Introduction to Vue.js Training

with examples and
hands-on exercises

WEBUCATOR

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Class Files

Download the class files used in this manual at https://static.webucator.com/media/public/materials/classfiles/VUE101-1.1.4.zip.

Errata

Corrections to errors in the manual can be found at https://www.webucator.com/books/errata/.

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Getting Started with Vue.js

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☑ Starting a new Vue project.

☑ Structuring a Vue project.

Introduction

Vue.js, often just called "Vue," is a progressive, incrementally adoptable, reactive front-end JavaScript framework. You'll learn what that means in this lesson and you'll also get started on your first Vue application.

1.1. Unpacking Vue.js

One thing that makes Vue different from other front-end JavaScript frameworks is its philosophy of allowing incremental adoption. You don't need to buy into an entire ecosystem with Vue when you first get started. It's easy to just include the Vue library in a page and start using it. As you become more skilled with it, you'll want to integrate it into a modern front-end development build, testing, and module structure, but, as you will see, Vue makes that process painless.

Exercise 1: Vue.js Hello, World!

10 to 15 minutes

In this exercise, you will make your first Vue application by simply including Vue.js in a page using a `script` element.

1. In the `ClassFiles/Vue/Exercises` folder, create a new file named `index.html` and write a basic HTML page containing a `div` element with an `id` attribute with a value of "app":

```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta name="viewport" content="width=device-width, initial-scale=1">
  <title>First Vue</title>
</head>
<body>
  <div id="app"></div>
</body>
</html>
```


2. Add the following `script` element in the `head` element of your new file to include the Vue library:

```
<script src="https://cdn.jsdelivr.net/npm/vue/dist/vue.js"></script>
```

3. Add the following `script` element right above the closing `</body>` tag:

```
<script>
  var app = new Vue({
    el: '#app',
    data: {
      message: 'Hello, Vue!'
    }
  });
</script>
```

4. Type the following `h1` element between the opening and closing `<div>` tags to dynamically display the `message` variable using Vue:

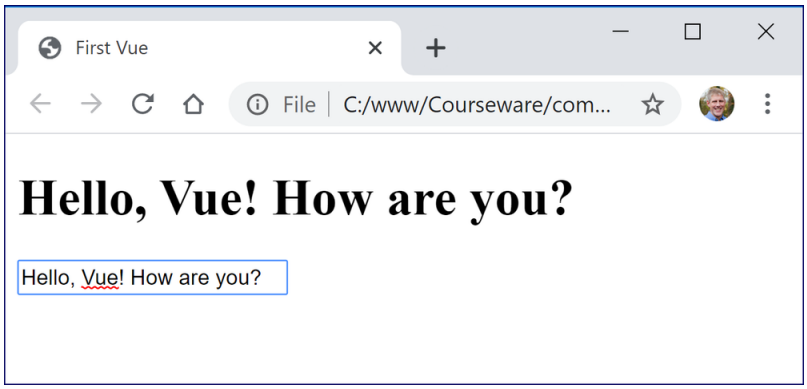
```
<div id="app">
  <h1>{{message}}</h1>
</div>
```

5. Save your HTML file and open it in a web browser. You'll see that `{{message}}` is dynamically replaced with the value that the `message` property of the `data` object was set to.

6. Type the following `input` element below the `h1` in your HTML file, but still inside the `div` with the `id` of "app":

```
<input v-model="message">
```


7. Refresh (or reopen) `index.html` in your browser. Type into the `input` field and notice that the contents of the `h1` are updated dynamically as you type:



Solution: Vue/Solutions/getting-started/index.html

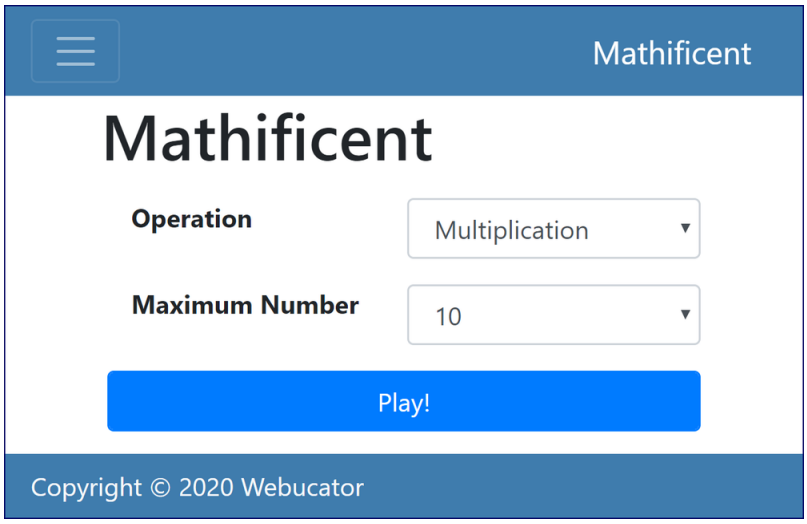
```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta name="viewport" content="width=device-width, initial-scale=1">
  <title>First Vue</title>
  <script src="https://cdn.jsdelivr.net/npm/vue/dist/vue.js"></script>

</head>
<body>
  <div id="app">
    <h1>{{message}}</h1>
    <input v-model="message">
  </div>
  <script>
    var app = new Vue({
      el: '#app',
      data: {
        message: 'Hello, Vue!'
      }
    });
  </script>
</body>
</html>
```


1.2. Introducing Our Project: Mathificent

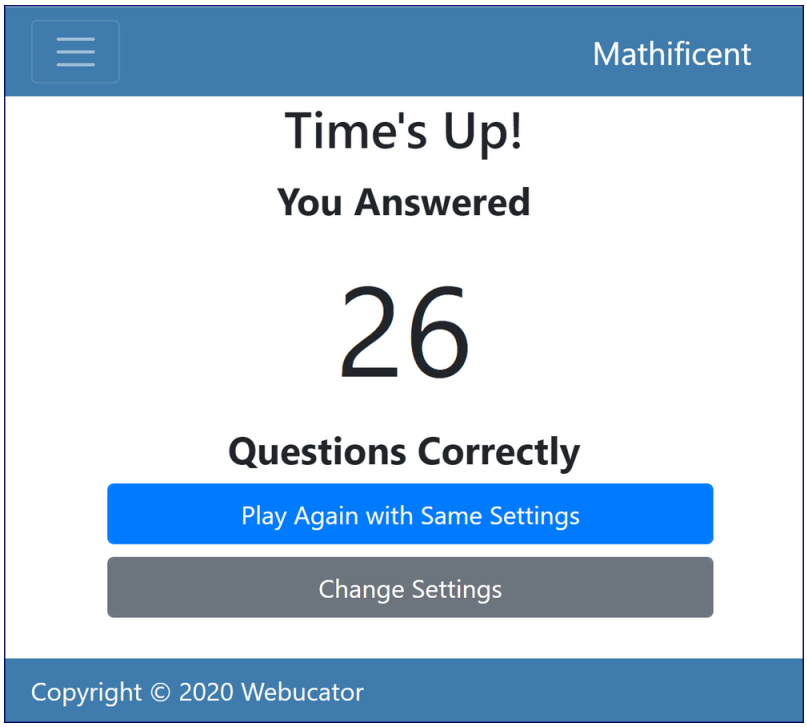
Throughout these lessons, you'll be using the latest Vue syntax and techniques to build a single-page application for practicing arithmetic. The application you'll be building is based on the game Mathificent, which you can view at `https://www.mathificent.com`. It consists of the following three views:

Config View



Game View

Times-Up View



Exercise 2: Get Started with vue-cli

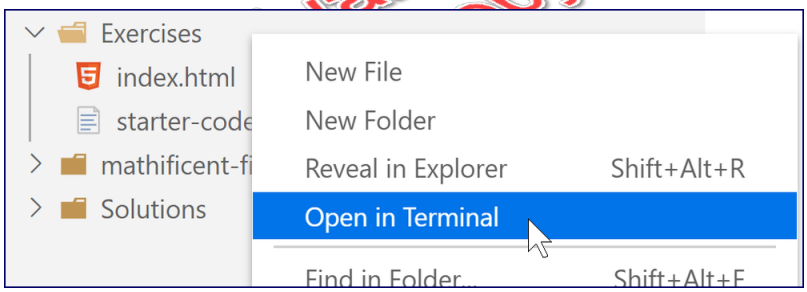
10 to 15 minutes

Including Vue in your HTML files and writing JavaScript in `script` blocks, as you did in the previous exercise, works for very small applications and demos. However, Vue developers use a tool called *vue-cli*, which makes managing larger applications easier and sets up a development environment for compiling and working with Vue components.

In this exercise, you will use vue-cli to create your first Vue application, which will serve as the starting point for the math game you will be building with Vue. After you've built your Vue application, you'll use npm to package and deploy the application to a development server.

Most of the process of building a simple application and installing the Node packages and scripts that make it run is done by vue-cli. This makes it easy to quickly start working on a project. So, let's jump in!

1. From your class files, open `Vue/Exercises` in the terminal by right-clicking the folder and selecting **Open in Integrated Terminal**:



2. Install vue-cli by running:

```
npm install -g @vue/cli
```

   This will take a minute to install.

3. After vue-cli is installed, create the **mathificent** application by running the following command:

```
vue create mathificent
```

   The script will ask you to make a choice regarding your development dependencies:

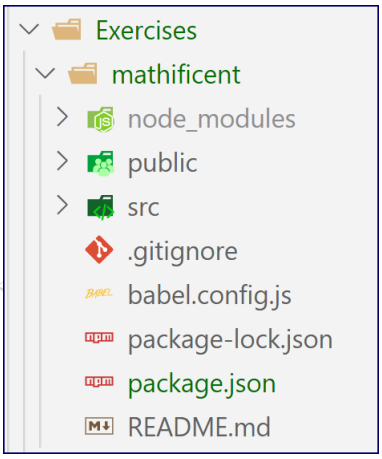
```
Vue CLI v4.1.2
? Please pick a preset: (Use arrow keys)
> default (babel, eslint)
  Manually select features
```

We'll be using the default choice, so you can just press **Enter** when the question appears. The dependencies will be downloaded and after a few minutes you'll have a new Vue project.

4. Make your new Vue project the working directory:

```
cd mathificent
```

At this point, your first Vue program has been created and you can look at the individual files it contains:



5. Run:

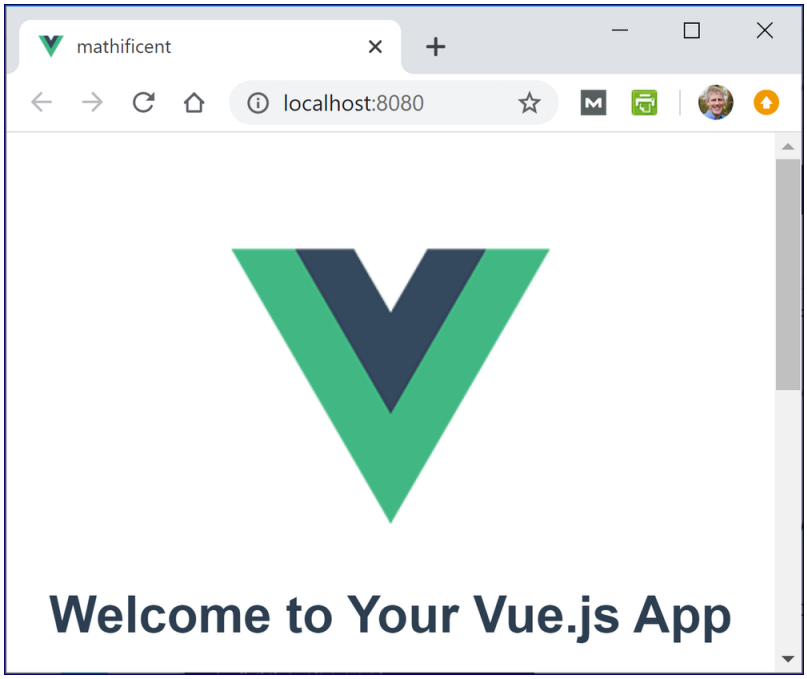
```
npm run serve
```

This is an npm script that was created when you ran `vue create`. Its job is to launch your Vue app using a development server. A development server is a web server that runs on a single software developer's computer and makes it possible for the developer to test out code as it is written and modified, without having to make it available for use by the entire internet.

6. When you see the following output, it means your development server is running:

```
App running at:
  - Local:   http://localhost:8080/
  - Network: http://192.168.1.222:8080/
```

Open a browser and go to `http://localhost:8080` to see your new Vue website:



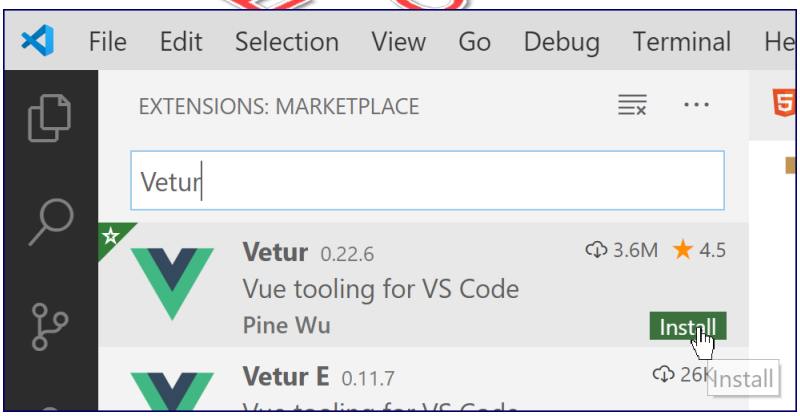
7. Back in the terminal, press **CTRL+C** to stop the app. When prompted, confirm that you want to do so.
8. Close the terminal window by pressing the trash can icon.

Exercise 3: Learning the Structure of a Vue App

20 to 30 minutes

In this exercise, you will start with a boilerplate Vue project and make some modifications to it to learn about the different files involved in Vue applications and the different parts of those files.

1. From the `mathificent` directory, open `src/App.vue` for editing.
2. By default, Visual Studio Code doesn't know how to properly highlight `.vue` files. To fix this problem, install the Vetur extension in Visual Studio Code. It is possible that Visual Studio Code will prompt you to install this extension when you first open a file with a `.vue` extension. If it does, just click **Install** in the prompt. If you're not prompted, install Vetur like this:
   A. Click the **Extensions** icon (below the bug) on the left of the **Explorer** panel.
   B. Search for "Vetur".
   C. Click the **Install** button.



3. When Vetur is done installing, click the **Explorer** icon in the left panel of Visual Studio Code to return to viewing your project files. When you open a `.vue` file, it should now be properly color-coded.
4. Notice the structure of the `App.vue` file: it has a `template` block at the top, followed by a `script` block, followed by a `style` block. In Vue, this file is called a "single-file component."

5. Examine the `template` block. It renders an image and another component, named `HelloWorld`:

```
<template>
  <div id="app">
    <img alt="Vue logo" src="./assets/logo.png">
    <HelloWorld msg="Welcome to Your Vue.js App"/>
  </div>
</template>
```

6. Open `src/main.js` in your editor. This is the main JavaScript file for the entire Vue application. This file is the only place in your application that imports the Vue framework and renders the one component that contains every other component, also known as the *root* component. In our application, the root component is `App.vue`:

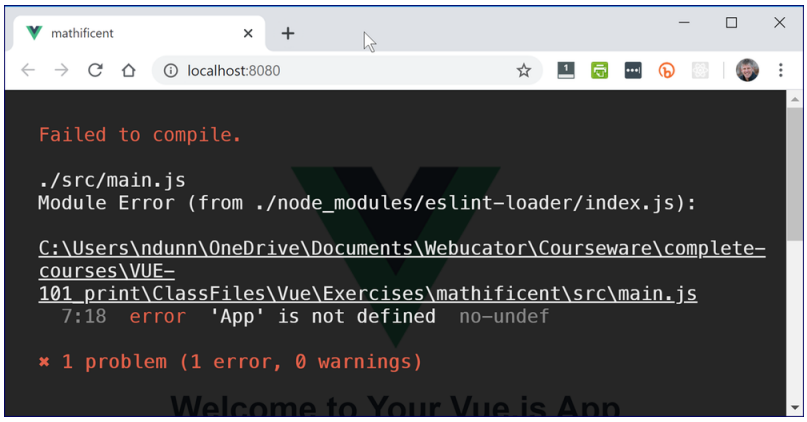
Exercise Code 3.1: main.js

```
1.  import Vue from 'vue'
2.  import App from './App.vue'
3.
4.  Vue.config.productionTip = false
5.
6.  new Vue({
7.    render: h => h(App),
8.  }).$mount('#app')
```


7. In `main.js`, comment out the `import` statement that imports `App`:

```
// import App from './App.vue'
```

8. Save your file.
9. If your development server isn't already running, start it by running `npm run serve` from the `mathificent` directory.
10. Once the development server starts up, go to `http://localhost:8080` in your browser, where you'll see this error message:



Because `App` is not imported, the reference to it on line 7 causes the application to fail to compile.

11. Return to your editor and remove the single-line comment before the `import` statement and save the file.
12. Return to your web browser and the application should refresh and be working again. Because Vue applications are made up of components that are linked together using `import` statements and any one file may have many `import` statements, one of the most common errors that you'll see in Vue development is caused by a component or file not being imported or not being imported correctly.
13. Look at the statement that begins with `new Vue`:

```
new Vue({
  render: h => h(App),
}).$mount('#app')
```

This statement creates an instance of the `Vue` object with a `render` function that renders your root component in the element with the `id` of "app".

14. Look at the `render` function, which returns a virtual DOM to be rendered in the page. A DOM (for **D**ocument **O**bject **M**odel) is an object representation of HTML elements, which it gets from the `template` in `App.vue`:

```
render: h => h(App);
```

This is a shorthand way of telling Vue to render a certain component. The longhand form of this function is as follows:

```
render: function (createElement) {
  return createElement(App);
}
```

This statement can be shortened using an arrow function to:

```
render: (createElement) => {
  return createElement(App);
}
```

Using a shorter (and less meaningful) variable name than `createElement`, the function can be shortened to:

```
render: (h) => {
  return h(App);
}
```


When a single statement follows the fat-arrow operator, that statement is evaluated and returned. As such, the code can be shortened even further to:

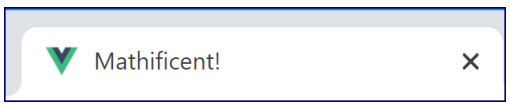
```
render: (h) => h(App);
```

And finally, because the function only takes one parameter, the parentheses around that parameter can be removed:

```
render: h => h(App);
```

Note that you will not need to reproduce this code. It is generated for you when you create your Vue project. Still, it's good to understand how the code works.

15. Open `public/index.html` in your editor. This is the HTML file that is loaded when your web browser loads `http://localhost:8080`.
16. Change the title from "`<%= htmlWebpackPlugin.options.title %>`" to "Mathificent!" and save the file. Notice that the title updates on the browser tab:



17. Find the `div` element with the "app" id. This is where `index.js` will render the root component for your application:

```
<div id="app"></div>
```

18. Notice that `index.html` doesn't have any code that imports `main.js`. This is because `index.html` is a template. When you start the development server (using `npm run serve`), the code in `main.js` (and therefore everything that it imports) is injected into `index.html` with `<script>` tags before the page opens in your web browser.
19. Open `src/App.vue` in your editor.
20. Delete the `img` element and notice that the browser updates and the image of the Vue logo is gone.
21. Open `HelloWorld.vue` from the `src/components` directory. This file contains some links to useful Vue resources. It also contains a larger `template` block than the `App.vue` component. You don't need to do anything with this component, so close it when you're done examining the code, and then delete the `HelloWorld.vue` file from the `components` directory. This will cause the app to fail to compile. We'll fix that…
22. In `App.vue`, delete the `HelloWorld` component from the `template` block, delete the `import` statement that imports it, and delete `HelloWorld` from the `components` property of the `export` statement:

```
<template>
  <div id="app">
    <HelloWorld msg="Welcome to Your Vue.js App"/>
  </div>
</template>

<script>
import HelloWorld from './components/HelloWorld.vue'

export default {
  name: 'app',
  components: {
    HelloWorld
  }
}
</script>
```

23. In the template, add an `h1` element with the word "Mathificent" inside it:

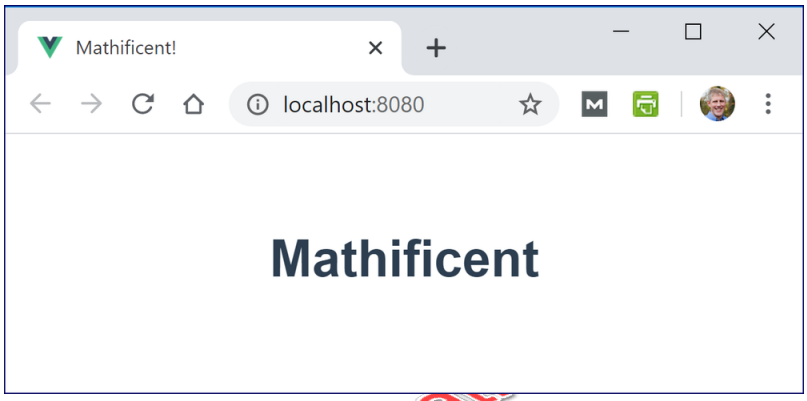
```
<template>
 <div id="app">
   <h1>Mathificent</h1>
 </div>
</template>
```

24. Your `App.vue` file should now look like this:

Exercise Code 3.2: App.vue

```
1.   <template>
2.     <div id="app">
3.       <h1>Mathificent</h1>
4.     </div>
5.   </template>
6.
7.   <script>
8.   export default {
9.     name: 'app',
10.    components: {
11.    }
12.  }
13.  </script>
14.
15.  <style>
16.  #app {
17.    font-family: 'Avenir', Helvetica, Arial, sans-serif;
18.    -webkit-font-smoothing: antialiased;
19.    -moz-osx-font-smoothing: grayscale;
20.    text-align: center;
21.    color: #2c3e50;
22.    margin-top: 60px;
23.  }
24.  </style>
```


25. And your application should now look like this in the browser.



26. If you see an error message, return to your `App.vue` file and make sure that it matches the solution exactly.
27. Remember to stop the app (**CTRL+C**) and close the terminal when you are done.

Conclusion

In this lesson, you have learned how to make a basic Vue application by including the Vue library into an HTML page and by installing and running vue-cli.

LESSON 2
Basic Vue Features

Topics Covered

☑ Vue templates.

☑ Breaking a Vue app into components.

☑ Passing data between components.

☑ Dynamic data.

Introduction

In this lesson, you will build a form that allows the user to choose a math operator and a number. In doing so, you will learn how to work within Vue templates, how to break an application into components and pass data between those components, how to modify that data on the fly, and how to work with computed properties and methods.

2.1. The Vue Instance

A Vue application consists of a root Vue instance created by invoking `new Vue` and passing an *options* object into the `Vue()` constructor function. In its most basic form, every Vue application looks like this:

```
const vm = new Vue({
  // options
}
```

Most often, the root Vue instance is broken up into components, which are each also Vue instances. Each of these components has its own *options* object as well.

The contents of the *options* object determines how the Vue application will work.

❖ 2.1.1. Instance Properties and Methods

In addition to the custom properties and functions that you write, every Vue object has certain built-in instance properties and methods that give you access to information and functionality. These all begin with a "`$`" sign to differentiate them from user-defined properties. We'll look at and use some of the instance properties and methods in the upcoming exercises. For now, the only thing you need to know is that any time you see a function or variable that starts with a "`$`" in Vue, that is something that is baked into Vue.

❖ 2.1.2. Reactivity and Data

Each Vue instance contains an object called `data`. This `data` property is what makes Vue reactive. When the Vue instance is created, everything inside the `data` object is loaded into Vue's *reactivity system*. When one of the properties in the reactivity system changes, Vue updates the view (by merging the data into templates) to reflect the new value.

2.2. Writing Vue Templates

Templates determine how a Vue instance will render. Templates are usually written using HTML, but they can also be written using JavaScript or an XML template language called JSX. Each Vue component has its own template, and these templates can contain other components as well as HTML and JavaScript.

Before we get into writing some templates, there are a couple of important rules and conventions that you should be aware of:

1. Every Vue template must have a single root element:

Good - One root element: div

```
<template>
  <div>
    <h1>Hello, world!</h1>
    <p>You're looking good today.</p>
  </div>
</template>
```

Bad - Two root elements: h1 and p

```
<template>
  <h1>Hello, world!</h1>
  <p>You're looking good today.</p>
</template>
```

2. You can use dynamic data and code in a template by surrounding it with double curly braces:

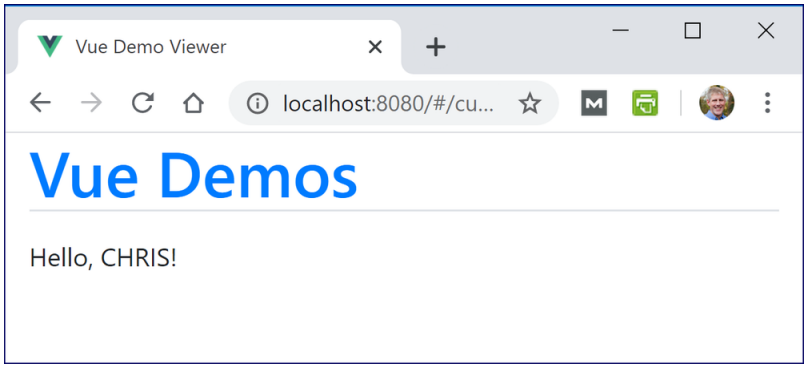
Demo 2.1: Vue/demo-viewer/src/components/basic-vue-features/CurlyBraces.vue


```
1.  <template>
2.    <div>
3.      <p>Hello, {{firstName.toUpperCase()}}!</p>
4.    </div>
5.  </template>
6.
7.  <script>
8.  export default {
9.    name: "CurlyBraces",
10.   data: function() {
11.     return {
12.       firstName: 'Chris'
13.     }
14.   }
15. }
16. </script>
```

Code Explanation

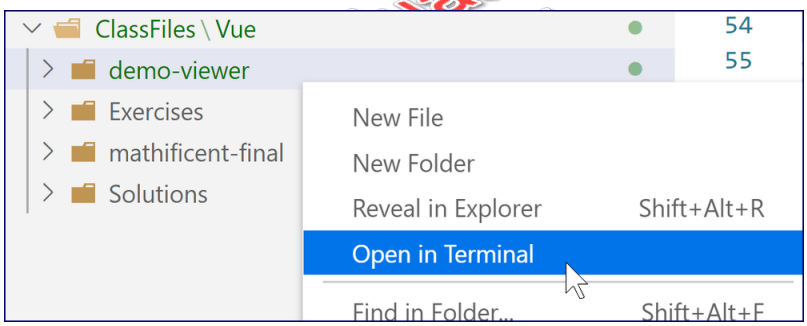
Notice that the `div` element holding the paragraph is the single root element for the template.

This creates the following page:



Notice that the content in the double curly braces is interpreted: instead of outputting "{{firstName.toUpperCase()}}", it outputs the value of `firstName` in all uppercase letters. Don't worry yet about the structure of the code in the `script` element. It is enough to see that `firstName` contains "Chris".

1. To run this file, open `Vue/demo-viewer` in the terminal by right-clicking the folder and selecting **Open in Integrated Terminal**:



2. Install the demo-viewer app using `npm install`:

```
npm install
```

   This will take a minute.

3. Once it has installed, run `npm run serve` and then open `http://localhost:8080` in your browser. Click the **Curly Braces** link under **Basic Vue Features**.

❖ 2.2.1. Curly Braces and v-html

Anything in between double curly braces will be output as plain text by default. For example, if a JavaScript variable contains less than and greater than signs, those signs will show up in their raw format instead of working as the beginnings and endings of HTML tags.

The `v-html` attribute (actually, it is a *directive* but we'll get into that later) is used to specify that some dynamic data should be output as HTML.

In the following example, the template will output a dynamically generated title, first using curly braces and then using `v-html`:

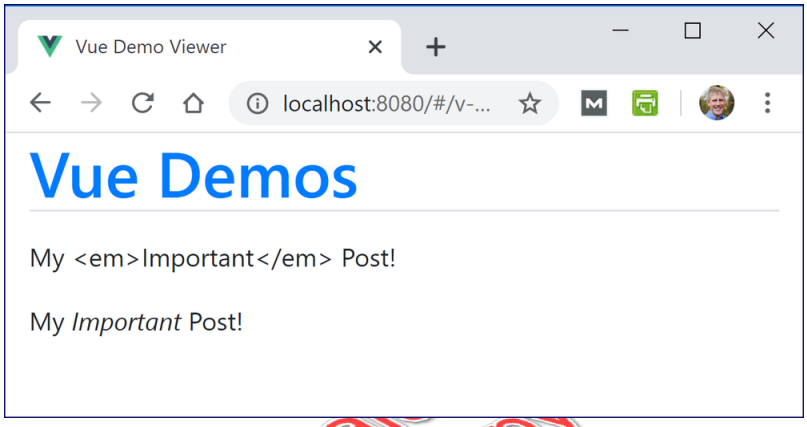
Demo 2.2: Vue/demo-viewer/src/components/basic-vue-features/VHtml.vue

```
1.  <template>
2.    <div>
3.      <p>{{title}}</p>
4.      <p v-html="title"></p>
5.    </div>
6.  </template>
7.
8.  <script>
9.  export default {
10.   name: "VHtml",
11.   data: function() {
12.     return {
13.       title: "My <em>Important</em> Post!"
14.     }
15.   }
16. }
17. </script>
```


Code Explanation

Again, don't worry about the `script` element yet, except to see that that is where `title` is defined.

If the demo-viewer app is still running, click the **Vue Demos** heading to get back to the home page. If it isn't already running, run `npm run serve` from the `demo-viewer` directory and then open `http://localhost:8080` in your browser. Then click the **v-html Directive** link under **Basic Vue Features**. You should see a page that looks like this:



Notice that the `<em>` tags are output literally when the double curly braces are used, but they are kept as HTML tags when the `v-html` directive is used. The code Vue creates looks like this:

```
<p>My &lt;em&gt;Important&lt;/em&gt; Post!</p>
<p>My <em>Important</em> Post!</p>
```

Remember to stop the app (**CTRL+C**) and close the terminal when you are done.

Exercise 4: Writing Templates

20 to 30 minutes

In this exercise, you will use HTML in Vue templates to create a user interface.

1. To add style to the app, we will use Bootstrap:
    A. Open `index.html` from the `public` directory in Visual Studio Code.
    B. Copy the following `<link>` tag:

```
<link rel="stylesheet" href="https://cdn.jsdelivr.net/npm/boot  ↵↵
strap@4.6.1/dist/css/bootstrap.min.css" integrity="sha384-zCbKRCUGaJD  ↵↵
kqS1kPbPd7TveP5iyJE0EjAuZQTgFLD2ylzuqKfdKlfG/eSrtxUkn" crossorigin="anony  ↵↵
mous">
```

    Paste it in the `head` in `index.html`.

    C. Copy the following three `<script>` tags:

```
<script src="https://cdn.jsde  ↵↵
livr.net/npm/jquery@3.5.1/dist/jquery.slim.min.js" integrity="sha384-
DfXdz2htPH0lsSSs5nCTpuj/zy4C+OGpamoFVy38MVBnE+IbbVYUew+OrCXaRkfj"
crossorigin="anonymous"></script>
<script src="https://cdn.jsdelivr.net/npm/popper.js@1.16.1/dist/umd/pop  ↵↵
per.min.js" integrity="sha384-9/reFTGAW83EW2RDu2S0VKaIzap3H66lZH81PoYlFh  ↵↵
bGU+6BZp6G7niu735Sk7lN" crossorigin="anonymous"></script>
<script src="https://cdn.jsdelivr.net/npm/bootstrap@4.6.1/dist/js/boot  ↵↵
strap.min.js" integrity="sha384-VHvPCCyXqtD5DqJeNxl2dtTyhF78xXNXd  ↵↵
kwX1CZeRusQfRKp+tA7hAShOK/B/fQ2" crossorigin="anonymous"></script>
```

    Paste them immediately before the close `</body>` in `index.html`.

2. Open `src/App.vue` in your editor.

3. Inside the `template` block, create a `<header>` element with the header navigation for our app by placing the following code inside the `div` element with the `id` of `app`, above the `h1` element:

```
<header>
  <nav class="navbar navbar-expand-lg navbar-dark">
      <button class="navbar-toggler" type="button"
        data-toggle="collapse" data-target="#navbarText">
          <span class="navbar-toggler-icon"></span>
      </button>
      <div class="collapse navbar-collapse" id="navbarText">
          <ul class="navbar-nav mr-auto text-left">
              <li class="nav-item active">
                  <a class="nav-link" href="/">Home</a>
              </li>
          </ul>
      </div>
      <a class="navbar-brand" href="/">Mathificent</a>
  </nav>
</header>
```


A Shortcut: Copy and Paste

You can copy and paste from `Exercises/starter-code.txt` if you would prefer not to type this out. You will find both this `header` element and the `footer` element (shown below) in that document. If you do so, be sure to review both carefully, so you understand what's going on. They both include some Bootstrap classes, and the `footer` includes some JavaScript enclosed in double curly braces.

4. Under the `h1` element in the `App.vue` template, type the footer:

```
<footer class="navbar fixed-bottom">
  <a href="https://www.webucator.com" class="text-light">
    Copyright &copy; {{new Date().getFullYear()}} Webucator
  </a>
</footer>
```

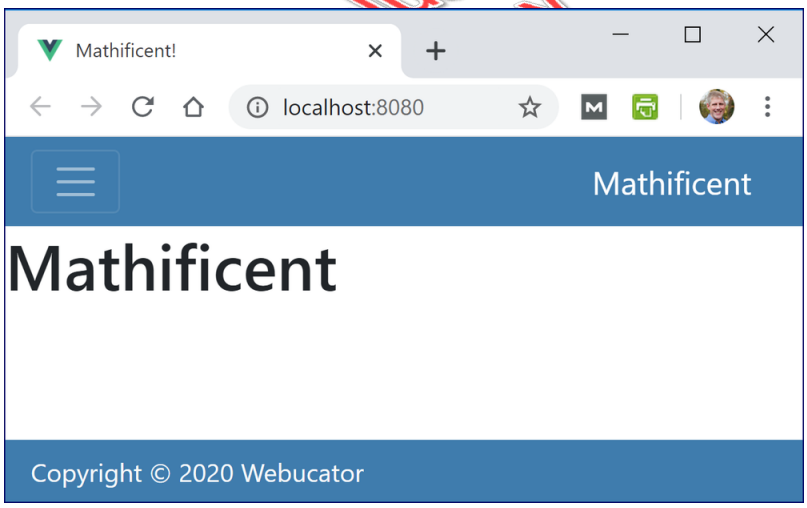
The JavaScript in the footer will dynamically populate the copyright year. Notice that it is enclosed in double curly braces. This lets Vue know that it should be interpreted.

5. In the `style` block at the bottom of `App.vue`, delete the existing rules and then add a rule to give the `header` and `footer` a steel blue background color:

```
<style>
header, footer {
  background-color: #3f7cad;
}
</style>
```

6. Save `App.vue`.

7. Open the `mathificent` directory at the terminal and run `npm run serve` and then open `http://localhost:8080` in your browser. You should now have a header, an `h1` element, and a footer:



Solution: Vue/Solutions/basic-vue-features/writing-templates/App.vue

```
<template>
  <div id="app">
    <header>
      <nav class="navbar navbar-expand-lg navbar-dark">
        <button class="navbar-toggler" type="button"
          data-toggle="collapse" data-target="#navbarText">
            <span class="navbar-toggler-icon"></span>
        </button>
        <div class="collapse navbar-collapse" id="navbarText">
          <ul class="navbar-nav mr-auto text-left">
            <li class="nav-item active">
              <a class="nav-link" href="/">Home</a>
            </li>
          </ul>
        </div>
        <a class="navbar-brand" href="/">Mathificent</a>
      </nav>
    </header>
    <h1>Mathificent</h1>
    <footer class="navbar fixed-bottom">
      <a href="https://www.webucator.com" class="text-light">
        Copyright &copy; {{new Date().getFullYear()}} Webucator
      </a>
    </footer>
  </div>
</template>

<script>
export default {
  name: 'app',
  components: {
  }
}
</script>

<style>
header, footer {
  background-color: #3f7cad;
}
</style>
```


Code Explanation

The preceding code shows the complete `App.vue` file.

Solution: Vue/Solutions/basic-vue-features/writing-templates/index.html

```
1.  <!DOCTYPE html>
2.  <html lang="en">
3.    <head>
4.      <meta charset="utf-8">
5.      <meta http-equiv="X-UA-Compatible" content="IE=edge">
6.      <meta name="viewport" content="width=device-width,initial-scale=1.0">
7.      <link rel="icon" href="<%= BASE_URL %>favicon.ico">
8.      <link rel="stylesheet" crossorigin="anonymous"
9.      href="https://stackpath.bootstrapcdn.com/bootstrap/4.5.0/css/boot ↵↵
            strap.min.css"
10.     integrity="sha384-9aIt2nRpC12Uk9gS9baDl411NQApFmC26EwAOH8WgZl5MYYxF ↵↵
            fc+NcPb1dKGj7Sk">
11.
12.     <title>Mathificent!</title>
13.   </head>
14.   <body>
15.     <noscript>
16.       <strong>We're sorry but <%= htmlWebpackPlugin.options.title %> doesn't
              work properly without
17.         JavaScript enabled. Please enable it to continue.</strong>
18.     </noscript>
19.     <div id="app"></div>
20.     <!-- built files will be auto injected -->
21.     <script src="https://code.jquery.com/jquery-3.5.1.slim.min.js"
22.     integrity="sha384-DfXdz2htPH0lsSSs5nCTpuj/zy4C+OGpamoFVy38MVBnE+IbbVYUew+Or ↵↵
            CXaRkfj"
23.     crossorigin="anonymous"></script>
24.     <script src="https://cdn.jsdelivr.net/npm/popper.js@1.16.0/dist/umd/pop ↵↵
            per.min.js"
25.     integrity="sha384-Q6E9RHvbIyZFJoft+2mJbHaEWldlvI9IOYy5n3zV9zzTtmI3UksdQRVvoxM ↵↵
            fooAo"
26.     crossorigin="anonymous"></script>
27.     <script src="https://stackpath.bootstrapcdn.com/bootstrap/4.5.0/js/boot ↵↵
            strap.min.js"
28.     integrity="sha384-OgVRvuATP1z7JjHLku ↵↵
            OU7Xw704+h835Lr+6QL9UvYjZE3Ipu6Tp75j7Bh/kR0JKI"
29.     crossorigin="anonymous"></script>
30.   </body>
31. </html>
```

Code Explanation

This is the HTML code that should be in `public/index.html`. It has the Bootstrap CSS and JavaScript added.

2.3. Using Components Inside Components

Each Vue component exports an object, known as the *options* object, because it holds the options for working with the component. This allows other Vue code to import the component. A simple options object is shown below:

Simple.vue

```
<script>
export default {
  name: 'Simple',
  components: {
  }
}
</script>
```


This `Simple` component can be imported into another component within the same directory using the following code:

```
import Simple from './Simple.vue'
```

And then it can be used in that component's template like this:

```
<template>
  <div>
    <Simple />
  </div>
</template>
```

This method of abstracting the parts of a user interface into reusable and self-contained components reduces the complexity of building dynamic user interfaces. For example, the user interface of a shopping cart in an e-commerce application can be very complex, but broken into its basic components, the template for rendering a shopping cart might look something like this:

```
<template>
  <div>
    <ListOfProducts />
    <TotalPrice />
    <ShippingOptions />
  </div>
</template>
```


The name Option

The `name` option, while only required for components that call themselves recursively, should generally be included as it makes debugging easier. For more information, see `https://vuejs.org/v2/api/#name`.

Exercise 5: Breaking an App into Components

30 to 45 minutes

In this exercise, you will break up the user interface of the Mathificent game into subcomponents. Although it is possible to write an entire Vue application in a single component, it is generally better to break the user interface into components that can be reused. So, let's make some components!

1. Create a new file in the `mathificent/src/components` directory named `Header.vue`. Note that the name of this file starts with a capital letter. In Vue, the names of components always start with a capital letter.
2. Inside this new file, add a `template` block and a `script` block.
3. Inside the `script` block, write the `export` statement:

```
export default {
  name: 'Header'
}
```


4. Cut the `header` element from `App.vue` and paste it inside the `template` element of `Header.vue`.
5. In the `export` statement in `App.vue`, add the `Header` component to the `components` property. This indicates that the `Header` component is a dependency of the `App` component:

```
export default {
  name: 'app',
  components: {
    Header
  }
}
```

6. Use an `import` statement inside the `script` block above the `export` statement to import `Header` into `App`.

```
import Header from './components/Header';
```

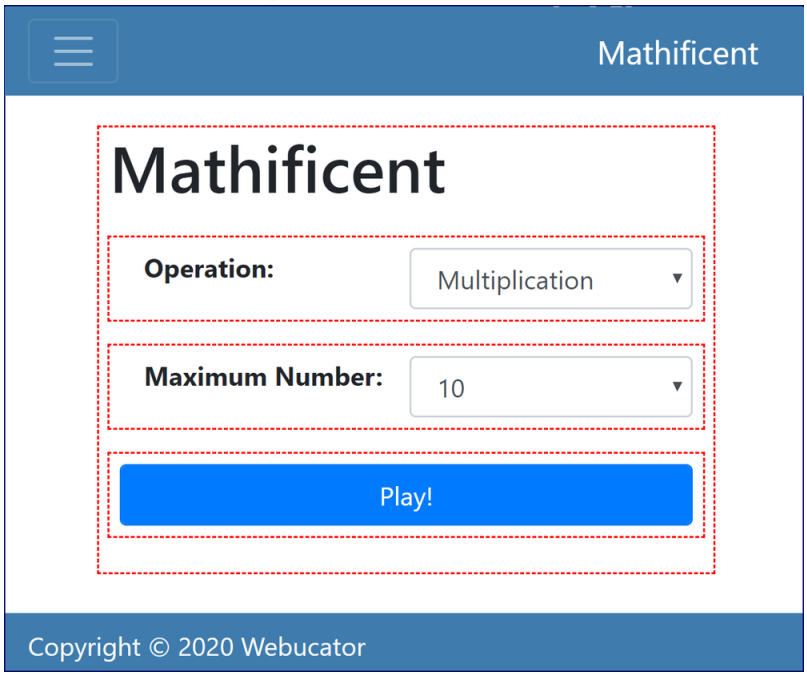
7. Notice that when we import the `Header` component, we need to use `./` before the path and we don't type the `.vue` at the end of the file name.

8. Inside the `template`, add a self-closing `<Header />` tag right before the `h1` element where the `<header>` tag previously was:

```
<template>
  <div id="app">
    <Header />
    <h1>Mathificent</h1>
    <footer class="navbar fixed-bottom">
      <a href="https://www.webucator.com">
        Copyright &copy; {{new Date().getFullYear()}} Webucator
      </a>
    </footer>
  </div>
</template>
```

9. Now, follow this same process to create and use a `Footer` component. When you're done, the app should appear just as it did before.

10. Take another look at the finished Mathificent program and think about how you might split up the main content of the app into components. Here's one way it could be done:



11. The first step in developing a user interface with components in Vue is to create a static version (meaning without any functionality) of the app. Create a new single-file component for each of the unique components in the following outline that you haven't already created:

    - `App`
        - `Header`
        - *`Main`*
            - *`SelectInput`*
            - *`PlayButton`*
        - `Footer`

12. In the `template` for each component, put a placeholder element containing the name of the component for now. For example, here's what the `SelectInput` component should look like:

```
<template>
 <div>SelectInput Component</div>
</template>

<script>
  export default {
    name: 'SelectInput'
  }
</script>
```


13. Now that you have all the components, it is time to put them together in the right order. Think about the hierarchy of components in your app:

    A. `App` contains `Header`, `Main`, and `Footer`.

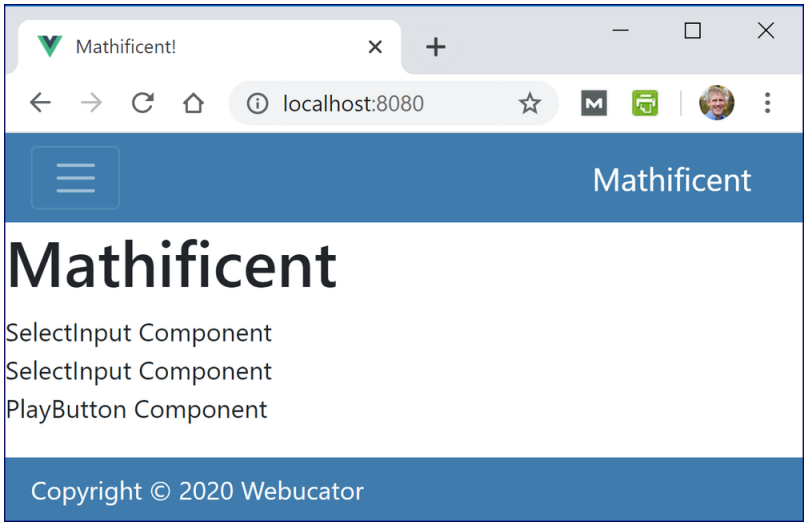
    B. `Main` contains the "Mathificent" `h1` element (moved from `App.vue`), two instances of `SelectInput`, and one `PlayButton`.

14. Import the correct components into `App.vue` and `Main.vue` and then modify the `export` statements of these two components to include the correct sub-components. Remember that, to output a child component in the `template` block, the parent component must:

    A. Import the component.

    B. Include the component in its `components` property.

The `Main` component's `template` should contain a `main` element rather than a `div` element. When you're done, it should look like this in your browser:



15. In the `PlayButton` component, replace the `div` element with a `button` using this code, which uses a couple of Bootstrap classes for styling:

```
<button class="btn btn-primary">Play!</button>
```


16. In the `SelectInput` component, code the `select` dropdowns using static options and labels for now. We'll make them dynamic shortly:

```
<div>
  <label for="select">Select Label</label>
  <select id="select">
    <option value="sample value">Sample Value</option>
  </select>
</div>
```

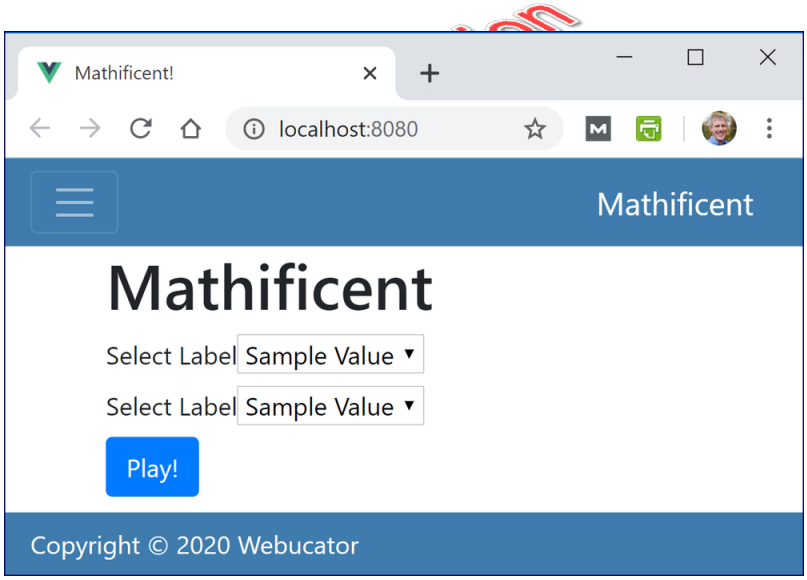
17. In `Main.vue`, add an `id` of "main-container" to the `main` element:

```
<template>
 <main id="main-container">
   <SelectInput />
   <SelectInput />
   <PlayButton />
 </main>
</template>
```

18. Add a `style` block to `Main.vue` and add a rule to set the element's width and give it some margin:

```
<style>
#main-container {
  margin: auto;
  width: 380px;
}
</style>
```

19. If it is not already running, start up your development server by running `npm run serve` from the `mathificent` directory in your terminal. Your application should now look like this:



Stop the app (**CTRL+C**) and close the terminal when you are done.

Solution: Vue/Solutions/basic-vue-features/breaking-into-components/App.vue

```
1.  <template>
2.    <div id="app">
3.      <Header />
4.      <Main />
5.      <Footer />
6.    </div>
7.  </template>
8.
9.  <script>
10. import Header from './components/Header';
11. import Main from './components/Main';
12. import Footer from './components/Footer';
13.
14. export default {
15.   name: 'app',
16.   components: {
17.     Header,
18.     Main,
19.     Footer
20.   }
21. }
22. </script>
23.
24. <style>
25. header, footer {
26.   background-color: #3f7cad;
27. }
28. </style>
```

Solution: Vue/Solutions/basic-vue-features/breaking-into-components/Header.vue

```
<template>
  <header>
    <nav class="navbar navbar-expand-lg navbar-dark">
        <button class="navbar-toggler" type="button"
          data-toggle="collapse" data-target="#navbarText">
            <span class="navbar-toggler-icon"></span>
        </button>
        <div class="collapse navbar-collapse" id="navbarText">
            <ul class="navbar-nav mr-auto text-left">
                <li class="nav-item active">
                    <a class="nav-link" href="/">Home</a>
                </li>
            </ul>
        </div>
        <a class="navbar-brand" href="/">Mathificent</a>
    </nav>
  </header>
</template>

<script>
  export default {
    name: 'Header'
  }
</script>
```


Solution: Vue/Solutions/basic-vue-features/breaking-into-components/Footer.vue

```
<template>
  <footer class="navbar fixed-bottom">
    <a href="https://www.webucator.com" class="text-light">
      Copyright &copy; {{new Date().getFullYear()}} Webucator
    </a>
  </footer>
</template>

<script>
  export default {
    name: 'Footer'
  }
</script>
```

Solution: Vue/Solutions/basic-vue-features/breaking-into-components/Main.vue

```
<template>
  <main id="main-container">
    <h1>Mathificent</h1>
    <SelectInput />
    <SelectInput />
    <PlayButton />
  </main>
</template>

<script>
  import SelectInput from './SelectInput';
  import PlayButton from './PlayButton';

  export default {
    name: 'Main',
    components: {
      SelectInput,
      PlayButton
    }
  }
</script>

<style scoped>
  #main-container {
    margin: auto;
    width: 380px;
  }
</style>
```

Solution: Vue/Solutions/basic-vue-features/breaking-into-components/SelectInput.vue

```
<template>
  <div>
    <label for="select">Select Label</label>
    <select id="select">
      <option value="sample value">Sample Value</option>
    </select>
  </div>
</template>

<script>
  export default {
    name: 'SelectInput'
  }
</script>
```

Solution: Vue/Solutions/basic-vue-features/breaking-into-components/PlayButton.vue

```
<template>
  <button class="btn btn-primary">Play!</button>
</template>

<script>
  export default {
    name: 'PlayButton'
  }
</script>
```


2.4. Passing Data to Child Components

The components that you include inside of another component's template are known as *child* components. The component that includes the child components in its own template is called the *parent* component. Parent components can pass data to child components as *props* (short for "properties"). To pass data as a prop, add an attribute to the tag for the custom component in the parent's template and assign the attribute a value.

For example, if you have a custom component that reverses the letters in a string, you might use that component several times in a parent component, each time passing in a different name as a prop:

```
<ReverseString stringToReverse="Chris" />
<ReverseString stringToReverse="Nat" />
```

However, simply passing a prop to a child won't make it usable in the child. You also need to add the prop to the `props` object of the child. The `props` object contains the props (and their data types) that can be passed into the component:

```
{
  props: {
    stringToReverse: String
  },
}
```

Once you've listed a prop in the `props` object, you can use that prop in the component.

Here is a working `ReverseString` component:

Demo 2.3: Vue/demo-viewer/src/components/basic-vue-features/ReverseString.vue


```
1.   <template>
2.     <h2>{{stringToReverse.split('').reverse().join('')}}</h2>
3.   </template>
4.
5.   <script>
6.   export default {
7.     name: "ReverseString",
8.     props: {
9.       stringToReverse: String
10.    }
11.  }
12.  </script>
```

Code Explanation

Again, this component can be included in a parent component's template like this:

```
<ReverseString stringToReverse="Chris" />
```

Run `npm run serve` from the `demo-viewer` directory and then open `http://localhost:8080` in your browser. Notice that there are two links to reverse strings. They pass different values to the `ReverseString` component. Click them to see the strings reversed.

❖ 2.4.1. Data Types

When you pass a value with the wrong data type in as a prop, Vue does not error. Instead, it outputs a warning, which you can see in the JavaScript console. The warning will read something like:

```
[Vue warn]: Invalid prop: type check failed for prop "num". Expected Number with value
5, got String with value "5".
```

For example, consider the following component:

Demo 2.4: Vue/demo-viewer/src/components/basic-vue-features/Square.vue

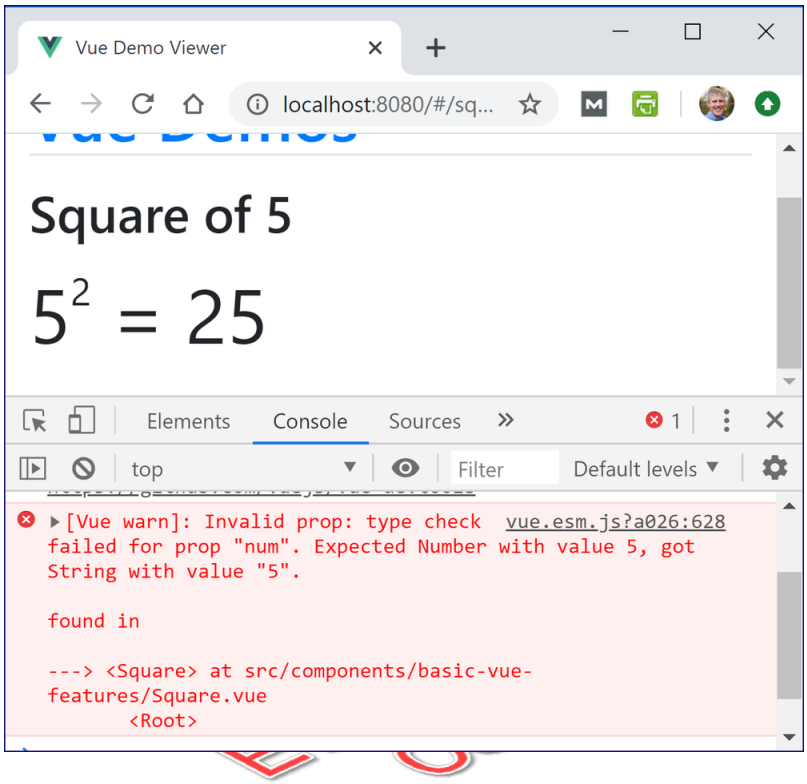
```
1.   <template>
2.     <div>
3.       <h2>Square of {{num}}</h2>
4.       <p>{{num}}<sup>2</sup> = {{num * num}}</p>
5.     </div>
6.   </template>
7.
8.   <script>
9.   export default {
10.    name: "Square",
11.    props: {
12.      num: Number
13.    }
14.  }
15.  </script>
     -------Lines 16 through 25 Omitted-------
```

Code Explanation

If you include this component with the following tag, a string will be passed in for the `num` value:

```
<Square num="5" />
```

Vue will generate the warning shown in the following screenshot:



However, by default, all prop values passed in as attributes in this way will be strings. We'll learn how to pass in different data types soon.

2.5. Dynamic Data in Templates

At its most basic level, the job of a Vue component is to merge dynamic data with template code to produce output. Vue provides several ways for generating and working with this dynamic data and for including it in templates:

1. Computed properties.
2. The `data` object.
3. The `methods` object.

We'll look at each of these now.

2.6. Computed Properties

As you saw in the previous example, JavaScript code within double curly braces in a template will get interpreted; however, it's generally not considered a good practice to muddle up your template with a lot of calculations and complex JavaScript. Instead, any time you have a piece of dynamic data that can be calculated based on other data in the template, you should consider making it into a *computed property*.

Computed properties are functions that are written as properties of the `computed` object in the options object of a Vue instance. For example, you can turn our message reversal code into a computed property like this:

```
{
  computed: {
    reversedString: function() {
      return this.stringToReverse.split('').reverse().join('');
    }
  }
}
```


With this computed property function written, you can now use the computed property inside your template like you would use any other property:

```
<template>
  <div>
    Your name in reverse is {{reversedString}}.
  </div>
</template>
```

Here is a working `ReverseStringComputed` component:

Demo 2.5: Vue/demo-viewer/src/components/basic-vue-features/ReverseStringComputed.vue

```
1.  <template>
2.    <h2>{{reversedString}}</h2>
3.  </template>
4.
5.  <script>
6.  export default {
7.    name: "ReverseStringComputed",
8.    props: {
9.      stringToReverse: String
10.   },
11.   computed: {
12.     reversedString: function() {
13.       return this.stringToReverse.split('').reverse().join('');
14.     }
15.   }
16. }
17. </script>
```


Code Explanation

Besides being useful for neatening up your template, computed properties have another superpower: they're cached. If the data that goes into calculating a computed property doesn't change, then there's no reason for the computed property to be updated when a template is rendered, so Vue will use the cached value of the computed property instead. This caching can make your application run faster by sparing the user's computer from having to do unnecessary calculations.

2.7. The data Object

Vue's `data` object contains the properties that control when the view updates. Because Vue monitors them and reacts to changes in them, these properties are called "reactive data."

The `data` property of a component holds a function that returns the component's state. By returning a function, rather than the data itself, each instance of a component within an application can have its own unique state. To understand this better, consider the following:

```
const a = function() {
  return ['a', 'b'];
};

const foo = a();
const bar = a();
```

Will `foo === bar` be `true` or `false`? Even though the two arrays hold the same content, it will be `false`, because the function creates and returns a new instance of the array every time it is called. As such, we can change the `bar` array without it affecting the `foo` array. As our Vue application only has one `Main` component, this doesn't make any difference here, but other components in the application will be used more than once. For those, it is essential that each has its own unique state.

2.7. The methods Object

The `methods` object contains the functions that modify properties in the `data` object. Unlike computed properties, the return values of methods are never cached and the function will do its job every time it is called. For this reason, you should use a computed property if the value returned is likely to be relatively static.

Consider the following component:

Demo 2.6: Vue/demo-viewer/src/components/basic-vue-features/SpellWord.vue

```
1.  <template>
2.    <div>
3.      <p>{{wordToSpell}}</p>
4.    </div>
5.  </template>
6.
7.  <script>
8.  export default {
9.    name: "SpellWord",
10.   props: {
11.     word: String
12.   },
13.   data: function() {
14.     return {
15.       index: 0,
16.       wordToSpell: ''
17.     }
18.   },
19.   methods: {
20.     spell() {
21.       if (this.index < this.word.length) {
22.         this.index++;
23.         this.wordToSpell = this.word.toLowerCase().substring(0, this.index);
24.         setTimeout(this.spell, 500);
25.       } else {
26.         this.wordToSpell = this.word.toUpperCase();
27.       }
28.     }
29.   },
30.   created: function() {
31.     this.spell();
32.   }
33. }
34. </script>
```


Code Explanation

Things to note about the `SpellWord` component:

1. It gets passed a `word` prop.
2. It has two `data` properties: `index` and `wordToSpell`, which default to `0` and `''`, respectively.

3. It has a `spell()` method which sets `this.wordToSpell` to a longer substring of `word` every half second until the complete word is spelled out, at which point, it sets `this.wordToSpell` to the full value of `word` in uppercase letters.

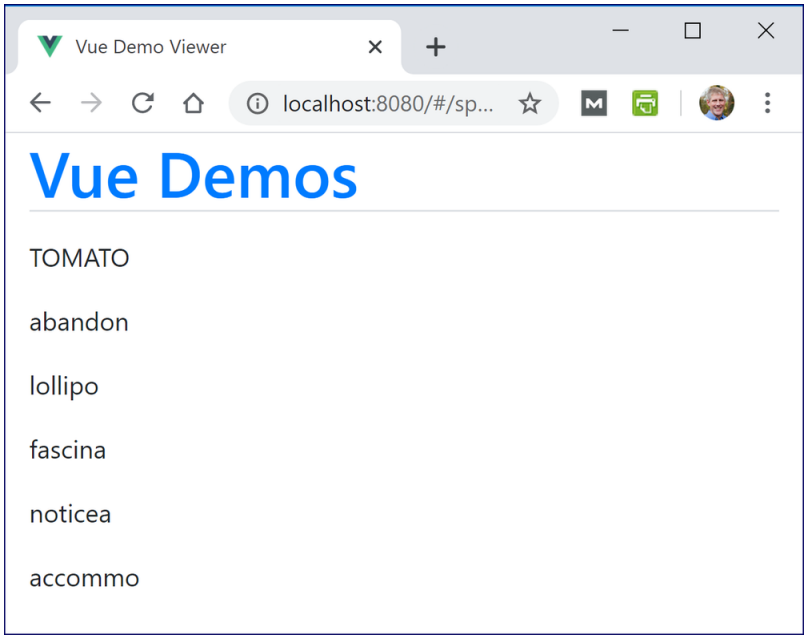
If the demo-viewer app isn't already running, run `npm run serve` from the `demo-viewer` directory and then open `http://localhost:8080` in your browser. Then click the **Spell Words** link under **Basic Vue Features**. You should see a page that spells out several words. The `SpellWords` component looks like this:

Demo 2.7: Vue/demo-viewer/src/components/basic-vue-features/SpellWords.vue

```
1.  <template>
2.    <div>
3.      <SpellWord word="Tomato" />
4.      <SpellWord word="Abandon" />
5.      <SpellWord word="Lollipop" />
6.      <SpellWord word="Fascinate" />
7.      <SpellWord word="Noticeable" />
8.      <SpellWord word="Accommodate" />
9.    </div>
10. </template>
11.
12. <script>
13. import SpellWord from './SpellWord.vue';
14.
15. export default {
16.   name: "SpellWords",
17.   components: {
18.     SpellWord
19.   }
20. }
21. </script>
```


Code Explanation

Here is the page midway through the spellings:



The most important thing to notice is that each `SpellWord` component has its own data. As explained earlier, this is because the `SpellWord` component's `data` object returns a function and not a static object.

The this Keyword

Take another look at the `spell()` method from the `SpellWord` component:

```
spell() {
  if (this.index < this.word.length) {
    this.index++;
    this.wordToSpell = this.word.toLowerCase().substring(0, this.index);
    setTimeout(this.spell, 500);
  } else {
    this.wordToSpell = this.word.toUpperCase();
  }
```

What is `this`? The `this` object is a special object in JavaScript that refers to the current object. In Vue components, `this` refers to the component itself. From a component's methods, you must use `this` to access the component's props, data properties, and methods themselves. If you fail to use `this`, the method will look for a local variable (one defined within the method itself) instead of an instance variable (one defined as a property of the component).

2.7. Instance Lifecycle Hooks

At the bottom of the `SpellWord` component, you may have noticed this code:

```
created: function() {
  this.spell();
}
```


The `created` property is an *instance lifecycle hook*. It runs immediately after an instance is created. We use it to call `this.spell()`, which then recursively calls itself every half second.

Conclusion

In this lesson, you have learned to change the data in Vue components and to dynamically update their templates.

LESSON 3
Directives

Topics Covered

☑ Vue.js directives.

☑ Conditional rendering with `v-if`, `v-else-if`, and `v-else`.

☑ Binding HTML elements to fields with `v-model` and `v-bind`.

☑ Creating event listeners with `v-on`.

☑ Looping with `v-for`.

☑ Emitting events from child components.

☑ Listening for events in parent components.

☑ Passing data in event emitters.

Introduction

Directives are special attributes that take JavaScript expressions as values. They make it possible to do many of the most common operations in a component directly in the template. In this lesson, in addition to learning about directives, you will learn to emit custom events and listen for those events in parent components.

3.1. Directives

Vue's built-in directives' are prefixed with "v-". For example, the `v-show` directive takes a JavaScript statement that evaluates to `true` or `false` and toggles the value of the element's `display` property based on the result of the statement:

```
<p v-show="loggedIn">You are logged in as {{yourName}}.</p>
```

In the above example, the paragraph containing the "logged in" message will only display if the variable named `loggedIn` evaluates to `true`.

Here is another example:

Demo 3.1: Vue/demo-viewer/src/components/directives/VShow.vue

```
1.  <template>
2.    <div>
3.      <h3>{{seconds}}</h3>
4.      <p v-show="seconds % 2 === 0">I love chocolate!</p>
5.      <p v-show="seconds % 2 === 1">I love vanilla!</p>
6.    </div>
7.  </template>
8.
9.  <script>
10. export default {
11.   name: "VShow",
12.   data: function() {
13.     return {
14.       seconds: new Date().getSeconds()
15.     }
16.   }
17. }
18. </script>
```


Code Explanation

If the demo-viewer app isn't already running, run `npm run serve` from the `demo-viewer` directory and then open `http://localhost:8080` in your browser. Then click the **v-show** link under **Directives**. If the current value of seconds on your computer's clock is even, you will get a message saying "I love chocolate!" Otherwise, you'll get a message saying "I love vanilla!" You can run the component again by refreshing the page.

The most common uses for directives are:

1. Conditional rendering with `v-if`, `v-else-if`, and `v-else`.
2. Binding HTML elements to fields with `v-model` and `v-bind`.
3. Creating event listeners with `v-on`.
4. Looping with `v-for`.

We'll be using all of these directives in our Mathificent app, so let's learn how they all work.

3.2. Conditionals with v-if / v-else-if / v-else

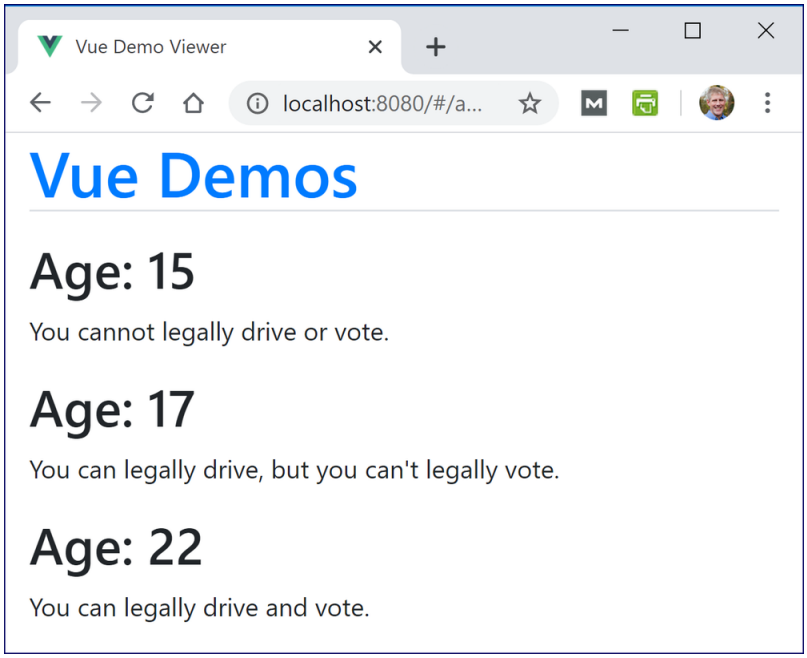
The `v-if`, `v-else-if`, and `v-else` directives work just like `if`, `else if`, and `else` in JavaScript:

Demo 3.2: Vue/demo-viewer/src/components/directives/Age.vue

```
1.   <template>
2.     <div>
3.       <h2>Age: {{age}}</h2>
4.       <div v-if="age >= 18">
5.         <p>You can legally drive and vote.</p>
6.       </div>
7.       <div v-else-if="age >= 16">
8.         <p>You can legally drive, but you can't legally vote.</p>
9.       </div>
10.      <div v-else>
11.        <p>You cannot legally drive or vote.</p>
12.      </div>
13.    </div>
14.  </template>
15.
16.  <script>
17.  export default {
18.    name: "Age",
19.    props: {
20.      age: Number
21.    }
22.  }
23.  </script>
     -------Lines 24 through 29 Omitted-------
```


Code Explanation

On the home page of the demo-viewer app, click the **Ages** link under **Directives**. This runs the `Ages` component, which outputs three `Age` components passing in `15`, `17`, and `22`. The message output is dependent on the value of the passed-in `age` prop:



As we saw earlier, the `v-show` directive can also be used for conditional rendering. The difference between using `v-if` and `v-show` is that `v-show` renders an element into the DOM and then determines whether or not to show it, using the CSS `display` property. The `v-if` directive evaluates its expression and determines whether or not to render an element into the DOM based on the result of the expression.

3.3. Two-way Binding with v-model

Two-way data binding in Vue makes working with forms and data simple. Here's an example:

```
<h3>{{message}}</h3>
<input v-model="message">
```

Two-way data binding creates a connection between the `input` element and a `data` property named "`message`" so that when the user enters data into the form `input`, it changes the value of the `data` property, and when the `data` property changes, it updates the value of the form `input`.

The `v-model` directive can also be used with other types of form fields:

Textareas

Binding textareas works the same way as binding text inputs:

```
<textarea v-model="comments"></textarea>
```

Checkboxes

To bind a checkbox, pass a Boolean value into the `v-model` directive. In the following example, `isChecked` will contain `true` or `false` depending on whether or not the checkbox is checked:

```
<h3>{{isChecked}}</h3>
<input type="checkbox" v-model="isChecked">
```

Also, because it is *two-way* binding, if you set the value of `isChecked` to `true` in the `data` object, the checkbox will be checked by default.

Radio Buttons

For radio buttons, the value of the selected radio button will be used to set the value of the bound `fruit` property:

```
<input name="fruit" value="banana" type="radio" v-model="fruit"> Banana
<input name="fruit" value="apple" type="radio" v-model="fruit"> Apple
<input name="fruit" value="pear" type="radio" v-model="fruit"> Pear
```

Again, because it is two-way binding, you can preselect a radio button by setting the value of `fruit` in the `data` object.

Select Menus

Select menus work just like radio buttons. The `v-model` attribute goes in the `<select>` tag:

```
<select name="veggie" v-model="veggie">
  <option disabled value="">Select a veggie</option>
  <option value="eggplant">Eggplant</option>
  <option value="squash">Squash</option>
  <option value="zucchini">Zucchini</option>
</select>
```

And again, because it is two-way binding, you can preselect an option by setting the value of `veggie` in the `data` object.

v-model Examples

Try out these `v-model` examples in the demo-viewer app. If it isn't already running, run `npm run serve` from the `demo-viewer` directory and then open `http://localhost:8080` in your browser. Then click the **v-model** link under **Directives**.

Here is the component code:

Demo 3.3: Vue/demo-viewer/src/components/directives/VModel.vue

```
1.   <template>
2.     <div>
3.       <h2>Text Input and Textarea</h2>
4.       <h3>{{message}}</h3>
5.       <input v-model="message" class="form-control">
6.
7.       <h3>{{comments}}</h3>
8.       <textarea v-model="comments" class="form-control"></textarea>
9.
10.      <h2>Checkbox</h2>
11.      <h3>{{isChecked}}</h3>
12.      <input type="checkbox" v-model="isChecked">
13.
14.      <h2>Radio Buttons</h2>
15.      <h3>{{fruit}}</h3>
16.      <input name="fruit" value="banana" type="radio" v-model="fruit"> Banana
17.      <input name="fruit" value="apple" type="radio" v-model="fruit"> Apple
18.      <input name="fruit" value="pear" type="radio" v-model="fruit"> Pear
19.
20.      <h2>Select Menu</h2>
21.      <h3>{{veggie}}</h3>
22.      <select name="veggie" v-model="veggie">
23.        <option disabled value="">Select a veggie</option>
24.        <option value="eggplant">Eggplant</option>
25.        <option value="squash">Squash</option>
26.        <option value="zucchini">Zucchini</option>
27.      </select>
28.    </div>
29.  </template>
30.
31.  <script>
32.  export default {
33.    name: "VModel",
34.    data: function() {
35.      return {
36.        message: 'Change me.',
37.        comments: '',
38.        isChecked: true,
39.        fruit: 'pear',
40.        veggie: 'squash'
41.      }
42.    }
     -------Lines 43 through 63 Omitted-------
```

3.4. One-way Data Binding, Repeating, and Event Handling

Vue can also do one-way data binding with the `v-bind` directive. The `v-bind` directive creates a one-way link from a dynamic property to any attribute you specify. To bind an attribute, prefix the attribute with `v-bind:`:

```
<button v-bind:disabled="isDisabled">Click me!</button>
```

When the value of `isDisabled` changes, the button's `disabled` property changes along with it.

❖ 3.4.1. v-bind Shorthand

The `v-bind` directive is one of the most frequently used Vue directives. To make using it even simpler, Vue contains a shorthand method for writing it. Instead of writing out the full `v-bind` directive followed by a colon and the attribute name, you can just use a colon before an attribute name, like this:

```
<button :disabled="isDisabled">Click me!</button>
```


Passing Non-String Values as Props

Earlier (see page 40), we showed the warning that you get when you pass a component a prop of the wrong data type. To pass in a non-string prop, use `v-bind` like this:

```
<Square v-bind:numToSquare="5" />
```

Or the shorthand version:

```
<Square :numToSquare="5" />
```

This tells Vue that the value of the `numToSquare` attribute is JavaScript and not an HTML string.

3.4. Repeating an Element using v-for

The `v-for` directive makes it easy to output multiple elements or components of the same type. Assume you have the following array of objects:

```
presidents: [
  {
    id: 1,
    name: "Washington"
  },
  {
    id: 2,
    name: "Adams"
  },
  {
    id: 3,
    name: "Jefferson"
  }
]
```

The following code will create a button for each president:


```
<button v-for="president in presidents" v-bind:key="president.id">
  {{president.name}}
</button>
```

The value of `v-for` is simple to understand: it's just `item in items`, where `items` is an array and `item` is the variable holding the current element in the array.

Vue uses the `key` to track each node. The value of each key in the series must be unique. In this case, we bind it to each array element's `id`.

Remember that we can use the shorthand for `v-bind`:

```
<button v-for="president in presidents" :key="president.id">
  {{president.name}}
</button>
```

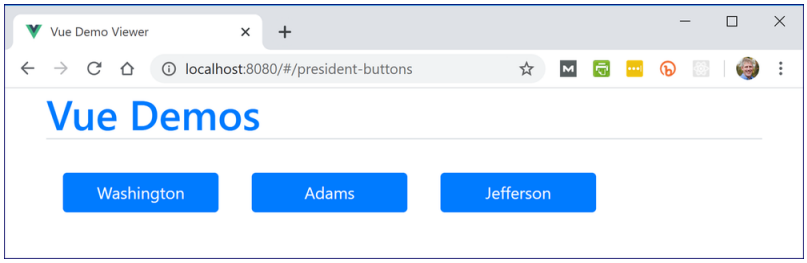
The following code shows the complete example:

Demo 3.4: Vue/demo-viewer/src/components/directives/PresidentButtons.vue

```
1.   <template>
2.     <div>
3.       <button class="btn btn-primary"
4.         v-for="president in presidents" :key="president.id">
5.         {{president.name}}
6.       </button>
7.     </div>
8.   </template>
9.
10.  <script>
11.  export default {
12.    name: "PresidentButtons",
13.    data: function() {
14.      return {
15.        presidents: [
16.          {
17.            id: 1,
18.            name: "Washington"
19.          },
20.          {
21.            id: 2,
22.            name: "Adams"
23.          },
24.          {
25.            id: 3,
26.            name: "Jefferson"
27.          }
28.        ]
29.      }
30.    },
31.  }
32.  </script>
     -------Lines 33 through 46 Omitted-------
```


Code Explanation

If the demo-viewer app isn't already running, run `npm run serve` from the `demo-viewer` directory and then open `http://localhost:8080` in your browser. Then click the **President Buttons** link under **Directives**. You should see a button for each president:

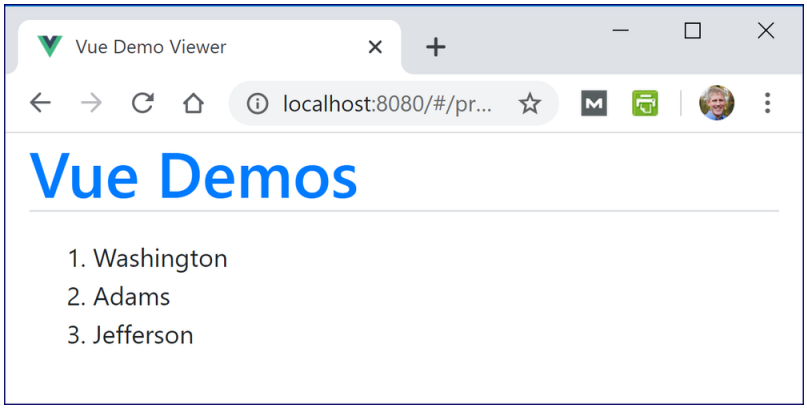


Try This

Open `Vue/demo-viewer/src/components/directives/PresidentButtons.vue` in your editor and change the template to output a list:

```
<template>
<ol>
<li v-for="president in presidents" :key="president.id">
  {{president.name}}
</li>
</ol>
</template>
```


The page should re-render and show a list:



Try adding another president to the array:

```
{
  id: 4,
  name: "Madison"
}
```

Another list item should appear.

3.4. Event Handling

Most HTML elements have certain events that can happen to them. For example, changing the value of a form field produces a "change" event, clicking an element produces a "click" event (for most elements), and when an element first loads into the browser DOM, it emits a "load" event.

Programmers use event listeners to listen for these events and, via *callback functions*, cause something else to happen in response.

In Vue, setting event listeners that trigger some other action can be done using the `v-on` directive. The `v-on` directive creates an event listener for the element it is a part of and it takes as its value a JavaScript statement or the name of a method (defined in the `methods` property) that should run when the event occurs.

The following code would call the `increment()` method every time the button is clicked and would set `count` to `0` when the mouse moves off of the button.


```
<button class="btn btn-primary"
  on:click="increment()"
  on:mouseout="count=0">{{count}}</button>
```

❖ 3.4.2. v-on Shorthand

The `v-on` directive, like the `v-bind` directive, is one of the most commonly-used directives. For this reason, it also has a shorthand form. Instead of writing the full `v-on` directive, you can just use the '`@`' symbol, followed by the event you want to listen for. For example:

```
<button class="btn btn-primary"
  @click="increment()"
  @mouseout="count=0">{{count}}</button>
```

The following code shows the complete example:

Demo 3.5: Vue/demo-viewer/src/components/directives/Counter.vue

```
1.   <template>
2.     <button class="btn btn-primary"
3.       @click="increment"
4.       @mouseout="count=0">{{count}}</button>
5.   </template>
6.
7.   <script>
8.   export default {
9.     name: "Counter",
10.    data: function() {
11.      return {
12.        count: 0
13.      }
14.    },
15.    methods: {
16.      increment: function() {
17.        this.count++;
18.      }
19.    }
20.  }
21.  </script>
     -------Lines 22 through 36 omitted-------
```


Code Explanation

If the demo-viewer app isn't already running, run `npm run serve` from the `demo-viewer` directory and then open `http://localhost:8080` in your browser. Then click the **Counter** link under **Directives**. Click the button to see the counter increment. Move your mouse off the button to see it get reset to `0`.

3.4. Putting it All Together

Take a look at the following code, which combines the `v-bind`, `v-for`, and `v-on` directives, and also uses the `v-html` directive to output unescaped HTML code. Note that it uses the shorthand versions of `v-bind` and `v-on`:

Demo 3.6: Vue/demo-viewer/src/components/directives/Quotes.vue

```
1.  <template>
2.    <div>
3.      <button class="btn btn-primary"
4.        v-for="quote in quotes" :key="quote.id"
5.        @click="currentQuoteId=quote.id"
6.        :disabled="isCurrentQuoteButton(quote)">{{quote.president}}</button>
7.      <article v-html="content"></article>
8.    </div>
9.  </template>
10.
11. <script>
12. export default {
13.   name: "Quotes",
14.   data: function() {
15.     return {
16.       currentQuoteId: 1,
17.       quotes: [
18.         {
19.           id: 1,
20.           president: "Washington",
21.           content: `It is <strong>infinitely</strong> better to have
22.                     a few <em>good</em> men than many
23.                     <em>indifferent</em> ones.`
24.         },
25.         {
26.           id: 2,
27.           president: "Adams",
28.           content: `<em>If conscience disapproves</em>, the
29.                     <strong>loudest</strong> applauses of the
30.                     world are of little value.`
31.         },
32.         {
33.           id: 3,
34.           president: "Jefferson",
35.           content: `The most valuable of all talents is that
36.                     of never using <em>two</em> words when
37.                     <em>one</em> will do.`
38.         }
39.       ]
40.     }
41.   },
42.   computed: {
43.     content: function() {
44.       const quote = this.quotes.find(quote => {
```

```
45.           return quote.id === this.currentQuoteId
46.         });
47.         return `<q>${quote.content}</q><br/> - ${quote.president}`;
48.       }
49.     },
50.     methods: {
51.       isCurrentQuoteButton(quote) {
52.         return (this.currentQuoteId === quote.id);
53.       }
54.     }
55.   }
56.   </script>
      -------Lines 57 through 75 Omitted-------
```

Code Explanation

Open the demo-viewer app in your browser. Then click the **Quotes** link under **Directives**. Click the buttons to see the presidents' quotes.

Things to notice:

1. The `v-for` directive is used to loop through the `quotes` array.
2. The shorthand version of the `v-on` directive is used to set `currentQuoteId` to `quote.id`, where `quote` is the current quote in the array loop.
3. The shorthand version of the `v-bind` directive is used to bind the `disabled` attribute to the `isCurrentQuoteButton()` method, which returns `true` if the passed-in quote is the current quote.
4. `content` is a computed property, which returns an HTML string to put into the `article` element.

3.5. Emitting Custom Events

In addition to the built-in events that HTML elements emit, it's possible to emit custom events in reaction to interactions. To emit a custom event, use the `$emit` instance method. The `$emit` method takes the name of your custom event and, optionally, a value. For example, the following button emits a custom "hide-me" event and passes the string "fade" to the callback function.

```
<button id="close-button"
  @click="$emit('hide-me', 'fade')">X</button>
```

You listen for custom events the same way that you listen for built-in events. The passed-in value, if there is one, is available through the `$event` parameter:

```
v-on:hide-me="hideChild($event)"
```


Or, using the shorthand:

```
@hide-me="hideChild($event)"
```

Take a look at the following component:

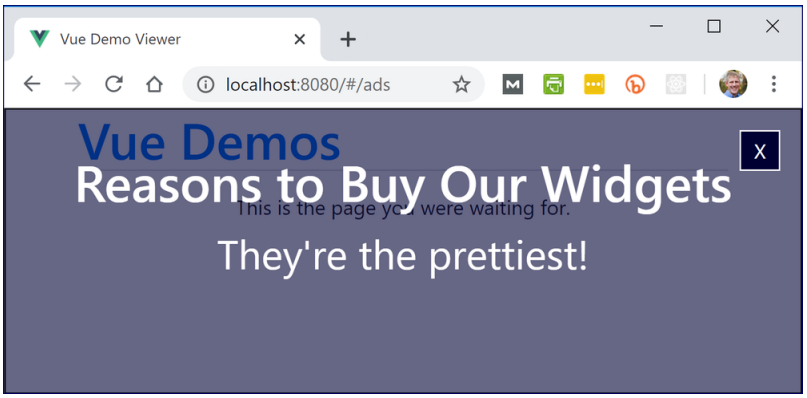
Demo 3.7: Vue/demo-viewer/src/components/directives/Ad.vue

```
<template>
  <div id="ad">
    <button id="close-button" v-show="num <= start - 3"
      @click="$emit('hide-me', 'fade')">X</button>
    <div id="ad-text">
      <h1>Reasons to Buy Our Widgets</h1>
      <p>{{reasons[reasonNum]}}</p>
    </div>
  </div>
</template>
<script>
export default {
  name: "Ad",
  props: {
    start: Number
  },
  data: function() {
    return {
      num: this.start,
      reasons: [
        "They're the cheapest!", "They're the coolest!",
        "They're the hottest!", "They're the awesomest!",
        "They're the prettiest!", "They're the best!"
      ],
      reasonNum: 0
    }
  },
  methods: {
    countDown() {
      this.num--;
      this.reasonNum++;
      if (this.num < 0) {
        this.$emit('hide-me');
      } else {
        setTimeout(this.countDown, 1000);
      }
    }
  },
  created: function() {
    setTimeout(this.countDown, 1000);
  }
}
</script>
-------Lines 44 through 84 Omitted-------
```

Code Explanation

Things to notice:

1. This component is meant to be imported into other components. It will create a semi-transparent ad that fully covers the viewport:



2. The `countDown()` method decrements the `num` property by `1` every second.
3. An "X" button will appear after three seconds have passed:

```
<button id="close-button" v-show="num <= start - 3"
  @click="$emit('hide-me', 'fade')">X</button>
```

4. When the "X" button is clicked, it will emit a custom "hide-me" event and pass "fade" to the callback function:

```
<button id="close-button" v-show="num <= start - 3"
  @click="$emit('hide-me', 'fade')">X</button>
```

5. The `countDown()` function also emits the custom "hide-me" event, but it doesn't pass in a value. It could. We're just demonstrating that it doesn't have to:

```
if (this.num === 0) {
  this.$emit('hide-me');
} else {
  this.timer = setTimeout(this.countDown, 1000);
}
```

To see this working, open the demo-viewer app in your browser. Then click the **Ad Container** link under **Directives**.

Next look at this component, which imports and display the `Ad` component:

Demo 3.8: Vue/demo-viewer/src/components/directives/AdContainer.vue

```
1.   <template>
2.     <div class="container">
3.       <Ad :start="5" @hide-me="hideMe($event)" v-show="visible"
4.         :class="className" />
5.       <p class="text-center">This is the page you were waiting for.</p>
6.     </div>
7.   </template>
8.
9.   <script>
10.  import Ad from './Ad.vue'
11.  export default {
12.    name: "AdContainer",
13.    components: {
14.      Ad
15.    },
16.    data: function() {
17.      return {
18.        visible: true,
19.        className: ''
20.      }
21.    },
22.    methods: {
23.      hideMe(className) {
24.        if (className) {
25.          this.className = className;
26.        } else {
27.          this.visible = false;
28.        }
29.      }
30.    }
31.  }
32.  </script>
```


Code Explanation

Here's the code that includes the `Ad` component:

```
<Ad :start="5" @hide-me="hideMe($event)" v-show="visible"
  :class="className" />
```

Things to notice:

1. The `start` attribute uses the `v-bind` shorthand. That could also be written: `v-bind:start="5"`. This indicates that the value of the `start` attribute is not an HTML string.
2. When the `hide-me` event fires, the `hideMe()` method will be called with the `$event` argument.
3. The `v-show` directive is tied to the `visible` property. If `visible` becomes `false`, the component will be hidden.
4. The `class` attribute is bound to the `className` property.

The `hideMe()` method looks like this:

```
hideMe(className) {
  if (className) {
    this.className = className;
  } else {
    this.visible = false;
  }
}
```


If a value is passed in for `className`, it sets `this.className` to `className`. Remember that, when the user clicks the "X" button, we pass in the "fade" class, which is a Bootsrap class that hides an element with a fade effect.

If no value is passed in for `className`, the method sets `this.visible` to `false`, which will abruptly hide the element.

To see this working, open the demo-viewer app in your browser. Then click the **AdContainer** link under **Directives**.

Additional Examples

There are two additional examples that use directives and event listeners in the demo-viewer app that you might find useful to review:

1. `Vue/demo-viewer/src/components/directives/Lists.vue`, which has a child `List` component.

2. `Vue/demo-viewer/src/components/directives/Quiz.vue`, which imports a JSON object.

Run the components in the demo-viewer app by clicking the **Lists** and **Quiz** links under Directives. Then review the code and make sure you understand how they work. Feel free to play around with the code.

Remember to stop the app (**CTRL+C**) and close the terminal when you are done.

Conclusion

In this lesson, you have learned to work with Vue.js's directives. In the next lesson, you will use these directives to build out the Mathificent game.

LESSON 4

Implementing Game Logic

Topics Covered

☑ Working with your new Vue skills.

Introduction

In this lesson, you will build out most of the Mathificent game in a series of exercises.

Exercise 6: Passing Data Between Components

20 to 30 minutes

In this exercise, you begin passing data between components.

1. In the `export` statement for `Main.vue`, after the `components` property, add a `data` function that returns an `operations` array for the **Operations** dropdown:

```
data: function() {
  return {
    operations: [
      ['Addition', '+'],
      ['Subtraction', '-'],
      ['Multiplication', 'x'],
      ['Division', '/']
    ],
  }
}
```


   Notice that each element of the `operations` array is a 2-element array containing the *text* (the operation name) and the *value* (the operation symbol) that will go in a select option.

2. Add a `computed` property to make an array of numbers for the **Maximum Number** dropdown.

```
computed: {
  numbers: function() {
    const numbers = [];
    for (let number = 2; number <= 100; number++) {
      numbers.push([number, number]);
    }
    return numbers;
  }
}
```

   Here, we're creating an array of numbers that we'll use to populate the **Maximum Number** `select` input. As with the `operations` array, each element of the `numbers` array is a 2-element array, containing the *value* and the *text* of the option in the select dropdown. In this case, the value and the text are the same: the number.

3. In the `Main` component's template, pass the properties you just created in `Main.vue` to the `SelectInput` components.

```
<SelectInput label="Operation" id="operation" :options="operations" />
<SelectInput label="Maximum Number" id="max-number" :options="numbers" />
```

4. In the `export` for `SelectInput`, specify the props that will be passed into the component:

```
export default {
  name:'SelectInput',
  props: {
    id: String,
    label: String,
    options: Array
  }
}
```

5. Use the value of the `label` prop as the `label` for the the `select`:

```
<label>{{label}}</label>…
```

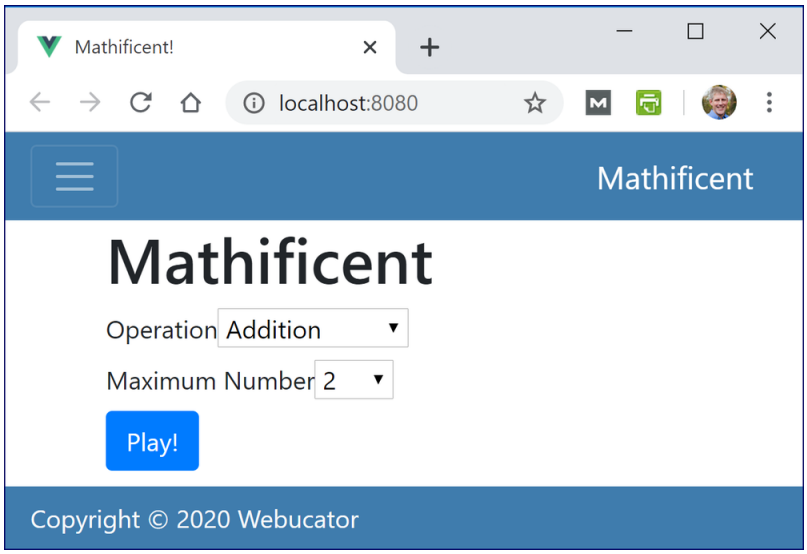

6. Bind the values of the `id` attribute of the `select` element and the `for` value of the `label` element to the `id` prop:

```
<label :for="id">{{label}}</label>
<select :id="id">
```

7. Use `v-for` to loop over the elements in the `numbers` array to make multiple `option` elements:

```
<option v-for="option in options" :key="option[1]"
  :value="option[1]">{{option[0]}}</option>
```

8. Start up your development server by running `npm run serve` from the `mathificent` directory in your terminal. Your application should now look like this:



Leave the app running for the remainder of this lesson.

Solution: Vue/Solutions/implementing-game/passing-data/Main.vue

```
1.  <template>
2.    <main id="main-container">
3.      <h1>Mathificent</h1>
4.      <SelectInput label="Operation" id="operation" :options="operations" />
5.      <SelectInput label="Maximum Number" id="max-number" :options="numbers" />
6.      <PlayButton />
7.    </main>
8.  </template>
9.
10. <script>
11.   import SelectInput from './SelectInput';
12.   import PlayButton from './PlayButton';
13.
14.   export default {
15.     name: 'Main',
16.     components: {
17.       SelectInput,
18.       PlayButton
19.     },
20.     data: function() {
21.       return {
22.         operations: [
23.           ['Addition', '+'],
24.           ['Subtraction', '-'],
25.           ['Multiplication', 'x'],
26.           ['Division', '/']
27.         ],
28.       }
29.     },
30.     computed: {
31.       numbers: function() {
32.         const numbers = [];
33.         for (let number = 2; number <= 100; number++) {
34.             numbers.push([number, number]);
35.         }
36.         return numbers;
37.       }
38.     }
39.   }
40. </script>
    -------Lines 41 through 47 Omitted-------
```

Solution: Vue/Solutions/implementing-game/passing-data/SelectInput.vue

```
<template>
  <div>
    <label :for="id">{{label}}</label>
    <select :id="id">
      <option v-for="option in options" :key="option[1]"
        :value="option[1]">
        {{option[0]}}
      </option>
    </select>
  </div>
</template>

<script>
  export default {
    name: 'SelectInput',
    props: {
      id: String,
      label: String,
      options: Array
    }
  }
</script>
```

Exercise 7: Vue Data Binding

25 to 40 minutes

In this exercise, you will bind data to `input` elements.

1. Add a `v-model` directive to the `select` element in the `SelectInput` component:

```
<select :id="id" v-model="currentValue">
```

2. To the component's `export` statement, add a `data` property that holds a function that returns `currentValue` with a default of an empty string:

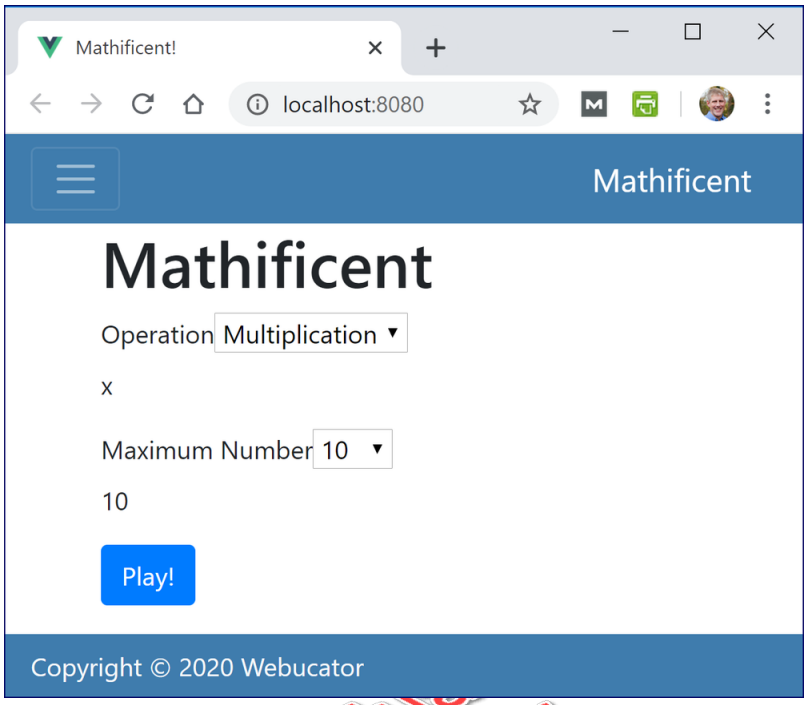
```
export default {
  name: 'SelectInput',
  props: {
    id: String,
    label: String,
    options: Array
  },
  data: function() {
    return {
      currentValue: ''
    }
  }
}
```


3. Add a `p` element below the `select` and output the value of `currentValue`:

```
<p>{{currentValue}}</p>
```

We are just putting this there temporarily to demonstrate how the current value changes.

4. At this point, each `SelectInput` element has its own internal state. If it is not already running, start up the Mathificent app and make selections from the two dropdowns. You should see something like this:



5. We need to be able to access the state of the `SelectInput` component from other components, so next we'll add an *event emitter* and cause the component to be controlled by its parent.

6. In `Main.vue`, add `operation` and `maxNumber` to the `data` object and give them default values:

```
data: function() {
  return {
    operations: [
      ['Addition', '+'],
      ['Subtraction', '-'],
      ['Multiplication', 'x'],
      ['Division', '/']
    ],
    operation: 'x',
    maxNumber: '10'
  }
},
```

7. Bind each instance of the `SelectInput` to a `data` property using `v-model` and pass that same property to `currentValue` as a prop:

```
<SelectInput :currentValue="operation" label="Operation"
  id="operation" v-model="operation" :options="operations" />
<SelectInput :currentValue="maxNumber" label="Maximum Number"
  id="max-number" v-model="maxNumber" :options="numbers" />
```

8. Inside the `Main` template, below the `PlayButton`, output the values of the `operation` and `maxNumber` properties for testing:

```
<p>current operation: {{operation}}</p>
<p>max number: {{maxNumber}}</p>
```

9. Back in `SelectInput`, remove the `currentValue` property from the `data` object and add `currentValue` as a `prop` inside the `SelectInput` component.

```
export default {
  name: 'SelectInput',
  props: {
    id: String,
    label: String,
    options: Array,
    currentValue: String
  }
}
```


10. Open your web browser and test out the app so far. **Some things to notice:**

    A. The `SelectInput` components have their own state and they receive initial values from the `Main` component. You can see this by refreshing the page and noting that the **Operation** and **Maximum Number** dropdowns have pre-selected options.

    B. However, changes in the `SelectInput` components aren't being reflected in `Main`. You can see this by making a change to one of the dropdowns and noticing that the value under the **Play** button doesn't get updated. To enable `SelectInput` to notify `Main` of changes, we need to emit an event from `SelectInput` when an option is selected. And, then we need to listen for that event in `Main`.

11. In `SelectInput`, emit an event when a new `option` is selected and pass the value of the new selected `option` to `Main`:

```
<select :id="id" v-model="currentValue"
  @input="$emit('input', $event.target.value)">
```

`$event` is the event that was fired. `$event.target` is the element on which the event was fired: the `select`. And `$event.target.value` is the current value of that element: the value of the `option` that was selected.

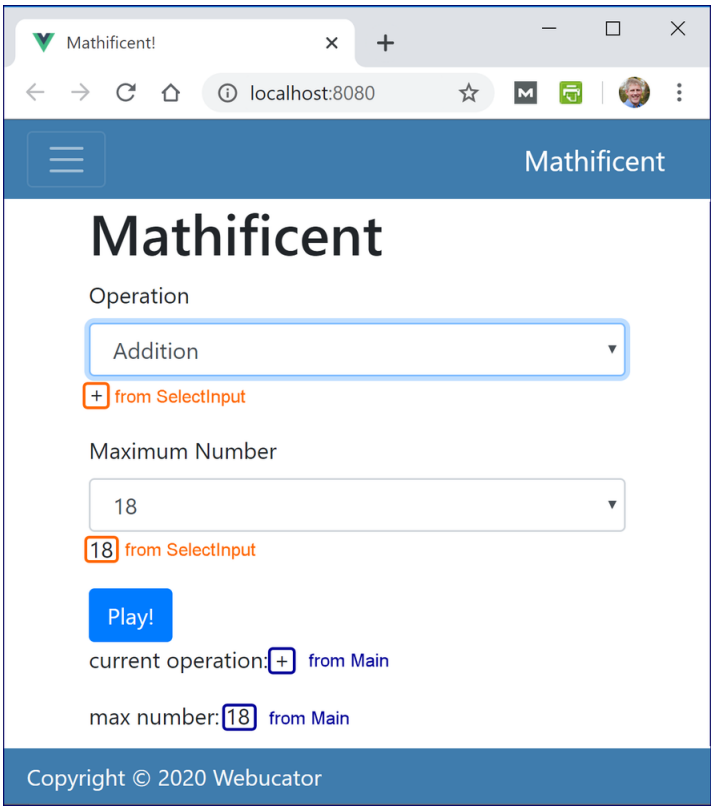
12. Inside `SelectInput`, set the current value of the select `input` using `v-bind` rather than `v-model`. Because it is being controlled by the `Main` component, the `SelectInput` no longer needs to maintain its own internal state:


```
<select :id="id" :value="currentValue"
  @input="$emit('input', $event.target.value)">
```

13. Style the `select` by applying a Bootstrap `form-control` class to it:

```
<select class="form-control" :id="id" :value="currentValue"
  @input="$emit('input', $event.target.value)">
```

14. Your application should now look like this (after changing the operation to addition and the maximum number to 18):



Change the values of the `select` menus and notice that both the values directly below them (from the `SelectInput` component) and the values below the **Play** button (from the `Main` component) get updated to reflect the change.

Solution: Vue/Solutions/implementing-game/data-binding/Main.vue

```
1.  <template>
2.    <main id="main-container">
3.      <h1>Mathificent</h1>
4.      <SelectInput :currentValue="operation" label="Operation"
5.        id="operation" v-model="operation" :options="operations" />
6.      <SelectInput :currentValue="maxNumber" label="Maximum Number"
7.        id="max-number" v-model="maxNumber" :options="numbers" />
8.      <PlayButton />
9.      <p>current operation: {{operation}}</p>
10.     <p>max number: {{maxNumber}}</p>
11.   </main>
12. </template>
13.
14. <script>
15.   import SelectInput from './SelectInput';
16.   import PlayButton from './PlayButton';
17.
18.   export default {
19.     name: 'Main',
20.     components: {
21.       SelectInput,
22.       PlayButton
23.     },
24.     data: function() {
25.       return {
26.         operations: [
27.           ['Addition', '+'],
28.           ['Subtraction', '-'],
29.           ['Multiplication', 'x'],
30.           ['Division', '/']
31.         ],
32.         operation: 'x',
33.         maxNumber: '10'
34.       }
35.     },
      -------Lines 36 through 53 Omitted-------
```

Solution: Vue/Solutions/implementing-game/data-binding/SelectInput.vue

```
1.  <template>
2.    <div>
3.      <label :for="id">{{label}}</label>
4.      <select class="form-control" :id="id" :value="currentValue"
5.          @input="$emit('input', $event.target.value)">
6.        <option v-for="option in options" :key="option[1]"
7.          :value="option[1]">{{option[0]}}</option>
8.      </select>
9.      <p>{{currentValue}}</p>
10.   </div>
11. </template>
12.
13. <script>
14.   export default {
15.     name: 'SelectInput',
16.     props: {
17.       id: String,
18.       label: String,
19.       options: Array,
20.       currentValue: String
21.     }
22.   }
23. </script>
```

Exercise 8: Implementing Conditional Rendering

25 to 40 minutes

In this exercise, you will use conditional rendering to switch between the game configuration and the game play screens.

1. First, let's do a little cleanup:
    A. In the `Main` component, remove the two testing `<p>` tags below the `<PlayButton>` tag.
    B. In the `SelectInput` component, remove the `<p>` tag below the `<select>` tag.
2. In the `Main` component, add a new `screen` variable to the `data` object and set its initial value to "config". Your `data` function should now look like this:


```
data: function() {
  return {
    operations: [
      ['Addition', '+'],
      ['Subtraction', '-'],
      ['Multiplication', 'x'],
      ['Division', '/']
    ],
    operation: 'x',
    maxNumber: '10',
    screen: 'config'
  }
}
```

3. Inside of the `main` element, add a `div` element with the `id` of "config-container" and a `v-if` directive to test whether the current value of `screen` is "config":

```
<main id="main-container">
  <div v-if="screen === 'config'" id="config-container">
    <h1>Mathificent</h1>
    <SelectInput :currentValue="operation" label="Operation"
      id="operation" v-model="operation" :options="operations" />
    <SelectInput :currentValue="maxNumber" label="Maximum Number"
      id="max-number" v-model="maxNumber" :options="numbers" />
    <PlayButton />
  </div>
</main>
```

At this point, the value of the `screen` property will always be "config" so the code inside the `div` with the `v-if` directive will always be displayed. But we're going to change that.

4. Below the `div` you just added, add another `div` with the `id` of "game-container" and a `v-else-if` directive. This `div` should display when the value of `screen` is "play". Also, give this `div` the Bootstrap class of "text-center".

    - Note that it is important that these two new `div` elements are contained in a parent element (the `main` element), because Vue requires the template to contain a single root element. The root element may contain any number of child elements.

5. Inside the `div` that displays when the value of `screen` is "play", add the placeholder text "Game Here":

```
<div v-else-if="screen === 'play'" id="game-container" class="text-center">
  Game Here
</div>
```

6. If it isn't running already, start the development server and open `http://localhost:8080` in your web browser. The configuration screen should be displaying.

7. While the development server is still running, open `Main.vue` in your editor and change the value of the `screen` property to "play". The browser should now display the placeholder text for the game.

8. If everything works correctly, change the initial value of the `screen` property back to "config" so that we can code a more dynamic way of changing it.

9. Add a new property to the `export` statement, called `methods`. Methods are the functions that your application uses to change its data properties:

```
export default {
  name: 'Main',
  components: {
    …
  },
  data: function() {
    …
  },
  methods: {

  },
  computed: {
    …
  }
}
```

10. Add two new functions inside the `methods` object: `config` and `play`. Inside these methods, change the value of `this.screen` to the correct values to change what is displayed.


```
methods: {
  config() {
    this.screen = "config";
  },
  play() {
    this.screen = "play";
  }
},
```

11. Add a `v-on` directive to the `button` element in `PlayButton` that emits a custom event:

```
<button class="btn btn-primary" @click="$emit('play-button-click')">
  Play!
</button>
```

12. Back in `Main`, call `play` when a `play-button-click` event occurs:

```
<PlayButton @play-button-click="play" />
```

13. Still in `Main.vue`, replace the "Game Here" text with a new "Change Game" button directly inside the conditional `div` for the "play" screen, and add a `v-on` directive to it to call the `config()` method when clicked:

```
<div v-else-if="screen === 'play'" id="game-container" class="text-center">
  <button class="btn btn-success" @click="config">Change Game</button>
</div>
```


14. In your browser, click the "Play" button and the "Change Game" button to switch between the **Play** screen and the **Config** screen.

Solution: Vue/Solutions/implementing-game/conditional-rendering/Main.vue

```
1.  <template>
2.    <main id="main-container">
3.      <div v-if="screen === 'config'" id="config-container">
4.        <h1>Mathificent</h1>
5.        <SelectInput :currentValue="operation" label="Operation"
6.          id="operation" v-model="operation" :options="operations" />
7.        <SelectInput :currentValue="maxNumber" label="Maximum Number"
8.          id="max-number" v-model="maxNumber" :options="numbers" />
9.        <PlayButton @play-button-click="play" />
10.     </div>
11.     <div v-else-if="screen === 'play'" id="game-container" class="text-center">
12.       <button class="btn btn-success" @click="config">Change Game</button>
13.     </div>
14.   </main>
15. </template>
16.
17. <script>
18.   import SelectInput from './SelectInput';
19.   import PlayButton from './PlayButton';
20.
21.   export default {
22.     name: 'Main',
      -------Lines 23 through 26 Omitted-------
27.     data: function() {
28.       return {
29.         operations: [
30.           ['Addition', '+'],
31.           ['Subtraction', '-'],
32.           ['Multiplication', 'x'],
33.           ['Division', '/']
34.         ],
35.         operation: 'x',
36.         maxNumber: '10',
37.         screen: 'config'
38.       }
39.     },
40.     methods: {
41.       config() {
42.         this.screen = "config";
43.       },
44.       play() {
45.         this.screen = "play";
```

```
46.         }
47.       },
      -------Lines 48 through 65 Omitted-------
```

Solution: Vue/Solutions/implementing-game/conditional-rendering/PlayButton.vue

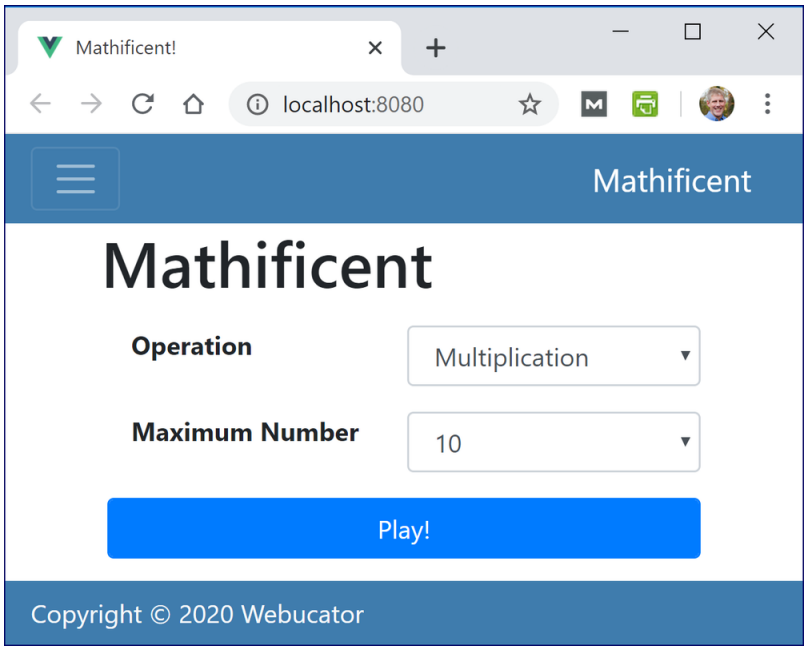
```
1.    <template>
2.      <button class="btn btn-primary" @click="$emit('play-button-click')">
3.        Play!
4.      </button>
5.    </template>
6.
7.    <script>
8.      export default {
9.        name: 'PlayButton'
10.     }
11.   </script>
```

Exercise 9: Improving the Form Layout

10 to 15 minutes

In this exercise, we'll quickly improve the form layout by breaking the components into Bootstrap rows and columns. Keep Mathificent running on the **Config** screen, so you can watch it update as you make these changes.

1. In the `template` of the `SelectInput` component:
    A. Add the `row`, `mx-1`, and `my-3` classes to the outer `div`. The `row` class makes the browser treat the `div` as a row. The `mx-1` and `my-3` classes give the row horizontal and vertical margins, respectively.
    B. Add the `col` and `font-weight-bold` classes to the `label` element.
    C. Add the `col` class to the `select` element.
2. In the `template` of the `PlayButton` component:
    A. Wrap the button in a `div` element and give the `div` the `row`, `mx-1`, and `my-3` classes.
    B. Add the `form-control` class to the `button` element.
3. The page should now look like this:



Solution: Vue/Solutions/implementing-game/form-layout/SelectInput.vue

```
<template>
  <div class="row mx-1 my-3">
    <label :for="id" class="col font-weight-bold">{{label}}</label>
    <select class="col form-control" :id="id" :value="currentValue"
        @input="$emit('input', $event.target.value)">
      <option v-for="option in options" :key="option[1]"
        :value="option[1]">
        {{option[0]}}
      </option>
    </select>
  </div>
</template>

<script>
  export default {
    name: 'SelectInput',
    props: {
      id: String,
      label: String,
      options: Array,
      currentValue: String
    }
  }
</script>
```


Solution: Vue/Solutions/implementing-game/form-layout/PlayButton.vue

```
<template>
  <div class="row mx-1 my-3">
    <button class="form-control btn btn-primary"
      @click="$emit('play-button-click')">
      Play!
    </button>
  </div>
</template>

<script>
  export default {
    name: 'PlayButton'
  }
</script>
```

Exercise 10: Making the Game UI

60 to 90 minutes

In this exercise, you will start building the user interface for the game. To see how the final game works, stop the development server if you have it running. Then run `npm install` followed by `npm run serve` from the `mathificent-final` directory and play around. Be sure to stop the server before moving on to the exercise.

1. Here is what the game will look like when it is complete:

   Using this screenshot, try to identify the individual elements that make up the user interface of the game.

2. Think about how many different components you need to make to build this user interface. It has:

   A. A score.

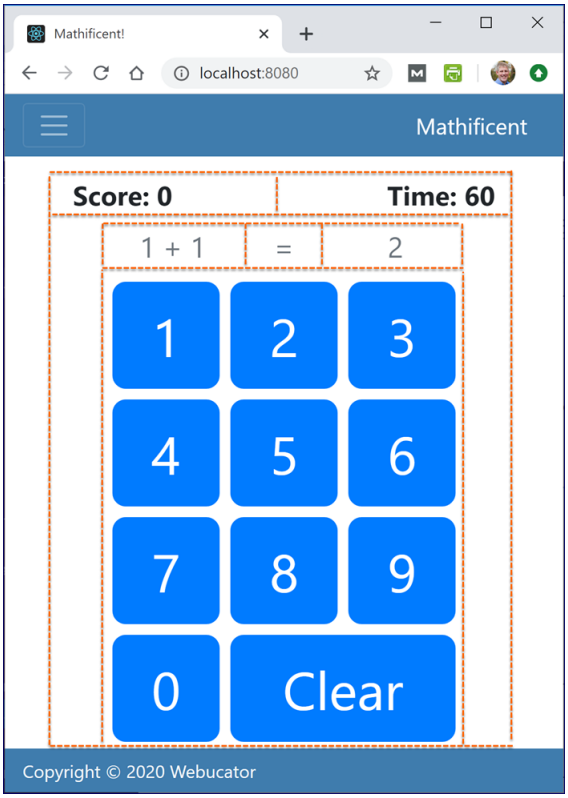
   B. A timer.

   C. An equation.

D. Ten number buttons.

E. A clear button.

You could lay that out in rows and columns like this:



Note that the buttons are all in a single row, but are constrained by the width of the container.

3. Start up your development server in `Exercises/mathificent` if it is not running already. Press the **Play** button to show the game. **As you proceed through the exercise, keep an eye on the web browser to see how the interface changes.**

4. Create placeholder components in the `components` directory for each of the following components (sample code is shown for the `Score` component):

A. `Score`

```
<template>
  <div>Score Component</div>
</template>

<script>
  export default {
    name: 'Score'
  }
</script>
```


B. `Timer`

C. `Equation`

For the number and clear buttons, we'll just use standard HTML `button` elements.

5. In the `Main` component, remove the **Change Game** button, import the components you just created, and display them in Bootstrap rows in the template using the tags and classes shown in the following code:

```
…
<div v-else-if="screen === 'play'" id="game-container" class="text-center">
  <div class="row border-bottom" id="scoreboard">
    <div class="col px-3 text-left">
      <Score />
    </div>
    <div class="col px-3 text-right">
      <Timer />
    </div>
  </div>
  <div class="row text-secondary my-2" id="equation">
    <Equation />
  </div>
  <div class="row" id="buttons">
    <div class="col">
      <button class="btn btn-primary number-button">1</button>
      <button class="btn btn-primary number-button">2</button>
      …
      <button class="btn btn-primary number-button">9</button>
      <button class="btn btn-primary number-button">0</button>
      <button class="btn btn-primary" id="clear-button">Clear</button>
    </div>
  </div>
</div>
```

```
…
import SelectInput from './SelectInput';
import PlayButton from './PlayButton';
import Score from './Score';
import Timer from './Timer';
import Equation from './Equation';

export default {
  name: 'Main',
  components: {
    SelectInput,
    PlayButton,
    Score,
    Timer,
    Equation
  },
…
```

6. Write and style the game components' subcomponents using HTML, CSS, and Bootstrap classes:

Exercise Code 10.1: Score.vue


```
1.  <template>
2.    <strong>Score: 0</strong>
3.  </template>
4.
5.  <script>
6.    export default {
7.      name: 'Score'
8.    }
9.  </script>
```

Exercise Code 10.2: Timer.vue

```
1.  <template>
2.    <strong>Time Left: 60</strong>
3.  </template>
4.
5.  <script>
6.    export default {
7.      name: 'Timer'
8.    }
9.  </script>
```

Exercise Code 10.3: Equation.vue

```
1.   <template>
2.     <div id="equation" class="row">
3.       <div class="col-5">1+1</div>
4.       <div class="col-2">=</div>
5.       <div class="col-5">2</div>
6.     </div>
7.   </template>
8.
9.   <script>
10.    export default {
11.      name: 'Equation'
12.    }
13.  </script>
14.
15.  <style scoped>
16.    #equation {
17.      font-size: 1.6em;
18.      margin: auto;
19.      width: 90%;
20.    }
21.  </style>
```


Code Explanation

Notice that the `style` tag includes a `scoped` attribute. This is so that the style rules only affect the component in which they are defined.

7. Next, instead of hardcoding ten number buttons, we'll dynamically generate the tags using the `v-for` directive. Make a new property in the `data` object in `Main.vue` called `buttons` and set its value to the numbers 1-9 and then a 0:

```
buttons: [1, 2, 3, 4, 5, 6, 7, 8, 9, 0]
```

8. Add a `v-for` directive to the `button` element to iterate over the `buttons` array:

```
<button class="btn btn-primary number-button"
  v-for="button in buttons" :key="button">{{button}}</button>
```

9. In the `Main` component's `style` block, add these rules to style the buttons and scoreboard:

```
button.number-button {
  border-radius: .25em;
  font-size: 3em;
  height: 2em;
  margin: .1em;
  text-align: center;
  width: 2em;
}

#clear-button {
  border-radius: .25em;
  font-size: 3em;
  height: 2em;
  margin: .1em;
  text-align: center;
  width: 4.2em;
}

#scoreboard {
  font-size: 1.5em;
}
```


10. The page should now look like this:

Solution: Vue/Solutions/implementing-game/game-ui/Main.vue

```
<template>
  <main id="main-container">
    <div v-if="screen === 'config'" id="config-container">
      <h1>Mathificent</h1>
      <SelectInput :currentValue="operation" label="Operation"
        id="operation" v-model="operation" :options="operations" />
      <SelectInput :currentValue="maxNumber" label="Maximum Number"
        id="max-number" v-model="maxNumber" :options="numbers" />
      <PlayButton :handleClick="play" />
    </div>
    <div v-else-if="screen === 'play'" id="game-container" class="text-center">
      <div class="row border-bottom" id="scoreboard">
        <div class="col px-3 text-left">
          <Score />
        </div>
        <div class="col px-3 text-right">
          <Timer />
        </div>
      </div>
      <div class="row text-secondary my-2" id="equation">
        <Equation />
      </div>
      <div class="row" id="buttons">
        <div class="col">
          <button class="btn btn-primary number-button"
            v-for="button in buttons" :key="button">{{button}}</button>
          <button class="btn btn-primary">Clear</button>
        </div>
      </div>
    </div>
  </main>
</template>

<script>
  import SelectInput from './SelectInput';
  import PlayButton from './PlayButton';
  import Score from './Score';
  import Timer from './Timer';
  import Equation from './Equation';

  export default {
    name: 'Main',
    components: {
      SelectInput,
```

```
45.         PlayButton,
46.         Score,
47.         Timer,
48.         Equation
49.       },
50.       data: function() {
51.         return {
52.           operations: [
53.             ['Addition', '+'],
54.             ['Subtraction', '-'],
55.             ['Multiplication', 'x'],
56.             ['Division', '/']
57.           ],
58.           operation: 'x',
59.           maxNumber: '10',
60.           buttons: [1, 2, 3, 4, 5, 6, 7, 8, 9, 0],
61.           screen: 'config'
62.         }
63.       },
64.       methods: {
65.         config() {
66.           this.screen = "config";
67.         },
68.         play() {
69.           this.screen = "play";
70.         }
71.       },
72.       computed: {
73.         numbers: function() {
74.           const numbers = [];
75.           for (let number = 2; number <= 100; number++) {
76.               numbers.push([number, number]);
77.           }
78.           return numbers;
79.         }
80.       }
81.     }
82.   </script>
83.
84.   <style scoped>
85.     #main-container {
86.       margin: auto;
87.       width: 380px;
88.     }
89.
```

```
90.     button.number-button {
91.       border-radius: .25em;
92.       font-size: 3em;
93.       height: 2em;
94.       margin: .1em;
95.       text-align: center;
96.       width: 2em;
97.     }
98.
99.     #clear-button {
100.      border-radius: .25em;
101.      font-size: 3em;
102.      height: 2em;
103.      margin: .1em;
104.      text-align: center;
105.      width: 4.2em;
106.    }
107.
108.    #scoreboard {
109.      font-size: 1.5em;
110.    }
111.  </style>
```

Exercise 11: Capturing Form Events

20 to 30 minutes

In this exercise, you will control the user input by capturing button clicks.

1. Add an `input` property to the `data` object in `Main` and give it a default value of an empty string (`''`). This will hold the user input generated through button clicks.

2. Add a `setInput()` method to the `Main` component's methods that appends a passed-in string (`value`) to the `input` property:

```
setInput(value) {
  this.input += String(value);
  this.input = String(Number(this.input));
}
```

   `this.input` holds a string, so we first convert the value passed to `setInput()` to a string and append it to `this.input`. For example, if `this.input` is `'5'` and `2` is passed to `setInput()`, we convert `2` to `'2'` by passing it to `String()` and then we append `'2'` to `'5'` to give us `'52'`. This works great most of the time. The one exception is when `this.input` already holds `'0'`. Then if you pass `2`, you will wind up with `'02'`. For that reason, we do this:

```
String(Number(this.input))
```

   `Number('02')` will convert `'02'` to `2`, and `String(2)` will convert `2` to `'2'`, which looks better than `'02'` in our game.

3. Make each number button element call `setInput()` and pass its value when clicked:

```
<button class="btn btn-primary number-button"
  v-for="button in buttons" :key="button"
  @click="setInput(button)">{{button}}</button>
```

4. Pass the value of `input` into the `Equation` component as a `prop` named `answer`, and modify the `Equation` component to display it in the place where the answer should be displayed. No code is shown for this one. See if you can do it on your own.

5. Add a method named `clear` to the `Main` component:

```
clear() {
  this.input = '';
}
```

6. Make the clear button call `clear()` when clicked:

```
<button class="btn btn-primary" id="clear-button"
  @click="clear">Clear</button>
```


7. In the app in the browser, click the **Play** button, and test whether clicking the number buttons adds the number to the displayed answer and whether clicking the **Clear** button resets the answer value.

Solution: Vue/Solutions/implementing-game/capturing-events/Main.vue

```
<template>
  <main id="main-container">
    <div v-if="screen === 'config'" id="config-container">
      <h1>Mathificent</h1>
      <SelectInput :currentValue="operation" label="Operation"
        id="operation" v-model="operation" :options="operations" />
      <SelectInput :currentValue="maxNumber" label="Maximum Number"
        id="max-number" v-model="maxNumber" :options="numbers" />
      <PlayButton @play-button-click="play" />
    </div>
    <div v-else-if="screen === 'play'" id="game-container" class="text-center">
      <div class="row border-bottom" id="scoreboard">
        <div class="col px-3 text-left">
          <Score />
        </div>
        <div class="col px-3 text-right">
          <Timer />
        </div>
      </div>
      <div class="row text-secondary my-2" id="equation">
        <Equation :answer="input" />
      </div>
      <div class="row" id="buttons">
        <div class="col">
          <button class="btn btn-primary number-button"
            v-for="button in buttons" :key="button"
            @click="setInput(button)">{{button}}</button>
          <button class="btn btn-primary" id="clear-button"
            @click="clear">Clear</button>
        </div>
      </div>
    </div>
  </main>
</template>

<script>
  import SelectInput from './SelectInput';
  import PlayButton from './PlayButton';
  import Score from './Score';
  import Timer from './Timer';
  import Equation from './Equation';

  export default {
    name: 'Main',
```

```
45.       components: {
46.         SelectInput,
47.         PlayButton,
48.         Score,
49.         Timer,
50.         Equation
51.       },
52.       data: function() {
53.         return {
54.           operations: [
55.             ['Addition', '+'],
56.             ['Subtraction', '-'],
57.             ['Multiplication', 'x'],
58.             ['Division', '/']
59.           ],
60.           operation: 'x',
61.           maxNumber: '10',
62.           screen: 'config',
63.           buttons: [1, 2, 3, 4, 5, 6, 7, 8, 9, 0],
64.           input: ''
65.         }
66.       },
67.       methods: {
68.         config() {
69.           this.screen = "config";
70.         },
71.         play() {
72.           this.screen = "play";
73.         },
74.         setInput(value) {
75.           this.input += String(value);
76.           this.input = String(Number(this.input));
77.         },
78.         clear() {
79.           this.input = '';
80.         }
81.       },
      -------Lines 82 through 121 Omitted-------
```

Solution: Vue/Solutions/implementing-game/capturing-events/Equation.vue

```
1.   <template>
2.     <div id="equation" class="row">
3.       <div class="col-5">1+1</div>
4.       <div class="col-2">=</div>
5.       <div class="col-5">{{answer}}</div>
6.     </div>
7.   </template>
8.
9.   <script>
10.    export default {
11.      name: 'Equation',
12.      props: {
13.        answer: String
14.      }
15.    }
16.  </script>
     -------Lines 17 through 24 Omitted-------
```

Exercise 12: Setting the Equation

30 to 45 minutes

In this exercise, you will write the code to create the equations displayed in Mathificent.

1. We will need to generate random integers for the equation. The function for generating random integers is not specific to Mathificent, so we will put it in a separate `helpers.js` file and import it:

    A. Create a new folder within the `src` folder called `helpers`.

    B. Within the `helpers` folder, create a file called `helpers.js`.

    C. In the `Exercises/starter-code.txt` file, you will find a JavaScript function called `randInt()` that looks like this:


```
export function randInt(low, high) {
  const rndDec = Math.random();
  return Math.floor(rndDec * (high - low + 1) + low);
}
```

    Copy and paste that code into `helpers.js` and save.

2. Open `Main.vue` in your editor.

3. Import the `randInt()` function:

```
import {randInt} from '../helpers/helpers';
```

4. Add the following `getRandNumbers()` function to the `methods` property. This function is available to copy from `Exercises/starter-code.txt`, but be sure to review it so you understand how it works:

```
getRandNumbers(operator, low, high) {
  let num1 = randInt(low, high);
  let num2 = randInt(low, high);
  const numHigh = Math.max(num1, num2);
  const numLow = Math.min(num1, num2);

  if(operator === '-') { // Make sure higher num comes first
    num1 = numHigh;
    num2 = numLow;
  }

  if(operator === '/') {
    if (num2 === 0) { // No division by zero
      num2 = randInt(1, high);
    }
    num1 = (num1 * num2);
  }
  return {num1, num2};
}
```


5. Add two new properties, `operands` and `answered`, to the `data` object of `Main`:

   - `operands` will have a value that's an object containing two properties: the two operands[1] in the math problem.
   - `answered` indicates whether the user correctly answered the problem. It should default to `false`.

   Here's the code to add:

```
operands: {num1: '1', num2: '1'},
answered: false
```

1. The *operands* are the numbers being operated on by the *operator*. In `5 + 3`, `5` and `3` are the operands.

6. Create a new method in the `Main` component called `newQuestion`, which generates a new question:

```
newQuestion() {
  this.input='';
  this.answered = false;
  this.operands = this.getRandNumbers(
    this.operation, 0, this.maxNumber
  );
}
```

7. Add a new computed property that will use the `operands` and `operation` to generate an equation:

```
question: function() {
  const num1 = this.operands.num1;
  const num2 = this.operands.num2;
  const equation = `${num1} ${this.operation} ${num2}`;
  return equation;
}
```


8. Pass `question` and `answered` into the `Equation` component as `props` and display the value of `question` in the correct place in `Equation`:

In Main.vue

```
<Equation :question="question"
  :answer="input"
  :answered="answered" />
```

In Equation.vue

```
<div class="col-5">{{question}}</div>
…
props: {
  question: String,
  answer: String,
  answered: Boolean
}
```

9. Back in `Main.vue`, add a call to `newQuestion` to the `play` method. This will cause a new question to be generated when the game starts:

```
play() {
  this.screen = "play";
  this.newQuestion();
},
```

10. Add a check for the correct answer to the `setInput` method. If the answer is correct, get a new question. Your `setInput` method should now look like this:


```
setInput(value) {
  this.input += String(value);
  this.input = String(Number(this.input));
  this.answered = this.checkAnswer(this.input,
                                   this.operation,
                                   this.operands);
  if (this.answered) {
    this.newQuestion();
  }
}
```

11. This will break the app, because we haven't added the `checkAnswer()` method yet. Copy the `checkAnswer()` method from the `starter-code.txt` file and add it to the `Main` component's methods. Review the function to make sure you understand it:

```
checkAnswer(userAnswer, operation, operands) {
  if (isNaN(userAnswer)) return false; // User hasn't answered

  let correctAnswer;
  switch(operation) {
    case '+':
      correctAnswer = operands.num1 + operands.num2;
      break;
    case '-':
      correctAnswer = operands.num1 - operands.num2;
      break;
    case 'x':
      correctAnswer = operands.num1 * operands.num2;
      break;
    default: // division
      correctAnswer = operands.num1 / operands.num2;
  }
  return (parseInt(userAnswer) === correctAnswer);
}
```


12. Make a new `data` property in `Main` called `score` to keep track of the score and set its initial value to `0`.
13. In `setInput`, increase the value of score when `answered` is `true`:

```
if (this.answered) {
  this.newQuestion();
  this.score++;
}
```

14. Pass `score` into the `Score` component, add it to the `Score` component's `props`, and display the score.
15. Try it out in the browser. You should now be able to answer question after question forever and ever.

16. The question changes are a little abrupt. It'd be nice to fade the old question out. We will use the Bootstrap "fade" class for this. In the `Main` component, add a computed property called `equationClass` whose value depends on the value of `answered`:

```
equationClass: function() {
  if (this.answered) {
    return 'row text-primary my-2 fade';
  } else {
    return 'row text-secondary my-2';
  }
}
```

Now, change the class of the `div` containing the `<Equation>` tag to be bound to `equationClass`:

```
<div :class="equationClass" id="equation">
  <Equation question={question} answer={userAnswer} />
</div>
```


Finally, we need to add a little delay before getting the next question so that the user has time to see the fade effect. In the `if` condition where you call `this.newQuestion()`, use a `setTimeout` to delay that call by 300 milliseconds:

```
if (this.answered) {
  setTimeout(this.newQuestion, 300);
  this.score++;
}
```

Try out the app again. After answering a question correctly, the equation and answer should fade away before a new question shows up. Things are working pretty well! Time to implement our timer.

Remember to stop the app (**CTRL+C**) and close the terminal when you are done.

Solution: Vue/Solutions/implementing-game/setting-the-equation/Main.vue

```
1.   <template>
2.     <main id="main-container">
     -------Lines 3 through 10 Omitted-------
11.      <div v-else-if="screen === 'play'" id="game-container" class="text-center">
12.        <div class="row border-bottom" id="scoreboard">
13.          <div class="col px-3 text-left">
14.            <Score :score="score" />
15.          </div>
16.          <div class="col px-3 text-right">
17.            <Timer />
18.          </div>
19.        </div>
20.        <div :class="equationClass" id="equation">
21.          <Equation :question="question"
22.            :answer="input"
23.            :answered="answered" />
24.        </div>
25.        <div class="row" id="buttons">
26.          <div class="col">
27.            <button class="btn btn-primary number-button"
28.              v-for="button in buttons" :key="button"
29.              @click="setInput(button)">{{button}}</button>
30.            <button class="btn btn-primary" id="clear-button"
31.              @click="clear">Clear</button>
32.          </div>
33.        </div>
34.      </div>
35.    </main>
36.  </template>
37.
38.  <script>
39.    import SelectInput from './SelectInput';
40.    import PlayButton from './PlayButton';
41.    import Score from './Score';
42.    import Timer from './Timer';
43.    import Equation from './Equation';
44.    import {randInt} from '../helpers/helpers';
45.    export default {
46.      name: 'Main',
47.      components: {
48.        SelectInput,
49.        PlayButton,
```

```
50.         Score,
51.         Timer,
52.         Equation
53.       },
54.       data: function() {
55.         return {
56.           operations: [
57.             ['Addition', '+'],
58.             ['Subtraction', '-'],
59.             ['Multiplication', 'x'],
60.             ['Division', '/']
61.           ],
62.           operation: 'x',
63.           maxNumber: '10',
64.           buttons: [1, 2, 3, 4, 5, 6, 7, 8, 9, 0],
65.           screen: 'config',
66.           input: '',
67.           operands: {num1: '1', num2: '1'},
68.           answered: false,
69.           score: 0
70.         }
71.       },
72.       methods: {
73.         config() {
74.           this.screen = "config";
75.         },
76.         play() {
77.           this.screen = "play";
78.           this.newQuestion();
79.         },
80.         setInput(value) {
81.           this.input += String(value);
82.           this.input = String(Number(this.input));
83.           this.answered = this.checkAnswer(this.input,
84.                                            this.operation,
85.                                            this.operands);
86.           if (this.answered) {
87.             setTimeout(this.newQuestion, 300);
88.             this.score++;
89.           }
90.         },
91.         clear() {
92.           this.input = '';
93.         },
94.         getRandNumbers(operator, low, high) {
```

```
95.           let num1 = randInt(low, high);
96.           let num2 = randInt(low, high);
97.           const numHigh = Math.max(num1, num2);
98.           const numLow = Math.min(num1, num2);
99.
100.          if(operator === '-') { // Make sure higher num comes first
101.            num1 = numHigh;
102.            num2 = numLow;
103.          }
104.
105.          if(operator === '/') {
106.            if (num2 === 0) { // No division by zero
107.              num2 = randInt(1, high);
108.            }
109.            num1 = (num1 * num2);
110.          }
111.          return {num1, num2};
112.        },
113.        checkAnswer(userAnswer, operation, operands) {
114.          if (isNaN(userAnswer)) return false; // User hasn't answered
115.
116.          let correctAnswer;
117.          switch(operation) {
118.            case '+':
119.              correctAnswer = operands.num1 + operands.num2;
120.              break;
121.            case '-':
122.              correctAnswer = operands.num1 - operands.num2;
123.              break;
124.            case 'x':
125.              correctAnswer = operands.num1 * operands.num2;
126.              break;
127.            default: // division
128.              correctAnswer = operands.num1 / operands.num2;
129.          }
130.          return (parseInt(userAnswer) === correctAnswer);
131.        },
132.        newQuestion() {
133.          this.input = '';
134.          this.answered = false;
135.          this.operands = this.getRandNumbers(
136.            this.operation, 0, this.maxNumber
137.          );
138.        }
139.      },
```

```
140.      computed: {
141.        numbers: function() {
142.          const numbers = [];
143.          for (let number = 2; number <= 100; number++) {
144.            numbers.push([number, number]);
145.          }
146.          return numbers;
147.        },
148.        question: function() {
149.          const num1 = this.operands.num1;
150.          const num2 = this.operands.num2;
151.          const equation = `${num1} ${this.operation} ${num2}`;
152.          return equation;
153.        },
154.        equationClass: function() {
155.          if (this.answered) {
156.            return 'row text-primary my-2 fade';
157.          } else {
158.            return 'row text-secondary my-2';
159.          }
160.        }
161.      }
162.    }
163.  </script>
      -------Lines 164 through 191 Omitted-------
```


Solution: Vue/Solutions/implementing-game/setting-the-equation/Score.vue

```
1.    <template>
2.      <strong>Score: {{score}}</strong>
3.    </template>
4.
5.    <script>
6.      export default {
7.        name: 'Score',
8.        props: {
9.          score: Number
10.       }
11.     }
12.   </script>
```

Solution: Vue/Solutions/implementing-game/setting-the-equation/Equation.vue

```
<template>
  <div id="equation" class="row">
    <div class="col-5">{{question}}</div>
    <div class="col-2">=</div>
    <div class="col-5">{{answer}}</div>
  </div>
</template>

<script>
  export default {
    name: 'Equation',
    props: {
      question: String,
      answer: String,
      answered: Boolean
    }
  }
</script>
-------Lines 19 through 20 Omitted----------
```


Solution: Vue/Solutions/implementing-game/setting-the-equation/helpers/helpers.js

```
export function randInt(low, high) {
  const rndDec = Math.random();
  return Math.floor(rndDec * (high - low + 1) + low);
}
```

Conclusion

In this lesson, you have used your Vue and JavaScript skills to build out the Mathificent game. We have a couple of improvements to make, but the game is relatively usable at this point.

LESSON 5
Transitions and Animations

Topics Covered

☑ The `transition` Component.

☑ Adding a timer.

Introduction

Transitions and animations often make the difference between a user interface that's functional and a user interface that feels natural and looks great.

5.1. Using the transition Component

Vue's `transition` component creates `enter` and `leave` transitions on elements as they appear in and are removed from view. In its simplest form, the `transition` component wraps around an element and takes a `name` attribute that will add and remove CSS classes at appropriate timings:

```
<transition name="fade">
  <h1 v-show="visible">Hello, world!</h1>
</transition>
```

The above code will cause a series of CSS classes to be added and removed:

1. `fade-enter` – this is the starting state for the entering transition. It's added one frame before the element is inserted and removed one frame after it's inserted.
2. `fade-enter-active` – this class is active during the entire entering transition.
3. `fade-enter-to` – this is the ending state for the transition. It's added at the same time as the `-enter` class is removed.
4. `fade-leave` – this is the the starting state for the exit transition.
5. `fade-leave-active` – this class is active during the entire exit transition.

6. `fade-leave-to` – this is the ending state of the exit transition.

❖ 5.1.1. Transitioning with CSS

By itself, the transition component doesn't add transitions, but by assigning CSS transitions or animations to these classes, you can create interesting effects. Here is a simple example:

Demo 5.1: Vue/demo-viewer/src/components/transitions/Fade.vue

```
1.  <template>
2.    <div class="container">
3.      <button class="btn btn-primary" @click="visible = !visible">
4.        {{toggleCommand}}
5.      </button>
6.      <transition name="fade">
7.        <h1 v-show="visible">Hello, world!</h1>
8.      </transition>
9.    </div>
10. </template>
11.
12. <script>
13.   export default {
14.     name: "Fade",
15.     data: function() {
16.       return {
17.         visible: false,
18.       }
19.     },
20.     computed: {
21.       toggleCommand: function() {
22.         return (this.visible ? 'Hide' : 'Show');
23.       }
24.     }
25.   }
26. </script>
27.
28. <style scoped>
29.   .fade-enter {
30.     opacity: 0;
31.   }
32.
33.   .fade-enter-active {
34.     transition: opacity 5s;
35.   }
36.
37.   .fade-enter-to {
38.     opacity: 1;
39.   }
40.
41.   .fade-leave {
42.     opacity: 1;
43.   }
44.
```

```
45.     .fade-leave-active {
46.       transition: opacity 5s;
47.     }
48.
49.     .fade-leave-to {
50.       opacity: 0;
51.     }
52.   </style>
```

Code Explanation

If the demo-viewer app isn't already running, run `npm run serve` from the `demo-viewer` directory and then open `http://localhost:8080` in your browser. Then click the **Fade Transition** link under **Transitions**. Click the **Show** button to see the "Hello, world!" text fade in. The button label will change to "Hide". Click the **Hide** button to see the text fade out.

Fancy Transitions

Transitions can get really fancy. See `https://vuejs.org/v2/guide/transitions.html` for some demos showing the cool things you can do by combining CSS and JavaScript with Vue's `transition` element.

Exercise 13: Adding the Timer

15 to 25 minutes

We'll now finish the functionality of the game by adding a timer. When the timer runs out, the screen will switch from the game to a **Time's Up!** view. First, we'll make that switch abruptly, and then we will add a transition.

1. Add a new property in the `data` object of `Main` named `gameLength` and give it a default value of `60`.
2. Add a new `data` property named `timeLeft` and give it a default value of 0.
3. Add a new method named `startTimer()` that sets an interval that decrements `timeLeft` by `1` every second and then clears the timer when `timeLeft` is `0`:

```
startTimer() {
  this.timeLeft = this.gameLength;
  if (this.timeLeft > 0) {
    this.timer = setInterval(() => {
      this.timeLeft--;
      if (this.timeLeft === 0) {
        clearInterval(this.timer);
      }
    }, 1000)
  }
}
```


4. Call `startTimer` from inside the `play` method.

```
play() {
  this.screen = "play";
  this.newQuestion();
  this.startTimer();
}
```

5. Add a new method named `restart()` that sets `score` to `0`, restarts the timer, and gets a new question:

```
restart() {
  this.score = 0;
  this.startTimer();
  this.newQuestion();
}
```

6. Use the `v-if` and `v-else` directives to show a **Time's Up!** view if the value of `timeLeft` is `0`. The latter part of your `template` block of `Main` should now look like this (you can copy and paste the new code from the `starter-code.txt` file):

```
<template v-if="timeLeft === 0">
  <h2>Time's Up!</h2>
  <strong class="big">You Answered</strong>
  <div class="huge">{{score}}</div>
  <strong class="big">Questions Correctly</strong>
  <button class="btn btn-primary form-control m-1"
   @click="restart()">
      Play Again with Same Settings
  </button>
  <button class="btn btn-secondary form-control m-1"
   @click="config()">
      Change Settings
  </button>
</template>
<template v-else>
  <div class="row border-bottom" id="scoreboard">
    <div class="col px-3 text-left">
      <Score :score="score" />
    </div>
    <div class="col px-3 text-right">
      <Timer />
    </div>
  </div>
  <div :class="equationClass" id="equation">
    <Equation :question="question"
      :answer="input"
      :answered="answered" />
  </div>
  <div class="row" id="buttons">
    <div class="col">
      <button class="btn btn-primary number-button"
        v-for="button in buttons" :key="button"
        @click="setInput(button)">{{button}}</button>
      <button class="btn btn-primary" id="clear-button"
        @click="clear()">Clear</button>
    </div>
  </div>
</template>
```

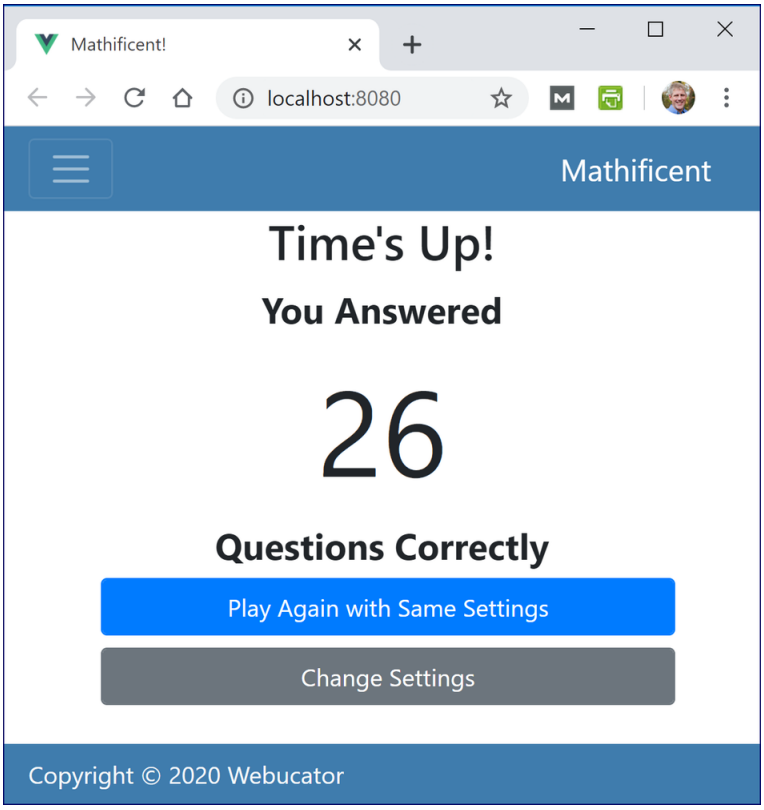

7. Pass the value of `timeLeft` into the `Timer` component as a `prop` and display it.

8. Finally, add the following two classes, which are used in the **Times Up!** screen, to `Main.vue`:

```
.big {
  font-size: 1.5em;
}

.huge {
  font-size: 5em;
}
```

9. Try out the game. The timer should count down and when it reaches `0`, the game should be replaced by the **Time's Up!** view:



Solution: Vue/Solutions/transitions-animations/adding-timer/Main.vue

```
1.   <template>
2.     <main id="main-container">
     -------Lines 3 through 10 Omitted-------
11.      <div v-else-if="screen === 'play'" id="game-container" class="text-center">
12.        <template v-if="timeLeft === 0">
13.          <h2>Time's Up!</h2>
14.          <strong class="big">You Answered</strong>
15.          <div class="huge">{{score}}</div>
16.          <strong class="big">Questions Correctly</strong>
17.          <button class="btn btn-primary form-control m-1"
18.            v-on:click="restart()">
19.              Play Again with Same Settings
20.          </button>
21.          <button class="btn btn-secondary form-control m-1"
22.            v-on:click="config()">
23.              Change Settings
24.          </button>
25.        </template>
26.        <template v-else>
     -------Lines 27 through 48 Omitted-------
49.        </template>
50.      </div>
51.    </main>
52.  </template>
53.
54.  <script>
     -------Lines 55 through 69 Omitted-------
70.      data: function() {
71.        return {
     -------Lines 72 through 84 Omitted-------
85.          score: 0,
86.          gameLength: 60,
87.          timeLeft: 0
88.        }
89.      },
90.      methods: {
     -------Lines 91 through 157 Omitted-------
158.       startTimer() {
159.         this.timeLeft = this.gameLength;
160.         if (this.timeLeft > 0) {
161.           this.timer = setInterval(() => {
162.             this.timeLeft--;
163.             if (this.timeLeft === 0) {
```

```
164.               clearInterval(this.timer);
165.             }
166.           }, 1000)
167.         }
168.       },
169.       restart() {
170.         this.score = 0;
171.         this.startTimer();
172.         this.newQuestion();
173.       }
174.     },
     -------Lines 175 through 195 Omitted-------
196.     }
197.   }
198. </script>
199.
200. <style scoped>
     -------Lines 201 through 227 Omitted-------
228.   .big {
229.     font-size: 1.5em;
230.   }
231.
232.   .huge {
233.     font-size: 5em;
234.   }
235. </style>
```


Solution: Vue/Solutions/transitions-animations/adding-timer/Timer.vue

```
1.   <template>
2.     <strong>Time Left: {{timeLeft}}</strong>
3.   </template>
4.
5.   <script>
6.     export default {
7.       name: 'Timer',
8.       props: {
9.         timeLeft: Number
10.      }
11.    }
12.  </script>
```

Exercise 14: Adding Transitions

15 to 25 minutes

Now that the game is complete, we'll add a cool sliding animation to transition between the game screen and the "Time's Up" screen.

1. Put an opening `<transition>` tag just before the `<template>` tag that tests whether the time is up. Give this `transition` element a `name` attribute with a value of "slide".

```
<transition name="slide">
  <template v-if="timeLeft === 0">
```

2. Wrap the "Time's Up" screen in a `div` element. A transition can be applied to any element that's rendered conditionally (meaning inside a `v-if` or a `v-show`), but it's only applied to a single element. In the case of our "Time's Up" screen, we have several elements. By wrapping them all in a single `div` element, however, we create the single element that the transition will be applied to.

```
<div>
  <h2>Time's Up!</h2>
  …
  </button>
</div>
```


3. Close the `transition` element after the closing `template` tag.
4. Change the `template` opening tag following the "Time's Up" screen so that it uses a `v-if` instead of `v-else`. This is necessary because `v-else` only works if it's the next element after a closing tag for an element that has a `v-if` directive.

```
<template v-if="timeLeft > 0">
```

5. Add a `transition` element around the game screen (just before the `template` tag you just edited) and give it a `name` attribute with a value of "slide-right":

```
<transition name="slide-right">
  <template v-if="timeLeft">
```

6. Wrap the code inside this `template` element with a `div` element.

7. Close the `transition` element after the closing `template` tag.
8. Start the development server and view the game as it is now. You'll notice that nothing has changed. To create the actual transition effects, we need to write some CSS.
9. Add the following CSS rules into the `style` section of the component. You can also copy them from the `starter-code.txt` file. These are the styles for the classes that will be added and removed during the transition of the "Time's Up" and game screens. Study these styles, along with the list of classes that get added and removed during a transition, and see if you can follow and predict what the transitions will look like.

```
.slide-leave-active,
.slide-enter-active {
  position: absolute;
  top: 56px;
  transition: 1s;
  width: 380px;
}
.slide-enter {
  transform: translate(-100%, 0);
  transition: opacity .5s;
}
.slide-leave-to {
  transform: translate(100%, 0);
  opacity:0;
}
.slide-right-leave-active,
.slide-right-enter-active {
  position: absolute;
  top: 56px;
  transition: 1s;
  width: 380px;
}
.slide-right-enter {
  transform: translate(100%, 0);
  transition: opacity .5s;
}
.slide-right-leave-to {
  transform: translate(-100%, 0);
  opacity:0;
}
```


10. Start your development server, if isn't already running, and play the game! When your time is up, the game screen should slide and fade to the side, while the "Time's Up" screen slides

and fades from the other side. When you start a new game from the "Time's Up" screen, the game screen will slide and fade into place. If you don't want to wait a full minute to see the transition, you can change the `gameLength` property to something short, like `5`.

Solution: Vue/Solutions/transitions-animations/adding-transitions/Main.vue

```
1.   <template>
     -------Lines 2 through 10 Omitted-------
11.      <div v-else-if="screen === 'play'" id="game-container" class="text-center">
12.        <transition name="slide">
13.          <template v-if="timeLeft === 0">
14.            <div>
15.              <h2>Time's Up!</h2>
     -------Lines 16 through 27 Omitted-------
28.          </template>
29.        </transition>
30.        <transition name="slide-right">
31.          <template v-if="timeLeft > 0">
32.            <div>
33.              <div class="row border-bottom" id="scoreboard">
     -------Lines 34 through 40 Omitted-------
41.              <div :class="equationClass" id="equation">
     -------Lines 42 through 45 Omitted-------
46.              <div class="row" id="buttons">
     -------Lines 47 through 54 Omitted-------
55.            </div>
56.          </template>
57.        </transition>
58.      </div>
59.    </main>
60.  </template>
     -------Lines 61 through 207 Omitted-------
208. <style scoped>
     -------Lines 209 through 242 Omitted-------
243.
244.   .slide-leave-active,
245.   .slide-enter-active {
246.     position: absolute;
247.     top: 56px;
248.     transition: 1s;
249.     width: 380px;
250.   }
251.
252.   .slide-enter {
253.     transform: translate(-100%, 0);
254.     transition: opacity .5s;
255.   }
```

```
256.
257.    .slide-leave-to {
258.      opacity:0;
259.      transform: translate(100%, 0);
260.    }
261.
262.    .slide-right-leave-active,
263.    .slide-right-enter-active {
264.      position: absolute;
265.      top: 56px;
266.      transition: 1s;
267.      width: 380px;
268.    }
269.
270.    .slide-right-enter {
271.      transform: translate(100%, 0);
272.      transition: opacity .5s;
273.    }
274.
275.    .slide-right-leave-to {
276.      opacity:0;
277.      transform: translate(-100%, 0);
278.    }
279. </style>
```

Exercise 15: Catching Keyboard Events

10 to 15 minutes

Finally, just to make our game a little more user friendly, let's catch keyboard events so the user can enter numbers with the keyboard.

1. In `Main.vue`, add a new method called `handleKeyUp` that handles `keyup` events:

```
handleKeyUp(e) {
  e.preventDefault(); // prevent the normal behavior of the key
  if (e.keyCode === 32 || e.keyCode === 13) { // space/Enter
    this.clear();
  } else if (e.keyCode === 8) { // backspace
    this.input = this.input.substring(0, this.input.length - 1);
  } else if (!isNaN(e.key)) {
    this.setInput(e.key);
  }
}
```


2. Now, add an event listener when the timer starts to capture `keyup` events, and remove this event listener when the timer clears:

```
startTimer() {
  window.addEventListener('keyup', this.handleKeyUp);
  this.timeLeft = this.gameLength;
  if (this.timeLeft > 0) {
    this.timer = setInterval(() => {
      this.timeLeft--;
      if (this.timeLeft === 0) {
        clearInterval(this.timer);
        window.removeEventListener('keyup', this.handleKeyUp);
      }
    }, 1000)
  }
```

3. Start your development server, if isn't already running, and play the game. You should be able to use your keyboard to answer questions. The **spacebar** and **Enter** keys should work like the **Clear** button, and the **Backspace** key should work to delete the last character added.

Solution: Vue/Solutions/transitions-animations/catching-keyboard/Main.vue

```
     -------Lines 1 through 165 Omitted-------
166.       startTimer() {
167.         window.addEventListener('keyup', this.handleKeyUp);
168.         this.timeLeft = this.gameLength;
169.         if (this.timeLeft > 0) {
170.           this.timer = setInterval(() => {
171.             this.timeLeft--;
172.             if (this.timeLeft === 0) {
173.               clearInterval(this.timer);
174.               window.removeEventListener('keyup', this.handleKeyUp);
175.             }
176.           }, 1000)
177.         }
178.       },
179.       restart() {
180.         this.score = 0;
181.         this.startTimer();
182.         this.newQuestion();
183.       },
184.       handleKeyUp(e) {
185.         e.preventDefault(); // prevent the normal behavior of the key
186.         if (e.keyCode === 32 || e.keyCode === 13) { // space/Enter
187.           this.clear();
188.         } else if (e.keyCode === 8) { // backspace
189.           this.input = this.input.substring(0, this.input.length - 1);
190.         } else if (!isNaN(e.key)) {
191.           this.setInput(e.key);
192.         }
193.       }
194.     },
     -------Lines 195 through 291 Omitted-------
```


Conclusion

In this lesson, you have learned how to use conditional rendering and transitions together to create dynamic effects and transitions in Vue user interfaces. You have also finished the Mathificent game by adding a timer and keyboard interaction. Congratulations!