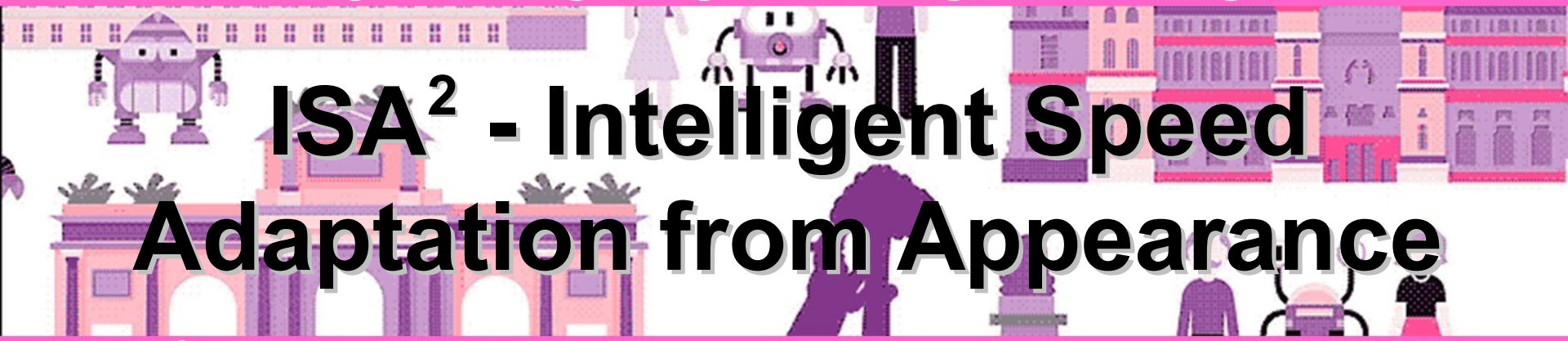
10th Workshop on Planning, Perception and Navigation for Intelligent Vehicles



ISA^2 - Intelligent Speed Adaptation from Appearance

MADRID 2018 IROS

PPNIV'18

Carlos Herranz-Perdiguero

Roberto J. López-Sastre

GRAM

Universidad de Alcalá

ISA stands for ...

- **I**ntelligent **S**peed **A***daptation* (or **A***ssistance)*
  - It is any system that ensures that vehicle speed does not exceed a safe or legally enforced speed.

Image credit: ETSC

Why ISA?

5.500 pedestrians killed in 2013

2000 cyclist killed in 2013

26.000 people killed in 2013

Speed is the primary factor in 1/3 of all fatal collisions
Up to 60% of drivers exceed speed limits

Why ISA?

ISA could cut collisions by 30%

ISA could cut deaths by 20%

Cars fitted with ISA could reduce CO2 emissions by 8%

How does an ISA system works today?

GPS Based

1 Car receives position information via GPS

2 Speed limit is updated from a digital map

This is also combined with traffic sing recognition solutions

But this model has limitations

GPS information is not accurate

- **Poor satellite visibility**
- **Meta information** might be **not correctly updated**
- **Precision is sometimes a problem** → frontage road vs. highway

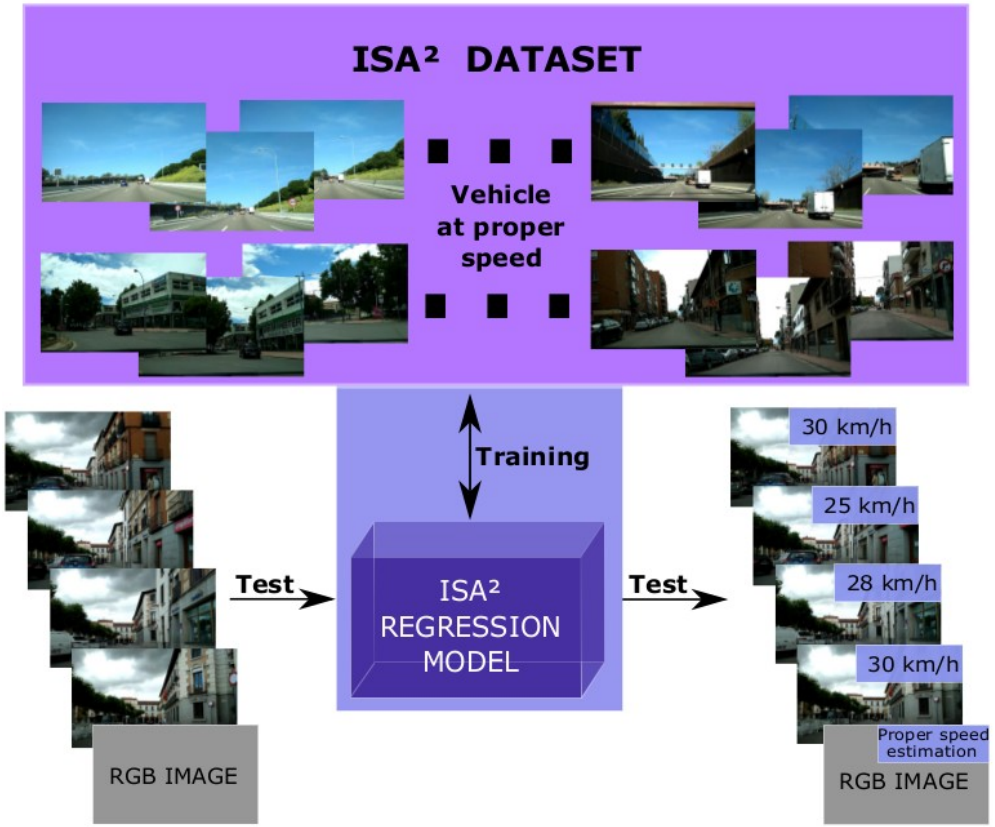
But this model has limitations

This type of solution does NOT take into account the real traffic situation

ISA^2

Intelligent Speed Adaptation from Appearance

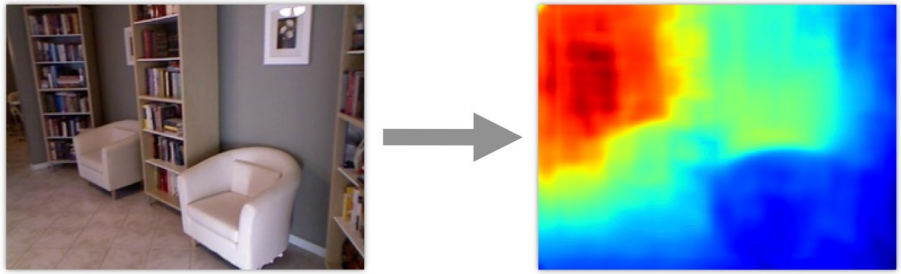
We introduce the idea of learning a regression model able to map the images (appearance) to a speed adequate to the traffic situation.



ISA^2

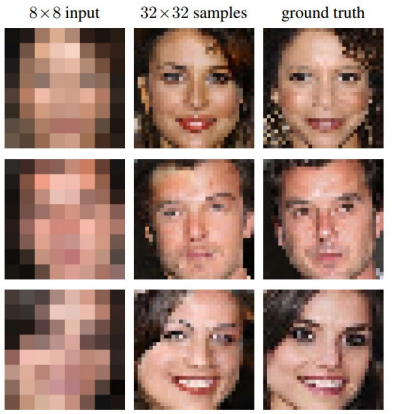
Great level of difficulty – even for a human!

A problem that it is ill-posed in its nature

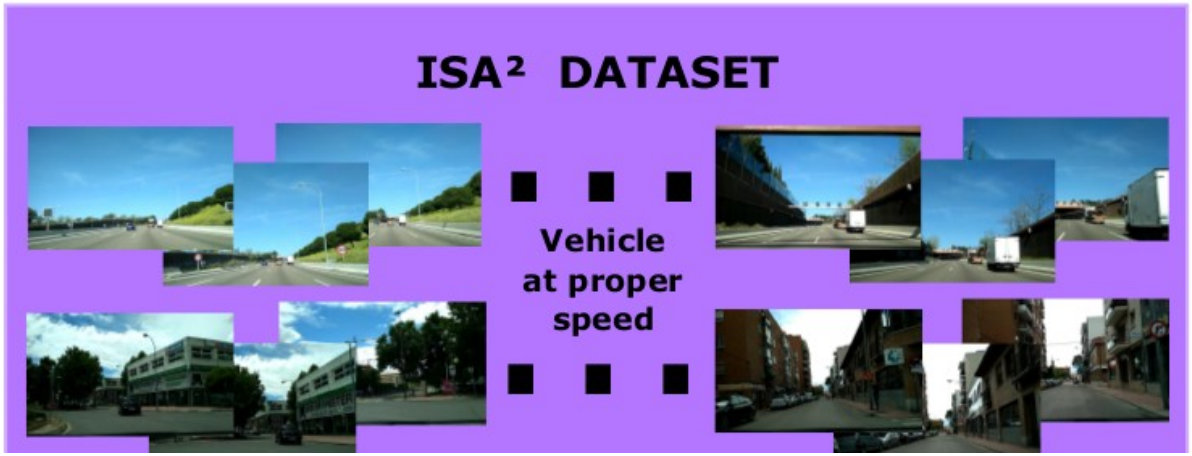


Single RGB Image

Depth Map



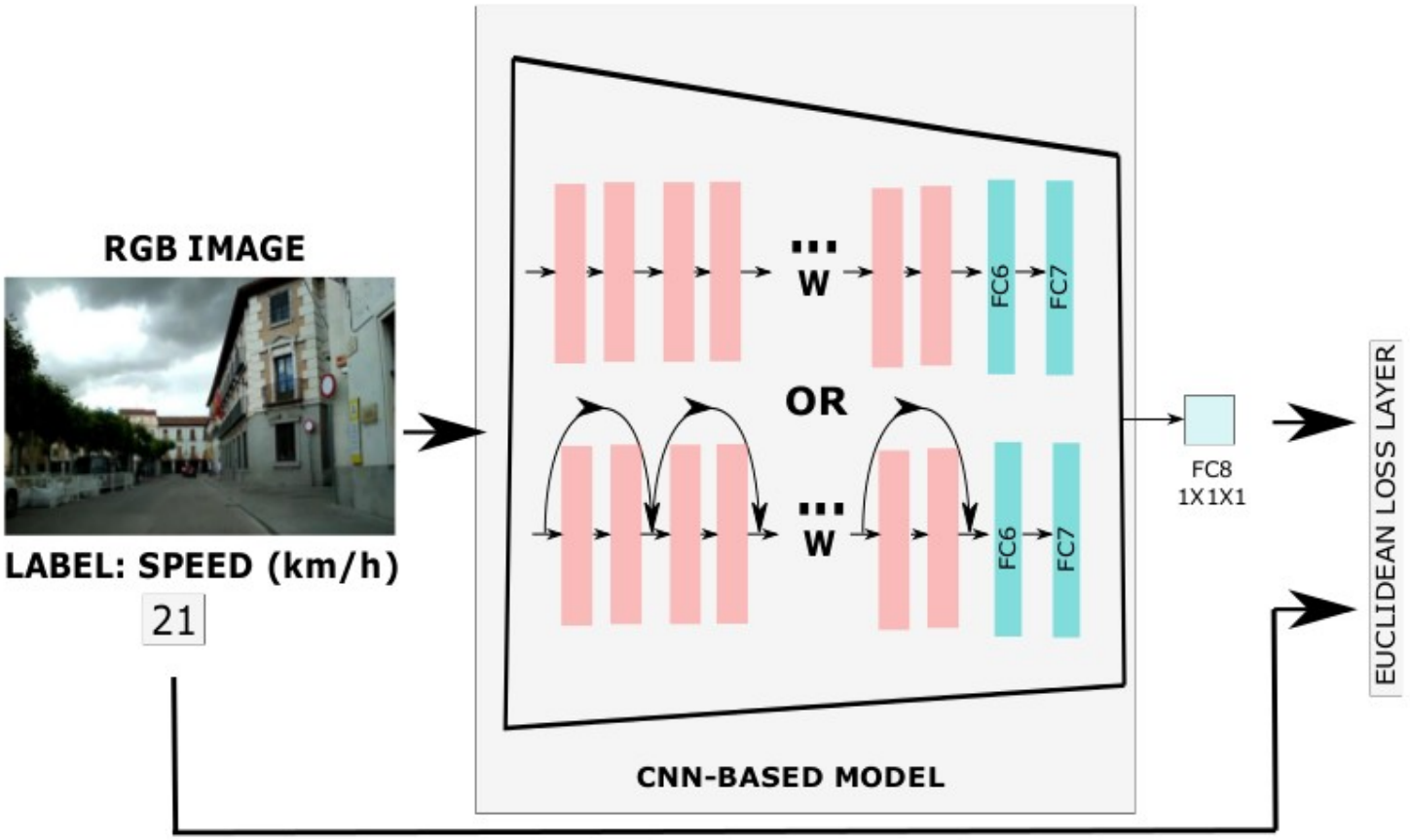
ISA^2 – The Dataset



- **5 video sequences (3 urban + 2 highway)**
- **149.055 annotated frames (proper speed km/h)**
- **Our driver has carefully tried to adjust the speed of the vehicle to what he considers to be an appropriate speed, according to the traffic situation.**
- **A novel version will be released soon (more videos and code).**

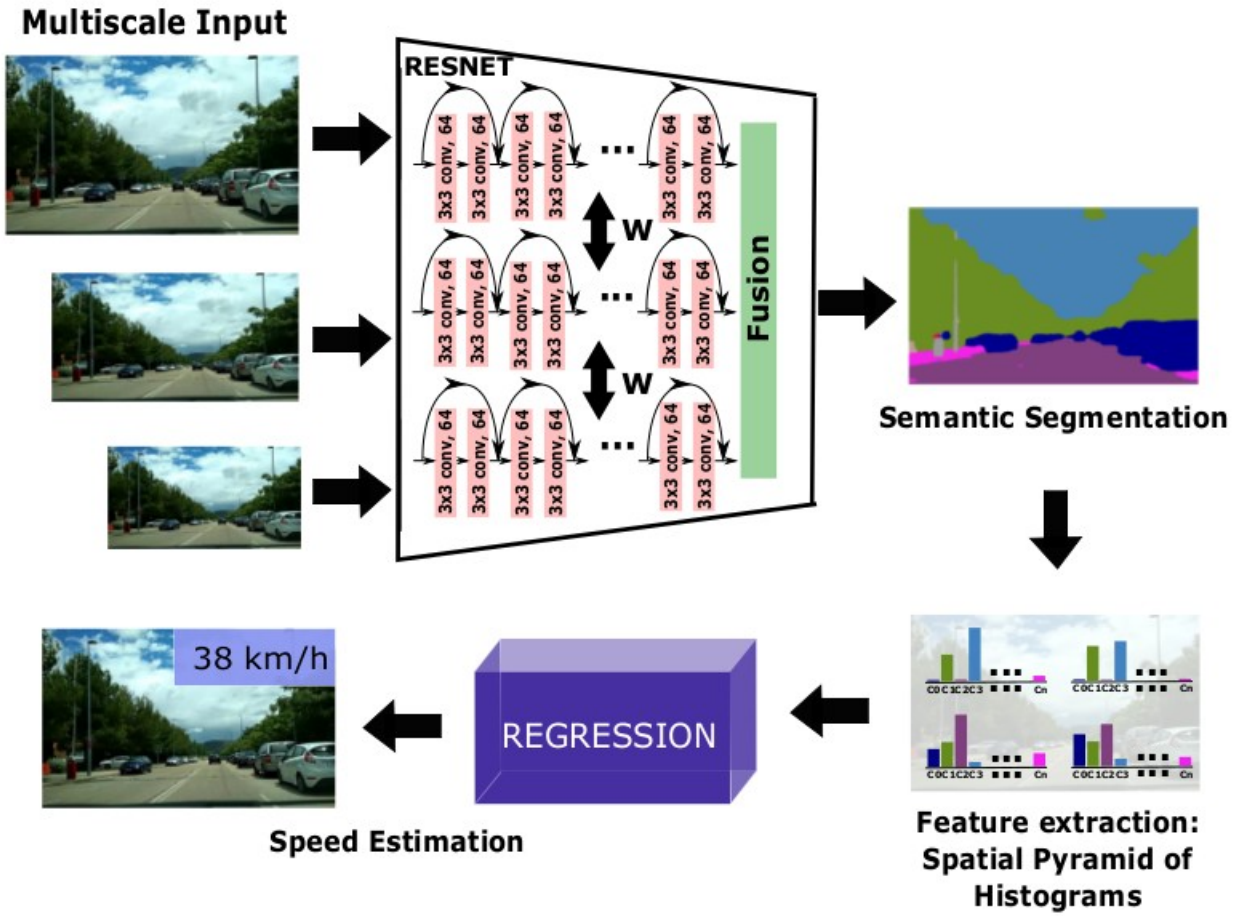
ISA^2 – The models

Approach 1 – A CNN for the estimation of the speed

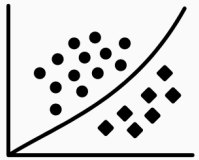


ISA^2 – The models

Approach 2 – ISA^2 from semantic segmentation

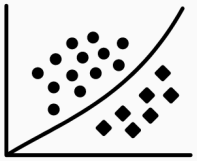


ISA^2 – The experiments



- Evaluation metric: **MAE** (Mean Average Error)
- Experimental setup
  - Caffe implementation of all the solutions.
    - ➔ Trained for 4k interations
    - ➔ SGD with momentum (0.9) and batch size 20
    - ➔ Learning rate 10^{-4} fo 2k iterations and then 10^{-5}
  - Different regressors for **Approach 2** → Linear, SVR, Lasso, Boosting Trees

ISA^2 – The experiments

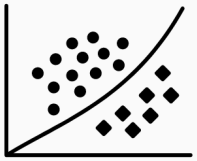


Experiment 1 → Joint training

We train **just one regression** function
for both urban and highway scenarios

	Method	Urban	Highway	Average
Approach 1	VGG-16	12.58	**11.57**	12.07
	ResNet-101	11.49	11.87	**11.68**
Approach 2	SS+Linear	9.15	15.78	12.46
	SS+SVR	10.69	16.76	13.72
	SS+Lasso	**8.74**	18.13	13.43
	SS+B. Trees	9.78	13.86	11.82

ISA^2 – The experiments



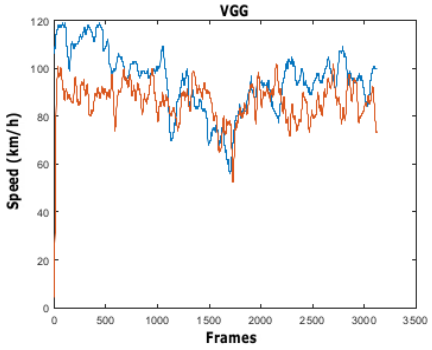
Experiment 2 → Independent training

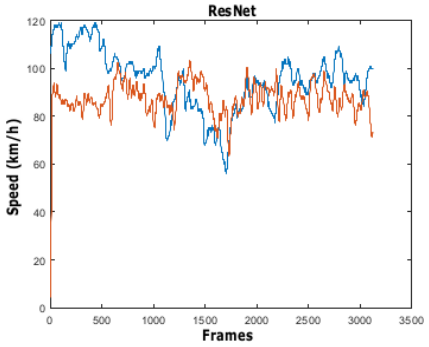
We train **two regression** functions
independently (one for urban and one for highway scenarios)

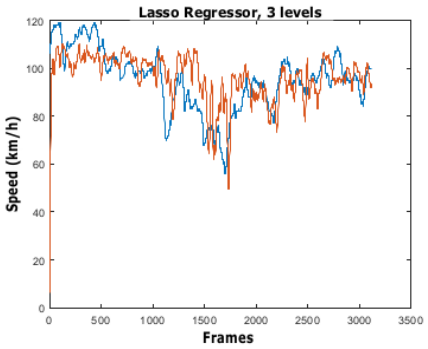
	Method	Urban	Highway	Average
Approach 1	VGG-16	11.86	12.48	12.17
	ResNet-101	9.59	12.79	11.19
Approach 2	SS+Linear	**6.02**	9.54	7.78
	SS+SVR	8.14	9.23	8.68
	SS+Lasso	6.67	8.72	**7.69**
	SS+B. Trees	8.81	**7.76**	8.28

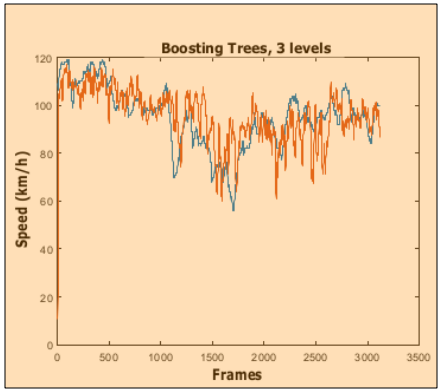
ISA^2 – The experiments

Highway results

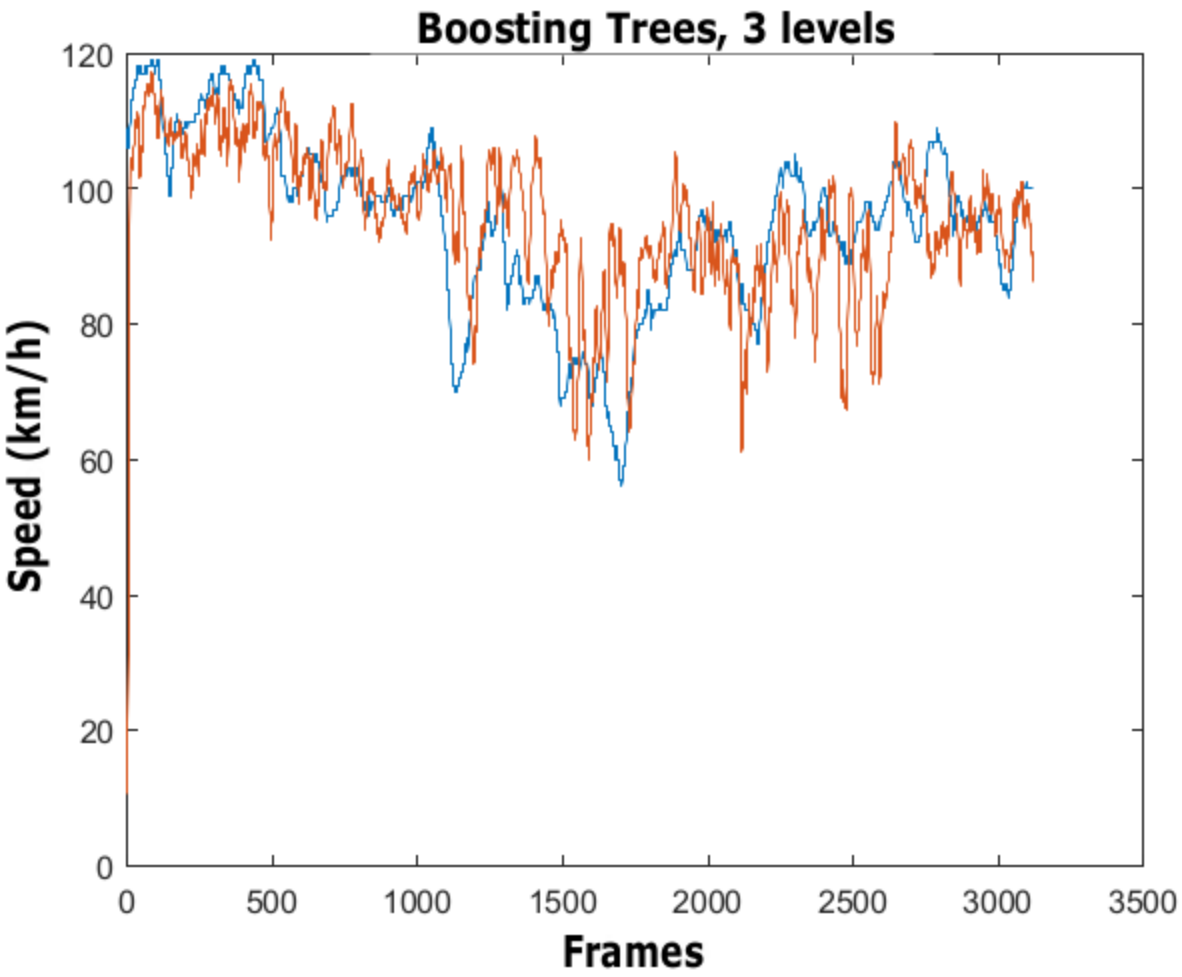








ISA^2 – The experiments



Proper Speed: 83 km/h
Estimated Proper Speed: 86 km/h

Proper Speed: 74 km/h
Estimated Proper Speed: 78 km/h

Proper Speed: 75 km/h
Estimated Proper Speed: 79 km/h

Proper Speed: 82 km/h
Estimated Proper Speed: 87 km/h

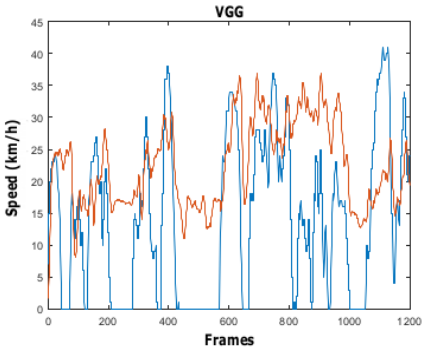
Proper Speed: 69 km/h
Estimated Proper Speed: 94 km/h

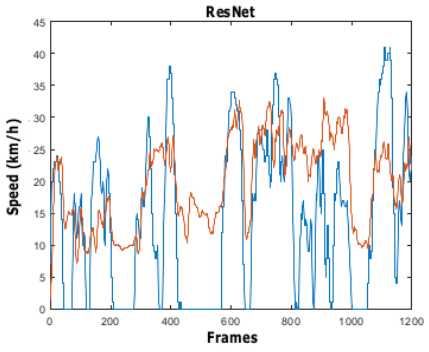
Proper Speed: 65 km/h
Estimated Proper Speed: 83 km/h

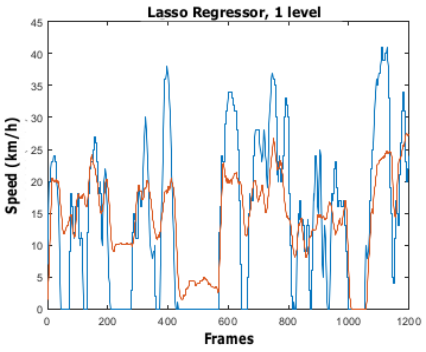
ISA^2 – The experiments

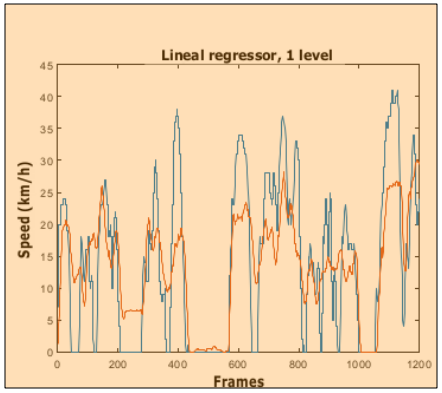
ISA^2 – The experiments

Urban results

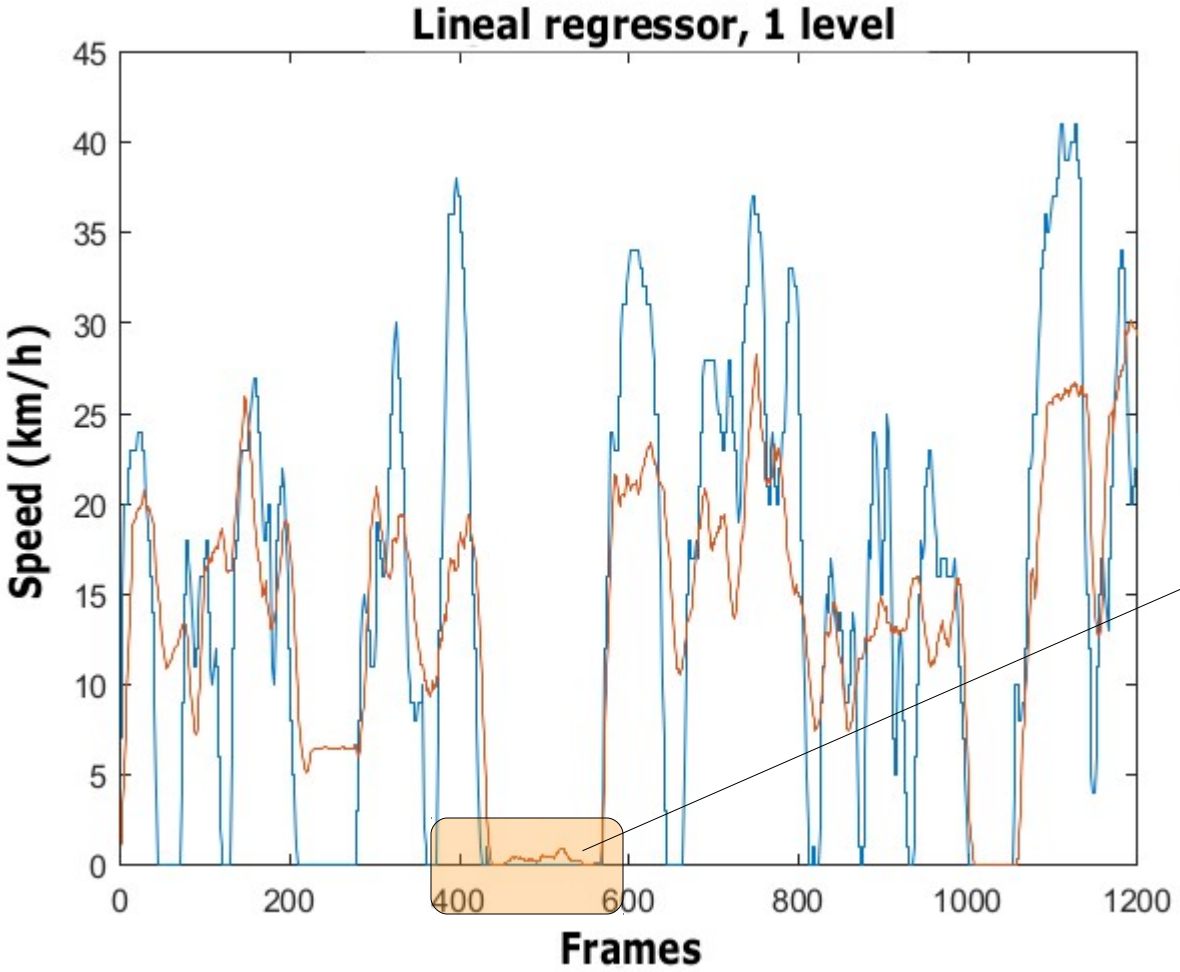






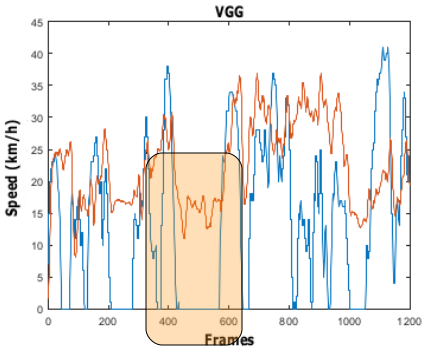


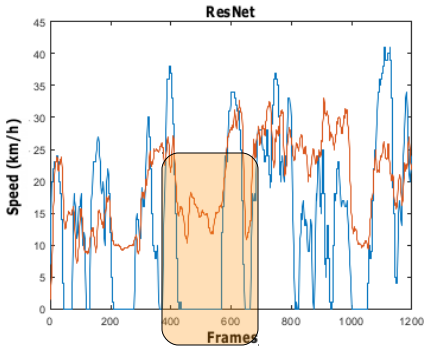
ISA^2 – The experiments

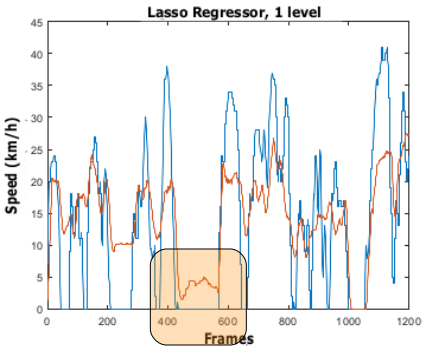


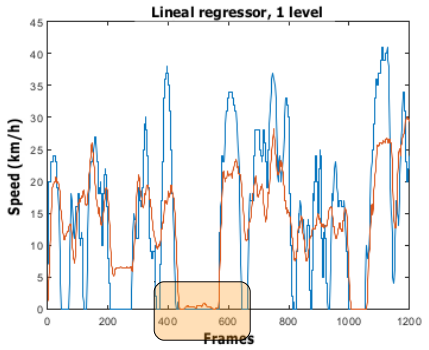
ISA^2 – The experiments

Urban results









Proper Speed: 8 km/h
Estimated Proper Speed: 9 km/h

Proper Speed: 21 km/h
Estimated Proper Speed: 21 km/h

Proper Speed: 0 km/h
Estimated Proper Speed: 0 km/h

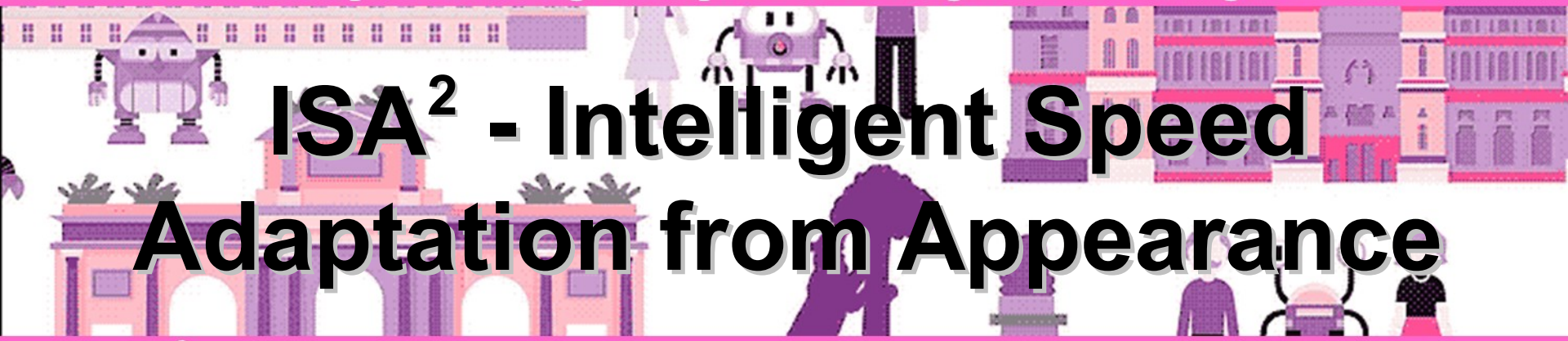
Proper Speed: 21 km/h
Estimated Proper Speed: 17 km/h

Proper Speed: 0 km/h
Estimated Proper Speed: 12 km/h

Proper Speed: 0 km/h
Estimated Proper Speed: 11 km/h

ISA^2 – The experiments

10th Workshop on Planning, Perception and Navigation for Intelligent Vehicles



ISA^2 - Intelligent Speed Adaptation from Appearance

MADRID 2018 IROS

PPNIV'18

Carlos Herranz-Perdiguero

Roberto J. López-Sastre

GRAM

Universidad de Alcalá