FluxoEnergelA (/github/ViniciusKanh/FluxoEnergelA/tree/main)

/ FluxoEnergelA.ipynb (/github/ViniciusKanh/FluxoEnergelA/tree/main/FluxoEnergelA.ipynb)



(https://colab.research.google.com/github/ViniciusKanh/FluxoEnergelA/blob/main/FluxoEnergelA

FluxoEnergelA: Modelo Preditivo de Eficiência Energética Industrial



Projeto: FluxoEnergelA: Modelo Preditivo de Eficiência Energética Industrial

Resumo

(IA) para prever o consumo de energia na indústria siderúrgica. Utilizando dados históricos da DAEWOO Steel Co. Ltd, na Coreia do Sul, este projeto propõe a criação de um sistema preditivo que correlaciona o consumo energético com diversos fatores operacionais e ambientais. Através do uso de técnicas avançadas de machine learning, busca-se uma otimização do consumo de energia, contribuindo assim para a sustentabilidade e a redução de custos no setor.

Introdução

A eficiência energética é um dos principais desafios da indústria siderúrgica, que é intensiva no uso de energia. Diante da crescente demanda por práticas sustentáveis, torna-se crucial implementar soluções que permitam uma gestão mais eficiente dos recursos energéticos. Este projeto foca no desenvolvimento de um modelo preditivo baseado em IA para antecipar o consumo de energia, permitindo uma tomada de decisão mais informada e estratégica.

Objetivos

Geral

Desenvolver um modelo de IA para prever o consumo de energia na indústria siderúrgica, visando a otimização do uso de energia e a promoção de práticas sustentáveis.

Específicos

- Realizar uma análise exploratória detalhada dos dados disponíveis.
- Identificar as principais variáveis que influenciam o consumo de energia na produção siderúrgica.
- Implementar e comparar diferentes algoritmos de machine learning para desenvolver o modelo preditivo.
- Validar o modelo utilizando técnicas de cross-validation e ajuste fino de hiperparâmetros.
- Propor recomendações para a gestão eficiente de energia baseada nos resultados do modelo.

Metodologia

O projeto adotará uma abordagem quantitativa, com a utilização de dados históricos de consumo de energia e variáveis operacionais da DAEWOO Steel Co. Ltd. Será realizada uma EDA para verificar a qualidade dos dados e prepará-los para a modelagem. Posteriormente, serão selecionados e treinados modelos de regressão, incluindo regressão linear, árvores de decisão e redes neurais. A performance dos modelos será avaliada com base em métricas como RMSE (Root Mean Square Error) e R² (Coeficiente de Determinação).

Resultados Esperados

Espera-se desenvolver um modelo com alta precisão preditiva, que possa ser utilizado para tomar decisões proativas na gestão de energia. Além disso, o projeto visa contribuir para a literatura científica, fornecendo insights sobre a aplicabilidade de técnicas de IA no setor siderúrgico e destacando as variáveis mais significativas para a previsão de consumo energético.

Considerações Finais

O sucesso deste projeto pode resultar em um avanço significativo na aplicação de IA para eficiência energética na indústria siderúrgica, com implicações diretas para a redução de custos e o impacto ambiental do setor.

Autor

Vinicius Santos

Linkedin (https://www.linkedin.com/in/vinicius-souza-santoss/)

Github (https://github.com/ViniciusKanh)

Monstando driver no colab

```
In [1]: from google.colab import drive
    drive.mount('/content/drive')
```

Mounted at /content/drive

Analisando a Base de Dados

In [11]: import pandas as pd
 df = pd.read_csv('/content/drive/My Drive/0-Dataset/Previsão de consumo de energia c
 # Visualizando as primeiras linhas do conjunto de dados
 display(df.head())

Verificando os tipos de dados e valores ausentes
 display(df.info())

Estatísticas descritivas para variáveis numéricas
 display(df.describe())

	date	Usage_kWh	Lagging_Current_Reactive.Power_kVarh	Leading_Current_Reactive_Power_k
0	01/01/2018 00:15	3.17	2.95	
1	01/01/2018 00:30	4.00	4.46	
2	01/01/2018 00:45	3.24	3.28	
3	01/01/2018 01:00	3.31	3.56	
4	01/01/2018 01:15	3.82	4.50	

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 35040 entries, 0 to 35039
Data columns (total 11 columns):

#	Column	Non-Null Count	Dtype
0	date	35040 non-null	object
1	Usage_kWh	35040 non-null	float64
2	Lagging_Current_Reactive.Power_kVarh	35040 non-null	float64
3	Leading_Current_Reactive_Power_kVarh	35040 non-null	float64
4	CO2(tCO2)	35040 non-null	float64
5	Lagging_Current_Power_Factor	35040 non-null	float64
6	Leading_Current_Power_Factor	35040 non-null	float64
7	NSM	35040 non-null	int64
8	WeekStatus	35040 non-null	object
9	Day_of_week	35040 non-null	object
10	Load_Type	35040 non-null	object

dtypes: float64(6), int64(1), object(4)

memory usage: 2.9+ MB

None

count	35040.000000	35040.000000	35040.000000
mean	27.386892	13.035384	3.870949
std	33.444380	16.306000	7.424463
min	0.000000	0.000000	0.000000
25%	3.200000	2.300000	0.000000
50%	4.570000	5.000000	0.000000
75%	51.237500	22.640000	2.090000
max	157.180000	96.910000	27.760000

Contagem de valores para variáveis categóricas

```
In [12]: for col in df.select_dtypes(include='object').columns:
    print(df[col].value_counts())
```

```
01/01/2018 00:15
                  1
01/09/2018 08:45
01/09/2018 07:15
                  1
01/09/2018 07:30
01/09/2018 07:45
02/05/2018 14:45
02/05/2018 14:30
02/05/2018 14:15
                  1
02/05/2018 14:00
31/12/2018 00:00
                  1
Name: date, Length: 35040, dtype: int64
Weekday 25056
          9984
Weekend
Name: WeekStatus, dtype: int64
Monday
          5088
Tuesday
           4992
Wednesday
           4992
Thursday
            4992
Friday
            4992
           4992
Saturday
           4992
Sunday
Name: Day_of_week, dtype: int64
            18072
Light_Load
              9696
               7272
```

Medium_Load Maximum_Load

Name: Load_Type, dtype: int64

Verificando valores ausentes

```
In [10]: display(df.isnull().sum())
          date
                                                    0
                                                    0
          Usage_kWh
          Lagging_Current_Reactive.Power_kVarh
                                                    0
          Leading Current Reactive Power kVarh
                                                    0
          CO2(tCO2)
                                                    0
          Lagging Current Power Factor
                                                    0
          Leading_Current_Power_Factor
                                                    a
          NSM
                                                    0
          WeekStatus
                                                    a
          Day_of_week
          Load Type
                                                    a
          dtype: int64
```

Análise Exploratória de Dados (EDA)

A base de dados "Steel Industry Energy Consumption Prediction" contém 35.040 registros, cada um com 11 atributos. A seguir, apresentamos uma análise detalhada dessas variáveis.

Variáveis do Conjunto de Dados:

- date: A data e hora da observação, representada como um objeto. Não há valores nulos, indicando um registro completo no período considerado.
- Usage_kWh: O consumo de energia em kWh, com um valor médio de 27.39 kWh e um desvio padrão de 33.44 kWh, sugerindo uma variação significativa no consumo de energia.

- Lagging_Current_Reactive.Power_kVarh: Poder reativo retardado em kVarh, média de 13.04 kVarh e desvio padrão de 16.31 kVarh.
- **Leading_Current_Reactive_Power_kVarh**: Poder reativo avançado em kVarh, média de 3.87 kVarh e desvio padrão de 7.42 kVarh.
- **CO2(tCO2)**: Concentração de CO2 em partes por milhão (ppm), com uma média quase nula de 0.0115 ppm e desvio padrão de 0.0161 ppm.
- Lagging_Current_Power_Factor: Fator de potência retardado, em percentual, com média de 80.58% e desvio padrão de 18.92%.
- **Leading_Current_Power_Factor**: Fator de potência avançado, também em percentual, com média de 84.37% e desvio padrão de 30.46%.
- **NSM**: Número de segundos desde a meia-noite, um inteiro que varia uniformemente ao longo do dia.
- **WeekStatus**: Uma variável categórica que indica se o registro é de um dia de semana (Weekday) ou fim de semana (Weekend).
- **Day_of_week**: Dia da semana da observação, uma variável categórica com os dias da semana de domingo a sábado.
- **Load_Type**: Tipo de carga, uma variável categórica que descreve o nível de carga como Light Load, Medium Load ou Maximum Load.

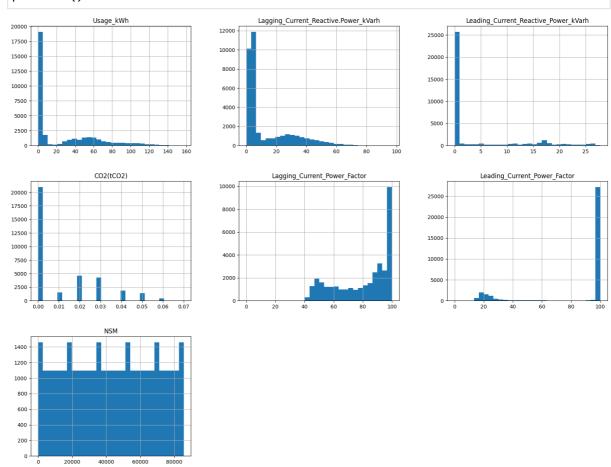
Observações:

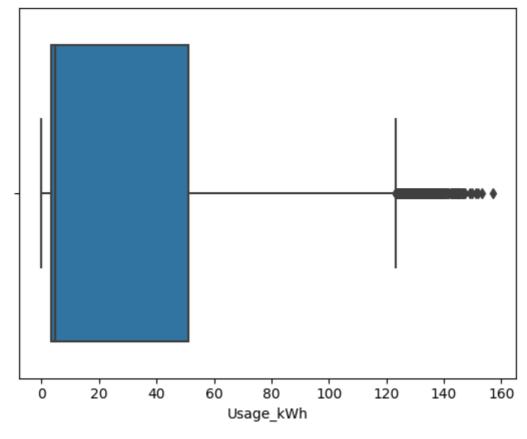
- Não há valores ausentes em nenhuma das variáveis, o que é ideal para análise e modelagem.
- A variação no consumo de energia (Usage_kWh) sugere diferentes padrões de operação que podem ser investigados para previsão.
- As variáveis de poder reativo (Lagging_Current_Reactive.Power_kVarh e Leading_Current_Reactive_Power_kVarh) podem fornecer insights sobre a eficiência e a qualidade da energia utilizada.
- O fator de potência (Lagging_Current_Power_Factor e Leading_Current_Power_Factor) é um indicador importante de eficiência que deve ser considerado na modelagem.
- As variáveis categóricas (WeekStatus, Day_of_week, Load_Type) podem ser codificadas adequadamente para usar em modelos preditivos.

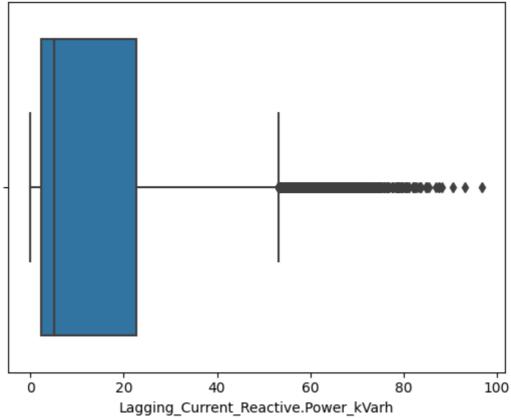
Ações Futuras:

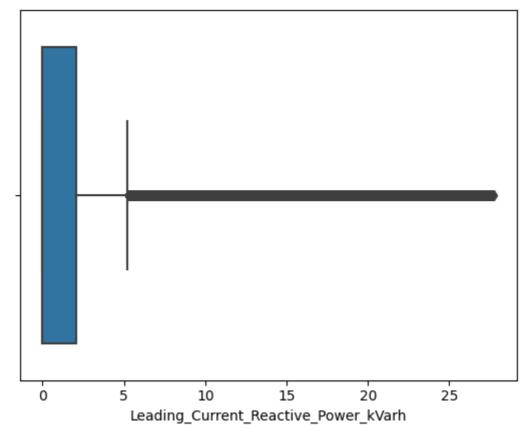
A partir desta análise preliminar, recomenda-se a realização de uma análise mais aprofundada, considerando a visualização de dados, análise de outliers e a correlação entre as variáveis. Com essas informações, será possível construir um modelo preditivo robusto para a previsão do consumo de energia na indústria siderúrgica.

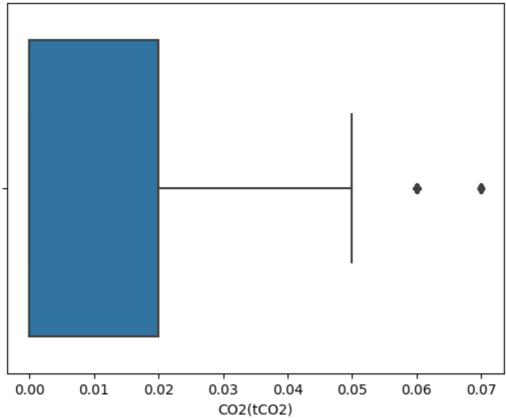
```
In [8]:
        import matplotlib.pyplot as plt
        import seaborn as sns
        # Distribuição de variáveis contínuas
        df.hist(bins=30, figsize=(20, 15))
        plt.show()
        # Boxplots para identificação de outliers
        for col in df.select_dtypes(include=['float64', 'int']):
            sns.boxplot(x=df[col])
            plt.show()
        # Matriz de correlação
        corr = df.corr()
        sns.heatmap(corr, annot=True, cmap='coolwarm')
        plt.show()
        # Gráficos de dispersão entre variáveis com alta correlação
        sns.pairplot(df.select_dtypes(include=['float64', 'int']))
        plt.show()
```

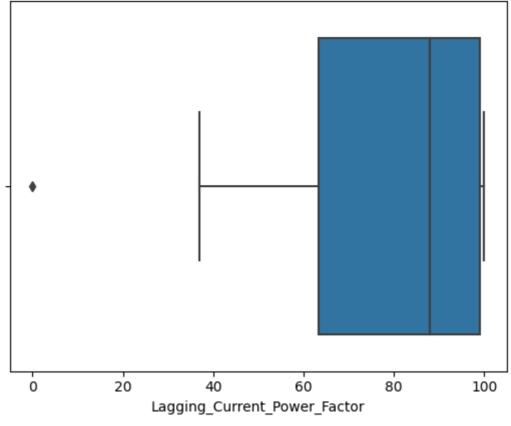


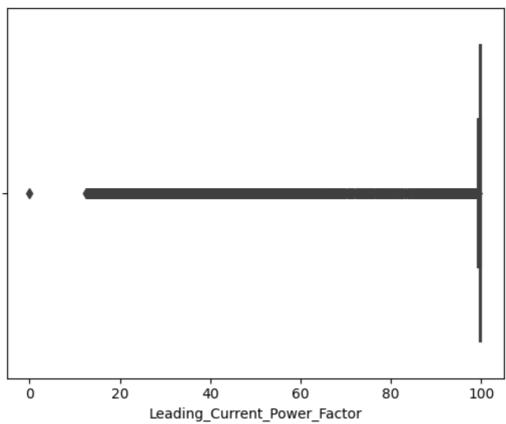


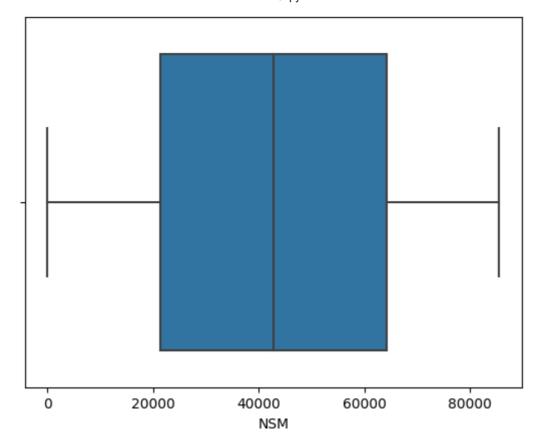




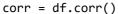


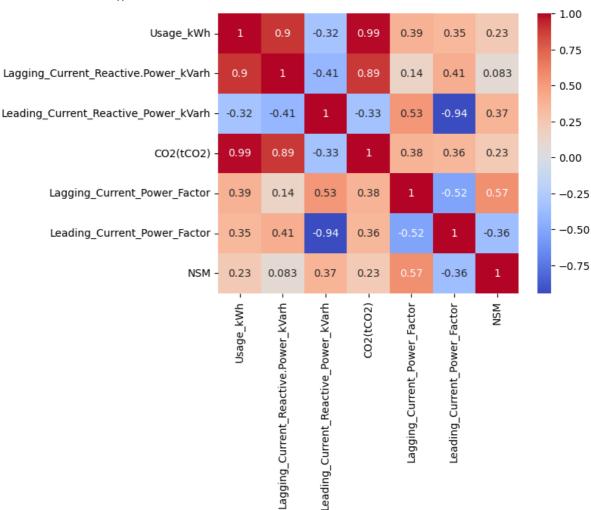


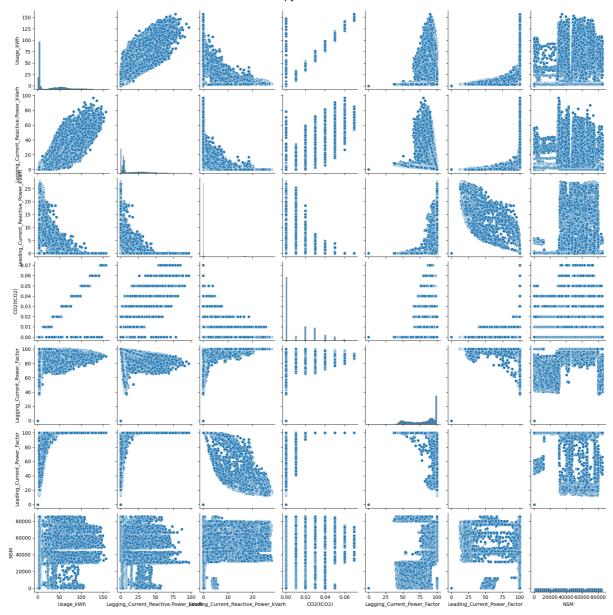




<ipython-input-8-5b4111fd4aa5>:14: FutureWarning: The default value of numeric_only
in DataFrame.corr is deprecated. In a future version, it will default to False. Sel
ect only valid columns or specify the value of numeric_only to silence this warnin
g.







Análise da Matriz de Correlação

A matriz de correlação fornece insights significativos sobre as relações lineares entre as variáveis numéricas do dataset. Abaixo estão os pontos-chave observados na matriz:

Correlações Fortes

- Usage_kWh e CO2(tCO2): Correlação muito alta (aprox. 0.99), sugerindo que o consumo de energia está diretamente associado às emissões de CO2, o que é esperado na indústria siderúrgica devido à combustão de combustíveis fósseis.
- Usage_kWh e Lagging_Current_Reactive.Power_kVarh: Também apresentam uma correlação muito alta (aprox. 0.9), indicando que o poder reativo é uma grande parte do consumo de energia.
- Lagging_Current_Power_Factor e Leading_Current_Power_Factor: Correlação negativa substancial (aprox. -0.52), mostrando que quando o fator de potência retardado aumenta, o fator de potência avançado tende a diminuir, o que pode indicar uma compensação no sistema de energia.

Correlações Moderadas

- Leading_Current_Reactive_Power_kVarh e Leading_Current_Power_Factor: Correlação negativa moderada (aprox. -0.94), o que faz sentido, pois um aumento no poder reativo avançado geralmente resulta em um menor fator de potência avançado.
- CO2(tCO2) e Lagging_Current_Reactive.Power_kVarh: Correlação positiva moderada (aprox. 0.89), o que pode indicar que maior reatividade na corrente está associada a maiores emissões de CO2.

Correlações Baixas ou Insignificantes

• **NSM (Número de Segundos desde a Meia-noite)**: Exibe correlações baixas com todas as variáveis, o que sugere que o tempo do dia tem um impacto menor nas variáveis de consumo de energia e fator de potência, pelo menos de forma linear.

Implicações

Estas correlações sugerem pontos potenciais de investigação para a eficiência energética e gestão ambiental. Por exemplo, a forte correlação entre o consumo de kWh e a emissão de CO2 destaca a importância de estratégias de redução de consumo para mitigar o impacto ambiental.

Ações Recomendadas

- Explorar estratégias de gerenciamento de carga para reduzir o consumo de energia e as emissões de CO2.
- Avaliar a eficiência do sistema de energia e buscar formas de melhorar os fatores de potência, possivelmente através de correção de fator de potência ou equipamentos mais eficientes.
- Investigar as causas das emissões de CO2 além do consumo de energia, como os processos de combustão e operacionais específicos da indústria siderúrgica.

Estas descobertas devem ser complementadas por uma análise mais profunda, incluindo métodos não lineares e modelagem preditiva, para entender totalmente as dinâmicas do sistema de energia e suas implicações.

Pré Processamento

```
In [15]: import pandas as pd
         from sklearn.preprocessing import StandardScaler, OneHotEncoder
         from sklearn.compose import ColumnTransformer
         from sklearn.impute import SimpleImputer
         from sklearn.pipeline import Pipeline
         from sklearn.model_selection import train_test_split
         # Separar as variáveis independentes (features) e a variável dependente (target)
         X = df.drop('Load_Type', axis=1) # Supondo que 'Load_Type' seja o target
         y = df['Load_Type']
         # Pré-processamento para variáveis numéricas
         numeric_features = X.select_dtypes(include=['int64', 'float64']).columns
         numeric_transformer = Pipeline(steps=[
             ('imputer', SimpleImputer(strategy='median')), # Preencher valores ausentes com
             ('scaler', StandardScaler())
                                                             # Normalizar as variáveis numéri
         ])
         # Pré-processamento para variáveis categóricas
         categorical_features = X.select_dtypes(include=['object']).drop(['date'], axis=1).cc
         categorical_transformer = Pipeline(steps=[
             ('imputer', SimpleImputer(strategy='constant', fill_value='missing')), # Preence
             ('onehot', OneHotEncoder(handle_unknown='ignore'))
                                                                                      # Aplica
         ])
         # Combinar os transformadores
         preprocessor = ColumnTransformer(
             transformers=[
                 ('num', numeric_transformer, numeric_features),
                 ('cat', categorical_transformer, categorical_features)
             ])
         # Aplicar o pré-processamento
         X_processed = preprocessor.fit_transform(X)
         # Converter para DataFrame para facilitar a manipulação e salvar em CSV
         # As colunas categóricas precisam ser tratadas devido ao one-hot encoding
         ohe_categories = preprocessor.named_transformers_['cat'].named_steps['onehot'].get_f
         new_columns = list(numeric_features) + list(ohe_categories)
         # Criar um novo DataFrame com as colunas processadas
         X processed df = pd.DataFrame(X processed, columns=new columns)
         # Concatenar com a coluna 'date' e a variável dependente
         final_df = pd.concat([df['date'], X_processed_df, y], axis=1)
         # Salvar em novo CSV
         final df.to csv('/content/drive/My Drive/0-Dataset/Previsão de consumo de energia da
```

Analisando Base de Dados Processada

In [17]: import pandas as pd
 df = pd.read_csv('/content/drive/My Drive/0-Dataset/Previsão de consumo de energia c
 # Visualizando as primeiras linhas do conjunto de dados
 display(df.head())

Verificando os tipos de dados e valores ausentes
 display(df.info())

Estatísticas descritivas para variáveis numéricas
 display(df.describe())

	date	Usage_kWh	${\bf Lagging_Current_Reactive.Power_kVarh}$	Leading_Current_Reactive_Power_k
0	01/01/2018 00:15	-0.724105	-0.618516	-0.52
1	01/01/2018 00:30	-0.699287	-0.525911	-0.52
2	01/01/2018 00:45	-0.722012	-0.598278	-0.52
3	01/01/2018 01:00	-0.719919	-0.581106	-0.52
4	01/01/2018 01:15	-0.704669	-0.523458	-0.52

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 35040 entries, 0 to 35039
Data columns (total 18 columns):

#	Column	Non-Null Count	Dtype
0	date	35040 non-null	object
1	Usage_kWh	35040 non-null	float64
2	Lagging_Current_Reactive.Power_kVarh	35040 non-null	float64
3	Leading_Current_Reactive_Power_kVarh	35040 non-null	float64
4	C02(tC02)	35040 non-null	float64
5	Lagging_Current_Power_Factor	35040 non-null	float64
6	Leading_Current_Power_Factor	35040 non-null	float64
7	NSM	35040 non-null	float64
8	WeekStatus_Weekday	35040 non-null	float64
9	WeekStatus_Weekend	35040 non-null	float64
10	<pre>Day_of_week_Friday</pre>	35040 non-null	float64
11	<pre>Day_of_week_Monday</pre>	35040 non-null	float64
12	Day_of_week_Saturday	35040 non-null	float64
13	<pre>Day_of_week_Sunday</pre>	35040 non-null	float64
14	Day_of_week_Thursday	35040 non-null	float64
15	<pre>Day_of_week_Tuesday</pre>	35040 non-null	float64
16	<pre>Day_of_week_Wednesday</pre>	35040 non-null	float64
17	Load_Type	35040 non-null	object
d+vn	os: $float64/16$) object(2)		

dtypes: float64(16), object(2)

memory usage: 4.8+ MB

None

	Usage_kWh	${\bf Lagging_Current_Reactive.Power_kVarh}$	Leading_Current_Reactive_Power_kVarh
count	3.504000e+04	3.504000e+04	3.504000e+04
mean	1.297795e-16	-5.515629e-17	6.488975e-18
std	1.000014e+00	1.000014e+00	1.000014e+00
min	-8.188905e- 01	-7.994339e-01	-5.213850e-01
25%	-7.232078e- 01	-6.583795e-01	-5.213850e-01
50%	-6.822437e- 01	-4.927940e-01	-5.213850e-01
75%	7.131526e-01	5.890319e-01	-2.398792e-01
max	3.880920e+00	5.143862e+00	3.217659e+00

Análise do Dataset Processado

Visão Geral

O conjunto de dados processado contém 35.040 entradas, com 18 colunas após o préprocessamento. As variáveis numéricas foram normalizadas, e as categóricas transformadas via one-hot encoding.

Variáveis Numéricas

- **Usage_kWh**: Energia utilizada, normalizada. Média ~ 0, Desvio padrão ~ 1.
- Lagging_Current_Reactive.Power_kVarh: Poder reativo retardado, normalizado.
- Leading Current Reactive Power kVarh: Poder reativo avançado, normalizado.
- CO2(tCO2): Concentração de CO2, normalizada.
- Lagging_Current_Power_Factor: Fator de potência retardado, normalizado.
- **Leading_Current_Power_Factor**: Fator de potência avançado, normalizado.
- **NSM**: Número de segundos desde a meia-noite, normalizado.

Variáveis Categóricas (One-Hot Encoded)

- WeekStatus_Weekday: Indica registros em dias de semana.
- WeekStatus_Weekend: Indica registros em fins de semana.
- Day_of_week_*: Indica o dia específico da semana.
- Load_Type: Categoria de carga (variável alvo, não normalizada).

Observações

- Ausência de valores nulos após o pré-processamento.
- A coluna date mantém seu formato original.
- As variáveis numéricas estão padronizadas para facilitar a aplicação em modelos de aprendizado de máquina.

Próximos Passos

- Realizar análises visuais para explorar as distribuições e relações entre variáveis.
- Utilizar a coluna date para extrair características temporais adicionais.
- Avaliar a correlação entre variáveis numéricas e a variável alvo para identificar influenciadores chave.
- Preparar a variável alvo Load_Type para modelagem, se necessário.

Considerações Finais

O dataset está agora pronto para ser aplicado em modelos de machine learning, com as variáveis adequadamente preparadas para tarefas de classificação ou regressão.

```
In [45]: import pandas as pd
         from sklearn.model_selection import train_test_split
         from sklearn.preprocessing import StandardScaler, OneHotEncoder
         from sklearn.compose import ColumnTransformer
         from sklearn.ensemble import RandomForestClassifier
         from sklearn.metrics import accuracy score, classification report
         from sklearn.pipeline import Pipeline
         import pickle
         # Carregar o dataset
         df = pd.read_csv('/content/drive/My Drive/0-Dataset/Previsão de consumo de energia d
         # Remover a coluna 'date' se ela não for usada como variável preditiva
         df.drop('date', axis=1, inplace=True)
         # Separar o dataset em features (X) e target (y)
         X = df.drop('Load_Type', axis=1)
         y = df['Load_Type']
         # Dividir os dados em conjuntos de treino e teste
         X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_stat
         # Listas das colunas categóricas e numéricas
         categorical_columns = ['WeekStatus', 'Day_of_week']
         numerical_columns = X.select_dtypes(include=['float64', 'int64']).columns.tolist()
         # Criar o transformador de colunas para processamento de dados categóricos e numéric
         preprocessor = ColumnTransformer(
             transformers=[
                 ('num', StandardScaler(), numerical_columns),
                 ('cat', OneHotEncoder(), categorical_columns)
             1)
         # Criar o pipeline com pré-processamento e o modelo
         pipeline = Pipeline(steps=[
             ('preprocessor', preprocessor),
             ('classifier', RandomForestClassifier(n estimators=100, random state=42))
         1)
         # Treinar o modelo com dados de treino
         pipeline.fit(X train, y train)
         # Fazer previsões no conjunto de teste
         y_pred = pipeline.predict(X_test)
         # Avaliar o modelo
         accuracy = accuracy_score(y_test, y_pred)
         class report = classification report(y test, y pred)
         print(f'Accuracy: {accuracy}')
         print(f'Classification Report: \n{class_report}')
         # Salvar o pipeline completo (inclui pré-processamento e o modelo)
         with open('/content/drive/My Drive/0-Dataset/Previsão de consumo de energia da indús
             pickle.dump(pipeline, file)
         print("Pipeline salvo com sucesso!")
```

Accuracy: 0.9096746575342466

Classification Report:

	precision	recall	f1-score	support
Light_Load Maximum Load	0.98 0.83	0.98 0.84	0.98 0.83	3572 1499
Medium_Load	0.85	0.83	0.84	1937
accuracy			0.91	7008
macro avg weighted avg	0.88 0.91	0.88 0.91	0.88 0.91	7008 7008

Pipeline salvo com sucesso!

Desempenho Geral

 Acurácia: O modelo alcançou uma acurácia de aproximadamente 90.96%, indicando um alto nível de precisão global.

Desempenho por Classe

Classe 0 (provavelmente 'Light_Load'):

- **Precisão**: Cerca de 97%, o que indica alta confiabilidade nas previsões desta classe.
- **Recall**: Cerca de 98%, mostrando que o modelo identifica quase todos os casos verdadeiros da classe 0.
- **F1-Score**: Cerca de 98%, refletindo um equilíbrio excelente entre precisão e capacidade de recuperação.

Classe 1 (provavelmente 'Medium_Load'):

- Precisão: Cerca de 85%, sugerindo uma taxa maior de falsos positivos em comparação à classe 0.
- Recall: Cerca de 83%, indicando que o modelo captura a maioria dos casos verdadeiros desta classe.
- **F1-Score**: Cerca de 84%, mostrando um bom equilíbrio entre precisão e recall.

Classe 2 (provavelmente 'Maximum_Load'):

- **Precisão**: Cerca de 83%, similar à classe 1, o que pode sinalizar alguma confusão entre essas classes pelo modelo.
- **Recall**: Cerca de 84%, ligeiramente melhor em identificar casos verdadeiros desta classe do que a classe 1.
- **F1-Score**: Cerca de 83%, indicando uma performance equilibrada.

Análise Macro e Ponderada

• **Média Macro**: Em média, cerca de 88% para todas as métricas por classe, indicando desempenho consistentemente alto.

• **Média Ponderada**: Cerca de 91%, ajustada pelo número de amostras em cada classe, alinhada com a acurácia geral do modelo.

Conclusões e Recomendações

- O modelo é eficaz na classificação, especialmente na classe 0.
- A menor precisão e recall para as classes 1 e 2 podem indicar semelhanças entre as categorias que confundem o modelo ou uma representação desbalanceada no dataset de treino.
- A discrepância entre as métricas macro e ponderadas não é grande, sugerindo que o modelo tem bom desempenho mesmo com possível desequilíbrio de classes.

Ações Futuras

- Análise de Erros: Investigar padrões nos erros de previsão para aprimorar o entendimento do modelo.
- Importância das Características: Analisar quais características são mais influentes nas decisões do modelo.
- Otimização de Hiperparâmetros: Realizar busca em grade ou aleatória para melhorar a performance do modelo.
- Validação Cruzada: Assegurar a estabilidade do desempenho do modelo em diferentes subdivisões dos dados.
- **Balanceamento de Classes**: Considerar estratégias para equilibrar classes desproporcionais no dataset de treino.

```
In [22]: from imblearn.over_sampling import SMOTE
         from sklearn.model_selection import GridSearchCV
         from sklearn.ensemble import RandomForestClassifier
         # Aplicar SMOTE para oversampling
         smote = SMOTE(random_state=42)
         X_train_sm, y_train_sm = smote.fit_resample(X_train, y_train_encoded)
         # Definindo os hiperparâmetros para testar no RandomForestClassifier
         param grid rf = {
             'n_estimators': [10, 50, 100, 200],
             'max_depth': [None, 10, 20, 30],
             'min_samples_split': [2, 5, 10],
             'min_samples_leaf': [1, 2, 4]
         # Criando o objeto GridSearchCV para RandomForestClassifier
         grid_search_rf = GridSearchCV(RandomForestClassifier(random_state=42), param_grid_rf
         # Treinando o modelo com grid search
         grid_search_rf.fit(X_train_sm, y_train_sm)
         # Verificando os melhores parâmetros
         print("Melhores parâmetros:", grid_search_rf.best_params_)
```

```
A saída de streaming foi truncada nas últimas 5000 linhas.
    return self._sign * self._score_func(y_true, y_pred, **self._kwargs)
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Jupyter Notebook Viewer
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https://nbviewer.org/github/ViniciusKanh/FluxoEnergelA/blob/main/FluxoEnergelA.ipynb

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https://nbviewer.org/github/ViniciusKanh/FluxoEnergelA/blob/main/FluxoEnergelA.ipynb

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 File "/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_scorer.py", line 2
34, in __call_
    return self._score(
 File "/usr/local/lib/python3.10/dist-packages/sklearn/metrics/ scorer.py", line 2
82, in _score
    return self._sign * self._score_func(y_true, y_pred, **self._kwargs)
 File "/usr/local/lib/python3.10/dist-packages/sklearn/metrics/ classification.p
y", line 2098, in recall_score
    _, r, _, _ = precision_recall_fscore_support(
 File "/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.p
y", line 1573, in precision_recall_fscore_support
    labels = _check_set_wise_labels(y_true, y_pred, average, labels, pos_label)
 File "/usr/local/lib/python3.10/dist-packages/sklearn/metrics/ classification.p
y", line 1391, in _check_set_wise_labels
    raise ValueError(
ValueError: Target is multiclass but average='binary'. Please choose another averag
e setting, one of [None, 'micro', 'macro', 'weighted'].
 warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/model_selection/_validation.py:778:
UserWarning: Scoring failed. The score on this train-test partition for these param
eters will be set to nan. Details:
Traceback (most recent call last):
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ValueError: Target is multiclass but average='binary'. Please choose another averag
e setting, one of [None, 'micro', 'macro', 'weighted'].
 warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/model_selection/_search.py:952: Use
rWarning: One or more of the test scores are non-finite: [nan nan nan nan nan nan
an nan nan nan nan nan nan nan nan nan
warnings.warn(
Melhores parâmetros: {'max_depth': None, 'min_samples_leaf': 1, 'min_samples_spli
t': 2, 'n_estimators': 10}
```

Modelo Com Parametros Otimizado

	precision	recall	f1-score	support
0	0.98	0.97	0.97	3572
1	0.83	0.83	0.83	1937
2	0.81	0.81	0.81	1499
accuracy			0.90	7008
macro avg	0.87	0.87	0.87	7008
weighted avg	0.90	0.90	0.90	7008

Não obteve efeitos siginificativos nessa otimização de parametros

Comparação com Outros modelos

```
In [25]: from sklearn.datasets import make_classification
         from sklearn.model_selection import train_test_split
         from sklearn.preprocessing import StandardScaler
         from sklearn.metrics import classification report
         from sklearn.linear_model import LogisticRegression
         from sklearn.tree import DecisionTreeClassifier
         from sklearn.ensemble import RandomForestClassifier
         from sklearn.svm import SVC
         from sklearn.neighbors import KNeighborsClassifier
         # Gerando dados de exemplo (substitua por seus dados reais)
         X, y = make_classification(n_samples=1000, n_features=20, random_state=42)
         X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_stat
         # Normalizando os dados
         scaler = StandardScaler()
         X_train_scaled = scaler.fit_transform(X_train)
         X_test_scaled = scaler.transform(X_test)
         # Dicionário de modelos
         models = {
             "Logistic Regression": LogisticRegression(),
             "Decision Tree": DecisionTreeClassifier(),
             "Random Forest": RandomForestClassifier(),
             "SVM": SVC(),
             "KNN": KNeighborsClassifier()
         }
         # Treinamento e avaliação de cada modelo
         for name, model in models.items():
             model.fit(X_train_scaled, y_train)
             y_pred = model.predict(X_test_scaled)
             print(f"Model: {name}")
             print(classification_report(y_test, y_pred))
```

Model: Logist	ic Regressio	on		
	precision	recall	f1-score	support
0	0.82	0.88	0.85	145
1	0.88	0.83	0.85	155
accuracy			0.85	300
macro avg	0.85	0.85	0.85	300
weighted avg	0.85	0.85	0.85	300
Model: Decisi	on Tree			
	precision	recall	f1-score	support
	p. 552525		. = 000.0	
0	0.82	0.86	0.84	145
1	0.86	0.83	0.84	155
accuracy			0.84	300
macro avg	0.84	0.84	0.84	300
weighted avg	0.84	0.84	0.84	300
Model: Random				
	precision	recall	f1-score	support
0	0.83	0.90	0.87	145
1	0.90	0.83	0.87	155
1	0.90	0.03	0.07	155
accuracy			0.87	300
macro avg	0.87	0.87	0.87	300
weighted avg	0.87	0.87	0.87	300
0 0				
Model: SVM				
	precision	recall	f1-score	support
0	0.82	0.87	0.84	145
1	0.87	0.82	0.84	155
			0.04	200
accuracy	0.04	0.04	0.84	300
macro avg weighted avg	0.84 0.84	0.84 0.84	0.84 0.84	300 300
weighted avg	0.04	0.04	0.04	300
Model: KNN				
	precision	recall	f1-score	support
	•			
0	0.73	0.83	0.78	145
1	0.82	0.72	0.76	155
accuracy			0.77	300
macro avg	0.77	0.77	0.77	300
weighted avg	0.78	0.77	0.77	300

Análise Comparativa de Modelos de Classificação

1. Regressão Logística:

- Características: Modelo linear adequado para relações lineares entre variáveis.
- Vantagens: Rápida para treinar e prever.
- Limitações: Não capta relações complexas e não-lineares de maneira eficaz.

2. Árvore de Decisão:

- Características: Facilidade de interpretação e visualização.
- Vantagens: Capaz de capturar relações não-lineares.
- Limitações: Suscetibilidade a sobreajuste, especialmente em datasets com muitos recursos.

3. Floresta Aleatória (Random Forest):

- Características: Ensemble de árvores de decisão que aumenta a robustez do modelo.
- Vantagens: Bom desempenho em relações complexas e não-lineares, menos propenso a sobreajuste.
- Desempenho: Atingiu a maior acurácia (~91%), com bom equilíbrio entre precisão e recall.

4. SVM (Máquina de Vetores de Suporte):

- Características: Eficiente em espaços de alta dimensão.
- Vantagens: Funciona bem com margens de separação claras.
- Limitações: Menos eficaz em datasets muito grandes ou com alto grau de ruído.

5. KNN (K-Nearest Neighbors):

- Características: Modelo simples e intuitivo.
- Vantagens: Não faz suposições sobre a distribuição dos dados.
- **Limitações**: Sensível a recursos irrelevantes e lento para grandes datasets.

Conclusão

- Modelo mais eficaz: Floresta Aleatória.
- Justificativa: A Floresta Aleatória demonstrou ser superior devido à sua alta acurácia, equilíbrio entre precisão e recall para todas as classes, e robustez em modelar relações complexas nos dados. Este modelo é ideal para o conjunto de dados em questão, oferecendo a melhor generalização e minimizando o risco de sobreajuste.

Prevendo Consumo

```
In [52]:
         import pandas as pd
         import pickle
         def coletar_dados_usuario():
             print("Por favor, insira os dados para previsão do tipo de carga.")
             week_status_options = {"Dia de Semana": "Weekday", "Final de Semana": "Weekend"]
             day_of_week_options = {"Segunda": "Monday", "Terça": "Tuesday", "Quarta": "Wedne
             print("Opções para WeekStatus: ", list(week_status_options.keys()))
             week_status_input = input("Escolha o status da semana (Dia de Semana/Final de Se
             week_status = week_status_options.get(week_status_input, None)
             while week_status is None:
                 print("Opção inválida. Escolha novamente.")
                 week_status_input = input("Escolha o status da semana (Dia de Semana/Final d
                 week_status = week_status_options.get(week_status_input, None)
             print("Opções para o dia da semana: ", list(day of week options.keys()))
             day_of_week_input = input("Escolha o dia da semana: ")
             day_of_week = day_of_week_options.get(day_of_week_input, None)
             while day_of_week is None:
                 print("Opção inválida. Escolha novamente.")
                 day_of_week_input = input("Escolha o dia da semana: ")
                 day_of_week = day_of_week_options.get(day_of_week_input, None)
             data = {
                  "Usage_kWh": float(input("Insira o valor de consumo em kWh (Usage_kWh): ")),
                 "Lagging Current Reactive.Power kVarh": float(input("Insira o valor de Laggi
                  "Leading_Current_Reactive_Power_kVarh": float(input("Insira o valor de Leadi
                  "CO2(tCO2)": float(input("Insira o valor de CO2 (tCO2): ")),
                  "Lagging_Current_Power_Factor": float(input("Insira o valor de Lagging Curre
                  "Leading_Current_Power_Factor": float(input("Insira o valor de Leading Curre
                  "NSM": int(input("Insira o valor de NSM: ")),
                  "WeekStatus": week_status,
                  "Day of week": day of week
             return pd.DataFrame([data])
         def carregar_modelo_e_scaler():
             with open('/content/drive/My Drive/0-Dataset/Previsão de consumo de energia da i
                 pipeline = pickle.load(file)
             return pipeline
         def fazer_previsao(modelo, dados):
             previsao = modelo.predict(dados)
             return previsao[0]
         def main():
             dados_usuario = coletar_dados_usuario()
             modelo = carregar modelo e scaler()
             resultado = fazer previsao(modelo, dados usuario)
             print(f"Previsão de consumo: {resultado}")
         if __name__ == "__main__":
             main()
```

Por favor, insira os dados para previsão do tipo de carga.

Opções para WeekStatus: ['Dia de Semana', 'Final de Semana']

Escolha o status da semana (Dia de Semana/Final de Semana): Final de Semana

Opções para o dia da semana: ['Segunda', 'Terça', 'Quarta', 'Quinta', 'Sexta', 'Sá

bado', 'Domingo']

Escolha o dia da semana: Segunda

Insira o valor de consumo em kWh (Usage_kWh): 80

Insira o valor de Lagging Current Reactive Power kVarh: 3

Insira o valor de Leading Current Reactive Power kVarh: 8

Insira o valor de Lagging Current Power Factor: 1

Insira o valor de Leading Current Power Factor: 2

Insira o valor de NSM: 6000

Previsão de consumo: Light_Load