Sommario

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# Introduction

A short introduction

# State management solutions presentation

I will present here the main concepts of every solution

## SetState and InheritedWidget/InheritedModel

Main concepts of setState and inheritedWidgets..

## Redux

Main concepts of Redux

## Bloc

Main concepts of bloc

## MobX

Main concepts of MobX

## GetX

Main concepts of GetX

# The Todo app

In this section I’m going to present the development of a Todo management mobile app using a series of State Management solutions and collect some measurements. In particular for every solution three development processes will be executed. First will be implemented the basic functionalities of the app. Then I will measure how much effort/code is needed to add other functionalities. In the last round some optimization will be made to the code in terms of UI renders and memory consumption.

## General overview

The development process is divided in three parts.

### Base functionalities

It offers the possibility to visualize and partially handle todos. It is composed of a single page: the HomePage. The HomePage is composed by an appbar and two tabs: the todo tab and the stats tab.

In the todo tab the list of todos is visualized. Is possible to filter the todo using a DropdownButton in the top right corner inside the AppBar.

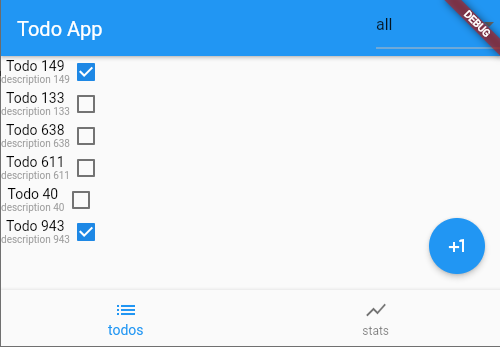
The possible filter values are:

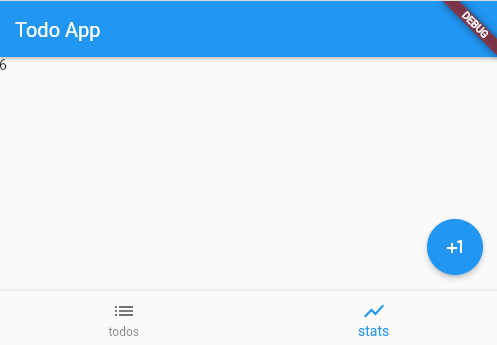
* **All** (visualize completed and pending todos)
* **Completed** (visualize completed todo)
* **Not Completed** (visualize pending todos)

The elements inside the list of todos are called TodoItems. TodoItems visualize the todo’s name and description using a Text widget and completion using a Checkbox. It is possible to use the checkbox to mark a Todo as completed or to mark it as pending.

In the stats Tab instead is possible to visualize the number of completed todos through a Text widget.

In the lower part a TabSelector allow to switch from tabs.





### Adding new features

Once basic functionalities got implemented a few more will be added as said above. In particular the AddTodo feature and the UpdateTodo feature will be added.

#### The Add todo Feature

This is a simple feature. It adds the possibility to create new Todos using the floatingbutton in the bottom right corner.

#### The Update feature

This feature allow to tap on a TodoItem to navigate to another route/page where a TextField and a confirm button will be present. Once inserted the new name for the todo clicking on the confirm button the route will be popped and the todo will be updated. This is a slightly difficult feature with respect to the add one for the fact we are going to pass the state from one route7tree to another.

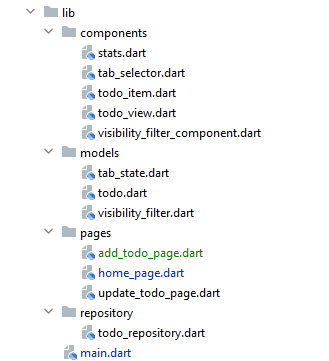
### Renders optimization

In this part some optimization for the widgets rendering will be made. In particular the aim is to use the least rerenders possible. The focus will be on the TodoView and TodoItems. We want the TodoView to rerender only when a structure change happends in the filteredTodo list and not on a single TodoItem’s internal aspects change. In other word when Todo are modified through the completion feature or the update feature only the corresponding TodoItem should be rerendered leaving the rest of the application intact.

## Implementation

### Shared project structure and files

Some parts of the code will be shared/reused between solution’s implementations. The complete structure of the app’s UI will be the same for every implementation such as the repository used to fetch Todos. On the following part the shared UI implementation will be presented.



The figure 2.2.3 illustrate the folder and files structure.

#### main.dart

void main() {  
 runApp(const MyApp());  
}

class MyApp extends StatefulWidget {  
 const MyApp({Key? key}) : super(key: key);  
  
 @override  
 State<MyApp> createState() => \_MyAppState();  
}  
  
class \_MyAppState extends State<MyApp> {  
  
 @override  
 Widget build(BuildContext context) {  
 return MaterialApp(  
 initialRoute: "/",  
 routes: {  
 "/": (context) => const HomePage(),  
 "/updateTodo": (context) => UpdateTodoPage(),

"/addTodo": (context) => AddTodoPage(),  
  
 },  
 );  
 }  
}

The entire app is wrapped into a MaterialApp widget with three routes. The HomePage , the UpdateTodoPage and the AddTodoPage.

#### Models and Repository

The **tab\_state.dart** file

enum TabState{  
 todos,stats  
}

Tab states represent the possible tabs in the homepage.

**visibility\_filter.dart**

enum VisibilityFilter{

completed,notCompleted,all

}

**todo.dart**

@immutable  
class Todo {  
 final int id;  
 final String name;  
 final String description;  
 final bool completed;  
  
 const Todo(  
 {required this.id,  
 required this.name,  
 required this.description,  
 required this.completed});  
  
 @override  
 bool operator ==(Object other) {  
 return (other is Todo) &&  
 other.description == description &&  
 other.name == name &&  
 other.id == id &&  
 other.completed == completed;  
 }  
  
 @override  
 String toString() {  
 return "{ id: $id completed: $completed}";  
 }  
  
 @override  
 *// TODO: implement hashCode* int get hashCode => super.hashCode;  
}

Todo model can change in different implementations. It is presented here as an immutable class but in some implementation is will be change to mutable.

**todo\_repository.dart**

class TodoRepository {  
 static Future<List<Todo>> *loadTodos*() async {  
 Random rand = Random();  
 List<Todo> todos = [];  
 List<int> ids = [];  
 while (ids.length < 6) {  
 int newInt = rand.nextInt(1000)+2;  
 if (!ids.contains(newInt)) {  
 ids.add(newInt);  
 }  
 }  
 todos = ids  
 .map((number) => Todo(  
 id: number,  
 name: "Todo " + number.toString(),  
 description: "description " + number.toString(),  
 completed: rand.nextBool()))  
 .toList();  
  
 await Future.delayed(const Duration(seconds: 2));  
 return todos;  
 }  
  
 static Future<void> *saveTodos*(List<Todo> todos) async {  
 await Future.delayed(const Duration(seconds: 2));  
 }  
}

TodoRepository has two static functions that simulate the loading and saving of todo to the Database. Those functions are async function with a duration of 2 seconds.

#### Pages

**home\_page.dart**

class HomePage extends StatefulWidget {  
 const HomePage({Key? key}) : super(key: key);  
  
 @override  
 State<HomePage> createState() => \_HomePageState();  
}  
  
class \_HomePageState extends State<HomePage> {  
 TabState tab = TabState.todos;   
  
 @override  
 Widget build(BuildContext context) {  
 return Scaffold(  
 appBar: AppBar(  
 actions: [  
 tab == TabState.todos  
 ? const VisibilityFilterComponent()  
 : Container()  
 ],  
 title: const Text("Todo App"),  
 ),  
 body: tab == TabState.todos ? const TodoView() : const Stats(),  
 bottomNavigationBar: TabSelector(  
 currTab: tab,  
 onTabChange:,  
 ),  
 floatingActionButton: tab == TabState.todos  
 ? FloatingActionButton(  
 child: const Icon(Icons.*plus\_one*),  
 onPressed: () {},  
 ) : null,  
 )  
 );  
 }  
}

Homepage uses a simple Scaffold widget. The AppBar contains a VisibilityFilterComponent only when the tab is set to Todos. The body can change from todos to stats tab using the bottomNaviagationBar TabSelector. An empty FloatingActionButton is present for future implementation.

(note: some small pieces could change in different solution’s implementation. in the above example the tab changing is implemented through setState but it will not be always the case. Also the HomePage can be muted to Stateless widget in other implementations.).

**update\_todo\_page.dart**

class UpdateTodoPage extends StatefulWidget {  
 final Todo todo;  
  
 const UpdateTodoPage({Key? key, required this.todo}) : super(key: key);  
  
 @override  
 State<UpdateTodoPage> createState() => \_UpdateTodoPageState();  
}  
  
class \_UpdateTodoPageState extends State<UpdateTodoPage> {  
 final textController = TextEditingController();  
  
 @override  
 Widget build(BuildContext context) {  
  
 return Scaffold(  
 appBar: AppBar(  
 title: const Text("Update Todo"),  
 ),  
 body: Column(  
 children: [  
 TextField(  
 controller: textController,  
 decoration: const InputDecoration(  
 border: OutlineInputBorder(), hintText: 'Enter a new name'),  
 ),  
 TextButton(onPressed: (){}, child: const Text("Confirm"))  
 ],  
 ));  
 }  
  
 @override  
 void dispose() {  
 textController.dispose();  
 super.dispose();  
 }  
}

The update todo page uses a Scaffold widget. The body is composed by a Column with inside a TextField and a TextButton. The TextButton is left empty for future implementation.

**add\_todo\_page.dart**

class AddTodoPage extends StatefulWidget {  
  
 const AddTodoPage({Key? key, required this.addTodoCallback}) : super(key: key);  
  
 @override  
 State<AddTodoPage> createState() => \_UpdateTodoPageState();  
}  
  
class \_UpdateTodoPageState extends State<AddTodoPage> {  
 final textControllerName = TextEditingController();  
 final textControllerDesc = TextEditingController();  
  
 @override  
 Widget build(BuildContext context) {  
  
 return Scaffold(  
 appBar: AppBar(  
 title: const Text("Add Todo"),  
 ),  
 body: Column(  
 children: [  
 TextField(  
 controller: textControllerName,  
 decoration: const InputDecoration(  
 border: OutlineInputBorder(), hintText: 'Enter a name'),  
 ),  
 TextField(  
 controller: textControllerDesc,  
 decoration: const InputDecoration(  
 border: OutlineInputBorder(), hintText: 'Enter a description'),  
 ),  
 TextButton(onPressed: (){},

child: const Text("Create"))  
 ],  
 ));  
 }  
  
 @override  
 void dispose() {  
 textControllerName.dispose();  
 textControllerDesc.dispose();  
 super.dispose();  
 }  
}

The add\_todo\_page uses a Scaffold widget. The body is composed by a Column with inside two TextField widgets and a TextButton widget. The TextButton is left empty for future implementation.

#### Components

**todo\_view.dart**

class TodoView extends StatelessWidget {  
  
 const TodoView({Key? key}) : super(key: key);  
  
 @override  
 Widget build(BuildContext context) {  
 print("Building TodoView");  
  
  
 return ListView.builder(  
 itemCount:,  
 itemBuilder: (context, index) {  
 return TodoItem(  
   
 );  
 },  
 );  
 }  
}

TodoView uses a ListView. itemCount and itemBuilder fields are left empty for future implementation.

**todo\_item.dart**

class TodoItem extends StatelessWidget {  
 final Todo todo;  
  
 const TodoItem({Key? key, required this.id}) : super(key: key);  
  
 @override  
 Widget build(BuildContext context) {  
 print("Building Todo Item $todo");  
  
 return InkWell(  
 onTap: () {  
 Navigator.*pushNamed*(context, "/updateTodo");  
 },  
 child: Row(  
 children: [  
 Column(  
 children: [  
 Text(todo.name,  
 style: const TextStyle(fontSize: 14, color: Colors.*black*)),  
 Text(todo.description,  
 style: const TextStyle(fontSize: 10, color: Colors.*grey*)),  
 ],  
 ),  
 Checkbox(  
 value: todo.completed,  
 onChanged: (value) {}),  
 ],  
 ),  
 );  
 }  
}

TodoItem is a stateless widget. Uses two Text widgets to display the Todo information and a Checkbox to change the Todo’s completion. It is wrapped in a InkWell widget to make is responsive to taps. Functions are empty for future implementation.

**tab\_selector.dart**

class TabSelector extends StatelessWidget {  
  
  
 const TabSelector(  
 {Key? Key})  
 : super(key: key);  
  
 @override  
 Widget build(BuildContext context) {  
 print("Building Tab Selector");  
  
 return BottomNavigationBar(  
 currentIndex: ,  
 onTap: (){},  
 items: TabState.values  
 .map((tab) => BottomNavigationBarItem(  
 label: describeEnum(tab),  
 icon: Icon(  
 tab == TabState.todos ? Icons.*list* : Icons.*show\_chart*,  
 ),  
 ))  
 .toList(),  
 );  
 }  
}

Tabselector uses a BottomNavigationBar with as many BottomNavigationBarItems as TabState.values (in our case two). Function fields are left empty for future implementation.

**visibility\_filter\_component.dart**

class VisibilityFilterComponent extends StatelessWidget {  
  
 const VisibilityFilterComponent(  
 {Key? key})  
 : super(key: key);  
  
 @override  
 Widget build(BuildContext context) {  
 print("Building Visibility filter");  
 return DropdownButton<VisibilityFilter>(  
 value:,  
 items: VisibilityFilter.values.map((filter) {  
 return DropdownMenuItem<VisibilityFilter>(  
 child: Text(describeEnum(filter)), value: filter);  
 }).toList(),  
 onChanged: (filter) {  
   
 },  
 );  
 }  
}

VisibilityFilterComponent uses a DropdownButton with as many DropwodnMenuItems as VisibilityFilter.values (in our case two). Function fields are left empty for future implementation.

**stats.dart**

class Stats extends StatelessWidget {  
 const Stats({Key? key}) : super(key: key);  
  
 @override  
 Widget build(BuildContext context) {  
 print("Building Stats");  
  
 return Text();  
 }  
}

Stats component is only a Text widget showing stats value.

### Inherited widget/model and SetState implementation

In this section Todo app will be implemented using two standard tools Flutter’s framework provides to handle state: **Inherited widget** (or the more advanced **InheritedModel**) and **setState**.

#### **State management solution’s introduction**

**setState** method notify the framework that the internal state of this object has changed.

Whenever you change the internal state of a [State](https://api.flutter.dev/flutter/widgets/State-class.html) object, make the change in a function that you pass to [setState](https://api.flutter.dev/flutter/widgets/State/setState.html).

setState(() { \_myState = newValue; });

The provided callback is immediately called synchronously. It must not return a future (the callback cannot be async), since then it would be unclear when the state was actually being set.

Calling [setState](https://api.flutter.dev/flutter/widgets/State/setState.html) notifies the framework that the internal state of this object has changed in a way that might impact the user interface in this subtree, which causes the framework to schedule a [build](https://api.flutter.dev/flutter/widgets/State/build.html) for this [State](https://api.flutter.dev/flutter/widgets/State-class.html) object.

If you just change the state directly without calling [setState](https://api.flutter.dev/flutter/widgets/State/setState.html), the framework might not schedule a [build](https://api.flutter.dev/flutter/widgets/State/build.html) and the user interface for this subtree might not be updated to reflect the new state.

**Inherited widget** are a base class for widgets that efficiently propagate information down the tree.

To obtain the nearest instance of a particular type of inherited widget from a build context, use *[BuildContext.dependOnInheritedWidgetOfExactType](https://api.flutter.dev/flutter/widgets/BuildContext/dependOnInheritedWidgetOfExactType.html).*

Inherited widgets, when referenced in this way, will cause the consumer to rebuild when the inherited widget itself changes state.

The convention is to provide a static method *of* on the [InheritedWidget](https://api.flutter.dev/flutter/widgets/InheritedWidget-class.html) which does the call to [BuildContext.dependOnInheritedWidgetOfExactType](https://api.flutter.dev/flutter/widgets/BuildContext/dependOnInheritedWidgetOfExactType.html). This allows the class to define its own fallback logic in case there isn't a widget in scope. In the example above, the value returned will be null in that case, but it could also have defaulted to a value.

An [InheritedWidget](https://api.flutter.dev/flutter/widgets/InheritedWidget-class.html) that's intended to be used as the base class for models whose dependents may only depend on one part or "aspect" of the overall model. An inherited widget's dependents are unconditionally rebuilt when the inherited widget changes.

**InheritedModel** widget is similar except that dependents aren't rebuilt unconditionally.

Widgets that depend on an [InheritedModel](https://api.flutter.dev/flutter/widgets/InheritedModel-class.html) qualify their dependence with a value that indicates what "*aspect*" of the model they depend on. When the model is rebuilt, dependents will also be rebuilt, but only if there was a change in the model that corresponds to the aspect they provided.

#### **Base app**

InheritedWidget requires to create a class where the state or part of the state will be contained and extends it to InheritedWidget. For our purpose a single class will be enough to contains all the state information. This class will be called TodoInheritedData.

class TodoInheritedData extends InheritedWidget{

Data that should be accessible down the tree must be placed inside it. In our case the only data needed is : a list of Todos, a VisibilityFilter , a Int for the stats ( for conciseness it will represent the number of completed todos) and another list of Todos that will contain the todos matching the filter. Inside the constructor final variables are initialized with the corresponding arguments and *stats* and *filteredTodos* list are computed. *filterTodo* function is just a function that takes the full list of todos and a filter and returns the filtered list. Important to notice is the fact that a *child* widget must be also passed in the constructor. This is because our TodoInheritedData is nothing else than a widget itself that wraps the data and make them accessible in the child tree.

class TodoInheritedData extends InheritedWidget{

final List<Todo> todos;  
 final List<Todo> filteredTodos;

final VisibilityFilter filter;

final int stats;

TodoInheritedData(  
 {   
 Key? key,  
 required this.todos,  
 required this.filter,  
 required Widget child})  
 : stats = todos.length,  
 filteredTodos = filterTodo(todos, filter),  
 super(child: child, key: key);

}

Is important to understand that TodoInheritedData widget is stateless. It cannot be changed (every value is final) but instead a new TodoInheritedData widget must be provided when a data change occurs.

The *updateShouldNotify* function must be overridden inside TodoInheritedData to avoid ui rebuilding when a new state without actual data changes occurs. Once a TodoInheritedData element is replaced with a new one this new element will take care to call the *updateShouldNotify* function to decide whether is necessary or not to notify changes in the subtree. If the function returns *true* the subtree is rebuilt, if return *false* instead is not.

@override  
bool updateShouldNotify(TodoInheritedData oldWidget) {  
 return !listEquals(oldWidget.filteredTodos, filteredTodos);  
}

In our case the *listEquals* function takes as parameters the old *filteredTodos* list and the new one and compare them element by element checking if changes were made. In the particular case no changes were performed it returns *true* and will lead the *updateShouldNotify* function to return *false* and not to rebuild the entire subtree.

At this point our TodoInheritedData can be used it in a stateful widget.

class TodoProvider extends StatefulWidget {  
 const TodoProvider({Key? key, required this.child}) : super(key: key);  
  
 final Widget child;  
  
 @override  
 \_TodoProviderState createState() => \_TodoProviderState();  
}

class \_TodoProviderState extends State<TodoProvider> {  
 List<Todo> todos = [];  
 VisibilityFilter filter = VisibilityFilter.all;

@override  
Widget build(BuildContext context) {  
 return TodoInheritedData(  
 todos: todos,  
 filter: filter,  
 child: widget.child,  
 );  
}

Note that the VisibilityFilter *filter* is set as *all* by default as convention.

We add also an *init* method to fetch the data from the repository on widget’s creation.

@override  
void initState() {  
 TodoRepository.*loadTodos*().then((todos) {  
 setState(() {  
 this.todos = todos;  
 });  
 });  
 super.initState();  
}

*loadTodos* is a TodoRepository’s async function that simulate the retrieval of the todos from a database.

We need to declare also the *of* method to retrieve our TodoInheritedData down the tree. This method is called is static and just extract the nearest TodoInheritedData element up in the tree using *dependOnInheritedWidgetOfExactType* method.

static TodoInheritedData? *of*(BuildContext context) {  
 final TodoInheritedData? result = context.dependOnInheritedWidgetOfExactType<TodoInheritedData>();

assert(result != null, 'No TodoInheritedData found in context');

return result;

}

At this point our TodoProvider widget can be incorporated as a parent of the Scaffold widget in the homepage. The usage of the Builder widget is due to the fact that data is accessible only in a context where a TodoProvider is already present. In other word TodoProvider’s data cannot be used in the same build method where it was instantiated into. Two options are possible; creating a separated file where to put our Scaffold or use a Builder widget that takes the current context and creates another with a TodoProvider widget.

@override  
Widget build(BuildContext context) {  
 return TodoProvider(  
 child: Builder(  
 builder: (context) {  
 return Scaffold(); }  
 );  
}

At this point the TodoView component can be populated. It is a stateless widget that will look up for the *filteredTodos* list in the TodoInheritedData inside the build method and create a ListView dynamically with it. The ListView will be composed by TodoItem widgets.

class TodoView extends StatelessWidget {  
  
 const TodoView({Key? key}) : super(key: key);  
  
 @override  
 Widget build(BuildContext context) {  
 print("Building TodoView");  
  
 final List<Todo> filteredTodos = TodoInheritedData.*of*(context).filteredTodos;  
  
 return ListView.builder(  
 itemCount: filteredTodos.length,  
 itemBuilder: (context, index) {  
 return TodoItem(  
 todo: filteredTodos.elementAt(index),  
 );  
 },  
 );  
 }  
}

TodoItem widget is stateless widget that take as paramenter a Todo and take care of displaing it with the structure defined in at page x.

class TodoItem extends StatelessWidget {  
 final Todo todo;  
  
 const TodoItem({Key? key, required this.id}) : super(key: key);  
  
 @override  
 Widget build(BuildContext context) {  
 return Row(  
 children: [  
 Column(  
 children: [  
 Text(todo.name,  
 style: const TextStyle(fontSize: 14, color: Colors.*black*)),  
 Text(todo.description,  
 style: const TextStyle(fontSize: 10, color: Colors.*grey*)),  
 ],  
 ),  
 Checkbox(  
 value: todo.completed,  
 onChanged: (value) {  
 }),  
 ],  
 ),  
 );  
 }  
}

At this point we got a single page (Homepage) that contains a TodoView showing *filteredTodos* list’s todos contained in the TodoInheritedData inside a TodoProvider widget. When the application starts we first see and empty page (todo are empty at the beginning) and then after few seconds a list of todos with their names, descriptions and completions appears. A list of fitered todos can be visualized but is not interactable yet.

In the app HomePage’s AppBar we already set up a VisibilityFilterComponent that is nothing else than a stateless widget. In its *build* method a DropdownButton’s value field is set up looking up for the filter values in the TodoInheritedData. Then the *items* field is filled with a list of DropdownMenuItem that comes from the mapping of all possible VisibilityFilter values to DropdownMenuItems.

class VisibilityFilterComponent extends StatelessWidget {  
  
 const VisibilityFilterComponent(  
 {Key? key})  
 : super(key: key);  
  
 @override  
 Widget build(BuildContext context) {  
 print("Building Visibility filter");  
 VisibilityFilter filter= TodoInheritedData.*of*(context).filter;  
 return DropdownButton<VisibilityFilter>(  
 value: filter,  
 items: VisibilityFilter.values.map((filter) {  
 return DropdownMenuItem<VisibilityFilter>(  
 child: Text(describeEnum(filter)), value: filter);  
 }).toList(),  
 onChanged: (filter) {  
   
 },  
 );  
 }  
}

For what concerns the *onChanged* field a function that takes as single parameter a filter value must be provided. In particular we want this function to change the state contained in the TodoInheritedData (the filter part) and to fire a rebuild of the TodoInheritedData subtree. As we mentioned above TodoInheritedData contains only final fields and should never be modified. Instead, a new TodoInheritedData element should be created in the TodoProvider build method with the modified data.

In the to TodoProvider.dart a function called *onChangeFilter* is added. This function takes the new filter values as parameter and changes the value of the filter in the stateful widget calling *setState*. Doing so the *build* function is called again with the new filter value and a new TodoInheritedData widget is created.

void onChangeFilter(VisibilityFilter filter) {  
 setState(() {  
 this.filter = filter;  
 });  
}

The *onChangeFilter* function must be provided to the TodoInheritedData to make it accessible in the widget’s subtree. To do so a new parameter is added in the TodoInheritedData as follow.

@override  
Widget build(BuildContext context) {  
 return TodoInheritedData(  
 todos: todos,  
 onChangeFilter: onChangeFilter,  
 filter: filter,  
 child: widget.child,  
 );  
}

class TodoInheritedData extends InheritedModel<int> {  
 {...}  
 final void Function(VisibilityFilter) onChangeFilter;  
 {...}

Now that the *onChangeFilter* function is accessible down in the tree it can be called in the *onChange* function we provide inside the VisibilityFilterComponent DropdownButton.

onChanged: (filter) {  
 TodoInheritedData.of(context).onChangeFilter(filter!);  
},

The *filteredTodos* list can now be changed applying different filters. However, the Checkbox inside every TodoItem is just showing if the particular todo is completed or pending but its *onChange* function is still empty and does nothing when tapped. When a tap on the checkbox occurs a change in the corresponding Todo’s completed field should be fired and a rebuild of the TodoItems performed. (for the moment we don’t care if the TodoItem only or the entire TodoView is rebuilt). To do so TodoIhneritedData should provide also a function down the tree that allow to perform this change. Going back again to the TodoProvider.dart file a *onSetCompleted* function is added to the TodoProvider stateful widget. This function takes as parameter the id of the Todo to be changed and the new value for the completed field.

void onSetCompleted(int id, bool completed) {  
 assert(todoExists(id) != null, 'No todo with id : $id');  
  
 setState(() {  
 todos = todos.map((e) {  
 if (e.id == id) {  
 return Todo(  
 id: id,  
 name: e.name,  
 description: e.description,  
 completed: completed);  
 } else {  
 return e;  
 }  
 }).toList();  
 });  
}

The *todos* list is scanned using a map. Once the todo with the corresponding id is found its *completed* value is changed to the new value. Calling the *setState* method on the TodoProvider stateful widget will cause the build method to run again and to create another TodoInheritedData. All the elements of the TodoImheritedData subtree are rebuilt too.

At this point is possible to visualize the *filteredTodos* list, change the *filter* and update Todo’s *completed* field. To implement the *stats* tab the Stats component must be connected to the corresponding data and the TabSelector’s logic defined. First, the stats value is retrieved in the Stats component widget using the *of* method and visualized in the Ui.

class Stats extends StatelessWidget {  
 const Stats({Key? key}) : super(key: key);  
  
 @override  
 Widget build(BuildContext context) {  
 print("Building Stats");  
  
 return Text(TodoInheritedData.*of*(context).stats.toString());  
 }  
}

Then a new TabState variable is created in the HomePage called *tab* and set as TabState.todos by default. A function called *onTabChange* will call the *setState* method modifying the *tab* value and causing the build method to run again.

TabState tab = TabState.todos;  
  
void onTabChange(int index) {  
 setState(() {  
 tab = TabState.values.elementAt(index);  
 });  
}

*tab* value and *onTabChange* function are now passed to the TabSelector component as parameters and used to populate the BottomNavigationBar widget.

class TabSelector extends StatelessWidget {  
 final TabState currTab;  
 final Function(int) onTabChange;  
  
 const TabSelector(  
 {Key? key, required this.currTab, required this.onTabChange})  
 : super(key: key);  
  
 @override  
 Widget build(BuildContext context) {  
 print("Building Tab Selector");  
  
 return BottomNavigationBar(  
 currentIndex: TabState.values.indexOf(currTab),  
 onTap: onTabChange,  
 items: TabState.values  
 .map((tab) => BottomNavigationBarItem(  
 label: describeEnum(tab),  
 icon: Icon(  
 tab == TabState.todos ? Icons.*list* : Icons.*show\_chart*,  
 ),  
 ))  
 .toList(),  
 );  
 }  
}

At this point all the basic functionalities have been implemented.

**Time spent: 2-3 hours**

**Lines of code written/updated: 86**

**Classes/widget created: 2** ( TodoInheritedData class and TodoProvider widget)

#### **Features addition**

**Todo creation feature:**

First thing is to create and make the *addTodo* feature/function accessible down the tree. A new function must be implemented in the TodoProvider widget and passed to the TodoInheritedData widget. This new function will be called *onAddTodo* and will take two parameters (*name* and *description*).

void onAddTodo(String name, String desc) {  
 Random rand = Random();  
 List<int> ids = todos.map((e) => e.id).toList();  
 int newId = rand.nextInt(1000) + 2;  
 while (ids.contains(newId)) {  
 newId = rand.nextInt(1000) + 2;  
 }  
 Todo newTodo = Todo(  
 id: newId,  
 name: name,  
 description: desc+ " " + newId.toString(),  
 completed: false);  
 List<Todo> newList = List.from(todos);  
 newList.add(newTodo);  
 setState(() {  
 todos = newList;  
 });  
}

After generating a new unique id it creates a new Todo object called *newTodo* with the *completed* field set to false. Adding the new Todo to the TodoProvider’s state *todos* list requires a bit of workaround. The state of a stateful widget is immutable. It can only be changed by the *setState* method. Unfortunately, the method *add* for lists is of type void and do not return a new list but instead add the new value to the existing one. For this reason directly calling the add method to the TodoProvider’s local lists *todos* will have no effect. That list is immutable and cannot be changed.

TodoProvider’s *todos* list must be completely replaced with a new list containing also the new todo. First a new temporary list called *newList* is created and populated with the element present in the *todos* list. Then the *newTodo* is added to this *newList* list. At this point is sufficient to replace the *todos* list with the new one inside the *setState* method.

To make this new function accessible down the tree is sufficient to add a new field in the TodoInheritedData (called *onAddTodo*) widget and pass the function on creation.

class TodoInheritedData extends InheritedWidget {  
 {...}  
 final void Function(String,String) onAddTodo;

{...}

@override  
Widget build(BuildContext context) {  
 return TodoInheritedData(  
 todos: todos,  
 onChangeFilter: onChangeFilter,  
 onAddTodo: onAddTodo,  
 onSetCompleted: onSetCompleted,  
 filter: filter,  
 child: widget.child,  
 );  
}

In the AddTodoPage a TextButton has been already set up and is ready to call this function once tapped. However, there is a small inconvenient. The AddTodoPage is accessed by pushing on top of the HomePage another route. In this new scope the Scaffold widget inside the AddTodoPage become the root of the tree of the current route. In other words, the AddTodoPage is not a part of the subtree of the HomePage but is a standalone tree instead. There is no instance of TodoProvider as ancestor of the AddTodoPage Scaffold widget and so it is not possible to call the *of* as before. Indeed calling the *of* method in a context where a TodoProvider is not present will cause the line

assert(result != null, 'No TodoInheritedData found in context');

to return *false* and rise a runtime error. The easiest method to proceed is to pass the *onAddTodo* function as a parameter to the AddTodoPage when we push it on top of the HomePage. So a new parameter called *addTodoCallback* is added to the AddTodoPage

class AddTodoPage extends StatefulWidget {  
  
 final void Function(String,String) addTodoCallback;

{. . .}

And the material app is notified about the necessity of this new argument in the AddTodoPage creation.

routes: {  
{. . .}

"/addTodo": (context) => AddTodoPage(  
 addTodoCallback: ModalRoute.*of*(context)!.settings.arguments  
 as Function(String, String)),  
},

At this point the *onChange* function of the TextButton inside the AddTodoPage can finally be populated as follow

TextButton(onPressed: () {  
 widget.addTodoCallback(textControllerName.text,textControllerDesc.text);  
 Navigator.*pop*(context);  
}

The current route (AddTodoPage) is also popped after the todo creation, and the HomePage is rebuilt (by the fact the TodoInheritedData changed).

**Time spent: 20-30 minutes**

**Lines of code written/updated: 24**

**Classes/widget created: 0**

**Todo updating feature:**

First thing is to create and make the *onUpdateTodo* feature/function accessible down the tree. A new function must be implemented in the TodoProvider widget and passed to the TodoInheritedData widget

void onUpdateTodo(int id, String newName,String newDesc) {  
 assert(todoExists(id) != null, 'No todo with id : $id');  
 List<Todo> newTodosList = todos.map((element) {  
 if (element.id == id) {  
 return Todo(  
 completed: element.completed,  
 description: newDesc,  
 name: newName,  
 id: element.id);  
 } else {  
 return element;  
 }  
 }).toList();  
 setState(() {  
 todos = newTodosList;  
 });  
}

class TodoInheritedData extends InheritedWidget {  
 ...  
 final void Function(int, String,String) onUpdateTodo;  
 ...

@override  
Widget build(BuildContext context) {  
 return TodoInheritedData(  
 todos: todos,  
 onChangeFilter: onChangeFilter,  
 onAddTodo: onAddTodo,  
 onSetCompleted: onSetCompleted,  
 onUpdateTodo: onUpdateTodo,  
 filter: filter,  
 child: widget.child,  
 );  
}

this new function will be called *onUpdateTodo* and takes three arguments: the *id* of the todo to be updated, the *newName* that should be set and the *newDesc*.

It first checks if a todo matching the id exists. Then, for the same immutability concept we dealt with when we spoke about the *onAddTodo* feature, a *newTodosList* is created and populated with the elements inside the *todos* list. Moreover, the todo with the corresponding id is update with the new name and new description. Finally, the *todos* list in the TodoProvider stateful widget is overridden with the *newTodosList* using the *setState* method.

For the same problem faced during the implementation of the add-Todo feature also in this case the *onUpdateTodo* function must be passed to the new route (no TodoProvider present in this context) as parameter. A new variable is added to the UpdateTodoPage ,beside the already existent one, called *callback*. This new variable will be a Function taking two Strings as arguments (the id will be already set up by the calling page).

class UpdateTodoPage extends StatefulWidget {  
 final Todo todo;  
 final void Function(String,String) callback;

The next step is to wrap the Row widget in the todo\_item.dart file inside a InkWell widget to make it sensible to taps.

InkWell(  
 onTap: () {},  
 child: Row...

Inside the onTap function the route UpdateTodoPage will be pushed but first a container for arguments must be set up. Indeed, Flutter Navigator allows to pass only a single object as argument between routes. In this case not only the *onUpdate Function* must be passed to the new route but also some information about the Todo itself. For this reason a wrapper class is created with the name *UpdateTodoPageArguments* as shown here

class UpdateTodoPageArguments {  
 final Todo todo;  
 final void Function(String ,String) updateState;  
  
 UpdateTodoPageArguments({required this.todo, required this.updateState});  
}

and inside the InkWell’s *onTap* function will be used to create a container for the arguments like this

Navigator.*pushNamed*(context, "/updateTodo",  
 arguments: UpdateTodoPageArguments(  
 todo: todo,  
 updateState: (String newName,String newDesc) {  
 TodoInheritedData.*of*(context, aspect: 0)  
 .onUpdateTodo(todo.id, newName,newDesc);  
 }));

A further change must be done in the MaterialApp’s “*/updateTodo”* route to populate the field of the UpdateTodoPage correctly.

routes: {  
 "/": (context) => const HomePage(),  
 "/updateTodo": (context) => UpdateTodoPage(  
 todo: (ModalRoute.*of*(context)!.settings.arguments  
 as UpdateTodoPageArguments)  
 .todo,  
 callback: (ModalRoute.*of*(context)!.settings.arguments  
 as UpdateTodoPageArguments)  
 .updateState,  
 ),

Now that the *onUpdateTodo* function is set up and correctly passed to the UpdateTodoPage is the time to call it inside the TextButton *onPressed* field like this

TextButton(onPressed: () {  
  
 widget.callback(textControllerName.text,textControllerDesc.text);  
 Navigator.*pop*(context);  
},

Once pressed the UpdateTodoPage will be popped, and the HomePage rebuilt to show the actual changes in the *todos* list.

**Time spent: 20-30 minutes**

**Lines of code written/updated: 43**

**Classes/widget created: 1 for arguments between routes**

#### **Render optimizations**

This was a pretty hard task. I spent some hour trying to figure out how make , when a single todo update occurs, rebuild the TodoItem only instead of the entire TodoView. Then I realized that it was just not feasible using InheritedWidgets. InheritedWidget indeed do not offer this possibility at all. Every widget in the TodoProvider’s subtree that access the state is registered as listener for state changes and once a state change occurs there are only two possibilities: notify all those widgets and rebuild them or not. In other words when a state change occurs and must be visualized the entire TodoProvider’s subtree must be rebuilt unconditionally. Flutter framework however offers a particular widget called InheritedModel to handle this scenario. InheritedModel work as InheritedWidget except for the fact that when a widget access the state (calling the *of* method) it must provide also a new additional parameter called *aspect*. *Aspect* can be whatever object for example a String or a Int but also a more complex data structure. The *aspect* parameter identifies on which part (or parts) of the state the widget is registering to.

**Migration to InheritedModel**

First thing to do is to substitute the extension to InheritedWidget with InheritedModel in the TodoInheritedData class (in the todo\_provider.dart file).

class TodoInheritedData extends InheritedWidget {

to

class TodoInheritedData extends InheritedModel<int> {

I decided to use Ints to identify aspects. In particular, widgets that need to rebuild on *filteredTodos* list structure change will register to aspect identified with the number **0**. Widgets that do never need to rebuild will register to aspect identified with number **1**. Widgets that need to rebuild when a change in a specific Todo with id **n** occurs will register to the aspect identified with the number **n**. (no Todos will have id with value 0 or 1. This is a convention I used to keep things simple. Other more complex structure could be used to avoid this behaviour). With *filteredTodos* structure I mean the length of the list. TodoView indeed should be entirely rebuilt only when a Todo is added or removed from the list changing its length. No todos replacement is considered by the fact that a replacement should be split into two separated actions ; a deletion and an insertion.

At this point the method *of* should be updated taking into account also the *aspect* parameter. Morevover, the *result* variable should be populated with the *inheritedFrom* static method belonging to the InheritedModel class instead of the *dependOnInheritedWidgetOfExactType* method belonging to InheritedWidget class.

static TodoInheritedData *of*(BuildContext context, {required int aspect}) {  
 final TodoInheritedData? result =  
 InheritedModel.*inheritFrom*<TodoInheritedData>(context, aspect: aspect);  
 assert(result != null, 'No TodoInheritedData found in context');  
 return result!;  
}

at this point all the lines of code that access the state with the *of* method must be changed taking into account the new implementation and the new *aspect* argument in this way

TodoInheritedData.*of*(context, aspect: aspect)

In particular the TodoView widget will pass as *aspect* the number 0 declaring that should be notified (and rebuild) only when a *filteredTodos*’s structure change occurs.

Instead TodoItem widgets will pass the corresponding Todo’s *id* as *aspect* parameter.

Now that every widget is registered only to the desired aspect of the data, is necessary to “teach” the TodoInheritedData to recognize which aspect of the data actually changed when a state change occurs. To do so InheritedModel provides a method called *updateShouldNotiyDepenedent* that is just like the InheritedWidget’s one *updateShouldNotify* but this time takes as argument also a Set of ints called *dependencies* (aspects). This method is called once for every widget that registered to state changes and the dependencies variable will contains all aspects the widgets registered to (only one for widget in our case). As follow the implementation of the method:

@override  
bool updateShouldNotifyDependent(  
 TodoInheritedData oldWidget, Set<int> dependencies) {  
 int currLen = filteredTodos.length;  
 int prevLen = oldWidget.filteredTodos.length;  
 bool structureRebuildlen = (dependencies.contains(0) && currLen != prevLen);  
 if (structureRebuildlen == true) {  
 return true;  
 } else {  
 List<int> currIds = filteredTodos.map((todo) => todo.id).toList();  
 List<int> prevIds =  
 oldWidget.filteredTodos.map((todo) => todo.id).toList();  
 bool sameIds = listEquals(currIds, prevIds);  
 bool structureRebuildcomp = (dependencies.contains(0) && !sameIds);  
 if (structureRebuildcomp == true) {  
 return true;  
 } else {  
 List<bool> components = [];  
 for (var element in filteredTodos) {  
 components.add(dependencies.contains(element.id) &&  
 !oldWidget.filteredTodos.contains(element));  
 }  
 bool res = components.fold(false,  
 (bool previousValue, bool element) => previousValue || element);  
 return res;  
 }  
 }  
}

This was tough to code but in the end worked well for the purpose. The figure 2.2.2 presents the pseudocode for the method

If( widgetRegisteredForStructureChange && strucutureChangeOccured)

{ return true;}else{

If( widgetRegisteredForSpecificTodoChange && thatTodoChanged){

Return true;}else{return false;}

Once the TodoItem’s checkbox is tapped just the TodoItem is rebuilt. No visual changes are shown, however. The widget will rebuild with the same information as before and this is due to the fact that the build method refers to the local Todo variable. This variable is populated on the TodoItem creation and cannot be changed. Indeed, a Todo is passed as argument in the constructor method from the TodoView and from that moment on will remain the same. No visual changes are shown because this local Todo indeed did not change. It is a copy of the actual Todo present in the *filteredTodos* list and for this reason is not affected by changes. This is a really bad behavior and is cause by the fact that sometimes, during programming , more than one level of information caching is required/used to avoid effort in coding or performance issues. In other words, a local copy of the data kept and referred to in case of data access in order to optimize the accesses in the main storage that can become quite expensive in large scenarios. A great example of that is the local copy of the database’s data used in many applications. Is more effective to fetch data from the database, save them locally, manipulate this local copy and only in case of real necessity access again the database to store them or retrieve other data. In large applications (but also in small ones like in this cases) more than one level of data caching is used. Particular attention is required to handle those levels to avoid inconsistency in what is visualized and the real data. In this case the *filteredTodos* list actually changed but the UI did not reflected it. The problem was generate by the fact that a copy of the real Todo was passed to the TodoItem widget instead of the id of the Todo and then use it to look up for the Todo in the centralized state (the TodoInheritedData). This of course will require more computational effort but also will guarantee a lot more stability and robustness.

Saying that the TodoItem’s local variable Todo is replaced with a int that represents the id of the Todo that the widget is visualizing. Then in the *build* method the corresponding Todo is looked up.

class TodoItem extends StatelessWidget {  
 final int id;  
  
 const TodoItem({Key? key, required this.id}) : super(key: key);  
  
 @override  
 Widget build(BuildContext context) {  
 final Todo todo = TodoInheritedData.*of*(context, aspect: id)  
 .todos  
 .where((element) => element.id == id)  
 .first;

At this point the application is working as intentioned and the renders optimization was successfully accomplished.

**Time spent: 8-10 hours**

**Lines of code written/updated: 49**

**Classes/widget created: 0**

### Redux implementation

In questa sezione la gestione dello stato verrà gestita tramite Redux.

#### Base app

### Implementazione con BLoC

In questa sezione verrà utilizzata la soluzione Bloc per la gestione dello stato.

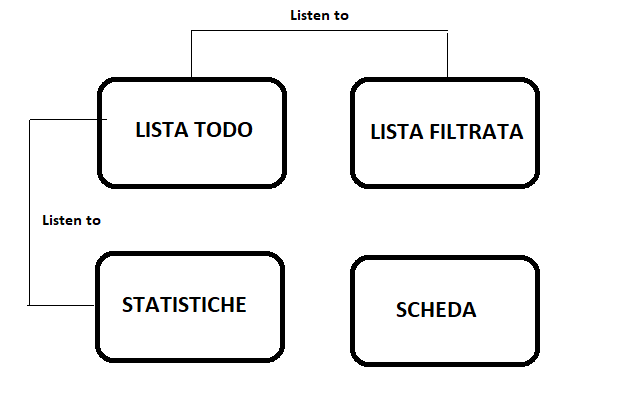
#### Implementazione delle funzioni base

**Gli stati**

Lo stato dell’applicazione sarà scomposto in quattro stati più piccoli: lo stato della lista Todo, lo stato della lista dei Todo filtrati e del filtro, lo stato delle statistiche e lo stato della scheda. Lo stato della lista dei Todo conterrà la lista di tutti i todo. Lo stato della lista dei Todo filtrati e del filtro conterrà un filtro e una lista di todo che rispettano quel filtro. Lo stato delle statistiche conterrà un numero intero che rispecchia il numero di todo completati. Infine, lo stato della scheda si occuperà di contenere l’informazione riguardo alla scheda attualmente visualizzata nella HomePage. Lo stato della lista dei todo e lo stato della scheda saranno autonomi e non dipenderanno da altri stati mentre lo stato del filtro e delle statistiche saranno collegati direttamente allo stato della lista dei todo. Questi ultimi infatti dovranno reagire ai cambiamenti dello stato della lista dei todo e modificarsi di conseguenza.

**States**

The application state is decomposed in four smaller states: the state of the list of todos, the state of the filtered list of todos and the filter, the state of the statistic and the state of the tab. The state of the list of todos contains the whole list of todos. The state of the filtered list of todos and the filter contains a filter ,of type VisibilityFilter ,and a list of todos matching the filter value. The state of the stats contains an int number indicating the number of completed todos. Lastly, the state of the tab contains the value of the HomePage’s active tab. The state of the list of todos and the state of the tab are independent. The state of the filter and the state of the stats , instead, are directly linked to the state of the list of todos. They will , indeed, react to the changes in the state of the list of todos and update consequently.

**Lo stato dei todo**

Per prima cosa iniziamo a definire e a dare un nome ai possibili stati in cui si potrà trovare la lista dei todo. Questi ultimi saranno solo due : TodosLoadingState e TodosLoadedState. Lo stato Loading starà a indicare che la lista dei todo è ancora in caricamento. Lo stato Loaded invece indicherà che la lista dei todo è stata caricata del database ed e disponibile. Per definire questi tre stati creiamo prima una classe astratta chiamata TodosState. Essa dovrà ,inoltre, estendere la classe Equatable. La classe Equatable servirà in seguito per definire l’operatore di uguaglianza tra stati e poter comprendere correttamente quando un nuovo stato viene emesso. I due stati che andremo a definire, Loading e Loaded , estenderanno entrambi la classe astratta TodosState. Lo stato Loading non avrà altre informazioni al suo interno mentre lo stato Loaded avrà una variabile contenente la lista dei todo.

First of all we start defining and naming the possible states of the list of todos. These state are only two: TodosLoadingState and TodoLoadedState. The Loading state indicates that the list of todos is still loading. The loaded state ,instead. Indicates that the list of todos has been successfully fetched from the database and is available. In order to define these two state a new abstract class is created first. It is called TodosState. It must extend the class Equatable. The class Equatable is useful to define equality between states without the need to override the equality operator in every state class. The TodosLoadingState does not contains other informations. The TodosLoadedState contains instead, a List variable filled with todos.

abstract class TodosState extends Equatable{  
 const TodosState();  
  
 @override  
 List<Object> get props => [];  
}  
class TodosLoadingState extends TodosState{  
 @override  
 String toString() => 'TodosState - TodosLoadingState';  
}  
class TodosLoadedState extends TodosState{  
 final List<Todo> todos;  
 const TodosLoadedState(this.todos);  
  
 @override  
 List<Object> get props => [todos];  
  
 @override  
 String toString() => 'TodosState - TodosLoadedState';  
} 20

**The state of the filtered list and the filter**

Also in this case there are only two possible states: FilteredTodosLoadingState and FilteredTodosLoadedState. The loading state identifies the fact that the filtered list hasn’t been computed (or todos fetched) yet. The Loaded state, instead, identifies the fact that the list of todos has been successfully fetched and the list of filtered todos computed. It contains two variables: a VisibilityFilter and a List of todos. An abstract class , called FilteredTodosState, must be created and extended with Equatable class. All other state classes ,of the filtered list’s state, will extend the FilteredTodosState class. Someone can notice that , the state of the filtered list and the filter ,contains two aspects of the application state: the filter and the filtered list. In this case it is possible to further split the state and create two separated blocs ,handling respectively the filter and the filtered list. From a general point of view ,the state should be divided in few possible pieces to keep things well separated and clean , like we do for classes and methods. However, the bloc pattern do not specify how granular should be the state fragmentation and , theoretically, we could decide to use a single bloc to handle the whole application ‘s state , like in Redux. In this particular case , I decided to implement a trade of and keep the filter and the filtered list in the same bloc. They concern two similar aspects of the data and ,splitting them , would require the bloc of the filtered todos to depend on the bloc of the filter, making its dependencies going from one bloc to two blocs ( the bloc of the todos and the bloc of the filter).

abstract class FilteredTodoState extends Equatable {  
 const FilteredTodoState();  
  
 @override  
 List<Object> get props => [];  
}  
  
class FilteredTodoLoadingState extends FilteredTodoState {  
 @override  
 String toString() => 'FilteredTodoState - FilteredTodoLoadingState';  
}  
  
class FilteredTodoLoadedState extends FilteredTodoState {  
 final List<Todo> todos;  
 final VisibilityFilter filter;  
  
 const FilteredTodoLoadedState(this.todos, this.filter);  
  
 @override  
 List<Object> get props => [todos, filter];  
  
 @override  
 String toString() => 'FilteredTodoState - FilteredTodoLoadedState';  
}

**The state of the stats**

Also in this case there only two possible states: StatsLoadingState and StatsLoadedState. The first identifies the fact that stats hasn’t been computed yet and do not contains any additional information inside. The second identifies the fact that stats are available and contains an int variable inside , called completed.

abstract class StatsState extends Equatable {  
 const StatsState();  
  
 @override  
 List<Object> get props => [];  
}  
  
class StatsLoadingState extends StatsState {  
 @override  
 String toString() {  
 return 'StatsState - StatsLoadingState';  
 }  
}  
  
class StatsLoadedState extends StatsState {  
 final int completed;  
  
 const StatsLoadedState(this.completed);  
  
 @override  
 List<Object> get props => [completed];  
  
 @override  
 String toString() {  
 return 'StatsState - StatsLoadedState : {completed: $completed}';  
 }  
}

**The state of the tab**

In order to define the states of the tab an enumeration is used.

enum TabState{  
 todos,stats  
}

**Events**

Now that states for every possible part of the application have been defined it’s the turn of Events. Events are just classes. They represent a specific actions the user can perform or also internal changes. They enable the states to mutate and create transitions.

**Events of the list of todos**

For the moment is sufficient to define two states only. One identifies the action of fetching todos from the database and is called LoadTodosEvent. It do not contains any other information. The other identifies the action of changing the completed field of a specific todo and is called SetCompletedTodoEvent. It contains two informations, the id of the specific todo and the new value for the completed field.

Also in this case a new abstract class is defined and extended with Equatable class. It is called TodosEvent. All other event classes concerning the state of the list of todo are extended with this class.

abstract class TodosEvent extends Equatable {  
 const TodosEvent();  
  
 @override  
 List<Object> get props => [];  
}

class LoadTodosEvent extends TodosEvent {  
 @override  
 String toString() => 'TodosEvent - LoadTodosEvent';  
}  
  
class SetCompletedTodoEvent extends TodosEvent {  
 final int id;  
 final bool completed;  
  
 const SetCompletedTodoEvent(this.id, this.completed);  
  
 @override  
 String toString() => 'TodosEvent - SetCompletedTodoEvent';  
}

**Events for the filtered list and the filter**

Two events are enough to define all possible transition for the state of the filtered list and the filter. One is called FilteredTodoChangeFilterEvent and is used to change the state of the filter. It contains , indeed, a VisibilityFilter variable that indicates the new value for the filter. The other event is called TodosUpdatedEvent . It informs the part of the state concerning the filtered list that the list of todo has changed and a new filtered list must be computed and a new FilteredTodosLoadedState emitted. It contains internally a variable providing the new list of todos.

Also in this case ,all event classes extend a common abstract class called FilteredTodoEvent which , in turn, extends the Equatable class.

abstract class FilteredTodoEvent extends Equatable {  
 const FilteredTodoEvent();  
  
 @override  
 List<Object> get props => [];  
}  
  
class FilteredTodoChangeFilterEvent extends FilteredTodoEvent {  
 final VisibilityFilter filter;  
  
 const FilteredTodoChangeFilterEvent(this.filter);  
  
 @override  
 List<Object> get props => [filter];  
  
 @override  
 String toString() => 'FilteredTodoEvent - FilteredTodoChangeFilterEvent {filter: $filter}';  
}  
  
class TodoUpdatedEvent extends FilteredTodoEvent {  
 final List<Todo> todos;  
  
 @override  
 List<Object> get props => [todos];  
  
 const TodoUpdatedEvent(this.todos);  
  
 @override  
 String toString() => 'FilteredTodoEvent - TodoUpdatedEvent';  
}29

**Events for the stats’s and tab’s state**

Both the state of the tab and the state of the stats require just one event. The event concerning the state of the tab is called ChangeTabEvent and contains internally a variable of type TabState indicating the value of the new tab. The event concerning the state of the stats is called StatsUpdatedEvent and is generated after the fetching or the updating of the list of todos. It contains internally the new list of todos.

Also in this case , both the event for the stats and the event for the tab extends respectively the abstact classes TabEvent and StatsEvent.

abstract class StatsEvent extends Equatable{  
 const StatsEvent();  
  
}  
class StatsUpdatedEvent extends StatsEvent{  
  
 final List<Todo> todos;  
 const StatsUpdatedEvent(this.todos);  
  
 @override  
 List<Object> get props => [todos];  
  
 @override  
 String toString() => 'StatsEvent - StatsUpdatedEvent';  
}

abstract class TabEvent extends Equatable{  
  
 const TabEvent();  
  
}  
  
class ChangeTabEvent extends TabEvent{  
 final TabState tab;  
  
 const ChangeTabEvent(this.tab);  
  
 @override  
 List<Object> get props => [tab];  
  
 @override  
 String toString() => 'TabUpdated { tab: $tab }';  
  
}

**The Blocs**

At this point both the events and the states ,necessary to implement di base functionalities of the application ,have been defined. Is possible ,then, to implement the classes, called blocs, that are going to define how new states are emitted in relation to the received events.

**The bloc for the list of todos**

To define the bloc for the list of todos is necessary to create a new class, that we name TodoBloc, and make it extends the Bloc class provided by the flutter\_bloc package. Moreover, it is necessary to provide , in the extension, also the type of events and states the bloc will manage. In our case , the ToboBloc class handles events of type TodosEvent and states of type TodosState, previously defined. A constructor must be defined inside which the bloc is initialized with a initial state. The initial state for the TodoBloc is of type TodoLoadingState by the fact that, at the application start, todos are still to be fetched from the database.

The Bloc class provided by the solution requires to override the “mapEventToState” method . The method is ,indeed, annoted with the @override notation meaning that the implementation we are giving substitutes the one in the class Bloc. The override is mandatory. The method mapEventToState takes as argument an event of type TodosEvent and returns a Stream of TodosStates. It is asynchronous ( indicated by the async\* annotation after the arguments) and do not terminate during the entire execution of the application. It keeps listening for new events, tough. Inside its implementation , a series of nested “if-else” structures have the task of identifing the type of the received event and to emit the consequent state. Indeed, the received event is always of the abstract type TodosEvent but can be of the subtype LoadTodosEvent or SetCompletedTodoEvent. Once the subtype is defined the event logic is processed and the new state emitted. The syntax yield\* Is used , Instead of the classic syntax “return”,because it allows to emit a new state, in the Stream , without terminating di mapEventToState method execution. If the return syntax is used , indeed, the new state is emitted correctly but the method is terminated and the application become unresponsive. For code readability, the logic to be executed when a to LoadTodoEvent or a SetCompletedTodoEvent is received has been moved to two other private methods called respectively mapLoadTodoToState and mapSetCompletedToState. This kind of practice is used also in the subsequence bloc implementation. The mapLoadTodoToState method takes as single argument an event of type LoadTodosEvent ( not a generic TodosEvent anymore) and bothers to fetch the todos from the database using the TodoRepository class. In case it successfully gets the list of todos it emits a new state of type LoadedTodoState containing the list of todos. In case of failure ,instead, the TodosLoadingState is emitted.

The mapSetCompletedToState takes as single argument anevent of type SetCompletedTodoEvent. After checking that the current state is of type TodosLoadedState ( in case it is not is meaningless to update the todo not having an actual list) a new list of todo is created containing the same todos as before except for the one with the id matching the one contained in the event. That todo, indeed, is replaced with a new one with the completed field set to the completed value contained in the event. Notice that a new instance of the list must be created and provided to the new state. If we just mutate the previous state’s list the Equatable class do not identify any difference between the previous state and the new emitted one, and so, do not notify all listeners.

class TodoBloc extends Bloc<TodosEvent, TodosState> {  
 TodoBloc() : super(TodosLoadingState());  
  
 @override  
 Stream<TodosState> mapEventToState(TodosEvent event) async\* {  
 if (event is LoadTodosEvent) {  
 yield\* \_mapLoadTodosToState(event);  
 } else if (event is SetCompletedTodoEvent) {  
 yield\* \_mapSetCompletedToState(event);  
 }   
 }  
  
 Stream<TodosState> \_mapLoadTodosToState(LoadTodosEvent event) async\* {  
 try {  
 final List<Todo> todos = await TodoRepository.*loadTodos*();  
 yield TodosLoadedState(todos);  
 } catch (e) {  
 yield TodoLoadingState();  
 }  
 }

Stream<TodosState> \_mapSetCompletedToState(  
 SetCompletedTodoEvent event) async\* {  
 if (state is TodosLoadedState) {  
 List<Todo> newList = (state as TodosLoadedState)  
 .todos  
 .map((todo) => todo.id == event.id  
 ? Todo(  
 name: todo.name,  
 description: todo.description,  
 id: todo.id,  
 completed: event.completed)  
 : todo)  
 .toList();  
 yield TodosLoadedState(newList);  
 }  
}

}

**The bloc for the filtered list and the filter**

The procedure is the same utilized for the todo bloc. A new class called FilteredTodosBloc is created and extended with the Bloc class. This new class handles the events of type FilteredTodosEvent and the states of type FilteredTodosState. Being the bloc of the filtered list of todos dependent from the bloc of the list of todos, an instance of this second one is passed inside the constructor and used later to listen for changes.

The instance of the bloc of the todos is saved in a local variable of type TodoBloc. In this case the constructor is a bit more articulated respect with before. It emits the initial state based on the state of the bloc of the todos. If it is a loaded state, the constructor computes and then emits a state of type FilteredtodosLoadedState using a filter of type all. If it is a loading state the constructor emits a state of type FilteredLoadingState.

class FilteredTodoBloc extends Bloc<FilteredTodoEvent, FilteredTodoState> {  
 final TodoBloc todoBloc;  
  
 FilteredTodoBloc({required this.todoBloc})  
 : super(  
 todoBloc.state is TodosLoadedState  
 ? FilteredTodoLoadedState(  
 (todoBloc.state as TodosLoadedState).todos,  
 VisibilityFilter.all,  
 )  
 : FilteredTodoLoadingState(),  
 )

}13

In addition, the constructor must register the bloc to the changes in the bloc of the list of todos. To do so the a particular variable of the TodoBloc instance is used. The variable is called “stream” and is present because the TodoBloc extends the Bloc class. It is , indeed, the stream variable where the mapEventToState method emits new states. We can register to its output using the method “listen”. Inside the listen method’s call a function must be provided. This function Is called everytime the steam value emits a new state. Inside this function the new emitted state can be accessed and used to implement some logic. Actually , we won’t implement the logic there but ,insteadm emit a new event that will be handled by the mapEventToState method defined later. In our case , the constructor registers to the TodoBloc stream . Once a new state is emitted it check if the state is of type TodoLoadedState. In case it is, it means that a new list of todos Is available. It can be the case that the list of todos has been just fetched or some todos have been update. In both of them,the bloc of the filtered list must compute a new filtered list and emit it through a new state. A specific event has been defined for this situation HERE RIFERIMENTo when the events related to the bloc of the filtered list has been implemented.

class FilteredTodoBloc extends Bloc<FilteredTodoEvent, FilteredTodoState> {  
 final TodoBloc todoBloc;  
 late StreamSubscription todoSubscription;  
  
 FilteredTodoBloc({required this.todoBloc})  
 : super(  
 todoBloc.state is TodosLoadedState  
 ? FilteredTodoLoadedState(  
 (todoBloc.state as TodosLoadedState).todos,  
 VisibilityFilter.all,  
 )  
 : FilteredTodoLoadingState(),  
 ) {  
 todoSubscription = todoBloc.stream.listen((state) {  
 if (state is TodosLoadedState) {  
 add(TodoUpdatedEvent((todoBloc.state as TodosLoadedState).todos));  
 }  
 });  
 }

It is the time to override the mapEventToState method defining the logic used to emit new state based on the received event. Like in the TodoBloc also In this case the method is asynchrounous and has as return type a stream of FilteredTodosState. The method takes as argument a single event of the generic abstraxt type FilteredTodosEvent. Inside the method, two nested “if-else” structures defines the type of the received event. There are only two possibility, indeed. The event can be of type FilteredTodosChangeFilterEvent or TodosUpdatedEvent. In the first case the private method mapTodoChangeFilterEventToState is called. In the second case the private method mapTodosUpdatedEventToState is called.

@override  
Stream<FilteredTodoState> mapEventToState(FilteredTodoEvent event) async\* {  
 if (event is FilteredTodoChangeFilterEvent) {  
 yield\* \_mapTodoChangeFilterEventToState(event);  
 } else if (event is TodoUpdatedEvent) {  
 yield\* \_mapTodoUpdatedEventToState(event);  
 }  
}8

The mapTodoChangeFilterEventToState method first checks that the state of the bloc of todos is of type TodosLoadedState ( in case it is not changing the filter is useless) and then it emits a new state of type FilteredTodosLoadedState containing the new filter and the new computed list of filtered todo using the new filter.

Stream<FilteredTodoState> \_mapTodoChangeFilterEventToState(  
 FilteredTodoChangeFilterEvent event) async\* {  
 if (todoBloc.state is TodosLoadedState) {  
 yield FilteredTodoLoadedState(  
 filterTodos((todoBloc.state as TodosLoadedState).todos, event.filter),  
 event.filter);  
 }  
}

The method mapTodoUpdatedEventToState checks that the TodoBloc’s state is of type TodosLoadedState and then emits a new state of type FilteredTodosLoadedState. The emitted state uses and contains the current filter ,if it is set, otherwise used the “all” filter.

Stream<FilteredTodoState> \_mapTodoUpdatedEventToState(  
 TodoUpdatedEvent event) async\* {  
 final filter = (state is FilteredTodoLoadedState)  
 ? (state as FilteredTodoLoadedState).filter  
 : VisibilityFilter.all;  
 if (todoBloc.state is TodosLoadedState) {  
 yield FilteredTodoLoadedState(  
 filterTodos((todoBloc.state as TodosLoadedState).todos, filter),  
 filter);  
 }  
}

The last thing to do is to ensure that the subscription to the todoBloc is disposed when the current bloc terminates.

@override  
Future<void> close() {  
 todoSubscription.cancel();  
 return super.close();  
}5

**The bloc for the stats**

This bloc is similar to the previous one except for the fact it has to deal with one event only: the StatsUpdatedEvent. Like usual the class StatsBloc is defined an extended with the Bloc class. The StatsBloc class handles event of the type StatEvent and states of the type StatsState. Also in this case the bloc depends on the bloc of the list of todo. For this reason a variable of type TodoBloc is added and initialized in the constructor. Also in the constructor a new initial state of type StatsLoadeingState is emitted. The subscription to the state stream of the TodoBloc is perfomed passing a function called onTodosStateChanged that check if the TodoBloc’s state is of type TodoLoadedState and , in case ,emits a event of type StatsUpdatedEvent. This event will be handled by the mapEventToState method implemented later. The function onTodosStateChanged is called also once in the constructor to update the stats in case the TodoBloc is already in a TodosLoadedState on StatsBloc creation.

class StatsBloc extends Bloc<StatsEvent, StatsState> {  
 final TodoBloc todoBloc;  
 late StreamSubscription todoSubscription;  
  
 StatsBloc({required this.todoBloc}) : super(StatsLoadingState()) {  
 void onTodosStateChanged(state) {  
 if (state is TodosLoadedState) {  
 add(StatsUpdatedEvent(state.todos));  
 }  
 }  
  
 onTodosStateChanged(todoBloc.state);  
  
 todoSubscription = todoBloc.stream.listen(onTodosStateChanged);  
 }

The mapEventToState method requires a single if statement because the only event is has to handle is the StatsUpdatedEvent. When received, the new stats are computed using the list of todo inside it and a new StatsLoadedState is emitted.

In the close method the subscription to the TodoBloc is terminated.

@override  
 Stream<StatsState> mapEventToState(StatsEvent event) async\* {  
 if (event is StatsUpdatedEvent) {  
 final numCompleted =  
 event.todos.where((todo) => todo.completed).toList().length;  
 yield StatsLoadedState(numCompleted);  
 }  
 }  
  
 @override  
 Future<void> close() {  
 todoSubscription.cancel();  
 return super.close();  
 }  
}

**The bloc for the tab**

The procedure is the same as before. This time the bloc is really simple. After creating the class TabBloc and extending it to the Bloc class, the states and events it must handle are specified. In the contructor the initial state is initialized and set to TabState.todos. The mapEventToState method is overridden connecting the only event with the emission of the state corresponding to the event TabState value.

class TabBloc extends Bloc<TabEvent,TabState>{  
 TabBloc() : super(TabState.todos);  
  
 @override  
 Stream<TabState> mapEventToState(TabEvent event)async\*{  
 if(event is ChangeTabEvent){  
 yield event.tab;  
 }  
 }  
  
}

**Observe blocs**

Here terminates the definition of the application’s state. All states ,events and the blocs connecting them have been defined. It is possible to start testing the logic of the application, in the main function for example, initializing an object of type TodoBloc and trying to emit new events using the Add method offered by the Bloc package.

void main() {  
   
 TodoBloc todoBloc= TodoBloc();  
 todoBloc.add(LoadTodosEvent());  
   
}

Il fatto di poter testare la logica senza aver dovuto scrivere un singolo widget né tantomeno definire alcuna interfaccia grafica fa capire quanto sia efficace e potente l’utilizzo del pacchetto Bloc. È infatti possibile separare la logica dalla visualizzazione in modo semplice e testare l’applicazione senza dover fare i conti con complicate dipendenza esterne. Inoltre, è possibile utilizzare un ulteriore strumento che aiuta il processo di debugging e di testing ; ovvero un BlocObserver. Quest’ultimo permette di intercettare gli eventi , le transizioni e gli errori durante l’utilizzo dei blocchi e di eseguire del codice quando questi avvengono. Creiamo una nuova classe e la estendiamo col la classe BlocObserver. Sarà cosi possibile ridefinire tre metodi ; “onEvent, onTransition,onError.” onEvent verrà chiamato ogni volta che viene emesso un evento in un blocco e avremo a disposizione all’interno del metodo l’oggetto blocco e l’oggetto evento corrispondente. onTransition invece verrà chiamato al verificarsi di una transizione di stato all’interno di un blocco e avrà a disposizione all’interno del metodo sia il blocco che un oggetto del tipo “Transition”. Un oggetto del tipo “Transition” contiene al suo interno : due stati, quello precedente e quello successivo alla transizione, e l’evento che ha dato luogo alla transizione. ( Attenzione : non sempre l’emissione di un evento avrà come conseguenza un cambio di stato. Alcuni eventi potrebbero essere ignorati o non generare alcuna transizione). Infine, il metodo onError verrà chiamato in caso di errore e avrà a disposizione ,al suo interno, del oggetto blocco che ha generato l’errore, dell’errore stesso e dell’oggetto di tipo StackTrace che riporta la situazione dello stack quando l’errore è stato generato. Nel nostro caso stamperemo solamente l’evento, la transizione e l’errore all’interno dei rispettivi metodi ma in altri scenari è possibile inserire codice più complesso e articolato.

class AppBlocObserver extends BlocObserver{  
 @override  
 void onEvent(Bloc bloc, Object? event) {  
 super.onEvent(bloc, event);  
 print("Event : " +event.toString());  
 }  
  
 @override  
 void onTransition(Bloc bloc, Transition transition) {  
 super.onTransition(bloc, transition);  
 print( transition.toString());  
 }  
 @override  
 void onError(BlocBase bloc, Object error, StackTrace stackTrace) {  
 print(error);  
 super.onError(bloc, error, stackTrace);  
 }  
}

Prima di chiamare il metodo runApp impostiamo il BlocObserver definito sopra come observer per l’applicazione.

**Rendere accessibile lo stato**

Come per l’implementazione con Redux e InheritedWidget anche in questo caso dobbiamo utilizzare un widget particolare chiamato BlocProvider per rendere accessibile lo stato, o parte dello stato, nel sottoalbero. Siccome lo stato della lista dei todo dovrà essere accessibile in tutta l’applicazione lo posizioniamo come radice dell’albero dell’applicazione. Quindi ,nel main, utilizziamo il metodo runApp offerto da Flutter e all’interno di esso istanziamo un widget di tipo BlocProvider. Bisogna inoltre fornire al widget di tipo BlocProvider il tipo di blocco che dovrà gestire, nel nostro caso TodoBloc. All’interno del widget vanno popolati due campi: “create” e “child”. Il campo create richiede una funzione che abbia come tipo di ritorno TodoBloc. Istanziamo quindi , all’ interno di essa, un blocco del tipo TodoBloc e emettiamo il primo evento LoadTodosEvent per caricare i todo. Il processo di caricamento dei todo dal database avverrà nel frattempo che il resto dell’applicazione viene costruito. Invece di scrivere la funzione per esteso utilizzeremo la notazione “a cascata” offerta da Flutter che permette di concatenare più azioni in un'unica linea di codice unendole con la notazione “..”. Inseriamo inoltre nel campo “child” il widget MyApp definito precedentemente.

void main() async {  
  
 Bloc.observer = AppBlocObserver();  
 runApp( BlocProvider<TodoBloc>(create:(context)=> TodoBloc()..add(LoadTodosEvent()),child: const MyApp()));  
}3

Oltre al blocco dei todo sarà necessario includere anche gli altri tre blocchi precedentemente definiti. All’interno del campo “routes” del widget MaterialApp ,oltre alla definizione delle varie pagine, facciamo in modo di inglobare il widget della HomePage all’interno di un MultiBlocProvider. Un MultiBlocProvider non è altro che un widget con all’interno un campo chiamato “providers” dove inserire una lista che BlocProvider ,ognuno con il suo blocco da rendere disponibile nel sottoalbero. Inseriamo quindi nel campo “providers” i BlocProvider per i tre blocchi. Nel blocco delle statistiche e nel blocco della lista filtrata passiamo come parametro al costruttore il blocco dei todo a cui accediamo tramite il metodo “of” offerto dal widget BlocProvider antenato. Da notare che la parte di stato relativa ai todo, di cui necessitiamo in tutte le pagine, è stata posizionata come antenato del widget MaterialApp in modo che sia accessibile ovunque. La parte di stato relativa alla lista filtrata, alle statistiche e alla scheda invece sarà accessibile solo all’interno del HomePage. E’ sempre buona prassi rendere accessibile lo stato (o le informazioni) nella minor parte possibile dell’applicazione per farsi sì che esso venga modificato solo dalle parti autorizzate. In questo modo il processo di testing e di debugging vengono agevolati notevolmente.

class MyApp extends StatelessWidget {  
 const MyApp({Key? key}) : super(key: key);  
  
 @override  
 Widget build(BuildContext context) {  
 print("building: MATERIAL-APP");  
 return MaterialApp(  
 initialRoute: "/",  
 routes: {  
 "/": (context) => MultiBlocProvider(providers: [  
 BlocProvider<TabBloc>(create: (context) => TabBloc()),  
 BlocProvider<StatsBloc>(  
 create: (context) =>  
 StatsBloc(todoBloc: BlocProvider.*of*<TodoBloc>(context))),  
 BlocProvider<FilteredTodoBloc>(  
 create: (context) =>  
 FilteredTodoBloc(todoBloc: BlocProvider.*of*<TodoBloc>(context))),  
 ], child: const HomePage()),  
 "/addTodo": (context) => const AddTodoPage(),  
 "/updateTodo" : (context) => UpdateTodoPage(todo: (ModalRoute.*of*(context)!.settings.arguments as Todo)),  
 },  
 );  
 }  
}

**Integrazione dello stato all’interno dell UI**

Ora che la logica è stata definita e resa accessibile nei vari sottoalberi non resta che collegarla alla UI precedentemente introdotta nel capitolo RIFERIMENTO.

**La HomePage**

Inglobiamo lo Scaffold in un widget di tipo BlocBuilder che ci servirà per accedere allo stato relativo alla scheda.( Partendo, infatti , da uno stato iniziale dove viene visualizzata la scheda dei todo ,e cambiando successivamente alla scheda delle statistiche ,il componente per la gestione dei filtri di visibilità dovra scomparire ,e cosi anche per il FloatingActionButton in basso a destra, il selettore di scheda dovrà invece aggiornarsi e la lista di todo essere sostituita con il testo delle statistiche.) L’intera HomePape (o quasi) dovrà essere infatti ricostruita in seguito a un cambio dello stato della scheda. Inseriremo tutta la creazione della Homepage all’interno della funzione da passare al campo “builder” del widget BlocBuilder. Specifichiamo inoltre la tipologia di blocco e di stati che dovrà gestire in modo tale che il BlocBuilder possa accedere alla parte di stato corretta. All’interno della funzione da inserire nel campo “builder” avremo accesso, infatti, allo stato sotto forma di oggetto del tipo inserito precedentemente, oltre che al contesto corrente.

class HomePage extends StatelessWidget {  
 const HomePage({Key? key}) : super(key: key);  
  
 @override  
 Widget build(BuildContext context) {  
 print("building: HomePage");  
  
 return BlocBuilder<TabBloc, TabState>(builder: (context, tabState) {  
 });  
 }  
}

Avendo accesso allo stato della scheda attraverso la variabile “tabState” la utilizzeremo per costruire lo Scaffold in modo tale che rispecchi lo stato corrente.

builder: (context, tabState) {  
 return Scaffold(  
 appBar: AppBar(  
 title: const Text("TodoApp"),  
 actions: [tabState == TabState.todos? VisibilityFilterComponent():Container()],  
 ),  
 body: tabState == TabState.todos ? const TodoView() : const Stats(),  
 bottomNavigationBar: const TabSelector(),  
 floatingActionButton:  
 tabState == TabState.todos  
 ? FloatingActionButton(  
 child: const Icon(Icons.*plus\_one*),  
 onPressed: () {  
 Navigator.*pushNamed*(context, "/addTodo");  
 })  
 : Container()  
  
 );  
}

**Il componente TodoView**

In questo caso l’unica parte dello stato a cui abbiamo bisogno di accedere è quella relativa alla lista filtrata e al filtro. Inglobiamo quindi il widget di tipo ListView all’interno di un BlocBuilder e gli comunichiamo tramite la notazione <> che dovrà dare accesso al blocco di tipo FilteredTodosBloc e al suo stato interno (di tipo FilteredTodoState). Nella funzione che passeremo al campo “builder” avremo accesso allo stato tramite la variabile chiamata “filteredTodosState”. Possiamo quindi stabilirne il tipo utilizzando la sintassi “is”. Nel caso lo stato sia di tipo FilteredTodosLoadingState ritorneremo un Widget di tipo CircularProgressIndicator per indicare che la lista è ancora in caricamento. In caso contrario all’interno della variabile filteredTodosState avremo accesso al campo “todos” (come definito a pass RIFERIMENTO) che conterrà la lista filtrata attuale e potremo quindi utilizzarla per popolare il widget di tipo ListView.

class TodoView extends StatelessWidget {  
 const TodoView({Key? key}) : super(key: key);  
  
 @override  
 Widget build(BuildContext context) {  
 return BlocBuilder<FilteredTodoBloc, FilteredTodoState>(  
 builder: (context, filteredTodoState) {  
 print("building: TodoView");  
  
 if (filteredTodoState is FilteredTodoLoadedState) {  
 return ListView.builder(  
 itemCount: filteredTodoState.todos.length,  
 itemBuilder: (context, index) {  
 return TodoItem(  
   
 todo: filteredTodoState.todos.elementAt(index));  
 });  
 } else if (filteredTodoState is FilteredTodoLoadingState) {  
 return const Center(child: CircularProgressIndicator());  
 } else {  
 return const Center(child: CircularProgressIndicator());  
 }  
 });  
 }  
}

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**il componente TodoItem**

siccome in questa parte del processo di implementazione non stiamo prendendo in considerazione nessun tipo di ottimizzazione, il componente TodoItem non necessità di cambiamenti rispetto a quanto riportato RIFERIMENTO. Il todo da visualizzare verrà passato come argomento al costruttore dal widget antenato (TodoView) e l’unico compito quello di esporlo all’utente. Dobbiamo tuttavia riempire il campo “onChanged” del widget Checkbox che ovviamente cambierà in base alla soluzione che stiamo utilizzando. In questo caso, non dovendo leggere nulla dallo stato ma solo scrivere, non sara necessario utilizzare un widget di tipo BLocBuilder ma sarà sufficiente accedere alla parte dello stato relativa ai todo ed emettere un nuovo evento. All’interno della funzione che passeremo al campo “ onChanged” avremo a disposizione una variabile chiama “completed” che starà a indicare il valore della Checkbox in seguito al nostro click. Utilizzando il metodo “of” ,offerto dal widget antenato BlocProvider ,otteniamo l’istanza piu vicina (al nodo corrente) del blocco dei todo e tramite il metodo “add” generiamo un evento di tipo SetCompletedTodoEvent passando come argomento la variabile “completed” e l’id del todo .

onChanged: (completed) {  
 BlocProvider.*of*<TodoBloc>(context)  
 .add(SetCompletedTodoEvent(id, completed!));  
}),

Ricapitolando in breve; alla pressione della Checkbox, all’interno di un TodoItem , verrà generato un nuovo evento all’interno del blocco dei todo (TodoBloc) . Questo evento provocherà una transizione di stato del blocco dei todo da uno stato del tipo FilteredTodoLoadedState non contenente la modifica a uno stato del tipo FilteredTodoLoadedState contenente la modifica. Successivamente i blocchi della lista filtrata (FilteredTodoBloc) e delle statistiche (StatsBloc) , che sono in ascolto dei cambiamenti di stato del blocco dei todo ,reagiranno emettendo un nuovo evento interno (rispettivamente TodoUpdatedEvent e StatsUpdatedEvent) il quale provocherà un cambio di stato dei due blocchi in questione verso un nuovo riportante la modifica. In seguito al cambiamento di stato della lista filtrata il componente TodoView verrà notificato e ricostruito di conseguenza ,rendendo la modifica visibile all’utente.

**Il componente VisibilityFilterSelector**

Questo componente dipendare unicamente dal blocco dell filtro e della lista filtrata. Inglobiamo quindi il DropdownButton all’interno di un BlocBuilder e indichiamo tramite la notazione <> che quest’ultimo dovra gestire il blocco del tipo FilteredTodosBloc e gli stati del tipo FilteredTodoState.

return BlocBuilder<FilteredTodoBloc, FilteredTodoState>(  
 builder: (context, filteredTodoState) {

Al’’interno della funzione “builder” creeremo e popoleremo una variabile di tipo VisibilityFilter in base allo stato del blocco della lista filtrata. In caso lo stato sia di tipo Loading assegneremo al filtro il valore “all” per convenzione. In caso lo stato sia di tipo Loaded accederemo all suo campo “filter” e lo useremo per assegnare la variabile.

final VisibilityFilter filter= filteredTodoState is FilteredTodoLoadedState? filteredTodoState.filter: VisibilityFilter.all;

a questo punto non resta che popolare il widget di tipo DropdownButton con la variabile appena creata. Particolare attenzione alla funzione che passeremo al campo “onChanged” dei singoli DropdownMenuItem. Quest’ultima infatti avrà il compito di emettere un nuovo evento del tipo FilteredTodosChangeFilterEvent col rispettivo valore del filtro.

onChanged: (filter) {  
 BlocProvider.*of*<FilteredTodoBloc>(context).add(FilteredTodoChangeFilterEvent(filter!));  
},8

**Il componente TabSelector**

Anche in questo caso modificare il widget inglobando la logica scritta in precedenza sarà semplice. L’intero widget dipenderà esclusivamente dallo stato della scheda. Inseriamo quindi il widget di tipo BottomNavigatorBar all’interno di un BlocBuilder e indichiamo ,tramite la notazione <> ,che dovra gestire il blocco di tipo TabBloc e gli stati di tipo TabState.

return BlocBuilder<TabBloc, TabState>(  
 builder: (context, currTab) {  
 return BottomNavigationBar(  
 currentIndex: TabState.values.indexOf(currTab),

4

Popoliamo il campo “onTap” del widget BottomNavigationBar in modo tale che al tocco di uno dei BottomNavigationBarItem venga emesso un nuovo evento di tipo ChangeTabEvent all’interno del blocco TabBloc con il rispettivo valore della scheda.

onTap: (index)=>BlocProvider.*of*<TabBloc>(context).add(ChangeTabEvent(TabState.values.elementAt(index))),

3

infine facciamo in modo che l’icona dei due BottomNavigationBarItem rispecchi lo stato della scheda.

Icon(  
 tab == TabState.todos ? Icons.*list* : Icons.*show\_chart*,  
),

3

**Il componente Stats**

Anche in questo caso l’unica dipendenza è con il blocco delle statistiche. Colleghiamo dunque il componente alla parte di stato di interesse tramite un BlocBuilder specificando che dovrà gestire il blocco di tipo StatsBloc e gli stati di tipo StatsState. All’interno della funzione “builder” andremo a verificare lo stato corrente. In caso lo stato sia di tipo StatsLoadedState ritorneremo un widget di tipo Text popolato con il campo “completed” offerto allo stato. In caso lo stato sia di tipo StatsLoadingState ritorneremo un widget di tipo CircularProgressIndicator per indicare che le statistiche sono ancora in caricamento.

return BlocBuilder<StatsBloc, StatsState>(  
 builder: (context, statsState) {  
 return statsState is StatsLoadedState ?Center(  
 child: Text(  
 statsState.completed.toString()),  
 ) : Center(child: const CircularProgressIndicator());  
 },  
);

6

**Conclusioni**

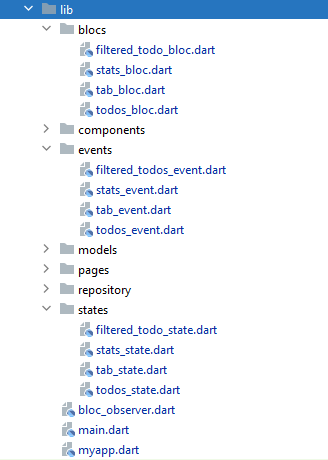
Tutte le funzionalità base dell’applicazione sono state sviluppate e funzionano correttamente. In generale il processo di sviluppo non ha avuto grossi intoppi. La l’unica parte complessa è stato creare i due blocchi del filtro e delle statistiche. Essendo essi dipendenti da un blocco esterno hanno richiesto un po’ più di attenzione per essere gestiti correttamente rispetto al resto dell’applicazione. Come si puo’ notare, sebbene lo sviluppo sia stato lineare, ha richiesto un numero notevole di linee di codice e di boilerplate. Riporto qui sotto alcuni dati riassuntivi:

Tempo impiegato (per comprendere e scrivere la soluzione) : 10-12 ore

Linee di codice aggiunte/modificate: 367

Classi create: 24

File creati:12



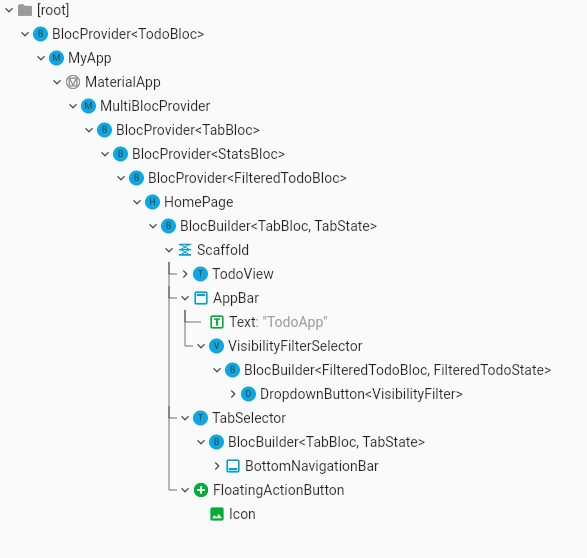


Immagine che contiene tavolo

Descrizione generata automaticamente

MobX

Implementation with mobx

### GetX

Implementation with getx

# The other app

# Comparisons

# Conclusions