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**Chapter 1: Introduction**

**Abstract**

The food we eat will have a profound effect on our health. Everybody has a strong opinion, diverse assertions about What is Healthy Nutrition. Changes in diet help many health problems including obesity, diabetes and certain risk factors for cancer and heart disease. Diet planning is the science of how food and nutrition effect on human health. Therefore, People around the world seeking to maintain their weight by limiting junk foods and eating more nutrition foods. For this an automated Dietitian is required to help people improve their health.

Smart dietician bot is an AI system that can gather daily intake of calories, weight, height, age, working hours (Activity Level) and analyze the given data and consult as a real dietician. Most importantly this dietician can take health condition (like diabetes or cardiac patients) into account and suggest their meal plans and suitable workout routines. Furthermore, this provides full details of the nutritional formula required for the body and necessary number of calories to burn fat/maintain BMI, increase with the plan by answering some queries.

This is appropriate for users who need to improve their health. Also appropriate for users who need to prevent from certain risk factors and to have care and consultation. Also, people can be in touch with the nutritional formula required for their body.

Artificial intelligent bot become visible as an important research area in recent past. Study about existing work on dietician Artificial intelligent bot useful for construct, a new solution.

1.1: Project AIM

We all know the adage, "You are what you eat." Maintaining your health is one of the first steps to managing weight, and a big step to maintaining your health is eating well every day.

Therefore, the project Dietitian-Bot goal is to process diet plans and give some better recommendations according to user conditions and needs. This application includes meal plan management plus Assistant to respond in a timely fashion and be all round user friendly. Assistant is the chatbot of the meal plan app. User don’t have to go through the application to get their generated diet plans and suggested recommendations by changing tabs, button clicks etc. Assistant makes the user interaction as easy and fast as possible to ensure that the users time is not wasted and that they get what they want without any difficulty or misunderstanding

from the application in one place by asking some queries. Ultimate aim of the project is to help people around the world to build a healthy society by consult as a real dietitian free of charge.

1.2: Project Background

To understand any complex system, at first, an abstracted high-level introduction of the subject and explanation of the architecture which perfectly considering the complex system and allows for a better understanding of details later is not only compulsory but also important. Therefore, in this section will cover the background research that I have conducted into different kind of chatbots and some of the advance technologies I’ve explored.

In Sri Lanka, we have become an overweight society. Our busy lifestyles and the abundance of convenience foods have fostered our expanding waistlines. Our society supports working long hours followed by responsibilities to our families, children and other things that take up time. Convenience food items and fast food restaurants provide a quick meal for people constantly on the go. An April 2010 Prevalence of overweight and obesity in Sri Lankan adults [1] report noted that “relatively high prevalence of overweight and obesity, particularly, abdominal obesity among adults in Sri Lanka which is a middle‐income country. Urgent public health interventions are needed to control the problem at an early stage.” The idea for this project was born when understanding the future risk of obesity and other related risk factors.

AI Bots (also known as Artificial Conversational Entity, chatbot) is a computer program or an artificial intelligence that conduct conversation via audio or

textual messages [2].

In 1950, Alan Turing’s well-known article “Computing and Machinery and Intelligence” [3], which projected the Turing test as a criterion of intelligence that depend on the fact that a real written discussion with a computer program to imitate a human in a real-time written conversation with a human judge. The historic chatbots are ELIZA (1966) which was mimicked human conversations by pattern matching and substitution methodology however passed the turning artificial intelligence test and PARRY (1972) was more advance than ELIZA also called “ELIZA with and attitude”. From 1966 onwards, computer programmers and business owners understood the usefulness Bots can provide to end users, specially when the information can be categorized into concrete and predictable subjects. Modern chatbots are more complex and feature natural language processing that can learn from user inputs. They can access APIs to get information users such as news, weather, time etc. They can even process orders and make bookings entirely through a chatbot interface. Chatbots are well suited for mobile devices as messaging is at the heart of a mobile phone.

Generally, bots use Natural Language processing techniques to Input versus analysis and output. Natural Language Processing (NLP) is the study of letting computers understand human languages [4]. Without NLP, human language sentences are just a series of meaningless symbols to computers. Computers don’t recognize the words and don’t understand the grammars. NLP can be regard as a “translator”, who will translate

human languages to computer understandable information. Traditionally, users need to follow well-defined procedures accurately, in order to interact with computers. For example, in Linux systems, all commands must be precise. A single replaces of one character or even a space can have significant difference. However, the emergence of NLP is changing the way of interacting. Apple Siri [5], Microsoft Cortana [6] and Google Assistant [7] have made it possible to give command in everyday languages and is changing the way of interacting. Assistant Photos

In this project uses the API provided by Microsoft called Language Understanding Intelligent Service (LUIS). It’s a well-developed REST API for Language Understanding.

1.3: Existing Projects

**Chapter 3: DESIGN AND DEVELOPMENT**

Before step in to the design stage of SDLC, project need to ensure if it is practical or not. Therefore, feasibility study must be done. It was challenging to accept final decision of software design for this project. After some several software designs, a practically possible software design was chosen which is technically feasible and has Schedule feasibility.

3.1: REQUIREMENTS

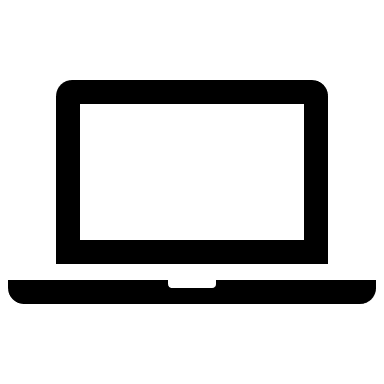
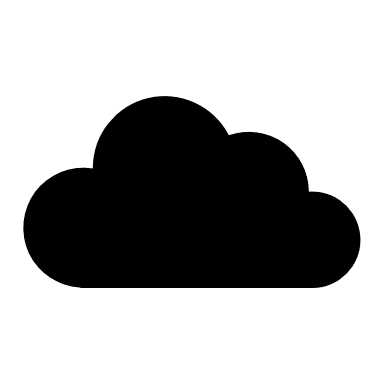
The following are the main system requirements which is to be catered by the software design.

* The application should predict the correct intent (highest score intent) by analyzing user given utterance.
* The application should extract the correct entities by analyzing user given utterance.
* An utterance can have only one top scoring intent, but it can have many entities.
* If user ask questions beyond the domain of application, then application should understand the domain and give a proper reply.
* The conversation should flow and always try to keep the user in control of the conversation.
* The application Should process accurate meal plans for users by analyzing user profile.
* The application should have an admin role for meal plan management and user management.
* User interface of the client-side should be user-friendly to provide better user experience.

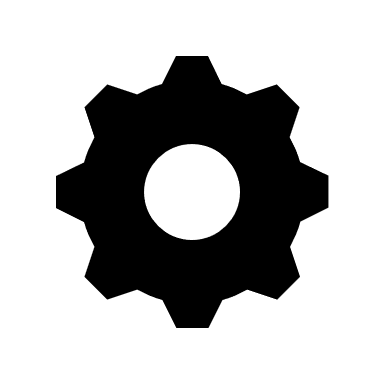
3.2: ARCHITECTURE

The entire application is programmed using Java following the MVC architecture.

After deeply go through the requirements above the entire process was outlined in the architecture overview.

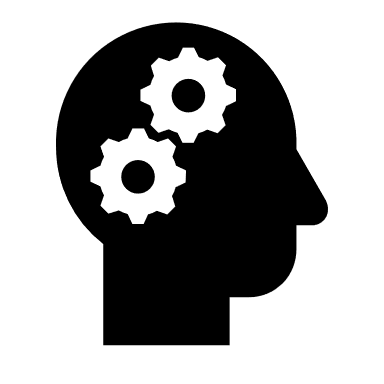


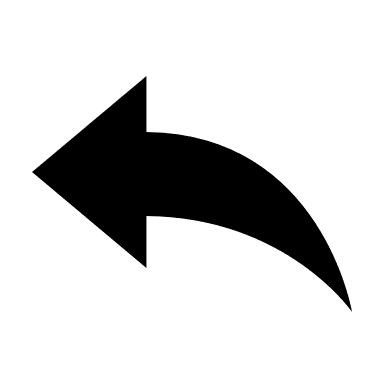


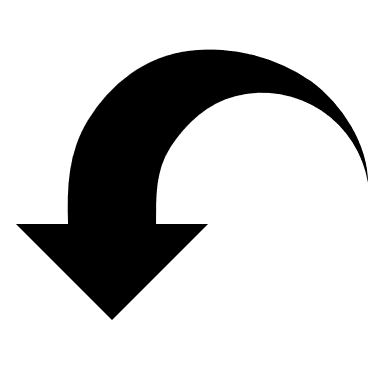


**User**

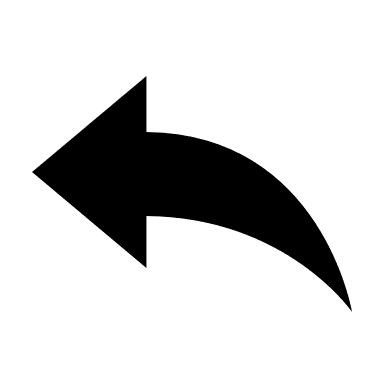
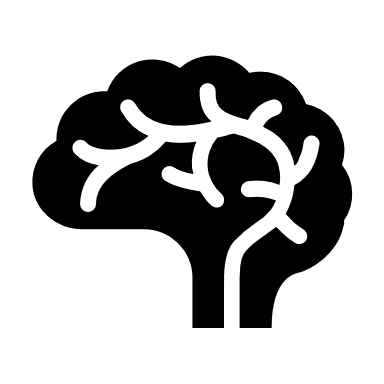
**Dietitian app running on pc** **Azure cloud**







**LUIS model**

 **Analyze user query**

**Predict the correct Intent and extract entities**

**Figure X Architecture overview**

Above diagram represents the process of entire application in short. The process of dietitian app can be break down into following Steps.

* User start the dietitian app.
* Application validates the user’s identity. If user didn’t verify, user must follow the sign-up procedure.
* After successful user identification, user can use the meal plan app in offline or get the help from dietitian assistant.
* If user prefer to get all information (suggested meal plans, recommendations etc.) from assistant, user can ask questions related to application domain. If user ask questions out of application domain app, then assistant gives a suitable response according to the situation.
* If user ask query from assistant, the application pass the user’s query to Azure cloud.
* After that Azure cloud connect with LUIS model.
* LUIS model analyzes the query and predict overall meaning, and extract attributes which is important to process in the application.
* Then LUIS model returns the attributes back to the application.
* Finally, application give good responses to the user by processing received attributes (intents, entities etc.) from LUIS model.

3.2.a: Class Diagram

After getting clear idea about the application architecture by careful analysis of the requirements above, the class diagram was drawn.

Place Figure cd

In Figure cd illustrates the class diagram according to the MVC architecture. For this, three types of objects have been used in the application.

**Model** - The model represents data and the rules that govern access to and updates of this data [8].

In Figure cd LUIS, User and MealPlan are the model classes.

**View** - The view renders the contents of a model. It specifies exactly how the model data should be presented. If the model data changes, the view must update its presentation as needed [8].

In Figure cd AdminUI, SignInUI, SignUpUI, and UserUI are the View classes.

**Controller** - The controller translates the user's interactions with the view into actions that the model will perform [8].

In Figure cd SetOfUsers, SetOfMealPlans, DietMaths and Validator are the Controller classes.

3.3: PROGRAMMING LANGUAGE

Smart dietitian bot is fully developed using Java, as there are built-in functions which are different API of JDK that supporting for app. Therefore, java provides rich solutions for this project criteria.

* ArrayList

Model the real-world objects in ArrayLists are easy, ArrayLists are more than just arrays. In this app SetOfUsers and SetOfMealPlans are the ArrayLists that used to store users and meal plans.

* String class

Operation of String concatenation support for populating responses of the assistant in a proper way. Also, tostring () function used to conversion process of strings.

* StringBuilder

StringBuilder plays a major role in assistant by appending user query along with bot response. Append function in StringBuilder supported to make better live chat interface.

* parseInteger () and parseDouble ()

These in-built functions in Integer and Double classes helped to conversion process of double and Integers and values.

* Vector class

Vector class also like ArrayList and implement dynamic array but has some changes. In this application vector class help to add rows to some tables in admin interface.

* Regex functions

A screenshot of a cell phone

Description generated with very high confidenceIn Java.util package provide regex built in functions like Pattern.compile(),matcher() Supported to validate some components in application like user registration, profile creation and guard from wrong entity values coming from the assistant etc.

Figure x-(Regular expression validation)

A screenshot of a cell phone

Description generated with high confidenceFigure x-(Regular expression validation)

* Support for file-oriented storage

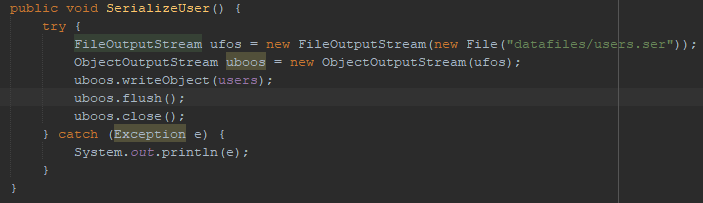
In java.io package provide Serializable interface for Java serialization. Also, FileInputStream and FileOutputStream do the file read and write process. Following is a screen shot of how the application store data in a file.

Figure x-(store users to a file.)

* Support of handling http request/response

Apache HttpComponents Client external library is used to make http requests and responses. Purpose of using this external library is to connect with Microsoft LUIS API.

* Support of handling json objects

After hit the LUIS endpoint then it returns the result as json response. Then from the methods of the java-json.jar external library, json response converted to a java object and pull the relevant data from that java object.

* Support to build attractive user interface for desktop application.

For the front end of application swing API provides a bunch of lightweight components that, to the Highest level possible, work parallel on all platforms.

3.4: METHODOLOGY

The design of the LUIS module is key to the correctness of the Natural Language

Processing and thus critical to the performance of diet assistant. Because the learning algorithm is close-sourced, most important task is to define the ​intent and ​entity clearly and labeling the sentence based on design.

Language Understanding (LUIS) is a cloud-based service that applies custom machine-learning to a user's conversational, natural language text to predict overall meaning, and pull out relevant, detailed information.

A screenshot of a cell phone

Description generated with high confidence

Figure: LUIS overview (Pedley, 2017)

A LUIS model includes:

* [**intents**](https://docs.microsoft.com/en-us/azure/cognitive-services/luis/home#intents): An intent represents a task or action the user wants to perform
* [**entities**](https://docs.microsoft.com/en-us/azure/cognitive-services/luis/home#entities): specific types of data in utterances such as number, email, or name
* [**example utterances**](https://docs.microsoft.com/en-us/azure/cognitive-services/luis/home#example-utterances): example text a user enters in the application

**Intents**

An [intent](https://docs.microsoft.com/en-us/azure/cognitive-services/luis/luis-how-to-add-intents), short for intention, is a purpose or goal expressed in a user's utterance. Each utterance is going to be classified into one intent, that is like the concept of “class” in supervised learning. For this project need to create an intent for each action like Greeting, getDietPlans, getStatus, getBMI, setAge, setHeight, setName and None intent etc. After Define a set of intents that corresponds to actions in assistant use the top scoring intent to trigger an action. For example, when "getDietPlans" intent is returned from LUIS, assistant call the getters of related java classes and populate to user interface. LUIS model come with the predefined intent, "[None](https://docs.microsoft.com/en-us/azure/cognitive-services/luis/luis-concept-intent#none-intent-is-fallback-for-app)" which is the fallback intent and used to teach LUIS utterances that are not significant to the app domain. For example, when user enter some utterance like “can you send a message to Alan” which is not important for the dietitian application then assistant prompt a proper message for user “sorry I didn’t get it, I’m trying to do my best for you”.

**Entities**

The [entity](https://docs.microsoft.com/en-us/azure/cognitive-services/luis/luis-how-to-add-entities) represents detailed information found within the utterance that is relevant to the user's request. An utterance can include many entities or none. Entities are optional but highly recommended. In this project Assistant use the list of entities as parameters to trigger an action. For example, in the utterance "Set my weight to 50 kilograms", a user asking from assistant to update his/her current weight to 50 kilograms, two entities are found "50" indicating user’s current weight and " kilograms" indicating the unit of mass. Then assistant call the Setters of related java classes to set the new value which is pull from user utterance and update current values. After that Assistant populate successful response to the user interface.

**Example utterances**

The example [utterance](https://docs.microsoft.com/en-us/azure/cognitive-services/luis/luis-how-to-add-example-utterances) is text input from the user that the consumer application must interpret. To train LUIS to extract intents and entities from them, it's important to add variety of different example [utterance](https://docs.microsoft.com/en-us/azure/cognitive-services/luis/luis-how-to-add-example-utterances)s for each intent. Active learning, or the procedure of continuing to train on new utterances, is absolutely necessary to machine-learned intelligence that LUIS provides. It can be a sentence, like “Let me know how many kilograms to loss to be in the ideal weight?”, or a part of a sentence, like “my BMI.” Utterances are not consistently well-formed, and there can be abounding utterance variation (that mean identical however made another way in word length and word placement) for a specific intent. Due to that reason, this project includes at least twelve example utterances to each intent.

**Design plan of LUIS app for Smart Dietitian Bot**

It is necessary to plan app before start making it in LUIS. Therefore, the design plan breakdown into several stages.

* Prepare a schema of the possible intents and entities that are pertinent to the domain of real dietitian and food nutrition science.
* Create an app in LUIS.
* Build model by adding intents, example utterances and label with entities according to the schema which is planned before.
* Train the model and test prediction results.
* Improve prediction accuracy by reviewing endpoint utterances, adding phrase lists and patterns.
* Finally retrain the model and publish.

| **Example user utterance** | **Intent** | **Entities** |
| --- | --- | --- |
| "Show my diet plans? " | getDietPlans |  |
| "My name is **John**" | setName | John |
| "Set my name to **Peter**" | setName | Peter |
| "Hello, Set my age to **30**" | setAge | 30 |
| "I am **40** years old" | setAge | 40 |
| "Could you please tell my **email** " | getEmail |  |
| "What is my **email** " | getEmail |  |
| "Show my **email** " | getEmail |  |
| "Set my height to **180** centimeters" | setHeight | 180, centimeters |

**Example JSON endpoint responses**

{

"query": "set my name to John",

"topScoringIntent": {

"intent": "setName",

"score": 0.89418155

},

"entities": [

{

"entity": "john",

"type": "username",

"startIndex": 15,

"endIndex": 18,

"score": 0.8410931

}

],

"sentimentAnalysis": {

"label": "positive",

"score": 0.8668431

}

}

{

"query": "show my diet plans",

"topScoringIntent": {

"intent": "getDietPlans",

"score": 0.9131645

},

"entities": [],

"sentimentAnalysis": {

"label": "positive",

"score": 0.813097

}

}

A screenshot of a cell phone

Description generated with very high confidence **Figure: LUIS dashboard**

3.5: TECHNICAL CHALLENGES

This section delineates the technical challenges faced all over the project.

**HTTP request and respond delay –** Handling http request/response via the java application has some delay than expected high speed. For this project Apache HttpComponents Client library is used to hit the Microsoft LUIS API endpoint. Apart from that there is another popular lightweight HTTP library called Unirest which is built and maintained by mashape. After checking the Unirest, there is no significant difference.

**API is under development – ​**Because API is still under development, therefore cannot fix to a version for the API, the API may change overtime. Besides, there are conflicts between the APIs and their documents or sample codes.

**Azure account –** Azure education account is limited to 10,000 transactions per month / 5 transactions per second to querying the LUIS endpoint.

**Need Proper training for LUIS model –** Training is the process of teaching Language Understanding (LUIS) app to improve its natural language understanding. Training LUIS app after updates to the model such as editing, adding, labeling, or deleting intents, entities, or utterances. Training and testing an app is an iterative process. Next trained LUIS app needs to test it with sample utterances to see if the intents and entities are predicted correctly. If they're not, make updates to the LUIS app, train, and test again.

3.5: DATABASE

As this dietitian project is a portable application, picking the most appropriate database or a file-oriented system was one of the major tasks. Following were the critical points to take a decision about final storage approach.

* Support for data encryption and authentication to ensure security of the application.
* Support for data compression.
* Support for object-oriented programming to ensure flexibility of data models.
* Should be maintain less.
* Support for the schema-less approach.
* Support for portability.
* Support from the community.

After deeply analyzing above critical points and need of developing portable desktop application, Java serialization mechanism selected as the best choice. Object serialization is a method in which the object’s state is transformed into a byte stream while deserialization is the reverse process of serialization. The most exciting fact is that the whole process is JVM independent, that means support for multiple platforms. Ultimately, this dietitian bot can run on different platforms without any data loss and without maintain. Especially the community like Stack overflow, Stack exchange were used to finish the job properly.

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