B2 - OVERHEAD LINES

PS 2. Latest Techniques in asset management, capacity enhancement, refurbishment.

10577_2022

Artificial intelligence applied to explore the causes of transmission line faults

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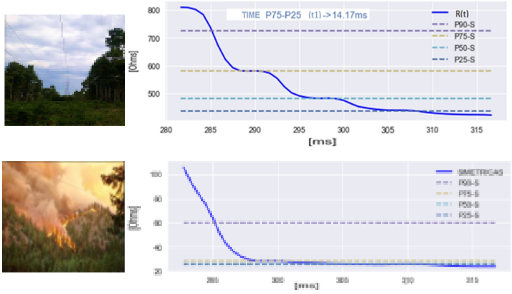
Motivation

CLOSE-UP VEGETATION TRANSMISSION LINE

FIRE UNDER TRANSMISSION LINE

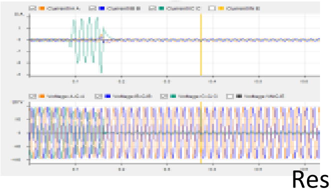
Problem Statment



¿How does it work today?

Fault characteristic

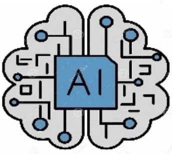
~ 4-6 horas



Resources and solutions

Value Proposal

Real Time



Fault characteristic

Early warning

Resources and solutions

http://www.cigre.org

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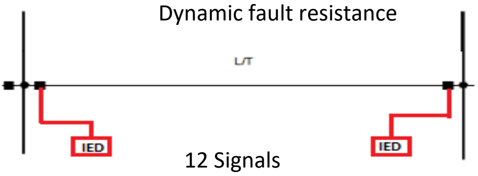
continued

¿How does it come true?

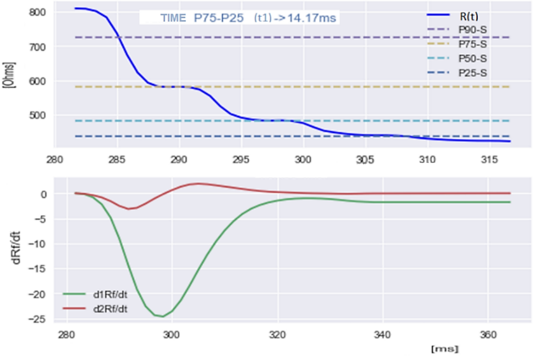
Dynamic fault resistance



12 Signals

$$RF(t) = \frac{VF(t)}{I2R(t) + I2S(t)}$$

Data-set building

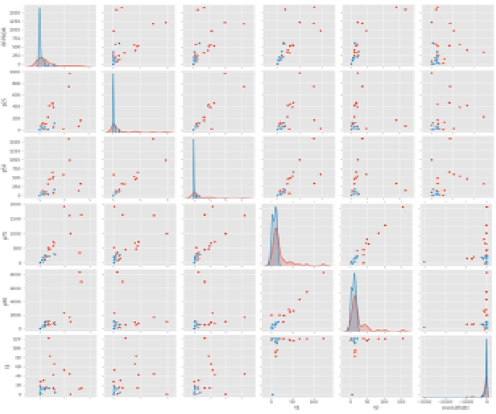


	Rf-PROM	p25	p50	p75	p90	t1	t2	min(df/dt)	Tipo
22	171.89	41.37	72.93	193.32	525.74	12.50	15.00	-52.05	0
12	253.16	11.58	48.47	208.63	1071.32	13.33	15.83	-89.82	0
8	35.88	34.15	34.57	36.67	40.55	8.33	7.50	-0.61	0
10	5.89	5.08	5.76	6.69	7.54	3.00	6.00	-0.26	1
30	1.98	1.83	2.00	2.10	2.20	0.00	5.83	-0.06	1
31	12.72	9.71	10.32	12.88	17.48	10.00	12.50	-2.20	1
30	1183.97	743.31	1581.39	1618.97	1719.80	44.17	46.67	-83.73	0
26	7.15	6.61	6.87	7.34	7.98	15.83	16.67	-0.32	0
33	10.72	6.32	7.92	9.48	23.82	4.75	2.75	-2.86	0

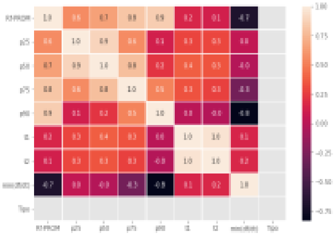
0: Vegetation

1: Fire

Data analysis



Close-up vegetation to transmission line



Fire under transmission line

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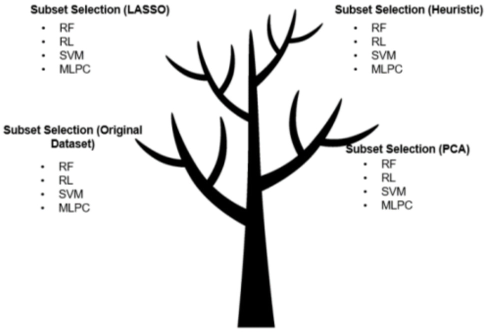
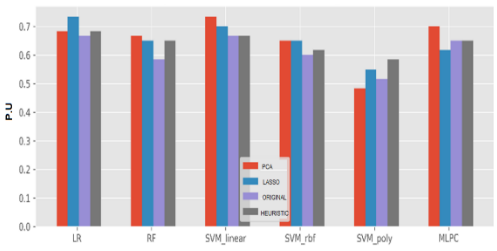
continued

¿How does it come true?

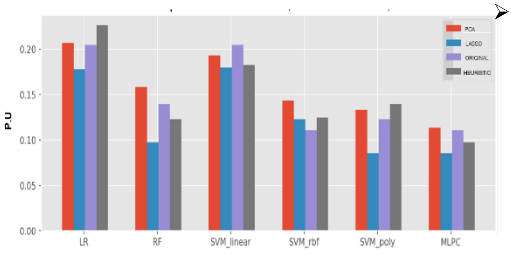
Implemented AI techniques and results



Accuracy of the trained models



Standard deviation of the trained models



Conclusions

- This research contributes to the strategic objectives 2030 of the ISA group, related to the digital transformation, generating value by achieving efficiencies in the operation and maintenance of the company's assets by being an input for the timely identification in the diagnosis of failure causes, resulting in the reduction of unavailability and OPEX.
- A methodology based on AI was successfully implemented as a test prototype using information from the oscillographic records to diagnose the types of faults caused by approaching vegetation or burning under the transmission lines.
- Different supervised AI techniques (RL, RF, SVM, MLPC) were implemented; selection techniques (lasso and heuristic), feature extraction techniques (PCA), and complete set were also tested, where the method was selected for accuracy and simplicity was MLPC.
- During the training, the need to expand the data-set with future faults was observed because currently, there are no more records reported for the types of faults proposed.

Future Work

- The next step involves other causes of transmission line faults. For example, distinguish between several low impedance causes like insulator faults and atmospheric discharge faults; furthermore, increase the data-set with information regarding meteorological variables like atmospheric discharge density and other information from the operation.
- Although the model does not predict the future, a fast diagnosis of fault causes helps the operators to make quick decisions to ensure the safe operation of the power system. For instance, if several transmission lines share the same area and there is a fire under those transmission lines, that may cause multiple outages and high operative costs if no action is taken. But instead of this the model helps to make a quick decision, then the operator can redistribute generation resources through this area, avoiding the secondary effects.