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# Crypt Predict

## Research Document

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# 1. Abstract

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The purpose of this document is to outline the research performed and information gained through the course of this project. It details a variety of different technologies as well as means of achieving goals. This document will of course, be updated throughout the life cycle of the project with newly researched information.

## 2. Introduction

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The purpose of this documentation is to provide an overview and synopsis of the research undertaken as part of this final year project. The aim of this project is to build a web based application that can predict the future price of specified cryptocurrencies to assist investors or traders in making decisions.

This document is broken up into several key sections, each of these sections contains its own sub-headings for different topics of research within that section. The initial section discusses the research conducted into the current largest cryptocurrencies in circulation. Following this is a much larger overarching topic of the different technologies researched for the purpose of this project, this includes but is not limited to both frontend and backend tech as well as several different Algorithms considered for this project. The research is concluded with a discussion of the different papers researched for the purpose of this project.

## 3. Cryptocurrency Market

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The Cryptocurrency economy is without a doubt one of the fastest growing economies on the globe.<sup>[1]</sup> Starting solely as Bitcoin, other cryptocurrencies such as Ethereum and Litecoin have gained a significant foothold in the market within the last year with both of their prices growing exponentially.<sup>[2]</sup> Within the cryptocurrency landscape there are over 1500 different currencies, with an overall market cap of over €256 trillion.<sup>[3]</sup> Below I will detail the information I gathered regarding the five different cryptocurrencies which as of writing have the highest market cap.

### 3.1. Bitcoin

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It should come as no surprise that Bitcoin is the market leader in the area of cryptocurrency, it being the first to emerge in 2009.<sup>[4]</sup> It dominates the cryptocurrency market with over sixteen million individual coins in circulation, each with a value of over €6000 as of November 2017.<sup>[3]</sup> Typically hailed as the ‘best’ cryptocurrency, it is still not safe from significant price fluctuations which typically in turn have an effect on other major cryptocurrencies within the marketplace.

### 3.2. Ethereum

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Ethereum is arguably the second highest contender in the cryptocurrency economy. The development of Ethereum was crowdfunded through a presale in 2014, with the system going live in July 2015.<sup>[6]</sup> A whopping 11.9 million coins were pre-mined for the people who had contributed during the presale, this number is equivalent to roughly 13% of the total circulating supply today.<sup>[7]</sup>

Up until March of 2017 Ethereum’s price had never risen above €13, however since then it has been growing rapidly. As of writing this, Ethereum’s peak price for the year so far was hit on September 1<sup>st</sup> when it reached €329, an increase of over 2400%.<sup>[8]</sup> Since this the price has dropped but appears to be holding steady around €258.<sup>[8]</sup>

### 3.3. Bitcoin Cash

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As previously mentioned, Bitcoin is the most significant coin within the cryptocurrency market. However, as the coin grew, and more people started using it there was a knock-on effect that transactions were taking longer and longer to process, because of this in July 2017 Bitcoin Cash was created by what is known as creating a ‘hard fork’ of the original Bitcoin stream.<sup>[5]</sup>

After the fork there was a period of fluctuation followed by a steady downward trend, however as of mid-October 2017 this has switched to a gradual upward climb in price. With a circulating supply of over sixteen million individual coins and its value growing to roughly €540 or equivalent to 0.084 of one Bitcoin in only a few months, it's certainly going to be a large part of the future markets

### 3.4. Ripple

As of November 2017, Ripple is considered the 4<sup>th</sup> largest cryptocurrency based on Market Cap. It is the currency in the larger Ripple system, which is a real-time gross settlement system, a currency exchange and a remittance network.[9] Similarly to Bitcoin the system uses a decentralized network which cannot be shut down and is based around a shared public ledger. The system has been adopted and used by companies such as UniCredit, UBS and Santander.<sup>[10]</sup>

At the creation of Ripple only 100 billion individual coins were created, there is no intention to create anymore in an effort to keep the currency scarce with an ever-decreasing supply available.

### 3.5. Litecoin

Litecoin is a peer-to-peer cryptocurrency that enables instant, near-zero cost payments to anyone in the world.<sup>[11]</sup> The network went live in 2011, it is inspired by Bitcoin, and in most regards, it is technically near identical. Litecoin kept a relatively steady price of roughly €4 until May of 2017 when they became the first of the top 5 cryptocurrencies to implement the Segregated Witness transaction format as well as the Lightning Network.<sup>[12]</sup> Since then Litecoin has climbed to the €78 mark and been consistently within the €35 to €55 range.<sup>[13]</sup>

### 3.6. Market Overview

<i>Position</i>	<i>Name</i>	<i>Market Cap</i>	<i>Current Price</i>	<i>Circulating Supply</i>
1	Bitcoin	€106,297,575,610	€6379.06	16,663,525 BTC
2	Ethereum	€24,612,232,883	€257.66	95,523,037 ETH
3	Bitcoin Cash	€9,051,814,924	€540.04	16,761,363 BCH
4	Ripple	€6,790,049,235	€0.176221	38,531,538,922 XRP
5	Litecoin	€2,562,898,877	€47.74	53,680,257 LTC

[14]

## 4. Frontend Technologies

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### 4.1. Hypertext Markup Language

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Hypertext Markup Language, also known as HTML, is the base of any website or web application. HTML elements are the building blocks of any webpage, with the use of HTML constructs, images and other aspects such as input forms can be added to create a well-structured webpage when rendered.

### 4.2. Cascading Style Sheets

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Cascading Style Sheets, or more commonly known as CSS, is another cornerstone language in the area of web development alongside HTML. CSS is used in pair with HTML to define the presentation of the webpage's elements. CSS is designed primarily to allow the separation of presentation and content, these aspects include things such as the layout, colours as well as fonts. Allowing for this separation improves the flexibility, improves the accessibility as well as allowing for multiple webpages to use the same .css file, reducing the complexity in styling multiple pages within the same domain.

### 4.3. Bootstrap

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Bootstrap is a readily available, ready made website framework. It provides HTML, CSS as well as a JavaScript functionality. Typically used for quick, easy and impressive web design for people without the in-depth knowledge required to build such a responsive site from scratch.

### 4.4. AngularJS

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AngularJS is arguably the second most popular JavaScript framework used within the web design sphere. It utilises a unique Model-View View-Model pattern which allows for the division between the UI and the backend logic. Angular has a variety of components at its disposal, one of the core components are its use of Directives. These allow for maximum code reuse through modularity



## 4.5. Ionic

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Ionic is a framework which is designated for the creation of hybrid applications, allowing for the development of both web based and mobile based applications almost simultaneously. This is achieved through Ionic being heavily based on the previously mentioned AngularJS framework.

## 4.6. Matplotlib

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Matplotlib is an open source plotting library designed to support interactive and publication quality plotting with syntax familiar to Matlab users'. This is considered the Grandfather of plotting libraries. It is extremely powerful and has an impressive collection of graphs.

## 4.7. Seaborn

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Seaborn is a visualization library based on matplotlib. It aims to make graphs much more visually appealing and to make complicated plots simpler to create. It is not considered to be a replacement to Matplotlib, but rather as a complement to it.

## 4.8. Bokeh

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Bokeh allows for the creation of interactive visualizations that are intended for modern browsers for presentation. Featuring several trading centric graphs with examples provided and extensive documentation, Bokeh can definitely be considered promising.

## 4.9. Plotly

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Plotly is different to the previous libraries in that it's an online tool for performing analytics and visualization. However, it does have exceptionally thorough python libraries to allow for easier use of their APIs. While being the clear leader in the interactivity of the graphs it has restrictions on the daily API calls without paying for an upgraded account.

## 5. Backend Technology

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### 5.1. Python

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Python is a programming language which was designed with two key principles in mind, to allow programmers to express ideas in less code than in other languages such as Java or C++ and to emphasize code readability. There are currently two versions of Python actively supported Python 2.x and Python 3.x however due to the nature of this project and its reliance on using the most up to date packages I will be using the most recent stable release of Python 3.x, that is Python 3.6.3.

One of the most enticing features of Python besides my previous development experience with it is Python's extensive standard library alongside its additionally available packages. As of November 2017, there are over 121,000 different packages available from the Python Package Index.<sup>[15]</sup> These packages offer a huge range of functionality varying from scientific computing, web scraping to web frameworks.

#### 5.1.1. Bigfloat

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The bigfloat package is a wrapper for the GNU MPFR Library which is a library written in C for 'performing multiple-precision floating point computation with correct rounding'.<sup>[16]</sup> It aims to 'provide a convenient and friendly Python interface to the operations and functions found in the MPFR library'.<sup>[17]</sup> When dealing with the precise numbers that come with Cryptocurrency this package would be invaluable when performing any form of calculations.

#### 5.1.2. Requests

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The Requests library allows you to perform HTTP requests and access the response as well as the response headers using Python. Being able to make these requests is absolutely essential to the project, without them there would be no means to access the REST APIs of the exchanges.

#### 5.1.3. APScheduler

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Advanced Python Scheduler, or APScheduler is a library that allows the user to scheduler Python code to be executed at a given time or at specified intervals. It works by the user adding or removing jobs to the queue as they please.<sup>[18]</sup>

#### 5.1.4. Statsmodels

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Statsmodels is a module for Python which provides a series of classes and functions for many different statistical models, as well as for conducting statistical tests and statistical data exploration.<sup>[19]</sup> This module will surely be vital in the prediction of future price as higher end algorithms heavily rely on mathematical and statistical calculations.

#### 5.1.5. Scikit-Learn

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Scikit-Learn is a machine learning package for Python. In their own words they offer “Simple and efficient tools for data mining and data analysis”.<sup>[20]</sup> The package offers an impressive variety of machine learning functions including, but not limited to Classification, Regression and Clustering. Further in the document I intend to discuss the different algorithms and functions I believe would be a good fit for the project.

#### 5.1.6. Numpy

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Numpy is an open source library for Python. It’s absolutely essential for any scientific or mathematical computations in Python, it contains key components such as powerful N-Dimensional Arrays, Linear Algebra and random number functionality.<sup>[21]</sup>

#### 5.1.7. Pandas

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Pandas is an open source library which provides high-performance and easy to use data structures as well as data analysis tools for Python.<sup>[22]</sup> The use of Pandas DataFrames for large scale data manipulation will be invaluable throughout this project.

#### 5.1.8. SlackClient

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While not entirely essential to the project, for the purpose of alerting when an issue occurs Slack is the perfect platform to generate and receive and potentially resolve these alerts. The SlackClient package is a client which actively supports the Slack Web API, allowing for the developer to generate and send real time messages amidst other functionality.<sup>[23]</sup>

## 5.2. Flask

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Flask is a Python micro-framework which is targeted at the development of websites and web applications. It utilises the Jinja templating which in turn allows the design of a Flask application to be incredibly modular, providing the developer to implement significant code reuse throughout the project.

## 6. Data Storage

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### 6.1. Relational Database

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A relational database is a collection of data, typically organised into a set of formal table from which this data can be accessed.<sup>[24]</sup> Querying a Relational Database is most commonly done using the Structured Query Language (SQL), by using this language the user can easily combine data from across multiple unique tables to form a single result without having to change the structure of the queried tables.

#### 6.1.1. MySQL

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MySQL is an open-source, relational database management system (RDBMS) provided by Oracle. While originally only usable through a command line interface, due to its widespread acclaim there are a significant amount of tools available to the user to provide a better experience through the use of a graphical user interface (GUI).

### 6.2. Non-Relational Database

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Non-Relational databases don't follow the conventional relationship model used for Relational databases, these can also be referred to as NoSQL databases. These types of databases are growing in popularity thanks to their capacity to deal with changes to the application.

#### 6.2.1. MongoDB

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MongoDB is a free, open source, document oriented database. It's written in C, C++ and Java script. Documents are created and stored as what is known as BSON or Binary JSON. One of the benefits to storing information in this manner is that there's no longer a need to define the structure of the Database before adding information to it, the other key benefit to using the BSON format is that it enables faster transferring of data making it ideal for any application requiring real-time data.<sup>[25]</sup>

## 6.3. CSV

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CSV, or Comma-Separated-Values, is a relatively basic means of storing data. Storing tabular data in plaintext, it allows for relatively easy means for working with data within Python, especially with the addition of Pandas ability to read in entire CSV files to a Dataframe.

## 7. Deployment

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While a web framework such as Flask typically have the capacity for local hosting already in place, this is far from a sustainable system due to their typical inability to scale to a higher level of operation. Thankfully there are plenty of options available for more suitable and scalable system. Below i'll detail several of these options found while conducting research.

### 7.1. WebFaction

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WebFaction is described as a 'Python friendly hosting option with affordable pricing and tons of useful features'.<sup>[26]</sup> With prices between \$10 and \$240 per month you are allocated a specified amount of resources including storage, processing power and bandwidth. At the \$10 price point these resources include 1GB of RAM, access to a shared multi-core CPU, 100GB on an SSD as well as 1TB of bandwidth.<sup>[27]</sup>

### 7.2. Heroku

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Heroku is a cloud platform for hosting web based applications that supports a wide variety of different programming languages and technologies. Heroku utilises lightweight Linux containers called 'Dynos' to run the applications.<sup>[28]</sup> Heroku prices range from \$7 to \$500 per month for varying amounts of resources available. They also have a free account option in which if the given Dyno will have limited resources and in the event that it doesn't receive traffic within 30 minutes, the Dyno will sleep until it is requested again.<sup>[29]</sup>

### 7.3. PythonAnywhere

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PythonAnywhere is a hosting service which, as the name suggests, specialises in hosting Python web applications. They have extensive pricing options outside of their free service, ranging from \$5 to \$500 per month, each with varying amounts of resources and possible web applications. In addition to hosting they offer the use of an in-browser Python IDE as well as Bash Consoles.<sup>[30]</sup>

## 8. Version Control

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With a project that spans such a period of time it's not difficult to anticipate it growing to a size larger than anything I have previously worked on. This fact, along with the best practice of utilising a version control software it's easy to see that not using a form of repository for this project would be starting the project on a very, very bad note.

### 8.1. Github

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Github is arguably the most well known and most used location for developers to store their code on the web. Github utilises user created storage containers called 'repositories' to store the code related to a given project. These repositories are by nature public, unless the user has either a paid or student account which both have the ability to make repositories private. The developer can then upload or 'commit' code to the repository which keeps a history of these commits, allowing the developer to rollback to any given point of development assuming the code was committed.<sup>[31]</sup>

### 8.2. Bitbucket

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Bitbucket is a repository management solution by Atlassian, designed to integrate with their other team-focused software such as Jira for tickets, Confluence for a knowledge base. Similarly to Github it allows for both public and private repositories.<sup>[32]</sup> The software available alongside Bitbucket, while impressive, I feel would ultimately be unnecessary for a project of this scale and would be far more suitable for a more team oriented project thanks to its simple inclusion of ticket tracking through Jira.

### 8.3. Apache Subversion

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Apache Subversion, or as it's commonly shortened to; SVN, is a free and open-source software developed by the Apache Software Foundation. It acts as a control system to track changes made to files, folders as well as directories. It assists users in recovering data and recording the changes made to the aforementioned elements over time.<sup>[33]</sup>



## 9. Literature Review

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While there appeared to be few previous studies which could be directly related to this project, I reviewed studies which I believed have significant relevance despite not being based on the same idea.

### 9.1. Analysis of the Cryptocurrency Market

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In his 2013 paper ‘Analysis of the Cryptocurrency Marketplace’<sup>[34]</sup> Alex Heid raises some interesting points, especially when compared to how the market has changed in the past few years. For example, after a review of the core aspects and the different types of cryptocurrency he writes about both the economics and the profitability of mining cryptocurrencies. Saying that people who had been consistently mining Bitcoin or Litecoin would have begun to earn returns on hardware investment as quickly as 6 months to one year. Comparably investing in some of the newest dedicated bitcoin mining hardware today, the Antminer S9 for example, would cost you \$1415 USD not accounting for shipping. This device could theoretically start earning you returns after just 3 months, the device is estimated to mine approximately \$472.92 USD worth of bitcoin per month in the current market, even with electricity costs factored in.<sup>[35]</sup>

He also discusses three different methodologies in regards to mining. The first of the two communities are Whitehat and Blackhat communities, these are typically seen as the ethical and unethical methods to mining. Whitehat suggesting that the miner uses their own already existing hardware to mine, where as a Black Hat miner would utilise a botnet to use the processing power of their victims’ hardware to mine on behalf of the attacker. The third is an area that has sparked discussion within the crypto-community. Known as Greyhat mining, it emerged after the discovery of websites that had JavaScript scripts that would actively use the CPU power of the visitor. While this wouldn’t be considered exceptionally profitable, bar a high traffic website being compromised, however it does bring an interesting proof of concept to light.

Further along both the ‘Legitimate’ and ‘Underground’ economic activity of cryptocurrency, in specific the ‘Criminal’ sub-section of Underground is particularly of relevance. He writes that the media have sensationalised the use of bitcoin and its potential for illegal activities. His argument seems to be against this, citing that ‘these illegal activities are also made possible through fiat cash’. I find this particularly interesting as in this past year there was a seizure of two of the largest darknet markets at the time, one of the administrators of these sites was found to have a net worth estimated at \$23 million USD.<sup>[36]</sup> That is not to say that all bitcoin and cryptocurrency use is for illegitimate reasons, but rather to illustrate the scale that this underground industry is operating at.

In the conclusion to his paper, Alex deems that interest surrounding both bitcoin and cryptocurrency will only continue to grow, that as the difficulty in mining increases so will the value of individual coins. That alongside the public interest growing, as will the government interest and regulations. Comparing the ‘current government attacks against cryptocurrency’ to mp3 technology or the ‘ongoing assault’ on .torrent technologies.

## 9.2. Is Bitcoin the Only Cryptocurrency in the Town?

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The paper ‘Is Bitcoin the Only Cryptocurrency in the Town? Economics of Cryptocurrency and Friedrich A.Hayek’<sup>[37]</sup> by Mitsuru Iwamura, Yakinobu Kitamura and Tstutomu Matsumoto aims to ‘overview the entire landscape of bitcoin-like cryptocurrencies’ in addition to ‘point out potential problems with bitcoin and propose some ideas for an alternative cryptocurrency’

After the initial introduction in section one the paper turns to its first point of criticism, Price Instability. Throughout this section they theorise that as the ‘Bitcoin fever’ grows, more people are attracted and as a result there’s an influx of monetary transactions. With the market value shooting from this influx of transactions more and more miners are attracted, with many professional engines and programmers participating in mining on a full-time basis. As a result of this bitcoin mining becomes very competitive and can only effectively be performed on higher end computers.

With the rewards from mining decreasing as the total supply of bitcoin in circulation rising ever closer to its binding limit and the rewards becoming lower and lower mining would reach a point where it was simply not profitable anymore. They theorise that with this downfall in mining people will begin to move to different cryptocurrencies, thus causing the price of bitcoin to fall, which in itself sends more miners looking for an alternative, more profitable cryptocurrency.

In section three they pose the question of ‘Where is the Interest Rate in a Cryptocurrency system?’. Making the comparison to money deposited in the bank earning a percentage of interest for the period it is kept in the bank. While they say that bitcoin can certainly have an interest rate calculated, due to its nature it’d be far more volatile and ‘practically useless’. Their main proposition regarding earning interest on cryptocurrency is by the means of lending, suggesting that it is just a matter of time until someone creates a system to generate the best rate of return for lending cryptocurrency.

They conclude the paper with the prediction that as the cryptocurrency economy progresses bitcoin would be taken over by other cryptocurrencies, with similar but improved technical and security structures. Citing that what is holding back the market is the lack of a cryptocurrency designed with proper economic rationales in mind.

### 9.3. Cryptocurrency: A New Investment Opportunity?

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‘Cryptocurrency: A New Investment Opportunity?’<sup>[38]</sup> by David Lee Kuo Chuen, Li Guo and Yu Wang ‘sets out to help the readers to understand cryptocurrencies, and to explore the risk and return characteristics using a portfolio of cryptocurrency represented by the Cryptocurrency Index (CRIX)’.

After the initial introductory section of the paper they begin to review cryptocurrency, including features of bitcoin, the altcoin markets as well as a collection of the top 10 cryptocurrencies based on the CRIX index. The ‘Cryptocurrencies and alternatives’ section raises an interesting comparison between bitcoin and other cryptocurrencies to the alternative investments that are typically made in an effort to diversify a person’s portfolio.

In section 3 the paper starts to analyse the diversification effects of cryptocurrencies. They gathered two datasets, one regarding cryptocurrencies as well their associated trading volume and price between 2011 and 2017, the other dataset being for more traditional investment assets. The data showed that overall cryptocurrency had a better daily return compared to the stock market. However, the CRIX was found to have a high return volatility with a negative skewness suggesting that there is a high tail risk in the cryptocurrency market. As pointed out in the paper there is a noteworthy fact that many cryptocurrencies show positive skewness, namely in the returns increase fast while but decrease slowly, demonstrating a good volatility to generate what could be additional investment opportunities.

In the fourth section ‘Investor Sentiment and Cryptocurrency Market’ they raise an interesting theory in saying that they ‘believe that the cryptocurrency market is mainly driven by investor sentiment, leading to a high volatility’, investor sentiment being the prevailing attitude of investors of the anticipated price development in a market. They further propose a ‘proxy of investor sentiment for each cryptocurrency and investigate its impact on cryptocurrency-based portfolio performance’. They raise the hypothesis that ‘Cryptocurrency with higher investor sentiment today tend to have lower future return than those with lower investor sentiment’, implying that ‘rational investors’ would enter the market and correct the mispricing.

In the paper’s conclusion they discuss the results of their experimentation showing that the CRIX and cryptocurrency can certainly be a good option to diversify a portfolio. They found that the average daily return of a cryptocurrency is higher than a more traditional asset, their analysis suggests an annual return of 12.39% for investors. However, bitcoin is still in an experimental stage, and as is concluded in the paper there are still significant issues to be resolved before cryptocurrencies become an asset of great interest to larger institutions. As with most things in the crypto-economy there is a high level of both complexity and risk.

## 10. Conclusion

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After conducting this research i've decided to use Bitcoin, Ethereum and Litecoin for the purpose of this project, between them I feel I have a good range of price difference as well as daily trade volume.

The frontend technologies which I plan to use will include:

- Bootstrap to reduce the time required in developing the face of the web application.
- Plotly to render both graphs which are both engaging and interactive.

The backend technologies I intend to use include:

- Python as the core programming language, between the authors past experience working with it and it's vast set of libraries it would be senseless not to.
- Flask will be used in addition to Python to form the HTTP handling aspect of the Web Application.
- CSV files will be used to store data related to the individual cryptocurrencies as well as data regarding past predictions which will be used to generate an overall accuracy score.

The project will ideally be hosted using PythonAnywhere due to its ease of setting up a Flask application, as well as past experience working with it. Additionally Github will be used to act as a means of version control for the project.

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