UNIVERSITY OF PADUA
UNIVERSITA' DEGLI STUDI DI PADOVA

# Autodiagnostica di anomalie attraverso algoritmi di machine learning

Enrico Muraro - 2019

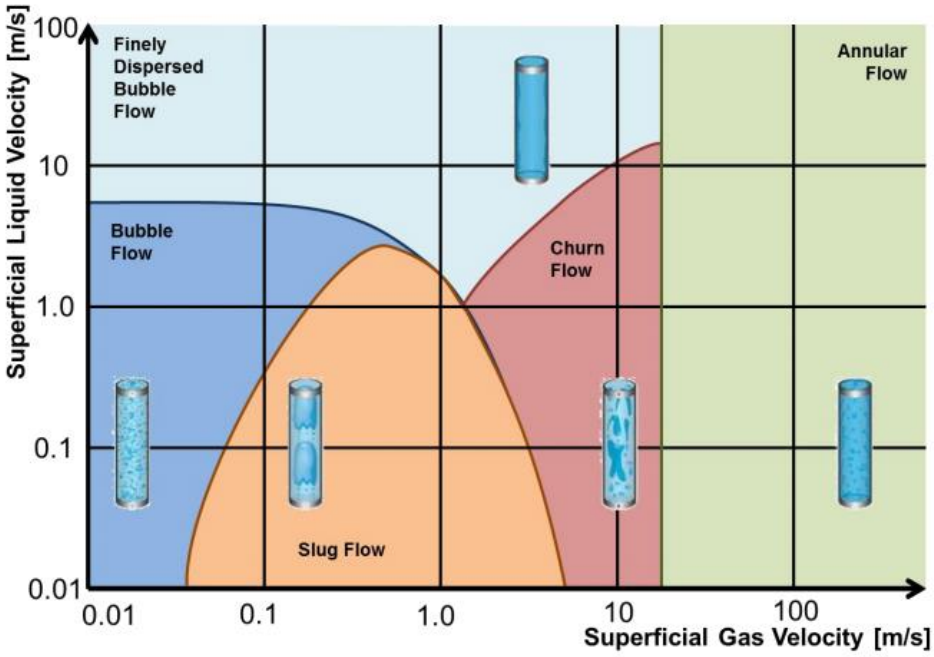
# Contesto aziendale




- Prodotti e servizi per l'industria petrolifera
- 11 stabilimenti nel mondo
- Più di 1500 dipendenti
- 70 anni di esperienza

# Multiphase Flow Meter

- Misurazione di flussi multifase in tempo reale
- Acqua, petrolio, gas
- Regime variabile
- Autodiagnostica delle anomalie




# Struttura dei dati



## Raw

- File binario
- 1 minuto di lettura
- 20 – 30 variabili
- BIX o BIN

## Riferimento

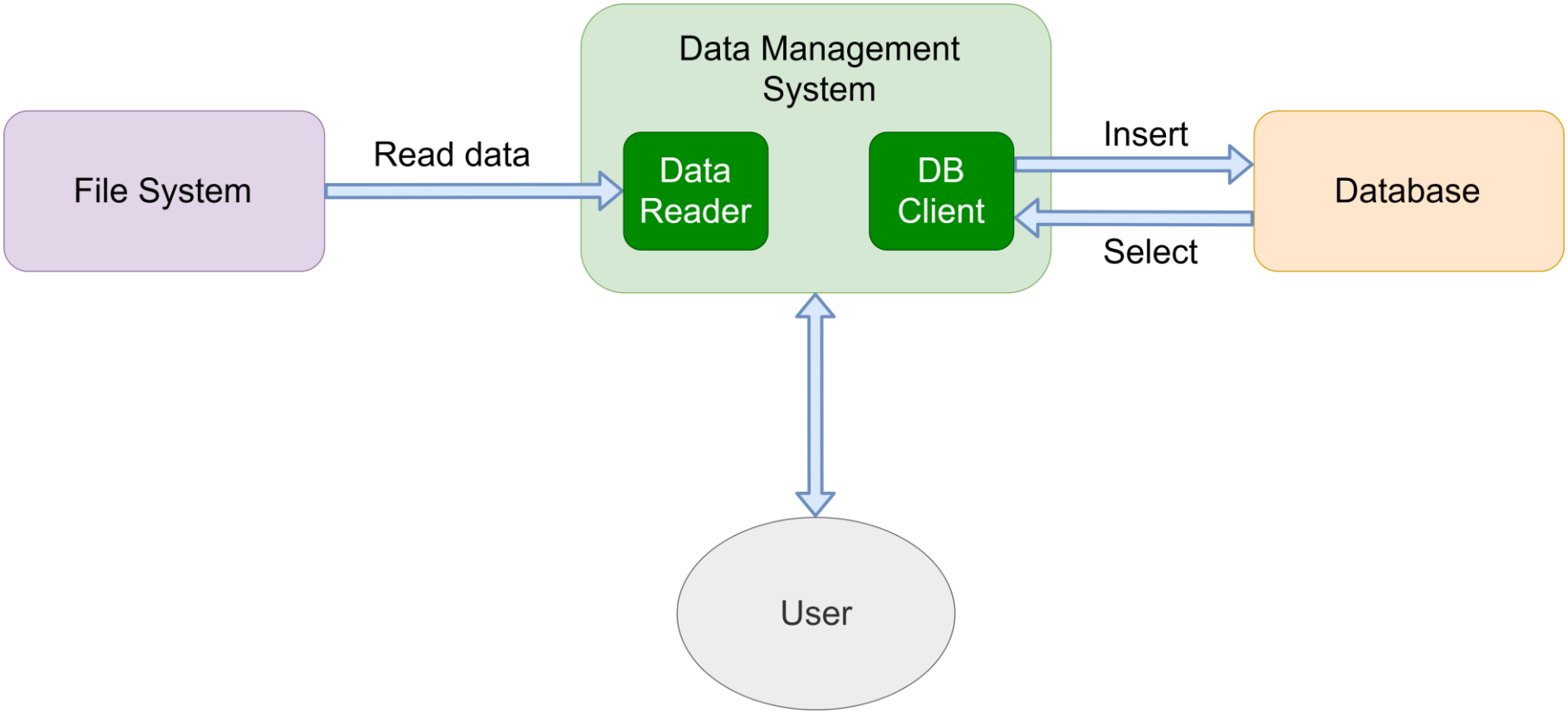
- File excel
- Qgas
- Qwater
- Qoil
- WLR
- GVF
- Pressione
- Temperatura

## Set-up

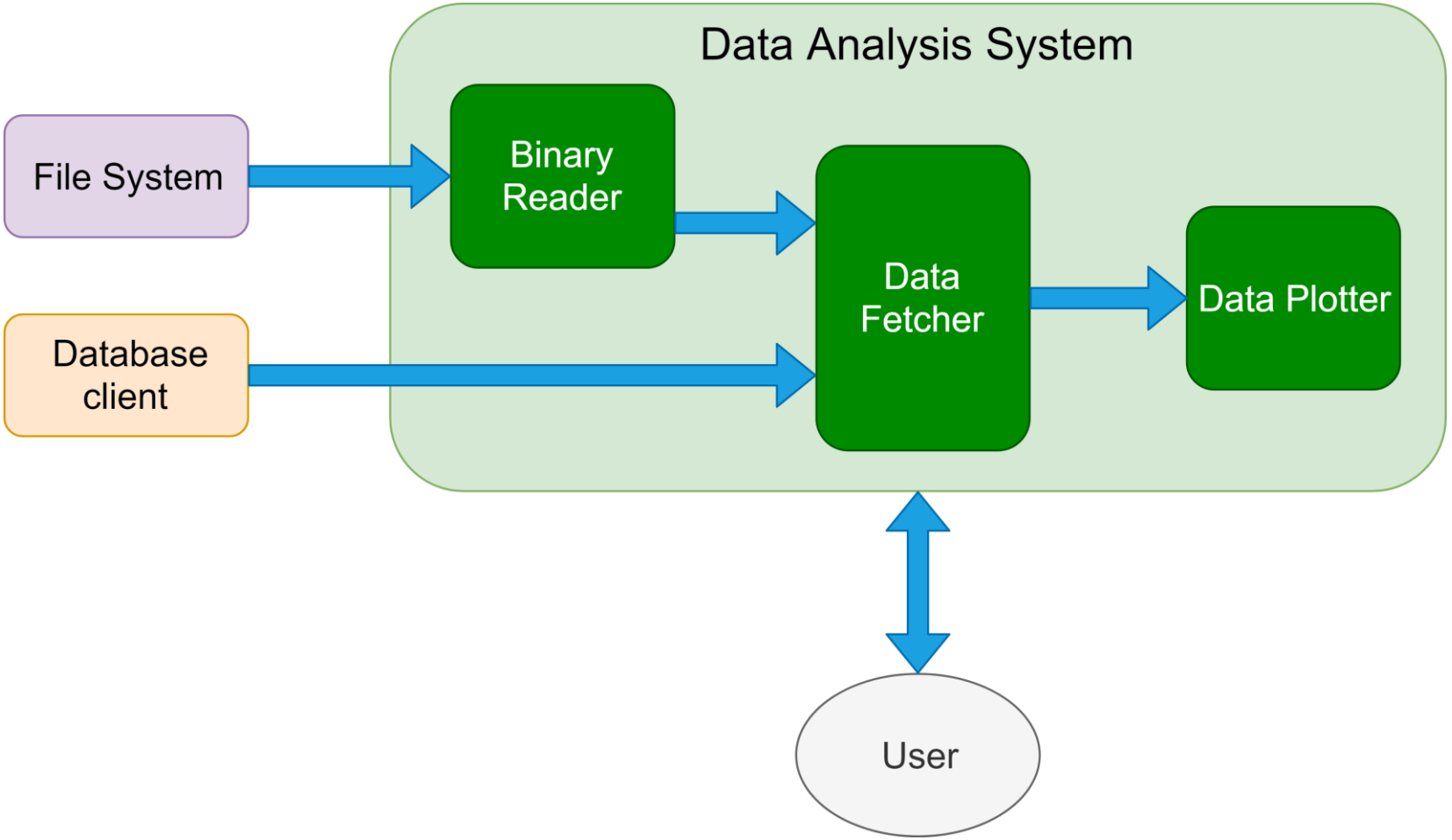
- File di testo
- Moduli installati
- Configurazione dello strumento

# Sistema di gestione dei dati





# Sistema di analisi dei dati



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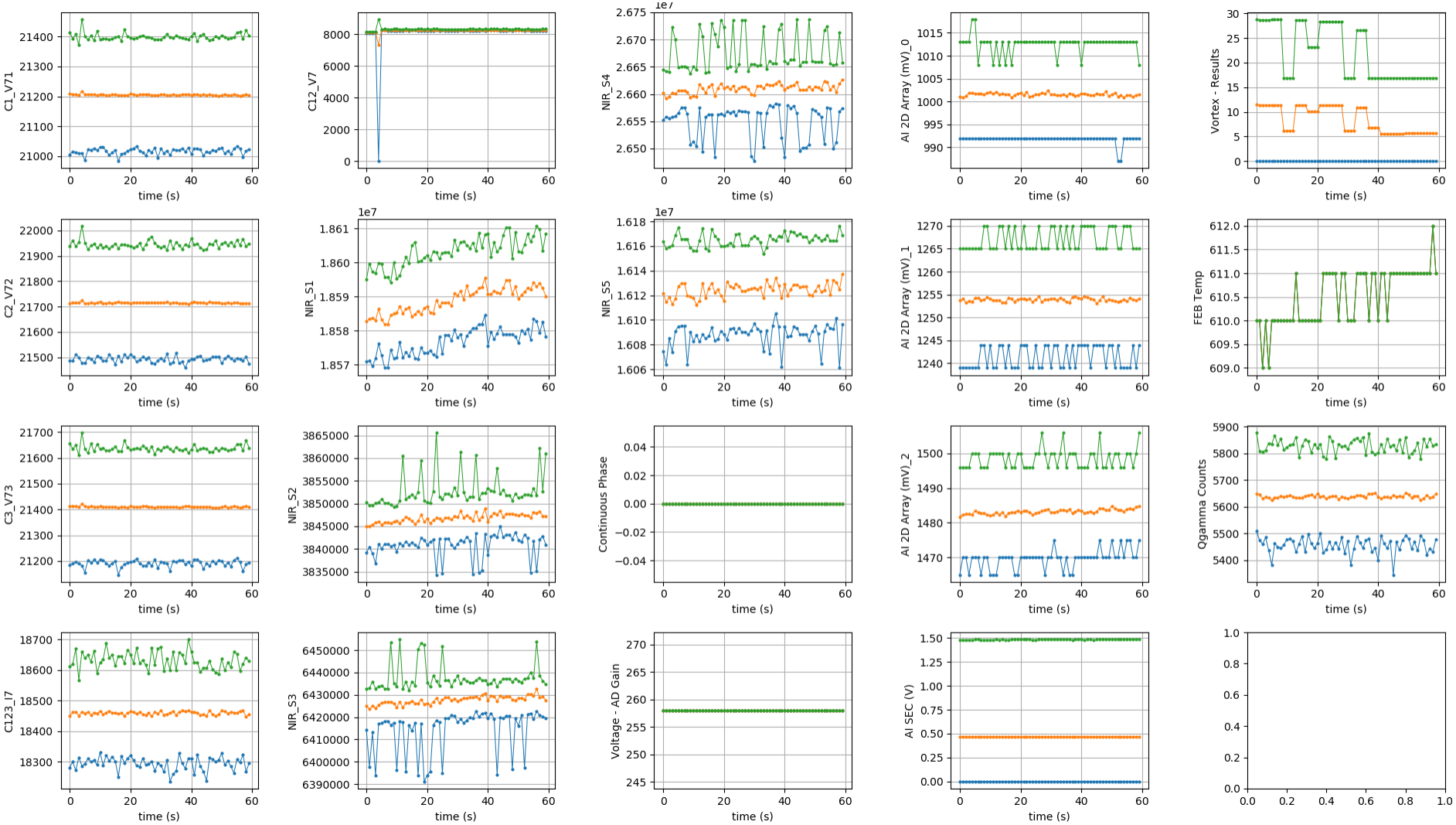

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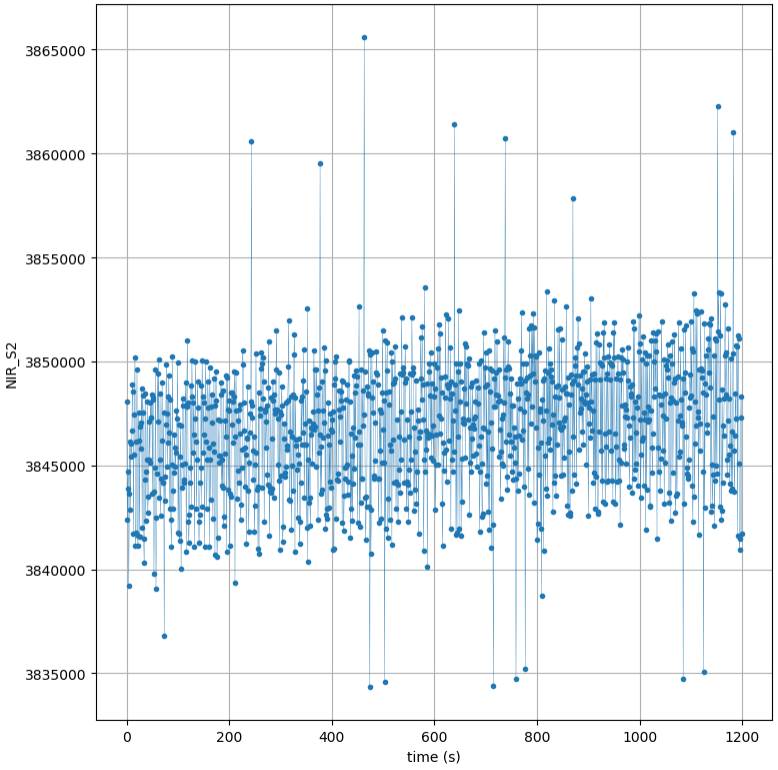


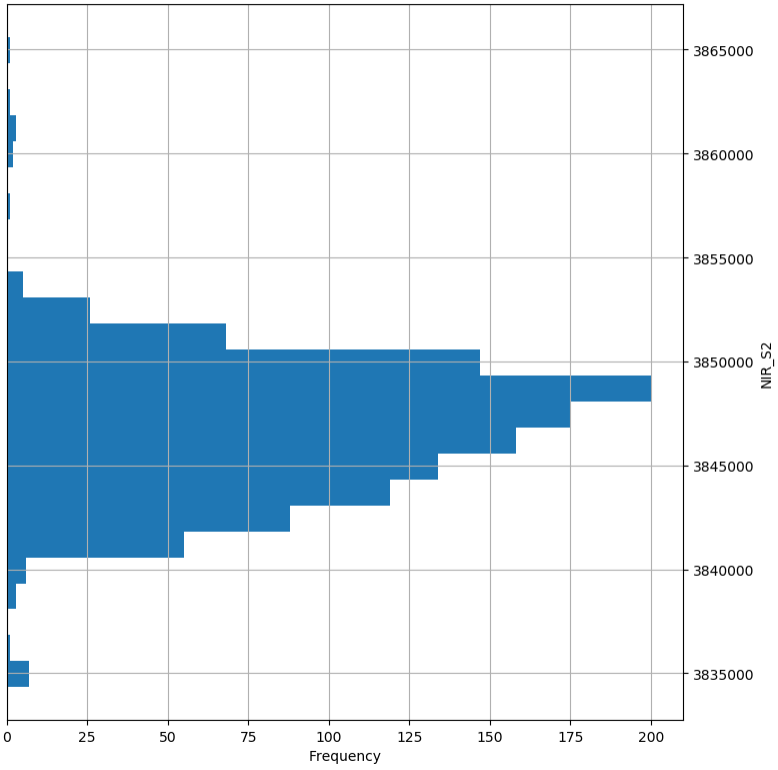

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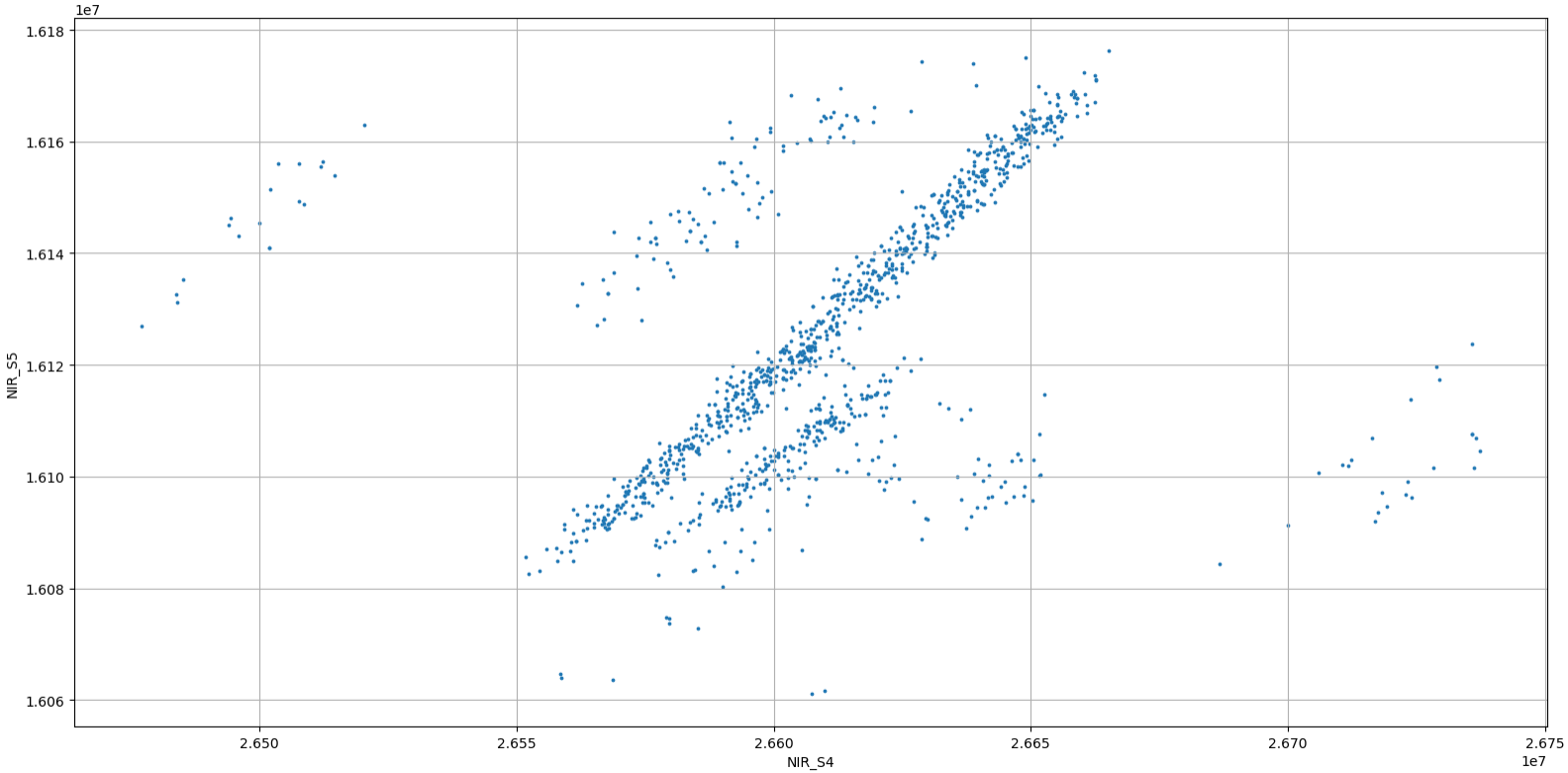
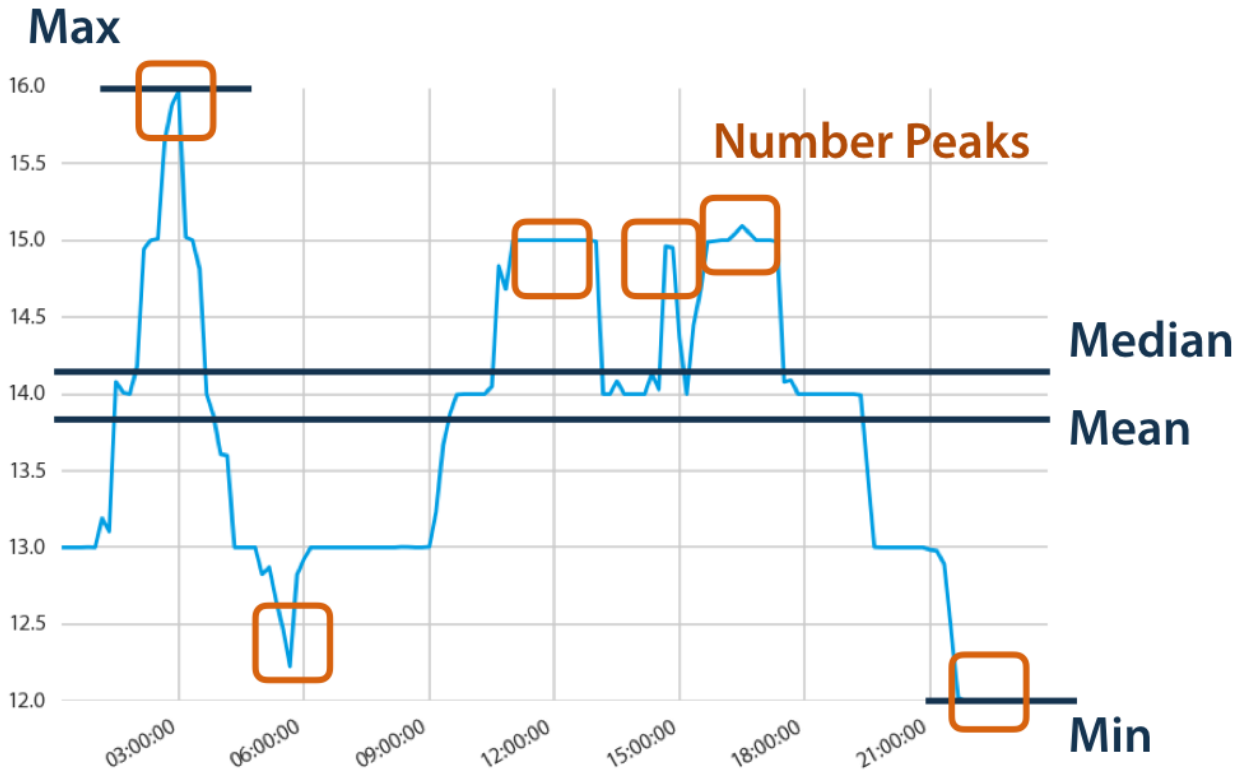


# Feature extraction

- Semplifica i dati di ingresso
- Rende l'apprendimento più veloce ed efficace




Feature scelte:

- Massimo
- Minimo
- Media
- Mediana
- Deviazione standard
- Varianza

# Anomaly detection

- Identificare dati anomali
- Diagnosticare lo stato di salute dello strumento
- Prevedere la rottura o il fallimento
- Supervisionato o non supervisionato

| Variable | #Samples | Classifier | Data | | | Noise | | |
|---|---|---|---|---|---|---|---|---|
| | | | Inliers | Outliers | Inliers % | Inliers | Outliers | Outliers % |
| C1_V71_0 | 5369 | ***HBOS*** | ***5037*** | ***332*** | ***93.82*** | ***3*** | ***533*** | ***99.44*** |
| | | IForest | 4987 | 382 | 92.89 | 1 | 535 | 99.81 |
| | | ***KNN*** | ***4977*** | ***392*** | ***92.70*** | ***0*** | ***536*** | ***100.00*** |
| | | LOF | 4519 | 850 | 84.17 | 527 | 9 | 1.68 |
| | | PCA | 4975 | 394 | 92.66 | 2 | 534 | 99.63 |
| C1_V71_1 | 1122 | HBOS | 1056 | 66 | 94.12 | 11 | 101 | 90.18 |
| | | ***IForest*** | ***1069*** | ***53*** | ***95.28*** | ***0*** | ***112*** | ***100.00*** |
| | | KNN | 1067 | 55 | 95.10 | 1 | 111 | 99.11 |
| | | LOF | 987 | 135 | 87.97 | 97 | 15 | 13.39 |
| | | PCA | 1077 | 45 | 95.99 | 0 | 112 | 100.00 |
| NIR_S1 | 7267 | ***HBOS*** | ***6854*** | ***413*** | ***94.32*** | ***0*** | ***726*** | ***100.00*** |
| | | IForest | 6839 | 428 | 94.11 | 0 | 726 | 100.00 |
| | | KNN | 6875 | 392 | 94.61 | 5 | 721 | 99.31 |
| | | LOF | 6307 | 960 | 86.79 | 714 | 12 | 1.65 |
| | | PCA | 6854 | 413 | 94.32 | 0 | 726 | 100.00 |

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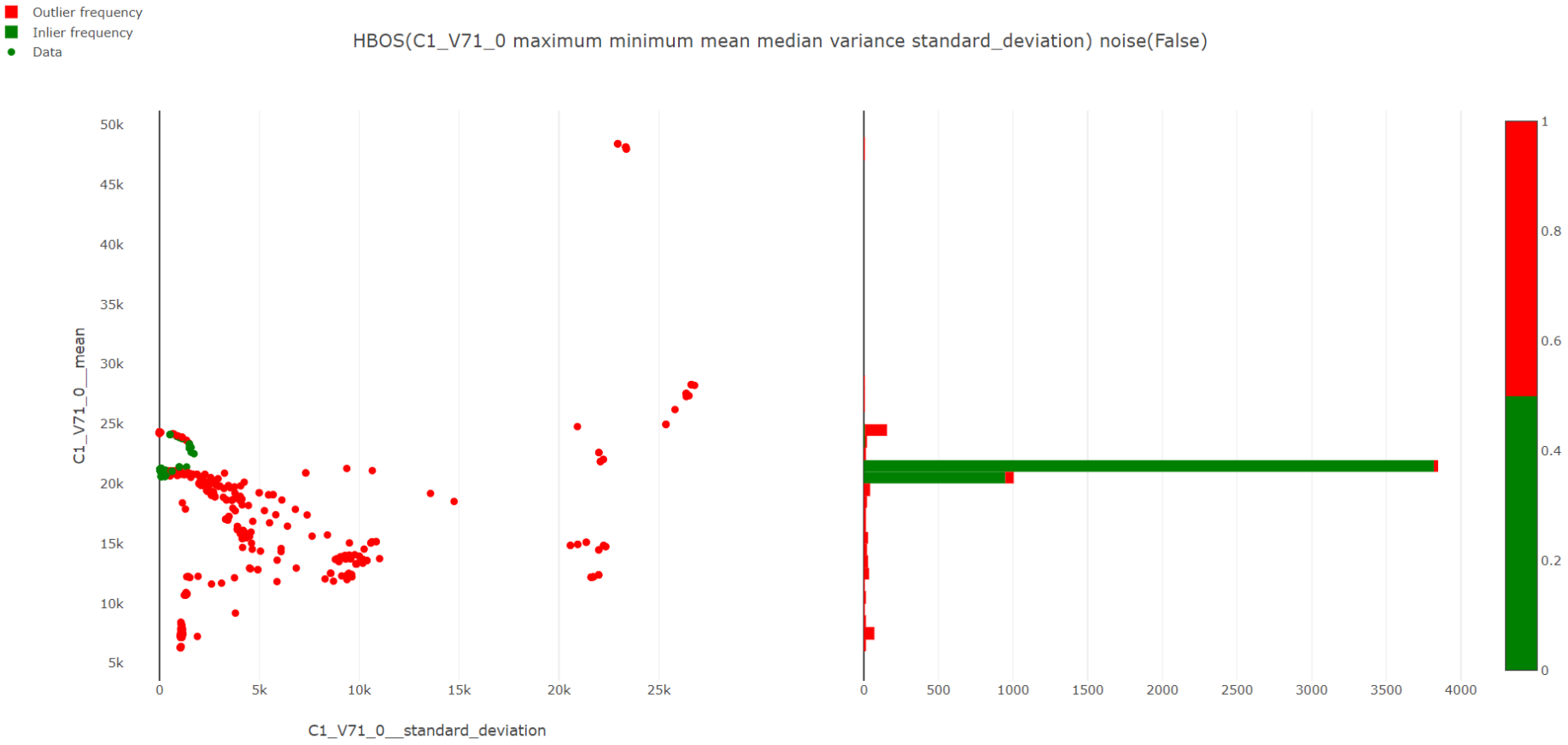

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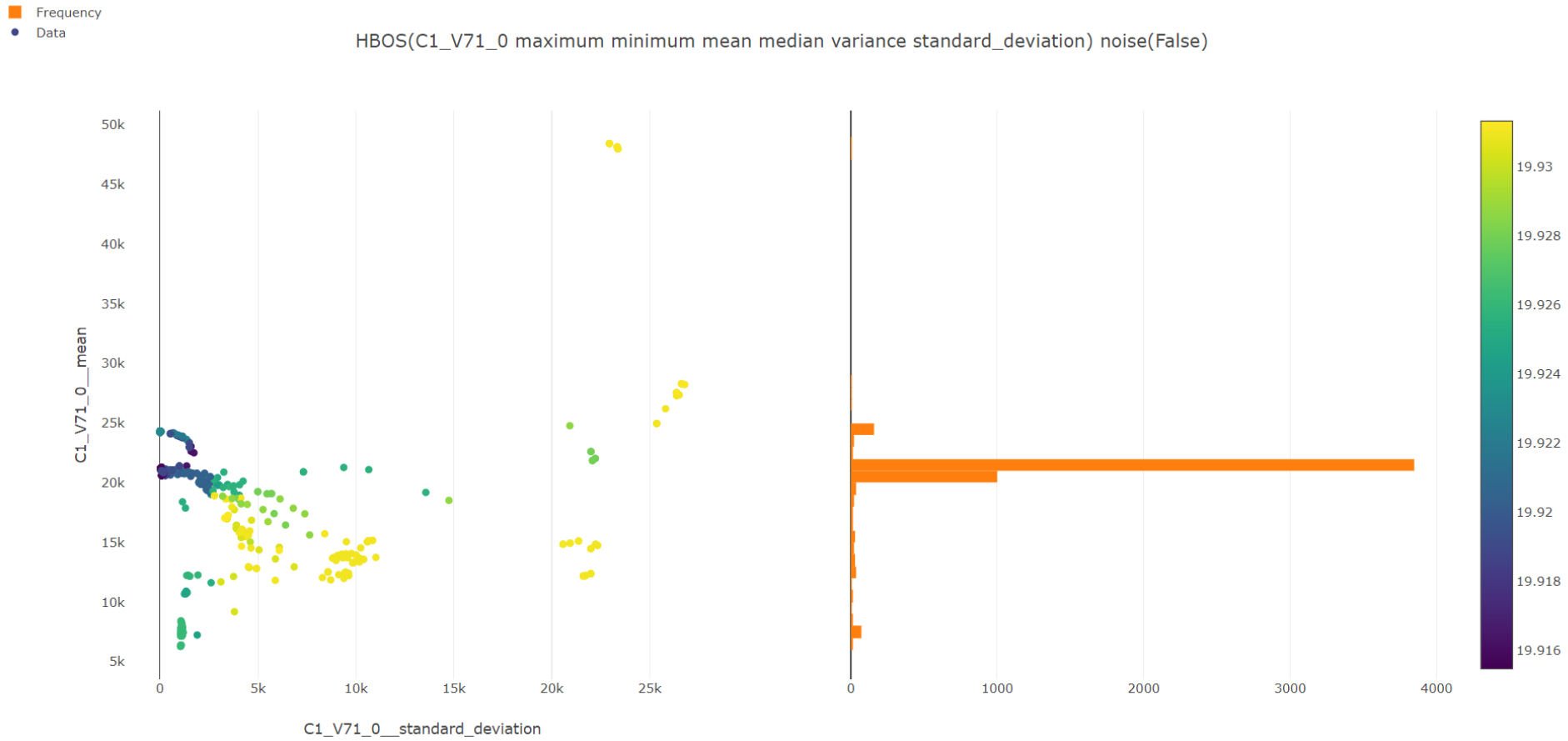

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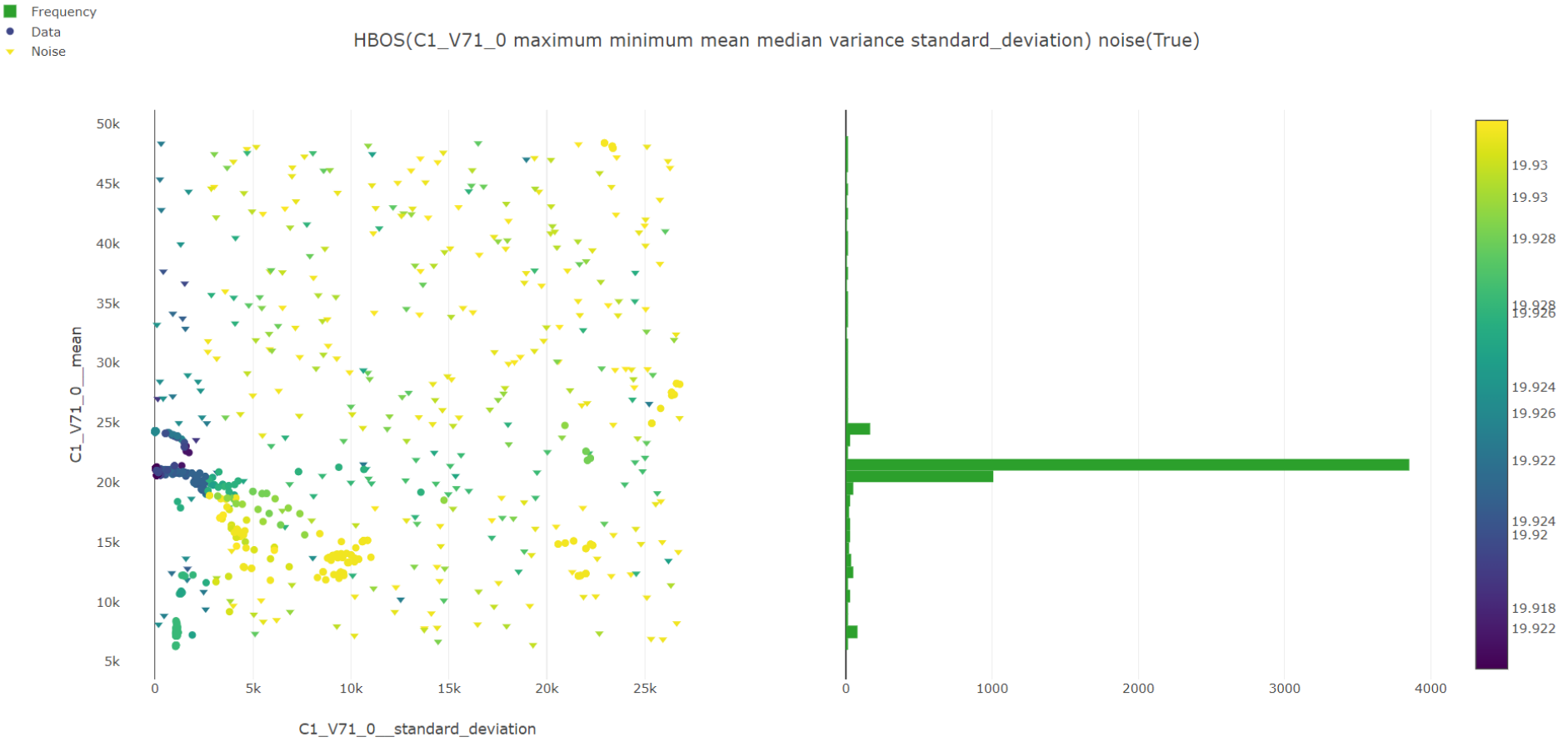

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