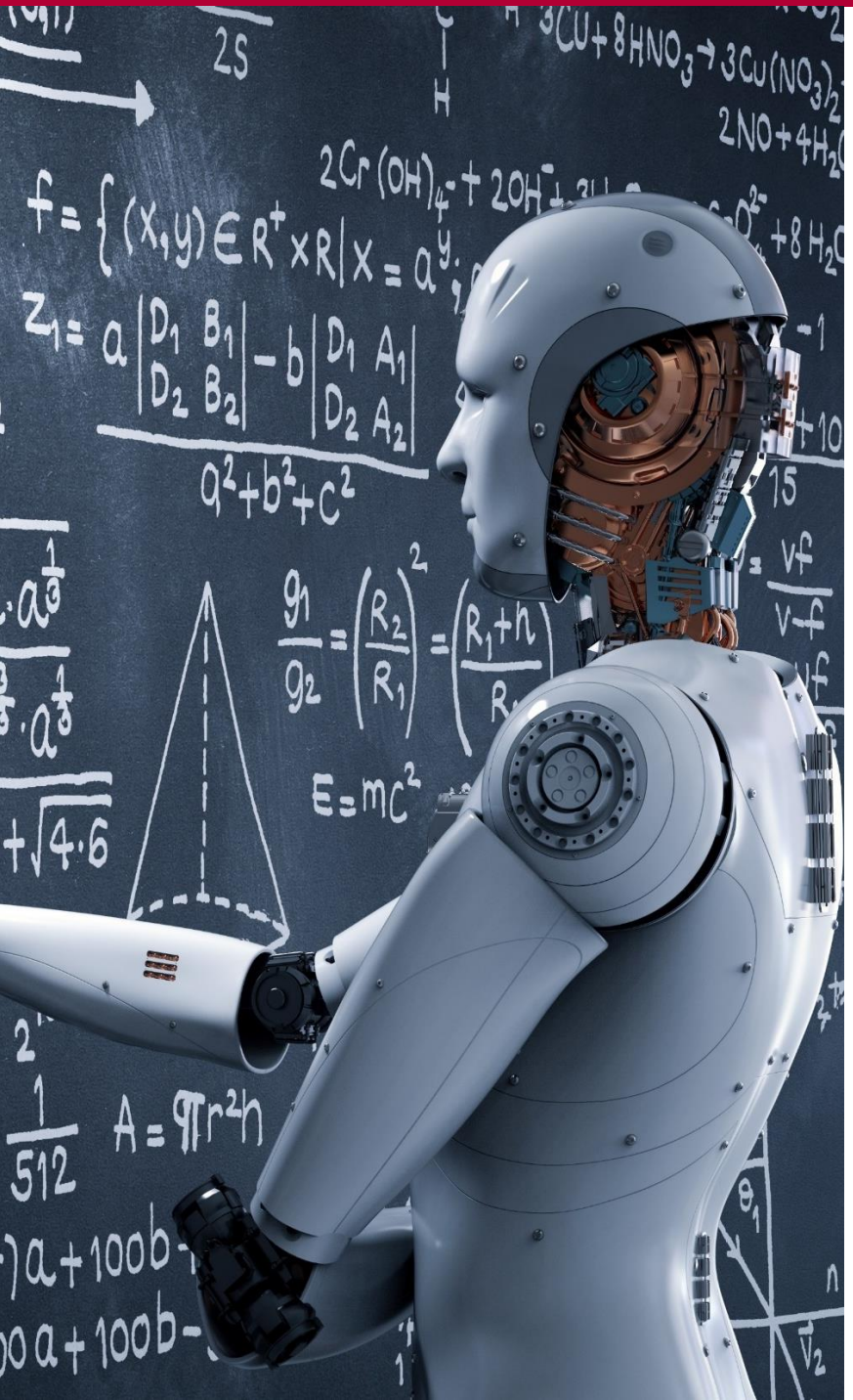

Research Center for
Information Management

Fraunhofer
FIT

Smart Sustainability Simulation Game

Case 1: Material Procurement - Unit 1
30.04.2024

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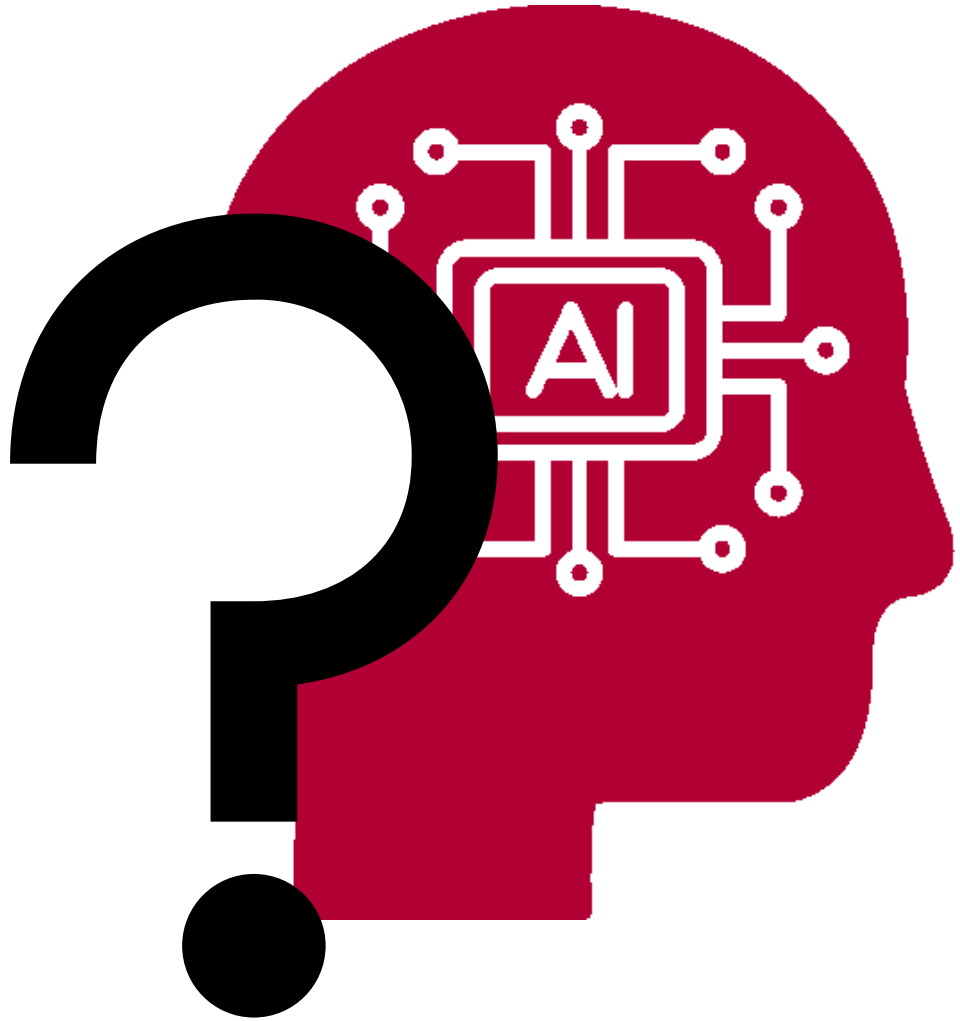
01

Organizational information

Rescheduling of Live Sessions due to holidays



Did all groups connect with each other?

02

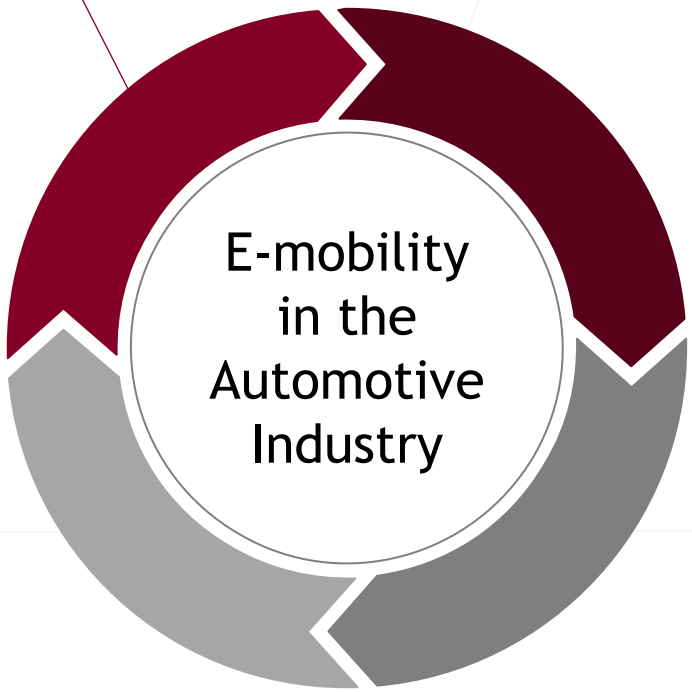
Case 1: Material Procurement - Unit 1

Overview of the cases

Case 1: Material procurement

- What materials should I buy and when?
- Value chain level: Procurement

→ Time Series Analysis



Case 2: Predictive Maintenance

- How often and when should I maintain my machine?
- Value chain level: Operations/production

→ Predictive Analytics

Case 4: Recycling

- How much effort do I put into recycling?
- Value chain level: After-sales-services

→ Process Mining

Case 3: Quality Management

- How to ensure good quality?
- Value chain level: Operations/production

→ Computer Vision

Procurement as a precondition for production

Procurement consists of the management of inventories, the control of incoming goods or the determination of the demand for raw materials and supplies. You use strategies for this and adapt the possibilities to the respective market situation.

- Obtaining and evaluation of offers
- Analysis of market situation
- Negotiation of conditions
- Preparation of contracts

Two types of procurement

What is operational procurement?

- Operational procurement department fulfills the **daily business** of a procurement department
- Operational procurement is responsible for the **continuous demand fulfillment** of a company from the point of view of **economic efficiency**
- Takes care of the **administrative** activities and **performing** procurement process:
  - Ordering and schedule tracking
  - Returns and reclamations
  - Meetings with suppliers and service providers

What is strategic procurement?

- Strategic procurement ensures the optimal **long-term demand fulfillment** of a company
- In essence, strategic procurement focuses on making strategic purchasing decisions
- Different activities ensure that the best decisions are made:
  - Conducting of market analysis
  - Price negotiations
  - Supplier selection and contracting

Challenges in strategic procurement

- Complex **web of suppliers** and **fluctuating prices** complicate procurement decisions
- Not only the price should be the determining factor, but also a **qualitative evaluation** of the offer is important
- **Sustainable procurement** is becoming increasingly important for building **customer relationships**
- **Big Data analysis** of pricing and supplier data enables **evidence-based** decision making

What is „Time Series Analysis“?

Time series analysis refers to all the methods, techniques, and models you can use to monitor and extract insights from time series data and its evolution in time.

Time series analysis helps organizations understand the underlying causes of trends or systemic patterns over time.

Time Series Analysis – Important Concepts

Trend Analysis

Identifies long-term movement in data (upward, downward, or null trend)

Example: User/sales/consumption (de-)growth

Seasonality:

Involves periodic fluctuations at consistent intervals, like holiday sales trends.

Example: seasonal sales of vegetables, traffic during holidays

Cyclicality:

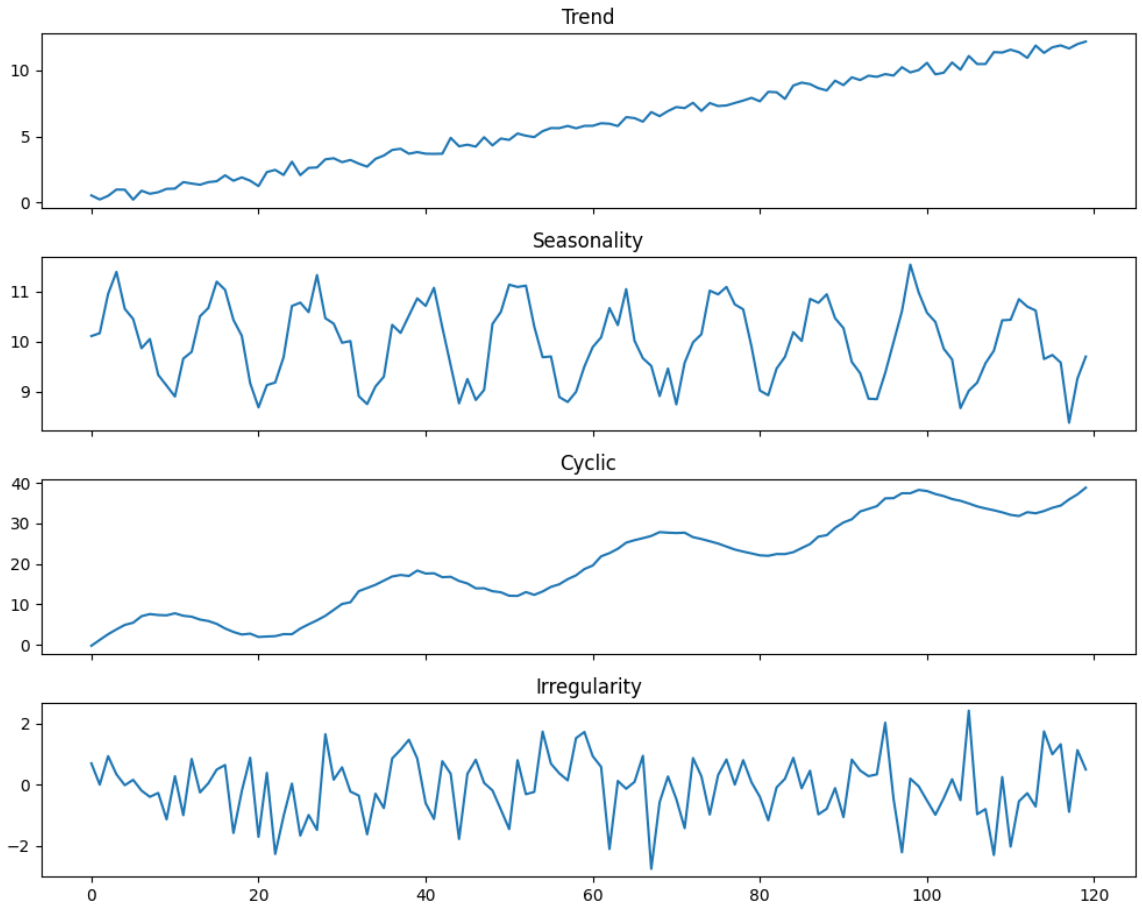
Describes fluctuations over extended periods (years/decades) not tied to seasonality.

Example: Growing BIP, demographical change in population

Randomness or Irregularity:

Represents unexpected, unpredictable events affecting the data.

Example: occurrence of natural disasters



Cryer, Jonathan D. Time series analysis. Vol. 286. Boston: Duxbury Press, 1986

Efron, Bradley, and Trevor Hastie. Computer age statistical inference, student edition: algorithms, evidence, and data science. Vol. 6. Cambridge University Press, 2021

Overview of time series analysis models and methods

TSA Toolbox

Traditional (univariate) Models | *Machine Learning Models*

Autoregression

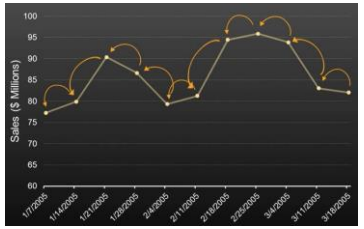
An autoregressive model forecasts the variable of interest using a linear combination of past values of the variable (called *lags*)

The term autoregression indicates that it is a regression of the variable against itself.

AR(*p*) model:

$$Y_t = c+\phi_1 y_{t-1}+..+\phi_p y_{t-p}+\varepsilon_t$$

Example of AR(1)



Moving Average

A moving average model forecasts the variable of interest using a linear combination of past errors of the series (called *error lags*) in a regression-like model.

MA(*q*) model:

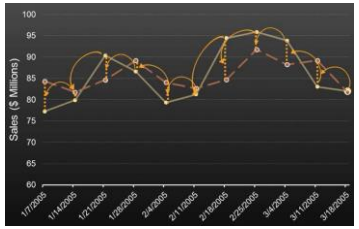
$$Y_t = c+\theta_1\varepsilon_{t-1}+\cdots+\theta_q\varepsilon_{t-q}+\varepsilon_t$$

$$Y_{t-1} = c + \theta\varepsilon_{t-2} + \varepsilon_{t-1}$$

$$Y_t = c + \theta\varepsilon_{t-1} + \varepsilon_t$$

$$Y_{t+1} = c + \theta\varepsilon_t + \varepsilon_{t+1}$$

Example of MA(1)



ARMA / ARIMA

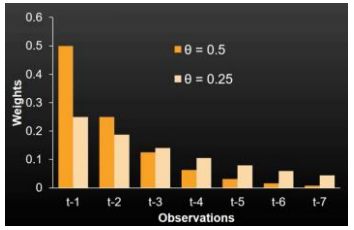
An ARMA model combines the approaches of the AR and MA models. Thus, the impact of previous lags along with the errors is considered for forecasting the future values of the time series.

An ARIMA model is a combination of an ARMA model with a number of differences applied on it in order to make it stationary (Integration).

Exponential Smoothing

Exponential smoothing models work by assigning exponentially decreasing weights for past observations to forecasting future values of the time series.

Exponential smoothing is generally used to make forecasts based on prior assumptions (e.g., seasonality or systematic trends).



Machine Learning

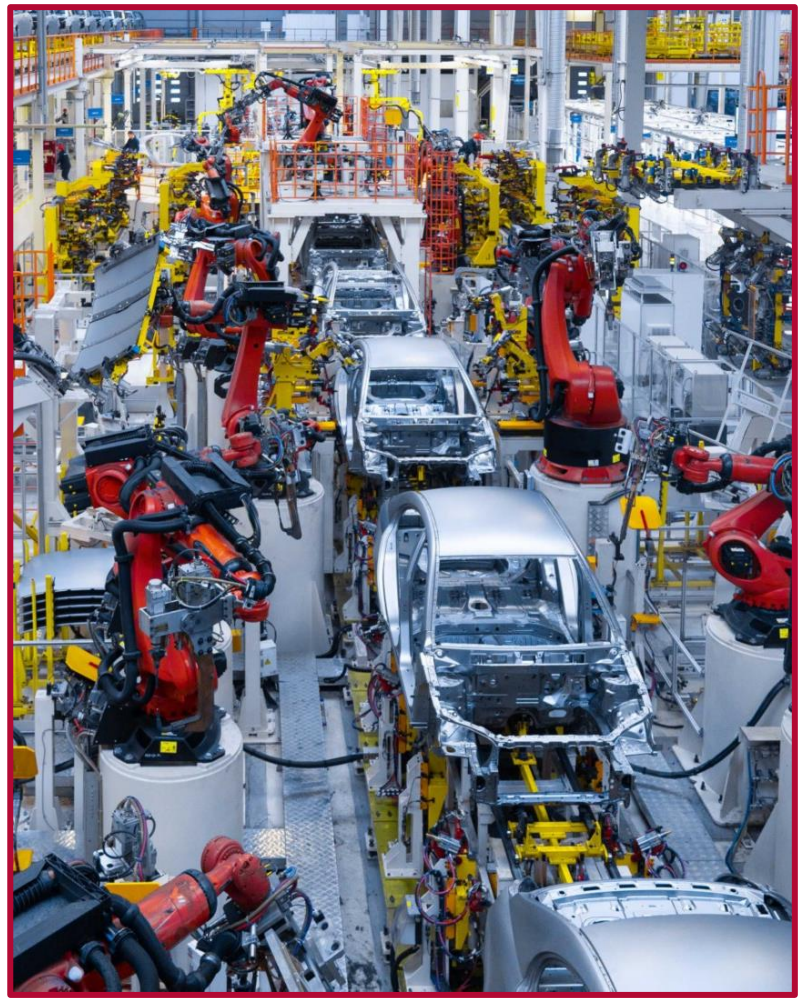
- Linear Regression, Decision Tree Regressor, Random Forest Regressor, RNN, LSTM, Transformer, Deep Neural Networks
- Distance-/Feature-/Shaplet-/Interval-/Dictonary based Classifier

Data-Centric AI

- Systematic improvement of data quality
- Performance estimation & model recommendation

Case 1: Material procurement

Case 1: Procurement department of Edison Cars AG



Change in demand

- Increasing end-consumer demand for low-emission vehicles
- The EU ban on the sale of new petrol and diesel cars by 2035

New product

- Board of Edison Cars AG made the strategic decision: Abandon current combustion-engine-based cars
- Switch to the production of electric car

Transformation of production

- Currently, the company is putting a lot of effort in transforming
- Development of a new production lines

Case 1: Procurement department of Edison Cars AG

The design of those **production lines** heavily **depends** on the **suppliers** of the resources that are required in the various production processes

- The procurement department was instructed to **choose suppliers** for each of the core resources
- **Production** of the new model **starts in 5 years**

- The CEO explicitly asked you to **not only** base your choice on **economic factors**
- Also consider **ecological and social implications**

The company management sets a fixed budget for procurement activities

Case 1: Procurement department of Edison Cars AG

Raw material needed
The team identified five raw materials that are still needed for production

First information
For one raw material, the team has selected three different potential suppliers

Type of information
The team gathered information on pricing, but also ecological and social aspects

More future information
Currently the team is working on more information

Case 1: Missing materials

Steel (600 kg)
Used in many vehicles for the production of engine and bodywork of a car

Aluminium (90 kg)
Part of the bodywork of a car. Parts of the engine block are also increasingly made of aluminum

Microchips (1200 units)
Required for the onboard electronics and the entertainment system

Cobalt (15 kg)
Together with nickel and manganese, cobalt is used for the cathode of the electric battery

Lithium (14 kg)
Central component of lithium-ion batteries

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Task

Predict the **daily prices** for steel for the next 4,5 years, i.e. for the period from 01.06.2024 to 31.12.2028 by **performing a time series analysis** of the data provided.

Perform the analysis for the of the **three suppliers** of steel. Predict the prices **for each day**.

Case 1: Description of steel suppliers

To this day, hardened steel is indispensable in the automotive industry, also when it comes to electric cars. It is the main part of the bodywork of a car. Per unit of the newly developed model, about 600 kg of steel are required.
Your team identified three potential suppliers:

East Metal Co.

- In the past, cheapest among the three options
- Struggling to comply with labor rights
- Reports on several cases of corruption
- Carbon emissions are at around 2,6 t[CO2]/t[steel]

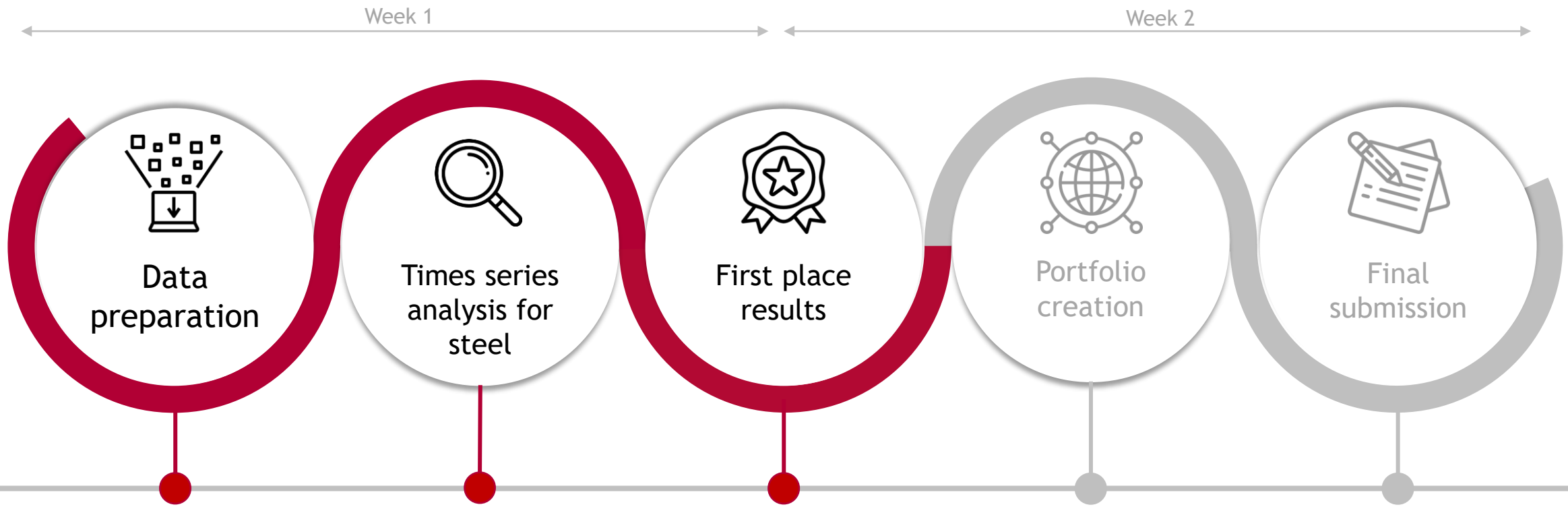
Sakura Steelworks

- Strong regulation of the production as well as governing processes
- Supplier faced problems with their supply chain but solved these problems in 2021
- Carbon emissions are at around 1,91 t[CO2]/t[steel]

Black Forest Steel Co.

- Strong regulation of the production as well as governing processes
- Supplier has to buy CO2-certificates
- Carbon emissions are at around 1,81 t[CO2]/t[steel]

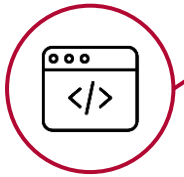
Case 1: Time schedule



Case 1: Input

Worksheet
Contains description of the task and the exact submission details

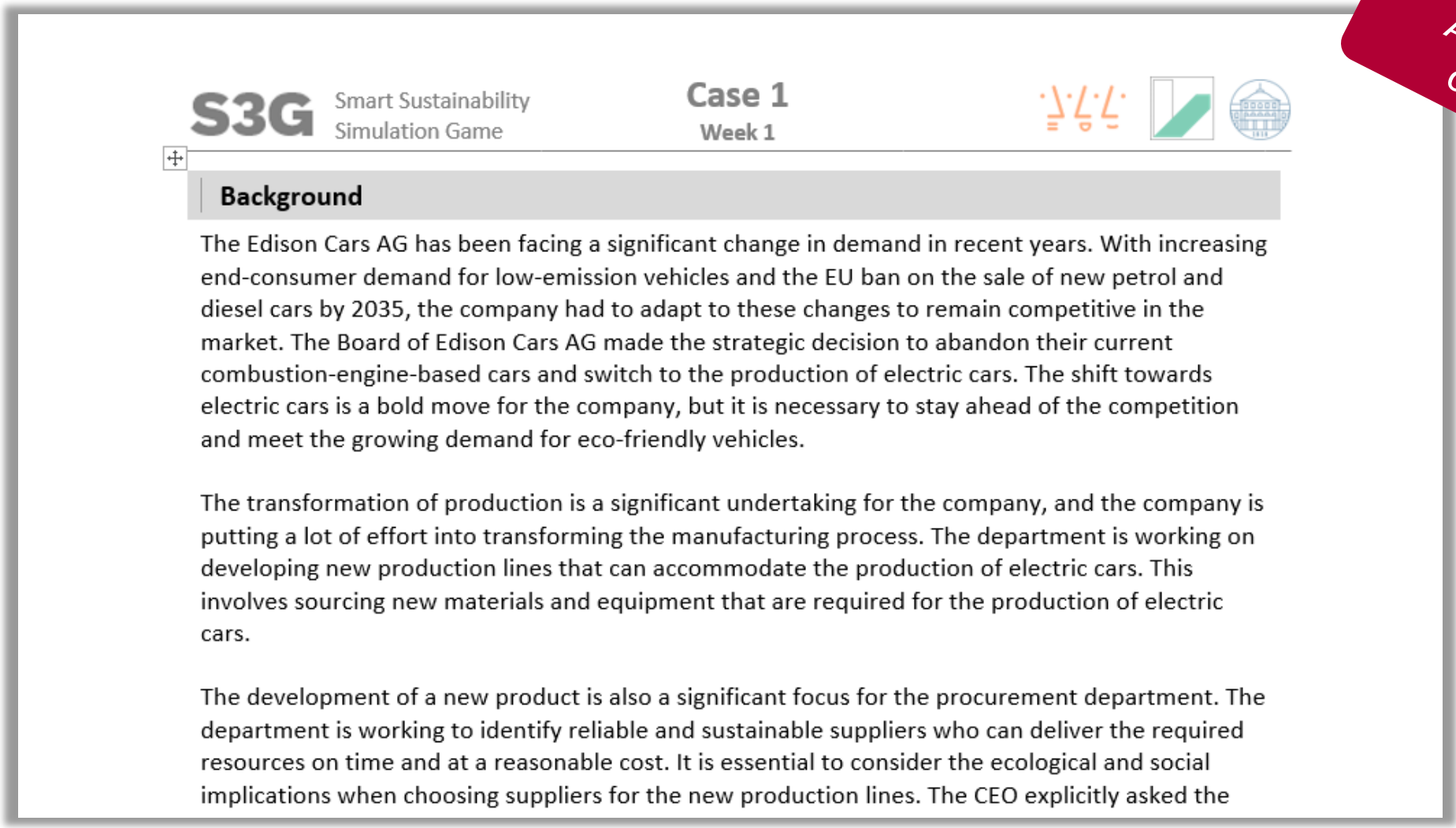
Code Template (if necessary)
Provides framework for the development and provides basic functionality



Task completion

Data
Represents different phenomena and interrelationships

Case 1: Worksheet



S3G Smart Sustainability Simulation Game

Case 1
Week 1

Background

The Edison Cars AG has been facing a significant change in demand in recent years. With increasing end-consumer demand for low-emission vehicles and the EU ban on the sale of new petrol and diesel cars by 2035, the company had to adapt to these changes to remain competitive in the market. The Board of Edison Cars AG made the strategic decision to abandon their current combustion-engine-based cars and switch to the production of electric cars. The shift towards electric cars is a bold move for the company, but it is necessary to stay ahead of the competition and meet the growing demand for eco-friendly vehicles.

The transformation of production is a significant undertaking for the company, and the company is putting a lot of effort into transforming the manufacturing process. The department is working on developing new production lines that can accommodate the production of electric cars. This involves sourcing new materials and equipment that are required for the production of electric cars.

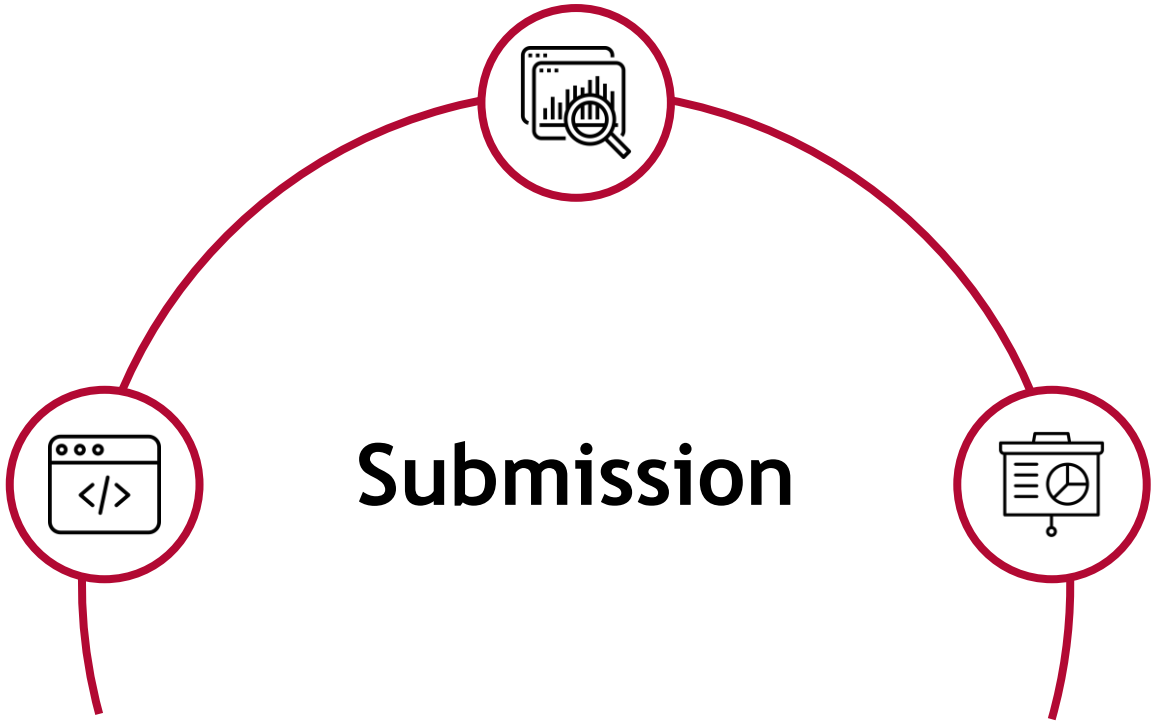
The development of a new product is also a significant focus for the procurement department. The department is working to identify reliable and sustainable suppliers who can deliver the required resources on time and at a reasonable cost. It is essential to consider the ecological and social implications when choosing suppliers for the new production lines. The CEO explicitly asked the

Available online

Case 1: Submission

The following documents must be emailed to **s3g@fim-rc.de** as one zip folder by **02:00 PM** on **06.05.2024:**

Time series data
Complete time series (original prices + forecasted prices) as continuous time series in CSV format

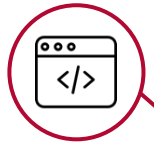


Code
Code file(s) for reproducing your results, with installation instructions if necessary

Presentation
A PowerPoint presentation explaining your approach

Case 1: Evaluation criteria

Code Quality
Is the code executable, readable and contains comments?

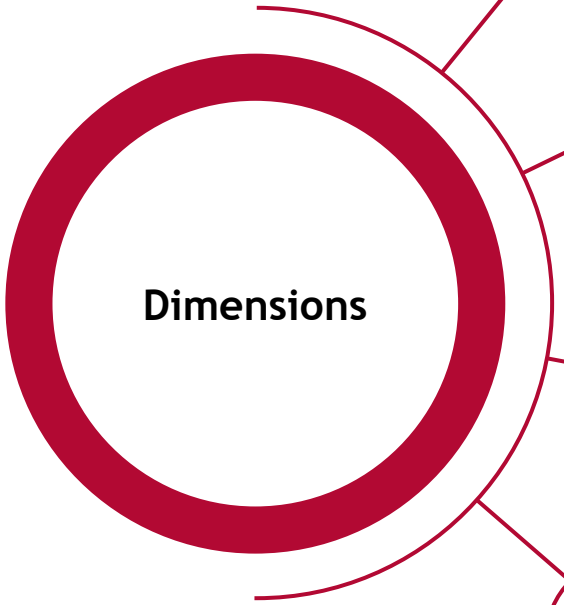


Prediction Quality
How closely do the predictions match reality?

Explanation
Is the selection of the approach presented in a comprehensible way?

Bonus
The best prediction (based on the MSE) receives a bonus

Case 1: Dimensions of decision-making



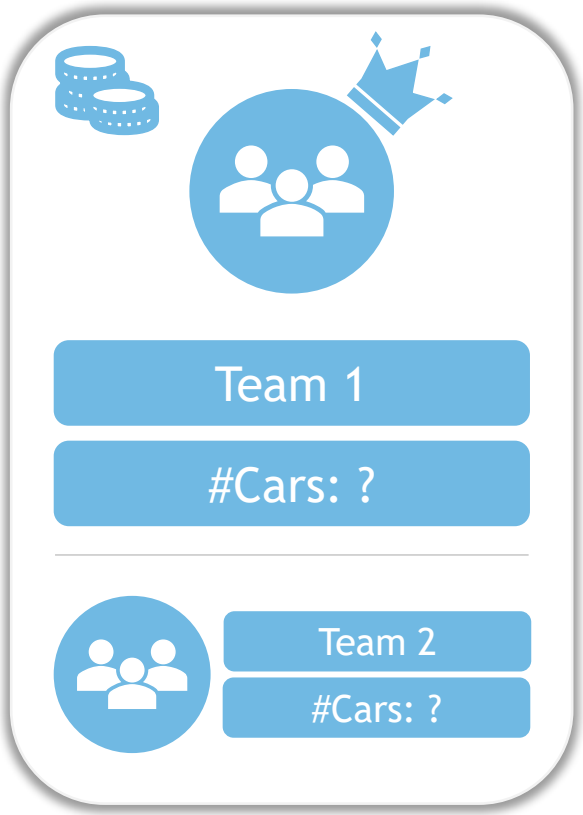
Technical
Evaluates the accuracy of the results. The large is the average price deviation between estimate and reality

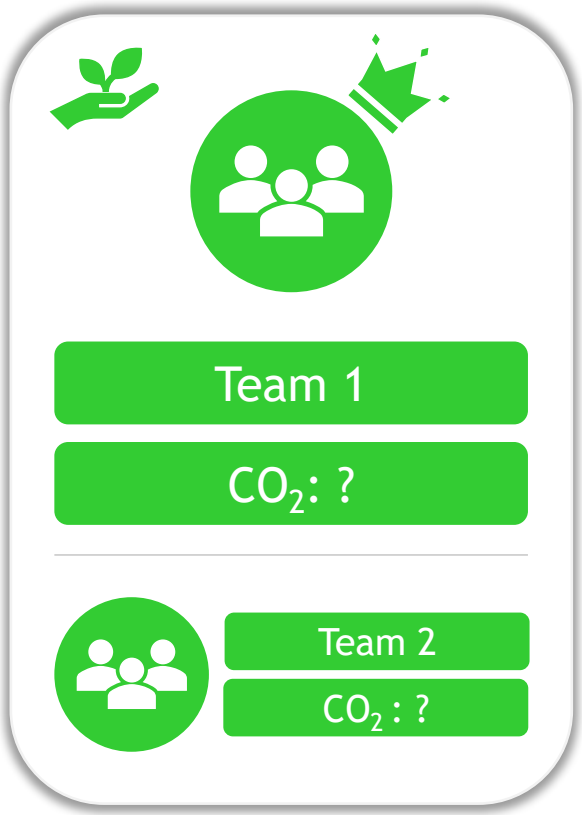
Economical
Evaluates economic benefits. We measured over the number of cars that can be produced with the available funds

Ecological
Evaluates the environmental sustainability. Measures how much CO2 was emitted for the procurement

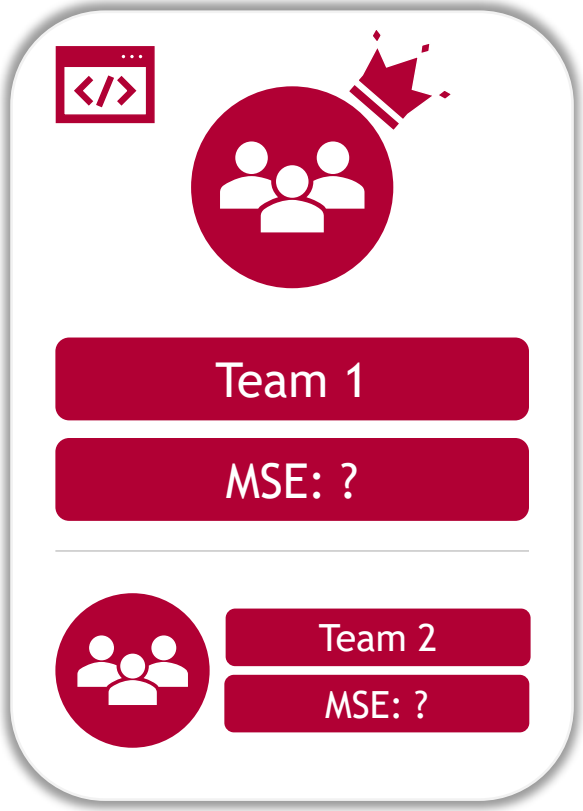
Social
Evaluates the social sustainability. Measures working conditions and social impact

Case 1: Leaderboard – Unit 1

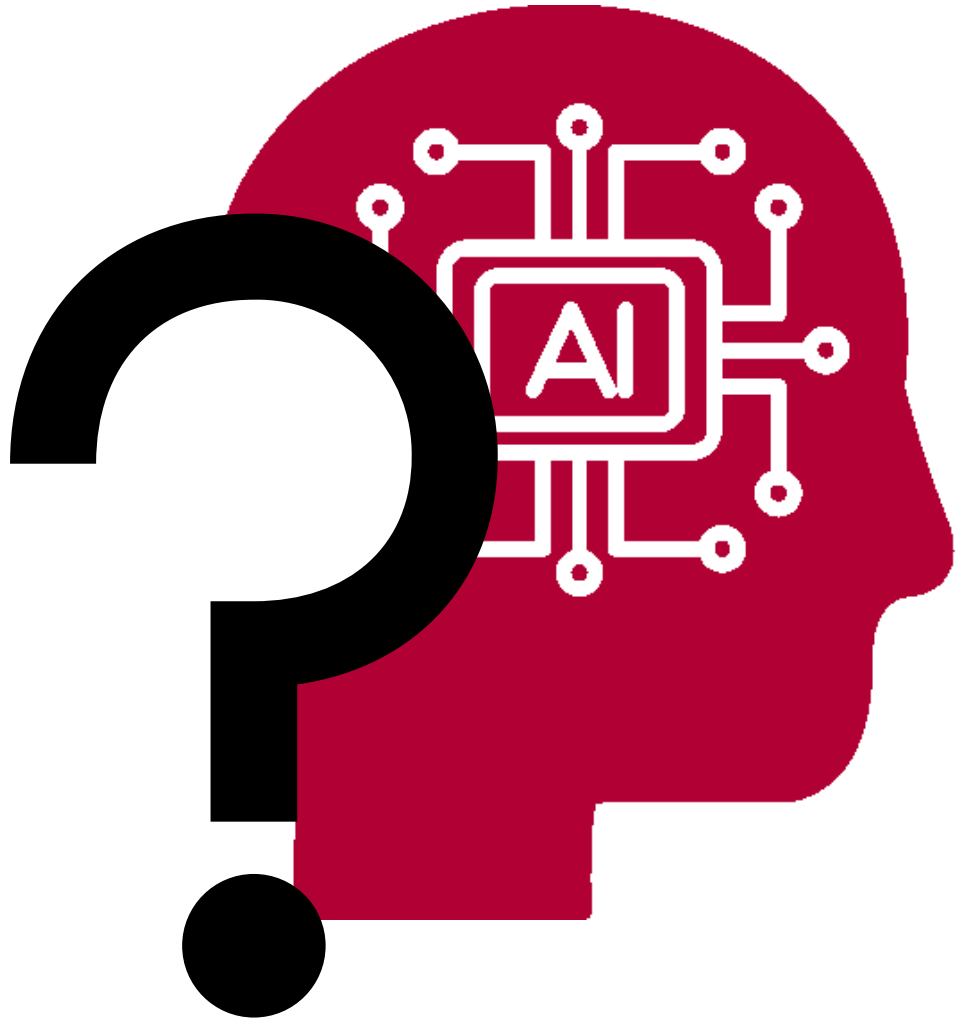




Case 1: Leaderboard – Unit 1



Case 1: Any Questions?



Any Questions?