



Lecture 2

Computer Vision Applied to Transport Problems

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ERASMUS+ Mobility

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University of Zagreb
Faculty of Transport and Traffic Sciences



Erasmus+



Personal Information



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EDUCATION

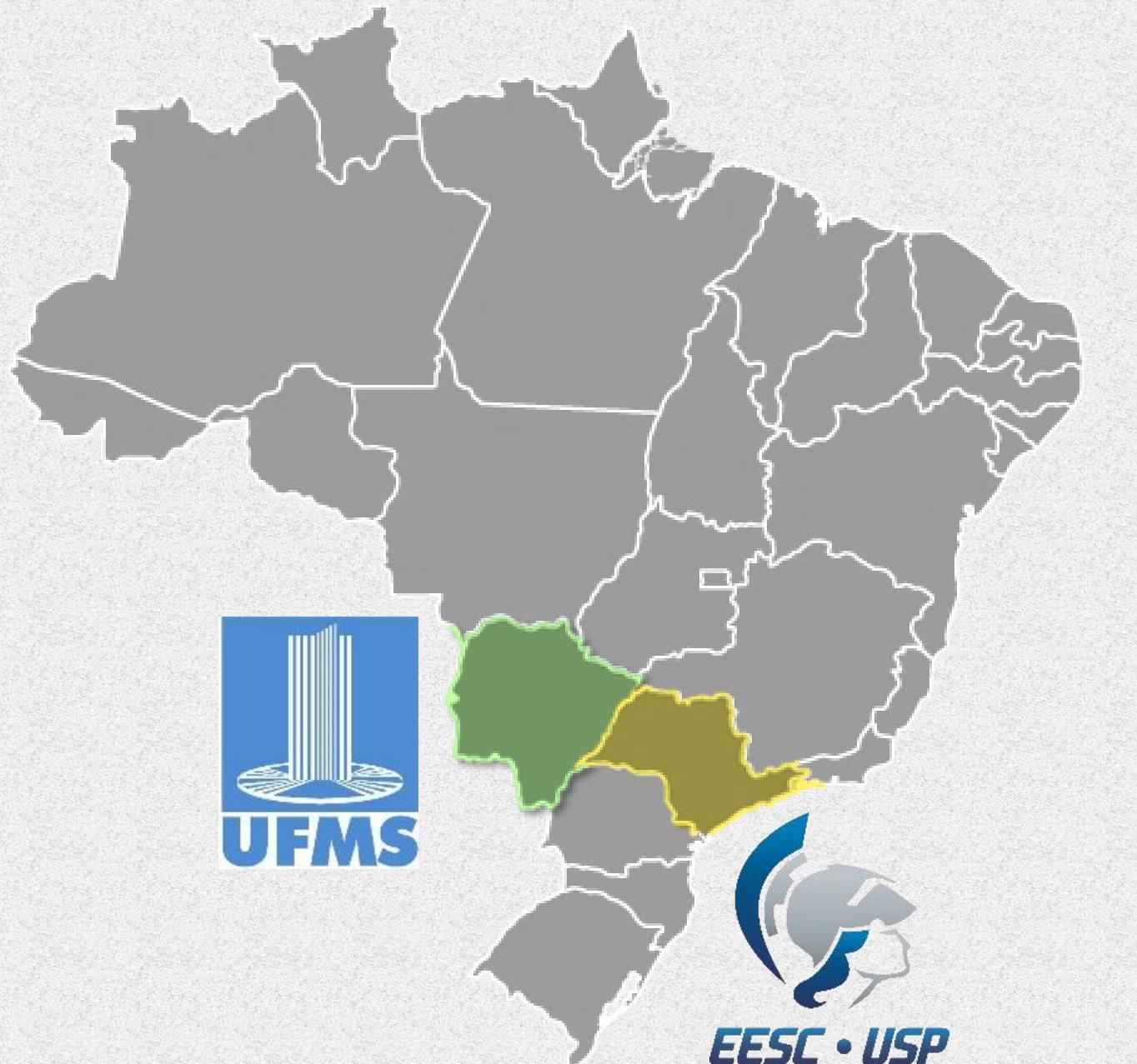
UFMS: Federal University of Mato Grosso do Sul
Civil Engineer

USP: São Carlos School of Engineering
MSc in Transport Engineering

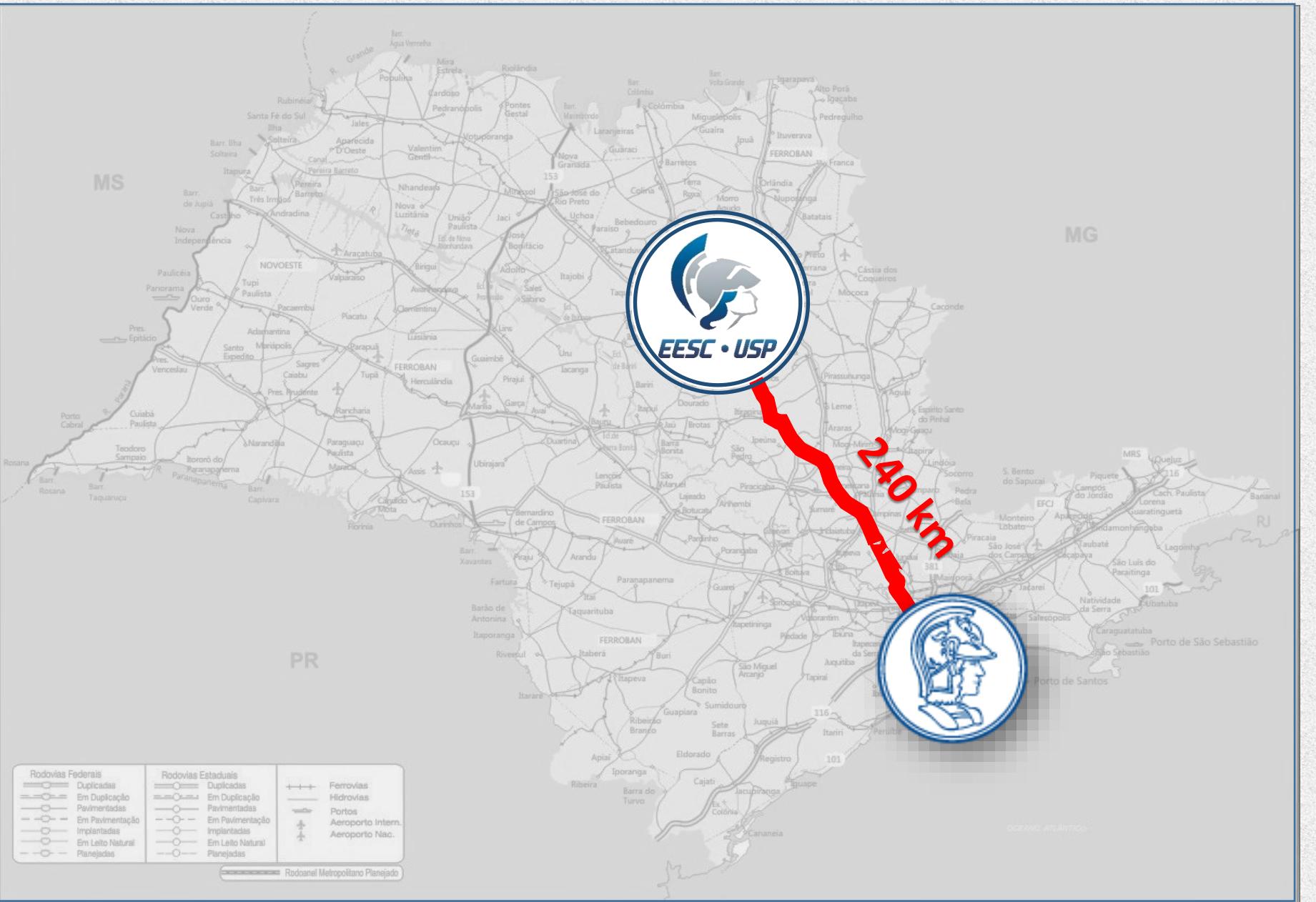
USP: São Carlos School of Engineering
PhD in Transport Engineering

UoM: Melbourne School of Engineering
PostDoc in Transport Engineering

Personal Information

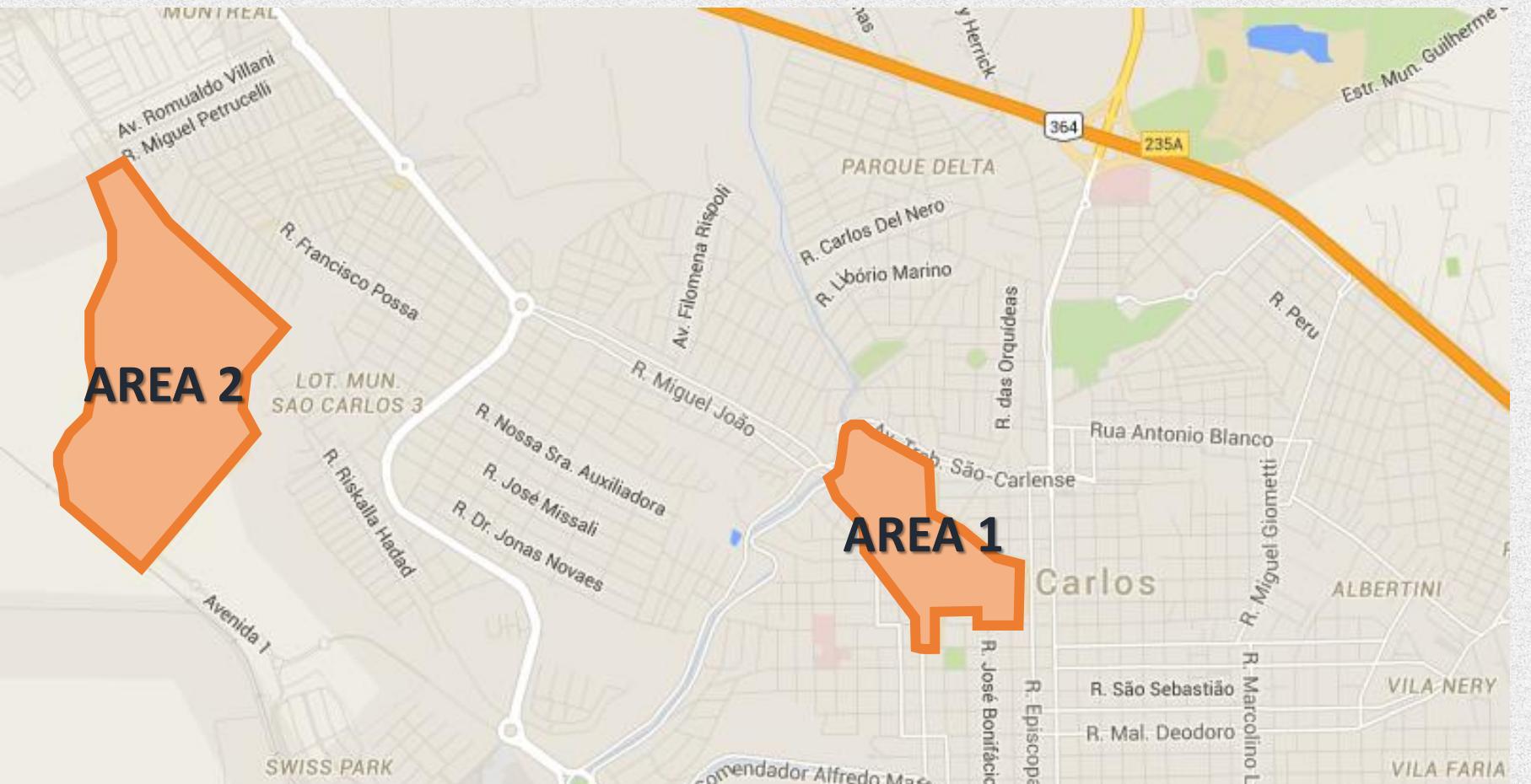


Personal Information



EESC • USP

Personal Information



USP - Campus São Carlos

DEPARTMENT OF TRANSPORT ENGINEERING

Planning and Operation

Urban planning
Public Transport
Supply and Demand Analysis
Traffic Engineering
Intelligent Transportation System
Mobility and Sustainability

Infrastructure and Geomatic

Road design and Drainage
Soil Analysis
Pavement Sustainability
Pavement Management
Global Position System
Geographic Information System

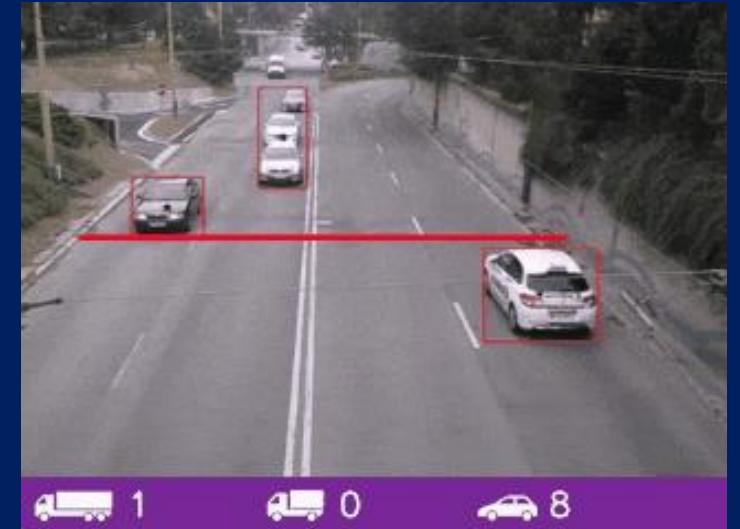
TRUCK IMPACT

- **Highway Capacity:**
*Effect of trucks on traffic flow
Calibration for Brazilian manual*
- **Road Freight Transport:**
~62% of loads on roads
- **Combination of vehicles:**
+40 different truck types



TRAFFIC DATA COLLECTION

- Computer Vision in traffic videos
- Vehicle **detection** and tracking
- Length **classification**





RESEARCH INTEREST

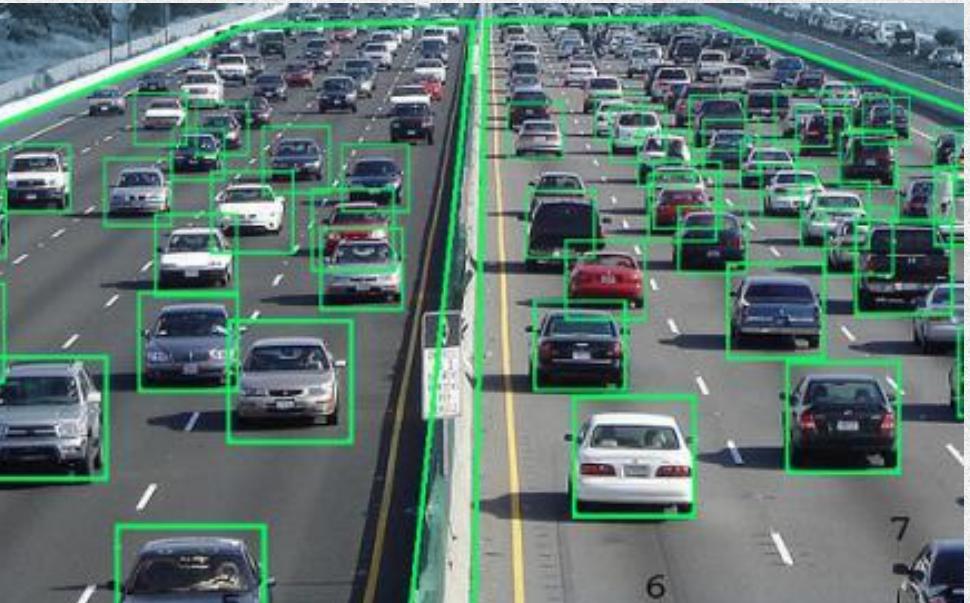
- **Multisensors and devices** to collect traffic data
- **Data Fusion and Machine Learning**
- Traffic and Driving **Simulation**
- **Users Behaviour** Analysis

Computer Vision



Computer Vision

“A picture is worth a thousand words”



Computer Vision

Computer Vision Tasks

Classification



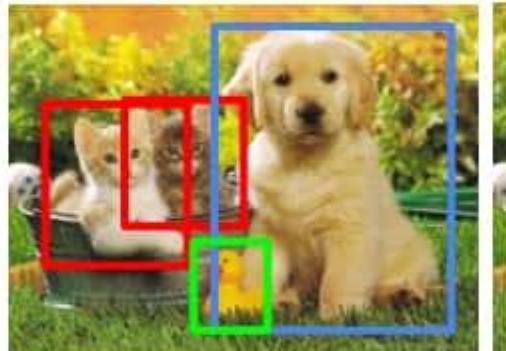
CAT

Classification + Localization



CAT

Object Detection



CAT, DOG, DUCK

Instance Segmentation

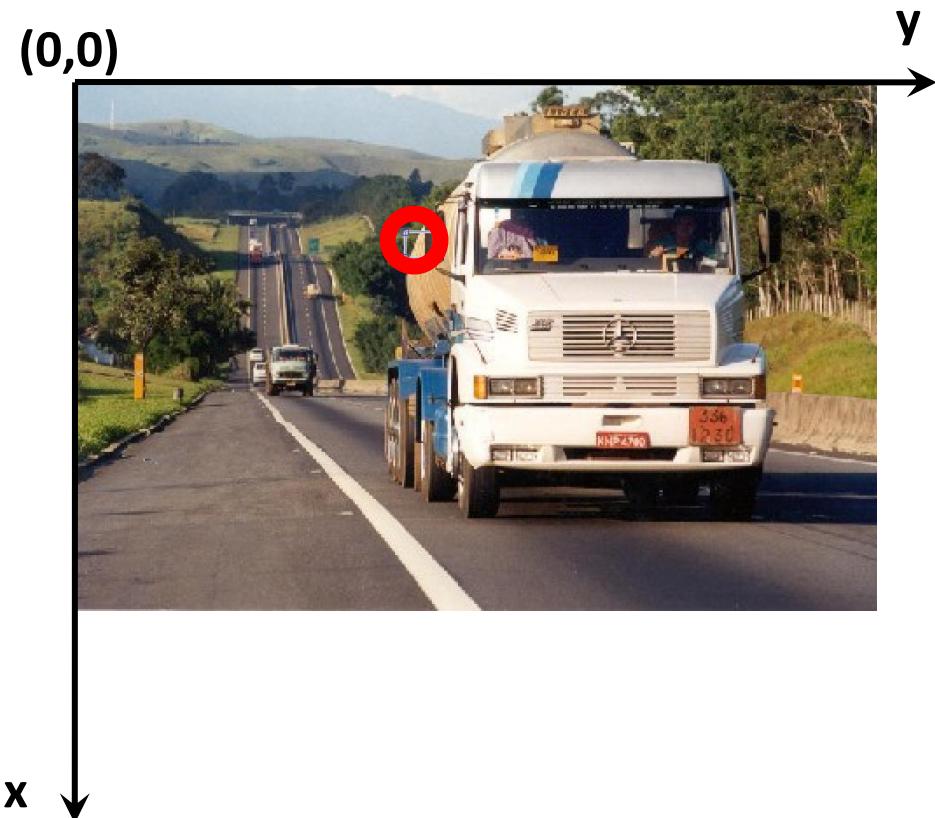


CAT, DOG, DUCK

Single object

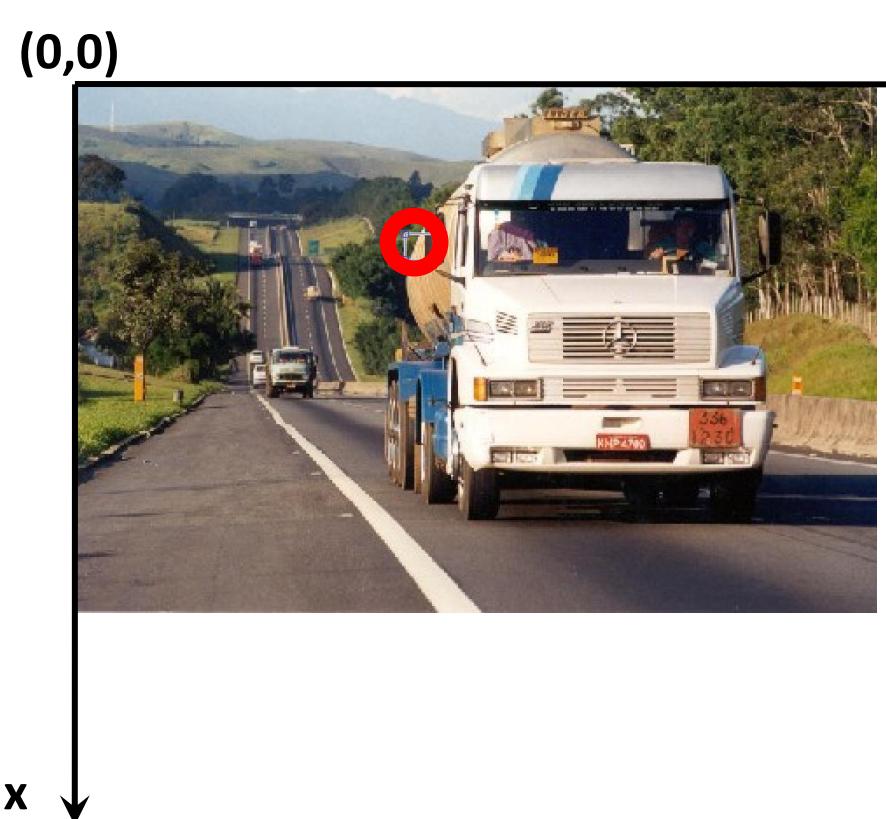
Multiple objects

DIGITAL IMAGE



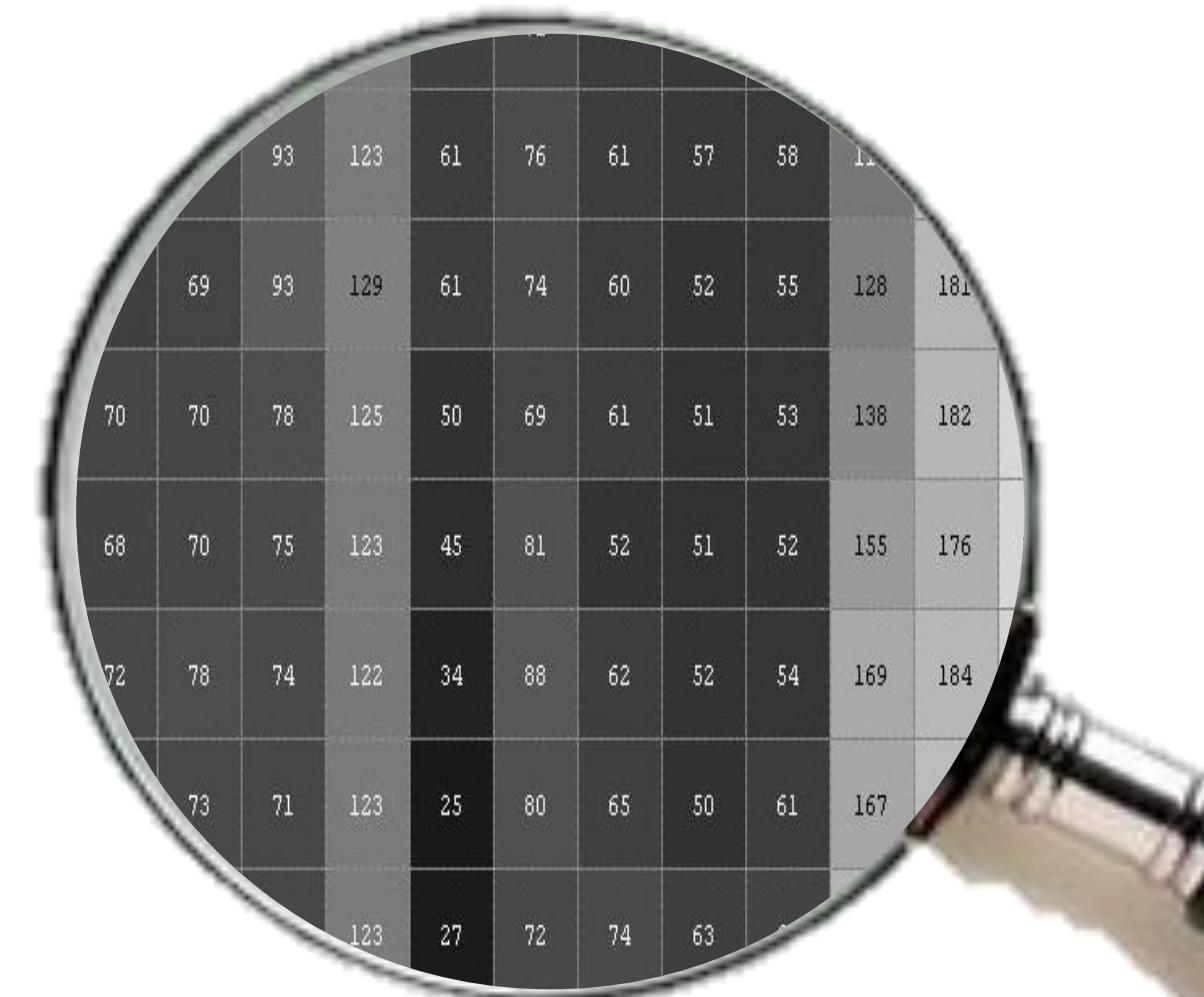
$$f(x, y) = \begin{bmatrix} f(0,0) & f(0,1) & \dots & f(0, N-1) \\ f(1,0) & f(1,1) & \dots & f(1, N-1) \\ \vdots & \vdots & \vdots & \vdots \\ f(M-1,0) & f(M-1,1) & \dots & f(M-1, N-1) \end{bmatrix}$$

DIGITAL IMAGE

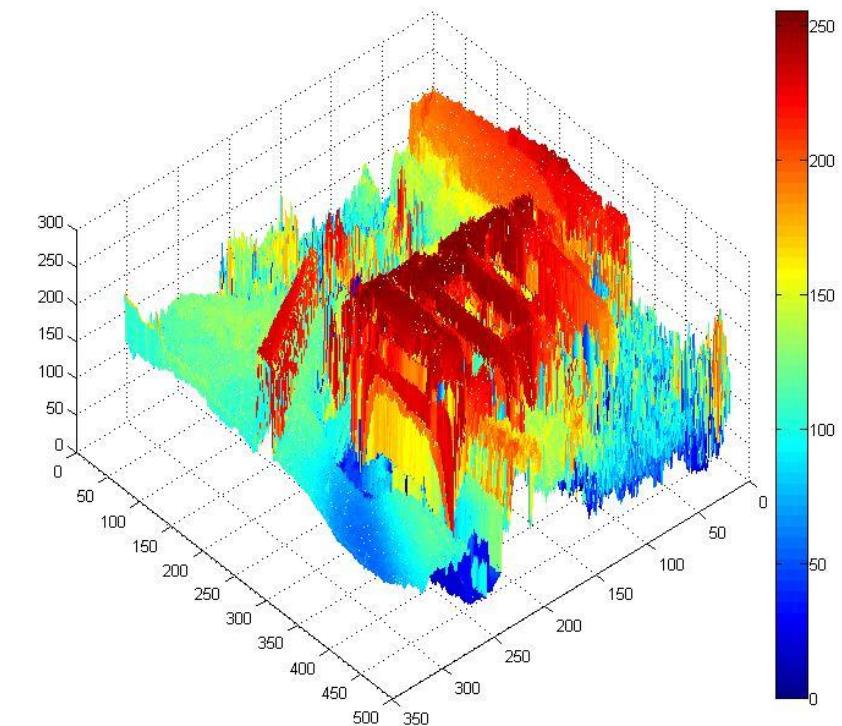
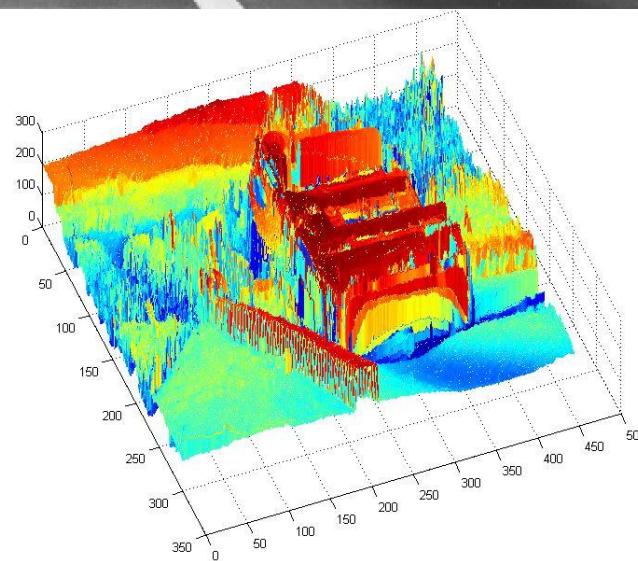


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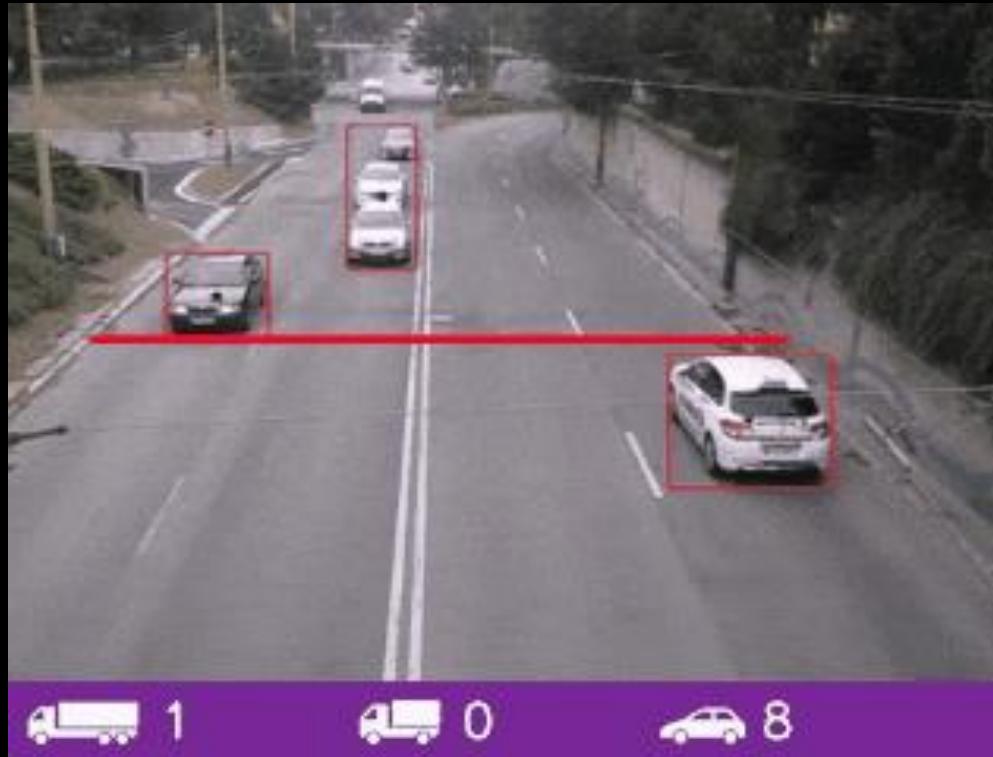
DIGITAL IMAGE



DIGITAL IMAGE



Traffic Parameters



Examples

Extract traffic flow parameters

■ Cunha, A.L. [2013]

- SxT diagram
- Background model
- Feature detection



Video frame 1



Video frame 2

■ Marcomini, L.A. [2018]

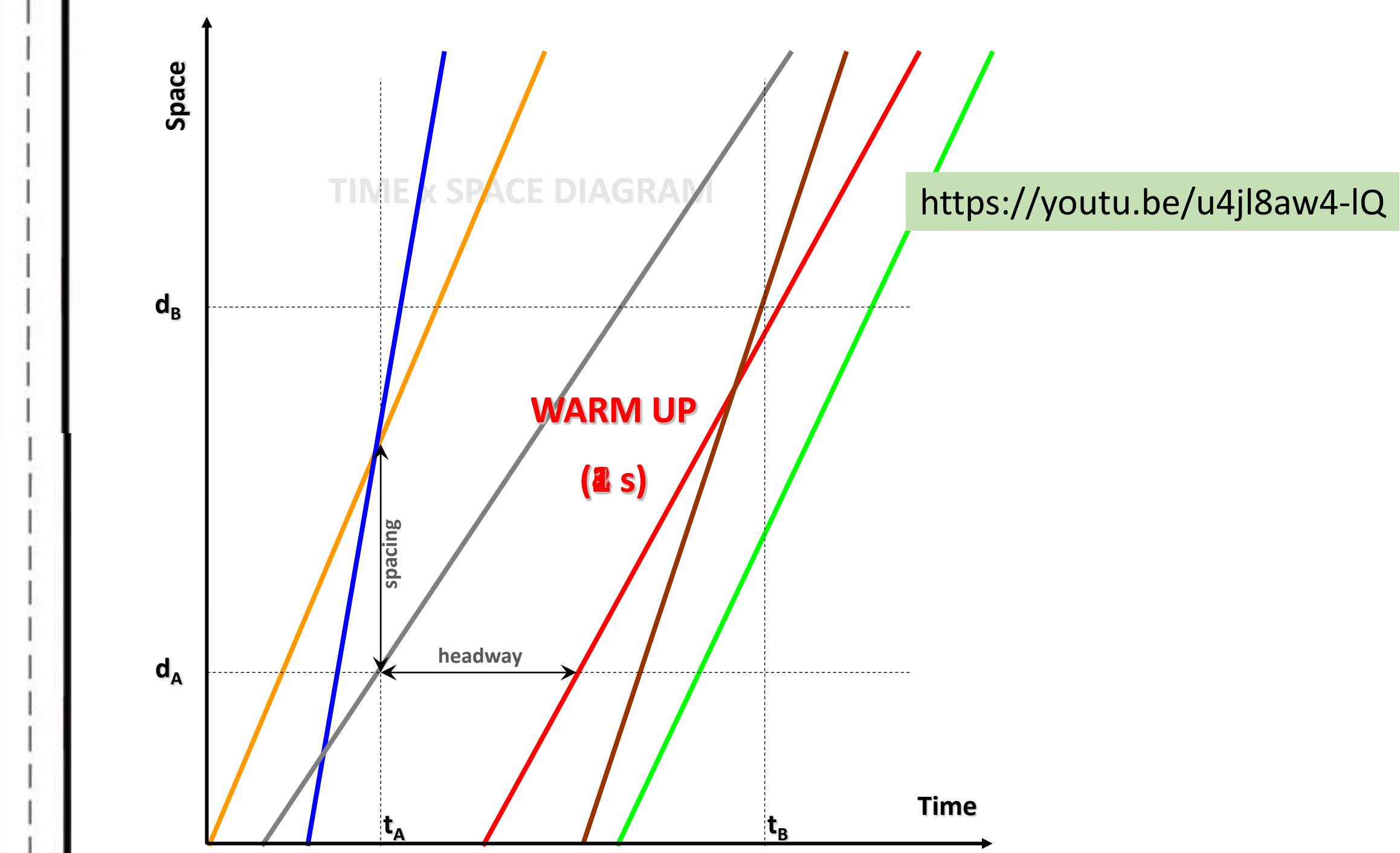
- SxT diagram
- Background model
- Tracking method

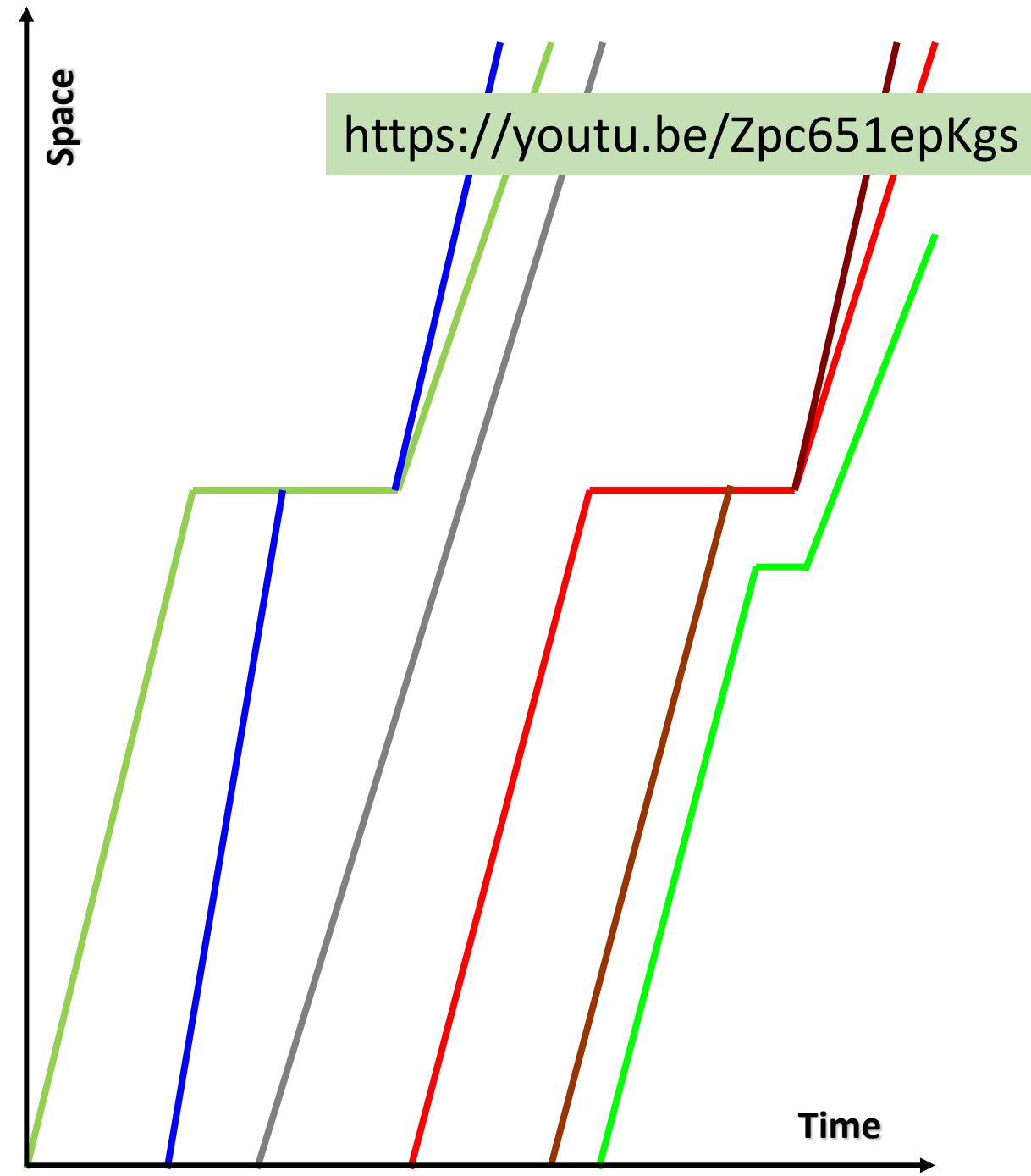
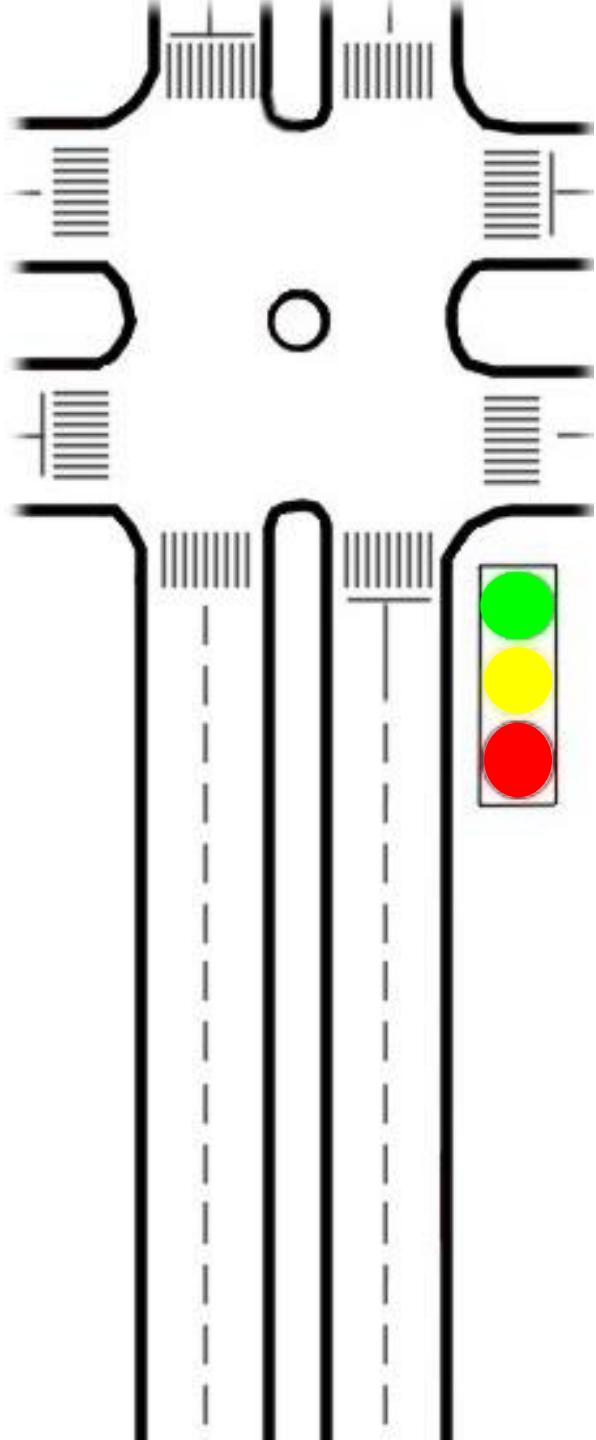


Video frame 3



Video frame 4



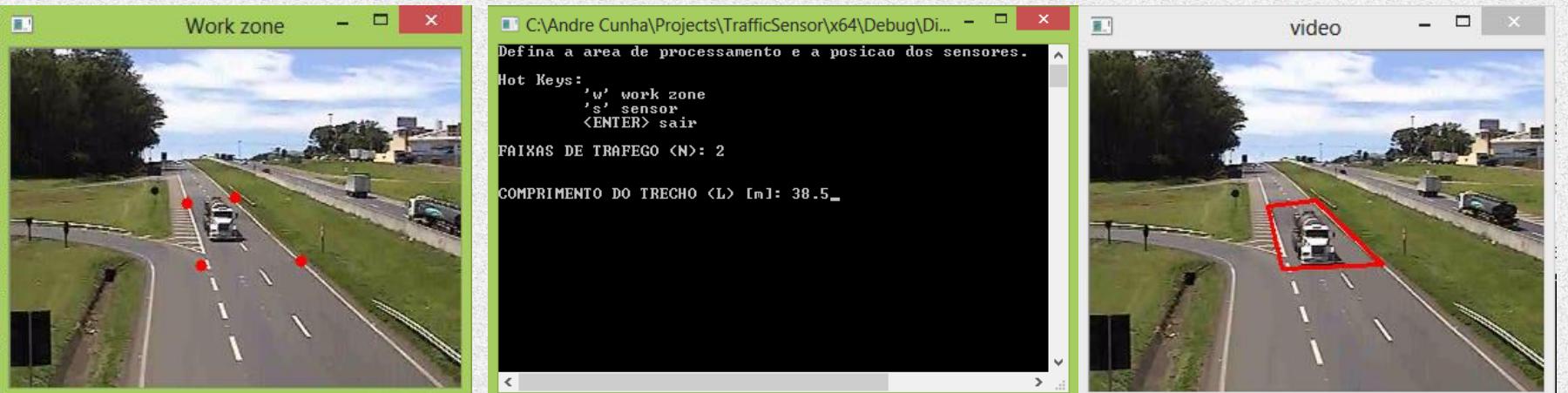


Examples

Extract traffic flow parameters

■ Cunha, A.L. [2013]

- SxT diagram
- Background model
- Feature detection

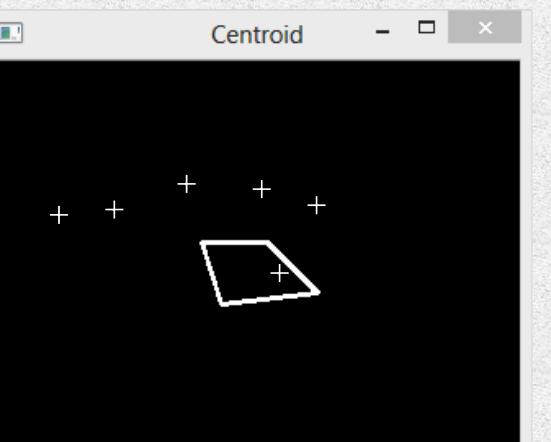
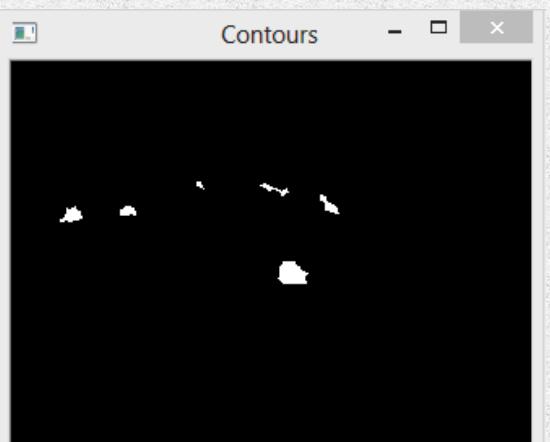


Examples

Extract traffic flow parameters

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- SxT diagram
- Background model
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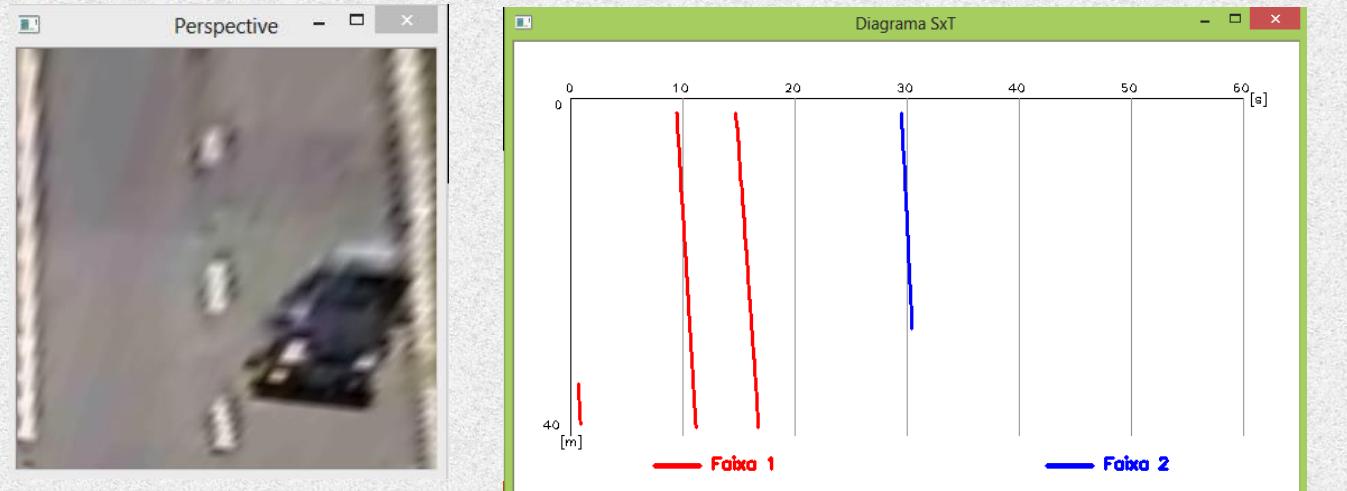


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■ Cunha, A.L. [2013]

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Extract traffic flow parameters

■ Marcomini, L.A. [2018]

- SxT diagram
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- Tracking method

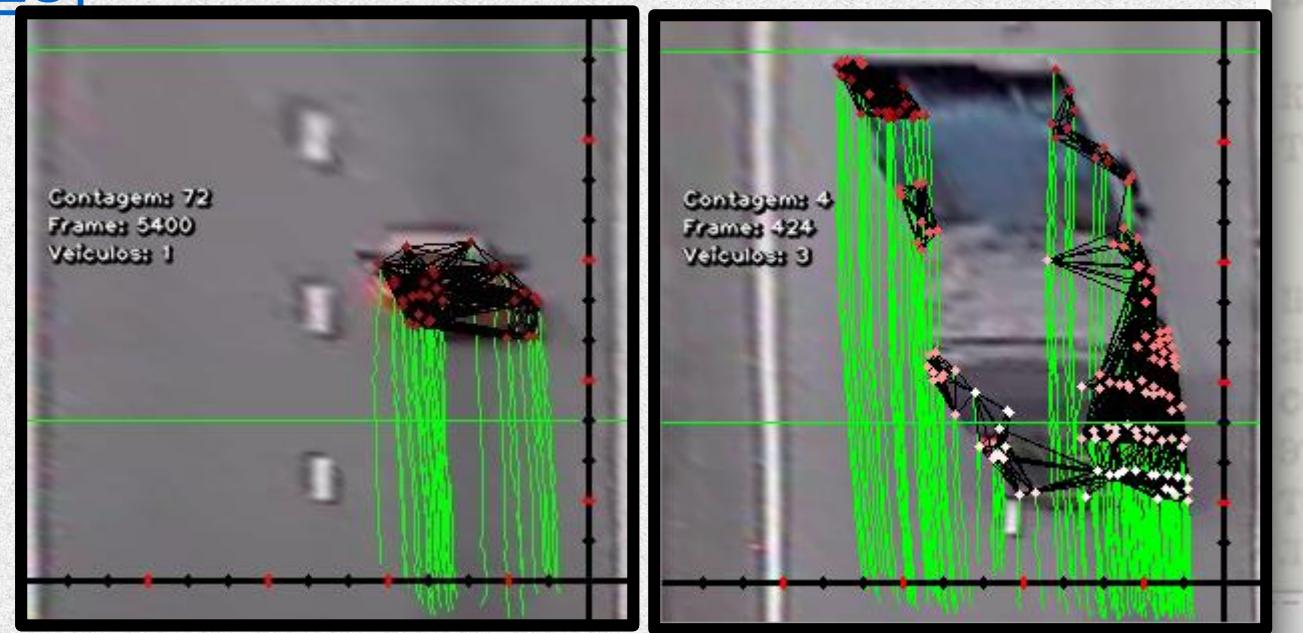


Examples

Extract traffic flow parameters

■ Marcomini, L.A. [2018]

- SxT diagram
- Background model
- Tracking method



Extract traffic flow parameters

PUBLICATIONS

- [\[2013\] Cunha, A.L.](#) PhD thesis
- [\[2018\] Marcomini, L.A.](#) Master's dissertation
- [2018] Marcomini, L.A.; Cunha, A.L.
A Comparison between Background Modelling Methods for Vehicle Segmentation in Highway Traffic Videos. <[arXiv](#)>
- [2019] Marcomini, L.A.; Cunha, A.L.
The impact of different video resolutions in a feature-based vehicle detection algorithm. <[ANPET Proceedings](#)>

Examples

Motorcycle rider behavior



Examples

Motorcycle rider behavior

■ Felicio, A.B. [2019]

- Create an Image Dataset (M, NM)
 - ~1,000 M and ~13,000 NM
 - [ImageNet](#)
 - [ImageProcessing Db](#)
 - [SIPI ImDb](#)
 - [MIO-TCD](#)
- Descriptors (texture)
- Classifier (SVM)

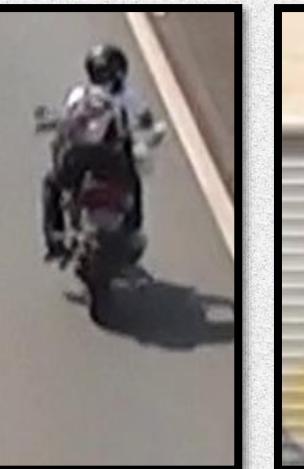
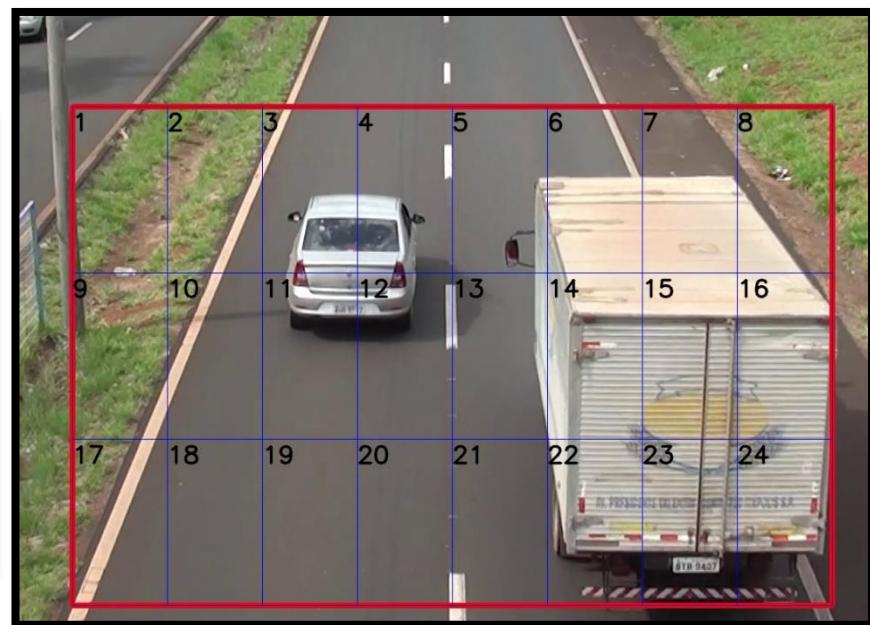
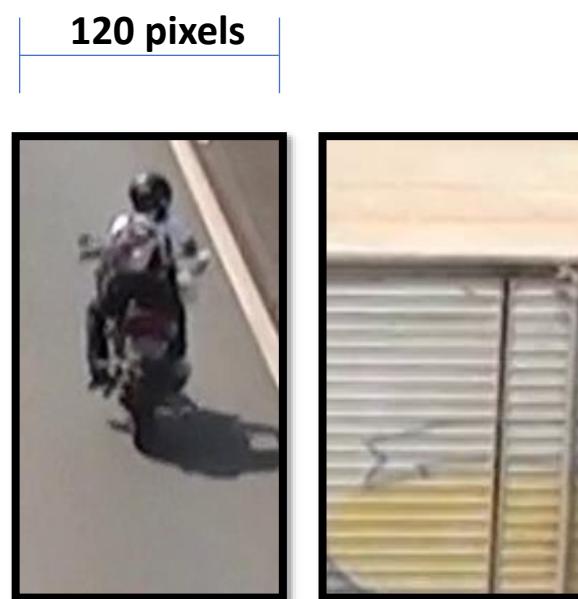
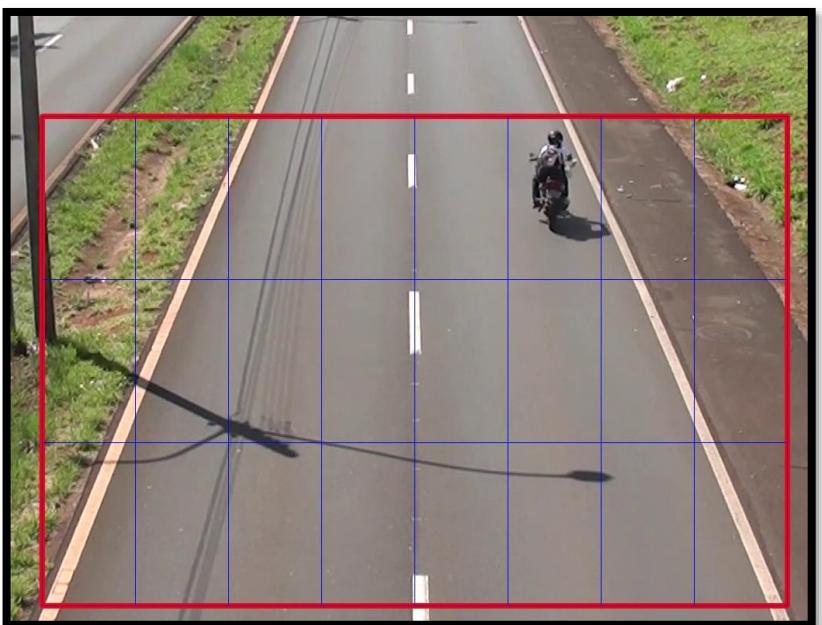
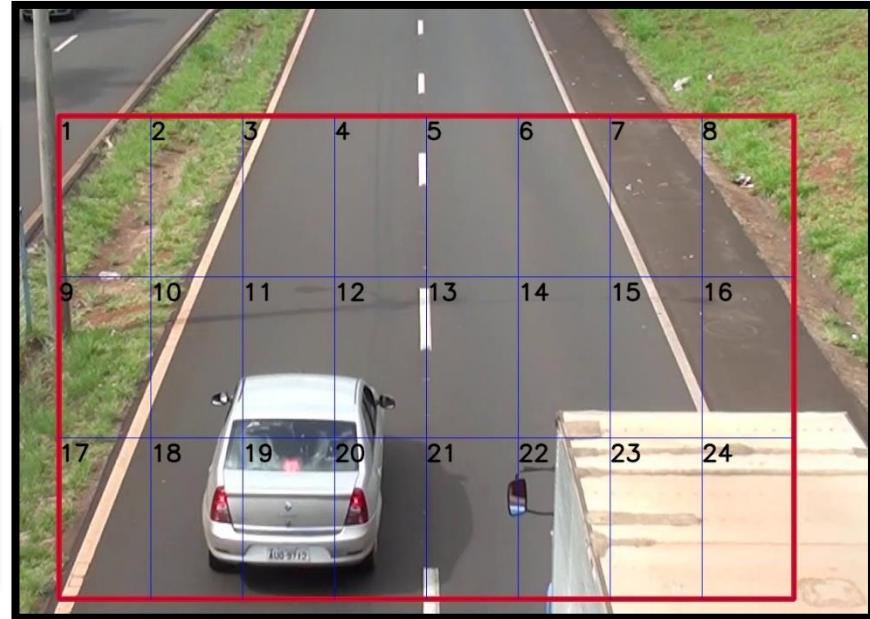
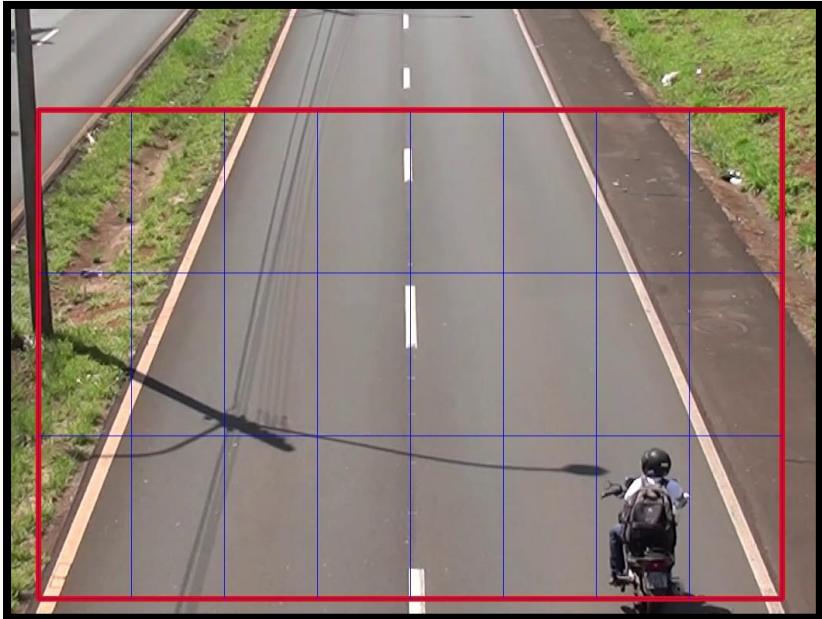


Image Dataset Composition

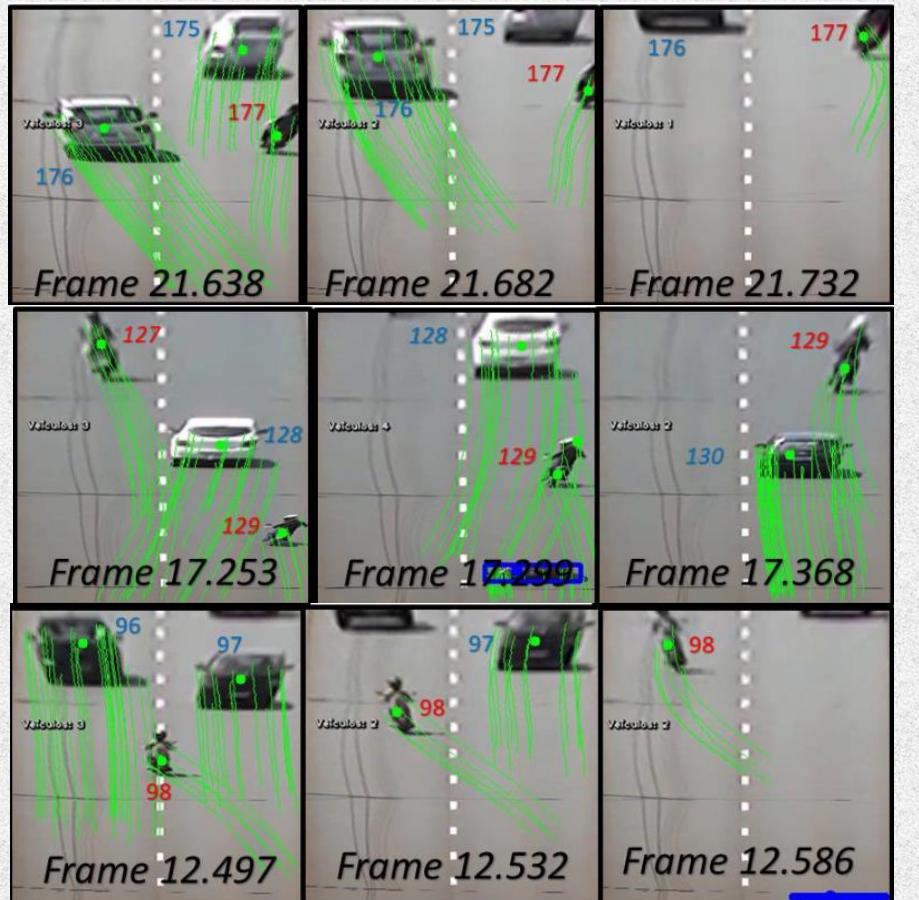


Examples

Motorcycle rider behavior

■ Felicio, A.B. [2019]

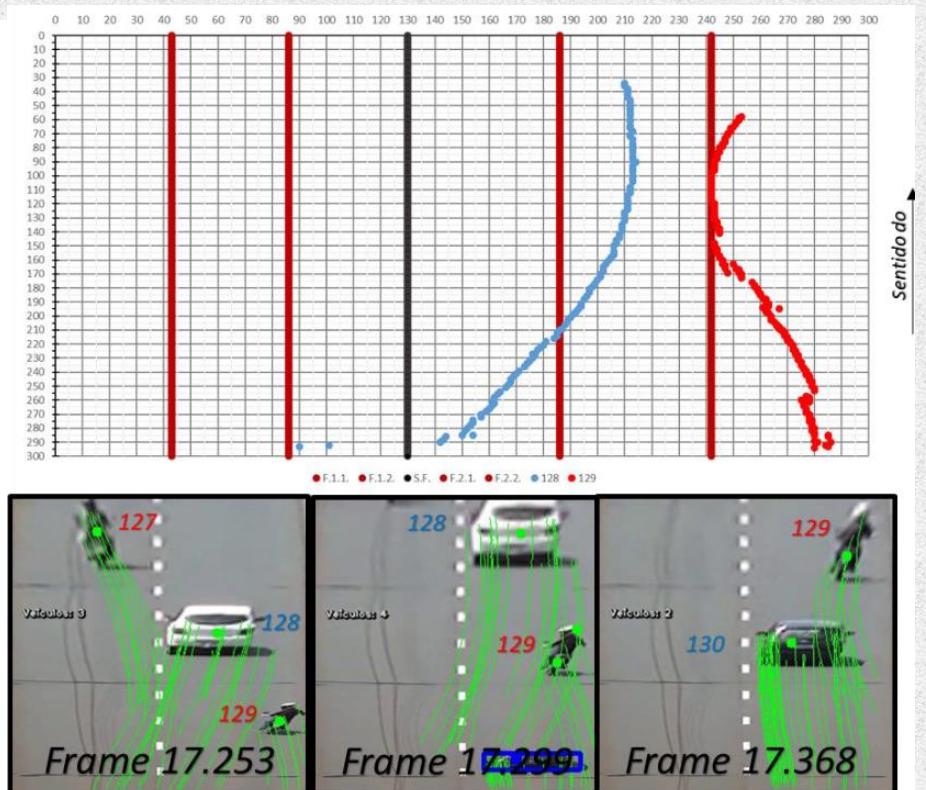
- LinearSVC + LBP Histogram:
 - accuracy > 0,91
 - AUROC > 0,95



Motorcycle rider behavior

■ Felicio, A.B. [2019]

- LinearSVC + LBP Histogram:
 - accuracy > 0,91
 - AUROC > 0,95
- Riders behavior:
 - prefer keep on right lane
 - use mostly 1/3 of the lane



Motorcycle rider behavior

PUBLICATIONS

- [\[2019\] Felicio, A.B.](#) Master's dissertation
- [2019] Felicio, A.B.; Cunha, A.L.
Classification of Motorcycles using Extracted Images of Traffic Monitoring Videos. <[arXiv](#)>

Examples

Truck Axe Detection



Examples

Truck axle detection

- Panice, N.R. [2018]



Examples

Truck axle detection

- Panice, N.R. [2018]
 - Segmentation (LBP)
 - Count axle (T. Hough)
 - Classify trucks



Examples

Truck axle detection

- Panice, N.R. [2018]
 - Segmentation (LBP)
 - Count axle (T. Hough)
 - Classify trucks

- Results
 - Segmentation: 68,3%~84,2%
 - Counting: 90%~93%



Examples

Truck axle detection

- Marcomini, L.A. [~2024]
 - SSD
 - Faster R-CNN
 - Yolo
- Preliminar Results
 - Yolo and SSD had similar accuracy and performance
 - mAP > 96%



Truck axle detection

PUBLICATIONS

- [\[2018\] Panice, N.R.](#) Master's dissertation
- [2020] Marcomini, L.A.; Cunha, A.L.
Truck axle detection labeled Dataset <[doi:10.5281/zenodo.3788068](https://doi.org/10.5281/zenodo.3788068)>
- [2021] Marcomini, L.A.; Cunha, A.L.
Truck image labeled Dataset <[doi:10.5281/zenodo.5744737](https://doi.org/10.5281/zenodo.5744737)>
- [2022] Marcomini, L.A.; Cunha, A.L.
Truck axle detection with Convolutional Neural Networks. <[arXiv](#)>



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<https://github.com/albnc>
<https://github.com/labITS-stt-eesc>