



Uma abordagem de manutenção preditiva baseada na segmentação de séries temporais

Daniel Coelho

Orientador: Prof. José Santos

Coorientador: Prof. Eugénio Rocha

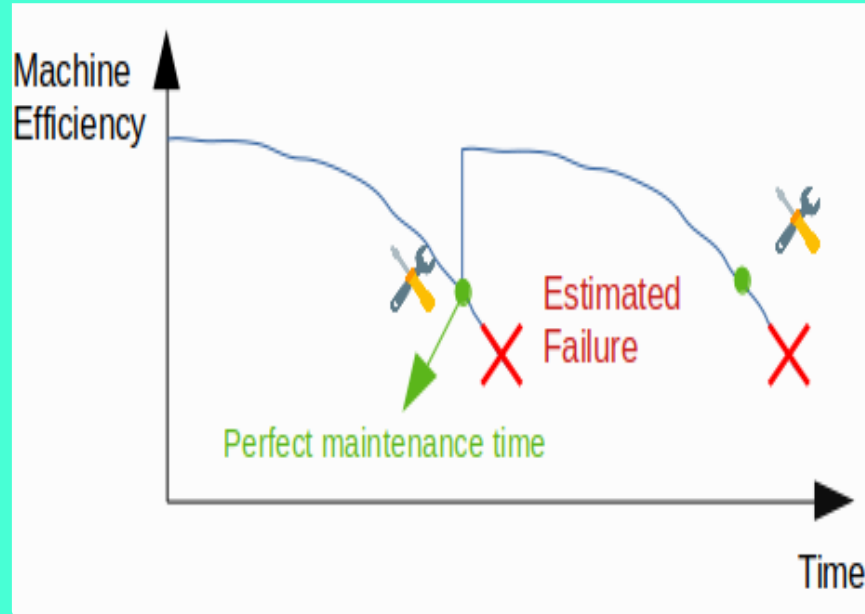
Supervisor (Empresa): Eng. Duarte Almeida



universidade
de aveiro



BOSCH



MANUTENÇÃO PREDITIVA

OBJETIVOS



CENTRALIZAÇÃO

Centralização dos dados de múltiplos equipamentos numa só plataforma



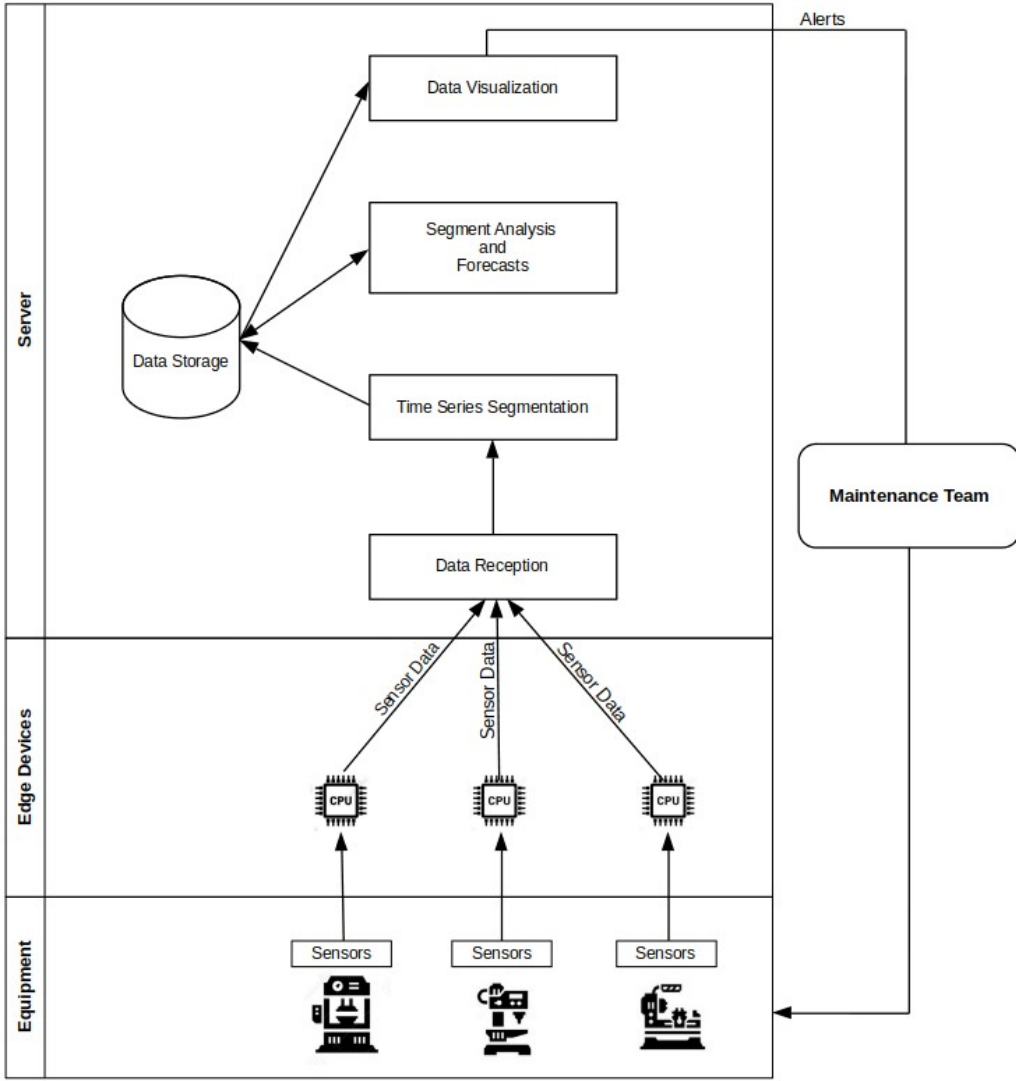
MANUTENÇÃO PREDITIVA

Desenvolvimento de um sistema de manutenção preditiva para a prensa Haulick & Roos

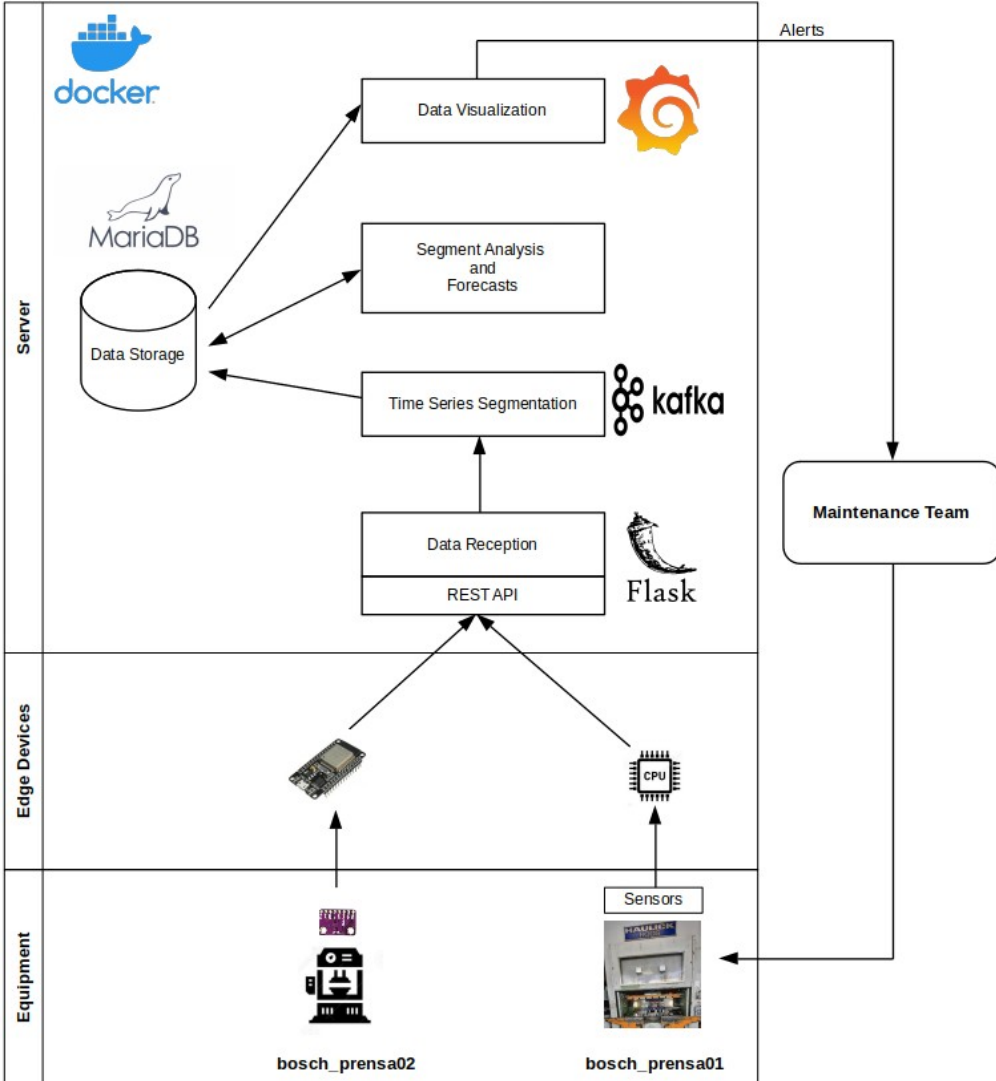


PLATAFORMA DE VISUALIZAÇÃO

Desenvolvimento de uma plataforma de visualização

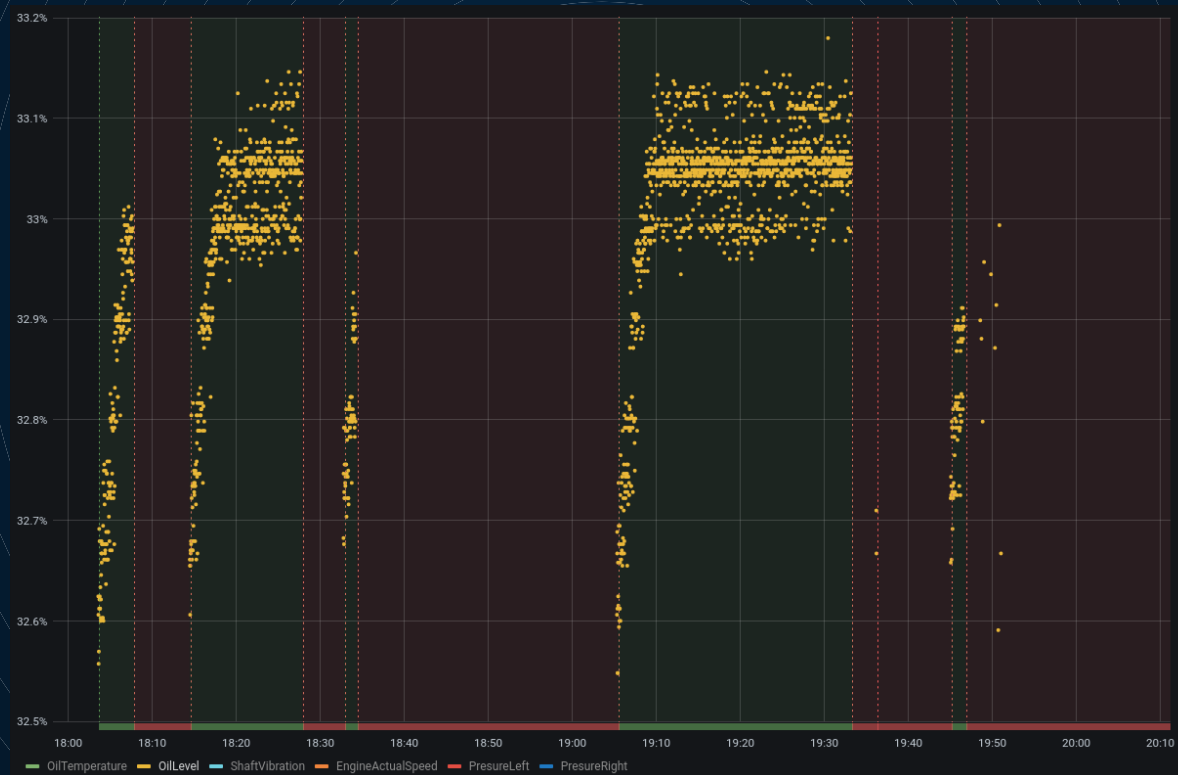


SOLUÇÃO PROPOSTA

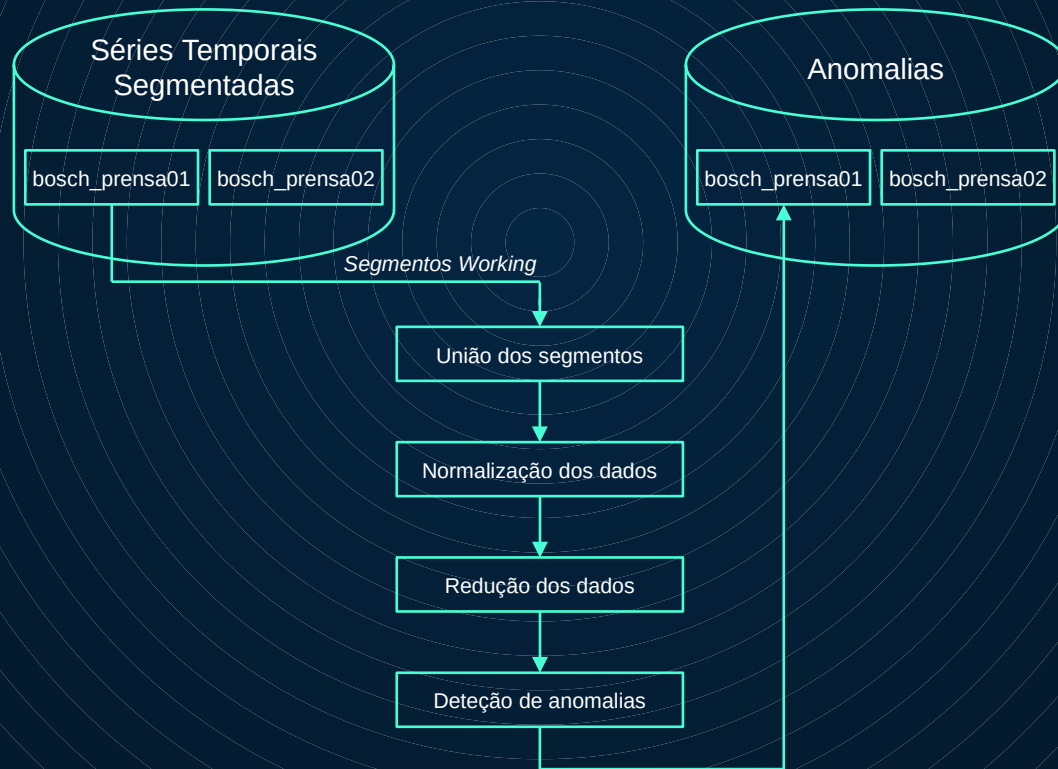


SOLUÇÃO IMPLEMENTADA

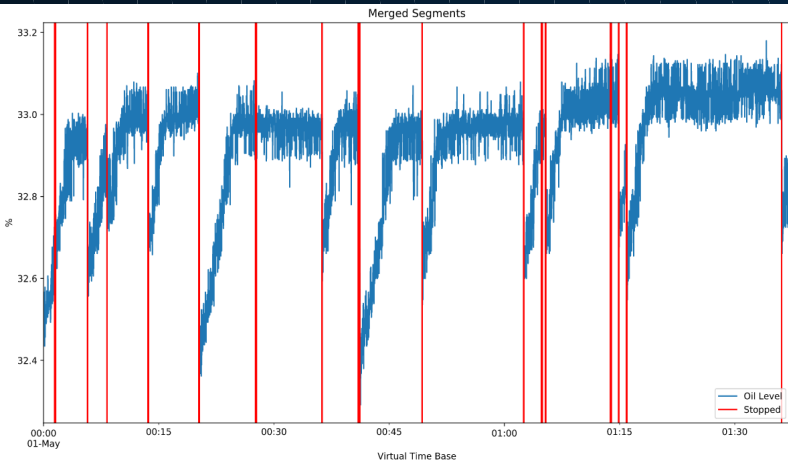
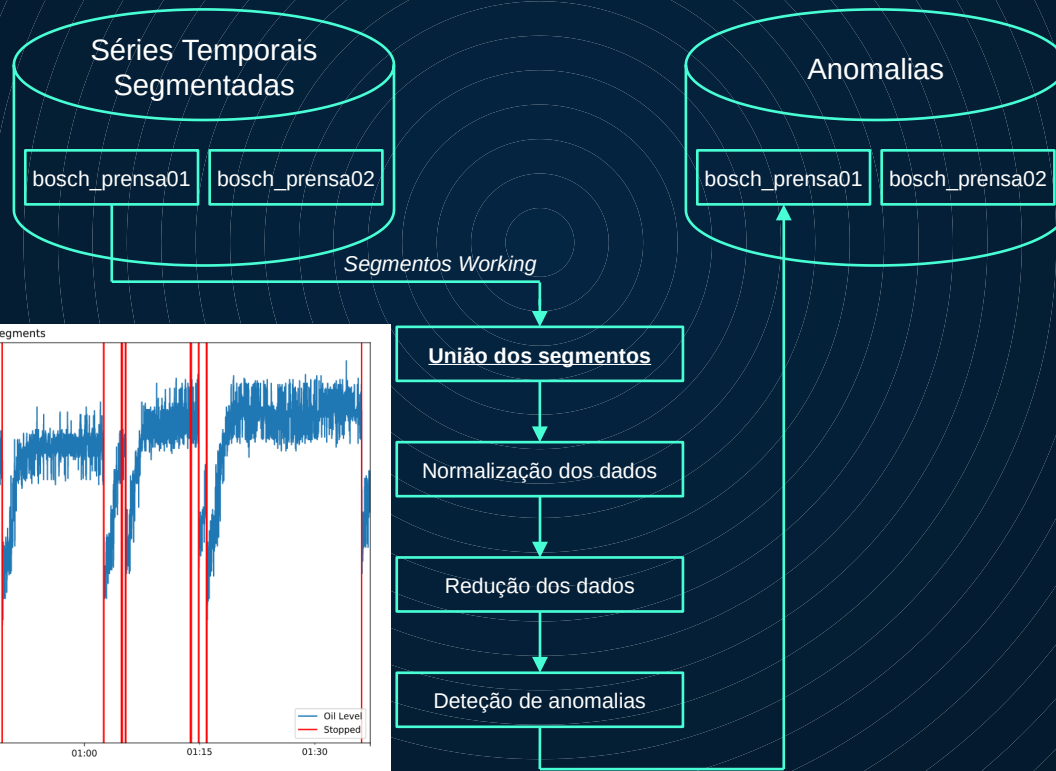
SEGMENTAÇÃO DE SÉRIES TEMPORAIS



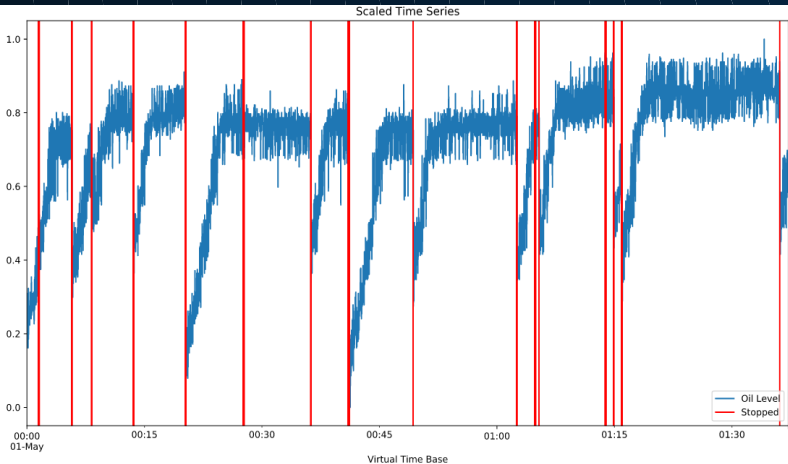
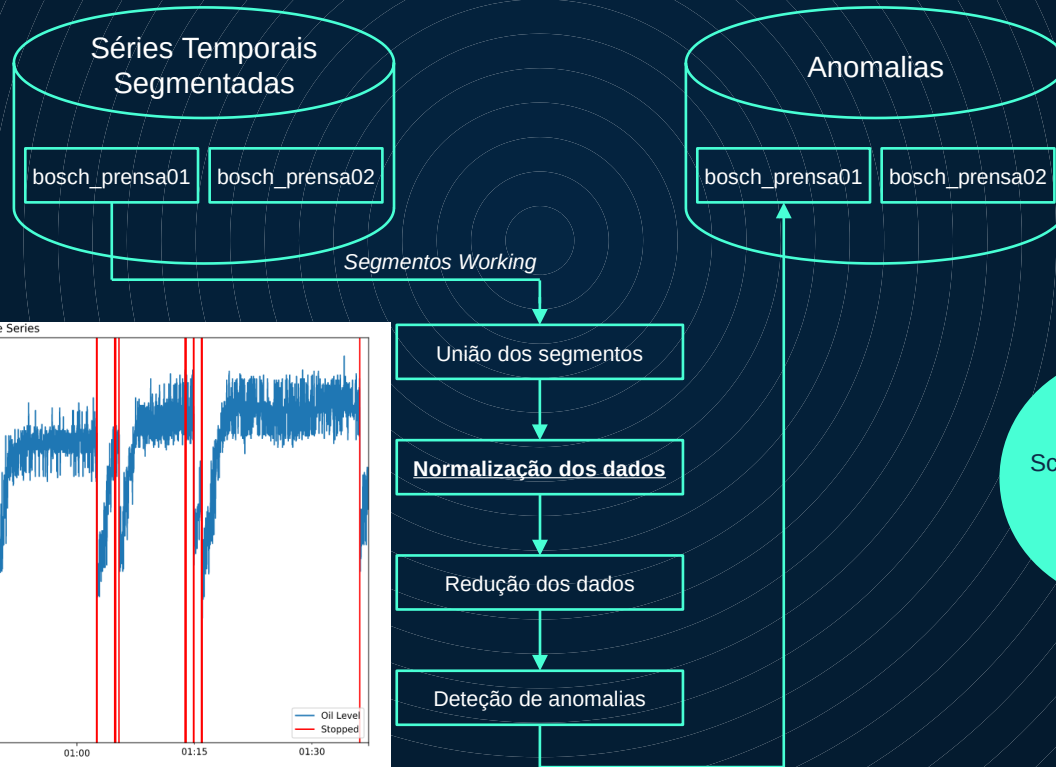
ANÁLISE DOS SEGMENTOS



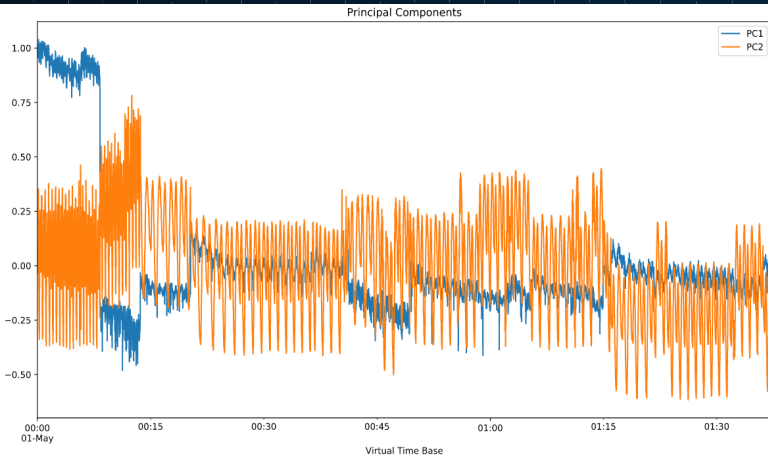
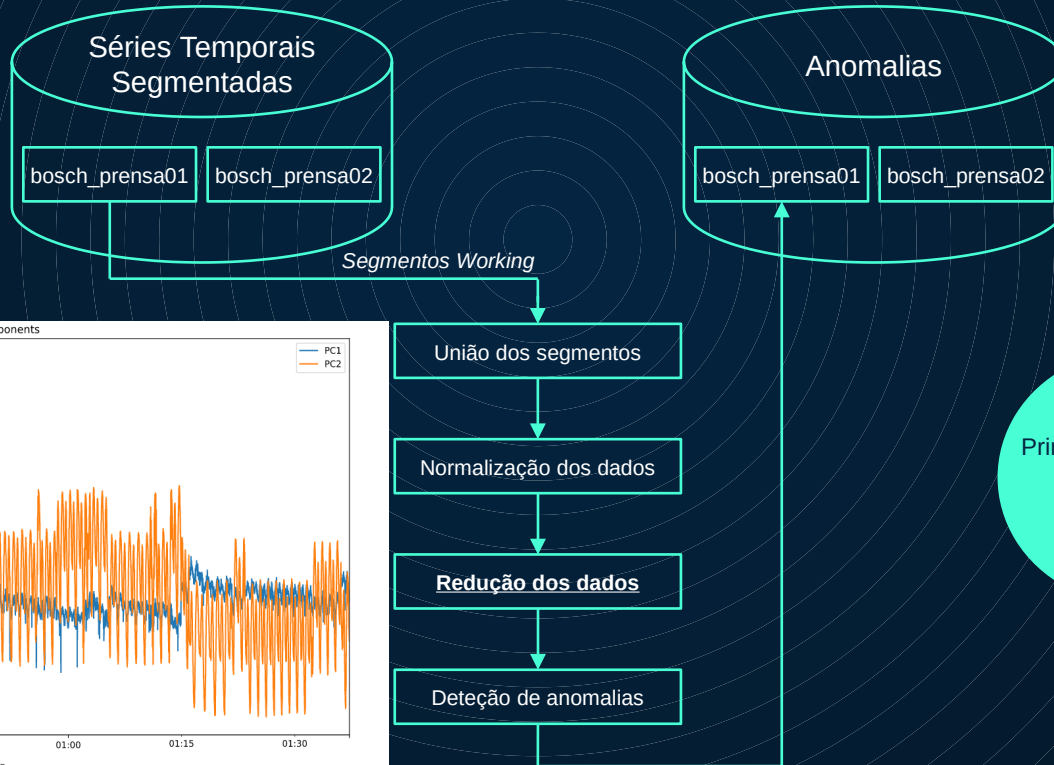
ANÁLISE DOS SEGMENTOS



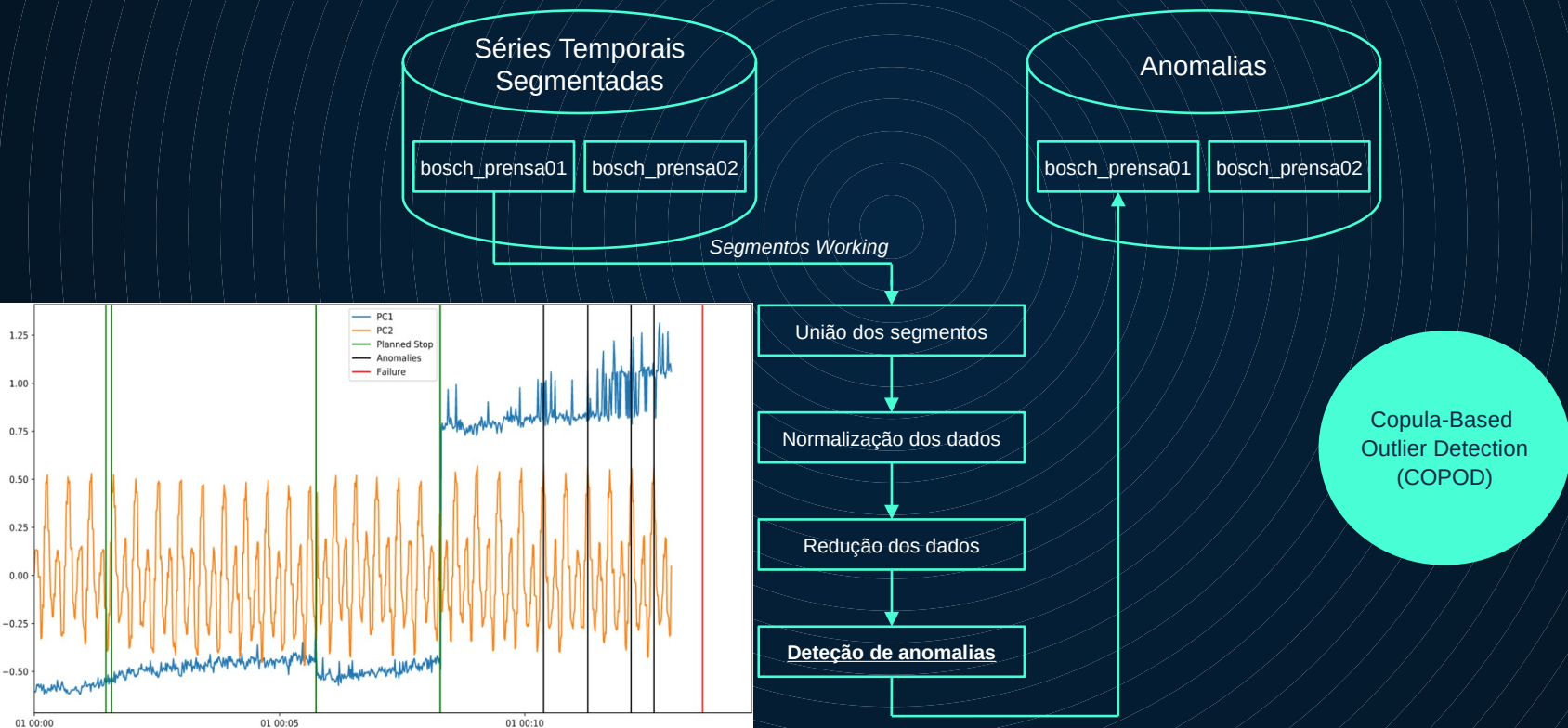
ANÁLISE DOS SEGMENTOS



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ANÁLISE DOS SEGMENTOS



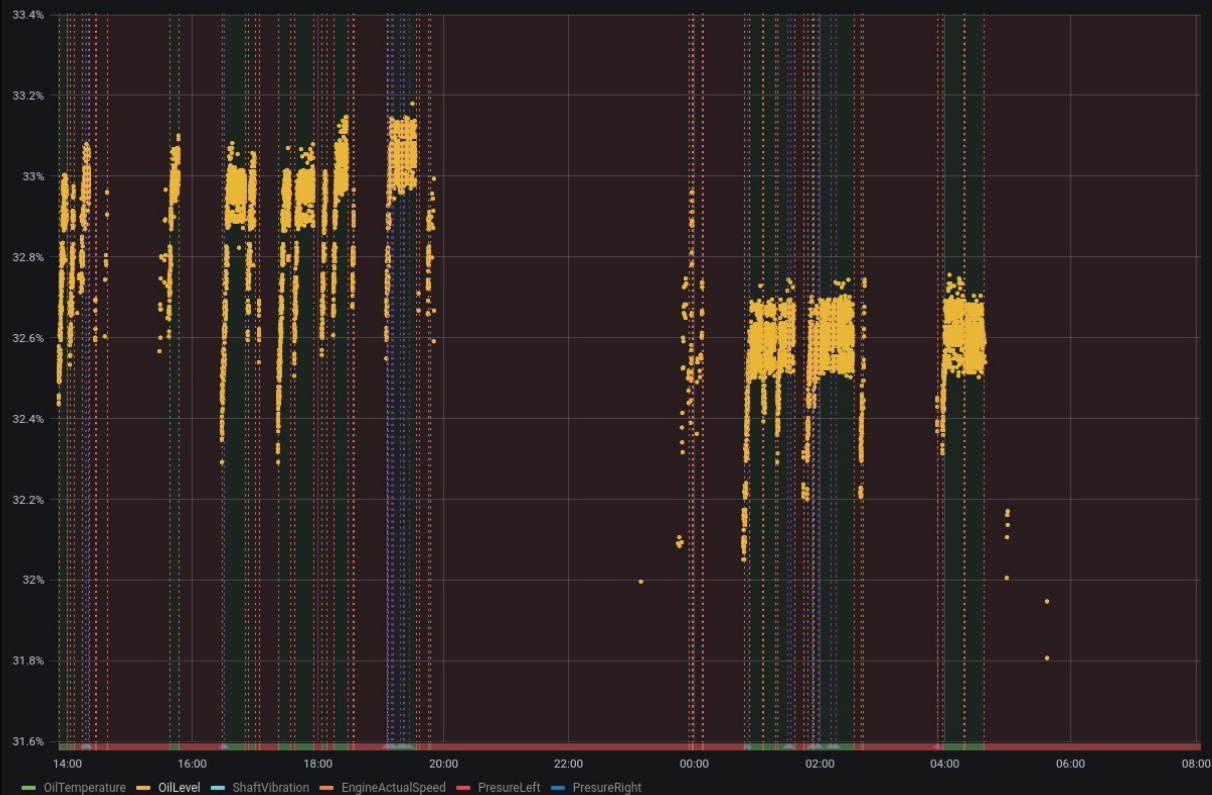
RESULTADOS OBTIDOS





Location bosch_prensa01 ▾

Time Series Segmentation



Current Prediction

Safe

Forecast History

| Time | Prediction |
|---------------------|------------|
| 2021-05-25 17:47:17 | Safe |
| 2021-05-25 17:57:32 | Safe |
| 2021-05-25 18:07:46 | Safe |
| 2021-05-25 18:18:01 | Safe |
| 2021-05-25 18:28:16 | Safe |
| 2021-05-25 18:38:32 | Safe |
| 2021-05-25 18:48:48 | Safe |
| 2021-05-25 18:59:05 | Safe |
| 2021-05-25 19:09:20 | WARNING |
| 2021-05-25 19:19:36 | WARNING |
| 2021-05-25 19:29:51 | WARNING |
| 2021-05-25 19:40:07 | Safe |
| 2021-05-25 19:50:22 | Safe |
| 2021-05-25 20:00:38 | Safe |

Number of Equipments

2

Working

1

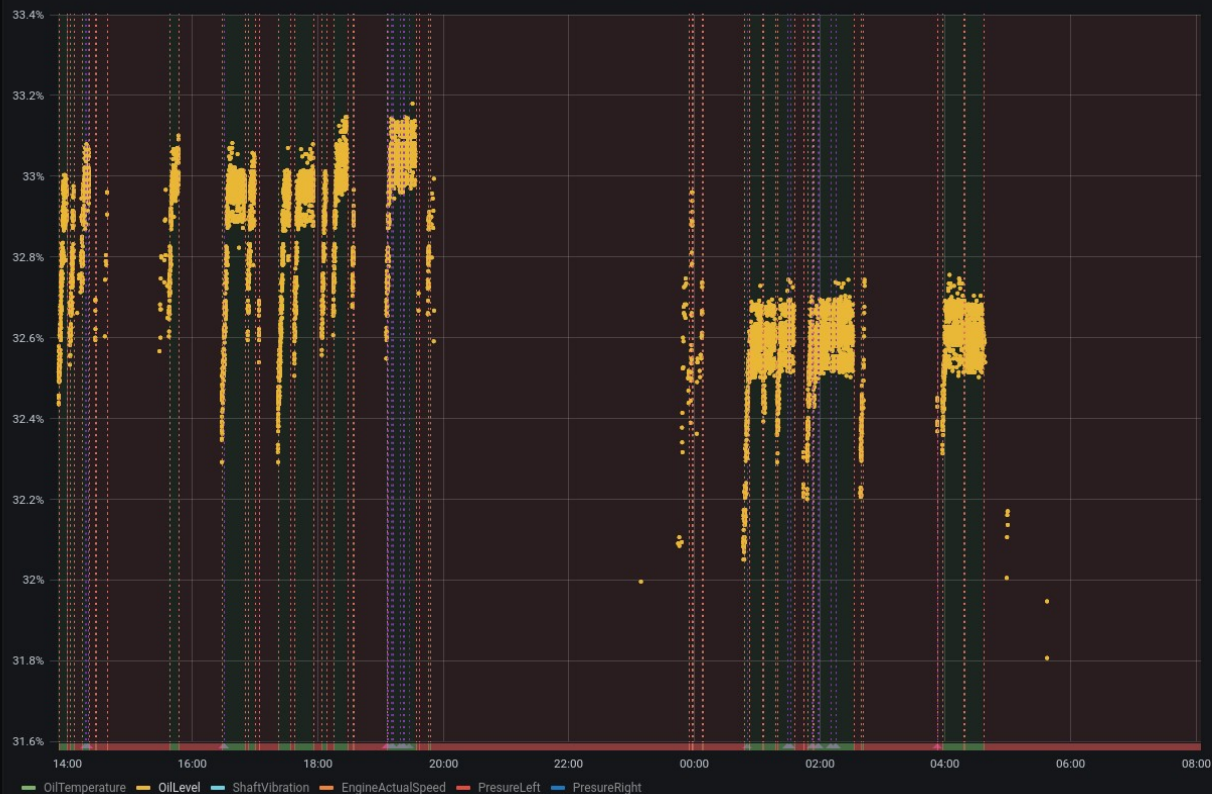
Stopped

1



Location bosch_prensa01 ▾

Time Series Segmentation



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| 2021-05-25 18:38:32 | Safe |
| 2021-05-25 18:48:48 | Safe |
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| 2021-05-25 19:19:36 | WARNING |
| 2021-05-25 19:29:51 | WARNING |
| 2021-05-25 19:40:07 | Safe |
| 2021-05-25 19:50:22 | Safe |
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Number of Equipments

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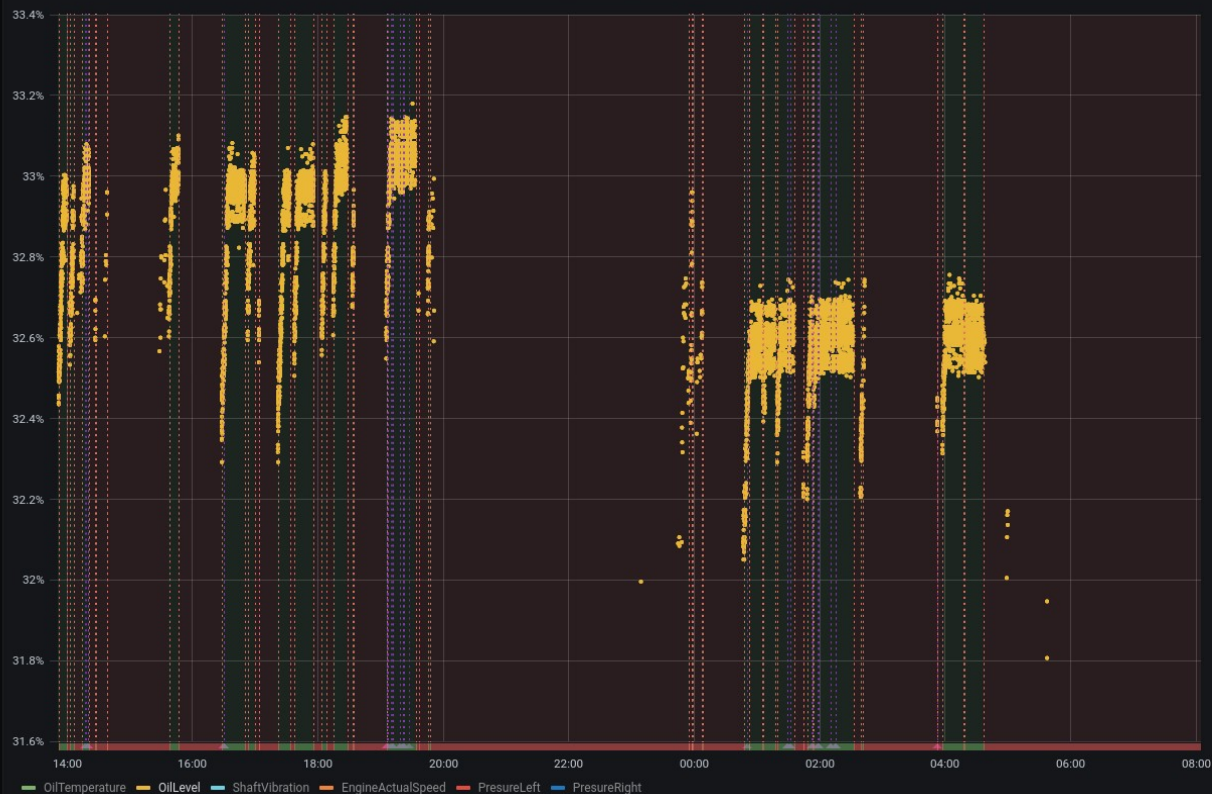
Working

1

Stopped

1

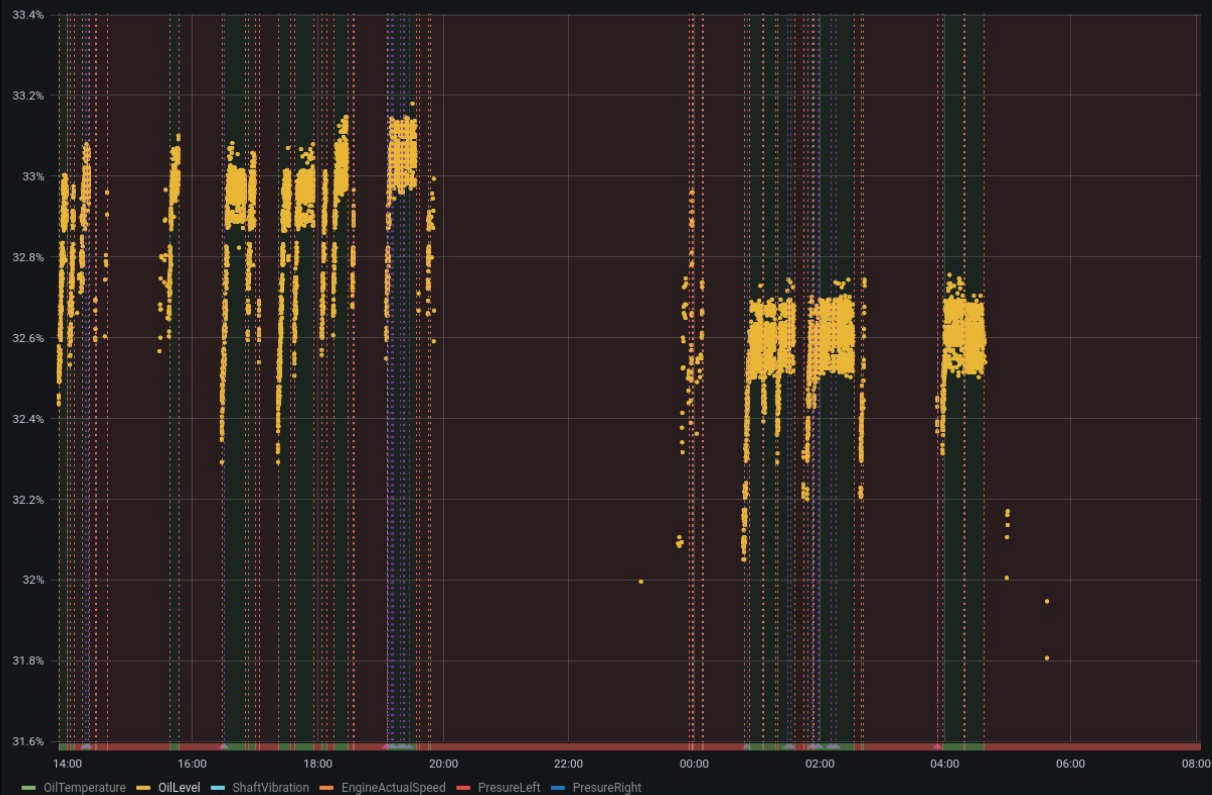
Time Series Segmentation





Location bosch_prensa01 ▾

Time Series Segmentation



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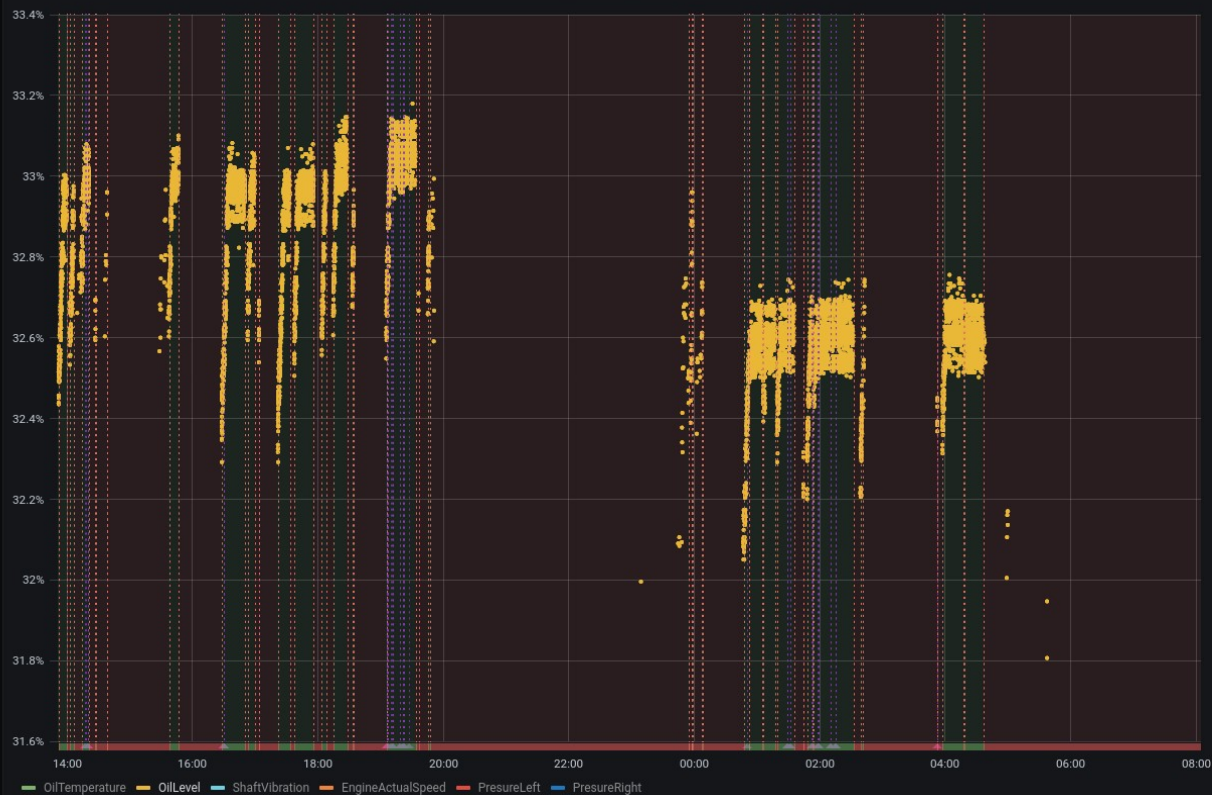
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Number of Equipments

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Working

1

Stopped

1



Location bosch_prensa01 ▾

Time Series Segmentation



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| 2021-05-25 18:28:16 | Safe |
| 2021-05-25 18:38:32 | Safe |
| 2021-05-25 18:48:48 | Safe |
| 2021-05-25 18:59:05 | Safe |
| 2021-05-25 19:09:20 | WARNING |
| 2021-05-25 19:19:36 | WARNING |
| 2021-05-25 19:29:51 | WARNING |
| 2021-05-25 19:40:07 | Safe |
| 2021-05-25 19:50:22 | Safe |
| 2021-05-25 20:00:38 | Safe |

Number of Equipments

2

Working

1

Stopped

1



Location bosch_prensa02 ▾

Time Series Segmentation



Current Prediction



Forecast History

No data

Number of Equipments

2

Working

1

Stopped

1

ANÁLISE DAS PREVISÕES



| Índice | Descrição | Início | Fim | Duração | Avaria? |
|----------|------------------------|----------------------------|----------------------------|-----------------|------------|
| 0 | Mudança do contentor | 25/05/2021 13:59:32 | 25/05/2021 14:02:54 | 00:03:22 | Não |
| <u>1</u> | Chapa encravada | 25/05/2021 14:25:56 | 25/05/2021 15:36:05 | 01:10:09 | Sim |
| 2 | Intervalo | 25/05/2021 15:46:43 | 25/05/2021 16:28:24 | 00:41:41 | Não |
| 3 | Mudança do contentor | 25/05/2021 16:59:15 | 25/05/2021 17:21:26 | 00:22:11 | Não |
| 4 | Mudança do contentor | 25/05/2021 17:32:52 | 25/05/2021 17:37:57 | 00:05:05 | Não |
| 5 | Mudança do contentor | 25/05/2021 17:55:49 | 25/05/2021 18:04:08 | 00:08:19 | Não |
| 6 | Intervalo | 25/05/2021 18:07:38 | 25/05/2021 18:15:04 | 00:07:26 | Não |
| 7 | Mudança do contentor | 25/05/2021 18:27:46 | 25/05/2021 19:05:53 | 00:38:07 | Não |
| <u>8</u> | Avaria mecânica | 25/05/2021 19:33:11 | 26/05/2021 00:48:08 | 05:14:57 | Sim |
| 9 | Intervalo | 26/05/2021 01:35:17 | 26/05/2021 01:47:56 | 00:12:39 | Não |
| 10 | Mudança do contentor | 26/05/2021 02:30:17 | 26/05/2021 02:39:18 | 00:09:01 | Não |
| 11 | Mudança da Ferramenta | 26/05/2021 02:42:34 | 26/05/2021 03:57:40 | 01:15:06 | Não |

DESCRIÇÃO DAS PARAGENS

PARAGENS PROVOCADAS POR AVARIA

| Índice | Avaria detetada? | Tempo de deteção da avaria | Nº de anomalias detetadas |
|----------|------------------|----------------------------|---------------------------|
| <u>1</u> | Sim | 00:04:23 | 5 |
| <u>8</u> | Sim | 00:23:51 | 17 |

PARAGENS NÃO PROVOCADAS POR AVARIA

| Índice | Avaria detetada? | Tempo de deteção da avaria | Nº de anomalias detetadas |
|--------|------------------|----------------------------|---------------------------|
| 0 | Não | - | - |
| 2 | Não | - | - |
| 3 | Sim | 00:23:37 | 4 |
| 4 | Não | - | - |
| 5 | Não | - | - |
| 6 | Não | - | - |
| 7 | Não | - | - |
| 9 | Não | - | - |
| 10 | Sim | 00:29:35 | 10 |
| 11 | Não | - | - |

EFICIÊNCIAS

| Accuracy | Precision | Recall | F_{β} - score |
|----------|-----------|--------|---------------------|
| 0.9394 | 0.5 | 1.0 | 0.9091 |

TEMPO DE PRODUÇÃO “GANHO”

04:55:06

CONCLUSÕES

- Com base nos resultados obtidos é possível afirmar que a abordagem proposta constitui uma solução viável no que diz respeito a sistemas de manutenção preditiva;
- Submissão de um artigo numa conferência intitulado de “Predictive maintenance on sensorized stamping presses by time series segmentation, anomaly detection, and classification algorithms”.

TRABALHO FUTURO

- Desenvolvimento de um algoritmo de otimização de forma a selecionar a melhor combinação dos hyperparâmetros.