Linear Algebra

Course Introduction

Automotive Intelligence Lab.

Contents

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Course Information

Class

- Lecture & Exercise

Communication with LMS

- Announcements
- Lecture notes
- Assignments

Prerequisites

- Computer(laptop, tablet, …) to write code on MATLAB.
- Basic algebra and geometry.
  - High-school level
- Basic programming skills.
  - Freshman level

Textbook

- We will provide lecture slides.

Reference

- "Introduction to Linear Algebra" – Gilbert Strang
- 3Blue1Brown (Youtube)
- Angelo's math notes (공돌이의 수학노트)
- Matlab

Course background

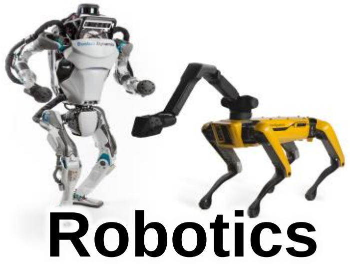
History of Linear Algebra

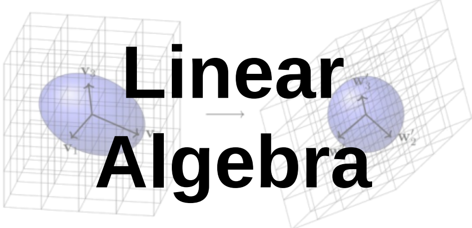
- **In the 17th century in the West and much earlier in China, matrices were just used to provide a compact notation for storing sets of numbers.**

- **In the 20th century, matrices and vectors were used for multivariate mathematics including calculus, differential equations, physics, and economics.**

- **But most people didn’t need to care about matrices until fairly recently.**
  - Here’s the thing: computers are extremely efficient at working with matrices.
  - And so, modern computing gave rise to modern linear algebra.

Why Learn Linear Algebra





Linear algebra is utilized in various fields for machine learning, autonomous driving, robotics, and others.

To understand how the algorithms work and to develop them, you should learn Linear Algebra !

Trend 1: Software Defined Vehicle (SDV)

- SDV (Software-Defined Vehicle) refers to vehicles whose functions and services are defined primarily by software.
- Continuous feature improvements are possible throughout the vehicle's lifespan via software updates.

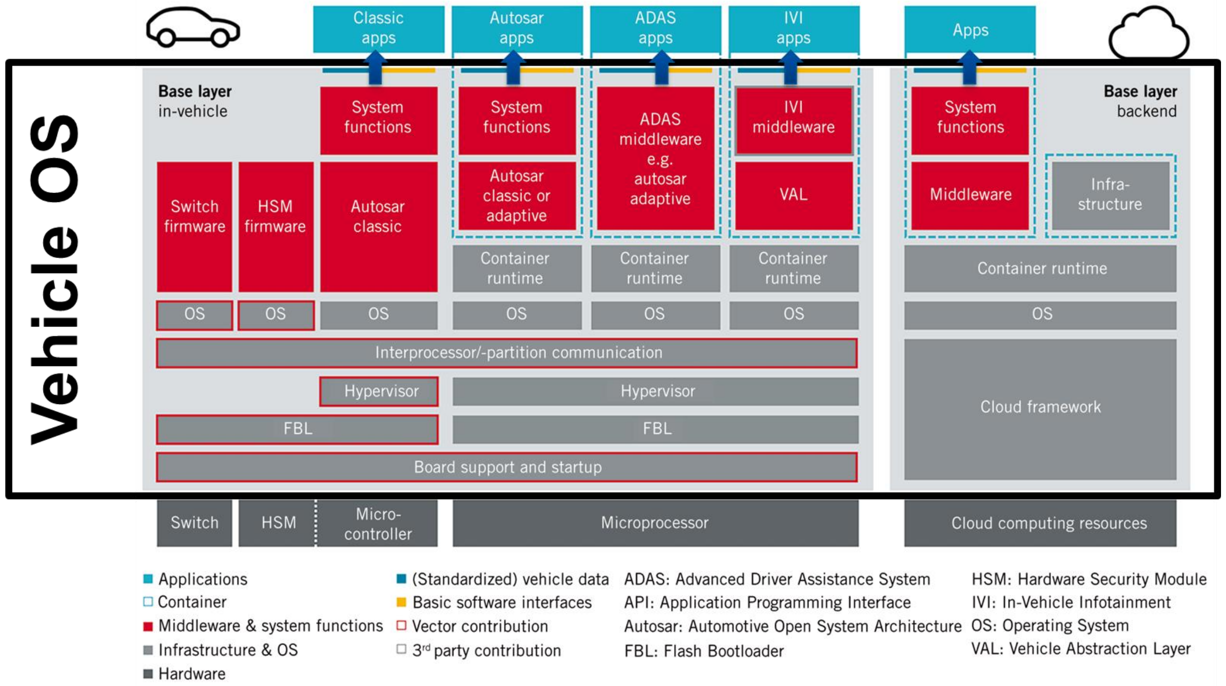


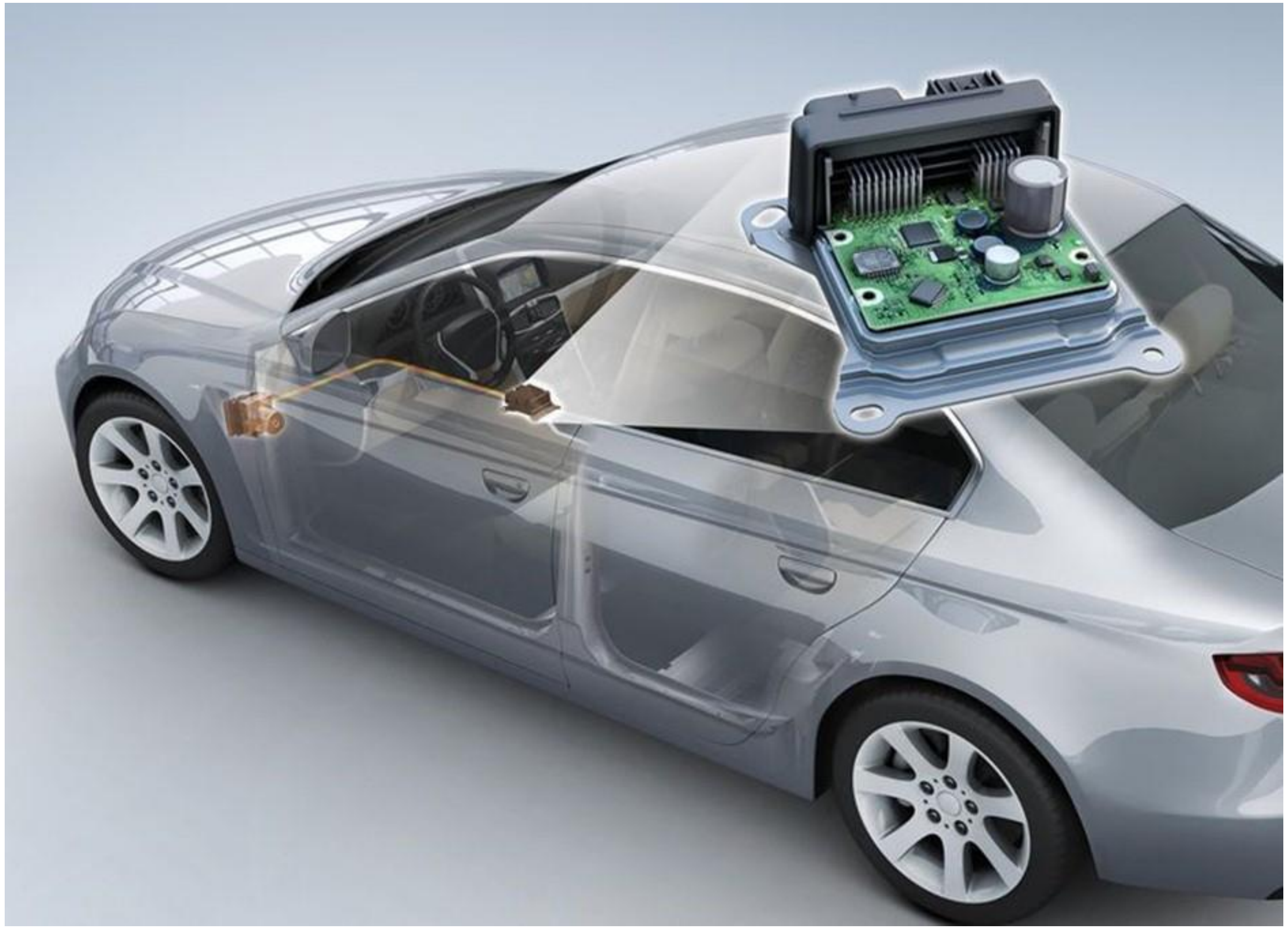
FIGURE 2 Architecture and building blocks of the base layer (© Vector Informatik)

Automobile in the 1st and 2nd Industrial Revolutions

- **Mechanization and mass production (- 1980)**

Automobile in the 3rd Industrial Revolution

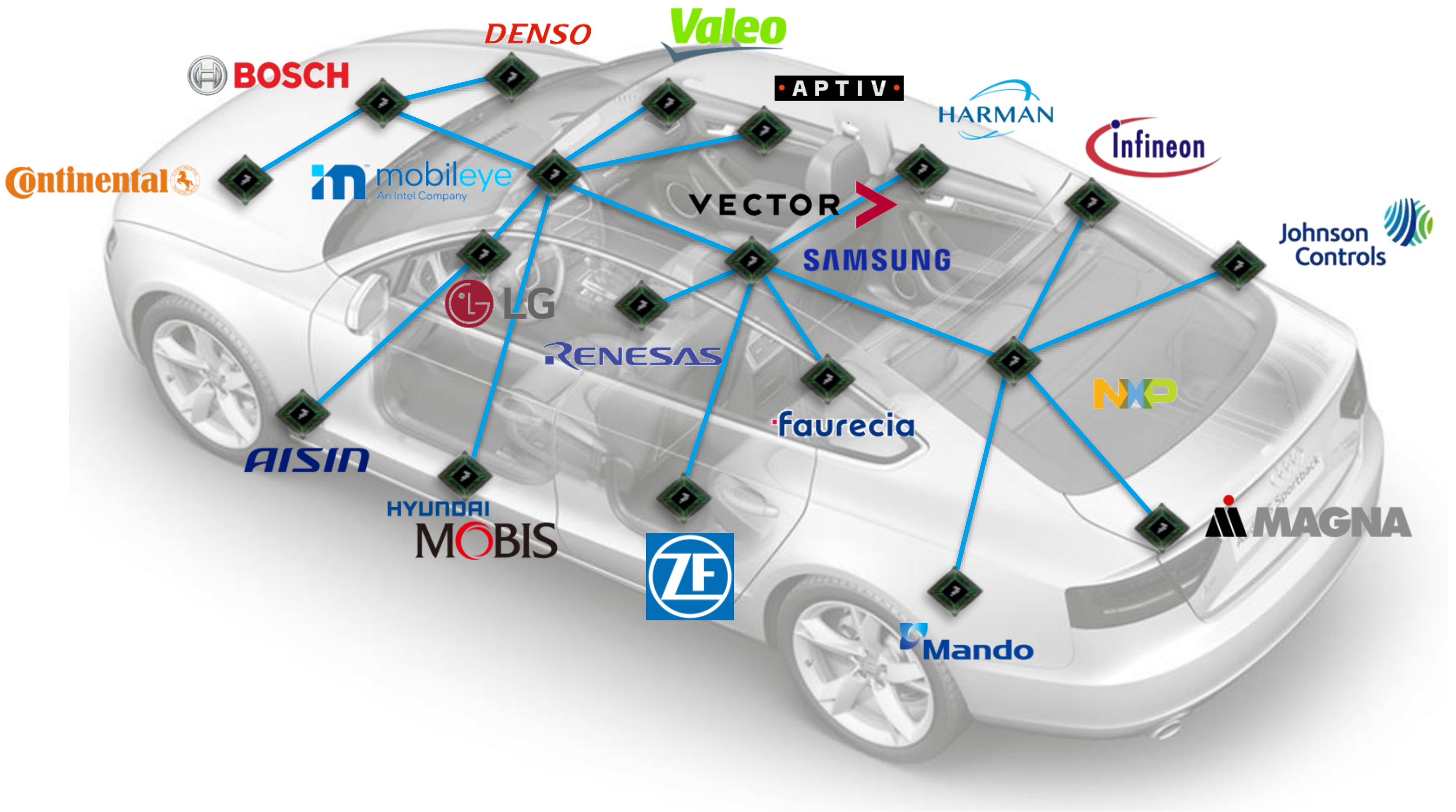
- Electronics and embedded system (1980 –)
- From this time on, software were applied to the automotive functions.



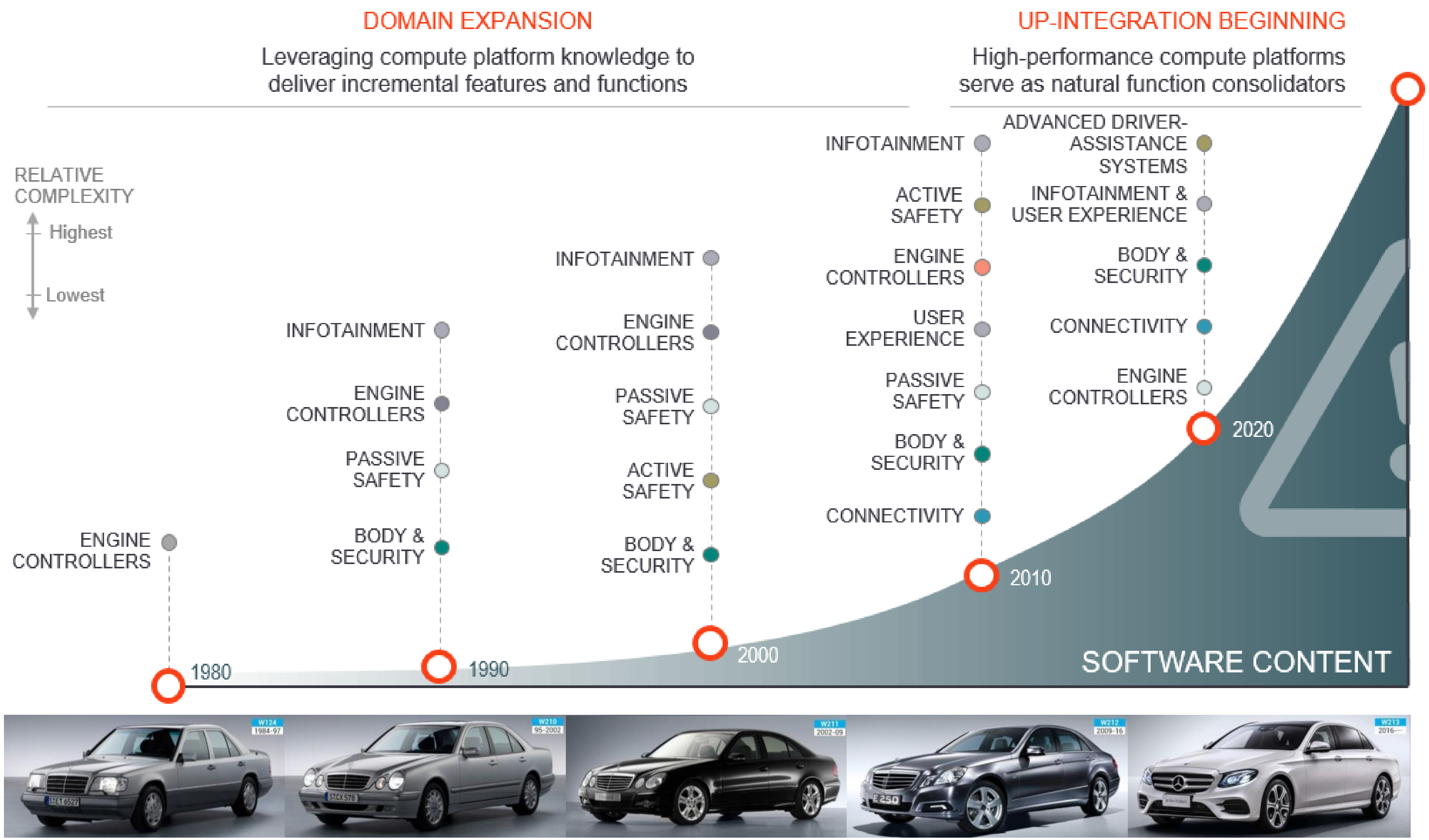
Current Automotive Industry

OEM – Supplier structure

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



Software Content in Automobile



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Vehicle OS (Software Platform)

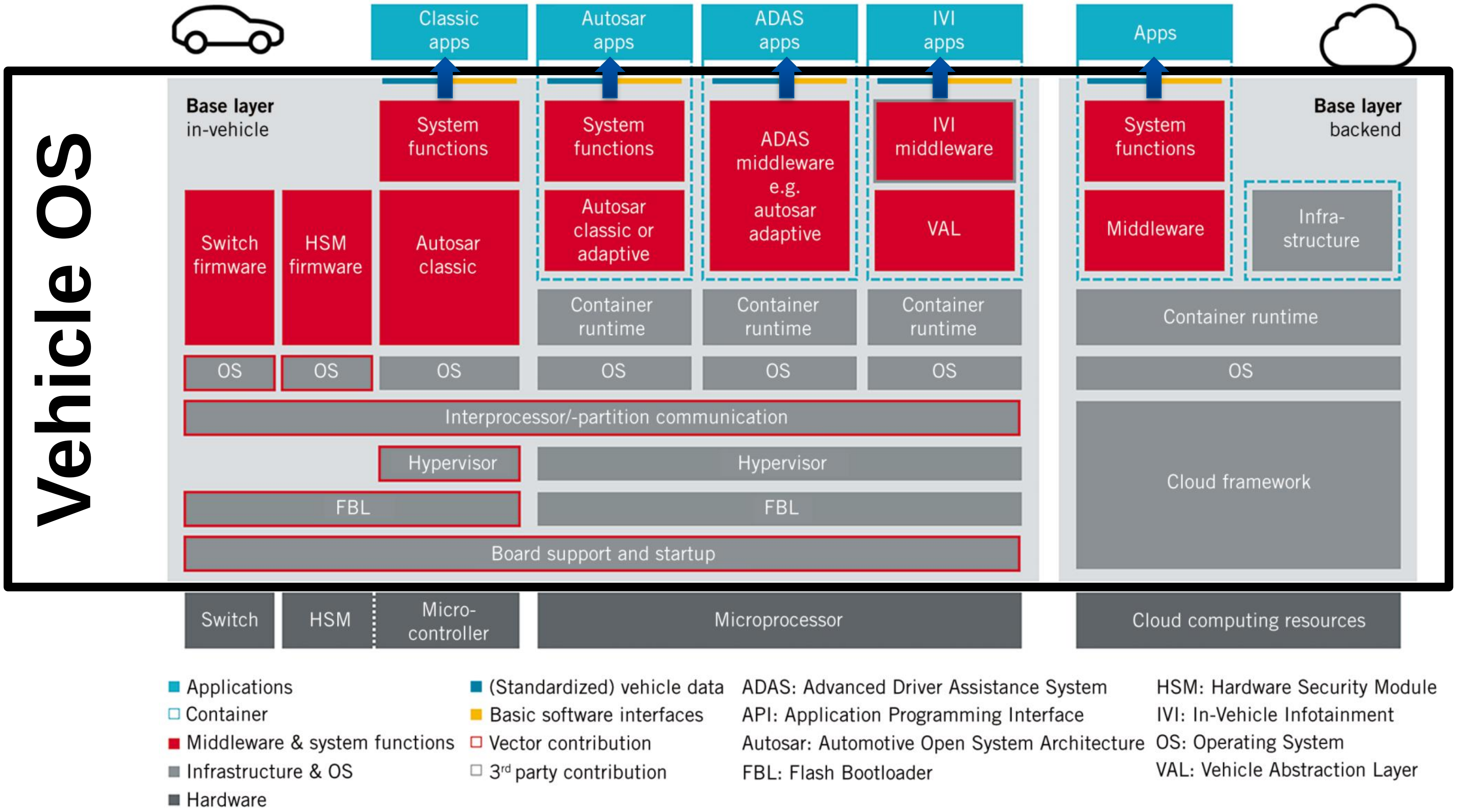


FIGURE 2 Architecture and building blocks of the base layer (© Vector Informatik)

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)

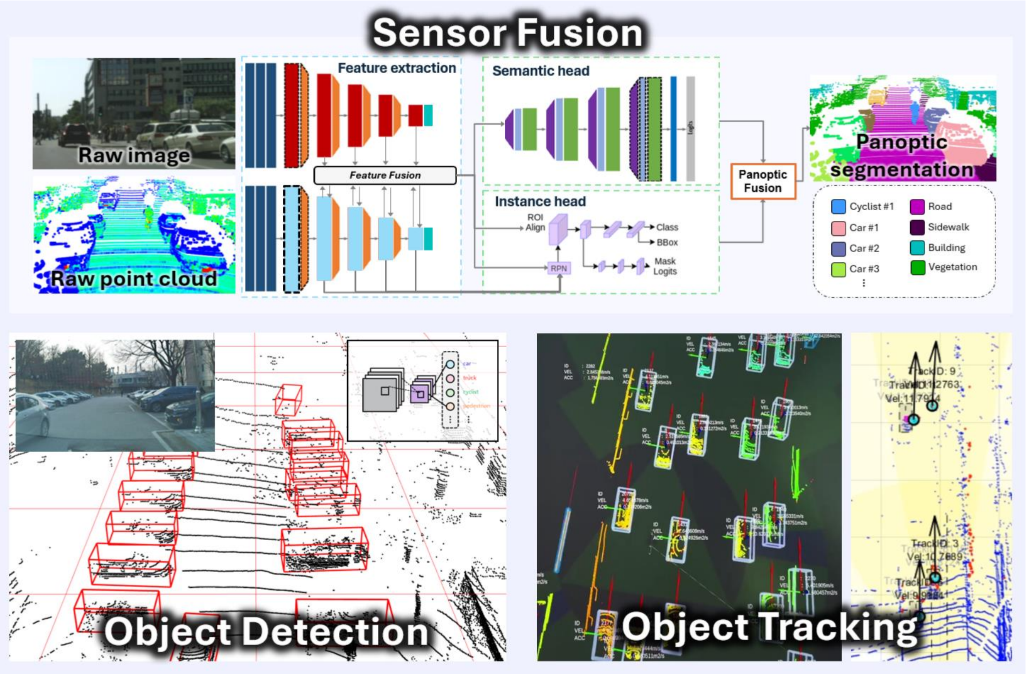
Features defined by **Hardware**

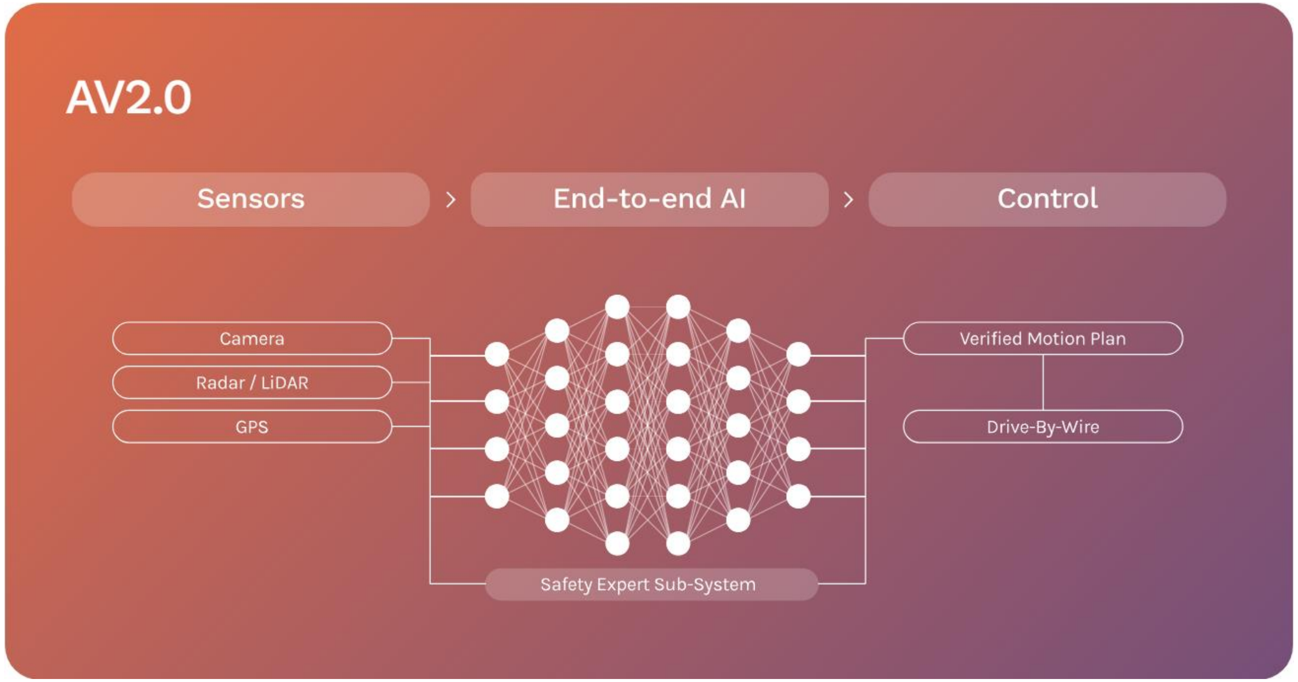
Features defined by **Software**

Software for Automobile

Trend 2: AI for Automobile

■ AI is being used for many functions in automobiles!

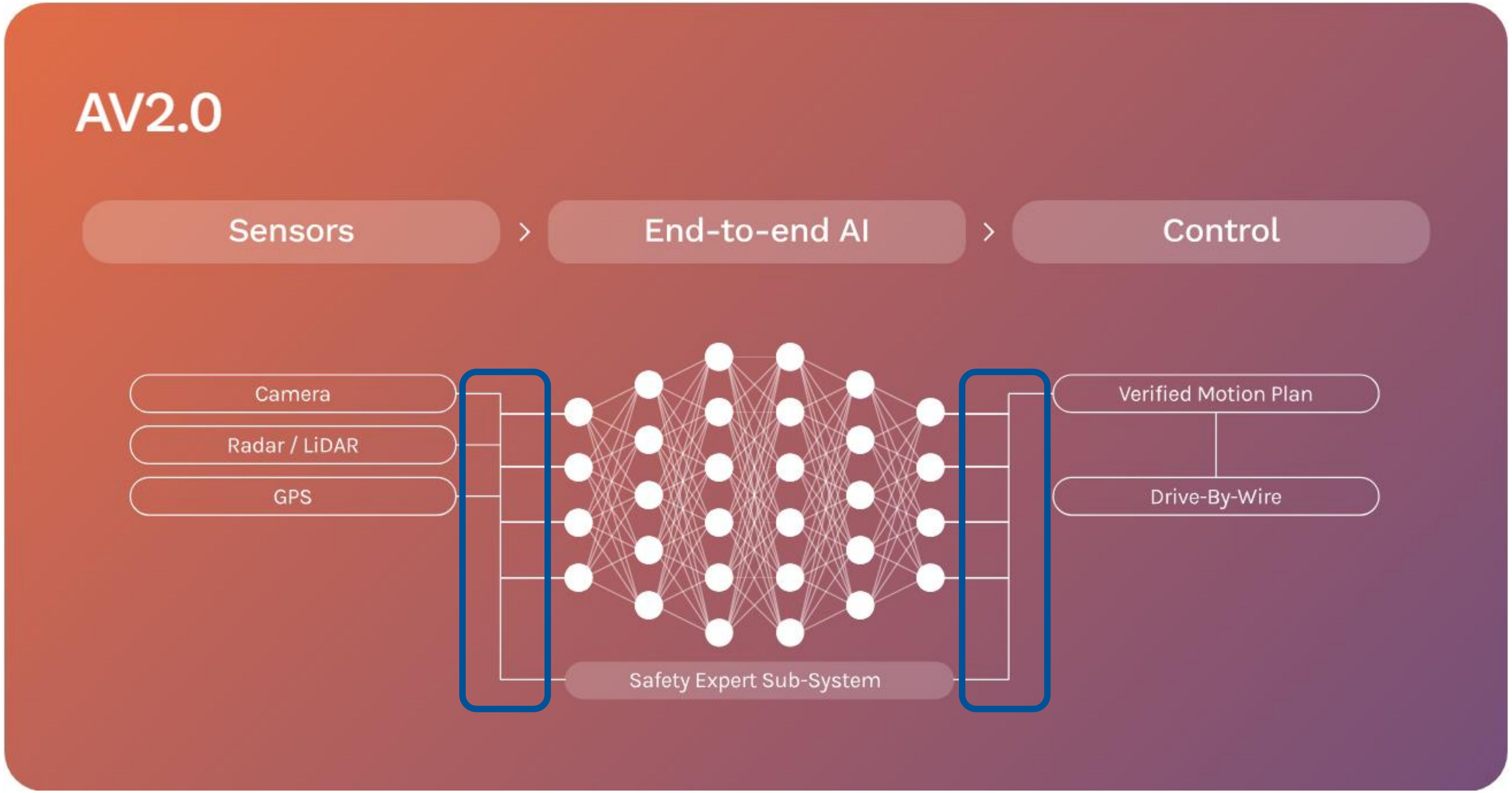




Applications of AI for Automotive Functions

End-to-End AI Autonomous Driving

- ▶ Data processing technology is essential!



https://wayve.ai/technology/

Course objectives

Course Objectives

- Understand linear algebra as an engineering tool, not as mathematics.
- Understand linear algebra through programming rather than solving problems by hand.
- Actively utilizes geometric visual examples through programming to aid understanding.
- Improve your programming skills through real world problems.

Traditional and Modern Linear Algebra

Traditional and Modern

Traditional	Modern
• Abstract. • Learned through proofs and equations. • Emphasizes proofs and abstract concepts, often with little relevance to practical applications or implementations.	• Computational. • Learned through code and applications. • Emphasizes geometric intuition and implementation of linear algebra concepts in practical applications.

Mathematical Proofs vs. Visualization and Examples

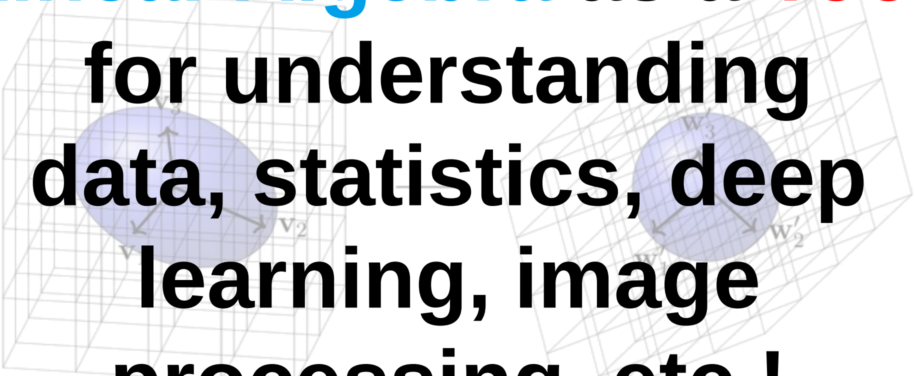
- **The two ways to understand math**
  - **Mathematical proofs**
    - A proof in mathematics is a sequence of statements showing that a set of assumptions leads to a logical conclusion.
    - Rigor but rarely intuition.
  - **Visualizations and examples**
    - Clearly written explanations, diagrams, and numerical examples help you gain intuition for concepts and operations in linear algebra.
    - More intuition than mathematical proofs.

- **This class will focus on visualizations and examples through MATLAB.**

This class will focus on

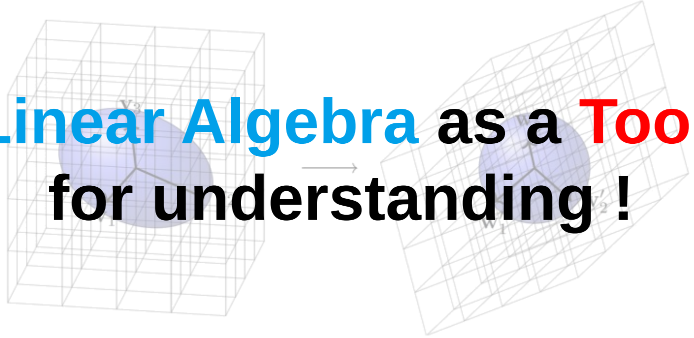
Modern
• Computational. • Learned through code and applications. • Emphasizes geometric intuition and implementation of linear algebra concepts in practical applications.

Especially here!



Linear Algebra as a Tool for understanding data, statistics, deep learning, image processing, etc.!

Instructional approach



Linear Algebra as a Tool
for understanding !

Mathematical

Theory
Concepts
Proof

Geometric intuition
of Linear Algebra

How to implement
Linear Algebra in code

Programming

Simple code
Examples
Visualizations

Proof based on Matlab


```matlab
% Creating a and b matrix with 4 by 4
a = rand(4)
b = rand(4)


% proof a*b is not same as b*a
a*b - b*a
```

Course schedule and evaluation

Schedule (I)

Week 1 – 8:

Week	Date	1st Class	2nd Class
1	03-05, 03-07	**Orientation (lecture)** - Introduction of objective, evaluation, and class - Introduction of MATLAB	**Chapter 1** Vector, part 1 : vectors and basic operations
2	03-12, 03-14	**Chapter 1** Vector, part 1 : vectors and basic operations	**Chapter 2** Vector, part 2 : expand concept of vectors
3	03-19, 03-21	**Chapter 2** Vector, part 2 : expand concept of vectors	**Chapter 3** Vector applications
4	03-26, 03-28	**Chapter 4** Matrices, part 1 : matrices and basic operations	**Chapter 4** Matrices, part 1 : matrices and basic operations
5	04-02, 04-04	**Chapter 5** Matrices, part 2 : expand concept of matrices	**Chapter 5** Matrices, part 2 : expand concept of matrices
6	04-09, 04-11	**Chapter 5** Matrices, part 2 : expand concept of matrices	**Chapter 6** Matrix applications
7	04-16, 04-18	**Chapter 7** Matrix inverse	**Chapter 7** Matrix inverse
8	04-23, 04-25	**Midterm Exam**	**Midterm Exam**

Schedule (II)

Week 9 – 16:

Week	Date	1st Class	2nd Class
9	04-30, 05-02	**Chapter 8** Orthogonal Matrices and QR Decomposition	**Chapter 8** Orthogonal Matrices and QR Decomposition
10	05-07, 05-09	**Chapter 9** Row reduction and LU Decomposition	**Chapter 9** Row reduction and LU Decomposition
11	05-14, 05-16	**Chapter 10** General Linear Models and Least Squares	**Chapter 11** Least Squares applications
12	05-21, 05-23	**Chapter 11** Least Squares applications	**Chapter 12** Eigen Decomposition
13	05-28, 05-30	**Chapter 12** Eigen Decomposition	**Chapter 13** MATLAB Onramp – Linear Algebra
14	06-04, **06-06**	**Chapter 14** Singular value Decomposition	-
15	06-11, 06-13	**Chapter 14** Singular value Decomposition	**Chapter 15** Eigen Decomposition and SVD applications
16	06-18, 06-20	**Final Exam**	**Final Exam**

Evaluation

10%: attendance

30%: assignment

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

30%: final project and/or exam.

Assignment

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

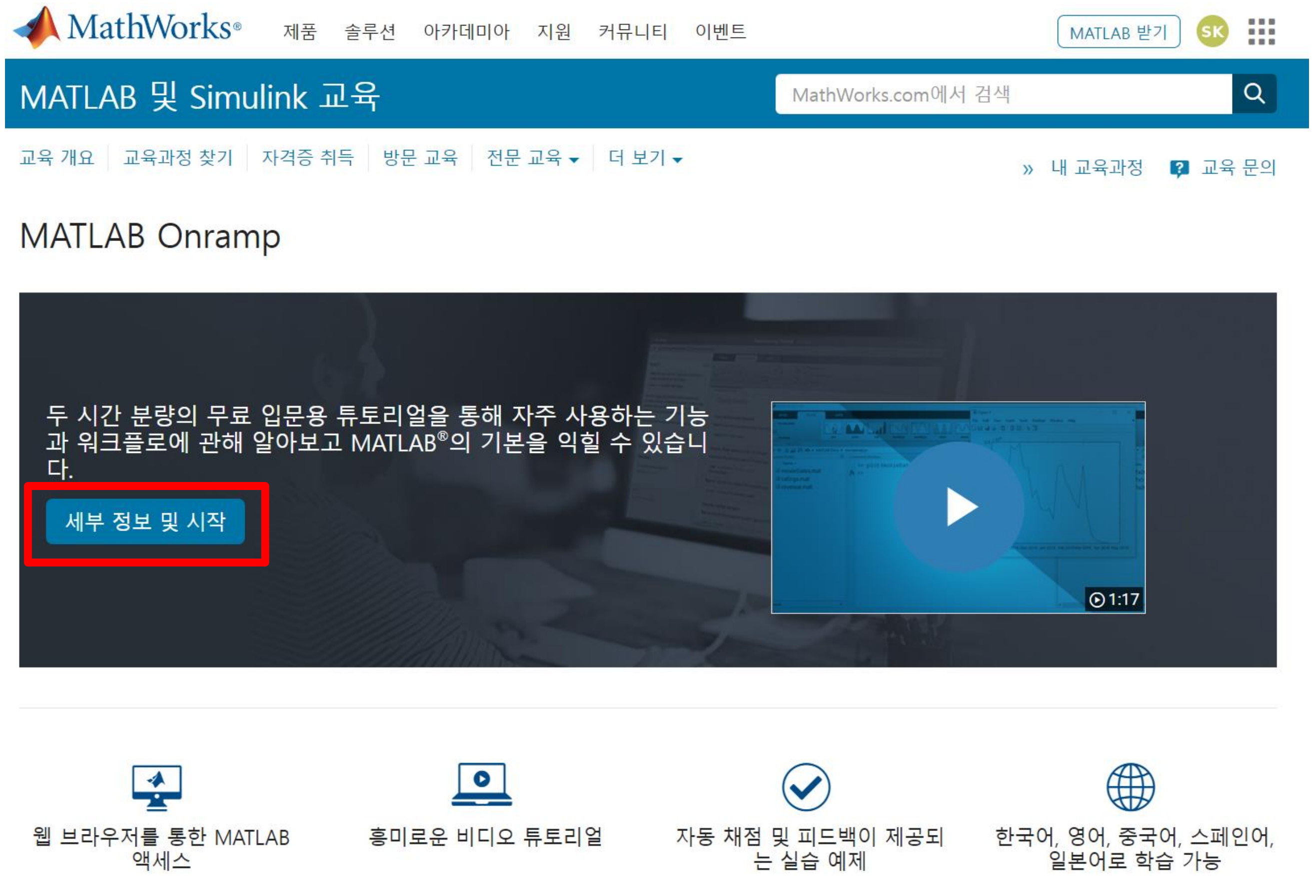
MATLAB Onramp

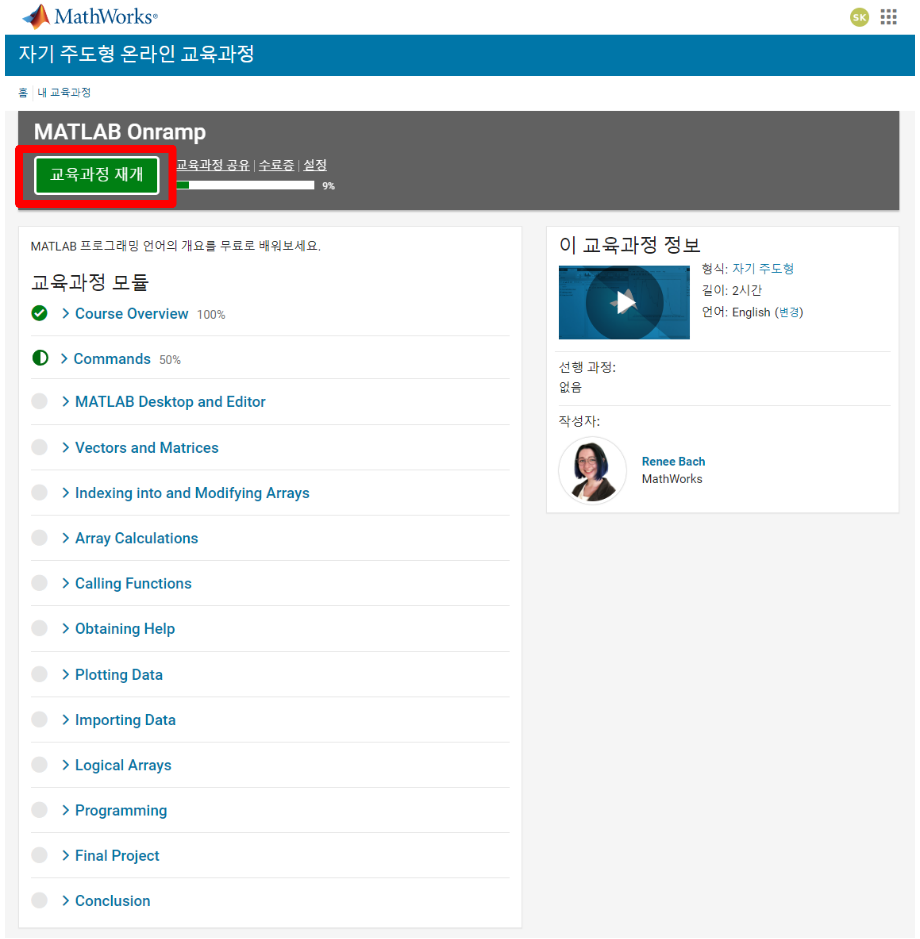
15개 모듈 | 2시간 | 언어

MATLAB의 기본 사항을 빠르게 학습할 수 있습니다.

MATLAB Onramp

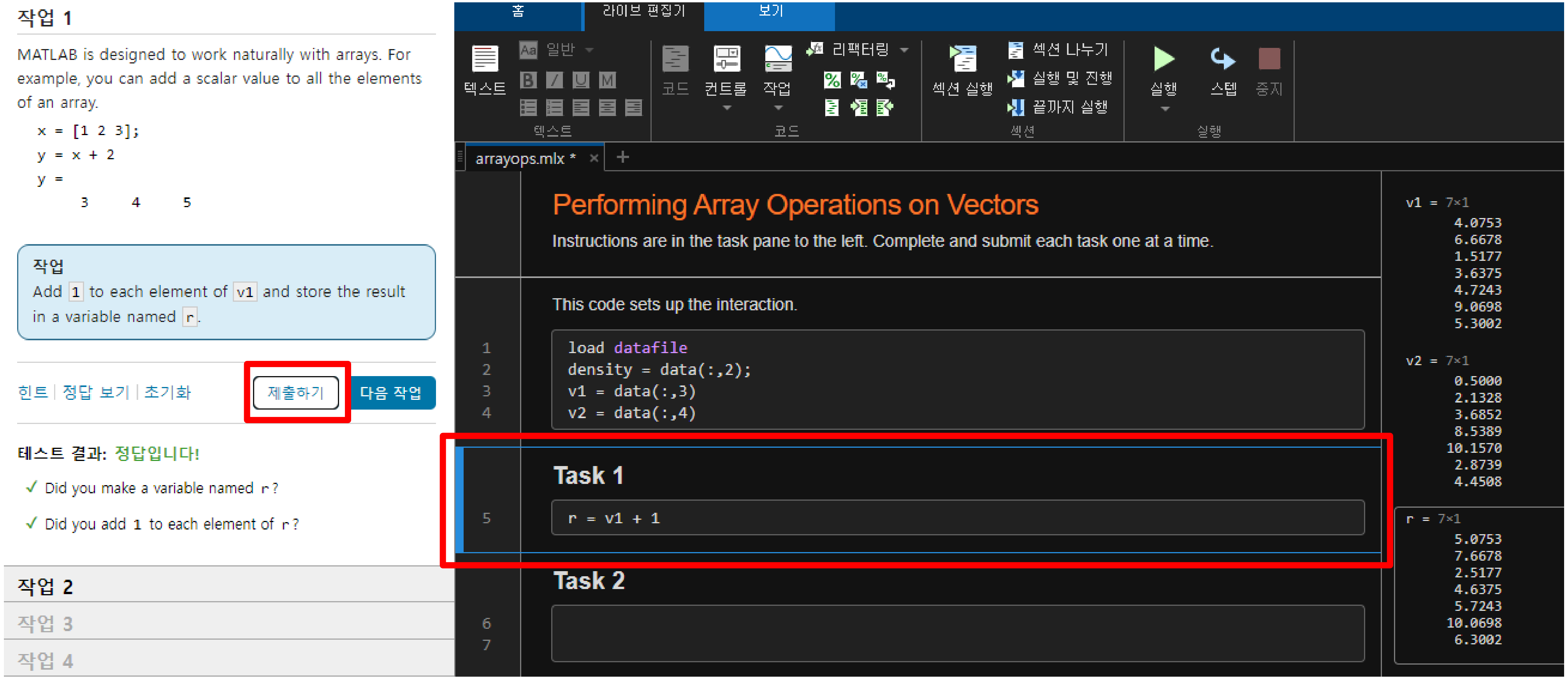
- **Start Onramp on matlab web browser**
  - ▶ https://kr.mathworks.com/learn/tutorials/matlab-onramp.html





MATLAB Onramp

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



THANK YOU
FOR YOUR ATTENTION