Automotive Sensors

Course Introduction

Automotive Intelligence Lab.

Contents

Course Staff

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Course Information

Communication

- Hanyang University LMS (http://lms.hanyang.ac.kr)
  - Announcements, lecture notes, assignments, etc.

Prerequisites

- Basic programming skills.
  - **Any language** (C / C++ / Java / Python / MATLAB) experience is fine.
- **A personal computer** that can run MATLAB for projects.

Textbook

- Lecture notes are mainly used for lecture.

Course background and objectives

Course Objectives

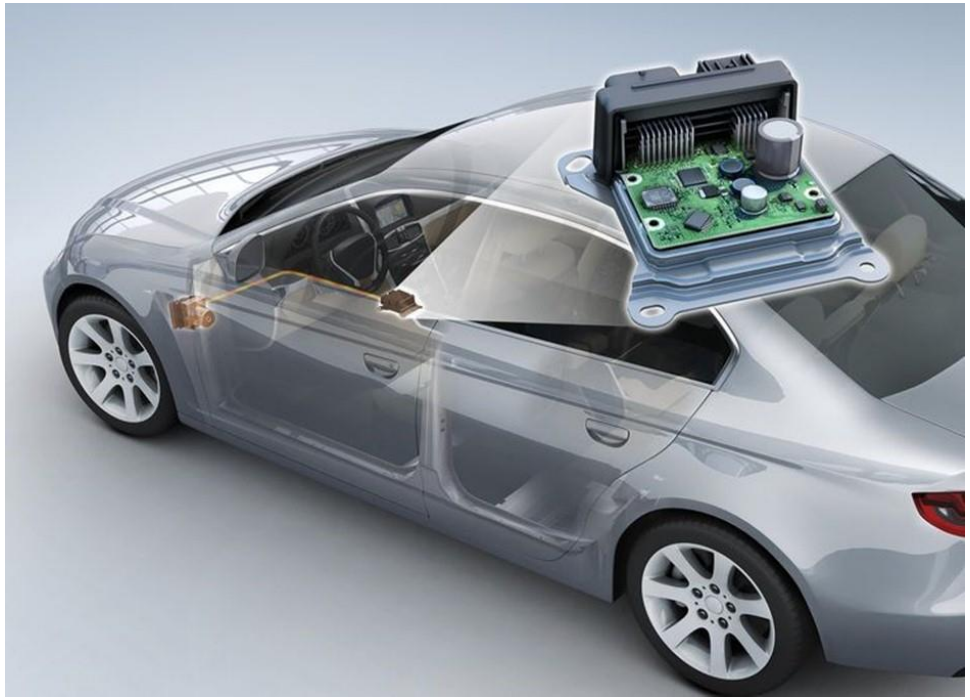
1. Learning the principles and types of sensors used in future cars.

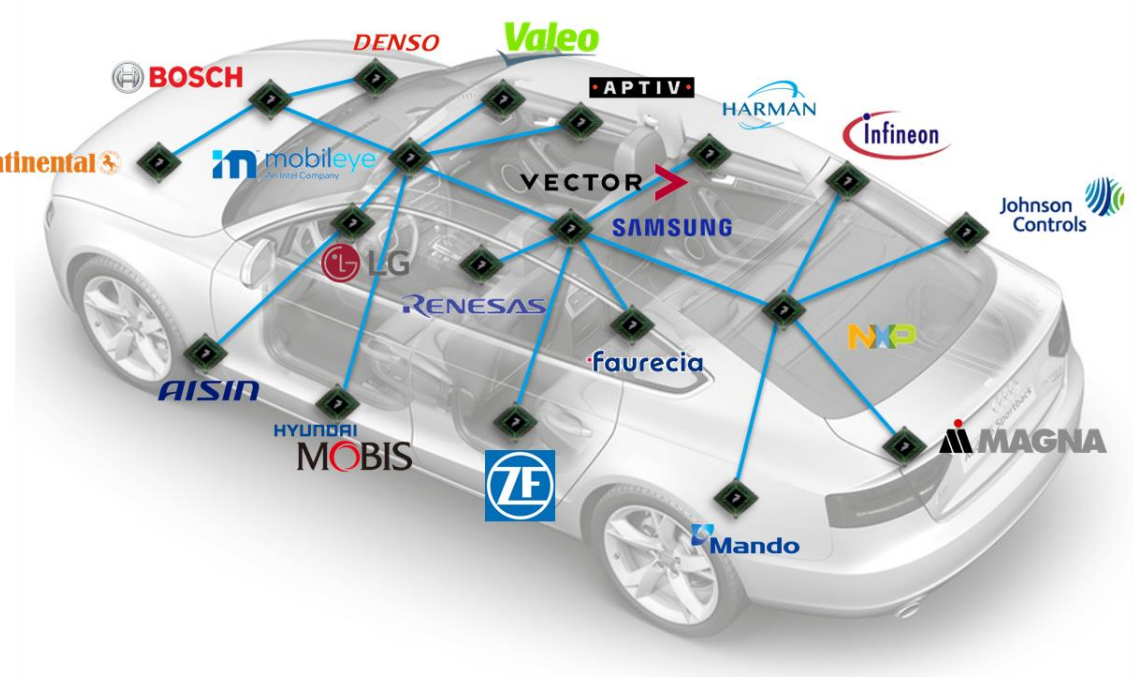
2. Learning sensor interface and data processing technology.

3. Developing software capabilities through sensor data processing practice.

Course Objectives 1

- Learning the principles and types of sensors used in future cars.
- Learning sensor interface and data processing technology.
- Developing software capabilities through sensor data processing practice.



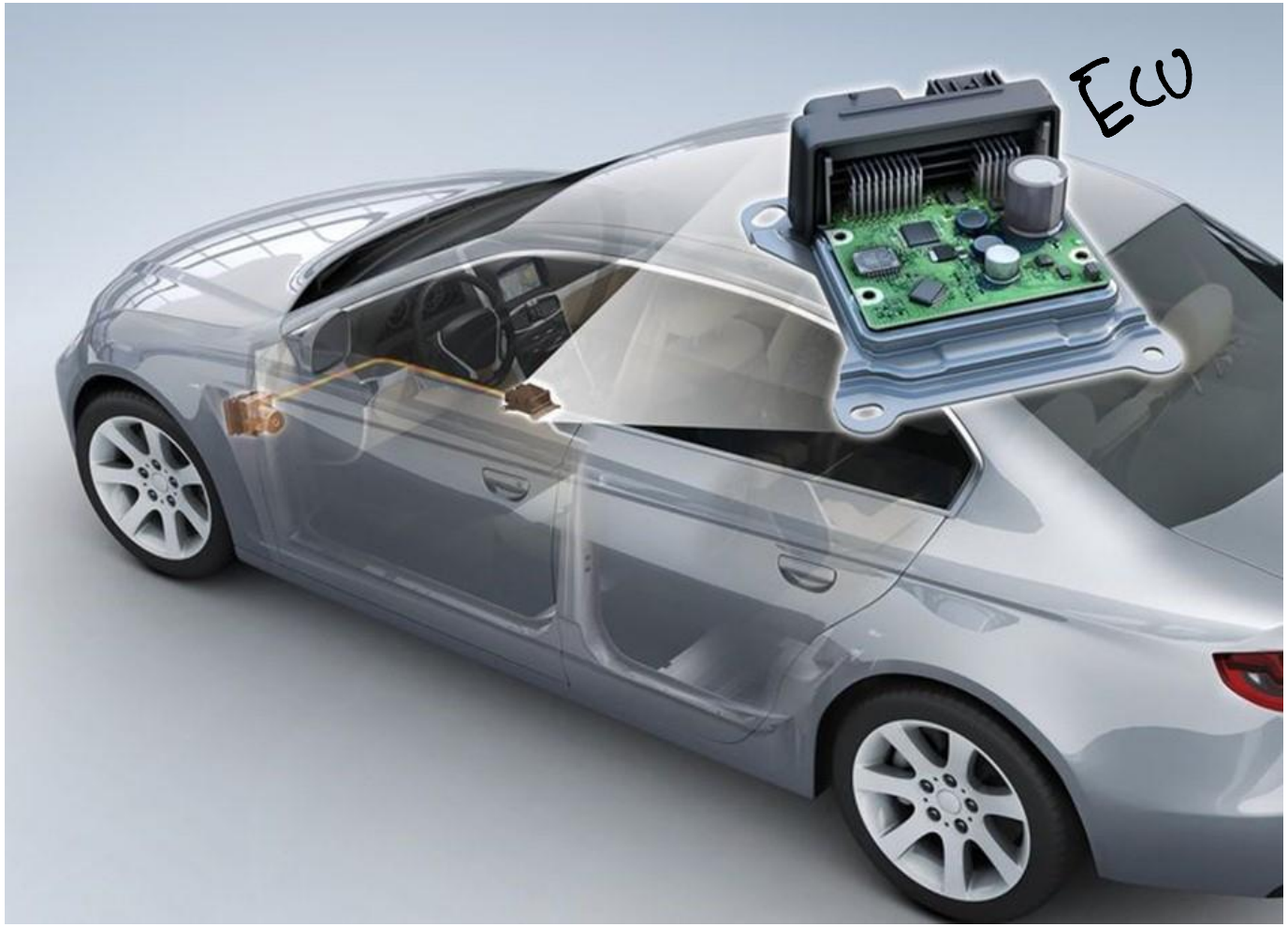


Automobile in the 1st and 2nd Industrial Revolutions

- Mechanization and mass production (- 1980)

Automobile in the 3rd Industrial Revolution

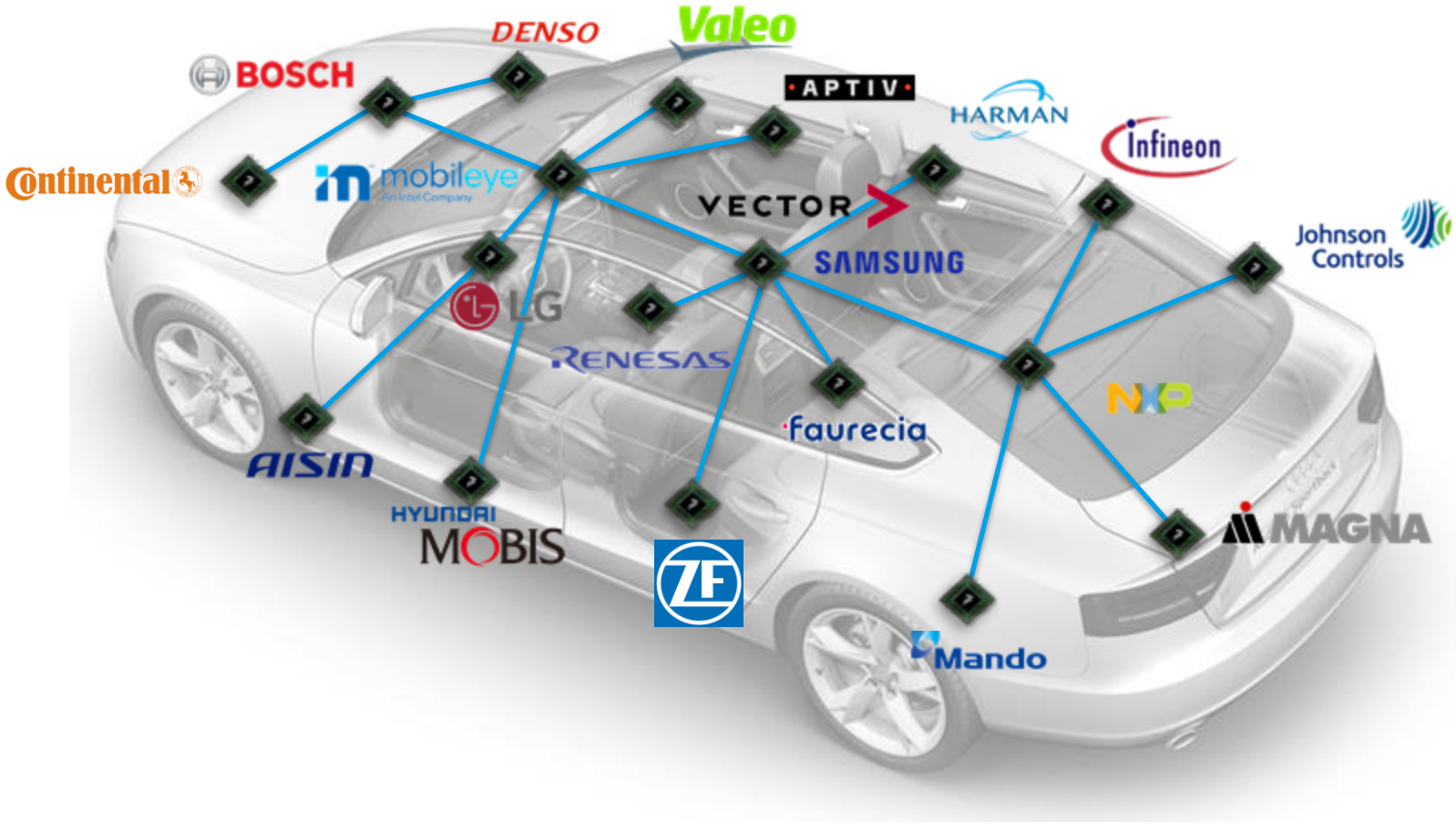
- Electronics and embedded system (1980 – Current)
- From this time on, electronic sensors were used extensively.



Current Automotive Industry

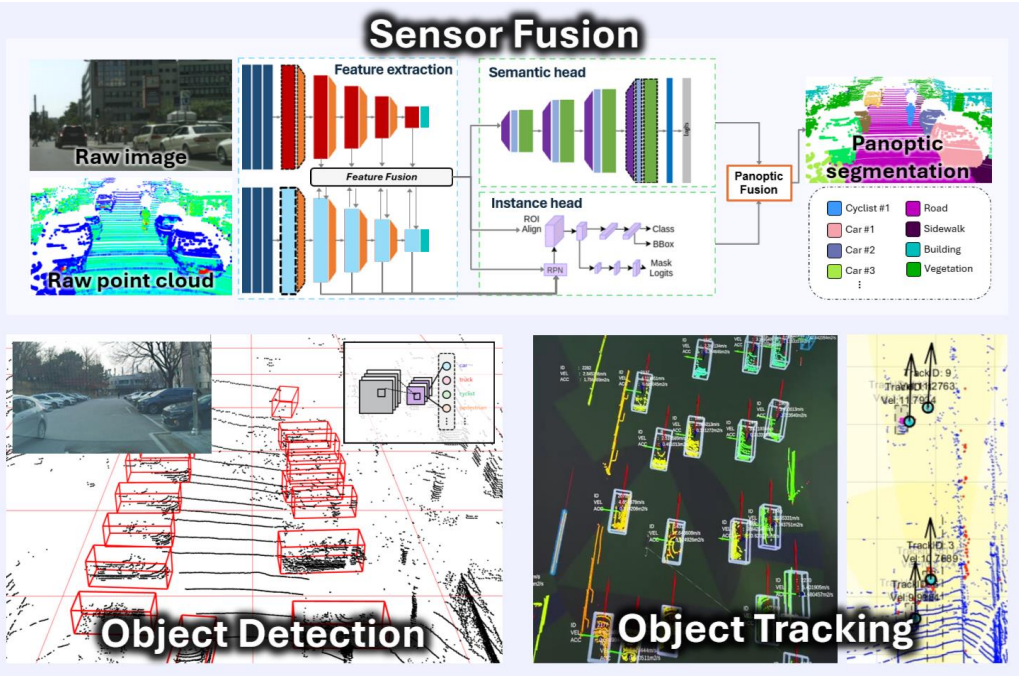
OEM – Supplier structure

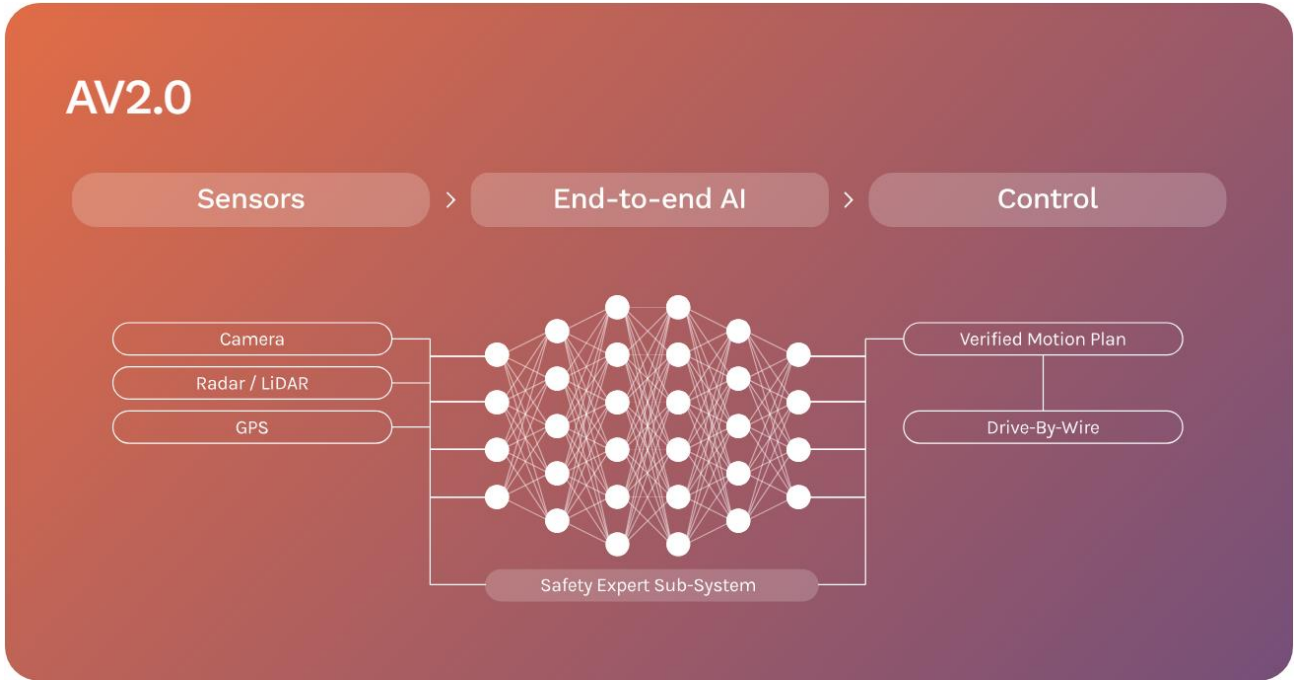
- HW-SW tightly coupled.
- Each supplier develops its own systems (sensors, computers, actuators) and the SW that relies on them.



Course Objectives 2

- Learning the principles and types of sensors used in future cars.
- **Learning sensor interface and data processing technology.**
- Developing software capabilities through sensor data processing practice.

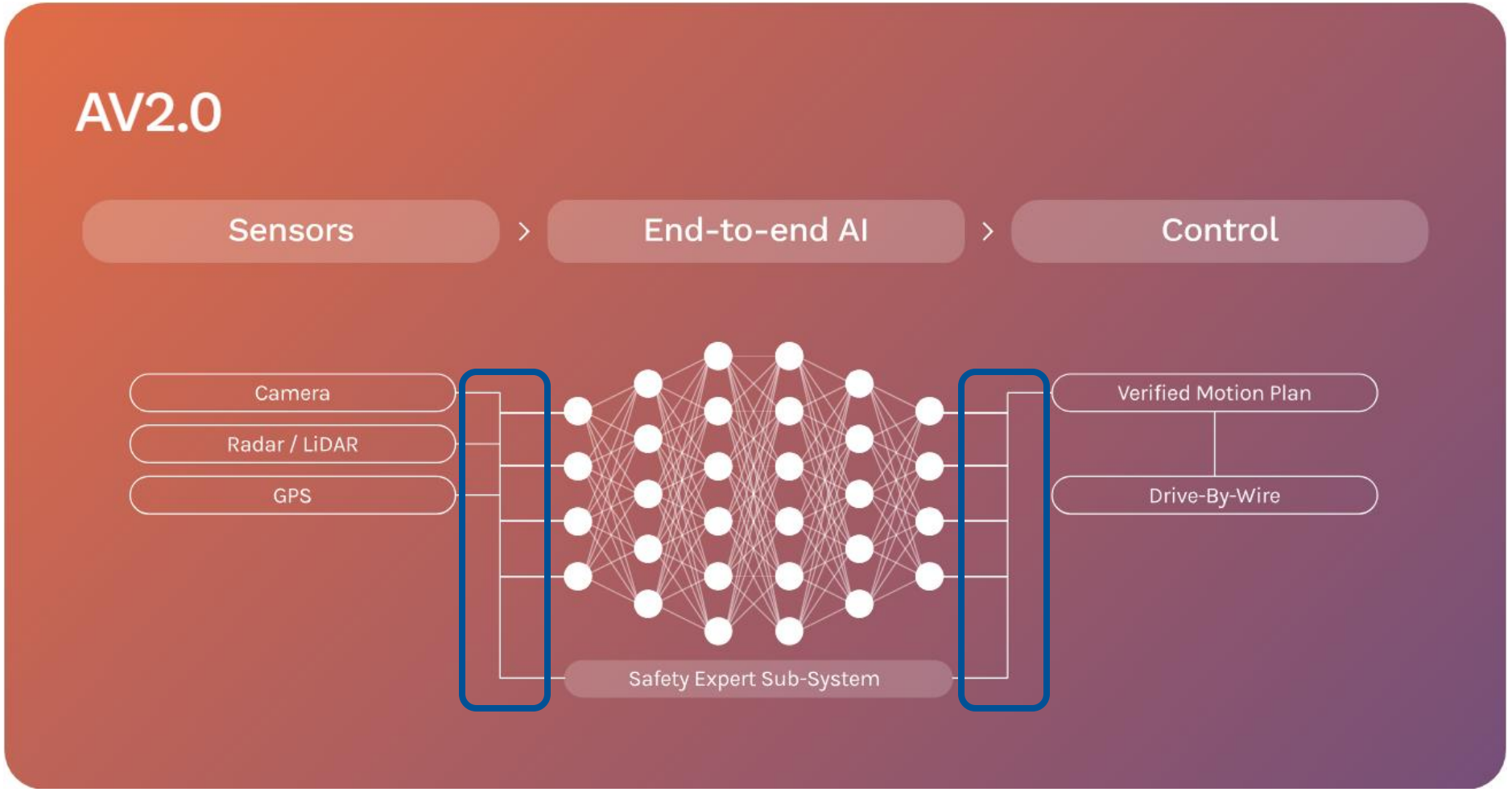




Applications of AI for Automotive Functions

End-to-End Autonomous Driving

- Sensor interface and data processing technology are very important!



https://wayve.ai/technology/

Course Objectives 3

- Learning the principles and types of sensors used in future cars.
- Learning sensor interface and data processing technology.
- **Developing software capabilities through sensor data processing practice.**

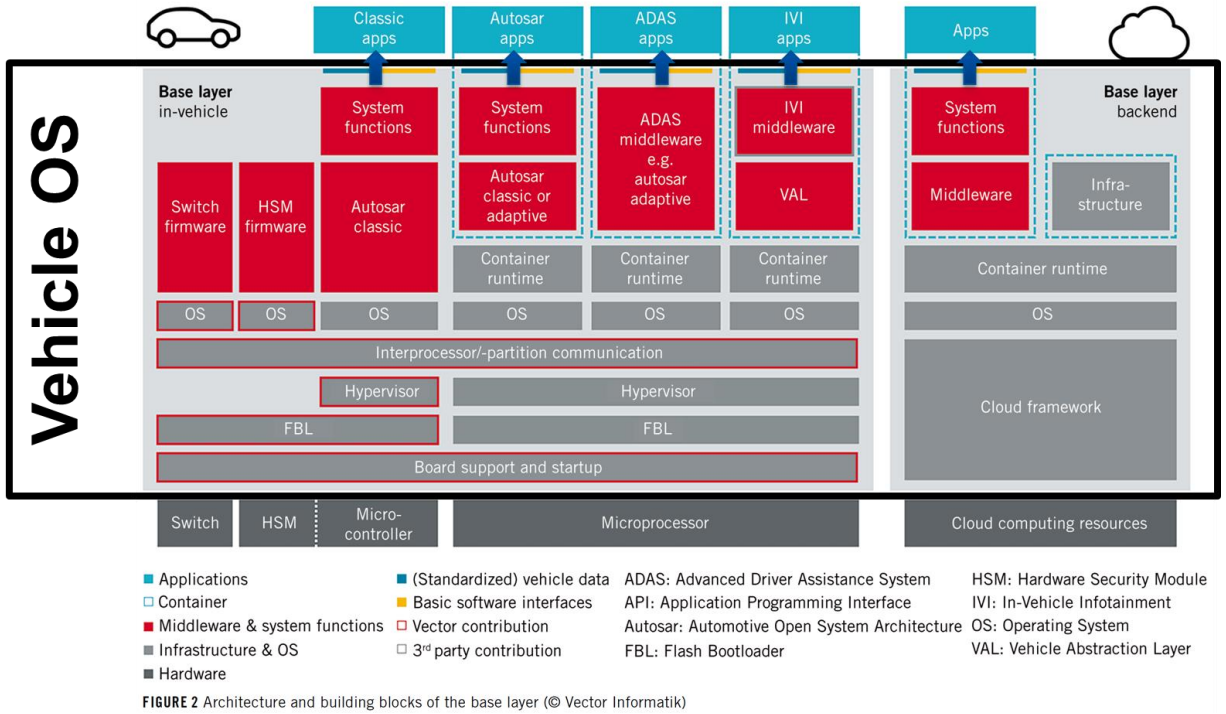
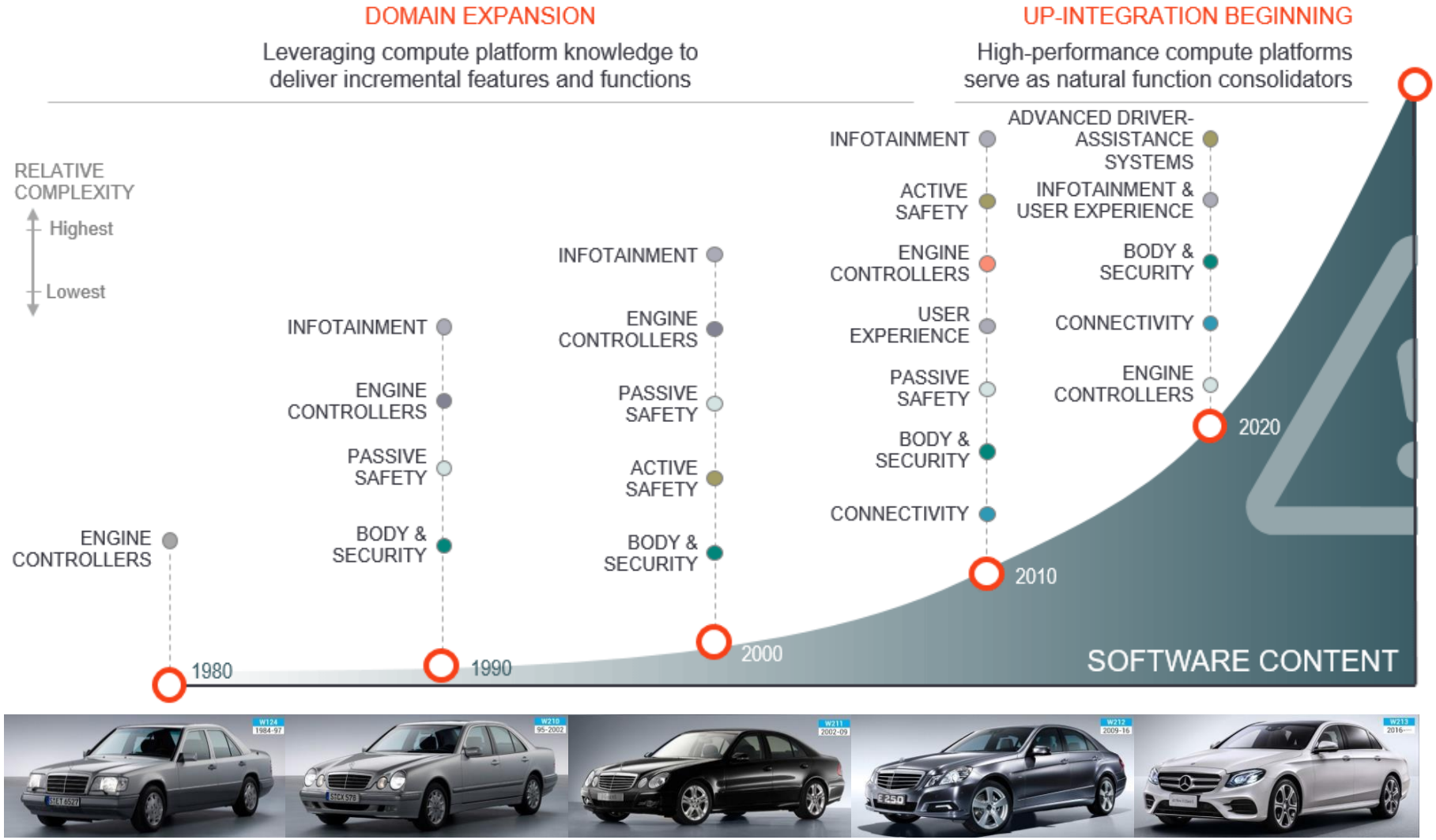


FIGURE 2 Architecture and building blocks of the base layer (© Vector Informatik)

Software Content in Automobile



[출처: Aptiv]

The Future of the Automotive SW Industry as seen on Cell Phones (I)

Features defined by Hardware

The Future of the Automotive SW Industry as seen on Cell Phones (II)

Features defined by Hardware → **Features defined by Software**

Software Defined Vehicle (SDV)

Vehicle OS (Software Platform)

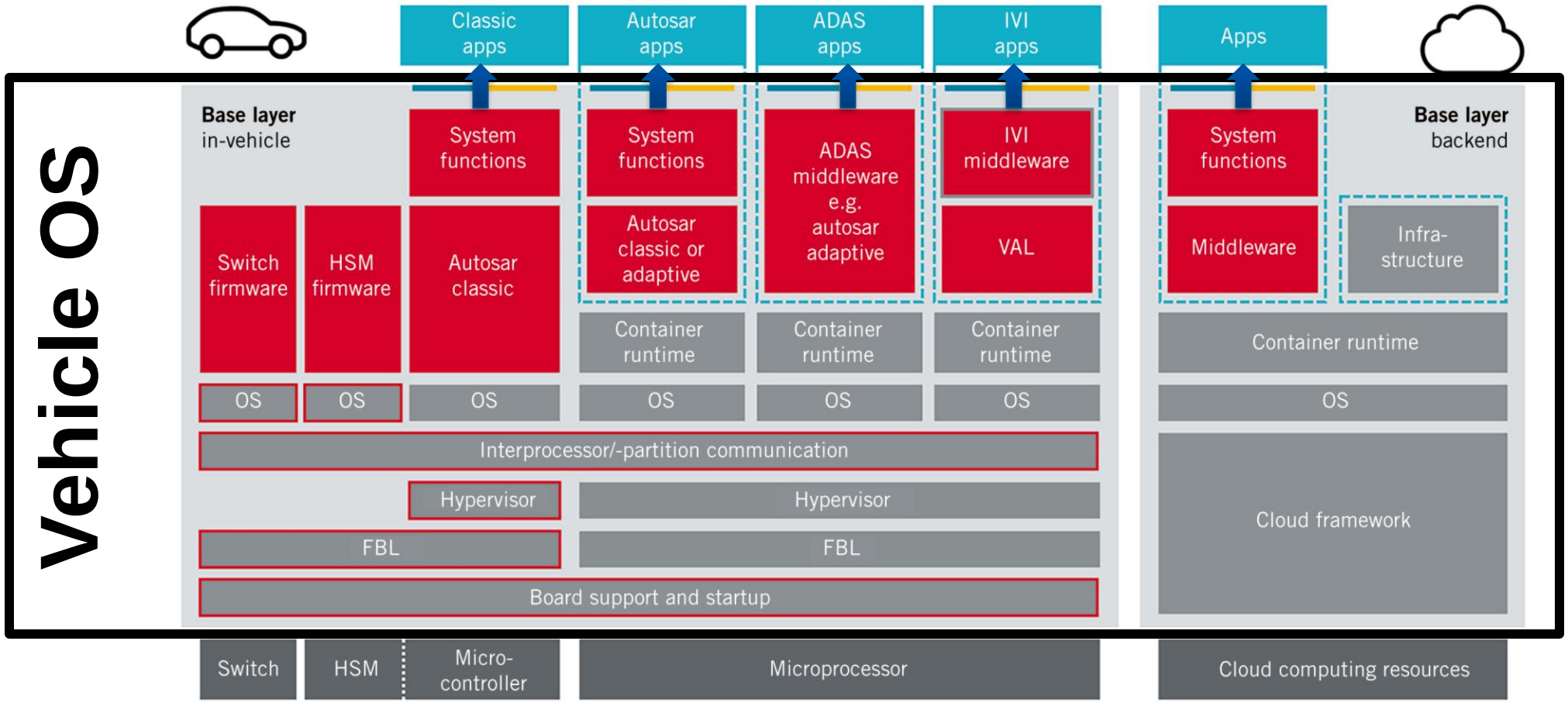


FIGURE 2 Architecture and building blocks of the base layer (© Vector Informatik)

Software for Automobile

Course overview

Course Overview

1st part: basic of automotive sensors

- Learning about the measurement principles of sensors.
- Learning about different types of automotive sensors.

2nd part: sensors for future automobile

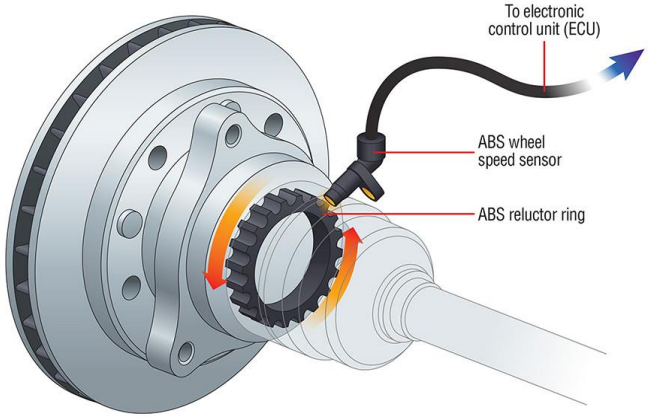
- Learning about the principles and data of sensors (GPS, IMU, LiDAR, Radar, Camera, etc.) used in future cars.
- Hands-on training on sensor data interface and processing.

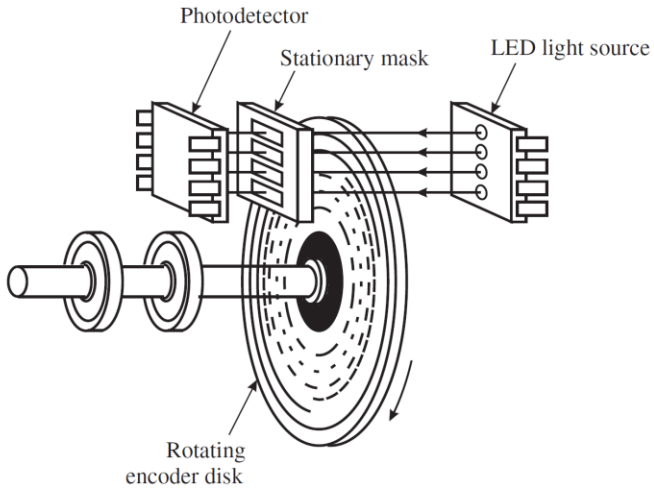
3rd Part: sensor data processing based on Kalman filter

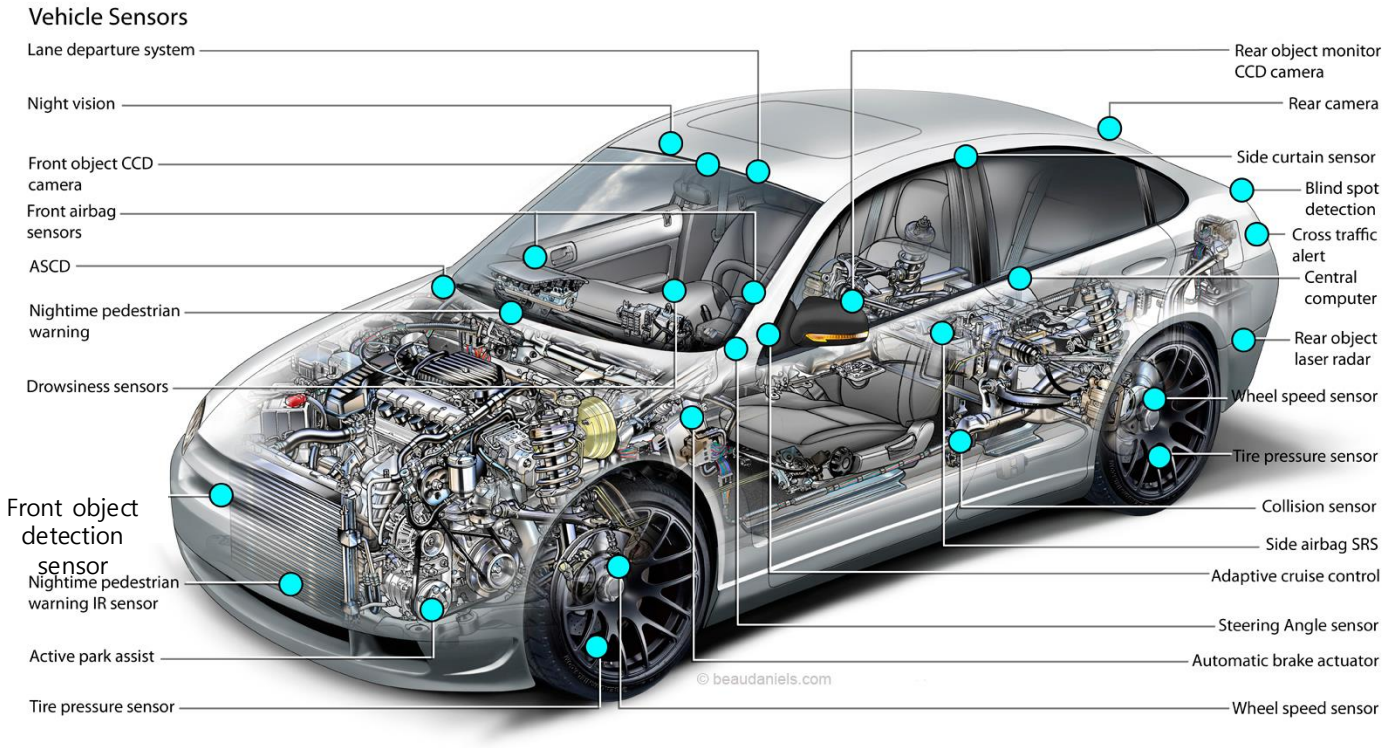
- Learning the basic theory of Kalman filter (KF) and Extended KF (EKF).
- Hands-on training on sensor data processing using KF and EKF.

1st Part: Basic of Automotive Sensors

- Learning about the measurement principles of sensors.
- Learning about different types of automotive sensors.

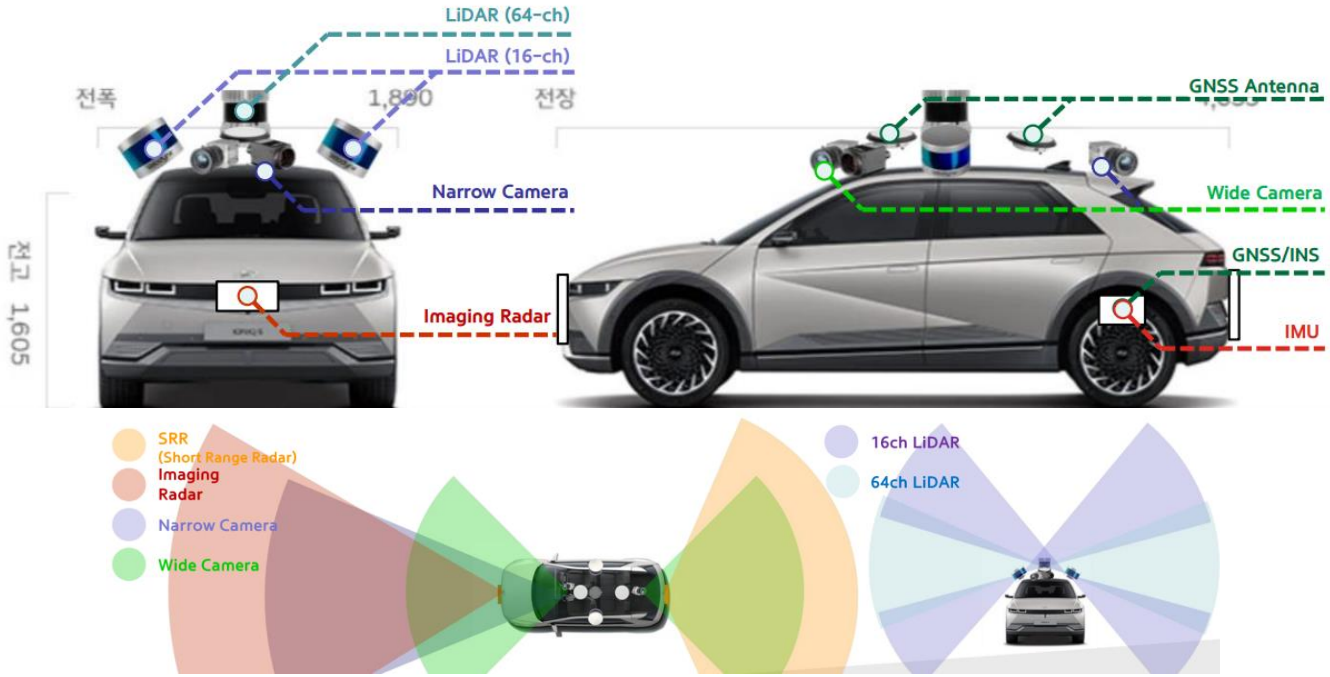


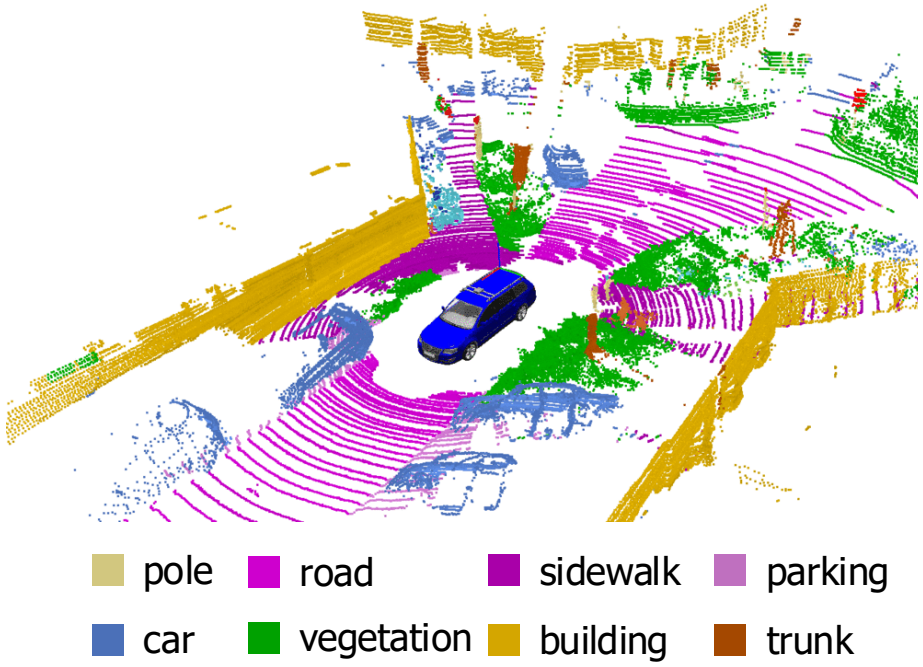




2nd Part: Sensors for Future Automobile

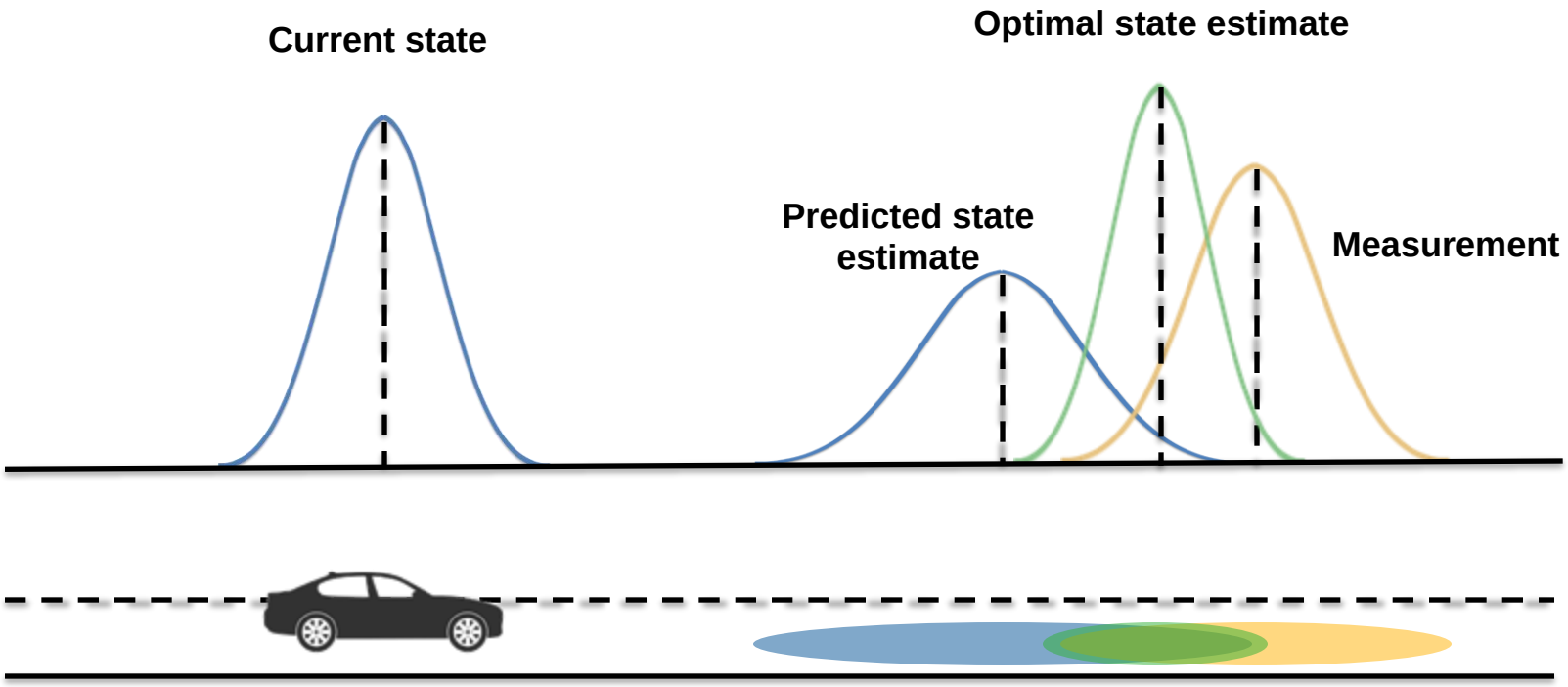
- Learning about the principles and data of sensors (GPS, IMU, LiDAR, Radar, Camera, etc.) used in future cars.
- Hands-on training on sensor data interface and processing.





3rd Part: Sensor Data Processing based on KF

- Learning the basic theory of Kalman filter (KF) and Extended KF (EKF).
- Hands-on training on sensor data processing using KF and EKF.



Schedule & Evaluation

Schedule

Week 1-8

Week	Date	1^{st} Class	2^{nd} Class
1	03-04, 03-06	**Lecture 0** Introduction - (Practice) MATLAB Onramp	1st part – **Lecture 1** Basic of sensors: definition and characteristics
2	03-11, 03-13	1st part – **Lecture 2** Sensor principal and type	1st part – **Lecture 2** Sensor principal and type
3	03-18, 03-20	2nd part – **Lecture 1** Encoder and IMU	2nd part – **Practice 1** Noise filtering
4	03-25, 03-27	2nd part – **Lecture 2** LiDAR	2nd part – **Practice 2** LiDAR point cloud pre-processing (ROI, down sampling, transformation)
5	04-01, 04-03	2nd part – **Lecture 3** Radar	2nd part – **Practice 3** Radar point cloud pre-processing (kd-tree, noise filtering, clustering)
6	04-08, 04-10	2nd part – **Lecture 4** GPS	2nd part – **Practice 4** Geodetic coordinate conversion and tile system
7	04-15, 04-17	2nd part – **Lecture 5** Calibration (sensor fusion)	2nd part – **Practice 5** Point cloud projection on camera image
8	04-22, 04-24	**Mid-term project and/or exam**	**Mid-term project and/or exam**

Schedule

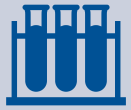
Week 9-16

Week	Date	1^{st} Class	2^{nd} Class
9	04-29, 05-01	3rd part – Lecture 0 Introduction to Kalman filter	3rd part – Lecture 1 Linear system theory
10	05-06, 05-08	3rd part – Practice 1 Linear algebra Onramp	3rd part – Practice 2 System modeling and simulation
11	05-13, 05-15	3rd part – Lecture 2 Probability theory 3rd part – Lecture 3 Least square estimation	3rd part – Practice 3 Least square
12	05-20, 05-22	3rd part – Lecture 4 Recursive Least square estimation	3rd part – Practice 4 Recursive least square
13	05-27, 05-29	3rd part – Lecture 5 Propagation of states and covariances	3rd part – Practice 5 State covariance propagation
14	06-03, 06-05	3rd part – Lecture 6 The discrete-time Kalman filter	3rd part – Practice 6 1d Kalman filter, 2d Kalman filter
15	06-10, 06-12	3rd part – Lecture 7 Extended Kalman filter	3rd part – Practice 7 Extended Kalman filter
16	06-17, 06-19	**Final project and/or exam**	**Final project and/or exam**

Evaluation

10%: attendance

30%: assignment



30%: mid-term project and/or exam.

30%: final project and/or exam.

Assignment

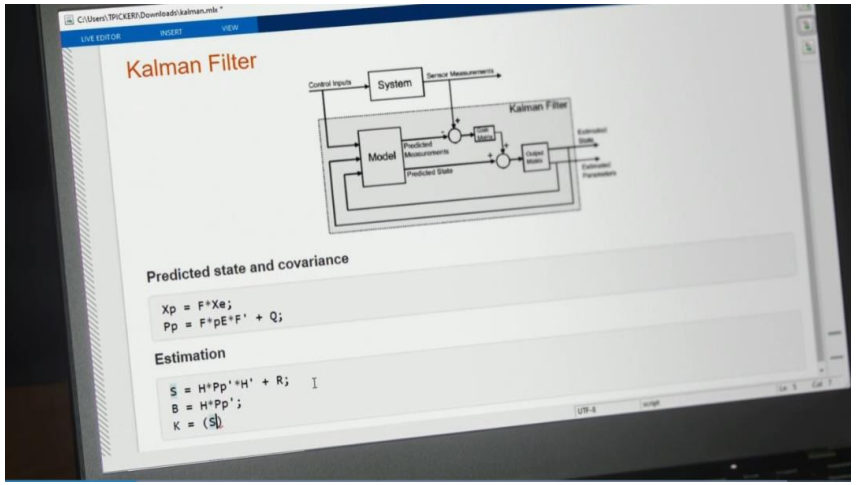
Practice

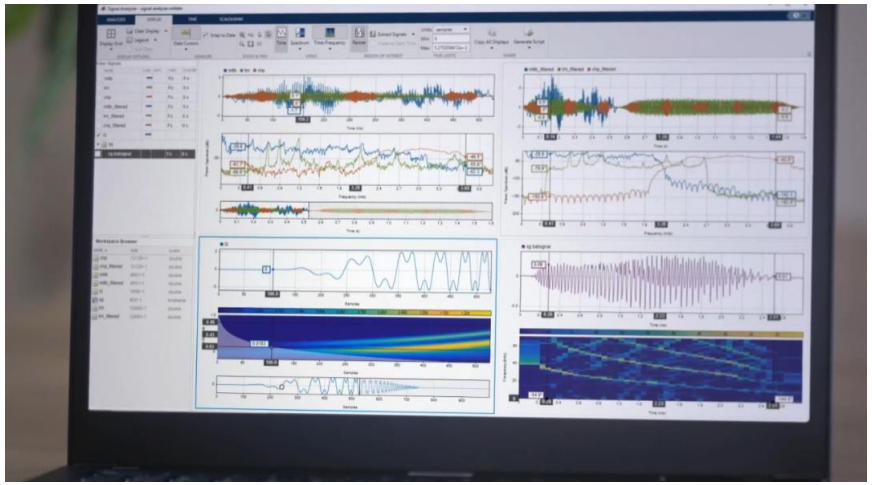
The class will

- Learn the Theory + **Coding**.

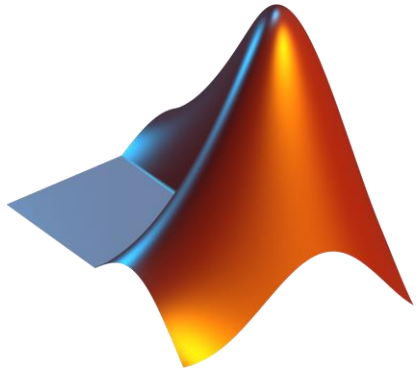
Students must…

- Prepare your **laptop**, **tablet**, or anything else you can write code in MATLAB.
  - You can use MATLAB on a cellphone “MATLAB Mobile”, but we recommend you prepare a laptop or tablet.





MATLAB Onramp



MATLAB?

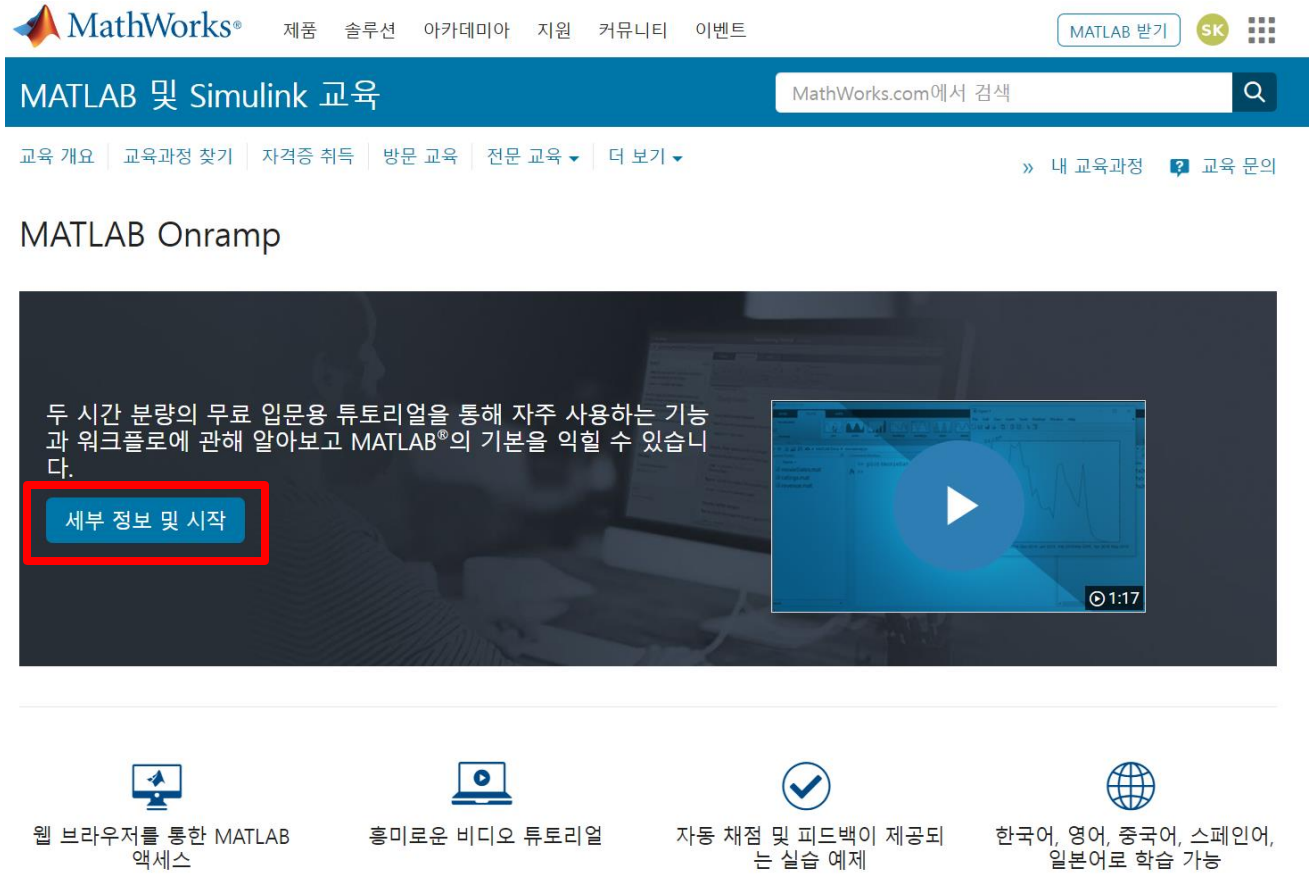
- **MATLAB** is a programming and numeric computing platform used by millions of engineers and scientists to analyze data, develop algorithms, and create models.

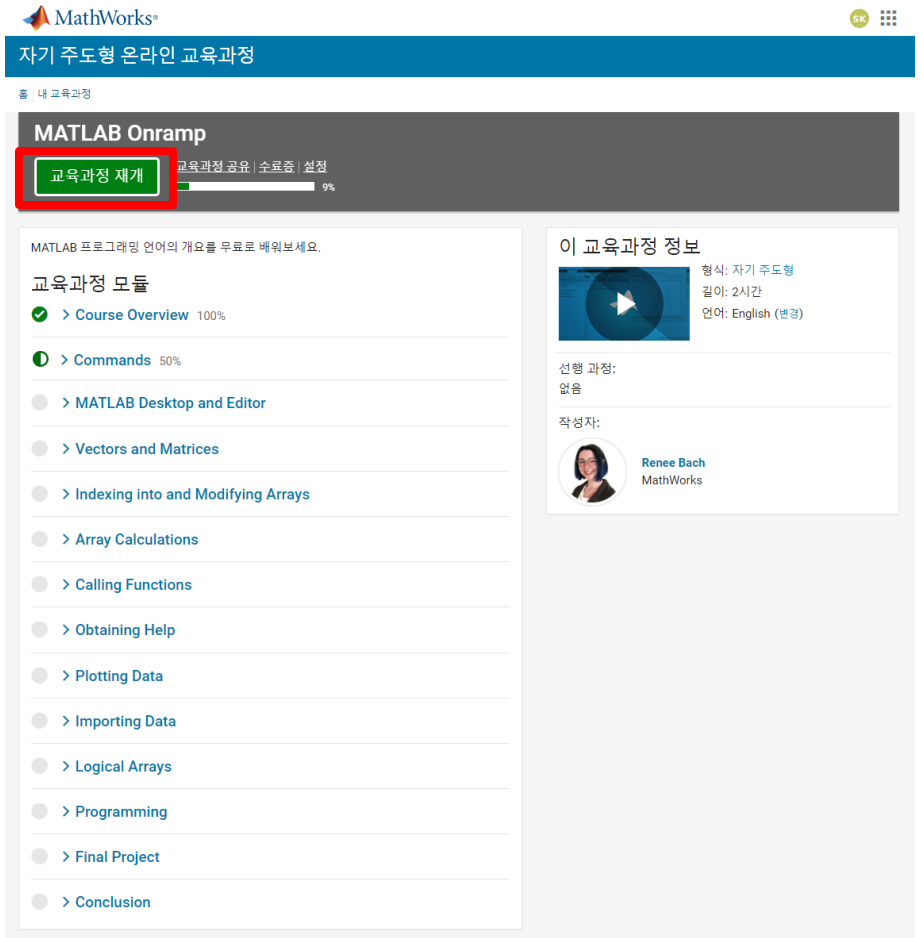
MATLAB Onramp

- MATLAB Onramp is a course that teaches you the basics of using MATLAB.
- Onramp consists of exercises to answer the questions correctly by entering commands directly and video lecture.

MATLAB Onramp

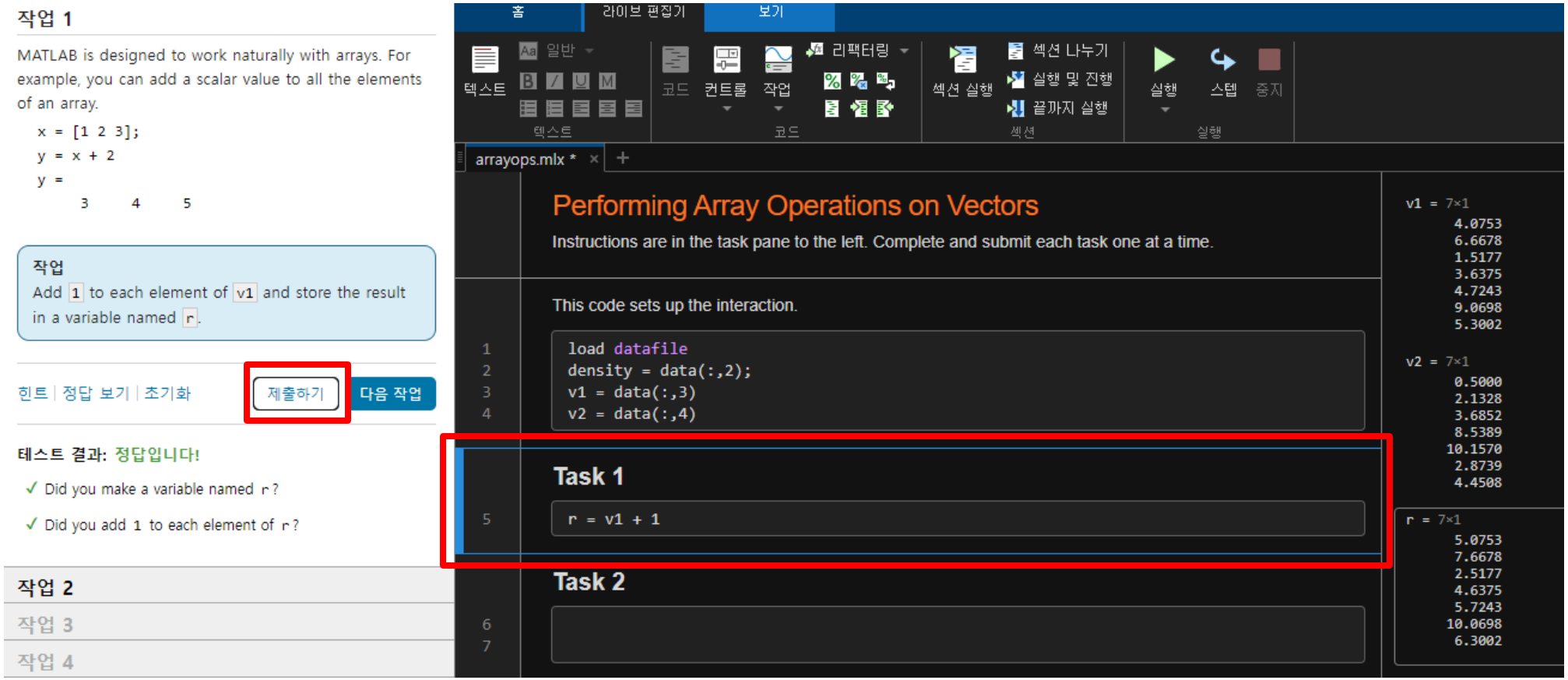
- **Start Onramp on matlab web browser.**
  - https://kr.mathworks.com/learn/tutorials/matlab-onramp.html





MATLAB Onramp

- You can submit the practice by entering the appropriate code in the command line or script for each task.



Assignment

- **Please submit your MATLAB Onramp certificate.**
  - Submit by **3/10 (One week)**.

- **How to turn in assignment.**
  - Log in on [HY-ON] → Enter [차량센서] class → Click [과제 및 평가: Assignment and Evaluation] → Click [1st Week Assignment - MATLAB Onramp] → Upload one PDF file.

THANK YOU
FOR YOUR ATTENTION