

TENFORCE
elisa company



AI-PROFICIENT
Artificial intelligence
for improved production efficiency,
quality and maintenance

JUNE 8TH, 2023



THE FUTURE IS WOW 2023



BRINGING AI TECHNOLOGY TO THE PRODUCTION LINE



“IA” for manufacturing





What is manufacturing?

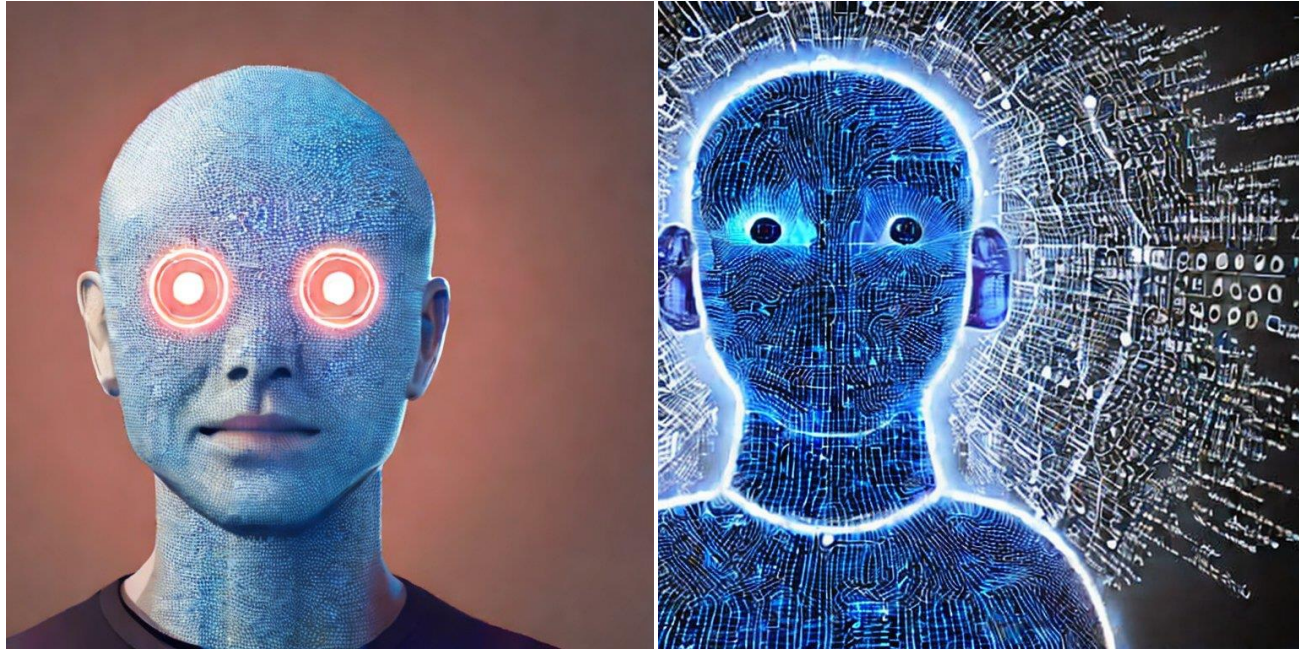


“what is manufacturing”





What is Artificial Intelligence?



“what is artificial intelligence”

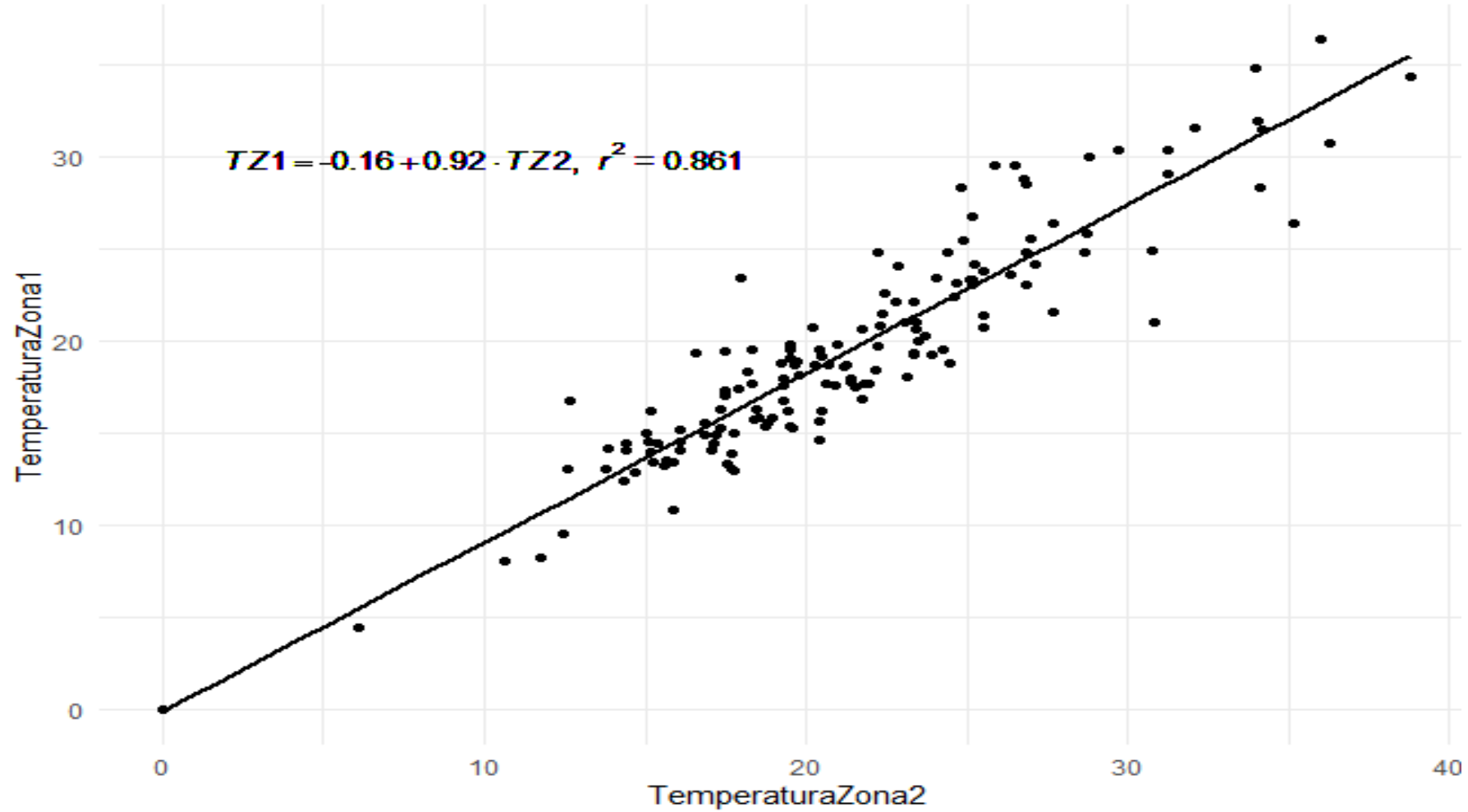


“what is manufacturing” – [Stable Diffusion](#)



“what is artificial intelligence” – [Stable Diffusion](#)





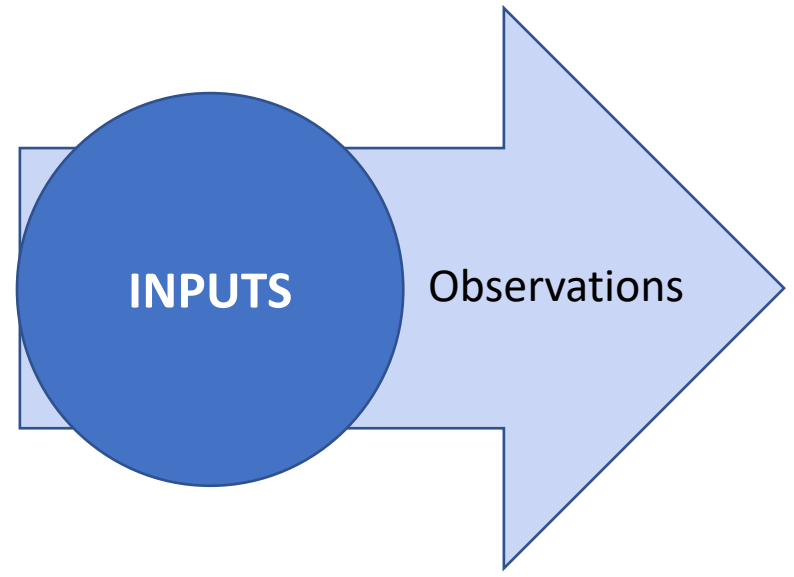
**Temperature Prediction Linear Model
(TPLM)**



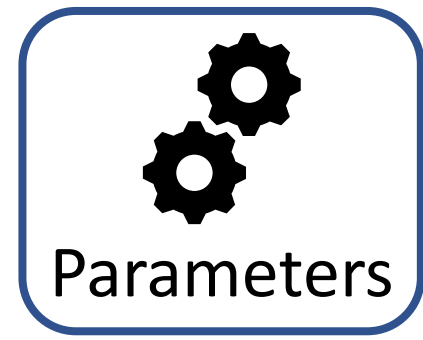


Data-driven models

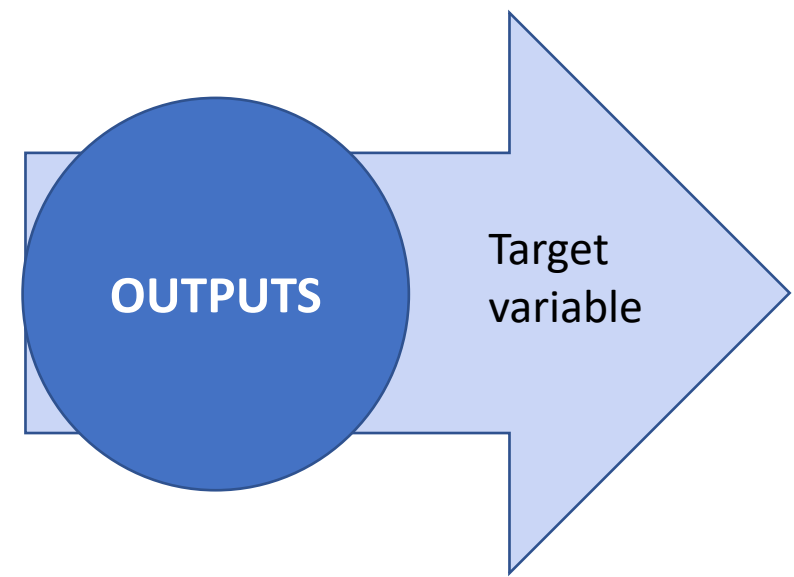
INPUTS



MODEL



OUTPUTS

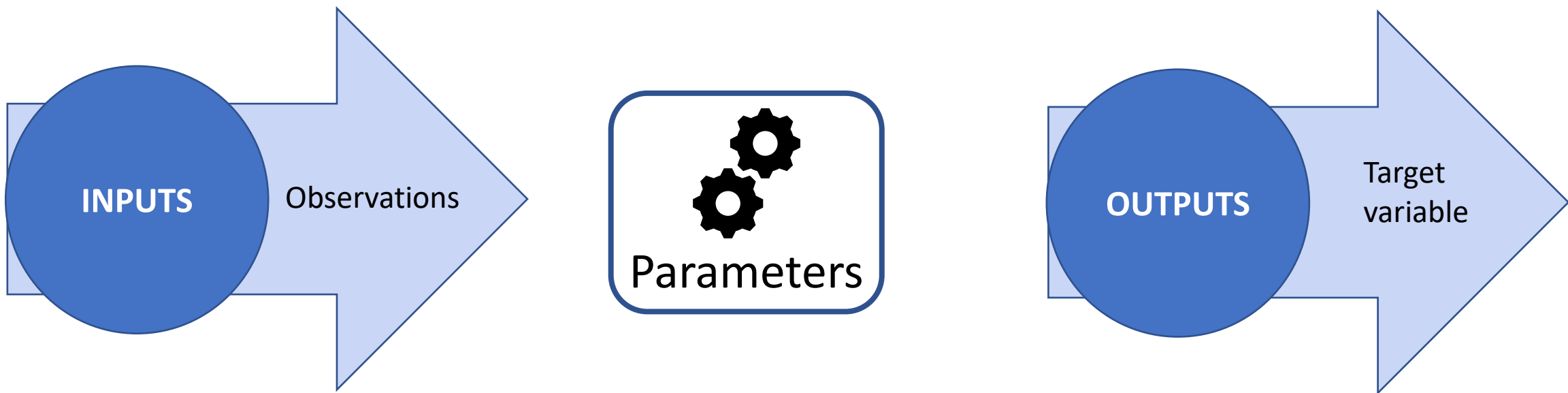




INPUTS

MODEL

OUTPUTS



“A plane taking off”



Stable diffusion



Temperature Zone 1 = 20°C



TPLM



Temperature Zone 2 = 18.6°C



Stable diffusion

- Training dataset: [LAION-5B](#) (5,85 billions de “image-text pairs”)
- Number of parameters: [890 millions](#)
- Computational cost:
 - 256 Nvidia A100 GPU total of 150.000 GPU-hours
 - Cost: 600.000 \$



TPLM

- Training dataset: 150 observations
- Number of parameters: 2 (slope and offset)
- Computational cost:
 - Pen and a paper

If temperature in Zone 1 is 20°

Then temperature in Zone 2 is 18.24°



SD
●

Model
parameters

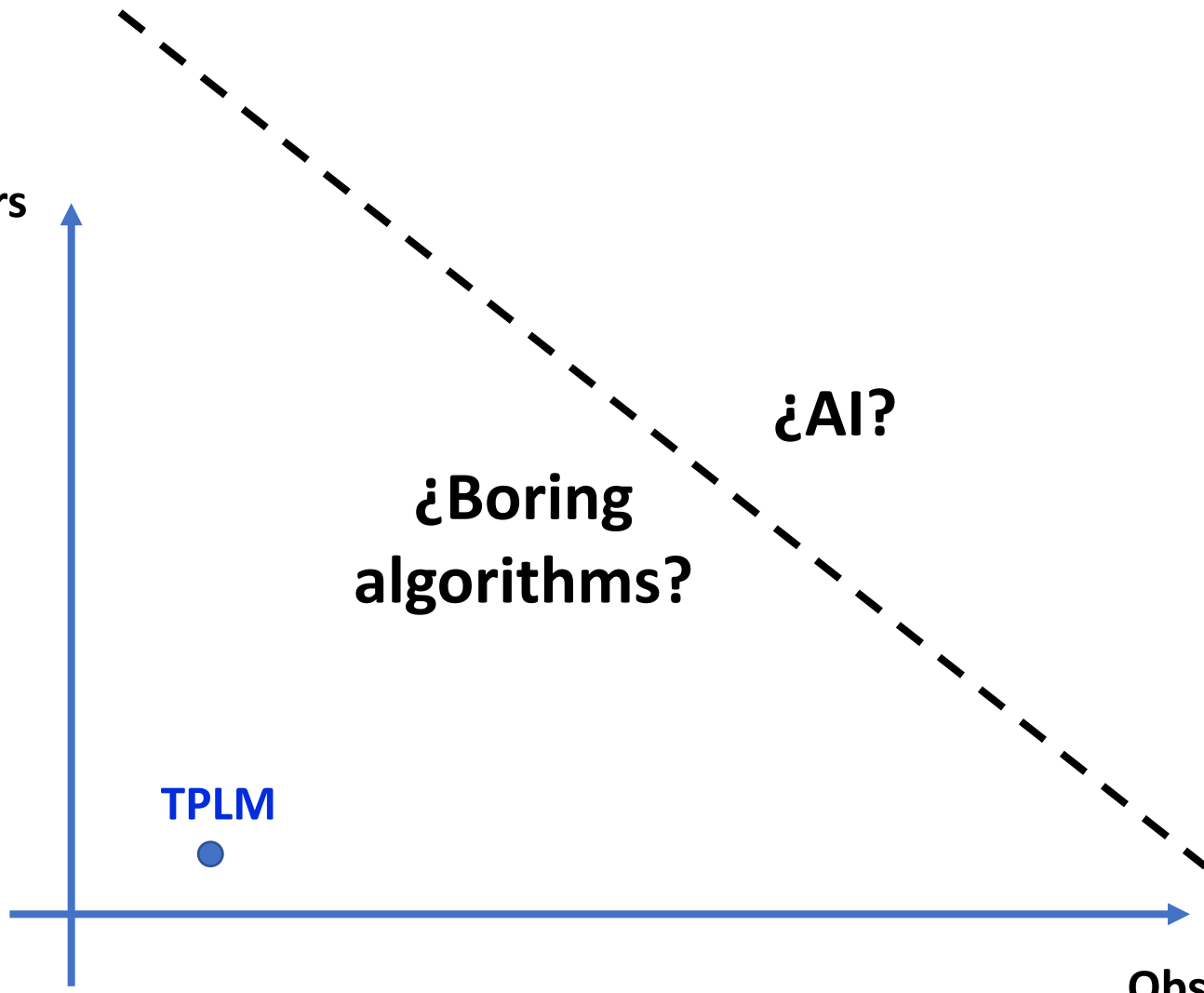
[...]

¿AI?

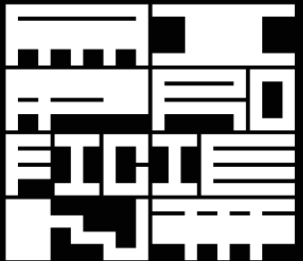
¿Boring
algorithms?

TPLM
●

Observations



Data-based models for Manufacturing



AI-PROFICIENT

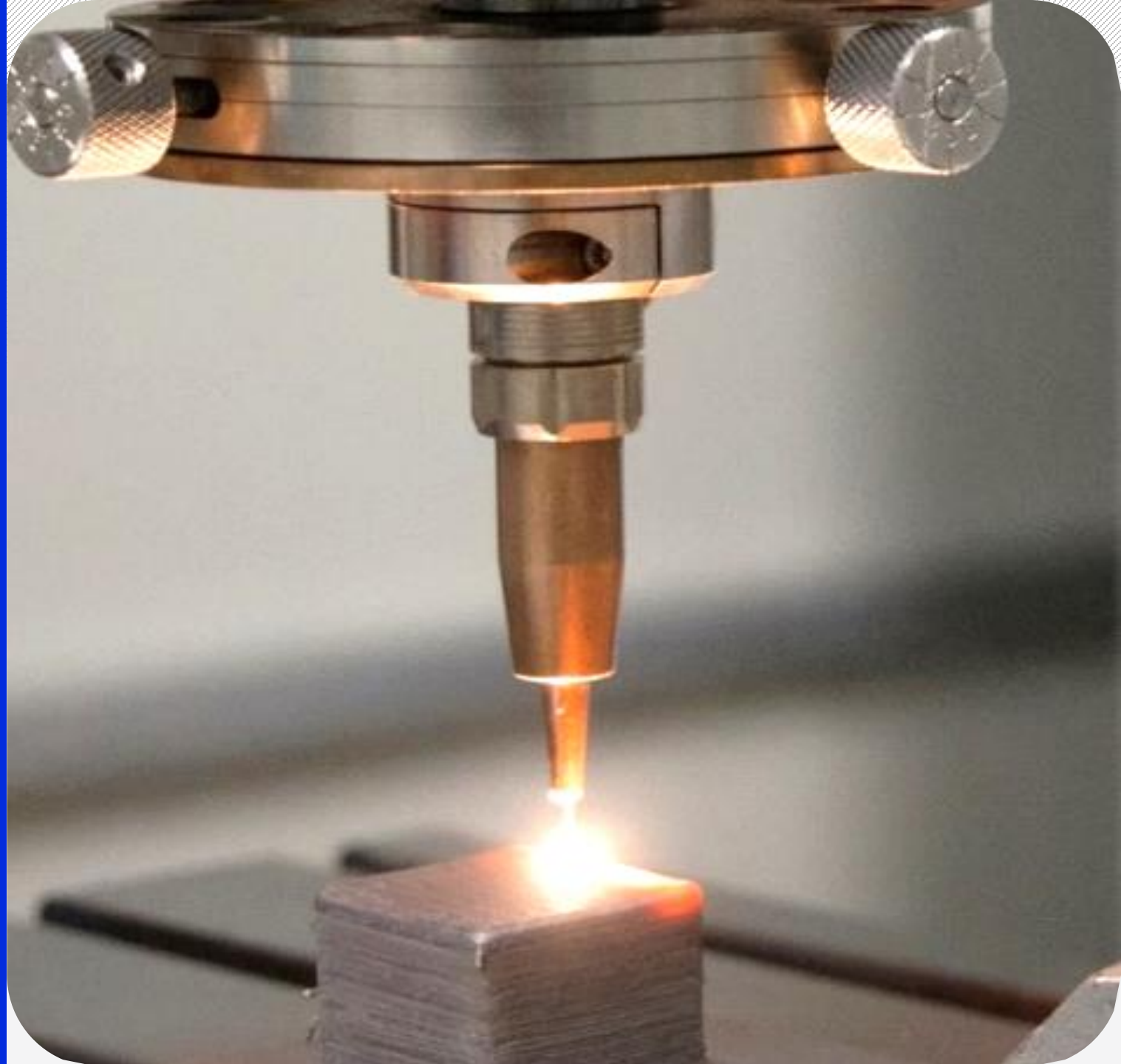
Artificial intelligence
for improved *production efficiency*,
quality and maintenance

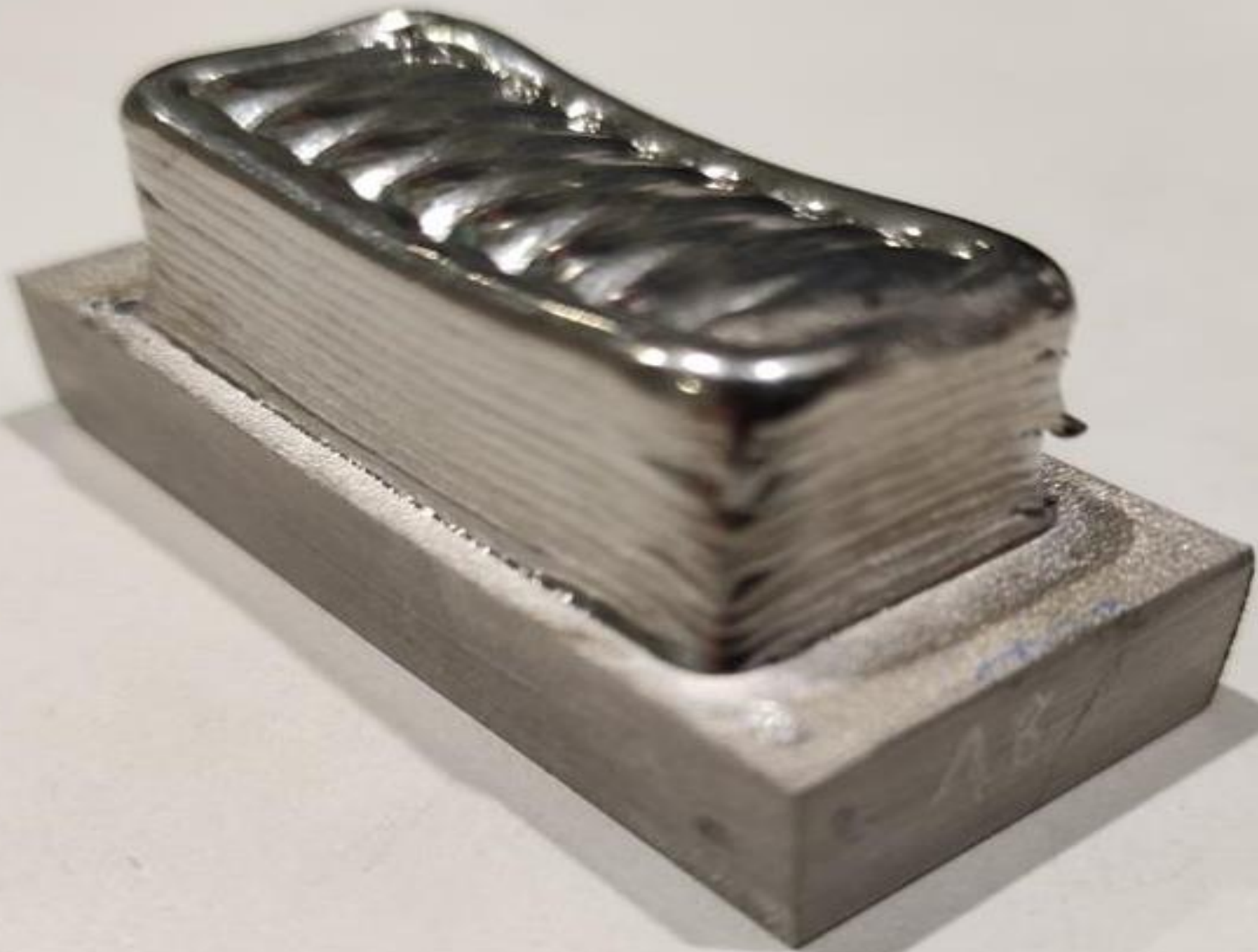


AI-PROFICIENT has received funding from the European Union's Horizon 2020
research and innovation programme under grant agreement No 957391.

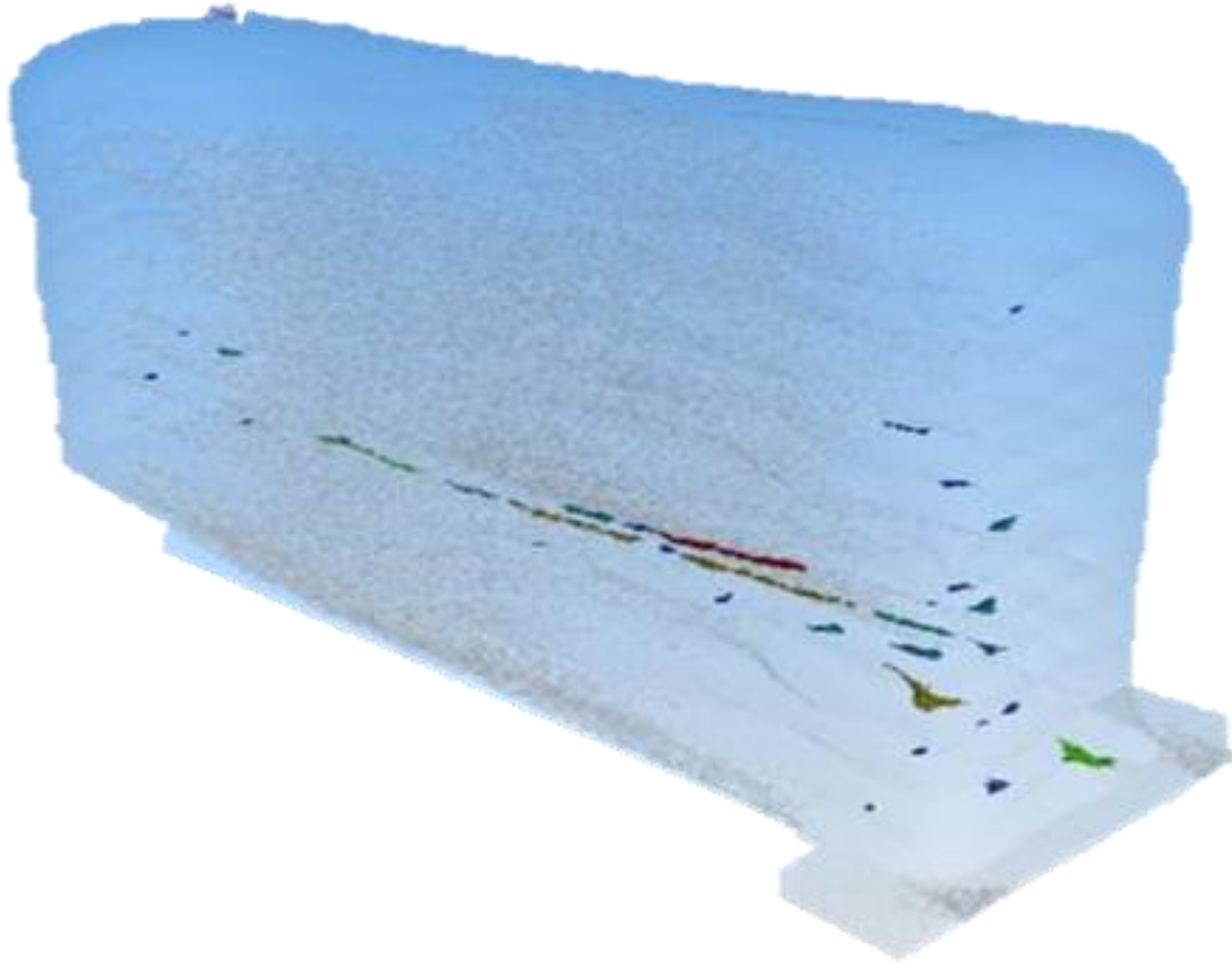


Pore detection in additive manufacturing





Problem



Pores created due to lack of uniform deposition

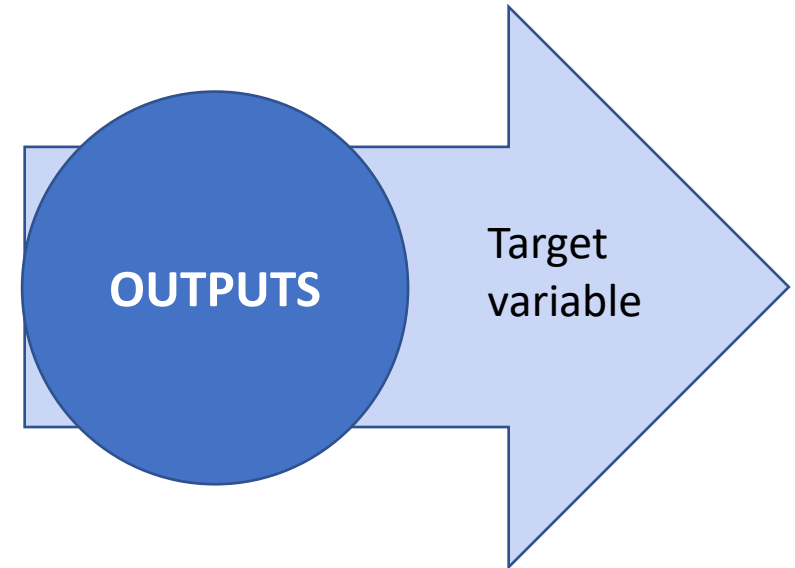
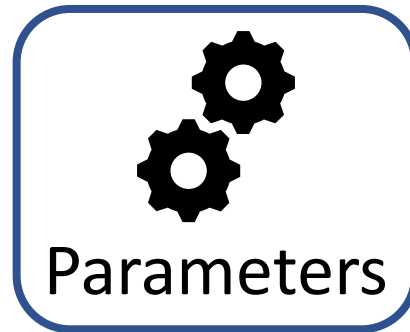
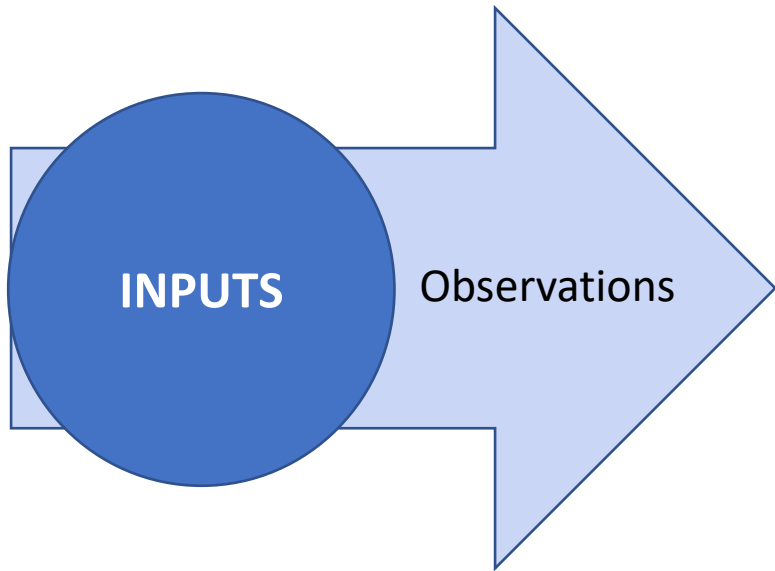




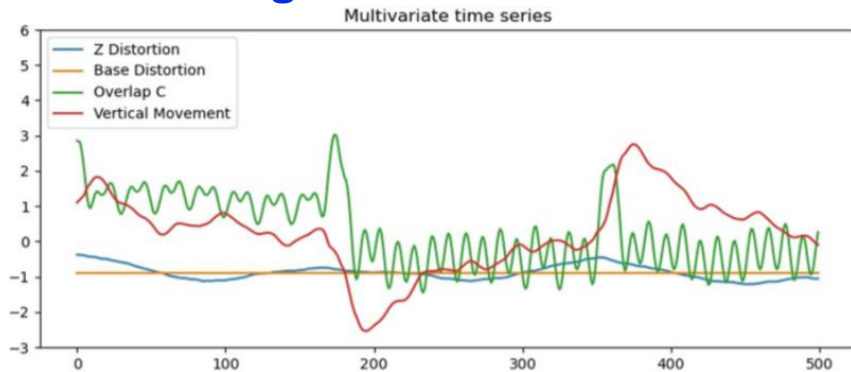
INPUTS

MODEL

OUTPUTS



Process signals



Pores {
- Existing
- Absent

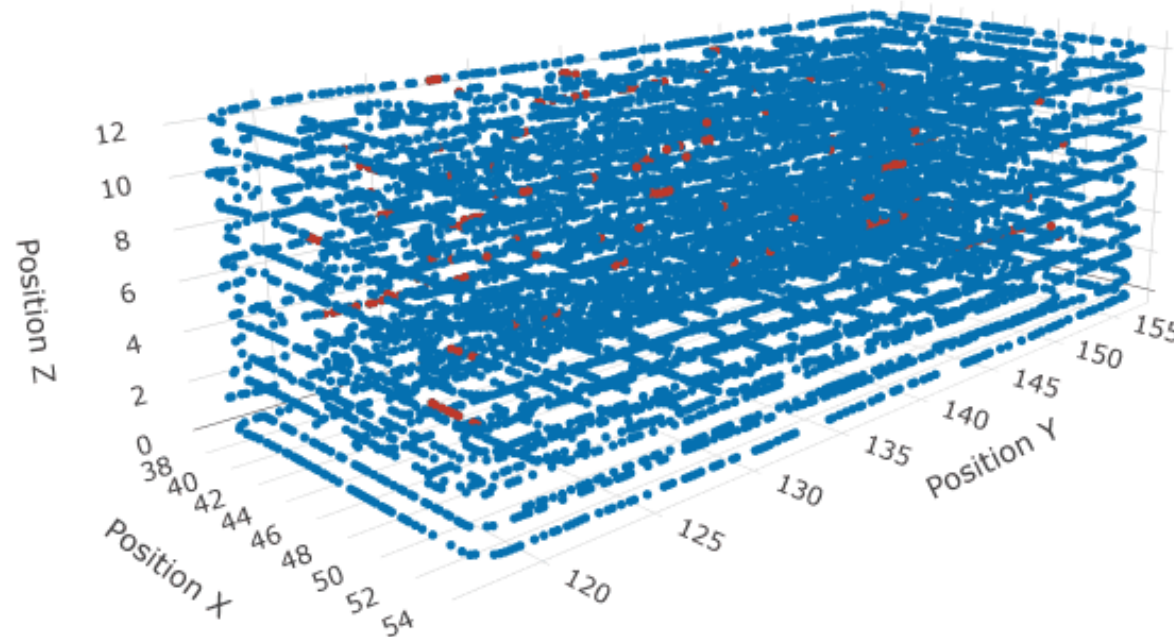
Process signals based pore estimation model :

- Training dataset: 60.000 observations (from 3 pieces)
- Tipo de modelo: Decision Tree



Solución

- Good
- Pore



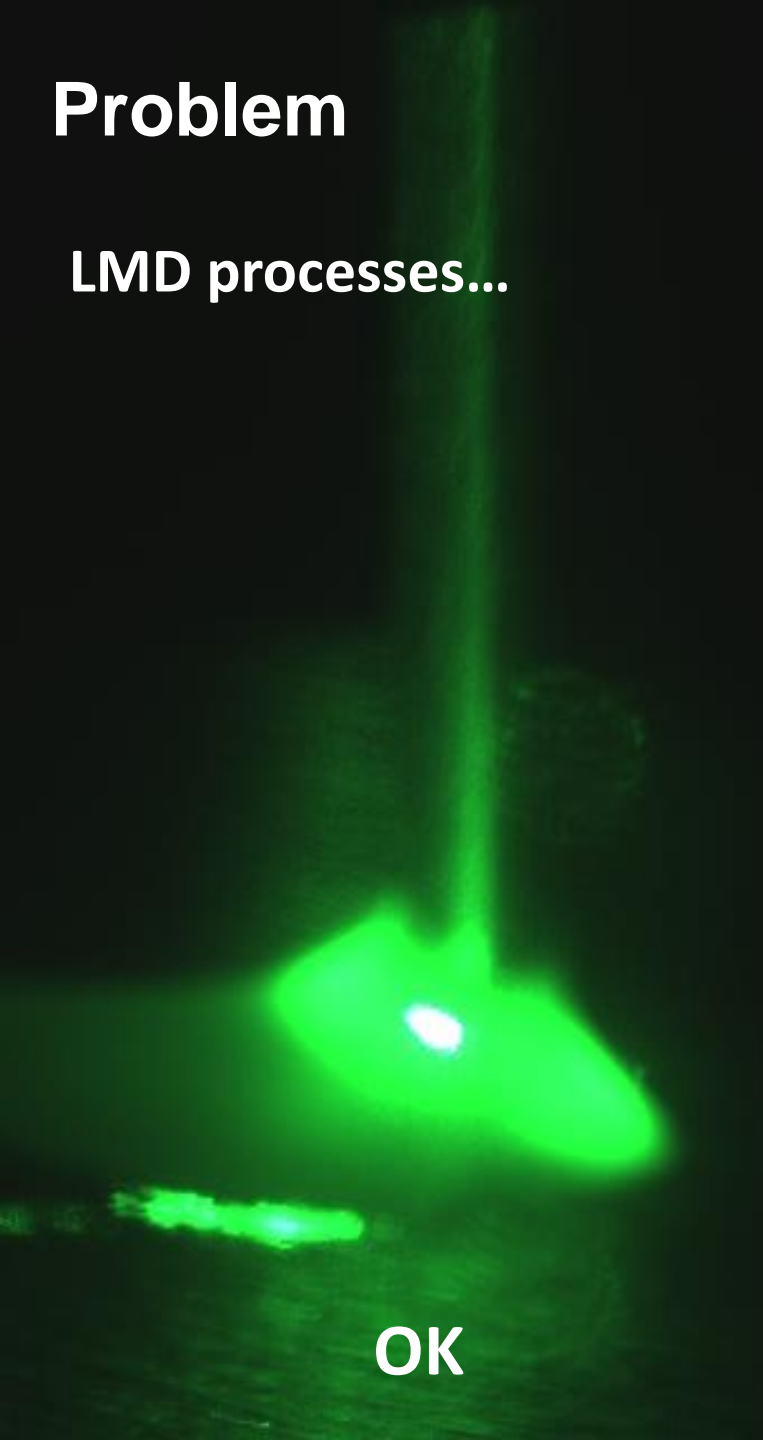
Pore estimation model based on process signals

LMD-Additive manufacturing process fault detection and stoppage

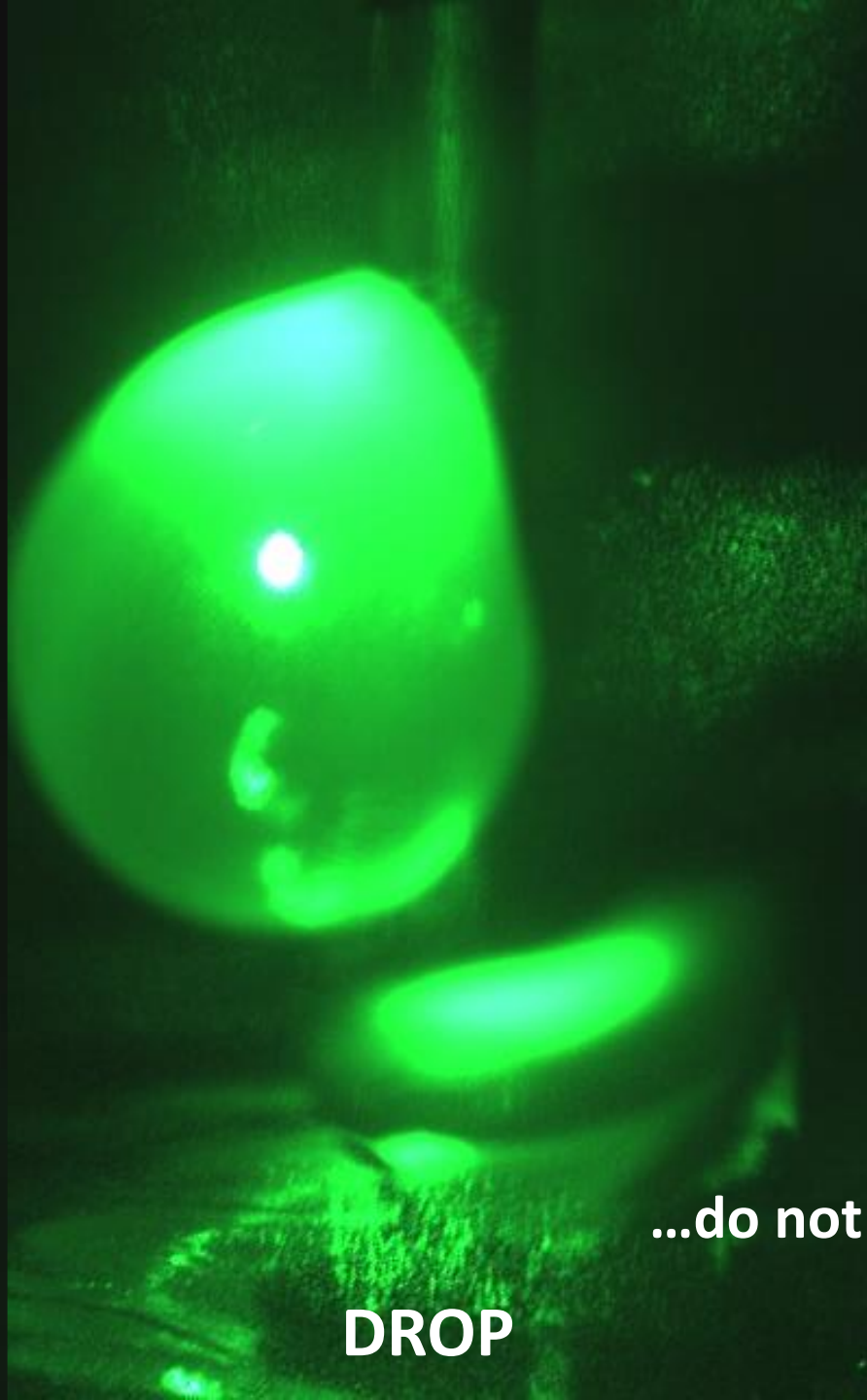


Problem

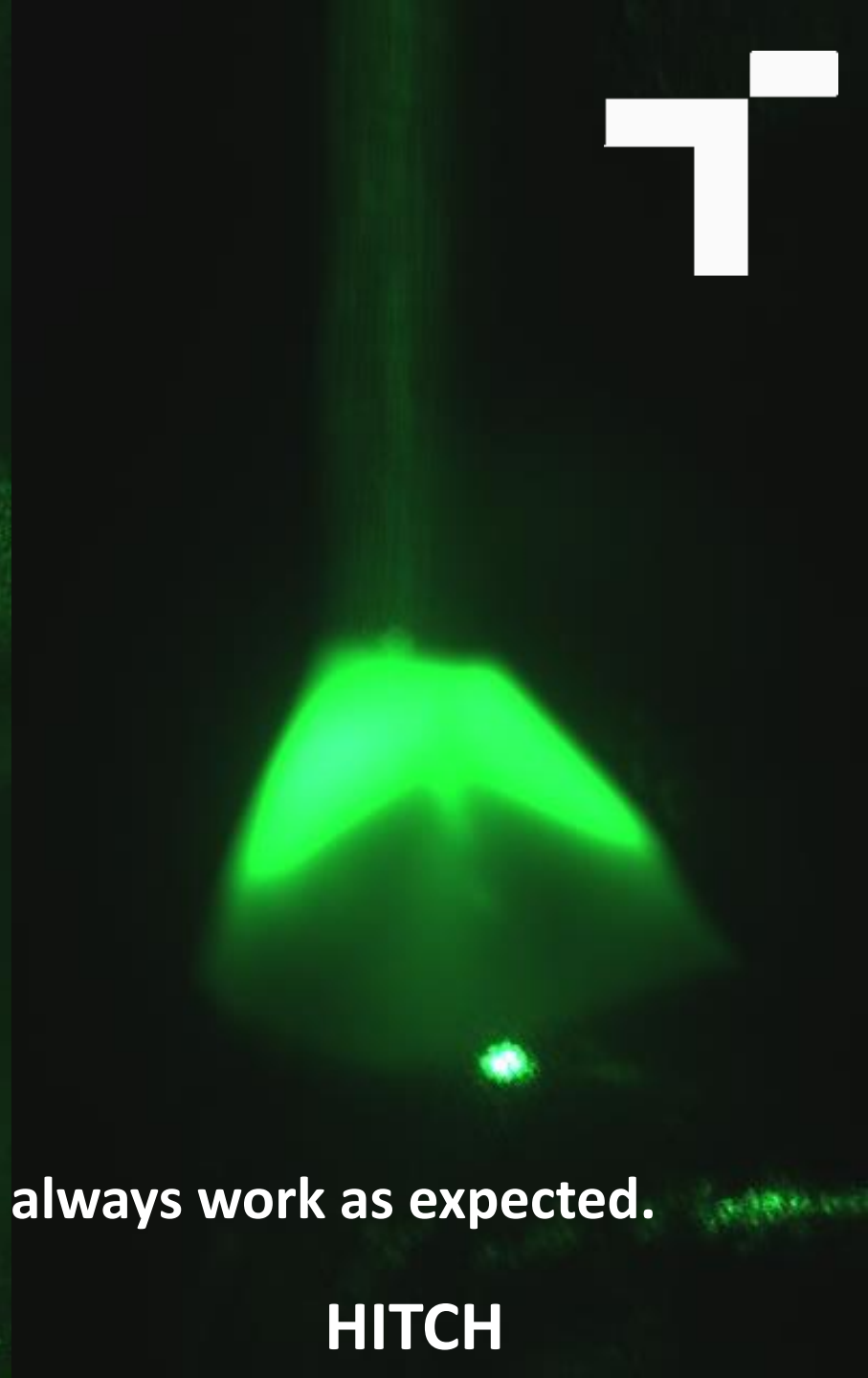
LMD processes...



OK



DROP



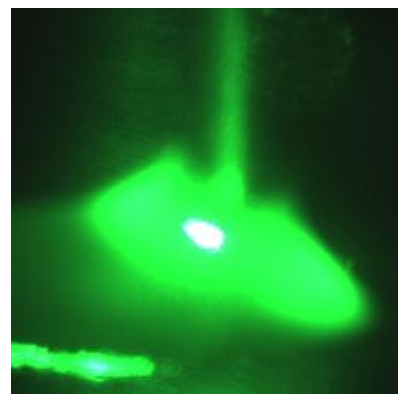
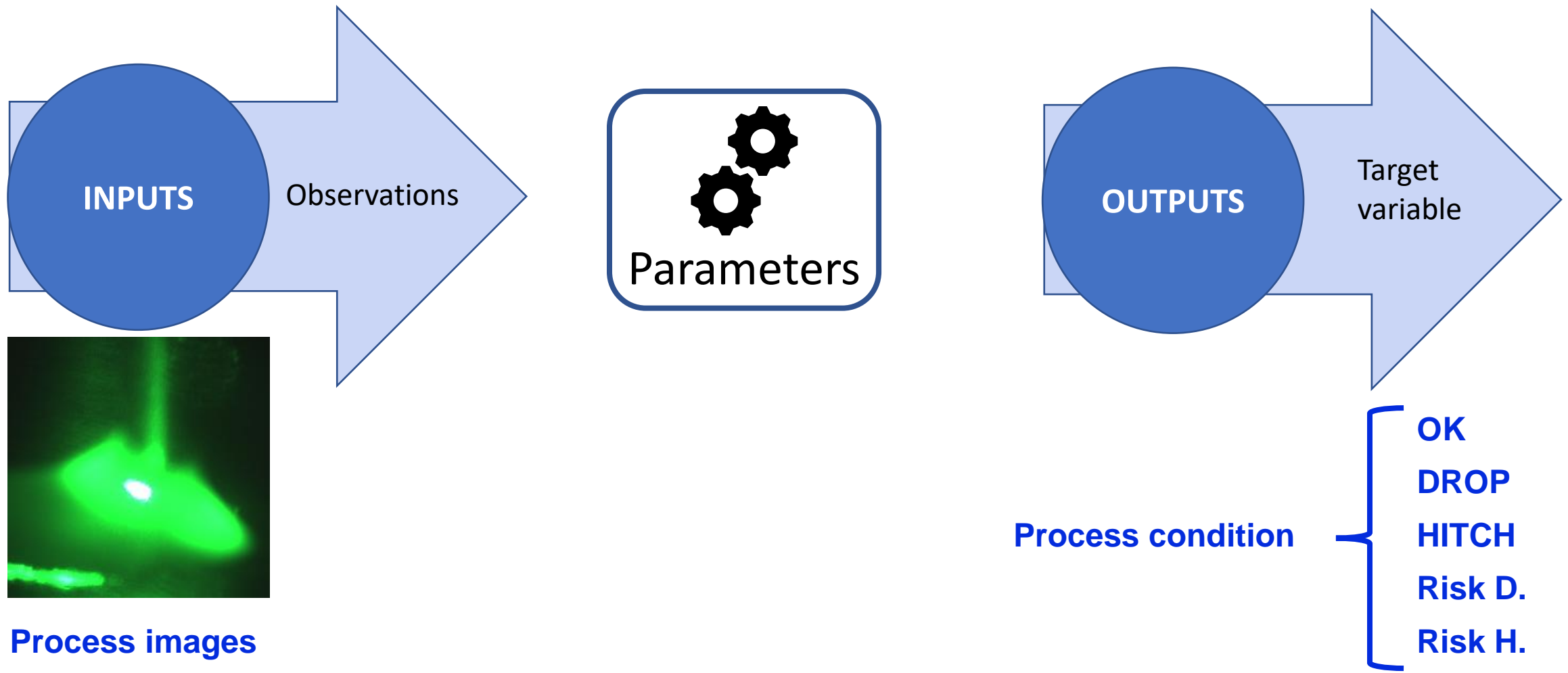
HITCH

...do not always work as expected.

INPUTS

MODEL

OUTPUTS

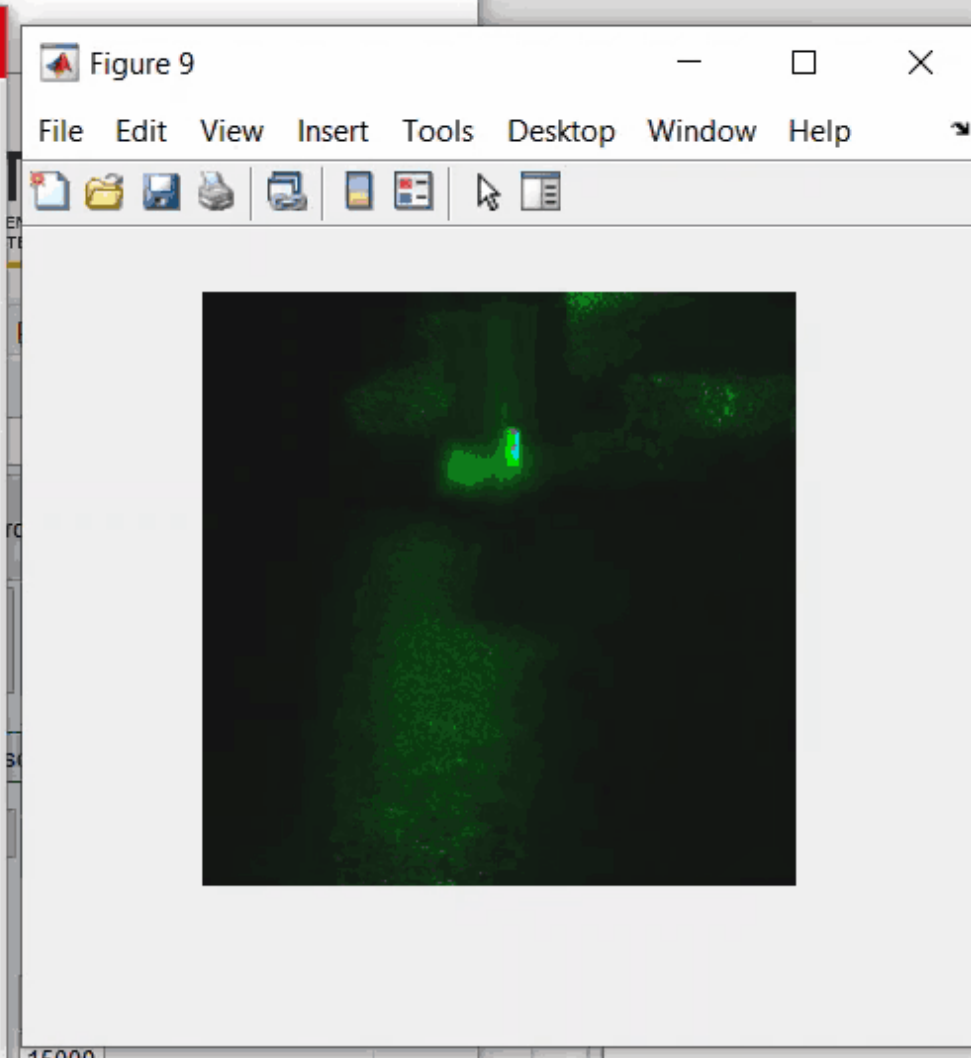
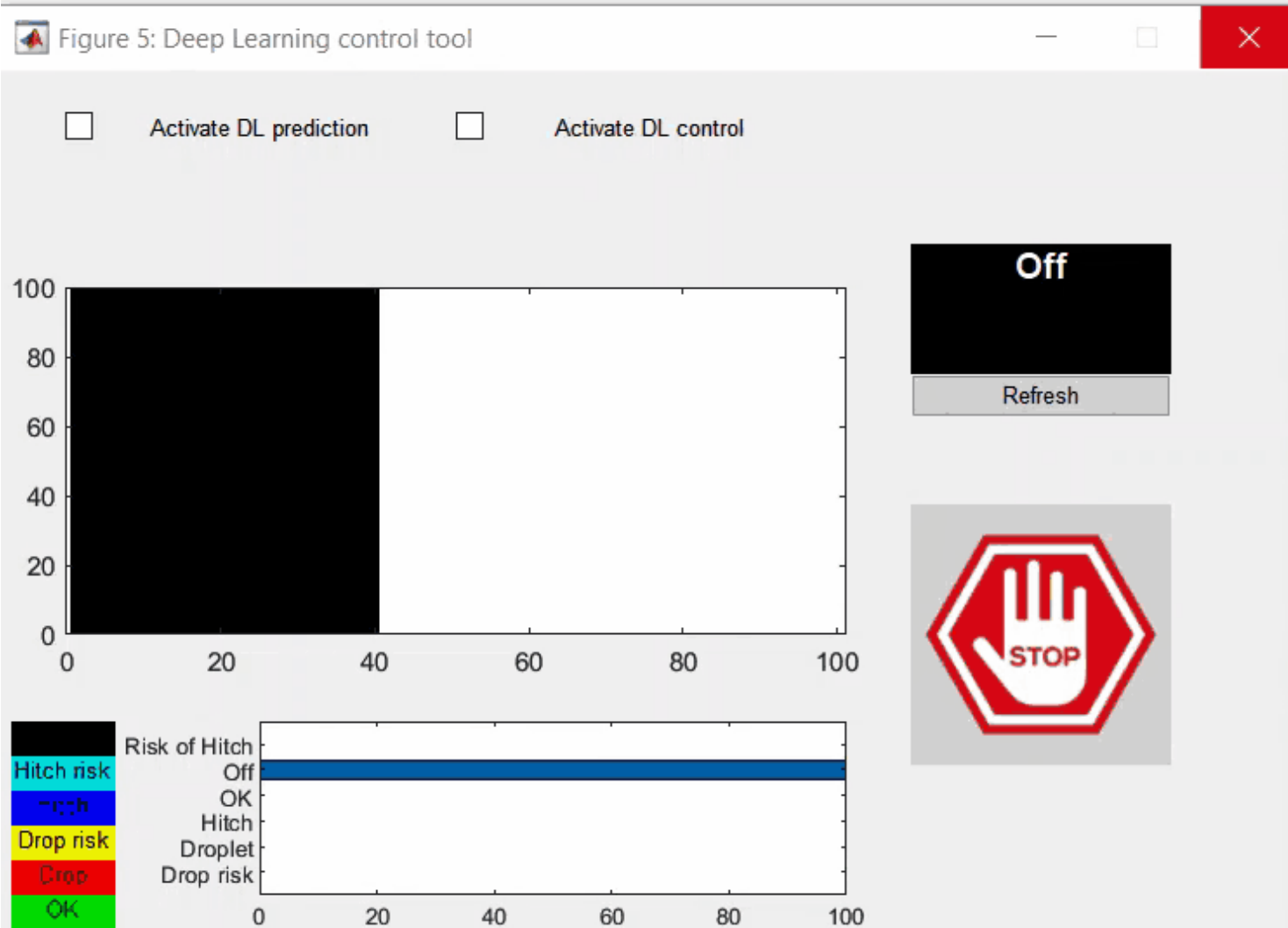


Process images

Vision based LMD process monitoring model:

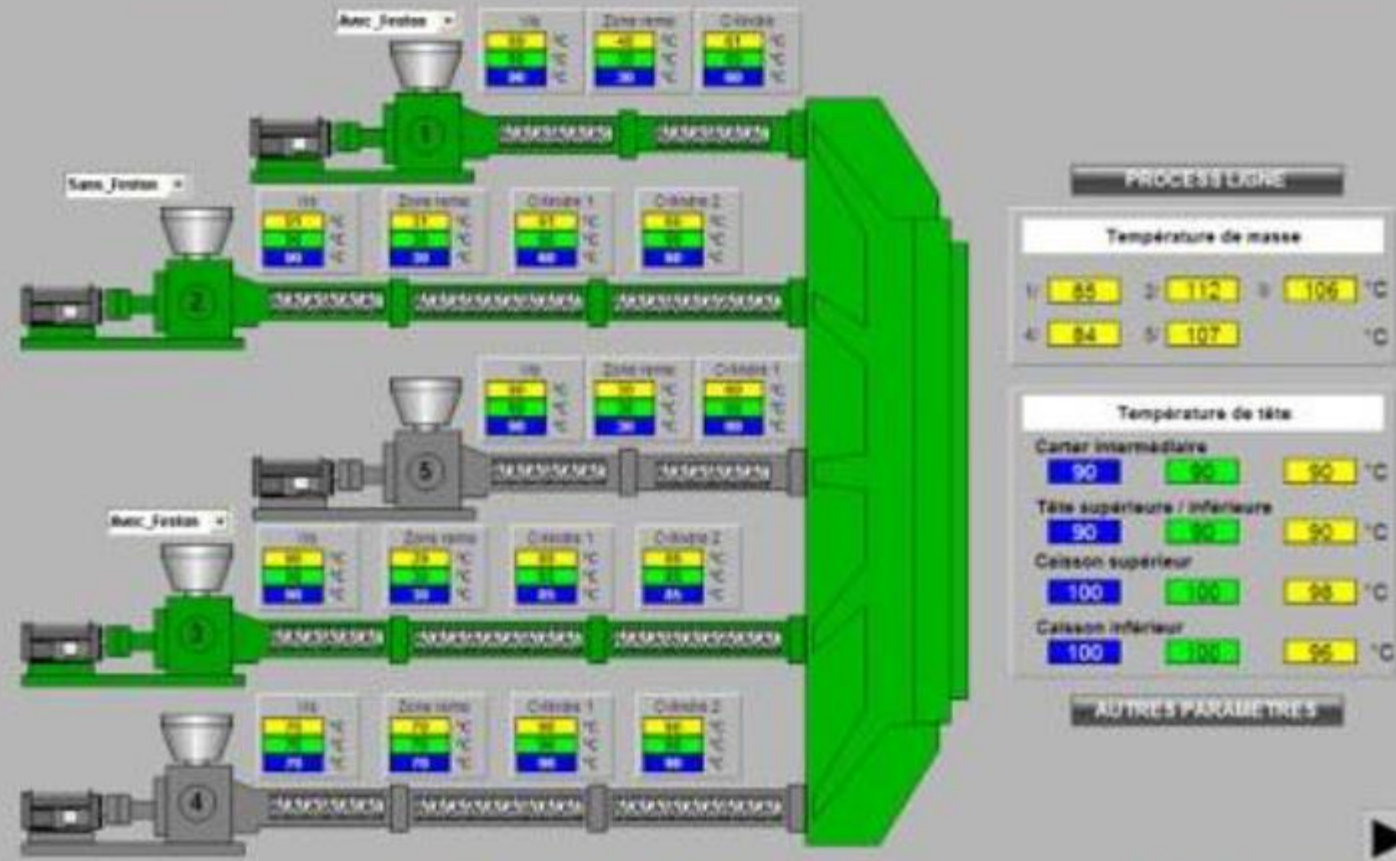
- Training dataset: 20.000 observations (9 Pieces)
- Model type: Deep Learning (EfficientNet-B3)
- Number of parameters: 12M

Solución



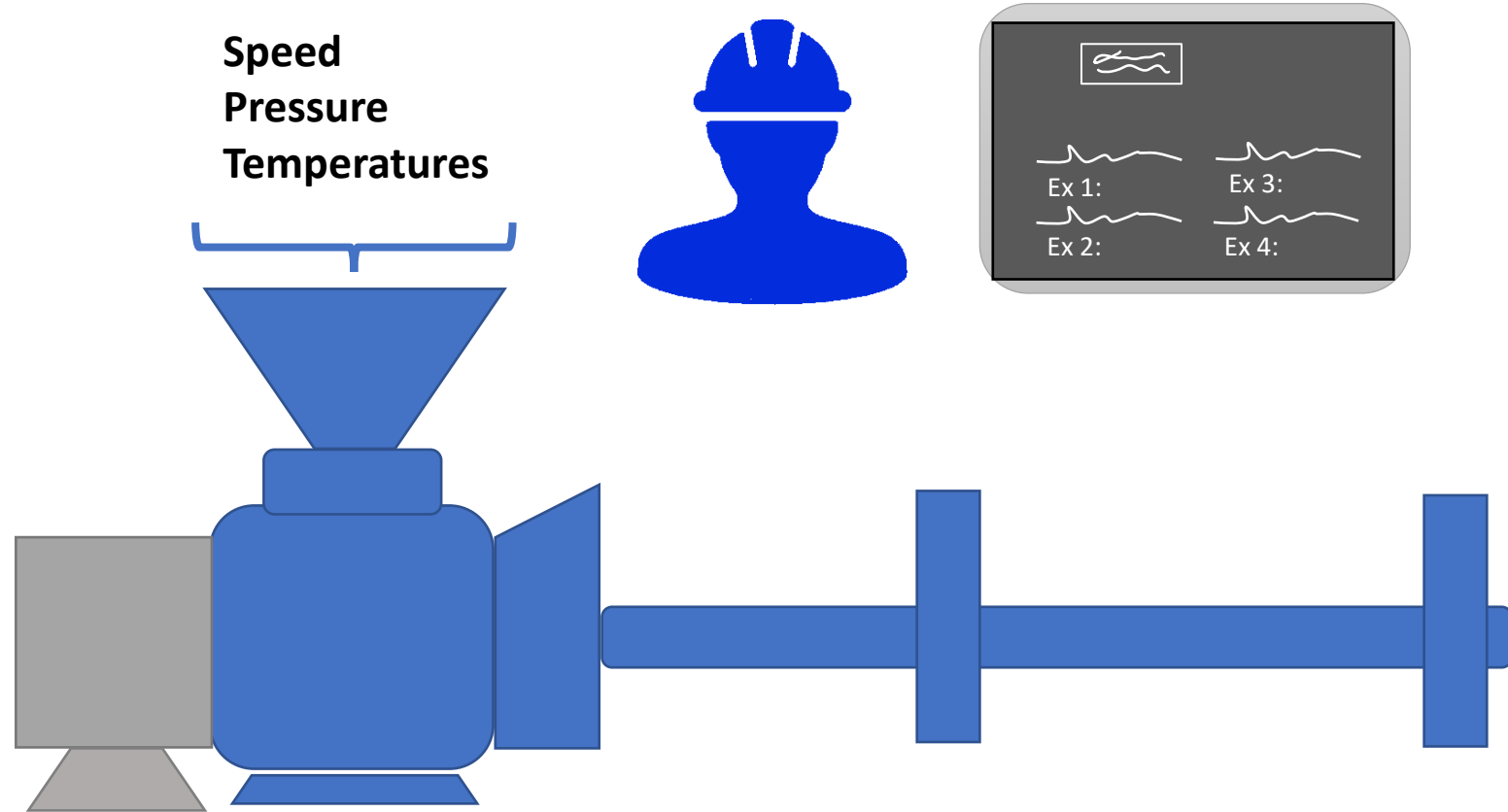
[Vision based LMD process monitoring model](#)

Extrusion process monitoring and optimization





Problem



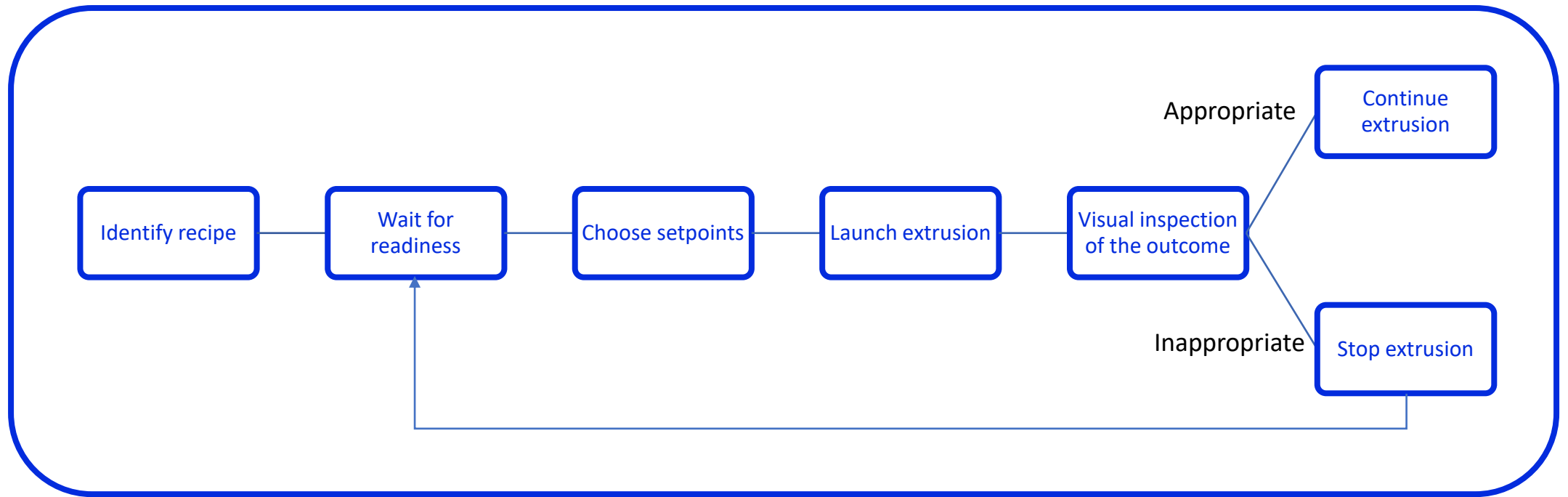
**Extrusion restart is a manual
experience-based process**



Problem



Extrusion setup process



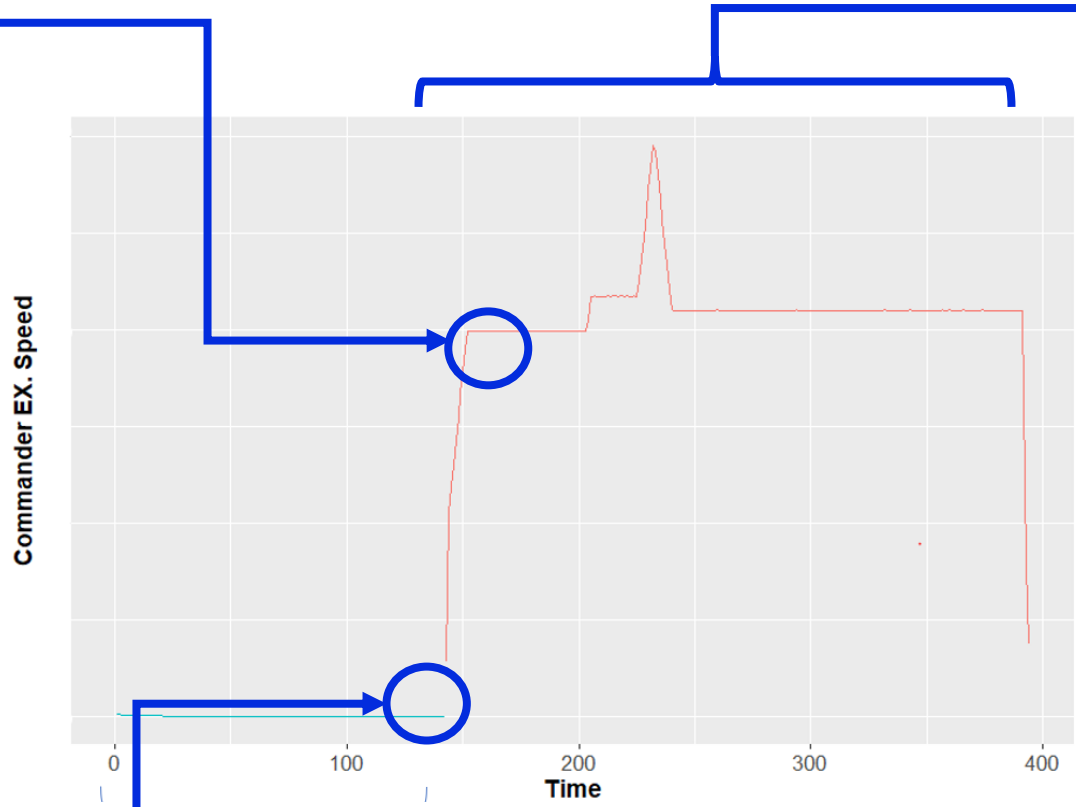


Problem

Setpoints
Speed

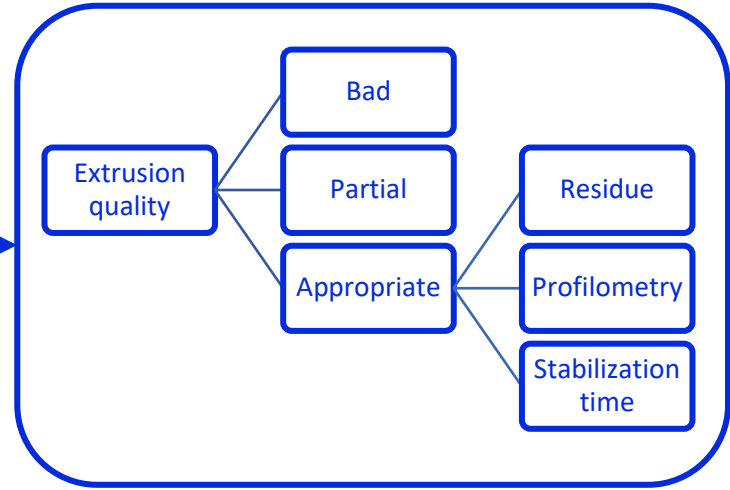


Readiness
Conditions
Pressure
Temperatures



Ex. in usage
— Yes
— No

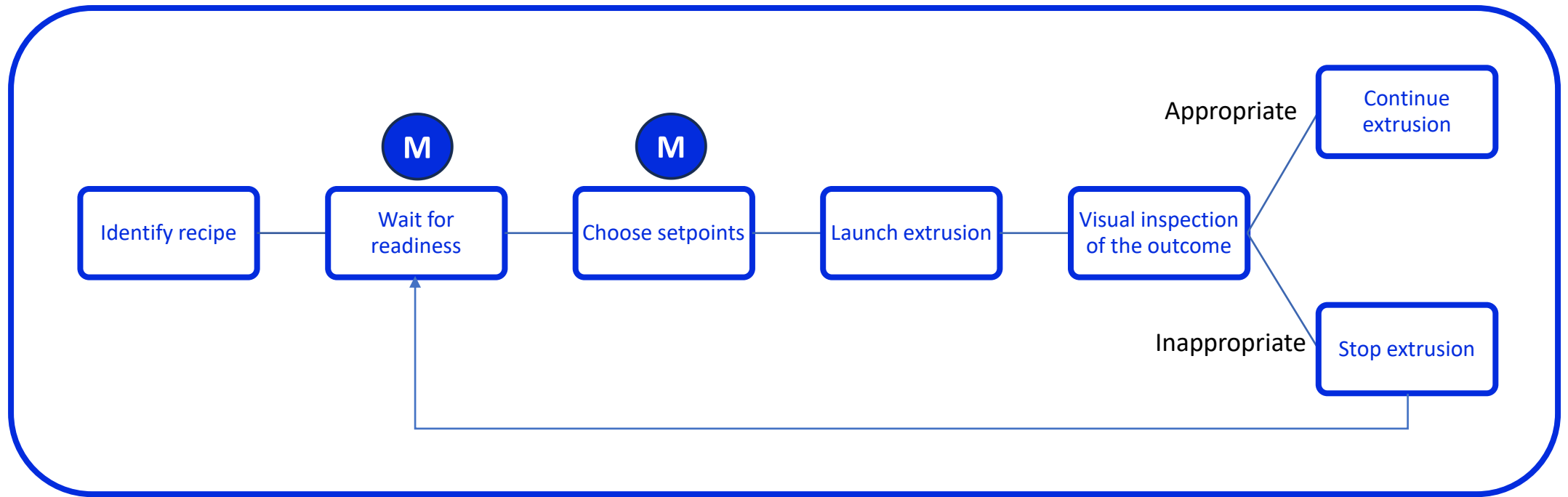
Extrusion outcome



Characterization of an extrusion

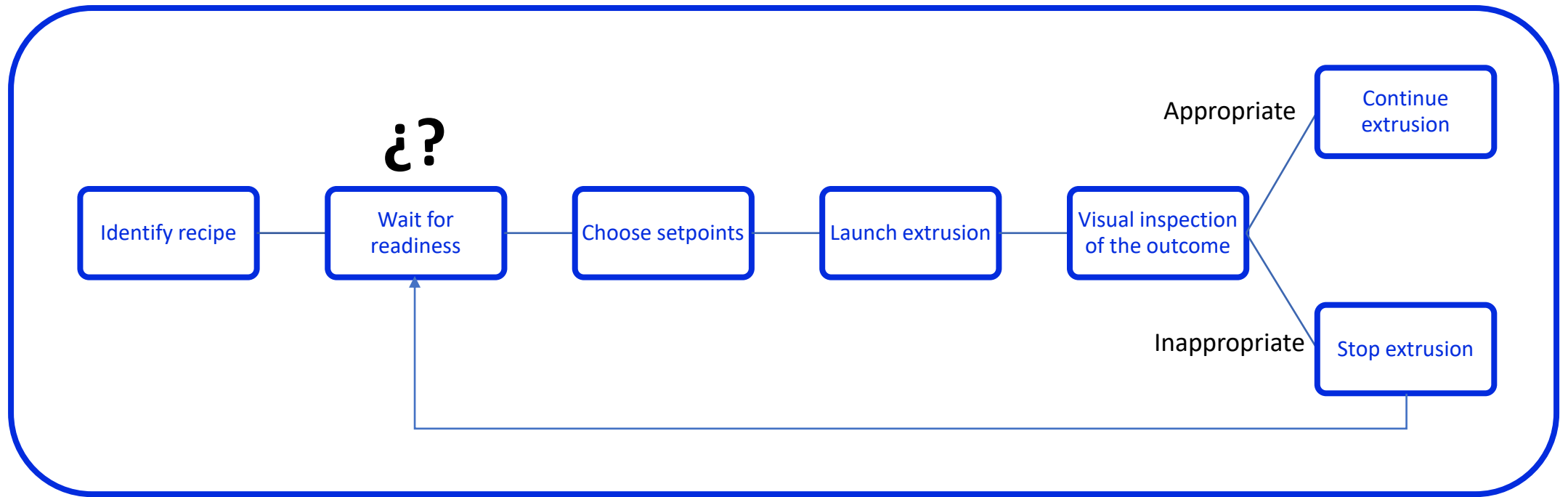


Extrusion setup process

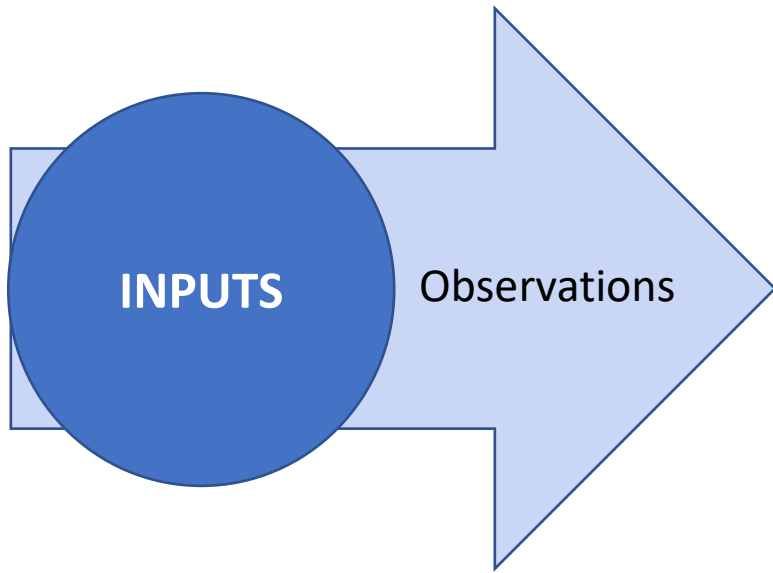




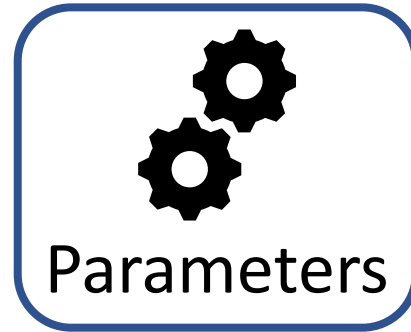
Extrusion setup process



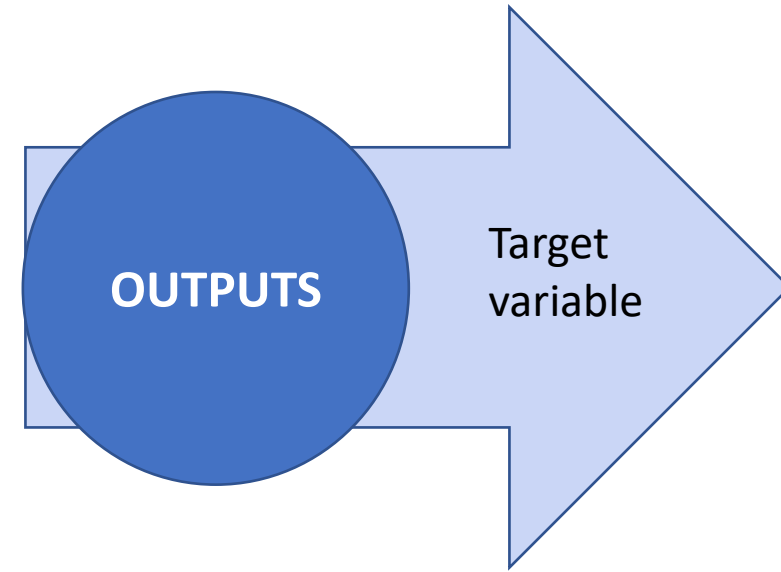
INPUTS



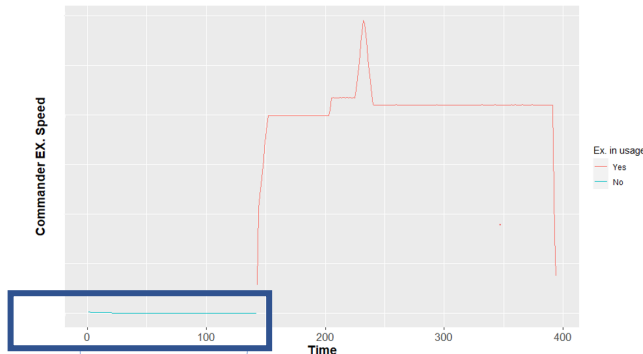
MODEL



OUTPUTS



Extrusion condition indicators



Extrusion quality:

- **Bad**
- **Partial**
- **Appropriate**

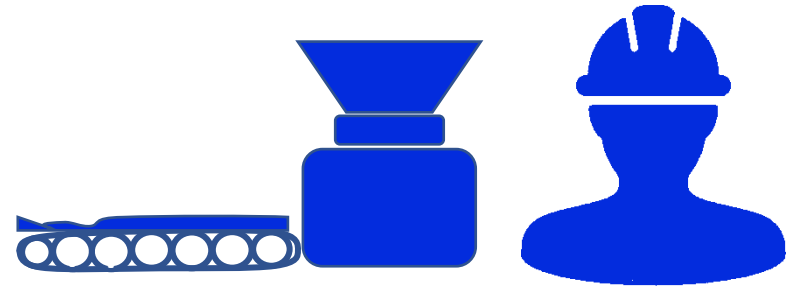
Extrusion readiness detection model:

- Training dataset: ~6000 observations (as many as extrusions) (3 years of data – 36GB)
- Model type: Random Forest - Classification

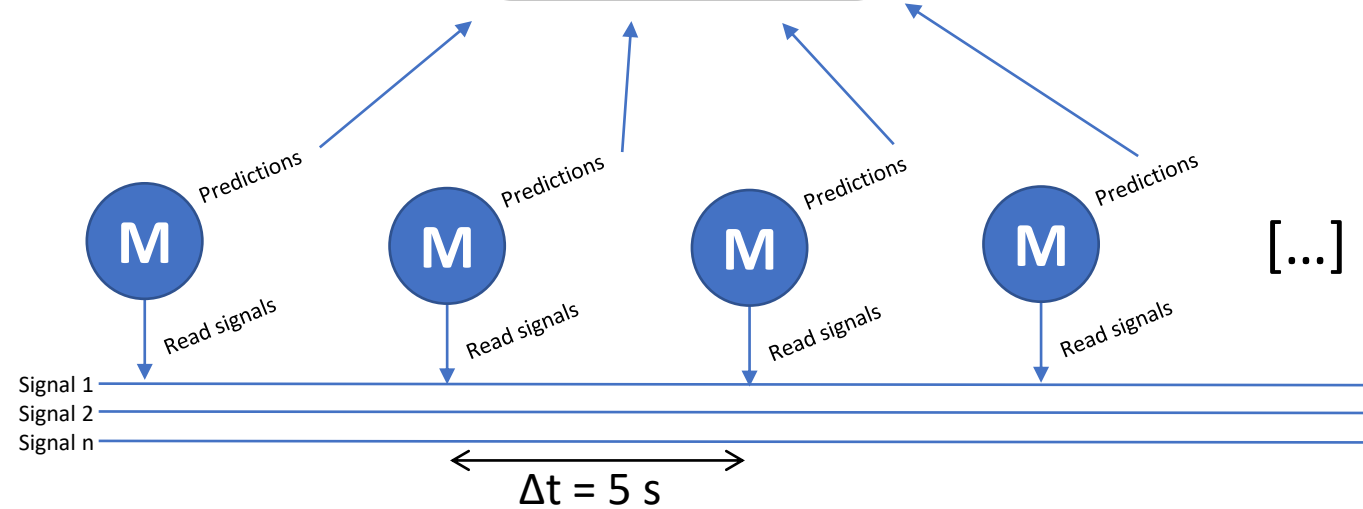
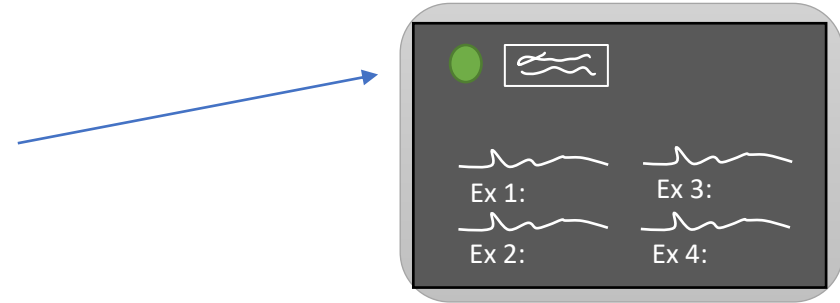


Extrusion support system

Solution

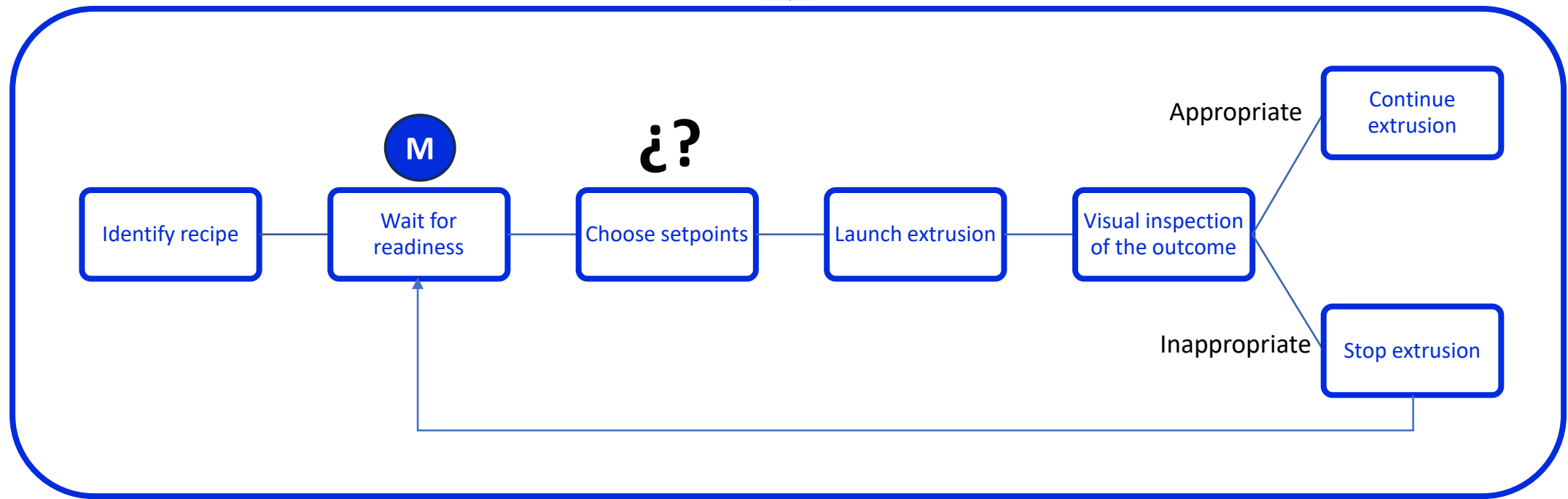


Readiness detector

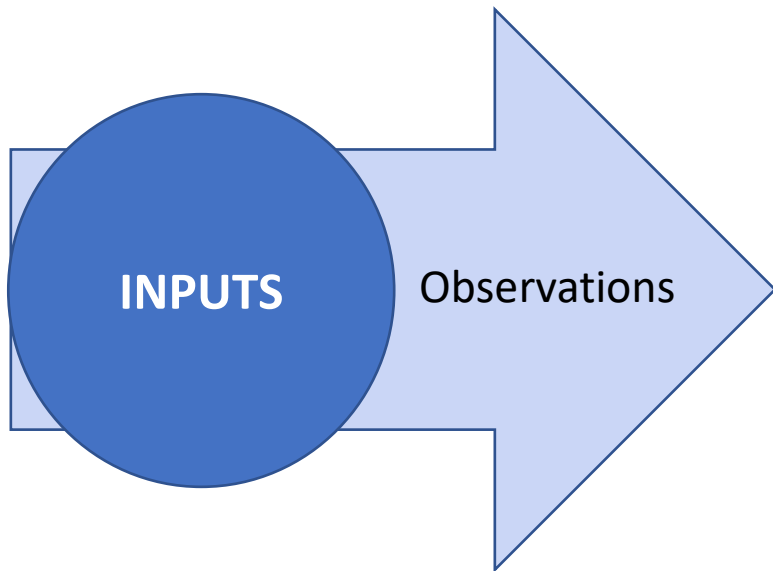




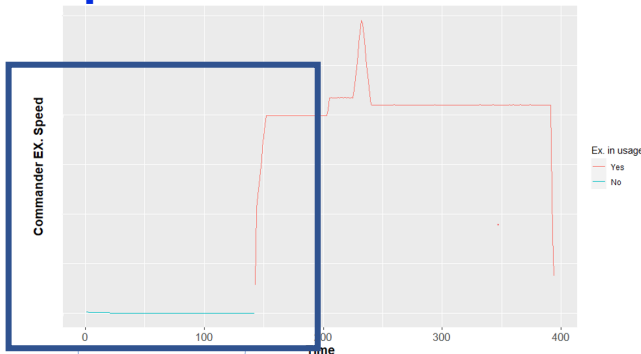
Extrusion setup process



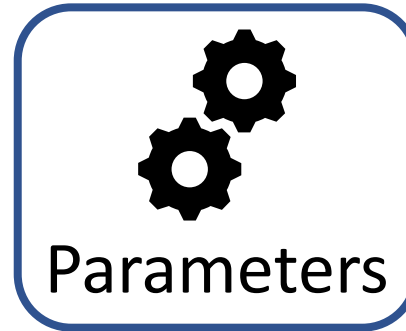
INPUTS



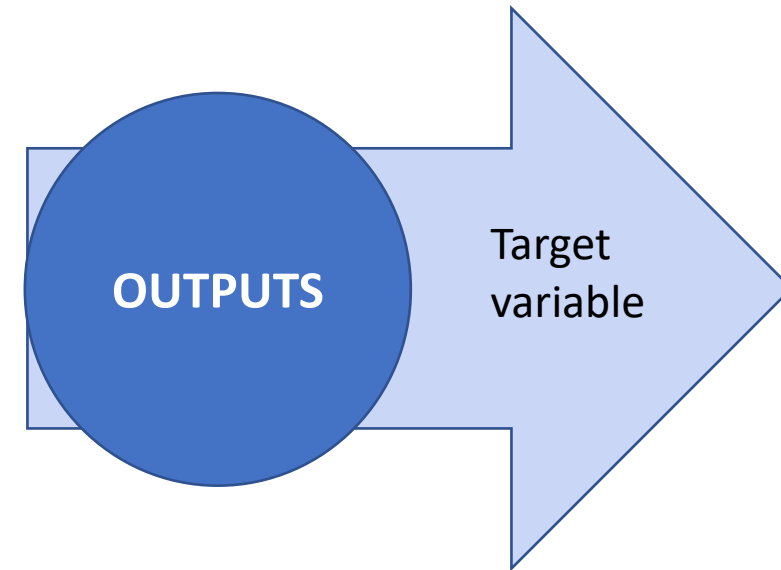
Condition indicators and operator setpoints



MODEL



OUTPUTS



Final extrusion quality

- Residue
- Profilometry
- Stabilization time

Extrusion subrogate model:

- Training dataset: ~3852 observations (only normal Good quality with profilometer measurement)
- Model type: Xgboost regressor.





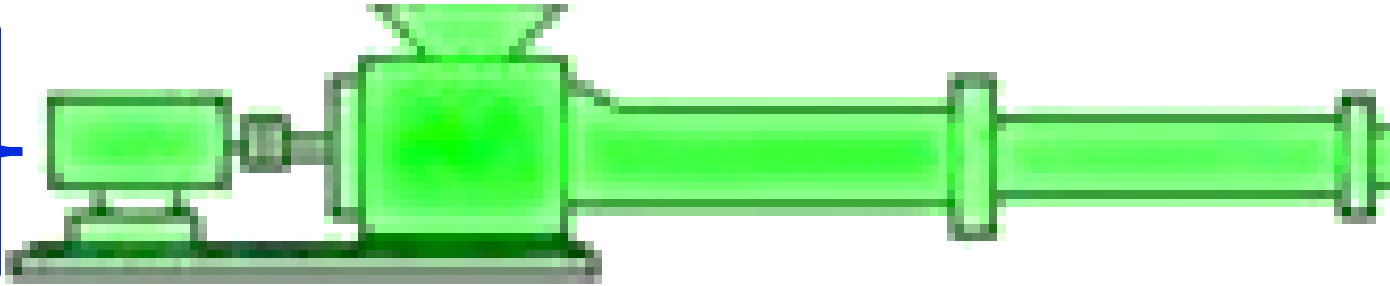
Real extruder

Setpoints

- Speed

Readiness Conditions

- Pressure
- Temperatures



Final extrusion quality

- Residue
- Profilometry
- Stabilization time

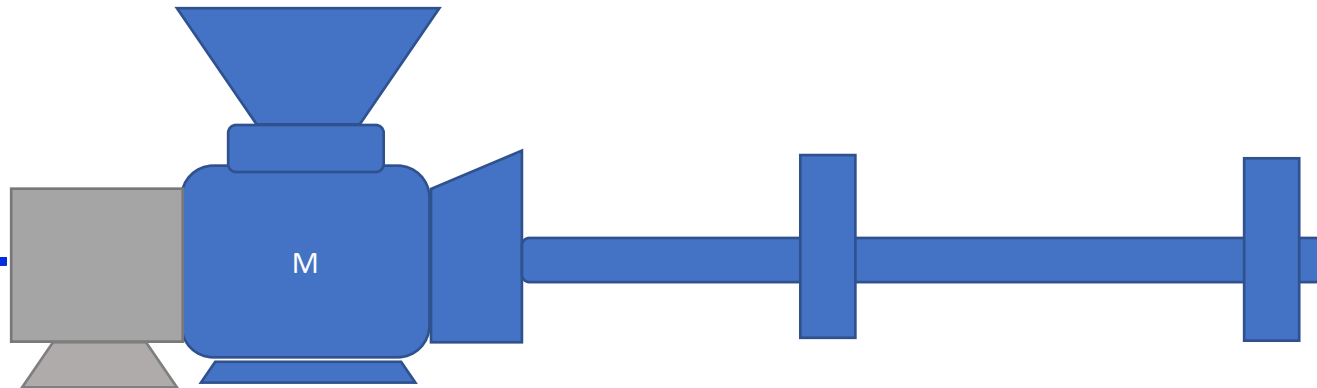
Extruder surrogate model

Setpoints

- Speed

Readiness Conditions

- Pressure
- Temperatures



Final extrusion quality

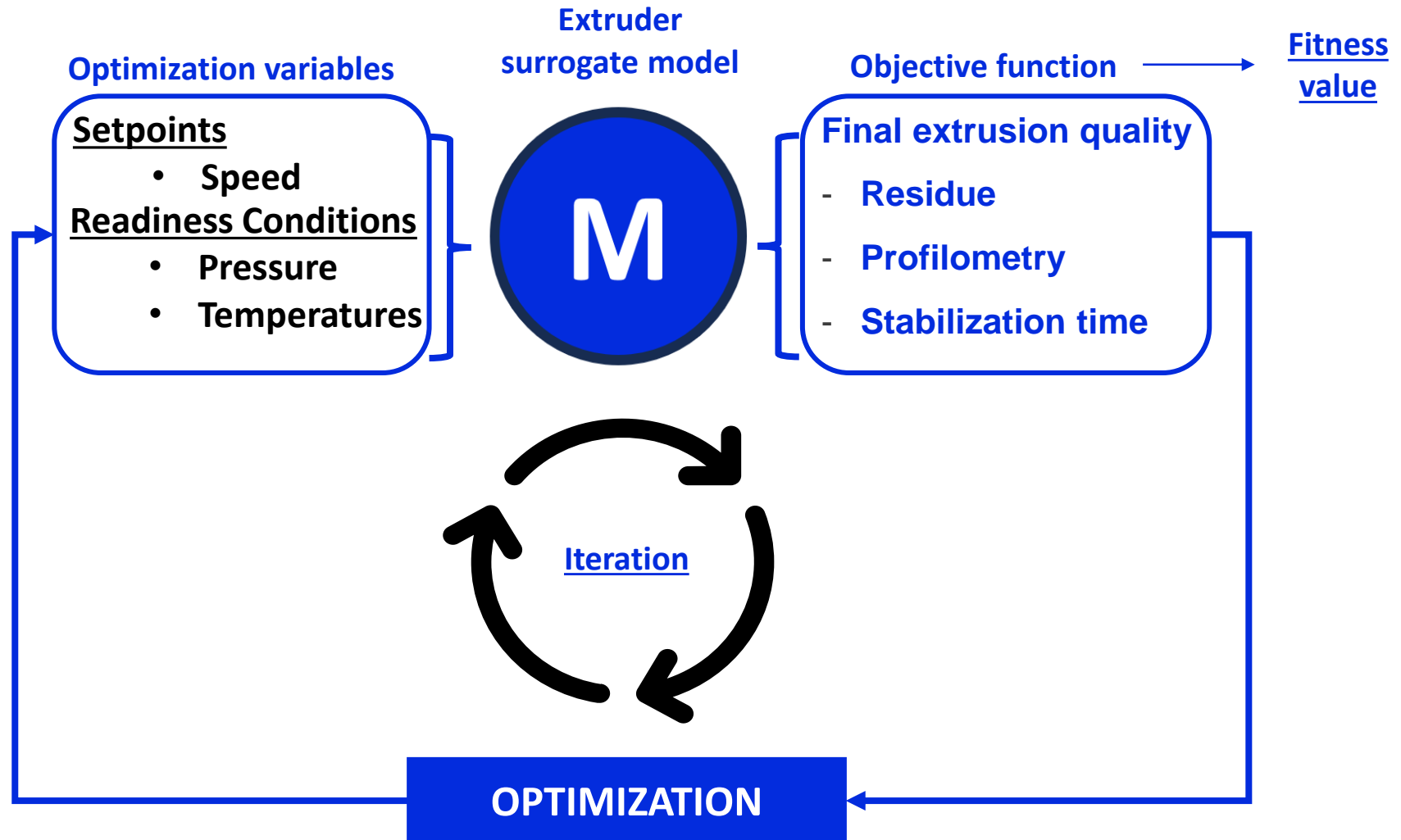
- Residue
- Profilometry
- Stabilization time

OPTIMIZATION



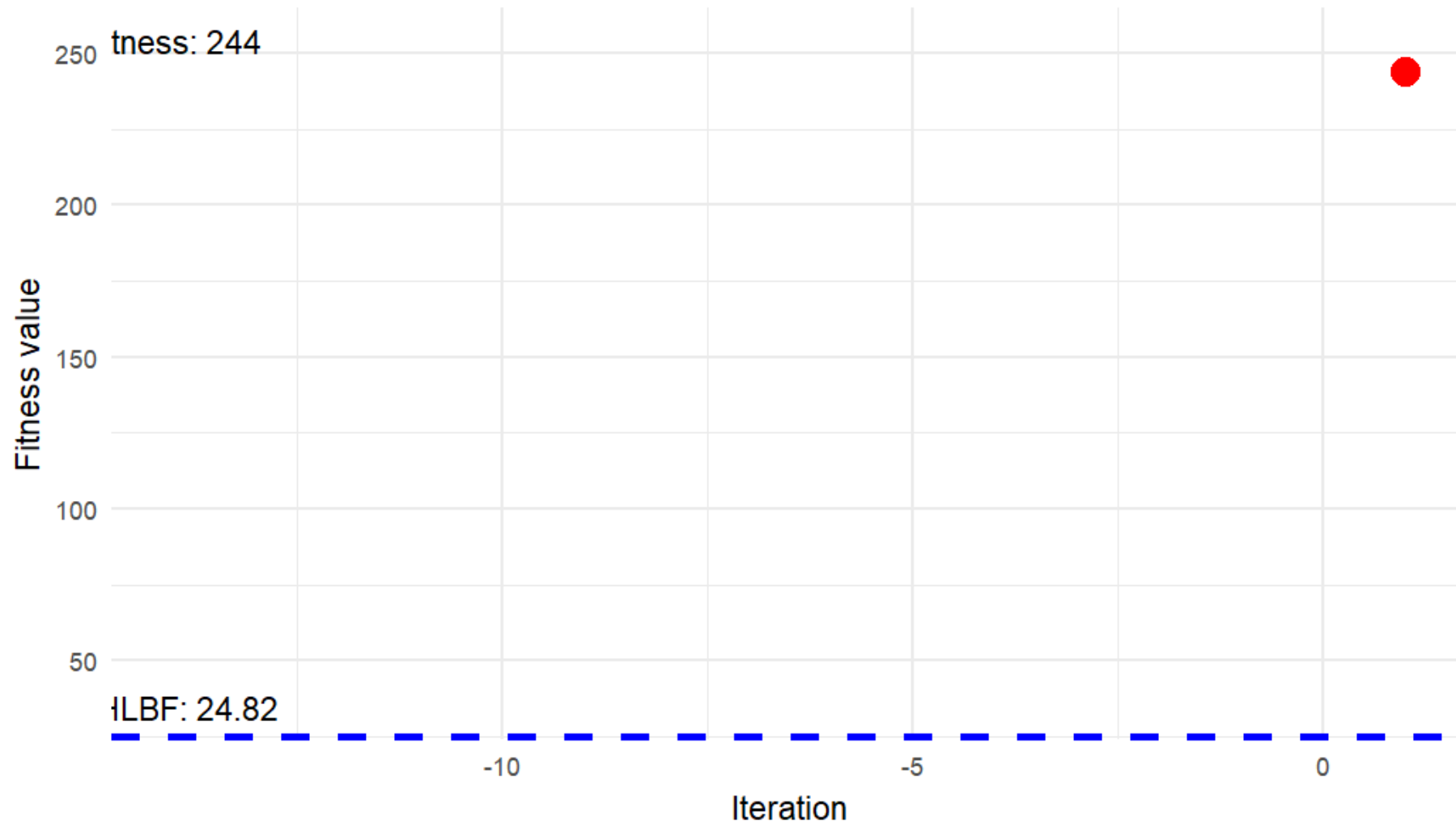


Extrusion optimization for a single recipe





Extrusion optimization for a single recipe



*Median Human Level Fitness

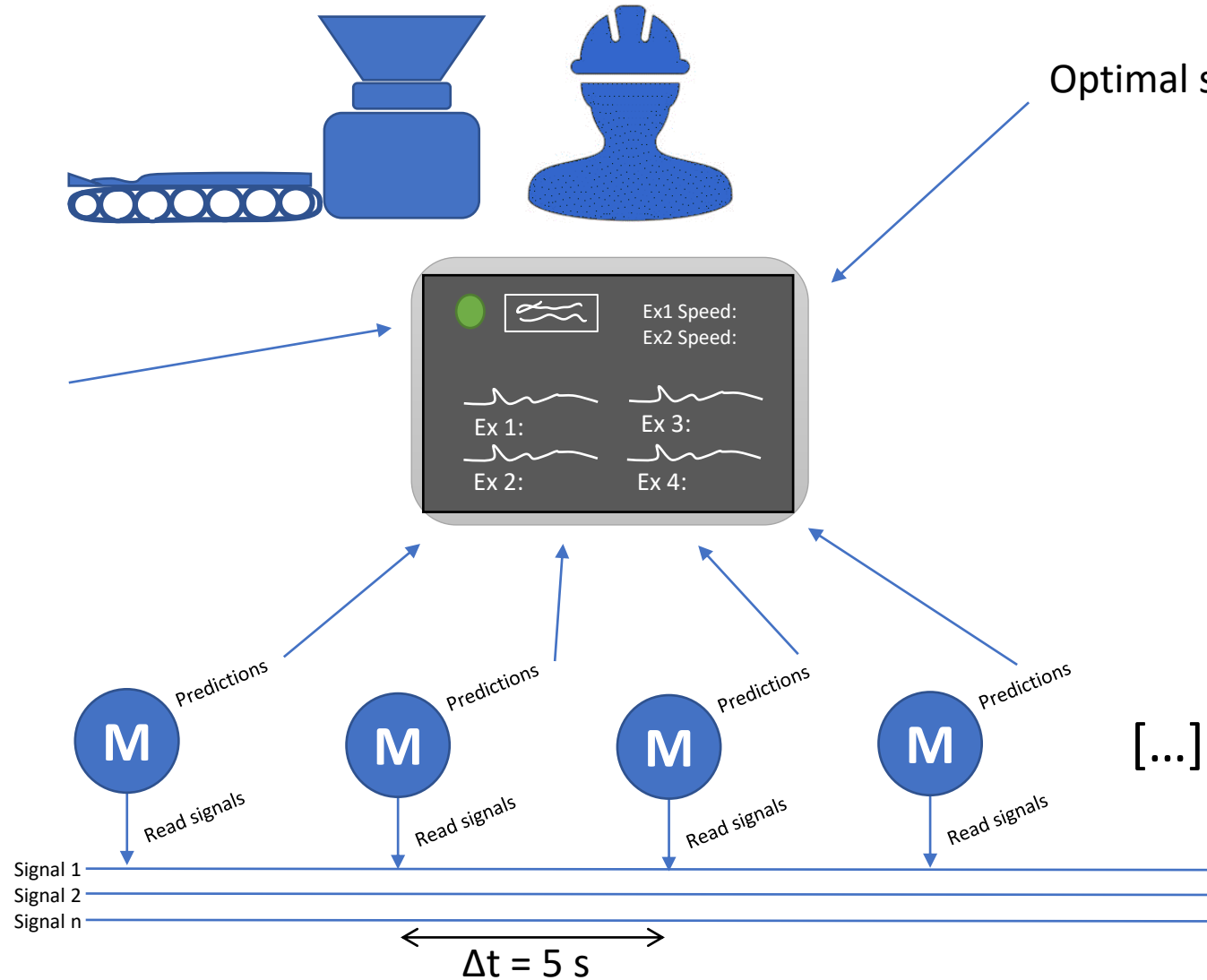


Extrusion support system

Solution

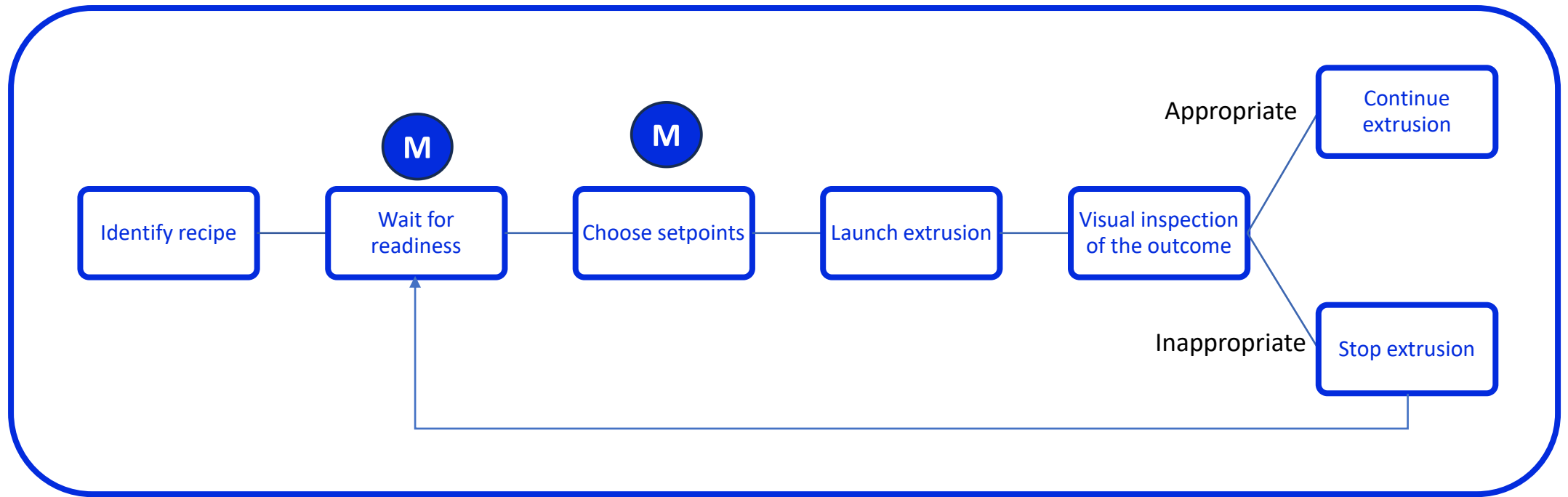
Readiness detector

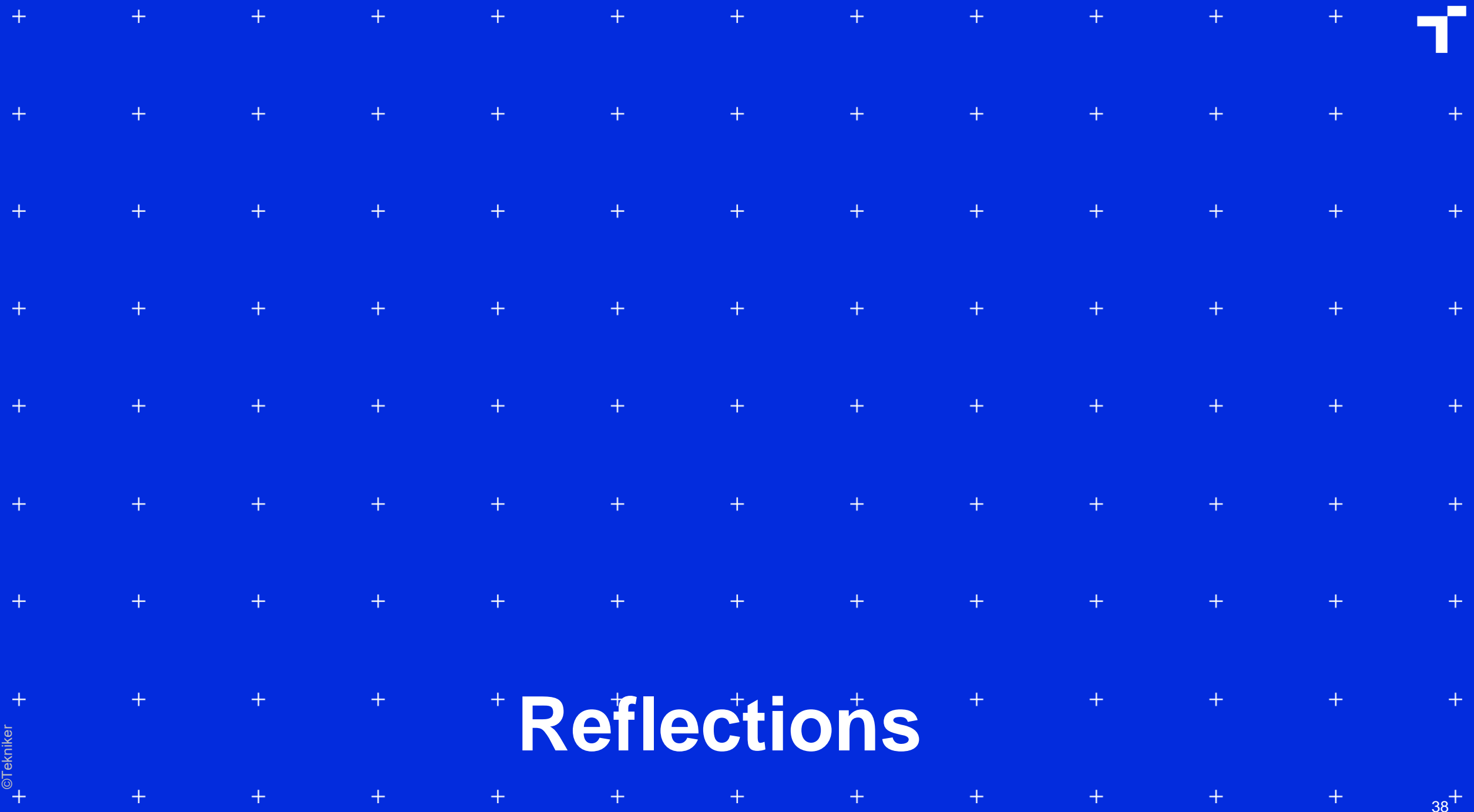
Optimal setting suggestion





Extrusion setup process

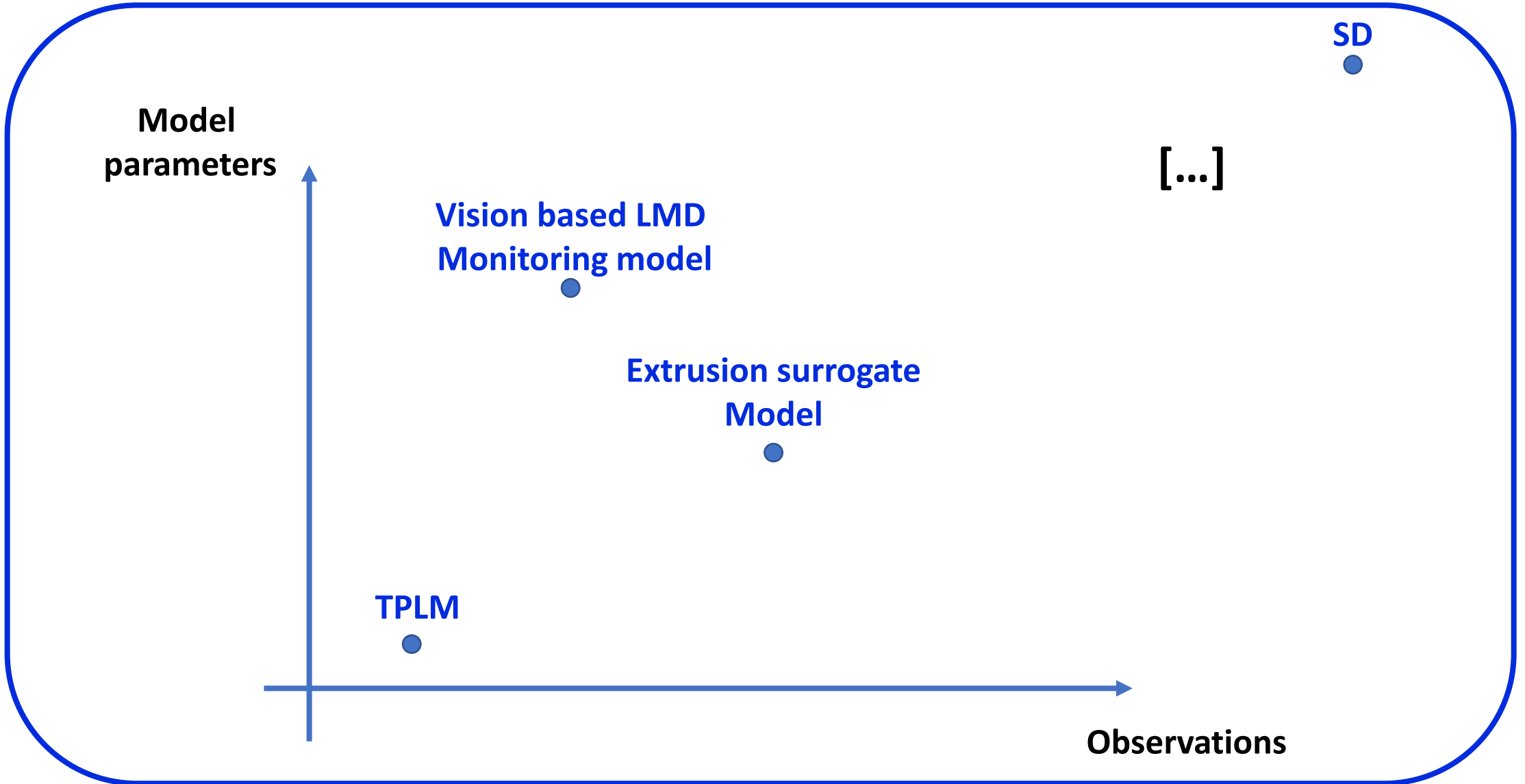




Reflections



Data-driven models



Model parameters

Vision based LMD
Monitoring model

Extrusion surrogate
Model

TPLM

[...]

SD

Observations



To IA or not to IA...

No data...

... no model

We have lots of data...

**It is hard to work with
domain specific data...
and understand
domain experts**

**Problems that can be solved with
data models**

**Digitization, is the first step towards
data models**

**Be patient, lots of data does not
mean lots of observations**

**TEKNIKER where domain knowledge
and ICT come together**

WHO WE ARE

R&D Centre
(not-for-profit Private Foundation) |
Applied research spanning 42 years

**Our mission is to deliver growth
and wellbeing to society at large
via R&D&I and to further the
competitiveness of the business
fabric in a sustainable manner**

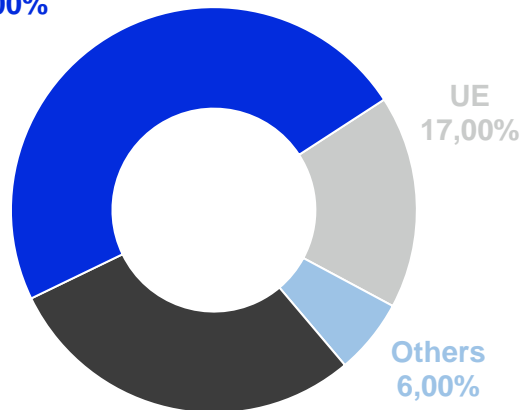
Specialised in Manufacturing



TEKNIKER IN FIGURES

€ TOTAL REVENUE TEKNIKER
25.6 M€

Industrial turnover
48,00%



Basque Government 29,00%



PEOPLE TEKNIKER
270

37% Women
63% Men

PhD resources
58 doctors
27 doctoral
students

81% university
degrees

DATA 2022



TOTAL REVENUES TEKNIKER
+ INVESTED COMPANIES
48.1 M€



PEOPLE TEKNIKER
+ INVESTED COMPANIES
366

CURRENT PORTFOLIO OF SHAREHOLDINGS IN COMPANIES



€ TOTAL REVENUES
INVESTED COMPANIES
22.5 M€



PEOPLE INVESTED COMPANIES
96



INDUSTRIAL PROJECTS

248 | Ongoing

START-UP'S

32 | Companies established

DISTINCTION | PUBLICATIONS

59 | 2021 Indexed publications

27 | Scientific publications in Q1

PATENTS

107 | Patents families

314 | Total filings

7 | First filings 2022

16 | Exploited families

EUROPEAN PROJECTS

HISTORY

287 | Projects

34 | Years of experience

23 % | Led projects

4,5 M€ | Annual average income



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