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# 1. Executive Summary

## 1.1. Introduction

Instagram is a popular social media app with over 2 billion active users worldwide. It allows users to share photos and videos, connect with friends and followers, and explore content from other users. Here I used Android Studio to analyze Instagram APK file with the help of Pixel 6 Pro (API 34) Virtual mobile device. This may include identifying the user account associated with the APK file, recovering details of photos and videos, and examining direct messages.

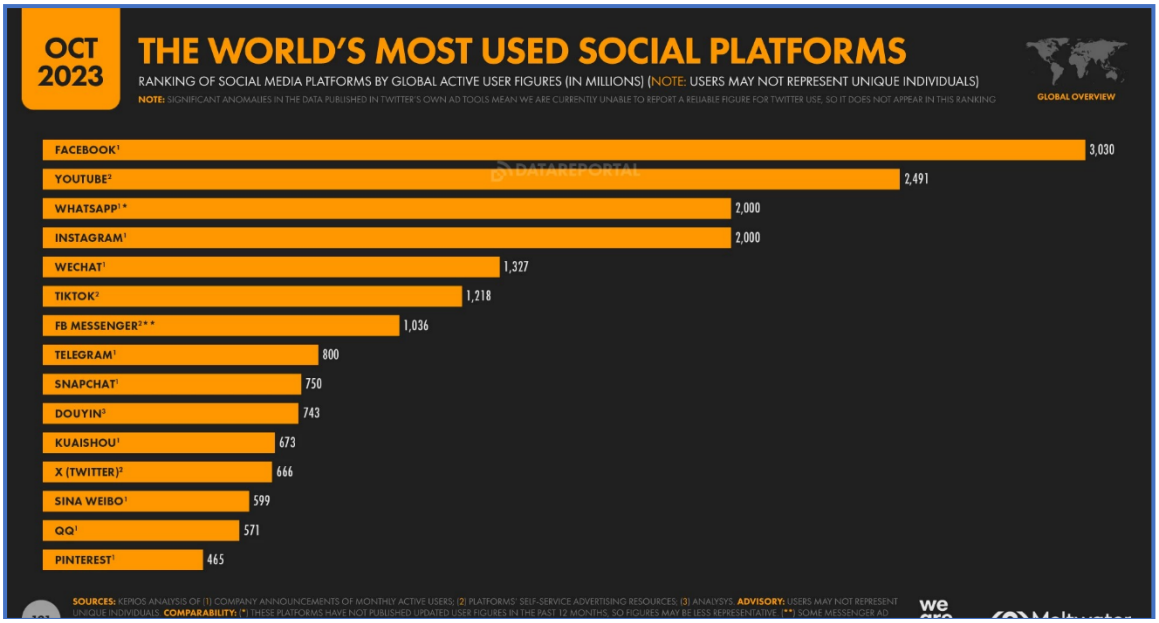



Fig 1: The most popular messaging apps in the world [1]

## 1.2. Objectives

The objective of this forensic investigation of an Instagram APK file is to collect and analyze evidence from Instagram to identify the user account associated with the APK file, gather information's of photos and videos, examine direct messages, and investigate other aspects of Instagram. The evidence collected from the APK file can also be used to support a criminal investigation or to identify and prosecute individuals who are using Instagram for illegal purposes.
Specifically, the objectives of a forensic investigation of an Instagram APK file may include:

- Identifying the user account associated with the APK file.
- Recovering details of photos and videos received & sent.
- Examining direct messages
- Reviewing the app's permissions
- Monitoring the user's geolocation
- Details of Devices logged in.
- Identifying how the app is collecting and using user data.

The specific objectives of a forensic investigation of an Instagram APK file will vary depending on the specific circumstances of the case. However, the overall goal is to collect and analyze evidence from the APK file to identify and prosecute individuals who are using Instagram for illegal purposes.

### 1.3. Key findings

The key findings of this forensic investigation are,

- Username account info
- User Profile picture
- User's friend list
- Logs
- Direct messages
- Login details of devices where the user account is logged in.
- GPS location
- IP Address

## 2. Methodology

ISO and NIST are two biggest organizations that have developed digital forensic frameworks to provide guidelines for the proper investigation and handling of digital evidence. Both frameworks aim to ensure the integrity, authenticity, and usability of digital evidence in legal and investigative proceedings.

**ISO/IEC 27037:2012**

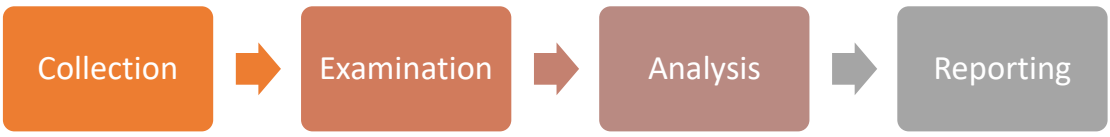
The International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) jointly developed ISO/IEC 27037:2012, titled "Guidelines for Identification, Collection, Acquisition, and Preservation of Digital Evidence." This framework provides a comprehensive set of guidelines for the handling of digital evidence throughout the investigative process, from identification and collection to preservation and analysis.

**NIST SP 800-86**

The National Institute of Standards and Technology (NIST) developed NIST SP 800-86, titled "Guideline on Digital Forensic Investigations," to provide a more detailed and prescriptive set of guidelines for conducting digital forensic investigations. This framework focuses on the technical aspects of digital forensics, including evidence acquisition, analysis, and reporting [2].

### 2.1. NIST Digital Forensics Process

According to the National Institute of Standards and Technology (NIST), Data collection, examination, analysis, and reporting are the four key phases of the digital forensics process. These phases are essential for conducting a thorough and accurate digital forensic investigation [2].




- **Data Collection** – The first phase of the digital forensics process is data collection, involves identifying, preserving, and collecting potential digital

evidence. The goal of data collection is to collect all relevant evidence in a way that minimizes the risk of contamination or alteration. There are several methods for collecting digital evidence, including:
    - Imaging: This involves creating a bit-for-bit copy of a digital storage device.
    - File carving: This involves recovering deleted files from a digital storage device.
    - Live acquisition: This involves capturing data from a live computer system.
- **Data Examination** – The second phase of the digital forensics process is data examination. This involves examining the collected data to identify and extract relevant information. The goal of data examination is to identify all relevant information and to extract it in a way that preserves its integrity. There are several methods for examining digital evidence, including:
    - Hashing: This involves creating a unique fingerprint of a digital file.
    - Carving: This involves searching for specific types of data, such as images or documents.
    - Parsing: This involves breaking down a file into its constituent parts.
- **Data Analysis –** The third phase of the digital forensics process is data analysis. This involves analyzing the extracted information to identify and interpret findings. The goal of data analysis is to draw conclusions about the events that occurred on the digital device. There are several methods for analyzing digital evidence, including:
    - Timeline analysis: This involves creating a timeline of events that occurred on a digital device.
    - Link analysis: This involves identifying relationships between different pieces of data.
    - Content analysis: This involves examining the content of files to identify patterns or anomalies.
- **Data Reporting –** The fourth phase of the digital forensics process is data reporting. This involves documenting the findings of the investigation. The goal of data reporting is to communicate the findings of the investigation in a clear, concise, and legally defensible manner. A data report should include the following information:
    - Scope of the investigation: This should include the purpose of the investigation, the dates of the investigation, and the resources used.
    - Findings: This should include a summary of the findings, including the evidence that was collected, the methods that were used, and the conclusions that were drawn.
    - Recommendations: This should include recommendations for further investigation or mitigation.

## 2.2. Forensic Methodology Applied

I have chosen three papers which are based on NIST Forensic Analysis methodology, which is similar to my analysis in the case of tools, data extraction & analysis process. Below are the three papers:

| Paper title | Authors | Description | Link |
|---|---|---|---|
| Forensic analysis of Instagram and path on | Reema Al Mushcab & Pavel Gladyshev | In this paper, they hope to sort some challenges of social network apps by performing a forensic analysis on Instagram and Path in a iPhone 5s device. | [3] |

| | | | |
|---|---|---|---|
| an iPhone 5s Mobile device | | The process was installing the app, exploring functionalities of app, taking a logical image of mobile and start analysis. The real objective of the analysis was to check any data is stored in the internal memory of the device. Then in the result few data are stored in the device memory and they showed those data's with their location. | |
| Forensic Analysis of Social Networks Based on Instagram | Ming Sang Chang & Chih Ping Yen | In this paper, Instagram was taken as the subject and Windows 10 machine & an Android smartphone from Bluestacks were used as testing devices. They analysed the traces left in different browsers in Windows 10 machine and in the device storage of Android smartphone. An Android VM from Bluestacks, ES File Explorer, CCleaner, Recuva, are the tools used in the analysis. The Forensic analysis was done by using WinHex, DB Browser for SQLite. | [4] |
| Forensic Analysis of Popular Social Media Applications on Android Smartphones | Fatma Güneş Eriş and Erhan Akbal | In this paper, the procedures for Data extraction and Forensic Investigation are explained. Here WhatsApp, Facebook, Messenger, Instagram and Twitter are installed in an android device [Sony Xperia Z2 LTE-A(D6503) 16 Gb Android 10.0)] and accessed normal functionalities of those apps. Then the Forensic Analysis has been done by using Oxygen Forensic, Paraben E3:DS and Magnet Axiom, DB Browser for SQLite & Android SDK. | [5] |

**Table 2.1**

## 2.3. Platform, App and Tools Selection

### 2.3.1. Platform

| S. No | Device | Details | Usage |
|---|---|---|---|
| 1. | Acer Nitro 5 AN515-55 | Intel (R) Core (TM) i7-10750H CPU @ 2.60GHz 2.59 GHz<br>8GB RAM<br>Windows 11 22H2 | Workstation |
| 2. | Android Studio Giraffe \| 2022.3.1 Patch 2 | Build #AI-223.8836.35.2231.10811636, built on September 14, 2023<br>Runtime version: 17.0.6+0-b2043.56-10027231 amd64<br>VM: OpenJDK 64-Bit Server VM by JetBrains s.r.o. | Android Emulator |

| | | | |
|---|---|---|---|
| 3. | Pixel 6 Pro | Disk Space used – 10 GB.<br>API Level - 34<br>Resolution – 1440 x 3120<br>(Can be Rooted) | Virtual Android Mobile Device |

**Table 2.2**
Refer Appendix for screenshot.

### 2.3.2. Mobile Application

| S. No | Application | Details | Usage |
|---|---|---|---|
| 1. | Instagram | 307.0.0.34.111- 370711653<br>minAPI28(x86_64) (nodpi) | Application used for Analysis |

**Table 2.3**
Refer Appendix for screenshot.

### 2.3.3. Sandbox Environment

| S. No | Device | Details | Usage |
|---|---|---|---|
| 1. | Oracle Virtual Box | VirtualBox Graphical User Interface Version 7.0.12 r159484 (Qt5.15.2) | Virtualization provider |
| 2. | Windows 11 | WinDev2310Eval VM in Oracle Virtual Box | Used as a Sandbox Environment. |

**Table 2.4**
Refer Appendix for screenshot.

### 2.3.4. Forensic Tools

| S. No | Application | Details | Usage |
|---|---|---|---|
| 1. | Autopsy | **Product Version:** Autopsy 4.21.0 (RELEASE)<br>**Sleuth Kit Version:** 4.12.1<br>**Netbeans RCP Build:** 15-387759c96ce1b891ec45ffaf524a53499455fe1a<br>**Java:** 17.0.8; Java HotSpot (TM) 64-Bit Server VM 17.0.8+9-LTS-211<br>**System:** Windows 11 version 10.0 running on amd64; Cp1252; en_US (autopsy)<br>**User Dir:** C:\Users\yog26\AppData\Roaming\autopsy | Automated tool for Digital Forensic Analysis |
| 2. | DB Browser for SQLite | Version 3.12.2<br>Built for x86_64-little_endian-llp64, running on x86_64.<br>Qt Version 5.12.8<br>SQLite Version 3.35.5. | Database File Viewer |

**Table 2.5**
Refer Appendix for screenshot.

# 3. App Investigation, Analysis and Findings

## 3.1. Acquisition

The first phase of the digital forensics process is data collection or acquisition, involves identifying, preserving, and collecting potential digital evidence. The goal of data collection is to collect all relevant evidence in a way that minimizes the risk of contamination or alteration.

Initially Oracle Virtual Box has been installed in the workstation and Windows 11 VM in the Virtual Box. Then the Android Studio was installed in the Sandbox Windows 11 VM with all needed dependencies. Then a Virtual device has been created with the latest Android version which is suitable for the Instagram Application. Then created an account and logged in, accessing all functionalities in the application, like messaging, saving reels, posting story and posts, etc. Once the application is accessed completely, there is a functionality in Instagram, where we can get a copy of our account's complete activity. Then a request was sent and got my complete activity in my account. Then I downloaded the activity as .html in my virtual device. Finally, the virtual device has been rooted by using SDK tool. The command to root the virtual device in the terminal of Android Studio was, "**C:\Users\yog26\AppData\Local\Android\Sdk\platform-tools>. /adb root**". Once the device is rooted, the data in the mobile device is pulled to the Sandbox Windows 11 VM using the command, **"./adb pull -a <remote folder> <destination folder>".** Now the pulled data from the android device can be used for analysis. This is the process of logical data acquisition. The next process is the Analysis phase.

## 3.2. Analysis

The second phase of the digital forensics process is data examination. This involves examining the collected data to identify and extract relevant information. The goal of data examination is to identify all relevant information and to extract it in a way that preserves its integrity [6].

### 3.2.1. DB Browser for SQLite

DB Browser for SQLite is a free and open-source database management tool designed to handle SQLite databases. It is available for Windows, macOS, and Linux operating systems. The tool provides a user-friendly graphical interface for managing SQLite databases, including creating, modifying, and deleting tables and data, executing SQL queries, and exporting data to various formats [7].

### 3.2.2. Autopsy

Autopsy is an open-source digital forensics platform and graphical interface (GUI) to The Sleuth Kit® and other digital forensics tools. It is used by law enforcement, military, and corporate examiners to investigate what happened on a computer. You can even use it to recover photos from your camera's memory card [8].

### 3.2.3. App Permissions

The App Permissions of Instagram in the virtual device can be seen in the below screenshot.

| Permissions | Access |
|---|---|
| Calendar | Allowed |
| Camera | Allowed |
| Contacts | Allowed |
| Location | Allowed |
| Microphone | Allowed |
| Nearby Devices | Allowed |
| Notifications | Allowed |
| Phone | Allowed |
| Photos and Videos | Allowed |

**Table 3.1**
Refer Appendix for screenshot.

The Pulled data from the Virtual device are analyzed by using DB Browser for SQLite and Autopsy. DB Browser for SQLite was used to view the databases extracted from the Virtual device. Autopsy is an automated forensic tool, where a case must be created and the base files like ISO image or logical files must be supplied to get the results. Here the extracted data was supplied into the Autopsy for analysis. Once it is done, the results can be seen as a tree structure on the left side of the Autopsy tool screen. Then we must check each and every file in the tree structure result, where we can get much crispy evidence. Here we got much evidence like friends list, direct messages, etc., The Autopsy report and those evidence are listed as screenshots in the Appendix.

### 3.2.4. Key Instagram Artifacts

Few of the data artifacts are listed below,

| **Location** | **Artifacts recovered** |
|---|---|
| data/com.instagram.android/databases /ig_msys_database_17843299797097473 | Information of the logged-in devices of this Instagram account |
| data/com.instagram.android/app_analytics/micro_batch/ com.instagram.android/null/19669/472067/batch-77228-d322dea8-7bfd-432d-973f-30d63de39b47-5.json | Account Logs |
| data/com.instagram.android/databases/ranked_user_62931729472 | Friends List |
| instagram-yog.anand.26-2023-11-08-DtZknv2a.zip/media | Profile photo, Posts, Stories, |
| data/com.instagram.android/databases/direct.db/messages | Direct Messages |

**Table 3.2**
Refer Appendix for screenshot.

# 4. Conclusion

In this study, we conducted a forensic analysis of the Instagram mobile app installed on a virtual Android device in Android Studio. The analysis focused on identifying and extracting artifacts related to user activities, including posted images, comments, likes, and private messages. We also examined the app's data storage mechanisms and the impact of different privacy settings on the retention of user data. The findings of the study revealed that Instagram generates a significant amount of data that can be used to reconstruct user activities. This data includes location information, device identifiers, and timestamps, in addition to the content of user posts, comments, and messages. We also found that the app's data storage mechanisms are designed to minimize the amount of data that is retained on the device, making it more challenging to conduct forensic analysis. The study also demonstrated that different privacy settings can have a significant impact on the retention of user data. For example, users who have enabled the "Location Tracking" setting will have their location data stored on the app's servers, while users who have disabled this setting will not. This data can be useful for investigators who are trying to track the movements of a suspect or to identify potential witnesses. This forensic analysis of the Instagram mobile app in a virtual Android device has revealed that the app is a rich source of digital evidence that can be used to reconstruct user activities. Investigators should be aware of the app's data storage mechanisms and privacy settings when conducting forensic analysis.

# 5. References


[1] Marinela Potor, 'The most popular messaging apps worldwide by country', Sinch engage. Accessed: Nov. 10, 2023. [Online]. Available: https://engage.sinch.com/blog/most-popular-messaging-apps-in-the-world/

[2] K. Kent, S. Chevalier, T. Grance, and H. Dang, 'Special Publication 800-86 Guide to Integrating Forensic Techniques into Incident Response Recommendations of the National Institute of Standards and Technology', *NIST*.

[3] R. Al Mushcab and P. Gladyshev, 'Forensic analysis of instagram and path on an iPhone 5s mobile device', *Proc IEEE Symp Comput Commun*, vol. 2016-February, pp. 146–151, Feb. 2016, doi: 10.1109/ISCC.2015.7405508.

[4] M. S. Chang and C. P. Yen, 'Forensic Analysis of Social Networks Based on Instagram', *International Journal of Network Security*, vol. 21, no. 5, p. 850, 2019, doi: 10.6633/IJNS.201909.

[5] Fatma Güneş, Eriş, and Erhan Akbal, 'Forensic Analysis of Popular Social Media Applications on Android Smartphones', *Dergibark*, 2021, doi: 10.17694/bajece.761271.

[6] Alyssa, 'Mobile Devices Forensics — Forensic Acquisition of an Android Studio Emulator | by Alyssa I. | Medium', Medium. Accessed: Nov. 10, 2023. [Online]. Available: https://medium.com/@ailaria/mobile-devices-forensics-forensic-acquisition-of-an-android-studio-emulator-1c272ee8a5b3

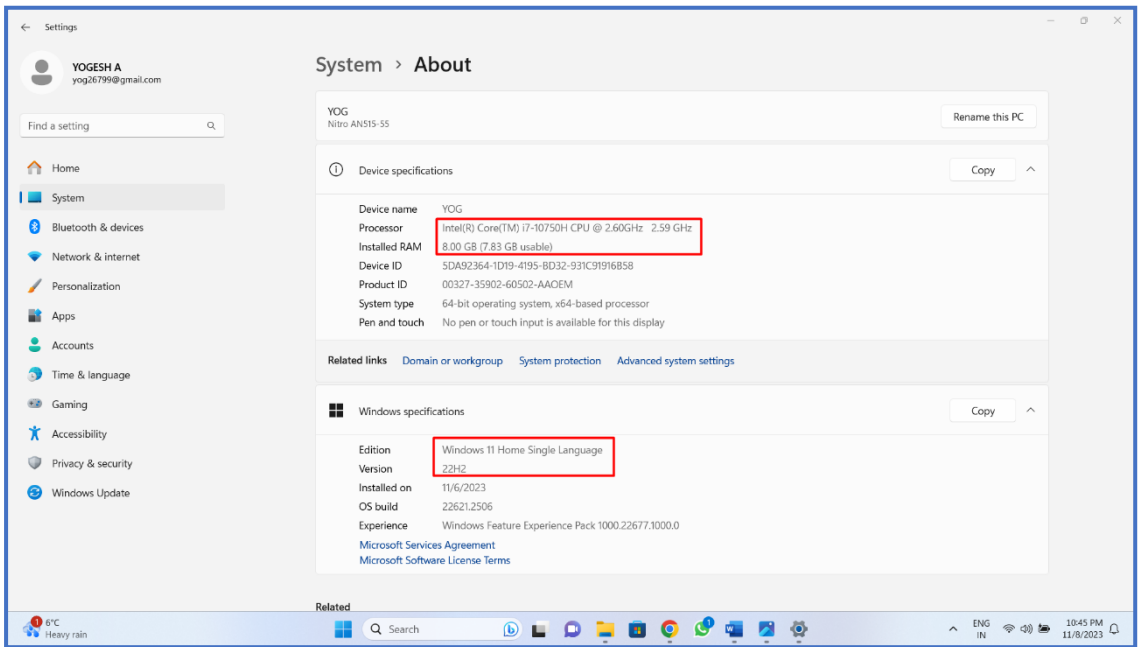
[7] DB Browser, 'DB Browser for SQLite', sqlitebrowser. Accessed: Nov. 10, 2023. [Online]. Available: https://sqlitebrowser.org/

[8] Autopsy, 'Autopsy - Digital Forensics', Autopsy. Accessed: Nov. 10, 2023. [Online]. Available: https://www.autopsy.com/

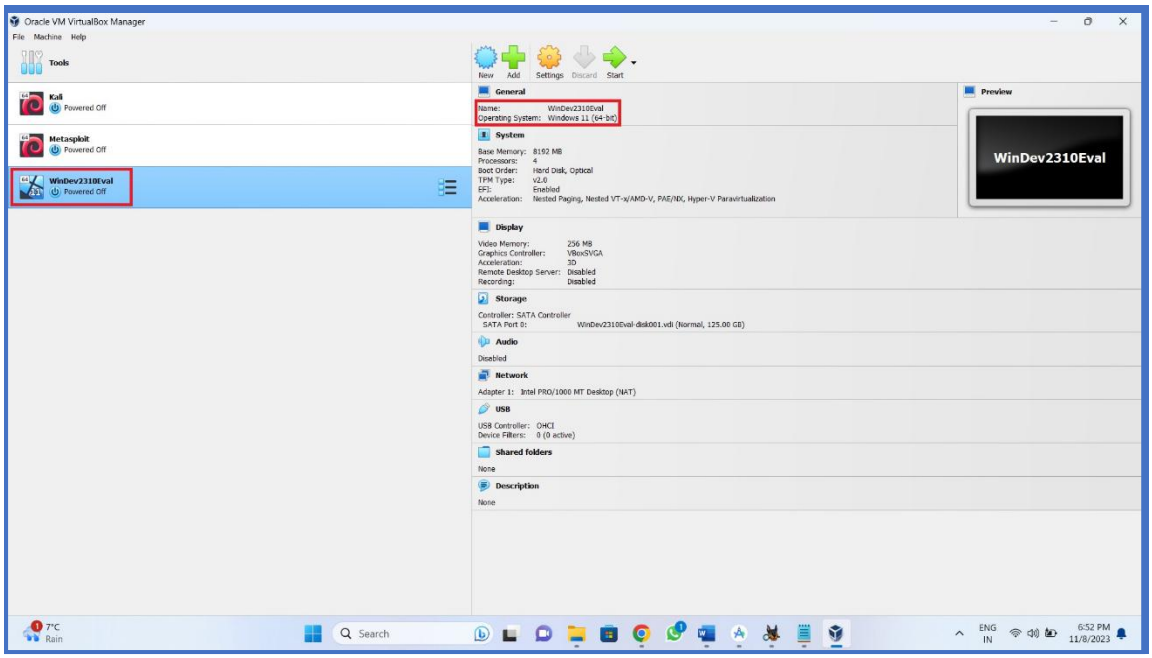
# 6. Appendix

## 6.1. Setup screenshots

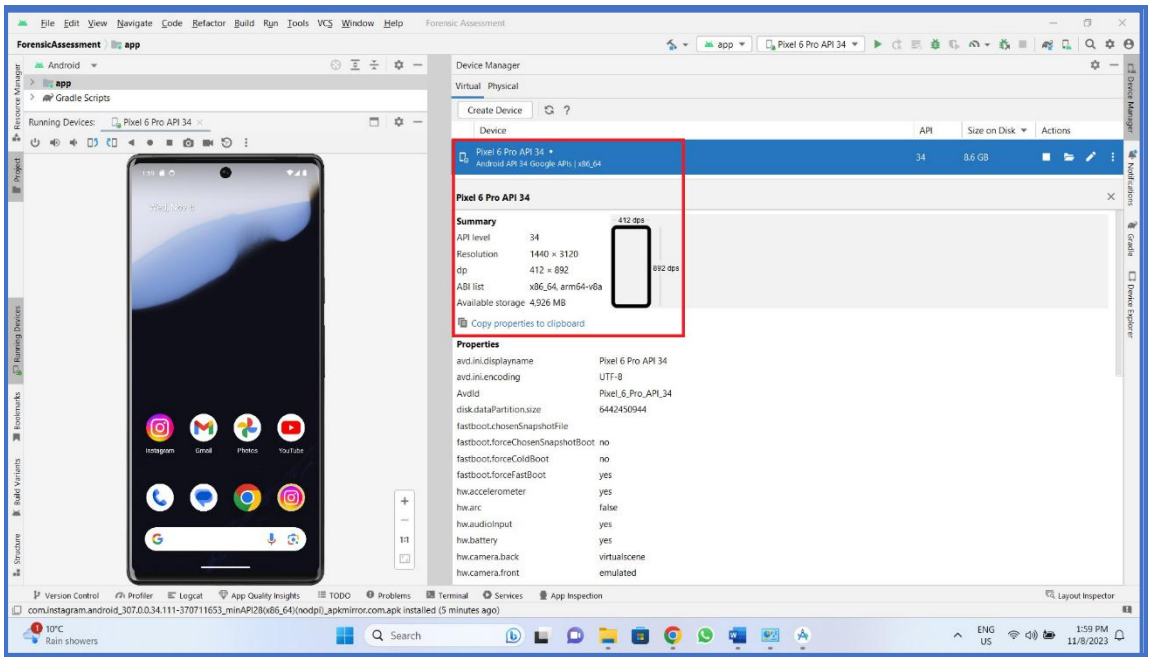
1. Workstation (Acer Nitro 5)




2. Sandbox Environment (Windows 11 VM in Virtual Box)

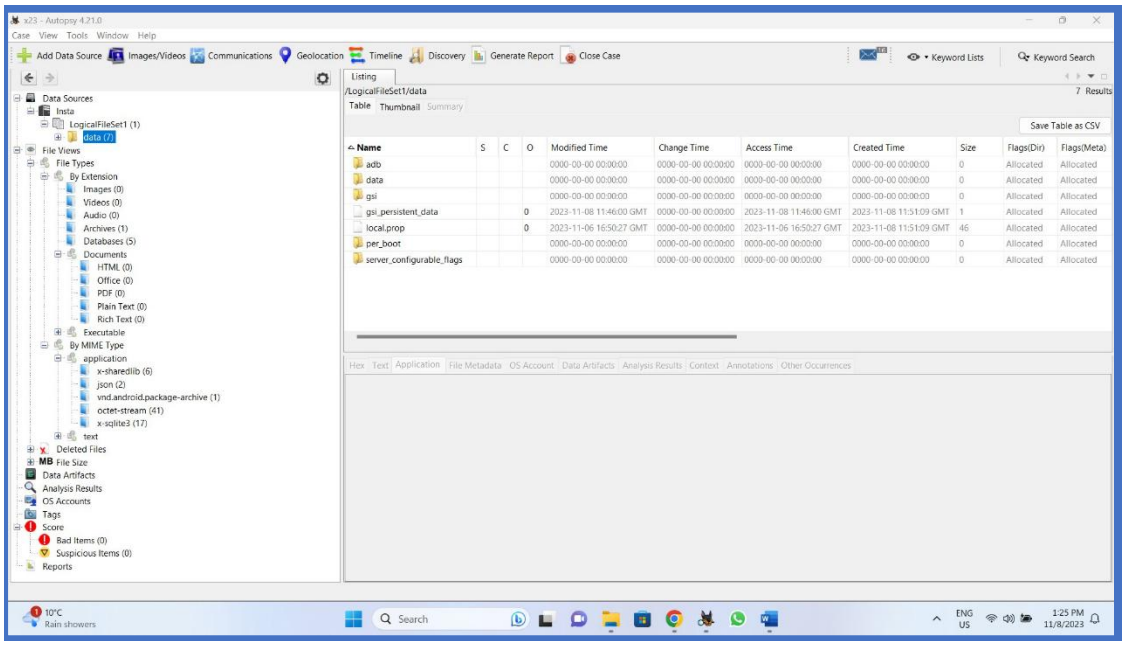


3. Android Studio & Pixel 6 Pro ( Virtual Mobile Device)

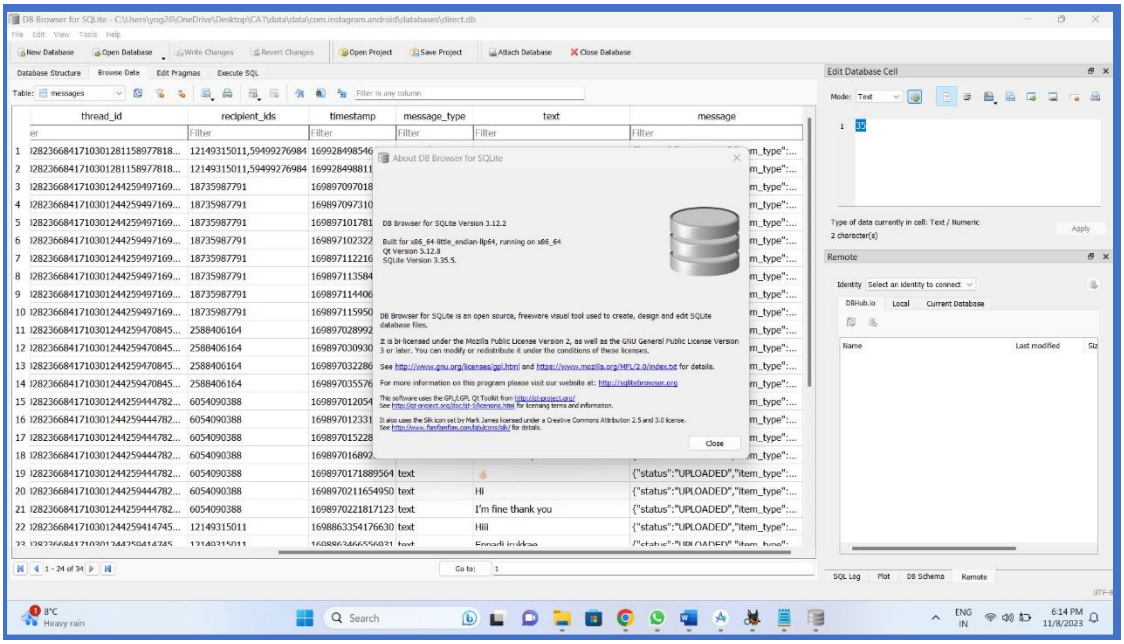


## 6.2. Acquisition screenshots

1. Autopsy

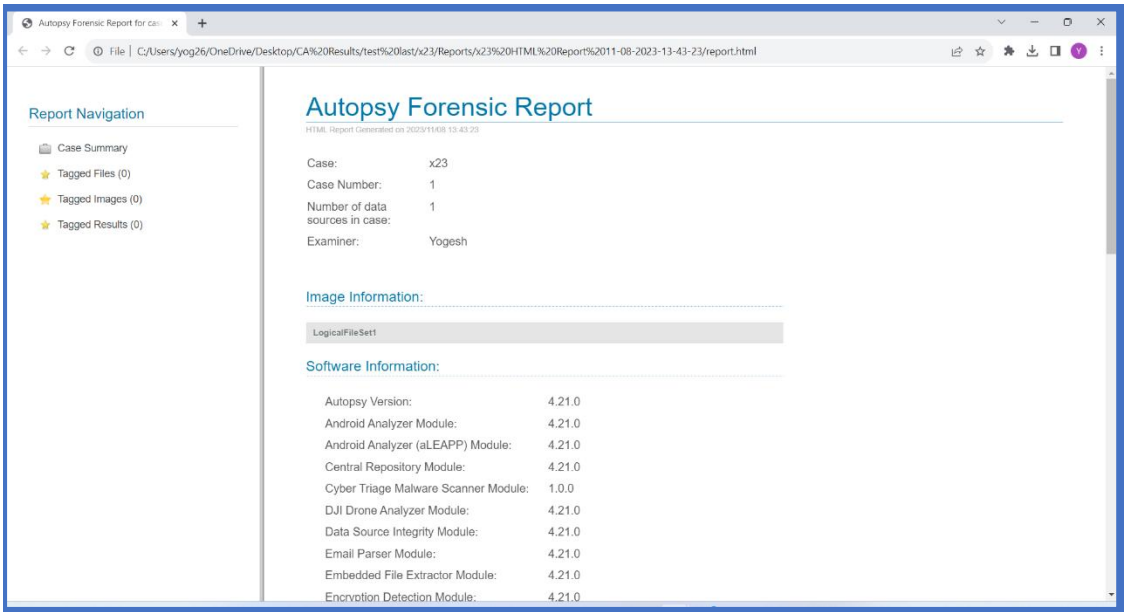


2. DB Browser for SQLite

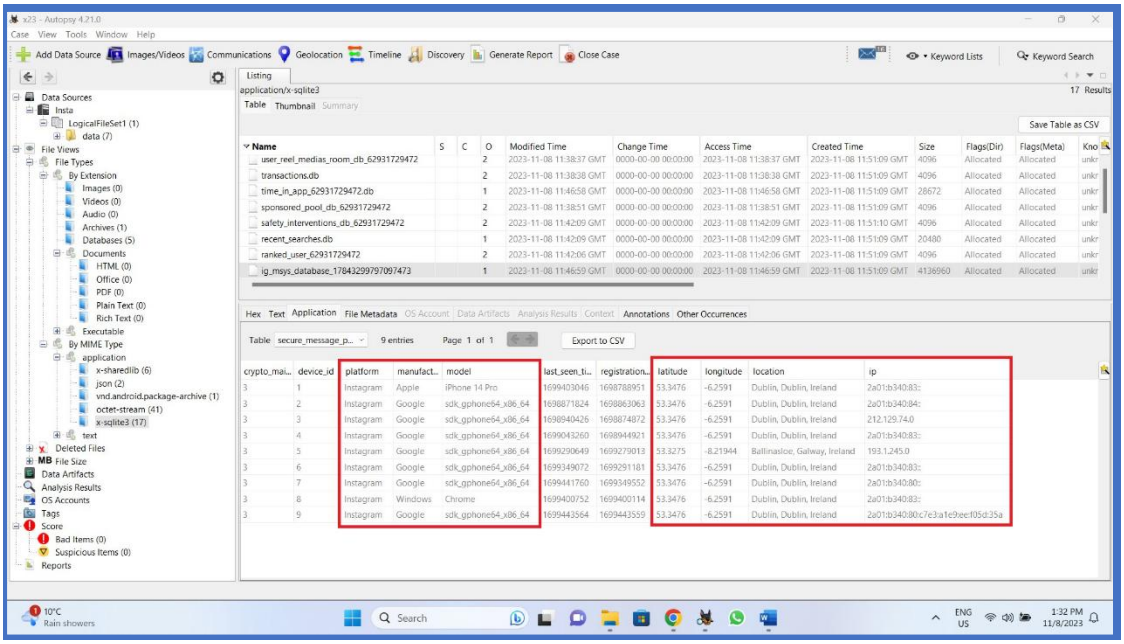



## 6.3. Analysis screenshots

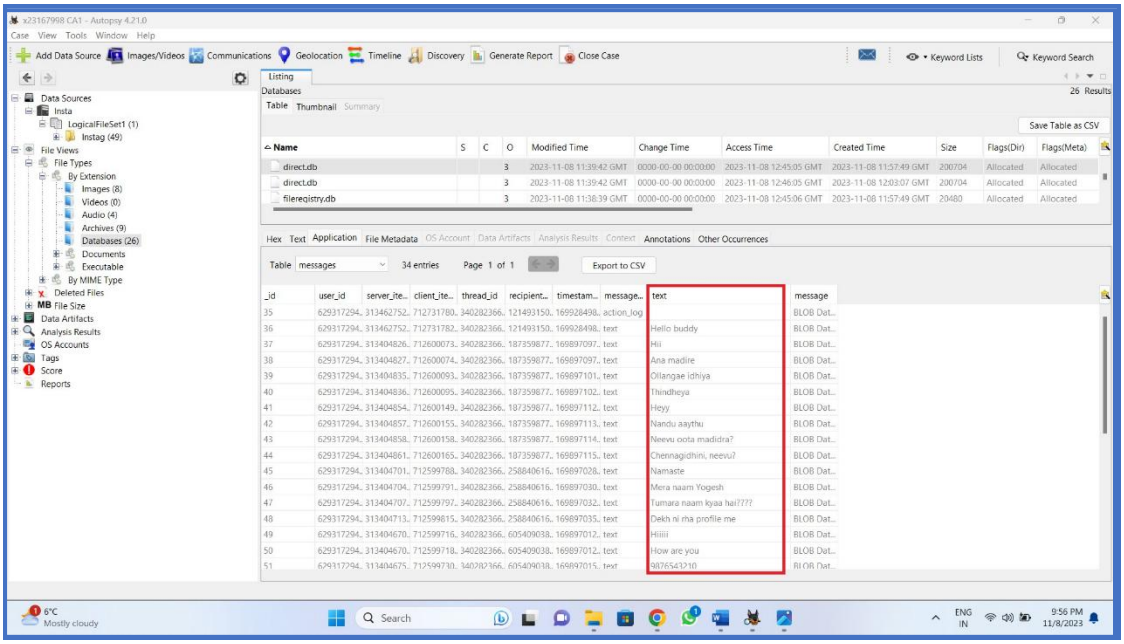
1. Autopsy Final Report



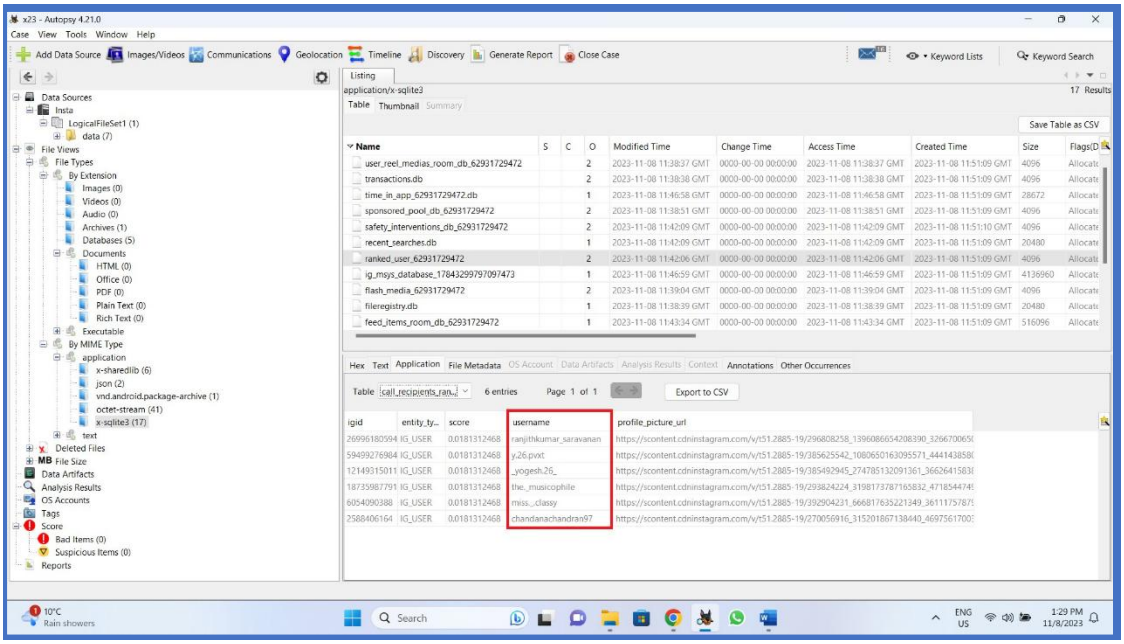
2. Logged in Devices Information



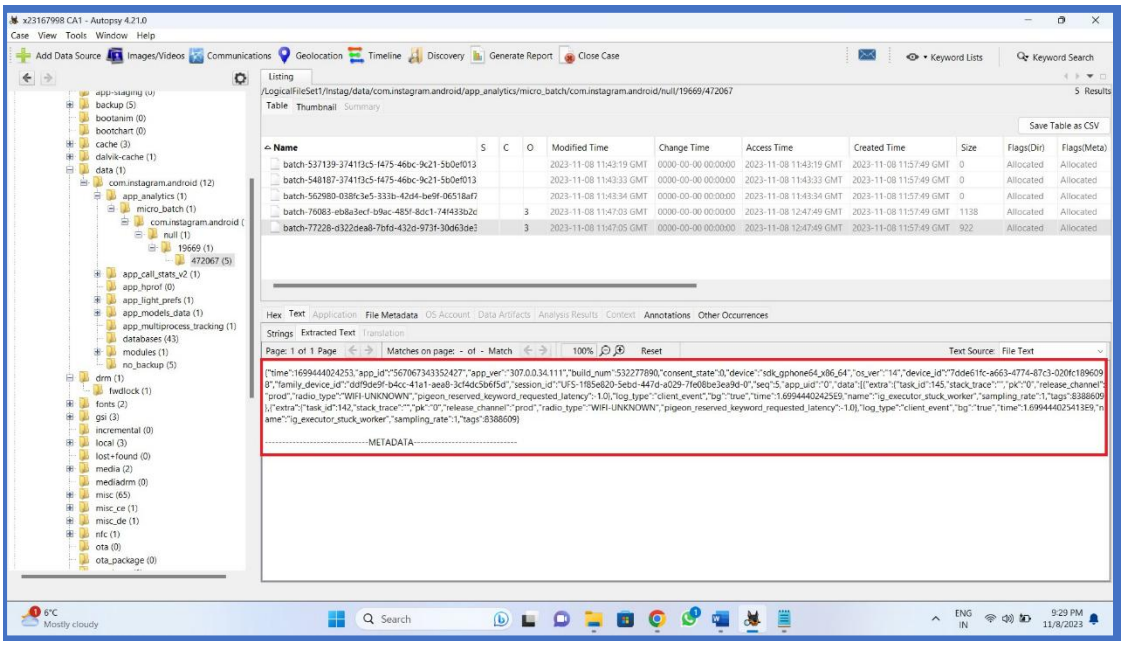
3. Direct Messages



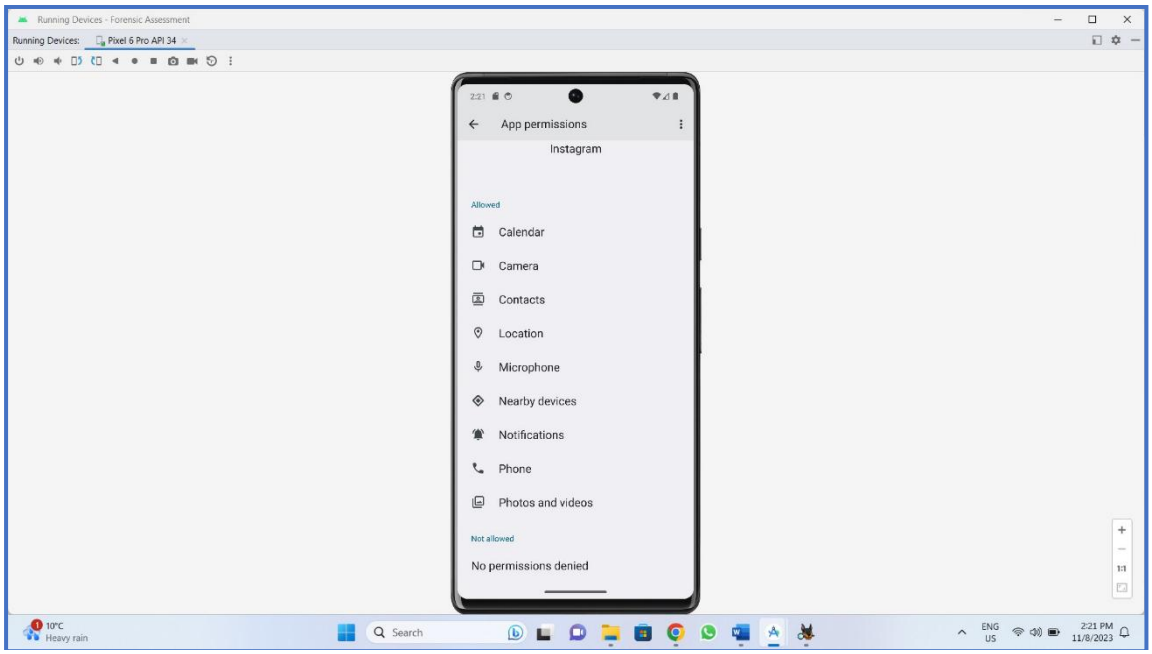
4. Instagram Account Friends list



5. Instagram Account Logs



## 6.4. App permissions




## 6.5. Table of artifacts

Retrieved by Autopsy:

| SHA 256 Hash | Artifacts recovered |
|---|---|
| **11ADD983BFF92F25141F9CEB04228887E934C9B871858E92E3775019AB4DE306** | Information of the logged-in devices of this Instagram account |
| **E3B0C44298FC1C149AFBF4C8996FB92427AE41E4649B934CA495991B7852B855** | Account Logs |
| **F8046FB6523B685349E4CEAA5B63D5653F3D4D9BC0291DD9546056BFABD76205** | Friends List |
| **AA1ABFE43F1E08A416333685ADABCE22CCB70842DE0EEF99935AD847C6046A89** | Profile photo, Posts, Stories,<br>Eg : Post in Instagram page. |
| **D2B81A6846A82A2F5DF69A60DB9CC4DEF70BA14B0F5B5D550E8A8E897FB0E1C3** | Direct Messages |