



CLONE AND FOLLOW THE SETUP INSTRUCTIONS

github.com/CodeSequence/ngconf2019-ngrx-workshop



A REACTIVE STATE OF MIND

WITH ANGULAR AND NGRX



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Google Developer Expert



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NgRx Core Team



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Angular Team



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NgRx Core Team





Open source libraries for Angular



Open source libraries for Angular

Built with reactivity in mind



Open source libraries for Angular

Built with reactivity in mind

State management and side effects



Open source libraries for Angular

Built with reactivity in mind

State management and side effects

Community driven

DAY ONE SCHEDULE

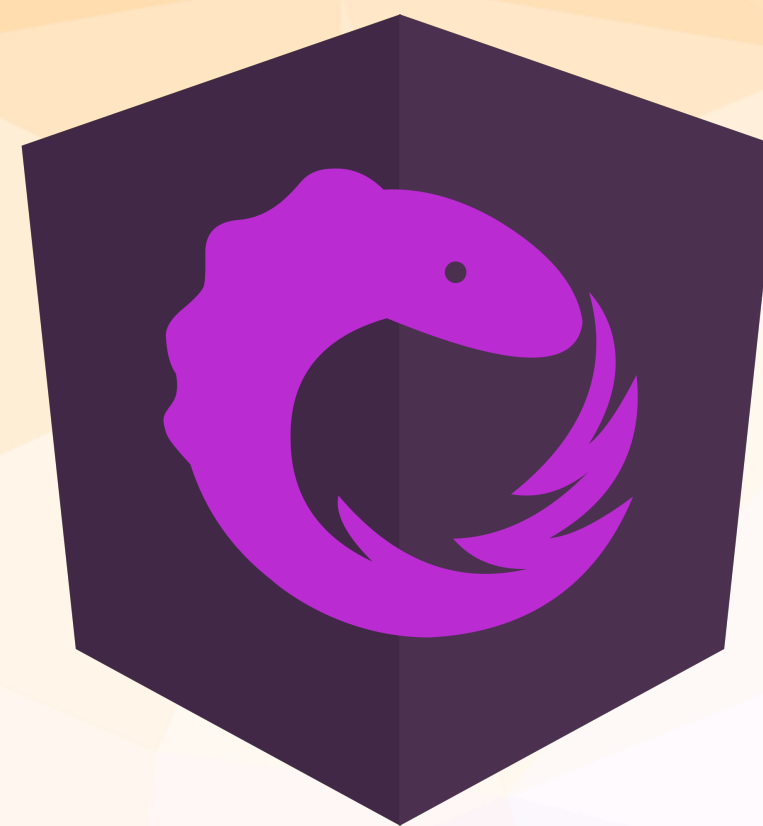
- Demystifying NgRx
- Setting up the Store
- Reducers
- Actions
- Entities
- Selectors

FORMAT

1. Concept Overview
2. Demo
3. Challenge
4. Solution

The Goal

**Understand the
architectural implications of
NgRx and how to build
Angular applications with it**



DEMYSTIFYING NGRX



“How does NgRx work?”



“How does NgRx work?”

- NgRx prescribes an architecture for managing the state and side effects in your Angular application. It works by deriving a stream of updates for your application's components called the “action stream”.
- You apply a pure function called a “reducer” to the action stream as a means of deriving state in a deterministic way.
- Long running processes called “effects” use RxJS operators to trigger side effects based on these updates and can optionally yield new changes back to the actions stream.

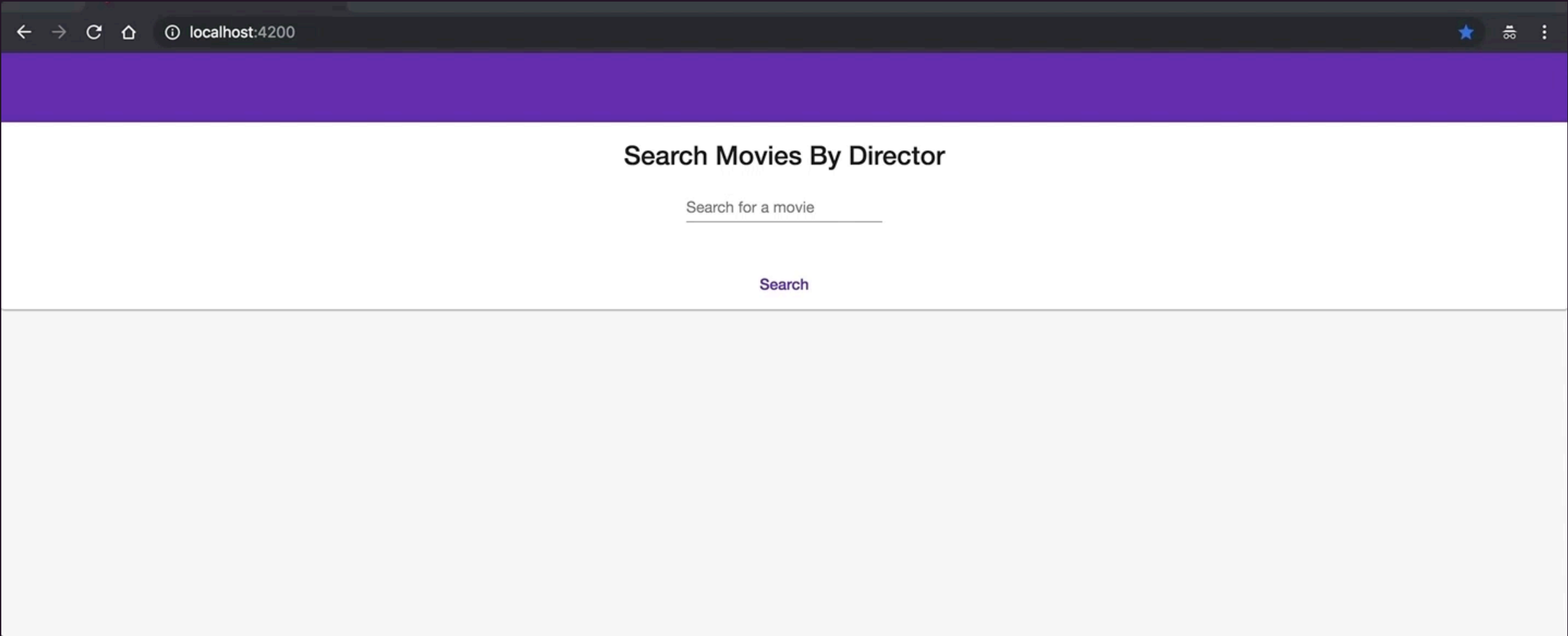


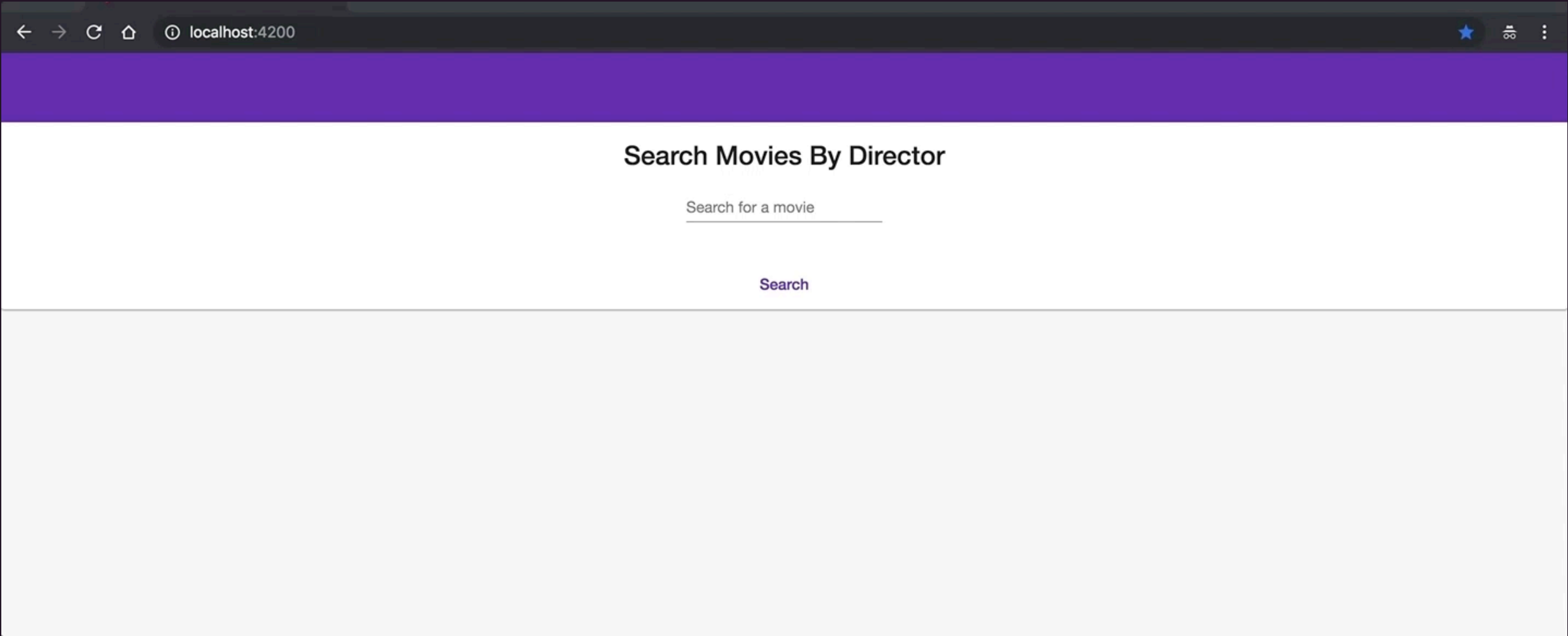


Let's try this a different way

You already know how NgRx works

COMPONENTS





Search Movies By Director

Search for a movie

Christopher Nolan

Search

Inception

Cobb, a skilled thief who commits corporate espionage by infiltrating the subconscious of his targets is offered a chance to regain his old life as payment for a task considered to be impossible: "inception", the implantation of another person's idea into a target's subconscious.

Favorite

```
<movies-list-item/>
```

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Favorite


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```

```
<movies-list/>
```

```
<search-movies-box/>
```

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Search for a movie

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<movies-list-item/>
```

```
<movies-list/>
```

```
<search-movies-box/>
```

```
<search-movies-page/>
```

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Favorite

```
<search-movies-page/>
```

```
<search-movies-box/>
```

```
<movies-list/>
```

```
<movies-list-item/>
```

`<search-movies-page/>`

`<search-movies-box/>`

`<movies-list/>`

`<movies-list-item/>`

`@Input() movies: Movie[]`

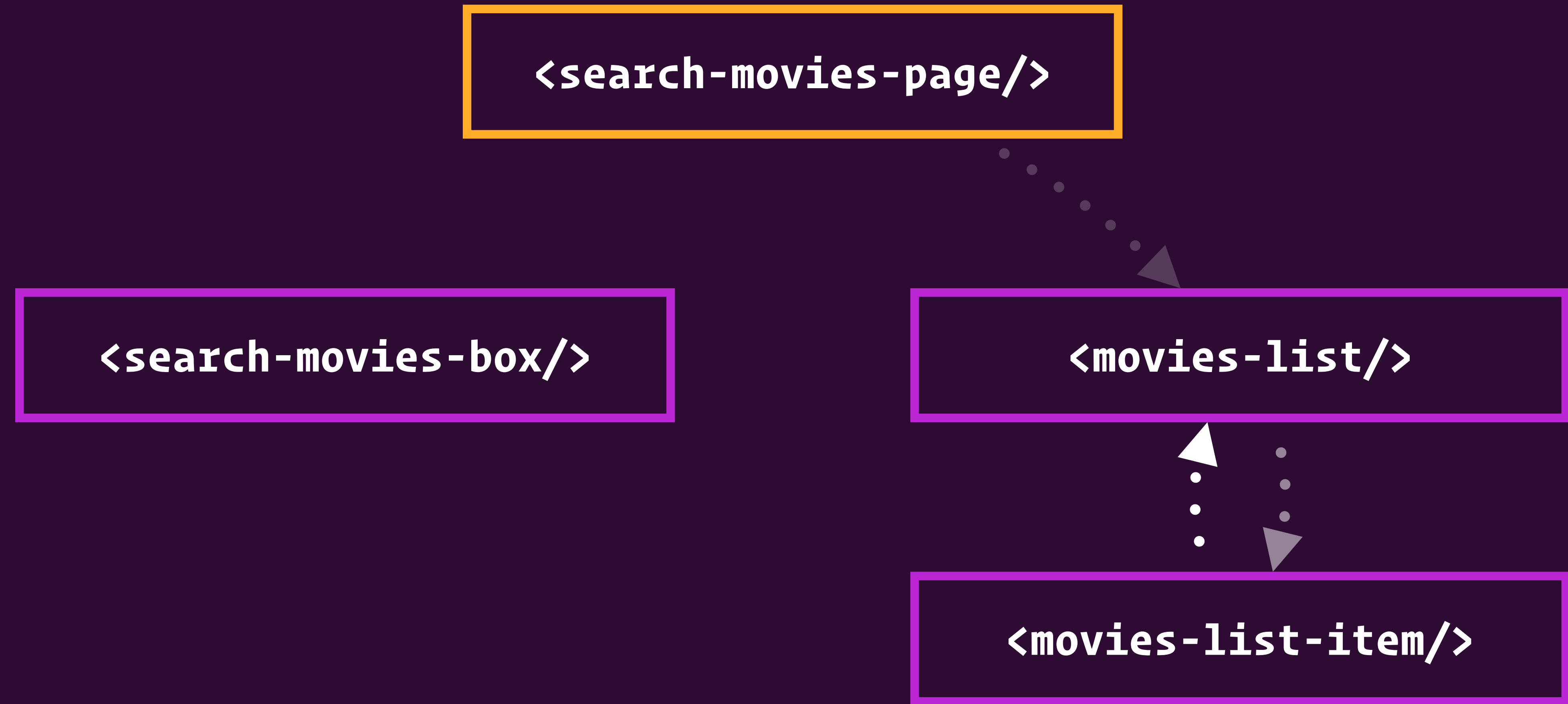
`<search-movies-page/>`

`<search-movies-box/>`

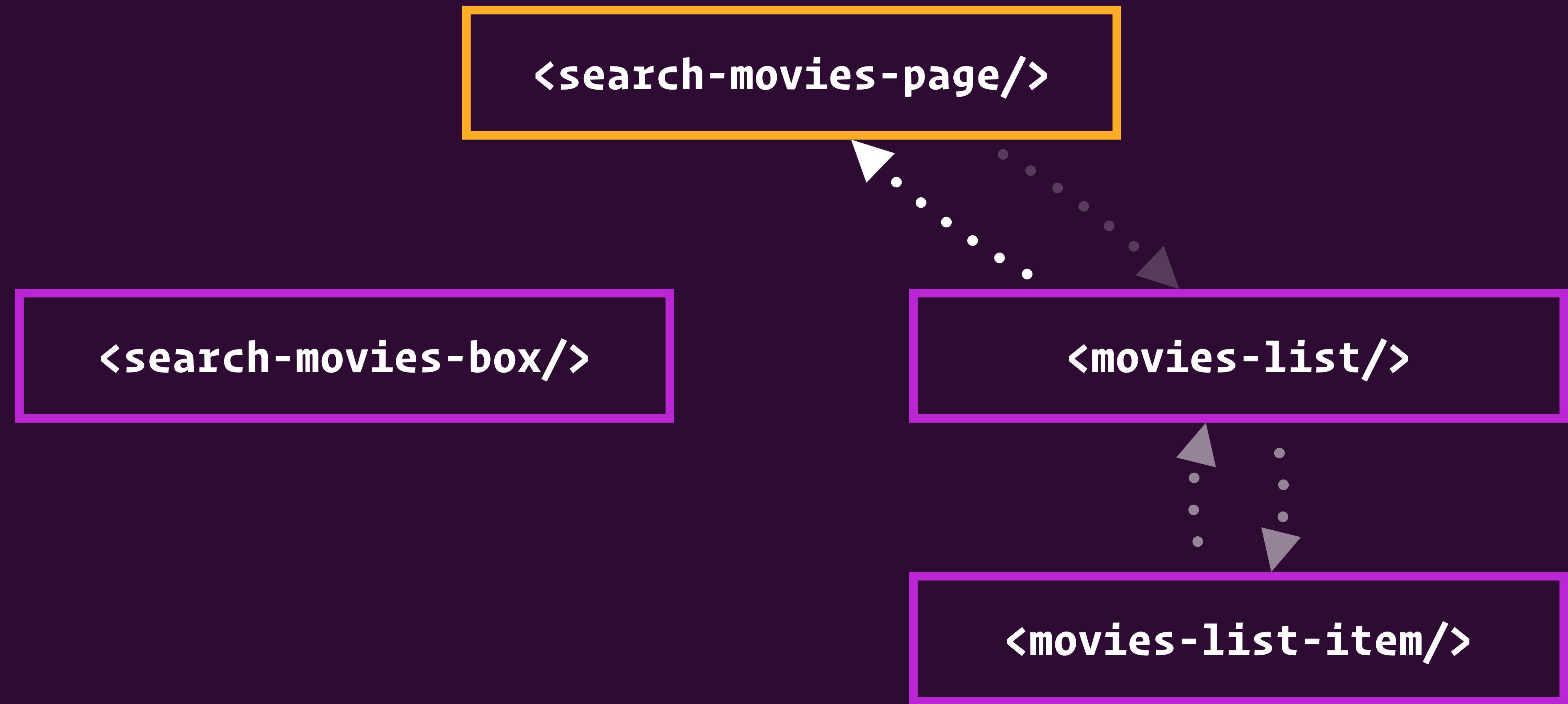
`<movies-list/>`

`<movies-list-item/>`

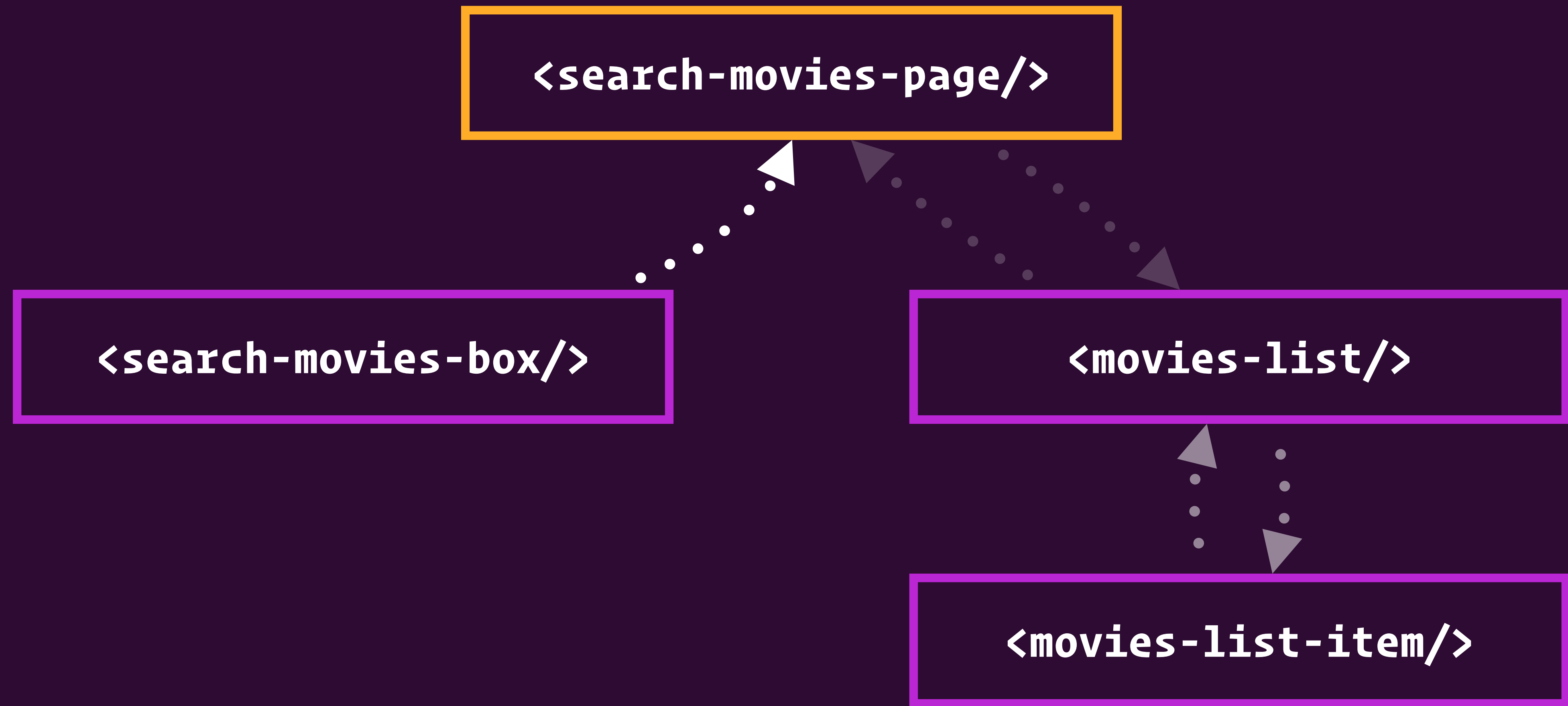
`@Input() movie: Movie`



@Output() favorite: EventEmitter<Movie>



`@Output()` favoriteMovie: EventEmitter<Movie>



@Output() search: EventEmitter<string>


```
@Component({
  template: `
    <search-movies-box (search)="onSearch($event)"></search-movies-box>
    <movies-list
      [movies]="movies"
      (favoriteMovie)="onFavoriteMovie($event)">
    </movies-list>
  `
})
class SearchMoviesPageComponent {
  movies: Movie[] = [];

  onSearch(searchTerm: string) {
    this.moviesService.findMovies(searchTerm)
      .subscribe(movies => {
        this.movies = movies;
      });
  }
}
```

```
@Component({
  template: `
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STATE

```
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}

```

SIDE EFFECT

```
@Component({
  template: `
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    </movies-list>
  `
})
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        this.movies = movies;
      });
  }
}
```

STATE CHANGE

```
<search-movies-page/>
```

```
<search-movies-page/>
```



Connects data to components


```
<search-movies-page/>
```

- ✓ Connects data to components
- ✓ Triggers side effects

```
<search-movies-page/>
```

- ✓ Connects data to components
- ✓ Triggers side effects
- ✓ Handles state transitions

OUTSIDE WORLD

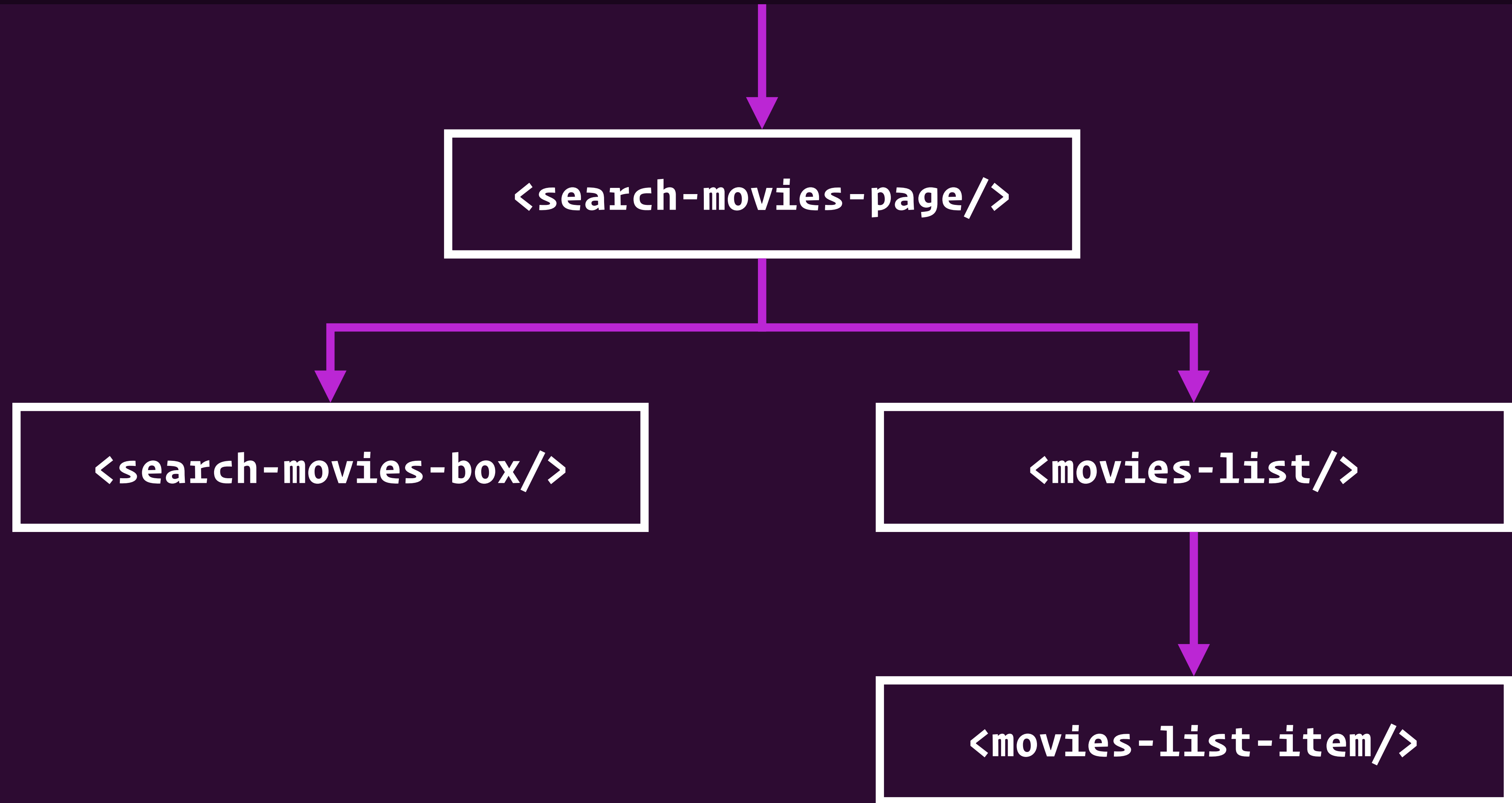
```
<search-movies-page/>
```

```
<search-movies-box/>
```

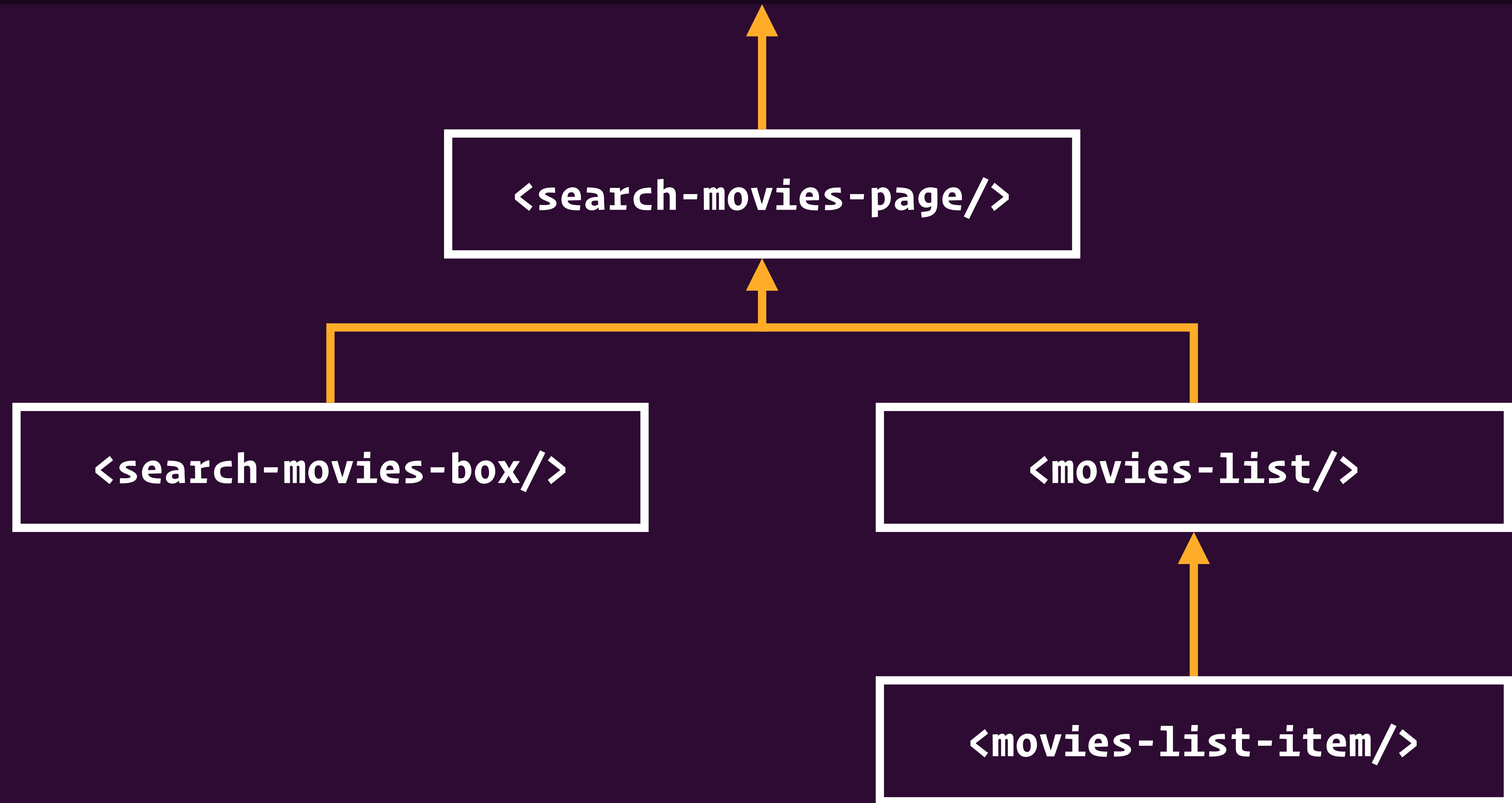
```
<movies-list/>
```

```
<movies-list-item/>
```

OUTSIDE WORLD



OUTSIDE WORLD





NGRX MENTAL MODEL

State flows down, changes flow up





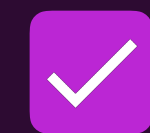

```
<search-movies-page/>
```

- ✓ Connects data to components
- ✓ Triggers side effects
- ✓ Handles state transitions

Single Responsibility Principle

```
<search-movies-page/>
```

```
<search-movies-page/>
```



Connects data to components

@Input() and @Output()

```
@Component({  
  selector: 'movies-list-item',  
})  
export class MoviesListItemComponent {  
  @Input() movie: Movie;  
  @Output() favorite = new EventEmitter<Movie>();  
}
```

Does this component know who
is binding to its input?

```
@Component({  
  selector: 'movies-list-item',  
})  
export class MoviesListItemComponent {  
  @Input() movie: Movie;  
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@Component({  
  selector: 'movies-list-item',  
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export class MoviesListItemComponent {  
  @Input() movie: Movie;  
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}
```


Does this component know who
is listening to its output?

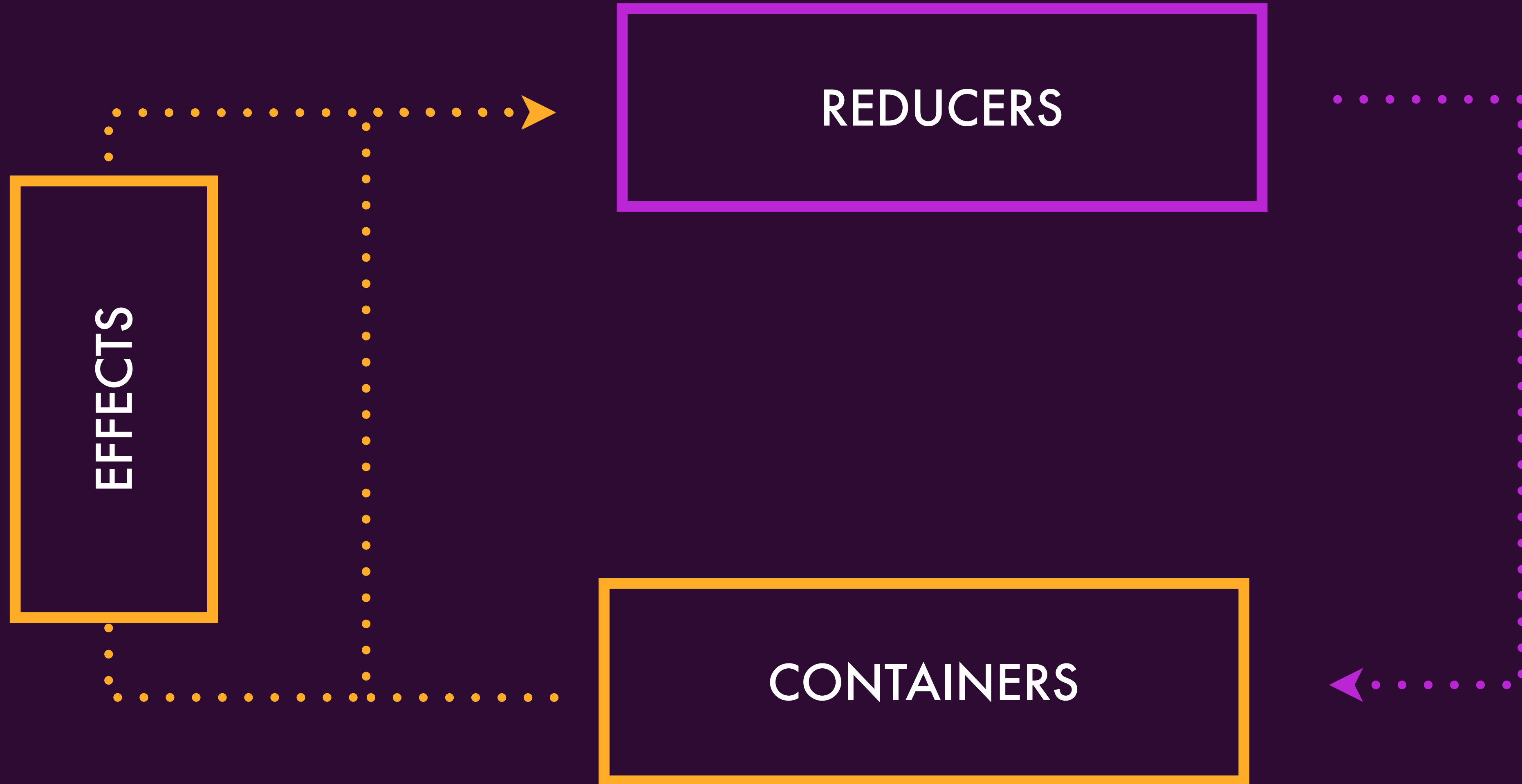
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  @Input() movie: Movie;  
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}
```

Inputs & Outputs offer Indirection

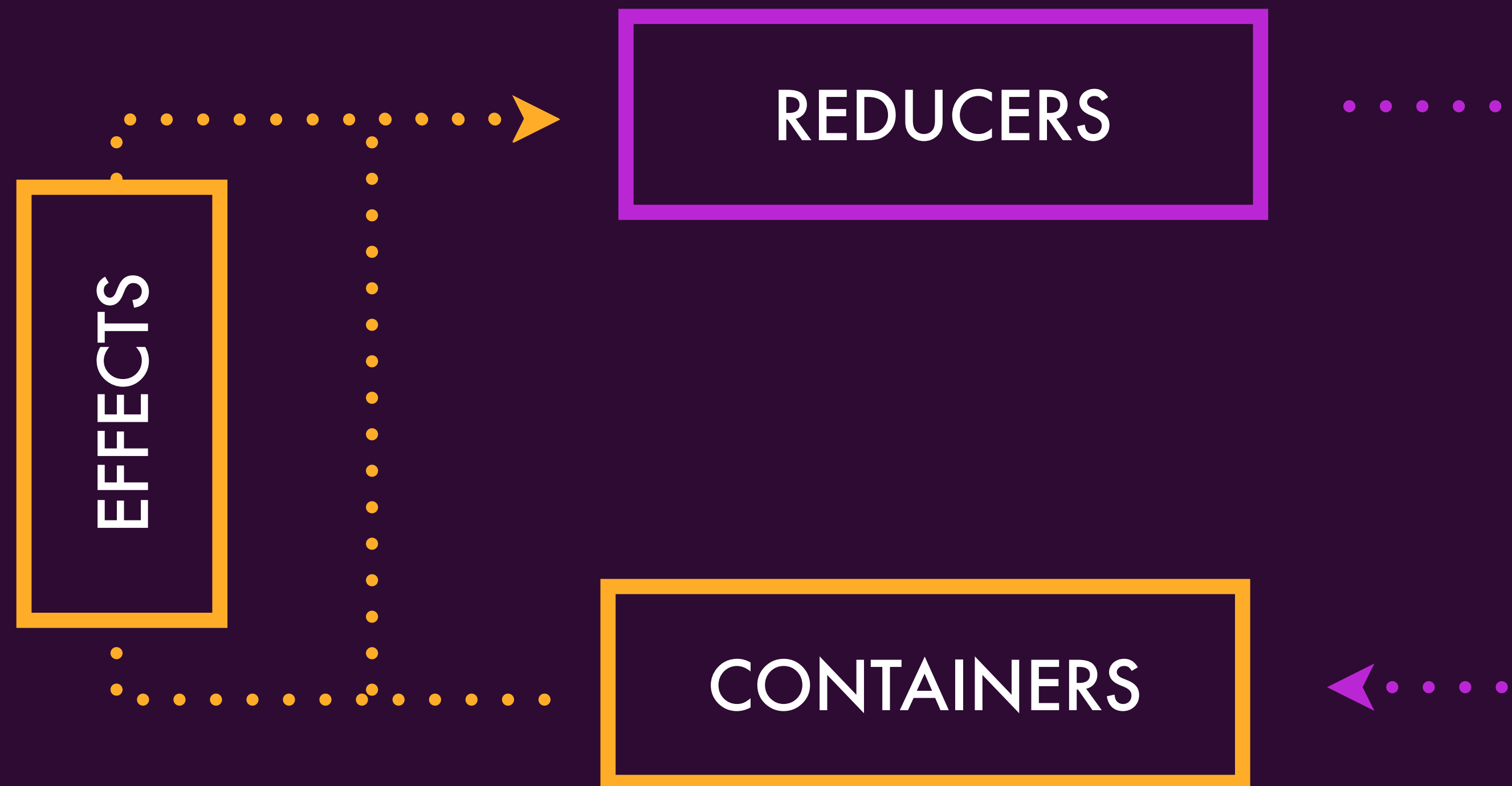


NGRX MENTAL MODEL

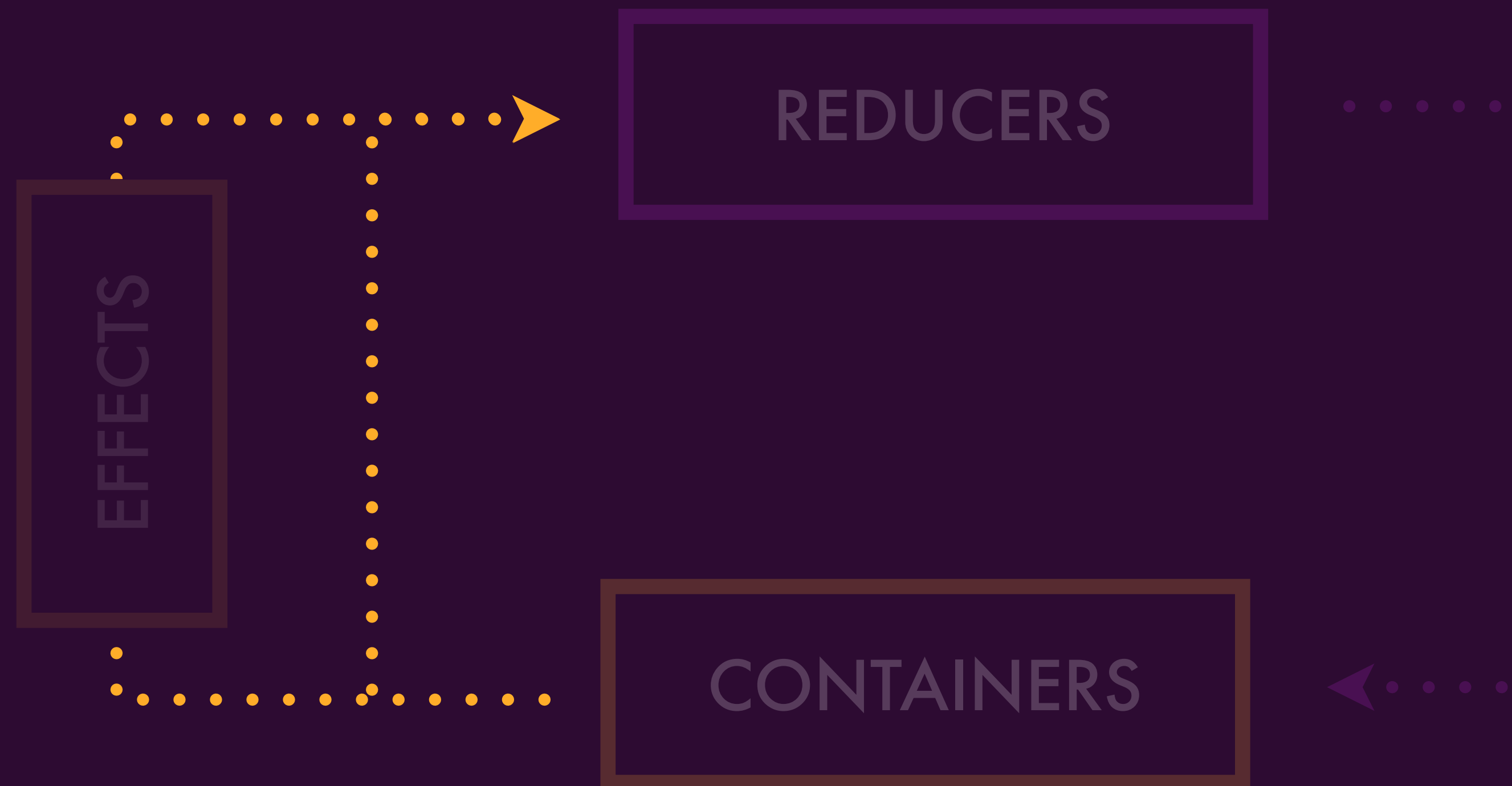
*There is indirection between consumer of state,
how state changes, and side effects*



ACTIONS



ACTIONS



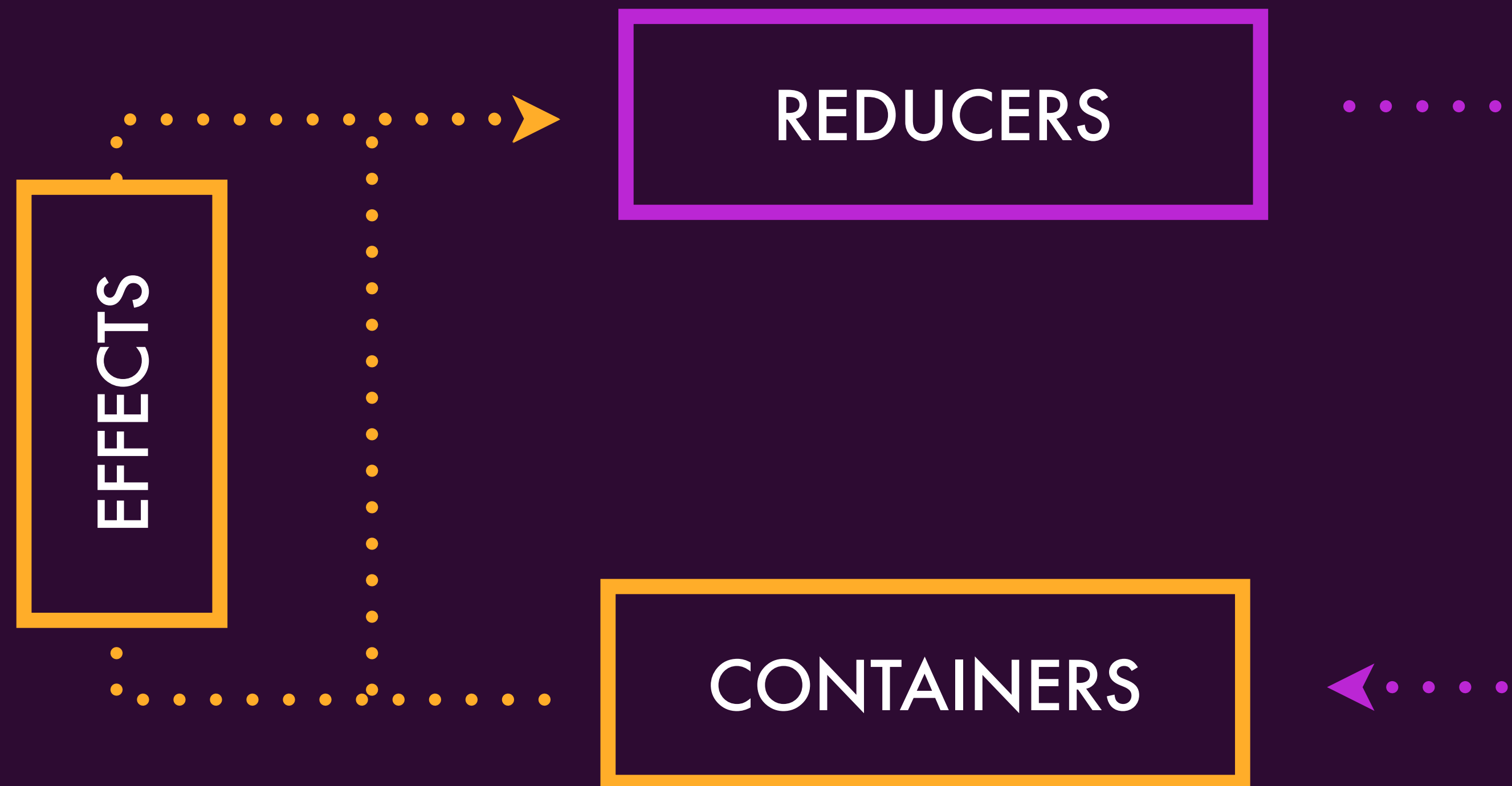
```
interface Action {  
    type: string;  
}
```



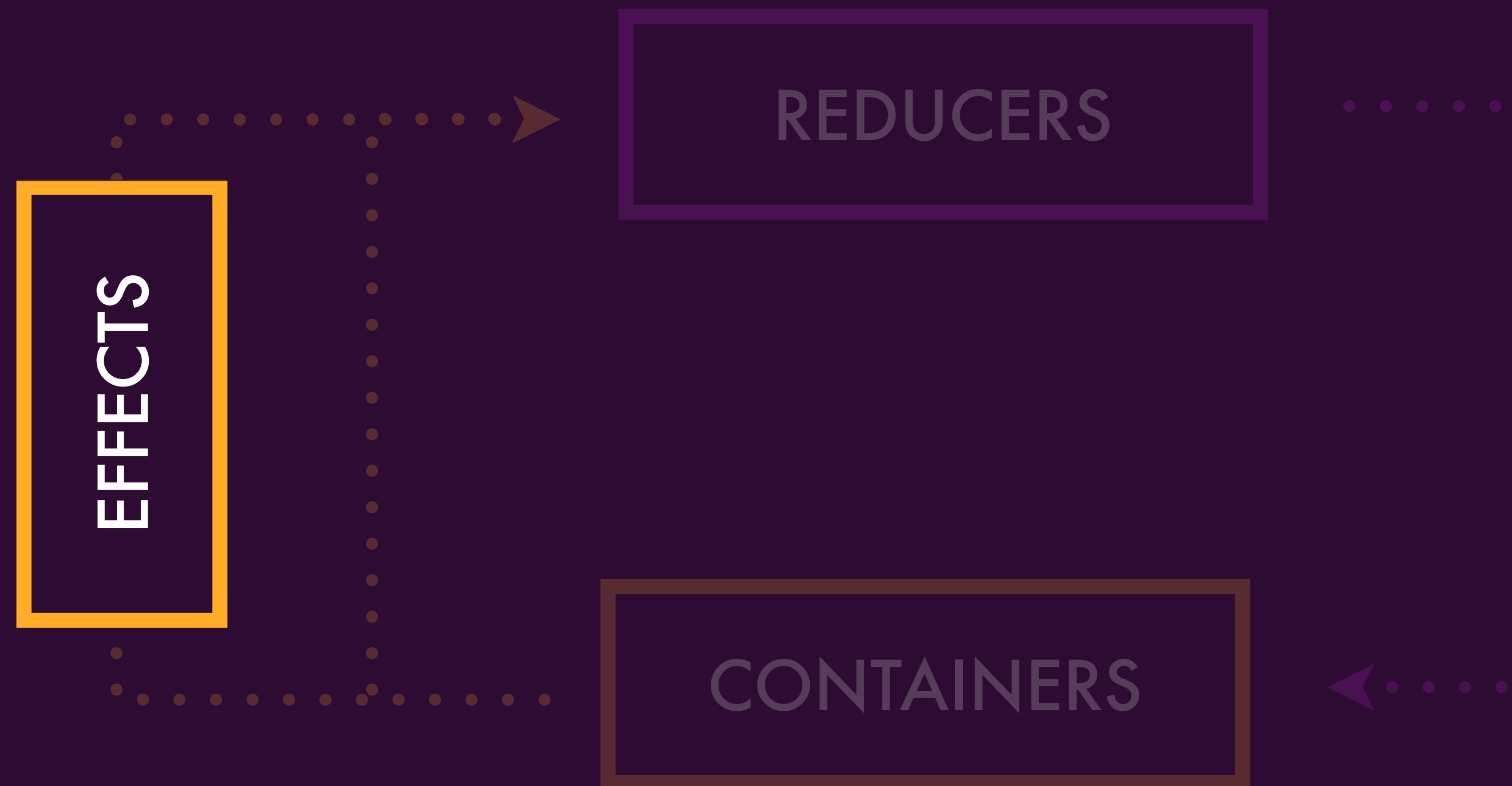
```
this.store.dispatch({  
  type: 'MOVIES_LOADED_SUCCESS',  
  movies: [{  
    id: 1,  
    title: 'Enemy',  
    director: 'Denis Villeneuve',  
  }],  
});
```

Global `@Output()` for your whole app

EFFECTS



EFFECTS








```
@Effect() findMovies$ = this.actions$  
  .pipe(  
    ofType('SEARCH_MOVIES'),  
    switchMap(action => {  
      return this.moviesService.findMovies(action.searchTerm)  
        .pipe(  
          map(movies => {  
            return {  
              type: 'MOVIES_LOADED_SUCCESS',  
              movies,  
            };  
          })  
        ),  
      },  
    );
```



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  .pipe(  
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          })  
        )  
    })),  
  );
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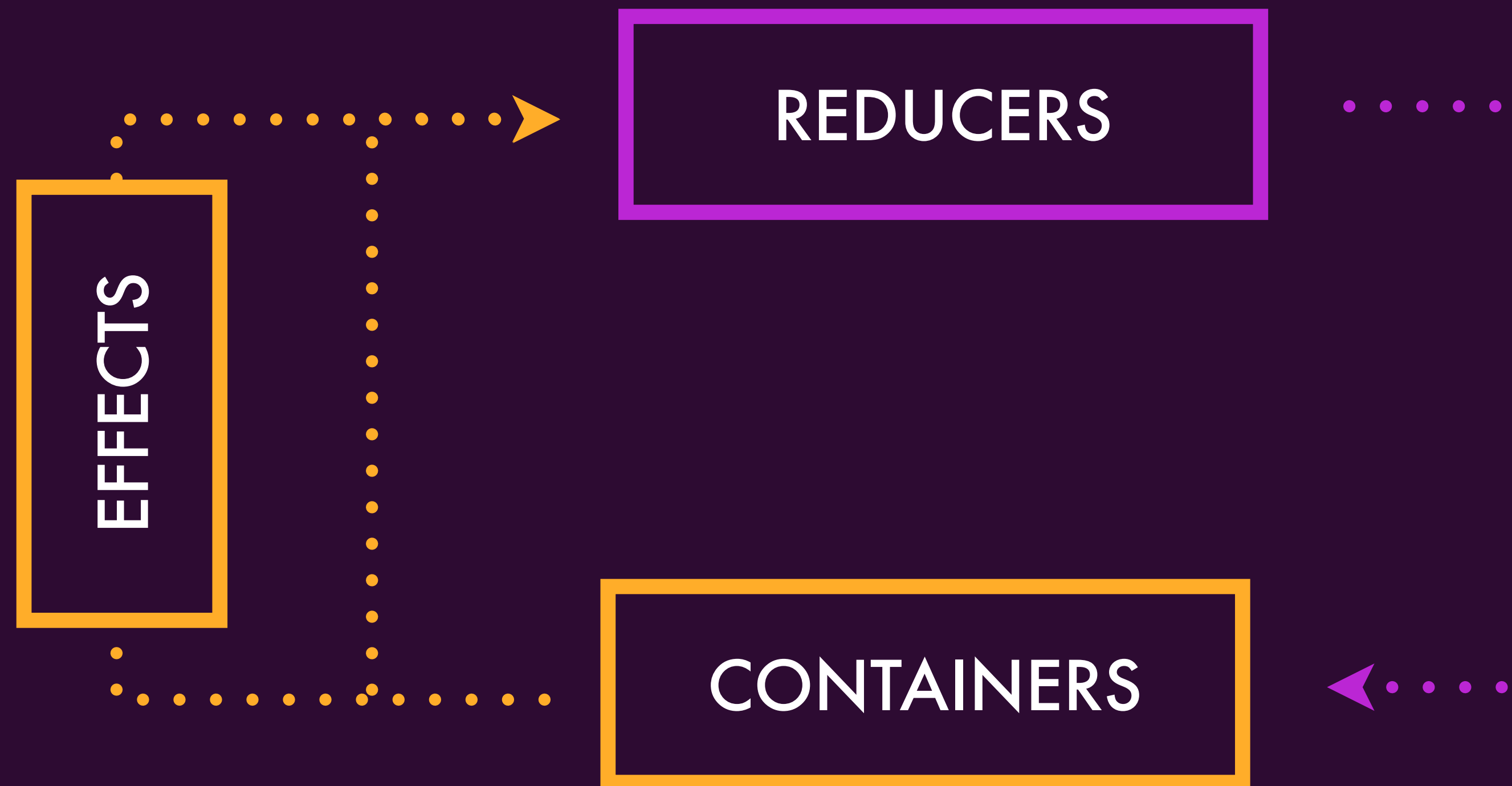
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          })  
        )  
    }  
  ),  
);
```

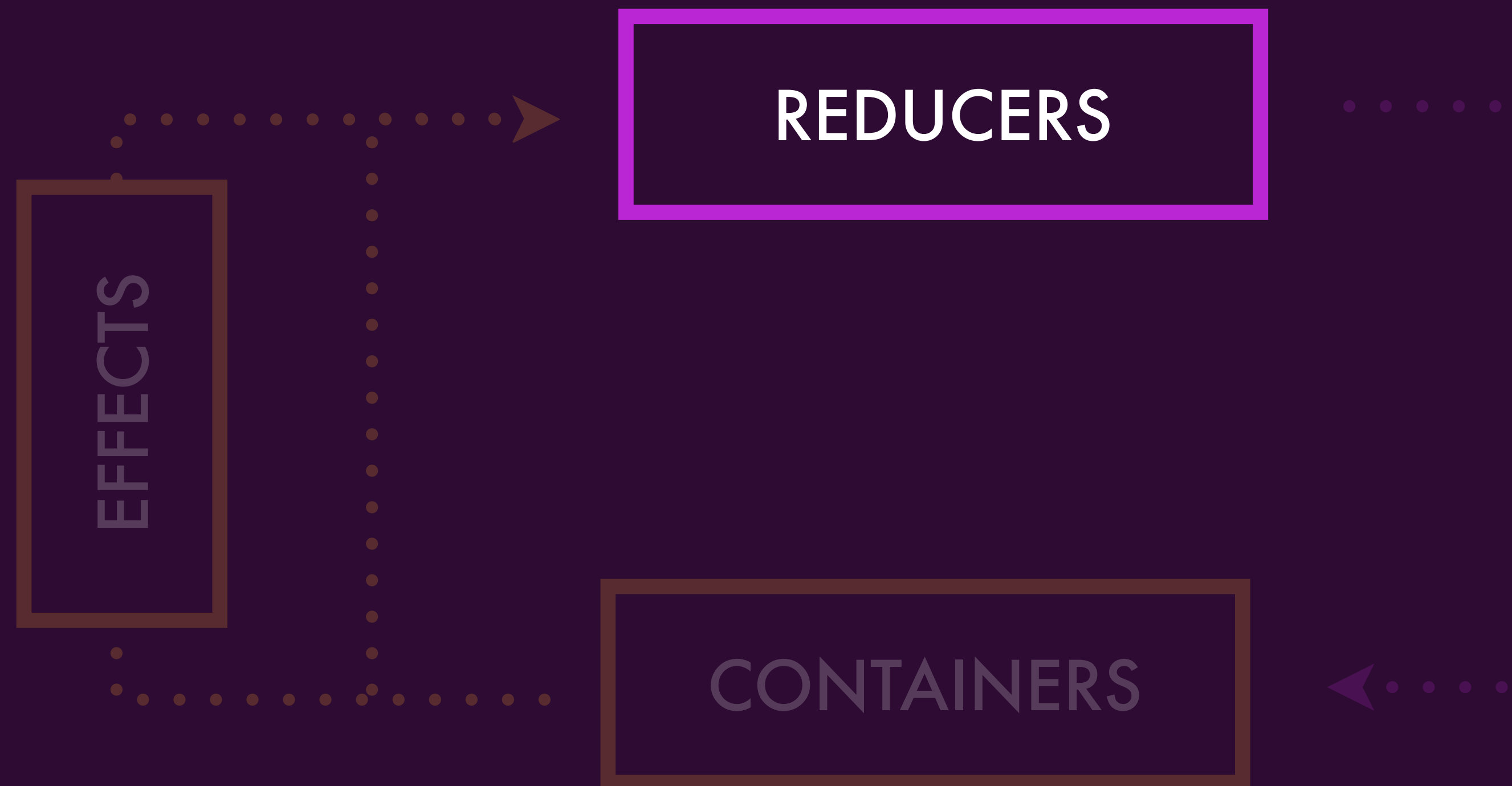
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            };  
          })  
        )  
    })),  
  );
```

REDUCERS



REDUCERS

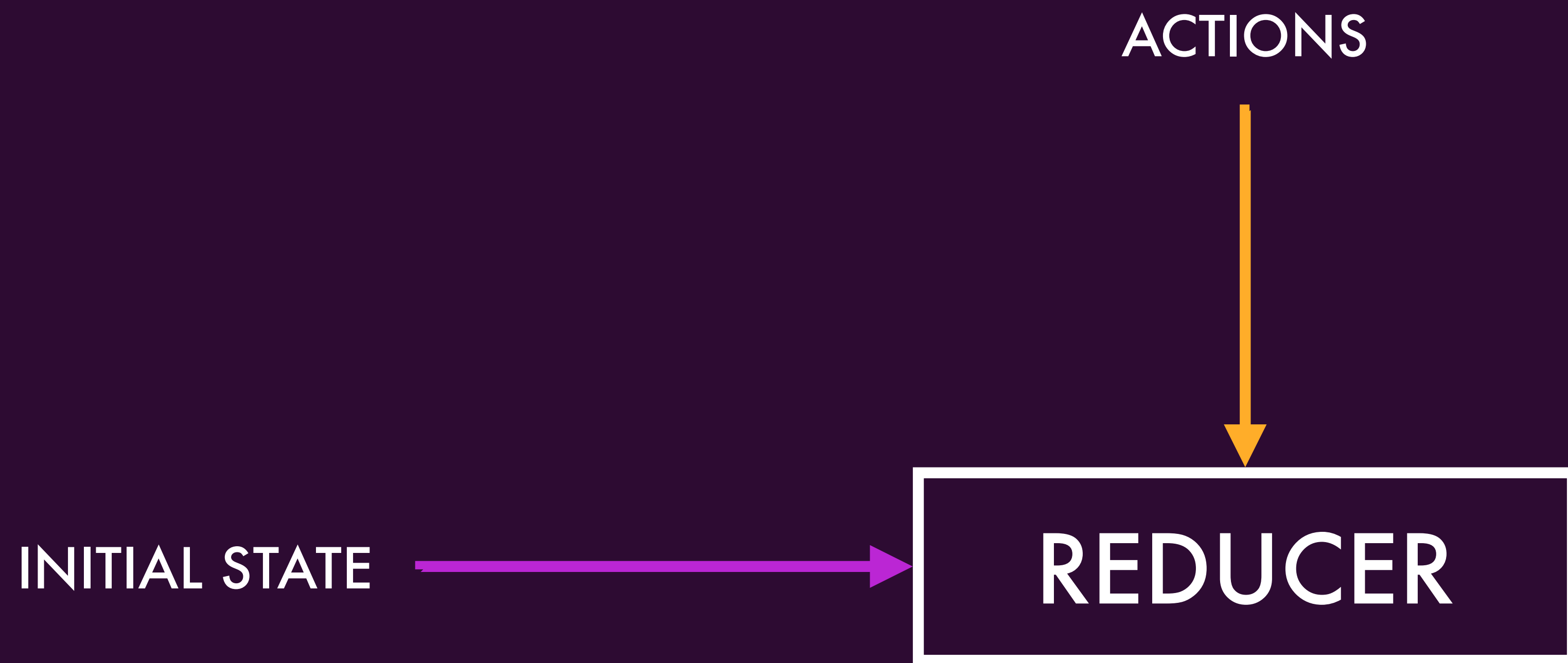


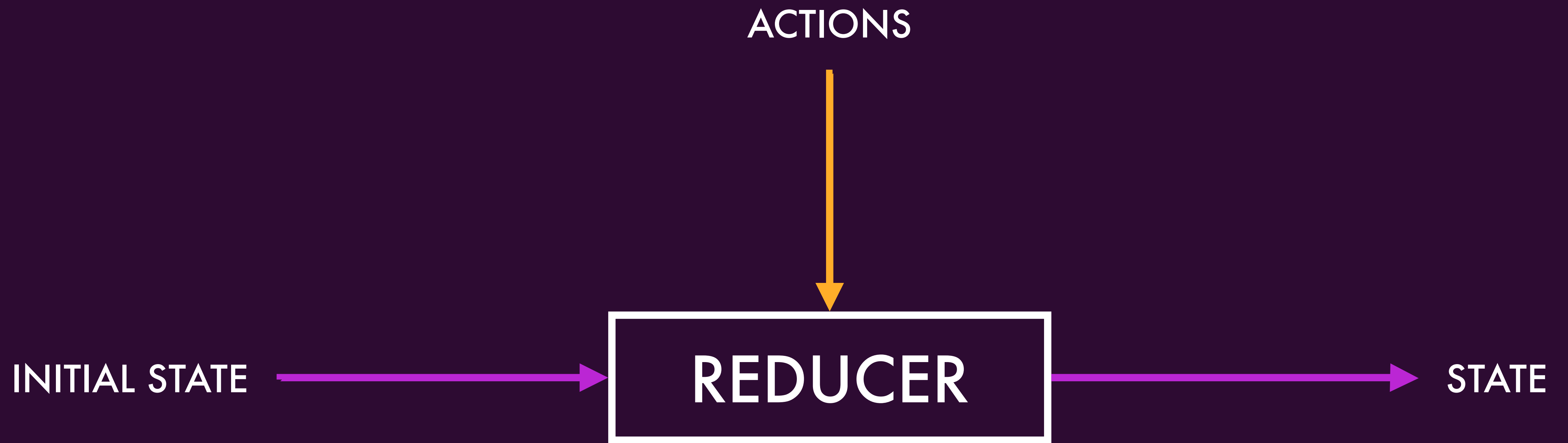
REDUCER

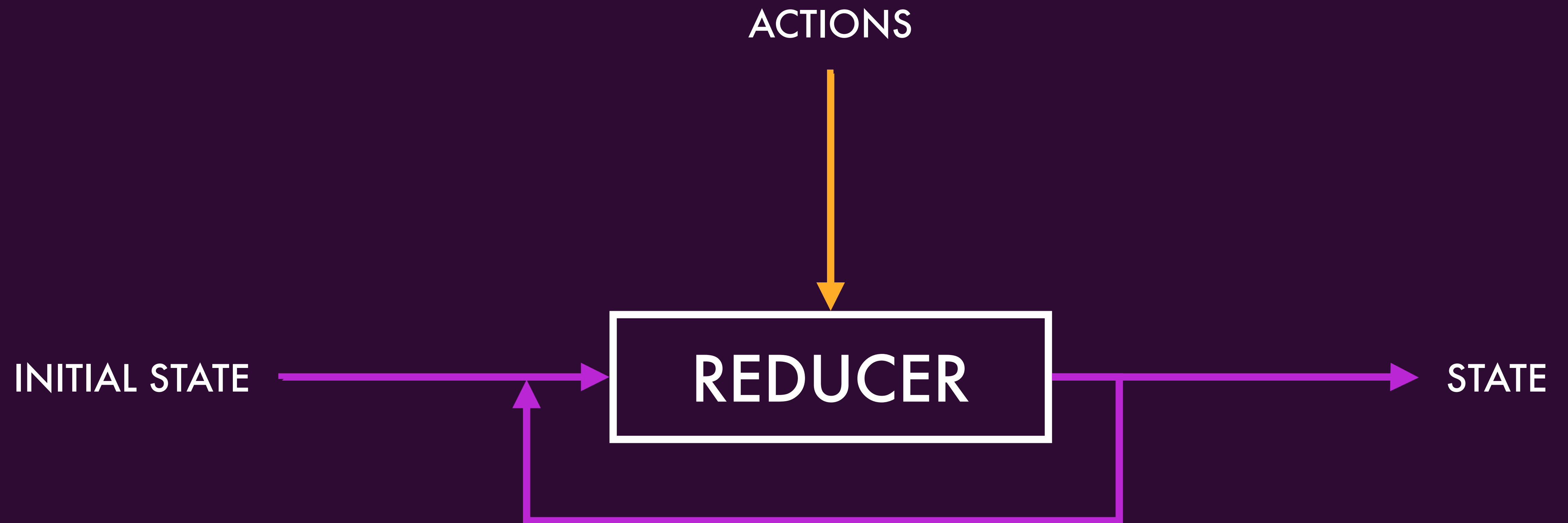
ACTIONS



REDUCER







```
function moviesReducer(state = [], action) {  
  switch (action.type) {  
    case 'MOVIES_LOADED_SUCCESS': {  
      return action.movies;  
    }  
  
    default: {  
      return state;  
    }  
  }  
}
```

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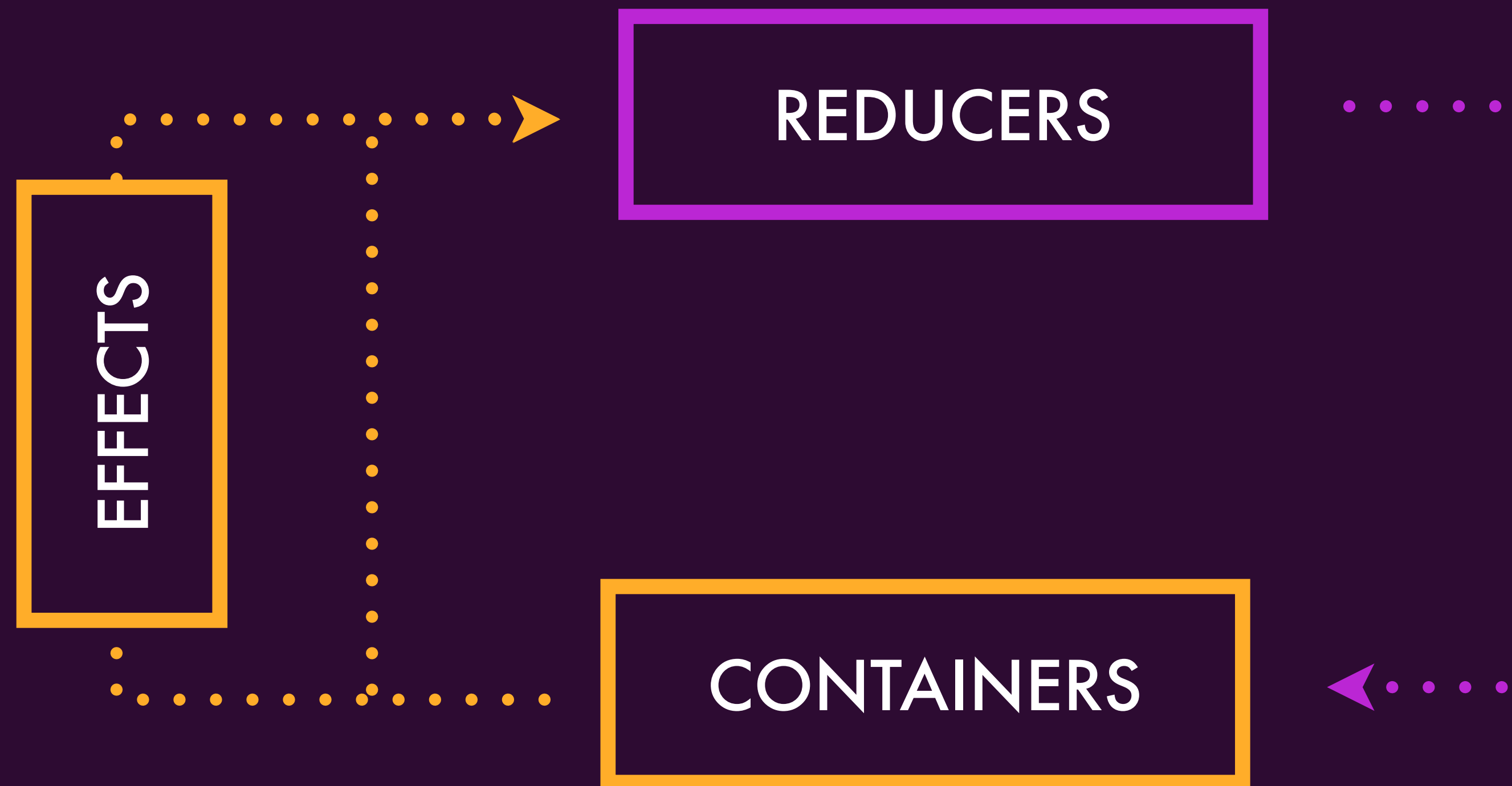
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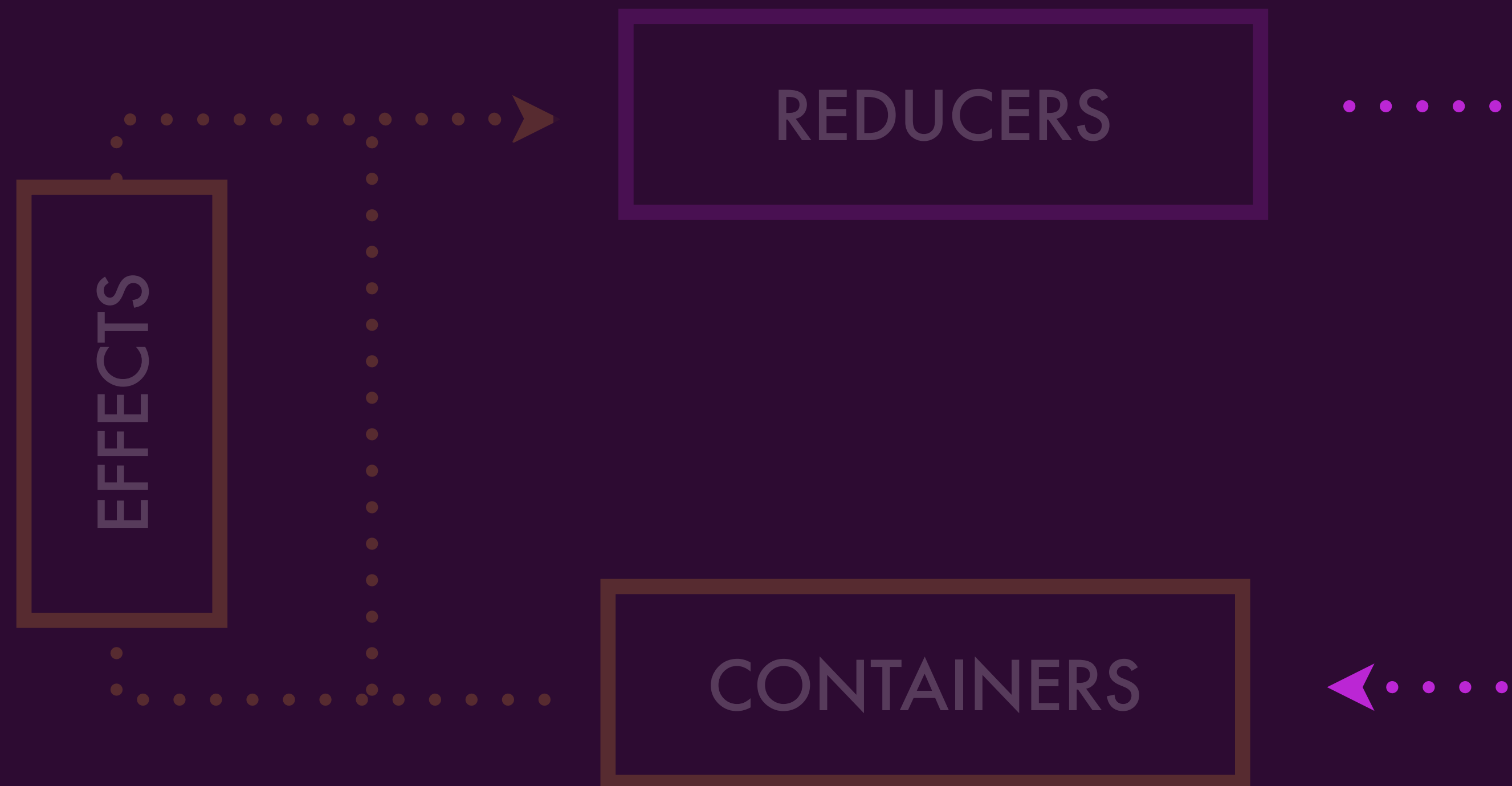
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      return state;  
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  }  
}
```

SELECTORS



SELECTORS



STORE



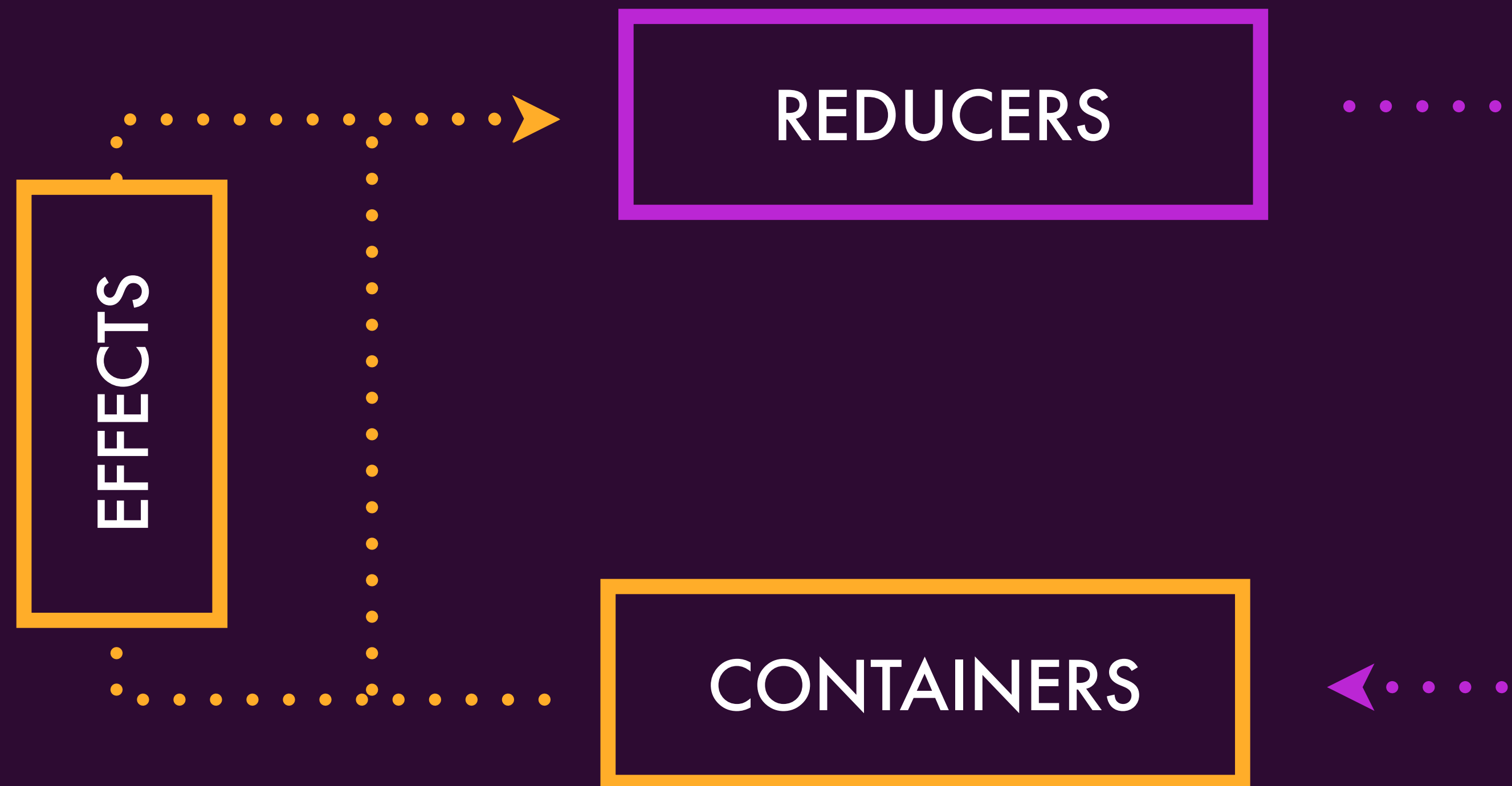
???

COMPONENTS


```
function selectMovies(state) {  
    return state.moviesState.movies;  
}
```

Global `@Input()` for your whole app

CONTAINERS



CONTAINERS



```
@Component({
  template: `
    <search-movies-box (search)="onSearch($event)"></search-movies-box>
    <movies-list
      [movies]="movies$ | async"
      (favoriteMovie)="onFavoriteMovie($event)">
    </movies-list>
  `
})
export class SearchMoviesPageComponent {
  movies$: Observable<Movie[]>

  constructor(private store: Store<AppState>) {
    this.movies$ = store.select(selectMovies);
  }

  onSearch(searchTerm: string) {
    this.store.dispatch({ type: 'SEARCH_MOVIES', searchTerm });
  }
}
```

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@Component({
  template: `
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    this.store.dispatch({ type: 'SEARCH_MOVIES', searchTerm });
  }
}
```

```
@Input() movies: Movie[]
```

```
store.select(selectMovies)
```

```
@Output() search: EventEmitter<string>()
```

```
this.store.dispatch({ type: 'SEARCH_MOVIES', searchTerm });
```



NGRX MENTAL MODEL

*Select and Dispatch are special
versions of Input and Output*

RESPONSIBILITIES

RESPONSIBILITIES

- ✓ Containers connect data to components

RESPONSIBILITIES

- ✓ Containers connect data to components
- ✓ Effects triggers side effects

RESPONSIBILITIES

- ✓ Containers connect data to components
- ✓ Effects triggers side effects
- ✓ Reducers handle state transitions



NGRX MENTAL MODEL

Delegate responsibilities to individual modules of code





- ✓ State flows down, changes flow up



- ✓ State flows down, changes flow up
- ✓ Indirection between state & consumer

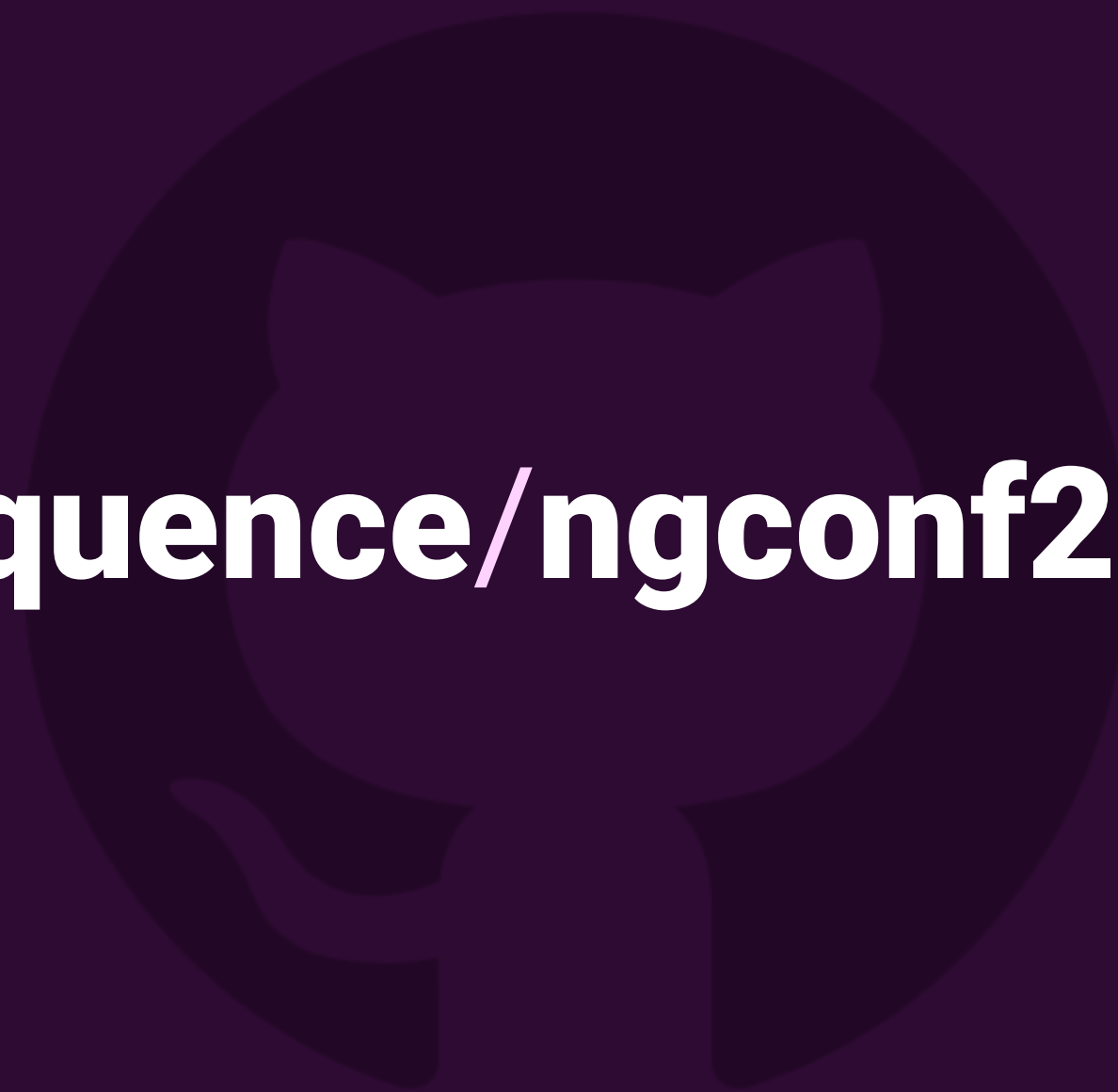


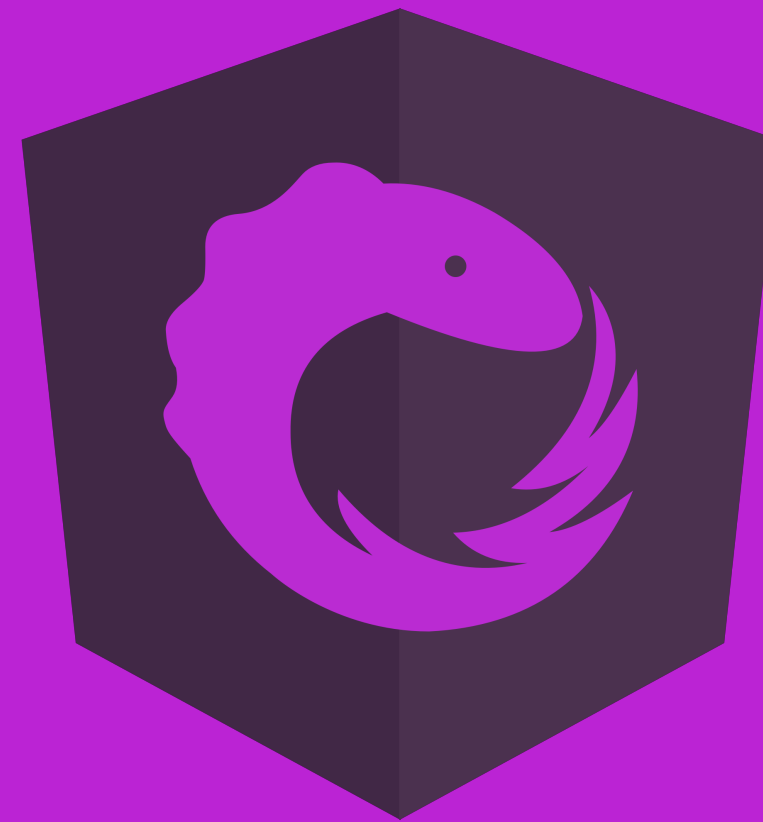
- ✓ State flows down, changes flow up
- ✓ Indirection between state & consumer
- ✓ Select & Dispatch => Input & Output



- ✓ State flows down, changes flow up
- ✓ Indirection between state & consumer
- ✓ Select & Dispatch => Input & Output
- ✓ Adhere to single responsibility principle

github.com/CodeSequence/ngconf2019-ngrx-workshop

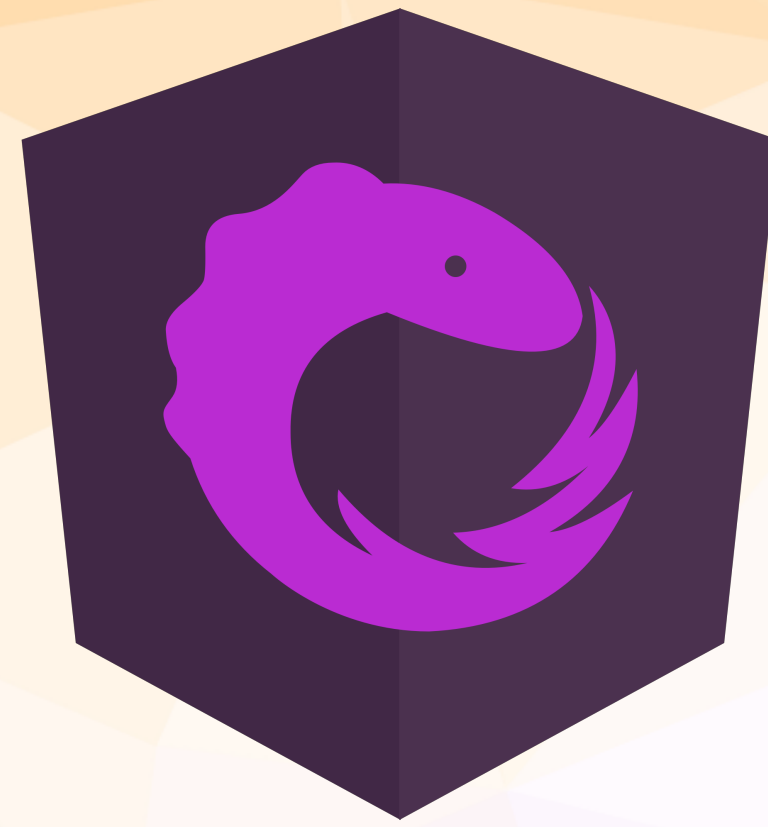




Demo

Challenge

1. Clone the repo at **<https://github.com/CodeSequence/ngconf2019-ngrx-workshop>**
2. Checkout the **challenge** branch
3. Familiarize yourself with the **file structure**
4. Where is **movies state** handled?
5. Where are the **movies actions** located?
6. How does the **movies state** flow into the movies component?
7. How are **events** in the **movies component** going to the **movies reducer**?



SETTING UP THE STORE

STORE

- ✓ State contained in a single state tree
- ✓ State in the store is immutable
- ✓ Slices of state are updated with reducers

```
export interface MoviesState {  
    activeMovieId: string | null;  
    movies: Movie[];  
}
```

```
export const initialState: MoviesState = {  
  activeMovieId: null,  
  movies: initialMovies,  
};
```



```
export function moviesReducer(  
  state = initialState,  
  action: Action  
): MoviesState {  
  switch (action.type) {  
    default:  
      return state;  
  }  
}
```

```
import * as fromMovies from "../movies/movies.reducer";  
import * as fromBooks from "../books/books.reducer";
```

```
export interface AppState {  
  movies: fromMovies.MoviesState;  
  books: fromBooks.BooksState;  
}
```

```
export const reducers: ActionReducerMap<AppState> = {  
  movies: fromMovies.reducer,  
  books: fromBooks.reducer  
};
```

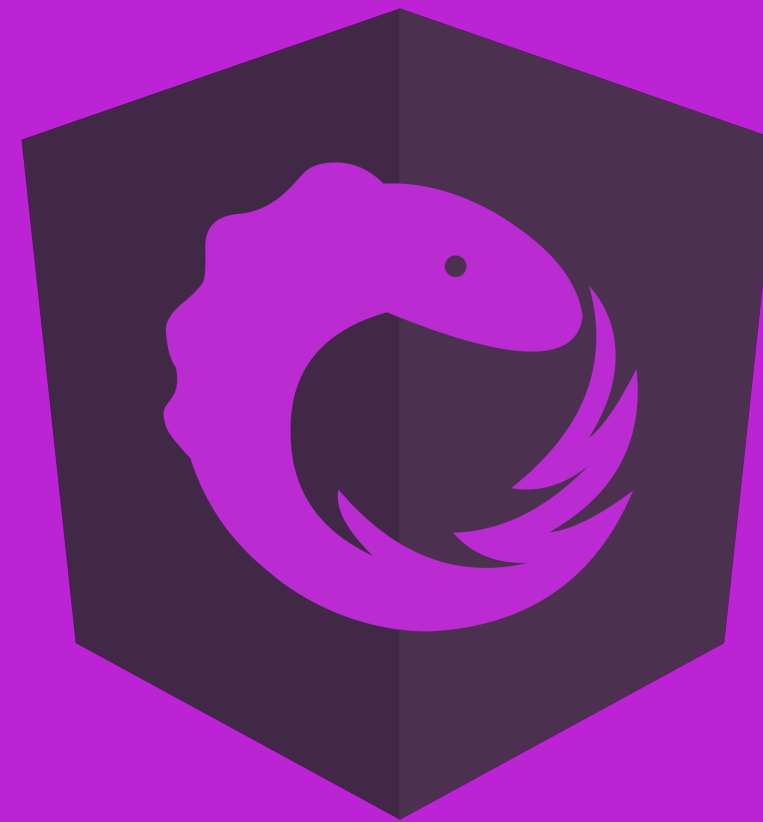
```
@NgModule({  
  imports: [  
    // imports ...  
    StoreModule.forRoot(reducers),  
    StoreDevtoolsModule.instrument({ maxAge: 5 }),  
  ],  
})  
export class AppModule {}
```

```
export class MoviesComponent implements OnInit {  
    movies$: Observable<Movie[]>;  
    constructor(private store: Store<AppState>) {  
        this.movies$ = store.select(  
            (state: AppState) => state.movies  
        );  
    }  
}
```

```
<app-movies-total [total]="total$ | async">
</app-movies-total>
<app-movies-list
  [movies]="movies$ | async"
  (select)="onSelect($event)"
  (delete)="onDelete($event)"
>
</app-movies-list>
```

STATE FLOWS DOWN





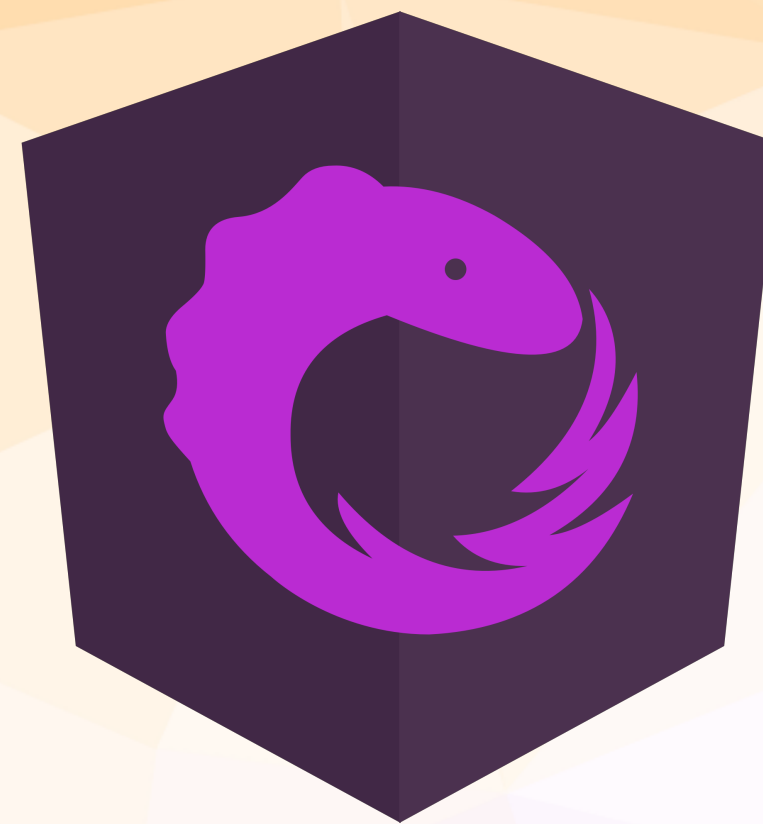
Demo

Challenge, pt 1

1. Open **books.reducer.ts**
2. Define an interface for **BooksState** that has **activeBookId** and **books** properties
3. Define an **initialState** object that implements the **BooksState** interface
4. Create a **reducer** that defaults to **initialState** with a **default** case in a switch statement that returns **state**

Challenge, pt 2

1. Open `shared/state/index.ts` and add books to the State interface and the books reducer to the reducers object
2. Open `books-page.component.ts` and inject the Store service into the constructor
3. Add an observable property to the component that gets all of the books from state using the select operator
4. Update `books-page.component.html` to use the async pipe to get the list of books



REDUCERS

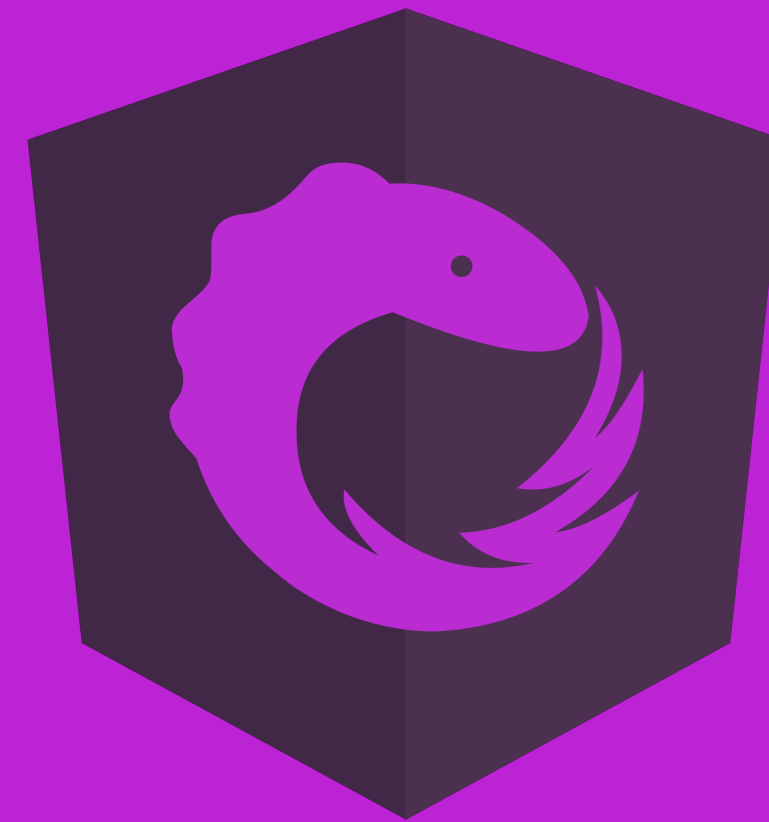
REDUCERS

- ✓ Produce new states
- ✓ Receive the last state and next action
- ✓ Switch on the action type
- ✓ Use pure, immutable operations

```
export function reducer(state = initialState, action: Action): MoviesState {
  switch (action.type) {
    case "select":
      return {
        activeMovieId: action.movieId,
        movies: state.movies
      };
    case "create":
      return {
        activeMovieId: state.selectedMovieId,
        movies: createMovie(state.movies, action.movie)
      };
    default:
      return state;
  }
}
```

```
const createMovie = (movies, movie) => [  
  ...movies,  
  movie  
];  
  
const updateMovie = (movies, movie) =>  
  movies.map(w => {  
    return w.id === movie.id  
      ? Object.assign({}, movie, w)  
      : w;  
  });  
  
const deleteMovie = (movies, movie) =>  
  movies.filter(w => movie.id !== w.id);
```

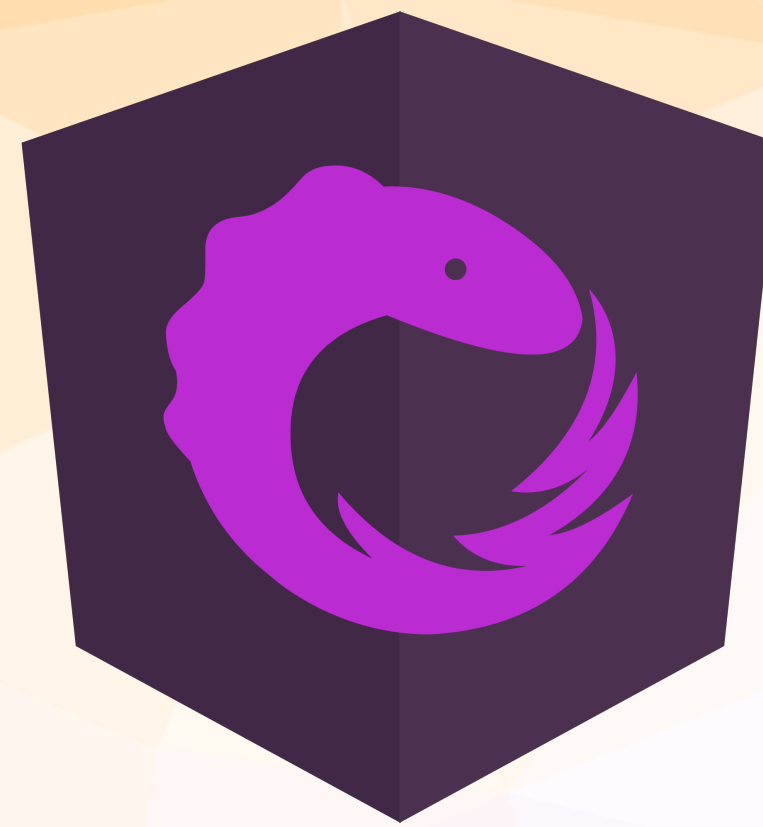
```
class MoviesComponent {  
  createMovie(movie) {  
    this.store.dispatch({  
      type: "create",  
      movie  
    });  
  }  
}
```



Demo

Challenge

1. Update the books reducer to handle “select”, “clear select”, “create”, “update”, and “delete” actions
2. Use the helper functions already in **books.reducer.ts**
3. Update **books-page.component.ts** to dispatch “select”, “clear select”, “create”, “update”, and “delete” actions from the component
4. Remove the **BooksService** from the component



ACTIONS

ACTIONS

- ✓ Unified interface to describe events
- ✓ Just data, no functionality
- ✓ Has at a minimum a type property
- ✓ Strongly typed using classes and enums

GOOD ACTION HYGIENE

- ✓ Unique events get unique actions
- ✓ Actions are grouped by their source
- ✓ Actions are never reused

```
class MoviesComponent {  
  createMovie(movie) {  
    this.store.dispatch({  
      type: "create",  
      movie  
    });  
  }  
}
```

```
export enum ActionTypes {  
  SelectMovie = "[Movies Page] Select Movie",  
  AddMovie = "[Movies Page] Add Movie",  
  UpdateMovie = "[Movies Page] Update Movie",  
  DeleteMovie = "[Movies Page] Delete Movie"  
}
```

```
export class SelectMovie implements Action {  
    readonly type = MoviesActionTypes.SelectMovie;  
  
    constructor(public movie) {}  
}
```

```
export class AddMovie implements Action {  
    readonly type = MoviesActionTypes.AddMovie;  
    constructor(public movie: MovieModel) {}  
}
```

```
export class UpdateMovie implements Action {  
    readonly type = MoviesActionTypes.UpdateMovie;  
    constructor(public movie: MovieModel) {}  
}
```

```
export class DeleteMovie implements Action {  
    readonly type = MoviesActionTypes.DeleteMovie;  
    constructor(public movie: MovieModel) {}  
}
```

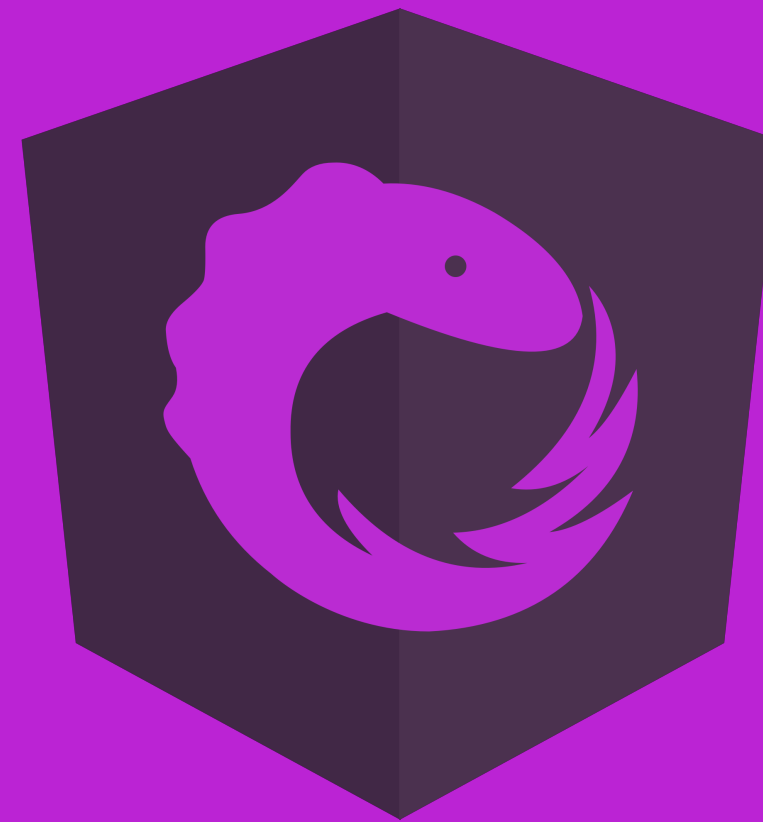
```
export type MoviesActions =  
  | SelectMovie  
  | AddMovie  
  | UpdateMovie  
  | DeleteMovie;
```



```
export function moviesReducer(  
  state = initialState,  
  action: MoviesActions  
): MoviesState {  
  switch (action.type) {  
    case MoviesActionTypes.MovieSelected:  
      ...  
    case MoviesActionTypes.AddMovie:  
      ...  
    case MoviesActionTypes.UpdateMovie:  
      ...  
    case MoviesActionTypes.DeleteMovie:  
      ...  
    default:  
      return state;  
  }  
}
```

```
createMovie(movie) {  
  this.store.dispatch({  
    type: "create",  
    movie  
  });  
}
```

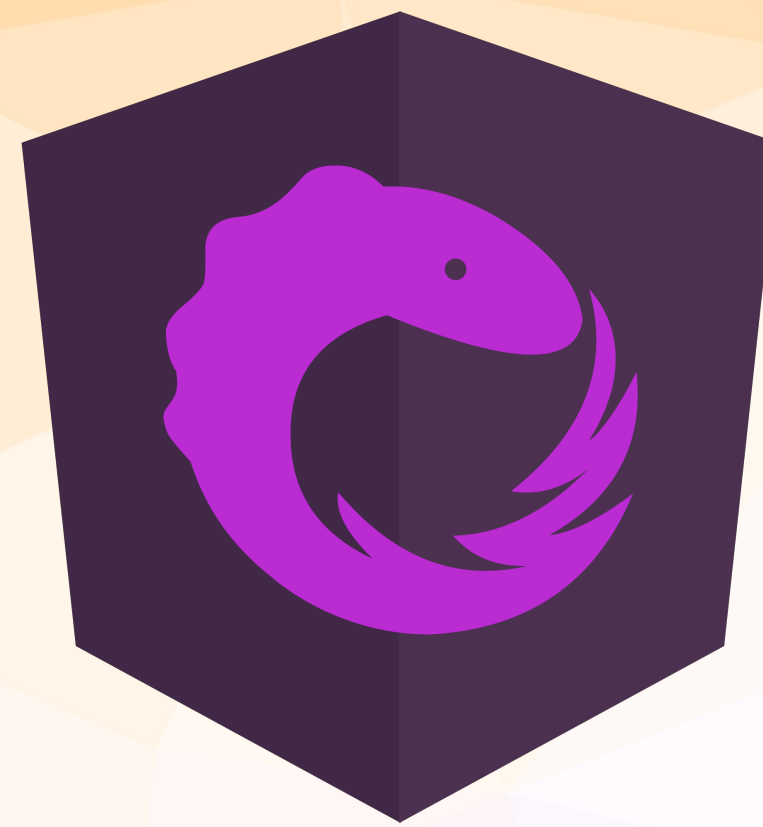
```
createMovie(movie) {  
    this.store.dispatch(new MoviesActions.AddMovie(movie));  
}
```



Demo

Challenge

1. Open **books-page.actions.ts** and create an **enum** to hold the various action types
2. Create **strongly typed actions** that adhere to **good action hygiene** for selecting a book, clearing the selection, creating a book, updating a book, and deleting a book.
3. Export the actions as a **union type**
4. Update **books-page.components.ts** and **books.reducer.ts** to use the new actions



ENTITIES

ENTITY

- ✓ Working with collections should be fast
- ✓ Collections are very common
- ✓ Common set of basic state operations
- ✓ Common set of basic state derivations

```
interface EntityState<Model> {  
    ids: string[] | number[];  
    entities: { [id: string | number]: Model };  
}
```



```
export interface MoviesState extends EntityState<Movie> {  
  activeMovieId: string | null;  
}  
export const adapter = createEntityAdapter<Movie>();  
export const initialState: Movie = adapter.getInitialState(  
  {  
    activeMovieId: null  
  }  
);
```

```
export interface MoviesState extends EntityState<Movie> {  
    activeMovieId: string | null;  
}  
export const adapter = createEntityAdapter<Movie>();  
export const initialState: Movie = adapter.getInitialState(  
    {  
        activeMovieId: null  
    }  
);
```

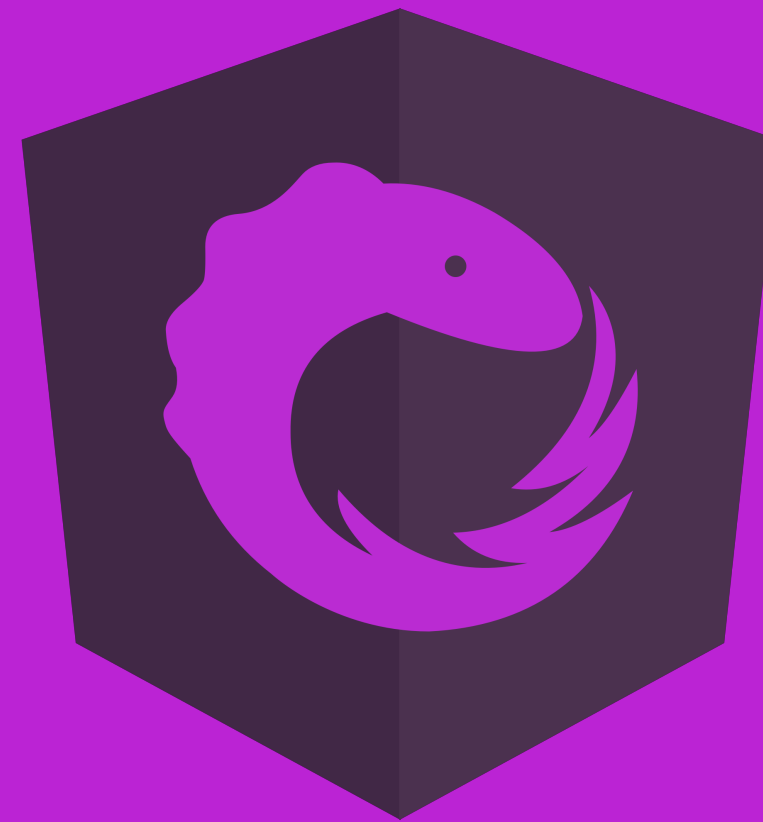
```
export interface MoviesState extends EntityState<Movie> {  
    activeMovieId: string | null;  
}  
export const adapter = createEntityAdapter<Movie>();  
export const initialState: Movie = adapter.getInitialState(  
    {  
        activeMovieId: null  
    }  
);
```

```
export interface MoviesState extends EntityState<Movie> {  
  activeMovieId: string | null;  
}  
export const adapter = createEntityAdapter<Movie>();  
export const initialState: Movie = adapter.getInitialState(  
  {  
    activeMovieId: null  
  }  
);
```

```
case MoviesActionTypes.AddMovie:  
  return {  
    activeMovieId: state.selectedMovieId,  
    movies: createMovie(state.movies, action.movie)  
  };  
}
```

```
case ActionTypes.AddMovie:  
    return adapter.addOne(action.movie, state);
```

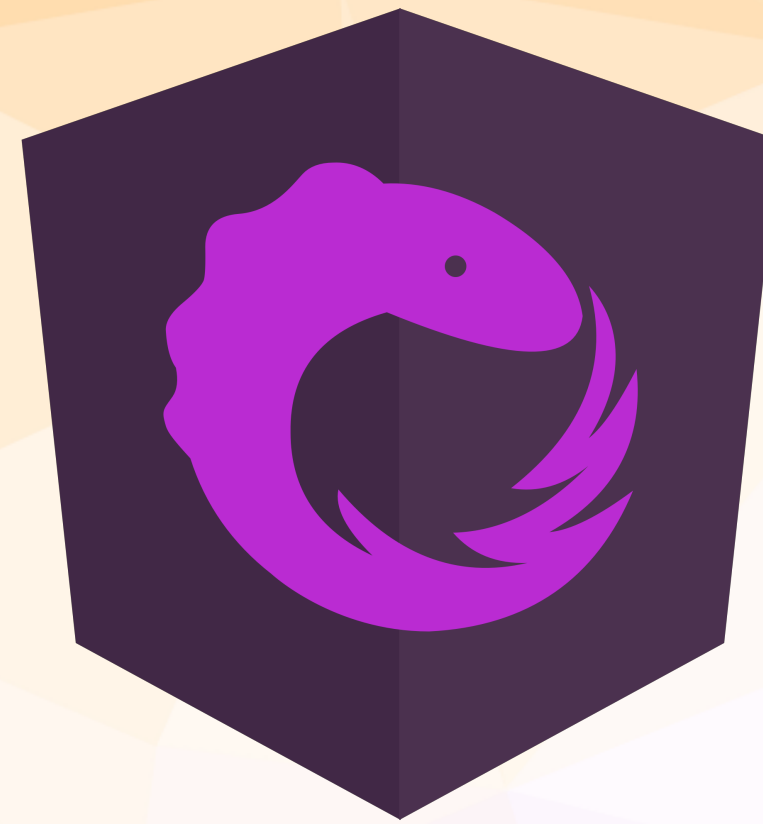
```
this.movies$ = store.select((state: any) =>  
    state.movies.ids.map(id => state.movies.entities[id])  
);
```



Demo

Challenge

1. Add an **“Enter”** action to **books-page.actions.ts** and dispatch it in the **getBooks()** method of **books.component.ts**
2. Update **books.reducer.ts** to use **EntityState** to define **BooksState**
3. Create an **unsorted entity adapter** for **BooksState** and use it to initialize **initialState**
4. Update the reducer to use the **adapter methods**
5. Add a case statement for the **“Enter”** action that adds all of the **initialBooks** to the state
6. Update the **books\$** selector in **books-page.component.ts** to use the **ids** and **entities** properties of the **books state** to get the list of **books**



SELECTORS

SELECTORS

- ✓ Allow us to query our store for data
- ✓ Recompute when their inputs change
- ✓ Fully leverage memoization for performance
- ✓ Selectors are fully composable

```
export const selectActiveMovieId = (state: MoviesState) =>  
  state.activeMovieId;
```

// get and export the selectors

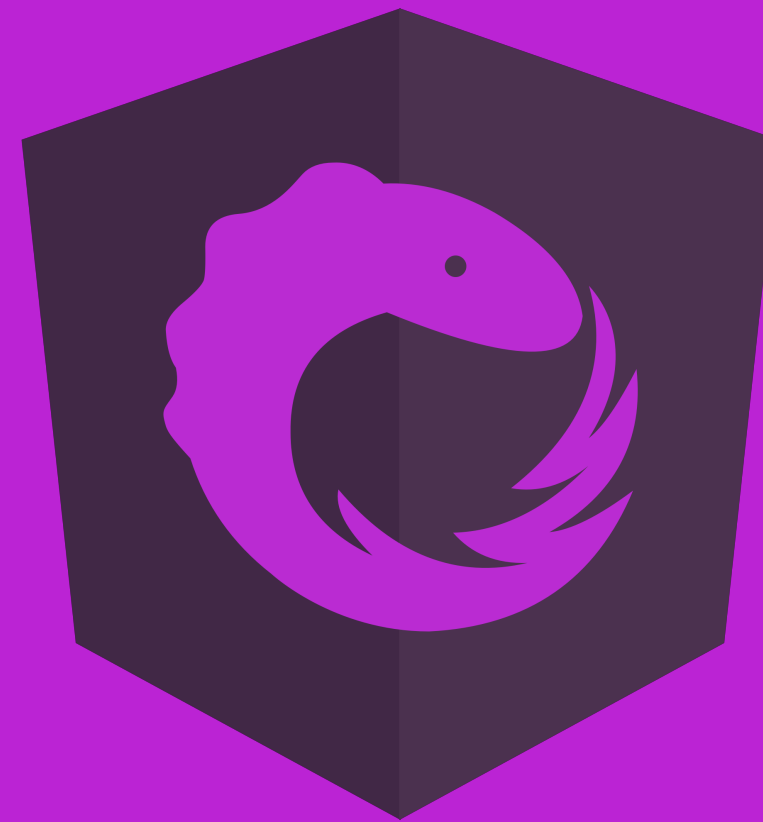
```
export const {  
  selectIds,  
  selectEntities,  
  selectAll  
} = adapter.getSelectors();
```

```
export const selectActiveMovie = createSelector(  
  selectActiveMovieId,  
  selectEntities,  
  (activeMovieId, movieEntities) =>  
    movieEntities[activeMovieId],  
);
```

```
export const selectMoviesState = (state: AppState) => state.movies;
export const selectAllMovies = createSelector(
  selectMoviesState,
  fromMovies.selectAll,
);
export const selectActiveMovie = createSelector(
  selectMoviesState,
  fromMovies.selectActiveMovie,
);
```

```
this.movies$ = store.select((state: any) =>  
    state.movies.ids.map(id => state.movies.entities[id])  
);
```

```
this.movies$ = store.select(selectAllMovies);
```

Demo

Challenge

1. Open **books.reducer.ts** and use the entity adapter to create selectors for **selectAll** and **selectEntities**
2. Write a **selector** in **books.reducer.ts** that gets **activeBookId**
3. Use **createSelector** to create a **selectActiveBook** selector using **selectEntities** and **selectActiveBookId**
4. Use **createSelector** to create a **selectEarningsTotal** selector to calculate the gross total earnings of all books using **selectAll**
5. Create global versions of **selectAllBooks**, **selectActiveBook**, and **selectBookEarningsTotal** in **state/index.ts** using **createSelector**
6. Update **books-page.component.ts** and its template to use the **selectAllBooks**, **selectActiveBook**, and **selectEarningsTotal** selectors





- ✓ State flows down, changes flow up



- ✓ State flows down, changes flow up
- ✓ Indirection between state & consumer



- ✓ State flows down, changes flow up
- ✓ Indirection between state & consumer
- ✓ Select & Dispatch => Input & Output



- ✓ State flows down, changes flow up
- ✓ Indirection between state & consumer
- ✓ Select & Dispatch => Input & Output
- ✓ Adhere to single responsibility principle

STORE

- ✓ State contained in a single state tree
- ✓ State in the store is immutable
- ✓ Slices of state are updated with reducers

REDUCERS

- ✓ Produce new states
- ✓ Receive the last state and next action
- ✓ Switch on the action type
- ✓ Use pure, immutable operations

ACTIONS

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ENTITY

- ✓ Working with collections should be fast
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- ✓ Common set of basic state derivations

SELECTORS

- ✓ Allow us to query our store for data
- ✓ Recompute when their inputs change
- ✓ Fully leverage memoization for performance
- ✓ Selectors are fully composable

DAY TWO SCHEDULE

- Effects++
- Advanced Actions
- Testing Reducers
- Testing Effects
- Wrap Up



CLONE AND FOLLOW THE SETUP INSTRUCTIONS

github.com/CodeSequence/ngconf2019-ngrx-workshop



A REACTIVE STATE OF MIND

WITH ANGULAR AND NGRX



Mike Ryan

@MikeRyanDev



Mike Ryan

@MikeRyanDev

Software Engineer at Synapse



Mike Ryan

@MikeRyanDev

Software Engineer at Synapse

Google Developer Expert



Mike Ryan

@MikeRyanDev

Software Engineer at Synapse

Google Developer Expert

NgRx Core Team



Brandon Roberts

@brandontroberts



Brandon Roberts

@brandontroberts

Developer/Technical Writer



Brandon Roberts

@brandontroberts

Developer/Technical Writer

Angular Team



Brandon Roberts

@brandontroberts

Developer/Technical Writer

Angular Team

NgRx Core Team





- ✓ State flows down, changes flow up



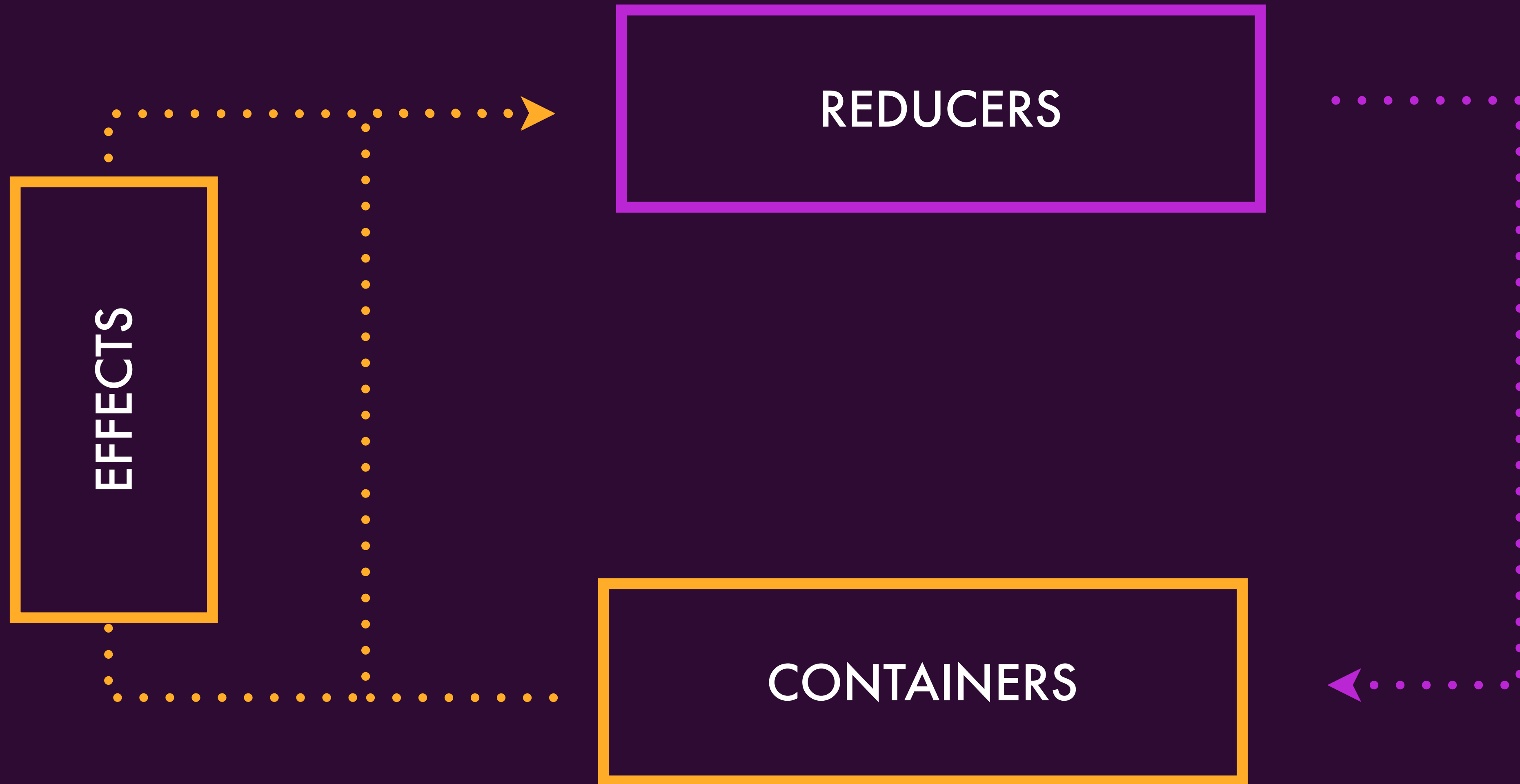
- ✓ State flows down, changes flow up
- ✓ Indirection between state & consumer

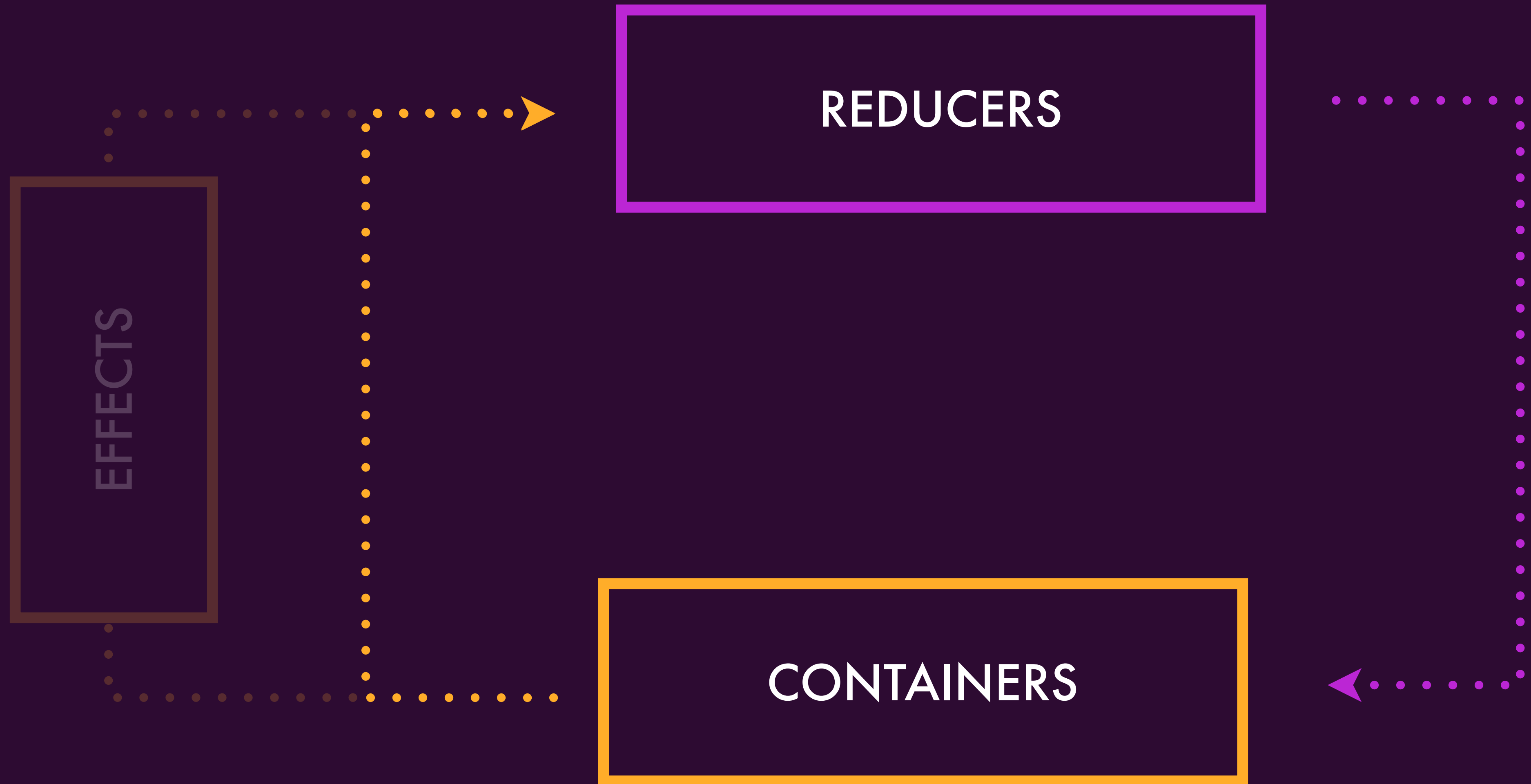


- ✓ State flows down, changes flow up
- ✓ Indirection between state & consumer
- ✓ Select & Dispatch => Input & Output



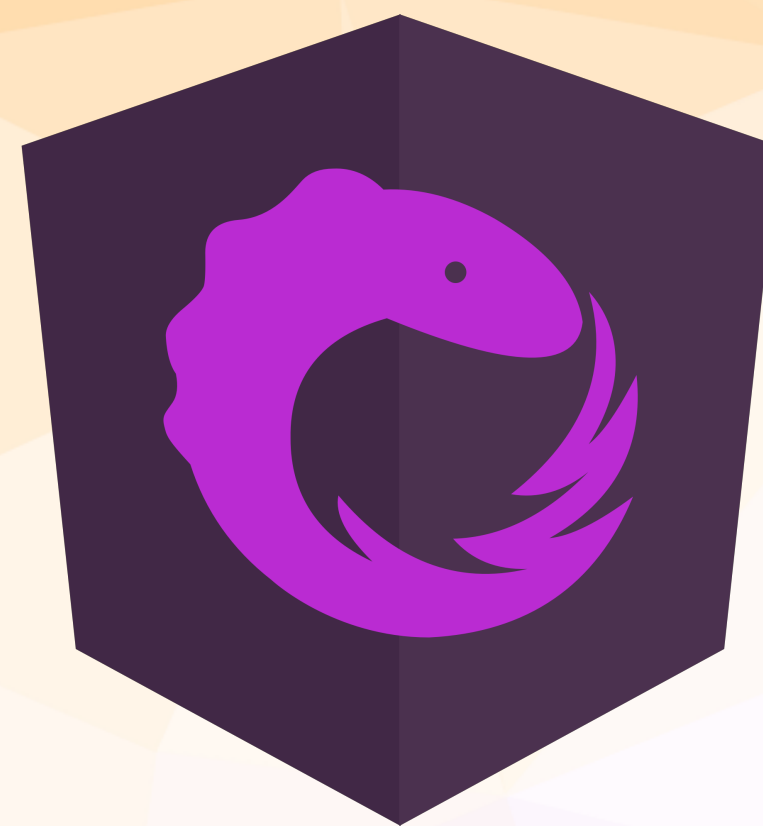
- ✓ State flows down, changes flow up
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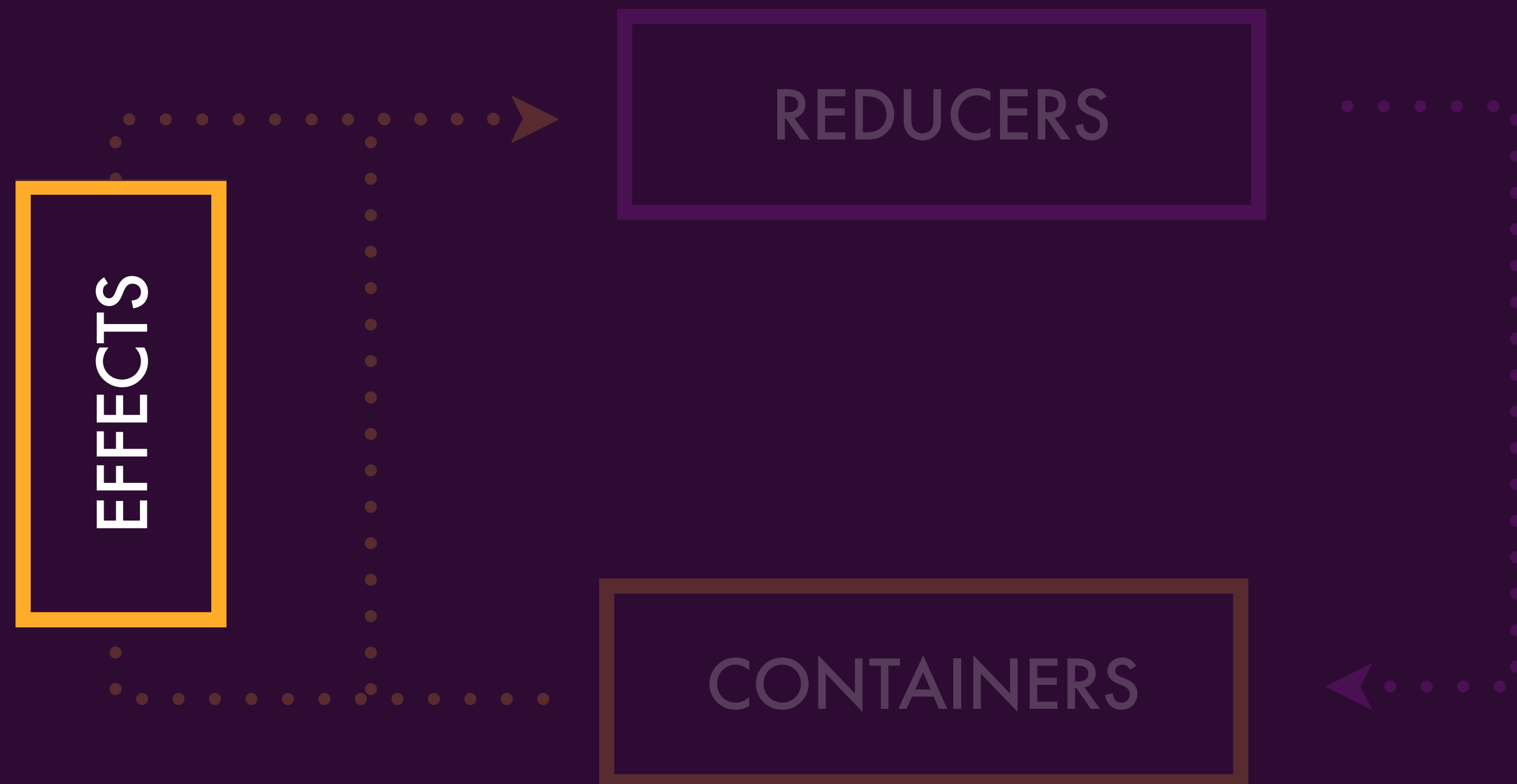
Challenge

1. Clone the repo at **<https://github.com/CodeSequence/ngconf2019-ngrx-workshop>**
2. Checkout the **04-selectors** branch
3. Familiarize yourself with the **file structure**
4. Where is **books state** handled?
5. Where are the **books actions** located?
6. How does the **books state** flow into the movies component?
7. How are **events** in the **books page component** going to the **books reducer**?



EFFECTS





EFFECTS

- ✓ Processes that run in the background
- ✓ Connect your app to the outside world
- ✓ Often used to talk to services
- ✓ Written entirely using RxJS streams

```
export enum MoviesApiActionTypes {  
  MoviesLoaded = '[Movies API] Movies Loaded',  
  MovieAdded = '[Movies API] Movie Added',  
  MovieUpdated = '[Movies API] Movie Updated',  
  MovieDeleted = '[Movies API] Movie Deleted'  
}
```

```
@Injectable()
export class MoviesEffects {
  constructor(
    private actions$: Actions<
      BooksPageActions . BooksActions
    >,
    private moviesService: MoviesService
  ) {}
}
```

```
export class MoviesEffects {
  @Effect() loadMovies$ = this.actions$.pipe(
    ofType(MoviesActionTypes.LoadMovies),
    mergeMap(() =>
      this.moviesService.all().pipe(
        map(
          (res: MovieModel[]) =>
            new MovieApiActions.MoviesLoaded(res)
        ),
        catchError(() => EMPTY)
      )
    )
  );
}
```

```
export class MoviesEffects {
  @Effect() loadMovies$ = this.actions$.pipe(
    ofType(MoviesActionTypes.LoadMovies),
    mergeMap(() =>
      this.moviesService.all().pipe(
        map(
          (res: MovieModel[]) =>
            new MovieApiActions.MoviesLoaded(res)
        ),
        catchError(() => EMPTY)
      )
    )
  );
}
```

```
export class MoviesEffects {
    @Effect() loadMovies$ = this.actions$.pipe(
        ofType(MoviesActionTypes.LoadMovies),
        mergeMap(() =>
            this.moviesService.all().pipe(
                map(
                    (res: MovieModel[]) =>
                        new MovieApiActions.MoviesLoaded(res)
                ),
                catchError(() => EMPTY)
            )
        )
    );
}
```



```
export class MoviesEffects {
    @Effect() loadMovies$ = this.actions$.pipe(
        ofType(MoviesActionTypes.LoadMovies),
        mergeMap(() =>
            this.moviesService.all().pipe(
                map(
                    (res: MovieModel[]) =>
                        new MovieApiActions.MoviesLoaded(res)
                ),
                catchError(() => EMPTY)
            )
        )
    );
}
```

```
EffectsModule.forFeature([MoviesEffects]);
```

```
const BASE_URL = "http://localhost:3000/movies";
```

```
@Injectable({ providedIn: "root" })
```

```
export class MoviesService {
```

```
  constructor(private http: HttpClient) {}
```

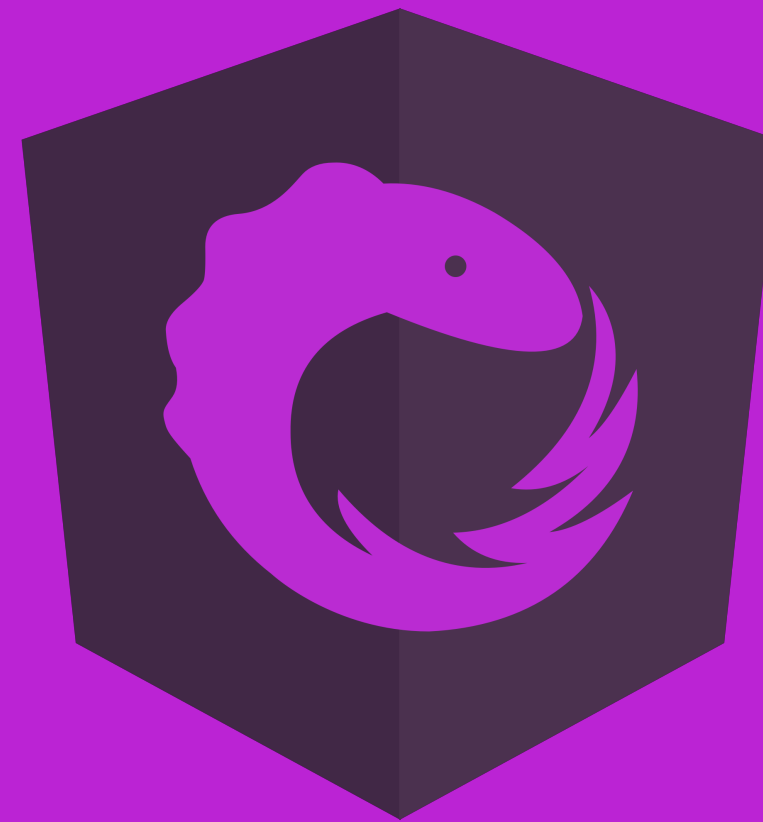
```
  load(id: string) {
```

```
    return this.http.get(`${BASE_URL}/${id}`);
```

```
  }
```

```
}
```

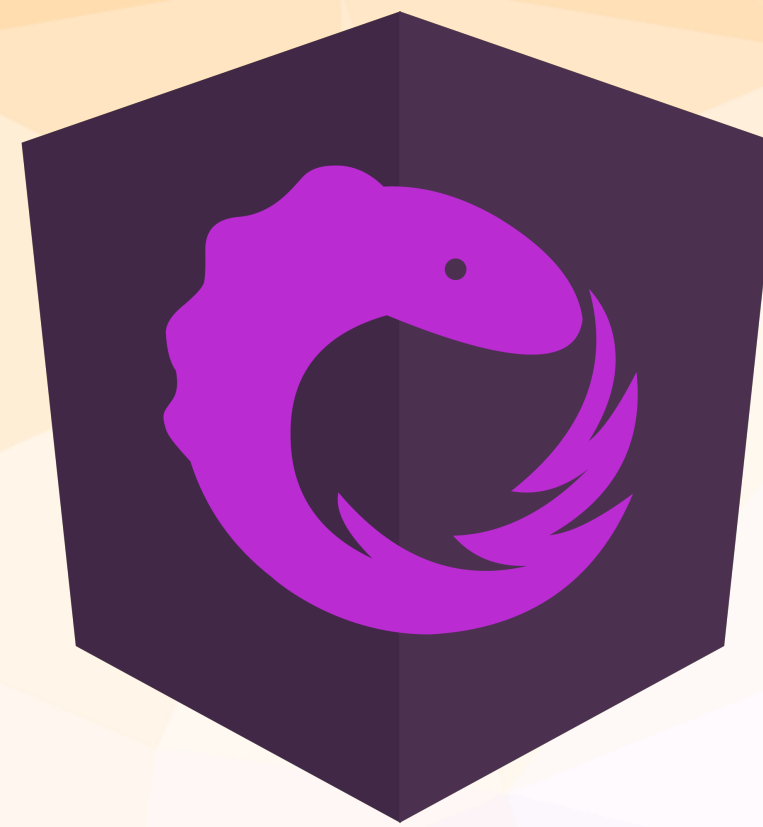
```
export function moviesReducer(  
  state = initialState,  
  action: MoviesActions | MoviesApiActions): MoviesState {  
  switch (action.type) {  
    case MoviesApiActionTypes.MoviesLoaded:  
      return adapter.addAll(action.movies, state);  
    case MoviesApiActionTypes.MovieAdded:  
      return adapter.addOne(action.movie, state);  
    case MoviesActions.UpdateMovie:  
      return adapter.upsertOne(action.movie, state);  
    case MoviesActions.DeleteMovie:  
      return adapter.removeOne(action.movie.id, state);  
    default:  
      return state;  
  }  
}
```



Demo

Challenge

1. Update **books-api.actions.ts** to export an action for **BooksLoaded** along with an **action union type**
2. Create a file at **app/books/books-api.effects.ts** and add an **effect class** to it with an **effect** called **loadBooks\$** that calls **BooksService.all()** and maps the result into a **BooksLoaded** action
3. Register the effect using **EffectsModule.forFeature([])** in **books.module.ts**
4. Update the **books reducer** to handle the **BooksLoaded** action by replacing the **Enter** action handler



ADVANCED EFFECTS

```
export class MoviesEffects {
    @Effect() loadMovies$ = this.actions$.pipe(
        ofType(MoviesActionTypes.LoadMovies),
        mergeMap(() =>
            this.moviesService.all().pipe(
                map(
                    (res: MovieModel[]) =>
                        new MovieApiActions.MoviesLoaded(res)
                ),
                catchError(() => EMPTY)
            )
        )
    );
}
```



```
export class MoviesEffects {
    @Effect() loadMovies$ = this.actions$.pipe(
        ofType(MoviesActionTypes.LoadMovies),
        mergeMap(() =>
            this.moviesService.all().pipe(
                map(
                    (res: MovieModel[]) =>
                        new MovieApiActions.MoviesLoaded(res)
                ),
                catchError(() => EMPTY)
            )
        )
    );
}
```

WHAT MAP OPERATOR SHOULD I USE?

mergeMap

Subscribe immediately, never cancel or discard

concatMap

Subscribe after the last one finishes

exhaustMap

Discard until the last one finishes

switchMap

Cancel the last one if it has not completed

RACE CONDITIONS!

`mergeMap`

Subscribe immediately, never cancel or discard

`exhaustMap`

Discard until the last one finishes

`switchMap`

Cancel the last one if it has not completed

CONCATMAP IS THE SAFEST OPERATOR

...but there is a risk of back pressure

BACKPRESSURE DEMO

<https://stackblitz.com/edit/angular-kbvxxx>

`mergeMap`

Deleting items

`concatMap`

Updating or creating items

`exhaustMap`

Non-parameterized queries

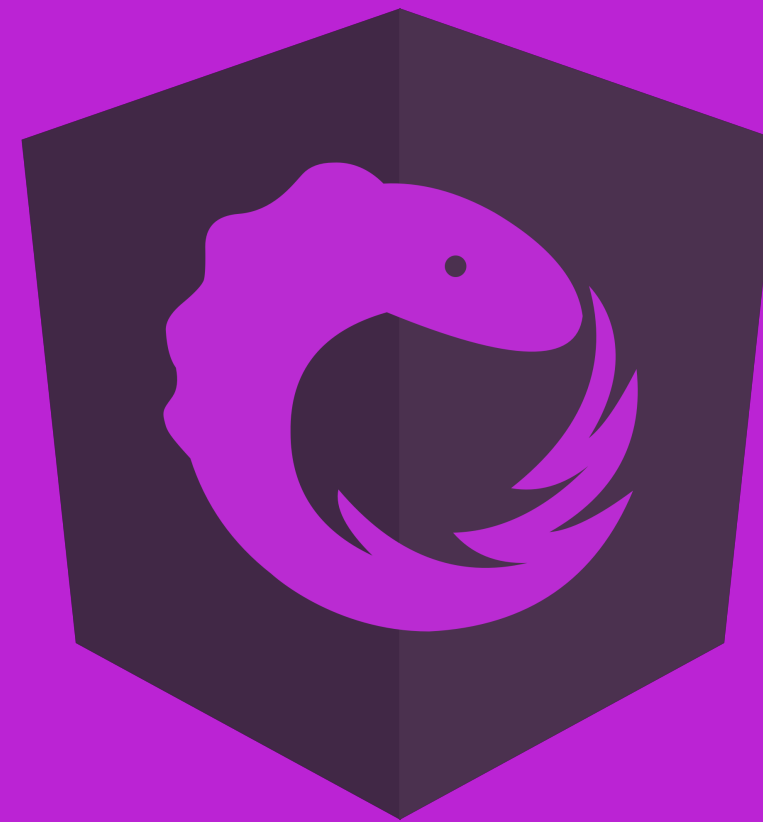
`switchMap`

Parameterized queries

```
@Effect() enterMoviesPage$ = this.actions$.pipe(  
  ofType(MoviesPageActions.Types.Enter),  
  exhaustMap(() =>  
    this.movieService.all().pipe(  
      map(movies => new MovieApiActions.LoadMoviesSuccess(movies)),  
      catchError(() => of(new MovieApiActions.LoadMoviesFailure()))  
    )  
  )  
);
```



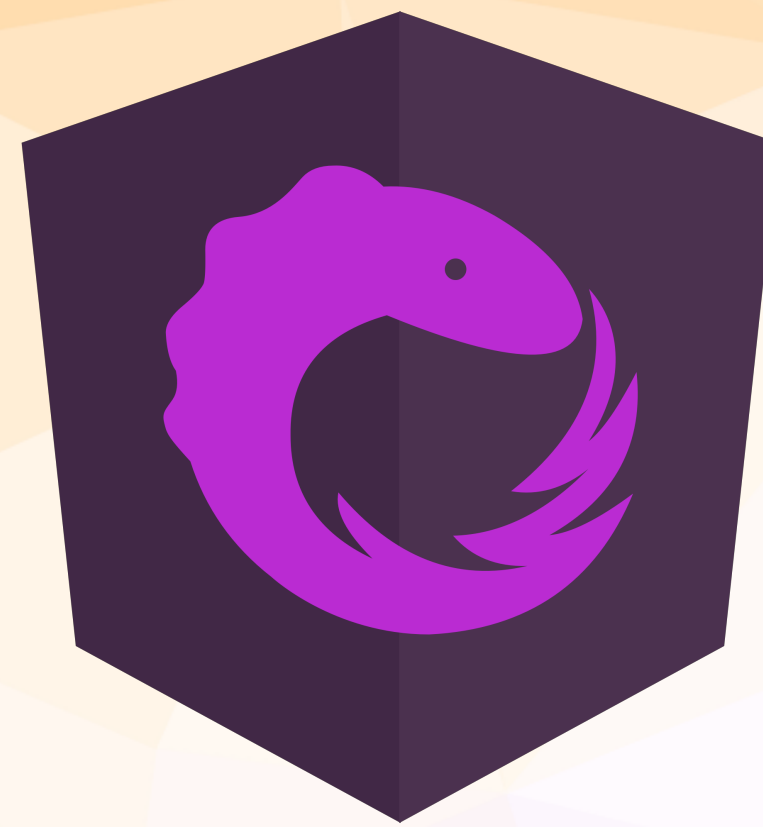
```
@Effect() updateMovie$ = this.actions$.pipe(  
  ofType(MoviesPageActions.Types.UpdateMovie),  
  concatMap(action =>  
    this.movieService.update(action.movie.id, action.changes).pipe(  
      map(movie => new MovieApiActions.UpdateMovieSuccess(movie)),  
      catchError(() =>  
        of(new MovieApiActions.UpdateMovieFailure(action.movie))  
      )  
    )  
  )  
);
```



Demo

Challenge

1. Add “Book Created”, “Book Updated”, and “Book Deleted” actions to **books-api.actions.ts** and update **books.reducer.ts** to handle these new actions
2. Open **books-api.effects.ts** and update the **loadBooks\$** effect to use the **exhaustMap** operator
3. Add an effect for **creating** a book using the **BooksService.create()** method and the **concatMap** operator
4. Add an effect for **updating** a book using the **BooksService.update()** method and the **concatMap** operator
5. Add an effect for **deleting** a book using the **BooksService.delete()** method and the **mergeMap** operator



ADVANCED ACTIONS

```
import { Action } from "@ngrx/store";
import { Book } from "src/app/shared/models/book.model";

export enum BooksApiActionTypes {
  BooksLoaded = "[Books API] Books Loaded Success",
  BookCreated = "[Books API] Book Created",
  BookUpdated = "[Books API] Book Updated",
  BookDeleted = "[Books API] Book Deleted"
}

export class BooksLoaded implements Action {
  readonly type = BooksApiActionTypes.BooksLoaded;

  constructor(public books: Book[]) {}
}

export class BookCreated implements Action {
  readonly type = BooksApiActionTypes.BookCreated;

  constructor(public book: Book) {}
}

export class BookUpdated implements Action {
  readonly type = BooksApiActionTypes.BookUpdated;

  constructor(public book: Book) {}
}

export class BookDeleted implements Action {
  readonly type = BooksApiActionTypes.BookDeleted;

  constructor(public book: Book) {}
}

export type BooksApiActions =
  | BooksLoaded
  | BookCreated
  | BookUpdated
  | BookDeleted;
```

```
import { Action } from "@ngrx/store";
import { Book } from "src/app/shared/models/book.model";

export enum BooksApiActionTypes {
  BooksLoaded = "[Books API] Books Loaded Success",
  BookCreated = "[Books API] Book Created",
  BookUpdated = "[Books API] Book Updated",
  BookDeleted = "[Books API] Book Deleted"
}

export class BooksLoaded implements Action {
  readonly type = BooksApiActionTypes.BooksLoaded;
```

```
import { Action } from "@ngrx/store";
import { Book } from "src/app/shared/models/book.model";

export enum BooksApiActionTypes {
  BooksLoaded = "[Books API] Books Loaded Success",
  BookCreated = "[Books API] Book Created",
  BookUpdated = "[Books API] Book Updated",
  BookDeleted = "[Books API] Book Deleted"
}

export class BooksLoaded implements Action {
  readonly type = BooksApiActionTypes.BooksLoaded;
```



```
import { Action } from "@ngrx/store";
import { Book } from "src/app/shared/models/book.model";

export enum BooksApiActionTypes {
  BooksLoaded = "[Books API] Books Loaded Success",
  BookCreated = "[Books API] Book Created",
  BookUpdated = "[Books API] Book Updated",
  BookDeleted = "[Books API] Book Deleted"
}

export class BooksLoaded implements Action {
  readonly type = BooksApiActionTypes.BooksLoaded;
```



```
export class BooksLoaded implements Action {  
  readonly type = BooksApiActionTypes.BooksLoaded;  
  
  constructor(public books: Book[]) {}  
}
```

```
export class BookCreated implements Action {  
  readonly type = BooksApiActionTypes.BookCreated;  
  
  constructor(public book: Book) {}  
}
```

```
export class BookUpdated implements Action {  
  readonly type = BooksApiActionTypes.BookUpdated;
```

```
export class BooksLoaded implements Action {  
    readonly type = BooksApiActionTypes.BooksLoaded;  
  
    constructor(public books: Book[]) {}  
}
```

```
export class BookCreated implements Action {  
    readonly type = BooksApiActionTypes.BookCreated;  
  
    constructor(public book: Book) {}  
}
```

```
export class BookUpdated implements Action {  
    readonly type = BooksApiActionTypes.BookUpdated;
```

```
export class BooksLoaded implements Action {  
  readonly type = BooksApiActionTypes.BooksLoaded;  
  
  constructor(public books: Book[]) {}  
}
```

```
export class BookCreated implements Action {  
  readonly type = BooksApiActionTypes.BookCreated;  
  
  constructor(public book: Book) {}  
}
```

```
export class BookUpdated implements Action {  
  readonly type = BooksApiActionTypes.BookUpdated;
```






```
export const loadMoviesFailure = createAction(  
  "[Movies API] Load Movies Failure"  
);
```

```
MovieApiActions.loadMoviesFailure();
```

```
export const updateMovieSuccess = createAction(  
  "[Movies API] Update Movie Success",  
  props<{ movie: Movie }>()  
);
```

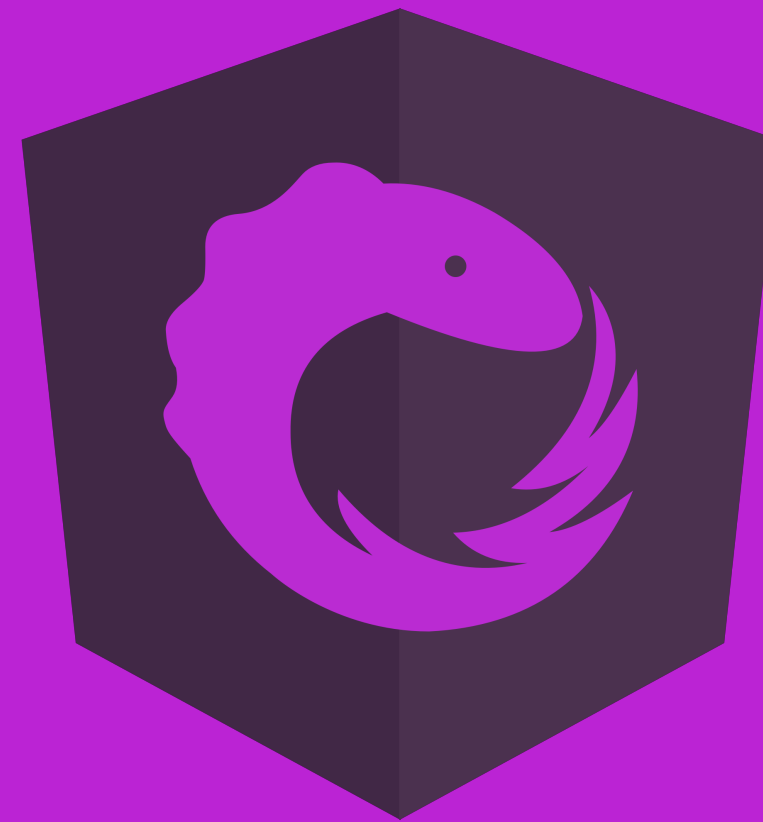
```
MovieApiActions.updateMoviesSuccess({ movie });
```

```
export type Union = ReturnType<  
  | typeof loadMoviesSuccess  
  | typeof loadMoviesFailure  
  // ...  
>;
```



```
@Effect() enterMoviesPage$ = this.actions$.pipe(  
  ofType(MoviesPageActions.enter.type),  
  exhaustMap(() =>  
    this.movieService.all().pipe(  
      map(movies => MovieApiActions.loadMoviesSuccess({ movies })),  
      catchError(() => of(MovieApiActions.loadMoviesFailure()))  
    )  
  )  
);
```

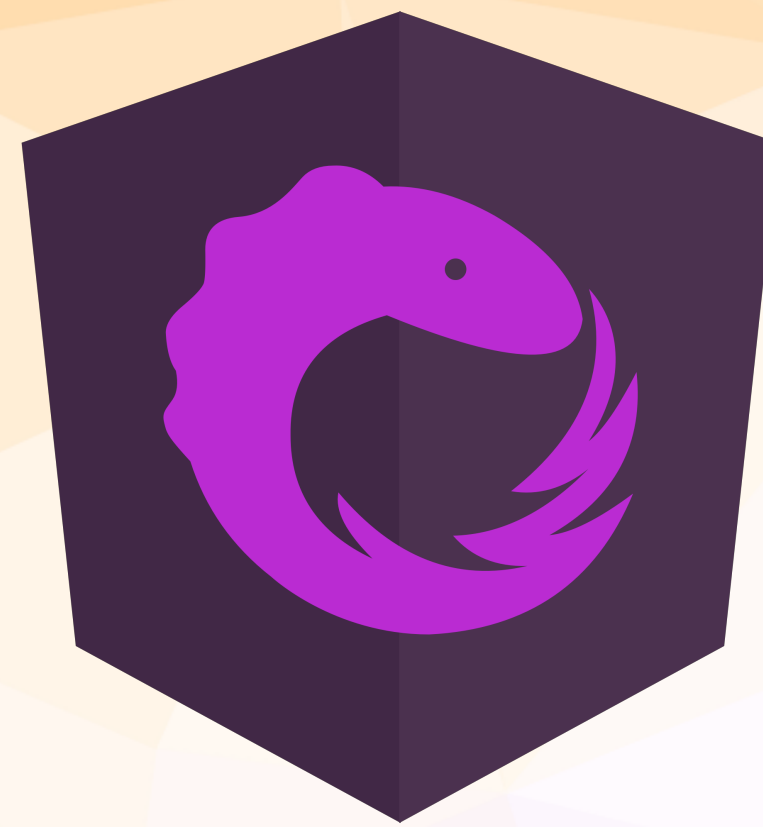
```
export function reducer(  
  state: State = initialState,  
  action: MovieApiActions.Union | MoviesPageActions.Union  
): State {  
  switch (action.type) {  
    case MoviesPageActions.enter.type: {  
      return { ...state, activeMovieId: null };  
    }  
  
    default: {  
      return state;  
    }  
  }  
}
```



Demo

Challenge

1. Update **books-page.actions.ts** to use the **createAction** helper and the **props factory** function
2. Use the **ReturnType** utility type to replace the action union
3. Update **books-api.actions.ts** to use the **createAction** helper and the **props factory** function
4. Use the **ReturnType** utility type to replace the action union
5. Update **books-page.component.ts**, **books-api.effects.ts**, and **books.reducer.ts** to use the new action format



EFFECTS EXAMPLES

```
@Effect() tick$ = interval(/* Every minute */ 60 * 1000).pipe(  
  map(() => clock.tickAction(new Date()))  
);
```

```
@Effect() = fromWebSocket("/ws").pipe(map(message => {  
  switch (message.kind) {  
    case "book_created": {  
      return WebSocketActions.bookCreated(message.book);  
    }  
  
    case "book_updated": {  
      return WebSocketActions.bookUpdated(message.book);  
    }  
  
    case "book_deleted": {  
      return WebSocketActions.bookDeleted(message.book);  
    }  
  }  
}))
```

```
@Effect()
createBook$ = this.actions$.pipe(
  ofType(BooksPageActions.createBook.type),
  mergeMap(action =>
    this.booksService.create(action.book).pipe(
      map(book => BooksApiActions.bookCreated({ book })),
      catchError(error => of(BooksApiActions.createFailure({
        error,
        book: action.book,
      }))))
  )
);
```



```
@Effect() promptToRetry$ = this.actions$.pipe(  
  ofType(BooksApiActions.createFailure),  
  mergeMap(action =>  
    this.snackBar  
      .open("Failed to save book.", "Try Again", {  
        duration: /* 12 seconds */ 12 * 1000  
      })  
      .onAction()  
      .pipe(  
        map(() => BooksApiActions.retryCreate(action.book))  
      )  
  )  
);
```

```

@Effect() promptToRetry$ = this.actions$.pipe(
  ofType(BooksApiActions.createFailure),
  mergeMap(action =>
    this.snackBar
      .open("Failed to save book.", "Try Again", {
        duration: /* 12 seconds */ 12 * 1000
      })
      .onAction()
      .pipe(
        map(() => BooksApiActions.retryCreate(action.book))
      )
  )
);

```

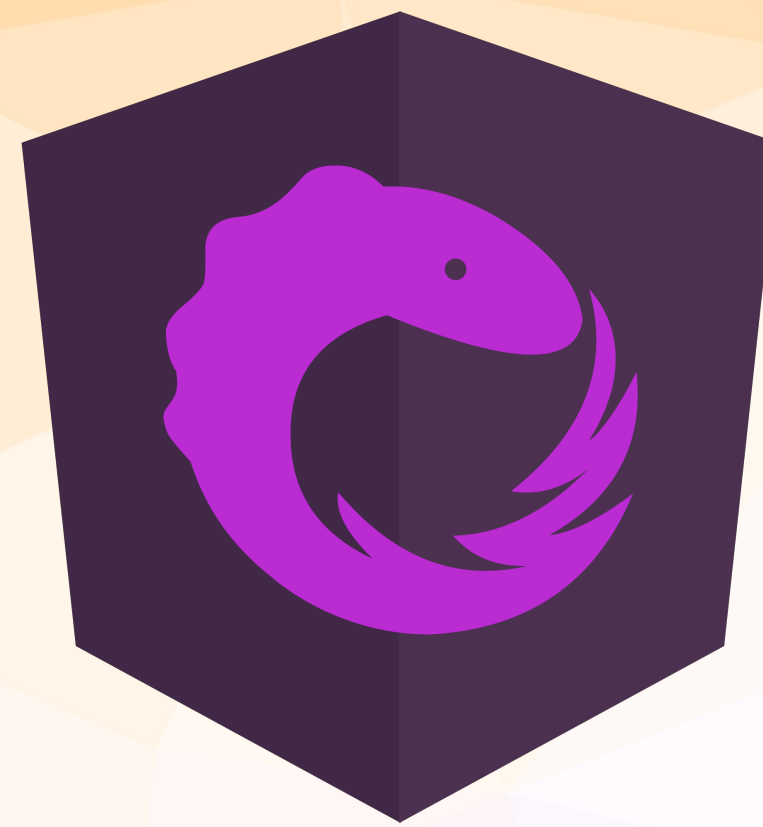
Failed to save book.

TRY AGAIN

```
@Effect()
createBook$ = this.actions$.pipe(
  ofType(
    BooksPageActions.createBook,
    BooksApiActions.retryCreate,
  ),
  mergeMap(action =>
    this.booksService.create(action.book).pipe(
      map(book => BooksApiActions.bookCreated({ book })),
      catchError(error => of(BooksApiActions.createFailure({
        error,
        book: action.book,
      })))
    )
  )
);
```

```
@Effect({ dispatch: false })
openUploadModal$ = this.actions$.pipe(
  ofType(BooksPageActions.openUploadModal),
  tap(() => {
    this.dialog.open(BooksCoverUploadModalComponent);
  })
);
```

```
@Effect() uploadCover$ = this.actions$.pipe(  
  ofType(BooksPageActions.uploadCover),  
  concatMap(action =>  
    this.booksService.uploadCover(action.cover).pipe(  
      map(result => BooksApiActions.uploadComplete(result)),  
      takeUntil(  
        this.actions$.pipe(  
          ofType(BooksPageActions.cancelUpload)  
        )  
      )  
    )  
  )  
);
```



TESTING REDUCERS

```
it("should return the initial state when initialized", () => {  
  const state = reducer(undefined, {  
    type: "@@init"  
  } as any);  
  
  expect(state).toBe(initialState);  
});
```

```
const movies: Movie[] = [  
  { id: "1", name: "Green Lantern", earnings: 0 }  
];  
  
const action = MovieApiActions.loadMoviesSuccess({  
  movies  
});  
  
const state = reducer(initialState, action);
```



```
const movie: Movie = {  
  id: "1",  
  name: "mother!",  
  earnings: 1000  
};  
const firstAction = MovieApiActions.createMovieSuccess({ movie });  
const secondAction = MoviesPageActions.deleteMovie({ movie });  
  
const state = [firstAction, secondAction].reduce(  
  reducer,  
  initialState  
);
```

```
const movies: Movie[] = [  
  { id: "1", name: "Green Lantern", earnings: 0 }  
];  
  
const action = MovieApiActions.loadMoviesSuccess({  
  movies  
});  
  
const state = reducer(initialState, action);  
  
expect(selectAllMovies(state)).toEqual(movies);
```

```
expect(state).toEqual({  
  ids: ["1"],  
  entities: {  
    "1": { id: "1", name: "Green Lantern", earnings: 0 }  
  }  
});
```

SNAPSHOT TESTING

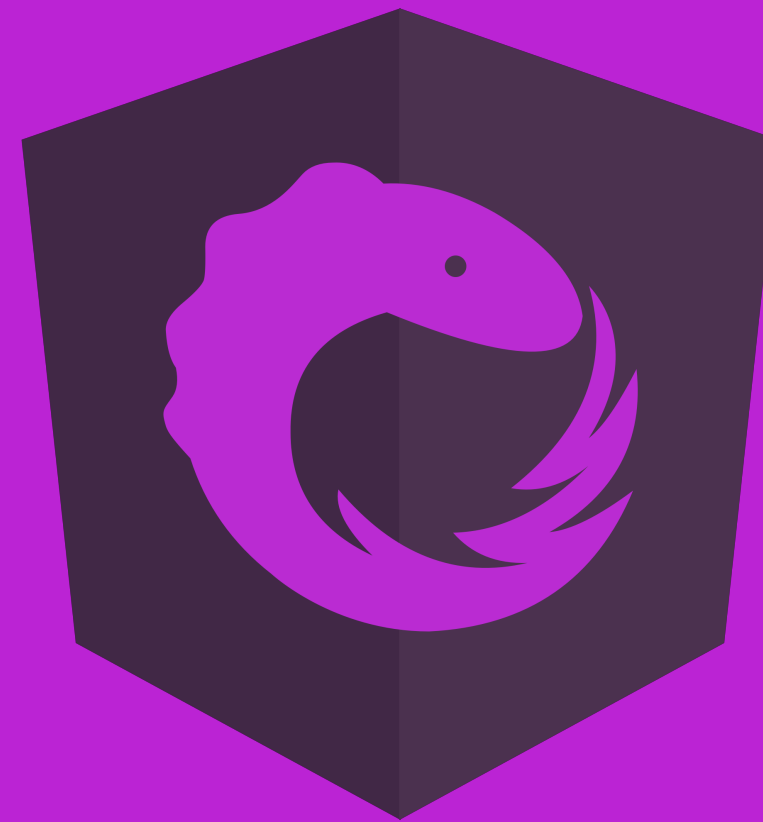
```
expect(state).toMatchSnapshot();
```

in: shared/state/__snapshots__/movie.reducer.spec.ts.snap

```
exports[
  `Movie Reducer should load all movies when the API loads them all successfully 1`
] = `
Object {
  "activeMovieId": null,
  "entities": Object {
    "1": Object {
      "earnings": 0,
      "id": "1",
      "name": "Green Lantern",
    },
  },
  "ids": Array [
    "1",
  ],
}
`;
```

SNAPSHOT TESTING

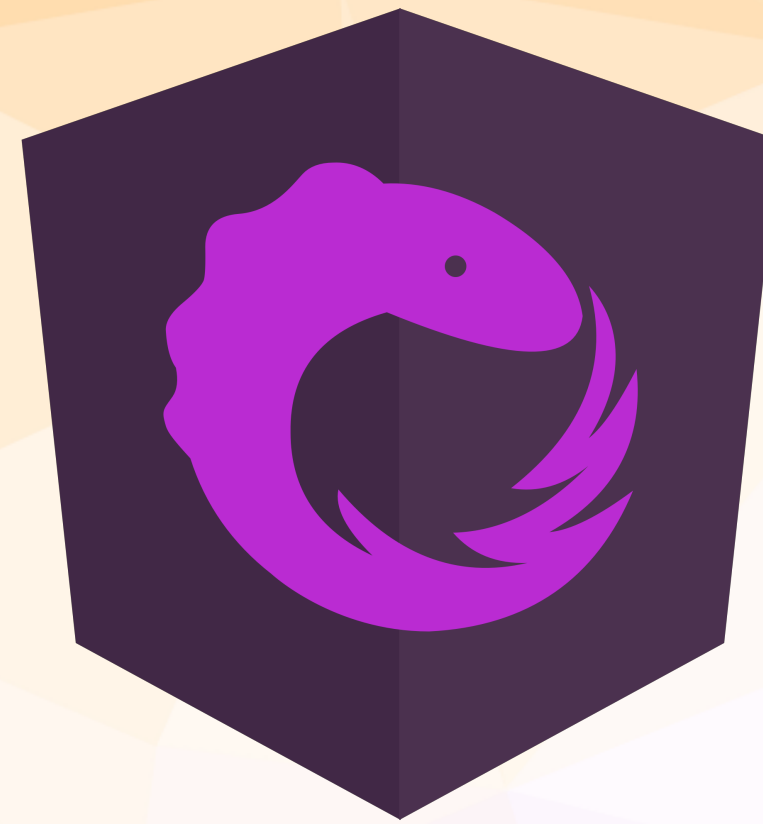
- ✓ Avoid writing out manual assertions
- ✓ Verify how state transitions impact state
- ✓ Can be used with components
- ✓ Creates snap files that get checked in



Demo

Challenge

1. Write a test that verifies the **books reducer** returns the initial state when no state is provided using the **toBe** matcher
2. Write tests that verifies the **books reducer** correctly transitions state for loading all books, creating a book, and deleting a book using the **toMatchSnapshot** matcher
3. Write tests that verifies the behavior of the **selectActiveBook** and **selectAll** selectors



TESTING EFFECTS

OBSERVABLE TIMELINES

```
import { timer } from "rxjs";  
import { mapTo } from "rxjs/operators";  
  
timer(50).pipe(mapTo("a"));
```

```
timer(50).pipe(mapTo("a"));
```



-----a|

```
timer(30).pipe(mergeMap(() => throwError('Error!'))))
```

...#

```
const source$ = timer(50).pipe(mapTo("a"));
const expected$ = cold("-----a|");

expect(source$).toBeObservable(expected$);
```

```
const source$ = timer(30).pipe(  
  mergeMap(() => throwError("Error!"))  
);  
const expected$ = cold("---#", {}, "Error!");  
  
expect(source$).toBeObservable(expected$);
```


-

10ms of time

a b c ...

Emission of any value

#

Error

|

Completion

COLD AND HOT OBSERVABLES

COLD

NETFLIX

HOT

Cable TV

Actions

Hot Observable

HttpClient

Cold Observables

Store

Hot Observable

fromWebSocket

Cold Observable

```
let actions$: Observable<any>;
```

```
beforeEach(() => {  
    TestBed.configureTestingModule({  
        providers: [provideMockActions(() => actions$)]  
    });  
});
```

```
actions$ = hot("---a---", {  
    a: BooksPageActions.enter  
});
```

```
const inputAction = MoviesPageActions.createMovie({
  movie: {
    name: mockMovie.name,
    earnings: 25
  }
});

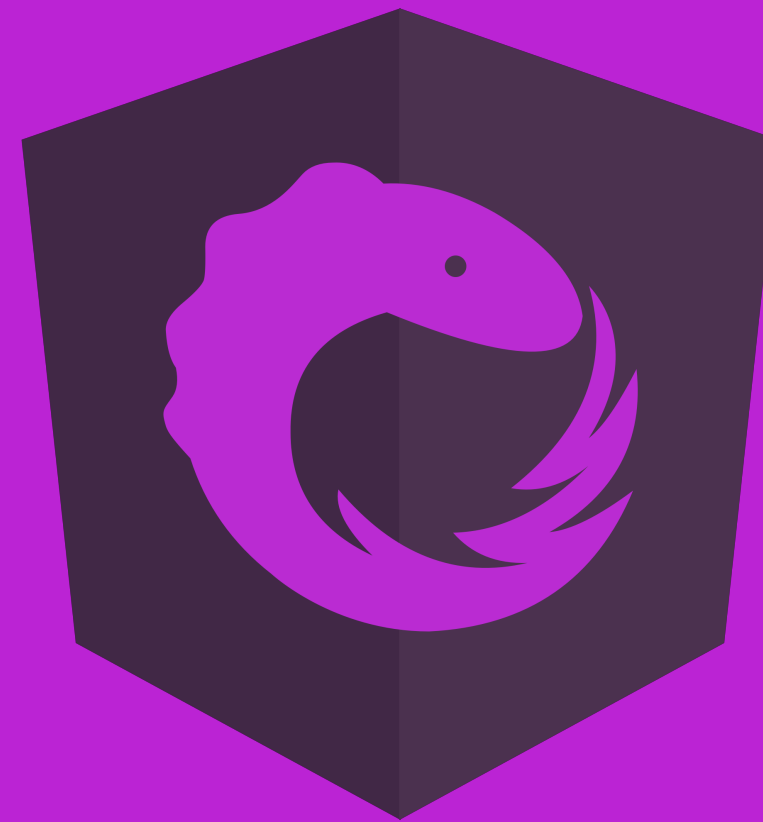
const outputAction = MovieApiActions.createMovieSuccess({
  movie: mockMovie
});

actions$ = hot("--a---", { a: inputAction });
const response$ = cold("--b|", { b: mockMovie });
const expected$ = cold("----c--", { c: outputAction });
mockMovieService.create.mockReturnValue(response$);

expect(effects.createMovie$).toBeObservable(expected$);
```

JASMINE MARBLES

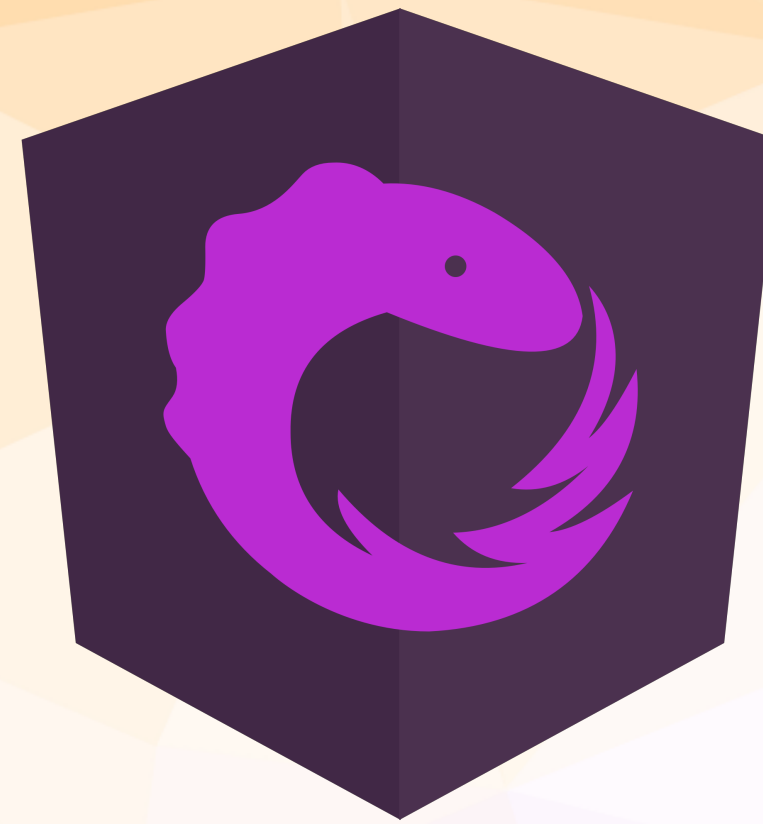
- ✓ Make assertions about time
- ✓ Describe Rx behavior with diagrams
- ✓ Verify observables behave as described
- ✓ Works with hot and cold observables



Demo

Challenge

1. Open `books-api.effects.spec.ts` and declare variables for the `actions$`, instance of the effects, and a mock `bookService`
2. Use the `TestBed` to setup providers for the effects, actions, and the book service
3. Verify the behavior of the `createBook$` effect using mock actions and test observables



FOLDER LAYOUT

LIFT

- ✓ Locating our code is easy
- ✓ Identify code at a glance
- ✓ Flat file structure for as long as possible
- ✓ Try to stay DRY - don't repeat yourself

```
src/  
  shared/  
    // Shared code
```

```
modules/  
  ${feature}/  
    // Feature code
```

```
modules/  
  ${feature}/  
    actions/  
      ${action-category}.actions.ts  
      index.ts  
  
    components/  
      ${component-name}/  
        ${component-name}.component.ts  
        ${component-name}.component.spec.ts  
  
    services/  
      ${service-name}.service.ts  
      ${service-name}.service.spec.ts  
  
    effects/  
      ${effect-name}.effects.ts  
      ${effect-name}.effects.spec.ts  
  
  ${feature}.module.ts
```

```
modules/  
  book-collection/  
    actions/  
      books-page.actions.ts  
      index.ts  
  
  components/  
    books-page/  
      books-page.component.ts  
      books-page.component.spec.ts  
  
  services/  
    books.service.ts  
    books.service.spec.ts  
  
  effects/  
    books.effects.ts  
    books.effects.spec.ts  
  
book-collection.module.ts
```

ACTION BARRELS

```
import * as BooksPageActions from "../books-page.actions";  
import * as BooksApiActions from "../books-api.actions";  
  
export { BooksPageActions, BooksApiActions };
```

```
import { BooksPageActions } from "app/modules/book-collection/actions";
```



```
src/  
  shared/  
    state/  
      ${state-name}/  
        ${state-key}/  
          ${state-key}.reducer.ts  
          ${state-key}.spec.ts  
          index.ts  
  
        ${feature-name}.state.ts  
        ${feature-name}.state.spec.ts  
        ${feature-name}.state.module.ts  
        index.ts  
  
    effects/  
      ${effect-name}/  
        ${effect-name}.effects.ts  
        ${effect-name}.effects.spec.ts  
        ${effect-name}.actions.ts  
        ${effect-name}.module.ts  
        index.ts
```

```
src/  
  shared/  
    state/  
      core/  
        books/  
          books.reducer.ts  
          books.spec.ts  
  
          core.state.ts  
          core.state.spec.ts  
          core.state.module.ts  
          index.ts  
  
        effects/  
          clock/  
            clock.effects.ts  
            clock.effects.spec.ts  
            clock.actions.ts  
            clock.module.ts
```

FOLDER STRUCTURE

- ✓ Put state in a shared place separate from features
- ✓ Effects, components, and actions belong to features
- ✓ Some effects can be shared
- ✓ Reducers reach into modules' action barrels



“How does NgRx work?”



“How does NgRx work?”





- ✓ State flows down, changes flow up



- ✓ State flows down, changes flow up
- ✓ Indirection between state & consumer



- ✓ State flows down, changes flow up
- ✓ Indirection between state & consumer
- ✓ Select & Dispatch => Input & Output



- ✓ State flows down, changes flow up
- ✓ Indirection between state & consumer
- ✓ Select & Dispatch => Input & Output
- ✓ Adhere to single responsibility principle

STORE

- ✓ State contained in a single state tree
- ✓ State in the store is immutable
- ✓ Slices of state are updated with reducers

REDUCERS

- ✓ Produce new states
- ✓ Receive the last state and next action
- ✓ Switch on the action type
- ✓ Use pure, immutable operations

ACTIONS

- ✓ Unified interface to describe events
- ✓ Just data, no functionality
- ✓ Has at a minimum a type property
- ✓ Strongly typed using createAction

ENTITY

- ✓ Working with collections should be fast
- ✓ Collections are very common
- ✓ Common set of basic state operations
- ✓ Common set of basic state derivations

EFFECTS

- ✓ Processes that run in the background
- ✓ Connect your app to the outside world
- ✓ Often used to talk to services
- ✓ Written entirely using RxJS streams

SNAPSHOT TESTING

- ✓ Avoid writing out manual assertions
- ✓ Verify how state transitions impact state
- ✓ Can be used with components
- ✓ Creates snap files that get checked in

JASMINE MARBLES

- ✓ Make assertions about time
- ✓ Describe Rx behavior with diagrams
- ✓ Verify observables behave as described
- ✓ Works with hot and cold observables

“How does NgRx work?”



“How does NgRx work?”



HELP US IMPROVE

[**https://bit.ly/2ROXvn0**](https://bit.ly/2ROXvn0)

FOLLOW ON TALKS

“Good Action Hygiene” by Mike Ryan

<https://youtu.be/JmnsEvoy-gY>

“Reactive Testing Strategies with NgRx” by Brandon Roberts & Mike Ryan

<https://youtu.be/MTZprd9tl6c>

“Authentication with NgRx” by Brandon Roberts

<https://youtu.be/46lRQgNtCGw>

“You Might Not Need NgRx” by Mike Ryan

https://youtu.be/omnwu_etHTY

“Just Another Marble Monday” by Sam Brennan & Keith Stewart

<https://youtu.be/dwDtMs4mN48>



1. **Identify the problem**
The first step in the design process is to identify the problem. This involves understanding the user's needs and the context in which the product will be used. For example, if you are designing a mobile app, you need to understand the user's behavior and the device's capabilities.

2. **Generate ideas**
Once you have identified the problem, the next step is to generate ideas. This involves brainstorming and sketching out potential solutions. It's important to think outside the box and consider a wide range of possibilities.

3. **Develop a solution**
After you have generated ideas, the next step is to develop a solution. This involves selecting the best idea and refining it into a concrete plan. You may need to create prototypes or mockups to test your ideas.

4. **Test and iterate**
The final step in the design process is to test and iterate. This involves creating a final design and testing it with users. You should gather feedback and make improvements as needed. The design process is iterative, meaning you may need to go back to earlier steps as you refine your solution.



@ngrx/schematics



@ngrx/schematics

@ngrx/router-store



@ngrx/schematics

@ngrx/router-store

@ngrx/data



@ngrx/schematics

@ngrx/router-store

@ngrx/data

ngrx.io



@MikeRyanDev

@brandontroberts

THANK YOU