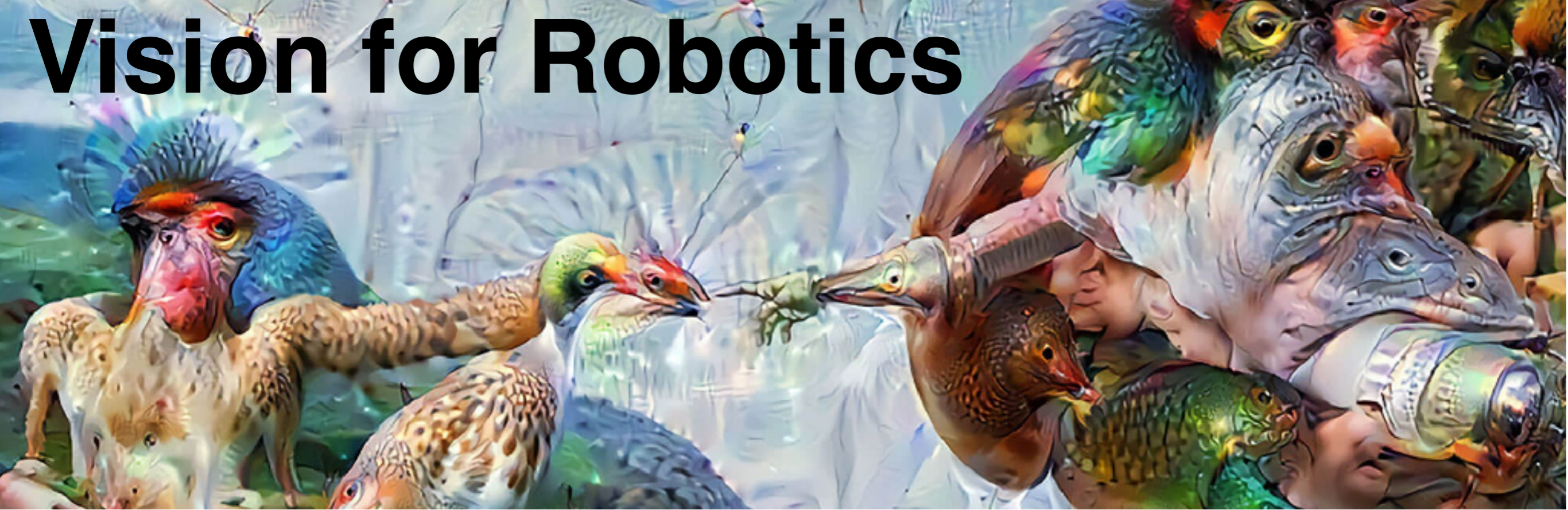


Vision for Robotics



<https://cw.fel.cvut.cz/b191/courses/b3b33vir>

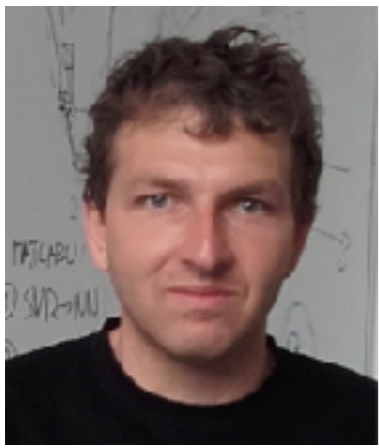
Karel Zimmermann



Czech Technical University in Prague
Faculty of Electrical Engineering, Department of Cybernetics

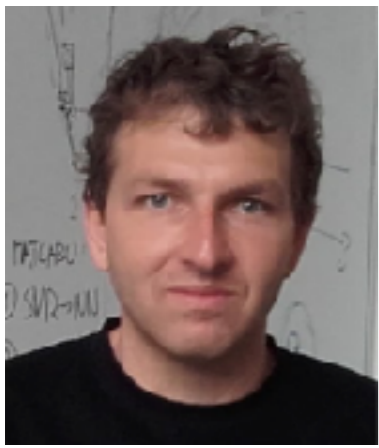
Outline

- Introduction of the VIR-team
- Outline of the course - lectures
- Outline of the course - labs
- Organization (homework, tests, semestral work)

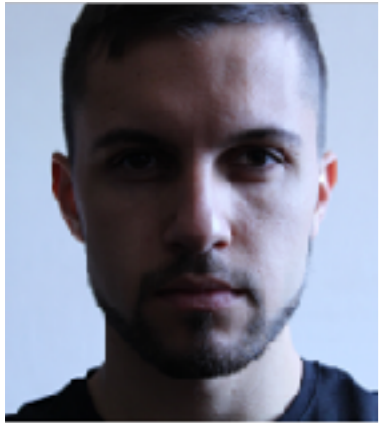


- **Karel Zimmermann**
(associate professor at CTU)
- main lecturer





- **Karel Zimmermann**
(associate professor at CTU)
- main lecturer



- **Teymur Azayev**
(PhD student since 2018)
- head of the labs
- motion control & deep learning



- **Patrik Vacek**
(PhD student since 2019)
- lab tutor



- Introduction of the VIR-team
- Outline of the course - lectures
- Outline of the course - labs
- Organization (homework, tests, semestral work)

Motivation for unusual organization

- What I did not like as a student:
 - lectures are boring and make me sleepy
 - weak connection between (i) theory (math, statistics, algebra) and (ii) applications (robotics)
 - non-interactive lectures
 - semestral work: limited space for own creativity
- What I do not like as teacher:
 - lectures are boring and make me sleepy
 - weak motivation of students for continuous studying
 - weak motivation of students for interactive discussions
 - weak motivation of students for originality
 - strong motivation of students for plagiarism

<https://cw.fel.cvut.cz/b201/courses/b3b33vir/start>

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14.12.2020	13	Exam Test ET
04.01.2021	14	Poster session (teams present their semestral works)



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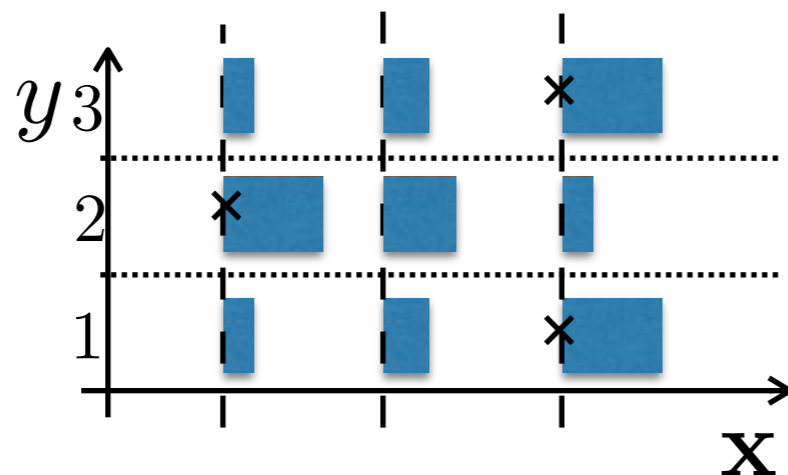


We will formulate classification and regression problems as Bayesian parameter estimation of a probability distribution

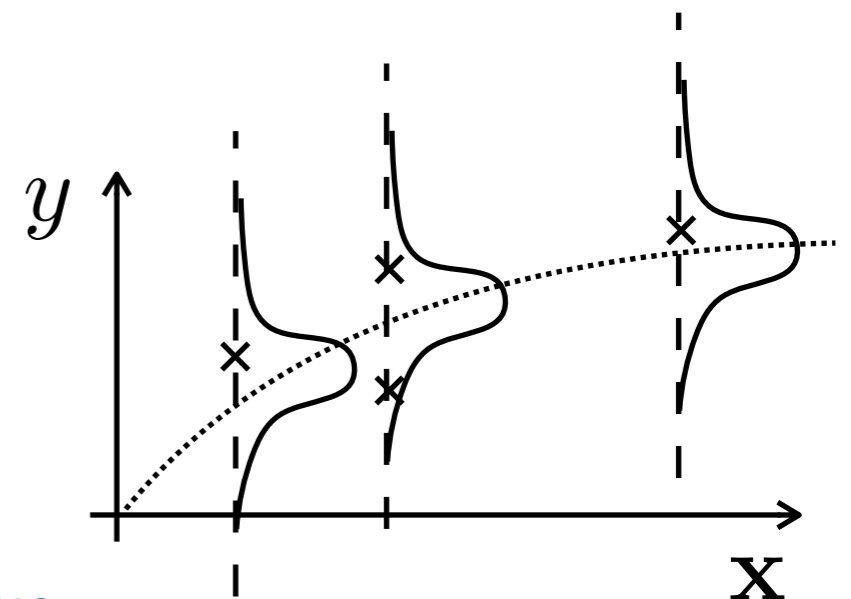
- Pre-requisites:
 - ALG (basic linear algebra)
 - PSI (probability, ML and Bayes rule)

$$\mathbf{w}^* = \arg \min_{\mathbf{w}} \left(\sum_i -\log(p(y_i | \mathbf{x}_i, \mathbf{w})) \right) + (-\log p(\mathbf{w}))$$

loss function



prior/regulariser



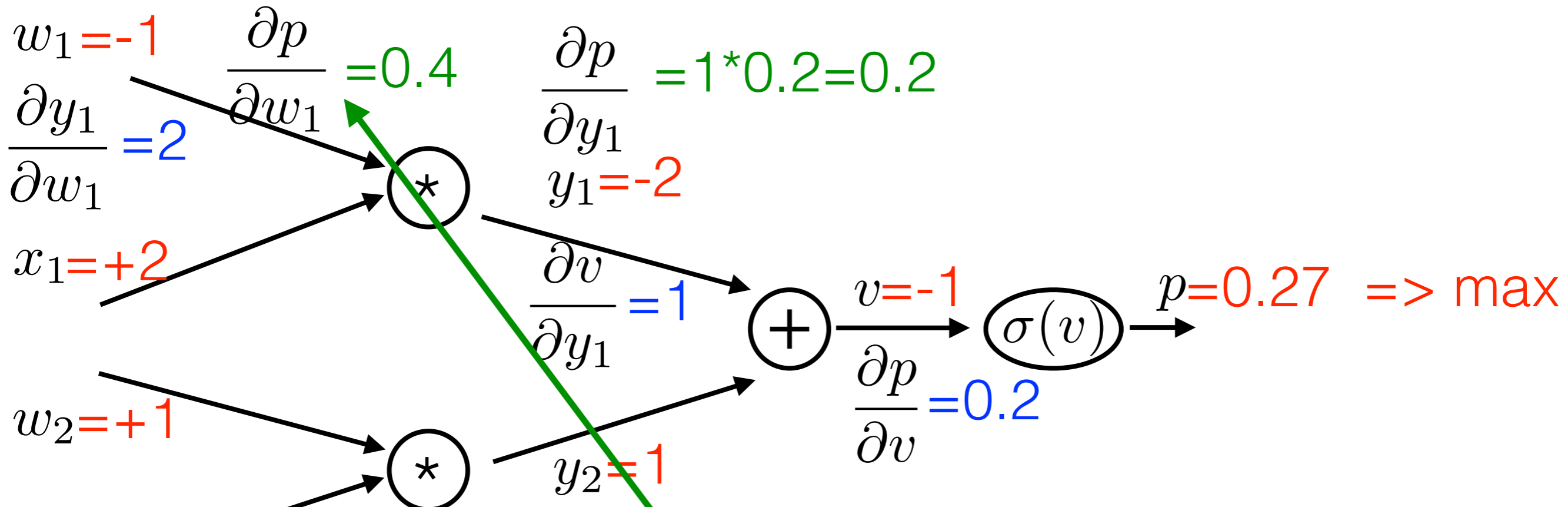
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Learning of single neuron



Edge gradient:

$$\frac{\partial p}{\partial w_1} = \frac{\partial p}{\partial y_1} \frac{\partial y_1}{\partial w_1}$$

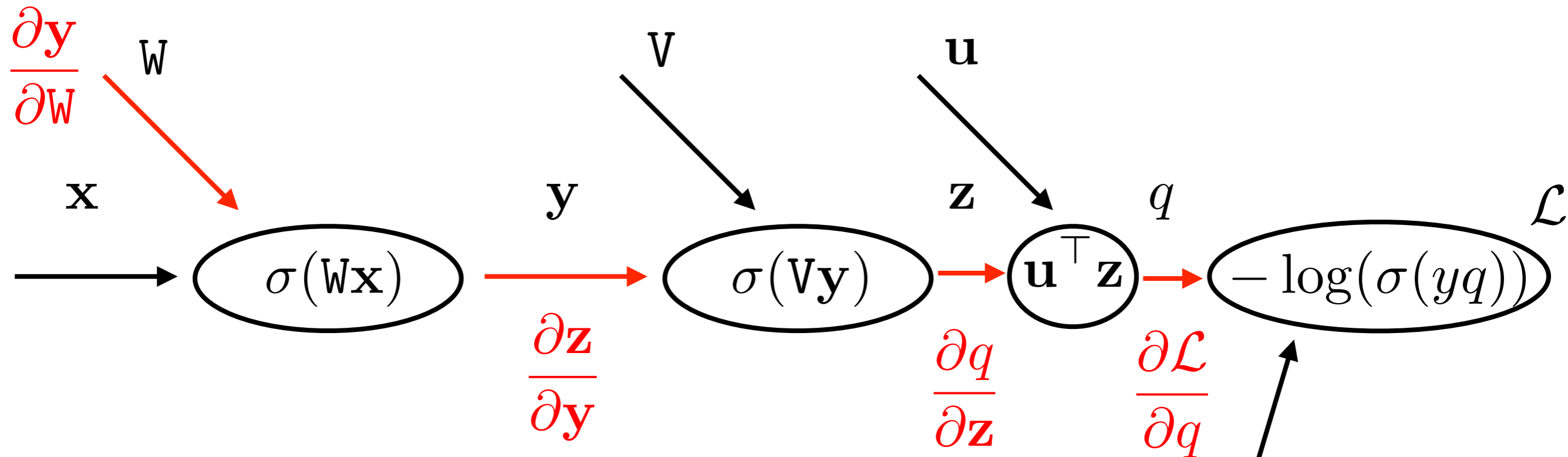
Chain-rule in computational graph

$$\frac{\partial p}{\partial w_1} = \frac{\partial p}{\partial v} \frac{\partial v}{\partial y_1} \frac{\partial y_1}{\partial w_1}$$



Learning of fully connected neural network

- Pre-requisites:
 - Math II (partial derivatives, chain-rule)



Gradient wrt W :
$$\frac{\partial \mathcal{L}}{\partial W} = \frac{\partial \mathcal{L}}{\partial q} \frac{\partial q}{\partial \mathbf{z}} \frac{\partial \mathbf{z}}{\partial \mathbf{y}} \frac{\partial \mathbf{y}}{\partial W}$$

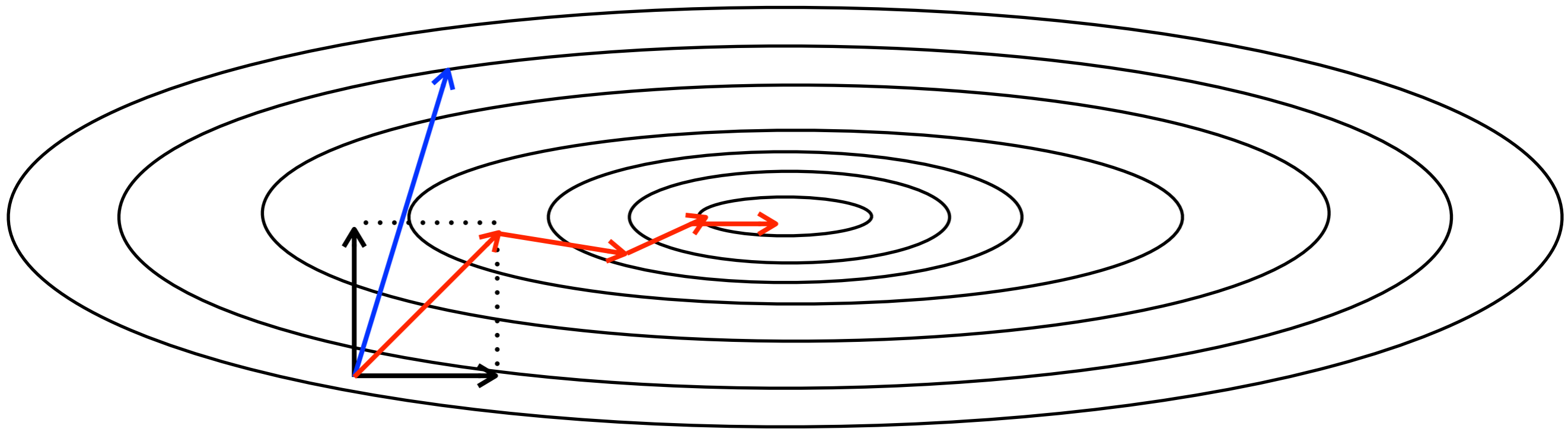
y



We will dive deep into learning

You will exploit what you have learnt in the optimization course

$$\mathbf{w}_{t+1} \approx \mathbf{w}_t - \alpha \left[\text{diag} \left(\nabla \mathbf{w}_t \nabla \mathbf{w}_t^\top \right)^{1/2} \right]^{-1} \frac{\partial f(\mathbf{w})}{\partial \mathbf{w}} \Big|_{\mathbf{w}=\mathbf{w}_t}$$
$$\mathbf{w}_{t+1} \approx \mathbf{w}_t - \frac{\alpha}{\sqrt{\nabla \mathbf{w}_t^2 + \epsilon}} \odot \nabla \mathbf{w}_t$$



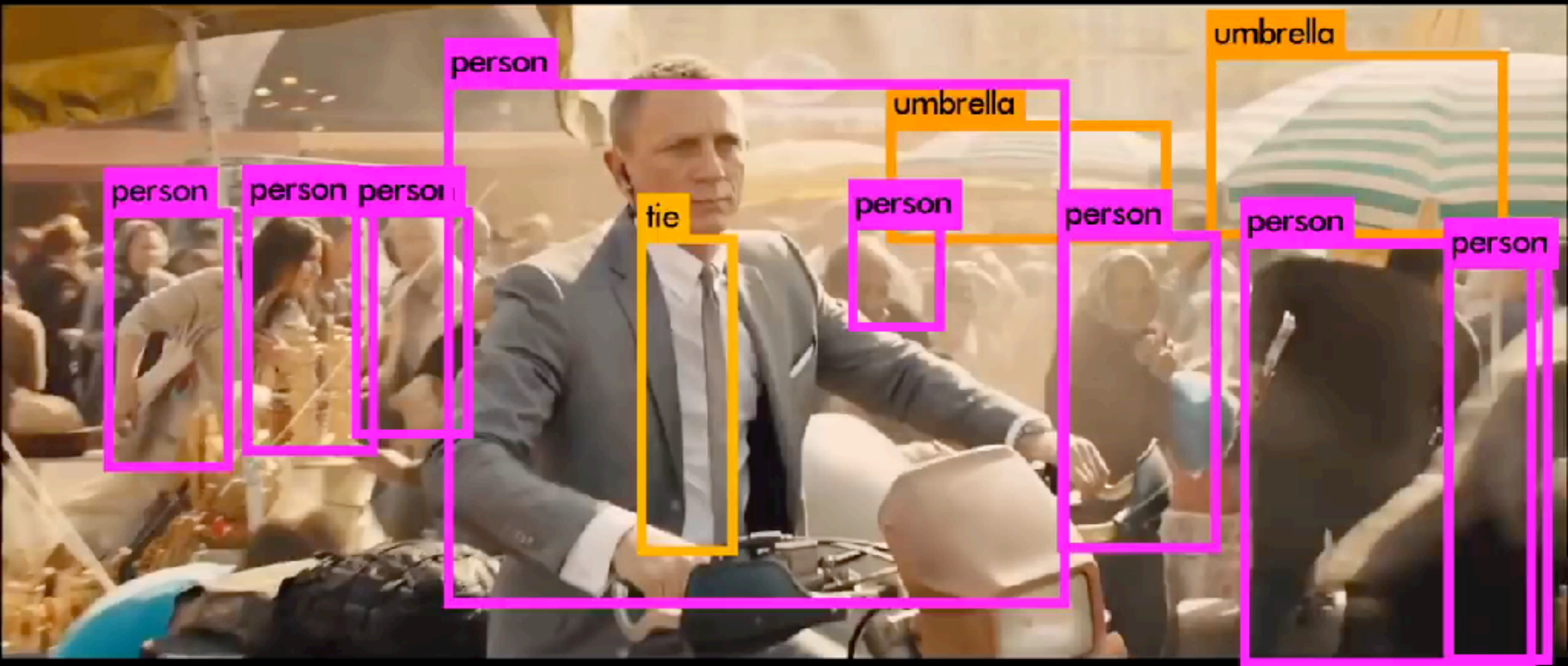
Pre-requisites: OPT



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We will study winning architectures in recognition, object detection and semantic segmentation



PoseTrack challenge (ICCV 2017/ECCV 2018)

<https://posetrack.net>



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Labs

- Head of the labs is Teymur
- You can use personal / school computers
- You will use Python, Numpy, PyTorch, Pycharm (consider install it in advance)

```
import numpy as np
```

<http://www.numpy.org>

```
import torch
```

<https://pytorch.org/>

The logo for PyCharm, featuring a green and yellow background with a black square containing the letters 'PC' and a white horizontal line, followed by the word 'PyCharm' in a bold, black, sans-serif font.

<https://www.jetbrains.com/pycharm/>



<https://colab.research.google.com/>



- Semestral work and homework have competitive setup:
 - GPUs available:
<https://cyber.felk.cvut.cz/cs/study/gpu-servers/>
- **cantor.felk.cvut.cz**
 - 16 jader / 32 threadu,
 - 256GB RAM, 500GB SSD,
 - 8 x NVIDIA GTX 1080Ti
- **taylor.felk.cvut.cz**
 - 16 jader / 32 threadu,
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Credit requirements and point summary

- **35 points** from the semestral work
 - evaluation based on students and lecturers voting
 - it is assumed that work will correspond to at least $3 \cdot 7 \cdot 6 = 126$ hours of work
- **25 points** from homework (HW1, HW2)
 - automatic evaluation
 - competitive setting if possible
- **40 points** from test (T1, ET)
 - including the exam test
- **minimum credit requirements** is:
 - 50 points (out of 100)
 - at least 1 point from each homework
 - at least 1 point from each test



Final grade

- final grade determined by the total number of points

No of points	Exam assessment
0-49	F
50- 59	E
60-69	D
70-79	C
80-89	B
90-100	A



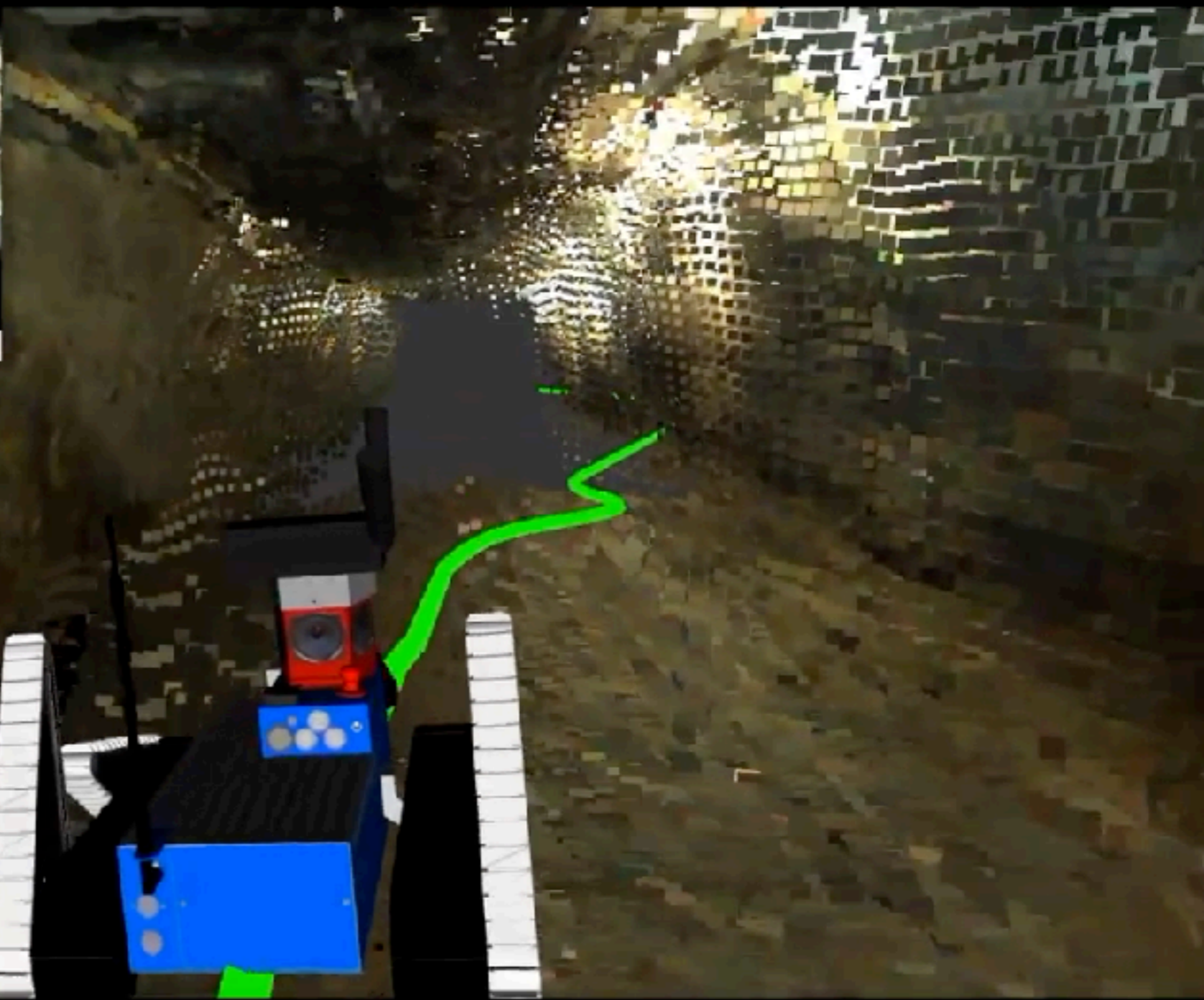
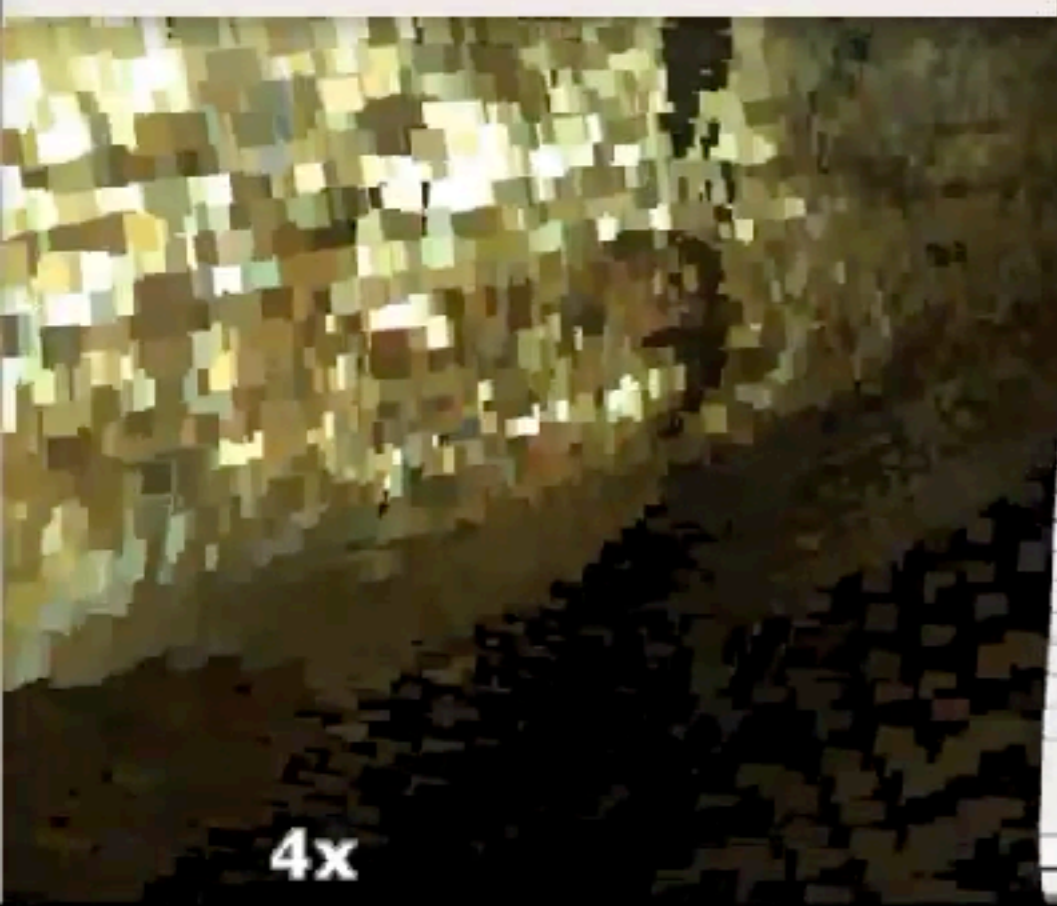
Summary

- We will be happy if you help in any possible way
 - suggesting better course logo
 - suggesting/preparing new homework
 - implementing nice demos (software or hardware)
 - giving any reasonable feedback
 - start your own research with us

What can you do?

- We're looking for students
 - competent in theory and practice (code development, work with real robotic platforms)
 - motivated to write top research papers with us
 - willing to work hard under our guidance
- We're offering:
 - diploma/bachelor theses, semester work or project
 - paid internships / summer jobs
 - international collaboration opportunities





4x



DARPA



**DARPA
SUBTERRANEAN
CHALLENGE**

Date: August 22, 2019

Pay to the
Order of:

CTU-CRAS

\$200,000.00

Dollars

Tunnel Circuit Systems Track Winner

Steven Walker

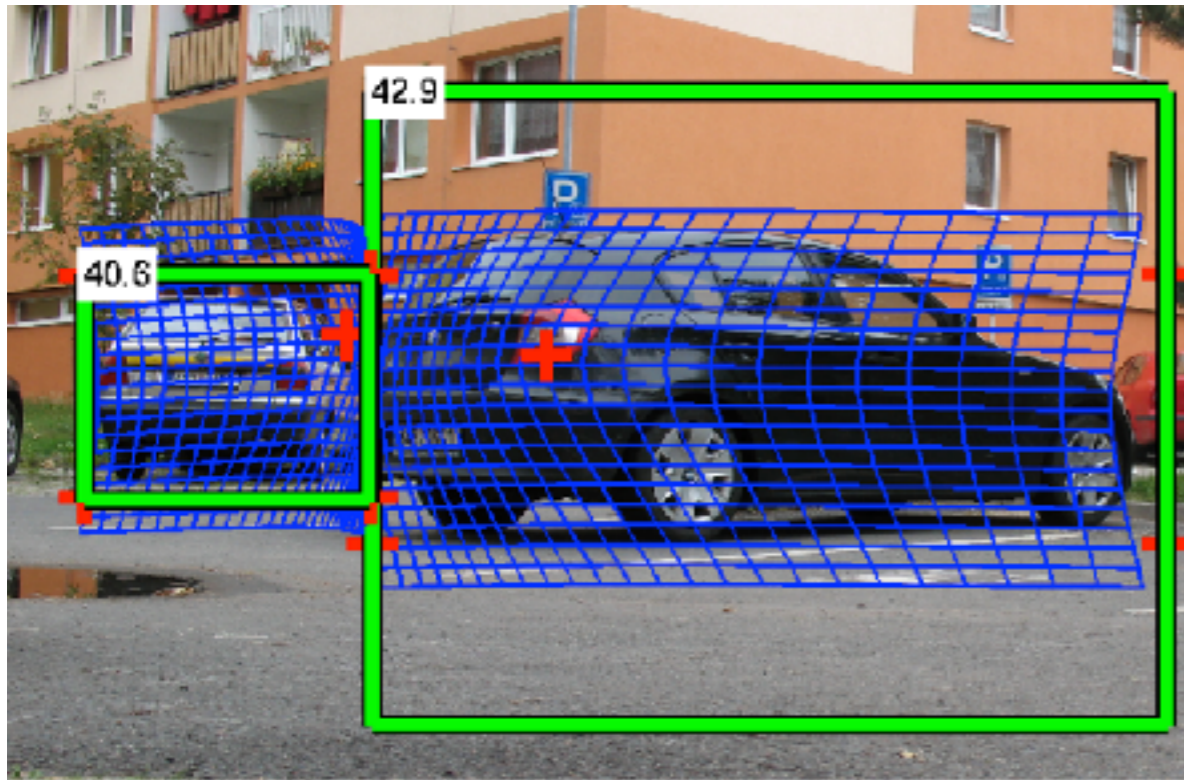
Memo
NOT A VALID CHECK

Dr. Steven Walker
Director, Defense Advanced Research Projects Agency

GREEN HORNS

2017
OVER

Object detection and tracking



- [1] K.Zimmermann, D.Hurych, T.Svoboda, *Non-Rigid Object Detection with Local Interleaved Sequential Alignment (LISA)*, **TPAMI (IF=5)**, 2014
- [2] K.Zimmermann, J.Matas, T.Svoboda, *Tracking by an Optimal Sequence of Linear Predictors*, **TPAMI (IF=5 selected for II.pillar evaluation)**, 2009.



Motion and compliance control of flippers



[3] Pecka, Zimmermann, Svoboda, Hlavac, et al.
IROS/RAL/TIE(IF=6), 2015-2018

[CZSOI Technical University in Prague](#)

[Faculty of Electrical Engineering, Department of Cybernetics](#)



Traffic sign detection and 3D localization



1.5 year PostDoc in Luc van Gool's lab at
Katholieke Universiteit Leuven

[4] R. Timofte, K. Zimmermann, Luc van Gool, Multi-view
traffic sign detection, recognition, and 3D localisation,
MVA (IF=1.5, over 200 citations), 2011



Czech Technical University in Prague
Faculty of Electrical Engineering, Department of Cybernetics

Experiment: Active 3D mapping

RGB (only for visualization)



Sparse measurements

Reconstructed map



[5] Zimmermann, Petricek, Salansky, Svoboda, Learning for Active 3D Mapping, **ICCV oral (rank A*, AC=2%)**, 2017

Faculty of Electrical Engineering, Department of Cybernetics

