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Creating a Playlist Manager with Thymeleaf & TS

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Contents

Abstract

Overview This project hosts the source code – which can be found on Github – for a web server that handles a playlist management system. A user is able to register, login and then upload tracks. The tracks are strictly associated to one user, similar to how a cloud service works. The user will be able to create playlists, sourcing from their tracks, and listem to them.

It should be noted there are two versions: a **HTML version**, which is structured as a series of separate webpages; and a **RIA version** (Section 8), which is structured as a single-page webapp. The functionalities are quite the same, the code changes mostly at a frontend level. For more information about the requirements for each version see Section 1, Section 2.

Both of the them feature the same CSS code (see Section 7).

Tools To create the project, our professor decided to adopt the following technologies: **Java**, for the backend server with servlets leveraging Jakarta's API capabilities; **Apache Tomcat**, to run the server; for the HTML version, **Thymeleaf**, a template engine; whereas for the RIA one **Typescript**.

Some liberties were taken in regards to the DMBS: we decided to use **MariaDB** instead of MySQL, since the former is a open source fork of MySQL, one of the most widely used DBMS.

Last but absolutely not least, this very document you are reading now has been typeset with none-other than **Typst** [1], the much needed successor to LaTeX. Also, to create sequence diagrams we made use of the `chronos` package [2].

Configuration & Run In order to run this project, the following packages and their respective versions are to be installed:

- Java JDK 24 [3]
- Apache Maven [4]
- Apache Tomcat 10 [5]
- Thymeleaf [6]
- MariaDB [7]

Then Maven will fetch all the corrected dependencies (such as the JDBC driver). We opted to use IntelliJ Idea Ultimate Edition [8] though there are no restrictions – feel free to use whatever editor you want, even Eclipse, *if you must*[1]. Once you made sure all the dependencies are correctly installed, let Tomcat deploy the server, which will be found at[2]:

http://localhost:8080/[version]_war_exploded

The credentials are stored in plain text in the database (see Section 5.2), while the tracks and images are stored in `target/webapp` (see Section 5.6).

The repository is bundled with some mock data, which can be found in the corresponding folders of each subproject. They are copyright free songs [9] because we didn't want to get sued 🤭 .

[1] *I wrote that* only *out of kindess, since I wouldn't recommend it even to my worst enemy. — `victuarvi`.*

[2] `[version]` is either `pure_html` or `js` depending on what you run.

1

Original submission (in Italian)

1.1 Versione HTML pura

Un'applicazione web consente la gestione di una playlist di brani musicali. Playlist e brani sono personali di ogni utente e non condivisi. Ogni utente ha username, password, nome e cognome. Ogni brano musicale è memorizzato nella base di dati mediante un titolo, l'immagine e il titolo dell'album da cui il brano è tratto, il nome dell'interprete (singolo o gruppo) dell'album, l'anno di pubblicazione dell'album, il genere musicale (si supponga che i generi siano prefissati) e il file musicale. Non è richiesto di memorizzare l'ordine con cui i brani compaiono nell'album a cui appartengono. Si ipotizzi che un brano possa appartenere a un solo album (no compilation). L'utente, previo login, può creare brani mediante il caricamento dei dati relativi e raggrupparli in playlist. Una playlist è un insieme di brani scelti tra quelli caricati dallo stesso utente. Lo stesso brano può essere inserito in più playlist. Una playlist ha un titolo e una data di creazione ed è associata al suo creatore. A seguito del login, l'utente accede all'HOME PAGE che presenta l'elenco delle proprie playlist, ordinate per data di creazione decrescente, un form per caricare un brano con tutti i dati relativi e un form per creare una nuova playlist. Il form per la creazione di una nuova playlist mostra l'elenco dei brani dell'utente ordinati per ordine alfabetico crescente dell'autore o gruppo e per data crescente di pubblicazione dell'abum a cui il brano appartiene. Tramite il form è possibile selezionare uno o più brani da includere. Quando l'utente clicca su una playlist nell'HOME PAGE, appare la pagina PLAYLIST PAGE che contiene inizialmente una tabella di una riga e cinque colonne. Ogni cella contiene il titolo di un brano e l'immagine dell'album da cui proviene. I brani sono ordinati da sinistra a destra per ordine alfabetico crescente dell'autore o gruppo e per data crescente di pubblicazione dell'abum a cui il brano appartiene. Se la playlist contiene più di cinque brani, sono disponibili comandi per vedere il precedente e successivo gruppo di brani. Se la pagina PLAYLIST mostra il primo gruppo e ne esistono altri successivi nell'ordinamento, compare a destra della riga il bottone SUCCESSIVI, che permette di vedere il gruppo successivo. Se la pagina PLAYLIST mostra l'ultimo gruppo e ne esistono altri precedenti nell'ordinamento, compare a sinistra della riga il bottone PRECEDENTI, che permette di vedere i cinque brani precedenti. Se la pagina PLAYLIST mostra un blocco e esistono sia precedenti sia successivi, compare a destra della riga il bottone SUCCESSIVI e a sinistra il bottone PRECEDENTI. La pagina PLAYLIST contiene anche un form che consente di selezionare e aggiungere uno o più brani alla playlist corrente, se non già presente nella playlist. Tale form presenta i brani da scegliere nello stesso modo del form usato per creare una playlist. A seguito dell'aggiunta di un brano alla playlist corrente, l'applicazione visualizza nuovamente la pagina a partire dal primo blocco della playlist. Quando l'utente seleziona il titolo di un brano, la pagina PLAYER mostra tutti i dati del brano scelto e il player audio per la riproduzione del brano.

1.2 Versione con JavaScript

Si realizzi un'applicazione client server web che modifica le specifiche precedenti come segue:

- Dopo il login dell'utente, l'intera applicazione è realizzata con un'unica pagina.
- Ogni interazione dell'utente è gestita senza ricaricare completamente la pagina, ma produce l'invocazione asincrona del server e l'eventuale modifica del contenuto da aggiornare a seguito dell'evento.
- L'evento di visualizzazione del blocco precedente/successivo è gestito a lato client senza generare una richiesta al server.
- L'applicazione deve consentire all'utente di riordinare le playlist con un criterio personalizato diverso da quello di default. Dalla HOME con un link associato a ogni playlist si accede a una finestra modale RIORDINO, che mostra la lista completa dei brani della playlist ordinati secondo il criterio corrente (personalizzato o di default). L'utente uò trascinare il titolo di un brano nell'elenco

e di collocarlo in una posizione diversa per realizzare l'ordinamento che desidera, senza invocare il server. Quando l'utente ha raggiunto l'ordinamentodesiderato, usa un bottone "salva ordinamento", per memorizzare la sequenza sul server. Ai successivi accessi, l'ordinamento personalizzato è usato al posto di quello di default. Un brano aggunto a una playlist con ordinamento personalizzato è inserito nell'ultima posizione.

2

Project submission breakdown

2.1 Database logic

LEGEND		
	Entity	Attribute
	Attribute specification	Relationship

Each **user** has a **username**, **password**, **name** and **surname**. Each musical **track** is stored in the database by **title**, **image**, **album title**, **album artist name** (single or group), **album release year**, **musical genre** and **file**. Furthermore:

- Suppose the *genres are predetermined* `// the user cannot create new genres`
- It is not requested to store the track order within albums
- Suppose each track can belong to a unique album (no compilations)

After the login, the user is able to **create tracks** by loading their data and then group them in playlists. A **playlist is a set of chosen tracks** from the uploaded ones of the user. A playlist has a **title**, a **creation date** and is **associated to its creator**.

For the UML diagram, see Section 3.

2.2 Behaviour

LEGEND		
	User action	Server action
	HTML page	Page element

After the login, the user **accesses** the **HOME PAGE** which **displays** the **list of their playlists**, ordered by descending creation date; a **form to load a track with relative data** and a **form to create a new playlist**. The playlist form:

- **Shows** the **list of user tracks** ordered by artist name in ascending alphabetic order and by ascending album release date
- The form allows to **select** one or more tracks

When a user **clicks** on a playlist in the **HOME PAGE**, the application **loads** the **PLAYLIST PAGE**; initially, it contains a **table with a row and five columns**.

- Every cell contains the track's title and album name
- The tracks are ordered from left to right by artist name in ascending alphabetic order and by ascending album release date
- If a playlist contains more than 5 tracks, there are available commands to see the others (in blocks of five)

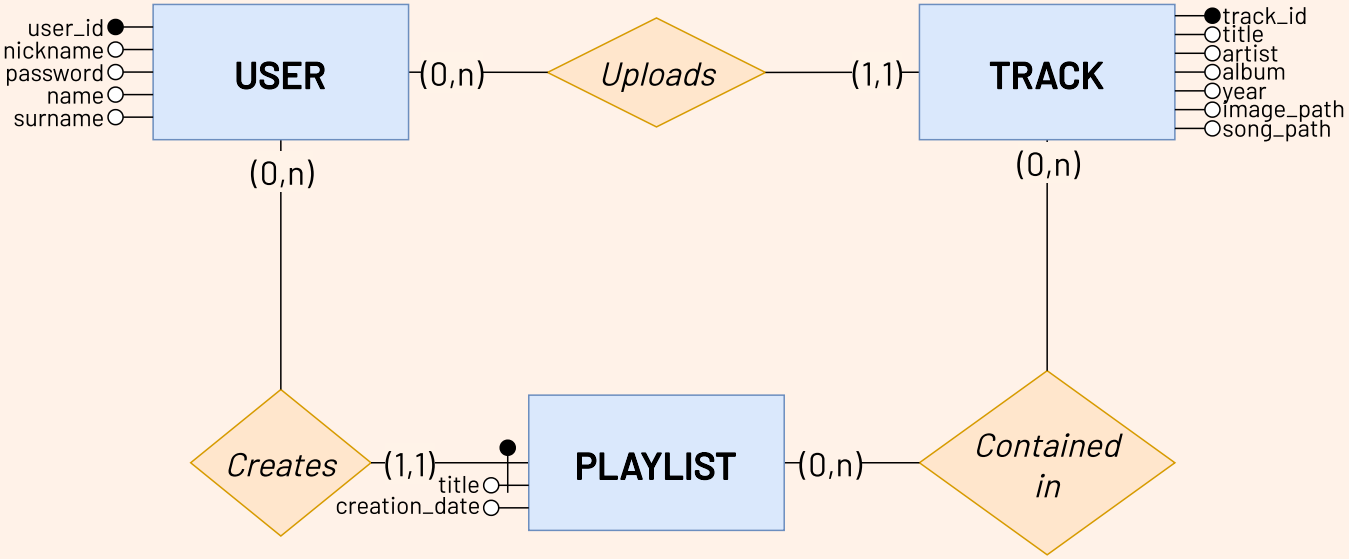


Figure 1: ER diagram, .

Playlist tracks navigation If the PLAYLIST PAGE:

1. Shows the first group and there are subsequent ones, a NEXT button appears on the right side of the row
2. Shows the last group and there are precedent ones, a PREVIOUS button appears on the left side of the row that allows to see the five preceding tracks
3. Shows a block of tracks and there are both subsequent and preceding ones, then on left and the right side appear both previous and next buttons

Track creation The PLAYLIST PAGE includes a form that allows to add one or more tracks to the current playlist, if not already present. This form acts in the same way as the playlist creation form.

After adding a new track to the current playlist, the application refreshes the page to display the first block of the playlist (the first 5 tracks). Once a user selects the title of a track, the PLAYER PAGE shows all of the track data and the audio player.

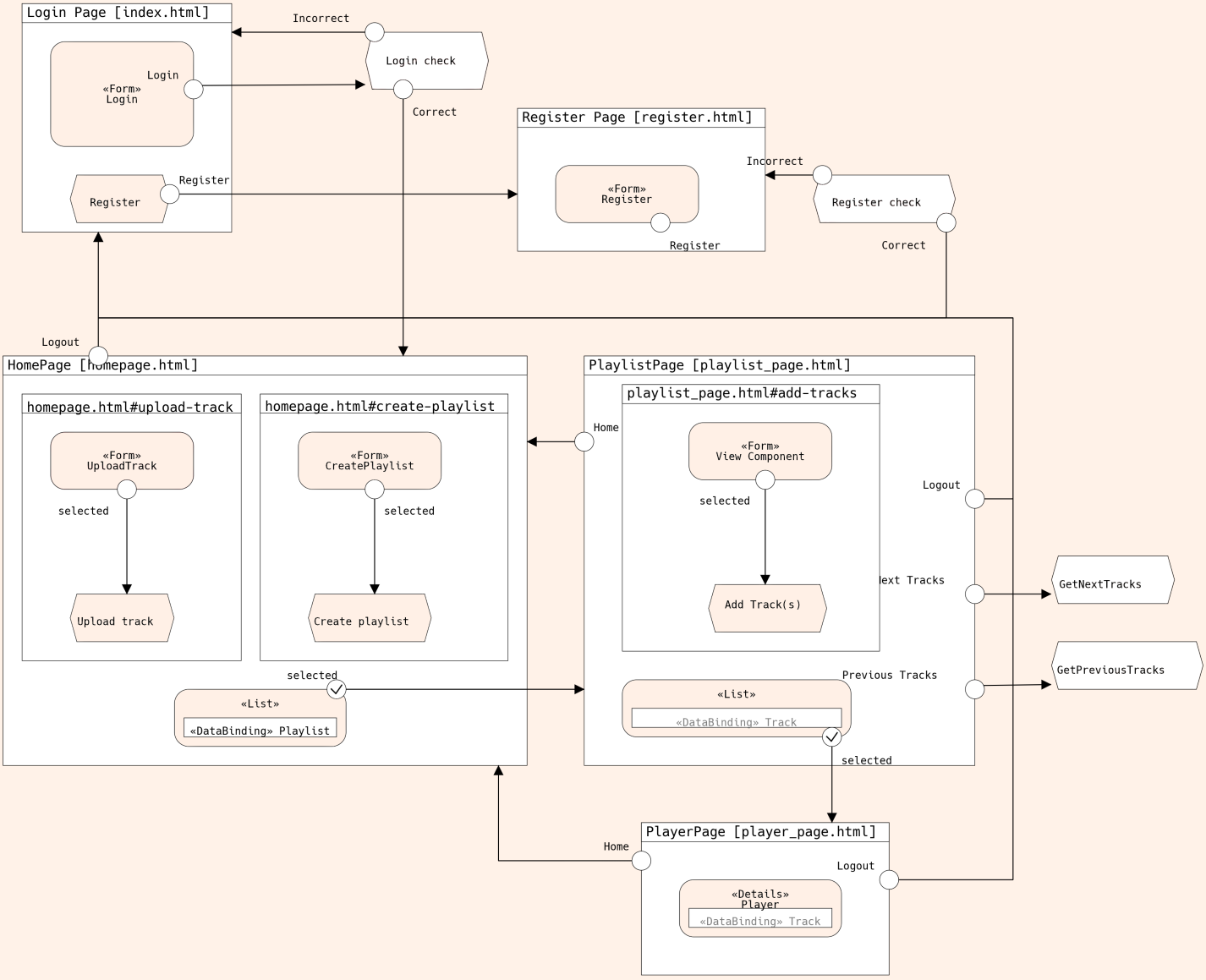


Figure 2: IFML diagram.

3

SQL database schema

3.1 Overview

The project requirements slightly change from `pure_html` and `js`, where the latter requires the tracks to support an individual custom order within the playlist to which they are associated – this is achieved via a simple addition in the SQL tables schema.

In both scenarios, the schema is composed by four tables: `user`, `track`, `playlist` and `playlist_tracks`.

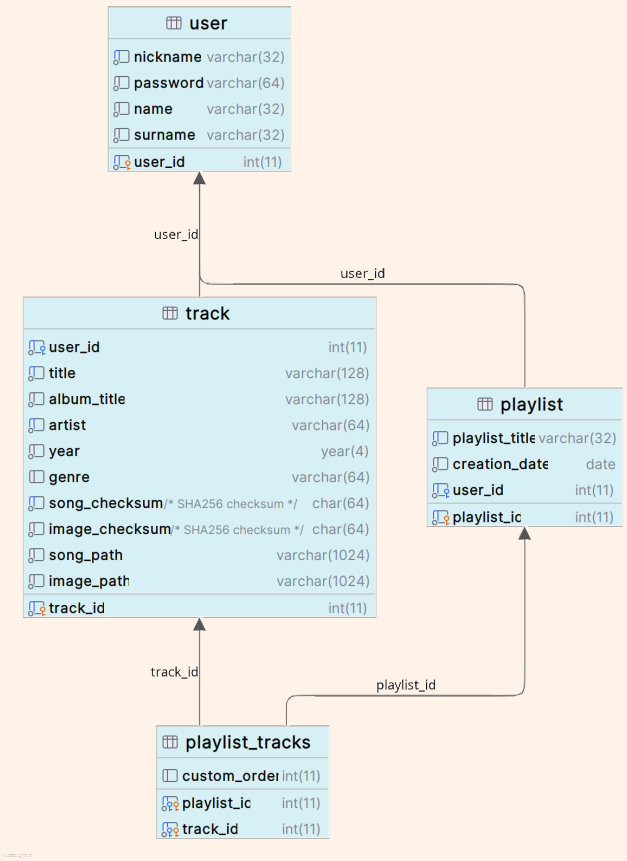


Figure 3: UML diagram.

3.2 The tables

- `user` table

```
CREATE TABLE user
(
    user_id  integer     not null
auto_increment,
    nickname varchar(32) not null unique,
    password varchar(64) not null,
    name     varchar(32) not null,
    surname  varchar(32) not null,

    primary key (user_id)
);
```

it is quite staightforward and standard. Apart from the `user_id` attribute, which is the primary key, the only other attribute that has a unique constraint is `nickname`. It couldn't be a multiple primary key because in that case there could have been multiple users with the same nickname, which isn't our goal.

- `track` table

```
CREATE TABLE track
(
    track_id       integer       not
null auto_increment,
    user_id        integer       not null,
    title          varchar(128)  not null,
    album_title    varchar(128)  not null,
    artist         varchar(64)   not null,
    year           year          not null,
    genre          varchar(64),
    song_checksum  char(64)      not null
default '0...0',
    image_checksum char(64)      not null
default '0...0',
    song_path      varchar(1024) not null,
    image_path     varchar(1024) not null,

    primary key (track_id),
    foreign key (user_id) REFERENCES user
(user_id)
        ON DELETE CASCADE ON UPDATE CASCADE,
    unique (user_id, song_checksum),
    unique (user_id, title, artist),
    check (genre in ('Classical', 'Rock',
'Edm', 'Pop', 'Hip-hop', 'R&B', 'Country',
'Jazz', 'Blues', 'Metal', 'Folk', 'Soul',
'Funk', 'Electronic', 'Indie', 'Reggae',
'Disco'))
);
```

this needs to be addressed since we implemented a special feature, which is the checksum for the song and the album image. As their name implies, they are the SHA256 checksums of the song and image: their purpose is to let the server store only one copy of the same file, which couldn't have been properly achieved by checking only the filename.

Next, the other attributes are pretty standard. As per the `user` table, there are some unique constraint placed on `user_id, song_checksum` to account for what is written above; while `user_id, title, artist` does the same job though internally in the database[3]. Finally, a track is strictly bound to a user: that's the the foreign key is for.

- `playlist` table

```
CREATE TABLE playlist
(
    playlist_id    integer     not null
auto_increment,
    playlist_title varchar(32) not null,
    creation_date  date        not null
default CURRENT_DATE,
    user_id        integer     not null,

    primary key (playlist_id),
    unique (playlist_title, user_id),
    foreign key (user_id) REFERENCES user
(user_id)
        ON DELETE CASCADE ON UPDATE CASCADE
);
```

once again this table is rather. The `creatione_date` attribute default to the current date, which is today; and again there is the unique constraint on `playlist_title, user_id` because a playlist is bound to a single User (who can't have duplicate playlists – that is with the same title) via the foreign key.

- `playlist_tracks` table

```
CREATE TABLE playlist_tracks
(
    playlist_id  integer not null,
    track_id     integer not null,
    -- present ONLY in the JS project
    custom_order integer,

    primary key (playlist_id, track_id),
    foreign key (playlist_id) REFERENCES
playlist (playlist_id)
        ON DELETE CASCADE ON UPDATE CASCADE,
    foreign key (track_id) REFERENCES track
(track_id)
        ON DELETE CASCADE ON UPDATE CASCADE
);
```

this table represents the "Contained in" relation in the ER diagram (Figure 1). Its primary key is multiple (the only one in the project) and has to link a track to a playlist – unlike the other tables, which *explicitly needed* a primary key *and* a unique constraints, in this case a composite key it's correct because a track can appear in multiple playlists.

As stated in the comment, the `custom_order` attribute is needed only in the JS project, because the HTML version doesn't need to account for overridden track order in a playlist.

[3] A User can't have duplicate track.

4

Codebase overview

4.1 Components

The projects is composed of the following components:

1. DAOs
    - PlaylistDAO
    - TrackDAO
    - UserDAO
    - DAO interface

The DAO interface has only the default method `close()`, which is used in nearly all DAOs – this way we are able to follow the DRY principle (*Don't Repeat Yourself*).

2. Entities
    - Playlist
    - Track
    - User

Unlike most WT projects, these are record classes [10]: basically they are built-in old-school beans. We opted their use to drastically reduce boilerplate and simplify the codebase.

3. Servlets
    - Login
    - HomePage
    - Playlist
    - Register
    - Track
    - Logout
    - AddTracks
    - CreatePlaylist

4. Filters
    - UserChecker
    - InvalidUserChecker
    - TrackChecker
    - SelectedTracksChecker
    - PlaylistChecker

5. Utils (short-term for Utilities)
    - ConnectionHandler
    - TemplateEngineHandler

As per the DAO interface, the same idea has been applied to the `ConnectionHandler` and `TemplateEngineHandler` classes.

4.2 DAOs methods

PlaylistDAO methods:

- getPlaylistTitle
- deletePlaylist
- getTrackGroup
- addTracksToPlaylist
- removeTracksFromPlaylist
- checkPlaylistOwner
- getUserPlaylists
- getPlaylistTracksByTitle
- createPlaylist
- getPlaylistTracksById

TrackDAO methods:

- addTrack
- isImageFileAlreadyPresent
- checkTrackOwner
- isTrackFileAlreadyPresent
- getTrackById
- getUserTracks

UserDAO methods:

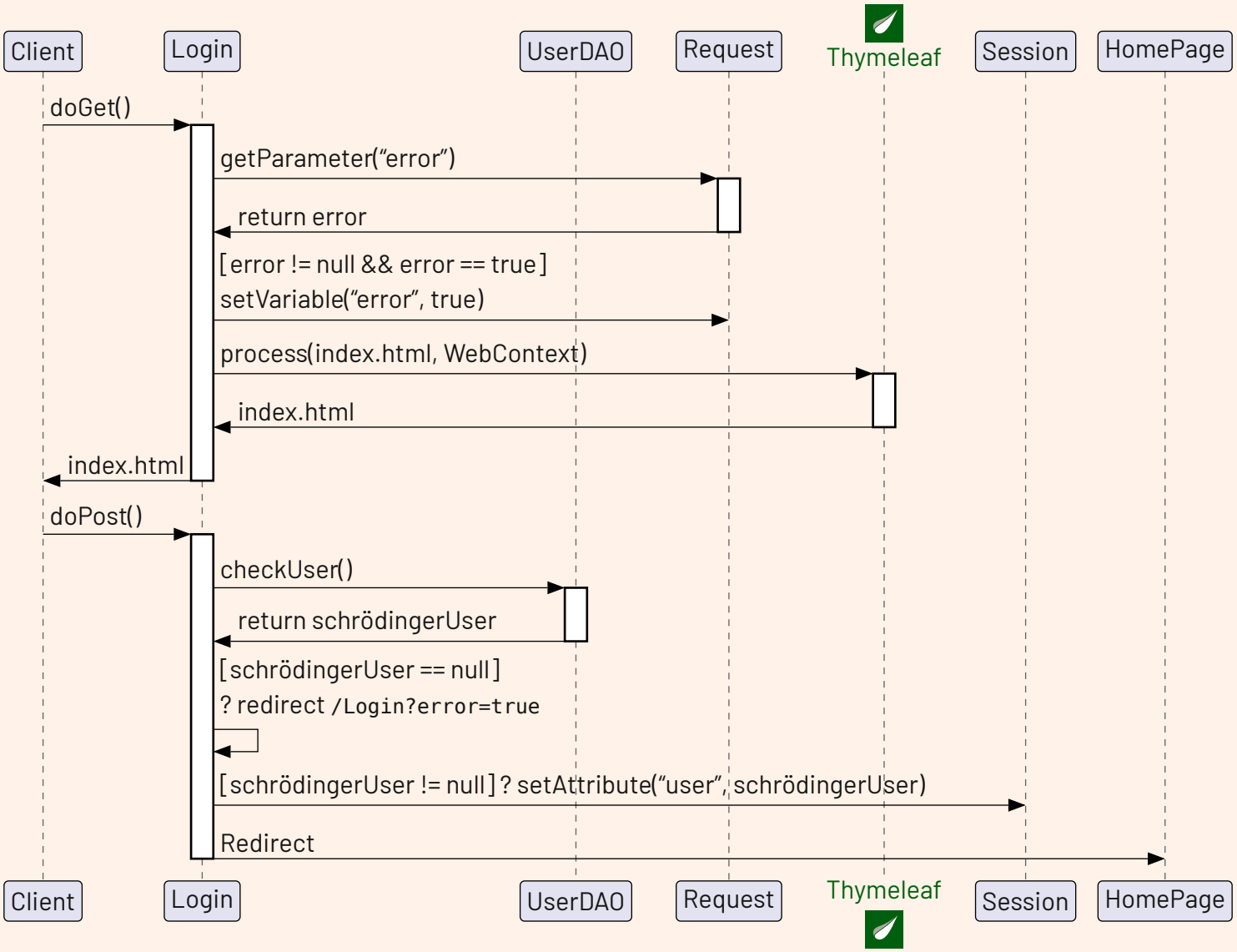
- checkUser
- addUser

All the methods are intuitively named and don't need further explanations. Either way, they are explanined throughout the next section in their respective sequence.

5

Sequence diagrams

5.1 Login sequence diagram



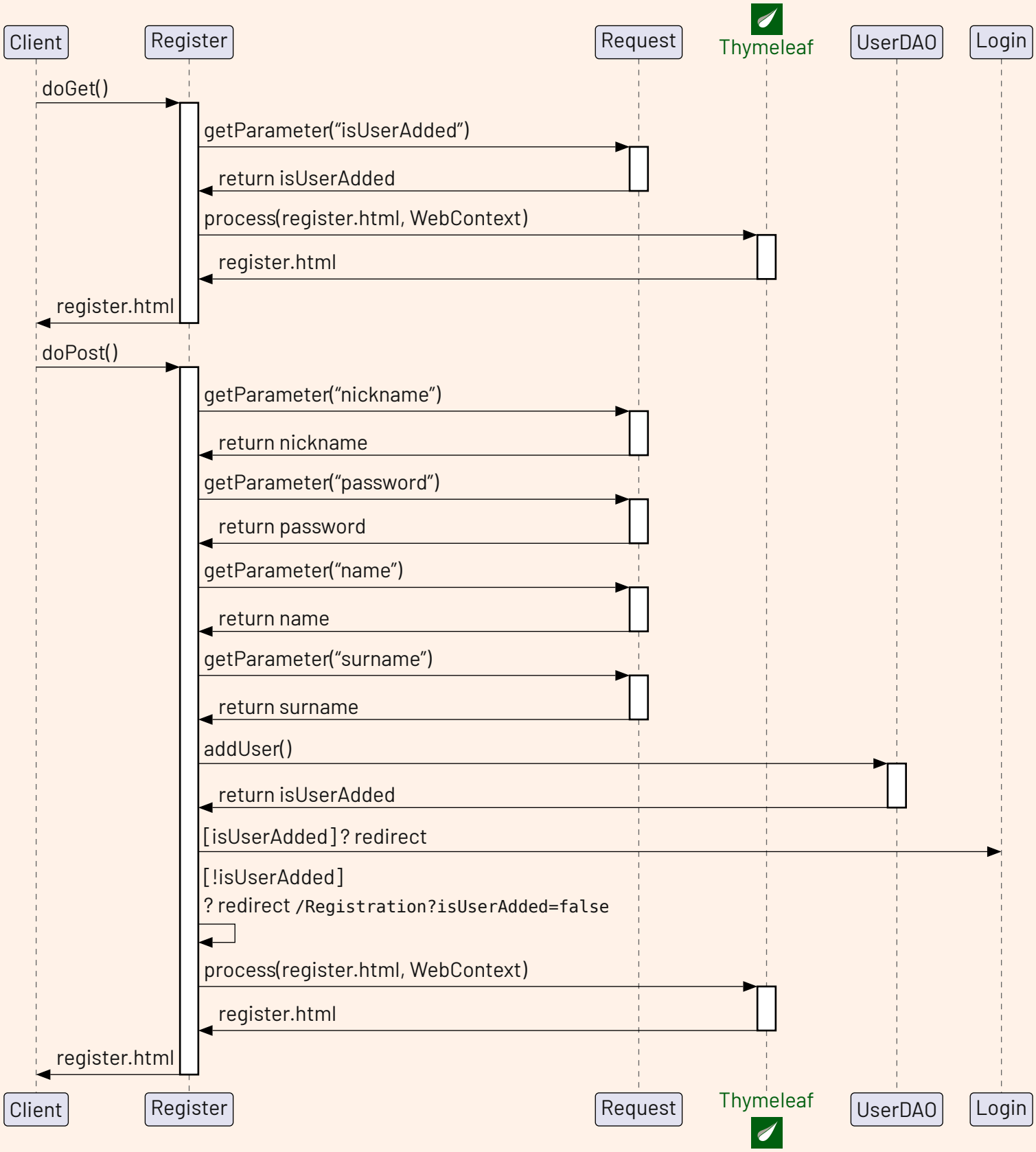
Comment

Once the server is up and running, the Client requests the Login page. Then, thymeleaf processes the request and returns the correct context, to index the chosen locale.
Afterwards, the User inserts their credentials.

Those values are passed to the `checkUser()` function that returns `schrödingerUser` – as the name implies, the variable might return a User; otherwise `null`. If `null`, then the credentials inserted do not match any record in the database; else the User is redirected to their HomePage and the `user` variable is set for the current session.

If there has been some error in the process – the credentials are incorrect, database can't be accessed... – then the servlet will redirect to itself by setting the variable `error` to true, which then will be evaluated by thymeleaf and if true, it will print an error; otherwise it won't (this is the case for the first time the User inserts the credentials).

5.2 Register sequence diagram



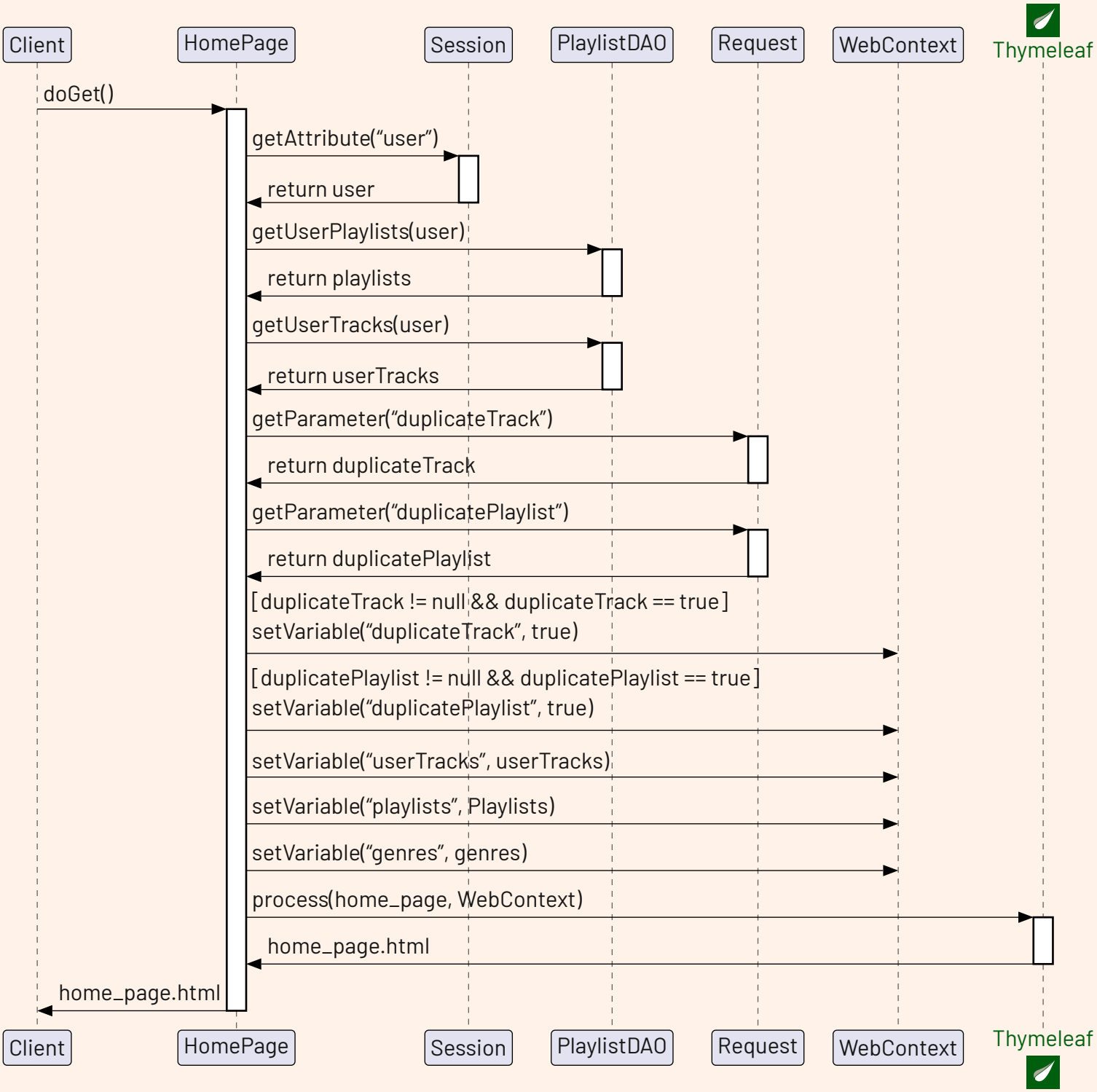
Comment

If the User is not yet registered, they might want to create an account. If that's the case, as per the Login sequence diagram, once all the parameters are gathered and verified (omitted for simplicity) initially thymeleaf processes the correct context, then the User inserts the credentials.

Depending on the nickname inserted, the operation might fail: there can't be two Users with the same nickname. If that does not happen, then `isUserAdded` is `true`, then there will be the redirection to the Login page.

Else the program appends `isUserAdded` with `false` value and redirects to the Registration servlet: thymeleaf checks for that context variable and if it evaluates to false, it prints an error.

5.3 HomePage sequence diagram



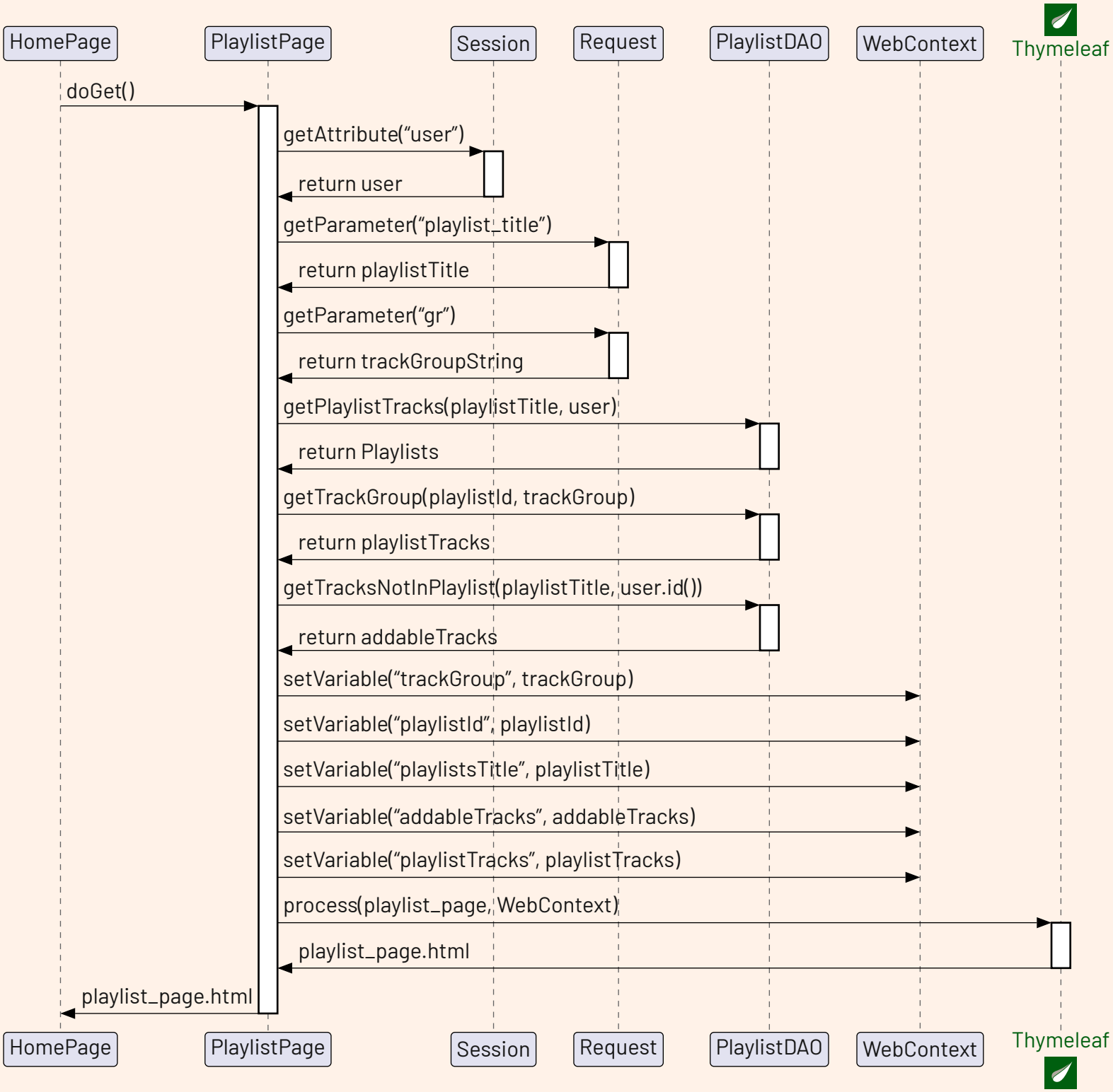
Comment

Once the Login is complete, the User is redirected to their HomePage, which hosts all their Playlists. In order to do so, the program needs to User attribute – which is retrieved via the session; then, it is passed to the `getUserPlaylists` function and finally thymeleaf displays all values.

From this page, the User can upload new tracks. for this reason the HomePage servlet fetches all the user tracks (which are not to be displayed). Then, as the User presses the upload button, the modal shows up allowing to fill the information for a new track (title, album, path, playlist...); the genres are predetermined: they are statically loaded from the `genres.json` file.

Once the information are completed, the servlet checks if a playlist or track is duplicate – hence the need to fetch all the tracks – and if so it redirectes to itself with a `duplicate` - error, the same principle applied to the precedent servlets. Otherwise, the track would have been successfully added.

5.4 PlaylistPage sequence diagram



Comment

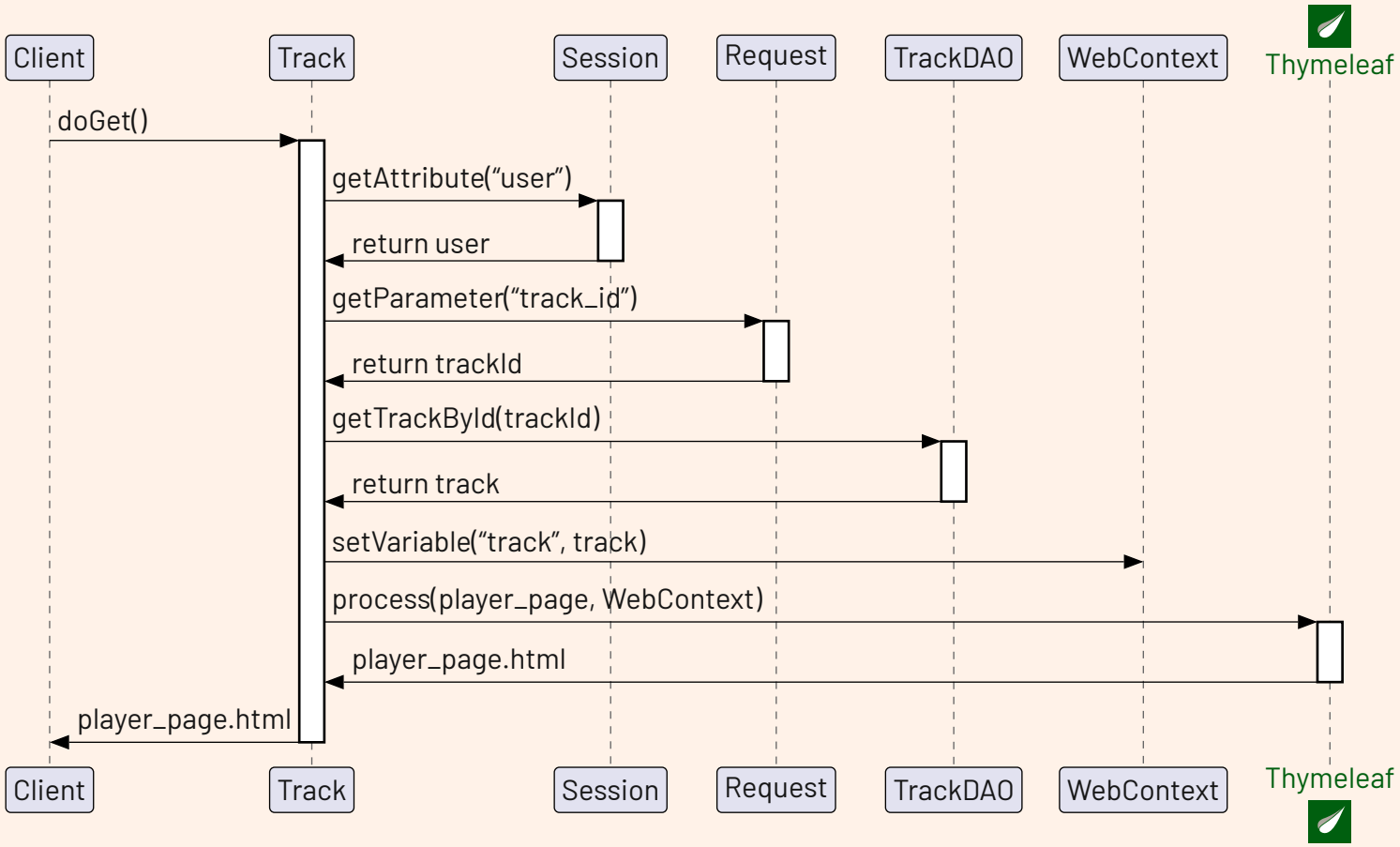
From the HomePage, the User is able to see all their playlists. By clicking on either one of them, the program redirects to the corresponding PlaylistPage, which lists all the tracks associated to that playlist.

In order to do so, the program needs the User attribute – which is retrieved via the session – and the title of the playlists, which is given as a parameter by pressing the corresponding button in HomePage.

Then those value are passed to `getPlaylistTracks()`*, that returns all the tracks. Finally, thymeleaf processes the context and display all the tracks.*

From this page the User is also able to add chosen tracks to a playlist. In order to do, similar to HomePage with the upload, the program fetches all tracks that can be added*, thats is the ones that are not already in a playlist, and displays them to a User via a dropdown menu (again similar to genres in HomePage).*

5.5 Track sequence diagram

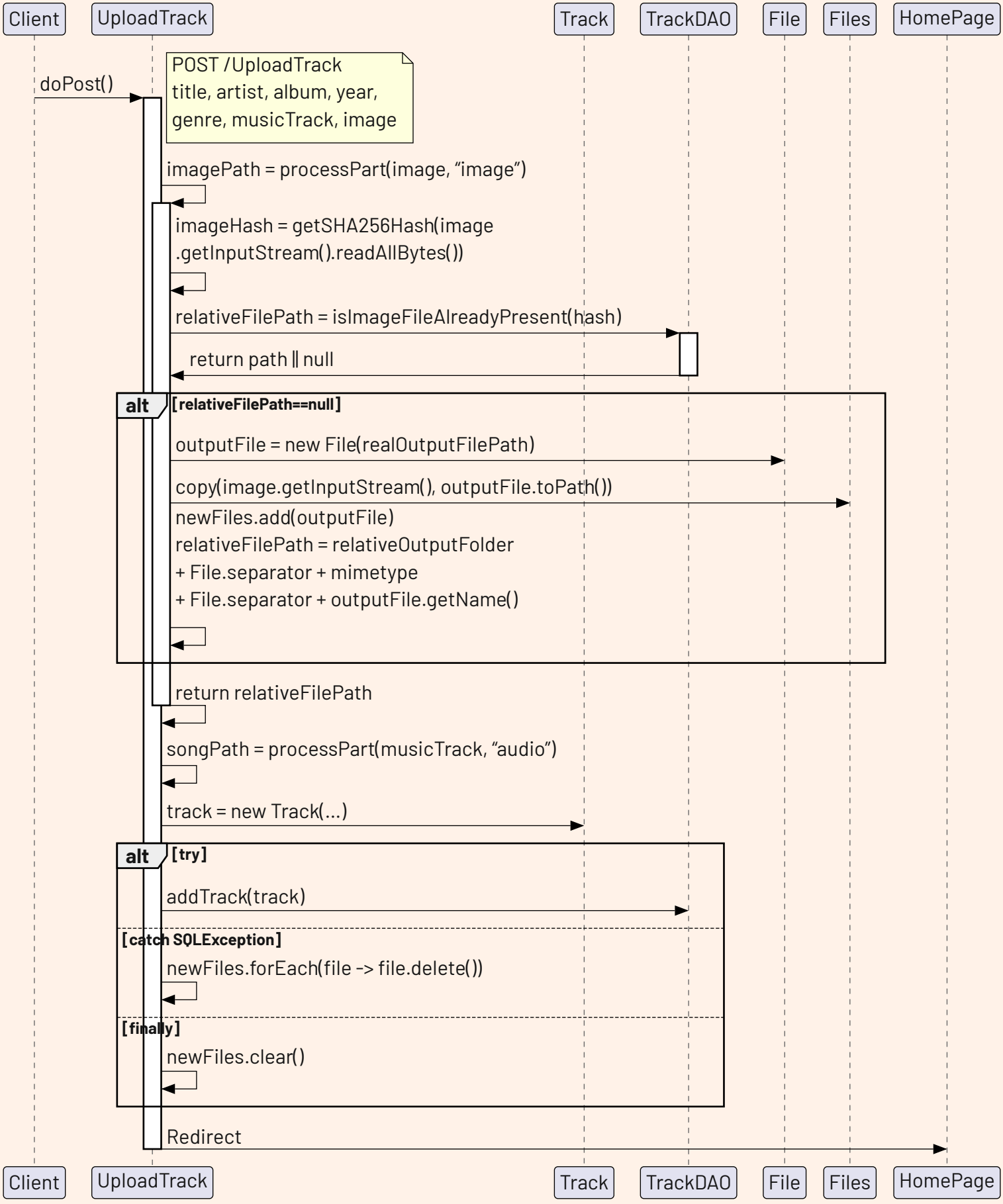


Comment

Once the program has lodead all the tracks associated to a playlist, it allows to play them one by one in the dedicated player page. In a similar fashion to the `getPlaylistTracks()` method, in order to retrieve all the information regarding a single track the program is given the `track_id` parameter by pressing the corresponding button.

Finally, `getTrackById()` returns the track metadata – that is title, artist, album, path and album image – thymeleaf  then processes the context and displays all the information. If an exception is caught during this operation, the server will respond with `ERROR 500` (see Section 6.5).

5.6 UploadTrack sequence diagram



Comment

The User can upload tracks from the appropriate form in the homepage (Section 5.3). When the POST request is received, the request parameters are checked for null values and emptiness (omitted in the diagram for the sake of simplicity), and the uploaded files are written to disk by the `processPart` method, which has two parameters: a Part object, which "represents a part or form item that was received within a multipart/form-data POST request" [11], and its expected MIME type. The latter does not need to be fully specified (i.e. the subtype can be omitted).

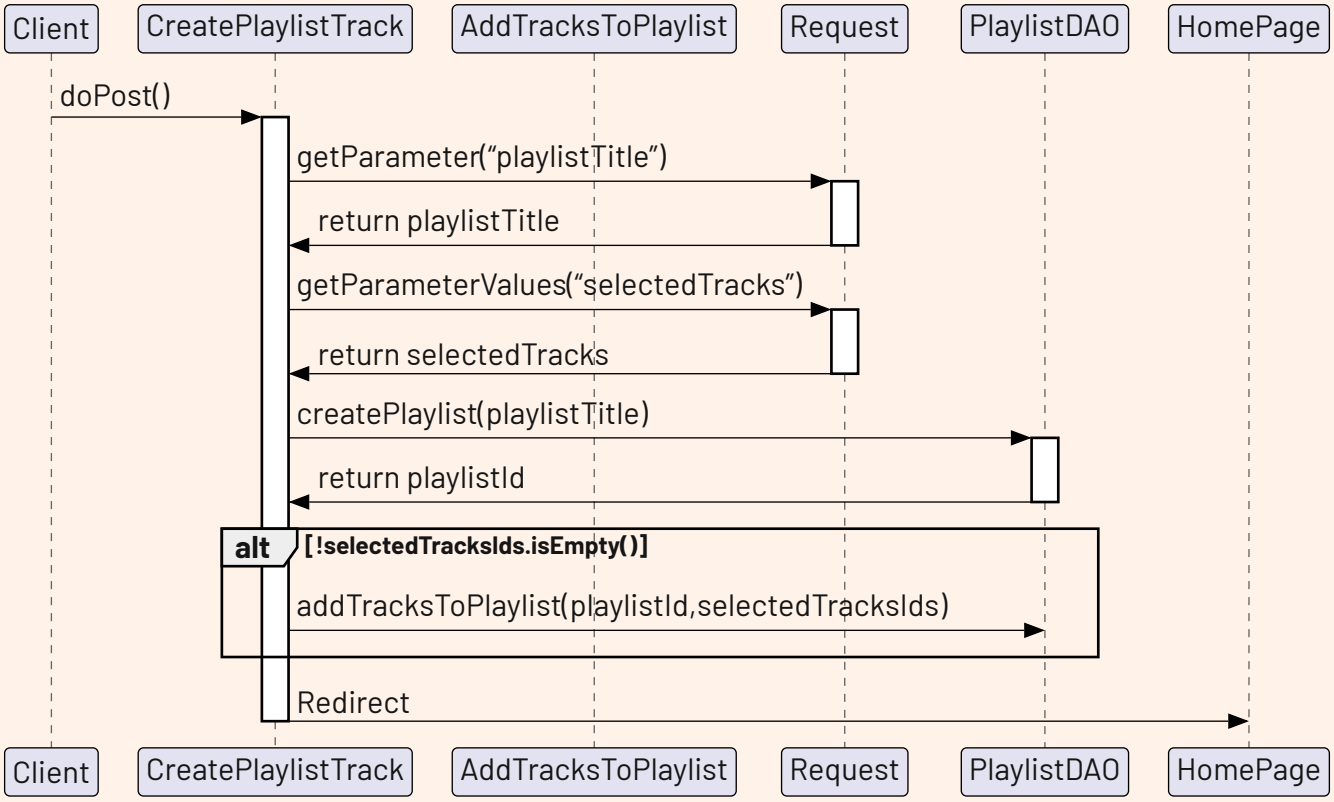
Before writing the file to disk, the method checks for duplicates of the file by calculating its SHA256 hash and querying the database with the two methods: `isTrackFileAlreadyPresent` and `isImageFileAlreadyPresent`; present in TrackDAO.

Those two return the relative file path corresponding to the file hash if a matching one is found, otherwise null. In the former case, `processPart` returns the found path and the new track is uploaded using the already present file, this avoiding creating duplicates; in the latter case `processPart` proceeds by writing the file to disk and returning the new file's path.

To write the file to the correct path in the webapp folder (`realOutputFolder`), the method `context.getRealPath(relativeOutputFolder)` is called, where `relativeOutputFolder` is obtained from the `web.xml` file and is, in our case, `"uploads"`; `realOutputFolder` is obtained by appending, with the needed separators, the MIME type to the result of `getRealPath`; to get `realOutputFilePath`, a random UUID and the file extension are appended to `realOutputFolder`. Having obtained the desired path, the file can be created and then written with the `Files.copy` method. The file can be found in target/artifactId-version/*uploads/ in the project folder.*

In conclusion, `processPart` adds the new file to the newFiles list in `UploadTrack` and returns the path relative to the webapp folder because that's where the application will be looking for when it has to retrieve files. Once this is completed, the new Track object is created and passed to the `addTrack` method of TrackDAO; if an `SQLException` is thrown, all the files in `newFiles` list are deleted and then, in the finally block, the list is cleared.

5.7 CreatePlaylist sequence diagram

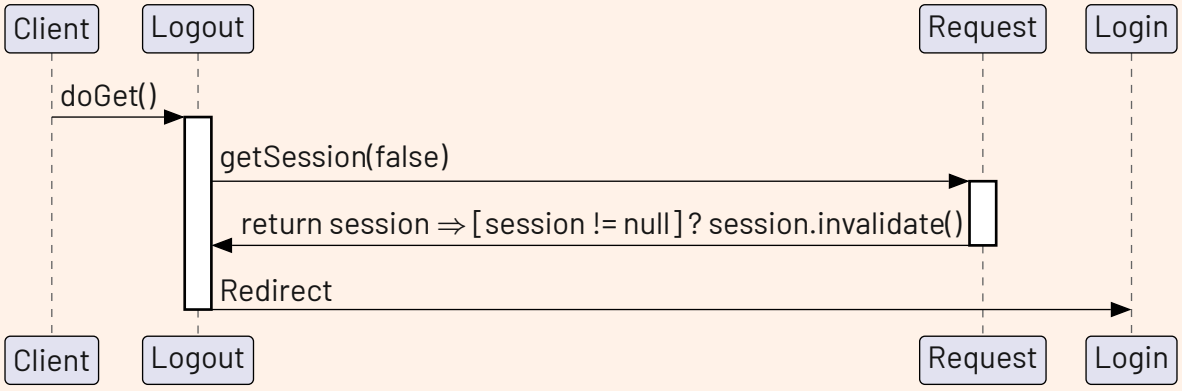


Comment

The user can create playlists with the appropriate form in the homepage. There, a title needs to be inserted and, optionally, one or more tracks can be chosen from the ones uploaded by the user. When the servlet gets the POST request, it interacts with the PlaylistDAO to create the playlist with the createPlaylist method and to add the selected tracks with the addTracksToPlaylist method.

Note that selectedTracksIds is a list of integers obtained by converting the strings inside the array returned by getParameterValues("selectedTracks") with the Integer.parseInt method.

5.8 Logout sequence diagram



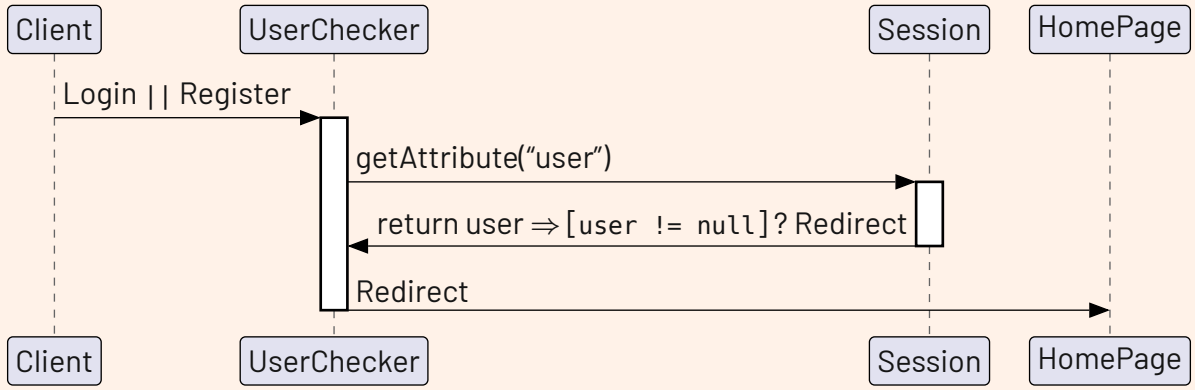
Comment

From every web page except Login and Register, the User is able to logout, at any moment. It's a simple `GET` request to the Logout servlet, which checks if the `user` session attribute exists; if it does, then it invalidates the session and redirects the User to the Login page.

6

Filter mappings

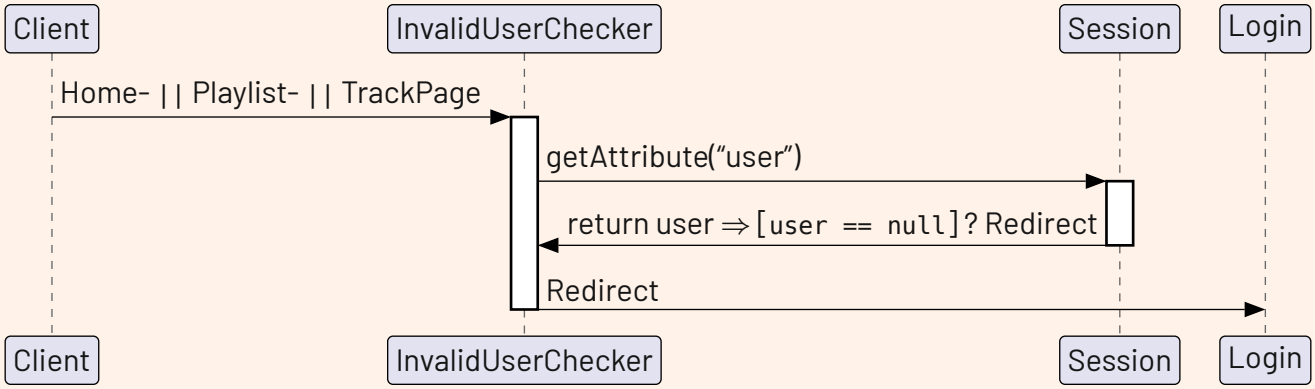
6.1 UserChecker filter



Comment

The `UserChecker` filter checks, once the client accesses the Login or Register webpage, if the User is logged. If that's the case, then the program redirects to the HomePage. If not, then the `InvalidUserChecker` filter comes in.

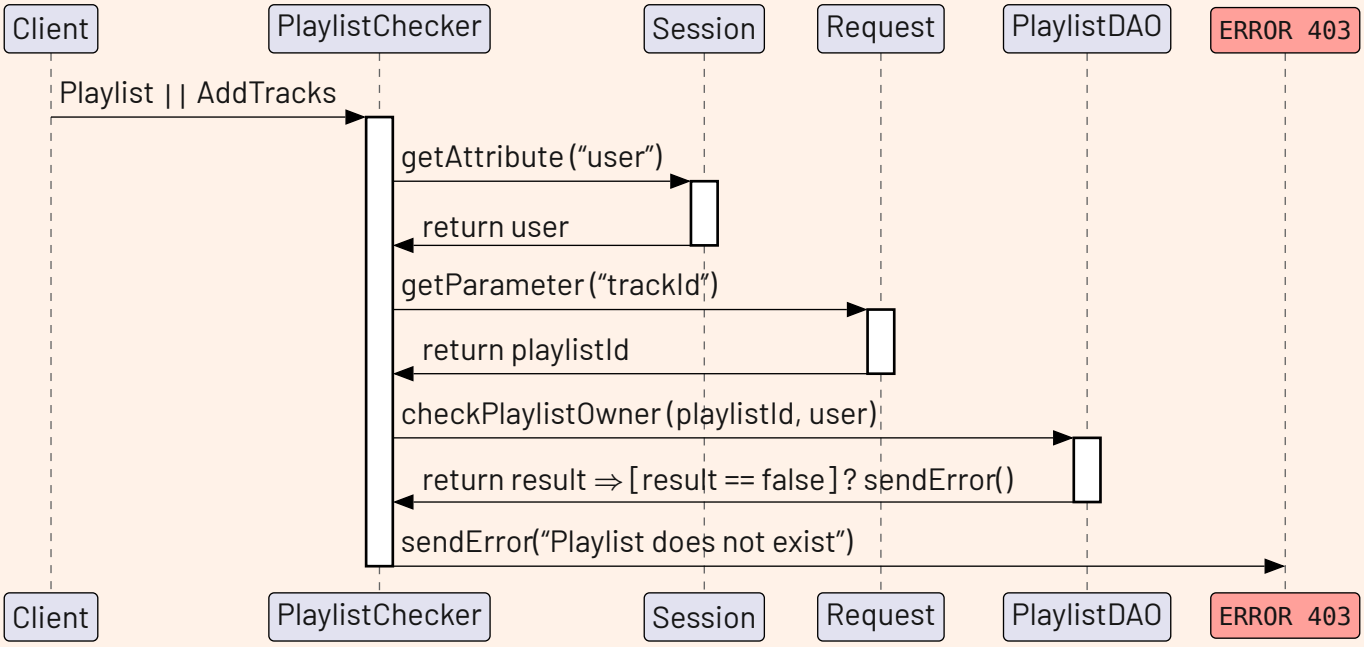
6.2 InvalidUserChecker filter



Comment

The `InvalidUserChecker` filter does the exact opposite of `UserChecker`. If the client accesses pages all the other pages – HomePage, PlaylistPage, TrackPage – and is not logged in, *then the program redirects to the Login page.*

6.3 PlaylistChecker filter



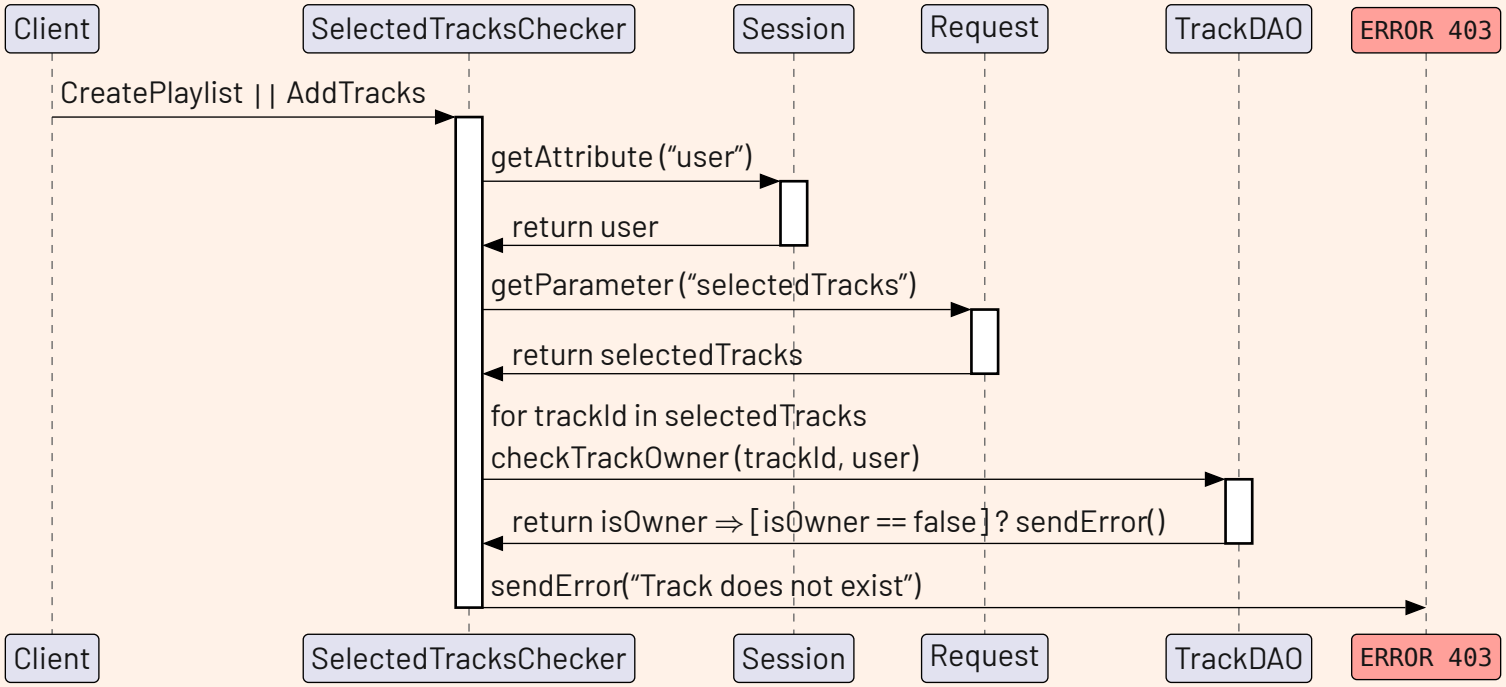
Comment

The `PlaylistChecker` filter is invoked in two scenario: after the User has clicked on a playlist on HomePage (Section 5.4) and when uploading a track (Section 5.6).

It is in charge of checking if the requested playlist actually belongs *to the User requesting or trying to upload it. This is done via obtaining the User attribute from the session – which is impossibile without extending the `HttpServlet` or `HttpFilter` classes – and getting the needed paramaters from the request.*

Finally, a query is performed against the database. If the result is false, then the server will respond with `ERROR 403: forbidden`.

6.4 SelectedTracksChecker filter



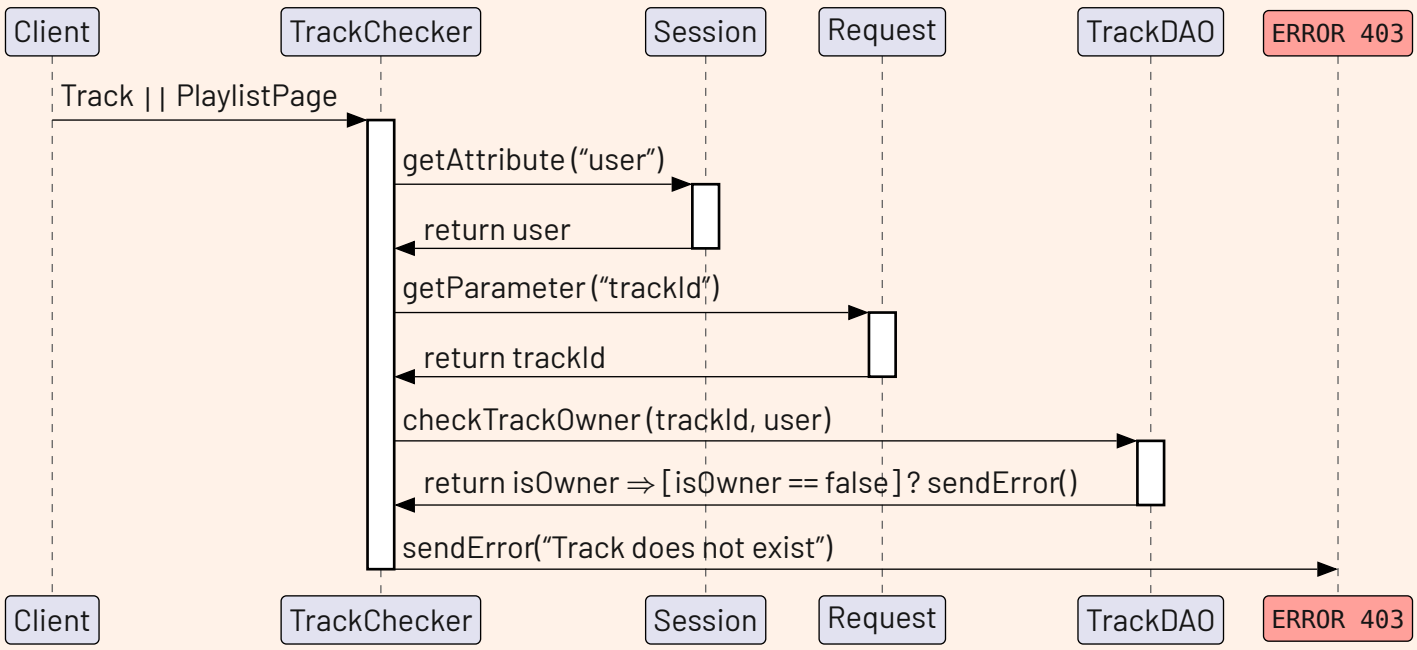
Comment

Even the `SelectedTracksChecker` filter is invoked in two scenarios: during the creation of a playlist (Section 5.7) and during the UploadTrack sequence (Section 5.6).

`SelectedTracksChecker` applies a very similar pipeline `PlaylistChecker`: instead of checking the playlist, it does the same job but for one of more tracks when the User requests to add them to a playlist.

Again similarly to `PlaylistChecker`, tt also obtains the User attribute from the session and the needed parameters; if the User does not have access rights to the requested track(s), the response is `ERROR 403`.

6.5 TrackChecker filter



Comment

Finally the `TrackChecker` filter does the same exact job as `SelectedTracksChcker`, but for a single track once a User presses the corresponding button in the `playlist_page` (see Section 5.5).

7

Cascading Style Sheets (CSS) styling

7.1 Introduction

The project is based on a single CSS file, `components.css`, and all the others rely upon it to retrieve the styles. Furthermore, all the colours are sourced from the `colors.css` file, which is based on *tinted-theming* [12], a collection of commonly used themes in the developing world. We have chosen to use the *Classic Light theme*[4].

If you want to change the overall theme of the website, just switch to a new colorscheme by looking at the tinted-theming gallery. In `colors.css` there are a few commented styles to choose from.

```
body {
    background-color: var(--default-
background);
    padding: 1rem 2rem 2rem 2rem;
    line-height: 1.6;
    word-spacing: 1px;
    font-family: "JetBrains Mono",
monospace;
    height: 100vh;
    text-overflow: ellipsis;
}
```

As stated earlier, the `background-color` is sourced from the `colors.css`. Then the padding is always `2rem`, except above, where it's `1rem`. The text is able to wrap thanks to `ellipsis` option on `text-overflow`.

After the body, we styled all the elements in a consistent manner.

7.2 Buttons

```
.button {
    color: var(--selection-background);
    background-color: var(--default-
foreground);
    border: 2px solid var(--dark-
foreground);
    height: 3rem;
    border-radius: 6px;
    font-weight: bold;
    vertical-align: middle;
    margin: 0.5rem 0 0.5rem 0;
    padding: 1em;
    font-family: "JetBrains Mono",
monospace;
}
```

Every button is derived from the one above. The text is aligned in the center both horizontally and vertically; its weight set to bold. Then there are some margin and padding to help the user see better[5]*.*

A notable exception to the buttons colorscheme is the `logout` button:

```
.logout {
    background-color: var(--variables);
    font-weight: bolder;
    color: var(--lighter-background);
}

.logout:hover {
    background-color: var(--data-types);
}
```

Both the `background-color`, `font-weight` and `color` are different, to further imply that the logout button is different from the others (upload track, create playlist...).

7.3 Containers

The first container the user sees is the Login one, which shares its design with Register and the track player:

```
.center-panel {
    width: 300px;
    background-color: var(--lighter-
background);
```

[4] This very documentation also is sourced from the exact same colourscheme.

[5] There will be later an exception.

```
    border: 1px solid var(--dark-
foreground);
    padding: 3rem;
    text-align: center;
}
```

An important aspect of login and register is their horizontal bar:

```
hr {
  display: block;
  height: 1px;
  border: 0;
  border-top: 1px solid var(--light-
background);
  margin: 1em 0;
  padding: 0;
}
```

which is not used in the track player.

A basic function of a Playlist Manager is being able to display all the playlists and tracks of a given user. To achieve that, we opted for a classic layout composed of a top and bottom navigation bars and a main, central section.

```
.nav-bar {
    width: 100%;
    margin: 0;
    display: flex;
    flex-wrap: wrap;
    align-content: space-around;
    justify-content: center;
    align-items: center;
    gap: 1rem;
}
```

The navigation bar is the same both above and below. It's a flex container because it's important to have a flexible container for the main-title (e.g. "All Playlists") and the buttons (with a variable number between screens).

The layout is computed as follows:

title	*spacer*	*button*	*button*	*logout*

so we created the `spacer` element:

```
.spacer {
    flex-grow: 1;
}
```

which takes all the space available.

Next, the tracks and playlists containers.

```
.items-container {
    width: 100%;
    display: grid;
    grid-template-columns: 1fr 1fr 1fr
1fr 1fr;
    align-content: baseline;
    justify-content: center;
    gap: 1rem;
    padding: 1rem 0 1rem 0;
}

.single-item {
    display: flex;
    flex-wrap: nowrap;
    background-color: var(--light-
background);
    border: 2px solid var(--data-types);
    border-radius: 5px;
    color: var(--lighter-background);
    padding: 1rem;
    height: 150px;
    font-family: "JetBrains Mono",
monospace;
    font-weight: 700;
    text-align: left;
    align-content: end;
    align-items: end;
    justify-content: space-between;
}

.single-item:hover {
    background-color: var(--variables);
    cursor: pointer;
}
```

According to project the specifications (Section 2), there must be at most 5 tracks per page*: we opted for a CSS grid. This works well along with the `body` previously set because the grid can expand and shrink its items accordingly.*

As per the navigation bar, the single items are themselves flexible boxes. The difference lies in the fact they are not allowed to wrap – one might ask: why not, since the tracks must list

> *both track title and album title? because we handle that line break manually with the
 tag.*

Last but not least, the errors.

```
.error{
    color: var(--variables);
    padding-top: 0.5rem;
    width: 100%;
    display: flex;
    flex-wrap: wrap;
    align-content: space-around;
    justify-content: center;
    align-items: center;
}
```

> *When the User tries to do something forbidden – adding duplicate tracks, creating a duplicate playlist... – an error will appear. It's exclusively used in the modal and due to how it's spaced it requires the `flex` display.*
>
> *The simpler implementation is `sql-error`:*

```
.sql-error {
    color: var(--variables)
}
```

> *which is used during registration.*

7.4 Modal

Finally, undoubtedly the most difficult CSS component in this project to comprehend is the modal, which is a dialog window created entirely with CSS.

A complex element, it can be broken in multiple parts:

- The window

```
.modal-window {
    position: fixed;
    background-color: rgba(255, 255, 255,
0.25);
    top: 0;
    right: 0;
    bottom: 0;
    left: 0;
    z-index: 999;
    visibility: hidden;
    pointer-events: none;
    transition: all 0.5s;
}
```

it's `hidden` by default, but once it's invoked it must be be above everything – this is handled by the `z-index` property. Its position must be `fixed`, since it's not a movable window; also it can't be targeted by cursor: `pointer-events` are none. Another key aspect is the background color: in order to make it stand from its background, a slight blurred white is needed:

- The target, when the user presses a button that launches the modal (e.g. Upload Track)

```
.modal-window:target {
    visibility: visible;
    opacity: 1;
    pointer-events: auto;
}

.modal-window > div {
    width: 400px;
    position: absolute;
    top: 50%;
    left: 50%;
    transform: translate(-50%, -50%);
    padding: 1em;
    background: var(--lighter-background);
    border: 2px solid var(--variables);
}
```

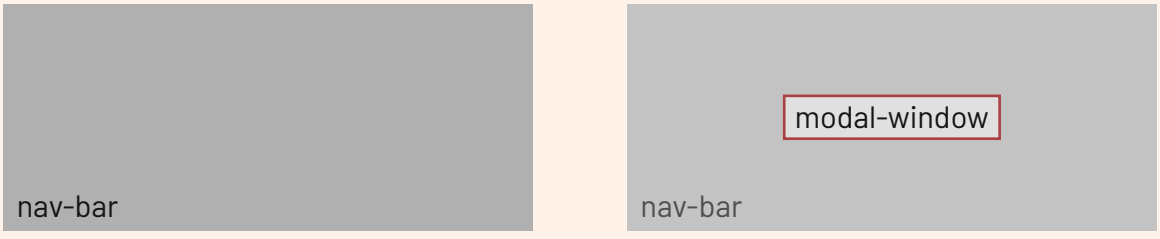


Figure 17: Modal representation.

once the modal has been invoked, its visibility must be switched to `visible` and `opacity` to 1. The child element `div` of the window must at the center of screen, both horizontally and vertically: this is managed with the `top`, `left` and `translate` properties.

- The close button

```
.modal-close {
    color: var(--lighter-background);
    background-color: var(--variables);
    border-radius: 5px;
    position: absolute;
    top: 2%;
    right: 2%;
    cursor: pointer;
    padding: 0.2rem;
    font-size: 0.8rem;
    font-weight: bold;
    text-align: center;
    text-decoration: none;
}

.modal-close:hover {
    color: black;
}
```

as stated previously, the `modal-close` button is an exception to the `button` rule. It's considerably smaller than the others, the cursor is immediately `pointer`. Its position is computed on the `modal-window`, from above right.

- The dropdown menus

```
select:invalid {
    color: #505050;
}
```

this pseudoclass causes the color in the placeholder in dropdown menus (Year, Genres) to be gray, as a a regular placeholder should be[6]

[6] Otherwise it would have been black as the text, which is not aesthetically pleasant.

8

RIA-specific features

Since the RIA project has been built upon the HTML+thymeleaf one, we opted to describe only *what has been changed or tweaked* starting from there instead of going through all the single components another time.

In brief, the main changes are as follows:

- Thymeleaf has been completely removed, since everything it did can be done via Javascript
- All the project now runs in a single webapp after the user has logged in[7]
- To account for the new User Experience, we developed the sidebar to host the various buttons (which works similarly to a bottom navigation bar on a smartphone application)
- To support the drag and drop feature, some modification were made to Java classes

Also, instead of Javascript we opted for **Typescript**. This was done mainly for two reasons: the retrocompability with Javascript (since Typescript transpiles in JS) and the static typing system, which can be quite bothersome in some cases, but saves a lot of time overall.

8.1 Sidebar

8.2 Modals

8.3 Updates to Java classes

[7] This effectively means that before the homepage, the playlist and the player were *all* separate webpages; now, they are all-in-one – hence why *Rich* Internet Application.

A

Cut content

During the development, we had many ideas and thought about ways to implement them – however, due to time and work restrictions, some features didn't make it to the final release. They can be categorized in features and optimizations.

A.1 Features

In regards to the features, we wanted to implement **Next/Previous** buttons for the Playlists too, to make the application behave in a more coherent way: according to the submission, only the tracks in the playlist must implement it. Following this cohesion, the same can be said about the **Delete** functionalities: initially, along with the creation of a track/playlist we wanted to add a delete option – if you add something, you might want to remove it at a later date.

JS For the JavaScript project – which is not correct to call like that, since we used TypeScript – there were plans to implement a localization function, similar to how the HTML project works. It would have been a parser for the `.properties` files already created: they would have been recycled. The most ambituos idea was, however, to deploy the JavaScript project to Github pages. This is not possible with thymeleaf since it needs a server running at all times, but with JavaScript running the in client... it was perfect. To access the database, I planned to use SQL.js [13] and SQLite [14].

CSS frameworks We all know CSS is awesome and very powerful, however, as is the case with many technologies, its usage in a raw form is often negleted: as no one dares to write in plain TeX because LaTeX exists, software like Hibernate abstract the SQL from the developer, the same applies to CSS. In the wild there are many frameworks – Tailwind-CSS, Sass just to name a few. We wanted to have our fair share and use Bulma [15]; in the end, we wrote everything ourselves.

A.2 Optimizations

The OG database The first database implementation was created with a different logic than the one we ended up with. I, thought that the tracks were a common pool, such as all the tracks of a streaming service, and then each user could select some among them. In this way, if a user wanted to upload a track and it was already been uploaded by someone else, the server would have just linked that track to the current user – this was to optimize track storage and forbid permit duplicates.

To support such a logic, there used to exist a `track`and a `user_tracks` tables. This allowed us to perform some other optimization: we had thought about of creating a trigger in the database: it would have deleted a track from the corresponding table if that track wasn't associated with at least a user (in the ER diagram it was a weak entity, that is it existed only as long as there was a link).

The issue was quite simple... the submission didn't specify this; instead, every user has their tracks. They can be the same exact files of another user – pretty much like how a cloud service works. And that's how the project works. Still, we couldn't just let the user upload track at will without some checks. And that trigger became the checksum pipeline.

Missing hashing One could argue: "You went above and beyond to ensure the user doesn't upload the same exact file multiple times, yet you don't even hash the passwords". And you would be right. We wanted to do that by leveraging the power of Password4J [16], but once again the specification didn't ask for it and so... we had other features to work on.

Connection pooling Another important optimization technique is connection pooling: to put it simply, instead of opening every time a new connection to the database – which is the most expensive operation database-wise – there is a pool of reusable

connections, that are always open. This way, the database is accessed once and then the query are performed by the same connections. The library of choice was HikariCP [17].

ORM The proper (or *elegant*) way interact with the database isn't by directly writing raw SQL code but by using APIs written for this very reason. There are many examples in web techologies – such as jQuery – though for the Java programming language, pioneer of the Object-Oriented Programming paradigma, there is a more potent concept: Object Relational Mapping (ORM). As the name suggests, a relational object is mapped to a Java object. By using Hibernate [18] a table could have mapped 1:1 to a class and its attributes: every query – select, insert, delete... – can be performed through it with commits, transactions and so on.

Probably the saddest turn back was not being able to use the Spring Boot framework [19], which is commonly used. It's a framework to create production-level applications: as such, it surely is useful to know, whatever the case. Also, during research of how thymeleaf operates, it was basically always paired with Spring Boot.

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