

Content Recommendation using Eye Gaze & Face Recognition

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The project seeks to predict food/course recommendations through the analysis of human's eye gaze and facial recognition

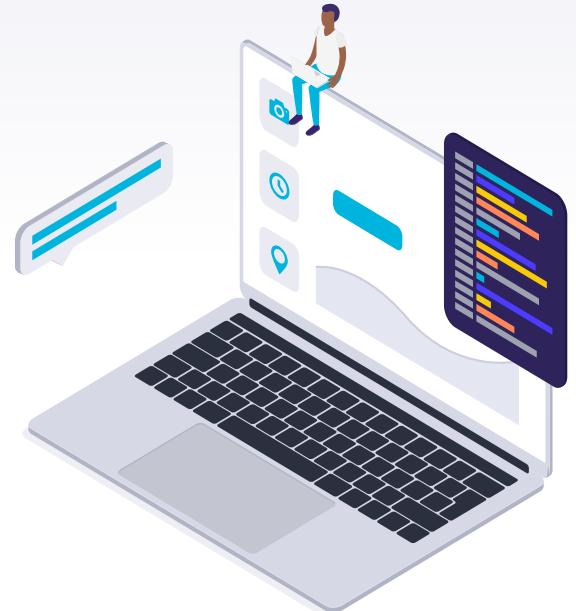
We aim to create a **reliable** application that provides users of all ages and/or gender with good food/course recommendations.

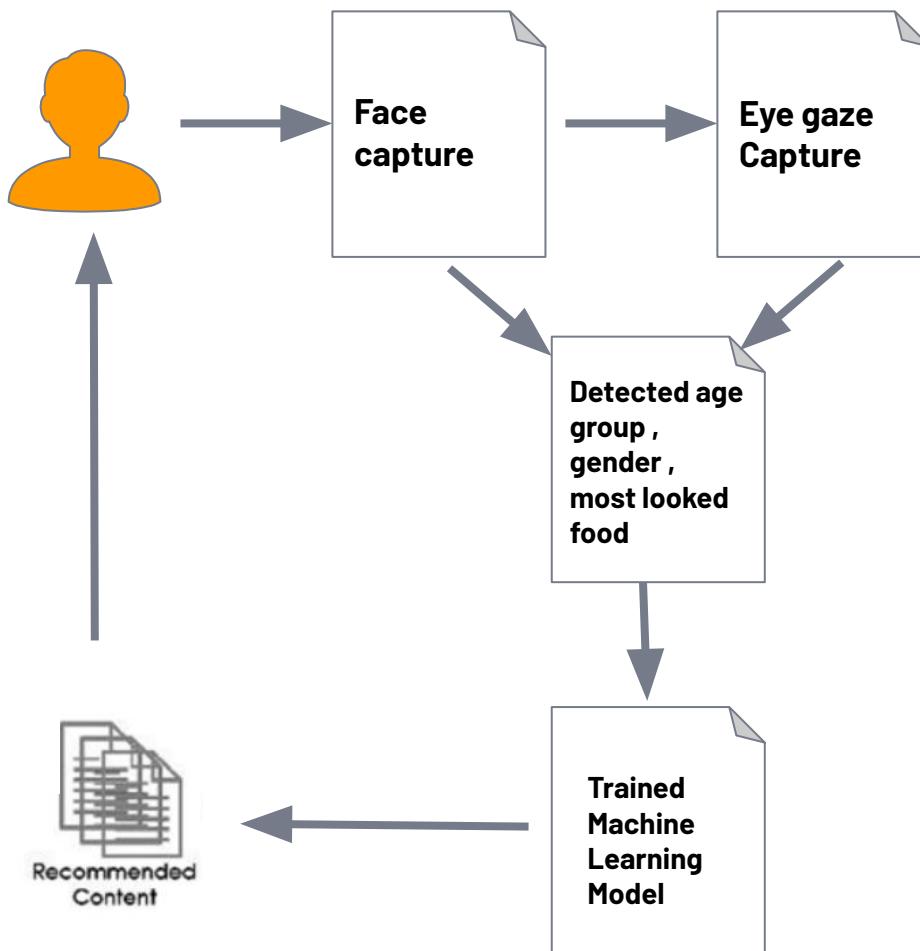


Key features included in our system:

1. Eye Gaze Tracking
2. Integrated facial recognition into existing application
3. Machine Learning Recommender
4. Practical application for users to use

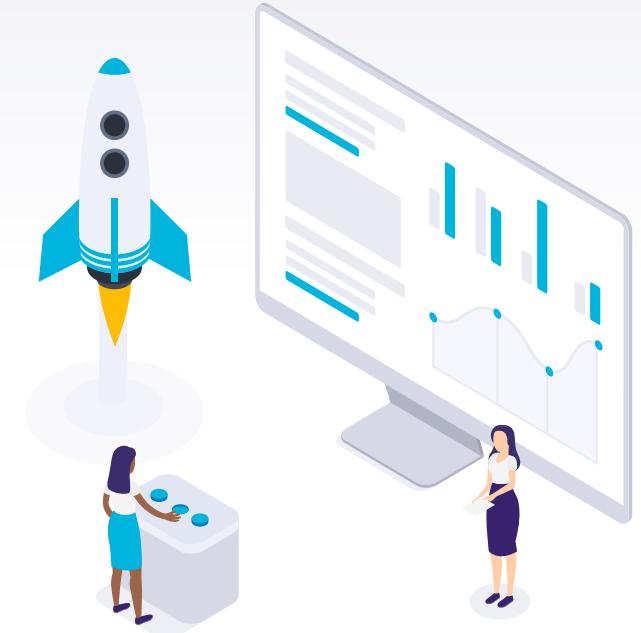
Sprint 1-3's System Design





Statement Of Work

- What is needed?
- What are our objectives?



Statement Of Work

What is needed?

- ▶ A batch of Data for Machine Learning purposes.
- ▶ Suitable Model and Algorithm to predict with best accuracy

What are our objectives?

- ▶ **Objective 1 :**
 - ▶ Train a Model with Data and Algorithm
 - ▶ Integrate trained Model
- ▶ **Objective 2 :**
 - ▶ Implement suitable Model to recommend food items



What have we done for Mid term

Sprint 1

Jovester

- ✓ Implement smile detection into facial recognition
- ✓ Integrate facial recognition into the deployable codes
- ✓ Integrate Collaborative Filtering Model into the facial recognition and eye tracking

Tricia

- ✓ Conduct Survey
- ✓ Update UX for the pages
- ✓ Data preparation
- ✓ Building & Implementing the embedded Collaborative Filtering Model into the deployable code

Sprint 2

Jovester

- ✓ Project outline
- ✓ Use a decision tree model for the recommender system

Tricia

- ✓ Designed and improved powerpoint slides
- ✓ Drew the System design
- ✓ Work on neural network collaborative filtering model
- ✓ Work on 2 collaborative model in which both uses different feature vectors
- ✓ Added evaluation metrics for each models
- ✓ Collected more data
- ✓ Do model comparison
- ✓ Integrate best model into app
- ✓ Fixed bugs on the app

Midterm(Sprint 1 & 2)

- 1. Collected more data (inclusive of Age & Gender)
- 2. Explored various models



Differences between new and old Dataset

Old

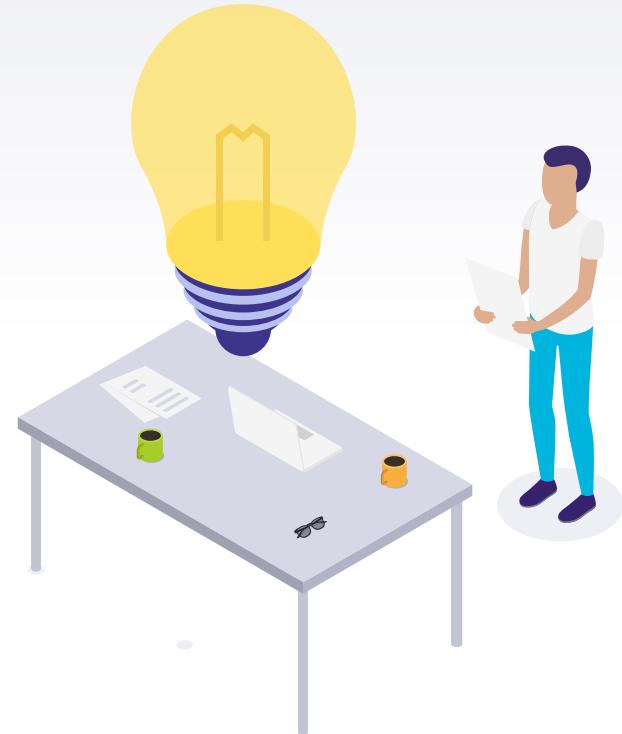
- Ratings
- Food Descriptions
- Address
- 24 rows of food records



NEW

- Ratings
- Food Descriptions
- Address
- **Age Group**
- **Gender**
- **Top 6 food preferences**
- **1000 rows of user and food record**

We've successfully
built 4 different
models



How we utilize the dataset in our model

Our 4 models mainly fall in this 3 types of model..

1

Decision Tree

Label Encoding features into dummy features.

Combine the food items data (0, 1) into a single string
- Eg,
000010000001101000
001001

Input : gender (dummy), age (dummy) and food item combination. Eg.
00000000000000000000000000000001
Output: 6 selected food items of similar users

2

Collaborative Filtering

Age Group + Gender = User group

1st Model :

- Vectors in the user-food matrix have been directly used as feature vectors

2nd Model:

- Singular value decomposition has been used to generate feature vectors.

How we utilize the dataset in our model

3

Neural Network

One hot encode categorical data

For every row of records ,
loop them, so that the i^{th}
food in the row is the
indicated food and the next
food(k^{th}) chosen by user will
be the recommended food for
that user .

Before:

User ID	Gender	Age Group	laksa	Chili Crab	Char Kway Teow	Japanese Bento	Curry laksa	
1	Female	65 and above	0	1	0	1	1	1

After:

	gender	age_group	indicated_food	rcmd_food
0	0	2	0	2
1	0	2	0	3
2	0	2	0	5
3	0	2	0	7
4	0	2	0	12

Model Evaluation (Sprint 1 & 2)

Decision Tree

- Score: 0.08%
- Accuracy: **37% - 22%**

Neural Net Collaborative Filtering

- Accuracy: 13.22%
- Classification Accuracy: 50%
- Intersection metrics: **0.501**

Model Evaluation (Sprint 1 & 2)

Collaborative filtering
(SVD)

Collaborative filtering
(user-food matrix &
cosine similarity)

- RMSE : 1.0350
- MSE: 1.071

- RMSE:**0.691**
- MSE: **0.527**

All Model's Evaluation (Sprint 1 & 2)

Decision Tree

- Score: 0.08%
- Accuracy:
 - 37% - 22%

Neural Net Collaborative Filtering

- Accuracy: 13.22%
- Classification Accuracy: 50%
- Intersection metrics: 0.50

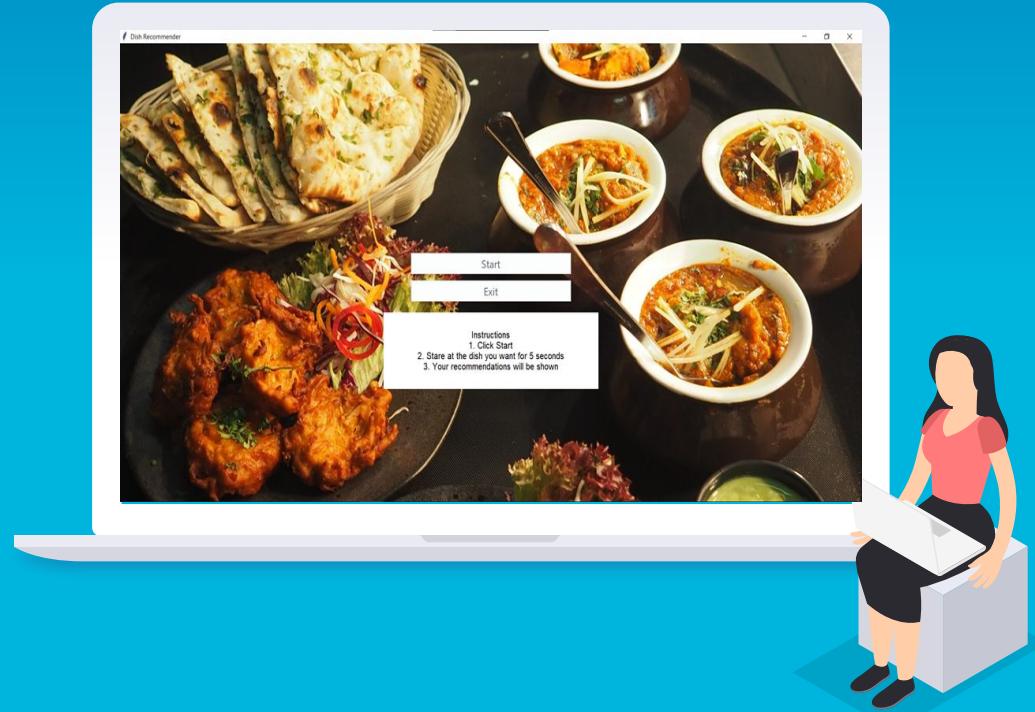
Collaborative filtering (SVD)

- RMSE : 1.0350
- MSE: 1.071

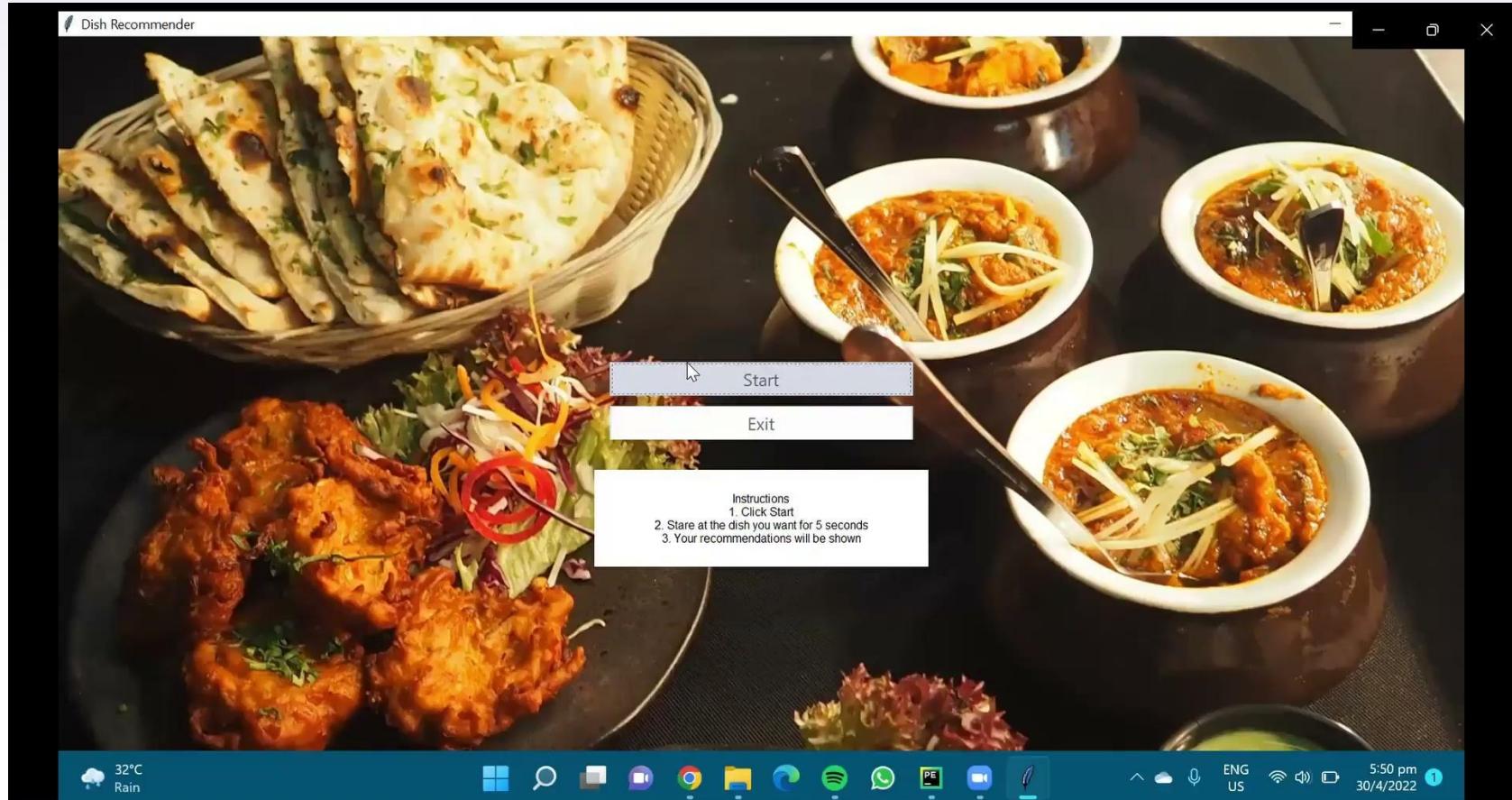
Collaborative filtering (vectors in the user -food matrix)

- RMSE:0.691
- MSE: 0.527

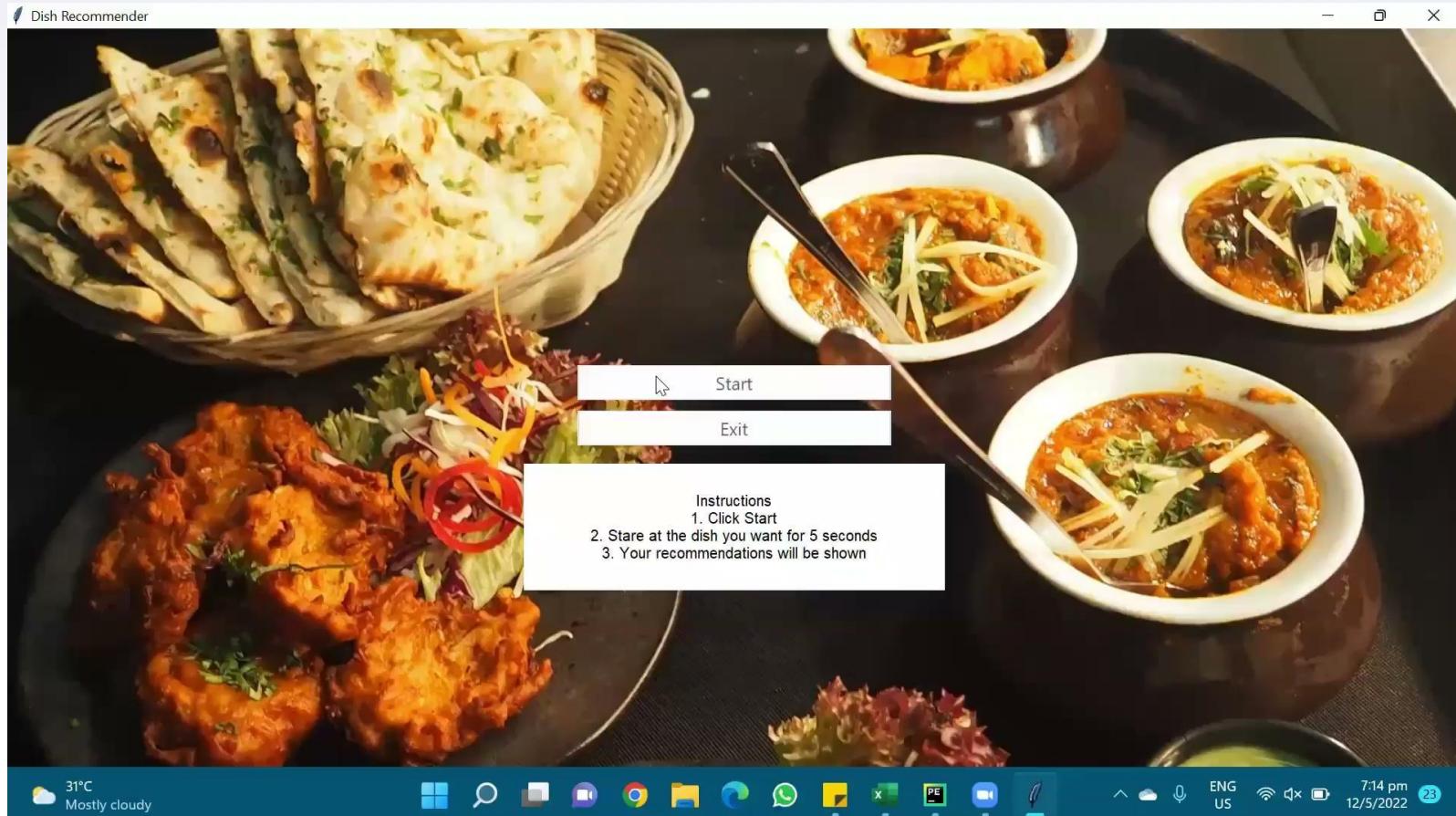
DEMO



User 1: Age Group: 25-54, Gender: Female, 1 Food : Laksa



User 2: Age Group: 14 and below , Gender: Male, 1 Food : Fish & Chips



What we have done for final

Sprint 3

Jovester

- ✓ Try out some other more models
- ✓ Tried out my own version of Similarity Search

Tricia

- ✓ Implemented 2 new models for the Food Dataset
- ✓ Evaluated model results
- ✓ Drew a graph for the RMSE , MSE and MAPE
- ✓ Replicate the interface of the Food recommender App to PyQt5
- ✓ Changed the menu design
- ✓ Redesigned the main page

Sprint 4

Jovester

- ✓ Implemented my Similarity Search
- ✓ Changed the facial recognition codes to detect gender
- ✓ Set a timer for it and a counter
- ✓ Conducted survey

Tricia

- ✓ Conducted survey to get responses for the Poly courses user scenario
- ✓ Cleaned the dataset
- ✓ Changed the layout of the app to fit the scenario
- ✓ Reposition the image heat map coordinates
- ✓ Adjusted the current models code so that it works well with the new dataset
- ✓ Changed location to hyperlink so that user can click on it in the recommendation pane
- ✓ Integrated both our work together

Sprint 3

1. Implemented 2 New models
2. Replicated Food Recommender App in New interface (Pyqt5)
3. Redesigned the food recommender app UI

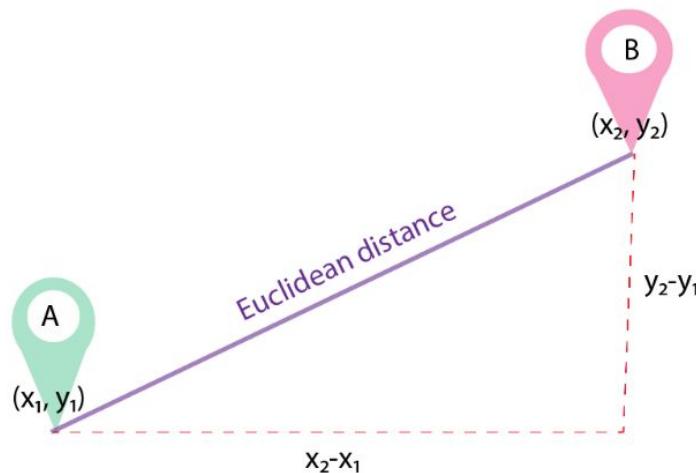


2 new models

1. Collaborative Filtering model that uses features from user-food matrix & **Euclidean distance similarity**
2. Collaborative Filtering model that uses features from user-food matrix & **Manhattan distance similarity**

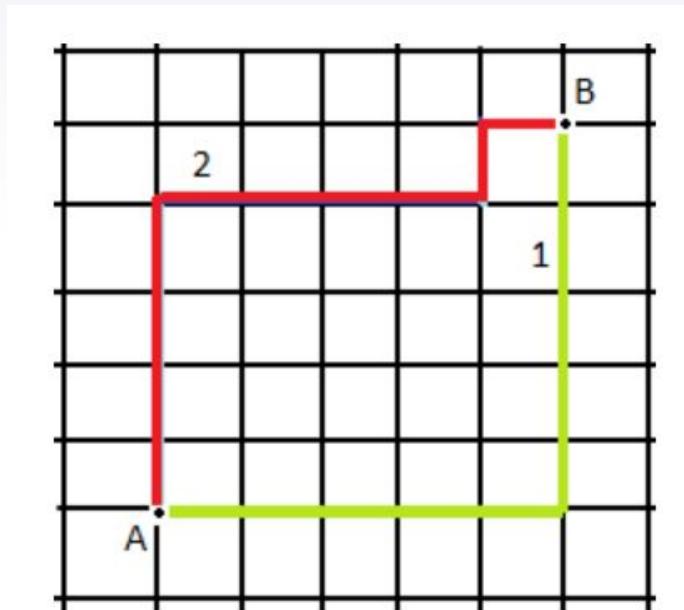


What's Euclidean distance similarity ?



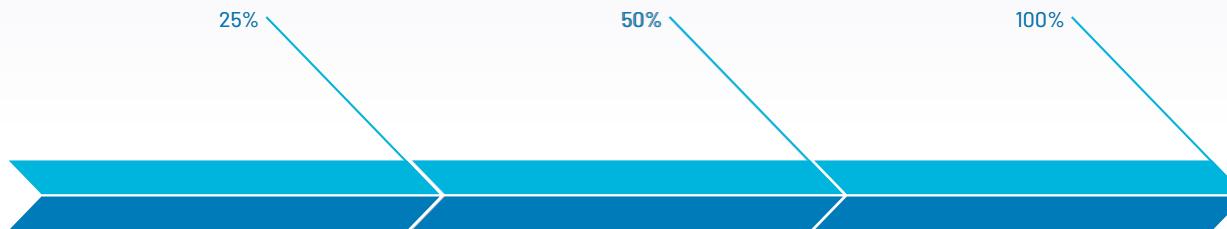
- Euclidean Distance represents the shortest distance between two points.
- The “closeness” is defined by the difference (“distance”) along the scale of each variable, which is converted to a similarity measure. This distance is defined as the **Euclidean distance**.

What's Manhattan distance similarity ?



- Manhattan Distance is the sum of absolute differences between points across all the dimensions.
- Manhattan distance is usually preferred over the more common Euclidean distance when there is high dimensionality in the data.

How was Euclidean/Manhattan distance similarity calculated ?

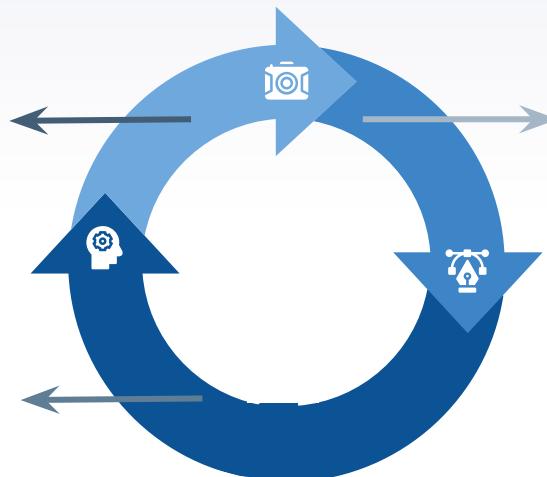
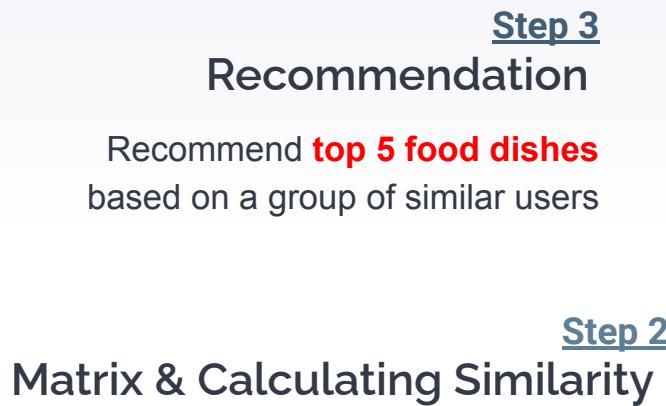


Find the distance

Scale it

Minus it with 1 to find the
similarity

How does this 2 models work ?



Step 1
Grouped data by Age Group and Gender

There'll be 10 collaborative filtering model (2 gender and 5 different age group)

- Vectors in the user-food matrix have been directly used as feature vector.
- Euclidean distance / Manhattan distance
Similarity is calculated using the various similarity measure.

Model Evaluation (Sprint 3)

Collaborative filtering
(user food matrix &
euclidean distance)

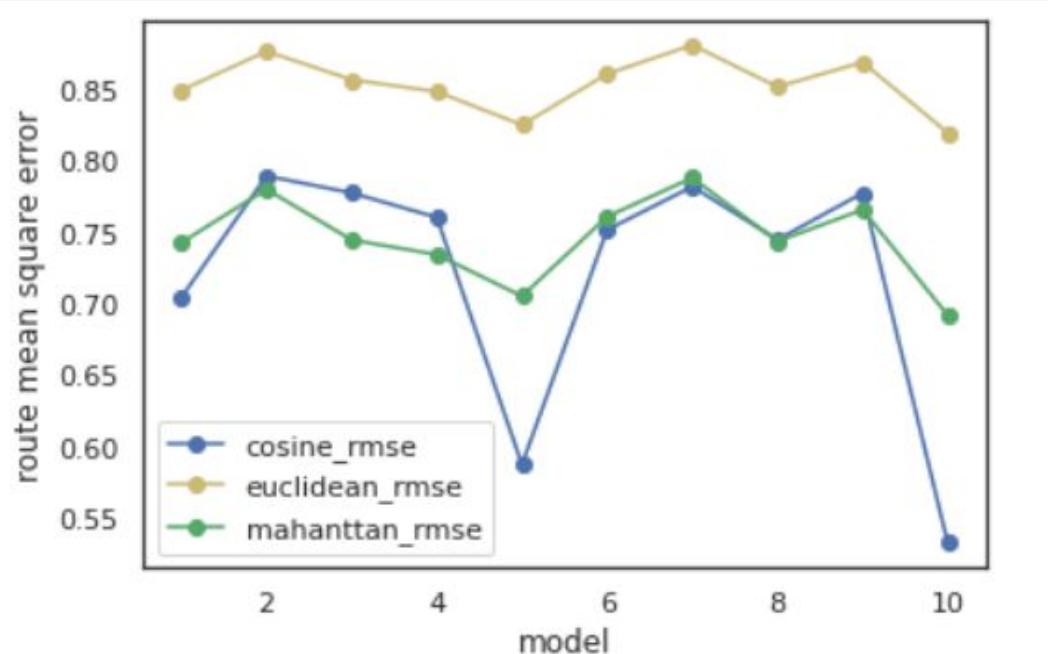
Collaborative filtering
(user food matrix &
Manhattan distance)

- RMSE : 0.848
- MSE: 0.720
- MAPE: 0.851

- RMSE : 0.736
- MSE: 0.543
- MAPE: 0.737

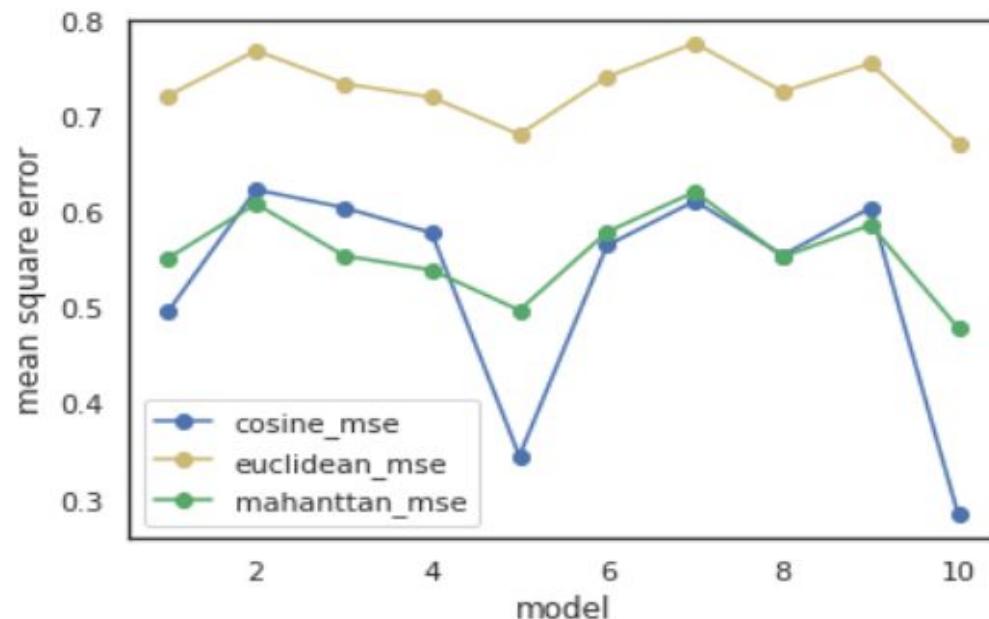
Graph - RMSE

Comparing sprint 3 models performance against sprint 2's chosen model



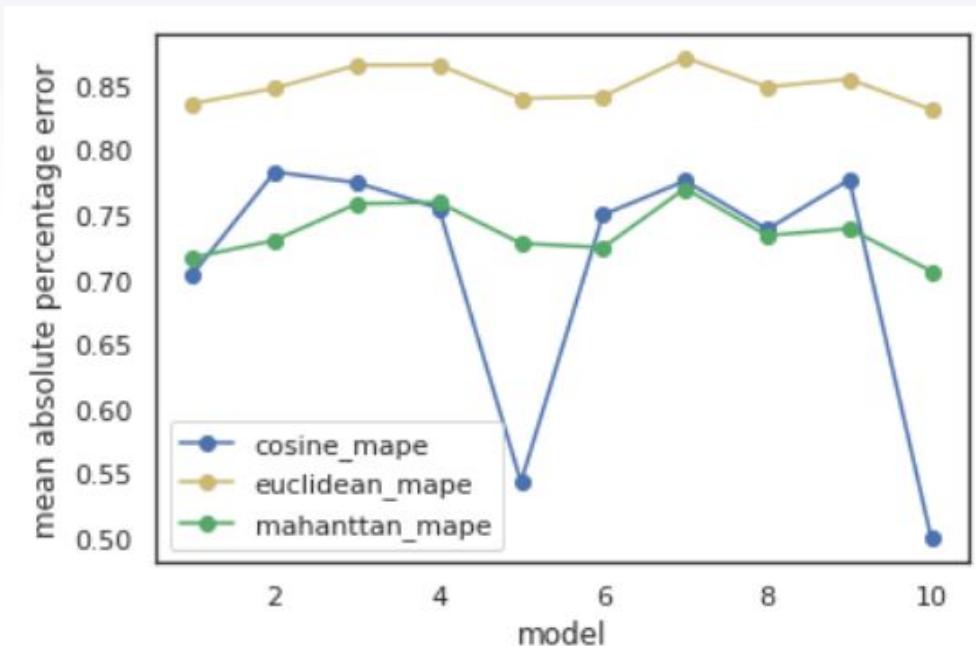
Graph - MSE

Comparing sprint 3 models performance against sprint 2's chosen model



Graph - MAPE

Comparing sprint 3 models performance against sprint 2's chosen model



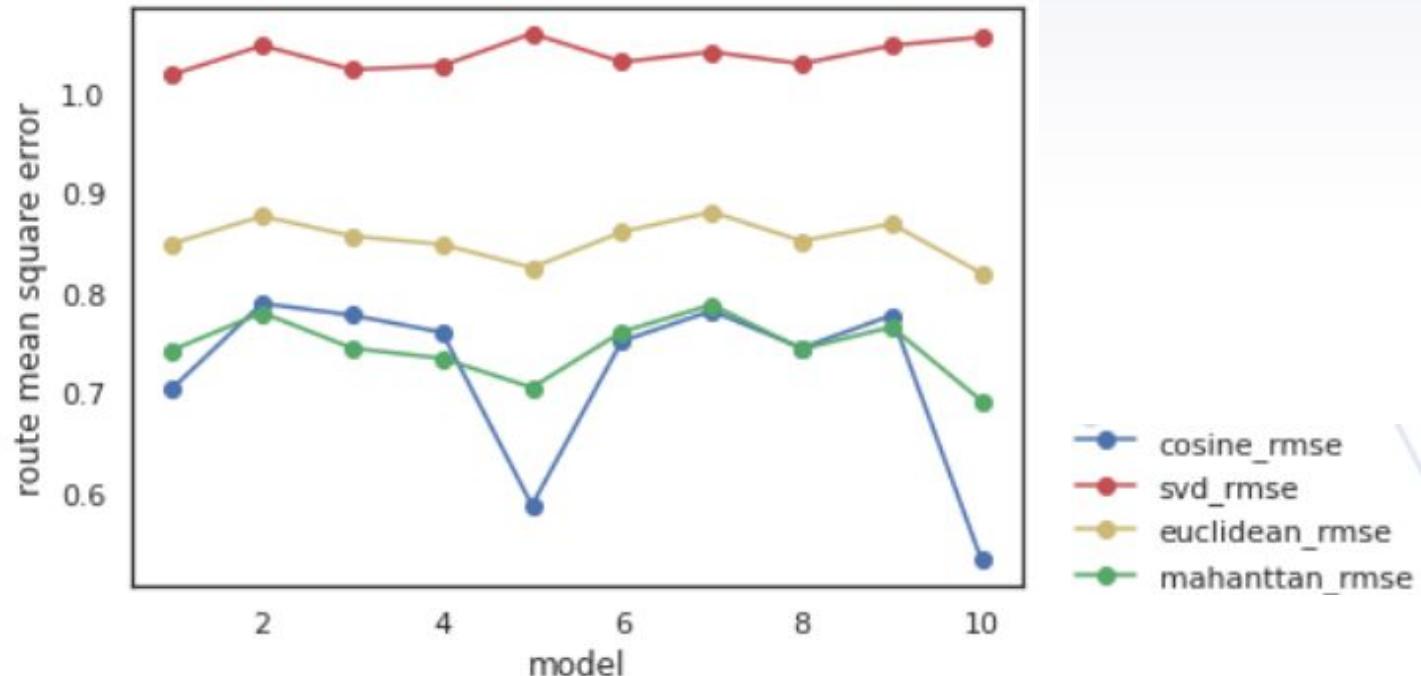
Predictions

Example : Female , 65 and above , Sliced Fish Soup

Cosine model	Euclidean Model	Manhattan Model
- Chinese Economy Rice	- Chinese Economy Rice	- Chinese Economy Rice
- Crab Bee Hoon Soup	- Crab Bee Hoon Soup	- Crab Bee Hoon Soup
- Bak Kut Teh	- Bak Kut Teh	- Bak Kut Teh
- hainanese chicken rice	- Duck Rice	- Duck Rice
- Hokkien Mee	- Roti Prata	- Hokkien Mee

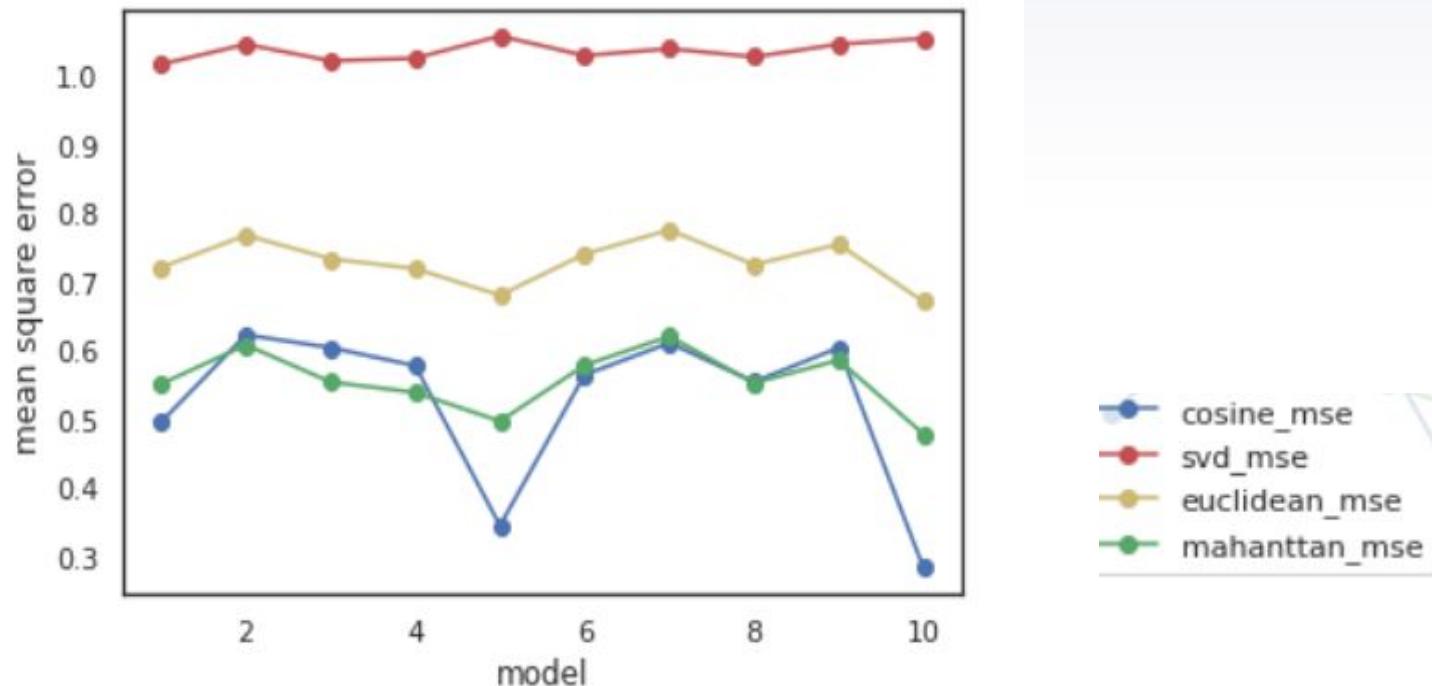
Graph - RMSE (All Models)

Comparing all models performance (from sprint 1 - 3)



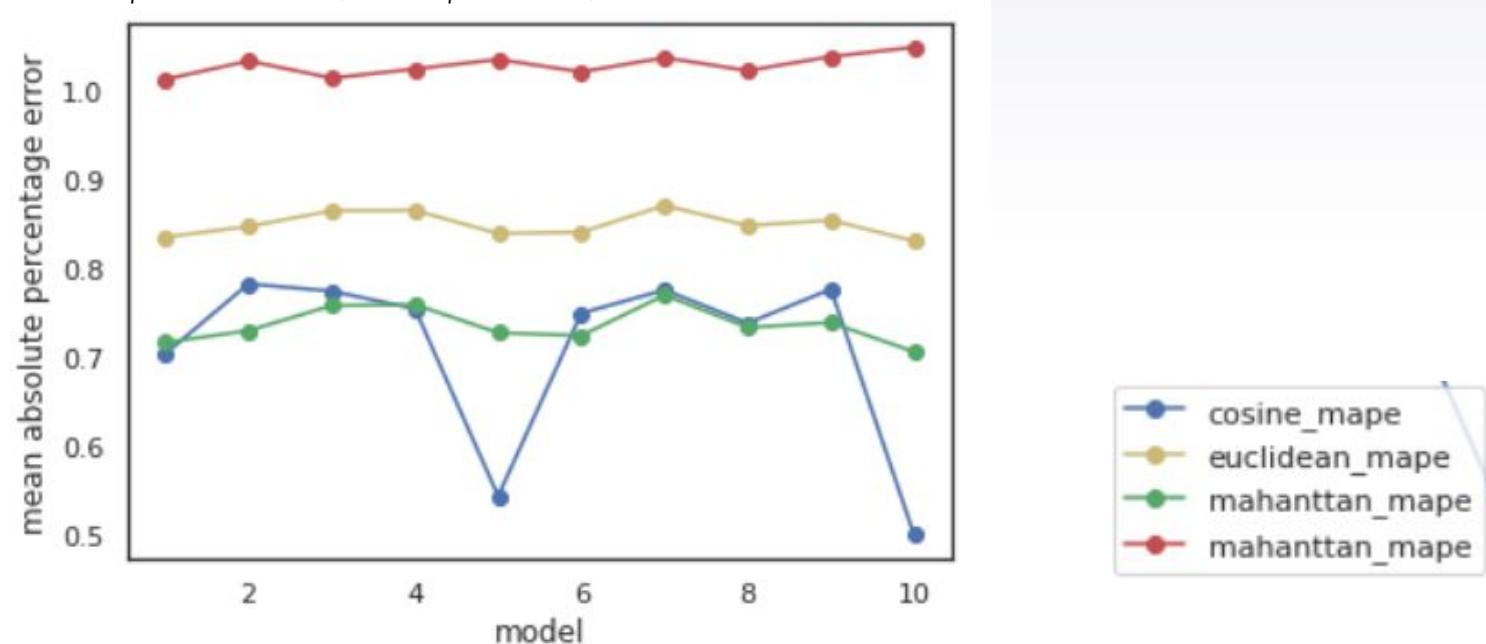
Graph - MSE (All Models)

Comparing all models performance (from sprint 1 - 3)



Graph - MAPE (All Models)

Comparing all models performance (from sprint 1 - 3)



All Model's Evaluation (Sprint 3)

Collaborative filtering
(SVD)

- RMSE : 1.0350
- MSE: 1.071
- MAPE: 1.030

Collaborative filtering
(user-food matrix &
cosine similarity)

- RMSE:**0.720**
- MSE: **0.527**
- MAPE: **0.710**

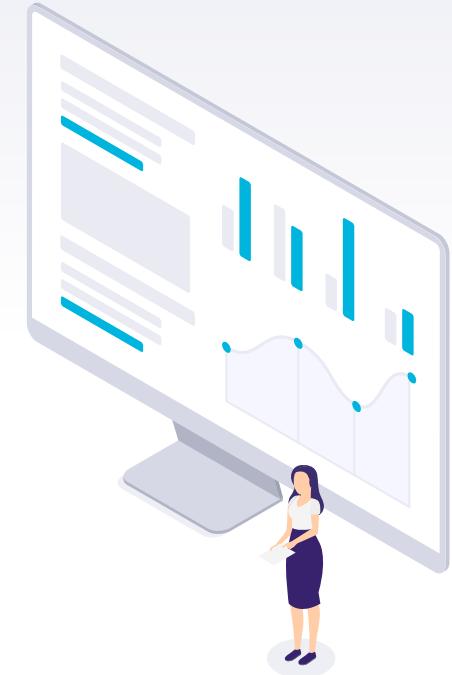
Collaborative filtering
(user food matrix &
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- RMSE : 0.848
- MSE: 0.720
- MAPE: 0.851

Collaborative filtering
(user food matrix &
Manhattan distance)

- RMSE : 0.736
- MSE: 0.543
- MAPE: 0.737

Thus , considering the **size of our dataset** and our **use case scenario** while evaluating how the various **model performs** , we chose to go with the **Collaborative filtering that uses vectors in the user -food matrix and cosine similarity.**



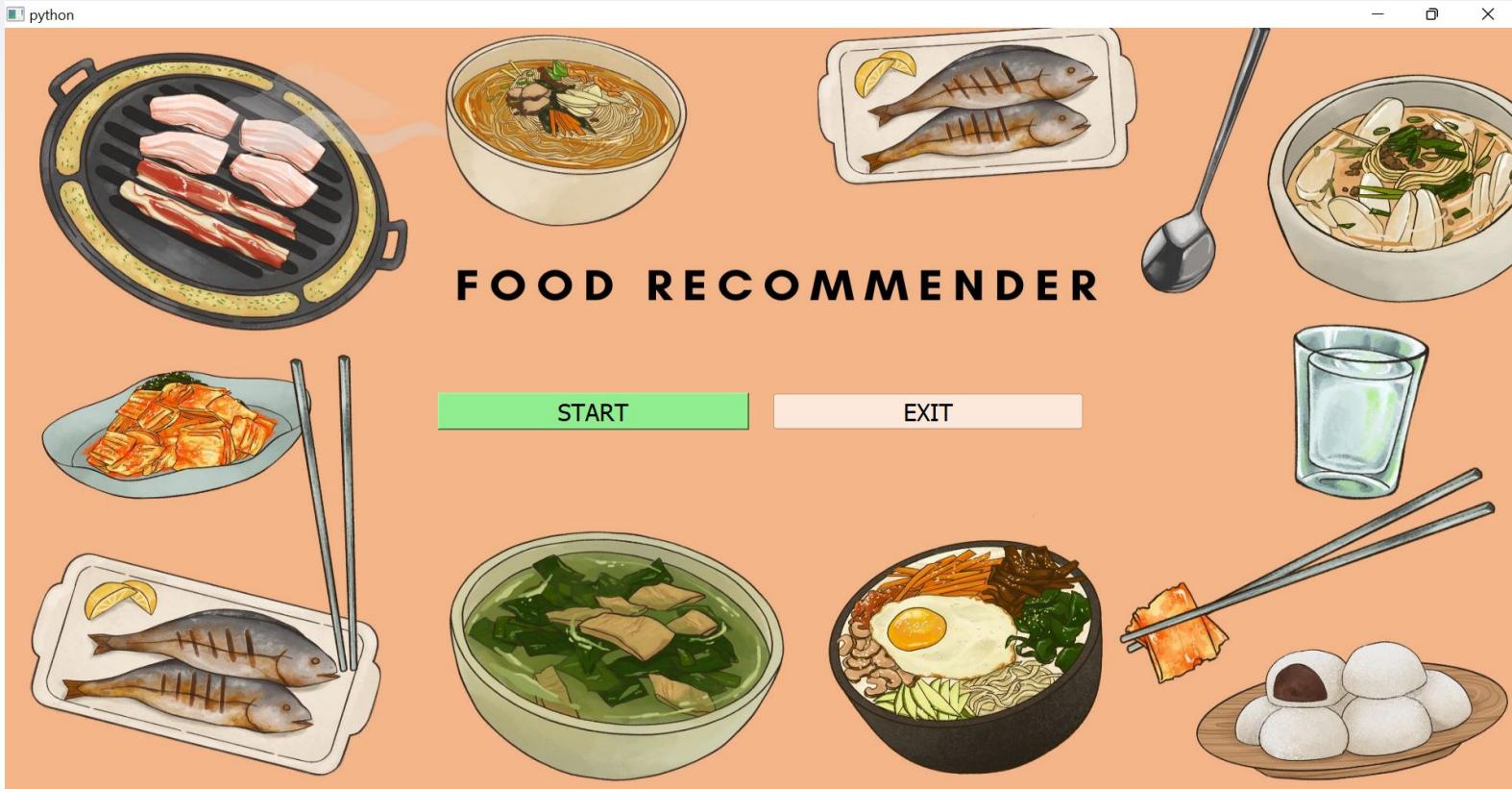
New Interface for food recommender

Previous interface: Tkinter

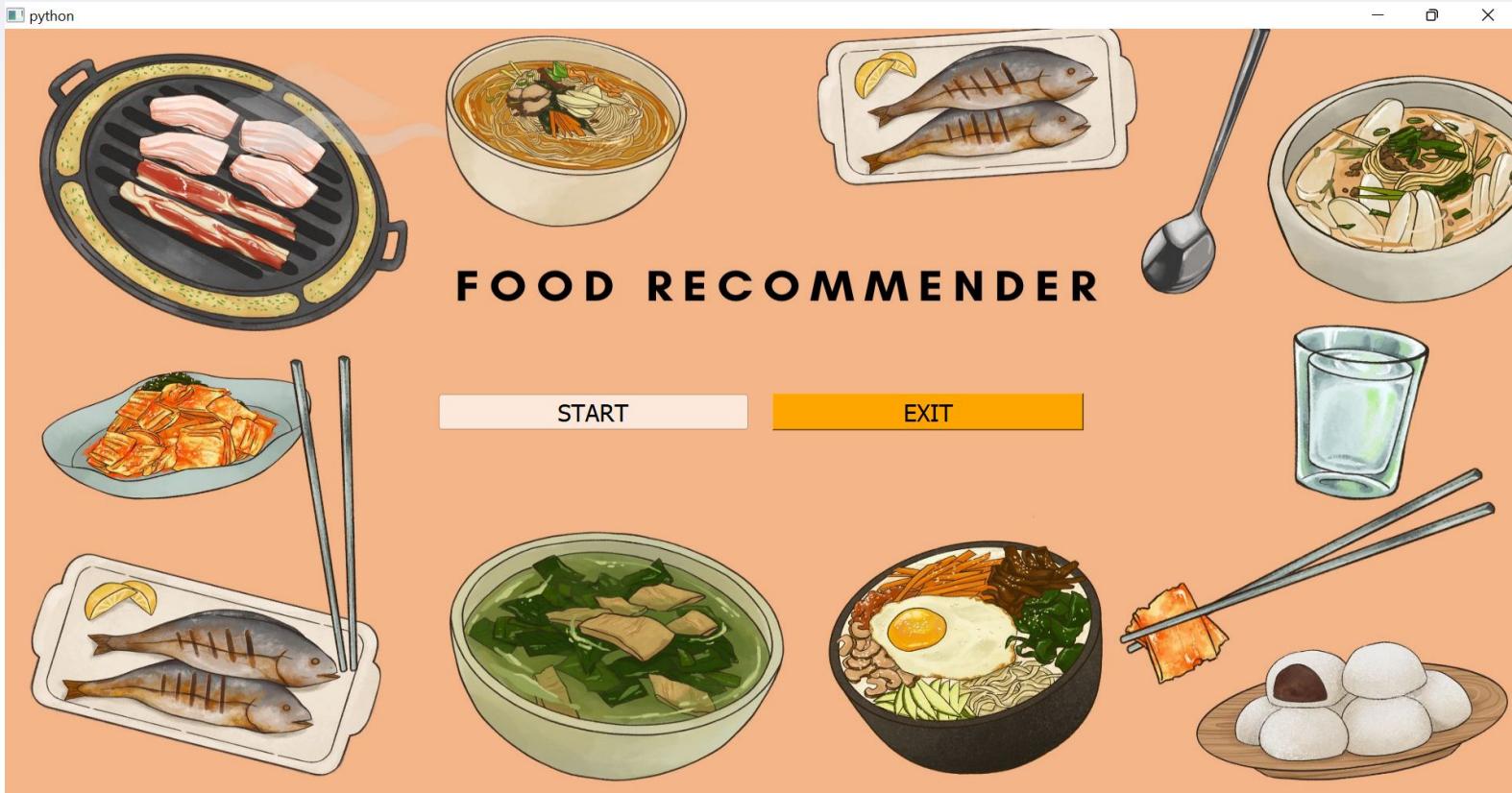
Current interface: **Pyqt5**



New Main Page design



New Main Page design



New Menu (1) design

WHATS FOR DINNER?



CHICKEN RICE



LAKSA



CHAR KWAY TEOW



CHILI CRAB



SLICED FISH SOUP



FISH N CHIPS



MIXED RICE



BENTO SET

New Menu (2) design

WHATS FOR DINNER?



FISH HEAD CURRY



CURRY LAKSA



DUCK RICE



YU SHENG



BAK KUT TEH



HOKKIEN MEE



KWAY CHAP



ROTI PRATA

New Menu (3) design

WHATS FOR DINNER?



BEEF KWAY TEOW



BLACK PEPPER CRAB



CEREAL PRAWN



ROTI JOHN



KATONG LAKSA



SAMBAL STINGRAY



CRAB BEE HOON SOUP



SATAY

New recommendations pane

python

Your Recommendations

You've picked: [hainanese chicken rice](#)

(Click to Find Out More!)

Fish and Chips



Happy Hawkers, Blk 531 Ang Mo Kio Ave 10. #01-2429

Japanese Bento



Casuarina Road, Tamako Meal, Casuarina Rd

Hokkien Mee



Fried Hokkien Prawn Noodles, Ang Mo Kio Ave 6. #01-41

Roti Prata



Prata Raya Singapore, AMK Hub No.53, #01-38

Kway Chap



Ying Yi Kway Chap Braised Duck. #01-145. Ang Mo Kio Ave 10

Quit

New recommendations pane

Prata Raya - Google Maps

<https://www.google.com/maps/place/Prata+Raya/@1.3689896,103.8477356,17z/data=!3m2!4b1!5s0x3...>

The map displays the location of Prata Raya at No. 53, Ang Mo Kio Avenue 3, #01-38/39, AMK Hub, 569933, 569933. The area is shown in green, indicating a park or residential zone. Other nearby establishments include Ajisen Ramen (AMK Hub), Ichiban Sushi (Ang Mo Kio), and Rasa Sayang Western Food. The map also shows several HDB blocks (e.g., Block 302 HDB, Block 348 HDB, Block 314 HDB) and local landmarks like the Deyi Secondary School.

Prata Raya

3.9 ★★★★☆ 593 reviews · \$\$

Restaurant

Directions Save Nearby Send to phone Share

✓ Dine-in · ✓ Takeaway · ✓ Delivery >

No. 53, Ang Mo Kio Avenue 3, #01-38/39, AMK Hub, 569933, 569933

Nearby restaurants Hotels Attractions Bars Coffee Takeout

Community Club

Ang Mo Kio Town Garden East

Strolling & jogging under rubber trees

Ang Mo Kio South Neighbourhood Police...

Block 590A HDB

Block 428 HDB

Block 437 HDB

Block 302 HDB

Block 348 HDB

Block 314 HDB

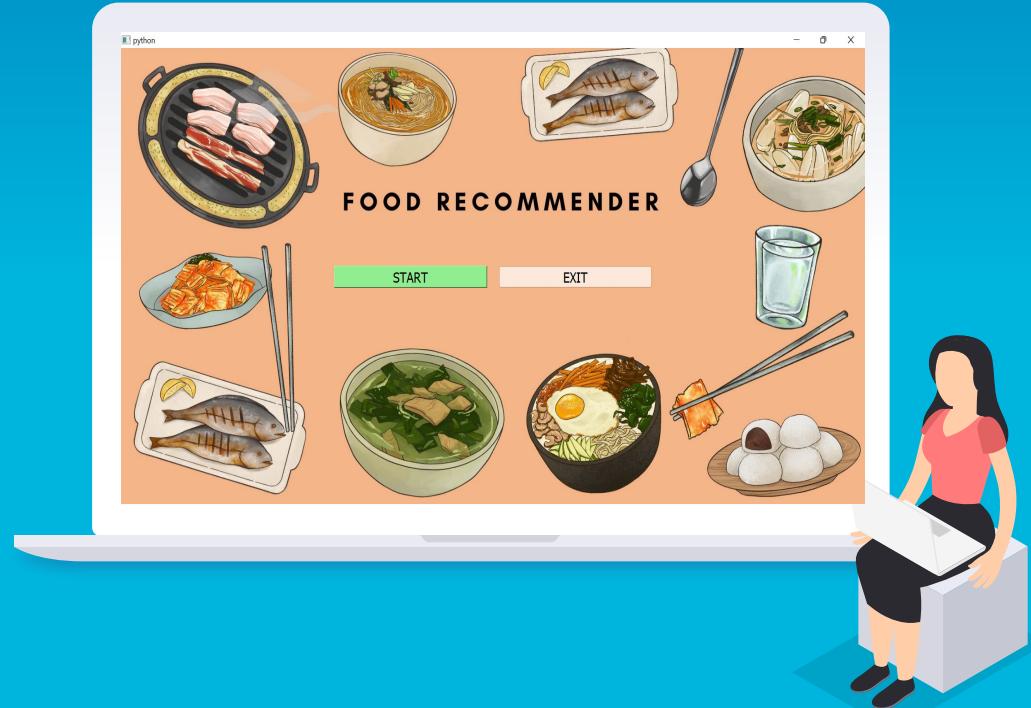
Deyi Secondary School

Ang Mo Kio Street 31

Ang Mo Kio Street 42

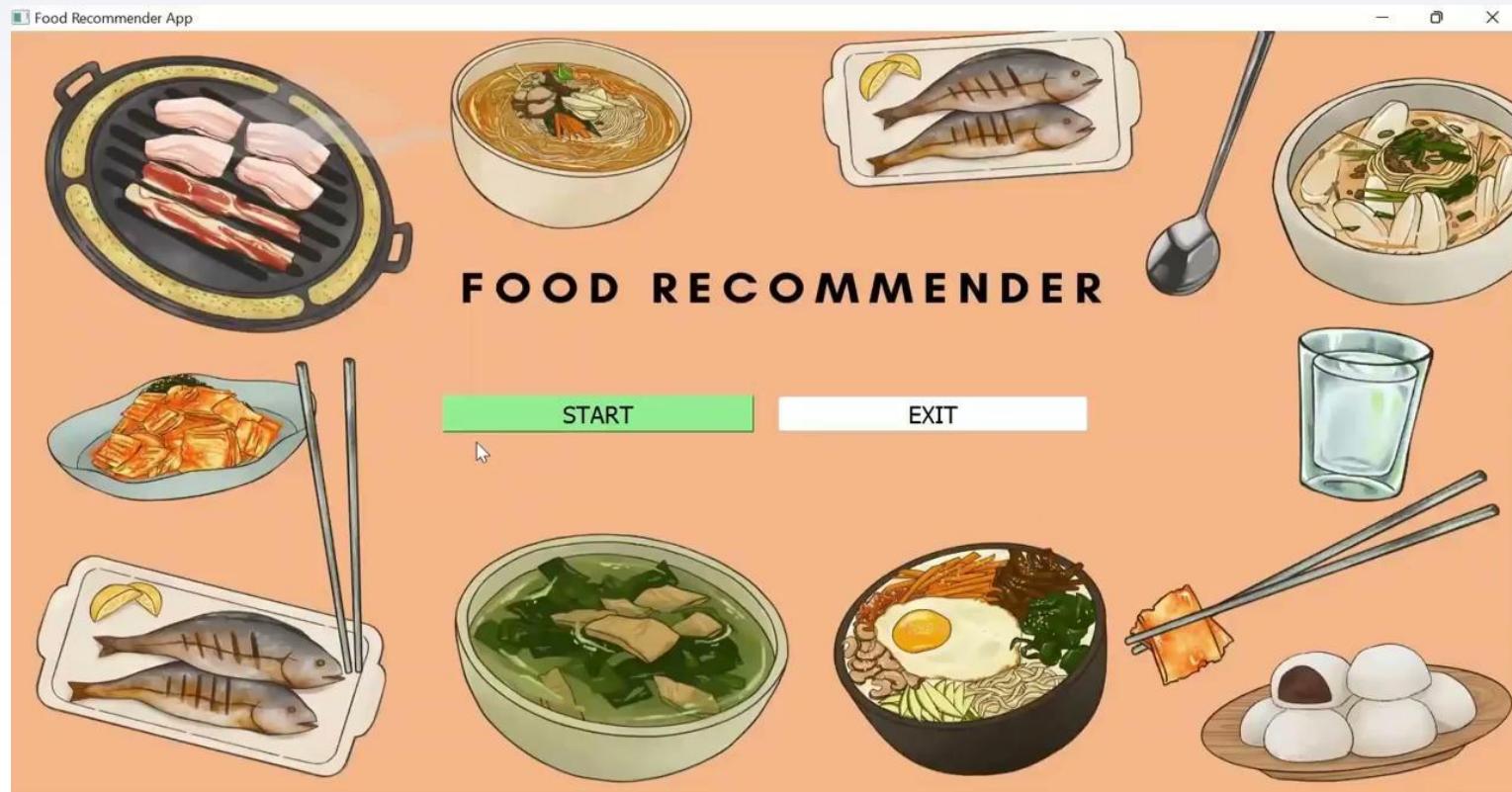
Map data ©2022 Google Singapore Terms Privacy Send feedback 100 m

DEMO



New Food Recommender App demo

User 1: Age Group: 15-24 , Gender: Male, 1 Food : Hainanese Chicken Rice



Sprint 4

1. New model for food dataset
2. New user scenario
3. New Dataset
4. New Design for pyqt5
5. Set timer in Face Recognition



New Model for food dataset



How does my similarity search works

Takes in 3(Gender, Age, Food Item) usual inputs and outputs a list of food to recommend to the user (In Order):

- Using the **Food Item Input**, only users that had chosen the same food item as well will be saved into a new DataFrame.
- The new DataFrame is then sorted in order of **Gender** and **Age_Group**.
- The user **Gender** and **Age Inputs** will be used to:
 - Sort users according the inputs.
 - Save them into another DataFrame.

How does my similarity search works

Continuing with how it works:

- Using that Dataframe, a percentage of each food items being chosen will be calculated and placed in a list:
 - eg, [5.800000000000001, 2.7, 2.3, 2.1999999999999997, 2.1999999999999997, 2.0, 1.9, 1.7999999999999998, 1.6, 1.5, 1.4000000000000001, 1.4000000000000001, 1.2, 1.0, 0.8999999999999999, 0.8999999999999999, 0.7000000000000001, 0.7000000000000001, 0.7000000000000001, 0.5, 0.5, 0.4, 0.4, 0.1].
- Excluding the user inputted food item, the 5 food items with the highest percentages will be saved into yet another list and are printed out to recommend the user 5 food items.

Why my own similarity search?

- More personalised and flexible.
- Models can be quite inaccurate.
- Wanted to challenge myself.
- Other similarity search algorithms are insufficient.

Although it is not a model which I am required to use, I strongly feel that a simple algorithm like this can allow better application and yield better results.

Predictions

Output Examples:

Example 1 : Male, 14 and below, Hokkien Mee

- Chilli Crab
- Hainanese Chicken Rice
- Fish and Chips
- Fish Head Curry
- Bak Kut Teh

Example 2 : Female, 65 and above, Yu Sheng

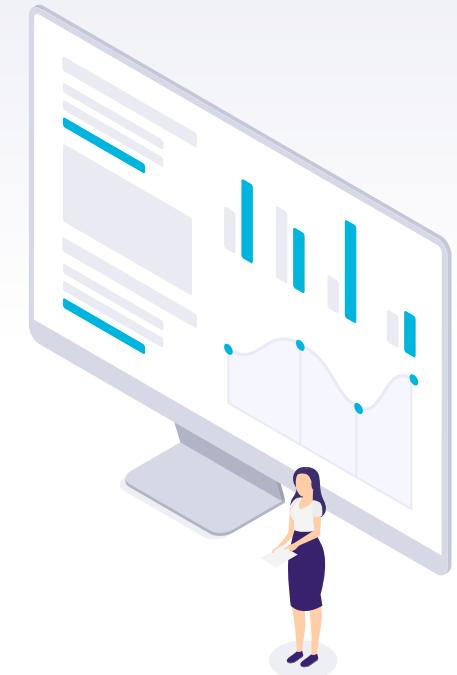
- Hainanese Chicken Rice
- Duck Rice
- Chinese Economy Rice
- Sliced Fish Soup
- Laksa

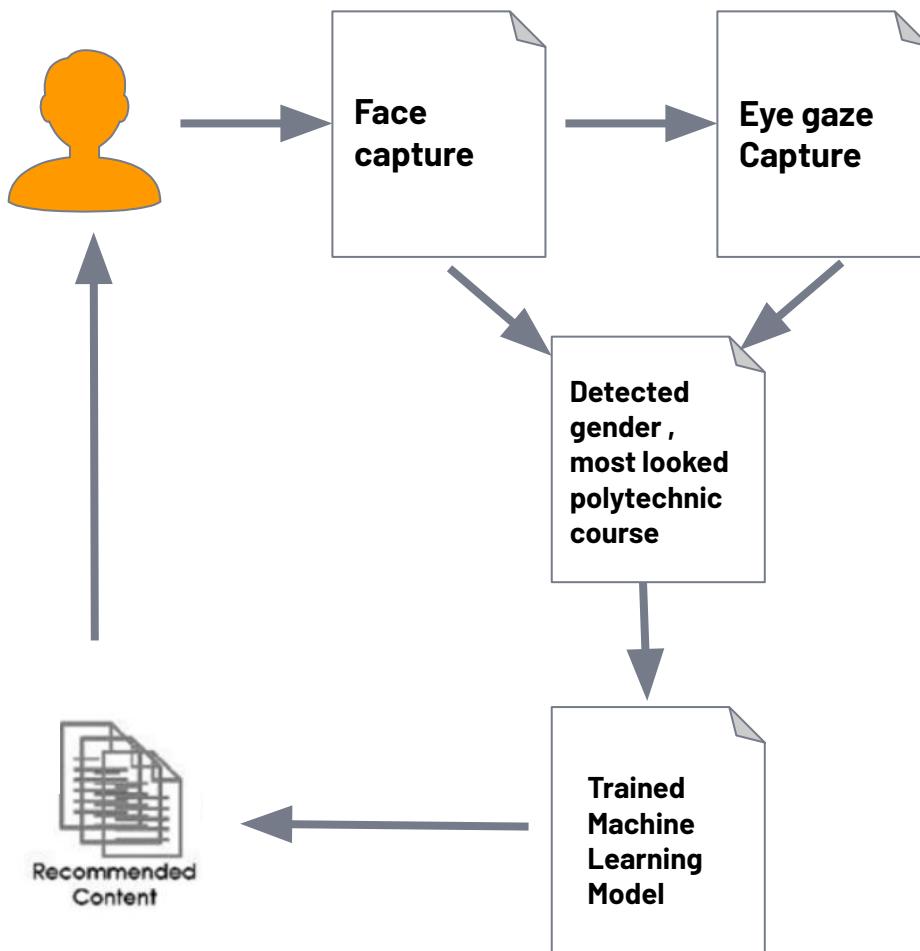
New User Scenario

Based on **user's gender** & **1 polytechnic course**
that the user gaze at , recommend top 5
polytechnic course that the group of similar
user has chosen



Sprint 4's System Design





New Dataset



1

Gender

2

Top 6 poly courses they
prefer

Collected **500 responses**

51 % Females
49% Males

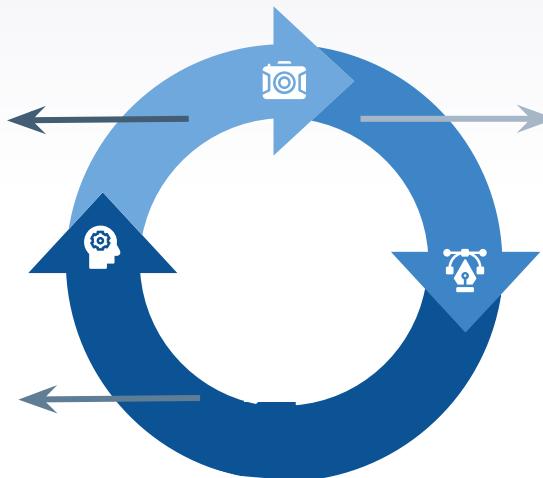
How did we utilize the poly courses dataset in our model

Step 3 Recommendation

Recommend **top 5 poly courses** based on a group of similar users

Step 2 Matrix & Calculating Similarity

Vectors in the user-course matrix have been directly used as feature vector. Similarity is calculated using the various similarity measure out there.



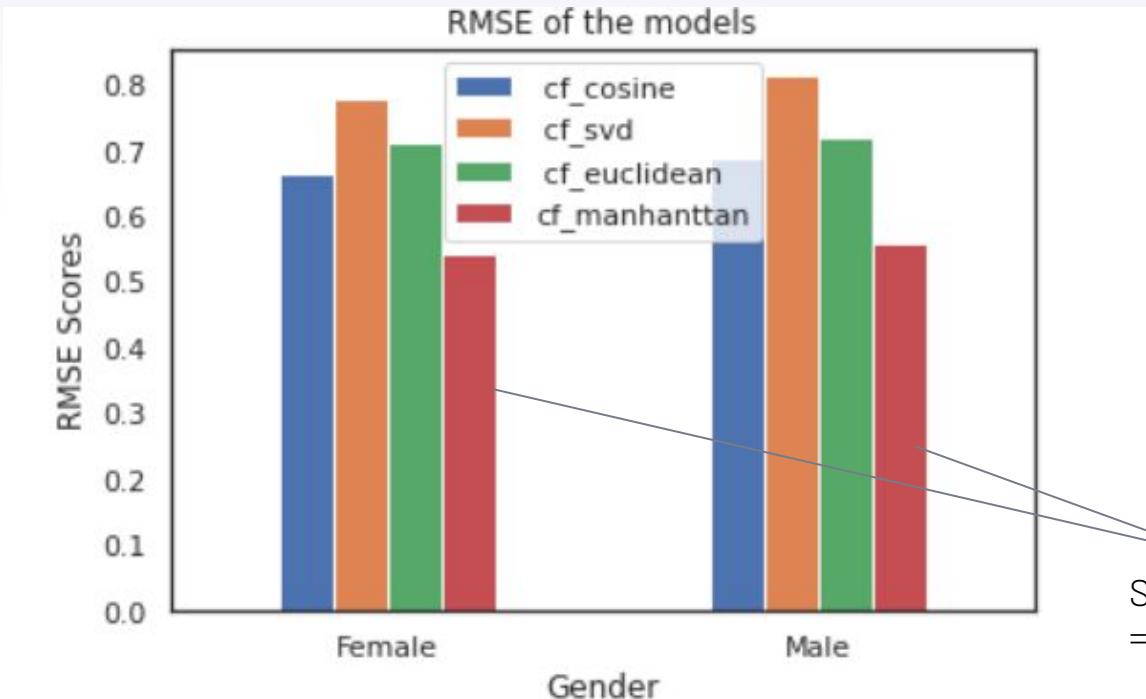
Step 1 Grouped data by Gender

There'll be 2 collaborative filtering model (1 for female and 1 for male)

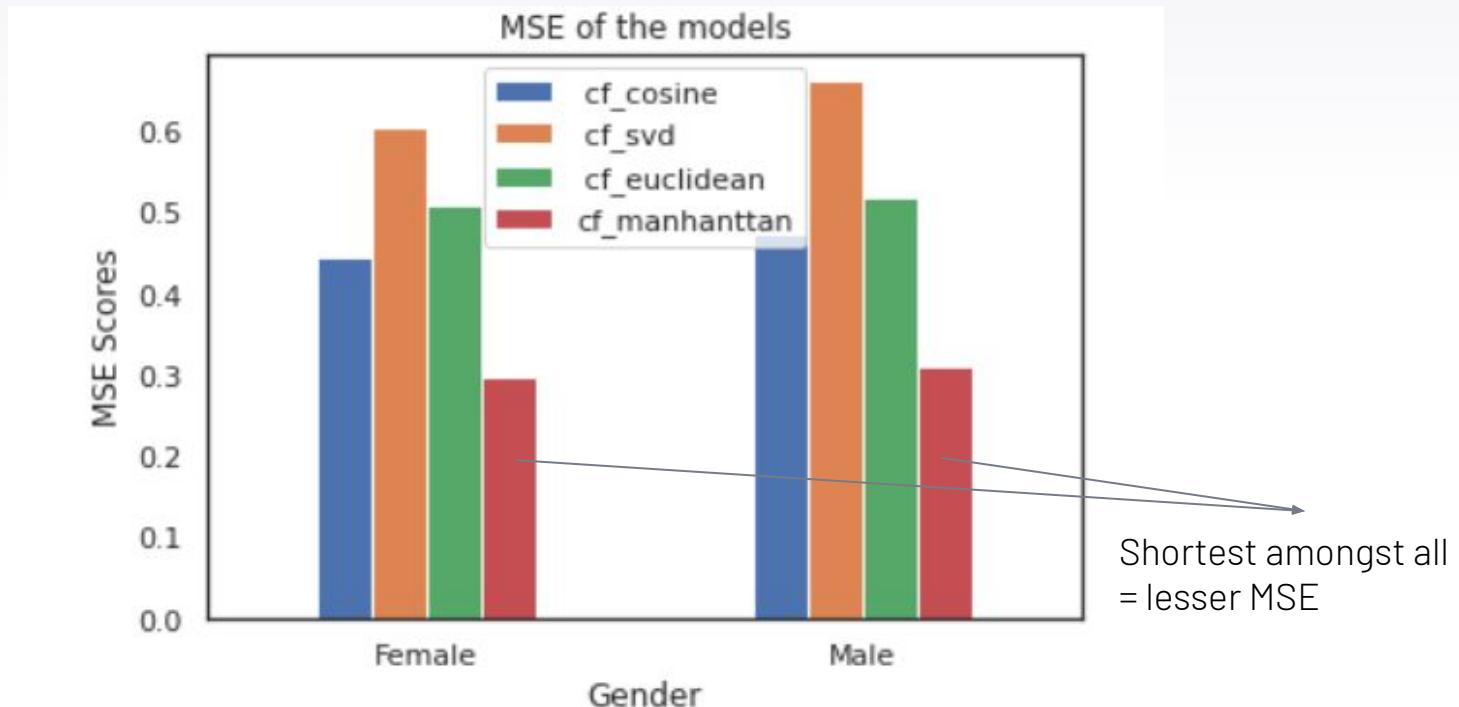
New Dataset Model Evaluation



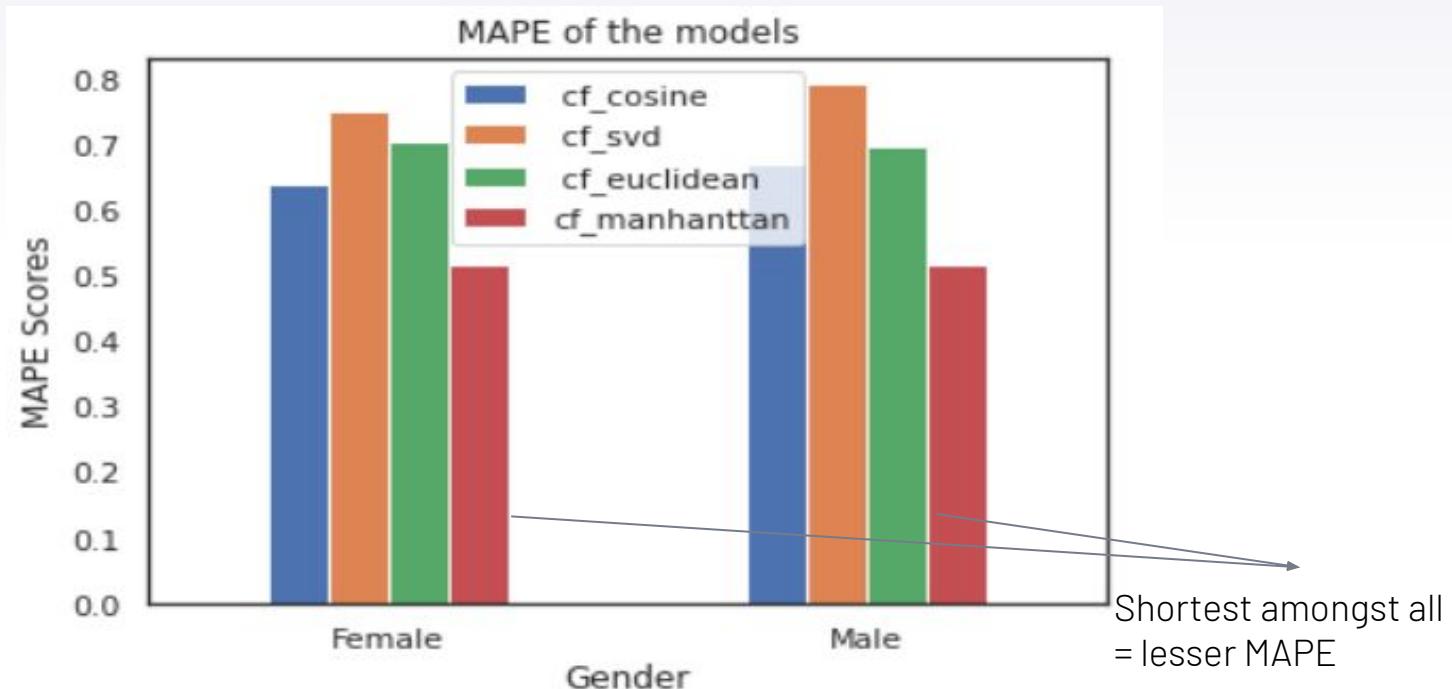
Graph - RMSE (All Models)



Graph - MSE (All Models)



Graph - MAPE (All Models)



Model Evaluation (Sprint 4)

Collaborative filtering
(SVD)

- RMSE : 0.796
- MSE: 0.626
- MAPE: 0.773

Collaborative filtering
(user-course matrix &
cosine similarity)

- RMSE:0.677
- MSE: 0.454
- MAPE: 0.657

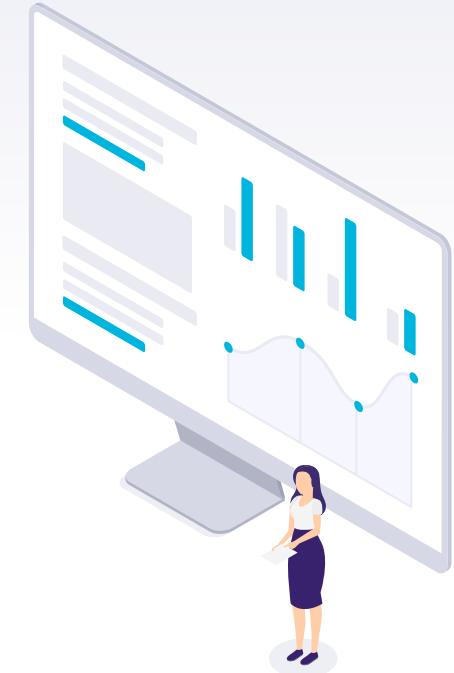
Collaborative filtering
(user course matrix &
euclidean distance)

- RMSE : 0.717
- MSE: 0.504
- MAPE: 0.703

Collaborative filtering
(user course matrix &
Manhattan distance)

- RMSE : **0.545**
- MSE: **0.295**
- MAPE: **0.518**

Thus , considering the **size of our dataset** and our **use case scenario** while evaluating how the various **model performs** , we chose to go with the **Collaborative filtering that uses manhattan distance as a similarity measure.**



► Facial Recognition

- In the Facial Recognition file, I changed it so that it records the results of the **Gender** and **Age Group** after 5 seconds.
- The result is based on the frequency of said **Gender** and **Age Group**; so after a 5 second long facial recognition scan, the most frequently detected **Gender** and **Age Group** will be recorded.
- The recorded results will be written into a txt file, in which it will be used for the food recommendation.

Polytechnic Course Recommender Main Page design



Polytechnic Course Recommender Main Page design



Polytechnic Course Recommender catalogue(1) design

python

N Y P C O U R S E C A T A L O G U E - O N E

The application window has a dark blue header bar with the title 'NYP COURSE CATALOGUE - ONE' in white. Below the header, there are two rows of four course categories each. Each category features a small image, the course name, and a brief description.

- Information Technology**: A woman wearing a VR headset with a digital interface overlay.
- Food & Beverage Business**: A man pouring liquid from a pot into a red cup in a kitchen.
- Motion Graphics Design**: Two people working on a large, colorful graphic design on a screen.
- Food Science & Nutrition**: Two people in lab coats working at a food processing machine.

- Experiential Product & Interior Design**: Two people in a room with a red sofa, one holding a laptop and the other holding a VR controller.
- Applied Chemistry**: A woman in a lab coat and gloves working with laboratory equipment.
- Business Management**: A woman standing and presenting to a group of people seated around a table.
- Infocomm & Security**: A woman looking thoughtfully at a computer screen displaying code.

Polytechnic Course Recommender catalogue(2) design

python

NYP COURSE CATALOGUE - TWO

Digital Game Art & Design

Biomedical Engineering

Mass Media Management

Social Work

AI & Data Engineering

Accountancy & Finance

Pharmaceutical Science

Common ICT Programme

Polytechnic Course Recommender catalogue(3) design

python

N Y P C O U R S E C A T A L O G U E - T H R E E

The collage consists of eight square images arranged in two rows of four. Each image is captioned with the course name below it.

- Oral Health Therapy:** A young girl sitting in a dental chair, looking at a dental model held by a healthcare professional wearing a mask and cap.
- Animation & Visual Effects:** Two individuals working at a desk with multiple computer monitors displaying 3D models and software interfaces.
- Common Business Programme:** A person giving a presentation to a group of students in a classroom setting, with a large screen showing a diagram.
- Cybersecurity & Digital Forensics:** A person in a green hoodie sitting at a desk, looking at a computer screen with various digital forensic tools and data displayed.
- Biologics & Process Technology:** Two individuals in lab coats and safety glasses working with laboratory equipment, including a large beaker on a stand.
- Business Intelligence & Analytics:** A person in a white shirt interacting with a large, futuristic-looking digital interface or projection.
- Aeronautical & Aerospace Technology:** Two individuals working on the exterior of a small aircraft in a workshop.
- Game Development & Technology:** A person wearing a VR headset and holding controllers, sitting in a red chair in a room with colorful, abstract wall art.

Polytechnic Course Recommender catalogue(4) design

python

NYP COURSE CATALOGUE - FOUR



The image shows a digital catalog page for NYP Course Catalogue - FOUR. The page has a dark blue header and footer. The main title "NYP COURSE CATALOGUE - FOUR" is centered at the top. Below the title are eight square images, each representing a different course program. Each image is accompanied by a caption below it.

- 

Banking & Finance
- 

Visual Communication
- 

Nursing
- 

Common Engineering Programme
- 

Business & Financial Technology
- 

Chemical & Pharmaceutical Technology
- 

Nanotechnology & Materials Science
- 

Aerospace Systems & Management

Polytechnic Course Recommender catalogue(5) design

python

NYP COURSE CATALOGUE - FIVE

The image shows a screenshot of a computer window with a dark teal header bar. The title "NYP COURSE CATALOGUE - FIVE" is centered in white capital letters. Below the title are eight square images, each representing a different course category. Each category has a caption below it.

- Sports & Wellness**: A man in a blue t-shirt with "SOUTHERN INSTITUTE SPORTS" on it is working on a piece of equipment in a lab setting.
- Architecture**: A man wearing a VR headset and holding a controller is interacting with a 3D architectural model of a building complex.
- Interaction Design**: Two people are looking at a large screen displaying a "USER EXPERIENCE IDEAL USER JOURNEY" diagram.
- Engineering with Business**: Three people are gathered around a table with a large screen displaying data and graphs, engaged in a discussion.
- Hospitality & Tourism Management**: Two women are interacting with a man in a suit who is holding a suitcase, possibly in a travel agency or airport setting.
- Infocomm & Media Engineering**: Two people are looking at a large screen displaying a futuristic interface with various data points and graphics.
- Electronic & Computer Engineering**: A person is interacting with a robotic arm using a tablet, demonstrating a control interface.
- Advanced & Digital Manufacturing**: A person is interacting with a large-scale industrial assembly line or simulation, pointing towards the components.

Polytechnic Course Recommender catalogue(6) design

python

N Y P C O U R S E C A T A L O G U E - S I X

Sports & Wellness

Architecture

Interaction Design

Robotics & Mechatronics

Hospitality & Tourism Management

Infocomm & Media Engineering

Electronic & Computer Engineering

Advanced & Digital Manufacturing

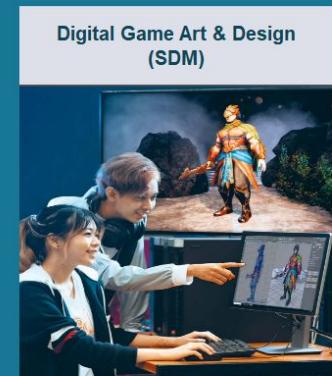
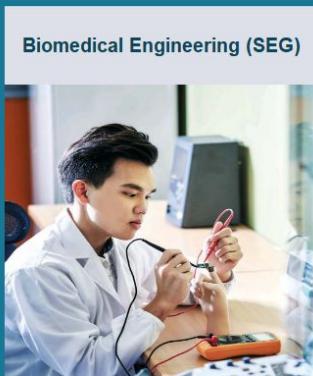
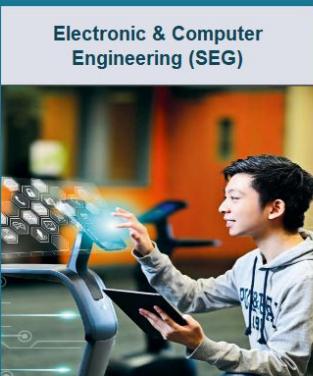
Polytechnic Course Recommendation pane

NYP Course Recommender App

Your Recommendations

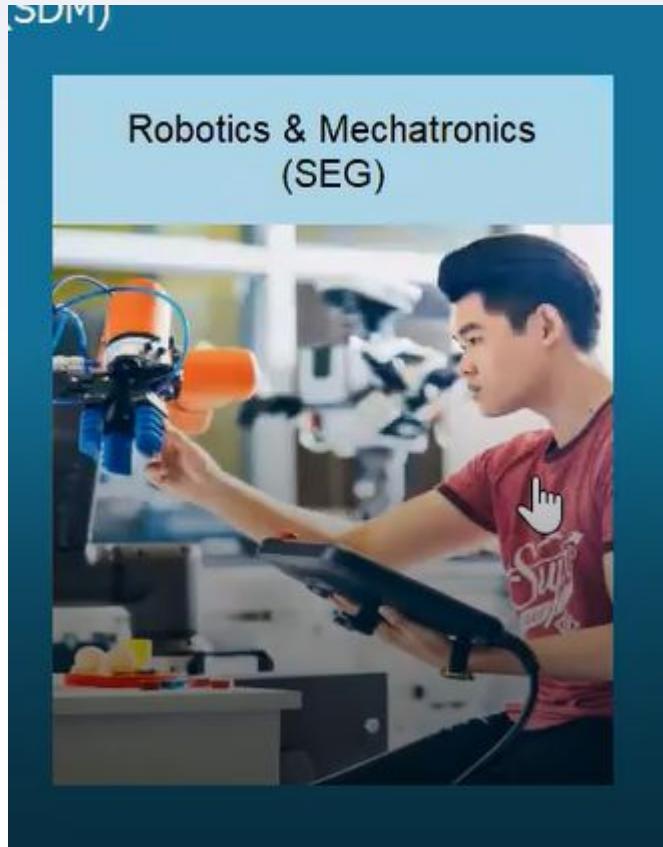
You've chosen: [AI Data Engineering \(SEG\)](#)

(Click to Find Out More!)



Quit

Polytechnic Course Recommendation pane



Polytechnic Course Recommendation pane

A screenshot of a web browser window titled "SIT Course Booklet.pdf". The address bar shows the URL: <https://www.nyp.edu.sg/content/dam/nyp/about-nyp/nyp-overview/media-room/public...>. The page content is a dark blue banner for the 2022 School of Information Technology. The banner features the text "2022 SCHOOL OF INFORMATION TECHNOLOGY #becausewecan" in white. Below the banner, the Nanyang Polytechnic logo is visible, consisting of the letters "NYP" in a stylized font followed by "NANYANG THE INNOVATIVE POLYTECHNIC". To the right of the logo, the text "Lead the change" is displayed in large, bold, white letters, followed by a smaller paragraph of text.

2022

SCHOOL OF
INFORMATION
TECHNOLOGY

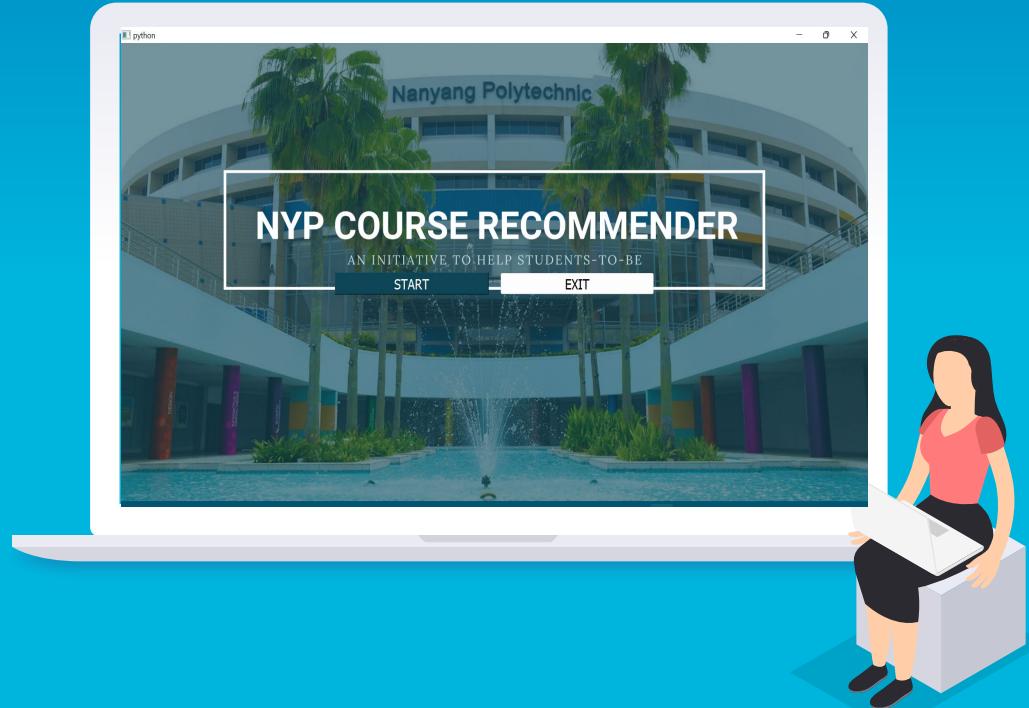
#becausewecan

NYP NANYANG
THE INNOVATIVE POLYTECHNIC

Lead
the change

together. We will prepare you to contribute to our nation's digital transformation. Working closely with the industry, we offer an engaging learning environment and curricula so that you cultivate an innovative and enterprising mindset to face the challenges of today's IT industry.

DEMO



Polytechnic Course Recommender App demo

Gender : Male | Course that received the most amount of gaze : Cybersecurity & Digital Forensics



Polytechnic Course Recommender App demo

Gender : Male | Course that received the most amount of gaze : AI & Data Engineering



Polytechnic Course Recommender App demo

Gender : Female | Course that received the most amount of gaze : Banking & Finance



Polytechnic Course Recommender App demo

Gender : Female | Course that received the most amount of gaze : Applied Chemistry



Problems Encountered (Tricia)



Challenging to evaluate which of the many model best fits our user scenario



Problems Encountered (Jovester)



**Having trouble getting a model that
satisfies my expectations for a
recommended food output**

Summary

01

Collaborative filtering with **cosine similarity**
works better on the food dataset

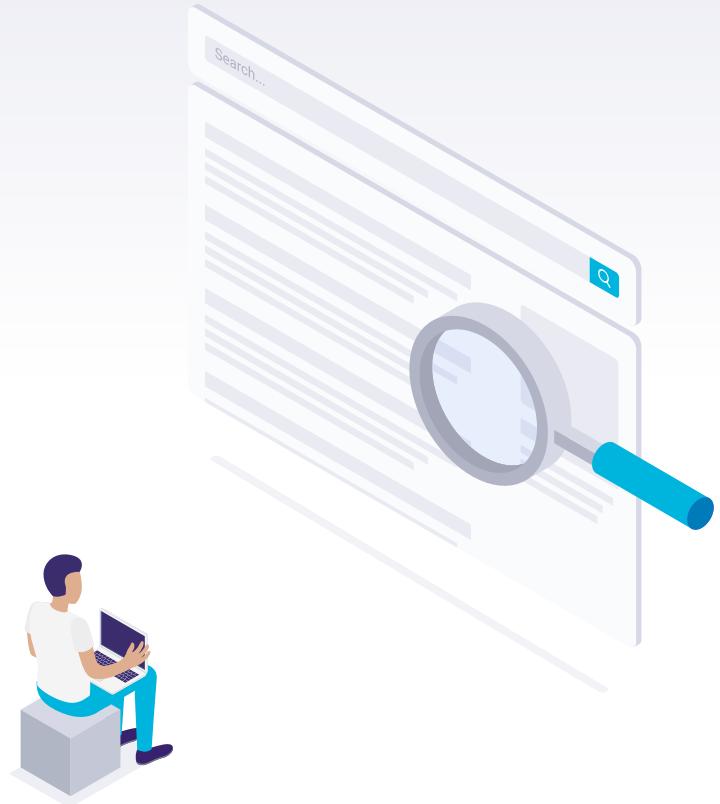
02

Collaborative filtering with **Manhattan distance**
similarity performs better on NYP course
dataset

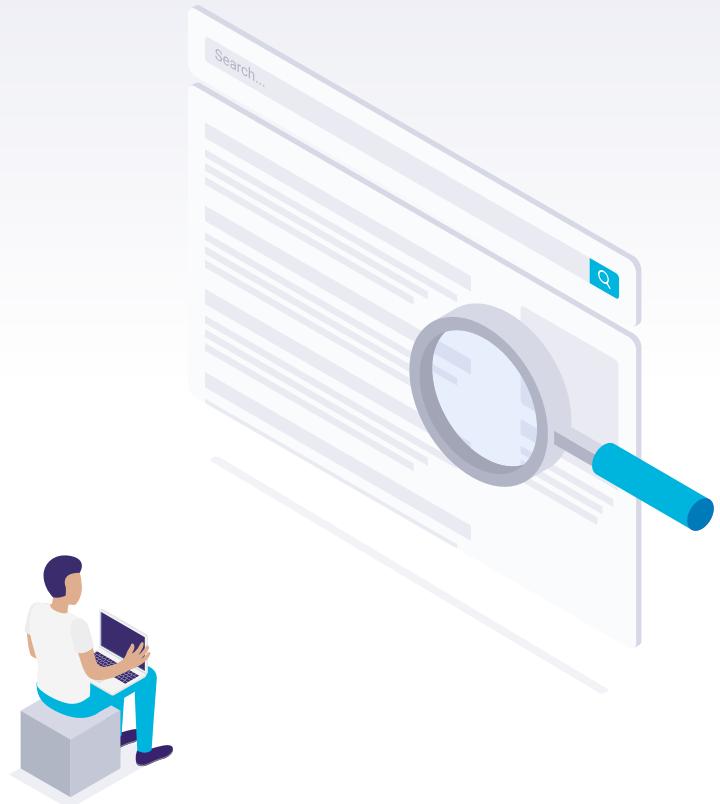
03

PyQt is **better than** Tkinter as it comes with many
powerful and advanced widgets.

THANK YOU!



Live DEMO



Any questions?

