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AutonomyML4School

[Aleksandr Petiushko](#)

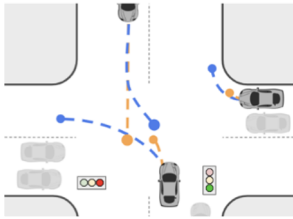
Autonomy Interaction Research

Presented at:

MOUNTAIN VIEW HIGH SCHOOL
Home of the Spartans

Content

Alex's Intro



- **Motto:** *Standing on the shoulders of giants*
- **Approach**: to combine Academia and Industry Research
  - Academia: Ph.D., lecturer on theory of ML/DL
  - Industry: TLM, Autonomy Interaction Research

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PhD THESIS

MIPT

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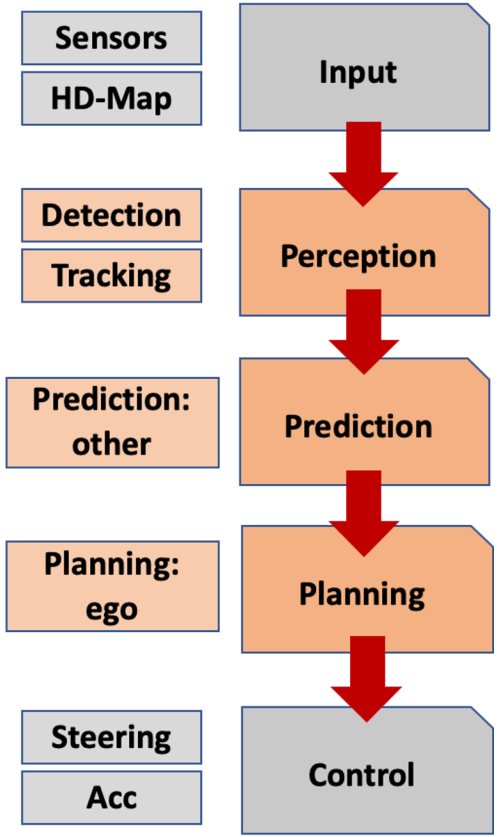
AD and SDV

- **AD** = Autonomous Driving: the *task*
- **SDV** = Self-Driving Vehicle: the *car*
- *AD* is one of the most complex and difficult tasks, both theoretically and practically

Safety of SDV and other agents on the road is crucial

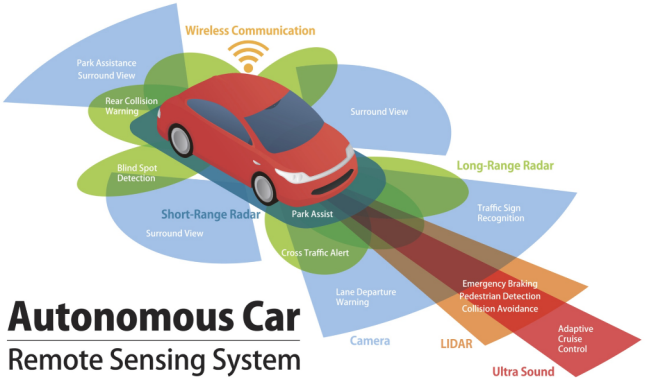
AD: ML Stack of Technologies

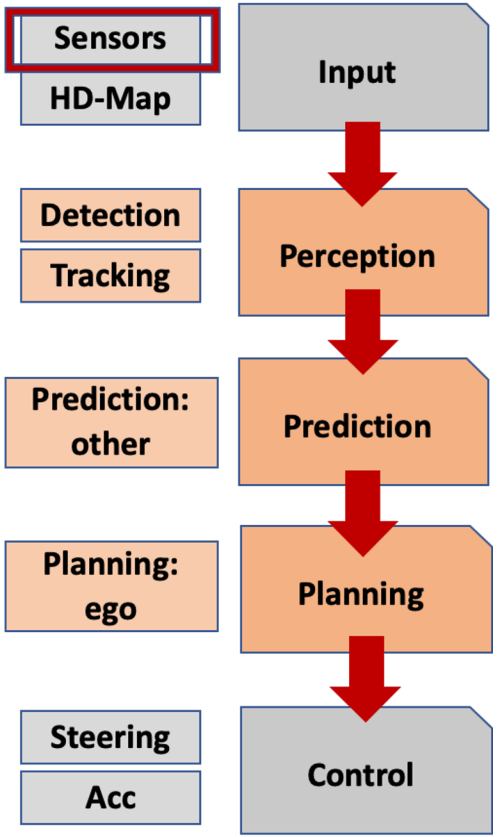
- The main **software** parts are the so-called **P**^{3}:
  - **P**erception, **P**rediction and **P**lanning
- **Hardware** parts:
  - Input: Sensors
  - Output: Control (steering, acceleration)
- High-Definition Map as the helper
  - **HD-Map** contains info about the road



SDV: Sensors

- Various **sensors** are used:
  - LIDAR
  - Radar
  - Ultra Sound
  - Cameras (*x N*)

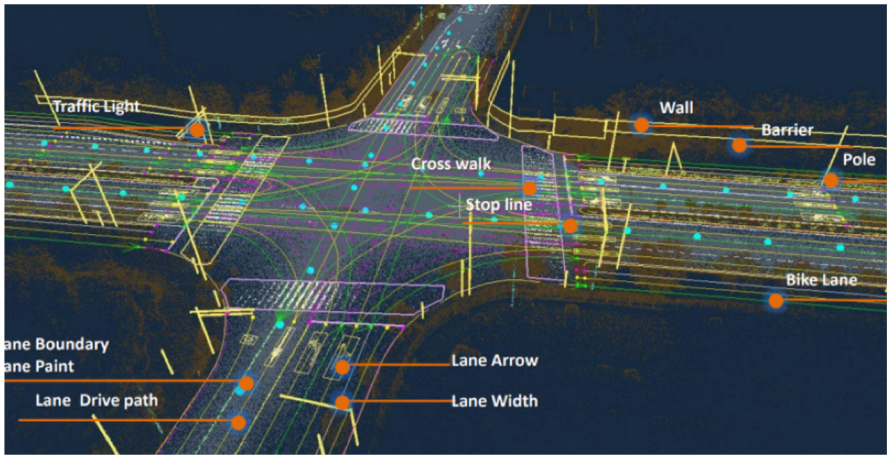


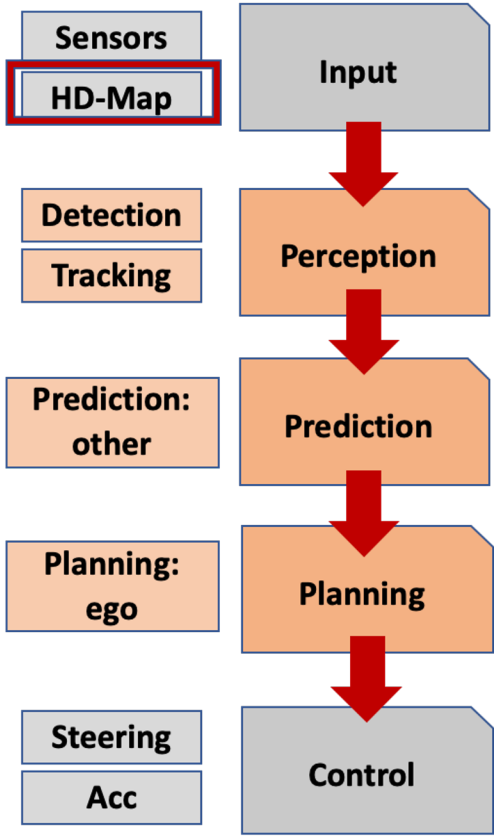


- **Problems**:
  - Expensive
  - Hard to synchronize

AD: HD-Map

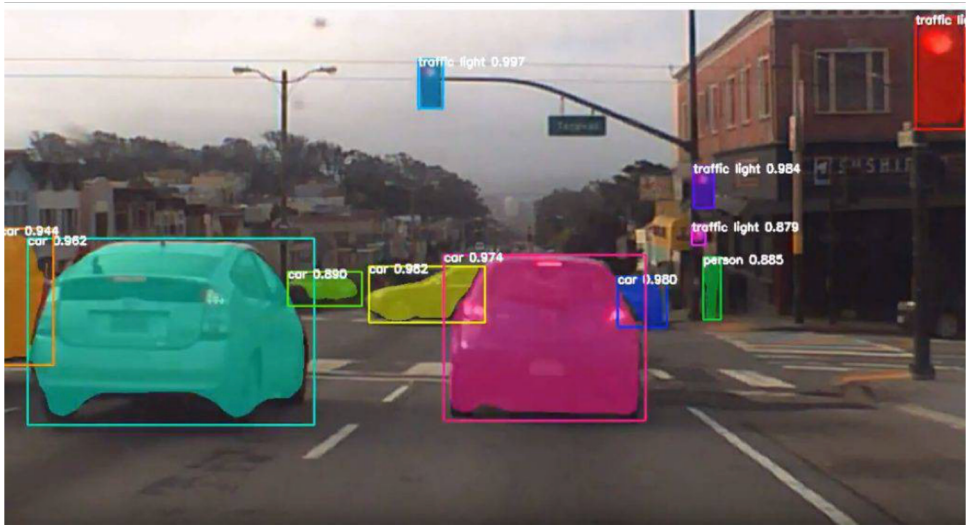
- Helpful for prediction and planning
  - Contains information about a **road**:
    - Lanes, crosswalks, traffic lights, etc.
- **Problems**:
  - Every company has its own format
  - Significant overhead

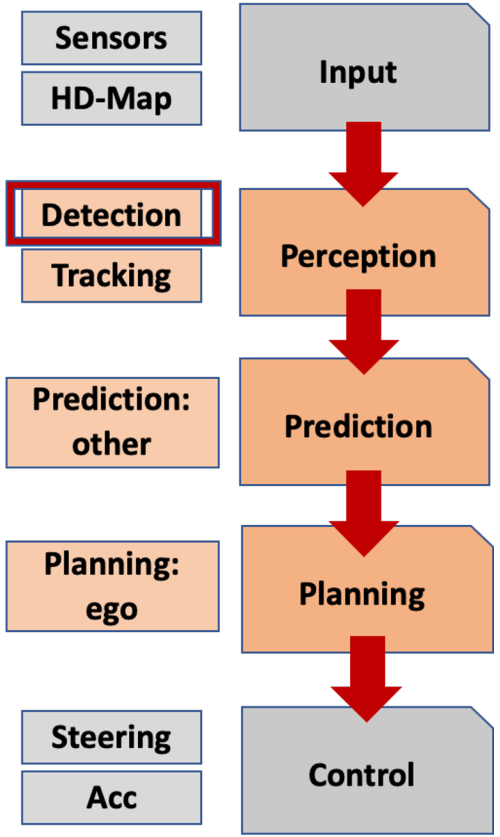




AD: Detection

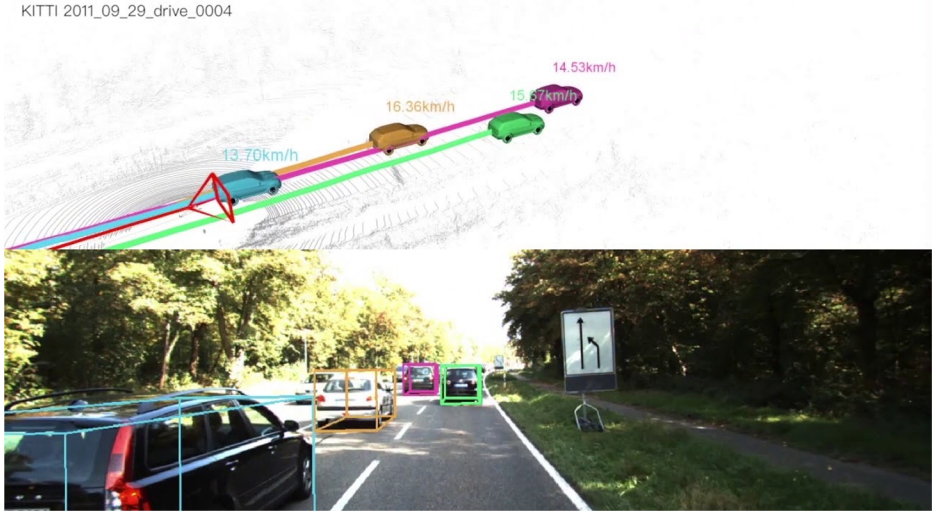
- The *first* step of the Perception part:
  - **Detection** (segmentation, depth-estimation, etc.) of the objects around
- **Problems**:
  - Long tail (small and unusual objects) and anomalies

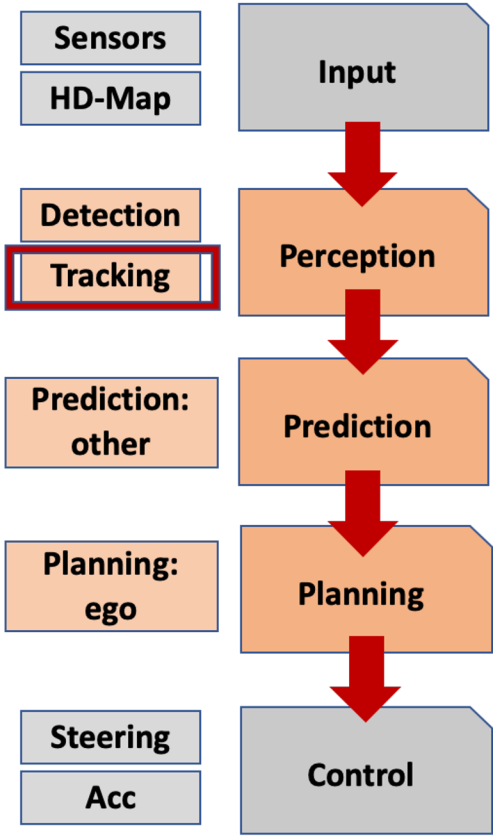




AD: Tracking

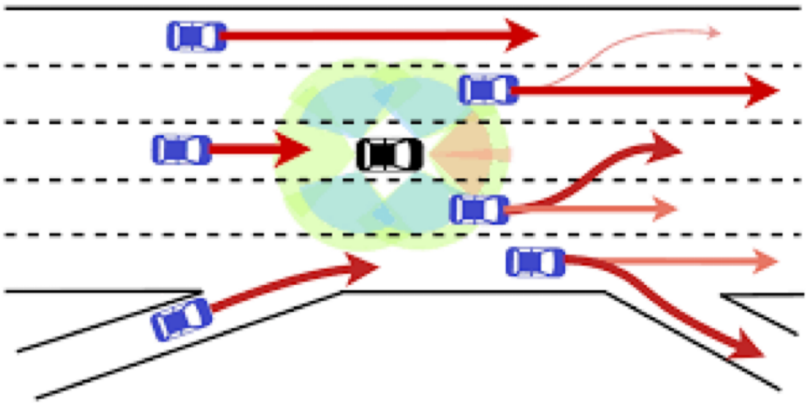
- The *second* step of the Perception part:
  - **Tracking** of the detected objects and estimation of their coordinates for the Prediction part
- **Problems**:
  - Track association of flickering objects

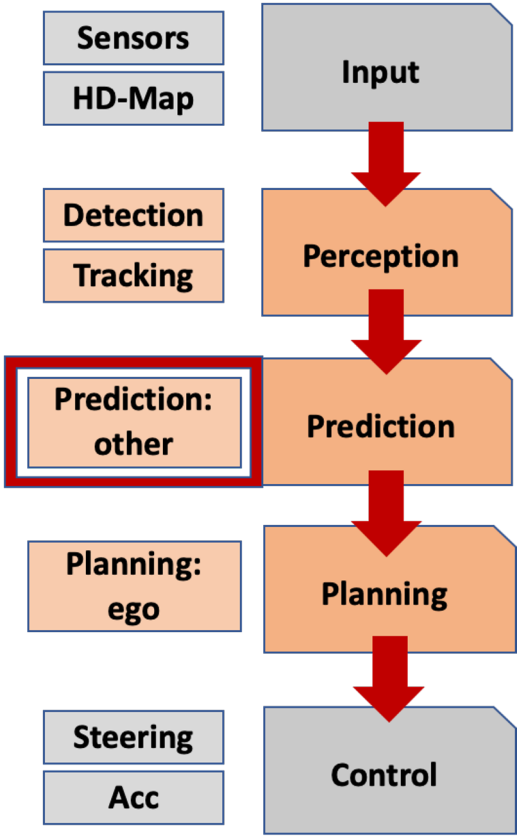




AD: Prediction

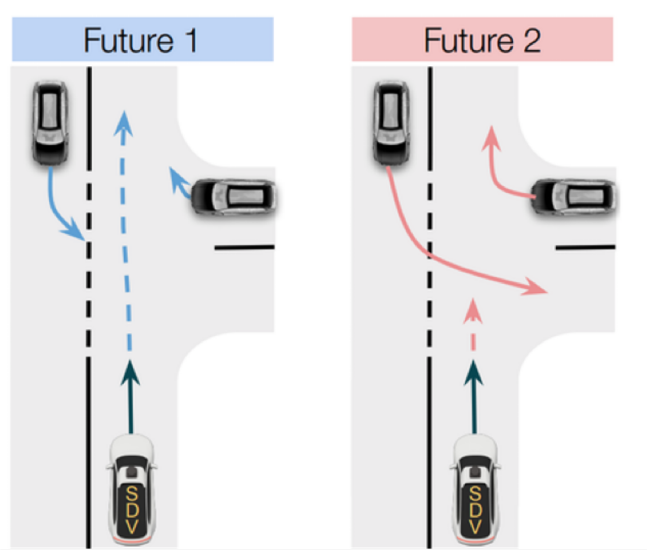
- Future trajectories **prediction** of all surrounding objects based on the *tracking history* and *HD-Map*
  - Usually, 1-10 second
- **Problems**:
  - Multi-modality for recall

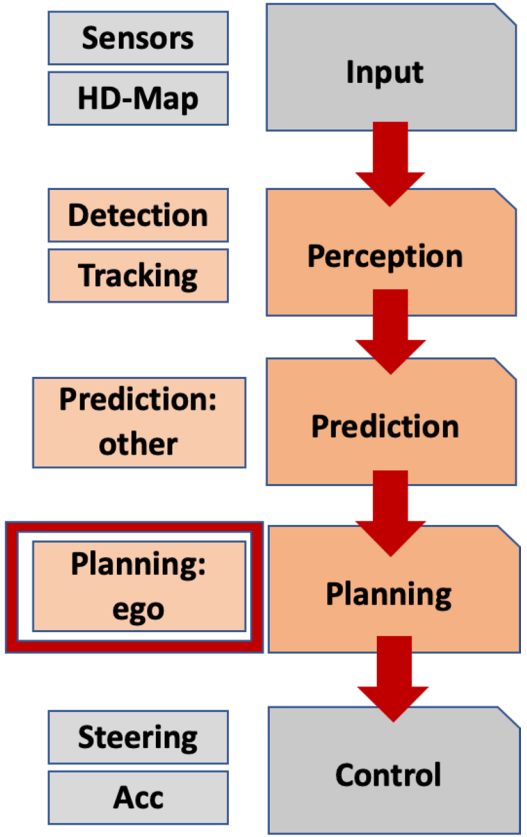




AD: Planning

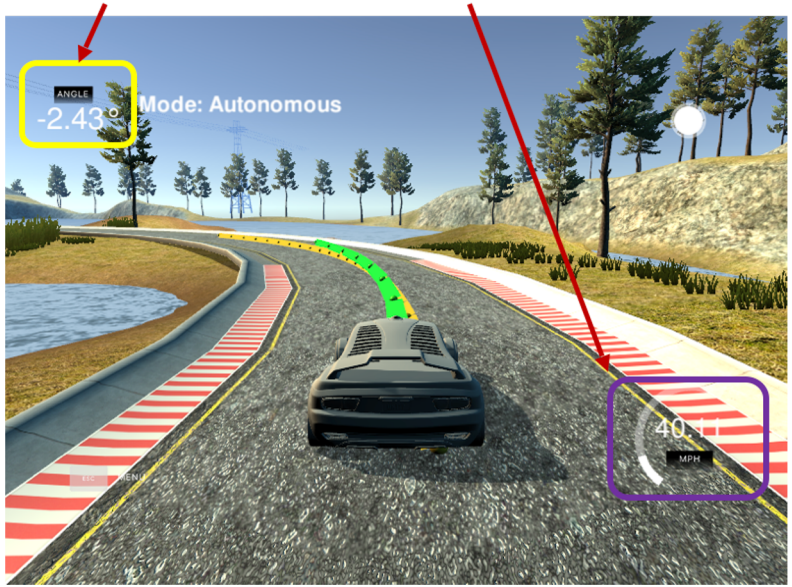
- **Planning** of SDV future actions based on the *predictions* and *HD-Map*
- **Problems**:
  - Consistent joint prediction and planning



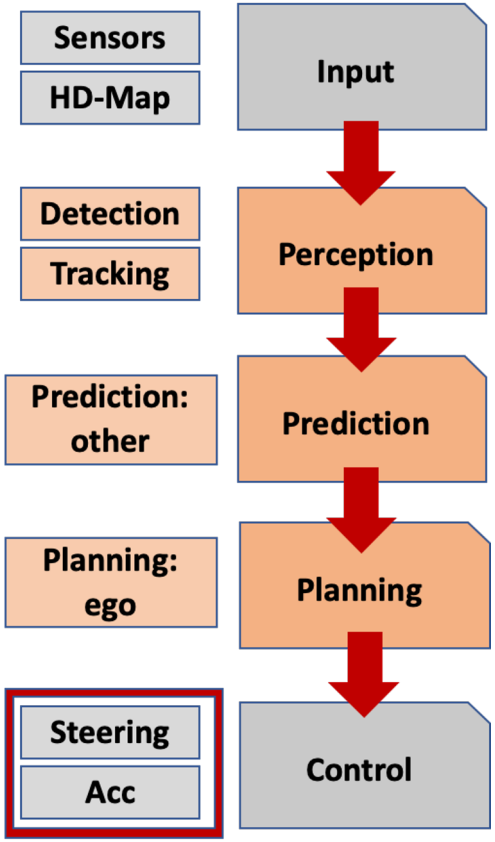


SDV: Control

- Realization and **control** of SDV actions based on *motion plan*
  - Steering control, acceleration control, etc.



- **Problems**:
  - Dynamic and kinematic limitations



Overview and *personal* Advice

- Right now there is a **big need** in:
  - Better **sensors**
    - Physics, optics, materials, …
  - Computer Vision **Long Tail** Comprehension
    - CNN, Transformers, …
  - Behavior **Prediction** and **Planning**
    - RNN, Transformers, RL, …
  - **Safety** guarantees
    - Formal validation, verification, robustness, …
  - ML **Infrastructure**
    - GPUs, Distributed trainingMulti-G

- **BUT**: no one knows what technology stack will be in 3-5 years
  - AD_GPT to solve AD?
- **Suggestion**:
  - Concentrate on **fundamental** things that will be used inevitably throughout the industry:
    - Probability theory, mathematical statistics, theory of optimization, decision theory, …


Thank
You.
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