



NUS
National University
of Singapore

CarsAI

INTELLIGENT REASONING SYSTEM

GROUP MEMBERS

Meng Zhaoyi

Sun Ming

Li Jiayi

Zhao Jiaxi

STUDENT ID

A0216420W

A0176222L

A0215492E

A0215278B

Contents

Executive Summary	1
1. Market research.....	2
2. System architecture	5
3. System Design and Implementation	6
3.1 Cognitive system.....	6
3.2 Database Construction	10
3.3 Services-Booking System	13
3.4 Knowledge-based System.....	15
3.5 Machine learning System.....	15
3.6 Web Server	16
4. Conclusion	19
APPENDIX.....	20
Appendix A: Project Proposal.....	20
Appendix B: Mapped System Functionalities against knowledge, techniques and skills of modular courses: MR, RS, CGS.....	25
Appendix C: Installation and User Guide.....	27
Appendix D: Individual project reports	28

Executive Summary

Affected by the COVID-19, many industries have been hit hard, and the automobile industry is no exception. Dealers cannot restore the original customer flow soon. It is undoubtedly a massive loss for vehicle manufacturers, especially whose sale is over millions. At the same time, the usual after-sales business cannot be carried out due to the pandemic. Consumers feel great inconvenience in both pre-sales and after-sales services. Therefore, it is essential to open up new online services.

As an established car manufacturer, Audi is well known in the field of automobile. To help Audi tide over the difficulties, we designed a car recommendation system, which saves human resources in the sales process, brings a personalized shopping experience to consumers, and improve the user experience of after-sales services. The system allows Audi to gain more advantages in the automotive market competition and make up for the pandemic's losses.

1. Market research

1.1 Industry background research

Owning a car is quite common in modern society as it brings much convenience and improve efficiency. There are 5.7 million people living in Singapore ^[1], while Singapore's number of registered vehicles was reported at 826,824 units in Aug 2020^[2]. It is obvious that Singapore's automobile market still has much potential. Besides, Singapore's motor vehicle sales recorded 5,835 units in Jul 2020, compared with 1,657 units in the previous month ^[3], which shows Singaporean have strong needs and purchasing power in this field.

From J. D. Power, a global market research website that conducts surveys of customer satisfaction and product quality of different car brands, Audi performed well in the previous decade ^[4]. Audi is also of great prevalence in Singapore, due to the annual market share of various brands ^[5], it is one of the top 10 locally popular brand.

Tab1: Market share of various brands of cars

Brand	Honda	Toyota	Benz	Hyundai	BMW	Kia	Mazda	Mitsubishi	Audi	Nissan
Partial	21.00%	17.90%	10.80%	7.80%	7.40%	5.80%	4.30%	4.20%	3.40%	3.30%

Hitten by the COVID-19, the automotive industry has been greatly affected, and Audi is no exception. According to the financial report, Audi achieved operating revenue of 20.476 billion euros in the first half of 2020, a decrease of 28.8% from 28.761 billion euros in the same period in 2019^[6]. In this situation, Audi needs to make a breakthrough.

¹ Population in Singapore [cited from]: <https://www.ceicdata.com/en/indicator/singapore/population>

² Singapore's Number of Registered Vehicles [cited from]: <https://www.ceicdata.com/en/indicator/singapore/number-of-registered-vehicles>

³ Singapore's Motor Vehicles Sales recorded 5,835 units in Jul 2020, compared with 1,657 units in the previous month. [cited from]: <https://www.ceicdata.com/en/indicator/singapore/motor-vehicles-sales>

⁴ Audi Annual Report 2019 [cited from]: <https://www.audi.com/en/company/investor-relations/reports-and-key-figures/annual-reports.html>

⁵ Annual market share of various brands in Singapore [cited from]: https://www.marklines.com/en/statistics/flash_sales/salesfig_singapore_2019

⁶ J. D. Power, a global market research company, conducts surveys of customer satisfaction, product quality [cited from]: <https://www.jdpower.com/cars/audi>

1.2 Target User

To help Audi step out of the COVID-19 shadows, our team purpose a car recommendation system to serve both the company and the customers and cover both pre-sale and after-sale service.

The pre-sale service is mainly designed for those who would like to buy an Audi automobile. Regardless of the pandemic, there is a lot of customers who purchase a car without knowing a vehicle's specifications. Before a customer makes a final purchase decision, he/she may spend a long time researching the details of a car, including the structure, the engine, the displacement, etc. While our recommendation system combines all these key parameters with customers' needs, the customer will never have trouble to choose a car while using our system. Besides, the Singapore Government only allows at most five people to appear in one region due to the pandemic, so it would be inconvenient for a customer to go to car dealers and choose their favorite vehicle. With our system, there is no need to make any appointments with the car dealer using phone calls; instead, they can access the system for recommendation and service booking.

Purchasing a car means to buy both the automobile itself and the additional services that including the insurance, the decoration, and services from automobiles service centers. We will recommend some suitable insurance and services according to the customers' needs. When customers would like to send their cars to the automobiles service center, our system will mark the service centers' location and connect with the Google calendar to remind the appointment with the service center.

The Audi company has more than 90 hundred employees worldwide; among the employees, most of them are salespeople. However, an experienced salesperson needs to be fully trained with quite an amount of costs. Considering this situation, we have designed our system to minimize dependence on human resources to help the company save huge costs on human resources.

1.3 Competitive product analysis

Based on our research, the Audi company does not have a complete online recommendation solution (also the same as other car companies) so far. If Audi tries our solution, they can be ahead of their competitors. There is no recommendation system online to help them decide on choosing a vehicle when it comes to the customers, in most situations, customers prefer to collect information from the Internet and ask for advice from related forums or salespeople if they intend to know the details about a specific car. However, the procedure of collecting information is usually tedious, and the advice from others may not fit the need as a different person has different ideas on something, so it is hard to say which car is best suits one. Besides, salespeople sometimes keen to recommend new models of vehicles but ignore the real needs of customers. As a result, consumers would find

that the car is not what they truly want after purchase the car.

1.4 Advantages of our car recommendation system

The epidemic has greatly changed the sales model of car dealers and will not change back to the original state in the foreseeable future. By studying car dealers' websites, we found that some of the online car selection systems they used cannot be considered a user-friendly system as they did not provide a proper recommendation feature to the customer. In fact, most of them only provide the specification of the cars to customers, they do not take into account the portraits and the real needs of different kinds of customer. Furthermore, some of their interfaces are hard to read, and many advertisements exist on the pages. Compared with them, our solution adopts Google Dialogflow as the interactive medium with customer, users can communicate directly with the Dialogflow agent to obtain information, they can even have conversations with Dialogflow agent for precise recommendation. Our system not only provides the recommendation service but also provides other services such as car maintenance appointments and dealer's location guidance to meet user needs in one stop.

2. System architecture

Figure 1 is the architecture diagram of our system. As you can see, the first part is the UI part, where we use Google Dialogflow as the medium to identify the user intents and to extract the keywords. The Dialogflow Agents are embedded in the web interface for car recommendation, service booking, and FAQs answering. These agents will extract the required information for different features through the process of the user's dialogue with them.

The second part is the Web Server part. The server works in the Node.js environment, and it can handle the car recommendation request. For the car recommendation, after receiving the user's intent and keywords from the Dialogflow agent, the server makes a call to an SVM script to make the recommendation based on the information provided by the user, and then using the result generated by the SVM, the server will make a request to the database to get the detail information of the target car as the SVM will only return a car's id to the server. Finally, the server will return the detailed information and the car's picture to the user through the web interface. The SVM is trained using the data obtained from questionnaires; the training data consists of a person's background information that includes the user's driving habits, lifestyle, and the infrastructure level of where the user stays. By chatting with the Dialogflow agent, user will receive the precise recommendation from our system.

Moreover, our system calls Google Calendar API to make service appointments for users, where users can book three different services, and the system will check if there is a time conflict. If there is a time slot for the appointment, the system will arrange this service on the user's calendar. Furthermore, the system is integrated with a knowledge base system to deal with the frequent-ask questions for car purchasing or car servicing, user can find the specific agent for FAQs in our web interface. Besides, the system uses Google MAP API to show the nearby automobiles service centers and routes on the contact web page.

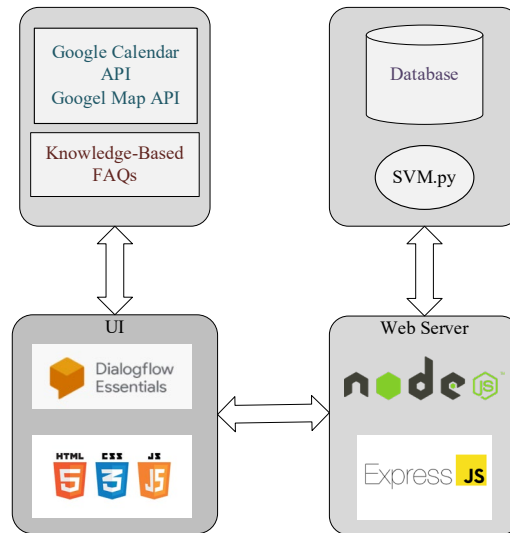


Figure 1: System Architecture

3. System Design and Implementation

3.1 Cognitive system

Google Dialogflow

Dialogflow is a natural language understanding platform that makes it easy to design and integrate a conversational user interface into a mobile app, web application, device, bot, interactive voice response system, etc. Dialogflow can analyze multiple input types from users, including text or audio inputs (like from a phone or voice recording). It can also respond to users in a couple of ways, either through text or with synthetic speech.

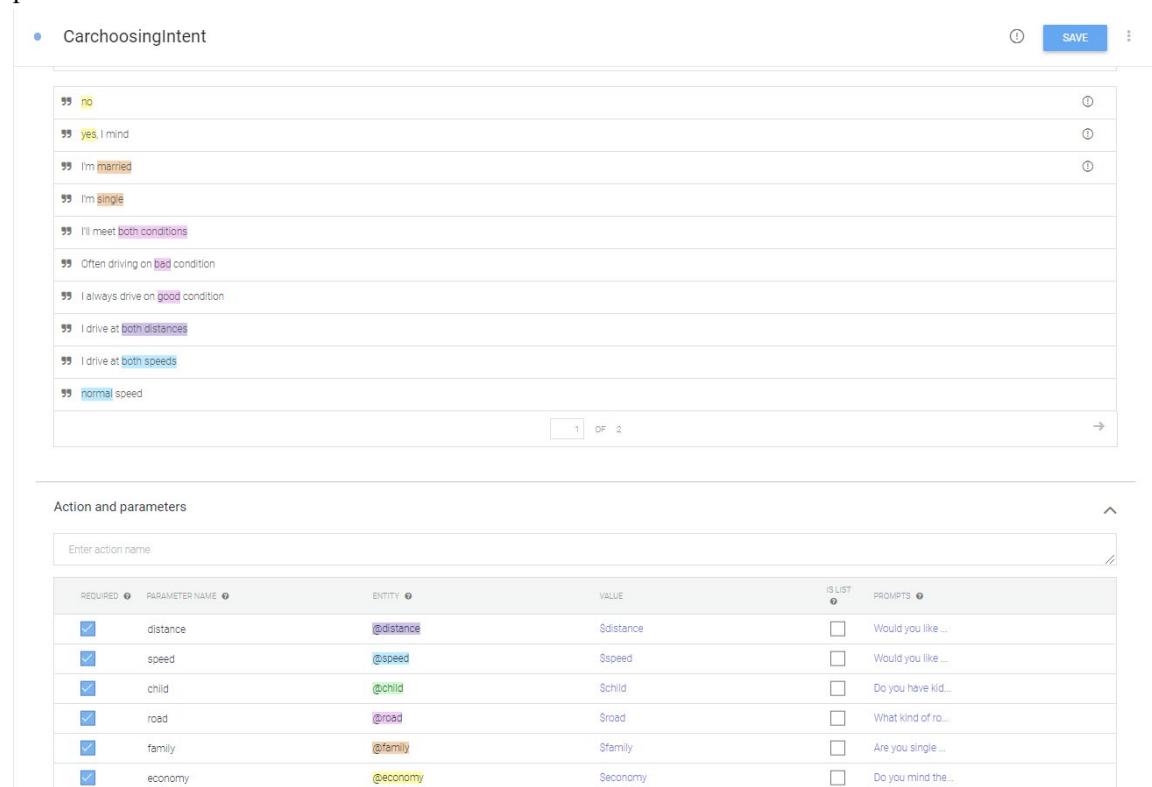
Dialogflow is an end-to-end, build-once, and deploy-everywhere development suite for creating conversational interfaces for websites, mobile apps, popular messaging platforms, and Internet of Things (IoT) devices. It can be used to build interfaces, such as chatbots and conversational, interactive voice response (IVR), that enable natural and rich interactions between users and systems.

As part of building a chatbot, Data need to be processed to create topics and then extract and save associated synonyms for given topics. This data is uploaded to Dialogflow Agent, and topics are uploaded in entities. Entities are Dialogflow's mechanism for identifying and extracting useful data from natural language inputs. With entities in place, intents need to be created in your agent that map user input to responses. In each intent, examples of user statements need to be defined that can trigger the intent, what to extract from the statement, and how to respond.

Dialogflow can connect to external systems on an intent-by-intent basis by using Fulfillment code, which is deployed as a webhook. During a conversation, fulfillment lets developers use the information extracted by Dialogflow's natural language processing to generate dynamic responses or trigger actions on your backend.

Dialogflow used in Car Recommendation feature

Regarding the Audi car recommendation feature, the Dialogflow agent chatbot will elicit user input by guiding them through a series of car selection questions. The user's answer will be matched with the intent, and the user's answer will be stored as the parameter value in the agent according to the set entity category and form. In CarsAI, there is a Carchoosing Intent and six entities (@child, @distance, @economy, @distance and @speed) in this feature to facilitate the extraction of parameters and data transmission.



The screenshot shows the Dialogflow console interface for the 'CarchoosingIntent'. The top section lists several training phrases with their corresponding entities highlighted. The bottom section, 'Action and parameters', displays a table of parameters for this intent.

REQUIRED	PARAMETER NAME	ENTITY	VALUE	IS LIST	PROMPTS
<input checked="" type="checkbox"/>	distance	@distance	Sdistance	<input type="checkbox"/>	Would you like ...
<input checked="" type="checkbox"/>	speed	@speed	Sspeed	<input type="checkbox"/>	Would you like ...
<input checked="" type="checkbox"/>	child	@child	Schild	<input type="checkbox"/>	Do you have kid...
<input checked="" type="checkbox"/>	road	@road	Sroad	<input type="checkbox"/>	What kind of ro...
<input checked="" type="checkbox"/>	family	@family	Sfamily	<input type="checkbox"/>	Are you single ...
<input checked="" type="checkbox"/>	economy	@economy	Seconomy	<input type="checkbox"/>	Do you mind the...

Figure 2: Example of Intent in Car Recommendation feature

Because the Car Recommendation system feature will customize the model selection according to each user's different living habits and driving habits, most of the intents created by CarsAI utilizes custom entities such as @diatasnce, @speed, and so on. But there will be system intents created and used in the car service reservation system feature, and that will be elaborated in the next part.

speed

SAVE

☒ Define synonyms ⓘ
 ☐ Regexp entity ⓘ
 ☐ Allow automated expansion
 ☐ Fuzzy matching ⓘ

high	in a high speed, high speed, high
normal	in a normal speed, normal speed, normal
both	both, both speeds
Click here to edit entry	

+ Add a row

Figure 3: Example of Custom entity in Car Recommendation feature

Dialogflow used in Car Service Reservation feature

Regarding the Car Service Reservation feature, the system will match the service type in the car service entity according to its input. It will guide the user to explain the time and date to call the Google Calendar API to schedule the service time on the user's Google calendar. The feature also has the ability to recognize whether there is a time confliction in the user's arrangement.

Training phrases ⓘ

Search training phrases 🔍

⌵

Add user expression

set an appointment for **drivers license** at **3pm** **tomorrow**

I would like to set an appointment for **3pm** **on Tuesday** ⓘ

Set an appointment **on Wednesday** at **2pm** ⓘ

Action and parameters ⌵

Enter action name

REQUIRED ⓘ	PARAMETER NAME ⓘ	ENTITY ⓘ	VALUE	IS LIST ⓘ	PROMPTS ⓘ
<input checked="" type="checkbox"/>	AppointmentType	@AppointmentType	\$AppointmentType	<input type="checkbox"/>	What services a...
<input checked="" type="checkbox"/>	Date	@sys.date	\$Date	<input type="checkbox"/>	What date will ...
<input checked="" type="checkbox"/>	Time	@sys.time	\$Time	<input type="checkbox"/>	What time? [1]
<input type="checkbox"/>	Enter name	Enter entity	Enter value	<input type="checkbox"/>	—

+ New parameter

Figure 4: Example of Intent and Entities in Car Service Reservation feature

In this feature, in addition to using the system entity (**@sys.time** and **@sys.date**), the reservation service type has also been customized to extract the service users want to book accurately. The following figure shows the custom entity of this feature (**@AppointmentType**).

AppointmentType SAVE

☒ Define synonyms ☐ Regexp entity ☐ Allow automated expansion ☐ Fuzzy matching

Drivers License	Drivers License, DL, license, test, real ID
Vehicle registration	Vehicle registration, registration, car registration, register
Car Maintenance	Car Maintenance, maintenance, car maintenance
Car Repairing	Car Repairing, Car repair, Repairing

[Click here to edit entry](#)

[Add a row](#)

Figure 5: Example of Custom entity in Car Service Reservation feature

After booking related car services through chatbot, Google calendar API will be called through the Inline Editor code to deploy the schedule to the user's calendar. As the following figure shows.

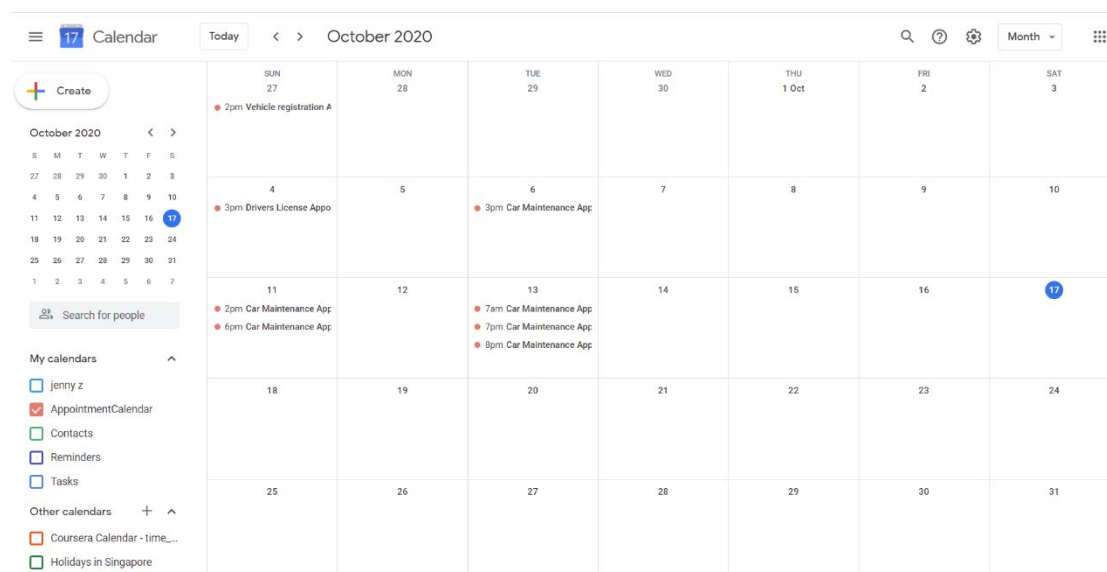


Figure 6: User Calendar display after calling Google Calendar API

Dialogflow used in FAQs feature

Regarding the FAQ feature, this system constructs dozens of common Audi car purchase maintenance and follow-up service questions crawled from different forums and official websites and provides corresponding solutions to Audi car owners' common problems through the friendly interactive interface powered by Google Dialogflow.

Audi
SAVE

☐

Question:

How to set Personal Points of Interest (POI) in local storage in the vehicle?

Answer:

Using an SD card, the user can load his/her own points of interest to the vehicle. This data is displayed on the map and can be used for navigation. The data is stored locally in the vehicle. The data is only sent to the AUDI AG when another service is used.

● ENABLED

Question:

What data is processed by the vehicle?

Answer:

If your vehicle has a wireless internet connection, you are enabled to share data between your vehicle and other systems (the data servers of AUDI AG or the data servers of service providers). In certain countries, the wireless internet connection is enabled by an on-board transmitting and receiving unit (permanently installed by the AUDI AG) or via a mobile device provided by you (e.g. a smartphone). This wireless internet connection enables the use of online features (information and control services for your vehicle). These include online services and applications/apps that are provided by the AUDI AG or other providers (the "Audi connect services" or the "services").

● ENABLED

Question:

Which Audi exclusive materials are available for you?

Answer:

Paint finish: A large selection of paint colours with over 50 shades is available for customising your vehicle. In order to meet the very high demands of AUDI AG and Audi Sport GmbH and to be able to guarantee extremely high paint quality over the long term, ultra-modern painting systems have been installed. The desired shade is mixed using organic and

● ENABLED

Figure 7: KB of FAQs

Webhook and Fulfillment Service

The chat agent will send an HTTP POST request with JSON Webhook from Dialogflow's server to the webhook service hosted by the web server whenever an intent is matched from the user's input. Subsequently, the web server will map the request with the corresponding fulfillment function by its matched intent. Typically, the fulfillment function will extract the JSON body's parameters' values and process it through business rules. If it fails to meet the form of entities' requirements, it will respond to the user via the chatbot to ask the user to provide the correct input. Otherwise, it will provide another question to elicit the next required input from the user via a chatbot response. For example, if the input provided by the user is an irrelevant and irregular answer (not matching the system or custom entity), the system will not extract the information as a parameter, and it will trigger the chatbot to ask users to input again.

3.2 Database Construction

Both the pre-sale service and the after-sale service need a great deal of data. When doing the pre-sale part, we crawling information from the Internet, while we call API at the after-sale service part. Because there is no proper API that contains vehicles' parameters, we have to crawl information

by ourselves. Calling Google calendar API helps our system locate automobiles service centers, and calling Google calendar API helps us arrange appointments for customers with centers.

Cars data

As mentioned above, we crawling car data from the website called "Auto Home," a website that contains specifications of all Audi cars on the market. We select eight attributes from the car that will influence customers to make purchase decisions as key attributes. The eight attributes we chose are cars' names, prices, intaking types, displacement, driving modes, maximum power, engine, and the picture resource. Taking one item as an example and showing the result in the following table:

Tab2: Characteristics of cars

Car Id	Price	Intake	Displacement	Drive Id	Power	Engine	Address
Audi A3 2020 to 35TFSI Sportback VI aggressive	193200	turbo	2	Lead precursor	110	1.4T 150 horsepower L4	https://www.autocar.co.uk/sites/autocar.co.uk/files/styles/gallery_slide/public

The data is inserted into the database:

	id	brand_id	price	intake_id	displacement	drive_id	max_power	engine_id	curise_id	pic_address
<input type="checkbox"/> Edit <input type="checkbox"/> Copy <input type="checkbox"/> Delete	1	Audi A3 paragraphs 2020 to 35 TFSI Sportback VI ag...	19320	turbo	1.4	Lead precursor	110	1.4 T 150 horsepower L4	Cruise control	https://www.autocar.co.uk/sites/autocar.co.uk/file...
<input type="checkbox"/> Edit <input type="checkbox"/> Copy <input type="checkbox"/> Delete	2	Audi A4 2020 Avant avant-garde 40 TFSI kinetic mod...	34180	turbo	2	Lead precursor	140	2.0 T 190 horsepower L4	Cruise control adaptive cruise at full speed	https://www.autocar.co.uk/sites/autocar.co.uk/file...
<input type="checkbox"/> Edit <input type="checkbox"/> Copy <input type="checkbox"/> Delete	3	Audi A5 Coupe 2020 paragraph 40 TFSI fashion type ...	37980	turbo	2	Lead precursor	140	2.0 T 190 horsepower L4	Cruise control	https://external-content.duckduckgo.com/iu/?u=http...
<input type="checkbox"/> Edit <input type="checkbox"/> Copy <input type="checkbox"/> Delete	4	Audi A6 Avant 2020 paragraph avant-garde 40 TFSI L...	44980	turbo	2	Lead precursor	140	2.0 T 190 horsepower L4	Cruise control adaptive cruise at full speed	https://www.autocar.co.uk/sites/autocar.co.uk/file...
<input type="checkbox"/> Edit <input type="checkbox"/> Copy <input type="checkbox"/> Delete	5	Audi A7 2020 40 TFSI luxury	57380	turbo	2	Lead precursor	140	2.0 T 190 horsepower L4	Cruise control	https://www.autocar.co.uk/sites/autocar.co.uk/file...
<input type="checkbox"/> Edit <input type="checkbox"/> Copy <input type="checkbox"/> Delete	6	Audi A8 paragraphs 2019 change Plus 50 TFSI A8L qu...	83880	turbo	3	Front all-wheel-drive	-	3.0 T 286 horsepower V6	Adaptive cruise control full speed cruise	https://www.autocar.co.uk/sites/autocar.co.uk/file...
<input type="checkbox"/> Edit <input type="checkbox"/> Copy <input type="checkbox"/> Delete	7	Audi S3 2019 S3 2.0 T Limousine	36380	turbo	2	Front all-wheel-drive	213	2.0 T 290 horsepower L4	Cruise control adaptive cruise	https://www.autocar.co.uk/sites/autocar.co.uk/file...

Figure 8: MySQL Database of CarsAI system

Customer Preference

To study customer preferences and make recommendations, we designed a questionnaire to investigate customers' preferences based on their background information. The questionnaire contains seven questions that help draw a customer background and clarify his/her favorite car.

Later on, the data will be used to train a machine learning model for the recommendation.

We obtained 260 samples from age between 20-60 years old as the training data, and based on these preferences data, our system is able to make precise recommendation.

Google Map API

To mark the automobiles service centers on the map so that customers can query these locations, we call the Google map API to realize the function. After registration, we can get the key. It is clear how many centers are there in Singapore, so customers can easily find which is the nearest center for them when using our systems.

The following image is the map allocated in our system, which shows Audi automobiles service centers' locations.



Figure 9: Audi sales store location information

After clicking the bottom at the left corner, the user can change the normal map into a satellite map.

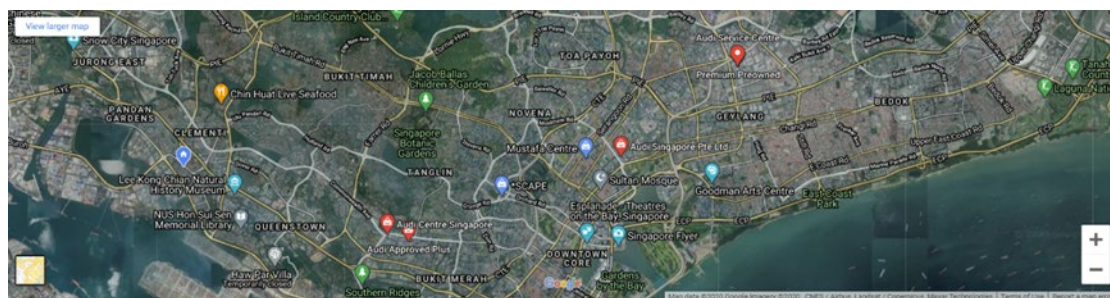


Figure 10: satellite map of Audi sales store location information

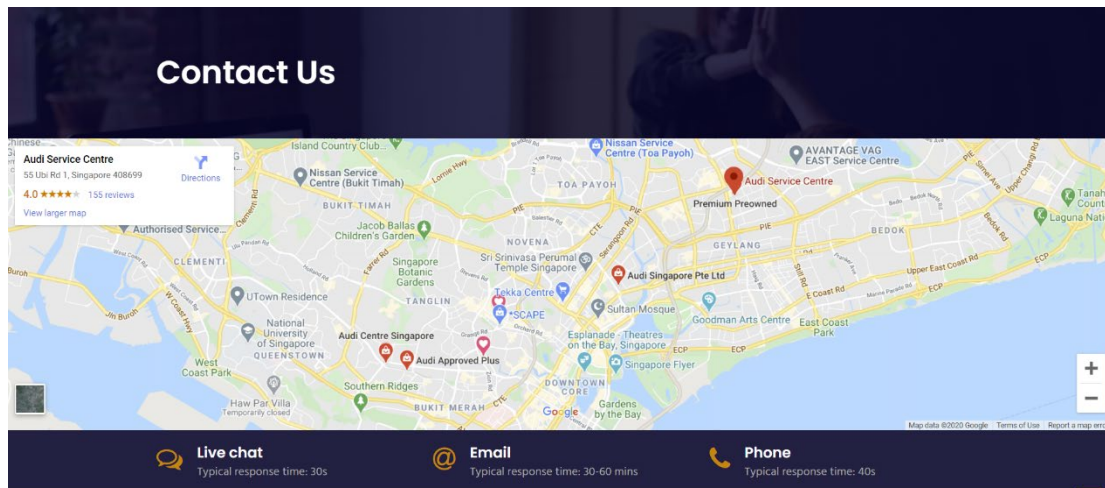


Figure 11: The webpage calling Map API

Google Calendar API

Date and scheduled event data need to be obtained by calling Google Calendar API. By compiling the Node.js file in the Inline Editor of Google Dialogflow, we can make calls to Google Calendar API, and the time format is set to the format of the East 8th district of Singapore time to adapt to the calendar habits of the user's location. Through user input, calling the Google Calendar API to get the date information, and then add events in the calendar. At the same time, users can also be notified whether there is a time conflict.

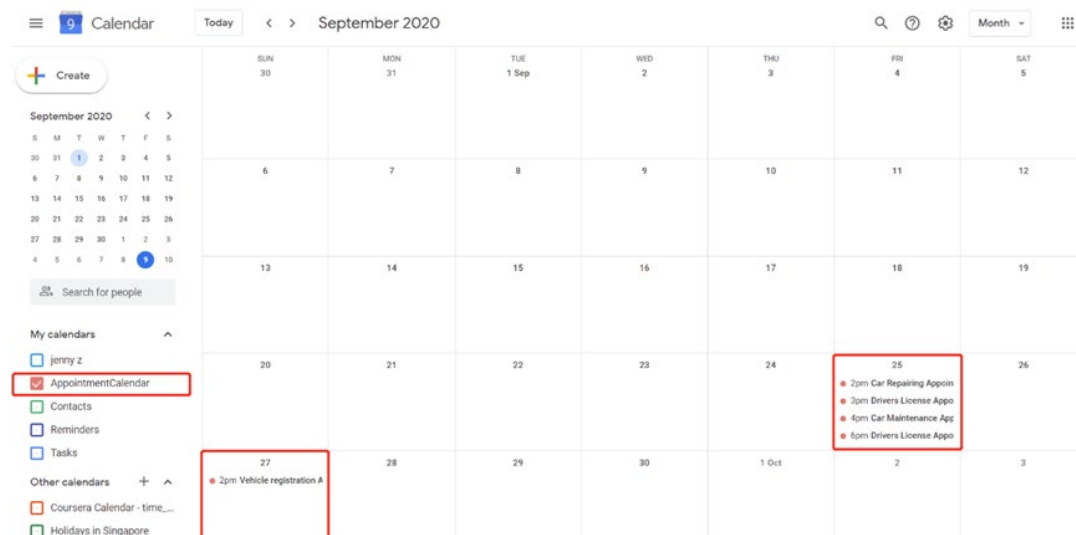
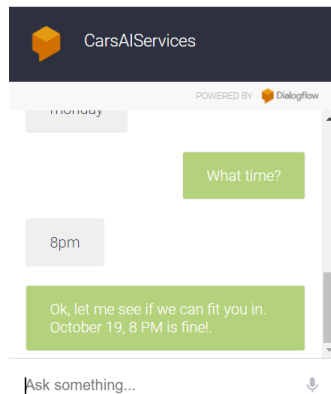


Figure 12: User Calendar display after calling Google Calendar API

3.3 Services-Booking System

This system is used to arrange and manage customer appointment car services. In the Inline

Editor of Google Dialogflow, the Google Calendar API is called first, and then the customer's appointment service and time will be arranged on the calendar. Users input the date, which are matched with the calendar date, and the system also records the reservation of each day. If there is no reservation in this period, the service can be added normally. If there is a reservation event, the user will be notified of the time conflict and change to another period.



Vehicle Registration

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud.

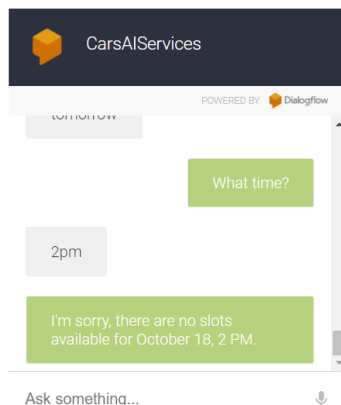
Car Maintenance

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud.

Car Repairing

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud.

Figure 13: Appointment result success interface



Vehicle Registration

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud.

Car Maintenance

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud.

Car Repairing

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud.

Figure 14: Appointment result failure interface

The Offline user can also use this system to reserve the service appointment.

3.4 Knowledge-based System

By searching for questions on the Audi owner's forum and related official websites and asking about the relevant experience of the management personnel of the Audi car dealer, CarsAI system has built a KB based on a large number of Audi car problems and solutions, including car use, insurance processing, and car maintenance and so on, Giving a one-stop solution platform for Audi owners. This system can still be used when the user has no network access as well.

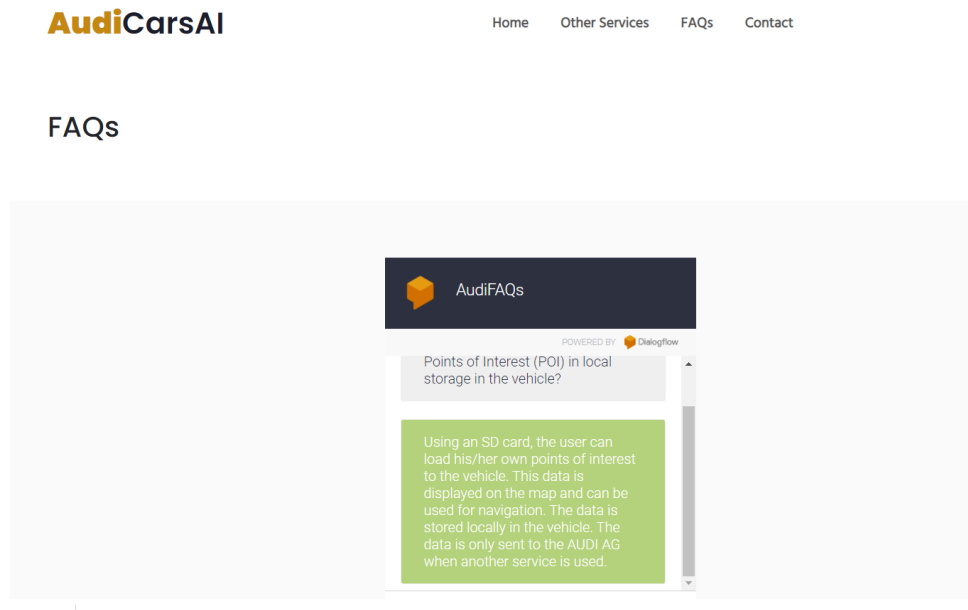


Figure 15: Knowledge-based System interface

3.5 Machine learning System

SVM

In machine learning, support vector machines (SVMs, also support vector networks) are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis.

The objective of the support vector machine is to find a hyperplane in N-dimensional space that distinctly classifies the data points. Maximizing the margin distance provides some reinforcement so that future data points can be classified with more confidence.

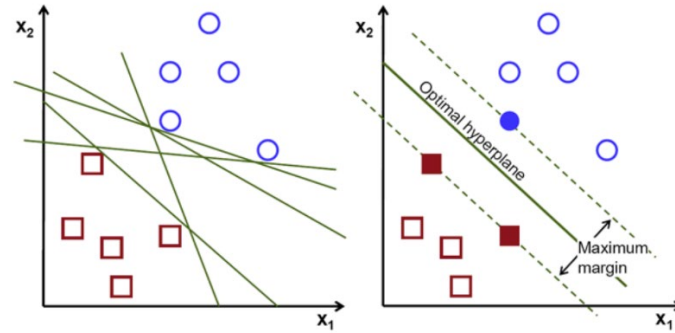


Figure 16: Possible hyperplane

Support vectors are data points that are closer to the hyperplane and influence the position and orientation of the hyperplane. Using these support vectors, we maximize the margin of the classifier. Deleting the support vectors will change the position of the hyperplane. These are the points that help us build our SVM.

In the car recommendation system feature, after receiving the user's input about living habits and driving habits through the Google Dialogflow, The webhook receive the parameters and then calls the SVM function. The trained SVM model is used to make customized recommendations for the models that the user may be satisfied with. The training data set is obtained through a questionnaire survey of some Audi car owners.

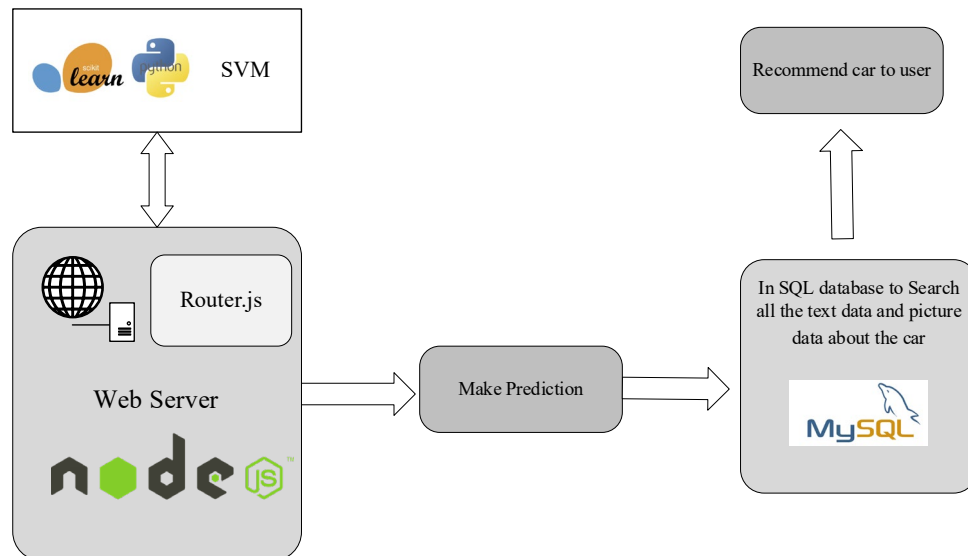


Figure 17: Implementation process of ML system

3.6 Web Server

The Web Server is developed under Node.js environment with Express.js framework and also various tools and packages such as Ajax, body-parser and so on. It acts as the middleware serving

multiple functions as below:

- I. Handling HTTP requests;
- II. Handling car recommendation request from front-end;
- III. Calling python scripts via child process

Handling HTTP requests

It primarily handles the HTTP requests on this system to fulfil other functions such as webhook service or fulfil clients' requests to serve web pages.

Handling car recommendation request from front-end

The server is hosting the Dialogflow agents and the HTML scripts. The user interfaces are built using HTML5, CSS3, jQuery.

The Dialogflow agent will identify the user's intent, extract the relevant keywords based on the inputs, and then send it to the server. The server will then call the ML algorithm to make an estimation. After getting the result generated by the Machine Learning algorithm, the server will then use the result to search among the database to obtain the target vehicle's specifications and the picture. If the target vehicle is successfully found in the database, the server will return the specifications and the picture to the web interface. The Dialogflow agent will notify the user that it finds a vehicle that suits the user. The user then has to click the "Show result" button to show the recommended vehicle's specification and picture.

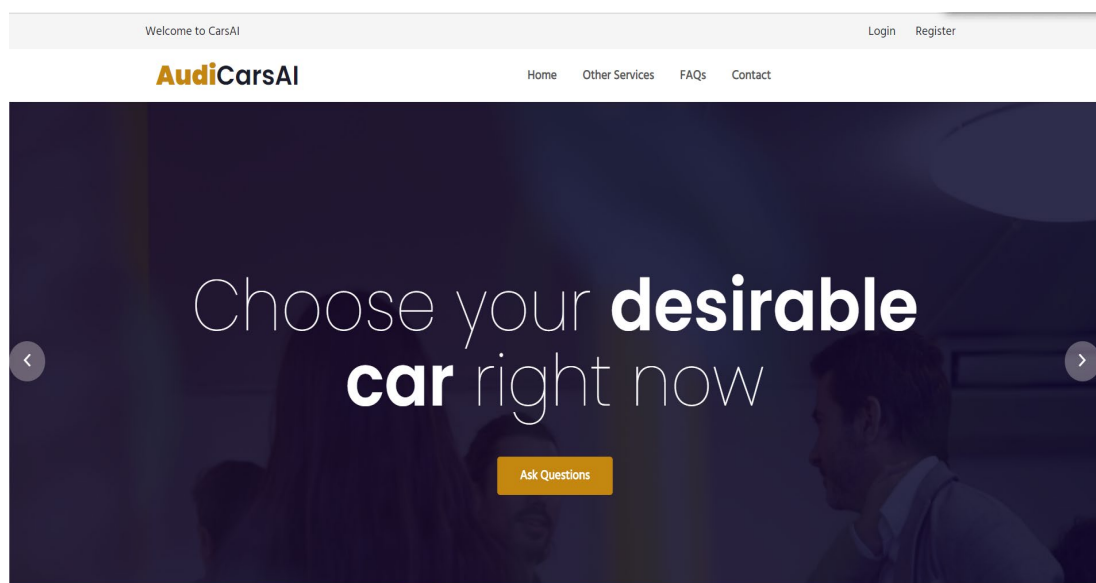


Figure 18: Homepage of CarsAI I

CarsAI Chatbot

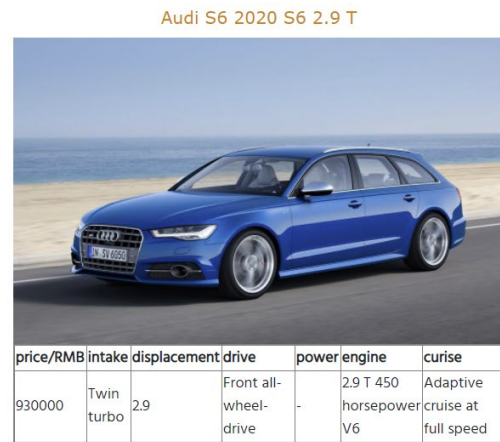
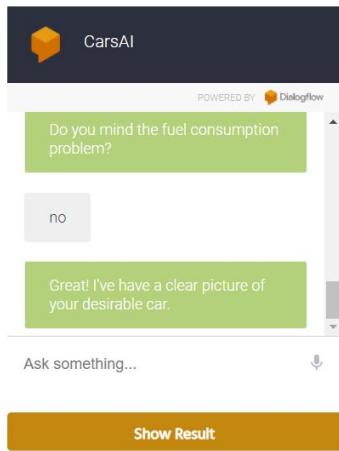


Figure 19: Homepage of CarsAI II

Calling python scripts via child process

The server will save the keywords extracted by the Dialogflow agent into a list of variables and then takes advantage of the child process to run the machine learning algorithm. These variables will be passed into the child processes to be used as input arguments by the python scripts. After getting the result processed by the machine learning algorithm, the server will find the vehicle's specifications and the picture corresponding to the result through the database connection pool. If the target vehicle was found in the database, the server returns specifications and the picture to the user interface, as shown in the subsection above.

4. Conclusion

In the project of this certificate, our team designed an interactive and friendly system - CarsAI for Audi that can provide users with one-stop car selection and follow-up services in response to the pain points of the current car market sales difficulties problem. With the help of the Google Dialogflow platform, through the user's input, the user's living and driving habits are learned, and the ML algorithm is used to predict the recommended vehicle, thereby calling the database The connection pool provides customers with complete vehicle information. At the same time, the system also provides customers with car service reservations and car dealer navigation services by calling Google Calendar API and Map API. Moreover, for users' common vehicle purchase and maintenance problems and so on, the system integrates a large number of common problems to construct Audi car problem KB which provides solutions according to users' actual problems. In summary, CarsAI is a comprehensive automobile sales and service system that integrates automobile selection, service, and problem inquiry.

APPENDIX

Appendix A: Project Proposal

GRADUATE CERTIFICATE: Intelligent Reasoning Systems (IRS) PRACTICE MODULE: Project Proposal

Date of proposal: 19 October 2020
Project Title: CarsAI
Sponsor/Client: <i>(Name, Address, Telephone No. and Contact Name)</i> Academic Self Sponsored Project.
Background/Aims/Objectives: <p>Affected by the COVID-19, the automobile industry has been hit hard. The government imposes restrictions on places with high crowds such as automotive service shop, which caused a sharp drop in the number of people going out for shopping and consumption, and almost stagnated automobile sales, resulting in increased inventory and huge pressure. At the same time, this also brings huge problems to the after-sales service of the automotive industry. Therefore, it is very important to open up new online channels. Both online pre-sales service and after-sales service will bring new automotive industry opportunities.</p> <p>Therefore, we have designed a car recommendation system for the veteran car manufacturer, Audi, to help consumers easily choose a suitable vehicle with the online recommendation system's help and have good after-sales service experience. The online car recommendation system can help new customers without any knowledge of cars choose their proper cars with SVM model's help. It will also provide thoughtful after-sales services by helping customers make appointments with the nearest automotive service shop.</p> <p>We use the machine learning algorithm to realize the recommendation system and deploy Google Dialogflow agents to give users intelligent help, which can help Audi make a breakthrough in their dilemma.</p>
Requirements Overview:

Research ability
 Programming ability
 System integration ability

Resource Requirements (please list Hardware, Software and any other resources)

Hardware proposed for consideration: CPU

Software proposed for consideration:

- XAMPP
- MySQL
- Ngrok
- Node.js
- Express.js
- Python

Number of Learner Interns required: (Please specify their tasks if possible)

A team of four project members.

Methods and Standards:

Procedures	Objective	Key Activities
Requirement Gathering and Analysis	The team should meet with ISS to scope the details of project and ensure the achievement of business objectives.	1. Gather & Analyze Requirements 2. Define internal and External Design 3. Prioritize & Consolidate Requirements 4. Establish Functional Baseline
Technical Construction	· To develop the source code in accordance to the design. · To perform unit testing to ensure the quality before the components are integrated as a whole project	1. Setup Development Environment 2. Understand the System Context, Design 3. Perform Coding 4. Conduct Unit Testing
Integration Testing and acceptance testing	To ensure interface compatibility and confirm that the integrated system hardware and system software meets requirements and is ready for acceptance testing.	1. Prepare System Test Specifications 2. Prepare for Test Execution 3. Conduct System Integration Testing 4. Evaluate Testing 5. Establish Product Baseline

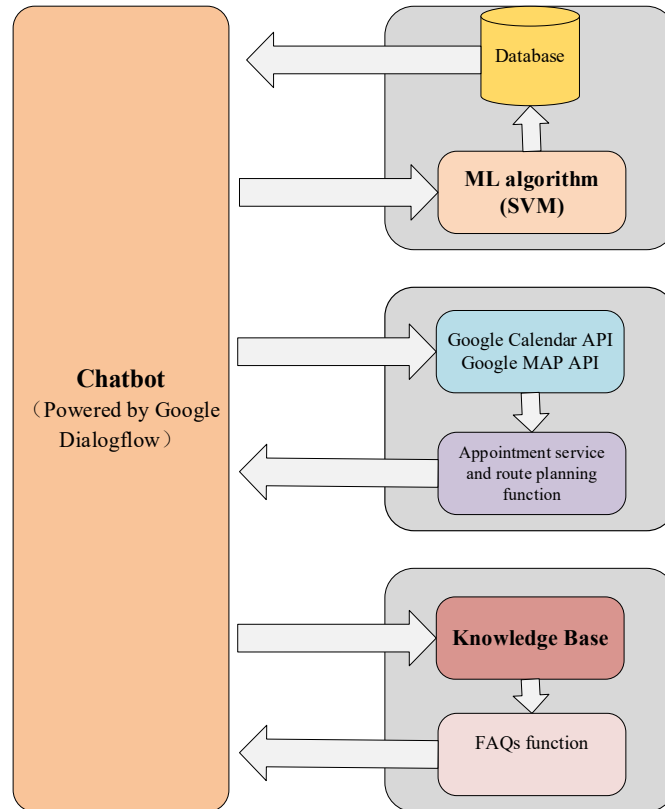
Acceptance Testing	To obtain ISS user acceptance that the system meets the requirements.	<ol style="list-style-type: none"> 1. Plan for Acceptance Testing 2. Conduct Training for Acceptance Testing 3. Prepare for Acceptance Test Execution 4. ISS Evaluate Testing 5. Obtain Customer Acceptance Sign-off
Delivery	To deploy the system into production (ISS standalone server) environment.	<ol style="list-style-type: none"> 1. Software must be packed by following ISS's standard 2. Deployment guideline must be provided in ISS production (ISS standalone server) format 3. Production (ISS standalone server) support and troubleshooting process must be defined.

Team Formation & Registration

Team Name: GROUP 5
Project Title (repeated): CarsAI.
System Name (if decided):
Team Member 1 Name: Meng Zhaoyi
Team Member 1 Matriculation Number: A0216420W
Team Member 1 Contact (Mobile/Email): Email: e0539413@u.nus.edu
Team Member 2 Name: Sun Ming
Team Member 2 Matriculation Number: A0176222L
Team Member 2 Contact (Mobile/Email): Email: e0224959@u.nus.edu
Team Member 3 Name: Li Jiayi

Team Member 3 Matriculation Number: A0215492E
Team Member 3 Contact (Mobile/Email): Email: e0535582@u.nus.edu
Team Member 4 Name: Zhao Jiaxi
Team Member 4 Matriculation Number: A0215278B
Team Member 4 Contact (Mobile/Email): Email: e0535368@u.nus.edu

Appendix B: Mapped System Functionalities against knowledge, techniques and skills of modular courses: MR, RS, CGS



	Function	Knowledge, Technique, Skills
Chatbot	Convert the conversation with the user into user intent, and the parameters that algorithm can identify.	<ol style="list-style-type: none"> 1. One part of cognitive system 2. Set the entity to accurately extract user needs 3. Give users answer options to facilitate extraction of requirements
ML algorithm	Feed the demand input parameters by the user into the trained SVM model to predict the vehicles that the user may like to realize the Car recommendation system	<ol style="list-style-type: none"> 1. The training data set is obtained through a questionnaire survey of some Audi car owners. 2. The webhook receive the parameters and then calls the SVM script. The trained SVM model is used to make customized recommendations for the models that the user may be satisfied with

Knowledge Base	Form KB based on the collected common problems, and provide solutions for users.	<ol style="list-style-type: none"> 1. By searching for questions on the Audi owner's forum and related official websites and asking about the relevant experience of the management personnel of the Audi car dealer to build a KB. 2. Including car use, insurance processing, and car maintenance and so on, Giving a one-stop solution platform for Audi owners. This system can still be used when the user has no network access as well.
----------------	--	--

Appendix C: Installation and User Guide

Please to this link:

<https://github.com/JIAYI-web/IRS-2020-10-30-IS02FT-GRP5-wdsfCarsAI/blob/main/ProjectReport/User%20Guide%20CarsAI.pdf>

Appendix D: Individual project reports

Individual project report i

Your name Meng Zhaoyi

1. Personal contribution to group project

- a) Data collection (Python crawler)
- b) Google Dialogflow setup
- c) Backend development (All the codes, including the SVM classifier)
- d) Frontend development (AJAX codes)

2. What learnt is most useful for you

I learned not to compete with anyone else. What I have learned from the project is that I'm not interested in competing, but interested in learning, in growing and in doing what's best for me.

3. How you can apply the knowledge and skills in other situations or your workplaces

Reasoning systems play an essential role in the implementation of artificial intelligence and knowledge-based systems. It can be deployed to various situations. Later on, I'll try to implement a recommender system on my personal website to recommend the most suitable products to potential customers.

Individual project report ii

Your name LI Jiayi

1. Personal contribution to group project

- a) Web front-end development
- b) Google Dialogflow setup
- c) Knowledge-based system configuration
- d) Making calls to the related API to implement system functions
- e) Report and video presentation

2. What learnt is most useful for you

Because this project is a system that integrates the learning of the three courses of Machine Reasoning, Reasoning system and Cognitive System, I think the most important part is to apply what lecturers said in the class to the practice including how to apply the ML algorithm in project to solve real problem, how to build KB to solve problems, how to make the project more practical and how to reasonably connect the front and back ends to make the project more integrated. I think the more important thing is the systematic thinking and algorithmic thinking that the teacher talked about in class, which allows us to have a clearer logic in the arrangement of the project and the application of knowledge.

3. How you can apply the knowledge and skills in other situations or your workplaces

In the Intelligent Reasoning System module, the three parts of the courses are very practical in the field of work. For example, the Google DialogFlow which we've learnt in Cognitive system classes can be used in many projects to interact with customers to extract key information. Reasoning system and Machine Reasoning system can make us better analyze customer needs and fulfill their needs. I think these are very helpful in future work areas.

Individual project report iii

Your name Sun Ming

1. Personal contribution to group project

- a) Design the architecture
- b) Web front-end development
- c) Google Map setup
- d) Mysql setup, config and Data import
- e) Routers setup
- f) Bug fix

2. What learnt is most useful for you

What is most significant for me is that we need to find the business value when we determine the topic of our project. There are many interesting points during our life, and if we can brainstorming, we can build up many beneficial projects. Then use the knowledge we learned from class to make it true.

3. How you can apply the knowledge and skills in other situations or your workplaces

We can collect users likes, then use KB to predict what customers preferred to and provide the commodity to them and it can increase sales.

We can add on the Google DialogFlow in website to answer customers questions automatically in time instead of manual. We can add some popular questions and can save both customers and us a lot of time.

Individual project report iv

Your name **Zhao Jiaxi**

1. Personal contribution to group project

- a) Collecting information
- b) Market researching
- c) Composing report
- d) Other assistant works

2. What learnt is most useful for you

Before these courses, I knew nothing about Machine Reasoning, Reasoning system and Cognitive System. Also, I was not experienced in building a complete system. With my teammates' intelligence and help, I learnt how to construct an industrialized system, how to convert the knowledge into user-friendly interface.

3. How you can apply the knowledge and skills in other situations or your workplaces

If I have a chance, I would like to build another recommendation system similar to what we have done in the project to help my workplace to form an online recommendation system. This project is a precious experience for me.