

RWR 4013

Digital Twins for Smart Cities

Dr. Ahmad Mohammadi

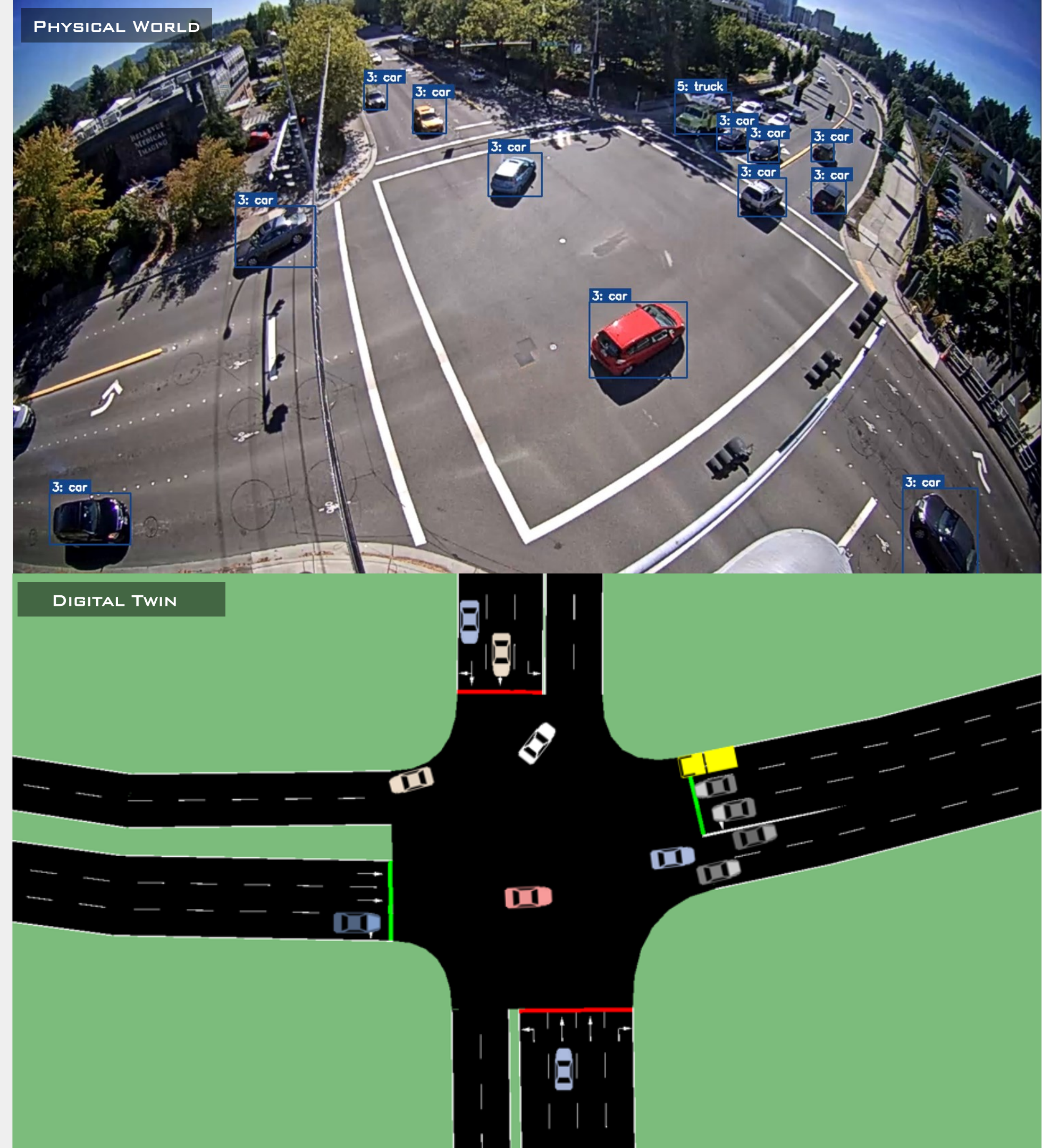
Week 1 | Session 1:
Introduction to Digital Twins
for Smart Cities

Fall 2026

RoadwayVR

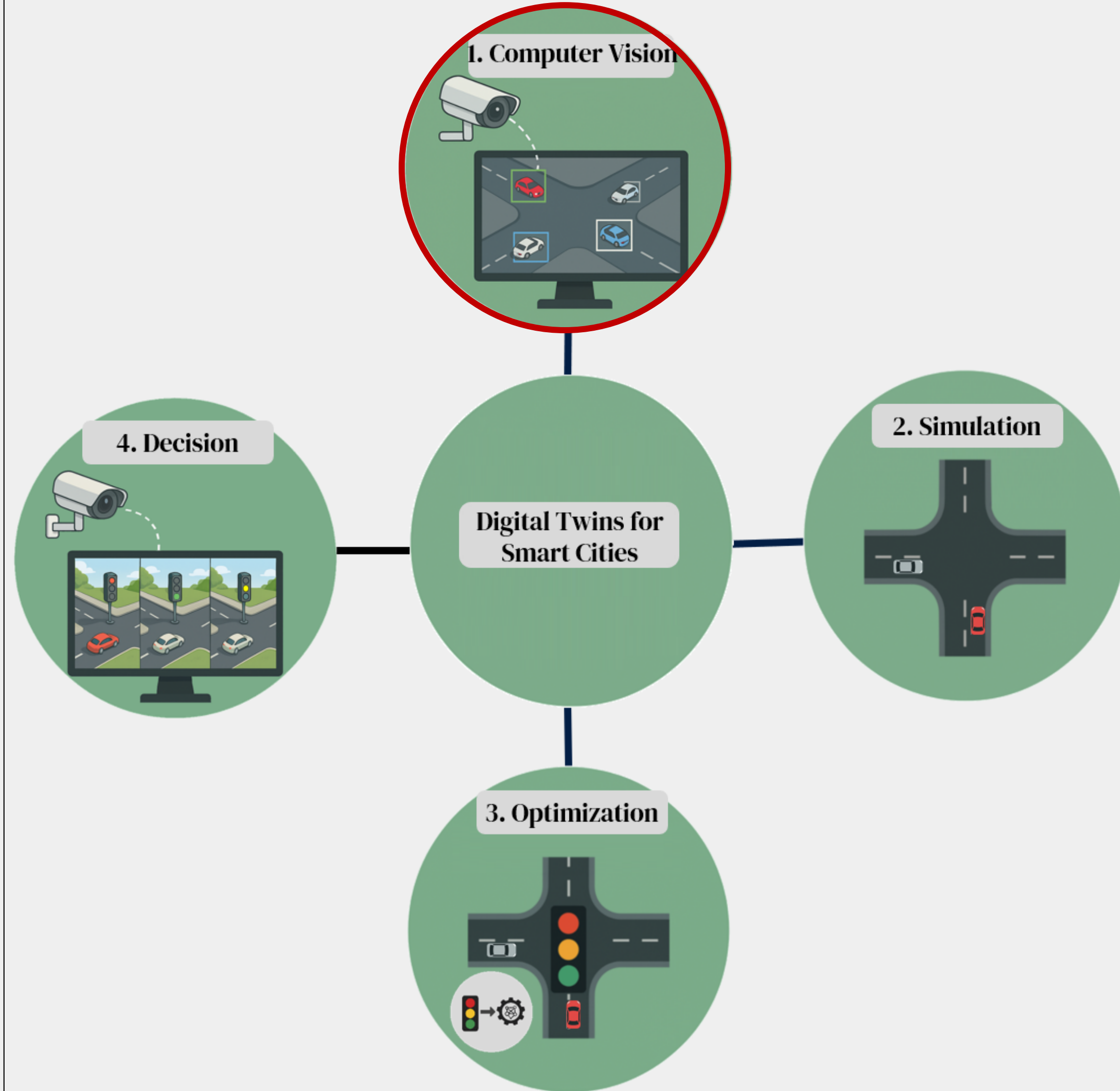


roadwayvr.github.io/DigitalTwinsforSmartCities



Agenda

- ☐ Introducing Instructor
- ☐ What is Smart Cities?
- ☐ What is Digital Twin?
- ☐ 4 Stages of a Digital Twin
- ☐ Overview of Course Syllabus in One Shot
- ☐ Course Learning Outcomes
- ☐ SimJam Application
- ☐ Course Outcomes
- ☐ Course Outline





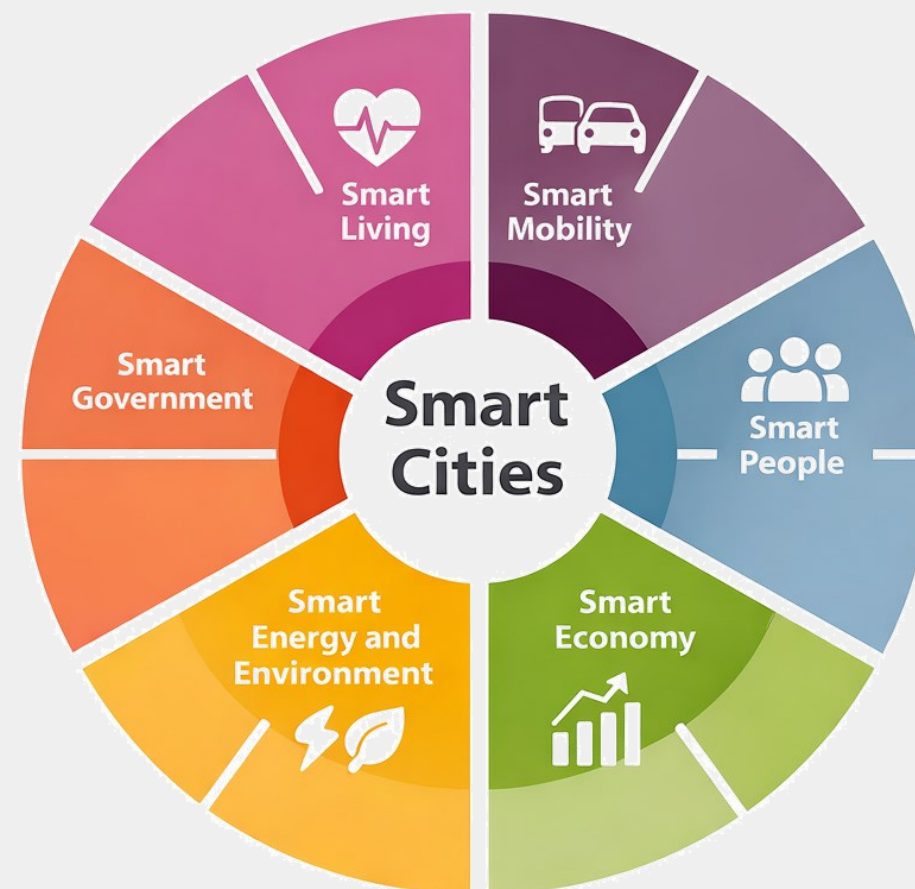
Instructor

- Ahmad Mohammadi
- PhD, Transportation Engineering
- Creator of RoadwayVR Course HUB
- **Email:** AhmadMohammadi1441@gmail.com

What is Smart City?

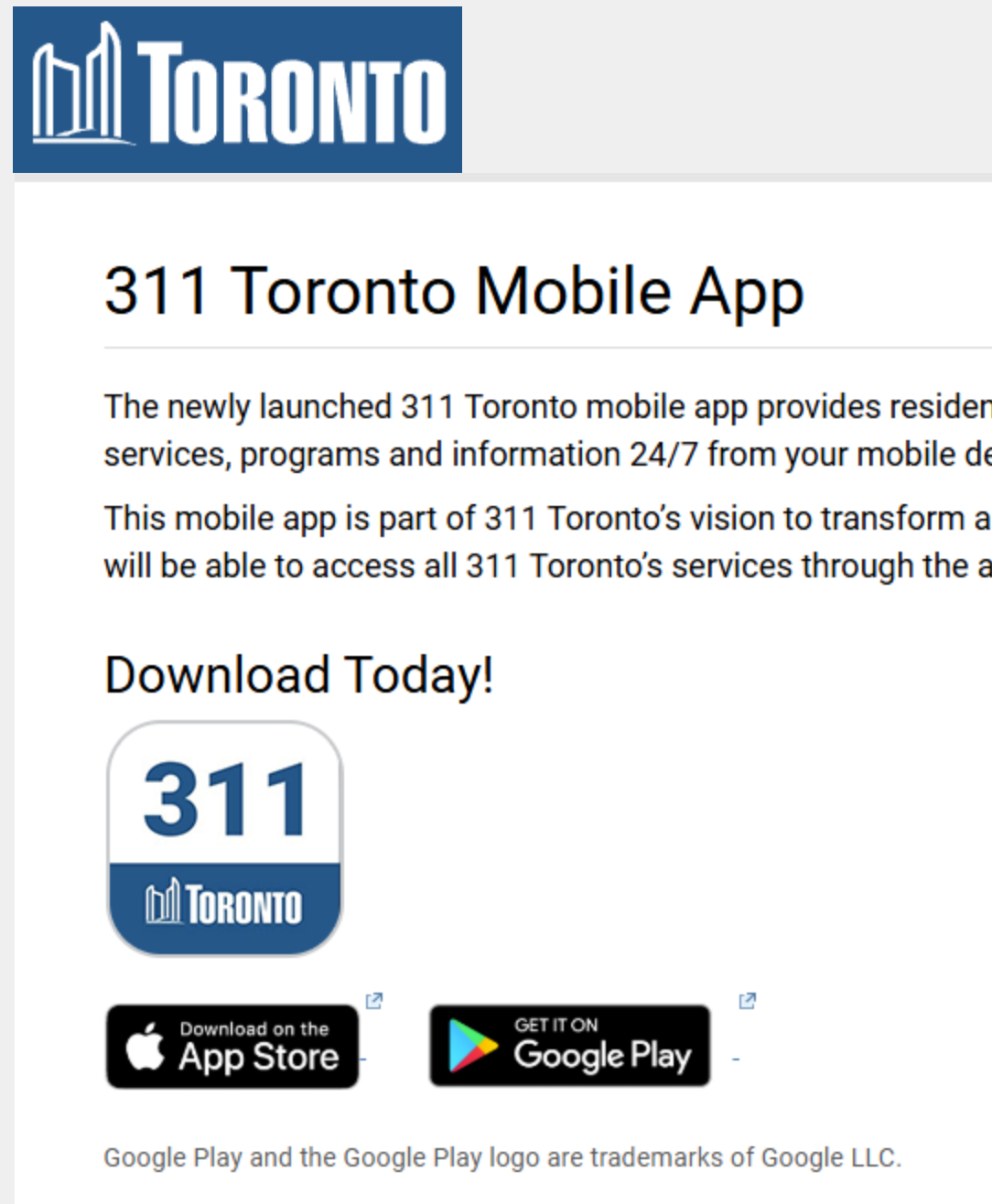
Smart City: Using data and digital tools to improve urban services, sustainability, and quality of life.

✓ **Domains:** mobility, energy, water, safety, health, planning



What is Smart City?

➤ Smart Living



Toronto

311 Toronto Mobile App

The newly launched 311 Toronto mobile app provides resident services, programs and information 24/7 from your mobile device. This mobile app is part of 311 Toronto's vision to transform and will be able to access all 311 Toronto's services through the app.

Download Today!

311
Toronto

Download on the App Store | GET IT ON Google Play

Google Play and the Google Play logo are trademarks of Google LLC.

<https://www.toronto.ca/home/311-toronto-at-your-service/311-mobile-apps/>

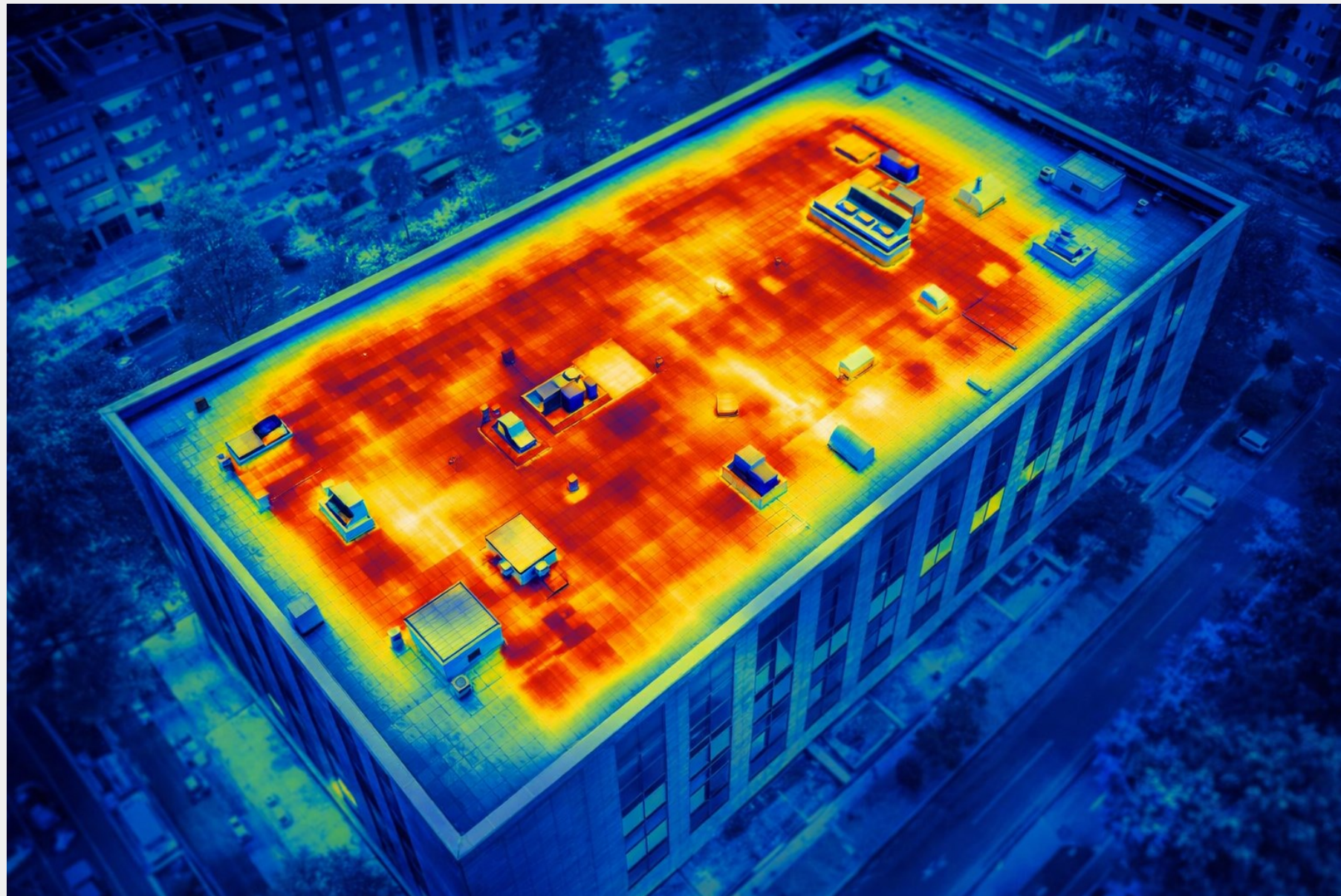
➤ Smart Government (Estonia digital ID-card)



<https://e-estonia.com/solutions/estonian-e-identity/id-card/>

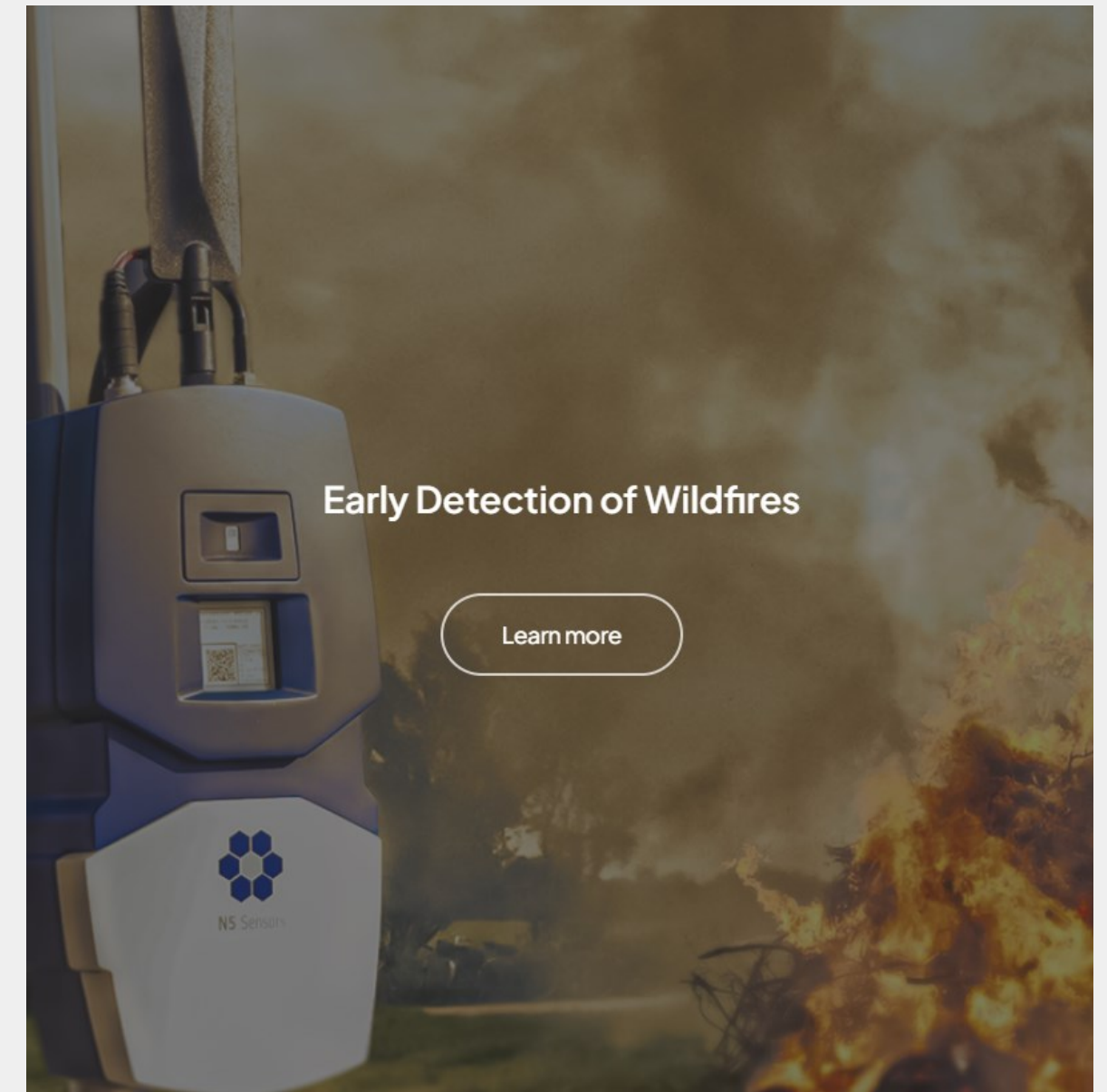
What is Smart City?

➤ Smart Energy and Environment



<https://www.kestrix.io/>

➤ Smart Energy and Environment



<https://kurrent.com/originals/maui-adopts-ai-enabled-fire-detection-following-deadly-2023-wildfire/>

What is Smart City?

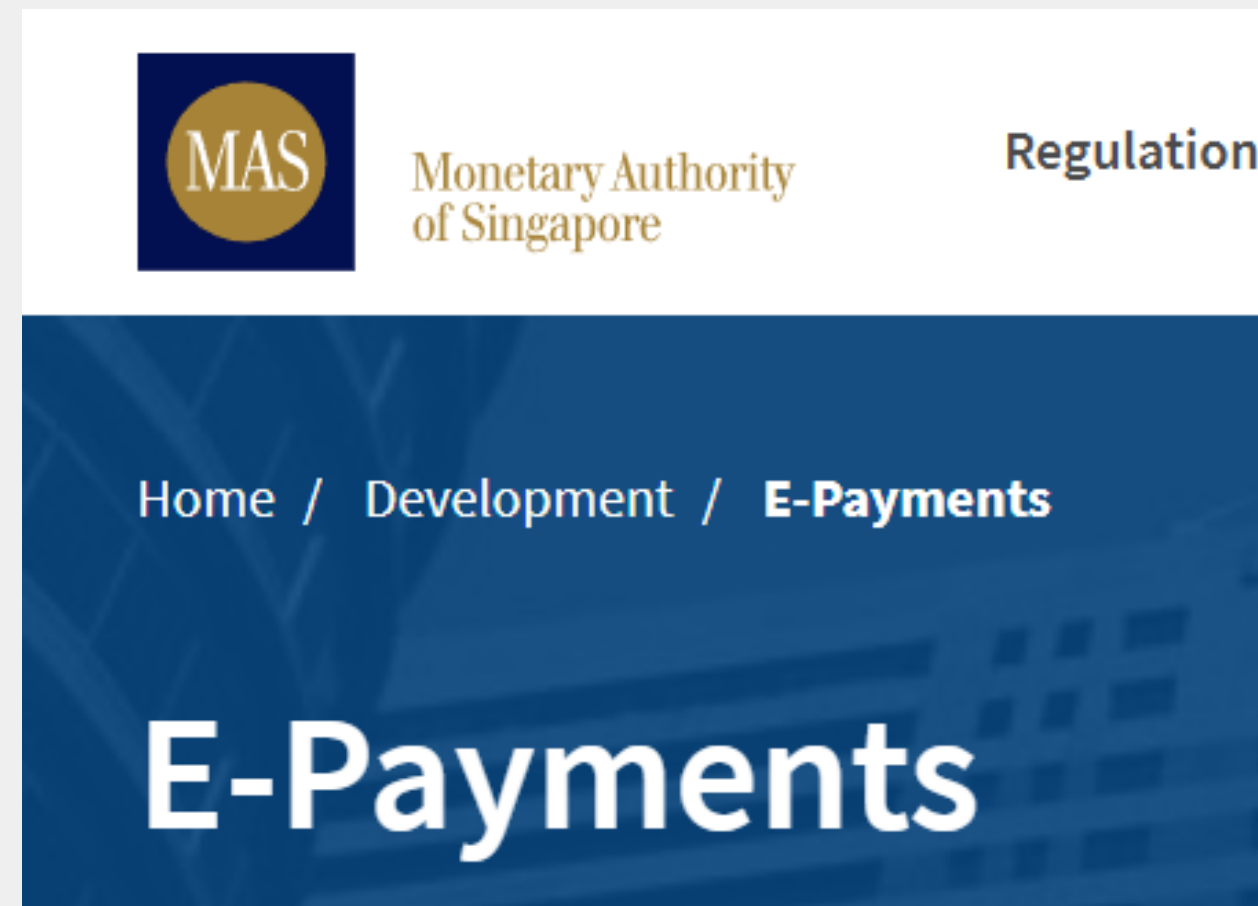
Smart People: Seoul's Policy Vote / participation portal (citizen engagement in decisions).



<https://english.seoul.go.kr/policy-vote>

What is Smart City?

- **Smart Economy:** cashless / digital payments (PayNow, e-payments): fast digital transactions for citizens and small businesses, boosting efficiency and enabling new services

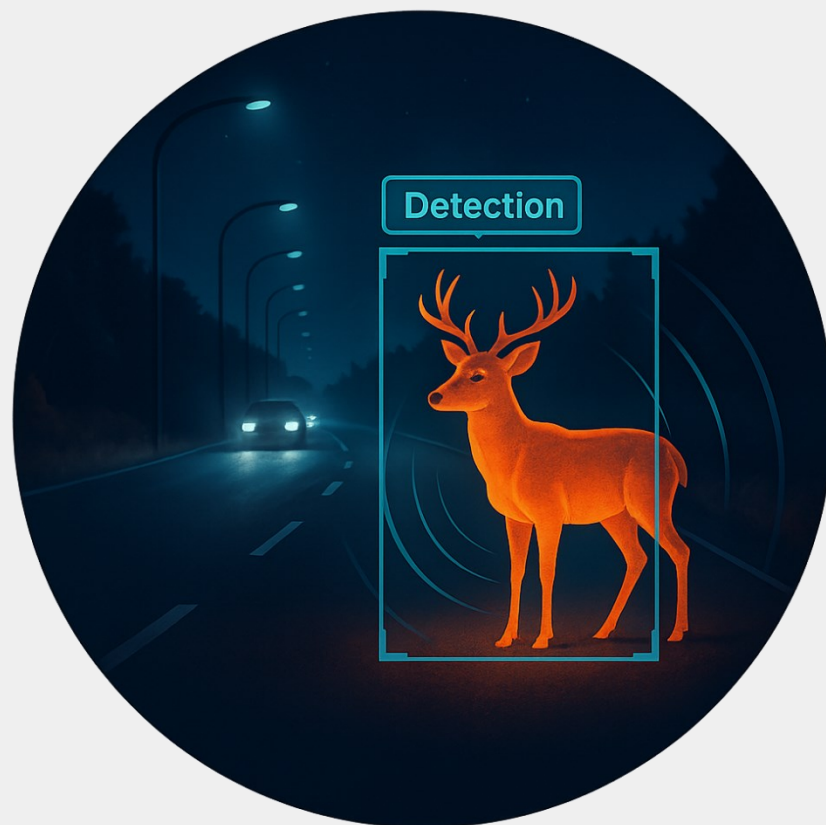


<https://www.mas.gov.sg/development/e-payments>

What is Smart City?

Smart Mobility: real-time traffic data to improve congestion, safety and emission

Real-Time Wildlife Detection
System in British Columbia



Real-Time Automated Speed
Enforcement Cameras in Ontario

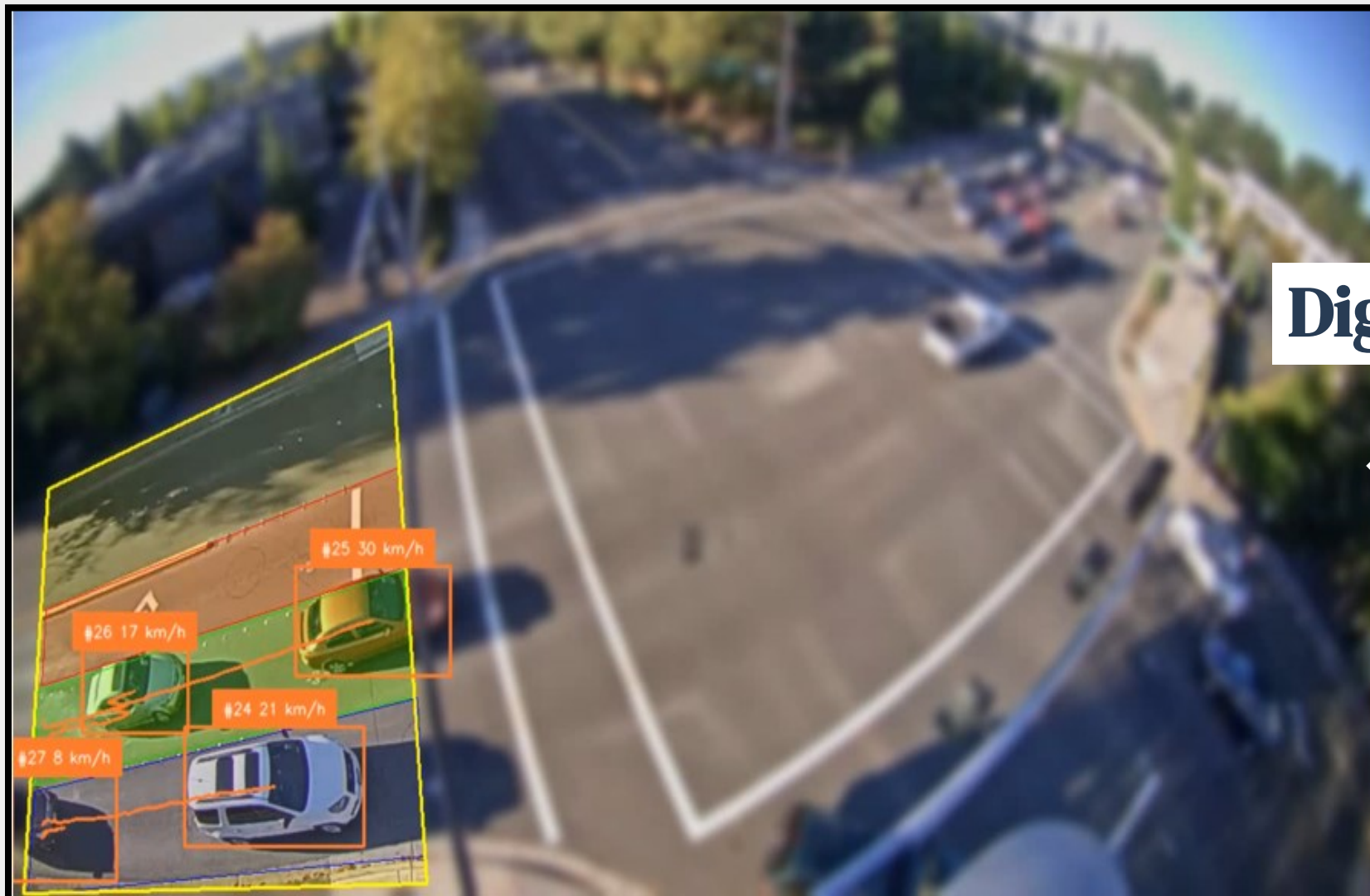


What is Digital Twin?

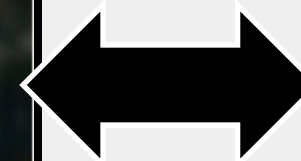
➤ **Digital Twin:** a “living” digital model that stays linked to the real world with data.

✓ A digital twin is one common approach/tool used inside smart cities

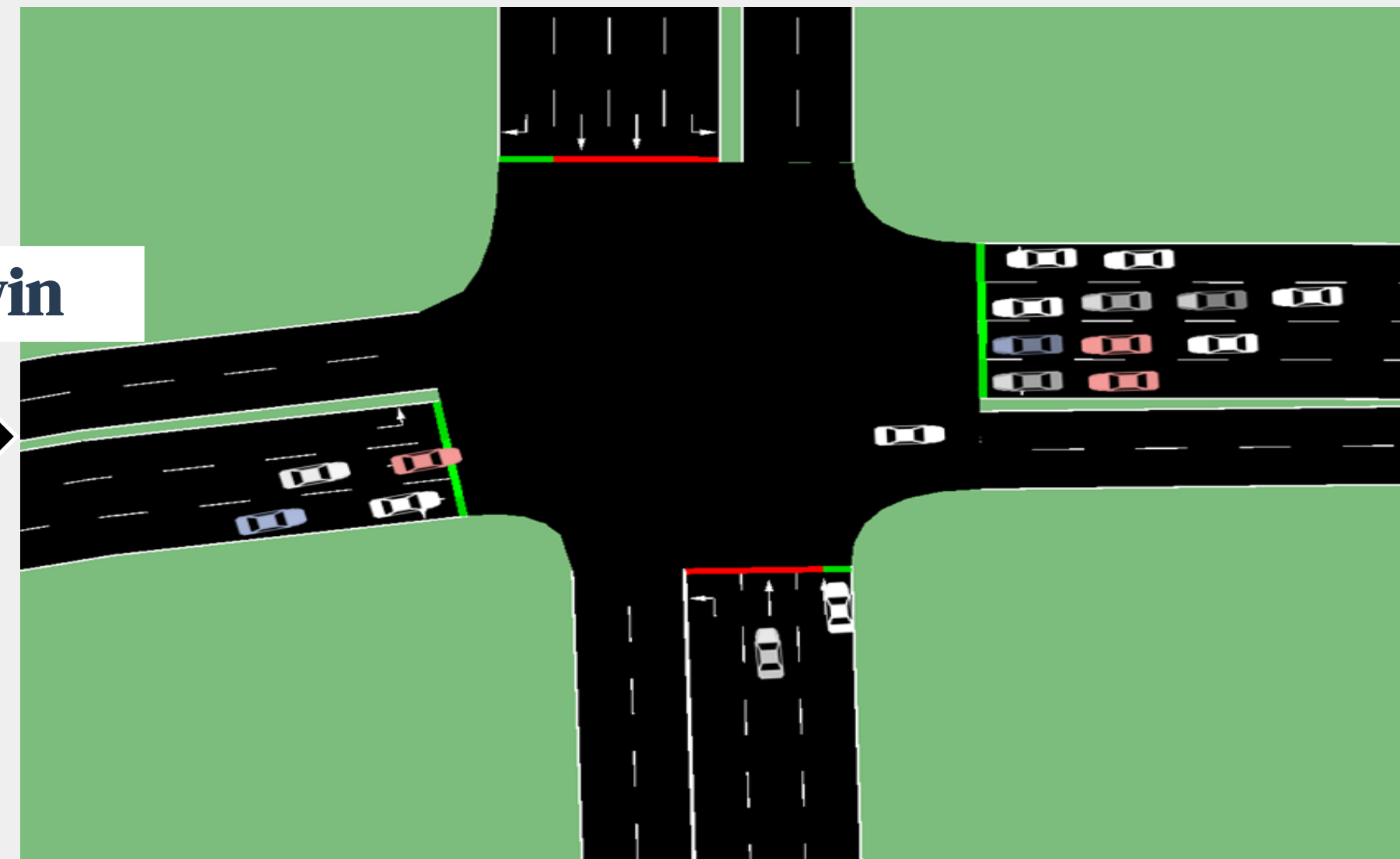
Real-World



Digital Twin



Digital Model

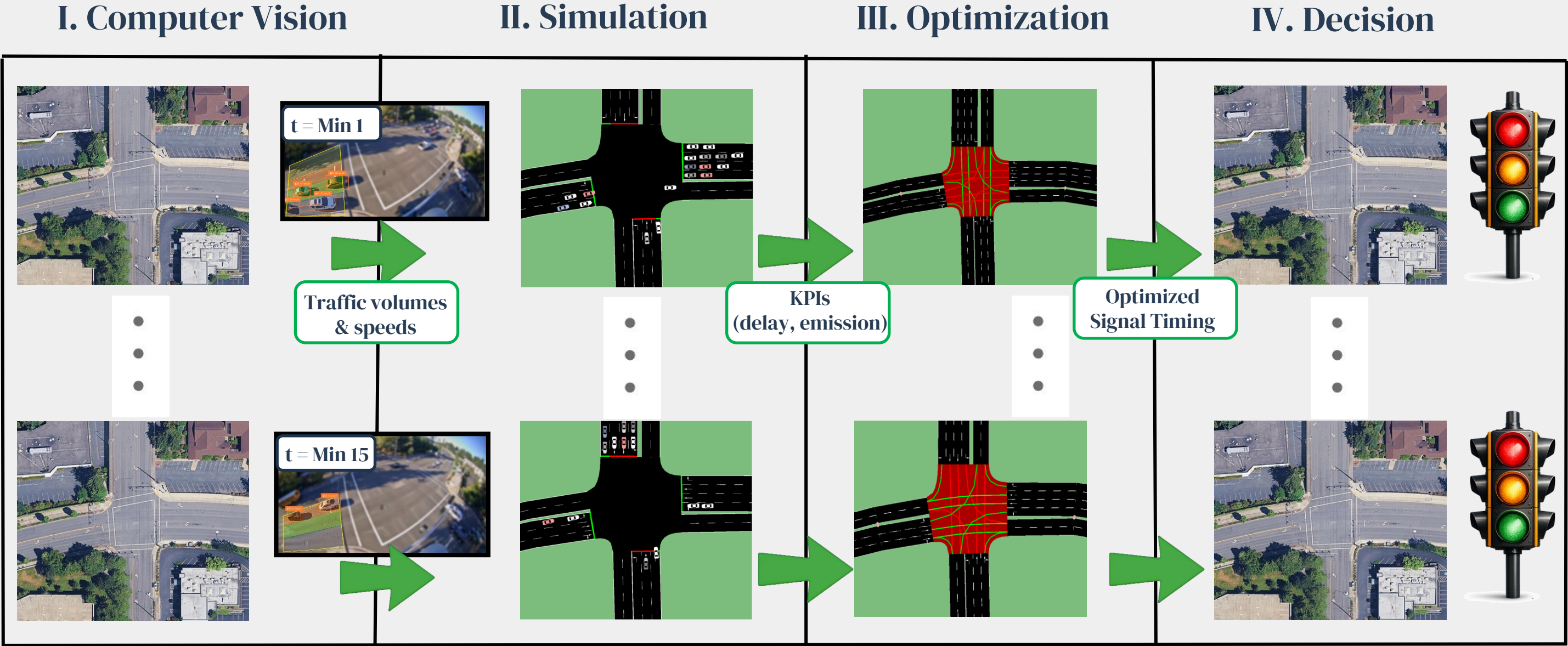


Four Stages of a Digital Twin

Digital Twin has four stages:

- ✓ **Data Layer:** collect real-world data using sensors (e.g., computer vision)
- ✓ **Model Layer:** digital replica of the real-world system (e.g., simulation)
- ✓ **Connection Layer:** integrate virtual and real-world and test scenarios (e.g., Optimization)
- ✓ **Service Layer:** choose the most effective scenario and communicate findings (e.g., Decision)

Overview of Course Syllabus in One Shot



Course Learning Outcomes



1. Computer Vision

Introduction to Computer Vision

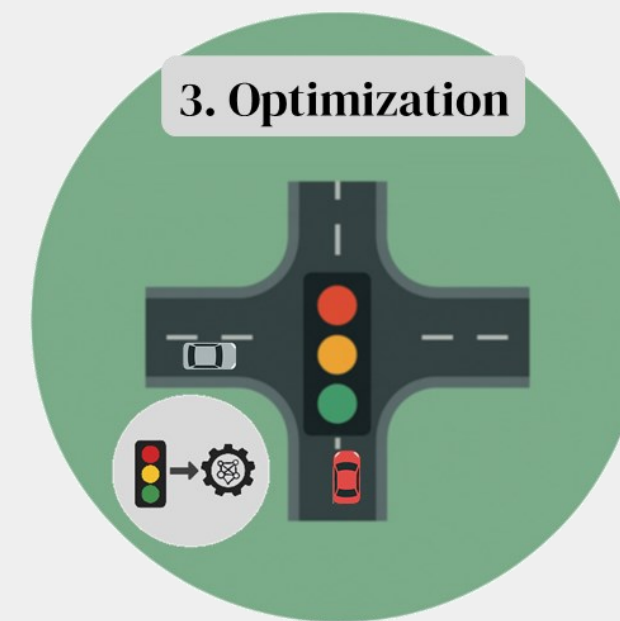
- ❑ Collect Video of a Real-World Intersection
- ❑ Design an AI (Computer Vision) Algorithm
- ❑ Count and Estimate the Speed of Traffic



2. Simulation

Introduction to Traffic Simulation

- ❑ Develop Digital Intersection in Simulation
- ❑ Enter The Traffic Data into the Simulation
- ❑ Develop A Digital Twin



3. Optimization

Introduction to Optimization Algorithms

- ❑ Introduce Traffic Signal Optimization
- ❑ Develop Key Performance Indicators (KPIs)
- ❑ Analyze KPIS (Delay, Emission, level of Service)



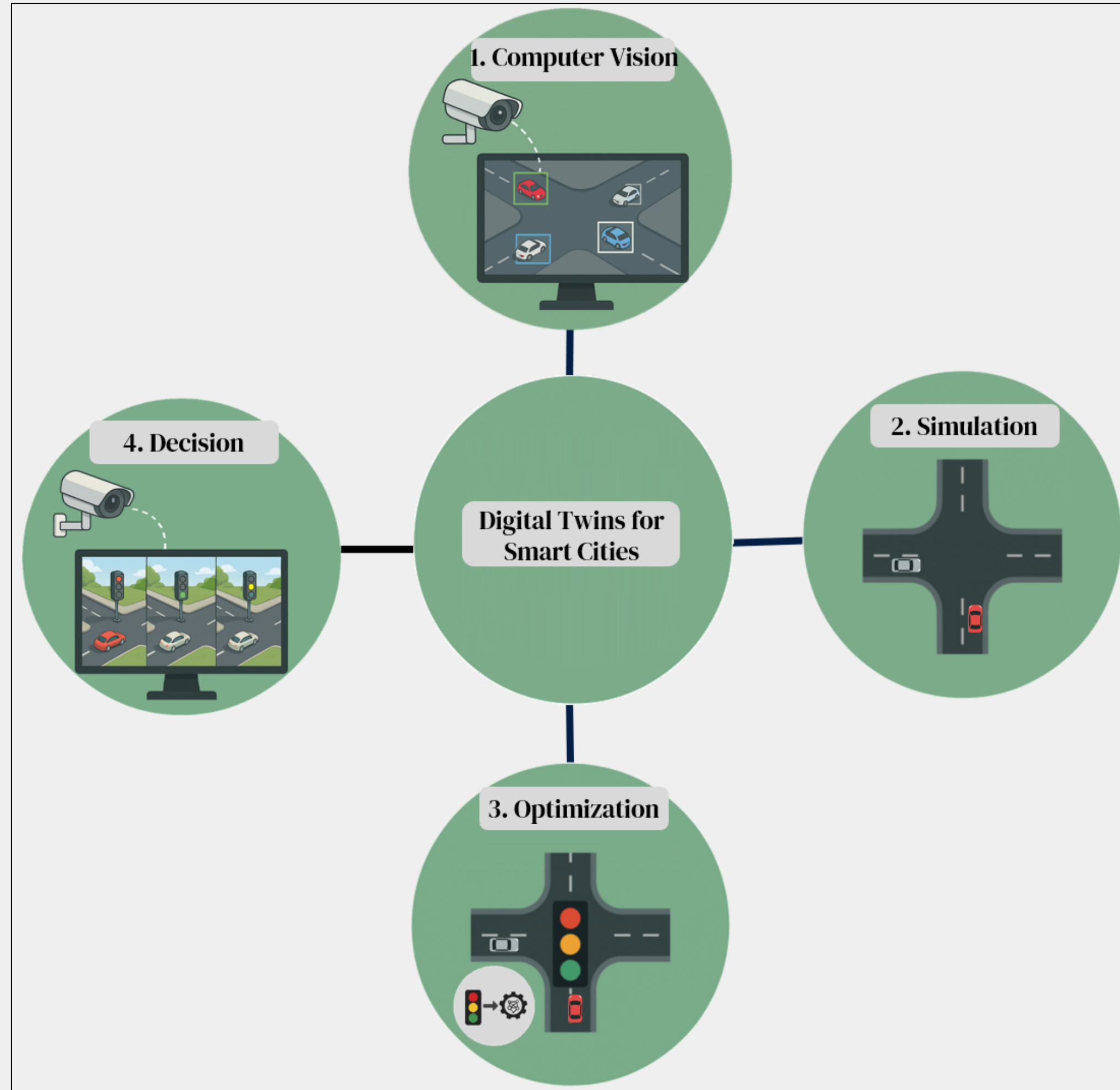
4. Decision

Communication & Presentation

- ❑ Select Best Signal Timing Strategy
- ❑ Create a Professional Presentation
- ❑ Write a Formal Technical Report

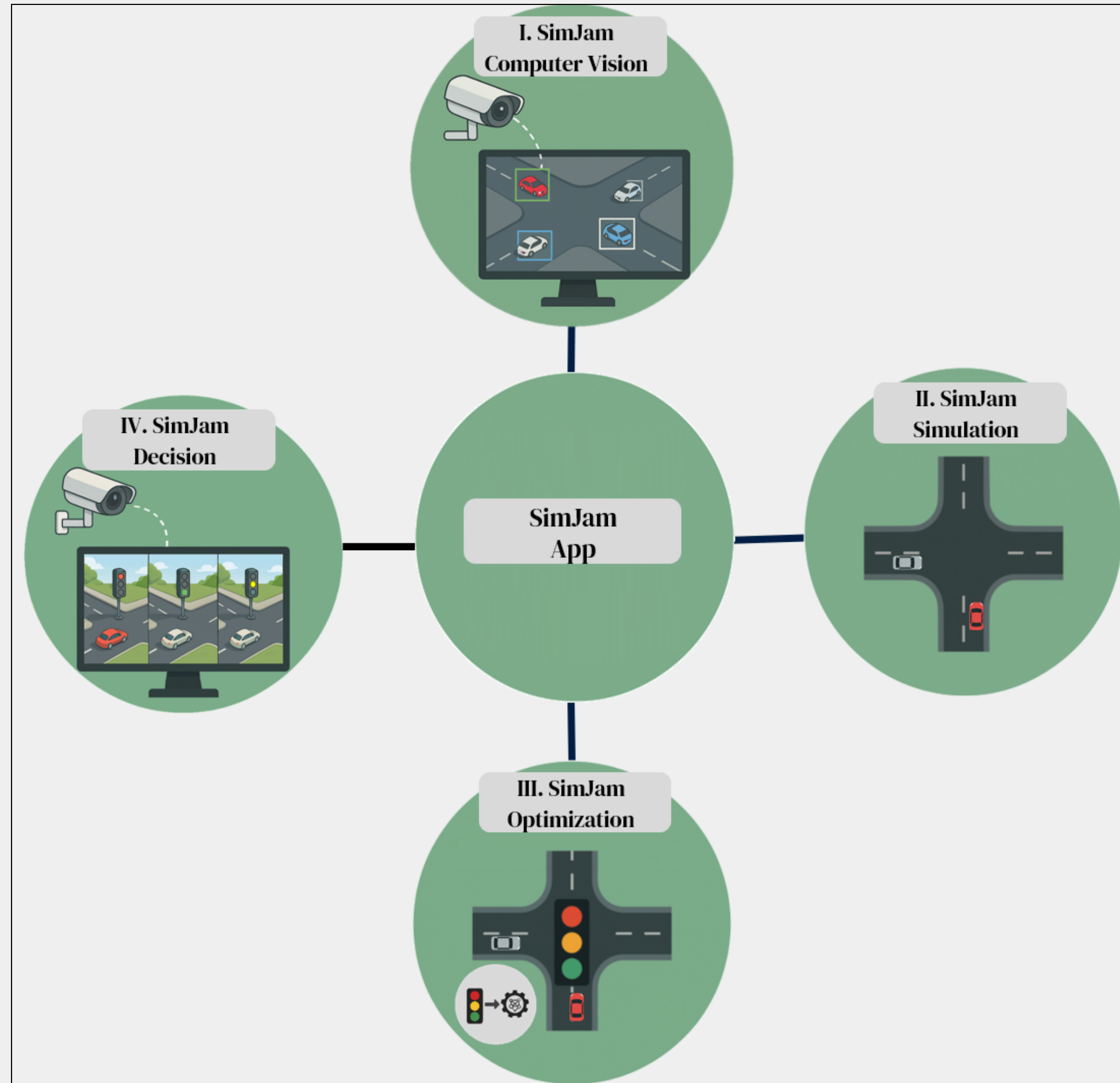
Overview of Course Syllabus in One Shot

❑ 1-Min Showcasing Video



SimJam Application

❑ 1-Min Showcasing Video



Overview of Course Syllabus

Course Textbook

- ☐ **No Designated textbook:**
- ☐ **Lecture notes & other needed materials will be posted on the course website**

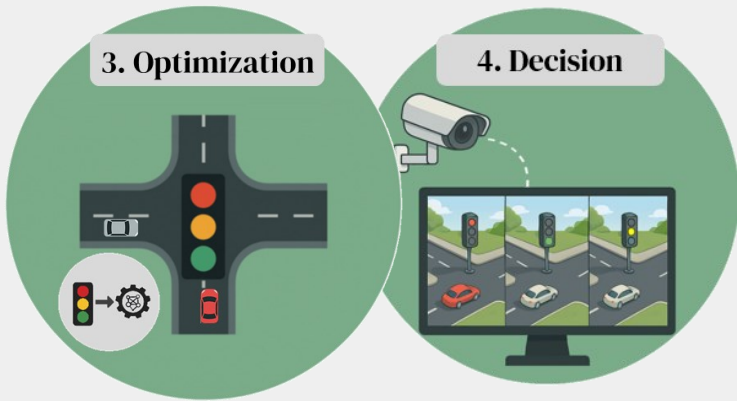
Course References:



University of California, Berkeley. Course Materials [CS180/280A: Intro to computer vision and computational photography] (Fall 2025):
Course Website:
<https://cal-cs180.github.io/fa25/>



Wunderlich, K., Vasudevan, M., & Wang, P. (2019). Traffic analysis toolbox... (FHWA-HOP-18-036). FHWA. Access:
PDF:
<https://ops.fhwa.dot.gov/publications/fhwahop18036/fhwahop18036.pdf>



Tao, F., Zhang, M., & Nee, A. Y. C. (2019). Digital twin driven smart manufacturing. Academic press.



CS180/280A: Intro to Computer Vision and Computational Photography
Computer Science Division
University of California, Berkeley

Course Information

Instructors: Angjoo Kanazawa, Alexei (Alyosha) Efros
GSIs: Justin Kerr, Konpat Preechakul, Chung Min Kim, Brent Yi
Tutors: Jameson Gatto, Jingfeng Yang, Natalie Wei, Jorge Diaz Chao
University Units: 4
Semester: Fall 2025
Gradescope Entry Code: VWX283
Ed: 100 | access code
Syllabus: PDF
Location: Hoes Faculty Wing F295
Time: Tues Thurs 12:30 - 1:59PM

Office Hours

Instructors: Angjoo & Alyosha (Tues/Thurs after lecture, 30 mins)
Mon: Konpat 10-11AM (BWV 1216), Brent 11-12PM (BWV 1216), Jorge 12-1PM (BWV 1216)
Tues: Jingfeng 4-5PM (Wheeler 202), Chung Min 5-6PM (Soda 320), Jameson 6-7PM (Cory 521)
Wed: Natalie 6-7PM (Doinelle 779)
Thurs: Justin 3-4PM (BWV 1215)

Prerequisites

This is a heavily project-oriented class, therefore good programming proficiency (at least **CS 61B**) is absolutely essential and knowledge of linear algebra (**MATH 54**, **MATH 56**, **MATH 110**, or **EECS 16A**) and multivariate calculus (e.g. **MATH 53**) are v
learning and neural networks is required in the second part of the course. You must have taken beforehand or are currently t
the open-endedness of this course, creativity is a class requirement.


Discussions


Discussions are GSI-led worksheets designed to help you better understand the concepts in class and in the projects. Attend
Sheets and solutions will be posted after each week.

Person	Time	
Konpat	Wed 10-11	Wheeler 108
Chung Min	Wed 1-2	Soda 310
Brent	Wed 3-4	Wheeler 120

Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software

2019 Update to the 2004 Version




 U.S. Department of Transportation
Federal Highway Administration

April 2019

Digital Twin Driven Smart Manufacturing

$M_{DT}=(PE,VE,S_s,DD,CN)$



Grading Scheme

Activity	Type	Frequency	Weight	What It Evaluates
Class participation	Participation	Weekly	5%	Active engagement, peer learning, professional communication
In-class deliverables	Progressive	Weekly	15%	Technical skills application, immediate feedback on modeling
Transportation News Brief presentation	Communication	Once per student	10%	Ability to analyze current events and present to peers
Assignments	Practice	Throughout term	10%	Concept reinforcement, preparation for midterm
Midterm examination (paper-based)	Summative	Week 8	25%	Conceptual understanding, calibration reasoning without software
Design project	Applied Project	Cumulative	35%	End-to-end planning workflow, professional deliverables

In-class Deliverables

- ❑ A total of 5 In-class Deliverables will need to be submitted through course website (submission date is fixed).
- ❑ In-class Deliverables is mandatory! If you don't submit one or more of the design lab report, you will lose 15% (out of 100%).

Periodic Evaluation

- ☐ Each student needs to present once about a news on Smart City at the start of class
- ☐ This will be scheduled

Design Project

- ❑ **Group project (students in a group)**
- ❑ **You will evaluate the contribution of yourself and other group members twice.**
- ❑ **This means that there is a possibility that each student in a group can obtain different scores associated with design project submissions.**

Assignments

- ❑ **There are 3 Assignments in overall**
- ❑ **Submissions are to be delivered on time**
- ❑ **Grade for a late submission will be deducted 20% per day late.
Accommodations may be made on a case by case with valid reasons
(illness, etc.).**
- ❑ **Nonetheless, if the solutions are posted online or reviewed in virtual
class, late submissions will no longer be accepted.**

Exam

□ Exam:

- **One Midterm examination**
- **Midterm Date/Time/Room:**
October 19th (Tue)/11:30am-01:00pm
- **The exam will be open notes/references exam.**

Missed Exam

- ❑ **Students who missed midterm test will require a valid reason and appropriate documentation (such as doctor's note for illness) to arrange a possible deferred exam.**
- ❑ **Arrangements can be made on a case by case basis**
- ❑ **Further accommodations will be possible through a formal petition to the Faculty**

Other Transportation Courses

- ❑ **RWR 4014 – Transportation Planning**
- ❑ **RWR 4015 – Traffic Simulation in Planning Applications**
- ❑ **RWR 4016 – Transportation Policy**
- ❑ **RWR 4017 - Introduction to GIS**