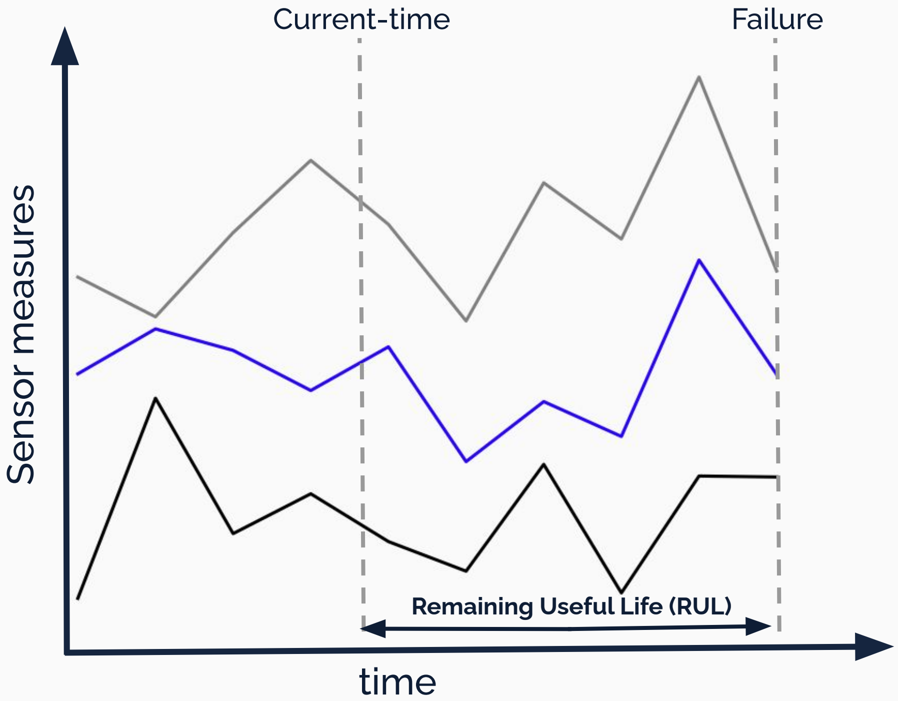
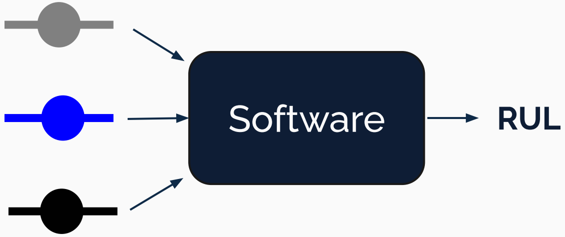
TIME-TO-FAILURE PREDICTION (TTF)

Forecasting plane engine failure with sensors data

Problem:

How to efficiently avoid significant breaks in the aircraft's engine?





Software

RUL

Description:

The objective of this project is to develop a comprehensive framework designed to explicitly model the relationship between time-series data and the time-to-failure event.

By focusing on this relationship, the framework aims to provide a robust tool for understanding and mitigating risks associated with time-dependent processes.

Value proposition:

SUSTAINABLE DEVELOPMENT GOALS

A survival analysis framework for aircraft components supports the UN Sustainable Development Goals by **improving component lifespan**, **reducing waste**, and **fostering innovation**.

8 DECENT WORK AND ECONOMIC GROWTH

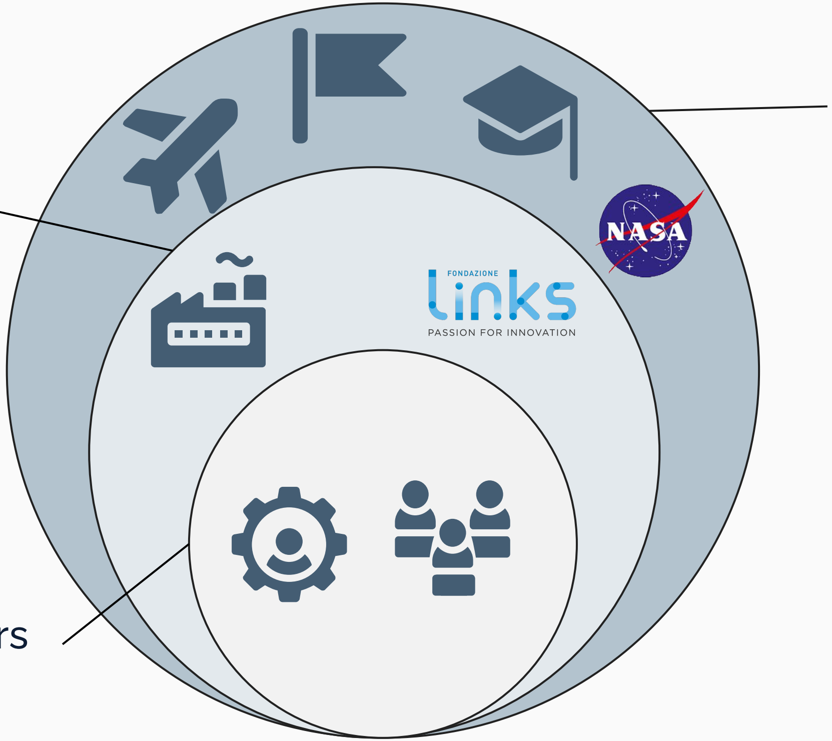
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

Objectives:

- Offer continuous maintenance assistance,
- Decrease components production
- Decrease maintenance time
- Improve the engine efficiency

Stakeholders:



Informed:

- Airlines and armies
- Governments
- Academics
- NASA

Involved:

- Links Foundation
- Airplane manufacturers

Product users:

- Maintenance engineers
- Maintenance workers

User persona

GEORGES L. BROOK

- 41 , American
- Master of aerospace engineering at Boston University

- Maintenance Engineer at Pratt & Whitney
- In charge of a team of 12 workers and 3 engineers

GOAL:

Repairing engines as efficiently as possible.

NEED:

Forecasting the health of the engine before opening it.

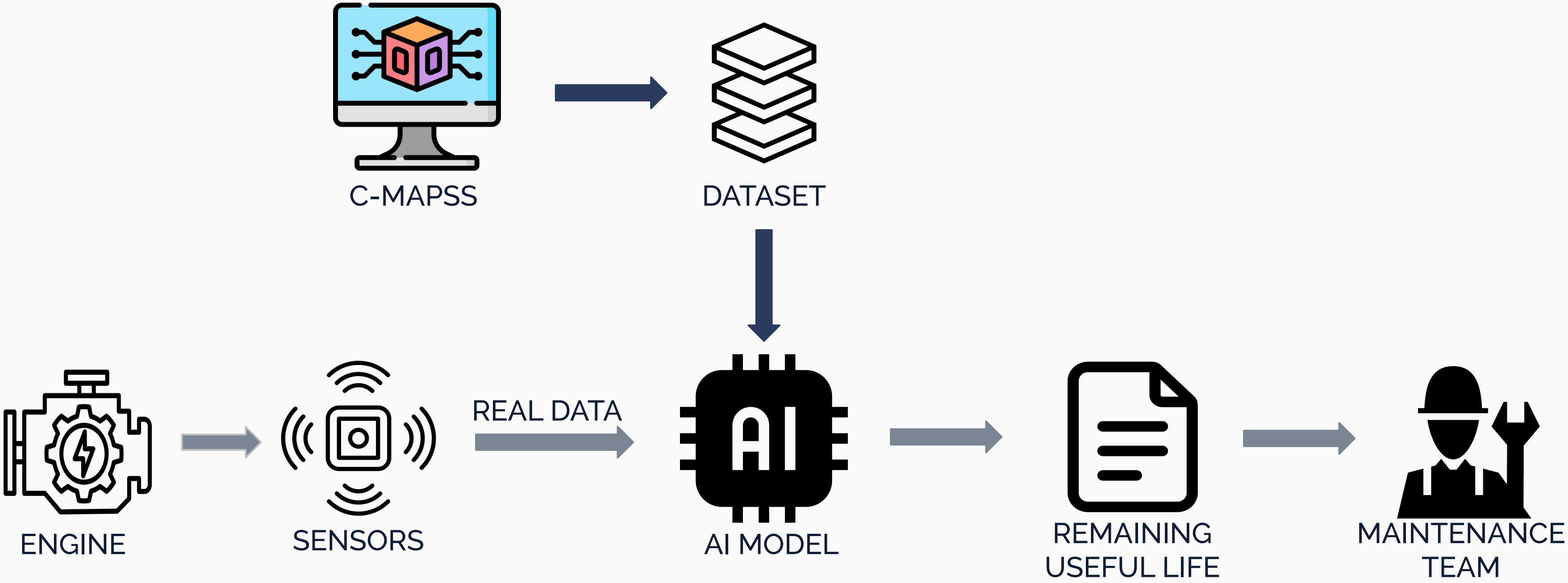
FRUSTRATION:

Not detecting actual failures. Having to test an entire engine while there is no failure.

User requirements

- Functional requirements:
  - **Predict**: The software output must represent the remaining useful lifetime of the engine.
  - **Underestimate**: The software should avoid overestimating the remaining useful lifetime.
  - **Learn**: The software should be able to learn with real-life data for fine tuning
- Non functional requirements:
  - **Accuracy**: The software should be as accurate as possible.
  - **Robustness**: The software should work in any environment.
  - **Adaptability**: The software should be easy to adapt to other plane architectures and failure types.
  - **Usability**: The software should be easy to use.

Functional diagrams:

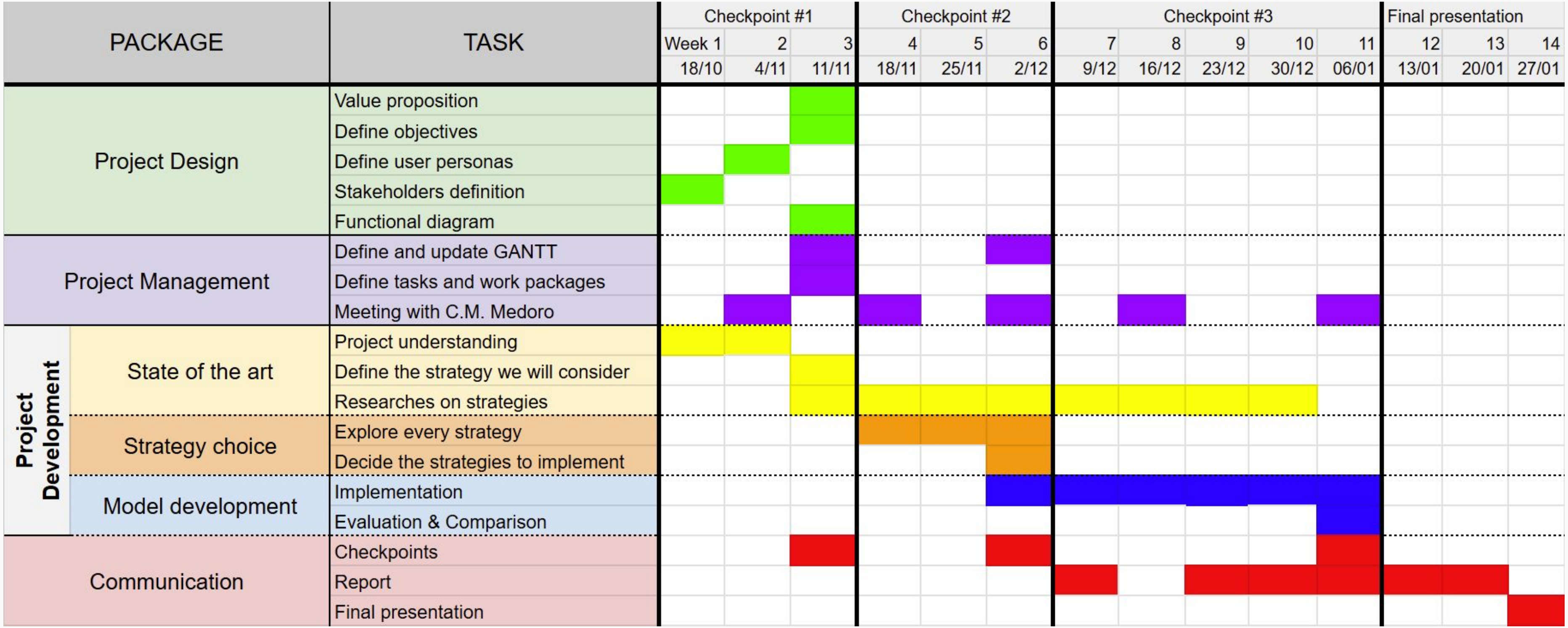


Strategies:

- Machine Learning Models
  - Regression
  - Classification
- Deep Learning
  - Feed Forward Neural Network
  - Long Short-Term Memory
  - Transformer

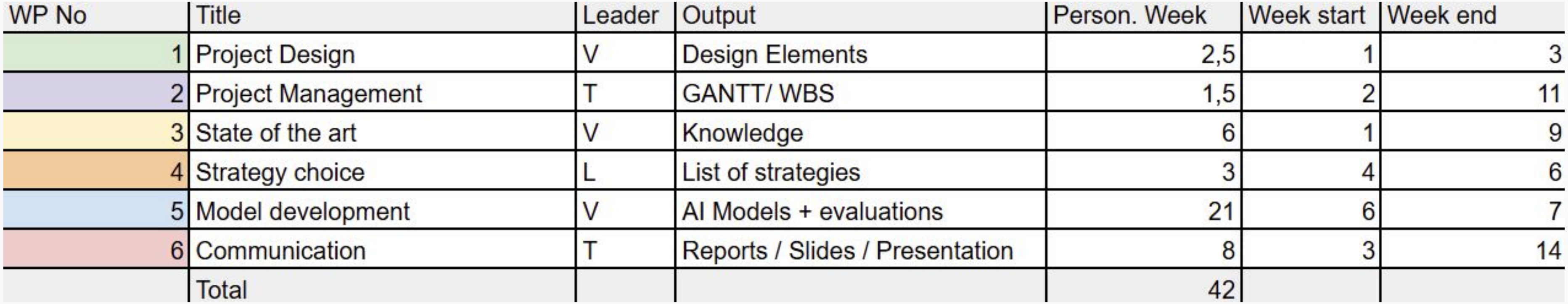
- Analyses and Predictions
  - Forecasting
  - Survival Analysis
- Condition Monitoring
  - Health index
  - Trajectory Comparison

GANTT



PACKAGE		TASK	Checkpoint #1			Checkpoint #2			Checkpoint #3					Final presentation		
			Week 1	2	3	4	5	6	7	8	9	10	11	12	13	14
			18/10	4/11	11/11	18/11	25/11	2/12	9/12	16/12	23/12	30/12	06/01	13/01	20/01	27/01
Project Design		Value proposition			🟩											
		Define objectives			🟩											
		Define user personas		🟩												
		Stakeholders definition	🟩													
		Functional diagram			🟩											
Project Management		Define and update GANTT			🟪			🟪								
		Define tasks and work packages			🟪											
		Meeting with C.M. Medoro		🟪		🟪		🟪		🟪			🟪			
Project Development	State of the art	Project understanding	🟨	🟨												
		Define the strategy we will consider			🟨											
		Researches on strategies			🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨				
	Strategy choice	Explore every strategy				🟧	🟧	🟧								
		Decide the strategies to implement						🟧								
	Model development	Implementation						🟦	🟦	🟦	🟦	🟦	🟦			
		Evaluation & Comparison											🟦			
Communication		Checkpoints			🟥			🟥					🟥			
		Report							🟥		🟥	🟥	🟥	🟥	🟥	
		Final presentation														🟥

Work Breakdown Structure



WP No	Title	Leader	Output	Person. Week	Week start	Week end
1	Project Design	V	Design Elements	2,5	1	3
2	Project Management	T	GANTT/ WBS	1,5	2	11
3	State of the art	V	Knowledge	6	1	9
4	Strategy choice	L	List of strategies	3	4	6
5	Model development	V	AI Models + evaluations	21	6	7
6	Communication	T	Reports / Slides / Presentation	8	3	14
	Total			42		

Any question ?

- Tanguy Dugas du Villard
- Vito Perrucci
- Lorenzo Suppa