Machine Learning model for alarm prediction in dialysis machines

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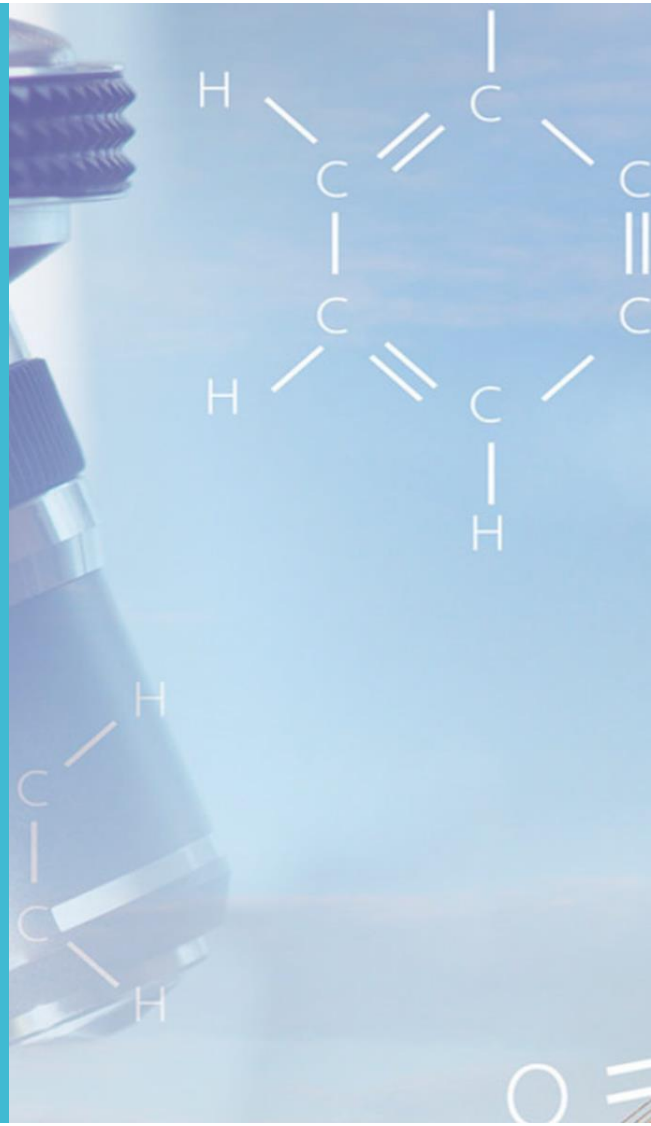
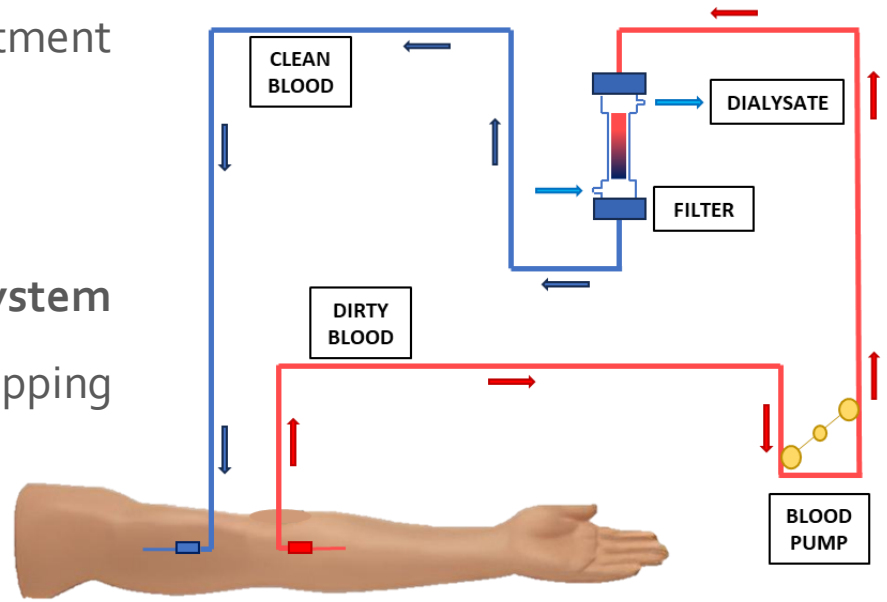


Goal & Scope

Hemodialysis (HD) is a life-saving treatment for patients with chronic renal failure.

Dialysis machines have an **alarm system** acting when an error occurs, often stopping the therapy until the error is fixed.



Possible solution?

A **model** able **to predict/anticipate** possible machine alarm signals…

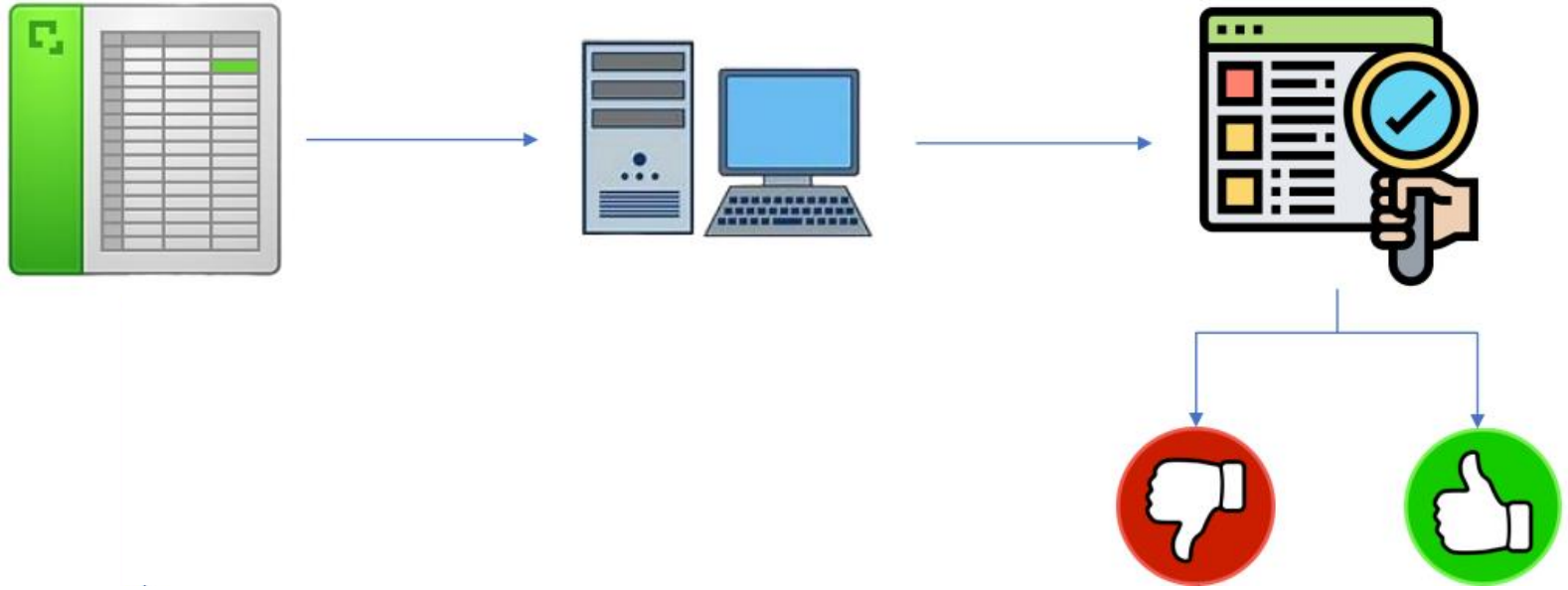
Random Forests (RF), a Machine Learning (ML) classifier!

Methodology

The general idea:

1. Dataset for training the model.
2. Model to be trained.
3. Alarm or normal condition as model output.

After the training, the model is tested on new data.



Methodology

The data used for training and testing the RF classifier model.

- input data
- output data
- **1** alarm condition of the machine
- **0** normal condition of the machine

Number of rows *«time jump»* = 20 (10 s)

Number of rows elapsed between *past rows* and *«type» rows predicted* = 15

degasPum	ufPressur	airDetAna	airDetPwr	foamDetR	TempUf	Ctot	SecondSte	buttonam	type	code
26000	5056	453	100	0					1	ARTERIAL LINE
26000	5058	452	101	0				HW_STOP	0	PUMP OFF
26000	5254	453	100	0				HW_STOP	0	PUMP OFF
26000	5201	453	100	0					0	DIALYSATE EXTERNAL
26000	5202	453	100	0					0	DIALYSATE EXTERNAL
26000	5203	452	100	0					0	DIALYSATE EXTERNAL
26000	5199	453	100	0					0	DIALYSATE EXTERNAL
26000	5193	453	100	0					0	DIALYSATE EXTERNAL
26000	5184	453	101	0					0	DIALYSATE EXTERNAL
26000	5169	453	100	0				HW_STOP	0	DIALYSATE EXTERNAL
26000	5156	452	101	0				HW_STOP	0	DIALYSATE EXTERNAL
26000	5165	453	100	0					1	PUMP OFF
26000	5567	453	100	0					1	PUMP OFF
26000	5482	452	100	0					1	PUMP OFF
26000	5483	453	100	0					1	PUMP OFF
26000	5425	453	100	0					1	PUMP OFF
26000	5449	452	100	0					1	PUMP OFF
26000	5419	453	100	0					1	PUMP OFF
26000	5407	453	100	0					1	PUMP OFF
26000	5428	453	101	0					1	PUMP OFF
26000	5402	453	100	0					1	PUMP OFF

Number of *past rows* used for prediction = 5

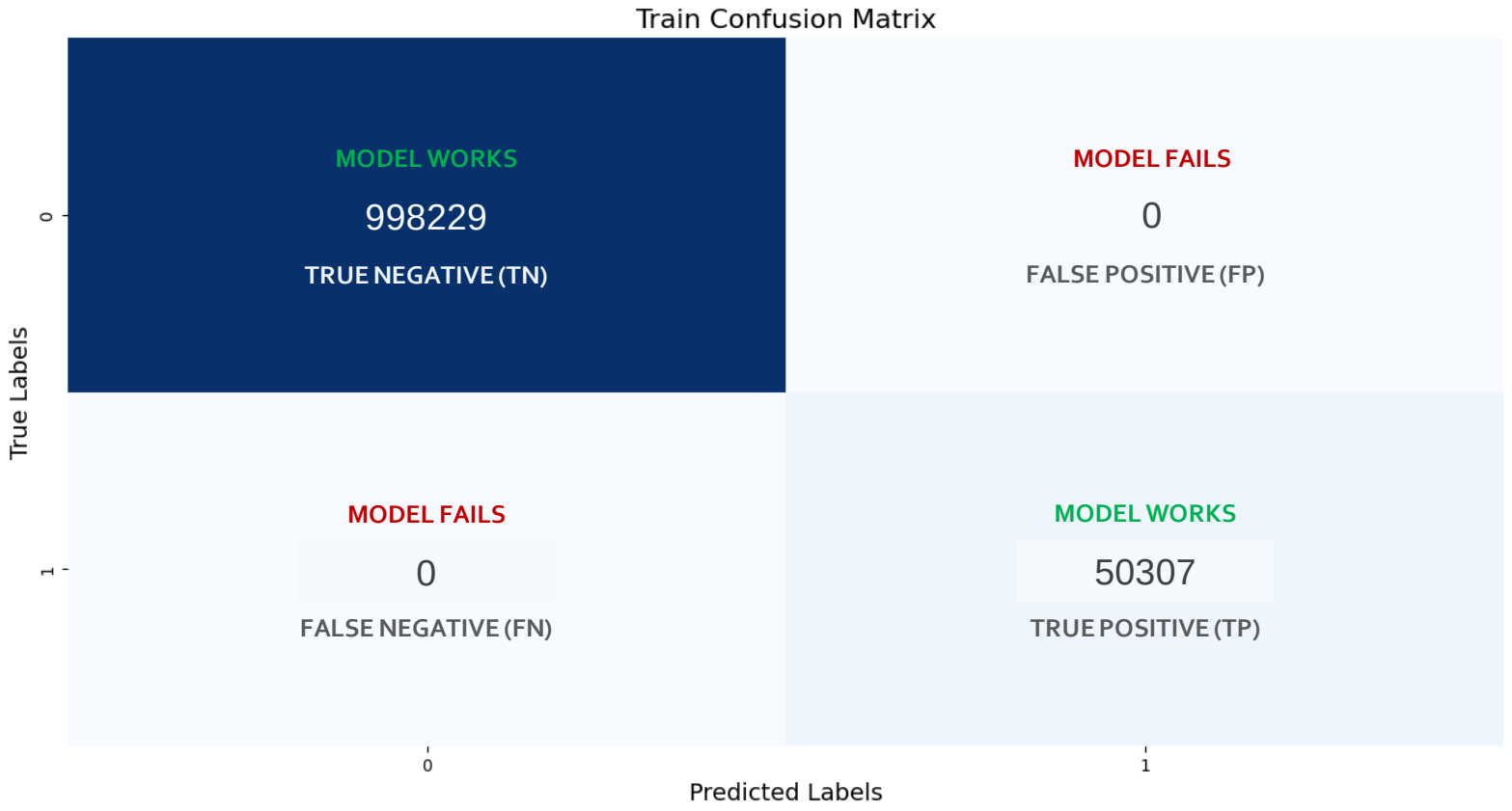
Number of *«type» rows* predicted = 1

Results # 1

The confusion matrix of the dataset used to train the RF model (top) and the performance parameters of the model (bottom).

1 alarm condition of the machine

0 normal condition of the machine



$$\text{Precision (P)} = \frac{TP}{TP+FP} = 1.00$$

$$\text{Recall (R)} = \frac{TP}{TP+FN} = 1.00$$

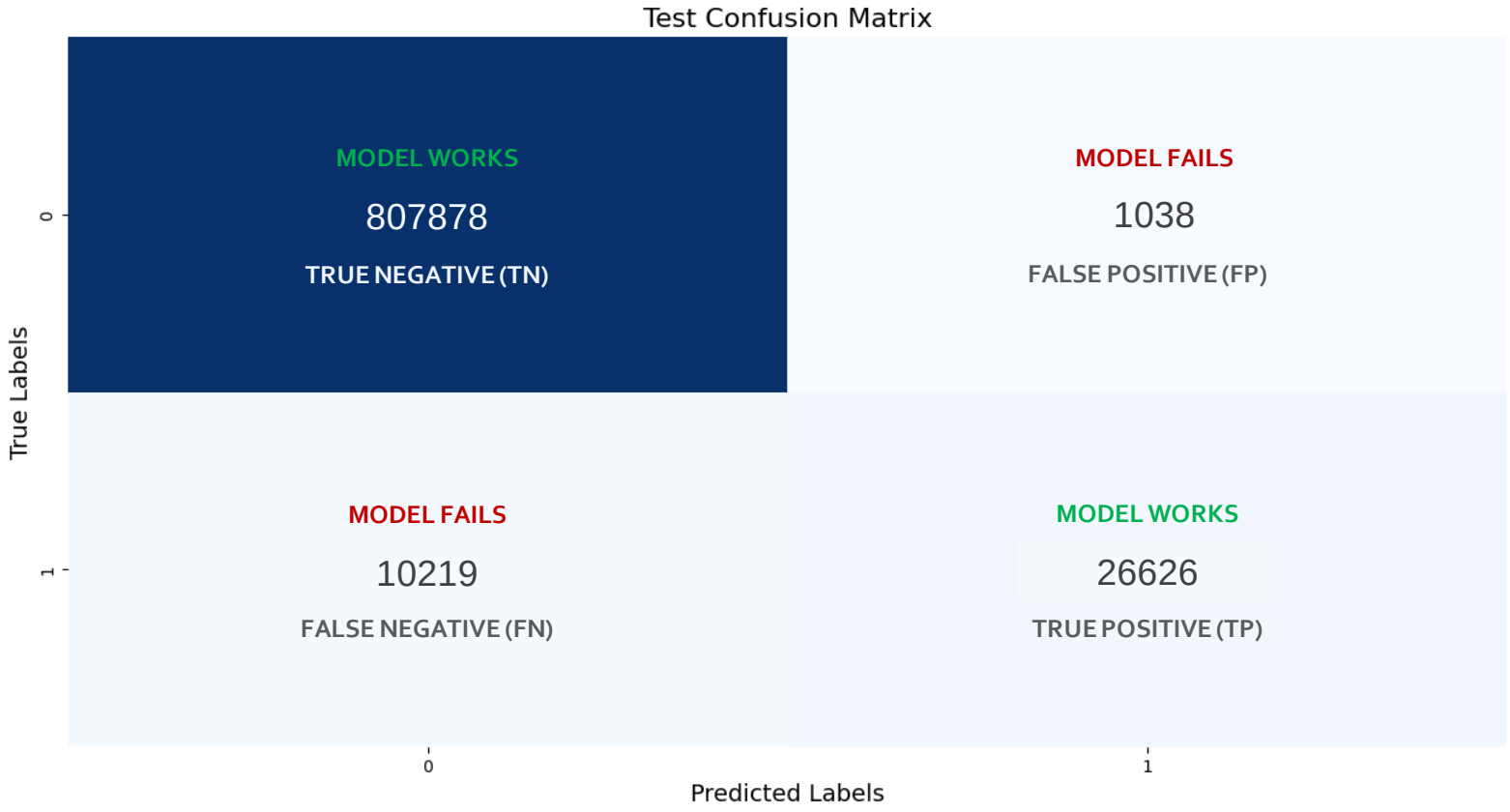
$$\text{F}_1\text{-Score} = 2 * \frac{P*R}{P+R} = 1.00$$

Results # 2

The confusion matrix of the dataset used to test the RF model (top) and the performance parameters of the model (bottom).

1 alarm condition of the machine

0 normal condition of the machine



$$\text{Precision (P)} = \frac{TP}{TP+FP} = 0.96$$

$$\text{Recall (R)} = \frac{TP}{TP+FN} = 0.72$$

$$\text{F}_1\text{-Score} = 2 * \frac{P*R}{P+R} = 0.82$$

Conclusions & Highlights

- The predictive ability of the model performed well, with a **F_1-Score value around 80%** for the test set.
- Extending the time window **beyond 20 rows** results in a reduction in the performance parameters of the RF model.
- Using an efficient prediction tool can **reduce the number of patient risks** during the treatment, suggesting to the operator how to act before the error happens.

Contacts

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Acknowledgments

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