

Machine Learning

Master in Artificial Intelligence and Robotics

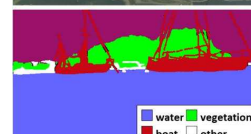
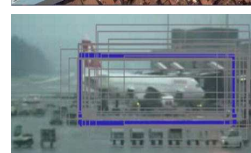
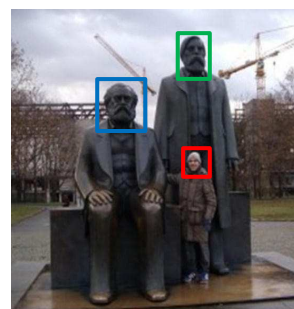
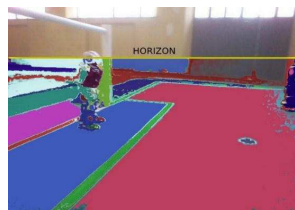
Sapienza University of Rome



Image Classification and Detection

Domenico Daniele Bloisi

November 2018

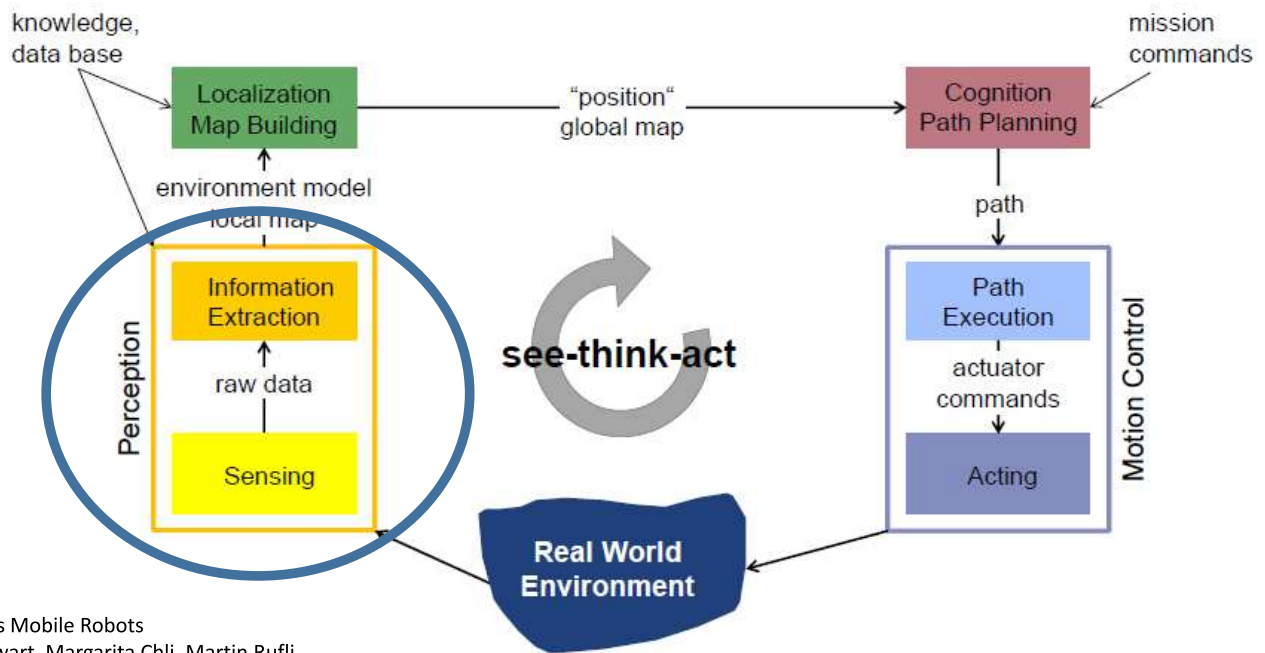


About me

- Assistant professor with the Department of Computer Science at University of Verona
profs.scienze.univr.it/~bloisi
- Team manager SPQR Robot Soccer Team
www.diag.uniroma1.it/~bloisi
spqr.diag.uniroma1.it
- Research interests: intelligent surveillance, multi-sensor data fusion, image processing, robotic vision, steganography



See-Think-Act Cycle

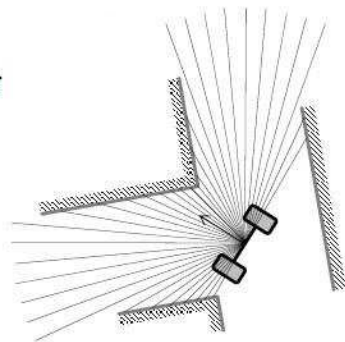


Autonomous Mobile Robots
Roland Siegwart, Margarita Chli, Martin Rufli

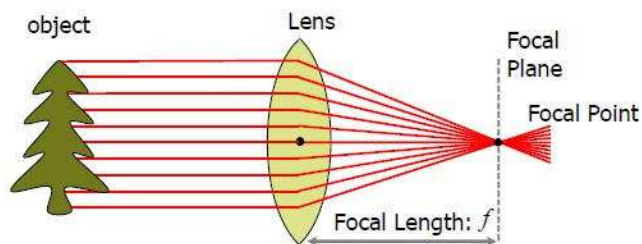
Sensors

■ Laser scanner

- time of flight

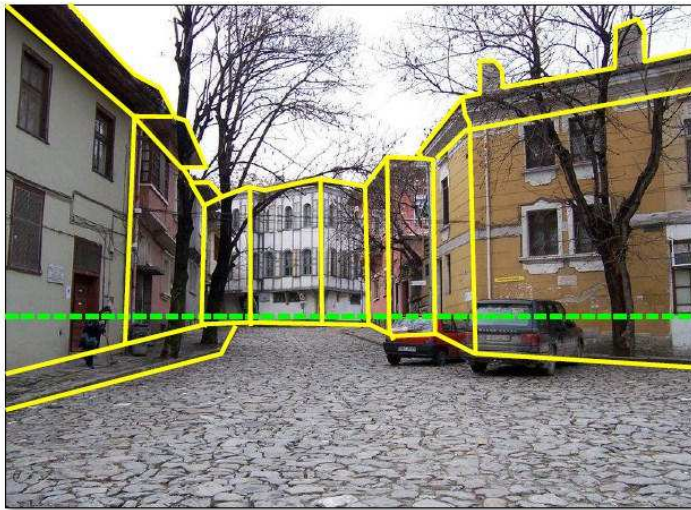


■ Camera



Autonomous Mobile Robots
Roland Siegwart, Margarita Chli, Martin Rufli

Geometrical and Semantic data



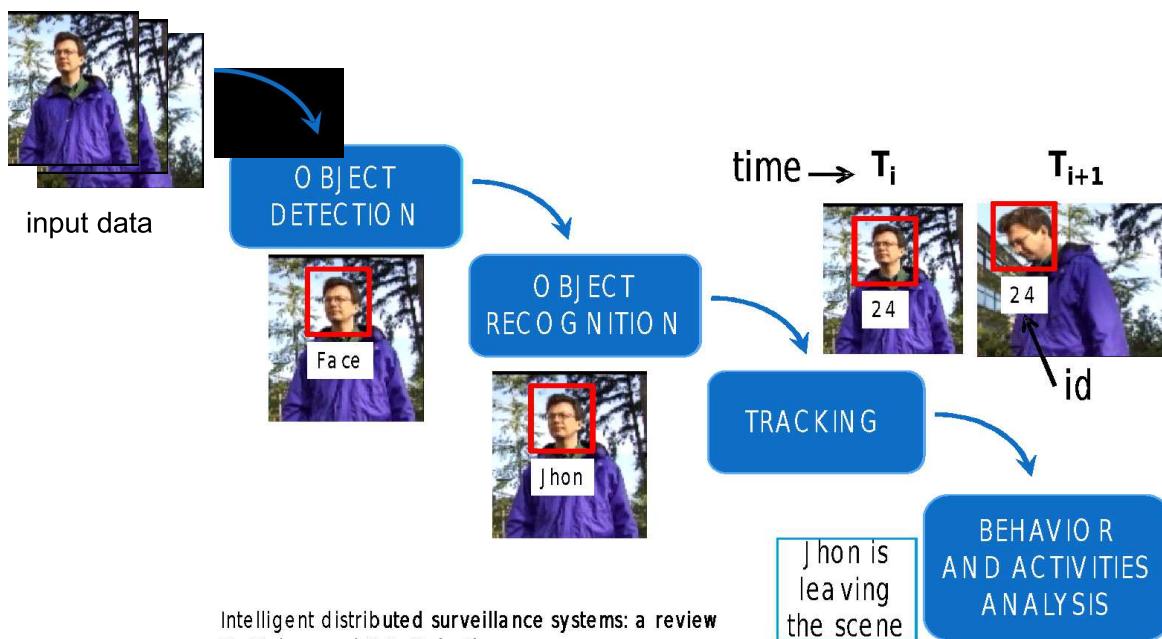
Geometrical info



Semantic info

Vision Algorithms for Mobile Robotics
Davide Scaramuzza

Flow of processing visual data



Intelligent distributed surveillance systems: a review
M. Valera and S.A. Velastin

Detecting objects in images



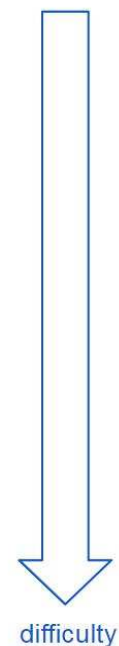
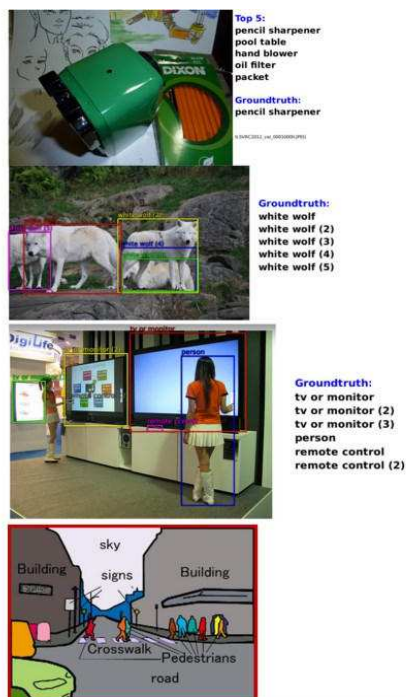
Classification, Localization, Detection, and Segmentation

- classification

- localization

- detection

- segmentation



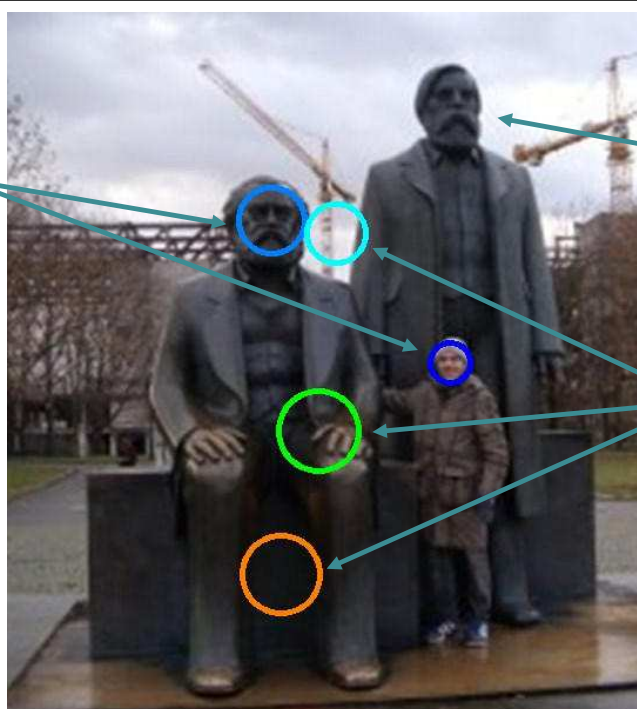
Face Detection Problem

Find regions in the image that contain instances of faces



Detection issues

TP
True
Positive

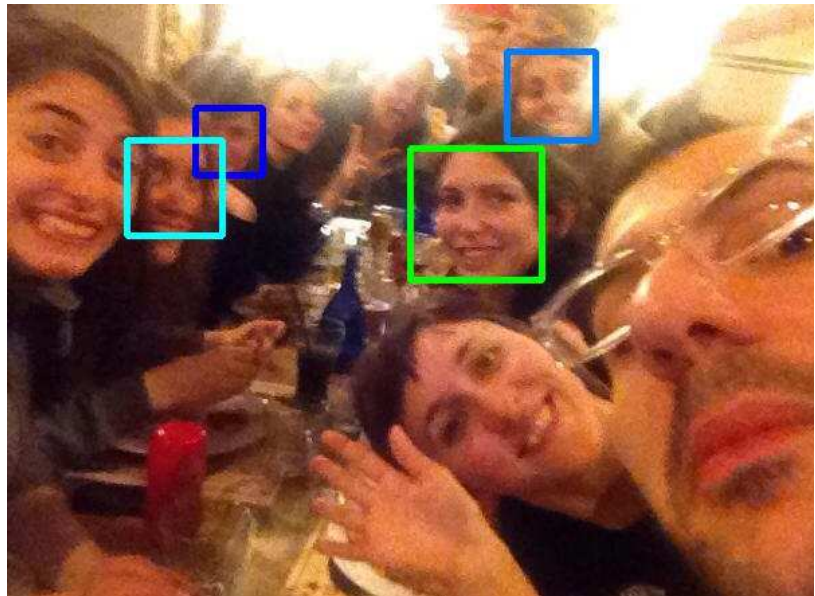


FN
False
Negative

FP
False
Positive

Additional issues

- Rotation
- Blurring
- Variations in illumination
- Occlusions
- Glasses
- ...



Detection vs Identification

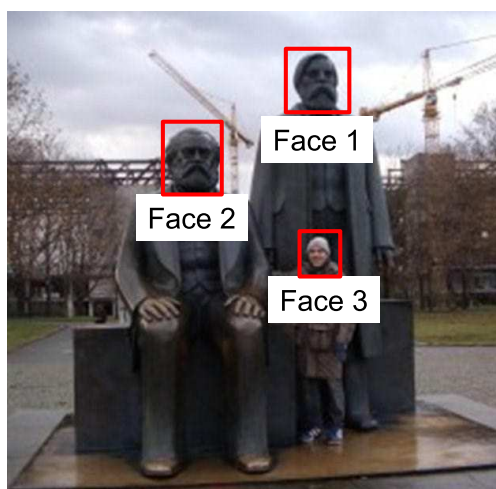


detection

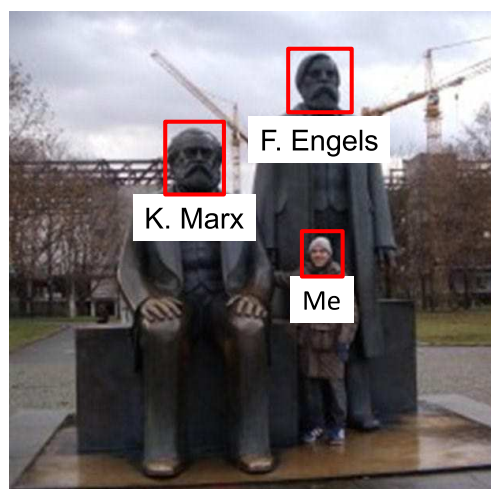


identification

Detection vs Recognition

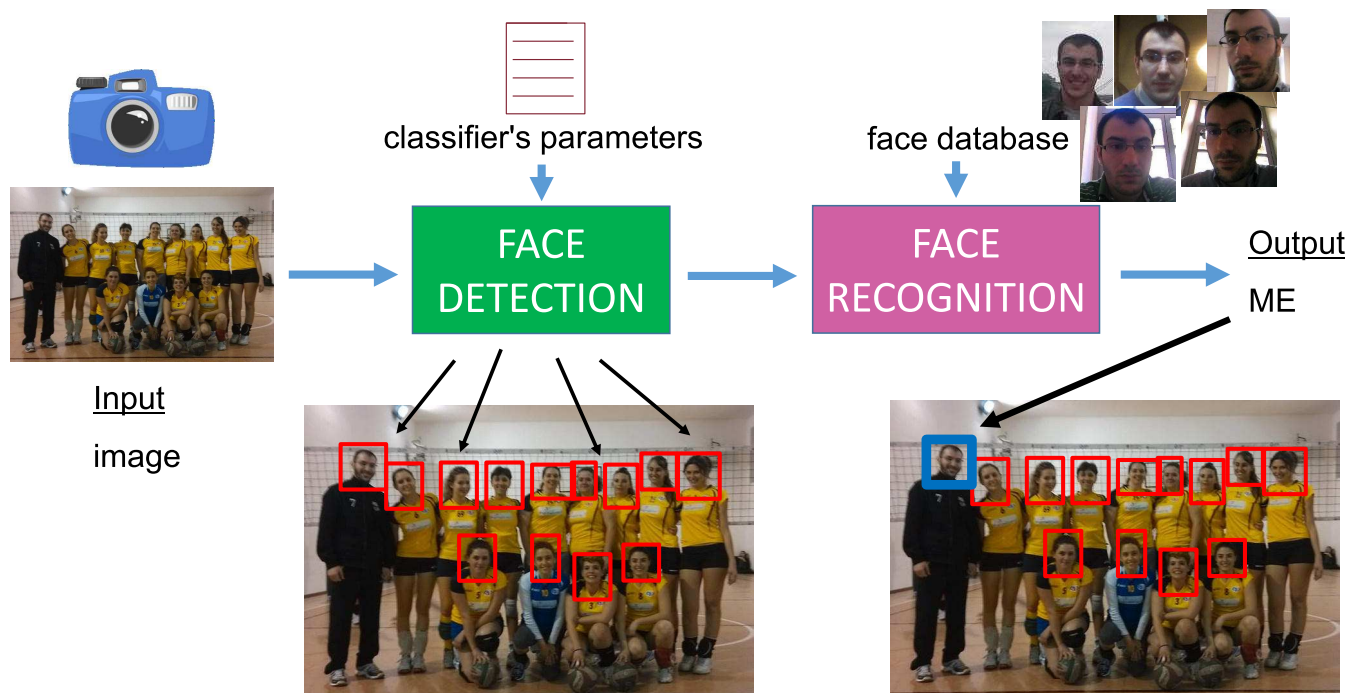


detection

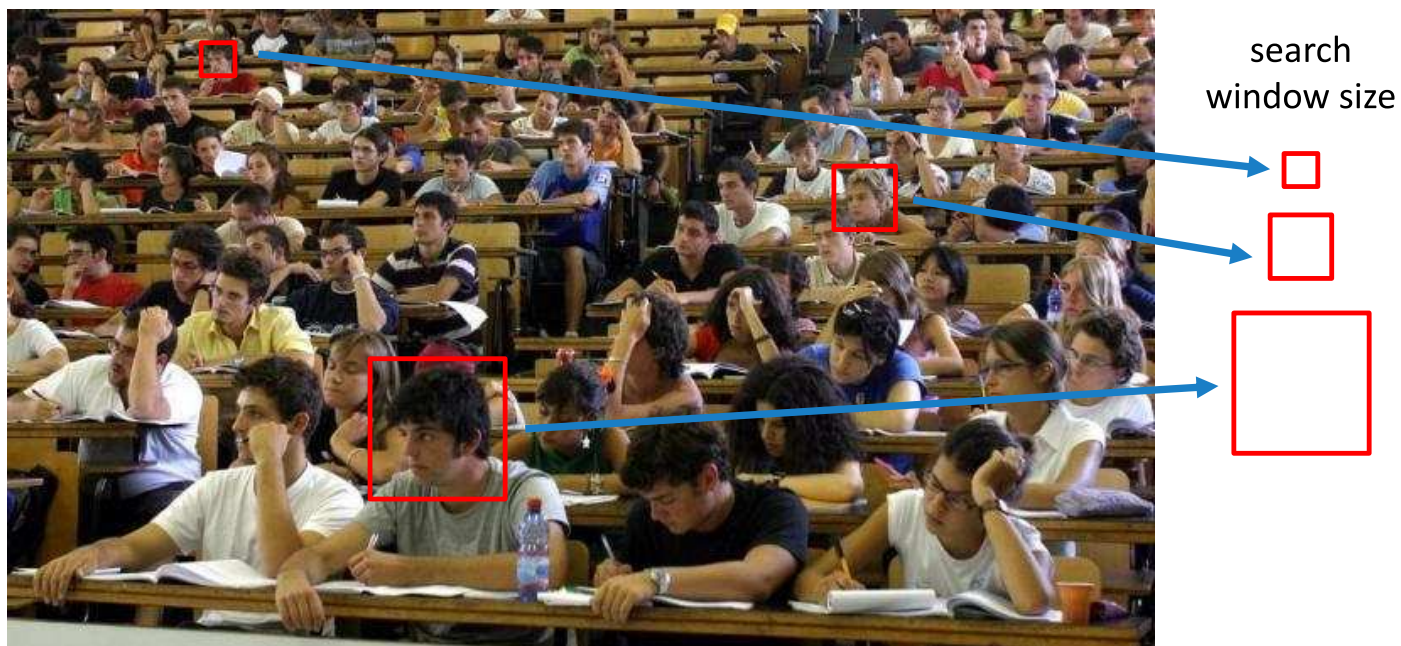


recognition

Detection & Recognition



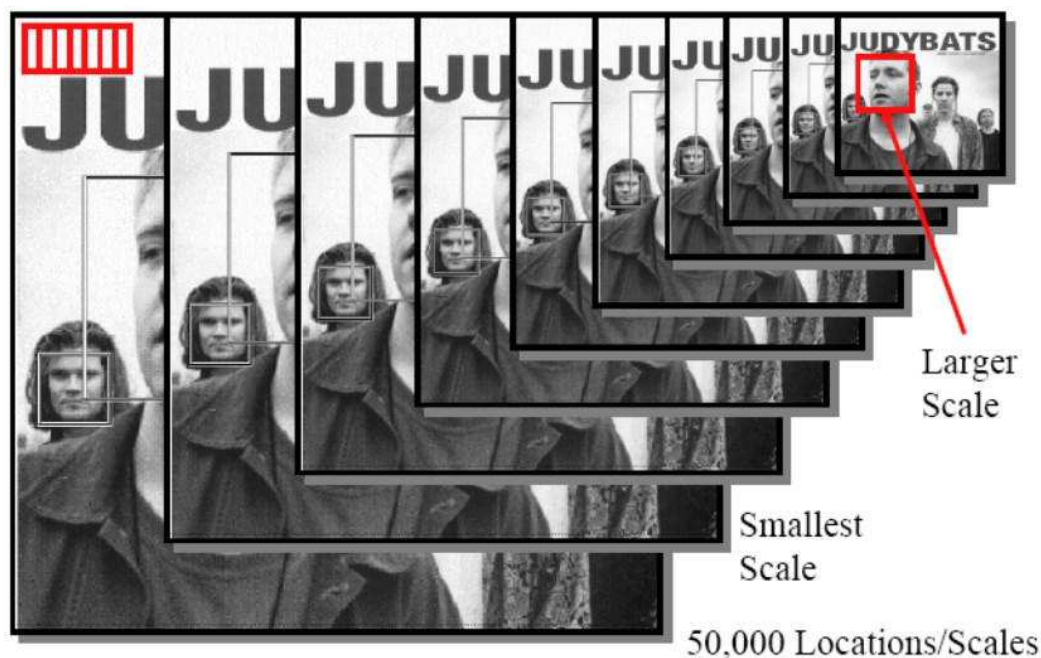
Multiscale search



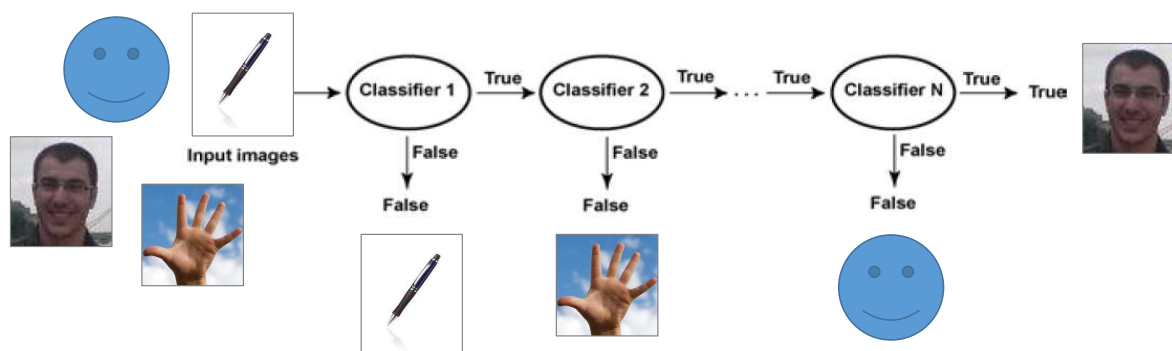
Input resizing



Image Pyramid



Cascade of classifiers



- A chain of classifiers that each reject some fraction of the negative training samples while keeping almost all positive ones
- Each classifier is an AdaBoost ensemble of rectangular Haar-like features sampled from a large pool

Training data

- Training Data
 - 5000 faces
 - All frontal, rescaled to 24x24 pixels
 - 300 million non-faces
 - 9500 non-face images
 - Faces are **normalized**
 - Scale, translation
- **Many variations**
 - Across individuals
 - Illumination
 - Pose



Deep Face

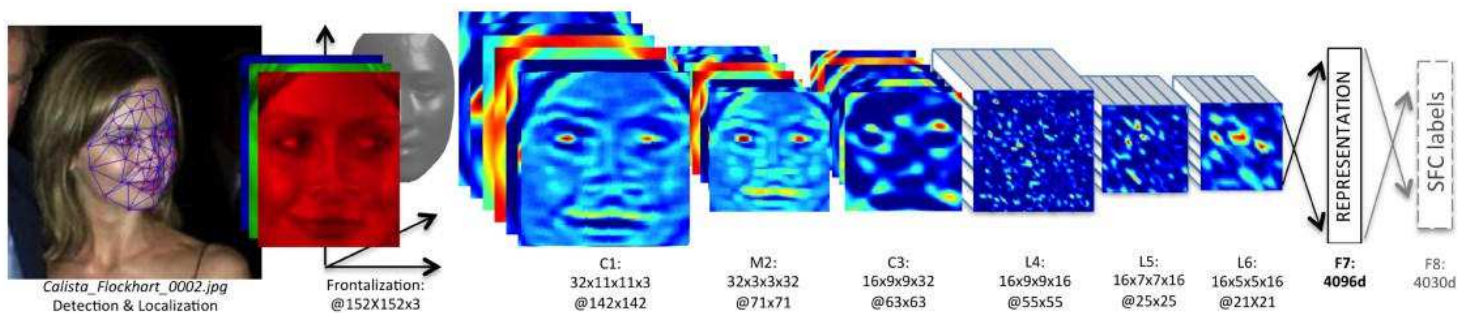


Figure 2. **Outline of the DeepFace architecture.** A front-end of a single convolution-pooling-convolution filtering on the rectified input, followed by three locally-connected layers and two fully-connected layers. Colors illustrate feature maps produced at each layer. The net includes more than 120 million parameters, where more than 95% come from the local and fully connected layers.

This figure from

Y. Taigman, M. Yang, M. Ranzato, L. Wolf, "DeepFace: Closing the Gap to Human-Level Performance in Face Verification," in IEEE Conference on Computer Vision and Pattern Recognition, pp. 1701-1708, 2014

Ball detection in RoboCup SPL Soccer



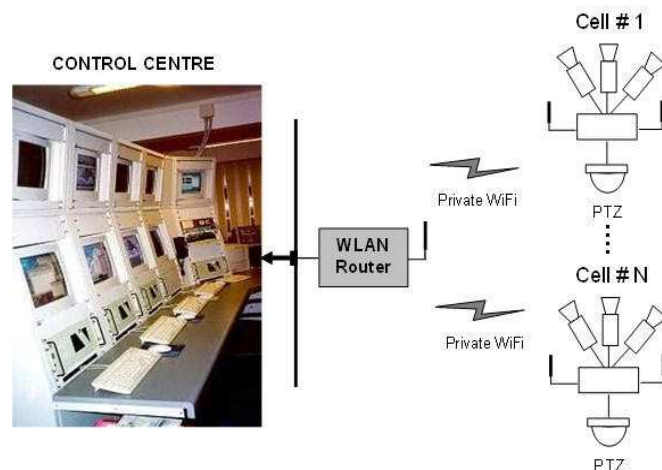
<https://youtu.be/ji0OmkaWh20>

ARGOS system

Automatic Remote Grand Canal Observation System



The *ARGOS* system controls a waterway of about 6 km length, 80 to 150 meters width, through 14 observation posts (Survey Cells)

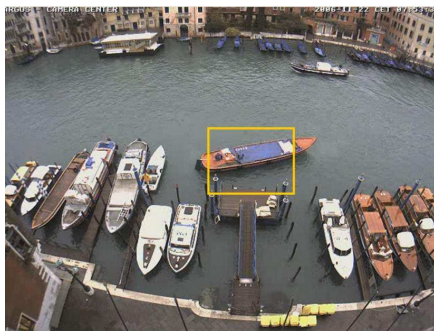


ARGOS system: boat tracking

https://youtu.be/9a70Ucgbi_U



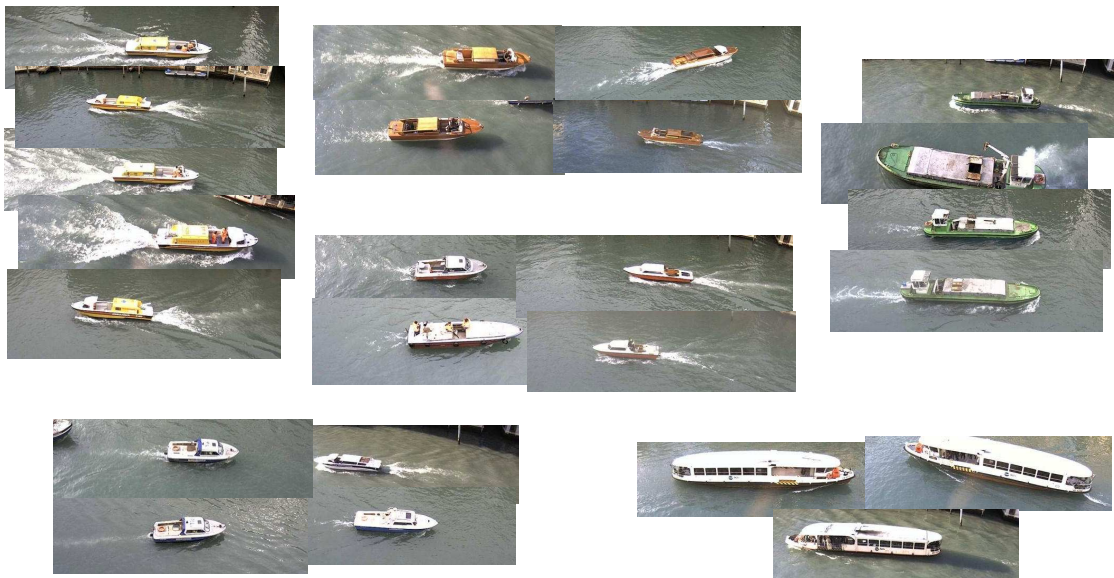
Speed limit control



Detecting boats
docking in the
highlighted
area

ARGOS captures screenshots
of the boats when passing
through the yellow line

Boat Classification



Boat Categories in Venice

1. Alligagna
2. Ambulanza
3. Barchino
4. Cacciapesca
5. Caorlina
6. Gondola
7. Lanciefino10m
8. Lanciefino10mBianca
9. Lanciefino10mMarrone
10. Lanciamaggioredi10m
11. Lanciamaggioredi10mBianca
12. Lanciamaggioredi10mMarrone
13. Motobarca
14. Motopontonerettangolare
15. MotoscafoACTV
16. Mototopo
17. Patanella
18. Polizia
19. Raccoltarifiutti
20. Sandoloaremi
21. SanpieroLa
22. Topa
23. VaporettoACTV
24. Vigili del Fuoco

ARGOS BOAT CLASSIFICATION

PEOPLE

Lancia fino a 10m

Lancia fino a 10m
bianca

Lancia fino a 10m
marrone

Lancia maggiore di
10m

Lancia maggiore di
10m bianca

Lancia maggiore di 10m
marrone

Alilaguna

Vaporetto ACTV

Motoscafo ACTV

GENERAL

Motobarca

Mototopo

Raccolta Rifiuti

Motopontone
rettangolare

PLEASURE CRAFT

Barchino

Potanella

Sanpierota

Cacciapesca

Topia

ROWING

Gondola

Sandalo a remi

Caorlina

PUBLIC UTILITY

Polizia

Ambulanza

Vigili del Fuoco

MarDCT dataset

<http://www.diag.uniroma1.it/~labrococo/MAR/>

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MarDCT

Maritime Detection, Classification and Tracking data set



DIPARTIMENTO DI INGEGNERIA INFORMATICA
E TELECOMUNICAZIONI PER SISTEMI INTEGRATI
SAPIENZA
UNIVERSITÀ DI ROMA

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SCENARIOS

Day Light PTZ Camera
 Moving day light PTZ camera
[view](#)

Infrared PTZ Camera
 Moving infrared PTZ camera
[view](#)

Multiple Cameras
 Three static day light cameras
[view](#)

Welcome to MarDCT home page

Maritime Detection, Classification, and Tracking (MarDCT) is a database of videos and images containing data coming from multiple sources (fixed, moving, and Pan-Tilt-Zoom cameras) and from different scenarios.

The aim of MarDCT is to provide visual data that can be used to help in developing intelligent surveillance system for the maritime environment. The data sets are divided according to the type of Ground Truth in: [Detection](#), [Classification](#) and [Tracking](#).

Feel free to contribute with your own data by [contacting us!](#)

MarDCT available files for detection

Data	Sensor	Location	Time	Camera	Reflections	View	GT Data
venice-1.m4v	EO	Venice, Italy	Afternoon	Static	Medium	Center	
venice-2.m4v	EO	Venice, Italy	Morning	Static	High	Center	
venice-3.m4v	EO	Venice, Italy	Morning	Static	High	Center	
venice-4.m4v	EO	Venice, Italy	Morning	Static	Low	Right	
venice-5.m4v	EO	Venice, Italy	Morning	Static	Low	Center	
venice-6.m4v	EO	Venice, Italy	Afternoon	Static	Low	Right	
venice-7.m4v	EO	Venice, Italy	Afternoon	Static	Medium	Left	
venice-8.m4v	EO	Venice, Italy	Afternoon	Static	Medium	Center	
venice-9.m4v	EO	Venice, Italy	Afternoon	Static	High	Right	
venice-10.m4v	EO	Venice, Italy	Night	Static	High	Center	
ir-1.avi	IR	Northern Europe	Night	Static	Low	Center	
ir-2.avi	IR	Northern Europe	Night	Static	Low	Center	
ir-3.avi	IR	Northern Europe	Night	Static	Low	Center	
IR-validation.zip	IR	Northern Europe	Night	Static	Low	Center	
reflections-1.avi	EO	Italy	Day	Static	High	Center	
reflections-2.avi	EO	Italy	Day	Static	High	Center	
reflections-3.avi	EO	Italy	Day	Static	High	Center	
italy-occlusions-1.avi	EO	Italy	Day	Static	Low	Center	

Examples



References and Credits

- P. Sermanet, "Object Detection with Deep Learning"
- K.H. Wong. "Ch. 6: Face detection"
- P. Viola and T.-W. Yue. "Adaboost for Face Detection"
- D. Miller. "Face Detection & Synthesis using 3D Models & OpenCV"
- S. Lazebnik. "Face detection"
- C. Schmid. "Category-level localization"
- C. Huang and F. Vahid. "Scalable Object Detection Accelerators on FPGAs Using Custom Design Space Exploration"
- P. Smyth. "Face Detection using the Viola-Jones Method"
- K. Palla and A. Kalaitzis. "Robust Real-time Face Detection"

Machine Learning

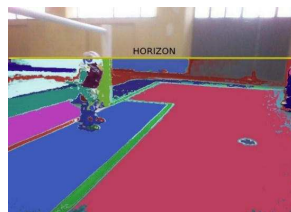
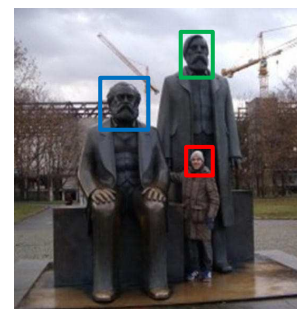
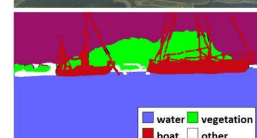
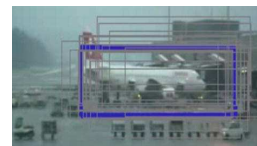
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Image Classification and Detection

Domenico Daniele
Bloisi



November 2018