**Major Project Report On**

**“**A Forensics Activity Logger to Extract User Activity from Mobile Devices”

Submitted to

**SRI INDU COLLEGE OF ENGINEERING AND TECHNOLOGY, HYDERABAD**

In partial fulfilment of the requirement for the award of Degree of

**BACHELOR OF TECHNOLOGY**

In

**“Computer Science and Engineering"**

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SRI INDU COLLEGE OF ENGINEERING AND TECHNOLOGY

(An Autonomous Institution under UGC, Accredited by NBA, Affiliated to JNTUH)

**DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING**



**CERTIFICATE**

This is to certify that the project work report entitled **“A Forensics Activity Logger to Extract User Activity from Mobile Devices”**which is being submitted **J.SAITEJA[19D41A0574], K.GOUTHAMKUMAR(19D41A0584),K.DHARANI(19D41A0588),K.AKASH (19D41A05B0),** in partial fulfilment for the award of the Degree of **BACHELOR OF TECHNOLOGY** in **COMPUTER SCIENCE AND ENGINEERING** of **SRI INDU COLLEGE OF ENGINEERING AND TECHNOLOGY, HYDERABAD,** is a record of the Bonafide work carried out by them under our guidance and supervision.

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**ACKNOWLEDGMENT**

The satisfaction that accompanies the successful completion of the task would be put incomplete without the mention of the people who made it possible, whose constant guidance and encouragement crown all the efforts with success.

We are thankful to Principal **Dr. G. SURESH** garu and Dean CSE & Allied Branches **Dr. K. S. Sadasiva Rao** garu for giving us the permission to carry out this project and for providing necessary infrastructure and labs.

We are highly indebted to **Dr. T. CHARAN SINGH,** Professor& Head , Department of Computer Science Engineering, for providing valuable guidance at every stage of this project.

We are grateful to our internal project guide **Mr. MAHESH KUMAR KOPPUNUR**, Assistant Professor for his constant motivation and guidance given by him during the execution of this project work. We would like to thank the Teaching & Non-Teaching staff of Department of Computer Science and engineering for sharing their knowledge with us, last but not least we express our sincere thanks to everyone who helped directly or indirectly for the completion of this project.

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**ABSTRACT**

Nowadays, mobile devices have become one of the most popular instruments used by a person on its regular life, mainly due to the importance of their applications. In that context, mobile devices store user’s personal information and even more data, becoming a personal tracker for daily activities that provides important information about the user. Derived from this gathering of information, many tools are available to use on mobile devices, with the restrain that each tool only provides isolated information about a specific application or activity. Therefore, the present work proposes a tool that allows investigators to obtain a complete report and timeline of the activities that were performed on the device. This report incorporates the information provided by many sources into a unique set of data. Also, by means of an example, it is presented the operation of the solution, which shows the feasibility in the use of this tool and shows the way in which investigators have to apply the tool.

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**CHAPTER - 1**

**INTRODUCTION**

**1.1 Introduction**

Nowadays, mobile devices are used for a wide spread of tasks (e.g., entertainment, education, communication, socialization, research, commercial transactions). As a result of said use, the devices store information related to the user´s behavior. Therefore, they constitute an important source of evidence for forensics analysis

Also, the forensics analysis uses a set of techniques that allow the collection and extraction of information from different devices without altering their original state . For example, it can recover deleted files, browsing history, instant messaging information, login data, among others, all these types of information are known as digital evidence. According to Iorio et al. there are three aspects that should be considered during the forensics analysis: i) avoid contamination of the evidence to prevent misinterpretations; ii) act methodically, that is, all the results of the forensics process must be well documented; and iii) control the chain of custody through the use of a protocol. Also, there are legal aspects to take into consideration when performing a forensics investigation, that do not comply always, these leads to the misuse of applications, fraud, theft, dissemination of copyrighted materials, etc. Thus, according to Taylor et al.it is necessary to follow all the legal guidelines corresponding to the jurisdiction where the conflict is generated, to avoid undue exposure of personal information

Also, there are a variety of applications (e.g., Encase, DFF, FTK, Helix, Oxygen, MOBILEdit, UFED), which are used for forensic analysis and allow the inspection of various elements of mobile devices (e.g., internal memory, applications, messages). Now, the so-called suites take all the previous points and join them in a single analysis creating a powerful and useful tool Also, it is important to take into account that there are advantages of using open source tools for forensics analysis during an investigation (e. g., no-cost, easy to examine in court, allows verification). But, commercial tools are also used because they provide a great variety of alternatives for analysis. In Yadav et al,it is presented a comparison among six commercial and open source applications. Those tools perform processes such as: recovering, performing keyword searches, recovering cookies, creating forensic images and locating partitions of the digital devices. Also, Shortall and Azhar and Tajuddin and Manaf present several popular forensic tools, such as Cellebrite UFED, MOBILedit Forensic, Forensic Toolkit, XRY, Oxygen Forensic Suite, EnCASE Forensic, and Paraben’s device seizure. Each one of them has different capabilities, effectiveness and options to acquire information, but also, they offer similar services, analysis techniques and ways to present retrieved data. For example, UFED looks for physical data on the hard drive in order to recover deleted data, while the Oxygen Forensic Suite has a variety of options to perform a deep forensics analysis. By the analysis of the indicated studies, and as far as we know, there are not solutions that provide a complete log of the users’ actions when using a mobile device, therefore the investigator needs to use more than one tool in order to recover all the data. Thus, this paper presents a tool, which has been implemented in Python , that generates a unique report with all the information about the mobile device user’s behavior, by means of the collection of information from different applications that are installed on the it, which runs on Android OS. This information is then used to obtain a track of the users’ activities while using the mobile device.

Recent studies on forensics analysis for mobile devices are mostly focused on Android and iOS operating systems, which also are only oriented to the study of specific applications. Anglano et al,study the artifacts generated by WhatsApp when it is deployed on devices running Android, and explain how those artifacts are correlated to extract several types of data. The tools that they use are: FTK Imager, SqliteMan and SQLite v.3 databases. On another study by the same authors, they analyze data obtained from Telegram; as a result, it presents the way to show the contact list, the chronology, the messages that have been exchanged, and the contents of the files that have been sent or received, all these with the use of the tools: SQLite database, UFED and Oxygen Forensic SQLite Viewer. Moreover, Alyahya and Kausar analyze Snapchat application on an Android platform by using two forensics analysis tools, Autopsy and AXIOM Examine. On the same context, Walnycky et al. analyze 20 Android applications (e.g., WhatsApp, Viber, Instagram, Facebook Messenger, Tango), in which the digital evidence that could be used for forensics analysis, is examined, and also they evaluate the security involved in sending/receiving data and application privacy

* 1. **Literature Survey**

The next generation for the forensic extraction of electronic evidence from mobile telephonesElectronic evidence extracted from a mobile telephone provide a wealth of information about the user. Before a court allows the trier of fact to consider the electronic evidence, the court must ensure that the subject matter, testimony of which is to be given, is scientific. Therefore, regard must, at the investigation stage, be given to fulfill the requirements of science and law, including international standards. Such compliance also moves the extraction of electronic evidence from mobile telephones into the next generation, a more rigorous position as a forensic science, by being able to give in court well- reasoned and concrete claims about the accuracy and validity of conclusions.

A critical review of 7 years of Mobile Device Forensics Mobile Device Forensics (MF) is an [interdisciplinary](https://www.sciencedirect.com/topics/computer-science/interdisciplinary) field consisting of techniques applied to a wide range of computing devices, including smartphones and satellite navigation systems. Over the last few years, a significant amount of research has been conducted, concerning various mobile device platforms, data acquisition schemes, and information extraction methods. This work provides a comprehensive overview of the field, by presenting a detailed assessment of the actions and methodologies taken throughout the last seven years. A multilevel chronological categorization of the most significant studies is given in order to provide a quick but complete way of observing the trends within the field. This categorization chart also serves as an analytic progress report, with regards to the evolution of MF. Moreover, since standardization efforts in this area are still in their infancy, this synopsis of research helps set the foundations for a common framework proposal. Furthermore, because technology related to mobile devices is evolving rapidly, disciplines in the MF ecosystem experience frequent changes. The rigorous and critical review of the state-of-the-art in this paper will serve as a resource to support efficient and effective reference and adaptation.

Digital evidence from mobile telephone applicationsIn this paper we examine the legal aspects of the forensic investigation of mobile telephone applications. Mobile telephone applications might be involved with a variety of types of computer misuse including fraud, theft, money laundering, dissemination of copyrighted materials or indecent images, or instances where mobile telephone applications have been involved in the transmission of malware for malicious or criminal purposes. In this paper we examine the process of the forensic investigation of mobile telephone applications, and the issues relating to obtaining digital evidence from mobile telephone applications

“Open Source Digital Forensics Tools : The Legal ArgumentThis paper addresses digital forensic analysis tools and their use in a legal setting. To enter scientific evidence into a United States court, a tool must be reliable and relevant. The reliability of evidence is tested by applying “Daubert” guidelines. To date, there have been few legal challenges to digital evidence, but as the field matures this will likely change. This paper examines the Daubert guidelines and shows that open source tools may more clearly and comprehensively meet the guidelines than closed source tools.

1. “Analysis of Digital Forensic Tools and Investigation ProcessPopularity of internet is not only change our life view, but change the view of crime in our society or all over the world. Increasing the number of computer crime day by day is the reason for forensic investigation. Digital forensic is used to bring justice against that person who is responsible for computer crimes or digital crimes. In this paper, we explain both type of forensic tool commercial as well as open source and comparisons between them. We also classify digital forensic and digital crimes according to their working investigation. In this paper, we proposed a model for investigation process to any type of digital crime. This model is simple and gives efficient result to any type of digital crimes and better way to improve the time for investigation.
2. “Forensic Acquisitions of WhatsApp Data on Popular Mobile PlatformEncryption techniques used by popular messaging services such as Skype, Viber and WhatsApp make traces of illegal activities by criminal groups almost undetectable. This paper reports challenges involved to examine data of the WhatsApp application on popular mobile platforms (iOS, Android and Windows Phone) using latest forensic software such as EnCase, UFED and Oxygen Forensic Suite. The operating systems used were Windows phone 8.1, Android 5.0.1 (Lollipop) and iOS 8.3. Results show that due to strong security features built into the Windows 8.1 system forensic examiners may not be able to access data with standard forensic suite and they must decide whether to perform a live forensic acquisition. This paper provides forensics examiners with practical techniques for recovering evidences of WhatsApp data from Windows 8.1 mobile operating systems that would otherwise be inaccessible.

Forensic investigation and analysis on digital evidence discovery through physical Cybercriminals are changing their strategies as users are less concerns on the smartphone and social networks security risks such as spams, that will threaten them as they are more dependent on the smartphone [1]. Thus, there's a need to perform the smartphone forensics analysis to retrieve and analysed the potentially great amounts and extremely valuable information on these devices. This paper investigates a wealth of personal and sensitive data by types of digital information as evidence and conducted forensic analysis on a popular smartphone Samsung Galaxy Note III. The standard approach applied to extract information from smartphone through physical acquisition and analysis using Cellebrite UFED. The results are presented to demonstrate the smartphone as a goldmine for investigators and as sources of digital evidence. Furthermore this research also presents the forensic tool and techniques for acquiring and examining digital evidence on this device. The evidence discovered include files, contacts, events of smartphone and social network data storage and location. The smartphone examined produced abundant user information and in total 98,127 artefacts were recovered. Performing the extraction and analysis of digital evidence over smartphone activities show the possibility of identifying potential suspects that could assist the forensic investigators in crime investigations.

**CHAPTER – 2**

**SYSTEM ANALYSIS**

**2.1 EXISTING SYSTEM:**

Nowadays, mobile devices have become one of the most popular instruments used by a person on its regular life, mainly due to the importance of their applications. In that context, mobile devices store user’s personal information and even more data, becoming a personal tracker for daily activities that provides important information about the user. Derived from this gathering of information, many tools are available to use on mobile devices, with the restrain that each tool only provides isolated information about a specific application or activity

**2.2 PROPOSED SYSTEM:**

Therefore, the present work proposes a tool that allows investigators to obtain a complete report and timeline of the activities that were performed on the device. This report incorporates the information provided by many sources into a unique set of data. Also, by means of an example, it is presented the operation of the solution, which shows the feasibility in the use of this tool and shows the way in which investigators have to apply the tool.

Detects and counts the number of files according to the type.

• Determines the number of sheets, columns and rows in a Microsoft Excel file and the number of lines in text files. This activity is performed to indicate the length of each file.

• Gets the column that contains the date and time of the users’ activity.

• Compares the date entered by the forensics investigator with the date of the evidence.

• Saves the filtered data.

• Merges the data in a single file.

• Organizes the data in a descending order, so it is chronologically order.

• Deletes repeated data.

• Assigns a code to each activity.

**2.3 SYSTEM REQUIREMENTS:**

**HARDWARE REQUIREMENTS:**

* System : i3 or Above.
* Hard Disk : 40 GB.
* Ram : 4 GB.

**SOFTWARE REQUIREMENTS:**

* **Operating System:** Windows 8 or above
* **Coding Language**: Python 3.7

**CHAPTER - 3**

**SYSTEM STUDY**

**3.1 FEASIBILITY STUDY**

The feasibility of the project is analyzed in this phase and business proposal is put forth with a very general plan for the project and some cost estimates. During system analysis the feasibility study of the proposed system is to be carried out. This is to ensure that the proposed system is not a burden to the company. For feasibility analysis, some understanding of the major requirements for the system is essential.

Three key considerations involved in the feasibility analysis are

* ECONOMICAL FEASIBILITY
* TECHNICAL FEASIBILITY
* SOCIAL FEASIBILITY

**ECONOMICAL FEASIBILITY**

This study is carried out to check the economic impact that the system will have on the organization. The amount of fund that the company can pour into the research and development of the system is limited. The expenditures must be justified. Thus the developed system as well within the budget and this was achieved because most of the technologies used are freely available. Only the customized products had to be purchased.

### **TECHNICAL FEASIBILITY**

This study is carried out to check the technical feasibility, that is, the technical requirements of the system. Any system developed must not have a high demand on the available technical resources. This will lead to high demands on the available technical resources. This will lead to high demands being placed on the client. The developed system must have a modest requirement, as only minimal or null changes are required for implementing this system.

**SOCIAL FEASIBILITY**

The aspect of study is to check the level of acceptance of the system by the user. This includes the process of training the user to use the system efficiently. The user must not feel threatened by the system, instead must accept it as a necessity. The level of acceptance by the users solely depends on the methods that are employed to educate the user about the system and to make him familiar with it. His level of confidence must be raised so that he is also able to make some constructive criticism, which is welcomed, as he is the final user of the system.

**CHAPTER - 4**

**SYSTEM DESIGN**

**4.1 UML DIAGRAMS**

UML stands for Unified Modeling Language. UML is a standardized general-purpose modeling language in the field of object-oriented software engineering. The standard is managed, and was created by, the Object Management Group.

The goal is for UML to become a common language for creating models of object oriented computer software. In its current form UML is comprised of two major components: a Meta-model and a notation. In the future, some form of method or process may also be added to; or associated with, UML.

The Unified Modeling Language is a standard language for specifying, Visualization, Constructing and documenting the artifacts of software system, as well as for business modeling and other non-software systems.

The UML represents a collection of best engineering practices that have proven successful in the modeling of large and complex systems.

The UML is a very important part of developing objects oriented software and the software development process. The UML uses mostly graphical notations to express the design of software projects.

**GOALS:**

The Primary goals in the design of the UML are as follows:

1. Provide users a ready-to-use, expressive visual modeling Language so that they can develop and exchange meaningful models.
2. Provide extendibility and specialization mechanisms to extend the core concepts.
3. Be independent of particular programming languages and development process.
4. Provide a formal basis for understanding the modeling language.
5. Encourage the growth of OO tools market.
6. Support higher level development concepts such as collaborations, frameworks, patterns and components.
7. Integrate best practices.

**USE CASE DIAGRAM:**

A use case diagram in the Unified Modeling Language (UML) is a type of behavioral diagram defined by and created from a Use-case analysis. Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases. The main purpose of a use case diagram is to show what system functions are performed for which actor. Roles of the actors in the system can be depicted.



Fig:1(Use case Diagram)

**CLASS DIAGRAM:**

In software engineering, a class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among the classes. It explains which class contains information.

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Fig:2(Class Diagram)

**SEQUENCE DIAGRAM:**

A sequence diagram in Unified Modeling Language (UML) is a kind of interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. Sequence diagrams are sometimes called event diagrams, event scenarios, and timing diagrams.

****

Fig:3(Sequence Diagram

**CHAPTER-5**

**MODULES**

**IMPLEMENTATION:**

**MODULES:**

**1)Upload Mobile Data**:

Using this module we will upload chat log HTML messages files to application

1. **Extract Data:**

Using this we will extract HTML data from uploaded file and then display content of that file.

**2**) **Apply Forensics Activity:**

Using this module we will extract file size, file creation and modification date and number of lines in that file

1. **Filter Data:**

In this module we apply HTML parsers to remove HTML tags from chat logs and then display clean chat messages between users.

**CHAPTER-6**

**SOFTWARE ENVIRONMENT**

# **What is Python :-**

Below are some facts about Python.

Python is currently the most widely used multi-purpose, high-level programming language.

Python allows programming in Object-Oriented and Procedural paradigms. Python programs generally are smaller than other programming languages like Java.

Programmers have to type relatively less and indentation requirement of the language, makes them readable all the time.

Python language is being used by almost all tech-giant companies like – Google, Amazon, Facebook, Instagram, Dropbox, Uber… etc.

The biggest strength of Python is huge collection of standard library which can be used for the following –

* + [Machine Learning](https://www.geeksforgeeks.org/machine-learning/)
  + GUI Applications (like Kivy, Tkinter, PyQt etc. )
  + Web frameworks like Django (used by YouTube, Instagram, Dropbox)
  + Image processing (like Opencv, Pillow)
  + Web scraping (like Scrapy, BeautifulSoup, Selenium)
  + Test frameworks
  + Multimedia

### **Advantages of Python :-**

Let’s see how Python dominates over other languages.

#### **1. Extensive Libraries**

Python downloads with an extensive library and it contain code for various purposes like regular expressions, documentation-generation, unit-testing, web browsers, threading, databases, CGI, email, image manipulation, and more. So, we don’t have to write the complete code for that manually.

#### **2. Extensible**

As we have seen earlier, Python can be**extended to other languages**. You can write some of your code in languages like C++ or C. This comes in handy, especially in projects.

#### **3. Embeddable**

Complimentary to extensibility, Python is embeddable as well. You can put your Python code in your source code of a different language, like C++. This lets us add **scripting capabilities**to our code in the other language.

#### **4. Improved Productivity**

The language’s simplicity and extensive libraries render programmers**more productive** than languages like Java and C++ do. Also, the fact that you need to write less and get more things done.

#### **5. IOT Opportunities**

Since Python forms the basis of new platforms like Raspberry Pi, it finds the future bright for the Internet Of Things. This is a way to connect the language with the real world.

#### **6. Simple and Easy**

When working with Java, you may have to create a class to print **‘Hello World’**. But in Python, just a print statement will do. It is also quite **easy to learn, understand,** and**code.** This is why when people pick up Python, they have a hard time adjusting to other more verbose languages like Java.

#### **7. Readable**

Because it is not such a verbose language, reading Python is much like reading English. This is the reason why it is so easy to learn, understand, and code. It also does not need curly braces to define blocks, and **indentation is mandatory.** This further aids the readability of the code.

#### **8. Object-Oriented**

This language supports both the **procedural and object-oriented**programming paradigms. While functions help us with code reusability, classes and objects let us model the real world. A class allows the **encapsulation of data** and functions into one.

#### **9. Free and Open-Source**

Like we said earlier, Python is **freely available.** But not only can you[**download Python**](https://data-flair.training/blogs/install-python-windows/) for free, but you can also download its source code, make changes to it, and even distribute it. It downloads with an extensive collection of libraries to help you with your tasks.

#### **10. Portable**

When you code your project in a language like C++, you may need to make some changes to it if you want to run it on another platform. But it isn’t the same with Python. Here, you need to**code only once**, and you can run it anywhere. This is called **Write Once Run Anywhere (WORA)**. However, you need to be careful enough not to include any system-dependent features.

#### **11. Interpreted**

Lastly, we will say that it is an interpreted language. Since statements are executed one by one, **debugging is easier** than in compiled languages.

Any doubts till now in the advantages of Python? Mention in the comment section.

### **Advantages of Python Over Other Languages**

#### Less Coding.

#### Almost all of the tasks done in Python requires less coding when the same task is done in other languages. Python also has an awesome standard library support, so you don’t have to search for any third-party libraries to get your job done. This is the reason that many people suggest learning Python to beginners.

#### 2. Affordable

Python is free therefore individuals, small companies or big organizations can leverage the free available resources to build applications. Python is popular and widely used so it gives you better community support.

**The 2019 Github annual survey showed us that Python has overtaken Java in the most popular programming language category.**

#### 3. Python is for Everyone

Python code can run on any machine whether it is Linux, Mac or Windows. Programmers need to learn different languages for different jobs but with Python, you can professionally build web apps, perform data analysis and [**machine learning**](https://data-flair.training/blogs/machine-learning-tutorials-home/), automate things, do web scraping and also build games and powerful visualizations. It is an all-rounder programming language.

### **Disadvantages of Python**

So far, we’ve seen why Python is a great choice for your project. But if you choose it, you should be aware of its consequences as well. Let’s now see the downsides of choosing Python over another language.

#### 1. Speed Limitations

We have seen that Python code is executed line by line. But since [Python](https://www.python.org/) is interpreted, it often results in **slow execution**. This, however, isn’t a problem unless speed is a focal point for the project. In other words, unless high speed is a requirement, the benefits offered by Python are enough to distract us from its speed limitations.

#### 2. Weak in Mobile Computing and Browsers

While it serves as an excellent server-side language, Python is much rarely seen on the **client-side**. Besides that, it is rarely ever used to implement smartphone-based applications. One such application is called **Carbonnelle**.

The reason it is not so famous despite the existence of Brython is that it isn’t that secure.

#### 3. Design Restrictions

As you know, Python is **dynamically-typed**. This means that you don’t need to declare the type of variable while writing the code. It uses **duck-typing**. But wait, what’s that? Well, it just means that if it looks like a duck, it must be a duck. While this is easy on the programmers during coding, it can**raise run-time errors**.

#### 4. Underdeveloped Database Access Layers

Compared to more widely used technologies like **JDBC (Java DataBase Connectivity)** and **ODBC (Open DataBase Connectivity)**, Python’s database access layers are a bit underdeveloped. Consequently, it is less often applied in huge enterprises.

#### 5. Simple

No, we’re not kidding. Python’s simplicity can indeed be a problem. Take my example. I don’t do Java, I’m more of a Python person. To me, its syntax is so simple that the verbosity of Java code seems unnecessary.

This was all about the Advantages and Disadvantages of Python Programming Language.

**History of Python : -**

What do the alphabet and the programming language Python have in common? Right, both start with ABC. If we are talking about ABC in the Python context, it's clear that the programming language ABC is meant. ABC is a general-purpose programming language and programming environment, which had been developed in the Netherlands, Amsterdam, at the CWI (Centrum Wiskunde &Informatica). The greatest achievement of ABC was to influence the design of Python.Python was conceptualized in the late 1980s. Guido van Rossum worked that time in a project at the CWI, called Amoeba, a distributed operating system. In an interview with Bill Venners1, Guido van Rossum said: "In the early 1980s, I worked as an implementer on a team building a language called ABC at Centrum voor Wiskunde en Informatica (CWI). I don't know how well people know ABC's influence on Python. I try to mention ABC's influence because I'm indebted to everything I learned during that project and to the people who worked on it."Later on in the same Interview, Guido van Rossum continued: "I remembered all my experience and some of my frustration with ABC. I decided to try to design a simple scripting language that possessed some of ABC's better properties, but without its problems. So I started typing. I created a simple virtual machine, a simple parser, and a simple runtime. I made my own version of the various ABC parts that I liked. I created a basic syntax, used indentation for statement grouping instead of curly braces or begin-end blocks, and developed a small number of powerful data types: a hash table (or dictionary, as we call it), a list, strings, and numbers."

**What is Machine Learning : -**

Before we take a look at the details of various machine learning methods, let's start by looking at what machine learning is, and what it isn't. Machine learning is often categorized as a subfield of artificial intelligence, but I find that categorization can often be misleading at first brush. The study of machine learning certainly arose from research in this context, but in the data science application of machine learning methods, it's more helpful to think of machine learning as a means of building models of data.

Fundamentally, machine learning involves building mathematical models to help understand data. "Learning" enters the fray when we give these models tunable parameters that can be adapted to observed data; in this way the program can be considered to be "learning" from the data. Once these models have been fit to previously seen data, they can be used to predict and understand aspects of newly observed data. I'll leave to the reader the more philosophical digression regarding the extent to which this type of mathematical, model-based "learning" is similar to the "learning" exhibited by the human brain.Understanding the problem setting in machine learning is essential to using these tools effectively, and so we will start with some broad categorizations of the types of approaches we'll discuss here.

**Categories Of Machine Leaning :-**

At the most fundamental level, machine learning can be categorized into two main types: supervised learning and unsupervised learning.

Supervised learning involves somehow modeling the relationship between measured features of data and some label associated with the data; once this model is determined, it can be used to apply labels to new, unknown data. This is further subdivided into classification tasks and regression tasks: in classification, the labels are discrete categories, while in regression, the labels are continuous quantities. We will see examples of both types of supervised learning in the following section.

Unsupervised learning involves modeling the features of a dataset without reference to any label, and is often described as "letting the dataset speak for itself." These models include tasks such as clustering and dimensionality reduction. Clustering algorithms identify distinct groups of data, while dimensionality reduction algorithms search for more succinct representations of the data. We will see examples of both types of unsupervised learning in the following section.

## **Need for Machine Learning**

Human beings, at this moment, are the most intelligent and advanced species on earth because they can think, evaluate and solve complex problems. On the other side, AI is still in its initial stage and haven’t surpassed human intelligence in many aspects. Then the question is that what is the need to make machine learn? The most suitable reason for doing this is, “to make decisions, based on data, with efficiency and scale”.

Lately, organizations are investing heavily in newer technologies like Artificial Intelligence, Machine Learning and Deep Learning to get the key information from data to perform several real-world tasks and solve problems. We can call it data-driven decisions taken by machines, particularly to automate the process. These data-driven decisions can be used, instead of using programing logic, in the problems that cannot be programmed inherently. The fact is that we can’t do without human intelligence, but other aspect is that we all need to solve real-world problems with efficiency at a huge scale. That is why the need for machine learning arises.

## Challenges in Machines Learning :-

While Machine Learning is rapidly evolving, making significant strides with cybersecurity and autonomous cars, this segment of AI as whole still has a long way to go. The reason behind is that ML has not been able to overcome number of challenges. The challenges that ML is facing currently are −

**Quality of data** − Having good-quality data for ML algorithms is one of the biggest challenges. Use of low-quality data leads to the problems related to data preprocessing and feature extraction.

**Time-Consuming task** − Another challenge faced by ML models is the consumption of time especially for data acquisition, feature extraction and retrieval.

**Lack of specialist persons** − As ML technology is still in its infancy stage, availability of expert resources is a tough job.

**No clear objective for formulating business problems** − Having no clear objective and well-defined goal for business problems is another key challenge for ML because this technology is not that mature yet.

**Issue of overfitting & underfitting** − If the model is overfitting or underfitting, it cannot be represented well for the problem.

**Curse of dimensionality** − Another challenge ML model faces is too many features of data points. This can be a real hindrance.

**Difficulty in deployment** − Complexity of the ML model makes it quite difficult to be deployed in real life.

## **Applications of Machines Learning :-**

Machine Learning is the most rapidly growing technology and according to researchers we are in the golden year of AI and ML. It is used to solve many real-world complex problems which cannot be solved with traditional approach. Following are some real-world applications of ML −

* Emotion analysis
* Sentiment analysis
* Error detection and prevention
* Weather forecasting and prediction
* Stock market analysis and forecasting
* Speech synthesis
* Speech recognition
* Customer segmentation
* Object recognition
* Fraud detection
* Fraud prevention
* Recommendation of products to customer in online shopping

# How to Start Learning Machine Learning?

Arthur Samuel coined the term **“Machine Learning”** in 1959 and defined it as a **“Field of study that gives computers the capability to learn without being explicitly programmed”.**

And that was the beginning of Machine Learning! In modern times, Machine Learning is one of the most popular (if not the most!) career choices. According to [Indeed](http://blog.indeed.com/2019/03/14/best-jobs-2019/), Machine Learning Engineer Is The Best Job of 2019 with a 344% growth and an average base salary of **$146,085** per year.

But there is still a lot of doubt about what exactly is Machine Learning and how to start learning it? So this article deals with the Basics of Machine Learning and also the path you can follow to eventually become a full-fledged Machine Learning Engineer. Now let’s get started!!!

### **How to start learning ML?**

### This is a rough roadmap you can follow on your way to becoming an insanely talented Machine Learning Engineer. Of course, you can always modify the steps according to your needs to reach your desired end-goal!

### Step 1 – Understand the Prerequisites:

### In case you are a genius, you could start ML directly but normally, there are some prerequisites that you need to know which include Linear Algebra, Multivariate Calculus, Statistics, and Python. And if you don’t know these, never fear! You don’t need a Ph.D. degree in these topics to get started but you do need a basic understanding.

#### (a) Learn Linear Algebra and Multivariate Calculus

Both Linear Algebra and Multivariate Calculus are important in Machine Learning. However, the extent to which you need them depends on your role as a data scientist. If you are more focused on application heavy machine learning, then you will not be that heavily focused on maths as there are many common libraries available. But if you want to focus on R&D in Machine Learning, then mastery of Linear Algebra and Multivariate Calculus is very important as you will have to implement many ML algorithms from scratch.

#### (b) Learn Statistics

Data plays a huge role in Machine Learning. In fact, around 80% of your time as an ML expert will be spent collecting and cleaning data. And statistics is a field that handles the collection, analysis, and presentation of data. So it is no surprise that you need to learn it!!!  
Some of the key concepts in statistics that are important are Statistical Significance, Probability Distributions, Hypothesis Testing, Regression, etc. Also, Bayesian Thinking is also a very important part of ML which deals with various concepts like Conditional Probability, Priors, and Posteriors, Maximum Likelihood, etc.

#### (c) Learn Python

Some people prefer to skip Linear Algebra, Multivariate Calculus and Statistics and learn them as they go along with trial and error. But the one thing that you absolutely cannot skip is [Python](https://www.geeksforgeeks.org/python-programming-language/)! While there are other languages you can use for Machine Learning like R, Scala, etc. Python is currently the most popular language for ML. In fact, there are many Python libraries that are specifically useful for Artificial Intelligence and Machine Learning such as [Keras](https://keras.io/" \t "_blank), [TensorFlow](https://www.tensorflow.org/), [Scikit-learn](https://scikit-learn.org/stable/), etc.

So if you want to learn ML, it’s best if you learn Python! You can do that using various online resources and courses such as [**Fork Python**](https://practice.geeksforgeeks.org/courses/fork-python) available Free on GeeksforGeeks.

### **Step 2 – Learn Various ML Concepts**

Now that you are done with the prerequisites, you can move on to actually learning ML (Which is the fun part!!!) It’s best to start with the basics and then move on to the more complicated stuff. Some of the basic concepts in ML are:

#### (a) Terminologies of Machine Learning

* **Model –**A model is a specific representation learned from data by applying some machine learning algorithm. A model is also called a hypothesis.
* **Feature –**A feature is an individual measurable property of the data. A set of numeric features can be conveniently described by a feature vector. Feature vectors are fed as input to the model. For example, in order to predict a fruit, there may be features like color, smell, taste, etc.
* **Target (Label) –**A target variable or label is the value to be predicted by our model. For the fruit example discussed in the feature section, the label with each set of input would be the name of the fruit like apple, orange, banana, etc.
* **Training –**The idea is to give a set of inputs(features) and it’s expected outputs(labels), so after training, we will have a model (hypothesis) that will then map new data to one of the categories trained on.
* **Prediction –**Once our model is ready, it can be fed a set of inputs to which it will provide a predicted output(label).

#### (b) Types of Machine Learning

* **Supervised Learning –**This involves learning from a training dataset with labeled data using classification and regression models. This learning process continues until the required level of performance is achieved.
* **Unsupervised Learning –**This involves using unlabelled data and then finding the underlying structure in the data in order to learn more and more about the data itself using factor and cluster analysis models.
* **Semi-supervised Learning –**This involves using unlabelled data like Unsupervised Learning with a small amount of labeled data. Using labeled data vastly increases the learning accuracy and is also more cost-effective than Supervised Learning.
* **Reinforcement Learning –**This involves learning optimal actions through trial and error. So the next action is decided by learning behaviors that are based on the current state and that will maximize the reward in the future.

### **Advantages of Machine learning :-**

#### **1. Easily identifies trends and patterns -**

Machine Learning can review large volumes of data and discover specific trends and patterns that would not be apparent to humans. For instance, for an e-commerce website like Amazon, it serves to understand the browsing behaviors and purchase histories of its users to help cater to the right products, deals, and reminders relevant to them. It uses the results to reveal relevant advertisements to them.

#### **2. No human intervention needed (automation)**

With ML, you don’t need to babysit your project every step of the way. Since it means giving machines the ability to learn, it lets them make predictions and also improve the algorithms on their own. A common example of this is anti-virus softwares; they learn to filter new threats as they are recognized. ML is also good at recognizing spam.

#### **3. Continuous Improvement**

As [**ML algorithms**](https://data-flair.training/blogs/machine-learning-algorithms/) gain experience, they keep improving in accuracy and efficiency. This lets them make better decisions. Say you need to make a weather forecast model. As the amount of data you have keeps growing, your algorithms learn to make more accurate predictions faster.

#### **4. Handling multi-dimensional and multi-variety data**

Machine Learning algorithms are good at handling data that are multi-dimensional and multi-variety, and they can do this in dynamic or uncertain environments.

#### **5. Wide Applications**

You could be an e-tailer or a healthcare provider and make ML work for you. Where it does apply, it holds the capability to help deliver a much more personal experience to customers while also targeting the right customers.

### **Disadvantages of Machine Learning :-**

#### **1. Data Acquisition**

Machine Learning requires massive data sets to train on, and these should be inclusive/unbiased, and of good quality. There can also be times where they must wait for new data to be generated.

**2. Time and Resources**

ML needs enough time to let the algorithms learn and develop enough to fulfill their purpose with a considerable amount of accuracy and relevancy. It also needs massive resources to function. This can mean additional requirements of computer power for you.

#### **3. Interpretation of Results**

Another major challenge is the ability to accurately interpret results generated by the algorithms. You must also carefully choose the algorithms for your purpose.

#### **4. High error-susceptibility**

[**Machine Learning**](https://en.wikipedia.org/wiki/Machine_learning) is autonomous but highly susceptible to errors. Suppose you train an algorithm with data sets small enough to not be inclusive. You end up with biased predictions coming from a biased training set. This leads to irrelevant advertisements being displayed to customers. In the case of ML, such blunders can set off a chain of errors that can go undetected for long periods of time. And when they do get noticed, it takes quite some time to recognize the source of the issue, and even longer to correct it.

**Python Development Steps : -**

Guido Van Rossum published the first version of Python code (version 0.9.0) at alt.sources in February 1991. This release included already exception handling, functions, and the core data types of list, dict, str and others. It was also object oriented and had a module system.  
Python version 1.0 was released in January 1994. The major new features included in this release were the functional programming tools lambda, map, filter and reduce, which Guido Van Rossum never liked.Six and a half years later in October 2000, Python 2.0 was introduced. This release included list comprehensions, a full garbage collector and it was supporting unicode.Python flourished for another 8 years in the versions 2.x before the next major release as Python 3.0 (also known as "Python 3000" and "Py3K") was released. Python 3 is not backwards compatible with Python 2.x. The emphasis in Python 3 had been on the removal of duplicate programming constructs and modules, thus fulfilling or coming close to fulfilling the 13th law of the Zen of Python: "There should be one -- and preferably only one -- obvious way to do it."Some changes in Python 7.3:

* Print is now a function
* Views and iterators instead of lists
* The rules for ordering comparisons have been simplified. E.g. a heterogeneous list cannot be sorted, because all the elements of a list must be comparable to each other.
* There is only one integer type left, i.e. int. long is int as well.
* The division of two integers returns a float instead of an integer. "//" can be used to have the "old" behaviour.
* Text Vs. Data Instead Of Unicode Vs. 8-bit

**Purpose :-**

We demonstrated that our approach enables successful segmentation of intra-retinal layers—even with low-quality images containing speckle noise, low contrast, and different intensity ranges throughout—with the assistance of the ANIS feature.

**Python**

Python is an interpreted high-level programming language for general-purpose programming. Created by Guido van Rossum and first released in 1991, Python has a design philosophy that emphasizes code readability, notably using significant whitespace.

Python features a dynamic type system and automatic memory management. It supports multiple programming paradigms, including object-oriented, imperative, functional and procedural, and has a large and comprehensive standard library.

* Python is Interpreted − Python is processed at runtime by the interpreter. You do not need to compile your program before executing it. This is similar to PERL and PHP.
* Python is Interactive − you can actually sit at a Python prompt and interact with the interpreter directly to write your programs.

Python also acknowledges that speed of development is important. Readable and terse code is part of this, and so is access to powerful constructs that avoid tedious repetition of code. Maintainability also ties into this may be an all but useless metric, but it does say something about how much code you have to scan, read and/or understand to troubleshoot problems or tweak behaviors. This speed of development, the ease with which a programmer of other languages can pick up basic Python skills and the huge standard library is key to another area where Python excels. All its tools have been quick to implement, saved a lot of time, and several of them have later been patched and updated by people with no Python background - without breaking.

**Modules Used in Project :-**

**Tensorflow**

TensorFlow is a [free](https://en.wikipedia.org/wiki/Free_software) and [open-source](https://en.wikipedia.org/wiki/Open-source_software) [software library for dataflow and differentiable programming](https://en.wikipedia.org/wiki/Library_(computing)) across a range of tasks. It is a symbolic math library, and is also used for [machine learning](https://en.wikipedia.org/wiki/Machine_learning) applications such as [neural networks](https://en.wikipedia.org/wiki/Neural_networks). It is used for both research and production at [Google](https://en.wikipedia.org/wiki/Google).‍

TensorFlow was developed by the [Google Brain](https://en.wikipedia.org/wiki/Google_Brain) team for internal Google use. It was released under the [Apache 2.0](https://en.wikipedia.org/wiki/Apache_License) [open-source license](https://en.wikipedia.org/wiki/Open-source_license) on November 9, 2015.

**Numpy**

Numpy is a general-purpose array-processing package. It provides a high-performance multidimensional array object, and tools for working with these arrays.

It is the fundamental package for scientific computing with Python. It contains various features including these important ones:

* A powerful N-dimensional array object
* Sophisticated (broadcasting) functions
* Tools for integrating C/C++ and Fortran code
* Useful linear algebra, Fourier transform, and random number capabilities

Besides its obvious scientific uses, Numpy can also be used as an efficient multi-dimensional container of generic data. Arbitrary data-types can be defined using Numpy which allows Numpy to seamlessly and speedily integrate with a wide variety of databases.

**Pandas**

Pandas is an open-source Python Library providing high-performance data manipulation and analysis tool using its powerful data structures. Python was majorly used for data munging and preparation. It had very little contribution towards data analysis. Pandas solved this problem. Using Pandas, we can accomplish five typical steps in the processing and analysis of data, regardless of the origin of data load, prepare, manipulate, model, and analyze. Python with Pandas is used in a wide range of fields including academic and commercial domains including finance, economics, Statistics, analytics, etc.

**Matplotlib**

Matplotlib is a Python 2D plotting library which produces publication quality figures in a variety of hardcopy formats and interactive environments across platforms. Matplotlib can be used in Python scripts, the Python and [IPython](http://ipython.org/) shells, the [Jupyter](http://jupyter.org/) Notebook, web application servers, and four graphical user interface toolkits. Matplotlib tries to make easy things easy and hard things possible. You can generate plots, histograms, power spectra, bar charts, error charts, scatter plots, etc., with just a few lines of code. For examples, see the [sample plots](https://matplotlib.org/tutorials/introductory/sample_plots.html) and [thumbnail gallery](https://matplotlib.org/gallery/index.html).

For simple plotting the pyplot module provides a MATLAB-like interface, particularly when combined with IPython. For the power user, you have full control of line styles, font properties, axes properties, etc, via an object oriented interface or via a set of functions familiar to MATLAB users.

**Scikit – learn**

Scikit-learn provides a range of supervised and unsupervised learning algorithms via a consistent interface in Python. It is licensed under a permissive simplified BSD license and is distributed under many Linux distributions, encouraging academic and commercial use. **Python**

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**Install Python Step-by-Step in Windows and Mac :**

Python a versatile programming language doesn’t come pre-installed on your computer devices. Python was first released in the year 1991 and until today it is a very popular high-level programming language. Its style philosophy emphasizes code readability with its notable use of great whitespace.

The object-oriented approach and language construct provided by Python enables programmers to write both clear and logical code for projects. This software does not come pre-packaged with Windows.

## How to Install Python on Windows and Mac :

There have been several updates in the Python version over the years. The question is how to install Python? It might be confusing for the beginner who is willing to start learning Python but this tutorial will solve your query. The latest or the newest version of Python is version 3.7.4 or in other words, it is Python 3.

**Note:** The python version 3.7.4 cannot be used on Windows XP or earlier devices.

Before you start with the installation process of Python. First, you need to know about your **System Requirements**. Based on your system type i.e. operating system and based processor, you must download the python version. My system type is a **Windows 64-bit operating system**. So the steps below are to install python version 3.7.4 on Windows 7 device or to install Python 3. [Download the Python Cheatsheet here.](https://myelearninghub.com/python-cheat-sheet/)The steps on how to install Python on Windows 10, 8 and 7 are **divided into 4 parts** to help understand better.

### Download the Correct version into the system

**Step 1:** Go to the official site to download and install python using Google Chrome or any other web browser. OR Click on the following link: [**https://www.python.org**](https://www.python.org/)



Fig:5(a)

Now, check for the latest and the correct version for your operating system.

**Step 2:** Click on the Download Tab.

****

Fig:5(b)

**Step 3:** You can either select the Download Python for windows 3.7.4 button in Yellow Color or you can scroll further down and click on download with respective to their version. Here, we are downloading the most recent python version for windows 3.7.4

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Fig:5(c)

**Step 4:** Scroll down the page until you find the Files option.

**Step 5:** Here you see a different version of python along with the operating system.



Fig:5(d)

• To download Windows 32-bit python, you can select any one from the three options: Windows x86 embeddable zip file, Windows x86 executable installer or Windows x86 web-based installer.

•To download Windows 64-bit python, you can select any one from the three options: Windows x86-64 embeddable zip file, Windows x86-64 executable installer or Windows x86-64 web-based installer.

Here we will install Windows x86-64 web-based installer. Here your first part regarding which version of python is to be downloaded is completed. Now we move ahead with the second part in installing python i.e. Installation

**Note:** To know the changes or updates that are made in the version you can click on the Release Note Option.

### Installation of Python

**Step 1:** Go to Download and Open the downloaded python version to carry out the installation process.



Fig:5(e)

**Step 2:** Before you click on Install Now, Make sure to put a tick on Add Python 3.7 to PATH.



Fig:5(f)

**Step 3:** Click on Install NOW After the installation is successful. Click on Close.



Fig:5(g)

With these above three steps on python installation, you have successfully and correctly installed Python. Now is the time to verify the installation.

**Note:** The installation process might take a couple of minutes.

### Verify the Python Installation

**Step 1:** Click on Start

**Step 2:** In the Windows Run Command, type “cmd”.



Fig:5(h)

**Step 3:** Open the Command prompt option.

**Step 4:** Let us test whether the python is correctly installed. Type **python –V** and press Enter.



Fig:5(i)

**Step 5:** You will get the answer as 3.7.4

**Note:** If you have any of the earlier versions of Python already installed. You must first uninstall the earlier version and then install the new one.

### Check how the Python IDLE works

**Step 1:** Click on Start

**Step 2:** In the Windows Run command, type “python idle”.



Fig:5(j)

**Step 3:** Click on IDLE (Python 3.7 64-bit) and launch the program

**Step 4:** To go ahead with working in IDLE you must first save the file. **Click on File > Click on Save**



Fig:5(k)

**Step 5:** Name the file and save as type should be Python files. Click on SAVE. Here I have named the files as Hey World.

**Step 6:** Now for e.g. **enter print**

**CHAPTER -7**

**SYSTEM TEST**

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub assemblies, assemblies and/or a finished product It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

### **TYPES OF TESTS**

Unit testing

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

Integration testing

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

Functional test

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.

Functional testing is centered on the following items:

Valid Input : identified classes of valid input must be accepted.

Invalid Input : identified classes of invalid input must be rejected.

Functions : identified functions must be exercised.

Output : identified classes of application outputs must be exercised.

Systems/Procedures : interfacing systems or procedures must be invoked.

Organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

System Test

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

White Box Testing

White Box Testing is a testing in which in which the software tester has knowledge of the inner workings, structure and language of the software, or at least its purpose. It is purpose. It is used to test areas that cannot be reached from a black box level.

Black Box Testing

Black Box Testing is testing the software without any knowledge of the inner workings, structure or language of the module being tested. Black box tests, as most other kinds of tests, must be written from a definitive source document, such as specification or requirements document, such as specification or requirements document. It is a testing in which the software under test is treated, as a black box .you cannot “see” into it. The test provides inputs and responds to outputs without considering how the software works.

**Unit Testing**

Unit testing is usually conducted as part of a combined code and unit test phase of the software lifecycle, although it is not uncommon for coding and unit testing to be conducted as two distinct phases.

**Test strategy and approach**

Field testing will be performed manually and functional tests will be written in detail.

**Test objectives**

* All field entries must work properly.
* Pages must be activated from the identified link.
* The entry screen, messages and responses must not be delayed.

**Features to be tested**

* Verify that the entries are of the correct format
* No duplicate entries should be allowed
* All links should take the user to the correct page.

# Integration Testing

Software integration testing is the incremental integration testing of two or more integrated software components on a single platform to produce failures caused by interface defects.

The task of the integration test is to check that components or software applications, e.g. components in a software system or – one step up – software applications at the company level – interact without error.

**Test Results:** All the test cases mentioned above passed successfully. No defects encountered.

Acceptance Testing

User Acceptance Testing is a critical phase of any project and requires significant participation by the end user. It also ensures that the system meets the functional requirements.

**Test Results:** All the test cases mentioned above passed successfully. No defects encountered.

**CHAPTER -8**

**OUTPUT SCREENS**



In above screen click on ‘Upload Mobile Data’ button to upload chat log file

Fig-7(a)

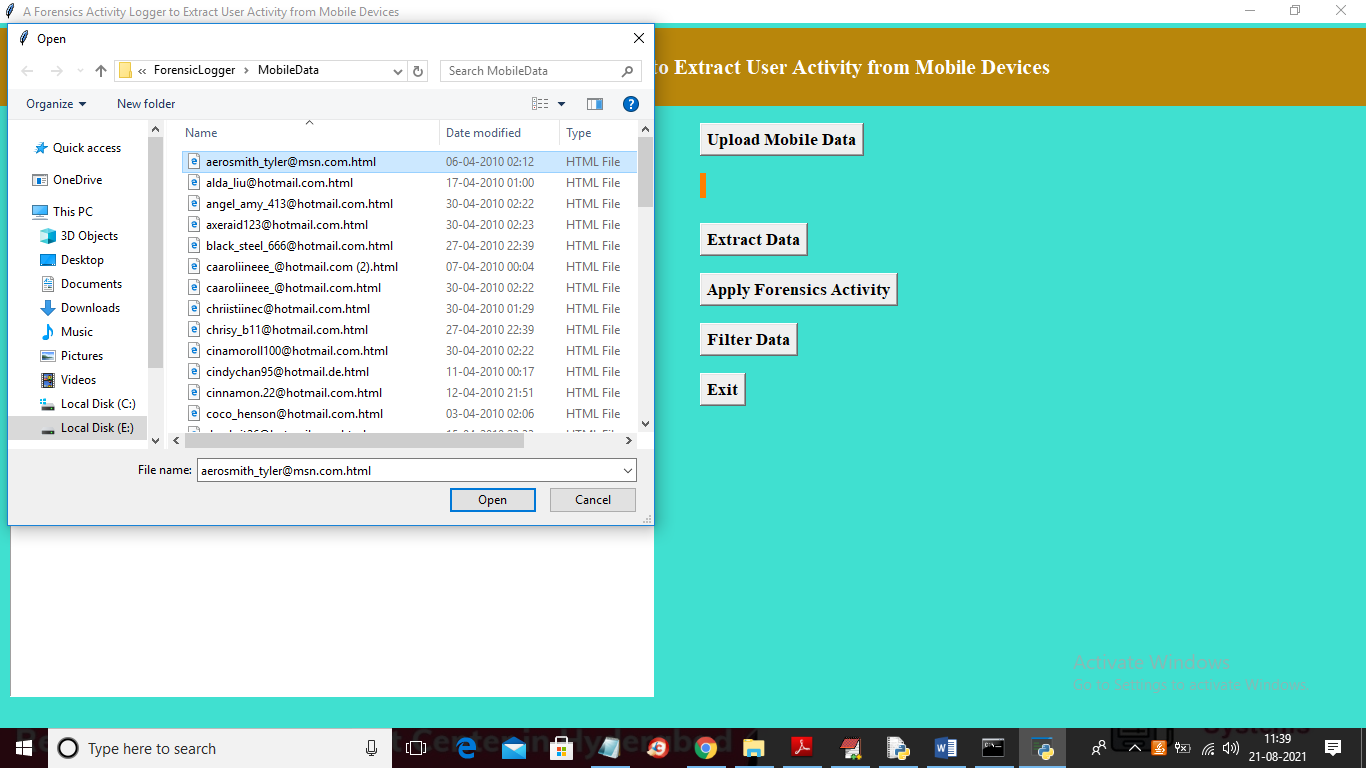


Fig-7(b)

In above screen I am selecting and uploading first chat log file and then click on ‘Open’ button to get below screen



Fig-7(c)

In above screen chat log file is uploaded and now click on ‘Extract Data’ button to extract content from file

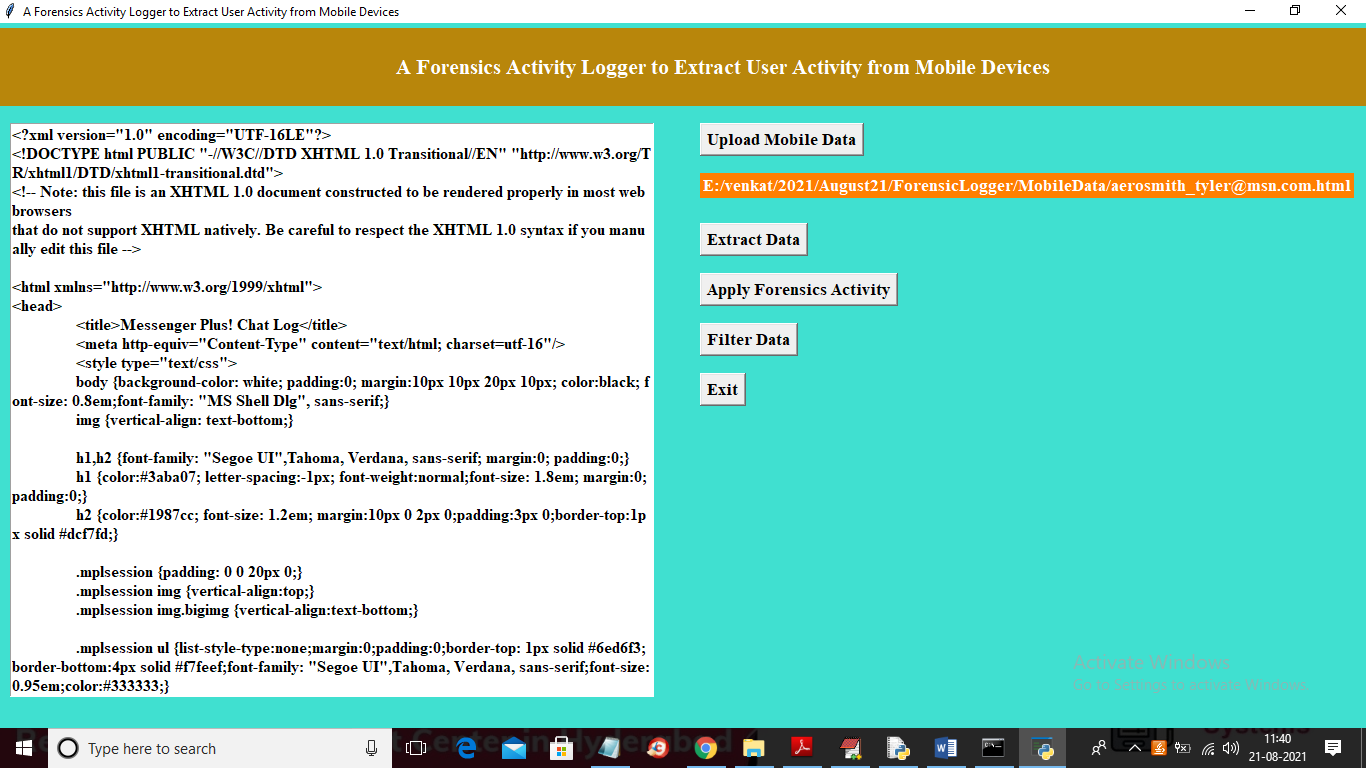


Fig-7(d)

In above screen we can see entire file content is in HTML format and user cannot understand anything from that so click on ‘Apply Forensics Activity’ to extract details from file



Fig-7(e)

In above screen in first line we can see file contains total 113 lines and we can see file created and modified date and file size is 39.272 KB and now we extracted all details and now click on ‘Filter Data’ button to removed out all HTML tags to clean chat message like below screen



Fig-7(f)

In above screen from HTML content we extracted chat messages and user can read above messages clearly. So by applying forensic activity logger we have clean chat messages from HTML tags. Similarly you can upload other file and extract messages. Now see other files

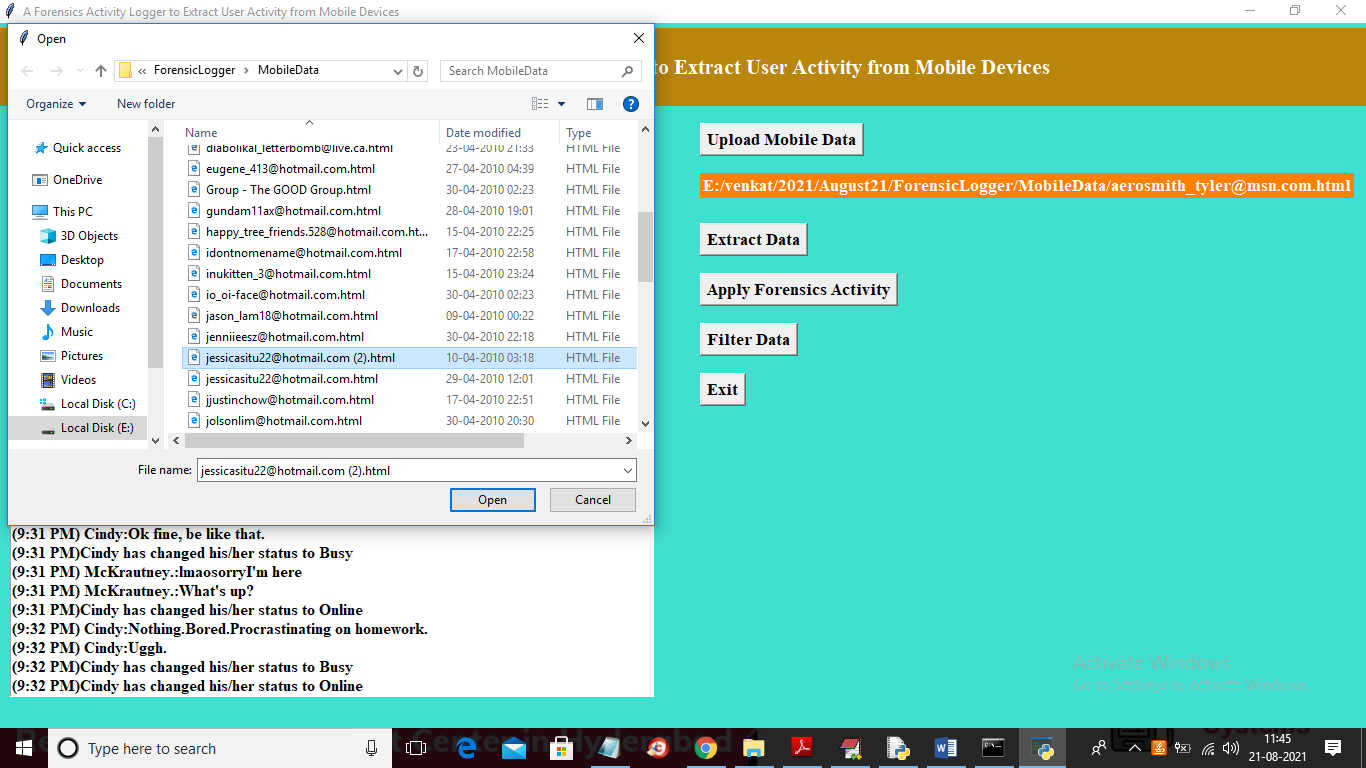


Fig-7(g)

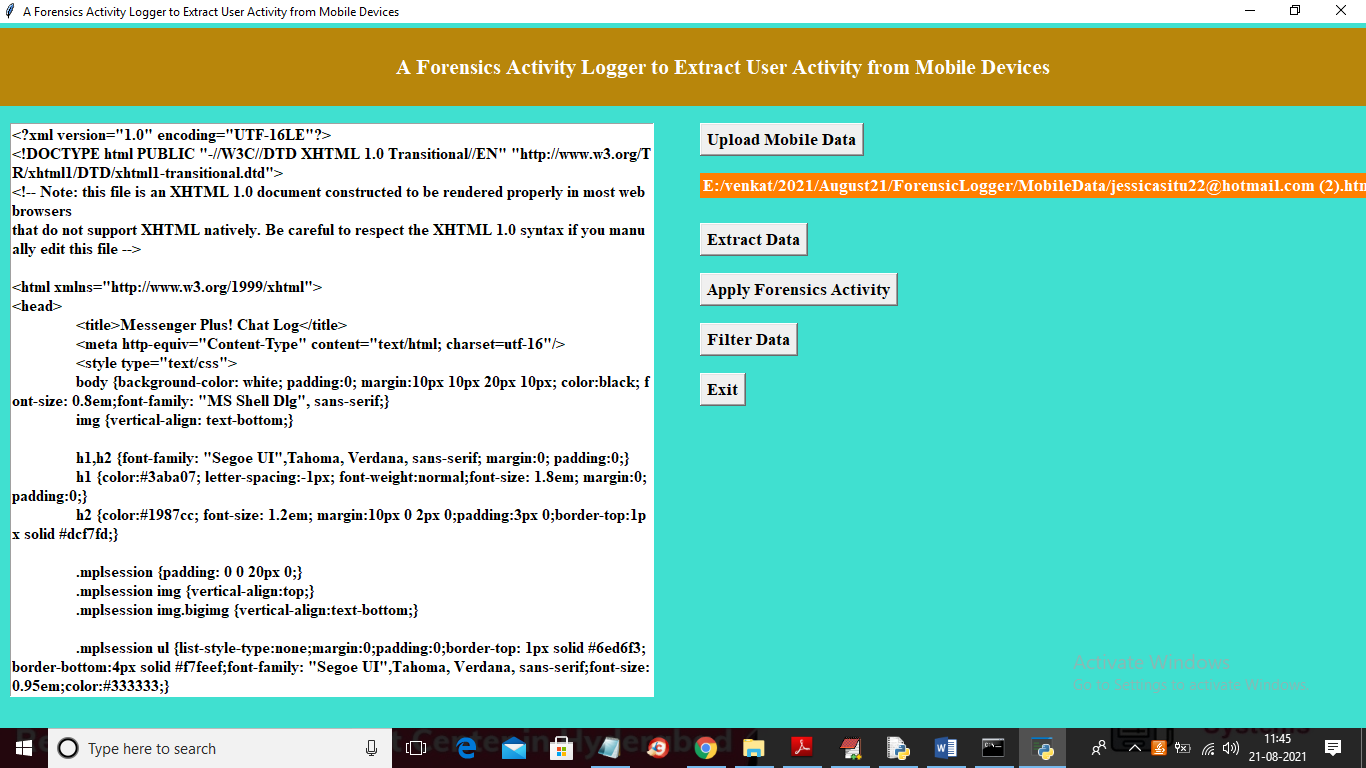


Fig-7(h)



Fig-7(i)

In above screen for new file the size 125 KB with 320 chat messages lines

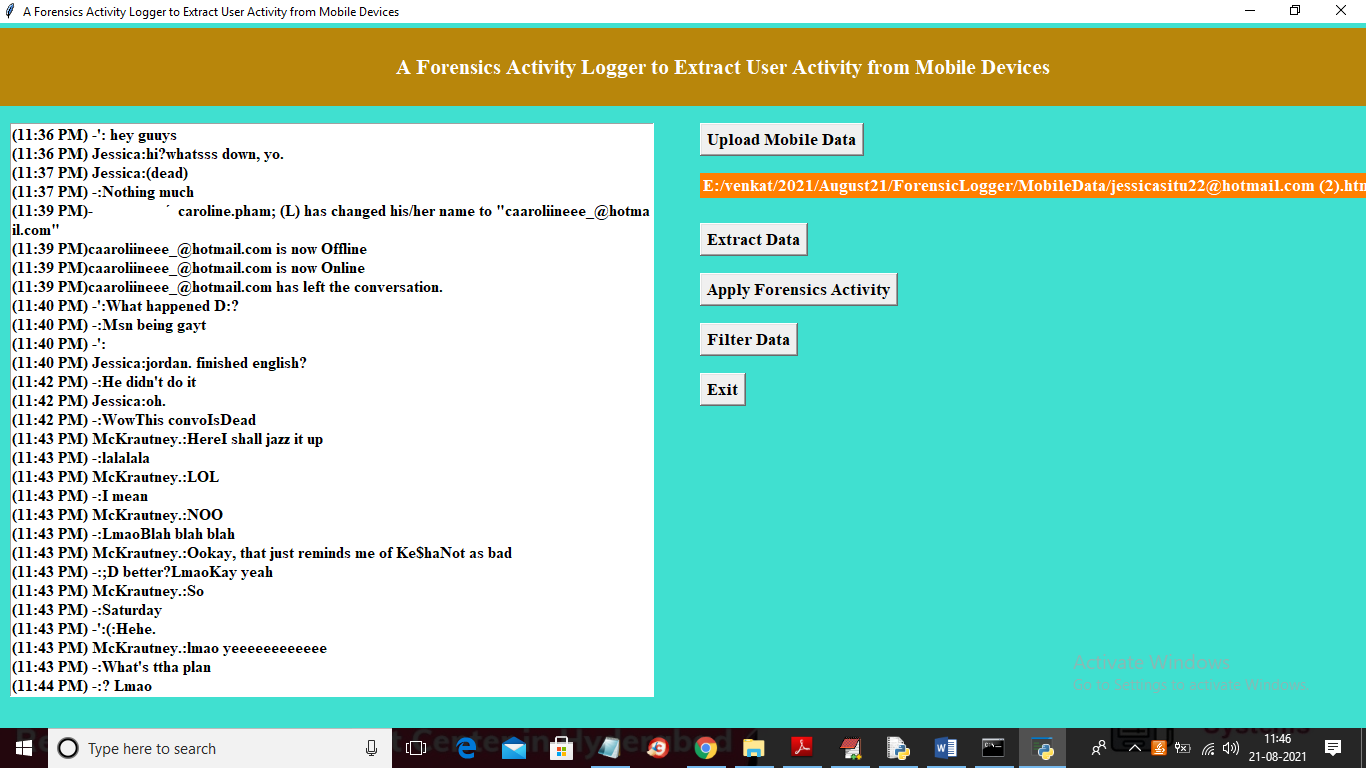


Fig-7(j)

**CHAPTER-9**

**CONCLUSION**

Based on several tests performed with different brands of Android mobile devices; it can be concluded that the activity registration tool is stable and complies with the requested examinations

The tool automates and reduces the time of evidence analysis. Selecting the right tools for the acquisition of evidence that serves as input to the application represents a crucial piece of research; however, none of them possess the ability to acquire all the information of a mobile device. Therefore, it is necessary to use several of them to improve the desired result. Finally, the advantage of using Python programming language, is that it allows to verify the source code and thus, validate that it does not alter the digital evidence

The main advantage found while using this tool is that it reduces the time used on an investigation and saves resources. This because each installed software returns large volumes of information that must be analyzed step by step by the researcher in charge. Thus, this tool avoids the manual use of more than one software to get all the information that is required for the case

The evidence has to be carefully manipulated, because if the information is altered in any way, this will not be valid for the investigation

**FutureWork**

Finally, the presented study, gives a first view on the handling of digital evidence in mobile devices with Android OS, this later can be developed for other operating systems such as iOS and Windows Phone. For further work, it is necessary to increase the interoperability to gather the information from third party solutions and propose connectors and generic ways to extract evidence. Also, it is important to measure and perform future improvements in certain non-functional characteristics of this tool (e.g., efficiency, latency, usabilit

**CHAPTER-10**

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