Ministry of High Education
Culture and Science City
High Institute of Computer Science and Information System

**High Institute of Computer Science and Information Systems**

Graduation Project:

# Wattary: A conversational AI Agent that interacts with humans and learns from their behaviors.

**Supervised By:**
Dr. Mohamed Ali Torad

**Assistant:**
Eng. Mohamed El-Shennawy

Project No. 1 Academic Year 2017 - 2018

Ministry of High Education
Culture and Science City
High Institute of Computer Science and Information System

# High Institute of Computer Science and Information Systems

Graduation Project:

Wattary: A conversational AI Agent that interacts with humans and learns from their behaviors.

## Prepared by:

41029 – أحمد محمد عبد الدايم
41134 – عمرو حامد علي
41143 – فاطمه محمد عباس
41183 – محمد عامر عبد العظيم
41190 – محمد عمر عارف
41193 – محمد محمود محمد الأمير
41201 – محمد يوسف محمد
41231 – مصعب أحمد محمد
41235 – مهند رؤوف عبد المنعم
41246 – نورهان سلامه جمعه

## Supervised By:

Dr. Mohamed Ali Torad

## Assistant:

Eng. Mohamed El-Shennawy

Project No. 1 Academic Year 2017 - 2018

# Acknowledgement

It is a matter of pleasure of acknowledgement by indebtedness to our Institute and to our supervisors:
**Dr. Mohamed Torad** and **Eng. Mohamed El-Shennawy** for their great and needy half in the completion of this project. We excess our thanks and gratitude to them.

They helped us and provided with their valuable guidance throughout the project.

Wattary's Team

# Objective & Summary

Through the quality and diversity of opportunities and the spread spectrum of choices we arrived at the idea of creating an AI agent, and we would like to further illustrate our reasons as follows:

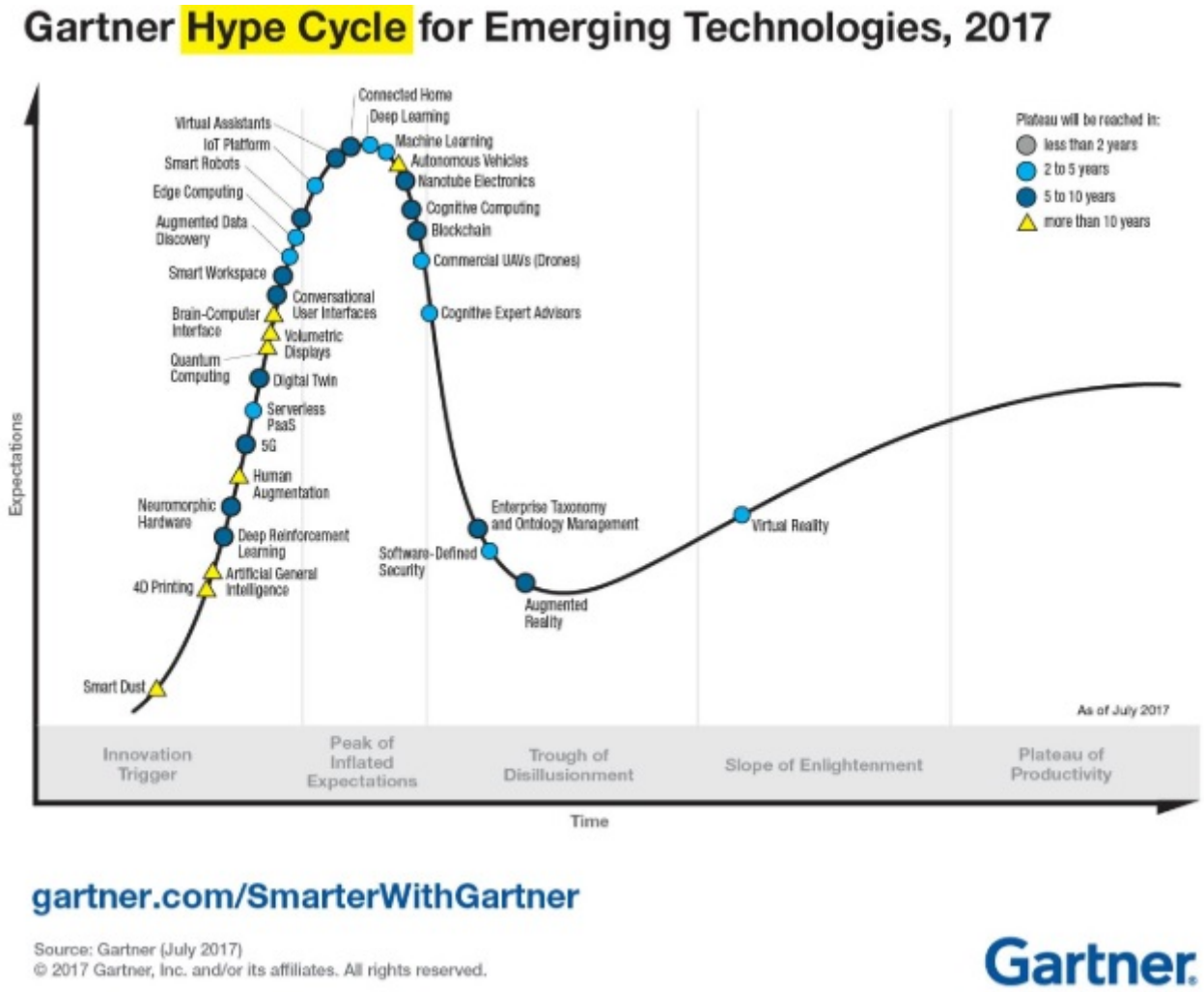
From the labor-market angle, the Gartner Hype Cycle for Emerging Technologies shows that Virtual Assistants is still on the top of the hype of the market for the year 2017 and it is expected to continue to do so.

From the objective angle, the core motive is that we are a bunch of like-minded students that have already decided to choose their careers as researchers, and choose Artificial Intelligence, Machine Learning, NLP, Computer vision, .etc. as the Area of Interest. Therefore, we know for a fact that our graduation project should be nothing but a springboard to what follows if we have a desire for distinction.

From the philosophical angle, needless to say that a bunch of philosophers have investigated the idea of artificial animal, such as Tomas Hobbes, arguing *For what is the heart but a spring; and the nerves, but so many strings; and the joints, but so many wheels.* And we also have the desire to stick to that.

From the scientific angle, AI is regularly cited as the field I would most like to be in by scientists in other disciplines. A student in physics might reasonably feel that all the good ideas have already been taken by Galileo, Newton, Einstein, and the rest. AI, on the other hand, still has openings for several full-time Einsteins and Edisons.

From the emotional angel, We have to confess that throughout all our study years in your institute- we were influenced by the idea of creating a sophisticated graduation project for the sake of helping ourselves to learn about the cutting-edge technologies that will undoubtedly help us in our careers.




**Gartner, Inc.** is an American research and advisory firm providing information technology-related insight for IT and other business leaders located across the world. Its headquarters are in Stamford, Connecticut, United States.

# Contents

# List of Tables

# Chapter 1

# Introduction

**Preface** Science has been - and still is - one of the most effective approaches that we use to reveal the secrets of this exotic world.
Alas, it stands helplessly in front of the mission of revealing the secrets of what behind its existance and development. i.e. our minds.
The human cognitive functions are the marvels that lead to all the development occured in our civilzation and in spite of all the efforts done by humans to understand its nature and mechanisms, they still refuse to uncover the most of its mysteries. A thing that would shorten the road to the human kind if it was done.

On the other hand, a bunch of scientists have decided not to stand with their hands folded, and have choosen to simulate an **artificial intelligence** in lieu of waiting for the real one to give us its secrets.

## 1.1 What is Artificial Intelligence?

AI is one of the newest fields in science and engineering. Work started in earnest soon after World War II, and the name itself was coined in 1956.

Technically, it is hard to specify a unique and absolute definition for the field of Artificial Intelligence since there exist a numerous philosopies that deal with it.

In the following lines, we will try to investigate each of them in a concise manner:

The denitions on top are concerned with thought processes and reasoning, whereas the ones on the bottom address behavior.
The denitions on the left measure success in terms of fidelity to human performance, whereas the ones on the right measure against an ideal performance measure, called rationality.

Table 1.1 shows the most common approaches defined AI.

| Thinking Humanly | Thinking Rationally |
|---|---|
| The exciting new effort to make computers think machines with minds in the full and literal sense (Haugeland, 1985) | The study of mental fuculties through the use of computational models (Charniak and McDermott, 1985) |
| The automation of activities that we associate with human thinking (Bellman, 1978) | The study of the computations that make it possible to preceive, reason and act. (Winston, 1992) |
| **Acting Humanly** | **Acting Rationally** |
| The art of creating machines that perform functions that require intelligence when performed by people. (Kurzweil, 1990) | Computational intelligence is the study of the design of intelligent agents (Poole et al., 1998) |
| The study of how to make computers do things at which, at the moment, people are better. (Rich and Knight, 1991) | AI ...is concerned with intelligent behavior in artifacts (Nilsson, 1998) |

Table 1.1: Definitions of AI

Historically, all four approaches to AI have been followed, each by different people with different methods.

### 1.1.1 Thinking humanly: The cognitive modeling approach

If we are going to say that a given program thinks like a human, we must have some way of determining how humans think. We need to get inside the actual workings of human minds. There are three ways to do this:

1. **Introspection:** trying to catch our own thoughts as they go.
2. **Psychological:** experiments observing a person in action.
3. **Through brain imaging:** observing the brain in action.

Once we have a sufficiently precise theory of the mind, it becomes possible to express the theory as a computer program.

### 1.1.2 Acting Humanly: The Turing Test approach

**Turing Test**

A computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or from a computer.

The computer would need to possess the following capabilities:

1. **Natural Language Processing [NLP]:** to enable it to communicate successfully in English.
2. **Knowledge representation:** to store what it knows or hears.
3. **Automated reasoning:** to use the stored information to answer questions and to draw new conclusions.
4. **Machine Learning:** to adapt to new circumstances and to detect and extrapolate patterns.

Turings test deliberately avoided direct physical interaction between the interrogator and the computer, because physical simulation of a person is unnecessary for intelligence.However, the so-called Total Turing Test includes a video signal so that the interrogator can test the subjects perceptual abilities, as well as the opportunity for the interrogator to pass physical objects through the hatch.

To pass the total Turing Test, the computer will need:

1. **Computer-vision:** to perceive objects.
2. **Robotics:** to manipulate objects and move about.

Yet AI researchers have devoted little effort to passing the Turing Test, believing that it is more important to study the underlying principles of intelligence than to duplicate an exemplar. The quest for articial flight succeeded when the Wright brothers and others stopped imitating birds and started using wind tunnels and learning about aerodynamics. Aeronautical engineering texts do not dene the goal of their field as making machines that fly so exactly like pigeons that they can fool even other pigeons.

### 1.1.3 Thinking rationally: The laws of thought approach

The Greek philosopher Aristotle was one of the first to attempt to codify right thinking, that is, irrefutable reasoning processes. His syllogisms provided patterns for argument structures that always yielded correct conclusions when given correct premises.
For example,

> **Socrates is a man; all men are mortal; therefore, Socrates is mortal**.

Logicians in the 19th century developed a precise notation for statements about all kinds of objects in the world and the relations among them. (Contrast this with ordinary arithmetic notation, which provides only for statements about numbers.)

There are two main obstacles to this approach:

1. First, it is not easy to take informal knowledge and state it in the formal terms required by logical notation, particularly when the knowledge is less than 100% certain.

2. Second, there is a big difference between solving a problem in principle and solving it in practice

### 1.1.4 Acting rationally: The rational agent approach

#### Agent

Agent comes from the Latin **agere**, to do, an agent is just something that acts.
All computer programs do something, but computer agents are expected to do more: operate autonomously, perceive their environment, persist over a prolonged time period, adapt to change, and create and pursue goals. A rational agent is one that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome.

In the laws of thought approach to AI, the emphasis was on correct inferences. Making correct inferences is sometimes part of being a rational agent, because one way to act rationally is to reason logically to the conclusion that a given action will achieve ones goals and then to act on that conclusion. On the other hand, correct inference is not all of rationality; in some situations, there is no provably correct thing to do, but something must still be done. There are also ways of acting rationally that cannot be said to involve inference. For example, recoiling from a hot stove is a reex action that is usually more successful than a slower action taken after careful deliberation. All the skills needed for the Turing Test also allow an agent to act rationally. Knowledge representation and reasoning enable agents to reach good decisions. We need to be able to generate comprehensible sentences in natural language to get by in a complex society. We need learning not only for erudition, but also because it improves our ability to generate effective behavior.

The rational-agent approach has two advantages over the other approaches:

1. First, it is more general than the laws of thought approach because correct inference is just one of several possible mechanisms for achieving rationality.

2. Second, it is more amenable to scientific development than other approaches based on human behavior or human thought.

In this context, we are delighted to introduce Wattary which is nothing but an AI personal assistant based on what so-called the rational agent approach.

First, let us look at what a person can typically gain from his human personal assistant. Broadly speaking, we would presume he might help with routine work such as: organizing calendar, telling news, booking a flight, reserving a table at a restaurant, or even help with basic house hold cores in a superficial way.

Wattary acts as a virtual personal assistant in lieu of the human one, for the betterment of the way that a person can do his routine Wattary can provide the following to every user:

1. An accessible conversational and vocal interface to interact with the user, that is, the user can access Wattary from his mobile phone or from a web application through voice or text and Wattary will respond for his commands in the same way.

2. A comprehensive control over users smart home through voice commands. [E.g. switch off the light, set the temperature to 22, .etc.]

3. Recommending a good restaurant to go, a movie to see tonight or a suitable book to read based on users taste.

It is worth mentioning that Wattary will do all of that through using machine learning algorithms i.e. the performance of Wattary will improve with every interaction!

An agent has to posses a bunch of capabilities in order to help it with the interaction with human process such as: Natural Language Processing, Machine Learning, Computer Vision etc.
i.e. capabilities that simulate the human percepts and cognitive functions, and we will explain these terms in details as follows:

## 1.2 Natural Lanugage Processing [NLP]:

Natural Language Processing is an area of computer science and artificial intelligence concerned with the interactions between computers and human (natural) languages, in particular how to program computers to process and analyze natural language.
We teach computers how to understand our raw natural language e.g. determining user intent from a sentence, performing spelling correction, understanfing English contractions, part-of-speech tagging, parsing sentences etc. and to provide an answer to our queries in a natural language form too, by teaching computers how to generate a natural language to represent some data.
In a practical context, NLP is analogous to teaching a language to a child.

## 1.3 Computer Vision

Computer vision is a field of computer science that works on enabling computers to see, identify and process images in the same way that human vision does, and then provide appropriate output. It is like imparting human intelligence and instincts to a computer. In reality though, it is a difficult task to enable computers to recognize images of different objects. Computer vision is closely linked with artificial intelligence, as the computer must interpret what it sees, and then perform appropriate analysis or act accordingly.

## 1.4 Machine Learning:

Machine learning is a subset of artificial intelligence in the field of computer science that often uses statistical techniques to give computers the ability to "learn" (i.e., progressively improve performance on a specific task) with data, without being explicitly programmed.

### 1.4.1 Overview

The name machine learning was coined in 1959 by Arthur Samuel. Evolved from the study of pattern recognition and computational learning theory in artificial intelligence, machine learning explores the study and construction of algorithms that can learn from and make predictions on data such algorithms overcome following strictly static program instructions by making data-driven predictions or decisions, through building a model from sample inputs. Machine learning is employed in a range of computing tasks where designing and programming explicit algorithms with good performance is difficult or infeasible.

Tom M. Mitchell provided a widely quoted, more formal definition of the algorithms studied in the machine learning field: "A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P if its performance at tasks in T, as measured by P, improves with experience E." This definition of the tasks in which machine learning is concerned offers a fundamentally operational definition rather than defining the field in cognitive terms. This follows Alan Turing's proposal in his paper "Computing Machinery and Intelligence", in which the question "Can machines think?" is replaced with the question "Can machines do what we (as thinking entities) can do?". In Turing's proposal the various characteristics that could be possessed by a thinking machine and the various implications in constructing one are exposed.

### 1.4.2 Machine Learning Tasks

Machine Learning Tasks are typically classified into two broad categories, depending on whether there is a learning "signal" or "feedback" available to a learning system:

- **Supervised learning:** The computer is presented with example inputs and their desired outputs, given by a "teacher", and the goal is to learn a general rule that maps inputs to outputs. As special cases, the input signal can be only partially available, or restricted to special feedback.
- **Reinforcement learning:** training data (in form of rewards and punishments) is given only as feedback to the program's actions in a dynamic environment, such as driving a vehicle or playing a game against an opponent.
- **Unsupervised learning:** No labels are given to the learning algorithm, leaving it on its own to find structure in its input. Unsupervised learning can be a goal in itself (discovering hidden patterns in data) or a means towards an end.

### 1.4.3 Machine Learning application:

Another categorization of machine learning tasks arises when one considers the desired output of a machine-learned system:

- In classification, inputs are divided into two or more classes, and the learner must produce a model that assigns unseen inputs to one or more (multi-label classification) of these classes. This is typically tackled in a supervised manner. Spam filtering is an example of classification, where the inputs are email (or other) messages and the classes are "spam" and "not spam".

- In regression, also a supervised problem, the outputs are continuous rather than discrete.

- In clustering, a set of inputs is to be divided into groups. Unlike in classification, the groups are not known beforehand, making this typically an unsupervised task.

Among other categories of machine learning problems, learning to learn learns its own inductive bias based on previous experience. Developmental learning, elaborated for robot learning, generates its own sequences (also called curriculum) of learning situations to cumulatively acquire repertoires of novel skills through autonomous self-exploration and social interaction with human teachers and using guidance mechanisms such as active learning, maturation, motor synergies, and imitation.

### 1.4.4 What is a classifier?

An algorithm that implements classification, especially in a concrete implementation, is known as a classifier. The term "classifier" sometimes also refers to the mathematical function, implemented by a classification algorithm that maps input data to a category.

#### Accuracy

is a weighted arithmetic mean of Precision and Inverse Precision (weighted by Bias) as well as a weighted arithmetic mean of Recall and Inverse Recall (weighted by Prevalence).Inverse Precision and Inverse Recall are simply the Precision and Recall of the inverse problem where positive and negative labels are exchanged (for both real classes and prediction labels). Recall and Inverse Recall, or equivalently true positive rate and false positive rate, are frequently plotted against each other as ROC curves and provide a principled mechanism to explore operating point tradeoffs. Outside of Information Retrieval, the application of Recall, Precision and F-measure are argued to be flawed as they ignore the true negative cell of the contingency table, and they are easily manipulated by biasing the predictions.The first problem is 'solved' by using Accuracy and the second problem is 'solved' by discounting the chance component and renormalizing to Cohen's kappa.

### 1.4.5 What is a Data-Set?

A data set (or dataset) is a collection of data. Most commonly a data set corresponds to the contents of a single database table, or a single statistical data matrix, where every column of the table represents a particular variable, and each row corresponds to a given member of the data set in question. The data set lists values for each of the variables, such as height and weight of an object, for each member of the data set. Each value is known as a datum. The data set may comprise data for one or more members, corresponding to the number of rows. The term data set may also be used more loosely, to refer to the data in a collection of closely related tables, corresponding to a particular experiment or event. An example of this type is the data sets collected by space agencies performing experiments with instruments aboard space probes. Data sets that are so large that traditional data processing applications are inadequate to deal with them are known as big data.

In the open data discipline, data set is the unit to measure the information released in a public open data repository. The European Open Data portal aggregates more than half a million data sets. In this field other definitions have been proposed but currently there is not an official one. Some other issues (real-time data sources non-relational data sets, etc.) increases the difficulty to reach a consensus about it.

### 1.4.6 What is a recommender system?

Recommender systems (RS) are a subclass of information filtering system that seek to predict the 'rating' or 'preference' that user would give to an item (such as music, books, or movies) or social element (e.g. people or groups) they had not yet considered, using a model built from the characteristics of an item (content-based approaches) or the user's social environment (collaborative filtering approaches).
Recommender Systems (RSs) are software tools and techniques providing suggestions for items to be of use to a user.

#### History

The first recommender system, Tapestry, was designed to recommend documents from newsgroups. The authors also introduced the term collaborative filtering as they used social collaboration to help users with large volume of documents.

### Applications

- **Product Recommendations:** Perhaps the most important use of recommendation systems is at on-line retailers, etc., e.g., Amazon or similar on-line vendors strive to present user's suggestions of products that they might like to buy. These suggestions are not random but based on decisions made by similar customers.

- **News Articles:** News services usually classify interesting news for some people to offer them to similar users. The similarity might be based on the similarity of important words in the documents, or on the articles that are read by people with similar reading tastes. (the same principles apply to recommending blogs, videos, etc.)

- **Movie/Music Recommendations:**e.g. Netflix offers customers recommendations of movies they might be interested in. These recommendations are based on ratings provided by users.

### Classification

Recommender systems are classified according to the technique used to create the recommendation (fill the blanks in the utility matrix):

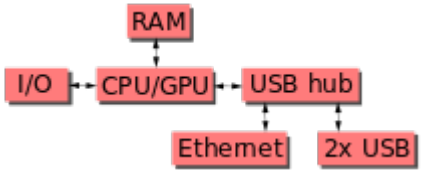
- **content-based**systems examine properties of the items recommended and offer similar items.

- **collaborative filtering** systems recommend items based on similarity measures between users and/or items. The items recommended to a user are those preferred by similar users.

- **Hybrid** mixing both previous approaches.

## 1.5 The Hardware Interface: Raspberry PI

The Raspberry Pi is a credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. The Raspberry Pi has the ability to interact with the outside world, and has been used in a wide array of digital maker projects.




This block diagram describes Model B in raspberry pi, the USB/Ethernet chip contains a five-point USB hub, of which four ports are available.

### 1.5.1 THE RASPBERRY PI 3'S SPECS

- Chipset: Broadcom BCM2837
- CPU: 1.2GHz quad-core 64-bit ARM cortex A53
- Ethernet : 10/100 (Max throughput 100Mbps)
- USB: Four USB 2.0 with 480Mbps data transfer
- Storage: MicroSD card or via USB-attached storage
- Wireless: 802.11n Wireless LAN (Peak transmit/receive throughput of 150Mbps), Bluetooth 4.1
- Graphics: 400MHz VideoCore IV multimedia
- Memory: 1GB LPDDR2-900 SDRAM
- Expandability: 40 general purpose input-output pins
- Video: Full HDMI port
- Audio: Combined 3.5mm audio out jack and composite video
- Camera interface (CSI)
- Display interface (DSI)

### 1.5.2 Components

- **ARM CPU/GPU** This is a Broadcom BCM2835 System on a Chip (SoC) that's made up of an ARM central processing unit (CPU) and a Videocore 4 graphics processing unit (GPU). The CPU handles all the computations that make a computer work (taking input, doing calculations and producing output), and the GPU handles graphics output.

- **GPIO** These are exposed general-purpose input/output connection points that will allow the real hardware hobbyists the opportunity to tinker.

- **RCA** An RCA jack allows connection of analog TVs and other similar output devices.

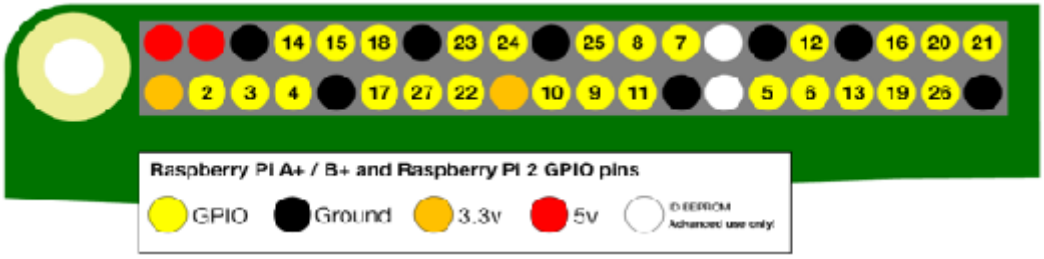
- **Audio out** This is a standard 3.55-millimeter jack for connection of audio output devices such as headphones or speakers. There is no audio in.

- **LED** Light-emitting diodes, for all of your indicator light needs

- **USB** This is a common connection port for peripheral devices of all types (including your mouse and keyboard). Model B has two. You can use a USB hub to expand the number of ports or plug your mouse into your keyboard if it has its own USB port.

- **HDMI** This connector allows you to hook up a high-definition television or other compatible device using an HDMI cable.
- **Power** This is a 5v Micro USB power connector into which you can plug your compatible power supply.
- **SD Card Slot** This is a full-sized SD card slot. An SD card with an operating system (OS) installed is required for booting the device.
- **Ethernet** This connector allows for wired network access and is only available on the Model B.

A powerful feature of the Raspberry Pi is the row of GPIO (general-purpose input/output) pins along the top edge of the board. A 40-pin GPIO header is found on all current Raspberry Pi boards.




the numbering of the GPIO pins is not in numerical order; GPIO pins 0 and 1 are present on the board (physical pins 27 and 28) but are reserved for advanced use

### 1.5.3 Voltages

Two 5V pins and two 3V3 pins are present on the board, as well as a number of ground pins (0V), which are unconfigurable. The remaining pins are all general purpose 3V3 pins, meaning outputs are set to 3V3 and inputs are 3V3-tolerant.

### 1.5.4 Outputs

A GPIO pin designated as an output pin can be set to high (3V3) or low (0V).

### 1.5.5 Inputs

A GPIO pin designated as an input pin can be read as high (3V3) or low (0V). This is made easier with the use of internal pull-up or pull-down resistors. Pins GPIO2 and GPIO3 have fixed pull-up resistors, but for other pins this can be configured in software.

As well as simple input and output devices, the GPIO pins can be used with a variety of alternative functions, some are available on all pins, others on specific pins.

- PWM (pulse-width modulation)
  - Software PWM available on all pins
  - Hardware PWM available on GPIO12, GPIO13, GPIO18, GPIO19
- SPI
  - SPI0: MOSI (GPIO10); MISO (GPIO9); SCLK (GPIO11); CE0 (GPIO8), CE1 (GPIO7)
  - SPI1: MOSI (GPIO20); MISO (GPIO19); SCLK (GPIO21); CE0 (GPIO18); CE1 (GPIO17); CE2 (GPIO16)
- I2C
  - Data: (GPIO2); Clock (GPIO3)
  - EEPROM Data: (GPIO0); EEPROM Clock (GPIO1)
- Serial
  - TX (GPIO14); RX (GPIO15)

At first, you should install the OS and software to the Raspberry Pi before mounting it all together. An OS is the basic operating system software that tells the Raspberry hardware what to do. Linux is perfect for this. We have chosen Raspbian, as it's one of the most advanced OS for the Raspberry with loads of help and tutorials on the internet. The OS, which is constantly being improved, recently had a graphical overhaul, and includes an optimized web browser, an office suite, programming tools, educational games, and other software. You need to prepare the SD card to be able to run Raspbian on the Raspberry. Now temporarily connect your Raspberry Pi board to LAN cable, a monitor (HDMI TV works out of the box, but a HDMI-to-DVI cable will do the job as well) and a USB keyboard for the basic setup. Insert the prepared SD card with the Raspbian installer on it and attach the power supply. The Raspberry should boot up and guide you through the setup process. After this, you should have a basic Raspbian OS running. Be sure to enable SSH in Raspbian so that you are able to control the Raspberry device also when there is no monitor and keyboard attached. And you should also enable the camera from the Raspbian setup menu so that we can use it for motion detection.

Then Once you've plugged in all the cables (a power supply, a monitor or TV, leads to connect to the monitor–typically HDMI, and a mouse and keyboard) and put SD Card in it , will be turned on raspberry pi automatically.

### 1.5.6 What is MQTT?

MQTT (Message Queue Telemetry Transport) is a lightweight messaging protocol which is ideal for communication of IoT connected devices. MQTT has three components: broker, publisher, and subscriber. A broker is an intermediary entity that handles the communication going on between devices. A publisher is a device that sends messages. A subscriber listens to the messages sent by the publisher.There is one more important thing in MQTT and that is a topic. A topic is necessary for communication between different devices. For example, Device A wants to send a message to Device B. To do so, there should be something common between the two and thats the topic.

### 1.5.7 What is a Smart Mirror and what can it do for us?

A Smart Mirror is like any other Mirror but it is manufactured with a lot of Hardware-Technology like LCD Display for information, internet connection, and Raspberry Pi (a brain that is an internet of things Operating System). Imagine waking up, going to your bathroom to get ready to conquer the day and you look into your mirror and you receive all the information you need to start your day, like weather information/forecast, emails, calendar, important news . All of this without moving a finger, thats the purpose of technology, to make our life easier.

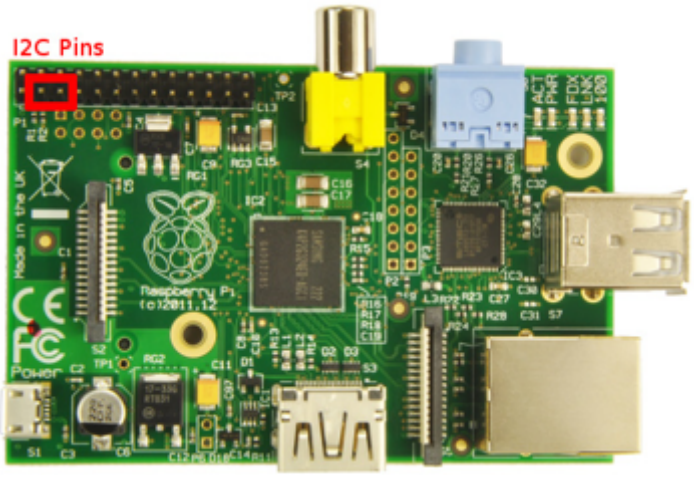
### 1.5.8 What is a WebCam?

A webcam  short for web camera  is a digital camera thats connected to a Raspberry Pi. It can send live pictures from wherever its sited to another location by means of the internet. It plugged into Raspberry Pi through USB ports . Include features :

- an integral microphone
- the ability to pan and tilt
- in-built sensors that can detect movement and start recording
- a light that, when on, will let you know that the camera is in use.

### 1.5.9 l2c Interfacing Raspberry PI to Arduino

The Inter-IC Bus (I-IC or I2C) standard defines the hardware and electrical characteristics of the interface between nearby devices using only two wires (and a third for ground reference). SMBus was introduced by Intel as a tight subset of I2C, strictly defining the interface between devices. The Raspberry Pi most commonly uses an SMBus implementation in Python 2.x.These are the images showing where the I2C pins are on the Raspberry Pi and Arduino.




On the Pi, the I2C pins (Pins 3 (SDA) and 5 (SCL)) .


On the Arduino Uno, the I2C pins are pins A4 (SDA) and A5 (SCL).

## 1.6 The Hardware Interface: Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board.

### 1.6.1 Different Types Of Arduino Boards:

- Arduino Uno (R3)
- LilyPad Arduino
- Red Board
- Arduino Mega (R3)
- Arduino Leonardo

### 1.6.2 Arduino Uno (R3)

The Uno is a huge option for your initial Arduino. It consists of 14-digital I/O pins, where 6-pins can be used as PWM(pulse width modulation outputs), 6-analog inputs, a reset button, a power jack, a USB connection and more. It includes everything required to hold up the microcontroller; simply attach it to a PC with the help of a USB cable and give the supply to get started with a AC-to-DC adapter or battery.

### 1.6.3 Relay for controlling AC light

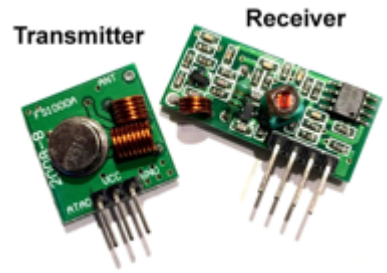
AC is alternating current 220v which powers the ac lights. Arduino cannot control high volt n amp, but a relay can do this job, which is the sole design of it. so we are using relay as switch to control high power devices.

### 1.6.4 RF-Transmitter

These RF Transmitter Modules are very small in dimension and have a wide operating voltage range (3V-12V). The low cost RF Transmitter can be used to transmit signal up to 100 meters (the antenna design, working environment and supply voltage will seriously impact the effective distance). It is good for short distance, battery power device development. These wireless transmitters work with 315MHz receivers. They are breadboard friendly and also work great with microcontrollers to create a very simple wireless data link.

### 1.6.5 RF-Reciever

These RF receiver modules are very small in dimension. The low cost RF Receiver can be used to receive RF signal from transmitter at the specific frequency which determined by the product specifications. Super regeneration design ensure sensitive to weak signal. The receiver has 4 pins, but we actually use 3 of them: GND (Ground), VCC (5V) and one DATA pin. Same as RF transmitter, these RF receivers are breadboard friendly too. Both RF transmitter and receiver must work in pair in order to communicate with each other.





using "IR reciever " to recieve the code of every channel ofremote that control of tv in serial monitor in IDE of arduino and send it again by "IR LED" that connected to pin 13 of arduino

### 1.6.6 CT - Talema AC1030 or SCT-013-000

provides you with information on your power consumption ,current sensor which produces a signal which your Arduino can understand. An Arduino only has analogue voltage inputs which measure 0-5V DC, so you need to convert the current output from the CT into a voltage reference and then scale the voltage reference into a 0-5V range.

### 1.6.7 WaterFlow Sensor

The water flow sensor consists of a plastic valve body, a water rotor and a hall-effect sensor. When the water flows through the rotor, rotor rolls and the speed of it changes with a different rate of flow. The hall-effect sensor outputs the corresponding pulse signal.

This type of sensor can be found on different diameters, water pressure (MPa) and flow rate (L/m) ranges. Make sure to select one that will cover your needs. The sensor that I have it has 20mm diameter, ¡1.75Mpa water pressure and 30 L/m flow rate range.

### 1.6.8 Servo Motor

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

## 1.7 The Android Interface

A mobile operating system developed by Google, based on a modified version of the Linux kernel and other open source software and designed primarily for touchscreen mobile devices such as smartphones and tablets. In addition, Google has further developed Android TV for televisions, Android Auto for cars, and Wear OS for wrist watches, each with a specialized user interface. Variants of Android are also used on game consoles, digital cameras, PCs and other electronics.

Initially developed by Android Inc., which Google bought in 2005, Android was unveiled in 2007, with the first commercial Android device launched in September 2008. The operating system has since gone through multiple major releases, with the current version being 8.1 "Oreo", released in December 2017. The core Android source code is known as Android Open Source Project (AOSP), and is primarily licensed under the Apache License.

### 1.7.1 Interface

Android's default user interface is mainly based on direct manipulation, using touch inputs that loosely correspond to real-world actions, like swiping, tapping, pinching, and reverse pinching to manipulate on-screen objects, along with a virtual keyboard. Game controllers and full-size physical keyboards are supported via Bluetooth or USB. The response to user input is designed to be immediate and provides a fluid touch interface, often using the vibration capabilities of the device to provide haptic feedback to the user. Internal hardware, such as accelerometers, gyroscopes and proximity sensors are used by some applications to respond to additional user actions, for example adjusting the screen from portrait to landscape depending on how the device is oriented, or allowing the user to steer a vehicle in a racing game by rotating the device, simulating control of a steering wheel.

### 1.7.2 Applications

Applications ("apps"), which extend the functionality of devices, are written using the Android software development kit (SDK) and, often, the Java programming language.Java may be combined with C/C++, together with a choice of non-default runtimes that allow better C++ support.The Go programming language is also supported, although with a limited set of application programming interfaces (API).In May 2017, Google announced support for Android app development in the Kotlin programming language.

The SDK includes a comprehensive set of development tools, including a debugger, software libraries, a handset emulator based on QEMU, documentation, sample code, and tutorials. Initially, Google's supported integrated development environment (IDE) was Eclipse using the Android Development Tools (ADT) plugin; in December 2014, Google released Android Studio, based on IntelliJ IDEA, as its primary IDE for Android application development. Other development tools are available, including a native development kit (NDK) for applications or extensions in C or C++, Google App Inventor, a visual environment for novice programmers, and various cross platform mobile web applications frameworks. In January 2014, Google unveiled an framework based on Apache Cordova for porting Chrome HTML 5 web applications to Android, wrapped in a native application shell.

## 1.8 The Web Interface

### 1.8.1 User Interface [UI]

User interface (UI) is a broad term for any system, either physical or software based, that allows a user to connect with a given technology. Many different kinds of user interfaces come with various devices and software programs.

Many of them have some basic similarities, although each one is unique in key ways. One main type of user interface is called a graphical user interface (GUI). This includes the interfaces for the modern operating systems many of us are familiar with, particularly Windows, as well as other kinds of software programs that are made to be driven mainly by icons or images rather than text commands. Users can contrast the graphical user interface to a text interface such as the MS-DOS system that was used to operate personal computers of earlier decades. Other kinds of user interfaces include touch screen interfaces, a common type of UI for mobile devices, and other physical types of interfaces for hardware pieces. For example, a remote control for a DVD player, audio system, television or game console can be thought of as a user interface for that device. Other kinds of software-oriented user interfaces are becoming more and more sophisticated, often using a combination of graphical and text elements to drive specific user activities.

# Chapter 2

# Technical-Concepts: The anatomy of Wattary

**The Big Picture** Technically speaking, Wattary percepts its environment through an artificial organs - camera and microphone -, investigates these perceptions in order to extract useful information for the sake of building its own experience with the capability of storing them in its artificial memory, and interact with human through its artificial mouth using what has already been in its memory.

## 2.1 Eye

The eye of Wattary has one main objective, that is, to perform a recognition for the face of the user in order to identify its identity.

### 2.1.1 Face Recognition

Face Recognition became a new trend in the security authentication systems. Modern FR systems can even detect, if the person is real(live) or not while doing face recognition, preventing the systems being hacked by showing the picture of a real person. We are sure, everyone wondered when Facebook implemented the auto-tagging technique. It identifies the person and tag him/her when ever you upload a picture. It is so efficient that, even when the persons face is occluded or the picture is taken in darkness, it tags accurately. All these successful face recognition systems are the results of recent advancements in the field of computer vision, which is backed by powerful deep learning algorithms. Let us explore one of such algorithms and see how we can implement a real time face recognition system. The whole idea of this component on our project is to make an authentication system using human face to easily identify users from their faces and no need for passwords anymore. In the real life, recognizing a person from his face

is a lot easy. Our brain is doing this operation perfectly by save some measurements of each persons face, but using a machine which measurements should we collect from each face to identify it; face database? Ear size? Nose length? Eye color? Something else? It turns out that the measurements that seem obvious to us humans (like eye color) dont really make sense to a computer looking at individual pixels in an image. Researchers have discovered that the most accurate approach is to let the computer figure out the measurements to collect itself. Deep learning does a better job than humans at figuring out which parts of a face are important to measure. The solution is to train a Deep Convolutional Neural Network which generates 128 measurements for each face.

The training process works by looking at 3 face images at a time:

1. Load a training face image of a known person

2. Load another picture of the same known person

3. Load a picture of a totally different person

Then the algorithm looks at the measurements it is currently generating for each of those three images. It then tweaks the neural network slightly so that it makes sure the measurements it generates for 1 and 2 are slightly closer while making sure the measurements for 2 and 3 are slightly further apart. This step is being repeated millions of times for millions of images of thousands of different people, the neural network learns to reliably generate 128 measurements for each person. Any ten different pictures of the same person should give roughly the same measurements.

Machine learning people call the 128 measurements of each face an embedding. The idea of reducing complicated raw data like a picture into a list of computer-generated numbers comes up a lot in machine learning (especially in language translation). The exact approach for faces we are using is ResNet Network which was invented in 2015 by researchers at Google but many similar approaches exist.

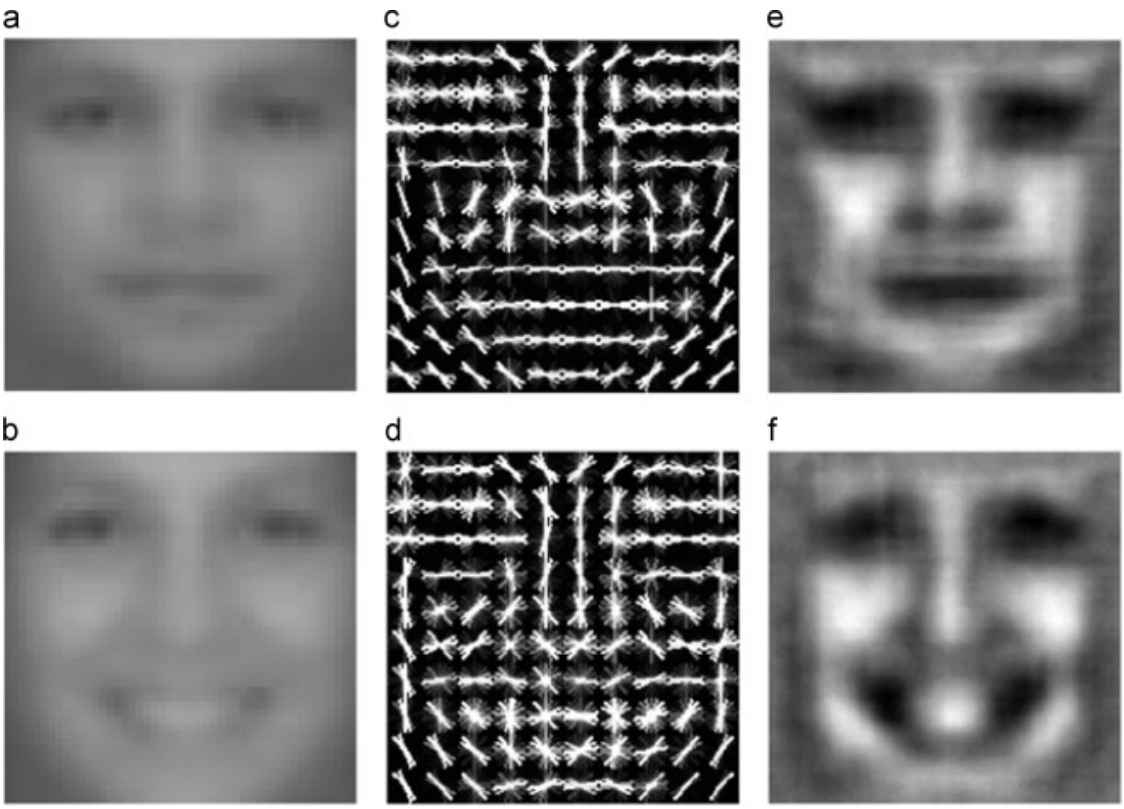
Unfortunately we couldnt train a convolutional neural network to output face embeddings because this process of training requires a lot of data and computer power. Even with an expensive NVidia Telsa video card, it takes about 24 hours of continuous training to get good accuracy.

To solve this problem we used a pre-trained network which generates the 128 measurements for any face and it gets an accuracy of 99.38

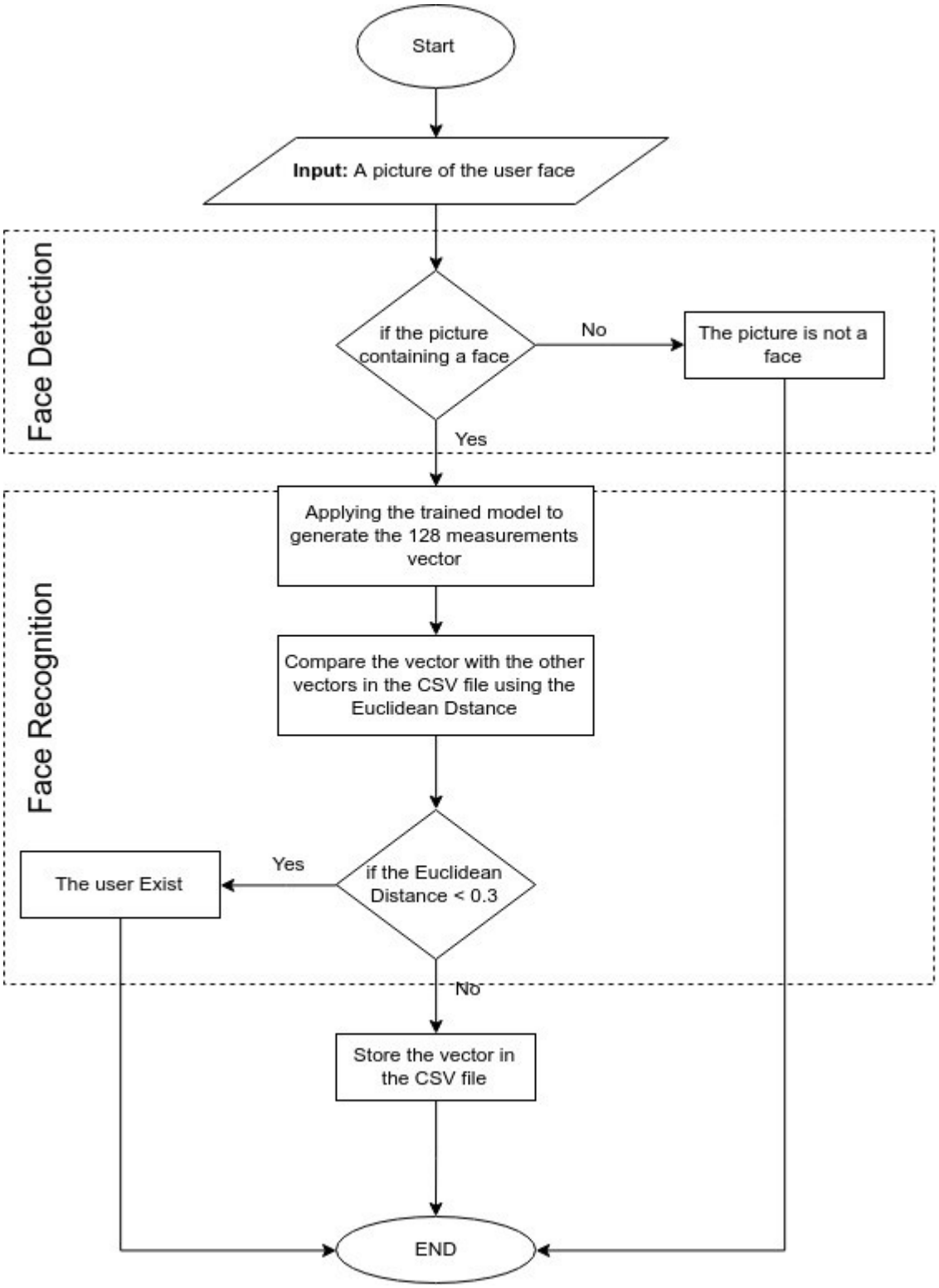
### 2.1.2 How the Eye works?

In android application, the user is asked to take a picture of his face from his camera or from gallery then this picture is being passed to the Brain component then to the Eye to check if this is a real picture picture or not. If this picture is a real image then the Eye component applies Face detection to detect faces in this picture.

Face detection is made using the new classic Histogram of Oriented.




The face detector function returns a cropped rectangle of the face if the picture contains at least one face which is sent to face recognition function, if the picture didnt contain any faces the Eye returns to the user to tell him that this picture doesnt contain any face. The face recognition function generates a 128 measurements vector using the ResNet pre-trained model then it applies the Euclidean Distance between this vector and the stored vectors, if the Euclidean Distance is less than 0.3 this means that the function recognized this person and returns to the user with this results, if the distance is larger than 0.3 this means that face recognition didnt recognize this person.


Start
Input: A picture of the user face
Face Detection
if the picture containing a face
No
The picture is not a face
Yes
Face Recognition
Applying the trained model to generate the 128 measurements vector
Compare the vector with the other vectors in the CSV file using the Euclidean Dstance
if the Euclidean Distance < 0.3
Yes
The user Exist
No
Store the vector in the CSV file
END

## 2.2 Ear:

The ear of Wattary has two main objectives:

- To perform speech recognition algorithms in the input voice and to produce its equivalent text.
- To pass this raw text through an NLP-Pipeline in order to unerstand the intent of the user.

**Speech recognition:** We have taken advantage of Google Speech API that built-in most of Android mobile phones to achieve the resulted text.

**NLP-Pipeline:** we grab the resulting text from the ear and pass it through a bunch of stages in order to determine user intent or extract general information using NLP algorithms, and store the resulting structured data into a database. [Wattarys Memory], and we are going to explain all of these stages as follows:

### 2.2.1 Layer 1: Expanding Contractions:

Needless to say that the usage of contractions in our daily English has gone viral through every aspect of our conversations but in order to perform NLP algorithms correctly we decided that we have to perform an expanding contractions layer which its output is nothing but the raw English words and we take advantage of the Regular Expressions module provided in the python programming language especially the substitution method in which we made a list of tuples each of them paired the expected contraction and its raw word.

- **Input**: We should've done this thing we didn't do.
- **Output**: We should have done this thins we did not do.

### 2.2.2 Layer 2: Tokenization:

It is nothing but a preprocessing step performed to divide the input string into a list of words or tokens.
We take advantage from the Regular Expression tokenizer provided in the NLTK library.

- **Input**: Swetch off the leight in the bedroom.
- **Output**: ['Swetch', 'off', 'the', 'leight', 'in', 'the', 'bedroom']

### 2.2.3 Layer 3: spelling Correction:

We took advantage from the spelling correction algorithm published by Peter Norvig in his website and we created a custom corpus which matches our needs.

- **Input**: ['Swetch', 'off', 'the', 'leight', 'in', 'the', 'bedroom']
- **Output**: [**'Switch'**, 'off', 'the', **'light'**, 'in', 'the', 'bedroom']

### 2.2.4 Layer 4: Intent & Tense Detection:

We have created a simple but beneficial Text-classifier for the sake of detecting users intent in general.
Also, we have created another one in order to determine the tense of the string.

- **Input**: Hello / Hi, / Howdy / hey
- **Intent Classifier Output**: greetings

- **Input**: How are you? / How is it going with you?
- **Intent Classifier Output**: Status-query

- **Input**: Switch on the light in the bedroom
- **Intent Classifier Output**: light-on
- **Tense Classifier Output**: **Imperative**

- **Input**: Did you switch on the light in the bedroom?
- **Intent Classifier Output**: light-on-query
- **Tense Classifier Output**: **Past-simple**

- **Input**: Have you switch on the light in the bedroom?
- **Intent Classifier Output**: light-on-query
- **Tense Classifier Output**: **Present-perfect**

### 2.2.5 Layer 5 : Part-of-speech Tagging:

In which we turn back to the resulted list of tokens and tag each of them with its suitable POS tag i.e. proper noun/preposition/Determiner...etc
We took advantage from the pre-trained model provided by the NLTK library.

- **Input**: ['Switch', 'off', 'the', 'light', 'in', 'the', 'bedroom']
- **Output**: [('switch', 'VB'), ('off', 'RP'), ('the', 'DT'), ('light', 'NN'), ('in', 'IN'), ('the', 'DT'), ('bedroom', 'NN')]

The following table 2.1 provide the set of tags and its meanings according to the penn-treebank:

| Tag | Description |
|---|---|
| CC | Coordinating conjunction |
| CD | Cardinal Number |
| DT | Determiner |
| EX | Existential there |
| FW | Foreign word |
| IN | Preposition or subordinating conjunction |
| JJ | Adjective |
| JJR | Adjective, comparative |
| JJS | Adjective, superlative |
| LS | List item marker |
| MD | Modal |
| NN | Noun, singular or mass |
| NNS | Noun, plural |
| NNP | Proper noun, singular |
| NNPS | Proper noun, plural |
| PDT | Predeterminer |
| POS | Possessive ending |
| PRP | Personal pronoun |
| PRPS | Possessive pronoun |
| RB | Adverb |
| RBR | Adverb, comparative |
| RBS | Adverb, superlative |
| RP | Particle |
| SYM | Symbol |
| TO | to |
| UH | Interjection |
| VB | Verb, base form |
| VBD | Verb, past tense |
| VBG | Verb, gerund or present participle |
| VBN | Verb, past participle |
| VBP | Verb, non-3rd person singular present |
| VBZ | Verb, 3rd person singular present |
| WDT | Wh-determiner |
| WP | Wh-pronoun |
| WP$ | Possessive wh-pronoun |
| WRB | Wh-adverb |

Table 2.1: Penn-treebank Tags

### 2.2.6 Layer 6 : Information Extraction Layer:

In which we took advantage from the Chunking and Chinking techniques provided by the NLTK library for the sake of extracting the important chunks from users input and collecting them in a specific list.
Weve used five chunkers in this layer, each of them called based upon the intent of the user resulted from layer four.

### 2.2.7 Layer 7: Organization:

In this layer, we have used a bunch of simple programming concepts in order to organize the resulted extracted information list into a specific dictionary contains a suitable label to each of its entry.

- **Input**: ['on', 'light', 'bedroom']
- **Output**: ['Appliance': 'light', 'State': 'On', 'Location', 'Bedroom']

### 2.2.8 Layer 8: Execution:

This role of this layer is nothing but providing a controlling mechanism upon all of the layers above. It has the capability of determining which of the layers is going to be performed and which of them is not and it do this depends on the intent of the user which resulted by Layer 4.

## 2.3 Brain: Back-End

The Back-End role is nothing but a controller that gather together all of the various branches and modules of Wattary and ensure they are work together very well.

Our application design is consisting of multiple endpoints each one responsible for specific task like register, login, etc. These endpoints are able to communicate with our Core Modules So, all our logics processed inside these endpoints.

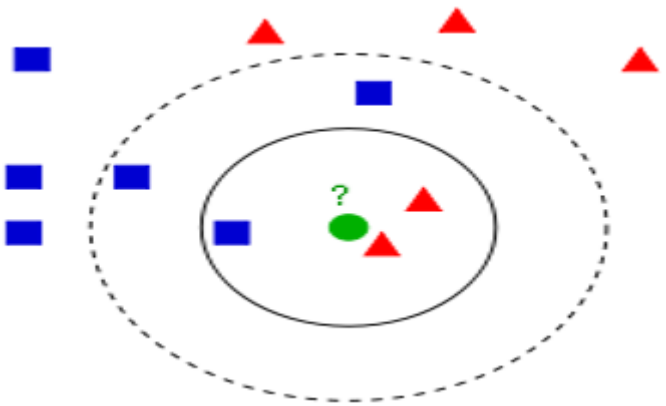
**classification of the dictionary** The type of the extracted information that the NLP-Pipeline provide determine the whole next sequence of steps that will be done to perform the actual execution of the command written by the user.

### 2.3.1 The Recommendation Workflow

Let's imagine the case that the user asked Wattary to recommend an action movie to him. In this case, the NLP-Pipeline will determine that the user intent is movie-recommendation and will extract the category of the movie. i.e. whether it is Action, Comedy, Romance, .. etc. and will pass these parameters to the used algorithm.

### 2.3.2 Nearest Neighbor Algorithm

The Nearest Neighbor (k-NN) algorithm is one of the simplest machine learning algorithms but works very well in practice. The idea is to predict a classification based on the k-nearest neighbors of the item we want to classify. No model is in fact learned, but the active user is used to search for the k most similar cases.



A simple approximation of k-NN is shown in Figure where we need to classify the green circle:
If we select k = 3, the nearest neighbors are 2 red triangles and a blue square, represented inside the solid black circle, the class of the circle will be red triangle. In the case of k = 5 (discontinuous black circle), the nearest neighbors are 2 red triangles and 3 blue squares, then the class of the circle will be blue square.

### 2.3.3 Input output

- **Input:** ['Category': 'Comedy', 'Type': 'Movie']
- **Output:** Recommended Movie: TED

### 2.3.4 The Appliance Workflow

Let's imagine the case that the user asked wattary to perform a specific command amongst his smart home appliances. In this case, the NLP-Pipeline will determine the user intent from the command and also will extract the useful information from the sentence in order to pass all of these parameters to the appliance workflow.

The NLP-Pipeline will provide a dictionary that describes which appliance the user want to control, and the state of it i.e. whether the user want to switch it on or off, and the location of the meant appliance.

We have created an another dictionary that contains a set of numbers, each of them mention to a specifice parameter from those that we used in our project. The next step is to translate these extracted parameters to its equivalent numbers that we have determined beforehand and passing the resulted numbers to the hardwre interface in order to execute the command in the real-life appliances.

After the execution, the rule of the mouth of Wattry comes and it will generate a specified response based on the received command and will pass it to the user through the web or the android interface.

### 2.3.5 Learning

### 2.3.6 Gaussian Naive Bayes (NB) Algorithm:

**Abstract**

In our agent we implemented a classification model to train on the users data and learn from his behavior in when he turn on/off the light of his rooms in the home by knowing the time he turned on/off the light and which room. We used Naive Bayes classifier to train and evaluate the prediction value(on/off) to the light depends on the time, day and room number. We describing further in this article how Naive Bayes works and what it's model construction.

**Introduction:**

The nave Bayes classifier is one of the simplest approaches to the classification task that is still capable of providing reasonable accuracy. Whereas in many cases it cannot compete with much more refined algorithms, such as decision trees, it sometimes does not stay far behind, and it may be even superior for certain specific application domains, with text classification being the most prominent example. Its simplicity  conceptual, implementational, and computational  makes it easy and inexpensive to try besides or before more sophisticated classifiers.

**Bayes Rule:**

It shows how the conditional probability of an event can be calculated based on its marginal probability and the inverse conditional probability. For two events A and B, the rule can be written as:

$$P(B) = \frac{P(A)P(B|A)}{P(B)}$$

Where:

- P(A) is the prior probability of A,
- P(A—B) is the conditional probability of A given B, also called the posterior probability of A,
- P(B—A) is the conditional probability of B given A, and
- P(B) is the probability of B.

In the most common setting, the rule is applied to inference about a set of mutually exclusive events A1, A2, , Ak that exhaust the probability space, i.e.,

$$P(Ai \cap Aj) = 0 \; for \; i \neq j$$

$$\sum_{i=1}^{k} P(Ai) = 1$$

Then from the law of total probability

$$P(B) = \sum_{j=1}^{k} P(Aj)P(Aj)$$

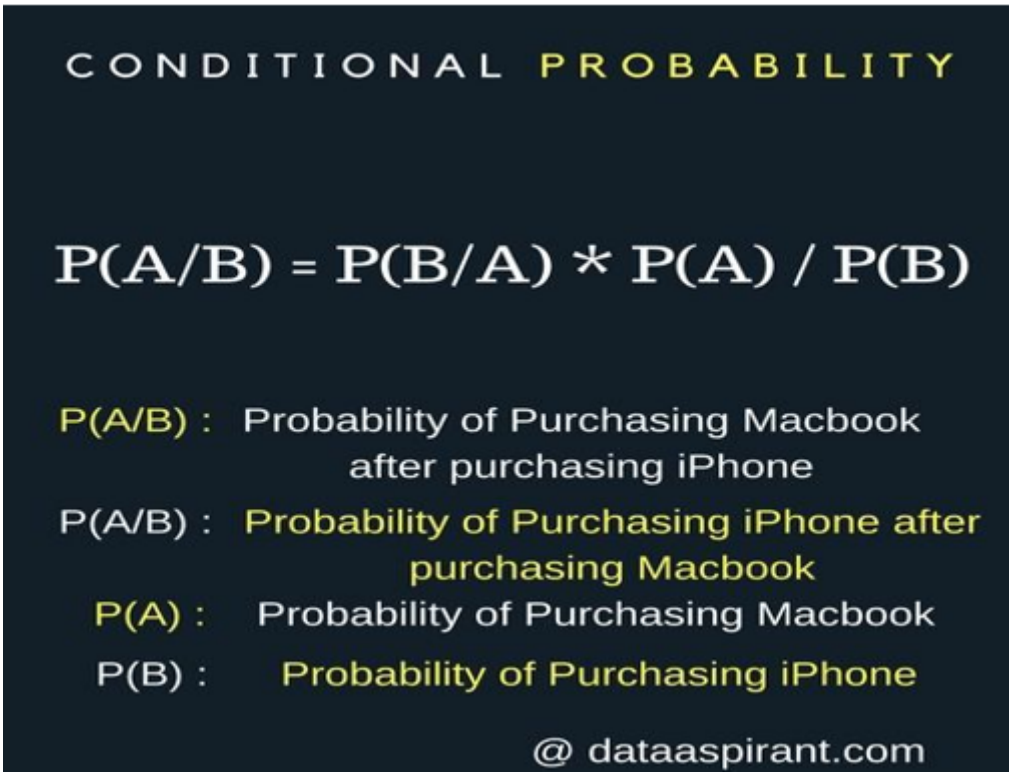
which allows one to rewrite the Bayes rule as

$$P(Ai|B) = \frac{P(Ai)P(B|Ai)}{\sum_{j=1}^{k} P(Aj)P(Aj)}$$

This form shows that P(B) acts as a normalizing constant,

$$\sum_{i=1}^{k} P(Ai|B) = 1$$

Note that, unlike the posterior probabilities P(Ai—B), the inverse conditional probabilities P(B—Ai) do not have to and usually do not sum up to 1. Typically, A1, A2, , Ak represent a set of alternative hypotheses, and B represents some available evidence that may affect their probability. Without taking the evidence into account, the hypotheses have their prior probabilities assigned. The Bayes rule shows how to incorporate the evidence and obtain posterior hypothesis probabilities. Each of the inverse conditional probabilities P(B—Ai) can be considered a measure of the extent to which the evidence supports (or refutes) the corresponding hypothesis Ai.




**Data Sets:**

The data set in this model is generated by the standard user behaviors with 4 attributes:

Date:

Date is in integer form converted from datetime data type by a function called trodinal in datatime module in python to be in this form in the Date Data Set.

```
In [8]:  1 DateTimeDF.head(10)
```

Out[8]:

| | Dates |
|---|---|
| 0 | 736815 |
| 1 | 736816 |
| 2 | 736817 |
| 3 | 736818 |
| 4 | 736819 |
| 5 | 736820 |
| 6 | 736821 |
| 7 | 736822 |
| 8 | 736823 |
| 9 | 736824 |

Time:
Time divided into two columns Hour — Minutes in integer.

Room Number:
Theres 3 rooms that we will train on in this model each one has an id:

- Hallway (1)
- Bedroom (2)
- Bathroom (3)

User Value:
Each sample in the data set describes the user value depends on the time of the day the date and the room number.

Down below 10 samples of the main Data Set:

```
In [5]:  1 bigData.head(10)
```

Out[5]:

| | Dates | Hour | Minutes | RoomNum | User_Value |
|---|---|---|---|---|---|
| 0 | 736815 | 1 | 0 | 1 | 0 |
| 1 | 736816 | 2 | 0 | 1 | 0 |
| 2 | 736817 | 3 | 0 | 1 | 0 |
| 3 | 736818 | 4 | 0 | 1 | 0 |
| 4 | 736819 | 5 | 0 | 1 | 1 |
| 5 | 736820 | 6 | 0 | 1 | 1 |
| 6 | 736821 | 7 | 0 | 1 | 0 |
| 7 | 736822 | 8 | 0 | 1 | 0 |
| 8 | 736823 | 9 | 0 | 1 | 0 |
| 9 | 736824 | 10 | 0 | 1 | 0 |

**Prediction**

Applying the nave Bayes classifier to predict class probabilities for a given instance x is even more straightforward. We just need to multiply the prior class probability and the conditional probabilities of the instances attribute values given the class, i.e., use P(ai = i—c = d) with i = ai(x):

$$P(d|x) = \frac{1}{b} P(c = d) \prod_{i=1} P(ai = ai(x)|c = d)$$

Where the normalizing constant b is obtained as:

$$b = \sum_{d' \in C} P(c = d') \prod_{i=1}^{n} P(ai = ai(x)|c = d')$$

Note that all probabilities needed to classify an arbitrary instance are estimated during model construction, and prediction requires just selecting and multiplying an appropriate subset of them, corresponding to the attribute values of the classified instance x.

### 2.3.7 Decision Tree Algorithm:

#### Abstract

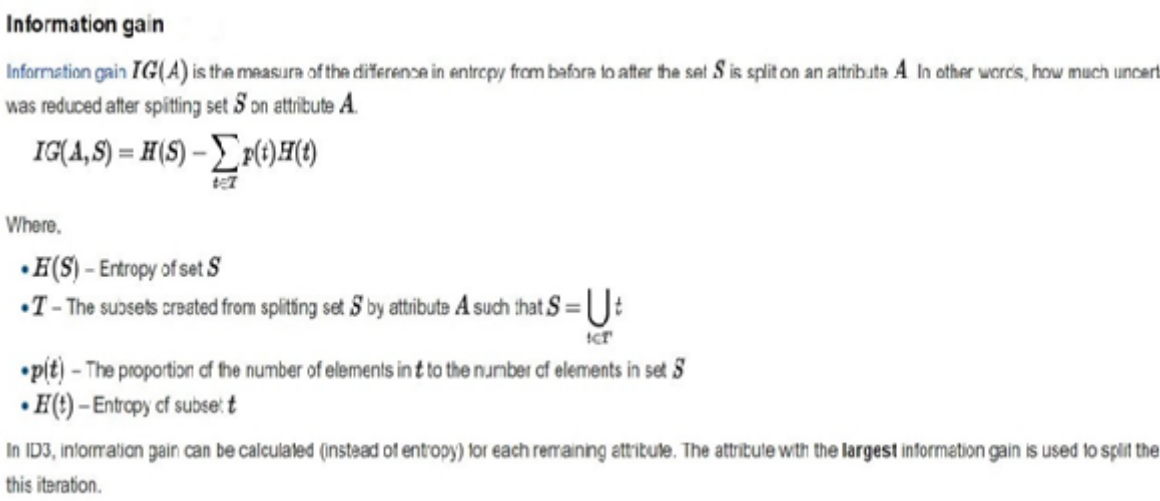
Is a classification model based on user previous data. The classifier fitting this data that getting from the database to make the best decision for the user , depending on his pervious behavior, using Decision tree algorithm. Decision tree is one of the most popular machine learning algorithms used all along.

#### Introduction

A decision tree is a tree where each node represents a feature (attribute), each link (branch) represents a decision (rule) and each leaf represents an outcome (categorical or continues value).

1. Decision tree often mimic the human level thinking so its so simple to understand the data and make some good interpretations

2. Decision trees actually make you see the logic for the data to interpret



**Information gain**

Information gain $IG(A)$ is the measure of the difference in entropy from before to after the set $S$ is split on an attribute $A$. In other words, how much uncert
was reduced after splitting set $S$ on attribute $A$.

$$IG(A,S) = H(S) - \sum_{t \in T} p(t)H(t)$$

Where,

- $H(S)$ – Entropy of set $S$
- $T$ – The subsets created from splitting set $S$ by attribute $A$ such that $S = \bigcup_{t \in T} t$
- $p(t)$ – The proportion of the number of elements in $t$ to the number of elements in set $S$
- $H(t)$ – Entropy of subset $t$

In ID3, information gain can be calculated (instead of entropy) for each remaining attribute. The attribute with the **largest** information gain is used to split the
this iteration.

Here we can see the logic how it is making the decision. Its simple and clear.

#### Decision Tree Rule

Information gain is used to decide which feature to split on at each step in building the tree. Simplicity is best, so we want to keep our tree small. To do so, at each step we should choose the split that results in the purest daughter nodes. A commonly used measure of purity is called information which is measured in bits. In order to define information gain precisely, we begin

by defining a measure commonly used in information theory, called entropy that characterizes the impurity of an arbitrary collection of examples.

**Entropy**

Entropy $H(S)$ is a measure of the amount of uncertainty in the (data) set $S$ (i.e. entropy characterizes the (data) set $S$).

$$H(S) = \sum_{c \in C} -p(c) \log_2 p(c)$$

Where,

- $S$ – The current (data) set for which entropy is being calculated (changes every iteration of the ID3 algorithm)
- $C$ – Set of classes in $S$ C={ yes, no }
- $p(c)$ – The proportion of the number of elements in class $c$ to the number of elements in set $S$

When $H(S) = 0$, the set $S$ is perfectly classified (i.e. all elements in $S$ are of the same class).

In ID3, entropy is calculated for each remaining attribute. The attribute with the **smallest** entropy is used to split the set $S$ on this iteration. The higher higher the potential to improve the classification here.

For a binary classification problem:

- If all examples are positive or all are negative then entropy will be zero , low.
- If half of the examples are of positive class and half are of negative class then entropy is one ,high

**Information gain**

Information gain $IG(A)$ is the measure of the difference in entropy from before to after the set $S$ is split on an attribute $A$. In other words, how much un was reduced after splitting set $S$ on attribute $A$.

$$IG(A, S) = H(S) - \sum_{t \in T} p(t) H(t)$$

Where,

- $H(S)$ – Entropy of set $S$
- $T$ – The subsets created from splitting set $S$ by attribute $A$ such that $S = \bigcup_{t \in T} t$
- $p(t)$ – The proportion of the number of elements in $t$ to the number of elements in set $S$
- $H(t)$ – Entropy of subset $t$

In ID3, information gain can be calculated (instead of entropy) for each remaining attribute. The attribute with the **largest** information gain is used to split this iteration.

### Dataset Preprocessing

#### Weather Madrid

Weather data Barajas Airport, Madrid, between 1997 and 2015. Gathered web https://www.wunderground.com/ The Weather Company, For testing the accuracy of the model, Containing about 6800 day this data has been

preprocessing to working well for the problem, Preprocessing in the data set like splitting the day, month, year, adding user value column which is where the user decision, replacing the messing values by the Mean value.

**Implementing and Testing the model**

**Data needed :**

1. Date: The date in which the decision has been made.
2. Time: The time in which the decision has been made.
3. Interior Value: Temperature degree inside the room.
4. Exterior Value: Temperature degree outside the room.
5. User Value: the user decision to turn the conditioner ON or OFF

| | DateTime | Dates | Hour | minutes | Interior_Value | Exterior_Value | \ |
|---|---|---|---|---|---|---|---|
| 0 | 2018-05-01 12:00:00 | 736815 | 12 | 0 | 25 | 30 | |
| 1 | 2018-05-02 13:00:00 | 736816 | 13 | 0 | 26 | 31 | |
| 2 | 2018-05-03 01:56:00 | 736817 | 14 | 0 | 25 | 30 | |
| 3 | 2018-05-04 12:56:00 | 736818 | 15 | 0 | 27 | 32 | |
| 4 | 2018-05-05 17:56:00 | 736819 | 19 | 0 | 28 | 33 | |

| | user_value |
|---|---|
| 0 | 1 |
| 1 | 1 |
| 2 | 1 |
| 3 | 1 |
| 4 | 0 |

**Score result**

| | |
|---|---|
| Accuracy of the model | 98 % |
| Dataset train size | 5449 day |
| Dataset test size | 1363 day |
| Output decision | On / Off |

The accuracy of the model is 98%.

## 2.4 Mouth

In which we take advantage of Natural Language Generation algorithms in order to provide what has already been in Wattarys memory in an unstructured data form again, and use Text-to-speech engine to provide the user with a human-like vocal.

In order to achieve an autmated generation of a human natural language, we have taken advantage from the context-free grammar concept which has an extensively use in the area of Compiers desing.

However, In our model, instead of using CFG to parse an input from the user, we have reversed its functionality to generate a correct sentence based on the POS tags from the Penn-treebank.

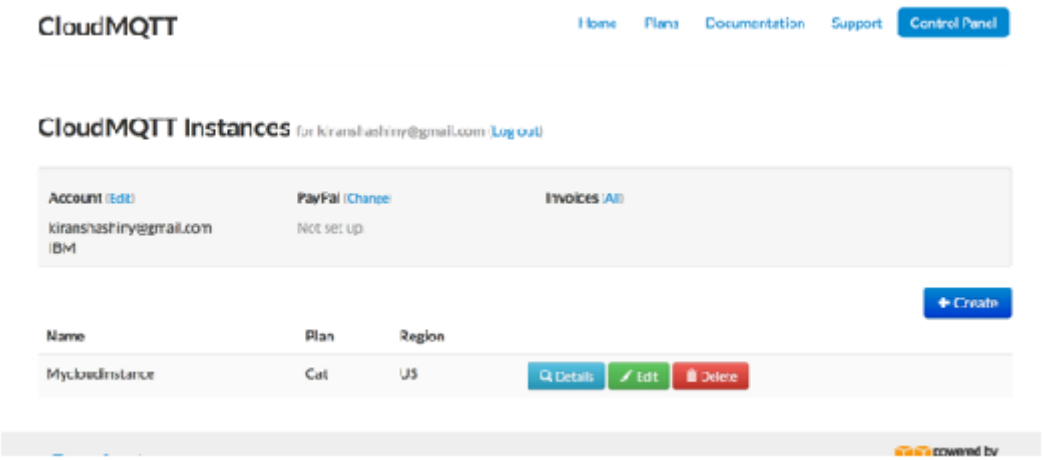
### 2.4.1 CFG and Natural Language Generation

```
S -> PRP VBP JJ
PRP -> "I"
VBP -> "am"
JJ -> "good" | "fine" | "ok"

S -> NN VBZ VB RB R
NN -> "Everything"
VBZ -> "is"
VB -> "going"
RB -> "extremely"
R -> "well"

S -> PR NND CC DD NNS VBP J
PR -> "My"
NND -> "logic"
CC -> "and"
DD -> "cognitive"
NNS -> "functions"
VBP -> "are"
J -> "Normal" | "working well"

S -> P VBZ DT JJJ
P -> "It"
VBZ -> "is"
DT -> "all"
JJJ -> "good"

S -> W
W -> "Good" | "Fine"
```

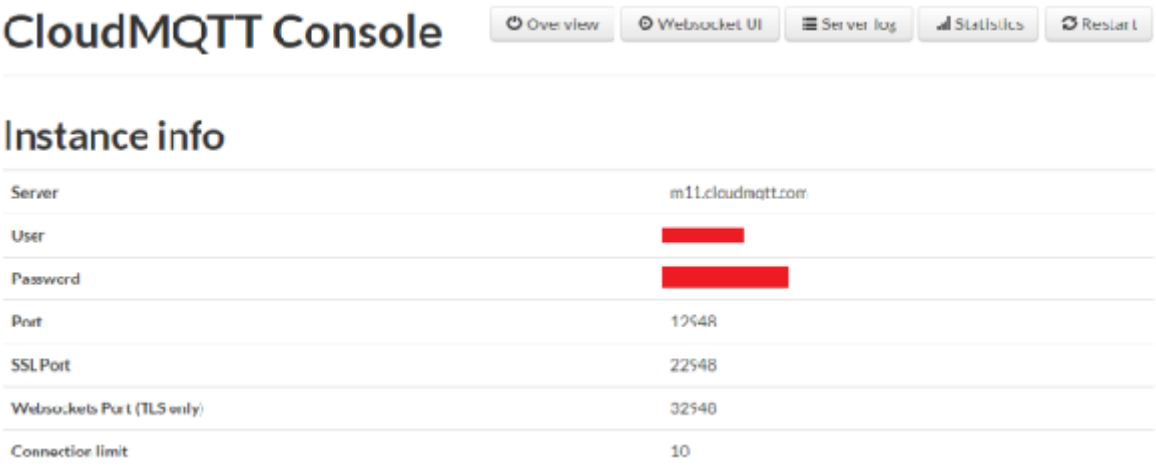
## 2.5 The Hardware Interface

### 2.5.1 Setting up MQTT

- Create an account on cloudmqtt.com
- Go to the control panel in top right corner
- Click on the "create" button

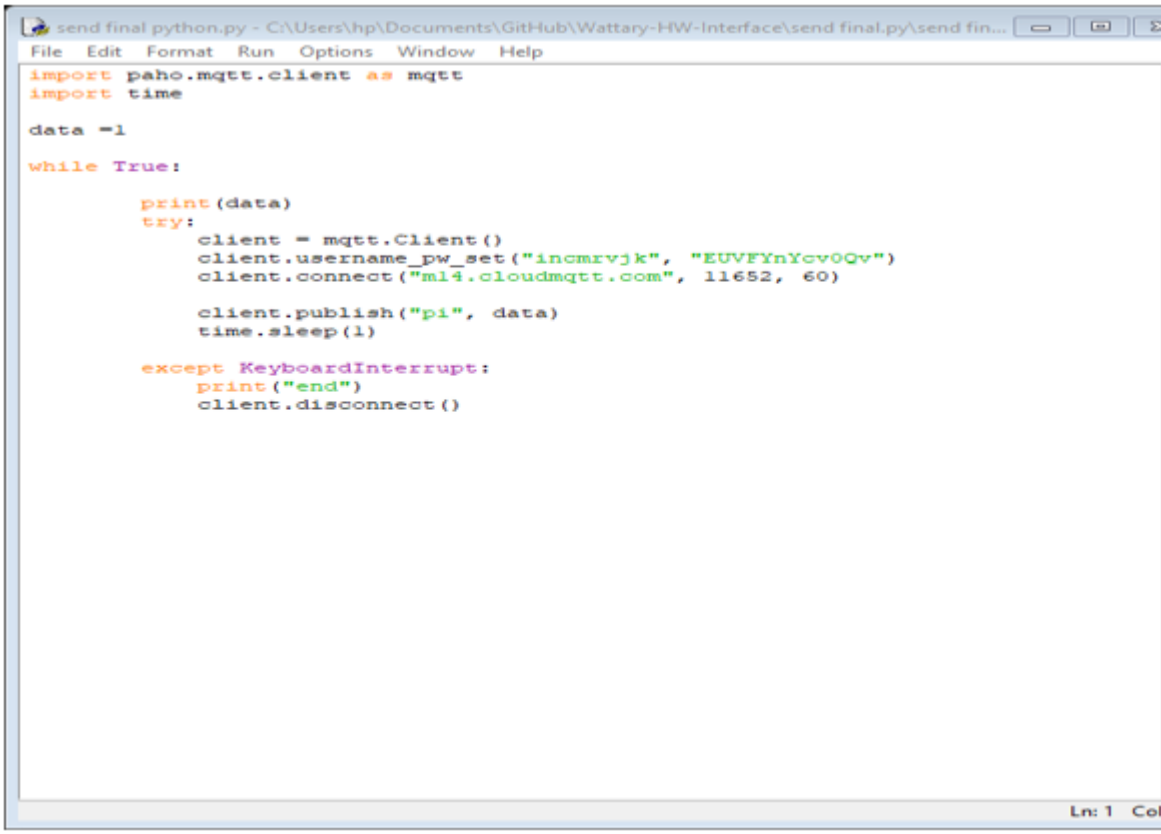



- Enter CMQTT in the "name" field

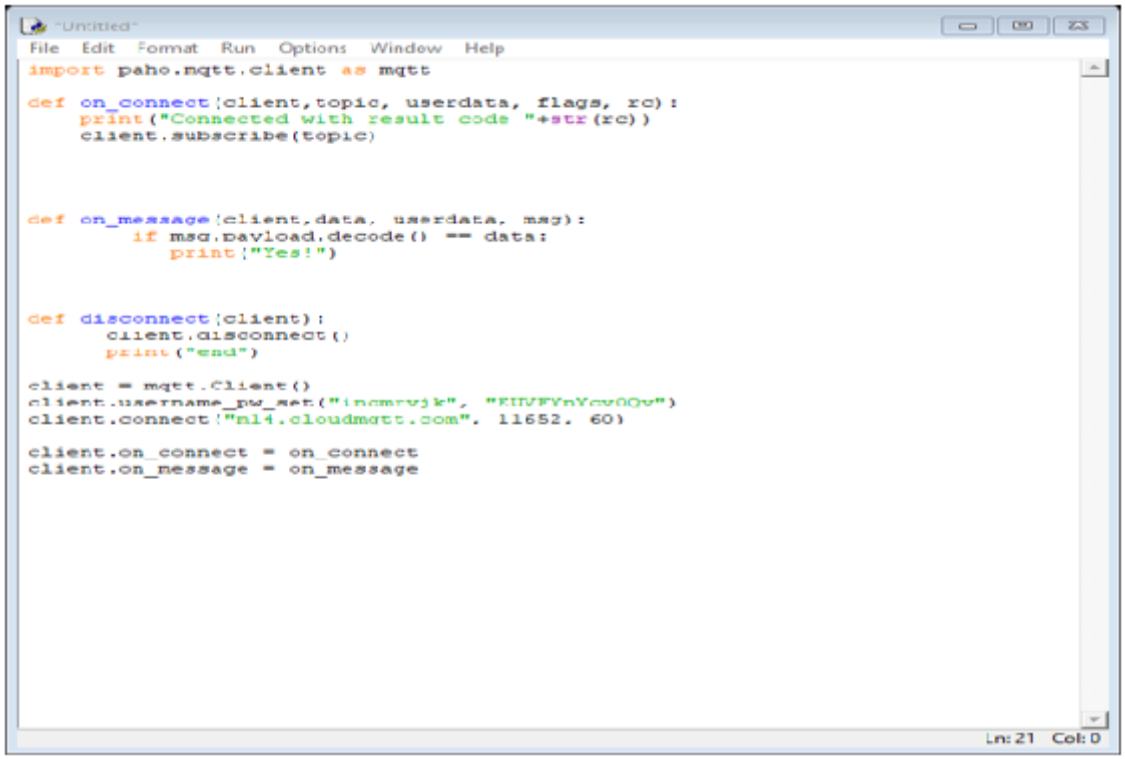


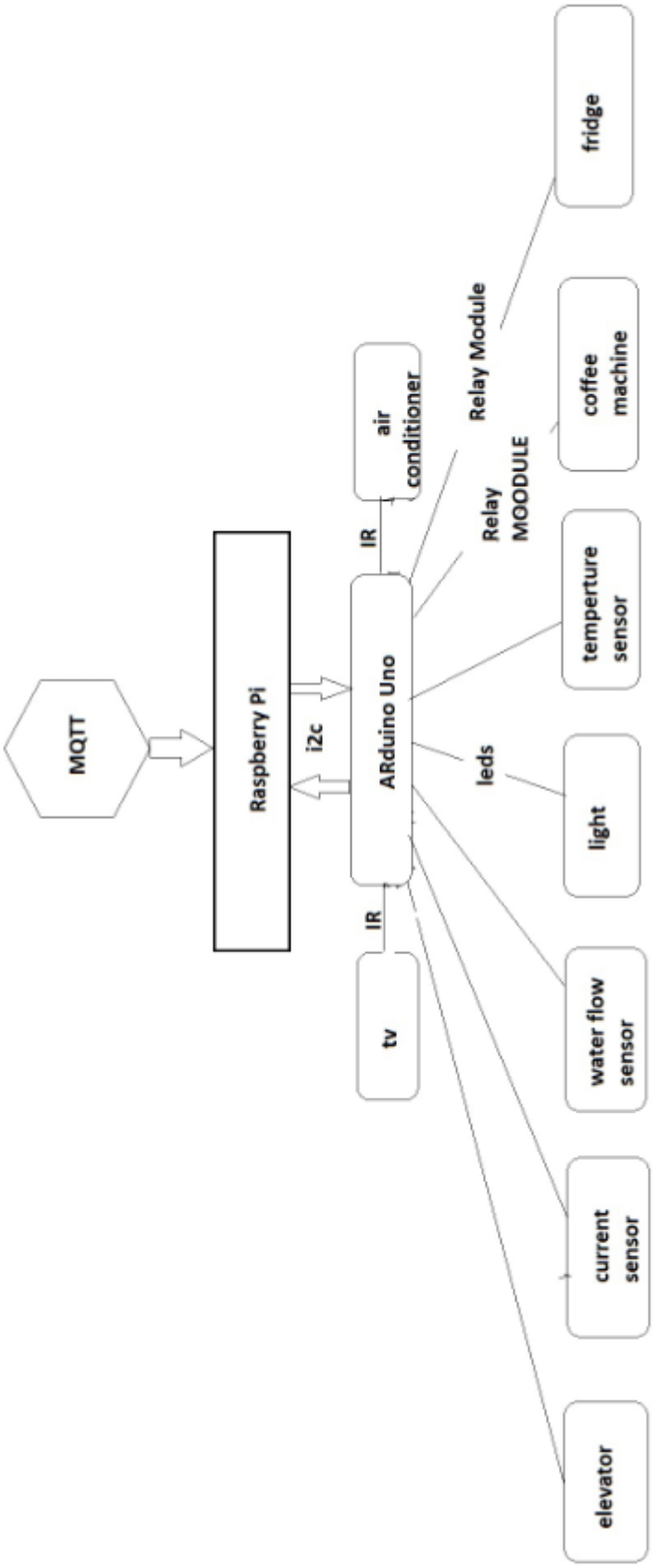

- On the same page, in manage users add a user with:
- Name: pi
- Password: pi

- Click on "save"
- Again on the same page at the end, add:
  - User: pi
  - Topic: pi
- And click on "save"
- Now, in the top bar, click on "WebSocket UI"
- You will see a page where all the data will be displayed



First Install MQTT for python through :
pip install paho-mqtt
Then run the sender code by using python 2.7




MQTT
Raspberry Pi
i2c
ARduino Uno
IR
air conditioner
IR
tv
Relay Module
Relay MOODULE
leds
fridge
coffee machine
temperture sensor
light
water flow sensor
current sensor
elevator

### 2.5.2 WebCam

We use this camera to know who is on the door and recognize the face and control the door through this. After connecting the camera with USB, we installed the fswebcamera program to capture individual images via:

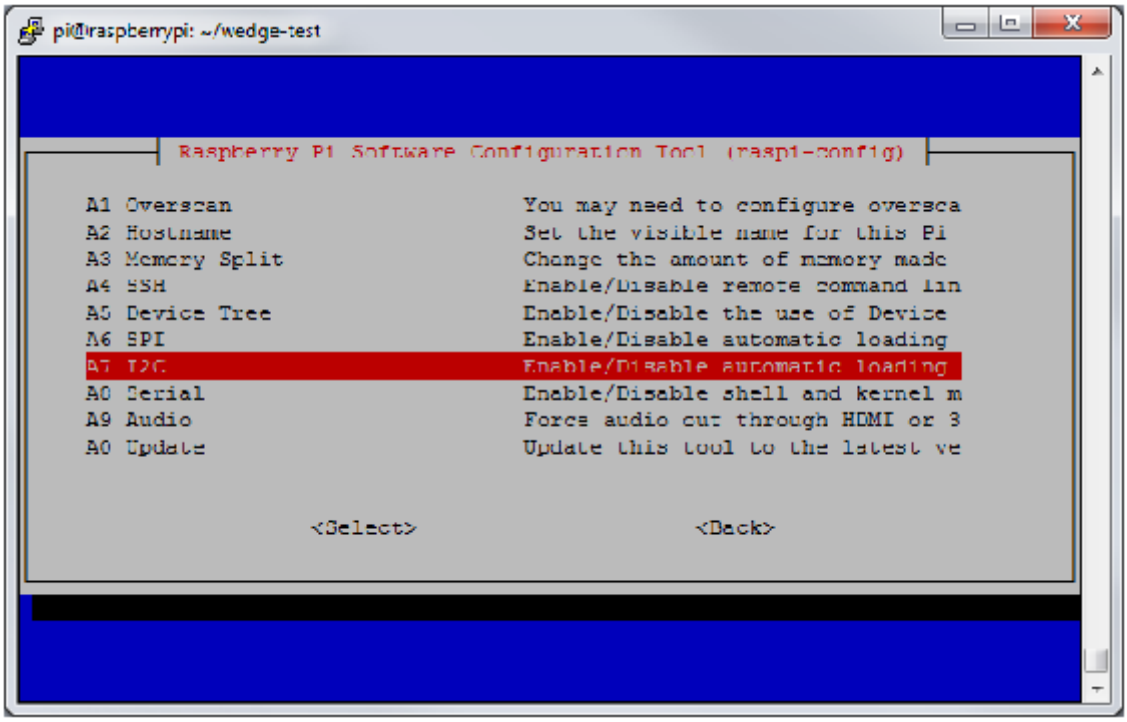
sudo apt-get install fswebcam y
and we also installed a program ffmpeg So we can record video via:
sudo apt-get install ffmpeg y
To play the video, we have installed a program mplayer via:
Sudo apt-get install mplayer y


These figers shows the basic component of the smart mirror , namely the raspberry pi 3 model B , where the smart mirror were programmed by it for the brains of the project as it has built in WIFI which is perfect for this

### 2.5.3 Configuration I2C on Pi

First Enable I2C on Raspberry Pi through :

1. Run sudo raspi-config.
2. Use the down arrow to select 9 Advanced Options
3. Arrow down to A7 I2C.
4. Select yes when it asks you to enable I2C
5. Also select yes when it tasks about automatically loading the kernel module.
6. Use the right arrow to select the ¡Finish¿ button.
7. Select yes when it asks to reboot.




With Raspberry Pi and I2C communication, we can connect the Pi with single or multiple Arduino boards. The Raspberry Pi has only 8 GPIOs, so it would be really useful to have additional Inputs and outputs by combining the Raspberry Pi and Arduino.

### How Does It Work?

The Raspberry Pi is running at 3.3 Volts while the Arduino is running at 5 Volts. We can use a level converter for the I2C communication. This is NOT needed if the Raspberry Pi is running as master and the Arduino is

running as slave.
Connecting Devices Identify SDA, SCL, and GND pins on both Raspberry Pi and the Arduino . Connect SDA to SDA, SCL to SCL, and GND to GND between the two devices.

**Procedure**

- Remove all wires from Arduino
- Connect the Arduino to the computer using USB
- Upload the Arduino sketch code into the Arduino
- Download the python code onto your Pi
- Connect the Arduino to the Pi, Note that the red wire connects to Pi physical pin 6, and the ground to pin 2.

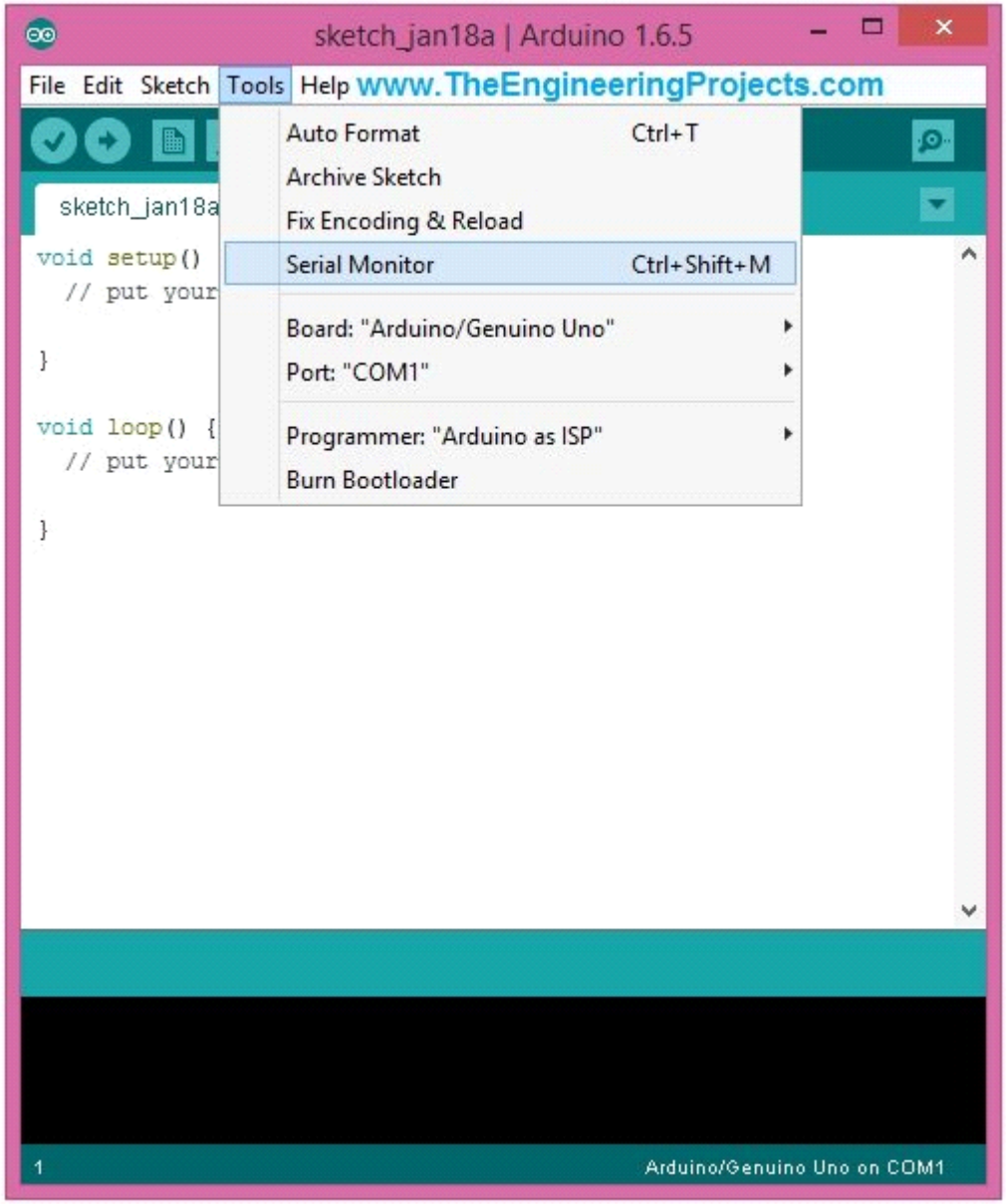
Then Run the controller program from the python: python3 ic2.py

### 2.5.4 switch on/off light

connect led to pin 13 and GND of arduino


serial monitor will recieve data from you using function "Serial.parseInt();"

if you write "1" in the serial the light is on "digitalWrite(13, HIGH);" and if you write "2" the light is off "digitalWrite(13, LOW);".



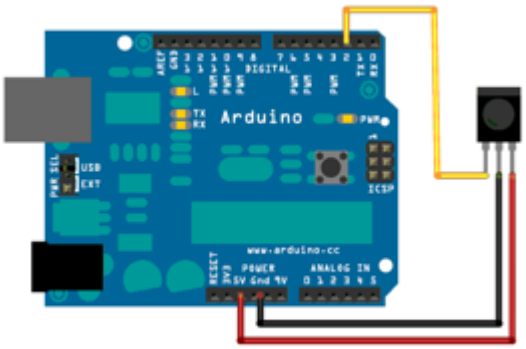

### 2.5.5 control channel of tv

in this feature we recieve the code of every channel and send it again using IR LED and IR reciever

**steps to recieve :**

- find the remote for whatever you want to control
- point it at the IR reciever

- press the button you want to get the code for ONE TIME
- watch the Serial Monitor
- paste the entire code into notepad or wordpad
- using function delayMicroseconds(); pulseiR( ); to send codes again .




control the channels by write the number of channel in serial monitor:

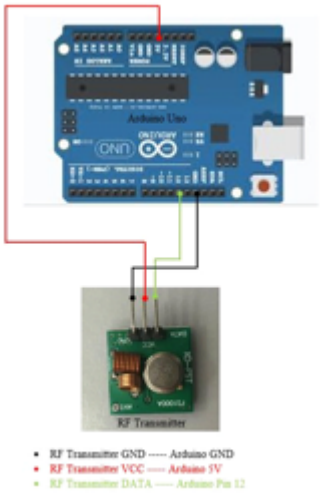
- "1" number of channel one
- "2" number of channel two
- "3" number of channel three
- "4" number of channel four
- "5" number of channel five
- "6" to turn on/off TV

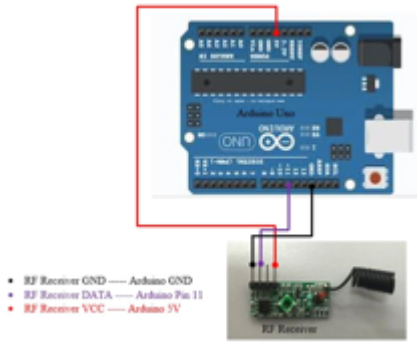
**control elevator using RF transmitter and reciever**

for each RF module, we are using different Arduino Uno to install them. For instances, RF transmitter is connected to Arduino Uno A while RF receiver is connected to Arduino Uno B.

- RF reciever GND——-Arduino GND
- RF reciever DATA——Arduino DATA
- RF reciever VCC———Arduino 5V
- RF transmitter GND——Arduino GND
- RF transmitter VCC——Arduino 5V

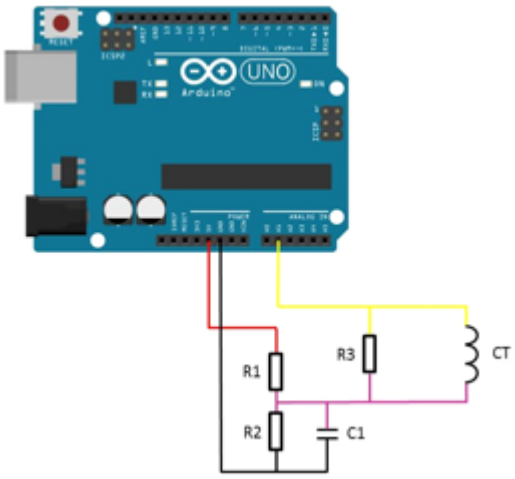
- RF transmitter DATA——Arduino pin1



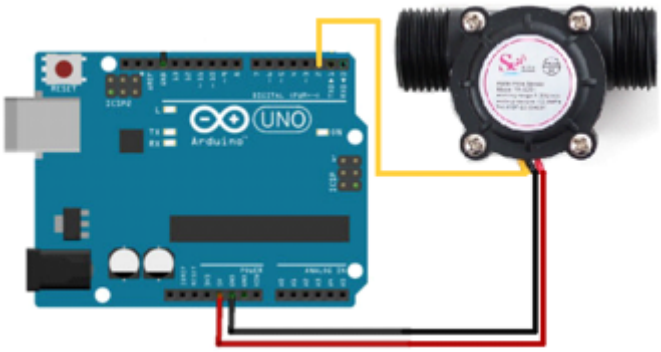

**power consumption USING CT SENSOR**

connect your sensor onto what you want to monitor. If you are wanting to monitor a couple of appliances then you should connect the CT onto the input lead of a multi-plug, anything you plug into the multi-plug with then be counted. Alternately, you can connect the CT directly onto your homes mains supply and monitor the whole houses usage as has been done here. Either way, you need to put the CT around one of the supply cables, preferably the red live cable. Be sure to only put it around 1 as it will not work if it is around both and it cant be connected around the earth wire (yellow, green stripped wire) as energy is not drawn through this wire. If you are connecting it to your mains, connect it to one of the output wires after the main breaker




**calculate water flow**

programmed your Arduino, Connect your sensor with your water tap, or just blow on it, l we will use the serial monitor for printing the water flow rate in liters per hour and the total of liters flowed since starting.




**control of curtains by servo**

The Servo has black to ground, red to 5V supply, and white to PWM pin 9. after connect arduino with servo ,programmed your arduino then open serial monitor to control curtain ,write "1" curtain will open, write "2" curtain will closed

## 2.6 The Android Interface

### 2.6.1 Login Activity

its a login page in which the user take a photo of his face using the camera of his device or by pick the photo from the device after taking the photo the

user will direct to crop the photo ,after that the photo will be uploaded to the firebase storage to send its Url to the server , and then matching process take place to check whether its a successful match or not

### 2.6.2 Sign-Up Activity

its sign-up page, that take some information form the new user, this information is :

1. Frist name
2. Last name
3. Password
4. Photo of his face using the camera of his device.

after taking the photo the user will direct to crop the photo , And then the photo will send to the firebase storage to get its Url and send it to the server with information about the user to save them and check if the user exist in the system or not , if the user doesnt exist in the system then new account will create for him, Upon registration it will notify the user if the process is successful or not because some issues related to network connection or similarity with other user already registered in the system database.

### 2.6.3 Notifications

Is notification system that remind the user every hour about recommended action the system can do for him like turning on the light or turn it off ,turning the air conditioner On or off and all that based on his actions that the system has learn from them

### 2.6.4 Animation

Start an activity using an animation.
Slide animation - Moves views in or out from one of the edges of the scene.
fade animation - Adds or removes a view from the scene by changing its opacity.

#### Floating Action menu

floating action menu which is basically a FAB which upon click displays multiple smaller FABs(Floating Action buttons).

### 2.6.5 Permission

To maintain security for the system and users, Android requires that apps declare the permissions they need before they can use certain system data and features. Depending on how sensitive the area is, the system may grant the permission automatically, or it may ask the user to approve the request.

### 2.6.6 Internet Access

In order to perform network operations in the application.

### 2.6.7 Camera access

to open the actual device camera and to take a photo.

### 2.6.8 shared preference

A SharedPreferences object points to a file containing key-value pairs to save the state of the user logged into the system or logged out of it, if the user still logging in the system the user will direct to his account ,if the user logged out of it the user will direct to sign up and log in page, saving the user name that will get from the server to send it with every massage from the user to the server

# Chapter 3

# Tools and Techniques

Hereby, we provide some information about the tools that we used to build our agent.

## 3.1 The Main Programming Language

### 3.1.1 Python Programming Language

We have decided to unify the main programming language that we will use amongst the various aspects of our project, and the language of choice is python and we have choosen it for its simplicity and sophistication, especially when it comes to AI applications.

Python is an easy to learn, powerful programming language. It has efficient high-level data structures and a simple but effective approach to object-oriented programming. Pythons elegant syntax and dynamic typing, together with its interpreted nature, make it an ideal language for scripting and rapid application development in many areas on most platforms.

The Python interpreter and the extensive standard library are freely available in source or binary form for all major platforms from the Python Web site, https://www.python.org/, and may be freely distributed. The same site also contains distributions of and pointers to many free third party Python modules, programs and tools, and additional documentation.

The Python interpreter is easily extended with new functions and data types implemented in C or C++ (or other languages callable from C). Python is also suitable as an extension language for customizable applications.

### 3.1.2 Benefits of Python

#### Extensive Support Libraries

It provides large standard libraries that include the areas like string operations, Internet, web service tools, operating system interfaces and protocols. Most of the highly used programming tasks are already scripted into it that limits the length of the codes to be written in Python.

#### Integration Feature

Python integrates the Enterprise Application Integration that makes it easy to develop Web services by invoking COM or COBRA components. It has powerful control capabilities as it calls directly through C, C++ or Java via Jython. Python also processes XML and other markup languages as it can run on all modern operating systems through same byte code.

#### Improved Programmers Productivity

The language has extensive support libraries and clean object-oriented designs that increase two to ten fold of programmers productivity while using the languages like Java, VB, Perl, C, C++ and C.
With its strong process integration features, unit testing framework and enhanced control capabilities contribute towards the increased speed for most applications and productivity of applications. It is a great option for building scalable multi-protocol network applications.

## 3.2 Computer Vision Tools

### 3.2.1 Dlib

Dlib is a general purpose cross-platform software library written in the programming language C++. Its design is heavily influenced by ideas from design by contract and component-based software engineering. Thus it is, first and foremost, a set of independent software components. It is open-source software released under a Boost Software License.

### 3.2.2 Skimage

is a collection of algorithms for image processing.

### 3.2.3 Scipy

SciPy is a free and open-source Python library used for scientific computing and technical computing. it contains modules for optimization, linear algebra, integration, interpolation, special functions, FFT, signal and image processing, ODE solvers and other tasks common in science and engineering. SciPy builds on the NumPy array object and is part of the NumPy stack which includes tools like Matplotlib, pandas and SymPy, and an expanding set of scientific computing libraries. This NumPy stack has similar users to other applications such as MATLAB, GNU Octave, and Scilab. The NumPy stack is also sometimes referred to as the SciPy stack.

## 3.3 NLP Tools

### 3.3.1 NLTK Library

NLTK is a leading platform for building Python programs to work with human language data. It provides easy-to-use interfaces to over 50 corpora and lexical resources such as WordNet, along with a suite of text processing libraries for classification, tokenization, stemming, tagging, parsing, and semantic reasoning, wrappers for industrial-strength NLP libraries, and an active discussion forum.

Thanks to a hands-on guide introducing programming fundamentals alongside topics in computational linguistics, plus comprehensive API documentation, NLTK is suitable for linguists, engineers, students, educators, researchers, and industry users alike. NLTK is available for Windows, Mac OS X, and Linux. Best of all, NLTK is a free, open source, community-driven project.

NLTK has been called a wonderful tool for teaching, and working in, computational linguistics using Python, and an amazing library to play with natural language.

### 3.3.2 Regular Expression

A regular expression, regex or regexp (sometimes called a rational expression) is, in theoretical computer science and formal language theory, a sequence of characters that define a search pattern. Usually this pattern is then used by string searching algorithms for "find" or "find and replace" operations on strings, or for input validation.

The concept arose in the 1950s when the American mathematician Stephen Cole Kleene formalized the description of a regular language. The concept came into common use with Unix text-processing utilities. Since the 1980s, different syntaxes for writing regular expressions exist, one being the POSIX standard and another, widely used, being the Perl syntax.

Regular expressions are used in search engines, search and replace dialogs of word processors and text editors, in text processing utilities such as sed and AWK and in lexical analysis. Many programming languages provide regex capabilities, built-in or via libraries.

## 3.4 Machine Learning

### 3.4.1 Sci-Kit Learn

Scikit-learn (formerly scikits.learn) is a free software machine learning library for the Python programming language. It features various classification, regression and clustering algorithms including support vector machines, random forests, gradient boosting, k-means and DBSCAN, and is designed to interoperate with the Python numerical and scientific libraries NumPy and SciPy.

#### Overview

The scikit-learn project started as scikits.learn, a Google Summer of Code project by David Cournapeau. Its name stems from the notion that it is a "SciKit" (SciPy Toolkit), a separately-developed and distributed third-party extension to SciPy. The original codebase was later rewritten by other developers. In 2010 Fabian Pedregosa, Gael Varoquaux, Alexandre Gramfort and Vincent Michel, all from INRIA took leadership of the project and made the first public release on February the 1st 2010. Of the various scikits.

#### implementation

Scikit-learn is largely written in Python, with some core algorithms written in Cython to achieve performance.

### 3.4.2 Pandas

In computer programming, pandas is a software library written for the Python programming language for data manipulation and analysis. In particular, it offers data structures and operations for manipulating numerical tables and time series. It is free software released under the three-clause BSD license. The name is derived from the term "panel data", an econometrics term for data sets that include observations over multiple time periods for the same individuals.

#### Features

- DataFrame object for data manipulation with integrated indexing.
- Tools for reading and writing data between in-memory data structures and different file formats
- Data alignment and integrated handling of missing data.
- Reshaping and pivoting of data sets.
- Label-based slicing, fancy indexing, and subsetting of large data sets.
- Data structure column insertion and deletion.
- Group by engine allowing split-apply-combine operations on data sets.
- Data set merging and joining.
- Hierarchical axis indexing to work with high-dimensional data in a lower-dimensional data structure.
- Time series-functionality: Date range generation and frequency conversion, moving window statistics, moving window linear regressions, date shifting and lagging

#### History

Developer Wes McKinney started working on pandas in 2008 while at AQR Capital Management out of the need for a high performance, flexible tool to perform quantitative analysis on financial data. Before leaving AQR he was able to convince management to allow him to open source the library. Another AQR employee, Chang She, joined the effort in 2012 as the second major contributor to the library. In 2015, pandas signed on as a fiscally sponsored project of NumFOCUS, a 501(c)nonprofit charity in the United States.

### 3.4.3 Numpy

is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays. The ancestor of NumPy, Numeric, was originally created by Jim Hugunin with contributions from several other developers. In 2005, Travis Oliphant created NumPy by incorporating features of the competing Numarray into Numeric, with extensive modifications. NumPy is open-source software and has many contributors.

- A powerful N-dimensional array object.
- sophisticated (broadcasting) functions.
- tools for integrating C/C++ and Fortran code.
- useful linear algebra, Fourier transform, and random number capabilities

#### History

There was a desire to get Numeric into the Python standard library, but Guido van Rossum decided that the code was not maintainable in its state then.[when?] In early 2005, NumPy developer Travis Oliphant wanted to unify the community around a single array package and ported Numarray's features to Numeric, releasing the result as NumPy 1.0 in 2006. This new project was part of SciPy. To avoid installing the large SciPy package just to get an array object, this new package was separated and called NumPy. Support for Python 3 was added in 2011 with NumPy version 1.5.0. In 2011, PyPy started development on an implementation of the NumPy API for PyPy.It is not yet fully compatible with NumPy

#### Traits

NumPy targets the CPython reference implementation of Python, which is a non-optimizing bytecode interpreter. Mathematical algorithms written for this version of Python often run much slower than compiled equivalents. NumPy addresses the slowness problem partly by providing multidimensional arrays and functions and operators that operate efficiently on arrays, requiring rewriting some code, mostly inner loops using NumPy. Using NumPy in Python gives functionality comparable to MATLAB since they are both interpreted, and they both allow the user to write fast programs as long as most operations work on arrays or matrices instead of scalars. In comparison, MATLAB boasts a large number of additional toolboxes, notably Simulink, whereas NumPy is intrinsically integrated with Python, a more modern and complete programming language.

### The nd array data structure

The core functionality of NumPy is its "ndarray", for n-dimensional array, data structure. These arrays are strided views on memory. In contrast to Python's built-in list data structure (which, despite the name, is a dynamic array), these arrays are homogeneously typed: all elements of a single array must be of the same type. Such arrays can also be views into memory buffers allocated by C/C++, Cython, and Fortran extensions to the CPython interpreter without the need to copy data around, giving a degree of compatibility with existing numerical libraries. This functionality is exploited by the SciPy package, which wraps a number of such libraries (notably BLAS and LAPACK). NumPy has built-in support for memory-mapped ndarrays.

### Why Numpy & Pandas

1. Having an R-style data frame (with column names!) can help a lot in keeping track of your data.

2. A numpy array requires homogeneous data. With a pandas dataframe, you can have different data types (float, int, string, datetime, etc) all in one place.

3. Pandas has built in functionality for a lot of common data-processing applications: for example, easy group by syntax, easy joins (which are also really efficient in pandas), rolling windows

4. Good IO capabilities

## 3.5 Hardware Tools

- Raspberry pi 3.
- Webcam
- Jumpers
- LCD Monitor
- Wooden Frame
- HDMI
- Power Supply

### 3.5.1 To implement the smart mirror we used these libraries:

1. TKinter Library : to create GUI programs
2. Locale Library : open access to the POSIX ( to access to locale database )
3. Threading Library : Accelerate the program by doing more than one parallel operation instead of sequentially
4. Time Library : to connect the time to the date of the pc
5. Requests Library : to open and retrieve links
6. Json Library : to send links
7. Traceback Library : (most recent call last ) print exception tracebacks inside your programs
8. Feedparser Library : to analyze the abstracts ( rss)
9. PIL Library : To handle images in terms of image processing in an easy way
10. Context manager : To work two processes with one another, if in a set of instructions among them

### 3.5.2 why "C" ?

using C to program the Arduino means usually being able to create smaller programs, and with more fine grained control of what happens. C is adopted worldwide to program for small microprocessors because it gives a good trade-off between development effort and program efficiency, and because of its history there are well-optimized libraries, extensive guides and ways to

solve problems. So if you find that Arduino language creates programs that are too big or too slow but you want to squeeze the performance out of your board, or you want a more modular approach, moving to C could be the right choice.

### 3.5.3 Arduino IDE

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux.

## 3.6 Web Interface — Front-End

Is the practice of converting data to graphical interface for user to view and interact with data through digital interaction using HTML, CSS and Java script.

### 3.6.1 What does User Interface (UI) mean ?

User interface (UI) is a broad term for any system, either physical or software based, that allows a user to connect with a given technology. Many different kinds of user interfaces come with various devices and software programs. Many of them have some basic similarities, although each one is unique in key ways.

### 3.6.2 WHAT IS RESPONSIVE DESIGN?

Responsive design is an approach to web page creation that makes use of flexible layouts, flexible images and cascading style sheet media queries. The goal of responsive design is to build web pages that detect the visitors screen size and orientation and change the layout accordingly.

### 3.6.3 HTML5

Hypertext Markup Language revision 5 (HTML5) is markup language for the structure and presentation of World Wide Web contents. HTML5 supports the traditional HTML and XHTML-style syntax and other new features in its markup, New APIs, XHTML and error handling.

HTML5 is an effort is to bring order to web development chaos by organizing common practices, embracing implementations from various browsers. It is massive, with over 100 specifications as part of the HTML5 specs. Understanding this, you can simplify by thinking of HTML5 this way. HTML5 is simply just an umbrella term for the next generation of web apps an how functionality will be expanded with better markup (HTML), better style (CSS), and better interactivity (JavaScript).

The specification of HTML5 that has been published currently is not yet final. HTML5 is expected due for Candidate Recommendation (CR) by 2012, and is expected for Proposed Recommendation (PR) by 2022. However, this doesnt mean that HTML5 is not ready for use. The proposed recommendation does mean however that there will be two interoperable implementations. As of 2011, browser vendors are actively adding support

for new features of HTML5.

There are three organizations that are currently in charge of the specification of HTML5:

1. Web Hypertext Application Technology Working Group (WHATWG) created the HTML5 specification and is in charge of the HTML5 development that provides open collaboration of browser vendors and other involved parties.

2. World Wide Web Consortium (W3C) is in charge with delivering the HTML5 specification.

3. Internet Engineering Task Force (IETF) is in charge of the development of HTML5 WebSocket API.

### 3.6.4 CSS

Cascading Style Sheets (CSS) is a standard (or language) that describes the formatting of markup language pages. CSS defines formatting for the following document types:

1. HyperText Markup Language (HTML)

2. Extensible HyperText Markup Language (XHTML)

3. Extensible Markup Language (XML)

4. Scalable Vector Graphic (SVG)

5. XML User Interface Language (XUL)

CSS enables developers to separate content and visual elements for greater page control and flexibility. A CSS file is normally attached to an HTML file by means of a link in the HTML file.

In December 1998, the World Wide Web Consortium (W3C) published the first CSS specification (CSS1). This was followed by CSS Level 2 (CSS2), and CSS Level 2, Revision 1 (CSS2.1)

### 3.6.5 CSS3

CSS3 makes changes to how some visual elements are implemented and rendered by a browser. However, it is not a single hugely unwieldy specification, unlike CSS2. CSS3 is separated into separate modules to facilitate development. This means that the specification comes out in chunks, with more stable modules than others.

Some would be ready for recommendation, while others would be marked as under development drafts, the most recent of which were published as early as June 1999

Some of the major modules of CSS3 are:

1. Box model
2. Text effects
3. Animations
4. Multiple column layout
5. 2D/3D transformations

### 3.6.6 JavaScript

HTML pages are fine for displaying static content, e.g. a simple image or text. However, most pages nowadays are rarely static. Many of todays pages have menus, forms, slideshows and even images that provide user interaction. Javascript is the language employed by web developers to provide such interaction. Since JavaScript works with HTML pages, a developer needs to know HTML to harness this scripting languages full potential. While there are other languages that can be used for scripting on the Web, in practice it is essentially all Javascript.

There are two ways to use JavaScript in an HTML file. The first one involves embedding all the JavaScript code in the HTML code, while the second method makes use of a separate JavaScript file thats called from within a Script element, i.e., enclosed by Script tags. JavaScript files are identified by the .js extension. Although JavaScript is mostly used to interact with HTML objects, it can also be made to interact with other non-HTML objects such as browser plugins, CSS (Cascading Style Sheets) properties, the current date, or the browser itself. To write JavaScript code, all you need is a basic text editor like Notepad in Windows, Gimp in Linux, or BBEdit. Some text editors, like BBEdit feature syntax highlighting for JavaScript. This will allow you easily identify elements of JavaScript code. The latest versions of Internet Explorer, Firefox, and Opera all support JavaScript.

### 3.6.7 BootStrap

Bootstrap is an open source toolkit for developing with HTML, CSS, and JS. Quickly prototype your ideas or build your entire app with our Sass variables and mixins, responsive grid system, extensive prebuilt components, and powerful plugins built on jQuery.

### 3.6.8 What is React?

React is a way to build user interfaces. It is only concerned with what you see on the front-end. React makes user interfaces very easy to build by cutting each page into pieces. We call these pieces components.

### 3.6.9 What is a React Component?

A React component is a bit of code that represents a piece of the page. Each component is a JavaScript function that returns a piece of code that represents a piece of a web page. To build a page, we call these functions in a certain order, put together the result, and show it to the user.

### 3.6.10 What is JSX ?

JSX is a XML-like syntax extension to ECMAScript without any defined semantics. Its NOT intended to be implemented by engines or browsers.
JSX syntax is intended to be used by preprocessors to transform HTML-like text in JavaScript files into standard JavaScript objects. Babel compiler is a subjective selection from React team for transforming ES6 code and JSX syntax to ES5 code. Using JSX, you can leverage the full power of JavaScript in HTML. You have to close all tags, always.

### 3.6.11 What is React Router ?

React Router is a collection of navigational components that compose declaratively with your application. Whether you want to have bookmarkable URLs for your web app or a composable way to navigate in React Native, React Router works wherever React is rendering.

### 3.6.12 What is the Virtual DOM?

The virtual DOM (VDOM) is a programming concept where an ideal, or virtual, representation of a UI is kept in memory and synced with the real DOM by a library such as ReactDOM. This process is called reconciliation

### 3.6.13 What is the React-Bootstrap?

React-Bootstrap is a complete re-implementation of the Bootstrap components using React. ... If you have React setup and React-Bootstrap installed you have everything you need. You can consume the library as CommonJS modules, ES6 modules via Babel, AMD, or as a global JS script.

### 3.6.14 What is the Axios?

Axios is promise-based and thus we can take advantage of async and await for more readable asynchronous code. We can also intercept and cancel requests, and theres built-in client side protection against cross site request forgery. But the best part about Axios? The easy to use API! Using it inside a React project is simple! In this example well use Axios to access the common JSON Placeholder API within a React application. We can start by adding Axios to our project

## 3.7 Back-End

### 3.7.1 HTTP

The Hypertext Transfer Protocol (HTTP) is designed to enable communications between clients and servers. HTTP works as a request-response protocol between a client and server. A web browser may be the client, and an application on a computer that hosts a web site may be the server.

### 3.7.2 API:

APIs (Application Programming Interfaces) are the tools that transport the information that the back-end produces to the front-end of the app.

### 3.7.3 Restful API

A RESTful API – also referred to as a RESTful web service – is based on representational state transfer (REST) technology, an architectural style and approach to communications often used in web services development.

### 3.7.4 EndPoints:

The endpoint is what you'll point your HTTP client at to interact with data resources.

### 3.7.5 Flask

Is a micro web framework written in Python. It is classified as a microframework because it does not require particular tools or libraries.

### 3.7.6 Request Module

Requests is an Apache2 Licensed HTTP library, written in Python, requests will allow you to send HTTP/1.1 requests using Python. With it, you can add content like headers, form data, multipart files, and parameters via simple Python libraries. It also allows you to access the response data of Python in the same way.

## 3.8 Android Tools

### 3.8.1 Java Programming Language

Java is a general-purpose computer-programming language that is concurrent, class-based, object-oriented, and specifically designed to have as few implementation dependencies as possible. It is intended to let application developers "write once, run anywhere" (WORA), meaning that compiled Java code can run on all platforms that support Java without the need for recompilation.] Java applications are typically compiled to bytecode that can run on any Java virtual machine (JVM) regardless of computer architecture. As of 2016, Java is one of the most popular programming languages in use.

### 3.8.2 XML

In computing, Extensible Markup Language (XML) is a markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable. The W3C's XML 1.0 Specification and several other related specificationsall of them free open standardsdefine XML

### 3.8.3 Firebase

Firebase is a mobile and web application development platform developed by Firebase, Inc. in 2011, then acquired by Google

**Services**

- Firebase Analytics
- Firebase Cloud Messaging
- Realtime Database
- Firebase Auth
- Firebase Storage

- Firebase Hosting
- Firebase Remote Config

**Storage**

Firebase Storage provides secure file uploads and downloads for Firebase apps, regardless of network quality. The developer can use it to store images, audio, video, or other user-generated content. Firebase Storage is backed by Google Cloud Storage.

### 3.8.4 Picasso

Picasso allows for hassle-free image loading in your Application

### 3.8.5 Android Image Cropper

Image Cropping Library for Android, optimized for Camera / Gallery.

### 3.8.6 Volley

Volley is an HTTP library that makes networking for Android apps easier and most importantly, faster.

### 3.8.7 Sound Cloud

An Android library project that provides a simple image cropping Activity

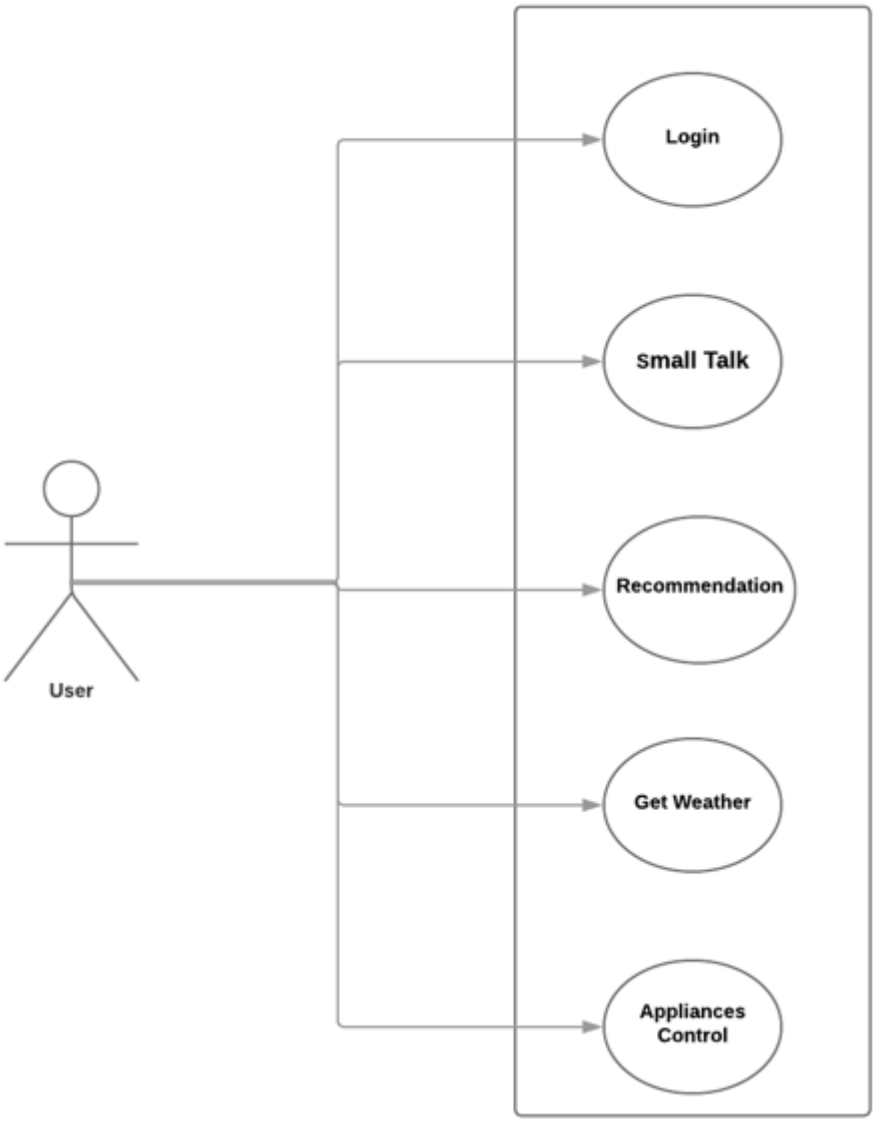
**Benefits**

- Automatic scheduling of network requests.
- Multiple concurrent network connections.
- Transparent disk and memory response caching with standard HTTP cache coherence.
- Support for request prioritization
- Cancellation request API. You can cancel a single request, or you can set blocks or scopes of requests to cancel.
- Ease of customization, for example, for retry and backoff.
- Strong ordering that makes it easy to correctly populate your UI with data fetched asynchronously from the network.
- Debugging and tracing tools

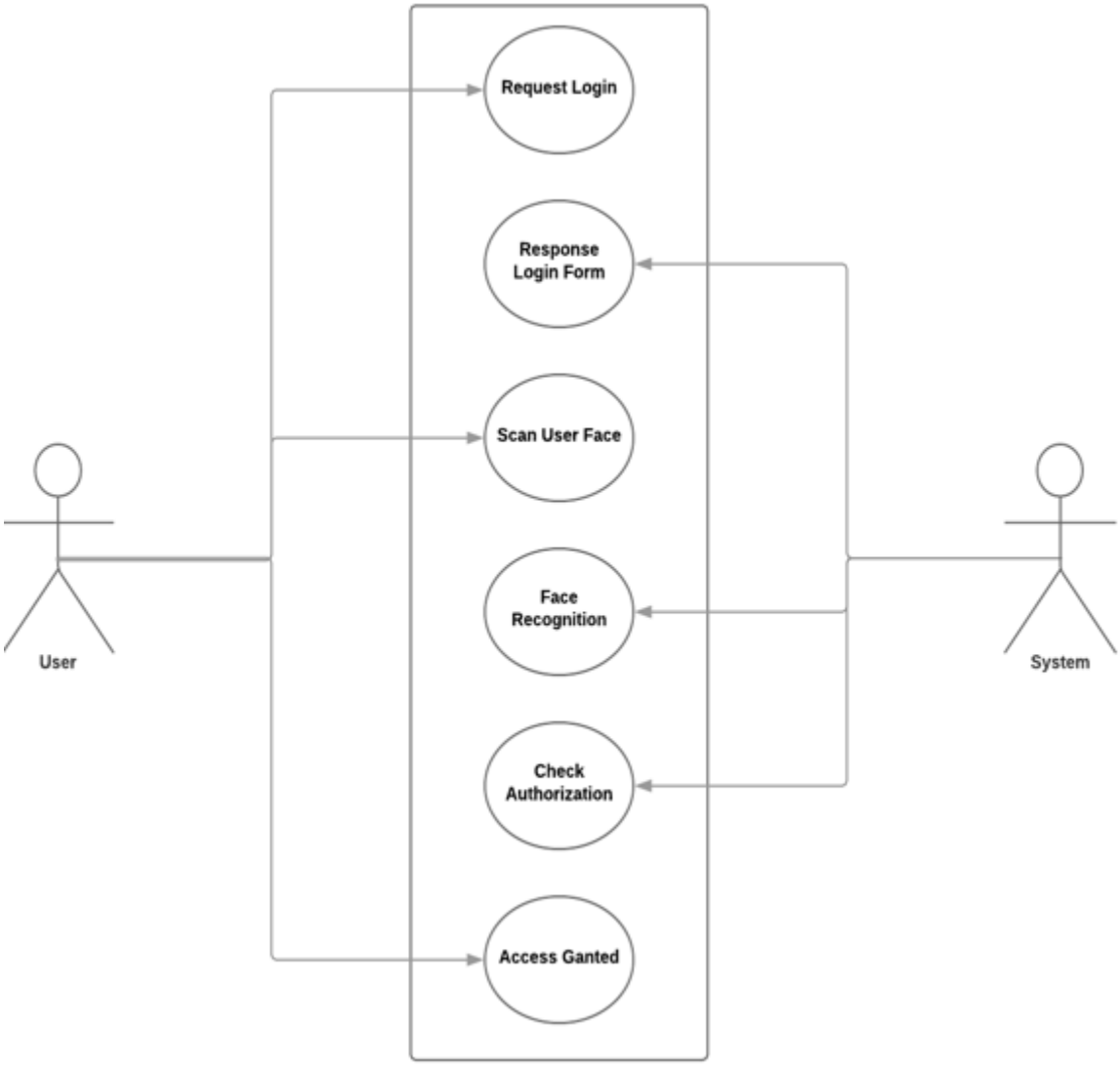
# Chapter 4

# Use Cases

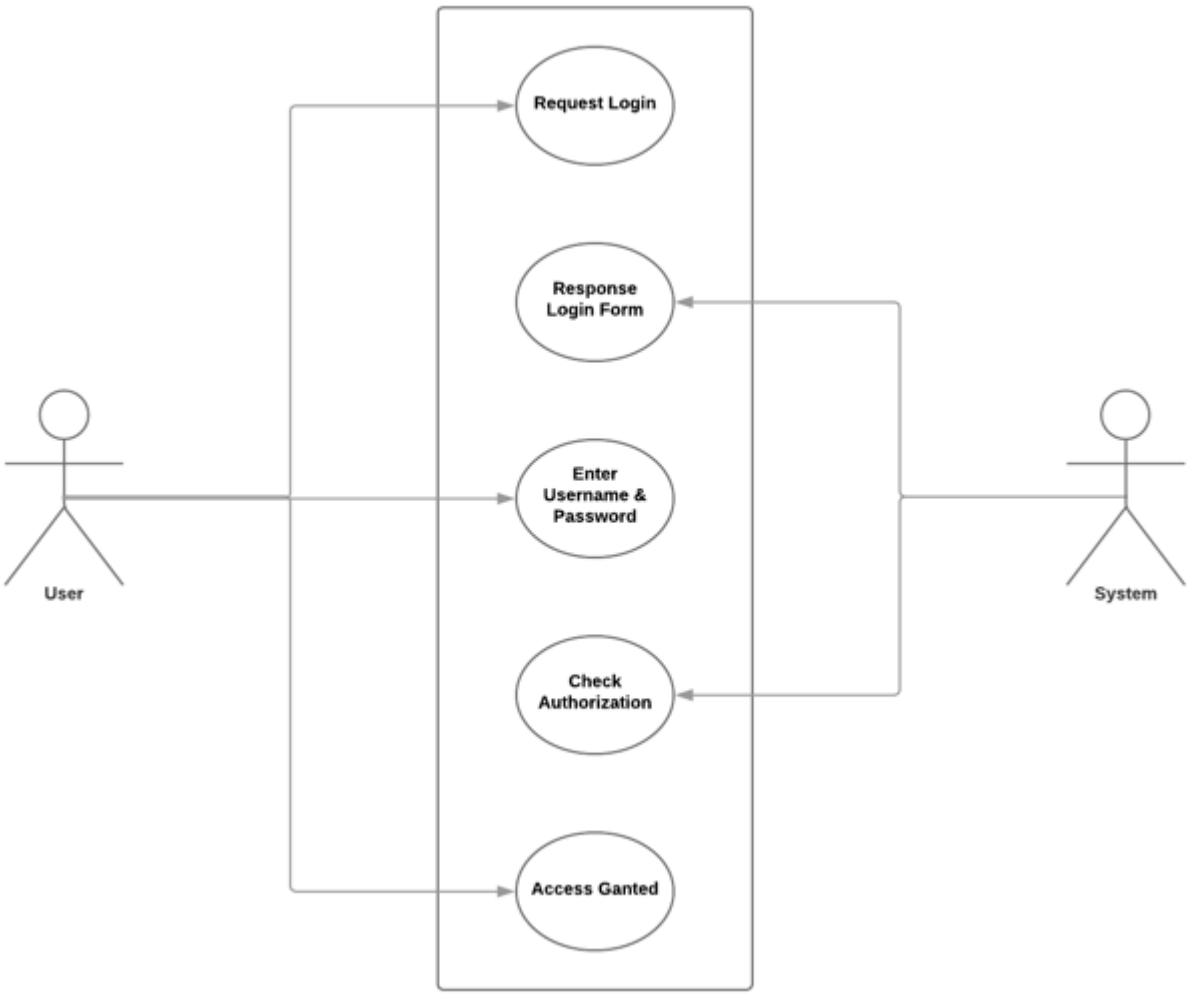
## 4.1 User Use Cases



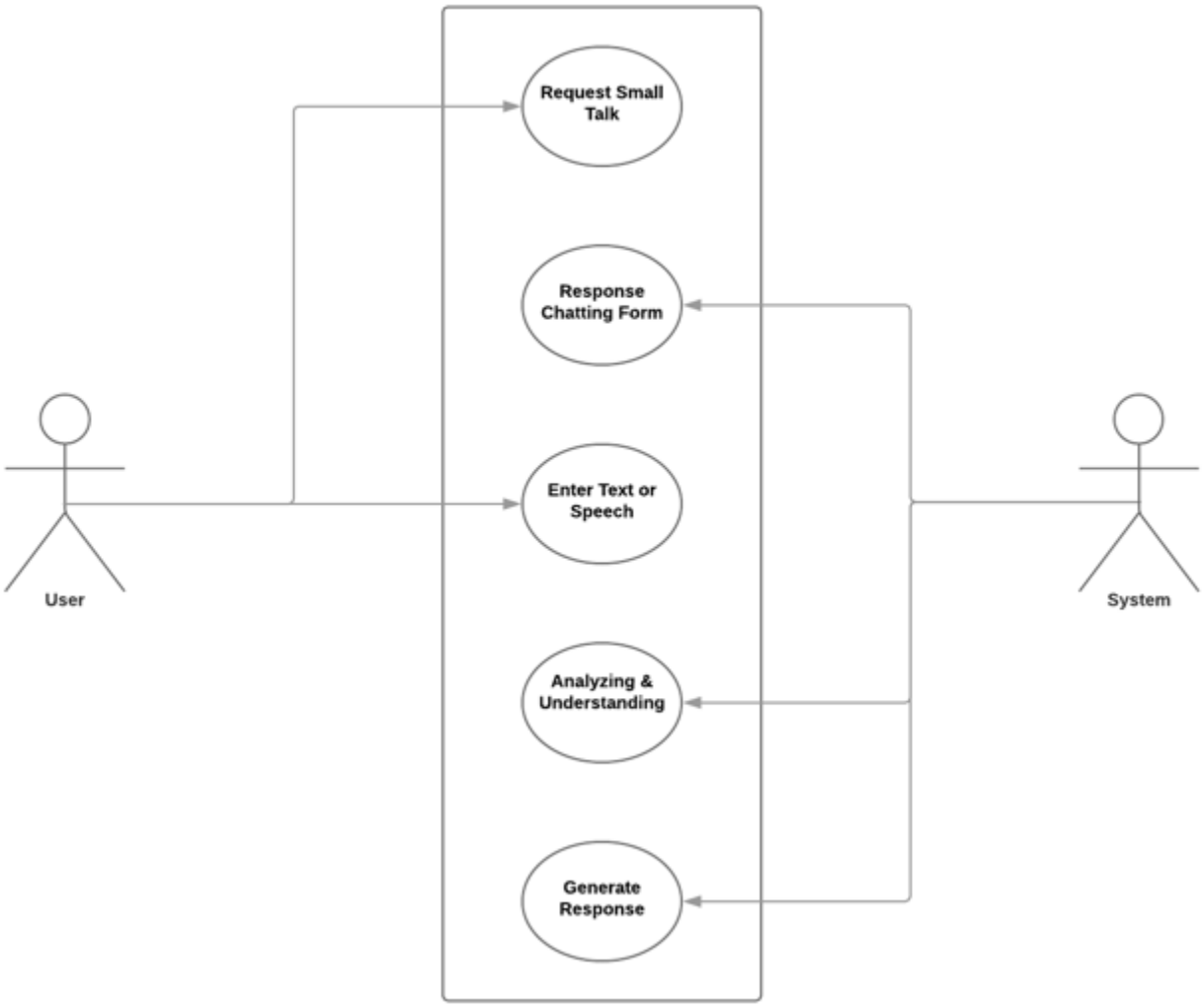
## 4.2 Android Login Use Case



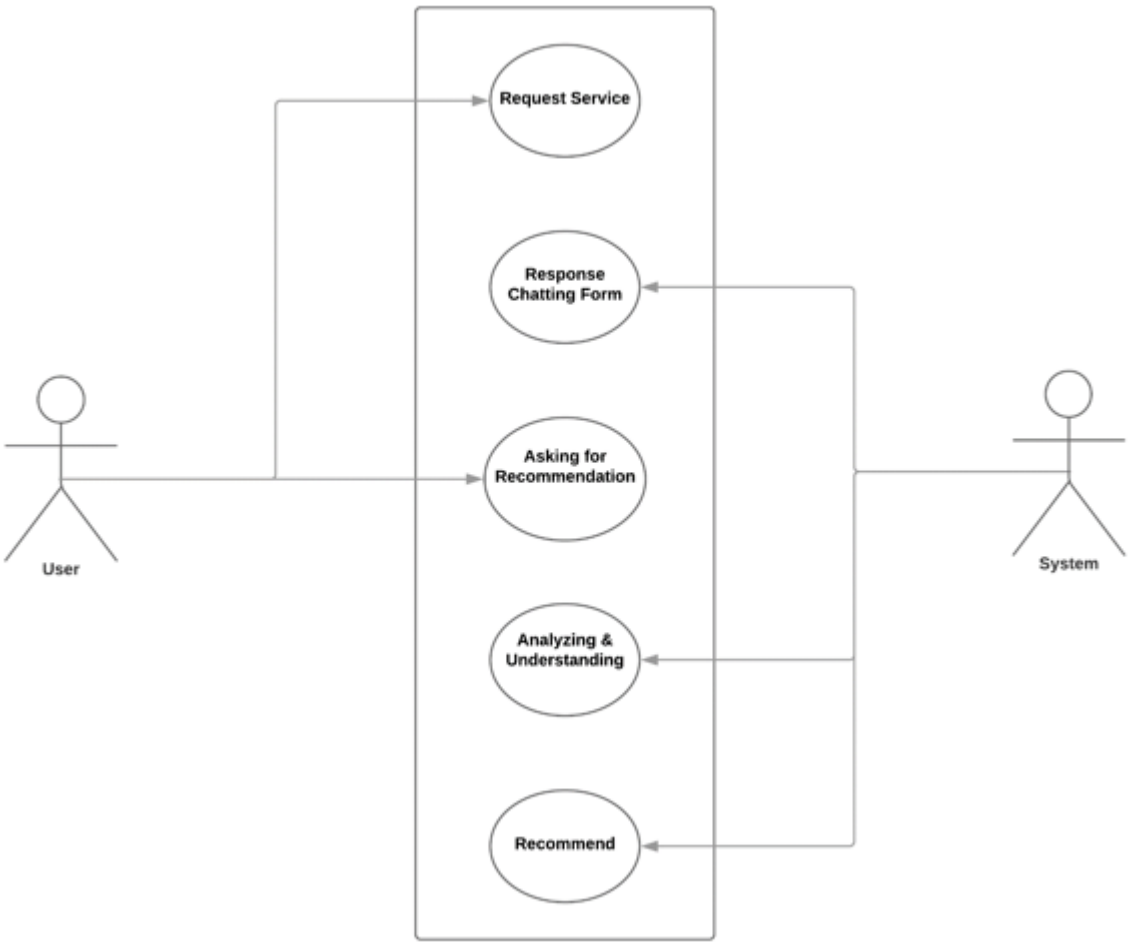
## 4.3 Web Login Use Case



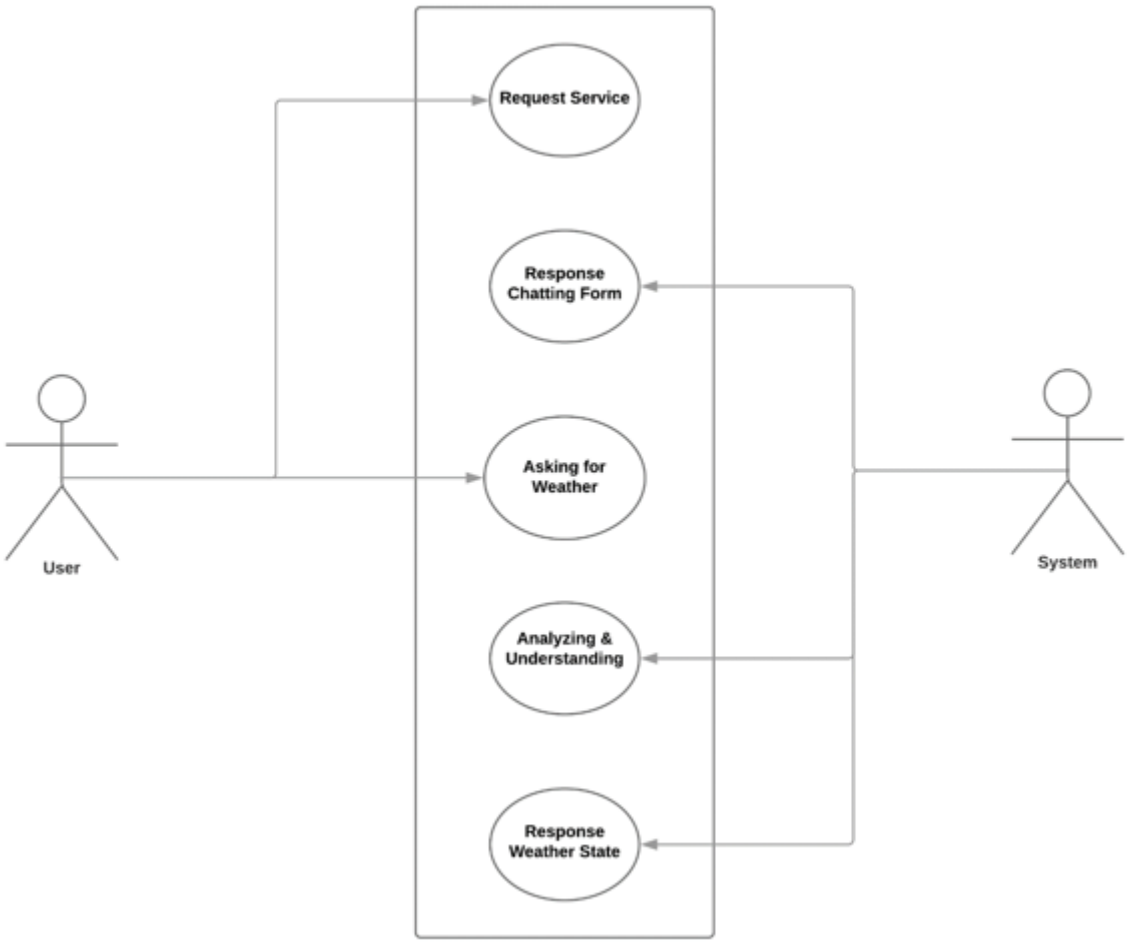
## 4.4 Small Talk Use Case



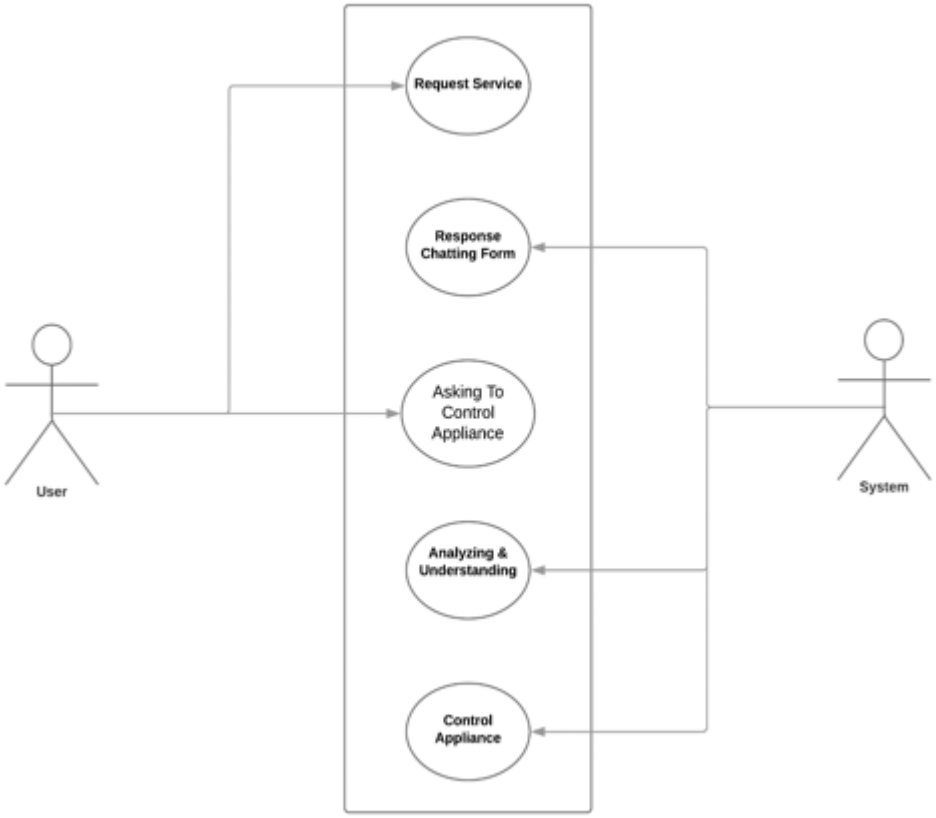
## 4.5 Recommender Use Case



## 4.6 Weather Use Case



## 4.7 Control Appliance Use Case



## 4.8 Narratives

### 4.8.1 Log in Narratives

Table 4.8.1 shows Log in Narratives

| | |
|---|---|
| Assumptions | User already has account. |
| Pre-Condition | User wants to log in. |
| Dialog | 1. User request log in.<br>2.System generates log in form.<br>3. User enters a face photo.<br>4. System checks the authorization.<br>Authorized: System open.<br>Not authorized : System returns error message |
| Post-Condition | Success: User successfully logged in.<br>Fail: System returns error message. |
| Termination | System failure.<br>Not recognized face. |

Table 4.1: Log in Narratives

### 4.8.2 Recommender item narrative

Table 4.8.2 shows Recommender item narrative

| | |
|---|---|
| Assumptions | User already logged in. |
| Pre-Condition | User wants to ask for item recommendation. |
| Initiation<br>1. User request a service. | Starts on user demand. heightDialog<br><br>2. System generates a chat form.<br>3. User asks for Recommendation<br>4. System perform analysis and understanding<br>5. System recommend an item<br>6. Available: Display the item<br>7. Not available : System returns error message |
| Post-Condition | Success: Recommended item displayed successfully.<br>Fail: System returns error message. |
| Termination | System failure. |

Table 4.2: Recommender item narrative

### 4.8.3 Weather command narrative:

Table 4.3 shows Weather Command Narratives

| | |
|---|---|
| Assumptions | User already logged in. |
| Pre-Condition | User wants to ask for Weather |
| Initiation<br>1. User request a service. | Starts on user demand. heightDialog<br><br>2. System generates a chat form.<br>3. User asks for weather<br>4. System perform analysis and understanding<br>5. System checks the weather<br>Available: Display weather.<br>Not available : System returns error message. |
| Post-Condition | Success: Weather displayed successfully.<br>Fail: System returns error message. |
| Termination | System failure. |

Table 4.3: Weather command narrative

### 4.8.4 Appliances control narrative:

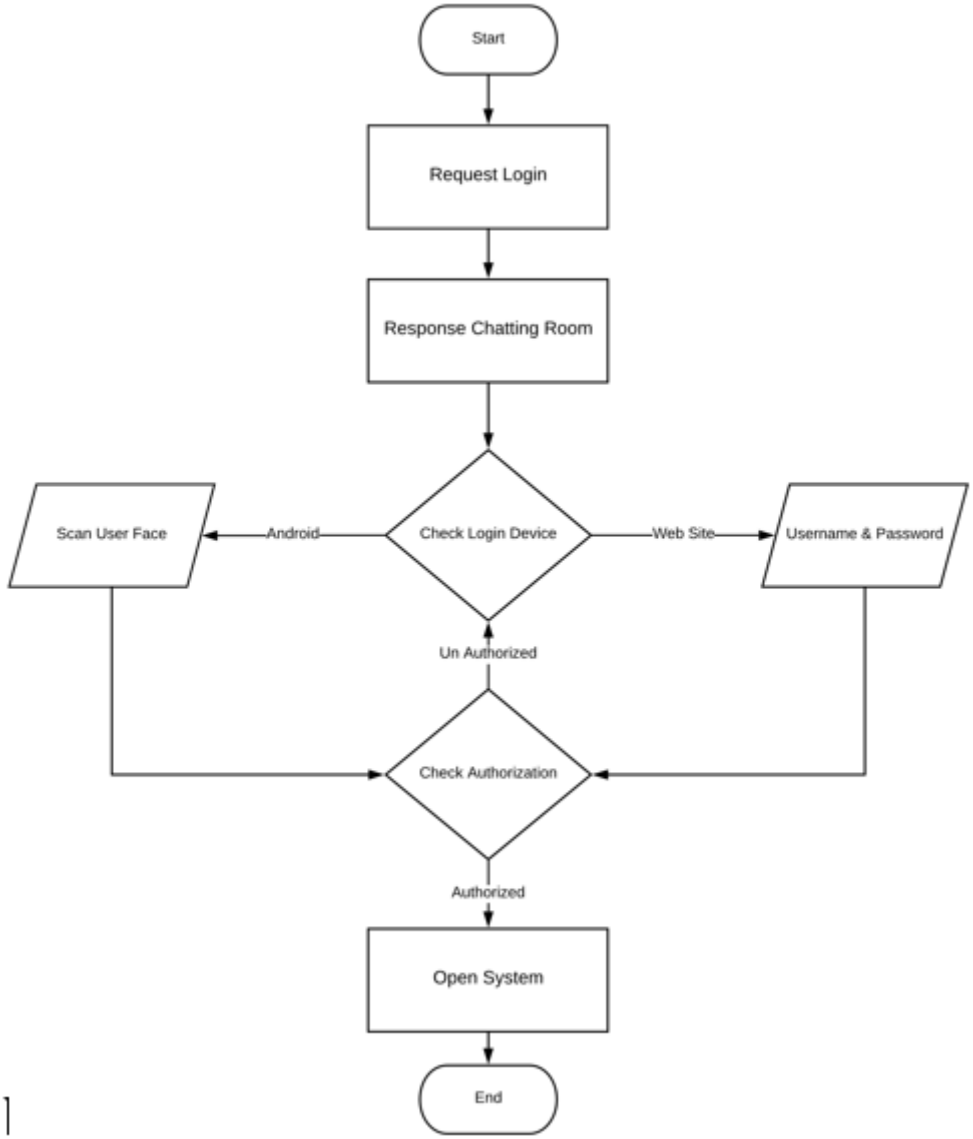
Table 4.4 shows Appliances Control Narratives.

| | |
|---|---|
| Assumptions | User already logged in. |
| Pre-Condition | User wants to ask for to control the appliances |
| Initiation<br>1. User request a service. | Starts on user demand. heightDialog<br><br>2. System generates a chat form.<br>3. User asks for appliance control.<br>4. System perform analysis and understanding<br>5. System controls the appliance<br>6. Available: Switch the appliance on/off<br>7. Not available : System returns error message |
| Post-Condition | Success: Weather displayed successfully.<br>Fail: System returns error message. |
| Termination | System failure. |

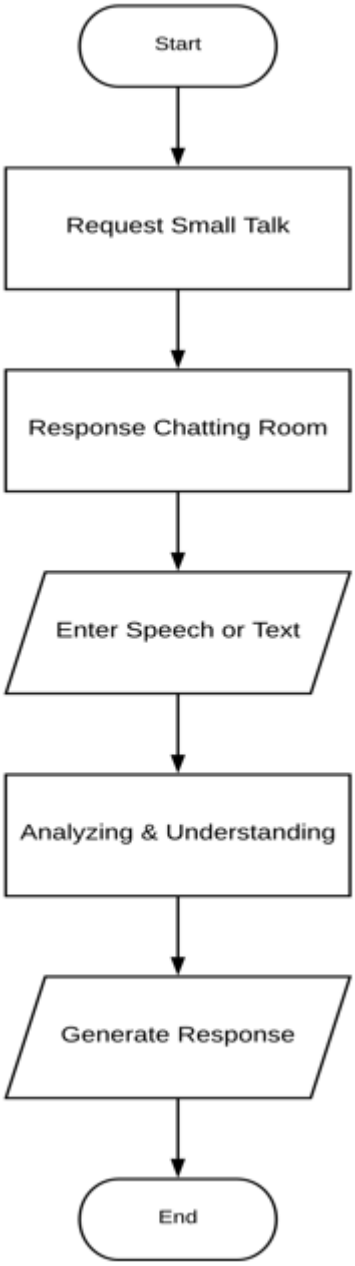
Table 4.4: Appliances control narrative

## 4.9 Flow Charts

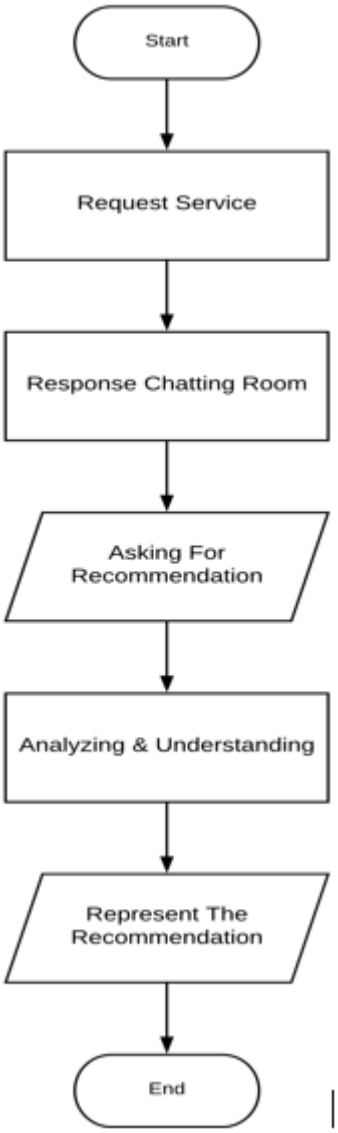
### 4.9.1 Log in Flow-Chart



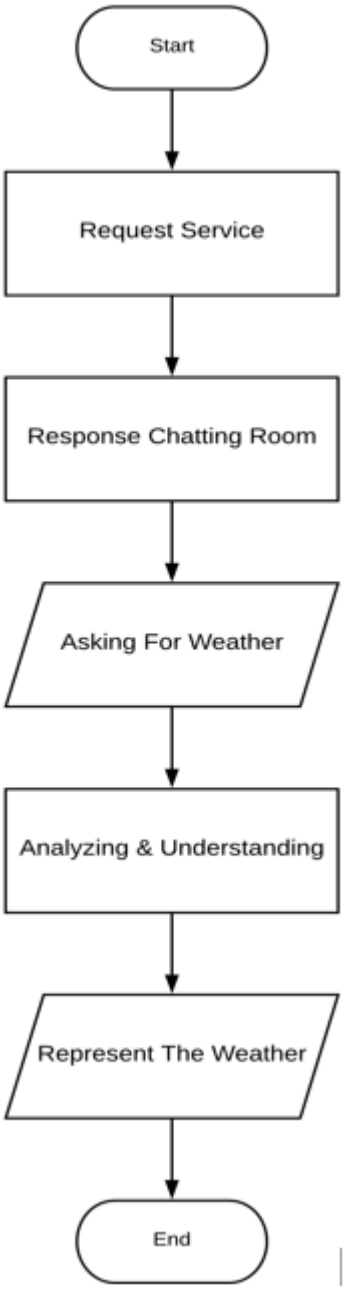
### 4.9.2 Small Talk Flow-Chart



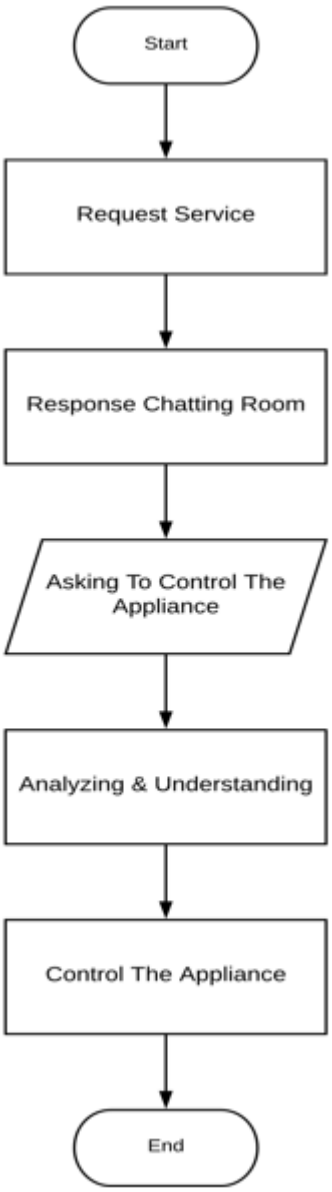
### 4.9.3 Recommender Flow-Chart



### 4.9.4 Weather Flow-Chart

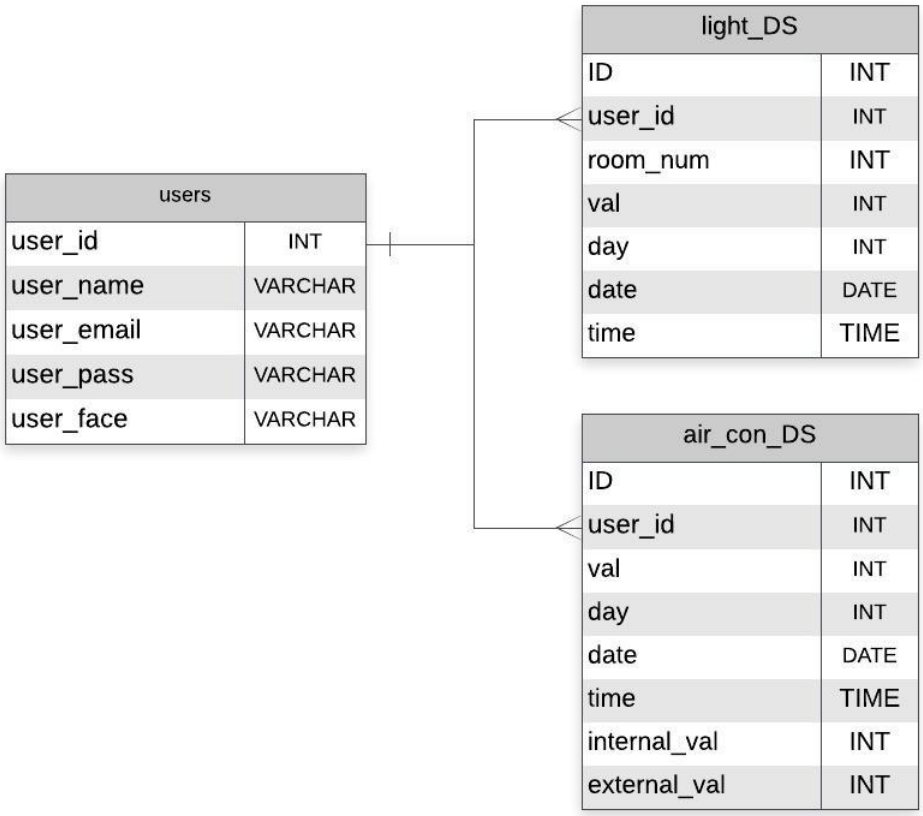


### 4.9.5 Appliance Control Flow-Chart



## 4.10 Sequence Diagram

## 4.11 ERD Diagram



# Chapter 5

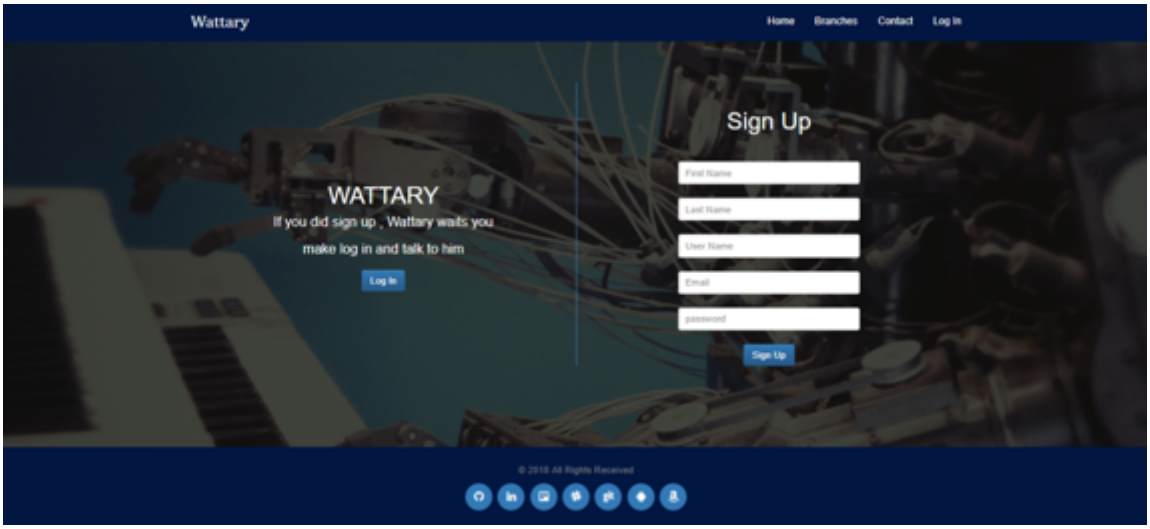
# User Documentation

## 5.1 How to use Wattary's Web application?

## 5.2 Signing up

You should sign up through entering:

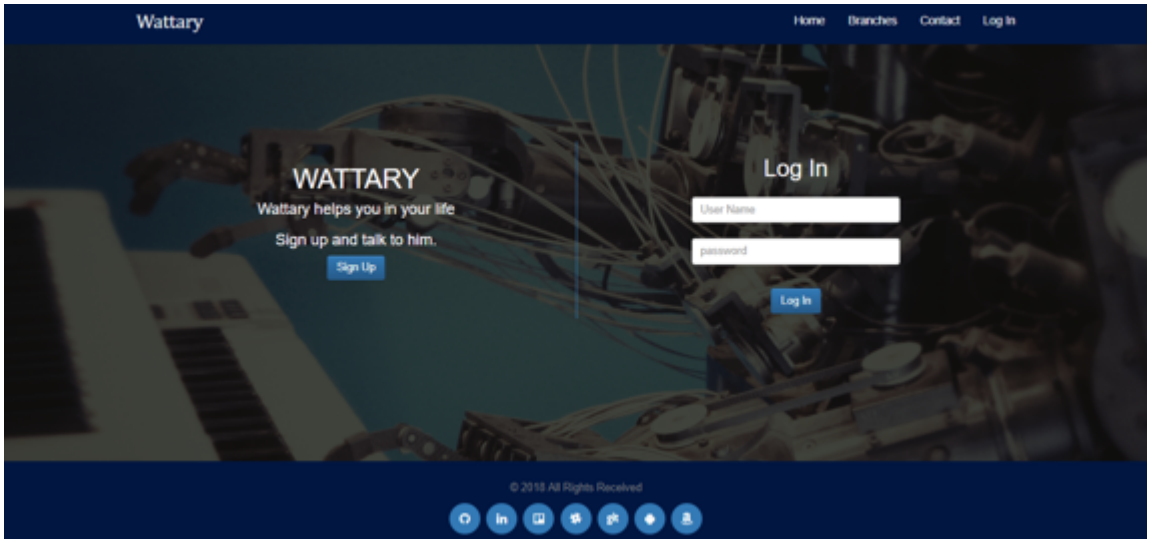
- First Name.
- Last Name
- User Name.
- Email Address.
- Password.



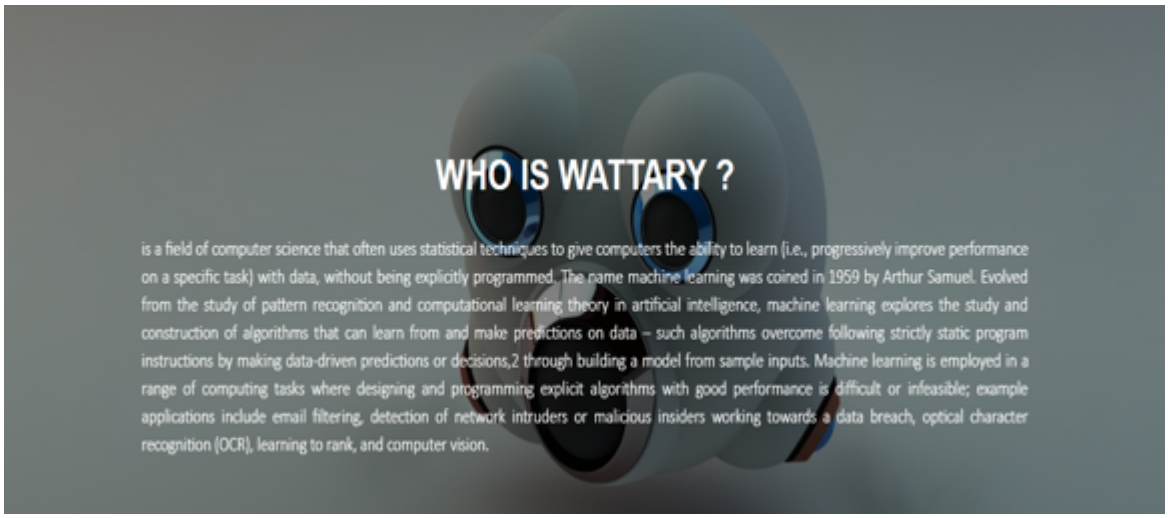
## 5.3 Loggin In

You should do log in in order to use the application:

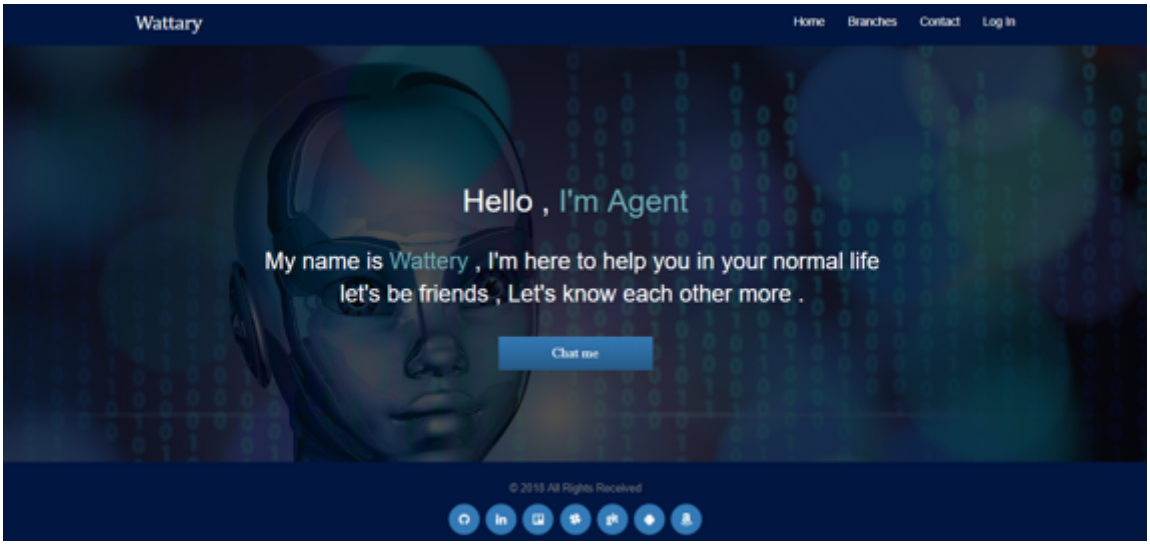
1. Enter the username.
2. Enter your password.
3. Press log in.



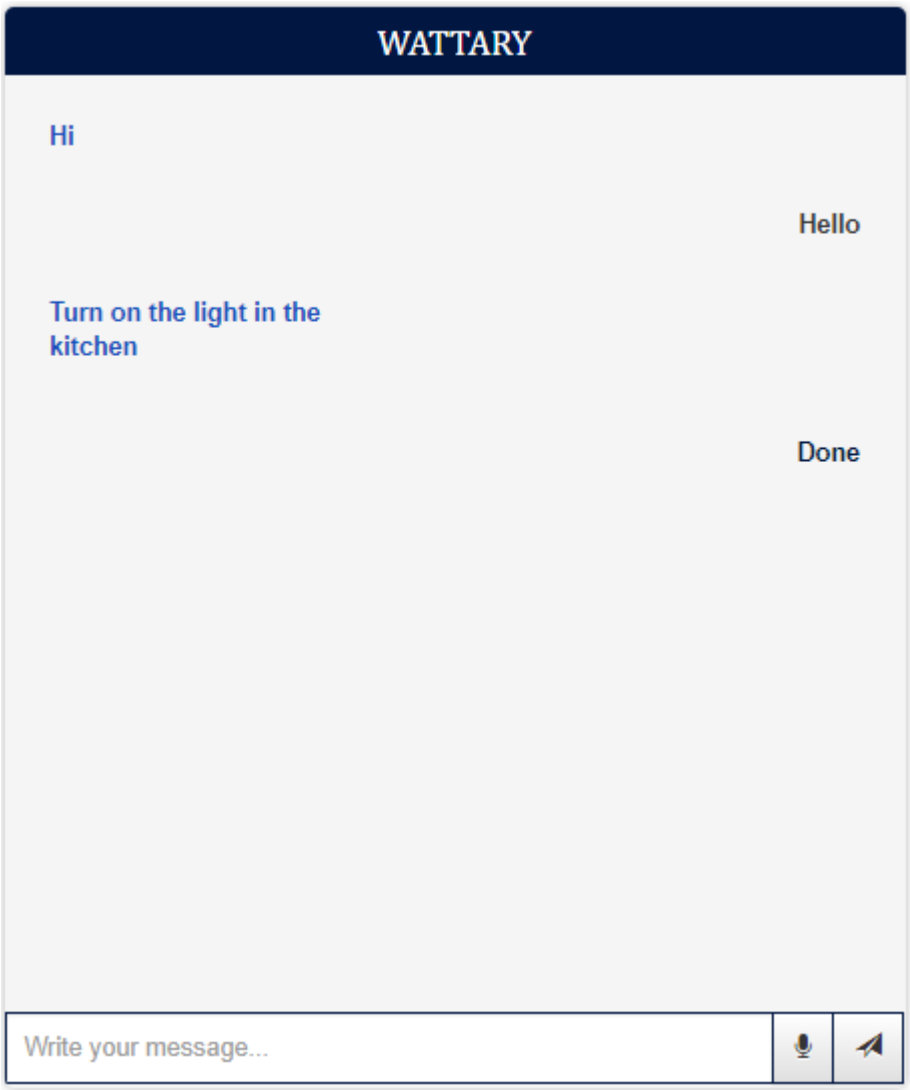

## 5.4 A simple description : Who is Wattary?



## 5.5 Contact Page




## 5.6 The Chat Page


WATTARY
Hi
Hello
Turn on the light in the kitchen
Done
Write your message...

## 5.7 How to use Wattary's Android Application?

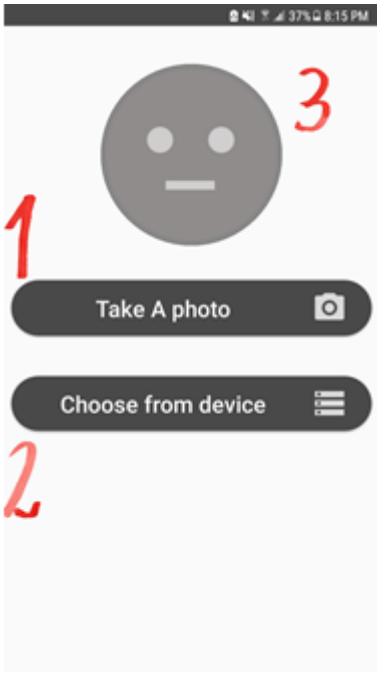
To use the android app, you must follow these instructions:

In this layout you can see two options to get into the app:

- Login
- Sign up


You have to sign up or sign in to use this app.

## 5.8 Login Layout

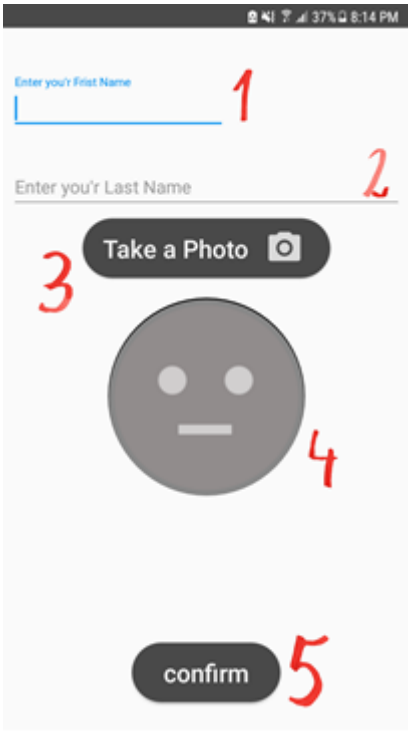



In this layout you can:

1. Take a photo of your face
2. Choose a photo from device
3. The photo that you have select

After that the server will receive the photo and determine if this user is already in or it dont exist.

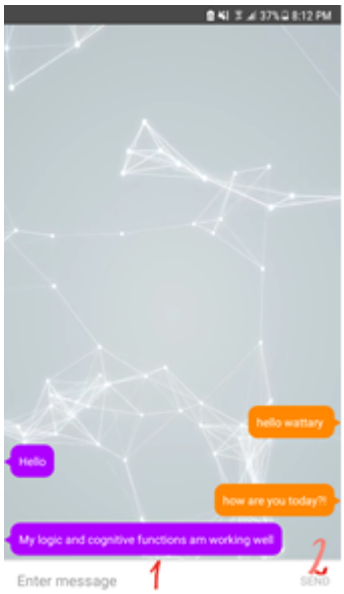
## 5.9 Sign up




This layout is designed to signup:

1. This field is to enter your first name
2. This field is to enter your last name
3. To take a photo
4. The photo that you have chosen
5. Confirming the signing in

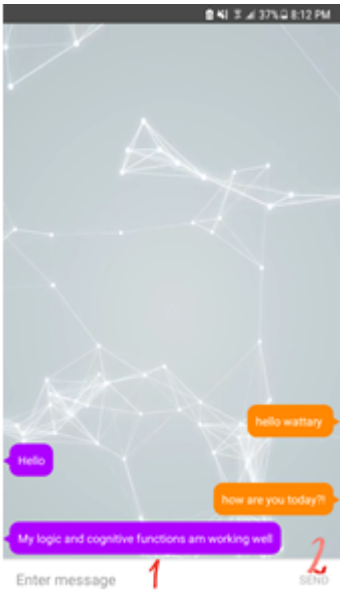
## 5.10 Main App Layout




This is the voice commander layout

1. Mic button to speak and give the command
2. Chat Layout
3. Remotes and utilities
4. TV. Remote
5. Air conditioner Remote
6. Electricity measuring
7. Water measuring
8. Sign out button

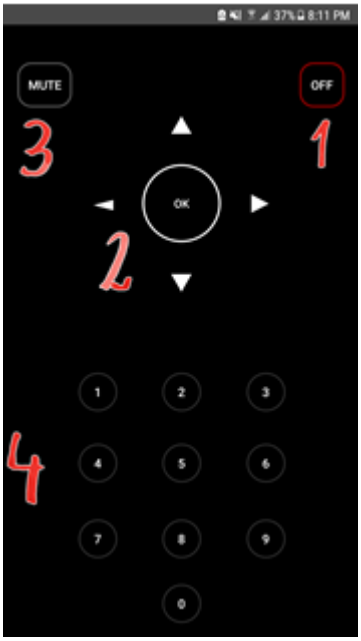
## 5.11 Chat Layout




This is chat commander layout, you can speak with wattary in chat here:

1. This field is to enter the command you want
2. Send button

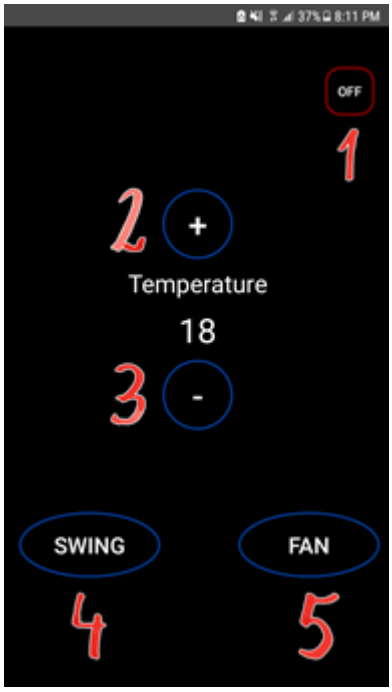
## 5.12 TV Remote



This layout is designed to take control of your TV. In Wattary app:

1. Switch the TV. On/Off.
2. Channel and Volume Changer.
3. Mute button
4. Keypad Buttons

## 5.13 Air conditioner Remote




This layout is designed to take control of your Air Conditioner in Wattary app:

1. Switch the Air Conditioner On/Off
2. Increase temperature
3. Decrease temperature
4. Swing Button
5. Fan Button

## 5.14 Electricity and Water measure Layout


Those layout is designed to measure the usage of Electricity and Water:

1. Measure button
2. Meter for Electricity ( kW/h ) Water ( Liter )

# References


- Russell, Stuart J. (Stuart Jonathan). (2010). Artificial intelligence : a modern approach. Upper Saddle River, N.J. :Prentice Hall
- Nitin Hardeniya, NLTK Essentials: Build cool NLP and machine learning applications using NLTK and other Python libraries , Packt Publishing.
- Krishna Bhavsar and Naresh Kumar, Natural Language Processing with Python Cookbook: Over 60 recipes to implement text analytics solutions using deep learning principles, Packt Publishing
- Dalal, Navneet, and Bill Triggs. "Histograms of oriented gradients for human detection." Computer Vision and Pattern Recognition, 2005. CVPR 2005. IEEE Computer Society Conference on. Vol. 1. IEEE, 2005.
- Parkhi, Omkar M., Andrea Vedaldi, and Andrew Zisserman. "Deep Face Recognition." BMVC. Vol. 1. No. 3. 2015.
- He, Kaiming, et al. "Deep residual learning for image recognition." Proceedings of the IEEE conference on computer vision and pattern recognition. 2016.
- Krizhevsky, Alex, Ilya Sutskever, and Geoffrey E. Hinton. "Imagenet classification with deep convolutional neural networks." Advances in neural information processing systems. 2012.
- Langley P, Iba W and Thompson K 1992. An analysis of Bayesian classifiers Proceedings of the Tenth National Conference on Artificial Intelligence.
- Pearl J 1988 Probabilistic Reasoning in Intelligent Systems. Morgan Kaufmann.
- Mitchell T 1997 Machine Learning. McGraw-Hill
- Graham P 2003 Better Bayesian filtering. Presented at the 2003 Spam Conference.

- Supposedly paraphrased from: Samuel, Arthur (1959). "Some Studies in Machine Learning Using the Game of Checkers". IBM Journal of Research and Development. 3 (3): 210229
- Samuel, Arthur L. (1988). "Some Studies in Machine Learning Using the Game of Checkers. I". Computer Games I. Springer, New York, NY. pp. 335365
- -Stevan Harnad (2008), "The Annotation Game: On Turing (1950) on Computing, Machinery, and Intelligence", in Epstein, Robert; Peters, Grace, The Turing Test Sourcebook: Philosophical and Methodological Issues in the Quest for the Thinking Computer, Kluwer
- ACC: Powers, David M W (2011). "Evaluation: From Precision, Recall and F-Measure to ROC, Informedness, Markedness  Correlation"
- http://scikit-learn.org/stable/modules/neighbors.html
- http://flask.pocoo.org/docs/1.0/

# Arabic Summary for the project

يهدف المشروع إلي إنشاء نظام مؤتمت للتحكم بالمنازل الذكيه عن طريق الأوامر الصوتيه أو الكتابيه وإضفاء طابع مُحادثي بين المستخدِم والنظام عن طريق الدمج بين خوارزميات الذكاء الاصطناعي ومعالجة اللغات الطبيعيه و تعلم الآله والرؤيه بالحاسوب. حيث يُمكّن النظام مُستخدمه من التحكم في الإضاءة و درجات الحراره وماكينة القهوه والتلفاز. كما يُتيح النظام لحامله أيضا خدمة اقتراح أفلام مبنية علي تفضيلات المستخدم المسبقة.

يُمكِن للمُستخدم الوصول للنظام من خلال إحدي طريقين : إما عن طريق الهاتف الجوال الخاص بالمستخدم أو عن طريق استخدام الحاسوب الشخصي ومن ثم الولوج لخوادم النظام والاستفادة منه.