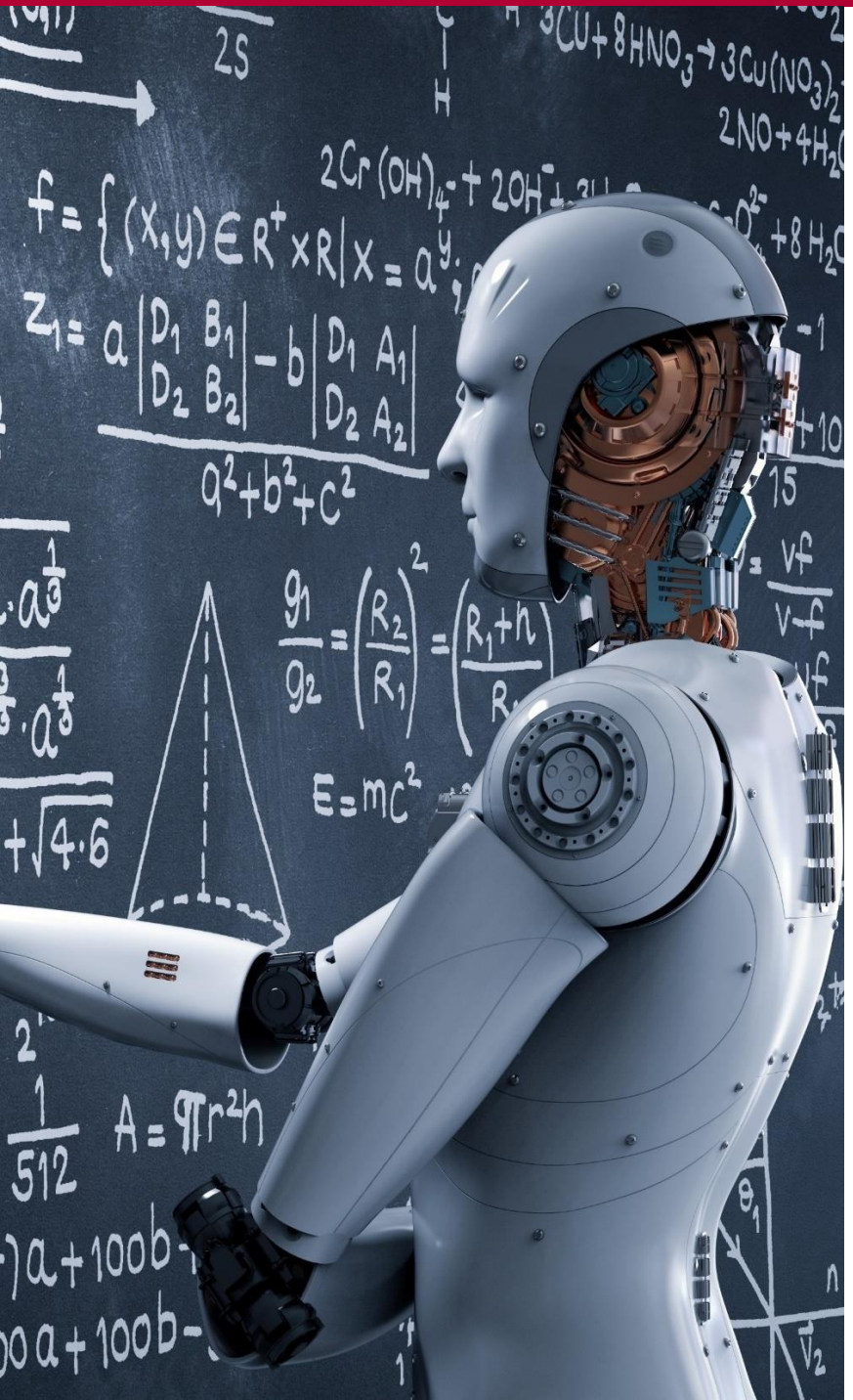

Research Center for
Information Management

Fraunhofer
FIT

Smart Sustainability Simulation Game

Case 2: Production - Unit 2
28.05.2024

FIM Research Center for Information Management
Fraunhofer Institute for Applied Information Technology FIT,
Branch Business & Information Systems Engineering

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Augsburg Bayreuth Frankfurt Luxembourg Munich Stuttgart

01

Organizational information

Masterarbeiten am Fachgebiet Digitales Management, WS 24-25

UNIVERSITÄT HOHENHEIM

1a. Bewerbung für das WS 24/25

- Vom **03.06. bis zum 23.06.** besteht die Möglichkeit für eine Bewerbung dezentral am Fachgebiet (per Umfragetool)
- Am **28.06.** erfolgt eine Rückmeldung, ob die Bewerbung erfolgreich ist
- HMM, Schwerpunkt M&M: Default ist die zentrale Bewerbung am Institut zwischen 15.6. und 15.7. mit Angabe von Präferenzen über Fachbiete hinweg

1b. Themenwahl

- Wir stellen **Themenausschreibungen** (sog. Onepager) auf unserer Website zur Verfügung, auf diese kann sich beworben werden
- Optional kann man auch einen **eigenen Themenvorschlag** einbringen

2. Zuteilung

- **Basierend auf Präferenzen und Kapazitäten** teilen wir die Themen unseres Fachgebiets zu

3. Konkretisierung

- Besprich das **Thema** mit einer/ einem Mitarbeitenden (wird zugeteilt)
- Erstelle eine Gliederung
- **Anmeldung** der Arbeit beim Prüfungsamt

4. Start der Masterarbeit

- Es gibt keine fixen Starttermine
- Stimme den **Starttermin individuell** mit den Mitarbeitenden ab

5. Bearbeitung

- Die Bearbeitung ist auf **Deutsch oder Englisch** möglich
- Bei Fragen kann **jederzeit** gerne auf uns zugegangen werden
- Nach der Abgabe geben wir gerne Feedback

Ansprechpartner für Abschlussarbeiten: Frederik Schöttl (frederik.schoettl@uni-hohenheim.de)
Webseite des Lehrstuhls für weitere Informationen: https://digital.uni-hohenheim.de/lehre

Infoveranstaltung HMM, M&M

Management Schwerpunkt Marketing und Management

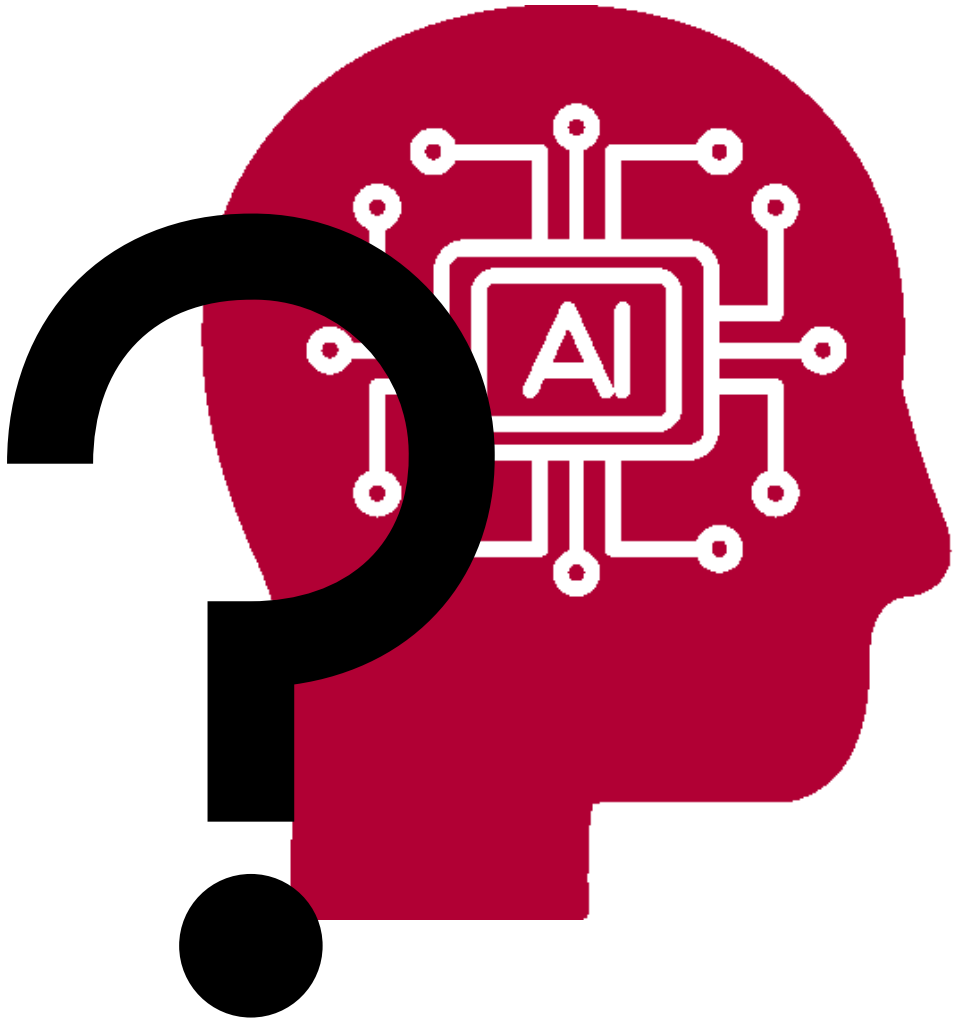
Online-Veranstaltung via Zoom für Schwerpunkt Marketing & Management:
11.06.2024, 16:30-18:00 Uhr

https://uni-hohenheim.zoom-x.de/j/61827628595?pwd=UjB3Yno4RXJrYUpMWFlwWFVRUzFCUT09

Meeting-ID: 618 2762 8595

Kenncode: R0rSvv

Time for Feedback



How was the first week?

Any Questions?

02

Case 2: Production – 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

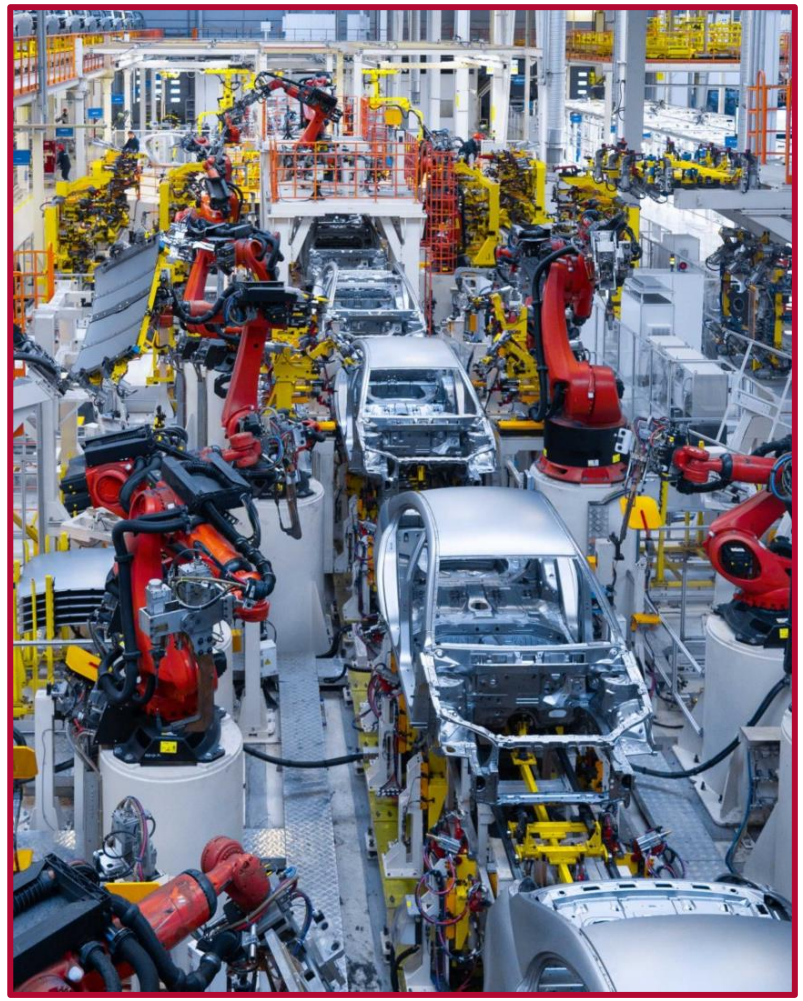
→ Process Mining

Case 3: Quality Management

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

→ Computer Vision

Case 2: Maintenance department of Edison Cars AG



Distributed production facilities

- Manufacturing of e-mobility vehicle batteries at four sites worldwide (Germany, China, South Africa, USA)
- Strong demand for e-mobility vehicle batteries requires permanent and saturated production

Central maintenance department

- Unscheduled machine breakdowns repeatedly lead to production stops and require cost- and time-intensive maintenance work
- Coordination of all activities to ensure permanent availability from the headquarters in Germany

Rethinking maintenance strategy

- The company has already made great efforts in the past to improve maintenance intervals to ensure permanent availability
- Board of Edison Cars AG made the strategic decision to move from reactive maintenance towards predictive maintenance

Case 2: Maintenance department of Edison Cars AG

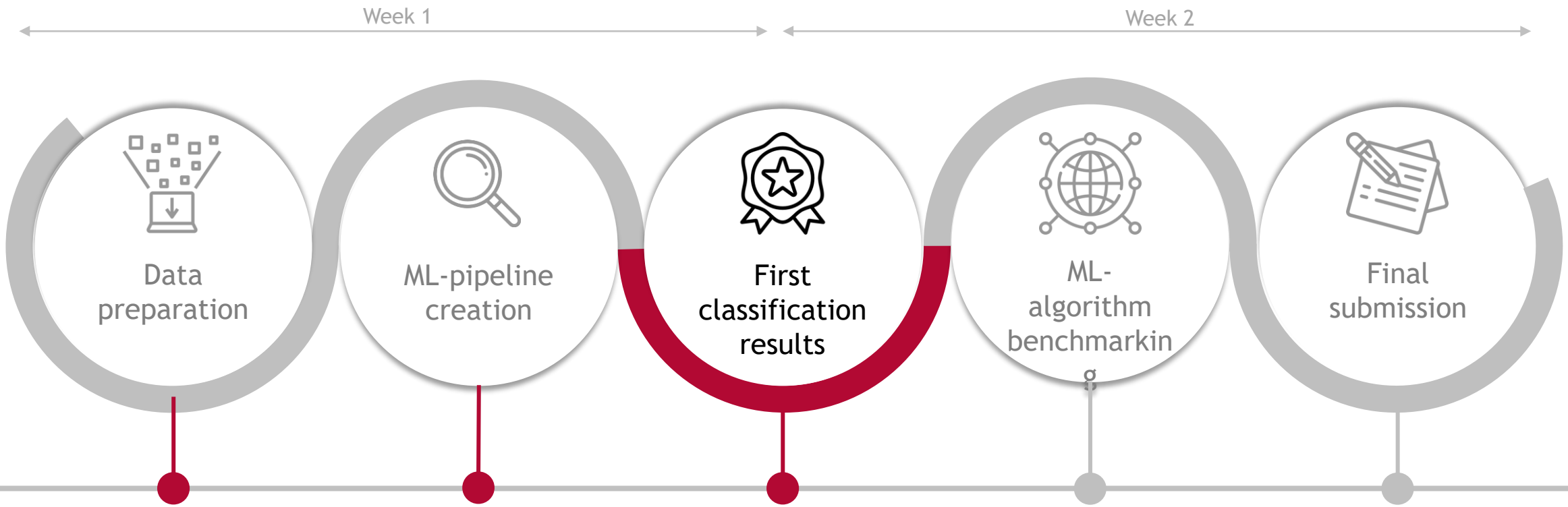
The production lines depend highly on a **functioning maintenance strategy**, as the failure of a single machine may shut down the entire process, resulting in **immense follow-up costs**

The head of maintenance demands an **efficient use of human resources** and aims at a **sustainable use of hardware** (e.g., sensor technology, spare parts)

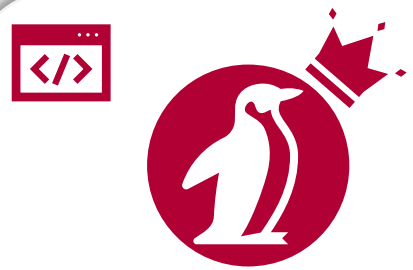
The CEO aims for **high machine availability** and does not accept downtimes that cause production losses

The Edison Cars AG is committed to revise the existing maintenance concept

Case 2: Time schedule



Case 2: Leaderboard – Unit 1



Team Penguin

Accuracy: ~99.7%

Team 1

#Cars: ?

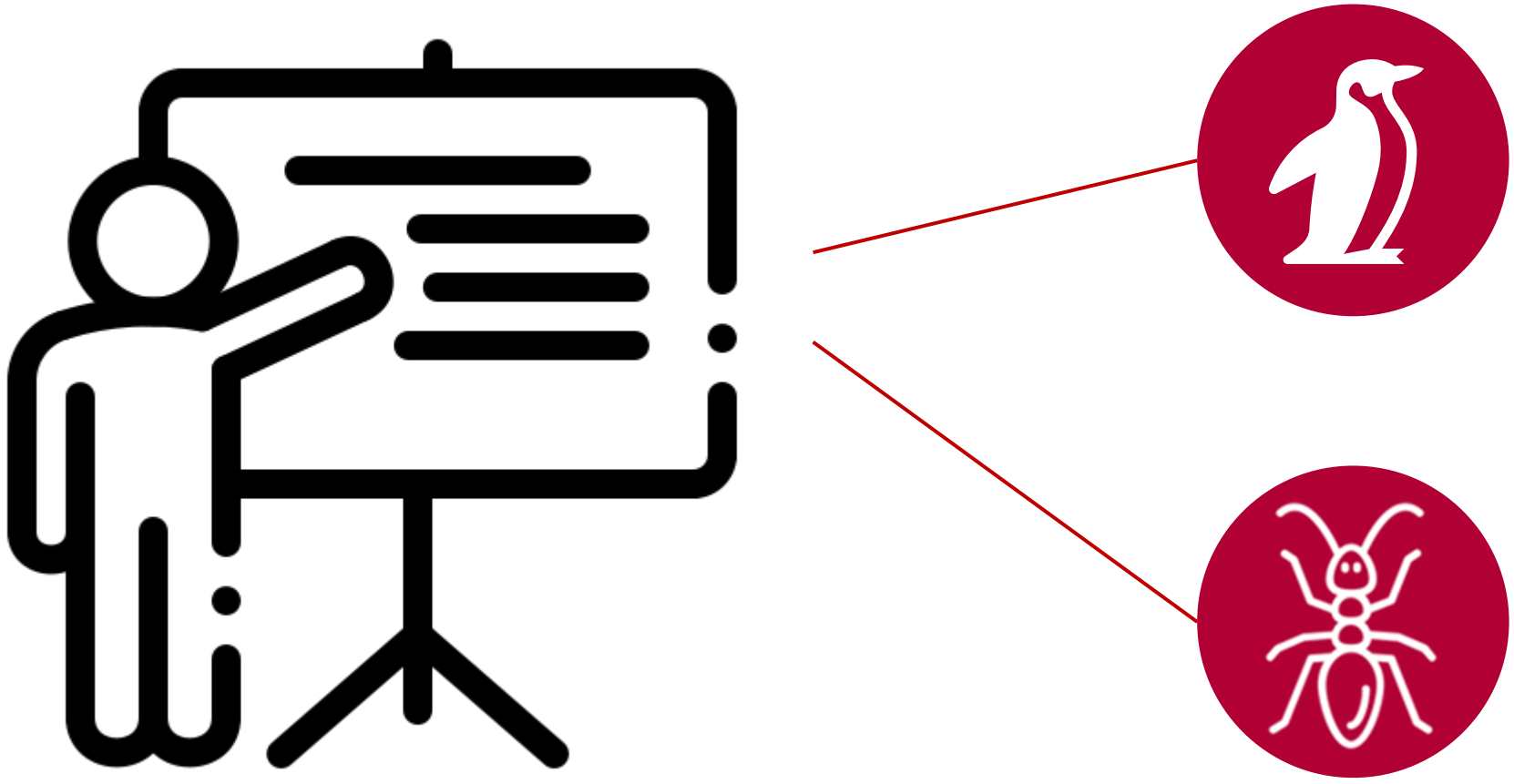
Team 1

CO_2: ?

Team 1

Impact: ?

Case 2: Presentation of results



Case 2: Maintenance department of Edison Cars AG

What was done very well

- All models perform very well with a prediction performance > 90%
- All groups describe the labeling in a technical way
- All groups provide a logical and structured argumentation flow

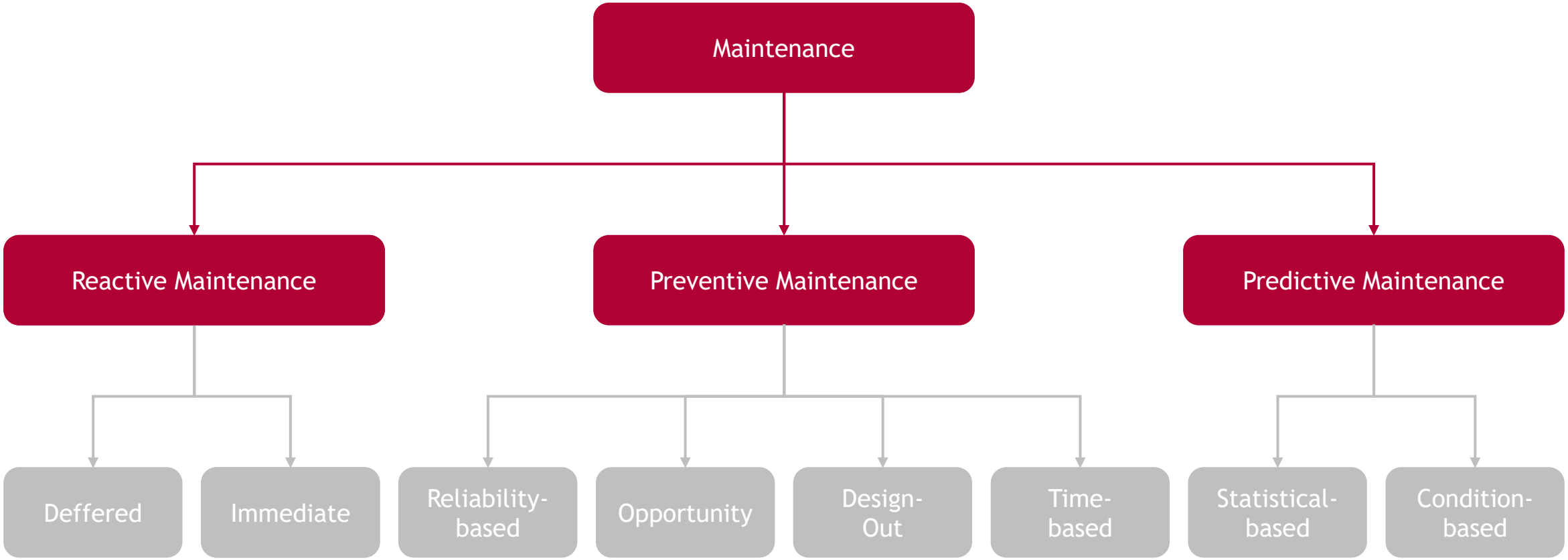
What could have been done better

- All groups forgot to describe the consequences that can arise from incorrect labelling (e.g., long downtime, costs for unnecessary maintenance, ...
- Do not forget that all robots work until they break down: Rethink your labeling strategies!

03

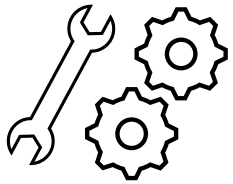
Case 2: Production – Unit 2

Maintenance can be categorized into different types



Different types of maintenance display different characteristics

Reactive Maintenance



Maintenance operations are only performed on assets that stop working

+
- Spare parts are fully used up
- No analytics or sensors needed

−
- High downtimes
- Failures damage assets

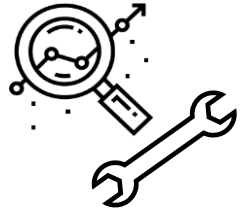
Preventive Maintenance

Systems are maintained at fixed intervals to ensure continuous availability

+
- No in process sensors needed
- Reduces unplanned downtimes

−
- High downtimes
- Failures damage assets

Predictive Maintenance

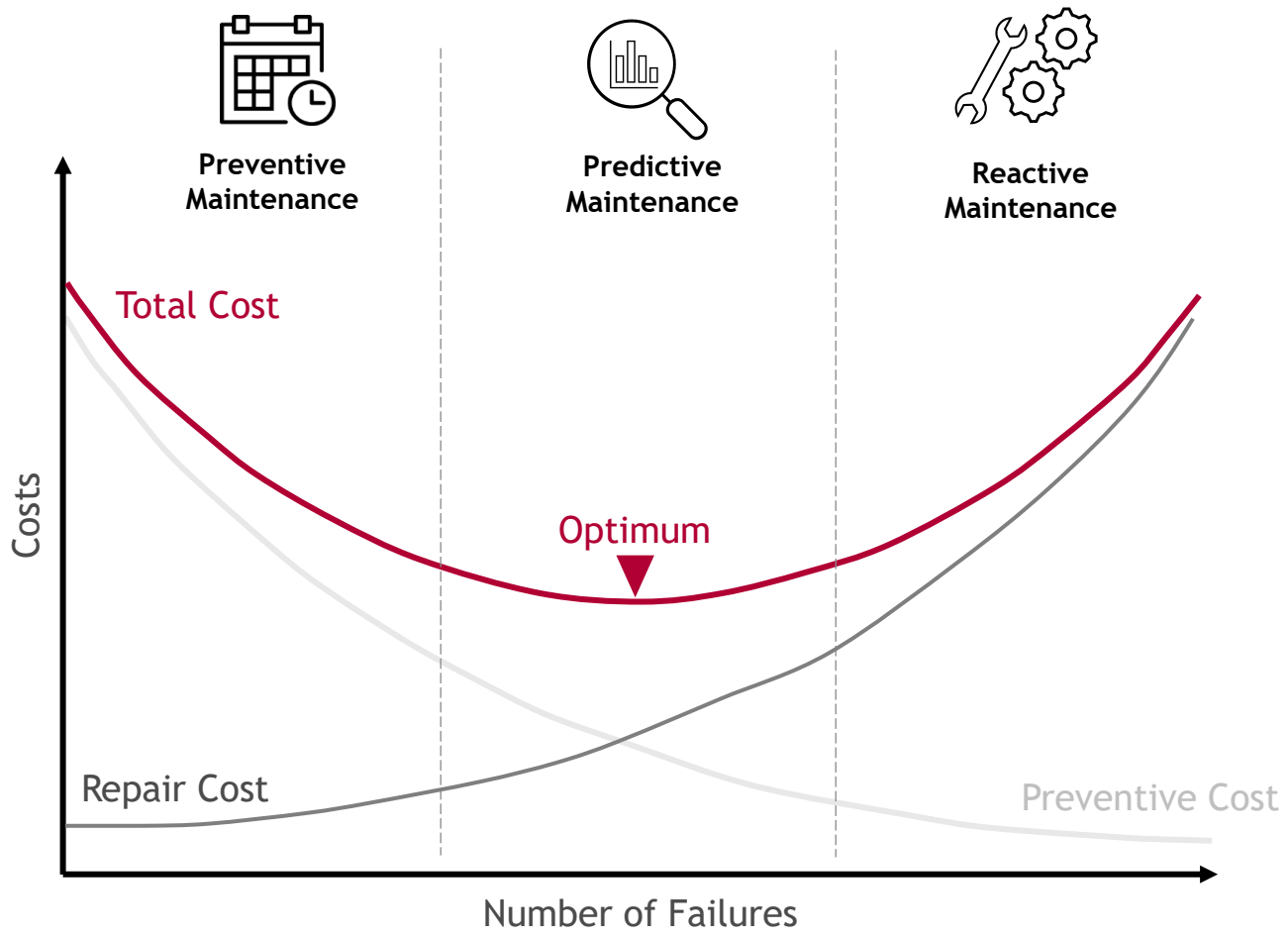


It uses predictive tools to determine when maintenance actions are needed

+
- Optimal equipment lifetime
- Minimizes unplanned downtimes

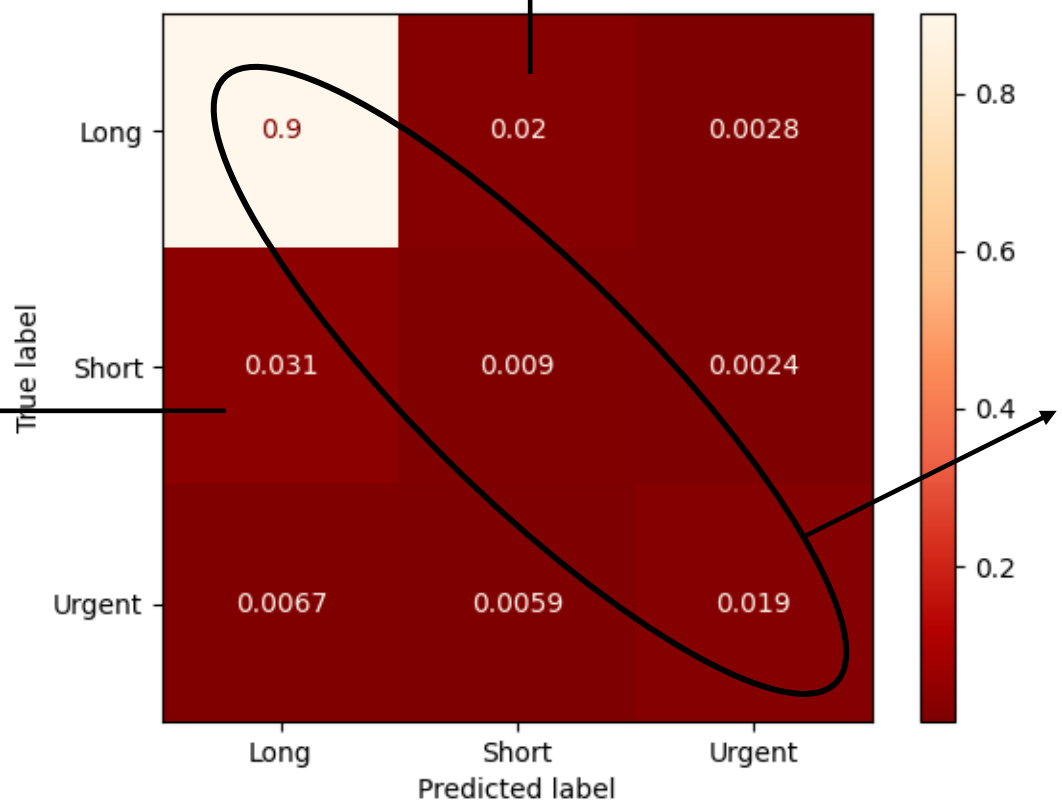
−
- Upfront investment
- Expert knowledge

Optimal cost-benefit ratio through predictive maintenance



Case 2: Maintenance strategy of Edison Cars AG

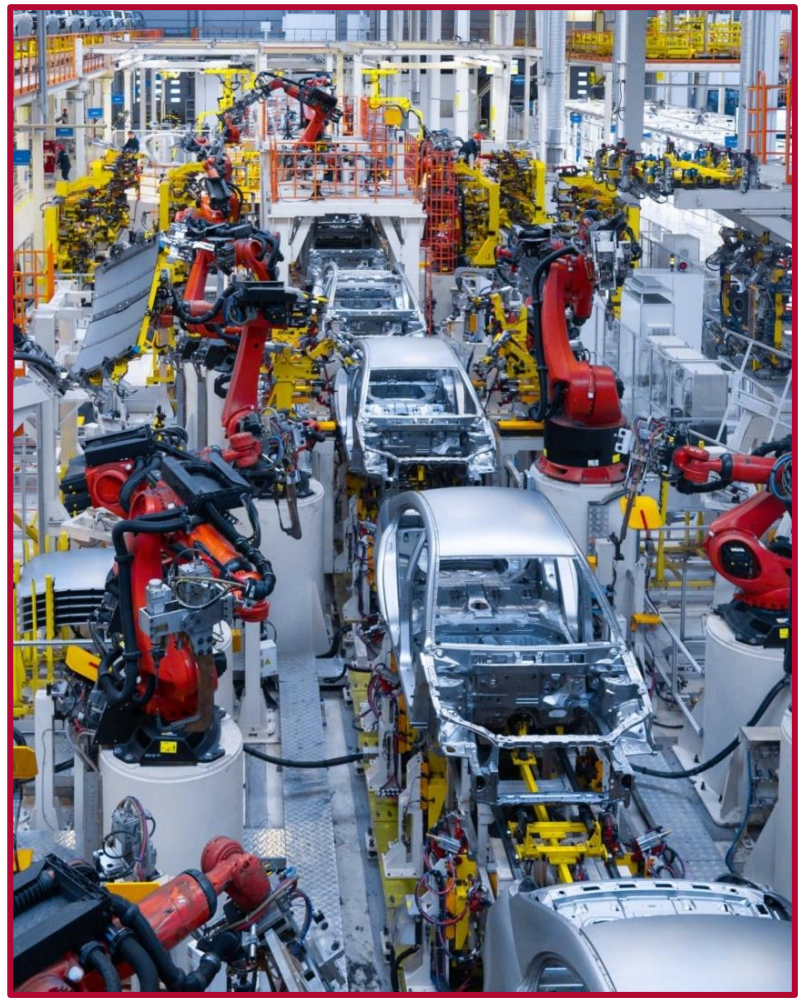
2 % of the machines are serviced although no maintenance is required



3 % of the machines are not maintained although maintenance is required

Accuracy of about 93 %

Case 2: Maintenance strategy of Edison Cars AG



High demand for production capacity

- The Edison Cars AG is on the verge of opening another facility for a new customer from the automotive sector with 10 robots
- Due to country-specific requirements, the Edison Cars AG is not allowed to use the same robots as in its existing facilities

Ambiguous maintenance strategy

- The purchase of robots from an alternative supplier means that the Edison Cars AG can not draw on previous maintenance experience
- To determine the optimal maintenance strategy the Edison Cars AG builds on simulation data

Tension regarding sustainability

- The Edison Cars AG aims to minimize the economic costs associated with the different maintenance concepts
- The customers of the Edison Cars AG attach a high emphasis that all sustainability dimensions are fulfilled simultaneously

Case 2: Maintenance strategy of Edison Cars AG

The production line in the new facility depends highly on a **functioning maintenance strategy**, as the failure of a single machine may shut down the entire process, resulting in **immense follow-up costs**

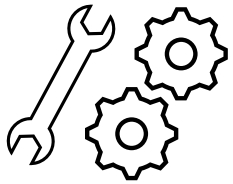
The head of maintenance strives for a **comparable maintenance strategy** across all sites worldwide

The CEO aims for **high machine availability** (regardless of the maintenance strategy) and does not accept downtimes that cause production losses

The Edison Cars AG is responsible to determine the optimal maintenance strategy before the start of production

Case 2: Maintenance strategy of Edison Cars AG

Reactive Maintenance

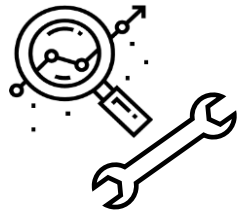


Maintenance operations are only performed on assets that stop working

Preventive Maintenance

Systems are maintained at fixed intervals to ensure continuous availability

Predictive Maintenance



It uses predictive tools to determine when maintenance actions are needed

Individual maintenance strategies require different maintenance intervals and thus cause different maintenance costs

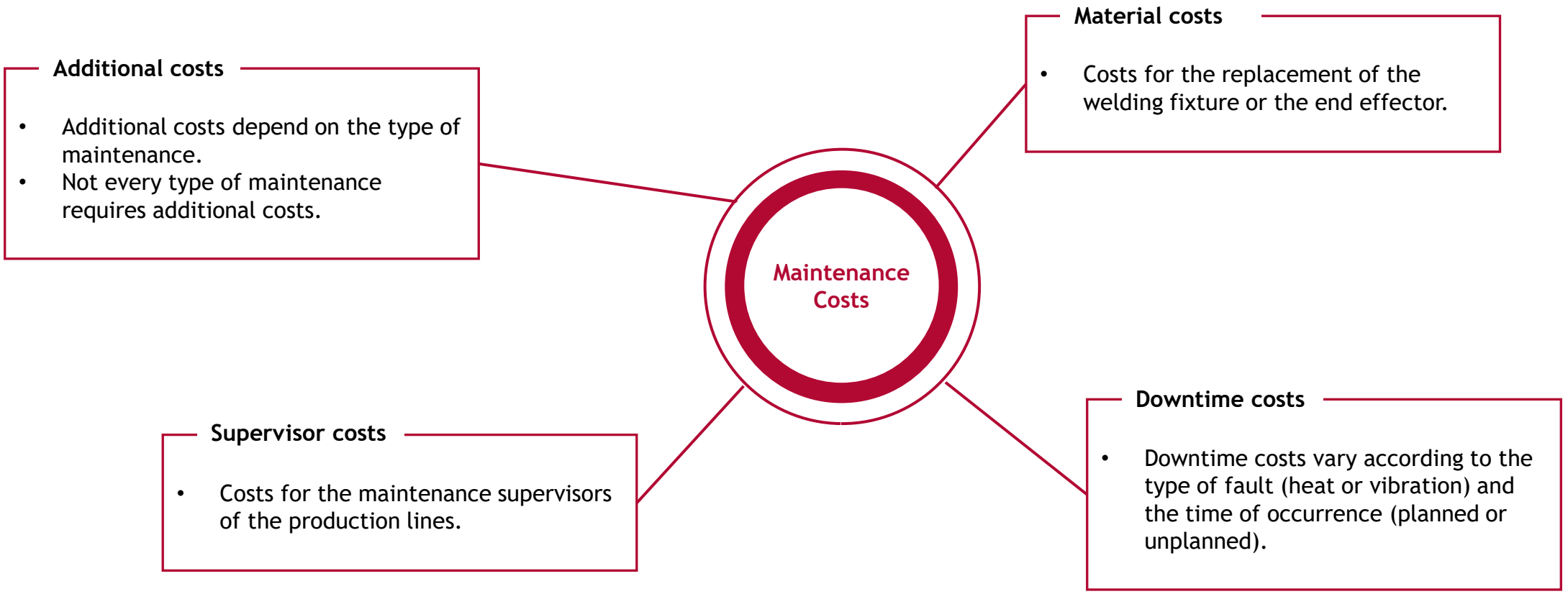
Case 2: Maintenance strategy of Edison Cars AG

		Maintenance Timing	
		Planned	**Unplanned**
Maintenance Cause	**Temperature**	The welding fixture overheats. It is cooled down and then put into operation again.	The welding fixture overheats and breaks down. It must be replaced by a new welding fixture.
	Vibration	The screws loosen in the end effector. They are tightened and then put back into operation again.	The screws loosen in the end effector and are damaged. The end effector has to be replaced.

Note #1:
Be aware that maintenance activities can vary

Note #2:
Consider the two damage patterns collectively

Case 2: Maintenance strategy of Edison Cars AG



Case 2: Maintenance strategy of Edison Cars AG

Simplified example

The Edison Cars AG relies on **sensor values from 10 industrial robots** to determine the **optimal maintenance strategy** for the new facility. The data sets is provided by KaKu and was derived from a **test scenario**. Be aware that in case of maintenance, both the welder and the screws are checked (and replaced if necessary).

Key information about the robots:

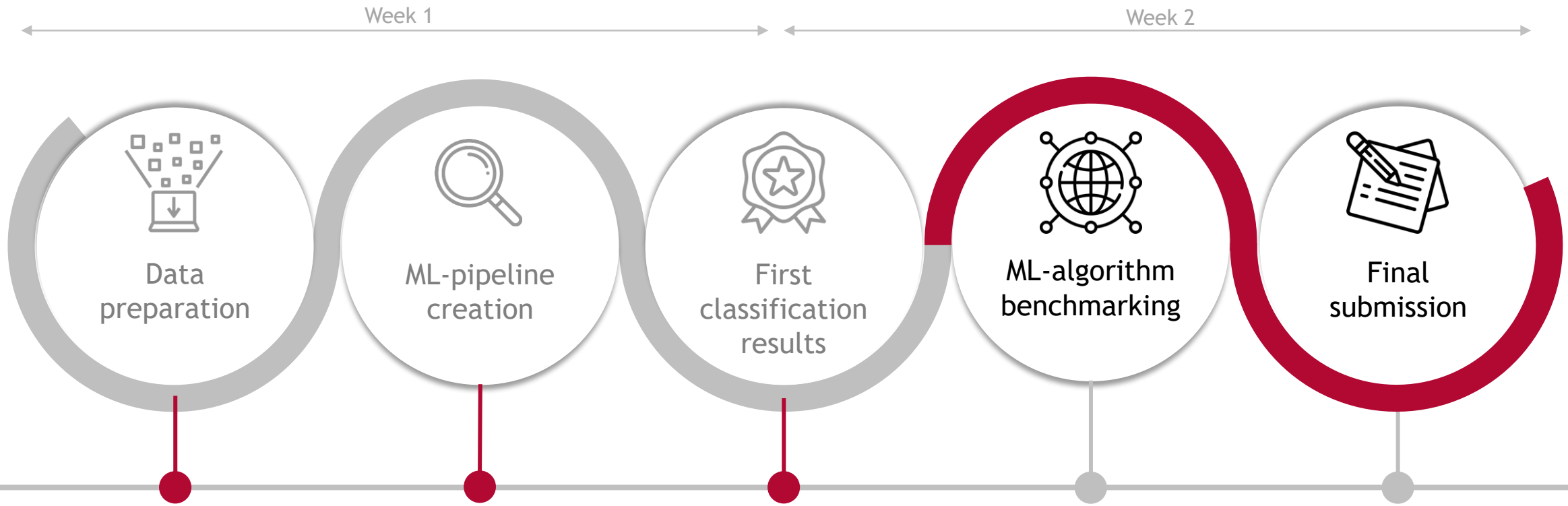
- From each robot you get about 6000 datapoints from KaKu.
- KaKu recommend that the robots should be maintained every 2500 datapoints.
- The most common reason for a defect industrial robot is a faulty welder and loose screws.
- The defect can be traced back to results from 4 temperature and 4 vibration sensors.

Case 2: Maintenance strategy of Edison Cars AG

Determine from the given information about predictive, preventive, and reactive maintenance the incurring **maintenance costs for one year**. From this, also determine the **ecological and social sustainability** associated with each type of maintenance.

The management of Edison Cars AG would like to ask you for a specific recommendation when selecting an optimal maintenance strategy

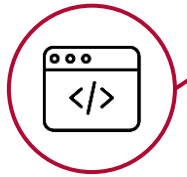
Case 2: Time schedule



Case 2: Input

Worksheet
Contains description of the task, texts which contain the calculation costs and the exact submission details

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



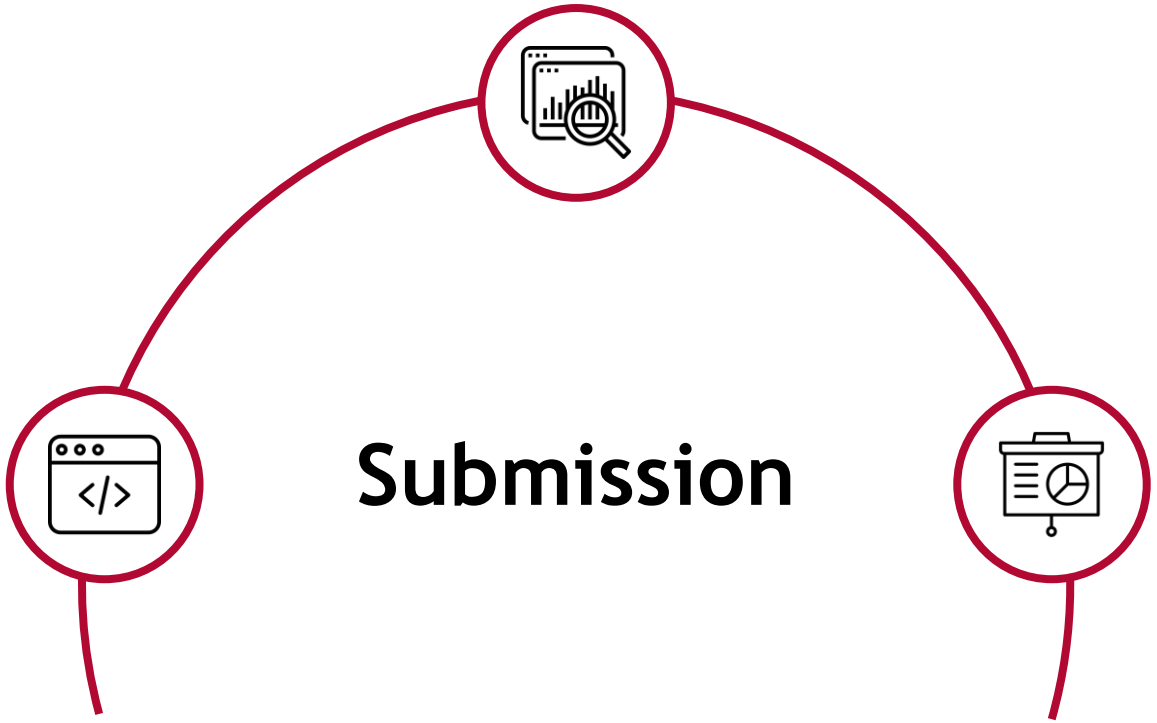
Task completion

Data
Represents the sensor values of 10 robots

Case 2: Submission

The following documents must be emailed to s3g@fim-rc.de as one zip folder by 02:00 PM on 03.06.2023:

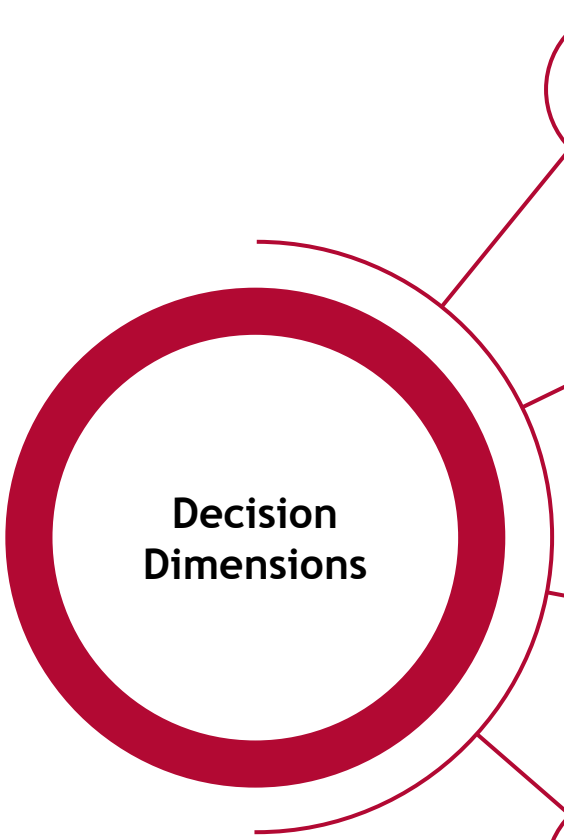
Confusion matrix and calculative decision
Decision support when selecting an optimal maintenance strategy



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

Presentation
A PowerPoint presentation explaining your decisions

Case 2: Dimensions of decision-making



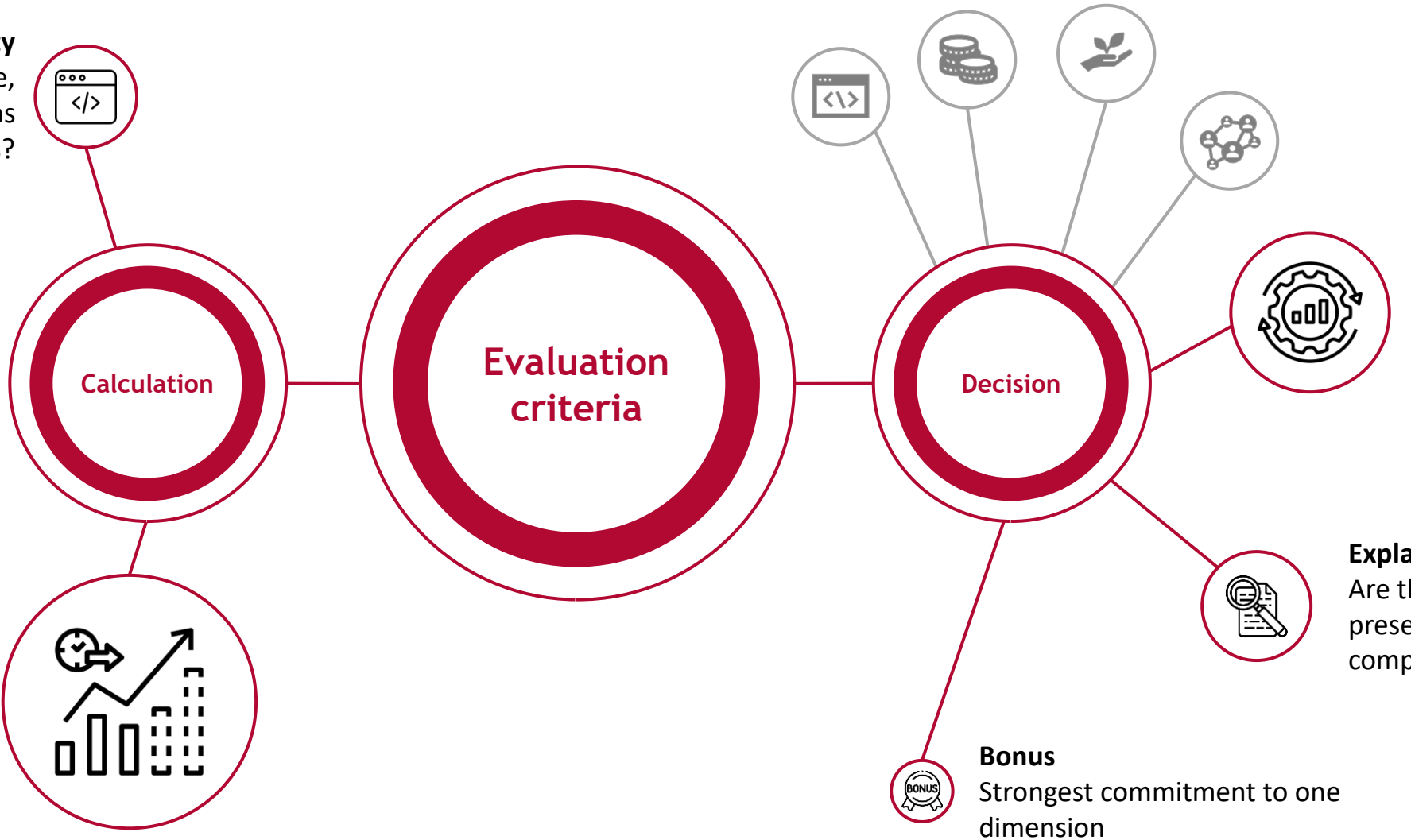
Technical
Evaluates the accuracy of the results.

Economical
Evaluates economic benefits. Measures which maintenance type has the smallest economic costs.

Ecological
Evaluates the environmental sustainability. Measures how much CO2 was emitted and how much material was wasted for each maintenance type.

Social
Evaluates the social sustainability. Measures working conditions for each maintenance type.

Case 2: Evaluation criteria



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

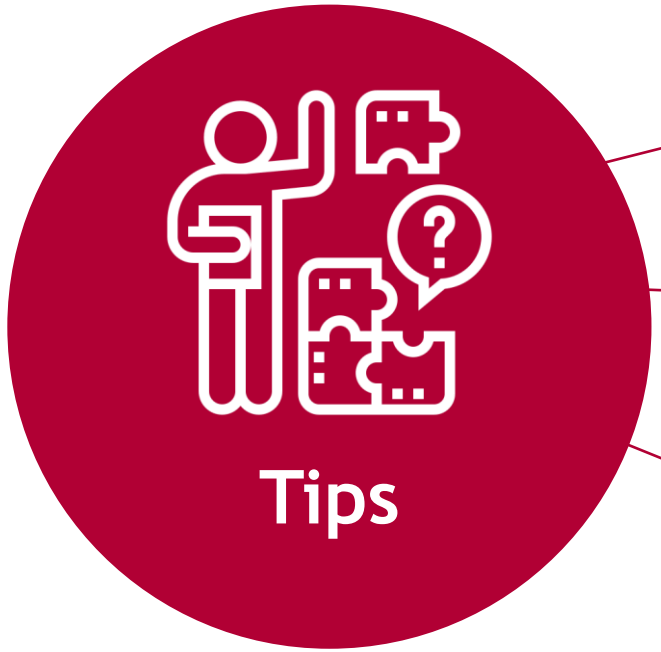
Prediction Quality
How good does the model work on the hidden test set?

Optimization results
Is an optimal decision made based on the maintenance prediction and evaluation dimensions?

Explanation
Are the decisions made presented in a comprehensible way?

Bonus
Strongest commitment to one dimension

Case 2: Tips for the implementation

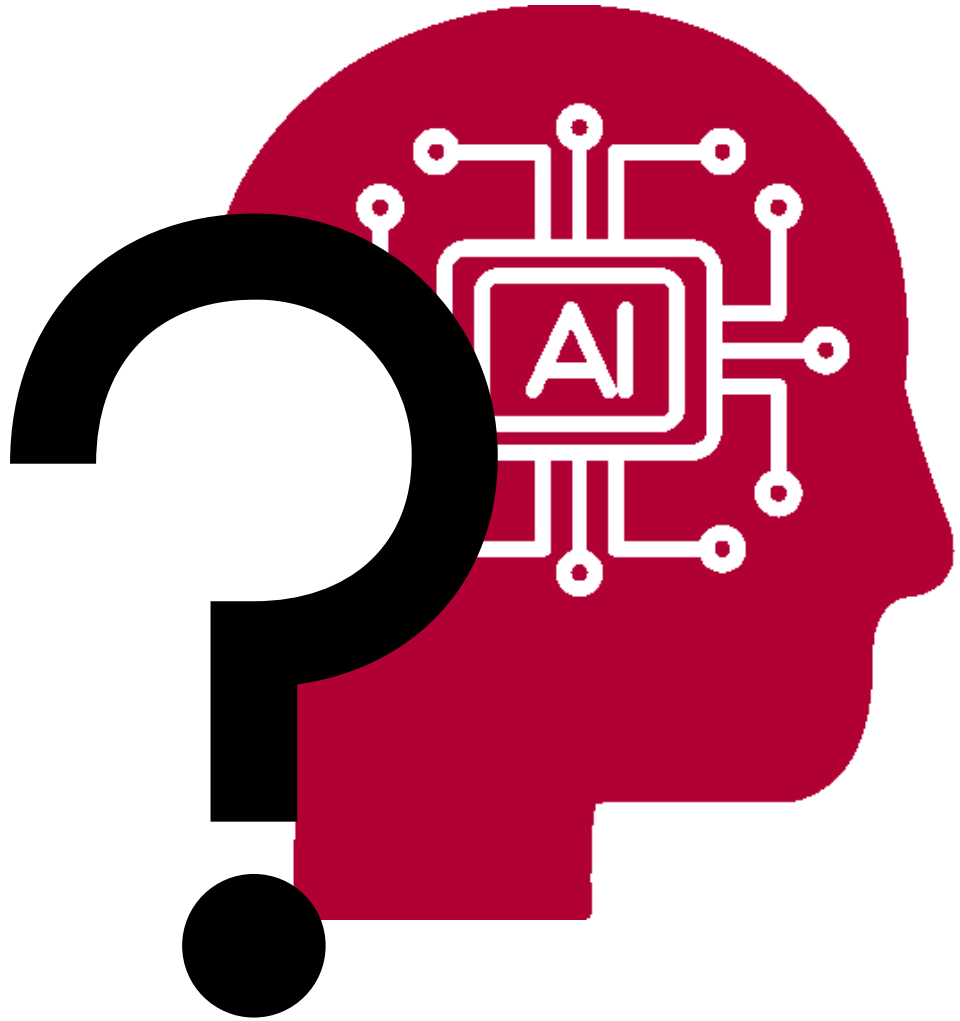


Be aware that maintenance strategies differ from type to type.

First analyze the given data sets before starting with calculating.

The most economical maintenance strategy is not necessarily the most ecological or social one.

Case 2: Any Questions?



Any Questions?