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Barcelona

Project
Module 6
Coordination

Video Surveillance for Road Traffic Monitoring

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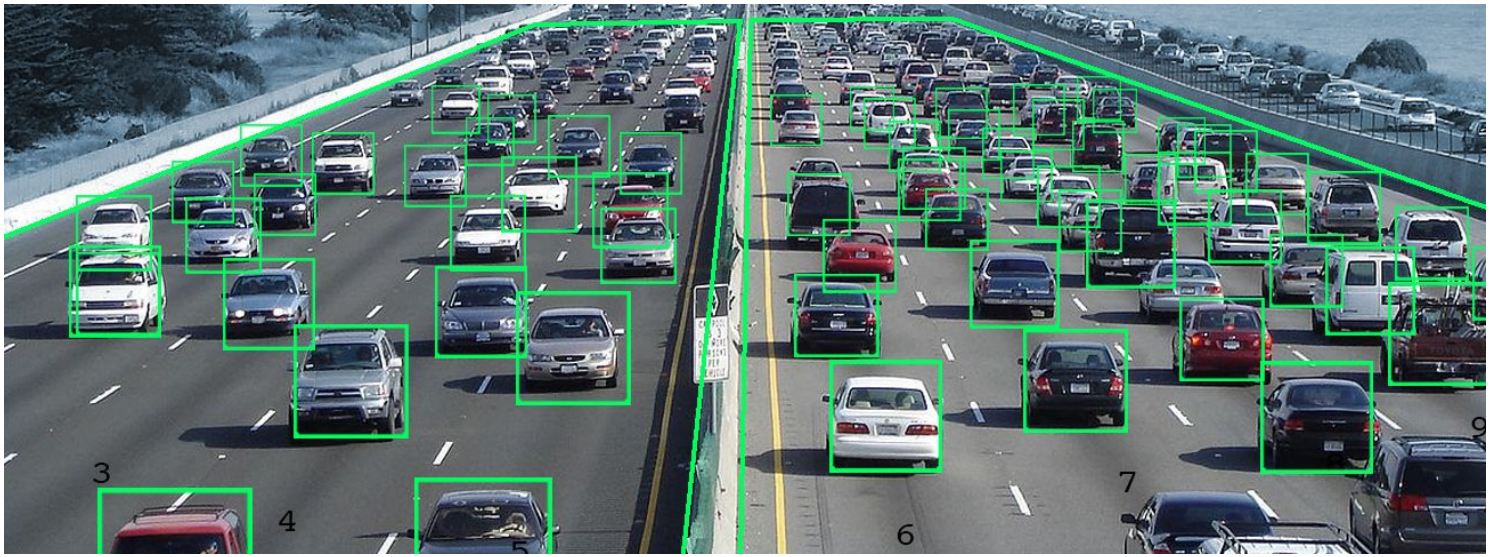
Motivation

- Vehicles play an important role in transportation systems.
- Most commonly used mean of transport.
- Problems: traffic jams, accidents, pollution, etc.



- **Road traffic monitoring** and Advanced Driver Assistance Systems (**ADAS**) are aimed to improve safety, efficiency and comfort at road transportation by means of information technologies.

Technical Project Goals

- **Learning goal**
  - To learn the basic concepts and techniques related to video sequences mainly for surveillance applications
- **Scope**
  - Use of statistical models to estimate the background information of the video sequence
  - Use of deep learning techniques to detect the foreground
  - Use optical flow estimations and compensations
  - Track detections with tracking algorithms
  - Analyze system performance evaluation
- **Applicability**
  - Any problem where video sequence analysis can be applied to obtain accurate automatic results

Project Flowchart

- Stages:
  - Background & foreground estimation
    - Model background using statistical models
  - Object detection & tracking
    - Extract foreground and uniquely identify them
  - Optical flow estimation
    - Improve tracking
  - Count cars, measure speed, track across different cameras

Methodology

- Students divided into groups of 4 people
- Semester is divided into 5 weeks
- Every week (Wednesday) students submit (GitHub) their homework
  - slides (google docs)
    - Include links to relevant files in the team's GitHub repository
  - code (github)
  - Intra group evaluation
- 1 hour class
  - ~30min devoted to discussions
    - Students present their results in class / Answer questions
  - ~30min to present next week's work

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Timetable

https://mcv.uab.cat/m6-video-analysis/

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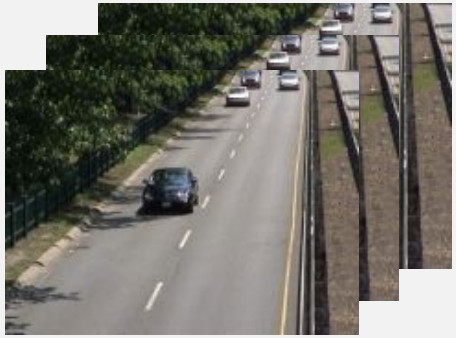
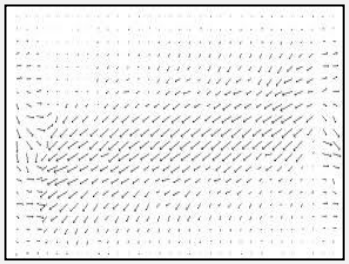
Project Schedule

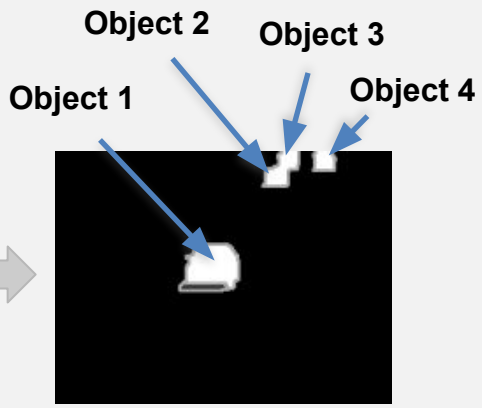


Background



Optical flow

Foreground



Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
• Introduction • Datasets • Evaluation metrics	• Background estimation • Stauffer & Grimson	• Segmentation • Object Detection • Tracking	• Optical flow • Tracking	• Multiple cameras • Speed • AI City Challenge	• Presentation workshop

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Programming Language

- Python
  - Pycharm, Spyder
- OpenCV
  - Python interfaces
- Pytorch, keras

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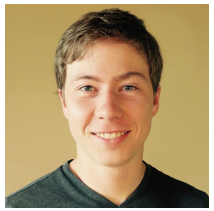
General tips: First steps in Python


- Tutorials in Python
  - Víctor Adell, Raúl Higueras, UPC Python Cookbook
  - Justin Johnson (Stanford University)



- Text editors with Python optimizations:
  - PyCharm (suggested)
  - Sublime Text
  - Atom
  - Spyder
  - Enthought Canopy

General tips: First steps in Python

Axel Barroso, Sergio Sancho, Alejandro Nespereira & Marc Carné, "Video surveillance for road traffic monitoring". Master in Computer Vision Barcelona 2017. [slides] [report]

As well as other projects from previous course editions:

- 2021, 2020, 2019, 2018, 2017, 2016

General tips: Get your Github education account

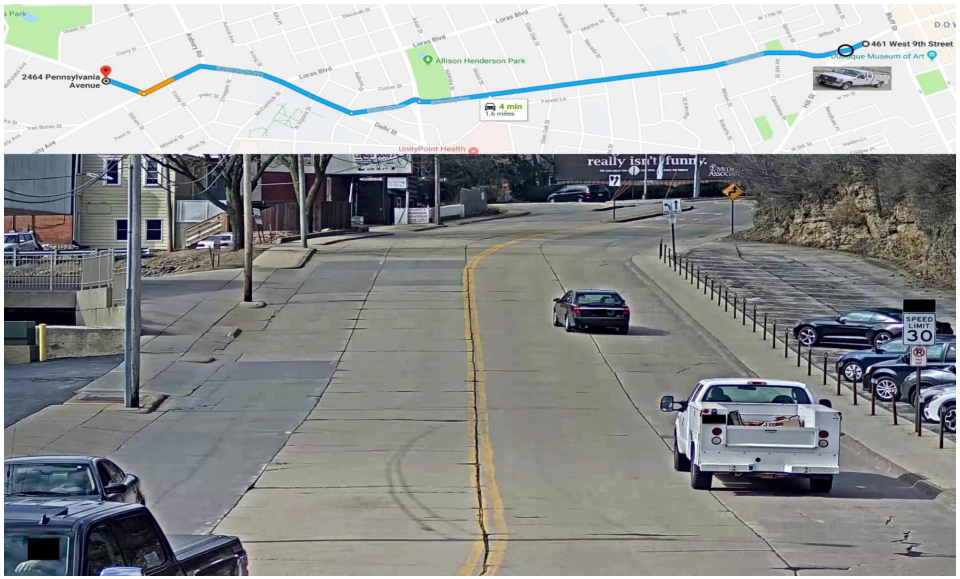
https://education.github.com/

Google cloud

- https://cloud.google.com
- Explanation slides

Datasets: NVIDIA AI CITY Challenge

- https://www.aicitychallenge.org/
  - 3.25 hours of videos from 40 cameras spanning 10 intersections
  - 5 scenarios: 3 training, 2 validation and 1 test
  - 229,680 bounding boxes for 666 distinct annotated vehicle identities.
  - Resolution 960p and 10fps.



Datasets: KITTI

- KITTI Vision Benchmark Suite
  - http://www.cvlibs.net/datasets/kitti
  - Optical flow ground truth

  - TRAINING DATASET
    - 194 image **pairs** + optical flow ground truth
  - TEST DATASET (subset)
    - 195 image **pairs** + optical flow ground truth

Project Evaluation

- The Project Development: PD
  - Weeks 1-4 (PD_i)
    - Delivered code + slides
    - Completion of tasks and optionals
    - Feedback and questions to professors in class
  - Week 5 (PD_5)
    - Full code + short report
- Intra-Group Evaluation:
  - Every week students quantize the % of workload done by each member of the team → Modify up to 50% of the grade
  - 2 weeks under grade 5 → split into a new team
- Final project presentation: $PP = 0.5 \cdot PP^{professor} + 0.5 \cdot PP^{students}$
- The final mark is $$V = \sum_{i=1}^{4} 0.15 \cdot PD_i + 0.3 \cdot PD_5 + 0.1 \cdot PP$$

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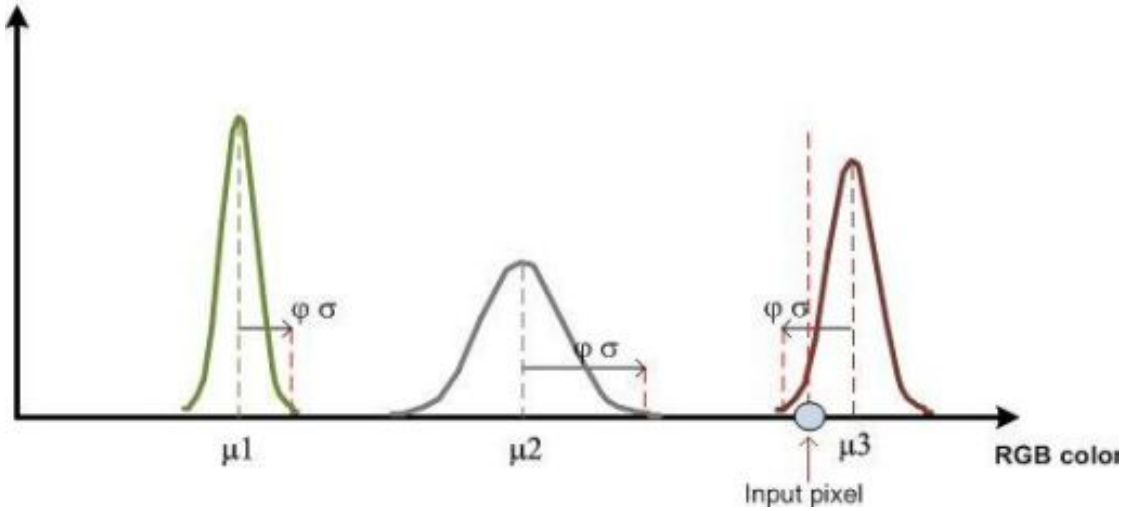
Assignments: Week 1

- Introduction to video sequence analysis and evaluation
  - Understand and familiarize with the programing framework used in the project
    - Google cloud / python
  - Learn about the databases to be used
  - Practice the evaluation metrics
  - Read / write video sequences

Assignments: Week 2

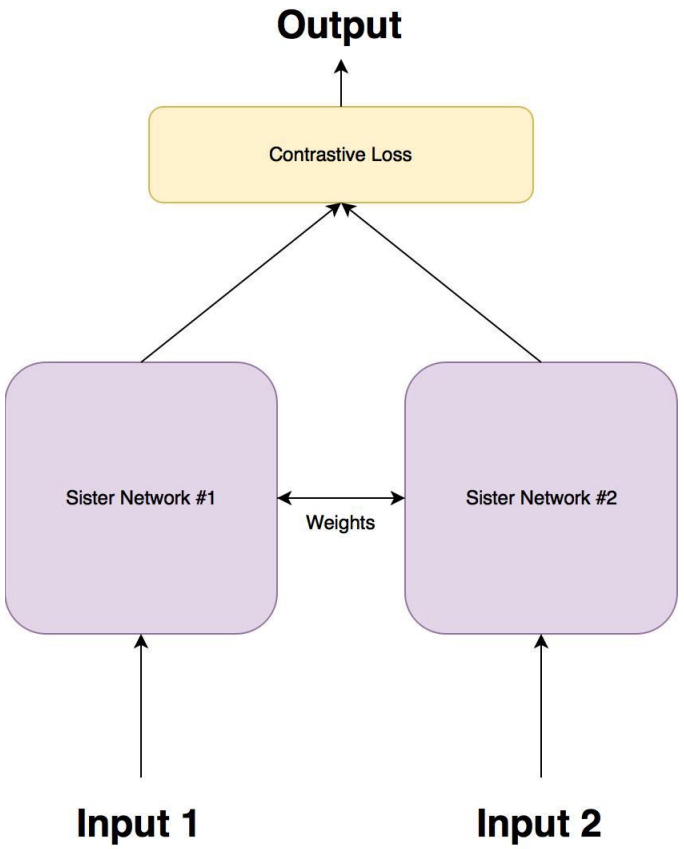
- Background estimation
  - Model the background pixels of a video sequence using a simple statistical model to classify the background / foreground
    - Single Gaussian per pixel
    - Adaptive / Non-adaptive
  - The statistical model will be used to preliminary classify foreground
  - Comparison with more complex models
    - Stauffer and Grimson / deep learning frameworks



Assignments: Week 3

- Object Detection
  - Fine-tune object detection network
  - SSD, Faster R-CNN, YoLo

- Tracking
  - Simple overlap
  - Kalman filter
  - Siamese network



Assignments: Week 4

- Optical flow
  - Motion Estimation by computing optical flow
  - Optical flow used to improve object detection and tracking

Assignments: Week 5

- Multi camera tracking
  - Improve siamese network to track vehicles across cameras

- Speed estimation

- Nvidia AI city challenge submission
  - **9th / 18th April!**