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Date: 8-Dec-2023

School Of Information Technology

Foundation of AI Assignment

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Problem Definitions (Computer Vision)

Industry:

Food & Beverage

Problem Statement:

Detecting Food Spoilage at supermarkets stores.

Summary of the industry

NTUC FairPrice is the largest supermarkets chain across Singapore. It has over 100 supermarkets around Singapore. Daily, NTUC staff must restock the huge inventory around the supermarkets.

Some supermarkets are as big as 90,000 sq fts i.e. FairPrice Xtra@Vivocity.

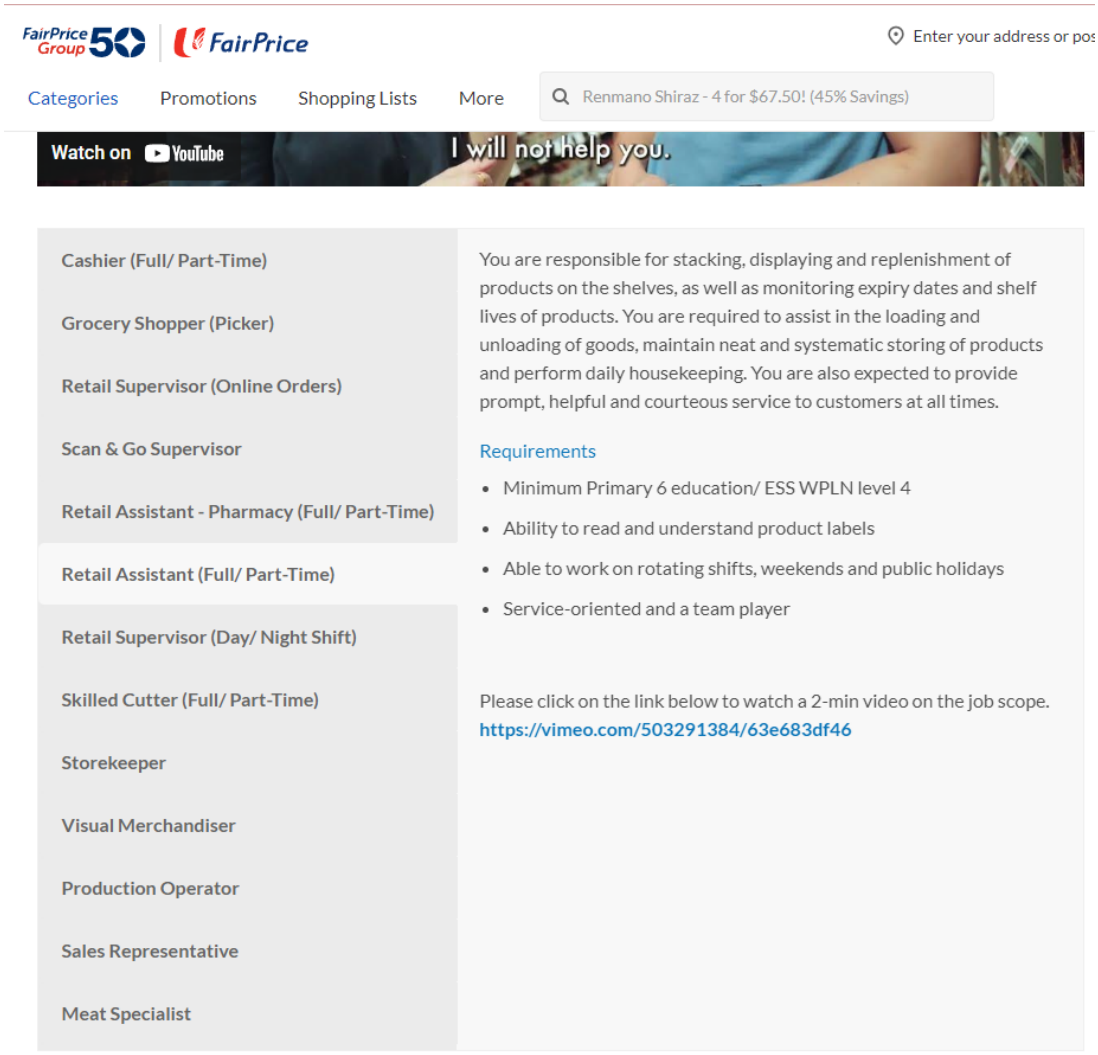


Image Credits: FairPrice(n.d.). Retail Assistant(Full/Part-Time). Retrieved 2023, December 4. From the FairPrice Website: https://www.fairprice.com.sg/careers/content/store/

As shown above, NTUC Staffs have many responsibilities, a subset stocking fruits and checking the quality of the fruits and vegetables.

Credits: ElizBear. (2019, August 29). FairPrice Xtra at Vivocity. Retrieved on December 4, 2023. From the ElizBear Website: https://elizbeartravel.com/2019/08/25/fairprice-xtra-at-vivocity/

As fruits and vegetables are highly perishable and the quality is quickly diminishing each day.

As shown by the images of many fruits above, it is laborious and time consuming, for a staff to check the quality of every fruit and vegetable cart.

The retail assistant when handling the fruits and vegetables would normally do the following:

1. Quick scan and sample of fruits and vegetable quality
2. Do it in a manner which doesn't obstruct customers.

The longer a staff checks at the same fruit aisle, it prevents customers from getting their groceries. Hence it must be done swiftly.

As NTUC Staff may make mistakes, it is up to the customers due diligence to check the quality of the fruits and vegetables.

Here are some possible issues.

Potential problem 1:

Rotten Lemon @ FairPrice

Image source: Taken by me, Ang Mo Kio FairPrice Xtra Fruits aisle taken on 4th December 2023.

Like the images above, primary research at FairPrice has provided me plenty of evidence of rotting fruits at the aisle.

During customer shopping at NTUC FairPrice, When the customer sees the rotting fruits on the fruit aisle. A bad impression is given that FairPrice has no quality control and poor staff training.

rotting apple @ FairPrice

Image source: taken by me Ang Mo Kio FairPrice Xtra Fruits aisle taken on 4th December 2023.

Bad impressions are lasting, these rotten fruits could be shared online which could damage the branding of NTUC fruits and vegetables quality. Customers are then more willing to choose other brands e.g. cold storage, Sheng Shiong. In turn NTUC will lose market share, Branding, and revenue due to simple oversights.

Potential Problem 2

Because there is simply too many fruits and vegetables to inspect the quality, usually staff may not sample all the vegetables in time, thus leading to the spoilage. This contributes to food wastage.

In 2019, A report by Today news have state that each household have thrown about 258$ worth of food yearly. Totalling up to 342$ million dollars of food waste.

Year	Food Waste Disposed of ('000 tonnes)	Food Waste Recycled ('000 tonnes)	Total Food Waste Generated ('000 tonnes)	Recycling Rate (%)
2022	667	146	813	18%
2021	663	154	817	19%
2020	539	126	665	19%
2019	607	136	744	18%
2018	637	126	763	17%

Image Credits: NEA. (n.d.). Food Waste Management. Retrieved 2023, November 16. From the National Environment Agency Website: https://www.nea.gov.sg/our-services/waste-management/3r-programmes-and-resources/food-waste-management

According to a study by McGill university, Prof Schwarez. Rotting apples emits ethylene gas which accelerates the process of fresh apples to rot.

If rotting fruits are not removed quickly, FairPrice will suffer loss of revenue & food wastage from fruits and vegetables.

Article Source: Schwarez.J. (2021, October 21) Rotten Apple really does spoil Barrel. Retrieved 2023 November 23. From the McGill University Website: https://www.mcgill.ca/oss/article/general-science/rotten-apple-really-does-spoil-barrel

Solution Formulation

Why should we use Artificial Intelligence to solve Food Spoilage? (593 words)

As mentioned earlier, it is labour and time intensive to do so. Of the 8000 Staff employed by FairPrice about 40% of them are above 50 years of age and 5% are of the age of 60 and above. By 2030 the number of these staffs will be in their 60s. The staff may not have the energy and thoroughness to check each fruit one by one to see if they are rotten, they will do it swiftly and move on to the next basket.

Next, food spoilage has common tell-tale signs, from odour & changes in the colour.

Since most of the fruits and vegetables degrade similarly, it can be automated with artificial intelligence.

Therefore, we do not need to subject staff to do manual labour of sorting fruits.

How will the solution be formulated?

We will formulate the solution by using Computer Vision.

It can be embedded into their phones and or scanners used at NTUC. Therefore, the hardware investment needed is limited. As NTUC FairPrice have many branches around Singapore, it is economical to reuse and upgrade existing infrastructure.

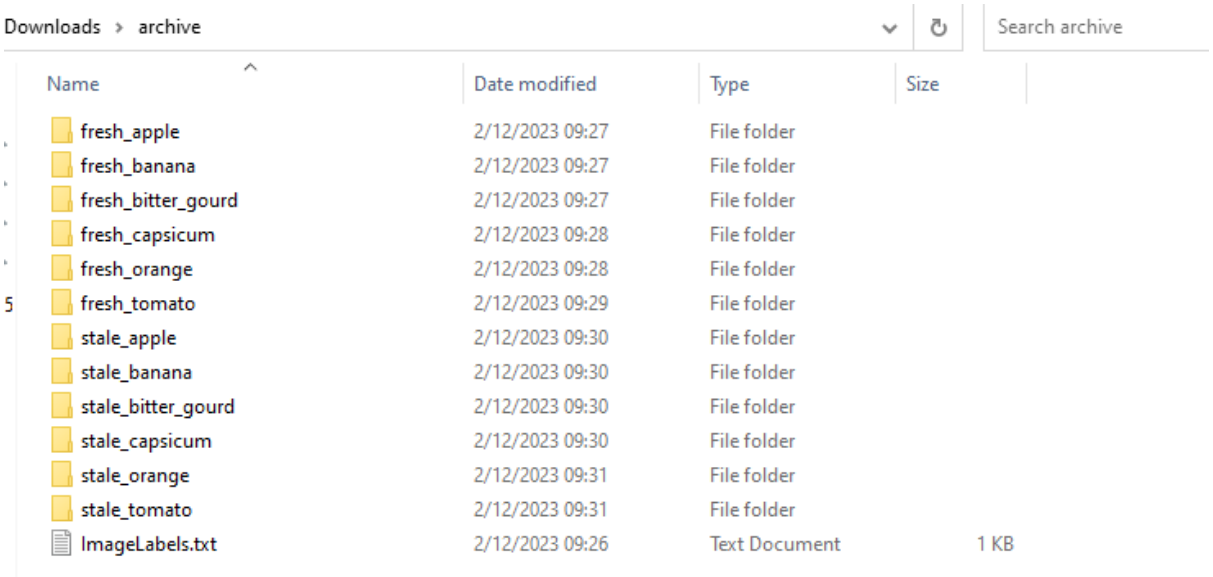
We can also apply the computer visions at weighing scales to help customers to verify that the fruits they are buying are indeed fresh and not rotting soon. This gives customers confidence in their supermarket brand and their own ability to discern the quality of their purchases.

Section A) State the Data used and why?

I will be using a dataset of fresh and rotten fruits and vegetables images.

Based on the dataset I have gathered:

Dataset Credits:
Raghav.R.P., Adithya.S., Rahul.S., & Naren.K. (2019). Fresh and Stale Images of Fruits and Vegetables. Retrieved 2023 November 28. From the Kaggle Website.
https://www.kaggle.com/datasets/raghavrpotdar/fresh-and-stale-images-of-fruits-and-vegetables



It contains Images of 6 Fruits and Vegetables:

1. Apple
2. Banana
3. Bitter Gourd
4. Capsicum
5. Orange
6. Tomato

It is grouped together into two categories:

1. Fresh
2. Stale

I chose this dataset as it offers at minimum 300 images to 1600 images of each fruit and vegetables. Lastly, these 6 fruits and Vegetables are commonly bought in supermarkets around Singapore.

Section B) why Computer Vision or NLP is chosen?

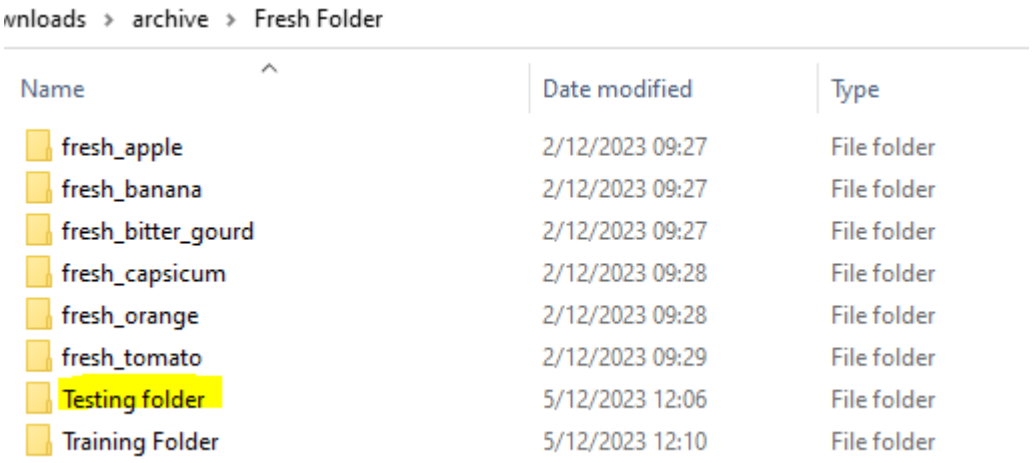
I chose computer vision because it has the least number of impacts on the NTUC staff working at FairPrice. As most of the staff are aging and fearful of complicated technologies. I intend to apply computer vision as seamlessly as possible to existing practices and tools.

Section C) Process of developing the AI system.

With the given dataset, I have decided to process the data further. Since we are using Google Teachable, it already does the training, testing and validation of the images.

To ensure accurate testing, I have preprocess the data into two split:

1. Training Data (90% split)
2. Test Data (10% Split)



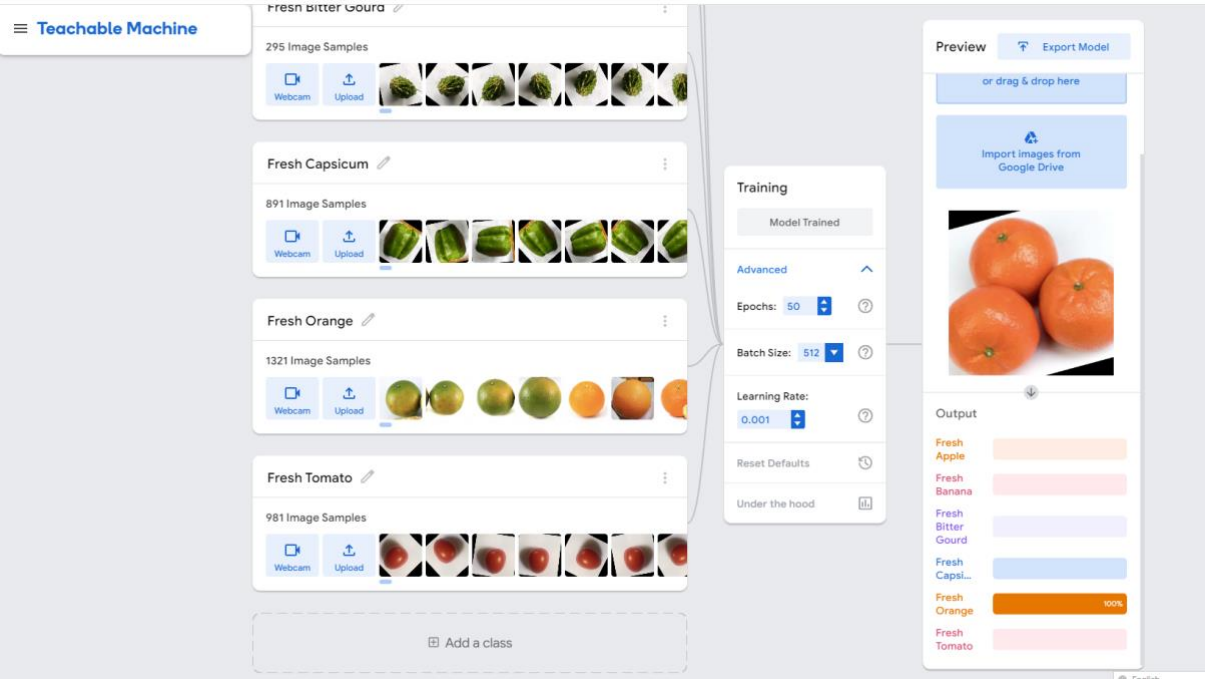
Images showing the test folders.

This ensures that my model is being tested on unknown images and not the training data.

I have also gathered additional fruits and vegetables that aren't part of the dataset to analyse how adaptable this AI is to unknown fruits and vegetables.

Testing if the AI is functional.

Before we test if the AI can detect whether the fruits are spoiled, I have run a test to see if the AI can differentiate between the fruits. This is to verify that teachable machine can handle about 6000 images or so at a given run.



During model training with NYP network, the page will go unresponsive. Workaround by clicking the wait for page to load until the model begins training.

From this Model I have learnt there too many labels. This will confuse the NTUC staff and make it overly complicated.

Thus, I will simplify the process of the AI to just 2 labels:

- Fresh
- Stale / Rotten

To ensure performance of this AI, it has to hit 90-100% accuracy as food safety is NTUC highest priority.

Section D) How to deploy the AI solution in the current environment to solve the problem.

Here are the following ways I will deploy the AI solution:

- Mobile Application Scanner
- Existing handheld scanners
- Weighing Machines

Image source: Amy(n.d.) Android POS Cash Register Ai Weighing Scales with Label Printer. Retrieved 7th December 2023. From the Made in China Website: https://szmasung.en.made-in-china.com/product/eFgfBAnYCOVW/China-Android-POS-Cash-Register-Ai-Weighing-Scales-with-Label-Printer.html

It can be implemented like the image above, where it scans the banana while weighing it. If it detects the banana is spoilt. The customer will be alerted to choose a alternative.

The purpose of implementing the AI solution into many existing applications is to allow NTUC staffs seamless adoption of AI technologies.

Section E) Other Explanations

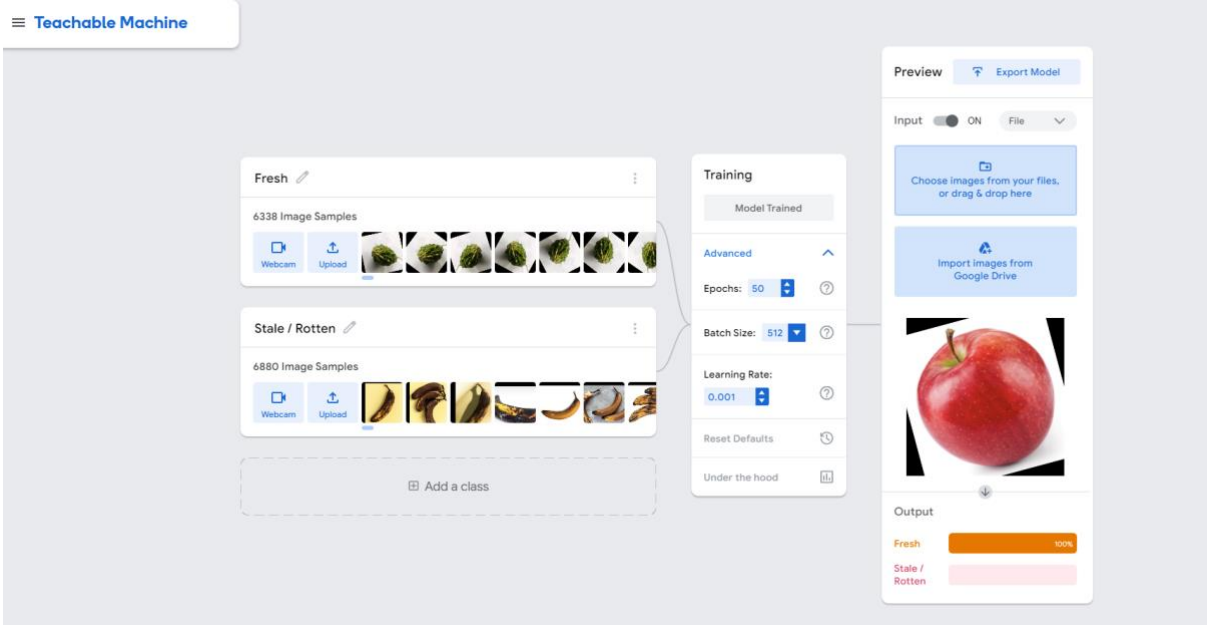
Image source: Starton.D. (2021, Feb 1). Can Robot Shoppers Tell If the Bananas Are Ripe? Retrieved 2023 December 7. From the Entrepreneurship Website: https://www.entrepreneur.com/science-technology/can-robot-shoppers-tell-if-the-bananas-are-ripe/359653

This Computer vision application should receive additional enhancements. This process should be automated. I suggest creating a simple robot which does the following:

- Scans through the baskets of fruits.
- Sort out the fruits which are spoiled.
- Label overripe fruits to be put on discounts.

This would save NTUC time and money in the long run. Moreover, divert the staff to complete other higher priority tasks.

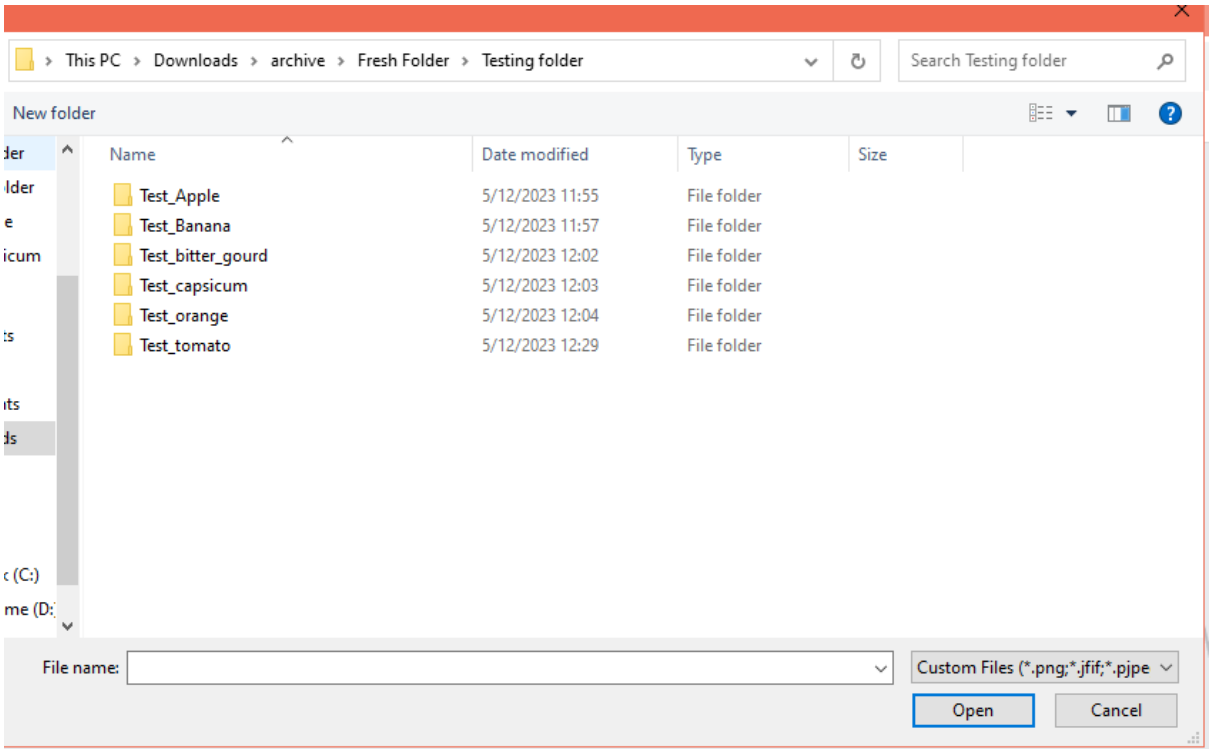
Prototyping Solutions



Teachable Machine when training 13,000 images, 512 batch size and 50 epochs will takes about 15 minutes to prepare and execute.

To access the teachable machine click here:

https://teachablemachine.withgoogle.com/models/OT7S20Ej6/



Above shows the folder I used for testing,

Here are the test case results.

Test Cases:

Test Case 1) Detect Fresh Fruits (images from testing folders dataset)

Tests no.	Type of Fruits	Actual	Predicted	Accuracy
1.	Apple	Fresh	Fresh	100%
2.	Banana	Fresh	Fresh	100%
3.	Bitter Gourd	Fresh	Fresh	100%
4.	Capsicum	Fresh	Fresh	100%
5.	Orange	Fresh	Fresh	100%
6.	Tomato	Fresh	Fresh	100%

Purpose of this test:

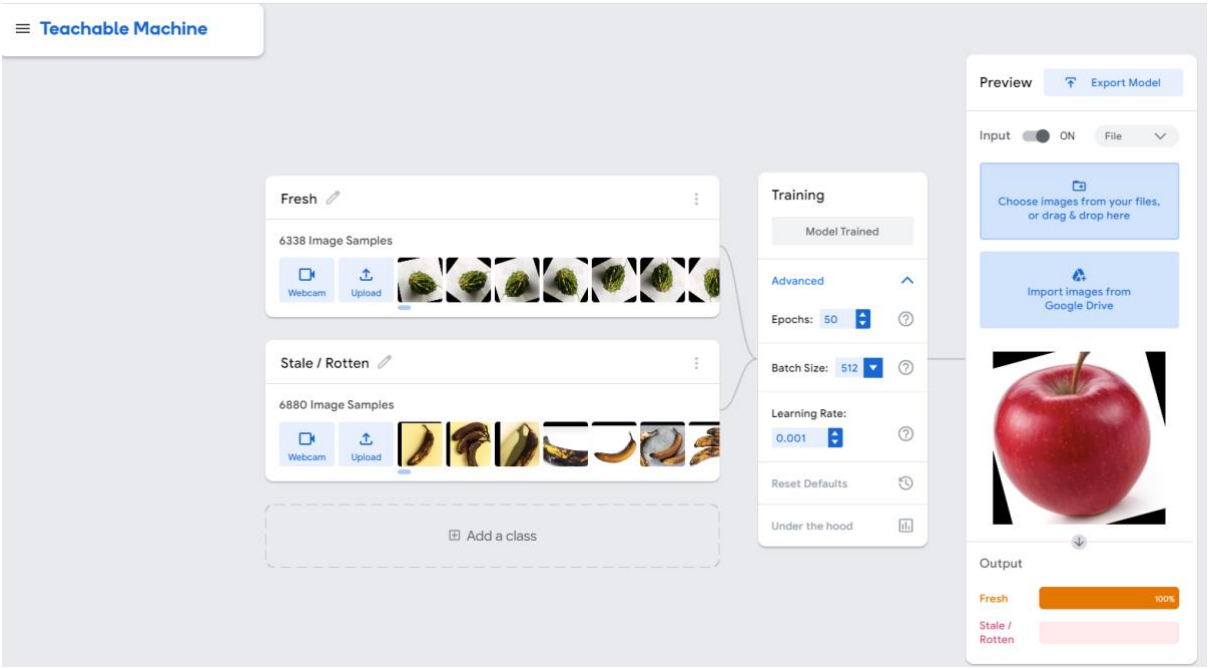
To verify that the fresh fruits can correctly be categorized. This ensures that the NTUC staffs can use the computer visions without error in an automated fashion.

Based on the results, it gave a 100% accuracy for fresh fruits categorization.

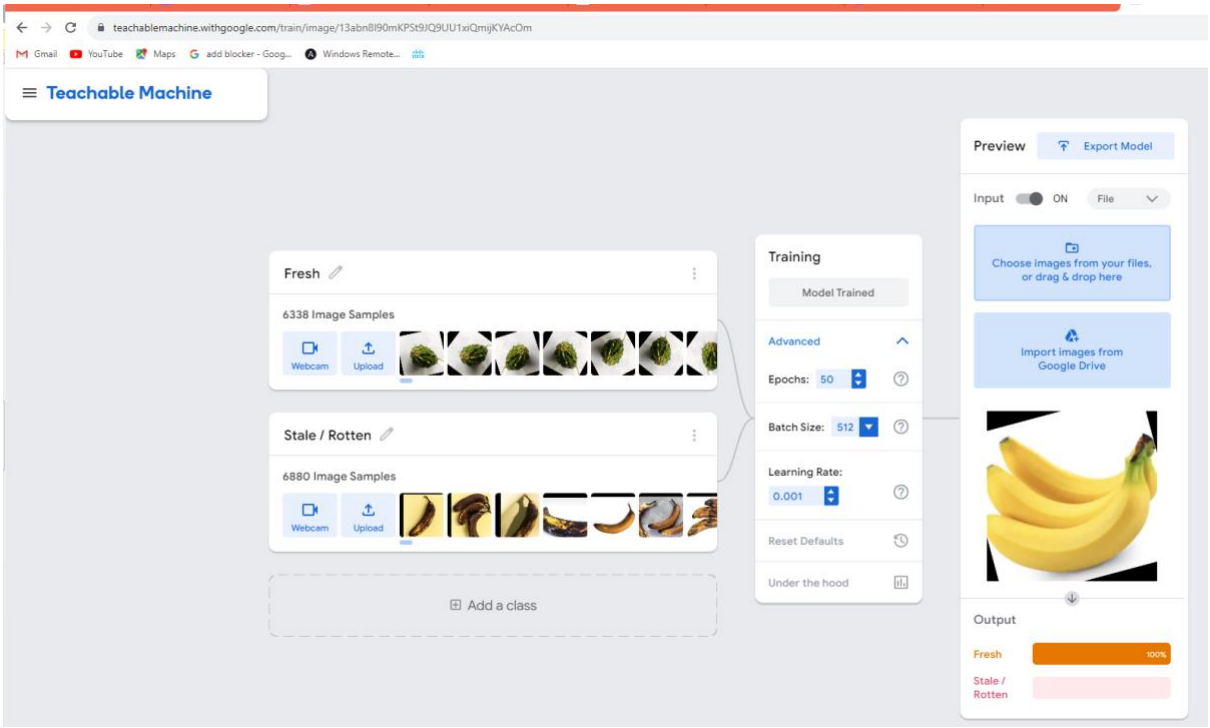
This is good as it shows that feeding the model more data improves the accuracy of the model until it reaches 100% competency.

Test Case 1 Screen Shots

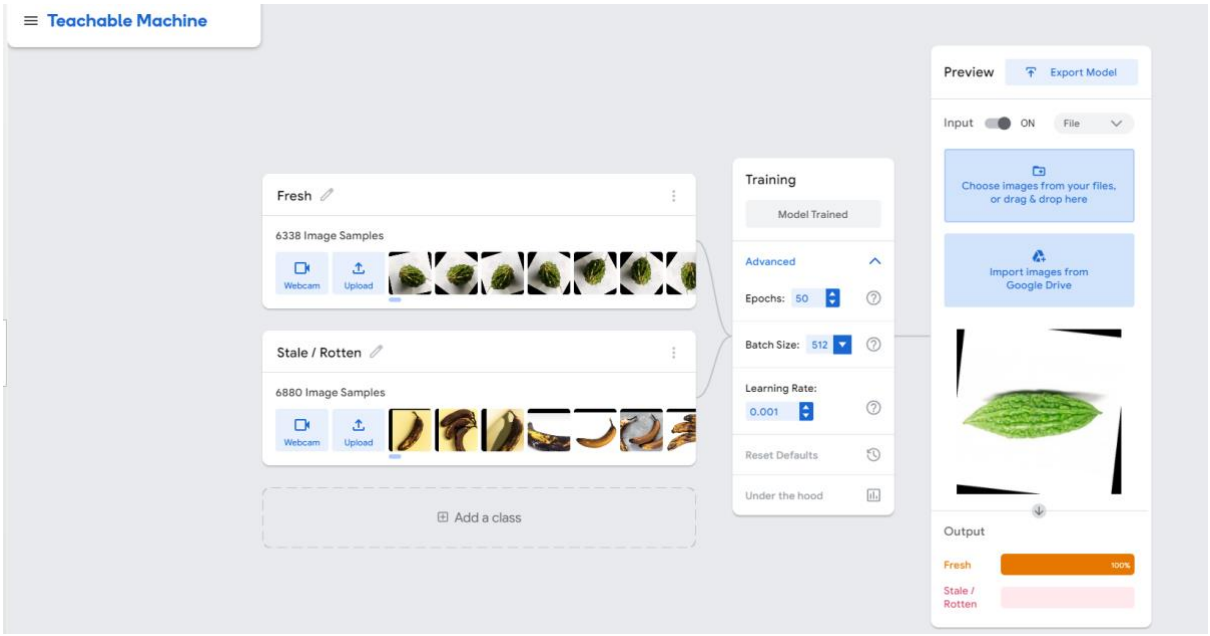
Apple



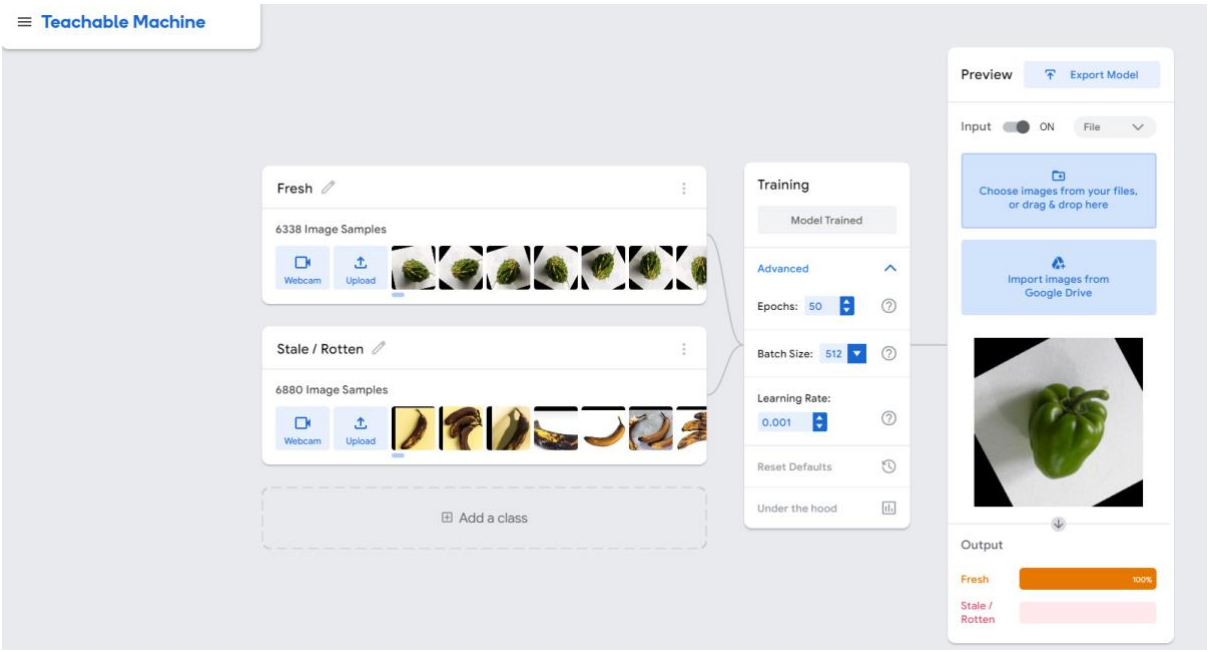
Banana



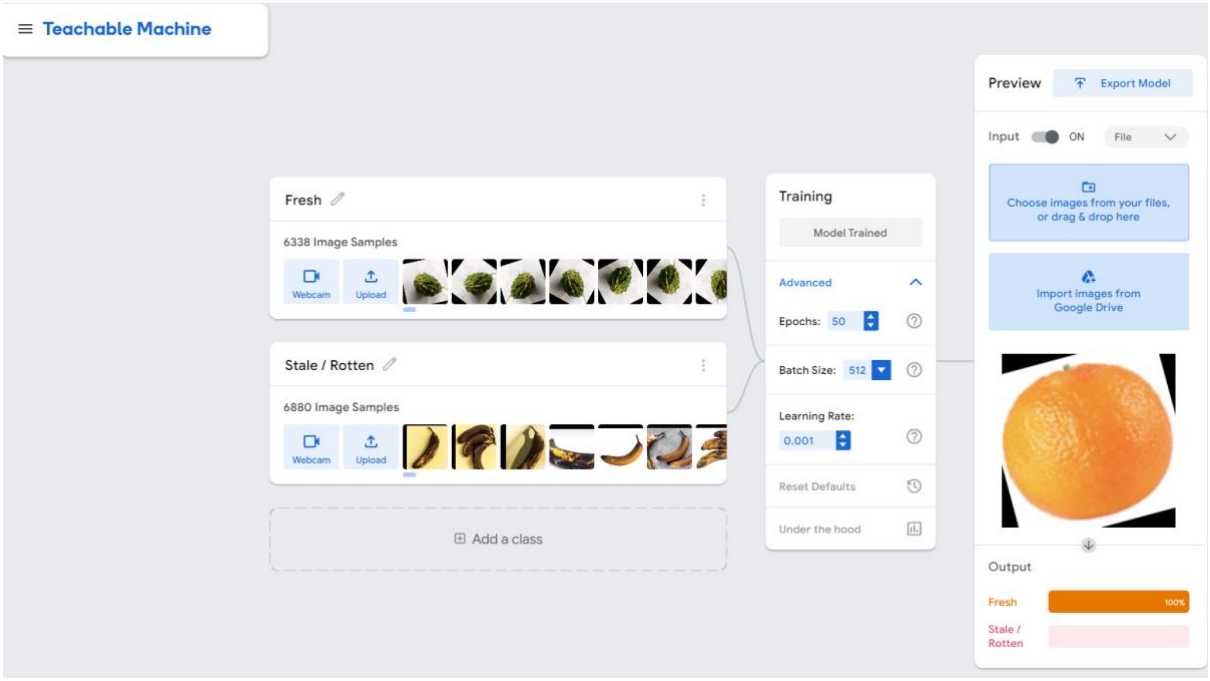
Bitter Gourd



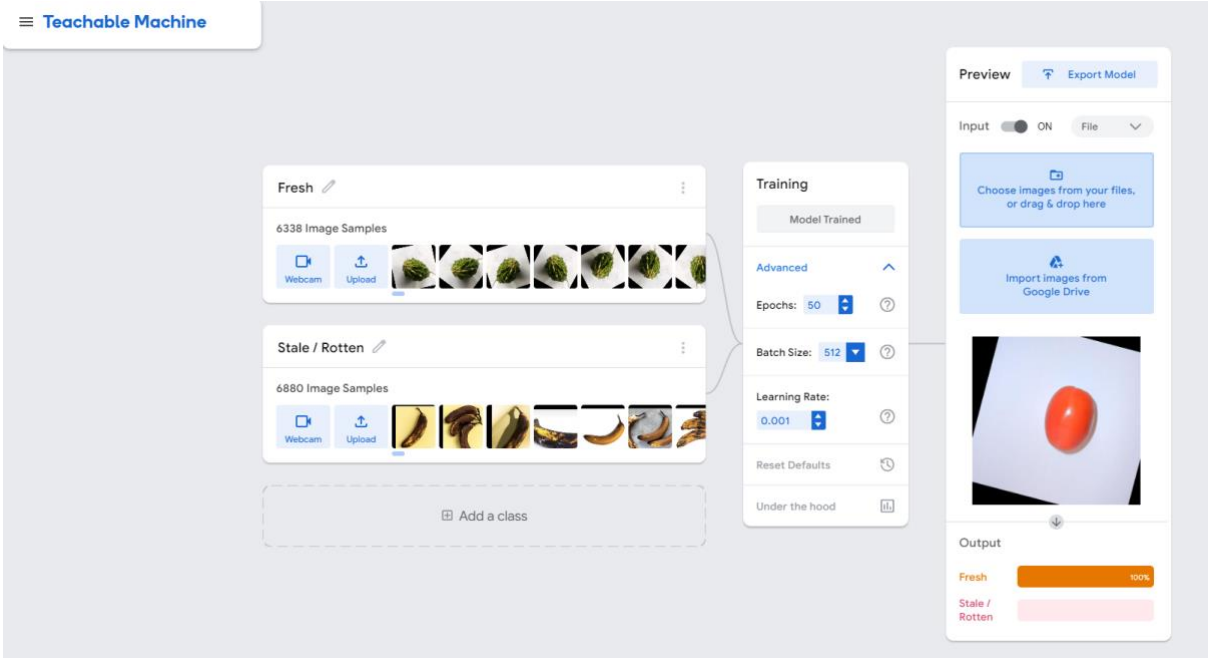
Capsicum



Orange



Tomato


Teachable Machine
Fresh
6338 Image Samples
Webcam
Upload
Stale / Rotten
6880 Image Samples
Webcam
Upload
Add a class
Training
Model Trained
Advanced
Epochs: 50
Batch Size: 512
Learning Rate:
0.001
Reset Defaults
Under the hood
Preview
Export Model
Input
ON
File
Choose images from your files, or drag & drop here
Import images from Google Drive
Output
Fresh
100%
Stale / Rotten

Test Case 2) Detect Rotten Fruit

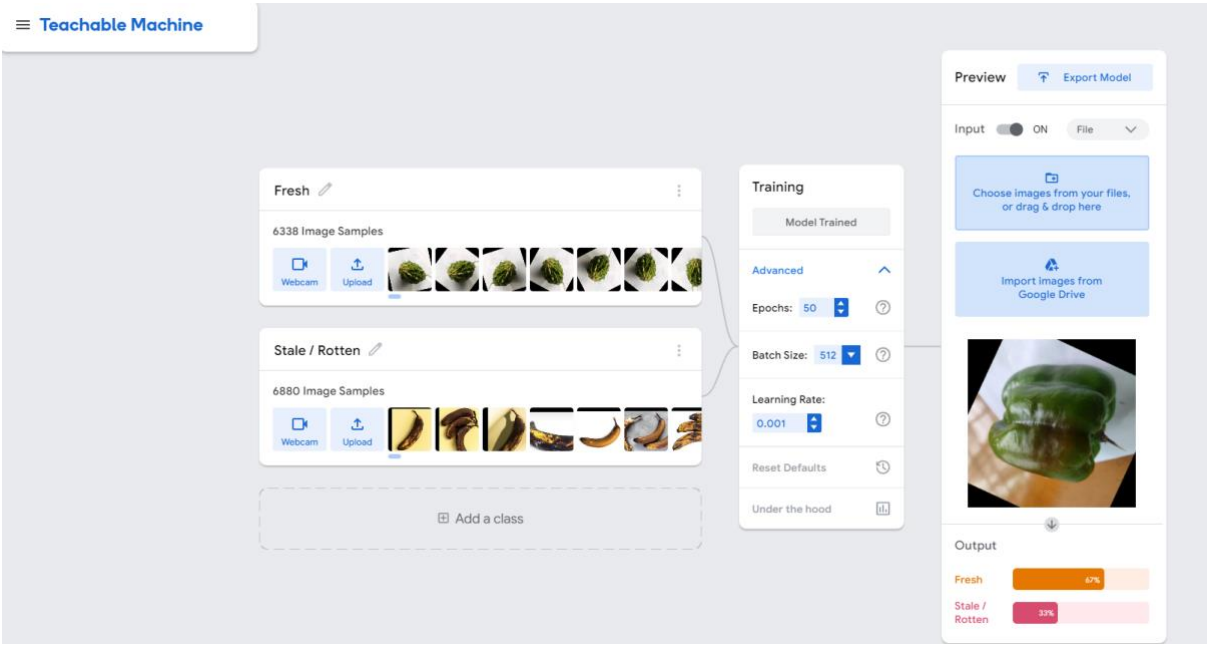
Tests no.	Type of Fruits	Actual	Predicted	Accuracy
1.	Apple	Rotten	Rotten	100%
2.	Banana	Rotten	Rotten	100%
3.	Bitter Gourd	Rotten	Rotten	100%
4.	Capsicum	Rotten	Fresh	0%
5.	Capsicum	Rotten	Fresh	69%
6.	Capsicum	Rotten	Rotten	33%
5.	Orange	Rotten	Rotten	100%
6.	Tomato	Rotten	Rotten	100%

Purpose:
To verify that the rotten fruits can be properly categorized.

Results:
The following fruits can be 100% be categorized as rotten:

1. Apple
2. Orange
3. Bitter gourd
4. Tomato
5. Banana

This is excellent as most fruits is accurately verified to be rotten using the testing data. This will allow NTUC staff to quickly scan through the baskets of fruits to spot for spoiled rotten fruits.



However, capsicum is having difficulties being classified as rotten, as shown by the three tests.

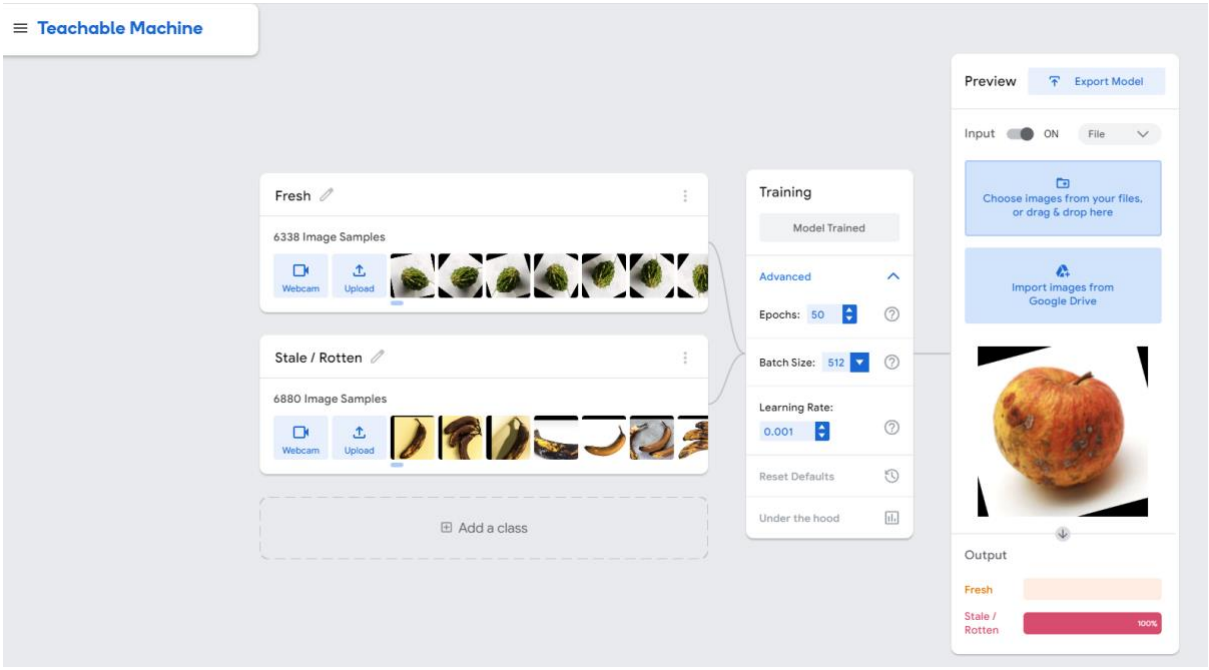
The AI often mistook the stale capsicum as fresh.

Upon manual inspection of the capsicum dataset, I found that it's very difficult to visually differentiate that capsicum is rotten based on colour alone.

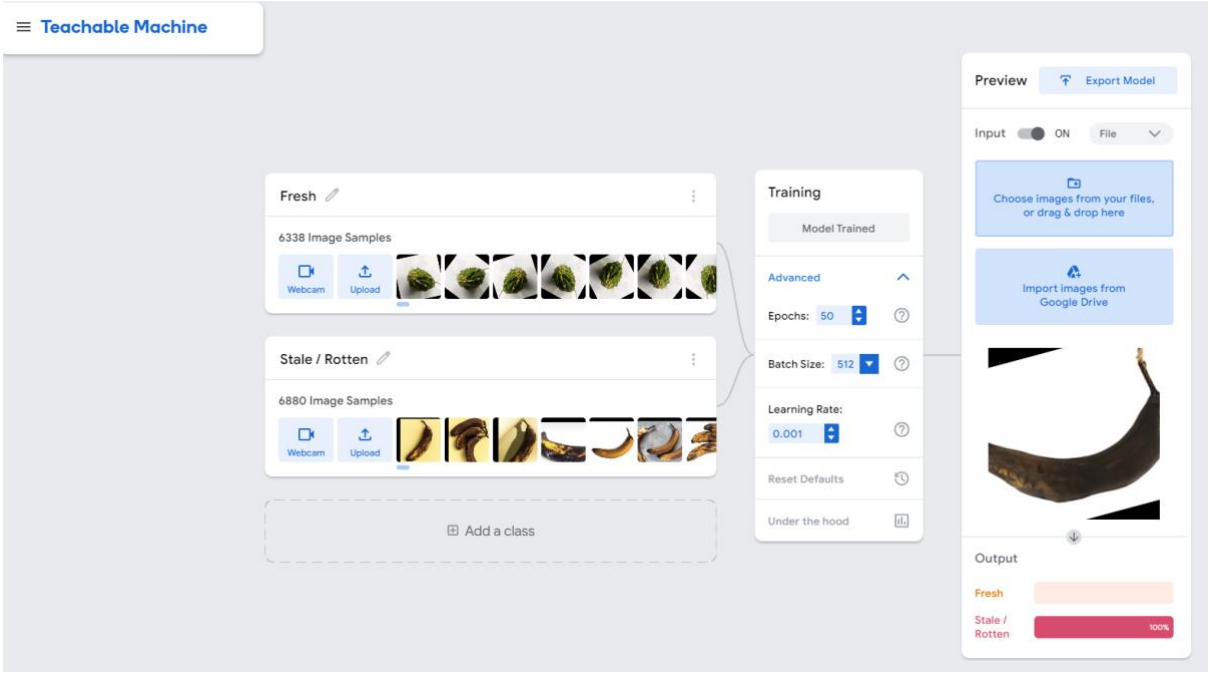
There are potential issues to this, as it's difficult to spot that capsicum is stale, it is possible that it introduces noise into the rotten fruit's detection and the accuracy while fantastic at 100%. It shows that it struggles with subtle signs of rotting. This shows that even with 13000 images, the AI can make mistakes.

Test Case 2 Screen Shots

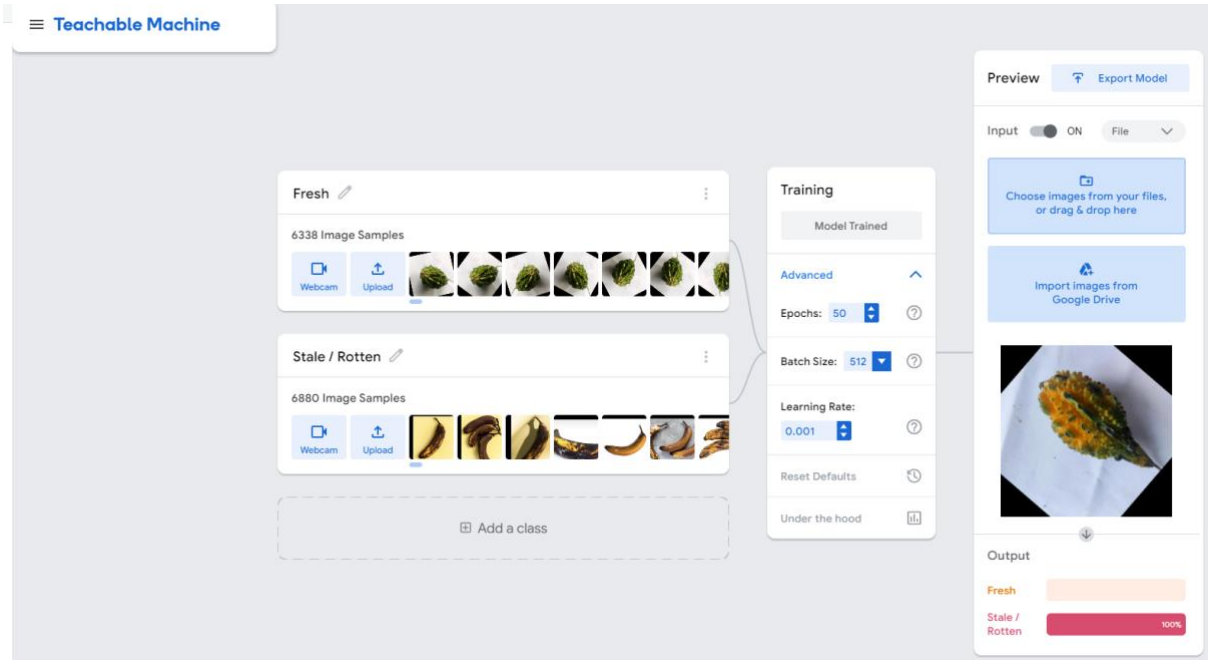
Rotten Apple



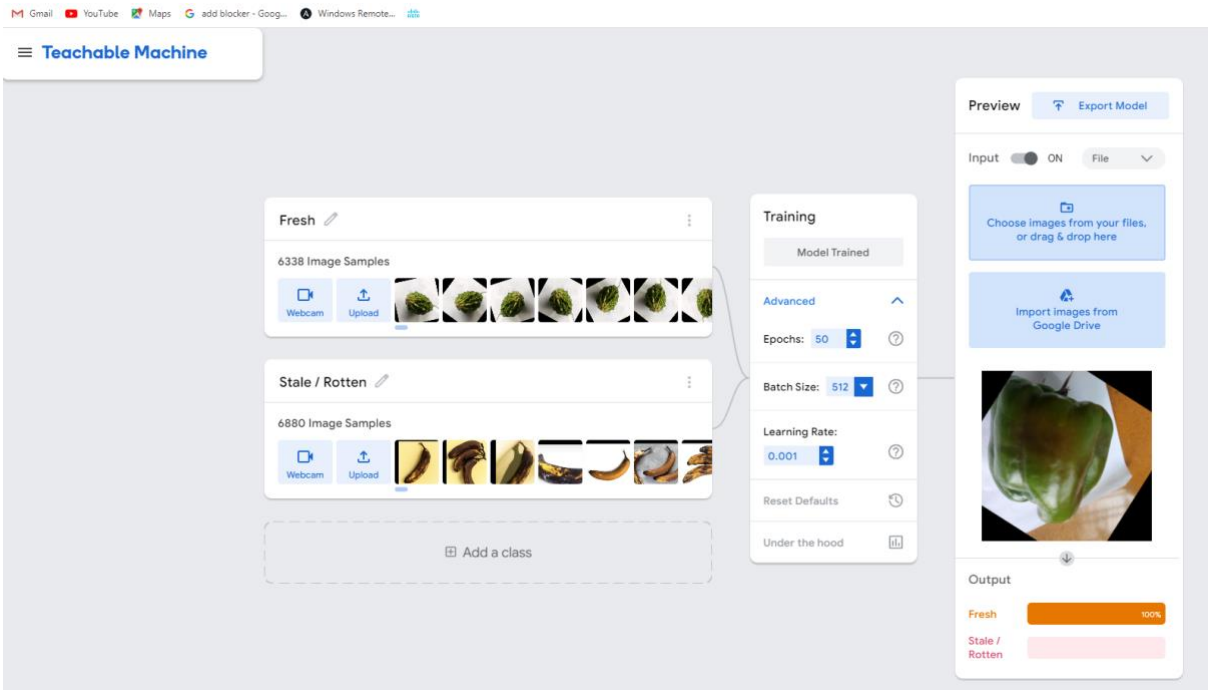
Rotten Banana



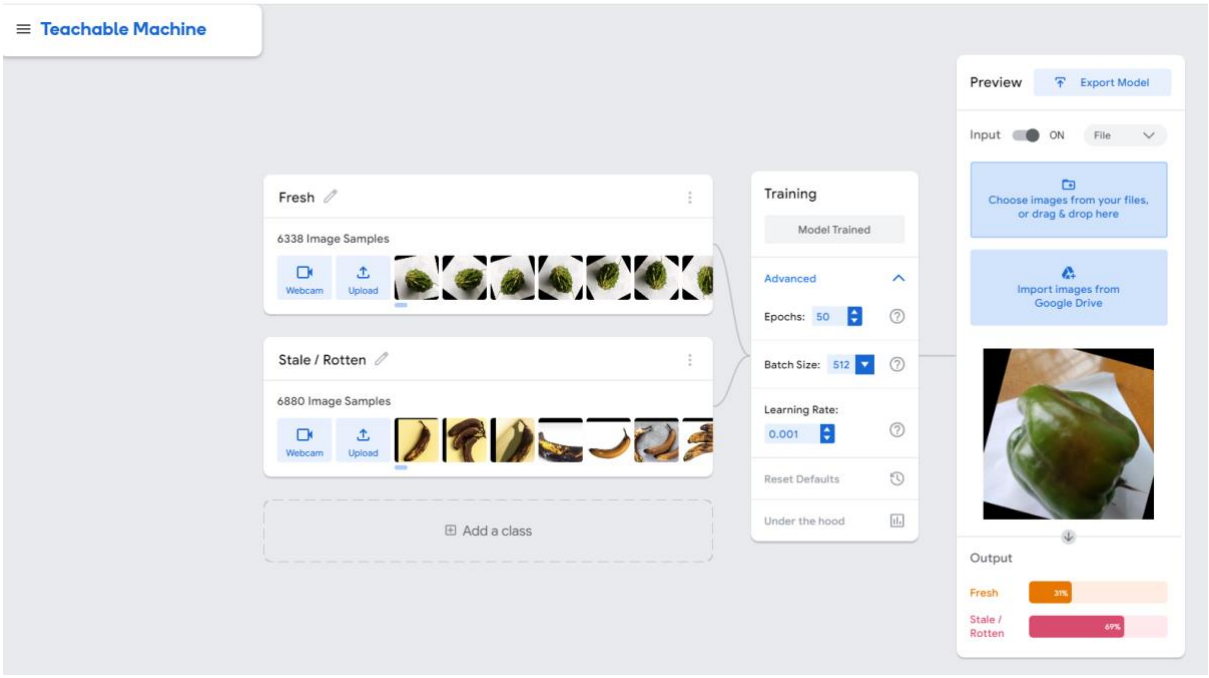
Rotten Bitter Gourd



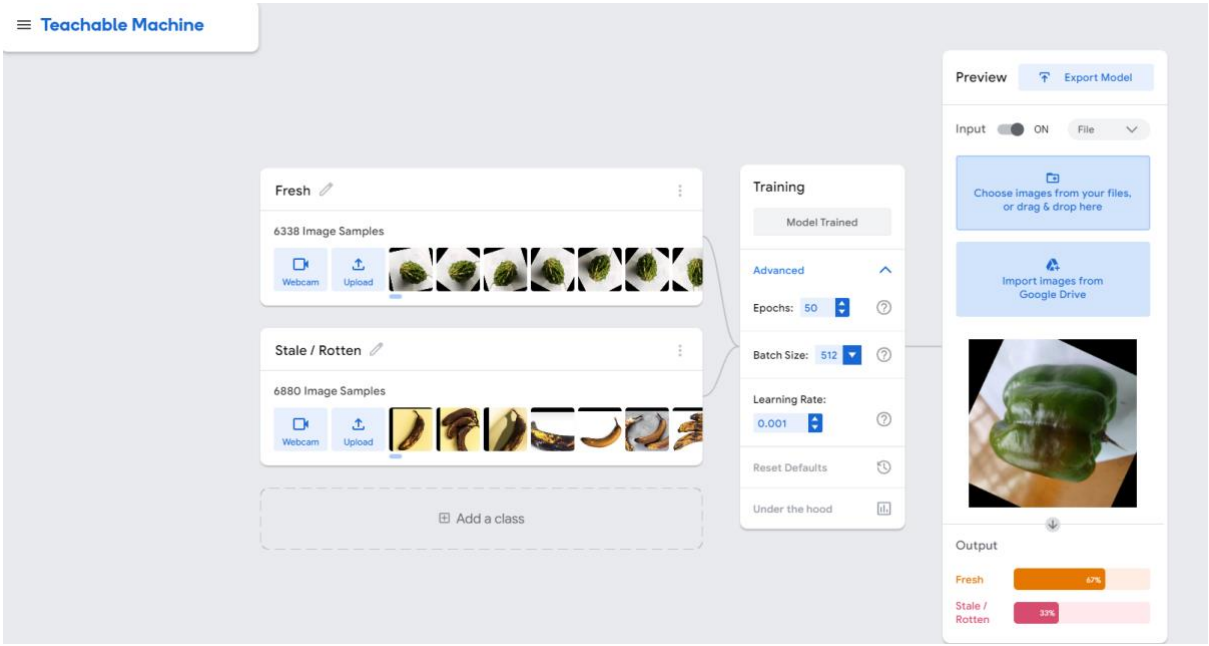
Rotten Capsicum #1



Rotten Capsicum #2



Rotten Capsicum #3



Test Case 3) Detect Mix of Fruits

Tests no.	Type of Fruits	Actual	Predicted	Accuracy
1.	Groups of Spoiled Fruits	Rotten	Rotten	100% (rotten)
2.	Groups of spoiled Tomatoes	Rotten	Fresh	0% (rotten)
3.	Groups of spoiled tomatoes	Rotten	Fresh	11% (rotten)
4.	Groups of Apple	1 Rotten Fruit	Fresh	100% (fresh)
5.	Groups of Apple	Fresh	Fresh	97%

The purpose of this test case:

To verify the accuracy of the model when introduced to unfamiliar groups of fruits. This is common in real life due to the layout of fruits baskets.

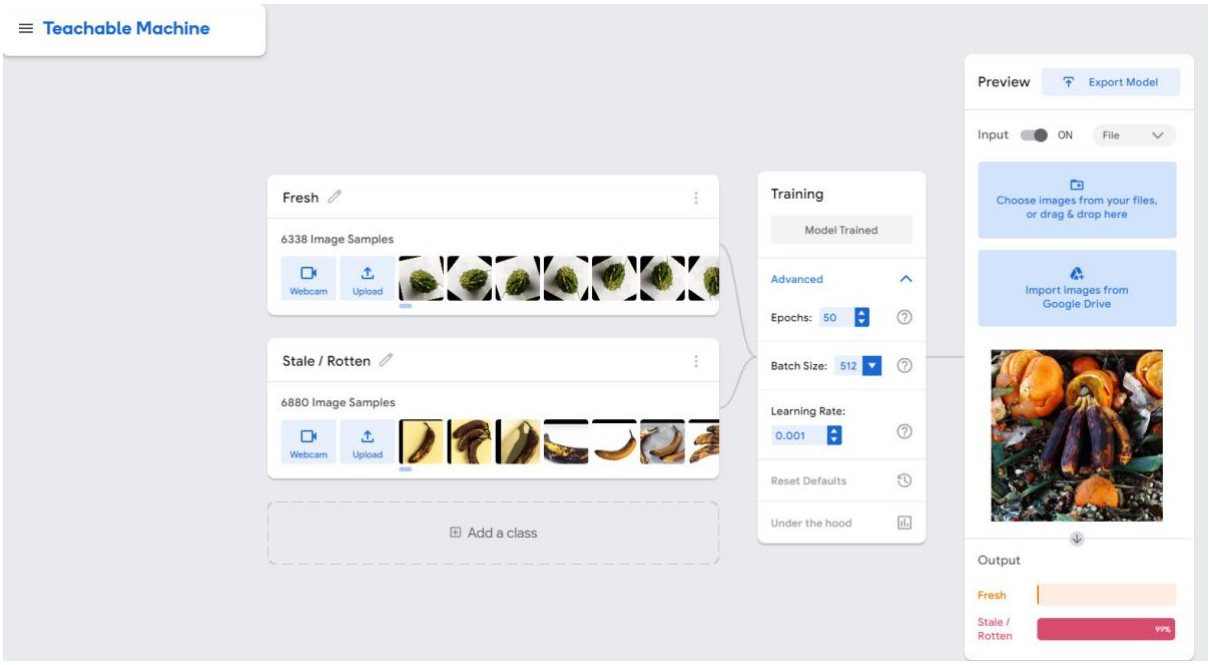
I will conclude that the AI is giving false negatives on the rotten tomatoes.
This is because the tomatoes images do not conform to the dataset of rotten tomato's it's being trained on.

For the green apple test, I will deduce that it failed due to the fact there is an overwhelming number of fresh apples present.

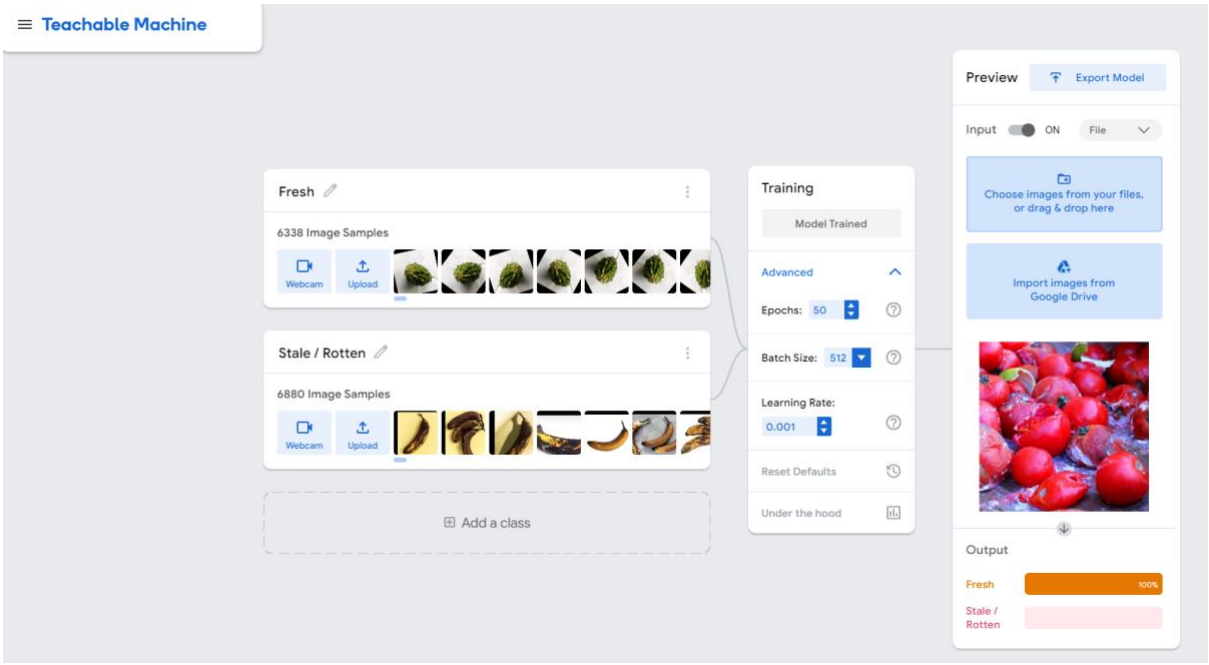
The test case has shown that the AI struggles when given a group of fruits. The accuracy is lower the further away the fruits is from the scanner.

While it could get the fruits correct more than 50% of the time. The poor accuracy suggest that this is one area we must work on to allow NTUC staff to effectively use this.

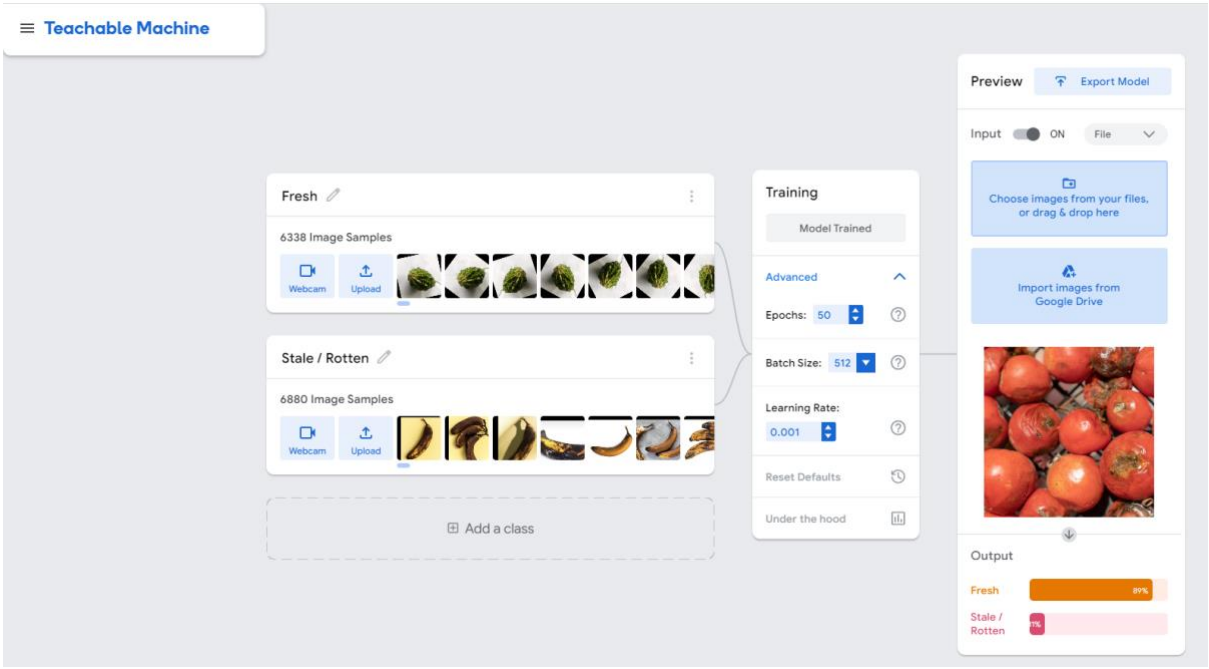
Group of Rotten Fruits



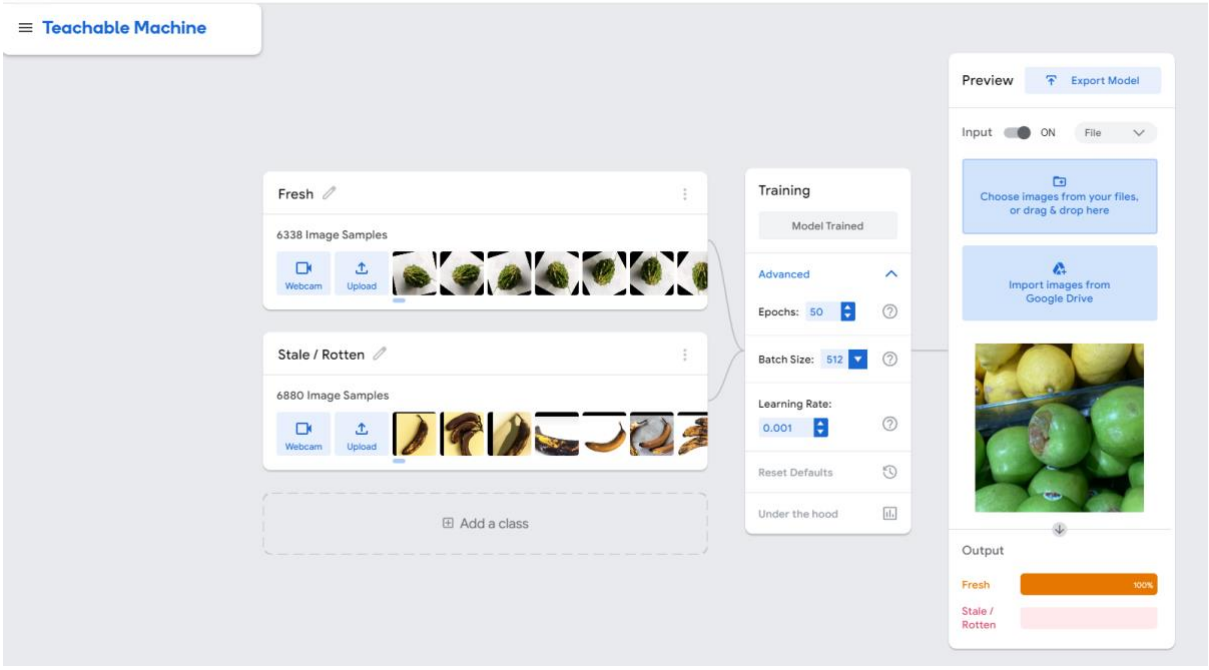
Group of Rotten Tomatoes



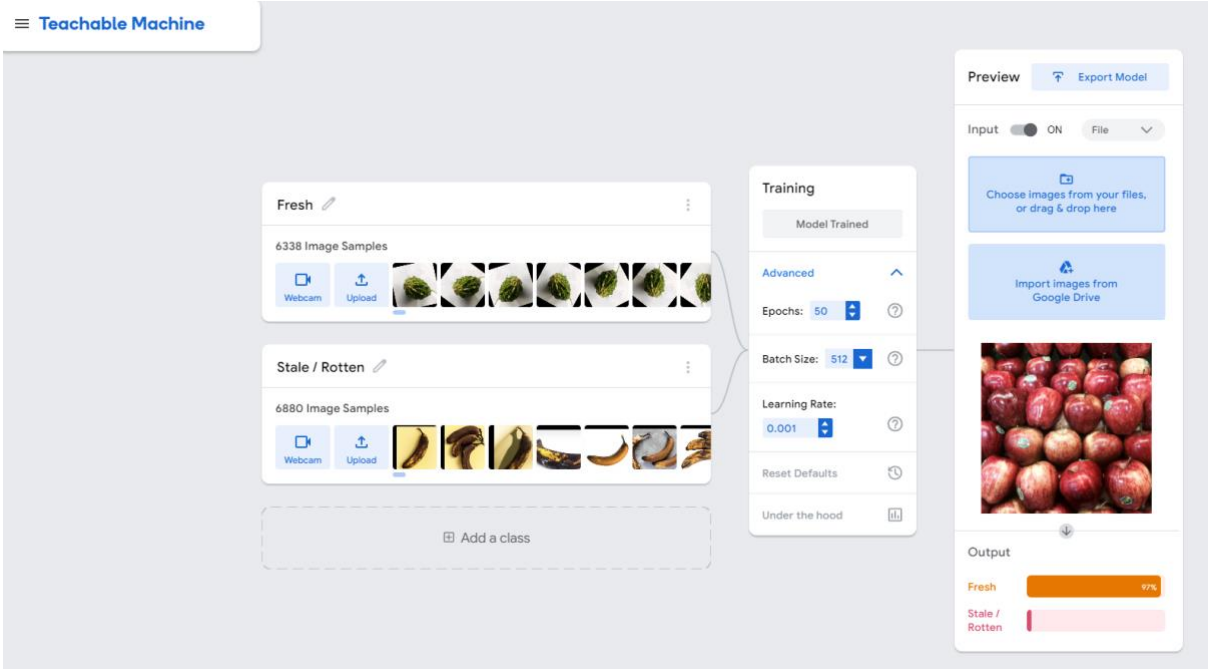
Group of rotten tomatoes #2



Group of mostly fresh apple and one rotten apple



Group of fresh apple



Test Case 4) Detect quality of fruits using webcam

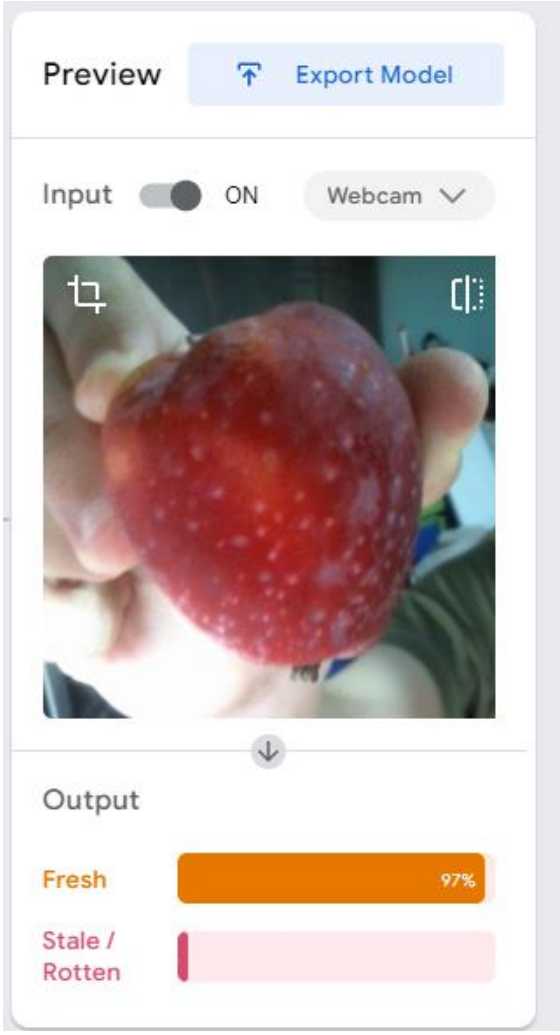
Tests no.	Type of Fruits	Actual	Predicted	Accuracy
1.	Strawberry Apple	Fresh	Fresh	97%

The purpose of this test:

To simulate real world scenario of using cameras such as smart phones to scan the quality of fruits. This is because while training the AI with images from the internet is helpful, we need to subject the model to real world objects to verify that it works. Moreover the computer vision will be used in situations where the fruits quality may not be so clear or the staff phones may not be so good.

I am satisfied that the results shows 97%. This suggest that real world implementation is successful.

Strawberry Apple



Test Case 5)

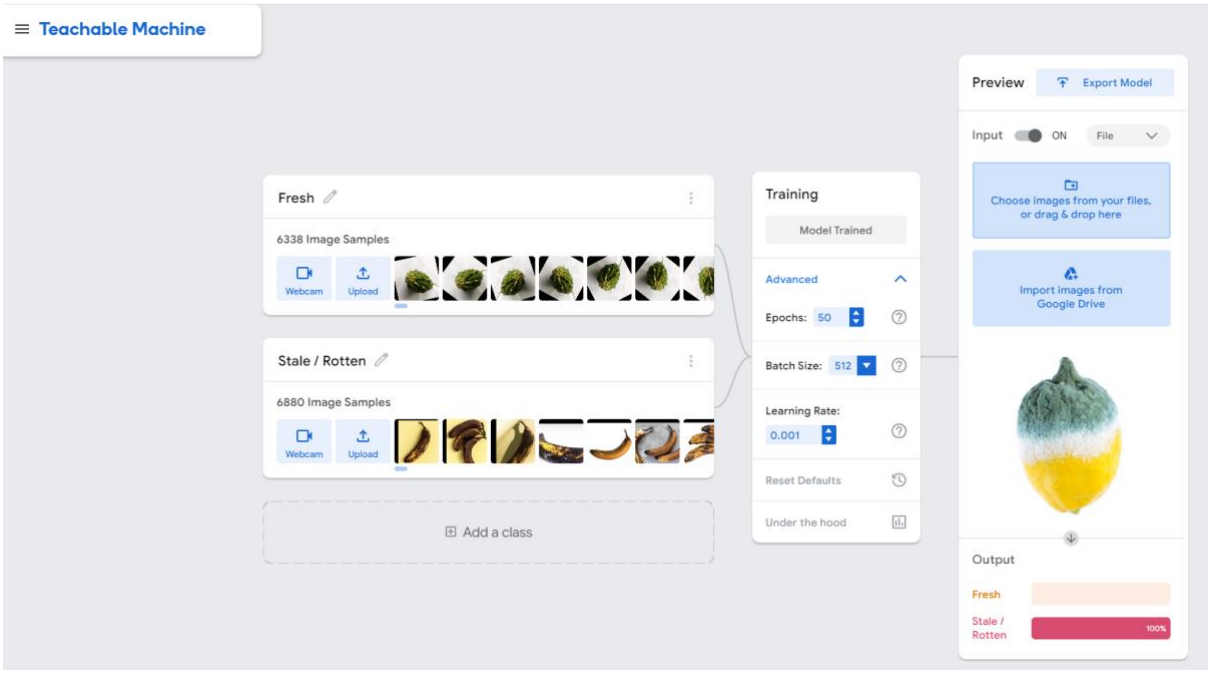
Detect Different Unknown Fruits

Tests no.	Type of Fruits	Actual	Predicted	Accuracy
1.	Rotten Lemon #1	Rotten	Rotten	100%
2.	Rotten lemon #2	Rotten	Rotten	100%
3.	Rotten Mango	Rotten	Rotten	100%
4.	Fresh Persimmon	Fresh	Fresh	100%
5.	Fresh Strawberry	Fresh	Fresh	100%

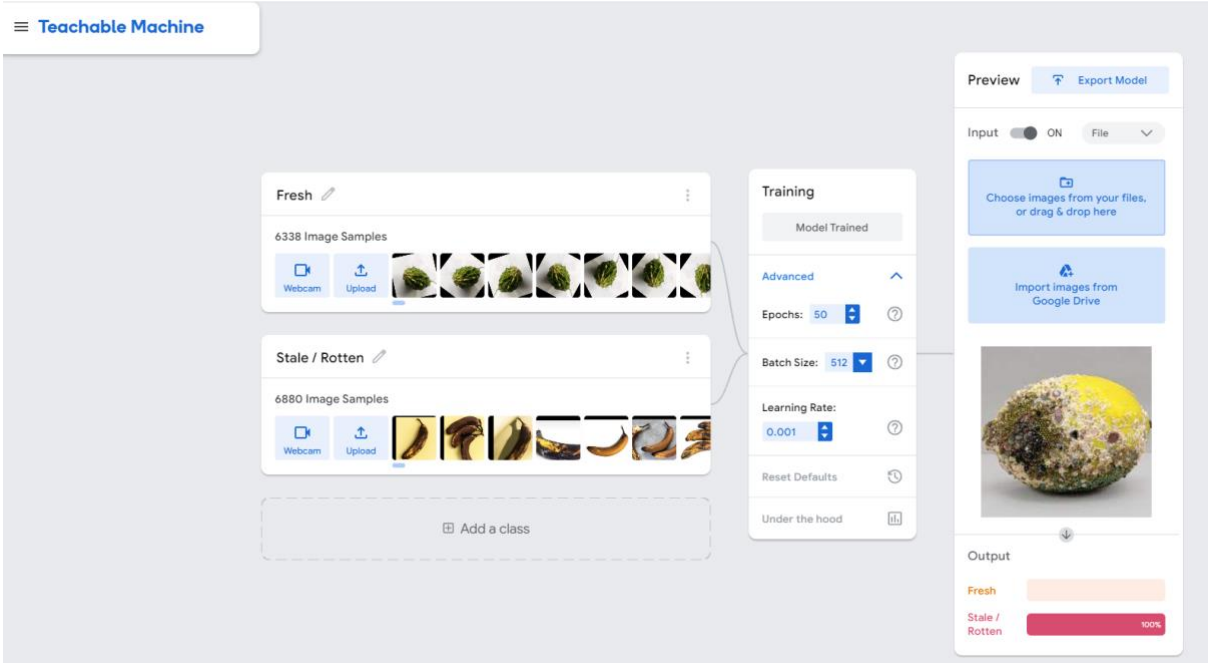
Purpose:
In real world scenarios, we will not test the fruits and vegetables based on known images. It is simply too time consuming. This is the most important test. Having high accuracy of unknown fruits and vegetables suggest that this AI is adaptable to new products.

Therefore, we need to verify that it is capable of testing new and unknown fruits and vegetables.
To my surprise it exceeded my expectations. This is good as NTUC staff do not need to retrain the model whenever a new fruit or vegetable has arrived. They can simply keep using.
This suggest that the cost of the computer vision would decrease as adoptions scales up.

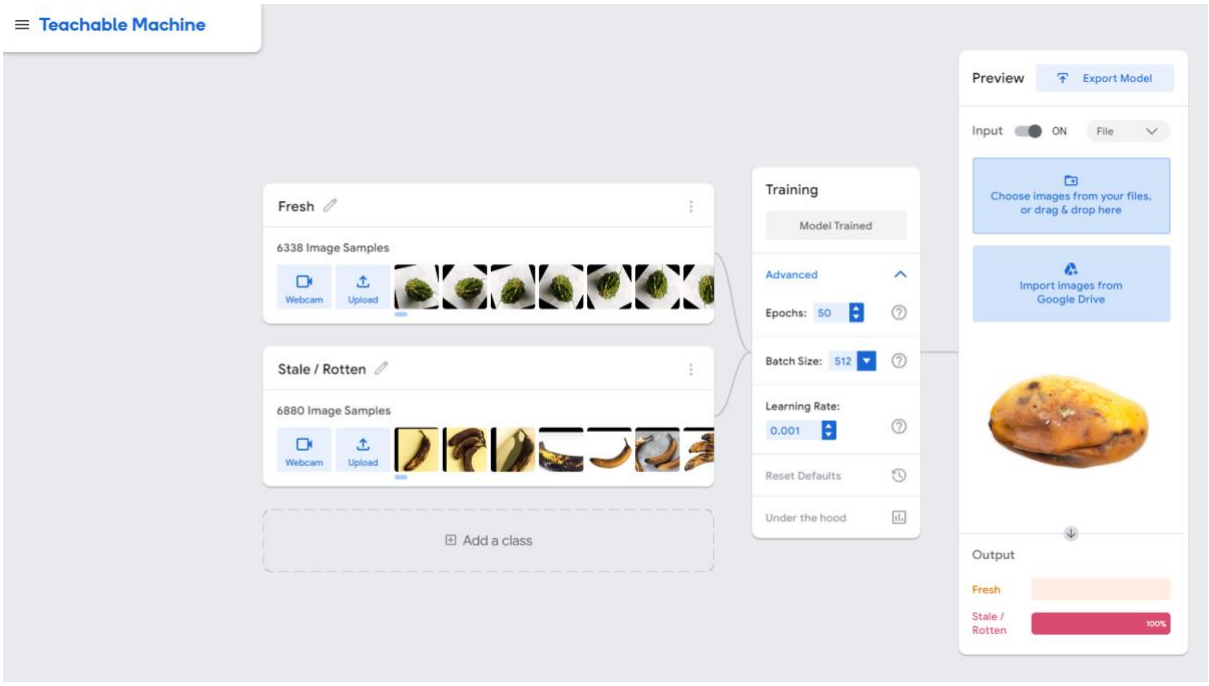
Rotten Lemon



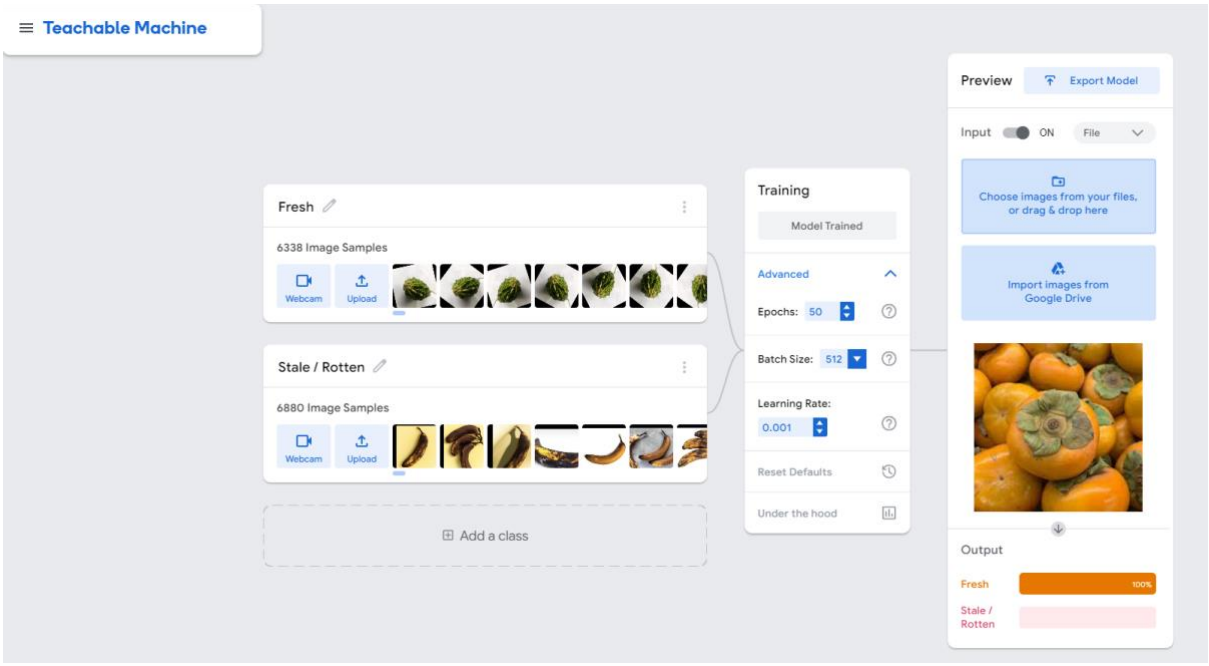
Rotten Lemon #2



Rotten Mango



Fresh Persimmon



Fresh Strawberry

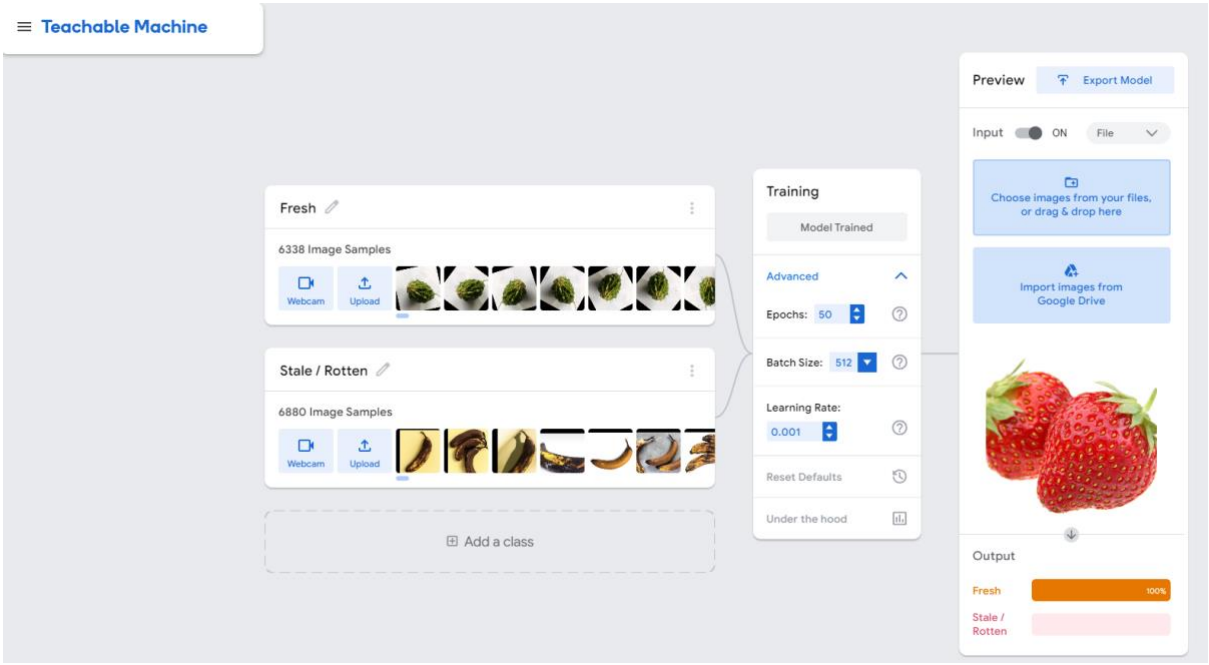


Image Used in Dataset Testing:

Link to the preprocessed Dataset (3GB)
https://drive.google.com/file/d/1JlAisUfqsdwubrcV4VGUBHSPBMfNkm1P/view?usp=sharing

Rotten lemon #1:

Image Source: Bonetta. (2016, May 17). oldy lemon isolated on white background (with clipping path) stock photo. Retrieved on 2023 December 2. From the istock phot website: https://www.istockphoto.com/photo/moldy-lemon-isolated-on-white-background-gm531418142-93783773

Rotten Lemon #2:

“Bad Lemon (Creep)” (2019). All images courtesy the artist and Josh Lilley, London. Photographs by Lance Brewer.

Retrieved on 2023 December 2nd from the colossal website:
https://www.thisiscolossal.com/2019/10/kathleen-ryan-moldy-fruit/

Rotten Mango:

Azovsky. (2021, December 23). Rotten exotic fruit. stock photo. Retrieved 2023 December 3 from the iStock website: https://www.istockphoto.com/photo/rotten-exotic-fruit-gm1360438454-433463202

Fresh Persimmon

Paradise Nursery. (n.d.) Fuyu Persimmon Tree. Retrieved 2023 December 3 from the Paradise Nursery website: https://paradisenursery.com/product/fuyu-persimmon-tree/

Fresh Strawberry:

Nyshko.L.(2010, May 20). Strawberry red berry closeup on white background. Retrieved 2023 December 3. From Alamy website: https://www.alamy.com/stock-photo-strawberry-red-berry-closeup-on-white-background-30301600.html

Group of Apples:

Roopesh.M.P (2014, November 29). Royal Gala Red Apple. Retrieved 2023 December 4. From the flickr website: https://www.flickr.com/photos/mproopesh/15717186240

Rotten Fruits mix:

Food Tank. (n.d.) Rotten, old fruit and vegetables. Fruit and vegetable waste on compost. Retrieved 2023 4 December 2023. From the Food Tank Website:https://foodtank.com/media/rotten-old-fruit-and-vegetables-fruit-and-vegetable-waste-on-compost/

Rotten Tomatoes #1

Adeoye.F. (2021 July 22). True! Consuming rotten tomatoes may cause liver cancer. Retrieved 2023 December 4 from the Dubawa Website: https://dubawa.org/true-consuming-rotten-tomatoes-may-cause-liver-cancer/

Rotten Tomatoes #2

Kocabas.B. (n.d.) Many rotten tomatoes in plastic box. Retrieved 2023 December 4. From the dreamtimes website: https://www.dreamstime.com/many-rotten-tomatoes-plastic-box-many-rotten-tomatoes-plastic-box-background-covered-mold-closeup-image131136713

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3. Rachelson.D(2023, Feburary 6) What is Recycling Contamination, and Why Does it Matter?. Retrieved 2023 November 16. From the Rubicon Website: https://www.rubicon.com/blog/recycling-contamination/
4. Libby.L.(n.d.). Food waste 101: The facts and solutions. Retrieved 2023 November 16. From the Wefourm website. https://www.weforum.org/agenda/2022/11/food-waste-101-the-facts-and-solutions/ nov 16

5. EPA(n.d.) Preventing Wasted Food At Home. Retrieved 2023 November 16. From the EPA website: https://www.epa.gov/recycle/preventing-wasted-food-home
6. Qi.DY.(2019, August 28). Food-Waste Study Reveals Much Fridge Food 'Goes There to Die'. Retrieved 2023 November 16. From the Sci tech Daily Website https://scitechdaily.com/food-waste-study-reveals-much-fridge-food-goes-there-to-die/
7. Food waste stories (2020 December 12) How fridges make us waste food. Retrieved 2023 November 16. From the Food Waste website. https://foodwastestories.com/2020/12/12/how-fridges-make-us-waste-food/
8. Tushara.E.(2023, November 13) New 'smart' community fridges in Bukit Timah, Bukit Gombak tackle food waste and improve efficiency. Retrieved on 2023 November 16. From the Straits Times Website https://www.straitstimes.com/singapore/new-smart-community-fridges-in-bukit-timah-and-bukit-gombak-tackle-food-waste-and-improve-efficiency nov 16
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10. FairPrice(n.d.) Are your Fresh Grocery Truly Fresh? Retrieved 2023 November 28. From the FairPrice Website: https://www.fairprice.com.sg/tips/healthy-living/are-your-fresh-grocery-truly-fresh/
11. Sonwani E, Bansal U, Alroobaea R, Baqasah AM and Hedabou M (2022) An Artificial Intelligence Approach Toward Food Spoilage Detection and Analysis. Front. Public Health 9:816226. doi: 10.3389/fpubh.2021.816226

Problem Two (Natural Language Processing)

Industry:

Hospitality and Tourism

Problem Statement:

Integrating the Self-help Directory kiosks and information services at Changi Airport to support the existing service communication channels.

Summary of the industry

Changi Airport is one of the busiest in the world. With December alone taking in about 4.62 million passengers.

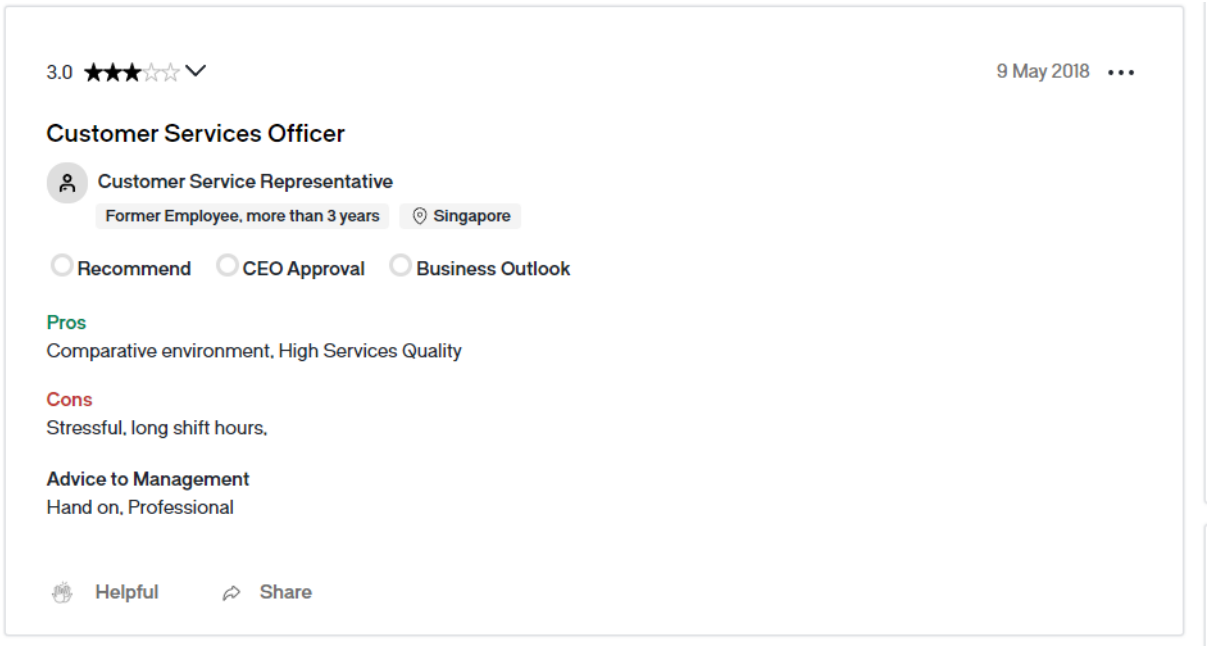
Image source: Tribune (2017, May 16). Fire Triggers Evacuation at Singapore's Changi Airport. Retrieved 2023 December 3. From the Tribune Website:
Fire triggers evacuation at Singapore's Changi airport (tribune.com.pk)

As shown in the image above. During peak travel time, many of the information services and directory kiosks will be crowded with tourists.

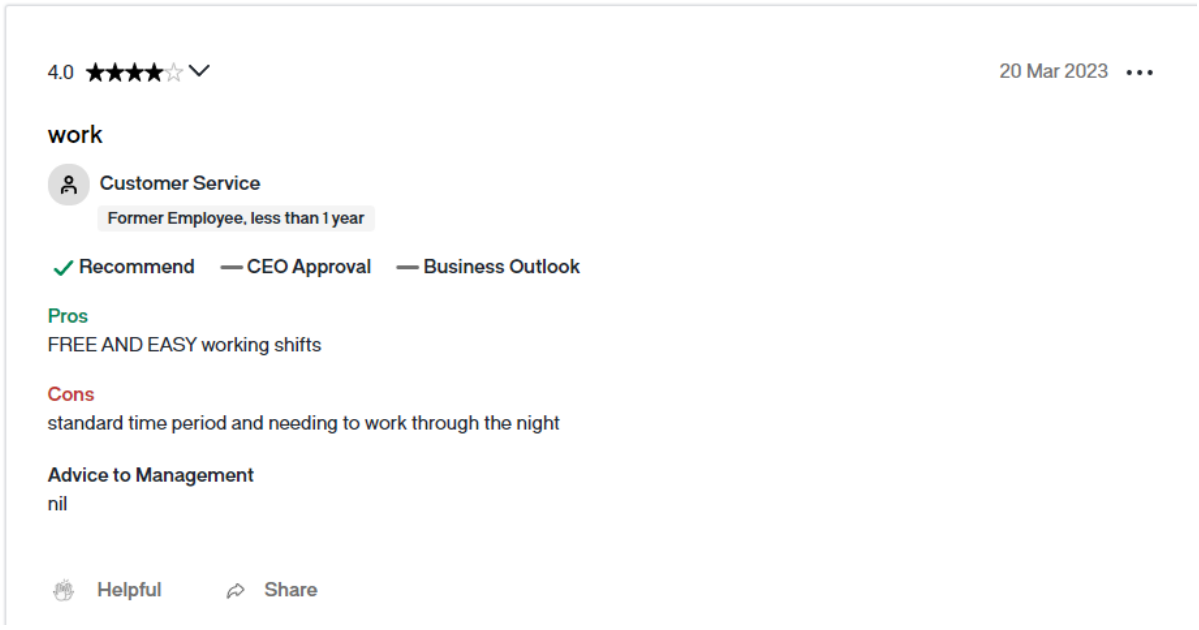
Long queues at information service counters will overwhelm tourists who just require simple enquiries. This also affects customer service staff as they must answer and take note of a lot of information, events, and enquiries by staff. All while maintaining a smile and friendly gesture.

Here is some feedback given by past Changi airport customer service staff at Glassdoor website.

Former Employee 1:



Former Employee 2:



As we can see here the huge inflow of tourists has an emotional toll on the staff. In the long run this will lead to lower performance during service.

Supplementing secondary research.

I surveyed around Terminal 1 to 4 and JEWEL about the types of tourists around Changi airport:

Tourists look for the following things:

- Directory Kiosks
- Information Service Counters
- Signage

While getting direction is easy. I have found that tourists spend a lofty amount of time gathering information about a place. As well as deciding what to do with that information.

I.e. what food is nice, what hotels are available, where is GST refund.

Here are some potential impacts:

Potential Impact 1:

For the customer Service Staff:

Image source: Changi Airport (n.d.) Operating 24/7: The Airport That Never Sleeps. Retrieved 2023 December 4 From the Changi Airport website: https://www.changiairport.com/corporate/media-centre/changijourneys/the-airport-never-sleeps/operating-24-7-the-airport-that-never-sleeps.html

As shown in the image above, the information counter about two staff.

During peak hours, Long shifts and night shifts will lead to emotional fatigue. The Staffs may not be able to perform as efficiently over long term.

Moreover, as Changi airport has many events that are ongoing, these staff have a lot of information that is required to be taken note of.

Changi airport customer service must be acquainted to the travelers' different culture and mannerism this puts a toll on the customer service.

Therefore staff at Changi airport will be overwork if not managed well.

Potential impact 2

For the tourists:

Image Source: taken by me 4th December 2023, Terminal 2

When they first landed into Singapore, tourists have multiple queries and help needed. When faced with long queues at information service counters and directory service kiosks. They may not find it worth queuing to ask a simple 1-minute question.

Changi Airport has tours for tourists on stopovers, not many of them are aware of these offers as it is not explicitly offered.

This will lead to the Singapore Tour being underutilized. When it's underutilized, it will be closed leading to loss of revenue for the tourism staff.

Tourists are missing out on the potential benefits they would have gotten if they were aware of it.

Inability to get information services help will also lead to a less satisfied tourist experience.

Solution Formulation

Why use AI?

Singapore is suffering from aging population which means less working age population.

STEM is also very popular amongst aspiring students.

National AI Strategy 2.0 follows years of planning, growth in AI sector 'not by chance': DPM Wong

DPM Lawrence Wong said a new plan is needed to gear the nation to adopt AI, which has become a "necessity", while mitigating its risks.
PHOTO: LIANHE ZAOBAO

Image source: Chia.O.(2023, December 6) National AI Strategy 2.0 follows years of planning, growth in AI sector 'not by chance': DPM Wong. Retrieved 2023 November 26. From the Straits Times Website: https://www.straitstimes.com/singapore/national-ai-strategy-20-follows-years-of-planning-growth-in-ai-sector-not-by-chance-dpm-wong

News about AI and Cyber security are very popular, this means STEM degrees and diplomas are very attractive to students. Less students will see Hospitality and Tourism as attractive career paths.

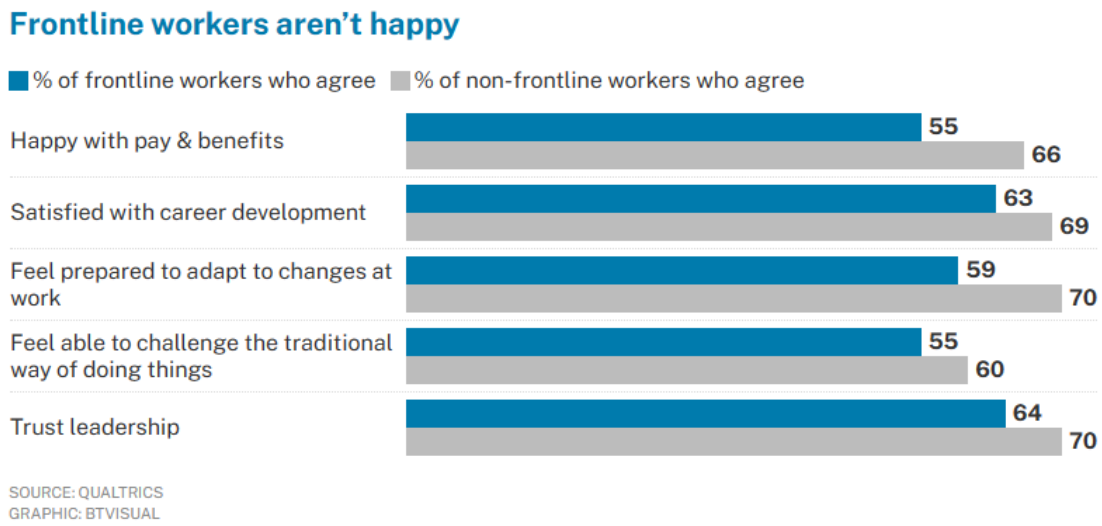


Image source:
Herbert.C. (2023, November 20). The 'new job honeymoon' phase is over for workers in Singapore. Retrieved 2023 December from the Business Times Website:
The 'new job honeymoon' phase is over for workers in Singapore, Working Life - THE BUSINESS TIMES

Moreover, customer service sector morale is declining, we will see these human resource pivoting to more rewarding industries.

Therefore, these push factors are contributing to a shrinking service industry.

To keep up with a smaller service industry, aging population, and IT boom.

AI & automation will be needed to fill in the gaps in the Singapore Tourism industry.

Section A) State the Data used and why?

We will be simulating common queries customers enquire at customer services and directory kiosks.

This will form the baseline for the chatbot to be trained on. Common queries are realistic and helps the chatbot to understand the context of the industry effectively and efficiently.

The end goal is allowing the chatbot to work hand in hand with the existing industry staff.

Section B) why Computer Vision or NLP is chosen?

NLP is chosen as it has the versatility and capabilities of helping tourists of all cultures & Nationality.

It can:

- Translate queries to tourists' native languages.
- Provide latest and up to date information about Changi Airport
- Accommodate to the various needs of the tourists.
- Personalized experiences

This helps fill in the gaps of the customer service staff. As most of the skills above take years to master. As compared to the NLP chatbot which has the advantage of training on years of dataset collected.

Section C) Process of developing the AI system.

We will train the chat bot via google dialog flow as a simple prototype. I have gathered the common questions based on experience travelling to Changi airport. As well as the frequently asked questions.

In order to test the effectiveness of the Chat bot function. It simply needs to fulfil the customer requests without errors or hanging conversations.

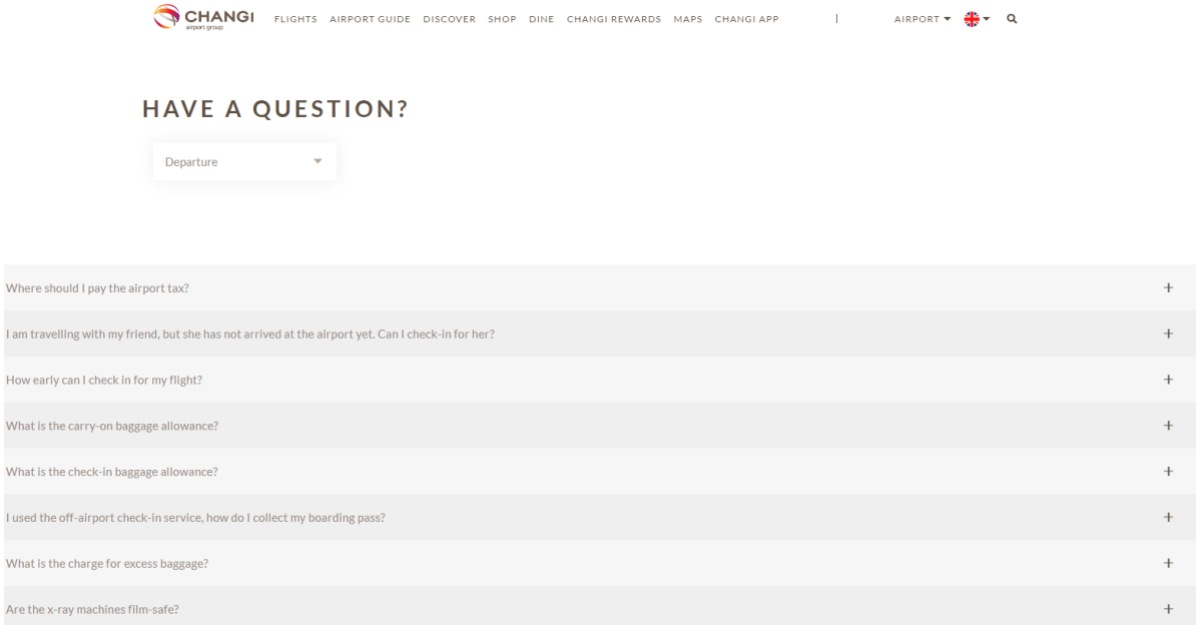


Image source: Changi Airport (n.d.) FAQ . Retrieved 6th December 2023. From the Changi Airport website: https://www.changiairport.com/en/faq.html

However as there are simply too many questions to go through, it is not feasible for me to make an extremely detailed chatbot without testing whether it could work.

The chat bot should also have some small talk functionality to satisfy curious tourists.

Places

Define synonyms | Regexp entity | Allow automated expansion | Fuzzy matching

Jewel	Jewel, Waterfall place, Waterfall, Dome
Terminal 1	Terminal 1, T1
Terminal 2	Terminal 2, T2
Terminal 3	Terminal 3, T3
Terminal 4	Terminal 4, T4
Arrival Hall	Arrival Hall, Landing Area, arrival hall
Departure Hall	Departure Hall, Going Back Area
Booking Area	Booking Area, Flight Counter
hoshino coffee	hoshino coffee, cafe, coffee house, coffee shop
toilet	toilet, gents, washroom, bathroom
	Click here to edit entry

Image source: by me, Entities of Places at Changi Airport

I have created entities such as:

- Places
- Personal Belongings
- Food

This helps give the AI contextual knowledge of Changi Airport to better suit the tourists.

My development strategy here is to train the chat bot to cover 5 key things:

- Finding Venue
- Activities Idea
- Hotels / Accommodation
- Food
- Reporting of Lost Items

These 5 Question types are the most important because it is frequently asked by tourists at information service counters and directory kiosks.

Section D) How to deploy the AI solution in the current environment to solve the problem.

We will deploy them to existing directory kiosks, information service counters. This will generate the less amount of expense as it just requires us to place the AI model into the information service counters and directory kiosks.

The processing power will be handled by google cloud, therefore there is no need for expensive hardware investments.

We can get inspiration of how this AI solution will look like from other countries.

Image source: Yomiuri Shimbu. (2021, September 20). AI being deployed by Japan railways to provide multilingual services. Retrieved 2023 November 27. From the Yomiuri website: https://japannews.yomiuri.co.jp/business/companies/20210920-34239/

As shown by this Kiosks. The tourist is interacting with the kiosks as though it's one to one.
As there is already existing implementation in other countries. The initial cost would not be that high as we can outsource the AI assistance to foreign companies to create an effective and interactive kiosk.

We will also deploy these chat bots at the luggage trolleys.

Image source: Changi Airport (2019, March). Five things you never knew about Changi's trolleys. Retrieved 2023 November 27. From the Changi Airport Website: https://www.changiairport.com/corporate/media-centre/changijourneys/the-changi-experience/five-things-you-never-knew-about-changis-trolleys.html

During my primary research, Tourists spend a lot of time strolling with their trolleys. Since google dialog flow allows for Speech to Text recognition. It is a perfect opportunity to integrate the chatbot into the trolleys as tourist can ask question right at their own convenience. However, this can be quite expensive to maintain.

Section E) Other Explanations

In all, using NLP will help streamline all queries and communications a tourist may need at change airport into a centralised system.

This will be a stepping stone in Singapore Digitalisation and AI capabilities.

Prototyping Solutions

To prototype this solution, we will be using google dialog flow the five chosen domains for this chat bot.

To access the Chatbot please follow this link:

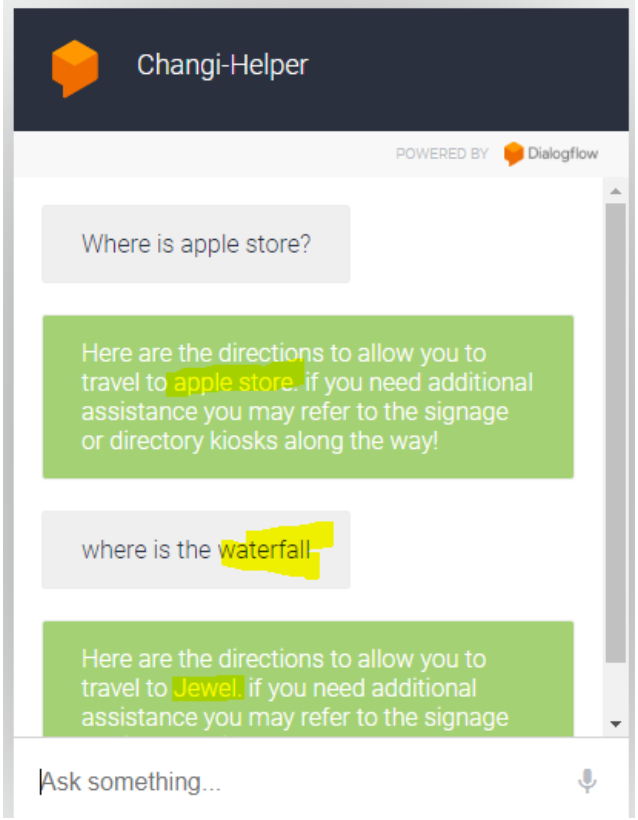
https://bot.dialogflow.com/d9f702ec-d9a9-4cfe-8706-235fb6218720

My development strategy here is to train the chat bot to cover 5 key things:

- Finding Venue
- Activities Idea
- Hotels / Accommodation
- Food
- Reporting of Lost Items

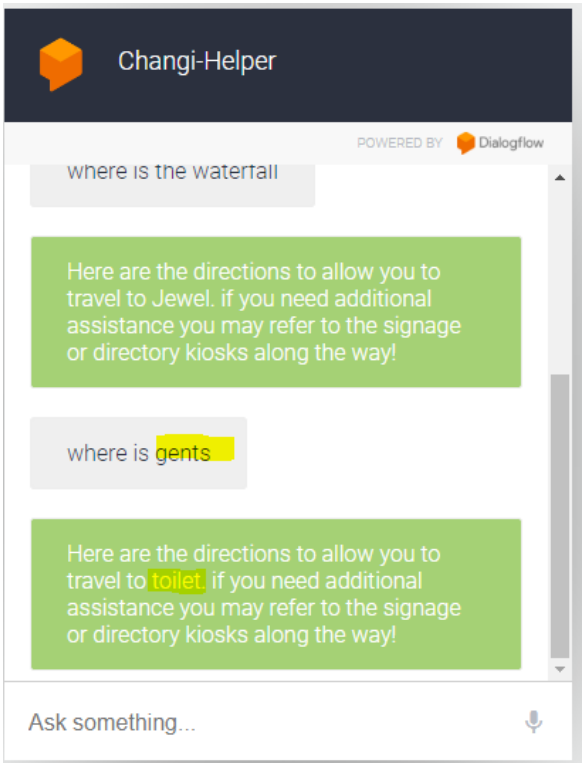
Test cases

Test Case 1) Looking for amenities



Purpose:

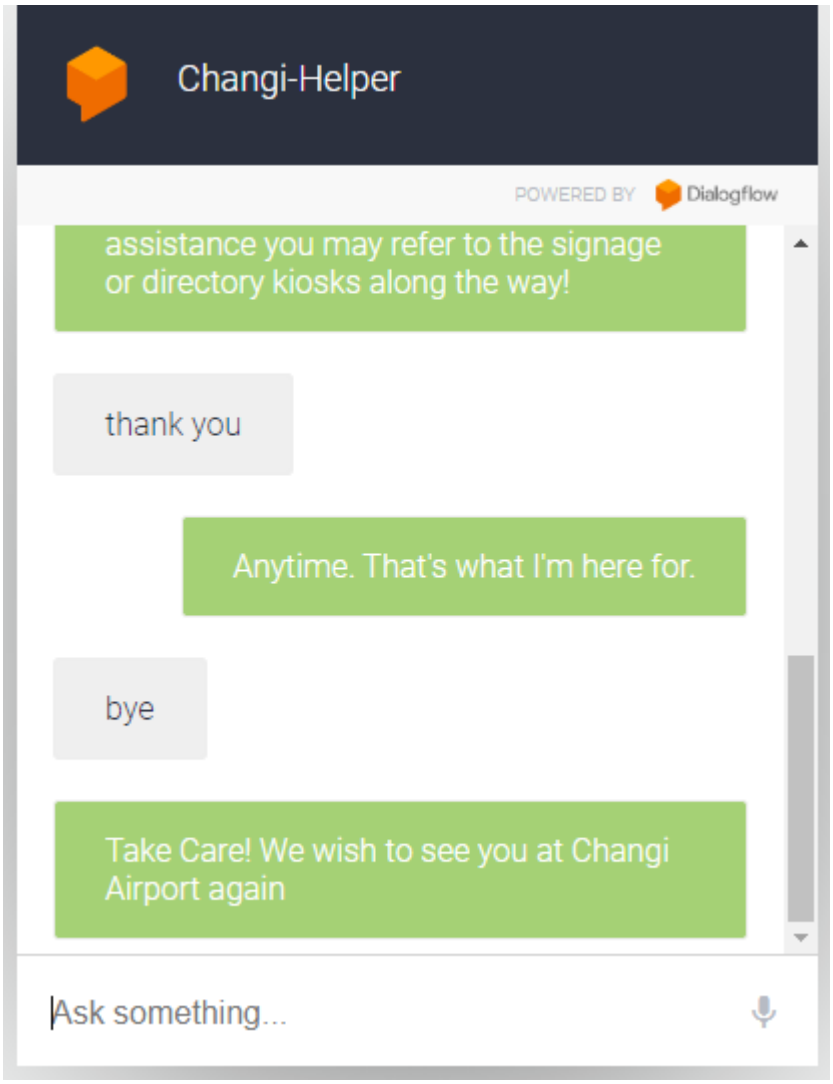
Tourists like to ask navigation questions to getting to their venue. The expected results should be a one word reply before the customer will be shown the route to the destination.



As shown in the picture above. The NLP is able to recognise that waterfall represents Jewel, and gents represents the toilet. This show that the AI has some contextual knowledge of the questions being asked.

The NLP also is able to reaffirm the user the direction of their place. This is achieved by using the Places Entity and putting in my own word list.

Jewel	Jewel, Waterfall place, Waterfall, Dome
Terminal 1	Terminal 1, T1
Terminal 2	Terminal 2, T2
Terminal 3	Terminal 3, T3
Terminal 4	Terminal 4, T4
Arrival Hall	Arrival Hall, Landing Area, arrival hall
Departure Hall	Departure Hall, Going Back Area
Booking Area	Booking Area, Flight Counter
hoshino coffee	hoshino coffee, cafe, coffee house, coffee shop
toilet	toilet, gents, washroom, bathroom



The tourist can give small talk to the AI. The conversation ending is natural and does not leave the tourist hanging.

Test case 2) Food recommendation

Purpose:

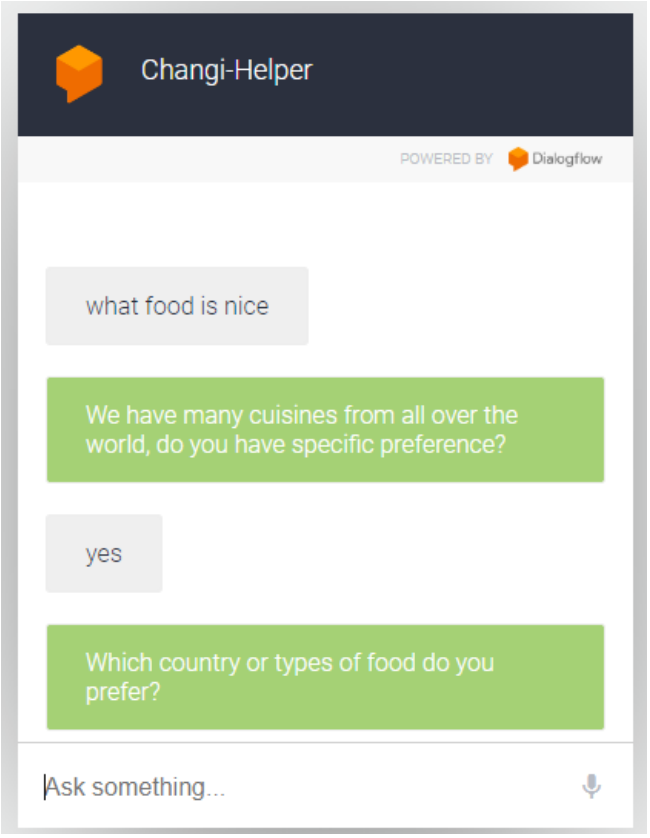
To recommend tourists food based on their preferences. This will allow tourist to choose the best food without looking at directory kiosks and figuring out if that restaurant is good.

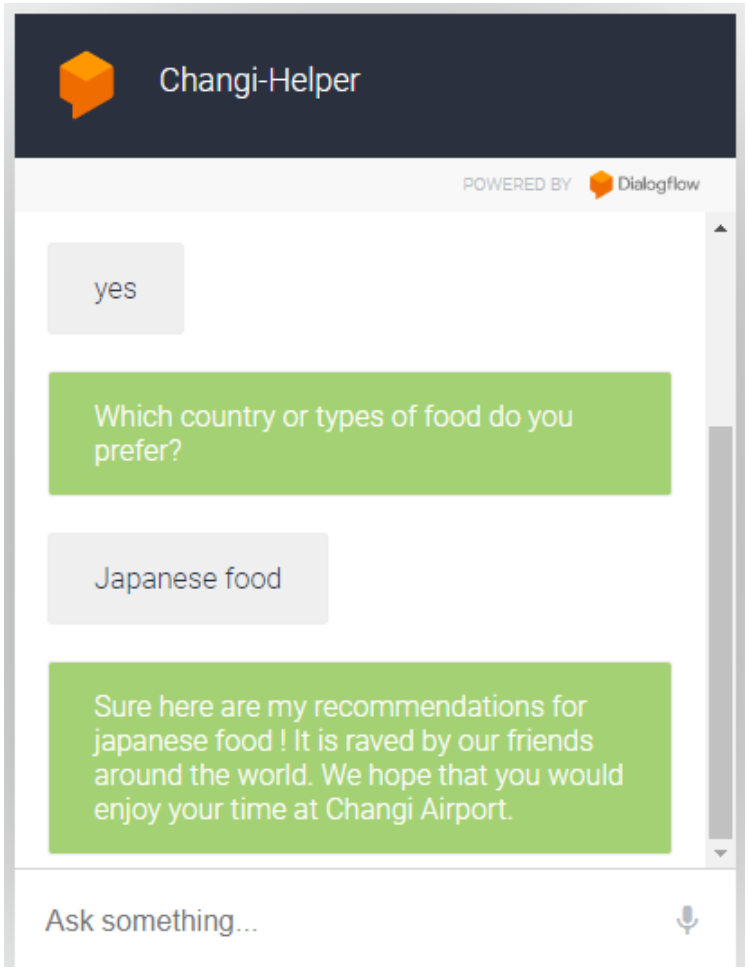
The test case has two conditions. The first is tourist has preference on the type of food they like.

The second is the tourist don't know what food is nice here and would like to have a recommendation.

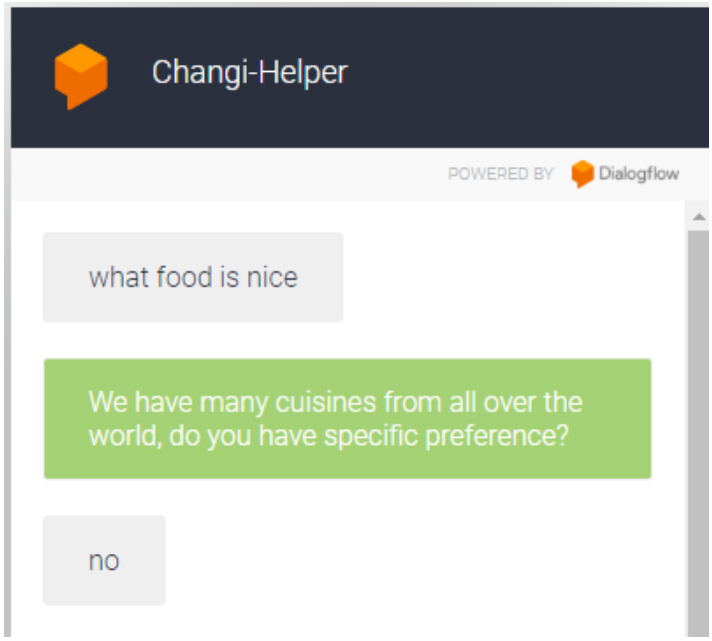
Based on the test cases below, the NLP has successfully helped the tourists to get their food preferences.

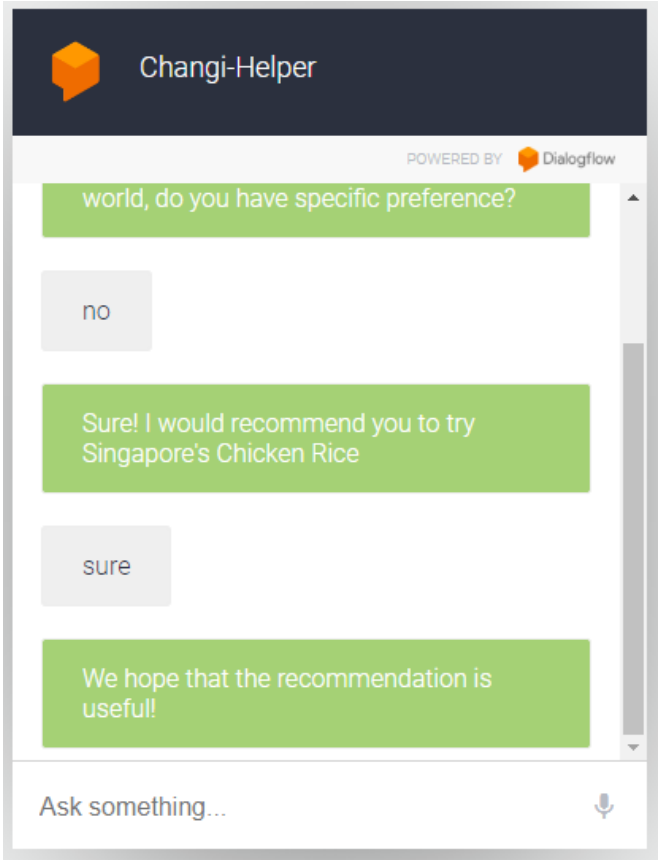
Scenario 1: has preference





Scenario 2: Has no preference.





Test Case 3) Hotel Booking

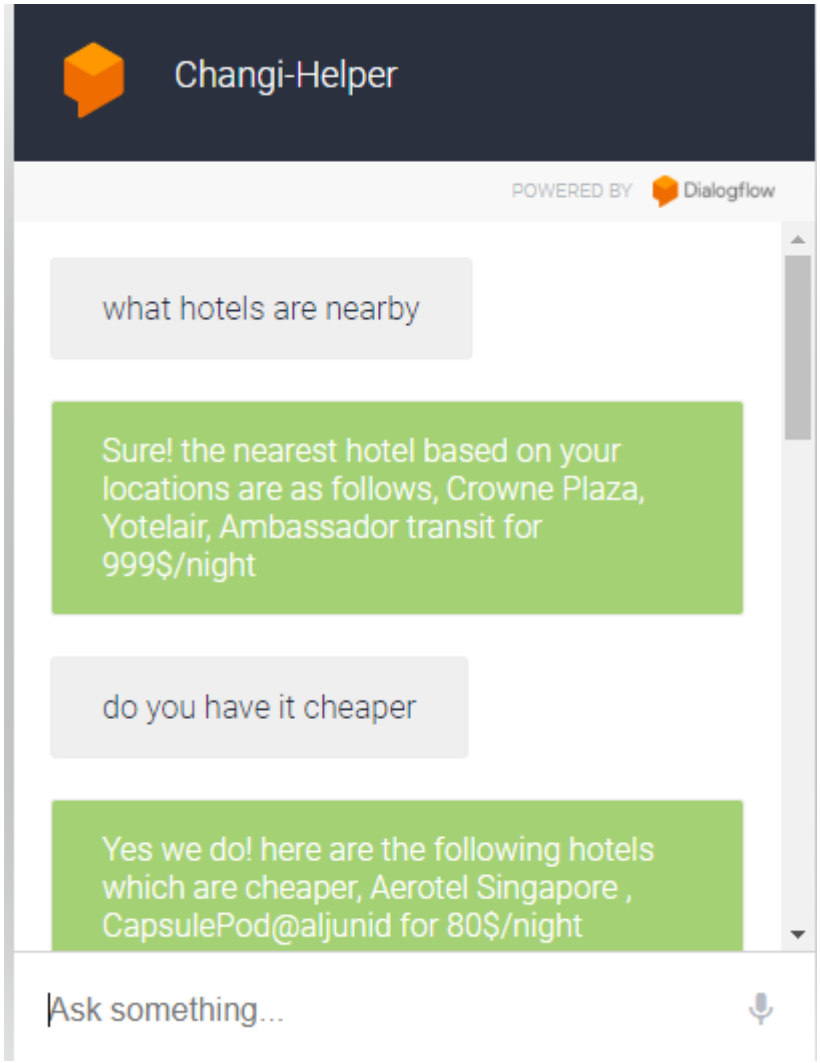
Purpose:

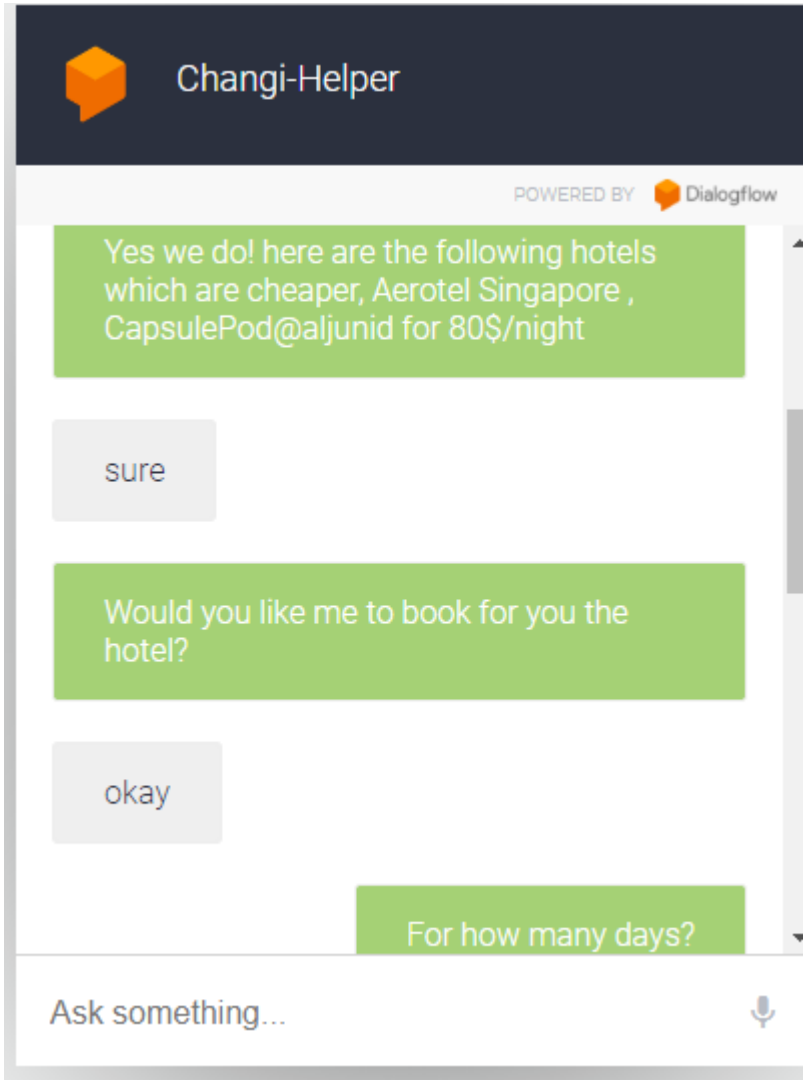
To allow tourists to book hotels when they are at change airport. As there are many hotels around Changi airport. It would make sense for the tourists to book the hotel nearby them. This gives the tourists a sense of convenience as booking can be done right at the airport and not at the hotel itself. The tourists just need to provide some information to reserve their spot at a nearby hotel.

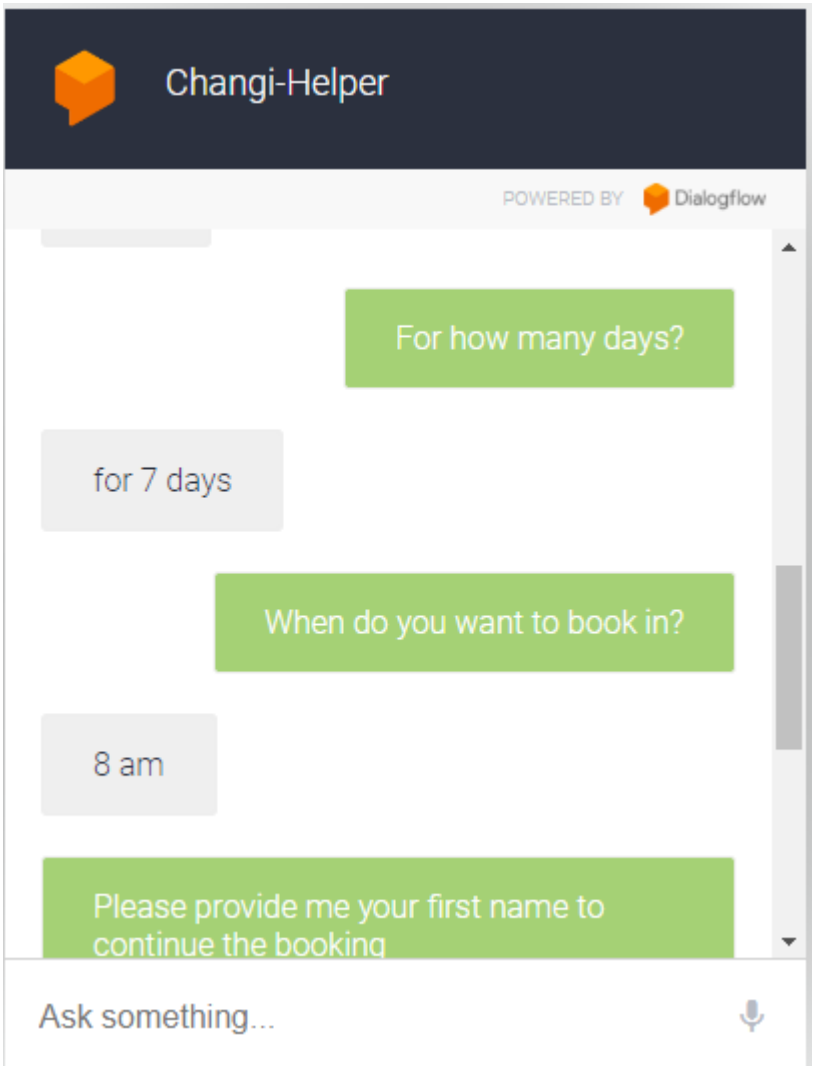
This helps resolve the issue of finding nearby hotels and booking them.

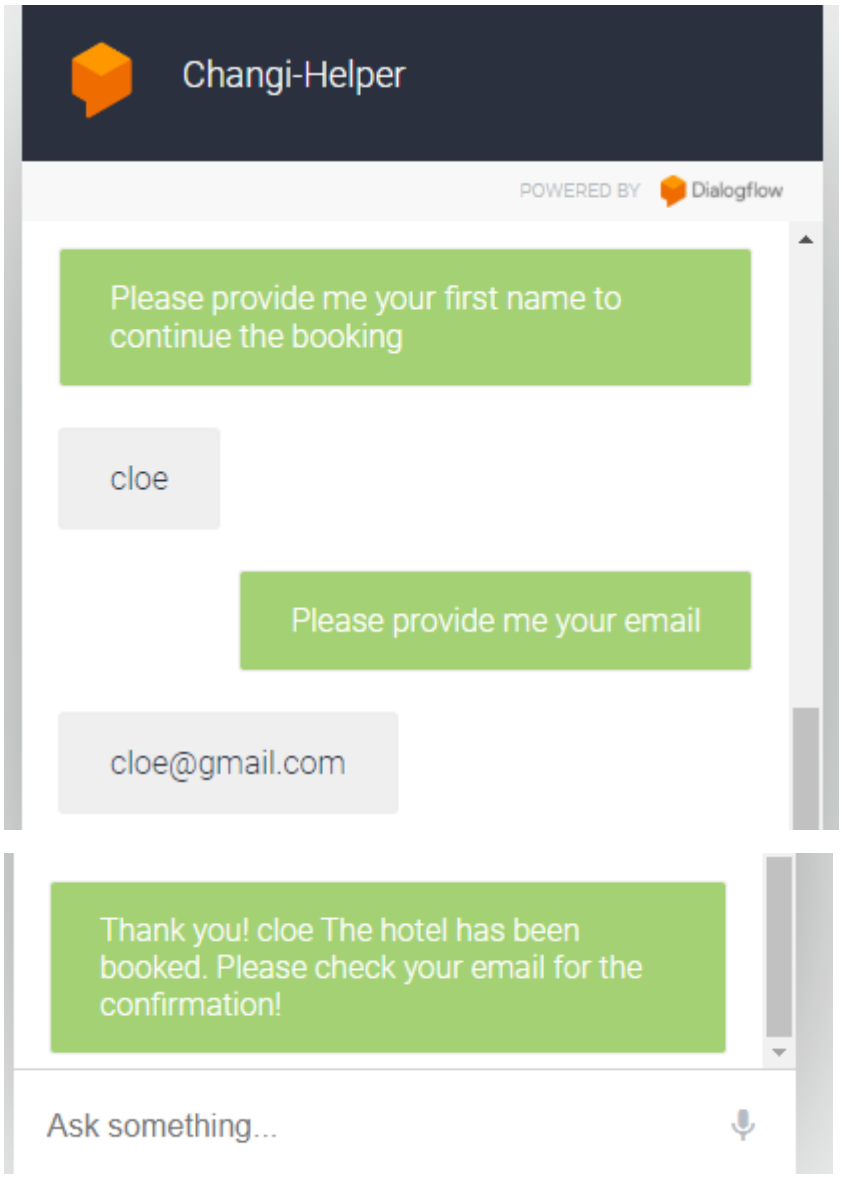
The conversation below shows the interaction between a persona, Cloe, and the chat bot.

Hotel Booking Conversation




Changi-Helper
POWERED BY Dialogflow
Yes we do! here are the following hotels which are cheaper, Aerotel Singapore , CapsulePod@aljunid for 80$/night
sure
Would you like me to book for you the hotel?
okay
For how many days?
Ask something...


Changi-Helper
POWERED BY Dialogflow
For how many days?
for 7 days
When do you want to book in?
8 am
Please provide me your first name to continue the booking
Ask something...

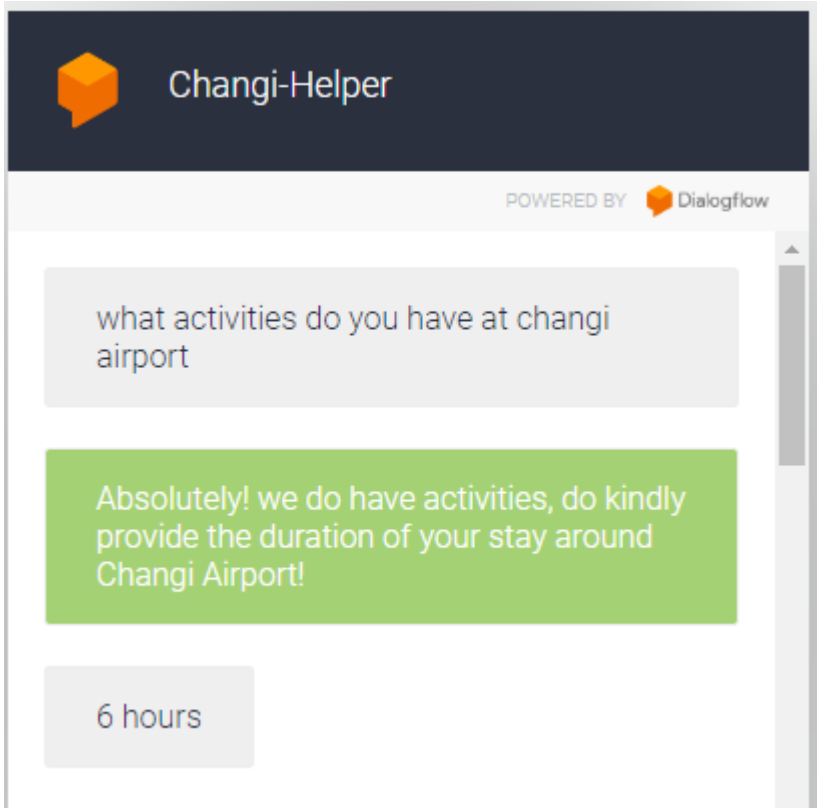

Changi-Helper
POWERED BY Dialogflow
Please provide me your first name to continue the booking
cloe
Please provide me your email
cloe@gmail.com
Thank you! cloe The hotel has been booked. Please check your email for the confirmation!
Ask something...

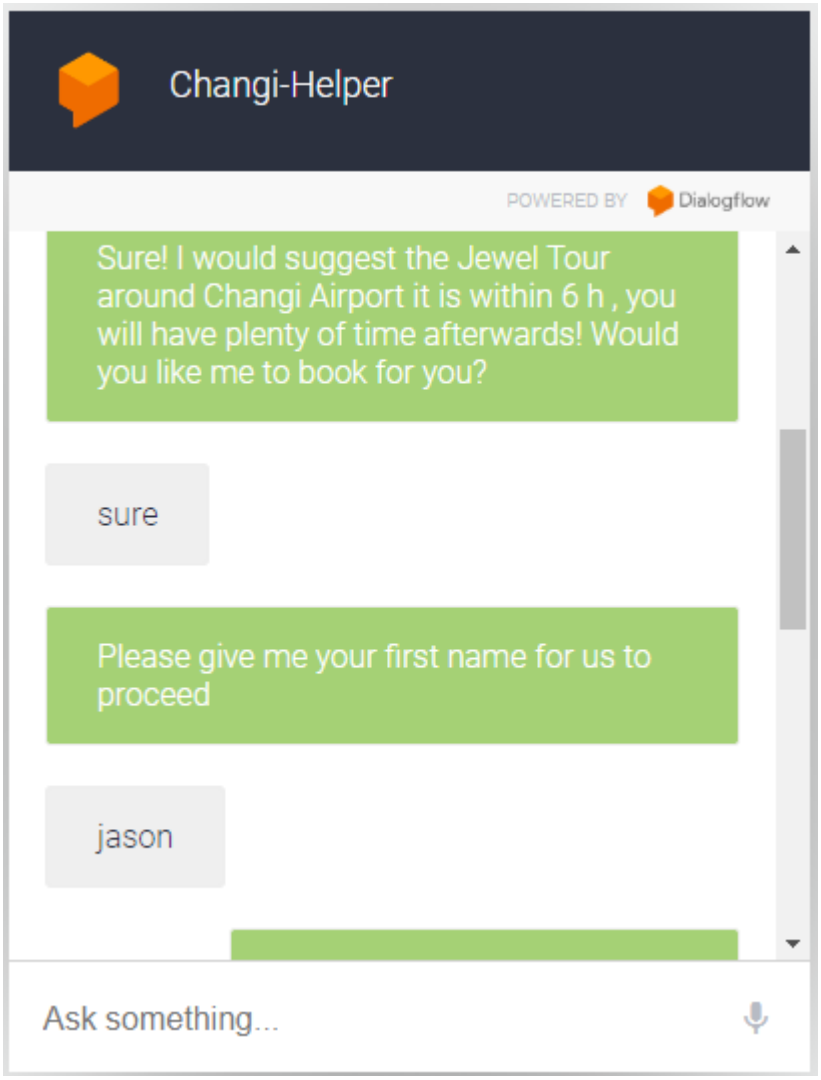
Test Case 4) Stopover Idea

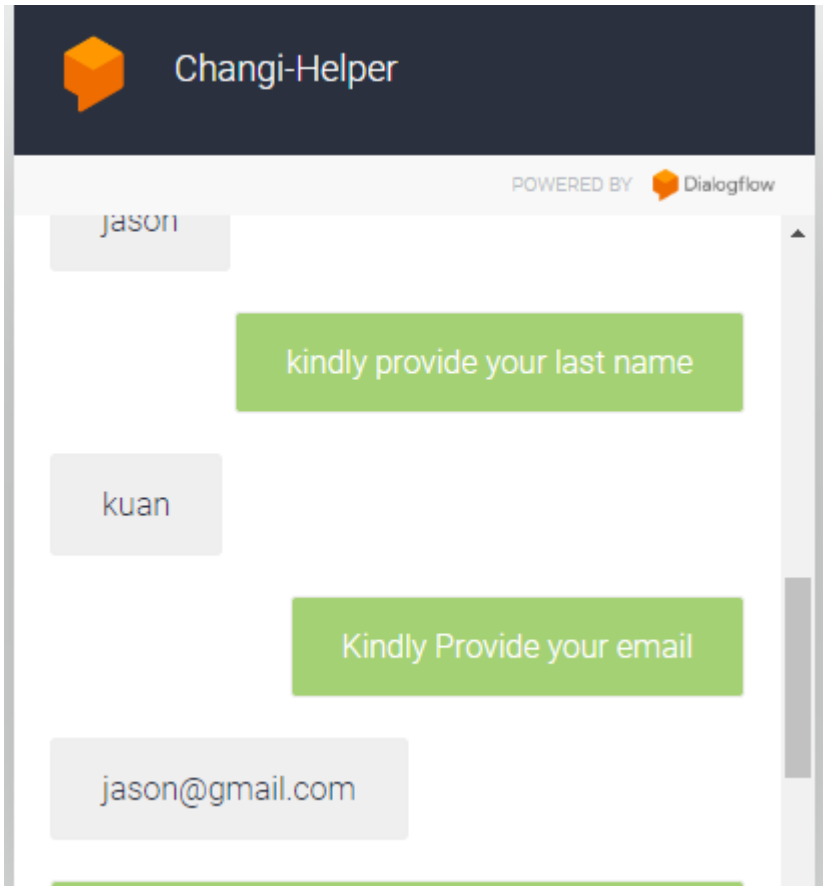
The purpose:
Many tourists do stop over at Singapore. However, many aren't sure of what they can do around the airport during those short hours. As such I am imbedding this into the chatbot to address that. Moreover, this test case allows tourists some idea activities that can be done at Changi Airport. If the tourist permits, they can book a tour with change airport to explore the facilities it offers.

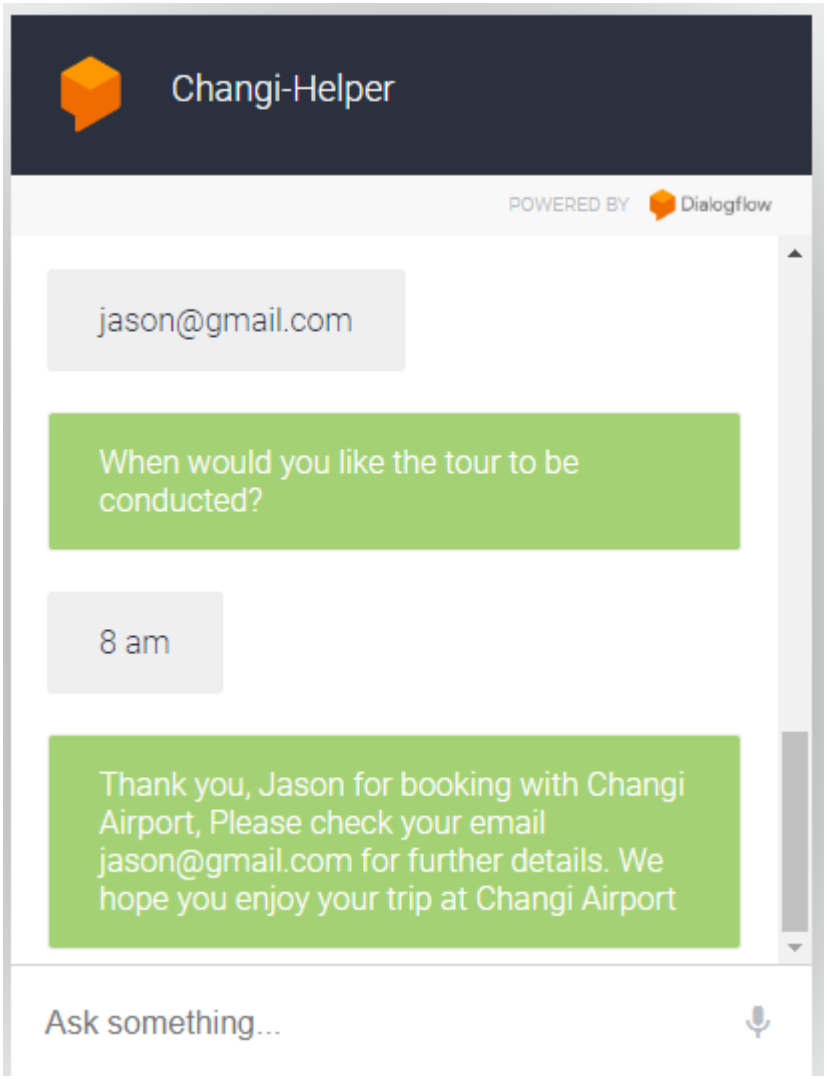
Below shows the conversation between Jason and the chatbot to simulate the query of activities at change airport.

Stopover Idea




Changi-Helper
POWERED BY Dialogflow
Sure! I would suggest the Jewel Tour around Changi Airport it is within 6 h , you will have plenty of time afterwards! Would you like me to book for you?
sure
Please give me your first name for us to proceed
jason
Ask something...


Changi-Helper
POWERED BY Dialogflow
jason
kindly provide your last name
kuan
Kindly Provide your email
jason@gmail.com


Changi-Helper
POWERED BY Dialogflow
jason@gmail.com
When would you like the tour to be conducted?
8 am
Thank you, Jason for booking with Changi Airport, Please check your email jason@gmail.com for further details. We hope you enjoy your trip at Changi Airport
Ask something...

Test Case 5) Reporting of Missing Items

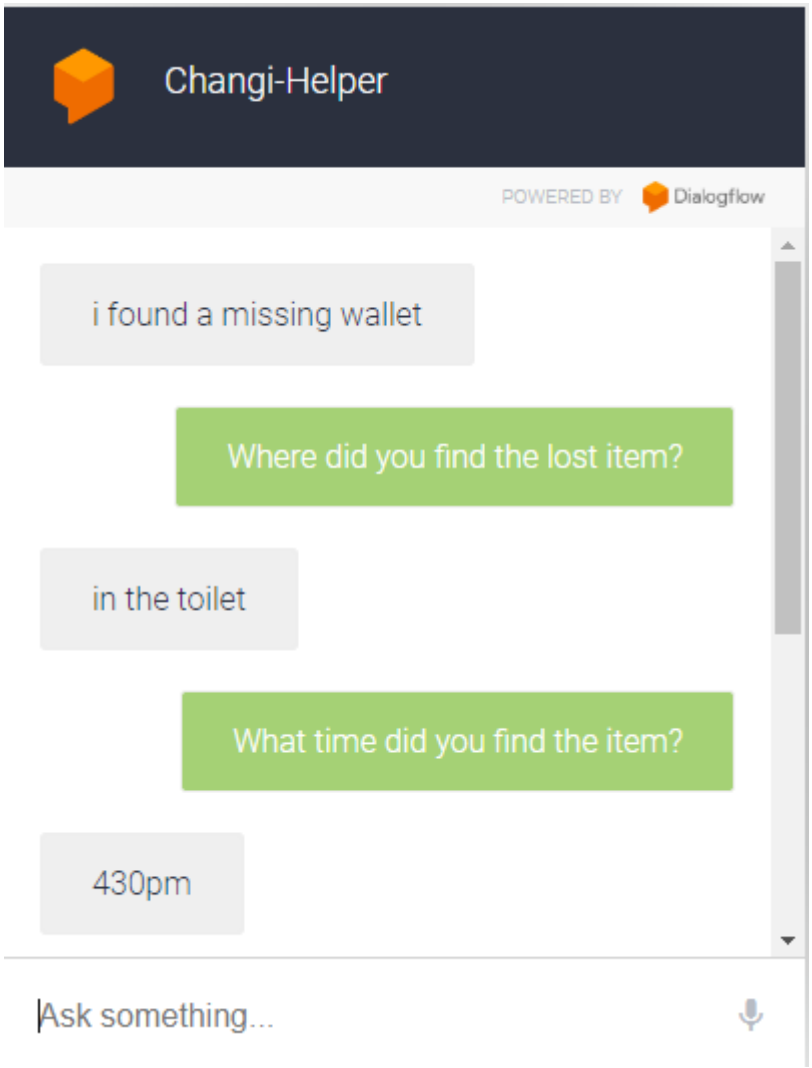
Purpose:

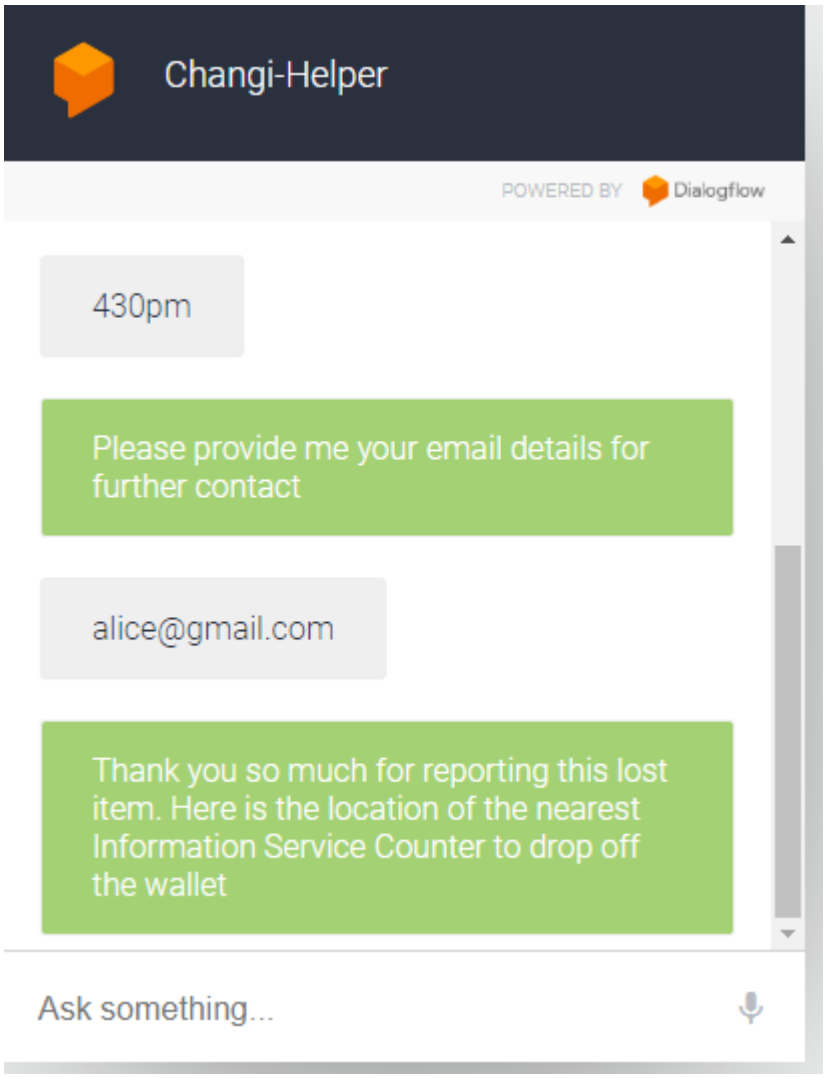
Many Tourists may lose their personal belongings at Changi airport. Therefore, it is essential that the chatbot has the ability to help log a missing item report to the information service counter.

This is useful because tourists often find missing items at places which are not near the information service counters. Having a NLP chatbot nearby to lodge the report will allow for timely reporting and placement of lost items in the lost and found corner.

Below shows the conversation of Alice reporting a missing item

Alice Found Missing Item




Changi-Helper
POWERED BY Dialogflow
430pm
Please provide me your email details for further contact
alice@gmail.com
Thank you so much for reporting this lost item. Here is the location of the nearest Information Service Counter to drop off the wallet
Ask something...

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