



PISA UNIVERSITY

TASK 2
LARGE-SCALE AND MULTI-STRUCTURED DATABASES

"PISAFlix 2.0" PROJECT DOCUMENTATION

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DESIGN DOCUMENT

DESCRIPTION

Have you ever found yourself in a gloomy day? Everyone is at home, no one knows what to do and time seems to slow down. That's the perfect time for a movie!

PisaFlix is a platform in which users can find quality and updated information regarding **movies**. It provides a service to help you to choose what film to watch. *PisaFlix* has a **comment** section that gives at the users the possibility to create a community around their favourite movies, exchanging opinions and news regarding them. It is also possible to add films to a **favourite** list in order to find them quicker. The possibility to see other users favourites it is essential to find new friends with the same cinematic tastes. Lastly it is possible to view interesting **statistics** on films, useful both for normal users and for other people involved in the production of films.

PisaFlix offers services that will change the way users approach the world of the movie, providing them everything they need to enjoy at best their passions.

REQUIREMENTS

MAIN ACTORS

The application will interact only with the **users**, distinguished by their privilege level:

- **Normal User:** a normal user of the application with the possibility of *basic inaction*.
- **Social Moderator:** a trusted user with the possibility to *moderate* the comments.
- **Moderator:** a verified user with the possibility to add and *modify* elements in the application, like films and cinemas.
- **Admin:** an *administrator* of the application, with possibility of a *complete interaction*.

FUNCTIONAL

1. *Users* can **view** the list of **Movies** available on the platform.
2. *Users* can **view** the information about a specific *Movie*.
3. *Users* can **view** the **statistics** of a *Cinema* or *Film* page.
4. *Users* can **view** a set of **analytics** on Movie and another user.
5. *Users* can **register** an account on the platform.
6. *Users* can **log in** as *Normal users* on the platform in order to do some specific operations:
 - a. If logged a *Normal user* can **add/remove** to **favourite** a *Movie*.
 - b. If logged a *Normal user* can **comment** a *Movie*.
 - c. If logged a *Normal user* can **modify** his *Movie Comments*.
 - d. A *Normal user* can **modify/delete** his account.
7. *Users* that can **log in** as *Social moderator* can do all operation of a *Normal user* plus:
 - a. If logged as *Social moderator* can **delete** other users' comments.
 - b. If logged as *Social moderator* can **recruit** others *Social moderators*.
8. *Users* that can **log in** as *Moderator* can do all operation of a *Social moderator* plus:
 - a. If logged a *Moderator* can **add/delete/modify** a *Movie/Projection*.
 - b. If logged as *Moderator* can **recruit** other *Moderators*

9. Users that can **log in** as *Admins* can do all operation of a *Moderator* plus:
 - a. If logged an *Admin* can **delete** another user's account.
 - b. If logged as *Admin* can **recruit** other *Admins*.

NON-FUNCTIONAL

1. The application's focus is the *quality* of the information provided to users.
2. The application needs to be **consistent**, in order to provide correct information to all the users.
3. The application needs to be **tolerant to partitions**, in order to scale the system if needed, preserving the consistency.
4. The application needs to store **replicas** of the data in case of server fault, all the replicas need to be **consistent**.
5. The transactions must be **monotonic**: every user must see the last version of the data and modifications are done in the same order that are committed.
6. The application needs to be *usable* and *enjoyable* for the user, therefore the system needs **limited response times**.
7. The *password* must be protected and stored *encrypted* for privacy issues.

ANALYTICS

In *PisaFlix* there are three main types of **analytics**:

- **Average Rating:** Chosen a *temporal interval*, the application shows the mean value of movie **rating** grouped by genre, director or actor.
- **Ranking:** Chosen a *temporal interval*, the application shows either a table with the most **involved user** or the most **engaged film** of the platform.

This is done by calculating a weighted sum: $I = (3 \cdot c) + (2 \cdot f) + (1 \cdot v)$.

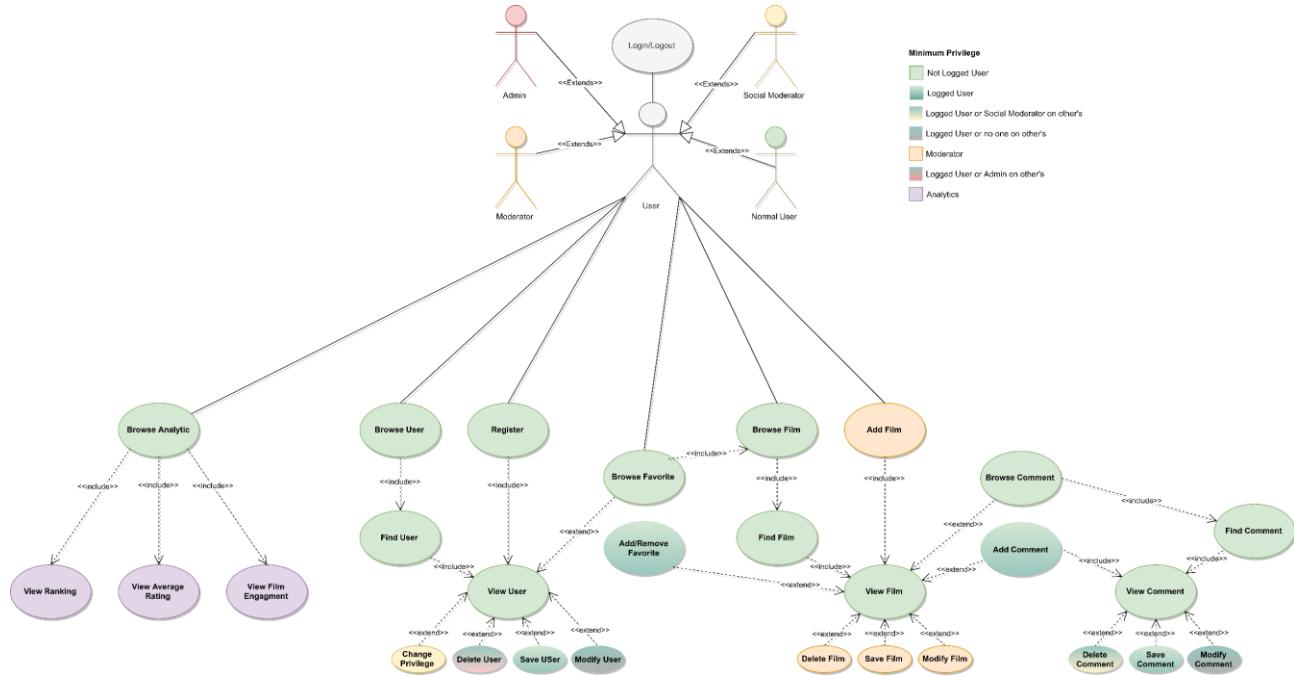
- If we are considering **user** activities: c stands for the number of *comments* that the user has done, f for the number of his *favourites*, and v for the number of film page *viewed* by the user.
- If, instead, we are considering **film** engages: c stands for the number of *comments* received by the film, f for the number of *favourites*, and v for the number of *visits* on the film page.

The above value is calculated for all films/users and it is used to **rank** them.

- **Film Engagement:** Chosen a *film* and two years (one for the *beginning* and one for the *end* of a period), the application shows the **engagement** of the chosen film *by year*, in the interval of time specified before. Moreover, the application will show also the **composition** of the engagement for a chosen year.

This is the formula for the engagement of a film $E = (3 \cdot c) + (2 \cdot f) + (1 \cdot v)$. It is a weighted sum where E is the *total engagement*, f is the *number of favourites* received by the film, c is the *number of comments* on that film, and v is the number of times that the page of the film has been *visited*.

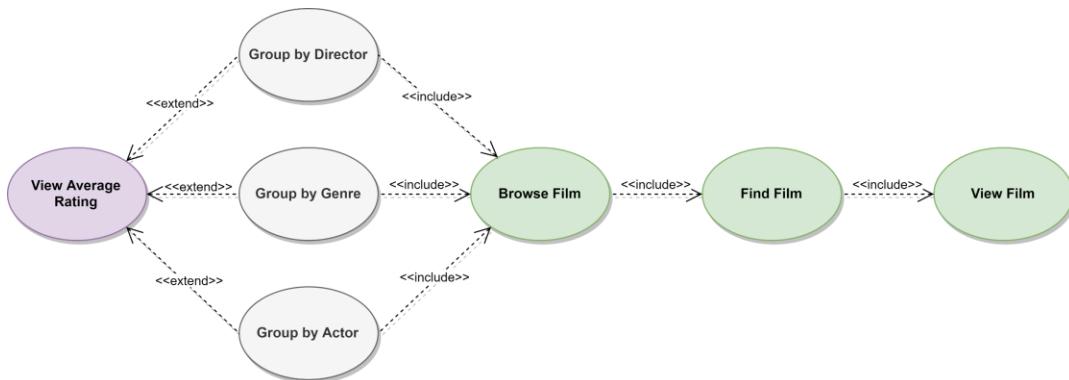
USE CASES



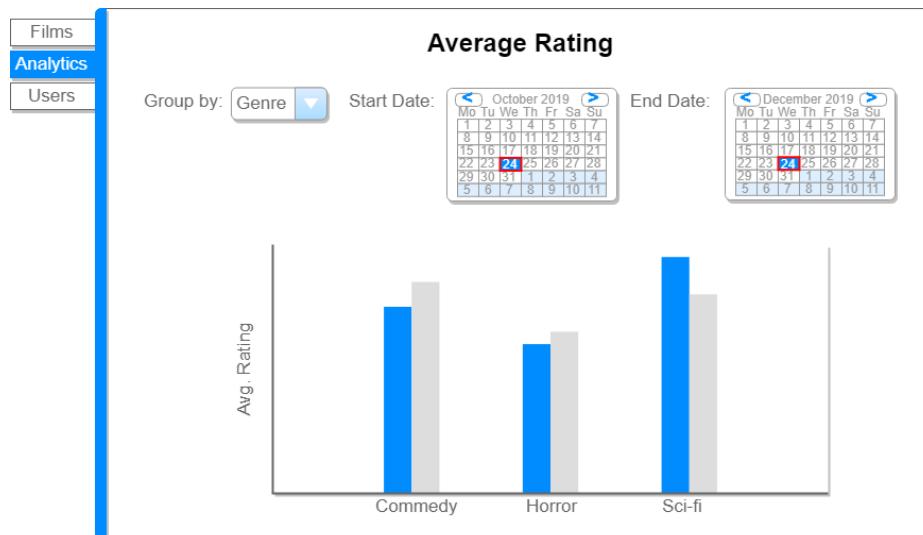
ANALYTICS USE CASES AND MOCKUPS

The use cases of the analytical functions are shown below.

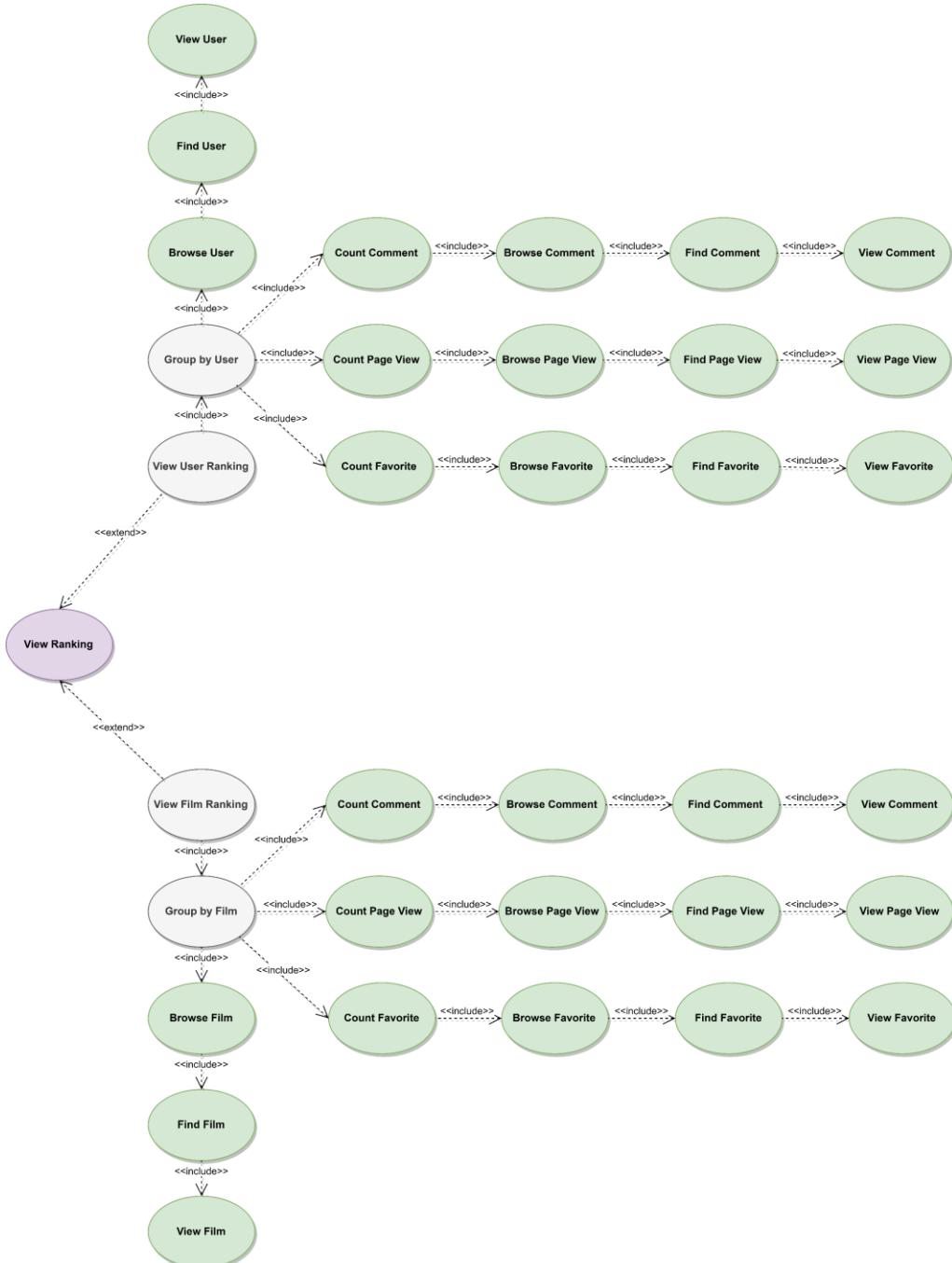
VIEW AVERAGE RATING



MOCKUP



VIEW RANKING



MOCKUP

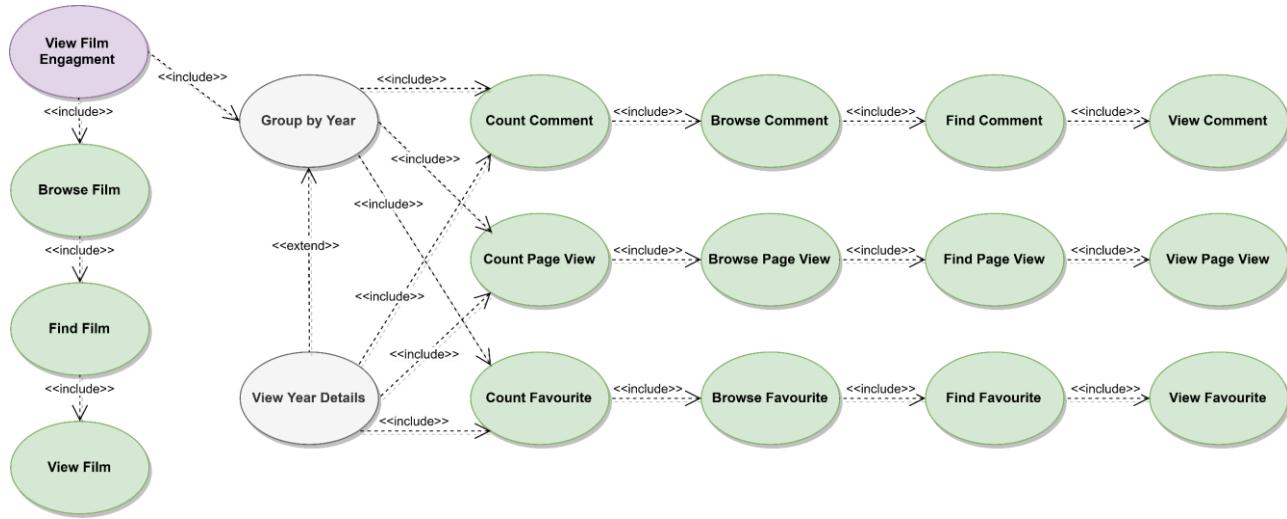
The mockup shows a web-based application interface for ranking films. The top navigation bar includes links for **Films**, **Analytics** (which is currently selected), and **Users**. The main content area is titled **Ranking** and features the following controls:

- Rank by:** A dropdown menu set to **Films**.
- Start Date:** A date picker showing October 2019, with a calendar grid below it.
- End Date:** A date picker showing December 2019, with a calendar grid below it.

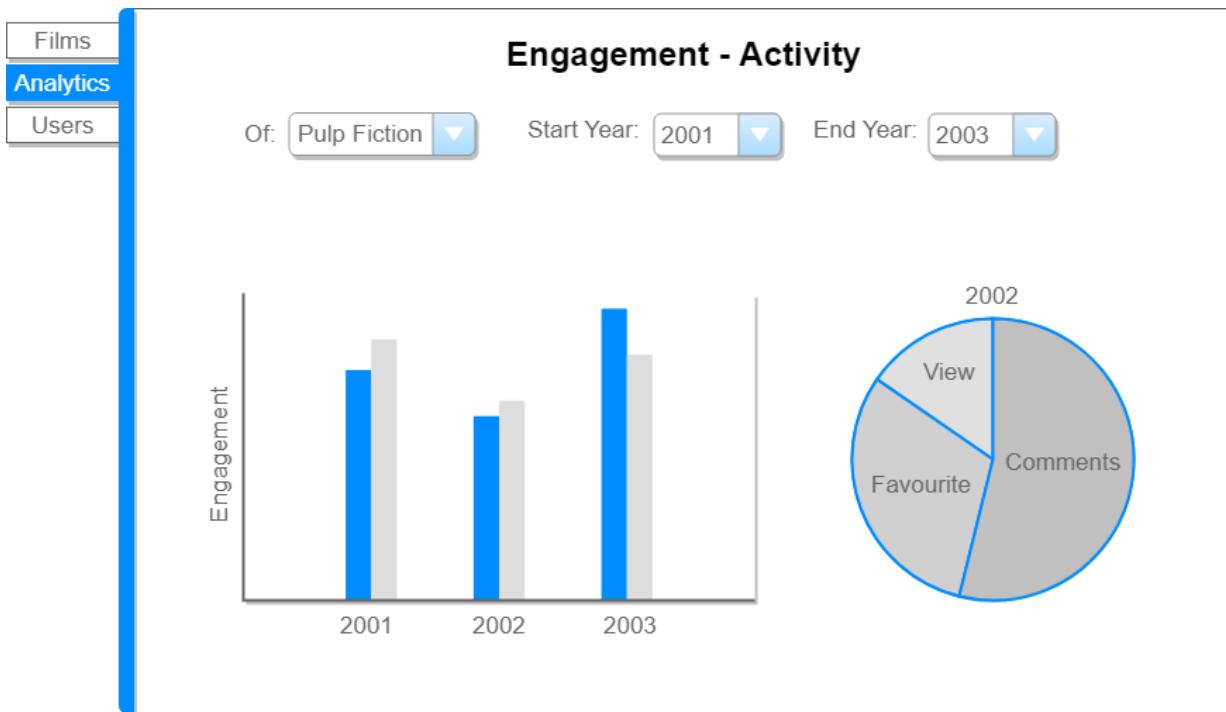
Below these controls is a table displaying the film ranking results:

Rank	Film	Score
1 st	2001: A Space Odyssey	12327
2 nd	Pulp Fiction	7000
3 rd	Albakira	3789
4 th	Joker	2019
5 th	A Pigeon Sat on a Branch Reflecting on Existence	1999
6 th	A Clockwork Orange	1070
7 th	The Great Beauty	897

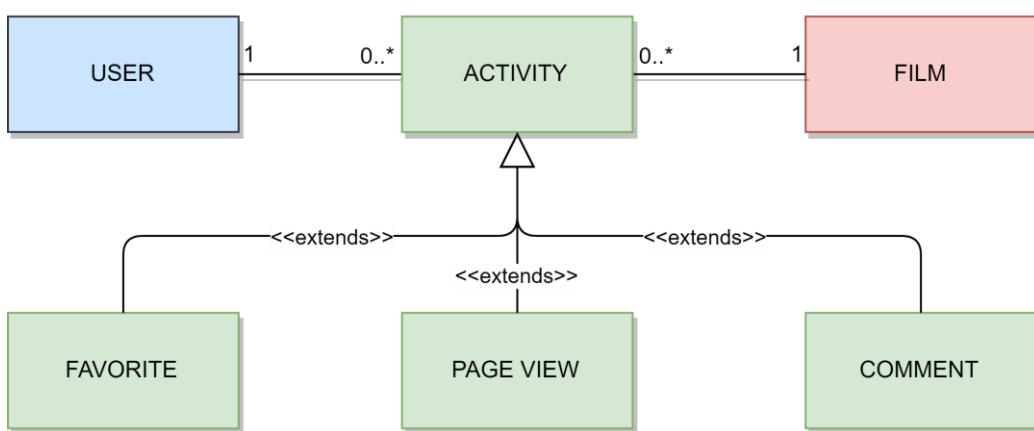
VIEW ENGAGEMENT ACTIVITY



MOCKUP

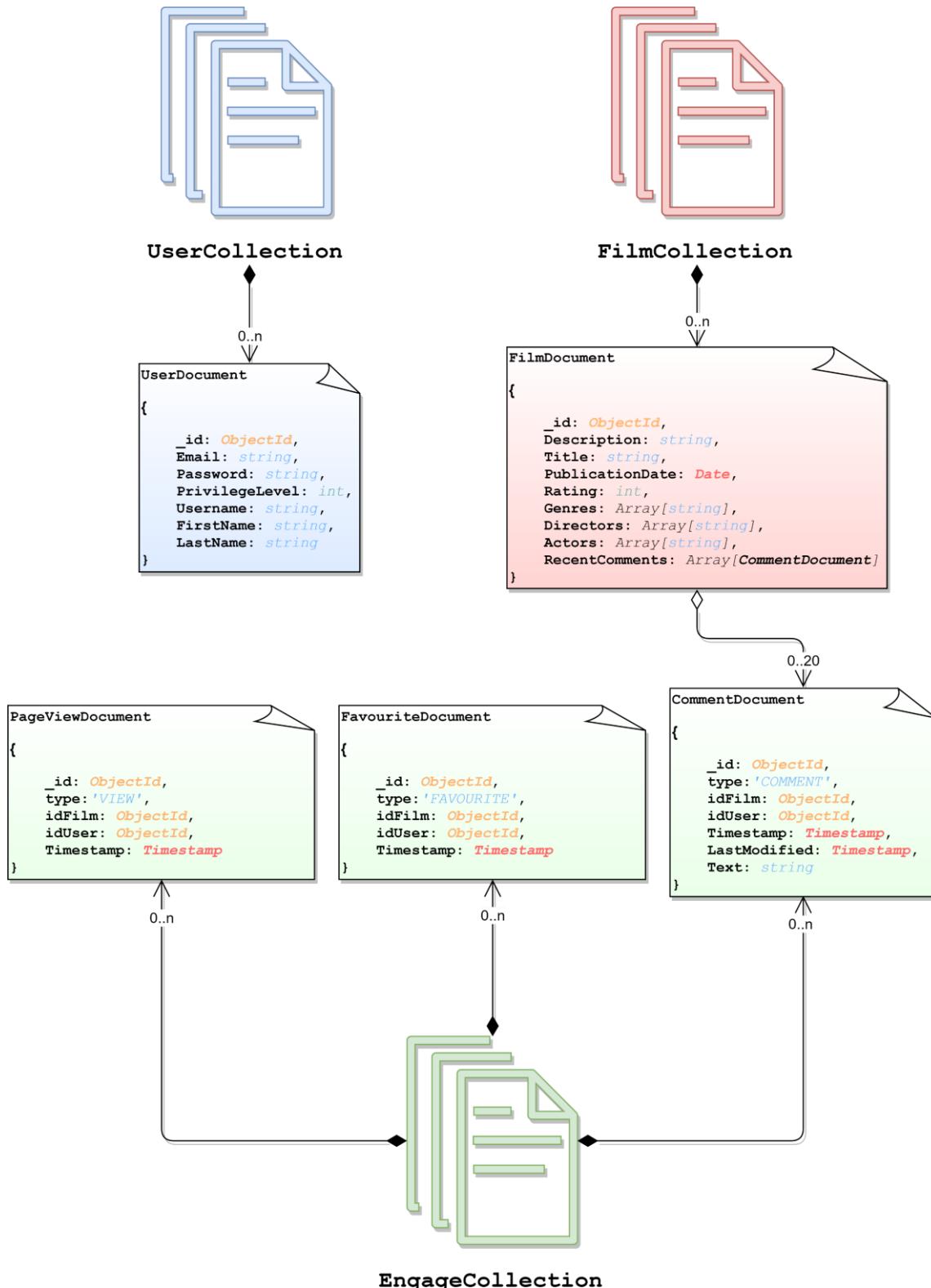


ANALYSIS CLASSES



DATA MODEL

Below is shown the schema of the documents and collections of the database:



The **favorite**, **view** and **comment** documents have been included in the same collection as they represent a relationship between a user and a film, with a timestamp of the time when it took place, only comments can also contain additional fields.

To improve performance in viewing movie pages, the twenty most **recent comments** are embedded within movie documents, so it's possible to retrieve them in one step.

The **favorites**, unlike the recent comments for the films, are generally limited in number for users and must always be shown together, as they have the purpose of shortcuts towards the favourite films. They have not been included embedded in the documents of the users also because all queries involving finding out how many times movies have been preferred in a time frame would always scroll through all users.

ARCHITECTURE

Users can use a java application with a **GUI** to take advantage of all the functionalities of the platform.

The client Application it's made in *Java* using **JavaFX framework** for the *front-end* and the **MongoDB driver** to manage *back-end* functionalities. **Services** and **JavaBean objects** compose the *middleware* infrastructure that connect *front-end* and *back-end*.

INTERFACE DESIGN PATTERN

The graphic user interface was build following the software design pattern of **Model-View-Controller**.

MODEL

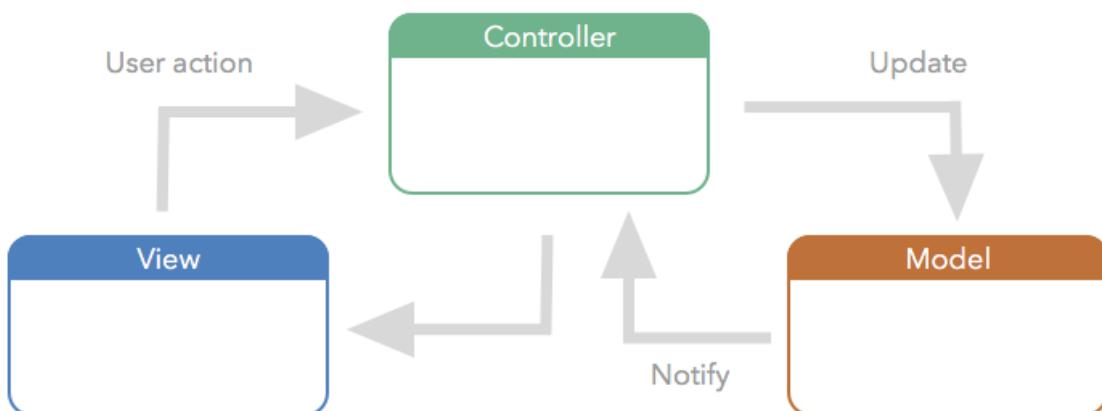
Services module represent the *model* and is the central component of the pattern. It is the application's dynamic data structure, independent of the user interface. It directly manages logic and rules of the application receiving inputs from the controller. The model is also responsible for managing the application's data in form of JavaBean objects, exchanging them with the controller.

VIEW

The **FXML files** represents the *view* and are responsible for all the components visible in the user's interface.

CONTROLLER

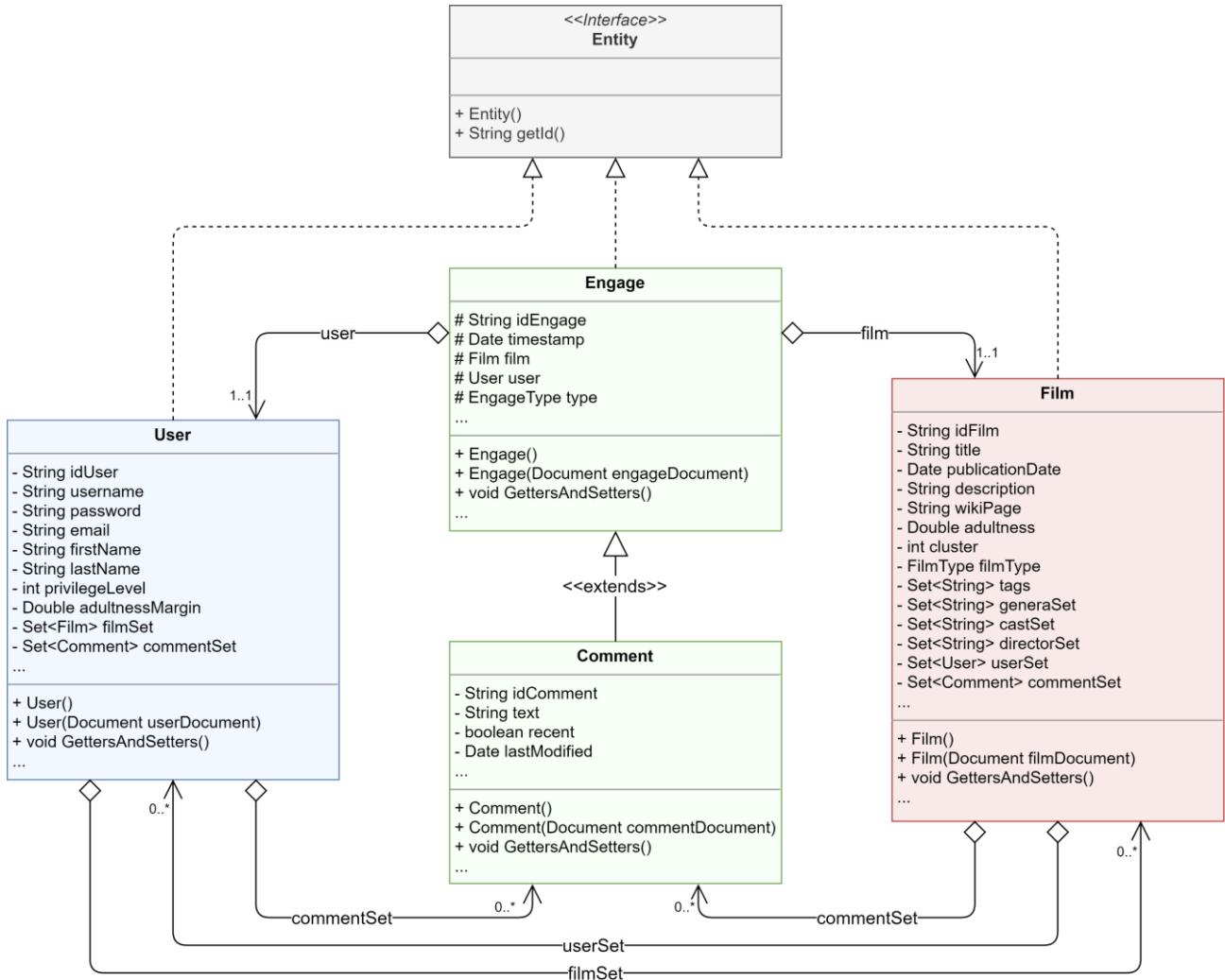
The **page controllers** are the *controller* of the application. They receive inputs from the *view* and converts them into commands for the *model* or *view* itself. Controllers can also validate inputs and data without the intervention of the *model*. Data is exchanged between *model* and *controller* using JavaBean objects.



SOFTWARE CLASSES

ENTITIES

Diagram of the classes:



ENTITY

Represent the interface of each entity.

USER

This entity class represents any **user**, in addition to the **personal information** necessary for their display on the application, the user's **privilege level** is present to allow him to perform only the actions allowed by it.

The getters and the class constructor are the only functions present; the various fields can be instantiated using directly a document with the various information.

COMMENT

This entity class represents any **comment**, extends **Engage** allowing to save additional information present only in comments.

The getters and the class constructor are the only functions present; the various fields can be instantiated using directly a document with the various information.

ENGAGE

This entity class fully represents **page-views** and **favourites**, is extended by the ***Comment*** class to inherit its common fields.

The getters and the class constructor are the only functions present; the various fields can be instantiated using directly a document with the various information.

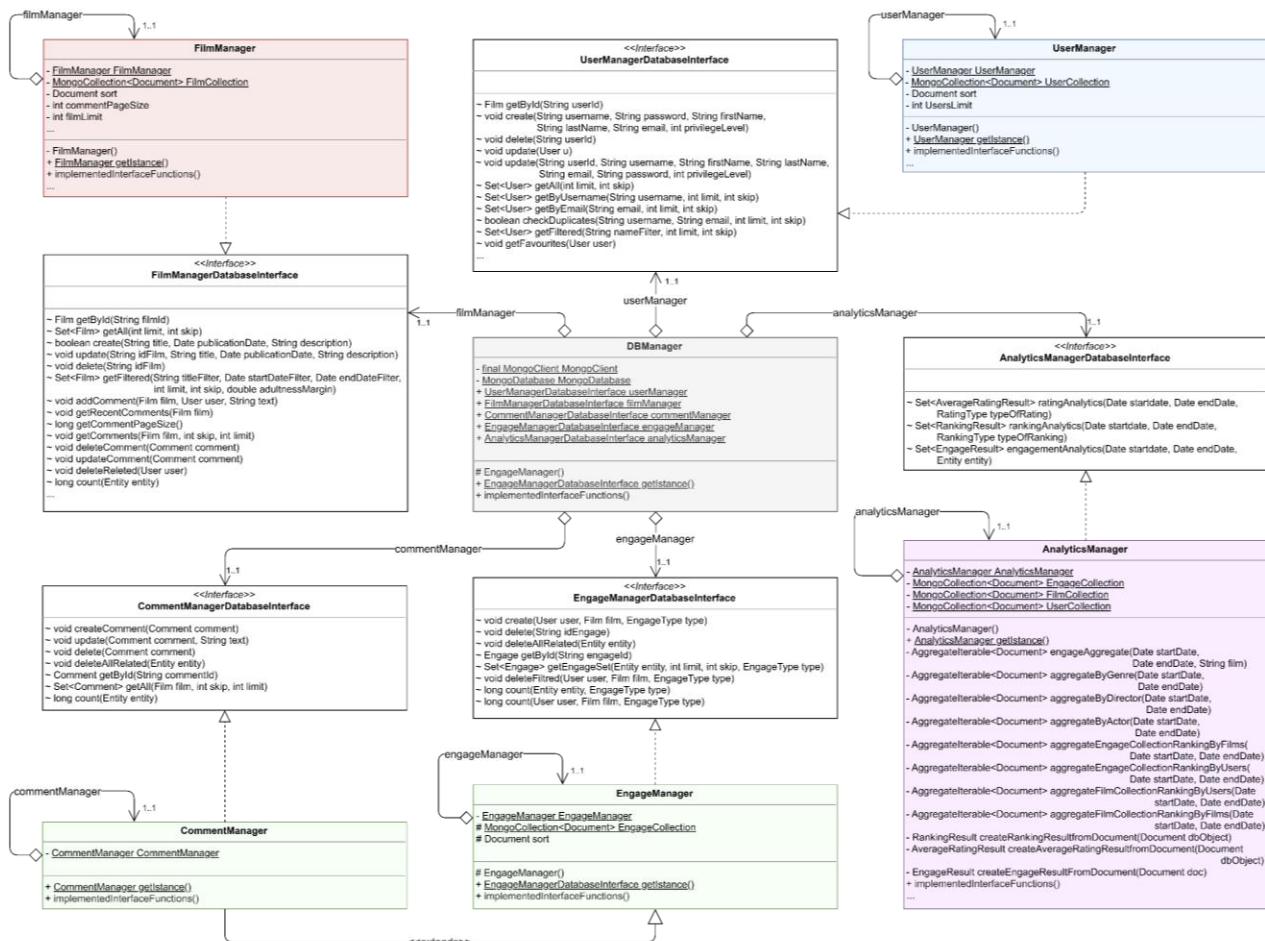
FILM

This entity class represents any **film** and its information.

The getters and the class constructor are the only functions present; the various fields can be instantiated using directly a document with the various information.

DB-MANAGER

The structure of DBManager:



All the managers are implemented following the software design pattern of ***singleton pattern*** which restricts the instantiation of a manager to *one* instance.

The main classes and functions are described below:

```
Singleton  
- singleton : Singleton  
- Singleton()  
+ getInstance() : Singleton
```

- **DBManager** is an utility class, it's a static class that contains all the other manager specific to certain operations, the other managers are accessible through the public members of the class, it automatically *initialize* all the managers on first call and the method *DBManager.Stop()* must be called at the end of the application in order to close the connection with *MongoDB* servers.
- **UserManagerDatabaseInterface** it's the interface which defines the basic operation that any user manager should have (independent from the technology)
- **UserManager** implements *UserManagerDatabaseInterface* and is in charge of manage all *CRUD* operation with the database for the users.

The function gets an extra two parameter, that are two integers: limit and skip. These two integers are used to get a pagination, retrieving always “limit” document, and then skipping “skip” document for the next page.

All functions are self-explanatory by the name except for:

- **getFiltered(String usernameFilter, int limit, int skip)** which search and returns all users who have “usernameFilter” in the username, if *usernameFilter* is not set the filter it's not taken into consideration and returns all users. Limit and skip are used for the purpose described before.
- **FilmManagerDatabaseInterface** it's the interface which defines the basic operation that any film manager should have (independent from the technology)
- **FilmManager** implements *FilmManagerDatabaseInterface* and is in charge of manage all *CRUD* operation with the database for the movies.

Some functions take two additional parameters, limit and skip, for the same reason of *UserManager*.

All functions are self-explanatory by the name except for:

- **getFiltered(String titleFilter, Date startDateFilter, Date endDateFilter, int limit, int skip)** which search and returns all movies which have “titleFilter” in the title and the publicationDate it's between “startDateFilter” and “endDateFilter”, if some filter is not set the filter it's not taken into consideration, if all filter are not set it returns all movies.
- **EngageManagerDatabaseInterface** it's the interface which defines the basic operation that any engage manager should have (independent from the technology)
- **EngageManager** implements *EngageManagerDatabaseInterface* and is in charge of manage all *CRUD operation* with the database for the engages, that are all possible operations for *favourites* and *views*, but the *CommentManager* extends it to add more.

Below are the descriptions of the main functions:

- **create(User user, Film film, EngageType type)** which create an engage, that can be of type, View or Favourite (Engages can have a third type that is Comment, but that case is managed by the *CommentManager*)
- **deleteAllRelated(Entity entity)** which delete all the engages, related to an entity e.g. delete all the views, favourites and comments, done by a User. In this case the function managed too the comments.
- **CommentManagerDatabaseInterface** it's the interface which defines the basic operation that any comment manager should have (independent from the technology)

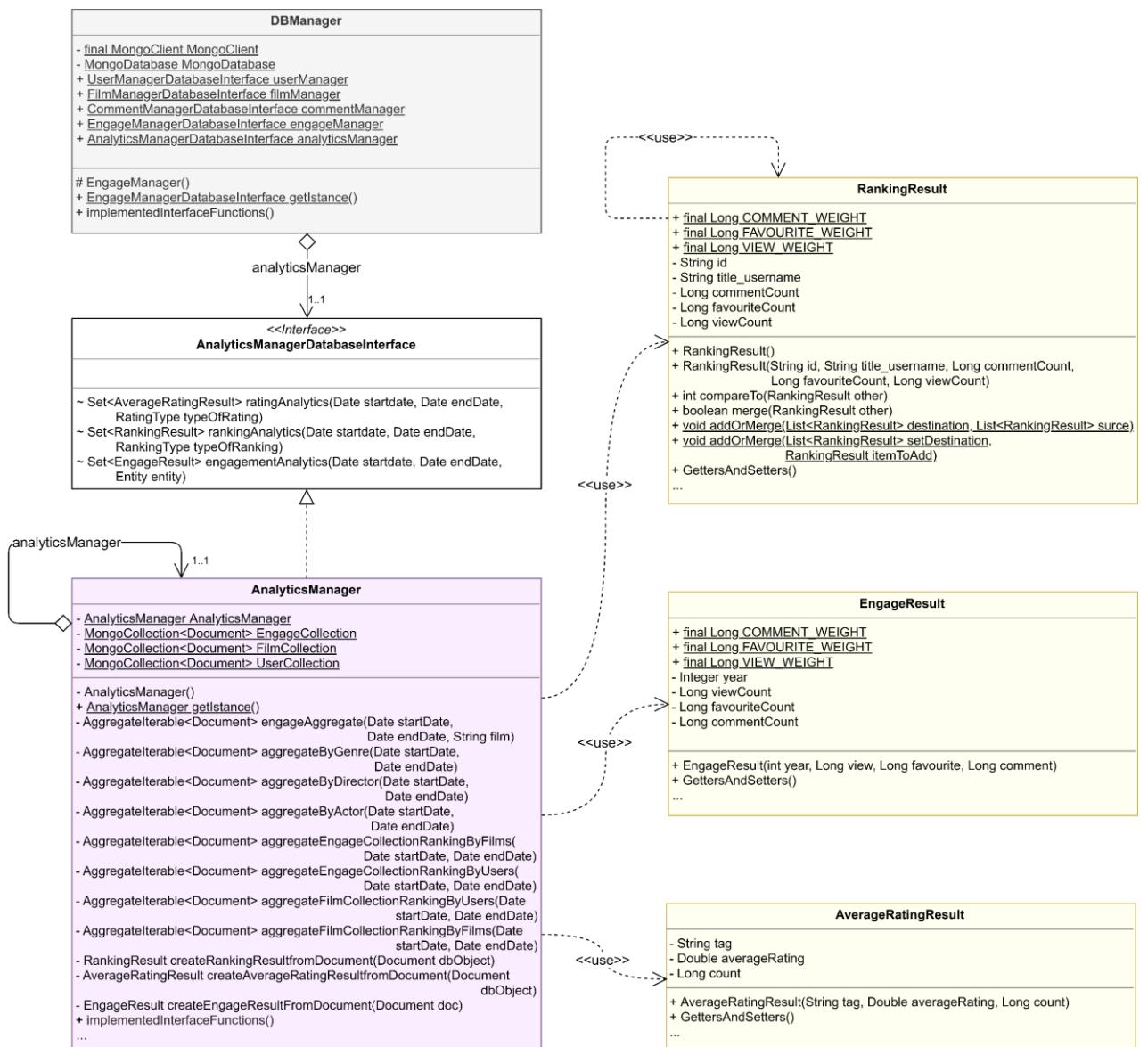
- **CommentManager** implements *CommentManagerDatabaseInterface* and extends *EngageManager* and is in charge of manage all *CRUD* operation with the database for the comment.
- **AnalyticsManagerDatabaseInterface** it's the interface which defines the basic operation that any analytic manager should have (independent from the technology)
- **AnalyticsManager** implements *AnalyticsManagerDatabaseInterface* and is in charge to perform the analytics described before in the documentation.

The function that perform the three analytics are:

- **ratingAnalytics(Date startDate, Date endDate, RatingType typeOfRating)** which perform the first analytics.
- **engagementAnalytics(Date startDate, Date endDate, Entity entity)** which perform the seconds.
- **rankingAnalytics(Date startDate, Date endDate, RankingType typeOfRanking)** which perform the third.

All the other function are for support of these three functions.

ANALYTICS ENTITIES

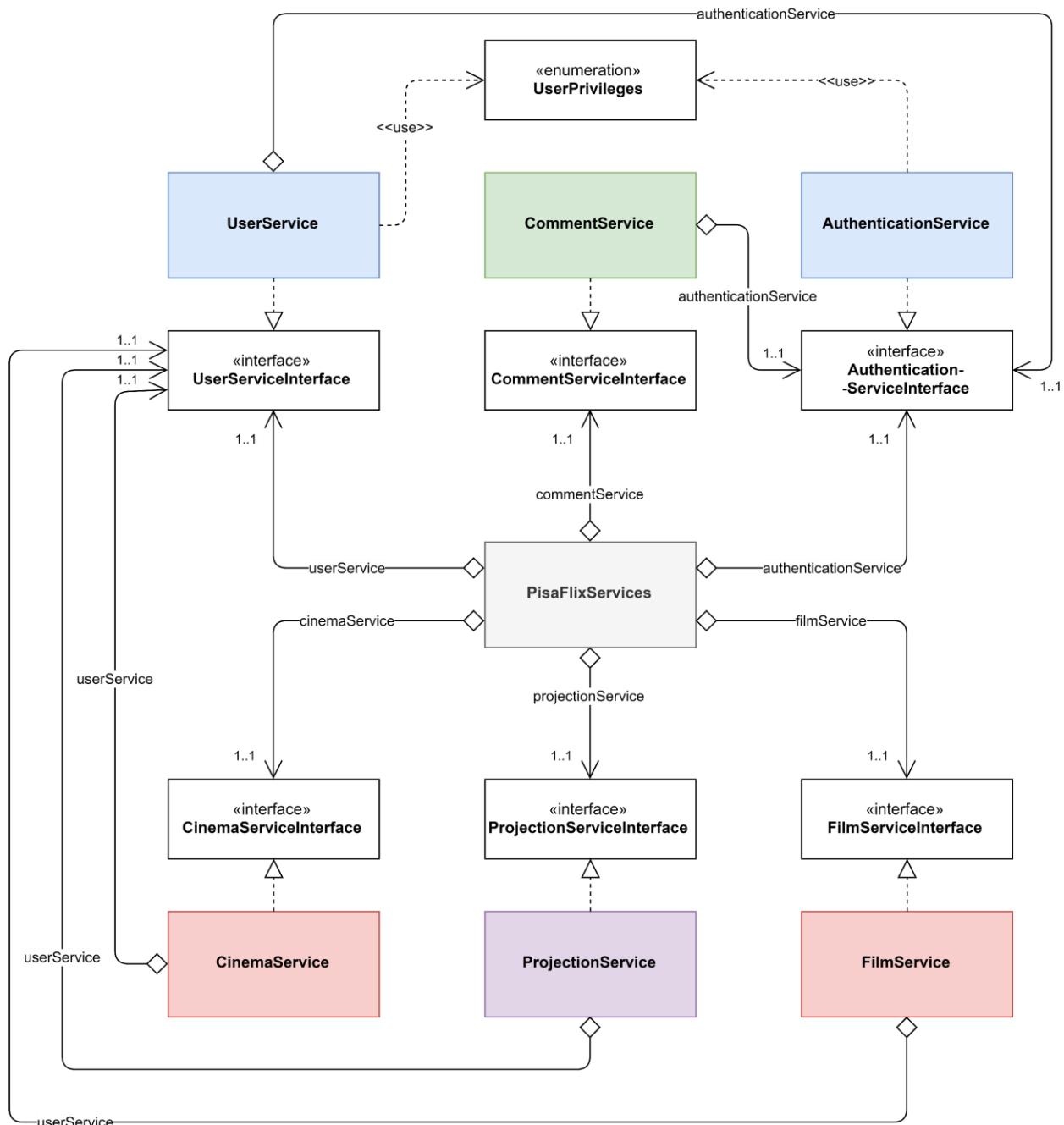


There are three **analytics entities**, and are associated with the related analytic:

- **AverageRatingResult** contains the result of first Analytic.
- **EngageResult** contains the result of second analytic.
- **RankingResult** contains the result of third analytic.

PISAFLIX-SERVICES

Due to its complexity, a schematic diagram of the services offered by the application is provided below:



The *PisaFlixServices* follows the same structure of DBManager, all single services follow the singleton software design pattern explained before

- **PisaFlixServices** is a utility class, it's a static class that contains all the other manager specific to certain operations, the other services are accessible through the public members of the class, it automatically initializes all the services on first call.

- **UserPrivileges** it's an enumeration class which maps the user privileges
 - NORMAL_USER -> level 0 of DB
 - SOCIAL_MODERATOR -> level 1 of DB
 - MODERATOR -> level 2 of DB
 - ADMIN -> level 3 of DB
- **AuthenticationServiceInterface** it's the interface which defines the basic operation that any authentication service should have (independent from the technology)
 - we will see the methods in detail in the class which implement it
- **AuthenticationService** implements *AuthenticationServiceInterface* and is in charge of managing the authentication procedure of the application, it uses *UserManagerDatabaseInterface* in order to operate with database and obtain data
 - void **login(String username, String password)** if called with valid credentials it makes the log in and saves the users information in a local variable opening a kind of session, it may throw *UserAlreadyLoggedException* if called with an already open session or *InvalidCredentialsException* if called with invalid credentials
 - void **logout()** it closes the session deleting user information stored in the local variable
 - boolean **isUserLogged()** it checks if the user is logged and gives back the result
 - String **getInfoString()** it provides some text information of the current session (ex. "logged as Example")
 - User **getLoggedUser()** get the information of the logged user
 - void **checkUserPrivilegesForOperation(UserPrivileges privilegesToAchieve, String operation)** checks if the logged user has the right privileges in order to do an operation, it does do nothing if he has them, otherwise it throws *InvalidPrivilegeLevelException*, it may also throw *UserNotLoggedException* if called without an active session, the field operation it used just to print the operation that we would like to perform in the error message.
 - void **checkUserPrivilegesForOperation(UserPrivileges privilegesToAchieve)** it just call **checkUserPrivilegesForOperation(UserPrivileges privilegesToAchieve, String operation)** with a default text for the "*operation*" field
- **UserServiceInterface** it's the interface which defines the basic operation that any user service should have (independent from the technology)
 - we will see the methods in detail in the class which implement it
- **UserService** implements *UserServiceInterface* and oversees all the operations that are specific for users, in order to work properly it use an *UserManagerDatabaseInterface* to exchange data with the DB and an *AuthenticationServiceInterface* for ensure a correct session status depending by the operation we want to perform
 - Set<User> **getAll()** returns all the users in the DB
 - User **getById(String id)** returns a specific user identify by its "id"
 - Set<User> **getFiltered(String nameFilter)** search and returns all users who have "nameFilter" in the username, if *nameFilter* is not set the filter it's not taken into consideration and returns all users.
 - void **updateUser(User user)** updates a user in the database with new information specify by its parameter

- void **register**(String *username*, String *password*, String *email*, String *firstName*, String *lastName*) it register a new user in the database, if some field It's not valid it throws *InvalidFieldException* specify also the reason why it was thrown
- void **changeUserPrivileges**(User *u*, UserPrivileges *newPrivilegeLevel*) allows the logged user to change the privileges of a user (it can also be itself) it throws *UserNotLoggedException* if called with no user logged, or *InvalidPrivilegeLevelException* if the logged user can't change the privileges of the target user;
- void **deleteUserAccount**(User *u*) allows the logged user to delete a user (it can also be itself) it throws *UserNotLoggedException* if called with no user logged, or *InvalidPrivilegeLevelException* if the logged user can't delete the target user;
- void **deleteLoggedAccount()** it just call **deleteUserAccount**(User *u*) with the user logged as parameter.
- Void **getFavourites**(User *user*) it calls the **getFavourites**(*user*) of the user manager which will update the favourite film set in the user object
- **FilmServiceInterface** it's the interface which defines the basic operation that any film service should have (independent from the technology)
 - we will see the methods in detail in the class which implement it
- **FilmService** implements *FilmServiceInterface* and is in charge of manage all operations that are specific for films, in order to work properly it uses *FilmManagerDatabaseInterface* to exchange data with the DB and *AuthenticationServiceInterface* to ensure that we have the right privileges depending by the operation that we want to perform
 - Set<Film> **getFilmsFiltered**(String *titleFilter*, Date *startDateFilter*, Date *endDateFilter*) search in the DB and returns all movies which have “*titleFilter*” in the title and the publicationDate it's between “*startDateFilter*” and “*endDateFilter*”, if some filter is not set the filter it's not taken into consideration, if all filter are not set it returns all movies.
 - Set<Film> **getAll()** returns all movies int the DB
 - Film **getById**(int *id*) returns a specific film identify by its “*id*”
 - void **addFilm**(String *title*, Date *publicationDate*, String *description*) allows to insert a new film in the DB, it throws *UserNotLoggedException* if called with no user logged, or *InvalidPrivilegeLevelException* if the logged user can't add a new film
 - void **updateFilm**(Film *film*) allows to modify a film in the DB, it throws *UserNotLoggedException* if called with no user logged, or *InvalidPrivilegeLevelException* if the logged user can't modify a film
 - void **deleteFilm**(String *idFilm*) allows to delete a film in the DB, it throws *UserNotLoggedException* if called with no user logged, or *InvalidPrivilegeLevelException* if the logged user can't delete a film
 - void **getRecentComments**(Film *film*) it calls the same method of the filmManager so that the Set of recent comments can be updated
 - void **addComment**(Film *film*, User *user*, String *text*) it calls the same method of the filmManager so that it can add a comment associated to the film passed as an argument.
 - long **getCommentPageSize()** it calls the same method of the filmManager so that it can return the number of comments to be displayed in one page.

- void **getCommentPage**(Film film, int page) it calls the same method of the filmManager so that it can update the set of comments in the object “film”. The page integer is used to calculate how many comments to skip in the query to the DB. This number obviously depends on the number of comments per page returned by **getCommentPageSize()**
- **CommentServiceInterface** it’s the interface which defines the basic operation that any comment service should have (independent from the technology)
 - we will see the methods in detail in the class which implement it
- **CommentService** implements *CommentServiceInterface* and is in charge of manage all operations that are specific for comments, in order to work properly it use an *CommentManagerDatabaseInterface* to exchange data with the DB, an *AuthenticationServiceInterface* in order to retrieve the current logged user and to ensure that we have the right privileges depending by the operation that we want perform
 - Comment **getById**(int *id*) returns a specific film identify by its “*id*”
 - void **addComment**(String *text*, User *user*, Film *film*) creates a new comment for a “*film*” made by a certain “*user*” and saves it in the *EngageCollection* (Note: this method should be used by the FilmManager if the number of nested comments exceed the limit imposed)
 - void **update**(Comment *comment*) allows to modify a comment in the DB, it throws *UserNotLoggedException* if called with no user logged, or *InvalidPrivilegeLevelException* if the logged user can’t modify the comment
 - void **delete**(Comment *comment*) allows to delete a comment in the DB, it throws *UserNotLoggedException* if called with no user logged, or *InvalidPrivilegeLevelException* if the logged user can’t delete the comment
 - long **count**(Entity *user*) it returns the number of comments written by the user passed as an argument.
- **EngageServiceInterface** it’s the interface which defines the basic operation that any engage service should have (independent from the technology)
 - we will see the methods in detail in the class which implement it
- **EngageService** implements *EngageServiceInterface* and is in charge of manage all operations that are specific for the engagement activities, in order to work properly it uses a *EngageManagerDatabaseInterface* to exchange data with the DB, an *AuthenticationServiceInterface* in order to retrieve the current logged user and to ensure that we have the right privileges depending by the operation that we want perform
 - void **create**(User *user*, Film *film*, EngageType *type*) it calls a method of the *EngageManager* that saves a document in the *EngageCollection* for an engagement activity done by the “*user*” on the “*film*”.
 - Engage **getById**(String *engagelId*) it returns the engagement object associated to the “*engagelId*” if present, null otherwise.
 - Set<Engage> **getEngageSet**(Entity *entity*, int *limit*, int *skip*, EngageType *type*) it returns a set of Engage entity associated to “*entity*” of the given “*type*” (Comment, Favourite, View), with the possibility to specify a limit and a skip.
 - void **deleteFiltred**(User *user*, Film *film*, EngageType *type*) it calls the same method in the *EngageManager* which deletes a document that matches the filters

- long **count**(Entity *entity*, EngageType *type*) it returns the number of documents in the EngageCollection that matches the type and the entity specified
- boolean **isAlreadyPresent**(User *userLogged*, Film *film*, EngageType *entityType*) it checks if an equal engage document is already been saved
- **AnalyticsServiceInterface** it's the interface which defines the basic operation that any analytics service should have (independent from the technology)
 - we will see the methods in detail in the class which implement it
- **AnalyticsService** implements *AnalyticsServiceInterface* and is in charge of manage all operations that gather data to be displayed in the analytics tab, in order to work properly it uses an **AnalyticsManagerDatabaseInterface** to exchange data with the DB
 - Set<EngageResult> **engagementAnalytics**(Date *startdate*, Date *endDate*, Entity *entity*) it calls the homonym method of the *AnalyticsManager*
 - Set<AverageRatingResult> **ratingAnalytics**(Date *startdate*, Date *endDate*, RatingType *typeOfRating*) it calls the homonym method of the *AnalyticsManager*
 - Set<RankingResult> **rankingAnalytics**(Date *startDate*, Date *endDate*, RankingType *typeOfRanking*) it calls the homonym method of the *AnalyticsManager*

INDEXES

The following are the indexes deemed necessary for an effective retrieval of documents from the database:

ENGAGE COLLECTION

- **Film (asc) Timestamp(desc)**: For the analytic that have been defined, film and timestamp, always go together in the match stage. An index like that can increase of a huge amount the performance of the db. Below is shown a comparison of query performance with and without indexes to demonstrate their effectiveness:

Query Performance Summary

Documents Returned: 8	Actual Query Execution Time (ms): 0
Index Keys Examined: 8	Sorted in Memory: no
Documents Examined: 8	Query used the following index: Film Timestamp

Query Performance Summary

Documents Returned: 0	Actual Query Execution Time (ms): 125
Index Keys Examined: 0	Sorted in Memory: no
Documents Examined: 291716	No index available for this query.

{Film: "5e2025be8472fbdeee121311", Timestamp: {\$gt:ISODate('2012-12-17T00:00:00Z'), \$lt:ISODate('2020-12-17T00:00:00Z')}}

Without the index, the query must range through all the collection.

The same index is also essential for the query that provides older comment pages on a particular film, as shown below:

Query Performance Summary

- Documents Returned: 11
- Index Keys Examined: 31
- Documents Examined: 11
- Actual Query Execution Time (ms): 0
- Sorted in Memory: no
- Query used the following index:
Type ↑ Film ↑ Timestamp ↓

Query Performance Summary

- Documents Returned: 11
- Index Keys Examined: 104
- Documents Examined: 104
- Actual Query Execution Time (ms): 0
- Sorted in Memory: no
- Query used the following index:
Film ↑ Timestamp ↓

Query Performance Summary

- Documents Returned: 11
- Index Keys Examined: 0
- Documents Examined: 2020782
- Actual Query Execution Time (ms): 863
- Sorted in Memory: yes
- No index available for this query.

Using a triple index (Type, Film, Timestamp) does not increase performance significantly, therefore it has not been added, in order to not weigh down the writing in the collection and avoid the memory consumption necessary to maintain it.

- **User(asc) Timestamp(desc):** For the same type of analytics, this index is also required, as shown below:

Query Performance Summary

- Documents Returned: 179
- Index Keys Examined: 179
- Documents Examined: 179
- Actual Query Execution Time (ms): 0
- Sorted in Memory: no
- Query used the following index:
User ↑ Timestamp ↓

Query Performance Summary

- Documents Returned: 179
- Index Keys Examined: 0
- Documents Examined: 2020782
- Actual Query Execution Time (ms): 829
- Sorted in Memory: no
- No index available for this query.

Without the index, the query must range through all the collection.

the same index is also essential to efficiently retrieve user's favorites, as shown below:

The screenshot shows a MongoDB query interface with the following configuration:

- Filter:** `{User: '5e1c97fe3191c9cc2705adda', Type: 'FAVOURITE'}`
- Project:** None
- Sort:** `{"Timestamp": -1}`
- Collation:** None
- View Details As:** Visual Tree (selected) or Raw JSON

Query Performance Summary:

- Documents Returned: 15
- Index Keys Examined: 1960
- Documents Examined: 1960
- Actual Query Execution Time (ms): 7
- Sorted in Memory: no
- Query used the following index:
User Timestamp

Query Performance Summary

- Documents Returned: 15
- Index Keys Examined: 15
- Documents Examined: 15

- Actual Query Execution Time (ms): 0
- Sorted in Memory: no
- Query used the following index:
Type User Timestamp

Query Performance Summary

- Documents Returned: 15
- Index Keys Examined: 0
- Documents Examined: 2020793

- Actual Query Execution Time (ms): 823
- Sorted in Memory: yes
- No index available for this query.

Using a triple index (Type, User, Timestamp) does not increase performance significantly, therefore it has not been added, in order to not weigh down the writing in the collection and avoid the memory consumption necessary to maintain it.

CINEMA COLLECTION

- PublicationDate(desc):** This index is necessary every time it is opened the page for searching films, as both the first opening and after a search, the films are sorted by publication date and limited in number so as to enter in one screen:

The screenshot shows a MongoDB query interface with the following configuration:

- Sort:** `{PublicationDate: -1}`
- Collation:** None
- MaxTimeMS:** 5000
- Skip:** 0
- Limit:** 27
- View Details As:** Visual Tree (selected) or Raw JSON

Query Performance Summary

Documents Returned: 27	Actual Query Execution Time (ms): 0
Index Keys Examined: 27	Sorted in Memory: no
Documents Examined: 27	Query used the following index: PublicationDate ↗

Query Performance Summary

Documents Returned: 27	Actual Query Execution Time (ms): 26
Index Keys Examined: 0	Sorted in Memory: yes
Documents Examined: 33399	⚠️ No index available for this query.

Without the index, the query must range through all the collection and re-order the documents in memory.

USER COLLECTION

- **PublicationDate(asc):** This index is necessary every time the login is made, in order to verify the existence of the username and the correctness of the password:



The screenshot shows the MongoDB Compass interface with a query filter applied: {Username: 'admin'}. Below the filter, there are three options: VIEW DETAILS AS, VISUAL TREE (which is selected), and RAW JSON.

Query Performance Summary

Documents Returned: 1	Actual Query Execution Time (ms): 0
Index Keys Examined: 1	Sorted in Memory: no
Documents Examined: 1	Query used the following index: Username ↑

Query Performance Summary

Documents Returned: 1	Actual Query Execution Time (ms): 0
Index Keys Examined: 0	Sorted in Memory: no
Documents Examined: 1018	⚠️ No index available for this query.

Without the index, the query must range through all the collection.

In conclusion, with the addition of these indexes almost all of the queries made on the database are covered, both by the analytics and by the normal functioning of the app, as the rest of the operations have been designed in order to use the index on the documents id directly.

REPLICAS

SETUP

To activate the replicas, the steps below must be followed:

1. Access one of the servers in the cluster.
2. In the mongo shell, create a configuration document, in our case:

```
1. MongoDB Enterprise LsmssdCluster-shard-0:PRIMARY > rsconf = {
```

```

2.         "_id": "mdbDefGuide",
3.         "members": [
4.             {"_id": 0, "host": "lsmsdcluster-shard-00-00-yeauu.mongodb.net:27017"},
5.             {"_id": 1, "host": "lsmsdcluster-shard-00-01-yeauu.mongodb.net:27017"},
6.             {"_id": 2, "host": "lsmsdcluster-shard-00-02-yeauu.mongodb.net:27017"}
7.         ]
8.     }

```

3. Pass the configuration to the function rs.initiate():

```
MongoDB Enterprise LsmsdCluster-shard-0:PRIMARY> rs.initiate(rsconf)
```

One of the servers will be elected randomly as primary and the replicas will be created with default settings.

READ FROM SECONDARIES

Applications that require strongly consistent reads should not read from secondaries replicas. They are usually within a few milliseconds of the primary, however there is no guarantee of this.

Since one of the requirements of this application expects great data accuracy, as long as a single server is able to manage all the reading requests, the use of secondary servers is not foreseen for this purpose. If the traffic will exceed the capacity of the primary server, the readings of the copies contained in the secondary servers can be activated, as explained below, to improve availability:

1. Access the secondary server (00 or 01 in our case):

```
mongo "mongodb://root:root@lsmsdcluster-shard-00-01-yeauu.mongodb.net:27017" -tls
```

2. Enter the following command which enables the reading of the documents contained in secondary server:

```
MongoDB Enterprise LsmsdCluster-shard-0:SECONDARY> rs.slaveOk()
```

ACTUAL CONFIGURATION

This is the configuration that is currently being used by the cluster for replicas:

```

1. MongoDB Enterprise LsmsdCluster-shard-0:PRIMARY> rs.status()
2. {
3.     "set" : "LsmsdCluster-shard-0",
4.     "date" : ISODate("2020-02-14T15:17:41.926Z"),
5.     "myState" : 1,
6.     "term" : NumberLong(21),
7.     "syncingTo" : "",
8.     "syncSourceHost" : "",
9.     "syncSourceId" : -1,
10.    "heartbeatIntervalMillis" : NumberLong(2000),
11.    "majorityVoteCount" : 2,
12.    "writeMajorityCount" : 2,
13.    "optimes" : {
14.        "lastCommittedOpTime" : {
15.            "ts" : Timestamp(1581693461, 2),
16.            "t" : NumberLong(21)
17.        },
18.        "lastCommittedWallTime" : ISODate("2020-02-14T15:17:41.801Z"),
19.        "readConcernMajorityOpTime" : {
20.            "ts" : Timestamp(1581693461, 2),
21.            "t" : NumberLong(21)
22.        },
23.        "readConcernMajorityWallTime" : ISODate("2020-02-14T15:17:41.801Z"),
24.        "appliedOpTime" : {
25.            "ts" : Timestamp(1581693461, 2),
26.            "t" : NumberLong(21)
27.        },

```

```

28.         "durableOpTime" : {
29.             "ts" : Timestamp(1581693461, 2),
30.             "t" : NumberLong(21)
31.         },
32.         "lastAppliedWallTime" : ISODate("2020-02-14T15:17:41.801Z"),
33.         "lastDurableWallTime" : ISODate("2020-02-14T15:17:41.801Z")
34.     },
35.     "lastStableRecoveryTimestamp" : Timestamp(1581693430, 3),
36.     "lastStableCheckpointTimestamp" : Timestamp(1581693430, 3),
37.     "electionCandidateMetrics" : {
38.         "lastElectionReason" : "stepUpRequestSkipDryRun",
39.         "lastElectionDate" : ISODate("2020-01-30T19:02:04.409Z"),
40.         "electionTerm" : NumberLong(21),
41.         "lastCommittedOpTimeAtElection" : {
42.             "ts" : Timestamp(1580410918, 1),
43.             "t" : NumberLong(20)
44.         },
45.         "lastSeenOpTimeAtElection" : {
46.             "ts" : Timestamp(1580410918, 1),
47.             "t" : NumberLong(20)
48.         },
49.         "numVotesNeeded" : 2,
50.         "priorityAtElection" : 7,
51.         "electionTimeoutMillis" : NumberLong(5000),
52.         "priorPrimaryMemberId" : 1,
53.         "numCatchUpOps" : NumberLong(0),
54.         "newTermStartDate" : ISODate("2020-01-30T19:02:05.180Z"),
55.         "wMajorityWriteAvailabilityDate" : ISODate("2020-01-30T19:02:06.571Z")
56.     },
57.     "members" : [
58.         {
59.             "_id" : 0,
60.             "name" : "lsmsdcluster-shard-00-00-yeauu.mongodb.net:27017",
61.             "health" : 1,
62.             "state" : 2,
63.             "stateStr" : "SECONDARY",
64.             "uptime" : 1282538,
65.             "optime" : {
66.                 "ts" : Timestamp(1581693461, 1),
67.                 "t" : NumberLong(21)
68.             },
69.             "optimeDurable" : {
70.                 "ts" : Timestamp(1581693461, 1),
71.                 "t" : NumberLong(21)
72.             },
73.             "optimeDate" : ISODate("2020-02-14T15:17:41Z"),
74.             "optimeDurableDate" : ISODate("2020-02-14T15:17:41Z"),
75.             "lastHeartbeat" : ISODate("2020-02-14T15:17:41.339Z"),
76.             "lastHeartbeatRecv" : ISODate("2020-02-14T15:17:41.822Z"),
77.             "pingMs" : NumberLong(0),
78.             "lastHeartbeatMessage" : "",
79.             "syncingTo" : "lsmsdcluster-shard-00-02-
yeauu.mongodb.net:27017",
80.             "syncSourceHost" : "lsmsdcluster-shard-00-02-
yeauu.mongodb.net:27017",
81.             "syncSourceId" : 2,
82.             "infoMessage" : "",
83.             "configVersion" : 2
84.         },
85.         {
86.             "_id" : 1,
87.             "name" : "lsmsdcluster-shard-00-01-yeauu.mongodb.net:27017",
88.             "health" : 1,
89.             "state" : 2,
90.             "stateStr" : "SECONDARY",
91.             "uptime" : 1282395,
92.             "optime" : {
93.                 "ts" : Timestamp(1581693460, 1),
94.                 "t" : NumberLong(21)
95.             },
96.             "optimeDurable" : {

```

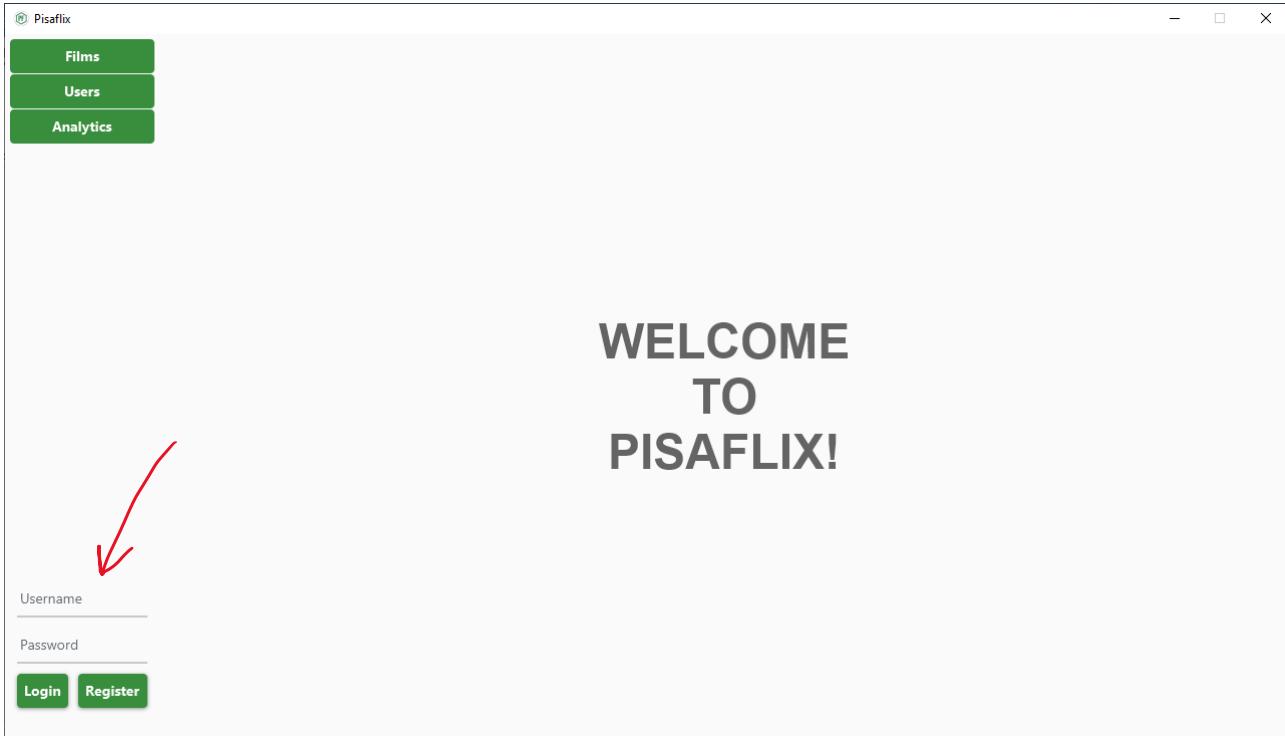
```

97.          "ts" : Timestamp(1581693460, 1),
98.          "t" : NumberLong(21)
99.        },
100.       "optimeDate" : ISODate("2020-02-14T15:17:40Z"),
101.       "optimeDurableDate" : ISODate("2020-02-14T15:17:40Z"),
102.       "lastHeartbeat" : ISODate("2020-02-14T15:17:40.556Z"),
103.       "lastHeartbeatRecv" : ISODate("2020-02-
14T15:17:40.381Z"),
104.       "pingMs" : NumberLong(0),
105.       "lastHeartbeatMessage" : "",
106.       "syncingTo" : "lsmsdcluster-shard-00-02-
yeauu.mongodb.net:27017",
107.       "syncSourceHost" : "lsmsdcluster-shard-00-02-
yeauu.mongodb.net:27017",
108.       "syncSourceId" : 2,
109.       "infoMessage" : "",
110.       "configVersion" : 2
111.     },
112.     {
113.       "_id" : 2,
114.       "name" : "lsmsdcluster-shard-00-02-
yeauu.mongodb.net:27017",
115.       "health" : 1,
116.       "state" : 1,
117.       "stateStr" : "PRIMARY",
118.       "uptime" : 1282545,
119.       "optime" : {
120.         "ts" : Timestamp(1581693461, 2),
121.         "t" : NumberLong(21)
122.       },
123.       "optimeDate" : ISODate("2020-02-14T15:17:41Z"),
124.       "syncingTo" : "",
125.       "syncSourceHost" : "",
126.       "syncSourceId" : -1,
127.       "infoMessage" : "",
128.       "electionTime" : Timestamp(1580410924, 1),
129.       "electionDate" : ISODate("2020-01-30T19:02:04Z"),
130.       "configVersion" : 2,
131.       "self" : true,
132.       "lastHeartbeatMessage" : ""
133.     }
134.   ],
135.   "ok" : 1,
136.   "$clusterTime" : {
137.     "clusterTime" : Timestamp(1581693461, 2),
138.     "signature" : {
139.       "hash" : BinData(0, "aGPqxF/y2bp+fusQVjFw9L9ECDo="),
140.       "keyId" : NumberLong("6764753214106501121")
141.     }
142.   },
143.   "operationTime" : Timestamp(1581693461, 2)
144. }

```

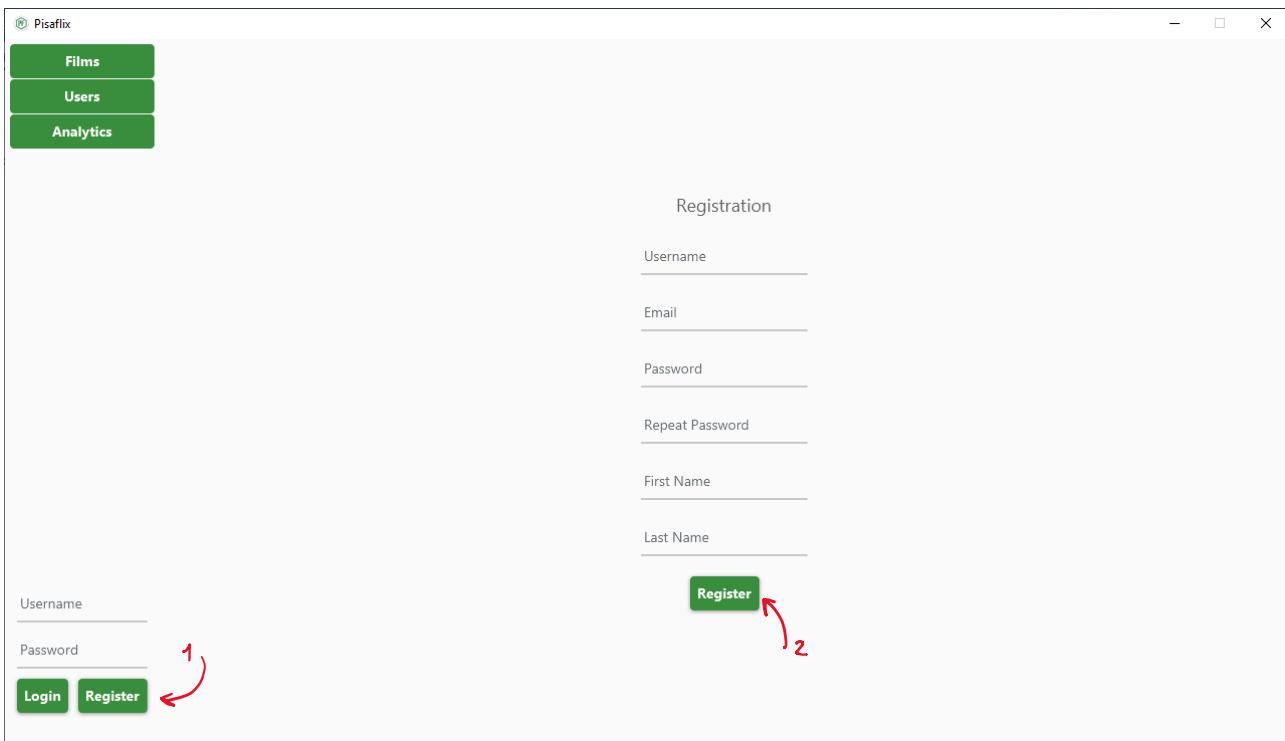
USER MANUAL

The graphic interface is divided in two sides; a menu on the left side and a space on the right side where the application pages will be displayed. Below the menu it is possible to log in by filling the apposite form:



REGISTRATION AND LOGIN

A new user can register by clicking the specific button (1) located in the bottom left corner. This will request the registration page which the user can fill up with his own information and then register (2):



The application will inform the user about any kind of issue after having clicked on the register button. The same is true for a successful registration:

The image displays two registration forms side-by-side, illustrating different outcomes of the registration process.

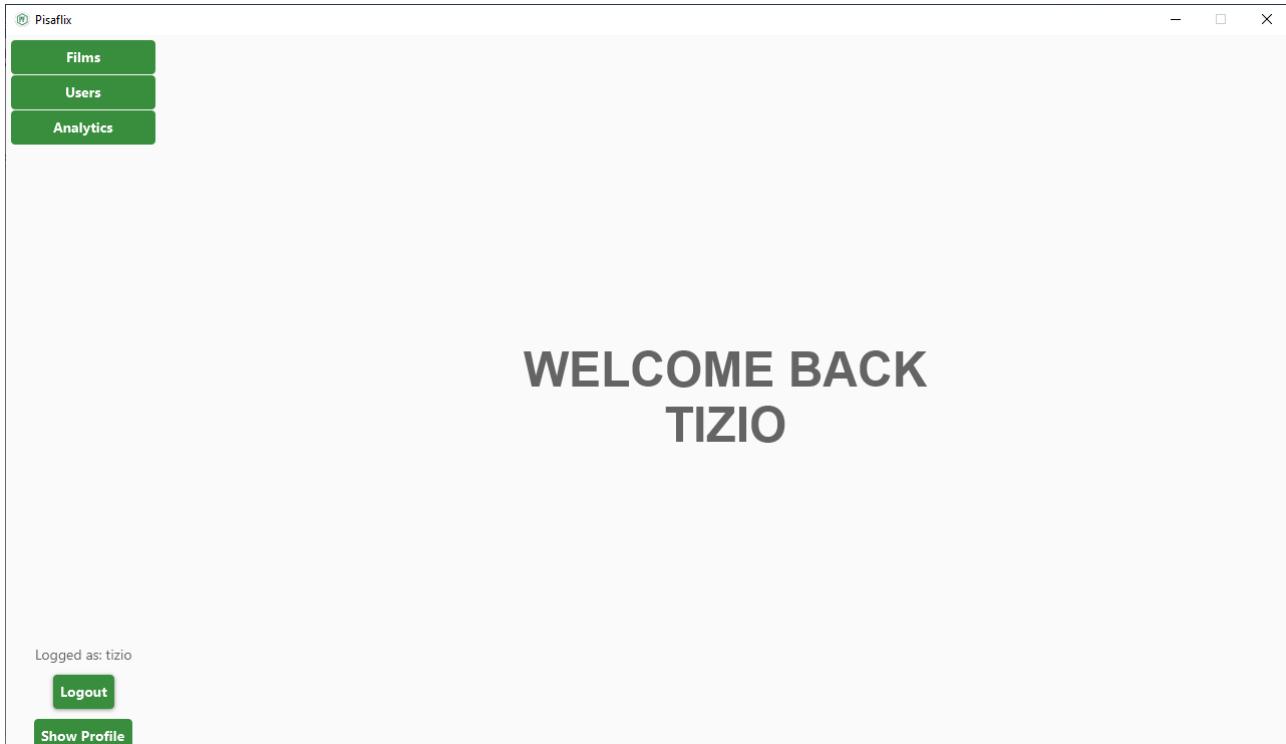
Left Form (Successful Registration):

- Username: test
- Email: tes@mail.com
- Password: ****
- Repeat Password: ****
- First Name: test name
- Last Name: test surname
- Register** button
- Message: Registration is done!

Right Form (Unsuccessful Registration):

- Username: test
- Email: tes@mail.com
- Password: ****
- Repeat Password: ****
- First Name: test name
- Last Name: test surname
- Register** button
- Message: Passwords are different

Once registered, the user can log in with the credentials chosen by filling up the form in the bottom left corner. This is the welcoming page:



BROWSING FILM

A user can browse (even without being registered) films by clicking the apposite bottom (1) in the top left corner:

Logged as: tizio

[Logout](#)

[Show Profile](#)

In the browse films the user can search for a specific item filtering by title:

Logged as: tizio

[Logout](#)

[Show Profile](#)

A user with the right privileges can also add a new film by clicking on the add button (1) of the top right corner:

The screenshot shows a user interface for a movie database. On the left, there's a sidebar with 'Films' (selected), 'Users', and 'Analytics'. Below the sidebar, it says 'Logged as: admin' and has 'Logout' and 'Show Profile' buttons. The main area is a grid of movie cards. Each card displays a movie poster, its title, release year, and a brief description with hashtags. In the top right corner of the grid, there is a green 'Add' button with a checkmark icon and the text 'Operazione completata' (Operation completed). A red arrow points to this 'Add' button.

FILM DETAILS

After clicking on a film during browsing, the application will show the film detail page which contains all the information about it and also all the recent comments made by users.

In that page a user, if logged, can add the film to its favourite (1) (by clicking the apposite button in the right side of the application) or comment it:

This screenshot shows the detailed view of a specific movie. The movie is titled 'The Game of Their Lives' (2005). The plot summary states: "The film details the true story of the 1950 U.S. soccer team which, against all odds, beat England 10 in the city of Belo Horizonte, Brazil during the 1950 FIFA World Cup. The story is about the family traditions and passions that shaped the players who made up this team of underdogs. One group of teammates were from The Hill neighborhood of St. Louis, Missouri. Another group came from the Corky Row district of Fall River, Massachusetts." There are two comments listed. The first comment, by 'eyashini8', reads: "The story has been mangled. The acting was unconvincing and the dialogue improbable. I can't believe I managed to stay awake through the whole thing. And the costumes ranged from not bad to ""which polyester knit fabric was?"" For curiosity value only." The second comment, by 'flattimerds', reads: "This movie fails to redeem itself, even after that possibility became miraculously available. I was certain that I was wasting my time through the first 80 minutes of gratuitous TV-preacher bashing (which might actually be appropriate if it were not handled with such apparent fiction and superficiality) when suddenly, at the very last moment, it seemed that a story was about to emerge. I was wrong. The only interesting tension in this film goes entirely unresolved and unexplained. It almost seems like this film was re-written in editing and they lacked the footage to explain the revision. So they released it. I can't believe I actually bought a used copy of this. I hate that I spent \$5.99 for it. But I have to much love for humanity to return or exchange it. Someone else might end up with it. Only the producer can be blamed fully, but any director that would put his name on this movie deserves a measure of disgust." Both comments have a timestamp, the author's name, and a 'By' indicator. To the right of the comments, there is a large movie poster for 'The Game of Their Lives'. At the bottom right, there is a red arrow pointing to a green 'Favorite' button with the text '+ Favorite (0)' and a text input field for comments.

Then the user can also modify/delete its own comments by right clicking on them:

Pisaflix

Films **Users** **Analytics**

The Game of Their Lives

2005 | Adultness: 35% | Cluster Tags: #drama #group #stori #team

The film details the true story of the 1950 U.S. soccer team which, against all odds, beat England 10 in the city of Belo Horizonte, Brazil during the 1950 FIFA World Cup. The story is about the family traditions and passions that shaped the players who made up this team of underdogs. One group of teammates were from The Hill neighborhood of St. Louis, Missouri. Another group came from the Corky Row district of Fall River, Massachusetts.

Written at: Fri Feb 07 16:15:08 CET 2020 By: tizio

"The story has been mangled. The acting was unconvincing and the dialogue improbable. I can't believe I managed to stay awake through the whole thing. And the costumes ranged from not bad to ""which polyester knit fabric was that?"" For curiosity value only."

Written at: Wed May 02 20:16:25 CEST 2018 By: eyashini8

This movie fails to redeem itself, even after that possibility became miraculously available. I was certain that I was wasting my time through the first 80 minutes of gratuitous TV-preacher bashing (which might actually be appropriate if it were not handled with such apparent fiction and superficiality) when suddenly, at the very last moment, it seemed that a story was about to emerge. I was wrong. The only interesting tension in this film goes entirely unresolved and unexplained. It almost seems like this film was re-written in editing and they lacked the footage to explain the revision. So they released it. I can't believe I actually bought a used copy of this. I hate that I spent \$5.99 for it. But I have to much love for humanity to return or exchange it. Someone else might end up with it. Only the producer can be blamed fully, but any director that would put his name on this movie deserves a measure of disgust.

Written at: Sat Dec 08 23:39:45 CET 2018 By: flattimerds

"This so-called international thriller was so dreadful that I didn't know whether to laugh or cry. The team of four writers who wrote this trash should be imprisoned for crimes against humanity. The eight producers who brought it to the market should

Logged as: tizio

Logout **Show Profile**

+ Favorite (0)

Write here a comment for the film...

Comment

To perform the update, click on update (1) once the change has been made:

Pisaflix

Films **Users** **Analytics**

The Game of Their Lives

2005 | Adultness: 35% | Cluster Tags: #drama #group #stori #team

The film details the true story of the 1950 U.S. soccer team which, against all odds, beat England 10 in the city of Belo Horizonte, Brazil during the 1950 FIFA World Cup. The story is about the family traditions and passions that shaped the players who made up this team of underdogs. One group of teammates were from The Hill neighborhood of St. Louis, Missouri. Another group came from the Corky Row district of Fall River, Massachusetts.

Written at: Fri Feb 07 16:15:08 CET 2020 By: tizio

great film!!!!

Written at: Wed May 02 20:16:25 CEST 2018 By: eyashini8

This movie fails to redeem itself, even after that possibility became miraculously available. I was certain that I was wasting my time through the first 80 minutes of gratuitous TV-preacher bashing (which might actually be appropriate if it were not handled with such apparent fiction and superficiality) when suddenly, at the very last moment, it seemed that a story was about to emerge. I was wrong. The only interesting tension in this film goes entirely unresolved and unexplained. It almost seems like this film was re-written in editing and they lacked the footage to explain the revision. So they released it. I can't believe I actually bought a used copy of this. I hate that I spent \$5.99 for it. But I have to much love for humanity to return or exchange it. Someone else might end up with it. Only the producer can be blamed fully, but any director that would put his name on this movie deserves a measure of disgust.

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Logged as: tizio

Logout **Show Profile**

+ Favorite (0)

bel film

Comment

With the right privileges a user can also delete other users' comments, in the same way:

The Game of Their Lives

2005 | Adultness: 35% | Cluster Tags: #drama #group #story #team

The film details the true story of the 1950 U.S. soccer team which, against all odds, beat England 10 in the city of Belo Horizonte, Brazil during the 1950 FIFA World Cup. The story is about the family traditions and passions that shaped the players who made up this team of underdogs. One group of teammates were from The Hill neighborhood of St. Louis, Missouri. Another group came from the Corky Row district of Fall River, Massachusetts.

Written at: Fri Feb 07 16:15:08 CET 2020 By: tizio

"The story has been mangled. The acting was unconvincing and the dialogue improbable. I can't believe I managed to stay awake through the whole thing. And the costumes ranged from not bad to "which polyester knit fabric was that?" For curiosity value only."

Written at: Wed May 02 20:16:25 CEST 2018 By: eyashinl8

This movie fails to redeem itself, even after that possibility became miraculously available. I was certain that I was wasting my time through the first 80 minutes of gratuitous TV-preacher bashing (which might actually be appropriate if it were not handled with such apparent fiction and superficiality) when suddenly, at the very last moment, it seemed that a story was about to emerge. I was wrong. The only interesting tension in this film goes entirely unresolved and unexplained. It almost seems like this film was re-written in editing and they lacked the footage to explain the revision. So they released it. I can't believe I actually bought a used copy of this. I hate that I spent \$5.99 for it. But I have to much love for humanity to return it. Someone else might end up with it. Only the producer can be blamed fully, but any director that would put his name on this movie deserves a measure of disgust.

Written at: Sat Dec 08 23:39:45 CET 2018 By: flattimerds

"This so-called international thriller was so dreadful that I didn't know whether to laugh or cry. The team of four writers who wrote this trash should be imprisoned for crimes against humanity. The eight producers who brought it to the market should

+ Favorite (0)

Write here a comment for the film...

Comment

BROWSING USERS AND DETAILS

Similarly to films, a user can also navigate through other users by clicking the apposite button (1) in the top left corner, there it can see all usernames and privileges.

With the right privileges a user can modify other user's privileges by right clicking on them and using the apposite menu (2):

StePetro	rbrittleban...	sawfan	wjeavesrl	ceuesdenrg	bgrangero	wjohannes...	boh	harryp
User	User	User	User	User	User	User	User	User
Modify								
Sci-fy-lover	sjoontjesrm	bbetancou...	pclearsrk	StarWarsLo...	tizio	HarryPotte...	llindsellrj	nstearnsrr
User	User	User	User	User	User	User	User	User
Kiddo	ccawserq	SawFan	mazzo	dpetronisrf	ekeattchri	jtwelftreerp	test	WPinocchio
User	User	User	User	User	User	User	User	User

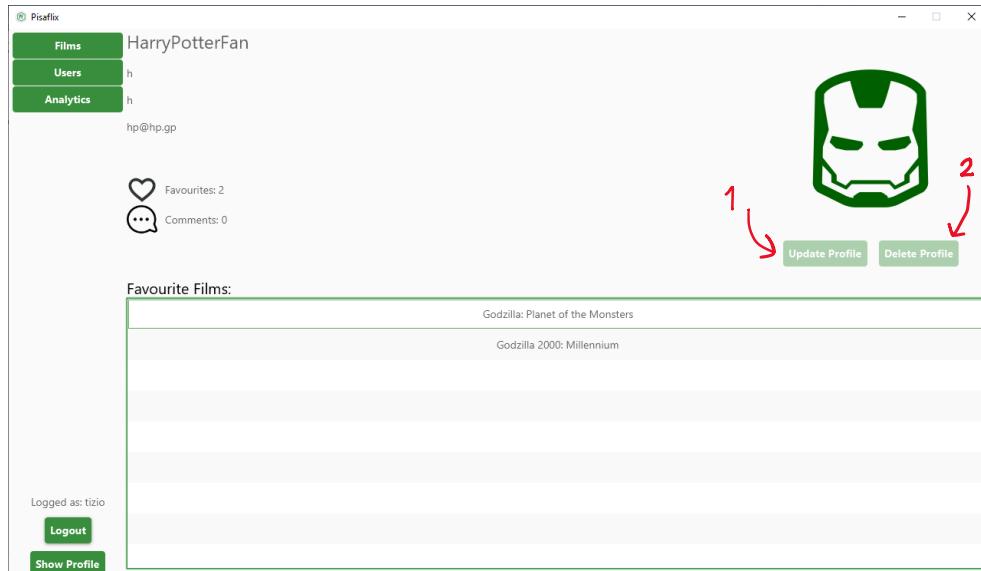
Logged as: admin

Logout Show Profile

Once the user clicks on a user while browsing it will open its detail page, there it's visible how many favourite/comment a user did and the list of his favourite films.

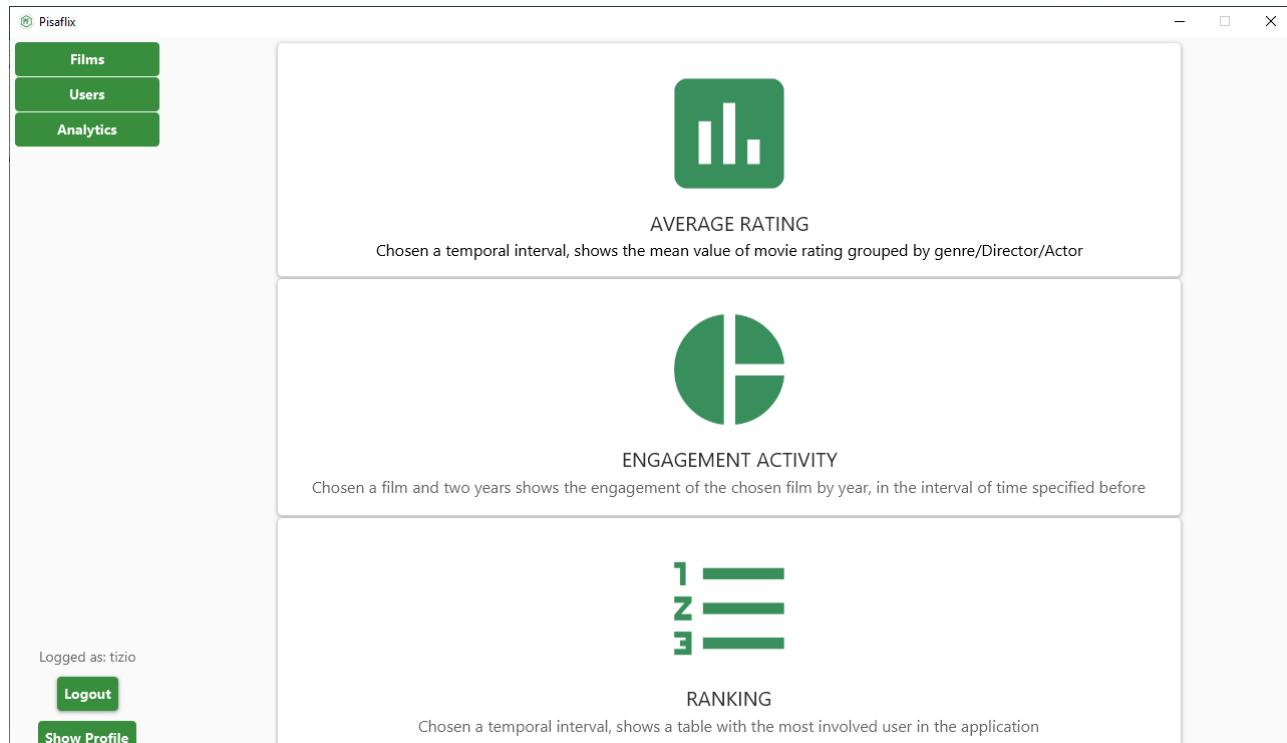
When browsing the user can also click on his own detail page, then he can modify (1) his information or delete (2) his account (the same page is accessible by the apposite button in the bottom left corner after the login).

With the right privileges, once a user detail page is opened, the user can have the possibility to delete (2) another user account.



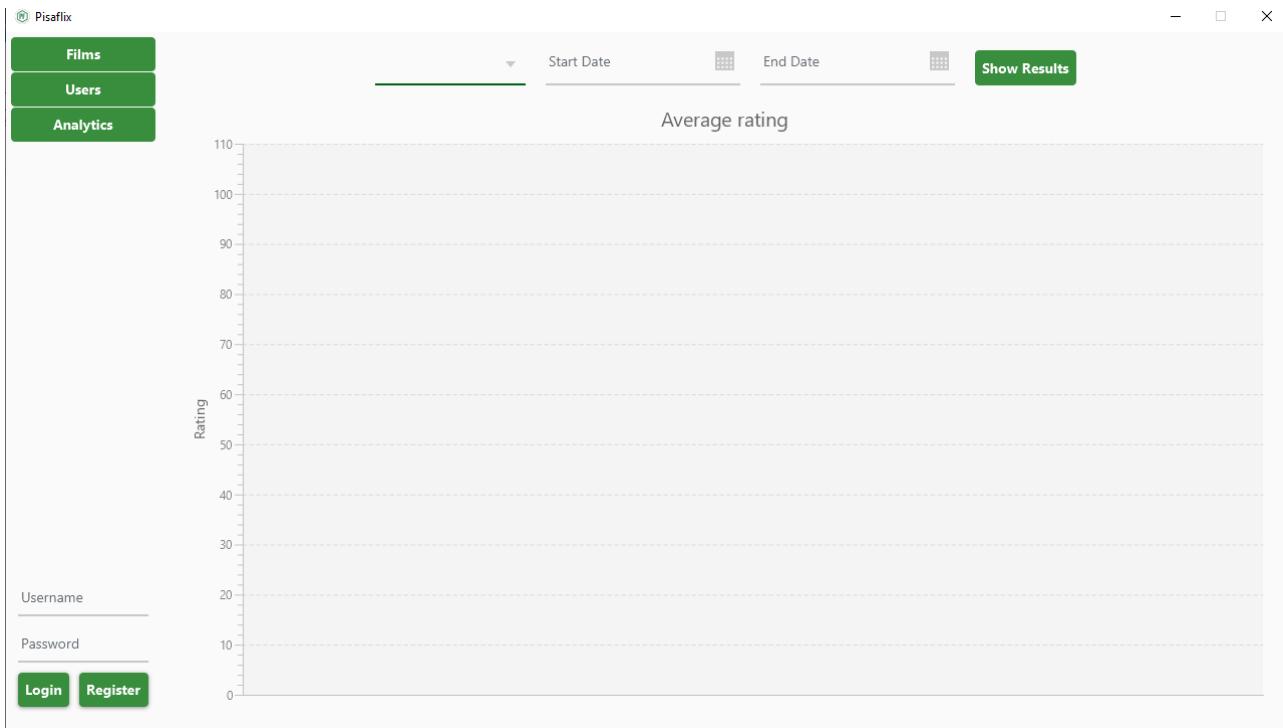
BROWSING ANALYTICS

By clicking on the Analytics button you can access the following page:

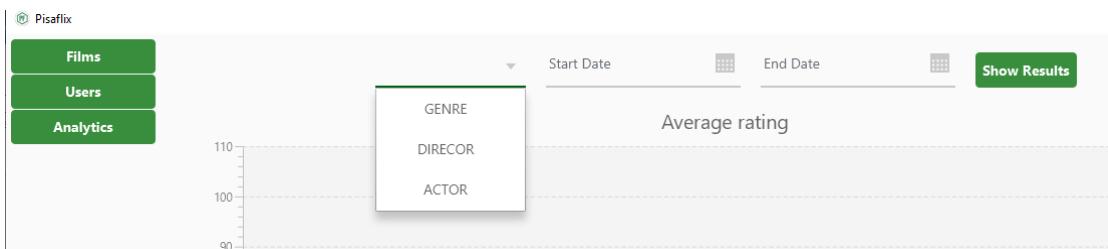


AVERAGE RATING

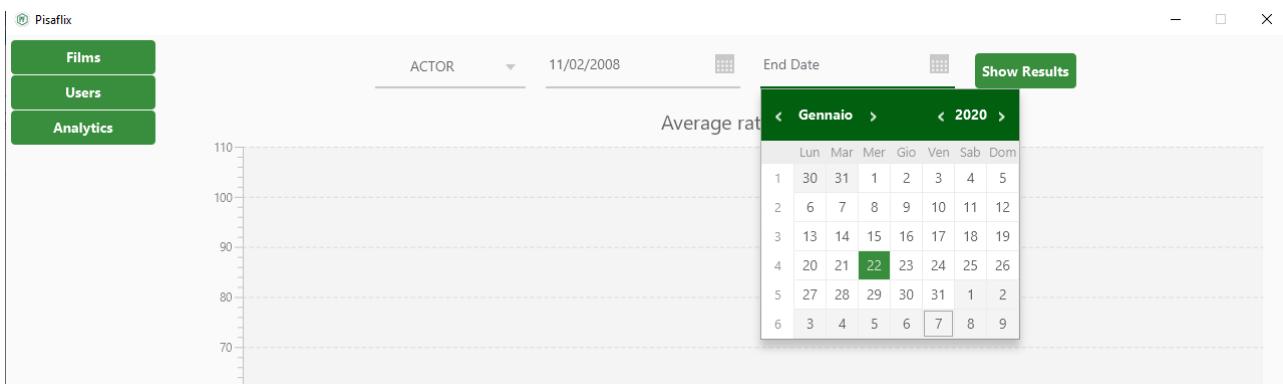
This is the main page:



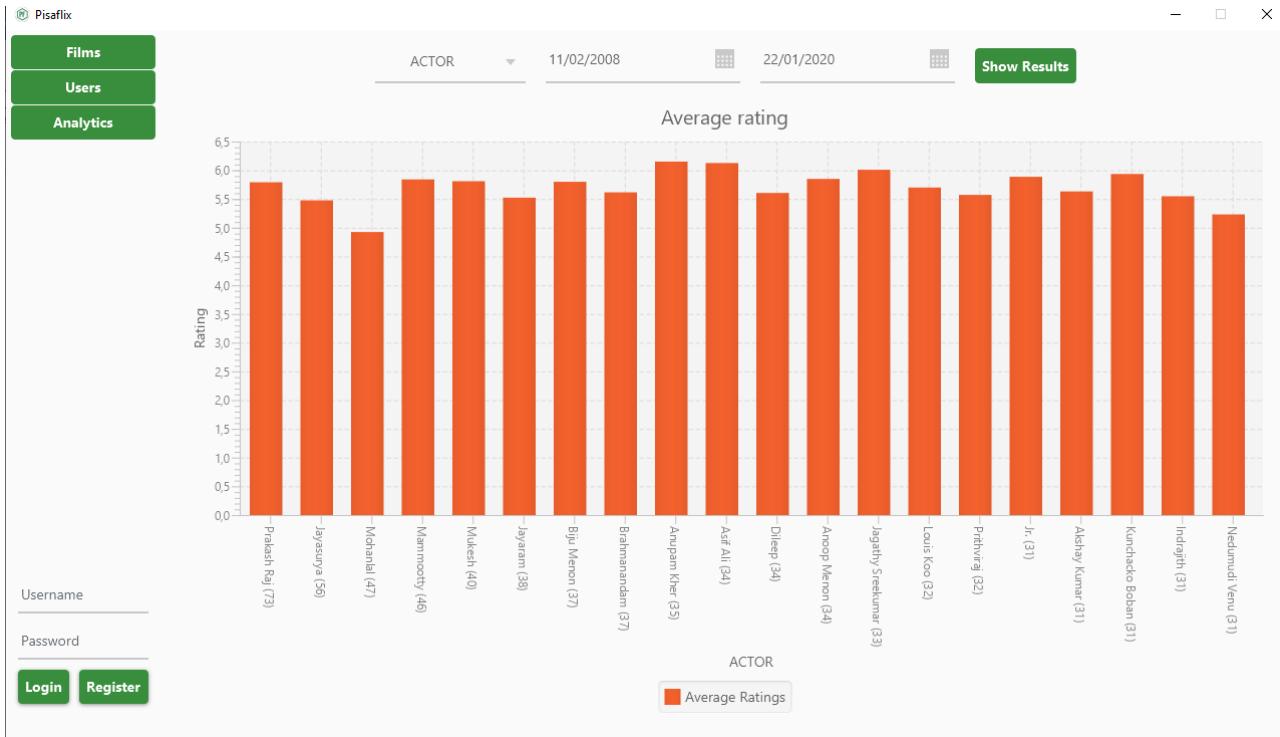
It is possible to select the subject of the analytics from a drop menu:



Then it is necessary to insert Start Date and End Date by either writing them or selecting them from a calendar menu:



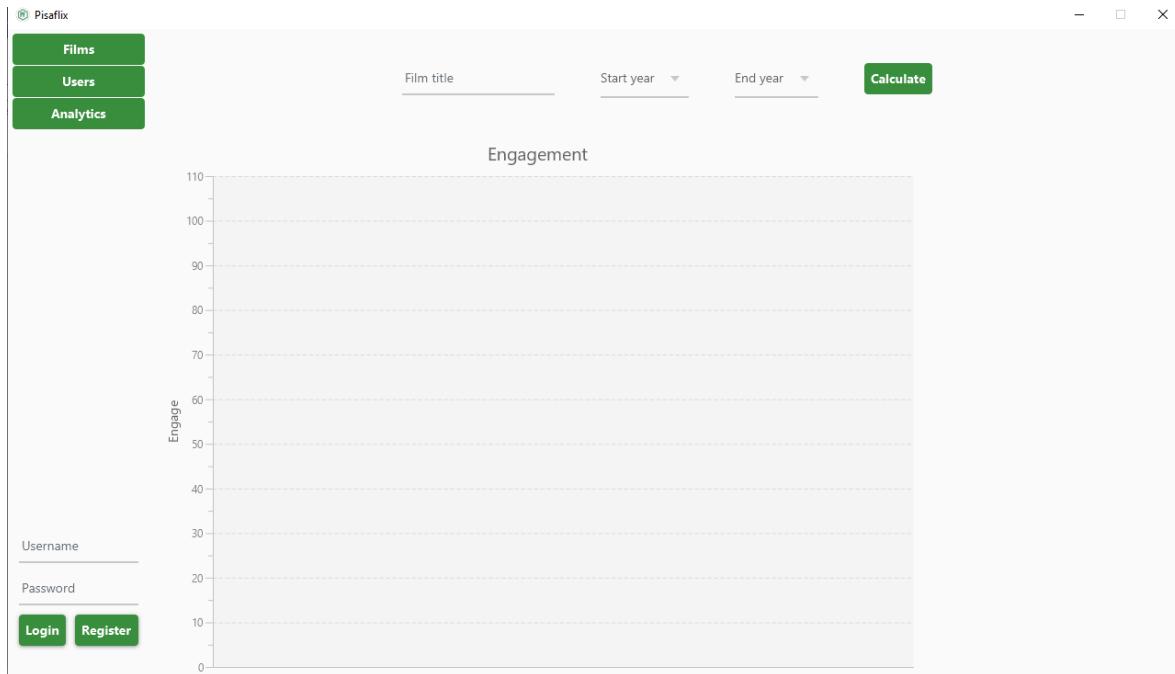
After clicking the “Show Results” button the bar chart will be populated:



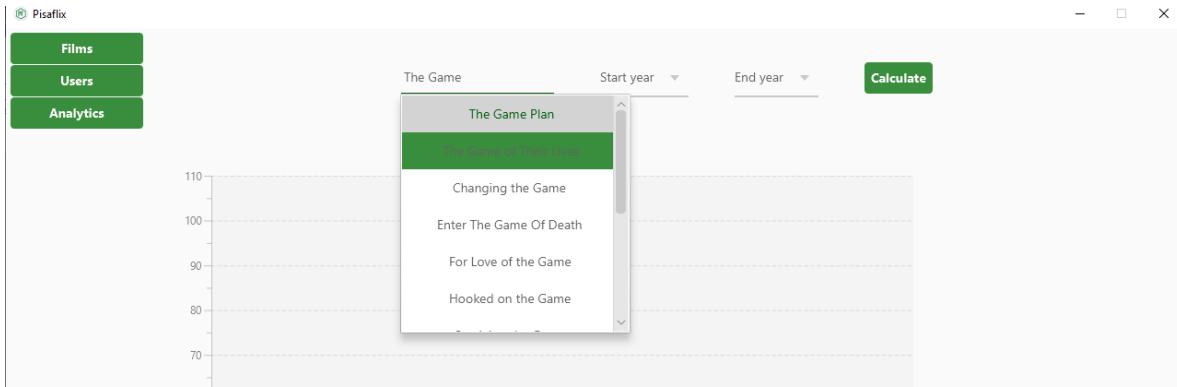
On the Y axis is present the average rating, on the X axis the name of the actor followed by the number of films in which he/she has acted in the specified time interval, the same chart is provided with the other selectable options.

ENGAGEMENT ACTIVITY

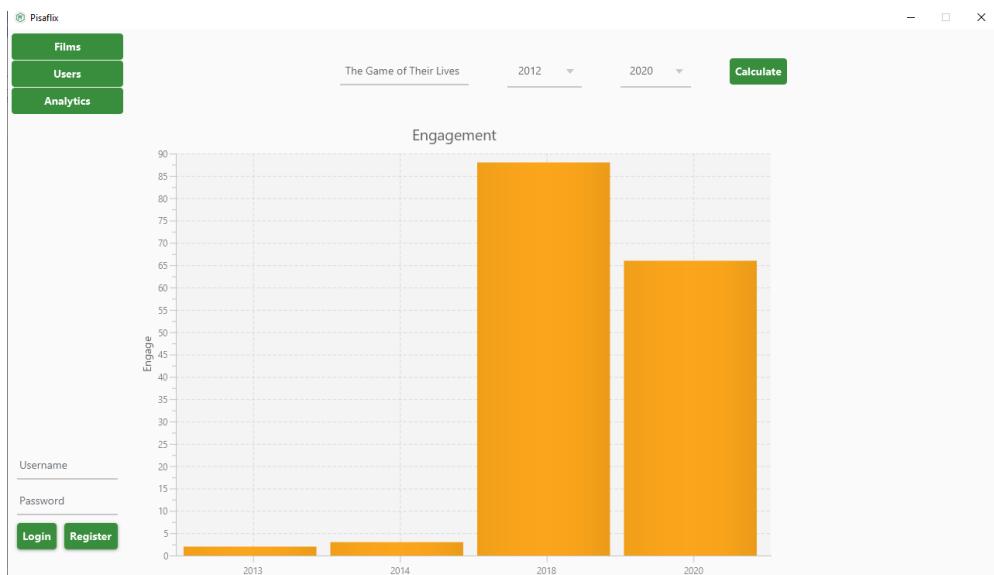
This is the main page:



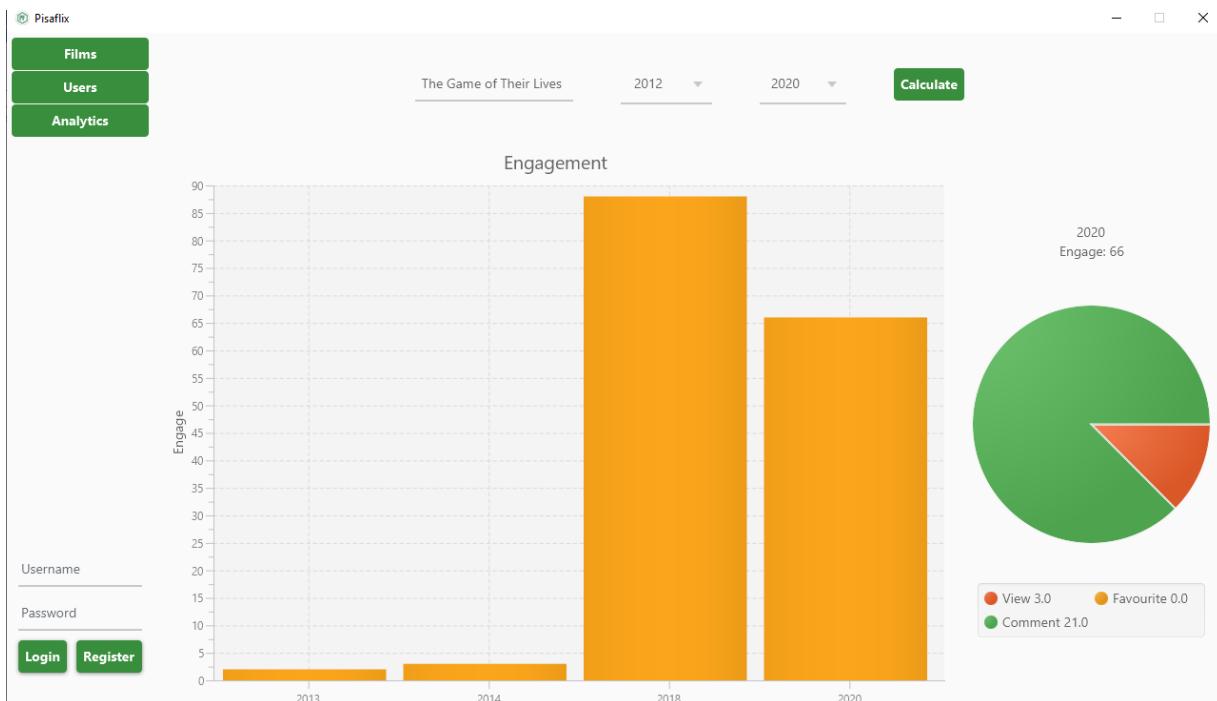
A user can insert a film by searching for it:



After the selection of the start year and the end year and by clicking the “Calculate” button, the bar chart will be populated:



By clicking on one column is it also possible to see a pie chart that explains the proportions of all the different components that contributed to the engagement value of that year:



RANKING

This is the main page:

The screenshot shows the Pisaflix application interface. On the left, there is a sidebar with three buttons: 'Films' (selected), 'Users', and 'Analytics'. The main area has a search bar with dropdown menus for 'Type' (set to 'FILM'), 'Start date' (set to '10/02/2011'), and 'End date' (set to '07/02/2020'). A green 'Show results' button is to the right. Below the search bar is a table header with columns 'Rank', 'Title/Username', and 'Score'. A message 'Nessun contenuto nella tabella' (No content in the table) is displayed. At the bottom left are 'Username' and 'Password' input fields, and 'Login' and 'Register' buttons.

After selecting either “FILM” or “USER” from the drop-down menu, and inserting the two required dates, by clicking on the “Show results” button the table will be populated:

The screenshot shows the same Pisaflix interface after applying the search filters. The table now contains 14 rows of results, each showing a rank, title, and score. The table has a vertical scrollbar on the right. The results are as follows:

Rank	Title/Username	Score
1	Eastern Promises	73
2	Sunshine	72
3	The Adventures of Pinocchio	72
4	Do Knot Disturb	72
5	Dude, Where's My Car?	72
6	Johnny Rocco	71
7	Forever Female	71
8	Decameron Nights	71
9	The Merry Widow	71
10	Unnudan	71
11	Athadu	70
12	The Bat	70
13	Kachche Dhaage	70
14	Olanlar Oldu	70

At the bottom left are 'Username' and 'Password' input fields, and 'Login' and 'Register' buttons.

The various results will be arranged by their score on the table showing the top twenty entities, it is also possible to double click on a film/user to visit its detail page.

