ELTE | FACULTY OF INFORMATICS

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ELTE – Chung-Ang AI Conference

AI in the Vehicle

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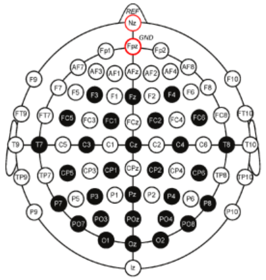
Corporate Advisor: Zoltán Kárász, PhD

Agenda

- Multi-Scale Object Detection with Temporal Stabilization

- Embedded Feature Selection for Highly Redundant Use-cases



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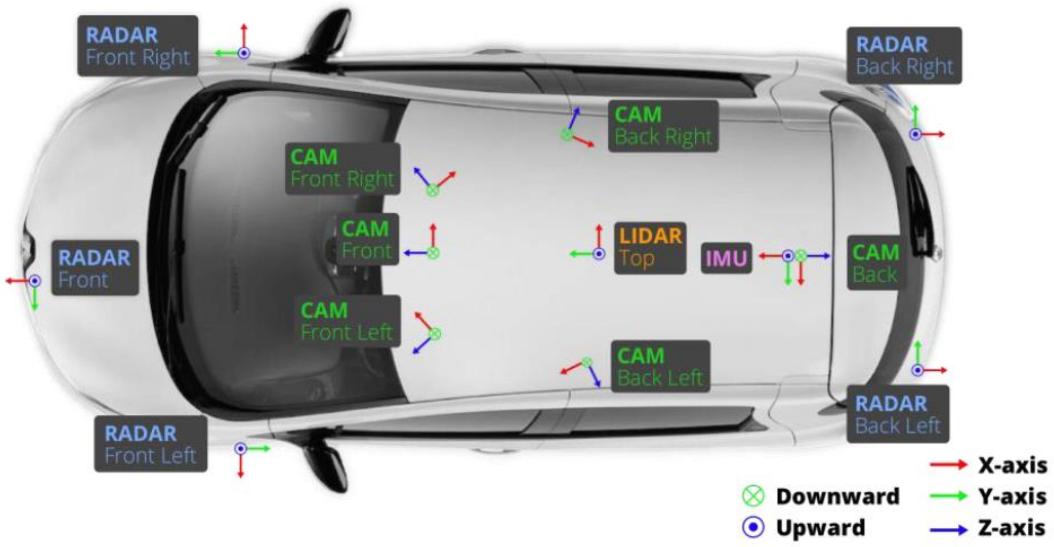
Driving Assist Systems

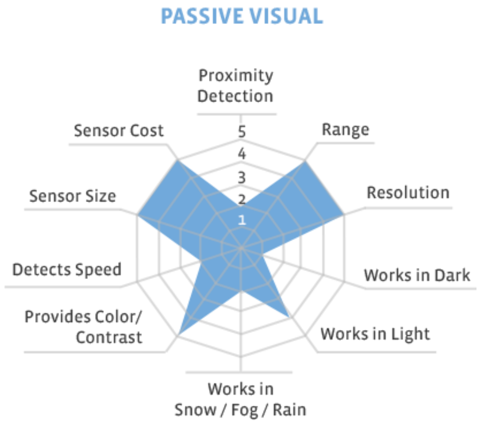
Abstract system-pipeline:

Perception → **Tracking** → Abstract env. representation → Behavior prediction → High-level functions

A possible sensorical setup:



Our selected sensor:

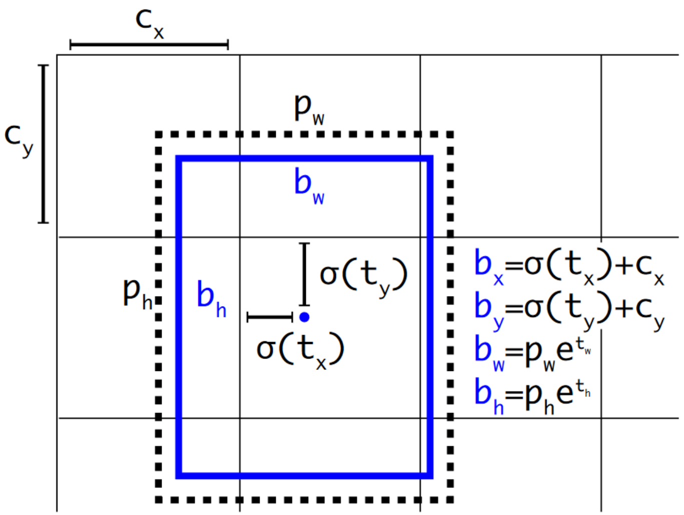


Holger Caesar, Varun Bankiti, Alex H. Lang, Sourabh Vora, Venice Erin Liong, Qiang Xu, Anush Krishnan, Yu Pan, Giancarlo Baldan, & Oscar Beijbom. (2020). nuScenes: A multimodal dataset for autonomous driving.

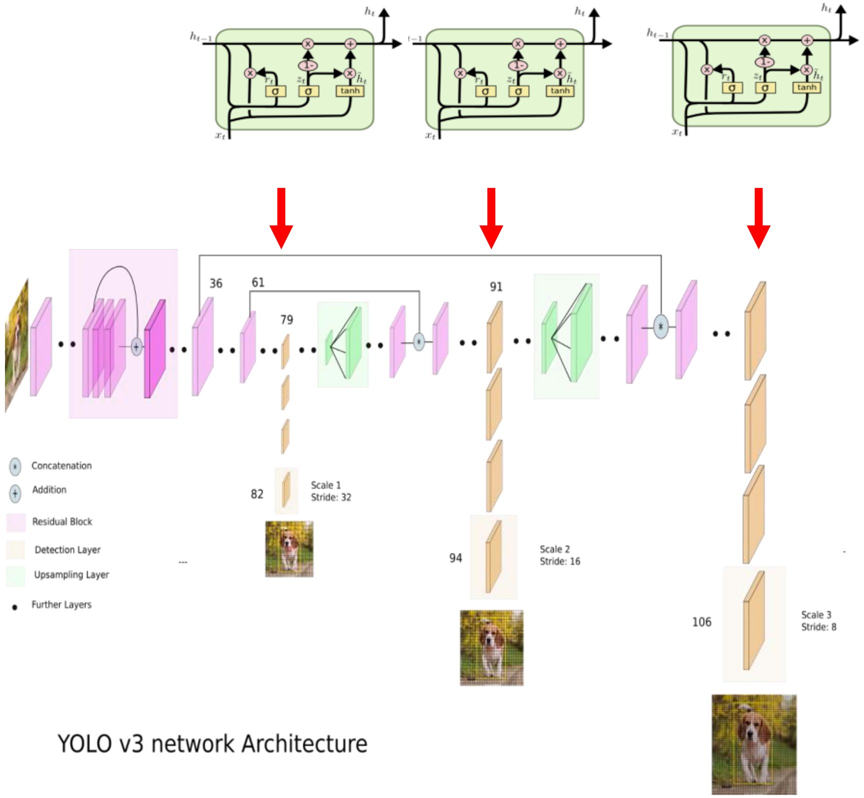
Temporal Stabilization

Challenges:

Anchor-based object representation:



YOLOv3 and its GRU extension:



Andreas Geiger, Philip Lenz, & Raquel Urtasun (2012).
Are we ready for Autonomous Driving? The KITTI Vision Benchmark Suite. In Conference on Computer Vision and Pattern Recognition (CVPR).

Joseph Redmon, & Ali Farhadi. (2018). YOLOv3: An Incremental Improvement.
Juan Terven, & Diana Cordova-Esparza. (2023). A Comprehensive Review of YOLO: From YOLOv1 and Beyond.

Temporal Stabilization Results

YOLOv3 with pretrained encoder:

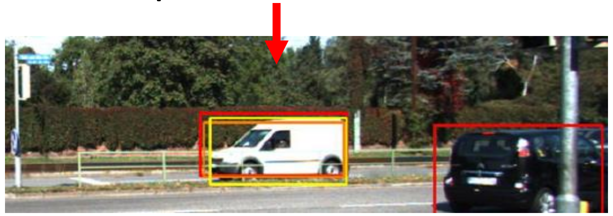
Class	Original YOLOv3			1 GRU ext.			3 GRU ext.		
	TP	FP	mAP	TP	FP	mAP	TP	FP	mAP
Car	2529	238	86.2%	2595	171	91.8%	2616	171	92.1%
Truck	246	19	90.1%	258	49	95.6%	259	145	94.6%
Pedestr.	396	52	76.4%	394	139	78.7%	404	412	82.2%
Cyclist	166	109	80.0%	171	86	85.6%	172	163	86.9%
	mAP=80.94%			**mAP=87.45%**			**mAP=88.11%**		

YOLOv3 without pretrained encoder:

Class	Original YOLOv3			3 GRU ext.		
	TP	FP	mAP	TP	FP	mAP
Car	2452	251	85.9%	2518	488	86.9%
Truck	235	42	84.2%	241	73	87.0%
Pedestr.	328	156	59.3%	343	323	59.9%
Cyclist	144	60	71.0%	149	131	69.7%
	mAP=75.95%			**mAP=77.95%**		

Prev. sample:

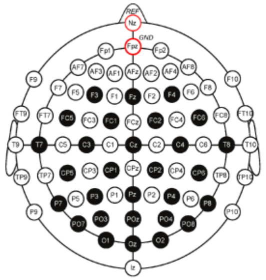
Curr. sample + YOLO:



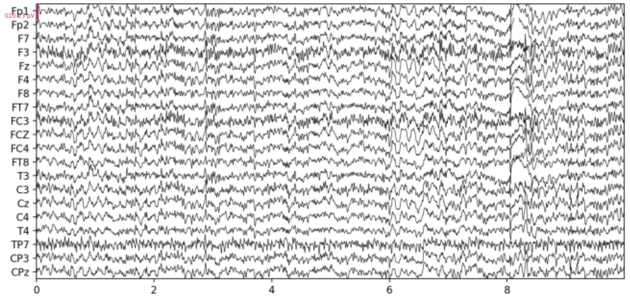
Curr. Sample + YOLO + GRU

Drowsiness Detection

EEG electrode setup



EEG signals



Handcrafted feature extraction

α- PSD, β- PSD, θ- PSD,

*PSD:power spectral density

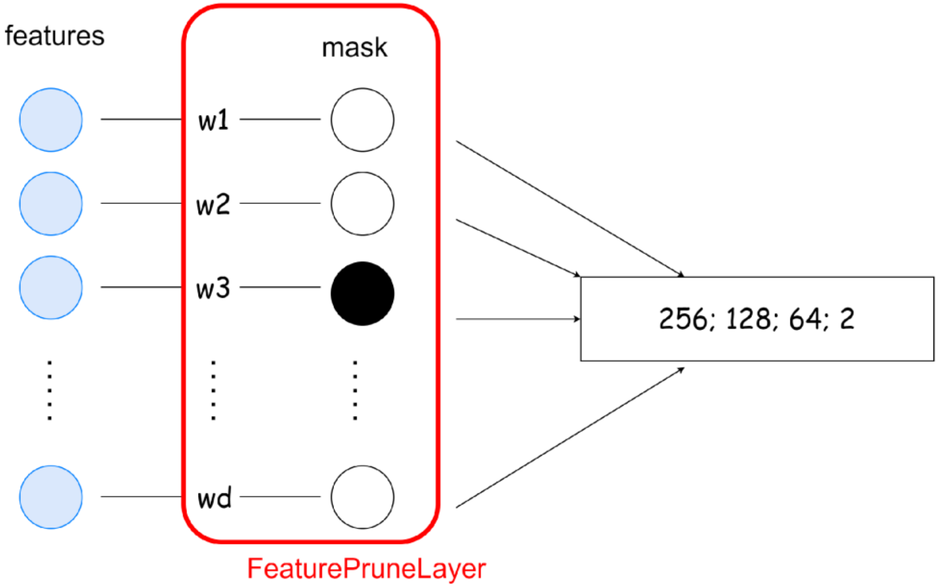
$$\frac{\theta+\alpha}{\beta}, \frac{\alpha}{\beta}, \frac{\theta+\alpha}{\alpha+\beta}, \frac{\theta}{\beta}, \frac{\theta}{\theta+\alpha}, \frac{\alpha}{\theta+\alpha}, \frac{\theta+\alpha}{\theta+\beta}$$

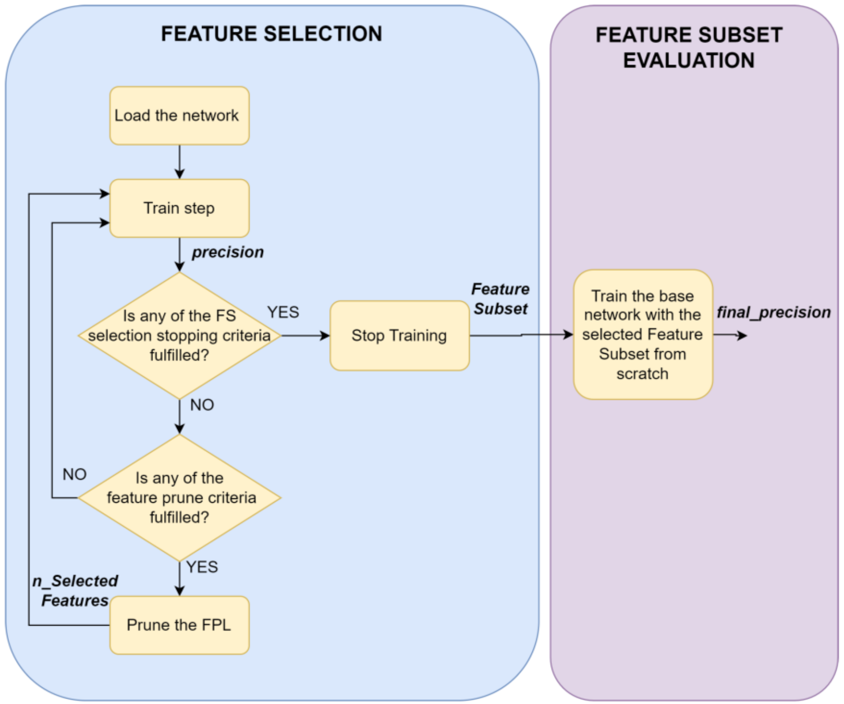
Drowsiness Detection Function

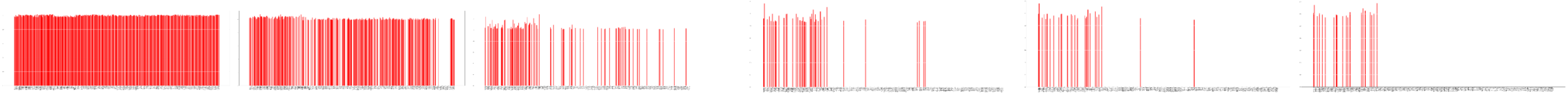
Challenge: Redundancy

Cui, J. EEG Driver Drowsiness Dataset. 2021. Available online: https://figshare.com/articles/dataset/EEG_driver_drowsiness_dataset/14273687/3

Embedded Feature Selection

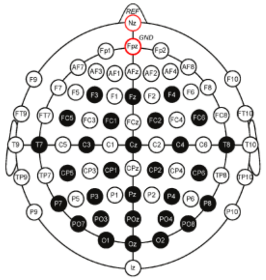


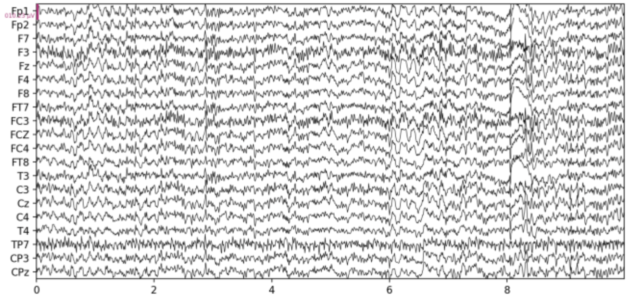


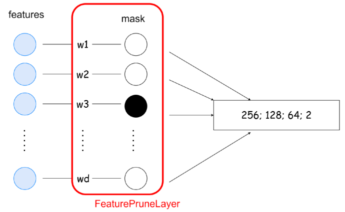


Drowsiness Detection Results

Drowsiness pipeline:







α- PSD, β- PSD, θ- PSD,

*PSD: power spectral density

$$\frac{\theta+\alpha}{\beta}, \frac{\alpha}{\beta}, \frac{\theta+\alpha}{\alpha+\beta}, \frac{\theta}{\beta}, \frac{\theta}{\theta+\alpha}, \frac{\alpha}{\theta+\alpha}, \frac{\theta+\alpha}{\theta+\beta}$$

Drowsiness Detection

Results:

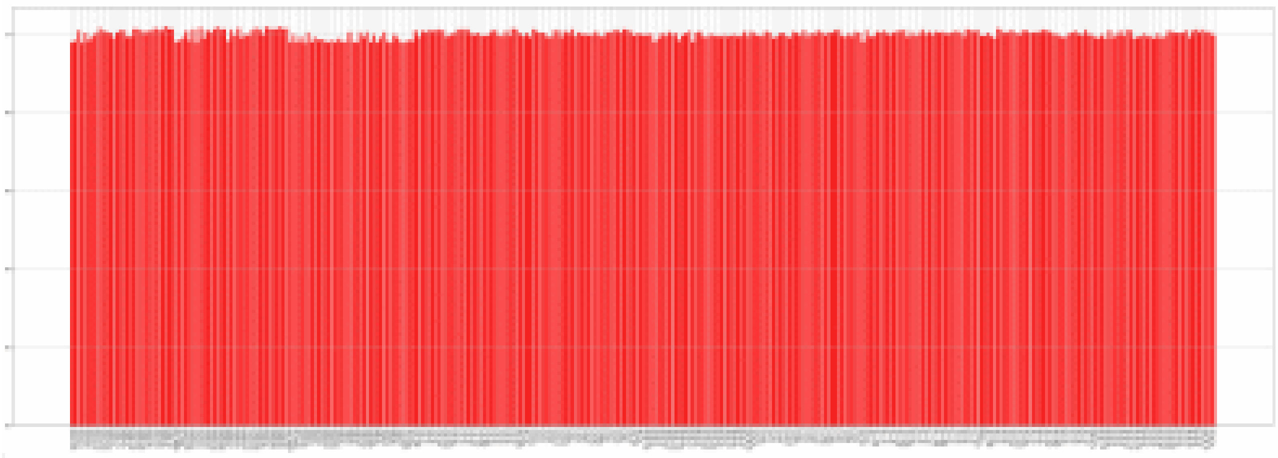
All features (#330)	
Precision	**Pseudo overfit**
0.926	0.037

*Precision: on test set
*Pseudo overfit: precision difference between measured on train and test set

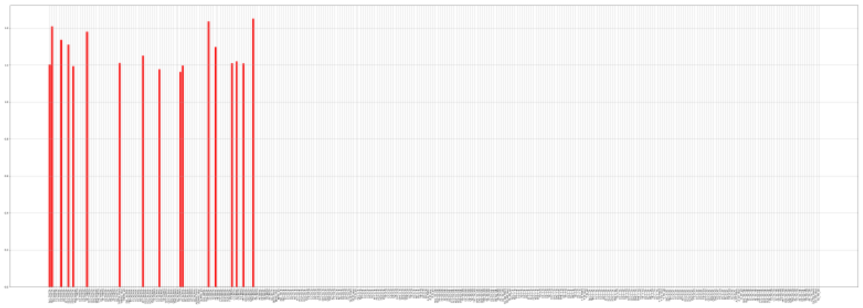
TOP 20% (#66)		TOP 10% (#33)		TOP 5% (#17)	
Precision	**Pseudo overfit**	**Precision**	**Pseudo overfit**	**Precision**	**Pseudo overfit**
0.953	**0.033**	**0.941**	**0.028**	**0.916**	**0.01**

Bencsik, B., Reményi, I., Szemenyei, M., & Botzheim, J. (2023). Designing an Embedded Feature Selection Algorithm for a Drowsiness Detector Model Based on Electroencephalogram Data. In Sensors (Vol. 23, Issue 4, p. 1874). MDPI AG. https://doi.org/10.3390/s23041874

Feature Selection Results

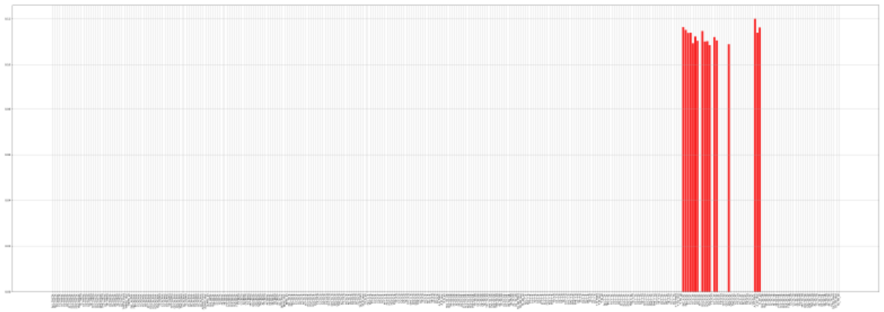


Embedded method



Vs.

Principal Component Analysis



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Thank You for Your Attention!

NEMZETI KUTATÁSI, FEJLESZTÉSI
ÉS INNOVÁCIÓS HIVATAL

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