `src/App.md` and modify `src/main.js` to import from `App.md` instead of `App.svelte`. Then change the content of `src/App.md` to use Markdown syntax instead of HTML.



DOGS

Name	Gender	Breed
Dasher	male	Whippet
Maisey	female	Treeing Walker Coonhound
Ramsay	male	Native American Indian Dog
Oscar	male	German Shorthaired Pointer

Figure 20.2 Dogs UI with Markdown

Listing 20.12 Component that uses Markdown syntax in `src/App.md`

```
<script>
  const dogs = [
   {name: 'Dasher', gender: 'male', breed: 'Whippet'},
   {name: 'Maisey', gender: 'female', breed: 'Treeing Walker Coonhound'},
   {name: 'Ramsay', gender: 'male', breed: 'Native American Indian Dog'},
   {name: 'Oscar ', gender: 'male', breed: 'German Shorthaired Pointer'}
  ];
</script>

# dogs

| Name | Gender | Breed |
| ---- | :----: | ----- |
{#each dogs as {name, gender, breed}}
  | {name} | {gender} | {breed} |
{/each}

<style>
  h1 {
    color: blue;
    margin-top: 0;
    text-transform: uppercase;
  }

  table {
    border-collapse: collapse;
  }

  td, th {
    border: solid lightgray 3px;
    padding: 0.5rem;
  }

  th {
    background-color: pink;
  }
</style>
```

This is Markdown syntax for a heading.

This is Markdown syntax for a table heading row.

The colons here specify that data in this column should be centered.

This is Markdown syntax for a table data row.

Note that it is important to not have a blank line before the `#each`. The table will not render properly if any lines of Markdown that define the table are separated.

To configure svelte-preprocess-markdown, follow these steps:

1. Enter `npm install -D svelte-preprocess-markdown`.
2. Edit `rollup.config.js`:
   - Add `import {markdown} from 'svelte-preprocess-markdown';` after the imports at the top of the file.
   - Add the following in the object passed to the `svelte` plugin:

     ```
     extensions: ['.svelte','.md'],
     preprocess: markdown()
     ```

To run this app, follow these steps:

1. Enter npm install.
2. Enter npm run dev.
3. Browse to localhost:3000.

20.4 Using multiple preprocessors

It is possible to use multiple preprocessors to transform content before it is passed to the Svelte compiler. To do so, edit the module bundler configuration file and specify an array for the value of the preprocess property.

For example, to use the svelte-preprocess and svelte-preprocess-markdown packages, specify the following in rollup.config.js:

```
preprocess: [sveltePreprocess(), markdown()],
```

After following the steps described earlier to install svelte-preprocess and typescript, you can change the script element in App.md from the previous example to use TypeScript as follows:

Listing 20.13 Using TypeScript in src/App.md

```
<script lang="ts">
  type Dog = {
    name: string;
    gender: string;
    breed: string;
  };

  const dogs: Dog[] = [
   {name: 'Dasher', gender: 'male', breed: 'Whippet'},
   {name: 'Maisey', gender: 'female', breed: 'Treeing Walker Coonhound'},
   {name: 'Ramsay', gender: 'male', breed: 'Native American Indian Dog'},
   {name: 'Oscar ', gender: 'male', breed: 'German Shorthaired Pointer'}
  ];
</script>
```

With this in place, if there is a typo in a dog property name such as “bred” instead of “breed,” the TypeScript compiler will flag the error.

20.5 Image compression

Another Svelte preprocessor to consider is svelte-image (https://github.com/matyunya/svelte-image). This uses the sharp image processing package (https://github.com/lovell/sharp) to automate image optimization.

This preprocessor looks for img elements to refer to local image files and replaces the src attribute value with a reference to an optimized image that it generates.

The svelte-image package also provides an Image component, which provides lazy loading of images. It also supports the srcset attribute for serving an appropriate image size based on screen width.

In the next chapter you will learn about implementing Android and iOS mobile applications using Svelte Native.

Summary

- Svelte is quite flexible when it comes to using alternative syntaxes for specifying code, markup, and styling.
- Any syntax can be supported if you are willing to write a preprocessor.
- The easiest way to configure preprocessing is to use svelte-preprocess and its auto-preprocessing mode.

21 Svelte Native

This chapter covers

- Svelte Native and NativeScript components
- Developing Svelte Native apps locally
- NativeScript styling
- Predefined NativeScript CSS classes
- The NativeScript UI component library

Svelte Native (https://svelte-native.technology/) enables implementing Android and iOS applications using Svelte by building on top of NativeScript (https://nativescript.org/). It's a big topic. The learning path includes how to structure a Svelte Native app, use provided components, use provided layout mechanisms, implement page navigation, use NativeScript-specific styling and themes, use third-party libraries, and integrate with device capabilities. We will only scratch the surface here, but we will cover enough to enable you to start building mobile apps.

NativeScript uses XML syntax (with custom elements), CSS, and JavaScript/TypeScript to create apps that run on Android and iOS devices. It renders native components rather than web views. NativeScript was created and is maintained by Telerik Corp., which was acquired by Progress Software in 2014.

NativeScript can be used without any web framework. In addition, there are integrations of several popular web frameworks with NativeScript. The NativeScript team supports Angular and Vue integrations, and the community at large supports React and Svelte implementations.

Svelte Native provides a thin layer over the NativeScript API that makes it relatively easy to remain compatible with future NativeScript versions. It was created by David Pershouse, who goes by halfnelson on GitHub and @halfnelson_au on Twitter.

The official Svelte Native tutorial and API documentation can be found on the Svelte Native website: https://svelte-native.technology/.

We will cover all the provided components at a high level. Then we will look at the steps for getting started creating Svelte Native applications. Finally, we will walk through a few example apps, including a basic Hello World app, one that demonstrates nearly all the provided components, and one that uses an add-on library to implement a hamburger (side-drawer) menu.

21.1 Provided components

NativeScript provides many components, and you can build more by combining them. A list of provided components can be found at https://docs.nativescript.org/ui/overview.

Svelte Native exposes all of these components as DOM elements to Svelte, and they are used as alternatives to the HTML elements used in Svelte apps. They are globally available and so can be used in custom Svelte components without importing them. Documentation on these Svelte components can be found at https://svelte-native.technology/docs.

The names of the provided NativeScript components are camel case and begin with a capital letter. However, the Svelte components that wrap them have names that begin with a lowercase letter. This distinguishes them from custom Svelte components whose names must start with an uppercase letter. For example, instead of `<Label text="Hello" />` you would write `<label text="Hello" />`. We will use the Svelte Native names here when discussing them.

The following sections describe each of the provided components at a high level. Section 21.7 provides examples of using each component.

21.1.1 Display components

The Svelte Native components that display data are listed in table 21.1 after the closest HTML element to which they correspond.

The `label` component can specify its content using a `text` attribute, text content, or a `formattedString` child with `span` children.

The `activityIndicator` component displays a platform-specific spinner to indicate that some activity, such as waiting for a response from an API service, is occurring.

Table 21.1 Display components

HTML element	Svelte Native component
`<label>`	`label`
`<img>`	`image`
`<progress>`	`progress`
None	`activityIndicator`
`<ul>` or `<ol>` plus `<li>`	`listView`
None	`htmlView`
None	`webView`

The `listView` component displays a scrolling list of items. Its `items` attribute is set to an array of values that can be any JavaScript type. To specify how each item should be rendered, include a `Template` child element whose content is components that render the item. To take action when an item is clicked, set `on:itemTap` to a function.

The `htmlView` and `webView` components are used to render a string of HTML. Using `webView` is preferred because `htmlView` has a very limited ability to apply CSS styling. The HTML string for an `htmlView` component is specified with an `html` attribute. The HTML string for a `webView` component is specified with a `src` attribute whose value can be an HTML string, a URL, or a path to an HTML file. Often instances of the `webView` component must be given a height because that isn't calculated based on its content. HTML from untrusted sources should be sanitized before it's passed to a `WebView` component because it is capable of executing JavaScript code.

21.1.2 Form components

The Svelte Native components that allow user input are listed in table 21.2 after the closest HTML element to which they correspond.

The `searchBar` component is similar to the `textField` component, but it adds a magnifying glass icon to the left of the input.

21.1.3 Action components

Components for actions include `actionBar`, `actionItem`, and `navigationButton`.

An `actionBar` is a toolbar that is displayed at the top of the screen. It typically contains a title and can also contain `actionItem` and `navigationButton` components.

`actionItem` components are buttons with platform-specific icons and positioning. An example is the iOS share icon that looks like a square with an arrow pointing up. For Android, the icon is identified by one of the `R.drawable` constants documented at

Table 21.2 Form components

HTML element	Svelte Native component
`<button>`	`button`
`<input type="text">`	`textField` (for single-line)
`<textarea>`	`textView` (for multiline)
`<input type="checkbox">`	`switch`
`<input type="radio">`	`segmentedBar` and `segmentedBarItem`
`<select>` and `<option>`	`listPicker`
`<input type="range">`	`slider`
`<input type="date">`	`datePicker`
`<input type="time">`	`timePicker`
None	`searchBar`

https://developer.android.com/reference/android/R.drawable. For iOS, the icon is one of the `SystemItem` constants documented at https://developer.apple.com/documentation/uikit/uibarbuttonitem/systemitem.

21.1.4 Dialog components

Functions that render a dialog include `action`, `alert`, `confirm`, `login`, and `prompt`. Table 21.3 describes the contents of each kind of dialog.

Table 21.3 Dialog components

Function name	Dialog contents
`action`	Message, vertical list of buttons, and a cancel button
`alert`	Title, message, and a close button
`confirm`	Title, message, cancel button, and OK button
`login`	Title, message, username input, password input, cancel button, and OK button
`prompt`	Title, message, input, cancel button, and OK button

21.1.5 Layout components

Provided components that organize their child components in a certain way are listed in table 21.4 after the closest CSS property value to which they correspond.

A `page` component can optionally contain an `actionBar` component, and it can only contain one top-level layout component.

Table 21.4 Layout components

CSS property	Svelte Native layout component
`display: inline`	`wrapLayout`
`display: block`	`stackLayout`
`display: flex`	`flexboxLayout`
`display: grid`	`gridLayout`
`position: absolute`	`absoluteLayout`
None	`dockLayout`

`absoluteLayout` requires its children to specify their absolute location with `left` and `top` attributes.

`dockLayout` positions its children on a given side of the screen: left, right, top, or bottom. The example in listing 21.1 shows how to create the classic layout with a header, footer, and left nav (see figure 21.1). Note that the header and footer children must come before the left child in order for them to span all the way across the display.

Listing 21.1 App that uses `dockLayout`

```
<page>
  <dockLayout>
    <label class="header big" dock="top" text="Header" />
    <label class="footer big" dock="bottom" text="Footer" />
    <label class="nav big" dock="left" text="Nav" />
    <stackLayout>
      <label text="Center child #1" />
      <label text="Center child #2" />
    </stackLayout>
  </dockLayout>
</page>

<style>
  .big {
    color: white;
    font-size: 24;
    padding: 20;
  }

  .footer {
    background-color: purple;
    border-top-width: 3;
  }

  .header {
    background-color: red;
    border-bottom-width: 3;
  }
  .nav {
    background-color: green;
    border-right-width: 3;
  }

  stackLayout {
    background-color: lightblue;
    padding: 20;
  }
</style>
```

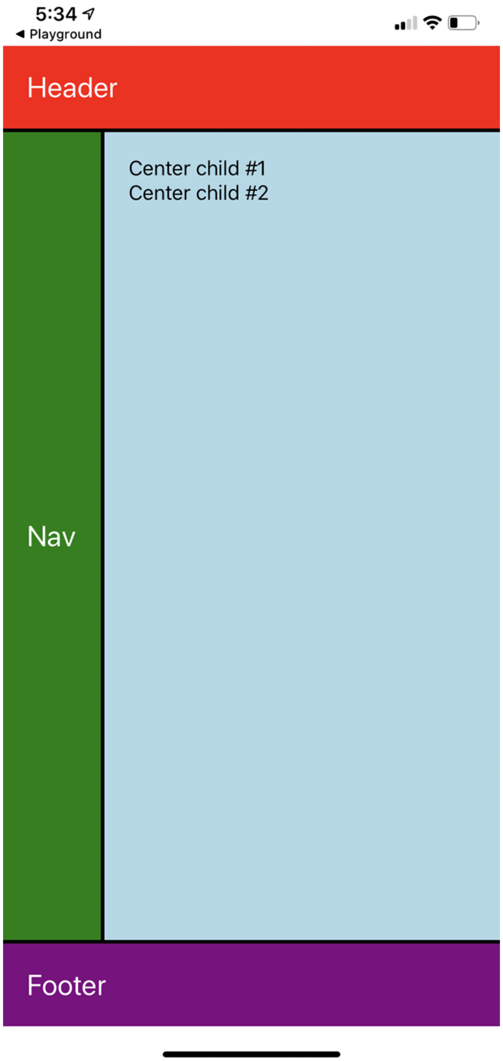


Figure 21.1 A `dockLayout` example

flexboxLayout implements most of CSS flexbox. Elements that use it can be styled using standard flexbox CSS properties. In addition, it supports the following attributes:

- justifyContent with values stretch (default), flex-start, flex-end, center, and baseline
- alignItems with values stretch (default), flex-start, flex-end, center, space-between, and space-around
- alignContent with the same values as justifyContent only affects containers with more than one line (rarely used)
- flexDirection with values row (default), column, row-reverse, and column-reverse
- flexWrap with values nowrap (default), wrap, and wrap-reverse

Child elements of flexboxLayout can specify the attributes alignSelf, flexGrow, flexShrink, flexWrapBefore, and order.

The gridLayout element organizes its children into cells inside rows and columns. A cell can span more than one row and/or column. This is *not* related to CSS grid layout. The row and column attributes, whose values are comma-separated lists, specify the number of rows and columns, the height of each row, and the width of each column.

There are three options for row and column sizes: an absolute number, auto, or *. Specifying auto makes it as small as possible to accommodate everything in that row or column. Specifying * makes it as large as possible after satisfying the requirements of the other rows or columns. Preceding * with a number acts as a multiplier. For example, columns="100,2*,*" means that the first column is 100 *device-independent pixels* (DIPs) wide, the second column is 2/3 of the remaining space, and the third column is 1/3 of the remaining space.

Child elements of gridLayout specify their grid position with row and column attributes. They can also specify rowSpan and colSpan attributes to span more than one row and/or column.

stackLayout is the most basic of the supported layouts. It simply lays out its children vertically (default) or horizontally. To lay out children horizontally, add the attribute orientation="horizontal".

wrapLayout is similar to stackLayout, but children wrap to the next row or column when space is exhausted. It differs from stackLayout in that its default orientation is horizontal. To lay out children vertically, add the attribute orientation="vertical". To specify a fixed width and/or height for each child, add the itemWidth and/or itemHeight attributes.

While not exactly being a layout, the scrollView component does act as a container for other components. It creates a fixed size area where its child components can be scrolled vertically and horizontally.

21.1.6 Navigation components

Components for creating navigation tabs include `tabs` (displayed at the top of the screen) and `bottomNavigation` (displayed at the bottom). The `tabs` component is more full-featured than `bottomNavigation`. For example, it supports switching tabs by swiping left or right across the content area below the tabs.

Both `tabs` and `bottomNavigation` have children that are `tabStrip` and `tabContentItem` components. The children of `tabStrip` components are `tabStripItem` components, which represent each of the tabs. The `tabContentItem` components hold the components to render when the corresponding tab is selected. The children of `tabContentItem` components are typically layout components containing many children.

`navigationButton` components are buttons for platform-specific functionality, such as the back button.

Another way to support page navigation is to use a side drawer. This is not provided in Native Script. It is an add-on that can be found in the Native Script UI library that is described in section 21.8. See the `RadSideDrawer` component.

21.2 Getting started with Svelte Native

The easiest way to get started with Svelte Native is to use the online REPL at https://svelte-native.technology/repl. This is similar to the Svelte REPL. It allows writing, testing, and saving (as GitHub Gists) Svelte Native apps without installing anything. However, unlike the Svelte REPL, it cannot currently download an app, show a list of saved REPL sessions, or recall them.

Another option is to use the online Playground at https://play.nativescript.org/. This has the same options as the Svelte Native REPL, but it also supports projects using any kind of NativeScript project including Angular, Vue, React, Svelte, plain JavaScript, and plain TypeScript.

Both the Svelte REPL and Playground will prompt you to install the NativeScript Playground and NativeScript Preview apps. Do this on all devices to be used for testing apps. For Android, search the Google Play store. For iOS, search the iOS App Store.

To run your app in NativeScript Playground on a device, click the Preview button in the upper right or click QR Code at the top. Both will display a QR code in a dialog. Scan this using the NativeScript Playground app on the devices. It will launch the NativeScript app inside the NativeScript Preview app.

Like the Svelte and Svelte Native REPLs, NativeScript Playground allows you to create an account, log in, and save projects that can be recalled later. To see and select previously saved projects, click Projects in the top nav bar.

After making code changes, click Save at the top. The app will reload on all the devices that have scanned the QR code of the app.

The left side of the Playground includes a file explorer and a palette of components. Component icons can be dragged into code to add an instance of them.

The bottom area has a Devices tab that lists the devices being used. Any number of devices can be tested simultaneously.

21.3 Developing Svelte Native apps locally

For serious development of a Svelte Native app, you will want to create a project where all the required files are available locally and your preferred editor or IDE can be used. To do this, follow these steps:

1. Install the NativeScript command-line interface (CLI) globally on your computer by entering `npm install -g nativescript`.
2. Verify installation by entering `tns`, which outputs help (“tns” stands for Telerik NativeScript).
3. Create a new app by entering `npx degit halfnelson/svelte-native-template` *`app-name`*.
4. Enter `cd` *`app-name`*.
5. Enter `tns preview` to build the app and display a QR code.
6. Open the NativeScript Playground app on a mobile device.
7. Tap Scan QR Code and point the camera at the QR code. The first time this is done, it will ask you to install the NativeScript Preview app if it is not already installed. Press Install to proceed.
8. The NativeScript Preview app will launch and display the app. Before making modifications, this will just display a rocket icon followed by the text “Blank Svelte Native App”.
9. On your computer, modify the app. Changes will live reload on the phone.

Live reload is very fast, taking only about three seconds for a small app.

Another option to consider, not covered here, is the Electron app NativeScript Sidekick. For information on this, see the NativeScript blog: http://mng.bz/04pJ.

Here is a basic Hello World Svelte Native app. Simply modify `app/App.svelte` to match the following.

Listing 21.2 Hello World Svelte Native app

```
<script>
  let name = 'World';
</script>

<page>
  <actionBar title="Hello World Demo" />
  <stackLayout class="p-20">
    <flexboxLayout>
      <label class="name-label" text="Name:" />
      <textField class="name-input" bind:text={name} />
    </flexboxLayout>
    <label class="message" text="Hello, {name}!" />
  </stackLayout>
</page>

<style>
  .message {
    color: red;
```

“p-20” is a provided CSS class that sets padding to 20.

```
    font-size: 50;
  }

  .name-input {
    font-size: 30;
    flex-grow: 1;
  }

  .name-label {
    font-size: 30;
    margin-right: 10;
  }
</style>
```

Note that no units are specified on CSS sizes.

Svelte Native apps can be run in an emulator for a specific device. This requires installing a lot of software that is specific to Android and iOS. For details on this, see https://svelte-native.technology/docs#advanced-install.

21.4 NativeScript styling

NativeScript supports a large subset of CSS selectors and properties. It also supports some NativeScript-specific CSS properties. All of these are documented at https://docs.nativescript.org/ui/styling.

CSS rules that should affect the entire application are placed in `app/app.css`. By default, this imports `~nativescript-theme-core/css/core.css` and `./font-awesome.css` (for icons).

> **NOTE** `nativescript-theme-core` is deprecated. Svelte Native still uses this by default and it works for now. See https://docs.nativescript.org/ui/theme for details.

Svelte Native component names are treated as custom element names. They can be used as CSS selectors for styling all instances of the component.

For CSS property values that represent a size, when no unit is specified, the value represents *device-independent pixels* (DIPs). This is the recommended unit to use. A “px” suffix can be added to size values for plain pixels that vary across devices, but using this unit is discouraged. Percentages with a “%” suffix are also supported.

Other supported CSS features include

- CSS variables
- The `calc` function
- The generic fonts `serif`, `sans-serif`, and `monospace`
- Custom fonts in TTF or OTF format found in the `app/fonts` directory
- Importing a CSS file from another with `@import url('file-path')`
- Using Sass (with some setup)

Some CSS shorthand properties are not supported. For example, instead of `border: solid red 3px;`, use `border-color: red; border-width: 3px;`. The `border-style` property is not supported. All borders are solid.

The `outline` shorthand property and all CSS properties whose names begin with `outline-` are not supported.

To change the style of text within a block of text, use the `formattedString` element with `span` elements as children. Each `span` can specify different styling. The `formattedString` element must be a child of a component that supports text content such as `button`, `label`, `textField`, and `textView`. The following listing shows an example of using `formattedString`.

Listing 21.3 `formattedString` example

```
<page>
  <stackLayout class="p-20">
    <label class="panagram" textWrap="true">
      <formattedString>
        <span class="fox">The quick brown fox</span>
        <span text=" jumps over " />
        <span class="dog">the lazy dog</span>
        <span text="." />
      </formattedString>
    </label>
  </stackLayout>
</page>

<style>
  .panagram {
    font-size: 30;
  }

  .fox {
    color: red;
    font-weight: bold;
  }

  .dog {
    color: blue;
    font-style: italic;
  }
</style>
```

A panagram is a sentence that contains all the letters of the alphabet.

This text will be red and bold.

This text will be black and normal.

This text will be blue and italic.

21.5 Predefined NativeScript CSS classes

Components can be styled by defining CSS classes that match their name. For example, the following makes all `label` components blue and bold:

```
label {
  color: blue;
  font-weight: bold;
}
```

NativeScript provides a set of predefined CSS classes that can be applied to NativeScript components for common styling needs. These are conveniences that can be used in place of explicitly applying CSS properties.

These predefined classes are appropriate for applying to `label` components:

- *Headings*—`h1`, `h2`, `h3`, `h4`, `h5`, and `h6`
- *Paragraphs*—`body` for medium-sized text
- *Footnotes*—`footnote` for small text
- *Alignment*—`text-left`, `text-center`, and `text-right`
- *Case*—`text-lowercase`, `text-uppercase`, and `text-capitalize`
- *Weight*—`font-weight-normal` and `font-weight-bold`
- *Style*—`font-italic`

The following snippet is an example of using a predefined class.

```
<label class="h1" text="This is BIG!" />
```

There are many provided CSS classes that specify the desired padding and margin (see table 21.5). In these class names, # is a placeholder for a number, which must be one of `0`, `2`, `5`, `10`, `15`, `20`, `25`, or `30`.

Table 21.5 CSS classes that specify padding and margin

Sides	Padding	Margin
All	`p-#`	`m-#`
Top (t)	`p-t-#`	`m-t-#`
Right (r)	`p-r-#`	`m-r-#`
Bottom (b)	`p-b-#`	`m-b-#`
Left (l)	`p-l-#`	`m-l-#`
Left and right	`p-x-#`	`m-x-#`
Top and bottom	`p-y-#`	`m-y-#`

There are several provided CSS classes for styling forms and form elements such as buttons. For details, see the NativeScript documentation for forms (https://docs.nativescript.org/ui/theme#forms) and for buttons (https://docs.nativescript.org/ui/theme#buttons).

The equivalent of the HTML horizontal rule `<hr>` element is to use an empty `stackLayout` with the `hr` class, as follows:

```
<stackLayout class="hr" />
```

To overlay the default horizontal rule with a thicker, colored rule, add CSS properties to the `hr` CSS class as follows:

```
.hr {
  --size: 10;
  height: var(--size);
```

```
    border-color: green;
    border-width: calc(var(--size) / 2);
  }
```

For more details on NativeScript styling, see https://docs.nativescript.org/ui/styling.

21.6 NativeScript themes

NativeScript supports styling themes through a large set of CSS classes. To install a default theme along with 11 more themes, enter `npm install @nativescript/theme`. Additional themes not provided by NativeScript can also be installed. Each theme simply overrides the predefined CSS classes. These support light and dark modes.

To use the default theme, edit `app/app.css` and replace the import of `core.css` with the following:

```
@import '~@nativescript/theme/css/core.css';
@import '~@nativescript/theme/css/default.css';
```

To use one of the other included themes, replace `default` in the second line above with one of `aqua`, `blue`, `brown`, `forest`, `grey`, `lemon`, `lime`, `orange`, `purple`, `ruby`, or `sky`.

21.7 Comprehensive example

Up until now, we've been using the Travel Packing app as our example, but we're going to switch gears here in the interest of brevity. The Svelte Native app in this section provides examples of using nearly all of the components included in NativeScript. It provides a good jumping off point for implementing your own Svelte Native applications.

The app has three pages, each presenting examples of components in a given category:

- The first category is components that display information. This includes the `label`, `webView`, `image`, and `progress` components.
- The second category is components that accept user input. This includes `textField`, `textView`, `switch`, `segmentedBar`, `datePicker`, `timePicker`, `listView`, `listPicker`, and `slider`.
- The third category is functions that render dialogs and components used for search queries. This includes the functions `login`, `prompt`, `action`, and `confirm`. It also includes the `searchBar` and `activityIndicator` components.

Page navigation is configured in `App.svelte` (see figure 21.2).

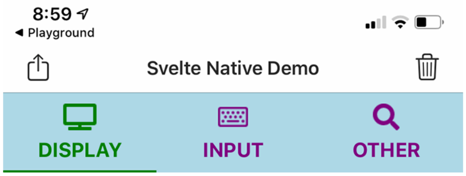


Figure 21.2 Component that handles page navigation

Listing 21.4 Component that handles page navigation in `app/App.svelte`

```
<script>
  import DisplayComponents from './DisplayComponents.svelte';
  import InputComponents from './InputComponents.svelte';
  import OtherComponents from './OtherComponents.svelte';

  function onTapDelete() {
    console.log('App.svelte onTapDelete: entered');
  }

  function onTapShare() {
    console.log('App.svelte onTapShare: entered');
  }
</script>

<page>
  <actionBar title="Svelte Native Demo">
    <!-- button with upload icon -->
    <actionItem on:tap="{onTapShare}"
      ios.systemIcon="9" ios.position="left"
      android.systemIcon="ic_menu_share" android.position="actionBar" />
    <!-- button with trash can icon -->
    <actionItem on:tap="{onTapDelete}"
      ios.systemIcon="16" ios.position="right"
      android.systemIcon="ic_menu_delete"
      text="delete" android.position="popup" />
  </actionBar>

  <tabs>
    <tabStrip>
      <tabStripItem>
        <label text="Display" />
        <image src="font://&#xF26C;" class="fas" />
      </tabStripItem>
      <tabStripItem>
        <label text="Input" />
        <image src="font://&#xF11C;" class="far" />
      </tabStripItem>
      <tabStripItem>
        <label text="Other" />
        <image src="font://&#xF002;" class="fas" />
      </tabStripItem>
    </tabStrip>

    <tabContentItem>
      <DisplayComponents />
    </tabContentItem>

    <tabContentItem>
      <InputComponents />
    </tabContentItem>

    <tabContentItem>
      <OtherComponents />
```

These three imports are for the “page” components.

The actionBar component is rendered at the top of the screen.

The tabs component is rendered below the actionBar. It contains one tab for each page of the app.

This is a monitor icon.

This is a keyboard icon.

This is a magnifying glass icon.

There is one tabContentItem for each tabStripItem. Each of these render a page of the app.

```
    </tabContentItem>
  </tabs>
</page>

<style>
  tabStrip {
    --tsi-unselected-color: purple;
    --tsi-selected-color: green;

    background-color: lightblue;
    highlight-color: green;
  }

  tabStripItem {
    color: var(--tsi-unselected-color); /* for icon */
  }

  tabStripItem > label {
    color: var(--tsi-unselected-color); /* for text */
  }

  tabStripItem:active {
    color: var(--tsi-selected-color); /* for icon */
  }

  tabStripItem:active > label {
    color: var(--tsi-selected-color); /* for text */
  }
</style>
```

> **NOTE** The `image` elements in listing 21.4, such as the monitor, keyboard, and magnifying glass icons, use FontAwesome icons. To find the hex code for a given icon, search for them at https://fontawesome.com/icons. For example, searching for "house" and clicking the "home" icon shows that its code is `f015` and its class is `fas`. The CSS classes `fab`, `far`, and `fas` are defined in `app/fontawesome.css`. The CSS class `fa-home` is not defined by default in Svelte Native.

The following app-wide CSS styling is added to the existing `app.css` file.

Listing 21.5 Global styling in `app/app.css`

```
button {
  background-color: lightgray;
  border-color: darkgray;
  border-width: 3;
  border-radius: 10;
  font-weight: bold;
  horizontal-align: center; /* to size according to content */
  padding: 10;
}

label {
  color: blue;
  font-size: 18;
  font-weight: bold;
}

.plain {
  color: black;
  font-size: 12;
  font-weight: normal;
}

.title {
  border-top-color: purple;
  border-top-width: 5px;
  color: purple;
  font-size: 20;
  font-weight: bold;
  font-style: italic;
  margin-top: 10;
  padding-top: 10;
}
```

This app uses several Svelte stores in order to share data across components. They are all defined in `stores.js`.

Listing 21.6 Stores in `app/stores.js`

```
import {derived, writable} from 'svelte/store';

export const authenticated = writable(false);
export const backgroundColor = writable('pink');
export const favoriteColorIndex = writable(0);
export const firstName = writable('');

// Not a store.
export const colors = ['red', 'orange', 'yellow', 'green', 'blue', 'purple'];

async function evaluateColor(color) {
  if (color === 'yellow') {
    alert({
      title: 'Hey there!',
      message: 'That is my favorite color too!',
      okButtonText: 'Cool'
    });
  } else if (color === 'green') {
    const confirmed = await confirm({
      title: 'Confirm Color',
      message: 'Are you sure you like that color?',
      okButtonText: 'Yes',
      cancelButtonText: 'No'
    });

    if (!confirmed) favoriteColorIndex.set(0);
  }
}
```

This is used as the background color of all the pages. It is pink when the user has not logged in. It is light green when they have.

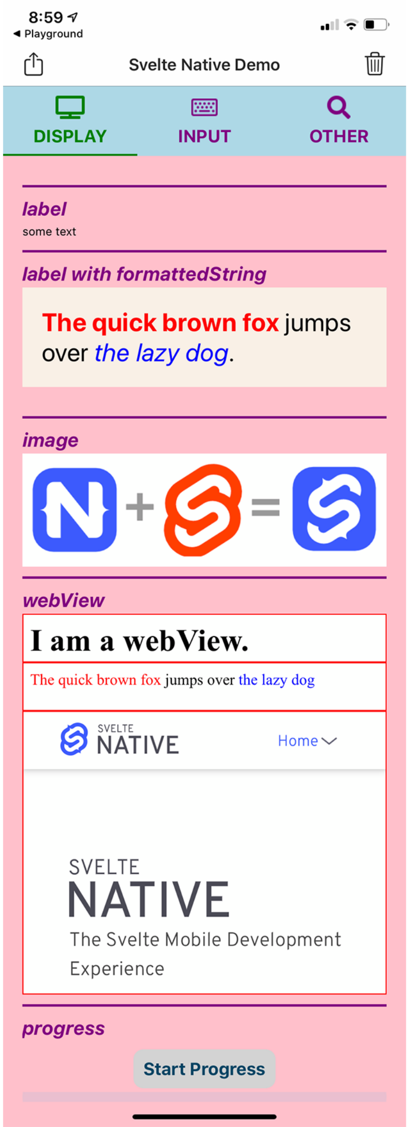
This function is called by the favoriteColor derived store defined below.

This sets the favorite color to "red" if the user doesn't like "green".

```
export const favoriteColor = derived(
   favoriteColorIndex,
  index => {
    const color = colors[index];
    evaluateColor(color);
    return color;
  }
);
```

This is a derived store based on the favoriteColorIndex store. It updates its value to a color name every time the value of the favoriteColorIndex store changes.

The page defined by the `DisplayComponents` component provides examples of components that display information (see figure 21.3).



some text

The quick brown fox jumps over the lazy dog.

I am a webView.

The quick brown fox jumps over the lazy dog

The Svelte Mobile Development Experience

Figure 21.3 `DisplayComponents` **component**

`htmlView` and `webView` issues

There are some issues to consider when using the `htmlView` and `webView` components.

The NativeScript docs say “The HtmlView component has limited styling capabilities. For more complex scenarios use the WebView component.” Using `htmlView` is fine for simple needs such as rendering rich text using bold and italics. For more advanced styling, use `webView`.

The `webView` component does not calculate its height based on its content, so it needs to be given a height in CSS unless the layout being used gives it a height.

The Svelte Native docs show that the `src` attribute of a `webView` can be set to a path to an HTML file. Webpack must be properly configured to include the HTML file in the bundle. For tips on doing this, see the issue at https://github.com/halfnelson/svelte-native/issues/138.

Listing 21.7 `DisplayComponents` **component in** `app/DisplayComponents.svelte`

```
<script>
  import {backgroundColor} from './stores';

  const myHtml = `
    <div>
      <span style="color: red">The quick brown fox</span>
      <span>jumps over</span>
      <span style="color: blue">the lazy dog</span>
    </div>
  `;

  let progressPercent = 0;

  function startProgress() {
    progressPercent = 0;
    const token = setInterval(() => {
      progressPercent++;
      if (progressPercent === 100) clearInterval(token);
    }, 10);
  }
</script>

<scrollView>
  <stackLayout
    backgroundColor={$backgroundColor}
    class="p-20"
  >
    <label class="title" text="label" />
    <label class="plain" text="some text" />

    <label class="title" text="label with formattedString" />
    <label class="panagram" textWrap="true">
      <formattedString>
        <span class="fox">The quick brown fox</span>
```

This is displayed in a webView below.

Tapping the “Start Progress” button causes this to be called. It animates the value of the progress bar.

This renders a string where runs of text can have different styling.

```
        <span text=" jumps over " />
        <span class="dog">the lazy dog</span>
        <span text="." />
      </formattedString>
    </label>

    <label class="title" text="image" />
    <wrapLayout class="image-frame">
      <image src="~/svelte-native-logos.png" stretch="aspectFit" />
    </wrapLayout>

    <label class="title" text="webView" />
    <webView src="<h1>I am a webView.</h1>" />
    <webView src={myHtml} />
    <webView style="height: 300" src="https://svelte-native.technology/" />

    <label class="title" text="progress" />
    <button on:tap={startProgress}>Start Progress</button>
    <progress class="progress" maxValue={100} value="{progressPercent}" />
  </stackLayout>
</scrollView>

<style>
  .dog {
    color: blue;
    font-style: italic;
  }

  .fox {
    color: red;
    font-weight: bold;
  }

  .image-frame {
    background-color: white;
    padding: 10;
  }

  .panagram {
    background-color: linen;
    color: black;
    font-size: 26;
    font-weight: normal;
    margin-bottom: 20;
    padding: 20;
  }

  progress {
    color: red;
    margin-bottom: 10;
    scale-y: 5; /* changes height */
  }

  webView {
    border-color: red;
    border-width: 1;
    height: 50;
  }
</style>
```

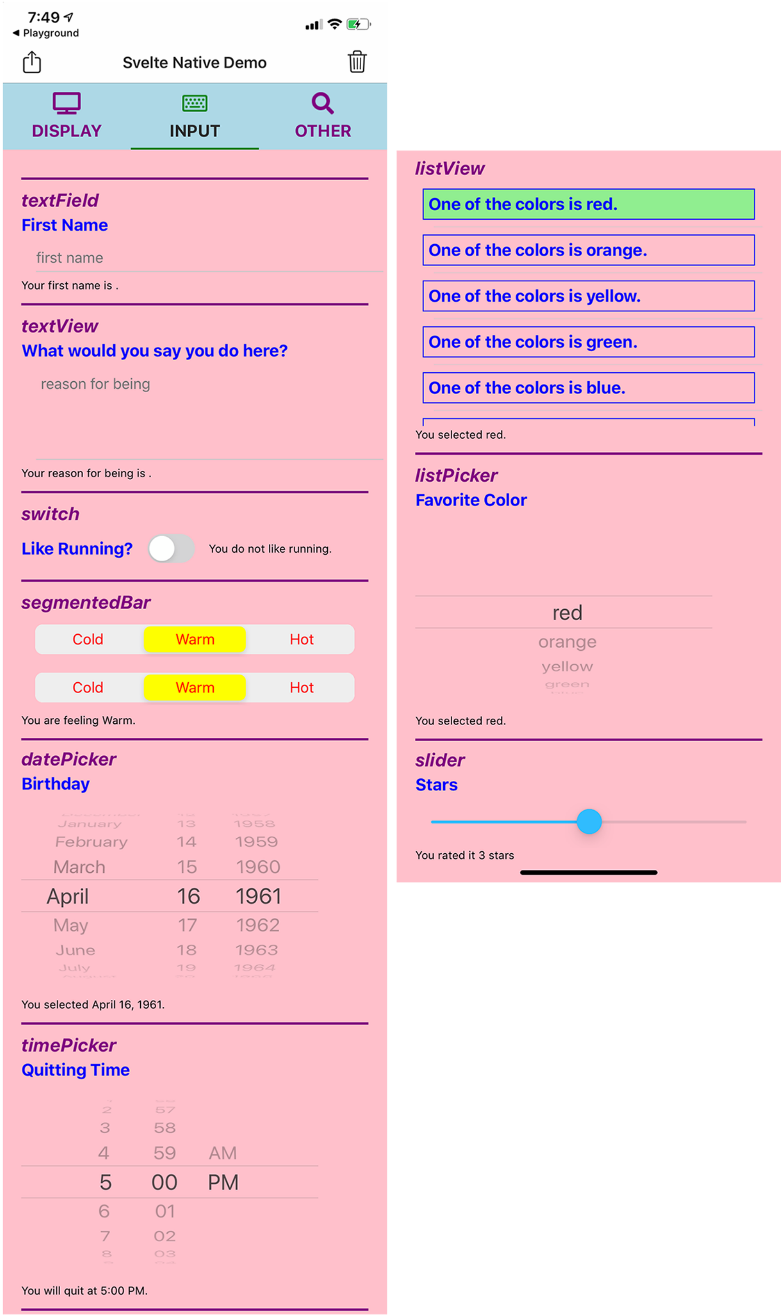
The CSS padding property doesn't affect image components. This is a workaround to add padding to an image.

Svelte Native treats ~ at the beginning of a file path as an alias to the app directory. This image can be found at https://github.com/mvolkmann/svelte-native-components/blob/master/app/svelte-native-logos.png.

The rendered page can be scrolled inside the webView component.

No webView content will be visible without this.

The page defined by the `InputComponents` component provides examples of components that gather user input (see figure 21.4).



Your first name is .

Your reason for being is .

You do not like running.

You are feeling Warm.

You selected April 16, 1961.

You will quit at 5:00 PM.

You selected red.

You selected red.

You rated it 3 stars

Figure 21.4 `InputComponents` **component**

Listing 21.8 `InputComponents` component in `app/InputComponents.svelte`

```
<script>
  import {Template} from 'svelte-native/components'

  import {
    backgroundColor,
    colors,
    favoriteColor,
    favoriteColorIndex,
    firstName
  } from './stores';

  const temperatures = ['Cold', 'Warm', 'Hot'];

  let birthday = new Date(1961, 3, 16);
  let likeRunning = false;
  let reason = '';
  let stars = 3;
  let temperatureIndex = 1;

  let quittingTime = new Date();
  quittingTime.setHours(17);
  quittingTime.setMinutes(0);
  quittingTime.setSeconds(0);

  function formatDate(date) {
    if (!date) return '';
    let month = date.toLocaleDateString('default', {month: 'long'});
    const index = month.indexOf(' ');
    if (index) month = month.substring(0, index);
    return `${month} ${date.getDate()}, ${date.getFullYear()}`;
  }

  function formatTime(date) {
    if (!date) return '';

    let hours = date.getHours();
    const amPm = hours < 12 ? 'AM' : 'PM';
    if (hours >= 12) hours -= 12;

    let minutes = date.getMinutes();
    if (minutes < 10) minutes = '0' + minutes;

    return `${hours}:${minutes} ${amPm}`;
  }

  function onFavoriteColor(event) {
    $favoriteColorIndex = event.value; // odd that this is an index
  }

  function onTapColor(event) {
    $favoriteColorIndex = event.index;
  }
```

This formats a Date object as a string like "April 16, 1961".

This formats a Date object as a string like "5:00 PM".

```
  function starChange(event) {
    stars = Math.round(event.value);
  }
</script>
```

This is an attempt to get the "stars" slider to snap to an integer value, but it does not work.

```
<scrollView>
  <stackLayout
    backgroundColor={$backgroundColor}
    class="p-20"
  >
    <!-- like HTML <input type="text"> -->
    <label class="title" text="textField" />
    <wrapLayout>
      <label text="First Name" />
      <textField class="first-name" hint="first name" bind:text={$firstName} />
      <label class="plain" text="Your first name is {$firstName}." />
    </wrapLayout>

    <!-- like HTML <textarea> -->
    <label class="title" text="textView" />
    <wrapLayout>
      <label text="What would you say you do here?" />
      <textView class="reason" hint="reason for being" bind:text={reason} />
      <label class="plain" text="Your reason for being is {reason}." textWrap=
     "true" />
    </wrapLayout>

    <!-- like HTML <input type="checkbox"> -->
    <label class="title" text="switch" />
    <wrapLayout>
      <label text="Like Running?" />
      <switch bind:checked={likeRunning} />
      <label
        class="plain"
        text="You{likeRunning ? '' : ' do not'} like running."
      />
    </wrapLayout>

    <!-- like HTML <input type="radio"> -->
    <label class="title" text="segmentedBar" />
    <segmentedBar
      bind:selectedIndex={temperatureIndex}
      selectedBackgroundColor="yellow"
    >
      <segmentedBarItem title="Cold" />
      <segmentedBarItem title="Warm" />
      <segmentedBarItem title="Hot" />
    </segmentedBar>
    <segmentedBar
      bind:selectedIndex={temperatureIndex}
      selectedBackgroundColor="yellow"
    >
      {#each temperatures as temp}
```

This shows another way to provide items to the segmentedBar component. The API docs show passing an array of items using the "items" prop, but that does not work. The children must be segmentedBarItem components.

```
    <segmentedBarItem title={temp} />
  {/each}
</segmentedBar>
<label
  class="plain"
  text="You are feeling {temperatures[temperatureIndex]}."
/>

<!-- like HTML <input type="date"> -->
<label class="title" text="datePicker" />
<wrapLayout>
  <label text="Birthday" />
  <datePicker bind:date={birthday} />
  <label class="plain" text="You selected {formatDate(birthday)}." />
</wrapLayout>

<!-- like HTML <input type="time"> -->
<label class="title" text="timePicker" />
<wrapLayout>
  <label text="Quitting Time" />
  <timePicker bind:time={quittingTime} />
  <label class="plain" text="You will quit at {formatTime(quittingTime)}." />
</wrapLayout>

<!-- like HTML <ul>, <ol>, or <select> -->
<label class="title" text="listView" />
<wrapLayout>
  <listView items={colors} on:itemTap={onTapColor}>
    <Template let:item={color}>
      <label
        class="list"
        class:selected={color === $favoriteColor}
        text="One of the colors is {color}."
      />
    </Template>
  </listView>
</wrapLayout>
<label class="plain" text="You selected {$favoriteColor}." />

<!-- like HTML <select> -->
<label class="title" text="listPicker" />
<wrapLayout>
  <label text="Favorite Color" />
  <listPicker
    items={colors}
    selectedIndex={$favoriteColorIndex}
    on:selectedIndexChange={onFavoriteColor}
  />
  <label class="plain" text="You selected {$favoriteColor}." />
</wrapLayout>

<!-- like HTML <input type="range"> -->
<label class="title" text="slider" />
```

This acts like an HTML select element when there is an on:itemTap handler.

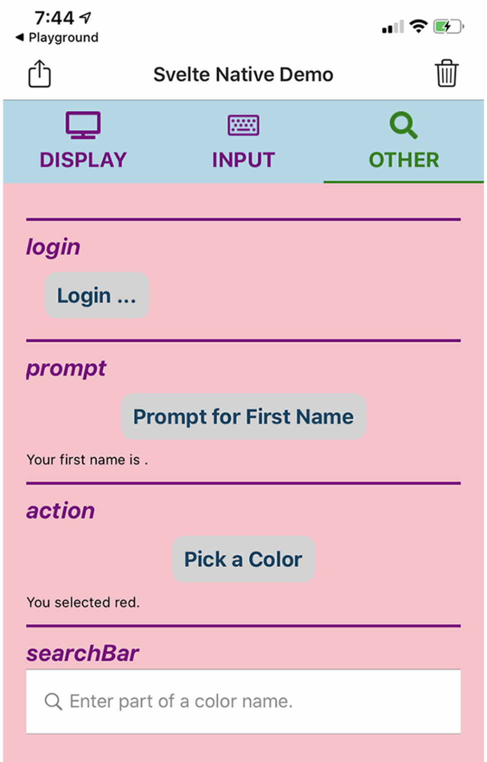
This is not reevaluated when the value of the favoriteColor store changes, so the presence of the selected CSS class is not updated.

```
    <wrapLayout>
      <label text="Stars" />
      <slider
        minValue={1}
        maxValue={5}
        value={stars}
        on:valueChange={starChange}
      />
      <label class="plain" text="You rated it {stars} stars" />
    </wrapLayout>
  </stackLayout>
</scrollView>

<style>
  .first-name {
    width: 100%;
  }

  .list {
    border-color: blue;
    border-width: 1;
    margin: 0;
  }

  .reason {
    width: 100%;
  }

  segmentedBar {
    color: red;
    margin-bottom: 10;
    margin-top: 10;
  }

  .selected {
    background-color: lightgreen;
  }
</style>
```

The slider position doesn't change when the starChange function changes the value of stars. See the issue at https://github.com/halfnelson/svelte-native/issues/128.

The page defined by the `OtherComponents` component provides examples of components that render a dialog or prompt for a search query (see figure 21.5).

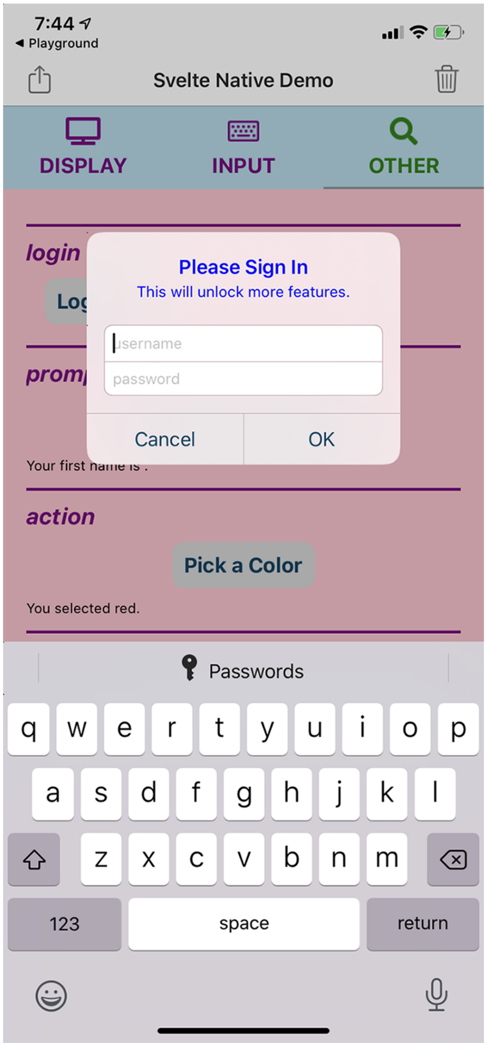
When the Login button is tapped, the dialog in figure 21.6 is displayed.



Your first name is .

You selected red.

Figure 21.5 `OtherComponents` component



This will unlock more features.

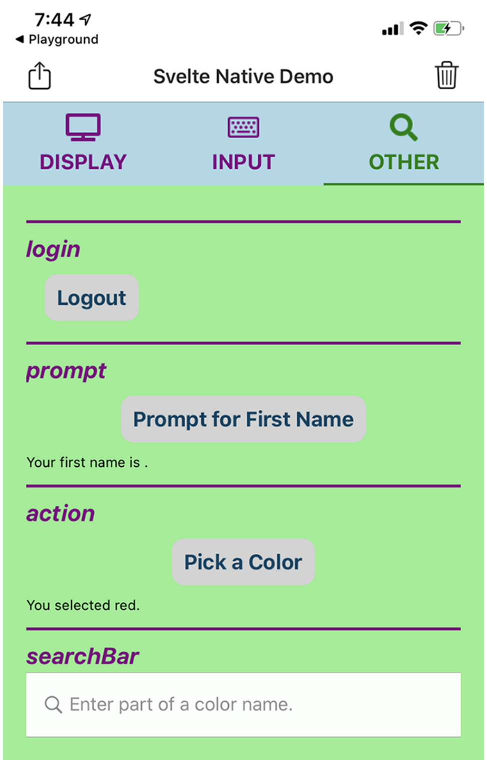
Your first name is .

You selected red.

Figure 21.6 Login dialog

If the user enters a correct username and password, the background of all the pages changes from pink to light green to indicate that they have been authenticated (see figure 21.7).

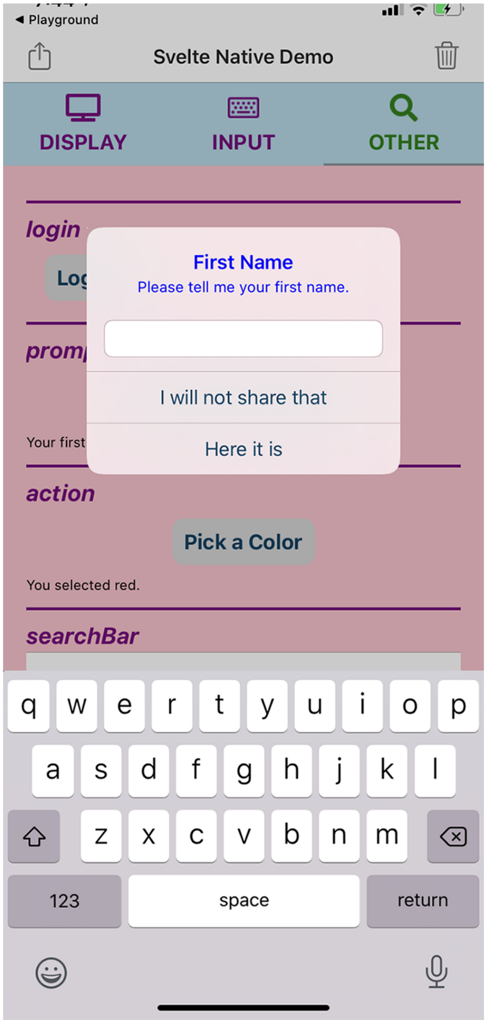
When the Prompt for First Name button is tapped, the dialog in figure 21.8 is displayed.



Your first name is .

You selected red.

Figure 21.7 After successful login



First Name

Please tell me your first name.

Your first

You selected red.

Figure 21.8 Prompt for first name

When the Pick a Color button is tapped, the dialog in figure 21.9 is displayed.

After entering part of a color name in the search input, a dialog like the one in figure 21.10 is displayed.

Listing 21.9 shows the code for `OtherComponents` that implements the preceding functionality.

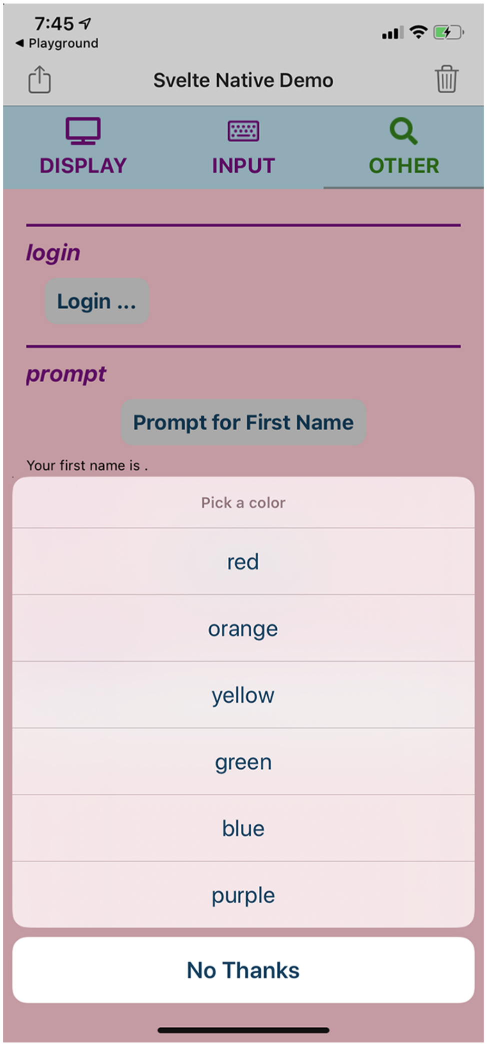


Figure 21.9 Prompt for color

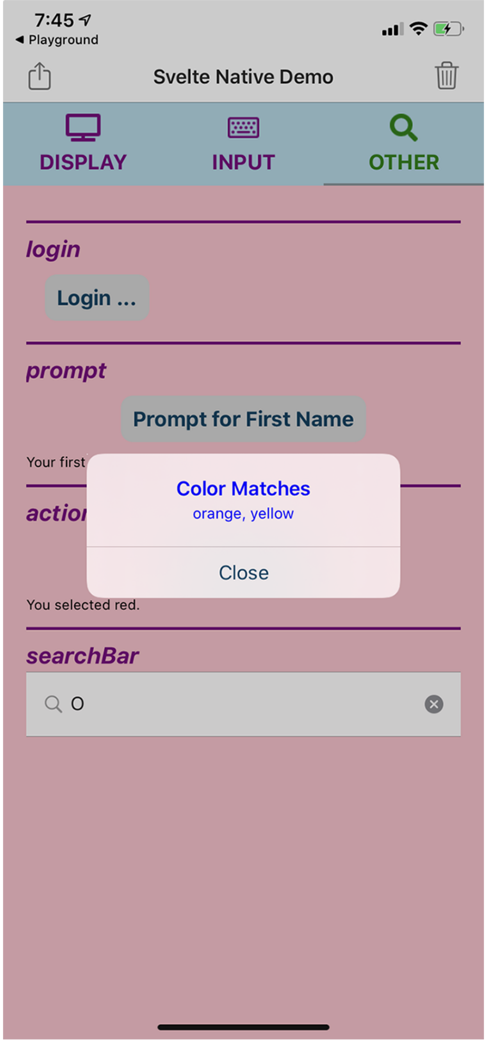


Figure 21.10 Search results

Listing 21.9 `OtherComponents` component in `app/OtherComponents.svelte`

```
<script>
  import {login} from 'tns-core-modules/ui/dialogs'
  import {
    authenticated,
    backgroundColor,
    colors,
    favoriteColor,
    favoriteColorIndex,
    firstName
  } from './stores';

  let busy = false;
  let query = '';

  // Should this be handled in stores.js?
  $: $backgroundColor = $authenticated ? 'lightgreen' : 'pink';

  async function getFirstName() {
    const res = await prompt({
      title: 'First Name',
      message: 'Please tell me your first name.',
      okButtonText: 'Here it is',
      cancelButtonText: 'I will not share that'
    });
    if (res.result) $firstName = res.text;
  }

  function onSearchSubmit() {
    busy = true;
    setTimeout(async () => { // to demonstrate activityIndicator component
      // The event object passed to this does not contain the search text
      // or any interesting properties.
      const q = query.toLowerCase();
      const matches = colors.filter(color => color.includes(q));
      busy = false;
      await alert({
        title: 'Color Matches',
        message: matches.length ? matches.join(', ') : 'no matches',
        okButtonText: 'Close'
      });
      query = ''; // reset
    }, 1000);
  }

  async function pickColor() {
    const NONE = 'No Thanks';
    const choice = await action('Pick a color', NONE, colors);
    if (choice !== NONE) {
      $favoriteColorIndex = colors.findIndex(c => c === choice);
    }
  }

  async function promptForLogin() {
    const res = await login({
      title: 'Please Sign In',
      message: 'This will unlock more features.',
      userNameHint: 'username',
      passwordHint: 'password',
      okButtonText: 'OK',
      cancelButtonText: 'Cancel',
    });
    if (res.result) {
      // Authenticate the user here.
```

```
      $authenticated = res.userName === 'foo' && res.password === 'bar';
      if (!$authenticated) {
        alert({
          title: 'Login Failed',
          message: 'Your username or password was incorrect.',
          okButtonText: 'Bummer'
        });
      }
    }
  }
</script>

<scrollView>
  <stackLayout
    backgroundColor={$backgroundColor}
    class="p-20"
  >
    <label class="title" text="login" />
    <wrapLayout>
      {#if $authenticated}
        <button on:tap={() => $authenticated = false}>Logout</button>
      {:else}
        <button on:tap={promptForLogin}>Login ...</button>
      {/if}
    </wrapLayout>

    <label class="title" text="prompt" />
    <button on:tap={getFirstName}>Prompt for First Name</button>
    <label class="plain" text="Your first name is {$firstName}." />

    <label class="title" text="action" />
    <button on:tap={pickColor}>Pick a Color</button>
    <label class="plain" text="You selected {$favoriteColor}." />

    <label class="title" text="searchBar" />
    <!-- Using gridLayout to position activityIndicator over searchBar. -->
    <gridLayout rows="*">
      <searchBar
        hint="Enter part of a color name."
        bind:text={query}
        on:submit={onSearchSubmit}
        row="0"
      />
      <!-- The activityIndicator height and width attributes
        control the allocated space.
        But the size of the spinner cannot be changed,
        only the color. -->
      <activityIndicator busy={busy} row="0"/>
    </gridLayout>
  </stackLayout>
</scrollView>

<style>
  activityIndicator {
    color: blue;
  }

  searchBar {
    margin-bottom: 10;
  }
</style>
```

21.8 NativeScript UI component library

NativeScript UI is a collection of NativeScript components that are not included by default. They include `RadAutoCompleteTextView`, `RadCalendar`, `RadChart`, `RadDataForm`, `RadGauge`, `RadListView`, and `RadSideDrawer`.

To use these components in a Svelte Native app, first create the app using `npx degit halfnelson/svelte-native-template` *`app-name`*. Then see the instructions on the NativeScript UI GitHub page at https://github.com/halfnelson/svelte-native-nativescript-ui.

`RadListView` is a particularly popular component. It renders a list of items with animations and support for many gestures including "pull to refresh" and "swipe actions."

Another popular component is `RadSideDrawer`. This provides a drawer-based side nav with a hamburger menu that is used for page navigation. Let's walk through an example that uses this.

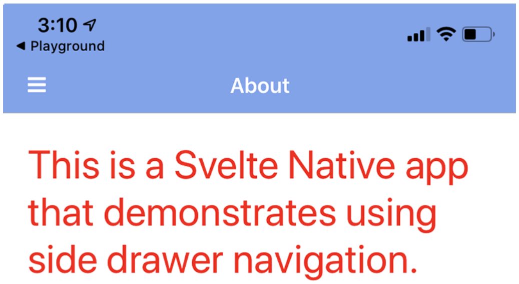
To prepare a Svelte Native app for using a `RadSideDrawer` component, do the following:

1. Enter `npm install svelte-native-nativescript-ui`.
2. Enter `tns plugin add nativescript-ui-sidedrawer`.

Our app will have two pages named "About" and "Hello". The About page merely describes the app. The Hello page allows the user to enter a name, and it renders a greeting message.

The side drawer contains the page names. To display the side drawer, click the hamburger icon in the upper left of a page, or drag right from the left edge of the screen. Tap a page name to close the side drawer and navigate to that page. Tap outside of the side drawer to close it without navigating to a different page.

Figures 21.11, 21.12, and 21.13 show the relevant parts of the two pages and the side drawer.



This is a Svelte Native app that demonstrates using side drawer navigation.

Figure 21.11 About page

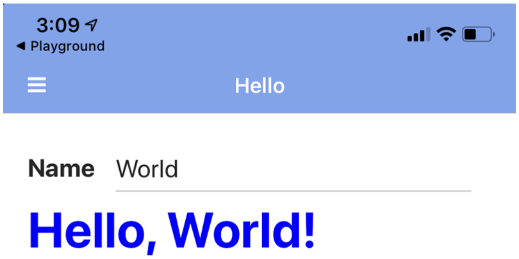


Figure 21.12 Hello page

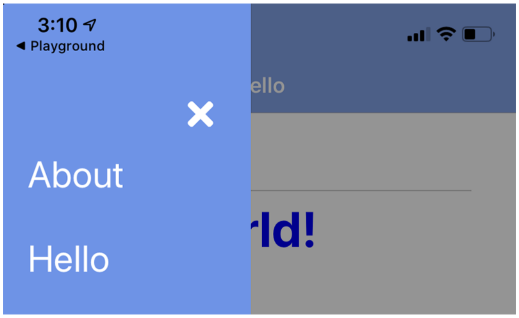


Figure 21.13 Side drawer open

Configuration of the side drawer is specified in `App.svelte`.

Listing 21.10 Topmost component in `app/App.svelte`

```
<script>
  import {onMount} from 'svelte';
  import RadSideDrawerElement from
    'svelte-native-nativescript-ui/sidedrawer';
  import AboutPage from './AboutPage.svelte';
  import HelloPage from './HelloPage.svelte';
  import {goToPage, setDrawer} from './nav';

  RadSideDrawerElement.register();

  let drawer;

  onMount(() => setDrawer(drawer));
</script>

<page>
  <radSideDrawer bind:this={drawer} drawerContentSize="200">
    <radSideDrawer.drawerContent>
      <stackLayout>
        <label
          class="fas h2"
          text="&#xF00D;"
          padding="10"
```

This is required to use the radSideDrawer element.

This lets nav.js know about the drawer.

The default drawer width is wider than this app needs, so we set it to 200.

This defines the content of the drawer.

This renders an “X” that can be clicked to close the drawer.

```
          horizontalAlignment="right"
          on:tap={() => drawer.closeDrawer()}
        />
        <label text="About" on:tap={() => goToPage(AboutPage)} />
        <label text="Hello" on:tap={() => goToPage(HelloPage)} />
      </stackLayout>
    </radSideDrawer.drawerContent>
    <radSideDrawer.mainContent>
      <frame id="mainFrame" defaultPage={HelloPage} />
    </radSideDrawer.mainContent>
  </radSideDrawer>
</page>

<style>
  label {
    color: white;
    font-size: 30;
    padding-bottom: 30;
  }

  stackLayout {
    background-color: cornflowerblue;
    padding: 20;
  }
</style>
```

This is where each of the pages will be rendered.

Functions for navigating to a given page (optionally passing it props) and toggling the drawer between being open and closed are defined in `nav.js`. The drawer is passed to `setDrawer` in the preceding listing for `App.svelte`.

Listing 21.11 Navigation functions in `app/nav.js`

```
import {navigate} from 'svelte-native';

let drawer;

export function setDrawer(d) {
  drawer = d;
}

export function goToPage(page, props) {
  drawer.closeDrawer();
  // Setting clearHistory to true prevents "<Back" button from appearing.
  navigate({page, props, clearHistory: true, frame: 'mainFrame'});
}

export function toggleDrawer() {
  drawer.toggleDrawerState();
}
```

This saves the drawer so it can be used in the goToPage and toggleDrawer functions.

This is currently only called when a page name in the drawer is tapped. However, it could be used from any page to navigate to another page.

"mainFrame" is the ID of the frame created in App.svelte.

This is called when the hamburger icon in the Header component is tapped.

Each page renders a `Header` component. It contains an `actionBar` that renders a hamburger icon and a page title. Tapping the hamburger icon opens the side drawer.

Listing 21.12 `Header` component in `app/Header.svelte`

```
<script>
  import {toggleDrawer} from './nav'
  import {isAndroid} from "tns-core-modules/platform"

  export let title = '';
</script>

<actionBar title={title}>
  {#if isAndroid}
    <navigationButton icon="res://menu" on:tap={toggleDrawer} />
  {:else}
    <actionItem icon="res://menu" ios.position="left" on:tap={toggleDrawer} />
  {/if}
</actionBar>

<style>
  actionBar {
    background-color: cornflowerblue;
    color: white;
  }
</style>
```

This holds a Boolean value that indicates whether the current device is running Android.

We want to display the hamburger menu in a platform-specific way.

The `AboutPage` component used in listing 21.10 is shown in the following listing.

Listing 21.13 `AboutPage` component in `app/AboutPage.svelte`

```
<script>
  import Header from './Header.svelte';
  import {singleLine} from './util';

  let description = singleLine`
    This is a Svelte Native app that demonstrates
    using side drawer navigation.
  `;
</script>

<page>
  <Header title="About" />
  <stackLayout class="p-20">
    <label text={description} textWrap="true">
    </label>
  </stackLayout>
</page>

<style>
  label {
    color: red;
    font-size: 32;
  }
</style>
```

This function name can appear at the beginning of a tagged template literal to turn a multiline, indented string into a single-line string with no indentation.

The HelloPage component used in listing 21.10 is shown in the following listing.

Listing 21.14 HelloPage component in app/HelloPage.svelte

```
<script>
  import Header from './Header.svelte';

  let name = 'World';
</script>

<page>
  <Header title="Hello" />
  <stackLayout class="p-20">
    <flexboxLayout>
      <label text="Name" />
      <textField bind:text={name} />
    </flexboxLayout>

    <label class="greeting" text="Hello, {name}!" textWrap="true" />
  </stackLayout>
</page>

<style>
  .greeting {
    color: blue;
    font-size: 40;
  }

  label {
    font-size: 20;
    font-weight: bold;
  }

  textField {
    flex-grow: 1;
    font-size: 20;
  }
</style>
```

The user can enter a name here.

The singleLine function used in listing 21.13 is shown in the following listing.

Listing 21.15 singleLine function in app/util.js

```
// This is a tagged template literal function that
// replaces newline characters with a space
// and then replaces consecutive spaces with one.
export function singleLine(literals) {
  return literals
    .join(' ')
    .replace(/\n/g, ' ')
    .replace(/  +/g, ' ')
    .trim();
}
```

That's it! Copy the techniques from this code into any Svelte Native apps where you want to use drawer-based page navigation.

21.9 Svelte Native issues

Svelte Native is a work in progress, and there are still some rough edges.

Some code errors cause the NativeScript Preview app to crash. This requires making code corrections, rerunning the `tns` command, returning to the NativeScript Playground mobile app, and rescanning the QR code. Sometimes after making a valid code change, the app will crash again, and a long stack trace with no references to your code will be output. If there really are no errors in your code, repeating these steps often results in the app running correctly.

You have almost reached the end of your journey, but keep reading. There is plenty of good material in the appendixes!

Summary

- Svelte Native builds on NativeScript to enable developing mobile applications using Svelte.
- NativeScript provides a set of predefined components.
- You can get started learning Svelte Native online using the Svelte Native REPL or the NativeScript Playground. Neither of these options requires installing any software.
- For more serious Svelte Native development, you will want to create a project locally and use your preferred editor or IDE for development.
- The NativeScript UI component library provides more advanced components than those provided by NativeScript.

appendix A *Resources*

This appendix lists important resources that are either directly or tangentially related to Svelte.

A.1 Svelte presentations

You have spent a lot of time reading this book. Take a break and watch some great videos!

- *Rethinking Reactivity* (http://mng.bz/OM4w)—This is a talk by Rich Harris given multiple times, most recently at the Shift Dev 2019 conference. It describes the motivations behind Svelte 3 and provides a brief introduction.
- *The Return of 'Write Less, Do More'* (http://mng.bz/YrYz)—This is a talk by Rich Harris given at JSCamp 2019.
- *Svelte 3 with Rich Harris* (http://mng.bz/GVrD)—This is a live stream rebroadcast where Rich Harris teaches John Lindquist about Svelte and Sapper.
- *Simplify Web App Development with Svelte* (http://mng.bz/zjw1)—This is a talk by Mark Volkmann given at Nordic.js 2019.
- *How to Create a Web Component in Svelte* (http://mng.bz/04XJ)—This is from a YouTube channel titled "A shot of code."

A.2 Svelte resources

Check out these official resources on Svelte.

- *Svelte home page*—https://svelte.dev/
- *Svelte tutorial*—https://svelte.dev/tutorial
- *Svelte API*—https://svelte.dev/docs
- *Svelte examples*—https://svelte.dev/examples
- *Svelte REPL (online)*—https://svelte.dev/repl

- *Svelte blog*—https://svelte.dev/blog
- *Svelte GitHub repository*—https://github.com/sveltejs/svelte
- *Svelte changelog*—https://github.com/sveltejs/svelte/blob/master/CHANGELOG.md
- *svelte.preprocess*—https://svelte.dev/docs#svelte_preprocess
- *Discord chat room*—https://discordapp.com/invite/yy75DKs
- *Community resources*—https://svelte-community.netlify.com/resources/

A.3 Framework comparisons

What good is learning something if you can't say it's better than the alternatives? Here are some resources that claim Svelte is better.

- *JS framework benchmarks*—https://krausest.github.io/js-framework-benchmark/current.html
- *A RealWorld Comparison of Front-End Frameworks with Benchmarks*—http://mng.bz/K26X

A.4 Sapper resources

Don't forget about Sapper. Even though it's not out of beta yet, it is still worth learning.

- *Sapper home page*—https://sapper.svelte.dev/

A.5 Svelte Native resources

Ready to move beyond browsers and write native mobile apps? Check out these resources to help you write Android and iOS apps using JavaScript and Svelte.

- *NativeScript*—https://nativescript.org/
- *NativeScript components*—https://docs.nativescript.org/ui/overview
- *NativeScript Playground*—https://play.nativescript.org/
- *NativeScript Sidekick*—https://nativescript.org/blog/welcome-to-a-week-of-native-script-sidekick/
- *NativeScript styling*—https://docs.nativescript.org/ui/styling
- *NativeScript UI*—https://github.com/halfnelson/svelte-native-nativescript-ui
- *Svelte Native home page*—https://svelte-native.technology/
- *Svelte Native API/docs*—https://svelte-native.technology/docs
- *Svelte Native REPL*—https://svelte-native.technology/repl

A.6 Svelte GL resources

How about some 3D graphics using JavaScript and Svelte?

- *@svelte/gl*—https://github.com/sveltejs/gl
- *A Svelte GL demo*—http://mng.bz/90Gj

A.7 Svelte tools

You're going to need some tools to help improve your Svelte code and make you more productive.

- *Ease Visualizer*—https://svelte.dev/examples#easing
- *publish-svelte (pelte) tool*—https://github.com/philter87/publish-svelte
- *Storybook for Svelte*—https://storybook.js.org/docs/guides/guide-svelte/
- *svelte-check*—https://github.com/sveltejs/language-tools/tree/master/packages/svelte-check
- *Svelte devtools*—https://github.com/RedHatter/svelte-devtools
- *svelte-image preprocessor*—https://github.com/matyunya/svelte-image
- *svelte-preprocess*—https://github.com/kaisermann/svelte-preprocess
- *svelte-preprocess-markdown*—https://alexxnb.github.io/svelte-preprocess-markdown/
- *svelte-type-checker*—https://github.com/halfnelson/svelte-type-checker
- *Svelte3 ESLint plugin*—https://github.com/sveltejs/eslint-plugin-svelte3

A.8 Svelte libraries

You don't have to write every line of code yourself. Using libraries like these can simplify your applications.

- *navaid routing library*—https://github.com/lukeed/navaid
- *Routify routing library*—https://routify.dev/
- *svelte-dialog*—https://github.com/mvolkmann/svelte-dialog
- *svelte-fa component that renders FontAwesome icons*—https://cweili.github.io/svelte-fa/
- *Svelte Material UI*—https://sveltematerialui.com/
- *Svelte Testing Library*—https://testing-library.com/docs/svelte-testing-library/intro
- *svelte-moveable*—https://github.com/daybrush/moveable/tree/master/packages/svelte-moveable
- *svelte-routing routing library*—https://github.com/EmilTholin/svelte-routing
- *svelte-spa-router routing library*—https://github.com/ItalyPaleAle/svelte-spa-router
- *sveltestrap Bootstrap implementation in Svelte*—https://bestguy.github.io/sveltestrap/
- *sveltik form library inspired by Formik*—https://github.com/nathancahill/sveltik

A.9 VS Code resources

The majority of JavaScript developers use VS Code to do their editing, and it has great support for Svelte.

- *VS Code editor*—https://code.visualstudio.com/
- *"Svelte" extension for VS Code*—http://mng.bz/jgxa
- *Svelte for VS Code*—https://marketplace.visualstudio.com/items?itemName=svelte.svelte-vscode

- *"Svelte 3 Snippets" extension for VS Code*—http://mng.bz/8pYK
- *"Svelte Intellisense" extension for VS Code*—http://mng.bz/EdBq
- *"Svelte Type Checker" extension for VS Code*—https://github.com/halfnelson/svelte-type-checker-vscode

A.10 Learning resources not specific to Svelte

You're going to need to learn things that are not specific to Svelte in order to write non-trivial applications. Here is a collection of non-Svelte resources that were mentioned in this book.

- *Ajax*—https://developer.mozilla.org/en-US/docs/Web/Guide/AJAX
- *B-tree*—https://en.wikipedia.org/wiki/B-tree
- *CSS media queries*—http://mng.bz/VgeX
- *CSS Modules*—https://github.com/css-modules/css-modules
- *CSS Specificity*—https://css-tricks.com/specifics-on-css-specificity/
- *CSS variables*—http://mng.bz/rrwg
- *Event bubbling and capture*—http://mng.bz/dyDD
- *Fetch API*—https://developer.mozilla.org/en-US/docs/Web/API/Fetch_API
- *Flexbox Froggy*—https://flexboxfroggy.com/
- *Flexbox video course from Wes Bos*—https://flexbox.io/
- *GitHub Actions*—https://github.com/features/actions
- *How to code an SVG pie chart*—https://seesparkbox.com/foundry/how_to_code_an_SVG_pie_chart
- *HTML Drag and Drop API*—http://mng.bz/B2Nv
- *IndexedDB*—http://mng.bz/lGwj
- *JSX*—https://reactjs.org/docs/introducing-jsx.html
- *Markdown syntax*—https://www.markdownguide.org/basic-syntax/
- *Passive listeners*—http://mng.bz/NKvE
- *Service workers*—http://mng.bz/D2ly
- *Web components*—https://www.webcomponents.org/introduction
- *Web Components in Action* by Ben Farrell (Manning, 2019)—https://www.manning.com/books/web-components-in-action
- *Web workers*—http://mng.bz/xWw8

A.11 Tools not specific to Svelte

Earlier you saw some Svelte-specific tools. You'll also want to use tools that are not specific to Svelte.

- *axe accessibility testing*—https://www.deque.com/axe/
- *BrowserStack*—https://www.browserstack.com/
- *Chrome DevTools*—http://mng.bz/AAEp
- *CodeSandbox*—https://codesandbox.io/

- *Color Contrast Checker*—https://webaim.org/resources/contrastchecker/
- *Cypress testing framework*—https://www.cypress.io/
- *ESLint*—https://eslint.org/
- *Firefox DevTools*—http://mng.bz/Z2Gm
- *Homebrew package manager for macOS and Linux*—https://brew.sh/
- *Jest testing framework*—https://jestjs.io
- *Lighthouse audit tool*—https://developers.google.com/web/tools/lighthouse
- *MongoDB*—https://www.mongodb.com/
- *Mustache*—https://mustache.github.io/
- *Netlify*—https://www.netlify.com
- *ngrok tunneling tool*—https://ngrok.com/
- *openssl*—https://www.openssl.org/
- *Parcel*—https://parceljs.org/
- *parcel-plugin-svelte*—https://github.com/DeMoorJasper/parcel-plugin-svelte
- *Pope Tech accessibility testing*—https://pope.tech/
- *Prettier*—https://prettier.io/
- *Rollup*—https://rollupjs.org/
- *Sass*—https://sass-lang.com/
- *sirv HTTP server*—https://www.npmjs.com/package/sirv
- *Snowpack*—https://www.snowpack.dev/
- *Storybook*—https://storybook.js.org
- *TypeScript*—https://www.typescriptlang.org/
- *Vercel*—https://vercel.com/
- *WAVE accessibility testing*—https://wave.webaim.org/
- *Webpack*—https://webpack.js.org/

A.12 Libraries not specific to Svelte

Earlier you saw some Svelte-specific libraries. You'll also want to use libraries that are not specific to Svelte.

- *dialog-polyfill*—https://www.npmjs.com/package/dialog-polyfill
- *DOM Testing Library*—https://testing-library.com/docs/dom-testing-library/intro
- *Express web server*—https://expressjs.com/
- *jsdom*—https://github.com/jsdom/jsdom
- *Marked markdown library*—https://marked.js.org
- *Page.js library*—https://visionmedia.github.io/page.js
- *Polka web server*—https://github.com/lukeed/polka
- *sanitize-html*—https://github.com/apostrophecms/sanitize-html

A.13 Assets not specific to Svelte

Here are links to things mentioned in the book that are not learning resources, tools, or libraries.

- *Chrome web store*—https://chrome.google.com/webstore/category/extensions
- *Firefox Add-ons*—https://addons.mozilla.org/en-US/firefox/
- *Fontawesome icons*—https://fontawesome.com/icons?d=gallery

appendix B
Calling REST services

Calling REST services from Svelte components is as easy as using the Fetch API that is built into modern web browsers.

Most REST services fall into one of the CRUD categories: create, retrieve, update, and delete. These map to the four HTTP verbs: `POST`, `GET`, `PUT`, and `DELETE`.

Suppose the following REST services have been implemented using any server-side technology stack:

- `POST /dog` to create a new dog where the request body contains a JSON description
- `GET /dog` to get all the dogs
- `GET /dog/{id}` to get a specific dog
- `PUT /dog/{id}` to update an existing dog where the request body contains a JSON description
- `DELETE /dog/{id}` to delete an existing dog

Let's walk through client-side functions that call these REST services using the Fetch API. These assume that the constant `SERVER_URL` is set to the base URL that is common to each of the REST services, such as `http://localhost:1234/dog`. These functions should be called from a `try` block so the corresponding `catch` block can handle any errors that occur.

> **NOTE** Alternatively, the Promise methods `then` and `catch` can be chained, but the code looks cleaner when the `await` keyword is used inside a `try` block, and errors are caught in a `catch` block.

The following function calls the REST service to create a dog. The JSON returned matches the JSON passed in, but typically also includes an `id` assigned to the newly created dog.

Listing B.1 `createDog` function in `dogs.js`

```
export async function createDog(dog) {
  const body = JSON.stringify(dog);
  const headers = {
    'Content-Length': body.length,
    'Content-Type': 'application/json'
  };
  const res = await fetch(SERVER_URL, {
    method: 'POST',
    headers,
    body
  });
  if (!res.ok) throw new Error(await res.text());
  return res.json();
}
```

This returns the new dog with an id property.

This function calls the REST service to retrieve all the dogs.

Listing B.2 `getDogs` function in `dogs.js`

```
export async function getDogs() {
  const res = await fetch(SERVER_URL);
  if (!res.ok) throw new Error(await res.text());
  return res.json();
}
```

This returns the dogs.

The next function calls the REST service to retrieve the dog with a given `id`.

Listing B.3 `getDog` function in `dogs.js`

```
export async function getDog(id) {
  const res = await fetch(SERVER_URL + '/' + id);
  if (!res.ok) throw new Error(await res.text());
  return res.json();
}
```

This returns the dog.

The next function calls the REST service to update an existing dog.

Listing B.4 `updateDog` function in `dogs.js`

```
export async function updateDog(dog) {
  const body = JSON.stringify(dog);
  const headers = {
    'Content-Length': body.length,
    'Content-Type': 'application/json'
  };
  const res = await fetch(SERVER_URL + '/' + dog.id, {
    method: 'PUT',
    headers,
    body
  });
  if (!res.ok) throw new Error(await res.text());
  return res.json();        <-- This returns the updated dog.
}
```

The next function calls the REST service to delete an existing dog with a given `id`.

Listing B.5 `deleteDog` **function in** `dogs.js`

```
export async function deleteDog(id) {
  const res = await fetch(SERVER_URL + '/' + id, {
    method: 'DELETE'
  });
  if (!res.ok) throw new Error(await res.text());
}
```

Note that throwing an `Error` from these functions causes the `Promise` they return to reject.

B.1 Headers

Most data provided by HTTP requests is supplied in the form of path parameters, query parameters, or a request body. Another way to supply data is to include headers. There are many header names with predefined meanings. Custom header names can also be specified.

You saw examples earlier of `POST` and `PUT` requests that include the `Content-Length` header and the `Content-Type` header to specify that a JSON body is included. For REST calls that require authentication, a token obtained from a login process is typically provided in an `Authentication` request header.

appendix C *MongoDB*

MongoDB is currently the most popular NoSQL database. Unlike relational databases that use SQL and are organized into tables that contains rows, and rows that contain columns, MongoDB stores *documents* in *collections*. Each collection can have multiple indexes to make queries faster. These indexes are implemented as B-tree data structures (https://en.wikipedia.org/wiki/B-tree). The documents are JSON objects that are stored in a binary JSON format called BSON.

Unlike relational databases that define the structure of a database with a schema, MongoDB does not use a schema to restrict what can be stored in a database. This speeds up development when the structure changes often, since no schema changes are required. It also allows properties present in the objects of a collection to vary.

In practice, all the documents that are added to a given collection typically have the same structure. For example, documents describing a person might all have the following structure:

```
{
  _id: ObjectId("5e4984b33c9533dfdf102ac8")
  firstName: "Mark",
  lastName: "Volkmann",
  address: {
    street: "123 Some Street",
    city: "Somewhere",
    state: "Missouri",
    zip: 12345
  },
  favoriteColors: ["yellow", "orange"]
}
```

Each document has an `_id` property that holds a unique identifier within its collection. Documents in other collections can have properties that refer to these. This can be used to simulate what are called *joins* in relational databases.

This appendix provides enough detail so that you can use MongoDB for implementing CRUD operations on collections of data. It does not cover more advanced topics, such as query optimization, replication, sharding, backups, and security. For detail on these and many other MongoDB topics, see *MongoDB in Action* by Kyle Banker, Peter Bakkum, Shaun Verch, Douglas Garrett, and Tim Hawkins (Manning, 2016).

We'll look at how to perform various actions from JavaScript code. Chapter 17 shows how to do the same using Sapper server routes.

C.1 Installing MongoDB

There are multiple ways to install MongoDB, and they vary based on the operating system of the computer. For details, see the MongoDB documentation (https://docs.mongodb.com/guides/server/install/). We will look at one way of installing for each operating system.

C.1.1 Installing MongoDB on Windows

Follow these steps to install MongoDB on Windows:

1. Browse to https://www.mongodb.com/try/download/community.
2. Click Server at the top to bypass requesting a free trial of MongoDB Atlas.
3. In the Version drop-down, select the version labeled "current release".
4. In the OS drop-down, select "Windows x64".
5. In the Package drop-down, select "msi".
6. Click the Download button.
7. Double-click the downloaded `.msi` file and follow the installer instructions.
8. Open a command prompt window.
9. Create the MongoDB data directory by entering `md \data\db`.

NOTE This will install MongoDB as a Windows service. It will consume resources even when not in use. When it's not needed, the service can be stopped or it can be uninstalled.

C.1.2 Installing MongoDB on Linux

Follow these steps to install MongoDB on Linux:

1. Browse to https://www.mongodb.com/try/download/community.
2. Click Server at the top to bypass requesting a free trial of MongoDB Atlas.
3. In the Version drop-down, select the version labeled "current release".
4. In the OS drop-down, select your version of Linux.
5. In the Package drop-down, select "TGZ".
6. Click the Download button.

7. Open a terminal window.
8. `cd` to the directory where the `.tgz` file was downloaded.
9. Enter `sudo tar -C /opt -xf {file-name}.tgz`.
10. Add the bin subdirectory of this directory to the `PATH` environment variable. For example, `/opt/mongodb-linux-x86_64-ubuntu1604-4.2.3/bin`.
11. Create the MongoDB data directory by entering `sudo mkdir -p /data/db`.
12. Set permissions on this directory by entering `sudo chmod +rw /data/db`.

C.1.3 Installing MongoDB on macOS

One option for installing on macOS is to follow the same basic steps as for Linux. Another approach is as follows:

1. Install Homebrew by entering the command shown at https://brew.sh/.
2. Enter `brew tap mongodb/brew`.
3. Enter `brew install mongodb-community`.

C.2 Starting the database server

The steps for starting a MongoDB server vary based on the operating system of the computer.

- On Windows, open a command prompt and enter `mongod`.
- On Linux, open a terminal window and enter `mongod`.
- On macOS, open a terminal window and enter `mongod --config /usr/local/etc/mongod.conf --fork`.

C.3 Using MongoDB shell

MongoDB shell is a kind of REPL that supports using JavaScript to interact with a MongoDB database.

> **NOTE** There are also many free tools that provide a GUI for performing the same operations. Some to consider can be found at www.guru99.com/top-20-mongodb-tools.html.

To start the MongoDB shell, enter `mongo`. This displays a prompt where JavaScript-based MongoDB commands can be entered.

Table C.1 is a cheat sheet of commands that can be entered to perform common operations. The following placeholders are used in the commands:

- `{db}` represents the name of a database.
- `{coll}` represents the name of a collection.
- `{obj}` represents a JavaScript object that describes a document.

It is best to use valid JavaScript names for collections. For example, avoid including dashes in their names.

Table C.1

Action	Command
List existing databases	`show dbs`
Create a new database	None; databases are automatically created when a collection is added
Make a given database the current one	`use {db}`
Show the current database	`db.getName()`
Delete the current database	`db.dropDatabase()`
List the collections in the current database	`show collections` or `db.getCollectionNames()`
Create a collection in the current database	`db.createCollection('{coll}')`
Add a document to a collection	`db.{coll}.insert({obj})`
Get the number of documents in a collection	`db.{coll}.find().count()` or `db.{coll}.find().length()`
Output the first 20 documents in a collection	`db.{coll}.find()`
Output the next 20 documents in a collection	`db.{coll}.find().skip(20)`
Output the first 20 documents in a collection that match criteria	`db.{coll}.find({criteria})`
Delete one document from a collection that matches criteria	`db.{coll}.deleteOne({criteria})`
Delete all documents from a collection that match criteria	`db.{coll}.deleteMany({criteria})`
Update one document in a collection that matches criteria	`db.{coll}.updateOne({criteria}, {$set: {updates}})`
Update all documents in a collection that match criteria	`db.{coll}.updateMany({criteria}, {$set: {updates}})`
Add an index to a collection	`db.{coll}.createIndex({ {prop-name}: 1 });` + 1 for ascending order, -1 for descending order
Delete a collection	`db.{coll}.drop()`
Exit from the shell	`exit`

The current database starts as "test," even if no such database exists yet. Here is an example session:

```
show dbs
use animals
db.createCollection('dogs')
```

We don't have an "animals" database yet.

A database doesn't have to exist to "use" it.

```
show dbs
db.createCollection('cats')
db.getCollectionNames();
db.dogs.insert({breed: 'Whippet', name: 'Dasher'})
db.dogs.insert({breed: 'TWC', name: 'Maisey'})
db.dogs.insert({breed: 'NAID', name: 'Ramsay'})
db.dogs.insert({breed: 'GSP', name: 'Oscar'})
db.dogs.find()
db.dogs.find({breed: 'Whippet'})
db.dogs.deleteMany({breed: 'Whippet'})
db.dogs.find()
db.dogs.update({breed: 'GSP'}, {$set: {name: 'Oscar Wilde'}})
db.dogs.update({_id: ObjectId('some-id')}, {$set: {name: 'Oscar Wilder'}})
db.dogs.drop()
db.getCollectionNames()
db.dropDatabase()
show dbs
```

Now we have an "animals" database because we created a collection in it.

The "animals" database now contains the collections "dogs" and "cats".

This deletes all the dogs with a breed of "Whippet".

This deletes the "dogs" collection.

This changes the name of the one dog with a given ID.

This shows that we no longer have a "dogs" collection.

This shows that the collection no longer contains Whippets.

This changes the name of all dogs with a breed of "GSP".

This deletes the "animals" database.

This outputs only the dogs with a breed of "Whippet".

This shows that we no longer have an "animals" database.

This outputs the first 20 documents in the "dogs" collection.

C.4 Using MongoDB from JavaScript

Now that you know how to use the MongoDB shell, let's see how to perform the same operations from a JavaScript program. Learning this will allow you to do the same things from server routes in a Sapper app.

There are several open source libraries for using MongoDB from various programming languages. The official library for Node.js is simply called `mongodb`. To install it, enter `npm install mongodb`.

The following code performs all the same operations you saw in the previous MongoDB shell session.

```
const MongoClient = require('mongodb').MongoClient;

// MongoDB thinks localhost is a different database instance than 127.0.0.1.
// The mongo shell uses 127.0.0.1, so we use that to hit the same instance.
// I thought maybe this was an issue with my /etc/host file,
// but I commented out all the lines that associated 127.0.0.1
// with something other than localhost and it didn't change anything.
//const url = 'mongodb://localhost:27017';
const url = 'mongodb://127.0.0.1:27017';

// These are recommended MongoDB options to avoid deprecation warnings.
const options = {useNewUrlParser: true, useUnifiedTopology: true};
```

```
async function logCollection(coll) {
  let result = await coll.find().toArray();
  console.log(coll.collectionName, 'contains', result);
}

async function logCollections(db) {
  const items = await db.listCollections().toArray();
  console.log(
    'collections are',
    items.map(item => item.name)
  );
}

async function logDatabases(client) {
  const dbs = await client
    .db()
    .admin()
    .listDatabases();
  console.log(
    'databases are',
    dbs.databases.map(db => db.name)
  );
}

// All uses of the "await" keyword must be in an "async" function.
async function doIt() {
  let client;
  try {
    client = await MongoClient.connect(url, options);
    // Show that we do not yet have an "animals" database.
    await logDatabases(client);

    // Use the "animals" database.
    const db = client.db('animals');

    // Create two collections in the "animals" database.
    const dogs = await db.createCollection('dogs');
    const cats = await db.createCollection('cats');

    // Show that we now have an "animals" database.
    await logDatabases(client);

    // Show that the collections were created.
    await logCollections(db);

    // Add four documents to the "dogs" collection.
    await dogs.insertOne({breed: 'Whippet', name: 'Dasher'});
    await dogs.insertOne({breed: 'TWC', name: 'Maisey'});
    await dogs.insertOne({breed: 'NAID', name: 'Ramsay'});
    await dogs.insertOne({breed: 'GSP', name: 'Oscar'});

    // Show that there are four documents in the "dogs" collection.
    const count = await dogs.countDocuments();
    console.log('dog count =', count);
    // Show the documents in the "dogs" collection.
    await logCollection(dogs);

    // Find all the Whippets in the "dogs" collection.
    result = await dogs.find({breed: 'Whippet'}).toArray();
    console.log('whippets are', result);

    // Delete all the Whippets from the "dogs" collection.
    console.log('deleting Whippets');
    await dogs.deleteMany({breed: 'Whippet'});

    // Show that the "dogs" collection no longer contains Whippets.
    await logCollection(dogs);

    // Update the name of all GSPs in the "dogs" collection.
    console.log('updating GSP name');
    await dogs.updateMany({breed: 'GSP'}, {$set: {name: 'Oscar Wilde'}});
    await logCollection(dogs);

    // Find a specific dog in the "dogs" collection.
    const dog = await dogs.findOne({name: 'Oscar Wilde'});

    // Update the name of a specific dog in the "dogs" collection.
    await dogs.updateOne({_id: dog._id}, {$set: {name: 'Oscar Wilder'}});
    await logCollection(dogs);

    // Delete the "dogs" collection.
    await dogs.drop();

    // Show that the "animals" database
    // no longer contains a "dogs" collection.
    logCollections(db);

    // Delete the "animals" database.
    await db.dropDatabase();

    // Show that the "animals" database no longer exists.
    await logDatabases(client);
  } catch (e) {
    console.error(e);
  } finally {
    if (client) client.close();
  }
}

doIt();
```

Congratulations! You now know the basics of using MongoDB.

appendix D
ESLint for Svelte

ESLint (https://eslint.org/) is a tool that bills itself as the “pluggable linting utility for JavaScript and JSX.” It can report many syntax errors and potential runtime errors. It can also report deviations from specified coding guidelines in order to make the code in an application more consistent.

To install everything needed to use ESLint in a Svelte or Sapper project, enter the following:

```
npm install -D eslint eslint-plugin-import eslint-plugin-svelte3
```

One benefit of the Svelte3 ESLint plugin is that it warns about unused CSS selectors. For more detail, see the eslint-plugin-svelte3 GitHub page (https://github.com/sveltejs/eslint-plugin-svelte3).

To configure the use of ESLint, create the following file in the top directory of each Svelte app.

Listing D.1 The `.eslintrc.json` file

```
{
  "env": {
    "browser": true,
    "es6": true,
    "jest": true,
    "node": true
  },
  "extends": ["eslint:recommended", "plugin:import/recommended"],
  "overrides": [
    {
      "files": ["**/*.svelte"],
      "processor": "svelte3/svelte3"
    }
  ],
  "parserOptions": {
    "ecmaVersion": 2019,
    "sourceType": "module"
  },
  "plugins": ["import", "svelte3"]
}
```

Add the following npm script to `package.json`:

```
"lint": "eslint --fix --quiet src --ext .js,.svelte",
```

To run ESLint, enter `npm run lint`. Here are examples of messages that can be output by ESLint:

```
/Users/mark/.../svelte-and-sapper-in-action/travel-packing-ch14/src/Baskets.svelte
  18:6   error  'hoveringOverBasket' is assigned a value but never used  no-unused-vars
  20:11  error  'dragStart' is defined but never used                    no-unused-vars
  25:2   error  Mixed spaces and tabs                                    no-mixed-spaces-and-tabs
```

For more information on Svelte-specific ESLint options, see the eslint-plugin-svelte3 GitHub page (https://github.com/sveltejs/eslint-plugin-svelte3).

Many editors and IDEs, including VS Code, have extensions for running ESLint as code is entered or when files are saved.

appendix E
Prettier for Svelte

Prettier (https://prettier.io/) is a code-formatting tool. It can be used from the command line and from inside many code editors. Prettier bills itself as an "opinionated JavaScript formatter," so although the way it formats code can be customized to some extent, there are intentionally only a small number of options.

Most developers prefer to work on software applications with a consistent, widely used coding style. Prettier delivers this for many languages and syntaxes, including JavaScript, TypeScript, JSON, HTML, CSS, SCSS, JSX, Vue, and Markdown.

To install everything needed to use Prettier code formatting in a Svelte or Sapper project, enter the following:

```
npm install -D prettier prettier-plugin-svelte
```

To configure Prettier options, create the file .prettierrc in the top project directory. By default, the Svelte Prettier plugin enforces a .svelte file section order of script elements, style elements, and HTML. This can be changed by adding the svelteSortOrder option in .prettierrc.

To specify options for Prettier that are customized to your preferences, create a file like the following in the top directory of each Svelte app.

Listing E.1 A .prettierrc file

```
{
  "arrowParens": "avoid",
  "bracketSpacing": false,
  "singleQuote": true,
```

Removes parentheses around single parameters in arrow functions

Omits spaces inside braces for import statements and object literals

Delimits JavaScript strings with single quotes instead of double

```
  "svelteSortOrder": "scripts-markup-styles",
  "trailingComma": "none"
 }
```

Uses the section order Rich Harris prefers

Removes trailing commas from multiline array and object literals

Add the following npm script to `package.json` in order to run Prettier on all files under the `public` and `src` directories that have a file extension of `.css`, `.html`, `.js`, or `.svelte`:

```
"format": "prettier --write '{public,src}/**/*.{css,html,js,svelte}'",
```

To run Prettier, enter `npm run format`.

Many editors and IDEs, including VS Code, have extensions for running Prettier as code is entered or when files are saved.

appendix F
VS Code

VS Code (https://code.visualstudio.com/) is a popular, open source code editor from Microsoft that is highly customizable. It supports many programming languages and provides syntax highlighting, error detection, and code formatting. It also has great Git integration, which makes it easy to check out a branch, see at a glance the current branch name, see a list of files that have been modified, see side-by-side diffs, commit changes, and push them. If you are not currently using VS Code for your Svelte and Sapper projects, you really should give it a try!

There are currently three popular Svelte-related VS Code extensions:

- Svelte for VS Code
- Svelte Intellisense
- Svelte 3 Snippets

We will look at how to configure and use each of these. In addition, check out the ESLint and Prettier extensions.

> **NOTE** For information on installing, configuring, and using VS Code extensions, see the VS Code documentation for "Extension Marketplace" (https://code.visualstudio.com/docs/editor/extension-gallery).

F.1 VS Code settings

Before using VS Code to work on Svelte and Sapper applications, there are a few things that should be configured.

For starters, install the ESlint and Prettier extensions. This enables these tools to automatically run inside VS Code after each code change or after every file save.

Also, modify some VS Code settings. To do this, open the Command Palette and enter "settings" (see figure F.1).

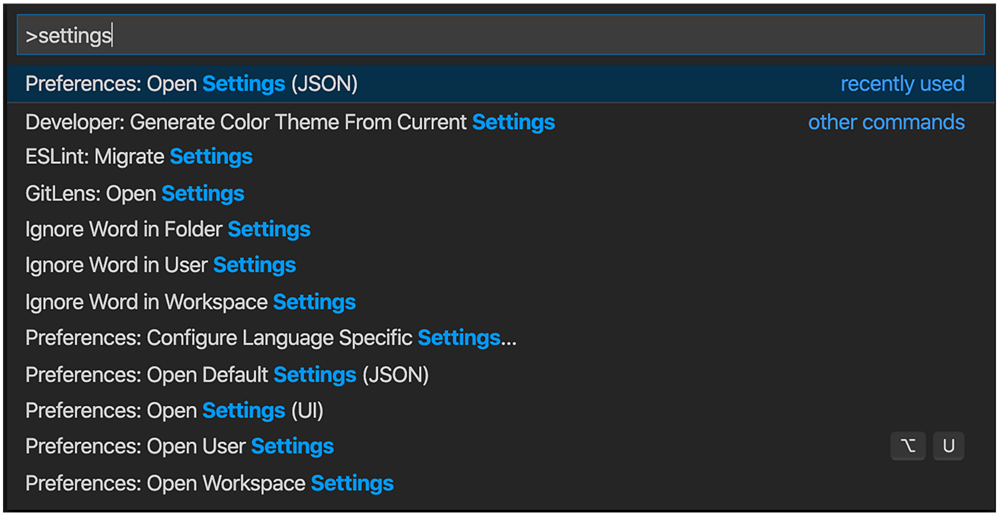

>settings
Preferences: Open Settings (JSON)
recently used
Developer: Generate Color Theme From Current Settings
other commands
ESLint: Migrate Settings
GitLens: Open Settings
Ignore Word in Folder Settings
Ignore Word in User Settings
Ignore Word in Workspace Settings
Preferences: Configure Language Specific Settings...
Preferences: Open Default Settings (JSON)
Preferences: Open Settings (UI)
Preferences: Open User Settings
⌥ U
Preferences: Open Workspace Settings

Figure F.1 VS Code Command Palette

> **NOTE** For information on using the Command Palette in VS Code, see the VS Code documentation (https://code.visualstudio.com/docs/getstarted/userinterface#_command-palette).

Then select Preferences: Open Settings (JSON) and add the following:

```
"editor.defaultFormatter": "esbenp.prettier-vscode",
"editor.formatOnSave": true,
```

This assumes that the Prettier - Code formatter extension has been installed.

Next, consider installing some of the Svelte-specific extensions described in the following sections.

F.2 *The Svelte for VS Code extension*

The Svelte for VS Code extension is available at http://mng.bz/zrJA. Install it to enable syntax highlighting, code formatting, and intellisense (code completion pop-ups) when editing `.svelte` files. It also supports the use of Emmet (https://emmet.io/) abbreviations for HTML and CSS.

A major feature of Svelte for VS Code is that it uses the Svelte Language Server at http://mng.bz/0ZYv. This communicates with development tools such as VS Code to provide diagnostic messages, auto-completions (for HTML, CSS, JavaScript, and TypeScript), hover information, code formatting (using Prettier), and more.

Svelte for VS Code also supports using alternative syntaxes in `.svelte` files such as TypeScript. A preprocessor must be configured for each alternative syntax. See chapter 20 for details on installing and configuring these.

F.3 The Svelte 3 Snippets extension

The Svelte 3 Snippets VS Code extension is available at http://mng.bz/mBQ4. Install it to enable the use of many snippets whose names begin with `s-` when editing files with an extension of `.svelte`, `.js`, or `.css`. Snippets enable you to enter a small amount of text that is expanded to more text in order to save typing time.

After typing at least `s-` a snippet can be selected from a popup list. Continue typing to narrow the list. To select a snippet, click it or use the up and down arrow keys to navigate to it, and press the Return key.

For example, selecting the `s-if-else-block` snippet adds the following:

```
{#if condition}
   <!-- content here -->
{:else}
   <!-- else content here -->
{/if}
```

The cursor will be positioned on `condition`. Enter a condition to replace this. Press the Tab key to advance to the comment in the `if` block and enter content to replace it. Press the Tab key again to advance to the comment in the `else` block and enter content to replace it. The other snippets work similarly.

Table F.1 summarizes some of the most useful snippets provided by this extension. A nice feature is that all you need to remember is to type `s-`. After that, you can read the list of available snippets in the popup list and select one.

Table F.1 Useful snippets

Snippet	Description
`s-await-short-block`	Adds an `{#await}` block with no `:then` or `:catch` sections
`s-await-then-block`	Adds an `{#await}` block with a `:then` section
`s-await-catch-block`	Adds an `{#await}` block with `:then` and `:catch` sections
`s-each-block`	Adds an `{#each}` block
`s-each-key-block`	Adds an `{#each}` block with a key
`s-each-index-block`	Adds an `{#each}` block with an index
`s-each-index-key-block`	Adds an `{#each}` block with an index and a key
`s-if-block`	Adds an `{#if}` block
`s-if-else-block`	Adds an `{#if}` block with an `{:else}` section
`s-on-event`	Adds `on:` event handling to an HTML element that refers to a function
`s-on-event-inline`	Adds `on:` event handling to an HTML element using an inline arrow function

Table F.1 Useful snippets *(continued)*

Snippet	Description
`s-script`	Adds a `script` element
`s-script-context`	Adds a `script` element with `context="module"`
`s-style`	Adds a `style` element

A complete list of the supported snippets can be found on the vscode-svelte-snippets GitHub page (https://github.com/fivethree-team/vscode-svelte-snippets).

F.4 The Svelte Intellisense extension

The Svelte Intellisense VS Code extension is available at http://mng.bz/5a0a. Install it to enable the following capabilities when editing `.svelte` files.

- Hover over a component instance, component prop, or function call to see its definition in a popup.
- Hold down the Ctrl key (Cmd key in macOS) and click a name to jump to its definition. This works for component imports, component instances, component props, named slots, functions, and variables.
- Type the beginning of some Svelte syntax to see a pop-up list of potential completions.

Completion for many Svelte-specific directives is supplied. This includes the `bind`, `class`, `in`, `out`, `transition`, and `use` directives. For example, after entering `<div bind:`, the options `clientHeight`, `clientWidth`, `offsetHeight`, `offsetWidth`, and `this` are offered.

Completion for block structures is also provided. After typing `{#`, the options `if`, `each`, and `await` are offered. Selecting one of these inserts a snippet for completing the block structure. However, the final } character on the last line of the snippet is currently omitted (see the issue at https://github.com/ArdenIvanov/svelte-intellisense/issues/24).

appendix G
Snowpack

Snowpack (www.snowpack.dev) is a tool for building web applications, and it is not specific to a particular framework. It supports React, Svelte, Vue, and more. The goal of Snowpack is to speed the development cycle by dramatically reducing build times. It provides an alternative to using a module bundler such as Webpack, Rollup, and Parcel.

Snowpack does not build a single "bundle" containing all the dependency code and app-specific code for the app. Instead, it uses Rollup to bundle each dependency as a separate ECMAScript module. This has the advantage of making build times faster because, after changes to the app code are detected, it only has to bundle the app code. Dependency bundling only occurs again when new dependencies are added or their versions change.

When the app starts, the browser separately downloads code for each bundled dependency rather than downloading a single bundle containing all the code. Browser support for HTTP2 and improved caching makes this efficient.

G.1 Using Snowpack with Svelte

The following steps will create a new Svelte app that uses Snowpack:

1. Create the app using Create Snowpack App (CSA):

```
npx create-snowpack-app snowpack-demo \
  --template @snowpack/apptemplate-svelte
```

2. `cd` to the new app directory:

```
cd snowpack-demo
```

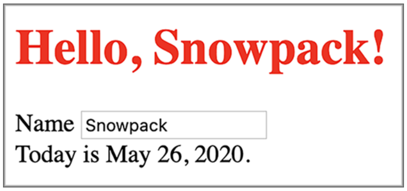
3. Start the development server:

   ```
   npm start
   ```

   This builds app and dependency modules in memory and serves them up to the browser.
4. Browse to localhost:8080.

Additional components can now be defined under the `src` directory. These will be detected and automatically bundled, and the browser will reload the changes.

The following example app contains nothing that is specific to Snowpack (see figure G.1). It merely demonstrates the use of Snowpack for managing dependencies. Two npm packages are used. To install them, enter `npm install date-fns lodash`.



Hello, Snowpack!

Name Snowpack

Today is May 26, 2020.

Figure G.1 Snowpack demo

Listing G.1 App that uses the `DateDisplay` component in `src/App.svelte`

```
<script>
  import _ from 'lodash';
  import DateDisplay from './DateDisplay';

  let name = 'Snowpack';
</script>

<h1>Hello, {_.startCase(name)}!</h1>

<label>
  Name
  <input bind:value={name}>
</label>

<DateDisplay />

<style>
  h1 {
    color: red;
  }
</style>
```

Listing G.2 `DateDisplay` **component in** `src/DateDisplay.svelte`

```
<script>
  import {format} from 'date-fns';
</script>

<div>
  Today is {format(new Date(), 'MMM dd, yyyy')}.
</div>
```

For tips on modifying an existing Svelte app to use Snowpack, see the Snowpack documentation (www.snowpack.dev/#migrating-an-existing-app).

In development mode (`npm start`), apps built with Snowpack only run in modern browsers. However, the result of a production build does run in older browsers, including IE 11.

To create a production build of an app, enter `npm run build`, which performs the following steps:

1. Creates the `build` directory, if not already present.
2. Creates the `build/web_modules` directory, if not already present.
3. Bundles each dependency into a separate `.js` file in `build/web_modules`.
4. Creates the `build/_dist_` directory, if not already present.
5. Compiles all `.svelte` files to `.js` and `.css` files under `build/_dist_`. These import dependencies from the `web_modules` directory .

For more information on creating production builds, see the Snowpack documentation (www.snowpack.dev/#snowpack-build). It describes an option to create a single bundle containing all the app-specific code and dependencies.

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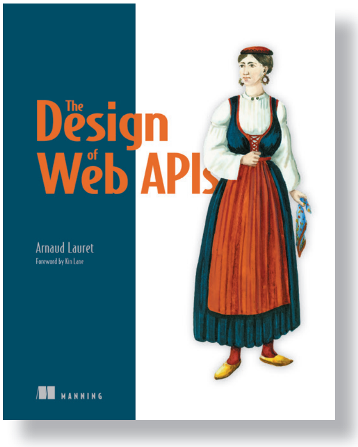

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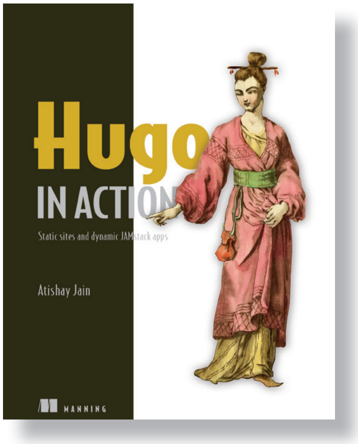

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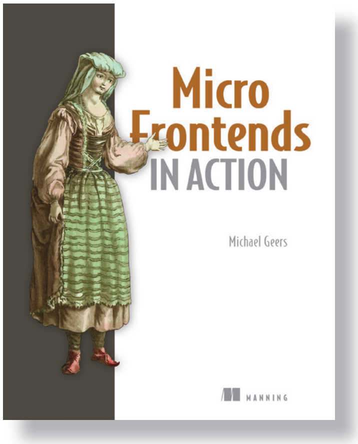

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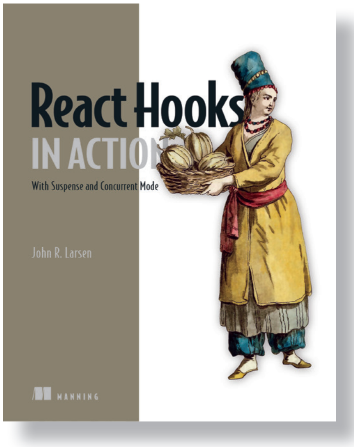

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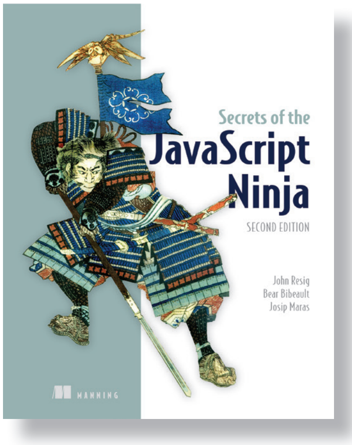

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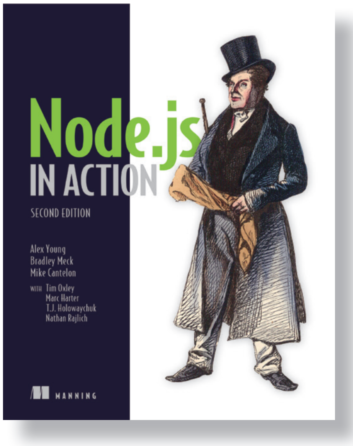

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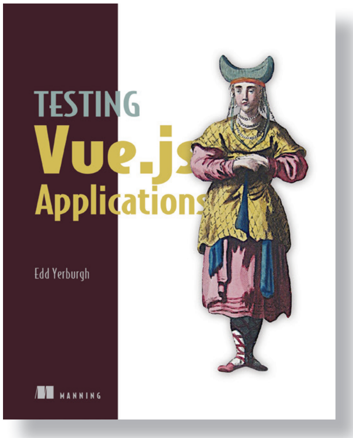

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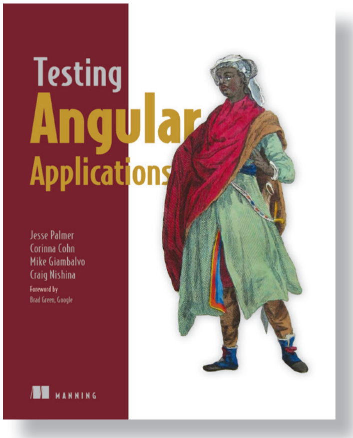

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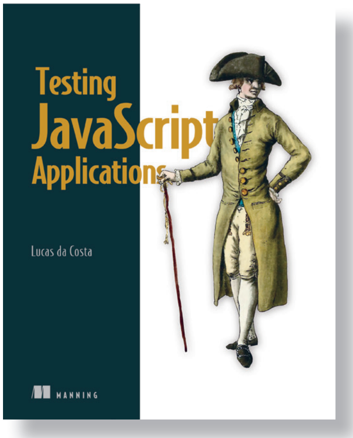

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