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[1] Introduction

This project aims to analyse and determine the random nature of the social media platform 'Twitter' by parsing Tweets and using them to control the virtual robots in a programming game called 'Robocode'. The data produced will be analysed to determine whether it is pseudo or truly random in an attempt to produce a new method of generating truly random numbers. The inspiration for this project originates from a social experiment called 'Twitch Play Pokémon'.

Twitch is the world's leading social video platform for streaming gaming-oriented content around the world. It was founded in June 2011 and currently amasses nearly 10 million visitors every day. The site is popular among both veteran and aspiring YouTubers and attracts the attention of big e-sports players and tournaments. (Twitch, 2017)

Twitch Plays Pokémon (TPP) was a social experiment by an anonymous Australian programmer and involves streaming a game of Pokémon on Twitch in the Game Boy emulator 'VisualBoyAdvance'. The anonymous programmer developed an Internet Relay Chat (IRC) bot, written in Python, which captures messages from the Twitch chat and parses those strings directly into commands for the game. The stream soon became popular and reached approximately 60,000 concurrent playing users. It took nearly 16 continuous days to complete the first game 'Pokémon Red'. Since then, numerous other Pokémon games from the franchise have been hosted and streamed on Twitch for the users to collaborate on. (Wikipedia, 2017) (Cunningham, 2014)

Robocode is a lightweight, open-source, programming game developed by Mathew A. Nelson as a personal endeavour in 2000. The goal is to create a virtual robot by writing the code yourself in Java or Microsoft .NET. The game acts as an intermediary between Twitter and the data visualisation by converting the parsed Tweets into instructions to control the robots and run the game. (Robocode, 2017)

Mathematics plays an important role in the conclusion of the project. Methods such as statistical regression and standard deviation should be used to determine the random nature of the results output from Robocode and graphed via D3.JS. This will conclude whether Twitter can be used as a TRNG.

This literature review intends to report on knowledge and ideas established from the given research findings. It assesses the relative strengths and weaknesses of such research and provides an opinion on the various findings. The latter end of the review evaluates and reflects on the research findings and justifies the choices that were ultimately made.

[2] Approach & Methods

The approach to the project requires a high degree of technical and mathematical knowledge. It makes extensive use of both object-orientated and procedural programming. Web development knowledge is also required which warrants the need for languages such as HTML, CSS, JavaScript and other libraries that provide helpful 'out-of-the-box' functionality. The required mathematical knowledge is mainly

statistical. The author of this project has prior knowledge and experience with high-level statistics from studying Mathematics at A-Level and such skills are directly transferrable to this project.

In order to write a literature review, it is essential that a wide range of relevant literature is assessed to produce research on the given topic. This includes sources such as websites, books, journals and sampled research such as questionnaires. However, given the obscurity of this projects' specification, there is little scholarly research available online that is directly relevant to the scope of the project. This is not the case for all of the research topics covered, nonetheless, the majority of literature sources for this review are available online.

[3] Research Findings

The following section describes the research that was carried out on the project specifics. This includes discovering possible technologies and development methodologies.

[3.1] Twitch Plays Pokémon

Twitch Plays Pokémon is the social experiment that inspired the initial idea for this project. Therefore, it is important to research into the inner workings of the experiment to gain a better understanding of how it works and how it was developed.

The original concept was developed by an anonymous Australian programmer, so there is no official developer documentation available. However, what we do know is that the script responsible for parsing chat commands on Twitch was written in a programming language called Python. The script interfaced with a Gameboy emulator called 'VisualBoyAdvance'. The script captures directional commands such as "A", "B", "Select" and "Start" which are sent to the emulator to control the game. An additional webpage was developed in JavaScript which was used to display a tally of moves that are shown within the stream. (Wikipedia, 2017)

This project takes this loose concept of controlling a game via an external influence but takes a tangential approach. Instead of text input from an IRC, the text contents of a Tweet will be used to control the Robots in Robocode.

[3.2] Software Development Methodologies

A software or system development methodology is a framework used to structure, plan and control the process of the development of an information system. The 'traditional' methodology is called 'Waterfall' but has since been superseded by newer modern methods that yield far greater efficiency, time management and cost savings. Such methodologies include Agile Software Development, Scrum, Rapid Application Development (RAD) and Extreme Programming (XP). There are many more out there all with their own advantages that cater to specific use cases. (itinfo, 2017)

Considering that all the aforementioned development methodologies are designed for software, *in theory*, any of them could be used and therefore be deemed 'suitable'. However, given the modularity and highly technical nature of the project, there are a few which stand out from the crowd.

Agile Software Development

Agile Development is an umbrella term for several iterative and incremental software development methodologies. Some of the more popular agile methodologies include Extreme Programming (XP), Scrum, Crystal and Feature-Driven Development (FDD). Although there are various agile methodologies that have their own unique approach, they all ultimately have the same vision and core values. The fundamentals of an agile methodology include iteration with continuous feedback to successively refine and deliver a software system. (versionone.com, 2017)

Such methodologies allow changes to be made at any point during development and ensure customer satisfaction. They allow the project to adapt to changes in circumstances meaning the software can be dynamic. This can ultimately save time and money as other methodologies may require the project to be started from the beginning if the requirements change. (360logica, n.d.)

Rapid Application Development (RAD)

Rapid Application Development is another software development methodology which heavily emphasizes rapid prototyping and iterative delivery. This method is a sharp alternative to the conventional waterfall model which heavily relies on having absolute system requirements and sequential design practices. (Powell-Morse, 2016)

One of the major advantages of RAD is that the methodology itself was designed around software development. To elucidate, given that software development is malleable and in constant evolution, a methodology that revolves around iterative delivery and experimentation is a perfect match. (Powell-Morse, 2016)

Feature-Driven Development (FDD)

The third and final suitable methodology for this project is Feature Driven Development. This is another variant of agile methodology and begins by establishing an overall model shape. However, unlike other methodologies, FDD uses the idea of “design by feature, build by feature”. Short iterations of development produce these small features that are useful to the clients. Developing my feature is one of eight development practices. Others include; Domain Object Modelling; Configuration Management and Inspections. (McLaughlin, n.d.)

[\[3.3\] Software Design Principles](#)

There are many design principles, patterns and general etiquette which a programmer must conform to when writing high quality, extensible code. Referred to as the ‘First Five Object-Orientated Design Principles’, S.O.L.I.D is an acronym that stands for such. It stands for the following principles;

- **Single Responsibility Principle (SRP)**
- **Open Closed Principle (OCP)**
- **Liskov Substitution Principle (LSP)**
- **Interface Segregation Principle (ISP)**
- **Dependency Inversion Principle (DIP)**

To summarise each of these design principles;

The Single Responsibility Principle says that a class should have one and only one reason to change, meaning that a class should only have one job. The Open Closed Principle says that Objects or entities should be open for extension, but closed for modification. The Liskov Substitution Principle states that functions that use pointers or references to base classes must be able to use objects of derived classes without knowing it. The Interface Segregation Principle says that a client should never be forced to implement an interface that it doesn't use, or clients shouldn't be forced to depend on methods they do not use. Finally, the Dependency Inversion Principle states that entities must depend on abstractions, not on concretions. High-level modules must not depend on the low-level module, but they should depend on abstractions. (Oloruntoba, 2015)

[3.4] Development Tools

Given the technical nature of this project, it is desirable from a development standpoint to choose tools that provide a smooth and efficient workflow. The first part of the project involves Java programming. Therefore, a Java Integrated Development Environment (IDE) is required.

An IDE is an application that facilitates software and application development. They are designed to encompass all programming tasks in one application. Subject to the language they include a code editor for writing source code. This differs from a regular text editor as it can provide intelligent suggestions to improve your code and has syntax highlighting to make code more readable. They have compilers built in and automatically compile code each time you save, removing the need for the developers to manually compile from the command line. They also include debugging tools that can help developers find and fix problems in the code by 'stepping through' each line of execution to find the bug. Finally, some IDE's have build automation tools that help automate some of the developers' common tasks to increase workflow efficiency and save time. (Veracode, 2017)

Eclipse is a very popular IDE famous for Java but also supports C, C++ and PHP. It provides all of the desired functionality and advantages that a developer would expect from an IDE. (TheEclipseFoundation, 2017)

JetBrains, formerly IntelliJ, is a software development company who create tools targeted towards software developers and project managers. (Wikipedia, 2017) Their suite of software has vastly expanded and now has a respectable 4 million users and have been adopted by reputable companies such as Valve, Samsung and NASA. (JetBrains, 2017)

[3.5] Twitter Social Network

Twitter Java Library

The first major section of the project involves connect to the Twitter API in a Java program so that Tweets can be downloaded from a user's timeline. This functionality is not natively supported in the Java API and so a third-party, community-written

library is required to achieve this. The official Twitter Developer Documentation lists all known functioning libraries that work with their API and there is only one listed under Java. This library is called 'Twitter4J', meaning 'Twitter for Java' and was published by Twitter handle @yusuke. (TwitterDeveloper, 2017)

Although Twitter4J is an unofficial Java library for the Twitter API, it is open-source and is available to download from GitHub. The website provides all the necessary .JAR files that can simply be copied in the Java programs' classpath to be used. The site also provides full Java Documentation (JavaDoc) which makes it easy to understand how the library works and how to use it. (Twitter4J, 2017)

Constraints

The Twitter API has a restriction called 'Rate Limiting'. This means that each user and access token has 15 requests per rate limit window. The HTTP GET request window is 15 minutes (Twitter, 2017). To access a user timeline, the 'getUserTimeline' method returns an object upon invocation. This object contains useful information such as date posted, username, profile image and tweet text. Furthermore, this particular method only allows a maximum of 3200 objects to be returned. Therefore, assuming every account used has a posted at least 3200 tweets, a maximum of 48,000 (15 x 3200) Tweets can be downloaded per 15 minutes.

To overcome the rate limiting restriction, the Twitter Development Documentation suggests methods to avoid being rate limited. One suggestion is the use of 'Caching'. This involves storing the API responses in the application or site if you expect to be using them a lot. The data can then be loaded from the local data store to ensure that calls are made to the API as infrequently as possible. (TwitterDeveloper, 2017)

[\[3.6\] Robocode Programming Game](#)

Robocode also imposes its own constraints on the project. Programming in Robocode is limited to either Java or a language from Microsoft's .NET Framework such as C#. Subject to the chosen language, there are specific system requirements that must be met.

Java requires that the Java 6 Standard Edition (SE) or newer must be installed on the system. Both the Java Runtime Environment (JRE) and the Java Developer Kit (JDK) must be installed. There are also important environment variables that must be set up prior to running Robocode. Detailed specification can be found on the Robocode ReadMe on Sourceforce.net [here](#). (Nelson, 2013)

.NET requires an API Plug-In to be installed on top of Robocode. This can be done by downloading the Robocode .Net .JAR file and running it. Furthermore, the .NET Framework itself needs installing which requires you to be running a Microsoft Windows Operating System and that the computer meets their minimum hardware specification requirements. (Microsoft, 2017)

[3.7] Database Technologies

A database is required to store the results from Robocode so they can be used further on in the project, making it a fundamental piece of technology.

Some examples of database types include; RDBMS; OODMS; ORDBMS and NoSQL. One of the more commonly used Database Management System (DBMS) is the Relational model, which can be used to manage transaction-orientated applications (OLTP). Conversely, non-relational databases, more commonly referred to as 'NoSQL', use document and column stores opposed to relations. (Foote, 2016)

This project is highly dependent on large datasets. Therefore, a database that is good at handling large datasets is desirable.

[3.8] Data Visualisation & Web Development

As previously mentioned, this project relies on large quantities of data. Therefore, in order to draw a conclusion from the findings, the data needs to be formatted and visualised so that a mathematical analysis can be conducted. Considering the data is stored electronically in a database, it is quick and easy to send the data to a webpage. Therefore, a charting library will need to be chosen to graphically represent the data objects on the webpage.

There is a wide range of programming libraries for charting available online. The vast majority of them are open-source and therefore freely available. There are many JavaScript libraries that are emerging as the most powerful tools for visualising data in the form of easy to understand, interactive charts. Some examples of the popular charting libraries are Chartist.js, FusionCharts, D3.JS, Dygraphs and Highcharts. (Singhal, 2015)

Many of the JavaScript libraries fit the requirements for the project. However, D3 (Data Driven Documents) is powerful, open-source and conforms to the W3C web standards and is compatible across multiple browsers. D3 is a JavaScript Library for manipulating the DOM in order to bring static data to life. The library manipulates HTML markup by creating SVG elements to create re-sizable data visualisations. (Bostock, 2017)

Visualisation Format

The format in which the data is visualised is quite important as it affects how the data can be analysed. Due to the nature of this project, and the agile software development methodology that was adopted, a lot of the latter research is still undergoing and has not been carried out yet. As mentioned in the next section 'Mathematical Data Analysis' there are particular statistical methods that will warrant certain visualisation formats. These are likely to include line graphs and scatter graphs.

MEAN Stack Development

Furthermore, to facilitate the use of the data visualisation library, a runtime environment will need to be chosen in order to run server-side JavaScript files so that data can be sent to the webpage to be rendered on the client-side.

The term MEAN stack refers to a collection of JavaScript based technologies used to develop web applications. MEAN is an acronym for MongoDB, ExpressJS, AngularJS and NodeJS. From the client to the server to the back-end database, MEAN is full stack JavaScript. (Raj, 2014)

Considering that the best database technology for this project is MongoDB, and that it makes use of JavaScript libraries for graphing functionality, it would make sense to use the MEAN Stack for the web development. Because all of the technologies are JavaScript orientated, it means that no further programming languages are required, making development easier and removing the need to learn new language syntax.

[3.9] Random Number Generation

When we think of randomness, most people think of a coin flip or a dice roll, but what does 'Random' actually mean? We can define randomness as something that is unpredictable and contains no recognisable patterns. (VSauce, 2014)

Pseudo-Random Number Generation (PRNG)

A PRNG is an algorithm that generates 'random' numbers. However, unlike a dice roll or a lottery ticket, the outcome is pre-calculated from tables of data to produce a sequence of numbers that appear to random. Modern PRNG algorithms are good enough now such that the number produced look exactly like they are random. (Haahr, 2017)

To illustrate, [Appendix 1](#) shows two bitmaps produced by different methods. A bitmap is a digital image composed of a matrix of dots. The first bitmap (on the left) is produced by Random.org and uses atmospheric pressure to generate the values used to produce the bitmap. Conversely, the second bitmap (on the right) is produced by the pseudo-random 'rand()' function from the PHP API in Microsoft Windows. As you see, this bitmap shows a clear pattern due to the repetition of generated numbers.

True-Random Number Generation (TRNG)

A TRNG is similar to a PRNG in as it generates random numbers. However, there is one fundamental difference. The values produced by a TRNG are 'truly-random', whereas previously mentioned, those from a PRNG are 'pseudo-random'.

[3.10] Mathematical Data Analysis

The final section of this project, before a conclusion is formed, is the mathematical analysis of the data. One all the Twitter Tweets have been serialised, passed into the Robocode program, and then exported from the match results, the data will be ready to be visualised and then analysed.

The problem, however, is it is impossible to definitively prove whether a given sequence of numbers is truly-random. The pragmatic approach is to take several sequences of random numbers produced by the RNG in question, then subject them to a series of statistical tests. As the sequences pass more test, our confidence in them (and the generator) increases. However, we also should expect some to fail as

random numbers also pose the chance to appear non-random. But if lots of the test fail, we should question the random nature of the generator. (Random.org, 2017)

One approach is a simple visual analysis. As previously mentioned, the data will be graphed via the D3.JS JavaScript Library. Humans are good at spotting patterns; therefore, a visualisation allows use to simply use our eyes and brain to directly analyse the data. Beyond this, statistical attributes such as standard deviation and variance will be measured to gain a more empirical conclusion. Standard deviation is the measure of how spread out numbers are. To calculate it, you simply square root the variance. The variance is calculated by finding the average of the squared differences from the mean. The sample size used is important as the accuracy increases with the size of the dataset. (MathsIsFun, 2017)

Another statistical method useful to the analysis of the data is linear regression. There are different types of regression, but it essentially attempts to model the relationship between two variables by fitting a linear equation (a straight line) to the observed data. The most common method for fitting a regression line is the method of least squares. This method calculates the best-fitting line for the data by minimising the sum of the squares of the vertical deviations from each data point to the line. This method shows any obvious outliers, the general correlation of the data points and how spread they are from the best-fit line. See [Appendix 2](#) for an example of a line of best fit. (Anon., n.d.)

[4] Evaluation & Reflection

The following section evaluates the previous research findings and reflects on the technologies and methodologies discovered. Conclusions are made on the chosen findings and justification is made to back them up.

[4.1] A Different Direction from Twitch Plays Pokémon

Due to the current direction this project is heading and how its objectives differ vastly from Twitch Plays Pokémon, no further research will be conducted on the experiment as this project now has its own foundation. It is clear that Twitch Plays Pokémon was simply the initial spark for an idea that is now heading in its own direction.

[4.2] Agile Software Development Methodology

During the research, there was one common element that was apparent in every agile software development methodology. This element was a team. Considering that this project is being under-taken by a single developer, a lot of the key aspects of the aforementioned methodologies break down and no longer provide the advantages that they should. Alternatively, a different hybrid approach was taken that involved taking inspiration from lots of different agile methodologies and applying them to the project as necessary.

[4.3] SOLID Software Design Principles

There are quite literally thousands of software design principles that can be chosen and implemented by a program developer. However, given the nature of this project and the small scale of the Java program that will be written, the aforementioned five

SOLID design principles will be considered during development. Subject to the size and complexity of the program, some principles may not need to be considered as their implementation may yield negligible results or even detriment to the program performance.

[4.4] JetBrains Software Development Suite

The chosen software for the development of this project was the JetBrains Software Development Suite. The first piece of software is 'IntelliJ IDEA'. IntelliJ is an IDE specifically designed to maximise developer productivity. It includes useful features such as code completion, framework assistance and VCS integration such as Git. All Java programming and management will be done in IntelliJ. (JetBrains, 2017)

The next piece of software is 'WebStorm'. This is another IDE/Editor that is designed specifically for a JavaScript ecosystem. It shares many of the same advantages and features as IntelliJ but is tailored more towards web, mobile, server and desktop development. (JetBrains, 2017)

Finally, 'DataGrip' is a database IDE that is designed for SQL developers. It also shares many of the features and advantages of an IDE, but is tailored towards database development. DataGrip allows the developer to add multiple database connections into the software where they can be managed and manipulated. Currently, DataGrip does not have native NoSQL support, but does have a plug-in that provides this feature. (JetBrains, 2017)

[4.5] Object Serialisation & Comma Separated Values

As mentioned earlier in the findings, there are limitations to the Twitter API. The major issue is with the rate limiting then prevents developers from making more than 15 calls to the API every 15 minutes. There are temporary solutions such as caching which stores the commonly used data in memory to reduce the number of calls made in the session window. However, considering that a large sample size is desirable with regards to data accuracy, a long-term solution is required.

The decision to 'serialise' the downloaded Tweets was made. This means that the data is stored locally on the computer's disk storage. The data will be formatted in CSV (Comma Separated Value) files. Each line of the file will contain the text from a single Tweet, where each character is delimited by a comma. Each file will contain 48,000 tweets from a single API window. A script can be configured to automate the process and could run every 15 minutes in order to collect a greater number of Tweets.

[4.6] Java Object Orientated Programming

The first major element of this project is handled via Object Orientated Programming. As mentioned in the findings, the virtual robots in Robocode can be programmed in either Oracle's Java, or in Microsoft's .NET Framework which utilises languages such as C#, F# or Visual Basic.

Both options provide no realistic performance advantage over the other, therefore, I decided to use Java as I am familiar with the language, its syntax, and the API. Furthermore, my chosen development suite, by JetBrains, contains a piece of

software called 'IntelliJ IDEA' which natively supports Java meaning I can reap the benefits that the IDE provides. Conversely, opting with the .NET Framework would mean learning an entirely new API and having to download and use a separate piece of software to develop in.

[4.7] MongoDB Non-Relational Database

There are quite literally thousands of different database technologies freely available online to choose from. Fortunately, the use-case for this database isn't very complex. This means that the usual rules you would follow when choosing a database, aren't too relevant. For example, it is normally important to consider the end result. This can reduce the change of any unpredictable queries popping up and causing serious performance problems. Considering that the queries used in this project are simply dumps of JSON data, consideration of the end result is not important. (Heller, 2016)

The document database 'MongoDB' was chosen for the project as it had many advantages over the conventional relational database. Firstly, MongoDB is 'schema-less', meaning it does not use schema models. This means that the structure of the data is not strict, and so each datum can have a different number of fields, content and sizes from the others. (tutorialspoint, 2017)

Moreover, MongoDB has a deep query ability using its document-based query language and also scales very well with size. Considering the huge quantity of Tweets that will be stored, of varying lengths, MongoDB caters for it very well.

To summarise, the research has shown that MongoDB is good for big data, clear object structure and deep querying and has therefore been selected as the database of choice for this project.

[4.8] D3.JS Data Visualisation JavaScript Library

D3.JS (Data Driven Documents – JavaScript Library) was chosen for a number of reasons. Firstly, it is very flexible and works seamlessly with existing web technologies and can manipulate any part of the Document Object Model (DOM). This gives it huge advantages over other libraries because it can be displayed however you like and isn't limited to small regions of a webpage. (Skau, 2013)

D3 is also quick and easy to use as it can be linked and used in an HTML file using one line of markup. Finally, as mentioned earlier in the research findings, D3 also conforms to the W3C web standards and is compatible across all browsers which will ultimately eliminate any potential issues regarding compatibility. (Singhal, 2015)

[4.9] Differentiating PRNG and TRNG

Now we know the difference between pseudo and truly-random number generation, it is important to keep this information in mind during the project. This is especially the case towards the latter end of the project when all the data has been collected and is stored in the database. The mathematical analysis will produce lots of empirical data that will ultimately form the conclusion. However, the values produced from the statistical analysis won't *really* mean anything without thinking about what they mean and placing them somewhere on the line between pseudo and true.

[4.10] Linear Regression & Standard Deviation

All of the methods in the research findings will be employed for the mathematical analysis of the data. This includes the aforementioned statistical methods such as Regression and Standard Deviation. At the time of writing this, the 'method of least squares' is planned to be used. However, future research may warrant the use of another type of regression. This applies to the mathematical analysis in general.

As research shows, there are lots of methods for determining the random nature of a set of numbers, so future research will dictate which methods are chosen to conclude the project.

[5] Version Log

Version	Description	Date
1	First Publication	

[6] Glossary of Terms

Term	Definition
AAA	Pronounced 'Triple-A', refers to the information classification of mid to major publishers of video games.
Agile	Relating to or denoting a method of project management, used especially for software development, that is characterized by the division of tasks into short phases of work and frequent reassessment and adaptation of plans.
API	Application Programming Interface. A set of functions and procedures that allow the creation of applications which access the features or data of an operating system, application, or other service.
C	C is a high-level and general-purpose programming language that is ideal for developing firmware or portable applications.
C#	Pronounced "C-Sharp". An object-oriented programming language from Microsoft that aims to combine the computing power of C++ with the programming ease of Visual Basic. C# is based on C++ and contains features similar to those of Java.
C++	++ is a general-purpose object-oriented programming (OOP) language, developed by Bjarne Stroustrup, and is an extension of the C language. It is therefore possible to code C++ in a "C style" or "object-oriented style."
Classpath	Classpath is a parameter in the Java Virtual Machine or the Java compiler that specifies the location of user-defined classes and packages. The parameter may be set either on the command-line, or through an environment variable.
D3 (.JS)	D3.JS (Data Driven Documents) is a JavaScript library used for creating SVG Data Visualisation on web pages.
DOM	Document Object Model. A programming API for HTML and XML documents. It defines the logical structure of documents and the way a document is accessed and manipulated.

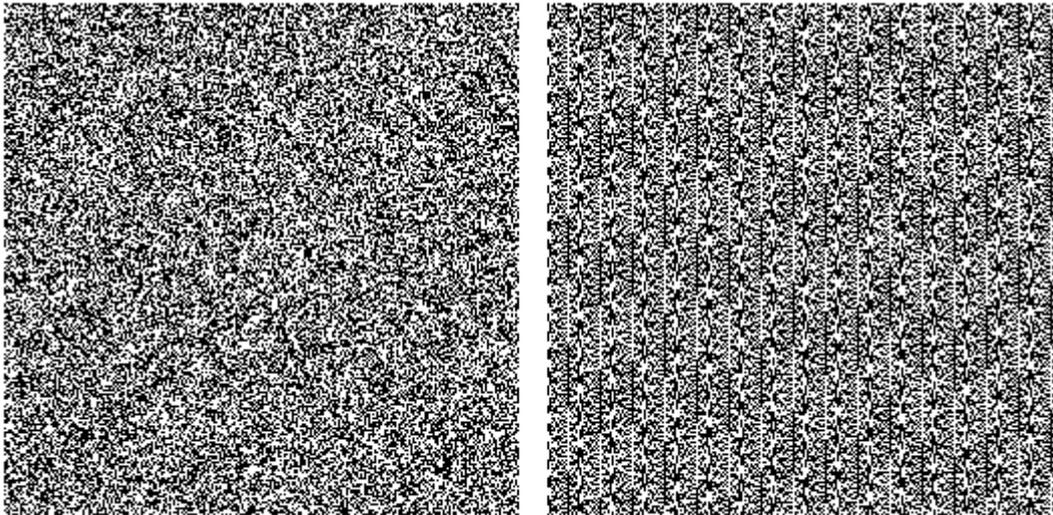
F#	A strongly typed, multi-paradigm programming language that encompasses functional, imperative, and object-oriented programming methods.
FDD	Feature Driven Development. an iterative and incremental software development process. It is a lightweight or Agile method for developing software. FDD blends a number of industry-recognized best practices into a cohesive whole.
Game Boy	the first handheld electronic device for playing cartridge games; also called Game Boy Color, Game Boy Advance, Nintendo DS. Usage Note. trademark of Nintendo. Dictionary.com's 21st Century Lexicon.
GET	An HTTP command used to request a file from a Web server. GET is widely implemented in HTML files (Web pages) for making database queries that do not involve any updating at the server side.
Git	A version control system for tracking changes in computer files and coordinating work on those files among multiple people. It is primarily used for source code management in software development, but it can be used to keep track of changes in any set of files.
Handle	In the context of the social media platform 'Twitter', Each Twitter handle has a unique URL, with the handle added after twitter.com. Example: http://twitter.com/username . Hashtag -- A Twitter hashtag refers to a topic, keyword or phrase preceded by the # symbol. An example is #skydivinglessons. Hashtags are used to categorize messages on Twitter.
HTML	Hyper-Text Markup Language. A standardized system for tagging text files to achieve font, colour, graphic, and hyperlink effects on World Wide Web pages.
HTTP	Hyper-Text Transfer Protocol. HTTP is the underlying protocol used by the World Wide Web and this protocol defines how messages are formatted and transmitted, and what actions Web servers and browsers should take in response to various commands.
IDE	Integrated Development Environment. A piece of software used for managing and developing applications.
IRC	Internet Relay Chat. An application layer protocol that facilitates communication in the form of text.
Java	a general-purpose computer programming language designed to produce programs that will run on any computer system.
Javadoc	Javadoc (originally cased JavaDoc) is a documentation generator created by Sun Microsystems for the Java language (now owned by Oracle Corporation) for generating API documentation in HTML format from Java source code.
JavaScript	An object-oriented computer programming language commonly used to create interactive effects within web browsers.
JetBrains	JetBrains is a software development company whose tools are targeted to software developers and project managers. They have a large suite of intelligent software used for programming and web development.

MEAN	a collection of JavaScript based technologies used to develop web applications. MEAN is an acronym for MongoDB, ExpressJS, AngularJS and Node.js. From client to server to database, MEAN is full stack JavaScript.
NASA	National Aeronautics and Space Administration, the federal agency that is responsible for aerospace research, aeronautics, and the civilian space program.
NoSQL	A NoSQL (originally referring to "Non-SQL" or "non-relational") database provides a mechanism for storage and retrieval of data that is modelled in means other than the tabular relations used in relational databases.
OLTP	Online Transaction Processing. A class of software programs capable of supporting transaction-oriented applications on the Internet. Typically, OLTP systems are used for order entry, financial transactions, customer relationship management (CRM) and retail sales.
OODBMS	Object-Orientated Database Management System. A database management system that supports the creation and modelling of data as objects. OODBMS also includes support for classes of objects and the inheritance of class properties, and incorporates methods, subclasses and their objects.
OOP	Object Orientated Programming. A programming language model organized around objects rather than "actions" and data rather than logic. Historically, a program has been viewed as a logical procedure that takes input data, processes it, and produces output data.
ORDBMS	Object Relational Database Management System. A database management system (DBMS) similar to a relational database, but with an object-oriented database model: objects, classes and inheritance are directly supported in database schemas and in the query language.
PHP	Hyper-Text Processor. A script language and interpreter that is freely available and used primarily on Linux Web servers.
PRNG	Pseudo-Random Number Generation. A program written for, and used in, probability and statistics applications when large quantities of random digits are needed.
Python	An interpreted, object-oriented programming language developed by Guido van Rossum. The name comes from one of van Rossum's favourite television shows, Monty Python's Flying Circus. Python is very portable since Python interpreters are available for most operating system platforms.
RAD	Rapid Application Development. A suite of software development methodology techniques used to expedite software application development. RAD uses predefined prototyping techniques and tools to produce software applications.
RDBMS	Relational Database Management System. a database management system (DBMS) that is based on the relational model invented by Edgar F. Codd, of IBM's San Jose Research Laboratory.

Robocode	Robocode is a programming orientated game, where the goal is to develop a robot battle tank to battle other tanks in Java or Microsoft .NET.
Scrum	A framework for managing software development. It is designed for teams of three to nine developers who break their work into actions that can be completed within fixed duration cycles (called "sprints"), track progress and re-plan in daily 15-minute stand-up meetings, and collaborate to deliver workable software every sprint.
SVG	Scalable Vector Graphics (SVG) is an XML-based vector image format for two-dimensional graphics with support for interactivity and animation. The SVG specification is an open standard developed by the World Wide Web Consortium (W3C) since 1999. SVG images and their behaviours are defined in XML text files.
TPP	Twitch Plays Pokémon. A "social experiment" and channel on the video game live streaming website Twitch, consisting of a crowdsourced attempt to play Game Freak's and Nintendo's Pokémon video games by parsing commands sent by users through the channel's chat room.
TRNG	True-Random Number Generation. A mathematical construct, either computational or as a hardware device, that is designed to generate a random set of numbers that should not display any distinguishable patterns in their appearance or generation.
Twitch	Twitch is a live streaming video platform owned by Twitch Interactive, a subsidiary of Amazon.com. In 2015, Twitch announced it had more than 1.5 million broadcasters and 100 million visitors per month.
Twitter	witter is a free social networking microblogging service that allows registered members to broadcast short posts called tweets.
URL	Uniform Resource Locator. A protocol for specifying addresses on the Internet.
VCS	Version Control System. A component of software configuration management, version control, also known as revision control or source control, is the management of changes to documents, computer programs, large web sites, and other collections of information.
Visual Basic	Commonly abbreviated to VB, Visual Basic is a programming environment from Microsoft in which a programmer uses a graphical user interface (GUI) to choose and modify preselected sections of code written in the BASIC programming language.
Windows	The most widely used operating system for desktop and laptop computers. Developed by Microsoft, Windows primarily runs on x86-based computers (the ubiquitous PC), although versions have run on Intel's Itanium CPUs.
XP	Extreme Programming. A software development methodology which is intended to improve software quality and responsiveness to changing customer requirements.

[7] Appendices

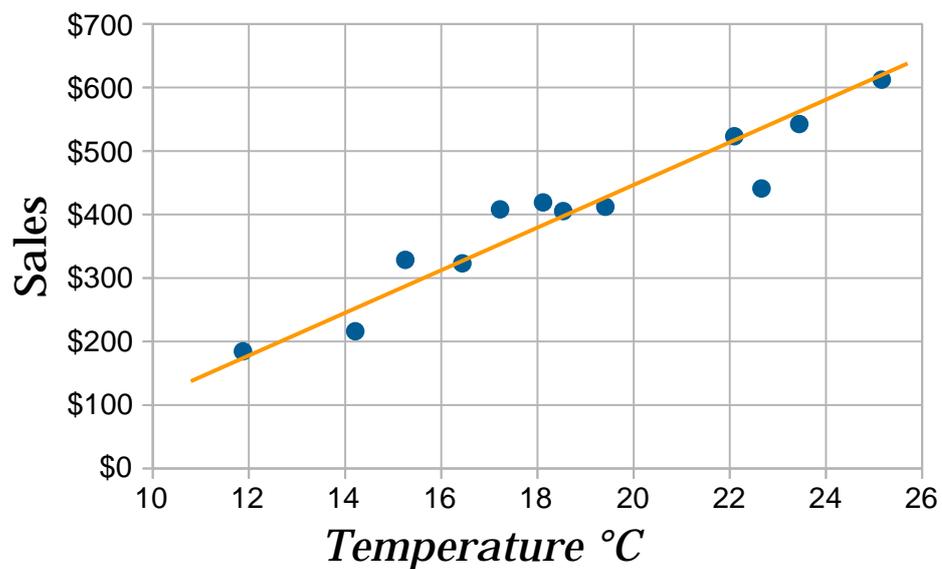
[7.1] Appendix 1 – True-Random Bitmap vs Pseudo-Random Bitmap



RANDOM.ORG

PHP rand() on Microsoft Windows

[7.2] Appendix 2 – Linear Line of Best Fit



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