NUI Galway
OÉ Gaillimh

Final Year Project Report

Body Composition Assistance App

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Declaration of Originality

"I hereby certify that this project is entirely my own work. Neither the project nor parts thereof have been published elsewhere in either paper or electronic form unless indicated otherwise through referencing."

Fergal Broderick

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Signature

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Date

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Chapter 1

Introduction

Body composition relates to the percentage of fat, bone, water and muscle in a human body. As the proportion of bone and water cannot really be altered, the makeup of fat and muscle in the body can drastically change its appearance. The desired proportion of muscle and fat will results in a "lean" body which reduces the risk of major health problems and is considered to be healthy. A healthy body with the desired body composition can be achieved through a combination of a healthy balanced diet and regular exercise. It is essential that humans consume the required level of nutrients to both fuel the body and repair and replenish the muscles after exercise. When an individual's diet leads them to intake too much nutrients from their food or in some cases too little, the result is often a poor body composition. In the case of not consuming enough food or nutrients (under-eating) the levels of muscle and fat in the body can become dangerously low. This can results in a weak immune system, infertility or Type 1 diabetes. In extreme cases where an individual suffers from an eating disorder such as anorexia or bulimia,

organ failure can occur. In contrast to under-eating, consuming too much food can lead to an increase in the proportion of fat in the body leading to the person being classed as overweight or in extreme cases, obese.

One of the main reasons people either gain or lose weight is that humans are poor at estimating the quantity of food they eat in a day. In many cases, people do not know the specific caloric values of the food they are eating, which can result in them consuming far more calories than needed. Conversely, when under-eating, there is a deficiency in the amount of nutrients absorbed by the body. This problem typically arises as it is difficult for humans to remember the nutritional information of a wide array of foods. In the past few years, the world has become more aware of the nutritional values of food, with this information often displayed on the packaging of products. Generally, the information displayed contains the ingredients, calories and split of nutrients in the product along with the recommended daily food intake. More recently, there has been an increase in the number of websites and apps which house a vast database of foods with their corresponding nutritional values along with keeping track of the amount of calories consumed on a given day. These tools have modernised how people follow a diet plan and control their weight.

The purpose of this project is to develop an application which allows the user to create a meal based on their specific calorie and nutrient restrictions. There are many food tracking applications on the market today however the majority of these applications track what the user has eaten already today. This project will aim to differ from these by recommending a specific amount of food for the user to eat. This will mainly be of benefit to the user for meals

consumed later in the day as traditionally this is the time of day where people do not stick to a diet plan and make bad food choices.

1.1 Project Objectives

The following is a list of objectives which was outlined at the beginning of Semester 1. These show the key functionality to be kept in consideration when developing the application.

- *Achieve an understanding of basic nutrition and it affects the body*
- *Implement a database which will store food products and their nutritional values*
- *The application should allow a user to add, update and delete foods from the database*
- *Implement functionality which will allow a user to Register and Login to the application*
- *The application should display all food items in the database and allow the user to perform a search on this data*
- *The application should allow the user to edit their macronutrient values*
- *Display accurate meal results based on the macronutrient values and foods selected by the user*

Chapter 2

Literature Review

In order to obtain a greater knowledge of the scientific background of the project, it is a requirement to complete a literature review of books and academic papers. In order to improve my knowledge of how the modern human diet in combination exercise plans can effect the composition on the human body, I carried out research of literature and academic papers throughout the duration of the project but this research was primarily done during Semester 1.

2.1 Obesity

Obesity is a state of excess body fat and it is a disease which is continuously affecting all kinds of countries throughout the world including developed and developing countries. It is one of the most prominent diseases with almost one in five youths being obese in the USA. Obesity is also associated with many other diseases including cardiovascular diseases, diabetes and several

cancers [1]. Global obesity has more than doubled since 1980 and today approximately 1.9 billion adults are overweight with 600 million of these obese. 41 million children under the age of 5 are either overweight or obese. It is widely acknowledge the importance of preventing and treating obesity and the estimated cost of obesity in Ireland is thought to be 1.3 billion (safeood.eu, 2012). Not only does this excess amount of body fat lead to a poorer quality of life and massive health care bills, it also greatly increases the risk of death. The two main causes of obesity are an inactive, sedentary lifestyle and a high caloric intake, however, it has also been shown that there can be a increased likelihood of developing obesity based on an individuals's genetics.

The most common measure of obesity is the body mass index (BMI). BMI is the ratio of a persons height and weight. The formula for BMI is weight in kilograms divided by height in metres squared [2]. A person with BMI score of over twenty five is considered to be overweight and people with a BMI greater than thirty are said to be obese. The ideal range for persons BMI is 20-25 meaning a BMI less than 20 is classed as underweight. Body Mass Index is not accurate in all cases however, as it does not take into account the percentage of fat or the percentage of muscle a person has. Many elite professional athletes, such as rugby players are often classed as morbidly obese by the Body Mass Index Scale where in reality they are generally healthy individuals. As a result of this inaccuracy, there has been a shift to the Body Fat Percentage formula in the past number of years and in some cases a combination of both measuring techniques can give the most accurate results. The Body Fat Percentage of a human is the calculated by

obtaining the total mass of fat on an individuals body and dividing it by the total body. Below is table which displays the range of values which are determined healthy and unhealthy for both males and females.

Description	Male	Female
Underweight	<8%	<20%
Healthy	9-20%	20-35%
Overweight	20-26%	35-40%
Obese	>26%	>40%

2.2 Nutrition

There are a number of factors behind weight gain in humans today with the main one being the intake of excess calories on a daily basis. For an individual to gain weight, the total energy intake must be greater than the total energy expenditure. Therefore, for a person to maintain their current weight, the total energy intake and output must be in equilibrium. If a persons total energy intake is greater than their energy output over a period of time, it will result in weight gain. Conversely, if the energy intake is less than the energy output, the individual will notice some weight loss. The total number of calories/energy a person need to maintain their current weight are dependant on a number of factors such as height, current weight, gender, level of activity throughout the day, metabolic rate, etc.

2.2.1 Calories

The unit of energy used in food is calories. There are two different types of calories, a small calorie (cal) and a large calorie (Cal, kcal). A small calorie is the amount of energy required to raise one gram of water by one degree celsius whereas a large calorie is the amount of energy required to raise one kilogram of water by one degree celsius. In general, the average number of calories need to be consumed by a person on a daily basis is normally between 1500 and 2500 large calories (kcal). If your body needs 1800 calories per day to maintain your weight, your body uses 1800 calories on performing the vital functions of the body such as breathing, transporting blood around the body and maintaining the current body temperature. All of these functions are all performed when your body is at rest. The amount of calories are burned when at rest is known as your Basal Metabolic Rate (BMR).

2.2.2 Macronutrients

Nutrients are molecules in food/substances used for energy and growth by the body. The two main groups of nutrients are macronutrients and micronutrients. Macronutrients are the substances which are need in large amounts by the body. In total there are three different macronutrients - Carbohydrates, Proteins and Fats. They all provide energy to human body in the form of calories. Below is a list of the energy information of the three macronutrients and it can be seen that the Fats are the most calorie dense macronutrient.

- 4 kcals per gram of Carbohydrates
- 4 kcals per gram of Protein
- 9 kcals per gram of Fat

Carbohydrates

Carbohydrates are the most important source of energy for the body. The human digestive system coverts carbohydrates to glucose and uses this glucose as an energy source. Carbohydrates therefore are vital for athletes and for people doing a high level of activity generally[7]. People will not achieve peak performance without adequate levels of carbohydrates, however excess intake of carbohydrates can lead to weight gain[5]. There are two different type of Carbohydrates - simple and complex. It has been shown that people on a low fat diet with complex carbohydrates can lose more weight than people on a low fat diet with simple carbohydrates [5].

Proteins

The body uses Protein to create new cells and to also repair existing cells. Protein is made up of amino acids and it is vital for growth. Protein is the primary macro nutrient needed when looking to gain weight by building muscle. An adequate amount of protein is needed to maintain lean body mass and increase muscle mass[4]. It is suggested that humans should consume between one and two grams of protein per kilogram of body weight[4].

Fats

Fats are composed of fatty acids and are an essential part of the human diet. There are three different categories of fatty acids which are Saturated Fats, Polyunsaturated Fats and Monounsaturated Fats. Research has shown that the type of fat consumed is more important than the amount of fat consumed. Monounsaturated fats and a percentage of polyunsaturated fats are beneficial to a persons health whereas the majority of Saturated fats are unhealthy when large quantities are consumed. Generally, humans consume far too much saturated fat which is leading to weight gain and to other health problems such as increased cholesterol and cardiovascular disease[6].

2.3 Exercise

One of the other main factors behind weight gain in humans today is their level of activity on a daily basis. The World Health Organisation recommends that the average adult gets around thirty minutes of moderate exercise every day. One type of exercise that helps with an individuals fat loss is Resistance training coupled with a nutrition plan with calorie deficit. Resistance training has been shown to boost metabolism. This is due to muscle fibres and cells tearing with placed under tension. As a result, more energy is needed to repair these cells and to create new cells[8]. When in a calorie deficit, the body can't get the required level of energy from food sources alone so it uses body fat to help repair cells which leads to a reduction in body fat. Cardio based activities such as walking, running or swimming can also prove very beneficial in supplementing weight loss[9]. These activities will increase the

total energy expenditure which provided the total energy intake is equal to or less than the persons BMR.

Exercise is also essential for people who are looking to gain weight. Resistance training coupled with the correct nutrition will lead to muscle growth. Resistance training with a calorie surplus will lead to muscle growth in contrast to weight loss where a calorie deficit is needed. For optimal muscle growth, many factors need to be accurate such as the split of macronutrients and in particular, protein[10].

Chapter 3

Technical Review

This chapter will provide a full technical review of the technologies used in developing this project including the environments, languages, frameworks and the version control used.

3.1 Mobile Application

I made the decision to develop this application as a mobile application as it would be of most convenience to the user. Many other fitness and well being applications are also mobile applications so it would be useful if the Body Composition App can be used alongside these applications. It would also allow users to use the app and get meal ideas on-the- go without needing access to a computer. There has been a large increase in the number of mobile users in the past five years. According to Comscore, the number of mobile only users is now greater than the desktop only users. In addition, the US adult smartphone users now spends 2 hours and 21 minutes on their

smartphone per day on average [3]. This suggests that the body composition app being a mobile application would reach a greater amount of people.

3.2 Android

Android is an Open Source Mobile Operating System which has been developed by Google. It is primarily used by touchscreen smartphones and tablets. Android Inc. was founded in October 2003 by Andy Rubin, Rich Miner, Nick Sears and Chris White in California. The reason for finding the company was to "allow smarter mobile devices that are more aware of it's owners location and preferences".[11]

The company was then acquired by Google two years later in 2005. After the acquisition of the company, a mobile operating the system was developed which was based on the Linux Kernel. Within three years of the acquisition, the first mobile device to run the Android 1.0 operating system was released. Since that first release, the growth in popularity of the Android OS has gone from strength to strength. The most recent version of Android is Android 7.1.1 "Nougat".

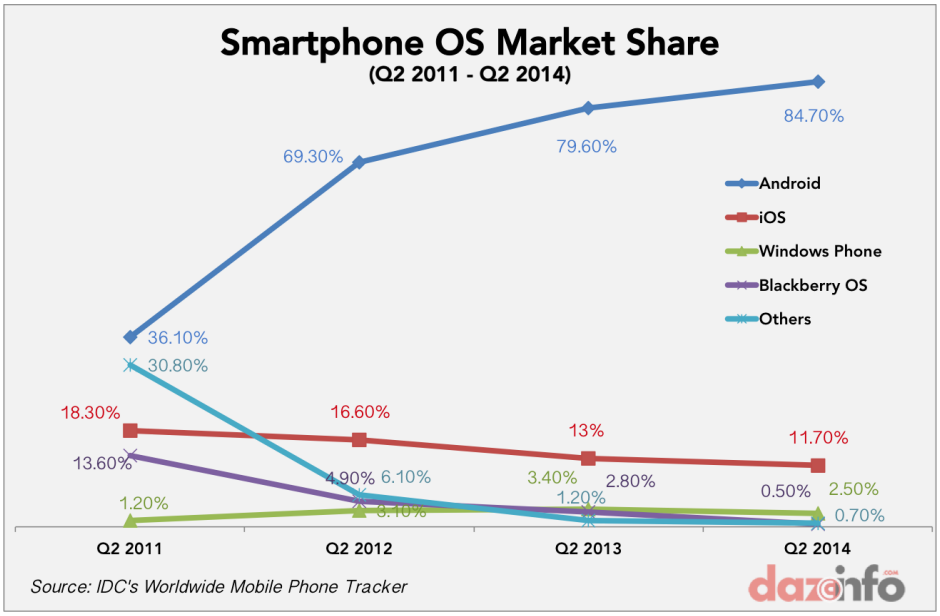


Figure 3.1: Market Share of Smartphone Operating systems, (IDC's World Mobile Phone Tracker, 2014

Approximately 85% of all smartphones in the world today run an android operating system. That is a growth of over 80% in the past seven years. The main reason Android holds such a large percentage of the market share is the large number of devices that run Android. There is a large variety of Android smartphones available from numerous smartphone manufacturers in comparison to iOS which is only used in Apple products.

3.3 Java

The Java programming language is the primary development language of Android. Java is different to other programming languages as Java code is

not compiled into machine code. Instead, Java is compiled to an intermediate format called bytecode. It relies on a Virtual Machine to interpret this bytecode and therefore all platforms that runs Java needs an implementation of a Virtual Machine. The name of the Android Virtual Machine is Dalvik and it's job is to interpret the Java bytecode and run the application on the processor. This is beneficial as Android apps can be developed on numerous platforms such as Windows, Linux and Mac and convert the source code to bytecode which can be executed on Android's built in Virtual Machine (Dalvik).

3.4 Data Storage

3.4.1 MySQL

MySQL is an open source database management system. It is the most popular open source database in the world and many large corporations such as Facebook and Google rely on MySQL. It is fast and reliable, therefore making it ideal for storing information such as user details and passwords.

3.4.2 SQLite

SQLite is the most widely used deployed database engine. It is an embedded SQL database engine which does not have a separate server process. SQLite reads and writes directly to the local disk files of the the device. This makes it a very reliable and fast database engine which makes ideal for an Android app.

3.4.3 PHP

PHP is an open source scripting language that is suited to web based development as it can be embedded in HTML. It is very useful for handling Http GET and POST requests and therefore can help with inserting, updating and querying a SQL database.

3.5 Android Studio

The Android Studio IDE was chosen as the environment to develop the application. It is the official IDE for the Android platform which made it the ideal choice for developing the Body Composition Assistance App. One of the main important features of Android Studio is that it provides an Android Virtual Device which is very useful for running and debugging applications. Android Studio also has integrated version control system meaning you don't have to manually commit changes to the source code.

3.6 Github

Git is a free and open source distributed version control system. The main advantage of Git is that it is Distributed meaning everyone has their own repository and can commit any changes to their localised repository and can access the history and versions and check in frequently without breaking the build. Due to the fact that the data is stored locally, Git is an extremely fast versioning control system. Git also has a centralised repository where all local changes can be synced and merged with one another.[12]

3.7 LaTex

LaTex was used to generate this paper. It is a document preparation system for high-quality typesetting. It is primarily used for scientific or technical documents. The main benefit of LaTex is that it uses markup tagging to define the structure of the document, determine the text, and adding citations and references.

This document was created using ShareLaTex which is an online LaTex editor. It is a server based application which can accessed through any web browser and allows compiling of projects to a PDF format.

Chapter 4

Technical Implementation

This chapter describes how the project was implemented, including the initial design, development and testing.

4.1 Initial Design

This section includes some high-level designs of the application from the early design stages. During the initial design of the application, it was decided that the database of food products would be a local database. The reasoning behind this was to allow the user to easily customise the database for their needs. In addition to this customizability, access to the database will be extremely fast giving the user an instant response. The use of a database server was most suitable for storing user details such as email and passwords. This is so that a list of users can be stored remotely in one location which is ideal for checking user credentials when logging in or registering. The app can communicate with this server using Http requests and responses. Figure

4.1 below shows a very high level view of the data storage architecture of the app and how the app communicates with the different data sources.

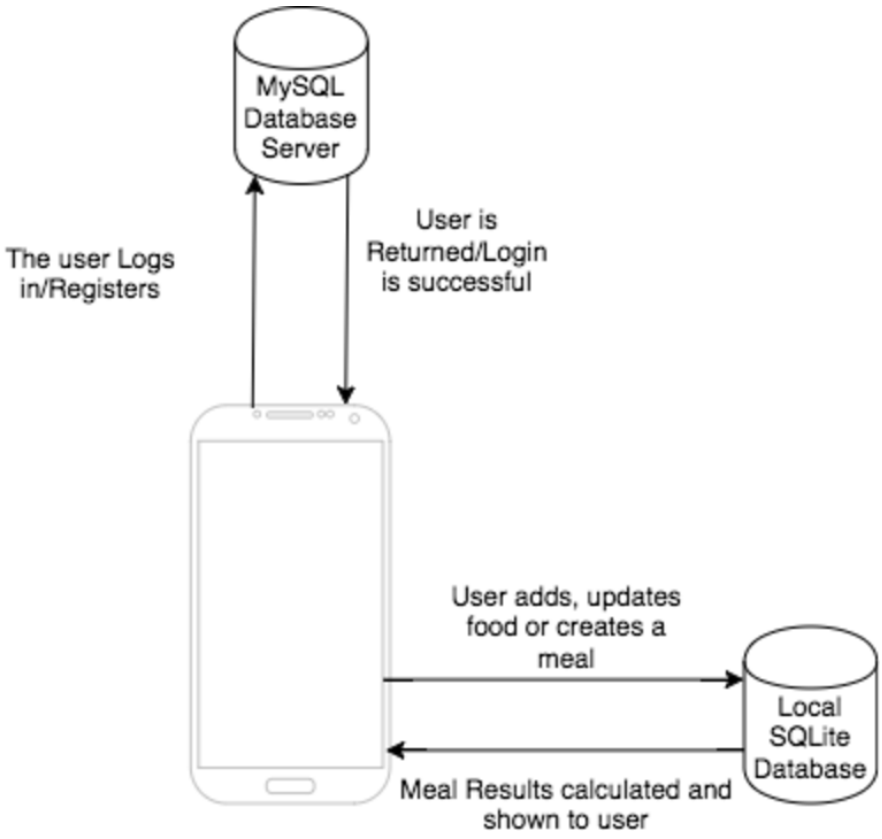


Figure 4.1: Initial Application Design

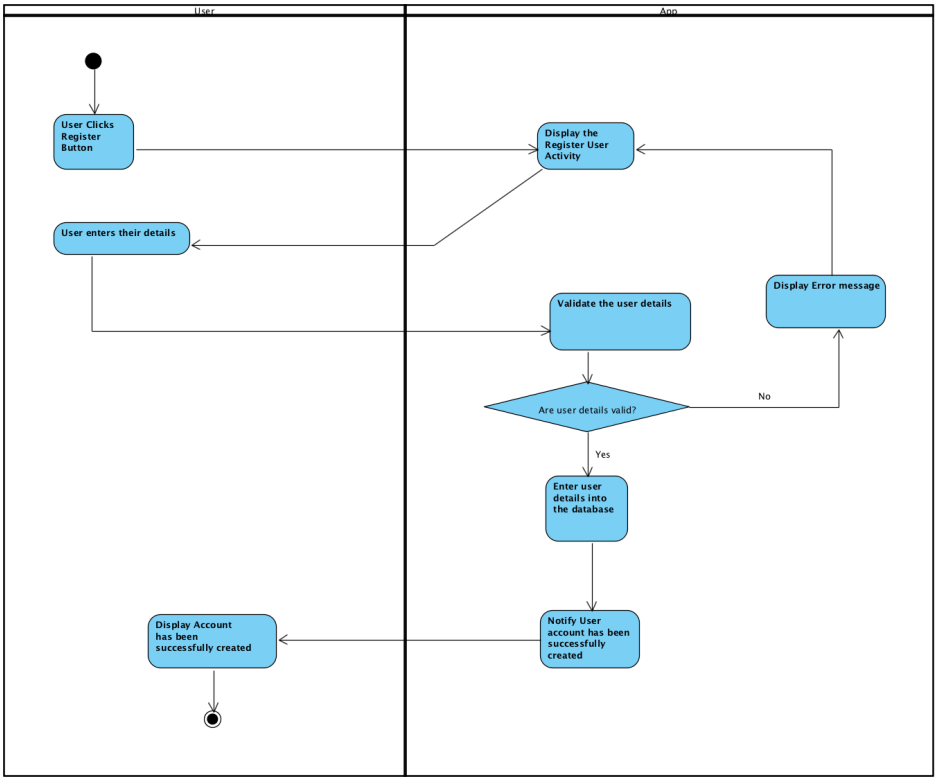


Figure 4.2: Activity Diagram for a User Registering

In the initial stages of the design some activity diagrams were created to design how the application will flow from one activity to another. Figure 4.2 shows the activity diagram for a user registering for the first time. It shows the flow of user interacting with the app.

Figure 4.3 is an Activity diagram which shows the process of a user creating a meal. The simple flow of the activity is first the user clicks on the create meal link which displays the Create Meal Activity. A list of foods will be generated and the user can choose three food items or less and submit them. The amount of each food to be eaten by user to hit their required

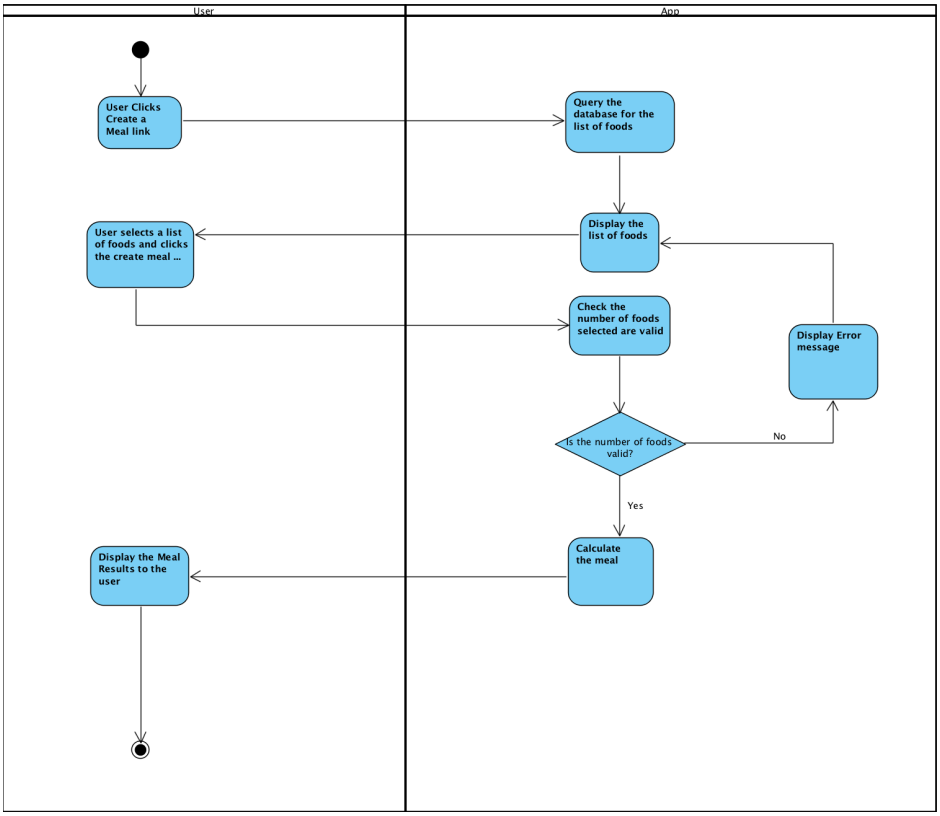


Figure 4.3: Activity Diagram for creating a new meal

macronutrient intake is then displayed to the user along with a breakdown of the macronutrient values of the meal.

4.2 Development

4.2.1 Creating Database

The first stage of the development process was implementing the code to create the local SQLite database. A Food Contract class was created class to create the local SQLite Database for the app. It defines the URI's for the app and also contains an inner class, Food Entry, which defines table name along with the names and types of the tables attributes. Each Entry in the database will contain a foods name along with its calories, carbohydrates, fat and protein per 100 grams.

```
//Name of database table
public final static String TABLE_NAME = "foods";

//All the columns that the table contains
public final static String _ID = BaseColumns._ID;
public final static String COLUMN_FOOD_NAME = "name";
public final static String COLUMN_FOOD_CAL = "calories";
public final static String COLUMN_FOOD_CARB = "carbohydrate";
public final static String COLUMN_FOOD_FAT = "fat";
public final static String COLUMN_FOOD_PROT = "protein";
public final static String COLUMN_FOOD_DESC = "description";
```

Figure 4.4: The constant values for the foods table

A content URI also had to be defined to provide a way for the content provider class to access the foods table along with all its data. A Uniform Resource Identifier (URI) is a string of characters which identifies a physical resource. The URI is in a very similar format to a URL. The content URI for the foods table "content://fyp.nuigalway.ie.bodycompostionassistance/foods"

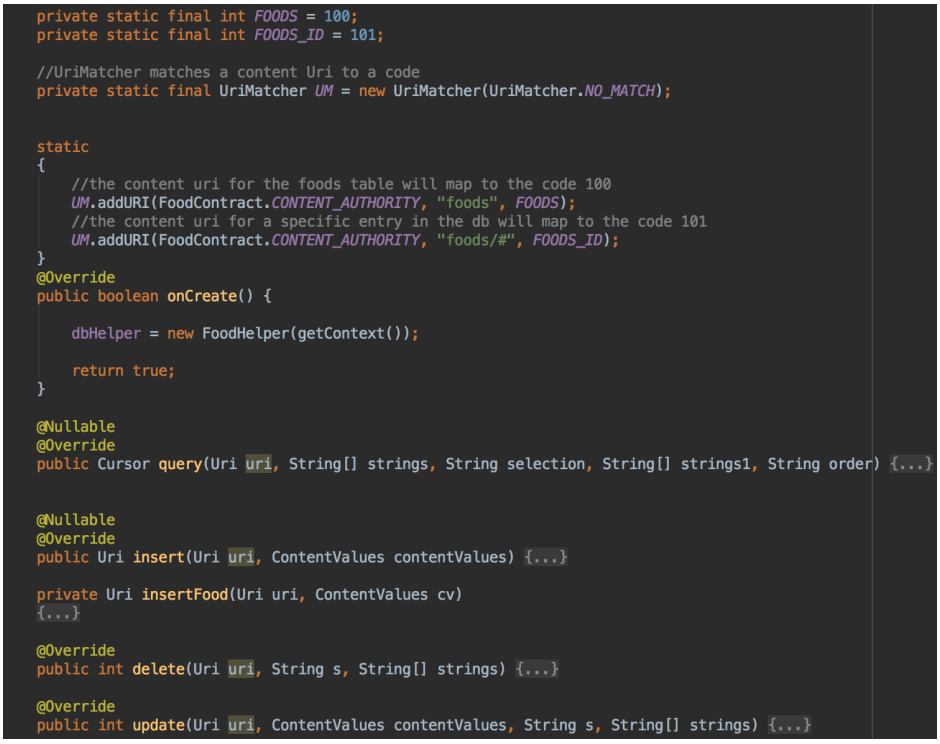
while appending the ID of a specific food to this URI corresponds to that foods entry in the database.

```
public static final String CONTENT_AUTHORITY = "fyp.nuigalway.ie.bodycompostionassistance";
public static final Uri BASE_CONTENT_URI = Uri.parse("content://" + CONTENT_AUTHORITY);

public static final String PATH_FOODS= "foods";


public static final class FoodEntry implements BaseColumns
{


    //Content URI which allows access to the foods db table from the content provider
    public static final Uri CONTENT_URI = Uri.withAppendedPath(BASE_CONTENT_URI, PATH_FOODS);
```

Figure 4.5: The Content URI for the foods table

The Database Helper class is the class used to create and manage the local database. It contains an onCreate method where an SQL query is executed to create a database table. It uses the Food Contract constant values to create the table attributes and also determines the types of these attributes. The use of the constant values means there is less of a risk of an SQL syntax error when creating the table. The SQL query also determines the primary key of the table and which values can be set as null.

The Food Provider class above contains the functionality to query, insert, update and delete from the database. This class acts as a content provider which controls the access to the database and hides the details of the data from the UI. If the database was changed to a different type of storage, the UI code of the application would not need to be changed as it could still work in tandem with the existing Food Provider. Another advantage is the UI code is directly interacting with Food provider when querying the



```
private static final int FOODS = 100;
private static final int FOODS_ID = 101;

//UriMatcher matches a content Uri to a code
private static final UriMatcher UM = new UriMatcher(UriMatcher.NO_MATCH);


static
{
    //the content uri for the foods table will map to the code 100
    UM.addURI(FoodContract.CONTENT_AUTHORITY, "foods", FOODS);
    //the content uri for a specific entry in the db will map to the code 101
    UM.addURI(FoodContract.CONTENT_AUTHORITY, "foods/#", FOODS_ID);
}
@Override
public boolean onCreate() {

    dbHelper = new FoodHelper(getContext());

    return true;
}

@Nullable
@Override
public Cursor query(Uri uri, String[] strings, String selection, String[] strings1, String order) {...}


@Nullable
@Override
public Uri insert(Uri uri, ContentValues contentValues) {...}

private Uri insertFood(Uri uri, ContentValues cv)
{...}

@Override
public int delete(Uri uri, String s, String[] strings) {...}

@Override
public int update(Uri uri, ContentValues contentValues, String s, String[] strings) {...}
```

Figure 4.6: The Food Provider Class

database and therefore database queries do not have to be manually created. The Food provider also acts as a layer of data validation as any invalid data entered can be caught by the Food provider. The main benefit of using a content provider is that other applications can easily access and use the data of this app. An example of this is how various messaging applications use the Contacts provider to access the list of contacts stored on a device.

Two codes need to be specified to identify the foods table and each specific entry in the database. A UriMatcher object is created to match Uri's in the Food provider. The UriMatcher helps the Content Provider to whether a specific URI is single entry in the foods table or the whole foods table. The

four database transaction methods use the Food Helper class to query, insert, update and delete from the database.

4.2.2 Passing Data between Activities

In an Android app, an activity represents a single screen in the app. A new instance of an activity can be started using the startActivity() method. This method takes an Intent object as it's parameter. An Intent object is a messaging object which notifies the activity to start and passes any data the activity needs. Figure 4.4 below, shows an intent in the CreateMealActivity which starts the MealResults activity and also passes an Arraylist of the foods the user wants in their meal.

```
createMealButton.setOnClickListener(new View.OnClickListener() {
    @Override
    public void onClick(View view) {

        Intent intent = new Intent(CreateMealActivity.this, MealResultActivity.class);
        intent.putExtra("foods", foods);
        startActivity(intent);
    }
});
```

Figure 4.7: An intent in the CreateMeal Activity

4.2.3 Displaying and Searching Data

The query method of the Food Provider is not very useful if the data returned cannot be displayed. The object returned from the is a Cursor object which contains the results of the query. In order to display this food data, it needs to be manipulated to be displayed to the user. The Food Adapter class can use this cursor as its data source and display the the foods and their

corresponding calories in a list format. This class extends the CursorAdapter class and inherits two methods, newView and bindView. The newView simply creates a blank list view and the bind view updates it to display the food name and calories. A Food Adapter object is used in the main activity of the app where the list of foods can be edited.

```
final ListView displayView = (ListView) findViewById(R.id.text_view_food);

View emptyView = findViewById(R.id.empty_view);
displayView.setEmptyView(emptyView);


cAdapter = new FoodAdapter(this, null);
displayView.setAdapter(cAdapter);
```

Figure 4.8: Setting the adapter to list view

The Display View is the view which will show all the foods in a list so the Food Adapter is set as the adapter for this view. This Food Adapter object is populated using the LoaderManager.LoaderCallbacks interface. It queries the Content Provider in it's onCreateLoader method. As can be seen in Figure 4.8 below, when the cursorFilter string is null, the SQL query returns the whole foods table. When the cursorFilter is not null, the SQL query is altered to only return database entries which have a name that contains the string cursorFilter which was entered in the search bar.

4.2.4 Login and Register

The Login and Register activities use a separate remote database to store data. An email and a password are the two credentials needed to log in to the app and these are both stored, along with the users first name and surname,

```
@Override
public android.content.Loader<Cursor> onCreateLoader(int i, Bundle bundle) {

    String selection;

    if(cursorFilter != null){
        selection =  "(" + FoodEntry.COLUMN_FOOD_NAME + " LIKE '%" + cursorFilter + "%')";
    }
    else
    {
        selection = null;
    }


    String[] results = {
            FoodEntry._ID,
            FoodEntry.COLUMN_FOOD_NAME,
            FoodEntry.COLUMN_FOOD_CAL
    };



    return new android.content.CursorLoader(this,
            FoodEntry.CONTENT_URI,
            results,
            selection,
            null,
            null);
}
```

Figure 4.9: LoaderManager onCreateLoader() method

in a MySQL database on the danu6 server. This is so that a user can log in to the app on any device. The Login and Register methods are handled by the Volley library which handles the data using Http GET and POST requests. Figure 4.9 below shows the LoginRequest class where the login request url is specified. This url is the location of the login.php file on the danu6 server. The LoginRequest constructor posts the request along with a Hashmap to login request URL. This Hashmap contains both the email and the password entered by the user in the Login activity.

When the login.php file receives the LoginRequest it queries the users database to see if the email and password in the request matches an entry in the database. The login.php file then returns a JSON object which contains

```
public class LoginRequest extends StringRequest{

    private static final String LOGIN_REQUEST_URL = "http://danu6.it.nuigalway.ie/fbroderick/Login.php";
    private Map<String, String> params;


    public LoginRequest(String email, String password, Response.Listener<String> listener)
    {
        super(Request.Method.POST, LOGIN_REQUEST_URL, listener, null);
        params = new HashMap<>();
        params.put("email", email);
        params.put("password", password);
    }
```

Figure 4.10: The login request which is submitted to the server

boolean value, "success". If this success is equal to true, the user is logged and able to use the main functions of the app but if the success is equal to false, the login has failed. The Login Activity contains a response listener to see if this login is a success or not. If the login is a success, the user is redirected to the home screen of the app whereas if the login fails, the user is asked to retry.

4.2.5 Meal Calculation

Throughout the development of the app, the formula to calculate the meal results has been altered many times. There is no one correct formula which will give the exact macronutrients requested by the user due to the varying nature of food values. This formula can be tweaked to prioritise what you think is most important. The current formula places greater emphasis on the overall calories of the meal. The meal generated by the app will always match the calories specified by the user as calories are deciding factor when gaining or losing weight.

4.3 Testing

Chapter 5

Results and Evaluation

5.1 Survey

5.2 Interview

Chapter 6

Conclusion

6.1 Future Work

In the future it would be good to integrate the app with wearable devices and activity trackers such as an activity watch. These devices offer a very accurate reading of the amount of calories a person needs every day along with the amount of calories. They calculate these values through GPS tracking, step counting and monitoring their heart. As the user manually enters their specific macronutrient values they are not guaranteed to reflect the exact calories and macronutrients needed.

Chapter 7

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