

# Exploring the Possibilities of Using Artificial Intelligence and ECG for Identifying Patients

Hatem ZEHIR  
[hatem.zehir@univ-annaba.dz](mailto:hatem.zehir@univ-annaba.dz)

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# Introduction to Biometrics

## What is Biometrics?

Biometrics refers to the identification and authentication of individuals based on their unique physiological or behavioral characteristics. This technology is widely used in various fields, including finance, public security, and healthcare.

Biometric systems have gained increasing prominence and adoption in a variety of fields and applications. They are now widely utilized in areas such as smartphones, banks, websites, and airports.

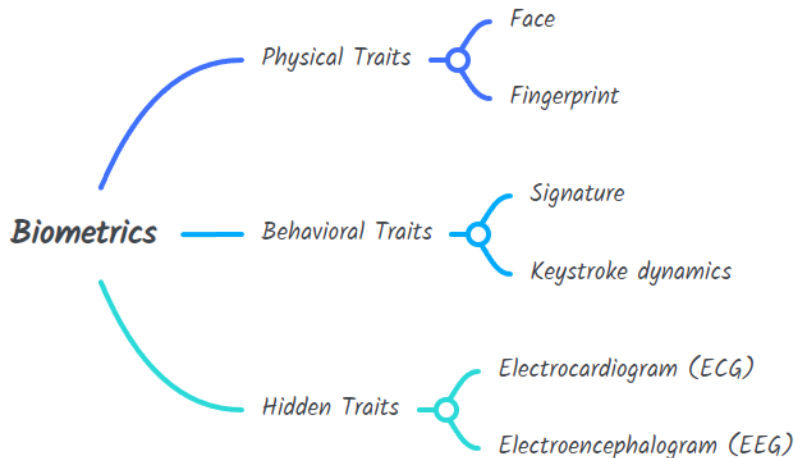
These systems serve as an alternative to conventional authentication techniques such as passwords, PIN codes and ID cards, biometric systems enable reliable identification and verification of individuals, enhancing overall system integrity and user experience.

Several biometric modalities have been investigated in the last decade such as iris, face, fingerprint, gait, and auditory perception responses.

Several attempts have been made to search for new biometric modalities that are resistant to attacks such as forgery and spoofing.

Biomedical signals such as ECG, EEG and EMG are regarded as emerging biometric modalities.

# Biometric modalities



**Figure 1:** A categorization of biometric modalities

# The Electrocardiogram

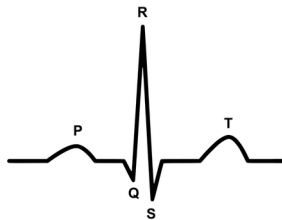


# What is Electrocardiogram?

## What is electrocardiogram?

An ECG is a graphical representation of the electrical activity of the heart. It helps assess the structure of the heart. ECG signals can be obtained from different sources.

A precise ECG diagnosis relies on the correct recording, processing, and presentation of the signal.



**Figure 2:** Schematic diagram of normal sinus rhythm for a human heart as seen on ECG

- P-Wave: Its frequency spans from 10 to 15 Hz, while its duration varies between 0.06 and 0.12 seconds.
- QRS-Complex: Its amplitude varies between 0.5 and 1 mV, and its duration spans from 80 to 120 ms.
- ST-Segment: Can be anywhere from 0.1 to 0.5 millivolts in amplitude, and it can last anywhere from 120 to 180 ms.

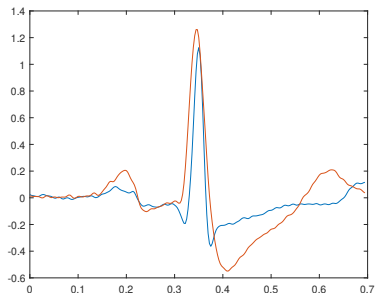
# Intra-Subject And Inter-Subject Variability

Intra-subject variability in ECG signals refers to the variations in an individual's ECG patterns due to factors such as emotional state, and health conditions.

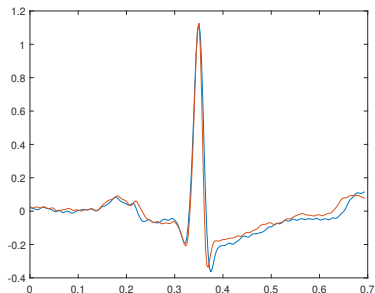
Inter-subject variability, on the other hand, refers to the differences in ECG patterns between individuals, which can be used for biometric identification.

ECG signals have been shown to have unique features among individuals, making them suitable for biometric applications. Studies have shown that ECG biometrics can work in real-life scenarios.

# Intra-Subject And Inter-Subject Variability



(a) Inter-subject variability



(b) Intra-subject variability

**Figure 3:** Demonstration of the Intra-Subject and Inter-Subject Variability in Electrocardiography (ECG)

# Deep Learning for ECG Biometrics

# What is deep learning

Deep learning is a subfield of artificial intelligence (AI) that focuses on training artificial neural networks to learn and make intelligent decisions by themselves. It involves training these networks with a large amount of data to recognize patterns and relationships within the data. The term "deep" refers to the multiple layers that make up these neural networks.

Deep learning finds applications in various fields, such as image and speech recognition, natural language processing, and computer vision. It excels at tasks that involve extensive data analysis and intricate patterns.

# Deep learning for ECG classification

Deep learning models have the ability to automatically learn and extract complex features from raw ECG signals. Unlike traditional feature extraction methods that rely on handcrafted features, deep learning models can effectively capture patterns in the ECG signals, leading to improved classification accuracy.

Also, they can handle large amounts of data. ECG datasets often contain a vast number of samples, making it challenging to manually analyze and classify them. Deep learning algorithms, such as CNNs or RNNs, are capable of processing large volumes of data efficiently. Moreover, deep learning models can generalize well to unseen data, allowing them to classify ECG signals accurately even when dealing with variations in noise, artifacts, or different patient populations.

Convolutional neural networks (CNNs) are a type of deep learning architecture that are well-suited for processing 2D or 3D data. CNNs are commonly used for image classification, but they can also be used for ECG signal classification. In ECG signal classification, CNNs are used to extract features from the ECG signal. These features are then used to classify the ECG signal into one of a set of predefined classes



Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) networks have also been utilized in ECG signal classification for biometrics. RNNs, including LSTM networks, are designed to model sequential data, making them suitable for capturing the temporal dependencies present in ECG signals.

These architectures maintain hidden states that retain information from previous time steps, allowing them to capture long-term dependencies effectively. RNNs and LSTMs have been successfully employed in tasks such as ECG-based authentication or verification, where the temporal dynamics of ECG signals play a crucial role in accurate biometric classification.

# ECG for Patients Identification

# Importance of patient identification in healthcare systems

Ensuring accurate patient identification is crucial for providing personalized and customized treatment while mitigating the potential dangers of medical errors. Patient misidentification poses grave risks, ranging from inaccurate diagnoses to administering incorrect medications, potentially leading to life-threatening outcomes.

However, healthcare organizations can effectively address these concerns by adopting robust identification protocols. By doing so, they can substantially minimize these risks and prioritize the well-being of their patients.

ECG biometrics can be utilized for patient identification by

- Acquiring the ECG signal through electrodes attached to the patient's body
- Extracting relevant features to create a unique biometric template
- Securely storing the template in a database or on a smart card
- Enrolling patients by linking their identity information to their ECG template
- Using matching algorithms based on AI to compare newly acquired ECG signals with stored templates for identification.

By incorporating ECG biometrics into a comprehensive identification system and addressing privacy concerns, healthcare facilities can enhance patient identification accuracy and security, contributing to personalized care and reducing the risks associated with misidentification.

# Conclusion

# Conclusion

In conclusion, the exploration of using artificial intelligence (AI) and electrocardiogram (ECG) data for identifying patients holds immense promise in the field of healthcare.

The combination of AI algorithms and ECG signals presents a powerful tool that can revolutionize patient identification, diagnosis, and treatment.

# Thank you!

E-mail: [hatem.zehir@univ-annaba.dz](mailto:hatem.zehir@univ-annaba.dz)