customTheme: "style"

Building Applications with Angular

Managing State with Redux

The Problem

- Different parts of an application need to reflect different aspects of its state
- Different parts of an application can *update* different aspects of its state
- Those updates can happen asynchronously

Roadmap

1. How should we keep track of our application's state?
2. What are the principal components of the Redux model?
3. How do we dispatch actions?
4. How do we respond to state changes?
5. What tools are available for working with Redux?

What Should a Good State Management System Do?

1. Provide a single source of truth
2. Provide separation of concern
    - Data and logic should be able to evolve separately
3. Improve scalability by having things *react* to events
    - As opposed to a caller dictating actions
4. Create a coherent framework so future developers will know where and how to add features
5. Provide uni-directional data flow so that future developers can reason about interactions

Why Do We Need a New Pattern?

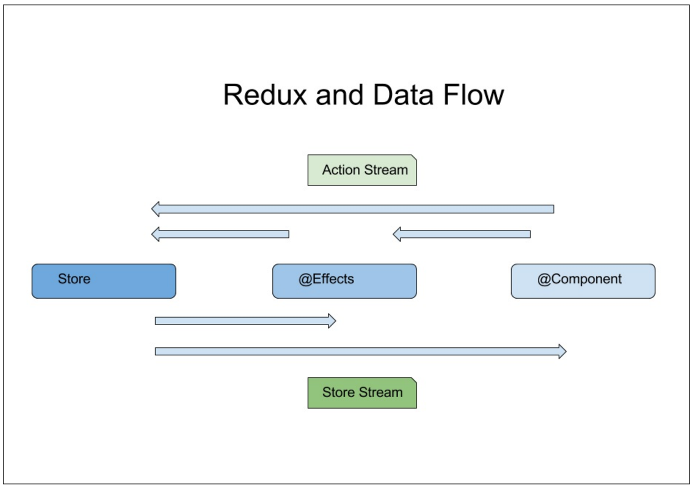
Server requests are different from user interactions:

1. User requests are handled by a single-threaded browser, while server requests are handled by multi-threaded servlets
2. User requests often modify the same objects but server requests usually modify different ones
3. Users expect to be notified about changes immediately: servers are more patient

Similarities of Structure - Redux vs Backend Architecture

Function	**Angular With Redux**	**Server**
Data Storage	Store	Database
Presentation View	@Component	Client API
Logic to massage data for Storage	@Effects	Services
Communication	Action / Observables	Function Invocation

Redux as a System



Redux and Data Flow

The Store

- Stores the entire current state of the application
- In principle, entire state replaced each time something changes
    - I.e., state is never modified in place
    - So no need to worry about concurrency effects
    - In practice, can often replace some parts and copy other parts forward
- Application components watch Observable streams for updates and change what they display

FIXME: diagram of state update

Actions

- Actions are objects that tell the store how to update itself
    - Use actions instead of direct function invocation so that they can be serialized
- Each action is an Object with:
    - type: identifies what kind of action this is (to allow selection and filtering)
    - payload: extra information needed to carry out the action
        - This is just a convention, but a widely-used one

Reducers

- When actions are dispatched, reducers are called passing in the current state and the action being dispatched
- A reducer is a pure function (without side-effects) with two parameters
    - state: Is the current redux state of your store
    - action: Is an Object that contains the type and payload
- Reducers should not mutate the state, but return a copy or a new state

```
export function reducer(state: AppState = [], action: Action) {
  switch (action.type) {
    case ITEM_ADD:
      //...do something with state
    default:
      return state;
  }
}
```

Plan for Refactoring

1. Define the *reducer* that turns a state and an action into a new state

2. Define actions
3. Main component will dispatch an action to add an item
4. Display will monitor the store for changes

Notes:

1. We will use @ngrx for our store
    - Many other implementations of the Redux pattern exist
2. We will leave room in our store to add more state later
3. Angular CLI doesn't know anything about @ngrx, so we have to do most of the work by hand

Redux Tools

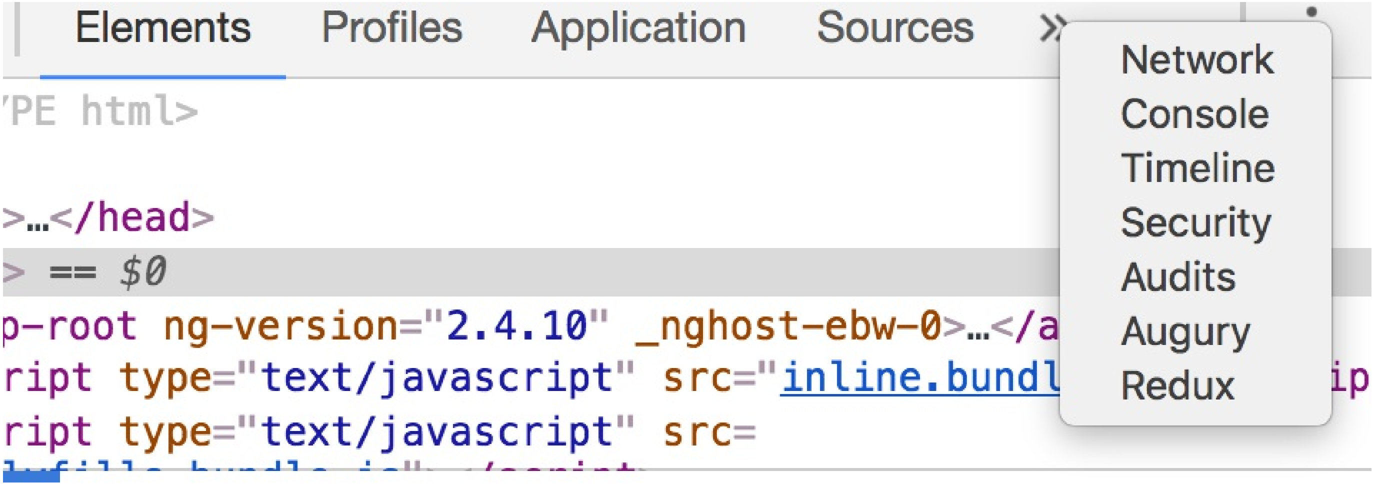
- Best way to learn Redux is to visualize what it's doing
- Use Redux DevTools Extension
    - Shows application state
    - Provides visualization of all actions that have been dispatch
    - Time travelling by moving backwards and forwards on actions that have been dispatch

Install Required Software

- `npm install @ngrx/core @ngrx/store --save`
- We will also install the ngrx dev tools
    - `npm install @ngrx/store-devtools --save`
- The `--save` option updates `package.json`
- So the next person can just do `npm install`

Install Redux Chrome Extensions

- Works with many other tools:
    - Chrome through the web store
    - Firefox
    - Electron and others
- After installing the extension in Chrome, there should be a tab in Chrome DevTools labeled "Redux".



```
'PE html>
>…</head>
> == $0
p-root ng-version="2.4.10" _nghost-ebw-0>…</a
ript type="text/javascript" src="inline.bundl                 ip
ript type="text/javascript" src=
```

Create the Reducer

- Create a new file `src/app/store.ts`
- Import `Action` to define the shape of actions
- Define constants for action names (as strings)
- Also define the initial state

    - An empty item list
- New state is the old list plus a new item
    - New item arrives as action's payload
- Do *not* use items.push to update existing state
    - More efficient...
    - ...but only if correctness and programmer time aren't issues

Create the Reducer

- Set up definitions

src/app/store.ts

```
import { Action } from '@ngrx/store';

export const ITEM_ADD = 'ITEM_ADD';

export interface AppState {
  items: string[];
}

const DEFAULT_STATE: AppState = {
  items: []
};
```

Create the Reducer

- Define the reducer function

src/app/store.ts

```
export function reducer(state: AppState = DEFAULT_STATE, action: Action) {
  let newState;

  switch (action.type) {

    case ITEM_ADD:
      newState = {items: [...state.items, action.payload]};
      return newState;

    default:
      return state;
  }
}
```

Add the Store to the Application

src/app/app.module.ts

```
import { StoreModule } from '@ngrx/store';
import { reducer } from './store';

@NgModule({
  declarations: [
    // ...as before...
  ],
  imports: [
    // ...as before...
    StoreModule.provideStore(reducer)
  ],
  // ...as before...
})
export class AppModule { }
```

- Note the provideStore call in imports

Add the StoreDevTools to the Application

- Import StoreDevtoolsModule into our module

```
import { StoreDevtoolsModule } from '@ngrx/store-devtools';

@NgModule({
  imports: [
    // ...as before...
    StoreModule.provideStore(reducer),
    // Note that you must instrument after importing StoreModule
    StoreDevtoolsModule.instrumentOnlyWithExtension({})
  ]
})
export class AppModule { }
```

Clean Up the Main Application's HTML

#####*src/app/app.component.html* (old)

```
<h1>{{title}}</h1>
<app-to-do-list [thingsToDo]="thingsToDo"></app-to-do-list>
<app-generic-input (newItem)="onNewItem($event)"></app-generic-input>
```

#####*src/app/app.component.html* (new)

```
<h1>{{title}}</h1>
<app-to-do-list></app-to-do-list>
<app-generic-input (newItem)="onNewItem($event)"></app-generic-input>
```

Dispatch Actions for New Items

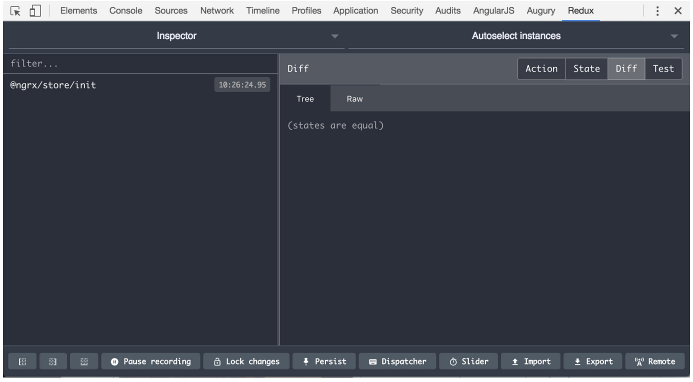
#####*src/app/app.component.ts*

```
import { Store } from '@ngrx/store';
import { AppState, ITEM_ADD, reducer } from './store';

export class AppComponent {

  constructor (private store: Store<AppState>) { }
  onNewItem(item: string) {
    this.store.dispatch({type: ITEM_ADD, payload: item});
  }
}
```

- Notes: no longer storing state in AppComponent

Redux DevTools

- New "Redux" tab in our browser's developer tools pane after successful installation, configuration and injecting the store



```
@ngrx/store/init 10:26:24.95
```

```
(states are equal)
```

Update the To-Do List Display

#####src/app/to-do-list/to-do-list.component.ts

```
import { Store } from '@ngrx/store';
import { AppState } from '../store';

export class ToDoListComponent implements OnInit {

  thingsToDo: string[];

  constructor(private store: Store<AppState>) { }

  ngOnInit() {
    this.store
      .select('items')
      .subscribe((items: string[]) => {this.thingsToDo = items.slice();});
  }
}
```

Picking That Apart

#####src/app/to-do-list/to-do-list.component.ts

```
    this.store
      .select('items')
      .subscribe((items: string[]) => {this.thingsToDo = items.slice();});
```

- The store is observable
- So we can filter (select) top-level elements by name
    - Only pay attention to events signalling changes to store['items']
- And subscribe to just those changes

- When we get a new list of items...
    - ...because that's all we're paying attention to...
- ...we copy it into the list we're displaying...
    - ...because we don't way to share state

Redux Seems Complex

So let's see how we'd go about deleting items:

1. Add a Delete button beside each item in the display.
2. Have the onDelete handler in ToDoListComponent dispatch an ITEM_DELETE event
    - With the text of the item to delete as its payload
3. Have the store update state when it receives that action
4. There is no Step 4

Update the To-Do List Display

#####src/app/to-do-list/to-do-list.component.html

```
<table>
  <tr>
    <th>Delete</th>
    <th>Item</th>
  </tr>
  <tr *ngFor="let item of thingsToDo">
    <td><button (click)="onDelete(item)">X</button></td>
    <td>{{item}}</td>
  </tr>
</table>
```

Provide the Deletion Method

#####src/app/to-do-list/to-do-list.component.ts

```
import { AppState, ITEM_DELETE } from '../store';

export class ToDoListComponent implements OnInit {

  // ...as before...

  onDelete(item) {
    this.store.dispatch({type: ITEM_DELETE, payload: item});
  }
}
```

- Compilation error because ITEM_DELETE doesn't yet exist

Upgrade the Store

#####src/app/store.ts

```
export const ITEM_DELETE = 'ITEM_DELETE';

export function reducer(state: AppState = DEFAULT_STATE, action: Action) {
  switch (action.type) {

  case ITEM_DELETE:
    newState = {
      items: state.items.filter(item => {return item != action.payload})
    };
    return newState;

  ...other cases...

  }
}
```

Getting Information from a Store

- State is exposed through the Store service as an Observable stream
- The select carries information away from the store
  - Store provides a .select() method to select pieces of state:
  - By key: this.store.select('people')
  - By nested key: this.store.select('city', 'people')
  - By function: this.store.select(state => state.people)
- Can chain other operators like .filter(), .map() to have finer-grained control over selected data

Handling Async Events in the Application With Redux

- The @ngrx/effects library is responsible for business logic and async actions
  - E.g., HTTP calls
- Does not keep local state
- Listens on the action stream
  - Adheres to "Action In/Action Out"
- Typical use is:
  1. Take user input
  2. make HTTP call
  3. Provide output to go into store

Handling Side Effects with @Effect

```
@Injectable()
export class CollectionEffects {
  constructor(
    private actions: Actions,
    private db: Database
  ) {}

  @Effect()
  removeBookFromCollection: Observable<Action> = this.actions
    .ofType(collection.ActionTypes.REMOVE_BOOK)
    .map((action: collection.RemoveBookAction) => action.payload)
    .mergeMap(book => this.db.executeWrite('books', 'delete', [ book.id ]))
    .map(() => {
      type : ActionTypes.REMOVE_BOOK_SUCCESS,
      payload : book.id
    })
    .catch(() => Observable.of(new collection.RemoveBookFailAction(book)));
}
```

FAQ

Is the reducer the store?

No, a reducer only describes *how* the store's state should change based on a dispatched action. Our actual state is stored outside of our reducers. In the case of `@ngrx`, state is stored within an `Observable` stream that can be listened to.

FAQ

Can I have more than one store?

No, redux uses one global store to manage state., however it is common practice to divide your store into separate areas of concern.

Just as we can configure our store like this: `StoreModule.provideStore(reducer)` We are also able to pass in an object and associate a reducer with a given piece of our state `StoreModule.provideStore({ todos: todosReducer, users: usersReducer })`

We can also take advantage of functional composition, and "combine" multiple reducers into one using the `combineReducers` helper function `@ngrx` provides.

FAQ

Does the UI broadcast actions and store broadcast actions back?

The UI should not broadcast actions directly, it can and often should dispatch actions through "action creator" methods which can be made available through a component or service.

In a more traditional Flux architecture, while a store may have broadcasted actions whenever state changed, Redux does not. Instead of reacting to actions dispatched out from our store, we instead react to the changes in our state itself, we don't concerned ourselves with *how* state has changed.

The actions are generally what we call the events being broadcasted to the store. When events leave the store due to a state change it is done through a store select.

FAQ

Instead of dealing with observables, can we simply call methods directly?

By calling methods directly, we must now take on the responsibility of manually managing state (often spread across numerous locations) and ensuring that all concerned portions of our application are notified of updated state. This approach tends to be more error-prone and is more difficult to maintain and scale in larger applications.

The advantage of Redux is that this state management is handled in one location which is easier to reason about, and our application can simply react whenever application state changes.

FAQ

I have an awesome idea/implementation that does the same thing, can I use that?

Absolutely. Ultimately Redux is just a pattern for state management. Be warned however that many of the strengths of Redux lie in its conventions and community support. Convention allows other developers to ramp up quickly on a pattern they're already familiar with, and community support means better tooling, more middleware,updates/bug fixes, and a larger knowledge base to draw upon. Choose whichever solution ends up being best for you and your team.