Annotated Reading of the **Essentials** Section of the *Vue.js Guide*

From section *Introduction* to section *Computed Properties and Watchers*

Casiano

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Annotated Reading of the Essentials Section of the *Vue.js Guide*

These are my notes written in pandoc markdown (Casiano 2021) from reading the guide of Vue.js (v2) (Vue 2021), the book (Djirdeh, Murray, and Lerner 2018), (Vuejs 2021), (VueSchool 2018), (VueSchool 2019) and other references.

This document only covers the initial sections of the *Essentials* part of the Guide, from section *Introduction* up to section *Computed Properties and Watchers*.

These notes have been ellaborated using pandoc to translate it the markdown to HTML.

At the current time (December 2021), this notes are experimental, since the HTML generated by pandoc has some incompatibilities with Vue and I had to resort to some awful tricks to made them work.

1. I'm using the pandoc-include filter
2. The citation styles have been taken from (Org 2021).
3. The HTML generation is reached using (Mushiyo 2017), a Pandoc HTML template that has a navbar on the top of the page for website navigation, and a TOC (table of contents) on the sidebar for page navigation

To see the result, you can

1. Open the deployment in the GitHub pages https://crguezl.github.io/learning-vue-geting-started-guide/ of the repo crguezl/learning-vue-geting-started-guide containing the notes or
2. To install it locally, fork the repo. You have to have `pandoc` installed and then
    1. Run `npm install-pandoc-dependencies` to install `pandoc-include`
    2. Run `npm start` to compile the sources and open the resulting `index.html` file.

You can download the pdf version of this document here or by clicking in the left upper corner.

Introduction to Vue.js

Vue (pronounced /vju /, like view) is a progressive framework for building user interfaces.

Unlike other monolithic frameworks, Vue is designed from the ground up to be incrementally adoptable.

The core library is focused on the view layer only, and is easy to pick up and integrate with other libraries or existing projects.

On the other hand, Vue is also perfectly capable of powering sophisticated Single-Page Applications when used in combination with modern tooling and supporting libraries.

Simple example

At the core of Vue.js is a system that enables us to declaratively render data to the DOM using straightforward template syntax:

```
<!-- development version, includes helpful console warnings -->
<script src="https://cdn.jsdelivr.net/npm/vue@2/dist/vue.js"></script>


<h2>
  <div id="app">
    {{ message }}
  </div>
</h2>

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

Execution:

```
{{ message }}
```

We have already created our very first Vue app!

This looks pretty similar to rendering a string template, but Vue has done a lot of work under the hood. The data and the DOM are now linked, and everything is now reactive!.

Check in the developer's tools How do we know?

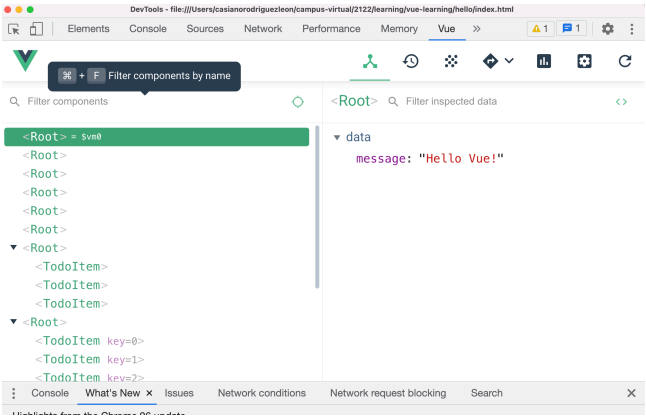
Open your browser's JavaScript console (right now, on the GH page) and

set app.message to a different value.

You should see the rendered example above update accordingly.

Exercise: Install Google Chrome extension for Vue

Install Google Chrome extension for Vue



Remember to config the extension to allow `file://` access

No interpolation occurs outside the Vue app entry point

This message appears verbatim:

```
<h3>{{ message }}</h3>
```

because it is outside the element to wich Vue has been anchored.

Execution:

{{ message }}

The v-bind directive

Here we define a second entry point for a second Vue app object:

```
<div id="app-2">
  <span v-bind:title="message">
    <strong>
      Hover your mouse over me for a few seconds
      to see my dynamically bound title!
    </strong>
  </span>
</div>

<script>
  var app2 = new Vue({
    el: '#app-2',
    data: {
      message: 'You loaded this page on ' + new Date().toLocaleString()
```

```
    }
  })
</script>
```

Execution:

Hover your mouse over me for a few seconds to see my dynamically bound title!

Here we are encountering something new.

1. The v-bind attribute you are seeing is called a directive.
2. Directives are prefixed with v- to indicate that they are special attributes provided by Vue, and as you may have guessed, they apply special reactive behavior to the rendered DOM.
3. Here, it is basically saying **keep this element's title attribute** up-to-date with the message property on the Vue instance.

If you open up your JavaScript console again and enter

app2.message = 'some new message',

you'll once again see that the bound HTML - in this case the title attribute - has been updated.

The `v-bind:attribute="expression"` directive is used to bind a `expression` to an HTML `attribute`.

Conditionals

It's easy to toggle the presence of an element, too:

```
<div id="app-3">
  <span v-if="seen">Now you see me</span>
</div>

<script>
var app3 = new Vue({
  el: '#app-3',
  data: {
    seen: true
  }
})
</script>
```

About this notes: This example initially didn't work due to `pandoc` modifying the directive `v-if` inside the source to `data-v-if`. I had to remove the `data-` prefix to make it work. See script `remove-data`in src/package.json. The same happens with some other directives.

Execution:

Now you see me

Loops: v-for

There are quite a few other directives, each with its own special functionality.

For example, the v-for directive can be used for displaying a list of items using the data from an Array:

```
<div id="app-4">
  <ol>
    <li v-for="todo in todos">
      {{ todo.text }}
    </li>
  </ol>
</div>

<script>
var app4 = new Vue({
  el: '#app-4',
  data: {
    todos: [
      { text: 'Learn JavaScript' },
      { text: 'Learn Vue' },
      { text: 'Build something awesome' }
    ]
  }
})
</script>
```

{{ todo.text }}

The `v-for` directive can be used also with objects.

```
<div id="appVforWithObjects" class="execution">
  <ul>
    <li v-for="(rent, city, index) in averageRent">
    {{ index }}: The average rent in {{ city }} is {{ rent }} €
    </li>
  </ul>
</div>

<script>
  let appVforWithObjects = new Vue({
    el: "#appVforWithObjects",
    data() {
      return {
        averageRent: {
```

```
        "Las Palmas": 747,
        "Santa Cruz de Tenerife": 787,
        "La Laguna": 691
      }
      }
    }
  })
</script>
```

Note that the order of arguments is `(value, key, index)`. The `value` goes first.

{{ index }}: The average rent in {{ city }} is {{ rent }} €

Handling User Input

```
<div id="app-5">
  <p>{{ message }}</p>
  <button v-on:click="reverseMessage">Reverse Message</button>
</div>

<script>
var app5 = new Vue({
  el: '#app-5',
  data: {
    message: 'Hello Vue.js!'
  },
  methods: {
    reverseMessage: function () {
      this.message = this.message.split('').reverse().join('')
    }
  }
})
</script>
```

{{ message }}

Reverse Message

v-model

Vue also provides the v-model directive that makes **two-way binding** between **form input** and **app state** a breeze:

```
<div id="app-6">
  <p>{{ message }}</p>
  <input v-model="message">
</div>
```

```
<script>
var app6 = new Vue({
  el: '#app-6',
  data: {
    message: 'Hello Vue!'
  }
})
</script>
```

Execution:

{{ message }}

The following example combines the `v-model` directive with the `v-if`, `v-else-if` and `v-else` directives:

```
<div id="appifvsshow" class="execution">
<strong>Select a dog:</strong>
<select v-model=selected><br/>
  <option value=0>First dog</option>
  <option value=1>Second dog</option>
  <option value=2>All the dogs</option>
</select>
<span>Selected option: {{ selected }}</span>
<p v-if="selected === '0'">First dog is {{ dogs[0] }}</p>
<p v-else-if="selected === '1'">Second dog is {{ dogs[1] }}</p>
<p v-else>All the dogs are {{ dogs }}</p>
</div>

<script>
let appifvsshow = new Vue({
  el: "#appifvsshow",
  data: {
    dogs: [ "terrier", "beagle", "chihuahua", "dalmatian" ],
    selected: null
  }
})
</script>
```

Select a dog: First dog Second dog All the dogs Selected: {{ selected }}

First dog is {{ dogs[0] }}

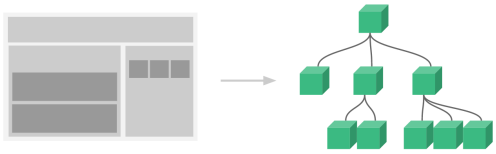
Second dog is {{ dogs[1] }}

All the dogs are {{ dogs }}

Composing with Components

The component system is another important concept in Vue, because it's an abstraction that allows us to build large-scale applications composed of small, self-contained, and often reusable components.

If we think about it, almost any type of application interface can be abstracted into a tree of components:



In Vue, a component is essentially a Vue instance with pre-defined options. Registering a component in Vue is straightforward:

```
// Define a new component called todo-item
Vue.component('todo-item', {
  template: '<li>This is a todo</li>'
})

var appXXX = new Vue({
  el: '#app-XXX',
  data: {
    groceryList: [
      { id: 0, text: 'Vegetables' },
      { id: 1, text: 'Cheese' },
      { id: 2, text: 'Whatever else humans are supposed to eat' }
    ]
  }
})
```

Now you can compose it in another component's template:

```
<div id="app-XXX">
  <ol>
    <todo-item
      v-for="item in groceryList"
    ></todo-item>
  </ol>
</div>
```

But this would render the same text for every todo, which is not super interesting:

Execution:

We should be able to pass data from the parent scope into child components.

Let's modify the component definition to make it accept a **prop**:

```
Vue.component('todo-item', {
  props: ['todo'],
  template: '<li>{{ todo.text }}</li>'
})
```

The `todo-item` component now accepts a "prop," which is like a *custom attribute*. This prop is called `todo`.

Now we can pass the `todo` into each repeated component using v-bind:

```
<div id="app-7">
  <ol>
    <todo-item
      v-for="item in groceryList"
      v-bind:todo="item"
      v-bind:key="item.id"
    ></todo-item>
  </ol>
</div>
```

Now when using the `todo-item` we bind the `todo` property to the `item` in the `groceryList` array so that its content can be dynamic.

We also need to provide each component with a "`key`," which will be explained later.

```
Vue.component('todo-item', {
  props: ['todo'],
  template: '<li>{{ todo.text }}</li>'
})

var app7 = new Vue({
  el: '#app-7',
  data: {
    groceryList: [
      { id: 0, text: 'Vegetables' },
      { id: 1, text: 'Cheese' },
      { id: 2, text: 'Whatever else humans are supposed to eat' }
    ]
  }
})
```

Execution:

Open the console and add to `app7.groceryList` a new item. See what happens.

See section Components Basics to know more about Vue Components.

In a large application, it is necessary to divide the whole app into components to make development manageable.

We will talk more about components later, but here's an (imaginary) example of what an app's template might look like with components:

```
<div id="app">
  <app-nav></app-nav>
  <app-view>
    <app-sidebar></app-sidebar>
    <app-content></app-content>
  </app-view>
</div>
```

The Vue Instance

Creating a Vue Instance

Every Vue application starts by creating a new Vue instance with the Vue function:

```
var vm = new Vue({
  // options
})
```

Although not strictly associated with the MVVM pattern, Vue's design was partly inspired by it. As a convention, we often use the variable `vm` (short for *ViewModel*) to refer to our Vue instance. (Vue 2021)

When you create a Vue instance, you pass in an options object. See the API.

These are the main properties of the options object:

- data
- props
- propsData
- computed
- methods
- watch

A Vue application consists of a root Vue instance created with `new Vue`, optionally organized into a tree of nested, reusable components.

For example, a todo app's component tree might look like this:

```
Root Instance
  TodoList
     TodoItem
       TodoButtonDelete
       TodoButtonEdit
```

```
TodoListFooter
   TodosButtonClear
   TodoListStatistics
```

All Vue components are also Vue instances, and so accept the same options object (except for a few root-specific options).

Data and methods

When a Vue instance is created, it adds all the properties found in its `data` object to Vue's reactivity system.

When the values of those properties change, the view will *react*, updating to match the new values.

```
// Our data object
var data = { a: 1 }

// The object is added to a Vue instance
var vm = new Vue({
  data: data
})

// Getting the property on the instance
// returns the one from the original data
vm.a == data.a // => true

// Setting the property on the instance
// also affects the original data
vm.a = 2
data.a // => 2

// ... and vice-versa
data.a = 3
vm.a // => 3
```

When this data changes, the view will re-render.

It should be noted that properties in data are only reactive if they existed when the instance was created. That means if you add a new property, like:

```
vm.b = 'hi'
```

Then changes to `b` will not trigger any view updates.

If you know you'll need a property later, but it starts out empty or non-existent, you'll need to set some initial value. For example:

```
data: {
  newTodoText: '',
```

```
  visitCount: 0,
  hideCompletedTodos: false,
  todos: [],
  error: null
}
```

The only exception to this being the use of `Object.freeze()`, which prevents existing properties from being changed, which also means the reactivity system can't track changes.

```
var obj = {
  foo: 'bar'
}

Object.freeze(obj)

new Vue({
  el: '#app',
  data: obj
})
```

```
<div id="app">
  <p>{{ foo }}</p>
  <!-- this will no longer update `foo`! -->
  <button v-on:click="foo = 'baz'">Change it</button>
</div>
```

In addition to data properties, Vue instances expose a number of useful instance properties and methods. These are prefixed with `$` to differentiate them from user-defined properties.

For example:

```
var data = { a: 1 }
var vm = new Vue({
  el: '#example',
  data: data
})

vm.$data === data // => true
vm.$el === document.getElementById('example') // => true

// $watch is an instance method
vm.$watch('a', function (newValue, oldValue) {
  // This callback will be called when `vm.a` changes
})
```

See Instance Properties in the API Reference.

Instance Lifecycle Hooks

Each Vue instance goes through a series of initialization steps when it's created - for example,

1. it needs to set up data observation,
2. compile the template,
3. mount the instance to the DOM, and
4. update the DOM when data changes.

Along the way, it also runs functions called **lifecycle hooks**, giving users the opportunity to add their own code at specific stages.

For example, the `created` hook can be used to run code after an instance is created:

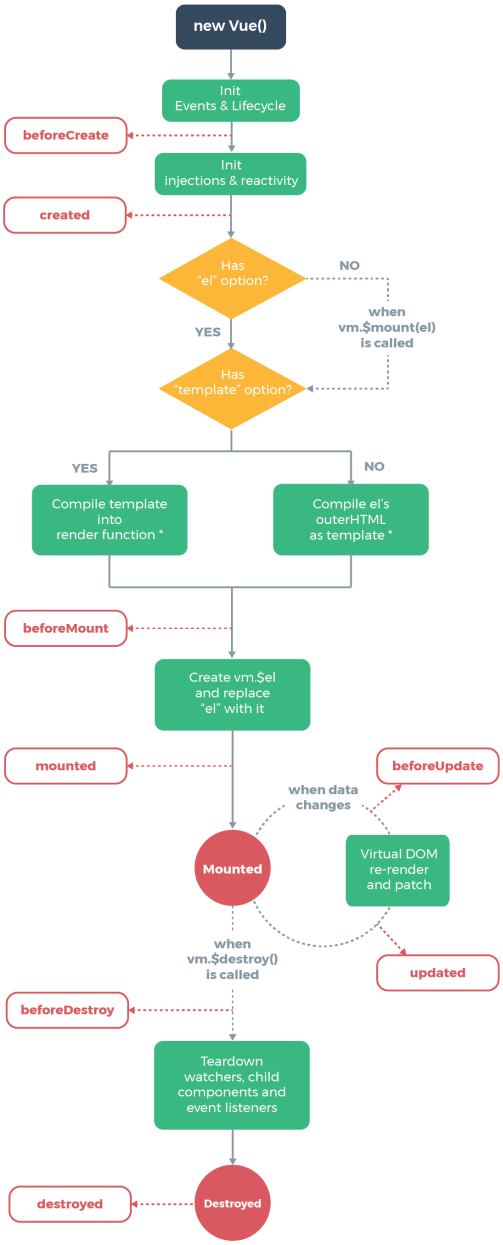
```
new Vue({
  data: {
    a: 1
  },
  created: function () {
    // `this` points to the vm instance
    console.log('a is: ' + this.a)
  }
})
// => "a is: 1"
```

There are also other hooks which will be called at different stages of the instance's lifecycle, such as `mounted`, `updated`, and `destroyed`.

All lifecycle hooks are called with their `this` context pointing to the Vue instance invoking it.

Lifecycle Diagram

Below is a diagram for the instance lifecycle. You don't need to fully understand everything going on right now, but as you learn and build more, it will be a useful reference.



* template compilation is performed ahead-of-time if using a build step, e.g. single-file components

Reactivity

What makes Vue different from any templating language?

Vue watches the `data` object for changes and updates the DOM when the data changes.

```
<div id="app-reactivity-1" class="execution">
  <p> {{ seconds }} have elapsed since you opened the page </p>
</div>
<script>
new Vue({
  el: "#app-reactivity-1",
  data: {
    seconds: 0
  },
  created() {
    setInterval(() => {
      this.seconds++
    }, 1000);
  }
})
</script>
```

The lifecycle hook `created` runs when the app is initiated.

{{ seconds }} have elapsed since you opened the page

How it works Vue's reactivity works by modifying every object added to the `data` object so that Vue is notified when it changes. Every property in an object is replaced with a getter and a setter so that you can use the object as a normal object, but when you change the property, Vue knows that it has changed.

The idea is that if you have some variable `userId`:

```
const data = {
  userId: 10
};
```

you can do something like this to control when `userId` changes:

```
const storedData = {};

storedData.userId = data.userId;

Object.defineProperty(data, 'userId', {
  get() {
    return storedData.userId;
  },
```

```
  set(value) {
    console.log('userId changed!');
    storedData.userId = value;
  },
  configurable: true,
  enumerable: true
})
```

Every component instance has a corresponding watcher instance, which records any properties **touched** during the component's render as dependencies.

Later on when a dependency's setter is triggered, it notifies the watcher, which in turn causes the component to re-render.

This isn't exactly how Vue does it, but it is a way to think about it. See (Macrae 2018).

Caveats There are some limitations on the way Vue's reactivity works.

Ading new properties to an object Because the getter/setter functions are added when the instance is initialized, only the properties defined at creation time are reactive; when you add later a new property, it won't be reactive if you do it directly.

```
<div id="appNewProperty" class="execution">
<a v-bind:href="formData.surname || 'unknown'">{{ formData.name }}</a>
</div>

<script>
const appNewProperty = new Vue({
  el: "#appNewProperty",
  data: {
    formData: {
      name: "Alan"
    }
  }
});

appNewProperty.formData.surname = "Turing"

</script>
```

If you set the mouse above the link you will see it points to `unknown` and not to `Turing`

{{ formData.name }}

Vue provides the function `Vue.set` that you can use to set reactive properties:

```
<div id="appNewPropertySet" class="execution">
<a v-bind:href="`assets/images/${formData.surname || 'unknown'}.png`">{{ formData.name }}</a
</div>

<script>
const appNewPropertySet = new Vue({
  el: "#appNewPropertySet",
  data: {
    formData: {
      name: "Alan",
    }
  }
});

Vue.set(appNewPropertySet.formData, "surname", "Turing");
</script>
```

If you set the mouse above the link you will see it points to `assets/images/Turing.png`

{{ formData.name }}

Setting items on an array You can't set items on an array by the index:

```
<div id="appSetItemOnArray" class="execution">
  <p>Computer Scientists: {{ cs }}</p>
  <p>cs[2] is {{ cs[2] }}</p>
</div>

<script>
const appSetItemOnArray = new Vue({
  el: "#appSetItemOnArray",
  data: {
    cs: ["Alan Turing", "John McCarty", "Denis Ritchie", "Ada Lovelace", "Grace Hopper"]
  }
});

appSetItemOnArray.cs[2] = "Alan Kay";
</script>
```

Computer Scientists: {{ cs }}

cs[2] is {{ cs[2] }}

However, you can use `Vue.set` to trigger the watchers:

```
<div id="appSetItemOnArray2" class="execution">
  <p>Computer Scientists: {{ cs }}</p>
  <p>cs[2] is {{ cs[2] }}</p>
</div>
```

```
<script>
const appSetItemOnArray2 = new Vue({
  el: "#appSetItemOnArray2",
  data: {
    cs: ["Alan Turing", "John McCarty", "Denis Ritchie", "Ada Lovelace", "Grace Hopper"]
  }
});

Vue.set(appSetItemOnArray2.cs, 2, "Alan Kay");
</script>
```

Computer Scientists: {{ cs }}

cs[2] is {{ cs[2] }}

Exercise: The instance lifecycle

A helpful resource to understand the instance lifecycle is the YouTube video (edutechional 2018). Watch the video and reproduce the steps. Leave the resulting code in the folder `lifecycle` of the assignment repo.

Template Syntax

Vue.js uses an HTML-based template syntax that allows you to declaratively bind the rendered DOM to the underlying Vue instance's data.

All Vue.js templates are valid HTML that can be parsed by spec-compliant browsers and HTML parsers.

Under the hood, Vue compiles the templates into Virtual DOM[1] render functions.

Combined with the reactivity system, Vue is able to intelligently figure out the minimal number of components to re-render and apply the minimal amount of DOM manipulations when the app state changes.

An Introduction to Render Functions

If you are familiar with Virtual DOM concepts and prefer the raw power of JavaScript, you can also directly write **render functions** instead of templates, with optional JSX support.

Here follows an example using a render function. Say you want to generate anchored headings:

[1]The virtual DOM (VDOM) is a programming concept where an ideal, or *virtual*, representation of a UI is kept in memory and synced with the "real" DOM by a library like Vue or React

```
<div id="app-XXX2" class="execution">
  <anchored-heading level="1">Section Hello</anchored-heading>
  Begining Blah blah ...
  <anchored-heading level="2">Subsection World</anchored-heading>
  Blah blah in subsection ...
    <anchored-heading level="1">Section Bye</anchored-heading>
  Blah blah final ...
</div>
```

In this case, we have to know a few things:

1. That children of a component are stored on the component instance at `this.$slots.default`,
2. That `render` has to produce the VDOM element using its argument `createElement`
3. How it works the createElement function passed to `render`

4. It is also convenient to know about the `v-slot` directive

```
<script>
Vue.component('anchored-heading', {
  render: function (createElement) {
    let default0 = this.$slots.default[0];
    let text = default0.text; // The text between the brackets
    console.log(default0);

    let name = text.replace(/\s+/g,'').replace(/\W+/g,'-');
    return createElement(
      'h' + this.level,
      [ createElement('a', // Building the child
                      { attrs:
                         {
                            name: name,
                            href: `#${name}`
                         }
                      },  text) ],
    )
  },
  props: [ "level" ]
})

var appXXX2 = new Vue({
  el: '#app-XXX2'
})
</script>
```

The example produces the following output:

Section Hello Begining Blah blah … Subsection World Blah blah in subsection … Section Bye Blah blah final …

Exercise: Introduction to Render Functions

See the video (Erik 2017). Reproduce the steps. Leave the result in the folder `renderfunctions` of the assignment repo.

Interpolations

Text The most basic form of data binding is text interpolation using the *Mustache* syntax (double curly braces):

```
<span>Message: {{ msg }}</span>
```

The mustache tag will be replaced with the value of the `msg` property on the corresponding data object. It will also be updated whenever the data object's `msg` property changes.

You can also perform one-time interpolations that do not update on data change by using the `v-once` directive, but keep in mind this will also affect any other bindings on the same node:

```
<span v-once>This will never change: {{ msg }}</span>
```

Check this example:

```
<h2 class="execution">
  <div id="appXXX4">
  <span>Message: {{ msg }}</span>
  <br/>
  <span v-once>This will never change: {{ msg }}</span>
  </div>
</h2>

<script>
  var appXXX4 = new Vue({
    el: '#appXXX4',
    data: {
      msg: 'Hello Vue!'
    }
  })
</script>
```

Open the dev tools, try to change `appXXX4.msg` and see what happens:

Message: {{ msg }} This will never change: {{ msg }}

Raw HTML The double mustaches interprets the data as plain text, not HTML. In order to output real HTML, you will need to use the `v-html` directive:

```
<p>Using mustaches: {{ rawHtml }}</p>
<p>Using v-html directive: <span v-html="rawHtml"></span></p>
```

The contents of the span will be replaced with the value of the `rawHtml` property, interpreted as plain HTML - data bindings are ignored.

See this example:

```
<div class="execution">
  <div id="appXXX5">
   <p>Using mustaches: {{ rawHtml }}</p>
   <p>Using v-html directive: <span v-html="rawHtml"></span></p>
  </div>
</div>

<script>
  var appXXX5 = new Vue({
    el: '#appXXX5',
    data: {
      rawHtml: '<i>Hello</i> {{ text }} <b>Vue</b>!',
      text: "Chazam!"
    }
  })
</script>
```

Using mustaches: {{ rawHtml }}

Using v-html directive:

Note that you cannot use `v-html` to compose template partials, because Vue is not a string-based templating engine.

Instead, components are preferred as the fundamental unit for UI reuse and composition.

Dynamically rendering arbitrary HTML on your website can be very dangerous because it can easily lead to XSS vulnerabilities.

Only use HTML interpolation on trusted content and never on user-provided content.

Attributes Mustaches cannot be used inside HTML attributes. Instead, use a `v-bind` directive:

```
<div v-bind:id="dynamicId"></div>
```

In the case of boolean attributes, where their mere existence implies `true`, `v-bind` works a little differently.

In this example:

```
<button v-bind:disabled="isButtonDisabled">Button</button>
```

If `isButtonDisabled` has the value of `null`, `undefined`, or `false`, the disabled attribute will not even be included in the rendered `<button>` element.

Using JavaScript Expressions So far we've only been binding to simple property keys in our templates. But Vue.js actually supports the full power of JavaScript expressions inside all data bindings:

```
{{ number + 1 }}

{{ ok ? 'YES' : 'NO' }}

{{ message.split('').reverse().join('') }}

<div v-bind:id="'list-' + id"></div>
```

These expressions will be evaluated as JavaScript in the data scope of the owner Vue instance.

One restriction is that each binding can only contain one single expression, so the following will NOT work:

```
<!-- this is a statement, not an expression: -->
{{ var a = 1 }}

<!-- flow control won't work either, use ternary expressions -->
{{ if (ok) { return message } }}
```

Template expressions are sandboxed and only have access to a whitelist of globals such as `Math` and `Date`.

You should not attempt to access user-defined globals in template expressions.

Directives

Directives are special attributes with the `v-` prefix.

Directive attribute values are expected to be a single JavaScript expression (with the exception of `v-for`, which will be discussed later).

A directive's job is to reactively apply side effects to the DOM when the value of its expression changes.

Let's review the example we saw in the introduction:

```
<p v-if="seen">Now you see me</p>
```

Here, the `v-if` directive would remove/insert the `<p>` element based on the truthiness of the value of the expression `seen`.

Arguments Some directives can take an *argument*, denoted by a colon after the directive name.

For example, the `v-bind` directive is used to reactively update an HTML attribute:

```
<a v-bind:href="url"> ... </a>
```

Here `href` is the argument, which tells the `v-bind` directive to bind the element's `href` attribute to the value of the expression `url`.

Another example is the `v-on` directive, which listens to DOM events:

```
<a v-on:click="doSomething"> ... </a>
```

Here the argument is the event name to listen to.

Dynamic Arguments Starting in version 2.6.0, it is also possible to use a JavaScript expression in a directive argument by wrapping it with square brackets:

Note that there are some constraints to the argument expression, as explained in the "Dynamic Argument Expression Constraints" section below.

```
<a v-bind:[attributeName]="url"> ... </a>
```

Here `attributeName` will be dynamically evaluated as a JavaScript expression, and its evaluated value will be used as the final value for the argument.

For example, if your Vue instance has a `data` property, `attributeName`, whose value is `"href"`, then this binding will be equivalent to `v-bind:href`.

Similarly, you can use dynamic arguments to bind a handler to a dynamic event name:

```
<a v-on:[eventName]="doSomething"> ... </a>
```

In this example, when `eventName`'s value is `"focus"`, `v-on:[eventName]` will be equivalent to `v-on:focus`.

Dynamic Argument Value Constraints Dynamic arguments are expected to evaluate to a string, with the exception of `null`. The special value `null` can be used to explicitly remove the binding. Any other non-string value will trigger a warning.

Dynamic Argument Expression Constraints Dynamic argument expressions have some syntax constraints because certain characters, such as spaces and quotes, are invalid inside HTML attribute names. For example, the following is invalid:

```
<!-- This will trigger a compiler warning. -->
<a v-bind:['foo' + bar]="value"> ... </a>
```

The workaround is to either use expressions without spaces or quotes, or replace the complex expression with a computed property.

When using in-DOM templates (i.e., templates written directly in an HTML file), you should also avoid naming keys with uppercase characters, as browsers will coerce attribute names into lowercase:

```
<!--
This will be converted to v-bind:[someattr] in in-DOM templates.
Unless you have a "someattr" property in your instance, your code won't work.
-->
<a v-bind:[someAttr]="value"> ... </a>
```

Modifiers Modifiers are special postfixes **denoted by a dot**, which indicate that a directive should be bound in some special way.

For example, the `.prevent` modifier tells the `v-on` directive to call event `.preventDefault()` on the triggered event:

```
<form v-on:submit.prevent="onSubmit"> ... </form>
```

Shorthands

The `v-` prefix serves as a visual cue for identifying Vue-specific attributes in your templates.

This is useful when you are using Vue.js to apply dynamic behavior to some existing markup, but can feel verbose for some frequently used directives.

At the same time, the need for the `v-` prefix becomes less important when you are building a SPA, where Vue manages every template.

Therefore, Vue provides special shorthands for two of the most often used directives, `v-bind` and `v-on`:

v-bind Shorthand

```
<!-- full syntax -->
<a v-bind:href="url"> ... </a>

<!-- shorthand -->
<a :href="url"> ... </a>

<!-- shorthand with dynamic argument (2.6.0+) -->
<a :[key]="url"> ... </a>
```

v-on Shorthand

```
<!-- full syntax -->
<a v-on:click="doSomething"> ... </a>
```

```
<!-- shorthand -->
<a @click="doSomething"> ... </a>

<!-- shorthand with dynamic argument (2.6.0+) -->
<a @[event]="doSomething"> ... </a>
```

They may look a bit different from normal HTML, but `:` and `@` are valid characters for attribute names and all Vue-supported browsers can parse it correctly.

In addition, they do not appear in the final rendered markup. The shorthand syntax is totally optional, but you will likely appreciate it when you learn more about its usage later.

Computed Properties and Watchers

Computed Properties

In-template expressions are very convenient, but they are meant for simple operations. Putting too much logic in your templates can make them bloated and hard to maintain. For example:

```
<div id="example">
  {{ message.split('').reverse().join('') }}
</div>
```

At this point, the template is no longer simple and declarative. You have to look at it for a second before realizing that it displays message in reverse. The problem is made worse when you want to include the reversed message in your template more than once.

That's why for any complex logic, you should use a computed property.

Basic Example

```
<div id="example">
  <p>Original message: "{{ message }}"</p>
  <p>Computed reversed message: "{{ reversedMessage }}"</p>
</div>

<script>
var vm = new Vue({
  el: '#example',
  data: {
    message: 'Hello'
  },
  computed: {
    // a computed getter
    reversedMessage: function () {
```

```
      // `this` points to the vm instance
      return this.message.split('').reverse().join('')
    }
  }
})
</script>
```

Result:

Original message: “{{ message }}”

Computed reversed message: “{{ reversedMessage }}”

Here we have declared a computed property `reversedMessage`.

The function we provided will be used as the getter function for the property `vm.reversedMessage`:

```
console.log(vm.reversedMessage) // => 'olleH'
vm.message = 'Goodbye'
console.log(vm.reversedMessage) // => 'eybdooG'
```

You can open the console and play with the example `vm` yourself. The value of `vm.reversedMessage` is always dependent on the value of `vm.message`.

You can data-bind to computed properties in templates just like a normal property.

Vue is aware that `vm.reversedMessage` depends on `vm.message`, so it will update any bindings that depend on `vm.reversedMessage` when `vm.message` changes.

And the best part is that we’ve created this dependency relationship declaratively:

the computed getter function has no side effects, which makes it easier to test and understand.

Computed Caching vs Methods You may have noticed we can achieve the same result by invoking a method in the expression:

```
<p>Reversed message: "{{ reverseMessage() }}"</p>
// in component
methods: {
  reverseMessage: function () {
    return this.message.split('').reverse().join('')
  }
}
```

Instead of a **computed** property, we can define the same function as a **method**. For the end result, the two approaches are indeed exactly the same.

However, the difference between methods and the computed properties is that the **computed properties are cached based on their reactive dependencies**.

A computed property will only re-evaluate when some of its reactive dependencies have changed.

This means as long as message has not changed, multiple access to the `reversedMessage` computed property will immediately return the previously computed result without having to run the function again.

This also means the following computed property will never update, because `Date.now()` is not a reactive dependency:

```
computed: {
  now: function () {
    return Date.now()
  }
}
```

In comparison, **a method invocation will always run the function whenever a re-render happens**.

Why do we need caching? Imagine we have an expensive computed property `A`, which requires looping through a huge Array and doing a lot of computations.

Then we may have other computed properties that in turn depend on `A`.

Without caching, we would be executing `A`'s getter many more times than necessary! In cases where you do not want caching, use a method instead.

Computed vs Watched Property Vue does provide a more generic way to observe and react to data changes on a Vue instance: **watch properties**.

When you have some data that needs to change based on some other data, it is tempting to overuse watch. However, it is often a better idea to use a computed property rather than an imperative watch callback. Consider this example:

```
<div id="demo">{{ fullName }}</div>
```

```
var vm = new Vue({
  el: '#demo',
  data: {
    firstName: 'Foo',
    lastName: 'Bar',
    fullName: 'Foo Bar'
  },
  watch: {
    firstName: function (val) {
```

```
      this.fullName = val + ' ' + this.lastName
    },
    lastName: function (val) {
      this.fullName = this.firstName + ' ' + val
    }
  }
})
```

The above code is imperative and repetitive. Compare it with a computed property version:

```
var vm = new Vue({
  el: '#demo',
  data: {
    firstName: 'Foo',
    lastName: 'Bar'
  },
  computed: {
    fullName: function () {
      return this.firstName + ' ' + this.lastName
    }
  }
})
```

Much better, isn't it?

Computed Setter Computed properties are by default getter-only, but you can also provide a setter when you need it:

```
// ...
computed: {
  fullName: {
    // getter
    get: function () {
      return this.firstName + ' ' + this.lastName
    },
    // setter
    set: function (newValue) {
      var names = newValue.split(' ')
      this.firstName = names[0]
      this.lastName = names[names.length - 1]
    }
  }
}
// ...
```

Now when you run `vm.fullName = 'John Doe'`, the setter will be invoked and `vm.firstName` and `vm.lastName` will be updated accordingly.

Watchers

While computed properties are more appropriate in most cases, there are times when a custom watcher is necessary.

That's why Vue provides a more generic way to react to data changes through the `watch` option.

This is most useful when you want to perform asynchronous or expensive operations in response to changing data.

For example:

```
<div id="watch-example">
  <p>
    Ask a yes/no question:
    <input v-model="question">
  </p>
  <p>{{ answer }}</p>
</div>
<!-- Since there is already a rich ecosystem of ajax libraries    -->
<!-- and collections of general-purpose utility methods, Vue core -->
<!-- is able to remain small by not reinventing them. This also   -->
<!-- gives you the freedom to use what you're familiar with.      -->
<script src="https://cdn.jsdelivr.net/npm/axios@0.12.0/dist/axios.min.js"></script>
<script src="https://cdn.jsdelivr.net/npm/lodash@4.13.1/lodash.min.js"></script>
<script>
var watchExampleVM = new Vue({
  el: '#watch-example',
  data: {
    question: '',
    answer: 'I cannot give you an answer until you ask a question!'
  },
  watch: {
    // whenever question changes, this function will run
    question: function (newQuestion, oldQuestion) {
      this.answer = 'Waiting for you to stop typing...'
      this.debouncedGetAnswer()
    }
  },
  created: function () {
    // _.debounce is a function provided by lodash to limit how
    // often a particularly expensive operation can be run.
    // In this case, we want to limit how often we access
    // yesno.wtf/api, waiting until the user has completely
    // finished typing before making the ajax request. To learn
    // more about the _.debounce function (and its cousin
    // _.throttle), visit: https://lodash.com/docs#debounce
```

```
    this.debouncedGetAnswer = _.debounce(this.getAnswer, 500)
  },
  methods: {
    getAnswer: function () {
      if (this.question.indexOf('?') === -1) {
        this.answer = 'Questions usually contain a question mark. ;-)'
        return
      }
      this.answer = 'Thinking...'
      var vm = this
      axios.get('https://yesno.wtf/api')
        .then(function (response) {
          vm.answer = _.capitalize(response.data.answer)
        })
        .catch(function (error) {
          vm.answer = 'Error! Could not reach the API. ' + error
        })
    }
  }
})
</script>
```

Result:

Ask a yes/no question:

{{ answer }}

Remember that `v-model` is a two-way binding for form inputs. It combines `v-bind`, which brings a JavaScript value from `.data` into the template, and `v-on:input` to update the JavaScript value.

The `v-model` directive works with all the basic HTML input types (`text`, `textarea`, `number`, `radio`, `checkbox`, `select`).

In this example this bidirectional behavior of `v-model` constitutes a problem since each time the user press a key the input changes producing a call to the watch handler function associated to changes in `question`.

```
  watch: {
    // whenever question changes, this function will run
    question: function (newQuestion, oldQuestion) {
      this.answer = 'Waiting for you to stop typing...'
      this.debouncedGetAnswer()
    }
  },
```

If we instead were calling directly `this.getAnwser()` then there is the risk of calling `axios.get('https://yesno.wtf/api')` for each pressed key. Something has to be done regarding this problem.

This is an example of how to use a lifecycle hook seen in section Lifecycle Diagram. When the Vue instance is created we use the `created` hook to create the `debouncedGetAnswer` method from the `getAnswer` method:

```
created: function () {
  this.debouncedGetAnswer = _.debounce(this.getAnswer, 500)
},
```

The call to the Lodash method `_.debounce(this.getAnswer, 500)`

```
_.debounce(func, [wait=0], [options={}])
```

creates a debounced function that delays invoking `func` until after `wait` milliseconds have elapsed since the last time the debounced function was invoked.

That alleviates the risk to throttle the network. Furthermore, inside `getAnswer` we check for the presence of a `?` character:

```
if (this.question.indexOf('?') === -1) {
  this.answer = 'Questions usually contain a question mark. ;-)'
  return
}
```

Doing nothing until the question mark appears.

In this case, using the `watch` option allows us

1. To perform an asynchronous operation (accessing an API),
2. With additional effort, to limit how often we perform that operation, and
3. Set intermediary states until we get a final answer.

None of that would be possible with a computed property.

The `watch` entry of the Vue instance has to be an object where

1. **keys** are expressions to watch and
2. **values** are the corresponding callbacks.
3. The value can also be a string of a method name, or an Object that contains additional options.
4. The Vue instance will call $watch() for each entry in the object at instantiation.

Note that you should not use an arrow function to define a watcher (e.g. `searchQuery: newValue => this.updateAutocomplete(newValue)`).

The reason is arrow functions bind the parent context, so this will not be the Vue instance as you expect and `this.updateAutocomplete` will be undefined.

In addition to the `watch` option, you can also use the imperative `vm.$watch` API.

Exercise: Examining Update Events with Computed Properties in Vue.js

Read *Examining Update Events with Computed Properties in Vue.js* (Hanchett and Listwon 2019), reproduce the examples and make a report in folder `examining-update-events-with-computed-properties` of the assignment repo.

Exercise: Vuejs Fundamentals

Follow the tutorial at (VueSchool 2018), reproduce the examples and leave the results in folder `vuejsfundamentals` of the assignment repo

The source is at repo vueschool/vuejs-fundamentals. The video seems to correspond to this commit: 844bdf75f6a17647e202813cf574a03a61541edf

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