The only introduction to Redux (and React-Redux) you'll ever need

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This article aims to explain the basic concepts of Redux and React Redux as simply and as clearly as possible, both through theory and examples by building three very simple applications.
It is divided into three parts — Redux alone, React-Redux for class components and React-Redux for functional components:

1. In the first part, we're going to take a look at Actions, Reducers and Store in Redux.
   Then, we are going to implement Redux in a simple, vanilla JavaScript application.
   Finally, we'll talk about initializing our application state and wiring up our application with the Redux DevTools browser extension.

2. In the second part, we are going to implement the same Redux application in React using class components and learn about React-Redux, the package that lets us connect with Redux from our React components.
3. In the third part, we are going to do the same implementation we did in the second part, but with functional components, utilizing the hooks that the React-Redux package offers. The application built in this part is added as a Git branch to the second application.
4. Finally, there is a bonus section which discusses the concepts of middleware and asynchronous actions in Redux. However, the code written there will not be included in any of the two GitHub projects.

The GitHub links to both projects:

- First application (Redux with vanilla JS)
- Second application (React with Redux) with class components
- Third application (React with Redux) with functional components

Note:

- Throughout the three parts, I will assume that you have a solid understanding of JavaScript and EcmaScript 6+
- Throughout the first part, I will assume that you have worked with NodeJS before (and have NodeJS and NPM installed on your computer) and at least know what Webpack and Babel are.
- Throughout the second part, I will assume that you are comfortable building a more complex application than a ToDo application in React and know what HOCs (Higher Order Components) are.
- Throughout the third part, I will assume that you at least understand the concepts of React hooks. If you don't, make sure you do.
- We won't write any styling in order to keep everything as simple as possible. I know what it's like when someone throws at you a bunch of unnecessary stuff at once for no reason and leaves you confused.
  However, a *src/index.css* is provided in applications two and three. So, if you

want to make your app look fancy, uncomment the appropriate line in *index.js* to include it.

- I won't enforce using any Redux browser extensions. We'll take a brief look at the Redux DevTools extension at the end of the first part of the article, but I would highly encourage you to get more familiar with it, since you will want to use it in almost all of your projects.
- I won't compare Redux with similar libraries like Flux. If you are interested in such topics, consider researching it on your own.

Also, I don't want this to be another ToDo tutorial (I'm sick of ToDo tutorials myself, it's like Hello World v2.0), so we're going to make an application for writing notes instead in which the user will be able to specify a title and a content for each note.

And without further ado, let's start learning!

Part One — Redux

Redux is a popular JavaScript library for managing the state of your application. It is very common and if you are working with React, chances are — you've already heard about it.

For those of you who have no idea what an application state is: it's like a global object which holds information that you use for various purposes later in the app (e.g. making decisions on which components to render and when, rendering the stored data etc).

An example that we face often is to display a loading indicator while the page is loading. In this case, if we used the store only for that purpose alone, the state object would store a boolean field whether the page is loaded and we'd use that field to toggle the display of the loading indicator.

Another example is — if we were to build a social media application, we would store several objects and arrays inside our application state — current user information, HTTP status, toast messages, notifications that the user would be getting, and if to be rendered in multiple places throughout the app — current posts and stories from the profiles the user is following, etc.

There are no rules as to which data should be kept in Redux, so, it's all up to you.

However, bear in mind to always store only serializable data.

Big applications have big application states and managing them gets more and more inconvenient as your app grows. Further, you may have components that make use of the same data, but are placed randomly in the DOM tree.
That's why we need state management libraries like Redux.

The way Redux works is fascinating and yet, so simple. Its pattern is very intuitive and its function names are self-explanatory. Trust me, you're going to love it!

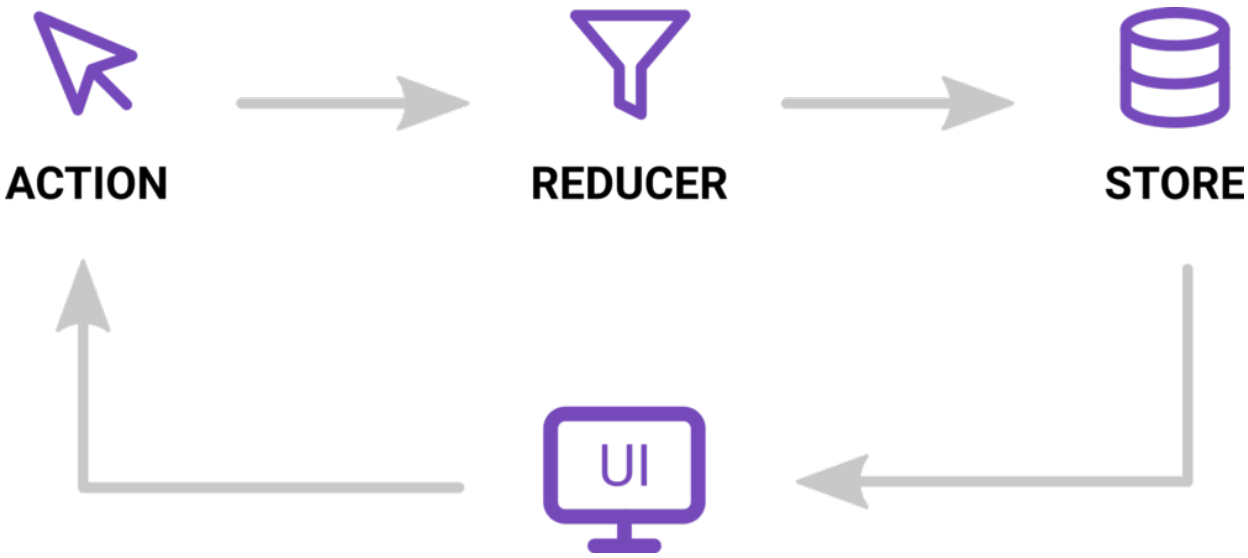
Before we dive into Redux, I want to mention two crucial patterns that Redux follows (and I would highly recommend you to always keep this information in the back of your mind while writing your Redux applications!):

One pattern that Redux follows is called "Single Source Of Truth", which means that we have only one place (called Store) where we store the only state for the whole application.
In other words, one app — one store — one state.

However, components in React or other frameworks are free to contain their own internal state as well. Normally, you wouldn't want to put literally everything in the application state.

Another pattern that Redux follows is called "immutability". And you will find this term quite often in other frameworks and libraries as well.
In short, immutability means that we don't change the state object and its properties directly. Instead, we make a new object, recalculate the new application state and update it with our newly created object. We want to leave our old state object intact.

The three building blocks of Redux



The three building blocks of Redux — Actions, Reducers and Store

Redux has 3 main parts:

1. Actions
2. Reducers
3. Store

Store

As you've already guessed, the store hold the state of the application.
The store is actually an object, not a class, although it may feel like one at first. It contains a few extra things other than your application's state as well (like functions and other objects).

Although, theoretically, it is possible to create multiple stores, this is against the pattern that Redux follows.
Remember, we create only one store per application!

We can subscribe to listen to events whenever the store updates. In a non-React app, we might use this subscription to update the UI, for example, as we will be doing in our application.

The state in Redux is in the form of a JavaScript Object and is often referred to as the "state tree". You can put whatever values you want to store in it and you can nest them as much as you need.

Actions

Actions are plain JavaScript objects that describe **WHAT** happened, but don't describe HOW the app state changes.

We just dispatch (send) them to our store instance whenever we want to update the state of our application. The rest is handled by the reducers, which we will familiarize ourselves with in just a moment.

One important thing to remember is that Redux requires our action objects to contain a type field. This field is used to describe what kind of action we are dispatching and it should usually be a constant that you export from a file.
All other fields in the action object are optional and are up to you.

For example: in the app that we're going to be building, whenever the user clicks the "Add Note" button, we will dispatch to our store something similar to the following action:

```
1  { type: ADD_NOTE, title: 'Some Title', content: 'This is an action object' }
```

action-example.js hosted with ❤️ by **GitHub** **view raw**

Notice, we are not handling any logic about how the store changes. We are only informing the store that we would like to add a new note with the provided title and content.
The title and content fields are optional. The type field, again, is required.

Another term that you'll often encounter is **Action Creators**.
They are basically functions that generate and return plain JavaScript objects. They are used so that we can "insert" dynamic data in our actions (or generate actions with dynamic data, in other words). In our case — we would have a function that accepts two parameters — title and content and it would return a plain JavaScript object with the information we provided.

```
1  function addNote(title, content) {
2    return { type: ADD_NOTE, title: title, content: content };
3  }
```

action-creator-example.js hosted with ❤️ by **GitHub** **view raw**

An action creator example

Reducers

Reducers are **pure** functions that define **HOW** the app state changes. In other words, they are used to recalculate the new application state or, at least a part of it.

Whenever we dispatch an action to our store, the action gets passed to the reducer. The reducer function takes two parameters: the previous app state, the action being dispatched and returns the new app state.

```
(previousState, action) => newState
```

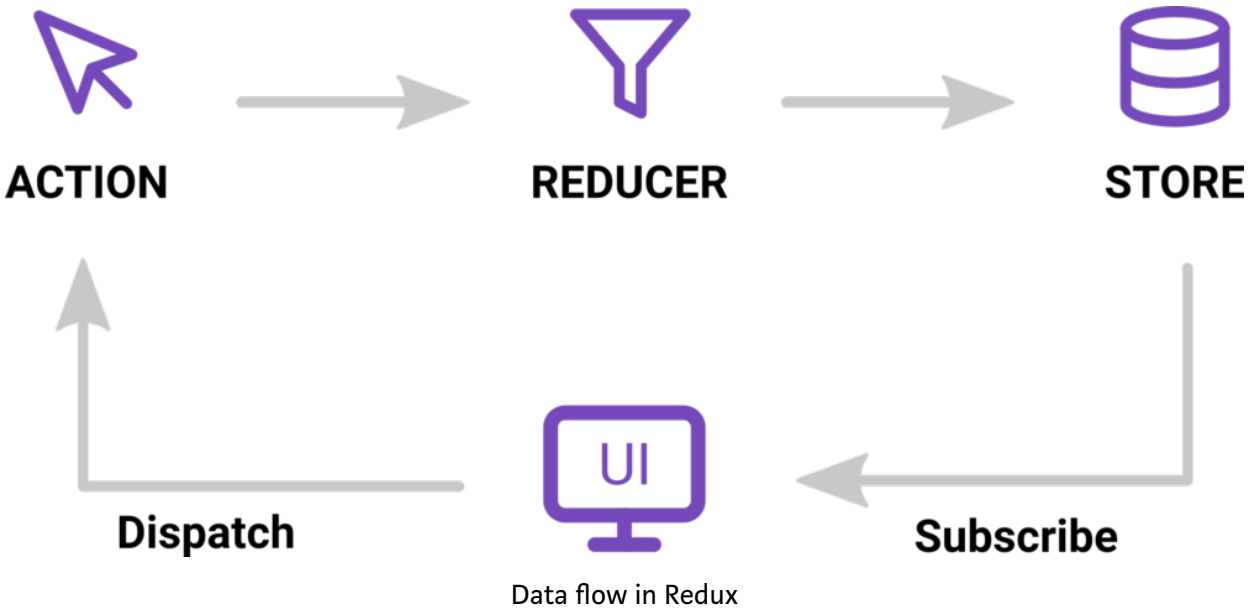
In other words, the reducer will calculate the new state of our app based on the action (and its type) we dispatched.

In a real-world application, your reducers most probably will get very complex. To deal with reducer complexity, we chunk them down in multiple, simpler reducers and later, we combine them with a Redux helper function called `combineReducers`.

The main reducer is conventionally called "Root Reducer".

Data Flow

Although it looks a bit complicated at first, the data flow in Redux is actually pretty simple.



Data flow in Redux

Let's say that the user triggers an event (for example, clicks the "Add Note" button) and the app state updates (i.e. a new note is inserted into the app state). Here's what happens under the hood:

1. The button click handler function *dispatches* an action to the store with the `store.dispatch()` method
2. Redux passes down the dispatched action to the reducer
3. The store saves the new state returned by the reducer
4. Since we have *subscribed* to the store, the function we provided will be called and it will update the UI accordingly (i.e., append the new note in the list of notes)

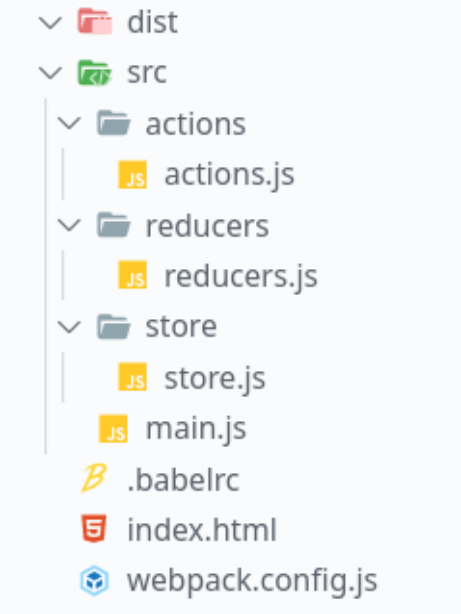
Setting up our app

Let's now start creating our first application.

- If you're on Linux or a Mac, just navigate to your projects directory and paste this in the terminal. It'll save you the trouble from having to create all the necessary files and folders by hand:

```
mkdir -p redux-notes-app/{dist,src/{actions,reducers,store}} &&
cd redux-notes-app && touch
{index.html,.babelrc,webpack.config.js,src/{actions
/actions.js,reducers/reducers.js,store/store.js,main.js}}
```

- If you're on Windows, create the necessary files and folders manually and make sure your folder structure is the same as mine:



- Inside your new project's directory run the following commands:

```
npm init -y

npm i redux webpack webpack-cli @babel/core babel-loader
@babel/preset-env --save-dev

// --- Yarn alternative --- //

yarn init -y

yarn add redux webpack webpack-cli @babel/core babel-loader
@babel/preset-env --dev
```

- Inside the `webpack.config.js` file insert the following content

```
const path = require('path');

const config = {
  entry: './src/main.js',
  output: {
    path: path.resolve(__dirname, 'dist'),
    filename: 'bundle.js',
  },
  module: {
    rules: [
      {
        test: /\.(js|jsx)$/,
        exclude: /node_modules/,
        use: {
          loader: 'babel-loader',
        },
      },
    ],
  },
};

module.exports = config;
```

The webpack.config.js file

- Inside the `.babelrc` file, add the following content

```
{
  "presets": ["@babel/preset-env"]
}
```

.babelrc hosted with ❤️ by **GitHub** **view raw**

The .babelrc file

- Inside the `package.json` file, add the following line in the scripts object

```
"dev": "webpack --watch --mode=development"
```

- Finally, run

```
npm run dev
// or, yarn run dev
```

And let's get down to business!

Defining our App State

Before you even start writing code, it's always a good practice to get a piece of paper and write down all the features of your application, draw schemes about how everything is interconnected and try to work out what you need in the application state and how the app state should look like at the end.

In other words, don't jump straight into writing code and do some planning instead!

> *"Every minute you spend in planning saves 10 minutes in execution; this gives you a 1,000 percent Return on Energy!" — Brian Tracy*

At the end, let's assume that our application state is going to look like this:

```
{
  notes: [
    {
      title: 'Note 1 Title',
      content: 'Note 1 Content'
    },
    {
      title: 'Note 2 Title',
      content: 'Note 2 Content'
    },

    ...

    {
      title: 'Note N Title',
      content: 'Note N Content'
    }
  ]
}
```

Each object inside the notes array will represent a single note.

In other words, our app state will be a very simple object consisting of only one property, notes, which will be an array of objects(individual notes).
Since we're not using an API, we'll assume that the IDs of the notes will be their indexes in the array — hence the missing ID field in the final note format.

Initial code

I've prepared some initial code that we're going to need for our application. Insert the following code in your `index.html` file:

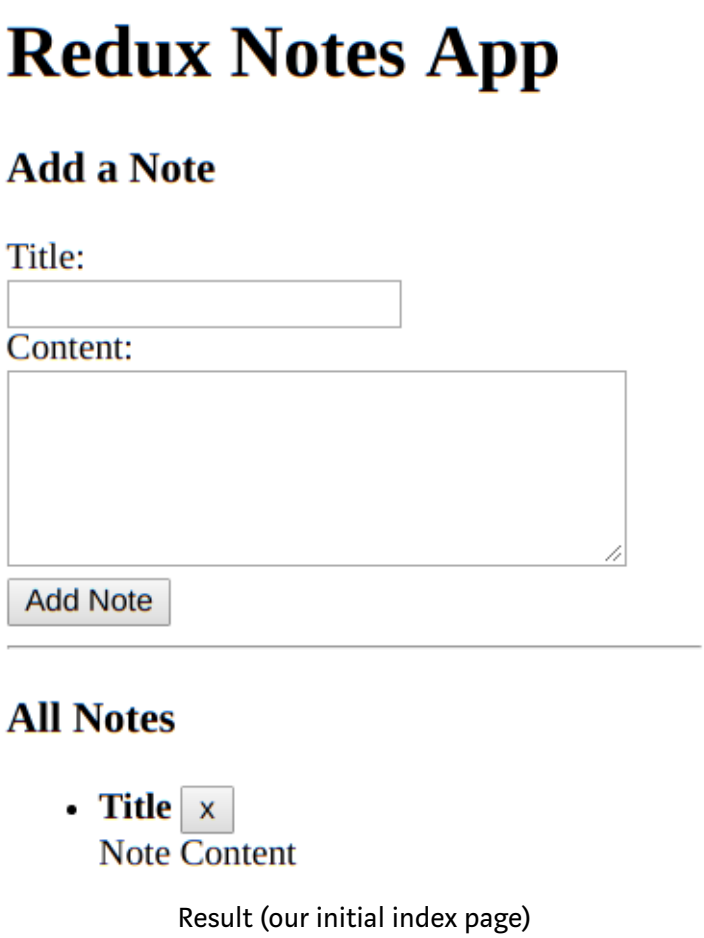
```html
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <meta http-equiv="X-UA-Compatible" content="ie=edge" />
    <title>Redux Notes</title>
  </head>
  <body>
    <h1>Redux Notes App</h1>

    <h3>Add a Note</h3>
    <form id="add-note">
      Title: <br />
      <input type="text" name="title" />
      <br />
      Content: <br />
      <textarea name="content" cols="30" rows="5"></textarea>
      <br />
      <button type="submit">Add Note</button>
    </form>

    <hr />

    <h3>All Notes</h3>
    <ul id="notes">
      <li>
        <b>Title</b>
        <button data-id="5">x</button>
        <br />
        <span>Note Content</span>
      </li>
    </ul>

    <script src="./dist/bundle.js"></script>
```

index.html

Now insert this code in your `src/main.js` file:

```
// ------ HTML references ------
let notesUList = document.getElementById('notes');
let addNoteForm = document.getElementById('add-note');
let addNoteTitle = addNoteForm['title'];
let addNoteContent = addNoteForm['content'];

// ------ Redux ------
function deleteNote(index) {
  // console.log(index);
}

function renderNotes() {
  setDeleteNoteButtonsEventListeners();
}

// ------ Event Listeners ------
addNoteForm.addEventListener('submit', (e) => {
  e.preventDefault();

  // console.log('Title:', addNoteTitle.value, 'Content:', addNoteContent.value
});

function setDeleteNoteButtonsEventListeners() {
  let buttons = document.querySelectorAll('ul#notes li button');

  for (let button of buttons) {
    button.addEventListener('click', () => {
      deleteNote(button.dataset.id);
    });
  }
}
```

stc/main.js



Result (our initial index page)

As you can see, we have quite a simple form with only title and content fields.
This form will be used for adding new notes.

The `ul#notes` is where we'll be rendering all of our notes as list items.
There is one hard-coded list item that serves as a template for what our notes will look like, which we will remove from our code right away.

We will let the user delete their notes as well by pressing the button right to the note's title. The `data-id` attribute on the button will help us get the id (index) of the note we'll be deleting, thus giving us the idea about which note we should delete.

Actions

Now that we know what we're going to do, let's start creating an action for adding a note.
Inside `actions.js`, we're going to add our initial code:

```
1  export const ADD_NOTE = 'ADD_NOTE';
2
3  export function addNote(title, content) {
4    return { type: ADD_NOTE, title: title, content: content };
5  }
```

actions-1.js hosted with ❤️ by GitHub view raw

src/actions/actions.js

Let me go line by line here to explain what's going on:

1. We are exporting a constant ADD_NOTE, since we're going to be needing it in several places later on.
   Yes, we could've gone everywhere writing the string 'ADD_NOTE', but that's just bad, bad practice! Imagine your project growing huge and out of the blue your boss says: "rename the ADD_NOTE action to ADD_NEW_NOTE". See where I'm going with this?

2. We are exporting the function `addNote` . As we've discovered earlier, this function is an action creator, which means that its job is to only return a plain object. And notice — it's not doing any logic. It just returns an object. Because, as we said before — actions define **WHAT** changed, not HOW!

This is the convention of Redux about actions.
It might look a little weird, but exporting constants and action creators is the most logical way to go about it, trust me.

Reducers

Before we create the store and start dispatching actions, let's create our main (root) reducer first:

```
import { ADD_NOTE } from '../actions/actions';

const initialState = {
  notes: [],
};

function rootReducer(state = initialState, action) {
  switch (action.type) {
    case ADD_NOTE:
      return {
        notes: [
          ...state.notes,
          {
            title: action.title,
            content: action.content,
          },
        ],
      };

    default:
      return state;
  }
}

```

src/reducers/reducers.js

As you can see, we are declaring an initial state object for our reducer, which in this case, turns out to be the state of the entire application because this is the only reducer in our app.

Just like we said before, reducers receive 2 parameters — previous state and the action being dispatched.
We are checking what the action type is and depending on its value, we are returning the new state.

Remember, we **NEVER** modify the state directly! We want to keep all our reducers immutable!
Notice, after all our cases are exhausted, we simply return our app state (more on this later, but this has to do with Redux initialization).

Note:

```
case ADD_NOTE:
  return {
    notes: [
      ...state.notes,
      {
        title: action.title,
        content: action.content
      }
    ]
  };
```

Here, we are returning the entire new state object of our app and we **assume** that the notes property is **the only** property of our new state.
If we had other properties in our previous state, they would get lost because we are not keeping them.

In cases where you have other properties and you don't want them to get excluded from your new state, use the spread operator before or after the notes property:

```
case ADD_NOTE:
  return {
    ...state, // <- like so
    notes: [
      ...state.notes,
      {
        title: action.title,
        content: action.content
      }
    ]
  };
```

One more thing: if the switch statement is hurting your eyes, you are fine going with if statements as well! However, more often than not, you will reach for the switch statement and over time you'll grow to like it.

Store

Let's now create our app store!

```
1  import { createStore } from 'redux';
2  import rootReducer from '../reducers/reducers';
3
4  export default createStore(rootReducer);
```

store-1.js hosted with ❤️ by **GitHub** **view raw**

src/store/store.js

Redux has this `createStore` function, which is remarkably simple and self-explanatory — it is used for creating the application store.
It accepts 3 parameters (the last 2 are optional), but for now, we're going to use only the first one, which accepts the root reducer of your application.

Next, we're going to import the store in our `main.js` file and dispatch some actions to see what our state looks before and after adding a few notes.

```
1  import store from './store/store';
2  import { addNote } from './actions/actions';
3
4  // We use store.getState() to get our app state from the store
5
6  console.log('Before:', store.getState());
7  store.dispatch(addNote('One', 'One content'));
8  store.dispatch(addNote('Two', 'Two content'));
9  store.dispatch(addNote('Three', 'Three content'));
10 console.log('After:', store.getState());
```

Excerpt from src/main.js

```
Before: {notes: Array(0)}
          notes: []
          __proto__: Object
After: {notes: Array(3)}
          notes: Array(3)
            0: {title: "One", content: "One content"}
            1: {title: "Two", content: "Two content"}
            2: {title: "Three", content: "Three content"}
              length: 3
            __proto__: Array(0)
          __proto__: Object
```

Chrome DevTools console

Adding Notes

To add a new note, we'll simply add 3 new lines in the form event handler:

```
addNoteForm.addEventListener('submit', (e) => {
  e.preventDefault();

  let title = addNoteTitle.value;
  let content = addNoteContent.value;
  store.dispatch(addNote(title, content));
});
```

main_addnoteseventlistener.js hosted with ❤ by GitHub view raw

Excerpt from src/main.js

All we're doing is simply dispatching an action to our store!
Our action creator object returns an object with the title and content values we are feeding it, which in fact are the content we put into our form fields. And that's it!

(re)Rendering Notes

As we mentioned earlier, the store in Redux is an object. It has a function called `subscribe`, which we can use for subscribing to changes made to the state tree, i.e. whenever we dispatch an action to the store.
We'll use the subscribe method to our advantage and use the subscription to re-render our notes.

Note: we're going to simply re-render all the Notes in our unordered list. Conversely, if you're using a framework / library like React, Angular or Vue, there's probably going to be some optimized diffing algorithm that will calculate what needs to be updated and save you the trouble of having to do this on your own or even completely re-rendering stuff in your DOM, like we do.

We're first going to update our `renderNotes` function:

```
function renderNotes() {
  let notes = store.getState().notes;

  notesUList.innerHTML = '';
  notes.map((note, index) => {
    let noteItem = `
      <li>
        <b>${note.title}</b>
        <button data-id="${index}">x</button>
        <br />
        <span>${note.content}</span>
      </li>
    `;
    notesUList.innerHTML += noteItem;
  });

  setDeleteNoteButtonsEventListeners();
}
```

Excerpt from src/main.js

And we're now going to subscribe to the store:

```
store.subscribe(() => {
  renderNotes();
});
```

main-storesubscribe.js hosted with ❤️ by **GitHub** **view raw**

Excerpt from src/main.js

Now, go back to your page and try to add a new Note!
It feels like magic, doesn't it?!

Unsubscribing from the store

If you want for some reason to unsubscribe from the store, the `store.subscribe` function returns a function. Thus, by calling that function we unsubscribe from the store:

```
const unsubscribe = store.subscribe(() => {
  renderNotes();
});

unsubscribe();
// Adding new notes won't trigger a change in the UI now
```

main-storeunsubscribe.js hosted with ❤ by GitHub view raw

Removing Notes

First, we'll go to our `actions.js` file and add a new constant and a new action creator.

```
export const REMOVE_NOTE = 'REMOVE_NOTE';

export function removeNote(id) {
  return { type: REMOVE_NOTE, id: id };
}
```

actions-removenote.is hosted with ❤ by **GitHub** **view raw**

Excerpt from src/actions/actions.js

Next, we'll go to our `reducers.js` file and add a new case to our switch statement (remember to import `REMOVE_NOTE` as well).

```
case REMOVE_NOTE:
  return {
    notes: state.notes.filter((note, index) => index != action.id)
  };
```

reducers-removenote.js hosted with ❤ by **GitHub** **view raw**

Excerpt from src/reducers/reducers.js

Finally, we'll update the `deleteNote` function in `main.js`.

```
function deleteNote(index) {
  store.dispatch(removeNote(index));
}
```

main-deletenote.js hosted with ❤ by **GitHub** **view raw**

Excerpt from src/main.js

Voilà! Now our users can delete notes. As easy as pie.

Initializing State

Before we get into initializing our app state, it would be wise to take a second look at reducers and really understand what's going on:

1) Each reducer has its own state, which might be different from the app state (e.g., you might have more than one reducer).
Now, because we only have one reducer (the root reducer), it ends up being the state of our app.

2) When Redux initializes our app, it sends an action that won't satisfy any of our cases in the switch statement.
In fact, if we log the action type it in the console, this is what we'll get the first time we visit the page:

Chrome DevTools console

Because we didn't supply an initial state of the app, the state is undefined, so it defaults back to our `initialState` object.

3) Your apps will most likely have more than one reducer, because they will be far more complex than a simple note / todo application.
In such cases, you will want to write multiple reducers.

Redux provides a function called `combineReducers` that lets us combine multiple reducers and pass them down to the `createStore` function as if they were a single reducer.

Here's where it gets interesting:
Inside the `combineReducers` function, we pass an object of our reducers. Each reducer handles its own part of the application state (reducers now don't care about the app state as a whole). Redux then builds the state of the application from all the keys and values of the object.

First, we'll create a new file `notesReducer.js` inside the `src/reducers` directory to

which we will move the code from the `src/reducers/reducers.js` file and modify it a little:

```
import { ADD_NOTE, REMOVE_NOTE } from '../actions/actions';

function notesReducer(notes = [], action) {
  switch (action.type) {
    case ADD_NOTE:
      return [
        ...notes,
        {
          title: action.title,
          content: action.content,
        },
      ];

    case REMOVE_NOTE:
      return notes.filter((note, index) => index != action.id);

    default:
      return notes;
  }
}

export default notesReducer;
```

src/reducers/notesReducer.js

Note: I've changed the first parameter from state to notes.
Since our reducer will only manage notes, it will always return an array. Any other piece of the state won't be passed down in the reducer!

Next, we'll add another reducer. Let's call it `visibilityFilter`. It will handle filtering notes by visibility.
Note: Because this article is getting really large, we won't write the UI for this part or extend the the visibility filter feature. That'll be for your homework!
Hint: To utilize the visibility filter, one option would be to add a `tags` field in your note objects. Then, you can add a couple of tags (e.g. archived and important) and add actions for changing the tags of a single note. Finally, add a *select* element that will help show only the notes tagged with archived, important or all notes.

```
import { SHOW_ALL } from '../actions/actions';

function visibilityFilter(visibility = SHOW_ALL, action) {
  switch (action.type) {
    case SHOW_ALL:
      return SHOW_ALL;

    default:
      return visibility;
  }
}

export default visibilityFilter;
```

src/reducers/visibilityFilter.js

Notice how we deal with only the visibility part of the state and we're not interested neither in the notes part of the application state nor the whole app state? That's why Redux is so powerful and awesome!

In the `actions.js` file, insert the following content:

```
export const SHOW_ALL = 'SHOW_ALL';

export function showAll() {
  return { type: SHOW_ALL };
}
```

actions-showall.is hosted with ❤️ by **GitHub** **view raw**

Excerpt from src/actions/actions.js

We are now going to combine the reducers in our `reducers.js` file.

```
import notesReducer from './notesReducer';
import visibilityFilter from './visibilityFilter';
import { combineReducers } from 'redux';

const reducers = combineReducers({
  notes: notesReducer,
  visibility: visibilityFilter,
});

export default reducers;
```

src/reducers/reducers.js

Finally, let's rewrite the `store.js` file to be more descriptive:

```
import { createStore } from 'redux';
import reducers from '../reducers/reducers';

export default createStore(reducers);
```

store-2.js hosted with ❤ by **GitHub** **view raw**

src/store/store.js

If we now try to log our state application in our `main.js` file, this is what we'll get:

```
▶ {notes: Array(0), visibility: "SHOW_ALL"}
```

Chrome DevTools console

See? Our state ended up as an object with the keys that we provided in the `combineReducers` function and each of our reducers manages its own piece of the state. Beautiful!

4) As the second parameter of the `createStore` function, we can supply the initial state of the application. This will overwrite any default values we have in our reducers.

Our application's initial state after being logged in Chrome's DevTools console

For example, if we kept a copy of our previous app's state in local storage, we would've gotten its value before supplying it as a second parameter.
However, make sure you only feed the second parameter synchronous data (the local storage API is synchronous, so no trouble there!).

"All right, but what if I want to load my initial state from an API instead?".
- Well, in that case, the easiest workaround you have is to load the data when some (for example, the root) component renders for the first time and dispatch as many actions as you need upon your API data arrival.
Of course, this means that by the time your API data arrives, Redux will be done initializing and you will still have default reducer data in your initial state, but there's nothing wrong with that. A simple loading indicator won't hurt your users!

Connecting our app with Redux DevTools browser extensions

The Redux DevTools extension is a very powerful tool.
I didn't want to force you using this until you were ready because I'm sure it would've felt a little overwhelming in the beginning of this article.

Anyway, add this line as the third parameter of the `createStore` function:

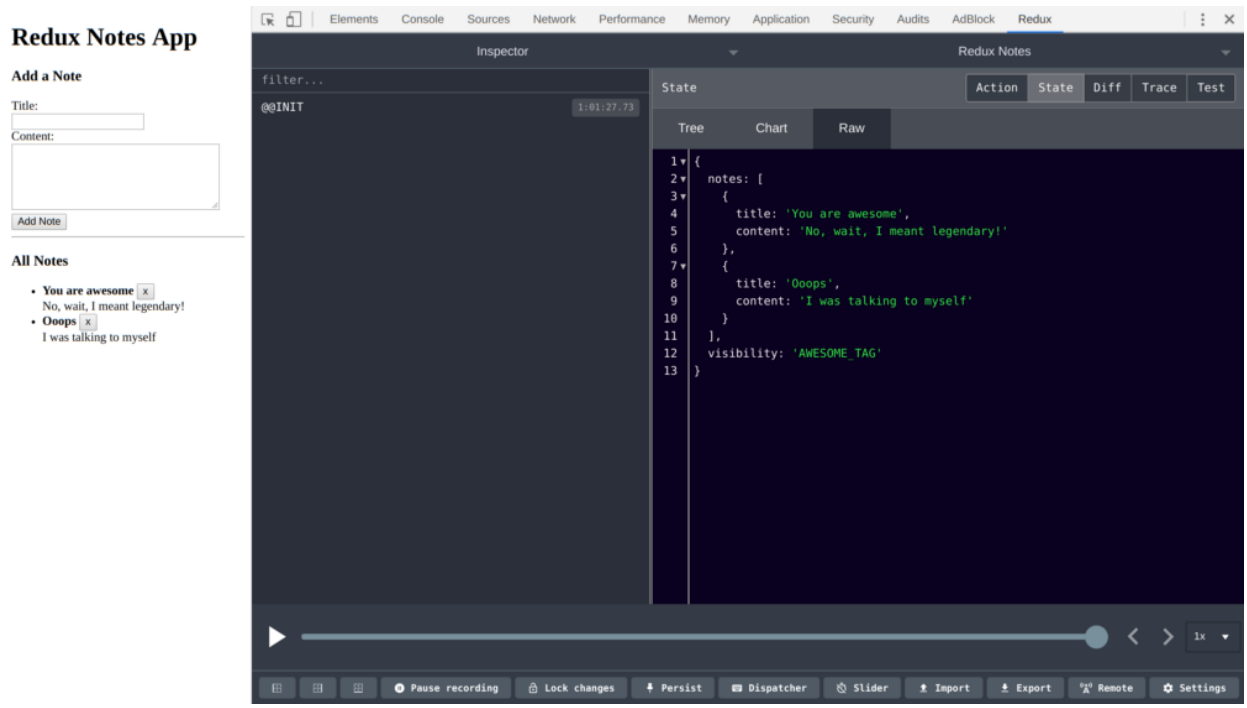
```
window.__REDUX_DEVTOOLS_EXTENSION__ &&
window.__REDUX_DEVTOOLS_EXTENSION__()
```

This is how your `store.js` file should look like now:

```
import { createStore } from 'redux';
import reducers from '../reducers/reducers';

let initialState = {
  notes: [
    { title: 'You are awesome', content: 'No, wait, I meant legendary!' },
    { title: 'Ooops', content: 'I was talking to myself' },
  ],
  visibility: 'AWESOME_TAG',
};

export default createStore(
  reducers,
  initialState,
  window.__REDUX_DEVTOOLS_EXTENSION__ && window.__REDUX_DEVTOOLS_EXTENSION__()
);
```

src/store/store.js

If you're not supplying an initial state of your application, just pass *undefined* as the second parameter and it should be okay.



Feel free to explore the Redux DevTools extension on your own

For more complex apps, however, make sure you check out the Redux DevTools extension docs.

The third parameter in the `createStore` function is where we'd put enhancers such as middleware in Redux. Make sure to check out the bonus section at the end of the article to learn about these concepts!

That's it about our first project. You can find it on GitHub here.

Part Two and Part Three prerequisite

As stated before, both applications from part two and three are going to be contained in the same GitHub project. You can find the application from the second part on the *master* branch, while the third one on the *hooks* branch.
We will be using create-react-app for creating both applications.

There is a package called react-redux which we use to wire up our React components with Redux. We are going to use this package in both, second and third parts in this article.

You can install both Redux and React-Redux packages by opening up a terminal window in your React project's directory and executing the following command:

```
npm i redux react-redux
// or, yarn add redux react-redux
```

Note: for the sake of keeping this example as simple as possible we won't implement the visibility filter in this project.

There are two things we need to know about React-Redux:

1) React-Redux provides a React component called Provider, which makes our application store available throughout our entire application.
This is done by surrounding the App with the Provider component in our `index.js` file and passing the store as a property to the Provider component.

```
// ...
import { Provider } from 'react-redux';
import store from './redux/store/store';

ReactDOM.render(
  <Provider store={store}>
    <App />
  </Provider>,
  document.getElementById('root')
);
// ...
```

Using the Provider component

We do this regardless of whether we are using class-based or functional components.
The store is a plain Redux store, just like the one we created before.

2) React Redux provides a `connect` function which we use for class-based components only. For functional components, however, we use hooks provided by the React Redux package.

Part Two — React-Redux for class-based components

We use the `connect` function whenever we want to "connect" a component to Redux, i.e. make a React component interact with our Redux store.
We almost never access the store directly. We just fire actions creators and all of the logic later is handled automatically by the `connect` function.

The `connect` function is actually a Higher Order Component.
It returns a function to which we supply the class name of our component (notice the extra parentheses after the `connect` function in the later example).
It also takes in two optional parameters: *mapStateToProps* and *mapDispatchToProps*.

The first parameter, *mapStateToProps*, has to do with subscribing to the store by mapping store values in our component's properties.
If we want to subscribe to the store, we provide a non-null first parameter.
Otherwise, if we don't want to subscribe to the store, we provide `null` as the first parameter.

The second parameter, *mapDispatchToProps*, has to do with injecting action creators in our component's properties. If we don't want to inject any action creators at all, we provide `null` as the second parameter as well.

mapStateToProps

This is the first parameter of the `connect` function.
As its name suggests, we map part of our application state into the actual properties of our component.

mapStateToProps is actually a function which takes the entire state of our app as its first parameter and returns an object of data that our component will need, i.e., the first parameter is equivalent to `store.getState()` .

This function takes an optional second parameter, which lets you use some of the component props. This can be useful when we need additional information from the component's props to retrieve data from the store.

```
(state, ownProps?) => stateProps
```

mapStateToProps is called every time our app state changes (the `state` parameter) or any field of the `ownProps` object changed.
Further, our component will re-render when either `ownProps` or `stateProps` is different, which means we'll always get the most recent values from the state.

mapDispatchToProps

As we previously mentioned, this parameter is used for mapping (injecting) action creators to the component's props.

mapDispatchToProps can actually be either an object or a function. The official React Redux documentation recommends it to be an object and to be fairly honest, most of the time that's what you'll go with.

In the case when it is an object, the keys will be mapped to the component's props. From there, we can call the action creator function to persist the new note to the state.

```
import { addNote } from '../redux/actions/actions'; // we use this only when ex

class NotesForm extends Component {
  // ...
  handleSubmission = (e) => {
    // ...
    let { title, content } = this.state;
    this.props.addNote(title, content); // here we use the addNote from the com
    // ...
  };
}

export default connect(
  null, // mapStateToProps is null, we don't care about what's in the store nor
  {
    addNote: addNote,
  } // mapDispatchToProps
)(NotesForm);
```

mapDispatchToProps use case

However, note that as we mentioned before, in React we don't access the store directly, thus, we never call `store.dispatch()`. We just call our action creator and the rest is handled magically by the `connect` function.

"What about if *mapDispatchToProps* is a function, not an object? And when would I want to use it as a function?"
I'm going to quote this from the React-Redux documentation, since it's pretty straightforward:

> *"Defining mapDispatchToProps as a function gives you the most flexibility in customizing the functions your component receives, and how they dispatch actions. You gain access to dispatch and ownProps. You may use this chance to write customized functions to be called by your connected components."*

`dispatch` and `store.dispatch` are actually the same thing, while the `ownProps`, as we already know, are the component props that get passed when creating the component.

There's one more thing I want to stress out about *mapDispatchToProps*:

The dispatch function will be available out of the box in your component if you don't provide a second parameter in the `connect` function or the object you returned from the *mapDispatchToProps* function returns a dispatch field.
For more information, visit this link from the React Redux documentation.

Recreating our Notes app in React with class-based components

I rewrote the App component to simply return our Notes component.
The Notes component renders two more components — NotesForm and AllNotes.

We will be keeping our `Notes`, `AllNotes` and `NotesForm` components in our `src/Notes` folder.

```
import React from 'react';
import Notes from './Notes/Notes';

function App() {
  return <Notes />;
}

export default App;
```

src/App.js

```
import React, { Component } from 'react';
import NotesForm from './NotesForm';
import AllNotes from './AllNotes';

export default class Notes extends Component {
  render() {
    return (
      <React.Fragment>
        <h1>React Redux Notes App</h1>

        <NotesForm />
        <hr />
        <AllNotes />
      </React.Fragment>
    );
  }
}
```

src/Notes/Notes.js

NotesForm

This component has to do with the form for adding notes.
All this component will ever do is dispatch an action to the store for adding a new note. Since we don't care about the app state and we have no intention to subscribe to it, we provide `null` as the first parameter (*mapStateToProps*).

```
import React, { Component } from 'react';
import { connect } from 'react-redux';
import { addNote } from '../redux/actions/actions';

class NotesForm extends Component {
  constructor(props) {
    super(props);

    this.state = {
      title: '',
      content: '',
    };
  }

  handleChange = (e) => {
    this.setState({ [e.target.name]: e.target.value });
  };

  handleSubmission = (e) => {
    e.preventDefault();

    let { title, content } = this.state;
    this.props.addNote(title, content);

    this.setState({ title: '', content: '' });
  };

  render() {
    return (
      <React.Fragment>
        <h3>Add a Note</h3>

        <form onSubmit={this.handleSubmission}>
          Title: <br />
          <input
            type="text"
            name="title"
            value={this.state.title}
            onChange={this.handleChange}
          />
          <br />
          Content: <br />
          <textarea
            name="content"
            value={this.state.content}
```

src/Notes/NotesForm.js

For the second parameter (*mapDispatchToProps*), however, we provide an object, through which we map the `addNote` action creator function we imported from the `actions.js` file.

The `connect` function does its magic and by simply calling `this.props.addNote()` in our component, we dispatch the add note action to the store.

AllNotes

We are going to use this component for rendering all the notes, which are stored in our Redux state. Likewise, we're going to need to dispatch an action to delete the state.
In other words, we'll have to fill out both parameters in the `connect` function.

Simply put, we'll have to subscribe to the state of our application (because we want to display immediately whenever a note gets added or deleted from the state) and map the `deleteNote` action to our component's props, since we will be needing it to dispatch an action for deleting the note.

```jsx
import React, { Component } from 'react';
import { connect } from 'react-redux';
import { removeNote } from '../redux/actions/actions';

class AllNotes extends Component {
  removeNote = (index) => {
    this.props.removeNote(index);
  };

  render() {
    const notesItems = this.props.notes.map((note, index) => (
      <li key={index}>
        <b>{note.title}</b>
        <button onClick={() => this.removeNote(index)}>x</button>
        <br />
        <span>{note.content}</span>
      </li>
    ));

    return (
      <React.Fragment>
        <h3>All Notes</h3>

        <ul>{notesItems}</ul>
      </React.Fragment>
    );
  }
}

const mapStateToProps = (state) => {
  return {
    notes: state.notes,
  };
};

const mapDispatchToProps = {
  removeNote: removeNote,
};
```

src/Notes/AllNotes.js

That's it about our second project as well. You can find it on GitHub here.

Part Three — React-Redux for functional components

Unlike class components, functional components don't make use of the Redux `connect` HOC to connect to the store and we don't get any Redux stuff injected into the component's props.
Instead, the react-redux package provides hooks that we use when writing Redux code for functional components:

1) useSelector
This hook, is a replacement (roughly speaking) for the `connect` function's *mapStateToProps* parameter.
The same accepts two parameters — a selector function and an equality function.

The selector function's purpose is to return a portion of the store. It does this with the help of its only parameter, the application's store.
For example, let's say that we want to get the notes of the application's store and store them in a constant in our component.
This is what our code will look like:

```
const notes = useSelector((store) => store.notes);
```

The *useSelector* hook uses `===` (a.k.a. strict reference equality check) to check whether the previously fetched value from the store is the same that we are currently getting. If that's not the case, the component re-renders.

For simple selectors that only return a portion of the Redux store and nothing more, you can omit the second parameter in this hook. However, when a new object is returned each time the hook runs (e.g., you are making some calculations in the selector function or are building a new object from multiple values of the store), then you should make use of the Redux's `shallowEqual` function. If that's not sufficient, give Reselect a try or try wrapping your component in useMemo instead.

If we take a look at `shallowEqual`'s source code, we'll quickly understand what this function does — it checks whether the previous and current values are equal by reference or in case of them being objects, it checks whether they contain the same properties, which again, must be equal by reference.

2) useDispatch

This hook returns a reference to the dispatch function from the Redux store. Dispatching an action is pretty straightforward — we just pass the action (or action creator function) to the dispatch function, as it would be the case in a non-React application:

```
const dispatch = useDispatch();
dispatch(addNote('Title', 'Content'));
```

3) useStore

This hook is pretty straightforward as well. It returns a reference to the Redux store object:

```
const store = useStore();
console.log(store.getState());
```

Recreating our Notes app in React with function components

We will have to change only the *AllNotes*, *Notes* and *NotesForm* components. We start by unwrapping each component from the `connect` function and converting them into functional components.

Notes

Since we don't use any Redux data, we simply convert the component into a functional component.

NotesForm

Here, we make use of the *useDispatch* hook. We import it from React Redux and later, we store it in a constant inside the component. Then, inside the `handleSubmission` function, we wrap the `addNote` function with our `dispatch` function which we previously stored.

AllNotes

Here, we use both *useSelector* and *useDispatch* hooks. We store the notes in a constant called `notes` using the former hook, while the latter is used just like in the *NotesForm* component. In this particular scenario, the `shallowEqual` function isn't useful at all, since we receive the same object from the store every time the component updates, but I wrote it solely for demonstration purposes.

We don't use *useStore* hook, since there is no use case for it in this scenario. To be fairly honest, you'll rarely reach for it.

That's all about the third project. You can find it on GitHub here.

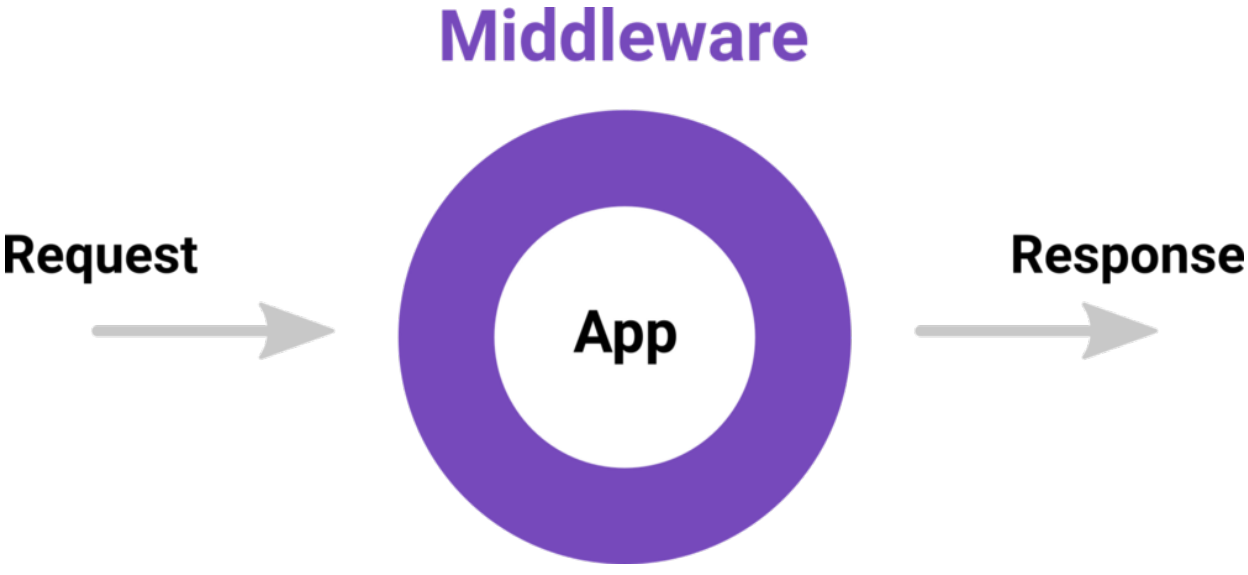
Bonus: Middleware, async actions and Redux Thunk

Store enhancers

React n Redux s React Redux y JavaScript le Web Development enhance the store by adding some extra functionality such as middleware. The only store enhancer that ships with Redux is the `applyMiddleware` function, which is used for supplying middlewares.

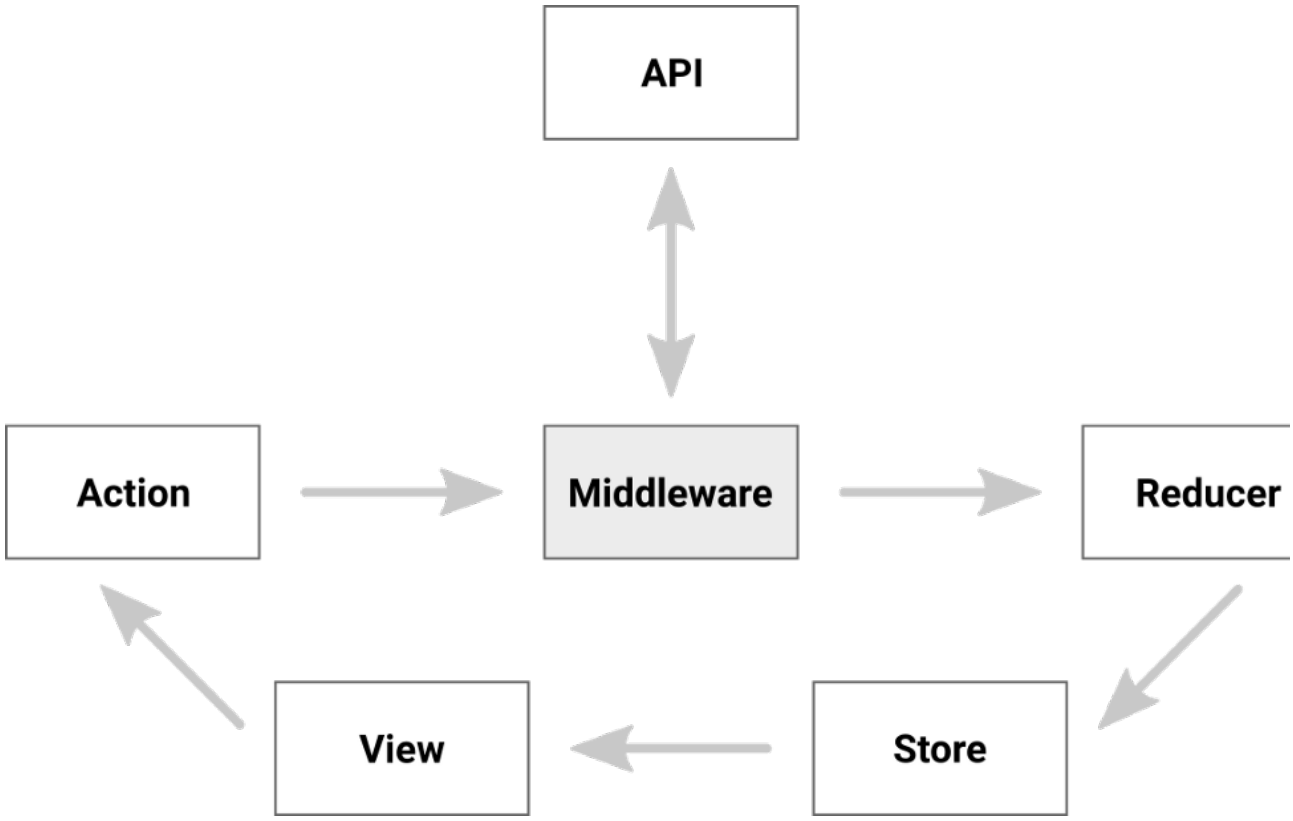
Middleware

ili aries / frameworks like Express.js in which a concept known as middleware exists, which actually is a layer that sits between requests and responses. It is executed on each request and is often used for authentication purposes (checking whether a user is logged in before executing some code).



The concept of middleware

Likewise, Redux middleware is executed before each dispatched action reaches a reduc
Middleware in Redux can be used for any number of reasons. The easiest and most harmless example is logging your action on each dispatch. One of the most advanced examples is building a DevTools extension for debugging purposes.



Middleware in Redux

Redux allows implementing middleware by providing an array of middlewares to the `applyMiddleware` function:

```
applyMiddleware(...middleware)
```

As the third parameter in the `createStore` function we supply the store enhancers we want to use. Like we previously mentioned, the only store enhancer that ships with Red is the `applyMiddleware` function.

Redux ships with a `compose` function, which helps you apply multiple store enhancers t the store. It is concerned with functional composition, a well-known pattern in function

programming. The Redux DevTools extension, too, ships with such function, which is used for its internal purposes.

We wrap the `applyMiddleware` function in either the Redux DevTools' `connect` function, or, as a fallback (when the user doesn't have the Redux DevTools extension installed), t Redux's `compose` function:

```
const composeEnhancers = window.__REDUX_DEVTOOLS_EXTENSION_COMPOSE__ || compose;

export default createStore(
 reducers,
 preloadedState,
 composeEnhancers(
   applyMiddleware(middlewareOne, middlewareTwo, ..., middlewareN)
 )
);
```

Redux's compose and applyMiddleware function example

Asynchronous actions through Redux-Thunk

So far we have been working with synchronous actions in Redux. However, asynchrono actions exist as well and depending on the project, there might be a ton of them. Nevertheless, don't get overwhelmed, as they are simple to understand as well:

Asynchronous actions means dispatching actions to the store in an asynchronous mann That's it.

For the sake of an example, let's say that we also had an API that helps us with CRUD operations on our notes and maybe the same also provides login and registration featur We may send an HTTP request to the API and dispatch some action upon receiving a response. Although there is nothing wrong with that approach, there is also another on — through dispatching asynchronous actions, for which a plethora of libraries exist: *redux-thunk*, *redux-promise*, *redux-promise-middleware*, *redux-observable*, *redux-saga* an *redux-pack*, to name a few.
As their names suggest, all use different technologies to achieve the same result — thunks, Promises or Observables.

We'll cover redux-thunk, because it's the most popular one, it's super easy to understan and it uses thunks, which is just a fancy word for a function wrapped inside another

function. To install it, run

```
npm i redux-thunk
// or, yarn add redux-thunk
```

Asynchronous actions in redux-thunk have the following pattern:

```
function actionName() {
  return function (dispatch, getState) {
    // dispatch(something()) at some point in time,
    //  e.g., after an API call
  };
}
```

redux-thunk-syntax.js hosted with ❤️ by **GitHub** **view raw**

Redux Thunk syntax

Instead of the function being an object creator and returning a plain object, it returns another function that accepts two parameters — the store's `dispatch` and `getState` functions, thereby enabling the delay of dispatching the desired action.

To show a practical example of redux-thunk, we'll write the following actions:

```
function getNotesAsync() {
  return function (dispatch) {
    fetch('https://yourapi.something/notes').then((data) => {
      dispatch(allNotes(JSON.parse(data)));
    });
  };
}

function createNoteAsync(note) {
  return function (dispatch) {
    fetch('https://yourapi.something/notes', {
      method: 'POST',
      body: note,
    }).then(() => {
      dispatch(addNote(note));
    });
  };
}
```

redux-thunk-example.js hosted with ❤️ by **GitHub** **view raw**

Redux Thunk async actions example

Note: we won't be implementing these, since we don't have an API, but I hope you get tl gist.

Conclusion

Congratulations on learning Redux and React Redux!

As your next step, I would highly recommend paying a visit to the official docs of the technologies put to use.
You might also want to consider the following additional resources that I think might gi you a more in-depth understanding of Redux and React Redux:

Resources to consider

1. Redux Docs
2. React-Redux Docs
3. Dan Abramov 's course on EggHead
4. Redux-related videos from Academind, The Net Ninja and Traversy Media

5. If you're using Angular, check out NgRx and NGXS

If you find any additional resources that helped you understand Redux better, please provide them in the comments below so that others can benefit from them as well.

I hope you enjoyed this article and that it at least helped you get a more clear picture about both Redux and React Redux.
As a challenge for you, try extending this project by:

- Adding a feature for editing the notes
- Adding an eye-pleasing design to the application and making it responsive
- Improving the UX of the application. Consider adding a form validation as well, to force the users to supply a content, but not necessarily a title for the new note that is about to be persisted to the store.
- Adding labels to the notes and extending the visibility filter which will filter notes to be displayed based on their labels
- Adding an archive functionality and an archive section where all the archived notes will be rendered
- Splitting the root reducer into multiple sub-reducers
- Creating a separate Note component
- Connect this app on the cloud or consider creating an API with your favorite programming language (if you're interested in back-end development)
- Think out of the box, use your own creativity and create an awesome project on a totally different topic instead!

Best of luck to you on your journey to further Redux mastery!