

Group 15

Web Applications of Stock Forecaster

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Software Engineering of Web Applications

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<http://ec2-54-172-245-12.compute-1.amazonaws.com/stockprice/signin.php>

RUTGERS UNIVERSITY

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1. Introduction

1.1 Individual Contribution Breakdowns

All team members contributed equally.

1.2 Project Background

Investing money in the stock market is relatively easy but investing successfully and earning a profit can be a challenge, actually most non-professional investors lose money every year. All investors dreamed of getting the perfect forecast of the stock market, although that is impossible to be perfectly precise, there are two principal methods for forecasting the price movement of stocks: technical analysis, fundamental analysis and data mining technologies.

Fundamental analysis is built on the belief that human society needs capital to make progress and if a company operates well, it should be rewarded with additional capital and result in a surge in stock price. Fundamental analysis is widely used by fund managers as it is the most reasonable, objective and made from publicly available information like financial statement analysis.

Technical analysis is seek to determine the future price of a stock based solely on the (potential) trends of the past price (a form of time series analysis). Numerous patterns are employed such as the head and shoulders or cup and saucer.

Alongside the patterns, statistical techniques are used such as the exponential moving average (EMA). Candle stick patterns are believed to be first developed by Japanese rice merchants, and nowadays widely used by technical analysts.

With the advent of the digital computer, stock market prediction has since moved into the technological realm. The most prominent technique involves the use of artificial neural networks (ANNs) and Genetic Algorithms.

For stock prediction with ANNs, there are usually two approaches taken for forecasting different time horizons: independent and joint. The independent approach employs a single ANN for each time horizon, for example, 1-day, 2-day, or 5- day.

The advantage of this approach is that network forecasting error for one horizon won't impact the error for another horizon, since each time horizon is typically a unique problem. The joint approach, however, incorporates multiple time horizons together so that they are determined simultaneously.

In this approach, forecasting error for one time horizon may share its error with that of another horizon, which can decrease performance. There are also more parameters required for a joint model, which increases the risk of over-fitting.

1.3 Project Goals

Selection of target customers: Our customers are small-time daily or weekly investors who trade on an individual basis and who do not have the time or resources to avail of commercial forecasting services or hire agents.

Selection of information to be tracked: We aim to collect and use 10 indicators or patterns for performing technical analysis and provide predictions. We also plan to provide services like RSS feeds, current stock quotes, price charts, recommendations and alerts to help our customer in making a wise investment decision.

Data collection: Our major data source is the Google Finance service which provides us with daily stock prices for an entire year. We mine current prices of stocks from Yahoo Finance.

Charting: Based on the information in the database, we plan to display the stock prices to the end-user using charts.

Machine learning: The logic to recognize trends in market for past one year and make wise decisions based on statistical inference should be coded in the machine in the form of efficient algorithms. We plan to use technical indicators and neural networks to frame such algorithms.

Implement Web services: We aim to design web services to connect to prediction models that track different stocks as queried by user and issue forecasts about price movement of a given stock.

Design web interface: A user-friendly web interface needs to be created and hosted to aid users to get valuable information and timely recommendations and tips about dealing with their stock options.

1.4 Project Introduction

Stock market prediction is the act of trying to determine the future value of a company stock or other financial instrument traded on a financial exchange. The successful prediction of a stock's future price could yield significant profit. The stock market is not an efficient market. Herding behavior is common among investors, all investors do not get all information at the same time and the time it takes to evaluate information before they act differs between investors.

Many investors do not show rational behavior. Greed and fear are strong feelings and may result in panic sales and stock market bubbles. Hence, to regulate the stock market to obtain maximum profit or achieve a certain objective in general without falling prey to inconsistencies, predicting stock behavior is a pressing requirement.

Prediction methodologies fall into two broad categories: fundamental analysis and technical analysis. Fundamental analysis of a business involves analyzing its income statement, financial statements and health, its management and competitive advantages, and its competitors and markets. It is more subjective compared to technical analysis. Fundamental analysis maintains that markets may misprice a security in the short run but that the "correct" price will eventually be reached.

Profits can be made by trading the mispriced security and then waiting for the market to recognize its "mistake" and recalculate the security price. On the other hand, Technical Analysis is an approach that uses information of past stock behavior in order to forecast future price movements.

Within the technical analysis community there exist several schools with different techniques, but they all have in common that they use price and volume history. A basic thought is that it takes time before the market reacts upon new information and that pattern often occur in price behavior which makes forecasting possible.

For our project, our goal is to help the small-time daily or weekly investors who trade on an individual basis and who do not have the time or resources to avail of commercial forecasting services or hire agents. To provide a better investment suggestions for them,

we need to create a web-based system, which could predict the future stock price based on the analysis of historical price. So what we should implement first is to download stock information from Yahoo Finance, then we should use implement prediction models to analyze the trends for our users.

In our project, we would use the Bayesian Curve Fitting to fit the stock price and make predication. In estimation theory and decision theory, a Bayes estimator or a Bayesian action is an estimator or decision rule that minimizes the posterior expected value of a loss function(i.e., the posterior expected loss). Equivalently, it maximizes the posterior expectation of a utility function. An alternative way of formulating an estimator within Bayesian statistics is Maximum a posteriori estimation. Besides, we would also use artificial neural network and support vector machine for long-term prediction.

With this realization, our project will attempt to benefit a broad range of investors by providing calculated predictions as a tool for them to make their own decision on whether to buy, sell, or hold the stock.

There are several factors that explain why technical analysis works:

1. Most speculators on the market act upon fundamental analysis, so that kind of facts influence stock prices strongly. But all operators do not get this information at the same time. When there are positive news of a company, those acting immediately can buy shares for a lower price than those getting the news later.
2. Large investors such as mutual funds and banks are often not placing their whole block orders at the same time when they are buying larger quantities of securities because this would risk triggering an unnecessary high price advance. Instead, the orders are spread over a period that can last several weeks. The resulting increased purchase pressure may result in a steady advancing trend under the period the purchases continue.
3. It is more psychological stressing to go against the trend than to follow it. People are herding animals and like to do as others are doing. This is why a rising stock price is a signal in itself that the price will advance even more. Of course one has to be careful with stocks that have been rocketing, because they will often recoil.



2. Interaction Diagram

2.1 System Design

2.1.1 Requirement

- *Functional Basic Requirements*

REQUIREMENTS	PRIORITY	DESCRIPTION
Predict	10	Deal with the data in a specific period and make prediction using different methods.
Search	9	Search the current information such as realtime and historical price of any stocks the users want.
Favorite	7	Provide users a way to add their favorite stocks in a tracking list.
Register	5	Register for a new account
Login	5	Sign in the user's own account
Update	3	Update the user information

- *On-Screen Appearance Requirements*

REQUIREMENTS	PRIORITY	DESCRIPTION
Home	10	Home page of all the applications for stock forecaster
Predict	9	Predict page provides prediction result and suggestions
Overview	7	Overview page for get information and graph of any stocks
Realtime	7	Realtime page for get realtime data for favorite stocks
Admin	7	Admin page for add and delete stocks
Join us	6	Join the membership to get permit to predict
Contact us	4	Contact us
Report	4	Get feedback from the users

2.1.2 Plan

The system is implemented as Web services for stock prediction. It will track different stocks and issue a forecast about the price movement for a given stock. We consider Yahoo finance to be data source. Yahoo finance provides an API to download free stock quote. By store stock data into MySQL database, a prediction model becomes deployable.

By login to the system with a valid id and password, the whole functions of the system is available to the user. We will implement web services to delivery information on web pages. Stock prices, trading volumes, and time are main features for forecasting.

Now we have the database system ready, any query about stock information will be responding and recorded into database. The data were obtained using a php-based query interface. Real time stock data collector runs from 9:30 am to 3pm. For short term use, we set the query interval to 60 seconds. The stock symbols, price, time and volume fill in database. Besides, several prediction models are on trial, especially Bayesian curve fitting.

2.1.3 Outline of the system

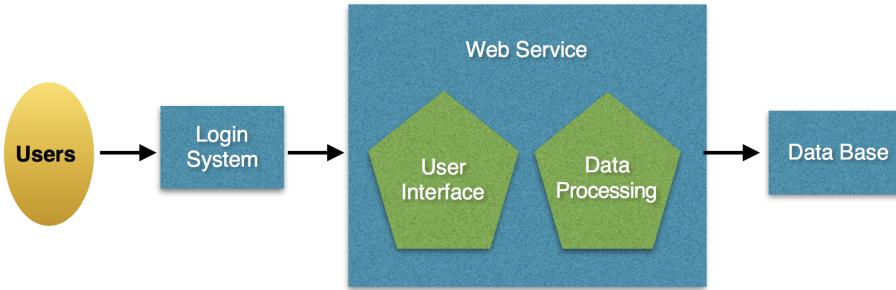


Figure 2.1: Outline of System

The outline of our designed stock forecaster system is shown in figure 1. Our project supports functions like searching, tracking and predicting. The focus is real-time data feed, from yahoo stock. The prediction is based in real data feeding and the history of data, thus making it a realistic prediction advisory. Investment suggestion(like decisions to buy, sell, hold and sit-out stocks) is highlight of the this project.

2.2 User cases

The diagram of user cases is demonstrated in figure 2, the details of user case are listed below:

- *Use Case 1: Search Stocks:*

The users would want to use the website to predict of how a certain stock will change and see its history. In our web system, the users could input the stock symbol in the search bar on the overview page. Once the stock is input the user will hit search and the application will send a request to the database asking for all current information available for the stock.

For overview page, the users would be asked to input stock names, type of value and also a specific period they are interested in. The users could check all current information associated with the searched stock, such as current price, current prediction, and a chart with the history of the stock for the specific period. Once the user is satisfied he can then exit the application or return to the home screen.

- *Use case 2: Add a Stock to Tracking List:*

The users would want to add a stock to their favorites. Once logged in the user will be brought to the home screen, there will be an admin page for the users to add or delete their

own watch lists. The user will input the stock symbol and the specific period in the search bar. Once the stock is input the application will send a request to the database asking for all current information available for the stock. The database will then send the information to the application. Once the stock is added in the watchlist, these information would be always stored in the user database unless they delete it by themselves. Once the user is satisfied he can then exit the application or return to the home screen.

- *Use case 3: Get Real Time Stock Performance:*

The users would want to get access to real time stock price of their favorite stocks. Once logged in the user will be brought to the home screen, there will be a real time page for the users to observe the information of the stocks they have added into the wish list. The real time page would be refreshed every five seconds. If the users wanna find the real time information of other stocks, they should first add it into the watch list on admin page. Then they would get real time current information. Once the user is satisfied he can then exit the application or return to the home screen.

- *Use case 4: Obtain Predicted Price:*

What is the most important part of our website is about the prediction. The users would like to get prediction of their favorite stocks. Once logged in the user will be brought to the home screen, there will be a prediction page for the users to predict. This page asks the users to choose the symbol, the prediction method, the specific period and the number of days past the end of the date range for which the users would like the forecast. Then once the users click the button, the results would be displayed on the website which would provide a forecast to the users.

- *Use case 5: Evaluation and Suggestion:*

The users would want to get evaluation and suggestion from our website. Once the users predict their favorite stocks, there would be a result of the predicted price. Our website would compare it with the real time price and give suggestions to users whether they would buy this stock.

- *Use case 6: Create an Account*

The users would want to create a new account. The user will open the application and be brought to the signin screen. Once the users first at the signin screen the user will then select “create an account.” The user will then be brought to an account creation page. The user will fill out the required information, such as username, email, phone number, gender, password and confirm your password. Once completed and submitted, the information will be sent to the database. The database will then check the availability of the information. If the information is available, then the database will set up the account, and log the user in.

The user will then be brought to the home page.

- *Use case 7: Change User Information*

The users would want to update the information on his profile. From the home screen the user will select “Profile” in the navigation bar. From the profile page the user will find the information about himself. The he could change any information and update the profile. Then the website will send a request to the database for information currently on the profile. The database will send the application this information. The application will then display the information and allow it to be edited. Once the user has completed his editing, he would submit the information. Once submitted the application will send the database the updated information. Once the application receives a success notification the user will be brought back to the home screen.

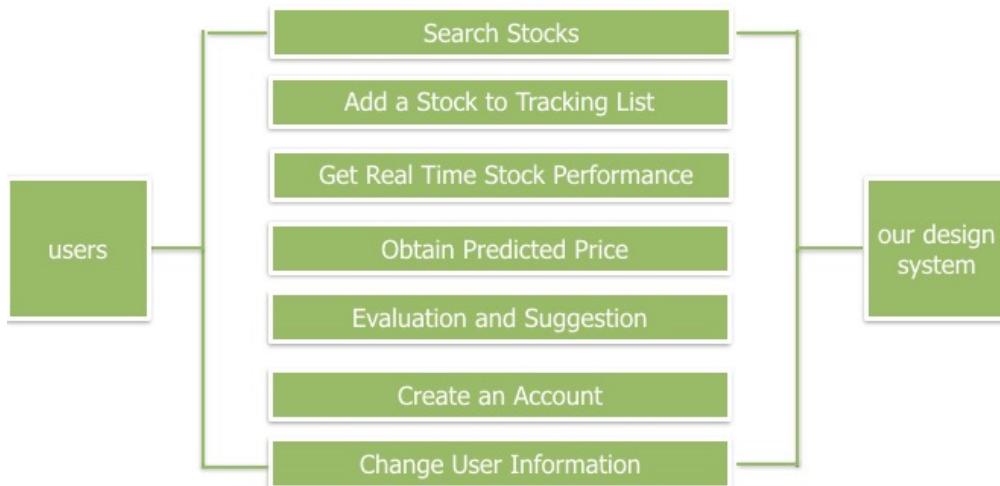


Figure 2.2: User Cases

2.3 Interaction diagram

As demonstrated in the figure, we will check the authority of the users at first. If true, the users will be allowed to enter our stock forecaster system and request the stock data and historical information. They could also request the prediction and suggestions of stocks. Then we will display the information that users request.

2.4 Special Features

- *Join the Membership:*

This page is an extra interesting design of our website. Every user is required to join our membership to acquire the prediction and the add wish list function. We provide 4 kinds of servers time. Once you active your membership, you can get access to our prediction page and the add wish list page. Then you can start your prediction and get useful information. This design would make the website profitable, which makes benefits to the web future construction.

- *Reports:*

It is also a useful and necessary design. From this Report page, the web designers would get feedback(such as NOT MOBLIE-Friendly) from the clients as soon as possible. The suggestions from the clients would make us to design better and better.



3. Diagram and Interface Specification

3.1 Collect stock information from Yahoo Finance API

Yahoo! Finance is a media property that is part of Yahoo!'s network. It provides financial news, data and commentary including stock quotes, press releases, financial reports, and original programming. It also offers some online tools for personal finance management.



The Yahoo Finance API provides a way for developers to get the latest information about the stock market. How the different stocks are doing. What's the current buying price for a single stock. How much is the difference of the current market value to that of yesterday's, etc.

We use PHP to collect 10 stocks real time information and one-year historical price. Generally, we implemented two versions of PHP scripts to collect the information of stock price. Yahoo finance API help us easily get the stock data, including open price, close price of any chose day and the price, volume and change points of present time.

Real Time Data	Historical Data
Symbol	Symbol
Time	Time
Open	Price
High	Volume
Low	
Close	
Volume	

Figure 3.1: data collection

3.2 Class diagram

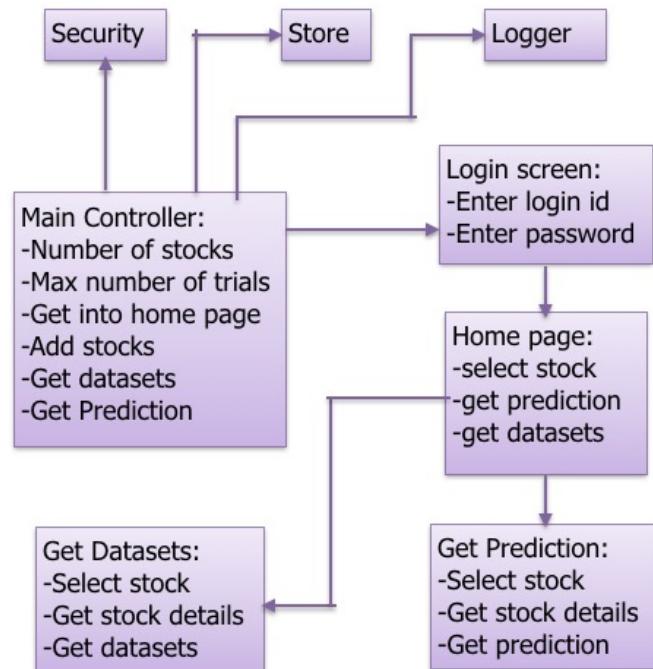


Figure 3.2: Class Diagram

3.3 Store information in MySQL

MySQL is an open-source relational database management system (RDBMS). Its name is a combination of "My", and "SQL", the abbreviation for Structured Query Language. The MySQL development project has made its source code available under the terms of the GNU General Public License, as well as under a variety of proprietary agreements.

MySQL was owned and sponsored by a single for-profit firm, the Swedish company MySQL AB, now owned by Oracle Corporation. For proprietary use, several paid editions are available, and offer additional functionality.

Using php and build a connection with local host database. The php script will inquire the data from the yahoo finance API every 60s and store the time, price, volume, into the associated stock table, after these steps we get the real time data of stocks we want. The database schema is demonstrated in figure. 4.

historical data					
Field	Type	Null	Key	Default	Extra
id	int(11)	NO	PRI	NULL	auto_increment
date	varchar(255)	NO		NULL	
open	double	NO		NULL	
high	double	NO		NULL	
low	double	NO		NULL	
close	double	NO		NULL	
volume	int(11)	NO		NULL	

realtime data					
Field	Type	Null	Key	Default	Extra
id	int(11)	NO	PRI	NULL	auto_increment
date	varchar(255)	NO		NULL	
time	varchar(255)	NO		NULL	
symbol	varchar(255)	NO		NULL	
ask	double	NO		NULL	
bid	double	NO		NULL	
open	double	NO		NULL	
volume	int(11)	NO		NULL	

Figure 3.3: Database Schema

```
style
+-----+
| Field | Type          | Null | Key | Default | Extra |
+-----+
| id    | int(11)        | NO   | PRI | NULL    | auto_increment |
| username | varchar(255) | NO   |     | NULL    |                |
| styletype | varchar(255) | NO   |     | NULL    |                |
| detail  | varchar(255)  | NO   |     | NULL    |                |
+-----+



userinformation
+-----+
| Field | Type          | Null | Key | Default | Extra |
+-----+
| id    | int(11)        | NO   | PRI | NULL    | auto_increment |
| username | varchar(255) | NO   |     | NULL    |                |
| email  | varchar(255)  | NO   |     | NULL    |                |
| telephone | bigint(10) | NO   |     | NULL    |                |
| gender  | varchar(255) | NO   |     | NULL    |                |
| password | varchar(255) | NO   |     | NULL    |                |
+-----+



problem
+-----+
| Field | Type          | Null | Key | Default | Extra |
+-----+
| id    | int(11)        | NO   | PRI | NULL    | auto_increment |
| reportdate | varchar(255) | NO   |     | NULL    |                |
| email  | varchar(255)  | NO   |     | NULL    |                |
| category | varchar(255) | NO   |     | NULL    |                |
| feedback | text          | NO   |     | NULL    |                |
+-----+
```

Figure 3.4: Database Schema

4. System Architecture and Design

4.1 System Architecture

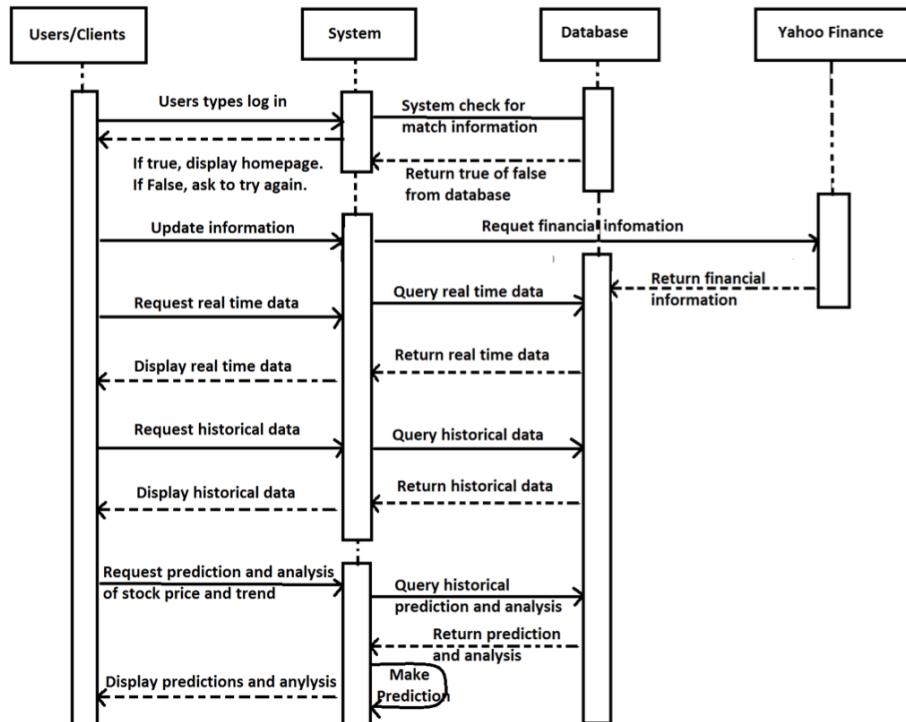


Figure 4.1: Interaction Diagram

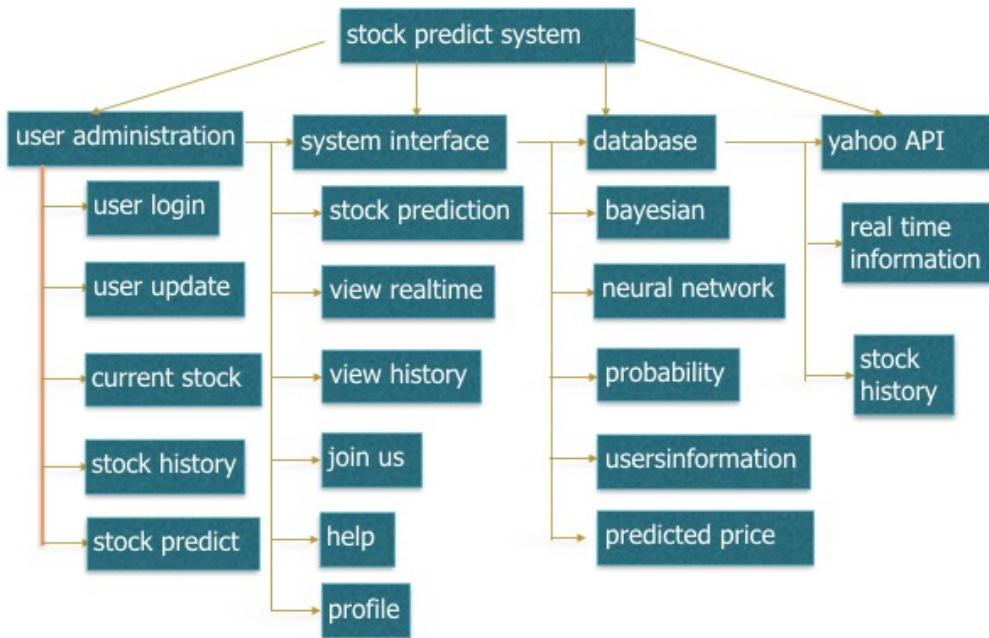


Figure 4.2: Architecture Diagram

You can see the system architecture in the picture. Our system is designed as 3 parts and connected to the yahoo API. In the user part, user can create own account and see the stock history and real time stock price. Then in the system interface, the user could acquire stock prediction and add their own tracking list. At last, the database part. All information are stored in the database. Like the stock information, user information, setting information.

4.2 Web Structure

The back end of this web page is based on PHP and MySQL. We use PHP to fetch data from Yahoo Finance API and store them into MySQL database. PHP also helps us push the data to the front end. PHP can be seen as a bridge connecting the front end and back end.

Web services transport their messages using HTTP, which means these messages are transmitted over port 80, an open port for Web server firewalls. Web service messages are transmitted as SOAP-formatted messages. SOAP messages are in XML format, meaning they are simply text, and not complex binary data. SOAP is designed to serialize both simple and complex data types, meaning SOAP can be used to easily transmit complex data from the client to the server and back again.

Finally, the protocols used by Web services - SOAP and HTTP - are open and well-known protocols, meaning Web services can be easily implemented on any platform. In fact, one of the great benefits of Web services is their interoperability. A Web service created

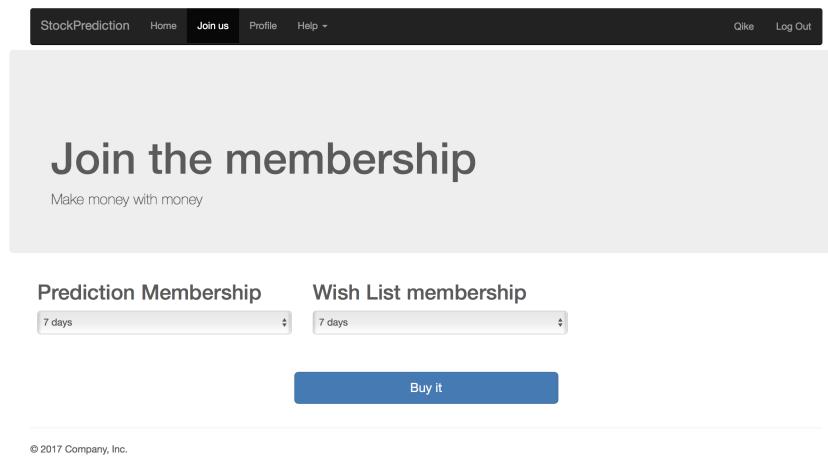
with the J2EE platform can be consumed by a client created with the .NET platform, and vice-a-versa.

Due to their interoperability, in enterprises Web services are commonly used as a unified means to access disparate systems. For example, a large enterprise may have data in a variety of systems, accessible through various platforms. HR data might be stored in an Oracle database and accessed via a J2EE application; sales data may be in a MS-SQL Server database accessed by a VB6 application; employee data may be in a DB2 database and accessed by a legacy software system. Clearly, it would be advantageous to be able to access all of this data uniformly from a single application. One option would be to rewrite all of these old applications so that a common data store and access program is used.

This approach is undesirable for a number of reasons, such as the cost and time it would take to replace the legacy software with new software. Rather, it might make more sense to provide Web service "front-ends" to each of these data stores and application interfaces. Then, a new application can uniformly access data from disparate resources all through a simple, standard Web service interface.

4.2.1 Join Us

First, to join our membership to acquire the prediction and the add wish list function. We provide 4 kinds of servers time. Once you active your membership, you can access our prediction page and the add wish list page. Then you can start your prediction and get useful information.



4.2.2 Add your wish list

Now you have to first add at least 10 stock into the database, which will increase your accuracy of your prediction.

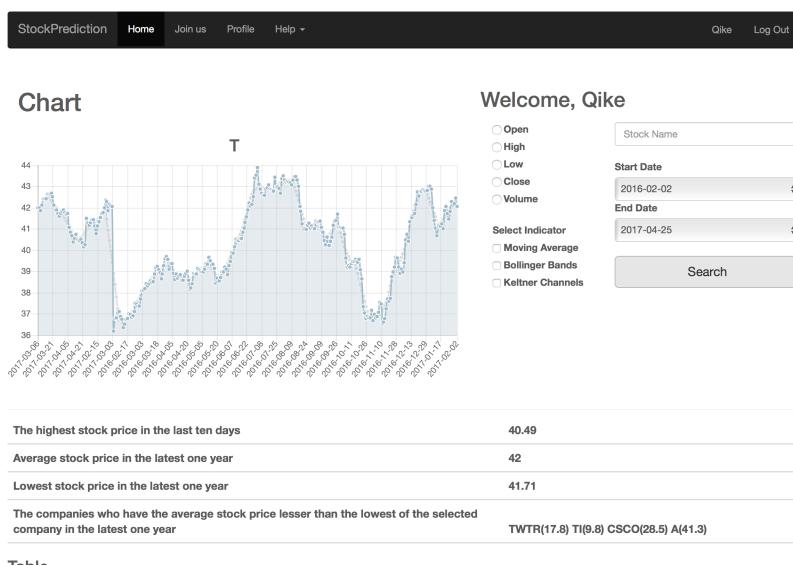
And if you don not want to track the stock any more, you can delete it from this page. It is a very humanize function and will make your wish list more efficient. All of the chosen stocks are added to the list of stocks within the database that predictions are made on. Historical prices for the given stocks are retrieved from the Price Provider and stored within the database.

The screenshot shows a web-based administration interface for a stock prediction system. At the top, there is a navigation bar with links for 'StockPrediction', 'Home', 'Join us', 'Profile', 'Help', 'Like', and 'Log Out'. Below the navigation bar, the word 'Admin' is displayed. The main content area is divided into two sections: 'Add' and 'Delete'. The 'Add' section contains fields for 'Stock Name' (with a placeholder 'Enter Stock'), 'Start Date' (with fields for Year, Month, and Day), and 'End Date' (with fields for Year, Month, and Day). A blue 'Add' button is located below these fields. The 'Delete' section contains a field for 'Stock Name' (placeholder 'Enter Stock') and a blue 'Delete' button. At the bottom of the page, there is a small copyright notice: '© 2017 Company, Inc.'

4.2.3 Overview

The Overview function is the most important function in our system. It can fetch the Open, High, Low, Close, Volume of the stock you want to see in a period and can calculate the values that you may want to use in buying a stock.

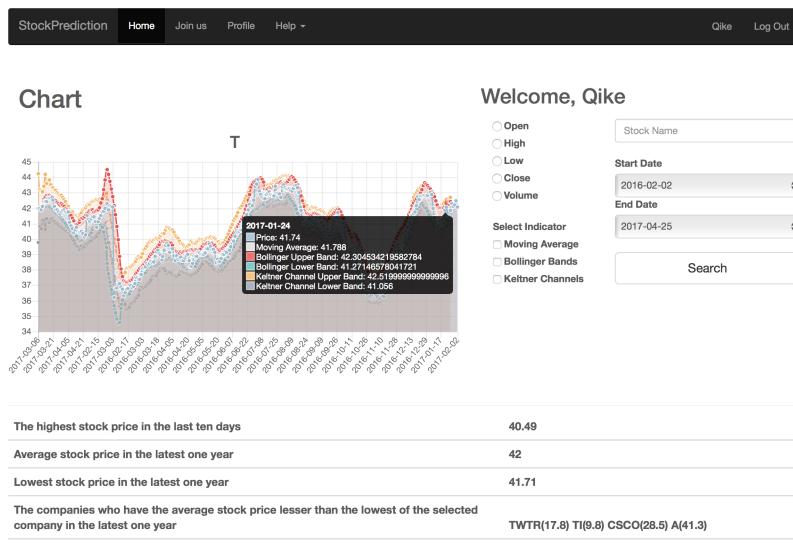
Choose Open and then type in a stock name then you will get the open price of the stock, which will be in the graph. The graph is very clear that you can see the change of the open price in the chart and in the table. You can see the tender in the chart and the exact number in the table.



And it also shows the the highest stock price of the companies you add in the wish list in last ten days. The average stock price of the 10 companies in the latest one year. The lowest stock price for any company in the latest one year. If you add less than 10 stocks, it won't show the last ten days cause the data is not enough.

They can also choose the indicator they want to use in the diagram. And will tell them if the stock is worth to buy and sell.

The highest price in the last ten days will calculate the latest 10 days highest price, but you have to add the date into your database first.



Now you can see the indicators work in the chart. Put your mouse on it you can see the Bollinger Upper band and lower band, and Kelntner upper band and lower band, and the

moving average.

The chart will be very clear.

4.2.4 Profile page

The screenshot shows a user profile page with a dark header bar containing links for StockPrediction, Home, Setting, Profile (which is highlighted), and Help. On the right side of the header are 'Like' and 'Log Out' buttons. The main content area is titled 'User Information'. It contains several input fields: 'Username' (Qike), 'Email' (qike@scarletmail.rutgers.edu), 'Phone Number' (917-555-1234), 'Gender' (female), 'Password' (1234), and 'Confirm Your Password' (1234). Below these fields is a blue 'Update' button. At the bottom left of the page is a small copyright notice: '© 2017 Company, Inc.'

In the profile page, you can change your profile, like change the email you register and change your password. Please remember your password with your email. If you forget your password or email you can email our and get back your password. The profile are all saved in our database.

4.2.5 Help page

The screenshot shows a help page with a dark header bar containing links for StockPrediction, Home, Join us, Profile, and Help. On the right side of the header are 'Like' and 'Log Out' buttons. The main content area features a large white box with the text 'Hello, User' and a smaller note below it: 'If you have any questions about this website, please feel free to contact us.' Below this box are five team member profiles arranged in two rows. The first row contains 'Shi Wang' (Team Leader, Email: sw712@scarletmail.rutgers.edu) and 'Yutong Gao' (Team Member, Email: yg296@scarletmail.rutgers.edu). The second row contains 'Hairong Wang' (Team Member, Email: hw385@scarletmail.rutgers.edu) and 'Qike Ying' (Team Member, Email: qy66@scarletmail.rutgers.edu). At the bottom left of the page is a small copyright notice: '© 2017 Company, Inc.'

In the Help page, you can contact our via email. We can reply you through email.

4.2.6 Report page

The screenshot shows a web page titled "Report". At the top, there is a navigation bar with links: StockPrediction, Home, Join us, Profile, Help (with a dropdown arrow), Like, and Log Out. Below the navigation bar, the main content area has a title "Report". Underneath the title, there is a section labeled "Category" with a dropdown menu. The menu contains four items: "NOT MOBILE-FRIENDLY", "POOR DESIGN", "OUTDATED CONTENT", and "Write down your feedback". The "OUTDATED CONTENT" option is highlighted with a blue background. Below the dropdown is a text input field with placeholder text "Enter Your Feedback". At the bottom of the form is a blue "Send" button. A small copyright notice at the very bottom left reads "© 2017 Company, Inc."

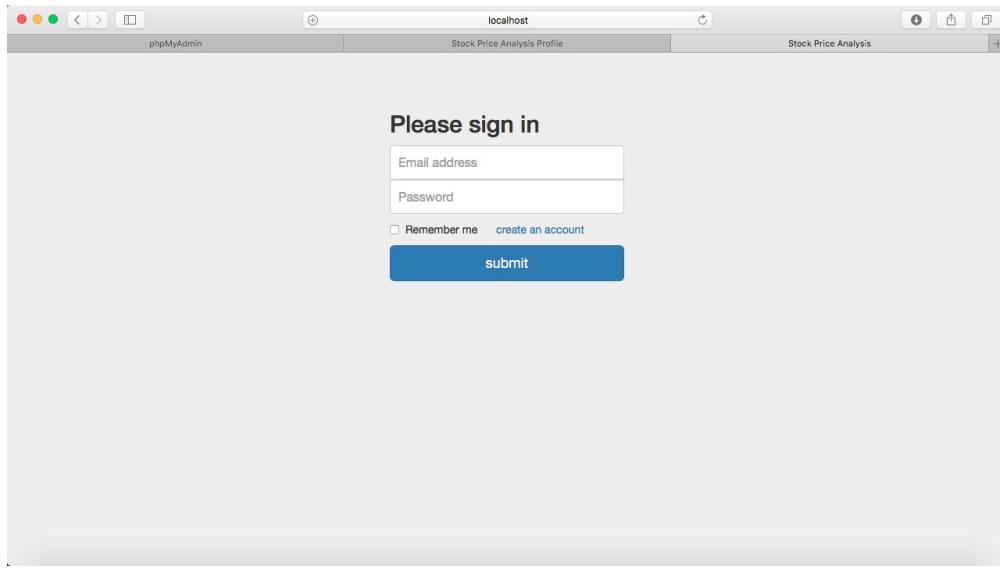
In this page, any problem will report to us and we will reply via email. Feel free to contact us and we will do our best to help the user.

4.2.7 Other functions

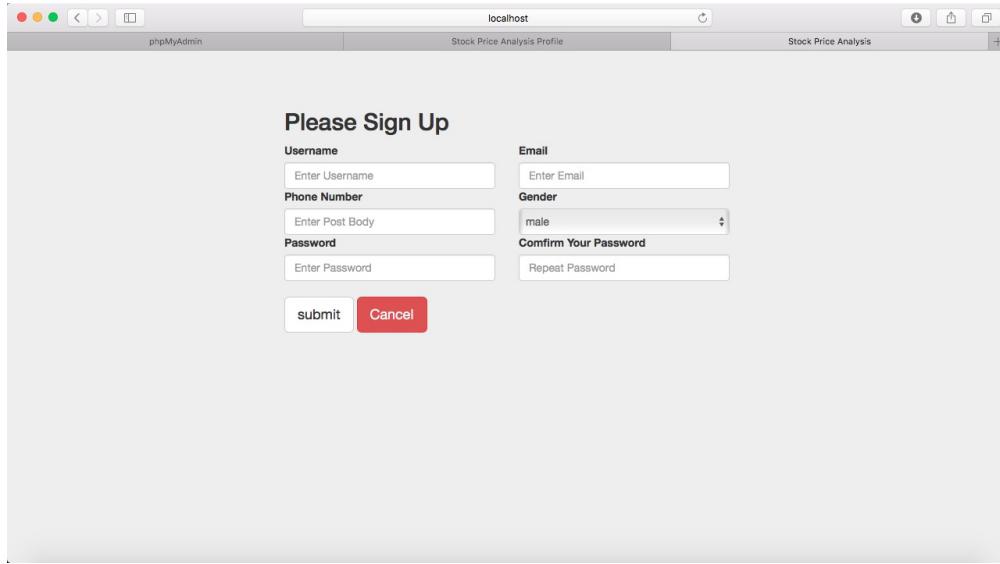
The web page is almost down but we may have some points that we did not know that users may like to add.

Like the log out button, we suggest that every time you leave your PC. To prevent the possibility that your profile will be changed while you are not at your PC.

4.3 Preliminary Design



When the user open the web page at the first time, they do not have access to its content. Therefore, the first thing the user will see is the login screen. On here, if they are already registered, they can simply fill in their user name and password in the boxes and click on login to access the site. If they are not registered, they can just click on the "Register" button.



They can then register by filling in the information and hitting the "Register" button. After registration or logging in, the User will be taken to the home page. The home page itself is customized according to the User's portfolio and the current stocks they have. The home page consists of all of the User's stock's shown on one graph. It will also show the

User which stock is gaining the most income and which one is the biggest loss. On the right hand side of the page, the User will see news articles and snippets of the stocks he/she has in their portfolio.



5. Prediction Algorithms

5.1 Algorithms

In this project, we have exploited three algorithms to make prediction of the stock price: Bayesian curve fitting, artificial neural network and support vector machine. The results displayed in the website are demonstrated as follows, the last five points represent the prediction of price in next five days.

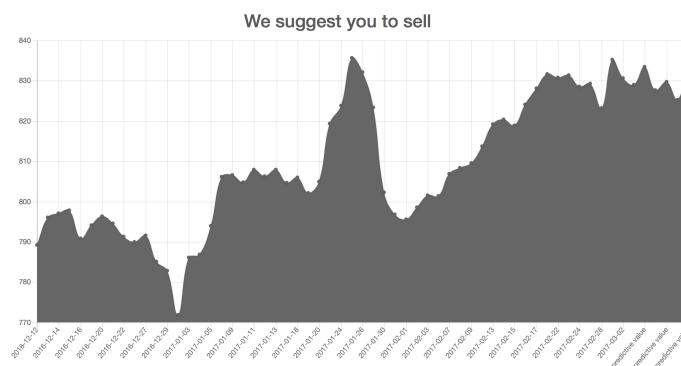


Figure 5.1: Prediction result using Bayesian curve fitting

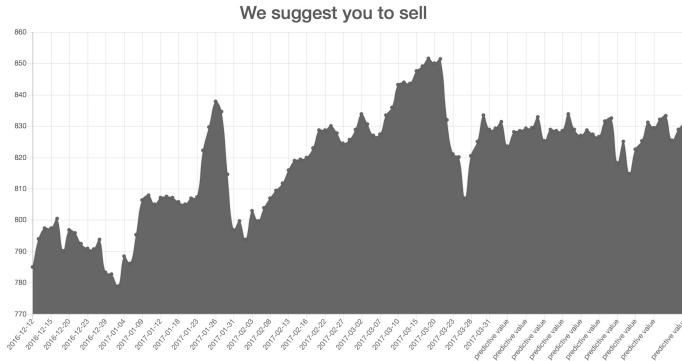


Figure 5.2: Prediction result using artificial neural network

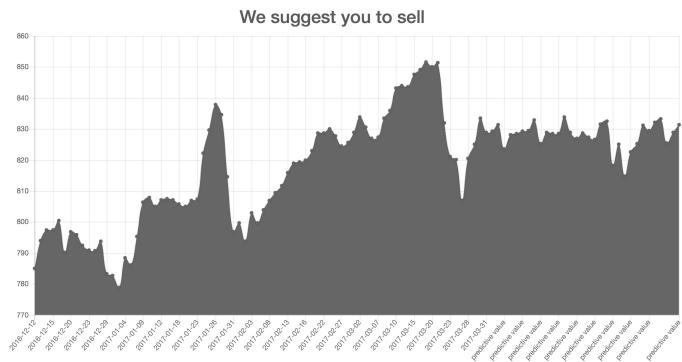


Figure 5.3: Prediction result using support vector machine

5.1.1 Bayesian curve fitting

Bayesian theorem is a common tool used in financial market. It is usually utilized for the short term prediction. This particular theorem is most often used to calculate what is called the posterior probability. The posterior probability is the conditional probability of a future uncertain event that is based upon relevant evidence relating to it historically. In other words, if you gain new information or evidence and you need to update the probability of an event occurring, you can use Bayes' theorem to estimate this new probability.

$$\begin{aligned}
 p(t|x, \mathbf{x}, \mathbf{t}) &= \mathcal{N}(t|m(x), s^2(x)) \\
 m(x) &= \beta \phi(x)^T \mathbf{S} \sum_{n=1}^N \phi(x_n) t_n \\
 s^2(x) &= \beta^{-1} + \phi(x)^T \mathbf{S} \phi(x). \\
 \mathbf{S}^{-1} &= \alpha \mathbf{I} + \beta \sum_{n=1}^N \phi(x_n) \phi(x)^T
 \end{aligned}$$

The advantage of Bayesian curve fitting is that it could provide us a theoretically continue smooth function (of course in this specific situation, that is prices prediction, it is discrete) which best fits on the former data. According to this method, we could derive the predicted mean function $m(x)$ and the sigma function at any time point either in the past or in the future. But the trade-off is that the further prediction makes the worse precision, and this is reasonable considering that never a stock price curve is a perfect polynomial function. So now, we have the predicted mean function and sigma function for the any specific time, what's the last step is fitting them into the Gaussian distribution function and randomly getting a result based on the function, which is the final predicted price that we need.

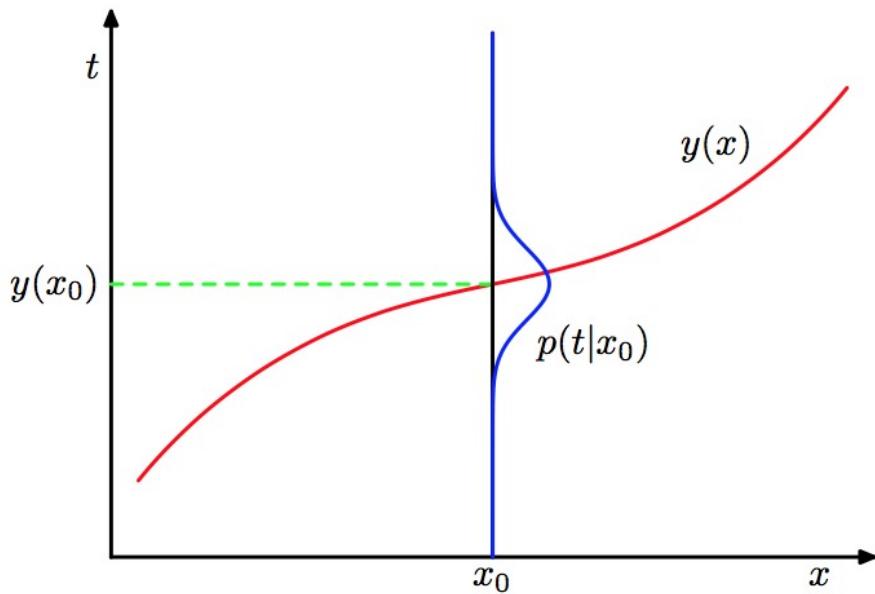


Figure 5.4: Bayesian curve fitting

In a fully Bayesian approach, we should consistently apply the sum and product rules of probability, which requires, as we shall see shortly, that we integrate over all values of w . Such marginalizations lie at the heart of Bayesian methods for pattern recognition.

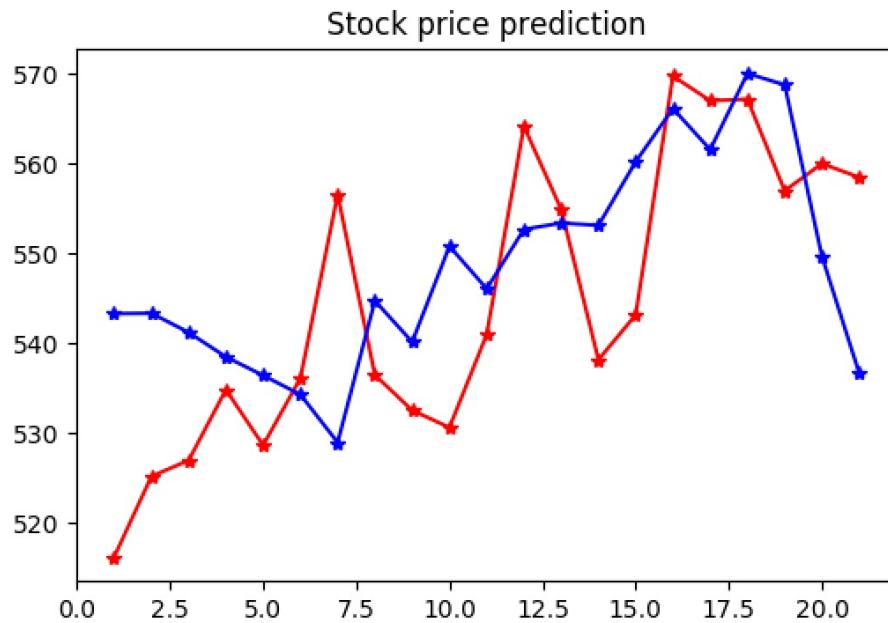


Figure 5.5: Implementation results in Python

5.1.2 Artificial neural network

To achieve a good performance long term prediction, Bayesian curve fitting is too weak for that because it makes solid assertion that the curve must fit in a polynomial function which we all know unreasonable for long term. Thus we need a more sophisticated and more robust method to find a pattern that the prices trend could fit in. And here we propose using neural network to achieve that.

To make this clearer, let's clarify what the input and output are. Input X is a vector consisted of different orders of the timestamps, here for example, the first feature is the 0 order of timestamps "5" that is 1, the second feature is the 1st order of timestamps "5" that is 5, the third is 2nd order of timestamps "5" that is 25 and so on so forth. The dimension of input is the order of prediction parameter M plus one (for the order 0).

In machine learning and cognitive science, artificial neural networks (ANNs) are a family of statistical learning algorithms inspired by biological neural networks (the central nervous systems of animals, in particular the brain) and are used to estimate or approximate functions that can depend on a large number of inputs and are generally unknown. Artificial neural networks are generally presented as systems of interconnected "neurons" which can compute values from inputs, and are capable of machine learning as well as pattern recognition thanks to their adaptive nature.

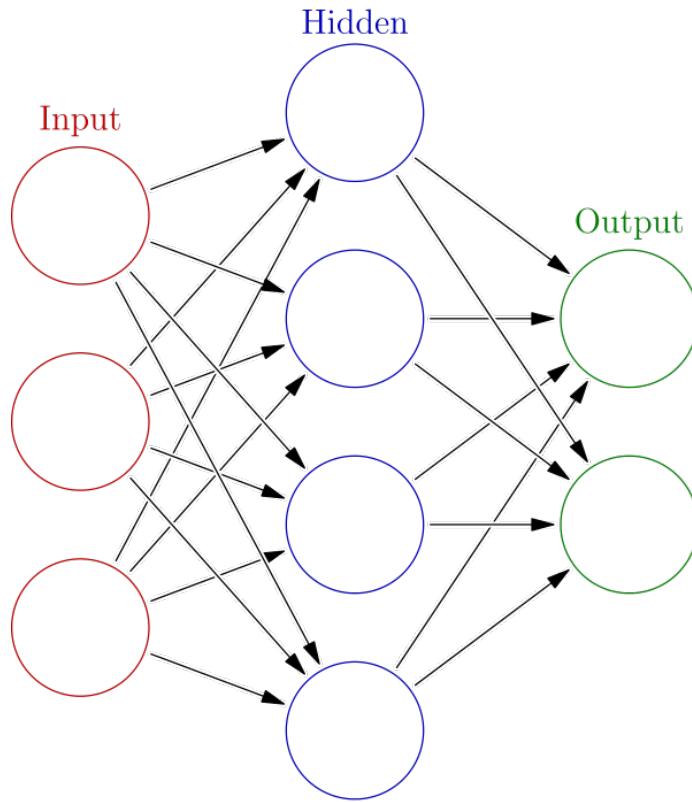


Figure 5.6: Sketch of artificial neural network

5.1.3 Support vector machine

Support vector machine (SVM) has usually been used in long term stock market forecasting. It is currently one of the most popular learning algorithms and has successfully been applied to numerous fields. Its popularity can be explained both by a high generalization performance and a mathematically well posed training method. In the context of financial data modeling, SVM is particularly appealing for multiple reasons. Firstly, it makes no strong assumptions on the data. Secondly, since it is not an empirical error minimization method, therefore it should not over-fit the data. In our project, we have also used SVM as our prediction algorithm.

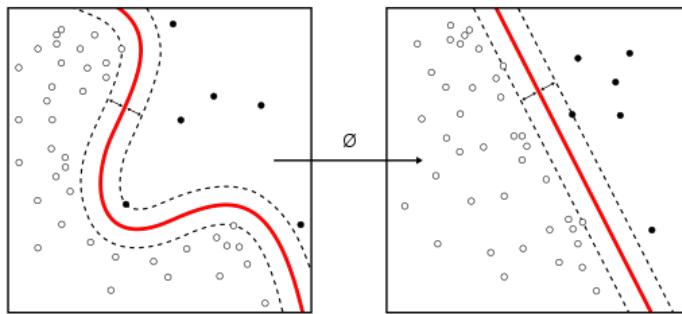


Figure 5.7: Support Vector Machine

5.2 Indicators

Technical indicators are distinguished by the fact that they do not analyze any part of the fundamental business, like earnings, revenue and profit margins. Technical indicators are used most extensively by active traders in the market, as they are designed primarily for analyzing short-term price movements. To a long-term investor, most technical indicators are of little value, as they do nothing to shed light on the underlying business. The most effective uses of technicals for a long-term investor are to help identify good entry and exit points for the stock by analyzing the long-term trend. In our project, we have exploited three indicators to help the users make decision: Moving Average(MA), Bollinger Band and Keltner Channel.



5.2.1 Moving Average

Moving Average includes simple moving average(SMA) and exponential moving average(EMA). SMA is simply an average of a security's price over a particular period. Because

of the limits of SMA, EMA was invented. EMA is type of moving average that gives more weight to recent prices in a attempt to make it more agile to new information. The time period is specified in the type of moving average; for instance, a 50-day moving average. This moving average will average the prior 50 days of price activity, usually using the security's closing price in its calculation. The main functions of MA is to identify trends and reversals and determine potential areas where an asset could find the support and resistance. MA can be used for confirming trends and set stop-loss, however, it could not predict new trends as a lagging indicator. In our project, we have calculated the SMA of 10-days as one of our indicator.

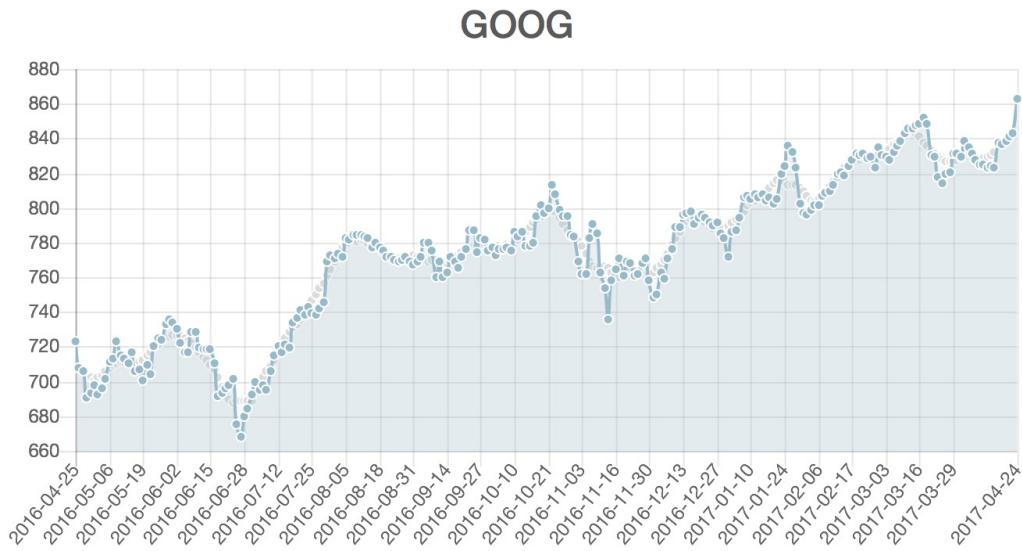


Figure 5.8: Moving Average

5.2.2 Bollinger Band

Bollinger bands are composed by a center line and two price channel above and below it respectively. The center line is the EMA which mentioned above, the price channels are the standard deviations of the stock. For a stock traded for a long period, albeit with some oscillations. To see the trend, traders use the MA to filter the price action and collect important information about how the market is trading. As long as the price do not move out of the channel, the trader can consider that price is moving as expected. Once the stock price continually touch the upper band or lower band, the price is thought to be overbought or oversold. It can triggers a sell signal or buy signal. We have use the Bollinger bands as our second indicator.

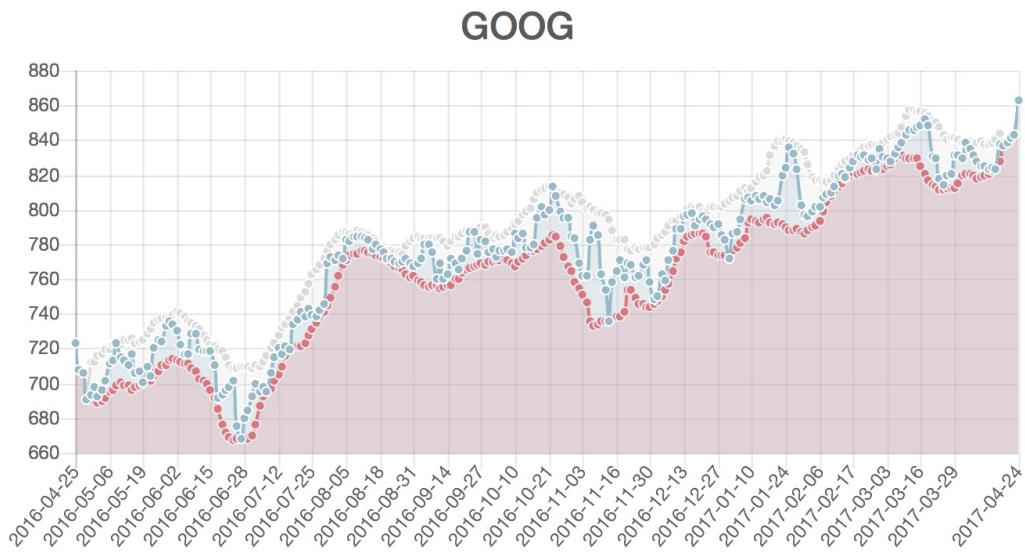


Figure 5.9: Bollinger Band

5.2.3 Keltner Channel

The third indicator in our project is Keltner Channel. It is a classical technical analysis indicator developed by Chester W. Keltner in 1960. This indicator is somewhat similar to the Bollinger Bands and Envelopes. It uses three plot lines: the middle line is the 10-day simple moving average applied to the typical price ($(high + low + close)/3$), the upper and the lower bands are produced by adding and subtracting the moving average of the daily price range (High and Low difference) from the middle line.

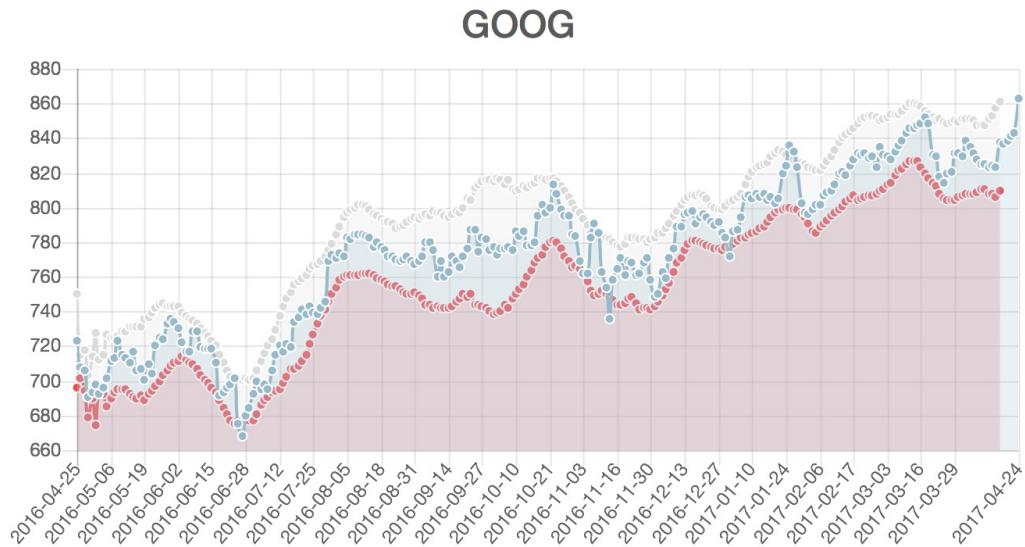
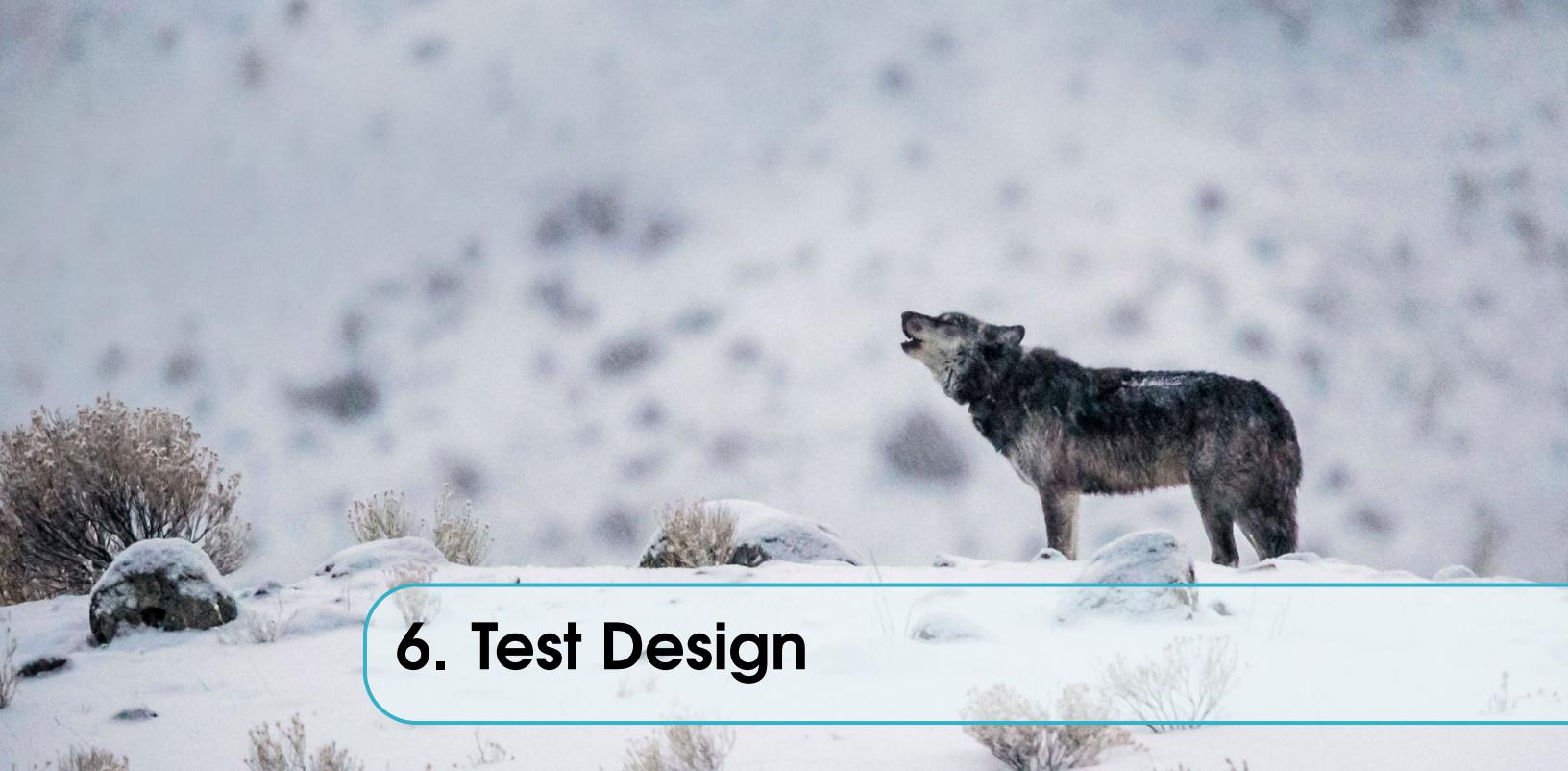


Figure 5.10: Keltner Channel

The classical strategy with this indicator is to go long when the price closes above the upper band and to go short when it closes below the lower band. It seems to be a rather viable entry system. Exits can be based on a very conservative stop-loss (as you see on the chart, the false signals are not uncommon), a rather high take-profit and a cross with the middle line. But we usually need to use other indicators for confirmation.



6. Test Design

6.1 User Interface Testing

A good controller is efficient for the stability and functionality of the proposed model and application. One can compare it to the engine of a car. Therefore, an important aspect of the controller is to keep track of certain stocks. This test can also check many other smaller issues along its path like an odometer that keeps track of the speed of a car. If an incorrect output is received then we can trace it to the cause(s) (engine, tire-rotation, pressure on gas-pedal, other calibrations) of the fault. Similarly, if the tracking of a stock is incorrect, perhaps it was a search of the stocks in the database or the current external website(Yahoo Finance). This can be checked through creating more boolean values. This test case is focused on the search function and uses the track function to display its findings (Function requirement 4). It will use state testing, to determine what the history of the grabbed stocks was so that it did grab the right ones. This is because in history there might be similar data such as industry, sector, and keyword however there will also be timestamps.

The next test case will be one checking if the stock entered is valid or not. If it is invalid it will be rejected and the user will be sent back to the home screen or have the option to log out. This pseudo code shows how we notice if the stock entered is a valid stock or not. We must compare the stock symbol typed in with a list of valid stock symbols. If the results come up false from our boolean check, then we reject the stock symbol.

6.1.1 Test 1 - Search for Stock

This is a very important part, user must search for stock that they want to add. Then it will saved to our database.

The for this use case is to primarily ensure that the search function is working and the input entered by user is read by the system properly. The first test case should describe going from the home screen to searching for a stock. When we enter a stock, after we have tested

the connection initially, we must check to make sure the program correctly gathers the right information. We have to first compare the stock ticker symbol typed in to the actual ticker found by our search. We do this by gathering both symbols and comparing the strings to verify that they match. After this we pull the data from the stock and again compare it with the actual data from that specific stock and check to make sure that the information is the same. Next we compare the predictions made by our algorithm to predictions we have calculated out by ourselves to check the accuracy of the algorithm's predictions. Finally we check to make sure all of the predicted values show up on the screen properly by comparing what should appear to what actually does. If any of these processes fail, an error code will appear.

Test 1 - Controller Received and Sent Input Request

This test will see if the input entered by the user is received and sent by the controllers in the system. It will make sure that the user controller can read input entered by the user. If the user controller cannot obtain this input then it will not be able to convey this information to the database controller and an error will occur internally and the stock page will not load for the user. This test will also see if the database controller is able to obtain the input request from the user controller. This test is to see if the stock that is searched by the user is sent properly to the system.

6.1.2 Test 2 - Database Connection

This test will make sure that the database controller sends the request to the database properly. It will also make sure that the information that the database sends back is the same information that the controller requested.

6.2 Overview Page

6.2.1 Test 1 - Load Page

This test will make sure that after the stock has been searched that the correct page is loaded. It will also make sure that the various components of the page are also loaded successfully. This will include the graphs.

6.2.2 Test 2 - Graph

This ensures that once user press the search button, the indicator and the stock graph will show out automatically. This ensures that the stock's graph on the page is correct and loads properly. There will be two graphs, one will have a dependency on yahoo finance data to populate and the other will have data that will be populated from our database. We will be able to identify issues due to the fact that we have two graphs pulling data from different sources. This could be useful because if one graph's data isn't loading properly we can pinpoint it on that graphs data source which will aid in debugging.

6.3 Web Page

6.3.1 Load Page

Like in the Overview Page, we will run a test for all the other pages on the website and make sure they load properly. These pages are profile, sign in, sign out, sign up, home page, Join us, help, report.

6.4 Prediction Algorithm Testing

The prediction algorithms will be tested using previous data. This has not been implemented yet in terms of actual testing, however manual testing has begun that compares the result of the moving average based off of historical data. This testing can be automated using programs that will test for validity of both the algorithm itself as well as the validity of the code. We will implement these tests for all of the algorithms that we intend on implementing, at least the Moving average and RSI for now.

6.4.1 Graph

This ensures that the stock's graph on the page is correct and loads properly. There will be one graphs, which will show the Bayesian Curving Fitting or the Neural Network prediction graph. We will be able to identify issues due to the fact that we have the graphs pulling data from different sources. This could be useful because if this graph's data isn't loading properly we can pinpoint it on that graphs data source which will aid in debugging.

6.5 Integration Testing

Our integration testing will be done using big bang integration. Prior to compiling each individual sub part, we will conduct unit testing on individual pieces of software in order to validate methods and strategies so that we can eliminate logical errors and concentrate on technical errors that may occur as a result of integration. There aren't too many external dependencies (the only is yahoo! finance api) and everything is relatively modular since everything has its own purpose and is independent of other aspects of the website so pinpointing issues shouldn't be too much of an issue. We will design larger test cases once the program is complete that will allow the programmer to quickly identify any areas of concern, whether it be connection issues, algorithm issues or even API issues just as a few examples.

6.6 Web Page Style Testing

This make sure that what ever we change the page we see, the style of the web page could make a harmonious style that suitable for every page.

6.7 Testing Non-functional Requirements

Non-functional requirements that requires keeping track of time, can be tested easily by issuing a dummy variable and sleeping the program for that specified time, and checking the state of the program afterwards. Furthermore, third party browser extensions will be used to measure website loading times. Other tests such as gaging the ability of a user to intuitively utilize the system will be conducted through observing random users' inputs when told to perform a certain task. For example, a certain user might be told to perform a search and the number of correct/incorrect mouse clicks will be recorded.



7. History Work

7.1 Data Collection Module

We first develop our database on MySQL. And download the csv files that meet the requirement. This help us build the foundation for later work.

This software project helped us learn new web development languages such as php and SQL as well as knowledge within stock trading. Key accomplishments include being able to set up a proper database and store as well as retrieve required data on demand. Furthermore, various prediction models were able to be researched and implemented to a fair degree of error. Besides technical factor's such as these, we also have benefited from research in web design as well as the experience of being in a team oriented environment.

7.2 Preliminary Presentation

This part main develop the architecture of our system. We start to develop our system primarily. We think about the team work break downs and the use cases. Then set down to the members.

And we talked about the prediction method we want to use and the indicators that may help the system more and more complete. As our team leader Shi said We could do perfect as every one contribute to the project. He taught us about the php language and how the design the system. How the combine the parts together and fetch information from database.

7.3 Future Work

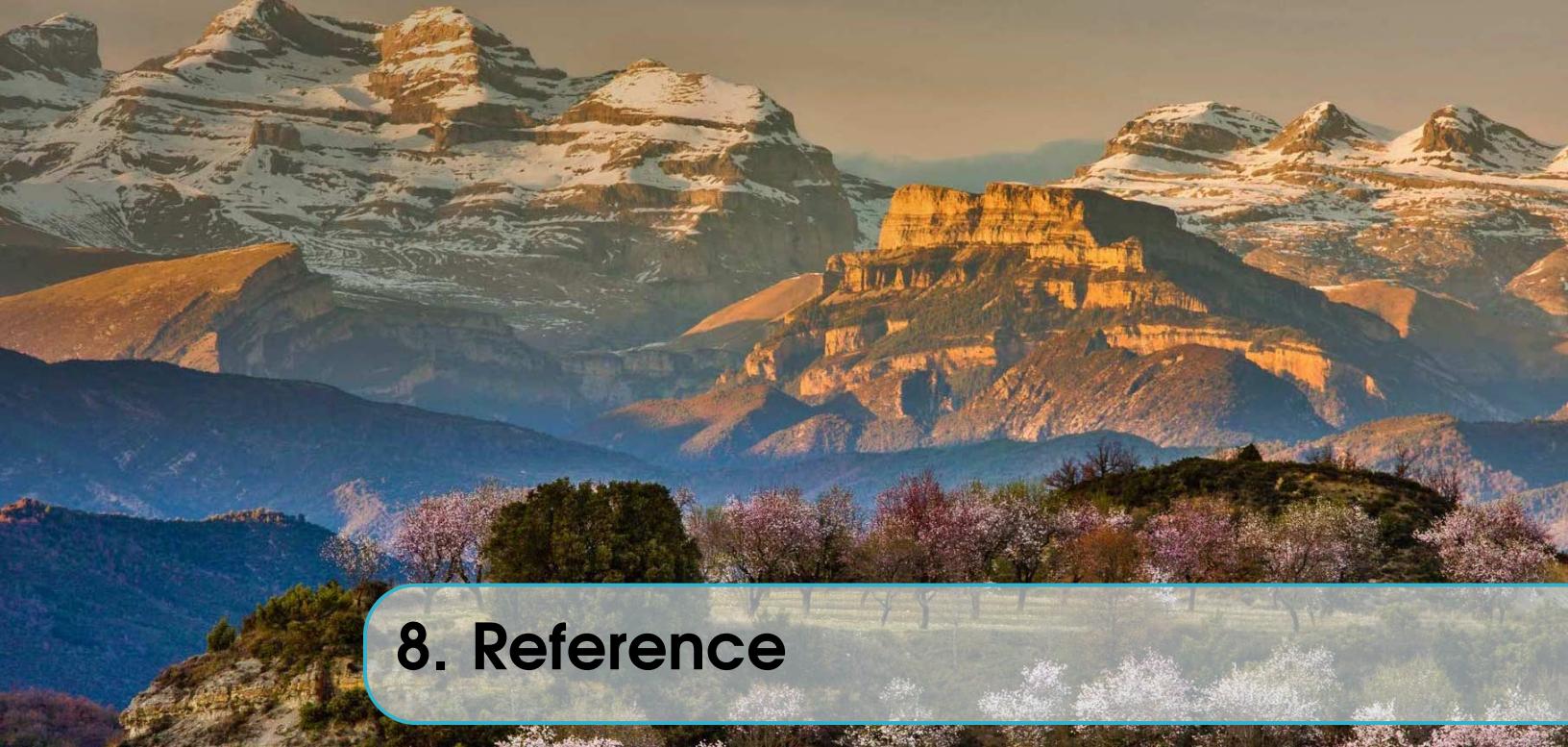
This product still needs a long way to go before it turns into a full scale application. If we had more time we would do several things. The first thing we want to do is to develop a full Join us page which will show more information, by the way, the payment is simulated which will never ask money for user.

Then we want to join more Prediction function which can be more intuitive and more friendly to user which could do the suggest more efficient.

Another thing important that we would like to include for the future would be the design patterns mentioned in section 8. These would be very beneficial and allow us to create a more refined product that could generate email alerts as well as allow the system to grow nicely. Like in the sign in page, we could also create a forget my password which can find the password by user themselves.

At last, we want to combine the prediction page with the overview page that can do things together and make all information more concentrate in one page.

There are lot of works we have not complete but if time permit we will consummate all of this things. The project gives us a concept and experience of design the web page using php and some javascript.



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