From Data to Action

Data & Telemetry BOOTCAMP

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Schmid Elektronik

SCHMID Elektronik

Shell Eco-marathon Partner

10.4.2026, SEM Indianapolis

Marco Schmid

Schmid Elektronik is **Shell Eco-marathon Partner**

About Shell Eco-marathon

For over 40 years, since 1985, the programme has consistently brought to life Shell's mission of Powering Progress together by providing more and cleaner energy solutions.

Watch the NEW film to learn more about Shell Eco-marathon'

Read more →

2026 Programme

The season opens a new chapter that reflects the changing face of STEM and introduces a comprehensive competition experience, leading to a truly Global Championship.

Learn more about the 2026 Programme here

Read more →

Partners

Our partners are essential to Shell Eco-marathon. Not only do we work together, but we combine resources and share ideas and innovations to help build a lower-carbon future.

SCHMID Elektronik | Shell

Shell Eco-marathon Partner

Read more →

NEW 2026

Shell Eco-marathon **Telemetry System**

NEW 2026

Logistics Nightmare

10 Years → OBC NXG

~~One Size fits all~~?

Shell Eco-marathon **Telemetry System**

Changes of Telemetry Focus: all Teams equal

All Energy Types

- ICE
- H2
- BE

For both Vehicle Categories

Data & Telemetry **Off-Track Award**: Developing a Strategy that:

#1 Accounts for the straights, slopes, crests and corners of a track

#2 Balances maximum energy efficiency with competitive lap times

#3 Ensures driver safety in all conditions, including rain and wind.

A **Sixth** OTA-Question

NEW 2026

1. **Data Strategy** to Achieve the Three Goals
2. Capturing Data with a **Telemetry** System
3. Gaining **Knowledge** from Race Data
4. Data-driven **Race Strategy** Development
5. **Driver** performance on Track
6. Qualitative and Quantitative **Results Improvement**

Publishing the OTA-Winners

NEW 2026

Shell Eco-marathon

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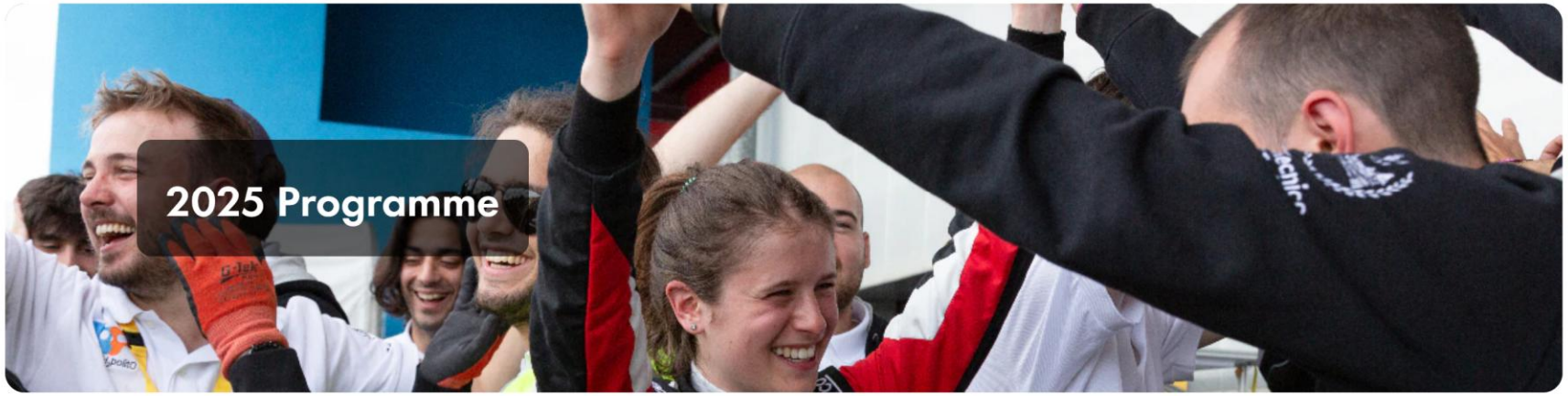


Celebrating 40 years of innovation by the world's best and brightest young minds

Shell Eco-marathon Europe and Africa 2025

Regional Competition / June 10 to 15, 2025

Silesia Ring, Kamień Śląski, Poland

Read more about Shell Eco-marathon Europe and Africa 2025

Publishing the OTA-Winners

NEW 2026

Data and Telemetry Award sponsored by Schmid Elektronik

The Data and Telemetry Award celebrates teams that harness the power of data to optimise vehicle performance and enhance overall strategy.

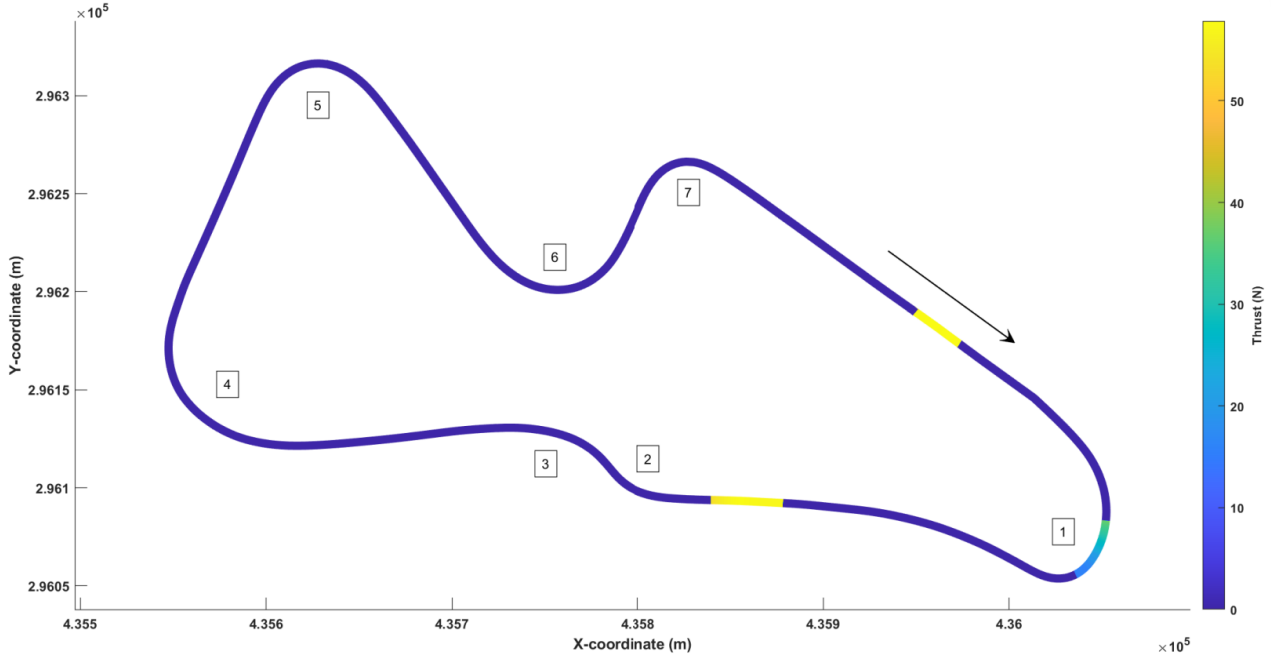
Winner: Imperial Eco-Marathon, Imperial College London, United Kingdom

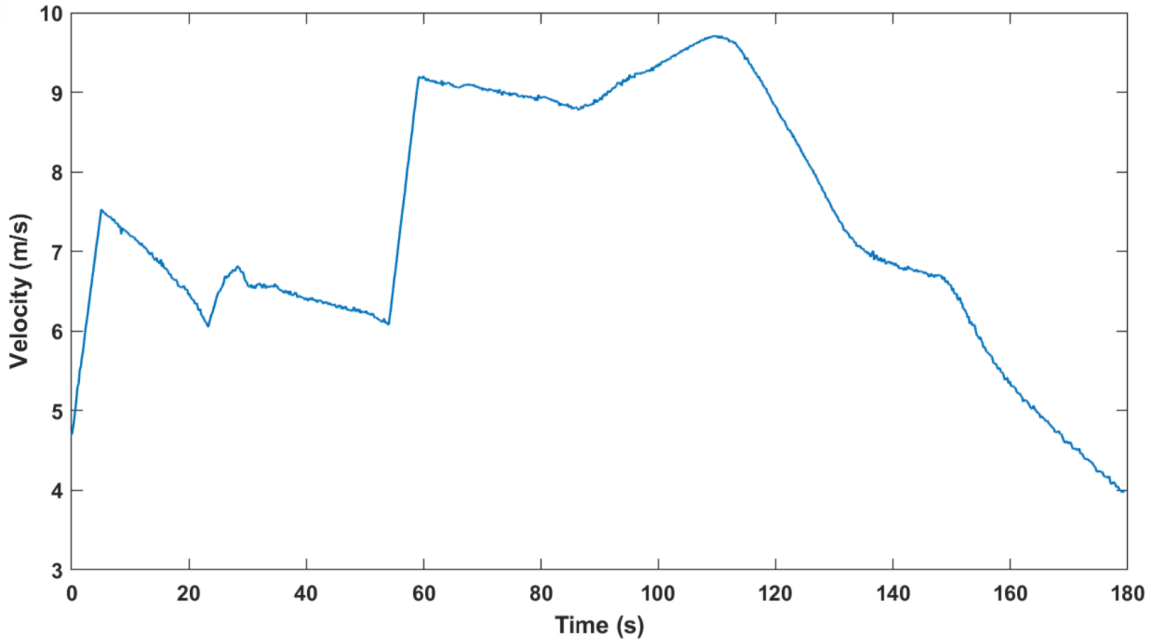
Judges' Remarks: Rigorously engineered telemetry and simulation underpin this entry. Instead of chasing a single perfect lap, the team optimizes the entire multi-lap attempt, preventing over-tuning of a single lap. A predictive throttle map and speed profile give the driver foresight, while live telemetry refines tactics in real time— a holistic, adaptive and data-driven masterclass!

Runner-Up: PROMETHEUS ECO RACING NTUA, National Technical University of Athens, Greece

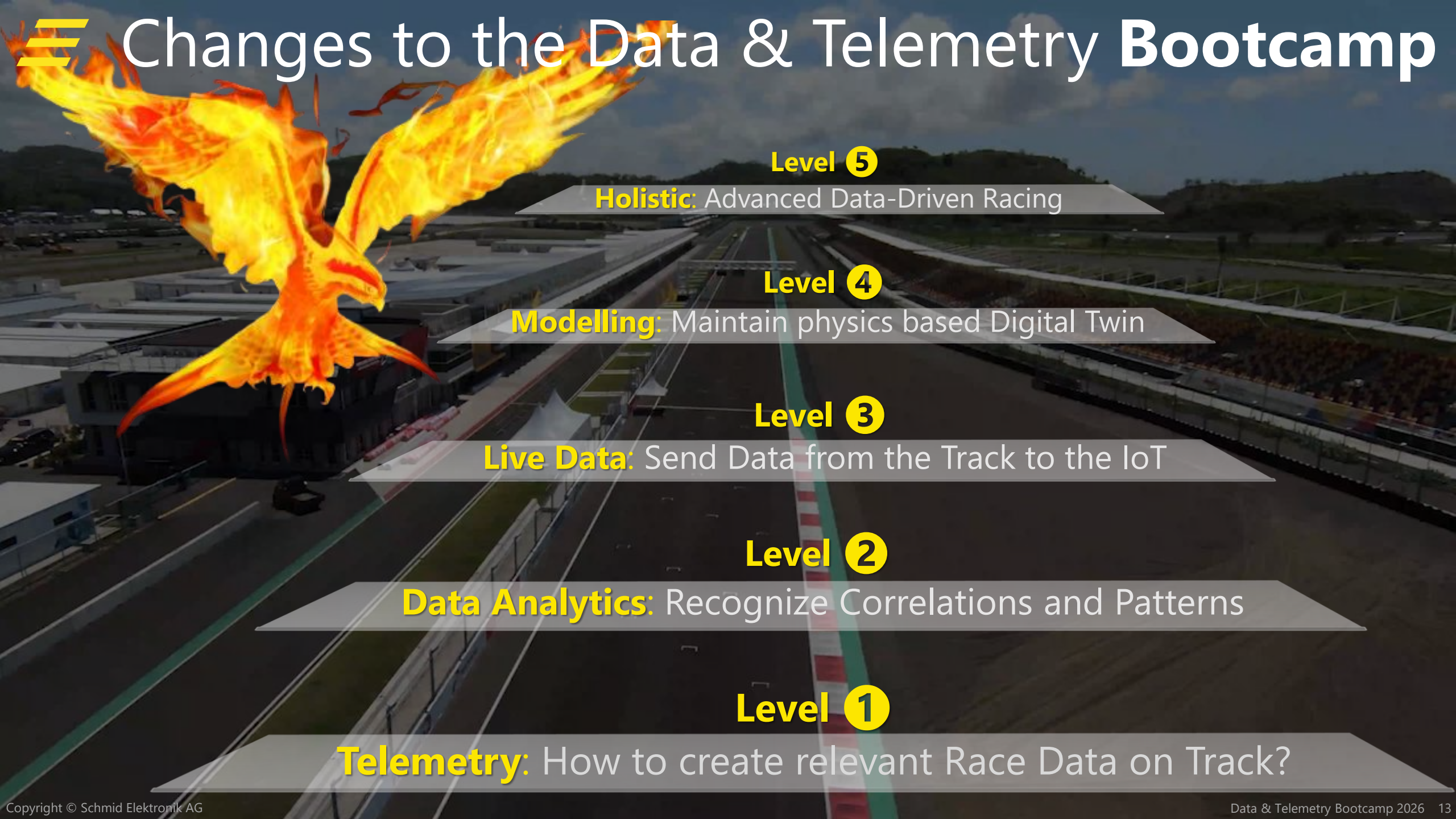
Read Imperial Eco-Marathon's winning entry (PDF, 4 MB)

Judges' Remarks: Rigorously engineered telemetry and simulation underpin this entry. Instead of chasing a single perfect lap, the team optimizes the entire multi-lap attempt, preventing over-tuning of a single lap. A predictive throttle map and speed profile give the driver foresight, while live telemetry refines tactics in real time - a holistic, adaptive and data-driven masterclass!





Changes to the Data & Telemetry **Bootcamp**



Level 5

Holistic: Advanced Data-Driven Racing

Level 4

Modelling: Maintain physics based Digital Twin

Level 3

Live Data: Send Data from the Track to the IoT

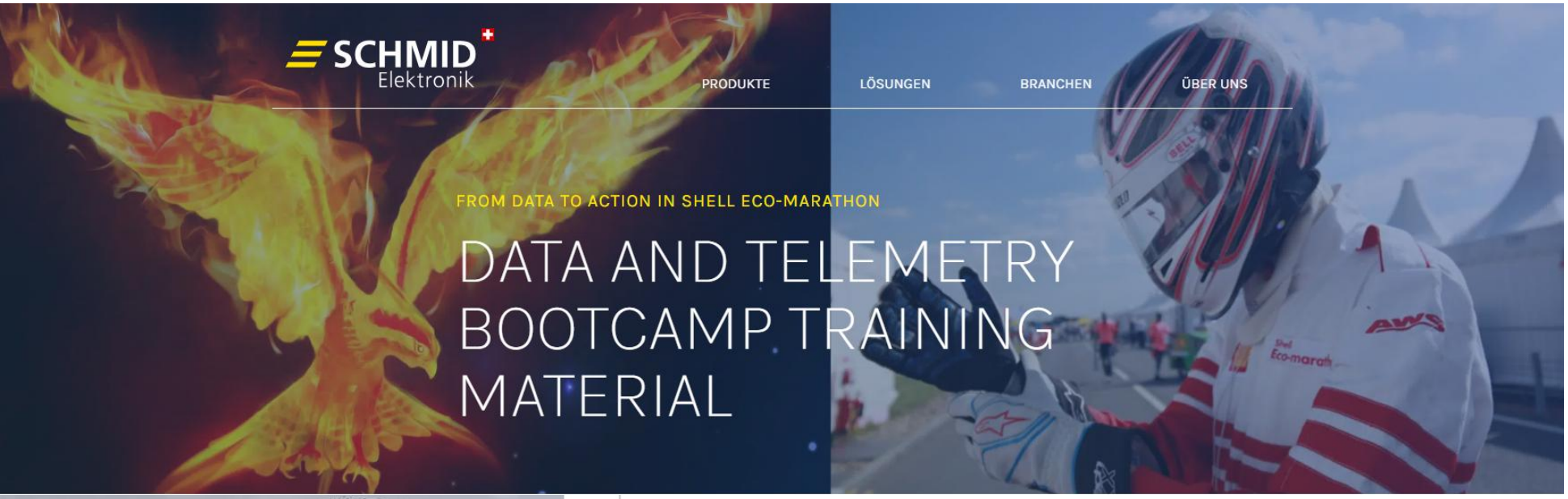
Level 2

Data Analytics: Recognize Correlations and Patterns

Level 1

Telemetry: How to create relevant Race Data on Track?

https://schmid-elektronik.ch/bootcamp-sem26/



Bootcamp Structure

YOU PROGRESS FROM LEVEL TO LEVEL, JUST LIKE IN A GAME.

In five steps, you will learn how data turns into knowledge and knowledge turns into action.

Level 1 | Telemetry: How to Create relevant Race Data on Track?
Level 2 | Data Analytics: Recognize Correlations and Patterns
Level 3 | Live Data: Send Data from the Track to the IoT
Level 4 | Modelling: Maintain Physics Based Digital Twin
Level 5 | Holistic: Advanced Data-Driven Racing

Classic Multigoal-Problem & Global Optimum

Why move from intuitive to data-driven Racing?

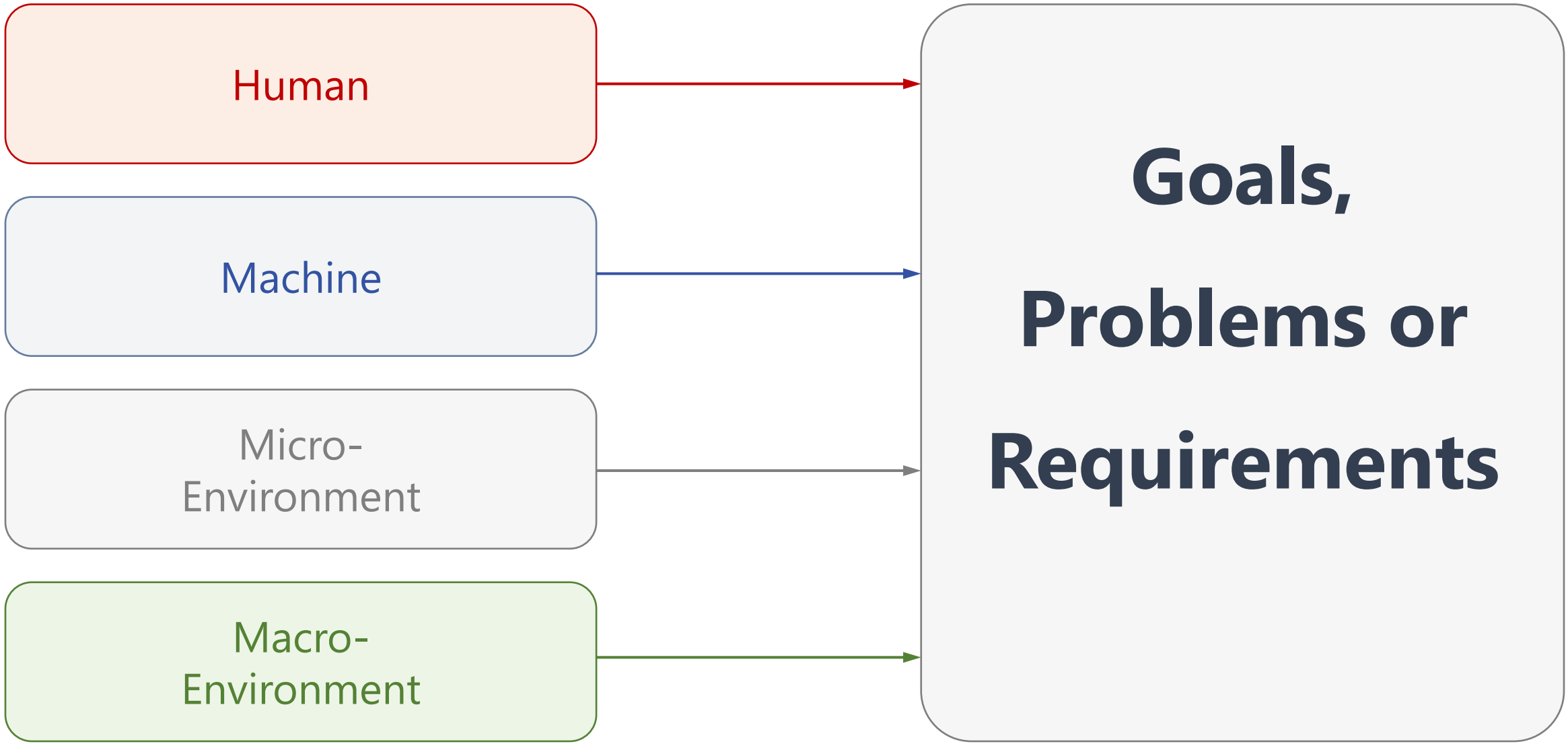
Classic Multigoal-Problem & Global Optimum

Telemetry

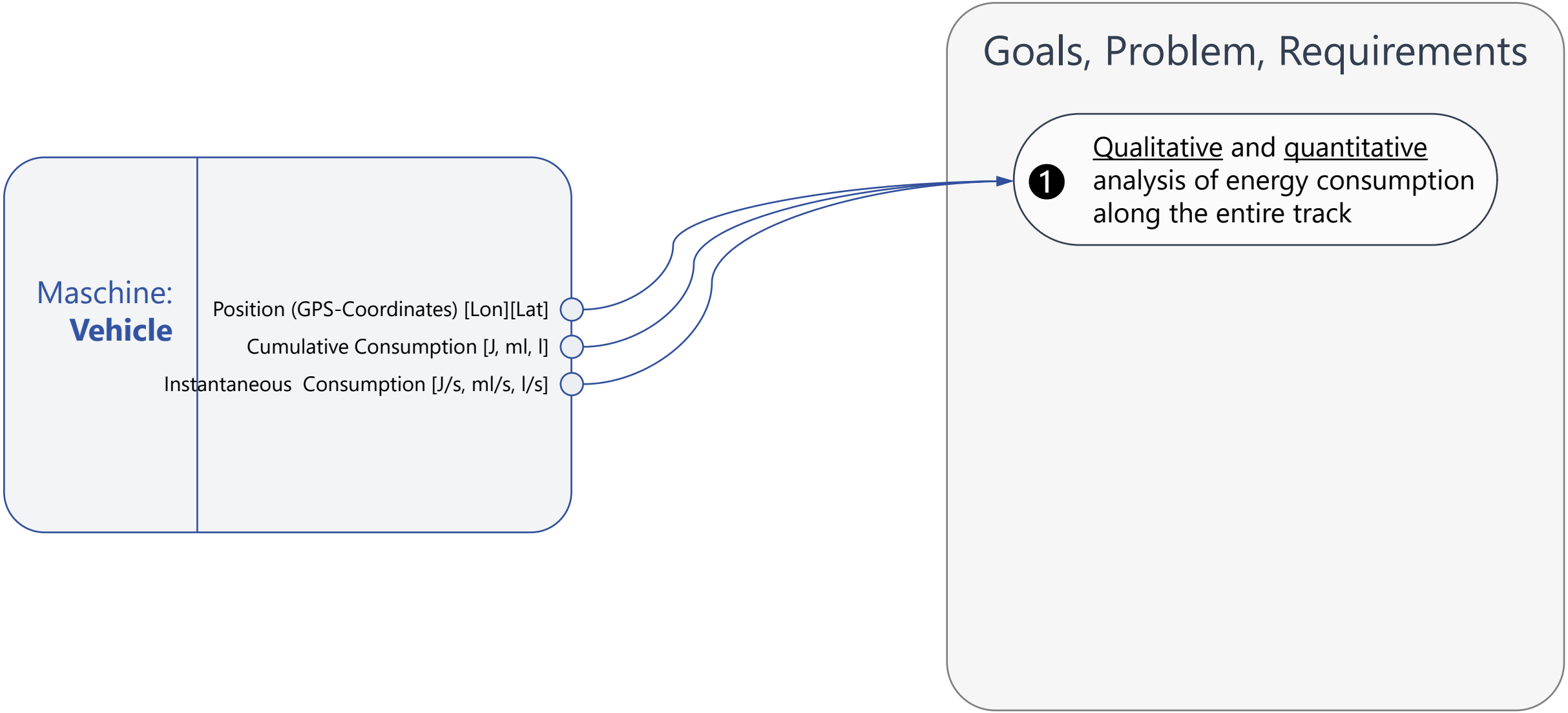
How to identify and create relevant race data on the track?

Level 1

What is your **Data Strategy** + relevant Data?



What is your **Data Strategy** + relevant Data?



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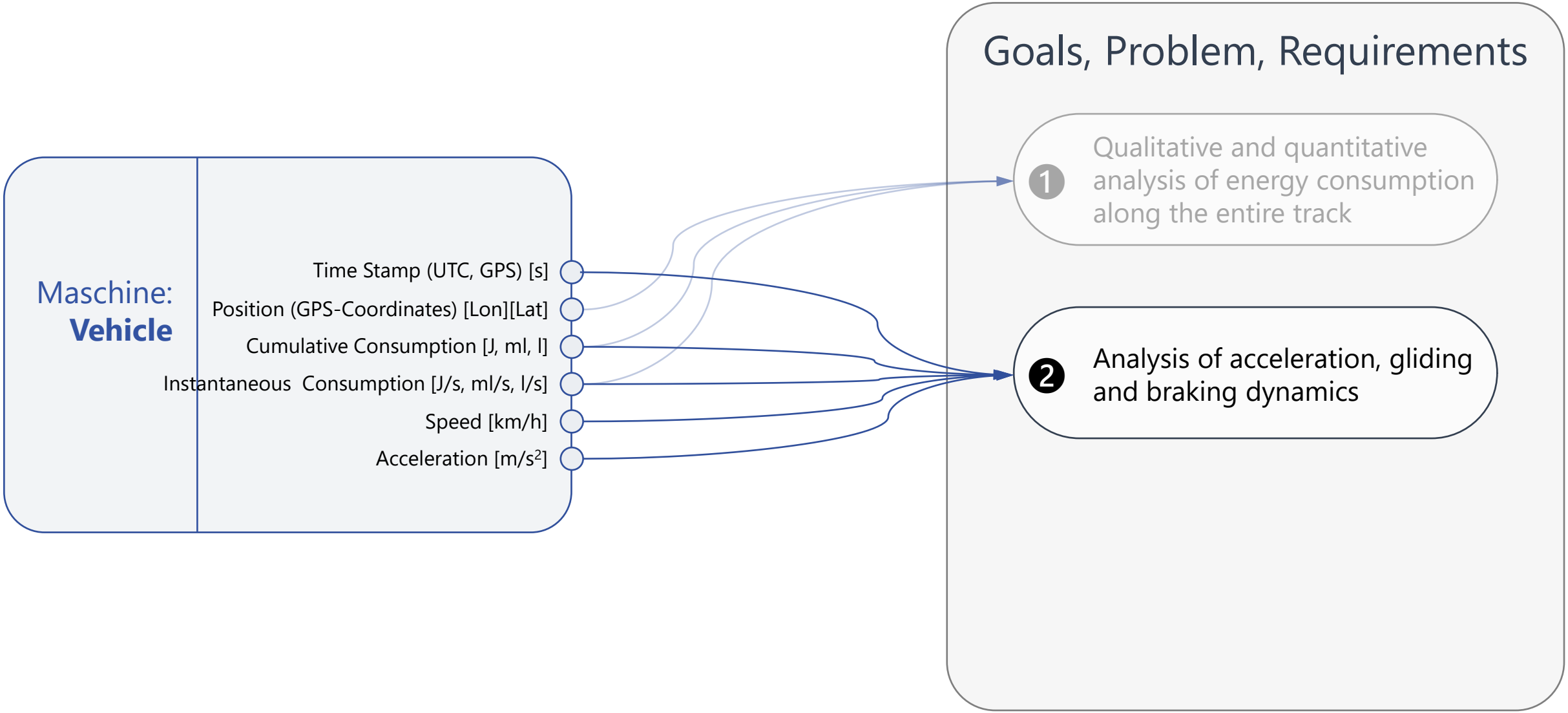

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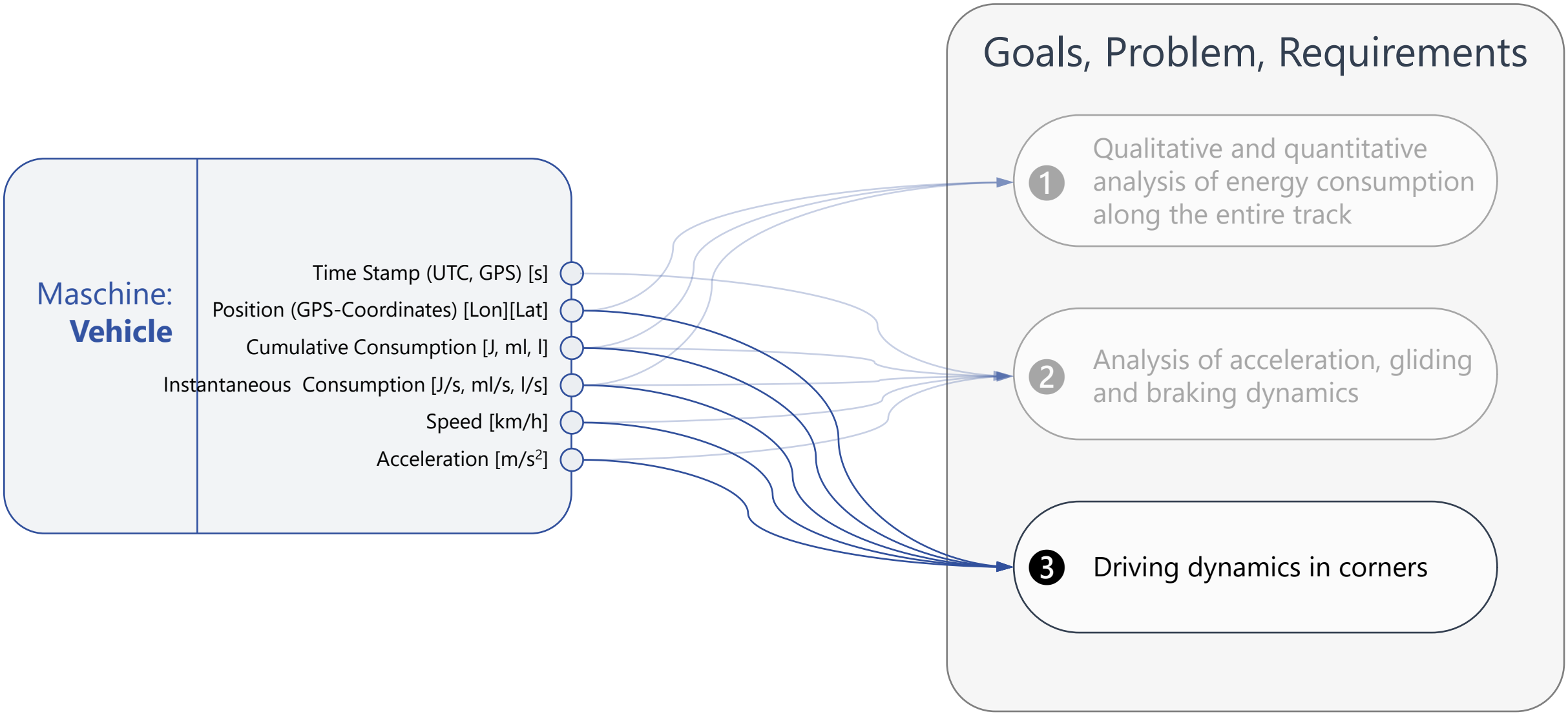
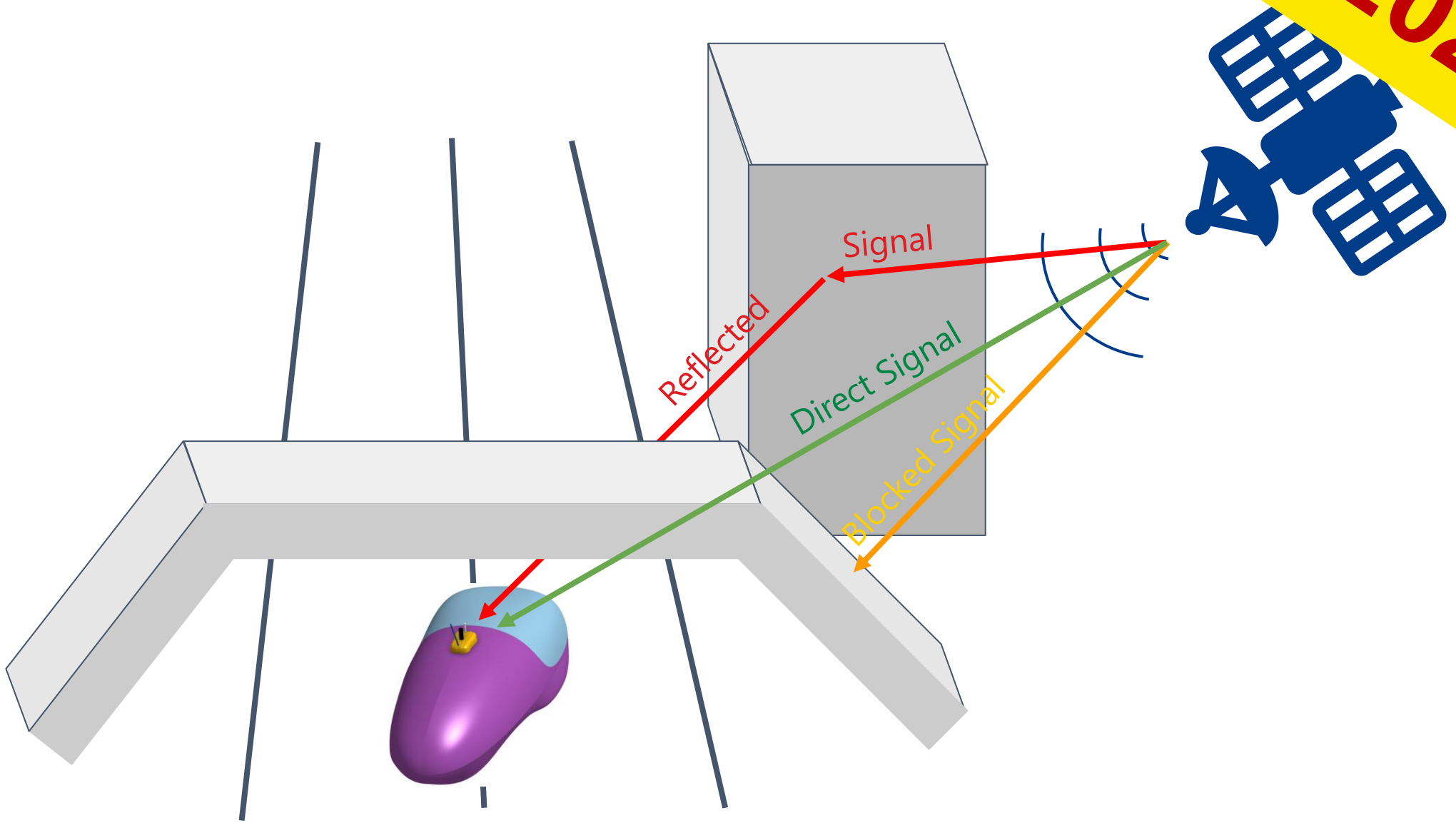
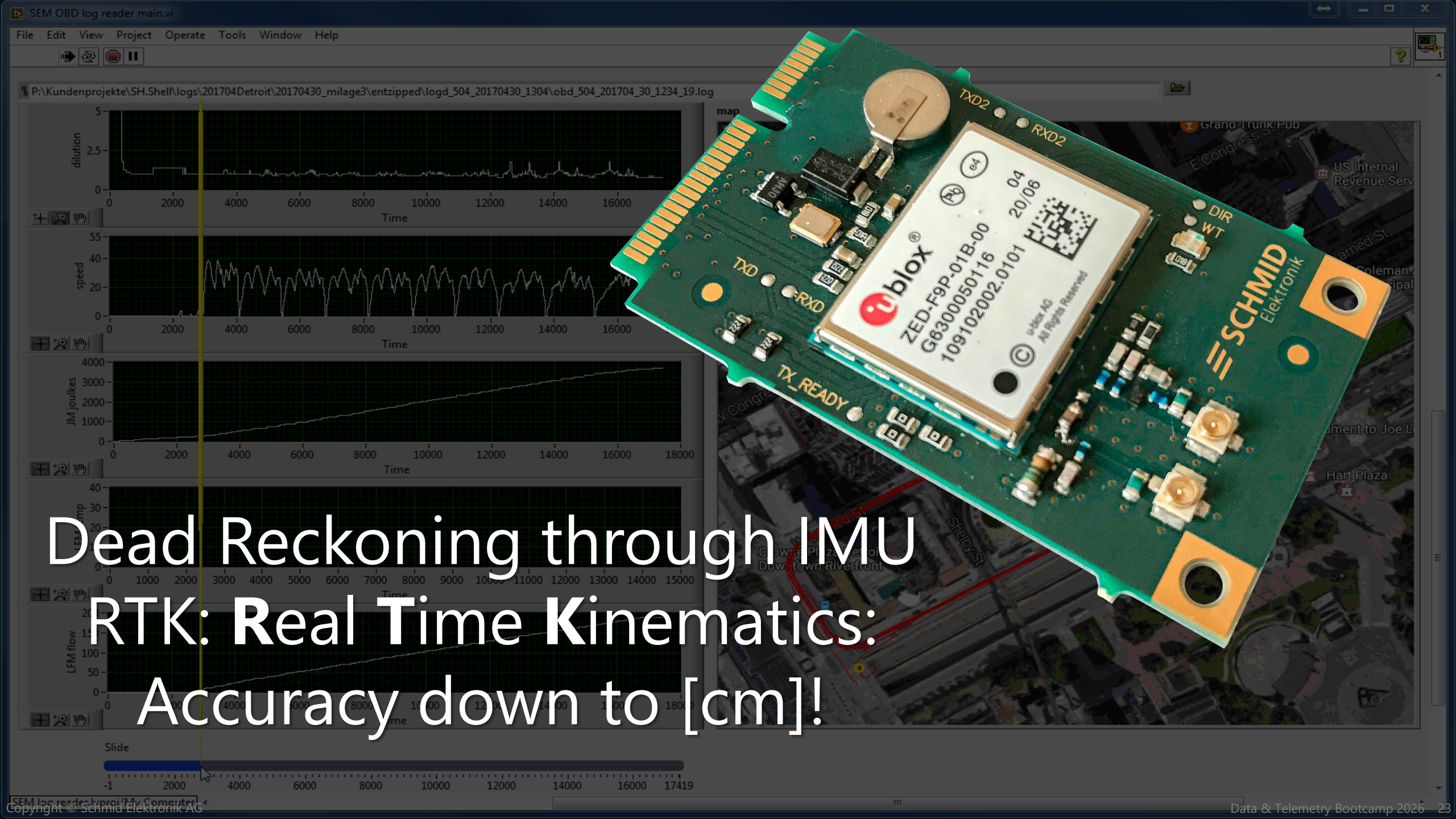


GPS Data and it's Challenge

NEW 2026



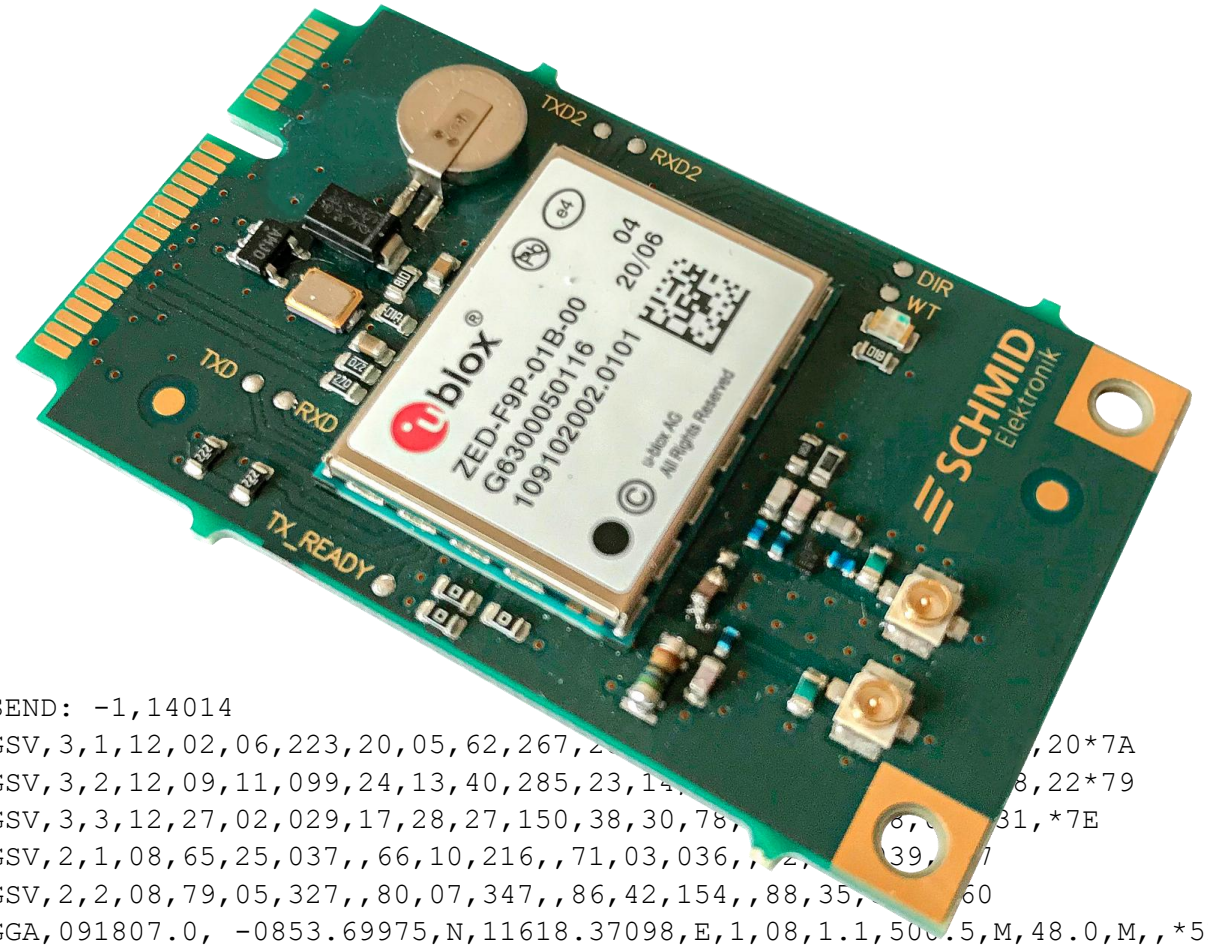


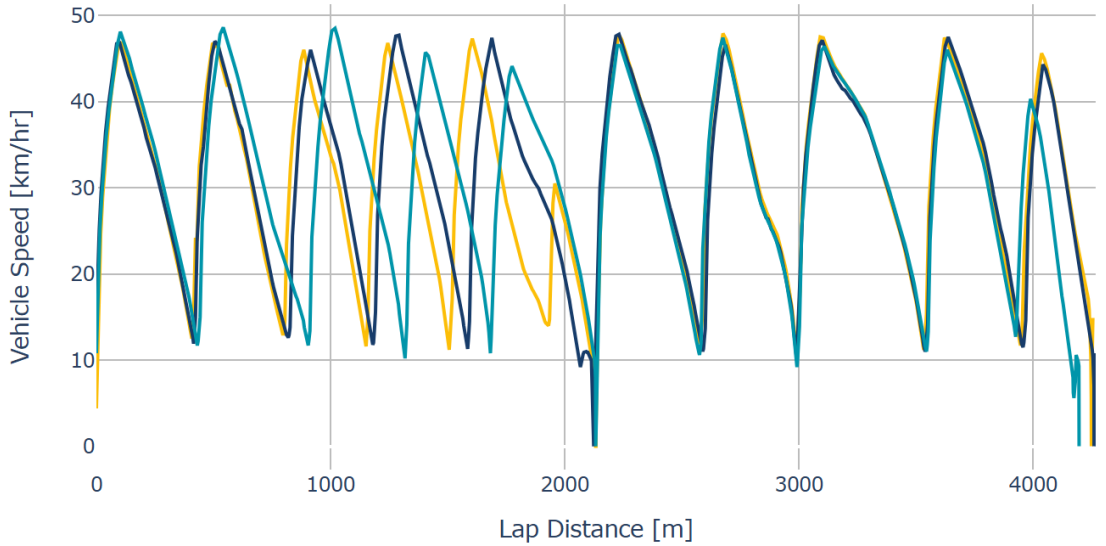
Passive Helix-Antenna and GPS RTK

Maxtena

M1621HCT-P-SMA

GPS-Sensor for **Position** and **Speed**



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^POSEND: -1,14014
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$GPGSV,3,2,12,09,11,099,24,13,40,285,23,14            8,22*79
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$GLGSV,2,1,08,65,25,037,,66,10,216,,71,03,036,,       39,*7
$GLGSV,2,2,08,79,05,327,,80,07,347,,86,42,154,,88,35,      60
$GPGGA,091807.0, -0853.69975,N,11618.37098,E,1,08,1.1,500.5,M,48.0,M,,*5D
$GNGNS,091807.0,-0853.69975,N,11618.37098,E,AN,08,1.1,500.5,48.0,,*66
$GPVTG,144.6,T,144.8,M,0.0,N,0.0,K,A*2D
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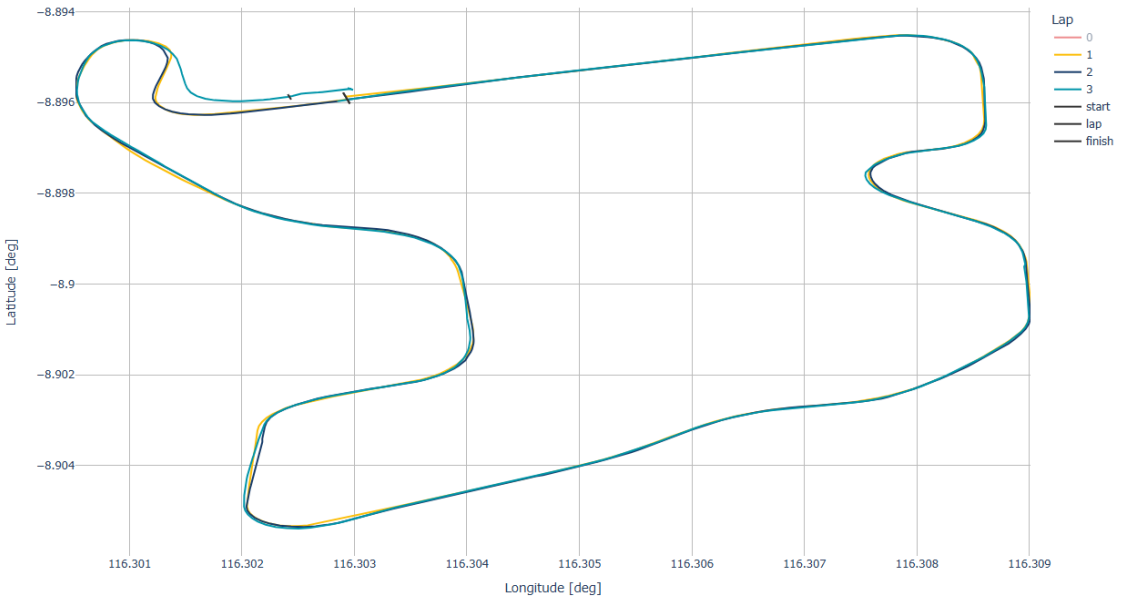
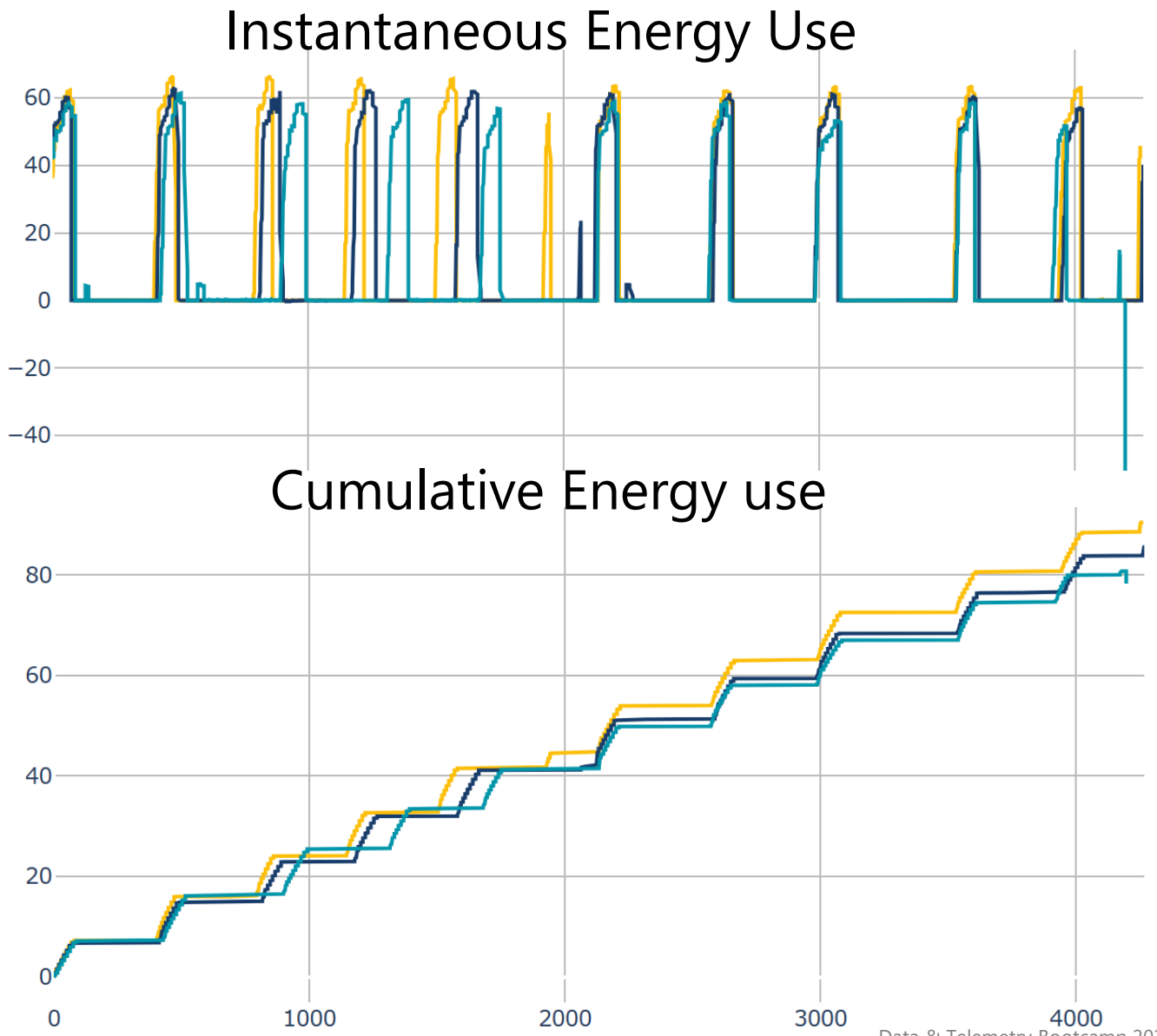
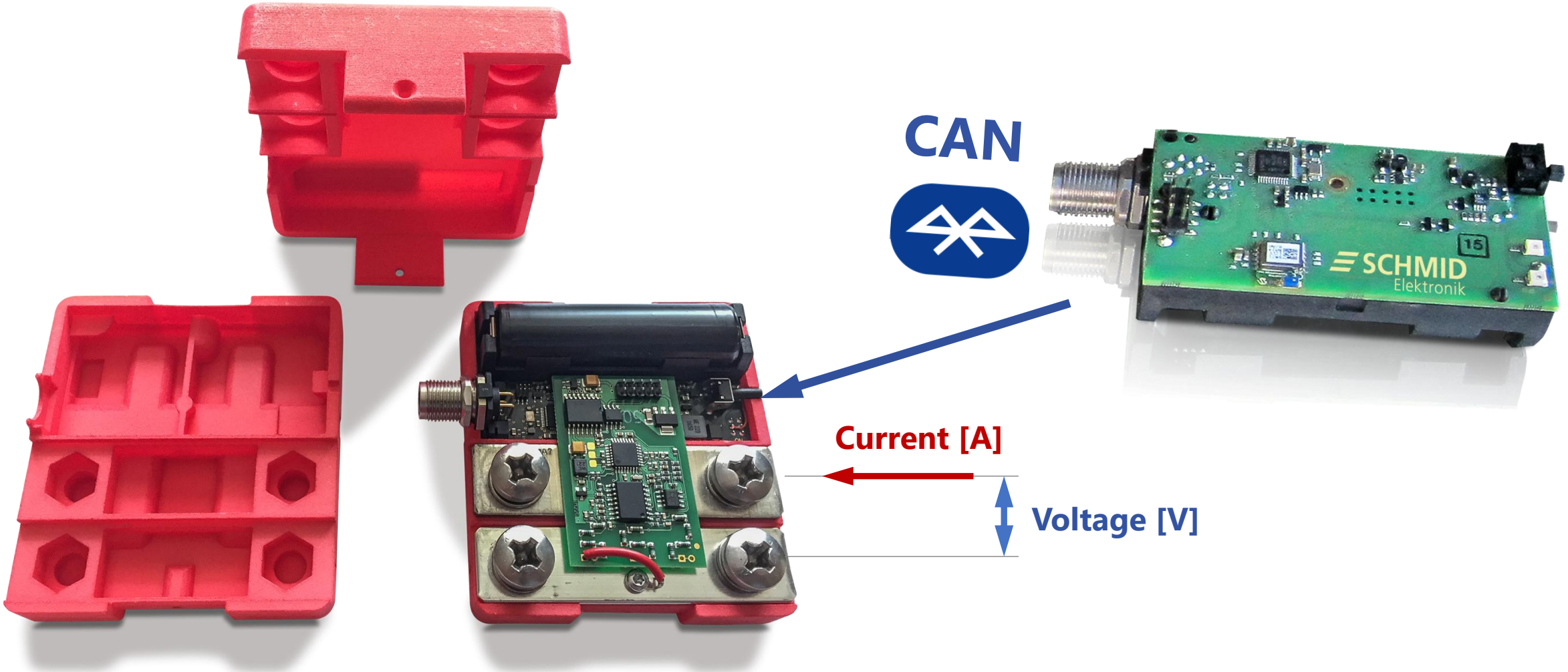


Joulemeter for **Electrical Energy**



Electrical Energy: **Sensorfusion**



Measures electrical Energy in Joules [J]

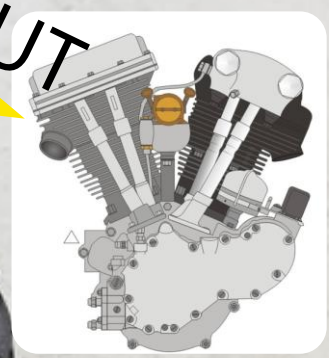
1 Joule [J] = 1 Wattsecond [Ws] = 1 **VA**s = 1 N m = 1 kg m^2 s^{-2}

NEW 2026

Liquids
in milli-liters [ml]
e.g 12.5ml

IN

OUT



Gasflow Meter for **Hydrogen**

Hydrogen in

normalized Liters [l], e.g 0.534l

Data & Telemetry WIKI 2026

NEW 2026

Shell
Eco-marathon Data & Telemetry Portal

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- **Track Coordinates**
- **Contact**

Student Documentation

Select your category/class from the following:

		Prototypes P	Urban Concepts UC
	ICE	Prototype Internal Combustion Engine	Urban Concept Internal Combustion Engine
Hybrid	ICE	Prototype Internal Combustion Hybrid Engine	Urban Concept Internal Combustion Hybrid Engine
	BE	Prototype Battery Electric	Urban Concept Battery Electric
	H2	Prototype Hydrogen without Supercapacitor	Urban Concept Hydrogen without Supercapacitor
Supercap	H2	Prototype Hydrogen with Supercapacitor	Urban Concept Hydrogen with Supercapacitor

CAN

GPS Receiver

4G/5G Modem

WIFI

Digital I/O

9x IMU

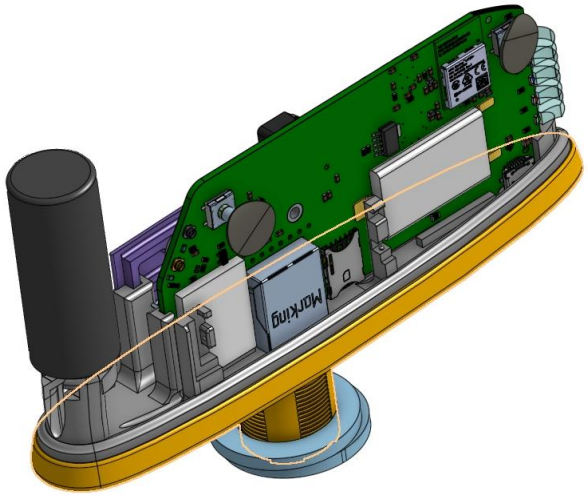
Battery Mgmt

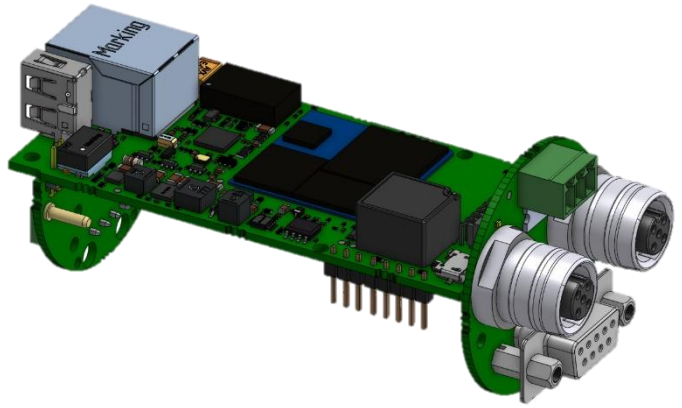
SIM Card

µSD

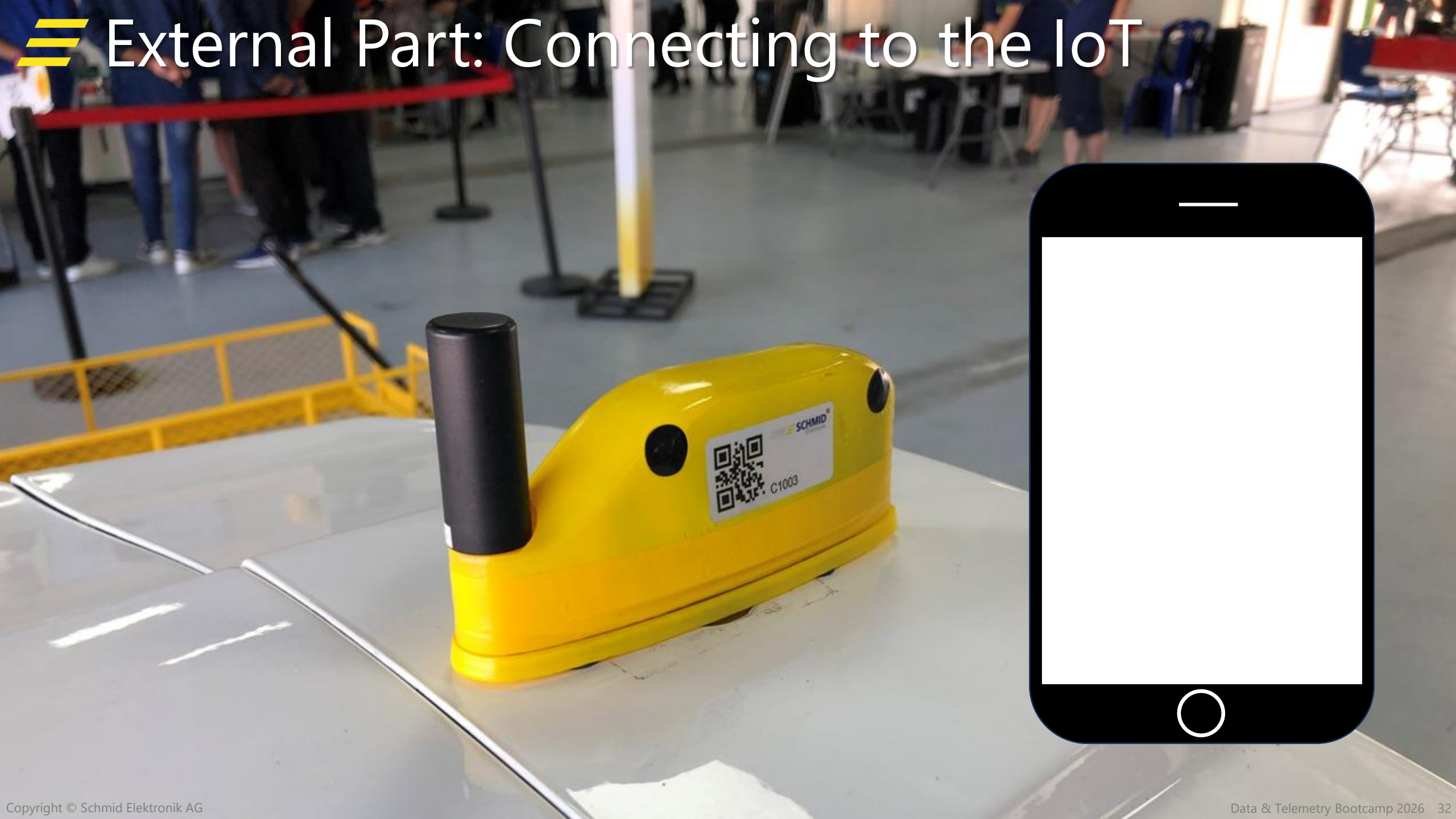
Blue Tooth

1x ARM **Cortex-A7** Cores and 1x **Cortex-M4** Core

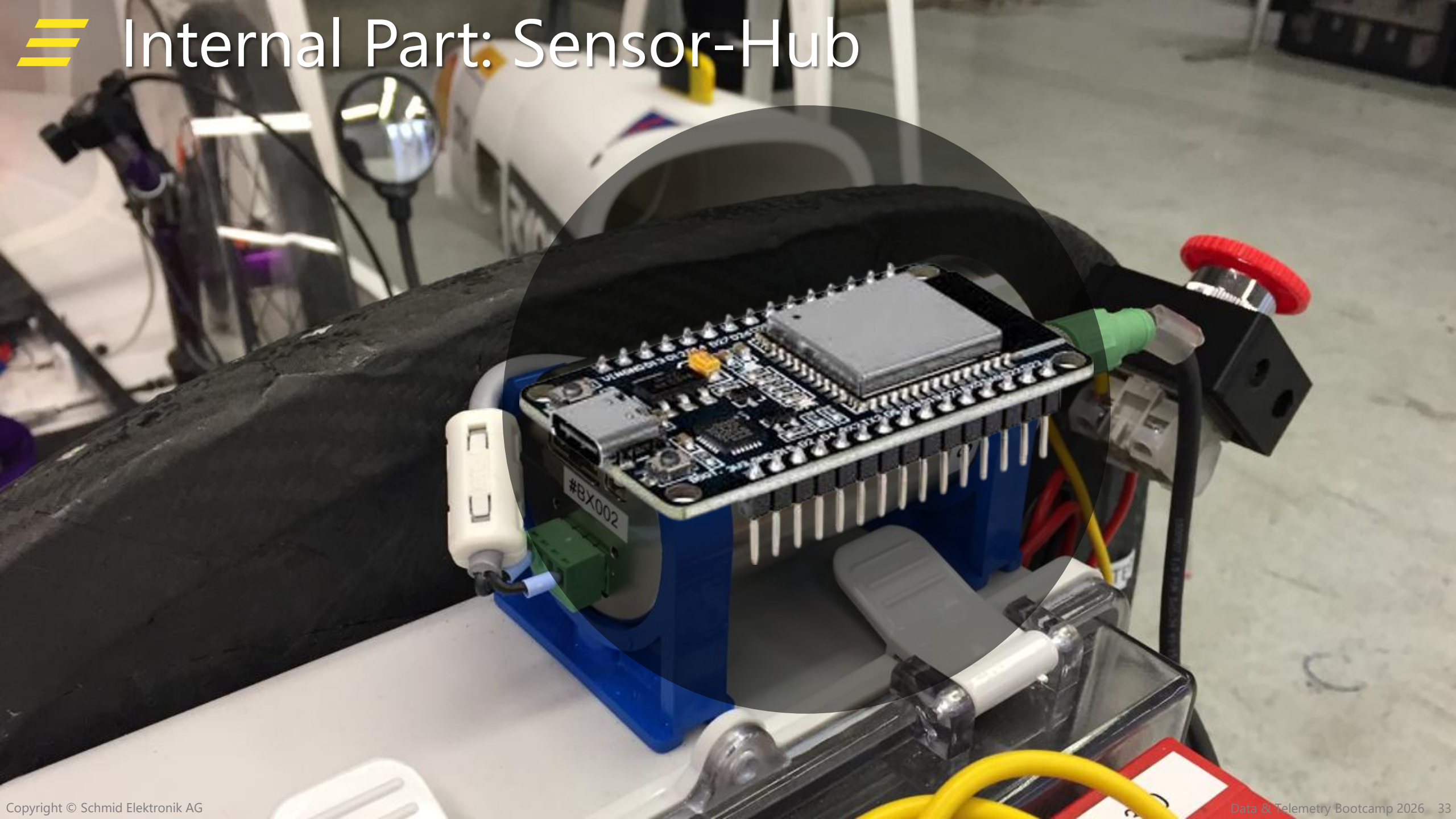




External Part: Connecting to the IoT



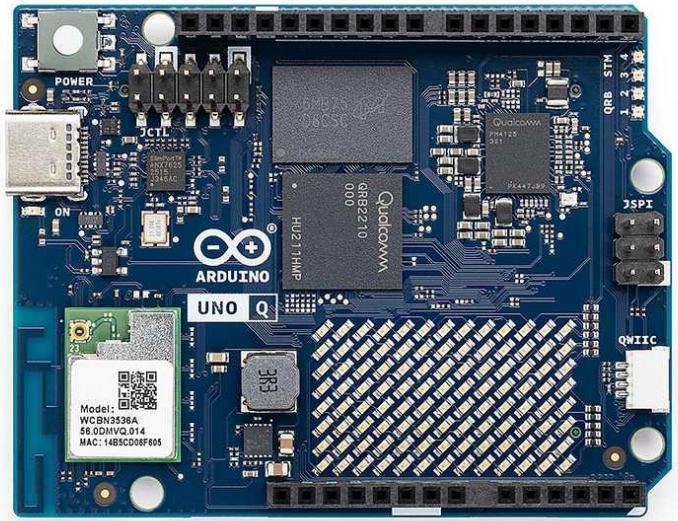
Internal Part: Sensor-Hub



Alternatives that I have seen in OTA-Papers

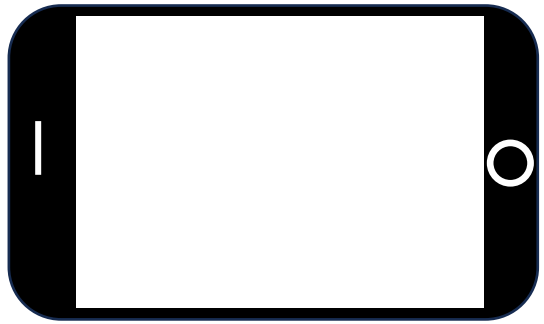
ESP32

Arduino

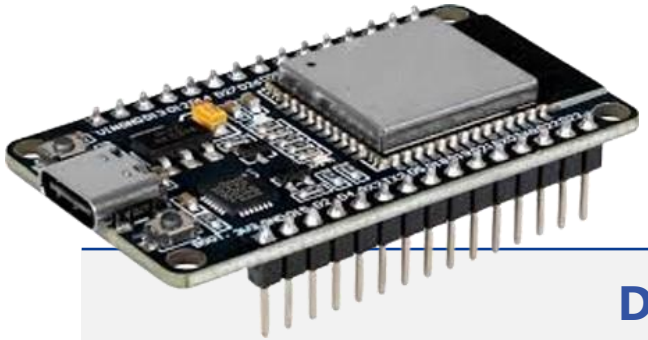


Raspi

Your Phone



Empowering you to create **your own Telemetry**



Data-API (Application Programming Interface)

CAN

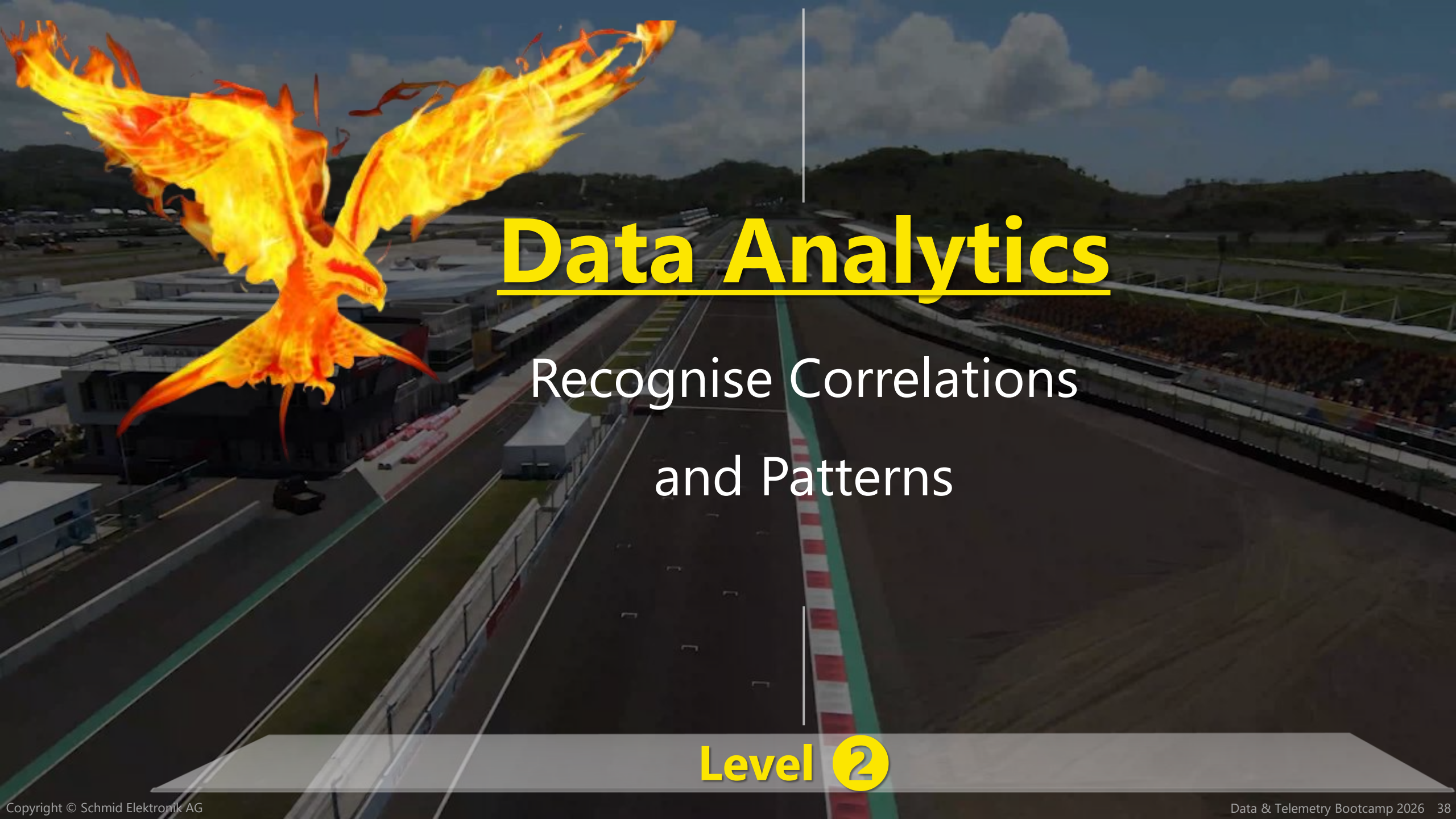
CAN

CAN

Joulemeter

Liquid Flowmeter

Gas Flowmeter



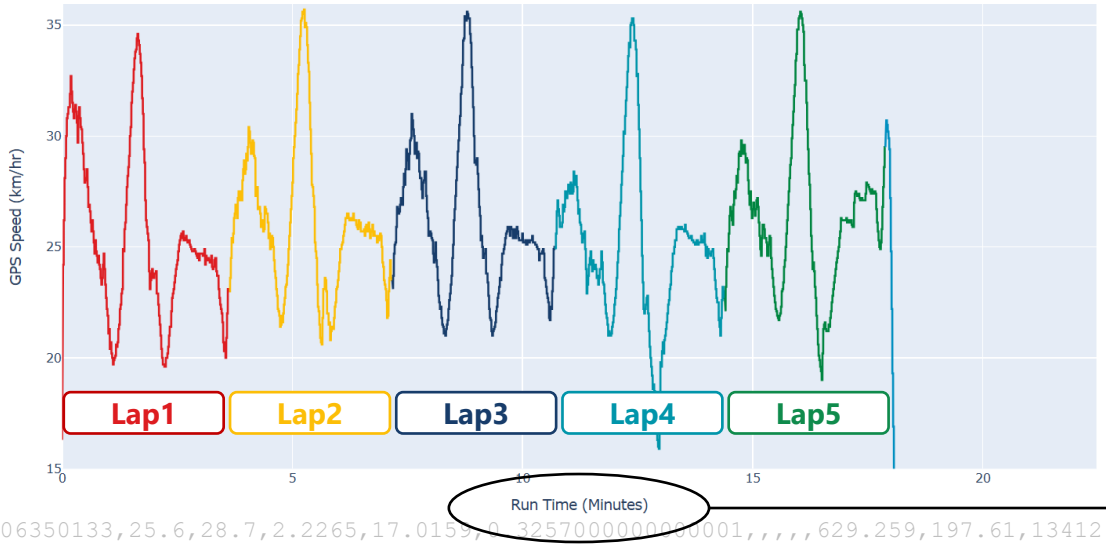
Data Analytics

Recognise Correlations and Patterns

Level 2

Time-Based «Chunk» to distance based Lap-to-Lap Data

NEW 2026

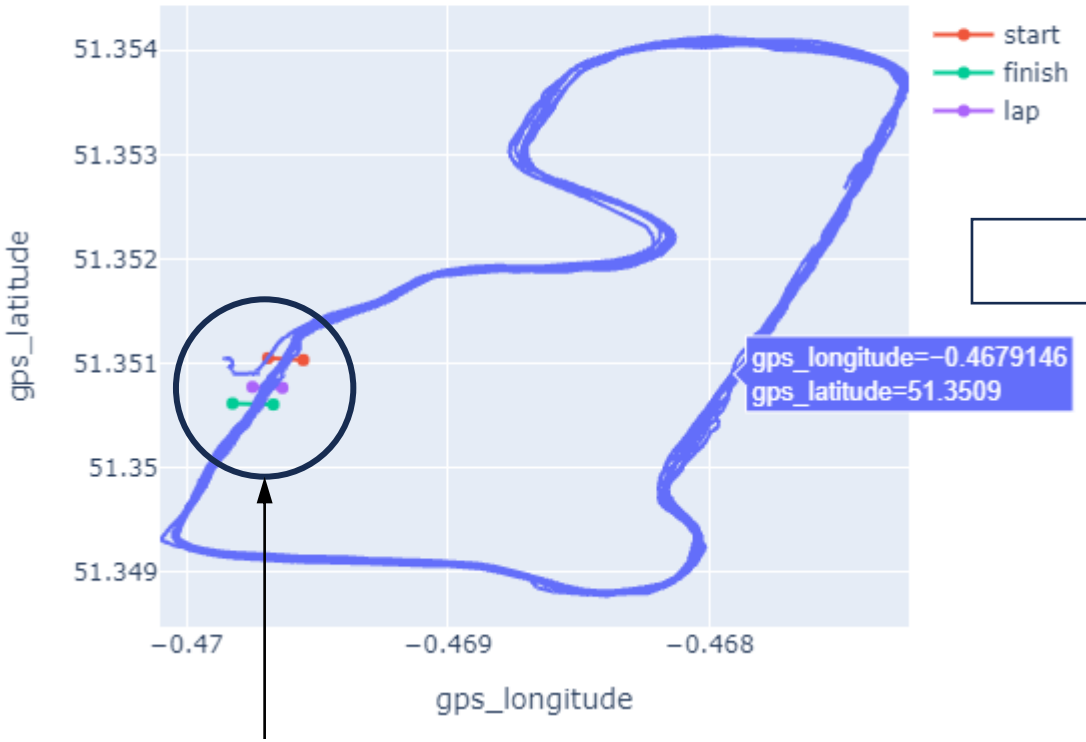


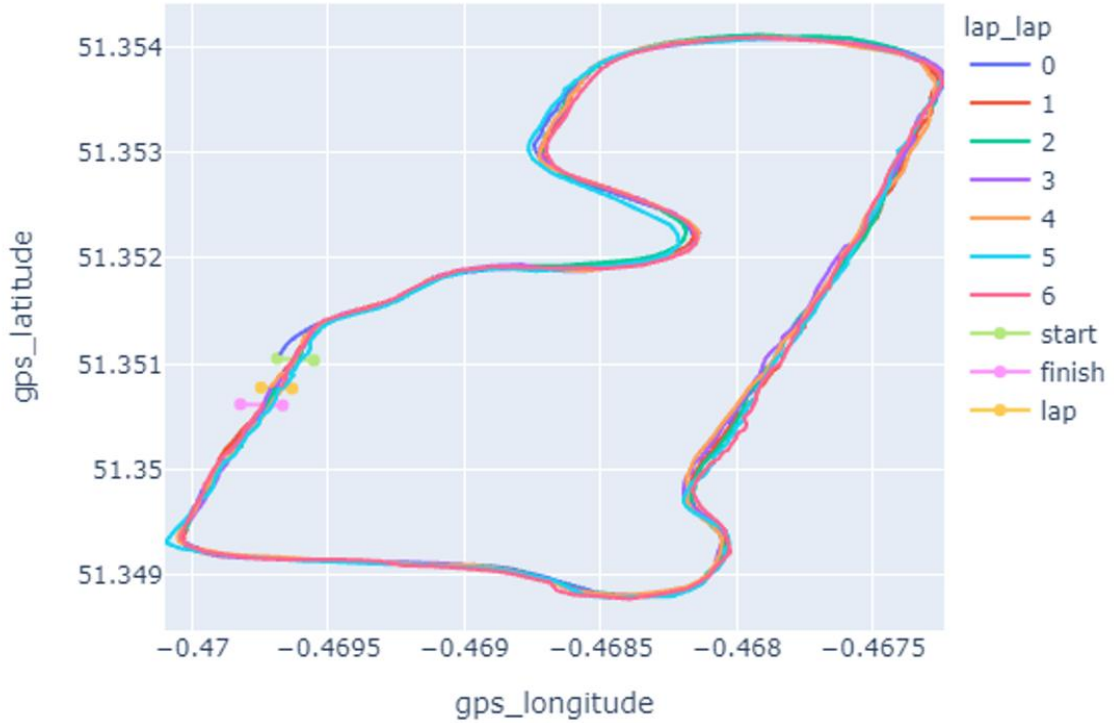
t=0 min

t=17 min

Time-Based «Chunk» to distance based Lap-to-Lap Data

```
fig = df.plot(x='gps_longitude', y='gps_latitude')
for name, points in lines.items():
    fig.add_trace(go.Scatter(x=points[0], y=points[1], name=name))
fig.show()
```






```
lines = {
    'start': ((-0.469553367, -0.4696881), (51.35103562, 51.3510535)),
    'finish': ((-0.469667683, -0.469823533), (51.35060957, 51.35061913)),
    'lap': ((-0.469633117, -0.46974765), (51.35076913, 51.35077756))
}
```

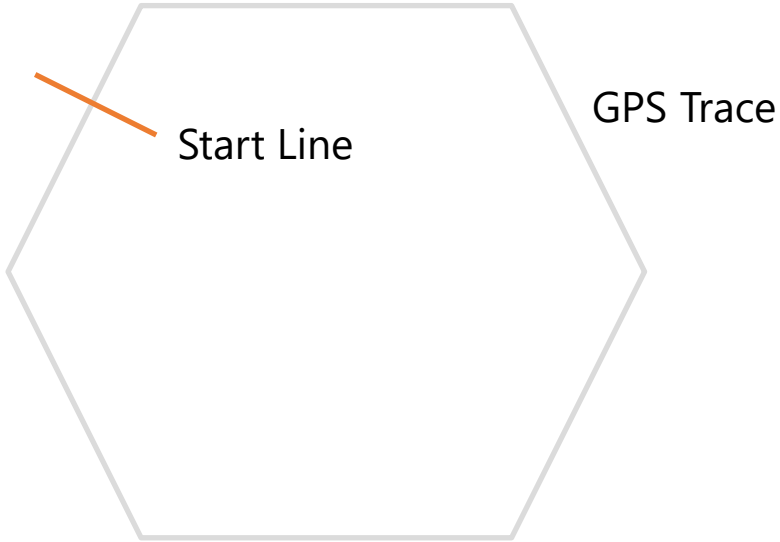
Time-Based «Chunk» to distance based Lap-to-Lap Data

```python
for line, points in lines.items():
    x1 = points[0][0]
    y1 = points[1][0]
    x2 = points[0][1]
    y2 = points[1][1]
    x3 = df.gps_longitude
    y3 = df.gps_latitude
    x4 = df.gps_longitude.shift(-1)
    y4 = df.gps_latitude.shift(-1)

    denom = ((x1 - x2) * (y3 - y4)) - ((y1 - y2) * (x3 - x4))
    t = round((((x1 - x3) * (y3 - y4)) - ((y1 - y3) * (x3 - x4))) / denom, 1)
    u = round((((x1 - x2) * (y1 - y3)) - ((y1 - y2) * (x1 - x3))) / denom, 1)

    df[f'{line}_cross'] = (t >= 0) & (t <= 1) & (u >= 0) & (u <= 1)
    df[f'{line}_lap'] = df[f'{line}_cross'].cumsum()
```

- Efficiently calculate when a vehicle has crossed one of the three lines entered previously: Line-segment intersection




```python
df.drop(index=df.loc[df.start_lap < 1].index, inplace=True)
df.drop(
    index=df.loc[df.finish_lap >= df.finish_lap.max()].index,
    inplace=True
)
```

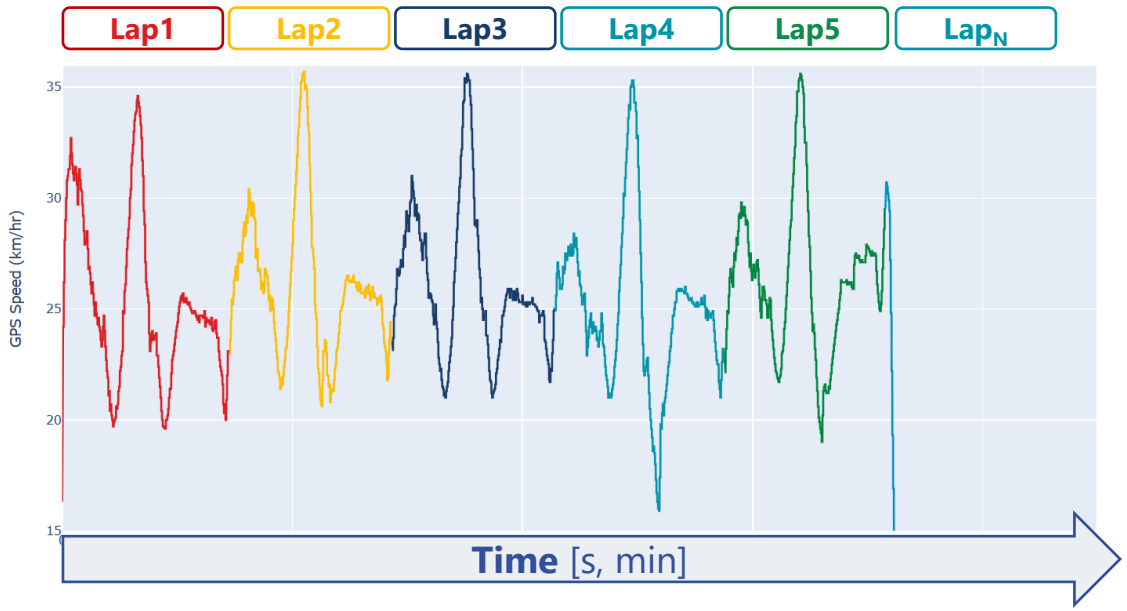
- Data at beginning and end of logfile is dropped

Formula: WIKIPEDIA „**Line-Line-Intersection**“

$$t = \frac{\begin{vmatrix} x_1 - x_3 & x_3 - x_4 \\ y_1 - y_3 & y_3 - y_4 \end{vmatrix}}{\begin{vmatrix} x_1 - x_2 & x_3 - x_4 \\ y_1 - y_2 & y_3 - y_4 \end{vmatrix}} = \frac{(x_1 - x_3)(y_3 - y_4) - (y_1 - y_3)(x_3 - x_4)}{(x_1 - x_2)(y_3 - y_4) - (y_1 - y_2)(x_3 - x_4)}$$

$$u = \frac{\begin{vmatrix} x_1 - x_2 & x_1 - x_3 \\ y_1 - y_2 & y_1 - y_3 \end{vmatrix}}{\begin{vmatrix} x_1 - x_2 & x_3 - x_4 \\ y_1 - y_2 & y_3 - y_4 \end{vmatrix}} = -\frac{(x_1 - x_2)(y_1 - y_3) - (y_1 - y_2)(x_1 - x_3)}{(x_1 - x_2)(y_3 - y_4) - (y_1 - y_2)(x_3 - x_4)},$$

Time-Based «Chunk» to distance based Lap-to-Lap Data



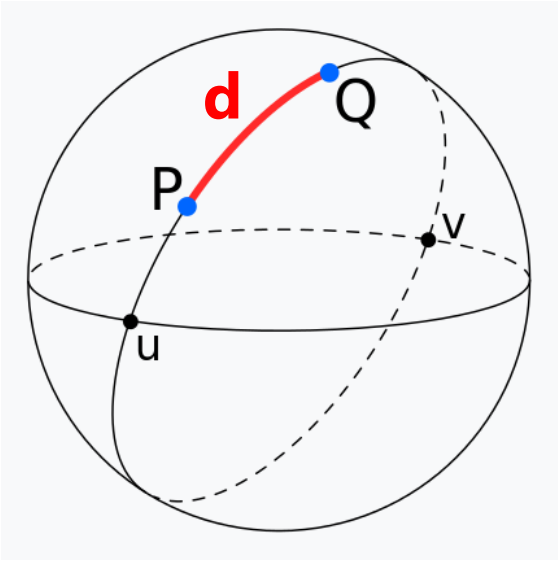
Time-Based «Chunk» to distance based Lap-to-Lap Data

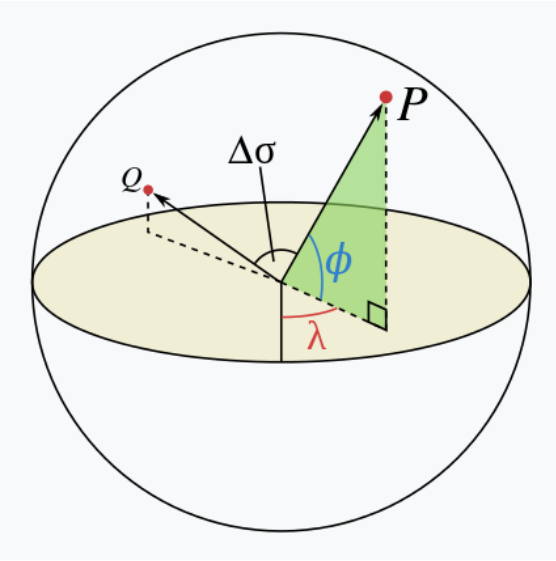
The Haversine Formula:

en.wikipedia.org/wiki/Haversine_formula

$$d = 2r \arcsin\left(\sqrt{\sin^2\left(\frac{\varphi_2 - \varphi_1}{2}\right) + \cos\varphi_1 \cdot \cos\varphi_2 \cdot \sin^2\left(\frac{\lambda_2 - \lambda_1}{2}\right)}\right)$$

φ_1, φ_2 are the latitude of point 1 and latitude of point 2,
λ_1, λ_2 are the longitude of point 1 and longitude of point 2.



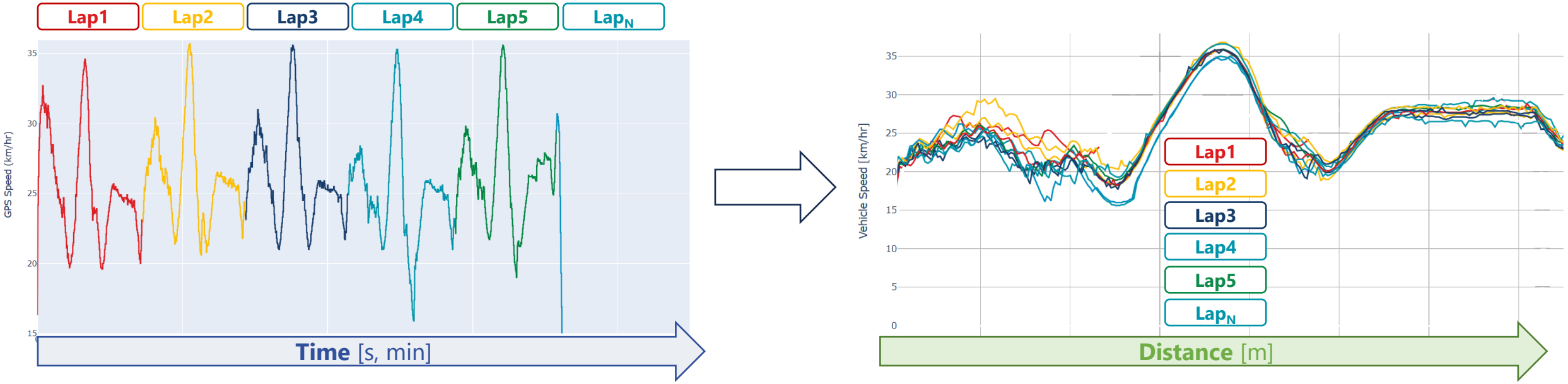



```
lon1 = df.gps_longitude / 180 * np.pi
lat1 = df.gps_latitude / 180 * np.pi
lon2 = df.gps_longitude.shift(1) / 180 * np.pi
lat2 = df.gps_latitude.shift(1) / 180 * np.pi

r = 6371000  Earth Radius in [km]

df['dist'] = (
    2
    * r
    * np.arcsin(
        (
            np.sin((lat2 - lat1) / 2) **2
            + np.cos(lat1) * np.cos(lat2) * np.sin((lon2 - lon1) / 2) ** 2
        )
        ** 0.5
    )
)
df['dist'] = df.dist.cumsum()
```

Time-Based «Chunk» to distance based Lap-to-Lap Data



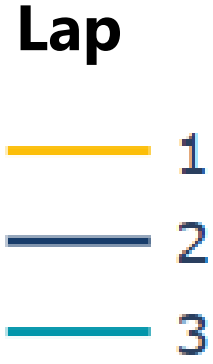
Python Code for this Transformation

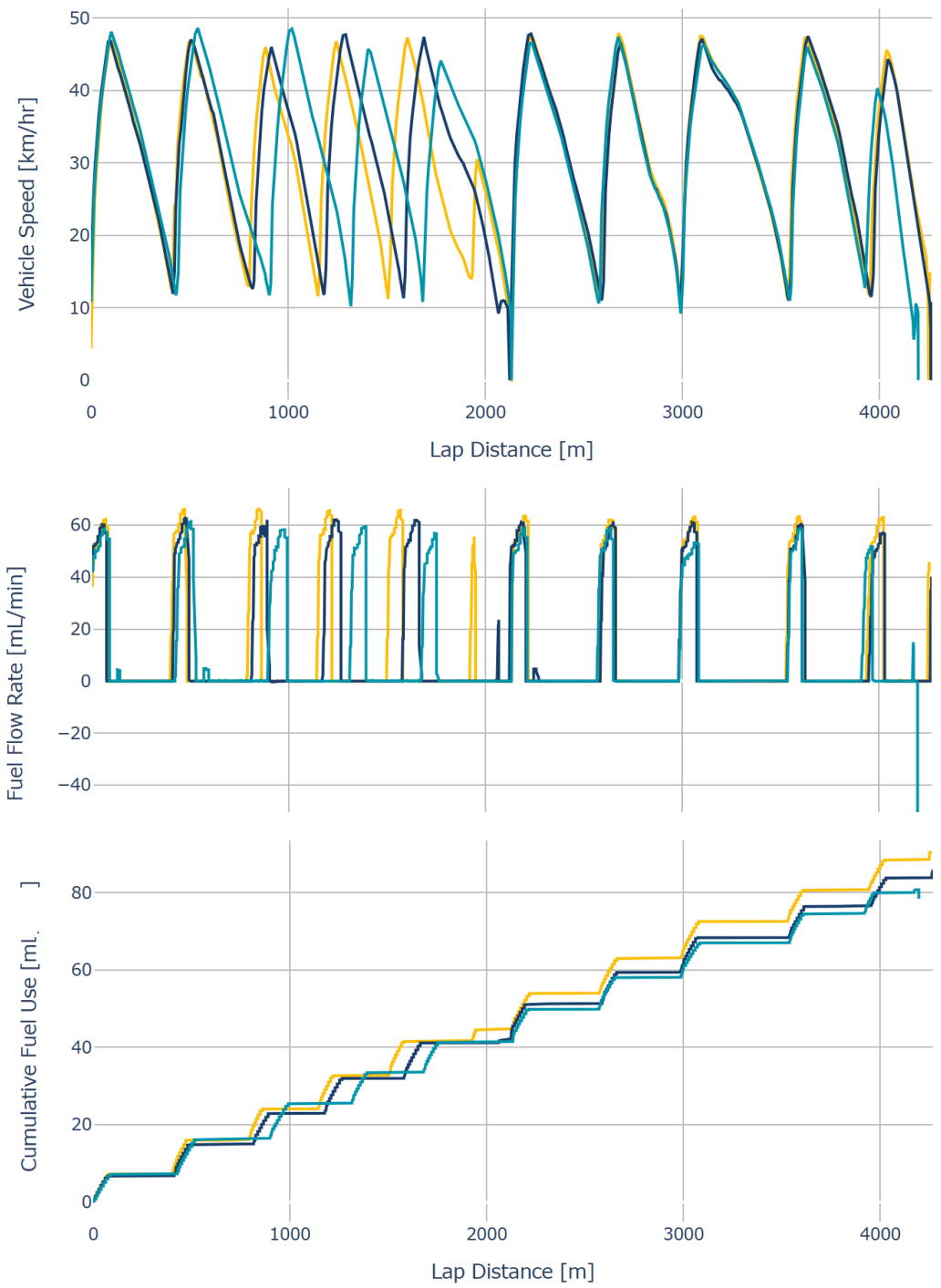
OPTIONAL: DOWNLOAD PYTHON-PACKAGES FOR THE ANACONDA-SUITE

This step is optional. The three sandboxes can be conveniently run directly in your own browser (Binder) via the three links above. If you want to use these two packages (Jupyter Lab), download the **Anaconda 2.7.0** suite here at anaconda.org.

Phoenix Bootcamp Python Code Space-Time Transformation	DOWNLOAD
Phoenix-Bootcamp Sandbox #1 Data Analysis	DOWNLOAD
Phoenix Bootcamp Sandbox #2 and #3 Knowledge Graph and AI	DOWNLOAD

Data Correlation



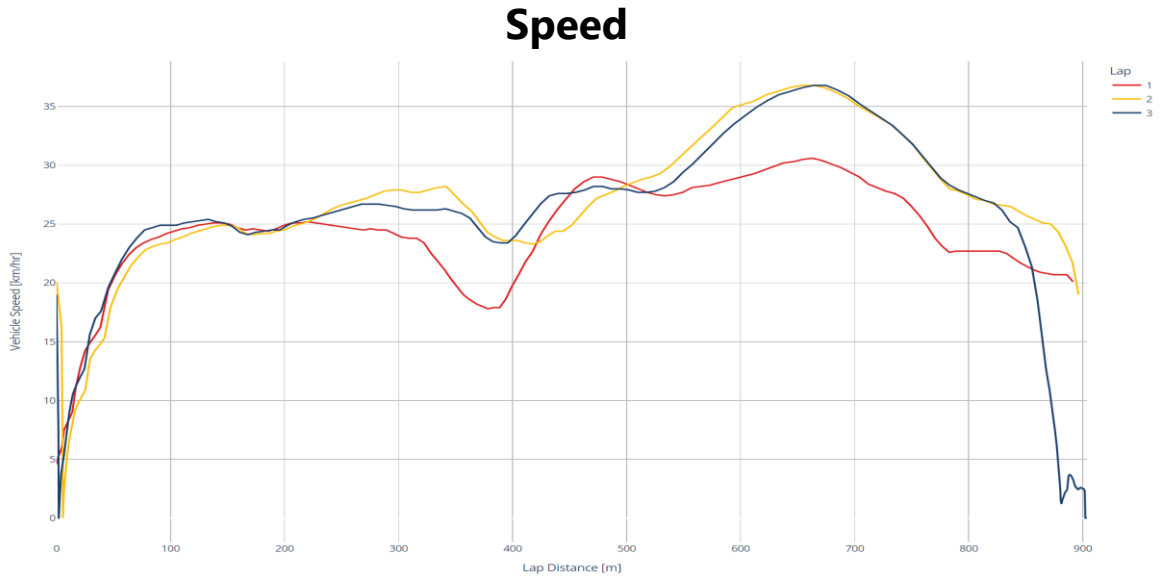


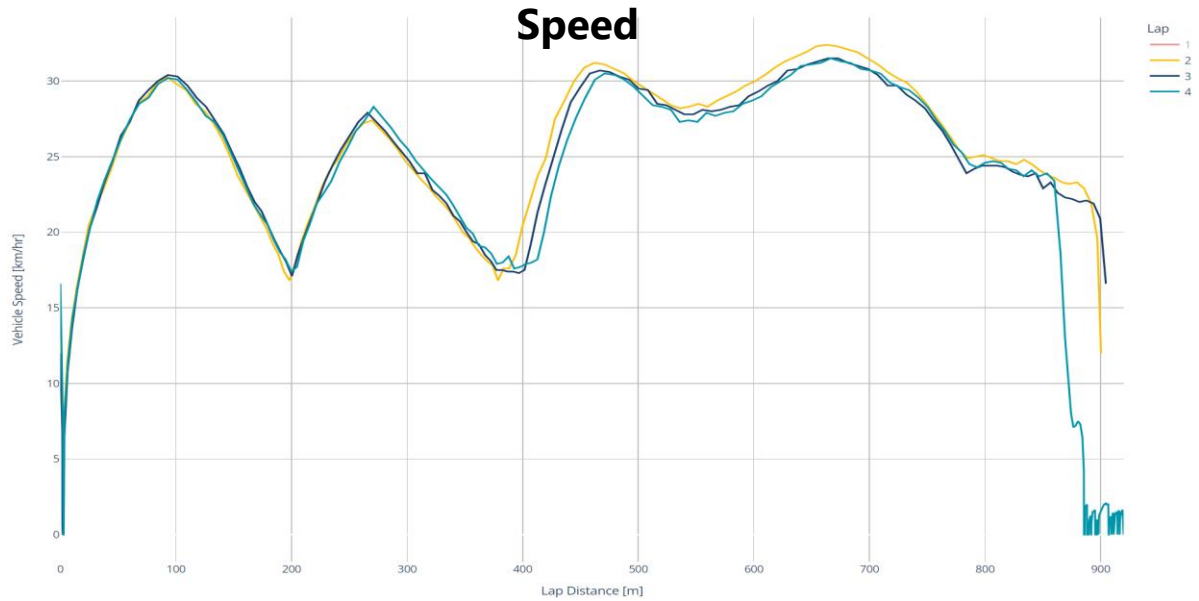
Speed [km/h]

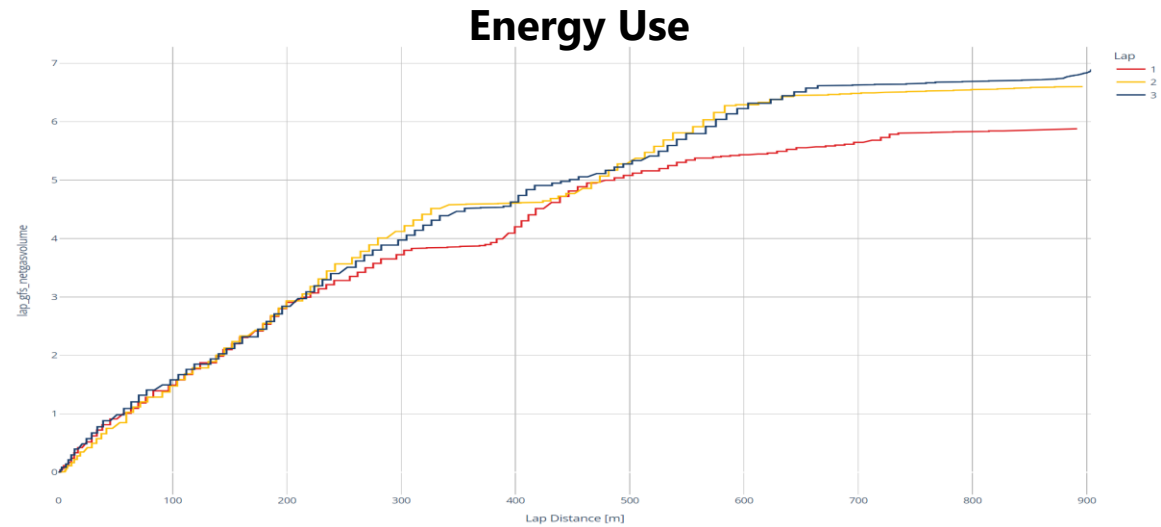
Instantaneous Energy Consumption [ml/min]

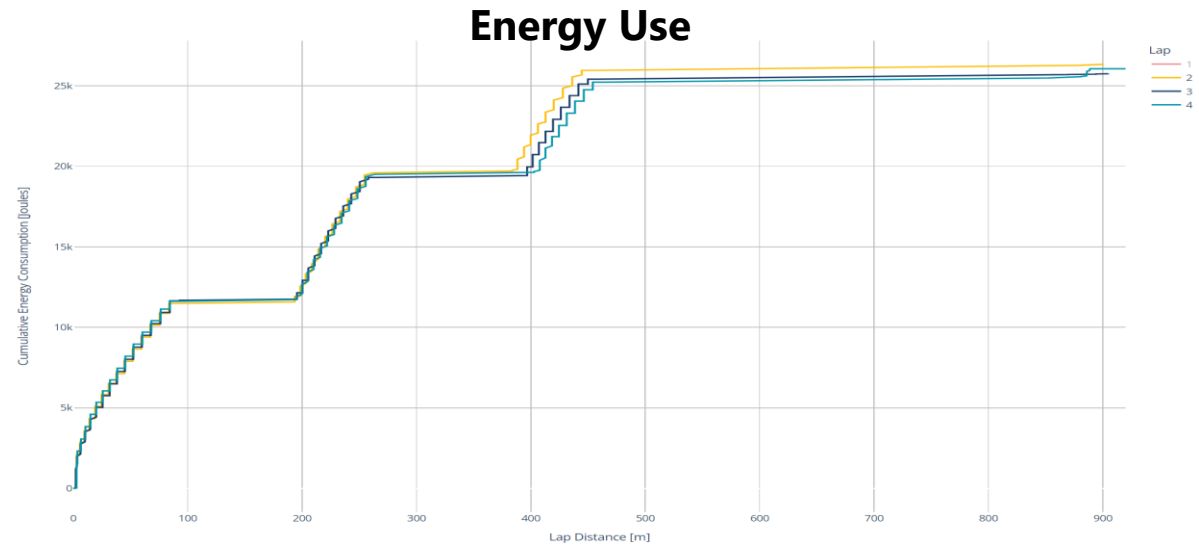
Cumulative Energy Consumption [ml]

Driving Consistency!

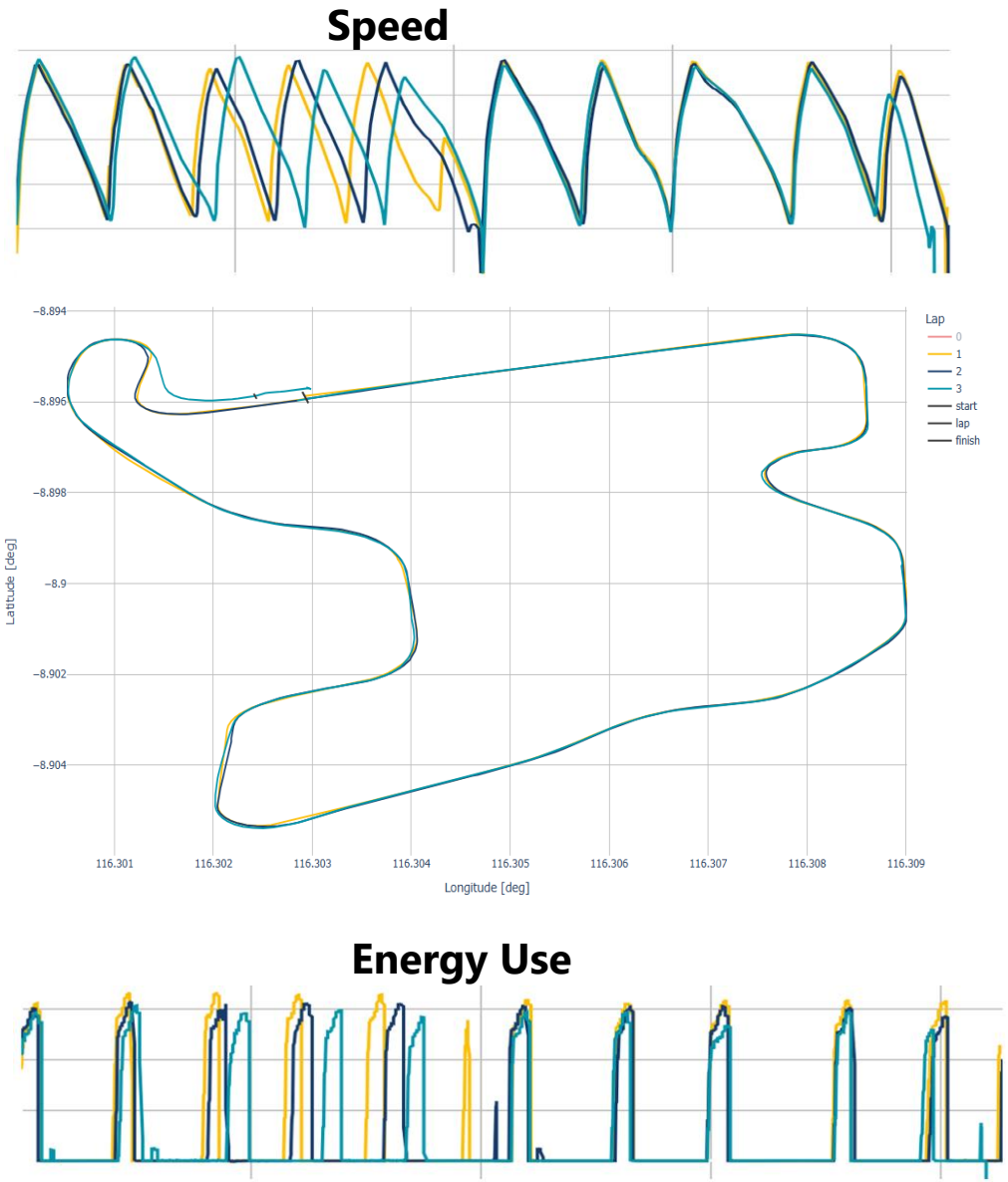




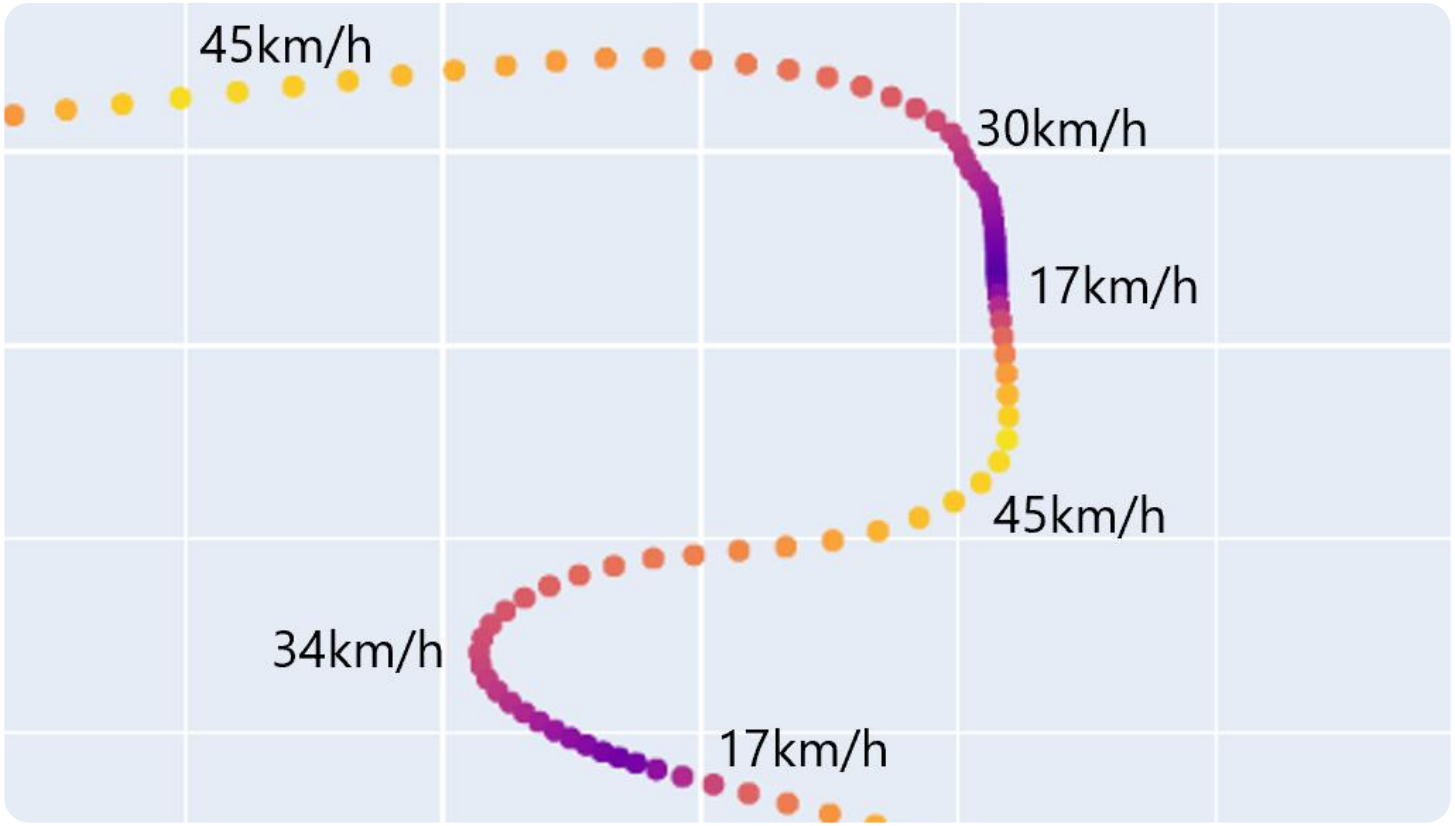




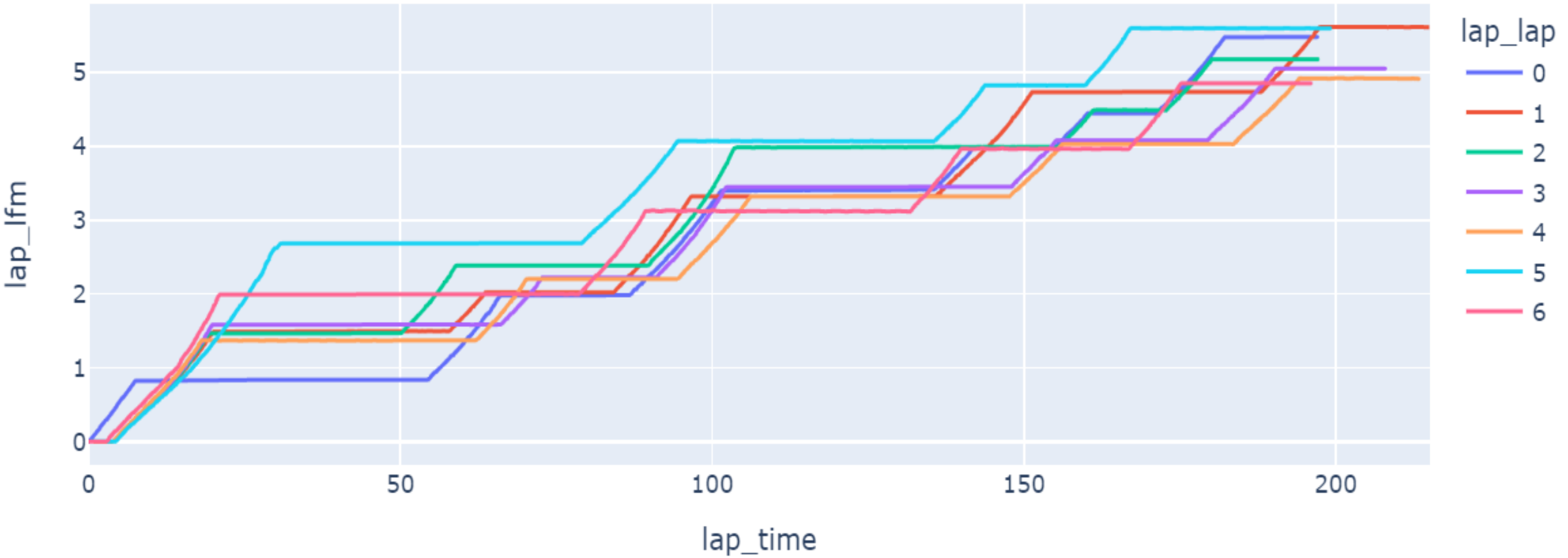
From **Pattern** to **Meaning**



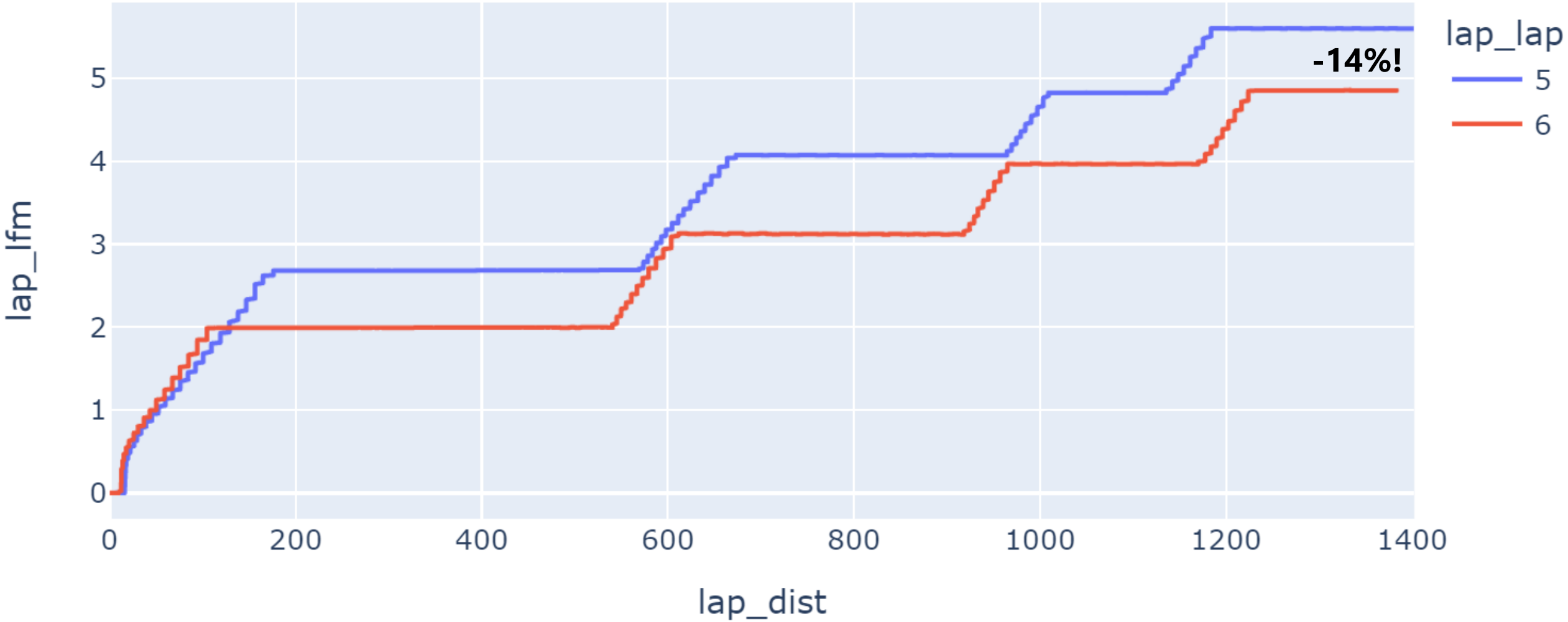
Pattern and Meaning



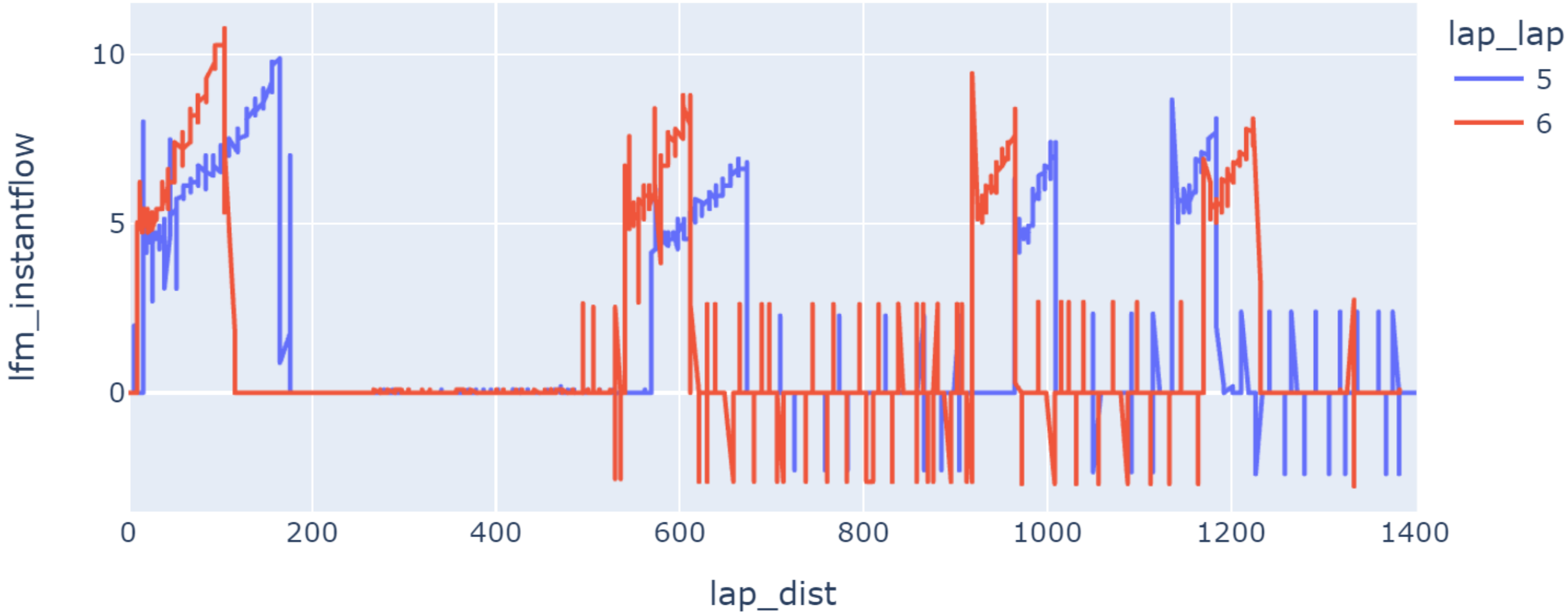
Quantitative Analysis: **Cumulative** Consumption



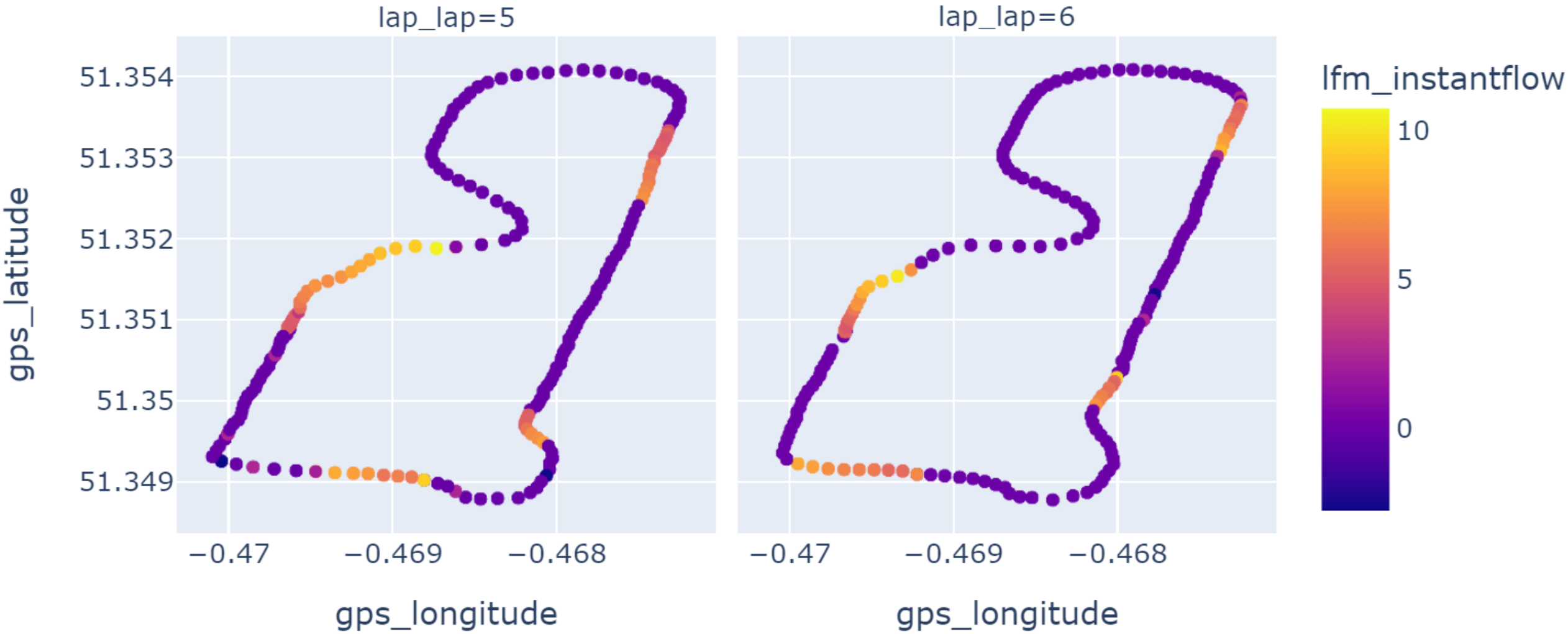
Quantitative Analysis: **Cumulative** Consumption



Quantitative Analysis: **Instantaneous** Consumption



Qualitative Analysis: **Burn & Coast Heatmap**



Iterative Learning based on MVP Philosophy

Pivot or Continue?

Idea

Learn

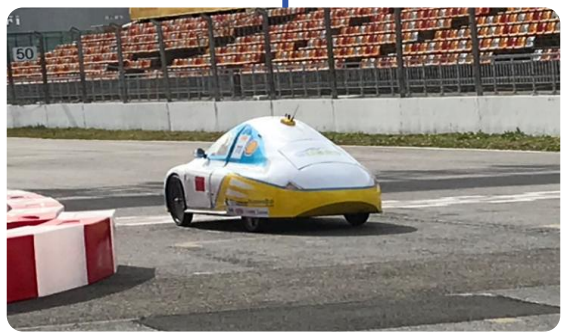
MVP

Build

Measure

Telemetry Data

Race Strategy



Learn: Quantitative Analysis of Energy Use

Strategy 1

Strategy 2

Strategy 3

Energy Use

500 1000 1500 2000 2500 3000 3500 4000

Lap Distance [m]

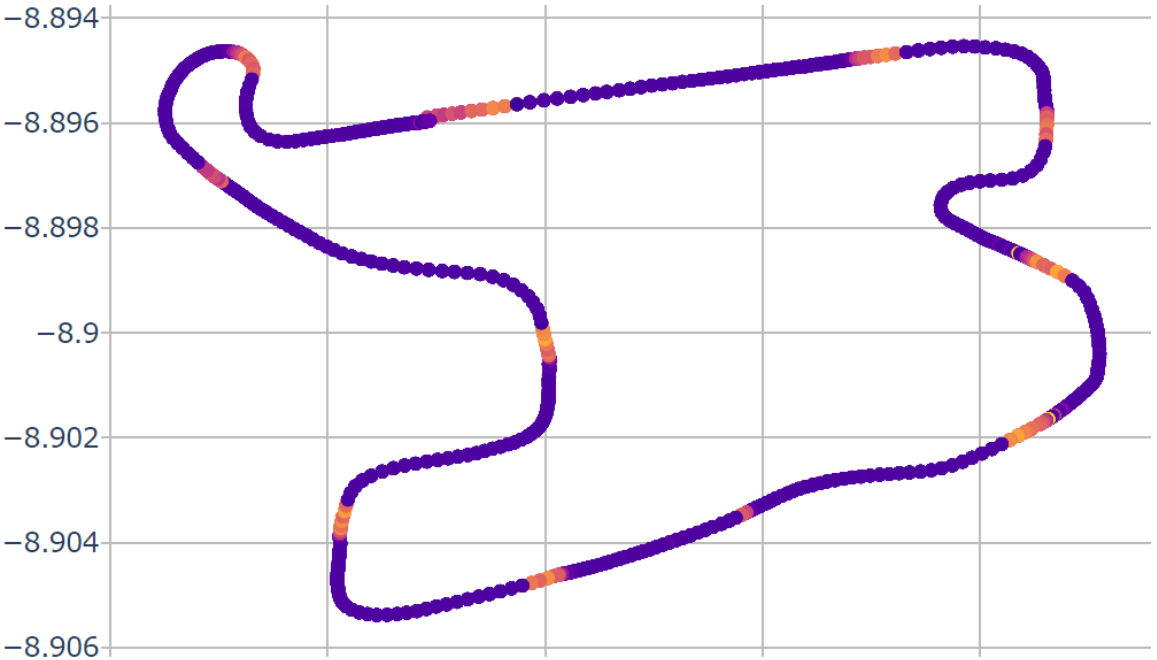
Best Strategy: 3

Distance travelled (m)

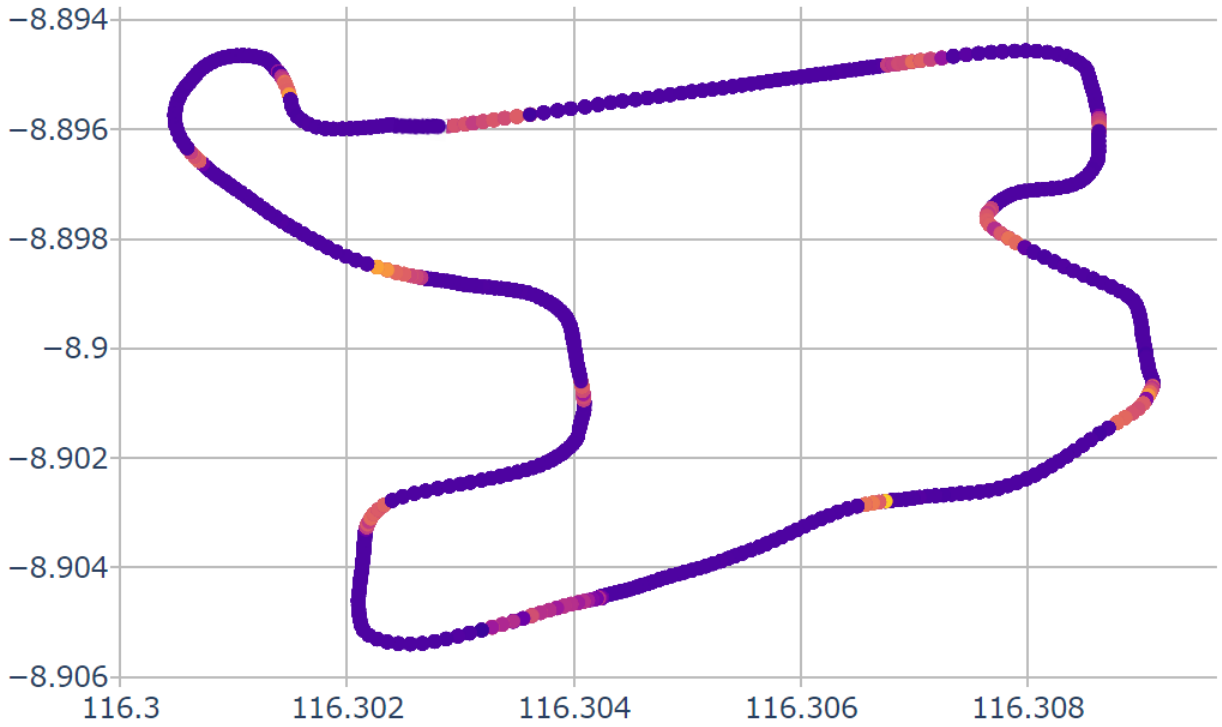
Learn: Qualitative Analysis of Driving Patterns

From Quantitative Analysis, we know:

Strategy **1**

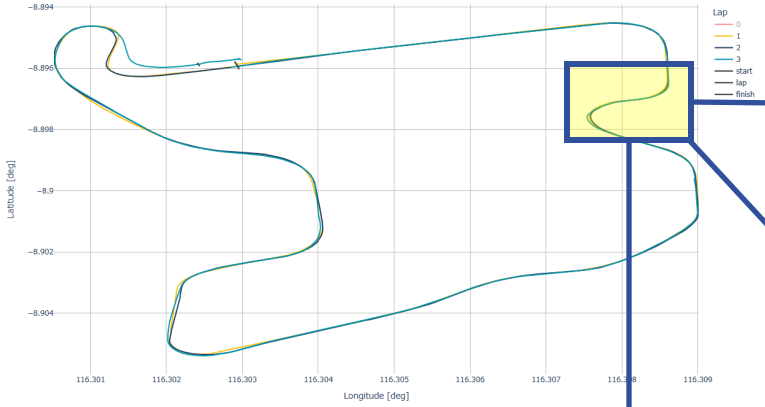


Strategy **3** (**better**!)

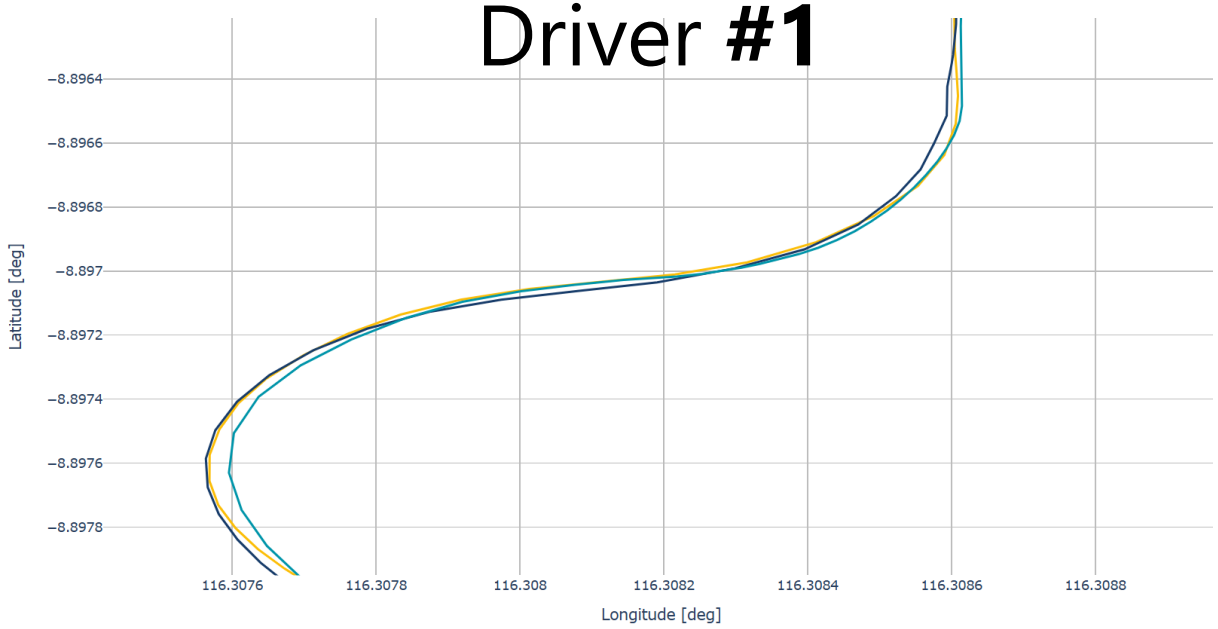


But Why?

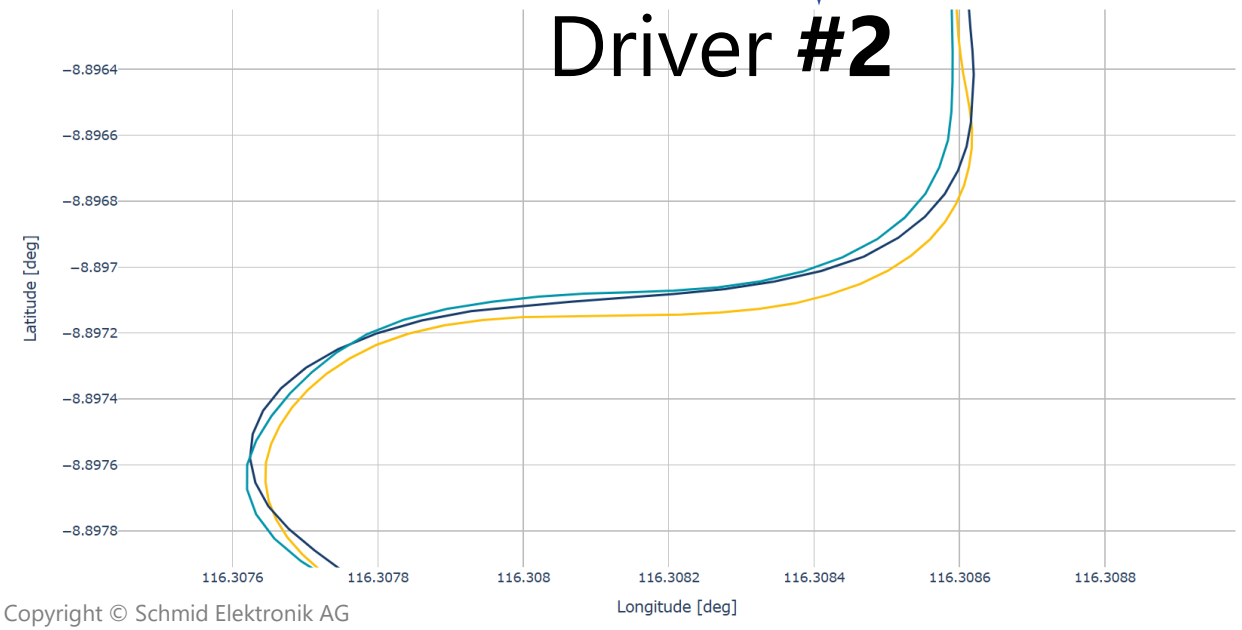
Race Lines in **Corners**



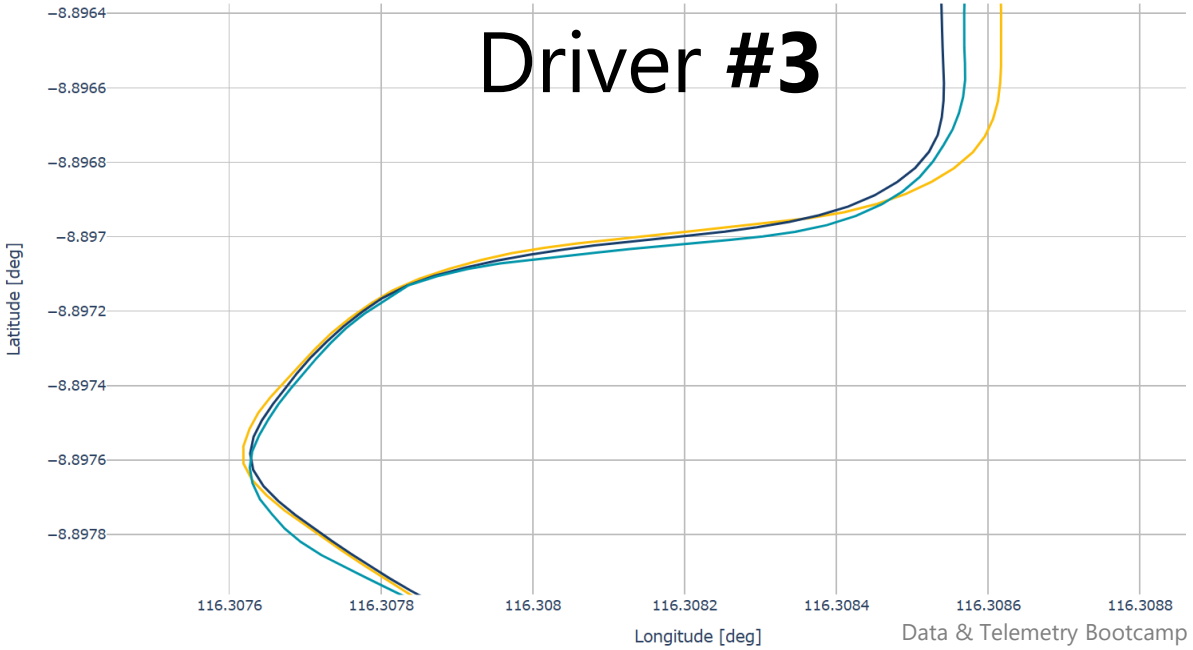
Driver #1



Driver #2

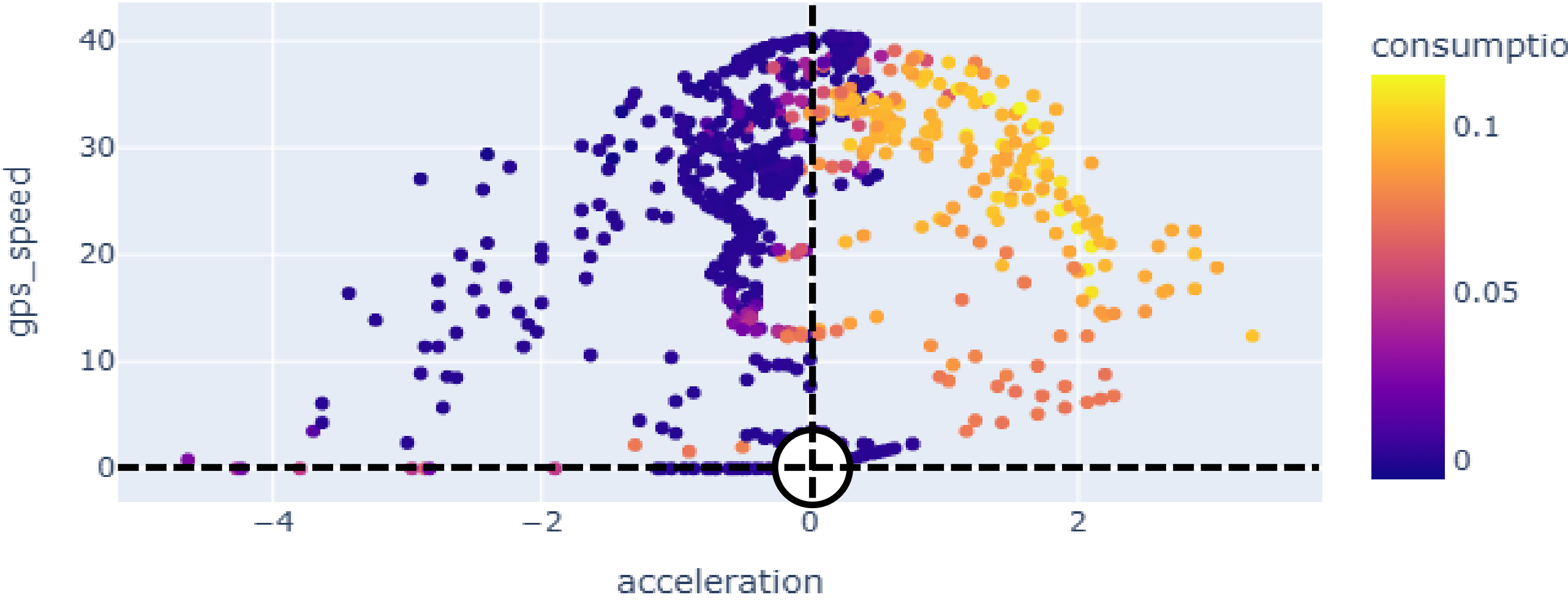


Driver #3

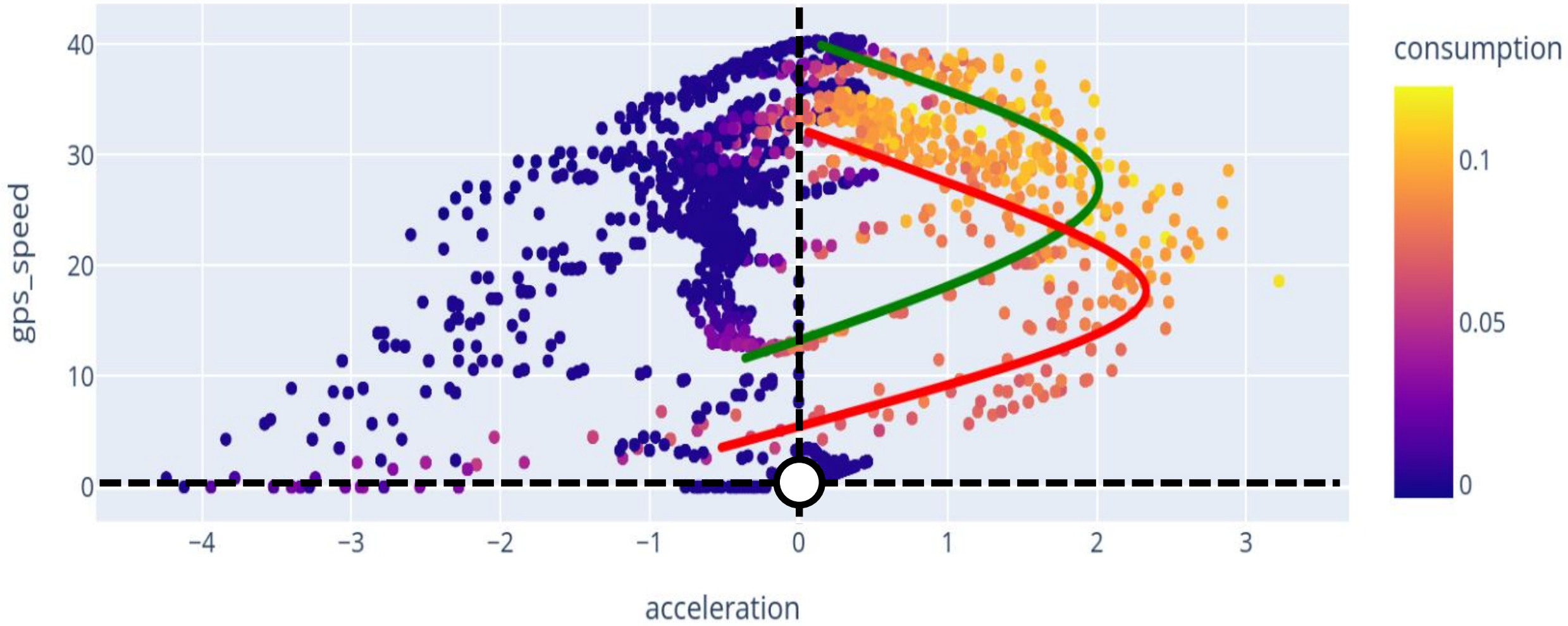


Data as a storyteller

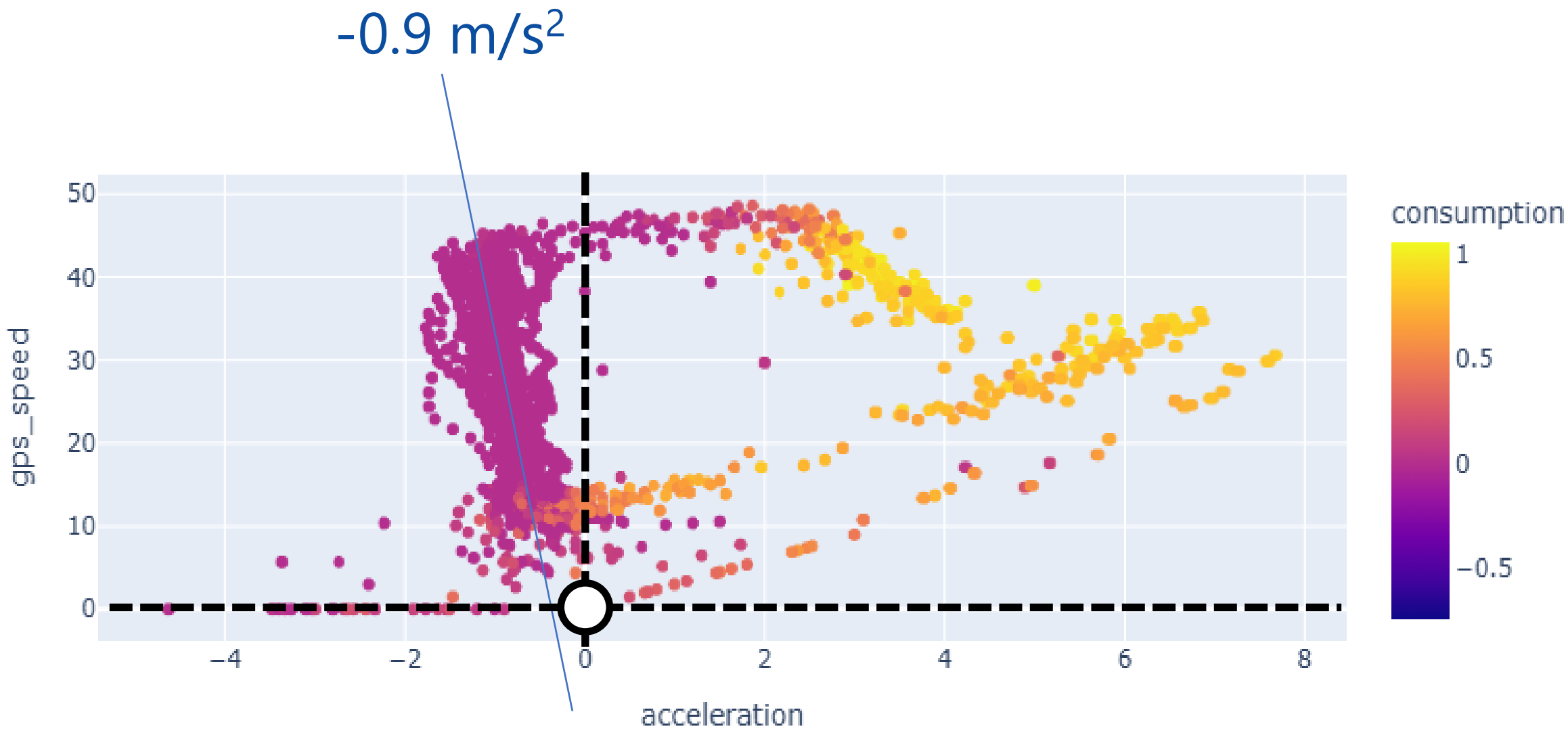
Label	Unit	Description
acceleration	m/s^2	How much the speed changes per second
consumption	W/s	How much energy is used per second



Data as a storyteller



Data as a storyteller: e.g. Coastdown-Testing



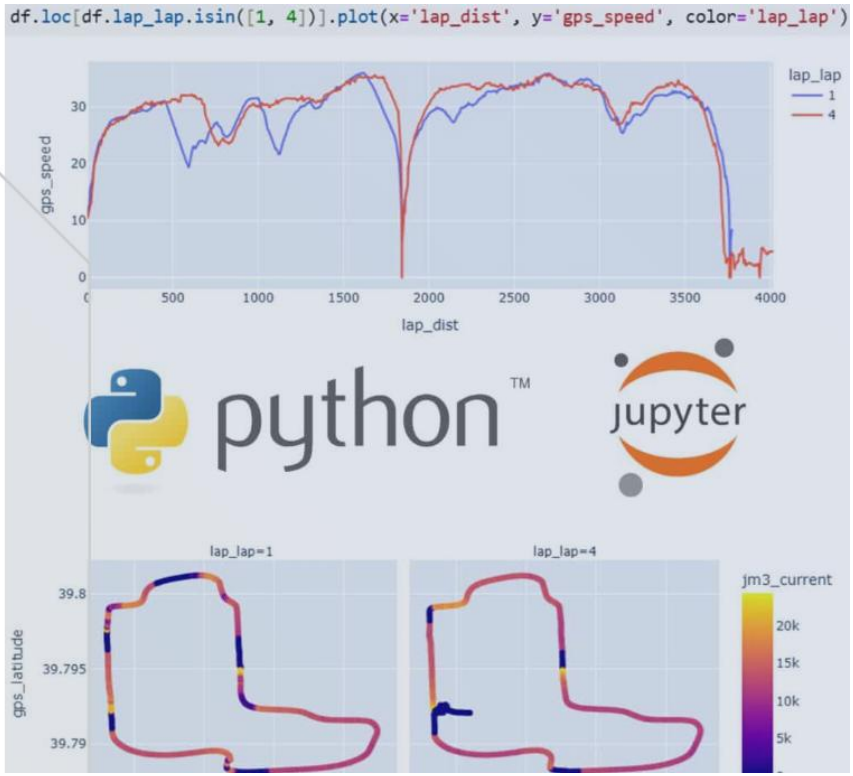
Python **Sandbox #1** to understand Race Data

Programming Sandbox #1

JUPYTER NOTEBOOK UND PYTHONCODE FOR LEVEL-3

Start Jupyter Notebook in your browser (Binder, ~1–2 min.) and play with Python. Start with real race data (speed, GPS) and calculate accelerations and energy consumption. Save the source code locally, because when you close the browser, the environment will be gone.

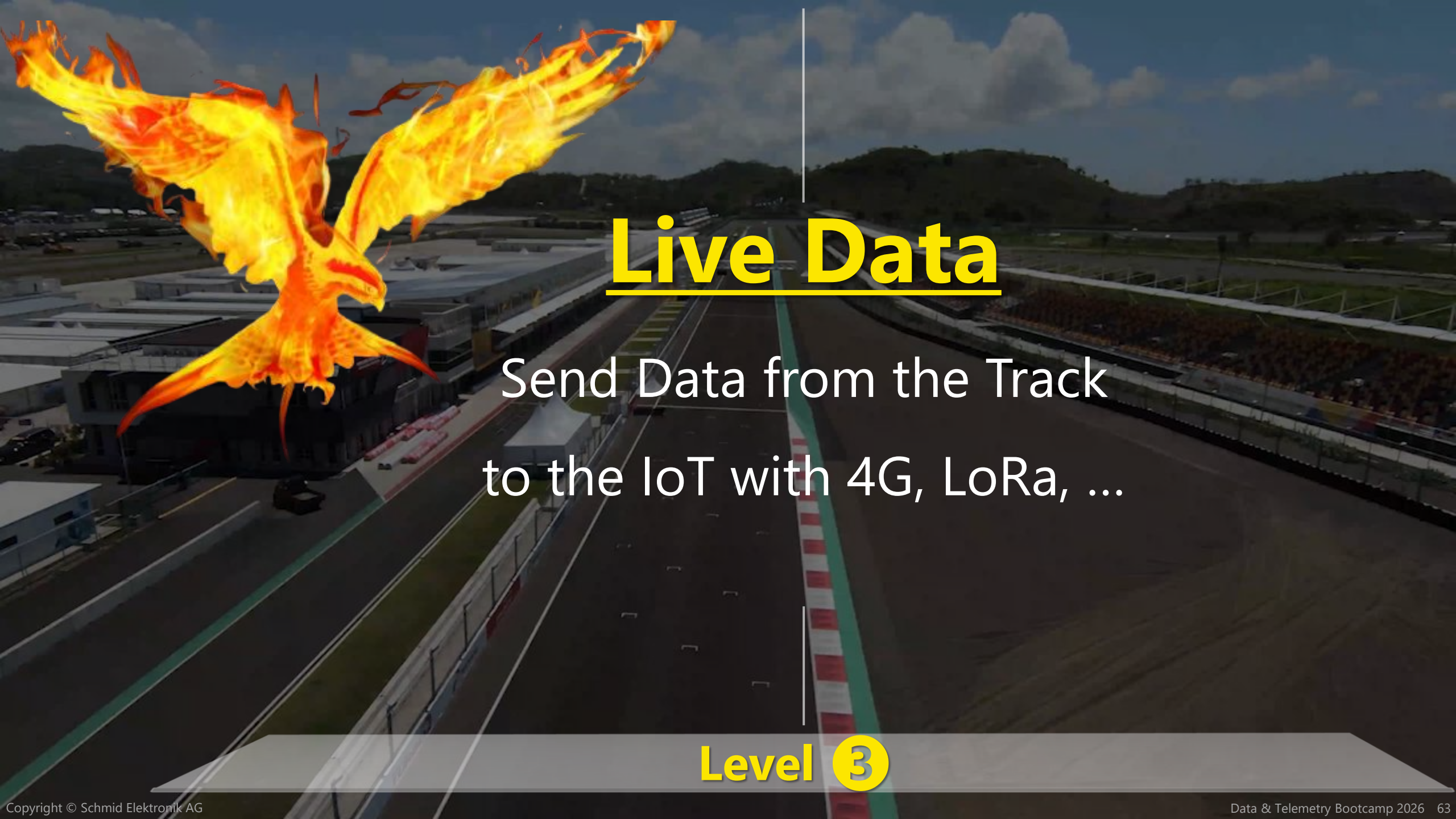
START SANDBOX #1 IN YOUR BROWSER ▷



pandas

plotly

NumPy



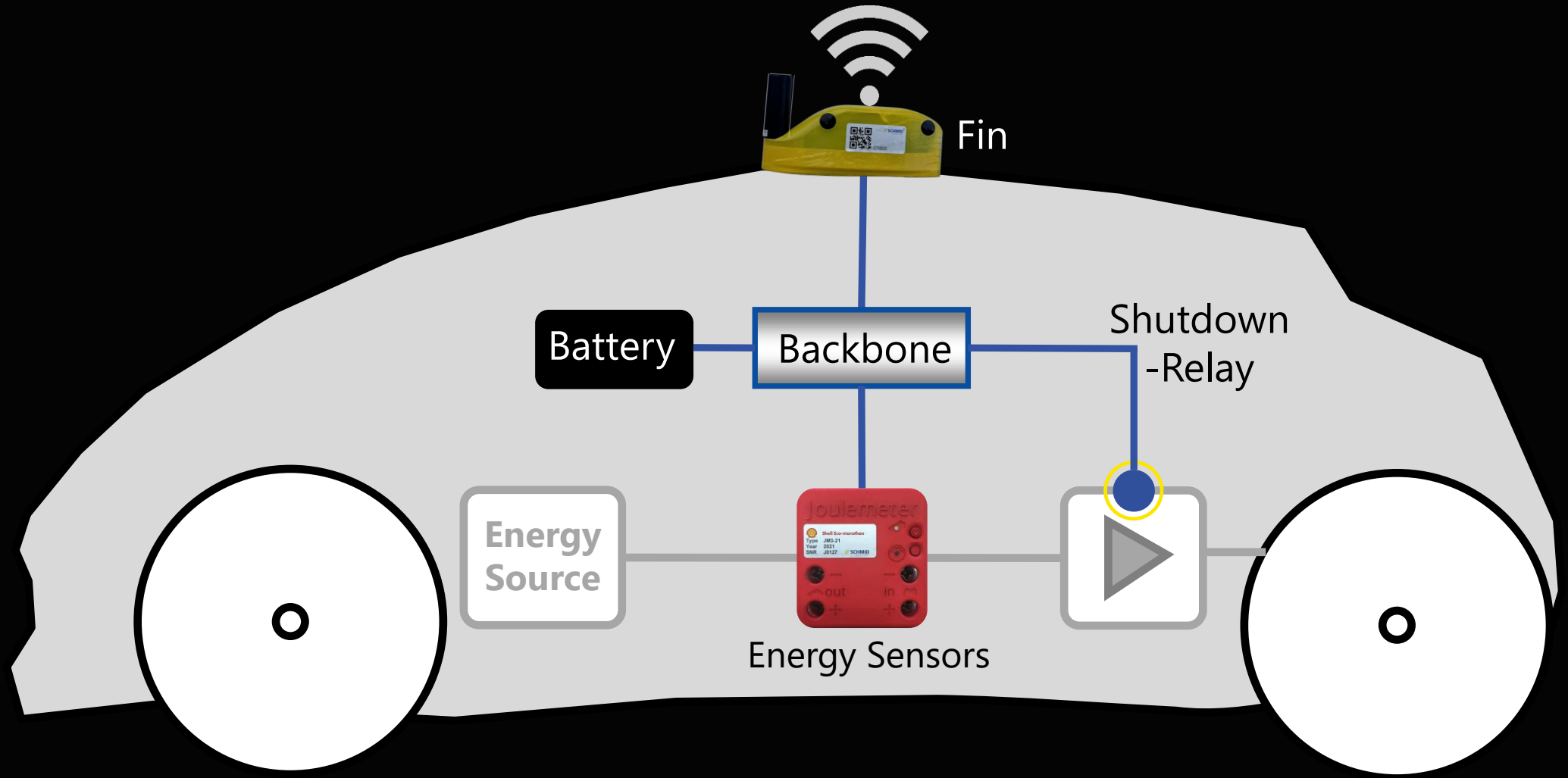
Live Data

Send Data from the Track

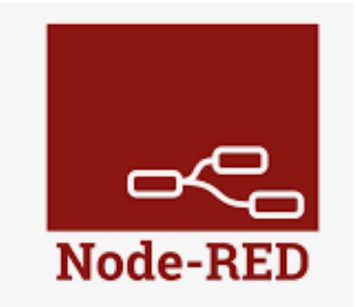
to the IoT with 4G, LoRa, …

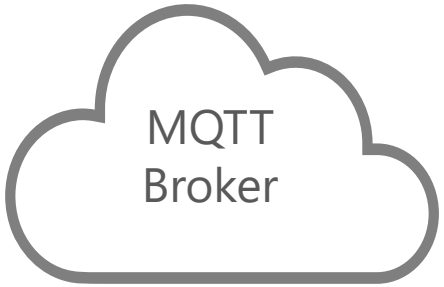
Level 3

```
imx6@obc:~$ mosquitto -c /etc/mosquitto/mosquitto.conf -d
imx6@obc:~$ mosquitto_sub -h localhost -v -t 'device/mqtt/data/506_data'
```

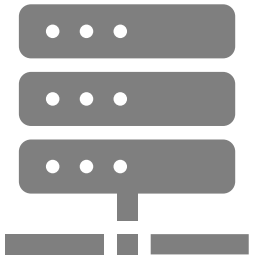


Live Dataflow in the IoT-Server

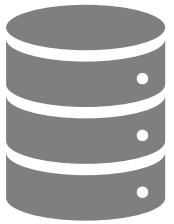




Kinetic Service

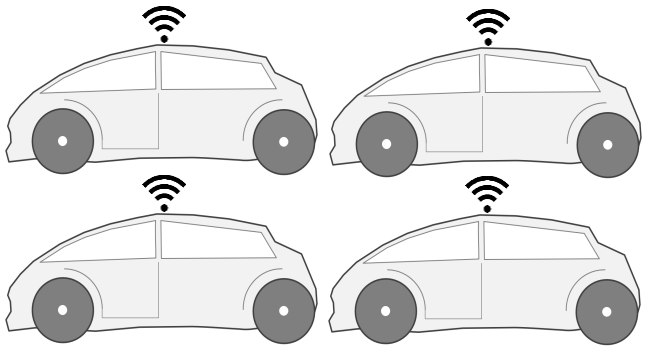


Data Validation
Boundary Check
Outlier Detection
Smooth GPS-Data

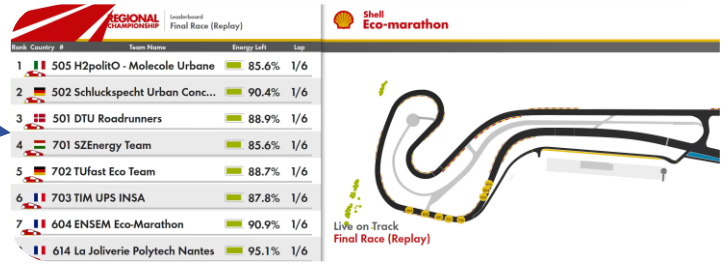


Database for
Static Data (SD-Card)

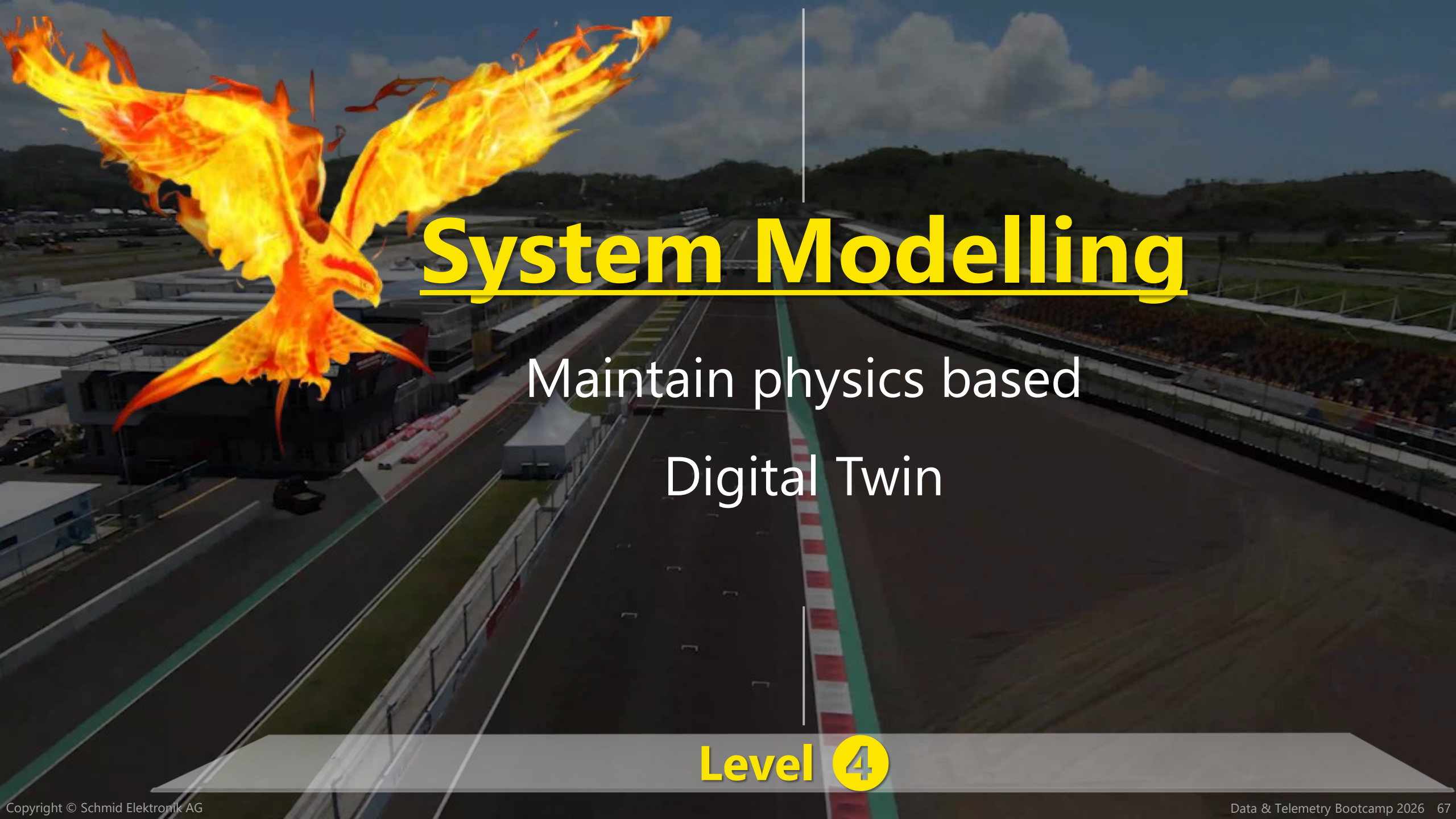
Telemetry
Monitoring



Onboard Computers
use **Publish/Subscribe**
Messaging



Live Data Visualization



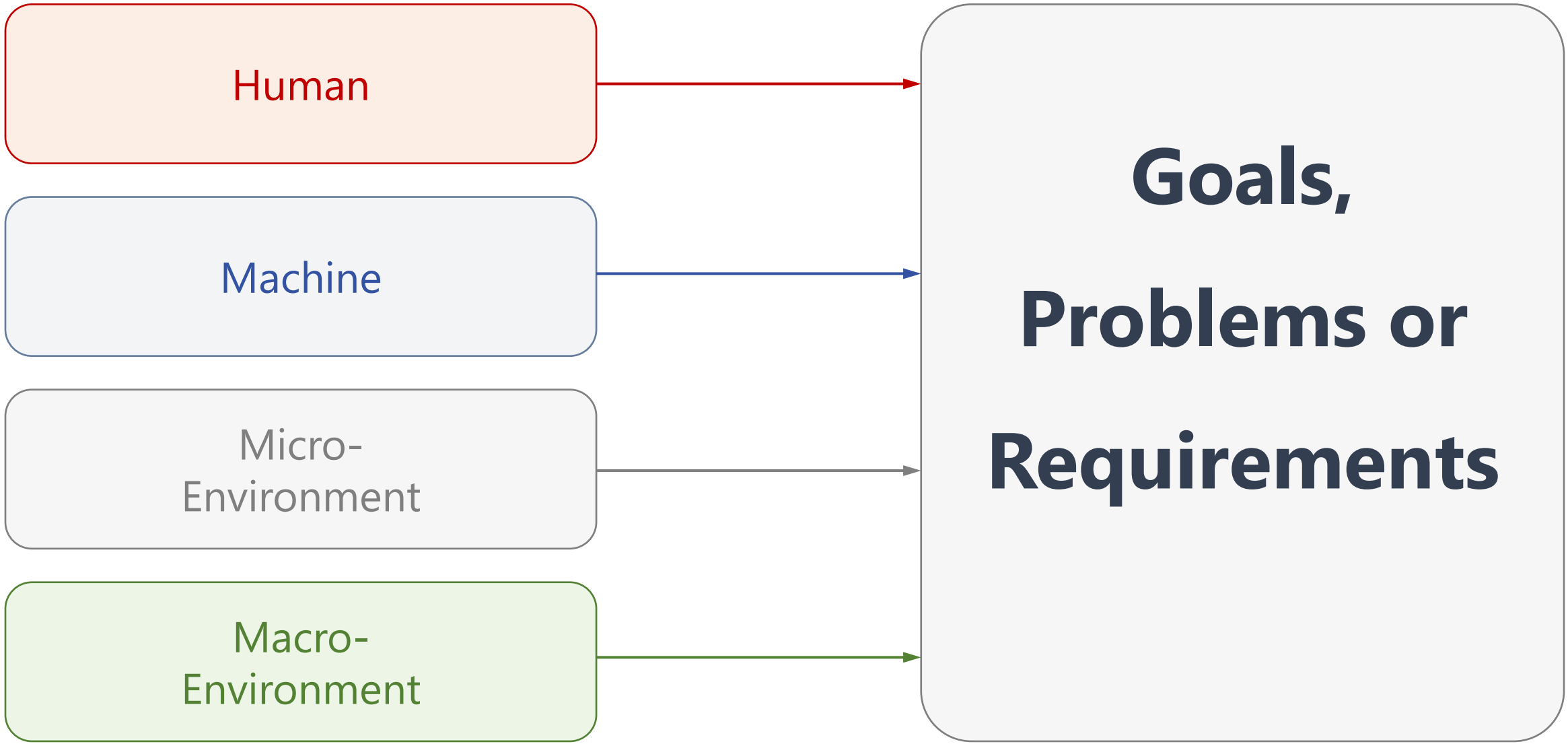
System Modelling

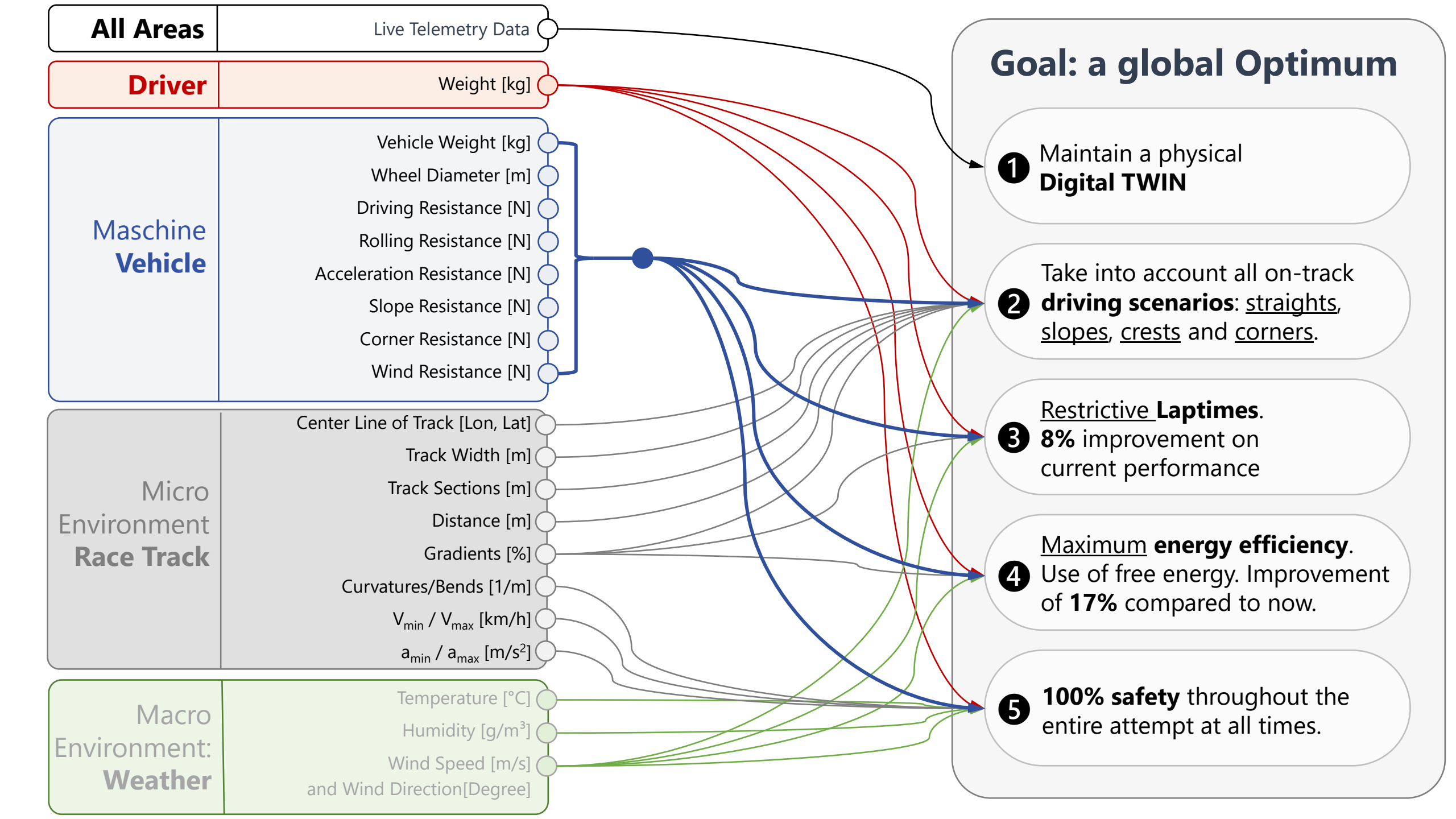
Maintain physics based

Digital Twin

Level 4

Scaling the Data Strategy




All Areas
Live Telemetry Data
Driver
Weight [kg]
Maschine
Vehicle
Vehicle Weight [kg]
Wheel Diameter [m]
Driving Resistance [N]
Rolling Resistance [N]
Acceleration Resistance [N]
Slope Resistance [N]
Corner Resistance [N]
Wind Resistance [N]
Micro
Environment
Race Track
Center Line of Track [Lon, Lat]
Track Width [m]
Track Sections [m]
Distance [m]
Gradients [%]
Curvatures/Bends [1/m]
V_{min} / V_{max} [km/h]
a_{min} / a_{max} [m/s^2]
Macro
Environment:
Weather
Temperature [°C]
Humidity [g/m^3]
Wind Speed [m/s]
and Wind Direction[Degree]
Goal: a global Optimum
1 Maintain a physical Digital TWIN
2 Take into account all on-track driving scenarios: straights, slopes, crests and corners.
3 Restrictive Laptimes. 8% improvement on current performance
4 Maximum energy efficiency. Use of free energy. Improvement of 17% compared to now.
5 100% safety throughout the entire attempt at all times.

Driver

Fitness

- Heartbeat
- Eye movement
- Cognitive Load

Behavior

- Throttle
- Brake
- Steering Wheel

Modelling the Track

Shell Eco-marathon Data & Telemetry Portal

Search

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student_documentation:home

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- Track Coordinates
- Contact

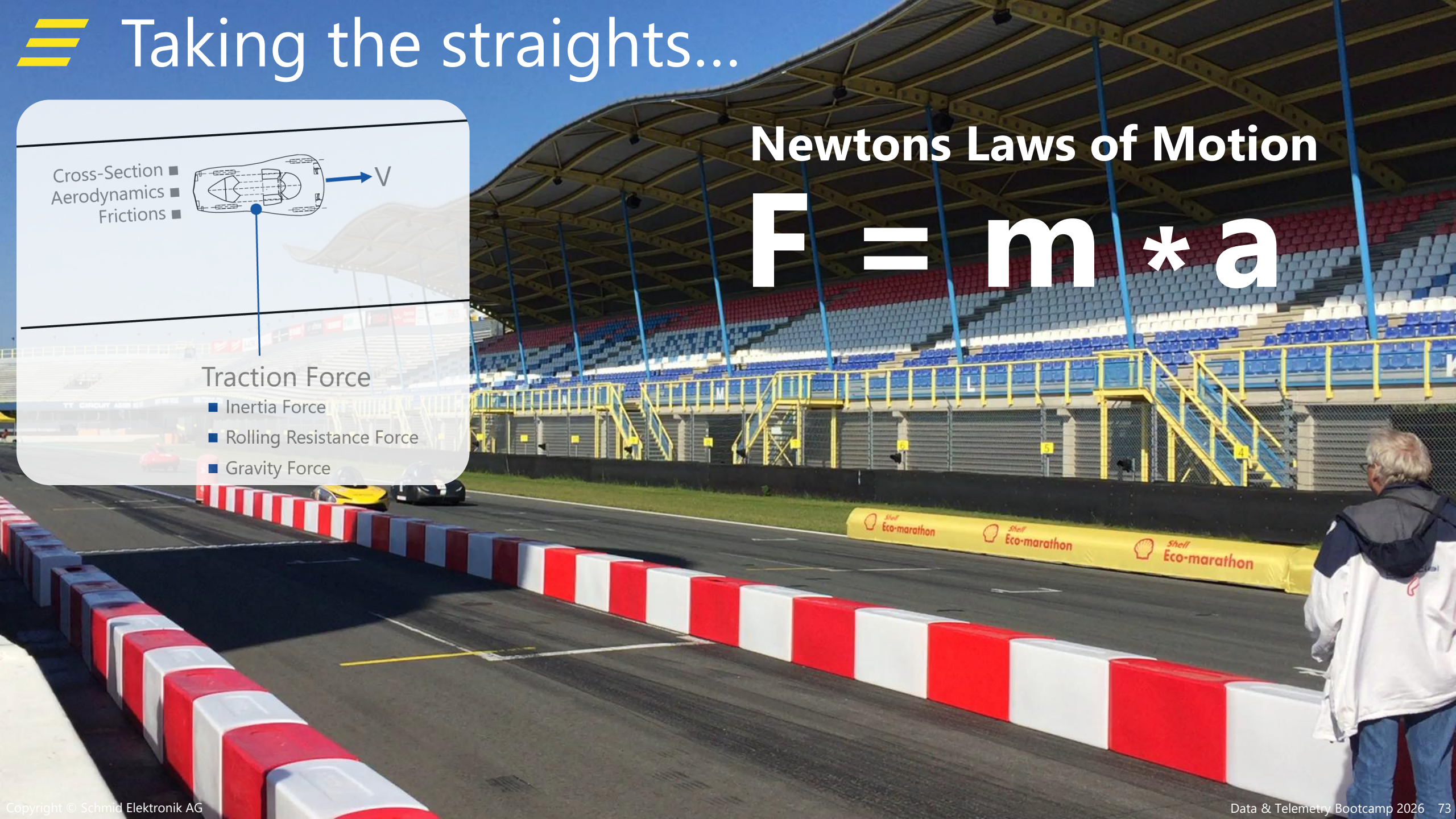
Student Documentation

Select your category/class from the following:

		Prototypes P	Urban Concepts UC
	ICE	Prototype Internal Combustion Engine	Urban Concept Internal Combustion Engine
Hybrid	ICE	Prototype Internal Combustion Hybrid Engine	Urban Concept Internal Combustion Hybrid Engine
	BE	Prototype Battery Electric	Urban Concept Battery Electric
	H2	Prototype Hydrogen without Supercapacitor	Urban Concept Hydrogen without Supercapacitor
Supercap	H2	Prototype Hydrogen with Supercapacitor	Urban Concept Hydrogen with Supercapacitor

Georgetown Rd
IMS Pag
Pagoda Plaza
Meyers Dr
Credentialed Parking
Interior Rd Course
7th St
6th St
5th St
4th St
Indianapolis Motor Speedway
Shaw Dr
Cagle Ln
Turn 2 VIP
Elevation
224
223
222
221
220
219
218
217
1
94
187
280
373
466
559
652
745
838
931
1024
1117
1210
1303
1396
1489
1582
1675
1768
1861
1954
2047
2140
2233
2326
2419
2512
2605

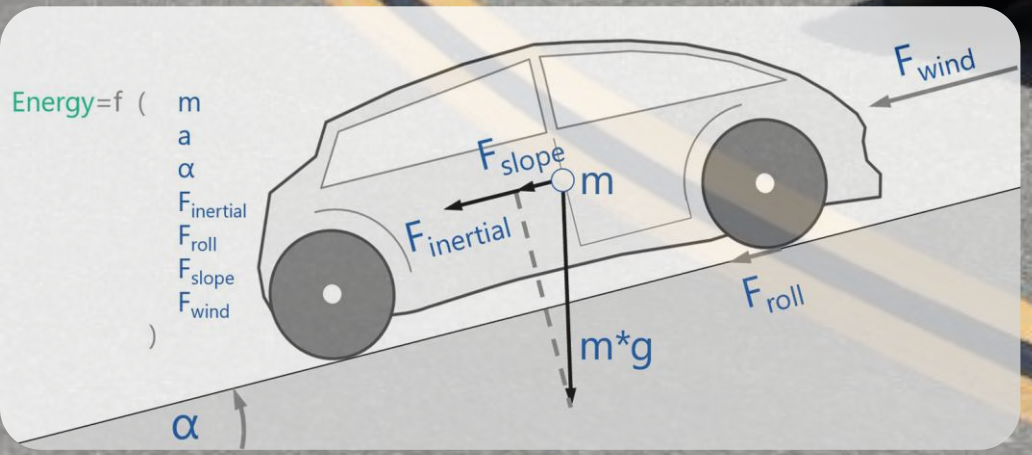
Taking the straights…



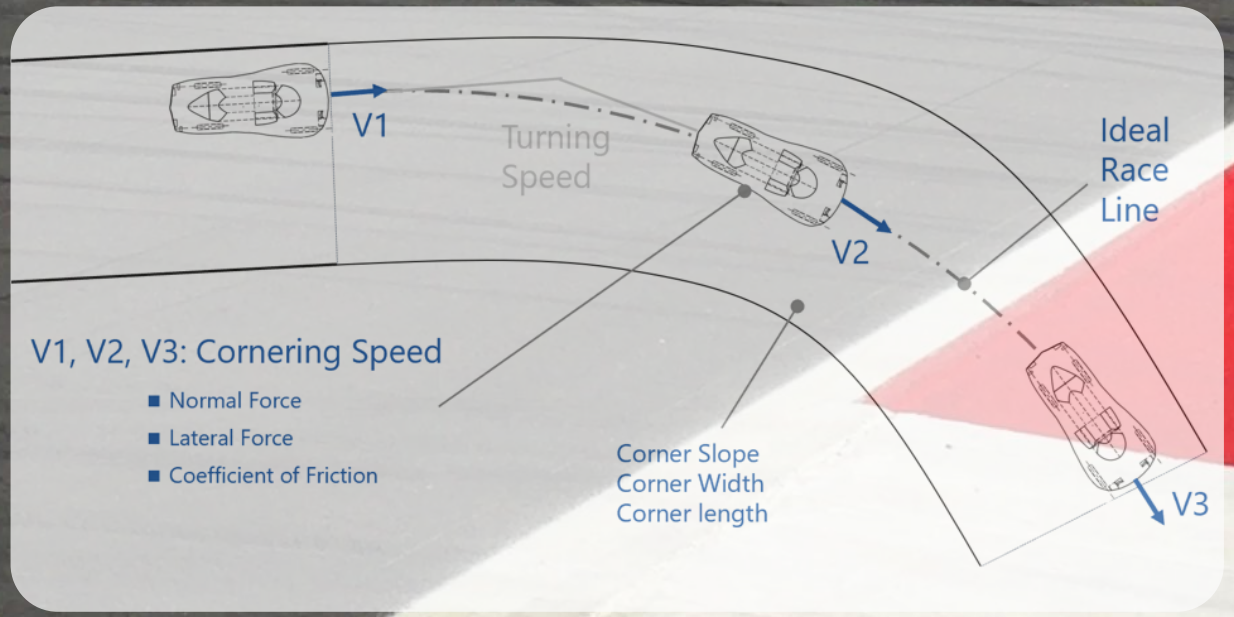
Managing the slopes …

$$dE = \frac{1}{3600}\left[mg(f\cos\varphi + \sin\varphi) + \frac{1}{2}(\rho C_x A \frac{(v_{EV} + v_w)^2}{3.6}) + \left(m + m_f\right)\frac{dv}{dt}\right]ds$$

dE	Mechanical energy required at the wheels to drive a distance ds [kWh]
m	Total vehicle mass [kg]
m_f	Fictive mass of rolling inertia [kg]
g	Gravitational acceleration [m/s^2]
f	Vehicle coefficient of rolling resistance [-]
φ	Road gradient angle [°]
ρ	Air density [kg/m^3]
C_x	Drag coefficient of the vehicle [-]
A	Vehicle equivalent cross section [m^2]
v_{EV}	Vehicle speed between the point i and the point j [km/h]
v_w	Wind speed projected to the opposing direction of the driving direction [km/h]
ds	Distance driven from point i to point j [km]



The corners are the holy grail

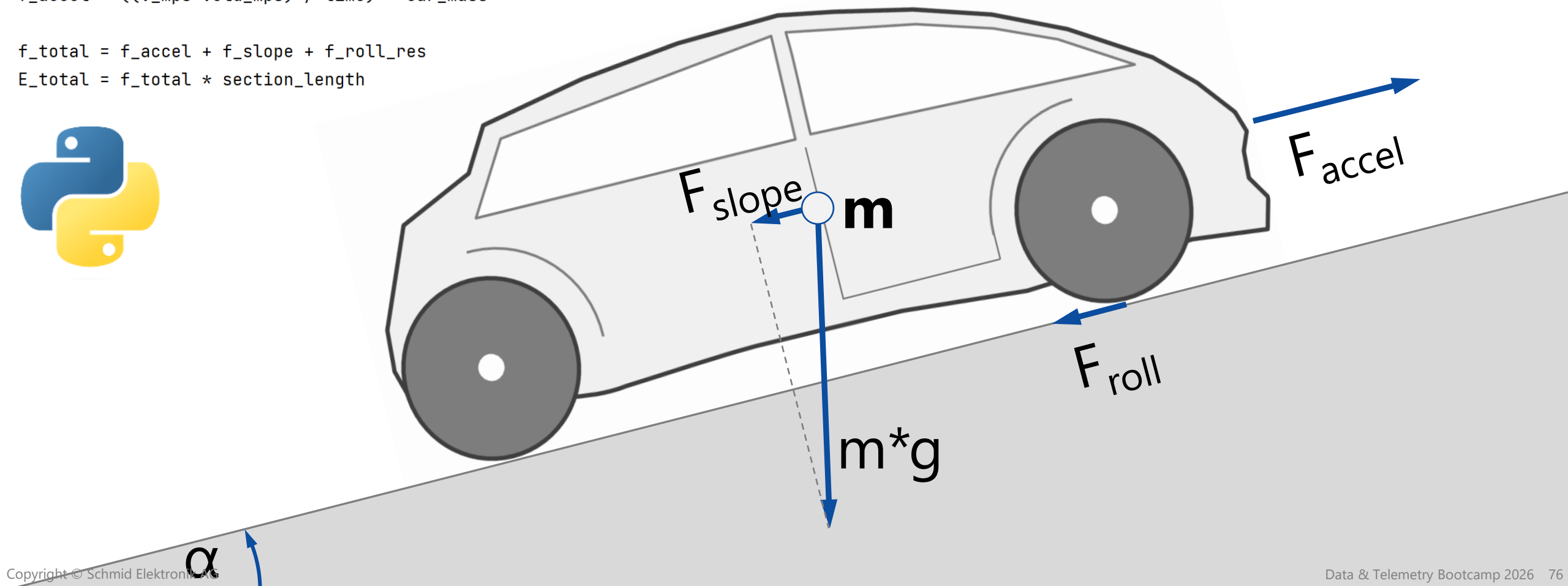


Vehicle Model

$$F_{total} = F_{roll} + F_{slope} + F_{accel}$$

```
vold_mps = vold/3.6
v_mps = v/3.6
time = 2 * section_length / (v_mps + vold_mps)
gradient_angle = math.tanh( (config.loc[x, "m above sea"]-config.loc[x-1, "m above sea"] ) / section_length)
f_roll_res = car_mass * g * math.cos(gradient_angle) * coeff_roll_res
f_slope = car_mass * g * math.sin(gradient_angle)
f_accel = ((v_mps-vold_mps) / time) * car_mass

f_total = f_accel + f_slope + f_roll_res
E_total = f_total * section_length
```

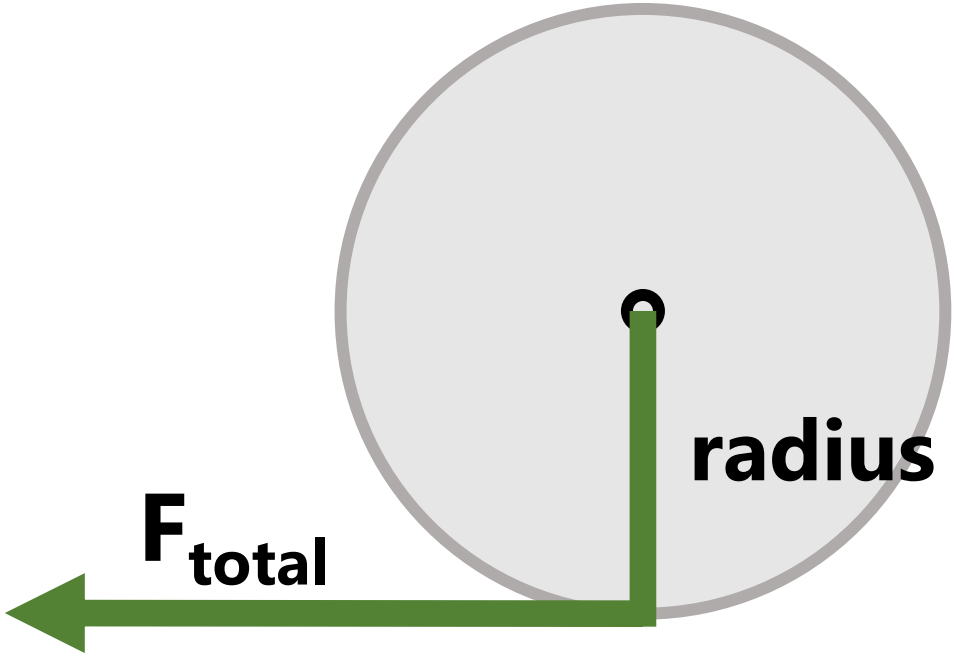


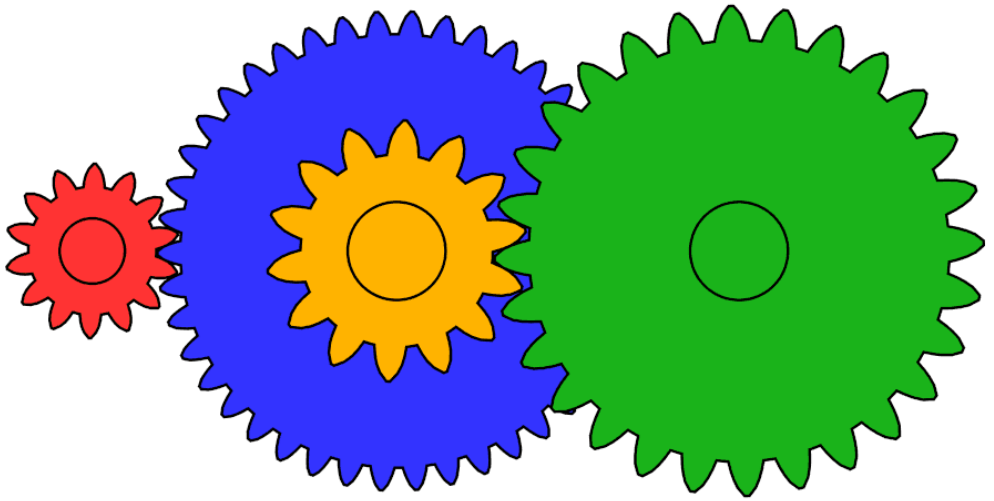
Power calculation for a series wound motor

Total Power P = F_{total} * v

Rotation speed ω = **v** * gear_ratio / radius

Torque τ = **P** / **ω**





Holistic Racing

Conflicting Goals, Global Optimum

Advanced Data-Driven

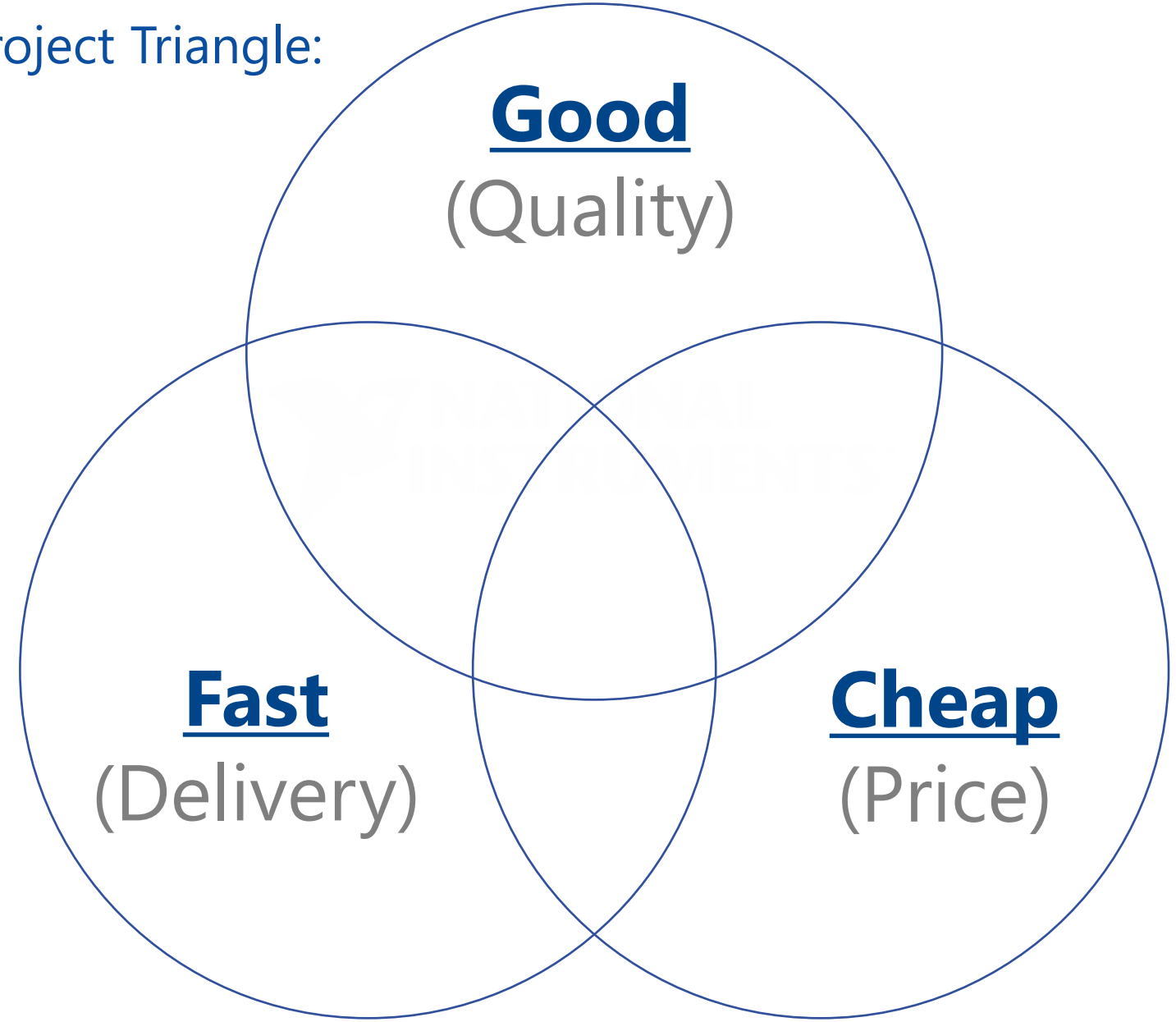
Racing Methods

Level 5

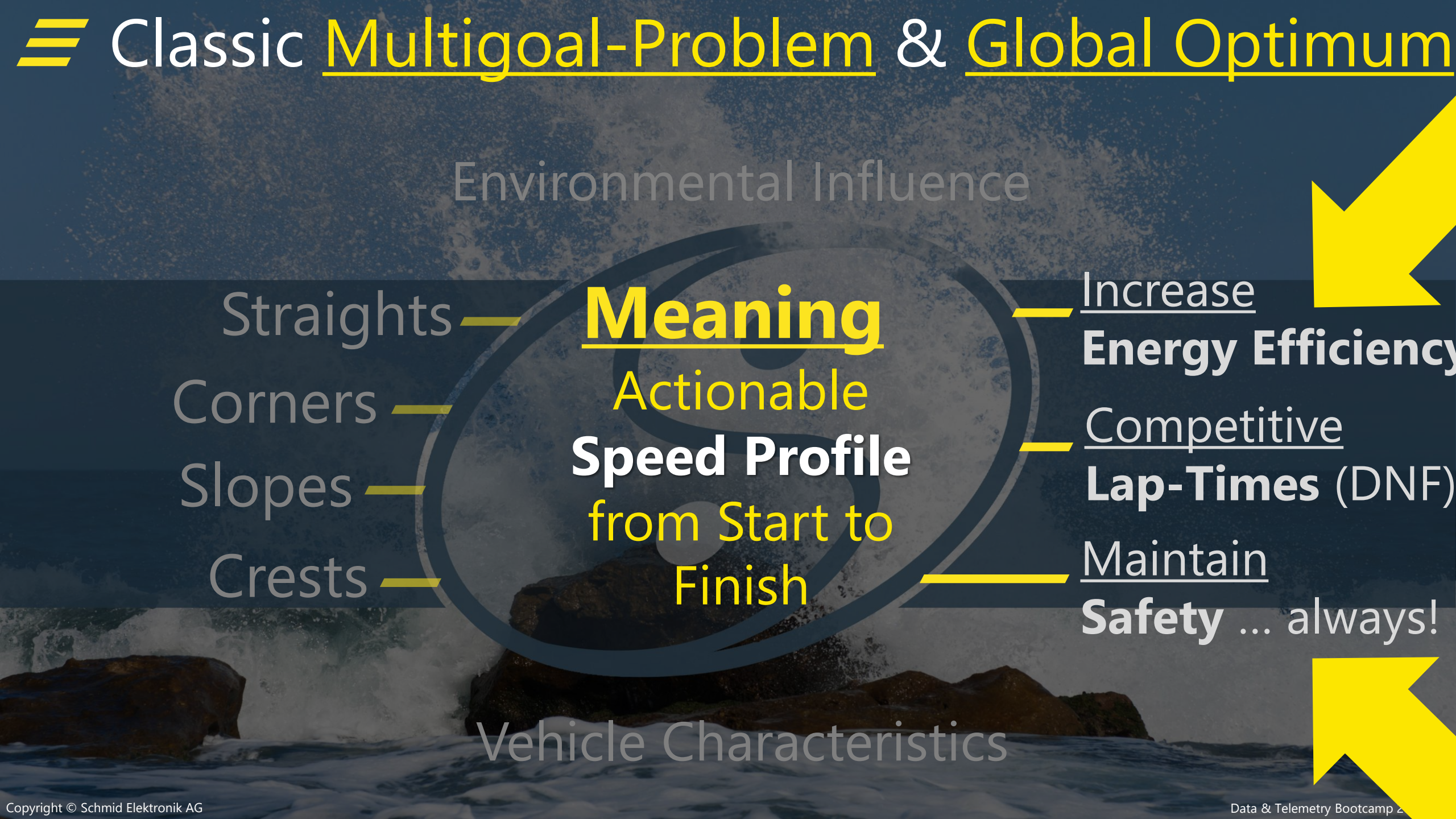
What are Conflicting Goals?

Conflicting Goals in Industrial Projects

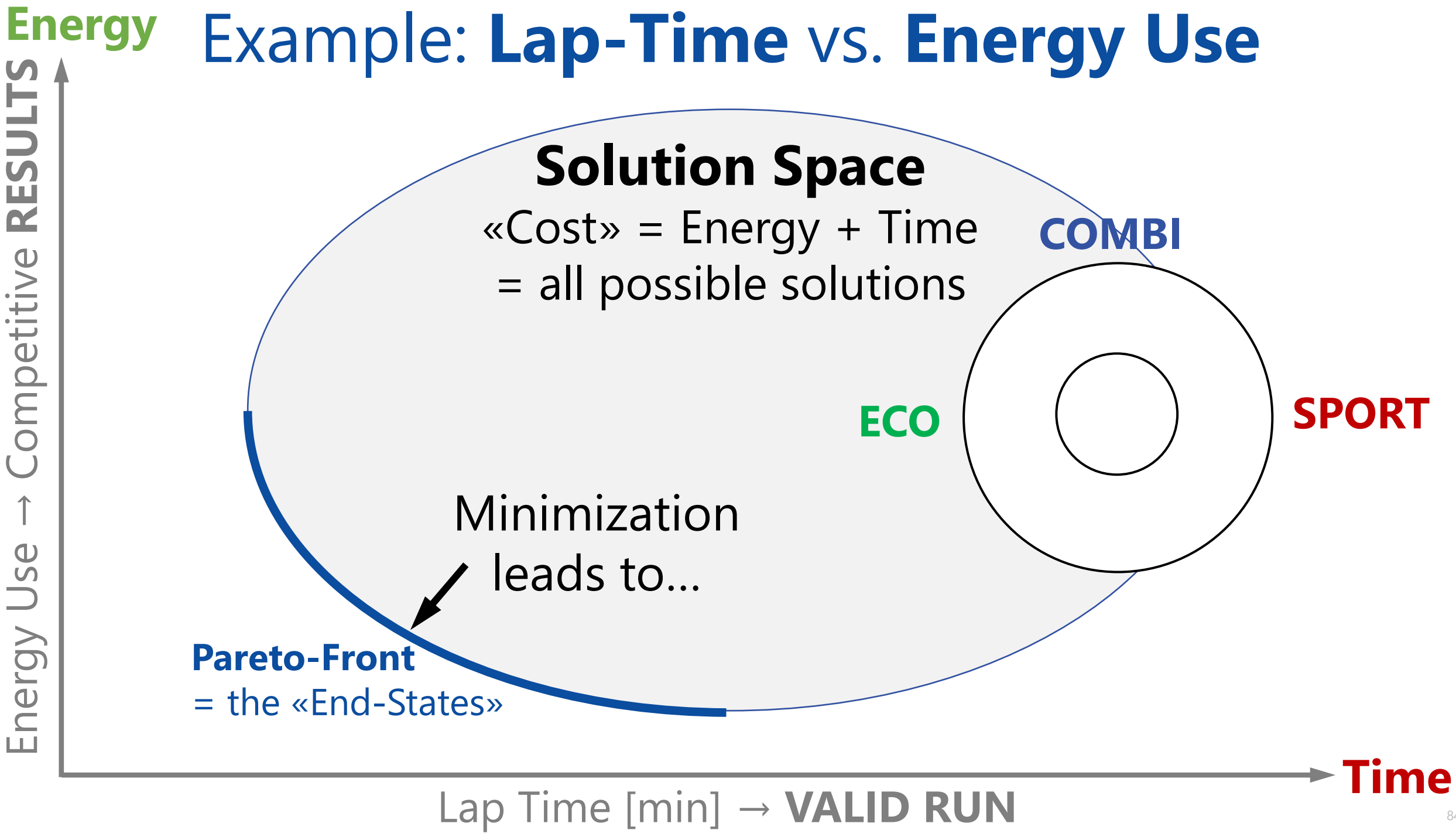
The Magic Project Triangle:



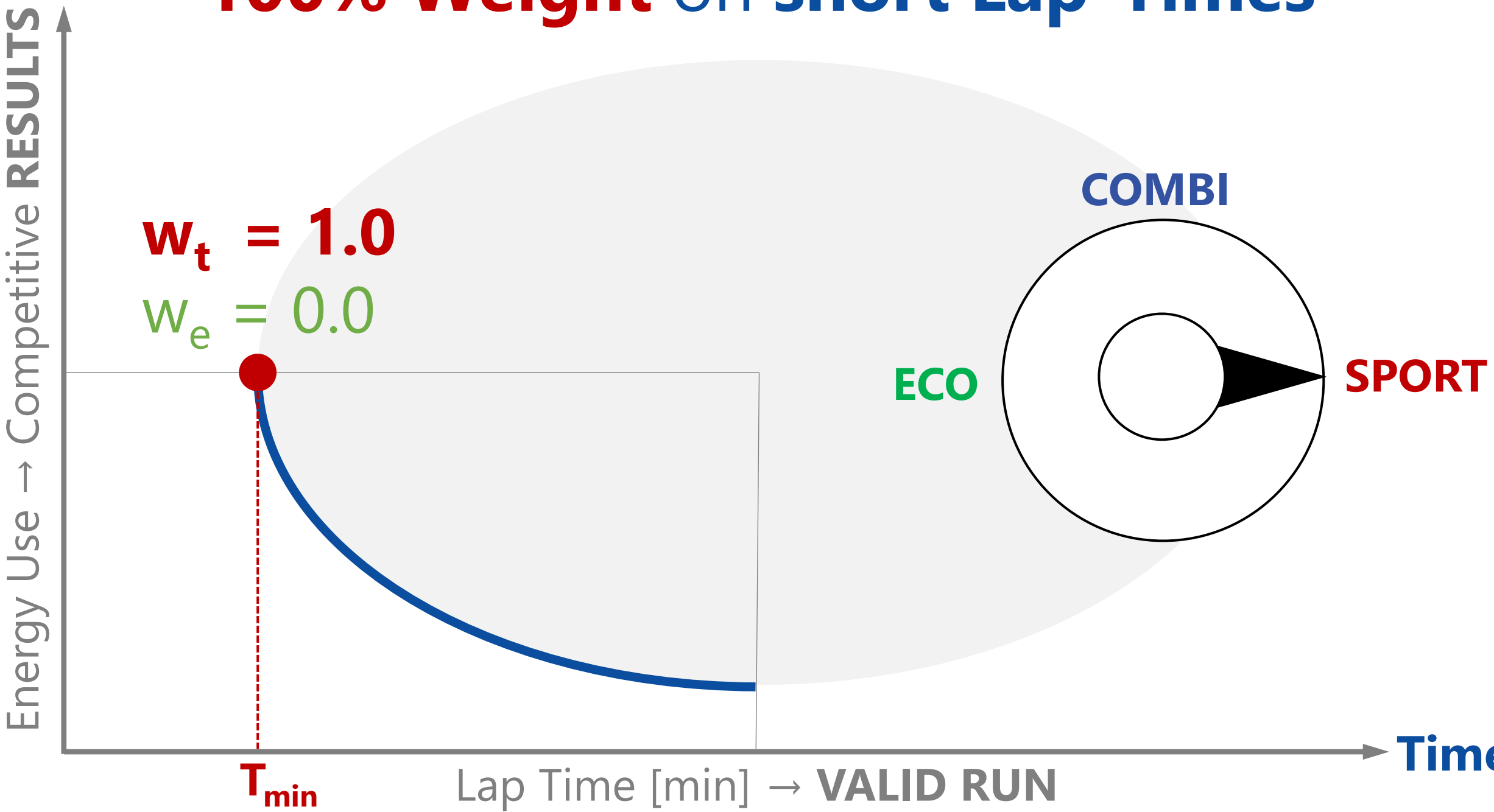
Classic Multigoal-Problem & Global Optimum



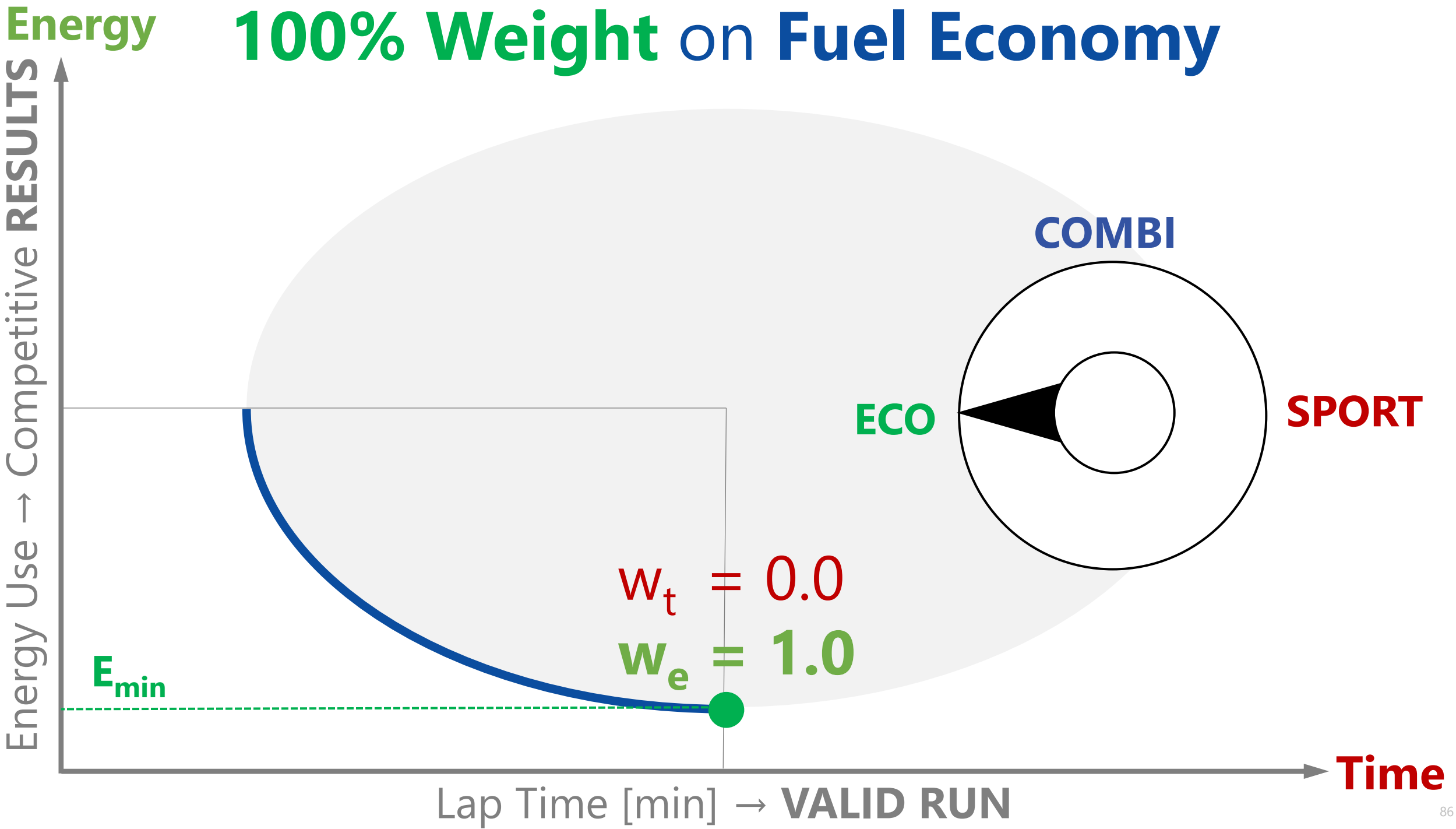
Example: **Lap-Time** vs. **Energy Use**



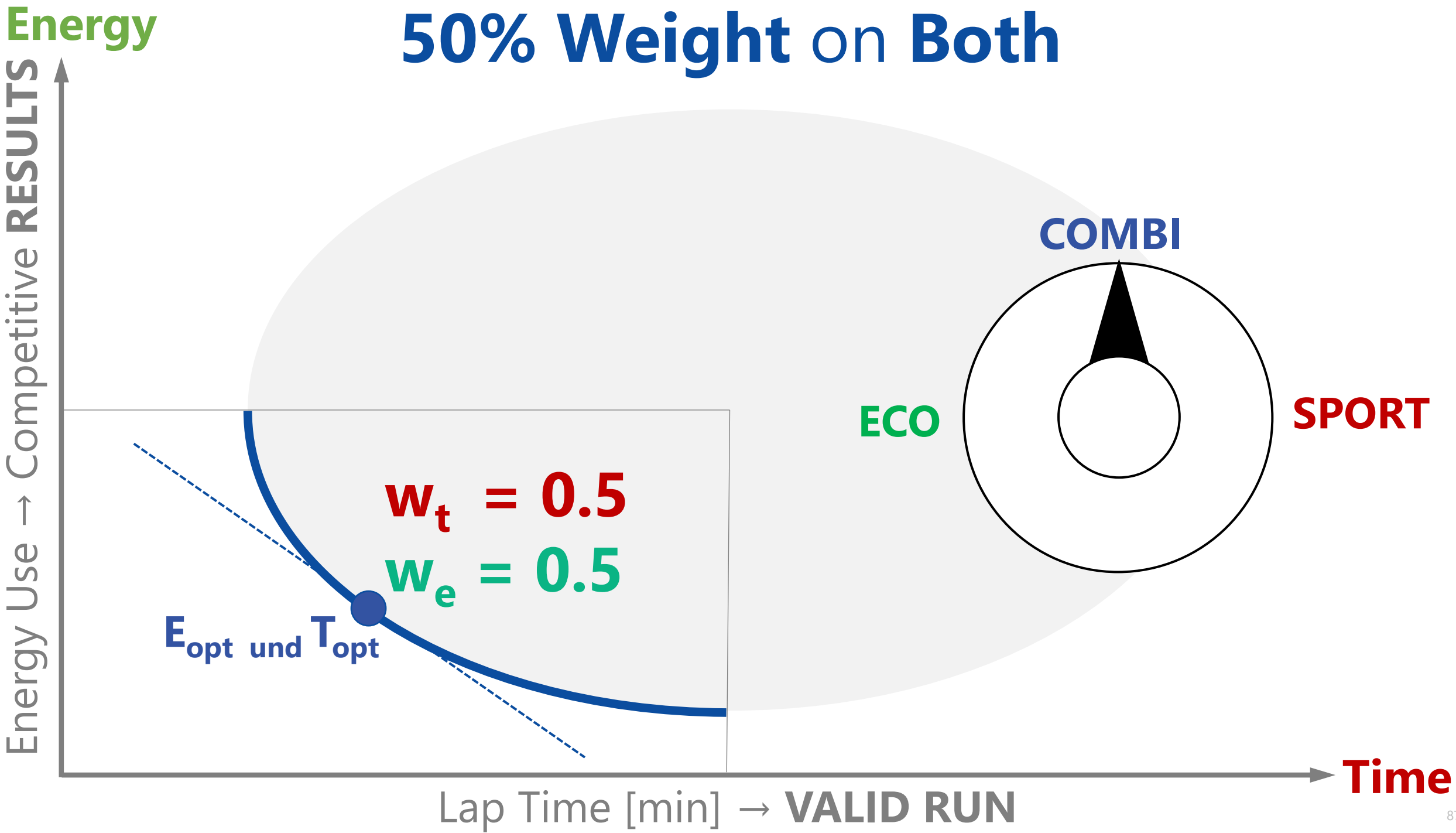
Energy **100% Weight** on **short Lap-Times**



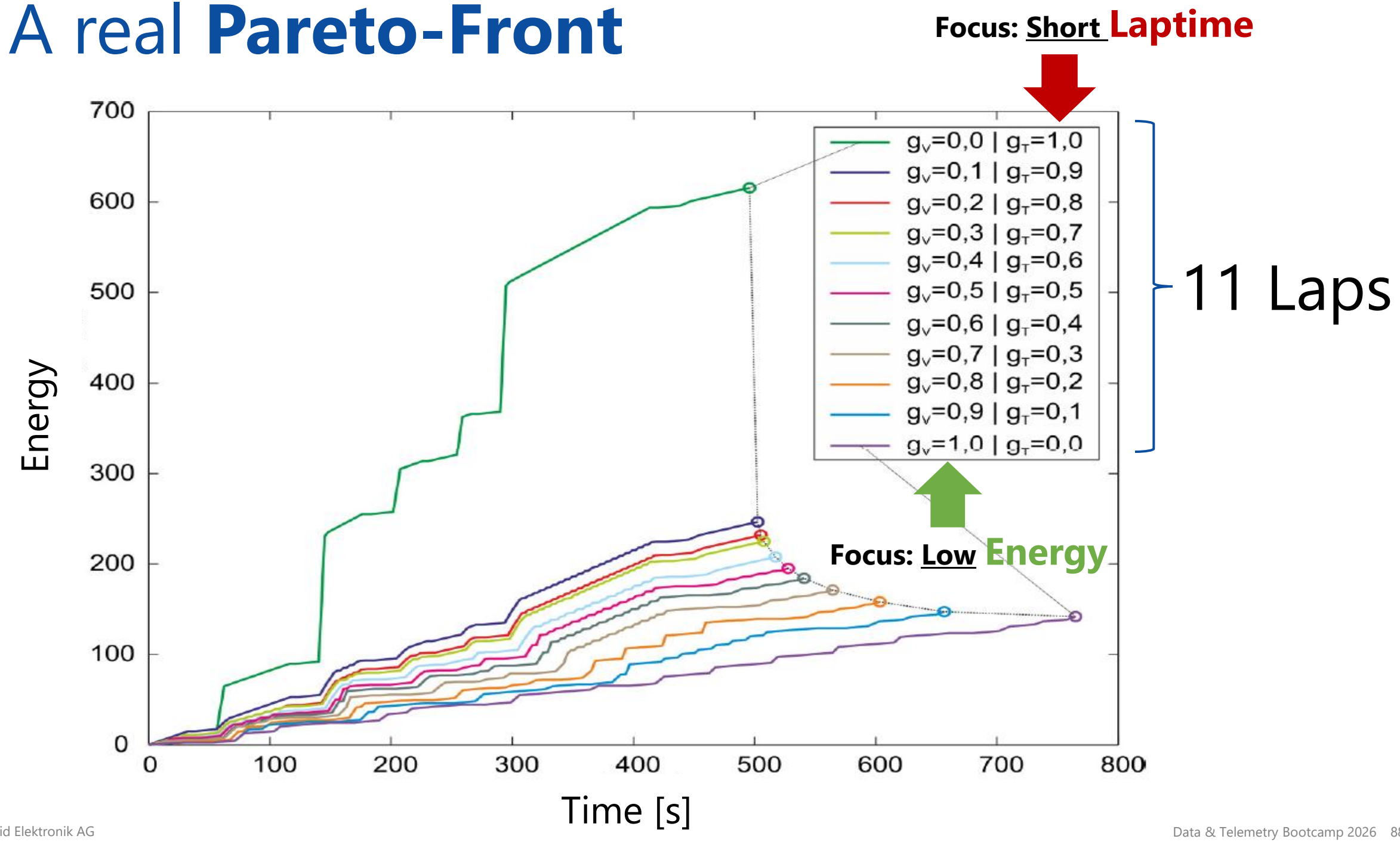
100% Weight on Fuel Economy



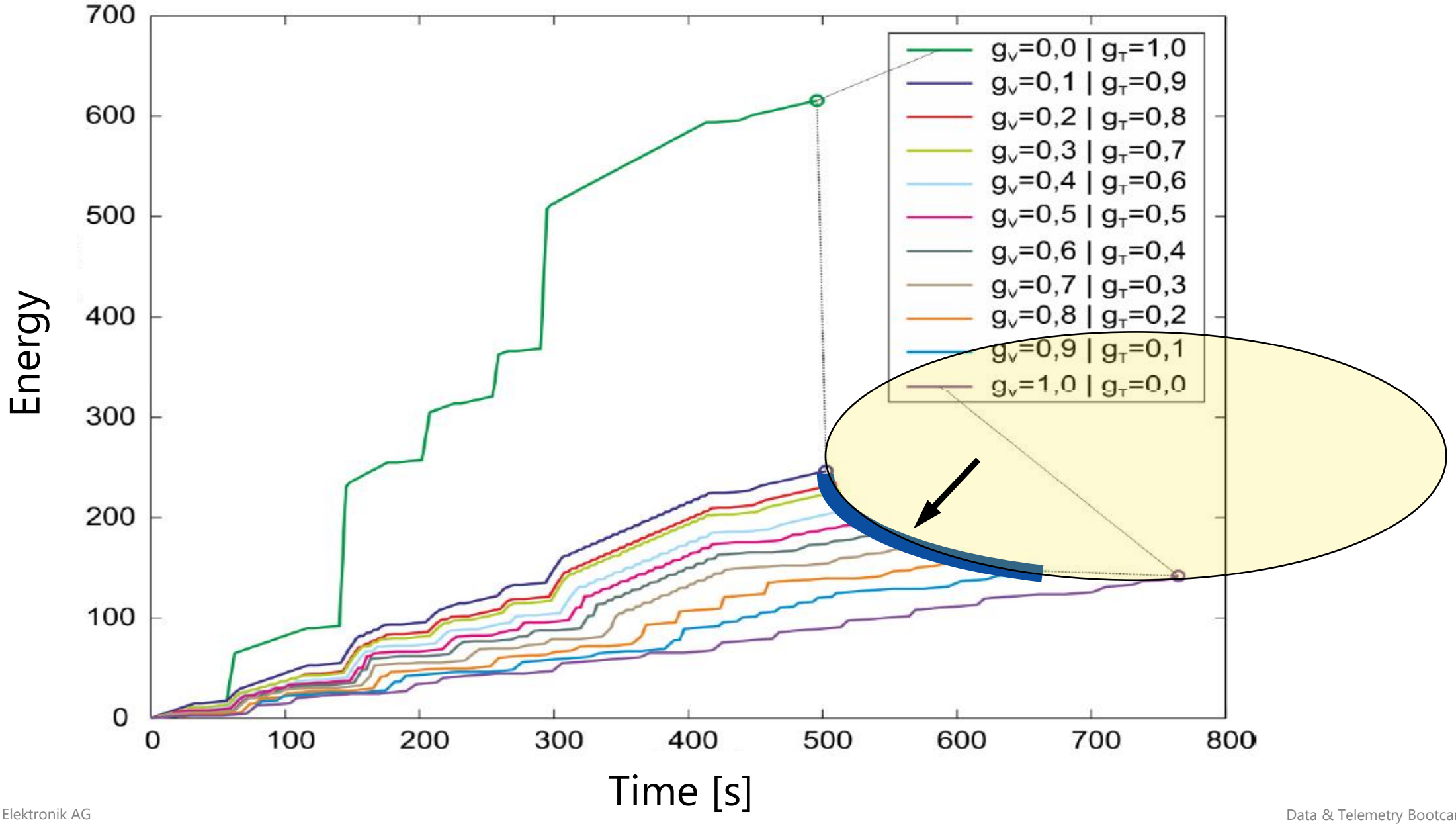
50% Weight on Both



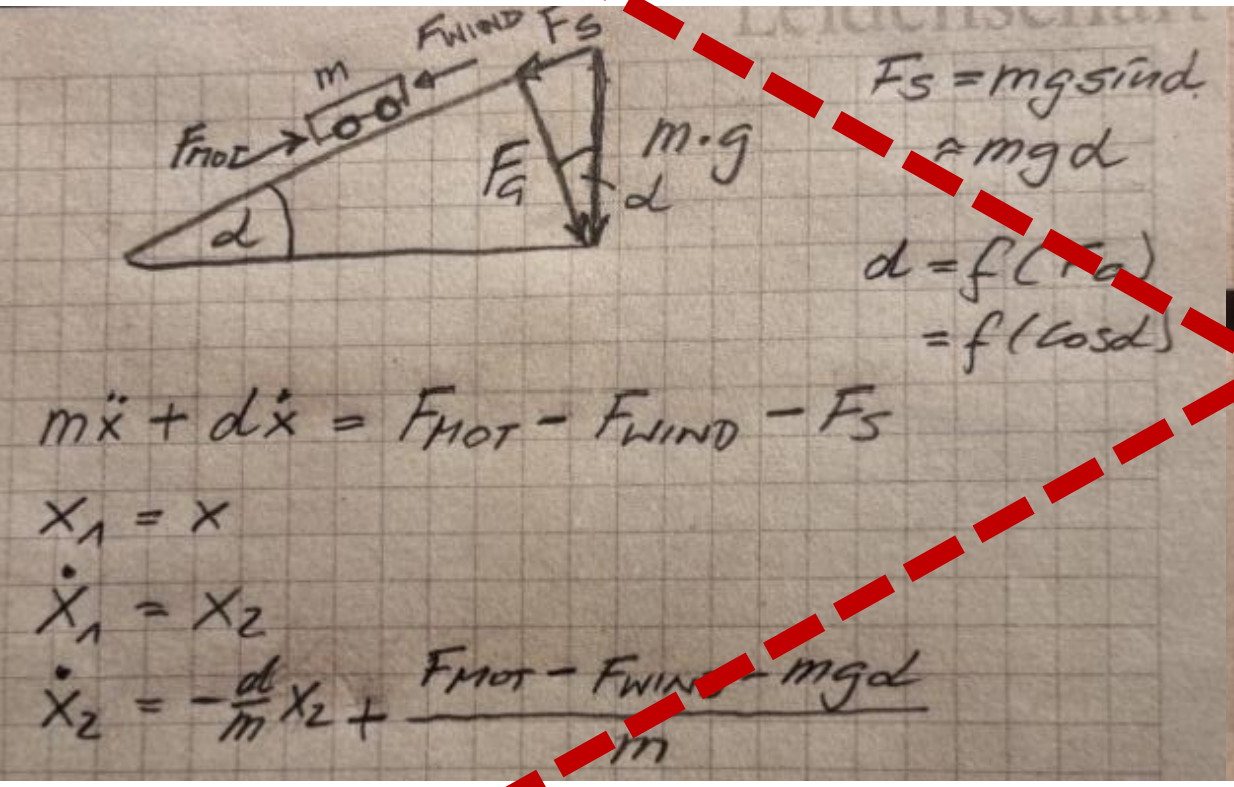
A real **Pareto-Front**

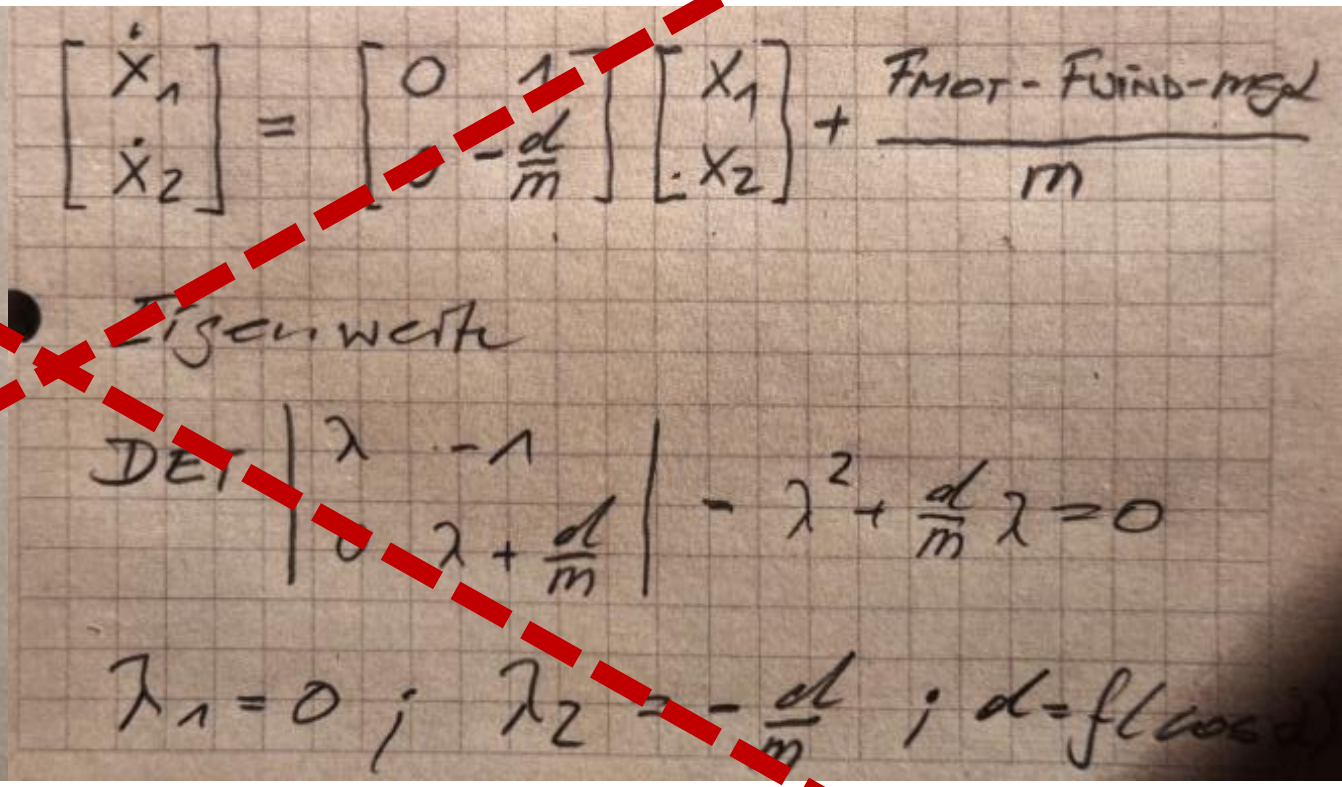


A real **Pareto-Front**



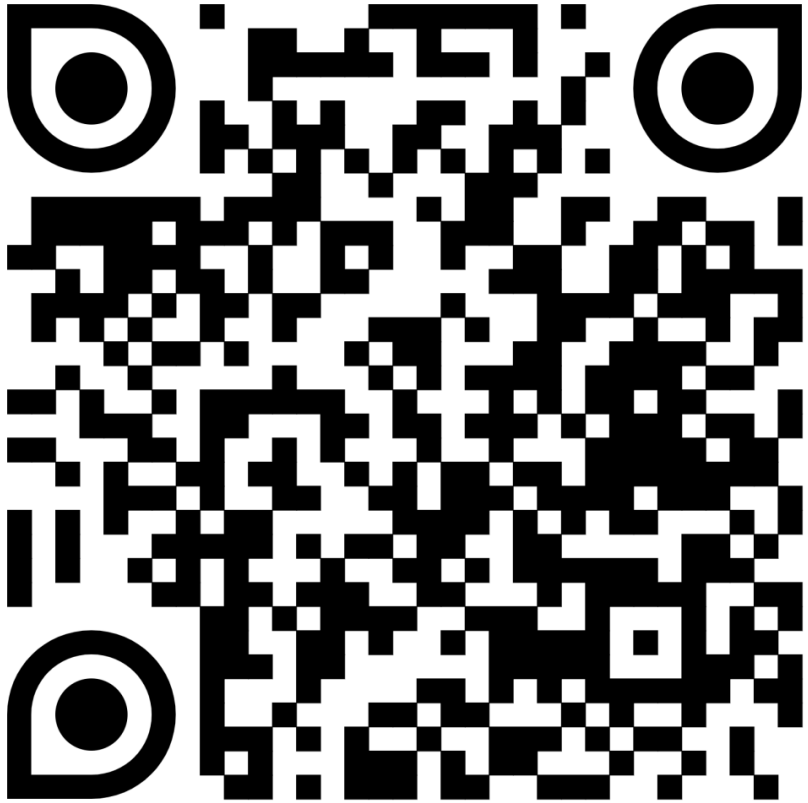
Motorsport = solving **complex** physical Problems





Traditional Way

Python Sandbox **#2** Using Knowledge Graphs



```
nodelist = nx.dijkstra_path(G, "x0_k0",f"x{x_end}_k{k_end}")
outputlist = []
for i in range(len(config.index)):
    outputlist.append(G.nodes[nodelist[i]]["v"])
```


```
output = pd.DataFrame(outputlist)
output.rename(columns={0:"Speed optimal"}, inplace = True)
output['distance'] = output.index * section_length
```

Programming Sandbox #2

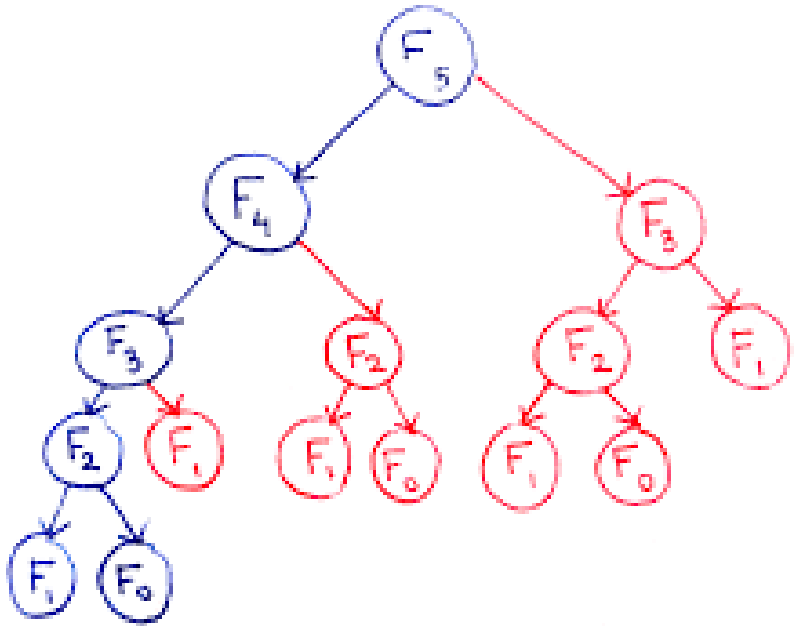
JUPYTER NOTEBOOK AND PYTHONCODE FOR LEVEL-5 (PHYSICAL MODELL)

Start up the Jupyter notebook in your browser (Binder, ~1-2 min.) and play with Python. Learn how to formulate the multigoal problem of data-driven racing with python and how to use a knowledge graph. Save the source code locally, because when you close the browser, the environment will be gone.

START SANDBOX #2 IN YOUR BROWSER ▷

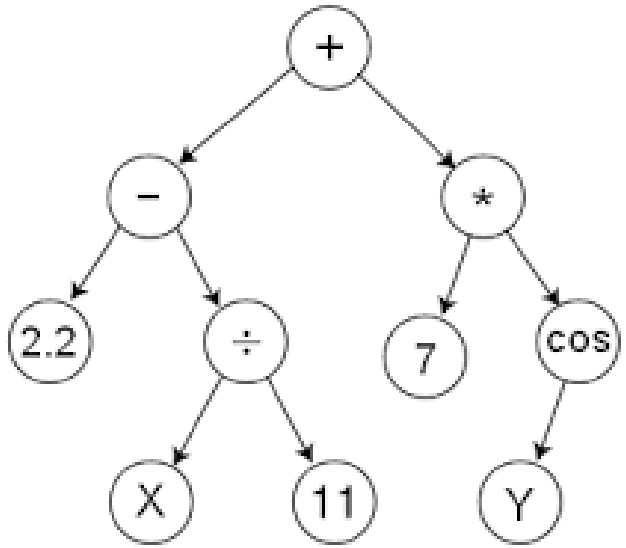
Promising and well established Approaches:

Dynamic Programming



Breaking Complex Problems **down** into simpler subproblems

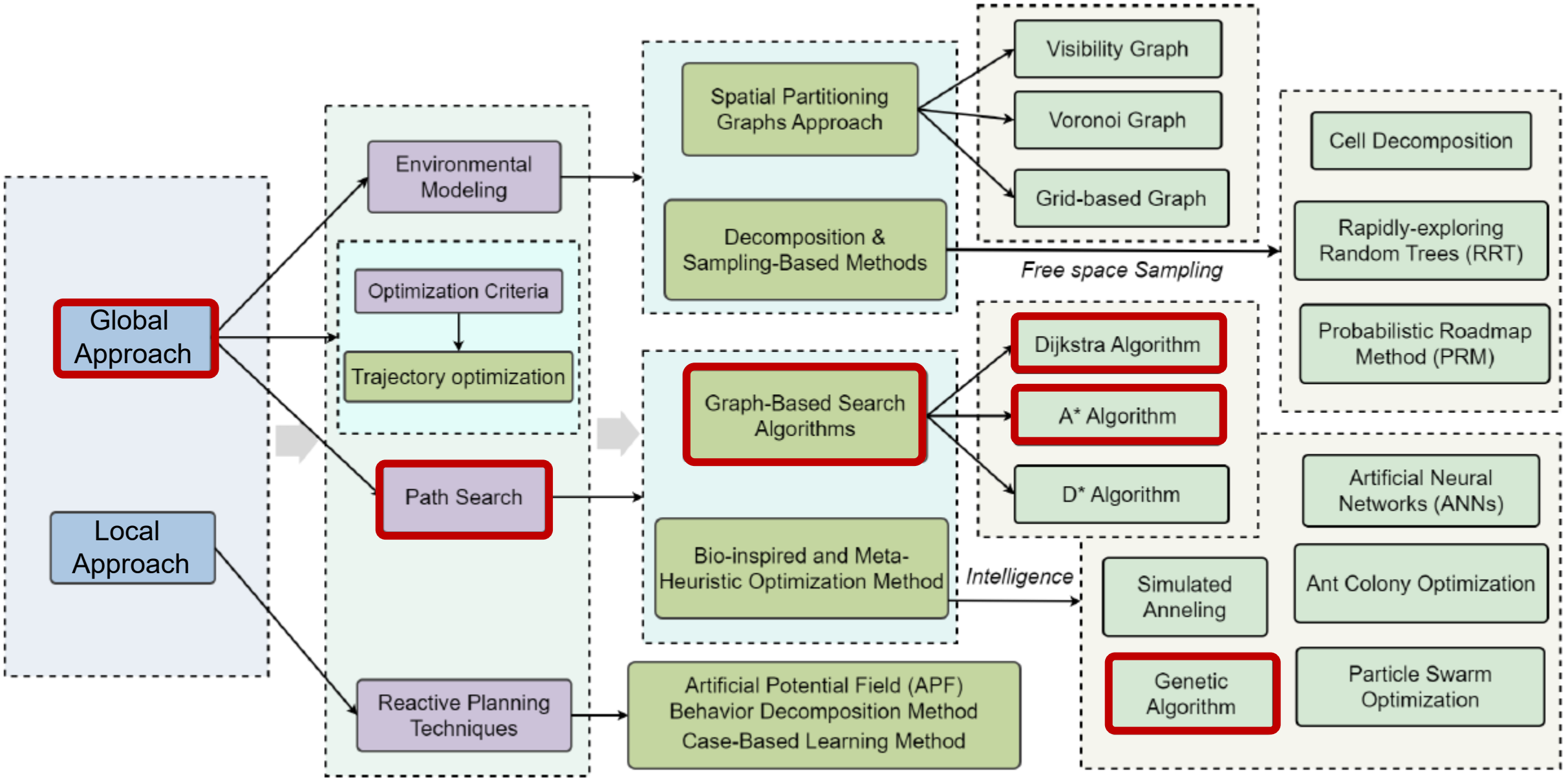
Genetic Programming



$$\left(2.2 - \left(\frac{X}{11}\right)\right) + \left(7 * \cos(Y)\right)$$

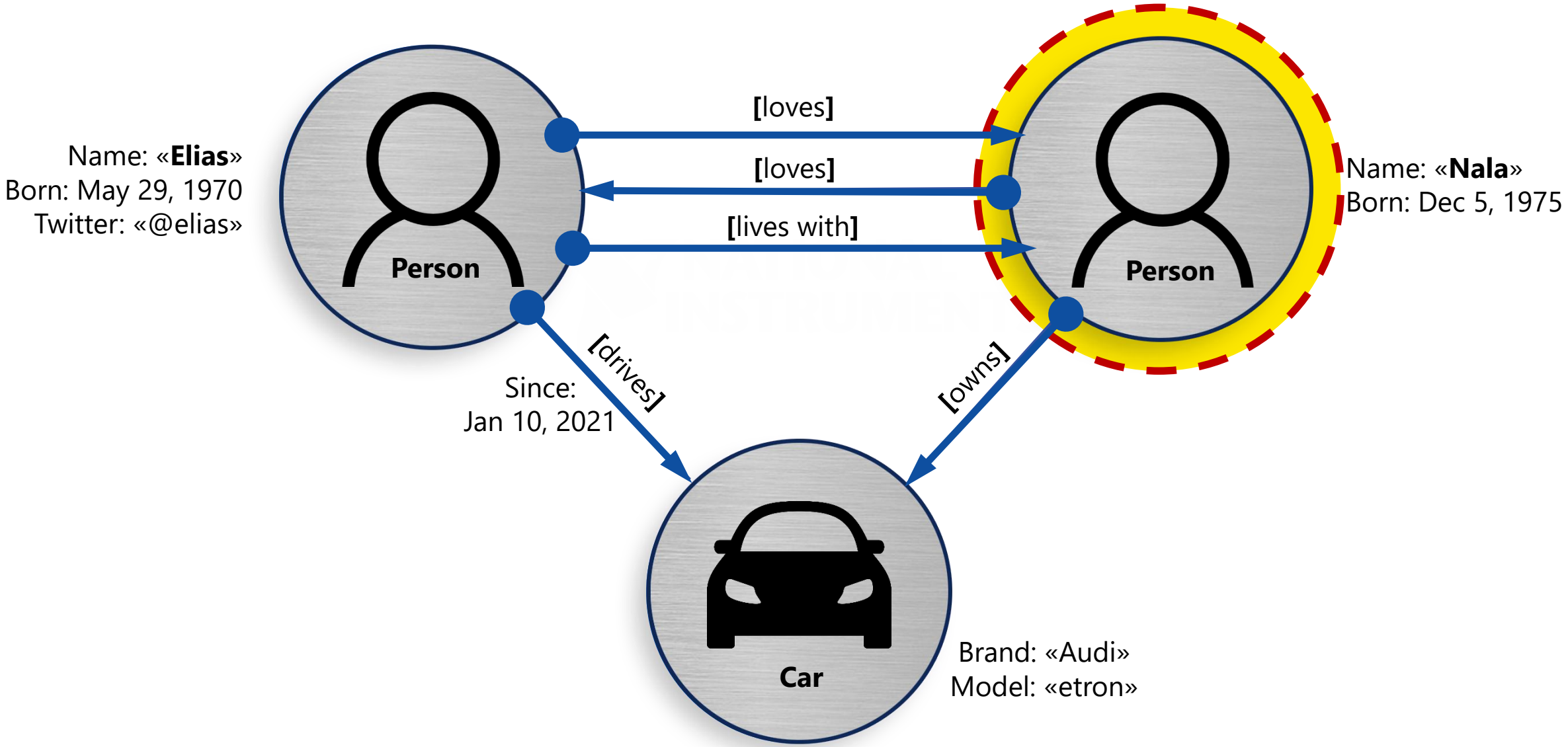
AI technique inspired by **natural evolution** that evolves computer programs to solve complex problems

Overview How to Solve Complex Problems

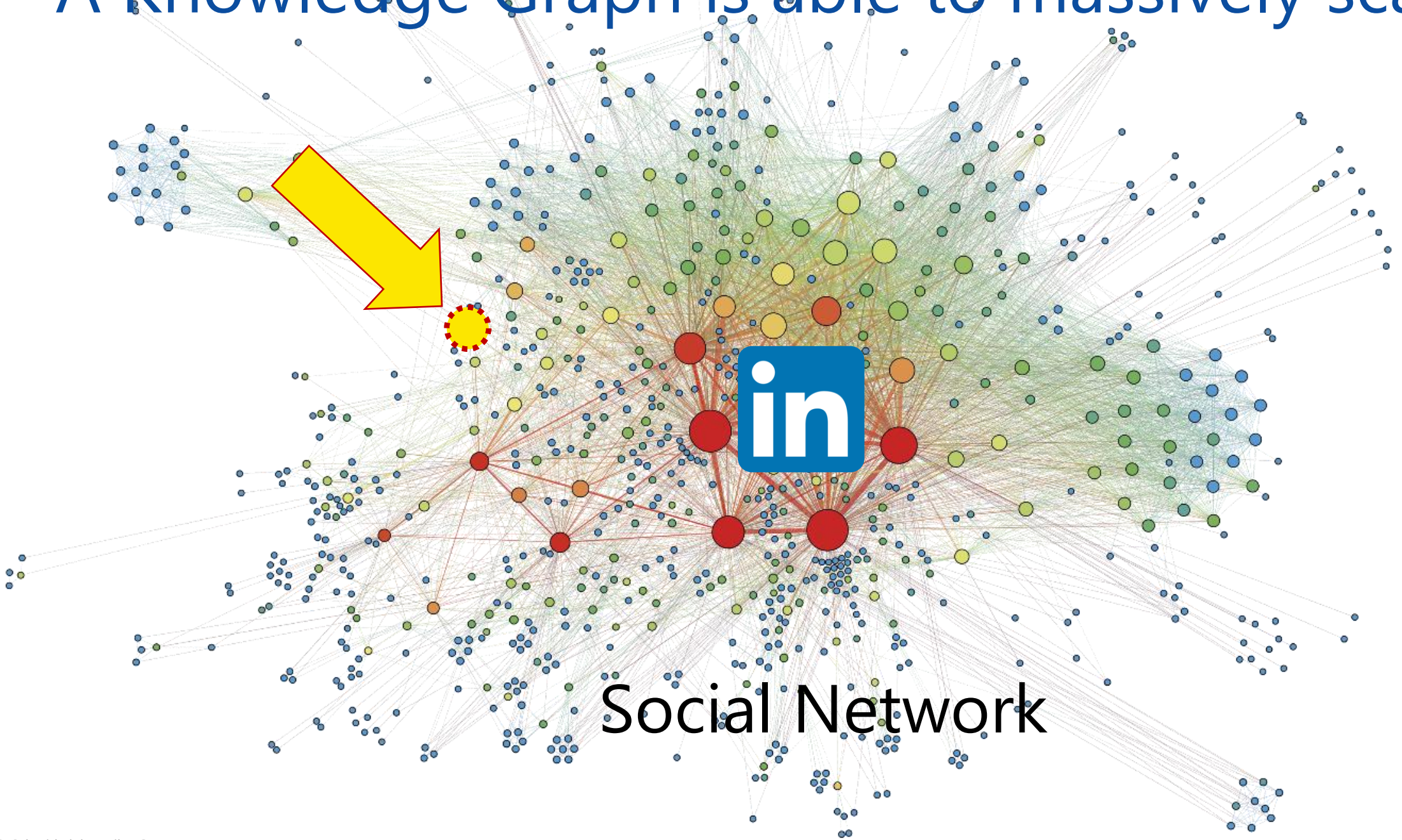


A Knowledge Graph with Nodes and Edges

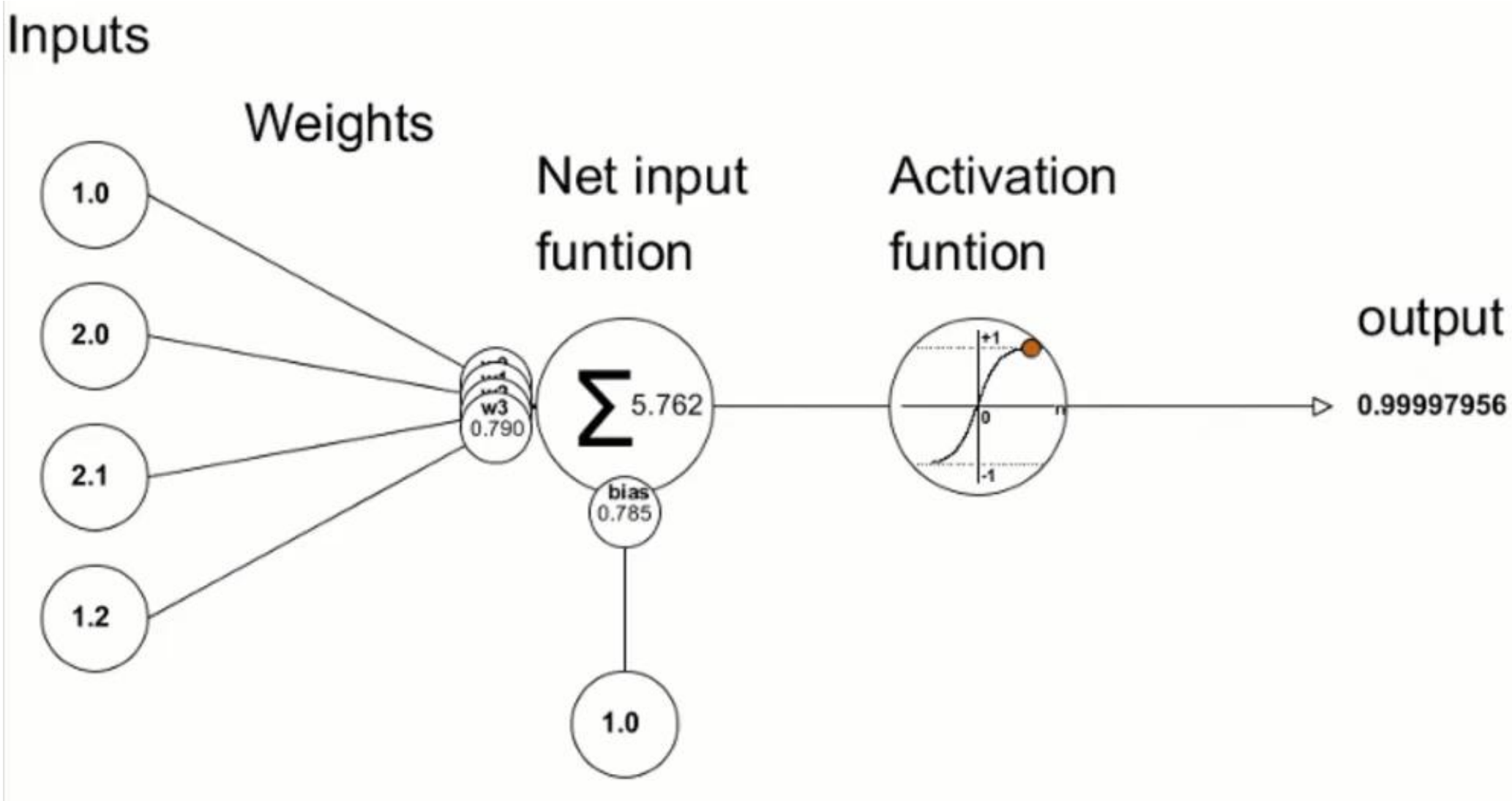
Understanding the «**Essence of Things**»



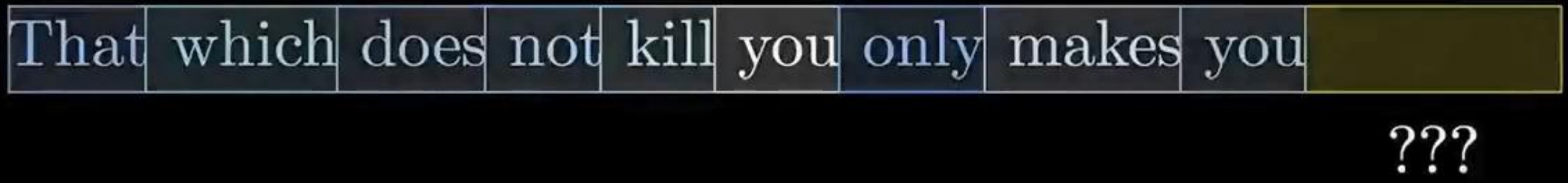
A Knowledge Graph is able to massively scale



From a single Neuron....



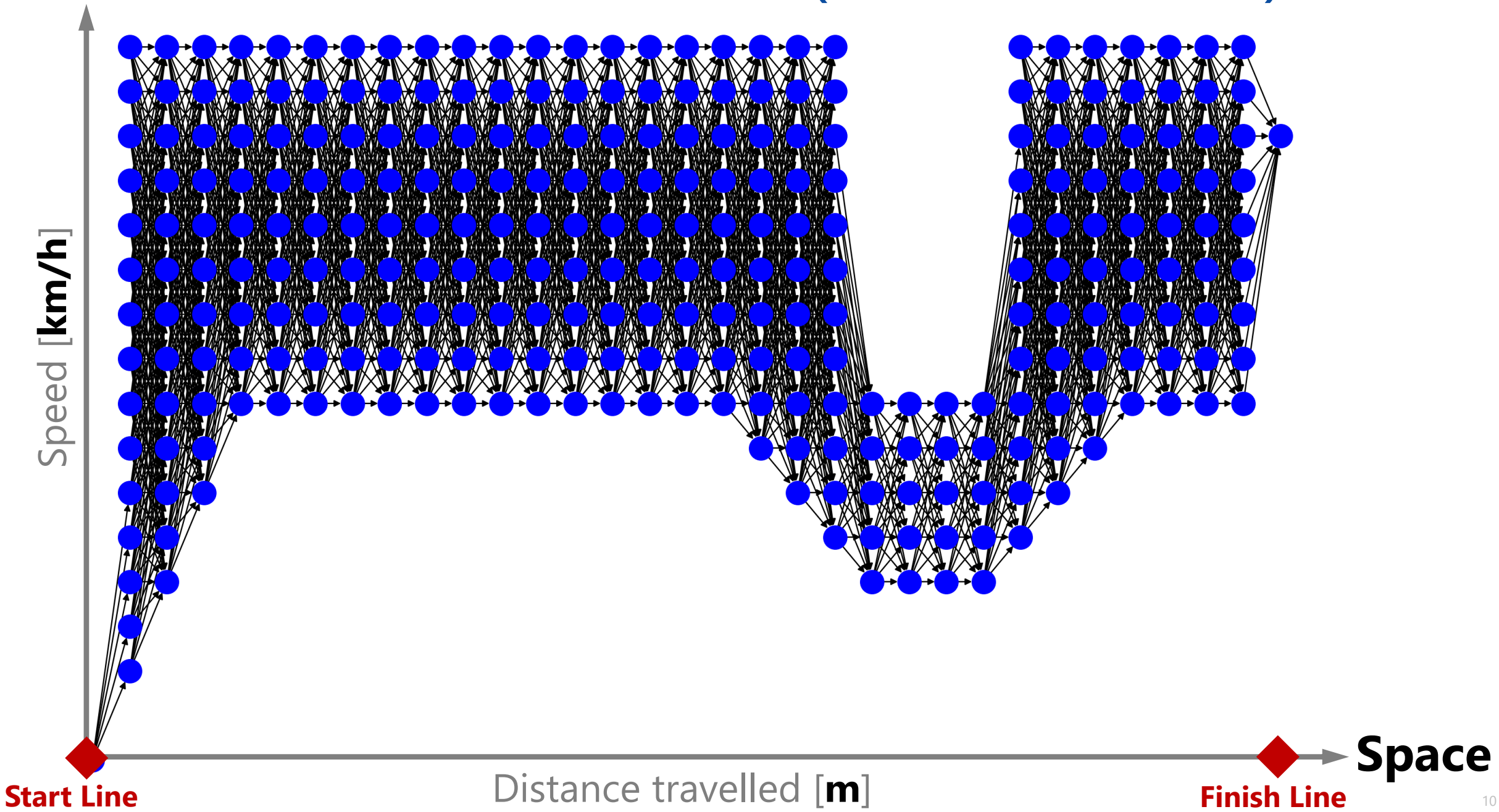
Tokens



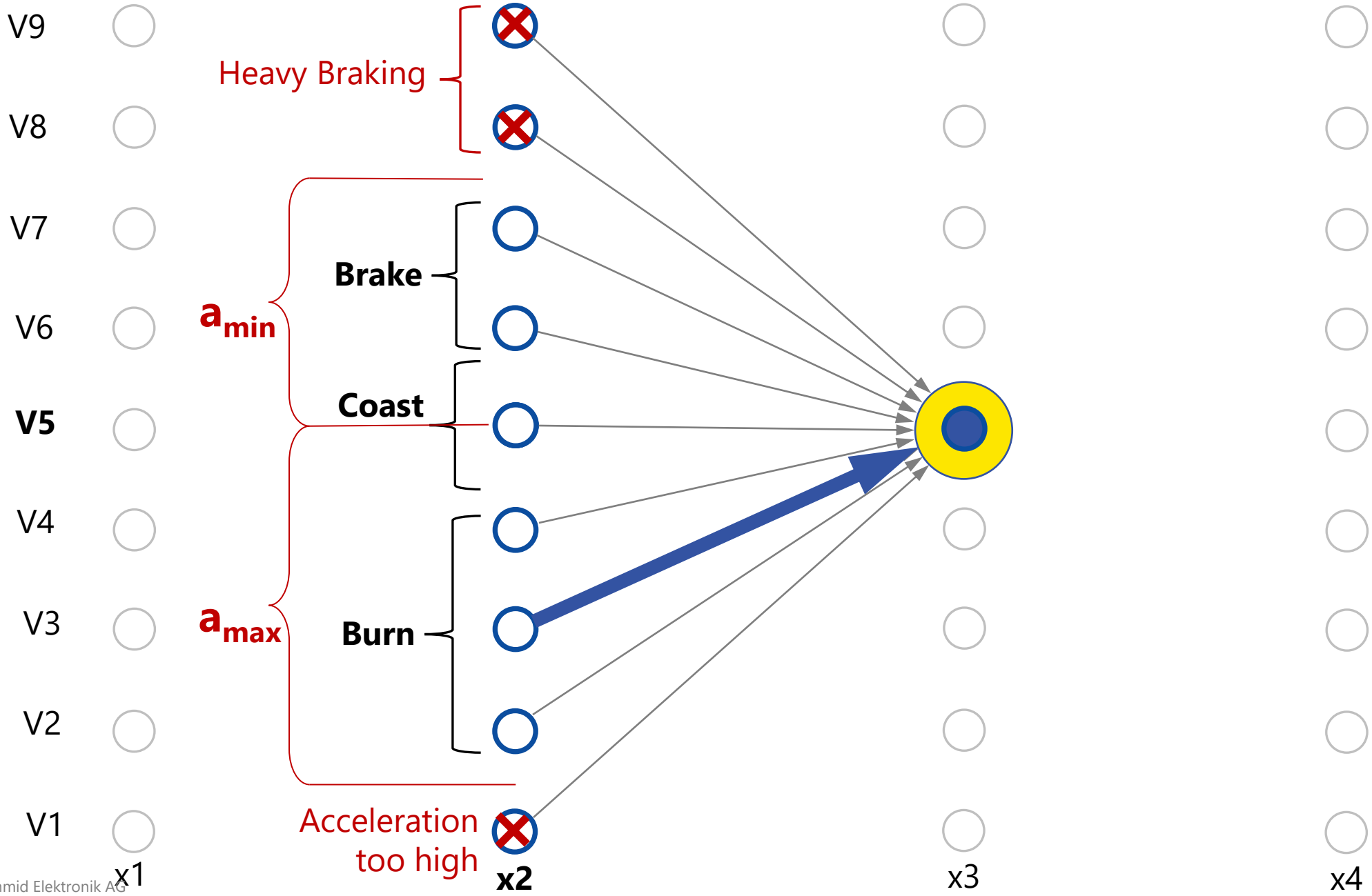
...to powerful Large Language Models (LLM)

...and to our Race Use Case

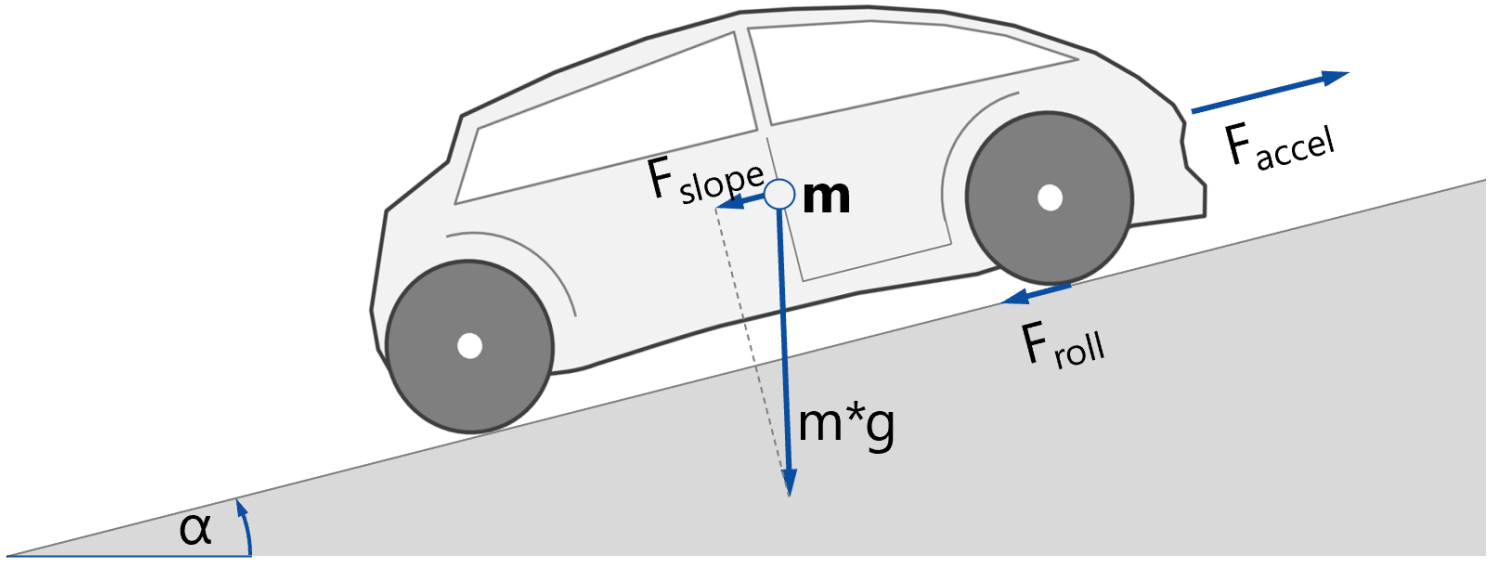
Define the **Nodes** (Vehicle States)

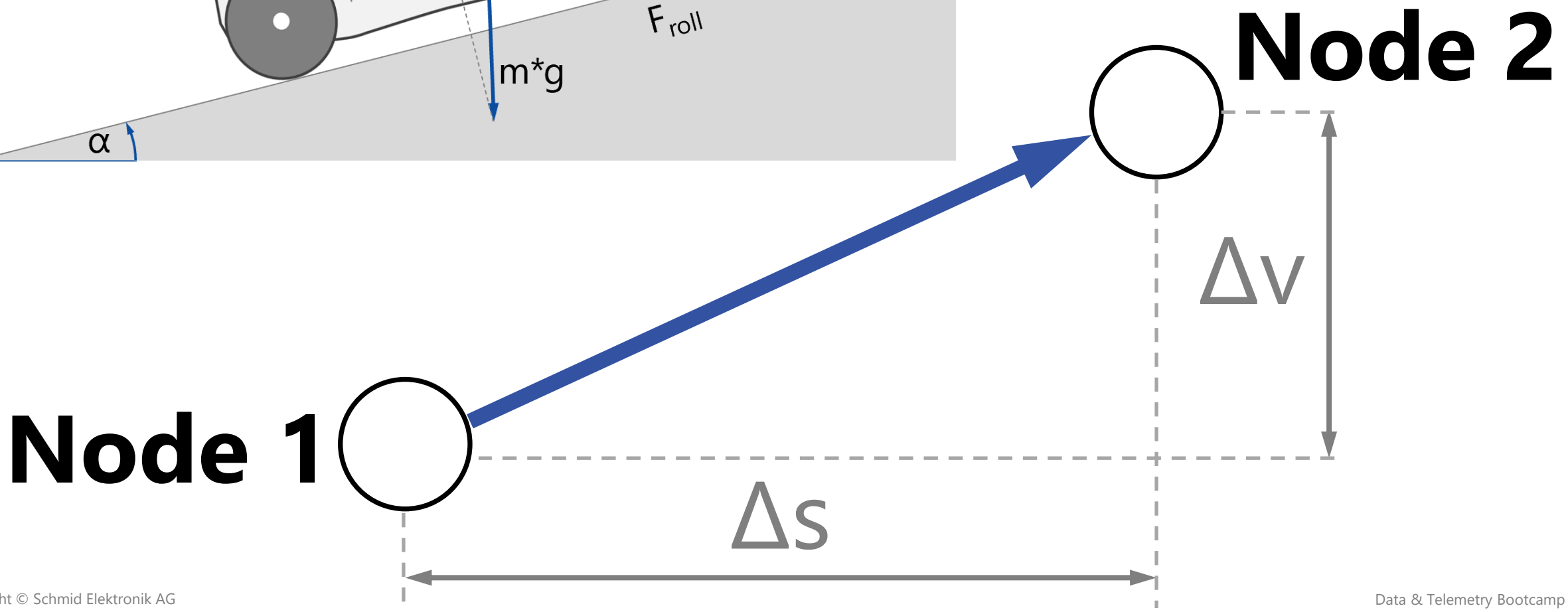


The Graphs **Edges**



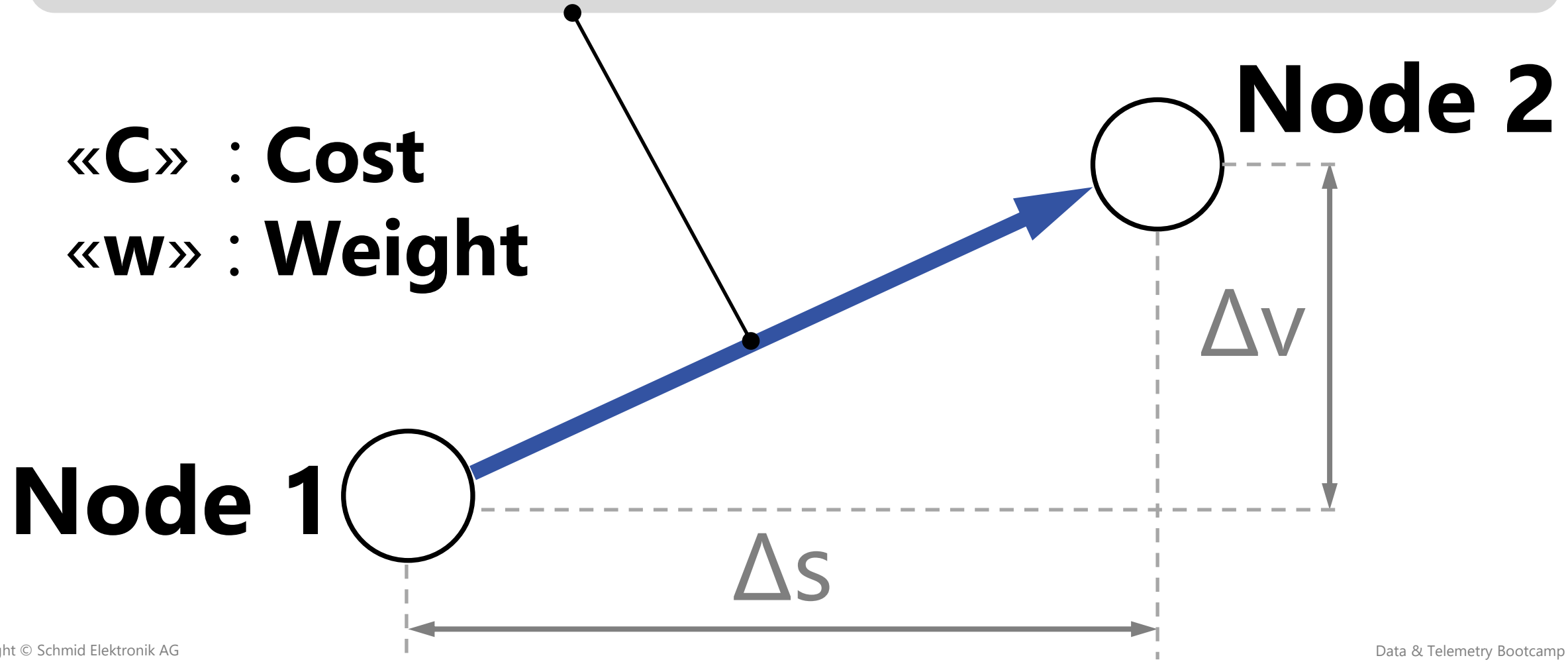
Each **State Change** is a **Decision** with a **Cost**

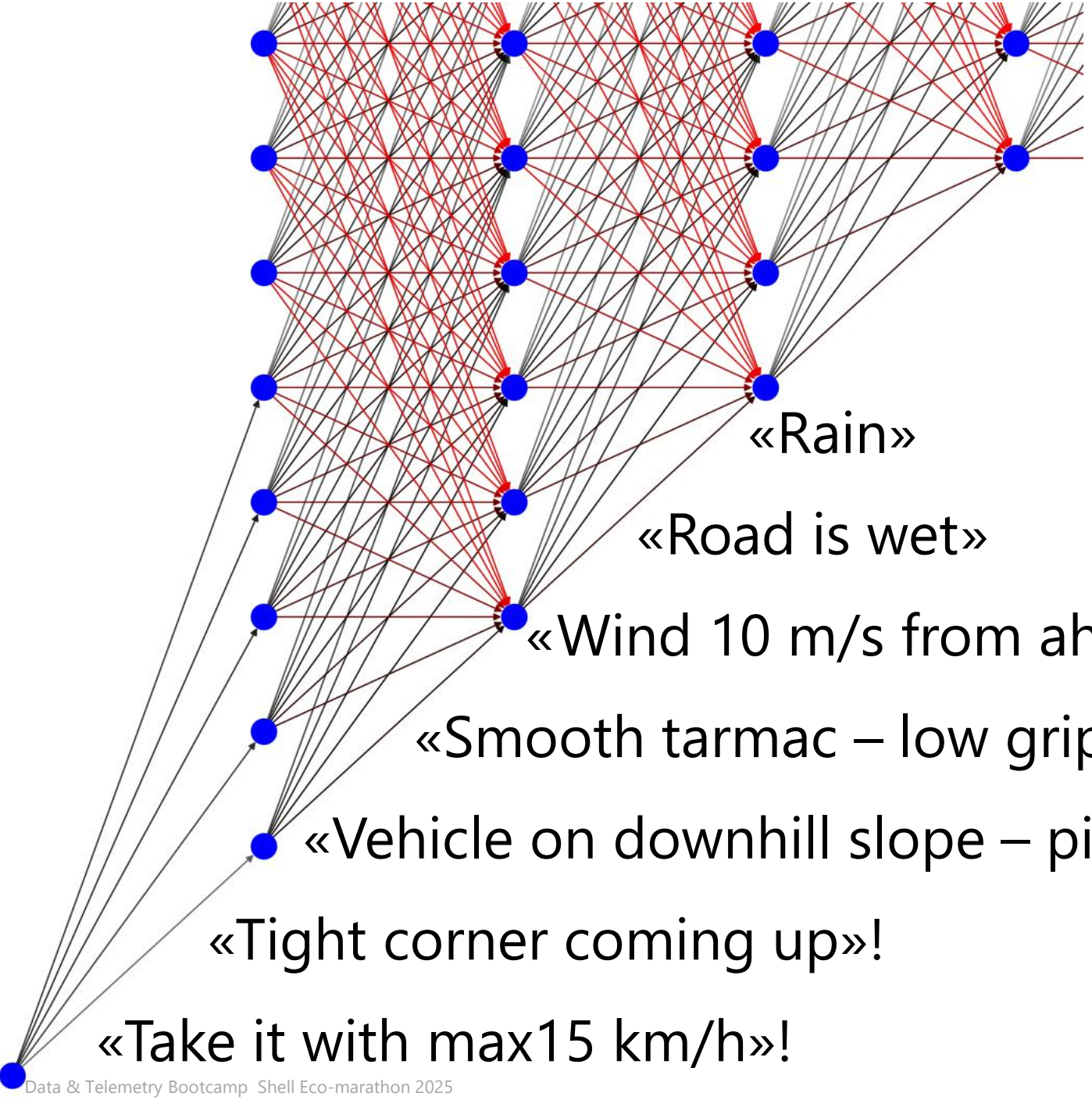




Each **State Change** is a **Decision** with a **Cost**

$$C_{edge} = C_{time} * w_{time} + C_{energy} * w_{energy} \rightarrow \text{MIN!}$$





Meaning

The perfect **speed profile**, **balancing** speed, energy efficiency, safety, vehicle characteristics and external influences

«Rain»

«Road is wet»

«Wind 10 m/s from ahead»

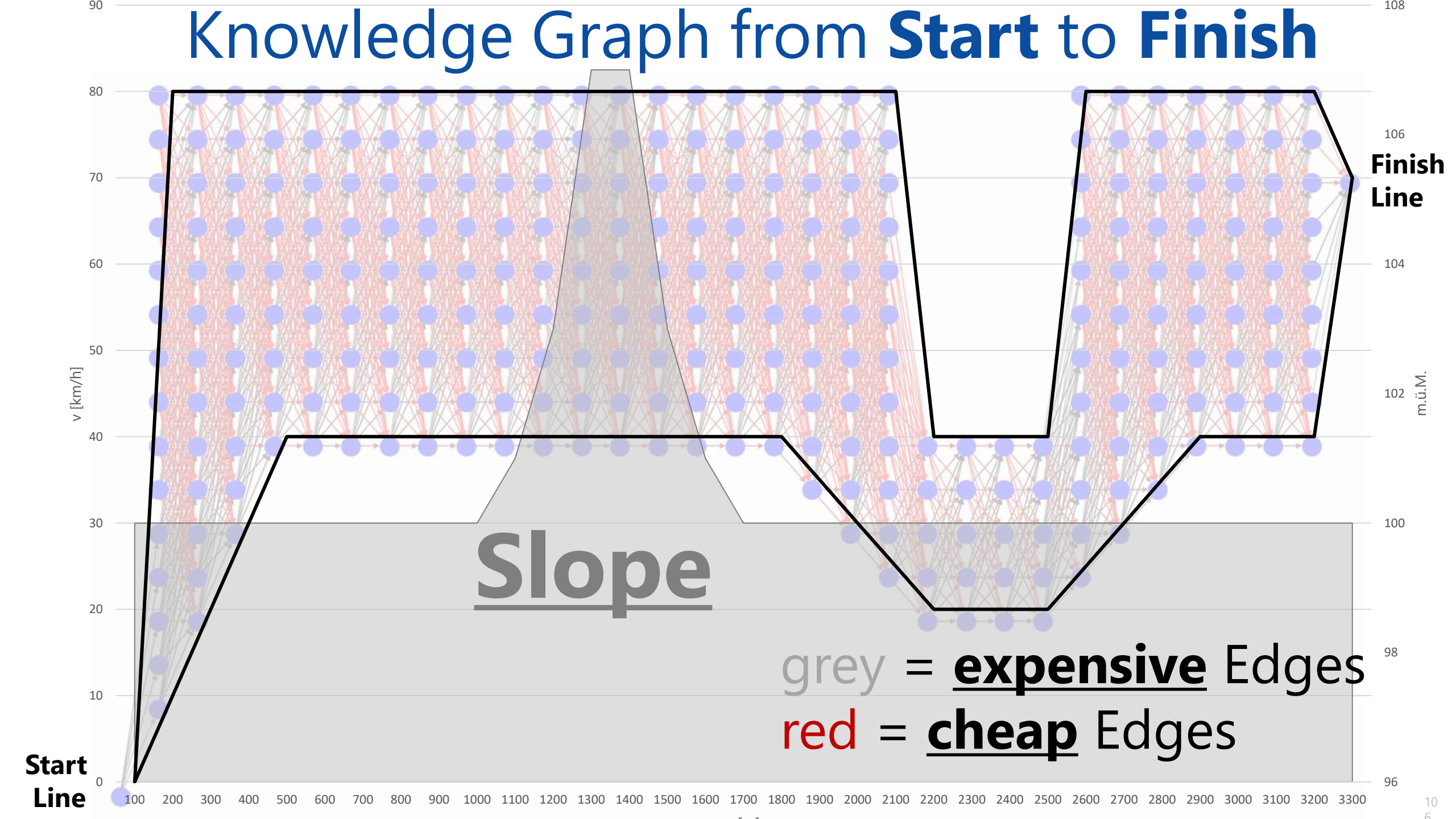
«Smooth tarmac – low grip»

«Vehicle on downhill slope – picking up speed»

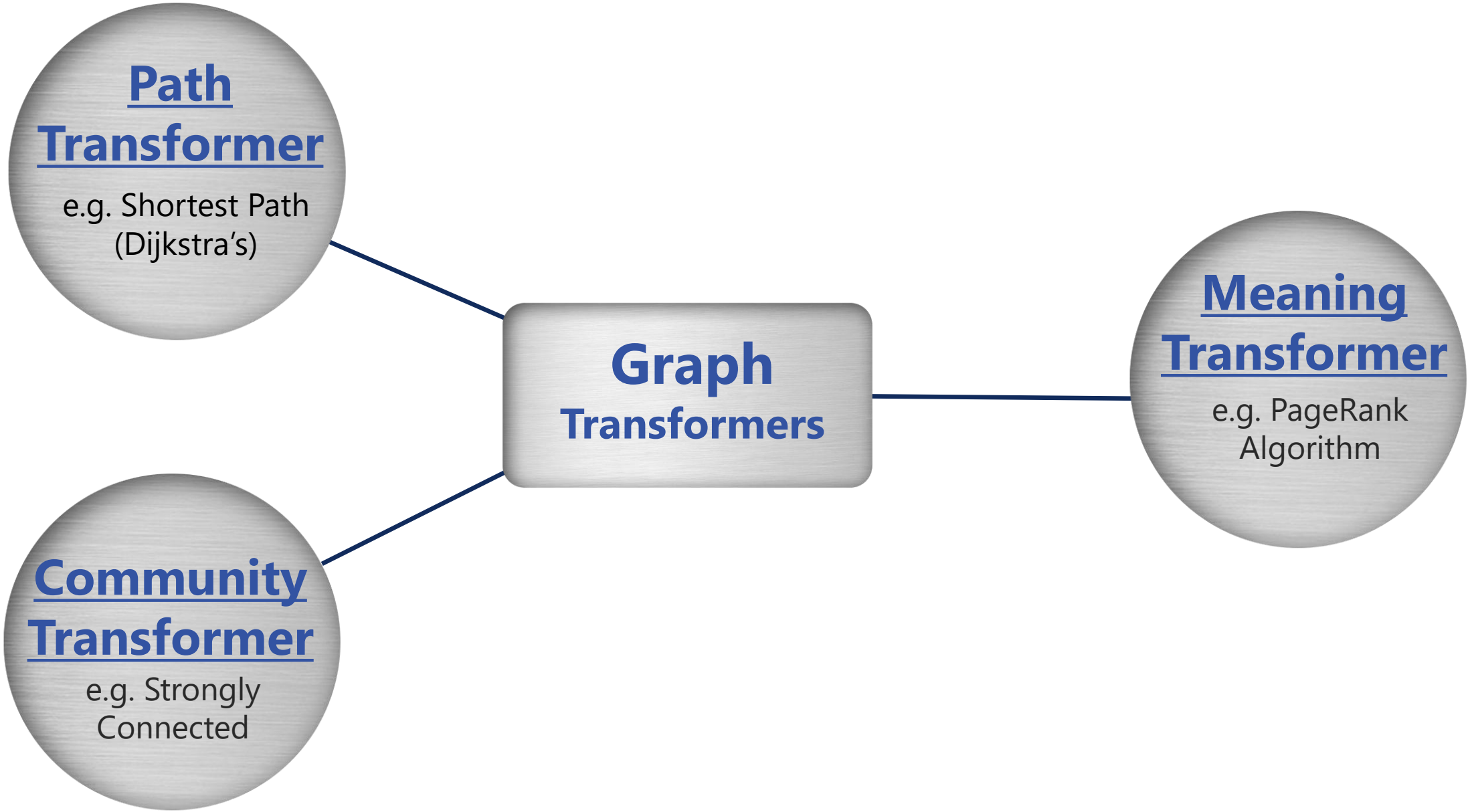
«Tight corner coming up»!

«Take it with max15 km/h»!

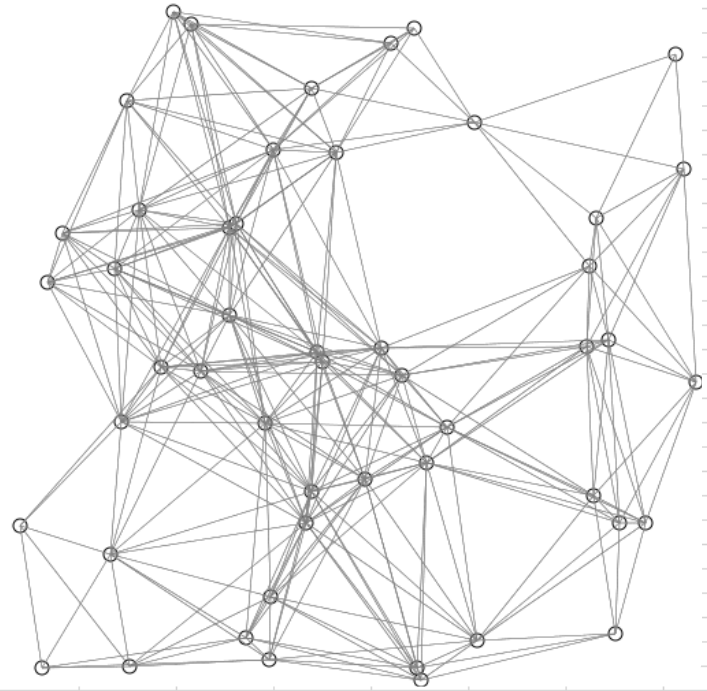
Knowledge Graph from **Start** to **Finish**



Transform a Graph into Meaning



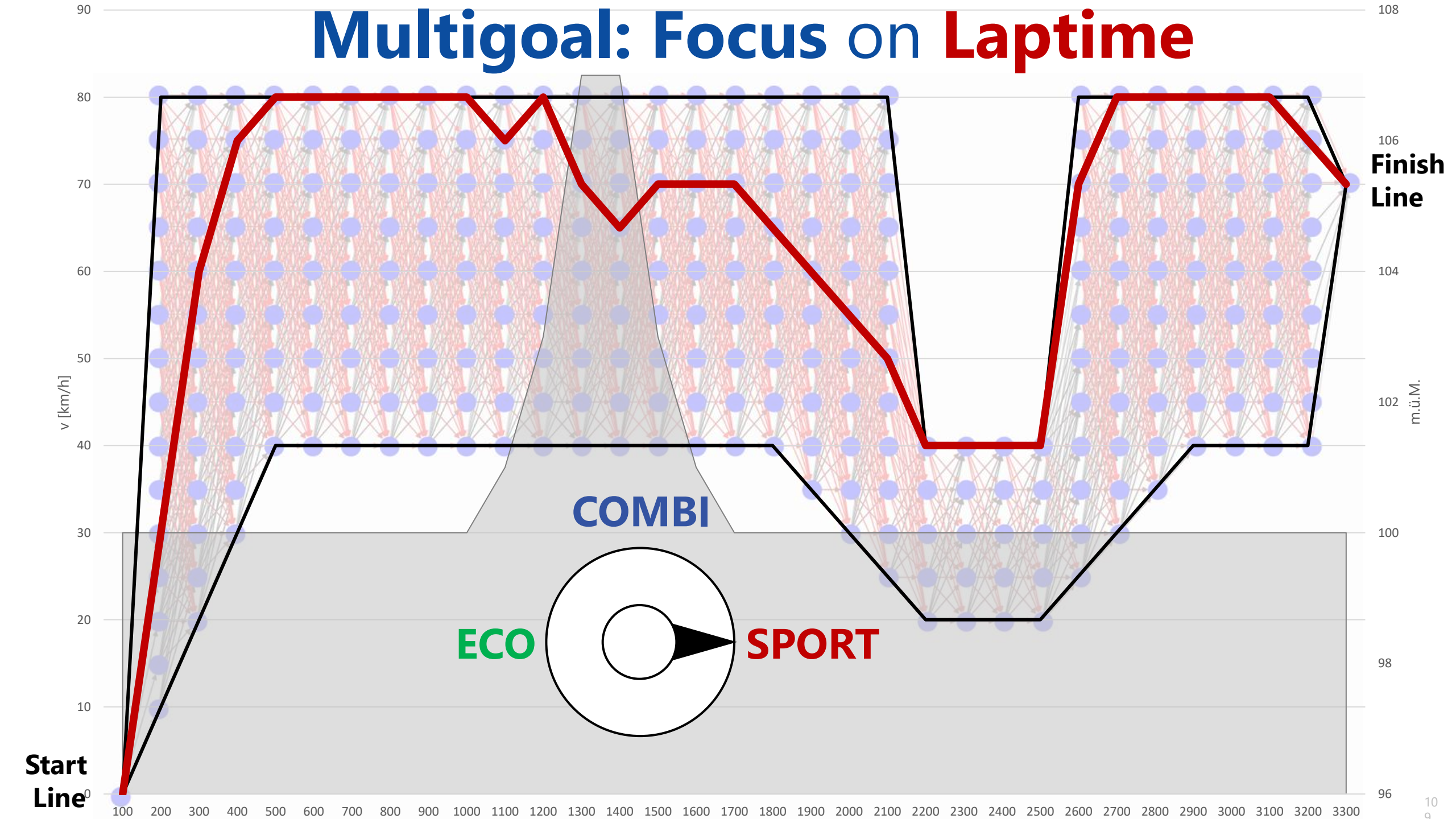
Path Transformer for our Race Problem



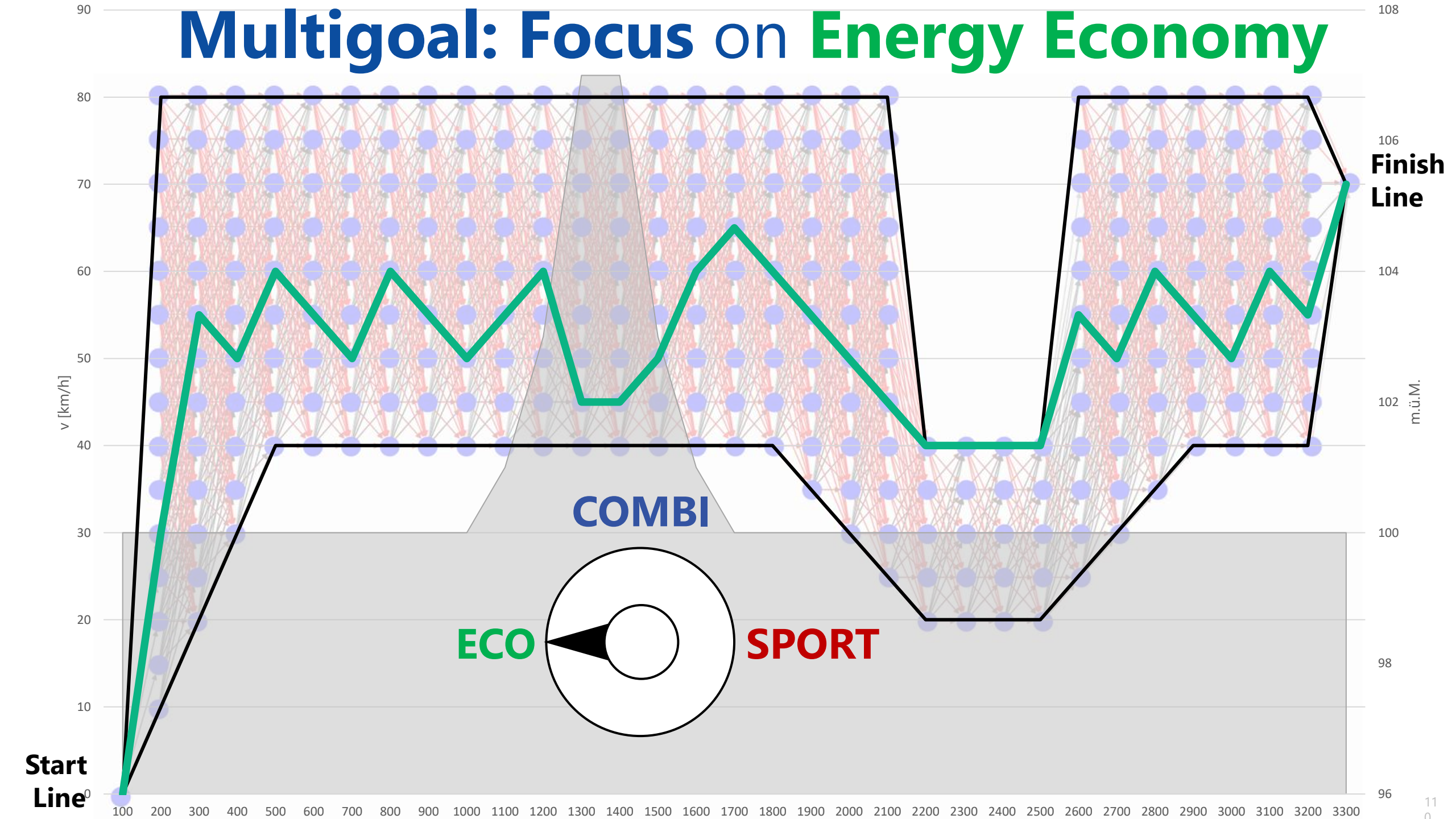
Dijkstra-Algorithm

A*-Algorithm

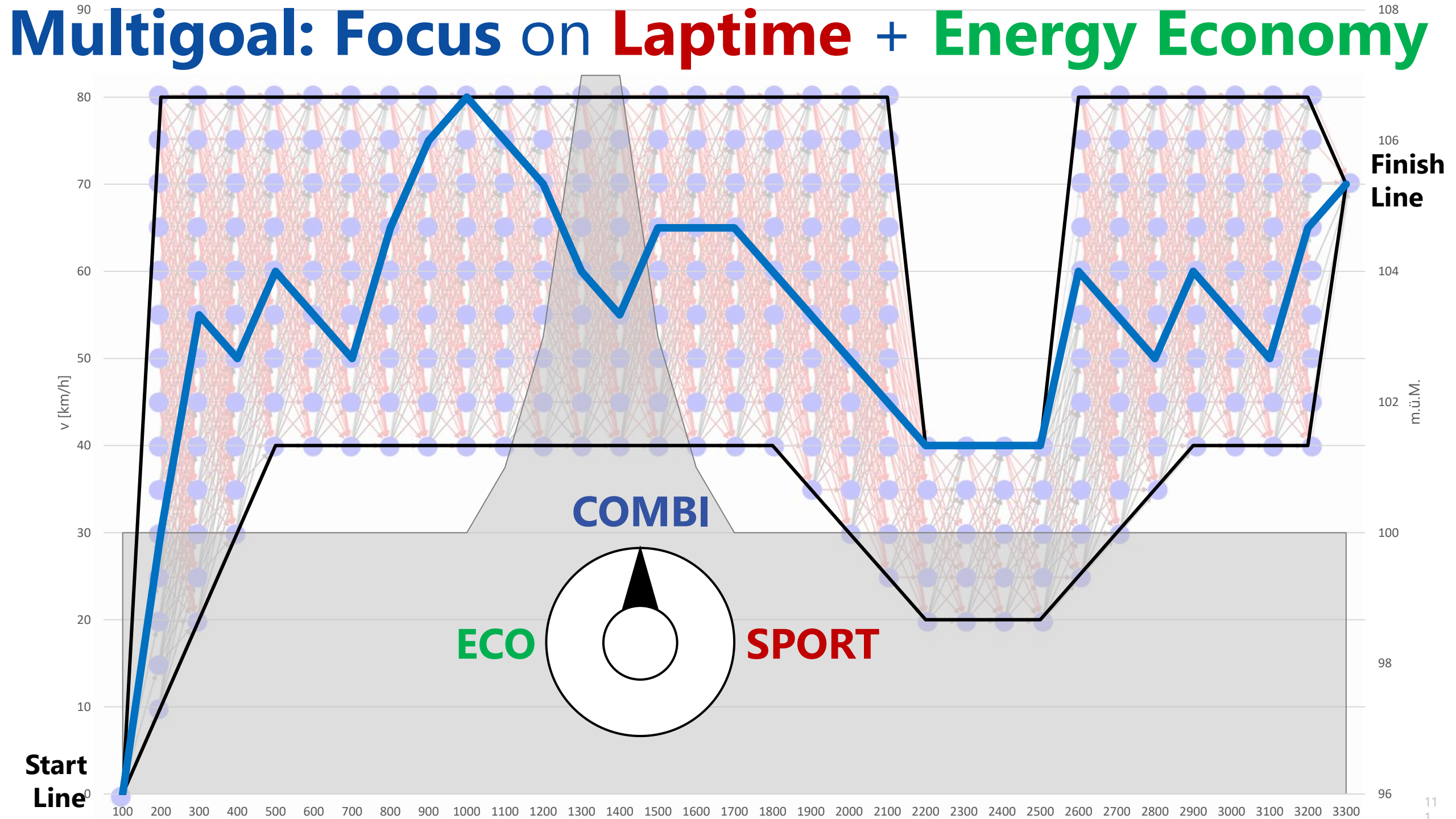
Multigoal: Focus on Laptime



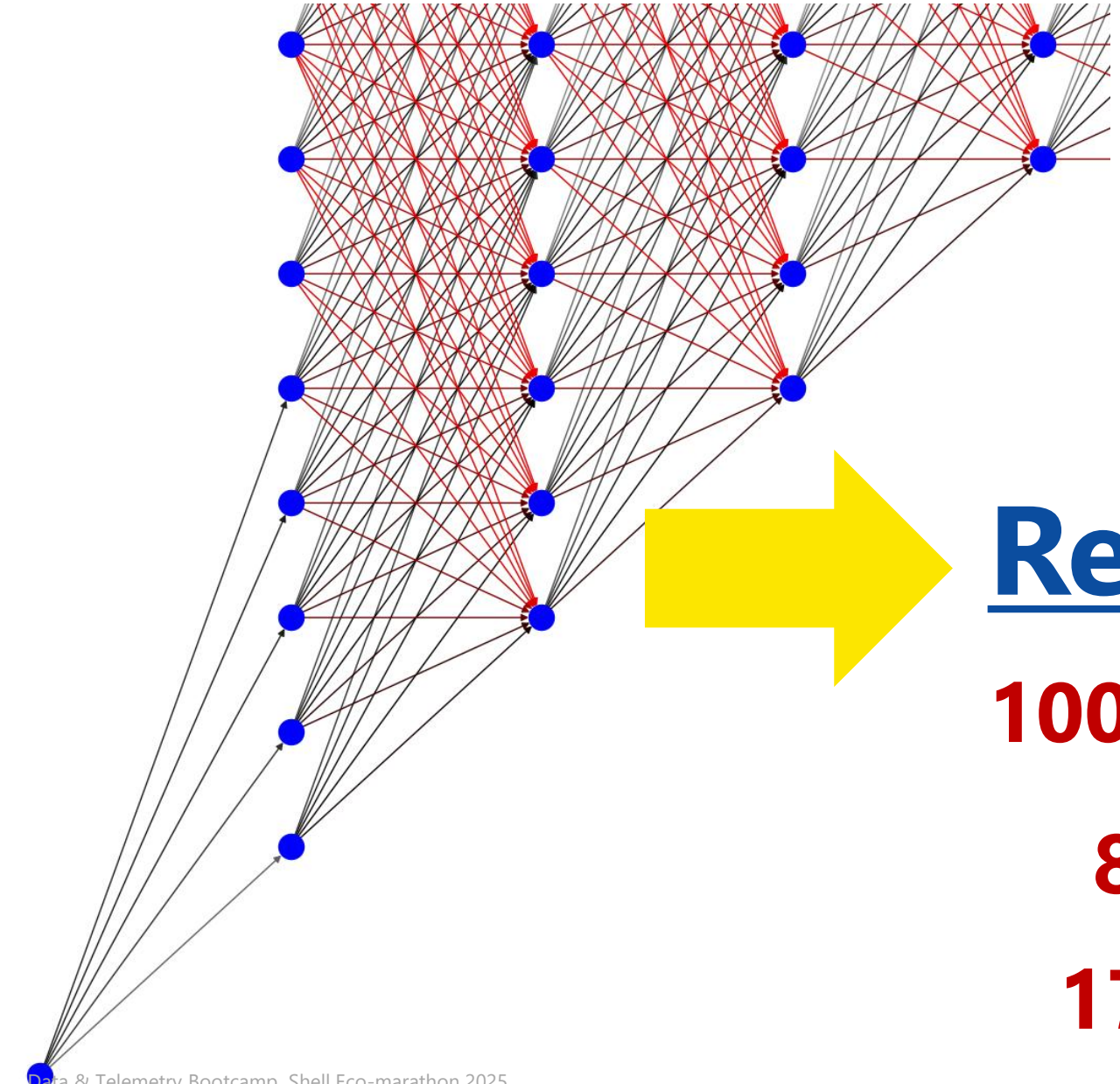
Multigoal: Focus on Energy Economy



Multigoal: Focus on Laptime + Energy Economy



Collecting **Knowledge** in the Nodes and Edges



Result:

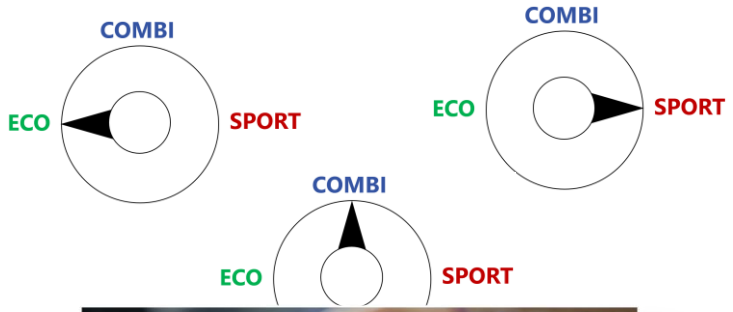
100% Accident-free Attempts

8% Shorter Lap Times

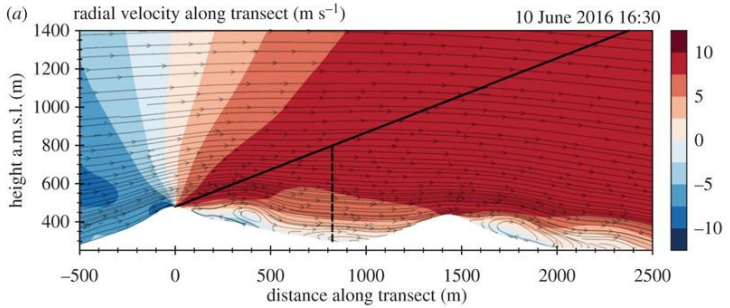
17% Higher Energy Efficiency

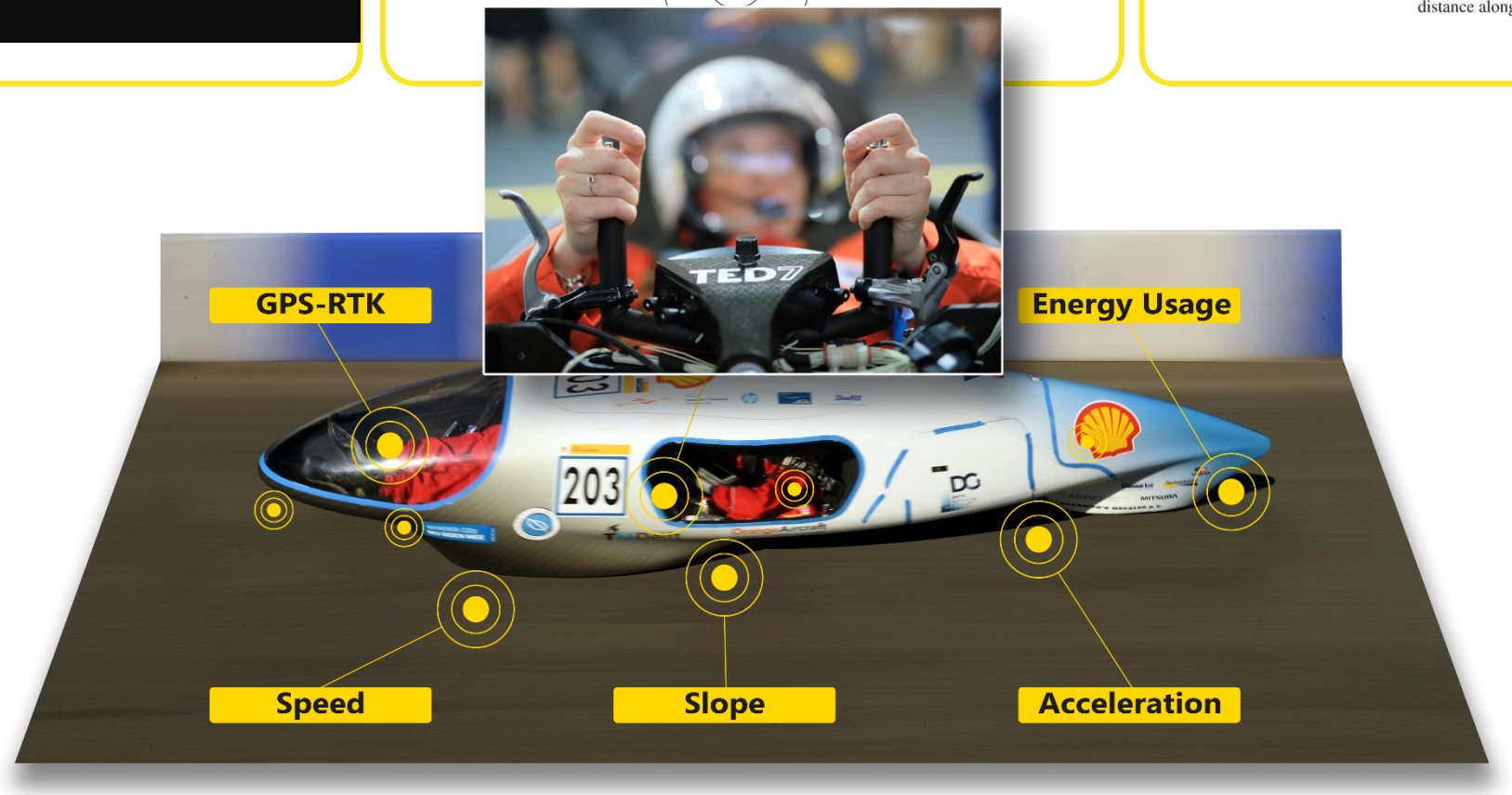
Include and adjust with **Telemetry Data**

Dynamically Changed **Driving Patterns**



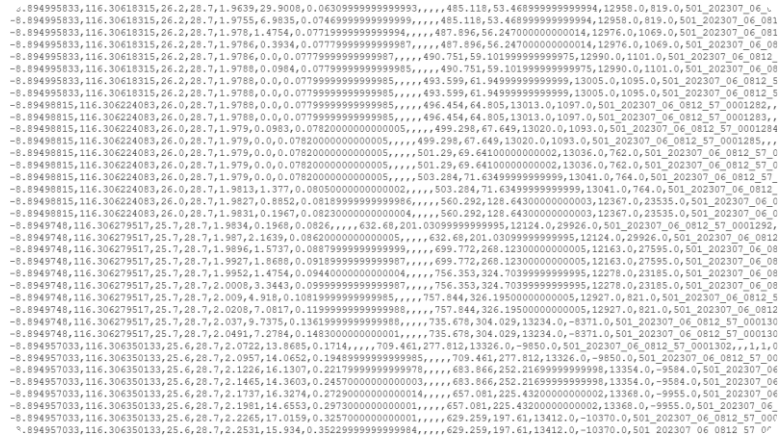
Include dynamic **Wheather Data**

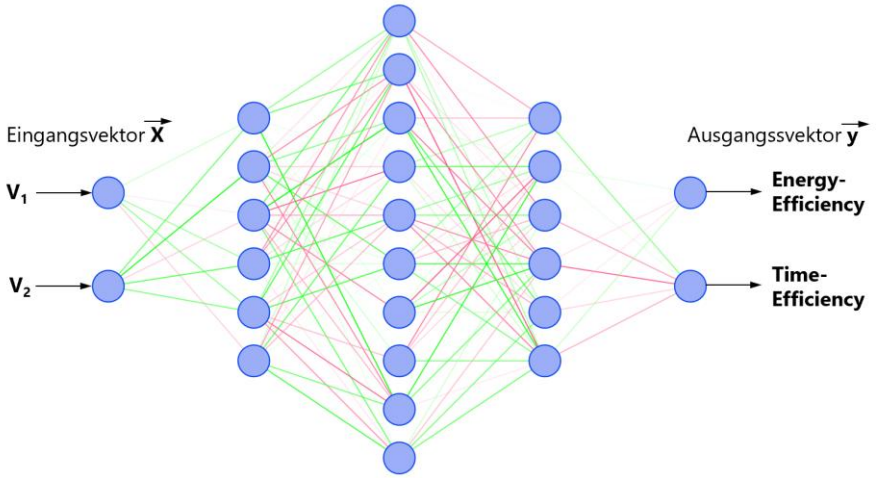


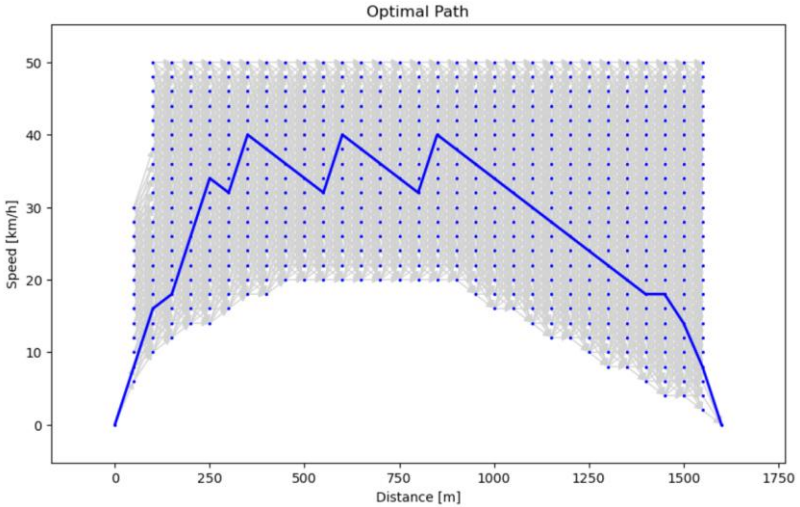


Then move to Neural Networks with DL/ML

NEW 2026







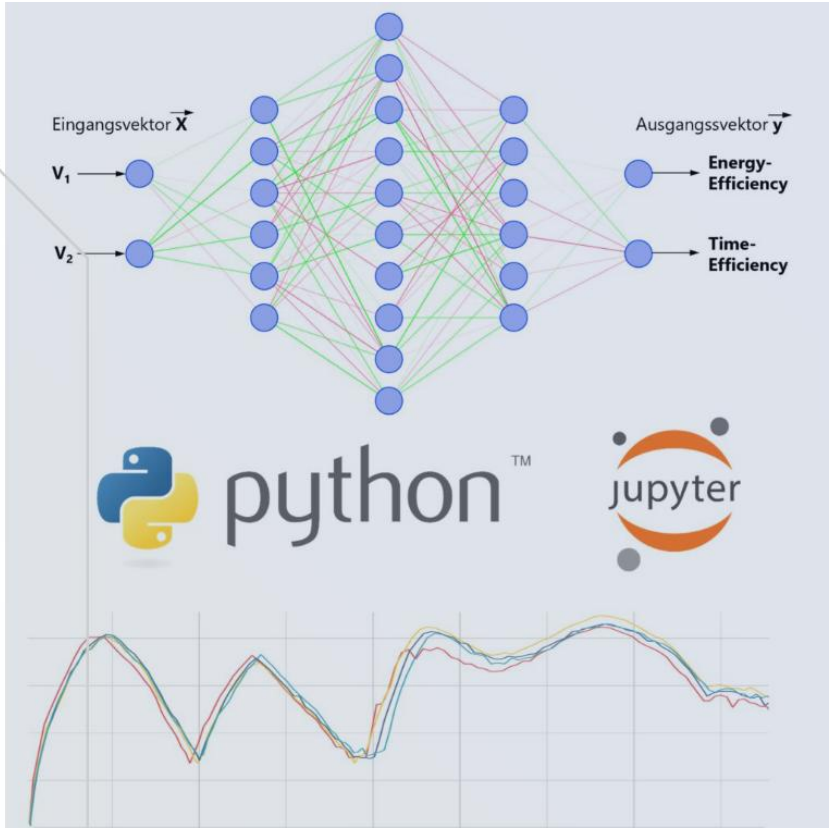
Python Sandbox **#3** Use AI with real Race Data

Programming Sandbox #3

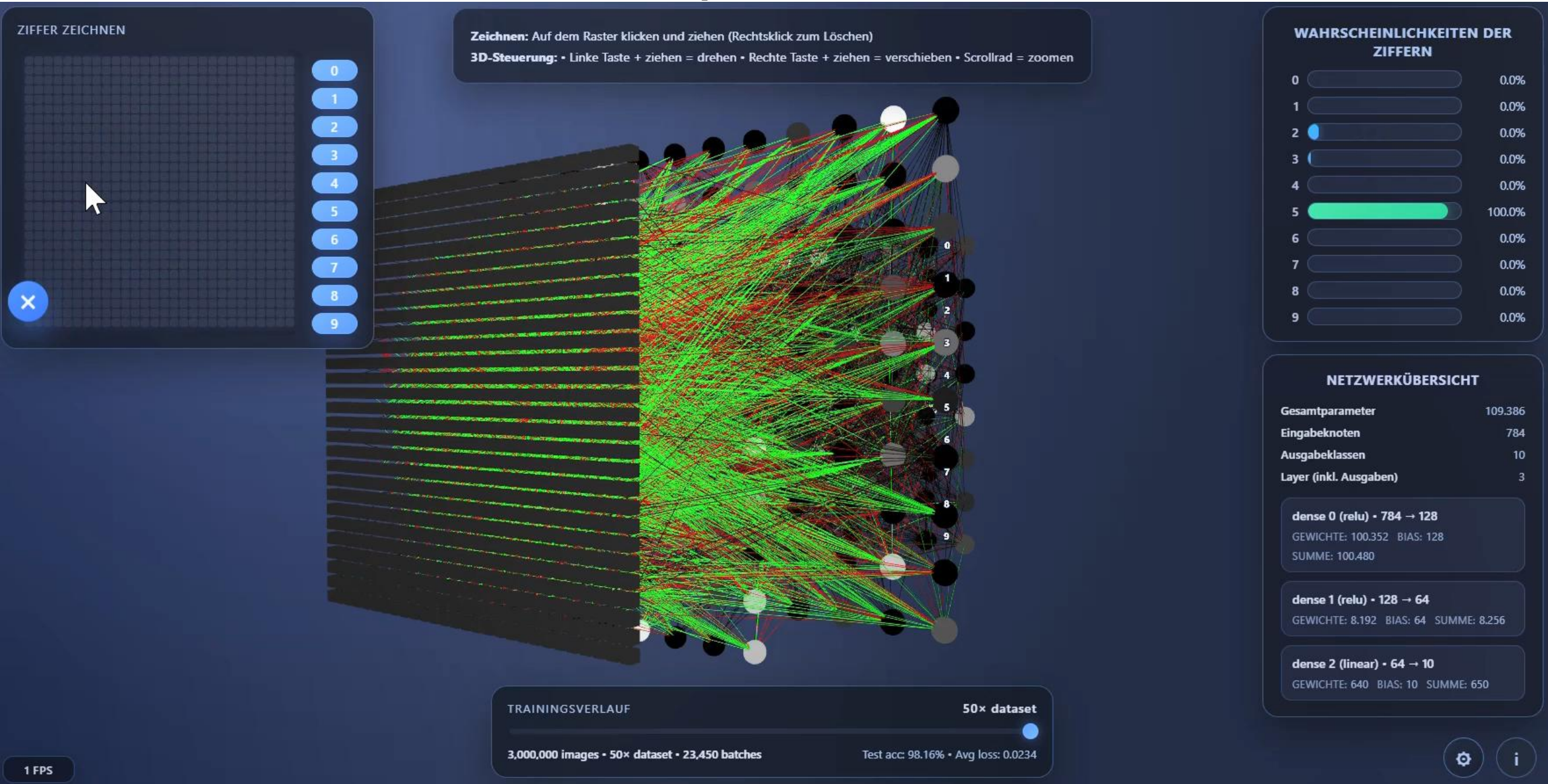
JUPYTER NOTEBOOK AND PYTHONCODE FOR LEVEL-5 (AI-APPROACH WITH NN, DL UND ML)

Start Jupyter Notebook in your browser (Binder, ~1-2 min.) and play with Python. There is some real race data waiting for you and you experiment with a neural network, deep learning and machine learning. Save the source code locally, because when you close the browser, the environment will be gone.

START SANDBOX #3 IN YOUR BROWSER ▷



Tinker with NN: https://nn-vis.noelith.dev/



The Sky is the Limit...

Train LLMs &
Race Agents

Vehicle Health
Monitoring

Efficiency
Prediction

CollisionWarning

ADAS

Use
Oponents

Driver Training
(Simulator)

Environment
- Wind
- Rain

Gameification

etc, etc, etc

Level 5

Holistic: Advanced Data-Driven Racing

Level 4

Modelling: Maintain physics based Digital Twin

Level 3

Live Data: Send Data from the Track to the IoT

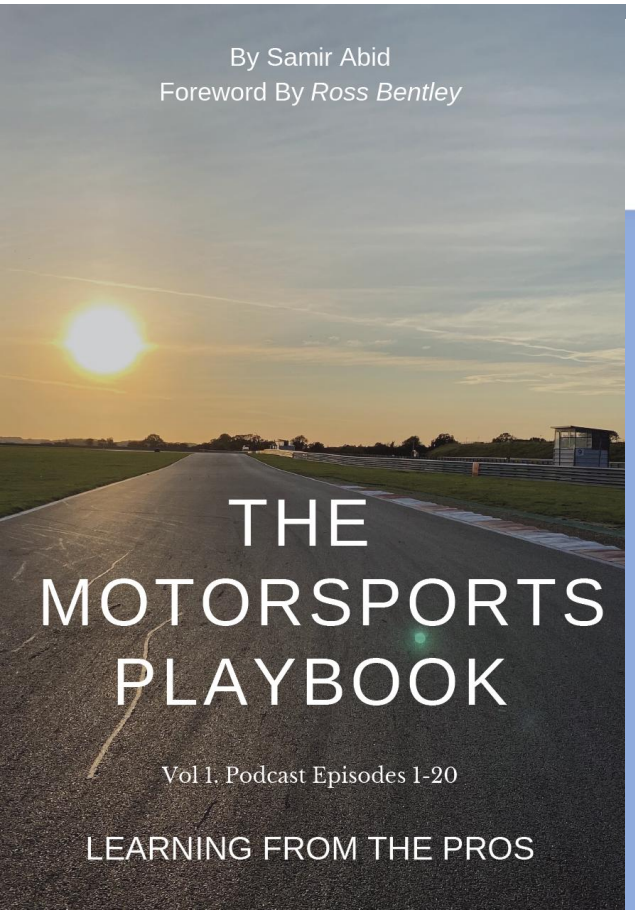
Level 2

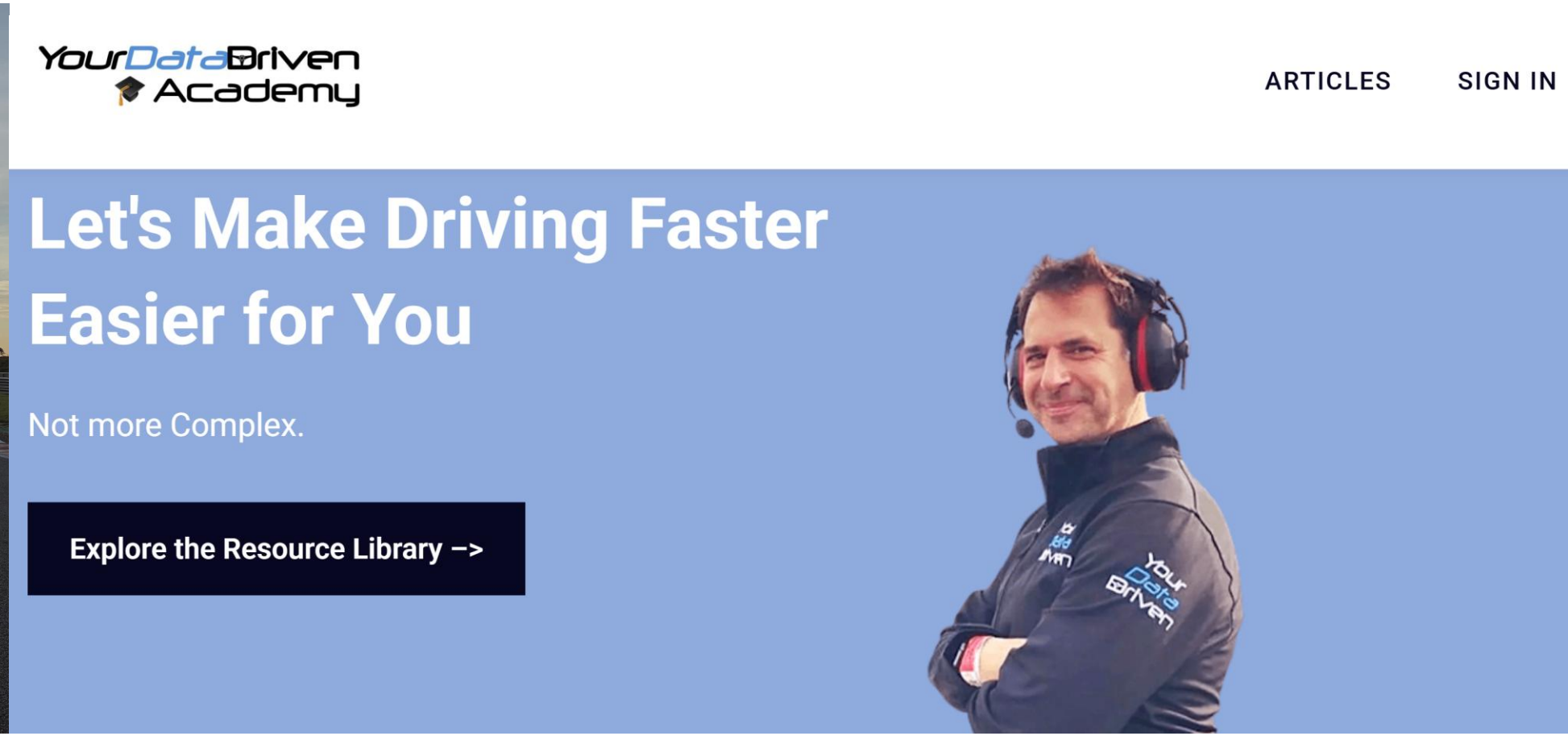
Data Analytics: Recognize Correlations and Patterns

Level 1

Telemetry: How to create relevant Race Data on Track?

Check out this guys Ressources



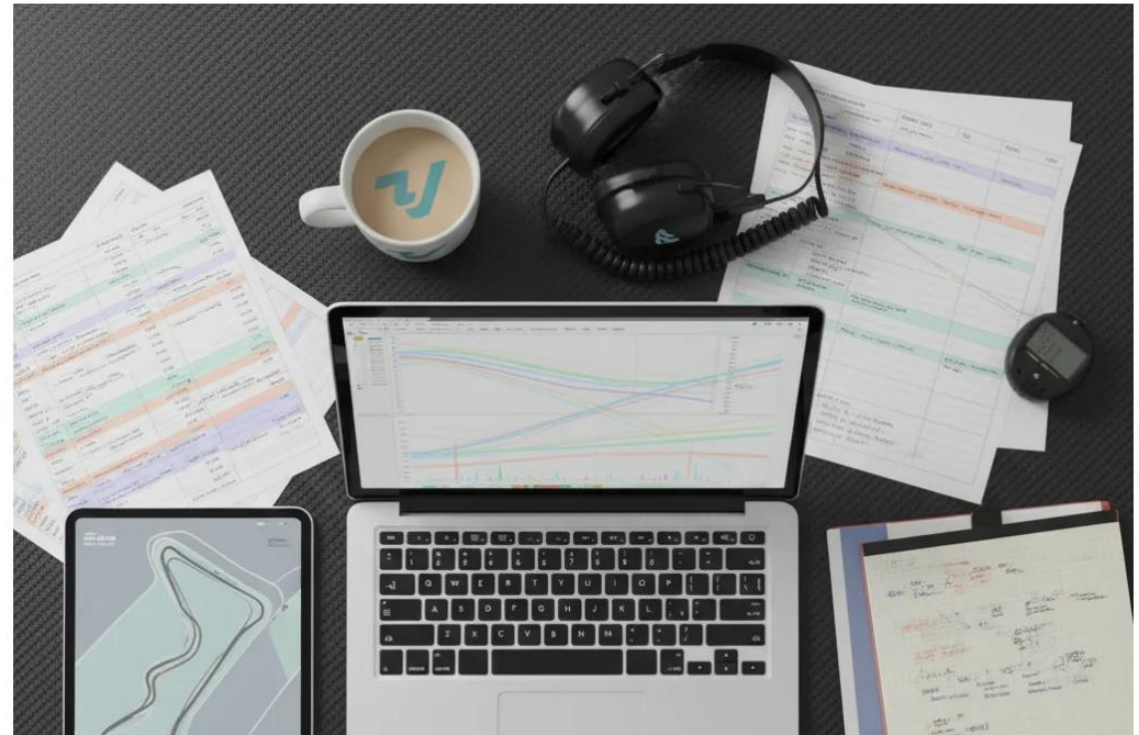


academy.yourdatadriven.com

Chapter 5: F1 Telemetry — 10 Chapter Python course using F1 data with the FastF1

Learn Python with F1 Data

Raul Garcia Following 16 min read · Oct 22, 2025



About Marco Schmid

Business

- CEO
- Head of R&D
- Owner

Private

- Married, two kids
- Year of construction: 1969
- Cooking, Wines
- Travelling, Nature, Camping
- Skiing
- Rollerblades

Technical Interests

- Embedded-Systems
- IoT-Systemes, Telemetry
- Knowledge Graphs / AI
- LabVIEW
- Minimum Viable Products
- Complexity
- Networks
- Shell Eco-marathon Trainer

Communities

SCHMID Elektronik | Shell Eco-marathon Partner

SWISS ENGINEERING STV UTS ATS

SWISS ENGINEERING ARTIFICIAL INTELLIGENCE

Partner SYSTEM INTEGRATION

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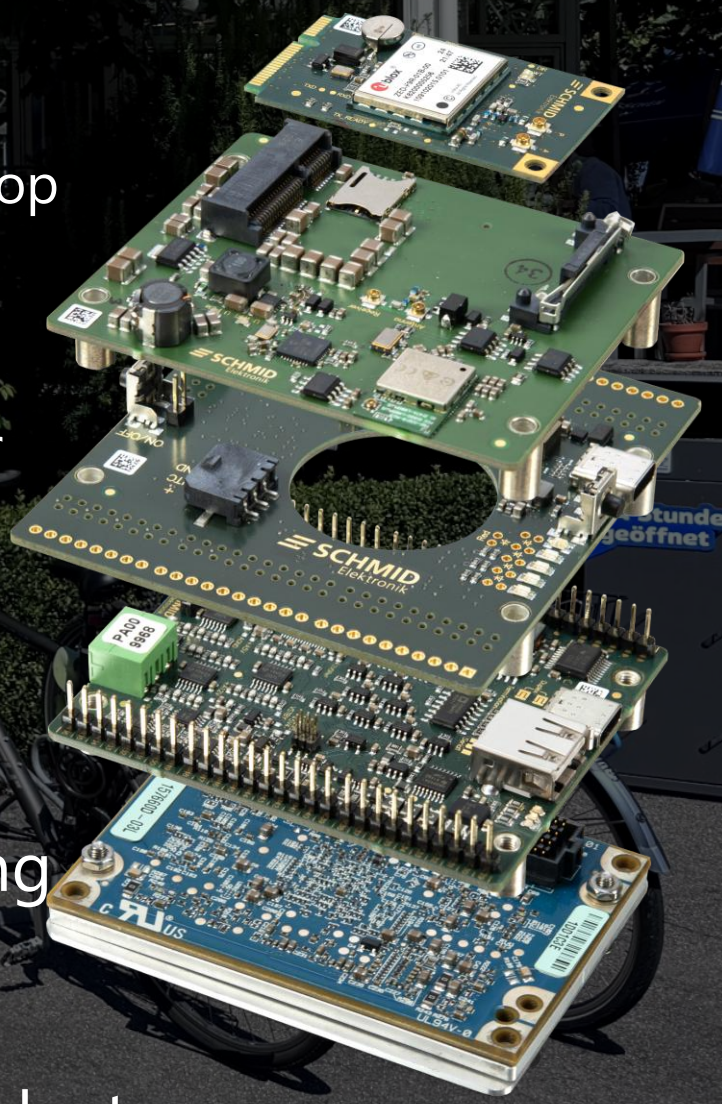
schmid-elektronik.ch

SCHMID Elektronik

- Family SME
- Elektronic one-stop-shop
- 38 Poeple
- 50+ Years
- Shell Partner
- NI Partner

- Design
- Prototyping
- MVPs
- Series Products



SCHMID Elektronik

Shell Eco-marathon Partner

Partner

SYSTEM INTEGRATION