UNIVERSITÀ DEGLI STUDI DI MESSINA

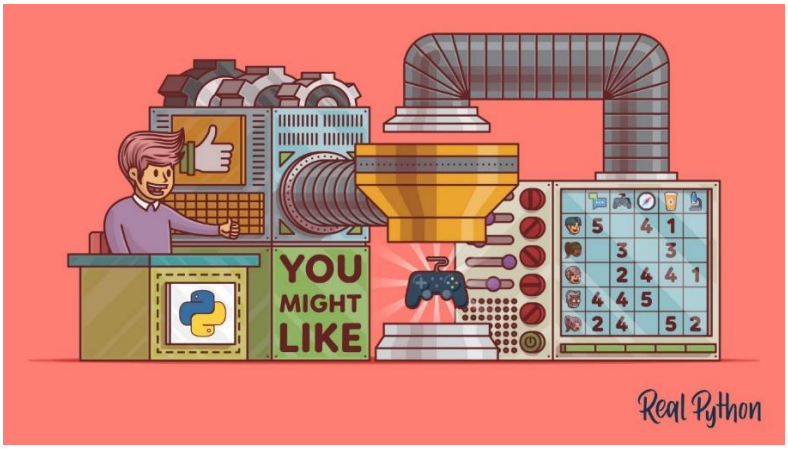
DIPARTMENT:

Scienze matematiche e informatiche, scienze fisiche e scienze della terra

DEGREE COURSE:

INFORMATICA

Software Development Project Report



Movie Recommendation System By Bot

By: Tien M. Nguyen

Guided by: Professor Distefano Salvatore

Academic year 2017-2018

Contents

I. Overview

1. Introduction

This is a project report for Software Engineering at the University of Messina taught by Professor Distefano Salvatore. The purpose of the project is to apply a process to create a complete system software product.

The idea of the system can be chosen freely with the consent of the professor and will be presented below.

The product development process I use is Scrum, one of the most popular frameworks for Agile implementation. I work on this project alone and I will play all three main roles in a Scrum project. Taking on all three roles in Scrum is not recommended because Scrum in particular and software development processes in general were born to solve problems related to independent interpersonal cooperation.

2. Project Idea

The idea of the project came from the idea of researching and building recommendation systems. From there, we create a system that can be applied the recommendation system.

II. Software process

1. Chosen process: Scrum

Scrum is one of the most popular frameworks for Agile implementation. Scrum focuses on managing iterative development rather than specific Agile practices.

2. Why Scrum?

As I say in the first section, Scrum is an Agile framework that is particularly suited for complex projects with rapidly changing requirements, which is often the case in software development. In this project, requirements change based on recommendation systems research is very likely to happen, so Scrum or Agile in general is a reasonable choice for this project. Additionally, Scrum allows for frequent iterations and feedback loops, which can help ensure that the final product meets the needs of stakeholders.

Mention of stakeholders, because this project only has the participation of one person, traditional Agile will not be suitable because all the members in the team will share all roles, all responsibilities. With Scrum, there is a clear division of roles in the three positions of Product Owner, Scrum Master and Development Team which makes it easier to simulate a team using this methodology. I can still understand the difficulty of each position in the project through the work that role needs to do.

Furthermore, Scrum can help ensure that the project remains on track and that potential issues are identified and addressed early on in the development process. Scrum's emphasis on frequent communication and collaboration can help ensure that all members of the team are aware of any potential issues and are working together to address them.

Overall, choosing Scrum can help ensure that the final product meets the needs of stakeholders, is delivered on time, and is of high quality.

3. Three phases in Scrum

There are three phases in Scrum:

- Initial phase: in this phase we establish the general objective for the project and design the software architecture. This phase includes the processes related to initiation of a project: Create Project Vision, Identify Stakeholder(s), Scrum Master and Product Owner, Form Scrum Team, Create Prioritized Product Backlog, and Conduct Release Planning.
- Sprint cycle phase: this is a series of sprint cycles, where each cycle develops an increment of the system. This phase includes the processes related to implementation of a project: Create Deliverables, Conduct Daily Standup, Groom Prioritized Product Backlog, and Deliver Deliverables.
- Project closure phase: wraps up the project, completes required documentation such as system help frames and user manuals and assesses the lessons learned from the project. This phase includes the processes related to releasing a project: Ship Deliverables and Retrospect Project.

4. Three main roles in Scrum

There are three main roles in Scrum:

- Product Owner: The Product Owner is responsible for maximizing the value of the product resulting from the work of the Development Team. They are also responsible for managing the Product Backlog. They do analysis, are business-oriented, do external interactions-interface. They will keep the team Build the right thing.
- Scrum Master: The scrum master is responsible for ensuring that Scrum is understood and enacted by all team members and stakeholders. They are servant leader, advisor, coach, mentor, facilitator. They will keep the team Build it fast.
- Development Team: The development team is responsible for delivering a potentially releasable increment of “Done” product at the end of each Sprint. They are self-management or self-organizing. They will keep the team Build things right.

5. Sprint cycle

Sprint are fixed length, normally 2-4 weeks. In this project one sprint is 5 working days.

Usually, each sprint will have 4 phases:

- Planning: before each sprint, the team selects what it will commit to delivering by the end of the sprint, starting at the top of the product Backlog. During the sprint, what the team committed to deliver does not change, and the end-date of the sprint does not change. If something major comes up, the Product Owner can direct the team to terminate the Sprint prematurely and start a new one.

- Implementation – Daily Scrum Meeting: each day, the team has a short meeting to update each other on progress and surface blocks. They stand up, to keep it fast. To keep the meeting to less than 15 minutes, everyone reports just 3 things: done since yesterday, done by tomorrow, and blocks. Burndown Chart are necessary for the team to successfully self-manage.
- Review: at the end of the sprint, the Product Owner, Team, Scrum Master, and Stakeholder(s) come together and see a demo of what the team has produced. The Product Owner gathers feedback from everyone on ways to improve what has been built. Review of the timeline, budget, potential capabilities, and marketplace for the next anticipated releases of functionality and capabilities.
- Retrospective: Team, Product Owner, and Scrum Master meet at the end of each Sprint to review their way of working, to improve effectiveness. Usually, it will take 3 hours for one month Sprint. This is the opportunity for the Scrum Team to improve and all members should be in attendance, discussing about: what went well, what could be improved, and what we will commit to improving in the next Sprint.

III. Initial phase

1. Project members

- Product Owner: Nguyen Minh Tien
- SCRUM Master: Nguyen Minh Tien
- Member in Team: Nguyen Minh Tien

Taking on all three roles in SCRUM is not recommended because SCRUM in particular and software development processes in general were born to solve problems related to independent interpersonal cooperation. I must do this project alone because I could not find the right partner at the right time. However, I will try to play each role independently so that I can understand in a project what the roles will contribute.

2. Project ideal

The Ideal of Project is a website where users can get suggested which movies they might like. They will also be able to rate on a 5-point scale the movies they have watched. The system will use a machine learning algorithm to determine which movies users will like based on data given. The more movies they rated, the more accurate the suggested movies would be.

No User Story given.

3. Technologies used

- Git for Source control
  Git is a popular version control system for tracking changes in software code, supporting collaboration, branching, and merging. It is widely used in software development to manage and organize code changes efficiently.
- Draw.io for Designing

Draw.io is a free, online diagramming tool for making flowcharts, UML diagrams, network diagrams, and more. It offers a simple interface, pre-made templates and shapes, collaboration, and integration with other tools. All diagrams in this project are drawn with Draw.io.

- Postman for Testing
  Postman has a GUI and can send and view HTTP requests and responses.
- Azure DevOps for Scrum management
  Azure DevOps is a suite of development tools, services, and features offered by Microsoft for software development teams to plan, develop, test, and deliver software. It includes services for Agile project management, continuous integration and delivery, testing, and more.
- PostgreSQL for Database Management
  PostgreSQL is an open-source object-relational database system that uses and extends the SQL language.
- Django for Backend
  Django is a high-level Python web framework used for developing dynamic and scalable web applications. It provides a clean and efficient way to build and maintain applications, with features such as URL routing, template engine, object-relational mapping, and security features.
- ReactJS for Frontend
  React is a JavaScript library for building user interfaces, commonly used for developing single-page applications and mobile applications. It uses a component-based approach, allowing developers to build complex UIs by composing simple and reusable components. React also uses a virtual DOM for efficient updates and rendering, making it fast and efficient for dynamic applications.

4. Requirements Analysis

In the initial iteration, I prioritized rapid development of the ideal solution and analyzed the data to identify the suitable machine learning models for the data.

The software will allow the user to perform the various functions:

- Create Account
- Login
- Search for movie
- Get suggested movie
- See a list of movies
- See a specific movie
- Rate a movie
- Logout

The “Create Account” operation allows a new user or guess who has just had access to the software to be able to register and access the software functions. Registration is required since we need user rating movie data.

The “Login” operation allows a user who already has access to the application to be able to reconnect to the system by entering the same data that he entered during the previous registration period.

The “Search for Movie” operation will allow a logged in user to find the exact movie they want to rate.

The “Get Suggested Movie” operation will allow a logged in user to get their might-like movies by the machine learning algorithm.

The “See a list of movies” operation will allow a logged in user to get a list after the operations “Search for Movie” or “Get Suggested Movie”.

The “Rate a Movie” operation will follow the “Search for Movie” which will allow user to rate a movie and save the rate in the database, maybe a function “Remove a Rate” will appear in the future.

The “Get Suggested Movie” operation is the main operation which will allow a user to get their suggested movies that they might like to depend on the machine learning model we develop.

Finally, the “Logout” operation will allow a logged in user to logout from system. Users will need to login again if they need to do any other action on the next connection.

4.1. Functional requirements

Functional requirements refer to the product features or functions that must be implemented by the development team to enable users to carry out their tasks. It is important to make these requirements clear for both the development team and stakeholders. Typically, functional requirements describe the system's behavior in specific circumstances. Below are functional requirements for software:

FR.1: Authenticate Management:

- FR.1.1: Registration User
- FR.1.2: Verify User

FR.2: Movie Management:

- FR.2.1: Movie Searching
- FR.2.2: Movie Suggestion

FR.3: Rating Management:

- FR.3.1: Create Rating

4.2. Non-functional requirements

Nonfunctional requirements, not related to the system functionality, rather define how the system should perform. Below are non-functional requirements for software:

NFR.1: Friendly Graphic User Interface.

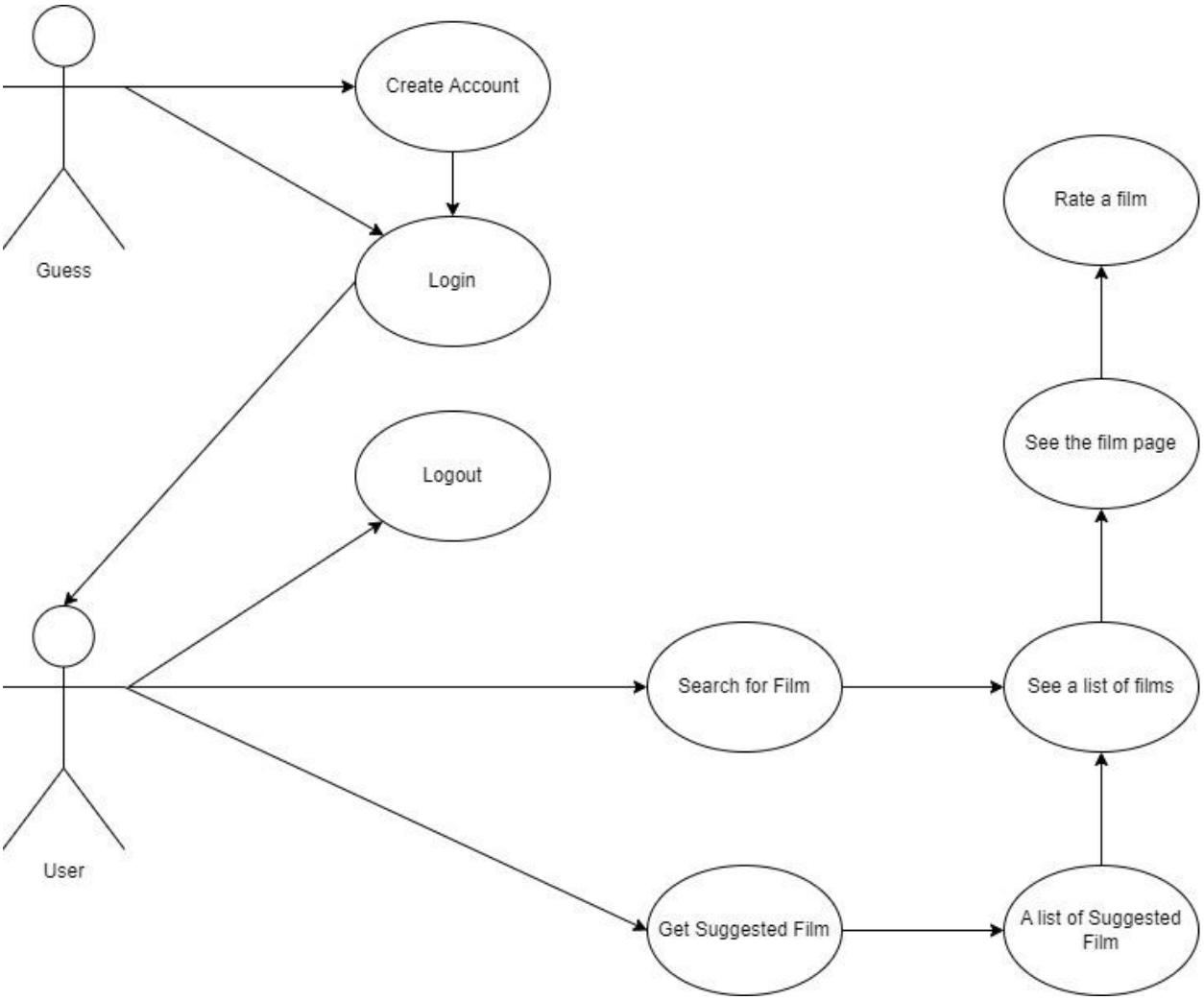
NFR.2: Multiplatform compatible.

NFR.3: Fast response to user.

NFR.4: Movie cover should be available.

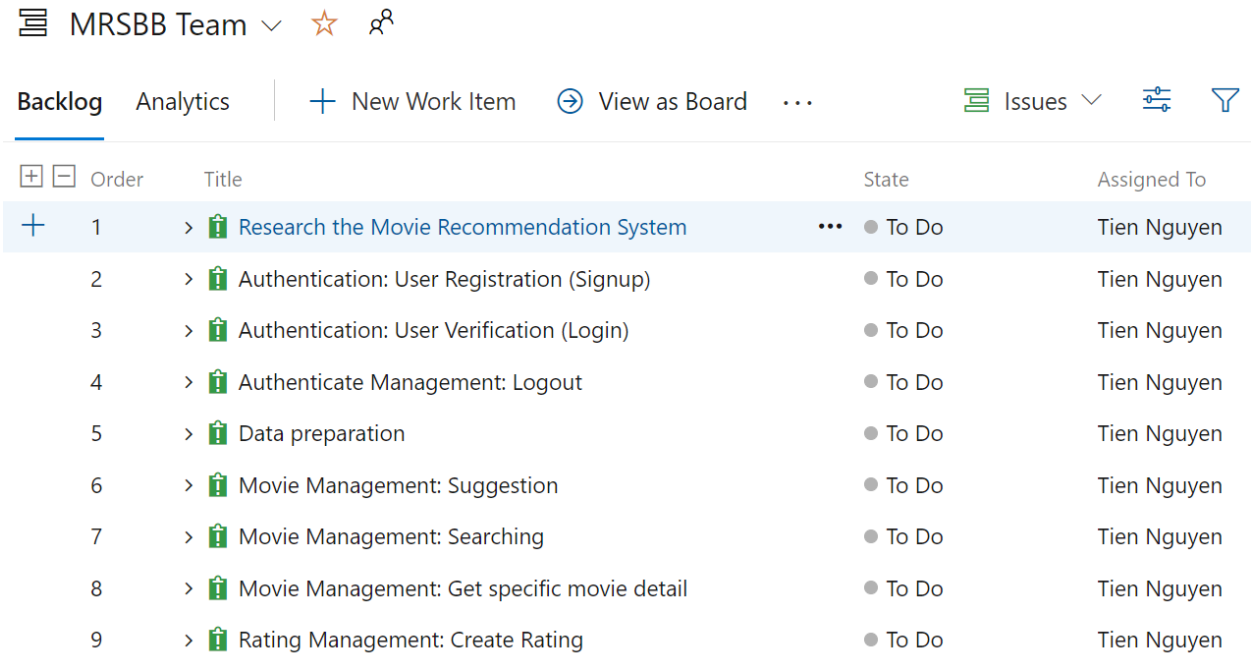
4.3. Use case diagram

The specifications for the first software prototype involve a thorough analysis of the customer requirements, which is important and requires careful attention as it determines whether the customer's needs goods are met or not. A "use case diagram" will be used to describe the relationship clearly and accurately between users and the actions they can take while using the software.



5. Backlog refinement

From the Requirements Analysis, as a Product Owner, I have refined the backlog as follows (priority order is from top to bottom).



Order	Title	State	Assigned To
1	Research the Movie Recommendation System	To Do	Tien Nguyen
2	Authentication: User Registration (Signup)	To Do	Tien Nguyen
3	Authentication: User Verification (Login)	To Do	Tien Nguyen
4	Authenticate Management: Logout	To Do	Tien Nguyen
5	Data preparation	To Do	Tien Nguyen
6	Movie Management: Suggestion	To Do	Tien Nguyen
7	Movie Management: Searching	To Do	Tien Nguyen
8	Movie Management: Get specific movie detail	To Do	Tien Nguyen
9	Rating Management: Create Rating	To Do	Tien Nguyen

6. Project estimation

There will be three approaches to building a Recommendation System so the First Issue will take 3 Sprints to complete.

At the same time, we can complete the authentication system in 2 Sprints and Data preparation in 1 Sprint.

There will be one last Sprint for combining components into a complete system.

All the designs will be done in Sprint where the feature or system is in “Doing” status.

Testing will take place right when a feature is in “Done” status as unit tests. The final test phase will take place when all the system is done as a system test.

So, there will be 4 Sprints:

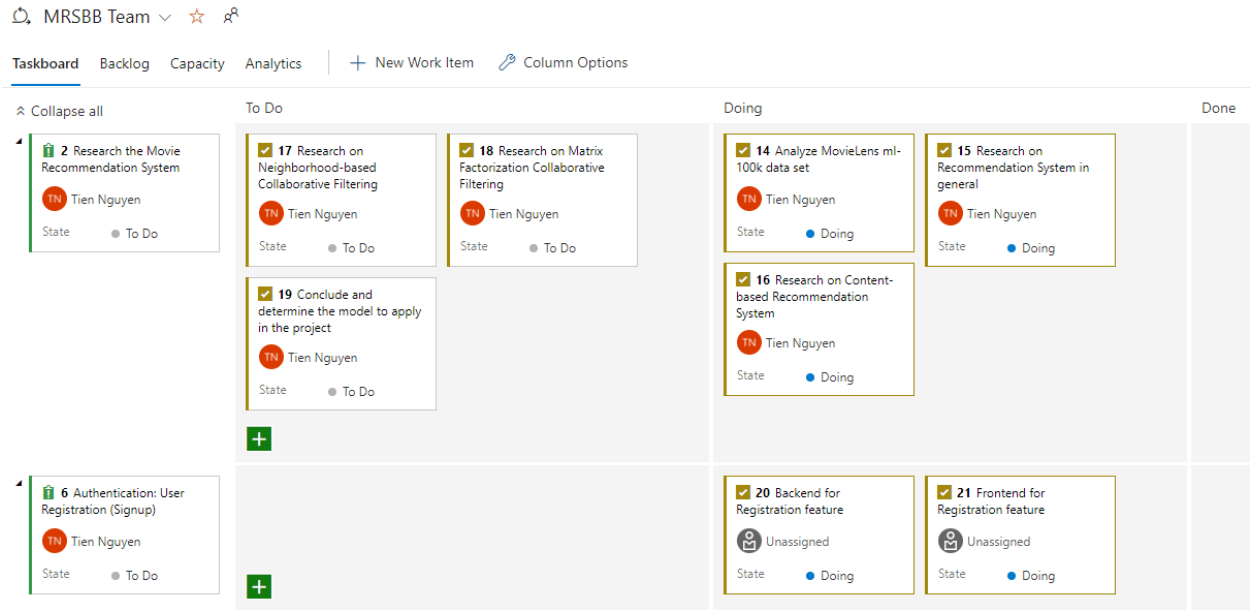
1. Sprint 1 runs from 2nd Jan to 6th Jan (5 working days). Issues: 1,2.
2. Sprint 2 runs from 9th Jan to 13th Jan (5 working days). Issues: 1,3,4.
3. Sprint 3 runs from 16th Jan to 20th Jan (5 working days). Issues: 1,5.
4. Sprint 4 runs from 23rd Jan to 27th Jan (5 working days). Issues: 6,7,8,9.

IV. Sprint cycles

1. Sprint 1

1.1. Planning

As we discussed in section III.5 Project estimation, in this Sprint, Issues 1 and 2 will be taken care of. All the tasks for these two issues are as below:



1.2. Implementation

The result of Analyze MovieLens ml-100k data set appears in the document: “Recommendation_System”.

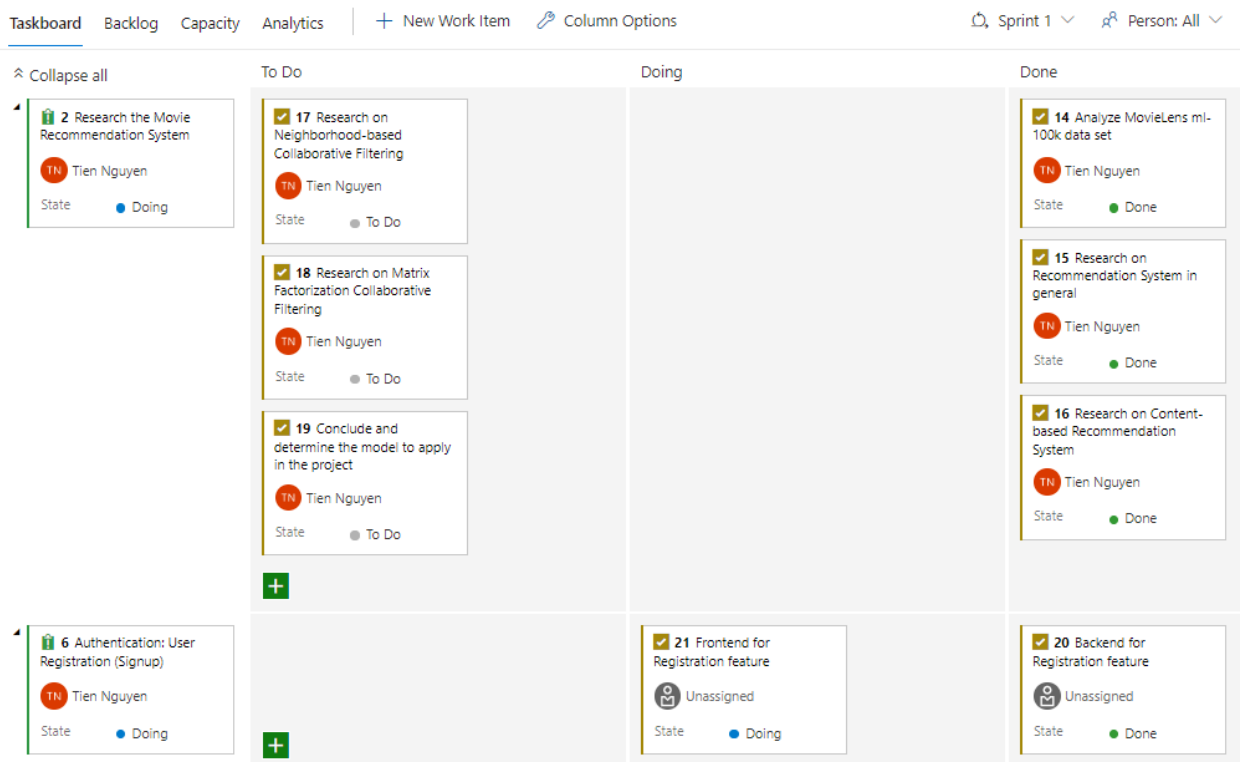
The result of Research on Recommendation System in general appears in the document: “Recommendation_System”.

The result of Research on Content-based Recommendation System appears in the document: “Recommendation_System”.

For Backend for Registration feature, I use Django for rapid development since its authentication system can be developed with a few configurations.

For Frontend for Registration feature, I use ReactJS, a popular JavaScript library for building user interfaces.

1.3. Review



After the first Sprint, most of the tasks set out have been completed. However, because I spent too much time learning about the recommendation system, I could not complete the authentication function.

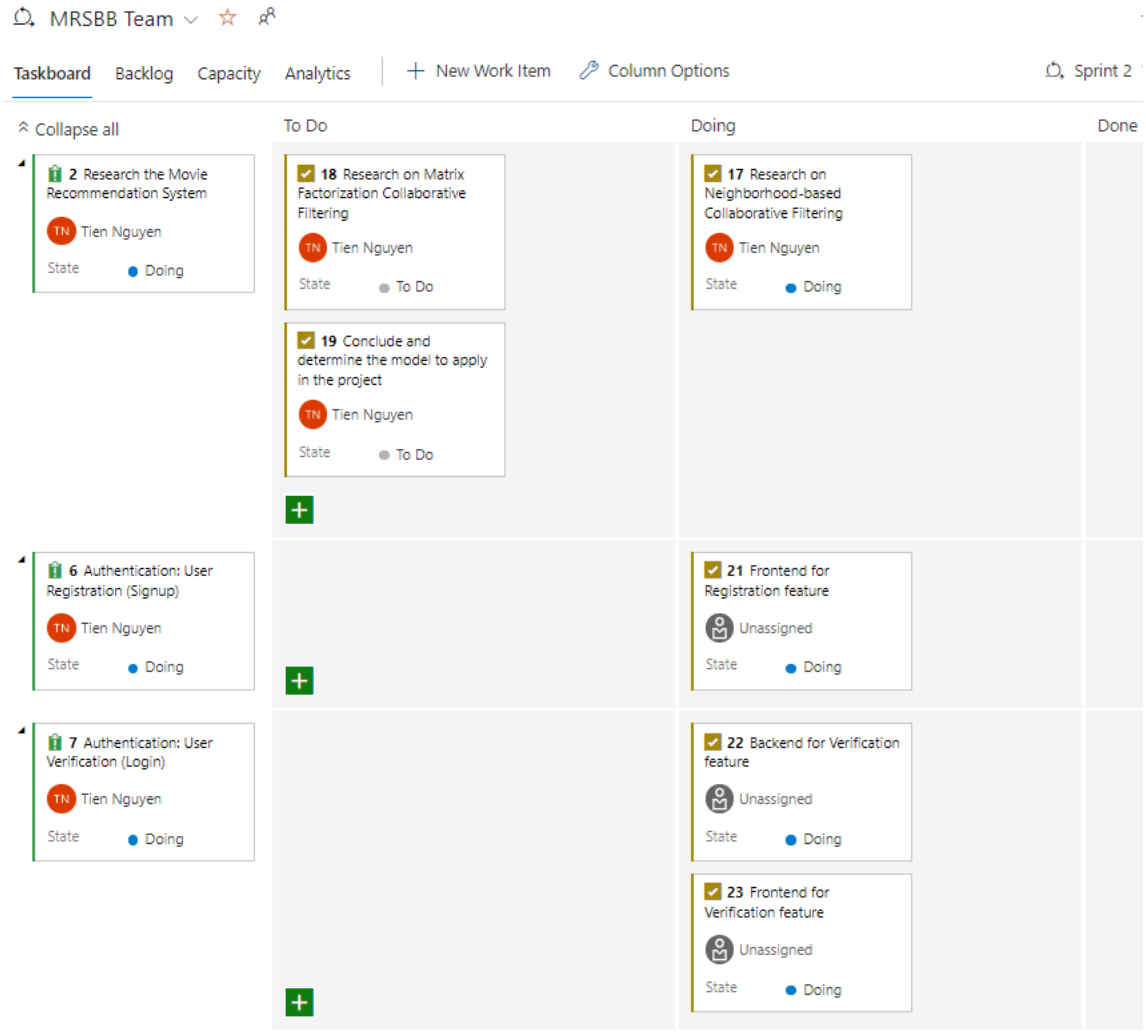
1.4. Retrospective

Certainly, in the next Sprint the time spent on the recommendation system will be reduced because the background knowledge has been learned in this Sprint. I'll have to try to build the authentication function in the next Sprint.

2. Sprint 2

2.1. Planning

As we discussed in section III.5 Project estimation, in this Sprint, Issues 1, 3 and 4 will be taken care of. All the tasks for these two issues are as below:



2.2. Implementation

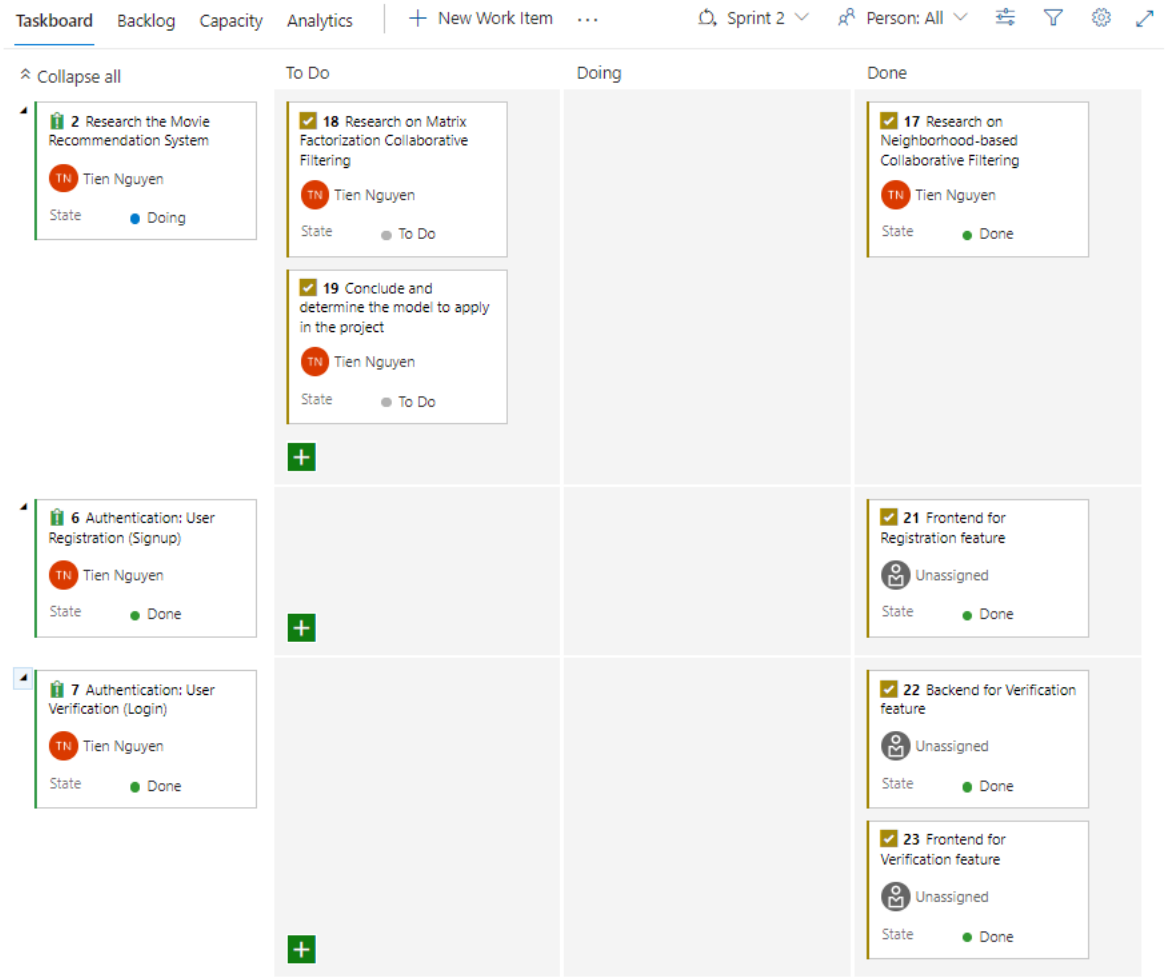
The result of Research on Neighborhood-based Collaborative Filtering appears in the document: “Recommendation_System”.

For Backend for Verification feature, I use Django for rapid development since its authentication system can be developed with a few configurations.

For Frontend for Verification feature and Frontend for Registration feature, I made it with ReactJS.

2.3. Review

So, what I planned for this week is done. I have finished tuning Django as well as creating a GUI with the help of the ReactJS framework.



2.4. Retrospective

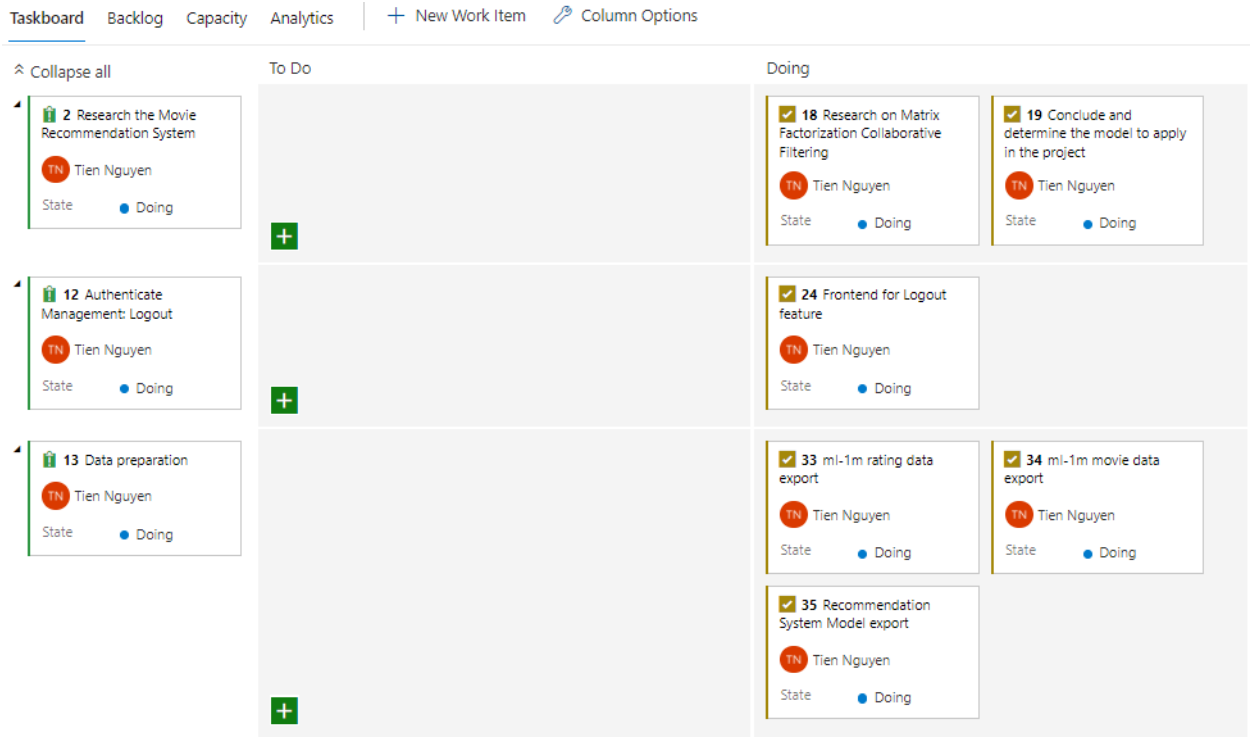
In the next week, I will research another algorithm for the Recommendation System from which to conclude and choose the best option for this project.

Along with that is to apply that recommendation system model to actual data and hope to be able to complete the application soon.

3. Sprint 3

3.1. Planning

As we discussed in section III.5 Project estimation, in this Sprint, Issues 1 and 5 will be taken care of. All the tasks for these two issues are as below:



3.2. Implementation

The result of Research on Matrix Factorization Collaborative Filtering appears in the document: “Recommendation_System”.

The result of Research on Conclude and determine the model to apply in the project appears in the document: “Recommendation_System”.

For Frontend for Logout feature, in client side I remove session so that user need to login again.

For Frontend for Verification feature and Frontend for Registration feature, done.

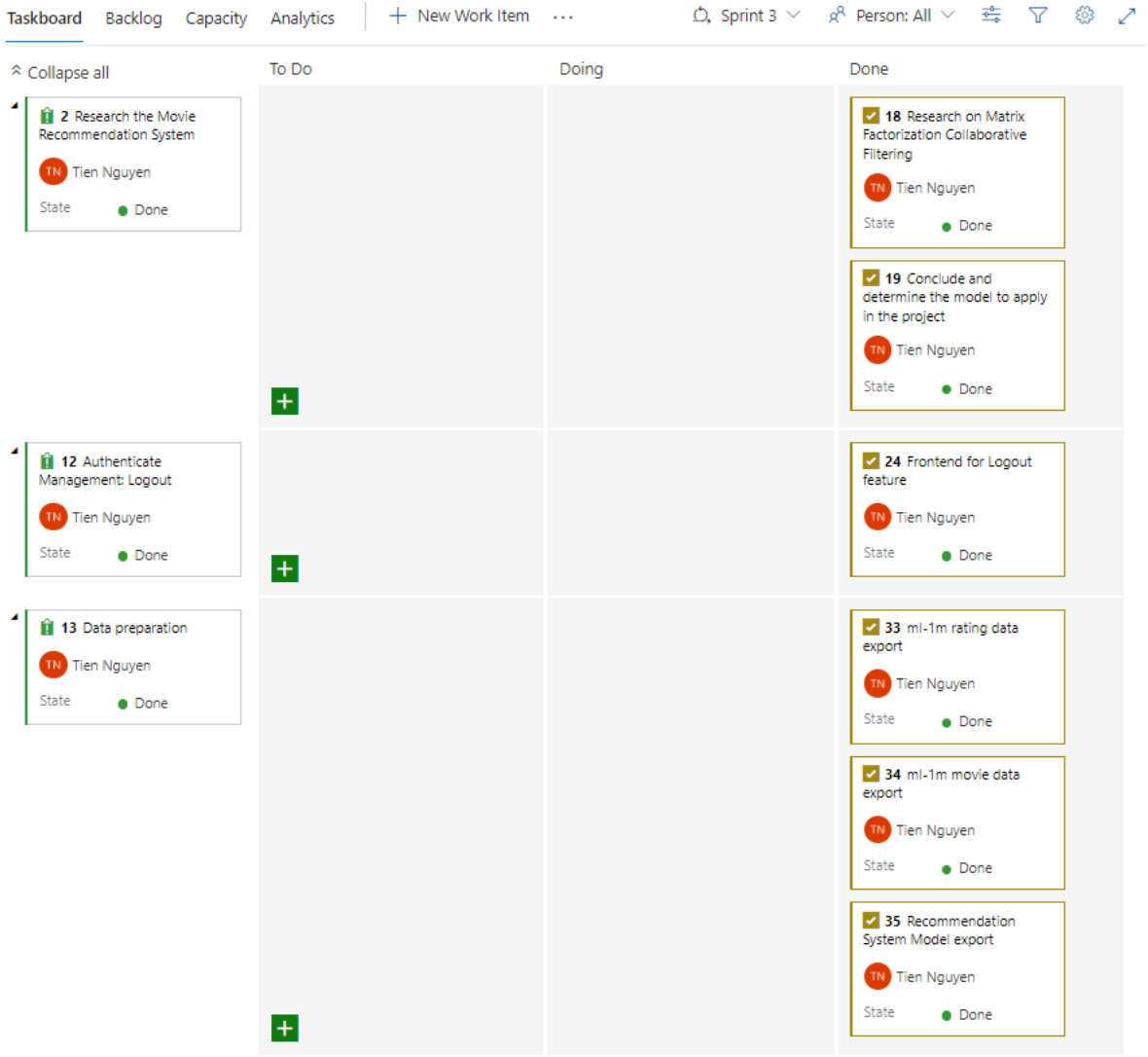
The result of ml-1m rating data export appears in the document: “Data_Preparation”.

The result of ml-1m movie data export appears in the document: “Data_Preparation”.

The result of Recommendation System Model export appears in the document: “Data_Preparation”.

3.3. Review

So, what I planned for this week is done. I have finished all the tasks taken.



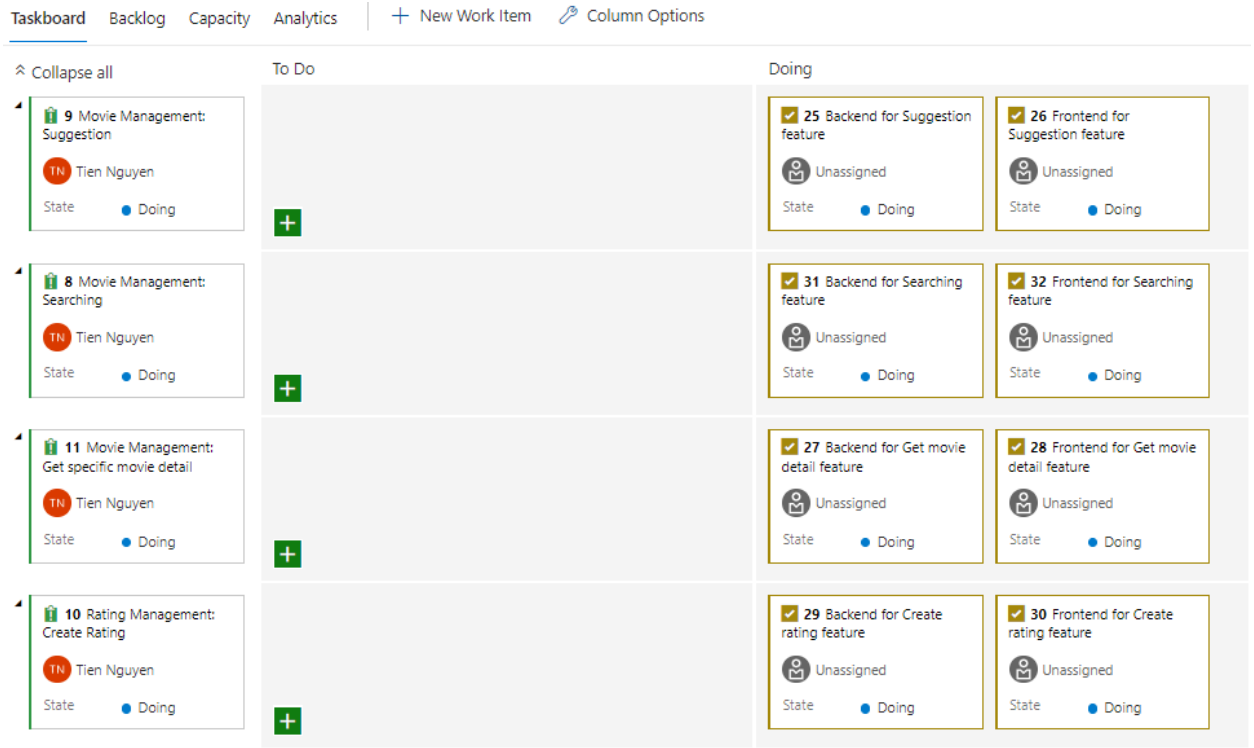
3.4. Retrospective

Perhaps if there are more requests from customers in the future, the Backend will have to change the framework to be able to customize it more deeply as well as master the logic thereby limiting security issues even though Django is supported by the community quite well. good but maybe one day there will be a zero-day vulnerability.

4. Sprint 4

4.1. Planning

As we discussed in section III.5 Project estimation, in this Sprint, Issues 6,7,8 and 9 will be taken care of. All the tasks for these two issues are as below:

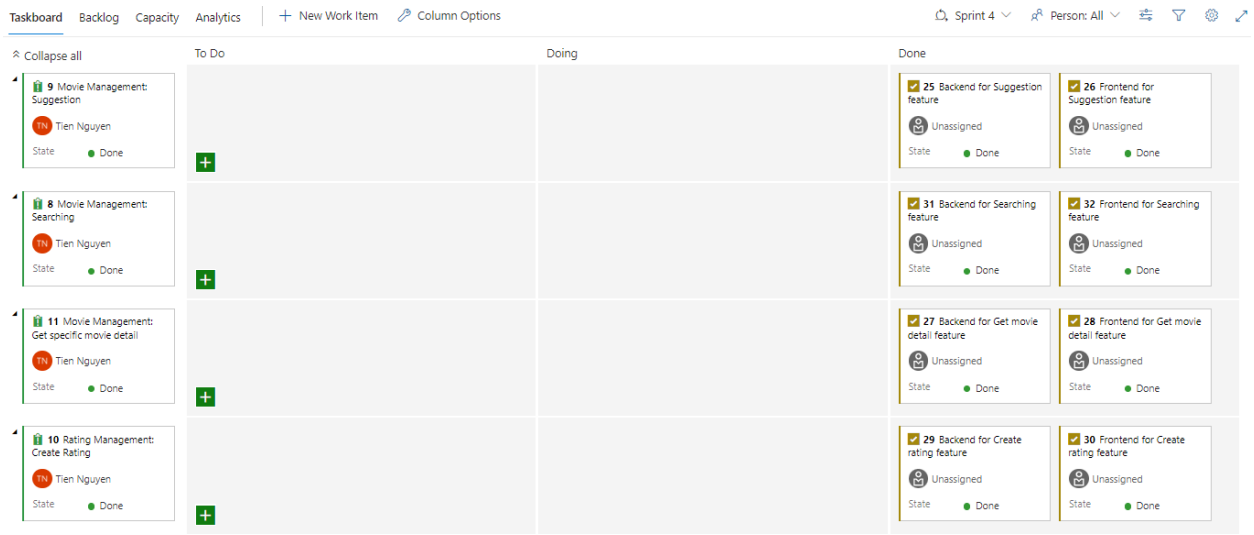


4.2. Implementation

All the tasks done by development.

4.3. Review

All the tasks done by development.



4.4. Retrospective

Perhaps if there are more requests from customers in the future, the Backend will have to change the framework to be able to customize it more deeply as well as master the logic thereby limiting security issues even though Django is supported by the community quite well. good but maybe one day there will be a zero-day vulnerability.

V. Project termination

1. Reason why project was terminated

After presenting the project progress to the Stakeholders, there were some points they were not satisfied with, and the Product Owner decided to immediately stop the project and start over.

Stakeholders: Professor Distefano Salvatore, Nguyen Minh Tien.

2. Product Owner mistakes

The Sprints are not properly described: the product and sprint backlog are incomplete; description is missing as well as priority assignment and task identification.

There is no role such as Admin who can manage movies and users.

3. Scrum Master mistakes

In the retrospective there are no burndown charts.

Django is good for rapid development but it's hard to deeply control the whole system.

And because of using Django, we are forced to use a RDBMS which is not good for machine learning model.

4. Development Team mistakes

Final design is missing, there are no architectural diagrams such as component/deployment/class diagrams explain the architectural, its components and the overall software system organization.

There is no algorithm design, which can be represented by activity, sequence/collab or state chart diagram.

The testing phase is missing.

There is quite a long description of the recommendation system, but it should be contextualized with the requirements and associated with specific tasks identified in the sprint backlog.

VI. Initial phase (2nd)

1. Project members

- Product Owner: Nguyen Minh Tien
- Scrum Master: Nguyen Minh Tien
- Development Team member: Nguyen Minh Tien.

Taking on all three roles in SCRUM is not recommended because SCRUM and software development processes in general were born to solve problems related to independent interpersonal cooperation.

2. Project Ideal

The Ideal of Project is a website where users can get suggested which movies they might like. They will also be able to rate on a 5-point scale the movies they have watched. The system will use a machine learning algorithm to determine which movies users will like based on data given. The more movies they rated, the more accurate the suggested movies would be.

3. User Story

The system should be divided into three separate components: Database, Backend, Frontend.

Backend will connect to Database through a driver library, Backend and Frontend will communicate with each other via HTML Request.

Database is optional and does not have to be noticed. The only note is to ensure the security of the data.

The Backend must be developed as can release designs in the end explaining to the Stakeholders the algorithms and mechanisms therein.

The Frontend will need the following features for users: Create Account, Login, Logout, etc. for Authentication; After login successfully, user can access to these features:

- Search Movie
  There will be an input form and users can get a list of movies matched to what they type.
- Suggest Movie
  Recommendation system will give users top movies they might like.

After clicking on any movie on the movies list, users will turn to a page where they can see more details about the movie, here users can create rating or update rating and delete rating.'

4. Reuse from terminated Scrum

- Data extraction
- Frontend with ReactJS Library
- Movie Recommendation System Research

5. Technologies used

- Git for Source control.
- Draw.io for Designing.
- Postman for Unit test.
- Azure Dev for Scrum management and CICD.
- Microsoft Azure for Deployment.
- MongoDB instead of ~~PostgreSQL~~ for Database.

- Flask Framework instead of ~~Django Framework~~ for Backend.
- ReactJS library for Frontend.

6. Requirements Analysis

6.1. User requirements

The software will allow the user to perform the various functions:

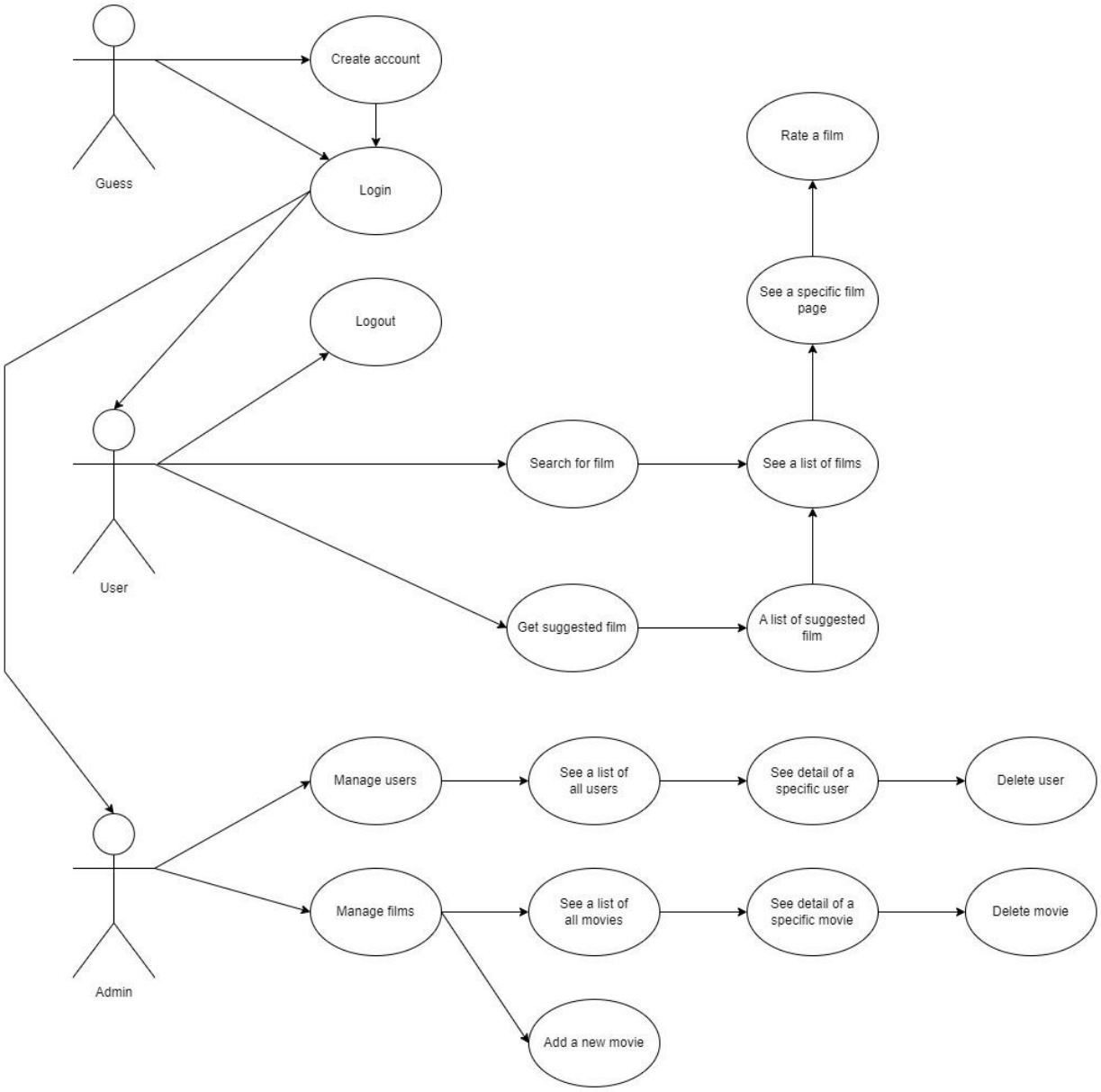
- Create Account
- Login
- Logout
- Search for movie
- Get suggested movie
- Get a specific movie detail
- Create new rating
- Read existed rating
- Update existed rating
- Delete existed rating

If the logged in user is an Admin, they will be able to perform the various functions:

- Login
- Logout
- Get a list of all users
- Get a specific user detail
- Delete a specific user
- Get a list of all movies
- Get a specific movie detail
- Delete a specific movie
- Add a new movie

6.2. Use case diagram

From the Functional Requirements analyzed in the previous section, I have come up with a use case diagram as follows:



6.3. Functional requirements

Functional requirements refer to the product features or functions that must be implemented by the development team to enable users to carry out their tasks. It is important to make these requirements clear for both the development team and stakeholders. Typically, functional requirements describe the system's behavior in specific circumstances. Below are functional requirements for software:

FR.1: User Authenticate Management:

- FR.1.1: User Registration
- FR.1.2: User Login
- FR.1.3: User Verification
- FR.1.4: User Logout
- FR.1.5: User Load

FR.2: Movie Management:

- FR.2.1: User Search Movie
- FR.2.2: User Get Movie Details

FR.3: Rating Management:

- FR.3.1: User Create Rating
- FR.3.2: User Read Rating
- FR.3.3: User Update Rating
- FR.3.4: User Delete Rating

FR.4: Recommendation System:

- FR.4.1: User Get Suggested Movies
- FR.4.2: User Get Prediction For A Movie

FR.5: Admin Authenticate Management:

- FR.5.1: Admin Login
- FR.5.2: Admin Logout
- FR.5.3: Admin Load

FR.6: Admin Users Management:

- FR.6.1: Admin Get All Users
- FR.6.2: Admin Get User Details
- FR.6.3: Admin Delete User

FR.7: Admin Movies management:

- FR.7.1: Admin Get All Movies
- FR.7.2: Admin Get Movie Details
- FR.7.3: Admin Add New Movie
- FR.7.4: Admin Delete Movie

6.4. Non-functional requirements

Nonfunctional requirements, not related to the system functionality, rather define how the system should perform. Below are non-functional requirements for software:

NFR.1: Friendly Graphic User Interface.

NFR.2: Multiplatform compatible.

NFR.3: Fast response to user.

NFR.4: Movie cover should be available

NFR.5: User passwords should be encrypted.

6.5. Domain requirements

Since the production will be a web application, domain requirements can include expectations related to performance, scalability and usability. In this project, the domain requirements are:

DR.1: Must have internet connection.

DR.2: Access through a Browser.

6.6. Data Preparation

Since the data set for model training is MovieLens ml-1m: [MovieLens 1M Dataset | GroupLens]

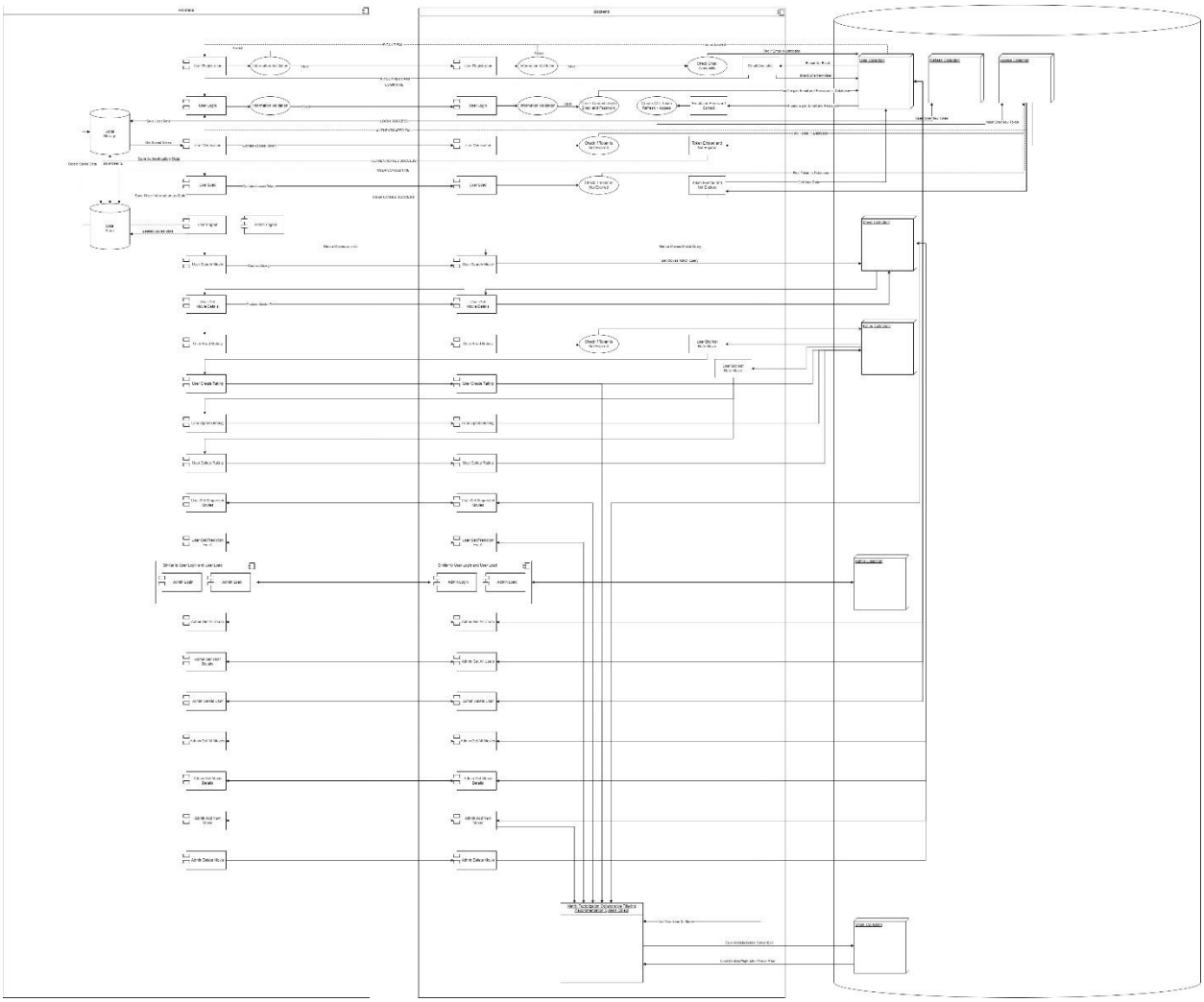
The data is not so clean, so I need to prepare 3 things:

- Ratings with Timestamp
  Last time, when I worked with PostgreSQL database, I needed to turn epoch timestamp to date data type to match SQL data type, but I no longer need it since I now use MongoDB.
- Movies with Poster URLs
  This is needed for NFR.4: Movie covers should be available. BeautifulSoup4 helped me.
- Trained $X, W, b\ and\ d$ to save starting time of Backend
  All 4 elements can be exported as a csv file.

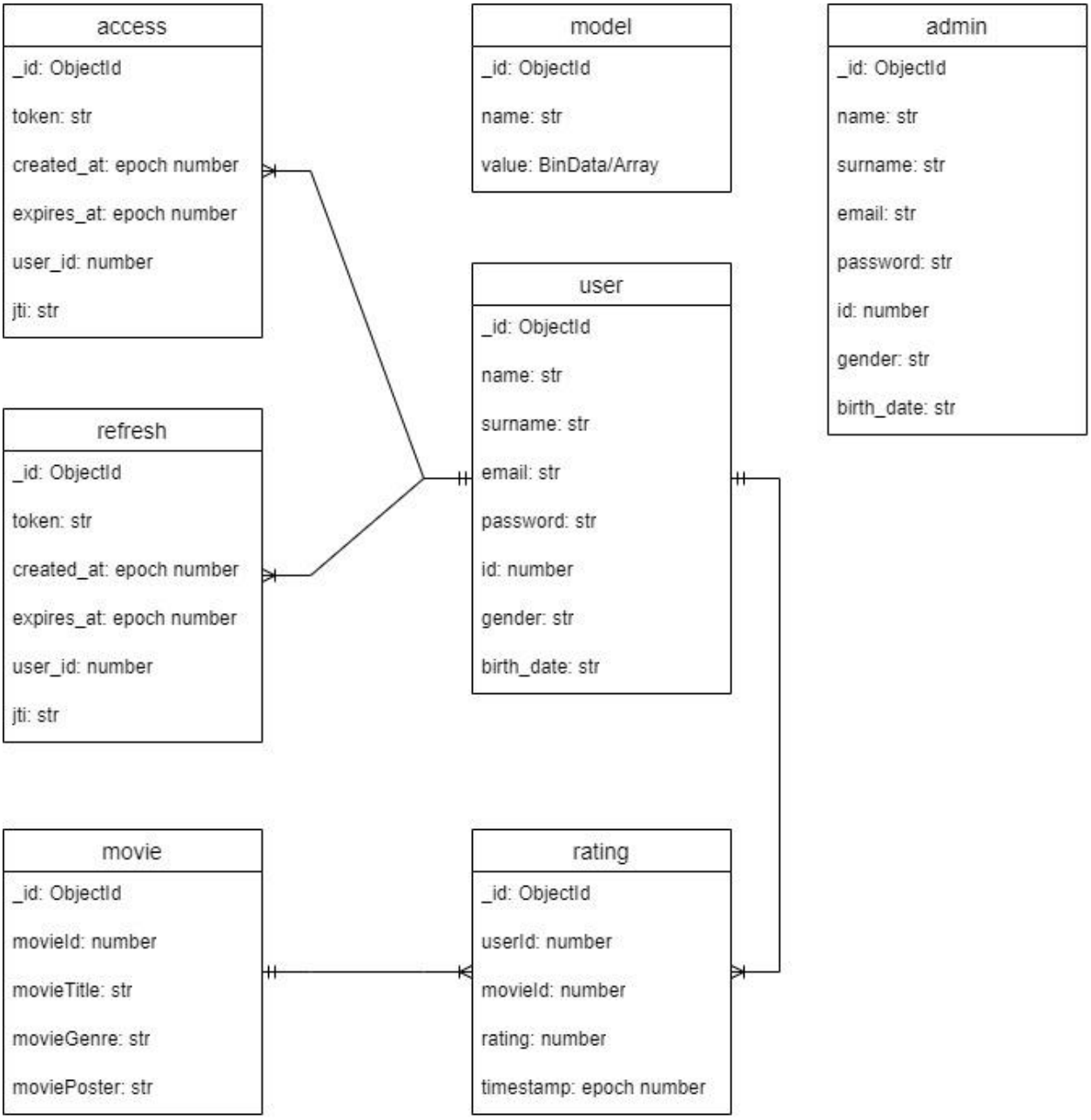
All the code for Data Preparation can be found in data_preparation.ipynb.

7. Architectural Design

7.1. Components Diagram

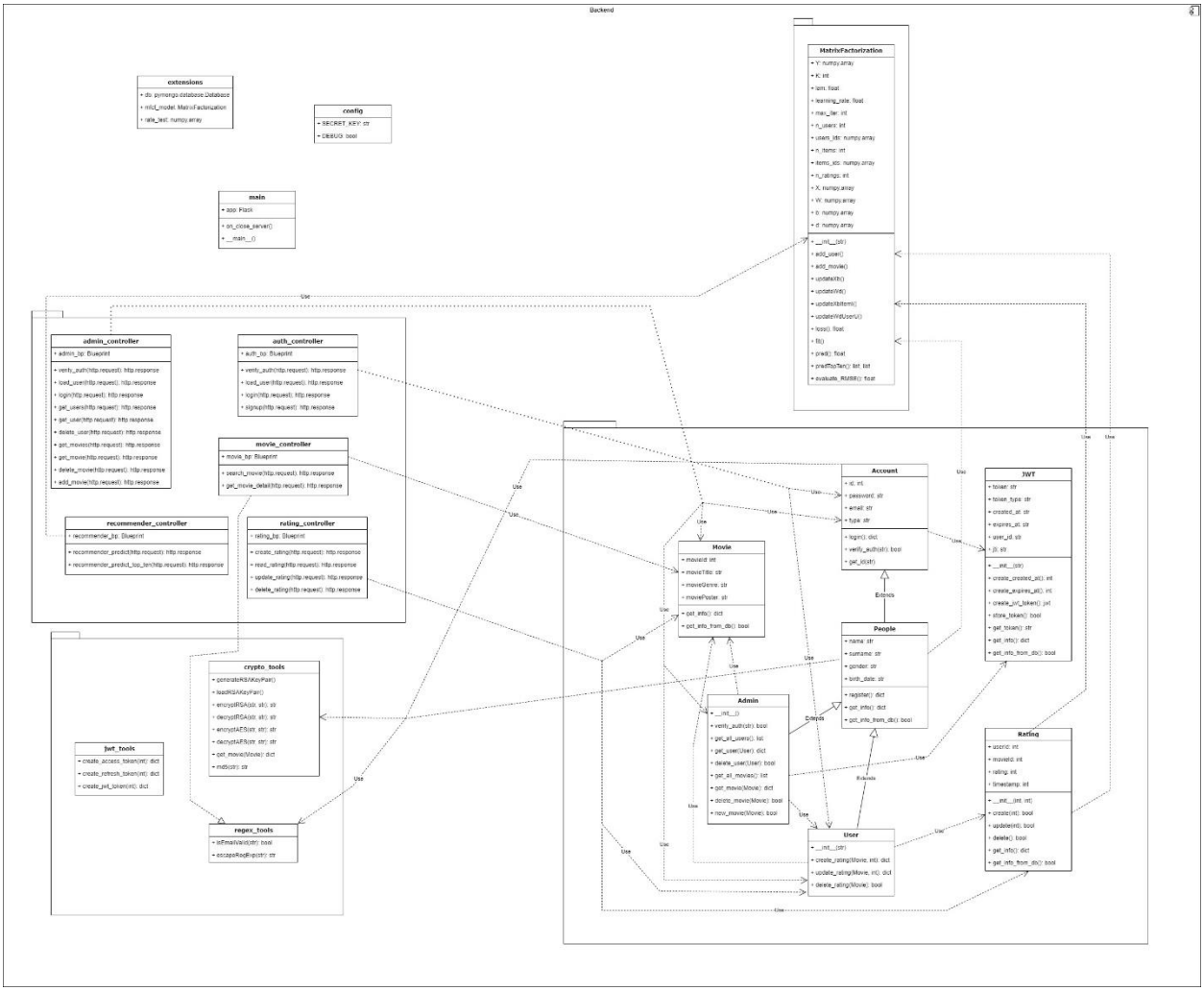


7.2. Database Design



7.3. Backend Design

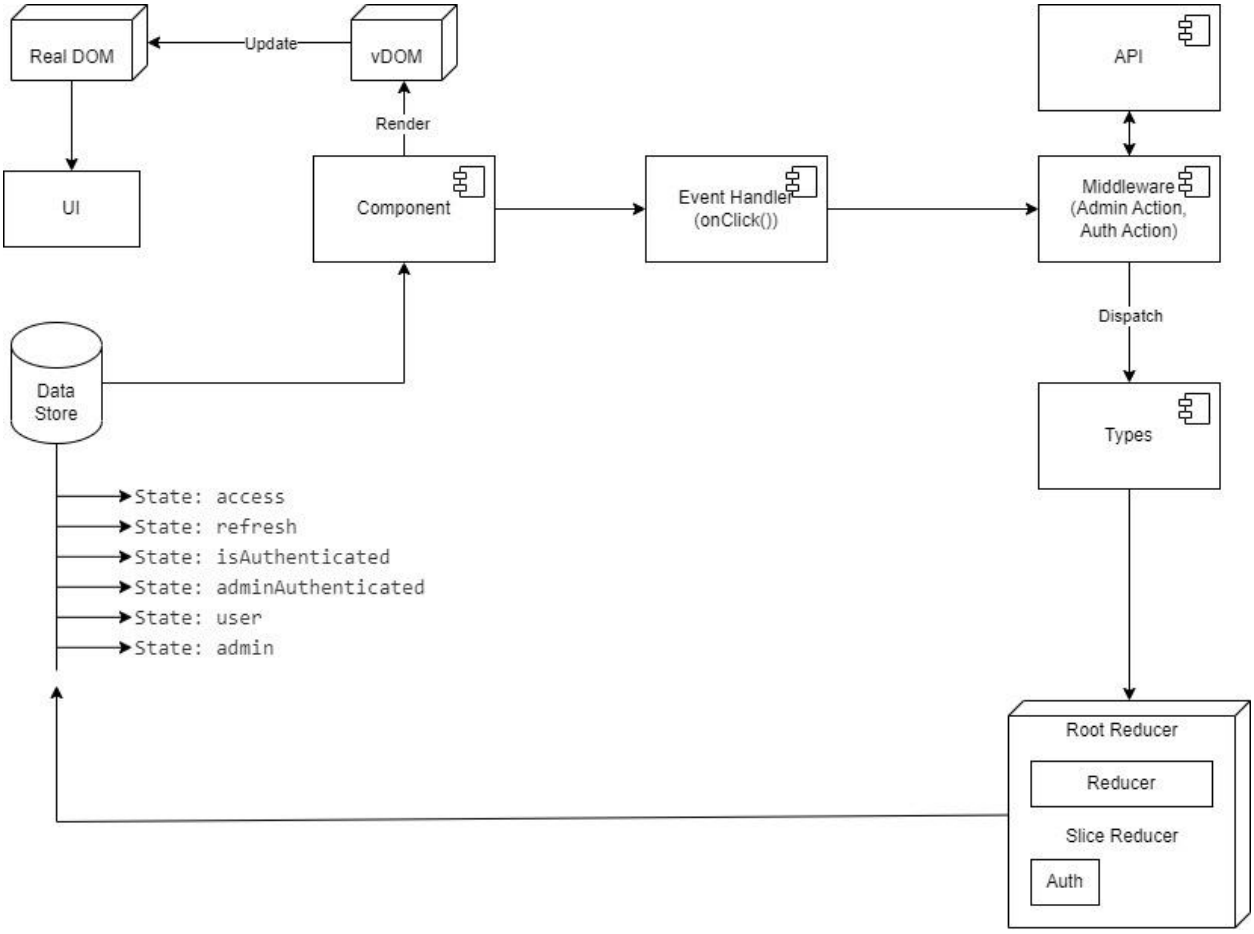
Class Diagram



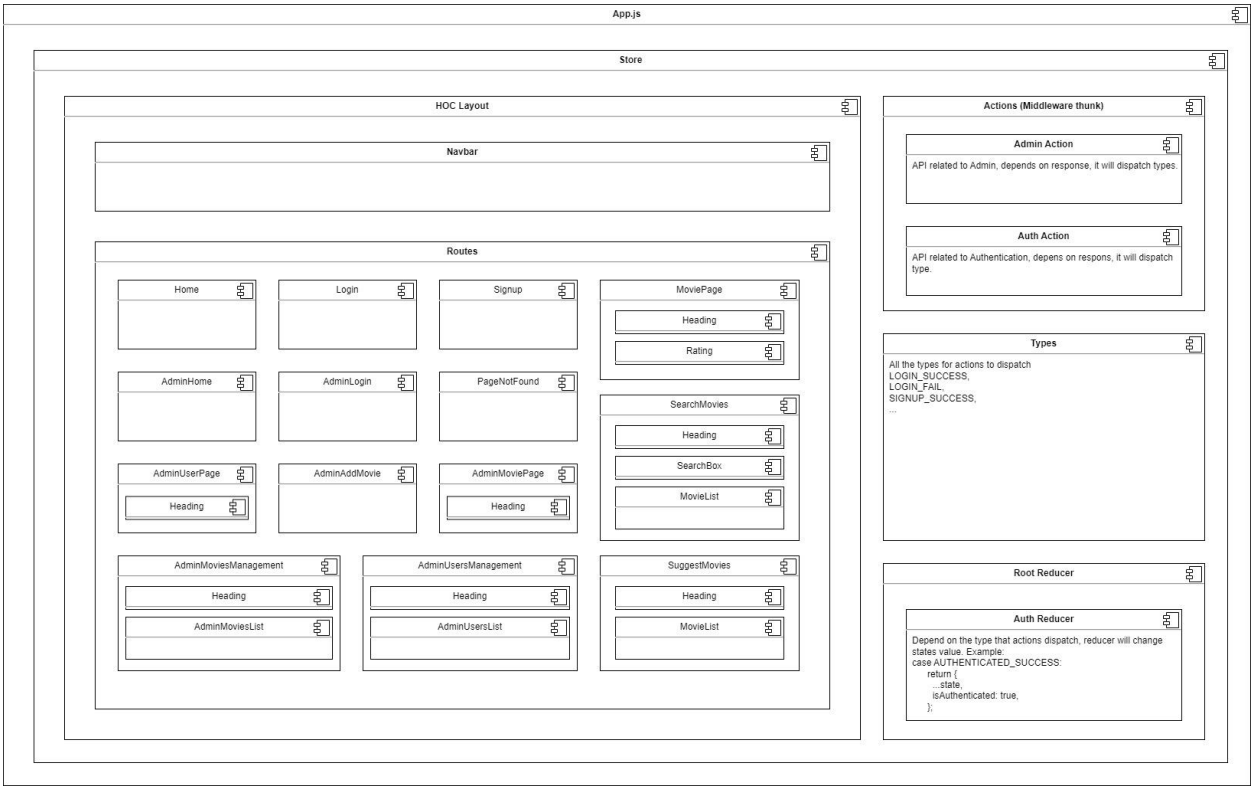
```
/MRSBB/Backend/
├── mrsbb-be/
│   ├── main.py
│   ├── config.py
│   ├── Dockerfile
│   ├── requirement
│   ├── controller/
│   │   ├── admin.py
│   │   ├── auth.py
│   │   ├── movie.py
│   │   ├── rating.py
│   │   ├── recommender.py
│   │   └── auth.py
│   ├── mlmodel/
│   │   └── recommender.py
│   ├── model/
│   │   ├── auth.py
│   │   ├── auth.py
│   │   ├── auth.py
│   │   ├── auth.py
│   │   ├── auth.py
│   │   ├── auth.py
│   │   └── auth.py
│   └── security/
│       ├── auth.py
│       ├── auth.py
│       ├── auth.py
│       └── keys/
│           ├── create.html
│           ├── index.html
│           └── update.html
└── mrsbb-venv/
```

7.4. Frontend Design

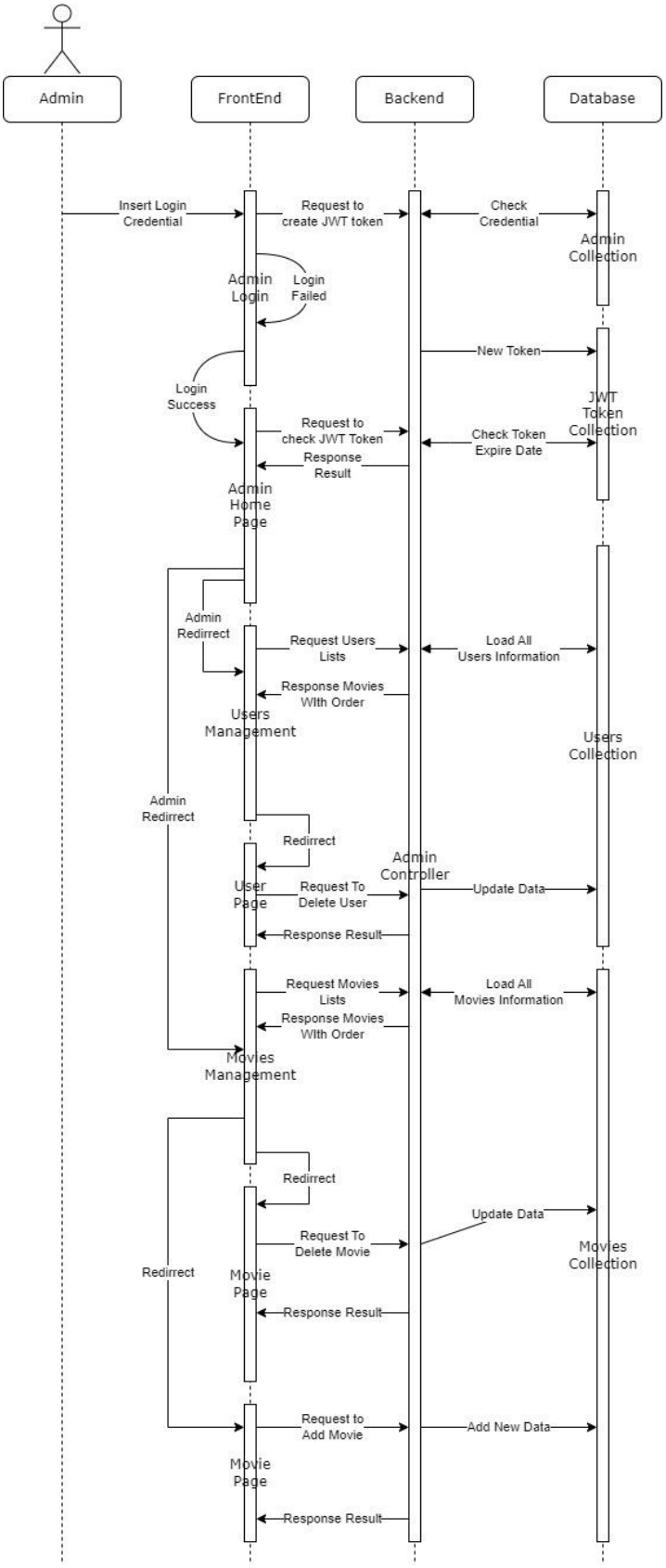
Redux Design Diagram

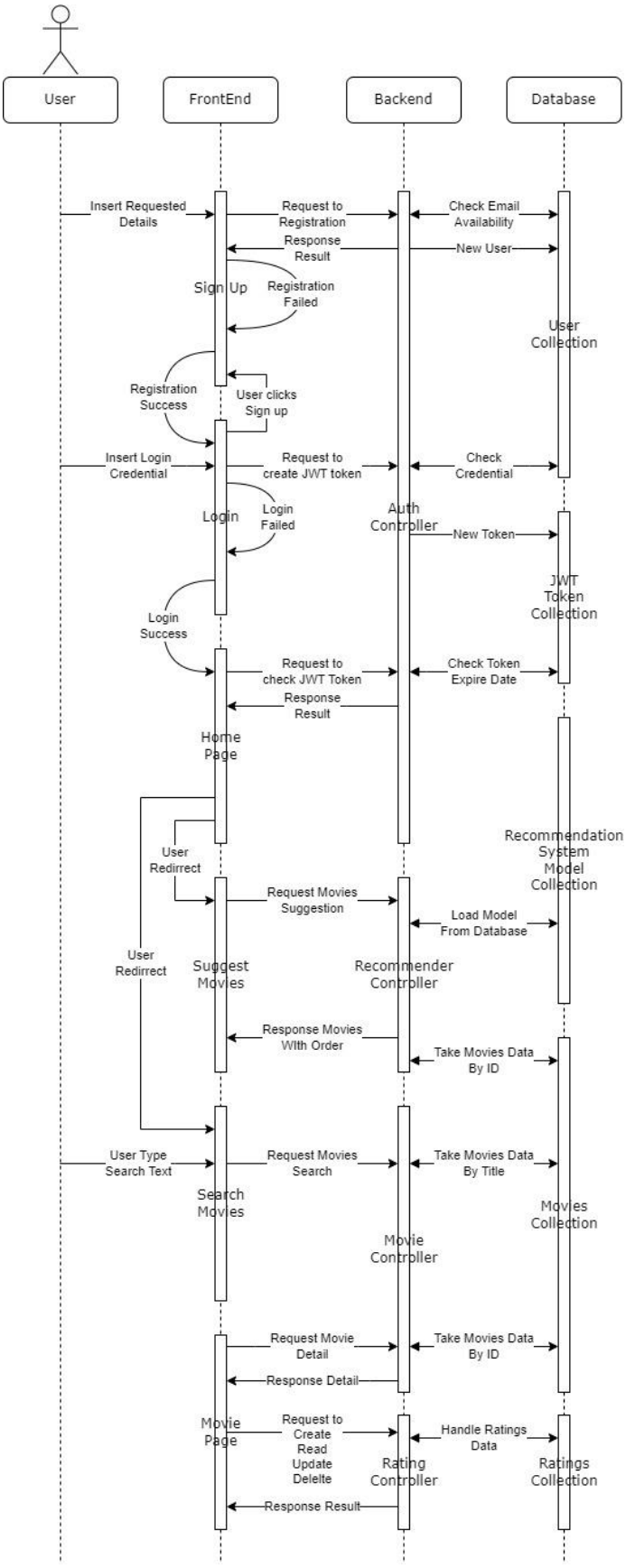


UI Layer Design Diagram



7.5. Sequence Diagram



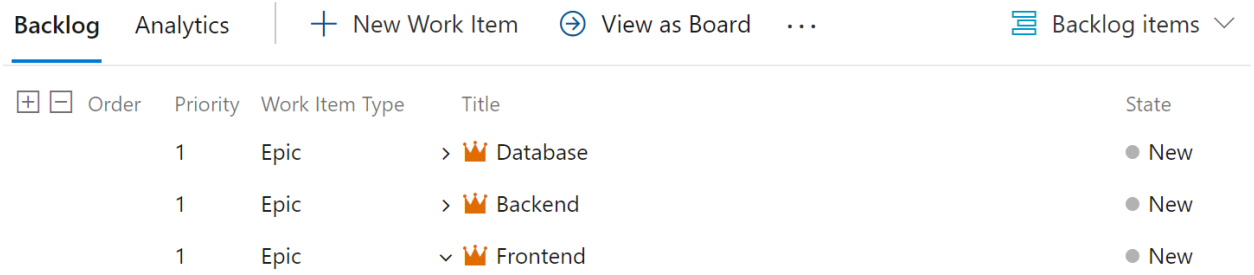

User
FrontEnd
Backend
Database
Insert Requested Details
Request to Registration
Check Email Availability
Response Result
New User
Sign Up
Registration Failed
User Collection
Registration Success
User clicks Sign up
Insert Login Credential
Request to create JWT token
Check Credential
Login
Login Failed
Auth Controller
New Token
JWT Token Collection
Login Success
Request to check JWT Token
Check Token Expire Date
Response Result
Home Page
Recommendation System Model Collection
User Redirrect
Request Movies Suggestion
Load Model From Database
User Redirrect
Suggest Movies
Recommender Controller
Response Movies With Order
Take Movies Data By ID
User Type Search Text
Request Movies Search
Take Movies Data By Title
Search Movies
Movies Collection
Movie Controller
Request Movie Detail
Take Movies Data By ID
Response Detail
Movie Page
Request to Create Read Update Delelte
Handle Ratings Data
Rating Controller
Ratings Collection
Response Result

8. Backlog refinement

From the Requirements Analysis, as a Product Owner, I have refined the backlog as follows.

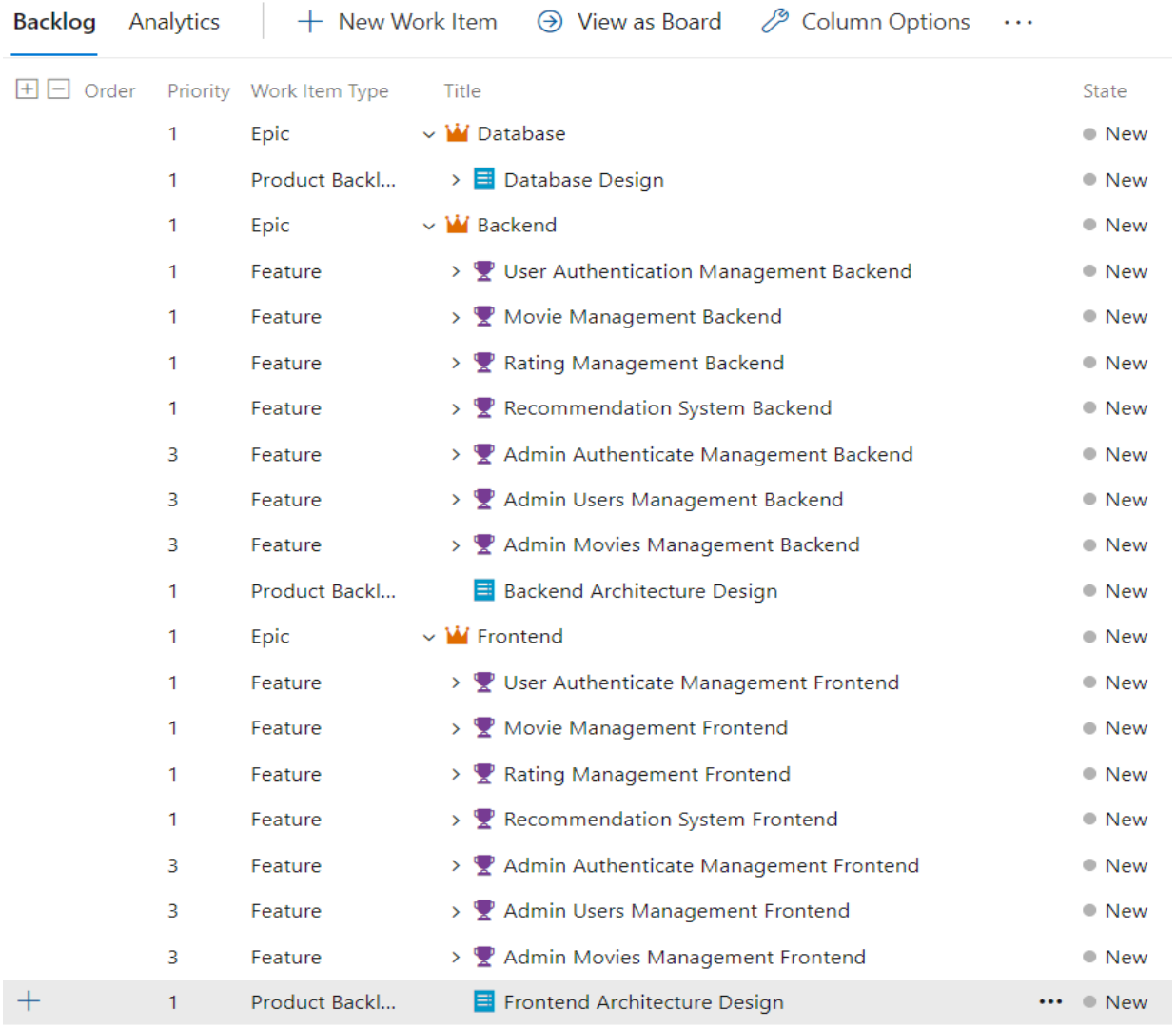
8.1. Epic

There are 3 epics corresponding to 3 components separated as stakeholders require in User Story



8.2. Feature

From 7 Functional Requirements we analyzed before, I created 14 corresponding features. Each Functional Requirement will need 2 features for Backend and Frontend. They are:



8.3. Product Backlog

There are 48 product backlogs to finish feature and complete the system:

MRSBB System Team | New Work Item | View as Board | Column Options

Order	Priority	Work Item Type	Title	State
	1	Epic	Database	New
	1	Product Backl...	Database Design	New
	1	Epic	Backend	New
	1	Feature	User Authentication Management Backend	New
	1	Product Backl...	User Registration Backend	New
	1	Product Backl...	User Login Backend	New
	1	Product Backl...	User Verification Backend	New
	2	Product Backl...	User Load Backend	New
	1	Feature	Movie Management Backend	New
	1	Product Backl...	User Search Movie Backend	New
	1	Product Backl...	User Get Movie Details	New
	1	Feature	Rating Management Backend	New
	1	Product Backl...	User Create Rating Backend	New
	1	Product Backl...	User Read Rating Backend	New
	3	Product Backl...	User Update Rating Backend	New
	3	Product Backl...	User Delete Rating Backend	New
	1	Feature	Recommendation System Backend	New
	1	Product Backl...	Release Algorithm Design	New
	1	Product Backl...	User Get Suggested Movies Backend	New
	4	Product Backl...	User Get Prediction For A Movie	New
	3	Feature	Admin Authenticate Management Backend	New
	3	Product Backl...	Admin Login Backend	New
	2	Product Backl...	Admin Load Backend	New

MRSBB System Team | New Work Item | View as Board | Column Options | ...

Order	Priority	Work Item Type	Title	State
	3	Feature	Admin Users Management Backend	New
	3	Product Backl...	Admin Get All Users Backend	New
	3	Product Backl...	Admin Get User Details Backend	New
	4	Product Backl...	Admin Delete User Backend	New
	3	Feature	Admin Movies Management Backend	New
	3	Product Backl...	Admin Get All Movies Backend	New
	3	Product Backl...	Admin Get Movie Details Backend	New
	3	Product Backl...	Admin Add New Movie Backend	New
	4	Product Backl...	Admin Delete Movie Backend	New
	1	Product Backl...	Backend Architecture Design	New
	1	Epic	Frontend	New
	1	Feature	User Authenticate Management Frontend	New
	1	Product Backl...	User Registration Frontend	New
	1	Product Backl...	User Login Frontend	New
	1	Product Backl...	User Verification Frontend	New
	1	Product Backl...	User Logout Frontend	New
	2	Product Backl...	User Load Frontend	New
	1	Feature	Movie Management Frontend	New
	1	Product Backl...	User Search Movie Frontend	New
	1	Product Backl...	User Get Movie Details Frontend	New
	1	Feature	Rating Management Frontend	New
	1	Product Backl...	User Create Rating Frontend	New
	1	Product Backl...	User Read Rating Frontend	New
	3	Product Backl...	User Update Rating Frontend	New
	3	Product Backl...	User Delete Rating Frontend	New

MRSBB System Team ☆ | + New Work Item | View as Board ···

Order	Priority	Work Item Type	Title	State
	1	Feature	Recommendation System Frontend	New
	1	Product Backl...	User Get Suggested Movies Frontend	New
	4	Product Backl...	User Get Prediction For A Movie Frontend	New
	3	Feature	Admin Authenticate Management Frontend	New
	3	Product Backl...	Admin Login Frontend	New
	3	Product Backl...	Admin Logout Frontend	New
	2	Product Backl...	Admin Load Frontend	New
	3	Feature	Admin Users Management Frontend	New
	3	Product Backl...	Admin Get All Users Frontend	New
	3	Product Backl...	Admin Get User Details Details	New
	4	Product Backl...	Admin Delete User Frontend	New
	3	Feature	Admin Movies Management Frontend	New
	3	Product Backl...	Admin Get All Movies Frontend	New
	3	Product Backl...	Admin Get Movie Details Frontend	New
	3	Product Backl...	Admin Add New Movie Frontend	New
	4	Product Backl...	Admin Delete Movie Frontend	New
	1	Product Backl...	Frontend Architecture Design	New

8.4. Priority assignment

There are 4 priority levels in this project.

1. Must do
2. High Priority
3. Second-level Priority
4. Low Priority

First, all epics will have priority 1 since they must have for system deployment.

To be able to do Priority Assignment work, let's go into the essence of the system:

The purpose of the project is to study the Recommendation System and apply it in practice. So, FR.4: Recommendation System will need priority 1. However, FR.4.2 will have priority 4 because in real life situations, the user usually will not need an exact prediction rating for a specific movie.

There are 3 must have components for Recommendation System, they are:

- Users

- Movies
- Ratings

The more Users have Ratings on Movies, the more Recommendation System increase accuracy, so FR.1, FR.2, FR.3 will have priority 1. However, FR.3.3 and FR.3.4 will have priority 3.

All FR related to Admin will have priority 3. However, FR.6.3, FR.7.4 will have priority 4.

Finally, all product backlogs related to Design will have priority 1.

All Priority appears in section 7.3 in the column Priority.

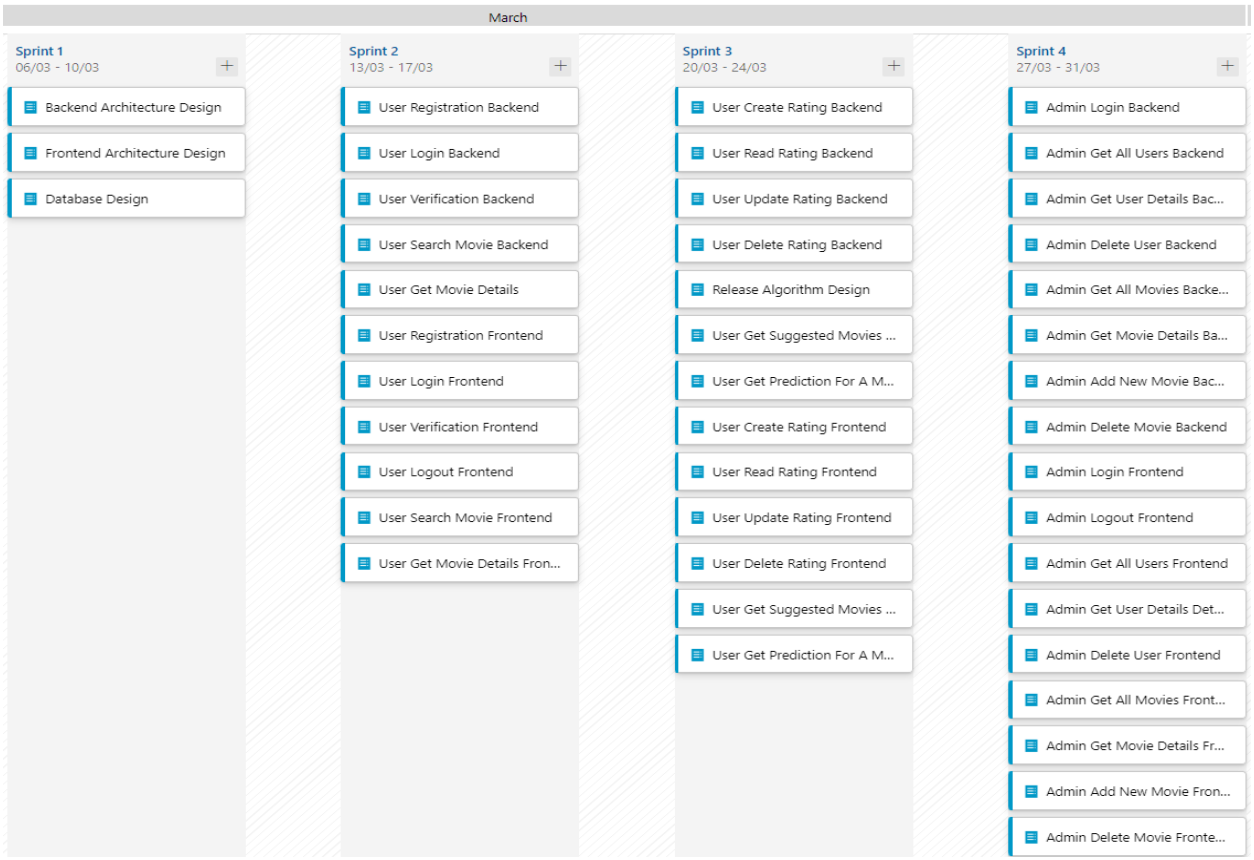
9. Project estimation (time and cost)

In this project, 1 Sprint is 5 working days long.

There are 4 Sprints:

1. Sprint 1 runs from 06/Mar/2023 to 10/Mar/2023 (5 working days).
2. Sprint 2 runs from 13/Mar/2023 to 17/Mar/2023 (5 working days).
3. Sprint 3 runs from 20/Mar/2023 to 24/Mar/2023 (5 working days).
4. Sprint 4 runs from 27/Mar/2023 to 31/Mar/2023 (5 working days).

Deployment cost: Azure Free Plan with 60mins using per day.



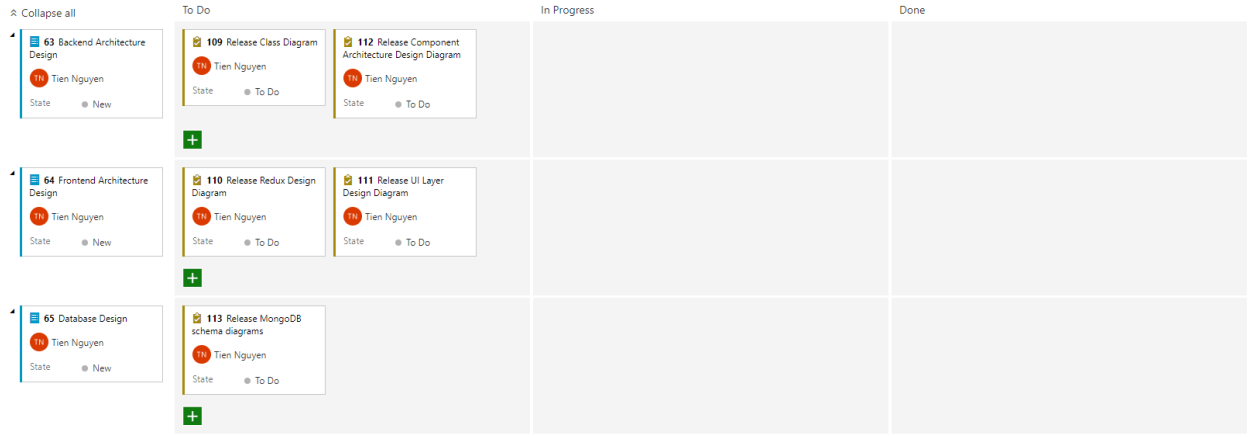
VII. Sprint cycles (2nd)

1. Sprint 1

1.1. Planning

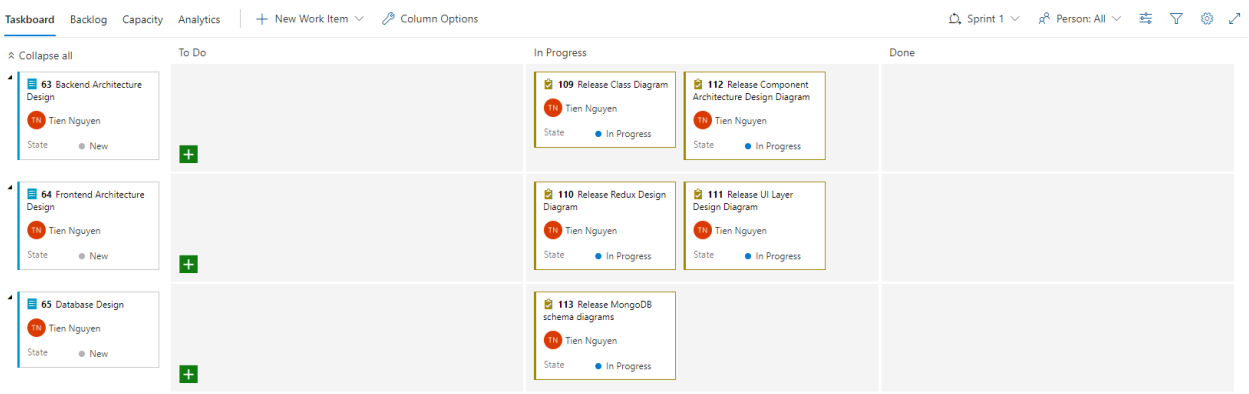
In Scrum Planning, we will do task identification. The team identifies the tasks that need to be complete to deliver the product backlog items that are selected for the sprint.

In Sprint 1, tasks will be as below:



1.2. Implementation

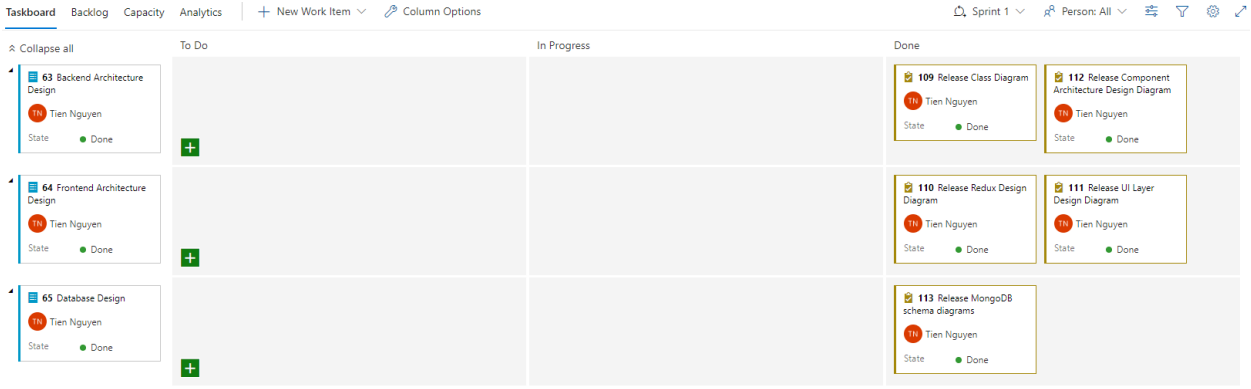
All the designs are located in section IV. Architectural Design.



1.3. Review

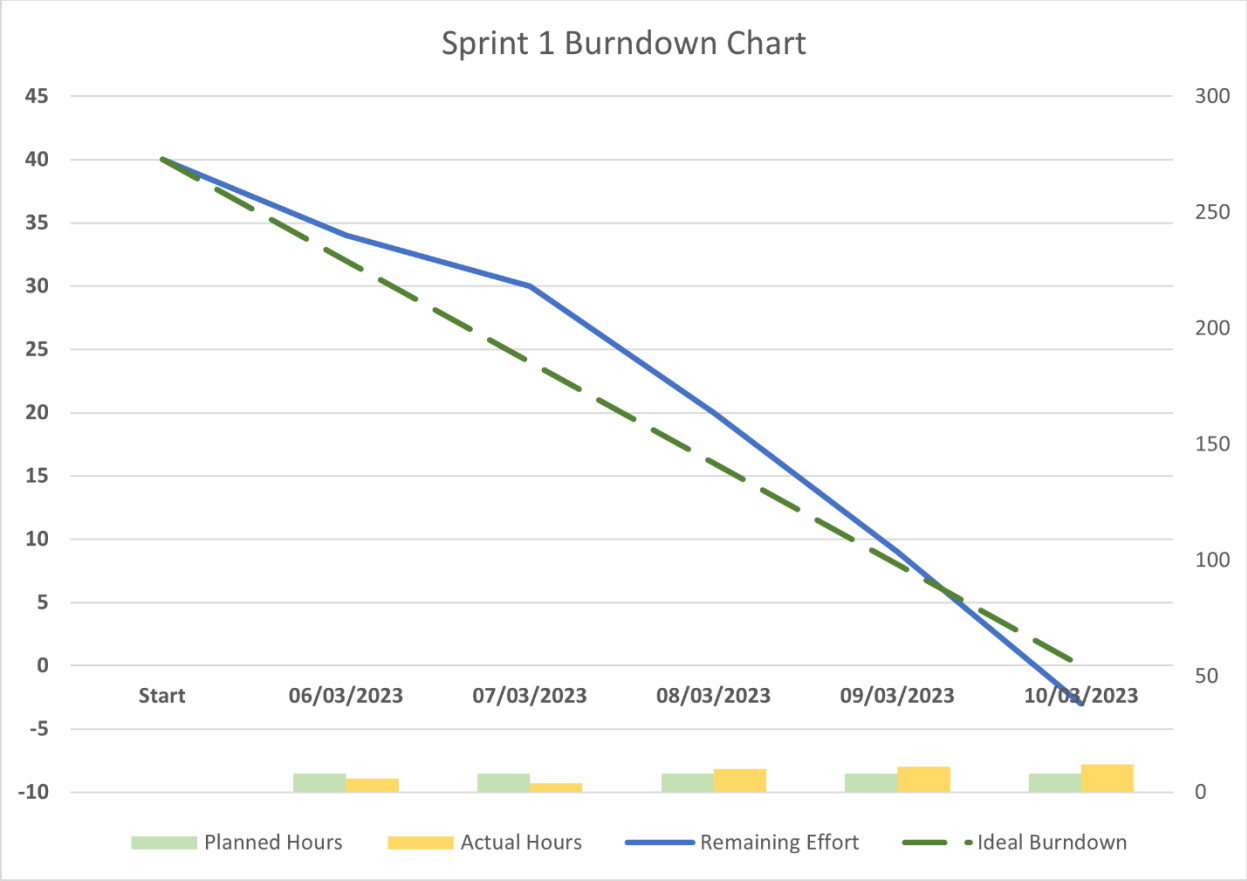
The most difficult task of a process is to have a good system design. With a good enough design after the Requirement Analysis process, the Development Team can accelerate quickly and

complete the Functional Requirements on time and perform as expected.



1.4. Retrospective

Release Burndown Chart for Sprint 1



Design takes more time than how long the team expected, at Day 1 and Day 2, the team couldn't find the right process to release design diagram. After Day 2, All the remaining days of the week, the team has to work overtime to release diagrams on time.

For more information, please refer to the file "Sprint_1_burndown_chart.xlsx".

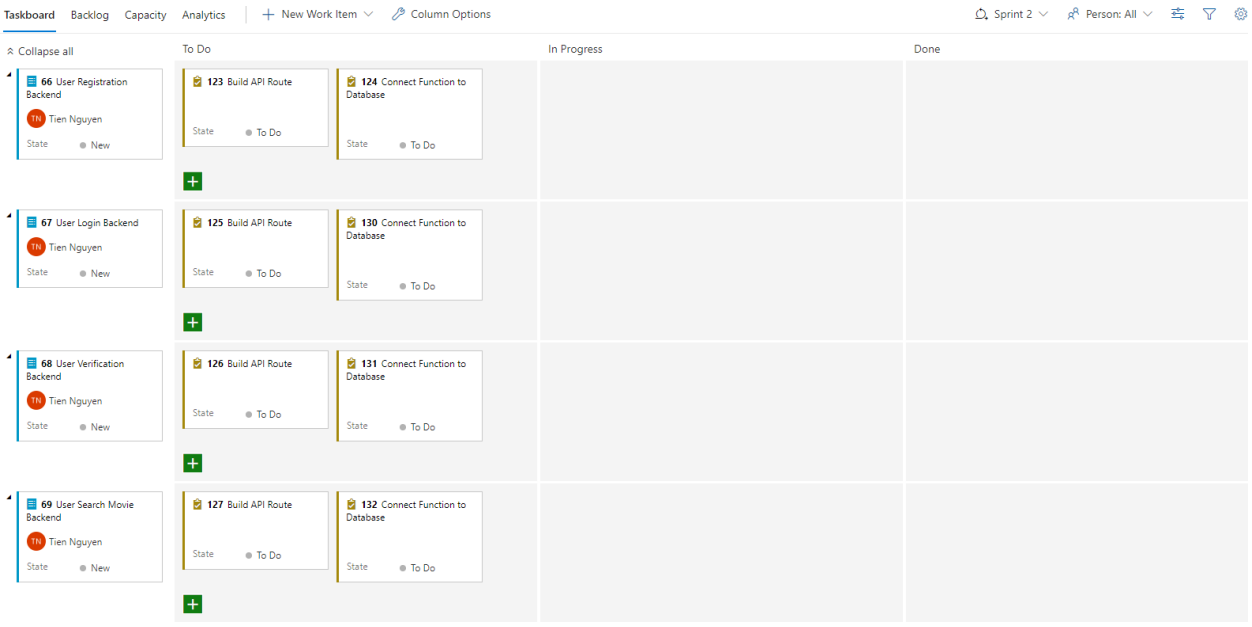
2. Sprint 2

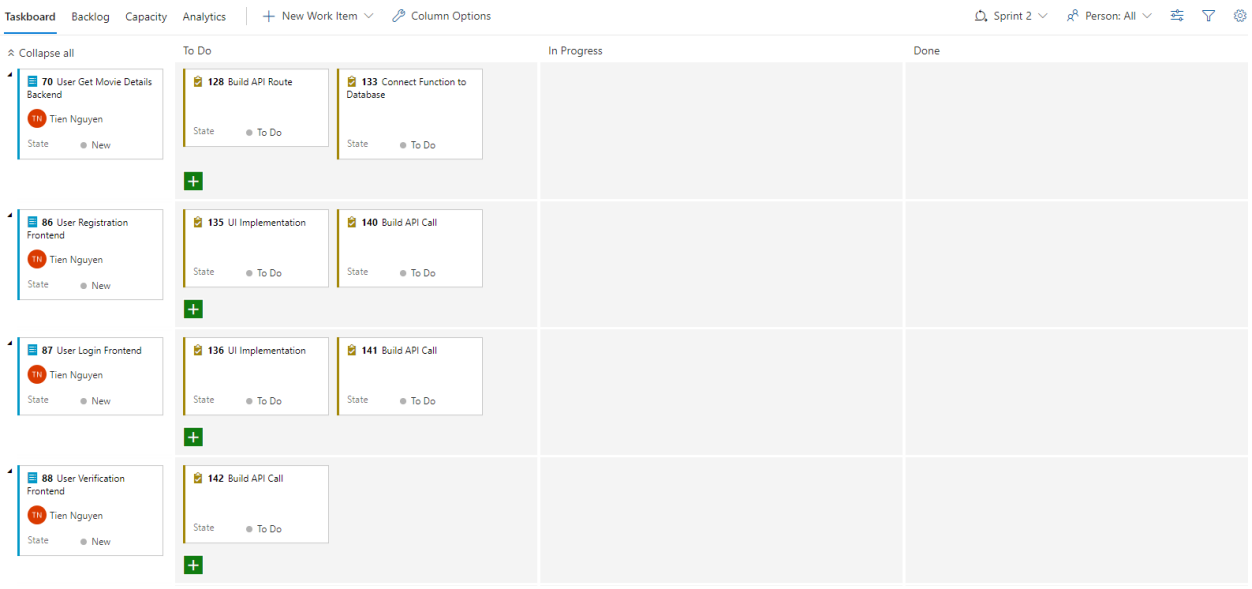
2.1. Planning

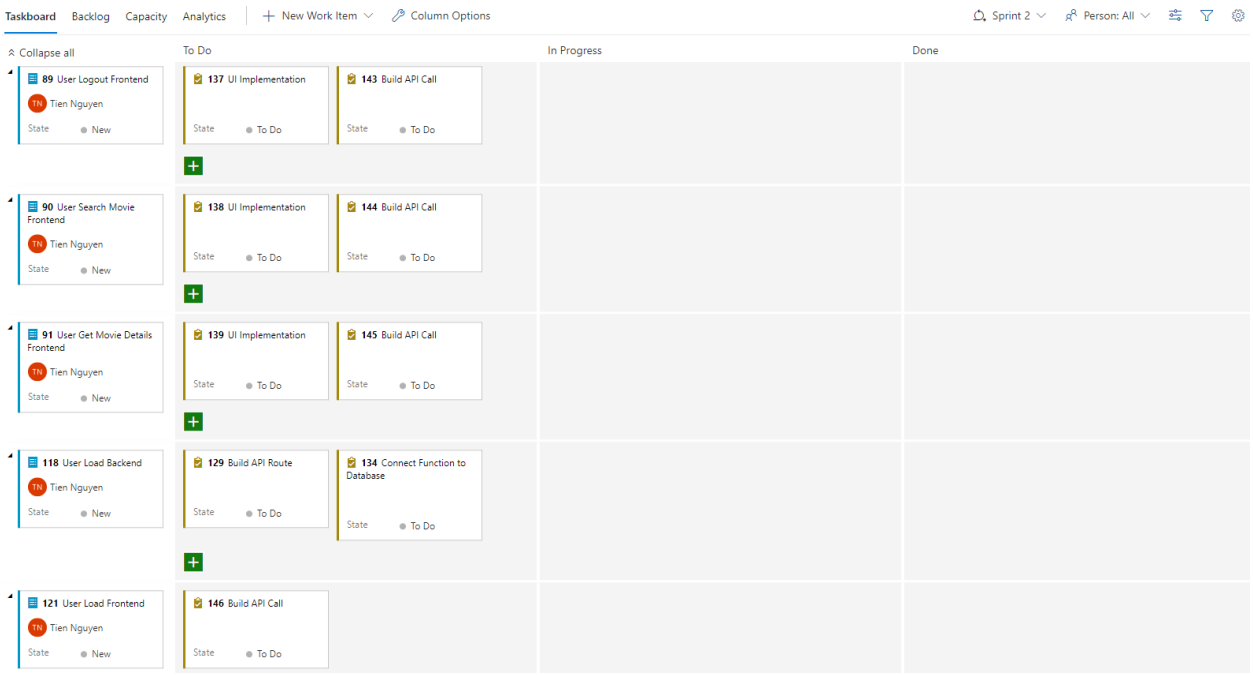
In the Sprint 1, because the team did not manage time good enough, so they have to work overtime at some point while there are days that they did not take all 8 hours for works.

In Sprint 2, the team should take more attention for time management.

Task identified for Sprint 2:





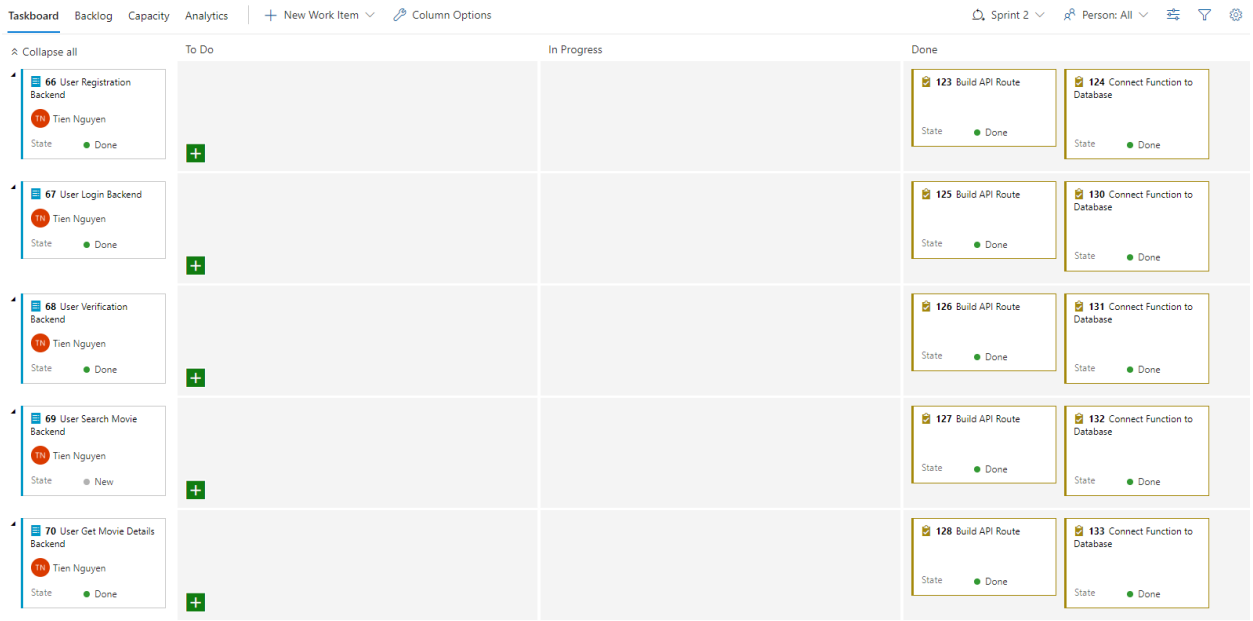


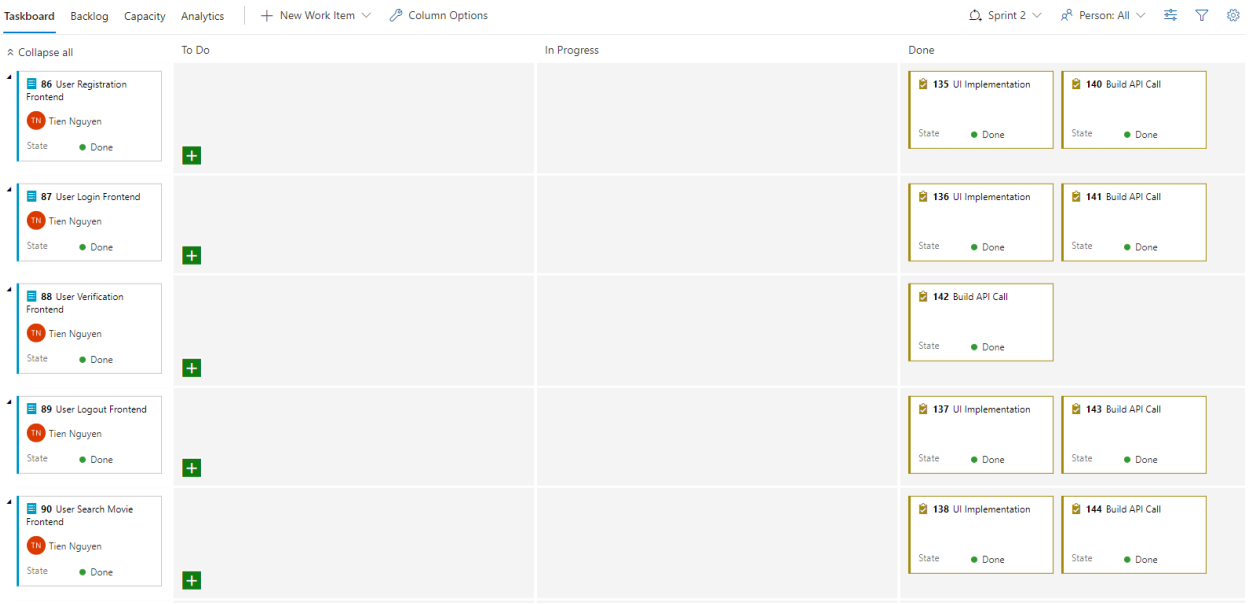
2.2. Implementation

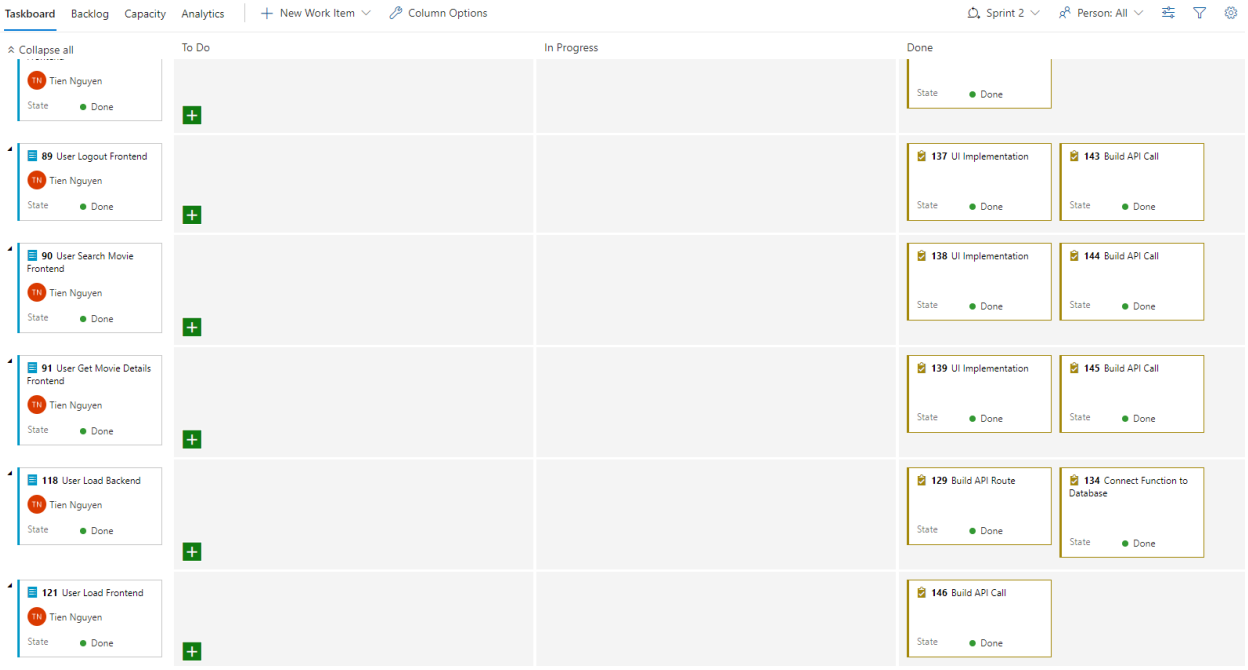
During the implementation, the team also did Unit Test using Postman after completing a feature but due to time rush, they were not able to complete the document for that. We will demonstrate testing in the following system testing section.

2.3. Review

Thanks to the design of the system in Sprint 1, the implementation in Sprint 2 can run more smoothly, there are no backlogs remaining.

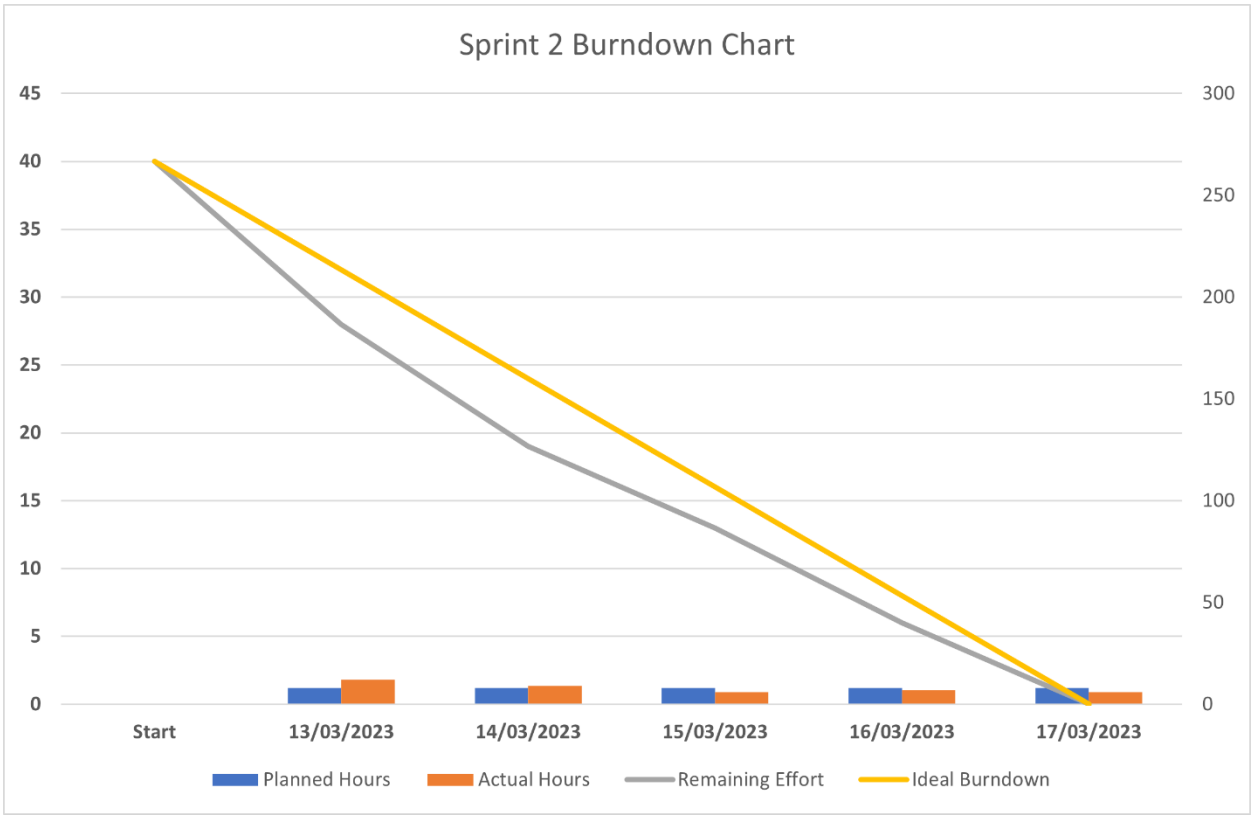



Taskboard
Backlog
Capacity
Analytics
New Work Item
Column Options
Sprint 2
Person: All
Collapse all
To Do
In Progress
Done
86 User Registration Frontend
Tien Nguyen
State
Done
135 UI Implementation
140 Build API Call
87 User Login Frontend
136 UI Implementation
141 Build API Call
88 User Verification Frontend
142 Build API Call
89 User Logout Frontend
137 UI Implementation
143 Build API Call
90 User Search Movie Frontend
138 UI Implementation
144 Build API Call


Taskboard
Backlog
Capacity
Analytics
New Work Item
Column Options
Sprint 2
Person: All
Collapse all
To Do
In Progress
Done
Tien Nguyen
State
Done
89 User Logout Frontend
137 UI Implementation
143 Build API Call
90 User Search Movie Frontend
138 UI Implementation
144 Build API Call
91 User Get Movie Details Frontend
139 UI Implementation
145 Build API Call
118 User Load Backend
129 Build API Route
134 Connect Function to Database
121 User Load Frontend
146 Build API Call

2.4. Retrospective

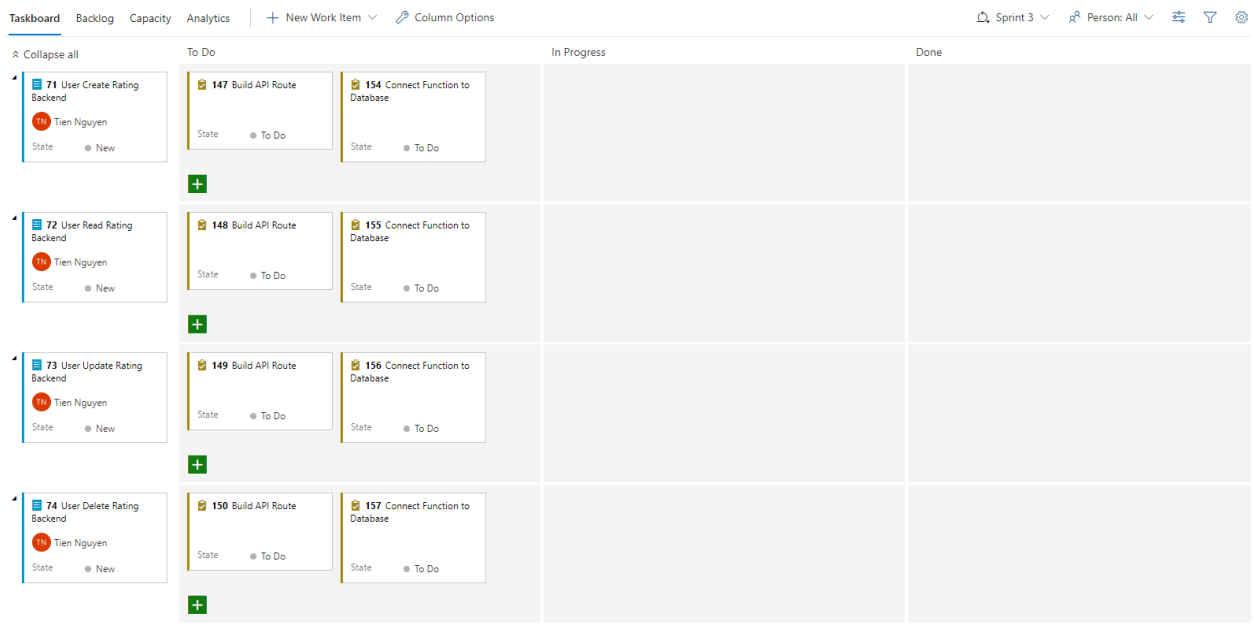
Release Burndown Chart:

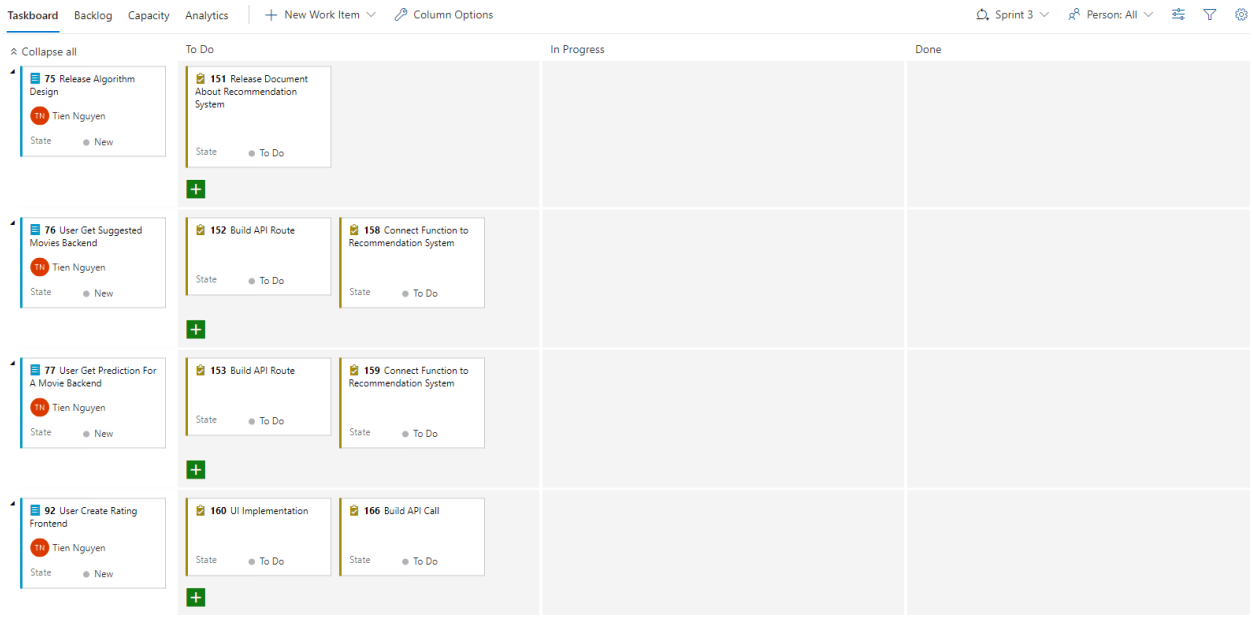


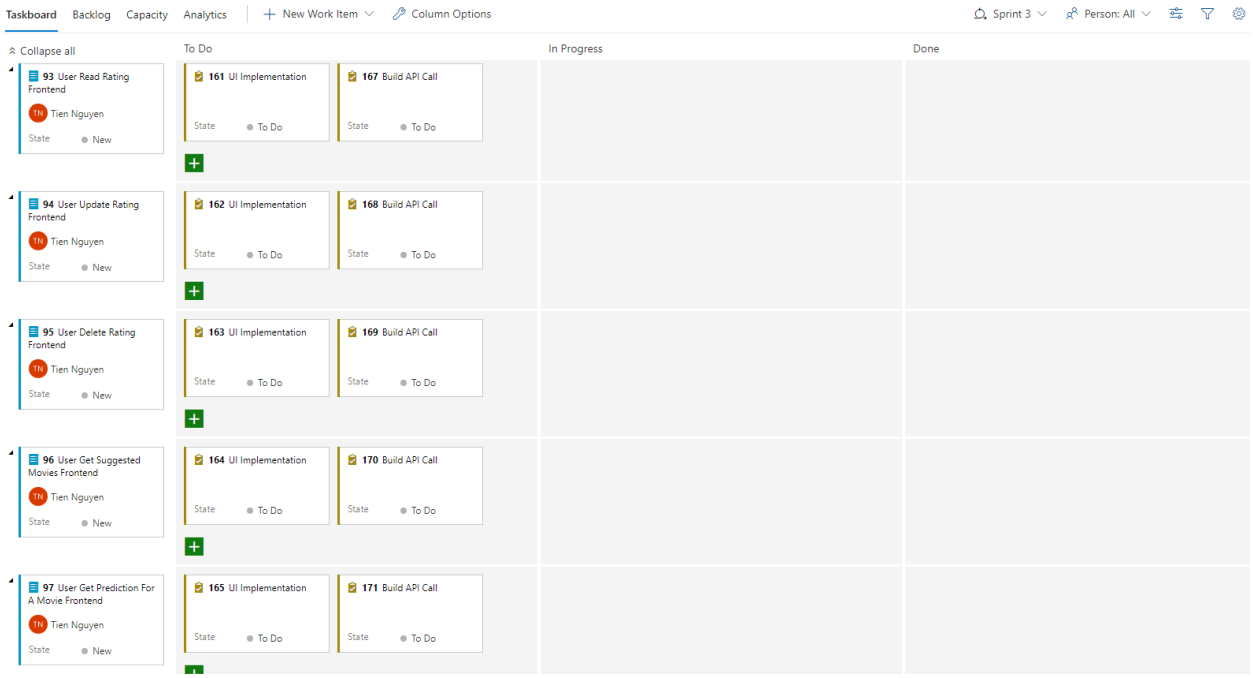
3. Sprint 3

3.1. Planning

Task identification for Sprint 3:





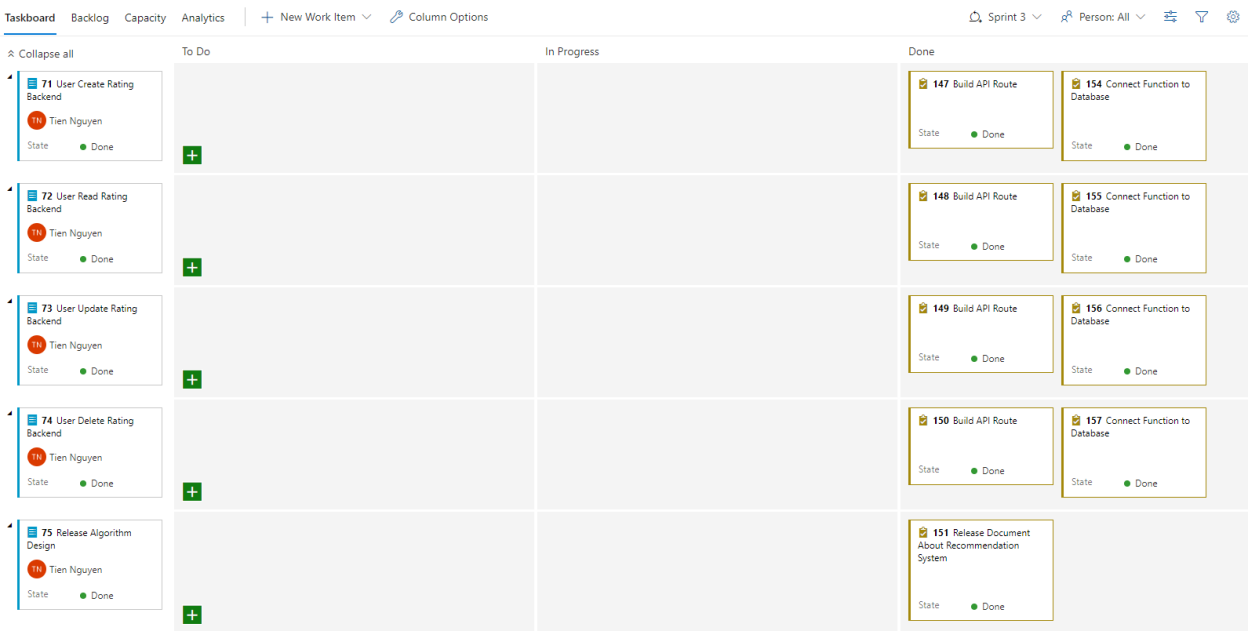


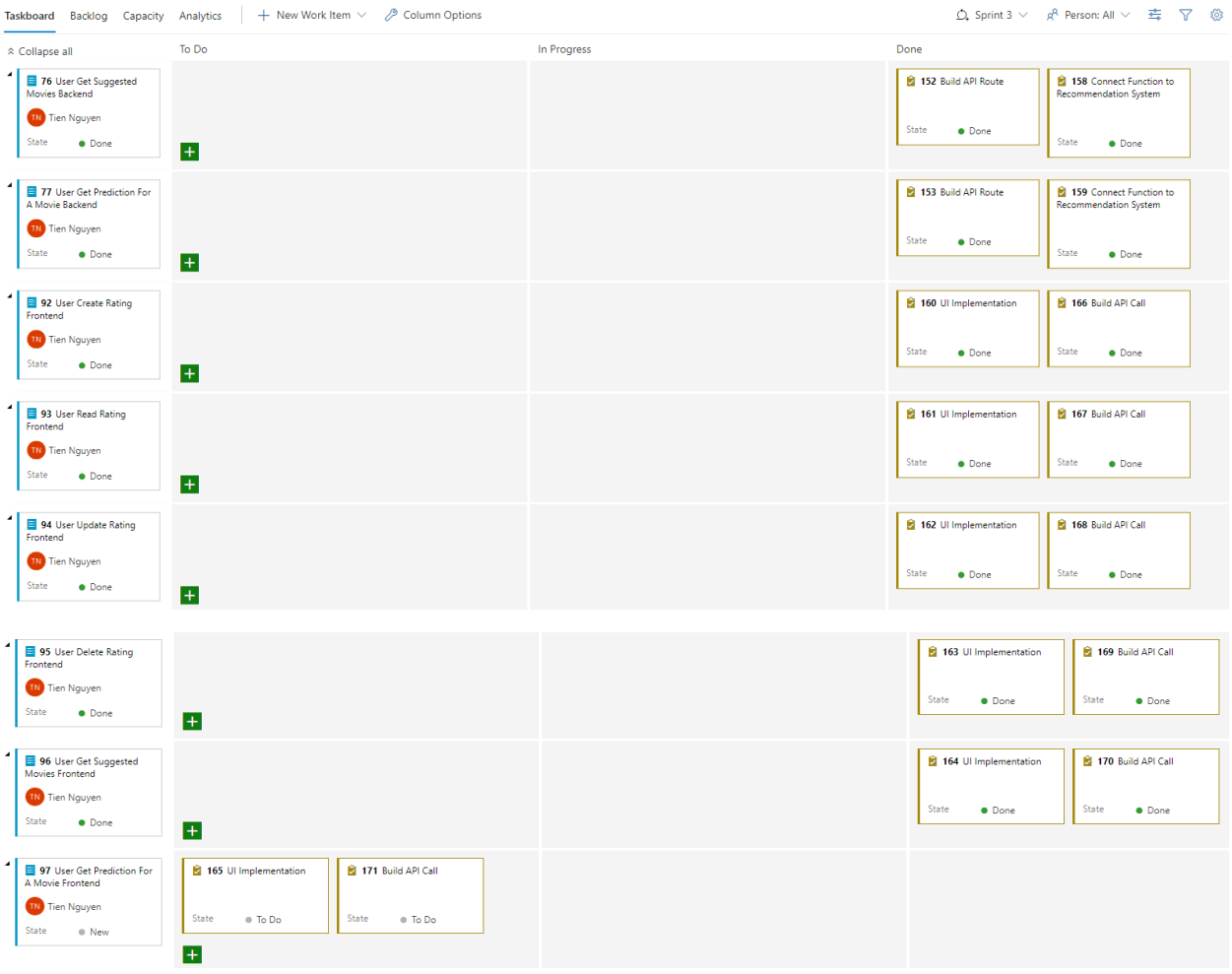
3.2. Implementation

I reuse most of the parts that have been programmed from Scrum before, of course, it will have to be slightly modified due to changes in the Database and API structure in the Backend.

3.3. Review

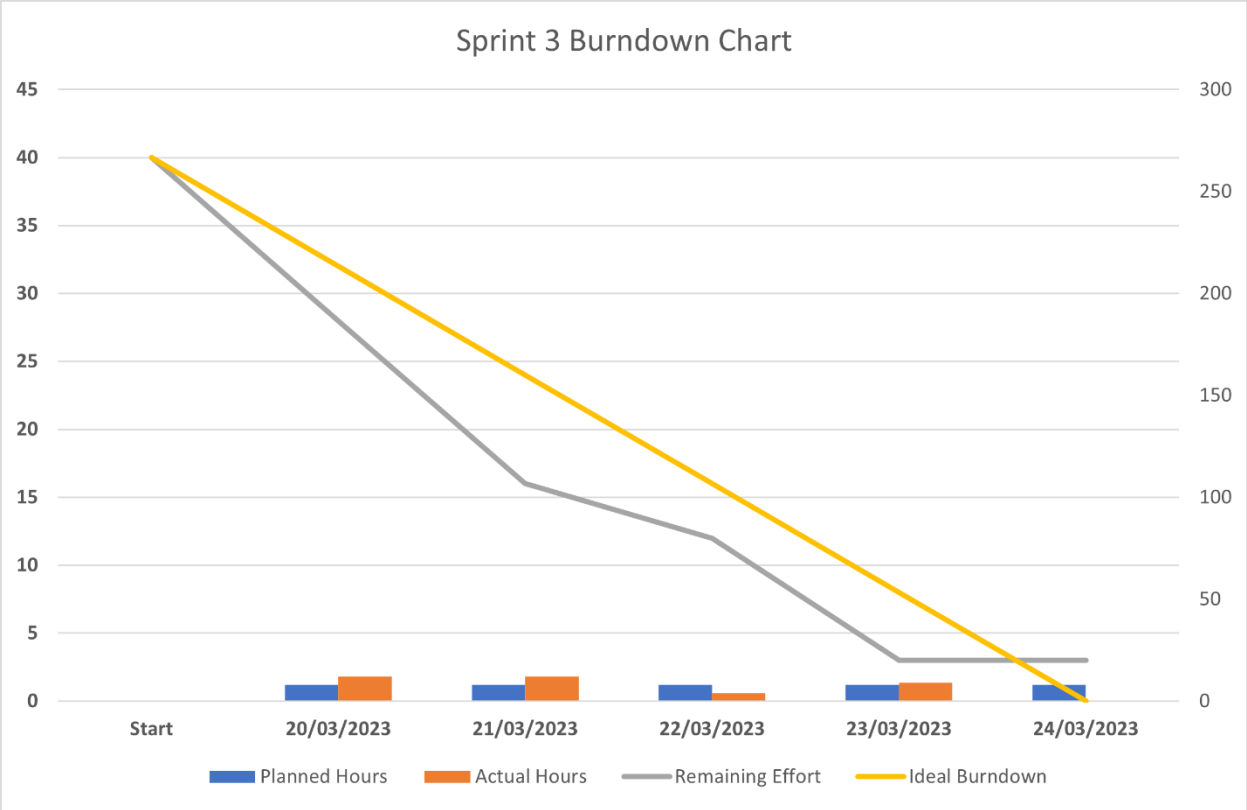
Implementation in Sprint 3 is quite smooth because most of the backlogs in Sprint 3 can be reused from the previous Scrum. However, there is still an unfinished backlog.


Taskboard Backlog Capacity Analytics New Work Item Column Options Sprint 3 Person: All
Collapse all
To Do
In Progress
Done
71 User Create Rating Backend
Tien Nguyen
State Done
147 Build API Route
State Done
154 Connect Function to Database
State Done
72 User Read Rating Backend
Tien Nguyen
State Done
148 Build API Route
State Done
155 Connect Function to Database
State Done
73 User Update Rating Backend
Tien Nguyen
State Done
149 Build API Route
State Done
156 Connect Function to Database
State Done
74 User Delete Rating Backend
Tien Nguyen
State Done
150 Build API Route
State Done
157 Connect Function to Database
State Done
75 Release Algorithm Design
Tien Nguyen
State Done
151 Release Document About Recommendation System
State Done


Taskboard Backlog Capacity Analytics New Work Item Column Options Sprint 3 Person: All
Collapse all
To Do
In Progress
Done
76 User Get Suggested Movies Backend
Tien Nguyen
State Done
152 Build API Route
State Done
158 Connect Function to Recommendation System
State Done
77 User Get Prediction For A Movie Backend
Tien Nguyen
State Done
153 Build API Route
State Done
159 Connect Function to Recommendation System
State Done
92 User Create Rating Frontend
Tien Nguyen
State Done
160 UI Implementation
State Done
166 Build API Call
State Done
93 User Read Rating Frontend
Tien Nguyen
State Done
161 UI Implementation
State Done
167 Build API Call
State Done
94 User Update Rating Frontend
Tien Nguyen
State Done
162 UI Implementation
State Done
168 Build API Call
State Done
95 User Delete Rating Frontend
Tien Nguyen
State Done
163 UI Implementation
State Done
169 Build API Call
State Done
96 User Get Suggested Movies Frontend
Tien Nguyen
State Done
164 UI Implementation
State Done
170 Build API Call
State Done
97 User Get Prediction For A Movie Frontend
Tien Nguyen
State New
165 UI Implementation
State To Do
171 Build API Call
State To Do

3.4. Retrospective

Release Burndown Chart:



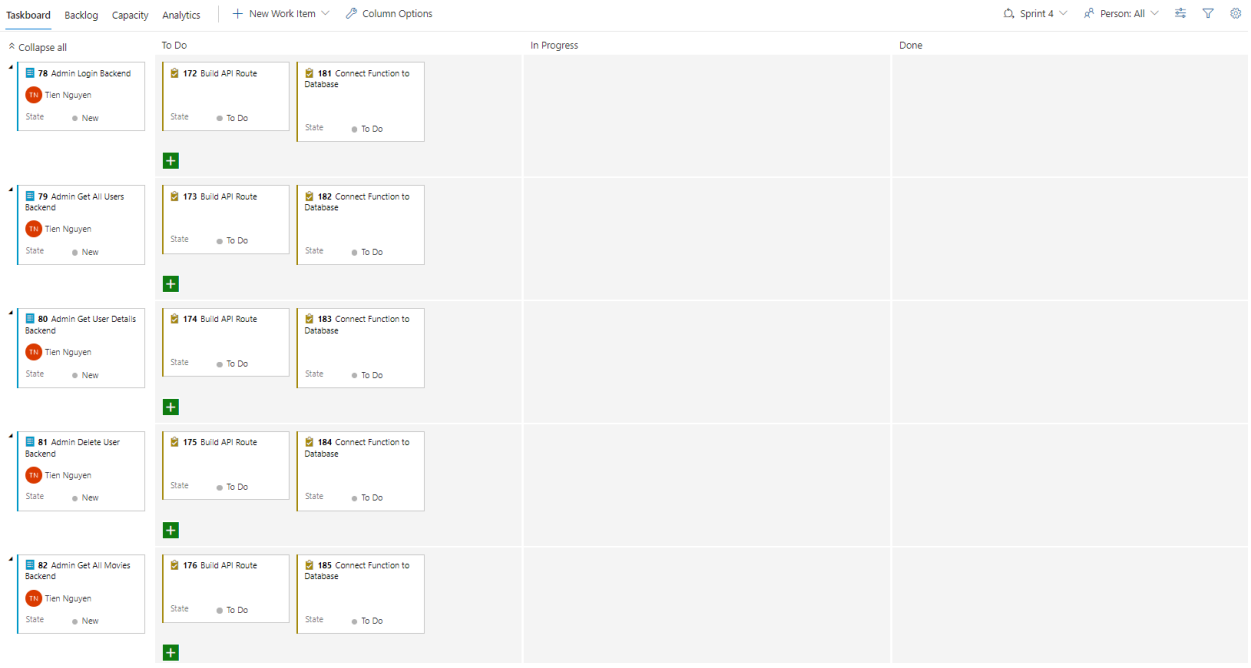
Looking at the Burndown Chart, we can see that the work was completed earlier than planned quite early in the beginning of the Sprint but by the end did not complete 100% of the Backlogs. Is there a problem with the team? This will be discussed in the Planning section of Sprint 4.

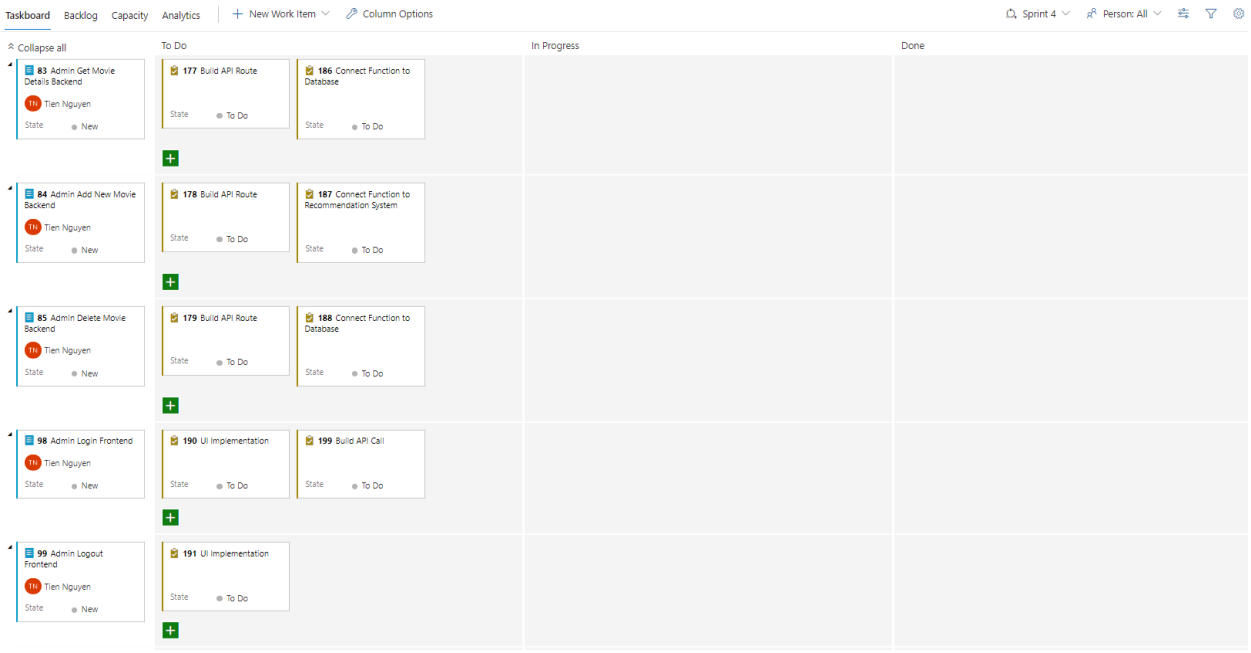
4. Sprint 4

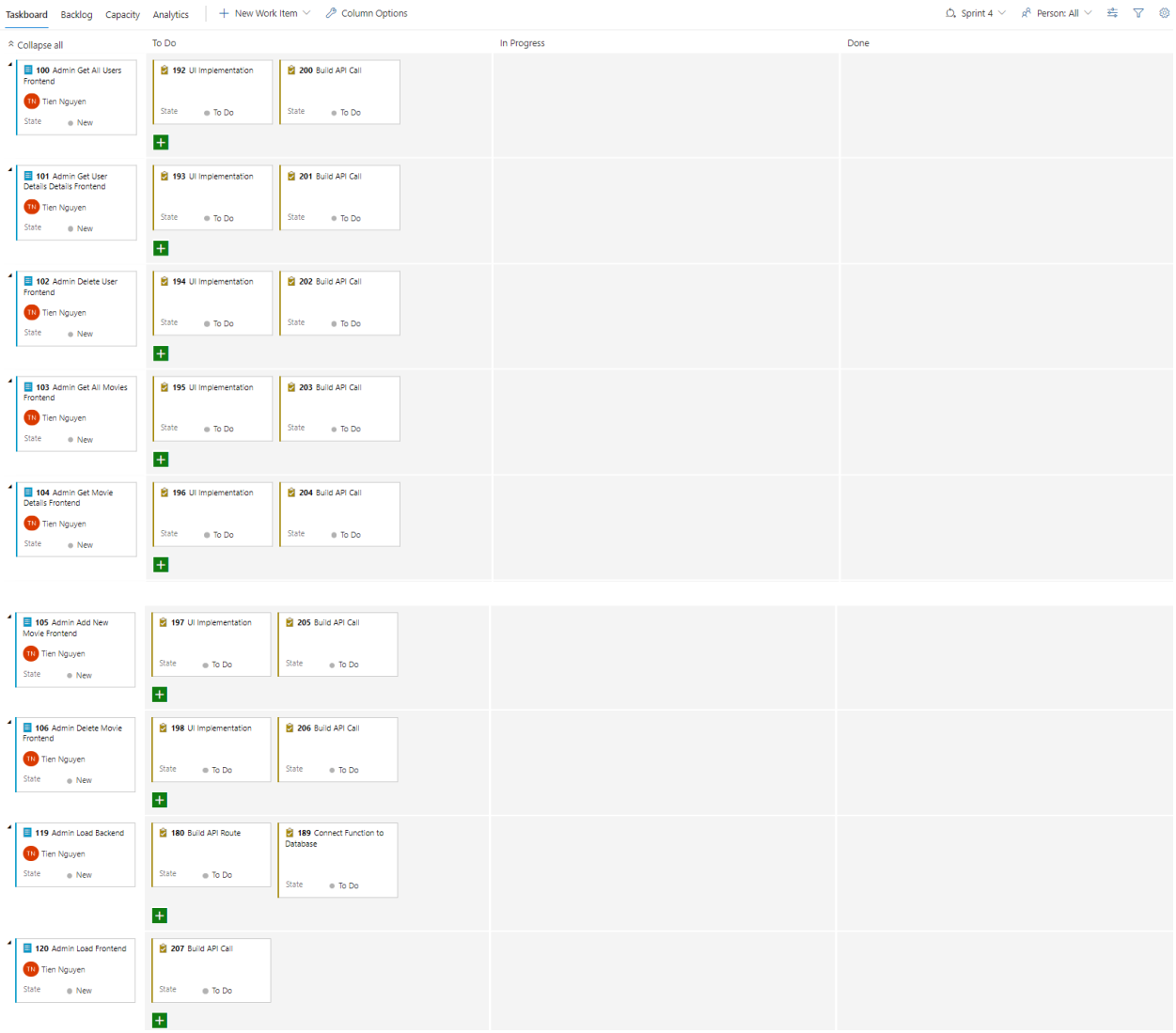
4.1. Planning

Sprint 4 is the place with the most Backlogs in all 4 Sprints, but we still have to add Backlog not completed in Sprint 3. This backlog has Priority 4 so we'll still do it last if Sprint 4 doesn't have enough time.

Task identified for Sprint 4 as below.


Taskboard
Backlog
Capacity
Analytics
New Work Item
Column Options
Sprint 4
Person: All
Collapse all
To Do
In Progress
Done
78 Admin Login Backend
Tien Nguyen
State
New
172 Build API Route
State
To Do
181 Connect Function to Database
State
To Do
79 Admin Get All Users Backend
Tien Nguyen
State
New
173 Build API Route
State
To Do
182 Connect Function to Database
State
To Do
80 Admin Get User Details Backend
Tien Nguyen
State
New
174 Build API Route
State
To Do
183 Connect Function to Database
State
To Do
81 Admin Delete User Backend
Tien Nguyen
State
New
175 Build API Route
State
To Do
184 Connect Function to Database
State
To Do
82 Admin Get All Movies Backend
Tien Nguyen
State
New
176 Build API Route
State
To Do
185 Connect Function to Database
State
To Do


Taskboard
Backlog
Capacity
Analytics
New Work Item
Column Options
Sprint 4
Person: All
Collapse all
To Do
In Progress
Done
83 Admin Get Movie Details Backend
Tien Nguyen
State
New
177 Build API Route
State
To Do
186 Connect Function to Database
State
To Do
84 Admin Add New Movie Backend
Tien Nguyen
State
New
178 Build API Route
State
To Do
187 Connect Function to Recommendation System
State
To Do
85 Admin Delete Movie Backend
Tien Nguyen
State
New
179 Build API Route
State
To Do
188 Connect Function to Database
State
To Do
98 Admin Login Frontend
Tien Nguyen
State
New
190 UI Implementation
State
To Do
199 Build API Call
State
To Do
99 Admin Logout Frontend
Tien Nguyen
State
New
191 UI Implementation
State
To Do



4.2. Implementation

In Sprint 4, there are 3 Functional Requirements implemented are:

FR.5: Admin Authenticate Management

FR.6: Admin Users Management

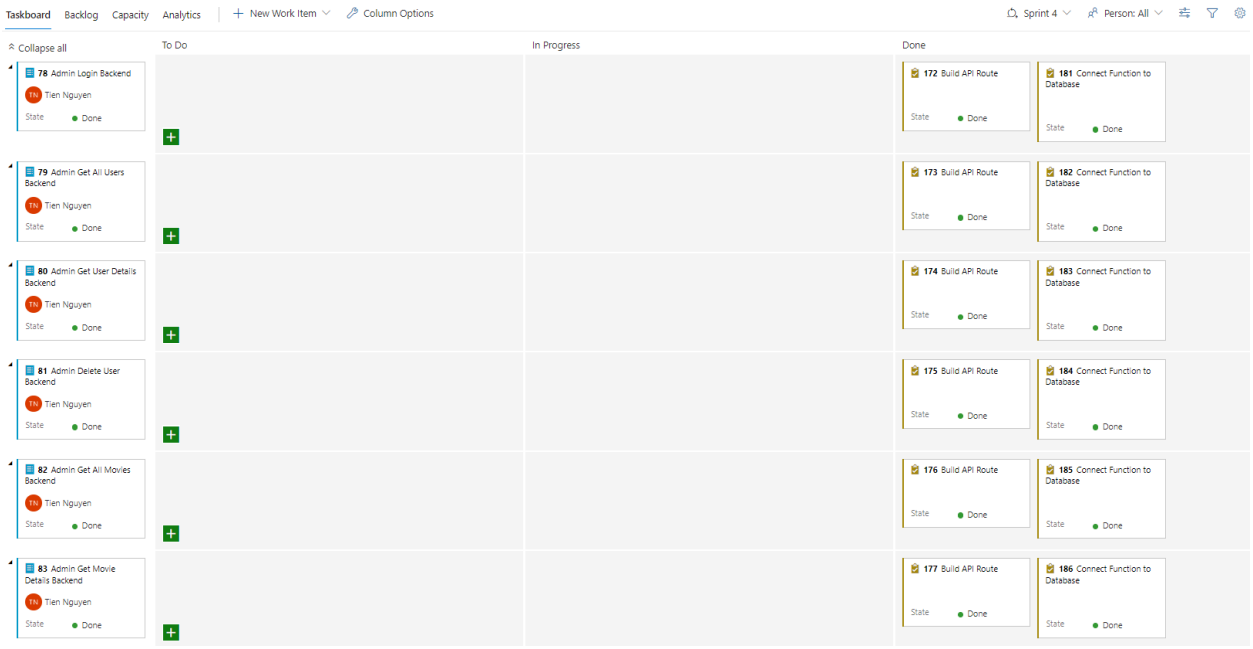
FR.7: Admin Movies management

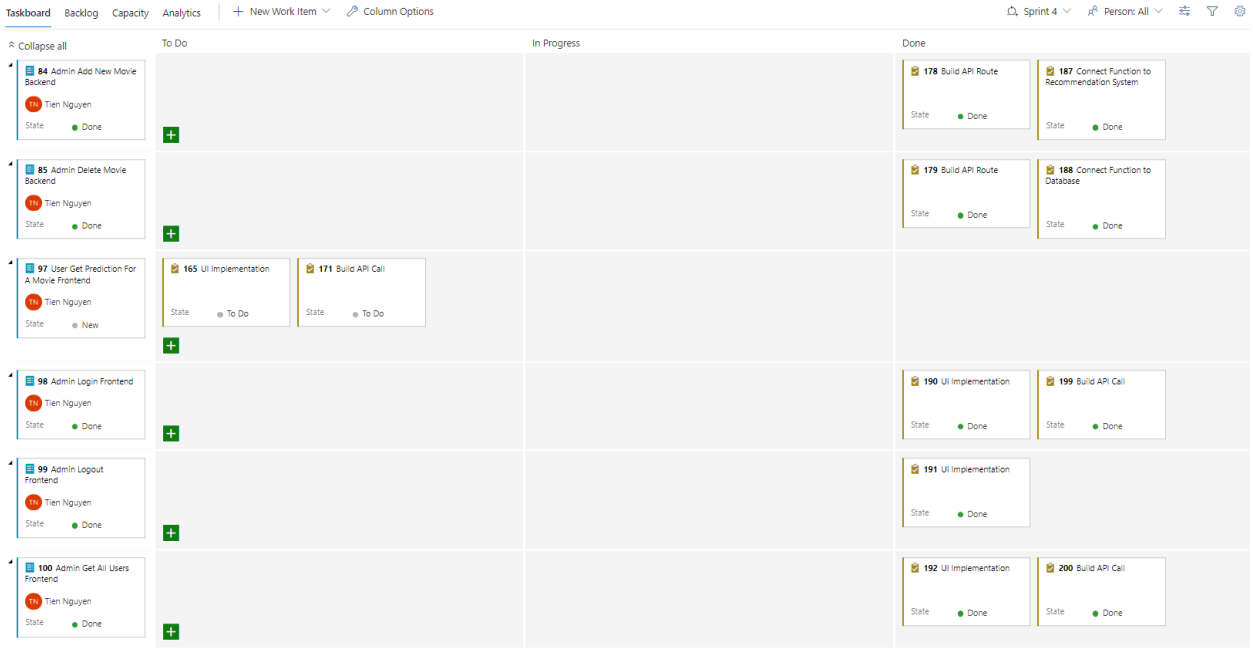
FR.5 is pretty similar to FR.1: User Authenticate Management so it will not take long time to implement.

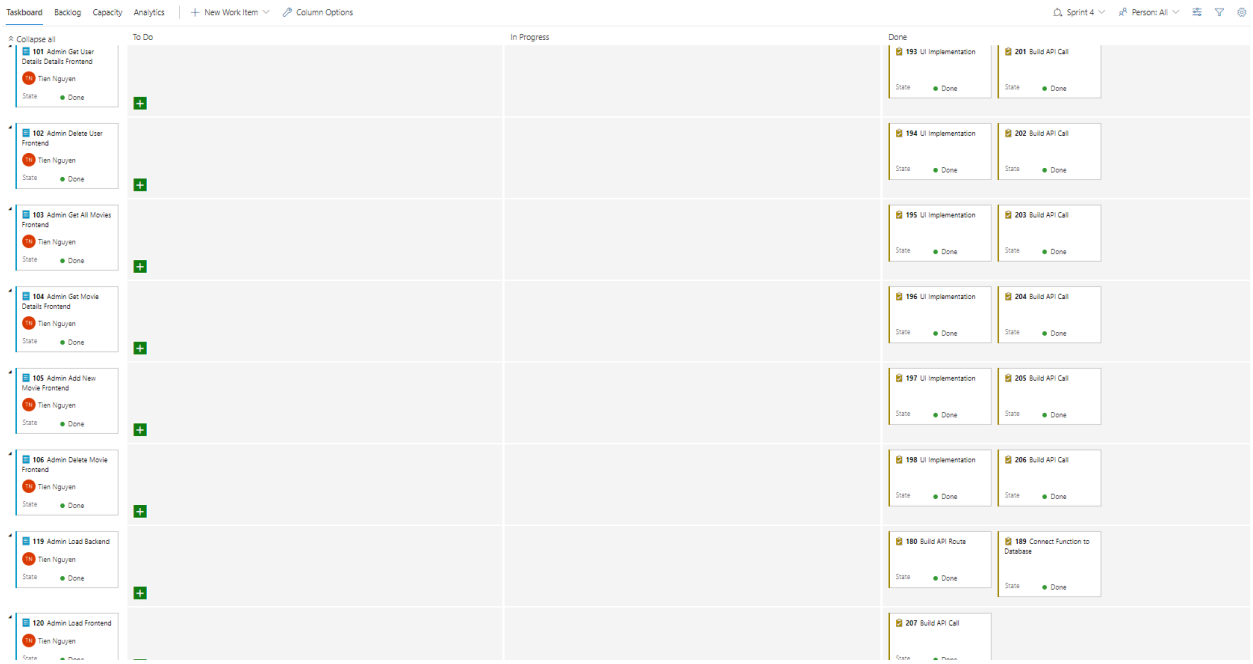
The other two FRs (6 and 7) also don't take too much time because there's no need to focus too much on UX when the UI just needs to be usable, not too beautiful.

4.3. Review

While all the Backlogs planned for Sprint 4 have been completed, the Backlogs from Sprint 3 have not yet been completed. However, the product can still be released because this Backlog is only in Priority 4, it's okay to have it or not.

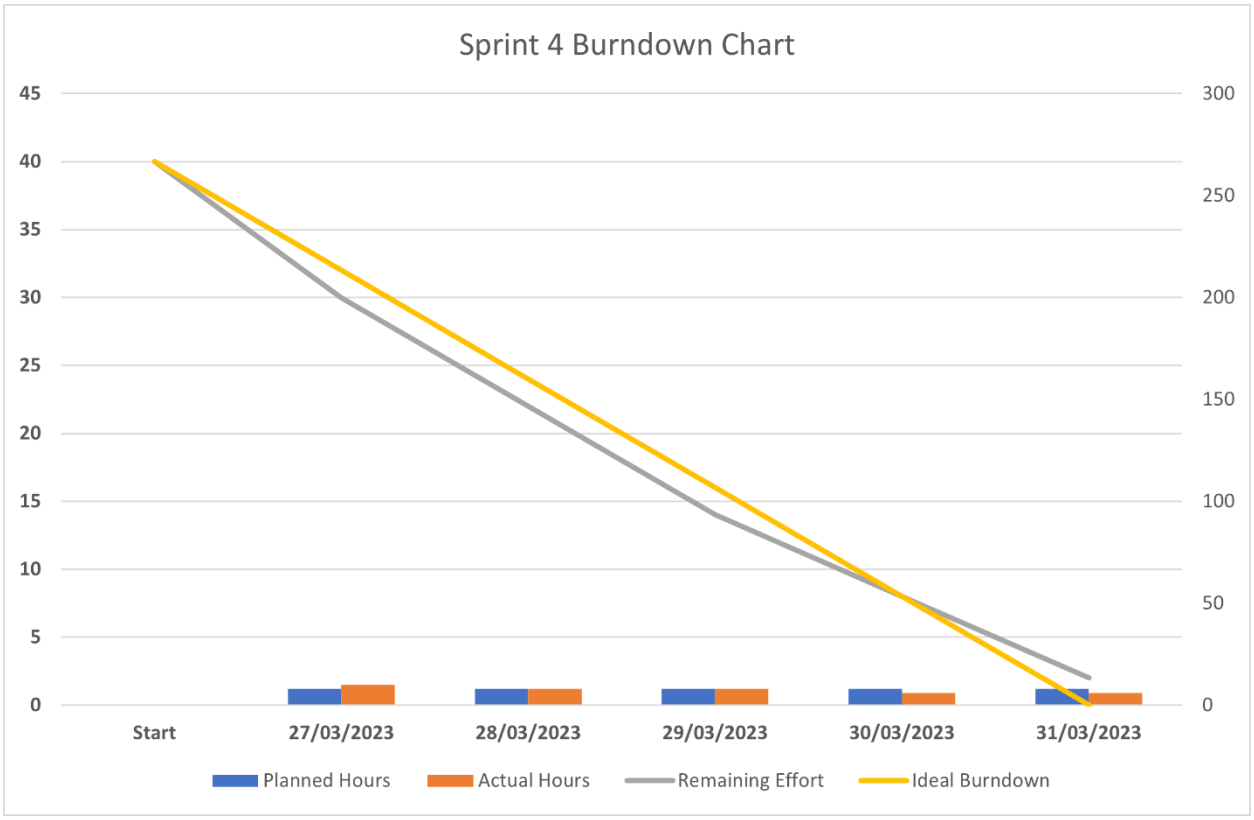






4.4. Retrospective

Release Burndown Chart

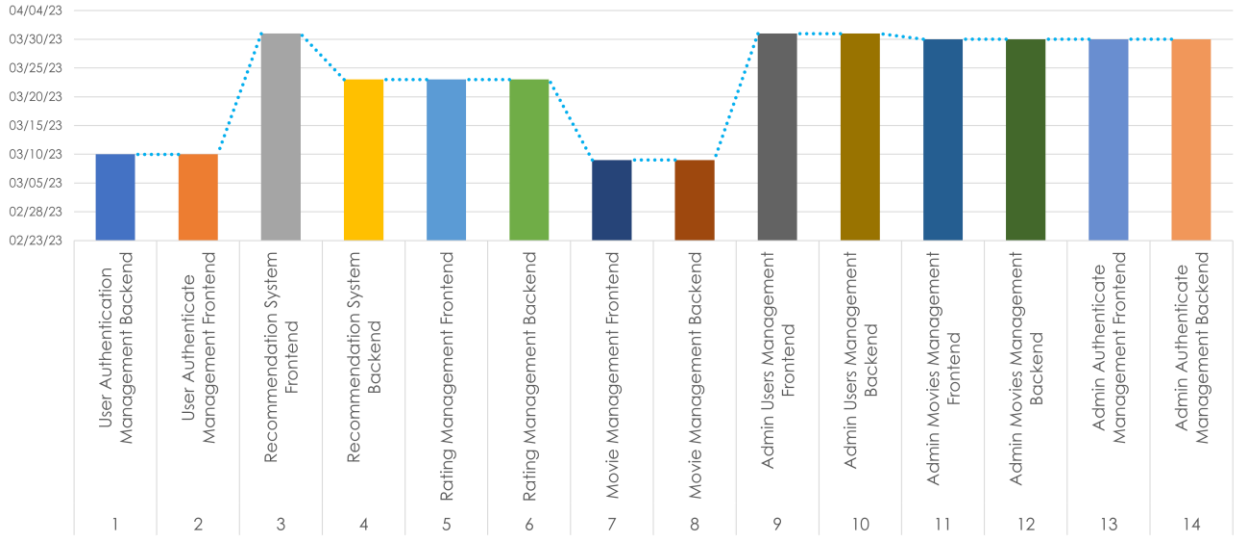


Looking at the Burndown Chart, we can see that the team has found the right pace and process for the project. The Backlogs are completed quite close to the time, not too late or too early like the previous times. Finishing too early is also not so good as finishing too late.

VIII. Project closure

1. Release Burn Up Chart

More Details in file “Release-Burn-Up-Chart.xlsx”



From the Burn Up Chart, we can see that most of the product's features are completed in the last Sprint. There are 4 features completed in the early stage, 3 features completed in the middle stage, and 7 features completed in the final stage.

2. Verification test

Questions need answers in verification test:

- Are we building the product right?
- Does the software meet the specifications?

FR.1: User Authenticate Management:

FR.1.1: User Registration

Passed: Verify that all required fields are present, such as email, password, confirm password, …

Passed: Verify that user can successfully register with valid information.

Passed: Checking if a user can register with valid data only in mandatory fields

Passed: A user get registered should be allowed to login to the application.

Passed: A user tries to register an existing email then an error message should get displayed.

Passed: Verify if the registration form has all the fields required by the requirement document.

Passed: Verify that a user can navigate to Login if they have an account.

FR.1.2: User Login

Passed: Verify that a user can log in with valid credentials.

Passed: Verify that a user cannot log in with invalid credentials.

Passed: Verify that a user cannot log in with invalid email and password.

Passed: Verify that Browser will save login session at local storage.

Passed: Verify that a user can navigate to Register if they don't have an account.

FR.1.3: User Verification

Passed: Verify that the user can successfully access the application with access token.

Passed: Verify that a logged in user doesn't need to login again if they refresh the web page.

Passed: Verify that a logged in user can navigate to another function of application.

FR.1.4: User Logout

Passed: Verify that at any function of the application, user can press logout.

Passed: Verify that after user press logout, all the information of user and token will be deleted.

FR.1.5: User Load

Passed: Verify that after user get verified, user information will be loaded.

Passed: Verify that user information will not be in local storage.

Passed: Verify that user information will be in Data Store as a state.

FR.2: Movie Management:

FR.2.1: User Search Movie

Passed: User cannot search for movie with less than 3 characters.

Passed: User can search for movie with more than 3 characters.

Passed: User will get fast response when call multiple searches at a short time.

Passed: User will get a list of movies with covers for a clear view.

FR.2.2: User Get Movie Details

Passed: User can get all information about a movie such as: Title, Genre.

Passed: User can see movie cover.

FR.3: Rating Management:

FR.3.1: User Create Rating

Passed: User will be allowed to create a new rating when they see a movie page.

Passed: After user rated a movie, their W, d in machine learning model get trained.

FR.3.2: User Read Rating

Passed: When a user sees a movie page, they can see their existing rating.

Passed: If user didn't rate that movie, it will display as blank star.

FR.3.3: User Update Rating

Passed: Verify if update rating function will only appear with existing rating.

Passed: Verify if update rating will change their W, d in machine learning model.

Passed: User should see updated rating value after server confirm.

FR.3.4: User Delete Rating

Passed: Verify if delete rating function will only appear with existing rating.

Passed: User should see blank rating star after server confirm rating is deleted.

FR.4: Recommendation System:

FR.4.1: User Get Suggested Movies

Passed: Verify if user can get a list of suggested movies.

Passed: Verify there is no rated movie in the list.

Passed: Evaluate model with training set, testing set.

FR.4.2: User Get Prediction for A Movie

Passed: API call for this function work.

FR.5: Admin Authenticate Management:

FR.5.1: Admin Login

Passed: Same as User Login

Passed: User credentials cannot be used to be login as admin.

Passed: Admin credentials cannot be used to be login as user.

FR.5.2: Admin Logout

Passed: When an admin press logout, there is no information left in the local storage.

Passed: When an admin press logout, there is no information left in the data store.

FR.6: Admin Users Management:

FR.6.1: Admin Get All Users

Passed: Admin can see all users in the database.

Passed: Click on the list will direct admin to see a specific user information.

FR.6.2: Admin Get User Details

Passed: Admin can see all information about user.

Passed: Admin cannot know user password nor see user encrypted password.

FR.6.3: Admin Delete User

Passed: Admin can only delete existing user.

Passed: Admin will access this feature in the specific user details.

FR.7: Admin Movies management:

FR.7.1: Admin Get All Movies

Passed: Admin can see all movies in the database.

Passed: Click on the list will direct admin to see a specific movie information.

FR.7.2: Admin Get Movie Details

Passed: Admin can see all information about movie.

FR.7.3: Admin Add New Movie

Passed: Admin can access this feature through FR.7.1.

Passed: After pressing a button, admin will turn into a page where they can fill the new movie.

FR.7.4: Admin Delete Movie

Passed: Admin can only delete existing movie.

Passed: Admin will access this feature in the specific movie details.

3. Validation test

Questions need answers in validation test:

- Are we building the right product?
- Does the software meet the user requirements?

Can this application suggest movies to the user? Accepted

How does this application suggest movies to users? By a machine learning model. Accepted.

To get more accurate suggestions, what does a user need to do? Give more ratings to more movies, update their rating or delete existing ratings.

To rate a movie, what does a user need to do? Create an account, login and access a movie page.

How can a user access a movie page? Through Movie Search or Movie Suggestion.

Basically, all the requirements of the stakeholders for the application have been met and the validation test passed.

4. Operation plan and Deployment order

Target cost: free plan.

There are 3 components in this project:

- Database
- Backend
- Frontend

Frontend will only work when it gets response from Backend.

Backend will only work when it gets data from database to process.

So, the deployment order will be as follows:

1. Database
2. Backend
3. Frontend

The cost plan will aim to free, details will be in the next sections.

4. Database Deployment

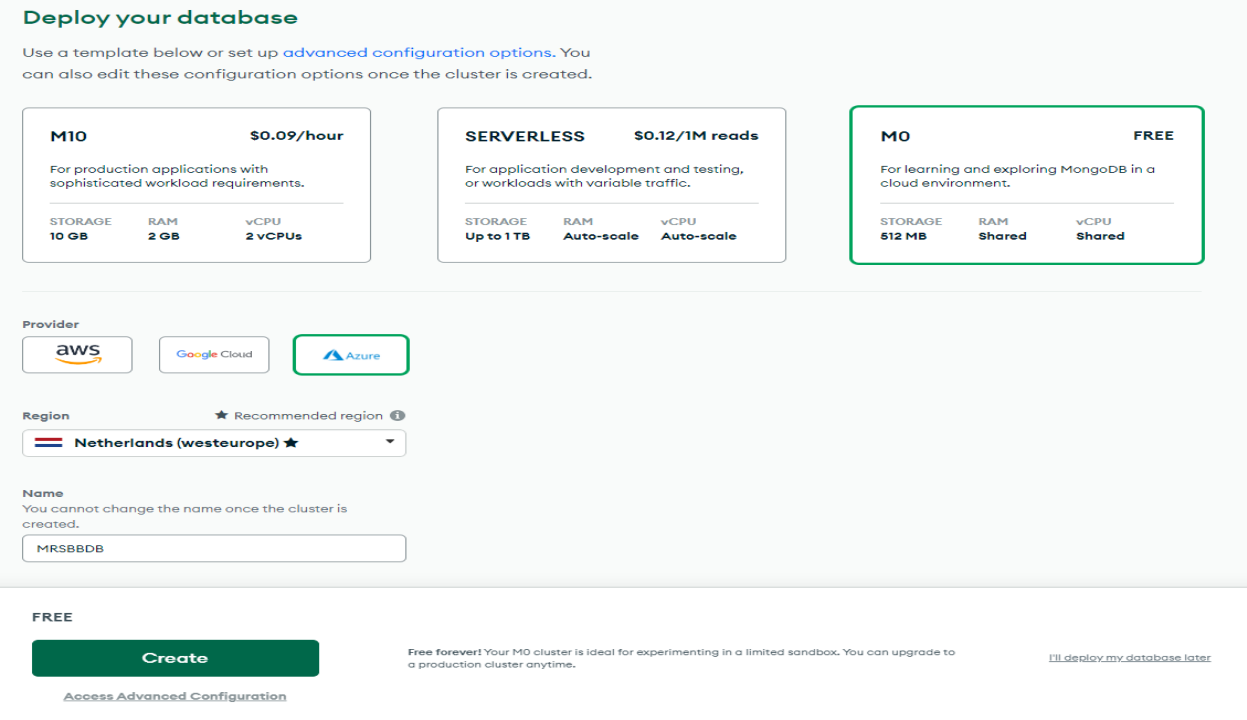
With a logged in user at MongoDB Atlas, we can deploy a free database:

The cost plan is M0.

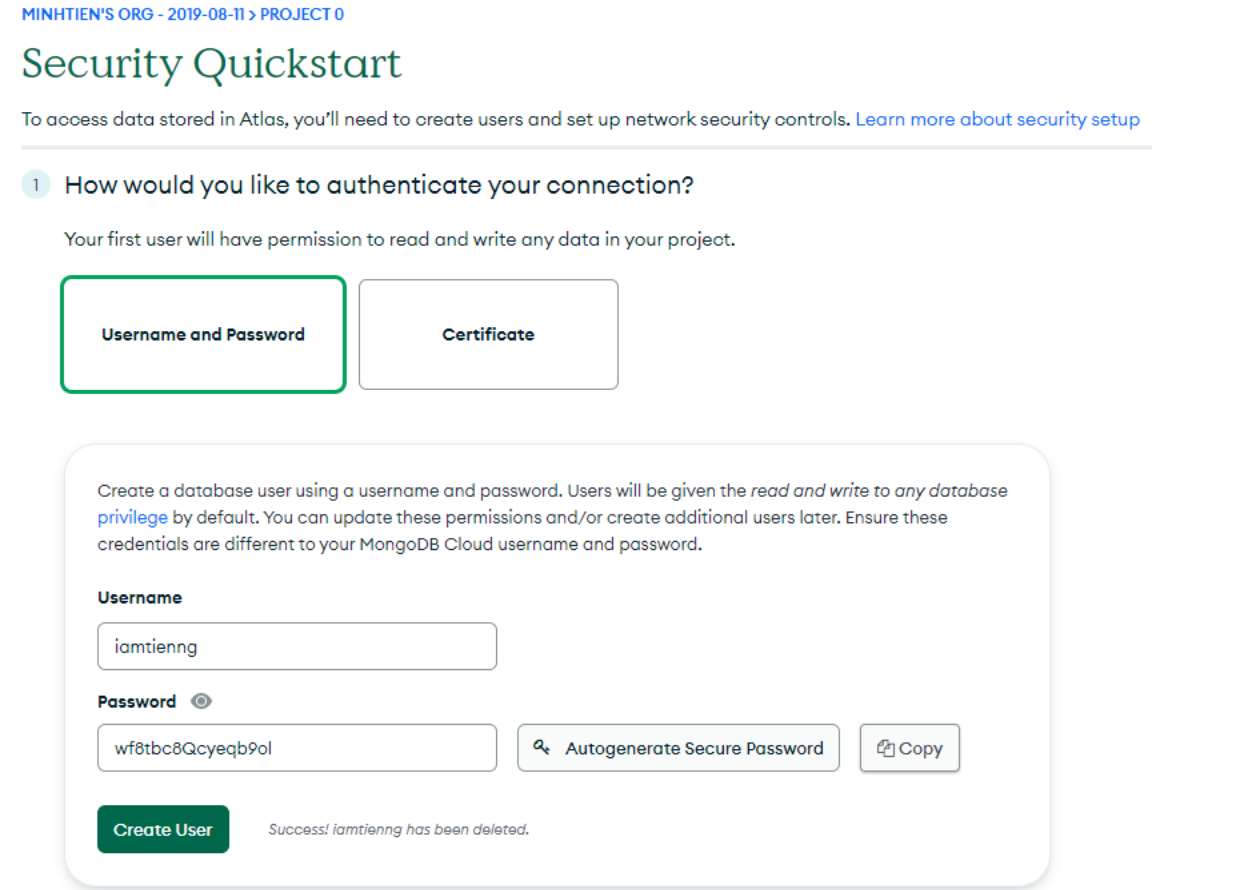
The provider is Azure.

The region is Netherlands (westeurope).

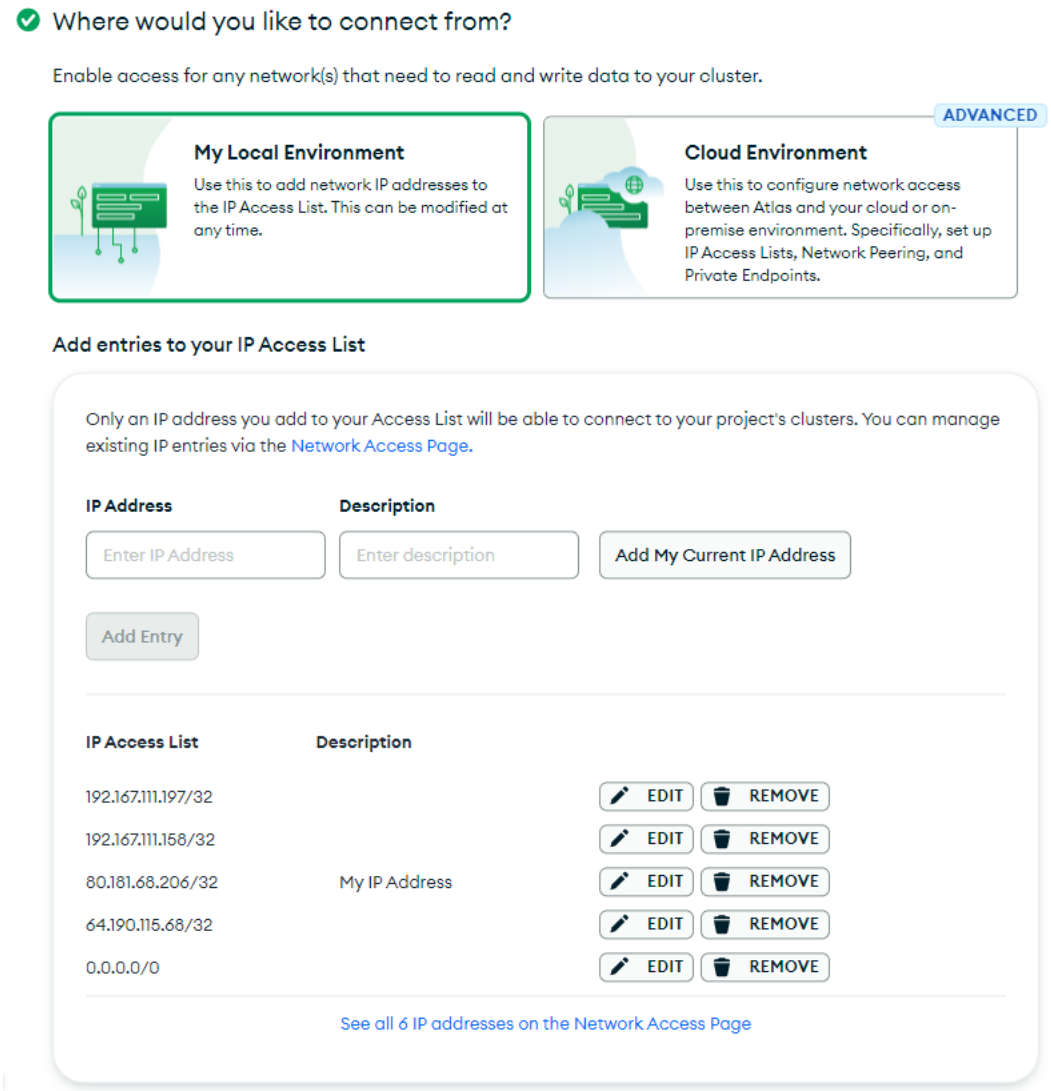
Name is MRSBBDB.



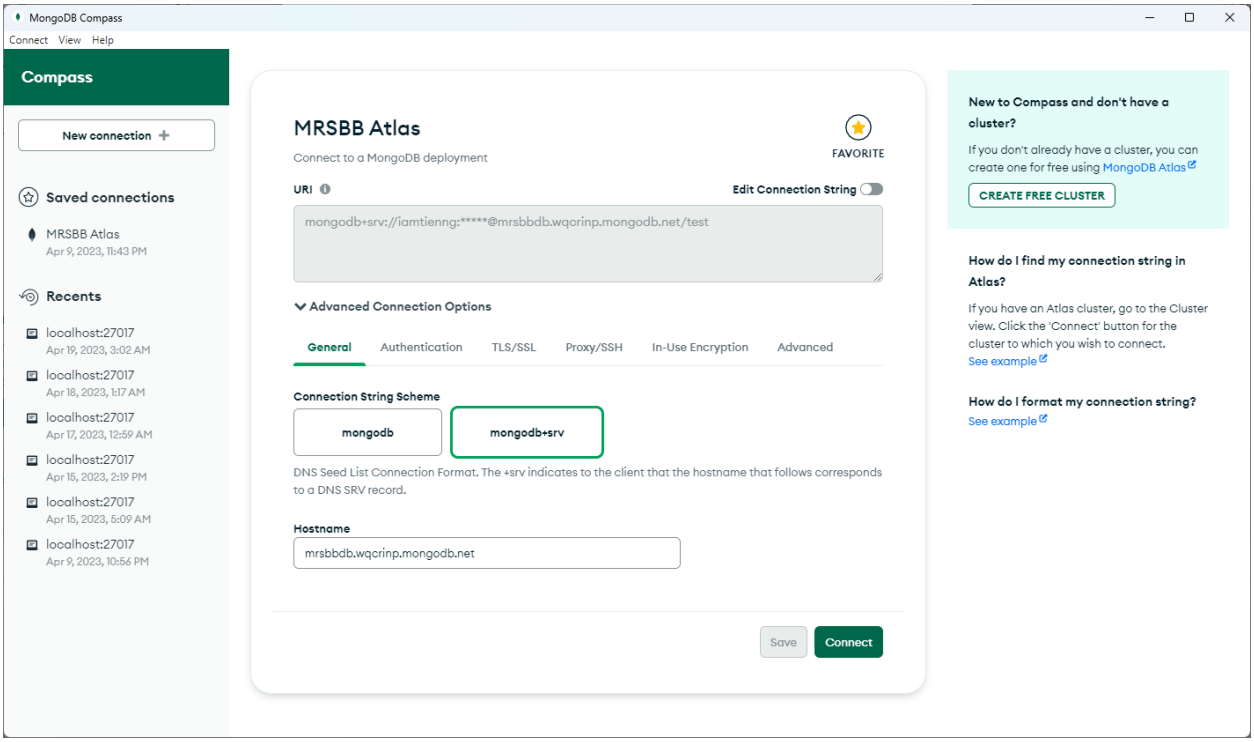
Next, we have to set up an authenticate method, in this project, I choose username and password



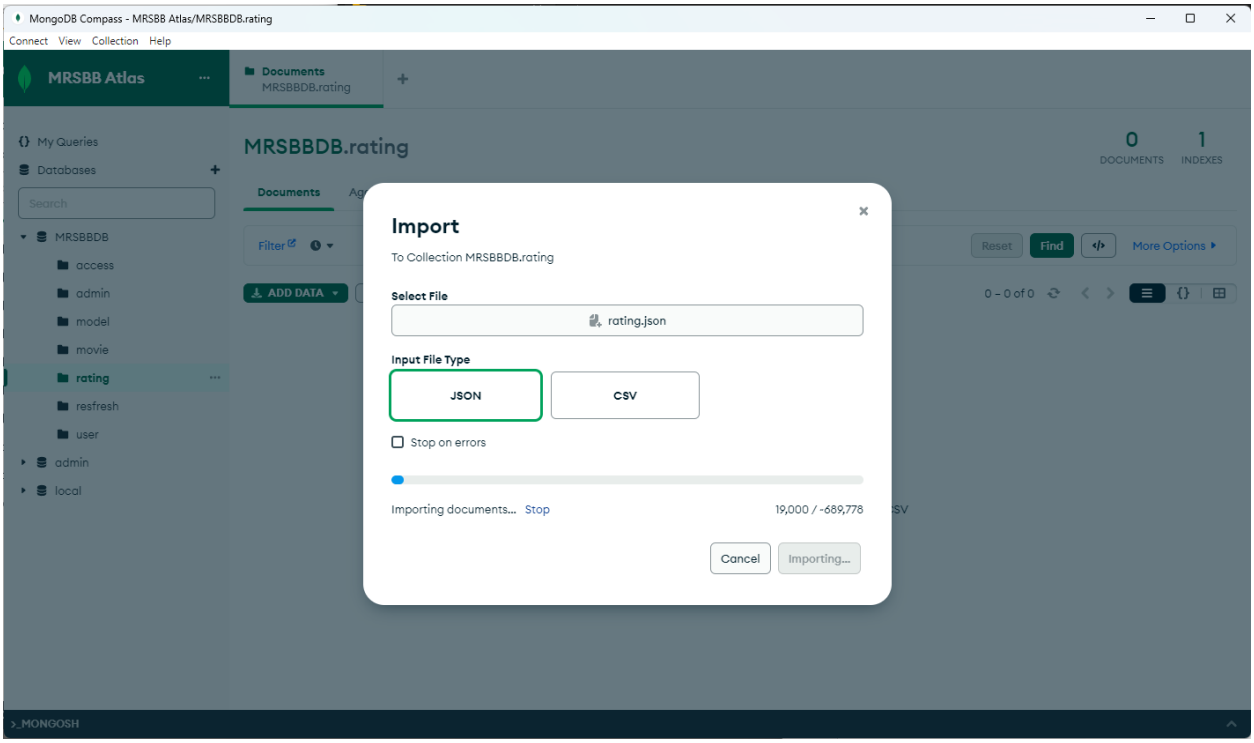
Next, we have to setup IP Access List, 0.0.0.0/0 is anywhere



Next, we connect the database with MongoDB Compass to setup initial data



Next, we create 7 collections and import all data in the json files in Database directory:



For Backend to access this deployed database, we have username, password and database url.

5. Backend Deployment

First, we need to setup requirement.txt file, this file will contain all the names of the packages and their respective versions that are needed for backend application. My requirement.txt file is:

```
Flask==2.2.2

Flask-Cors==3.0.10

wheel==0.40.0

rsa==4.7.2

pycryptodome==3.15.0

PyJWT==2.6.0

pandas==1.5.3

scikit-learn

pymongo==3.12.0

dnspython==2.3.0
```

With this requirement.txt file, a package-management system written in Python called Pip will install automatically when we set up docker container.

Next, we need to set up the Dockerfile, my Dockerfile will be as follows:

```
# author: @iamtienng
# start by pulling the python image
FROM python:3.10-buster

# copy the requirements file into the image
COPY ./requirement.txt /app/requirement.txt

# switch working directory
WORKDIR /app

# install the dependencies and packages in the requirements file
RUN pip install -r requirement.txt

# copy every content from the local file to the image
COPY . /app

# configure the container to run in an executed manner
ENTRYPOINT [ "python" ]

CMD ["main.py" ]
```

Before we move to next step, be sure change the localhost database to the database we deployed in the file extensions.py:

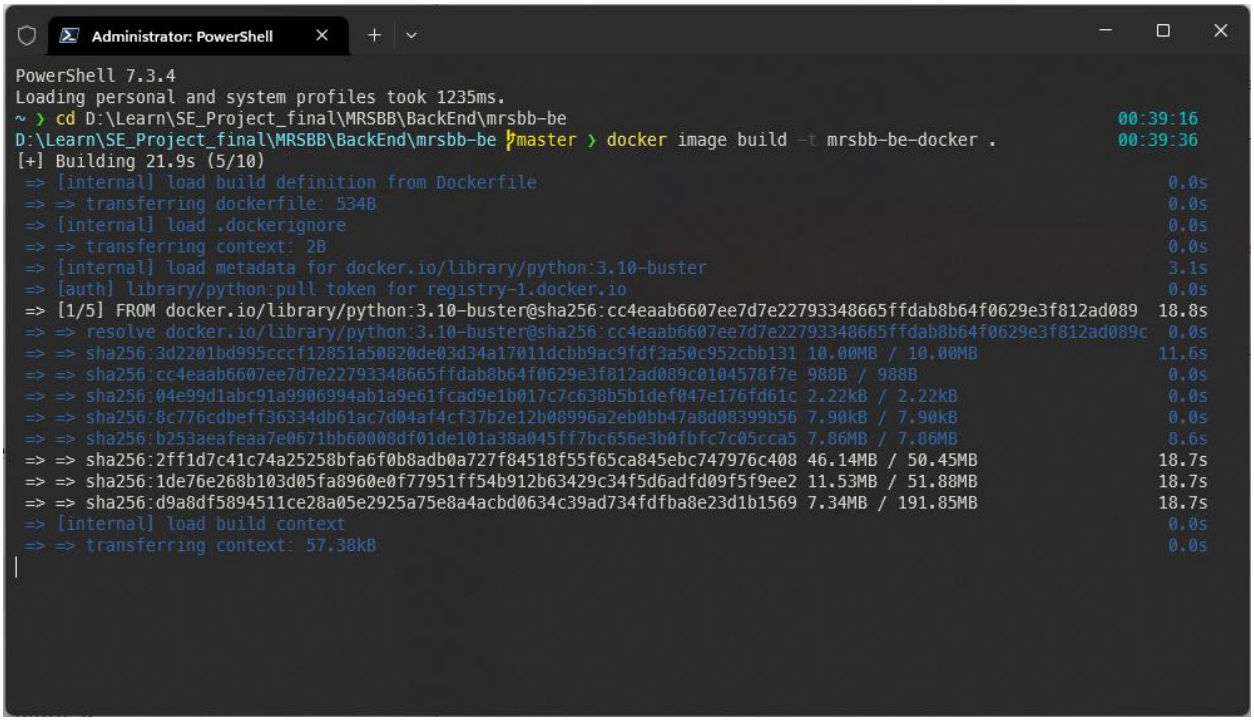
```
# connect to the database
# usernameDB = "iamtienng"
# passwordDB = "d4O8CmCGCeCI8vzA"
client = MongoClient(
    'mongodb+srv://iamtienng:d4O8CmCGCeCI8vzA@mrsbbdb.wqcrinp.mongodb.net/?retryWrites=true&w=majority')
# localhost
# client = MongoClient("localhost", 27017)
db = client["MRSBBDB"]
```

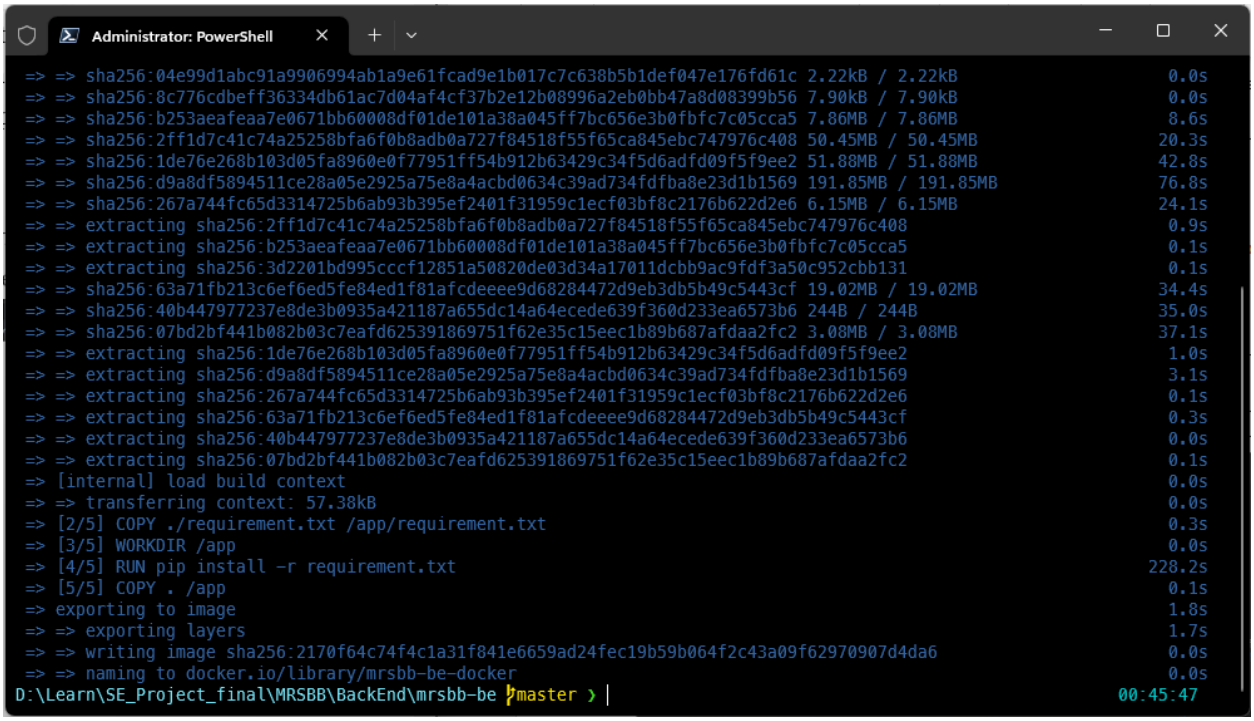
Also, for deployment on azure, add this to Flask app main:

```
port = int(os.environ.get('PORT', 5000))
app.run(debug=False, host='0.0.0.0', port=port)
```

Run this command below in the terminal, we will build a docker image.

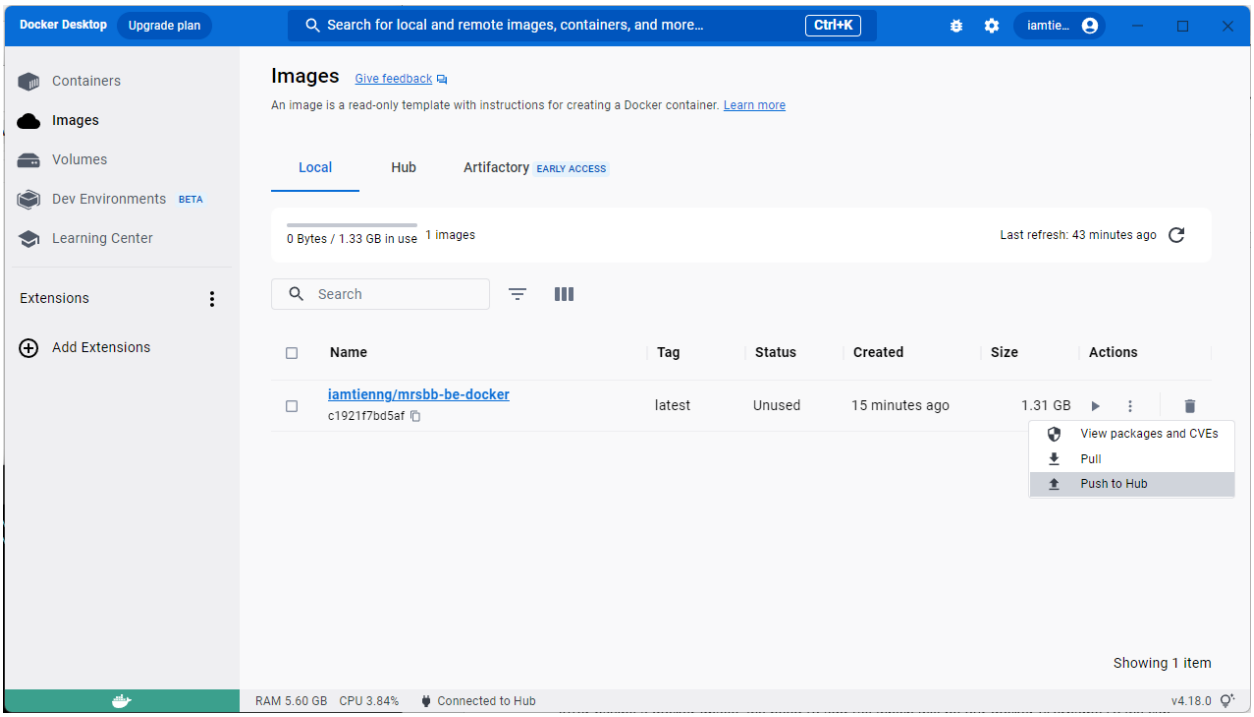
```
docker image build -t mrsbb-be-docker .
```



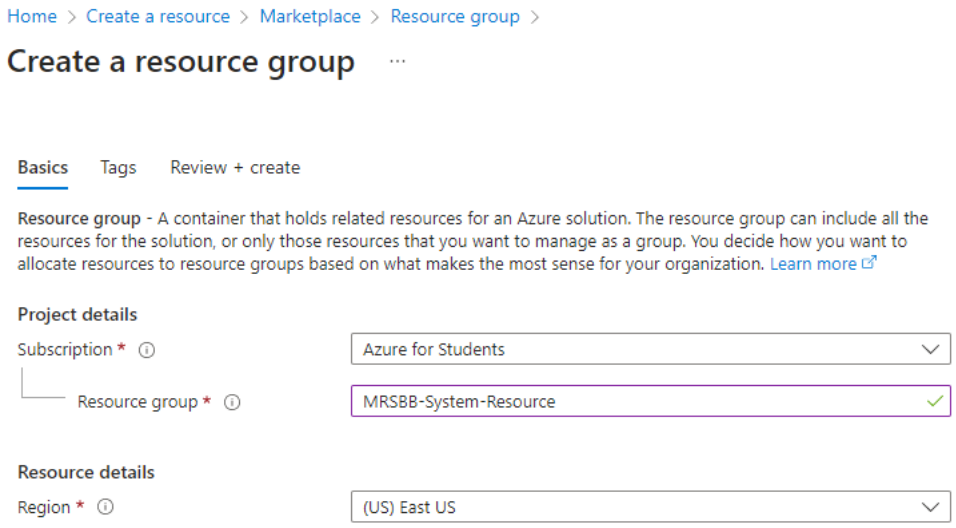


After having a docker image, we need to add tag which will be our docker username so we can push the image to docker hub with this command:

```
docker tag mrsbb-be-docker iamtienng/mrsbb-be-docker
```



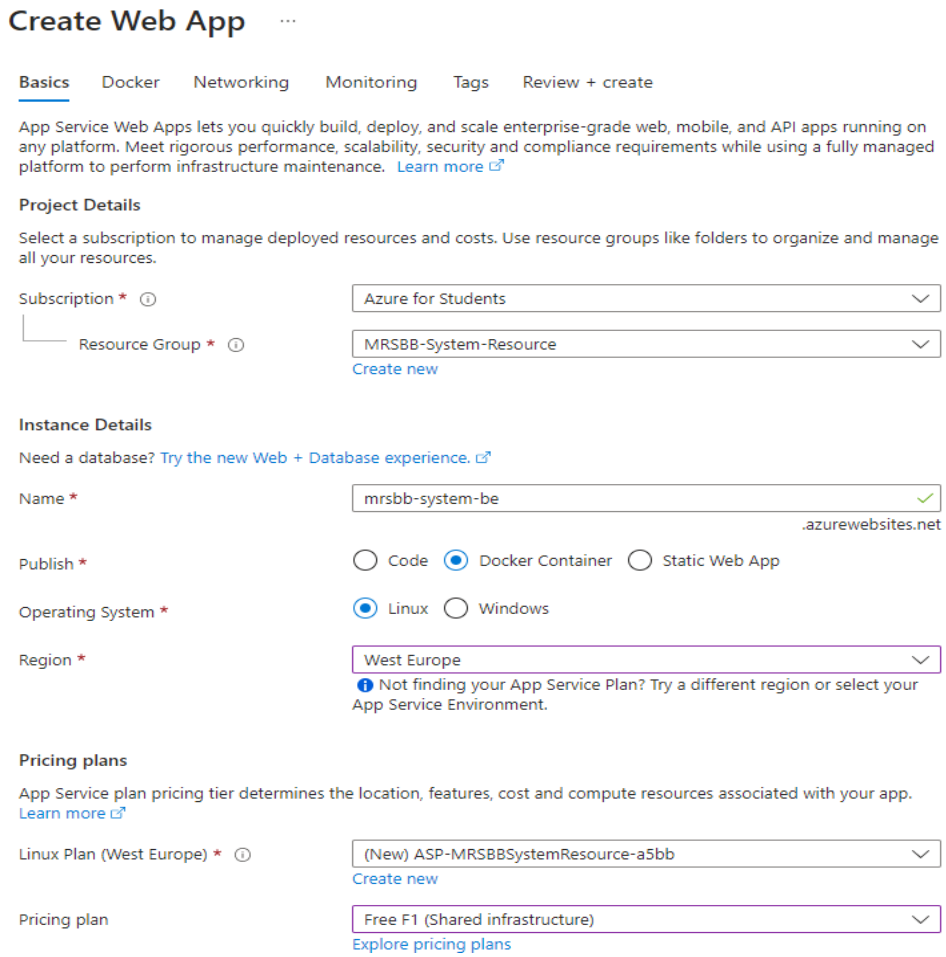
Create a resource group on Azure portal:



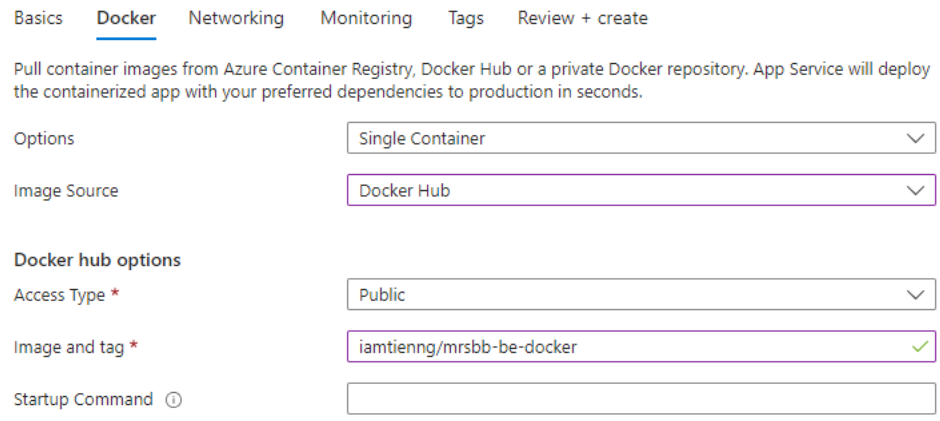
Create Web App on Azure portal:

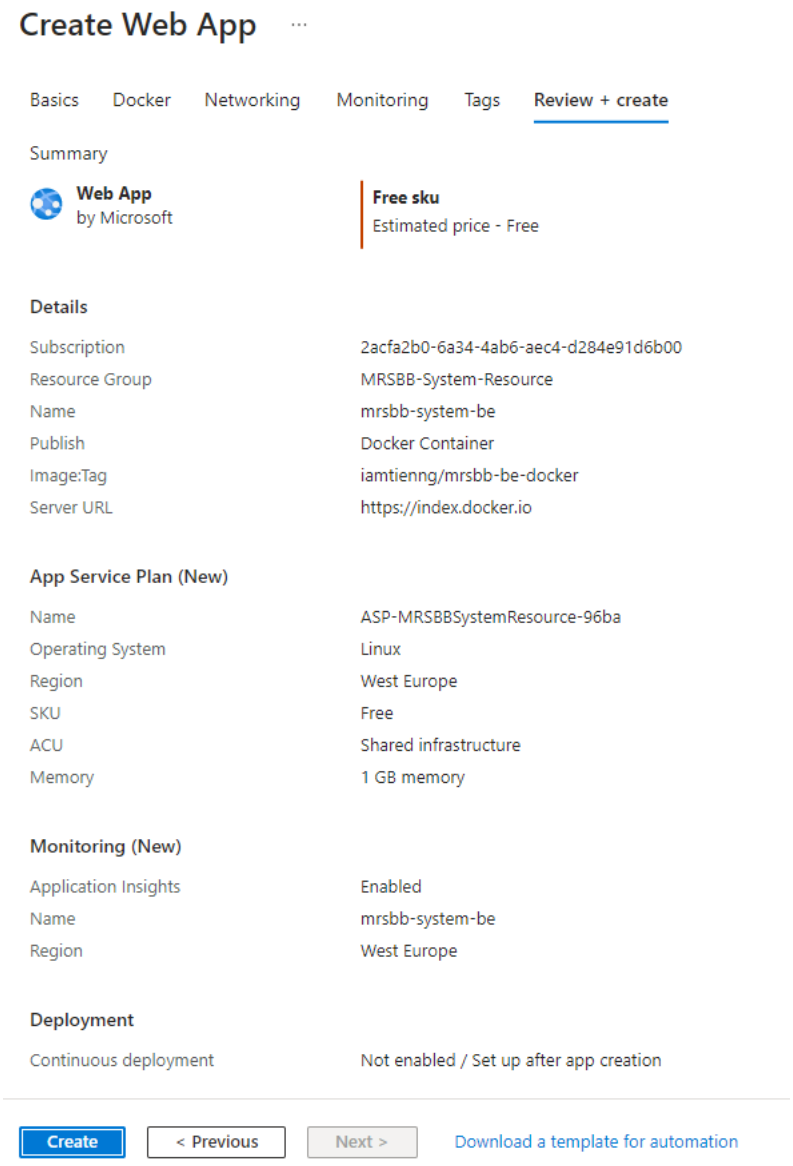
The pricing plan is Free F1.

Domain name will be mrsbb-system-be.azurewebsites.net

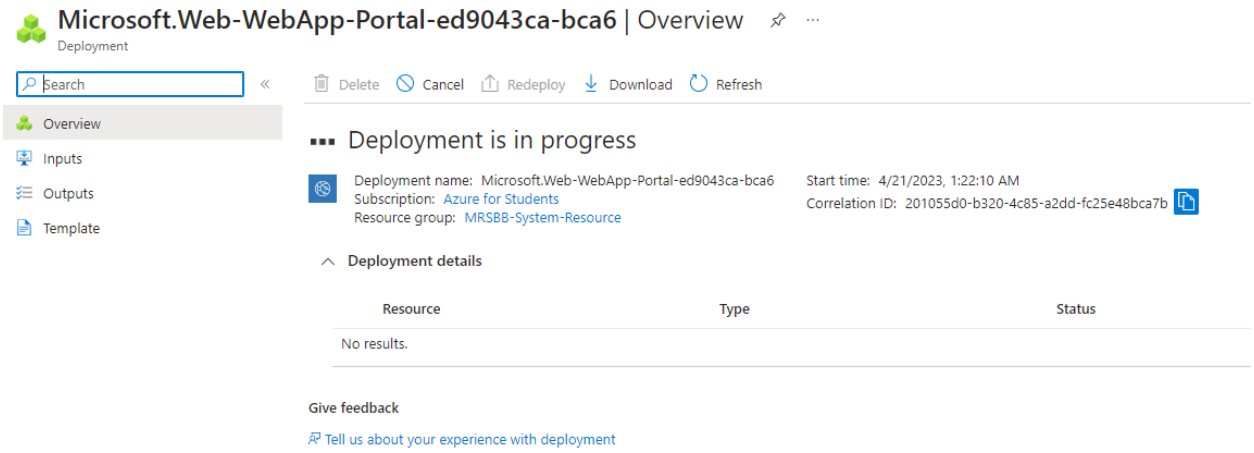


After that we need to identify the docker image and tag

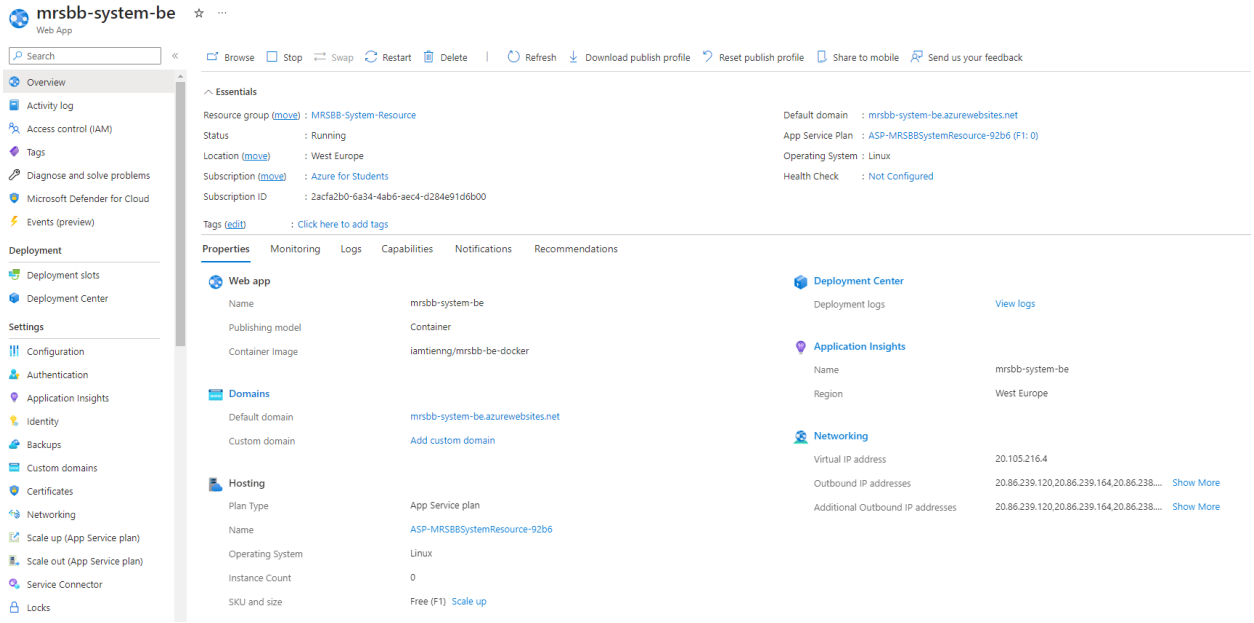




After creating the webapp, we need to wait for azure to deploy.

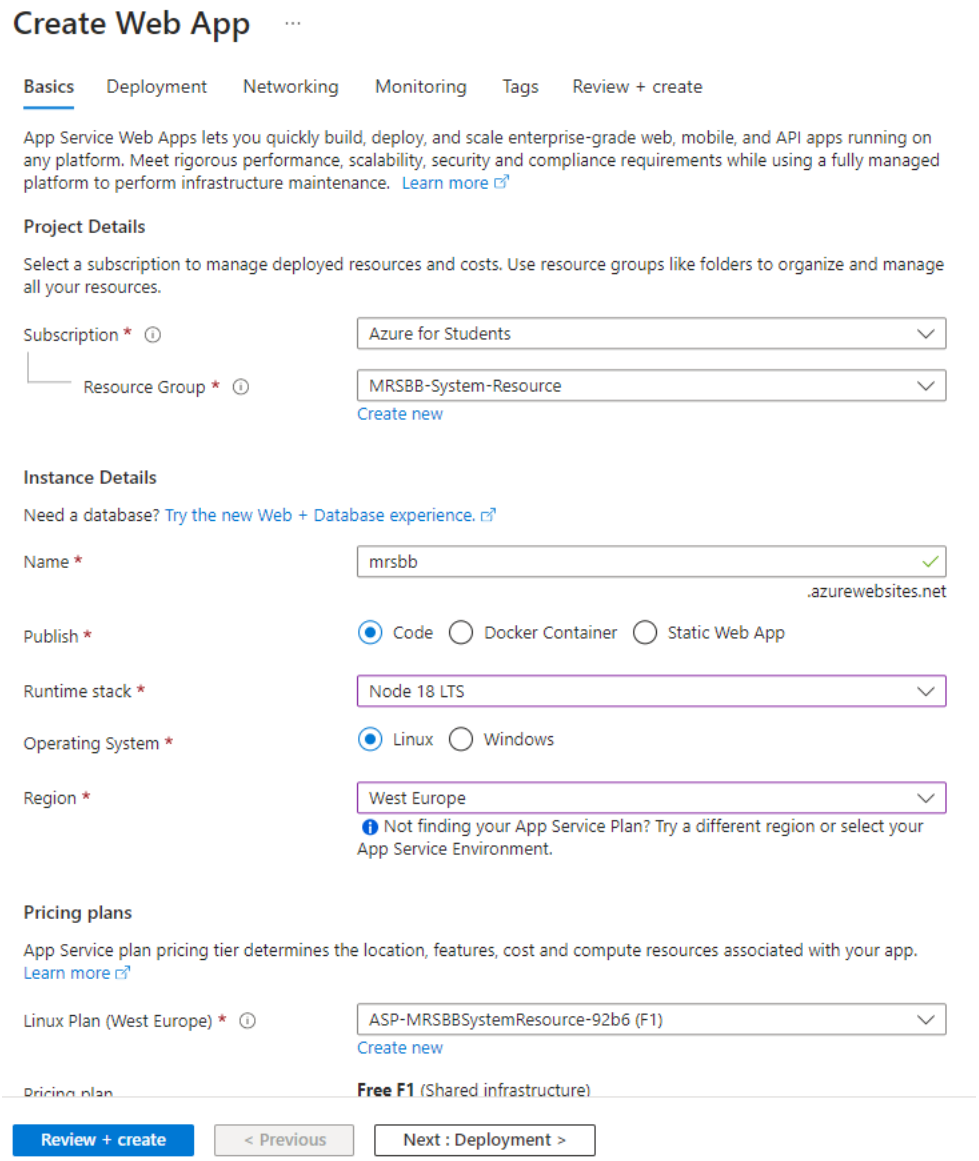


After that, our Backend is completely deployed



6. Frontend Deployment

Again, we create another Web App on Azure portal for Frontend:

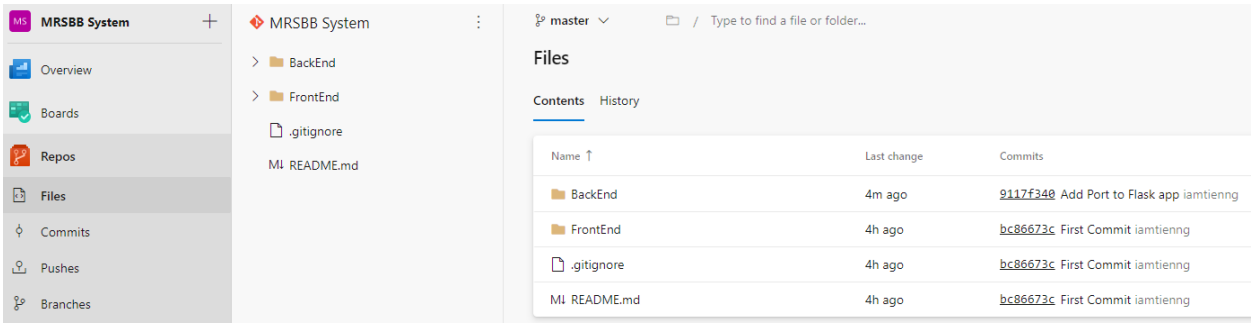


But this time, we will not configure on Azure portal, we will use Azure DevOps Pipeline instead.

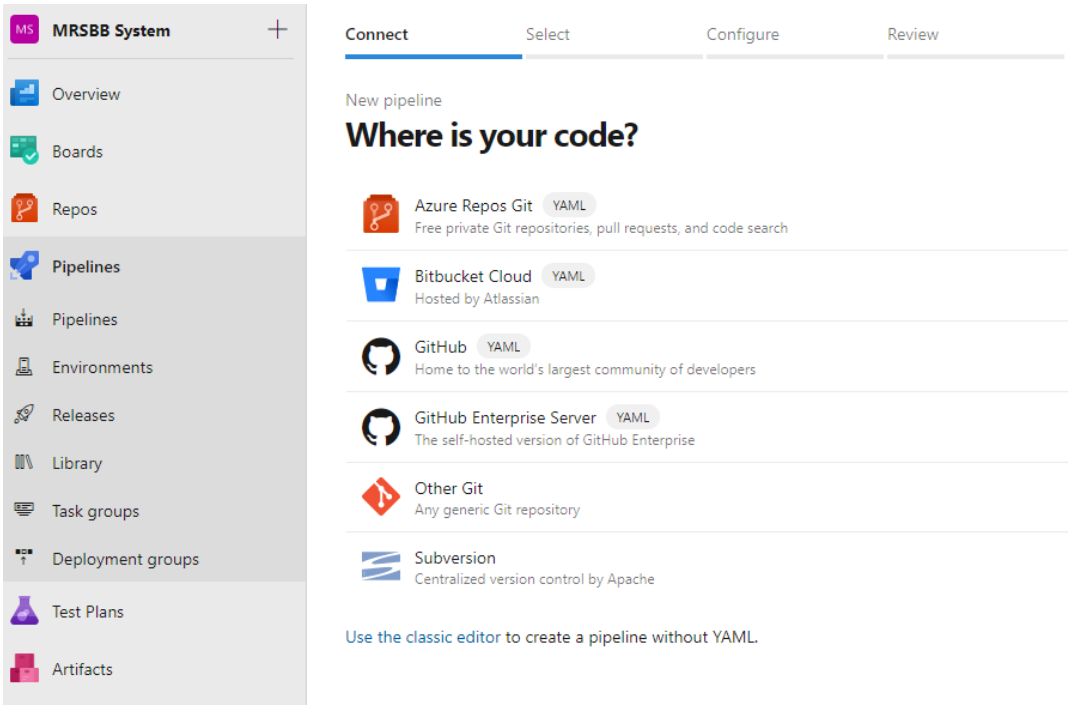
Before we handle Pipeline, we need to change Backend API URL in Frontend by modifying the .env file:

```
REACT_APP_API_URL = "https://mrsbb-system-be.azurewebsites.net/"
# localhost
# REACT_APP_API_URL = "http://localhost:5000"
```

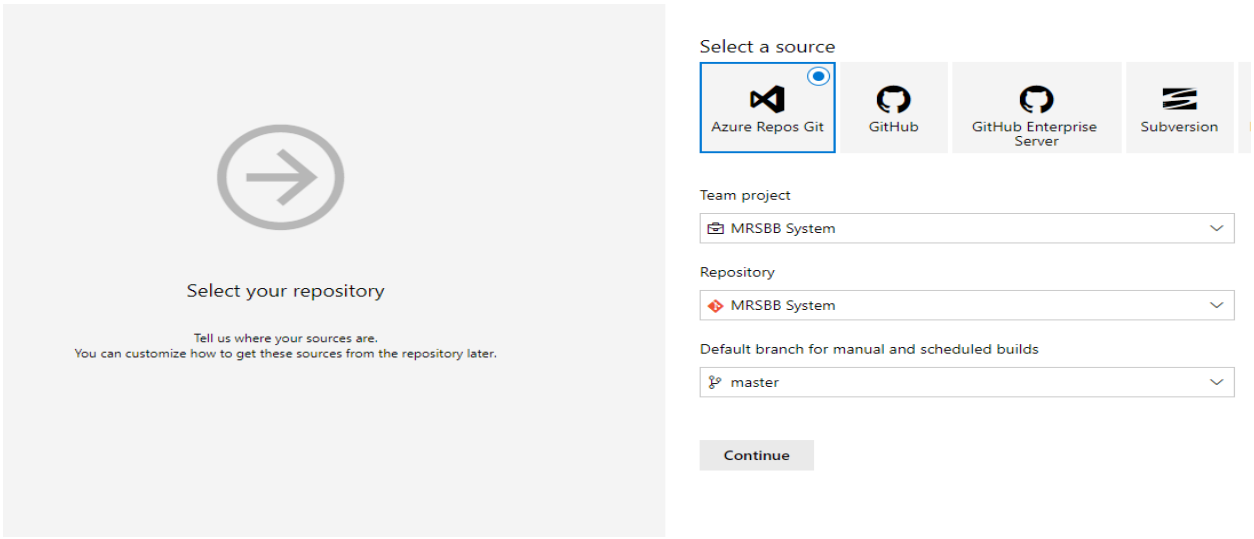
After that, we need to use Git to push our source code to Repos in MRSBB System Project on Azure DevOps:



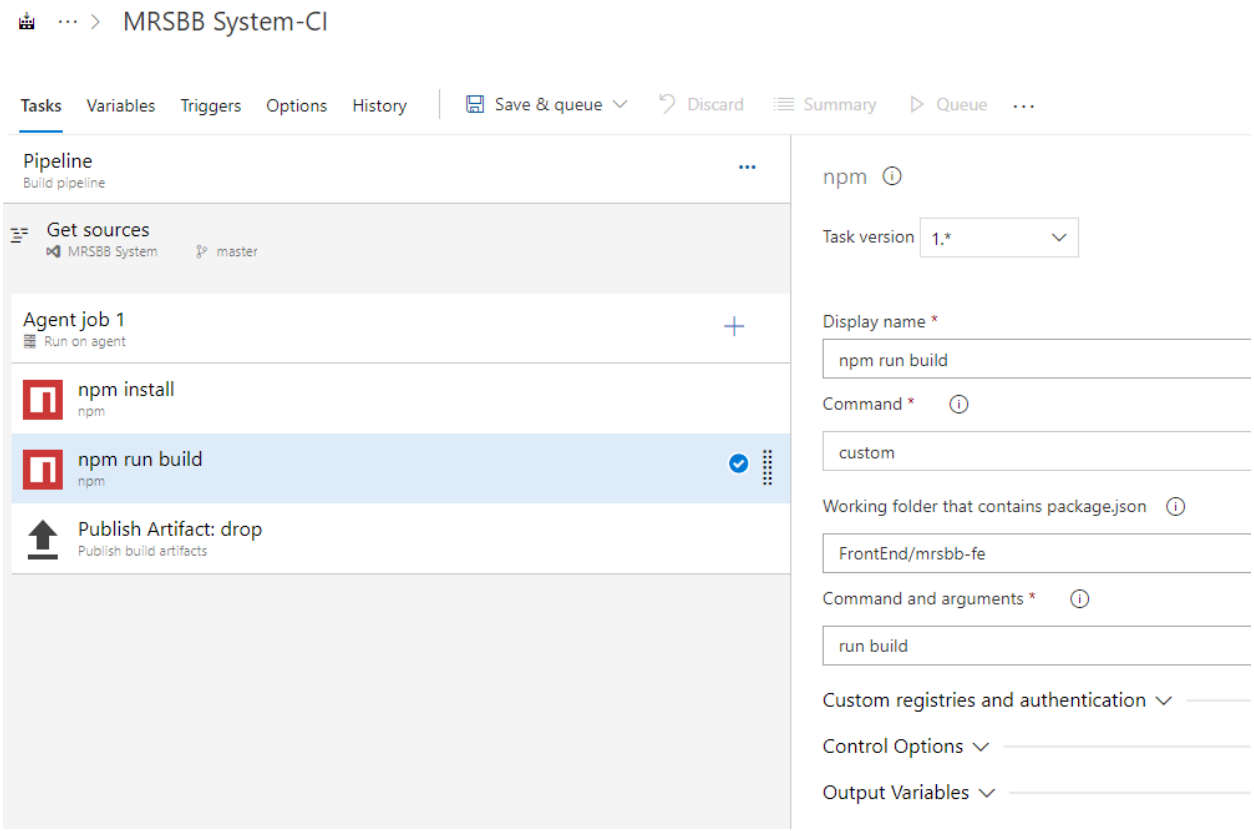
Select “Use the classic editor”.

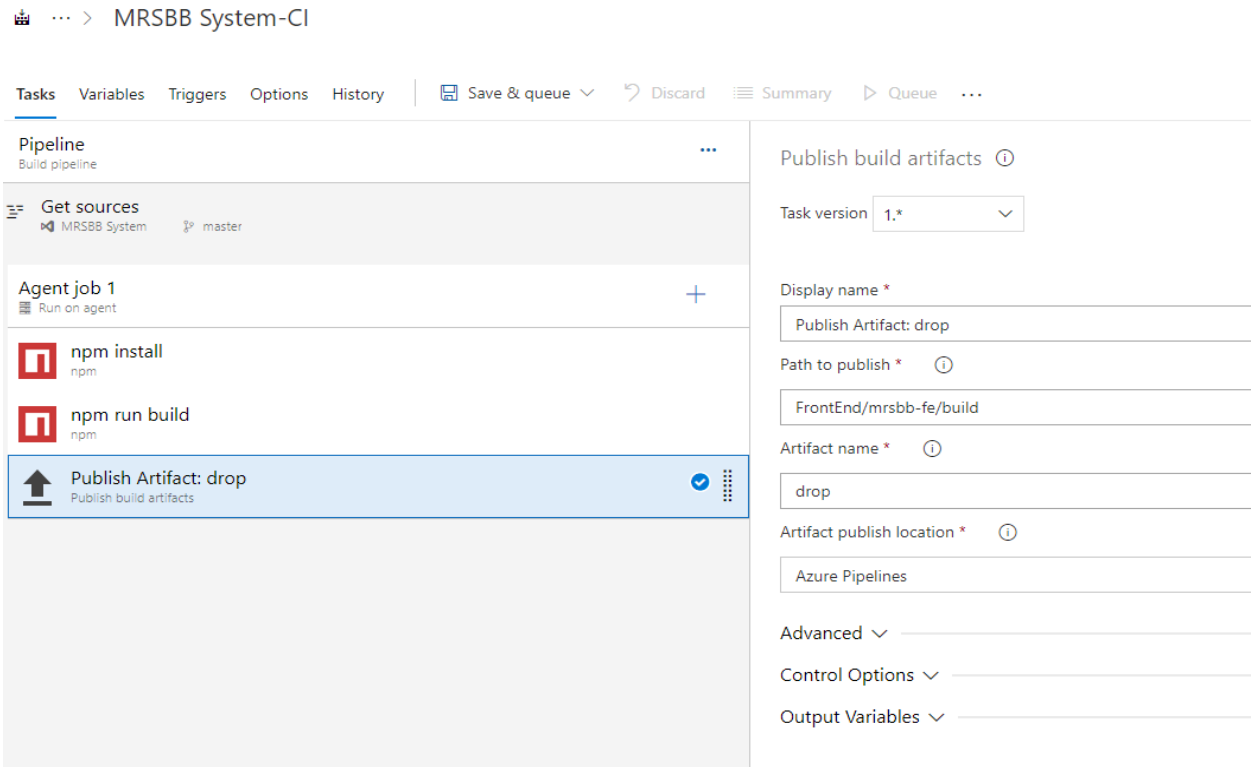


Select Azure Repos Git as repository for Pipeline

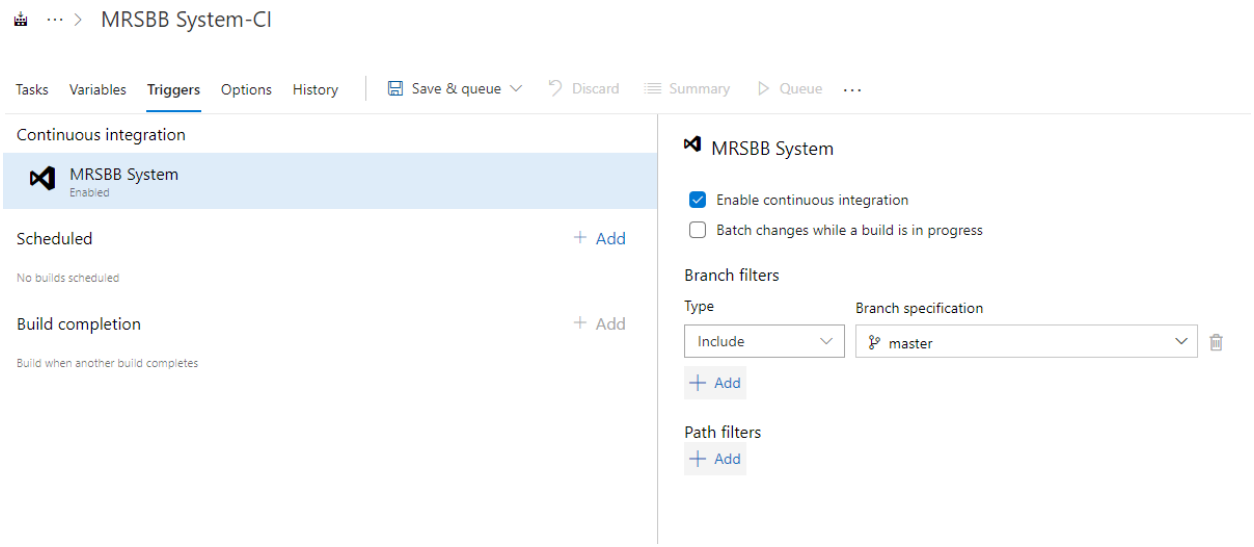


Choose to start with an Empty job. We will set up 3 jobs, careful the path for npm run build and Publish Artifact: drop

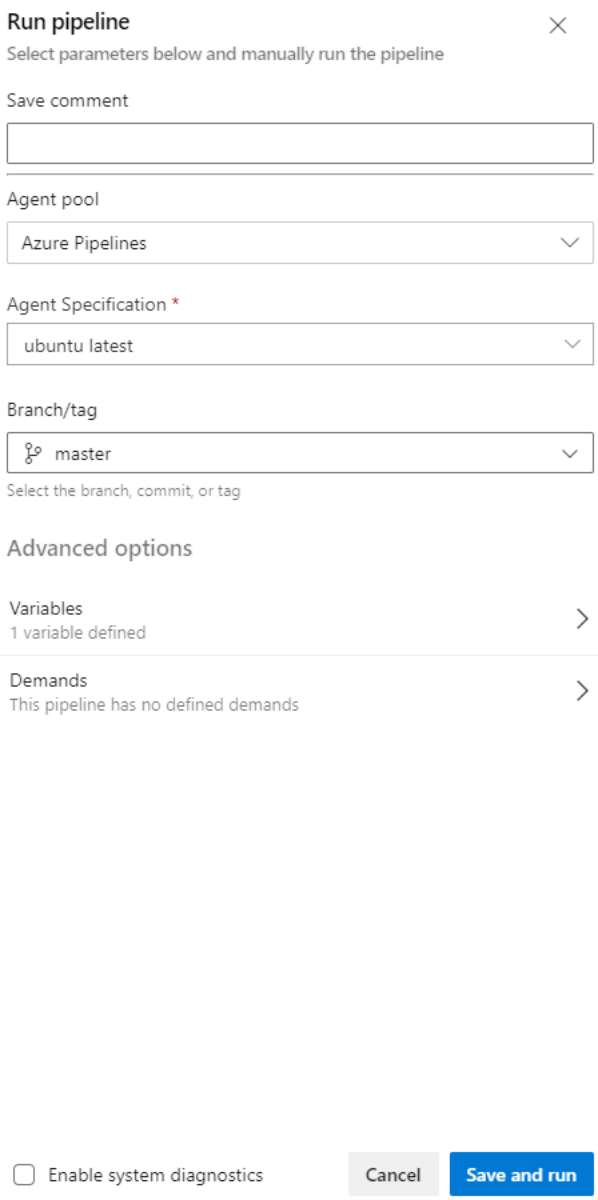




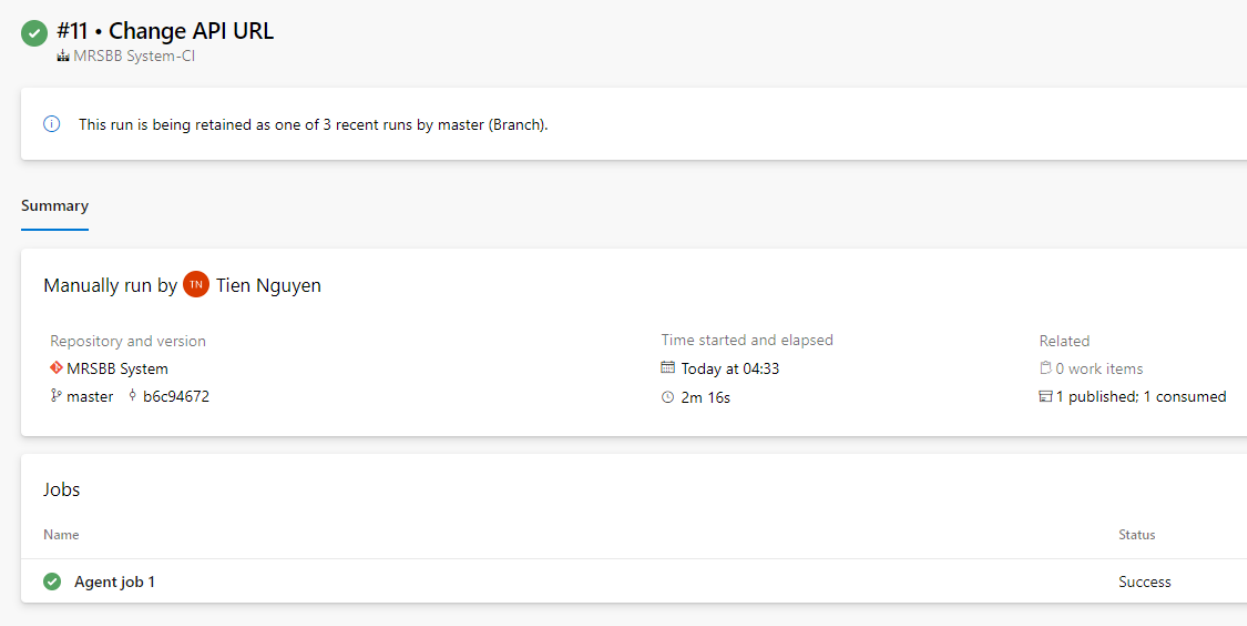
Go to the Triggers tab and select Enable continuous integration.



Click on Save & queue dropdown in the top menu and then click on Save & queue option. Run pipeline modal will open. Change Agent Specification to ubuntu latest and click on Save and run button.


Run pipeline
Select parameters below and manually run the pipeline
Save comment
Agent pool
Azure Pipelines
Agent Specification *
ubuntu latest
Branch/tag
master
Select the branch, commit, or tag
Advanced options
Variables
1 variable defined
Demands
This pipeline has no defined demands
Enable system diagnostics
Cancel
Save and run

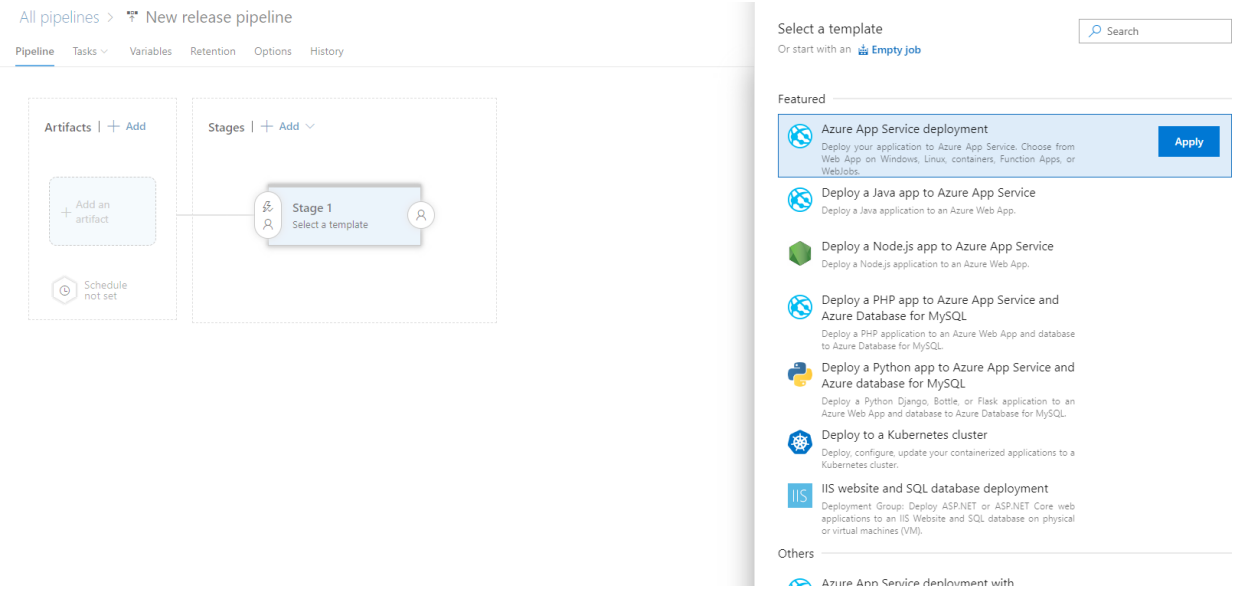
After queue and run



Steps to create a Release Pipeline

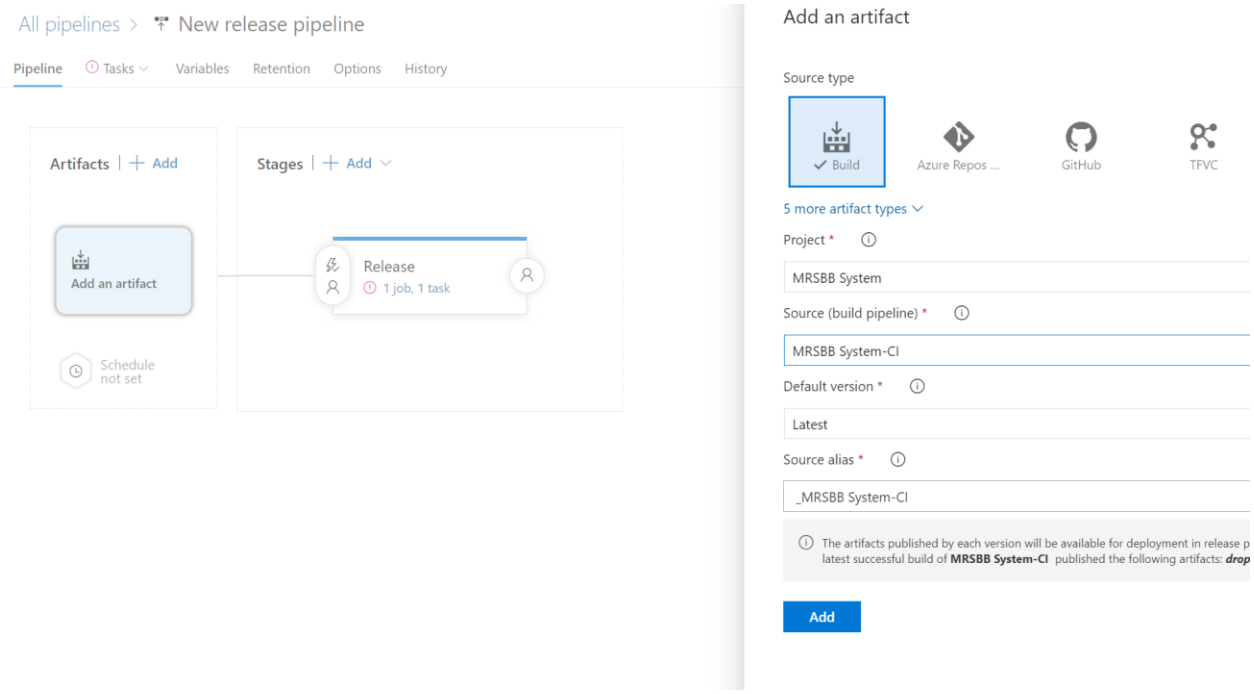
1. Create a new pipeline by selecting Pipelines -> Releases and clicking on New pipeline button.

2. Select template Azure App Service deployment and click on Apply button.



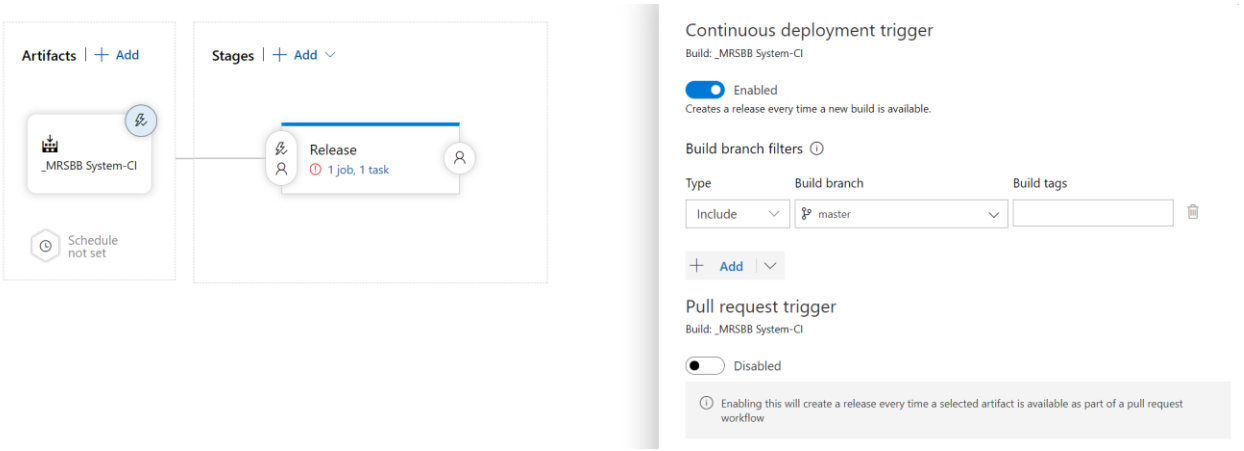
3. Set Stage name to Release.

4. Click on Add an artifact and select the build pipeline that we created previously as Source. Click on Add button.

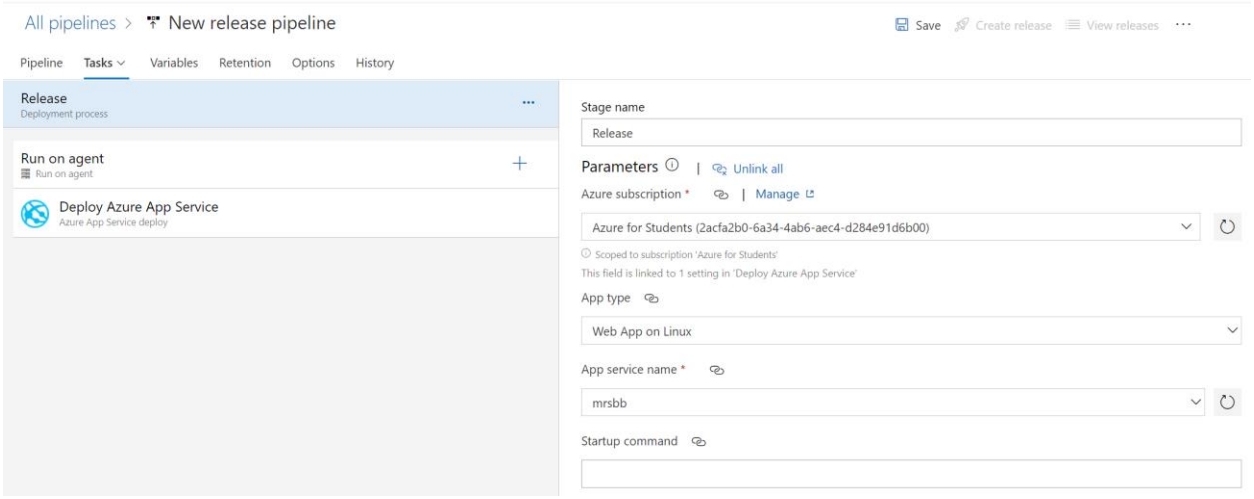


Steps to configure Continuous Deployment

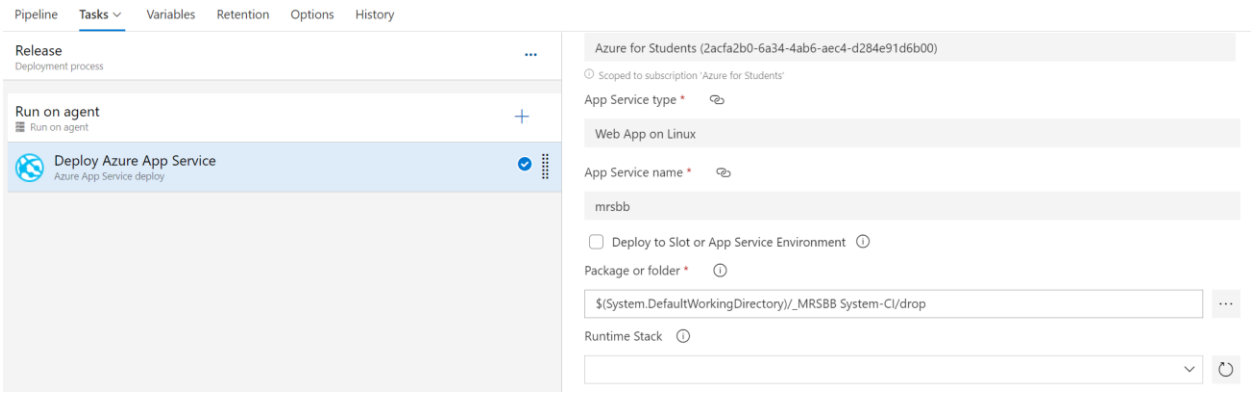
1. Click on the lightning icon in Artifacts and enable Continuous deployment trigger. This will create a new release every time a new build is available. Also add main branch as build branch filter and close the dialog.



2. Click on 1 job, 1 task link in Stages block to finish configuration of the Azure App Service deployment. Select our Azure subscription. We will be asked to authorize it by clicking on Authorize button. Also select App service name which we created previously.



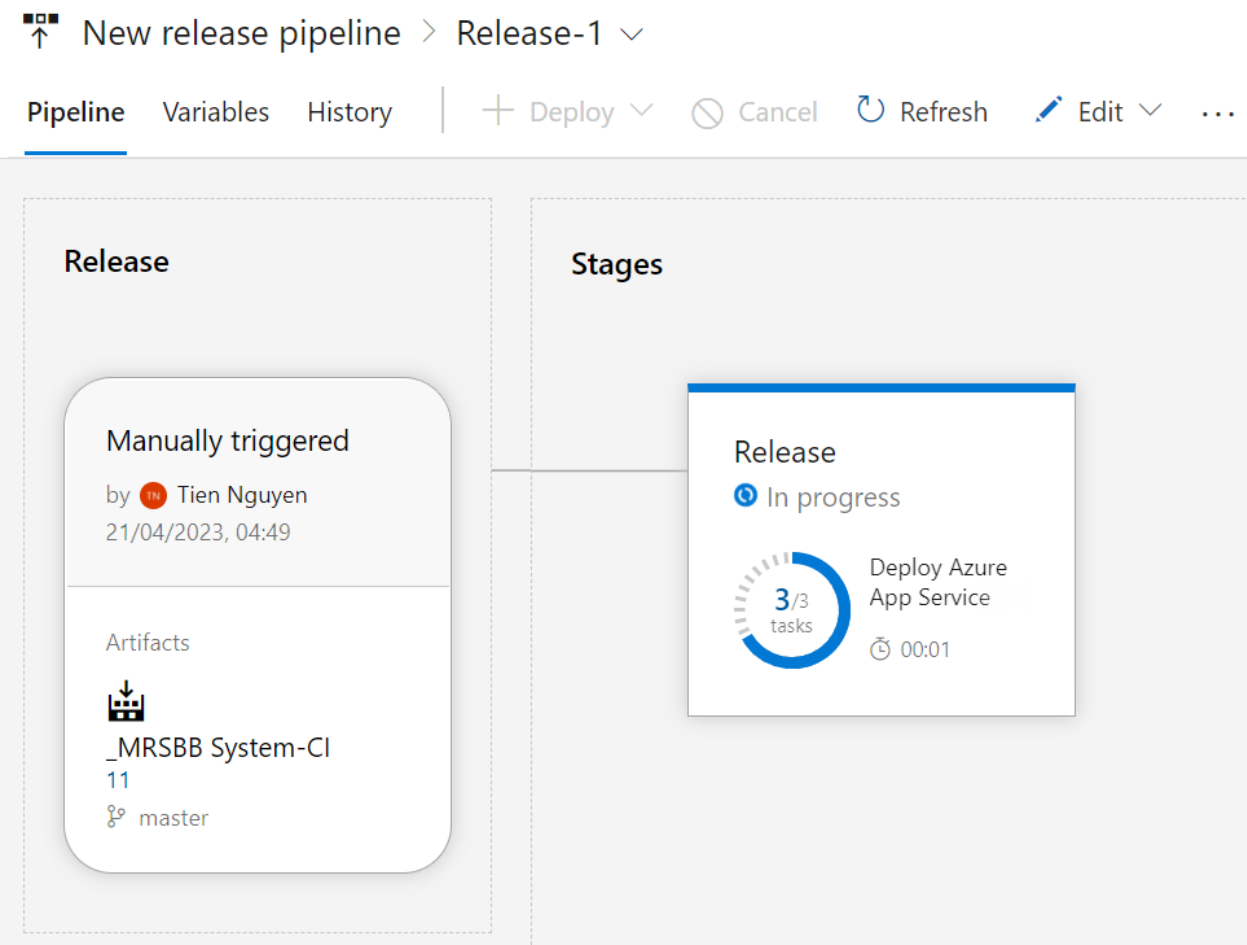
3. Click on Deploy Azure App Service and select drop folder as folder which contains app service contents generated in build process.



4. Click on Save in the top right corner and then click on OK without changing anything in the modal dialog which will appear.

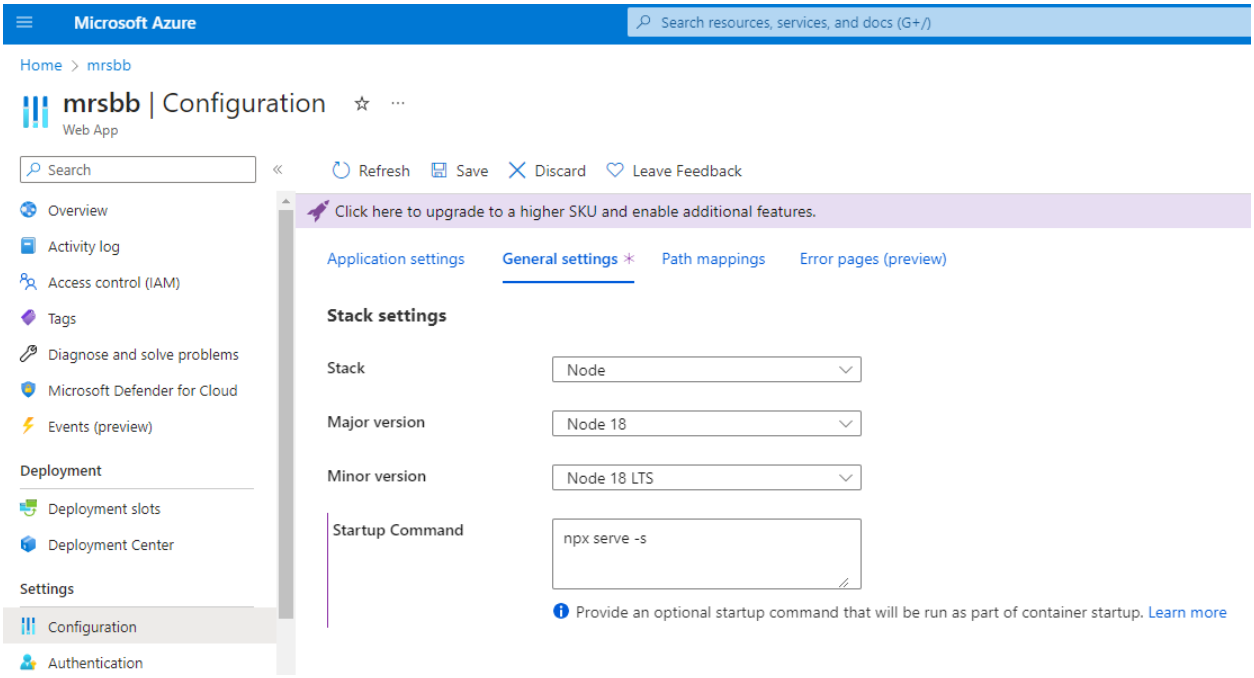
5. Now click on Create release (next to the Save button) which will become enabled. Another modal dialog will appear, but we can leave everything as it is and click on the Create button.

6. Under Pipelines -> Releases we can see the newly created release pipeline running. It may take a few minutes until it succeeds.



Once release pipeline is successfully completed, we should be able to see your deployed application on https://mrsbb.azurewebsites.net

Finally, we need to setup Startup Command in Configuration of mrsbb on Azure Portal



From now on whenever we push new source code to the main branch, a new deployment for Frontend will be automatically run.

7. Scale solutions

A machine learning-based system in general and a recommendation system in particular will both be better as soon as the system becomes viral and has a large amount of data from a large number of users. At this point, we have to deal with the scale of the system.

There are two solutions to this problem that correspond to the two traditional scaling methods:

- Scale-up: Keeping only one object of the recommendation system when the Backend is initialized is great for Scale Up. But we are deploying the system as a micro-service (using docker to package the container and run it on a virtual machine of the azure server) and won't be able to take advantage of creating multiple replicas to serve more users. Updating the model in the database is extremely resource-intensive because the model needs to be updated with both a matrix as well as an array each time it needs to be updated.
- Scale-out: To be able to Scale Out the system. We can redesign the database so that each element in model W, X, d, b is a separate table. Every time there is a new user, W will be added a row and d will be added a number. Similarly, X and b will be added new values when Admin adds a new movie. Every time a user uses Rating Management, we only need to update a row of W and a value in list d to be able to use that value for another replica of the Backend. When the user needs to get the predicted rating for a movie, we only

need to load a line of W and X and a value of d and b to get the result, not the whole model as before.

IX. Recommendation System Algorithm Design

The model for Recommendation System in this project is the 3rd model in the research: Matrix Factorization. For full details about the model, please refer to the file "Recommendation_System". I will write a quick explanation follow.

1. Foundation

A key idea in recommendation systems, particularly in collaborative filtering, is the utility matrix. It is a matrix that records how a recommendation system's users interact with the items or simply rate them. The cells of the matrix contain the ratings or interactions between the users and the items, while the rows and columns of the matrix represent the users and the items, respectively.

	A	B	C	D	E	F
Bohemian Rhapsody	5	5	0	0	1	?
I Love Rock 'N Roll	5	?	?	0	?	?
Hotel California	?	4	1	?	?	1
Twinkle, Twinkle Little Star	1	1	4	4	4	?
Happy and You Know It	1	0	5	?	?	?

Figure 3.6: An example of utility matrix with song recommendation system. Songs (items) are rated by users on a scale from 0 to 5 stars. The "?" marks indicate that the data does not yet exist in the database. The recommendation system needs to manually fill in these values.

In content-based recommendation systems, each item is described by a vector x called the item profile. In that method, we need to find a coefficient vector w corresponding to each user such that the known rating that user gives the item is approximately equal to:

$$y \approx w^T x = x^T w$$

With this approach, the utility matrix Y, assuming it is filled, will approximate to:

$$Y \approx \begin{bmatrix} x_1^T w_1 & x_1^T w_2 & \dots & x_1^T w_N \\ x_2^T w_1 & x_2^T w_2 & \dots & x_2^T w_N \\ \dots & \dots & \dots & \dots \\ x_M^T w_1 & x_M^T w_2 & \dots & x_M^T w_N \end{bmatrix} = \begin{bmatrix} x_1^T \\ x_2^T \\ \dots \\ x_M^T \end{bmatrix} [w_1\ w_2\ \dots\ w_N] = X^T W$$

M: number of items.

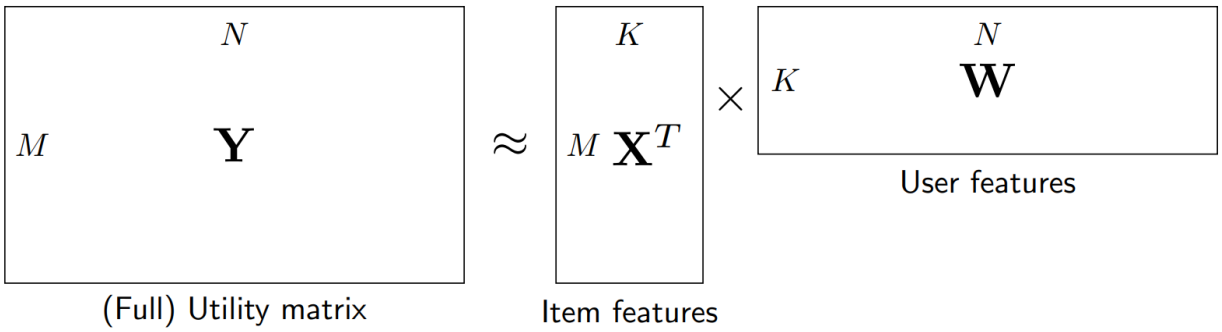
N: number of users.

Now, suppose that we do not need to pre-construct the x profile items, but that the feature vector for each of these items can be trained concurrently with each user's model (here, a coefficient vector). This means, the variables in the optimization problem are both X and W; where, X is the matrix of the entire profile item, each column corresponds to an item, W is the matrix of the entire user model, each column corresponds to a user.

With this approach, we are trying to approximate the utility matrix $Y \in R^{MxN}$ by the product of two matrices $X \in R^{MxK}$ and $W \in R^{KxN}$. Usually, K is chosen to be a much smaller number than

M, N. Then, both the X and W matrices have a rank not exceeding K. Therefore, this method is also called low-rank matrix factorization.

$$\mathbf{Y} \approx \hat{\mathbf{Y}} = \mathbf{X}^T\mathbf{W}$$



2. Loss Function

The loss function for the Matrix Factorization Collaborative Filtering can be written as:

$$\mathcal{L}(X, W, b, d) = \frac{1}{2s}\sum_{n=1}^{N}\sum_{m:r_{mn}=1}(x_m^T w_n + b_m + d_n - y_{mn}) + \frac{\lambda}{2}(\|X\|_F^2 + \|W\|_F^2)$$

$r_{mn} = 1$ if m-th item has been rated by n-th user.

s: number of ratings in dataset.

y_{mn}: rating of $n-th$ user for $m-th$ item.

$\|X\|_F$: Frobenius norm of X.

$\frac{1}{2s}\sum_{n=1}^{N}\sum_{m:r_{mn}=1}(x_m^T w_n + b_m + d_n - y_{mn})$ is the loss data, is the mean error of the model.

$\frac{\lambda}{2}(\|X\|_F^2 + \|W\|_F^2)$ is l_2 regularization loss, help avoid overfitting.

Simultaneous optimization of X, W, b, d is relatively complicated. Instead, the method used is to optimize one of the two pairs $(X, b), (W, d)$ in turn, while the other pair is fixed. This process is repeated until the loss function converges.

3. Optimizing the loss function

When the pair (X, b) is fixed, the pair (W, d) optimization problem can be decomposed into N subproblems:

$$\mathcal{L}_1(w_n, d_n) = \frac{1}{2s}\sum_{m:r_{mn}=1}(x_m^T w_n + b_m + d_n - y_{mn})^2 + \frac{\lambda}{2}(\|w_n\|_2^2)$$

Each problem can be optimized using gradient descent. Our important job is to calculate the derivatives of each of these small loss functions with respect to w_n, d_n. Since the expression in the sign Sigma depends only on the items that have been rated by the user in question (corresponding to $r_{mn} = 1$), we can simply by making $\hat{X}_n$ a submatrix generated by the columns of X corresponds to the items that have been rated by user n, $\hat{b}_n$is the corresponding sub-bias vector, and $\hat{y}_n$ is the corresponding rating. Then:

$$\mathcal{L}_1(w_n, d_n) = \frac{1}{2s}\left\|\hat{X}_n^T w_n + \hat{b}_n + d_n\mathbf{1} - \hat{y}_n\right\|^2 + \frac{\lambda}{2}(\|w_n\|_2^2)$$

With 1 is the vector with all elements equal to 1 and the appropriate size. Its derivative is

$$\nabla_{w_n}\mathcal{L}_1 = \frac{1}{s}\hat{X}_n\left(\hat{X}_n^T w_n + \hat{b}_n + d_n\mathbf{1} - \hat{y}_n\right) + \lambda w_n$$

$$\nabla_{b_n}\mathcal{L}_1 = \frac{1}{s}\mathbf{1}^{\boldsymbol{T}}\left(\hat{X}_n^T w_n + \hat{b}_n + d_n\mathbf{1} - \hat{y}_n\right)$$

Update equation for $\boldsymbol{w_n}, \boldsymbol{d_n}$:

$$w_n \leftarrow w_n - \eta\left(\frac{1}{s}\hat{X}_n\left(\hat{X}_n^T w_n + \hat{b}_n + d_n\mathbf{1} - \hat{y}_n\right) + \lambda w_n\right)$$

$$d_n \leftarrow d_n - \eta\left(\frac{1}{s}\mathbf{1}^{\boldsymbol{T}}\left(\hat{X}_n^T w_n + \hat{b}_n + d_n\mathbf{1} - \hat{y}_n\right)\right)$$

η is the learning rate.

Similarly, each column x_m of X, which is the feature vector for each item, and b_m can be found by optimizing the problem:

$$\mathcal{L}_2(x_m, b_m) = \frac{1}{2s}\sum_{n:r_{mn}=1}(w_n^T x_m + d_n + b_m - y_{mn})^2 + \frac{\lambda}{2}(\|x_m\|_2^2)$$

Let $\widehat{W}_m$ be the matrix created with the columns of W corresponding to the users who have rated item m, $\hat{d}_m$ the corresponding bias sub-vector, and $\hat{y}_m$ the corresponding rating vector. The problem becomes:

$$\mathcal{L}_2(x_m, b_m) = \frac{1}{2s}\left\|\widehat{W}_m^T x_m + \hat{d}_m + b_m\mathbf{1} - \hat{y}_m\right\|^2 + \frac{\lambda}{2}(\|x_m\|_2^2)$$

Update equation for $\boldsymbol{x_m}, \boldsymbol{b_m}$:

$$x_m \leftarrow x_m - \eta\left(\frac{1}{s}\widehat{W}_m\left(\widehat{W}_m^T x_m + \hat{d}_m + b_m\mathbf{1} - \hat{y}_m\right) + \lambda w_m\right)$$

$$b_m \leftarrow d_m - \eta\left(\frac{1}{s}\mathbf{1}^{\boldsymbol{T}}\left(\widehat{W}_m^T x_m + \hat{d}_m + b_m\mathbf{1} - \hat{y}_m\right)\right)$$

4. Development in Python

First, we will write a Matrix Factorization class that performs the optimization of variables with a utility matrix given in the form of Y_data just like with NBCF. First, we declare some necessary libraries and initialize the Matrix Factorization class:

```
import json
import pandas as pd
import numpy as np

class MF(object):
    def __init__(self, Y, K, lam = 0.1, Xinit = None, Winit = None,
    learning_rate = 0.5, max_iter = 10000, print_every = 100):
        self.Y = Y      # represents the utility matrix
        self.K = K      # number of features
        self.lam = lam  # regularization parameter
        self.learning_rate = learning_rate  # for gradient descent
        self.max_iter = max_iter            # maximum number of iterations
        self.print_every = print_every      # print loss after each a few iters
        self.n_users = int(np.max(Y[:, 0])) + 1
        self.users_ids = np.unique(np.asarray(Y[:,0].reshape(Y[:,0].shape[0])))
        self.n_items = int(np.max(Y[:, 1])) + 1
        self.items_ids = np.unique(np.asarray(Y[:,1].reshape(Y[:,1].shape[0])))
        self.n_ratings = Y.shape[0]
        self.X = np.random.randn(self.n_items, K) if Xinit is None else Xinit
        self.W = np.random.randn(K, self.n_users) if Winit is None else Winit
        self.b = np.random.randn(self.n_items)  # item biases
        self.d = np.random.randn(self.n_users)  # user biases
```

Next, we write loss, updateXb, updateWd methods for class MF:

```
# return current loss value
def loss(self):
    L = 0
    for i in range(self.n_ratings):
        # user_id, item_id, rating
        n, m, rating = int(self.Y[i, 0]), int(self.Y[i, 1]), self.Y[i, 2]
        L += 0.5*(self.X[m].dot(self.W[:,n]) + self.b[m] + self.d[n] - rating)**2
    L /= self.n_ratings
    # regularization, don't ever forget this
    return L + 0.5*self.lam*(np.sum(self.X**2) + np.sum(self.W**2))
```

```
def updateWd(self):
    for n in self.users_ids:
        # get all items rated by user n, and the corresponding ratings
        ids = np.where(self.Y[:, 0] == n)[0]
        item_ids, ratings = self.Y[ids, 1].astype(np.int32), self.Y[ids, 2]
        Xn, bn = self.X[item_ids], self.b[item_ids]
        for i in range(30): # 30 iteration for each sub problem
            wn = self.W[:, n]
            error = Xn.dot(wn) + bn + self.d[n] - ratings
            grad_wn = Xn.T.dot(error)/self.n_ratings + self.lam*wn
            grad_dn = np.sum(error)/self.n_ratings
            # gradient descent
            self.W[:, n] -= np.array(self.learning_rate*grad_wn.reshape(-1))[0]
            self.d[n]    -= self.learning_rate*grad_dn
```

```
def updateXb(self):
    for m in self.items_ids:
        ids = np.where(self.Y[:, 1] == m)[0] # row indices of items m
        user_ids, ratings = self.Y[ids, 0].astype(np.int32), self.Y[ids, 2]
        Wm, dm = self.W[:, user_ids], self.d[user_ids]
        Wm = Wm.reshape(Wm.shape[0], Wm.shape[1])
        for i in range(30): # 30 iteration for each sub problem
            xm = self.X[m]
            error = Wm.T.dot(xm).reshape(-1,1) + self.b[m] + dm - ratings
            grad_xm = Wm.dot(error)/self.n_ratings + (self.lam*xm).reshape(-1,1)
            grad_bm = np.sum(error)/self.n_ratings
            # gradient descent
            self.X[m] -= np.array((self.learning_rate*grad_xm).T)[0]
            self.b[m] -= rs.learning_rate*grad_bm
```

The next part is the main optimization process of MF (fit), predicting the new rating (pred) and evaluating the model quality by root-mean-square error (evaluate_RMSE).

```
def fit(self):
    for it in range(self.max_iter):
        self.updateXb()
        self.updateWd()
        if (it+1) % self.print_every == 0:
            rsme_train = self.evaluate_RMSE(self.Y)
            # print("iter = ",it+1 ,", loss = "+self.loss(),", RMSE train =
",rsme_train)
            print(it+1)
            print(self.loss())
            print(rsme_train)
            print(self.evaluate_RMSE(rate_test))
```

```
def pred(self, u, i):
    # predict the rating of user u for item i
    u, i = int(u), int(i)
    try:
        pred = self.X[i, :].dot(self.W[:, u]) + self.b[i] + self.d[u]
    except:
        return 0
    return max(0, min(5, pred))

def evaluate_RMSE(self, rate_test):
    n_tests = rate_test.shape[0]
    SE = 0
    for n in range(n_tests):
        pred = self.pred(rate_test[n, 0], rate_test[n, 1])
        SE += (pred - rate_test[n, 2])**2

    RMSE = np.sqrt(SE/n_tests)
    return RMSE
```

At this point, we have built into the Matrix Factorization class with the necessary methods.

5. Model input explanation

Input for Matrix Factorization will be:

Utility matrix Y is a numpy.ndarray which includes all existed ratings, there are 4 columns in Y, userId, movieId, rating, timestamp.

```
rs.Y
```
✓ 0.0s Python

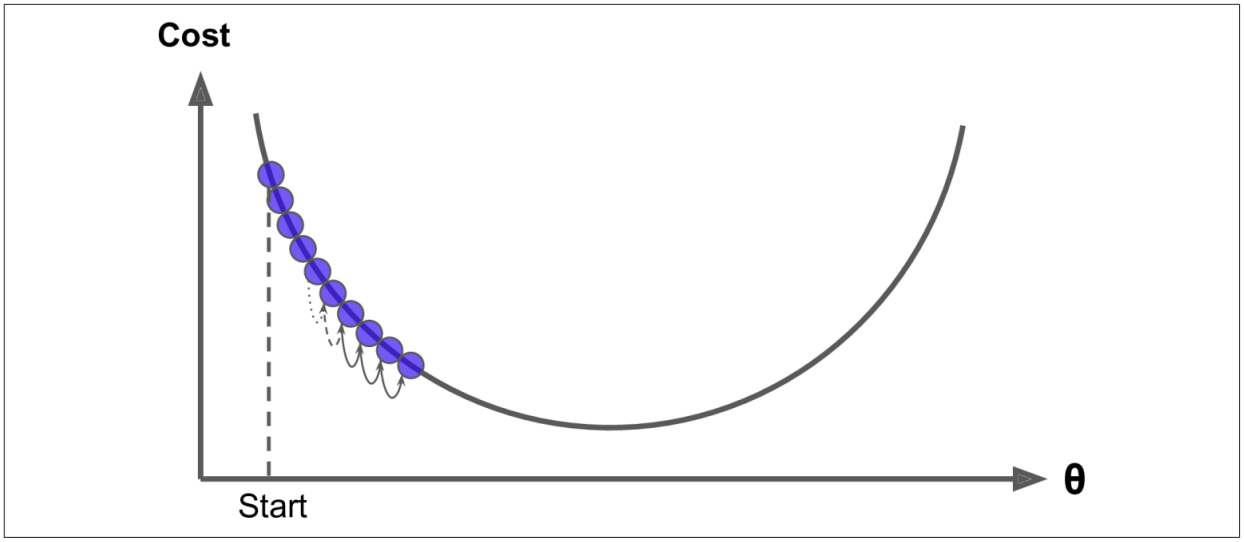
```
matrix([[        0,         0,         5, 874965758],
        [        0,         1,         3, 876893171],
        [        0,         2,         4, 878542960],
        ...,
        [      942,      1187,         3, 888640250],
        [      942,      1227,         3, 888640275],
        [      942,      1329,         3, 888692465]], dtype=int64)
```

K: number of features, this value is used to approximate the utility matrix $Y \in R^{MxN}$ by the product of two matrices $X \in R^{MxK}$ and $W \in R^{KxN}$.

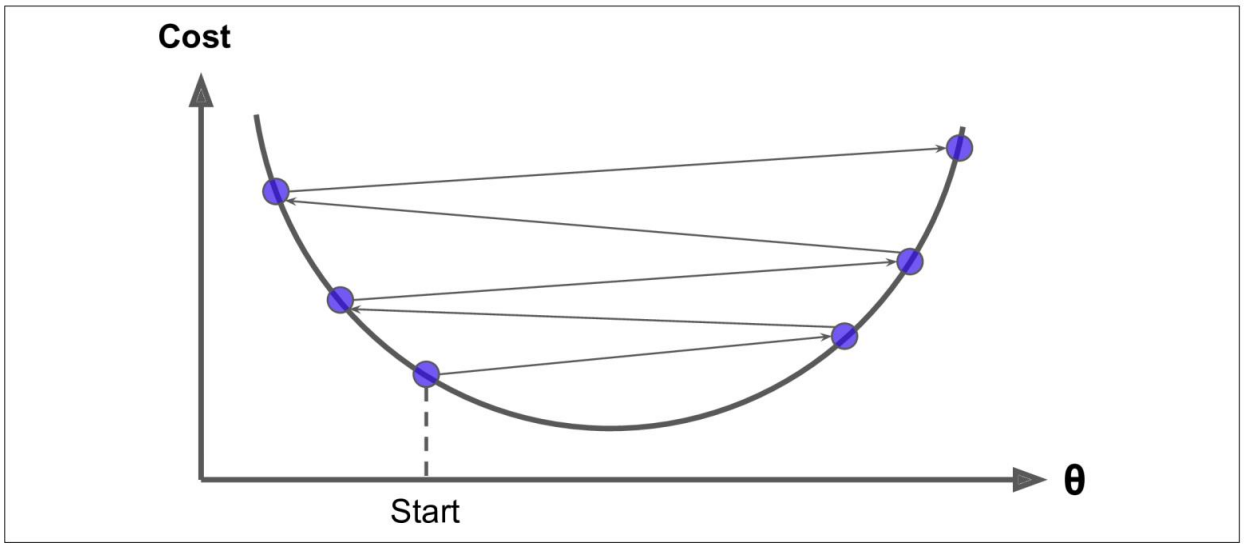
lam: lambda λ

learning_rate: learning rate of model

Example of learning rate too small:



Example of learning rate is too large



max_iter: maximum iteration of gradient descent used to find X and W, it appears in fit().

print_every: this value is for system to report processing during the training session.

n_users: number of existed users

users_ids: a list of all user ids

n_items: number of existed movies

items_ids: a list of all movie ids

n_ratings: number of existed ratings

X: a matrix has size $n\_items \times K$

```
rs.X
```
✓ 0.0s Python

```
array([[ 1.62476921, -0.18699334, -0.2235872 , ..., -0.17356157,
         1.20560839, -0.0139317 ],
       [-0.46995351, -2.11226004,  0.71141291, ...,  0.08181904,
         0.14493894, -1.84104401],
       [ 0.47721143,  1.29224774, -2.03788142, ..., -0.84664553,
        -0.02935711,  1.67643089],
       ...,
       [ 1.20005374, -1.23662352,  1.00701845, ..., -0.42077396,
        -2.2942159 , -1.59070611],
       [-0.01463026,  0.81649247,  0.36473521, ..., -1.58257472,
         0.28027851, -0.9680526 ],
       [ 1.24440303, -2.55109522,  1.05026741, ...,  0.83776664,
         0.12984461,  0.42833674]])
```

W: a matrix has size $K \times n\_users$

```
rs.W
```
✓ 0.0s Python

```
array([[-0.70215581, -1.38512364,  0.20842535, ...,  1.59358238,
         1.27215489,  1.74206167],
       [-1.96754498, -0.82362947,  1.02092632, ..., -0.17511587,
         0.5934071 , -1.81855495],
       [-0.57283232, -1.203771  , -2.40503652, ...,  0.7468749 ,
         0.30285366, -0.09902802],
       ...,
       [ 1.51474366, -1.3398714 ,  1.30850692, ..., -1.25718713,
        -0.14669722, -1.92611484],
       [ 0.98760926,  0.35513189, -0.82111377, ..., -0.12451902,
        -1.28860538, -0.38356291],
       [-0.82390424, -0.49598753,  1.1977729 , ..., -0.24305448,
         0.22599195,  0.91993007]])
```

b: item biases, an array with length of n_items.

d: user biases, an array with length of n_users.

6. Model explanation

With the input Y, we try to determine $X, W, b\ and\ d$ such that the formula $y_{mn} \approx x_m^T w_n + b_m + d_n$ will come close to value in Y.

Loss function is a way we calculate the difference between the value in Y and value calculated by $X, W, b\ and\ d$.

The way we find the right $X, W, b\ and\ d$ is gradient descent with the update formula shown before.

When $X, W, b\ and\ d$ are optimized, we can use them to calculate the prediction for unknown value in utility matrix Y.

7. Functions that affect the model

FR.1.1: User Registration

When a new user signs up, the model needs to update with n_users, users_ids, W and d.

FR.3.1: User Create Rating, FR.3.3: User Update Rating, FR.3.4: User Delete Rating

When a new user handles a rating, the model should update W and d for that user.

FR.7.3: Admin Add New Movie

When an Admin adds a new movie, same as FR.1.1, we need to update the model.

8. Model application

When Backend component started, there will be an object of matrix factorization in extensions.py.

There are 5 initial inputs: Y, X, W, b, d.

For X, W, b and d, we load it with saved trained model in database, if there is nothing in database, we will load it in the csv file I prepared in Data Preparation section.

```
# load models for mfcf model if the model does not exist in the database
W = np.asarray([])
X = np.asarray([])
d = np.asarray([])
b = np.asarray([])
if len(list(db["model"].find())) == 0:
    W = np.loadtxt('./data/W.csv', delimiter=',')
    X = np.loadtxt('./data/X.csv', delimiter=',')
    d = np.loadtxt('./data/d.csv', delimiter=',')
    b = np.loadtxt('./data/b.csv', delimiter=',')

    wf = {"name": "W", "value": bson.Binary(pickle.dumps(W, protocol=2))}
    xf = {"name": "X", "value": bson.Binary(pickle.dumps(X, protocol=2))}
    df = {"name": "d", "value": d.tolist()}
    bf = {"name": "b", "value": b.tolist()}

    db["model"].insert_one(wf)
    db["model"].insert_one(xf)
    db["model"].insert_one(df)
    db["model"].insert_one(bf)
else:
    for model in db["model"].find():
        if model['name'] == "W":
            W = np.asarray(pickle.loads(model['value']))
        elif model['name'] == "X":
            X = np.asarray(pickle.loads(model['value']))
        elif model['name'] == "d":
            d = np.asarray(model['value'])
        elif model['name'] == "b":
            b = np.asarray(model['value'])
```

For Y, we need to load all ratings in database

```
# load all ratings as utility matrix for mfcf model
ratings_cursor = db['rating'].find()
ratings_dataframe = pd.DataFrame(list(ratings_cursor), columns=[
    'userId', 'movieId', 'rating', 'timestamp']).astype({'userId': int,
'movieId': int, 'rating': int, })
ratings_matrix = np.asmatrix(ratings_dataframe)
rate_train, rate_test = train_test_split(
    ratings_matrix, test_size=0.2, random_state=10)
```

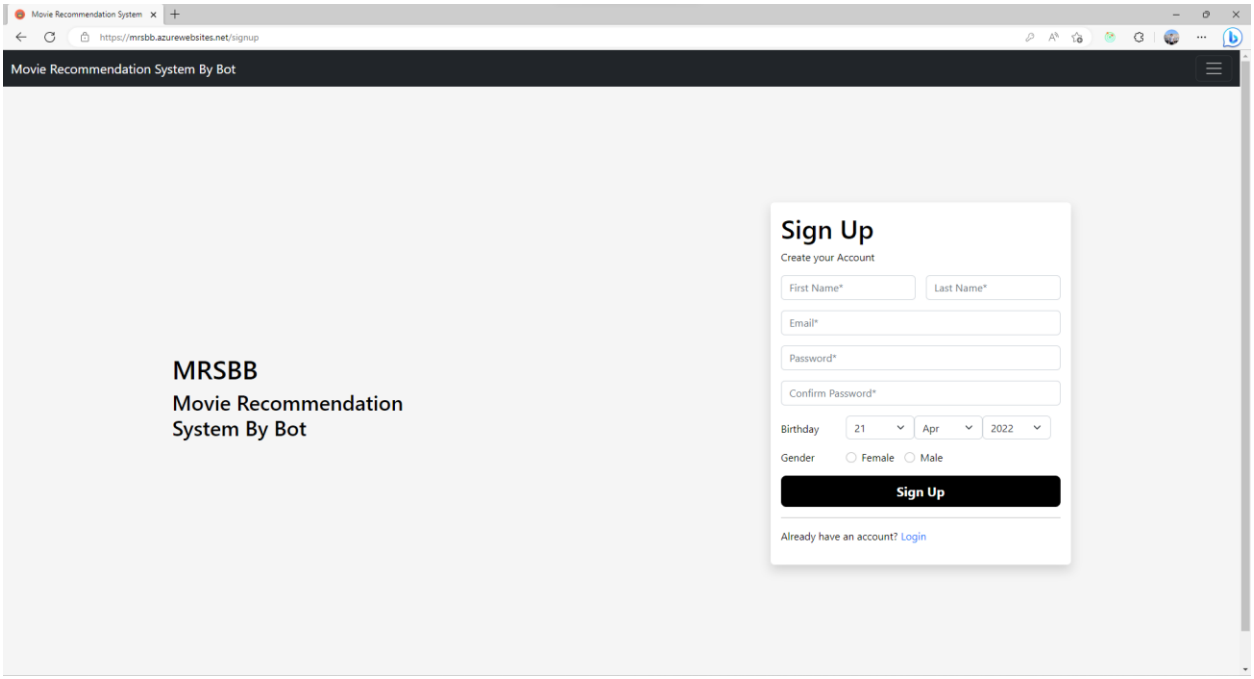
Finally, we can create a model object that live when server running:

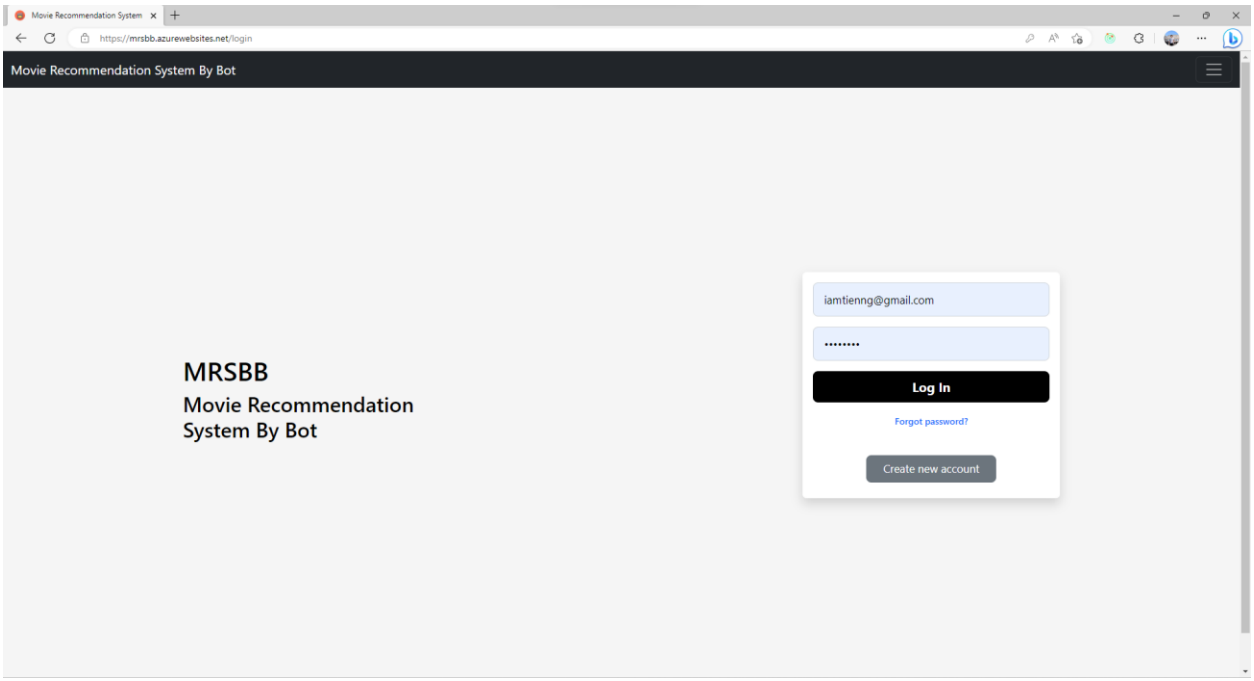
```
# load all ratings as utility matrix for mfcf model
ratings_cursor = db['rating'].find()
ratings_dataframe = pd.DataFrame(list(ratings_cursor), columns=[
    'userId', 'movieId', 'rating', 'timestamp']).astype({'userId': int,
'movieId': int, 'rating': int, })
ratings_matrix = np.asmatrix(ratings_dataframe)
rate_train, rate_test = train_test_split(
    ratings_matrix, test_size=0.2, random_state=10)

# mfcf machine learning model
mfcf_model = MatrixFactorization(
    Y=ratings_matrix, K=50, lam=.01, Xinit=X, Winit=W, bInit=b, dInit=d,
learning_rate=50, max_iter=30)
```

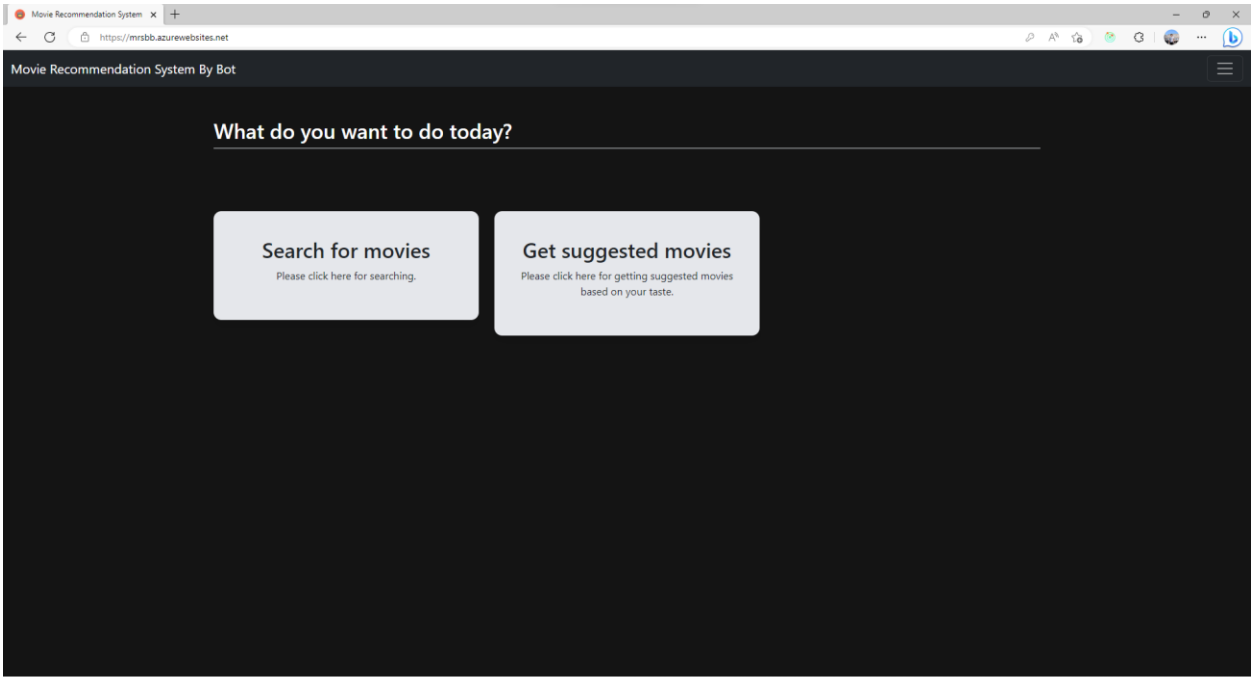
Whenever a function that affects model is called, it will call directly to the only one live object.

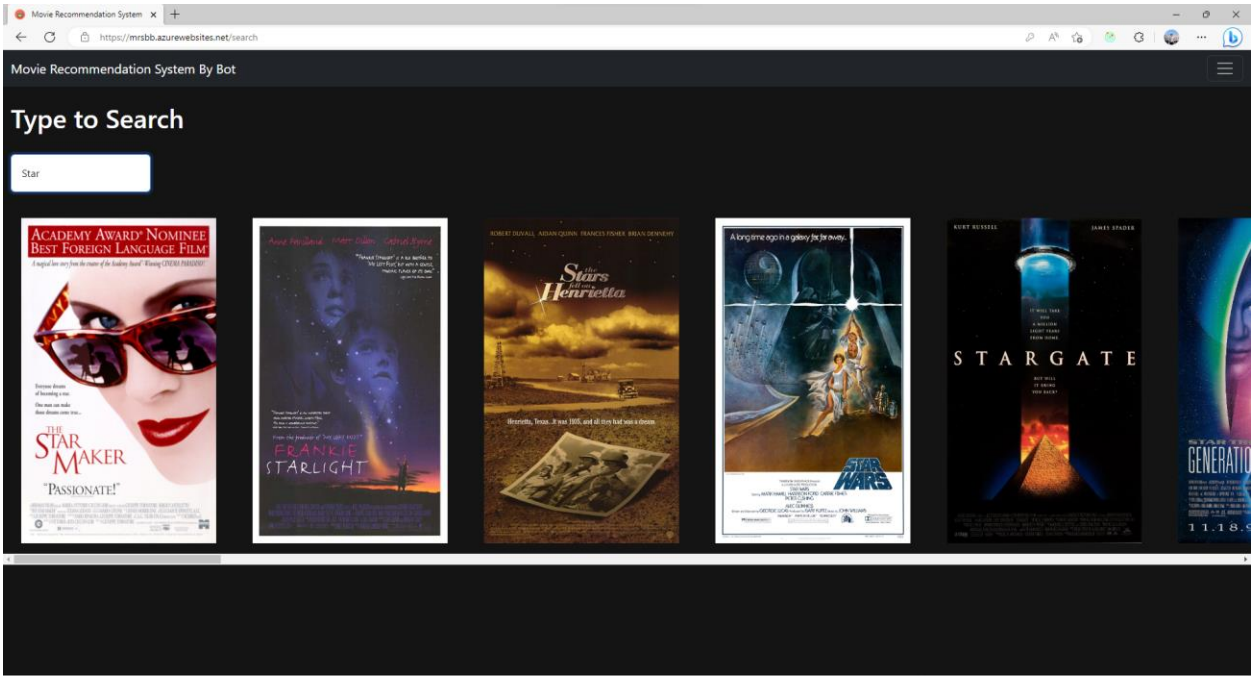
For example, please refer to the register method in People class.

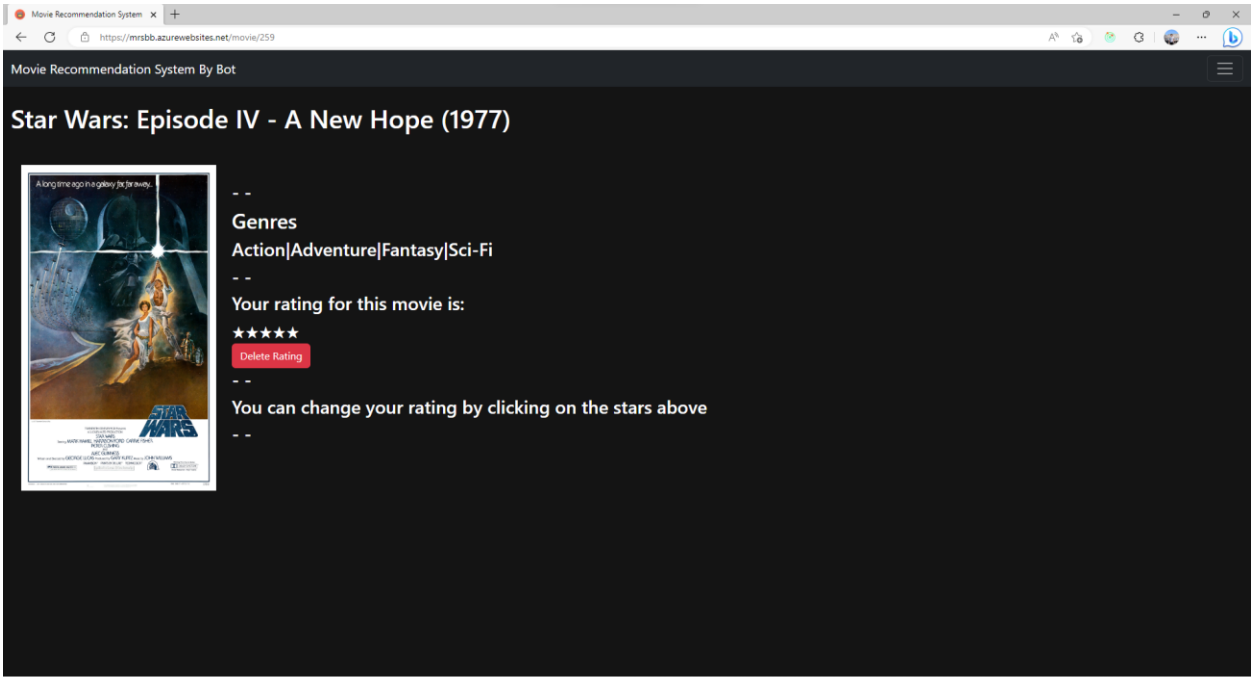
X. Production Screenshots

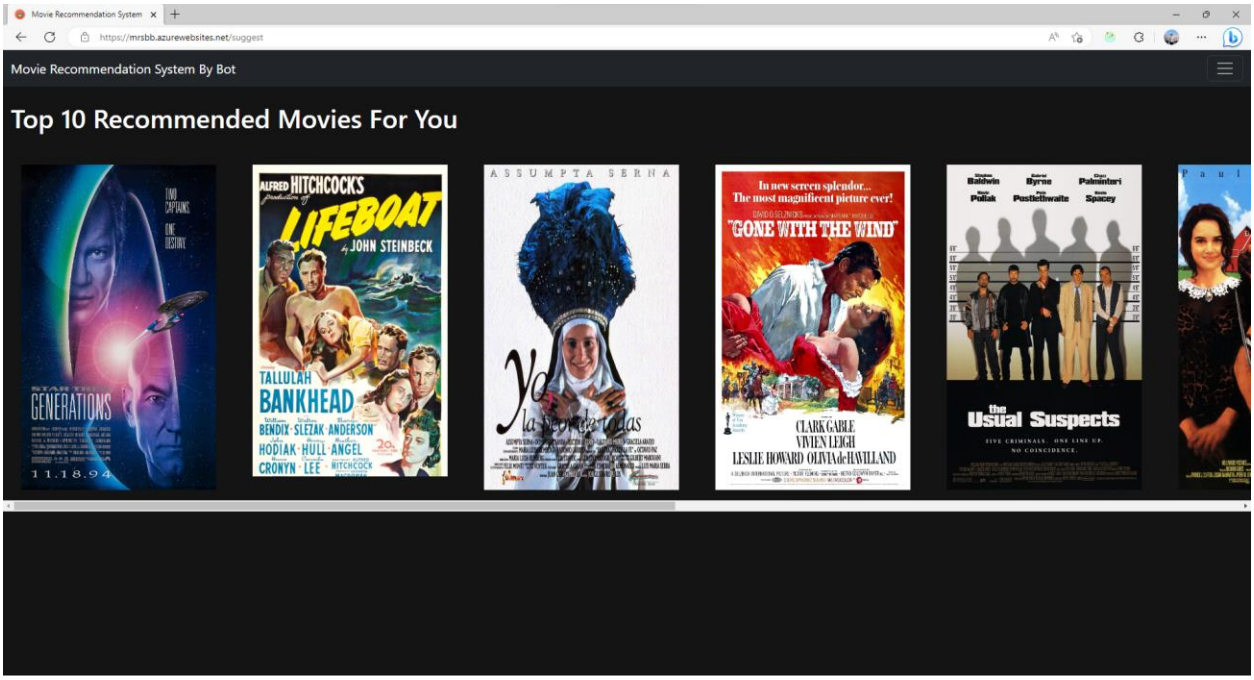


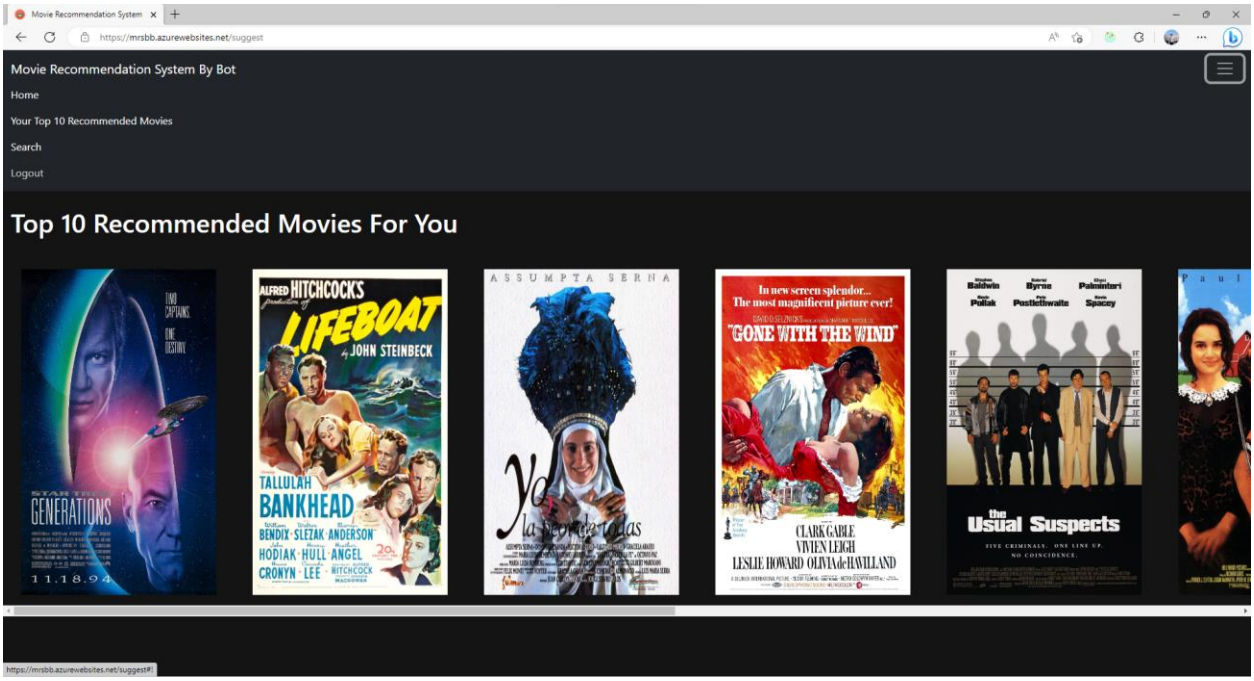


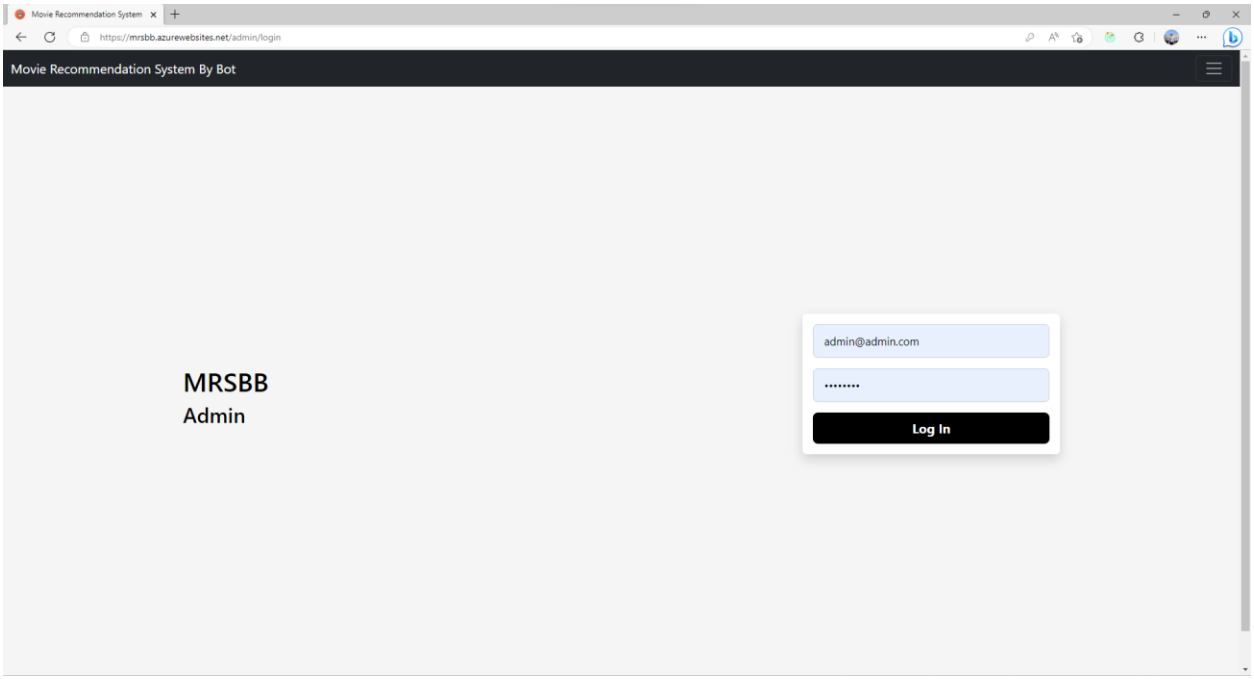

Movie Recommendation System
https://mrsbb.azurewebsites.net
Movie Recommendation System By Bot
What do you want to do today?
Search for movies
Please click here for searching.
Get suggested movies
Please click here for getting suggested movies based on your taste.

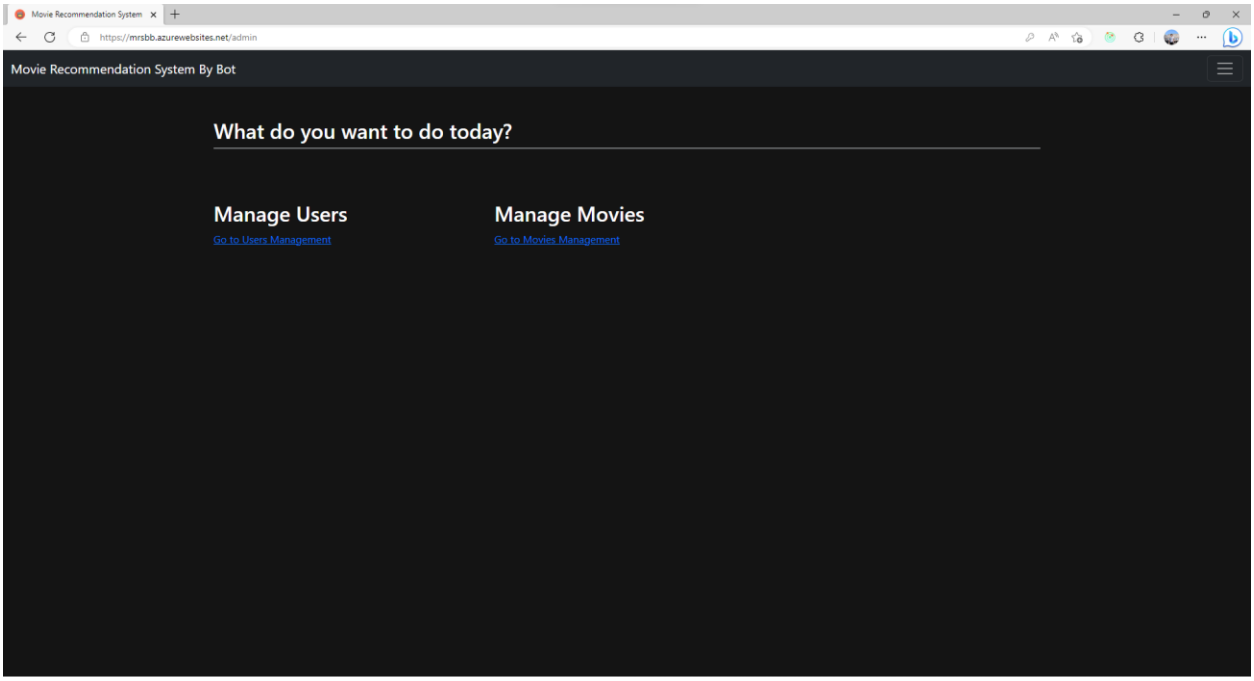

Movie Recommendation System
https://mrsbb.azurewebsites.net/search
Movie Recommendation System By Bot
Type to Search
Star
ACADEMY AWARD® NOMINEE BEST FOREIGN LANGUAGE FILM
THE STAR MAKER
"PASSIONATE!"
FRANKIE STARLIGHT
The Stars Fell on Henrietta
STAR WARS
STARGATE

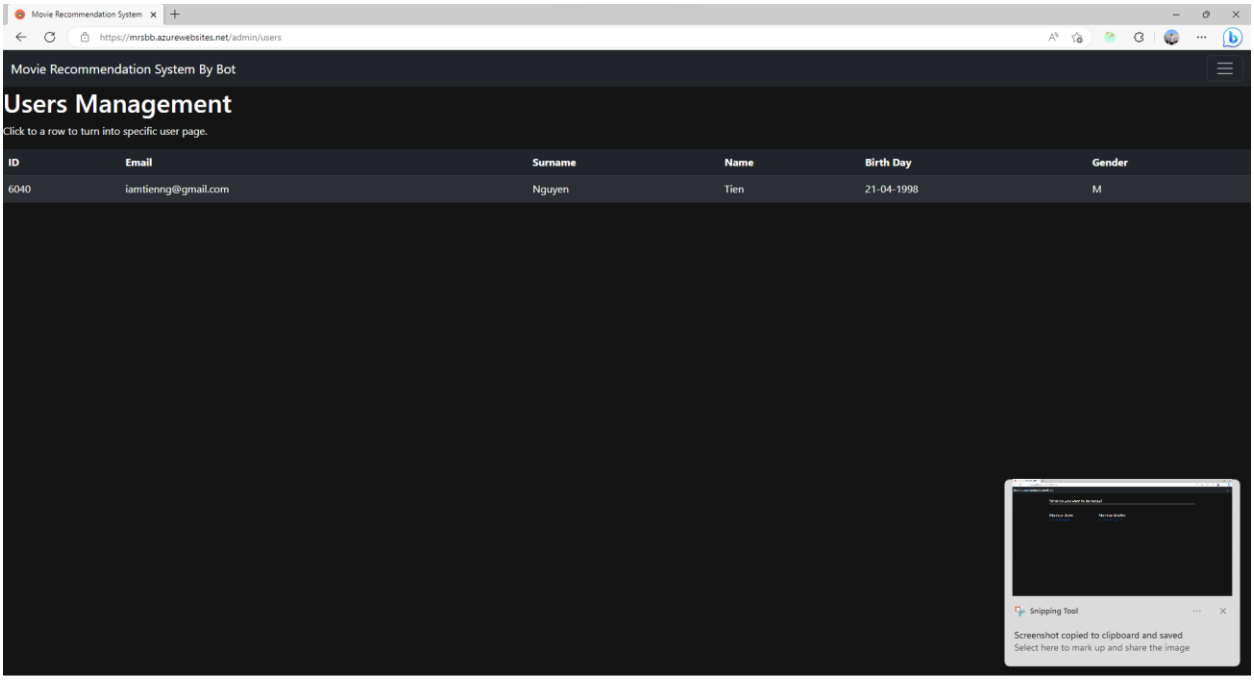

Movie Recommendation System
https://mrsbb.azurewebsites.net/movie/259
Movie Recommendation System By Bot
Star Wars: Episode IV - A New Hope (1977)
- -
Genres
Action|Adventure|Fantasy|Sci-Fi
- -
Your rating for this movie is:
★★★★★
Delete Rating
- -
You can change your rating by clicking on the stars above
- -

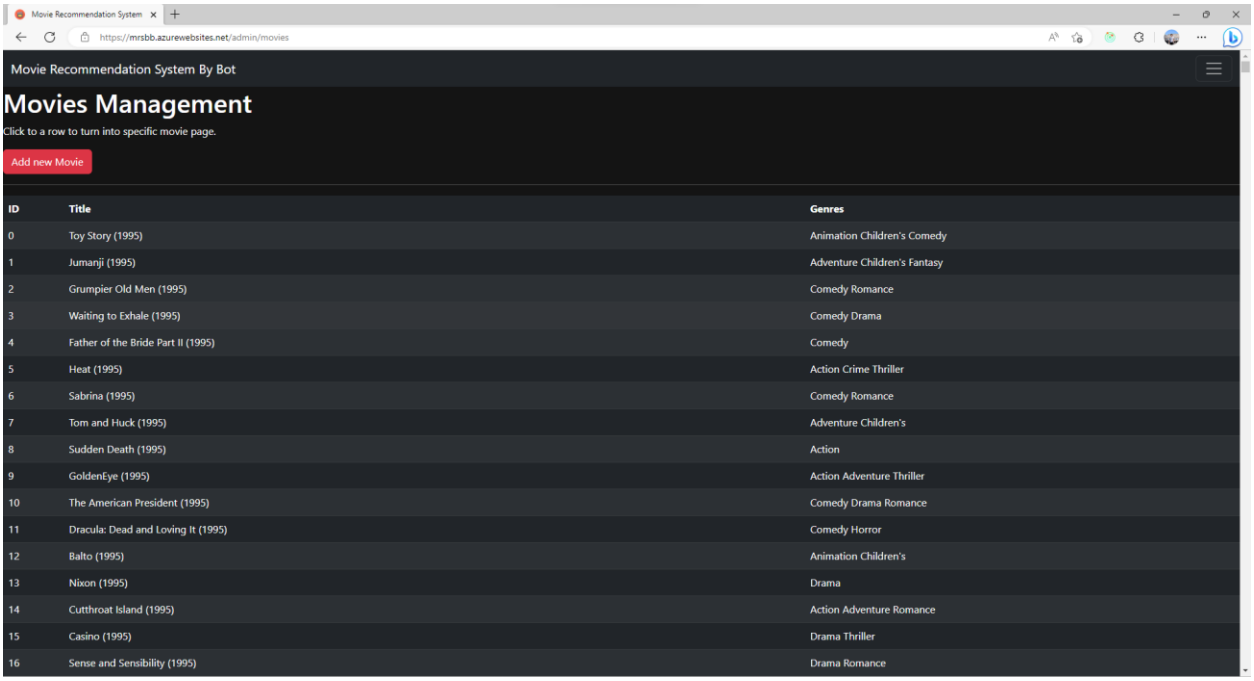

Movie Recommendation System
https://mrsbb.azurewebsites.net/suggest
Movie Recommendation System By Bot
Top 10 Recommended Movies For You
GENERATIONS
LIFEBOAT
BANKHEAD
GONE WITH THE WIND
the Usual Suspects

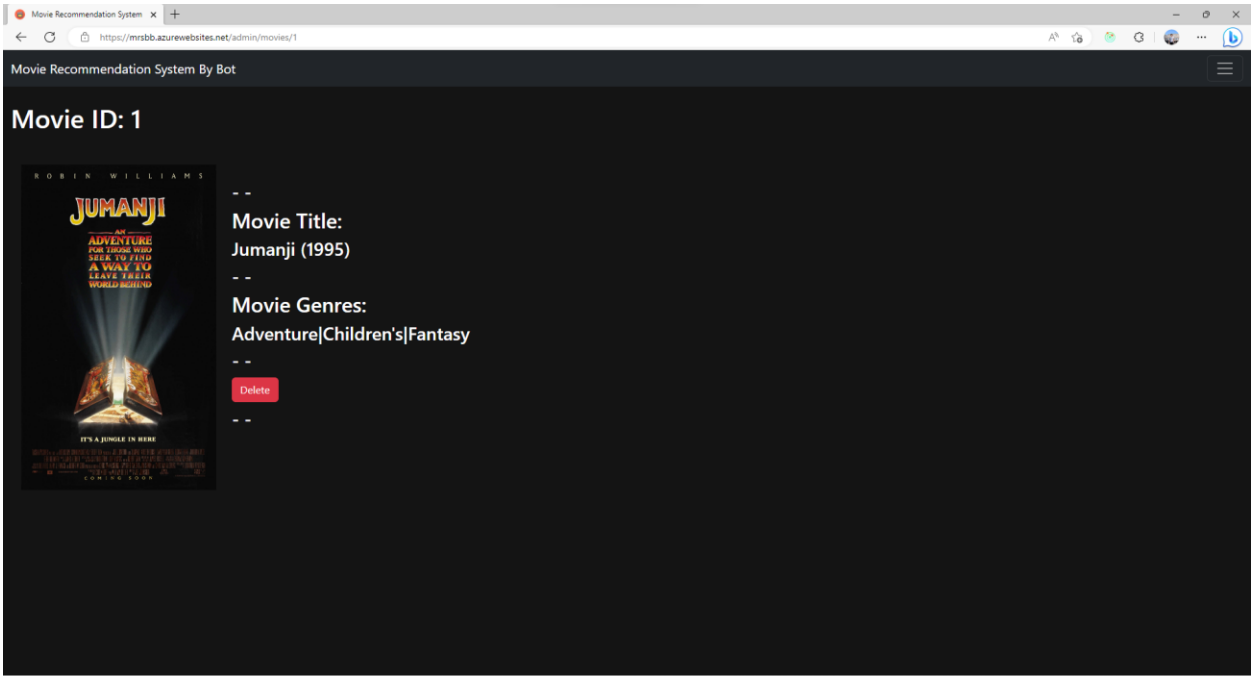

Movie Recommendation System
https://mrsbb.azurewebsites.net/suggest
Movie Recommendation System By Bot
Home
Your Top 10 Recommended Movies
Search
Logout
Top 10 Recommended Movies For You
GENERATIONS
LIFEBOAT
BANKHEAD
GONE WITH THE WIND
the Usual Suspects

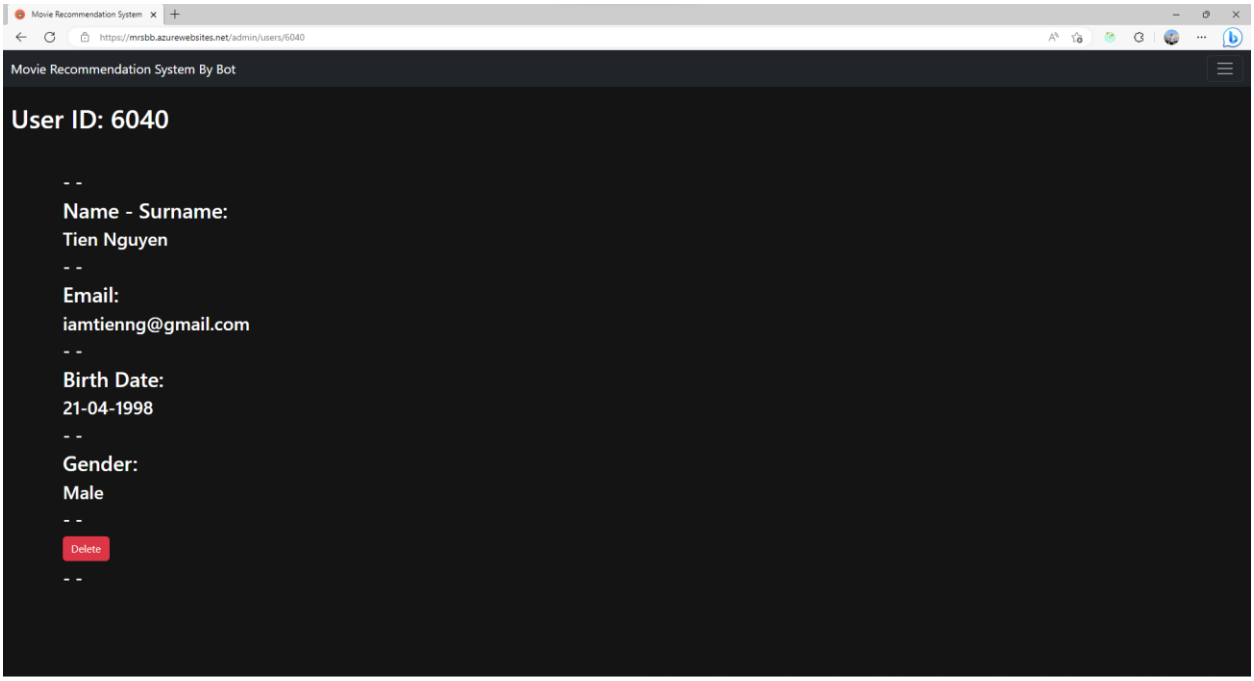

Movie Recommendation System
https://mrsbb.azurewebsites.net/admin/login
Movie Recommendation System By Bot
MRSBB
Admin
admin@admin.com
Log In

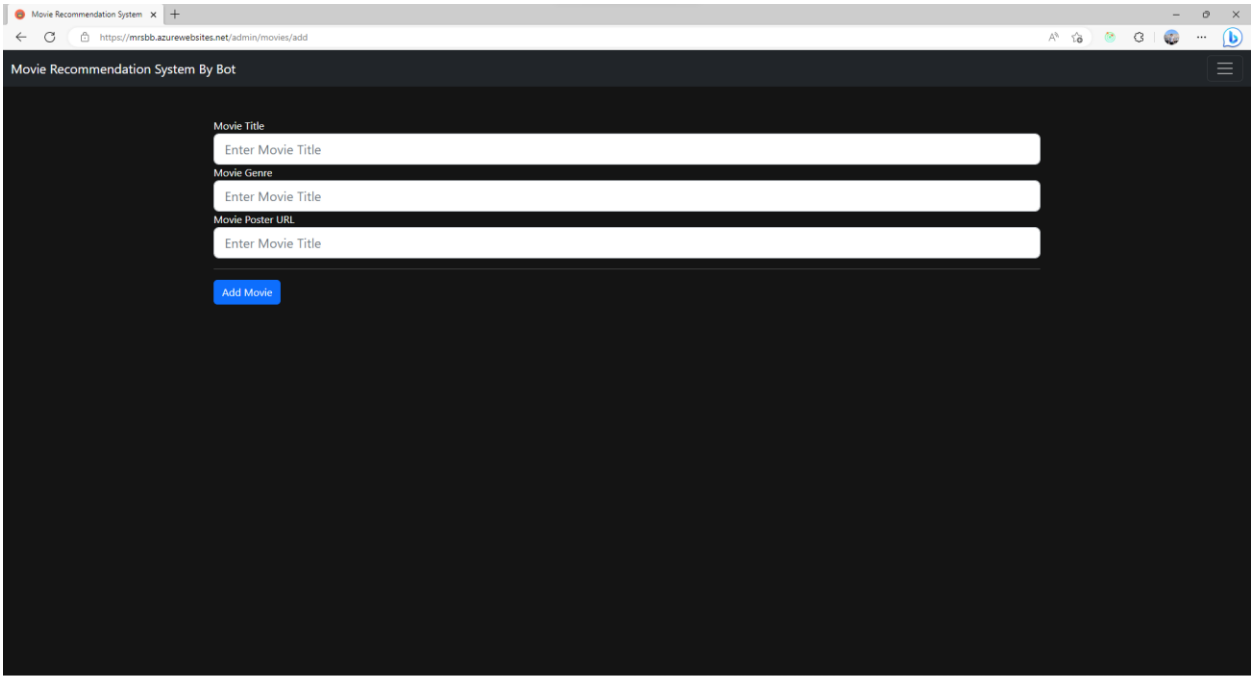

Movie Recommendation System
https://mrsbb.azurewebsites.net/admin
Movie Recommendation System By Bot
What do you want to do today?
Manage Users
Go to Users Management
Manage Movies
Go to Movies Management


Movie Recommendation System
https://mrsbb.azurewebsites.net/admin/users
Movie Recommendation System By Bot
Users Management
Click to a row to turn into specific user page.
ID
Email
Surname
Name
Birth Day
Gender
6040
iamtienng@gmail.com
Nguyen
Tien
21-04-1998
M
Snipping Tool
Screenshot copied to clipboard and saved
Select here to mark up and share the image


Movie Recommendation System
https://mrsbb.azurewebsites.net/admin/movies
Movie Recommendation System By Bot
Movies Management
Click to a row to turn into specific movie page.
Add new Movie
ID Title Genres
0 Toy Story (1995) Animation Children's Comedy
1 Jumanji (1995) Adventure Children's Fantasy
2 Grumpier Old Men (1995) Comedy Romance
3 Waiting to Exhale (1995) Comedy Drama
4 Father of the Bride Part II (1995) Comedy
5 Heat (1995) Action Crime Thriller
6 Sabrina (1995) Comedy Romance
7 Tom and Huck (1995) Adventure Children's
8 Sudden Death (1995) Action
9 GoldenEye (1995) Action Adventure Thriller
10 The American President (1995) Comedy Drama Romance
11 Dracula: Dead and Loving It (1995) Comedy Horror
12 Balto (1995) Animation Children's
13 Nixon (1995) Drama
14 Cutthroat Island (1995) Action Adventure Romance
15 Casino (1995) Drama Thriller
16 Sense and Sensibility (1995) Drama Romance


Movie Recommendation System
https://mrsbb.azurewebsites.net/admin/movies/1
Movie Recommendation System By Bot
Movie ID: 1
ROBIN WILLIAMS
JUMANJI
AN ADVENTURE FOR THOSE WHO SEEK TO FIND A WAY TO LEAVE THEIR WORLD BEHIND
IT'S A JUNGLE IN HERE
COMING SOON
- -
Movie Title:
Jumanji (1995)
- -
Movie Genres:
Adventure|Children's|Fantasy
- -
Delete
- -


Movie Recommendation System
https://mrsbb.azurewebsites.net/admin/users/6040
Movie Recommendation System By Bot
User ID: 6040
- -
Name - Surname:
Tien Nguyen
- -
Email:
iamtienng@gmail.com
- -
Birth Date:
21-04-1998
- -
Gender:
Male
- -
Delete
- -


Movie Recommendation System
https://mrsbb.azurewebsites.net/admin/movies/add
Movie Recommendation System By Bot
Movie Title
Enter Movie Title
Movie Genre
Enter Movie Title
Movie Poster URL
Enter Movie Title
Add Movie