Computer science @ DIETI

Piero Bonatti, Sergio Di Martino, Francesco Isgrò, Daniel Riccio,
And more...

Main research activities

- Machine Learning
- Logic-based AI
- Cognitive robotics
- Software engineering
- Formal methods
- Game theory

People here today

- **Machine Learning**   Francesco Isgrò, Daniel Riccio
- **Logic-based AI**   myself
- Cognitive robotics
- **Software engineering**   Sergio di Martino
- Formal methods
- Game theory

A few words on the other work

- **Cognitive robotics**
  - Assistive robotics   Silvia Rossi
  - Collaborative robotics   Alberto Finzi
- Some keywords
  - Active perception
  - Cognitive architectures
  - Planning
  - Activity recognition and orchestration ….

A few words on the other work

- **Formal methods**
  - Automated software / protocol verification
- Some keywords
  - Model checking (logic-based reasoning)
- Involved people
  - Adriano Peron, Massimo Benerecetti, Fabio Mogavero, ...

A few words on the other work

- **Game theory**
  - Software synthesis
  - Automated auctions
  - Privacy (Disincentives to the abuse of personal data)
- Keywords
  - Mechanism design
- Involved people
  - Marco Faella, Luigi Sauro, myself

Logic-based AI

- Sample contributions
  - Novel logics for
    - Strategic reasoning (e.g. find equilibria in a game)
    - Commonsense reasoning (e.g. applicable to biomedical ontologies)
    - Security & Privacy (e.g. representing policies and checking compliance)
  - Correct and complete reasoning algorithms for these logics
  - Characterization of the (intrinsic) computational complexity of reasoning
- Keywords
  - Modal/dynamic logics
  - Nonmonotonic logics
  - Scalable reasoning
- Involved people
  - Myself, Luigi Sauro, Nello Murano

Logic-based AI (II)

- Some recent EU H2020 projects focused on **compliance w.r.t. the GDPR**

  - SPECIAL (finished dec 2019)

  - TRAPEZE (ongoing)

    - Policy language based on a profile of **OWL2 Web Ontology Language** (description logics)
    - Scalable specialized reasoner (**~500µs/compliance check**)
    - Explanation facility

- Use case partners

People:

- *Andrea Apicella*
- ***Francesco Isgrò***
- *Andrea Pollastro*
- *Roberto Prevete*
- *Guglielmo Tamburrini*

Research themes

- **Deep learning:**
  - **User-centered XAI**
  - **Trainable Activation Functions**
  - **Graph Convolutional neural networks**
- **Ethical issues and AI**

Some Current application domains

- **EEG signal classification and explanation**
- **Parking occupancy rate prediction**
- **Blood glucose level prediction and explanation**
- **Autonomous driving**

People:

- *Andrea Apicella*
- *Piero Bonatti*
- *Anna Corazza*
- ***Francesco Isgrò***

Privacy preserving Data Mining

- Predict some characteristics about a population,
  while protecting the privacy of individuals
- Guaranteeing privacy is necessary to
  - persuade the users to give us their data;
  - respect the law (infractions to GDPR are very expensive)
- Differential Privacy
  - We work on conditions which help DP
    - large data set
    - large clusters
    - no outliers

People:

- *Andrea Apicella*
- *Piero Bonatti*
- *Anna Corazza*
- ***Francesco Isgrò***

Information extraction

- Aim: extracting information from different sources, such as text and images
- Focus on the interaction with domain knowldedge
- Different ways of **representing** and **integrating** such domain knowledge.
- Some considered problems:
    - extract medical and pharmaceutical entities and relations from medical records
    - Describe the content of an image (probabilistic ontology)
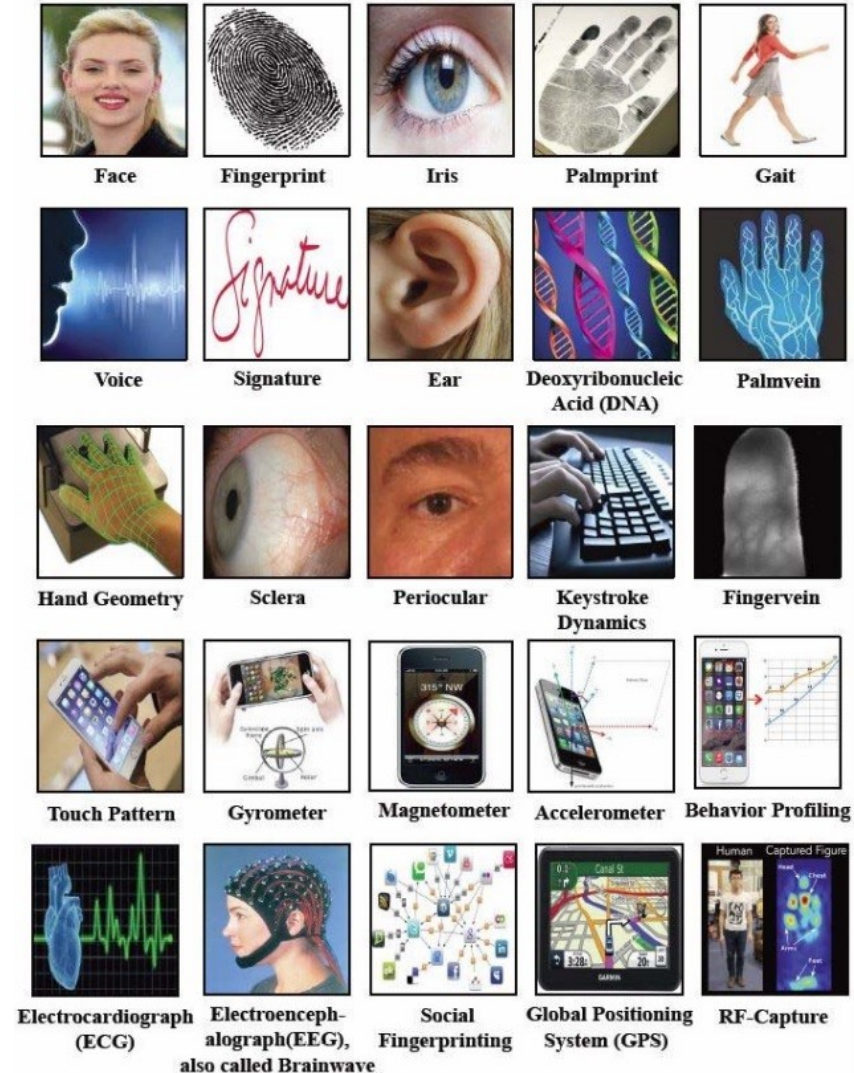   - Sentiment analysis

Biometrics

Biometrics are body measurements related to human characteristics.

Biometric authentication is used in computer science as a form of identification and access control.
It is also used to identify individuals in groups that are under surveillance.

Although there are many physical and behavioral characteristics proposed as biometrics to date, our attention is mainly focused on face and iris, for the following reasons:

- contact-less;
- well accepted;
- reliable;
- stable (only the iris).

Face Fingerprint Iris Palmprint Gait

Voice Signature Ear Deoxyribonucleic Acid (DNA) Palmvein

Hand Geometry Sclera Periocular Keystroke Dynamics Fingervein

Touch Pattern Gyrometer Magnetometer Accelerometer Behavior Profiling

Electrocardiograph (ECG) Electroenceph-alograph(EEG), also called Brainwave Social Fingerprinting Global Positioning System (GPS) RF-Capture

State of the Art technology

For both face and iris, the technology is ripe for research, commercial and government applications.

System	Accuracy
VGG-Face	97.78 %
Facenet	99.63 %
OpenFace	93.80 %
DeepFace	97.35 %
DeepId	99.15 %

VGG-Face

ArcFace   Facenet

deepFace

Dlib   OpenFace

DeepID   DeepFace
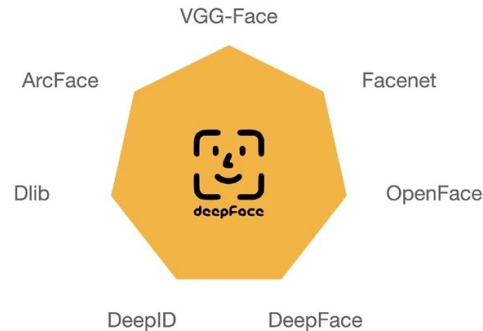
Labeled Face in the Wild
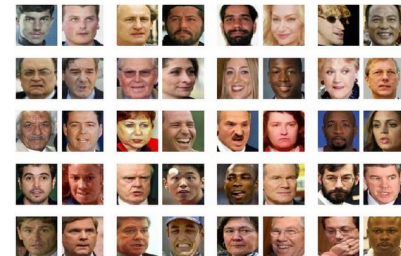
India's Aadhaar/Unique ID (UID) project

Both iris

Enrollment of one billion subjects
Accuracy = 99.73%
False reject rate (FPIR) = 0.057%
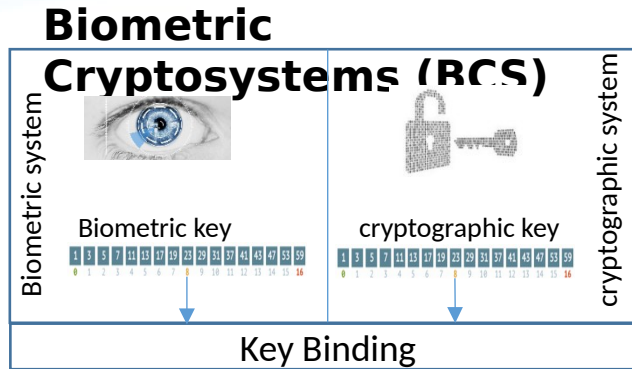False accept rate (FNIR) = 0.035%
FTE: 0.14%
Usability ： >99.5%

Potential Applications

Combining Biometrics and Crypthography
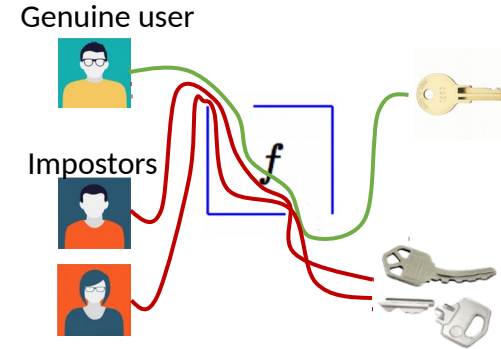Mapping different biometric keys B_i of the same user on a single cryptographic key K_j
Mapping biometric keys of impostor users to different cryptographic keys $K \neq K_j$

Biometric Cryptosystems (BCS)

Biometric system

Biometric key

| 1 | 3 | 5 | 7 | 11 | 13 | 17 | 19 | 23 | 29 | 31 | 37 | 41 | 43 | 53 | 59 |

cryptographic system

cryptographic key

| 1 | 3 | 5 | 7 | 11 | 13 | 17 | 19 | 23 | 29 | 31 | 37 | 41 | 43 | 53 | 59 |

Key Binding

Genuine user

Impostors

Combining Biometrics and Blockchains
By mapping a biometric key into a unique sequence of bits and taking advantage of cryptographic hasing, a blockchain can be used as a single and public repository for managing identities by many different services, as long as they are accredited by a single authority.
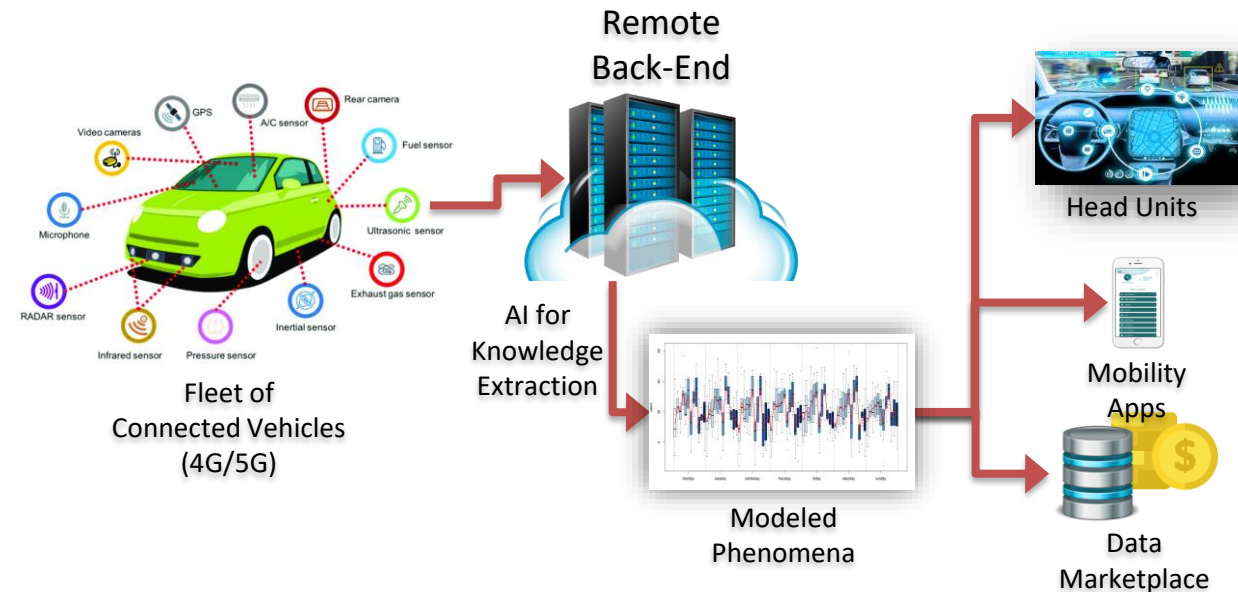

Biometric trait

CLIENT

SERVICE

AUTHORITY

BLOCKCHAIN
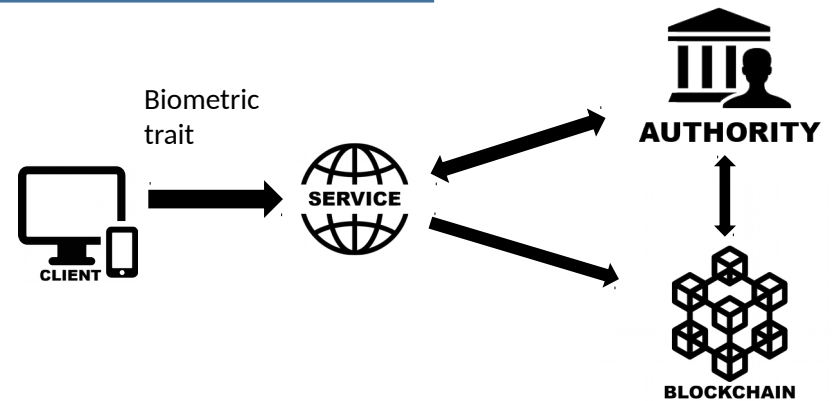
Real-time biometric analytics in crowd
Deep features guarantee high levels of accuracy.
The time they require to process a biometric trait are acceptable in one-shot applications. However, they become prohibitive when many subjects have to be analyzed/tracked in real-time videos.
The same problems arise in reidentification applications.

AI for Intelligent Transportation Systems

- **Mission:**
  - Definition/validation of data-driven approaches for Sustainable Mobility.
  - Exploitation of massive spatio-temporal datasets, from vehicles (e.g.: crowd-sensing).

- **Some investigates scenarios:**
  - Location-Based Services for Connected Vehicles
  - Predictions of Parking availability
  - Predictions of the impact of non-recurring events on traffic
  - …

- **External Partners:**
  - Stellantis
  - Volkswagen
  - Local and national transportation agencies

- **Dataset:**
  - On-Street Parking availability data from San Francisco (~5Gb) and Melbourne (>30GB)
  - GPS Traces from:
    - Public transportation vehicles
    - Private vehicles

Remote Back-End

Head Units

AI for Knowledge Extraction

Fleet of Connected Vehicles (4G/5G)

Modeled Phenomena

Mobility Apps

Data Marketplace

Contact:

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AI for Software Maintenance and Evolution

- **Mission:**
  - Definition/validation of approaches based on AI/ML/NLP applied on software source code, to improve software project management/evolution.

- **Some investigates scenarios:**
  - Detecting Error-Prone Software Development Patterns
  - Code similarity for:
    - Test Case Selection/Prioritization
    - Clone detection

- **External Partners:**
  - USI (CH), UCL (UK), ...
  - Local and national software companies

- **Dataset:**
  - Product/Process metrics for many industrial web applications.
  - Massive amounts of "cleansed" open software projects (from public software repositories)
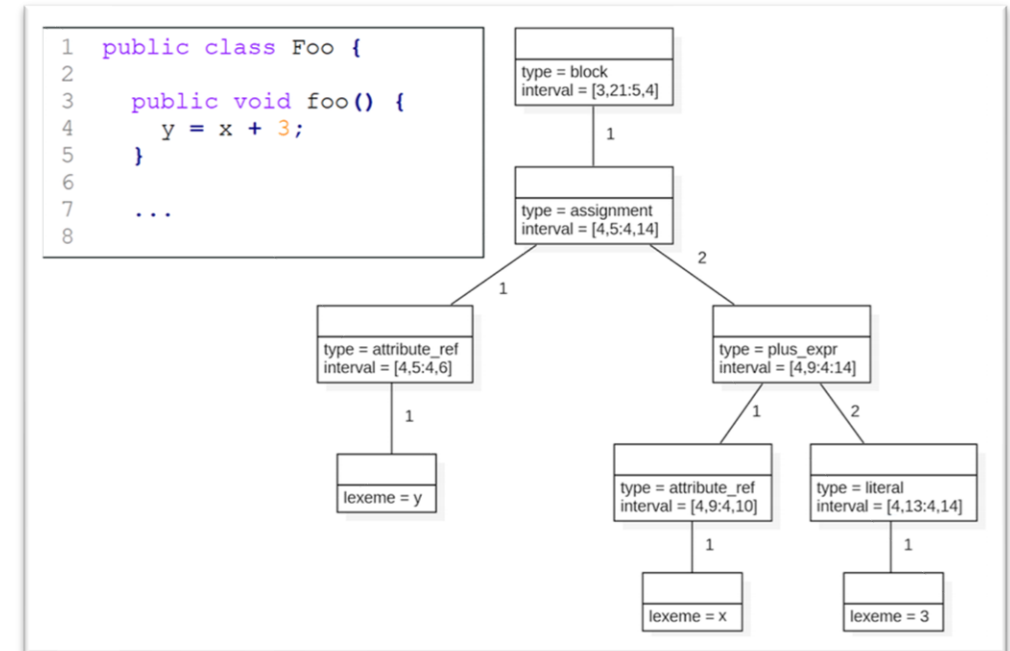
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