자율주행 산업 및 직무 강연

- Introduction to Autonomous Driving -

Autonomous Driving Research Engineer

April 21, 2021

Contents

Why Autonomous Driving?

Why Autonomous Driving?

- **Do we really need autonomous driving ?**
  - Convenience

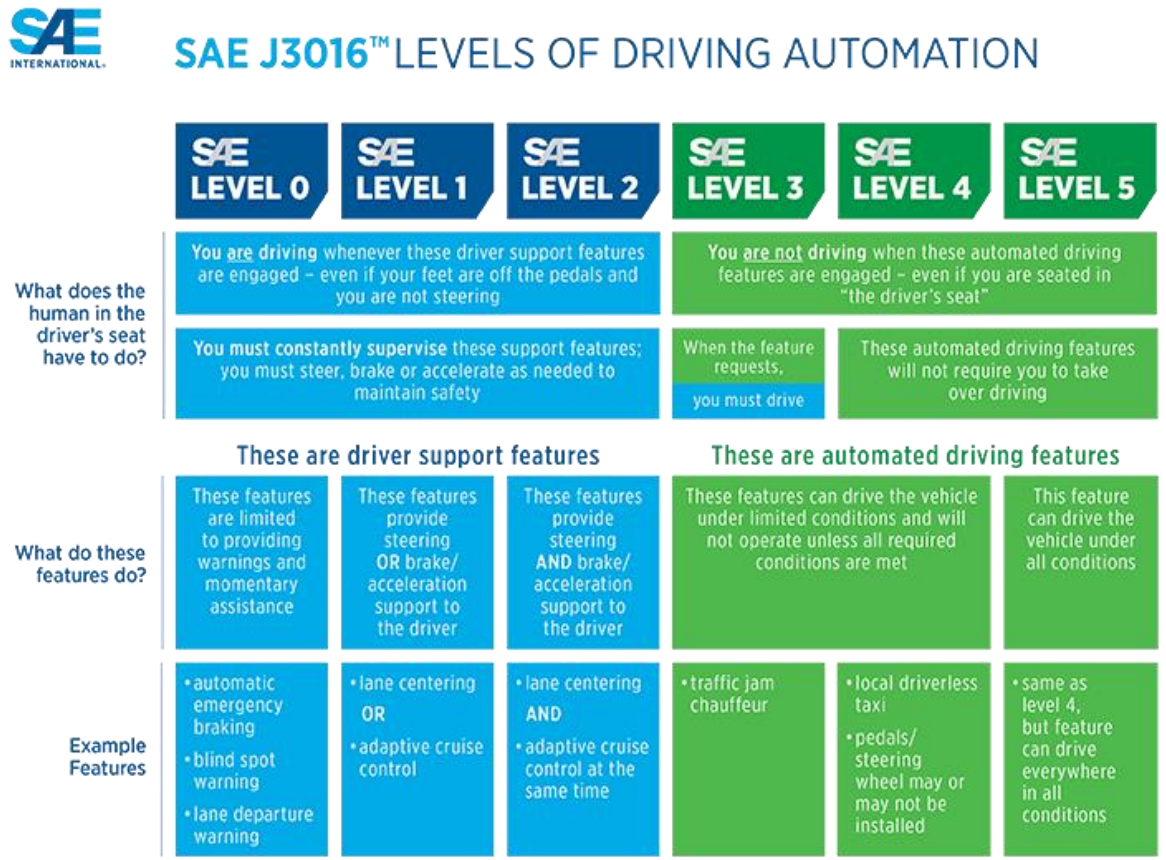
Why Autonomous Driving?

- **Do we really need autonomous driving ?**
  - Safety

Definition of Autonomous Driving

Definition of Autonomous Driving

- **Classification by Technical Level**
  - by SAE (국제자동차기술자협회)

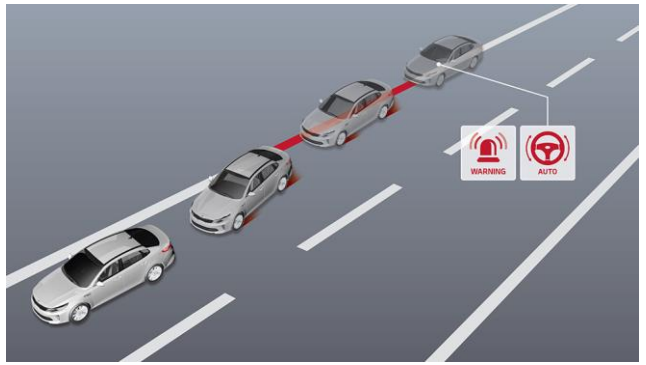


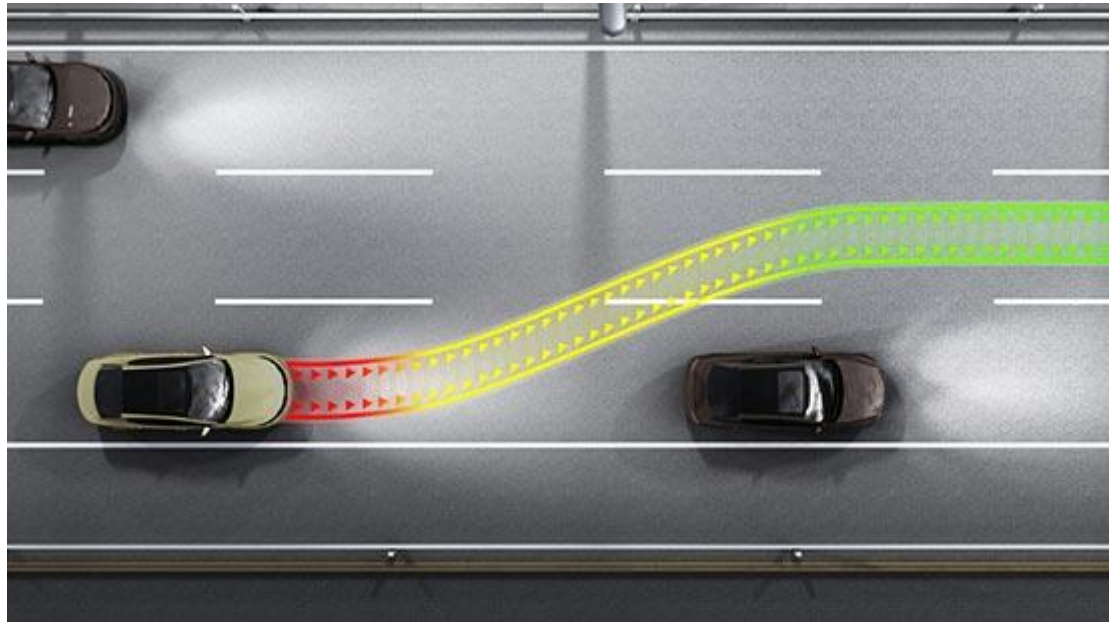
Definition of Autonomous Driving

- **Classification by Technical Level**

Definition of Autonomous Driving

- **Current AD system?**
  - maybe...level 2...?
  - ADAS (advanced driving assistance system)

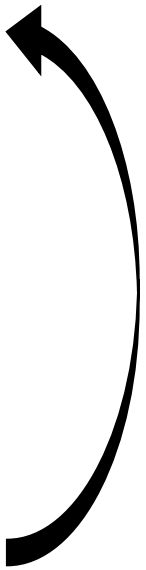




Module of AD system

Module of AD system

- **What is autonomous driving?**
  - To reach the goal
    - 주변에 무엇이 있는가
    - 여긴 어디이고
    - 나는 어디에 있는가
    - 주변상황을 예측하고 판단한 뒤
    - 목적지까지 가기 위해 계획을 세우고
    - 적절하게 움직인다
    - ...
    - 도착했나?



인지 (Perception)

지도 (Mapping) / 측위 (Localization)

예측(Prediction)

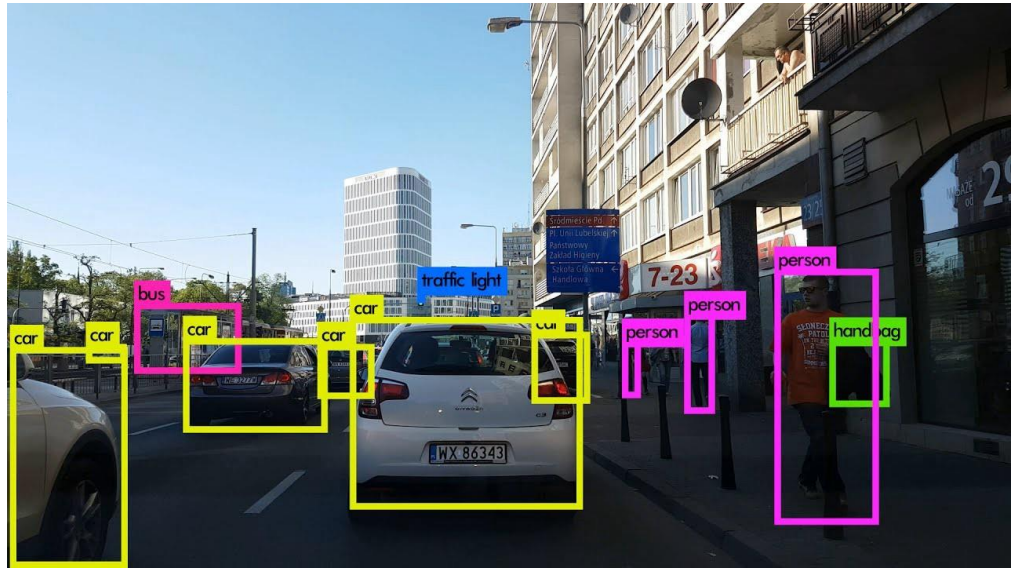
판단(Decision Making)

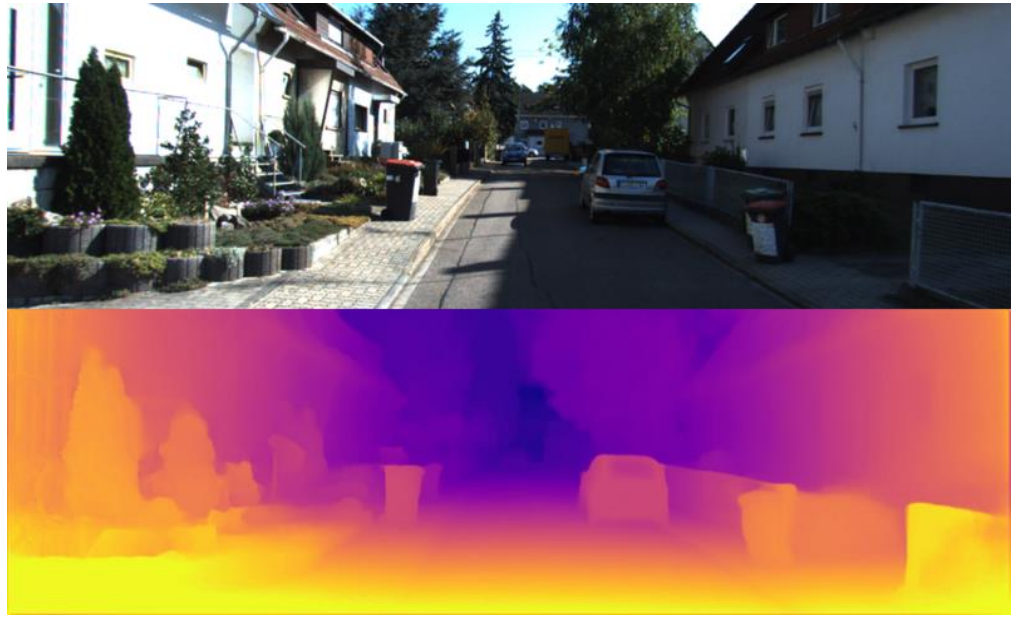
계획 (Planning)

제어 (Control)

Module of AD system

- **Perception**
  - Camera
    - Computer vision



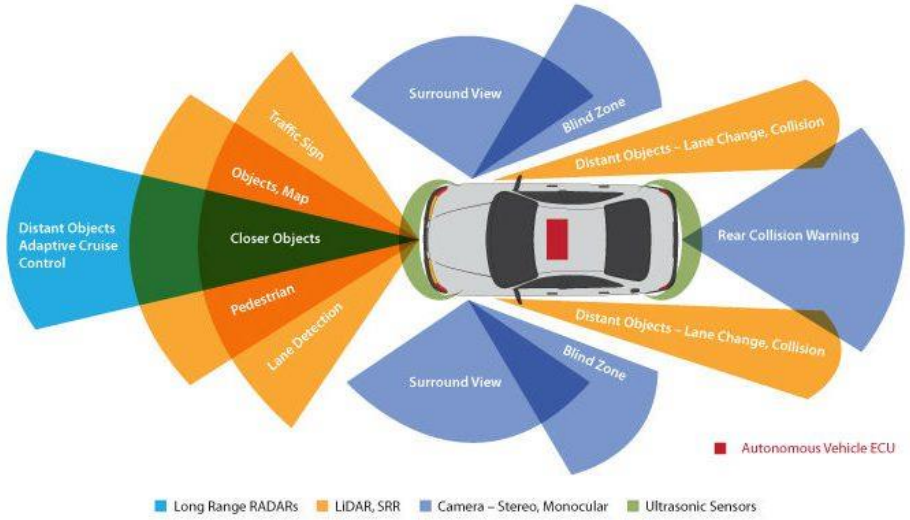


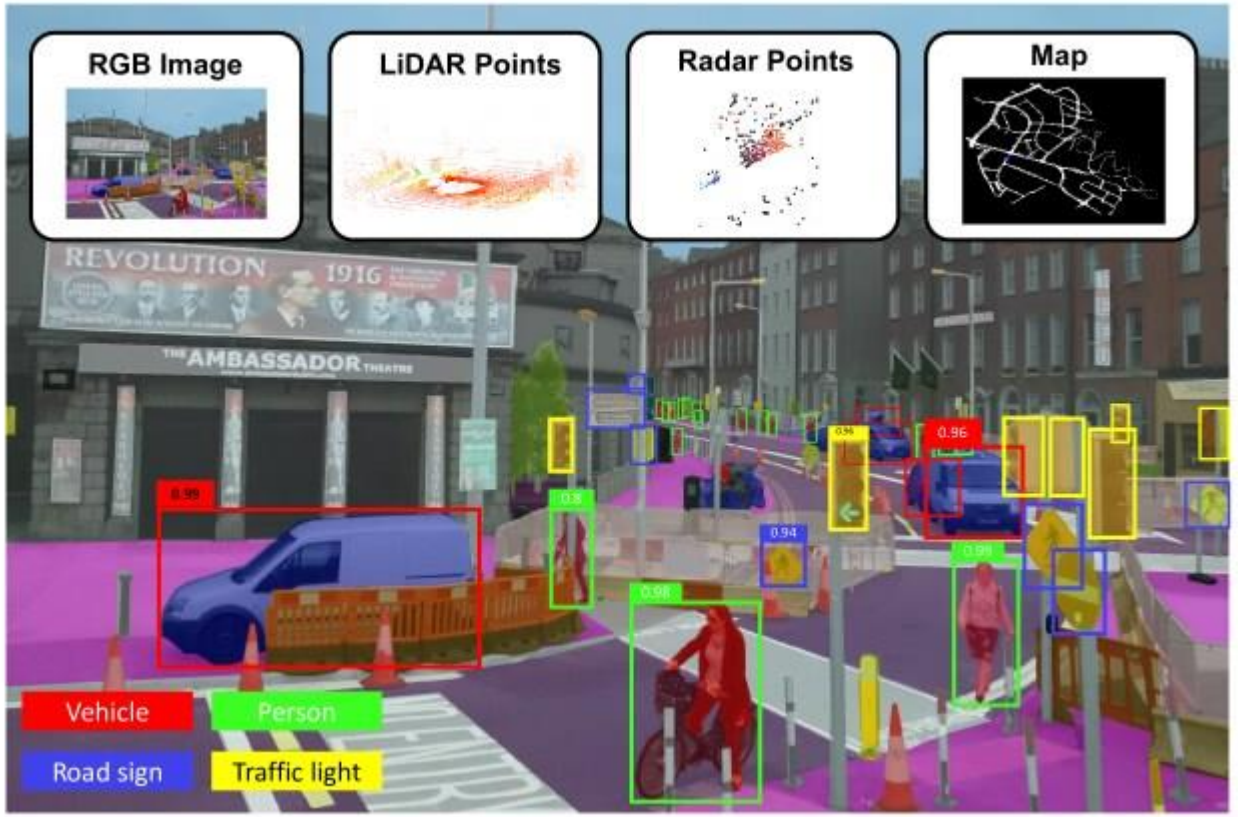
Module of AD system

- **Perception**
  - Lidar
  - Radar

Module of AD system

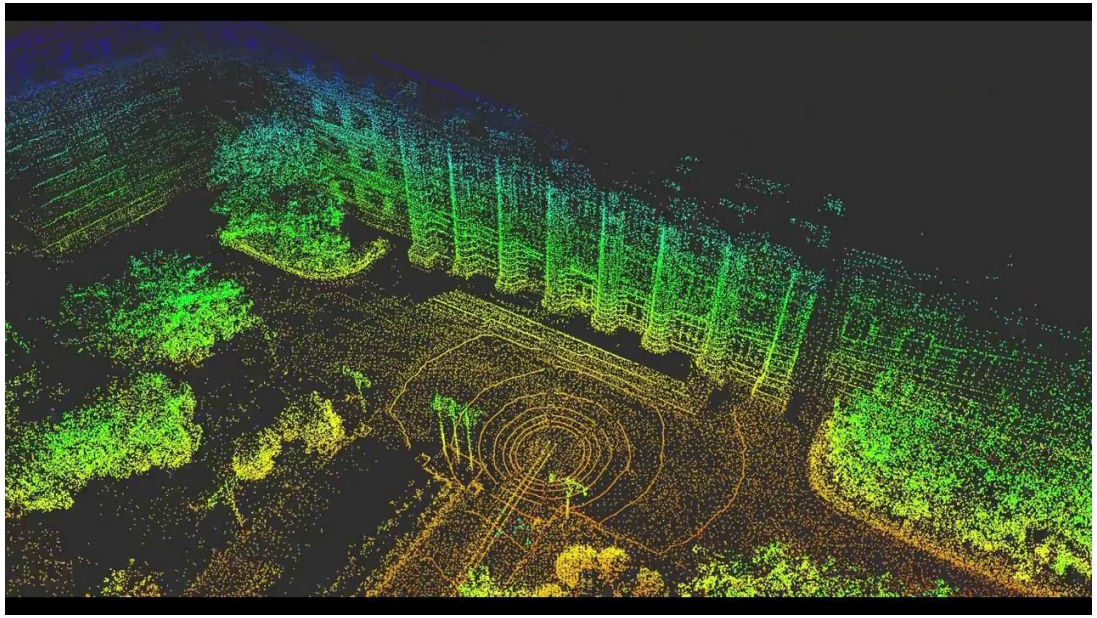
- **Perception**
  - Sensor fusion
    - Pros and Cons of each sensor
    - Gathering Advantages

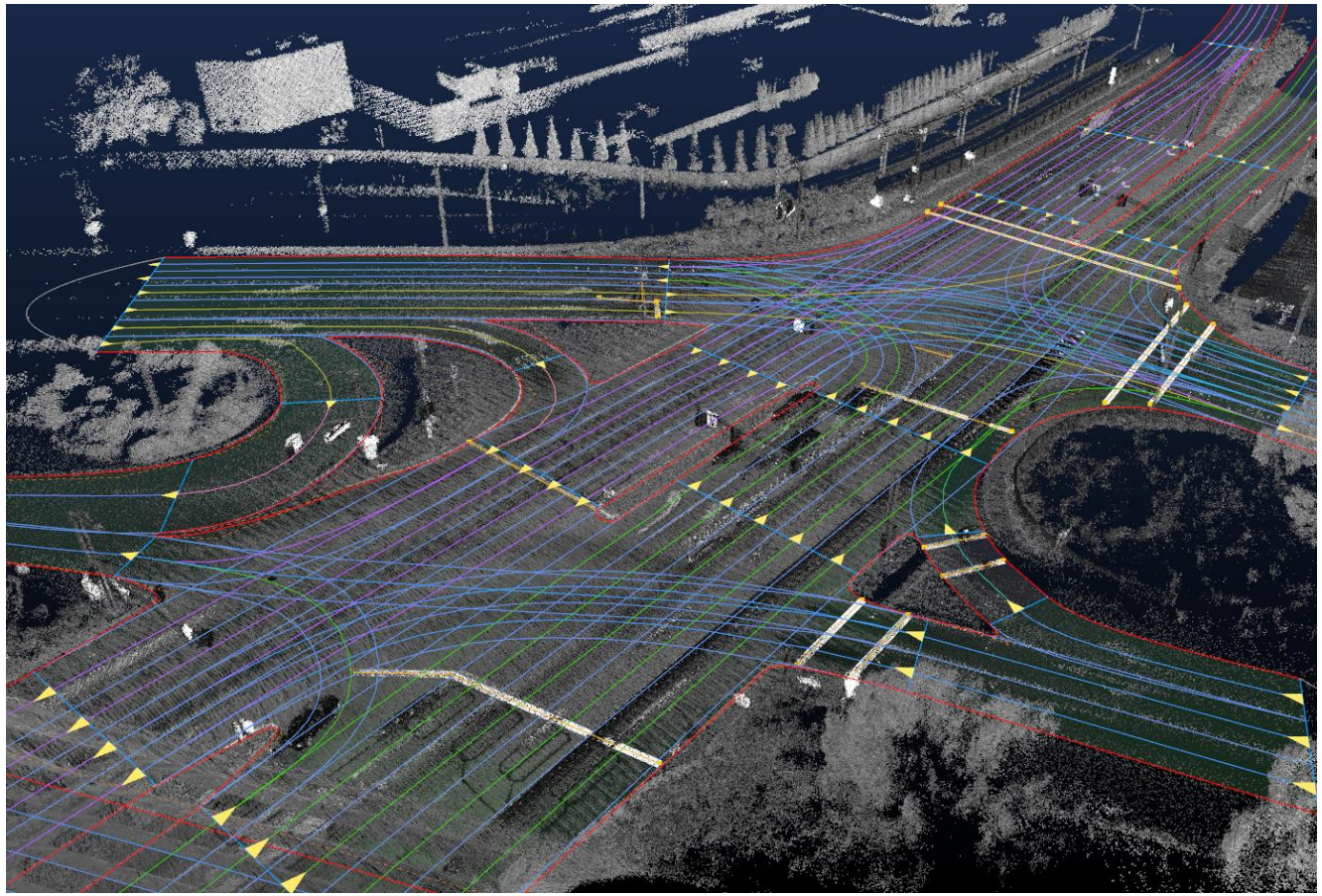




Module of AD system

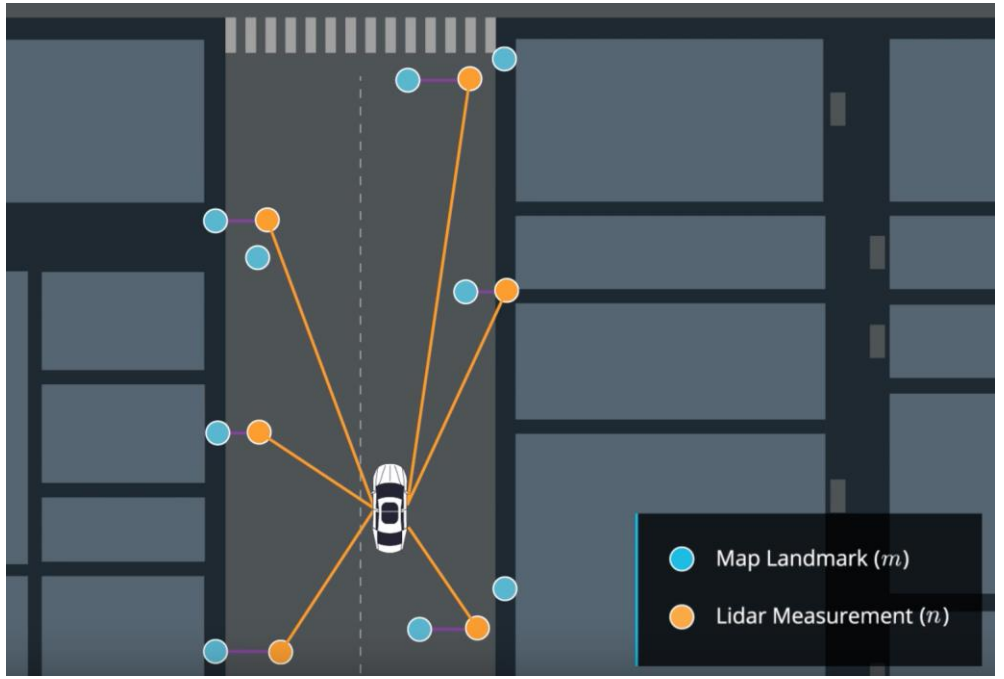
- **Mapping**
  - HD map





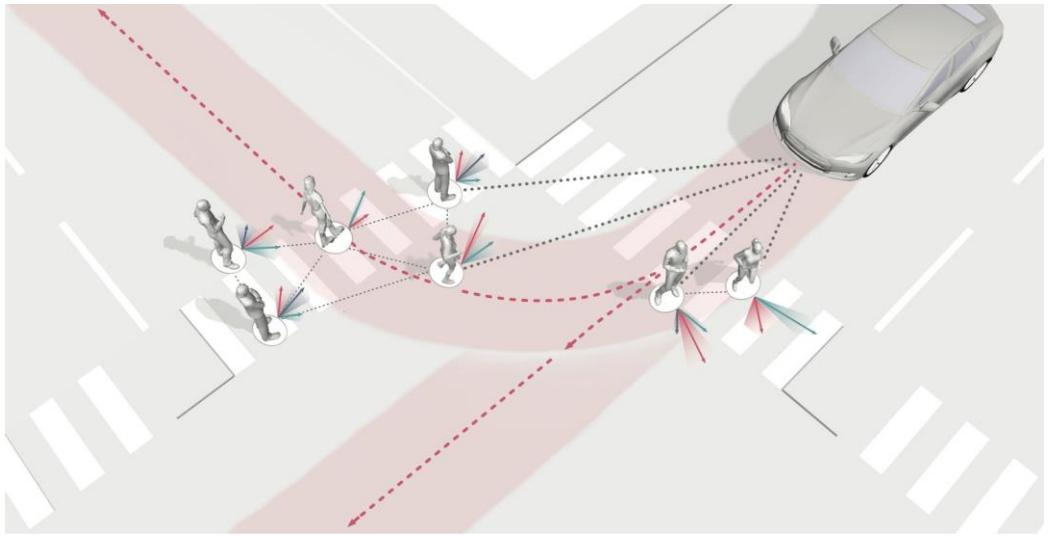
Module of AD system

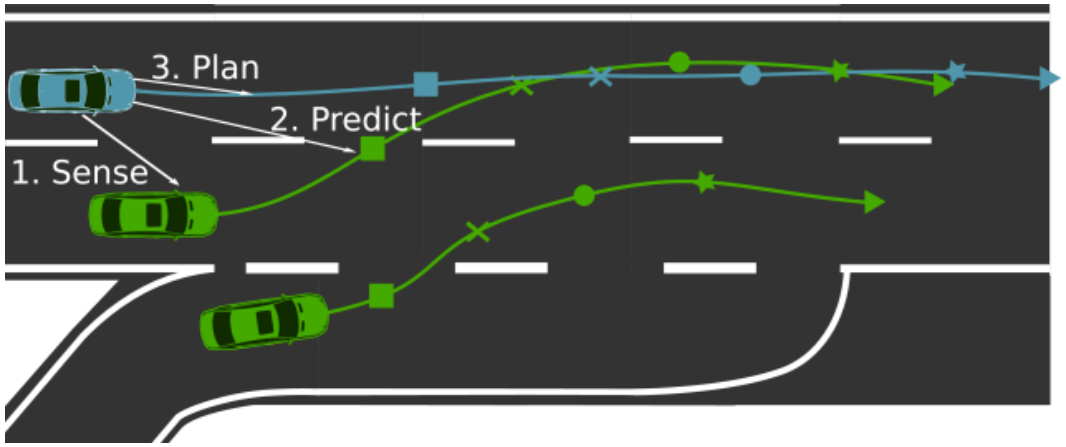
- **Localization**
  - GPS
  - Env. Sensors
  - Dead reckoning



Module of AD system

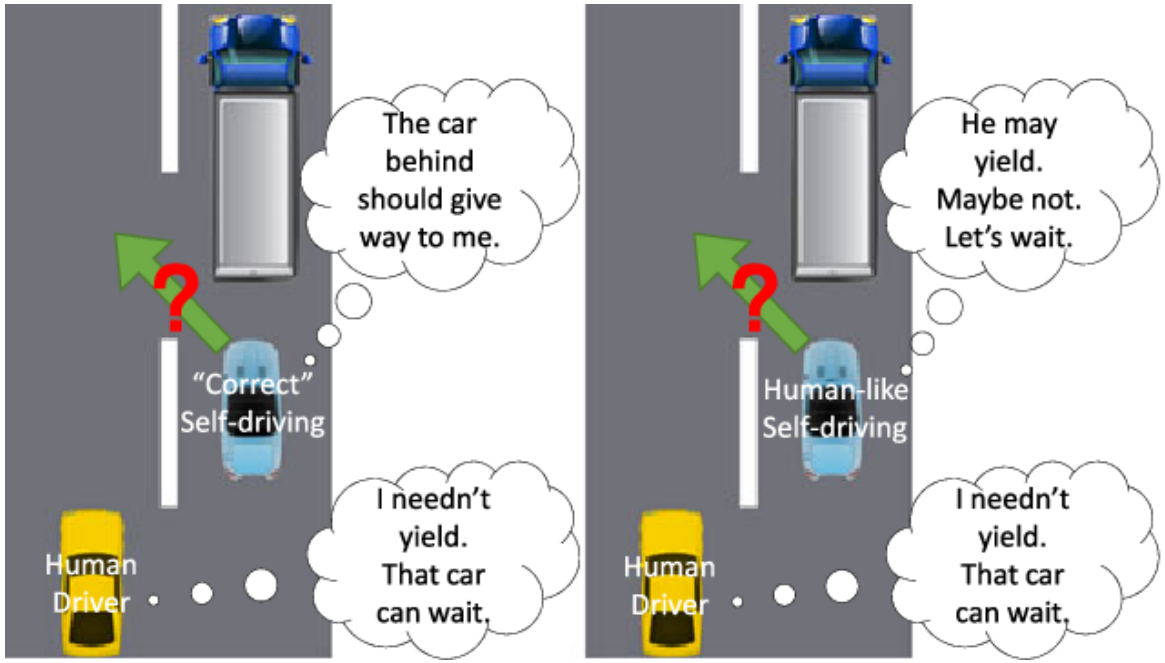
- **Prediction**

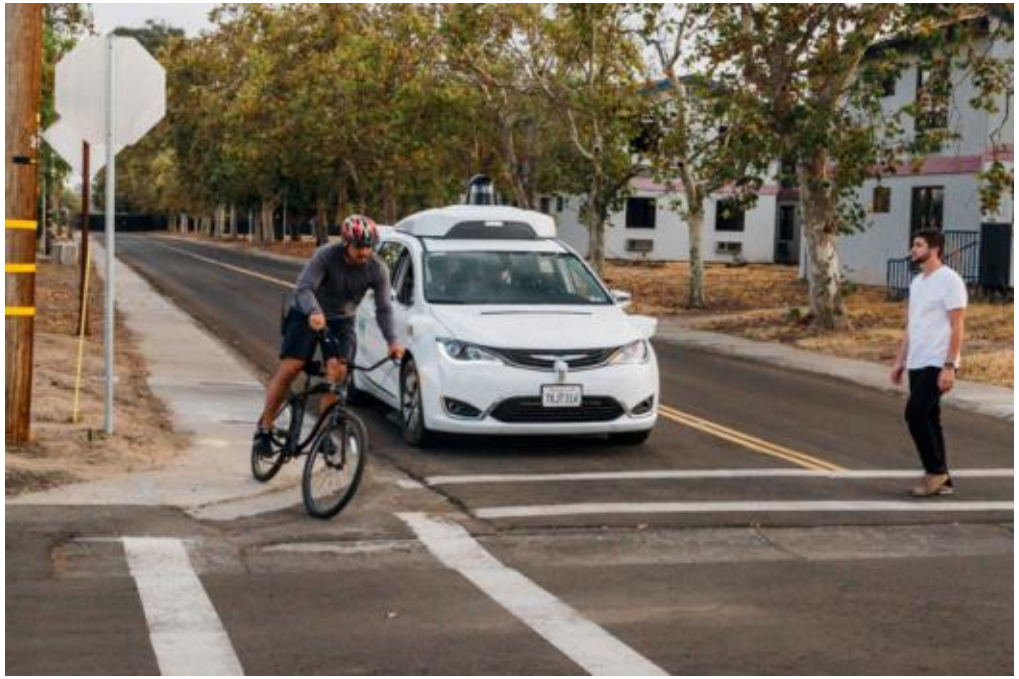




Module of AD system

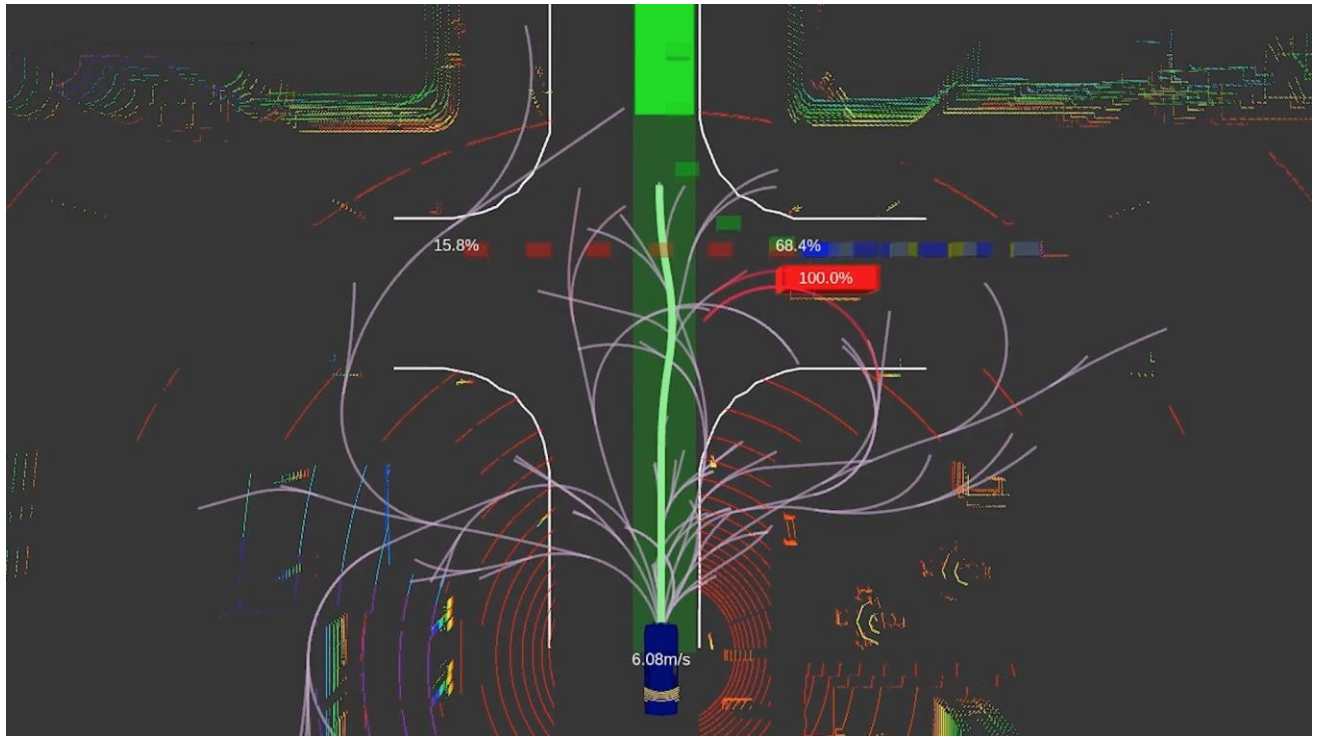
- **Decision Making**

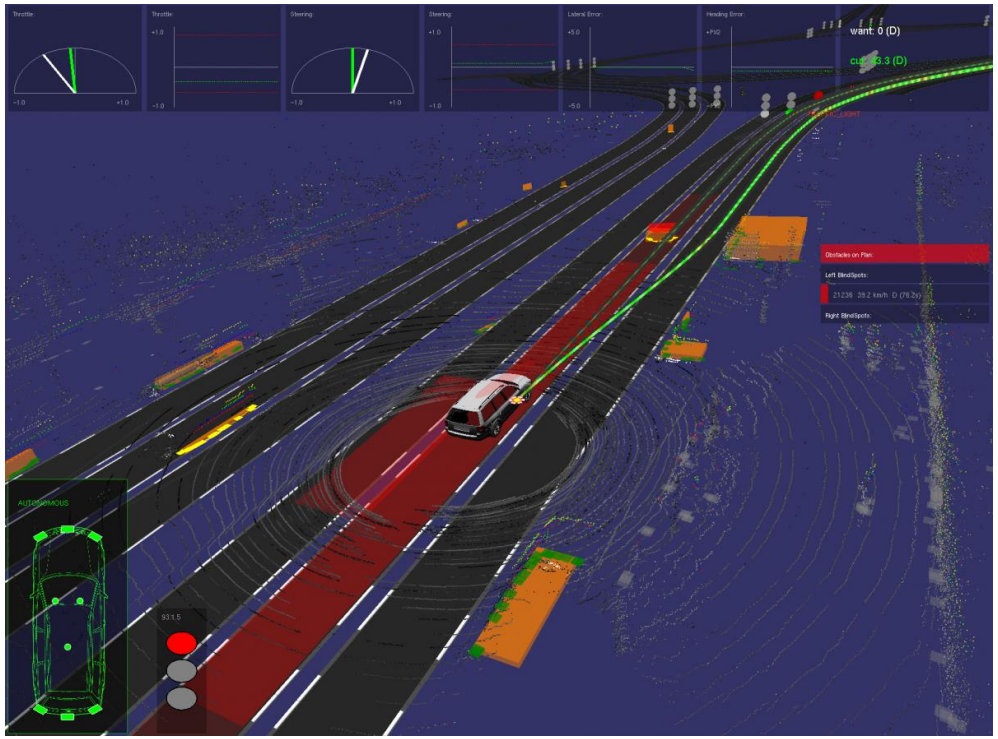




Module of AD system

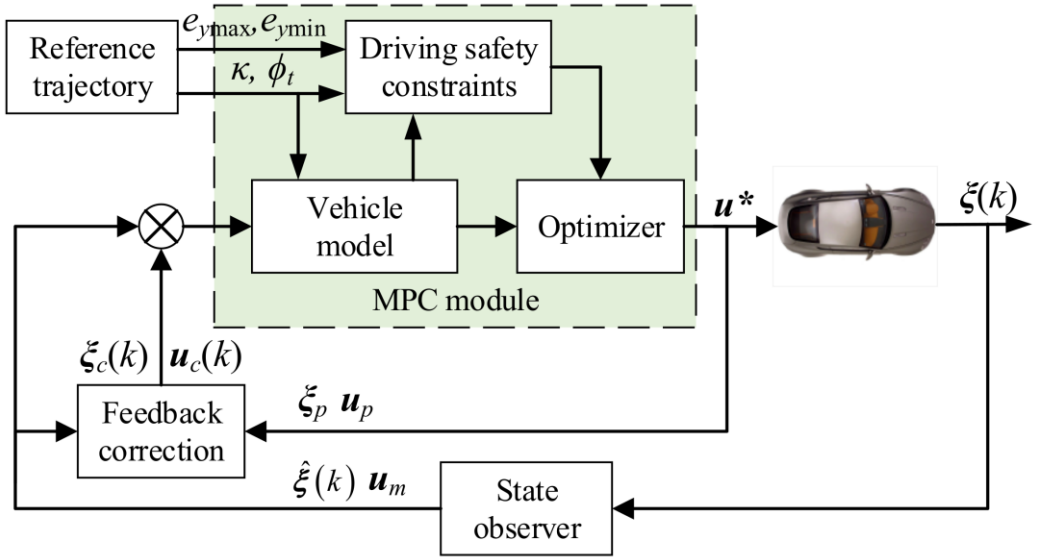
- **Planning**





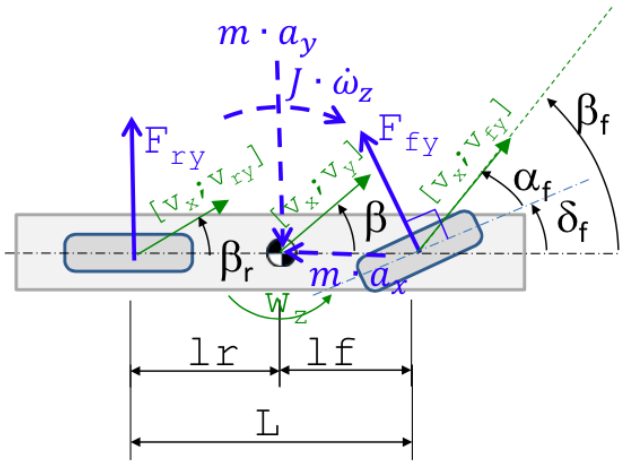
Module of AD system

- **Control**
  - Dynamics
  - Control Theory



Physical model:

- Path radius >> the vehicle. Then, all forces (and centripetal acceleration) are approximately co-directed.
- Small tyre and vehicle side slip. Then, angle=sin(angle)=tan(angle).
  (Angles are not drawn small, which is the reason why the forces not appear co-linear in figure.)



Mathematical model:

Equilibrium:

$$m \cdot (\dot{v}_x - \omega_z \cdot v_y) \approx F_{fx} + F_{rx}; where\ \dot{v}_x = 0;$$
$$m \cdot (\dot{v}_y + \omega_z \cdot v_x) \approx F_{fy} + F_{ry};$$
$$J \cdot \dot{\omega}_z \approx F_{fy} \cdot l_f - F_{ry} \cdot l_r;$$

Constitution: $F_{fy} = -C_f \cdot s_{yf}; \quad F_{ry} = -C_r \cdot s_{yr};$

Compatibility:

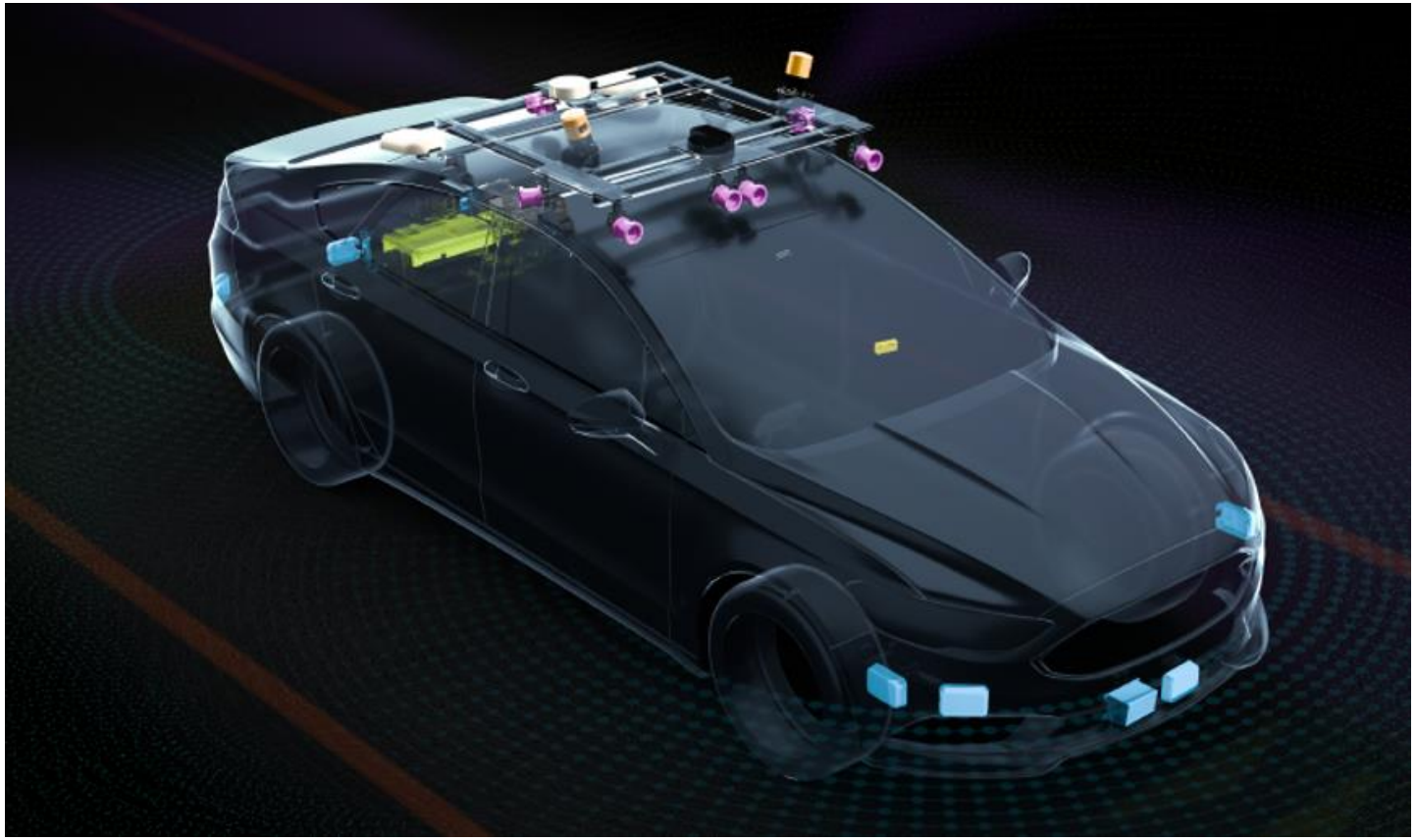
$$\left\{ \begin{array}{c} \delta_f + \alpha_f = \beta_f; \quad \beta_f \approx \frac{v_{fy}}{v_x} = \frac{v_y + l_f \cdot \omega_z}{v_x}; \\ \alpha_r = \beta_r \approx \frac{v_{ry}}{v_x} = \frac{v_y - l_r \cdot \omega_z}{v_x}; \\ \alpha_f \approx s_{yf}; \quad \alpha_r \approx s_{yr};; \end{array} \right\}$$

Eliminate $F_{fy}, F_{ry}, \alpha_f, \alpha_r, \beta_f, \beta_r$ yields:

$$m \cdot \dot{v}_y + \frac{C_f + C_r}{v_x} \cdot v_y + \left(\frac{C_f \cdot l_f - C_r \cdot l_r}{v_x} + m \cdot v_x \right) \cdot \omega_z \approx$$
$$\approx C_f \cdot \delta_f;$$
$$J \cdot \dot{\omega}_z + \frac{C_f \cdot l_f - C_r l_r}{v_x} \cdot v_y + \frac{C_f \cdot {l_f}^2 + C_r \cdot {l_r}^2}{v_x} \cdot \omega_z \approx$$

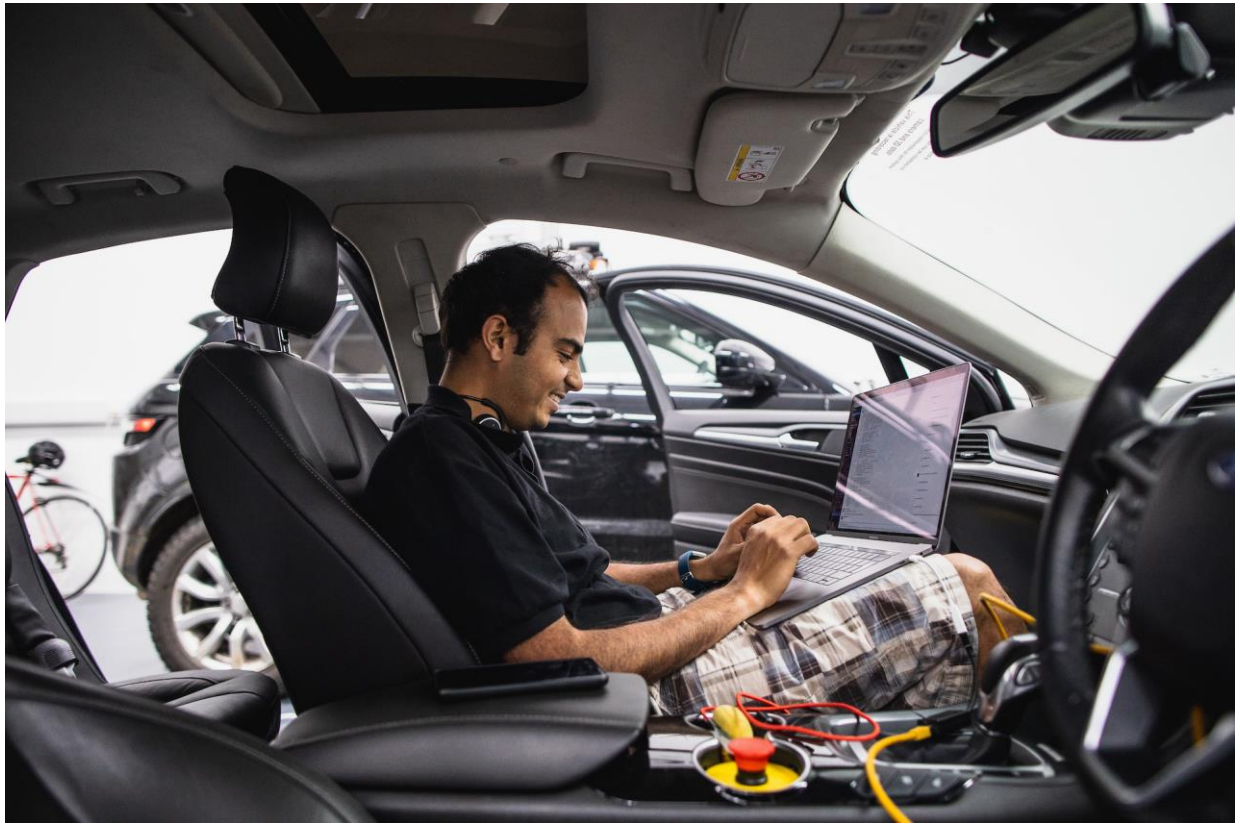
Module of AD system

- **Embedded system**
  - Low level programming
  - Optimization
- **System Arch.**



Module of AD system

- **Validation / Test Engineer**



Module of AD system

- **What do you want?**

Required Competence

Required Competence

- **Collection of Technologies**
  - Mechanical / Electric & Electronic / Computer engineering
  - Mathematics, Science, AI, Data science, Programming
  - etc...

Required Competence

- **Understanding about Vehicle**
  - Modeling/Dynamics
  - Just interesting

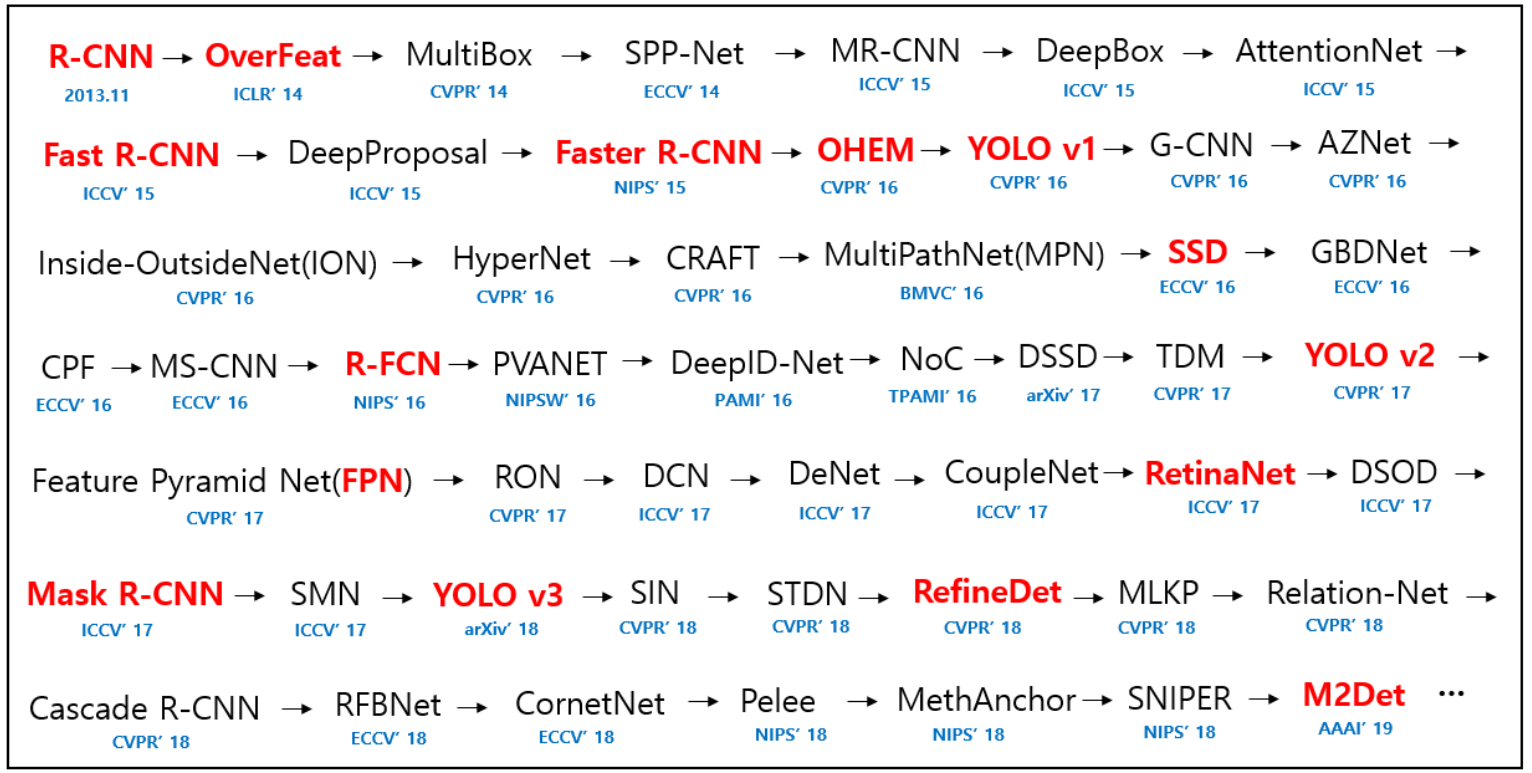
- **Domain Knowledge**
  - is still needed!!!

Required Competence

- **SW development ability**
  - Programming
    - You need familiar and appropriate language
    - CS knowledge - Algorithm, Data structure
  - Development
    - Research alone is not enough
    - Need many many practice

Required Competence

- **Study**
  - Do you like study?
    - even after employment
  - Enjoy new things
    - theory and some skills



Required Competence

- **Strong point**
  - Why should we hire you?

Q&A