Mobile Forensics, Big Data and Artificial Intelligence: Current Status, Challenges and Future Directions

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HELLENIC POLICE FORENSIC SCIENCE DIVISION
DIGITAL FORENSICS DEPARTMENT

Hellenic Police Forensic Science Division (F.S.D.) is the National Forensic Service of Greece and provides significant scientific support and assistance to the work of the Police, but also to the work of all Prosecuting Authorities and Law Enforcement Agencies.

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HELLENIC POLICE FORENSIC SCIENCE DIVISION
DIGITAL FORENSICS DEPARTMENT

- Specialized personnel (30 certified Digital Forensic Experts)
- What we do:
  - data recovery
  - decryption
  - examination
  - analysis
  - correlations
  - reporting

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Structure of the Paper

1. Introduction
2. Mobile Investigations and Digital Forensics
3. Issues in Mobile Forensics
4. Mobile Forensics and AI Solutions
5. Conclusions

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INTRODUCTION

The present study aims to explore:

- **the status of Mobile Forensics** in relation with **Big Data and AI**
- **the current challenges** in Mobile Forensics
- **the corresponding applications and solutions** AI provides to the challenges that investigators face
- **the legal issues and technology integration** of AI functions and software
- **the particularly useful AI research topics** that would benefit Mobile Forensics in the long term.

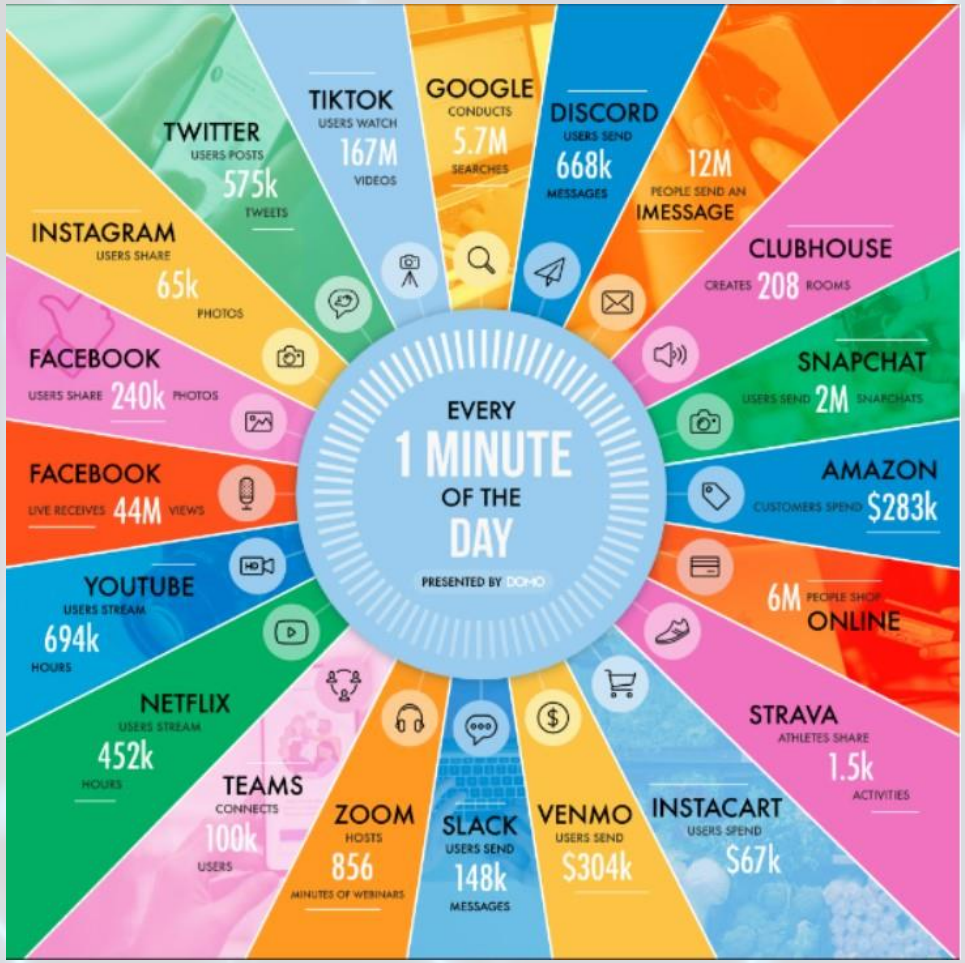
MOBILE INVESTIGATIONS AND DIGITAL FORENSICS

Digital forensics has grown rapidly due in part to the **increase in mobile devices**.

Forensic investigators face **numerous challenges dealing with digital evidence obtained from mobile devices**, which are correlated with:

- **Cloud Computing**
- **Internet of Things**
- **Big Data**

MOBILE INVESTIGATIONS AND DIGITAL FORENSICS



The amount of data generated **in two days** is as much as all data generated **in human history until 2003.**

The **advancements in mobile technology** in combination with the **acceptance and widespread adoption of mobile devices** by the community have led to a significant rise in mobile forensics cases.

The digital forensics market is expected to grow **from $4.62B in 2017 to $9.68B by 2022**, an annual compound growth rate of almost **16%.**

MOBILE INVESTIGATIONS AND DIGITAL FORENSICS

Mobile devices receive data from many sources, such as:

- computers,
- cloud servers,
- social media platforms,
- network components,
- drones,
- smart vehicles,
- wireless cameras
- smart home devices,

while new technologies come into existence and are integrated into this diverse ecosystem with the progression of science and industry.

CLOUD COMPUTING

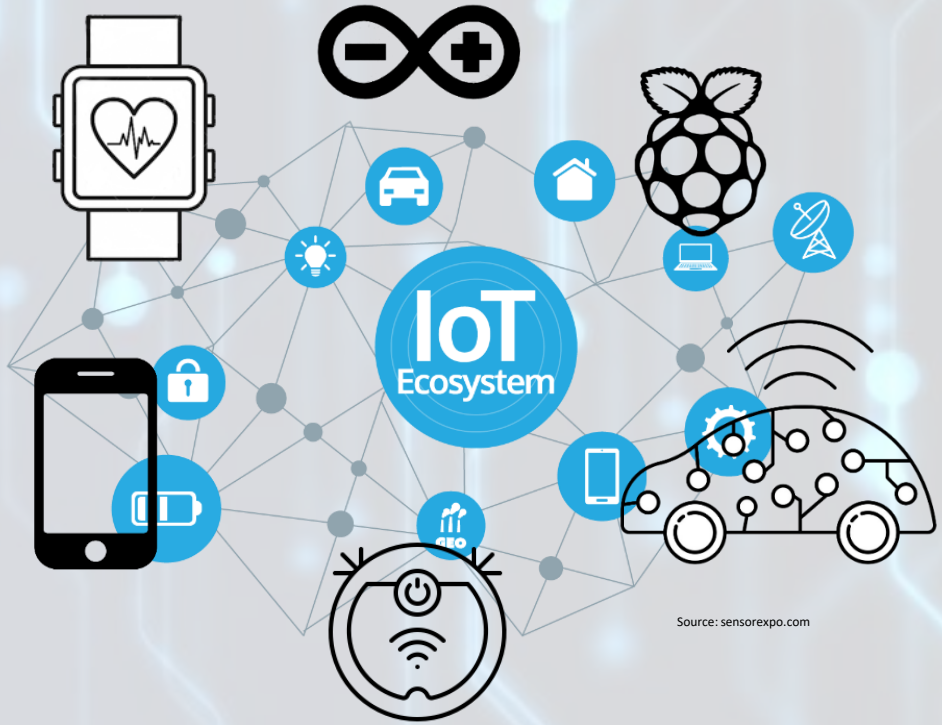
Cloud computing provides **large amounts of data** that can be utilized by examiners **to discover valuable artifacts** for criminal cases.

Cloud Computing Drivers:

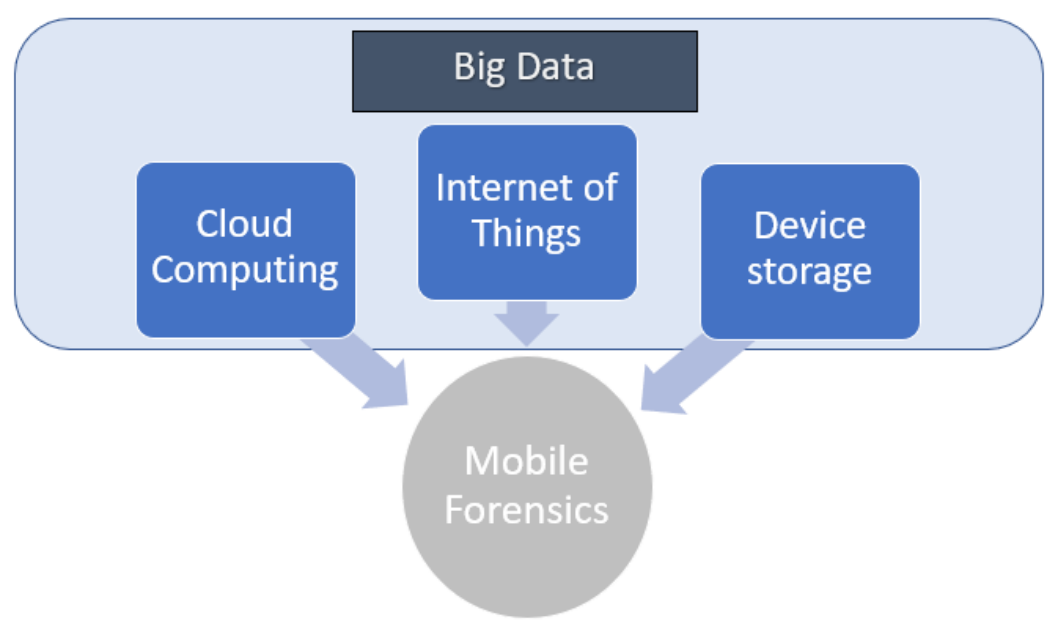
- ever-increasing **need for data storage services**,
- the availability of **high-capacity networks**,
- **low-cost computers and storage devices**,
- the widespread **adoption of hardware virtualization**,
- **service-oriented architecture** and
- **autonomic and utility computing.**

INTERNET OF THINGS

- More and more devices are part of daily **IoT Ecosystem** (e.g. IP cameras, vehicles, electric scooters, smart vacuum cleaners).
  - Gaining particular attention from cybercriminals.
  - May contain information of great forensic value.
  - IoT environment is deeply interconnected with smartphones and the respective applications.
- **Device storage** is being increased, hence the **data** to be examined.



BIG DATA



In a study done by IDC, it is expected that by 2025 we will have more than **175 zettabytes of data**.

Due to the conjunction of Big Data with **Information Technology**, **Cloud computing** and the **IoT ecosystem**, it is a particularly important research subject in the domain of Digital Forensics.

Big datasets come with **algorithmic challenges** that previously did not exist. Hence, there is seen by some to be a need to **fundamentally change the processing ways**.

From the analysis of the current status of Mobile Forensics, we can conclude that it is affiliated with all aspects of Digital Forensics, most notably with Cloud Forensics, IoT and Big Data Forensics.

ISSUES IN MOBILE FORENSICS

A. Volume of data

B. Variety and Variability of data

VOLUME OF DATA

Big Data:

- **high-volume**,
- **high-velocity** and/or
- **high-variety** information

Big Data demands **cost-effective**, **innovative forms of information processing** that enable **enhanced insight, decision making, and process automation (Gartner)**.

In mobile forensics, the meaning and value of the data volume to be examined and analyzed is inherently interconnected to the requirement for **fast, efficient procedures and techniques**, as well as **accurate and concrete results.**

VARIETY AND VARIABILITY OF DATA

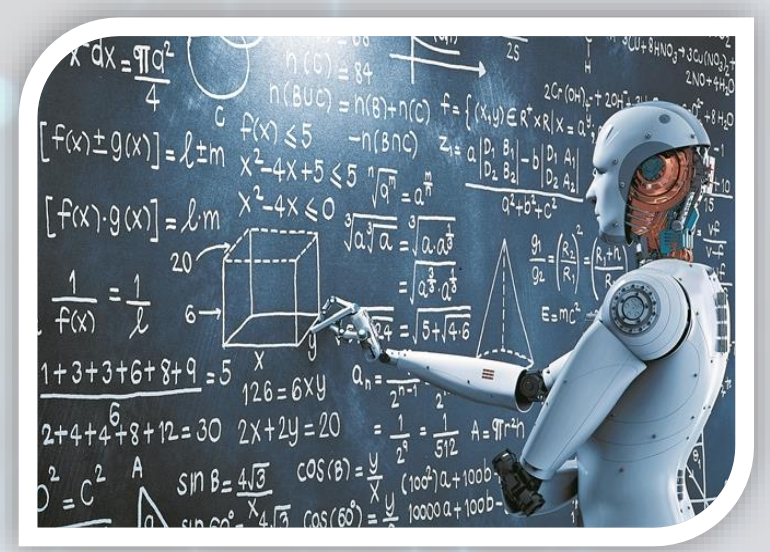
- ***Structured Data (****numbers, dates, groups of words or strings****)***
- ***Unstructured Data (****information that either does not have a pre-defined data model or cannot be structured in an orderly fashion, such as in ordered rows and columns as found in databases****)***

One of the main contributors to the variety and variability of data in mobile forensic investigations is the **IoT ecosystem**.

The most important challenges for Forensic Examiners:

- **data storage**,
- **data format**,
- **the diversity of IoT devices**,
- **support for these devices by current digital evidence software**.

MOBILE FORENSICS AND AI SOLUTIONS

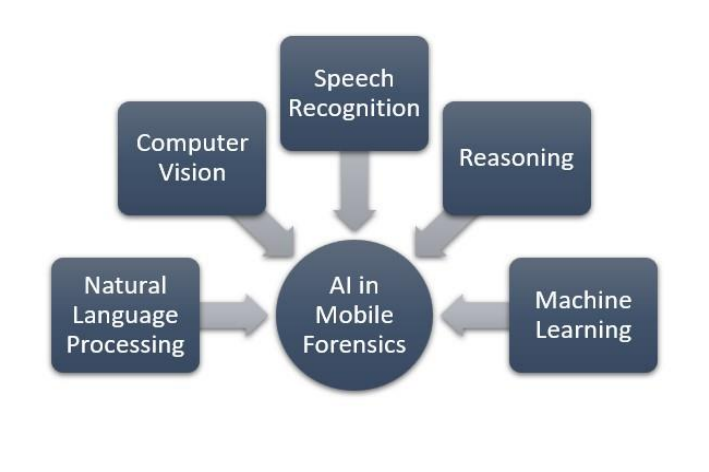


Artificial Intelligence has the potential for **providing the necessary expertise** and **helps in the standardization, management and exchange of a large amount of data, information and knowledge** in the forensic domain.

Results from of AI research:

- **reduction in the volume of evidence** to be examined
- **reduction in execution times** obtained with the distributed processing of the evidence
- implementation of systems that can **reduce human knowledge into a set of standardized rules**

CURRENT TOOLS

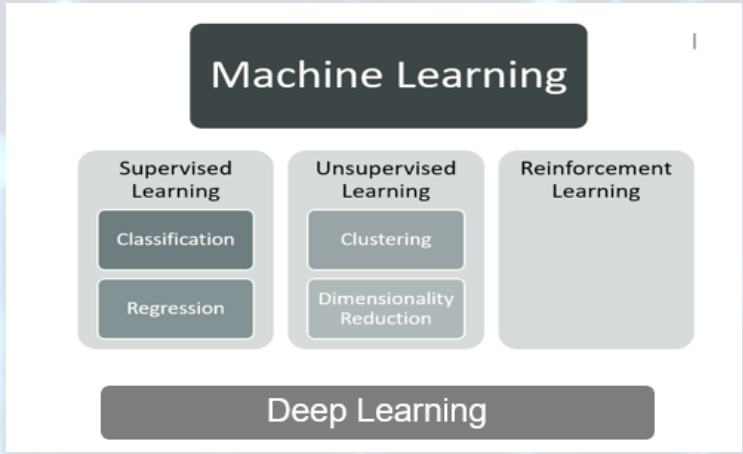


AI Techniques in Mobile Forensics:

- **Case Based Reasoners (CBRs),**
- **Pattern Recognition,**
- **Knowledge Discovery,**
- **System Adaptation,**
- **Refinement of Knowledge and**
- **Machine Learning (Symbolic Learners and Sub Symbolic Learners)**

Machine Learning:

- ✓ **Supervised Learning**
- ✓ **Unsupervised Learning**
- ✓ **Reinforcement Learning**
- ✓ **Deep Learning - Artificial Neural Networks**



CURRENT TOOLS

Important **forensic processes** by current tools:

- **image classification** and
- **video classification**

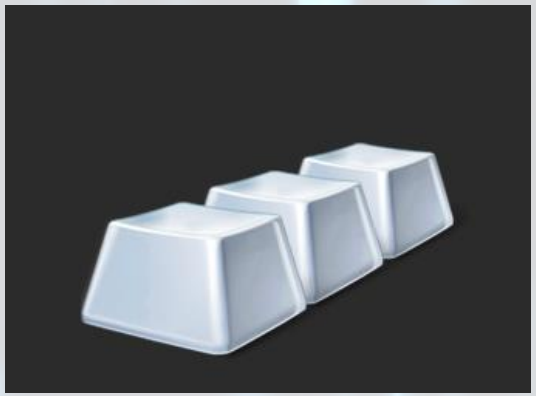
for predetermined categories, such as weapons, documents, nudity, faces and vehicles.

Other **useful AI functions**:

- Speech-To-Text Recognition
- Chat Classification
- Text Document Analysis - Text Clustering

Improvements into the accuracy of image and video classification by forensic tools would be **very beneficial** for the field of Mobile Forensics.

Examples of **image misclassification** into the category "Nudity":



TECHNOLOGY INTEGRATION AND LEGAL ISSUES

Challenges for the complete integration of AI related forensic technologies:

- lack of proper **regulatory framework**
- the general **fear and absence of trust** for the technology
- **shortage of computer systems** capable of supporting AI applications and features
- **complexity** in AI and ML algorithms
- **insufficiency of relevant datasets**, which are necessary for machine learning

TECHNOLOGY INTEGRATION AND LEGAL ISSUES

Legal Issues for the complete integration of AI related forensic technologies:

- **Legal Value of Artifacts**
- **Algorithmic Transparency**
- **Protection of Data Privacy**

Assessment of Evaluation metrics:

- **Accuracy**
- **True Positive Rate (Sensitivity)**
- **True Negative Rate (Specificity)**
- **Precision**
- **Recall**
- **F1-Score**

CONCLUSIONS

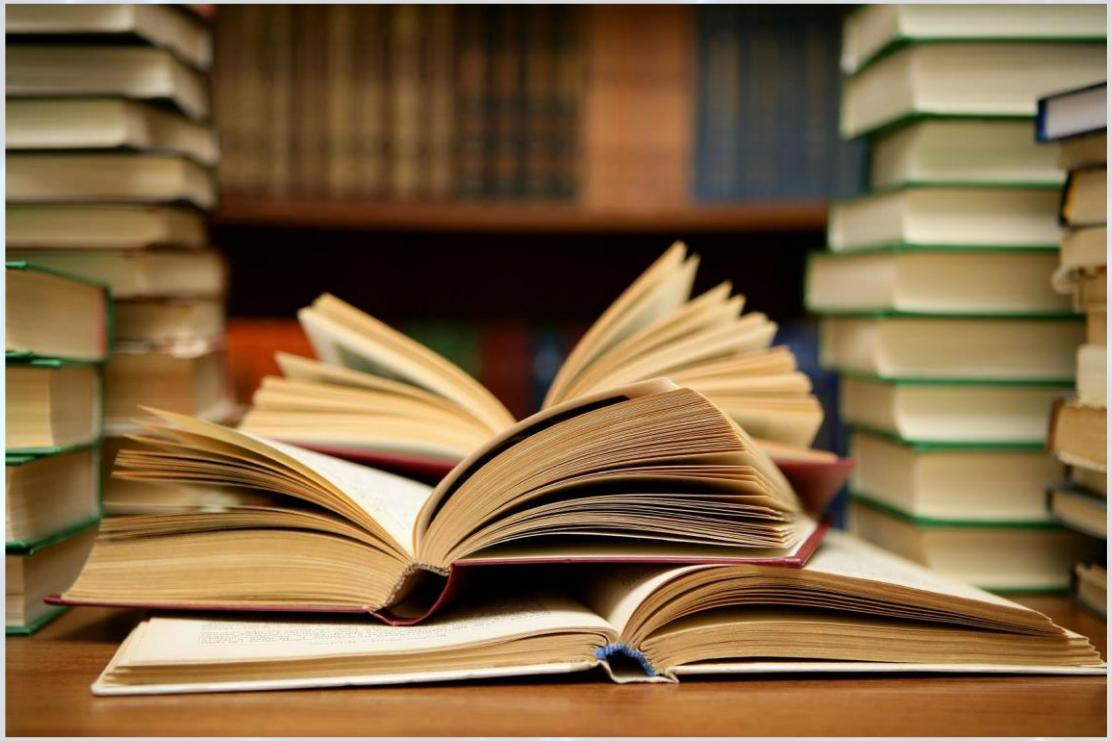
The establishment and development of **AI and Machine Learning techniques** in the field of Mobile Forensics seems inevitable and it could **revolutionize the practice of digital forensics investigations**.

Legal issues should be taken into consideration and regulatory measures should be put in place, in order to **utilize the benefits of the research with respect to legal proceedings and data privacy**.

The rapid advancements in **Mobile Networks, Cloud Computing, Internet of Things and Big Data technologies** indicate that a new era in Digital and Mobile Forensics is emerging, so **the potential and the concerns regarding Artificial Intelligence should be examined as soon as possible**.

RECOMMENDATIONS FOR FUTURE WORK

A. **Pattern Recognition – Computer Vision**
B. **Natural Language Processing**
C. **Open – source tools**
D. **Standardized procedures and legal issues**



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Thank you for your time!

QUESTIONS?

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