AN ANALYSIS OF SMS SPAM FEATURES

IFN 701 Project 1- Data Analysis and Research Project

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1. Introduction

This document details a plan for a data analysis and research project involving the investigation of Short Message Service(SMS) Spam. This project aims to create a data analysis and predictive model that is enabled to understand and automatically identify whether an SMS is a spam message or a legitimate message. This project will be performed using a publicly available dataset acquired from Kaggle and by creating a supporting codebase in R Markdown.

1.1 Context of the Project

SMS is an integral feature of common mobile devices that allows users to exchange communication as short text messages (Ahonen, Tomi T., 2011). According to Informa Telecoms and Media, several trillion SMSs are exchanged yearly and there has been a growth in this exchange from 5 trillion worldwide messages in 2010 to 8.7 trillion messages in 2015(Global SMS traffic to reach 8.7 trillion by 2015: study). SMS messages are an important source of revenue for mobile network operators with this component of revenue being estimated to $136.9 billion in 2015(Global SMS traffic to reach 8.7 trillion by 2015: study).

The exchange of SMS messages has however been hampered by the submission of unsolicited messages that are sent in bulk to subscribers, without their consent and authorization, with the intent to acquire their confidential, personal and valuable information and possibly to misuse it(Whitepapers). According to a Cloudmark analysis, 92% of spam messages are fraud(Whitepapers).

The most common types of spam messages sent to the recipients are(Whitepapers):

- Have won a Gift Card Message,
- Account Phishing Spam Message,
- SMS Service Message,
- Accident Compensation Spam Message, and
- Payment Protection Insurance (PPI)Compensation Spam Message.

There has been a growth in reception of spam messages of 300% from 2011 to 2012(Whitepapers).This growth attributes to two main reasons:

1. The availability of affordable unlimited pre-pay SMS packages which has made SMS spamming a cost-effective opportunity for spammers to extract valuable information out of the recipients(Khemapatapan, C, 2011).
2. Messaging is regarded as a trusted service among the subscribers which makes them more comfortable sharing their confidential information. As a result, messages have a higher response rate as compared to any other service. (Khemapatapan, C, 2011) According to June 2013 statistics, 43% of messages were responded in the first 15 minutes of receiving them.(SMS Marketing Statistics, 2017)

Spam messages not only affect the consumers but also the Mobile Network Operators. The reasons that makes this problem a significant one are:

Mobile Network Operators(MNOs) suffer a huge loss on account of maintaining their network, operations and providing increased customer care services to the customers. Spamming also tarnishes their reputation making them lose many valuable customers(Khemapatapan, C, 2010).

Customers are also left annoyed and worried as their confidential, personal and valuable information is at stake(Khemapatapan, C, 2010).

Many network operators have provided means to their customers to block Spam SMS, which sometimes leads to filtration of legitimate message as a spam due to its characteristics matching to those of a spam message(Khemapatapan, C, 2010).

1.2 Related Work and Research Gap

There have been a number of anti-spam measures built to solve this problem like (Khemapatapan, C, 2010)–

- Blacklisting - This technique forbids access to a service if the name is written on the list.
- Simple Filtering - This technique analyses the traffic data and identifies the individual subscriber causing huge volumes of it.
- Spoofing/Faking Detection Techniques

These techniques are brittle, simple and straightforward in nature as they do not really take the special and core characteristics of spam messages into account. Moreover, with advances in spamming methods and careful fabrication of spam messages to make them appear as legitimate, there is an urgent need to build a more sophisticated and appropriate model to eradicate this issue. (Khemapatapan, C, 2010)

Moreover, because of the private nature of SMS exchanges, data to study this problem is scarce.(Khemapatapan, C, 2010)

1.2.1 How this Project Addresses the Problem

I would work on bridging up the gap by working on the publicly available dataset available at Kaggle. It comprises of 5,574 English, real and non-encoded text messages. All of the messages have accurately been tagged as legitimate and spam. The dataset consists of a total of 425 Spam messages manually selected from Grumbletext website. All of the claims made on this site about the text message being spam are identified and investigated through carefully scrutinizing over a hundreds of webpages. (SMS Spam Collection)

I would address the problem of SMS Spam by carrying out an exploratory analysis on this dataset and building a data analysis and a predictive model that would be able to accurately identify whether the SMS is Spam or Legitimate.

Aims and Objectives of the Project

Objective of the Project –

1. To analyze the data to understand the differentiating features of SMS Spam.
2. To build a predictive model which can accurately predict whether the SMS is a Spam SMS or a Legitimate SMS.

The project objective can be achieved by answering the below questions:

1. *What are the characteristics that distinguish Spam messages from Legitimate messages?*
2. *What is the effectiveness of the classification methods – Support Vector Machine, Decision Trees, Logistic Regression or Bayesian Classifiers in identifying SMS Spam?*

Particularly, the main **aim of this project** is to carry out data analysis on the dataset acquired from Kaggle in the following order:

- Carrying out an exploratory analysis on the dataset to explore and learn about the data.
- Statistically predicting and modelling the data
- Result Interpretation

Brief Overview of Methods used in the Project

In this project, I will develop a data analysis including the investigation of a number of predictive models. This analysis is structured in 4 phases (Guo, P., 2013):

1. **Preparation Phase -**

   This phase includes data acquisition and manipulation.

2. **Analysis Phase -**

   This phase includes carrying out exploratory analysis on the dataset followed by writing the code to build the predictive model. The code would then be executed and refined in case of any issues or bugs.

3. **Reflection Phase -**

   This phase would go parallel with the Analysis Phase. The core activity that will be carried out in this phase is to think and communicate the ideas and outputs of the code written in the Analysis Phase.

4. **Final Delivery Phase -**

   In this phase, I would finalize the code in R markdown and write down all the observations in the Analysis Report.

Therefore, the two ***target deliverables*** of the project would be -

1. R Markdown
2. Analysis Report

Outcome of the Project

The result of this project will produce:

- A better understanding of characteristics and features that make a spam SMS different from a legitimate SMS.
- A predictive model that can accurately identify whether an SMS is spam or legitimate.

These outcomes would indirectly affect the society in a better way. The learnings and research could be converted into operational products in future that would aid accurate identification and filtration of spam SMS.

2. Project Methodology

This section would give a clear idea of all the methods that would be used to make this project a success, keeping in mind the time constraint and the target deliverables.

The project methodology that would best suit this project is ***Data Analysis***. This methodology would be a conjuncture of 4 phases(Guo, P., 2013):

1. Preparation Phase
2. Analysis Phase
3. Reflection Phase
4. Final Delivery Phase

All of these 4 phases are a further conjuncture of various activities. These will be explained in detail in the following sections.

2.1 Pictorial Representation

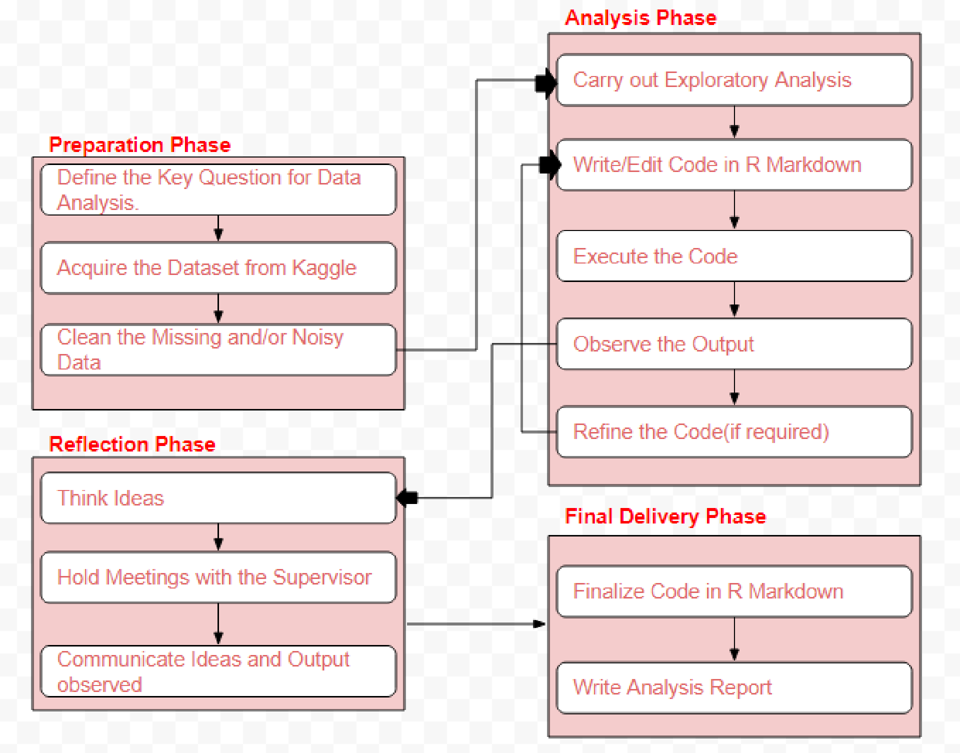
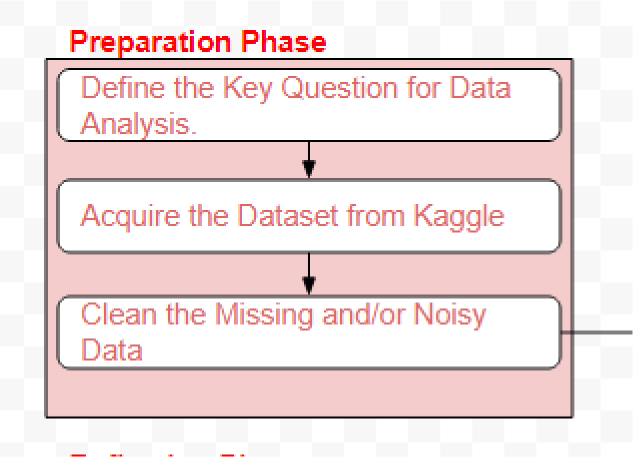

Analysis Phase
Carry out Exploratory Analysis
Write/Edit Code in R Markdown
Execute the Code
Observe the Output
Refine the Code(if required)
Preparation Phase
Define the Key Question for Data Analysis.
Acquire the Dataset from Kaggle
Clean the Missing and/or Noisy Data
Reflection Phase
Think Ideas
Hold Meetings with the Supervisor
Communicate Ideas and Output observed
Final Delivery Phase
Finalize Code in R Markdown
Write Analysis Report

Figure 1: Project Methodology Workflow(Guo, P., 2013)

2.1.1 Preparation Phase


Preparation Phase
Define the Key Question for Data Analysis.
Acquire the Dataset from Kaggle
Clean the Missing and/or Noisy Data

Preparation phase allows us to lay the foundation for the analysis. This phase starts with defining the objective of the project – what the project is about and what do we aim to do in it.

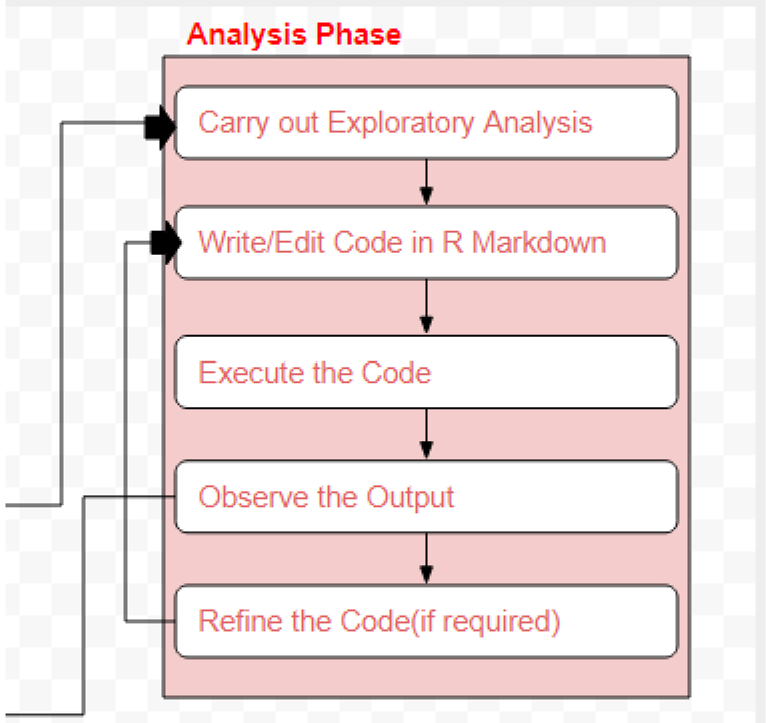
Once the objective has been clearly laid and understood, we acquire the data that would be helpful in achieving the objective. As mentioned earlier, I have acquired the dataset from Kaggle.

Post acquiring the data, I would want to scan through the data to see if there are any missing, noisy or semantically erroneous data in the dataset(Guo, P., 2013). Removing these entries from the dataset would help me perform the analysis in an appropriate manner.

Input	Output
Data acquired from Kaggle	Key question for data analysis. Clean data

Table 1: Input/Output Table for Preparation Phase

2.1.2 Analysis Phase


Analysis Phase
Carry out Exploratory Analysis
Write/Edit Code in R Markdown
Execute the Code
Observe the Output
Refine the Code(if required)

Analysis phase is the most important phase of this project where I would be working towards the predictive model. This phase would start with an exploratory analysis of the dataset followed by continuous iterative cycle of writing the code in R Markdown, executing it an defining it till we get to the desired outcome(Guo, P., 2013).

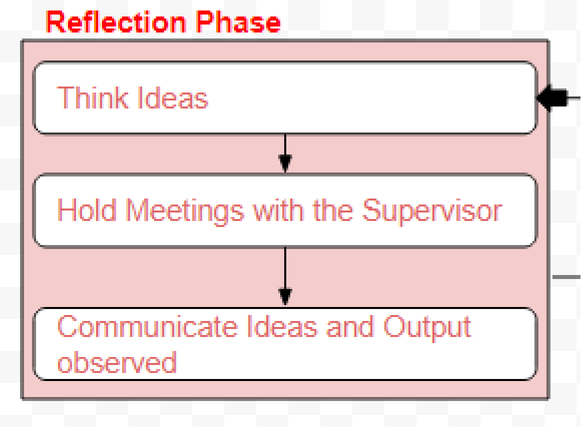
I would be continuously consulting my Supervisor, online forums like – Stack Overflow, etc., and relevant research papers while iterating the code.

Input	Output
Clean data from Preparation Phase.	Features and characteristics of spam SMS.

	Predictive model

Table 2: Input/Output Table for Analysis Phase

2.1.3 Reflection Phase


Reflection Phase
Think Ideas
Hold Meetings with the Supervisor
Communicate Ideas and Output observed

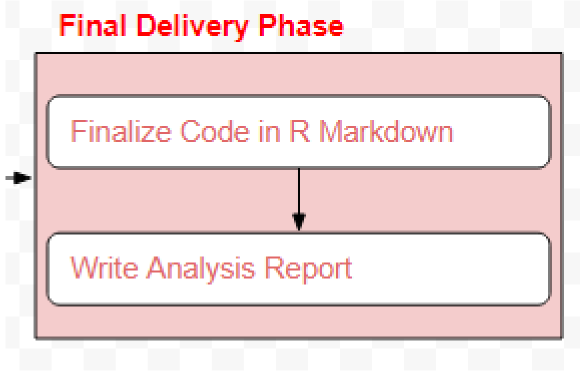
Reflection phase goes parallel with analysis phase. This phase would involve meetings with the Supervisor wherein the input would be the observed output in the analysis phase(Guo, P., 2013).

Discussions in the meeting would lead to new and better ideas of how to make the predictive model better. Therefore, the output of the meeting would be a new to-do list for me(Guo, P., 2013).

Input	Output
Output from the Analysis Phase	Suggestions to make the project better. New To-Do List.

Table 3: Input/Output Table for Reflection Phase

2.1.4 Final Delivery Phase



The concluding phase for this project would be the Final Delivery Phase in which I would be disseminating all the observations and learnings in the form of a Presentation and a Report for the final submission.

Input	Output
Outputs and observations from Analysis and Reflection Phase	Code in R Markdown Analysis Report

Table 4: Input/Output Table for Final Delivery Phase

2.2 Breakdown of Tasks

Period	Period Activities	Deliverables	Duration
Period 1: Initial Project Setup	Finalize project team. Ethics Clearance Finalize project scope and objective Make a repository in GitHub Produce Project Proposal Download R Download dataset	Project Unit Study Agreement Ethics exemption Repository in GitHub Project Plan	4 weeks (Week 1 – Week 4)

Period 2: Data Analysis	Clean the data Explore the data Statistical Prediction and Modelling of the data Interpret the results Write the Analysis Report	Code in R Markdown Analysis Report	6 weeks (Week 5 – Week 10)
Period 3: Recommendations	Provide recommendations to the Supervisor Seek recommendations from Supervisor	Recommendations and Suggestions	1 week (Week 11)
Period 4: Wrap Up	Project conclusion activities	Prepare Project Presentation Prepare Project Report	2 weeks (Week 12 – Week 13)

Table 5: Breakdown of Tasks

3. Project Management Approach

The project will be managed by *Dynamic Systems Development Method (DSDM)*. This approach encourages iterative and incremental delivery, essentially keeping parameters: time, cost and quality fixed (The DSDM Agile Project Framework, 2014). It focusses on solution optimization and control risk by permitting change of requirements throughout the development period and active involvement of stakeholders through continuous communication, review and feedback. I have chosen to work in this agile framework because of two main reasons:

- *Time Constraint* – The project needs to be delivered in the next 8 weeks. Therefore, working in timeboxes would ensure that the product is delivered on time.
- *Quality Control* – Meeting the laid quality standards is as important as delivering the product on time. Therefore, frequent review and feedback, of work done, by the Supervisor would help producing deliverables of the expected quality.

3.1 MoSCoW Prioritization for Scope

Prioritization	Deliverables
Must Haves (60%)	Data Analysis of different features of SMS Spam. Investigation to understand the most effective classification method.
Should Haves (20%)	Recommending development of a model of the most effective classification method.

Could Haves (20%)	To evaluate if development of this model is feasible or not.
Won't Haves	Building an operational product accurately identifying a spam SMS.

Table 6: MoSCoW Prioritization for Scope

3.2 Detailed Weekly Plan/ Task Breakdown Structure

In this project, activities like – setting up project team of Project Student and Supervisor and describing the overall project and its high level requirements have been completed in the first four weeks (Week 1 – Week 4), i.e., the foundation and the feasibility phases.

The plan for the remaining 8 weeks (Week 5 – Week 13) is to divide them into increments, which further would be divided into timeboxes. The breakup of these weeks into increments and timeboxes is as follows:

Item	Details
Number of Increments	2
Duration of each Increment	4 weeks
Timeboxes in each Increment	3
Duration of each Timebox	1 week
Deployment Period in each Increment	1 week

Table 7: Weeks breakup into Increments and Timeboxes

Each timebox and increment would end with a review and feedback session. This will be conducted in weekly meetings and would also focus on the creation of new tasks list for next timebox.

Detailed plan for each increment is as follows:

Increment 1 - Analyze Features of Spam SMS

Phases	Feasibility	Foundation	Timebox 1	Timebox 2	Timebox 3	Deploy
Goal	Initial project setup	Project planning				
Items	Finalize project team	Investigation of the project's background Document project proposal	Find research papers related to the topic. Explore the dataset and read it.	Read at least half of the articles. Clean the data to remove missing and noisy data.	Read the remaining papers. Write the code in R Markdown using Decision Tree Classification method.	Finalize the code in R Markdown and Analysis Report for this Classification Method.

	Define project objective and scope. Ethics Clearance		Share the research papers with the Supervisor and determine the relevant ones.	Share the work done with the Supervisor and seek feedback.	Share the work done with the Supervisor and seek feedback.	
Deliverables	Project Unit Study Agreement Ethics exemption	Project plan/proposal document	25 – 30 research papers Dataset knowledge	Clean data	Knowledge on characteristics of spam SMS.	Code and Analysis Report for Decision Tree Classification Method.
Duration	2 weeks (24/07 - 06/08)	2 weeks (07/08 - 20/08)	1 week (21/08 - 27/08)	1 week (28/08 03/09)	1 week (04/09 - 10/09)	1 week (11/09 - 17/09)

Table 8: Detailed Weekly Plan for Increment 1

Increment 2 - Analyze Features of Spam SMS

Phases	Timebox 1	Timebox 2	Timebox 3	Deploy	Concluding the Project
Items	Write the code in R Markdown using Support Vector Machine Classification method. Share the work done with the Supervisor and seek feedback.	Write the code in R Markdown using Logistic Regression. Share the work done with the Supervisor and seek feedback..	Write the code in R Markdown using Bayesian Classifiers. Share the work done with the Supervisor and seek feedback.	Finalize the code in R Markdown and Analysis Report for all Classification Methods. Investigation of effectiveness of each of the used Classification methods in determining if the SMS is spam or legitimate.	Prepare Project Presentation. Prepare Project Report. Submit report.

Deliverables	Knowledge on different characteristics of spam SMS.	Knowledge on different characteristics of spam SMS.	Knowledge on different characteristics of spam SMS.	Code and Analysis Report for all Classification Methods.	Project presentation Final report
Duration	1 week (18/09 - 24/09)	1 week (25/09 01/10)	1 week (02/10 - 08/10)	1 week (09/10 - 15/10)	2 weeks (16/10 - 29/10)

Table 9: Detailed Weekly Plan for Increment 2

3.4 Communication Plan

In order to ensure success of the project, on-time delivery of the deliverables and meeting the laid quality standards for the outcome, the project team (Project Student and the Supervisor) would follow the Agile Manifesto - "We value Individuals and Interactions over Processes and Tools" very closely(The DSDM Agile Project Framework, 2017).

Therefore, we would follow the below laid down communication plan very closely to ensure frequent and active engagement of all the stakeholders.

Item	Purpose of Communication	Communication Strategy Opted	Frequency	Participating Stakeholders
Status Meeting	To discuss the progress and status of the project.	Face to Face Communication	Weekly	• Project Student • Supervisor
Collaborative Working	To work closely with the Supervisor and take feedback.	Working in the assigned Lab at University	Weekly	• Project Student • Supervisor
Status Report/Document	To keep a track of the tasks completed/in progress since last week.	• Prepare the report. • Email to the Supervisor. • Put it on GitHub. • Show it in the weekly meeting.	Weekly	• Project Student
Quick Communication	To consult the Supervisor in case of any issues.	• E-mail • Slack	As and when required.	• Project Student • Supervisor
Review and Feedback Sessions	To get the work done reviewed by the Supervisor and get constructive feedback on it.	• Face to Face Communication • E-mail • Slack	At the each of each increment.	• Project Student • Supervisor

Table 10: Communication Plan

3.5 Potential Project Risks and Risk Mitigation Strategies

Potential Risk	Consequences	Risk Level	Risk Severity	Overall Risk	Risk Mitigation Plan
Lack of active involvement of the Supervisor	The supervisor might be busy and not have enough time to attend the scheduled meeting. This could result in a solution deviated from expectations, or a solution not meeting the laid quality standards.	High	Medium	High	Weekly meeting with the supervisor. Quick communication over Slack.
Solution Deviation from Expectations	If the solution does not meet the requirements, it might consume a lot of time to re-work on mending it to make it aligned with the requirements.	Medium	High	Medium	Frequent and Incremental Delivery of Solution.
Loss of Key Resources	Loss of code and data stored on a hard-drive or computer might pose a risk in case the physical storage device is disrupted.	Medium	High	High	Store the code online – GitHub Repository
Project Delivery Exceeding the Promised Time	It will lead to breach of one of the core principles of DSDM: On-Time Delivery.	Medium	High	Medium	Follow the Detailed Weekly Plan closely. Inform the Supervisor of all the impediments faced.

Table 11: Risk Assessment

4. Ethics

There was no ethics clearance required for the project.

5. References

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6. Appendix

Corrections made in Response to Feedback for Week 3 Presentation

Supervisor's Feedback

Comment	Response
Explore reasons behind former techniques being simple and straightforward.	Done.
Add Slack as a mode of communication	Done.
Improvise project objective.	Done.
Explain the dataset being used.	Done.

Moderator's Feedback

Comment	Response
Elaboration needed for project objective.	Done.
Explain the project background.	Done.