



Ambient intelligence for smart living

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Ambient Intelligence for Smart Living

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Summary

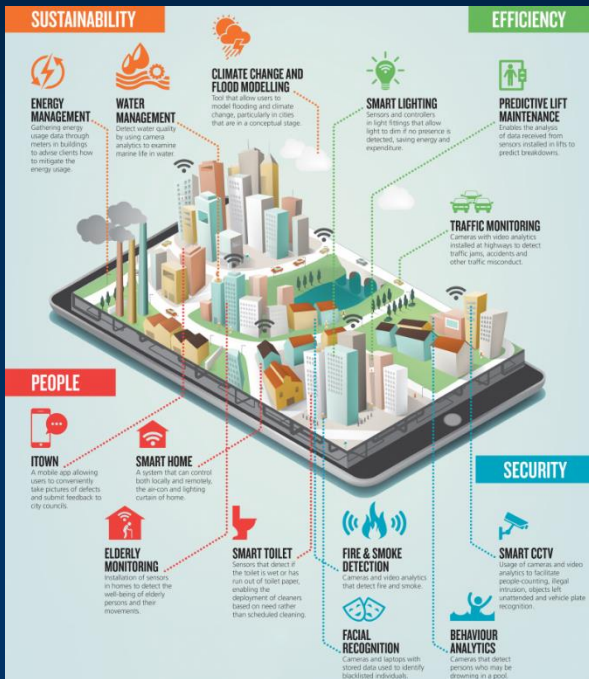
- Ambient Intelligence
- Environment issues:
 - Understanding needs
 - Adapting and evolving
- Technologies for intelligent environments
 - Artificial Intelligence, machine learning, data mining, ...
 - Biometrics
 - Cloud/Fog computing, Internet-of-Things, Cyber-Physical Systems
- Technology convergence for an integrated pervasive support to ambient intelligence



Ambient Intelligence

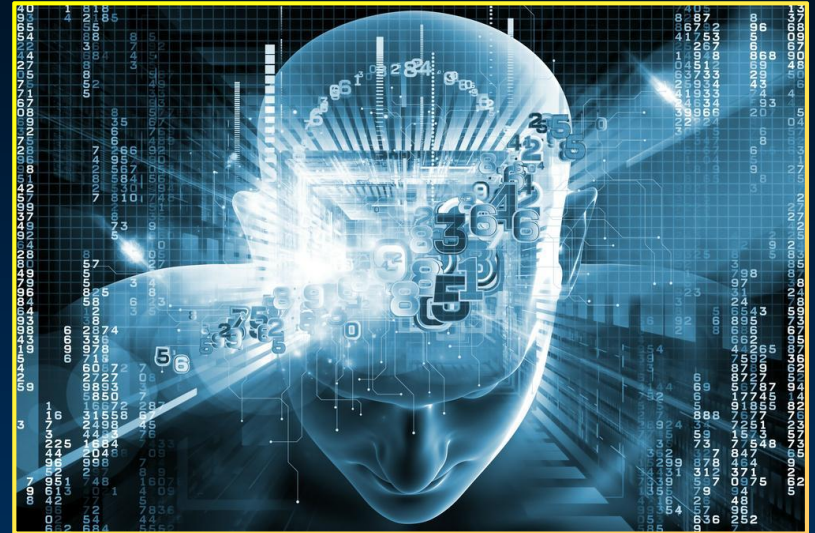
- Technologies pervasively embedded in the environment
 - to facilitate human-system interaction
 - to ensure livability by autonomously adjusting the environmental conditions

Smart Environments for Smart Living



Understanding the Environment

- Understanding needs
- Identifying solutions
- Learning from the real world
- Dynamically adjusting
- Learning preferences
- Monitoring evolution



*Artificial Intelligence
Machine learning
Pattern recognition
Signal and image processing
Data analytics and data mining*



Characterizing Individuals

- Identifying individuals
- Identifying classes of individuals
- Identifying behaviors
- Profiling
- Personalized services

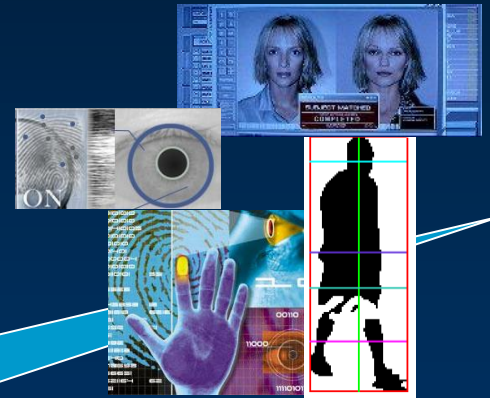
Biometrics



Something
you **have**



Something you **know**



Something you **are**

Smart Environments



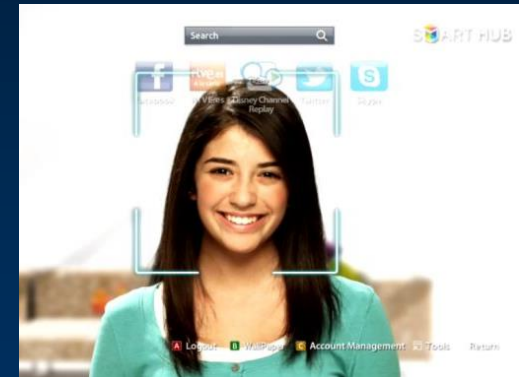
Smart Home



Kitchen and Restaurants



Smart Entertainment Systems



Children Protection



Smart Cars



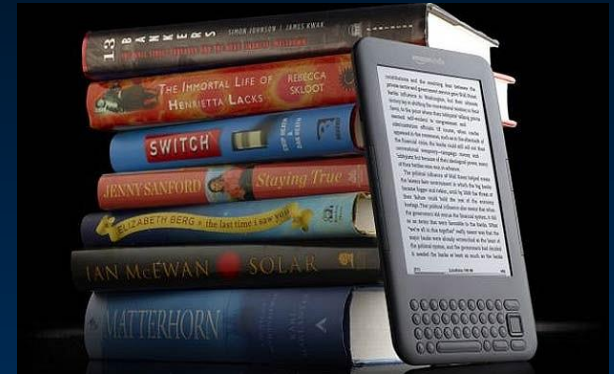
Smart Transportation Systems



Intelligent Traffic Management



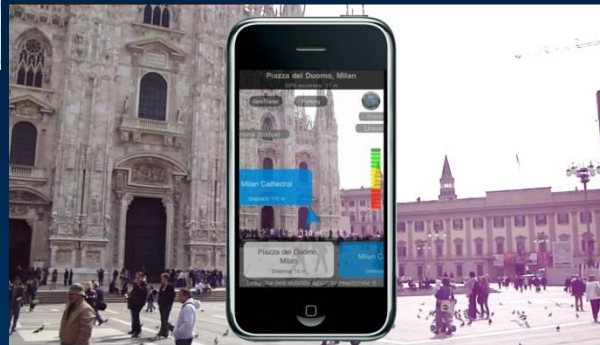
Rental Services



Intelligent Shops



Information Kiosks and Augmented Reality



Ticket Offices and Entrance Gates



Museums and Exhibitions



Health Care and Hospitals



Health Services



Smart Cities



Artificial Intelligence for Intelligent Systems

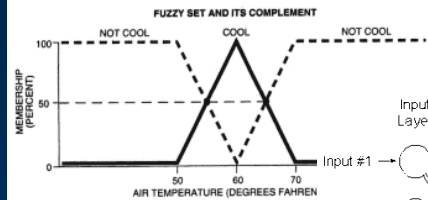
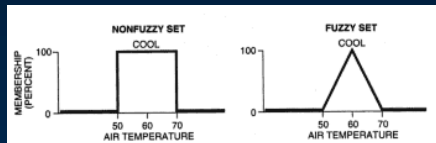


Artificial Intelligence for adaptive systems

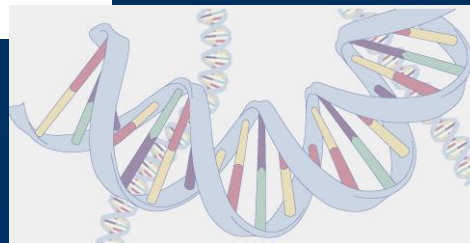
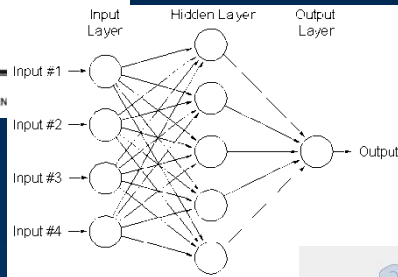
Machine Learning

Knowledge Extraction

Fuzzy Systems



Neural Networks



Smarter

Adaptive

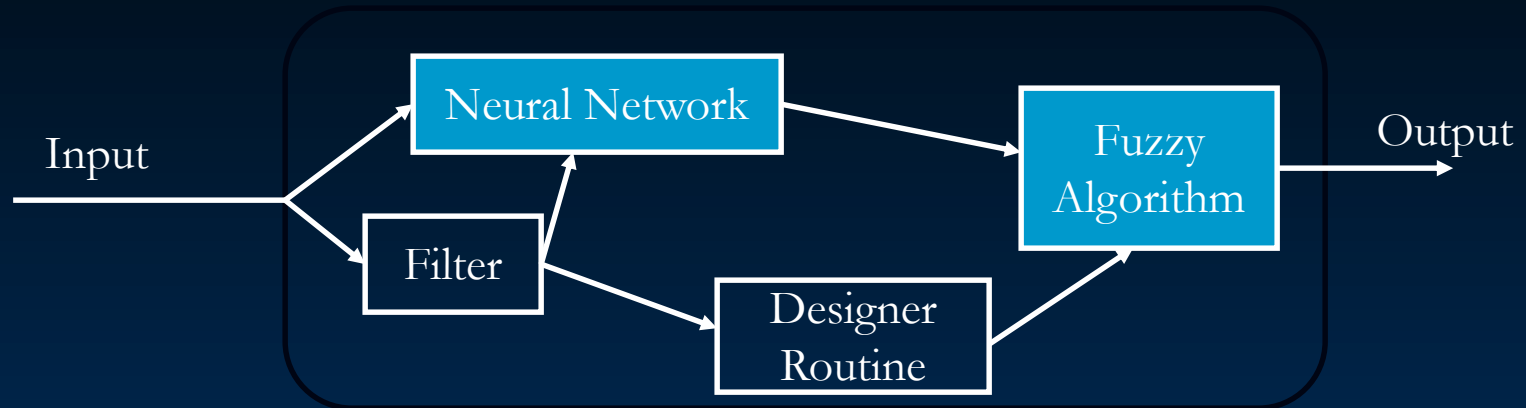


Evolvable

Evolutionary Computing



Composite Systems



TRADITIONAL PARADIGMS +
ARTIFICIAL INTELLIGENCE =

+ MORE DESIGN DEGREES OF FREEDOM
+ ACCURACY
+ PERFORMANCE



Technological Aspects for Ambient Intelligence

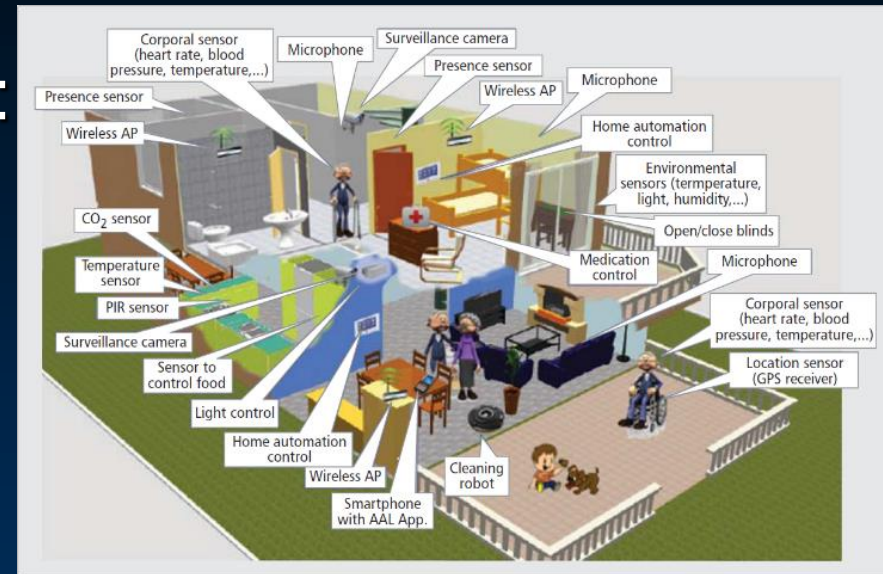
- A. Signal and image acquisition
- B. Signal and image preprocessing
- C. Feature extraction and selection
- D. Data fusion
- E. Classification and quality measurement
- F. Control
- G. System optimization



A. Signal and Image Acquisition

■ Conventional techniques:

- sensor enhancement
- sensor linearization
- sensor diagnosis
- sensor calibration



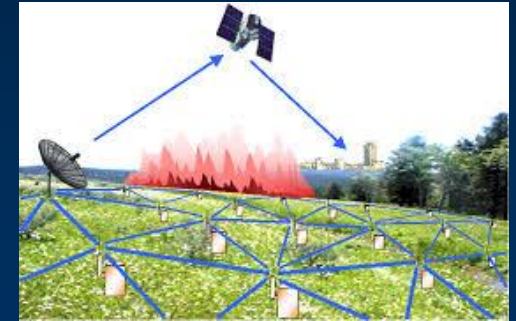
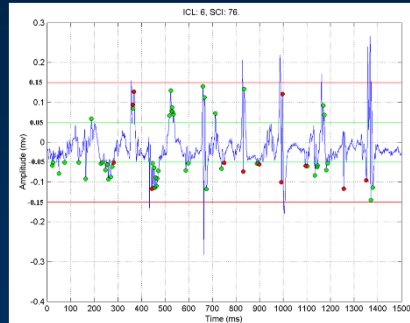
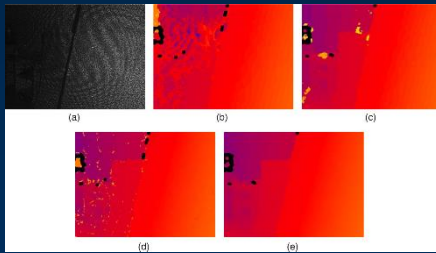
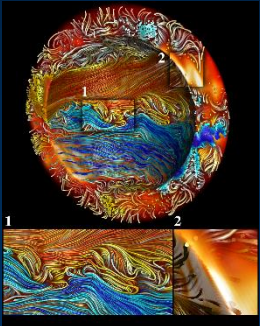
■ Artificial intelligence approaches

- self-calibration
- non-linearities reduction
- error and faults detection



B. Signal Preprocessing

- *Signal preprocessing:*
enhancing signals and correcting errors
- *Features processing:*
extract from the input signals a set of features



➔ Neural and fuzzy techniques

for signal and feature processing:

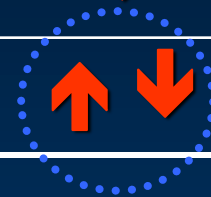
- Adaptivity, intelligence, learning from examples, ...



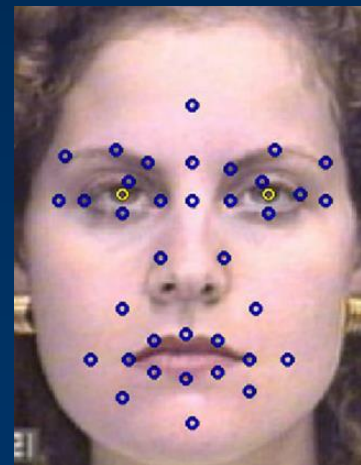
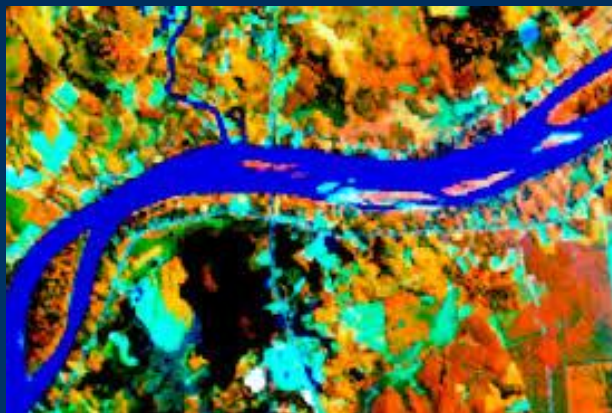
C. Feature Extraction and Selection

■ How many features?

	Complexity	Accuracy
Few features	↓	↓
Many features	↑	↑ ↓



?!?



Feature Extraction Algorithms

- Principal Component Analysis
- Linear Discriminant Analysis
- Independent Component Analysis
- Kernel PCA
- PCA network
- Nonlinear PCA
- Feed-Forward Neural Networks
- Nonlinear autoassociative network
- Multidimensional Scaling
- Self-Organizing Map (MAP)

Feature Selection Algorithms

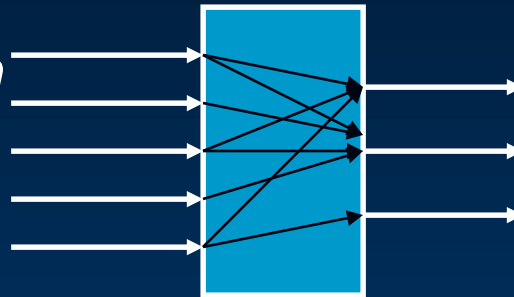
- Exhaustive Search
- Branch and Bound
- Sequential Forward Selection
- Sequential Backward Selection
- Sequential Floating Search methods



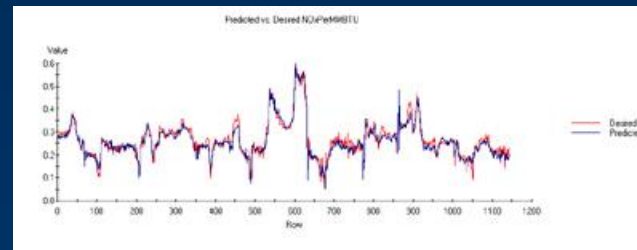
D. Artificial Intelligence for Data Fusion

- Fuse the available features/sensors signals to obtain more meaningful information

- *Sensor fusion*



- *Virtual sensors*



E. Artificial Intelligence for Classification, Clustering and Pattern Recognition

Features



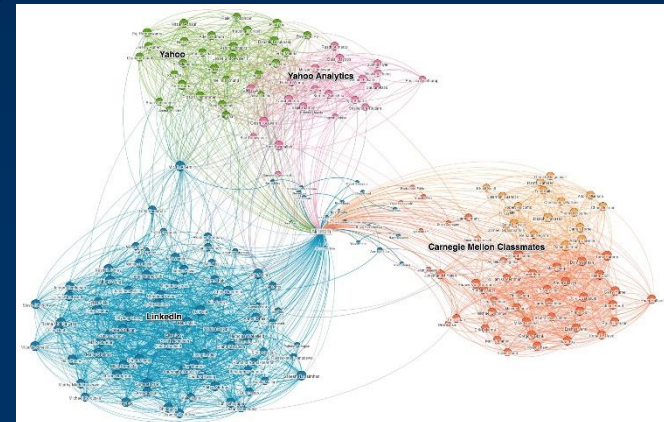
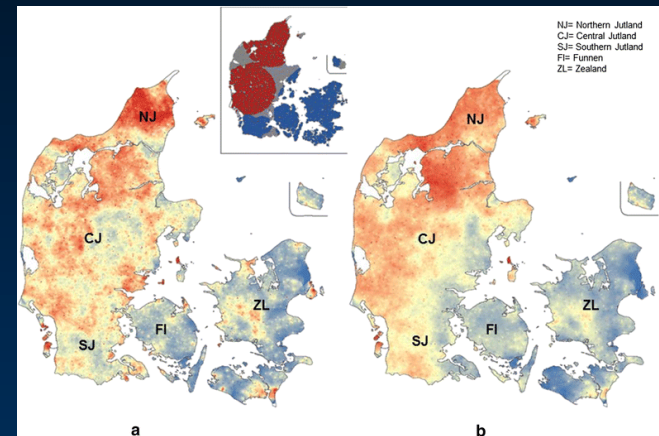
d-dimensional vector



an integer:
classification
of the quality



a floating point value:
an index of quality



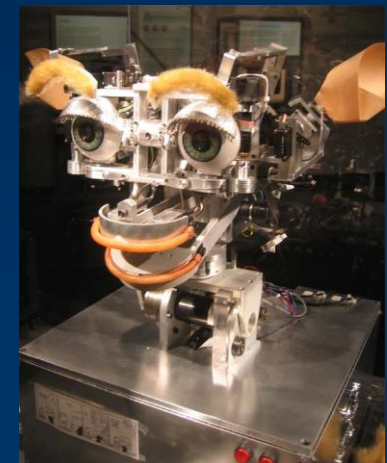
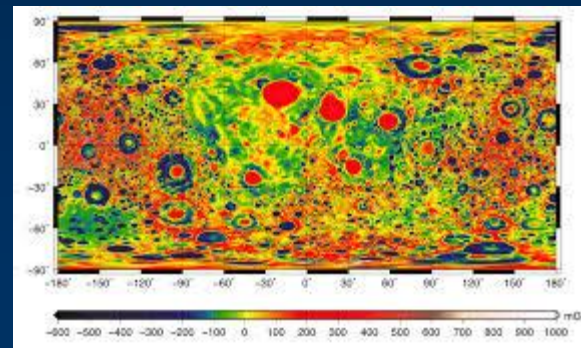
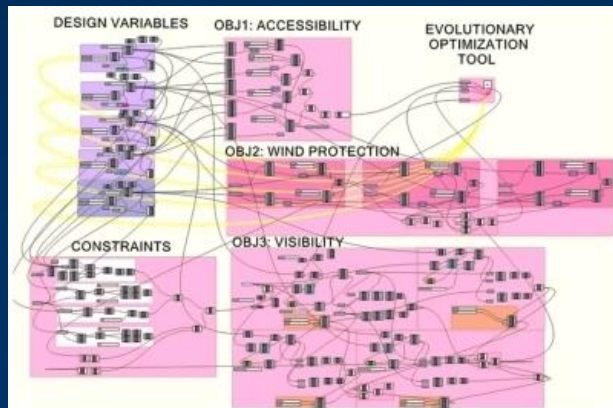
F. Control

- Neural-based control to capture the desired behavior through examples
- Fuzzy-based control to capture non-crisp definition of quantities



G. System Optimization

- System parameters difficult to fix
- Very often *trial-and-error approaches*
- *Evolutionary computation* techniques can solve this optimization task



Identification for Adaptivity



Biometric Identification

- *Person identification*
 - for assigning known needs, preferences, and desires
 - for recording new needs, preferences and desires for future use
- *Person classification*
 - for applying known characteristics of a class of persons for services and operations
 - for refining the characteristic services and operations of the class of persons
- *Person action understanding*
 - for applying services and operations to a human action



Biometrics

*Automated methods of recognizing
a person or a class of persons
based on physiological or behavioral characteristics*



Physiological Traits

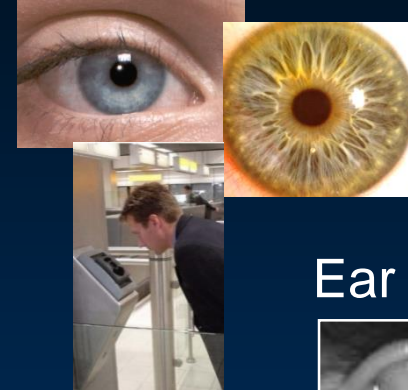
Fingerprint



Face



Iris



Ear shape



Keystroke



Signature & Handwritten text



Palmprint



Hand veins



Gait



Palm geometry



Behavioral Traits

Gesture



Age & Gender



Emotion



Weight



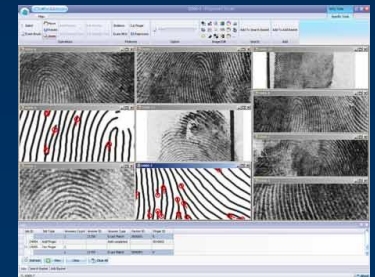
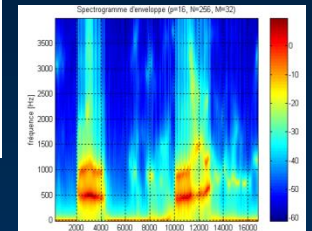
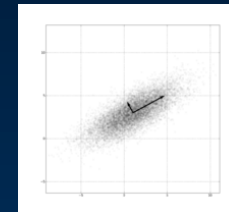
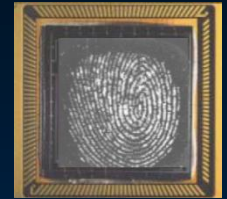
Unconstrained and Less-constrained Biometrics

- Unconstrained biometrics
 - Uncooperative subjects
 - Uncontrolled scenarios
- Less-constrained biometrics aim at using samples captured
 - Contactless
 - Higher distances
 - Natural light conditions
 - On the move
 - ...



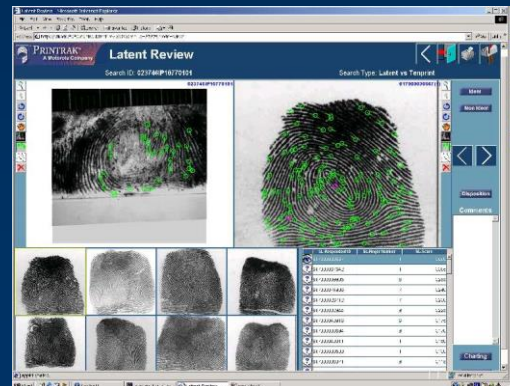
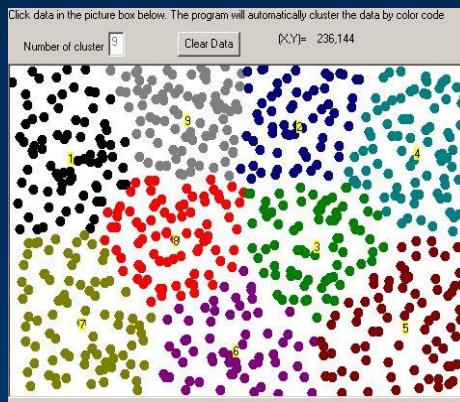
Technologies for Biometric Systems (1)

- Sensors and measurement systems
 - Biometric sensors, liveness
- Signal processing
 - Feature extraction, liveness tests
- Image processing
 - Face, fingerprint, hand, iris, gait, ear, ...



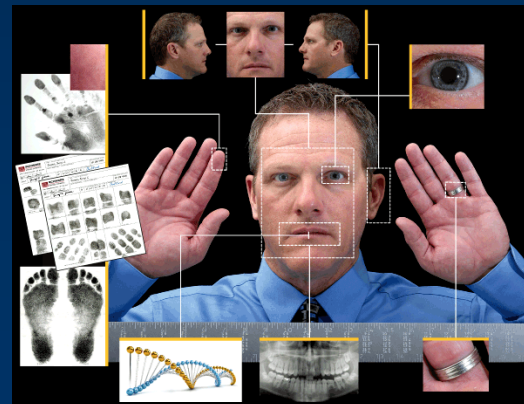
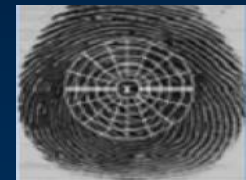
Technologies for Biometric Systems (2)

- Sensor data fusion
 - Matching module, multimodal biometric systems
- Classification and clustering
 - Characterization for template management and searching
- Security and privacy



Artificial Intelligence for Biometrics

- A. Signal and image acquisition
- B. Signal and image preprocessing
- C. Feature extraction and selection
- D. Data fusion
- E. Classification



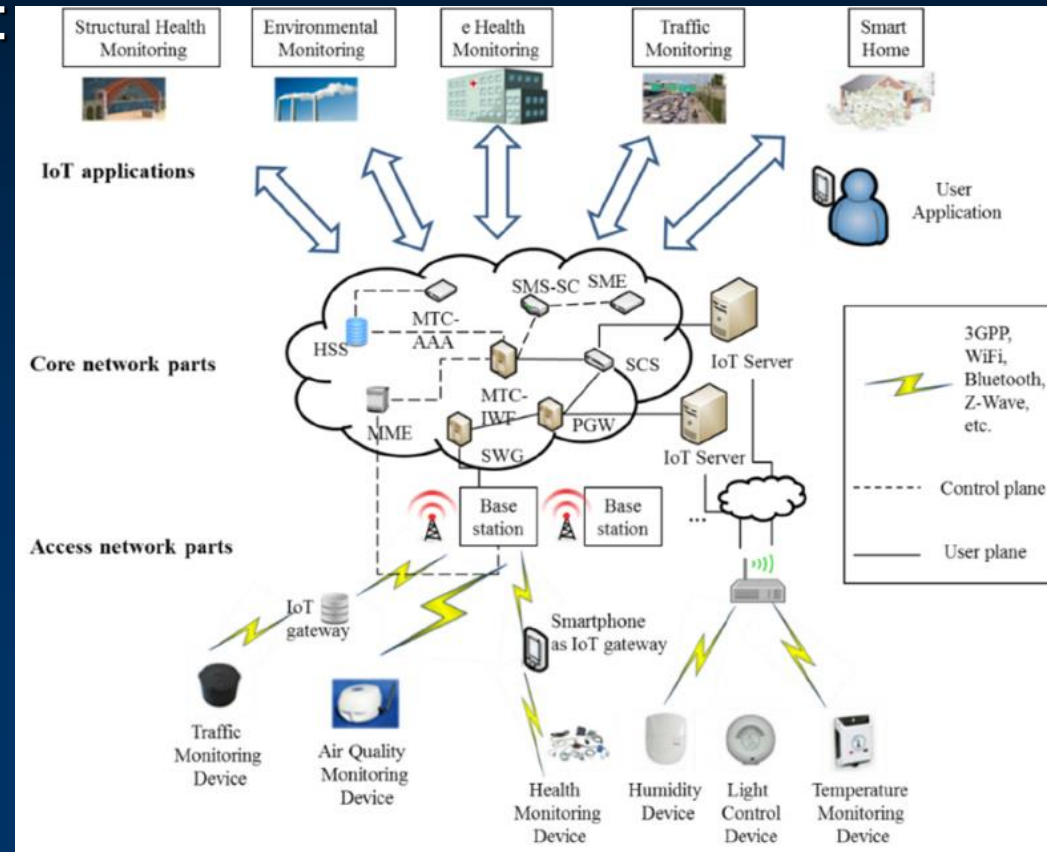
Infrastructures



Interconnections (1)

■ Internet of Things

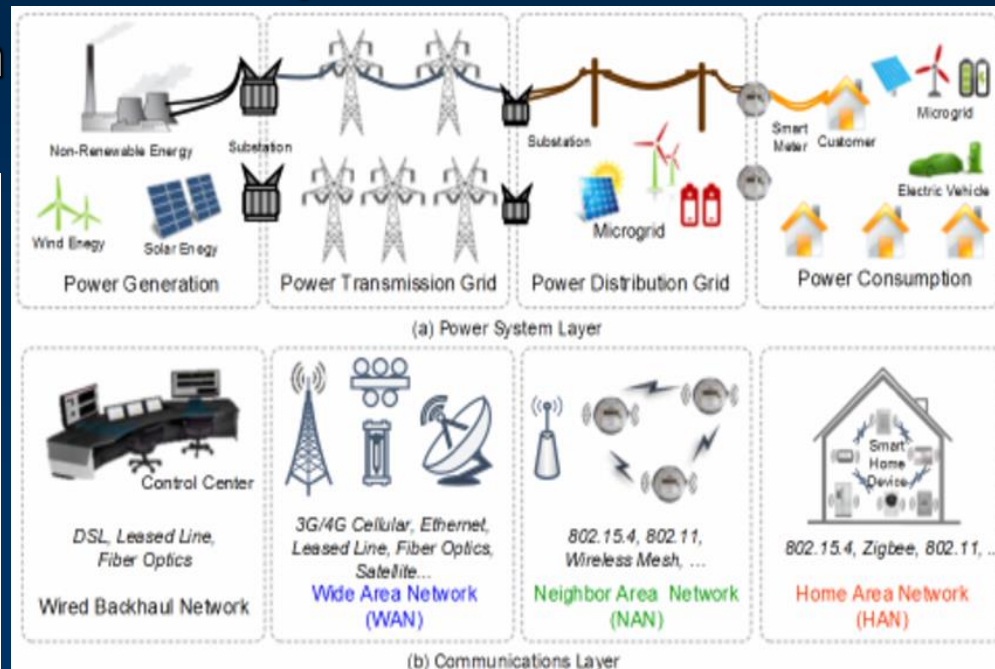
- Non-dedicated (shared) communication infrastructure
- Generic infrastructure: interfaces, protocols, basic services, standards
- Global connectivity
- Generic support to applications



Interconnections (2)

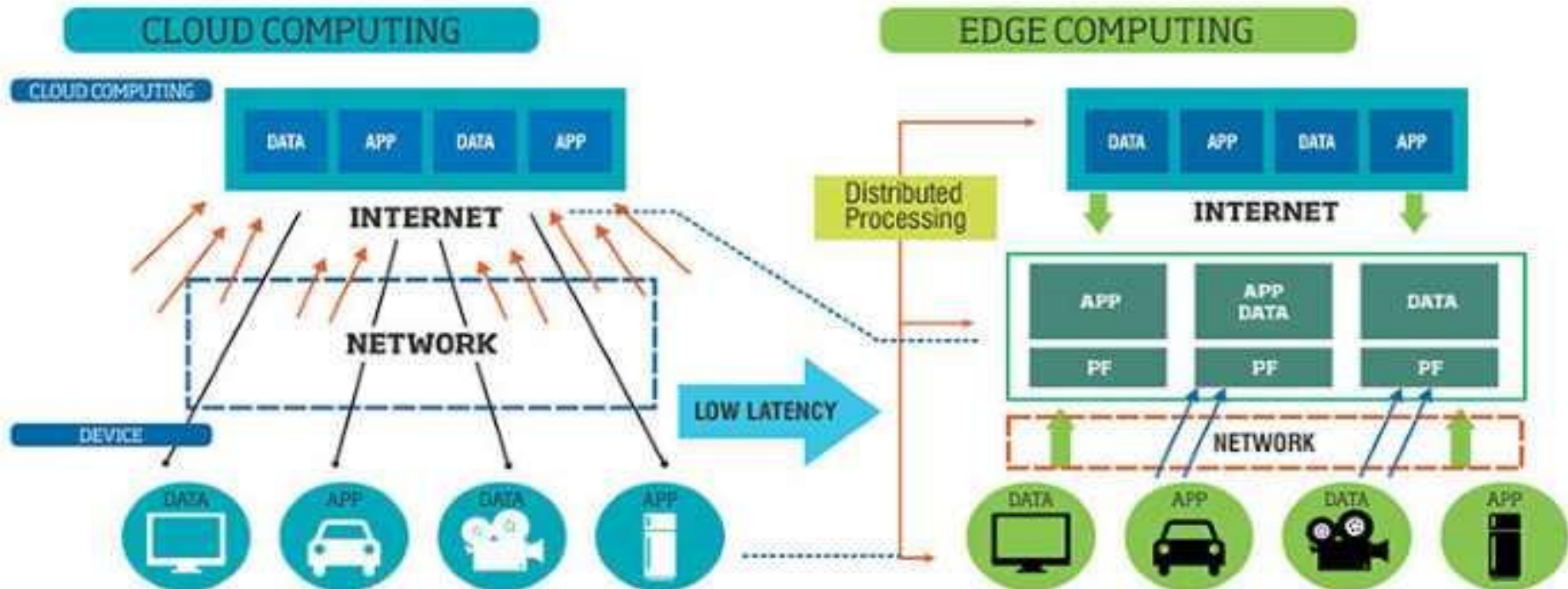
■ Cyber-Physical Systems

- Dedicated communication and processing infrastructure
- Specialized infrastructure: monitor and control systems sensors – data processing and storage – actuators
- Virtualized or dedicated connectivity
- Dedicated an application



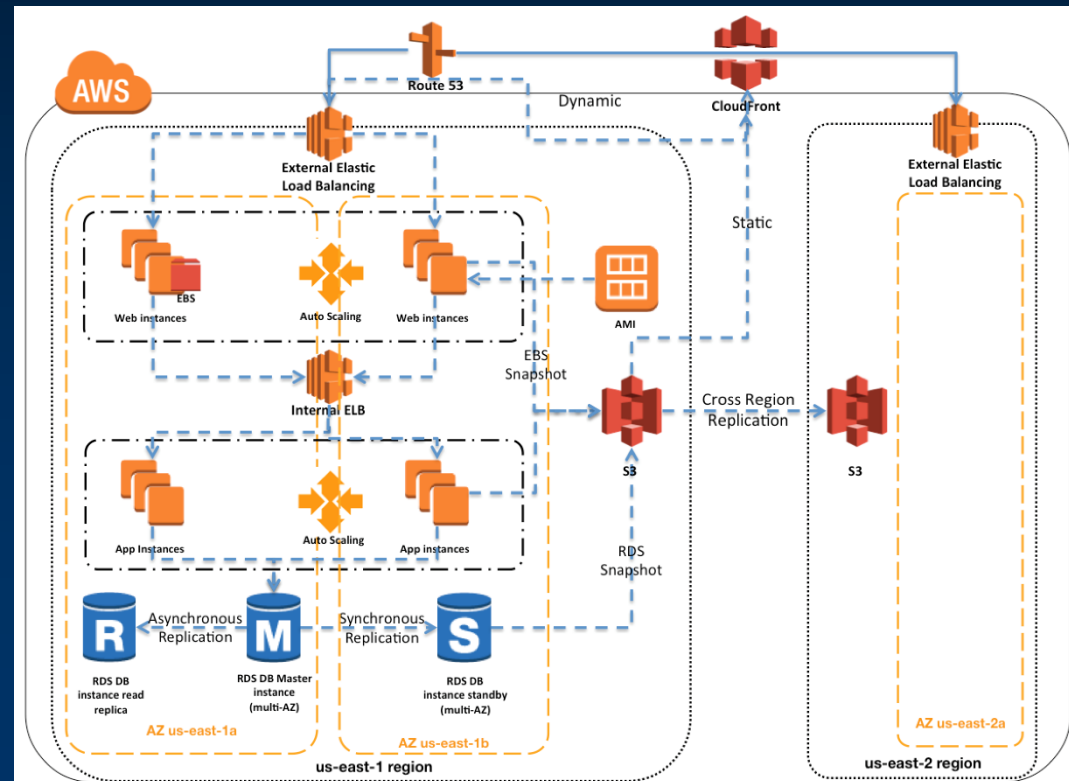
Processing and Storage

- Cloud computing
- Fog computing
- Edge computing



Infrastructure Characteristics

- Security and privacy
- Dependability and resilience
- Interoperability
- Scalability
- Energy



Ambient Intelligence for Smart Living

Opportunities for an effective, efficient, privacy-aware use of adaptivity to support smart living!



Thanks!

Thanks!

Thanks!



Thank you

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