**11LE13P-7302 Laboratory**
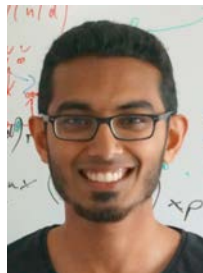**Deep Learning for Autonomous Driving**

# Team



Prof. Wolfram
Burgard
Instructor

Dr. Daniel
Buscher
Tutor

Abhinav
Valada
Tutor

Johan
Vertens
Tutor

Oier
Mees
Tutor

Andreas
Eitel
Tutor

Ayush
Dewan
Tutor

# Organization Details

- Time: Every Friday 4pm-6pm
  building 082, computer pool R 00 029
- We will be there for questions, but we expect you to work on your own
- Attendance is required **every week**
- We expect you to have basic knowledge in ML (e.g. heard the ML lecture or did deep learning lab)
- Homepage: http://ais.informatik.uni-freiburg.de/teaching/ss18/driving_lab

# Organization Details

- Four lectures
  - Autonomous cars
  - Introduction to deep learning
  - Pytorch tutorial
  - Advanced deep learning
- Group project (2-3 people)
- Four subtasks, submit each subtask within specified time (code, results)
- Final poster session + demo + pitch talk (3min)

# Communications & Computing

- We will use Slack for group communications
- dl4ad.slack.com
- Signup with your university email or contact valada@cs.uni-freiburg.de for access
- We will use the Google Cloud Platform for GPU computing
- Linux VMs with NVIDIA Tesla K80
- Pool computers for other preprocessing

# Contacts (tutors)

- Abhinav Valada:  valada@cs.uni-freiburg.de
- Johan Vertens:   vertensj@cs.uni-freiburg.de
- Oier Mees:  meeso@cs.uni-freiburg.de
- Andreas Eitel:  eitel@cs.uni-freiburg.de
- Ayush Dewan:  dewan@cs.uni-freiburg.de
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# AIS Perception Car

# rAIS Car

# Projects

- Semantic free space estimation (AIS percep car)
- Semantic 3D object detection (AIS percep car)
- Steering angle & speed prediction (AIS percep car)
- End-to-end driving (rAIS car)
- Vision-based localization (AIS percep car)
- Road segmentation (rAIS car)

Fill the form on the course website for project assignment ➡ by Wednesday, 25th April

# P1: Semantic free space estimation

- Predict free space & semantic boundaries of objects in free space
➡ Use images
➡ FCNs
➡ At least 6 semantic classes
➡ Cityscapes, KITTI, ApolloScape, Berkely DeepDrive datasets
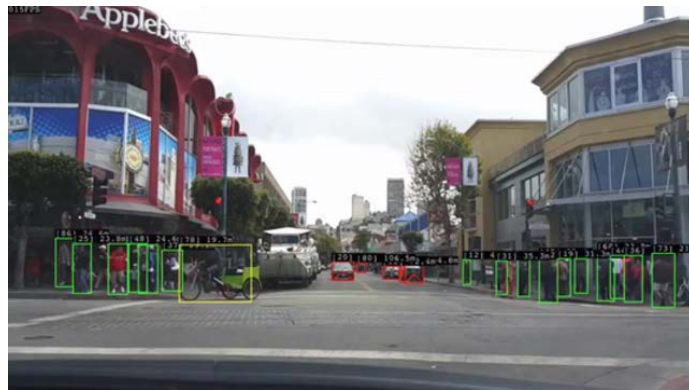➡ Should run in real-time



**Bonus:**
- Lane detection
- Get on KITTI leaderboard

# P2: Semantic 3D object detection

- Predict 3D bounding boxes & semantic category
- ➡ Use images and/or LiDAR
- ➡ Region proposal network
- ➡ CNN for classification and detection
- ➡ Distance to bounding boxes should be an output
- ➡ KITTI dataset
- ➡ Should run in real-time



**Bonus:**

- Get on KITTI leaderboard
- Extend to instance segmentation

# P3: Steering angle & speed prediction

- Predict steering angles & speed (into the future…)
- ➡ Use a sequence of images and/or optical flow
- ➡ Model as Sequence-to-sequence prediction
- ➡ Recurrent CNN
- ➡ Udacity dataset
- ➡ Should run in real-time



Ground Truth Angle: 5.1
Speed: 27.134 m/s

Predicted Angle: 3.22
Error: –1.88

**Bonus:**
- Beat Team Komanda
- Improve with prior from other tasks

# P4: End-to-end driving for the rAIScar



- Learn to drive from imitation
- Drive around with the rAIScar and record images, steering and acceleration commands, ...
- Train regression network for control behavior from public dataset
- Re-train network on your campus dataset and deploy on rAIScar for autonomous driving
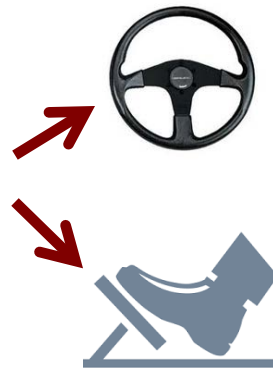
# P5: Vision-based localization

- Metric localization (x,y) with AIS perception car

- Multiple dataset collection runs on campus, ground truth from Applanix positioning system

- Deep pose regression: train a deep ConvNet to map from current image to global (x,y) pose

- Data fusion: add visual odometry to improve localization accuracy
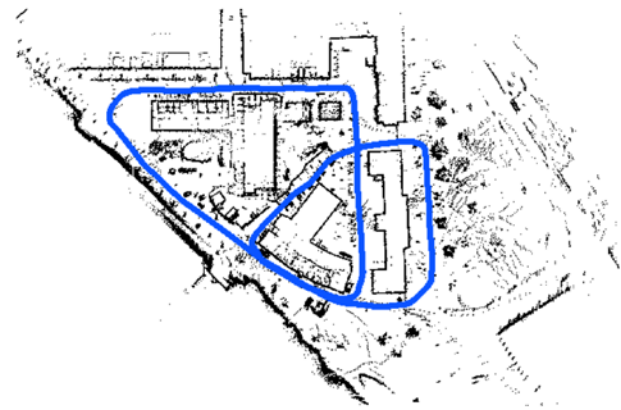
# P6: Semantic road segmentation for the rAISCar



- Semantic road and lane segmentation

- Fully convolutional neural networks: train a encoder-decoder net to infer pixel-wise road/lane classifications

- Pre-train net on public KITTI dataset

- Transfer vision system to rAISCar

- Fine-tune net with automatic labeling of lanes in indoor motion capture system

# Thank you for your attention!