

RELATÓRIO DOS TESTES REALIZADOS

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Parâmetros do Modelo de GNN utilizados nos Testes

- 1 Bloco STGI-Residual
 - 4 Camadas de convolução STGC
 - Função de perda: Erro quadrático
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Métricas e Otimizadores Utilizados

- Learning Rate inicial: 0.01
 - Diminui gradativamente até 0.0001
 - Função de otimização: Adam
 - Métricas utilizadas: MAE, MAPE, RMSE e NRMSE
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Geração dos Dados

- Intervalo entre amostras de curto prazo: 10 minutos
 - Intervalo entre amostras de médio prazo: 30 minutos
 - Intervalo entre amostras de longo prazo: 60 minutos
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Divisão dos Dados

- Primeiros 40% dos dados utilizados como conjunto de treinamento
 - 10% seguintes utilizados como conjunto de validação
 - Restante utilizado como conjunto de teste
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Modelo de Regressão Linear Utilizada

- Modelo de Rede Neural com uma camada densa
 - Função de Perda: MSE (Erro Quadrático em geral não converge neste modelo)
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Forma de Treinamento

- O número de épocas utilizado nos treinamentos variou conforme o teste
 - Utilizou-se um número suficiente de épocas para que o treinamento convergir
 - O tamanho do batch utilizado foi 1, a fim de simplificar os testes
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Tipos de Testes

Teste de Comparação de Modelos

- Comparou-se o resultado do treinamento do modelo de GNN, com o modelo de regressão linear, com um modelo de CNN, e com outros 2 modelos nos quais treinou-se modelos individuais de regressão linear e de CNN para cada sensor
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Teste de Esparsidade Temporal

- Esse teste consiste em remover amostras consecutivas
 - Um valor de esparsidade 2, por exemplo, significa que entre duas amostras consecutivas do dataset resultante, uma amostra foi removida
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Teste de Anos do Conjunto de Teste

- Esse teste consiste em treinar o modelo com apenas os dados de janeiro de 2010 e verificar os valores previstos para conjuntos de testes correspondentes a um período de 1 ano
- No teste realizado, utilizou-se um período de tempo entre 2010 e 2023
- Utilizou-se dados de apena um sensor

Teste de Extensão do Conjunto de Teste

- Esse teste consiste em treinar o modelo com apenas os dados de janeiro de 2010 e verificar os valores previstos, incrementando o período do conjunto de teste sequencialmente em 1 ano
- No teste realizado, utilizou-se um período de tempo entre 2010 e 2023
- Utilizou-se dados de apena um sensor

Teste de Extensão Temporal

- Esse teste consiste em incrementar sequencialmente o período dos dados em 1 ano, começando por 2010 e terminando em 2023
- Os dados são divididos entre em conjuntos de treinamento, validação e teste utilizando a proporção 0.4, 0.1, 0.5.
- Utilizou-se dados de apenas um sensor

Teste de Esparsidade Geográfica Aleatória

- Esse teste consiste em remover de forma aleatória uma determinada porcentagem dos sensores e suas respectivas amostras
 - Nos gráficos, o eixo X indica a razão de sensores removidos
-

Teste de Esparsidade Geográfica - Subgrafo

- Esse teste consiste em aumentar de forma artificial o espaçamento entre sensores, removendo sensores consecutivos de um trecho e suas respectivas amostras
 - Nos gráficos, a medida de esparsidade é a mesma do teste de esparsidade temporal
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Teste de Sensibilidade Espacial

- Esse teste consiste em trocar o grafo original por grafos genéricos e observar o impacto nas métricas
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Teste de Interpolação

- Esse teste consiste em remover de forma aleatória uma determinada porcentagem dos dados do dataset
 - Nos gráficos, o eixo X indica a razão de dados removidos
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Teste de Ruído

- Criou-se matrizes de ruído com valores de ruído aleatórios (distribuição uniforme) variando de 0 a algum múltiplo de 10 e somou-se esta matriz com os dados
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PEMSd3

Dataset



Informações do Dataset

1. Dataset que contém dados de subregião do estado da Califórnia
2. Contém mais de 20 anos de dados coletados
3. Todo dia o dataset é atualizado com novos dados
4. O dataset ‘corrigé’ erros na captura dos dados aplicando técnicas como interpolação
5. Possui diversos dados além do fluxo de veículos e velocidade.
6. Faltam informações geográficas para permitir a construção do grafo dos sensores, associando cada sensor com uma via e uma direção

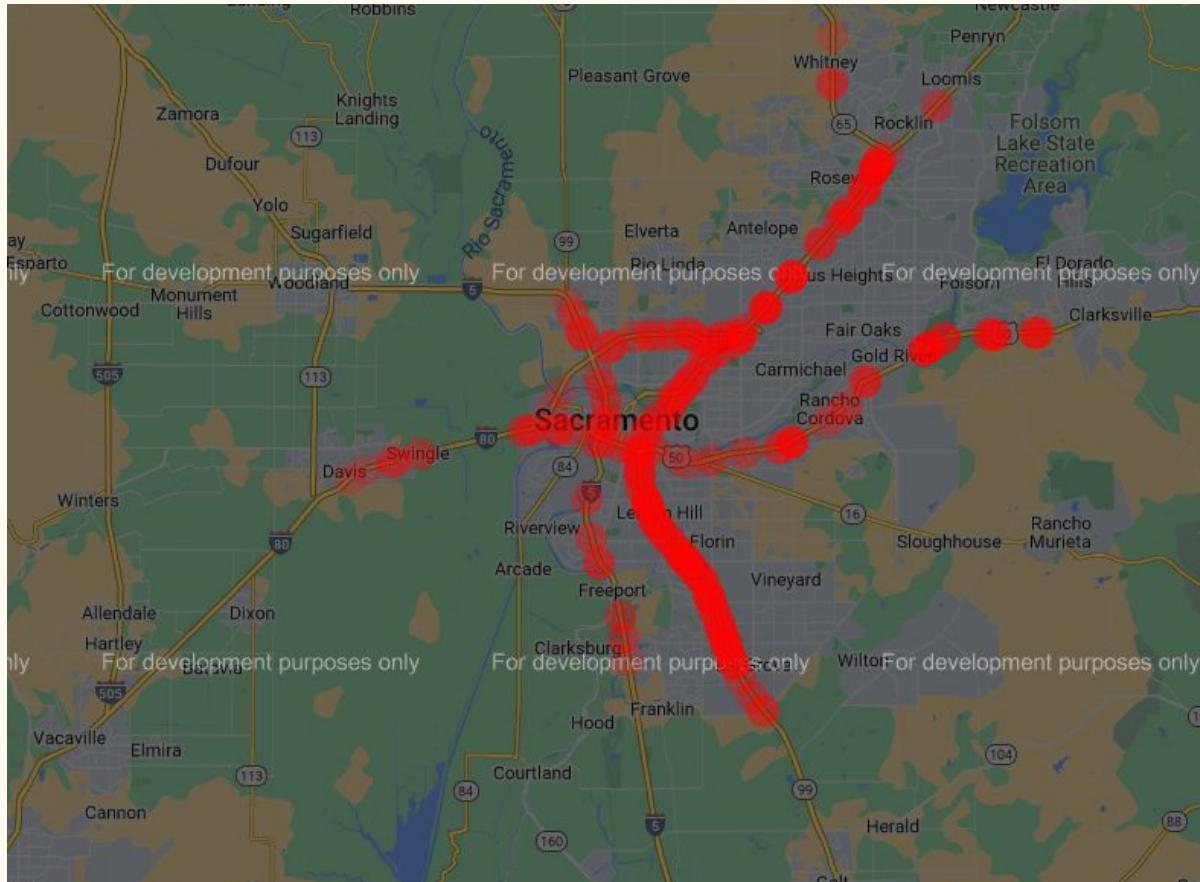
Características Gerais dos Dados

1. Amostras com intervalo de 5 minutos
2. Poucos dados faltantes (<5%) (em geral em amostras mais recentes que ainda não foram tratadas adequadamente)
3. Maioria dos sensores possuem dados de velocidade

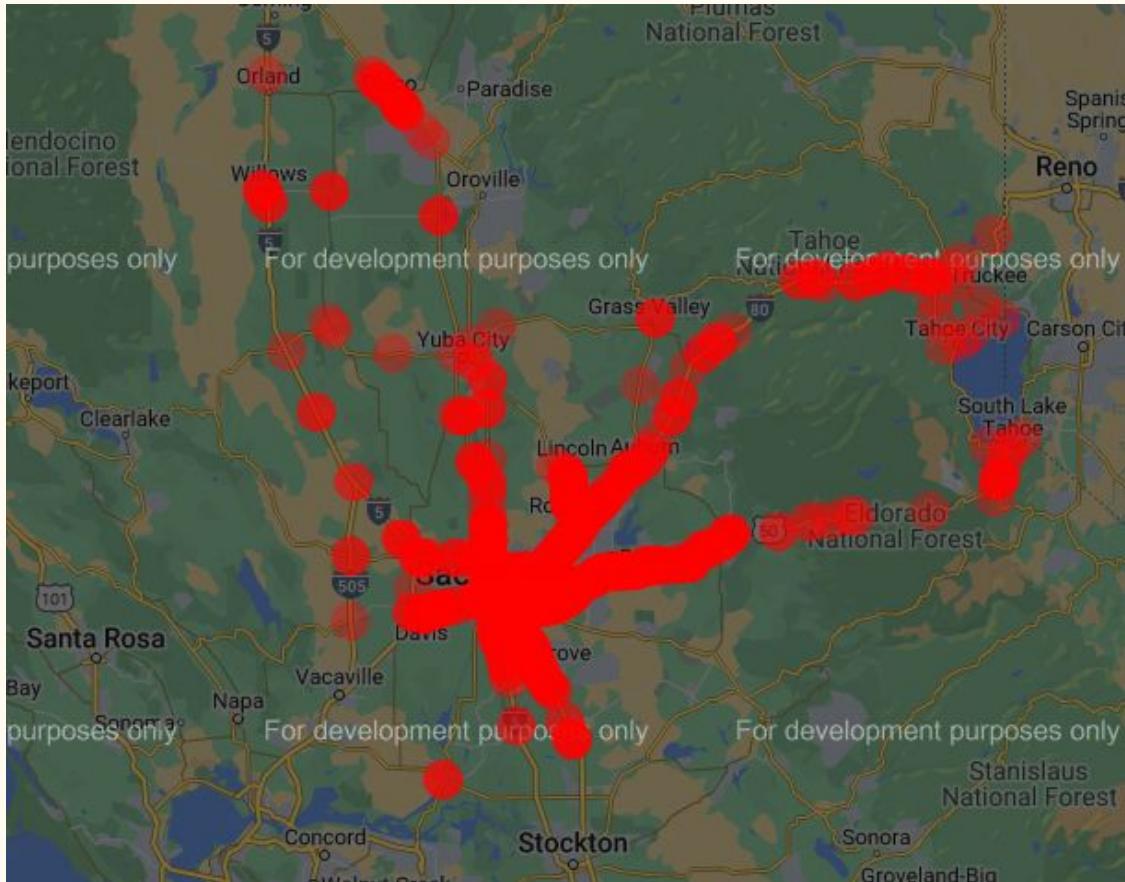
Características dos Dados Utilizados

1. Dados de janeiro a agosto de 2023
2. 331 sensores utilizados (alguns outros sensores não possuíam amostras neste período)

Mapa com sensores do grafo selecionado



Mapa com todos os sensores do dataset

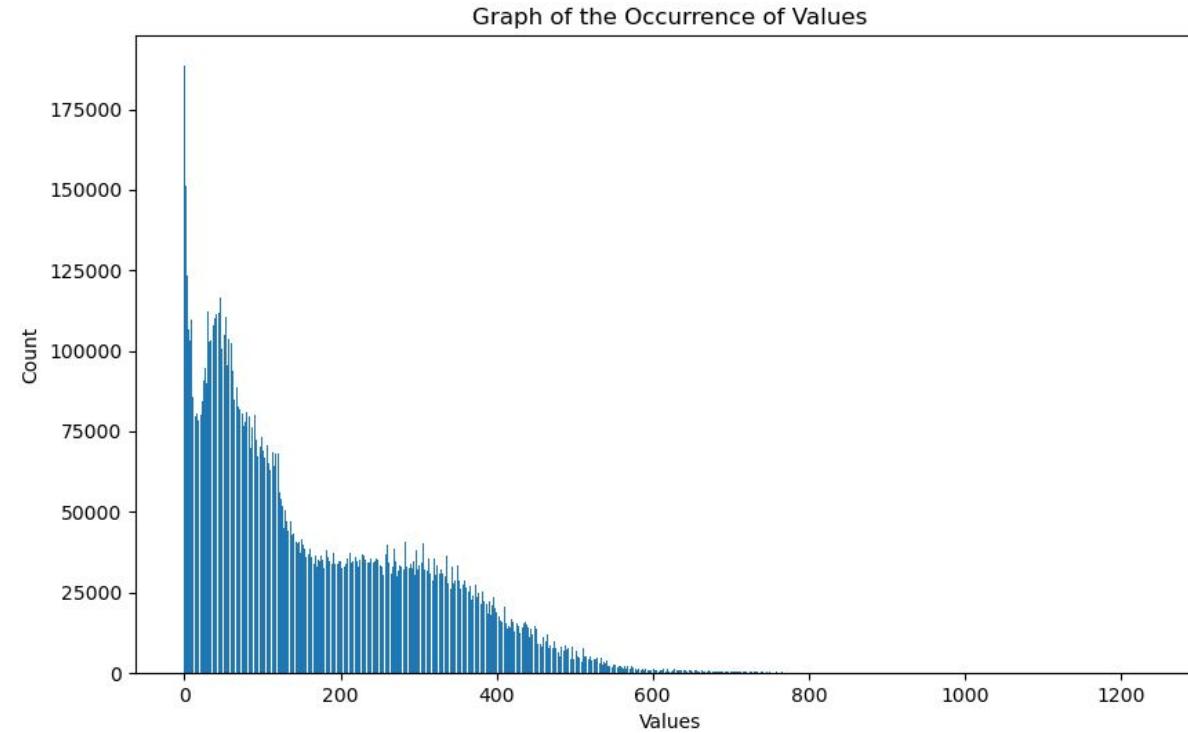


Métricas

Medidas Estatísticas da Série Temporal

Min	Max	Mean	Median	Variance	Variance Coefficient	Std	Asymmetry Coefficient
0.0	1245.0	167.8902681208863	122.0	19727.2634546542	83.65808126028237	140.45377693267702	0.9347064873381764

Histograma da Série Temporal

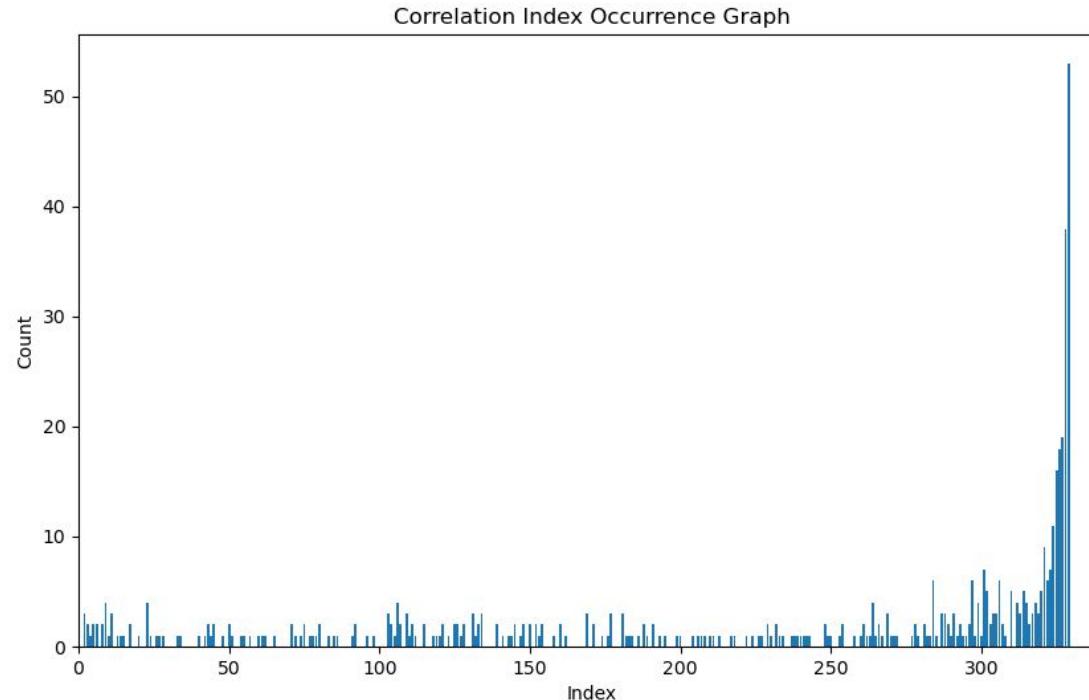


Correlação dos Sensores

Gerando a matriz de correlação a partir da série temporal observou-se que:

1. Os valores são altos em geral os menores valores são 0.7 ou 0.8
2. Os sensores conectados em geral possuem os menores valores de correlação ao contrário do que poderia se esperar

Correlação dos Sensores



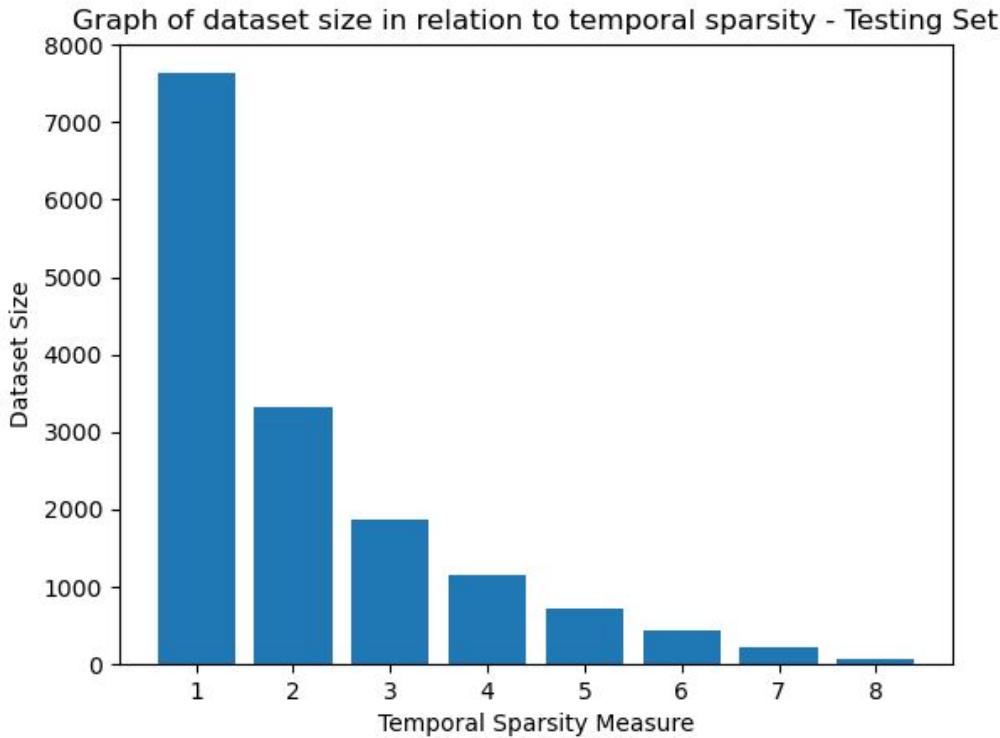
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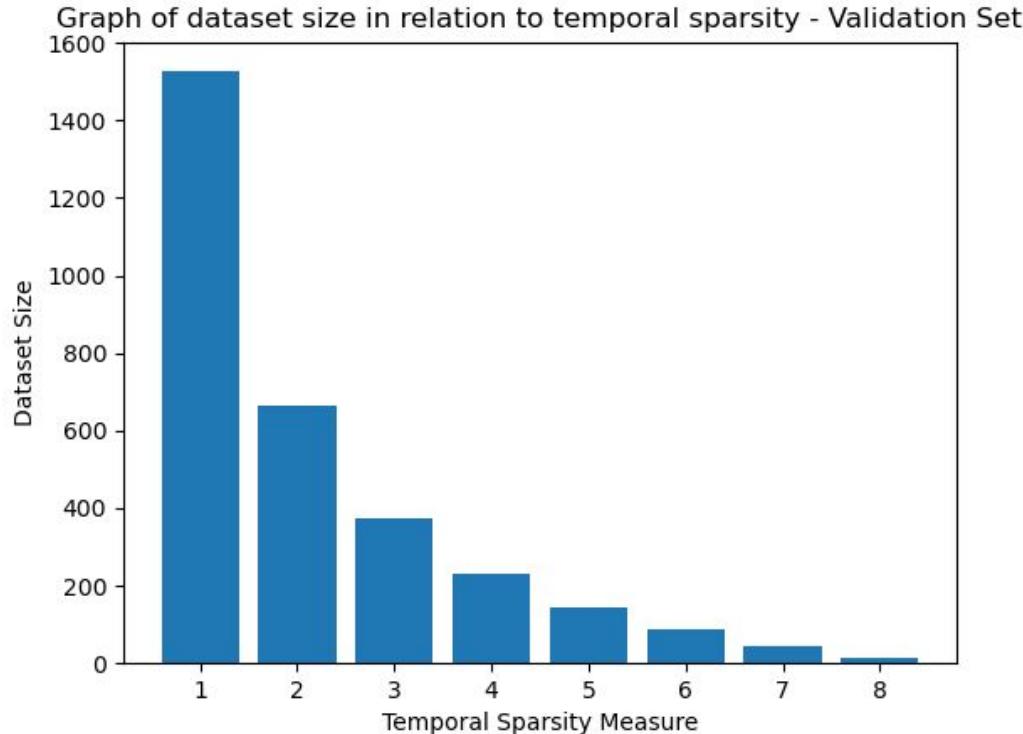
Teste de Esparsidade Temporal

- Utilizou-se apenas $\frac{1}{4}$ do dataset citado (meses de janeiro e fevereiro)
 - O restante do dataset serviu para maior precisão na interpolação dos dados faltantes
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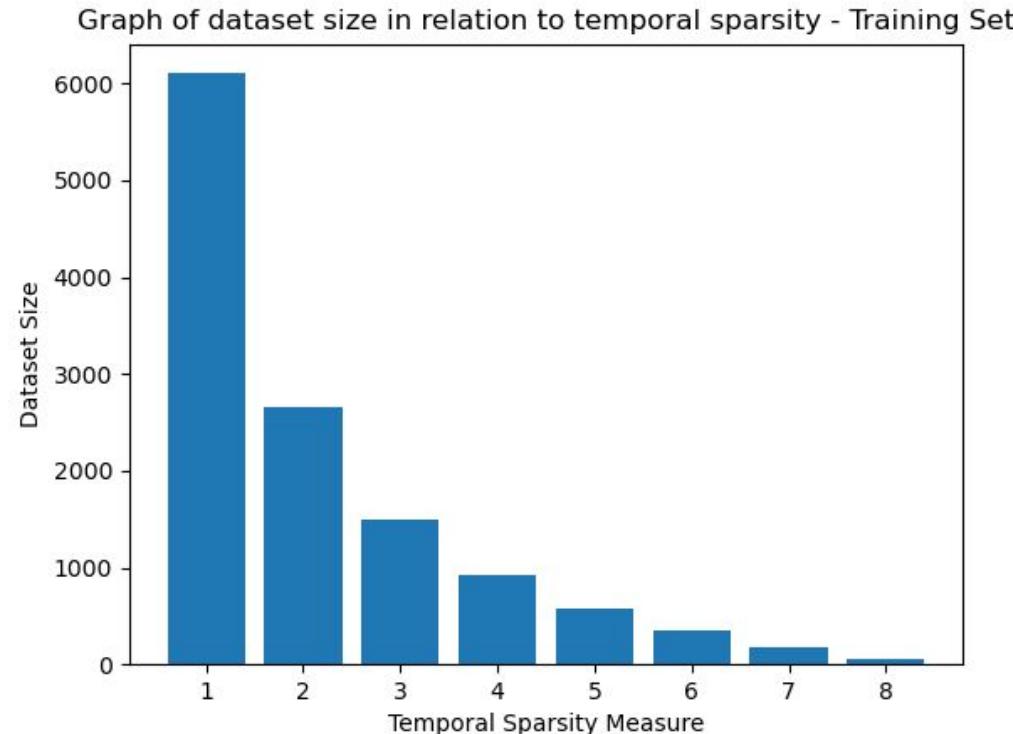
Relação entre Medida de Esparsidade Temporal e Tamanho do Dataset



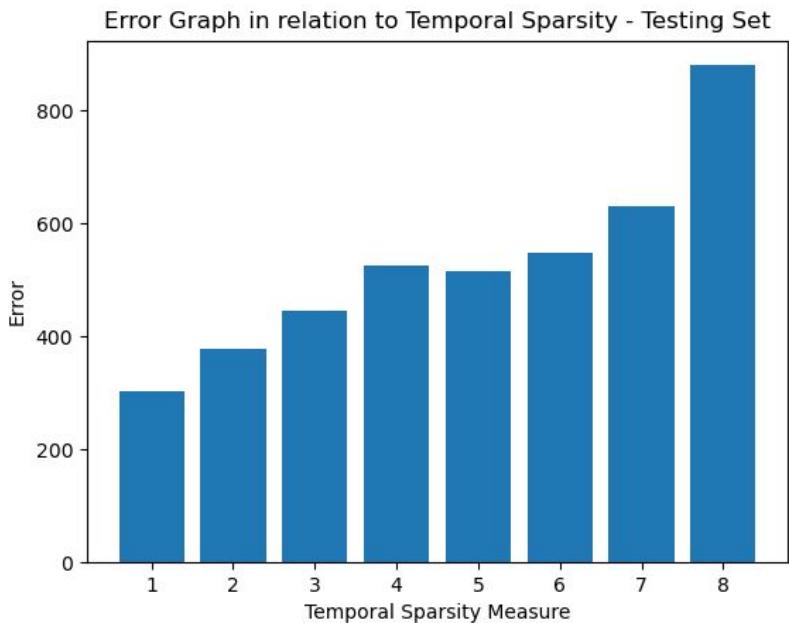
Relação entre Medida de Esparsidade Temporal e Tamanho do Dataset



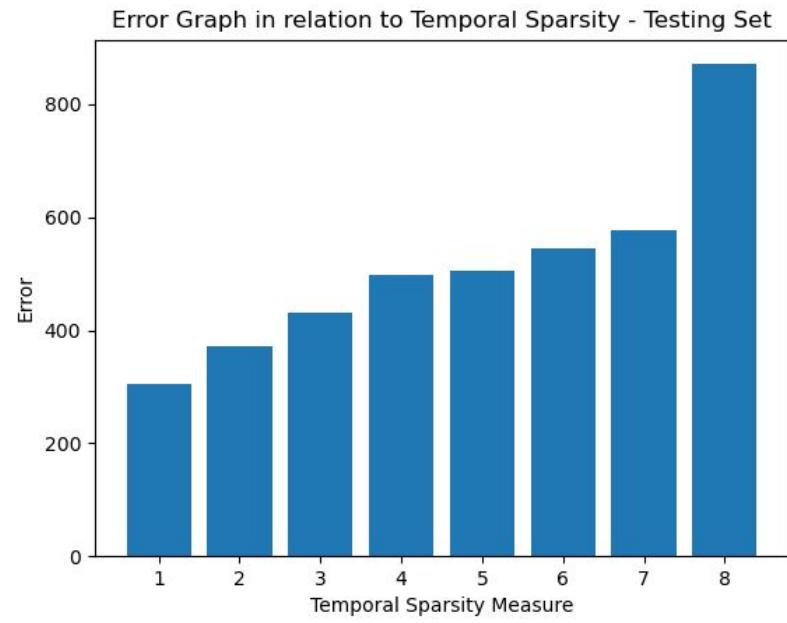
Relação entre Medida de Esparsidade Temporal e Tamanho do Dataset



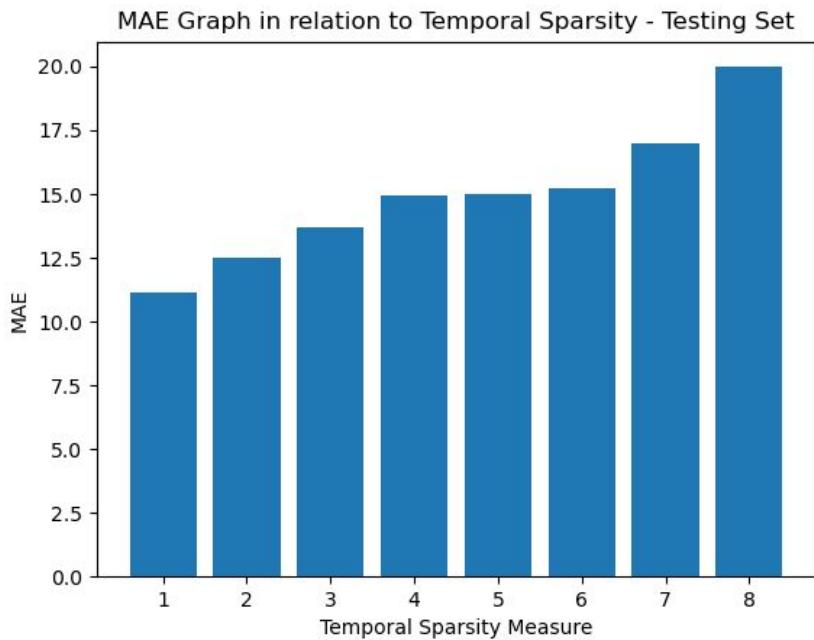
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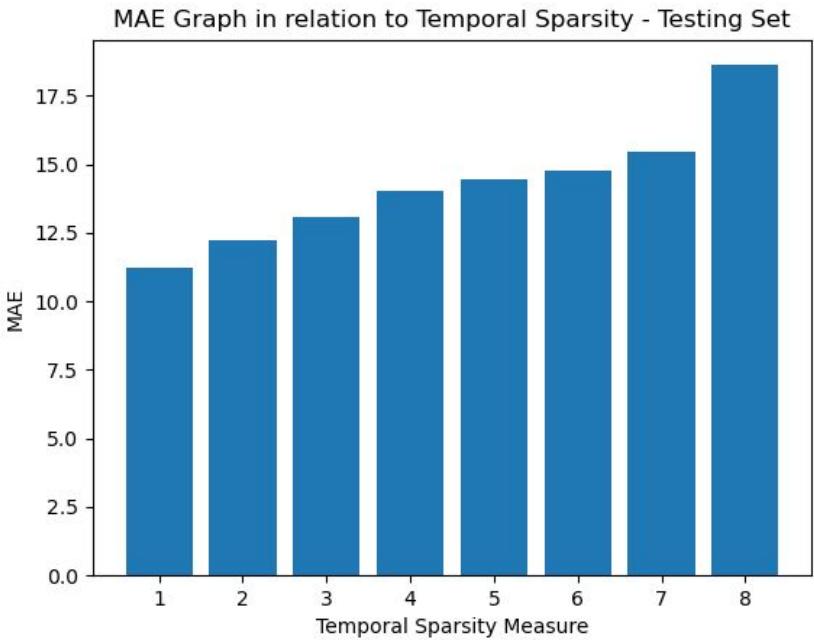
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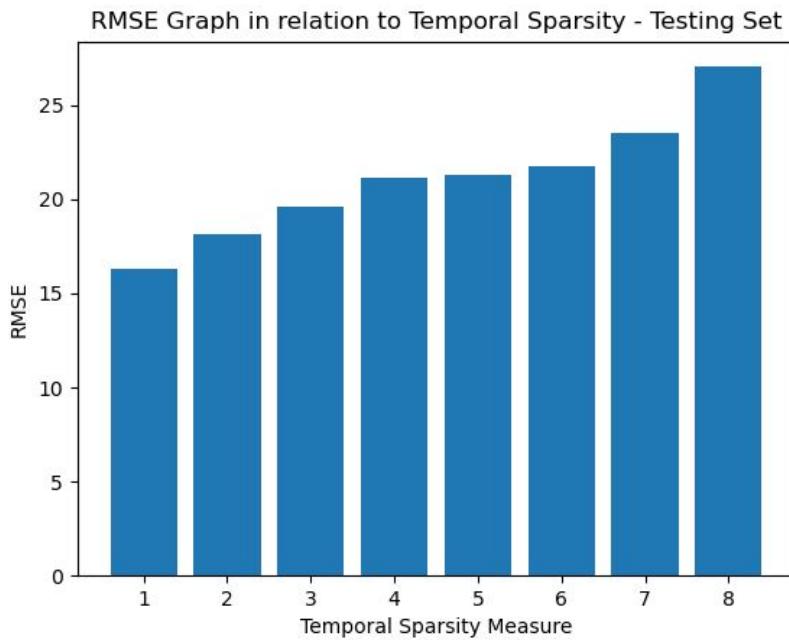
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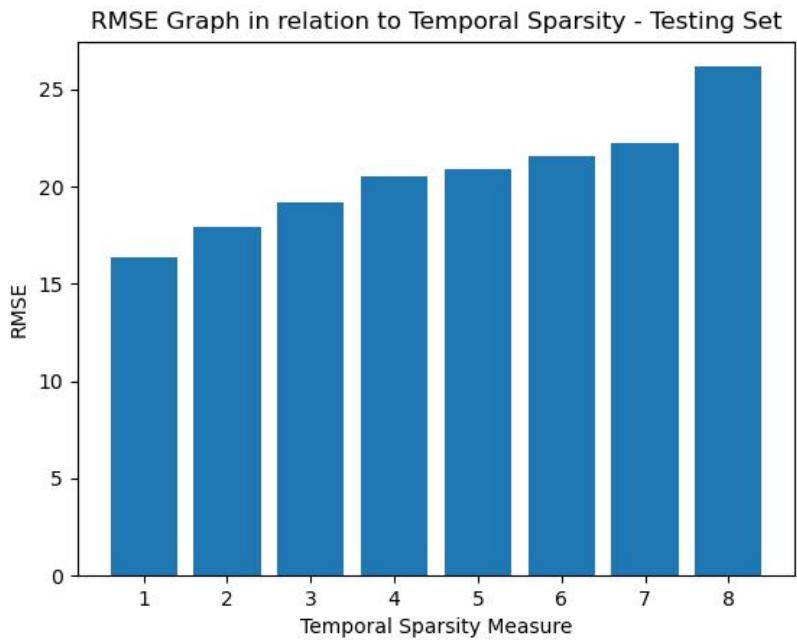
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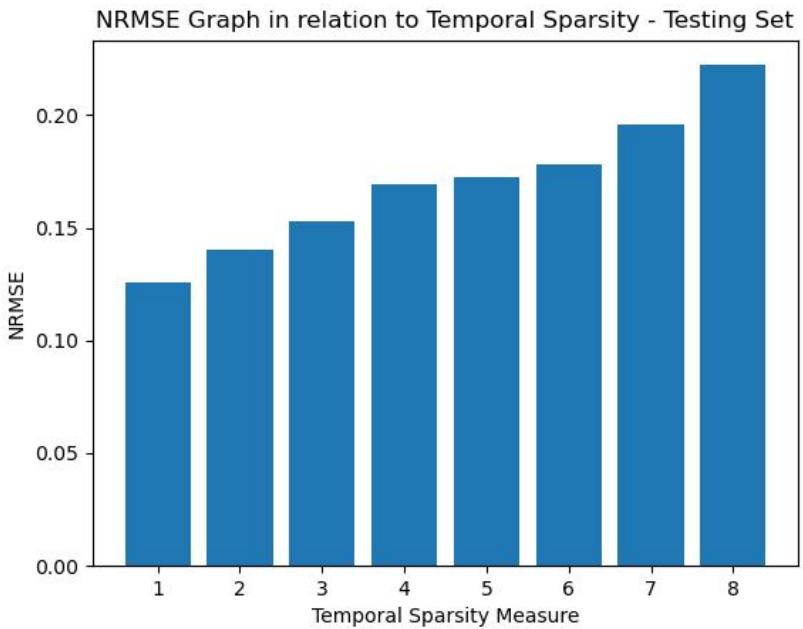
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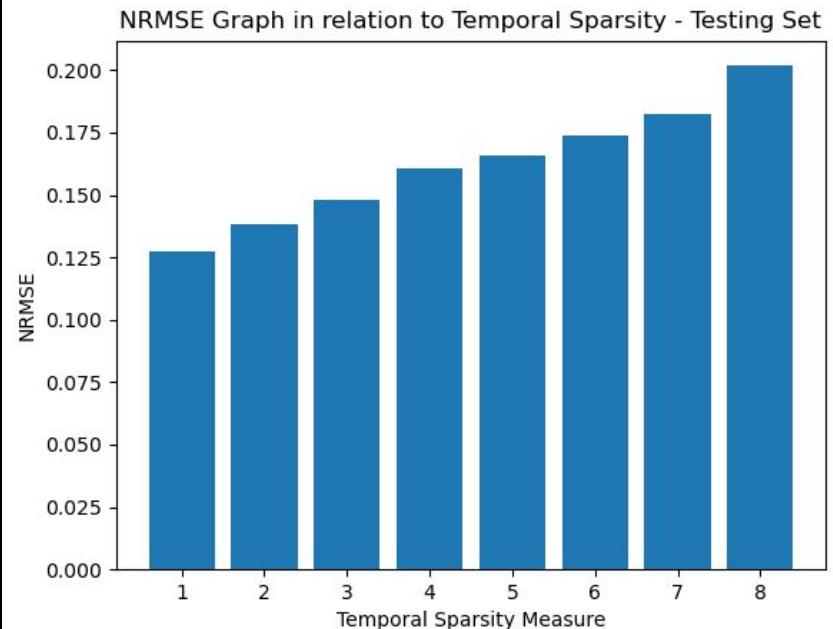
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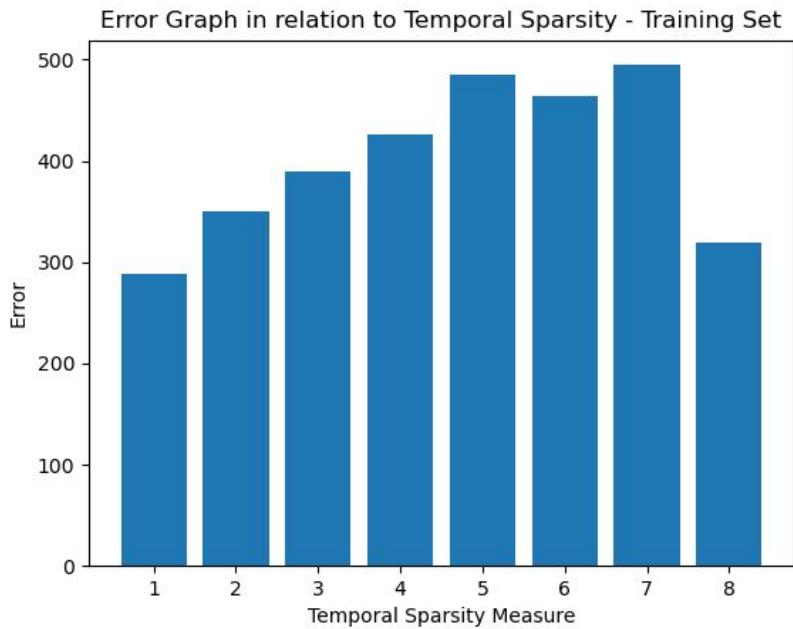
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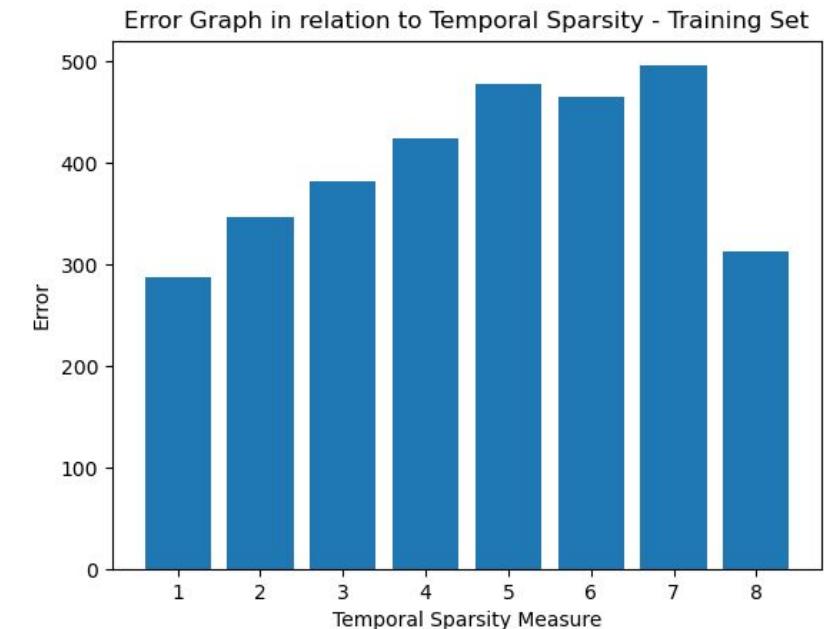
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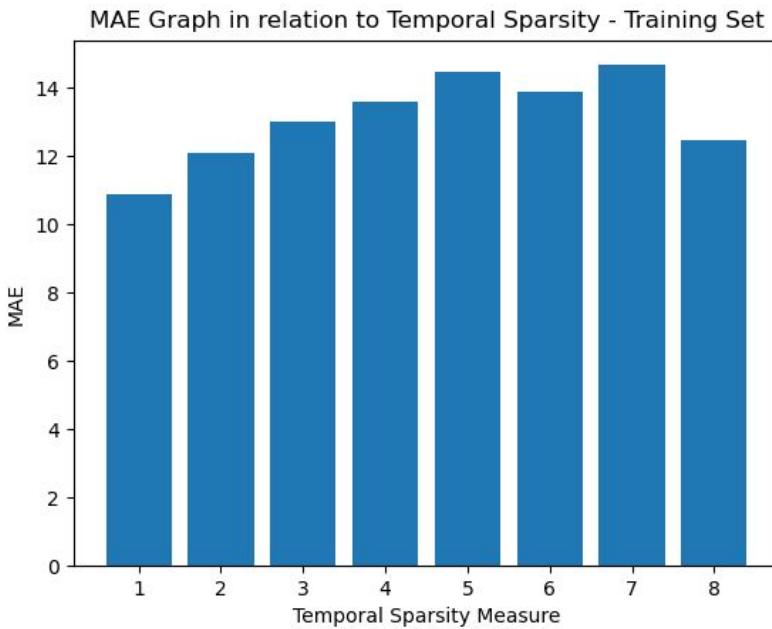
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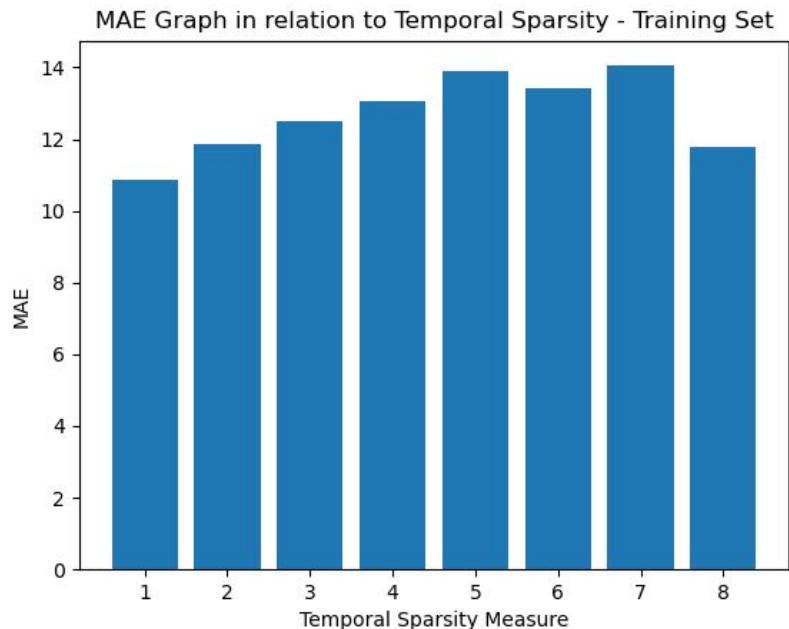
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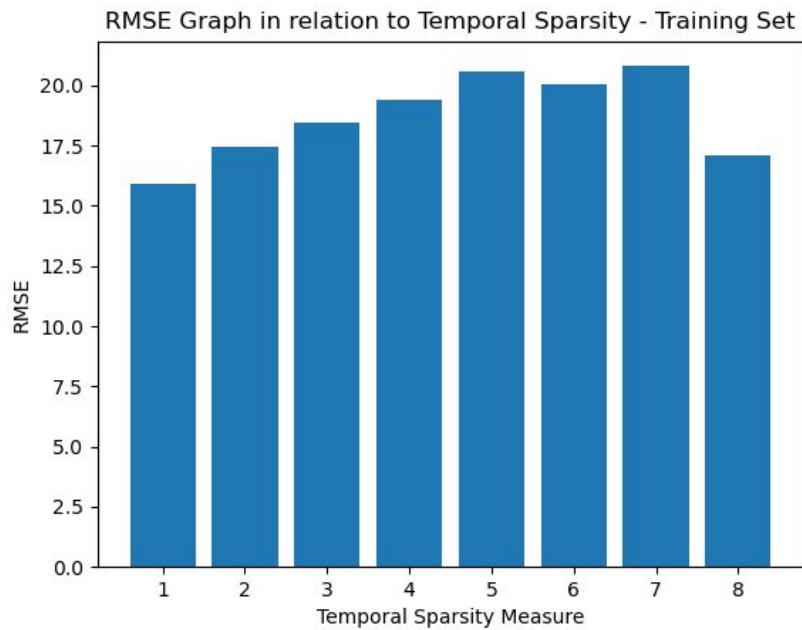
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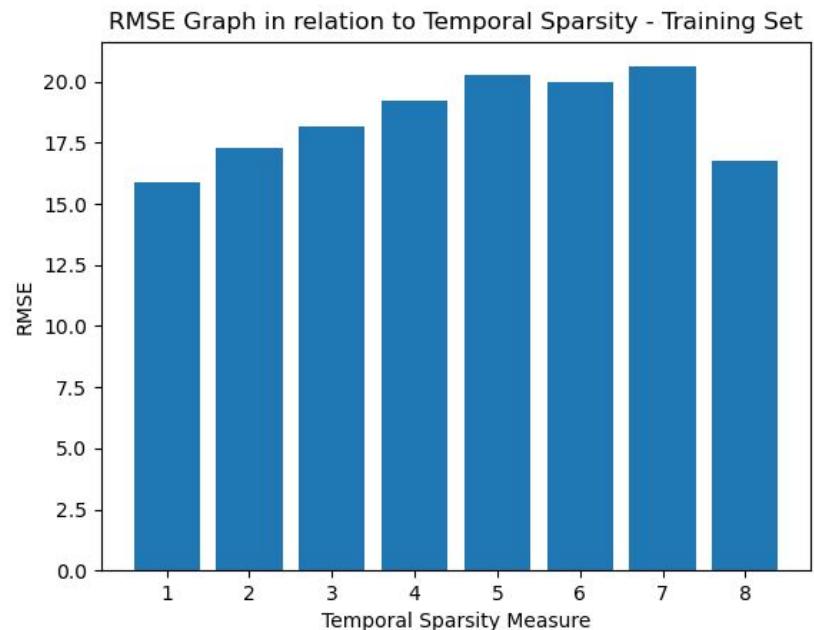
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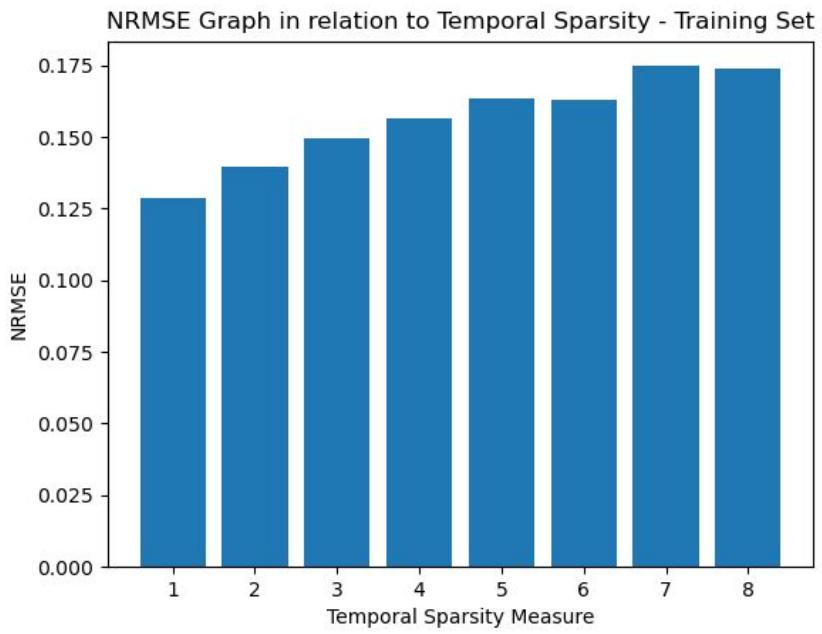
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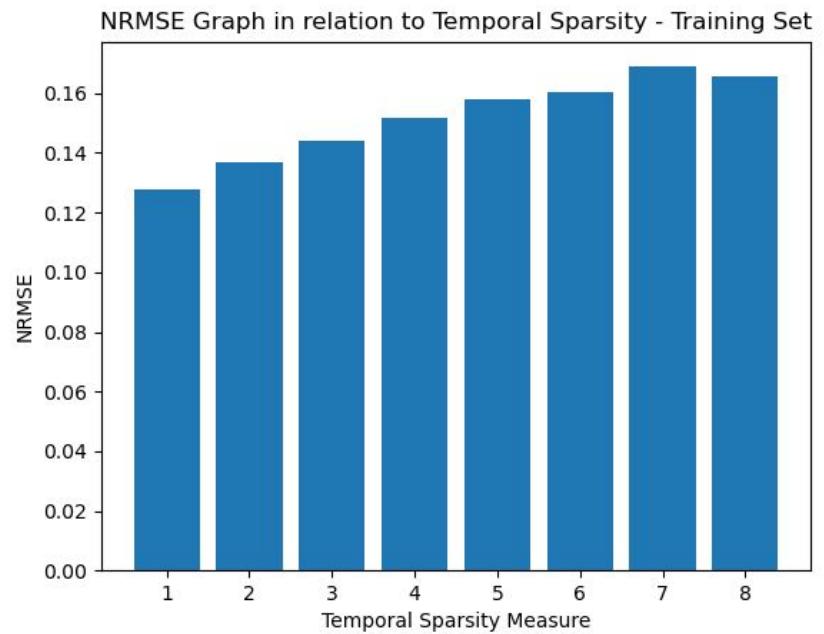
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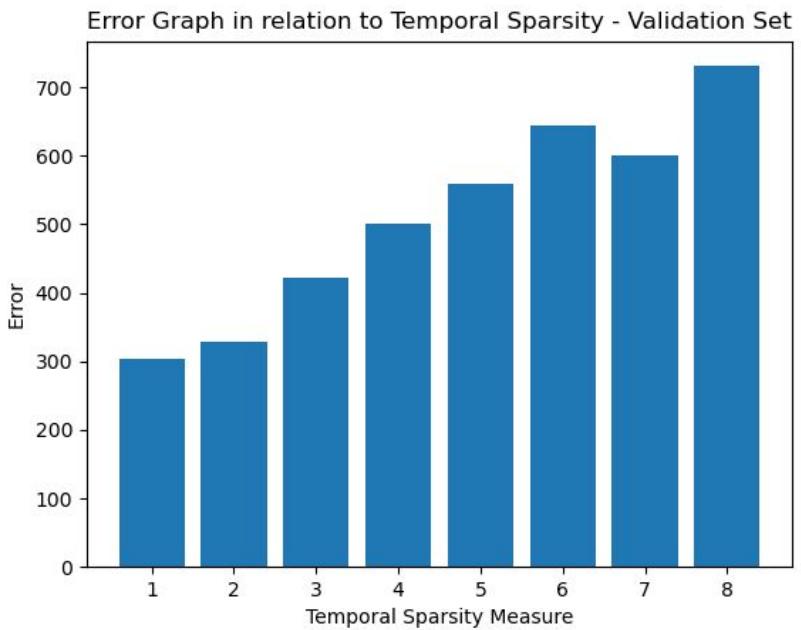
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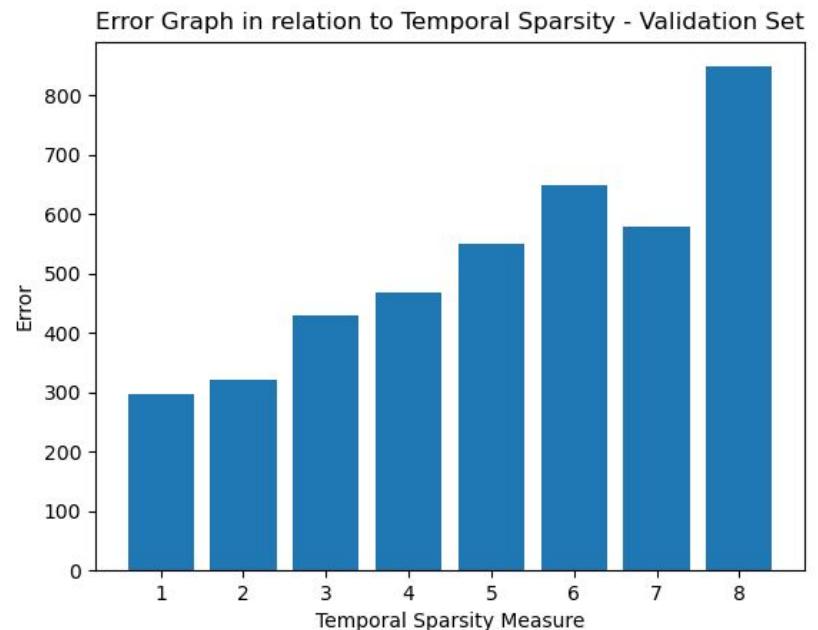
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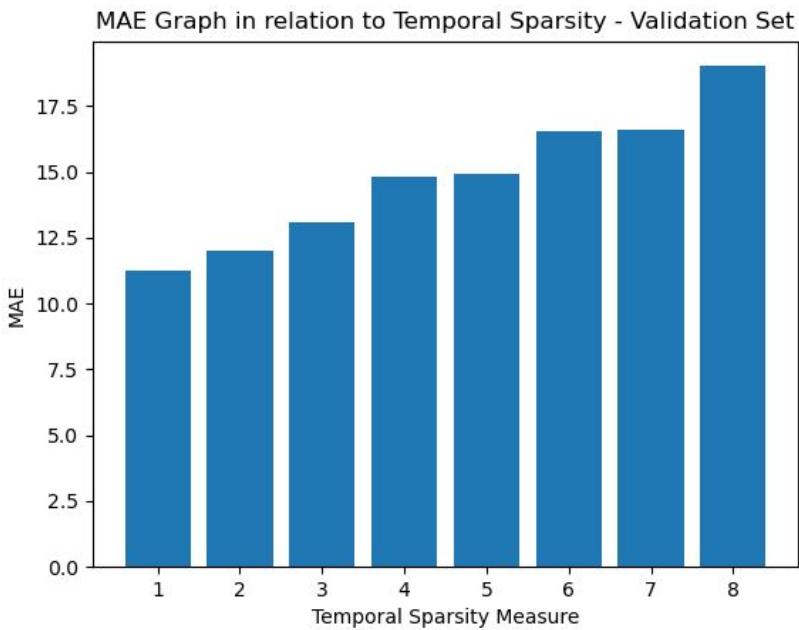
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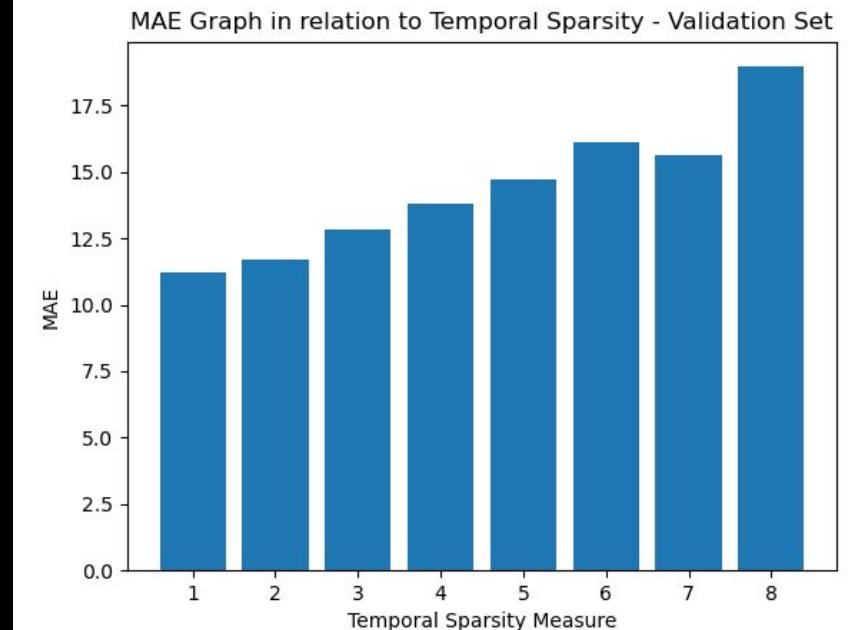
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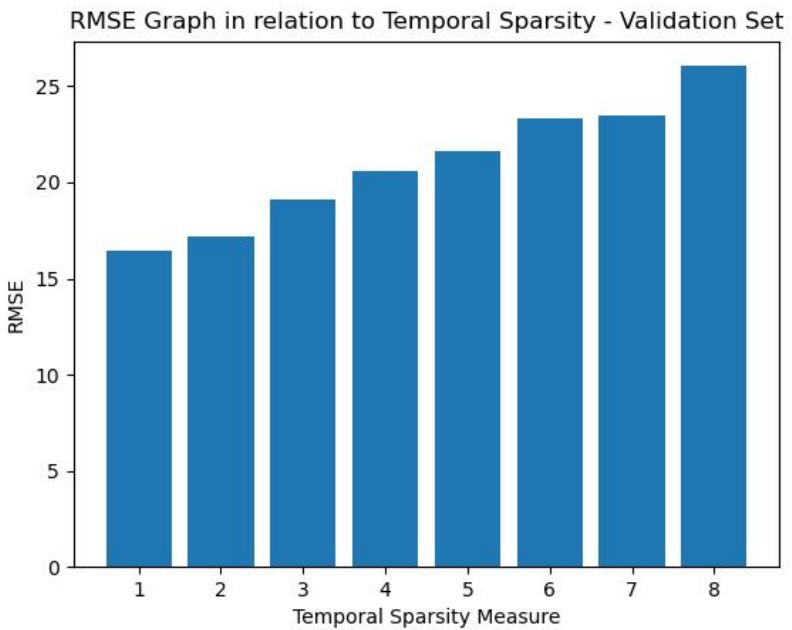
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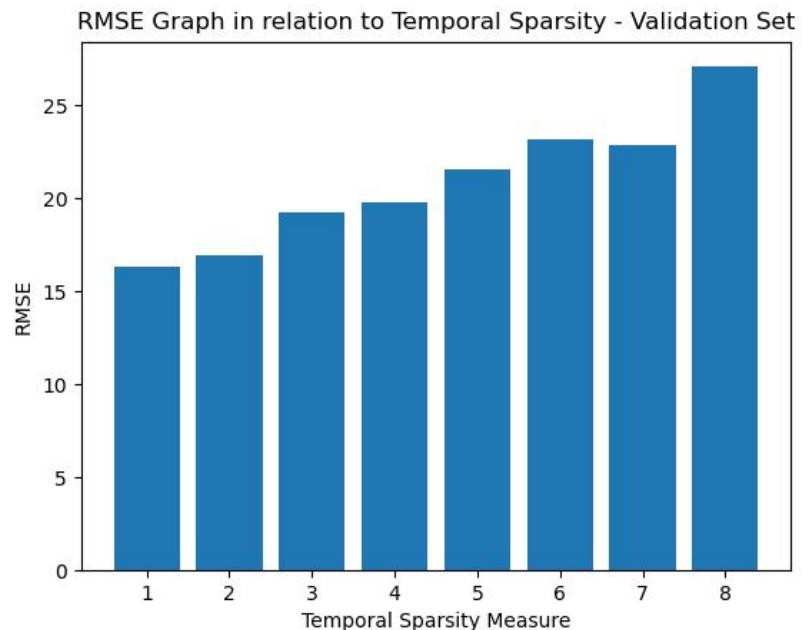
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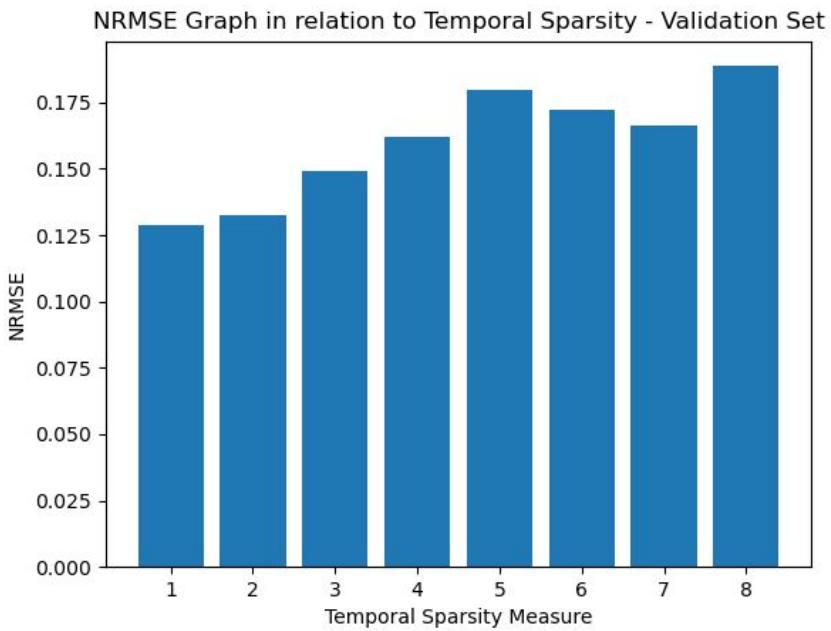
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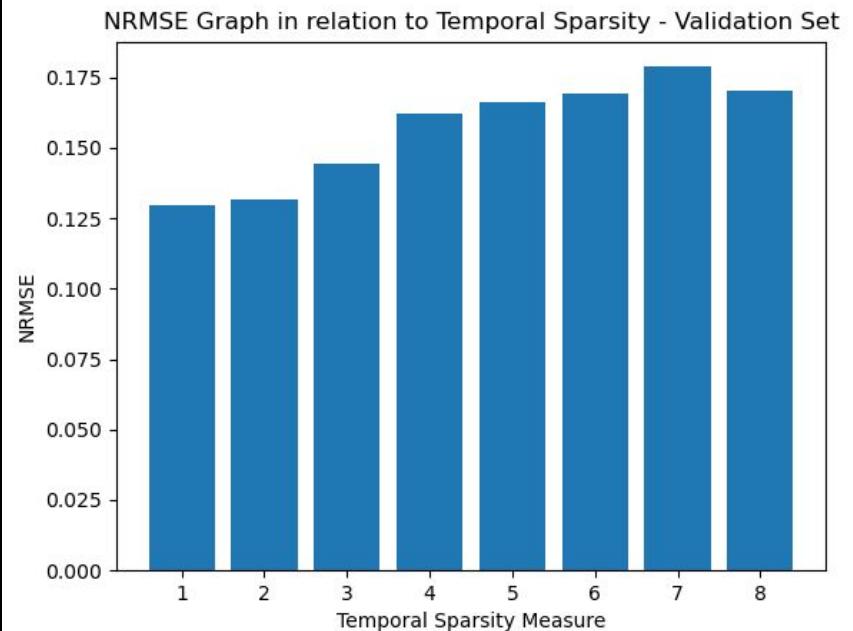
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GNN



Regressão

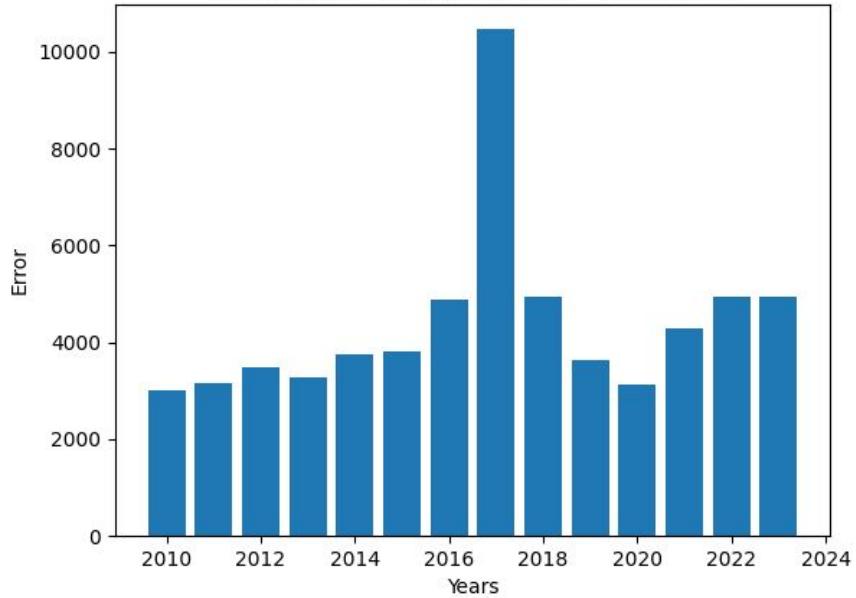


Teste de Anos do Conjunto de Teste

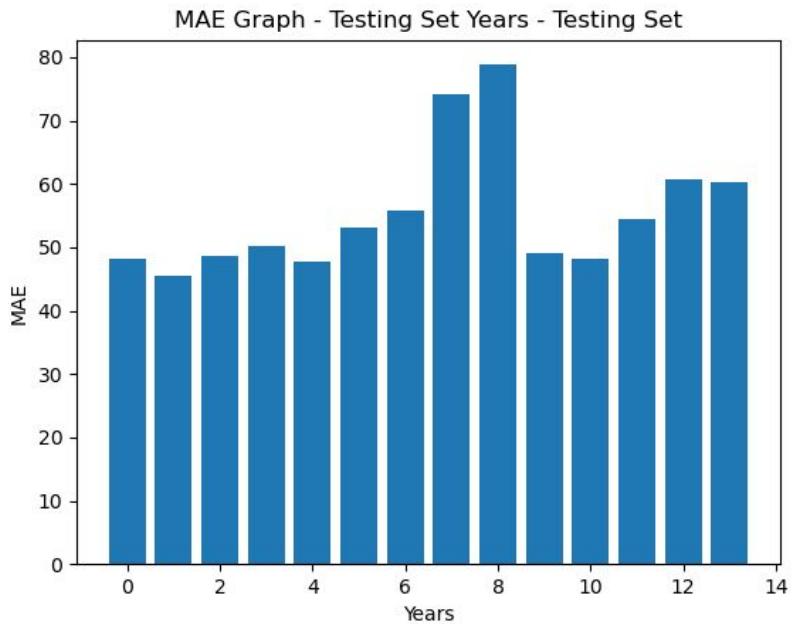
- Utilizou-se dados de um sensor,
de 2010 a 2023
-

GNN

Error Graph - Testing Set Years - Testing Set

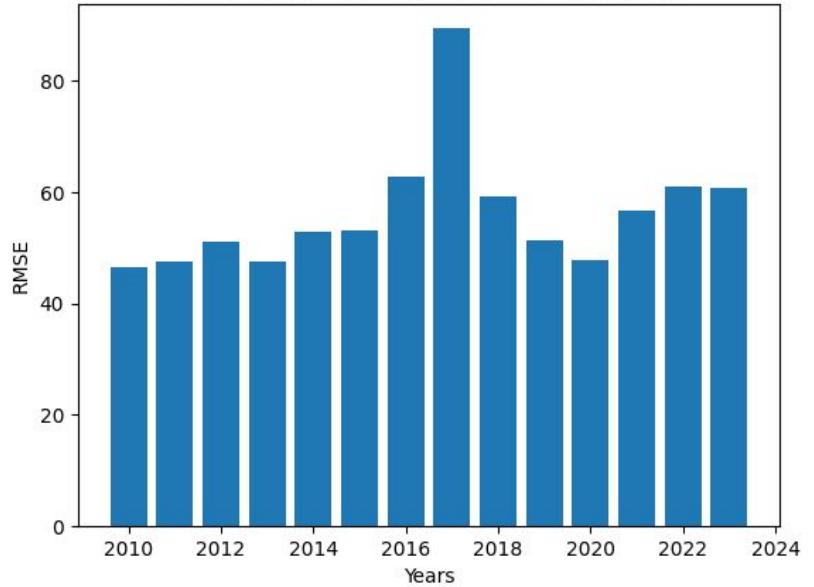


GNN



GNN

RMSE Graph - Testing Set Years - Testing Set

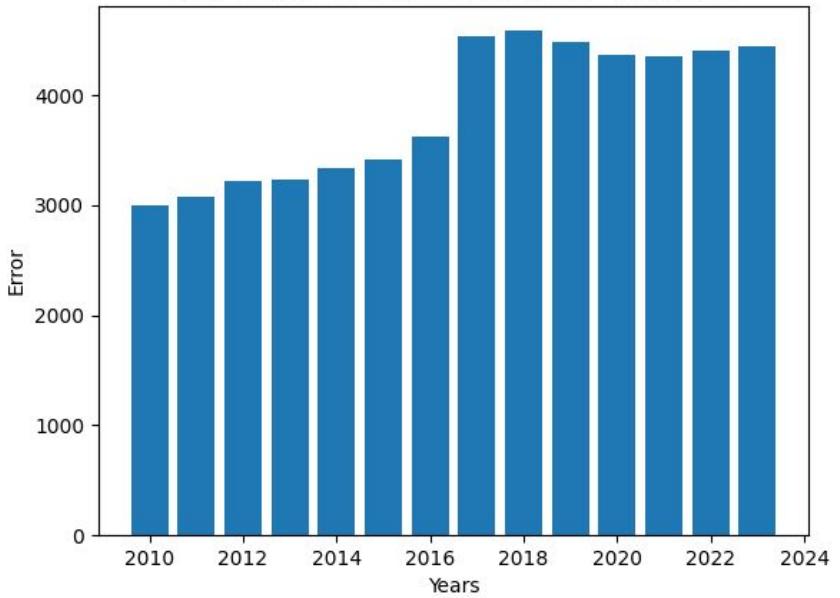


Teste de Extensão do Conjunto de Teste

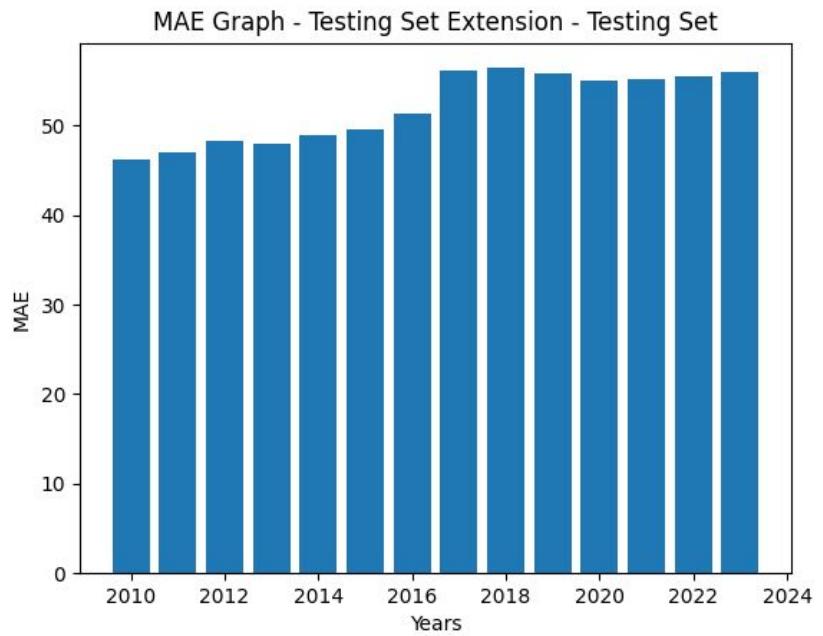
- Utilizou-se dados de um sensor, de 2010 a 2023

GNN

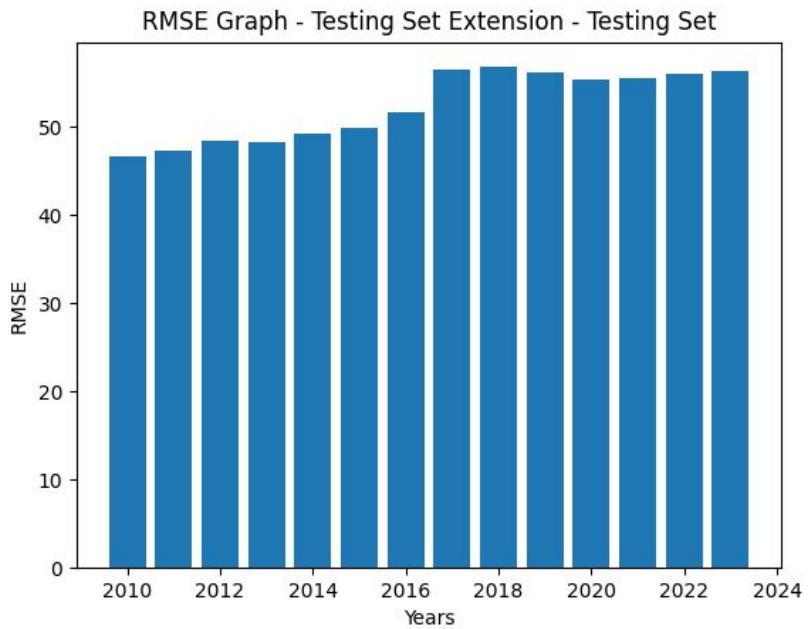
Error Graph - Testing Set Extension - Testing Set



GNN



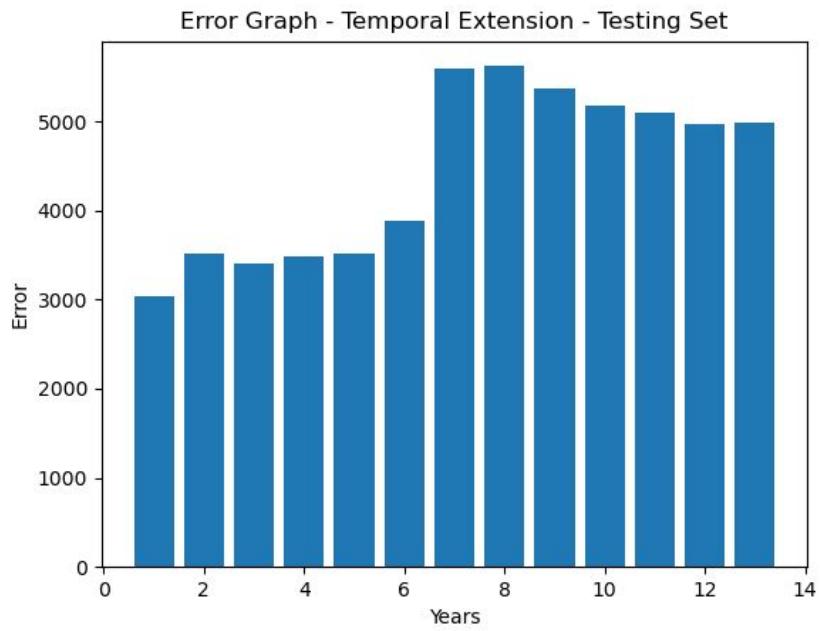
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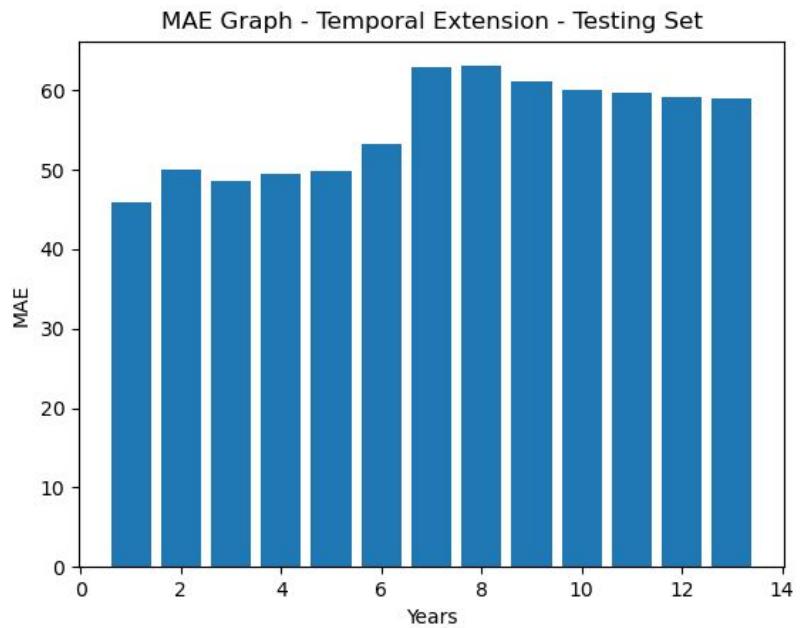
Teste de Extensão Temporal

- Utilizou-se dados de um sensor,
de 2010 a 2023
-

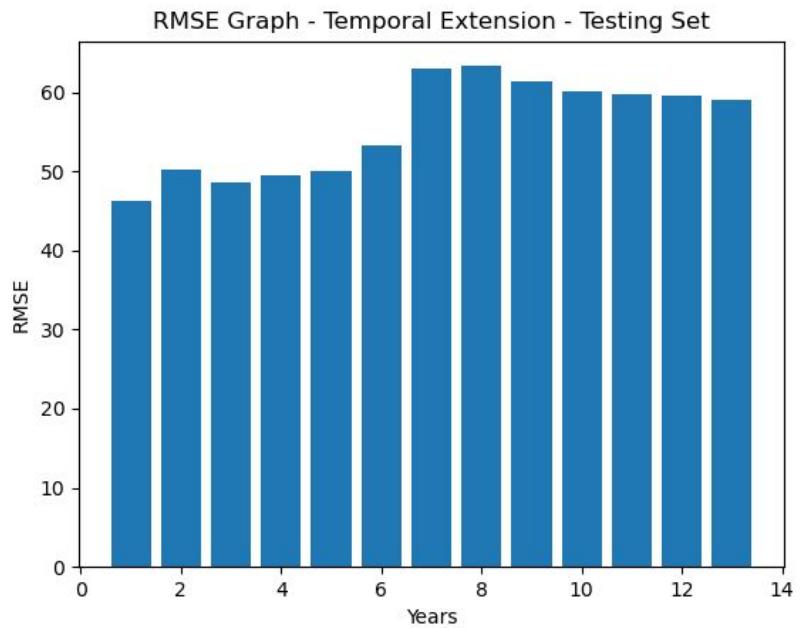
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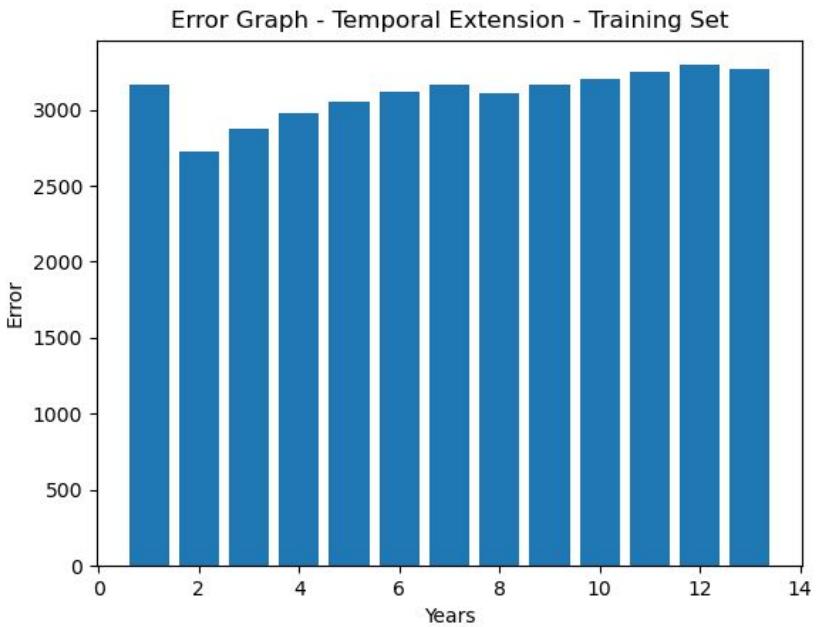
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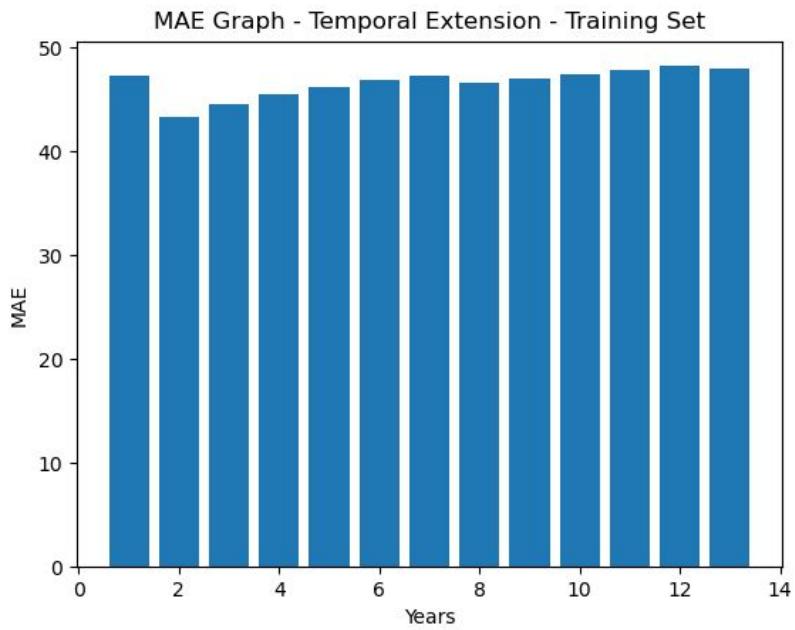
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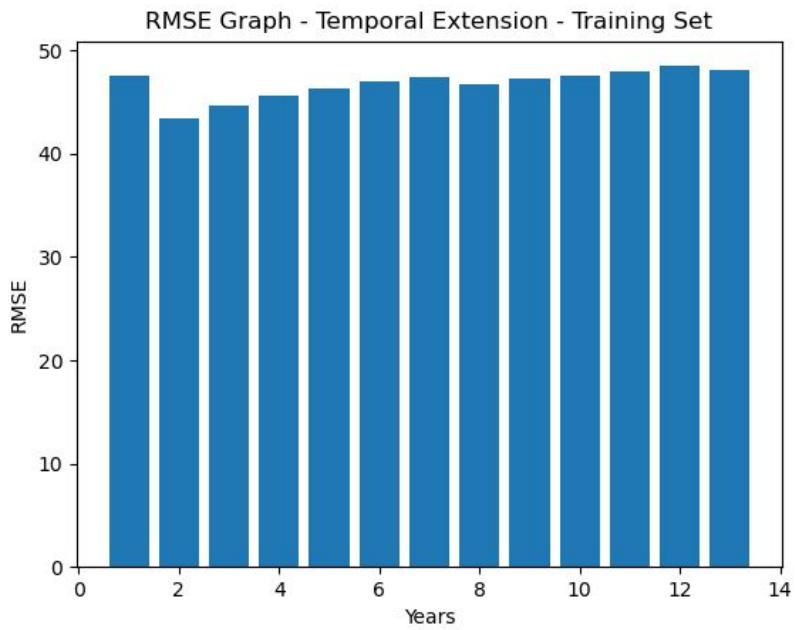
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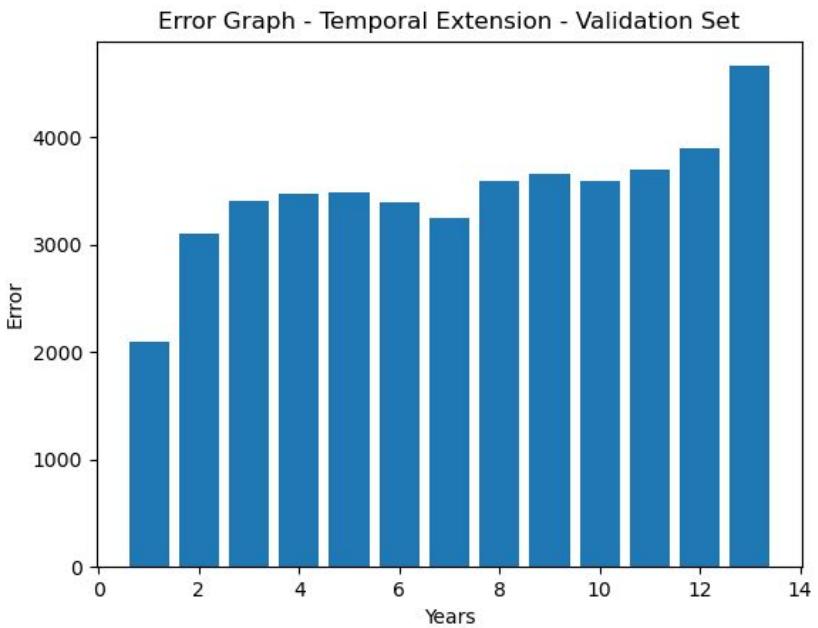
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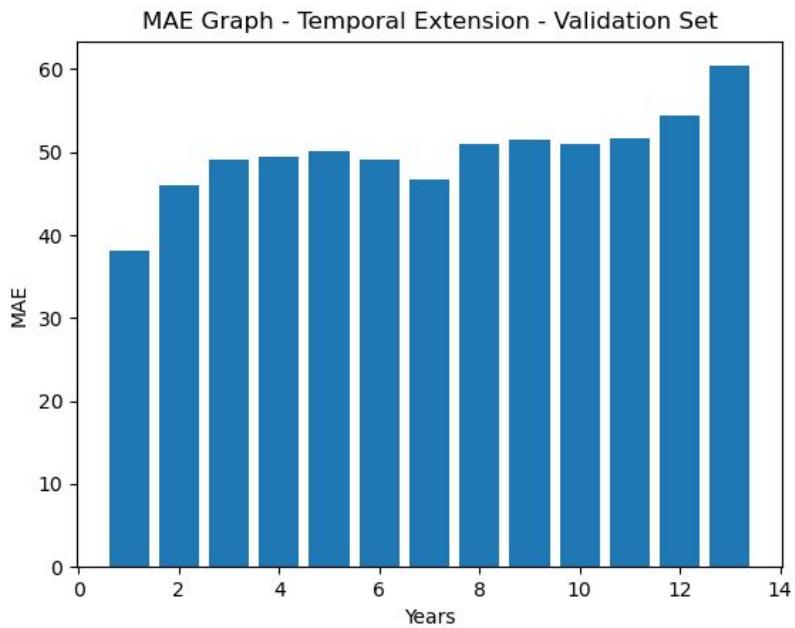
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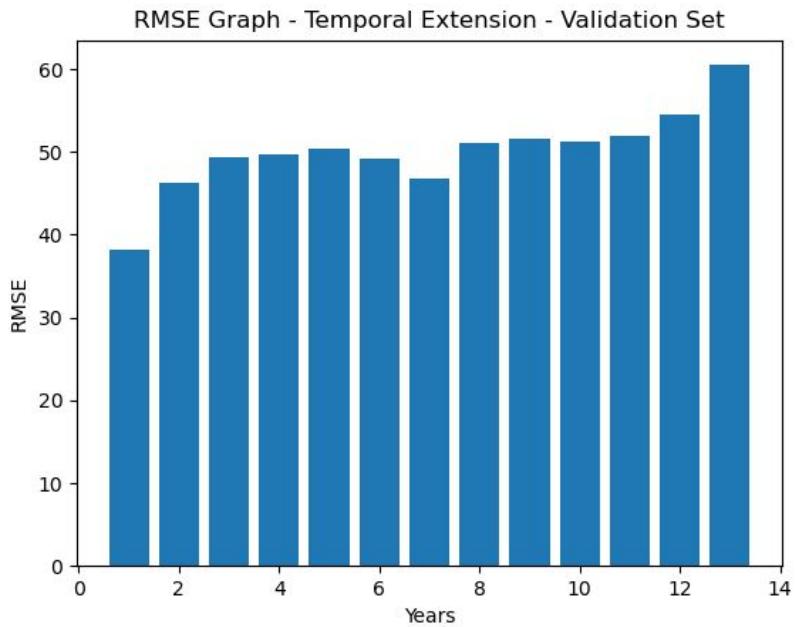
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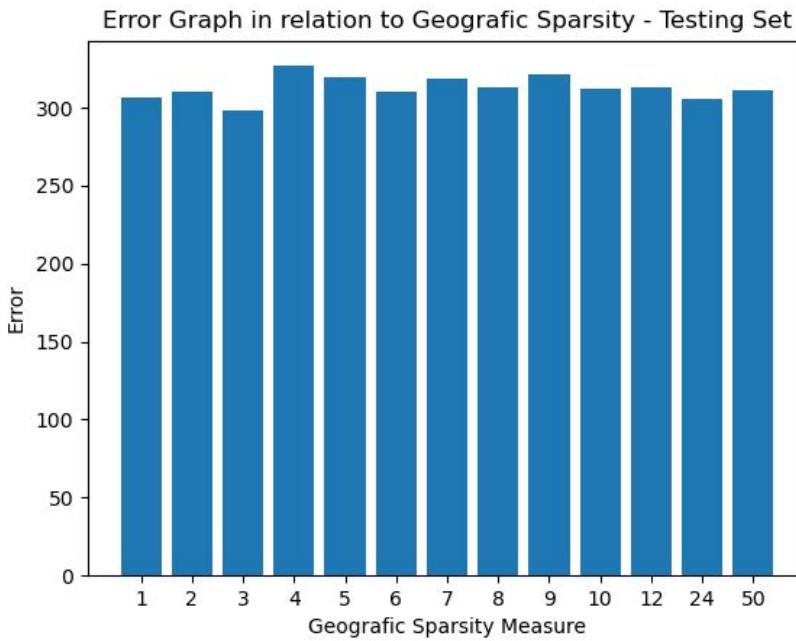
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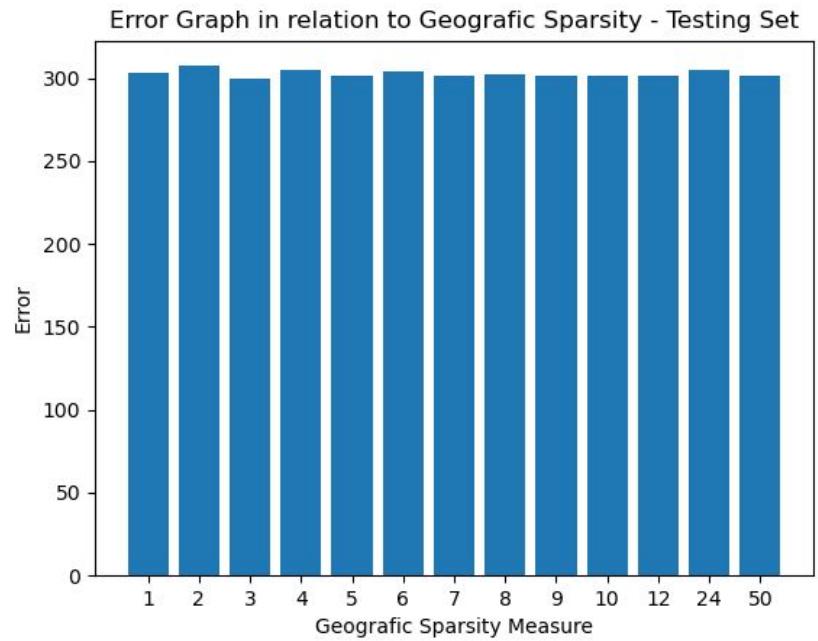
Teste de Esparsidade Geográfica - Trecho 1

- Utilizou-se apenas 1/8 do dataset citado (mês de janeiro)
 - O restante do dataset serviu para maior precisão na interpolação dos dados faltantes
-

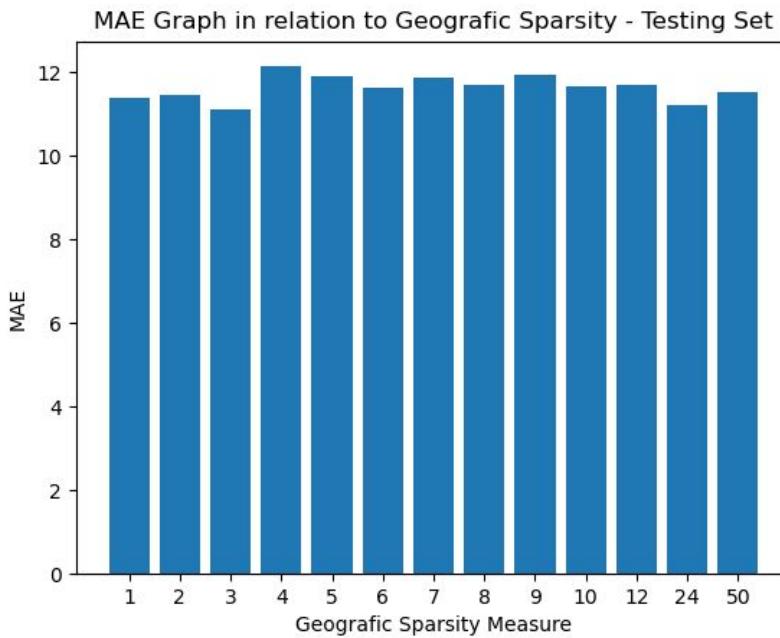
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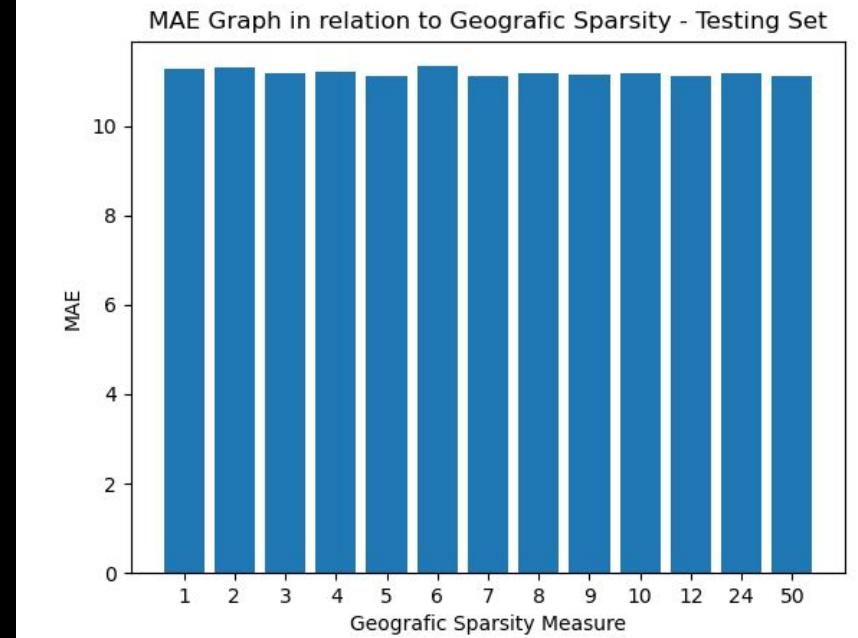
Regressão



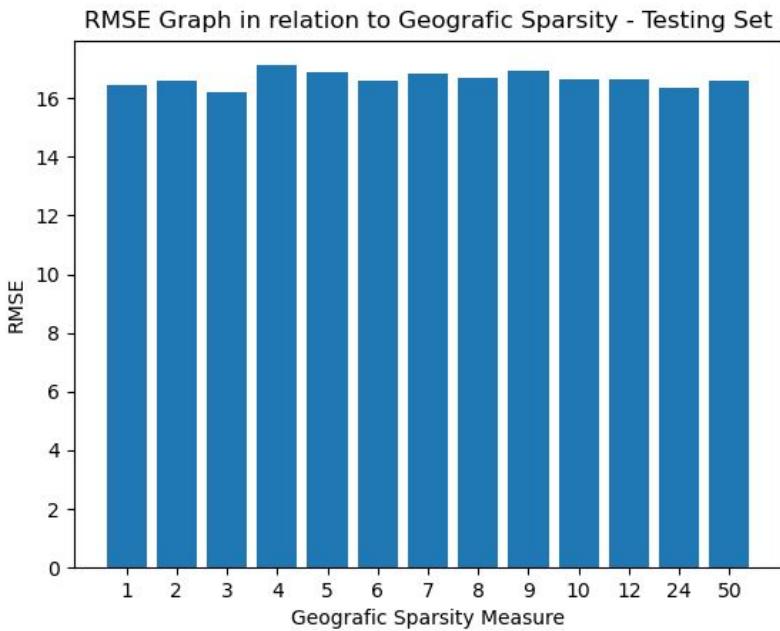
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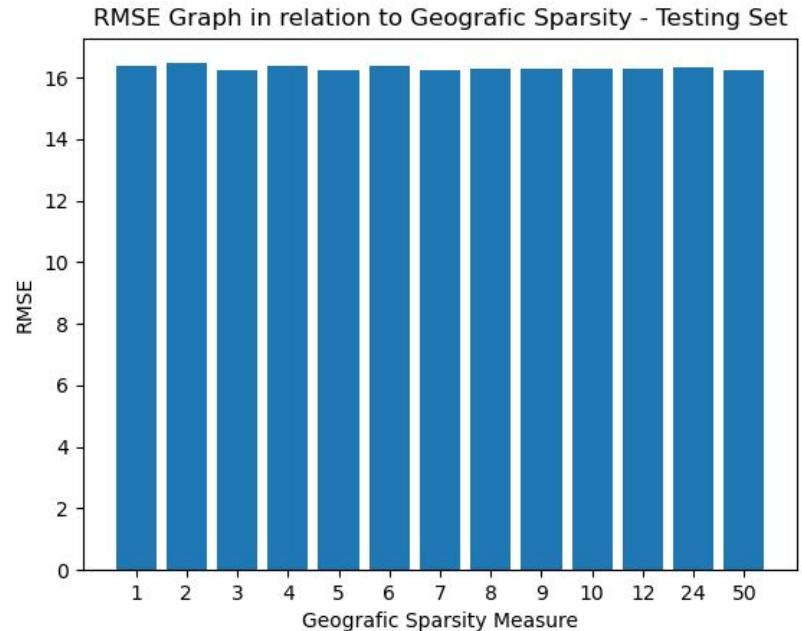
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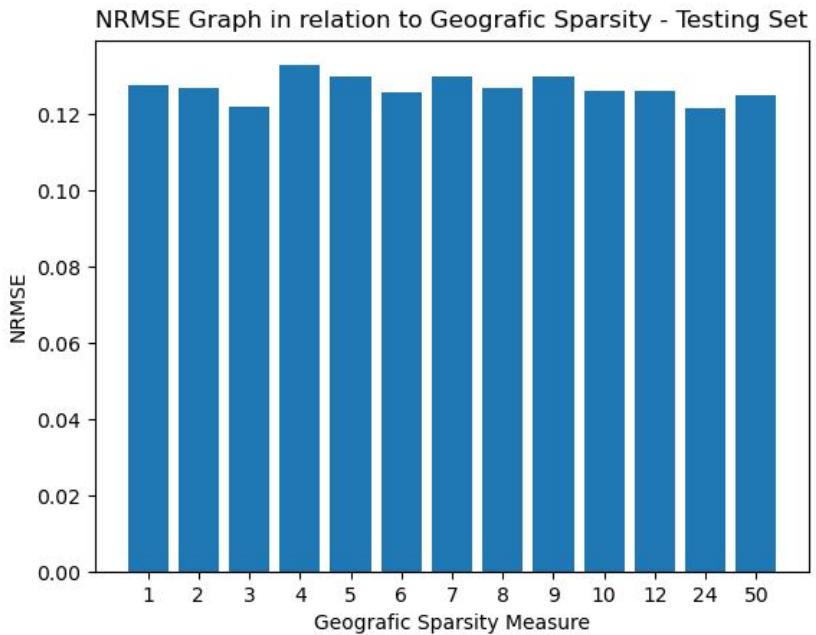
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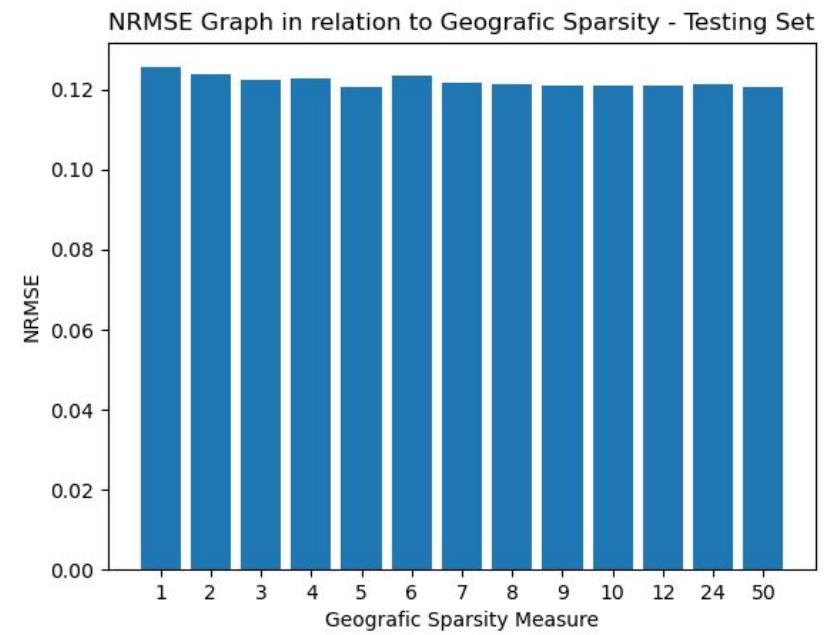
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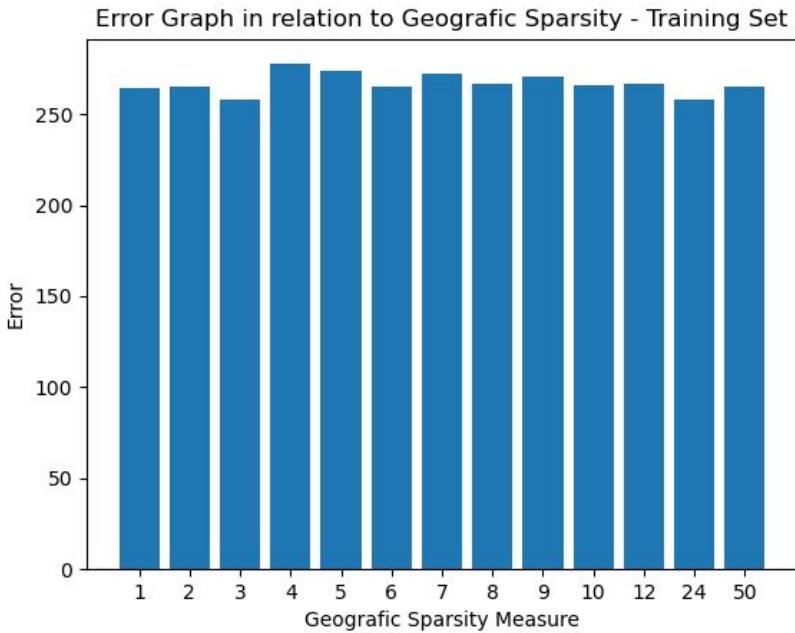
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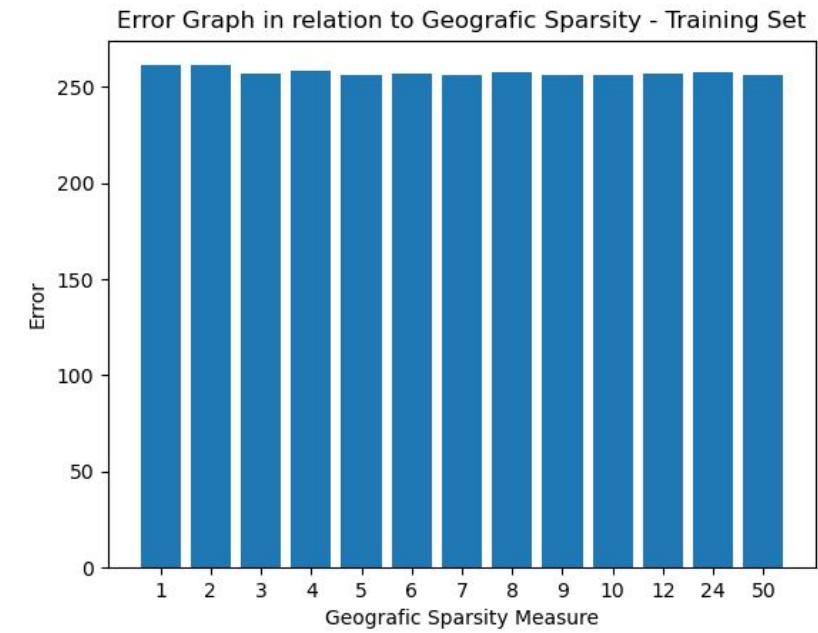
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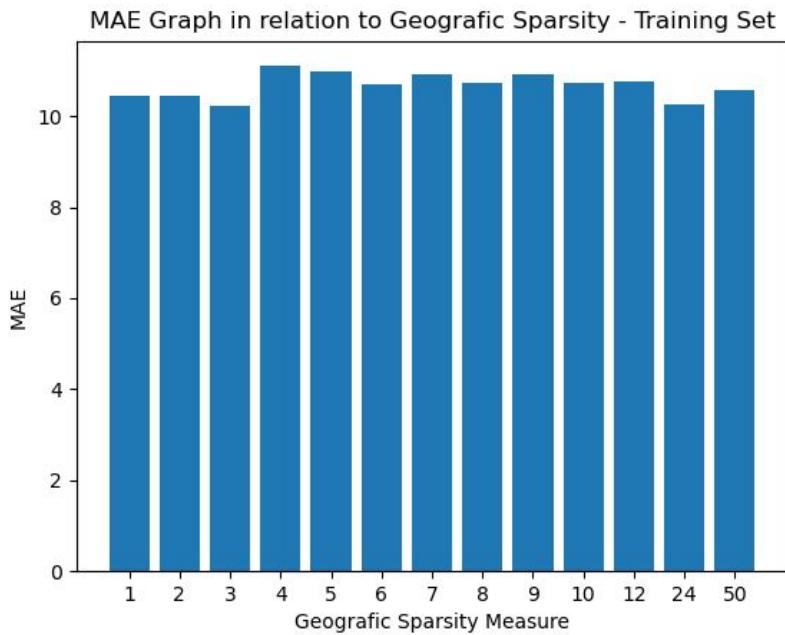
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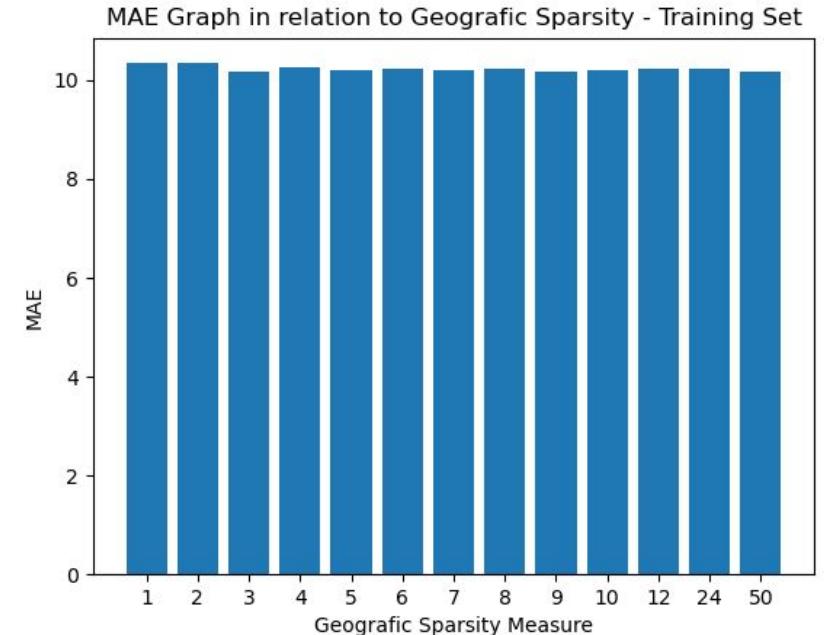
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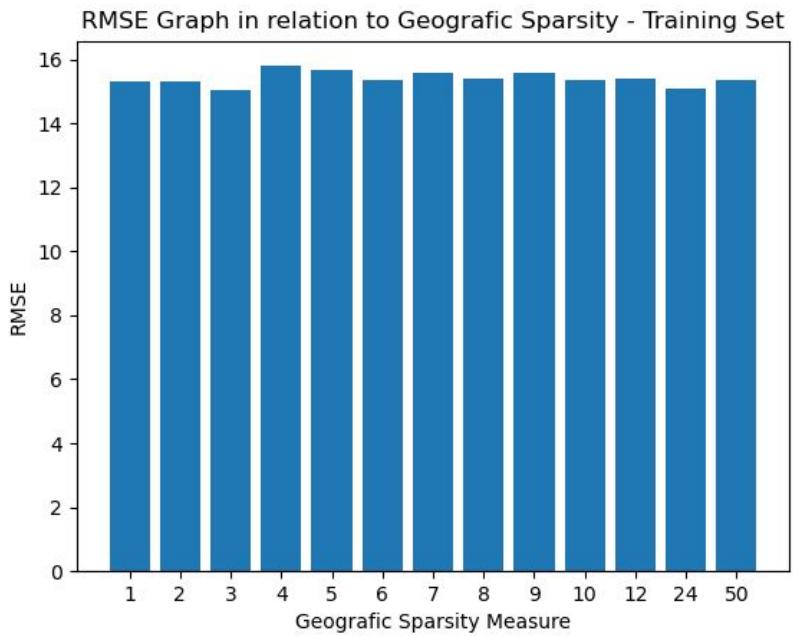
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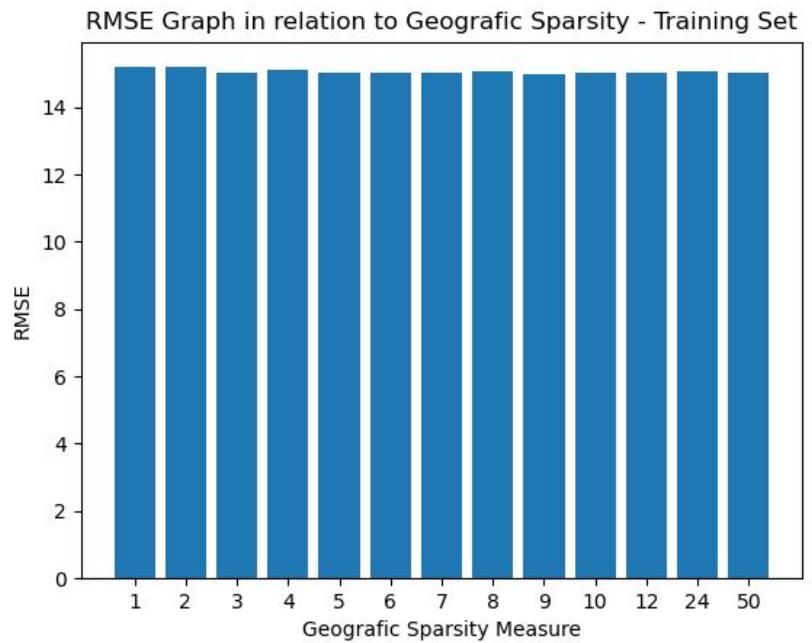
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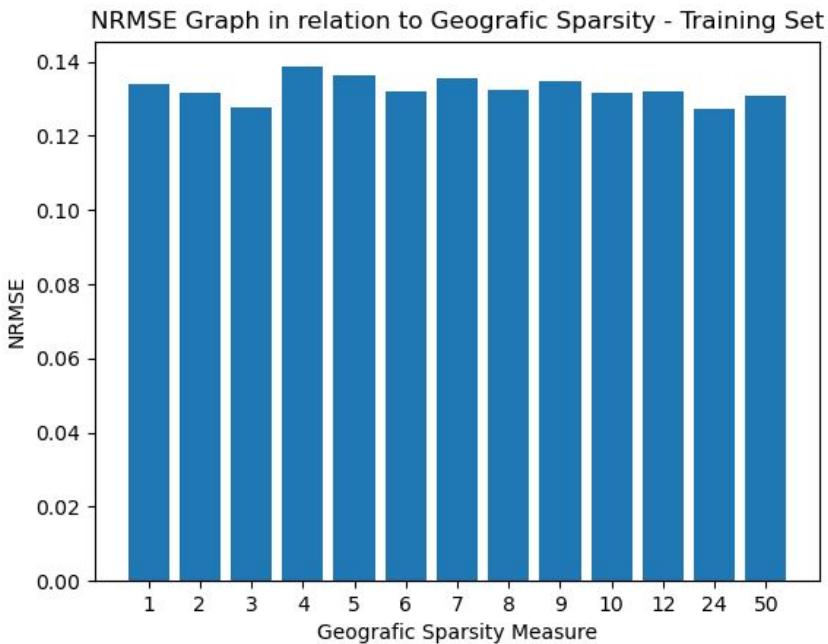
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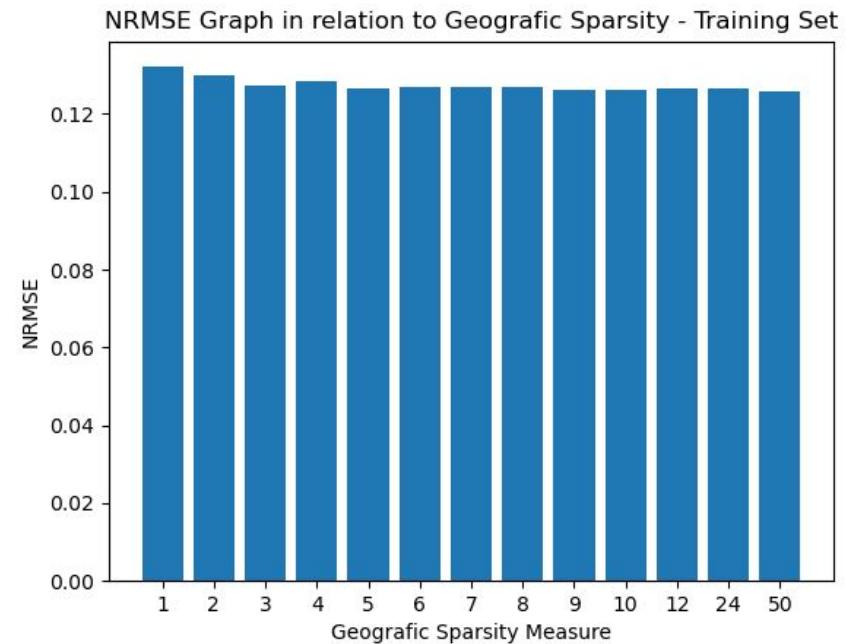
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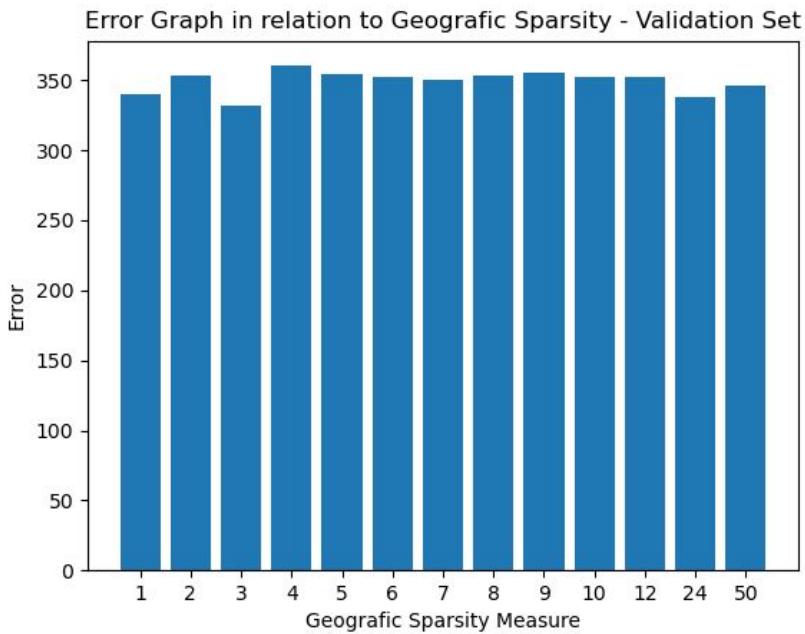
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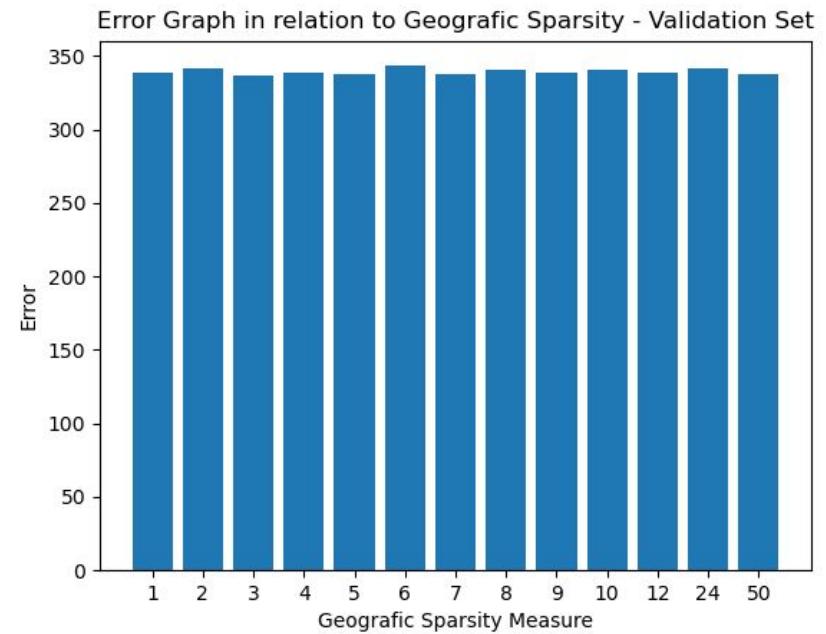
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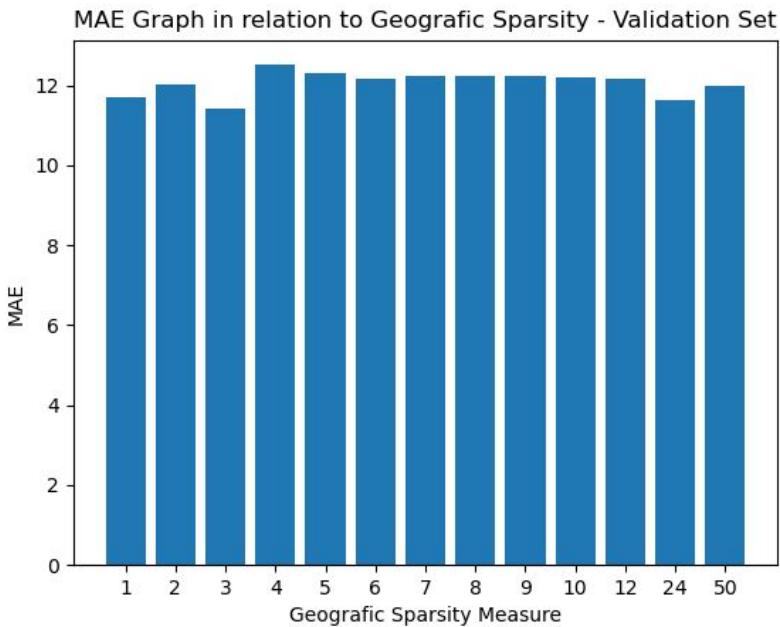
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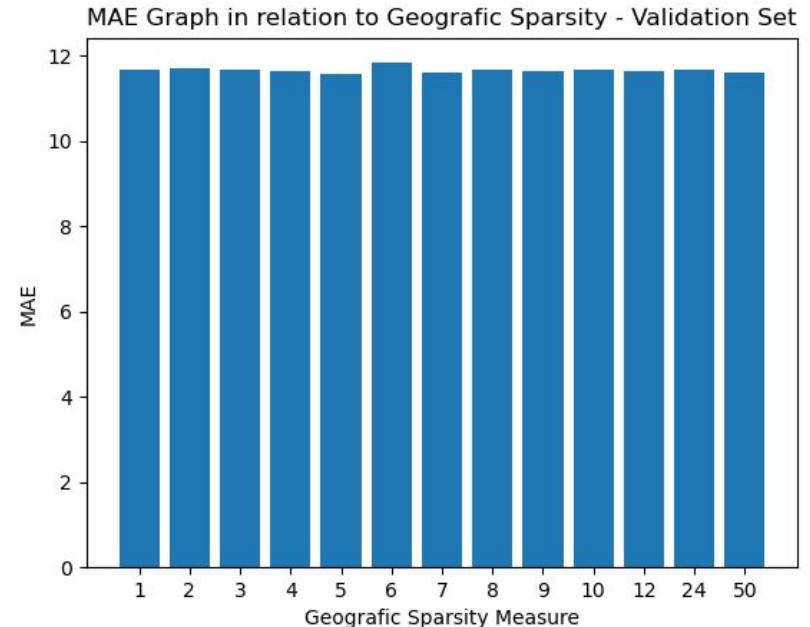
Regressão



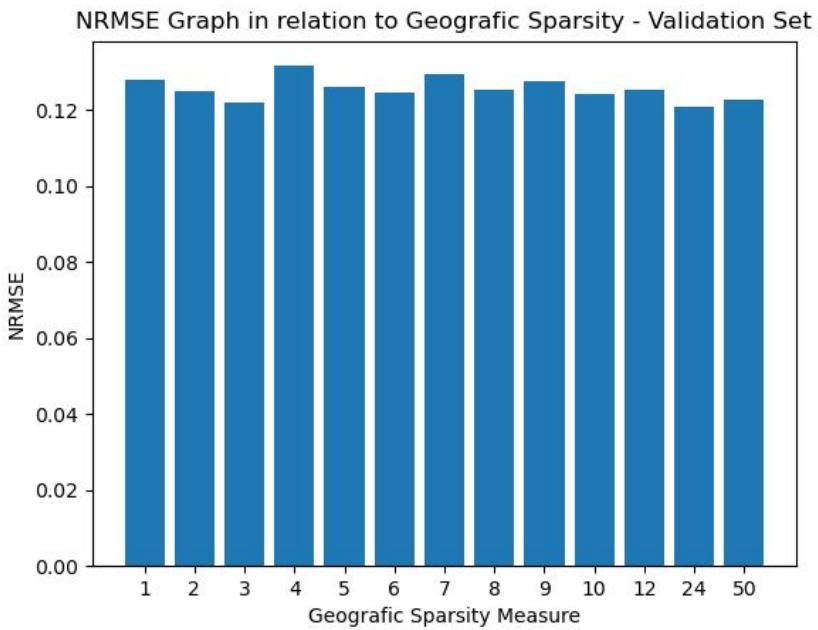
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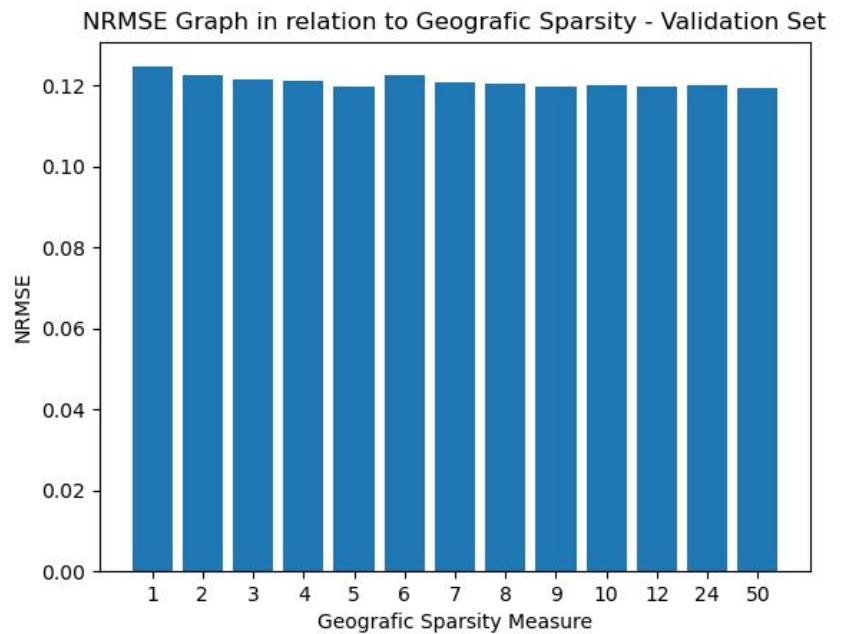
Regressão



GNN



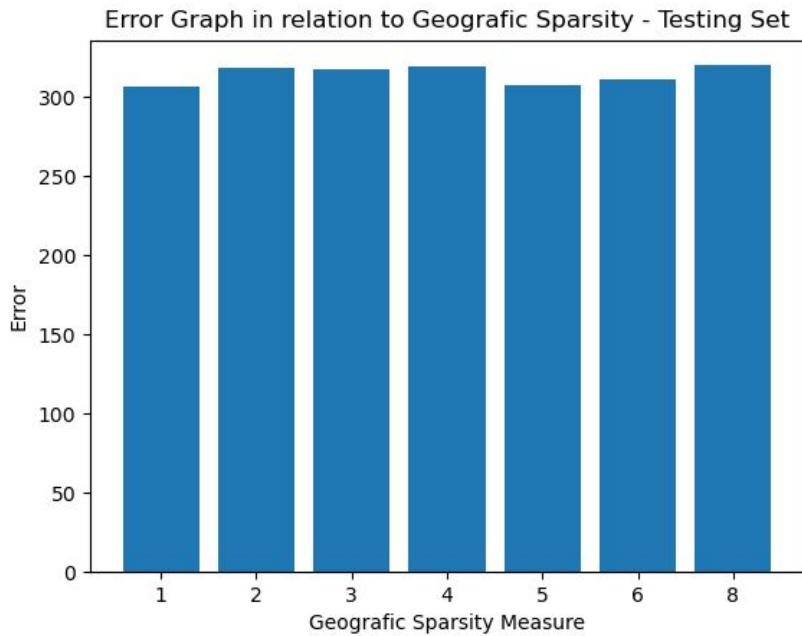
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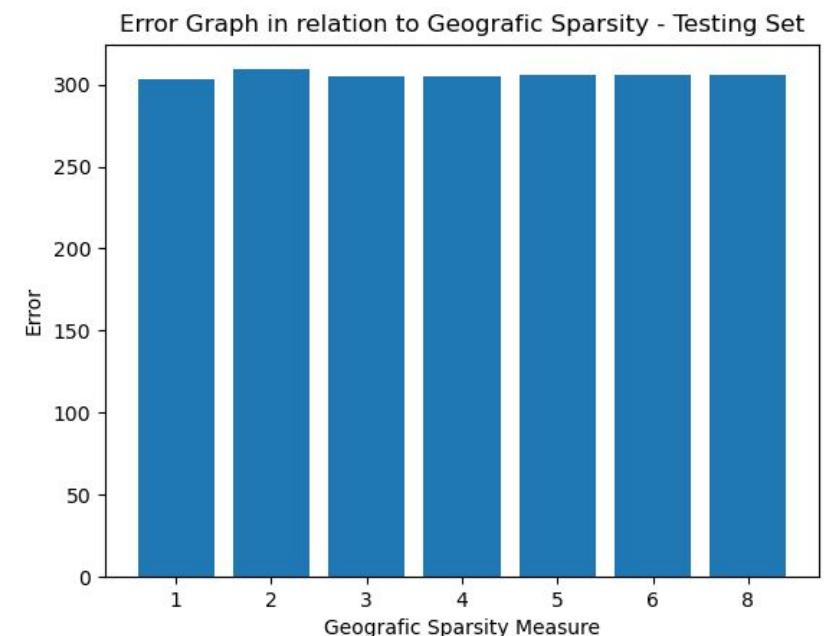
Teste de Esparsidade Geográfica - Trecho 2

- Utilizou-se apenas 1/8 do dataset citado (mês de janeiro)
 - O restante do dataset serviu para maior precisão na interpolação dos dados faltantes
-

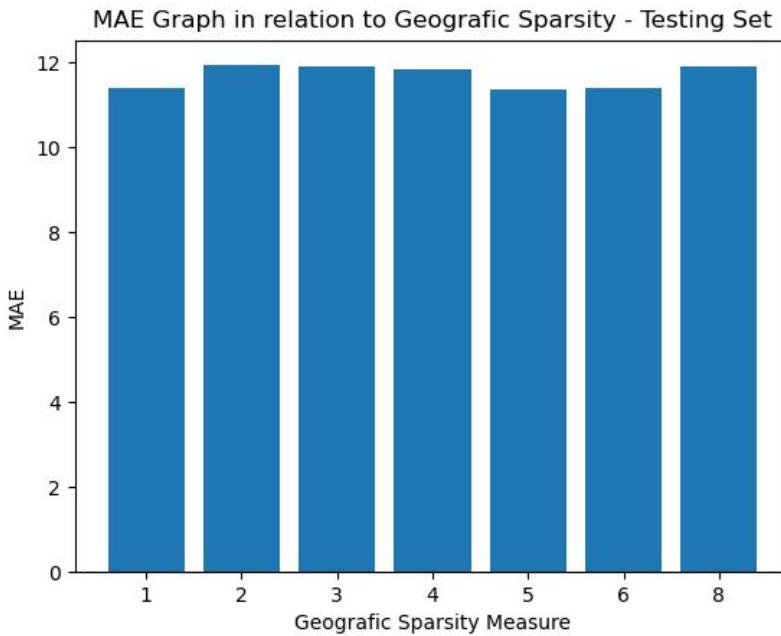
GNN



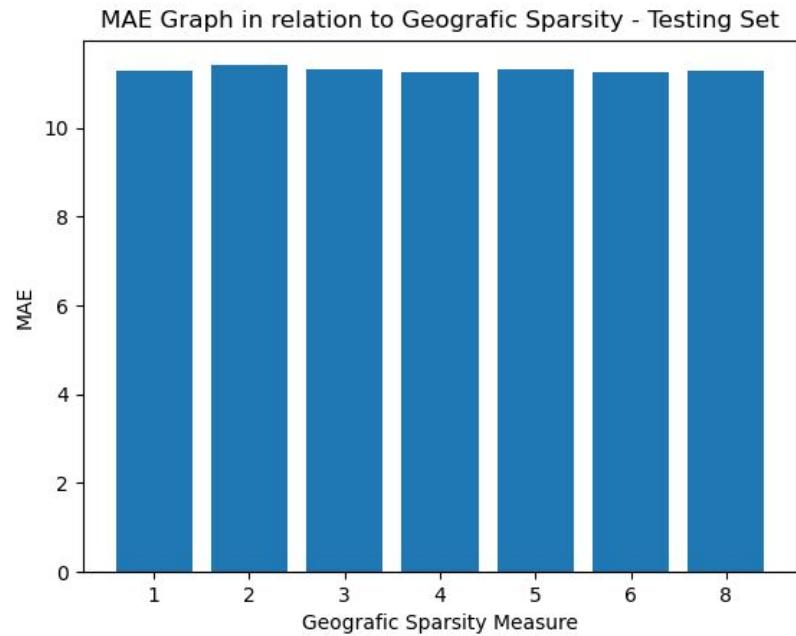
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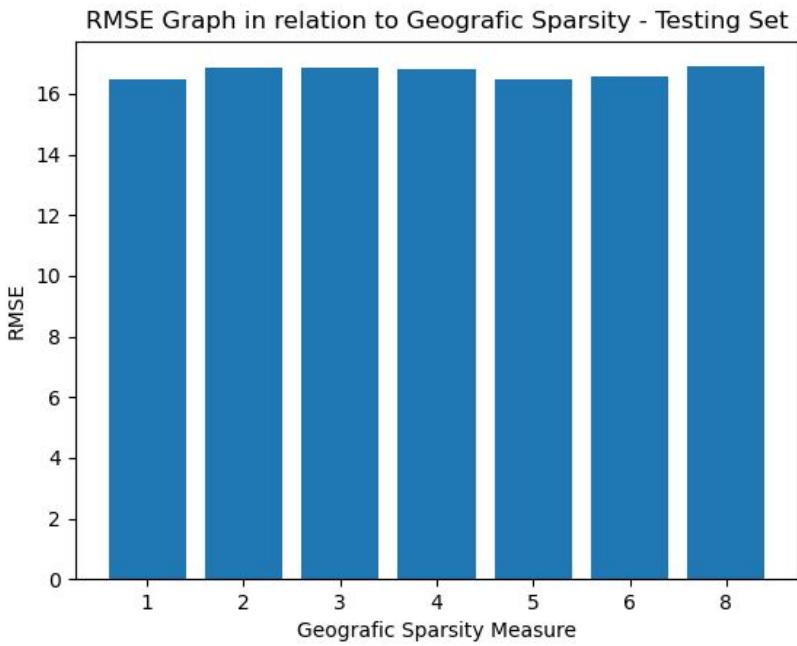
GNN



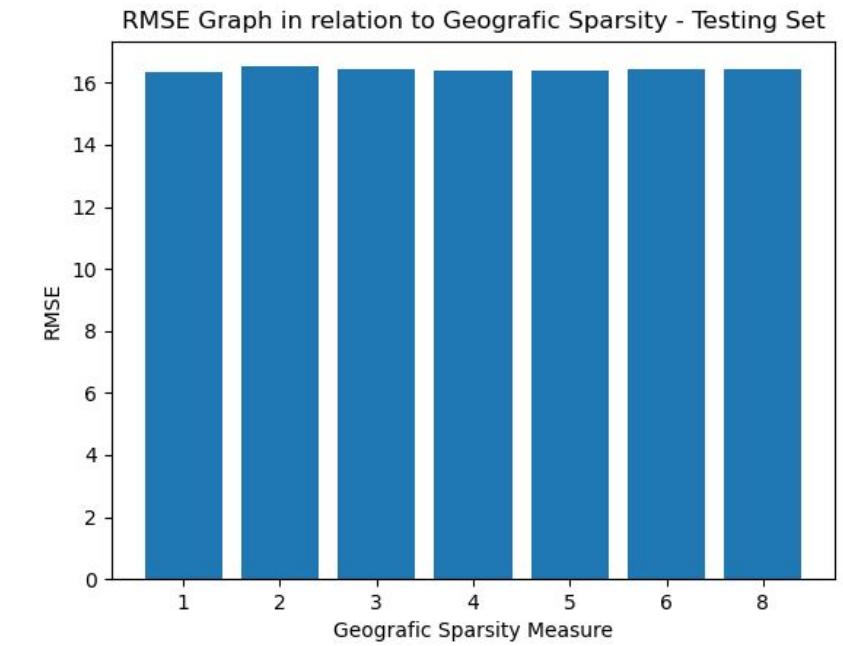
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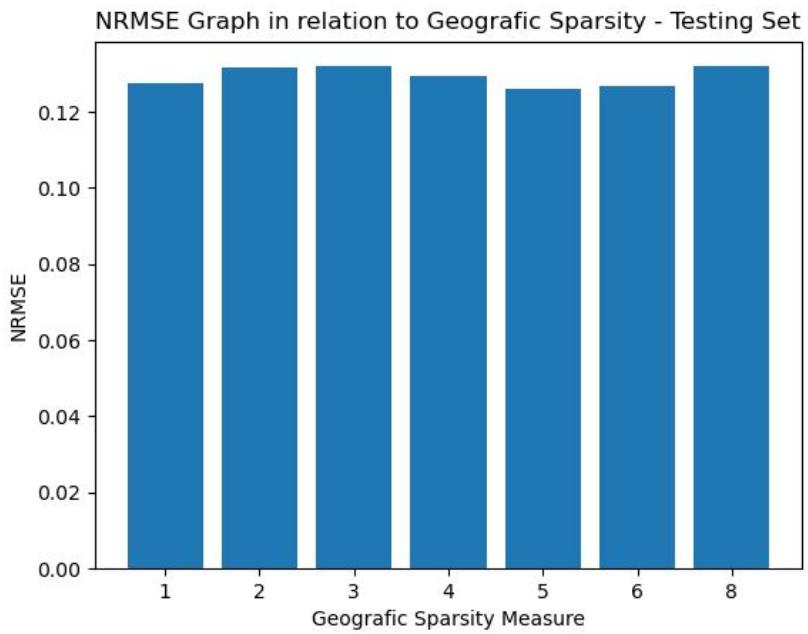
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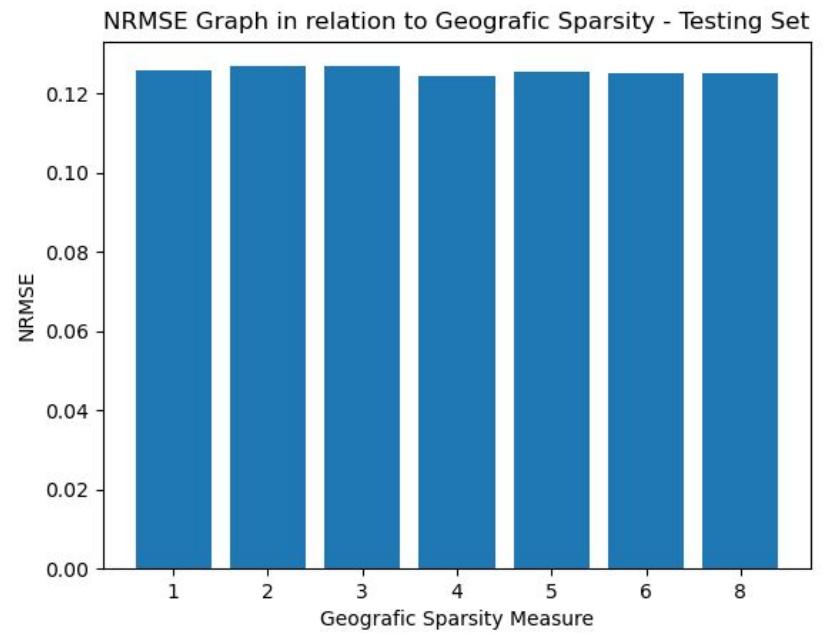
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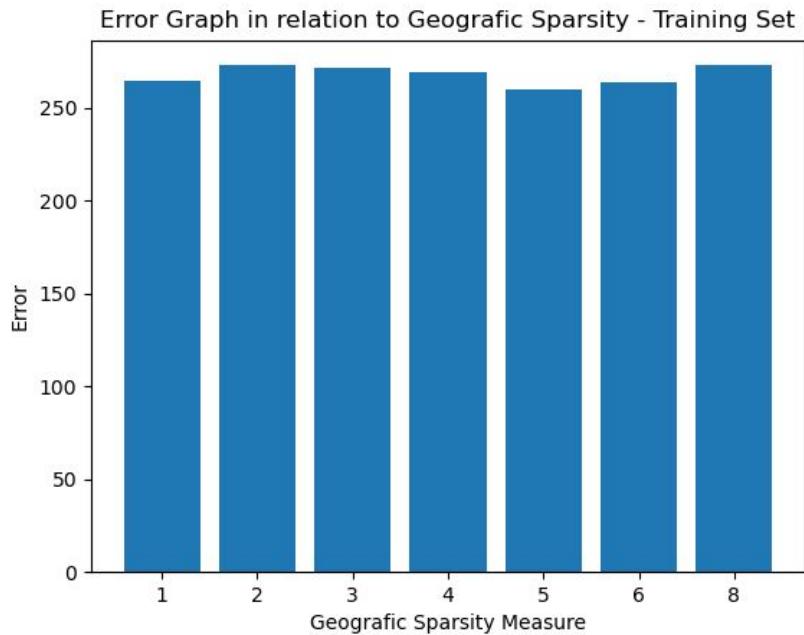
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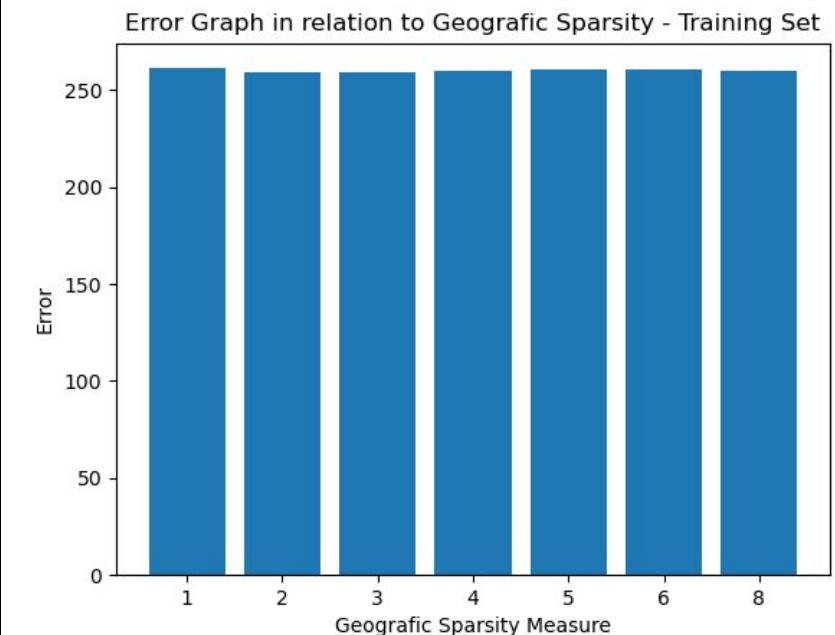
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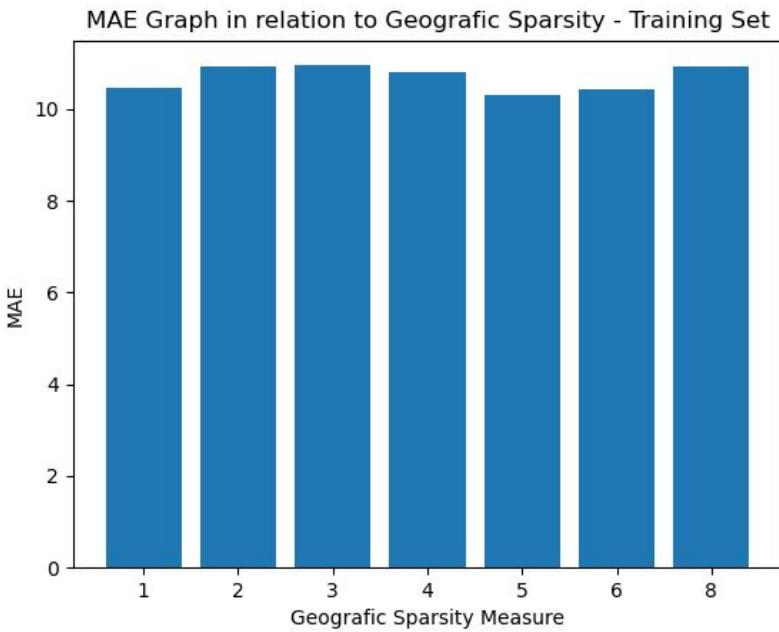
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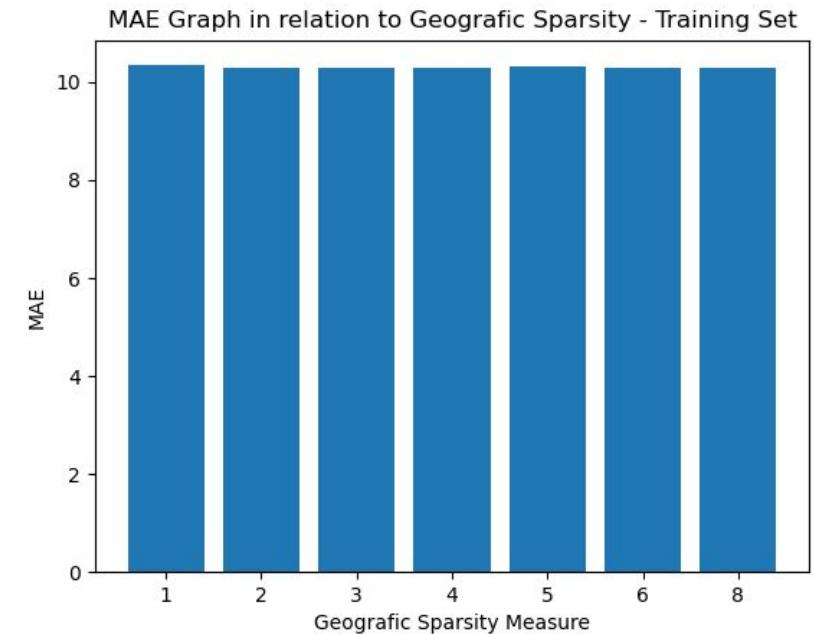
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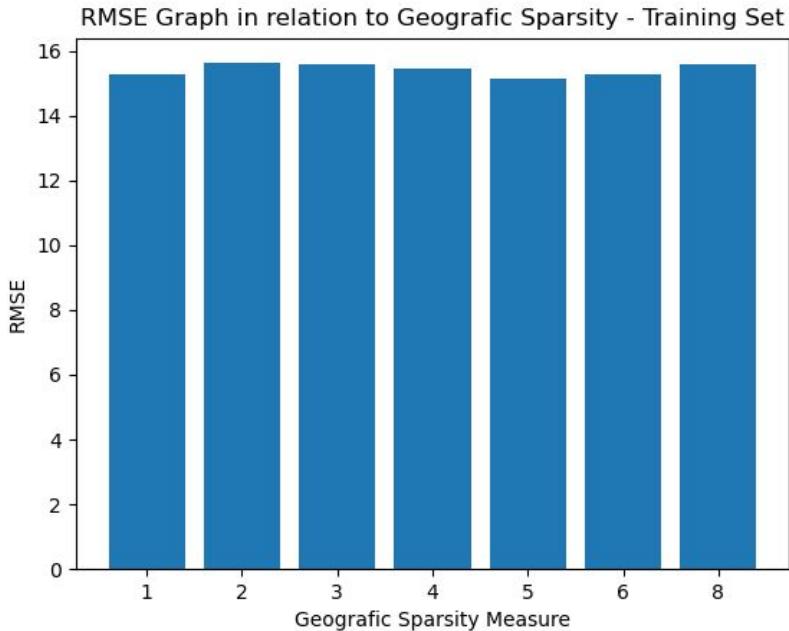
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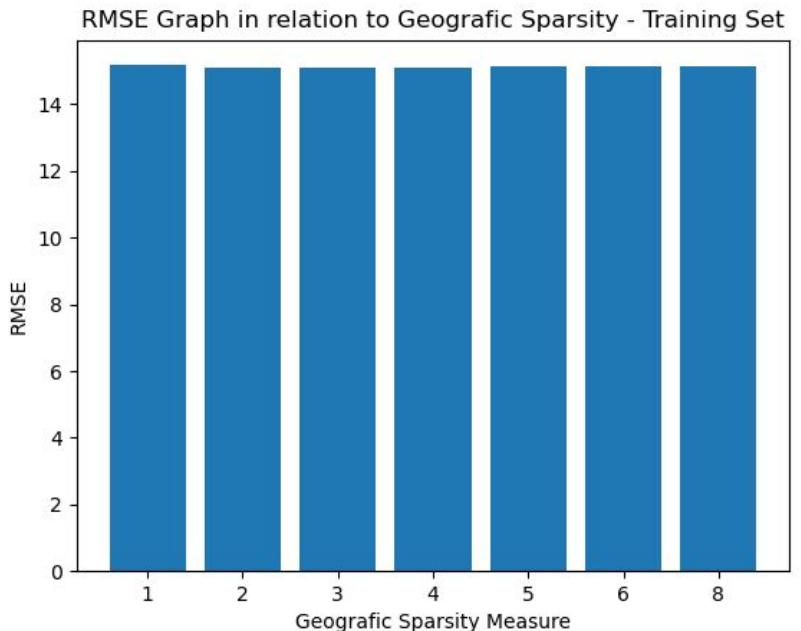
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GNN

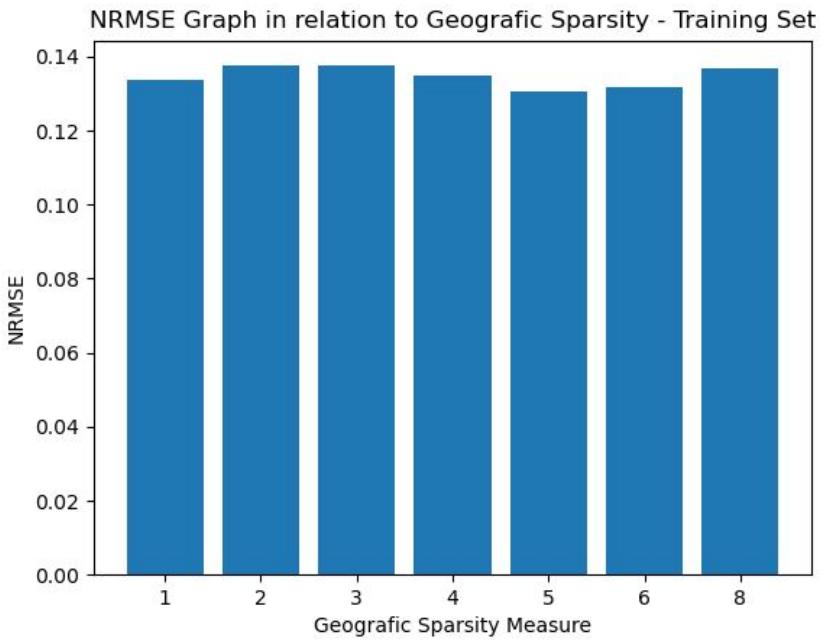


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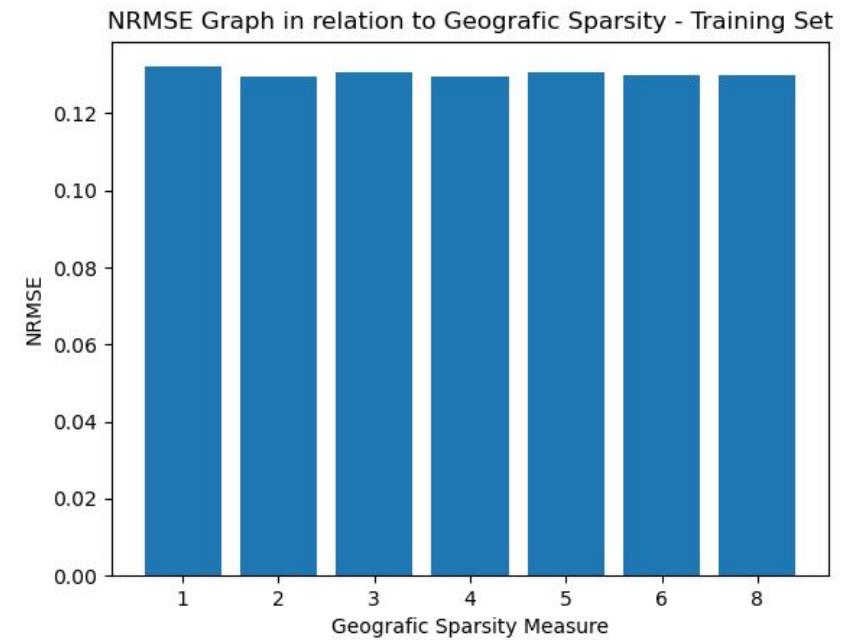


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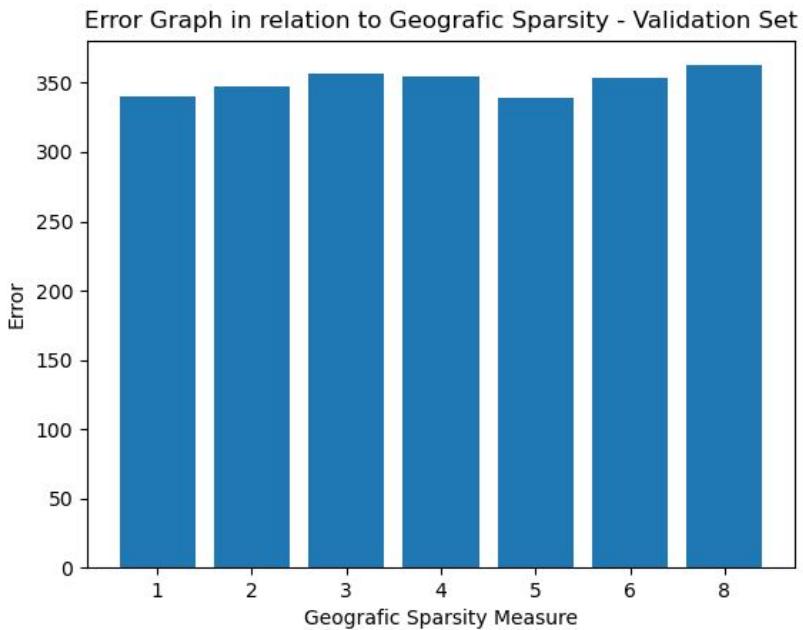
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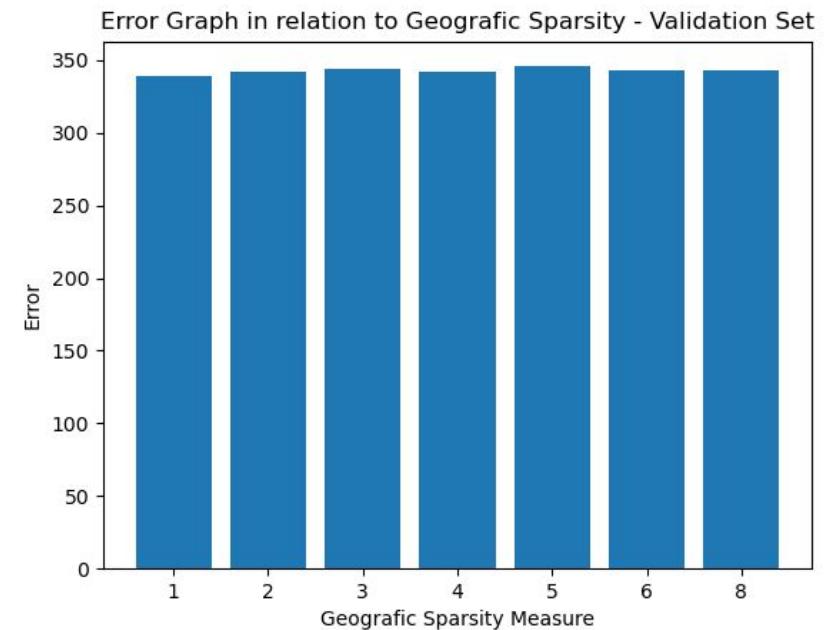
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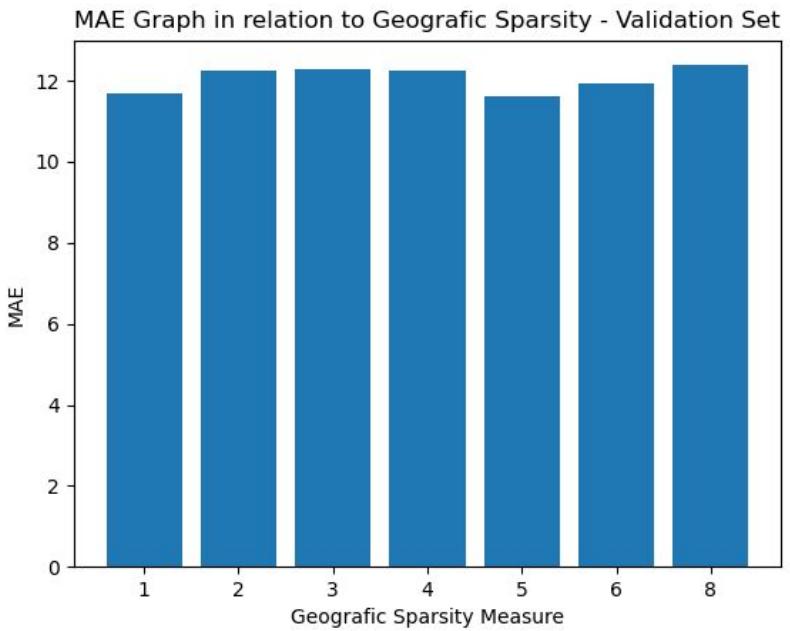
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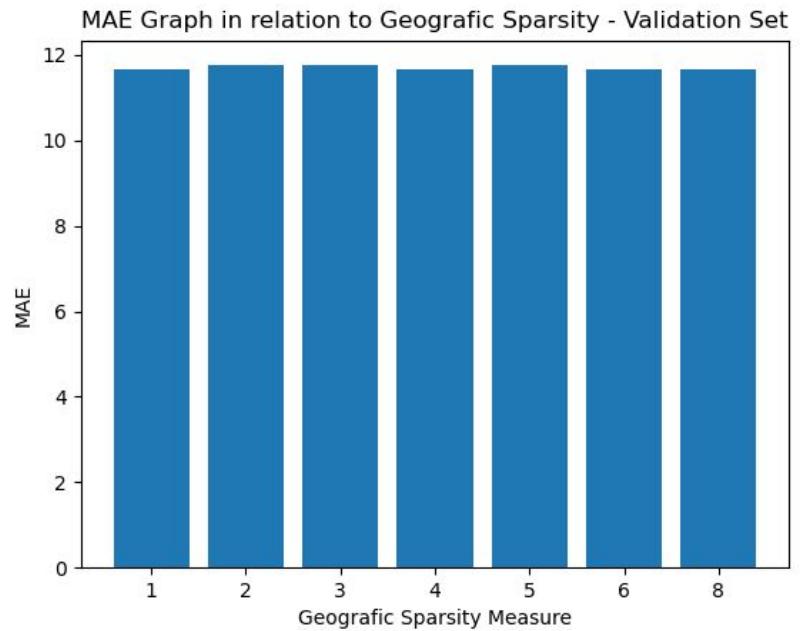
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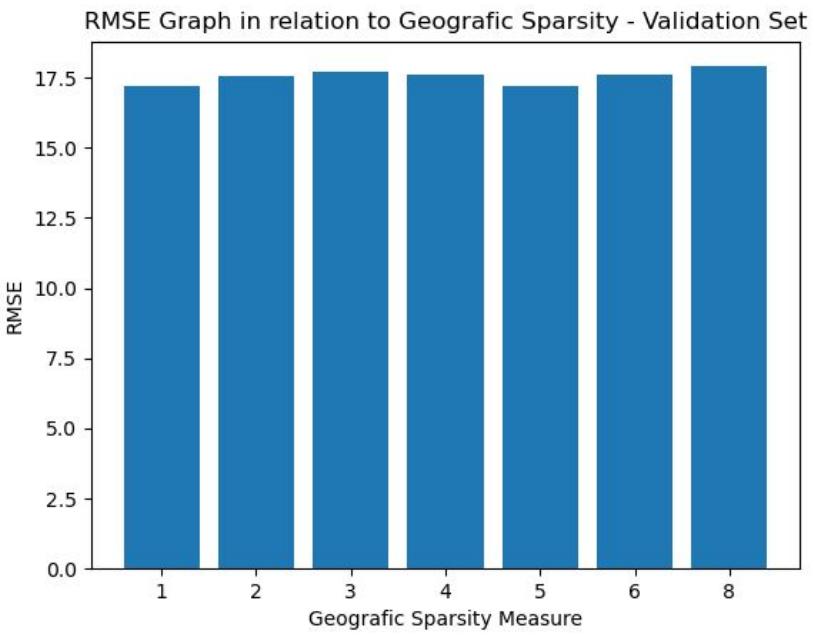
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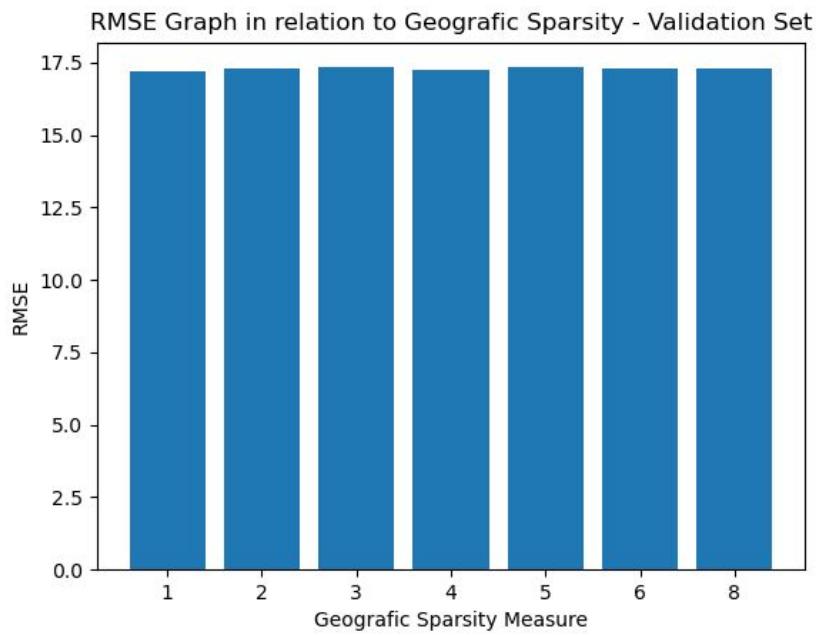
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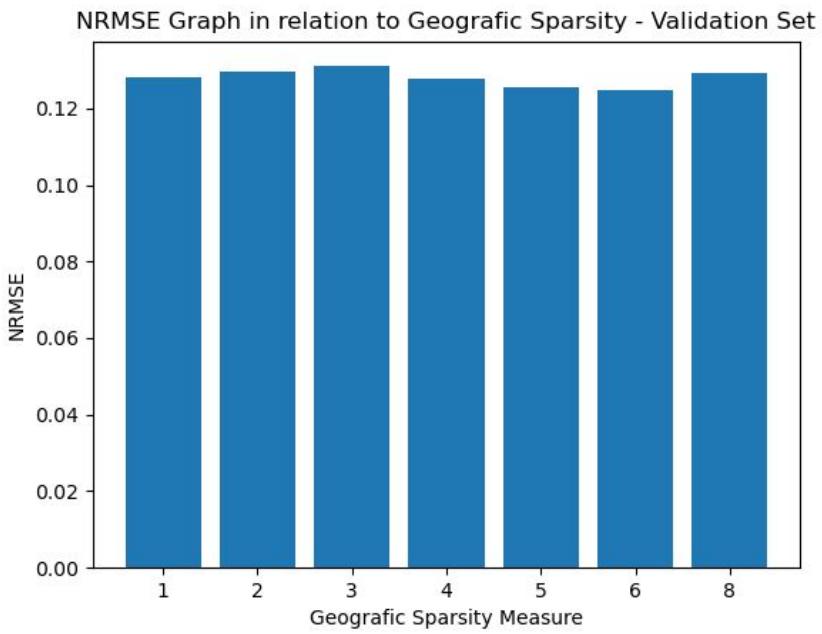
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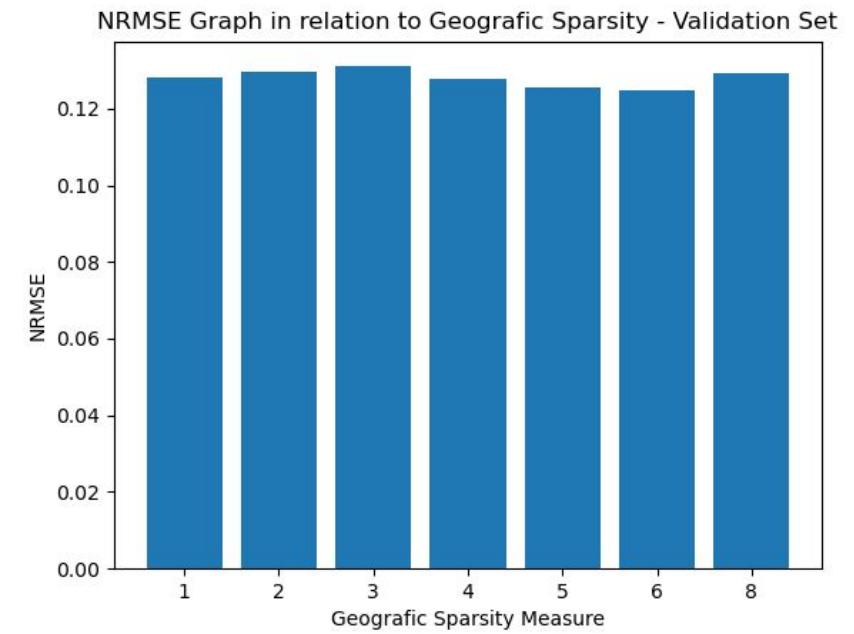
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GNN



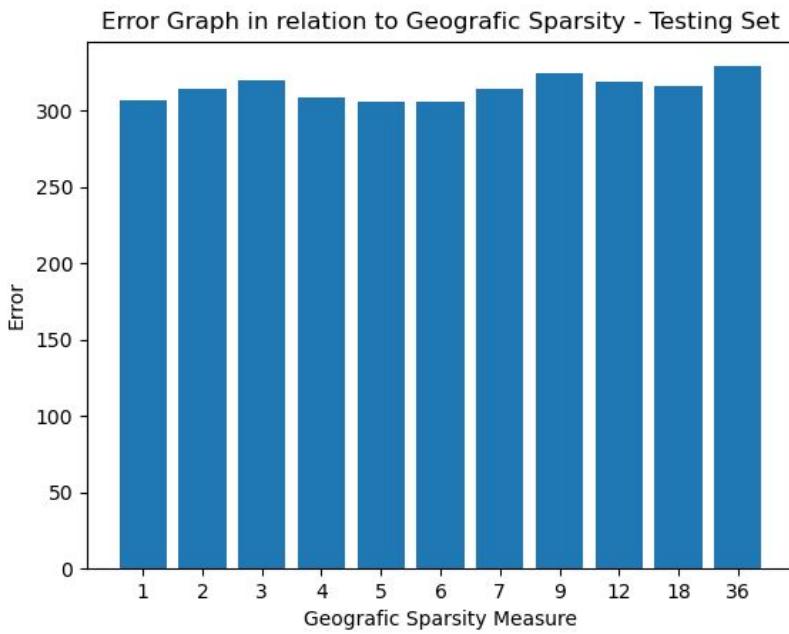
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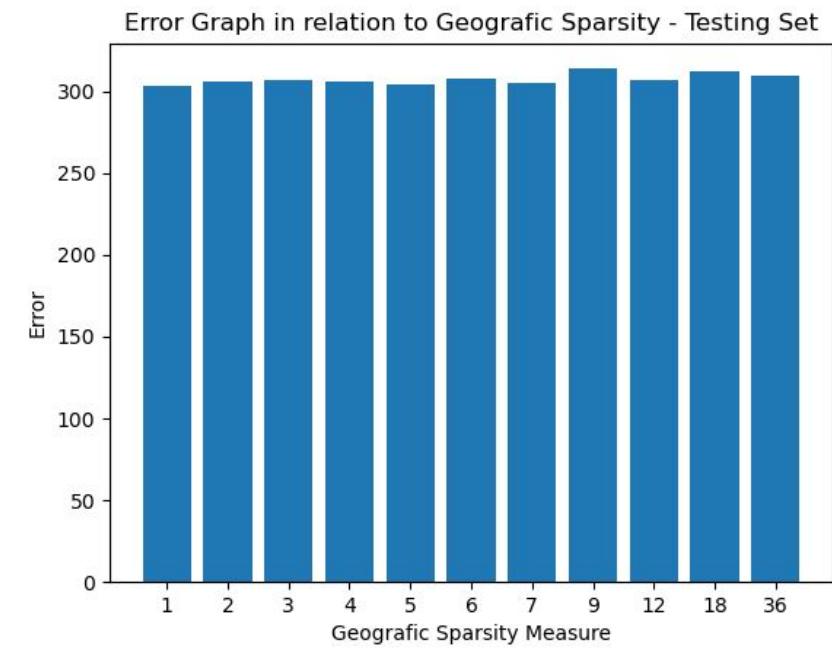
Teste de Esparsidade Geográfica - Trecho 3

- Utilizou-se apenas 1/8 do dataset citado (mês de janeiro)
 - O restante do dataset serviu para maior precisão na interpolação dos dados faltantes
-

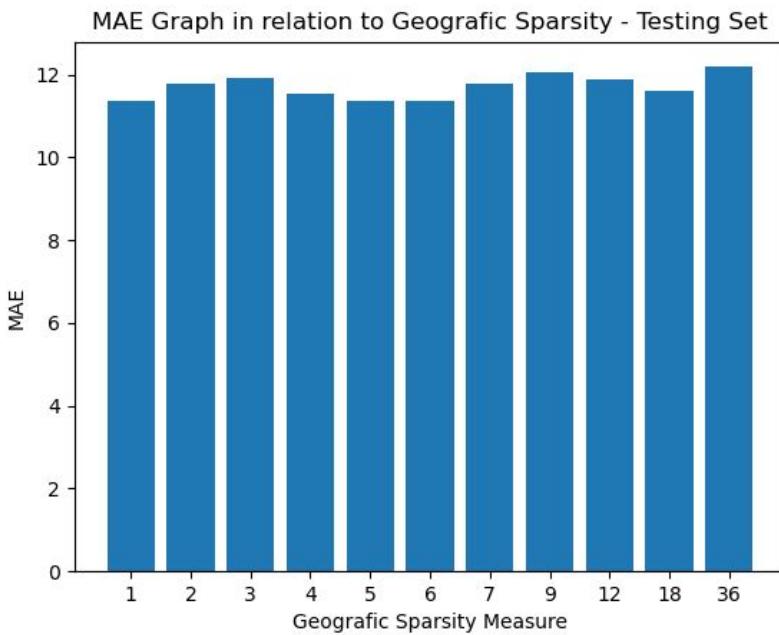
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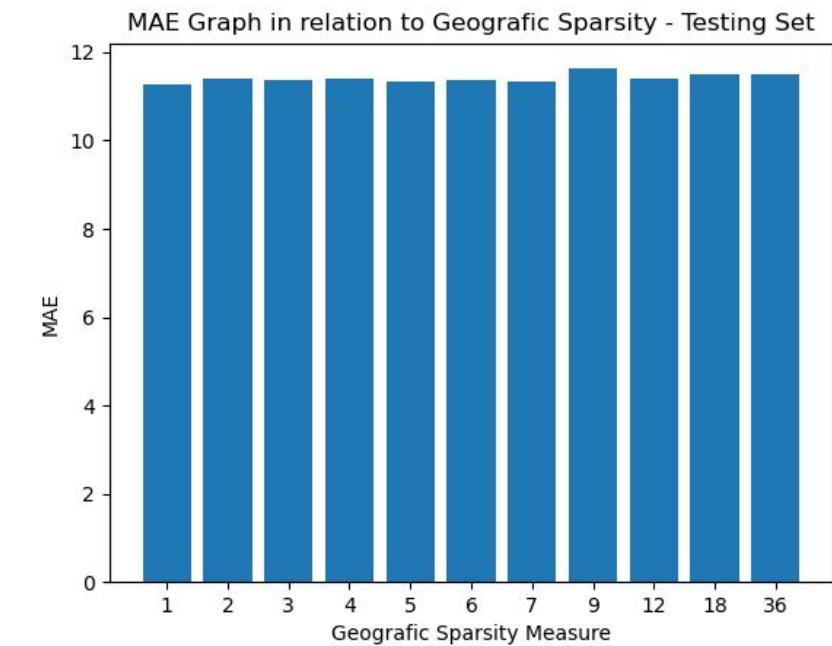
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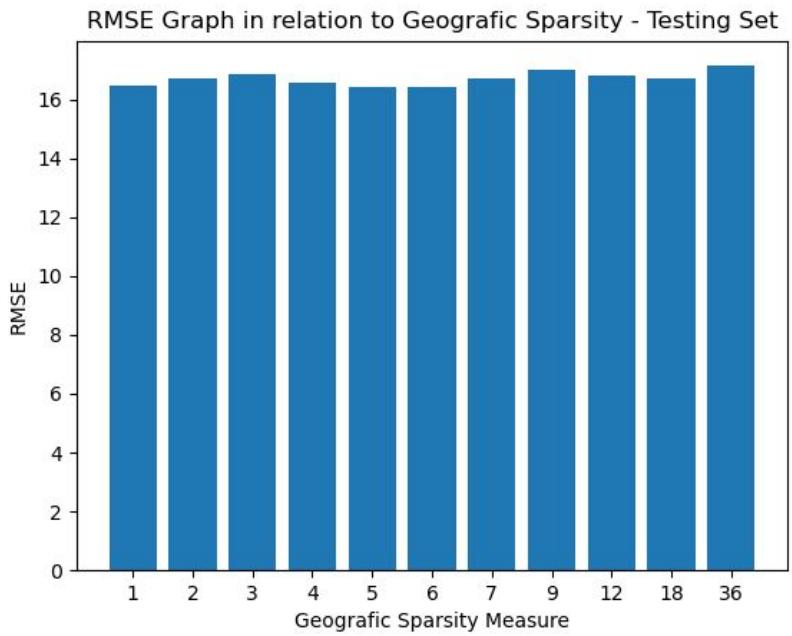
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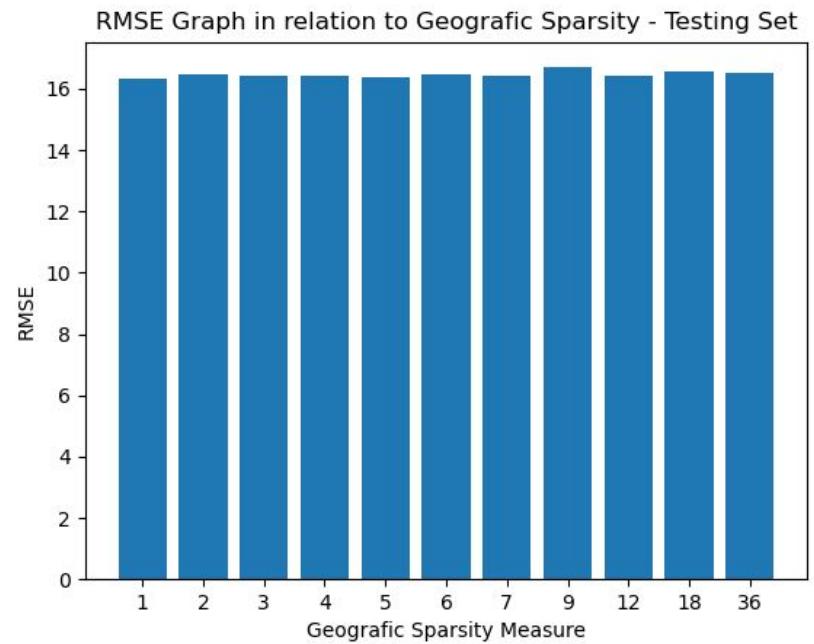
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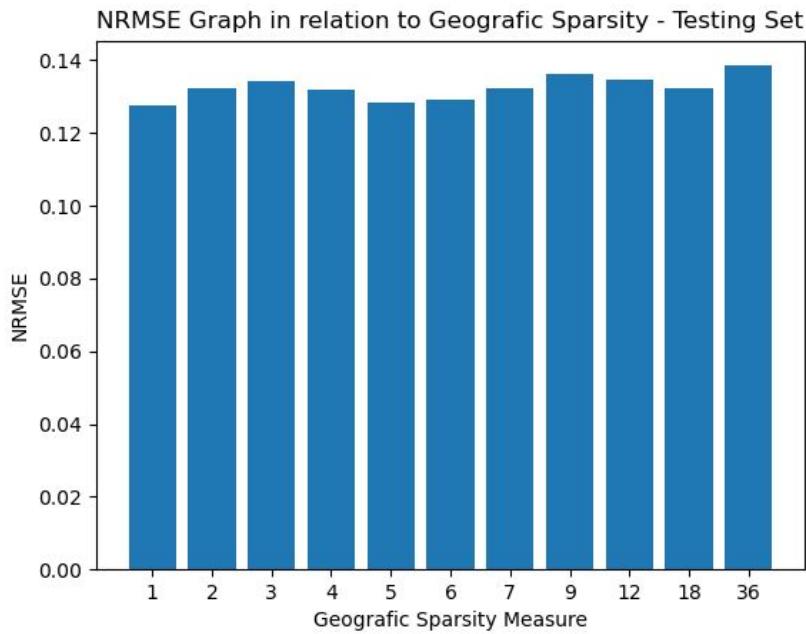
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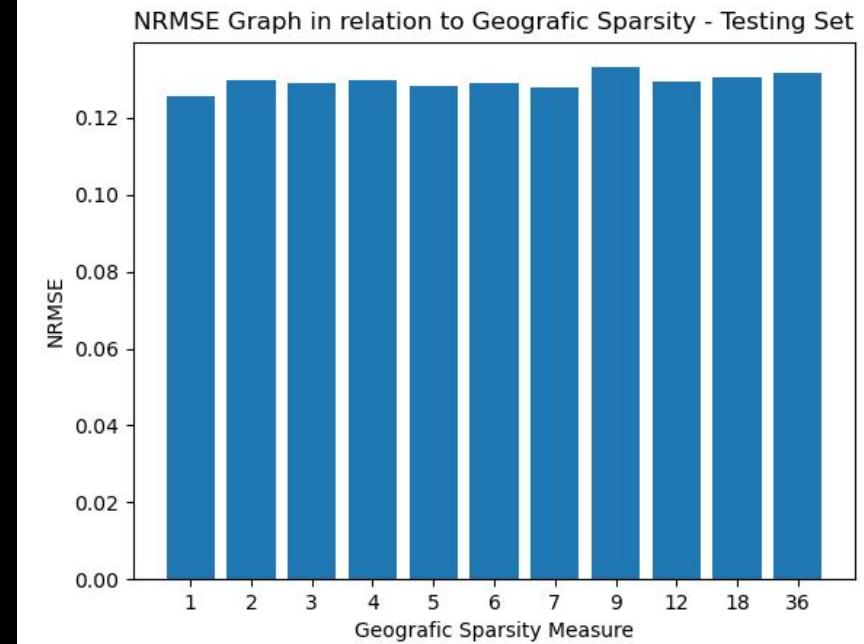
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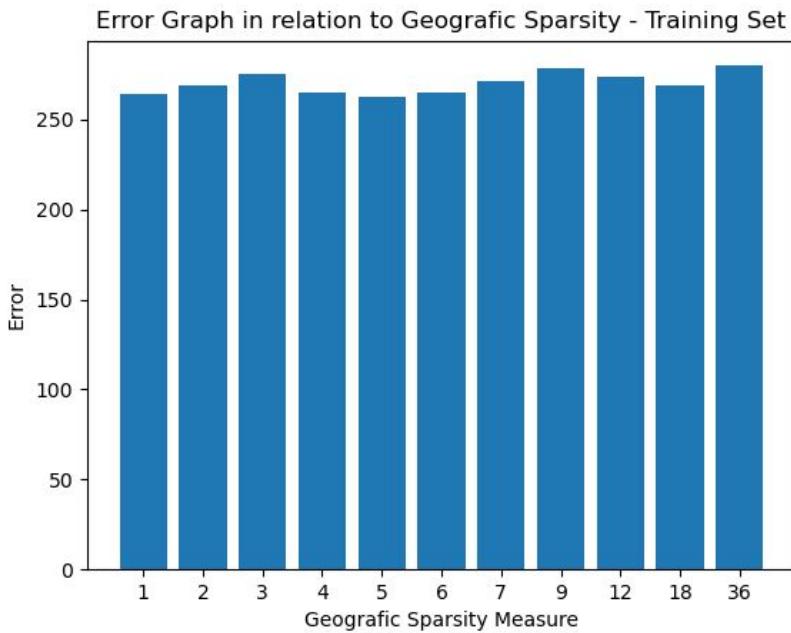
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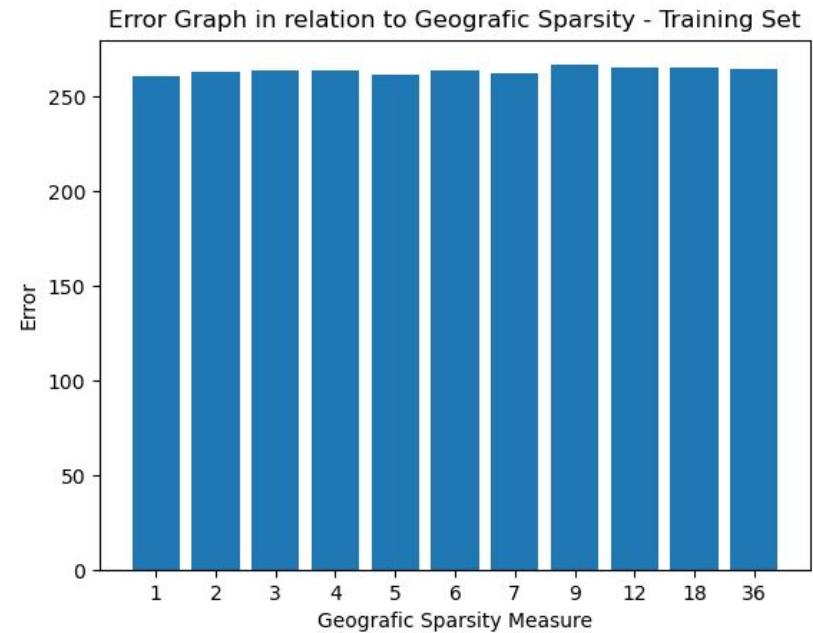
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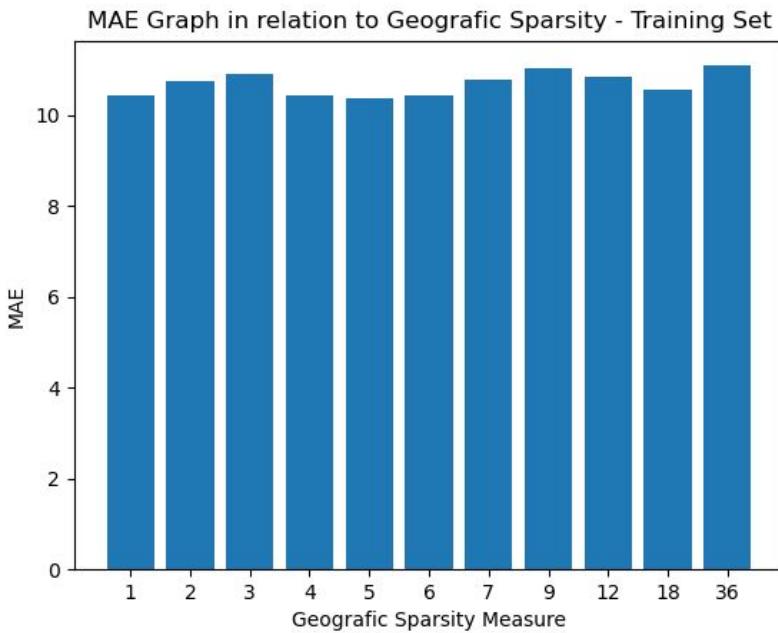
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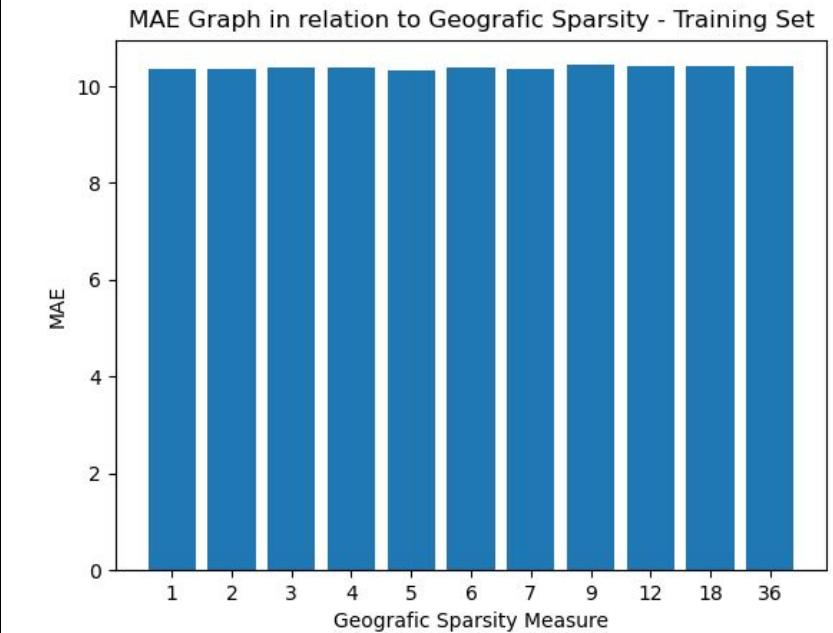
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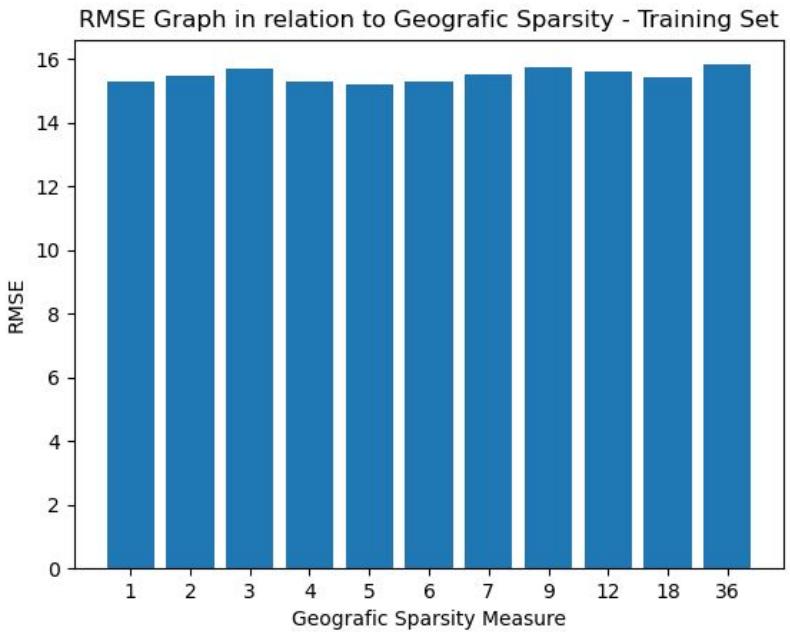
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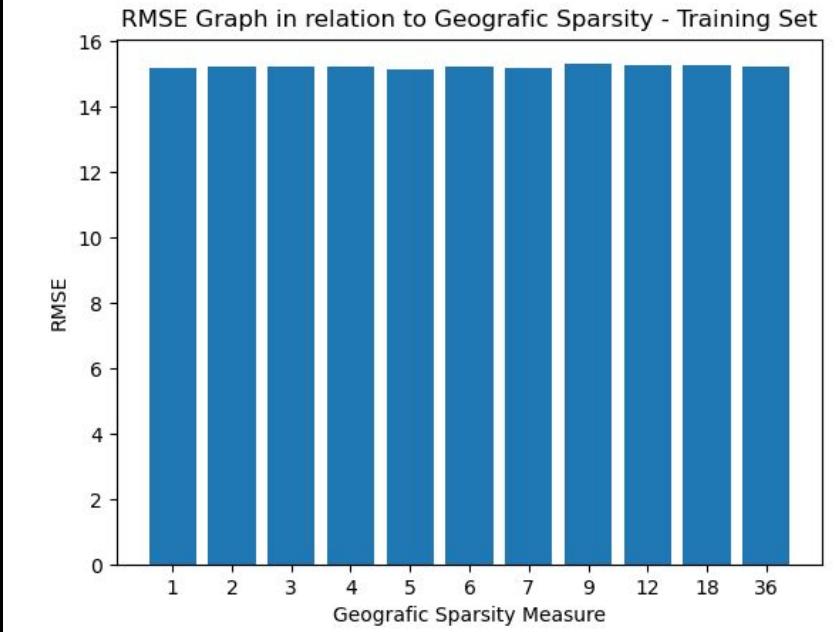
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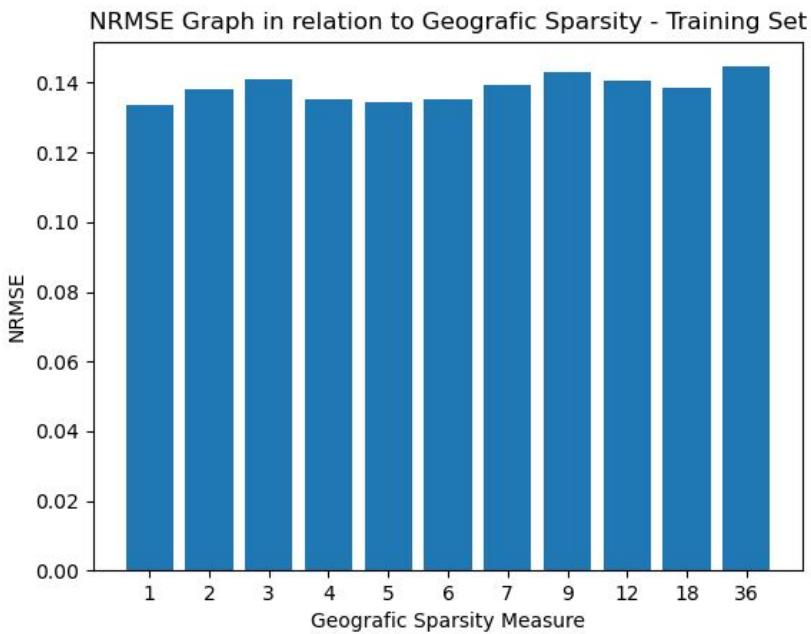
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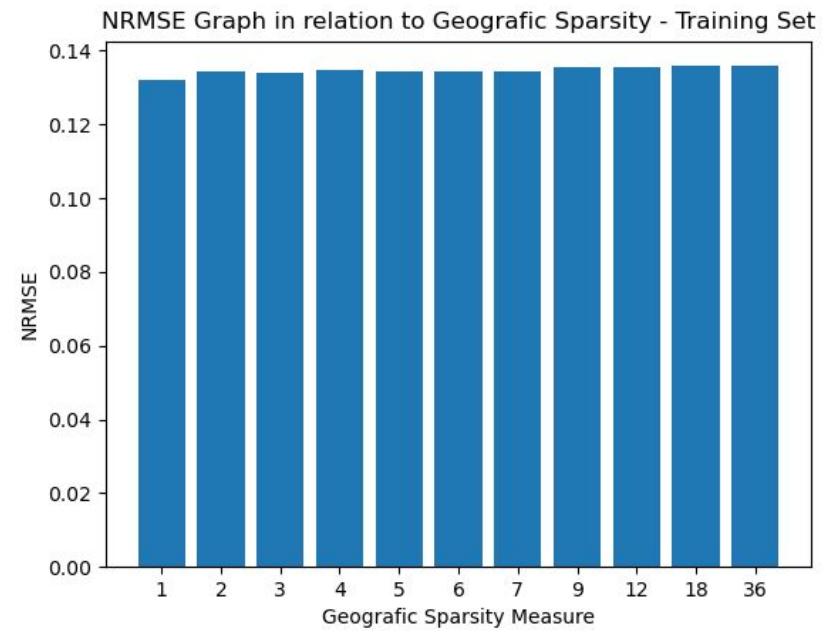
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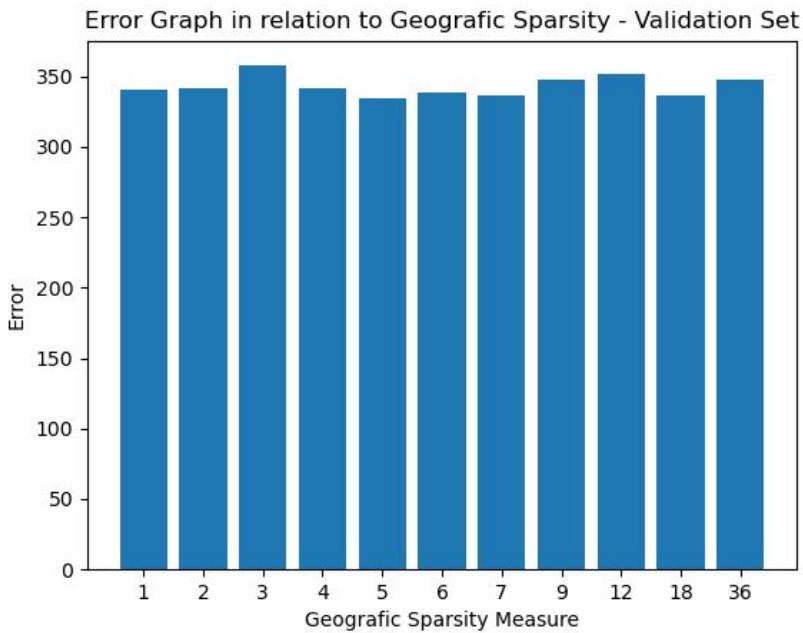
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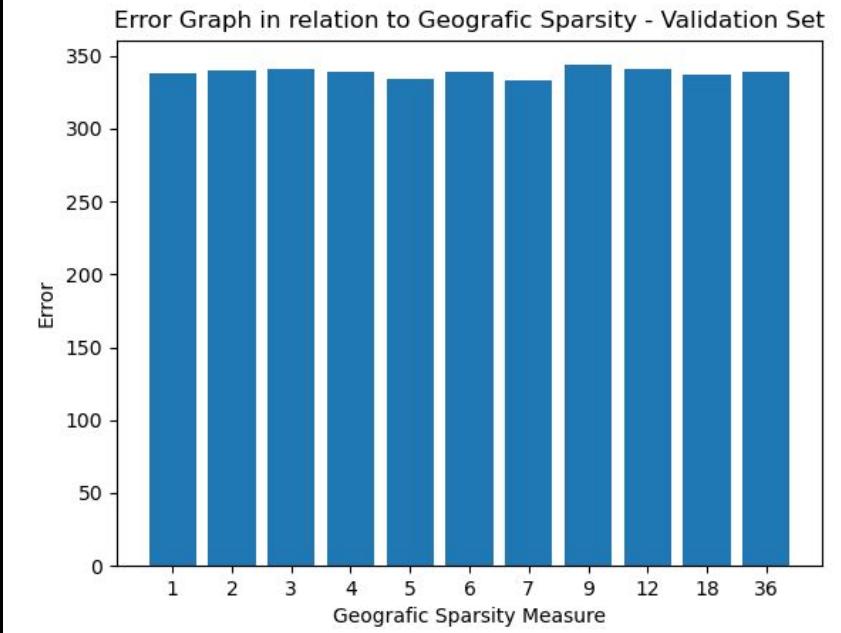
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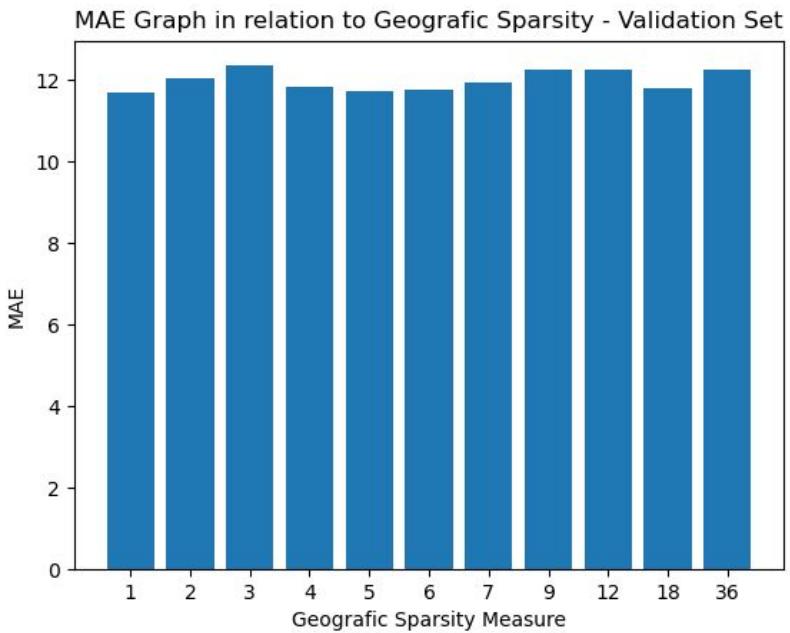
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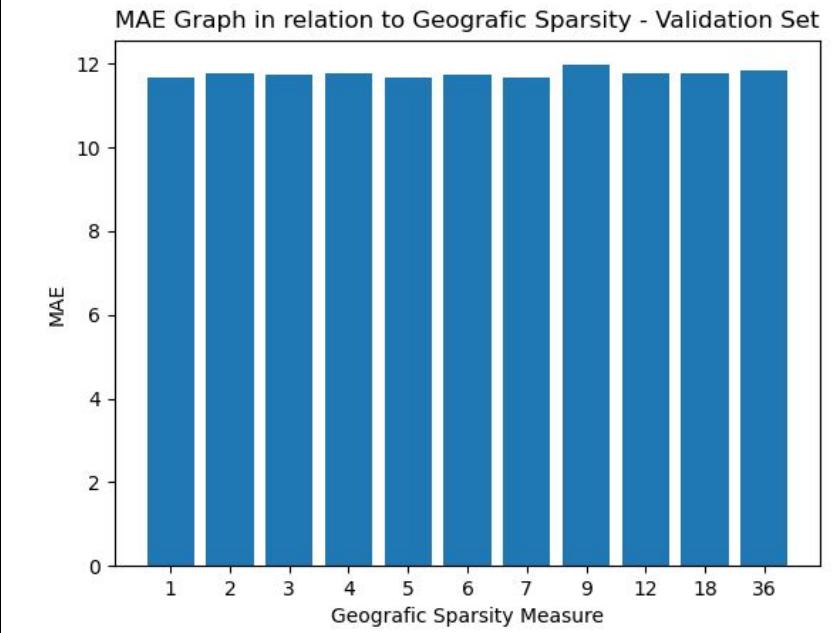
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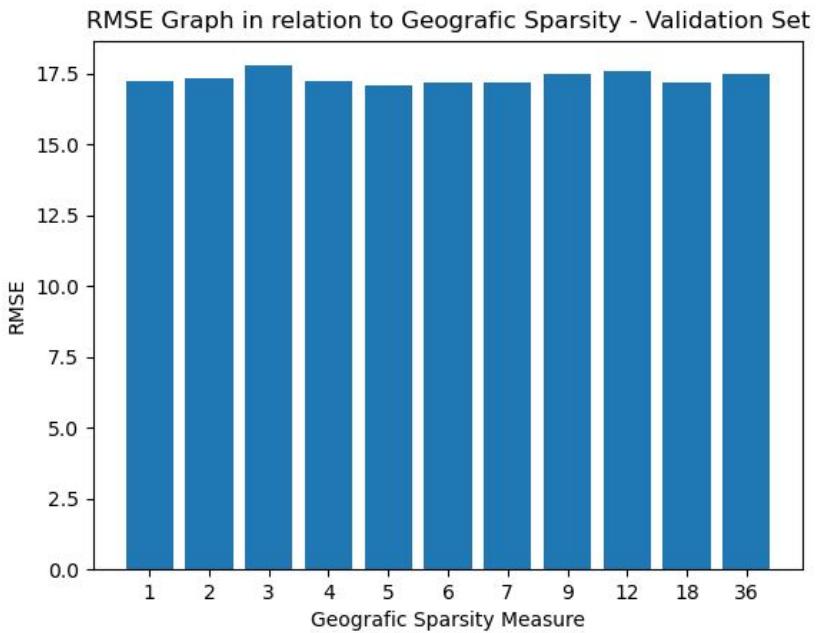
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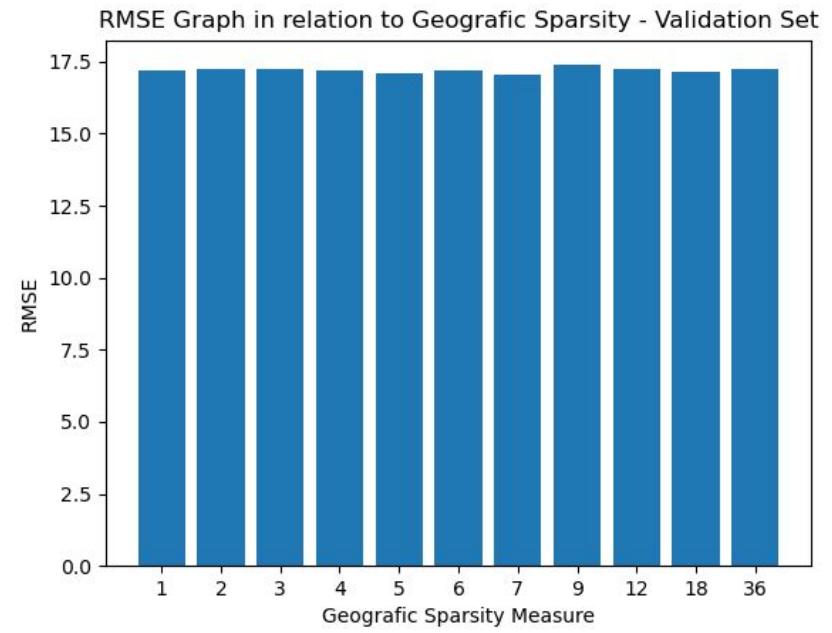
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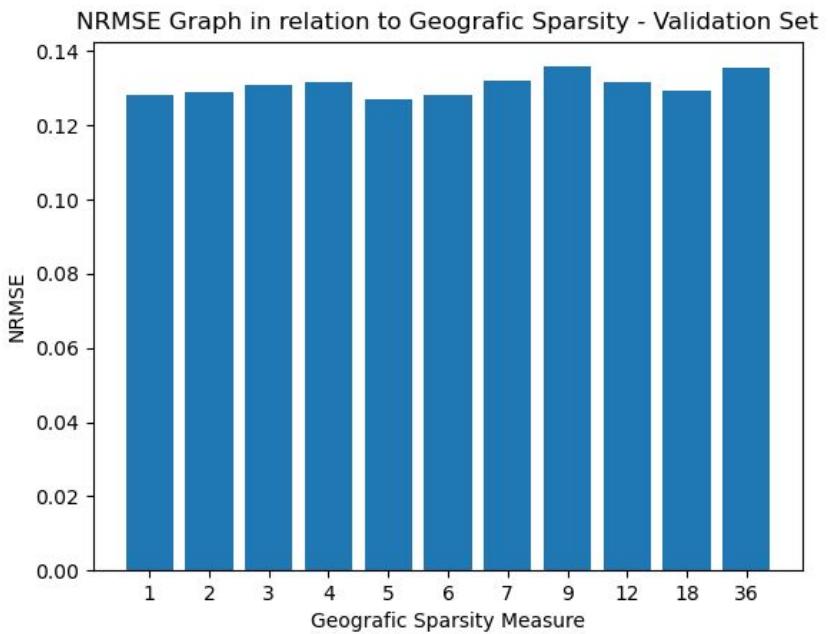
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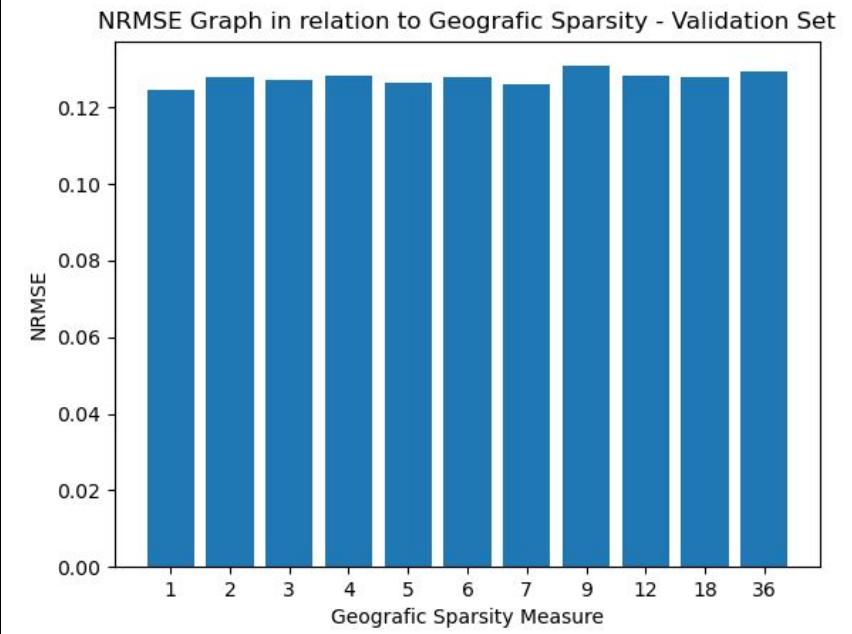
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GNN



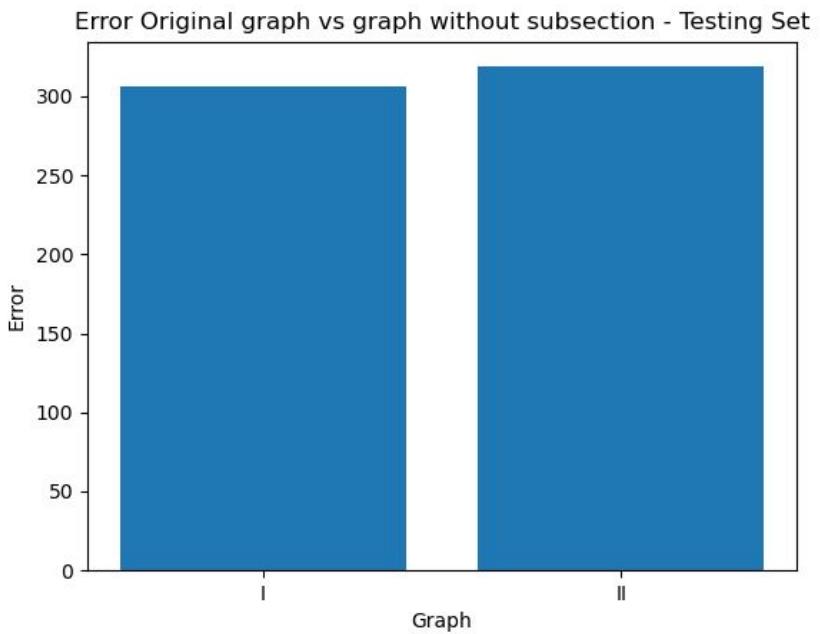
Regressão



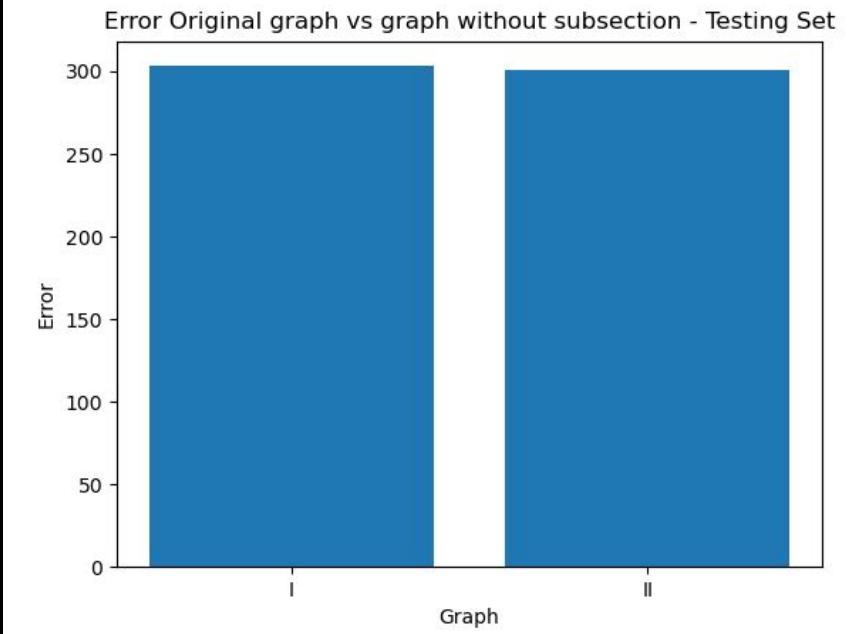
Teste de Exclusão Geográfica - Trecho 1

- Utilizou-se apenas 1/8 do dataset citado (mês de janeiro)
 - O restante do dataset serviu para maior precisão na interpolação dos dados faltantes
 - “I” é o grafo original e “II” o grafo após a exclusão do trecho
-

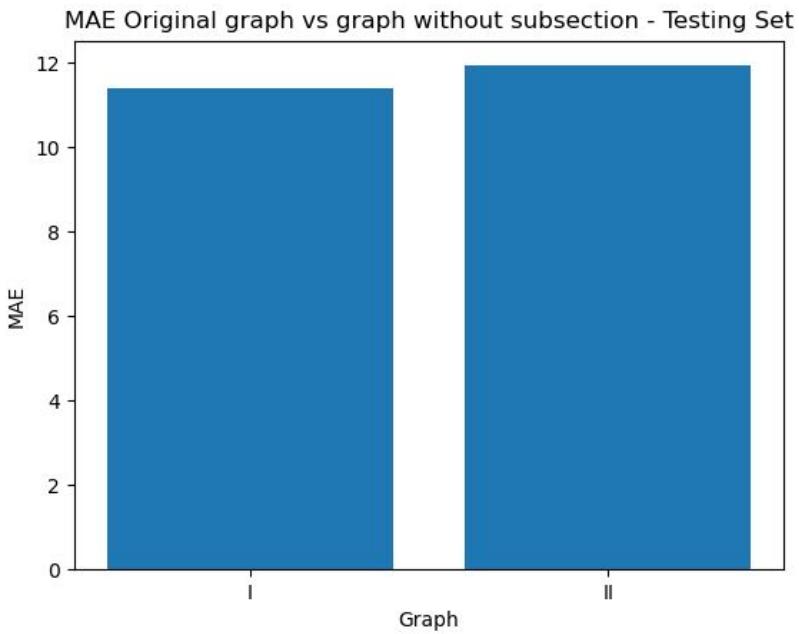
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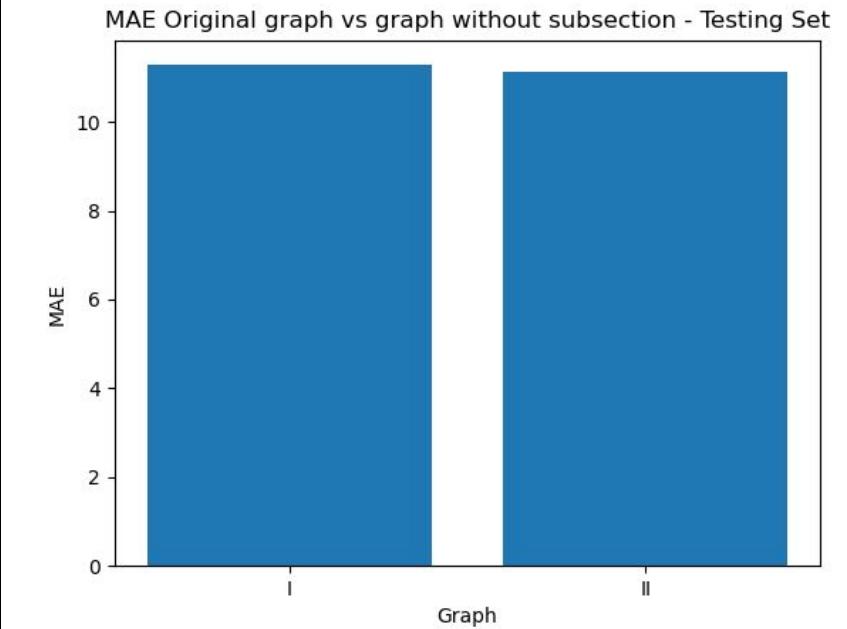
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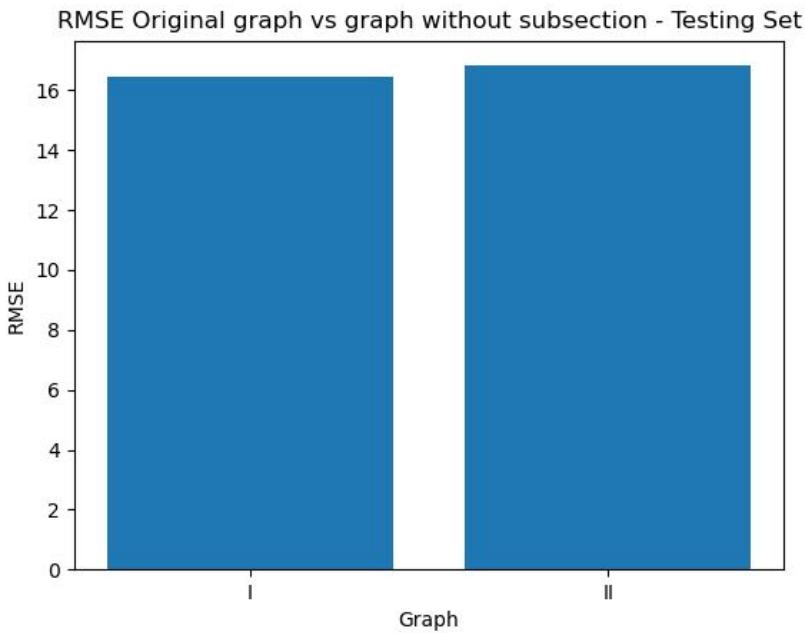
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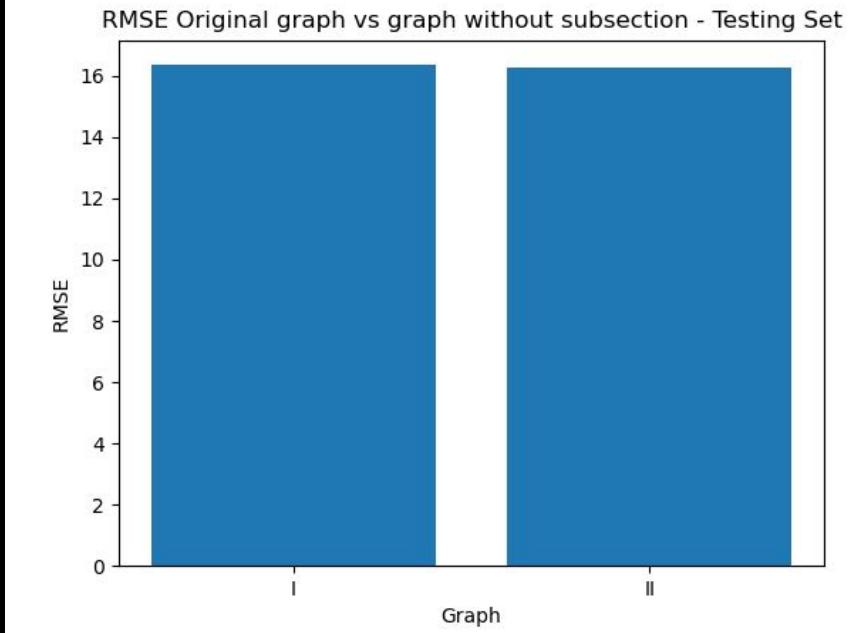
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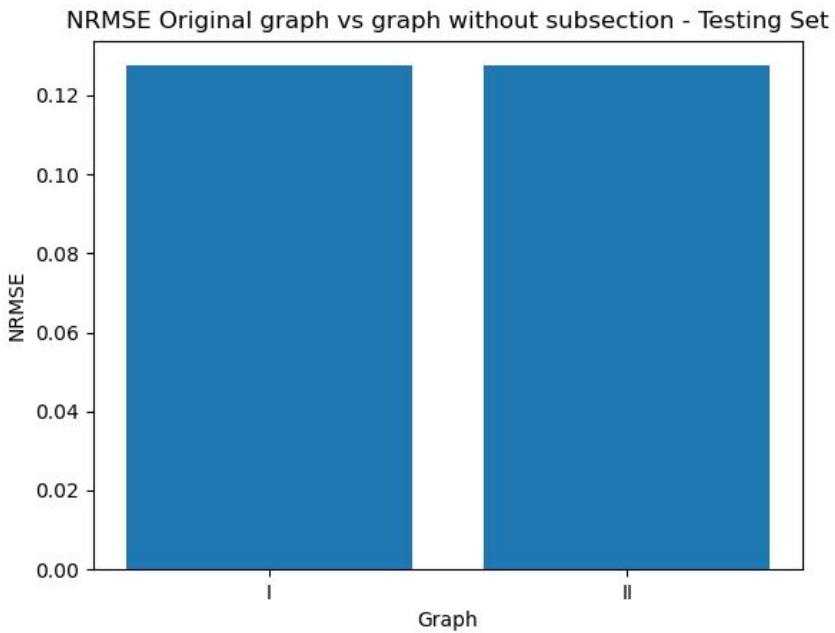
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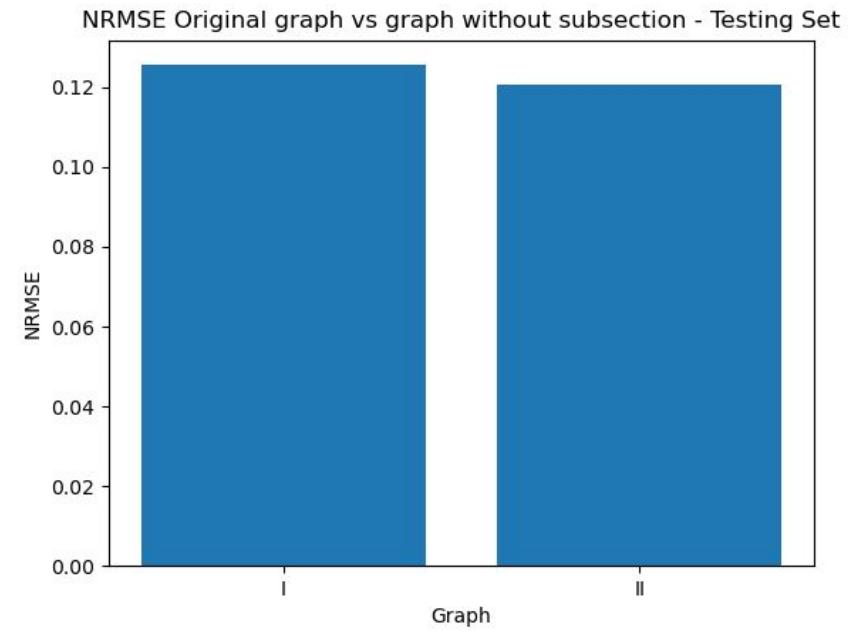
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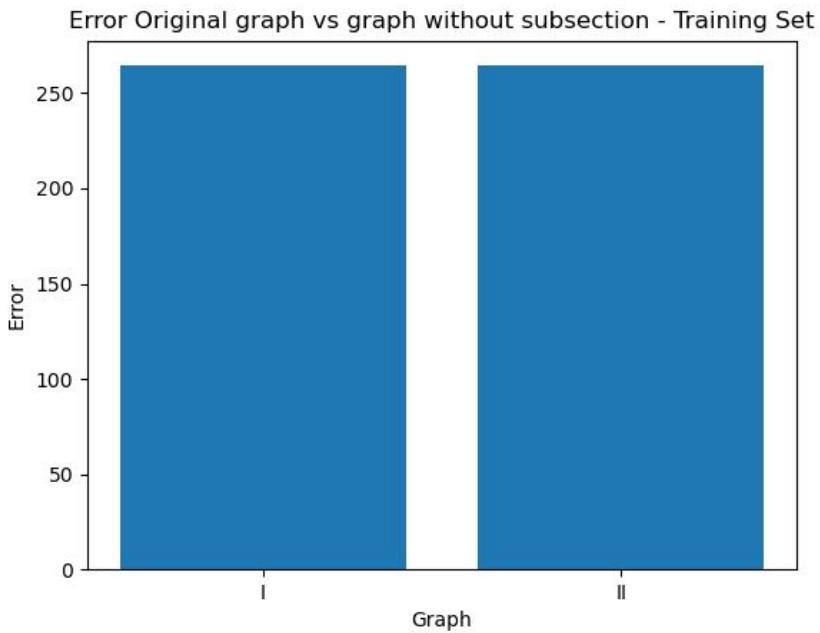
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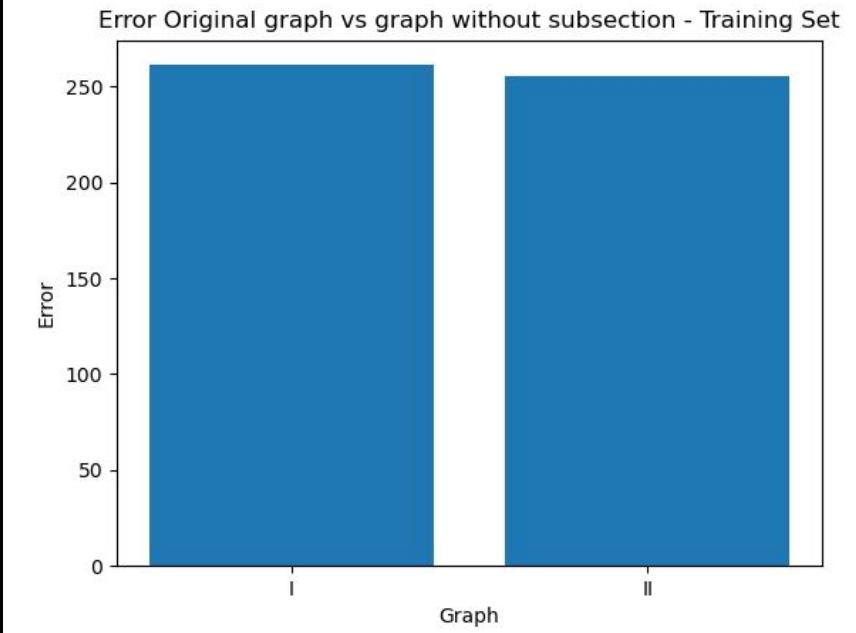
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GNN

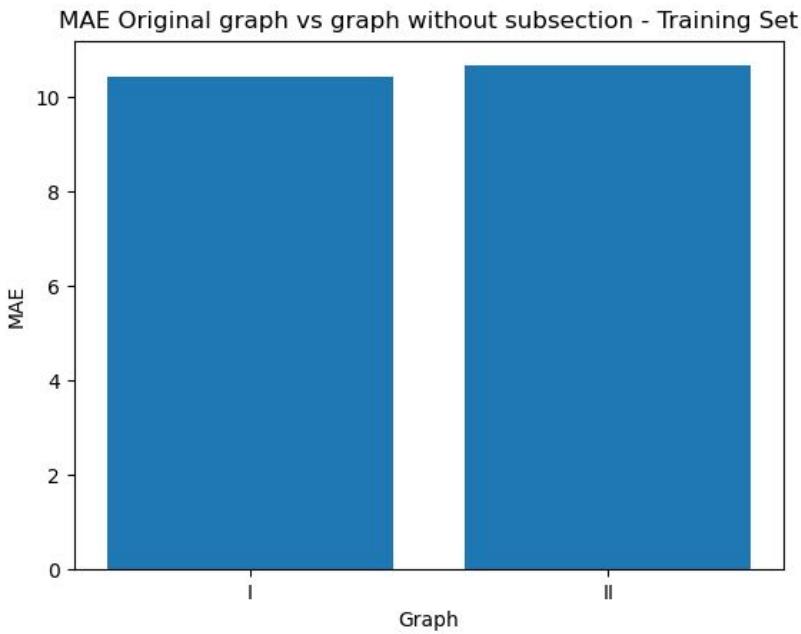


Regressão

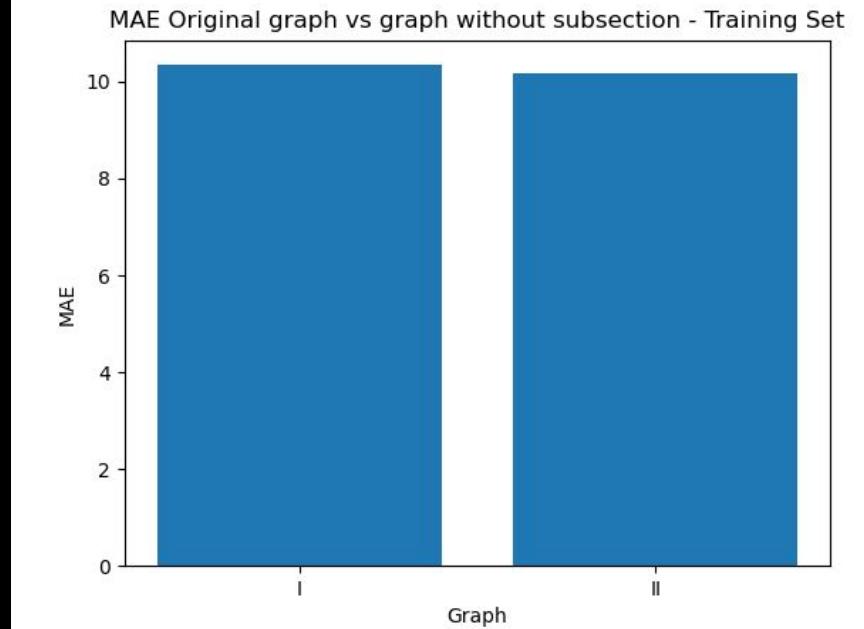


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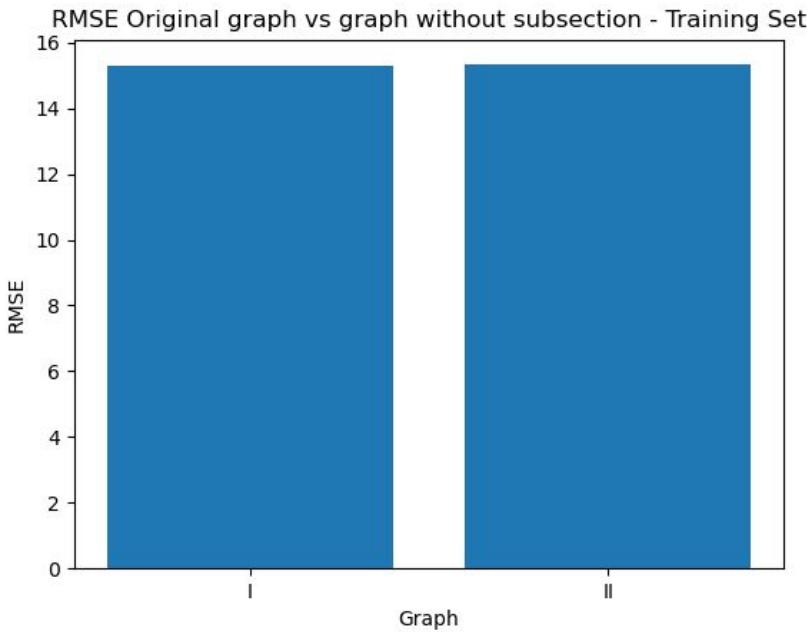
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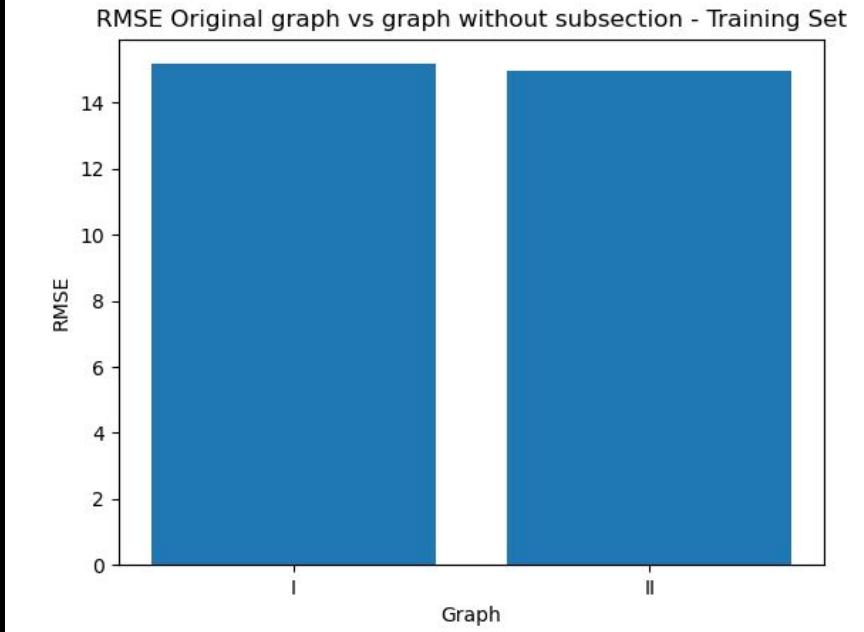
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GNN

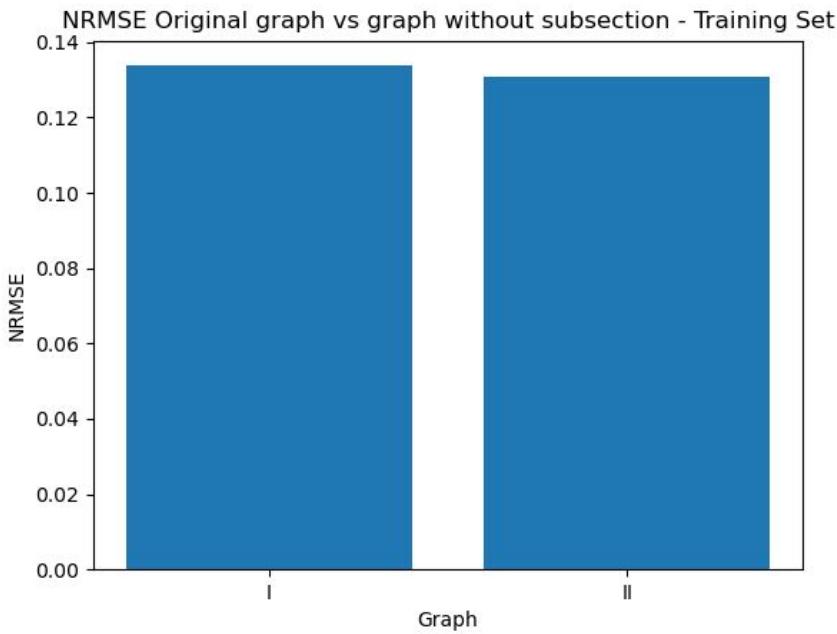


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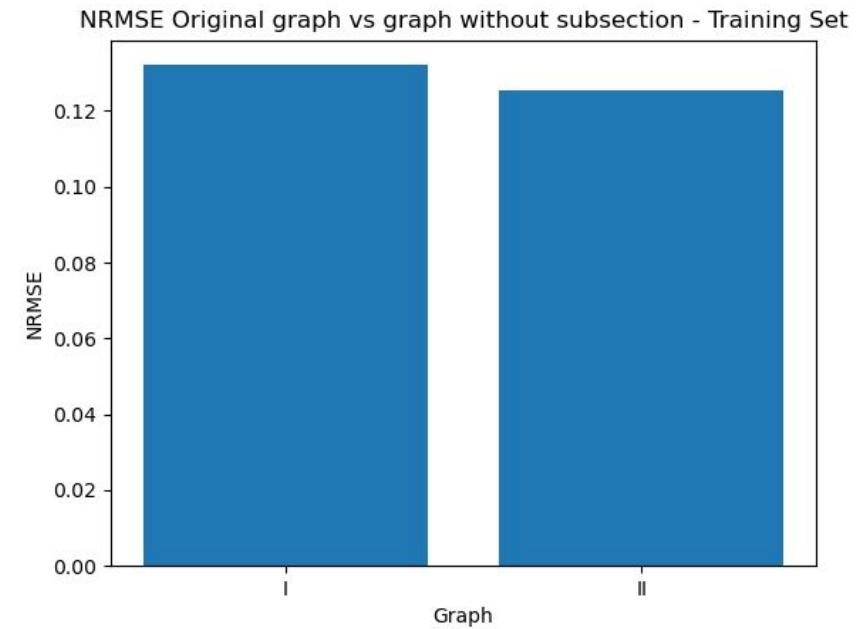


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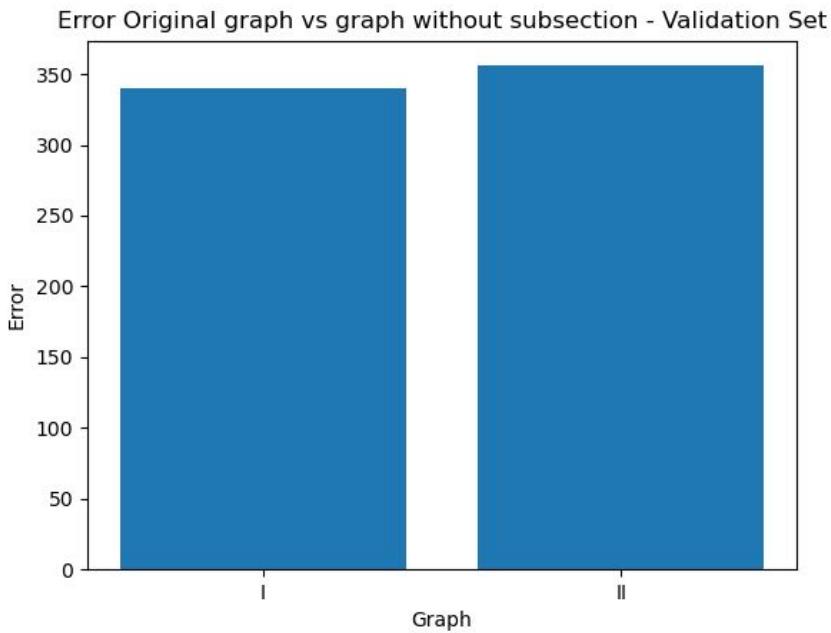
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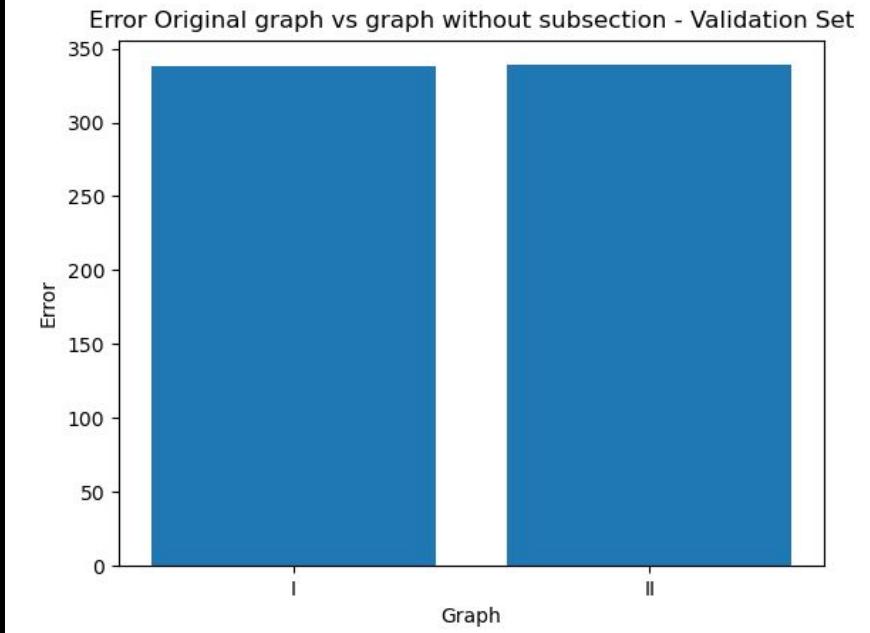
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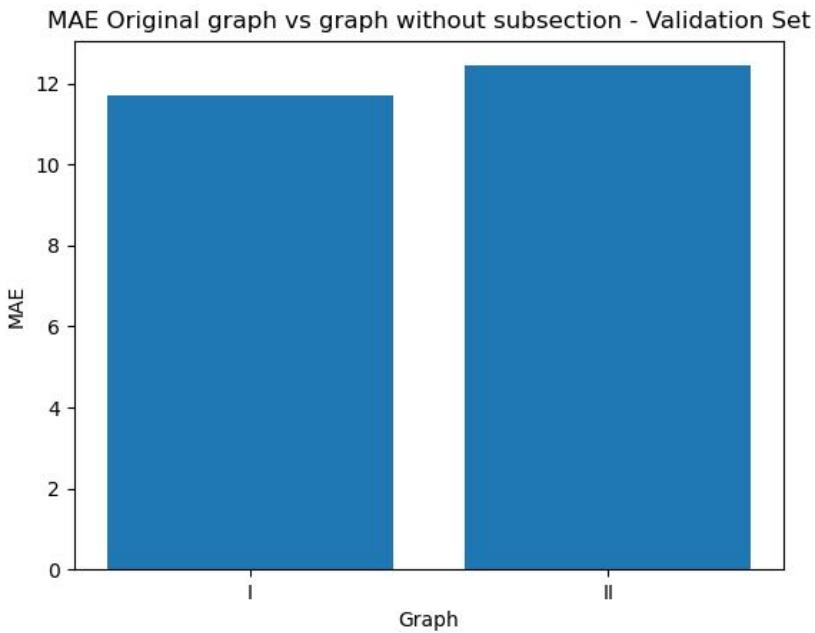
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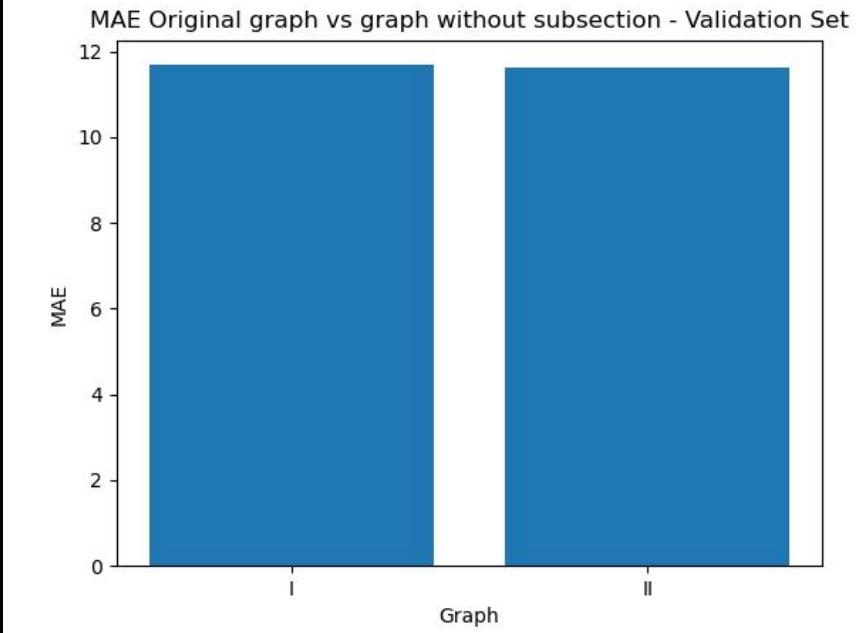
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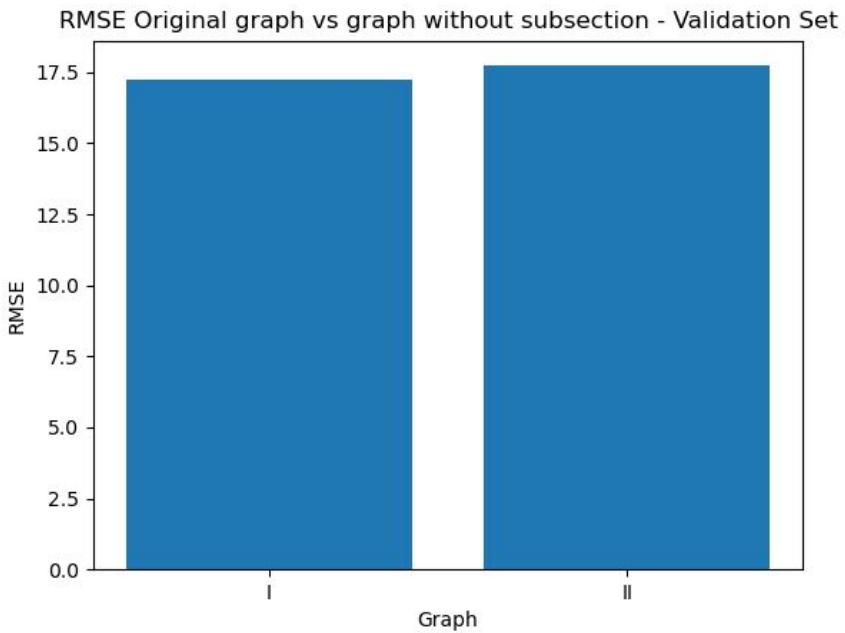
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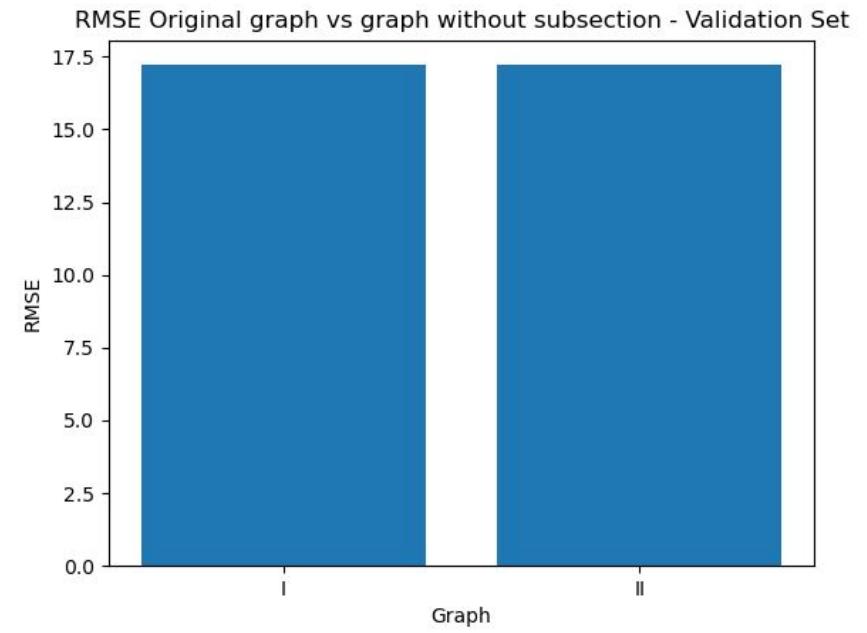
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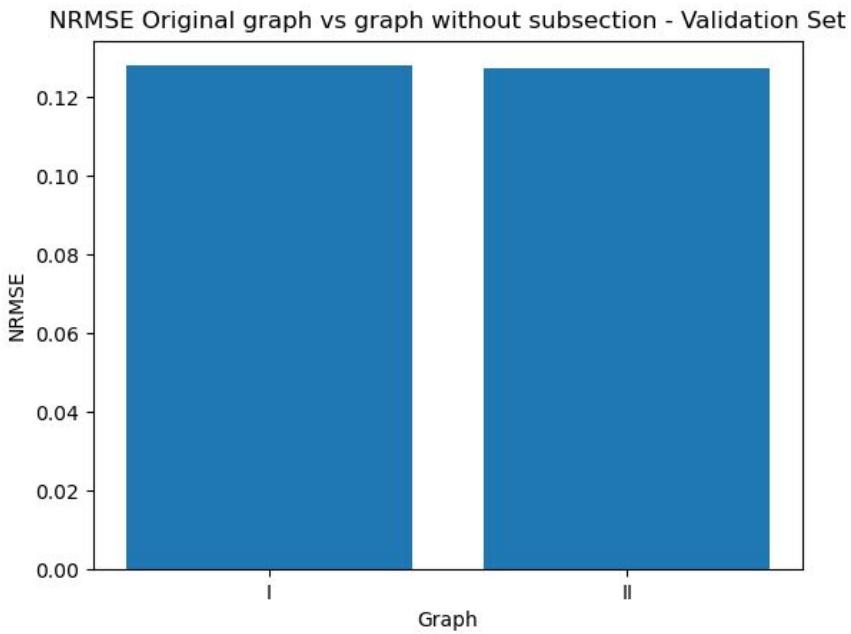
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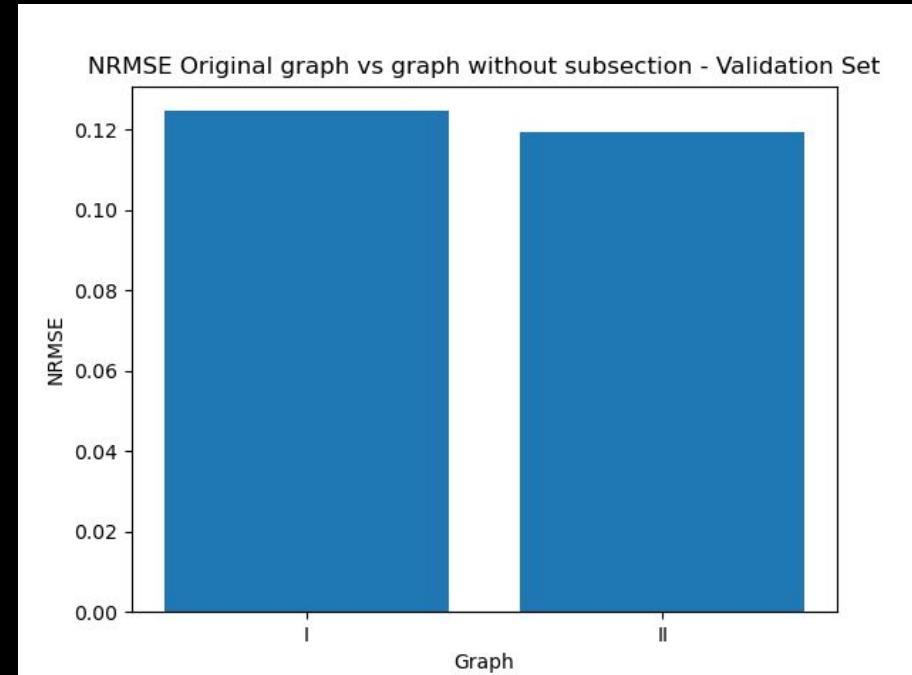
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GNN



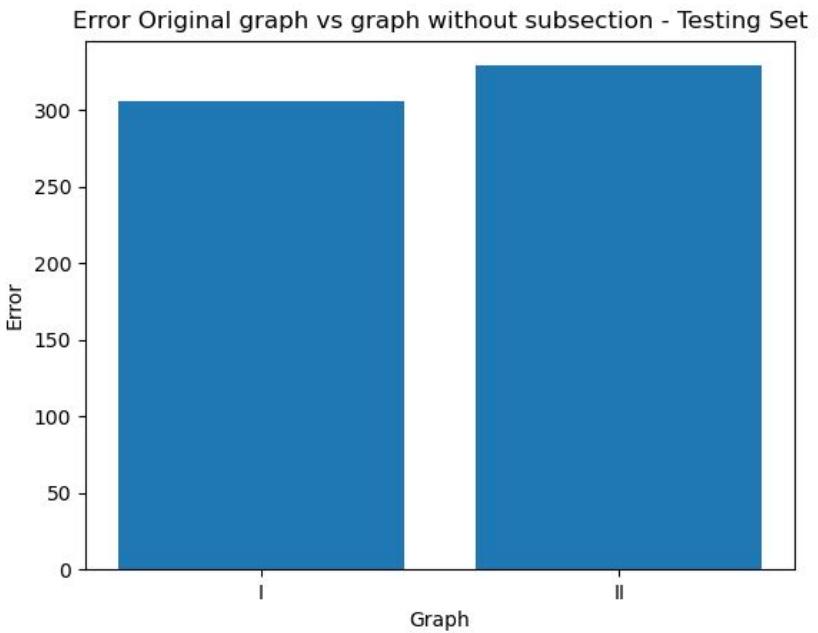
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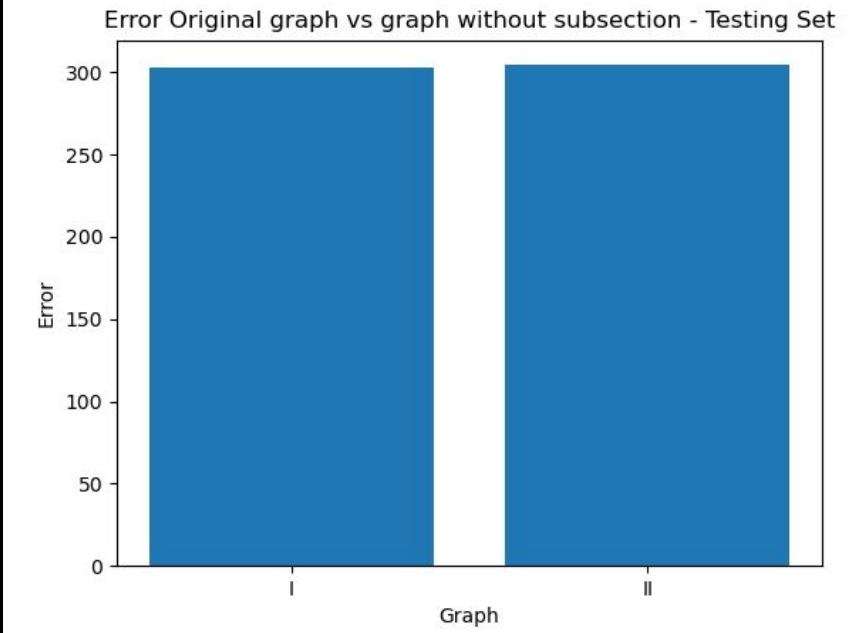
Teste de Exclusão Geográfica - Trecho 2

- Utilizou-se apenas 1/8 do dataset citado (mês de janeiro)
 - O restante do dataset serviu para maior precisão na interpolação dos dados faltantes
 - “I” é o grafo original e “II” o grafo após a exclusão do trecho
-

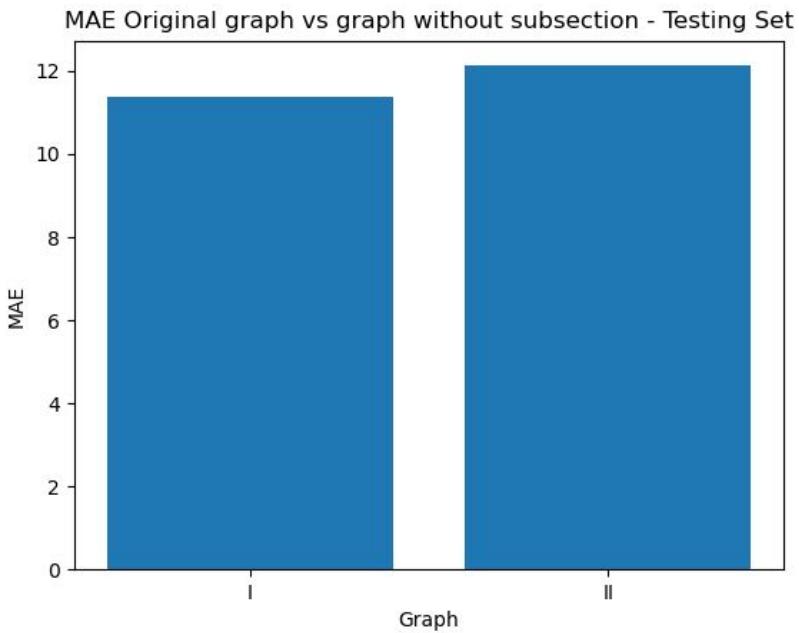
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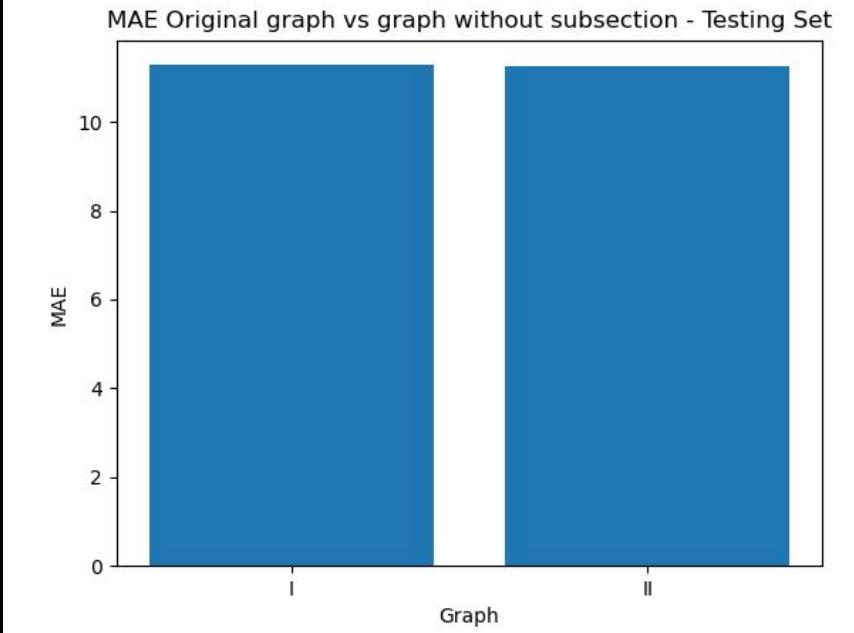
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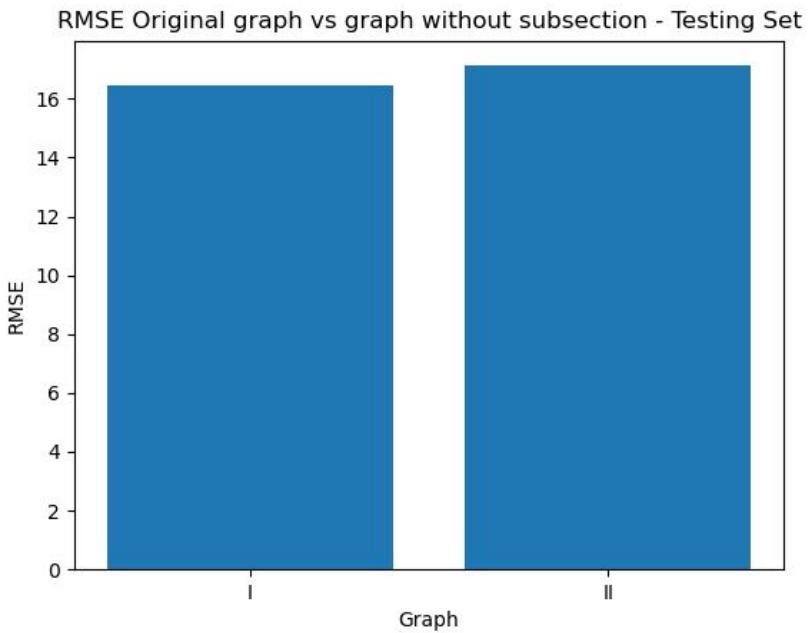
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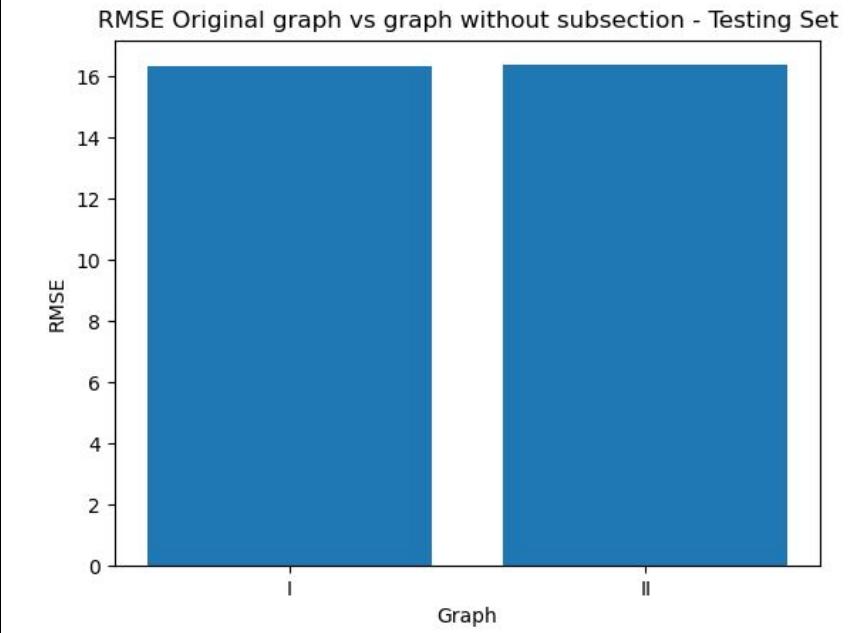
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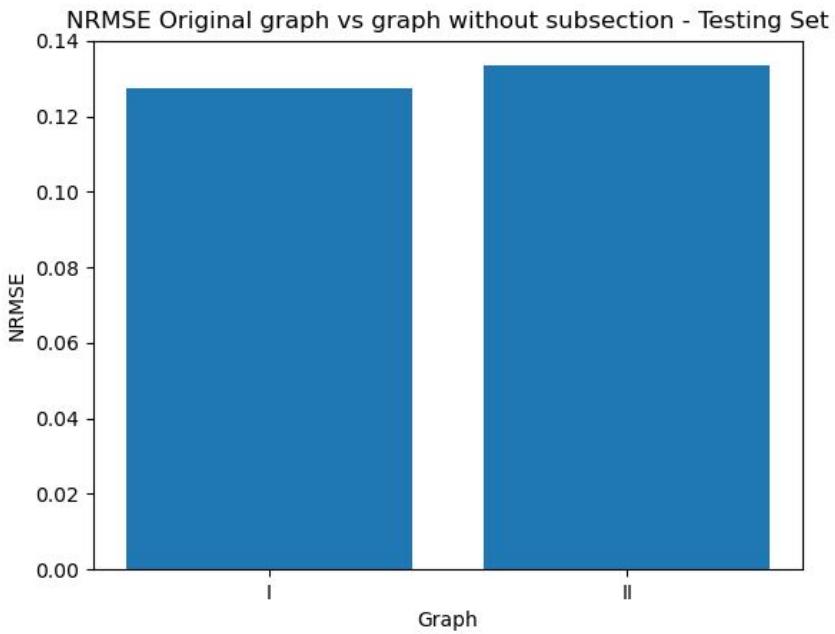
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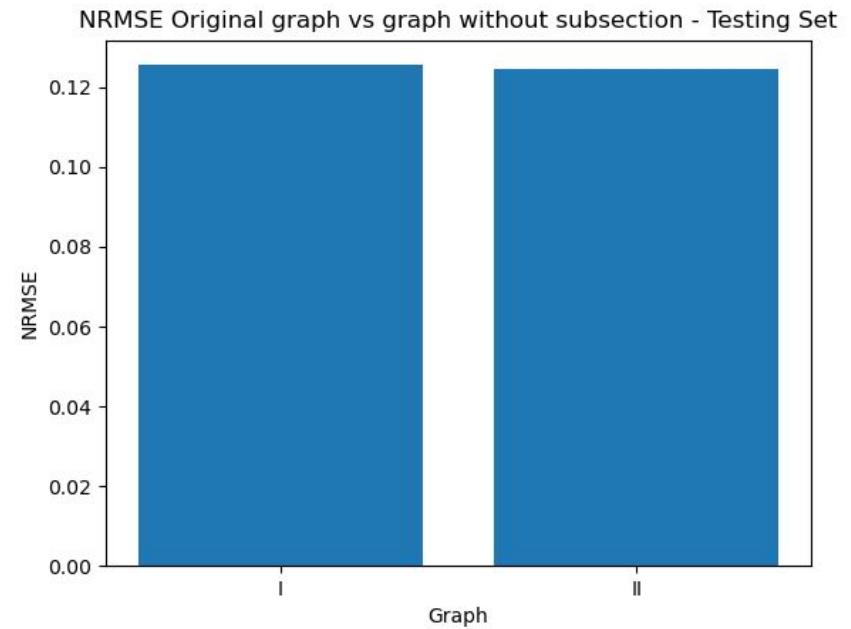
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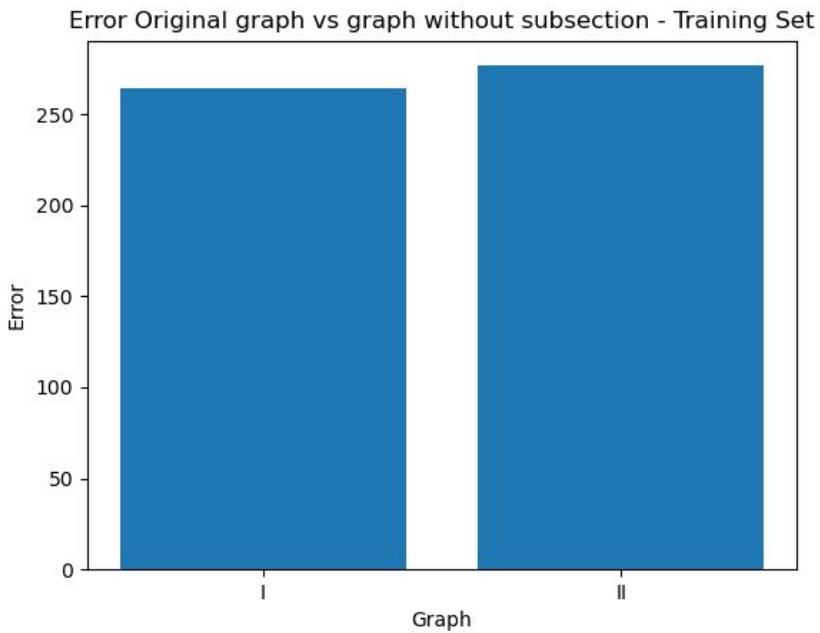
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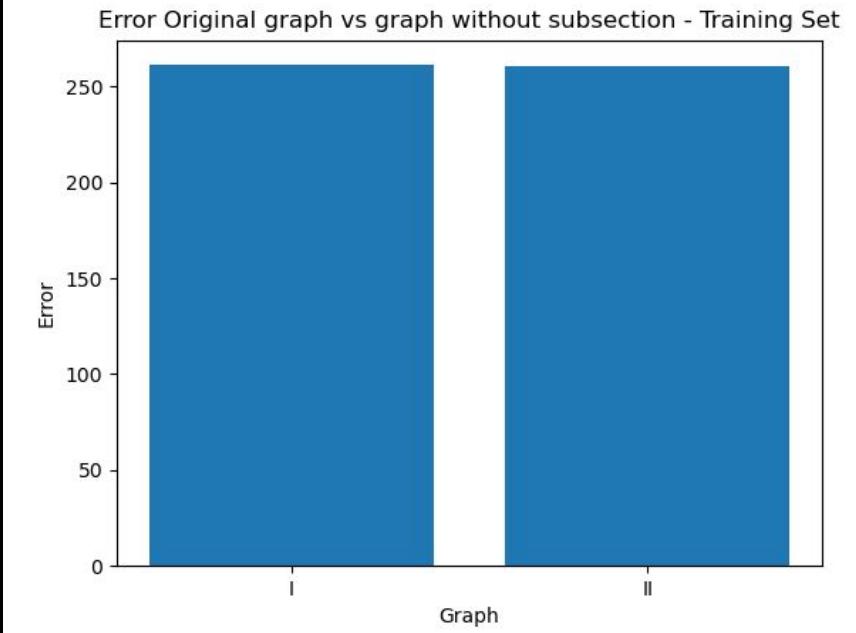
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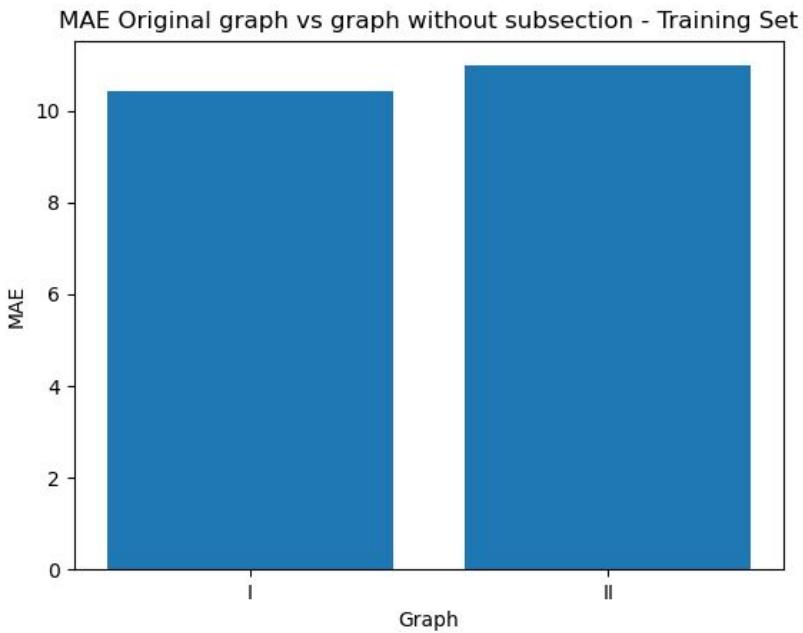
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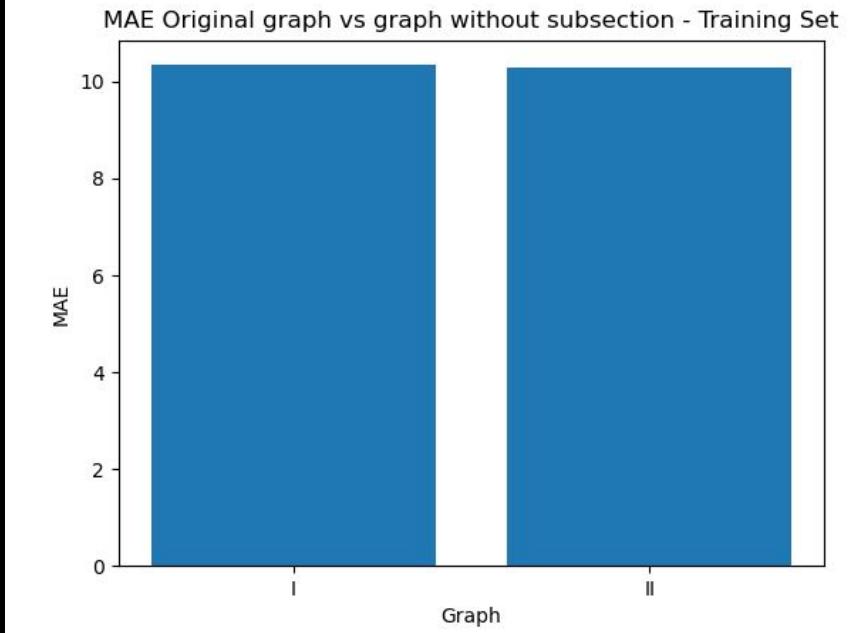
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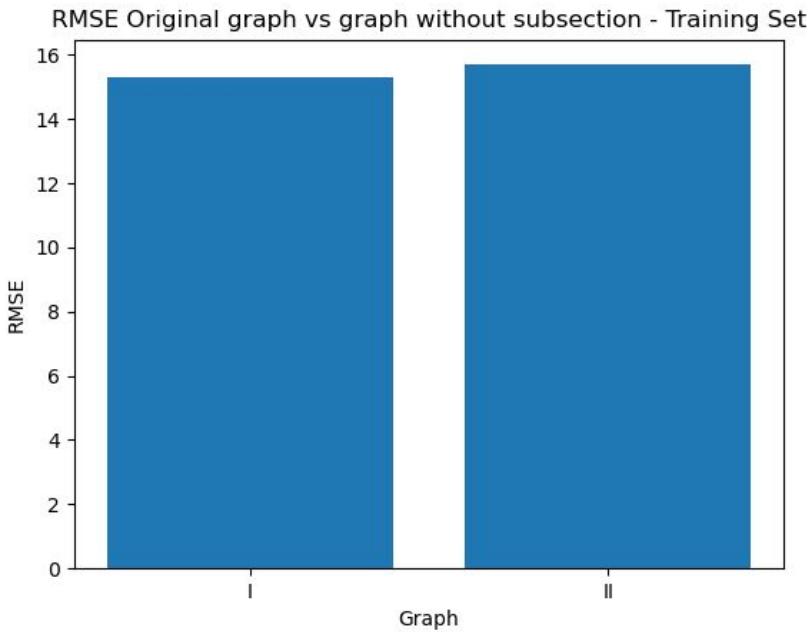
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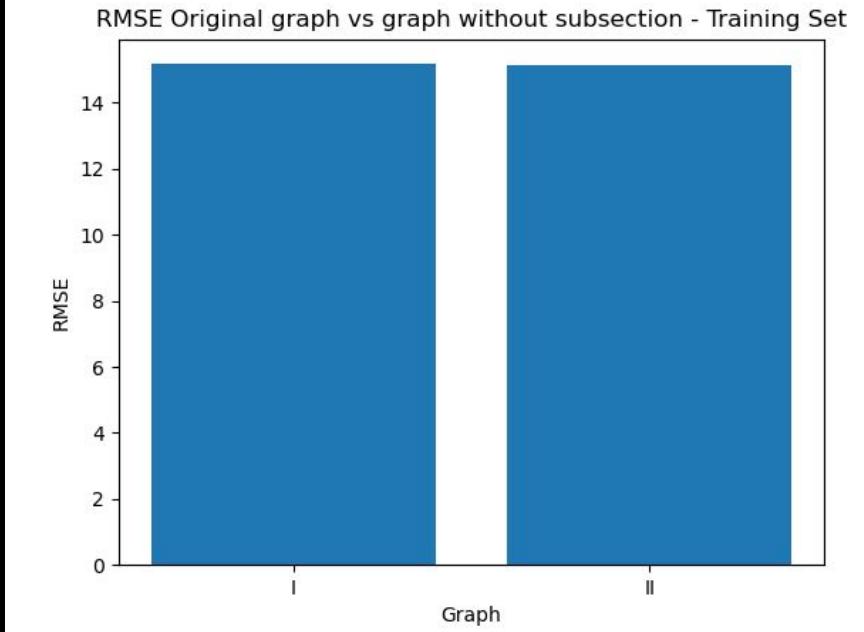
Regressão



GNN

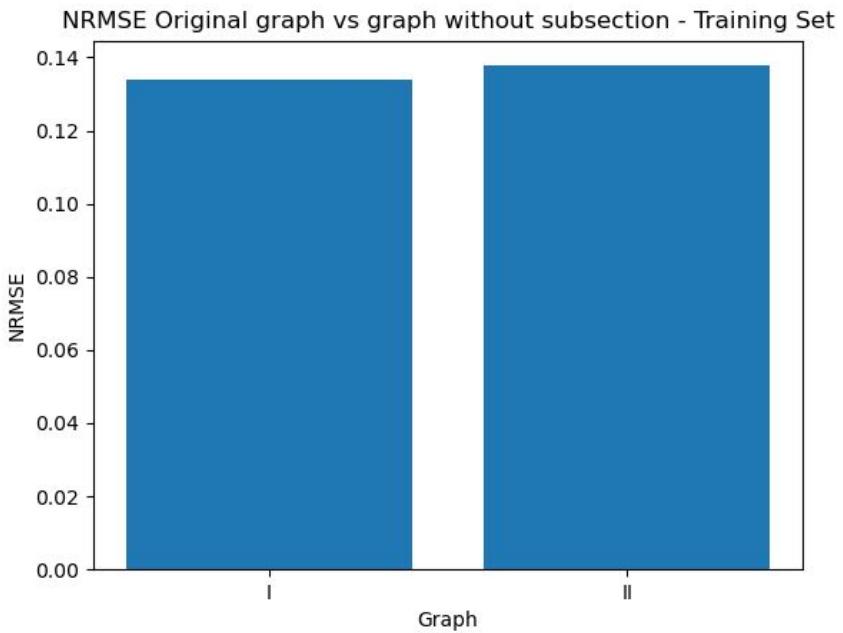


Regressão

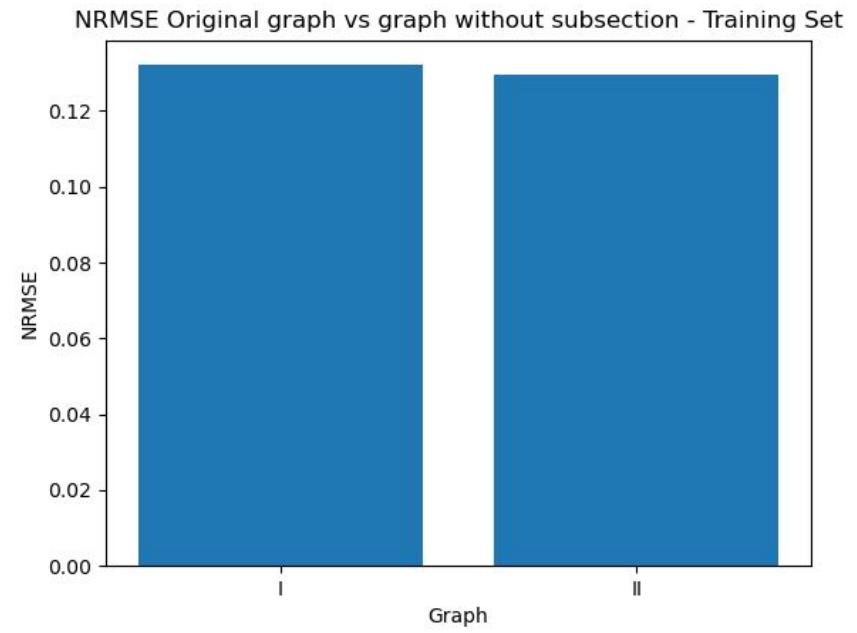


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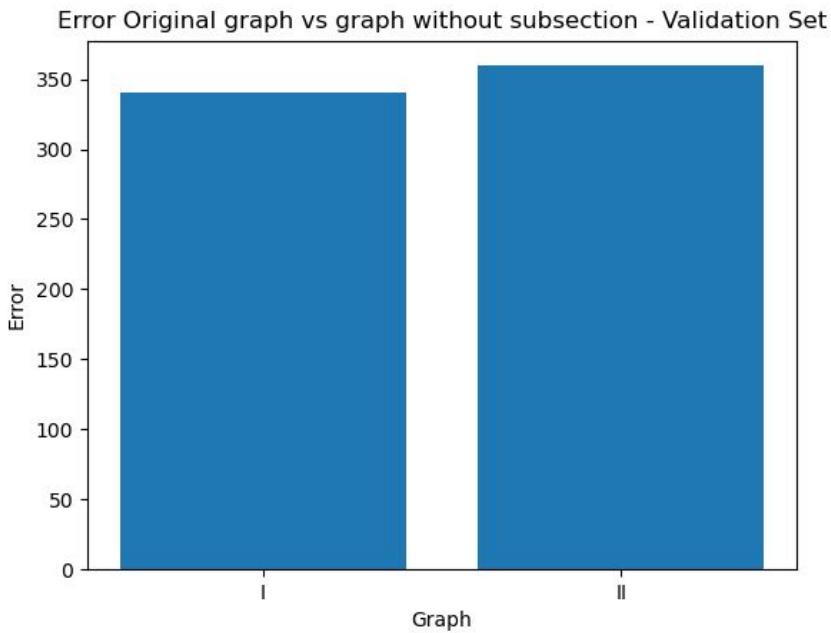
GNN



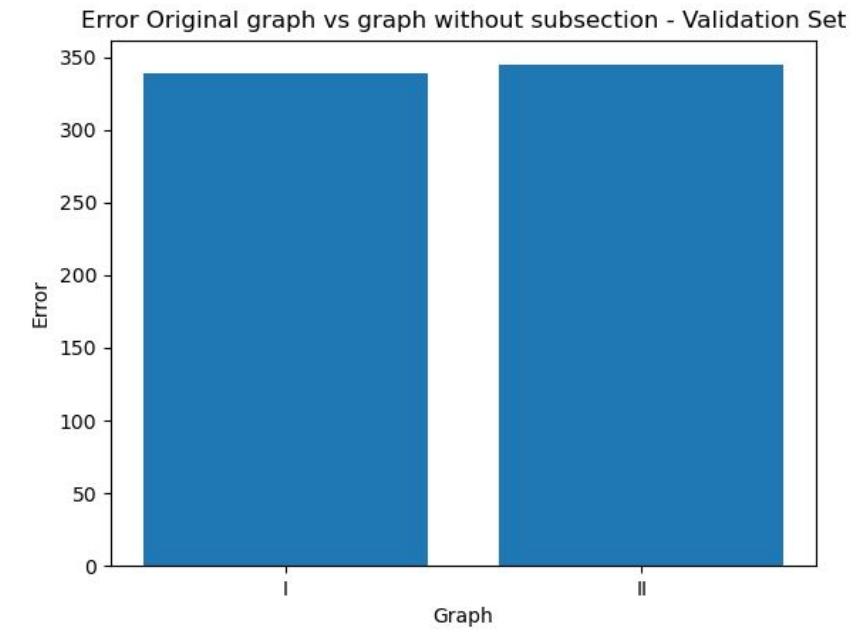
Regressão



GNN

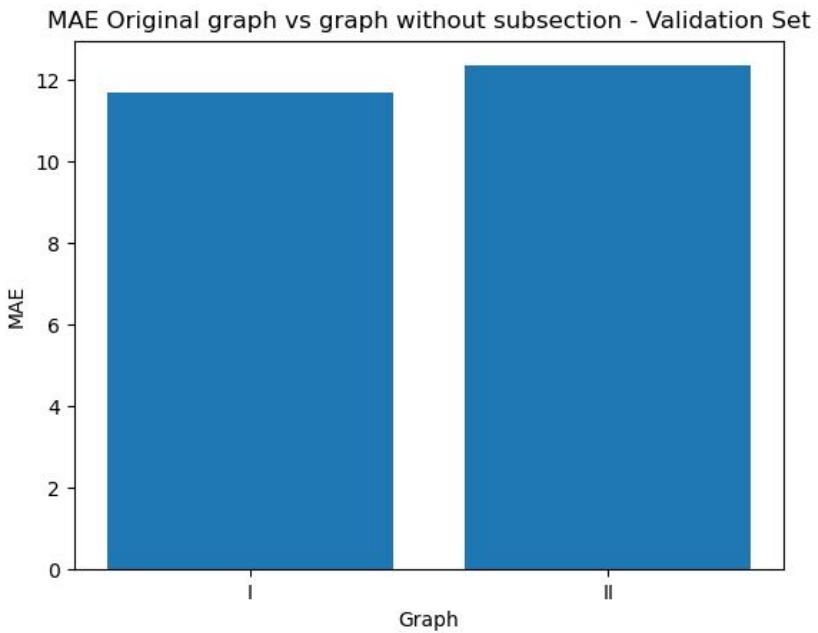


Regressão

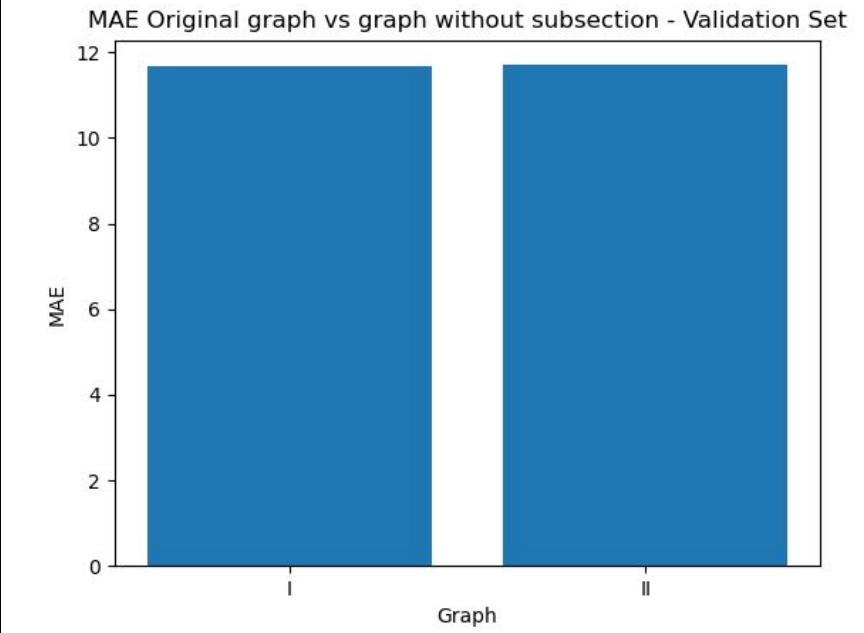


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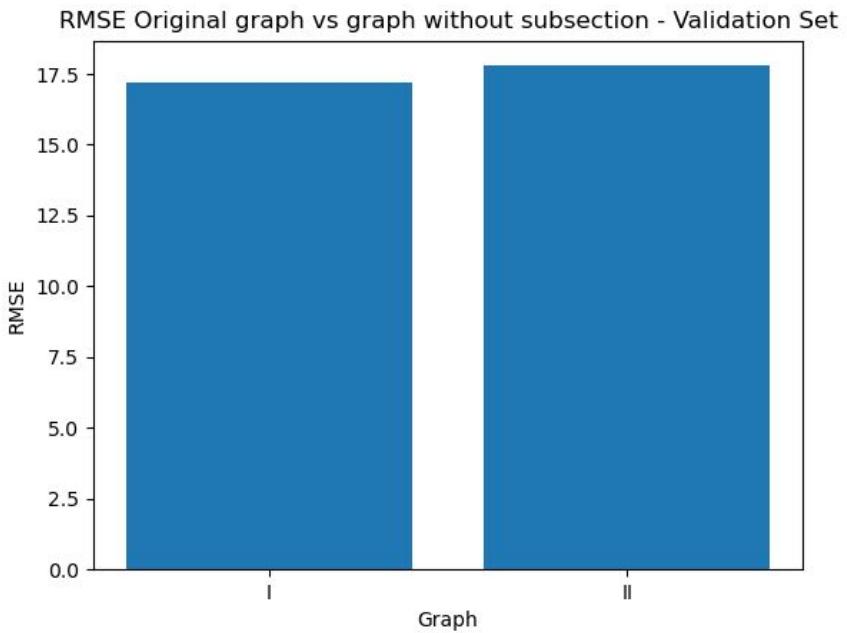
GNN



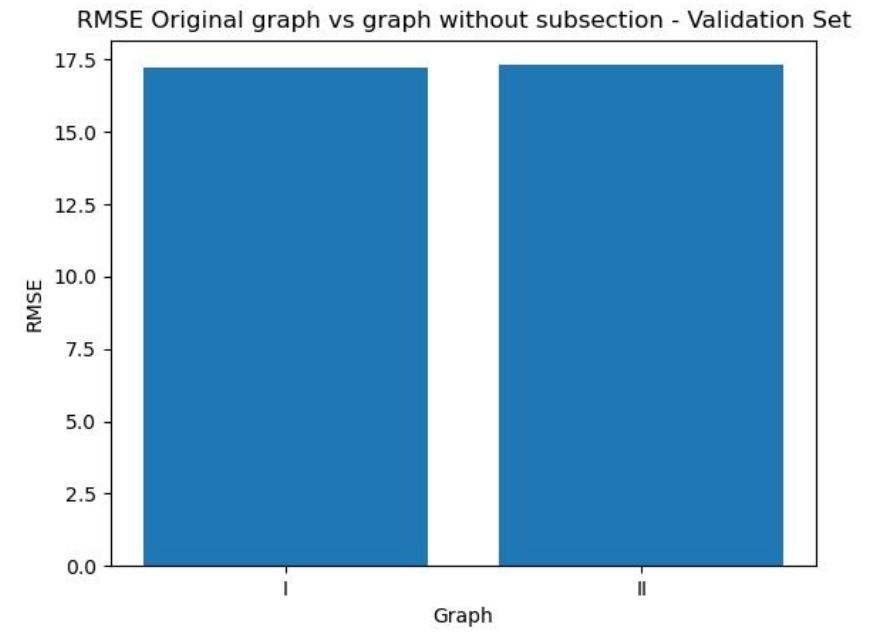
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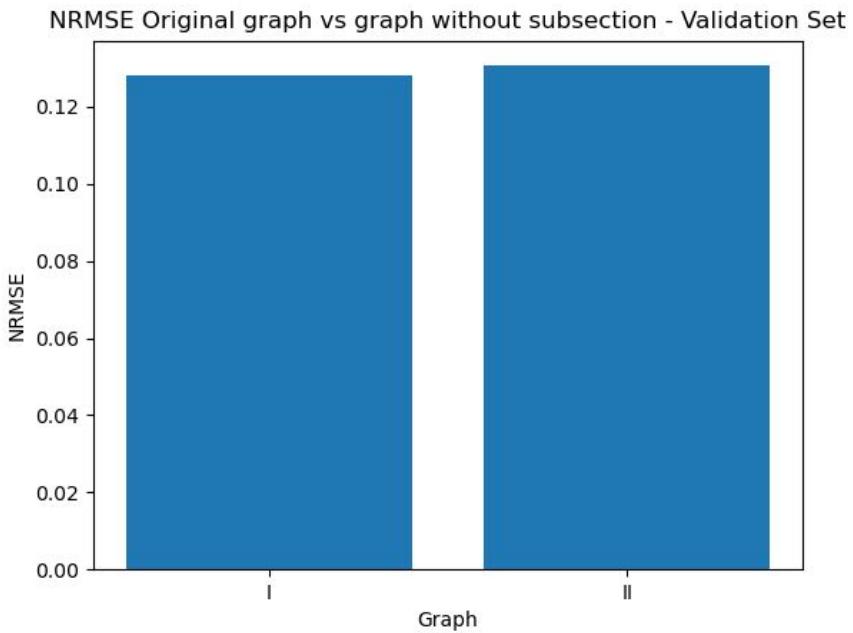
GNN



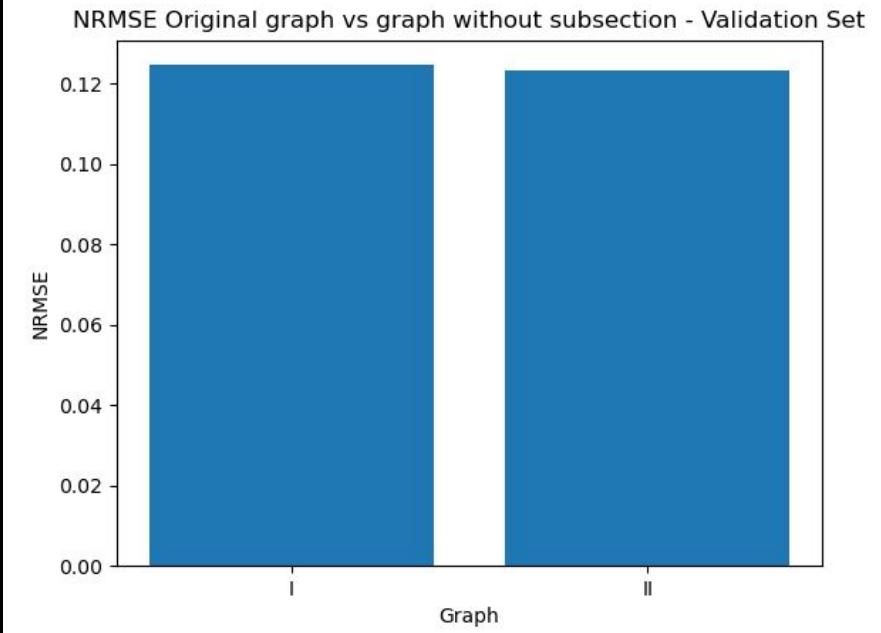
Regressão



GNN



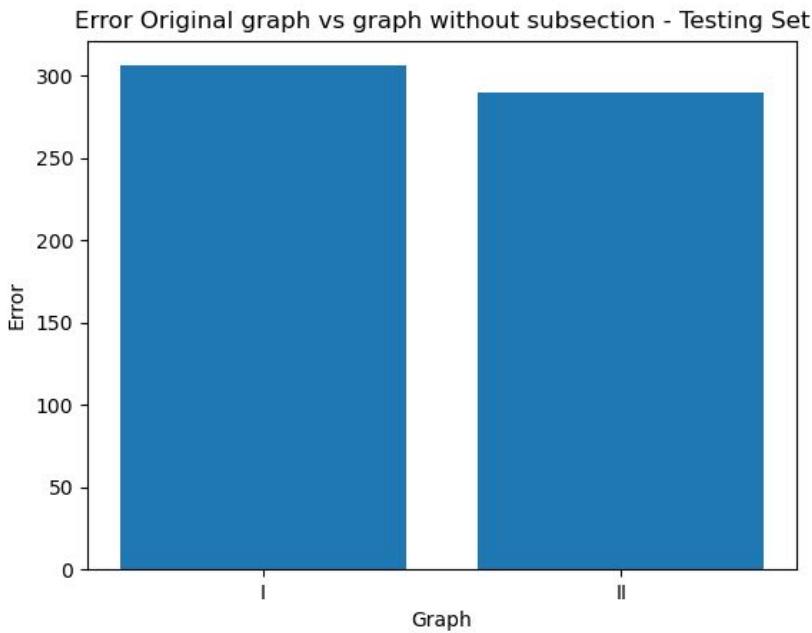
Regressão



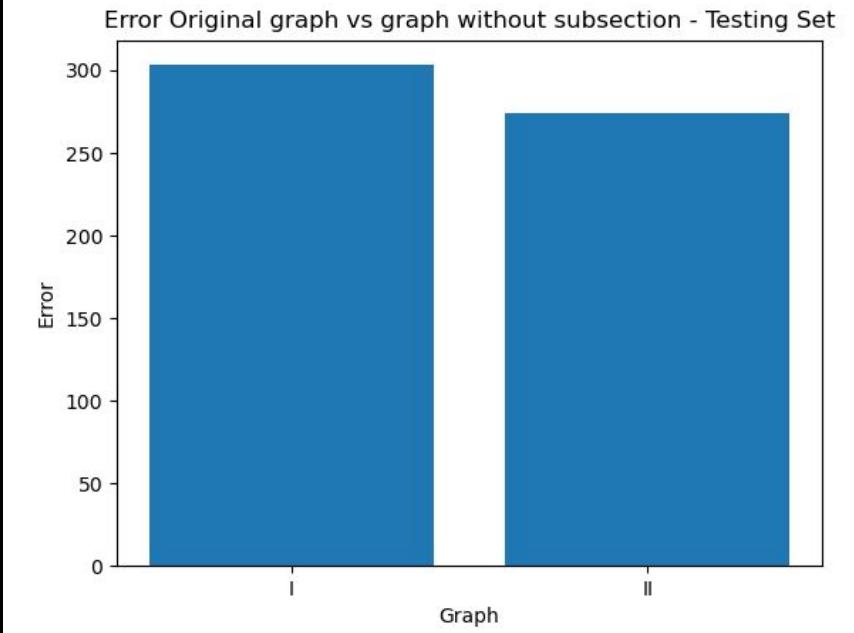
Teste de Exclusão Geográfica - Trecho 1 + 2

- Utilizou-se apenas 1/8 do dataset citado (mês de janeiro)
 - O restante do dataset serviu para maior precisão na interpolação dos dados faltantes
 - “I” é o grafo original e “II” o grafo após a exclusão do trecho
-

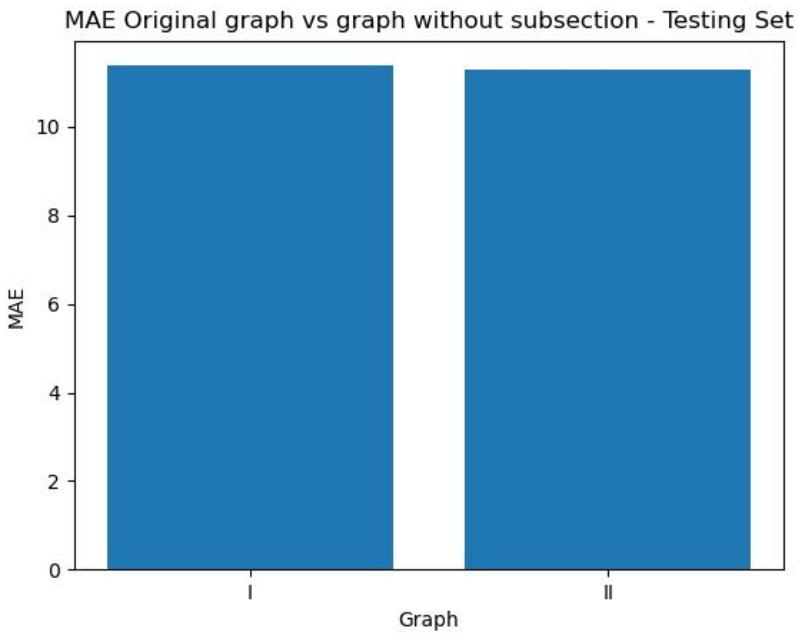
GNN



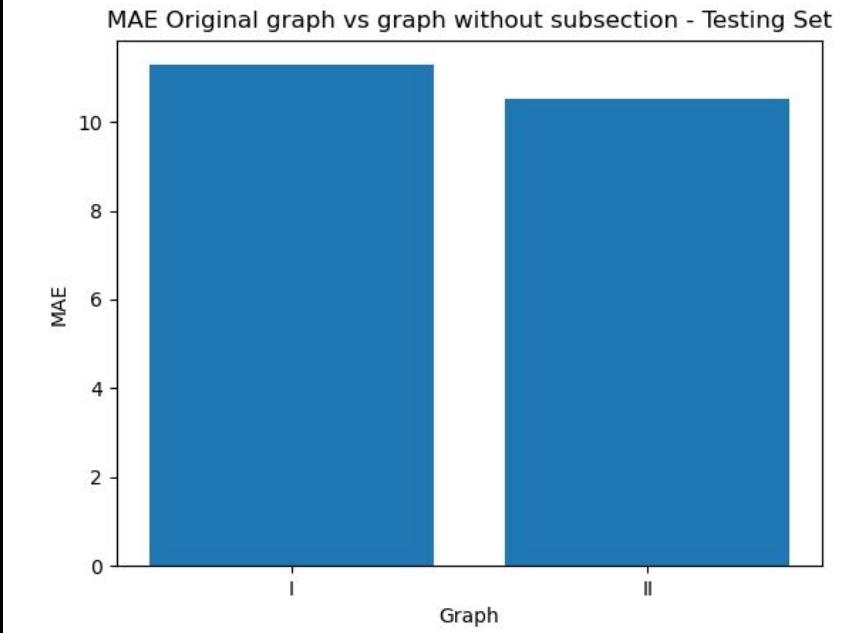
Regressão



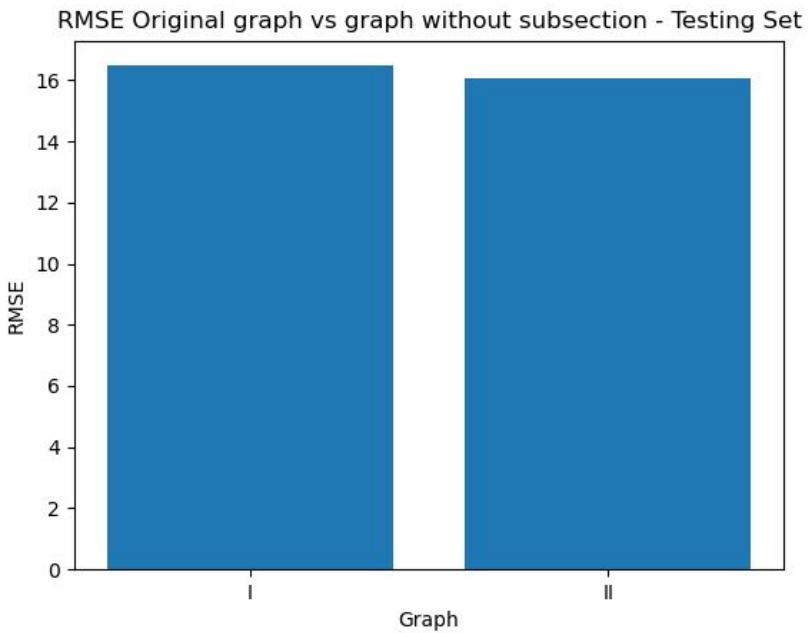
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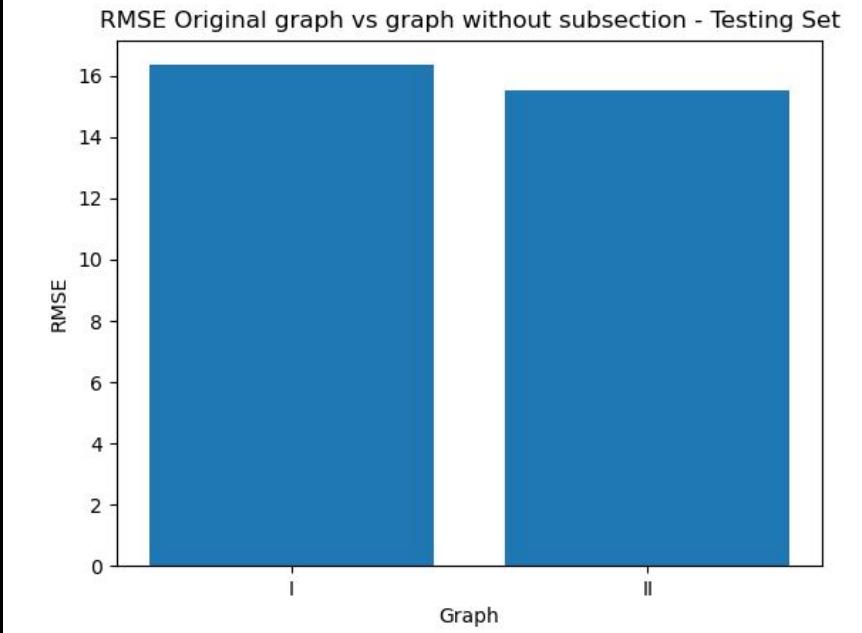
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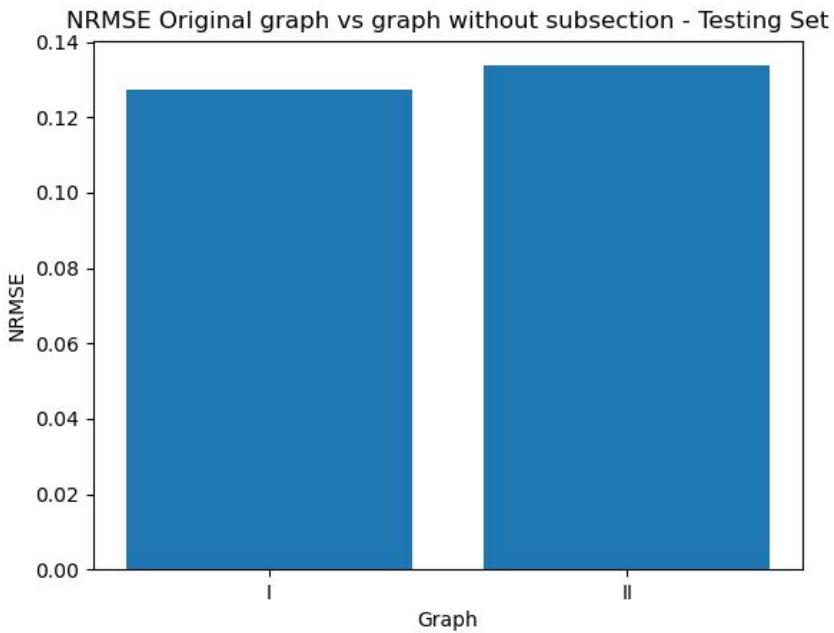
GNN



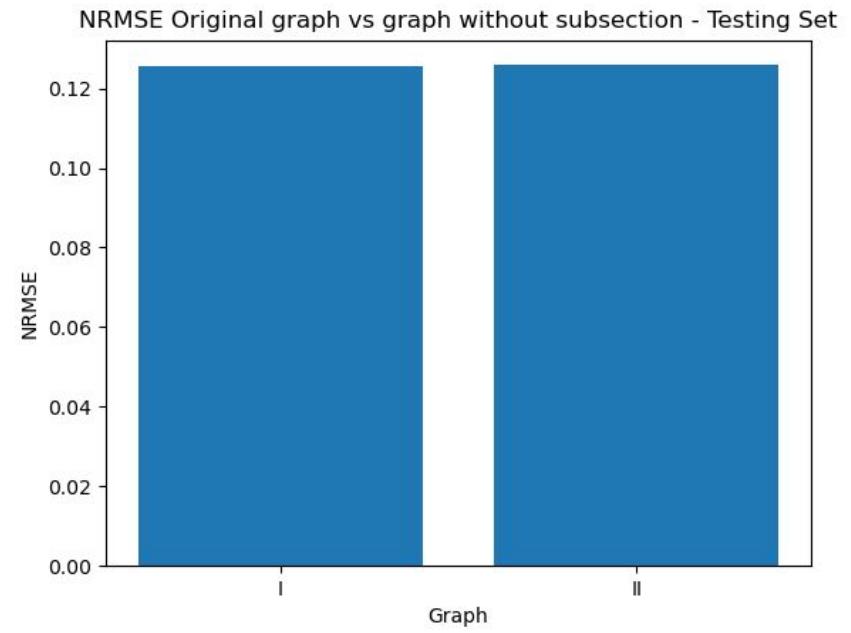
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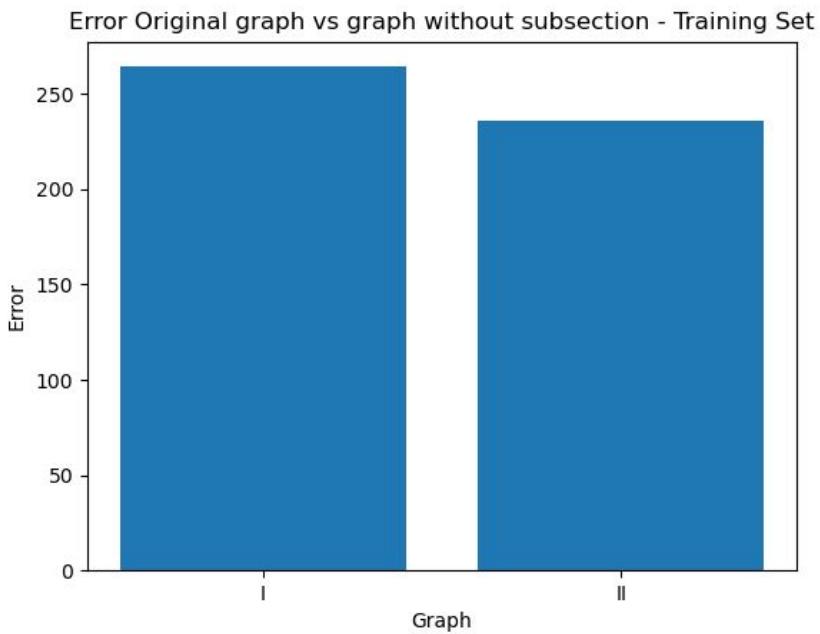
GNN



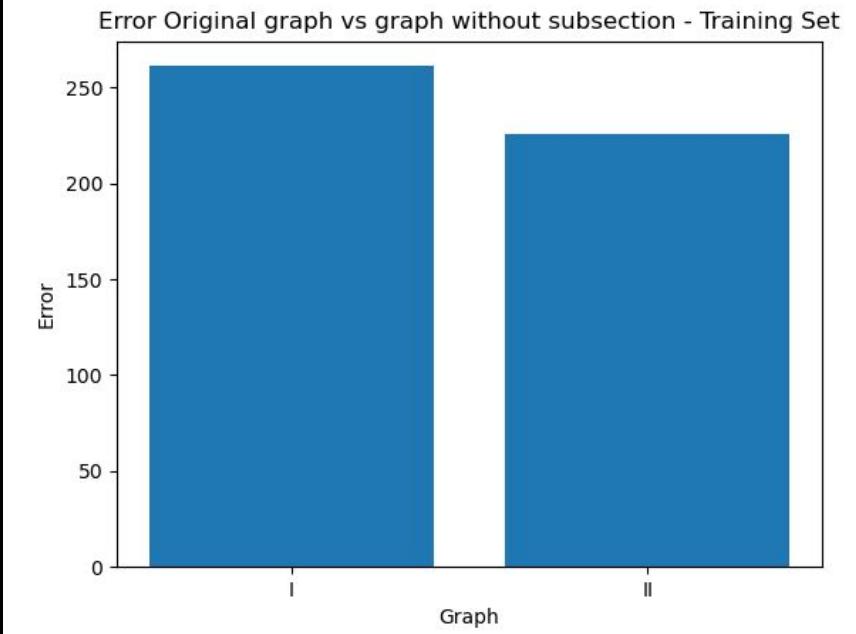
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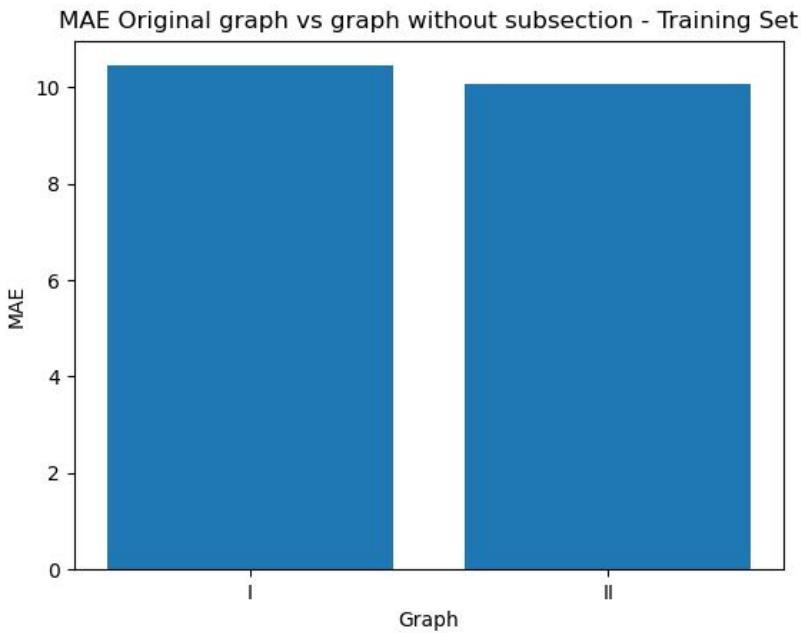
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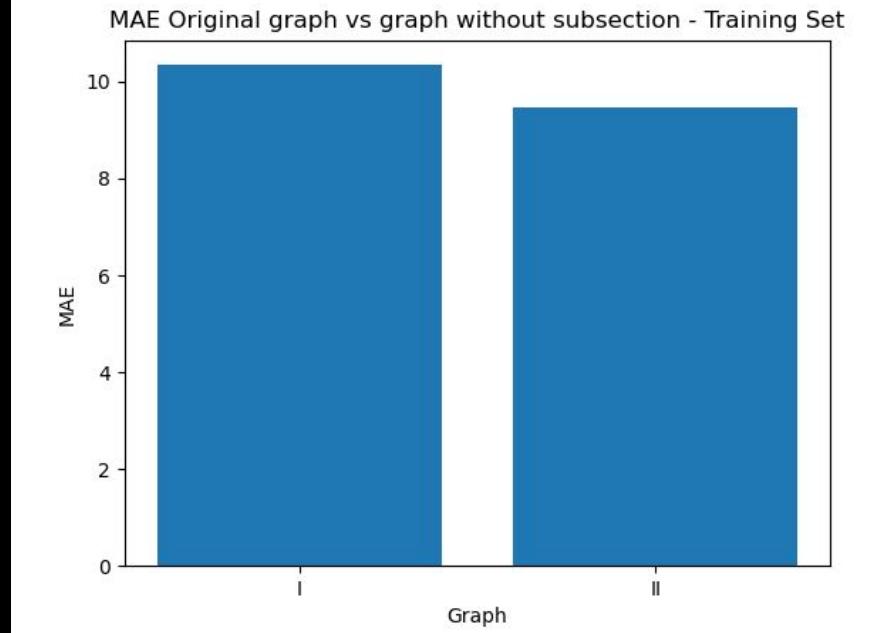
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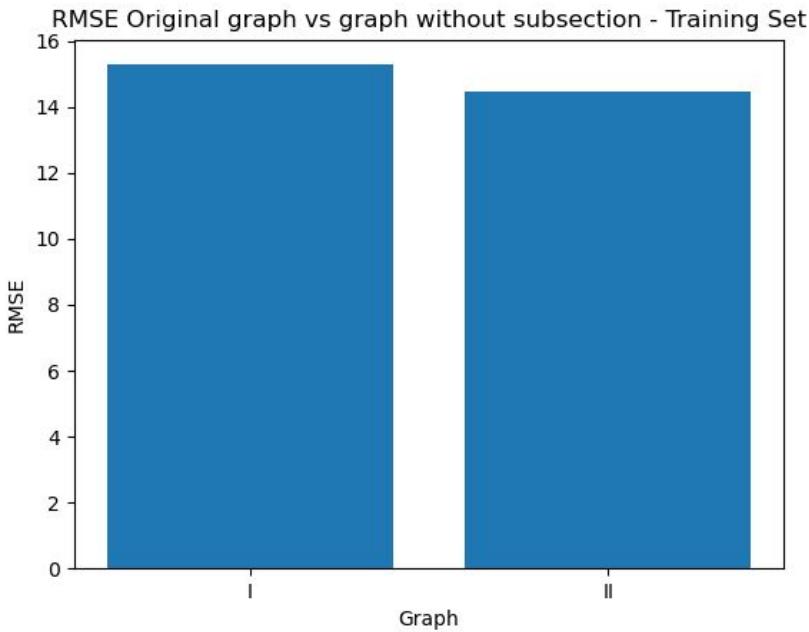
GNN



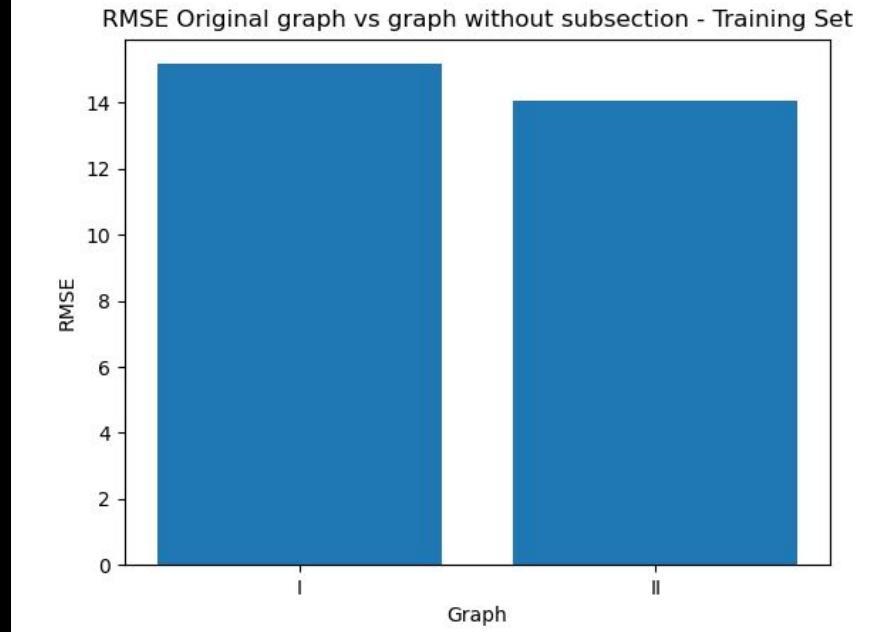
Regressão



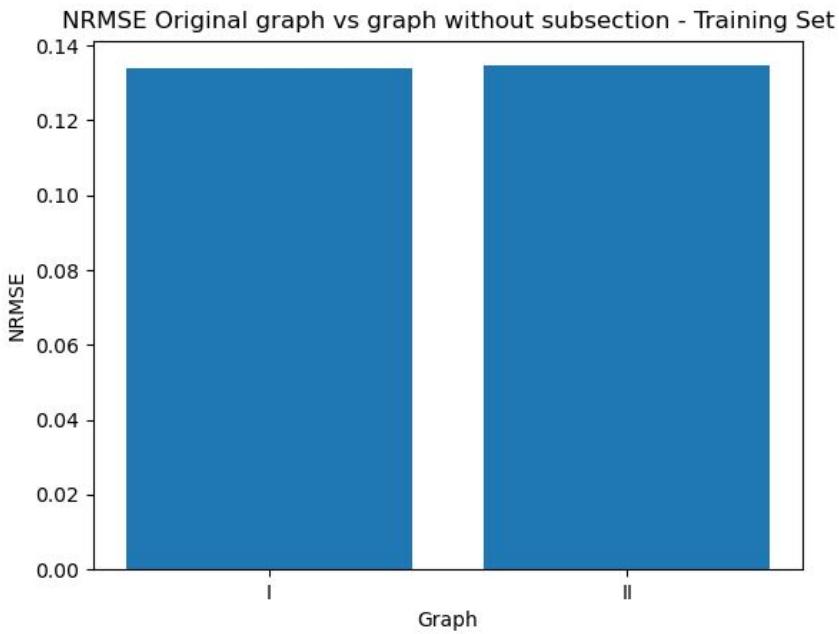
GNN



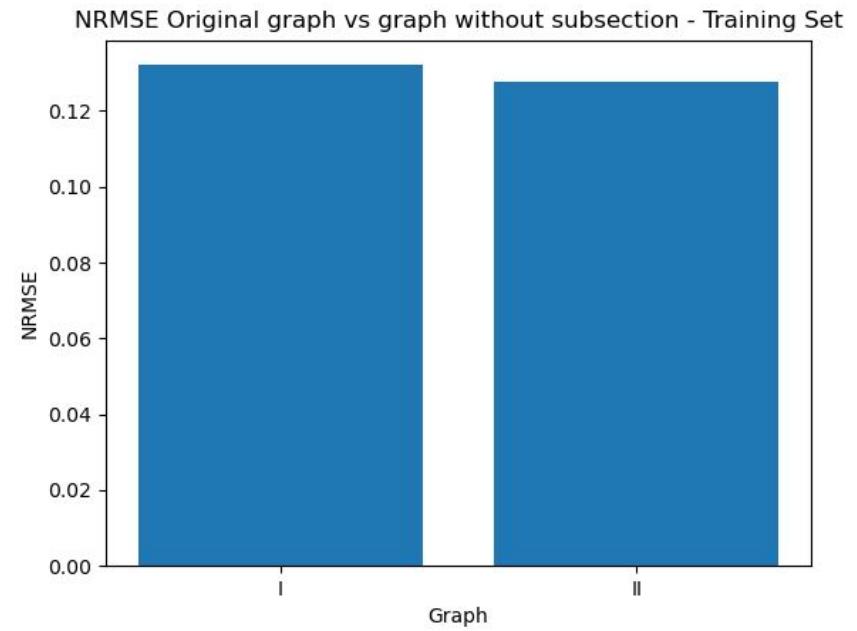
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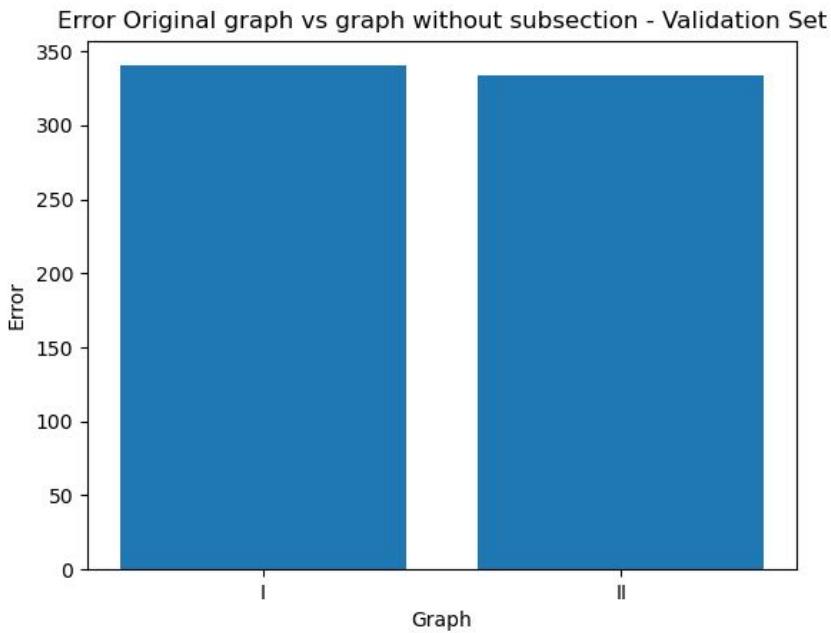
GNN



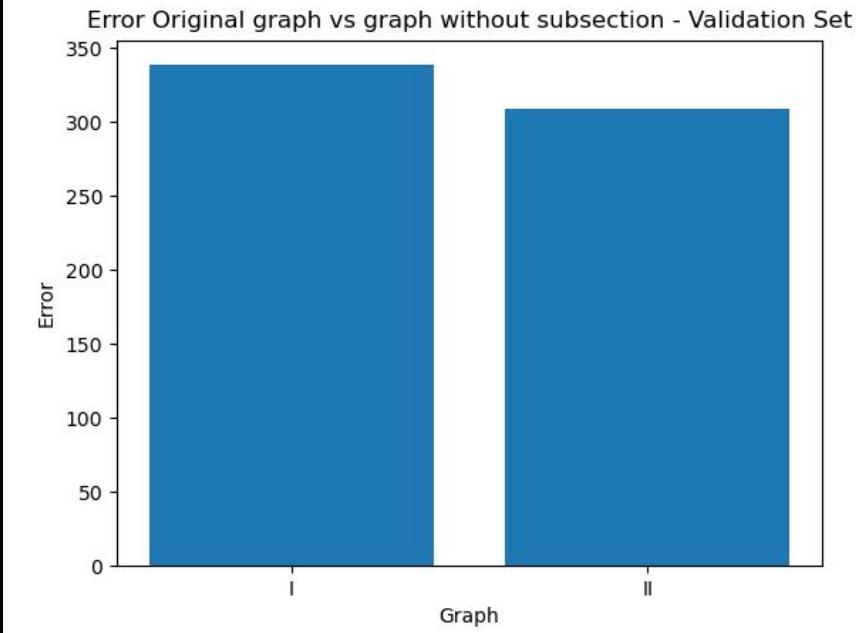
Regressão



GNN

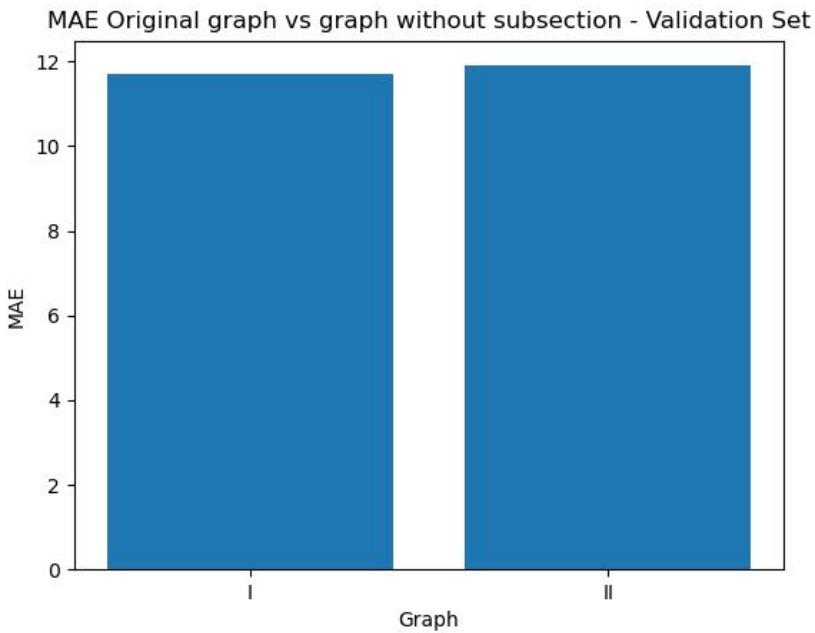


Regressão

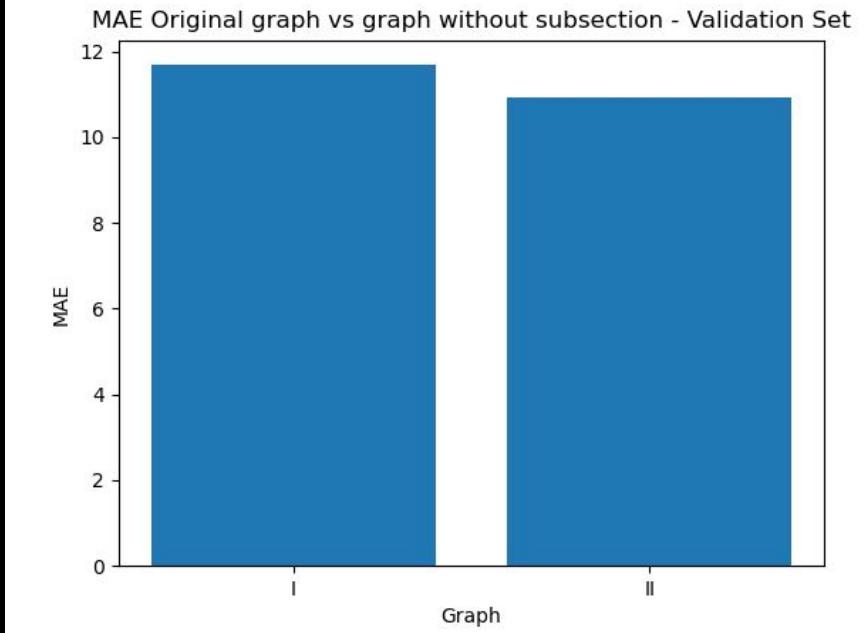


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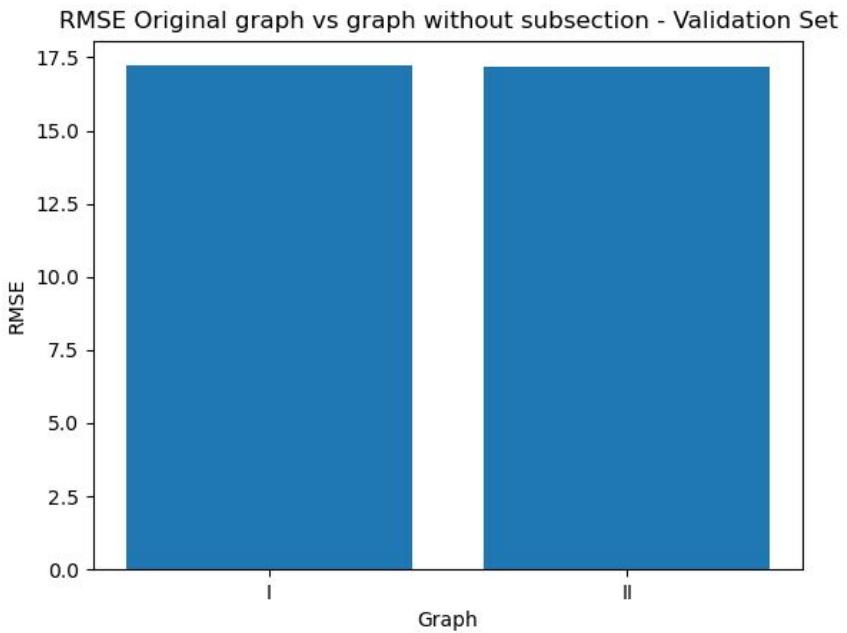
GNN



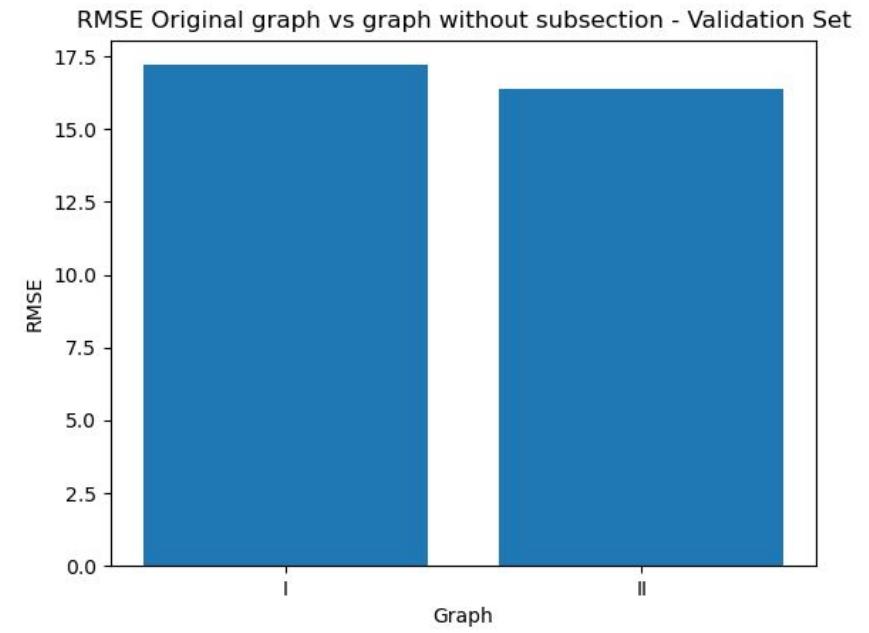
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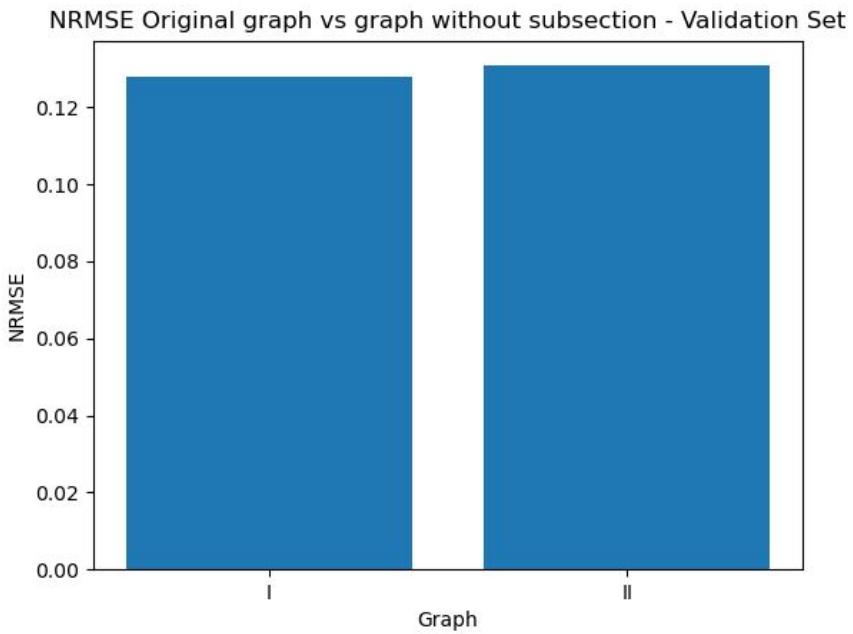
GNN



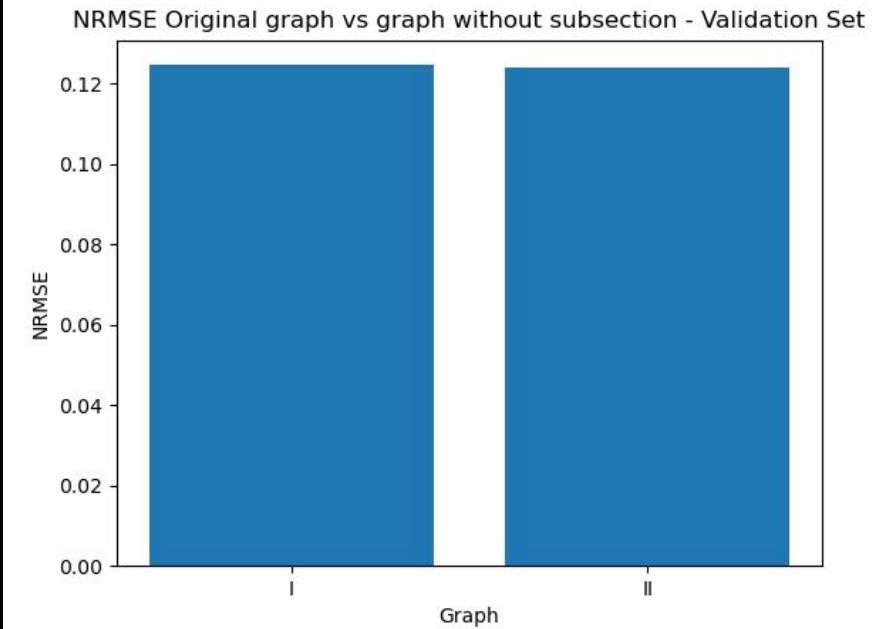
Regressão



GNN



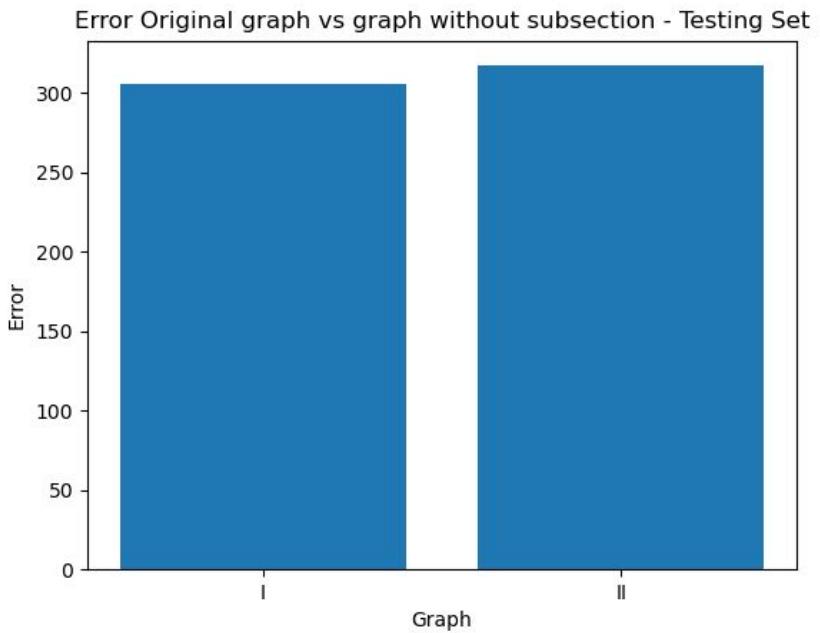
Regressão



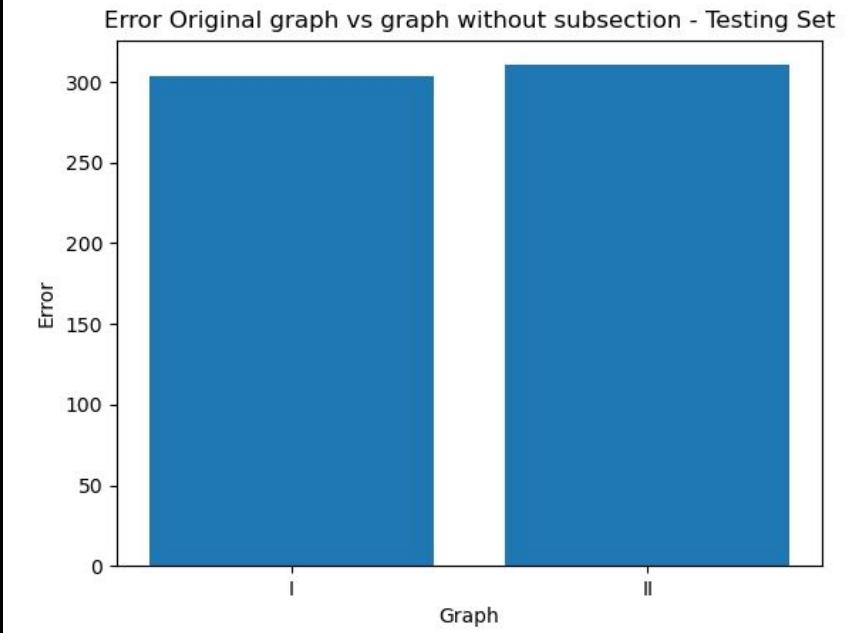
Teste de Exclusão Geográfica - Trecho 3

- Utilizou-se apenas 1/8 do dataset citado (mês de janeiro)
 - O restante do dataset serviu para maior precisão na interpolação dos dados faltantes
 - “I” é o grafo original e “II” o grafo após a exclusão do trecho
-

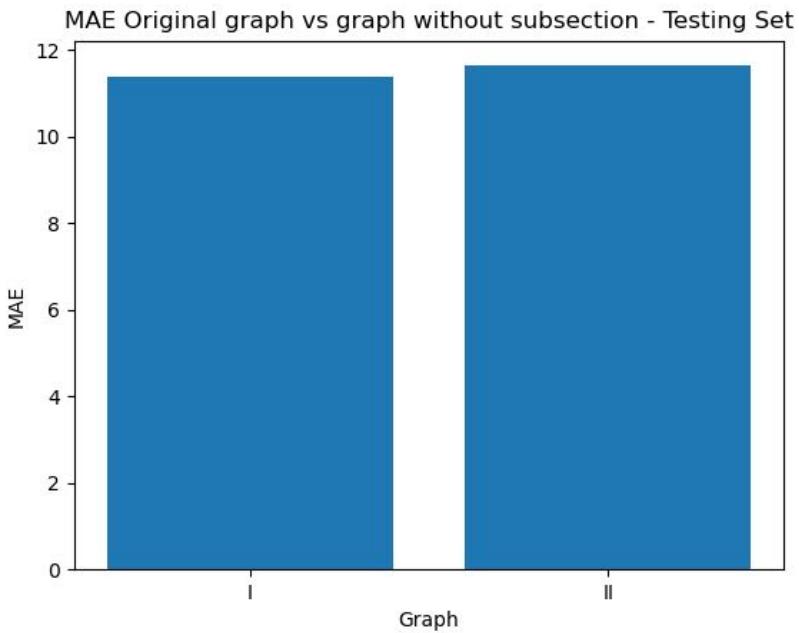
GNN



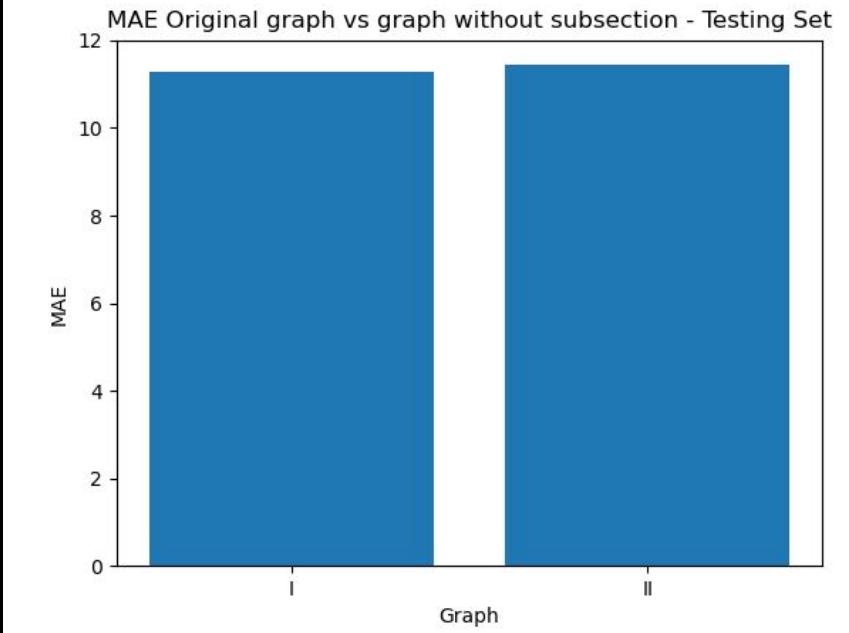
Regressão



GNN

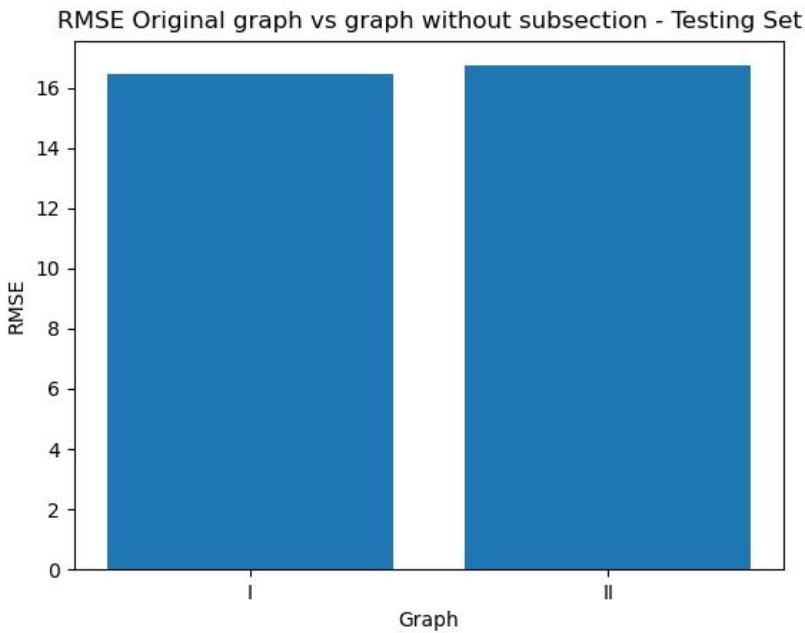


Regressão

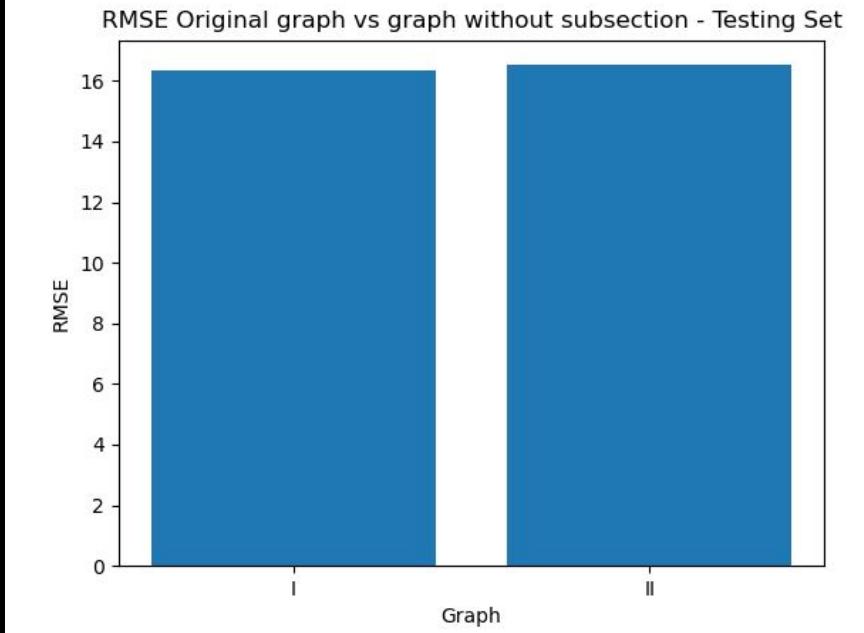


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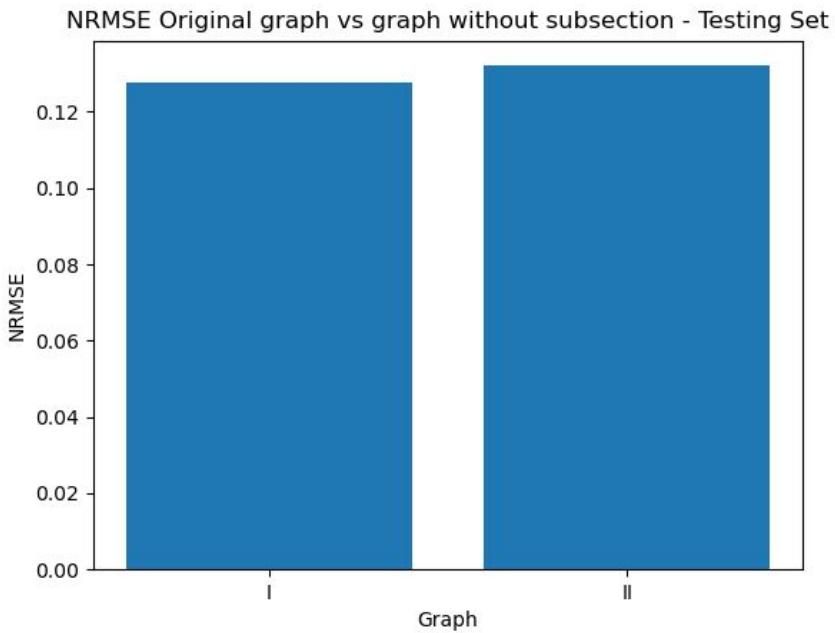
GNN



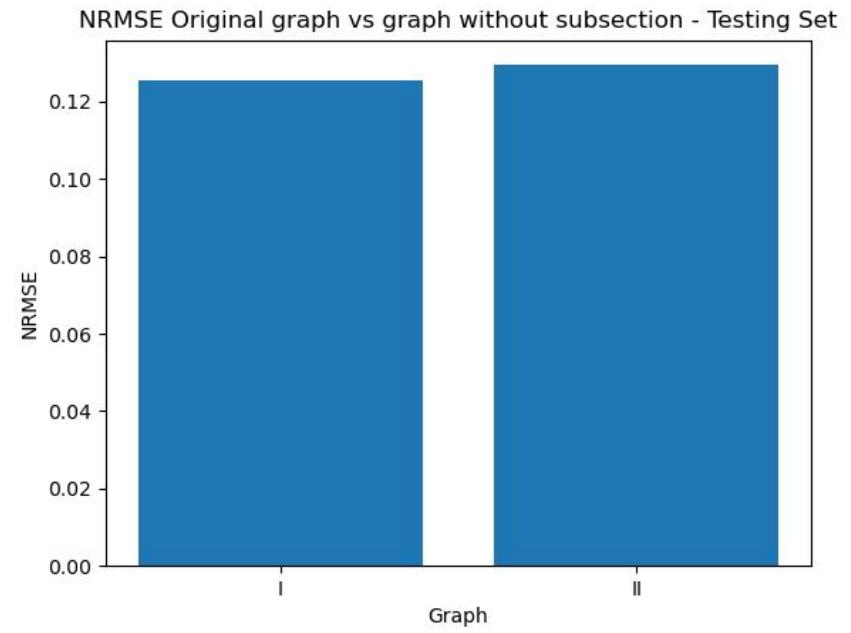
Regressão



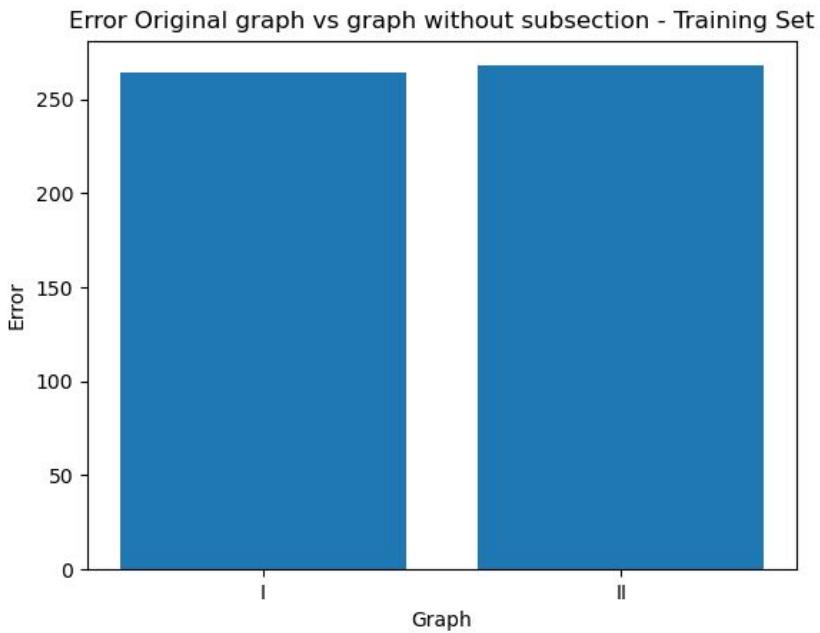
GNN



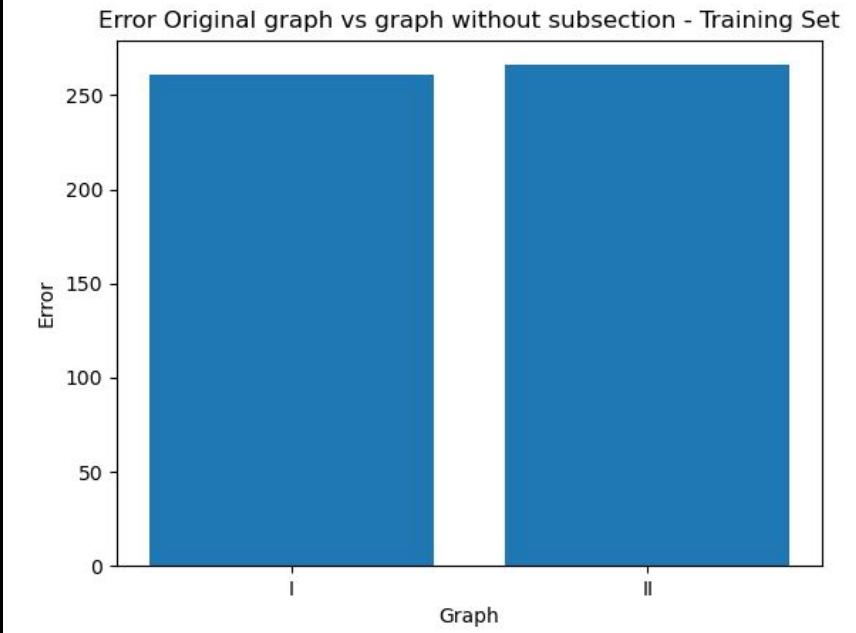
Regressão



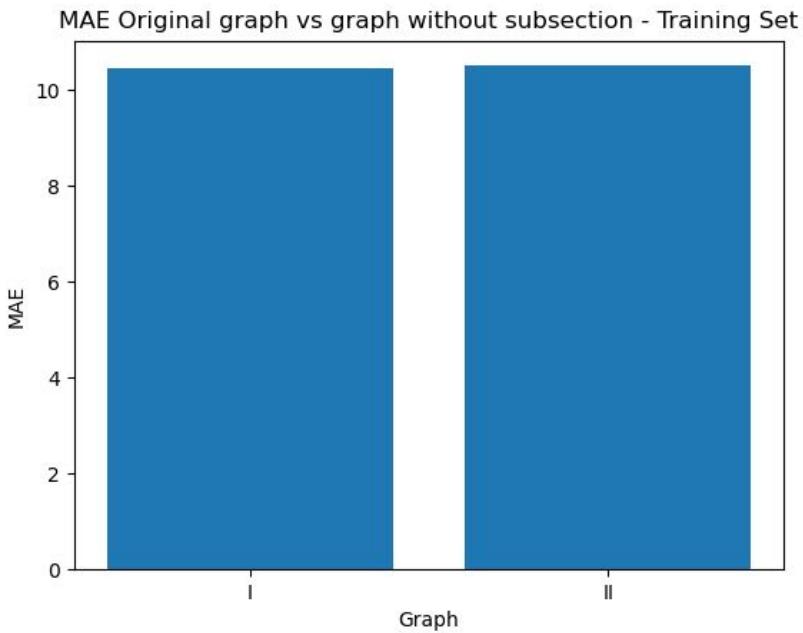
GNN



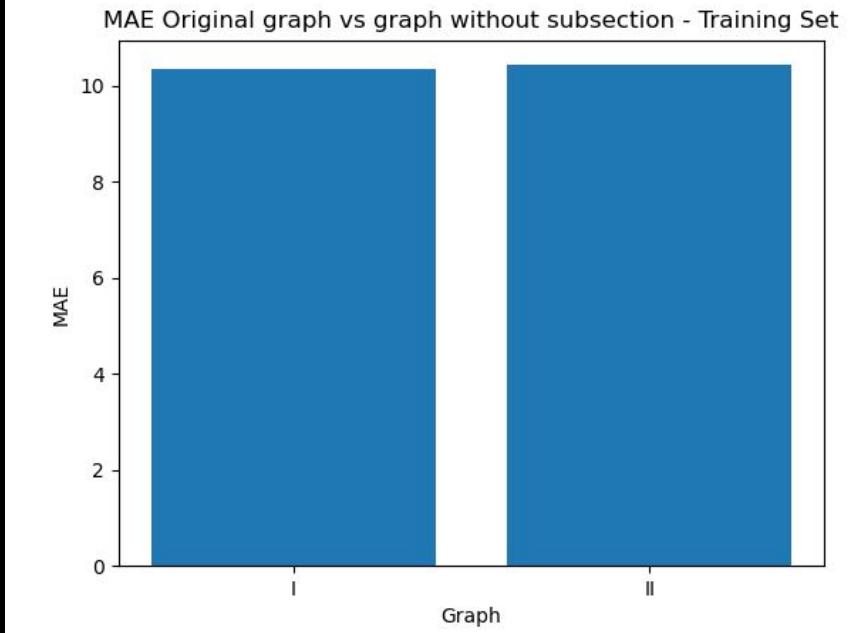
Regressão



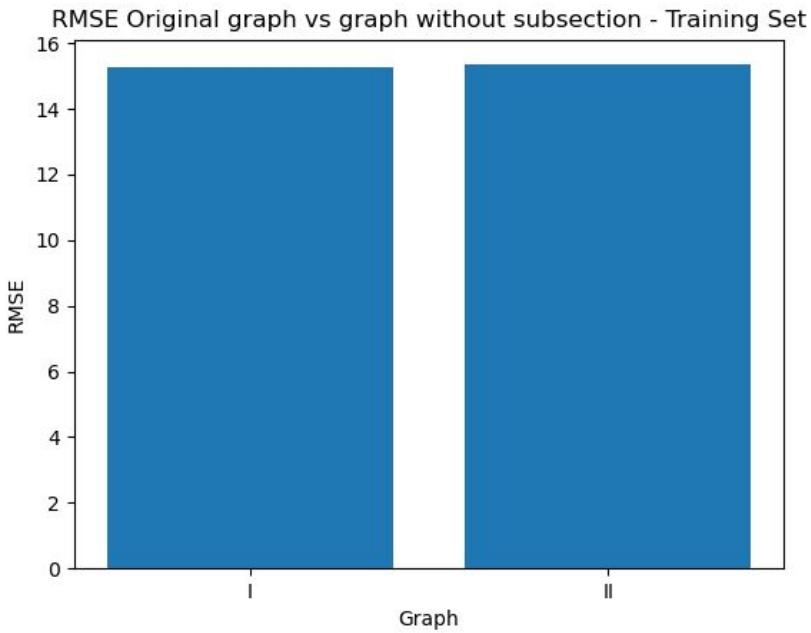
GNN



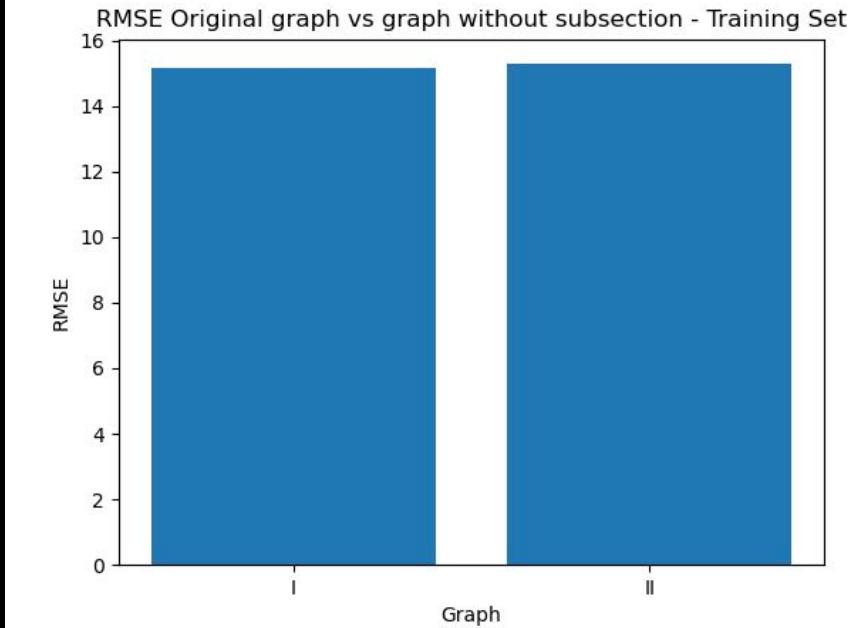
Regressão



GNN

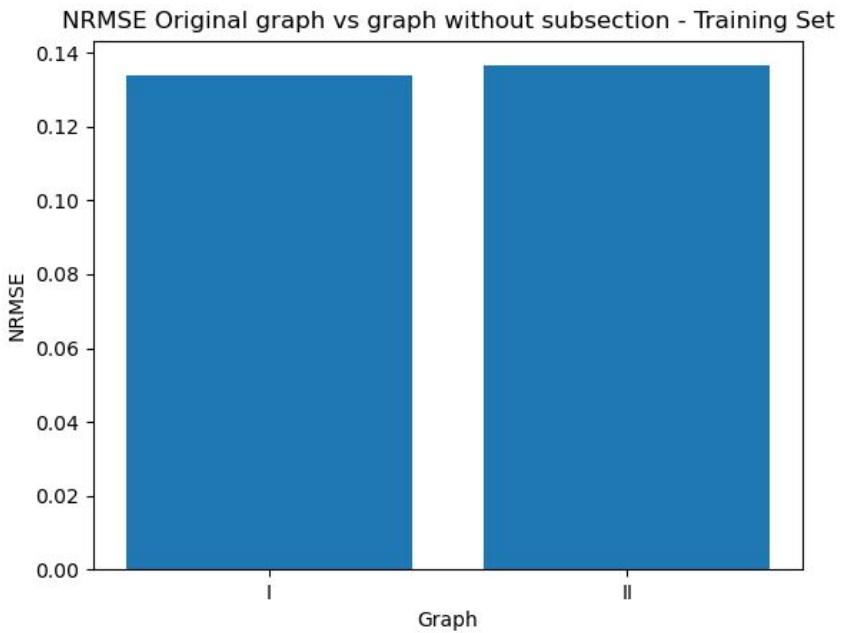


Regressão

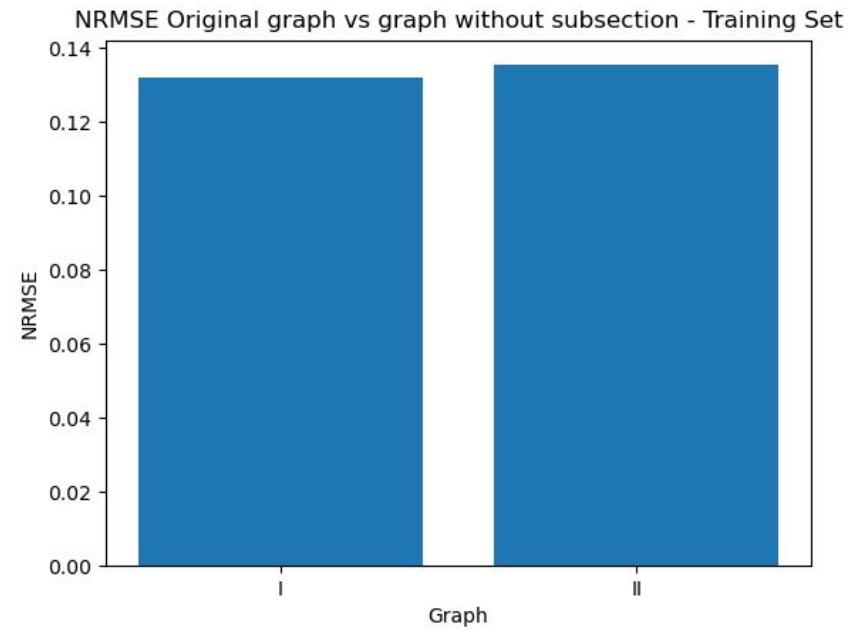


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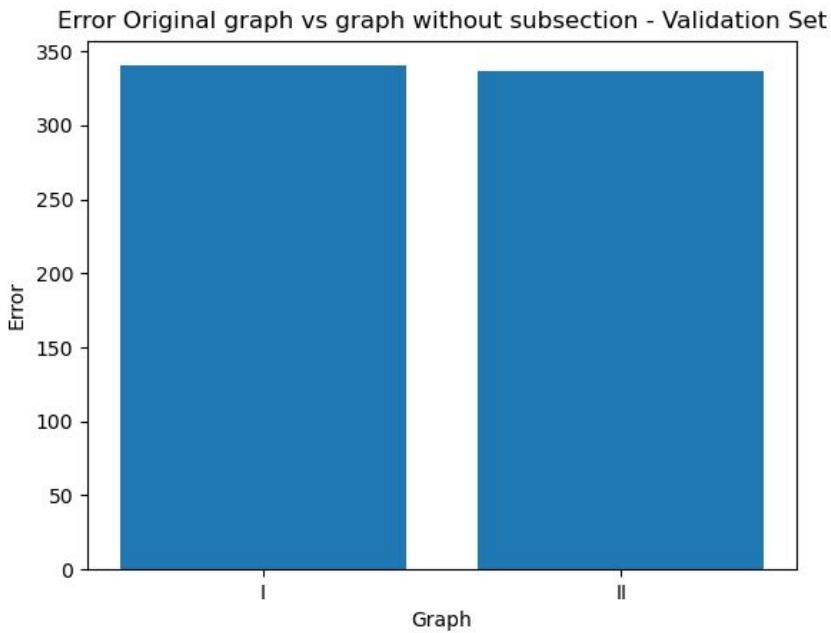
GNN



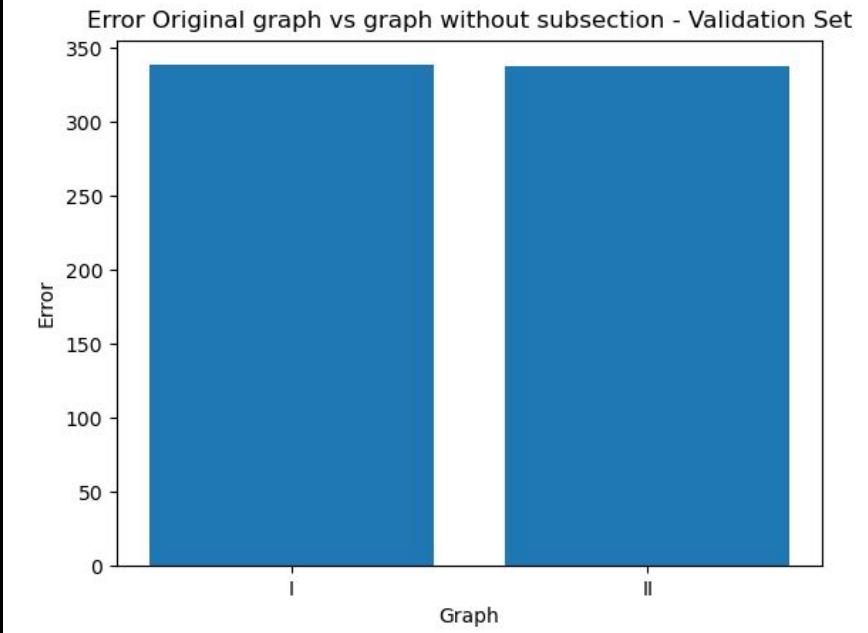
Regressão



GNN

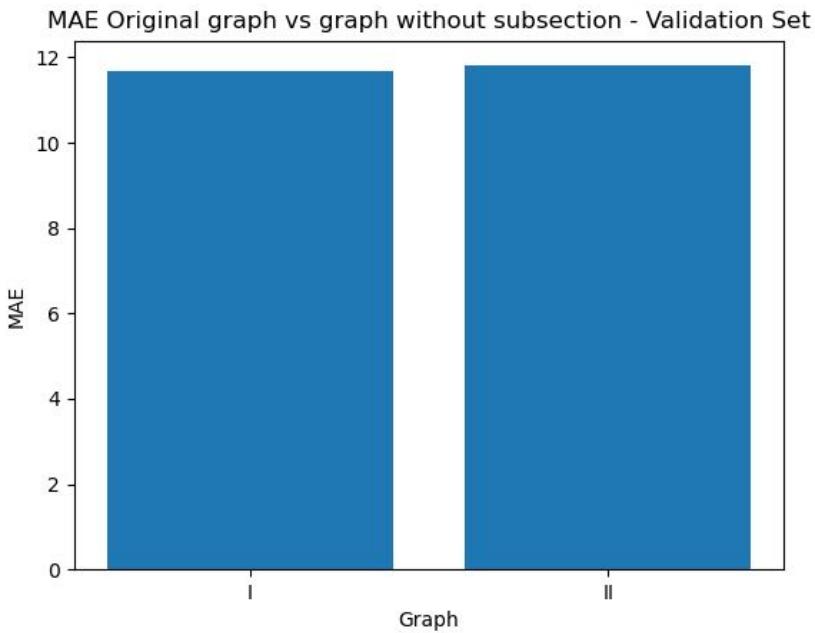


Regressão

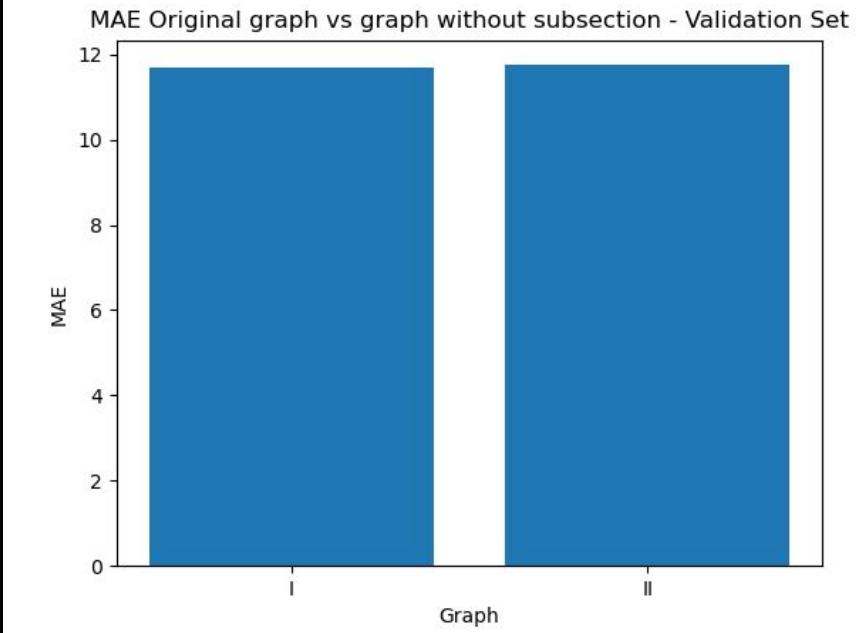


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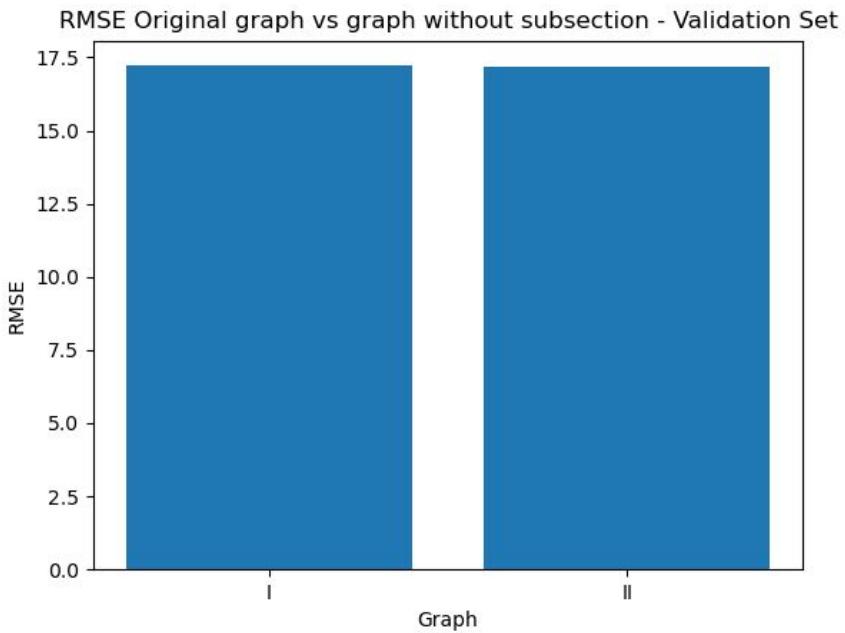
GNN



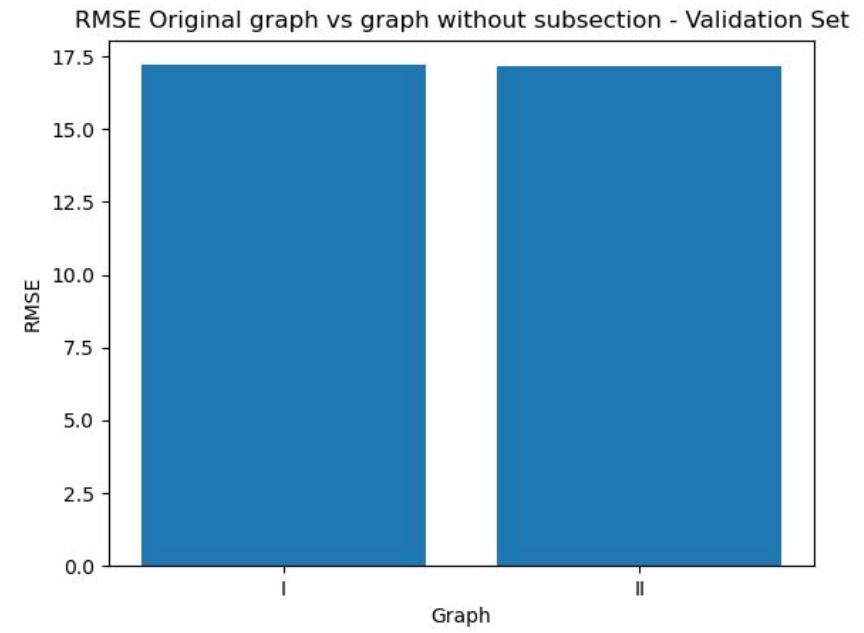
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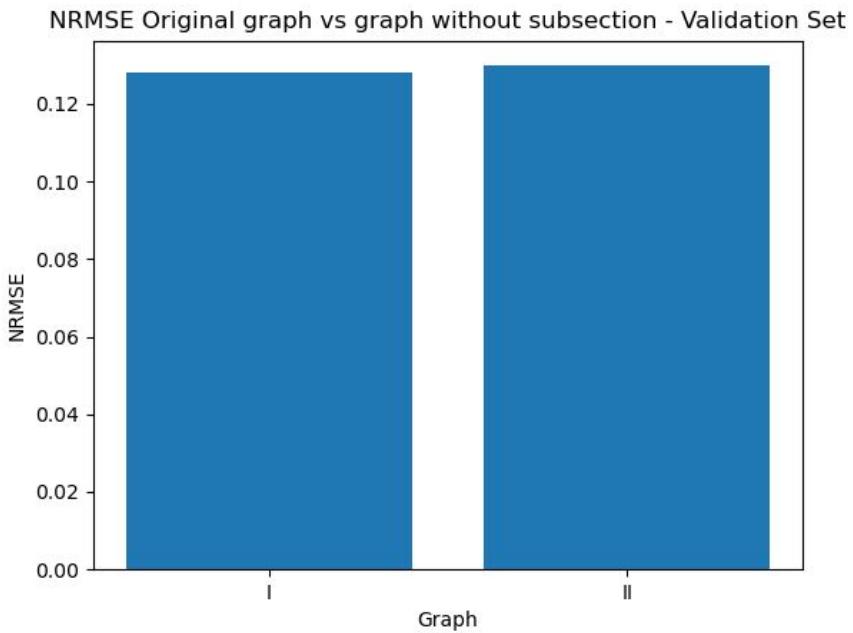
GNN



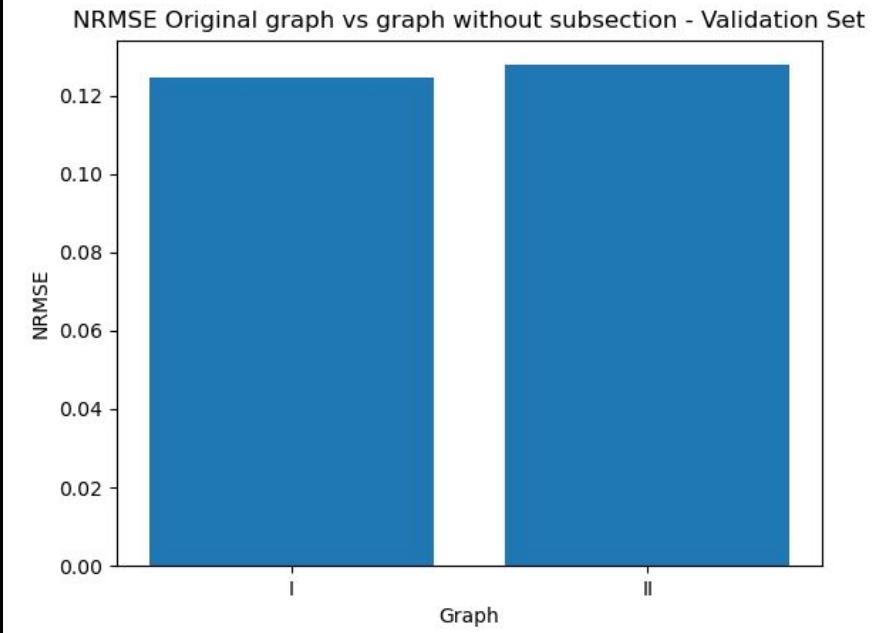
Regressão



GNN



Regressão

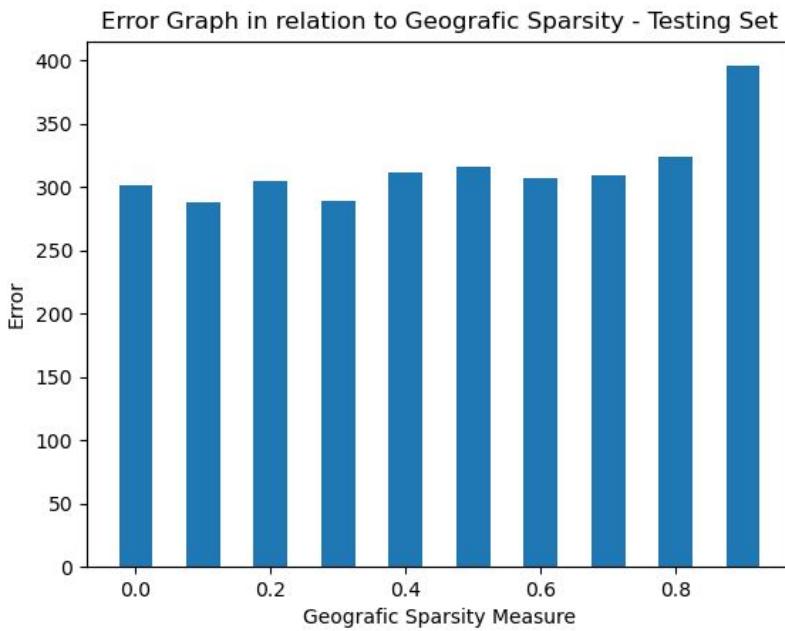


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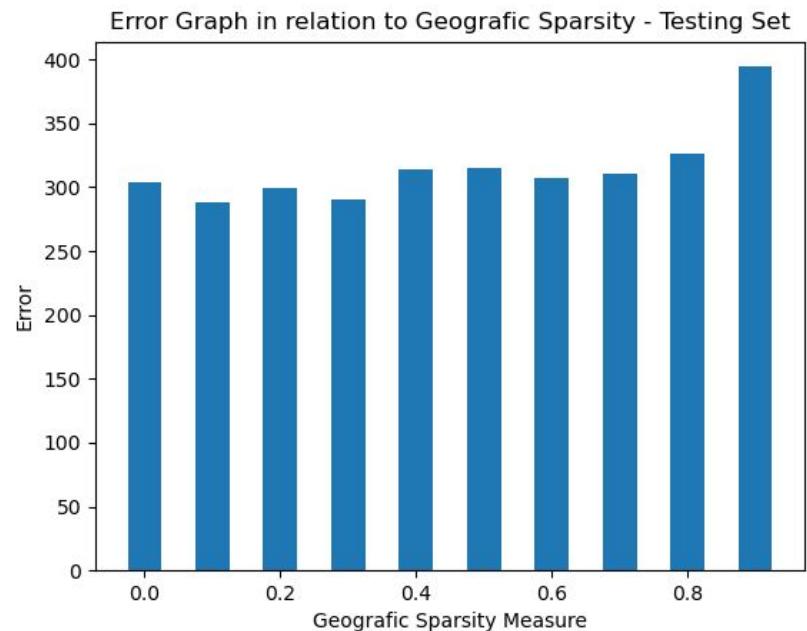
Teste de Esparsidade Geográfica - Aleatória

- Utilizou-se apenas $\frac{1}{4}$ do dataset citado (meses de janeiro e fevereiro)
 - O restante do dataset serviu para maior precisão na interpolação dos dados faltantes
-

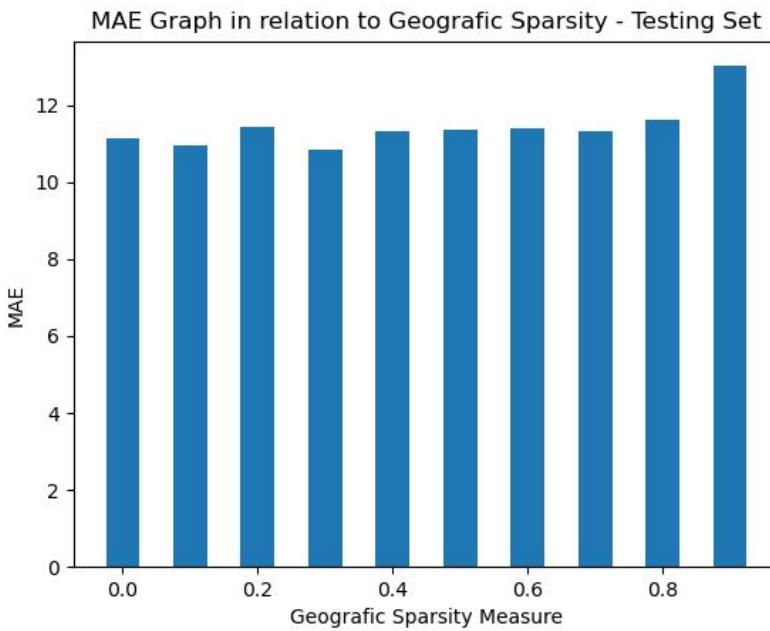
GNN



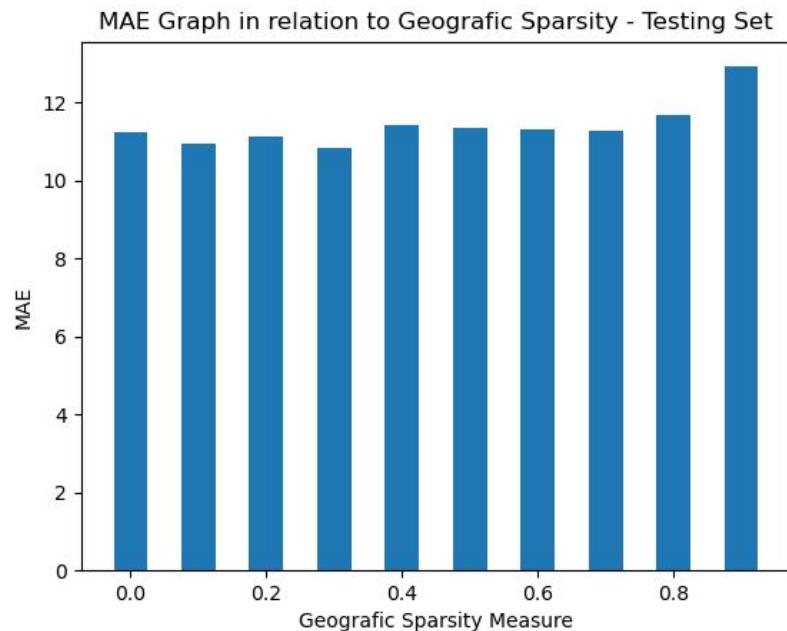
Regressão



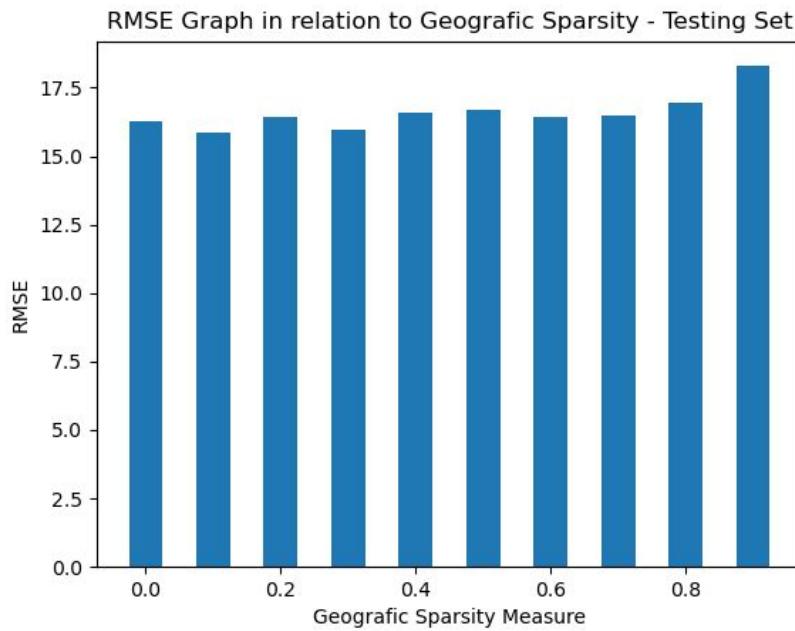
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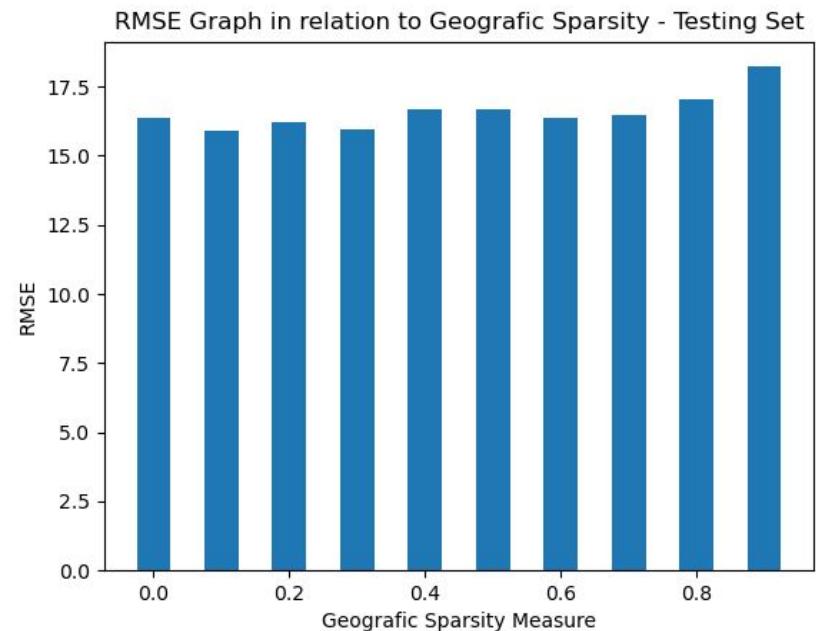
Regressão



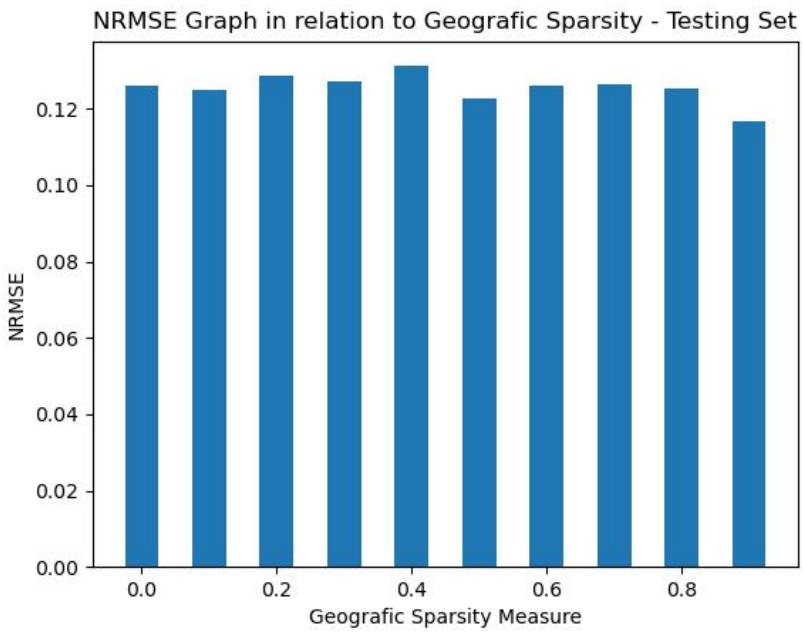
GNN



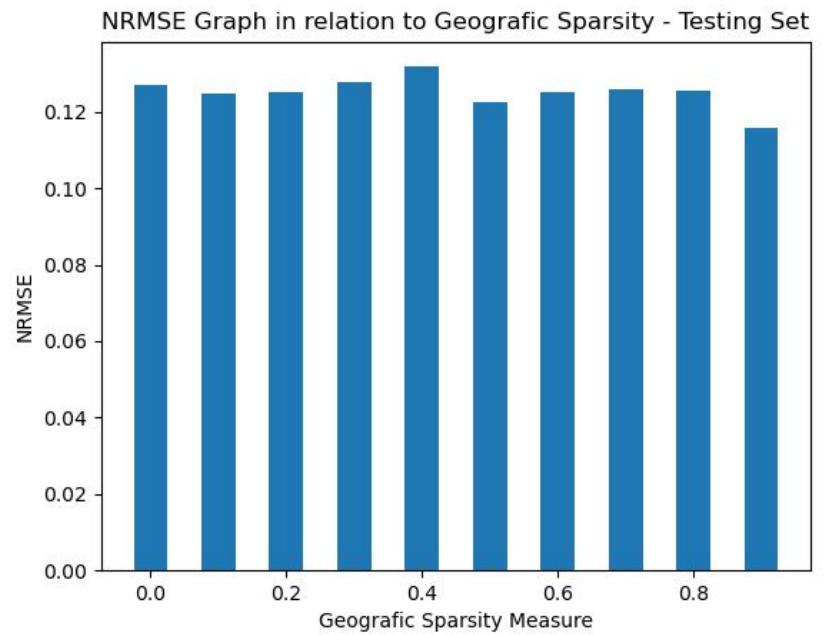
Regressão



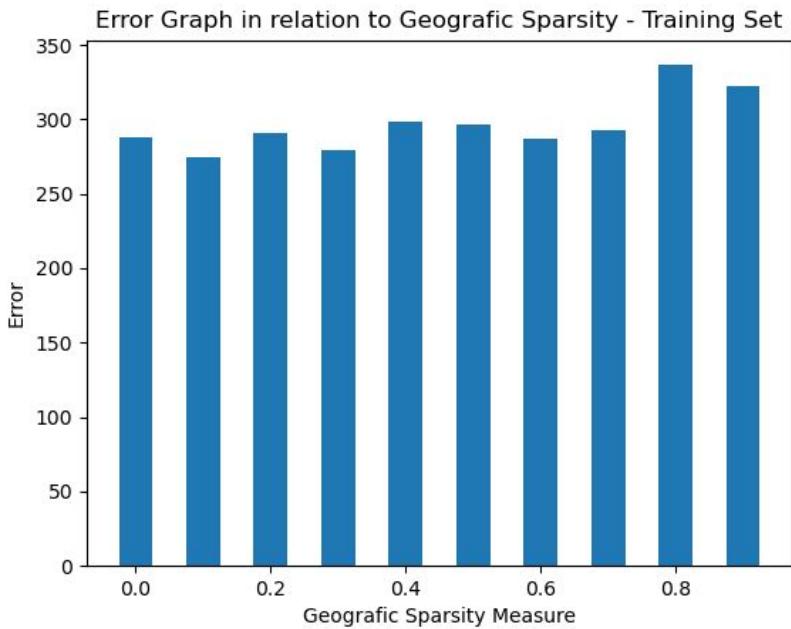
GNN



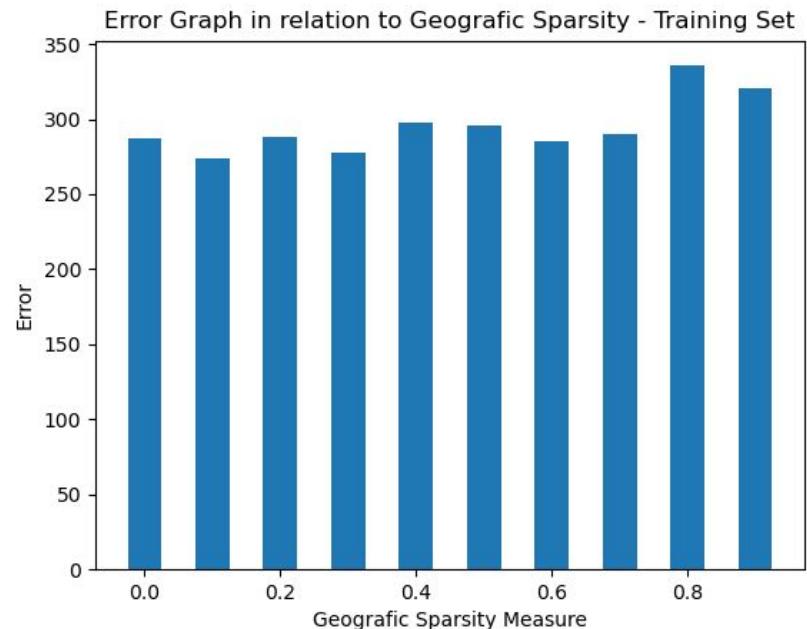
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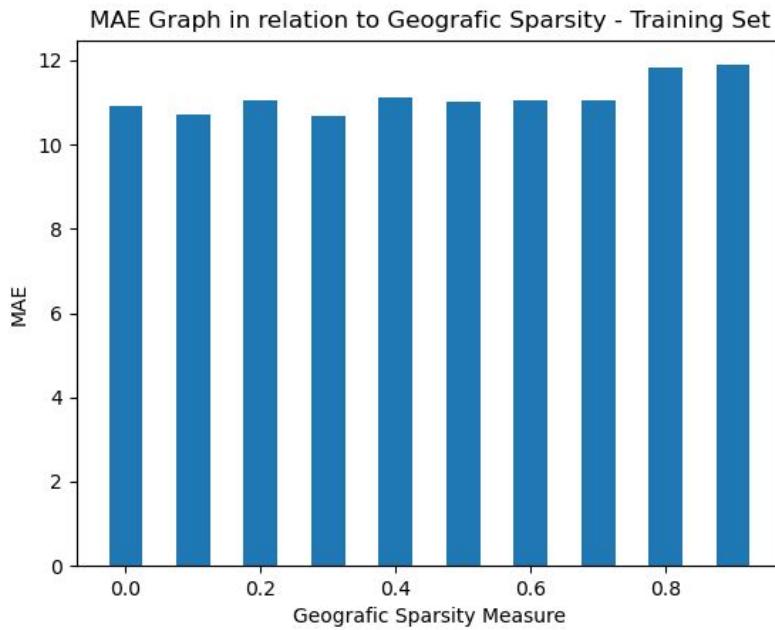
GNN



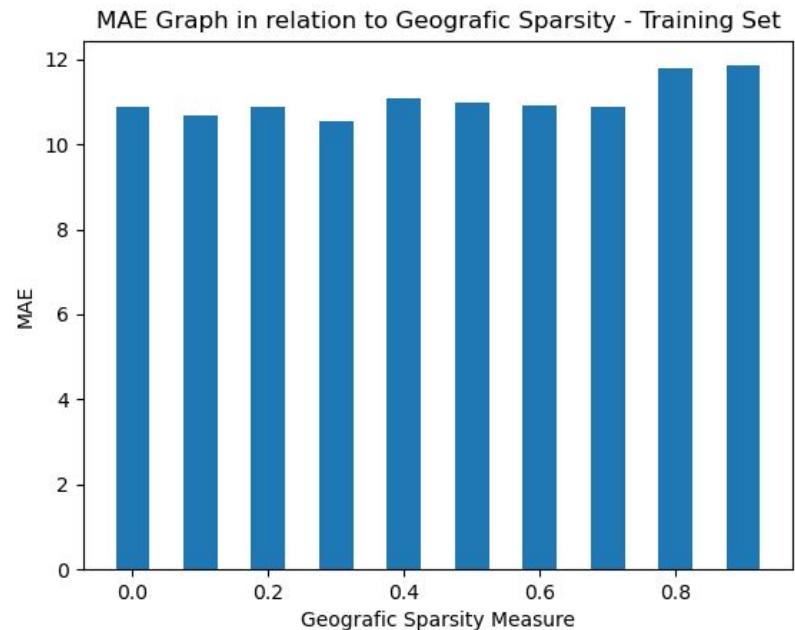
Regressão



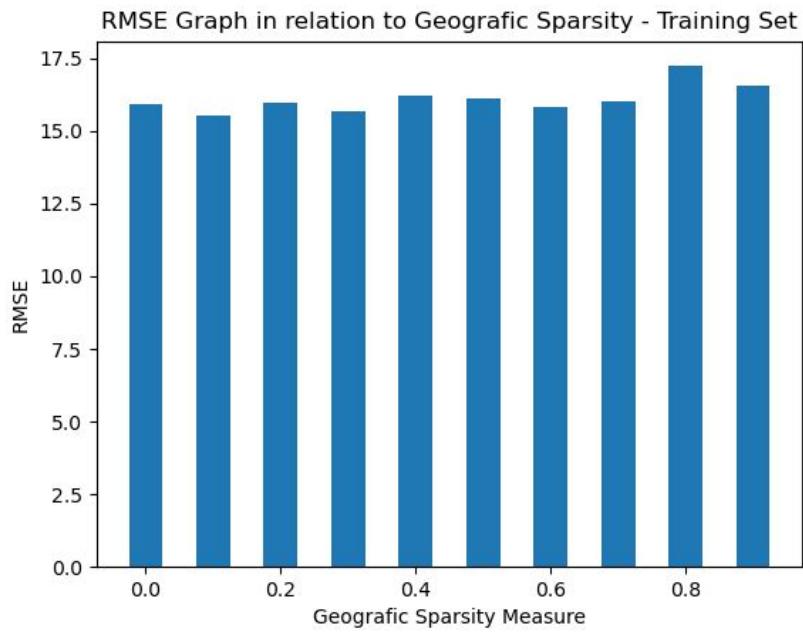
GNN



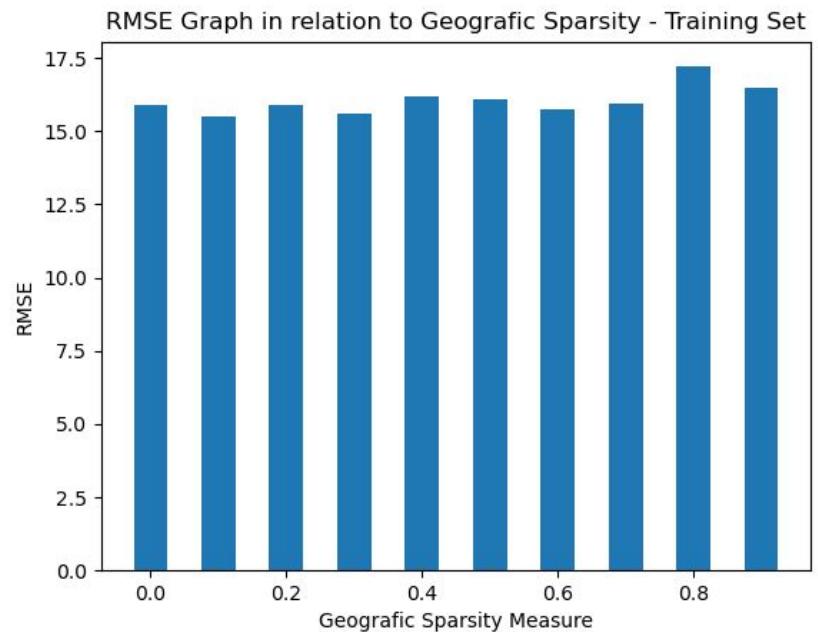
Regressão



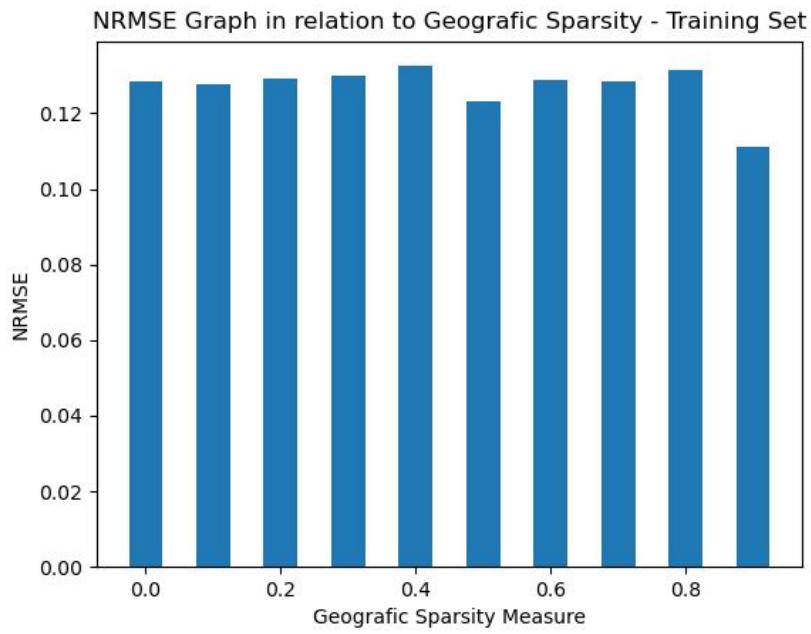
GNN



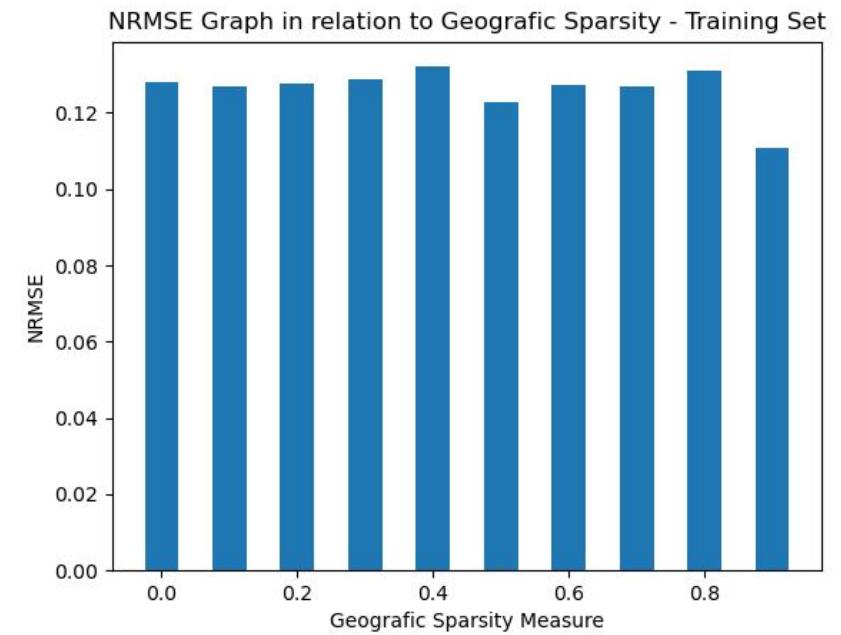
Regressão



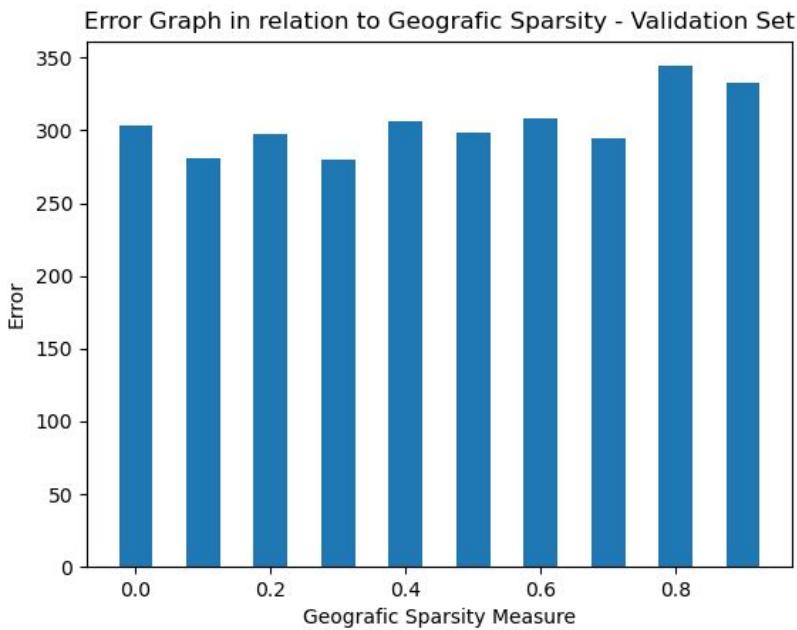
GNN



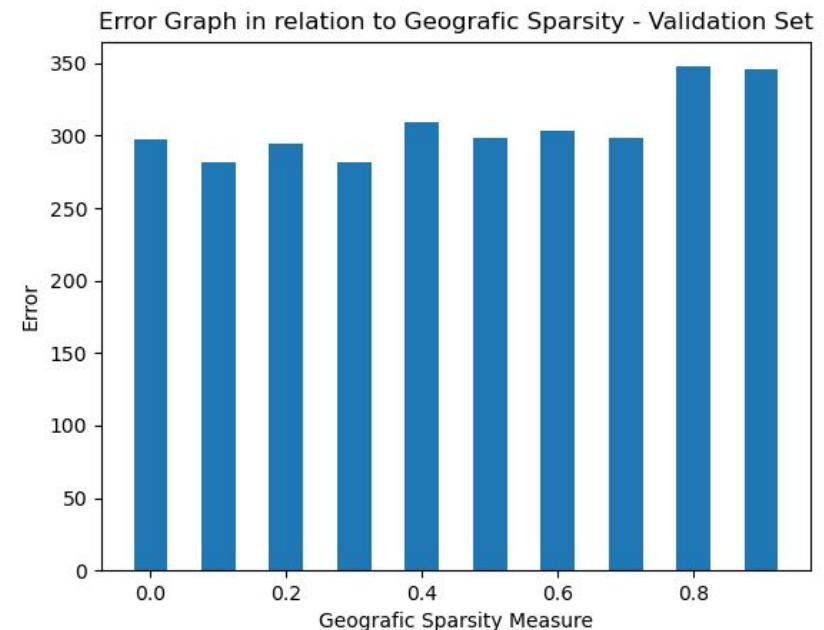
Regressão



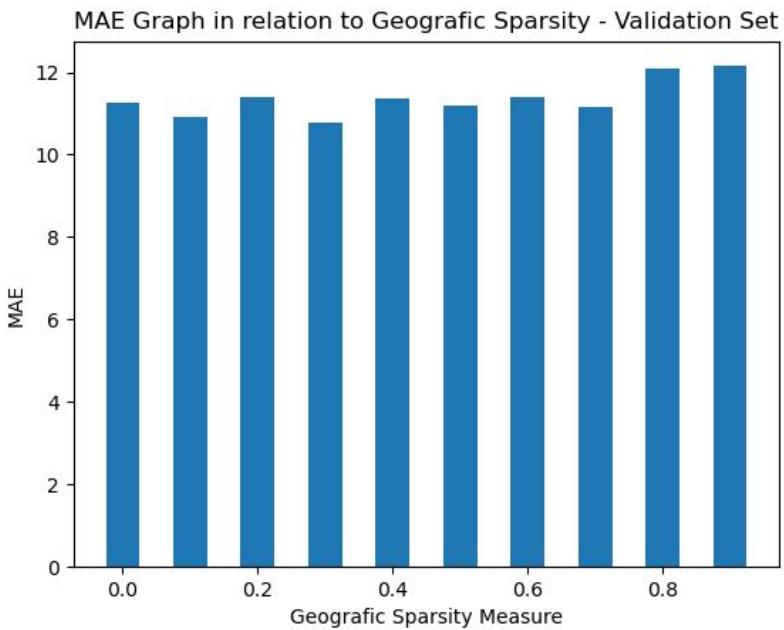
GNN



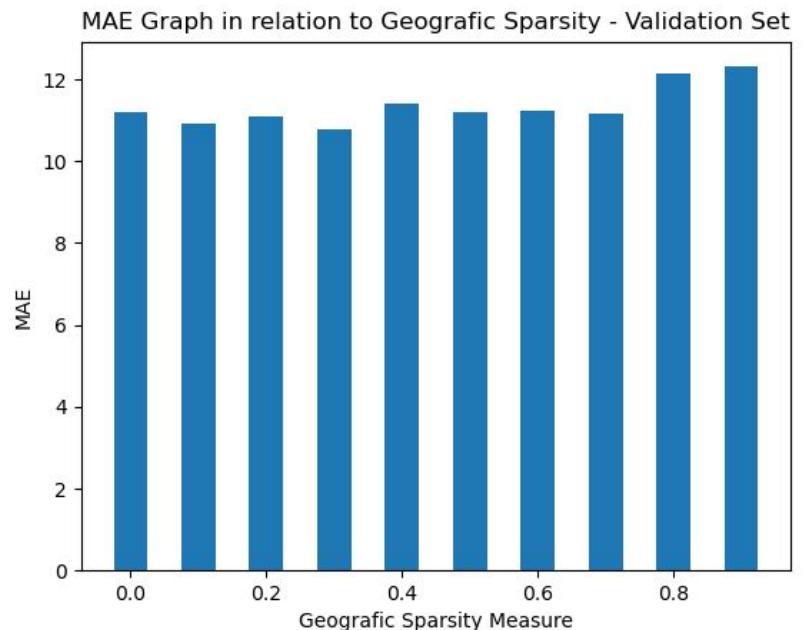
Regressão



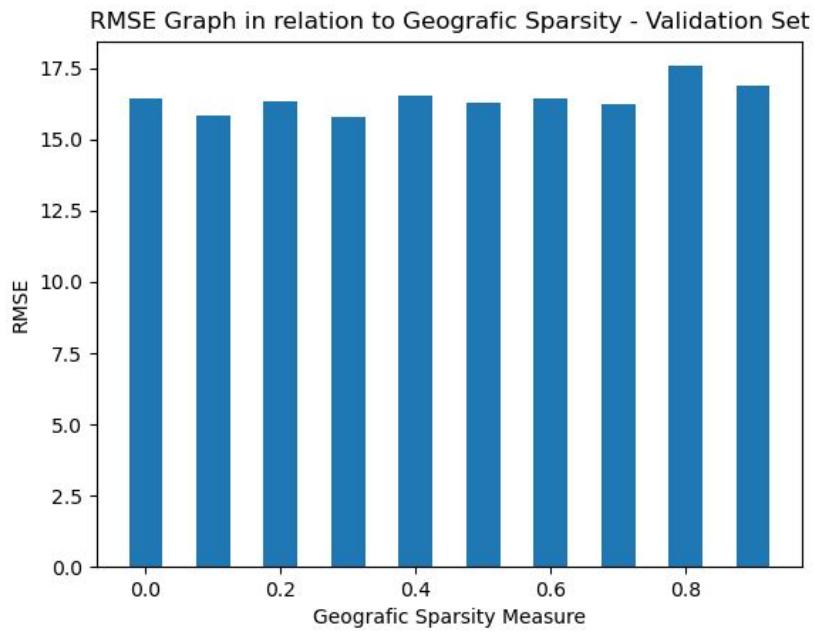
GNN



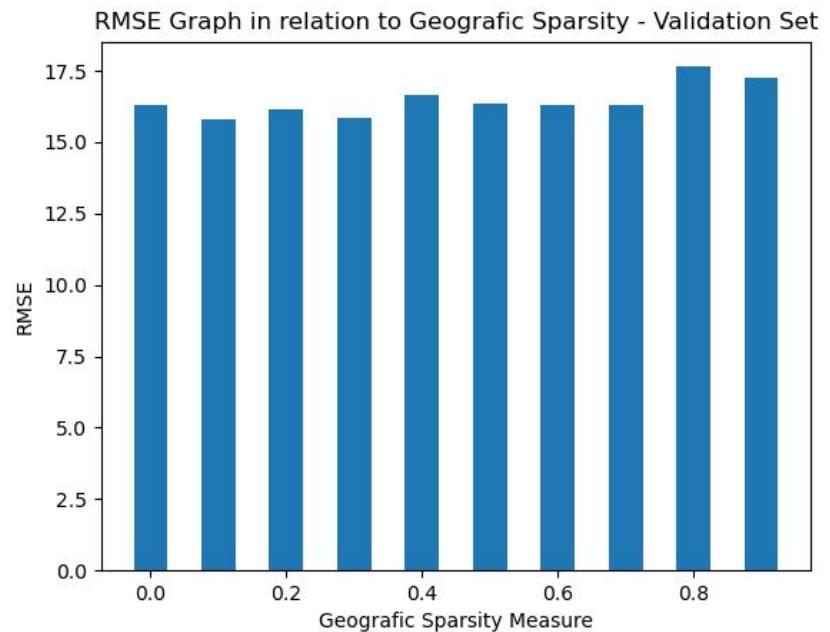
Regressão



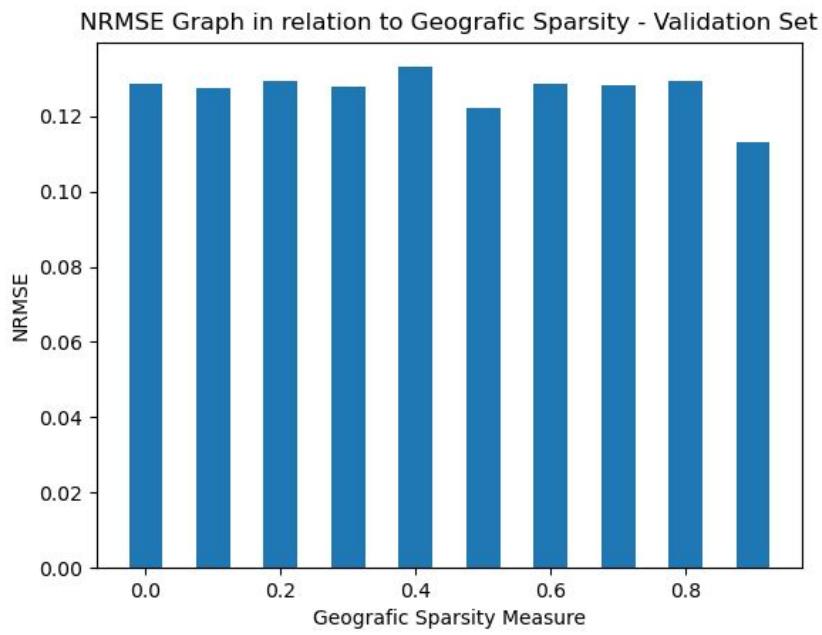
GNN



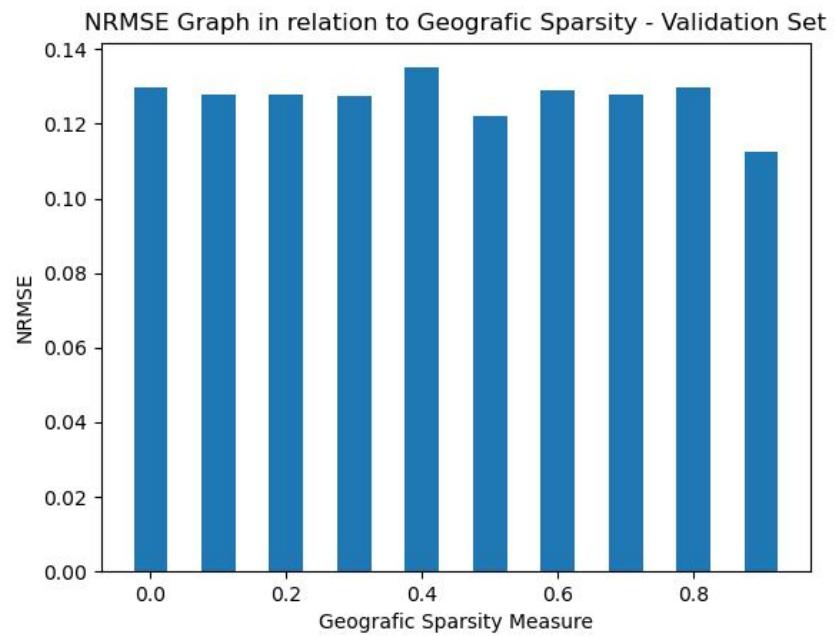
Regressão



GNN



Regressão



Teste de Interpolação

- Utilizou-se apenas 1/8 do dataset citado (mês de janeiro)
 - O restante do dataset serviu para maior precisão na interpolação dos dados faltantes
 - Para cada porcentagem de valores removidos gerou-se histogramas da série temporal interpolada para comparações
-

Gráfico de Ocorrência dos Valores - 0% de valores removidos

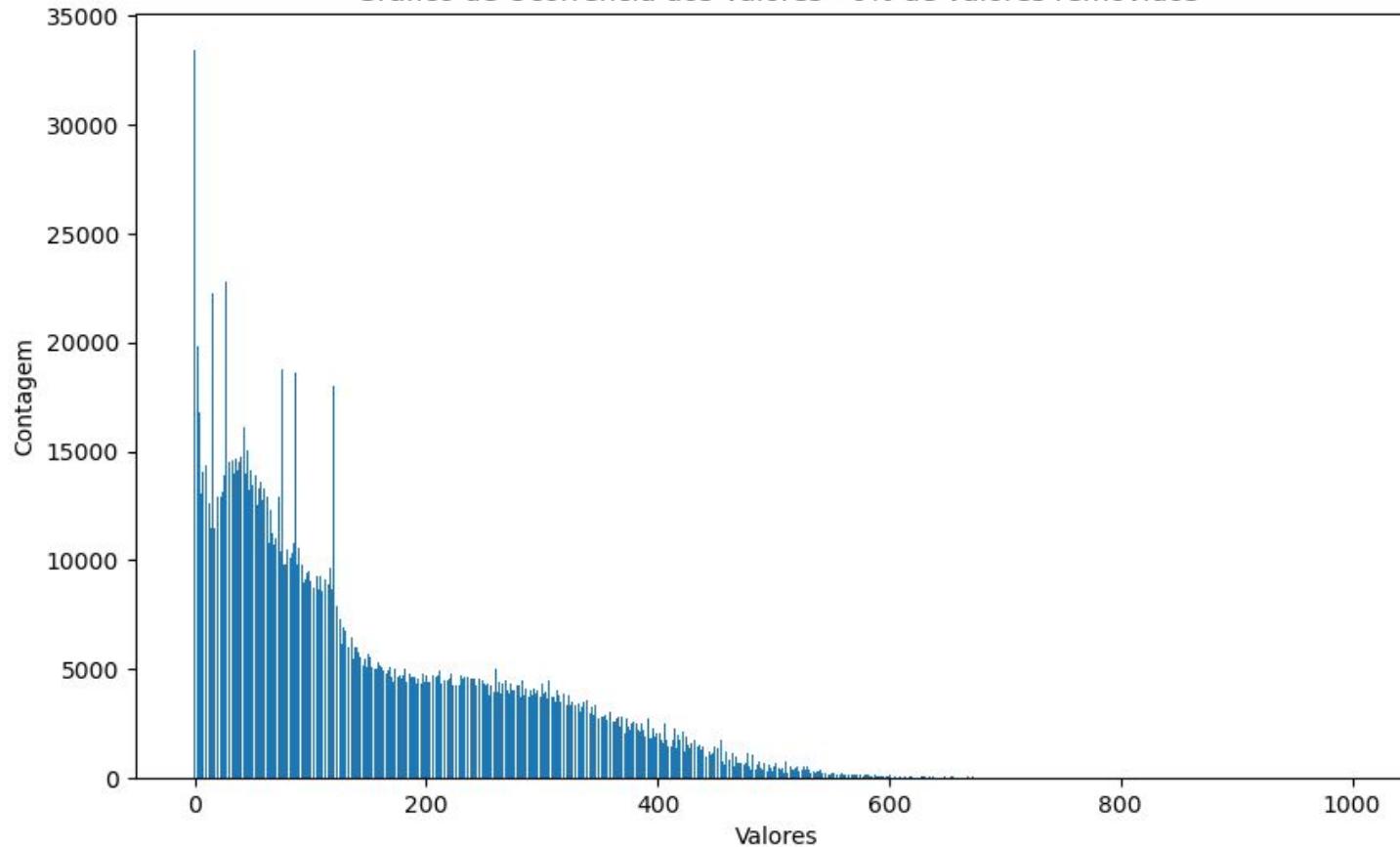


Gráfico de Ocorrência dos Valores - 10% de valores removidos

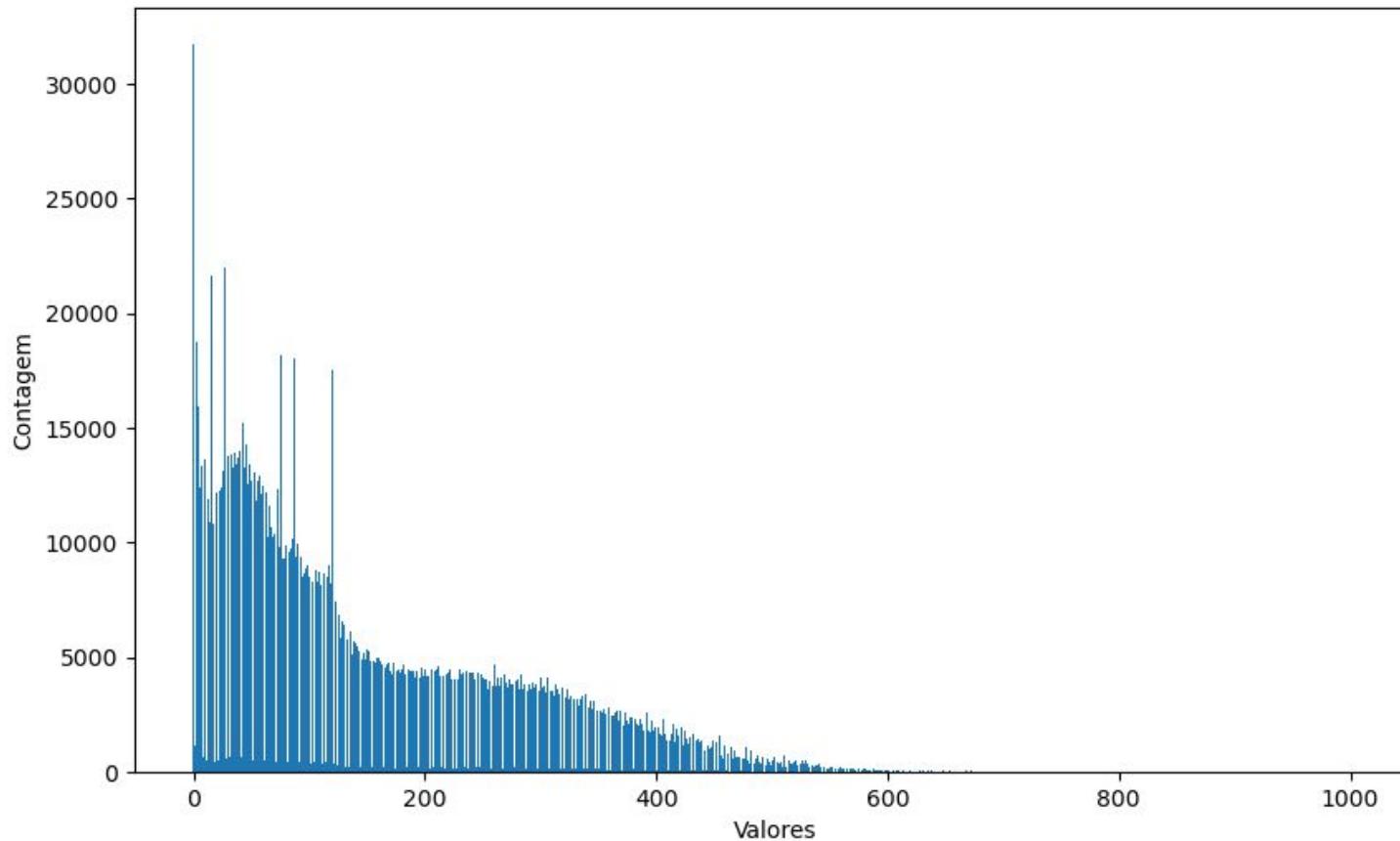


Gráfico de Ocorrência dos Valores - 20% de valores removidos

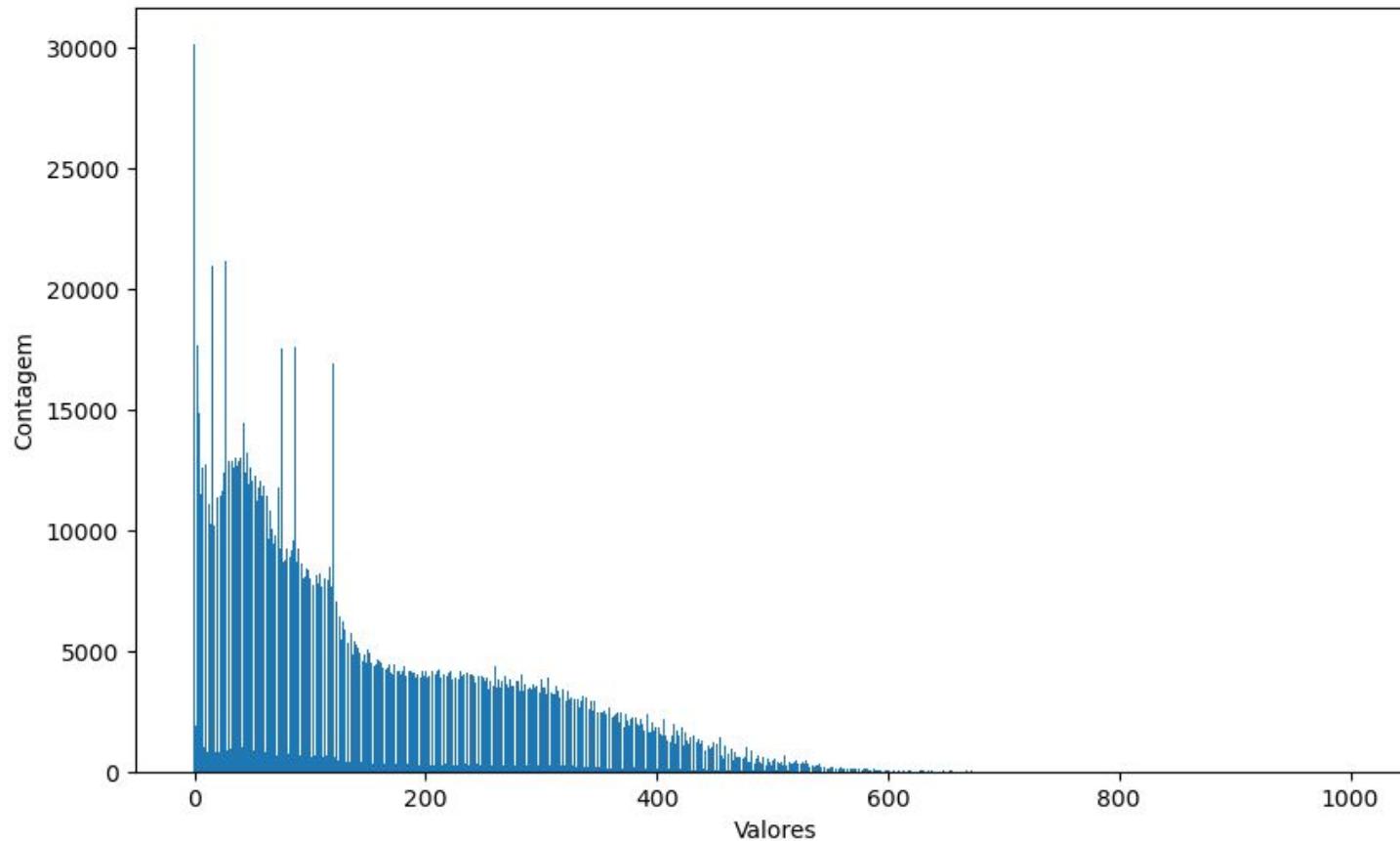


Gráfico de Ocorrência dos Valores - 30% de valores removidos

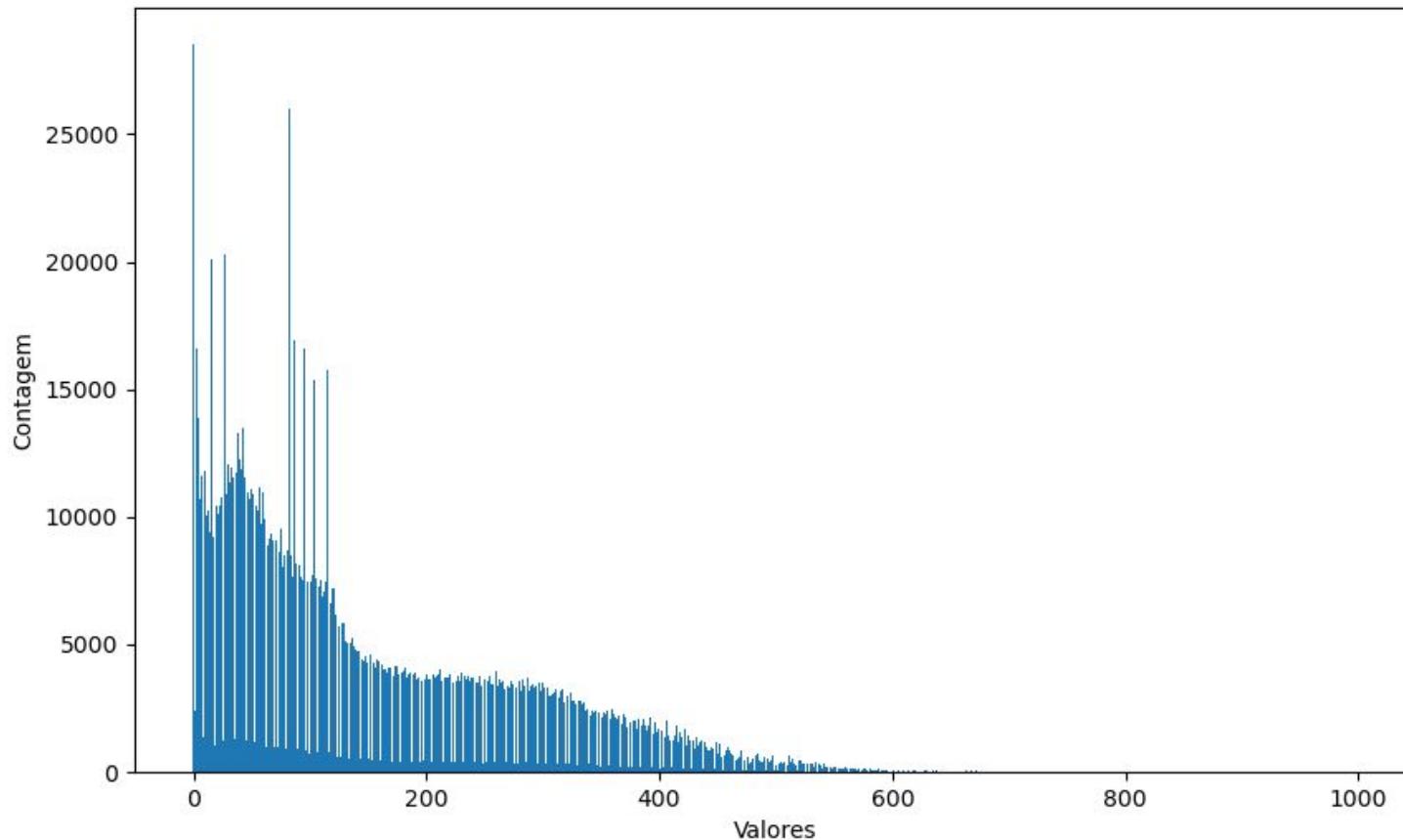


Gráfico de Ocorrência dos Valores - 40% de valores removidos

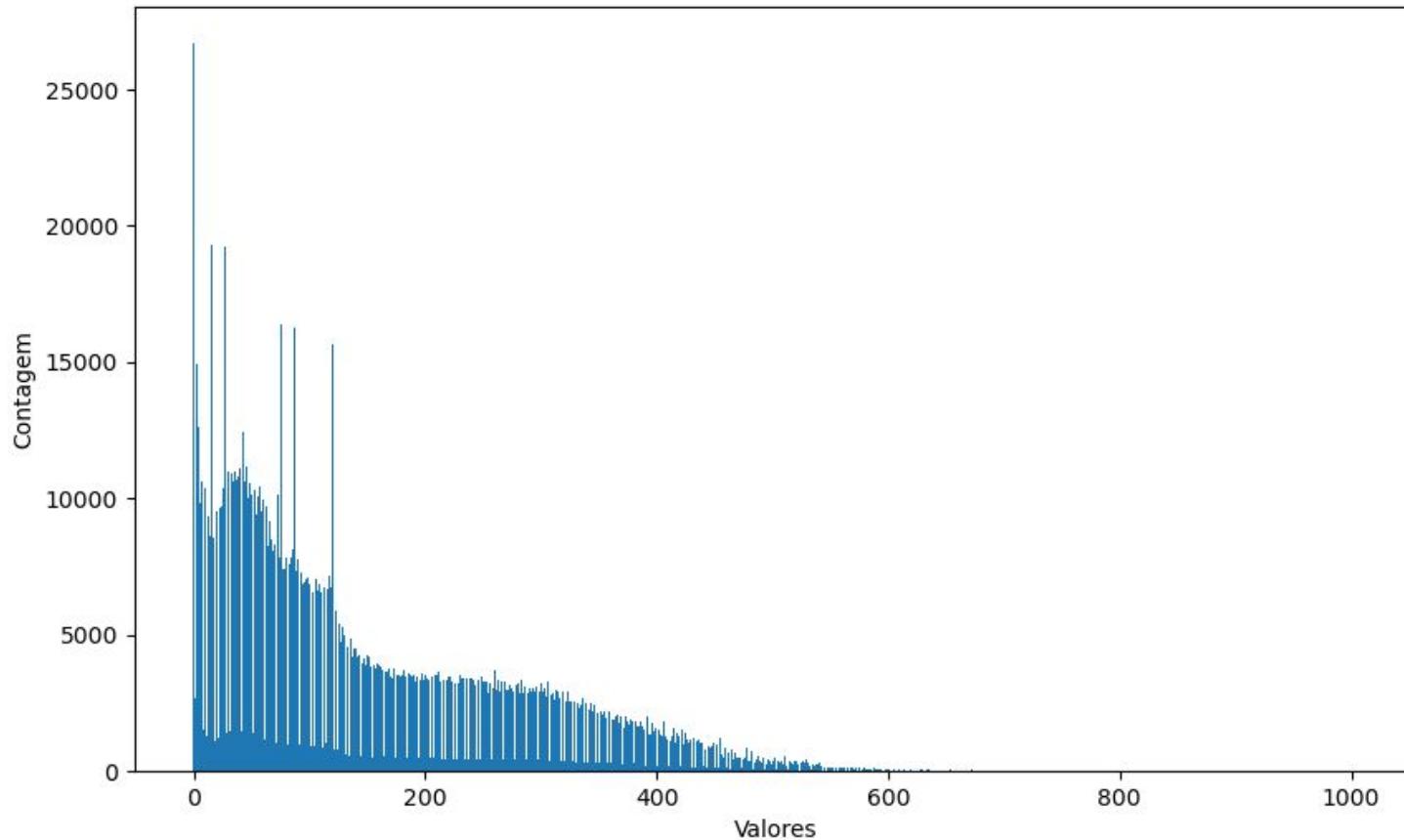


Gráfico de Ocorrência dos Valores - 50% de valores removidos

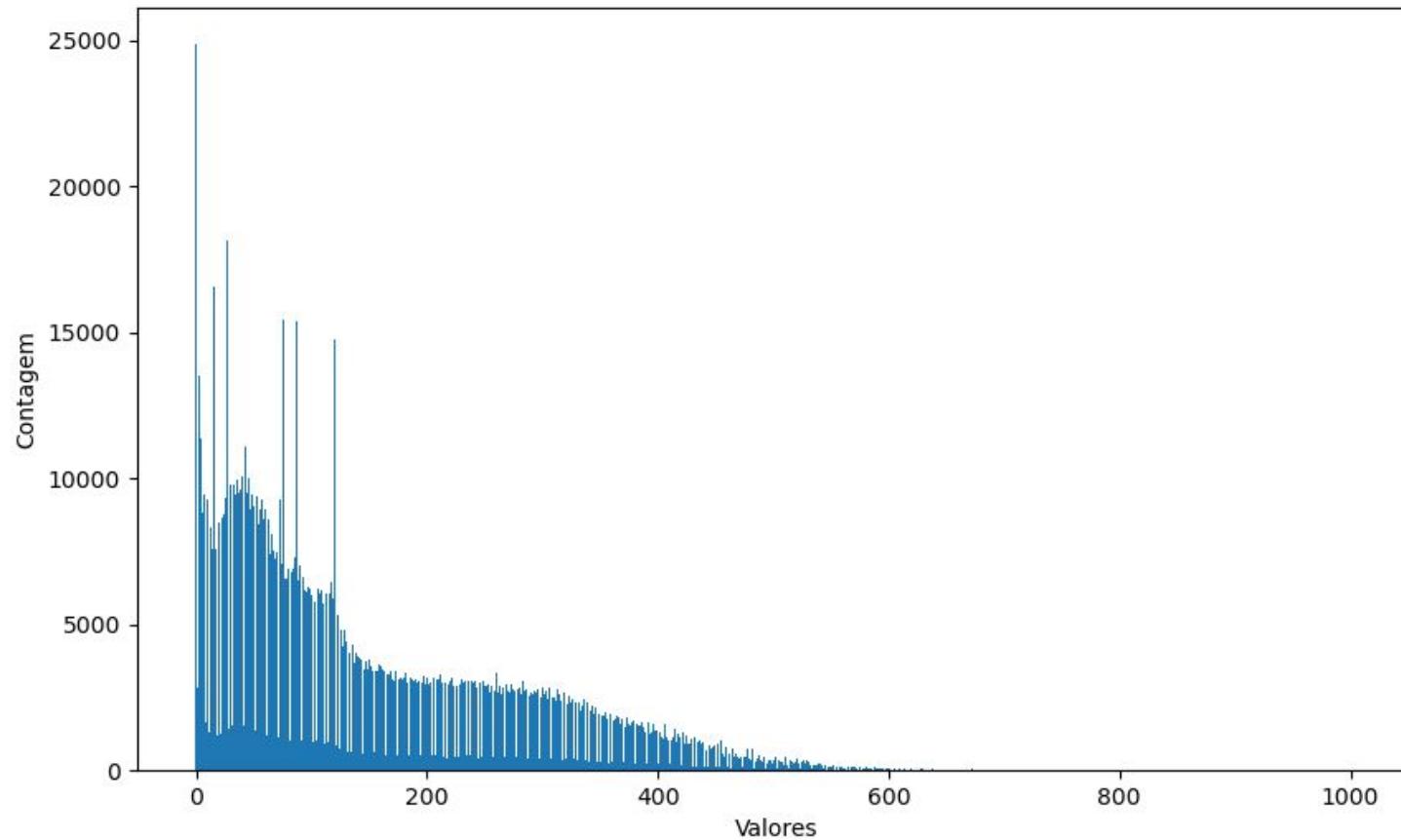


Gráfico de Ocorrência dos Valores - 60% de valores removidos

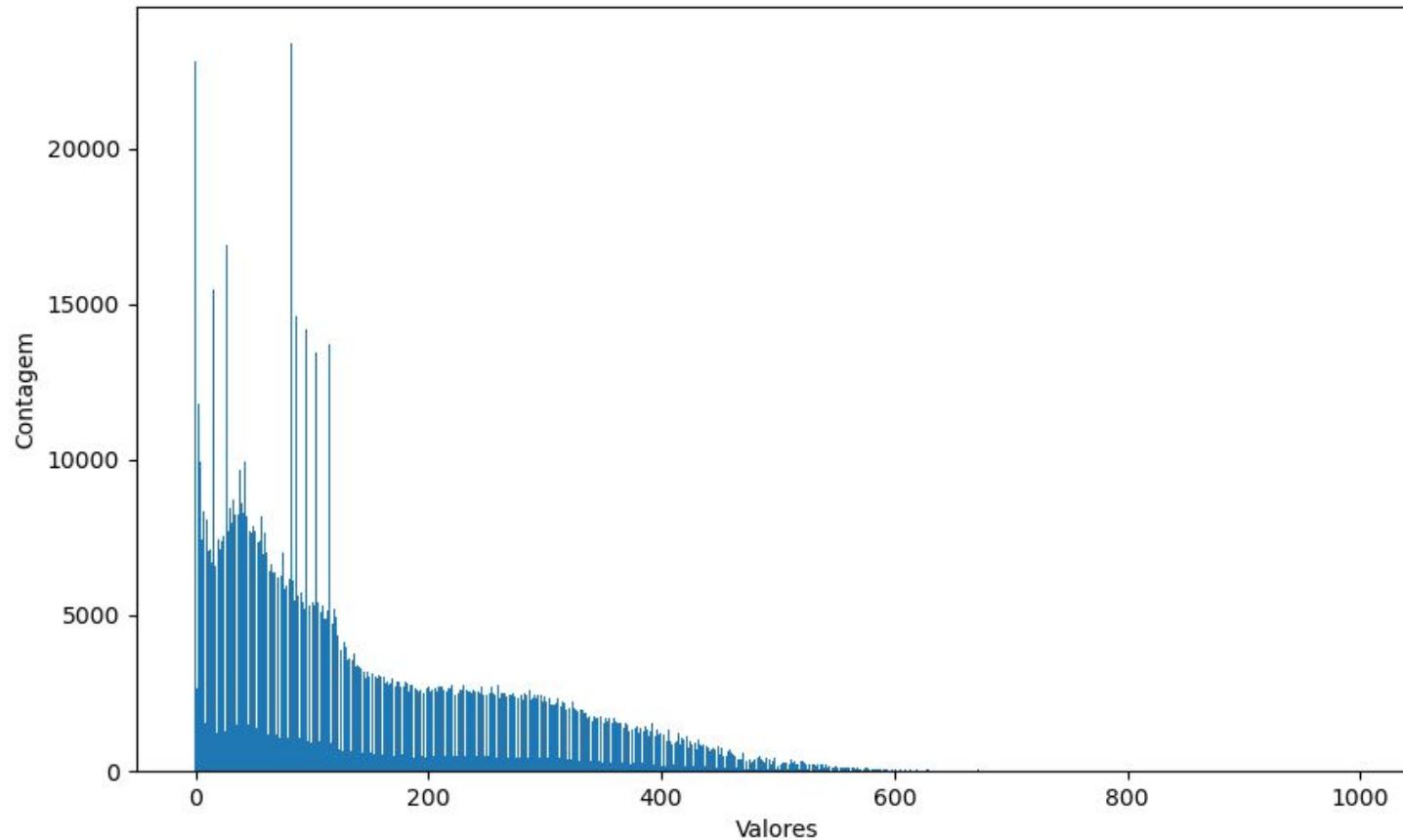


Gráfico de Ocorrência dos Valores - 70% de valores removidos

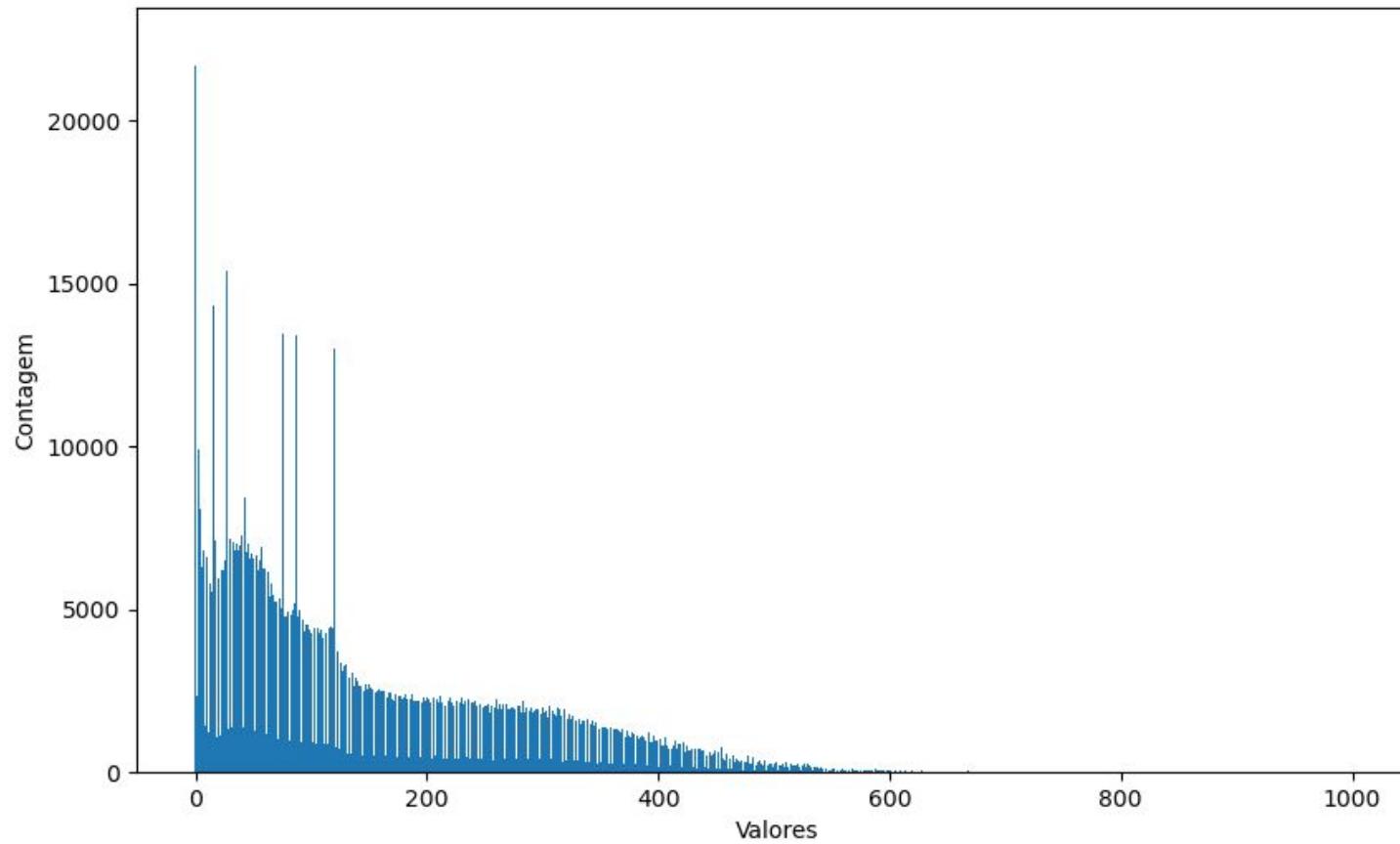


Gráfico de Ocorrência dos Valores - 80% de valores removidos

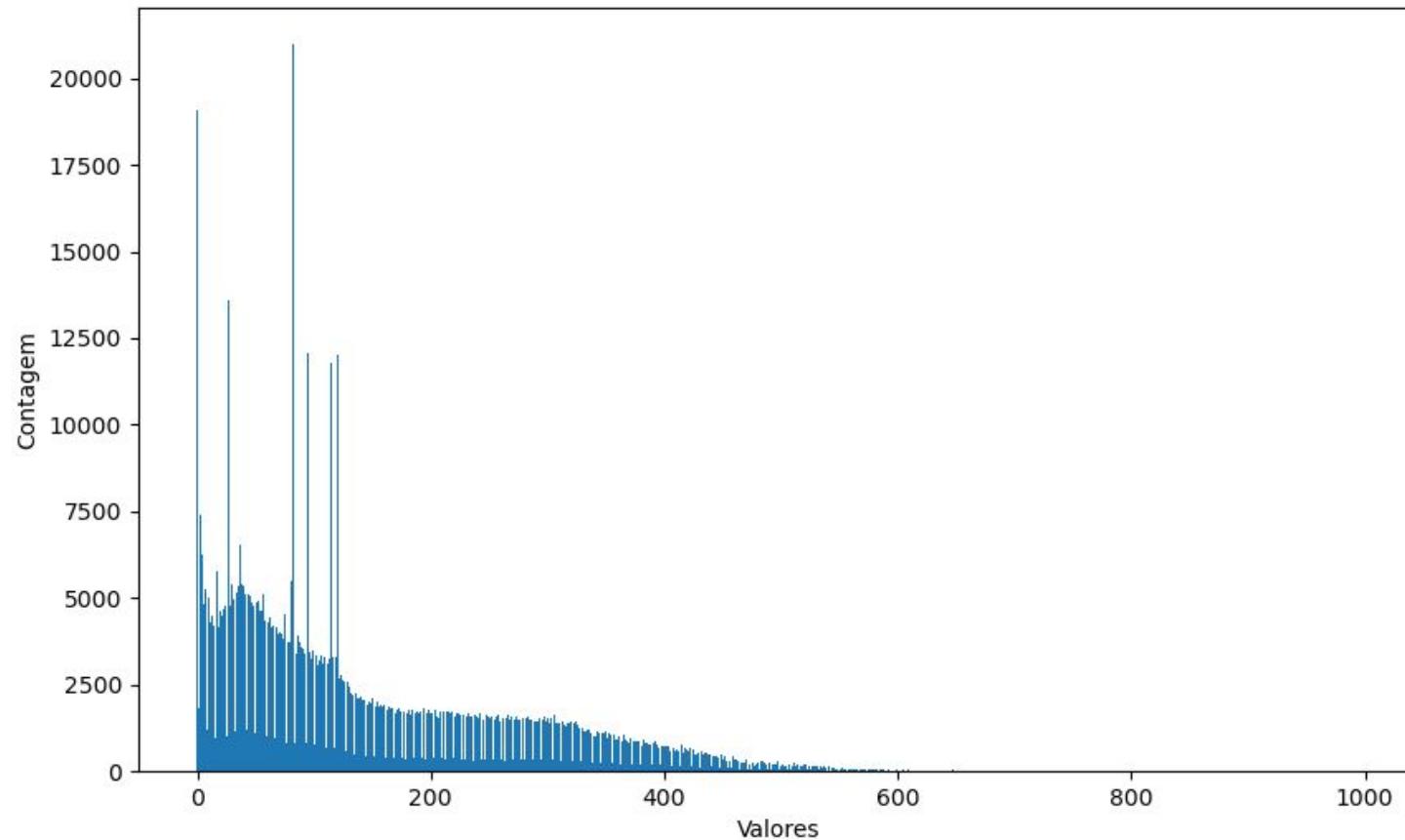
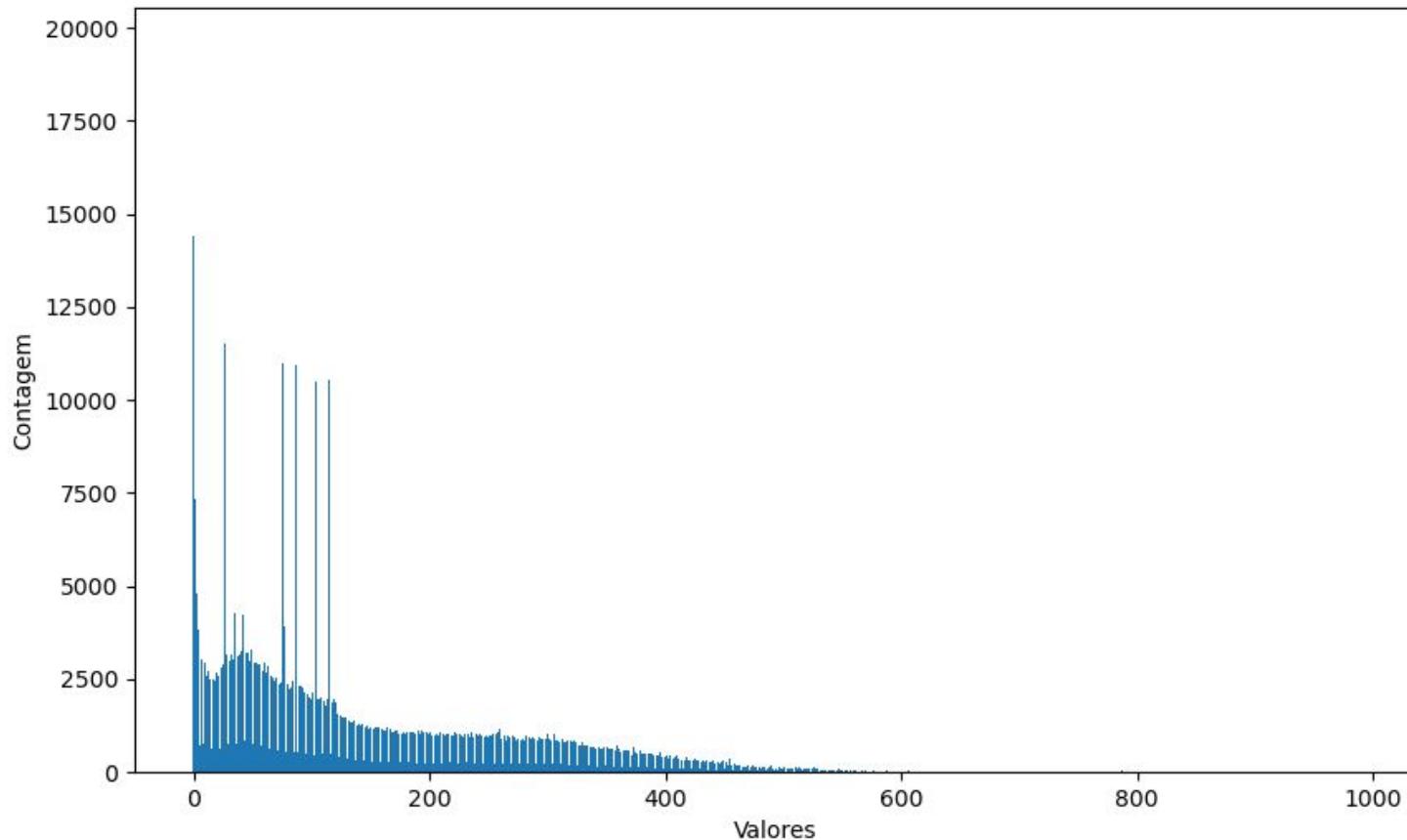
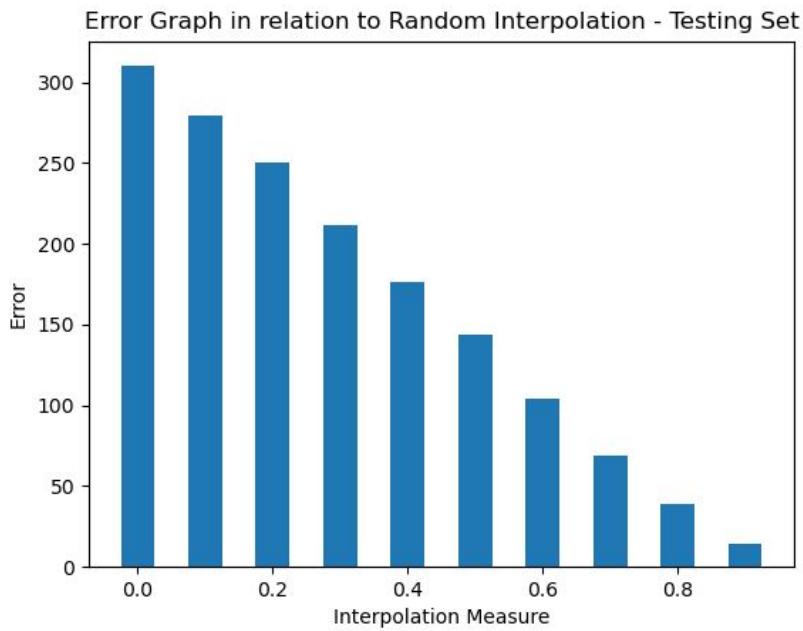


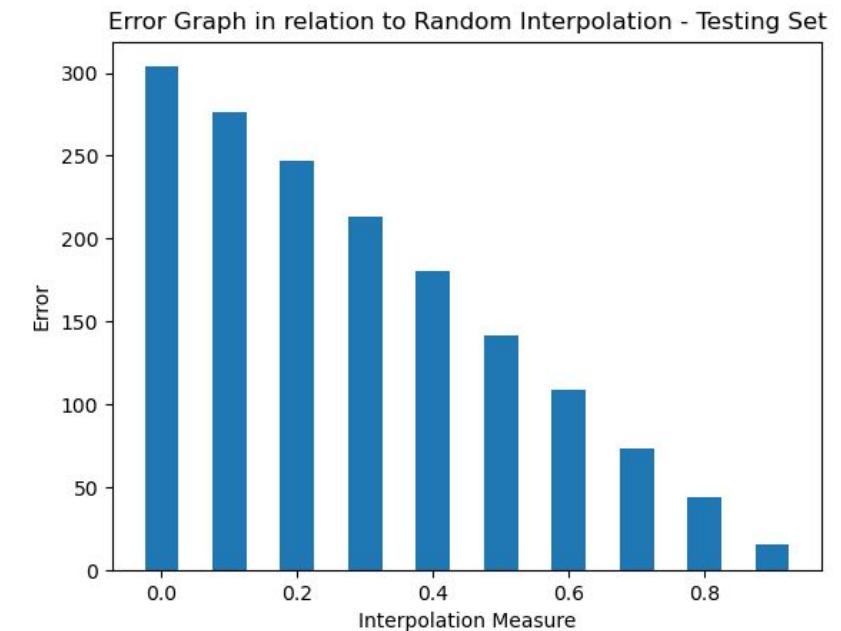
Gráfico de Ocorrência dos Valores - 90% de valores removidos



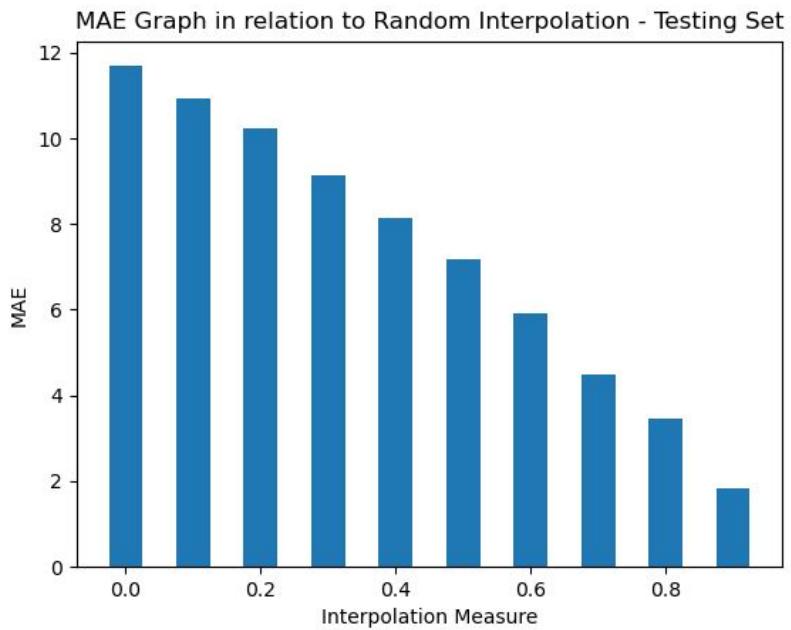
GNN



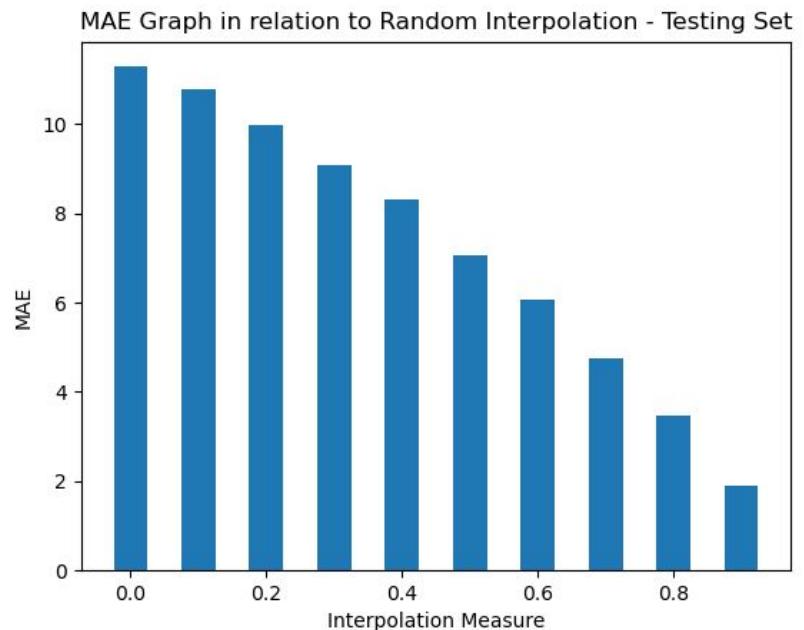
Regressão



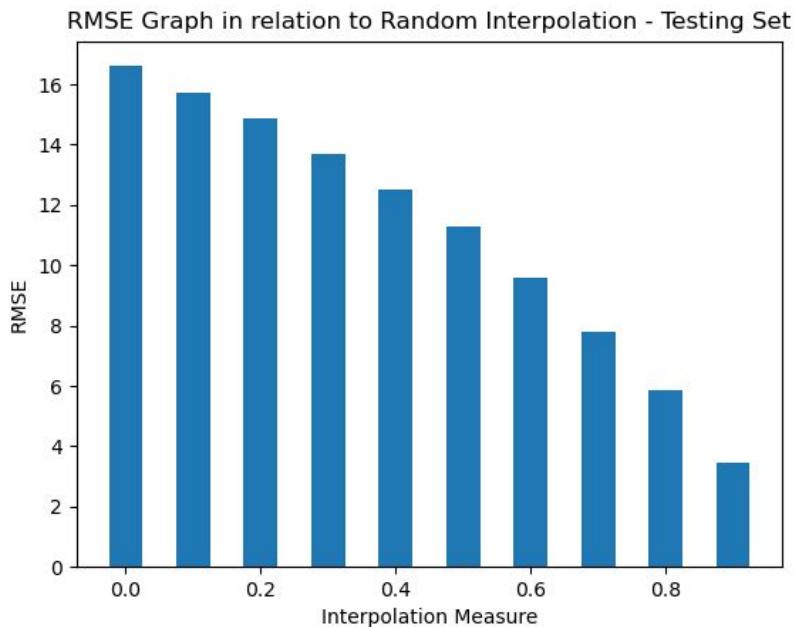
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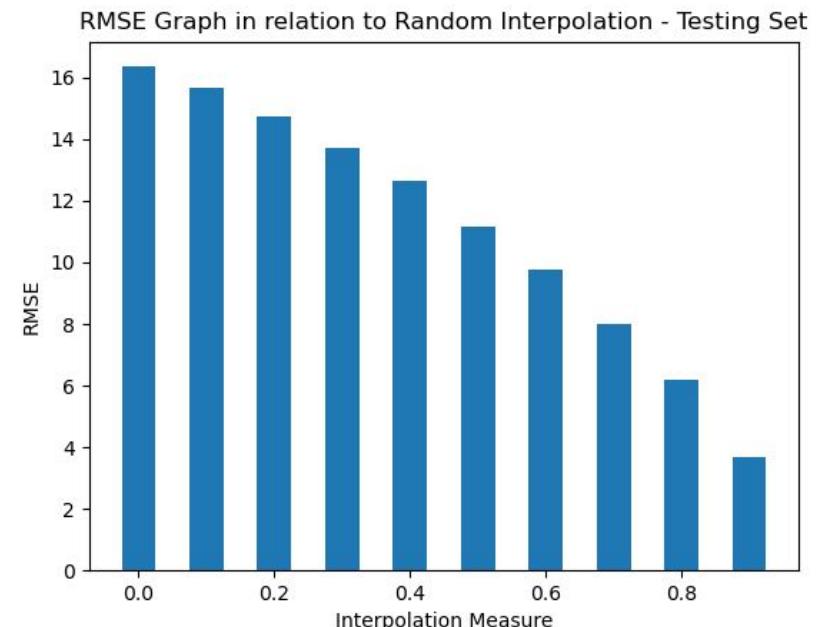
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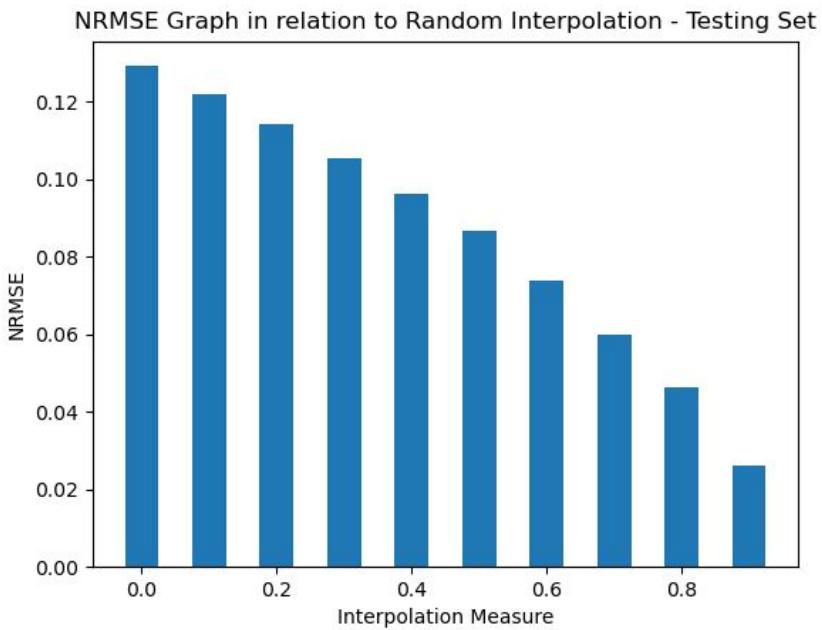
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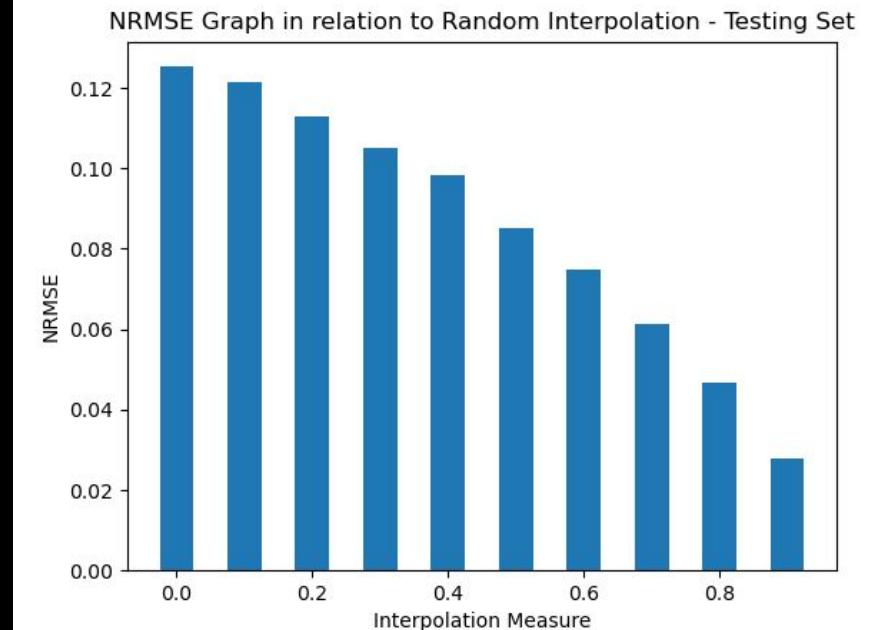
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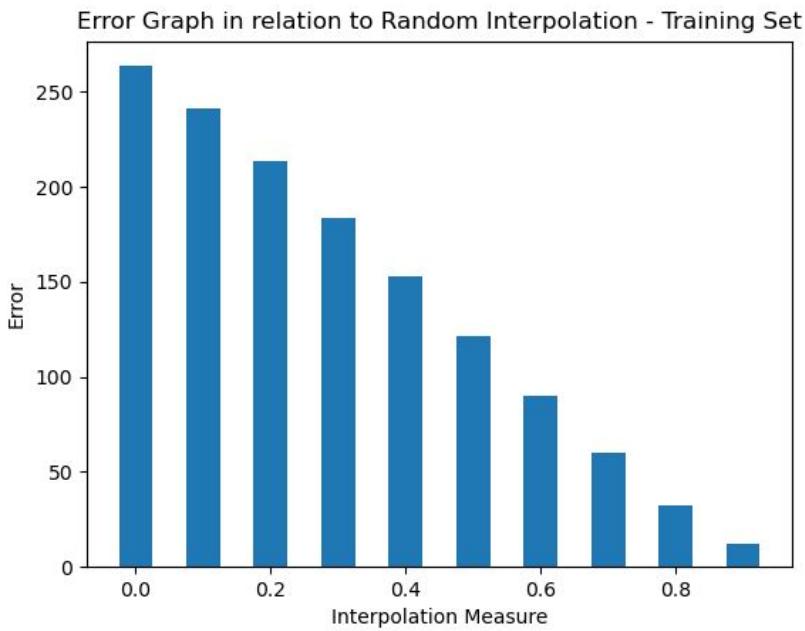
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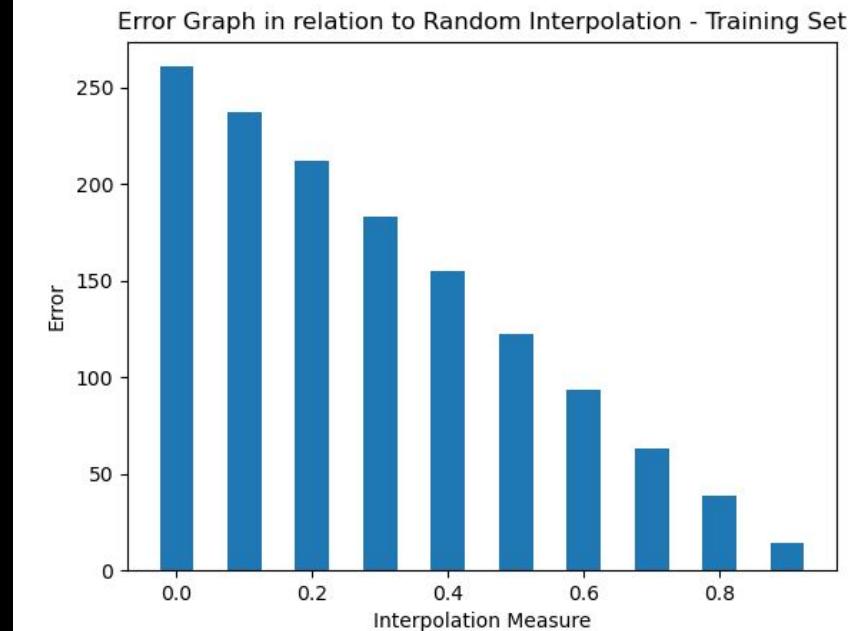
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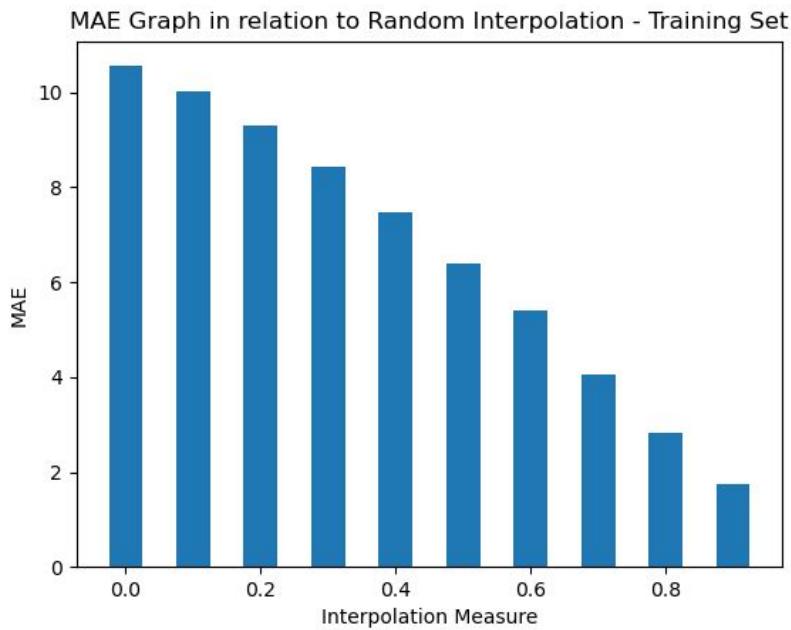
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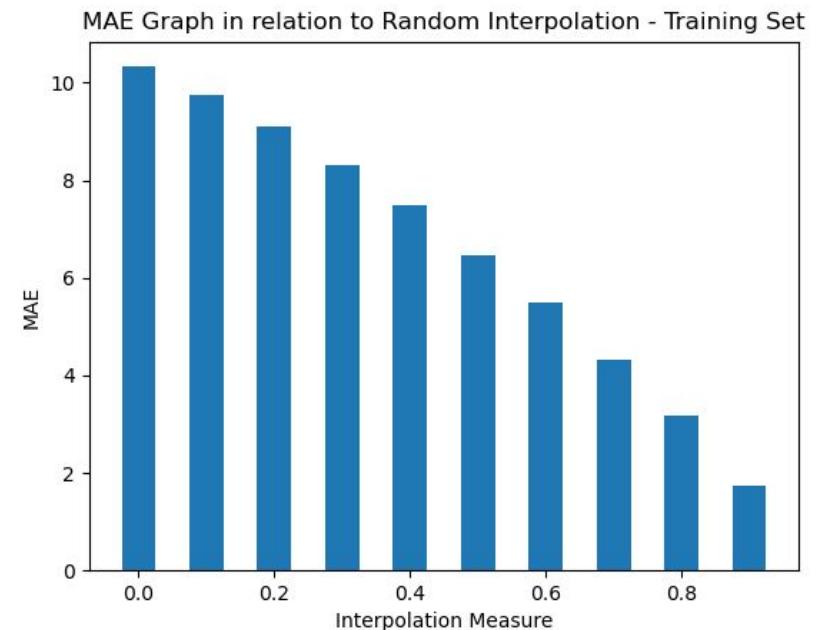
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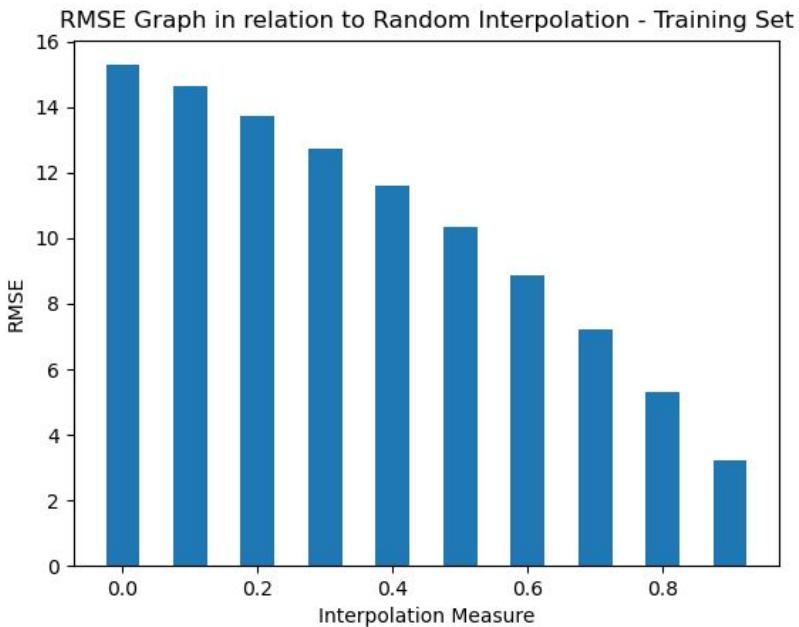
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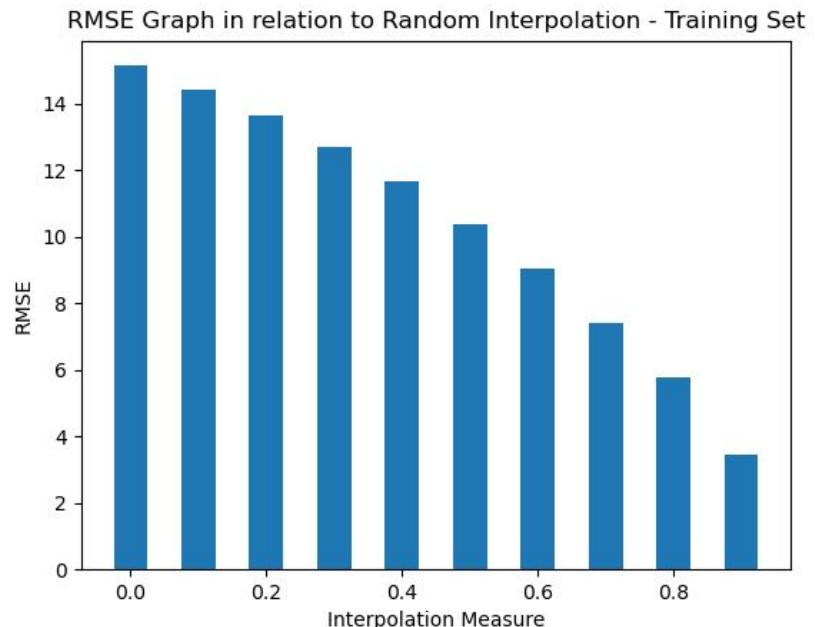
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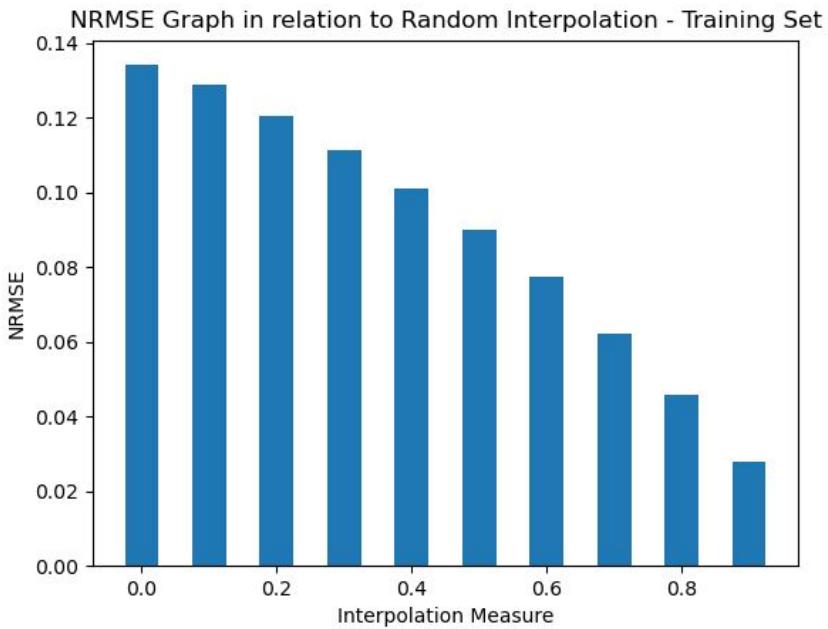
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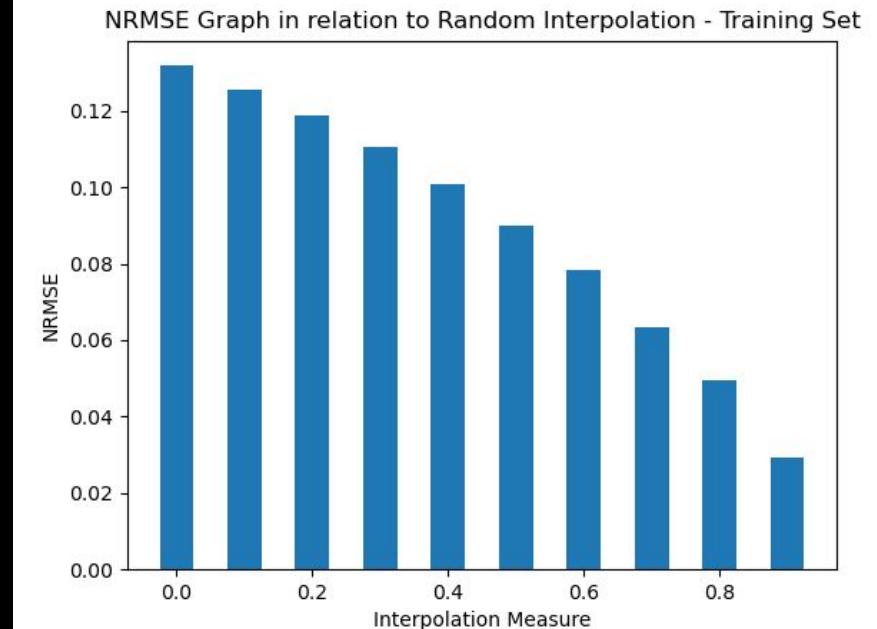
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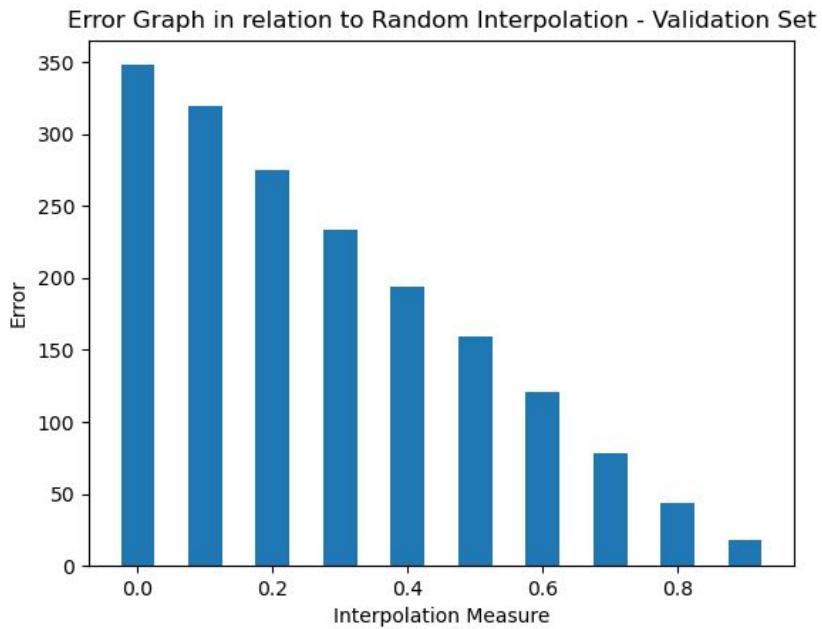
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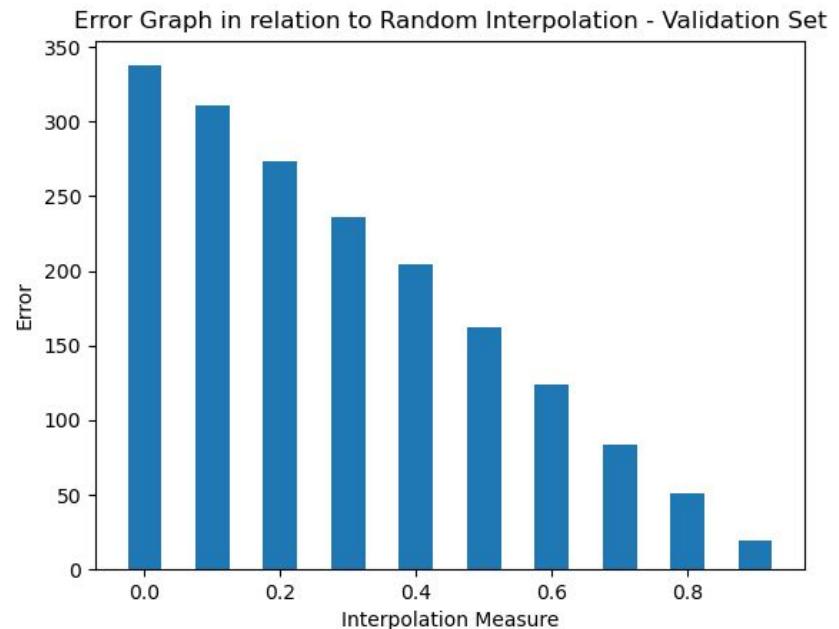
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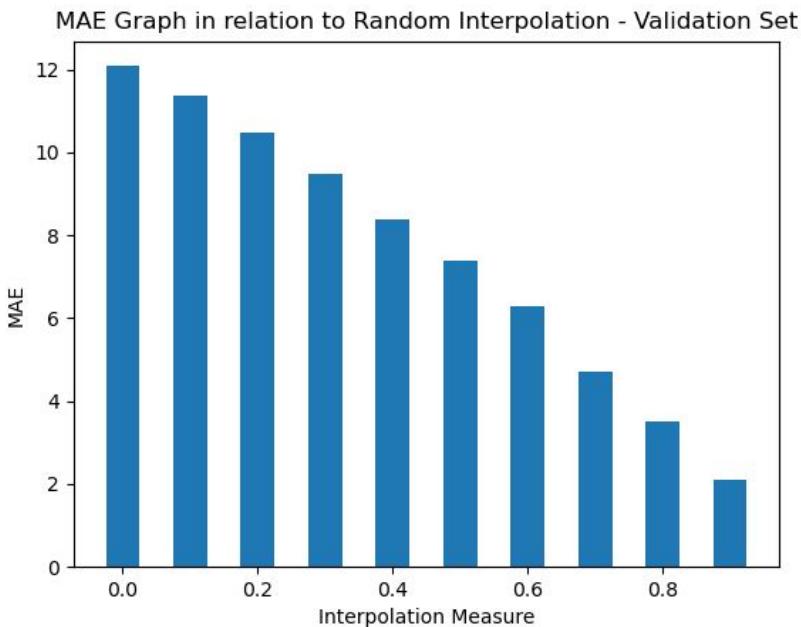
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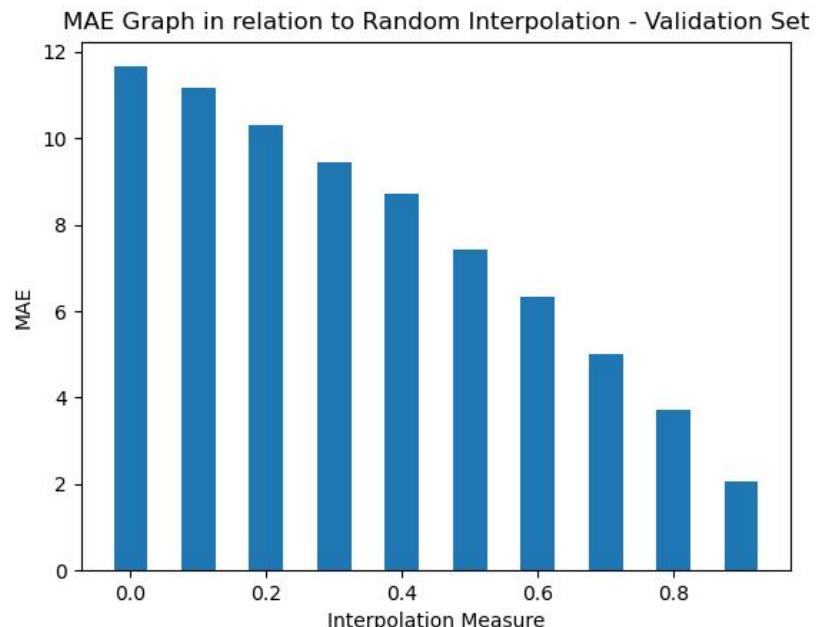
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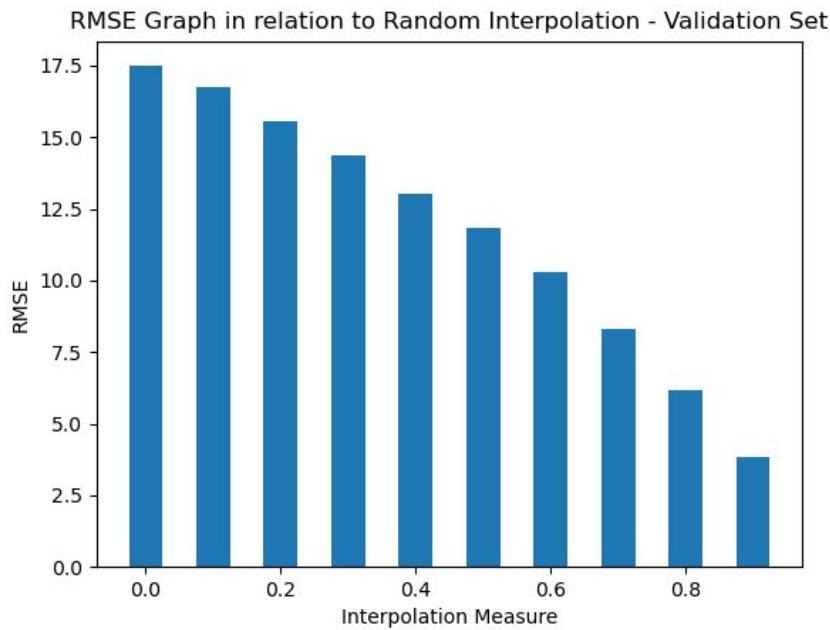
GNN



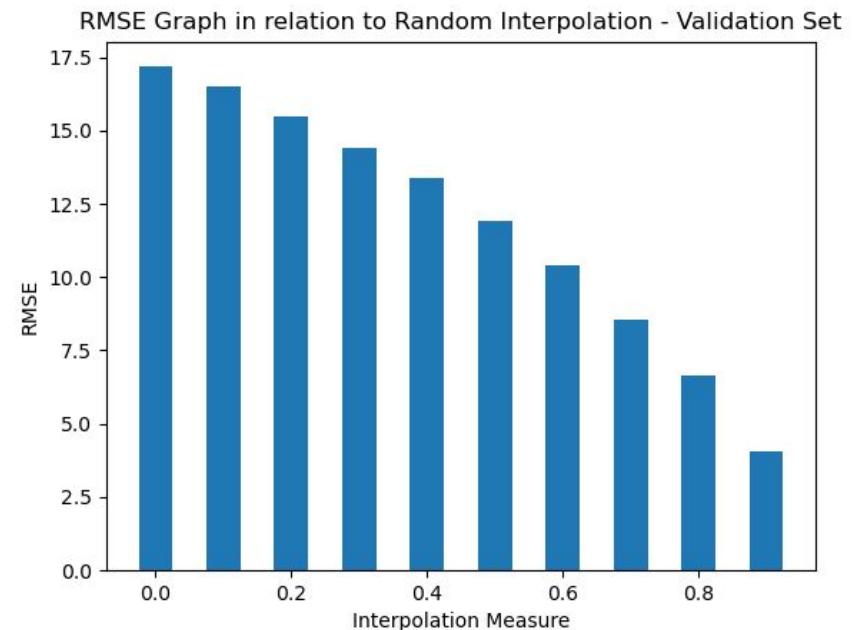
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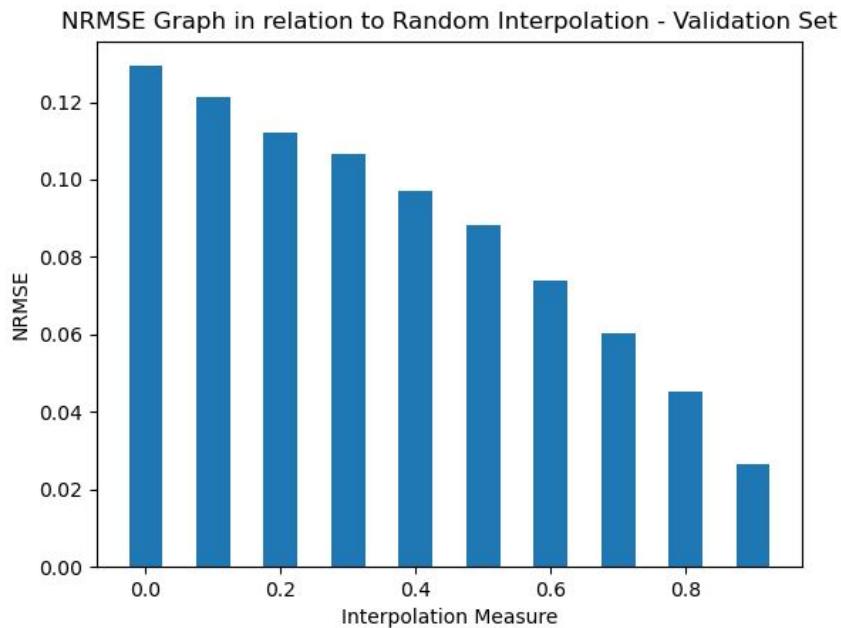
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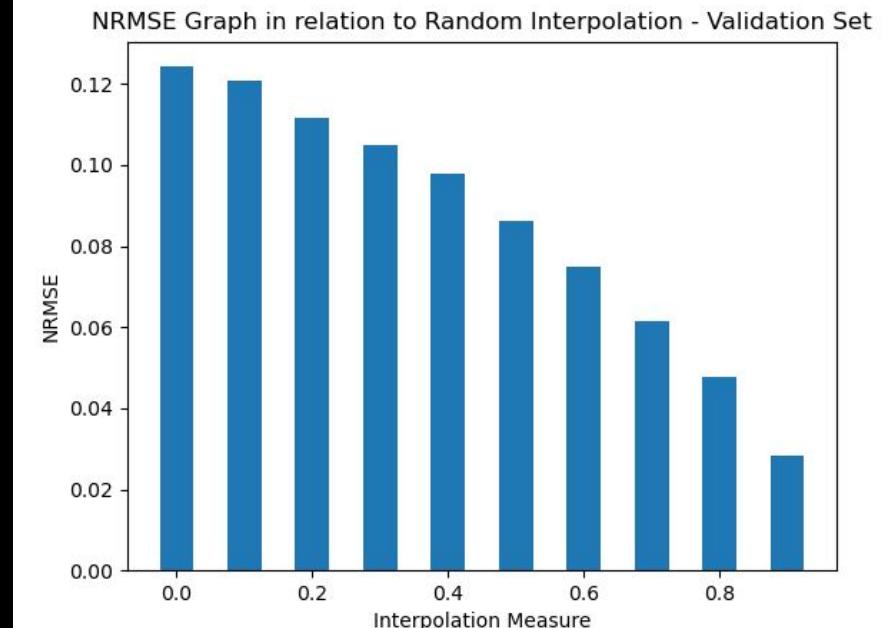
Regressão



GNN



Regressão



Teste de Ruído

- Criou-se matrizes de ruído com valores de ruído variando de 0 a algum múltiplo de 10
 - Esta matriz foi somada com os dados do dataset PEMSD3
 - Utilizou-se somente $\frac{1}{8}$ do dataset (mês de janeiro)
-

Informações das Matrizes de Ruído

Os índices dos gráficos correspondem as seguinte matrizes de ruído:

1. I: Matriz de ruído com valores entre 0 e 10
2. II: Matriz de ruído com valores entre 0 e 100
3. III: Matriz de ruído com valores entre 0 e 1000
4. IV: Matriz de ruído com valores entre 0 e 10000
5. V: Matriz de ruído com valores entre 0 e 100000
6. VI: Matriz de ruído com valores entre 0 e 1000000

Informações dos Gráficos

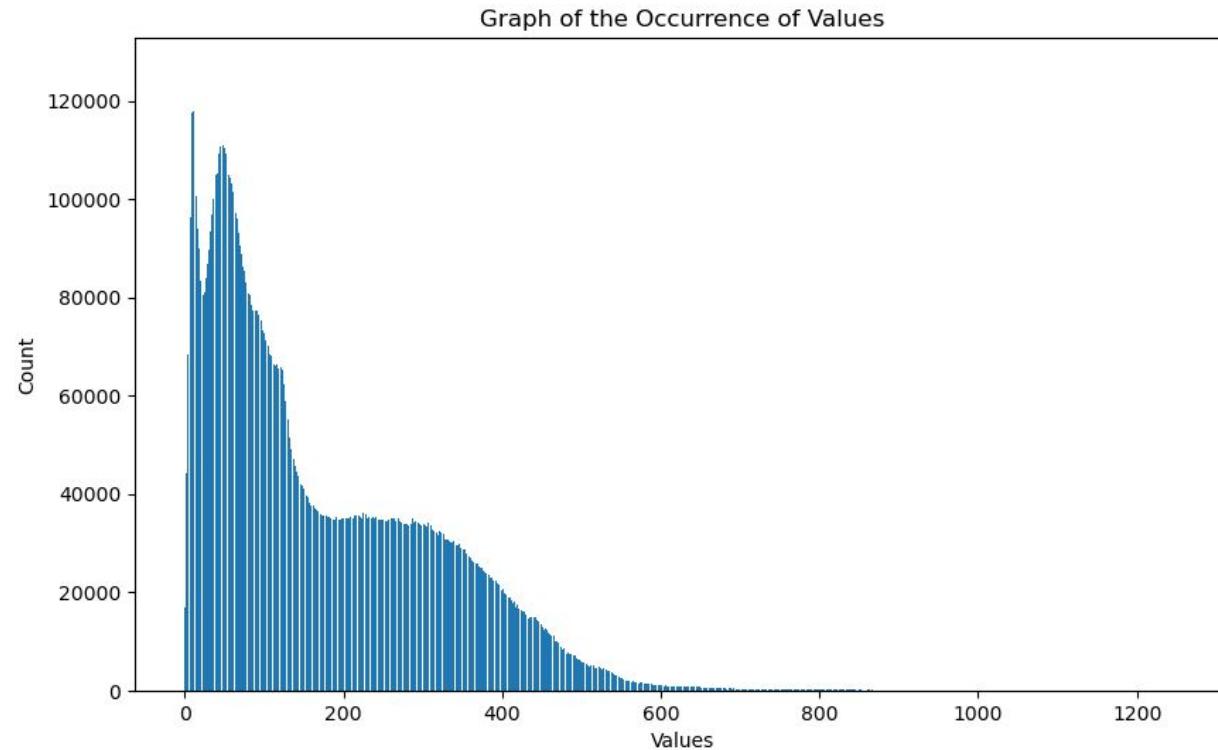
Para cada matriz de ruído foram gerados dois gráficos:

- Um gráfico para o histograma dos valores de ruído
- Um gráfico para indicando o índice de correlação de cada sensor

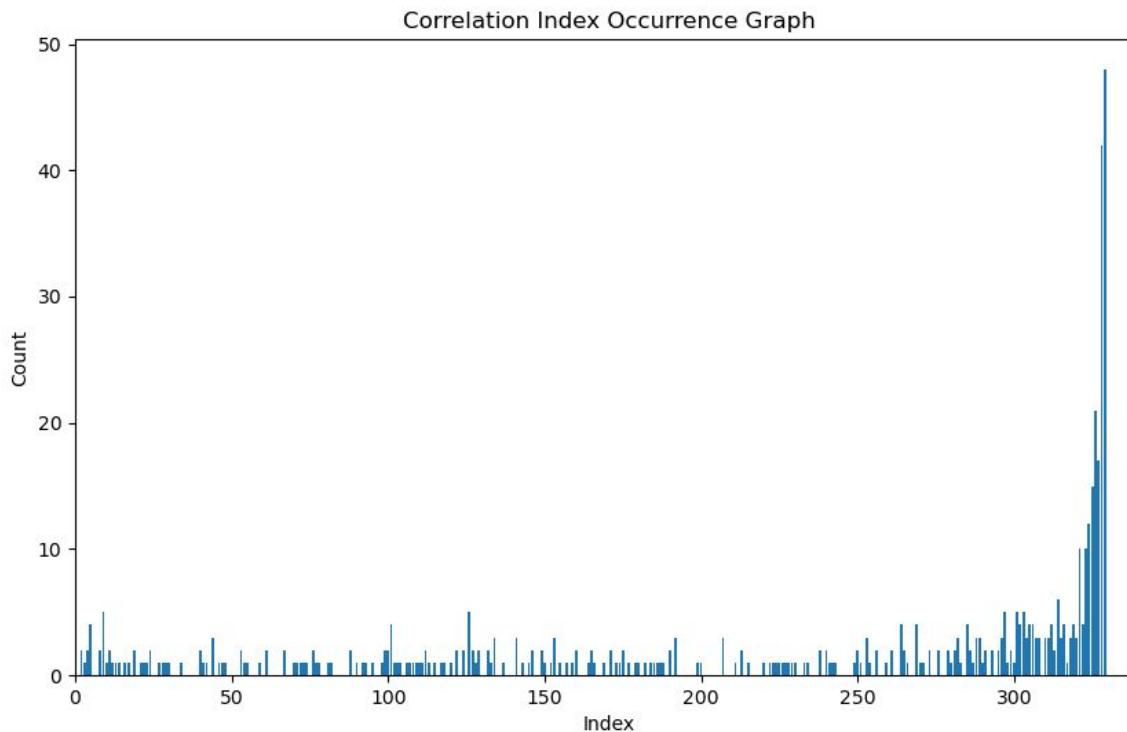
Informações das Matrizes de Ruído

Dataset	Min	Max	Mean	Median	Variancy	Variancy Coefficient	Std	Asymmetry Coefficient
I	0.0	1255.0	172.89080137139882	127.0	19737.397262996485	81.25929571141145	140.48984754421397	0.9340069096129328
II	0.0	1311.0	217.90185868105587	177.0	20577.124832246995	65.83114538557486	143.44728938619576	0.8772344123406653
III	0.0	2165.0	667.8428702537509	668.0	103246.00137442492	48.11298771477529	321.3191581191898	0.0781449138829378
IV	0.0	11025.0	5168.692788383467	5169.0	8354554.653272916	55.92177302150299	2890.4246492985967	-1.9077615868822463e-05
V	0.0	101161.0	50167.06768561903	50170.0	833193979.5277388	57.53794473446092	28865.09967985108	-4.4364174318853966e-06
VI	0.0	1000846.0	500160.6900547016	500214.0	83364081091.83568	57.7271249228954	288728.3863630933	-6.926430164730045e-05

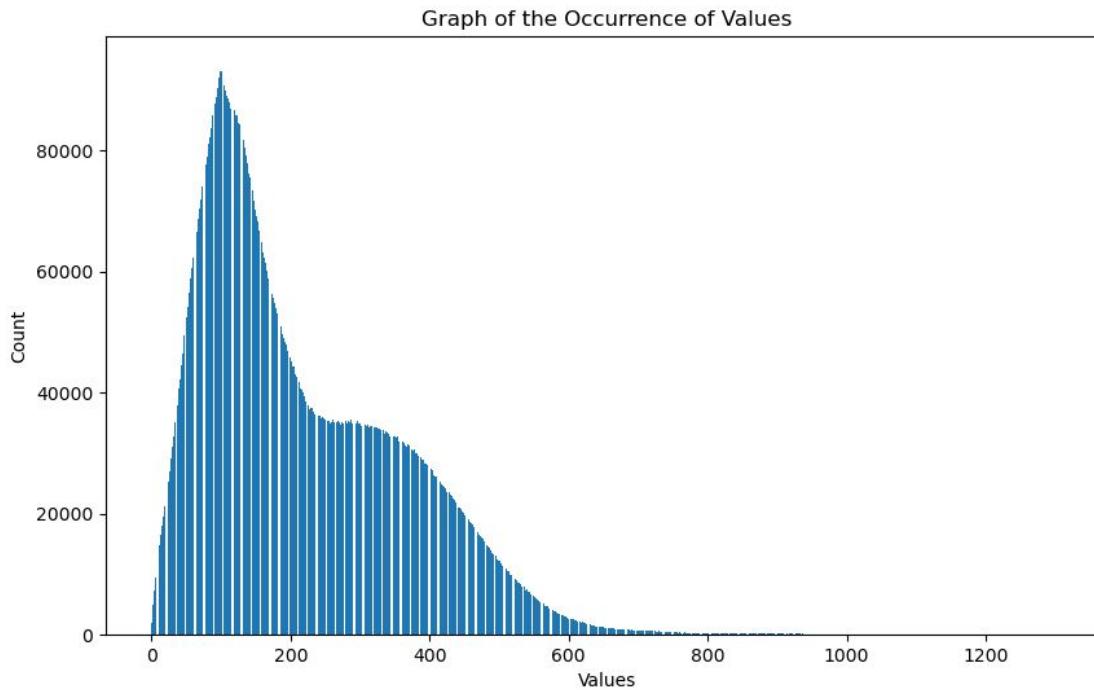
Matrizes de Ruído I



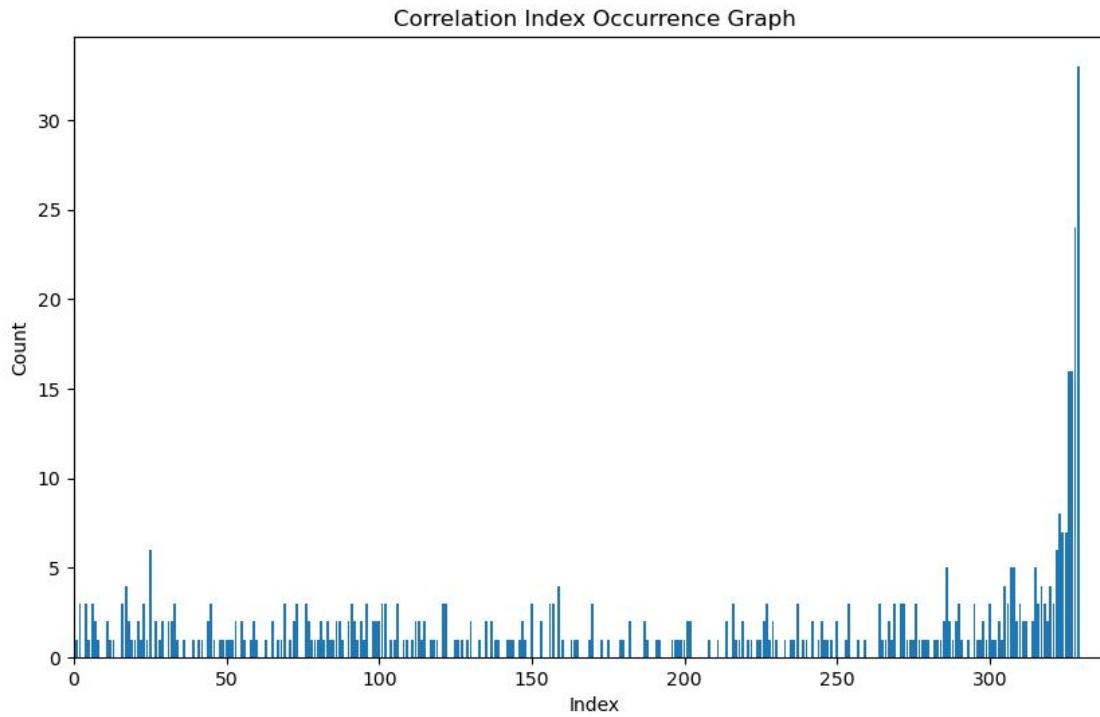
Matrizes de Ruído I



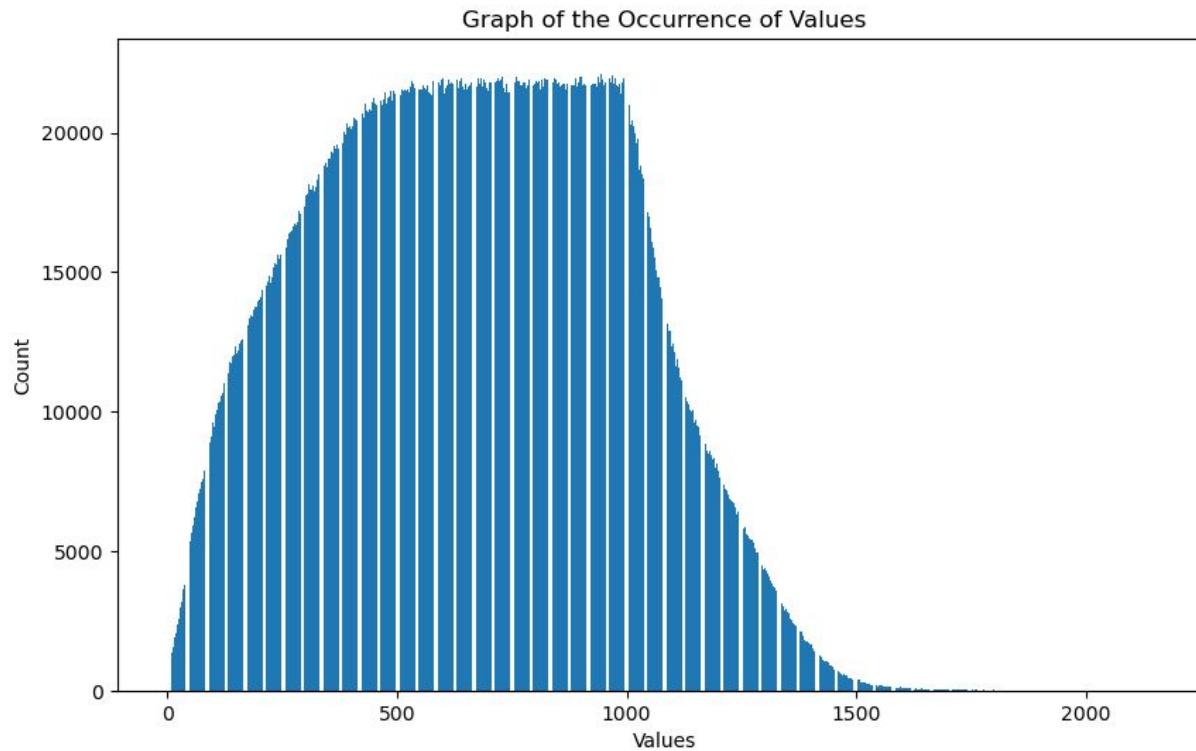
Matrizes de Ruído II



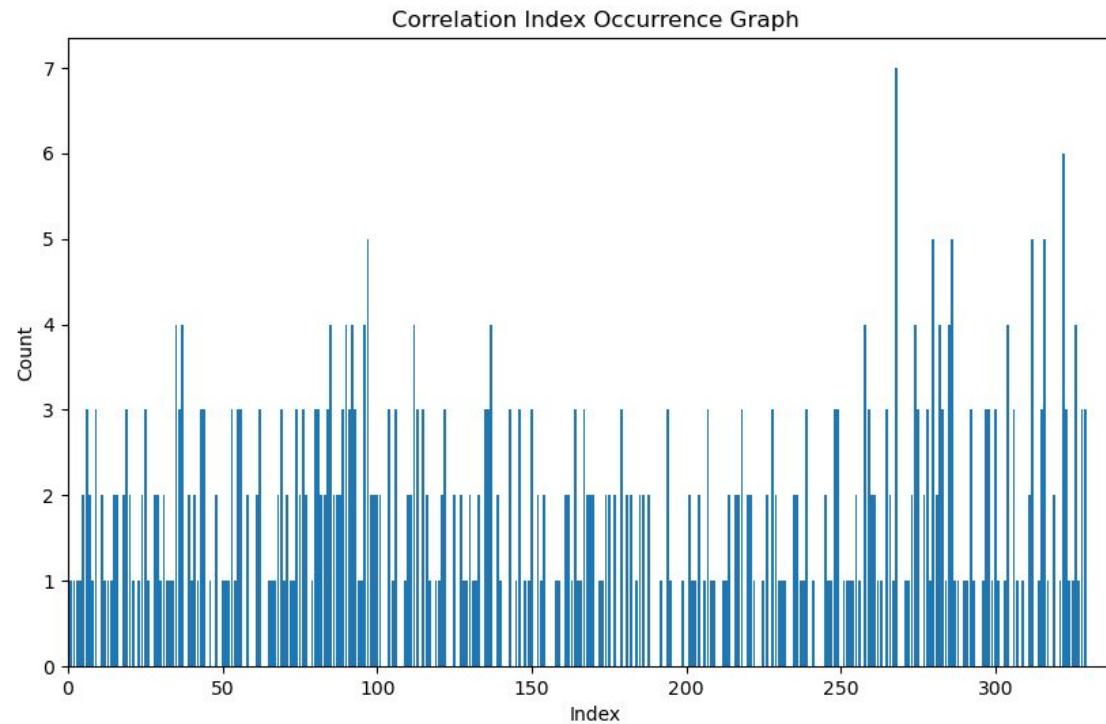
Matrizes de Ruído II



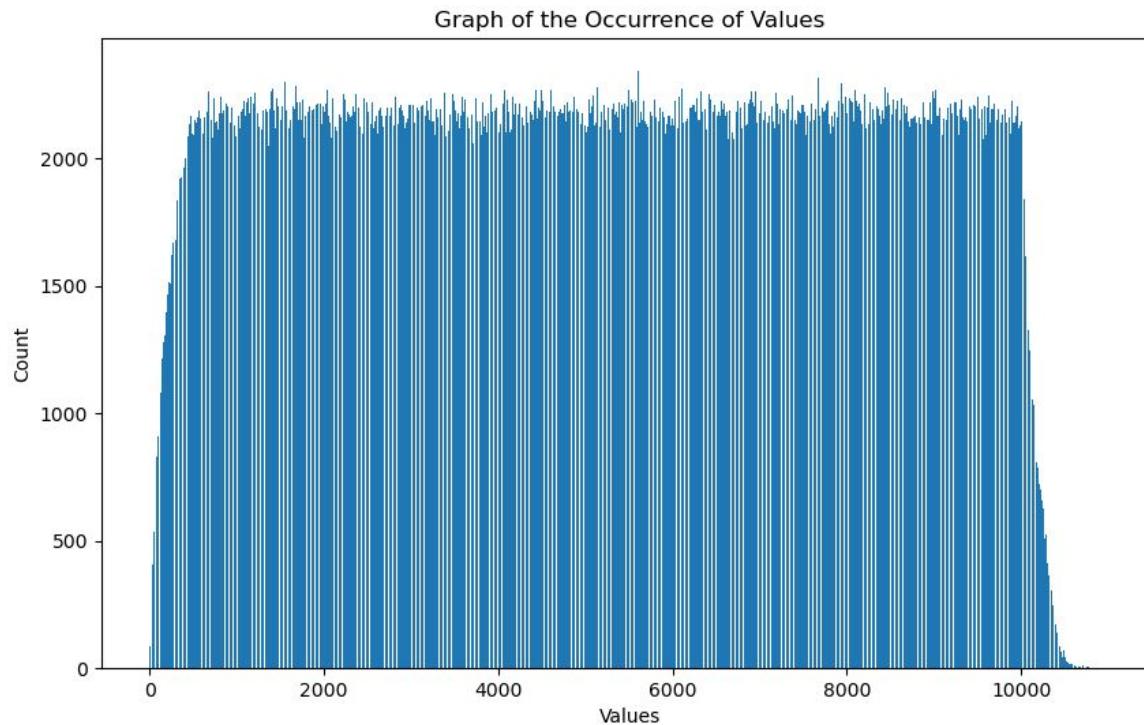
Matrizes de Ruído III



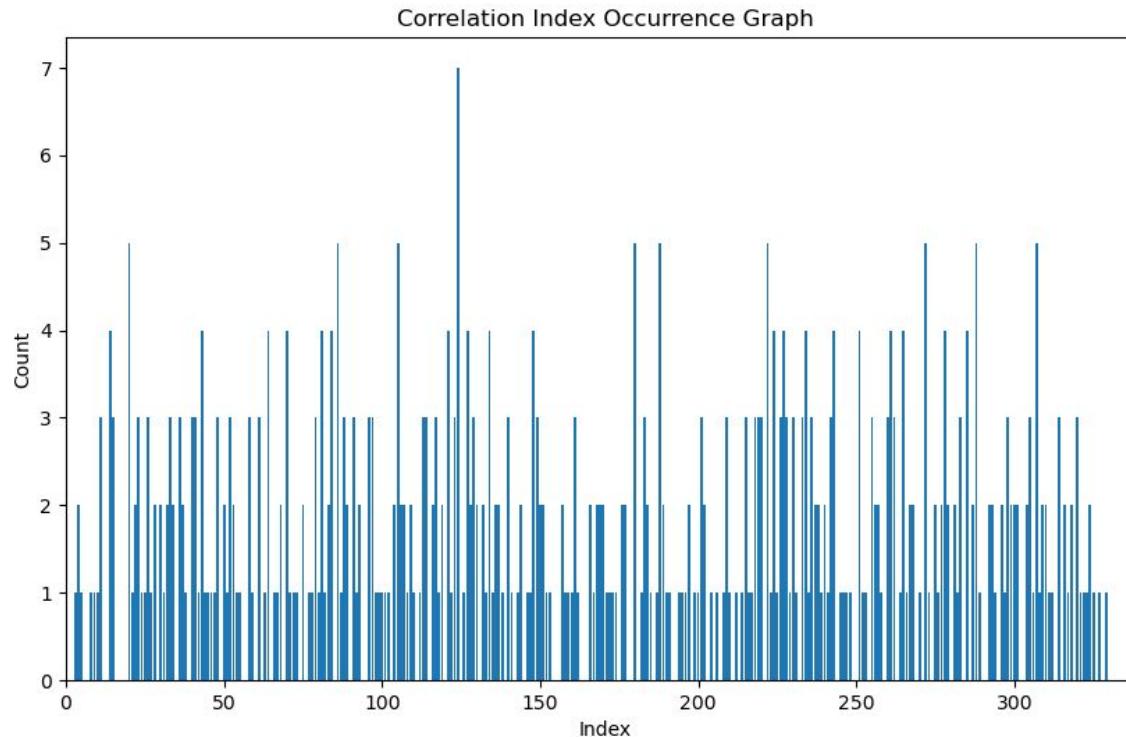
Matrizes de Ruído III



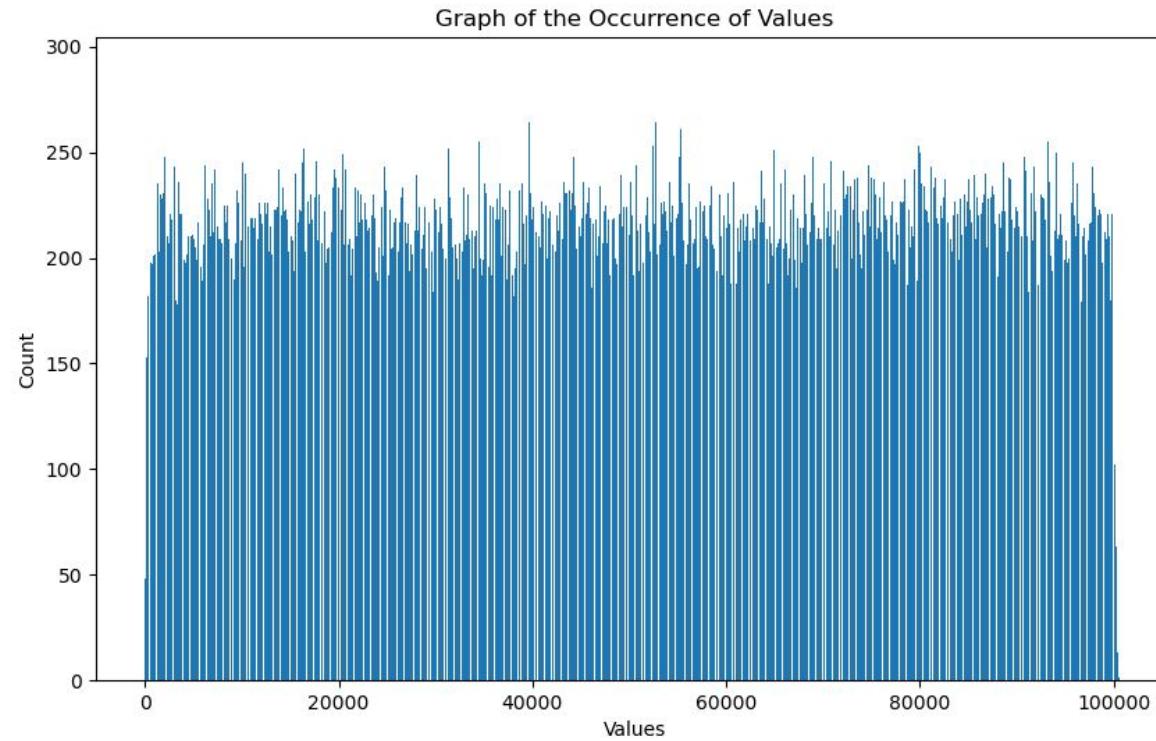
Matrizes de Ruído IV



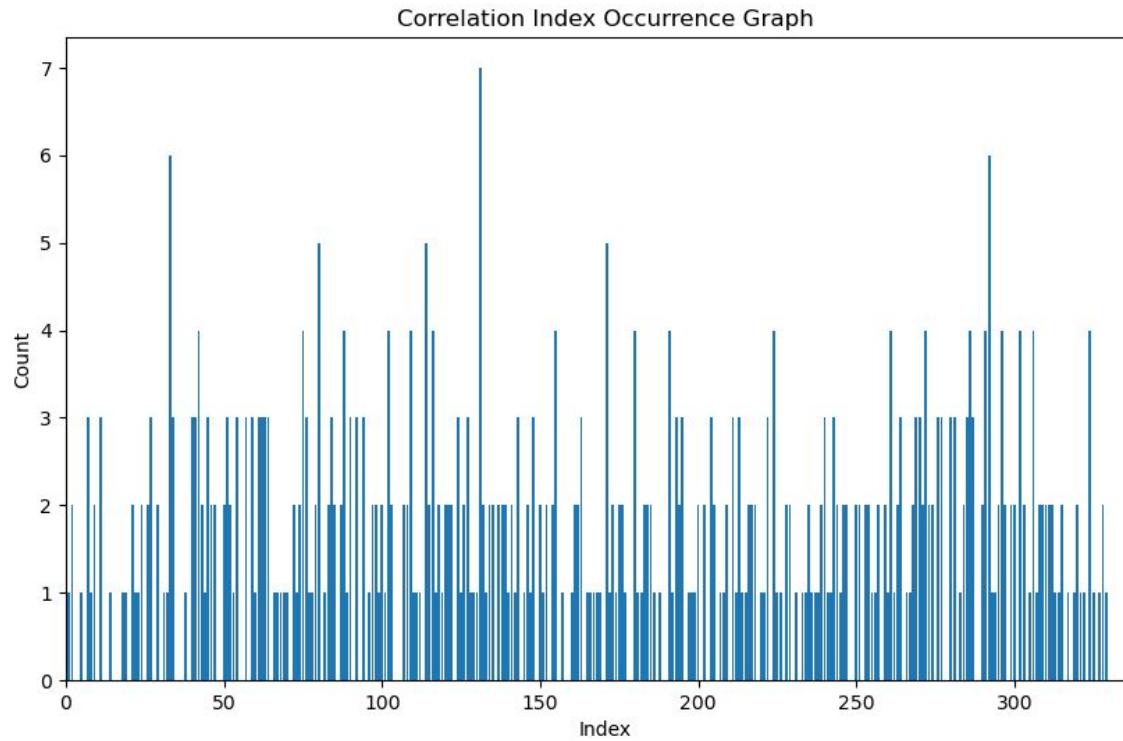
Matrizes de Ruído IV



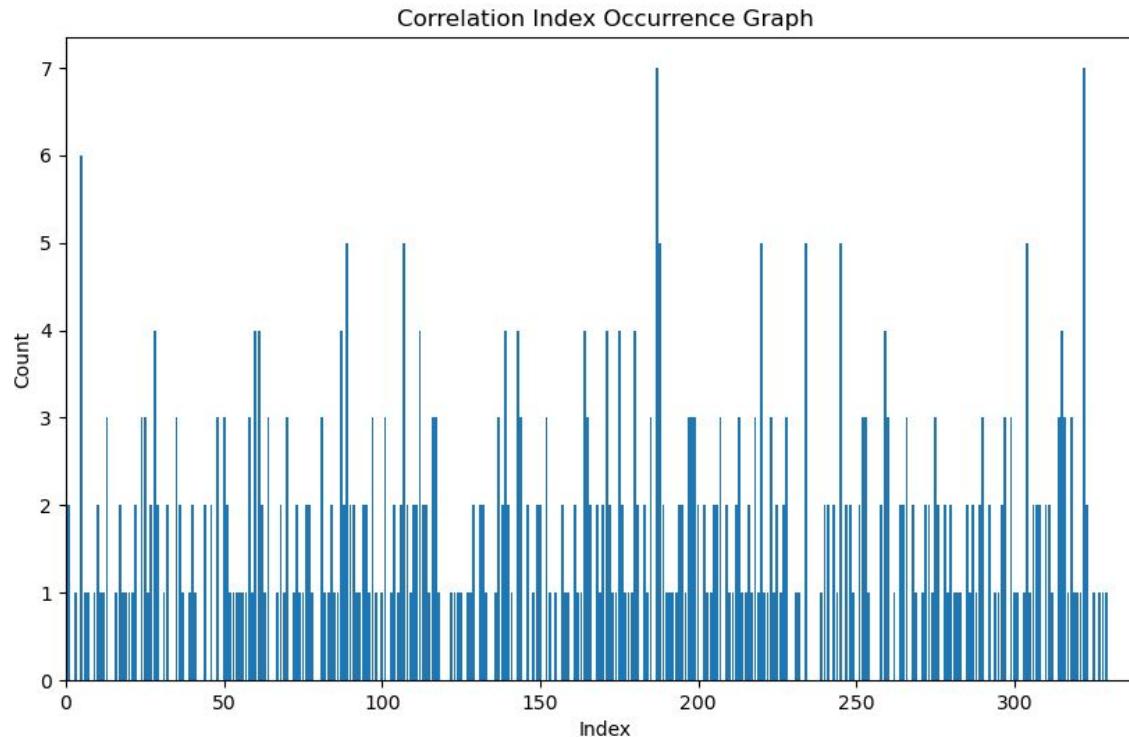
Matrizes de Ruído V



Matrizes de Ruído V

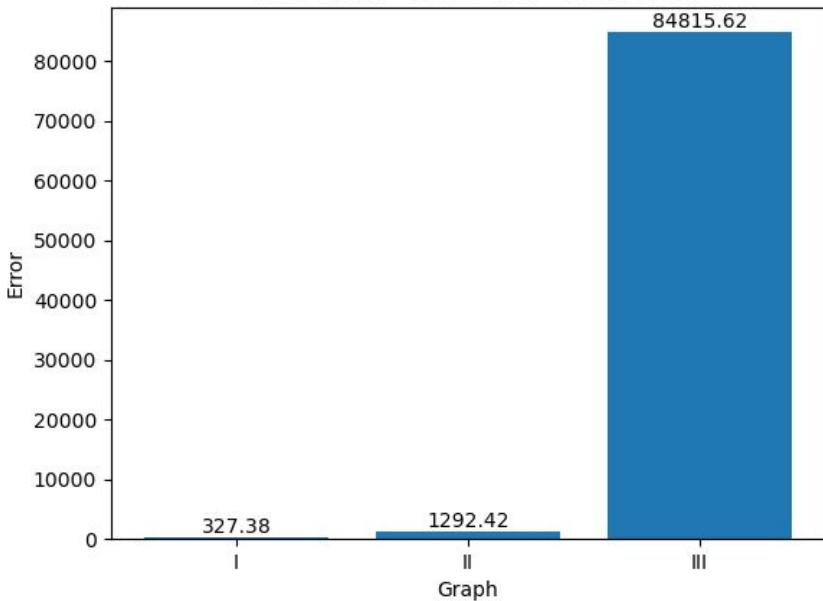


Matrizes de Ruído VI



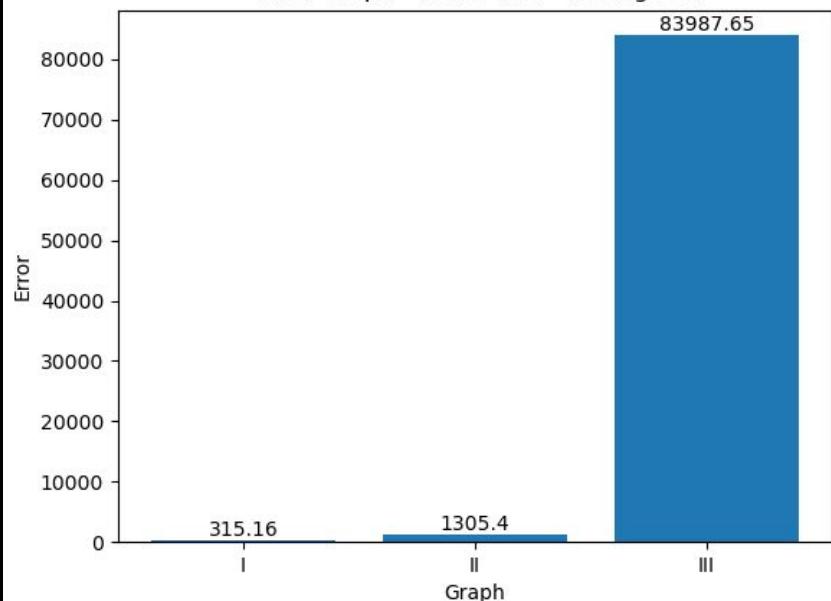
GNN

Error Graph - Noise Test - Testing Set

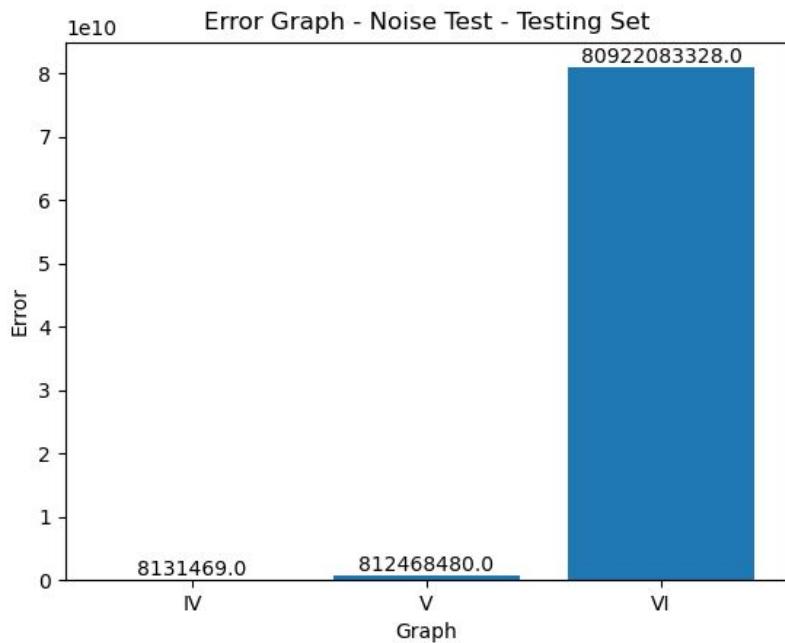


Regressão

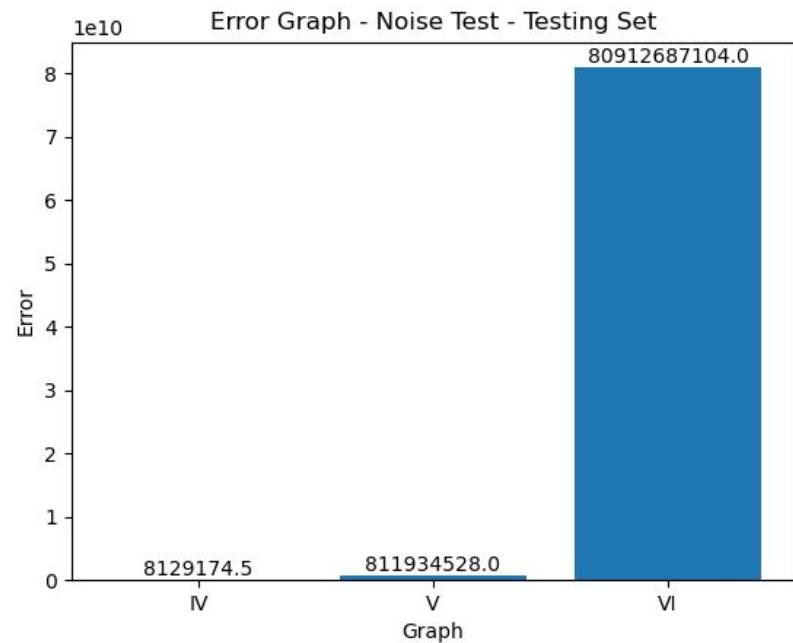
Error Graph - Noise Test - Testing Set



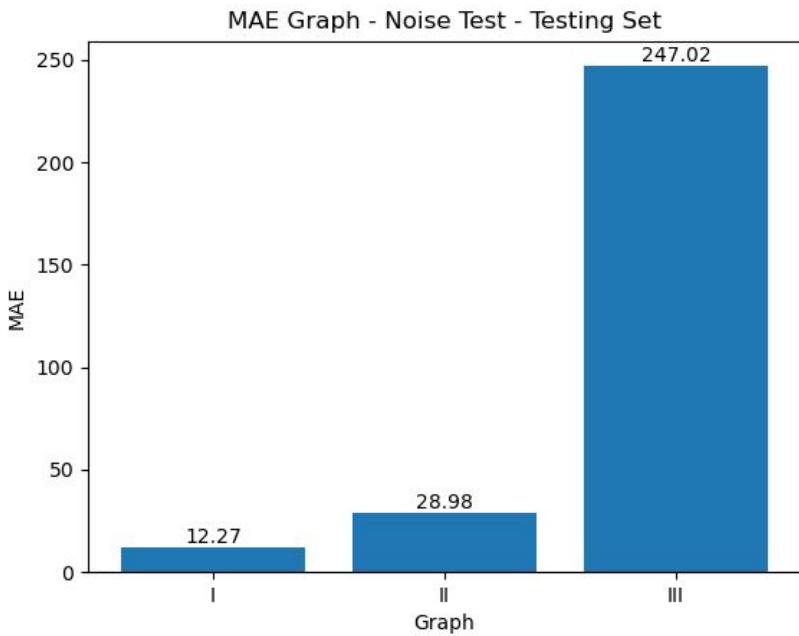
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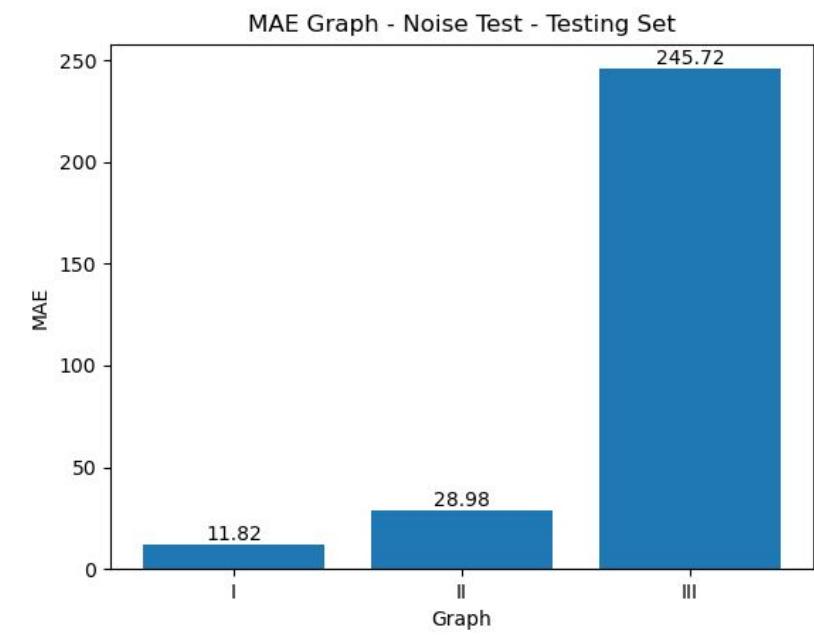
Regressão



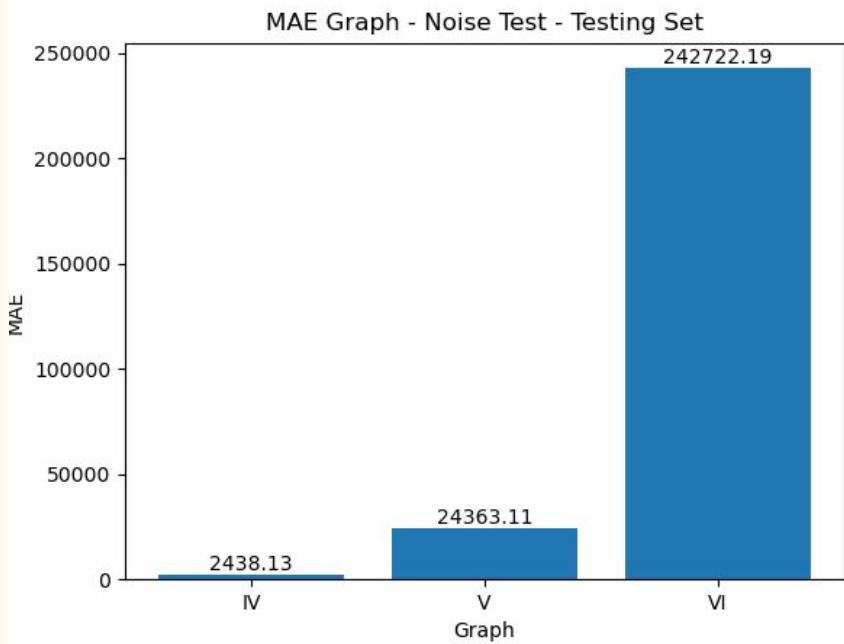
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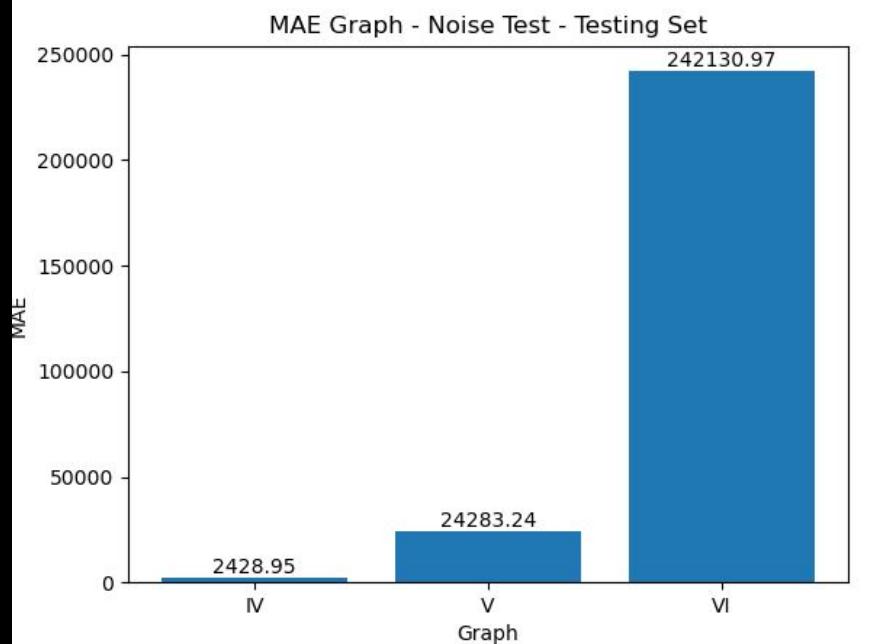
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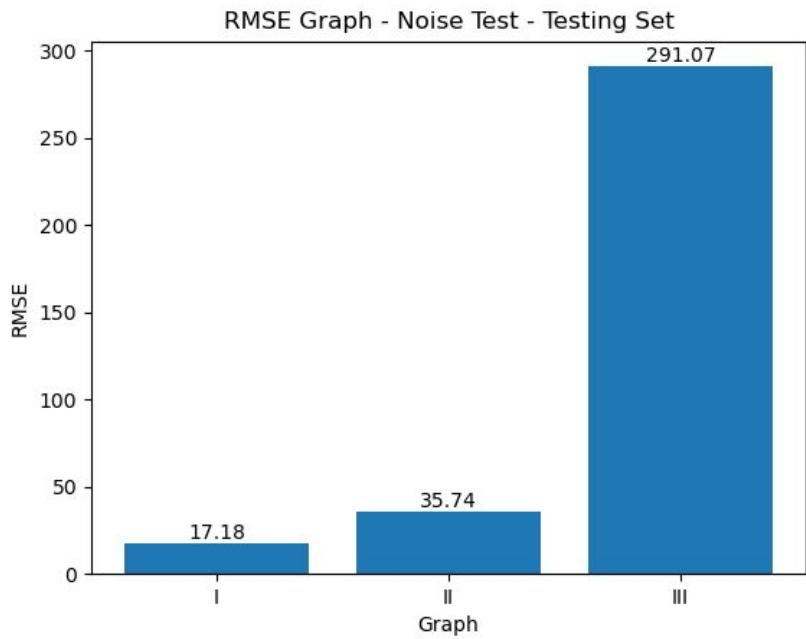
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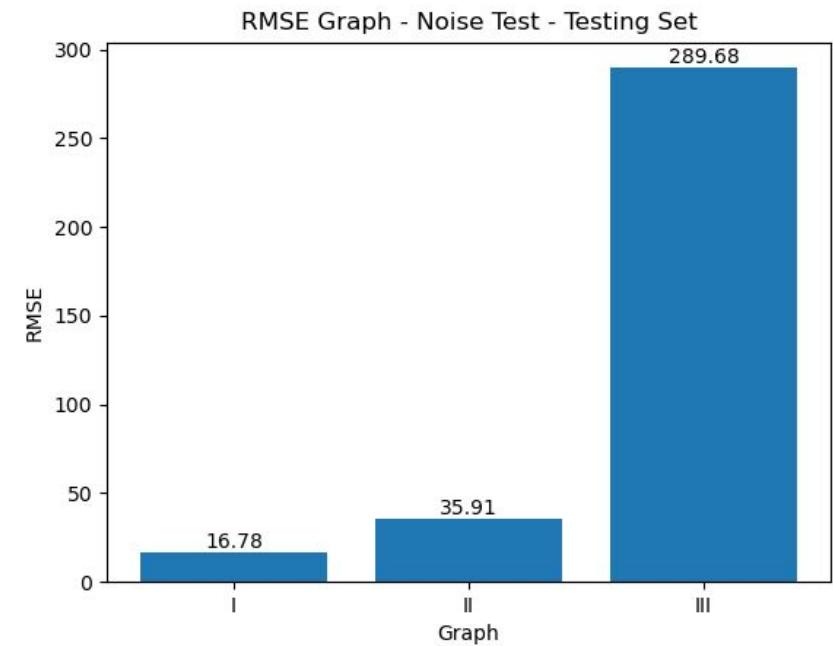
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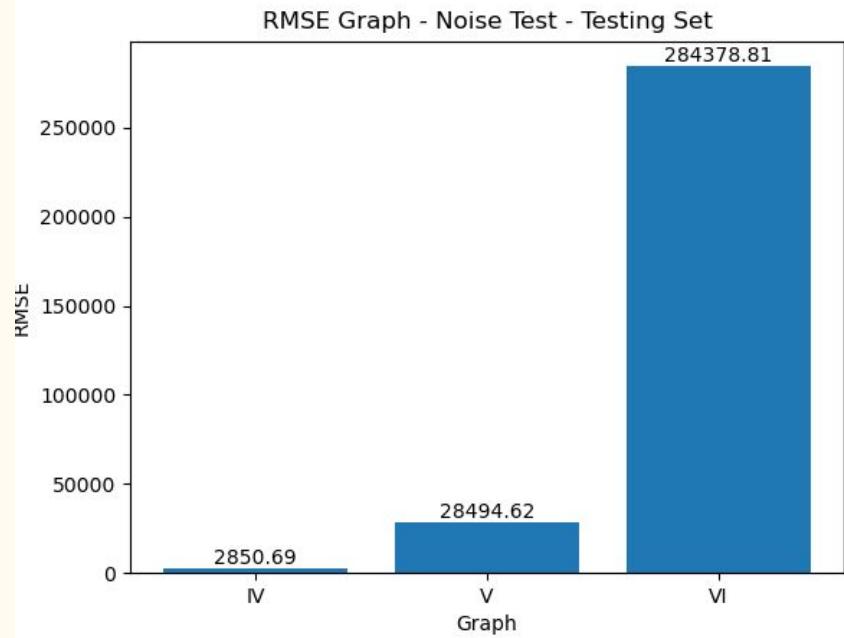
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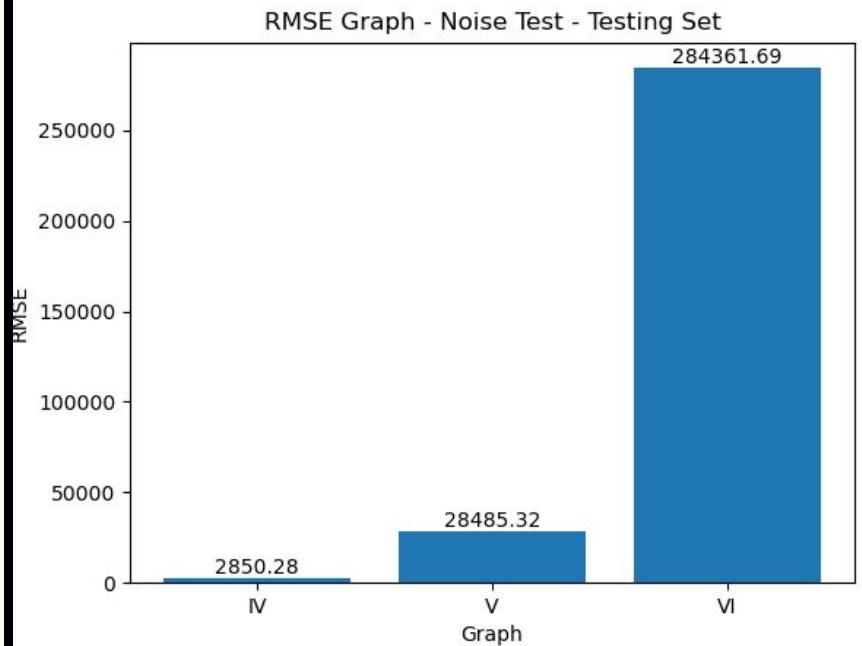
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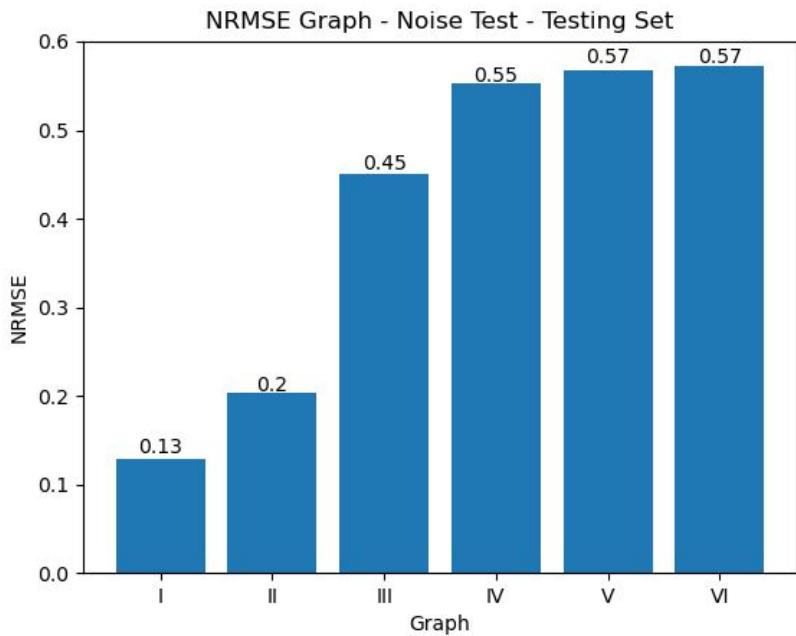
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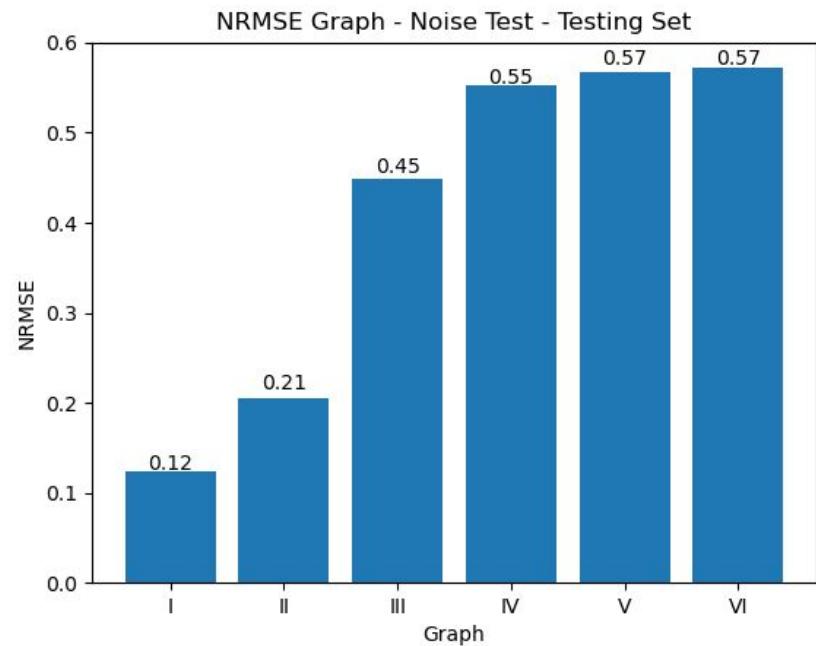
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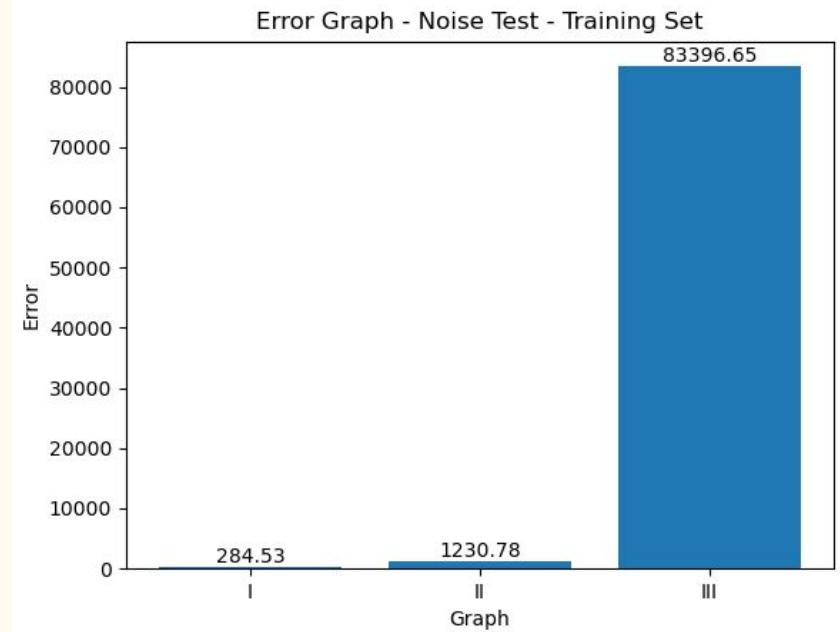
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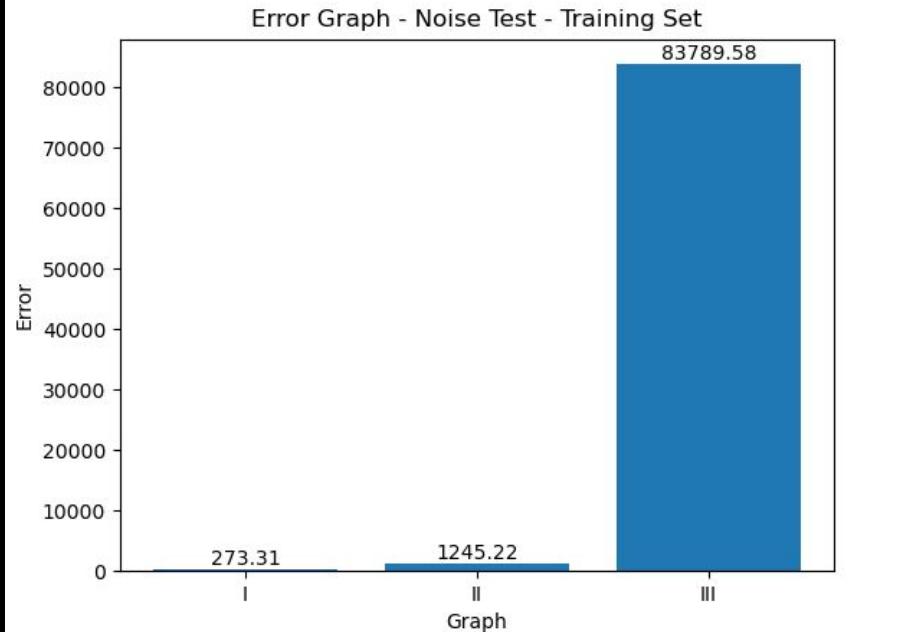
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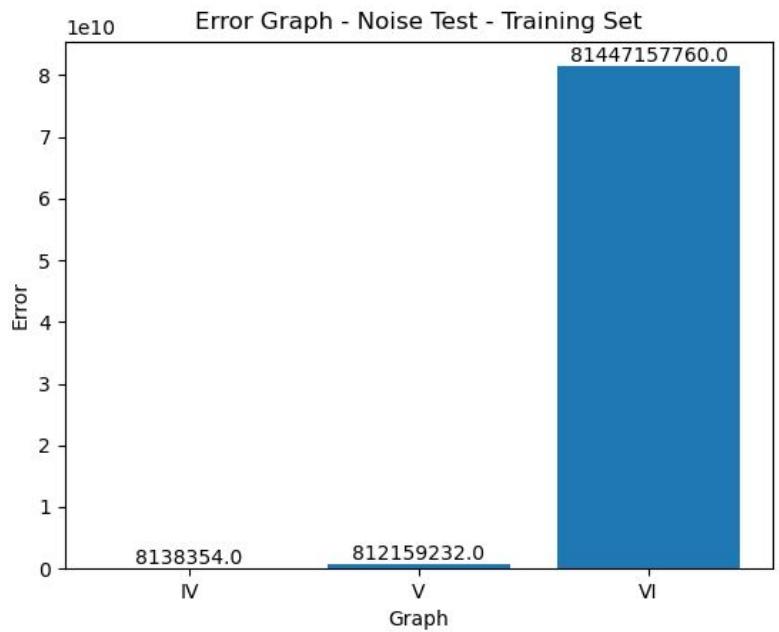
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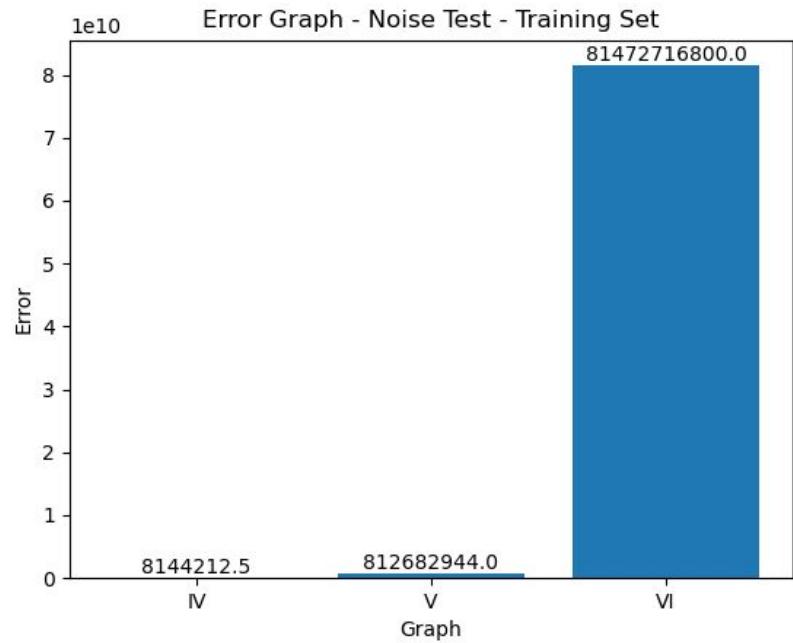
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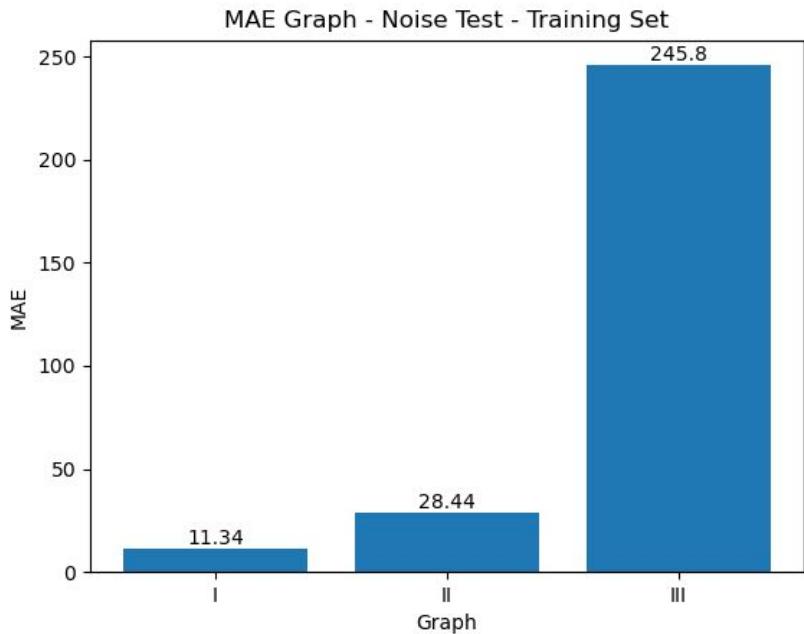
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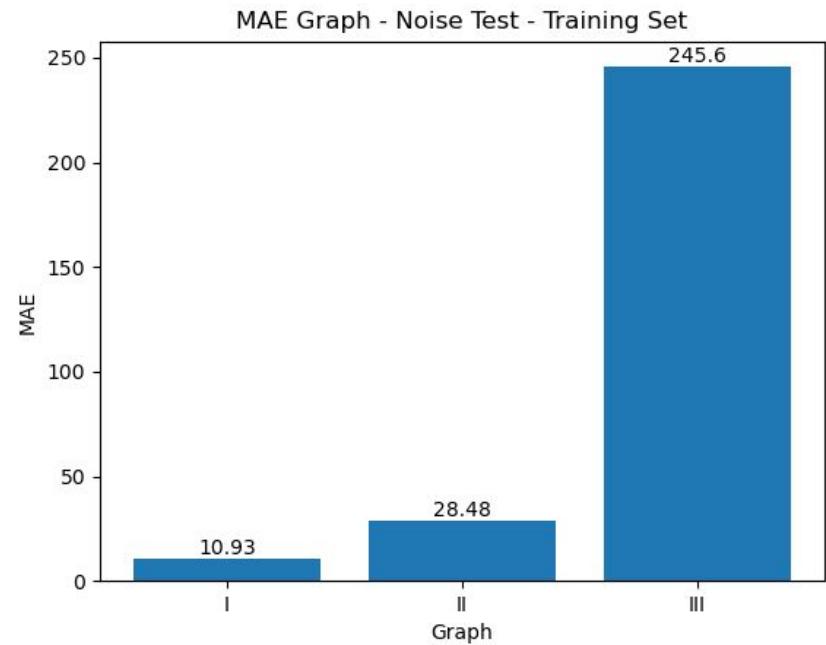
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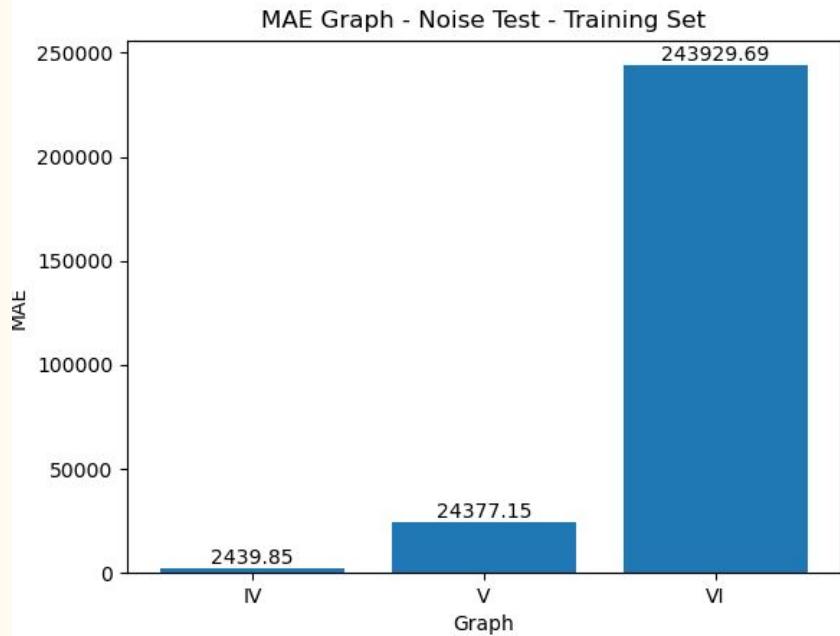
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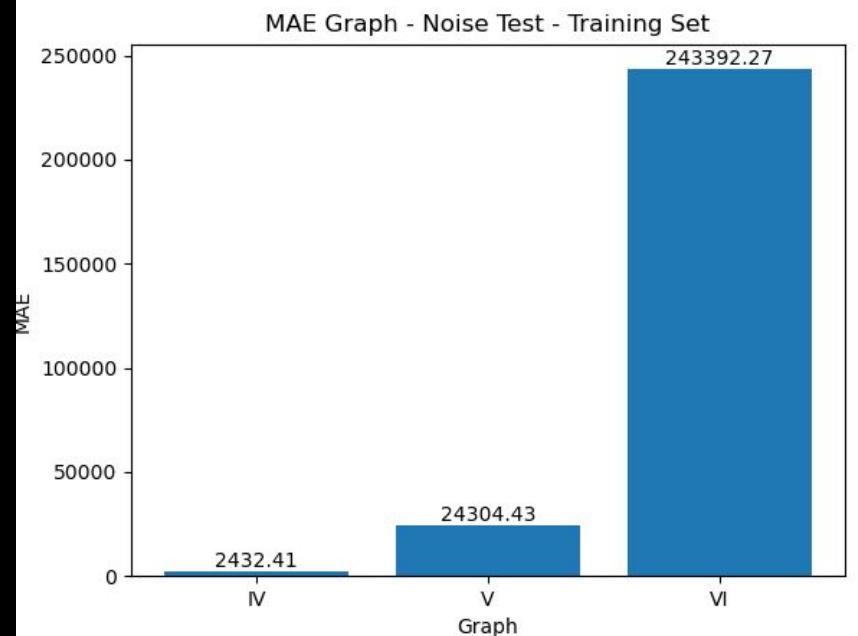
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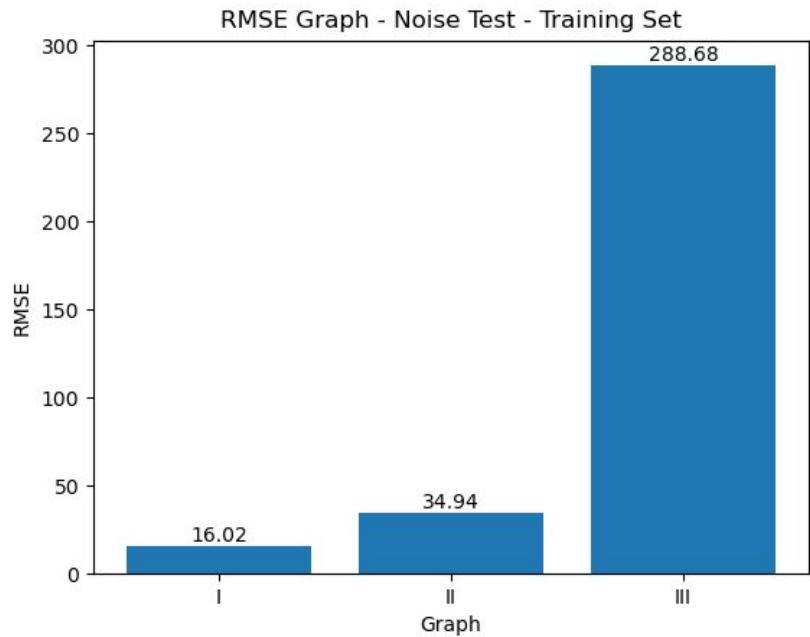
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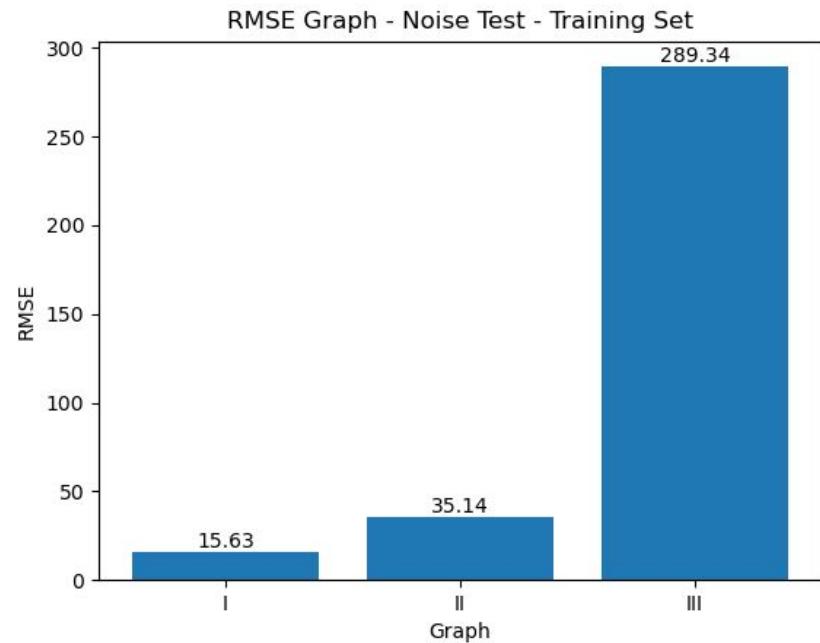
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GNN

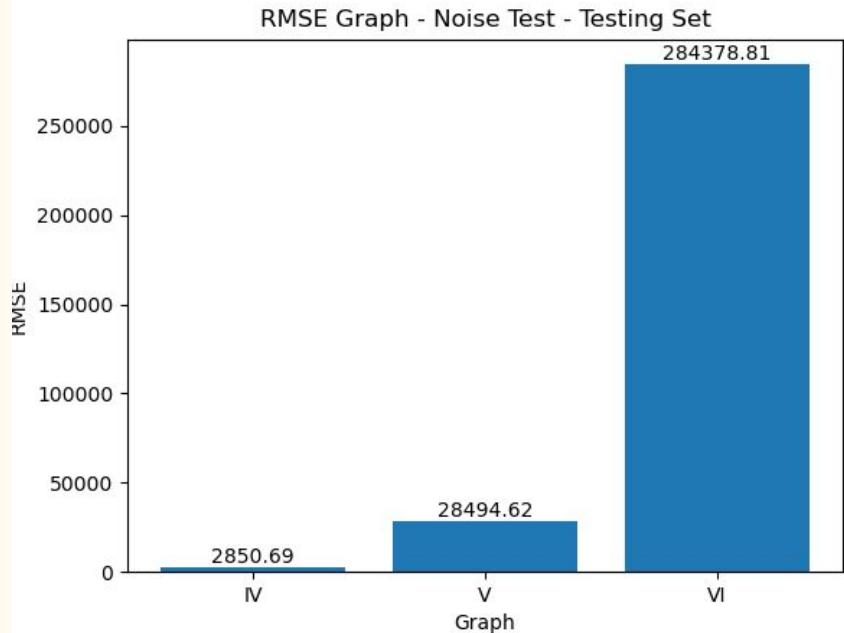


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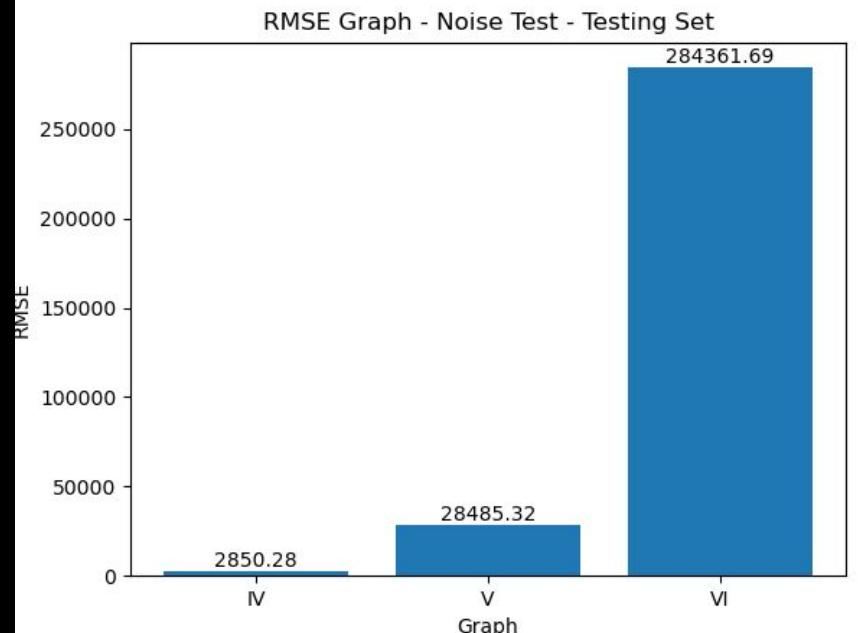


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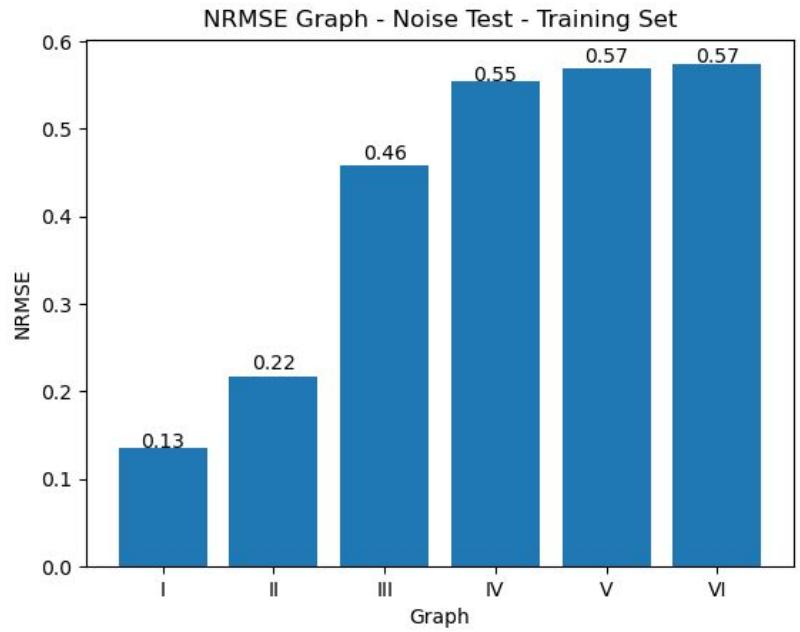
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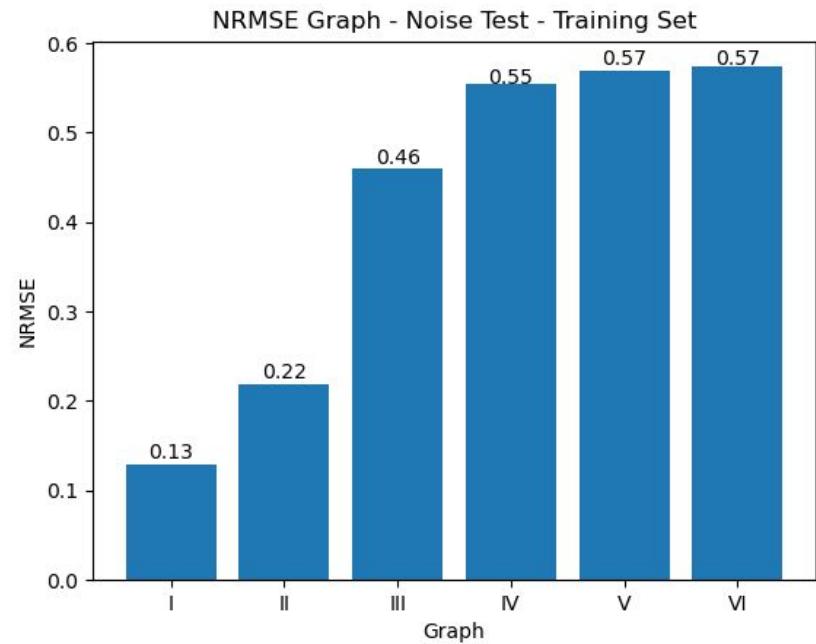
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GNN

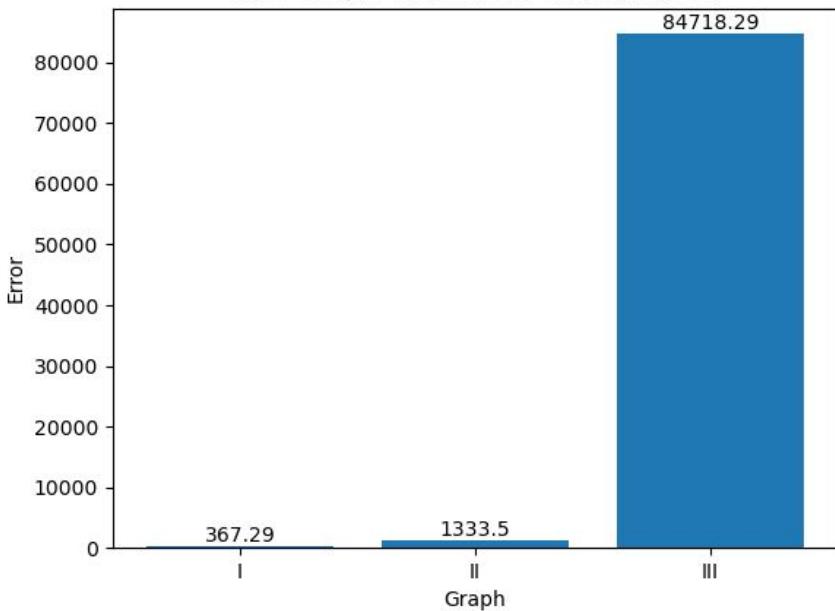


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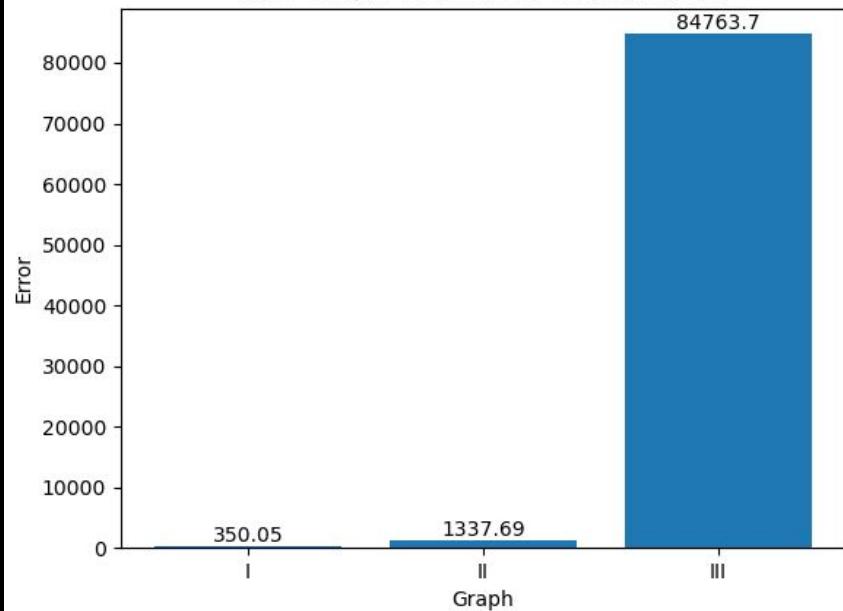
GNN

Error Graph - Noise Test - Validation Set

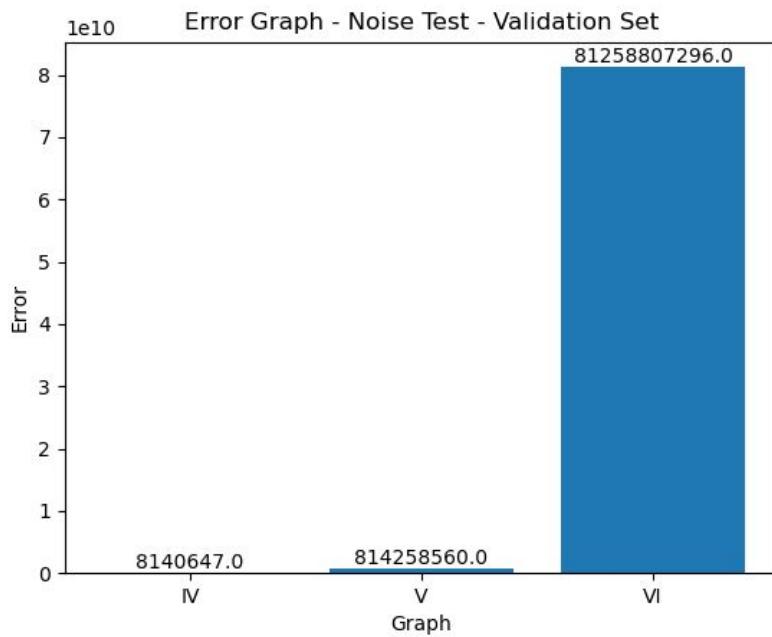


Regressão

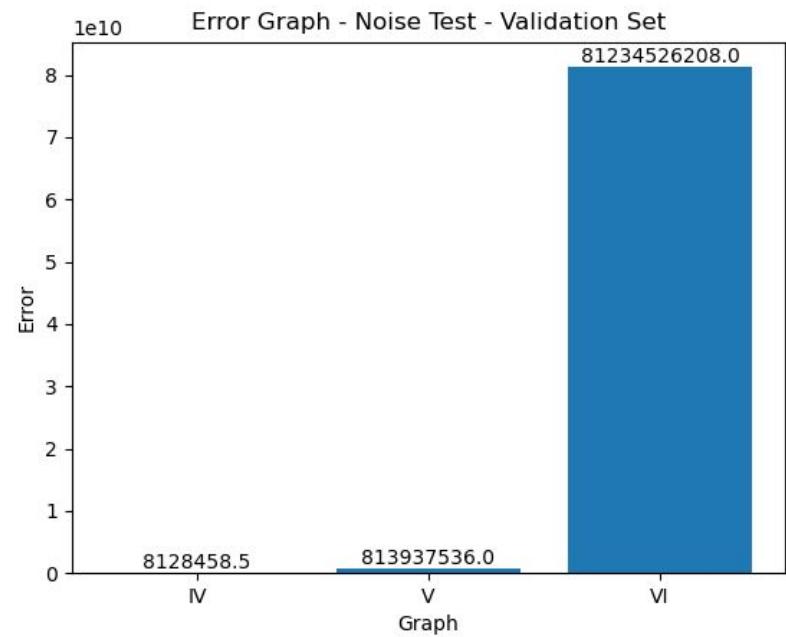
Error Graph - Noise Test - Validation Set



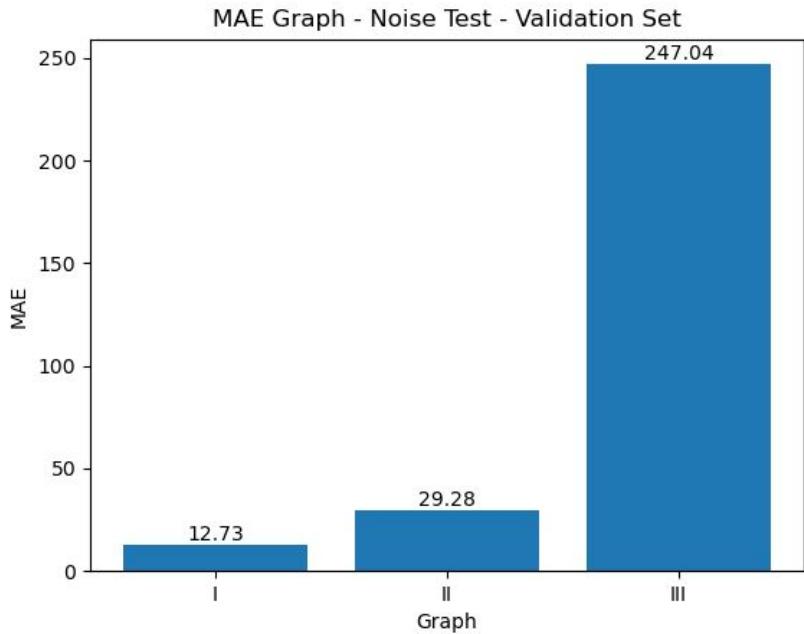
GNN



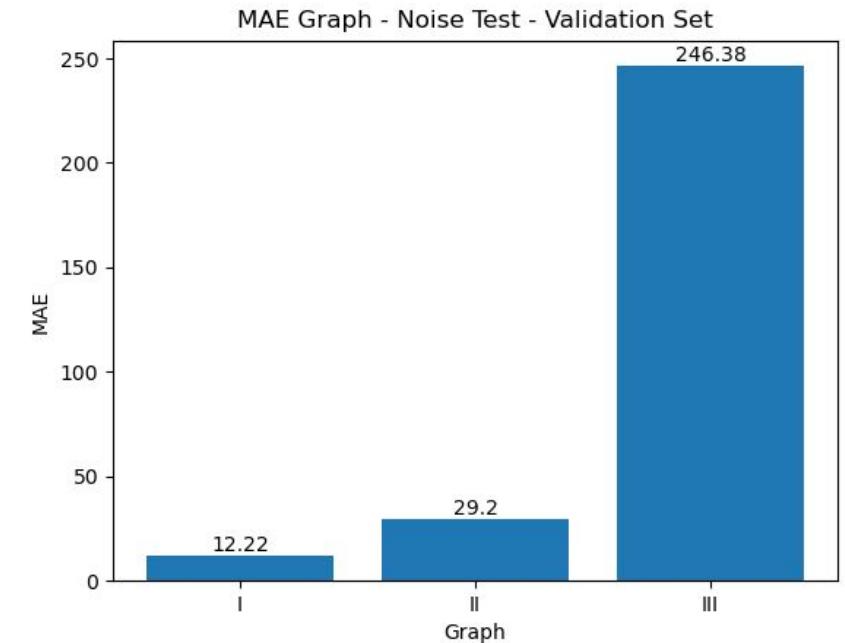
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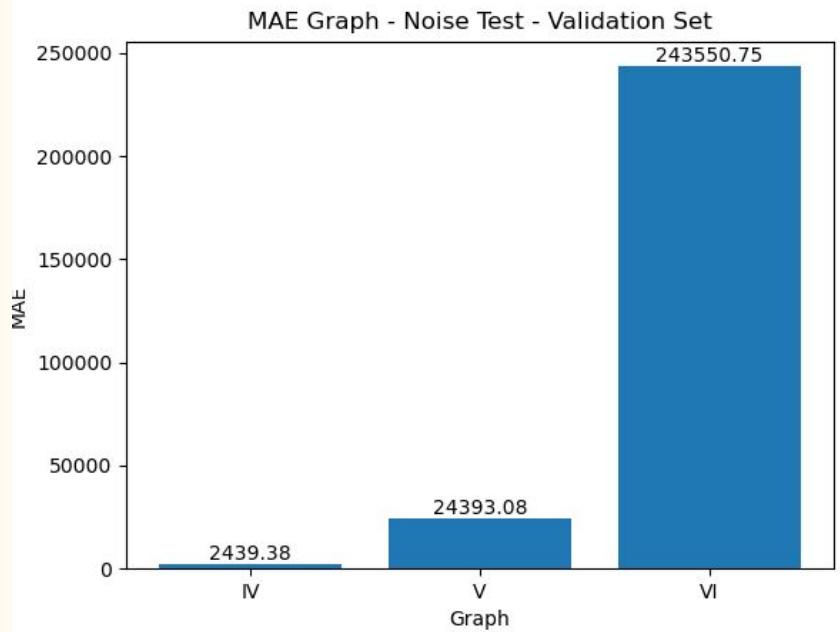
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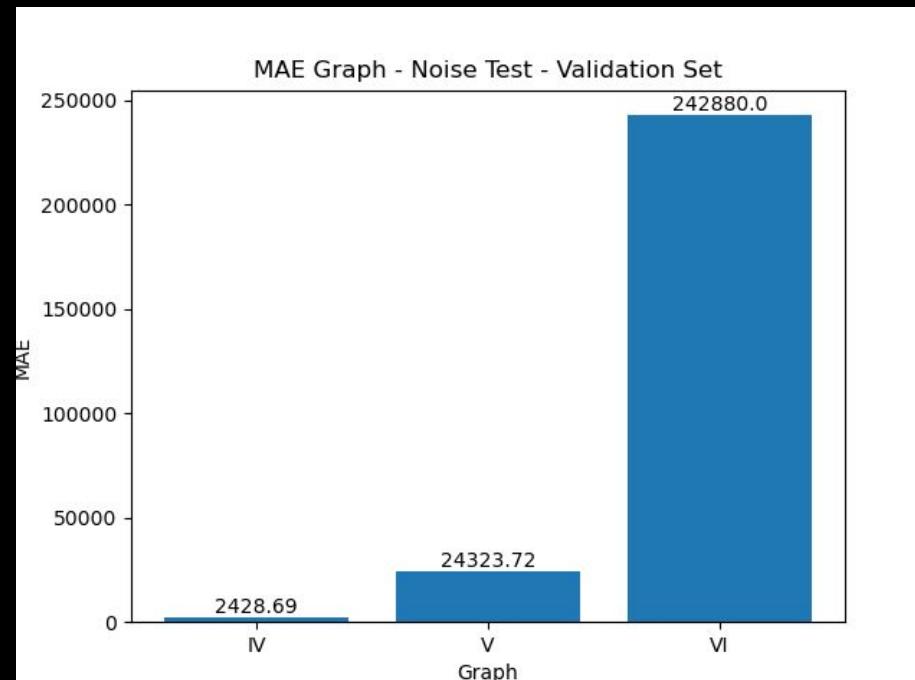
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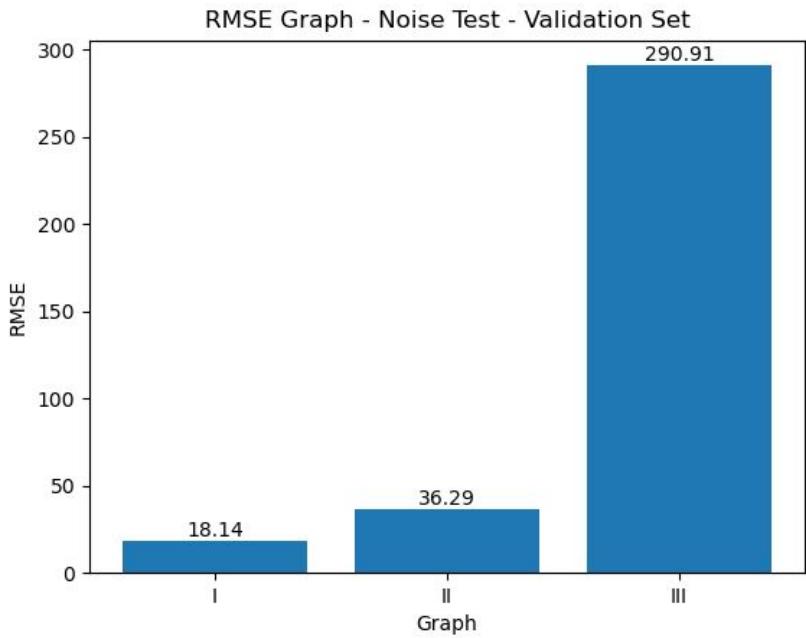
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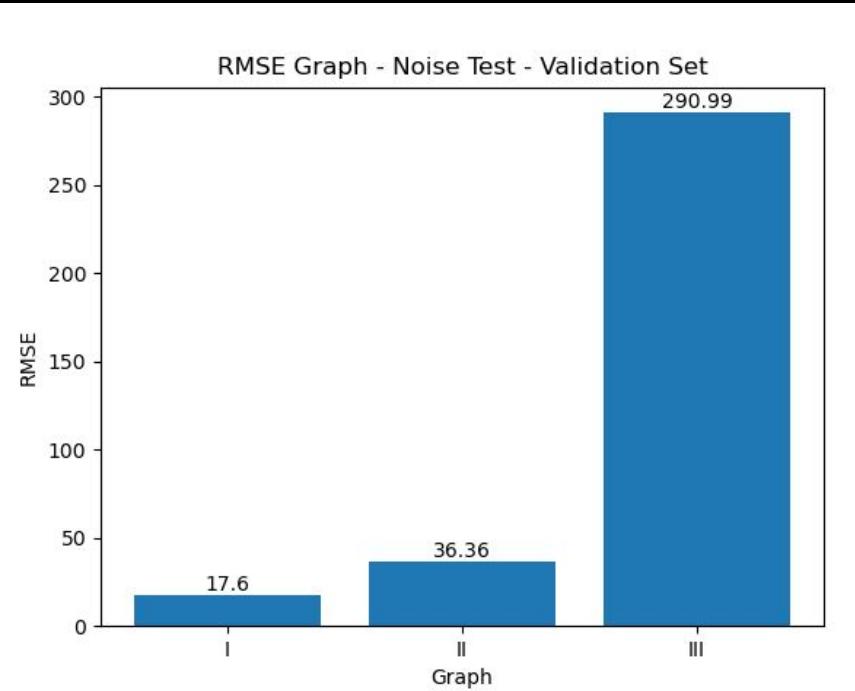
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GNN

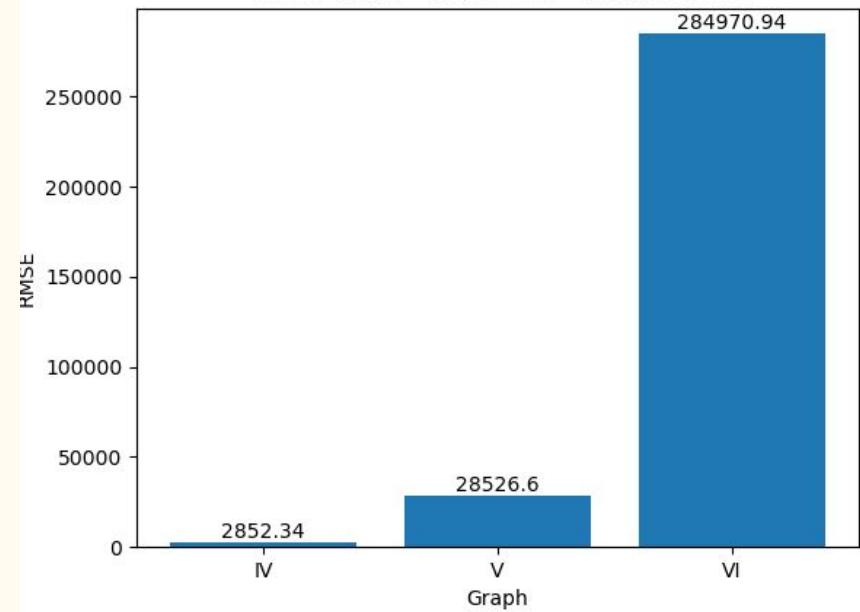


Regressão



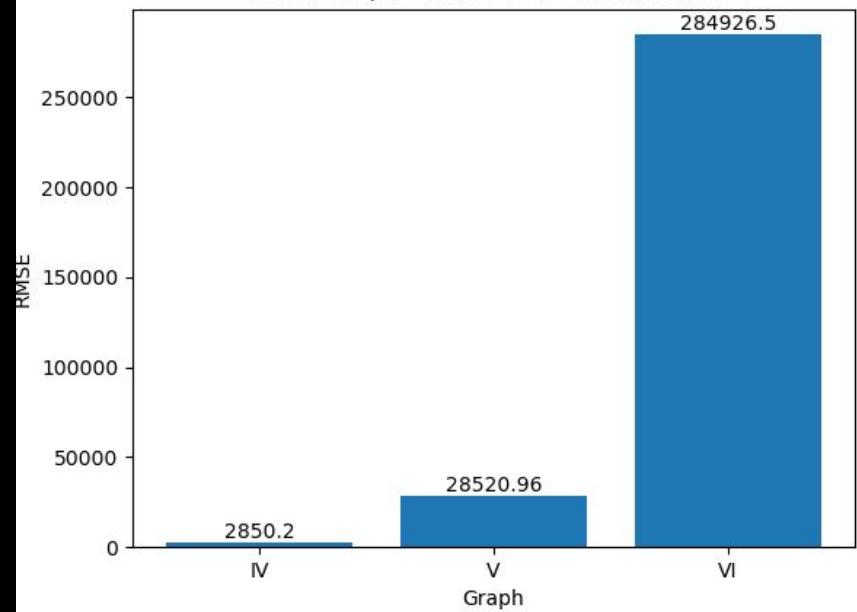
GNN

RMSE Graph - Noise Test - Validation Set

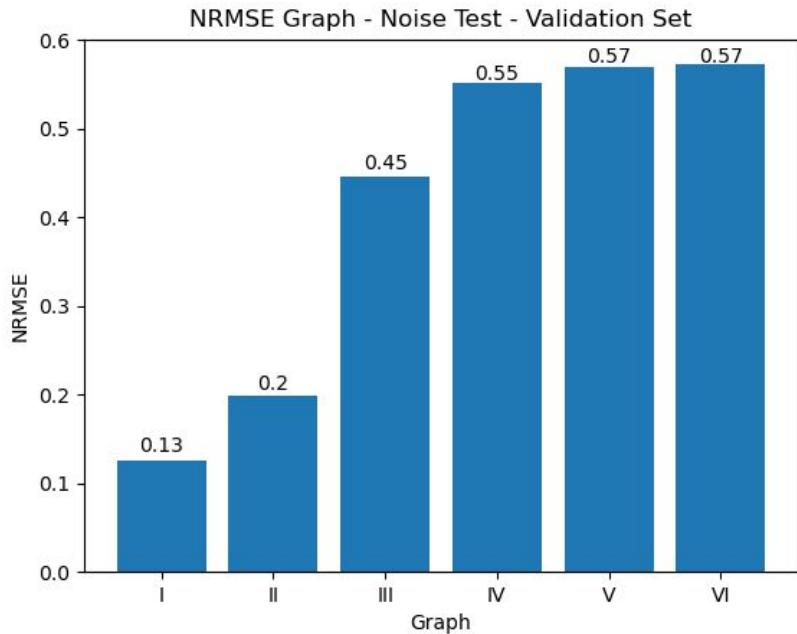


Regressão

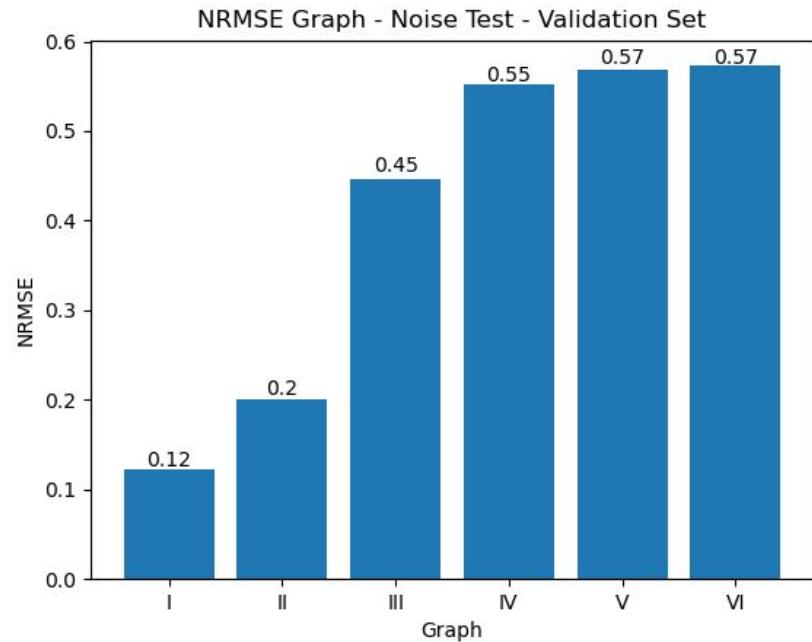
RMSE Graph - Noise Test - Validation Set



GNN



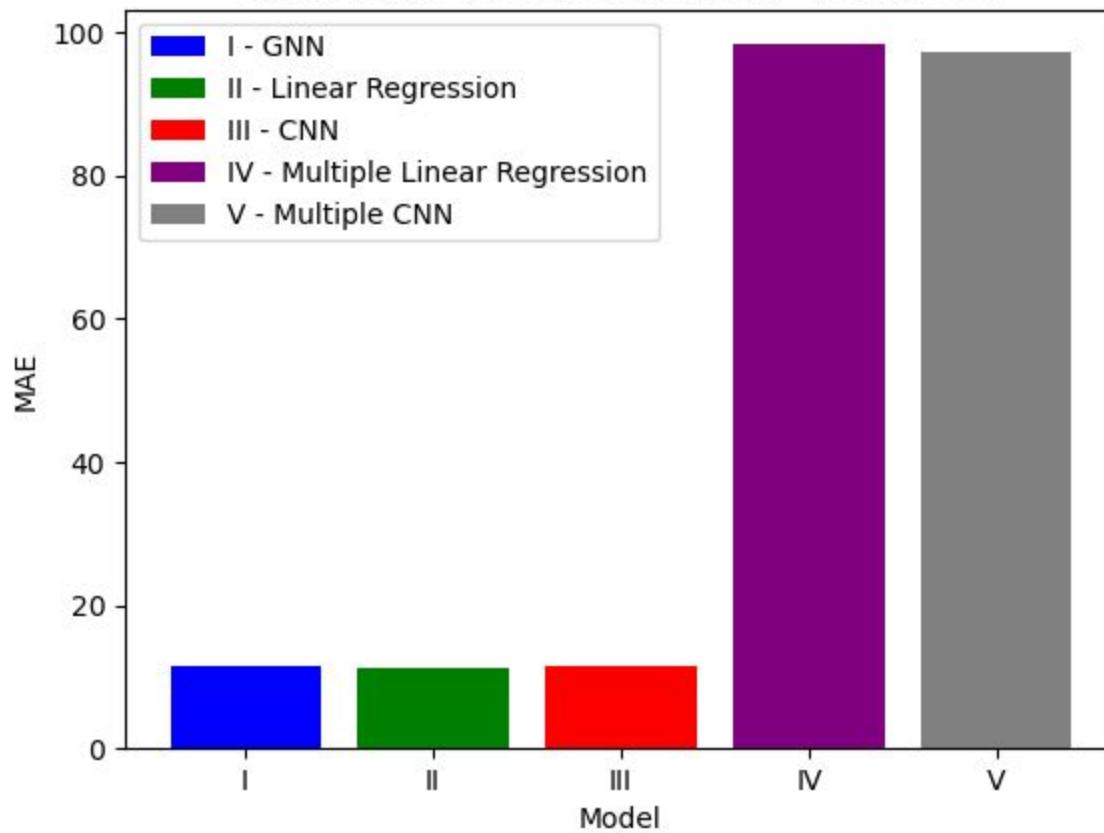
Regressão



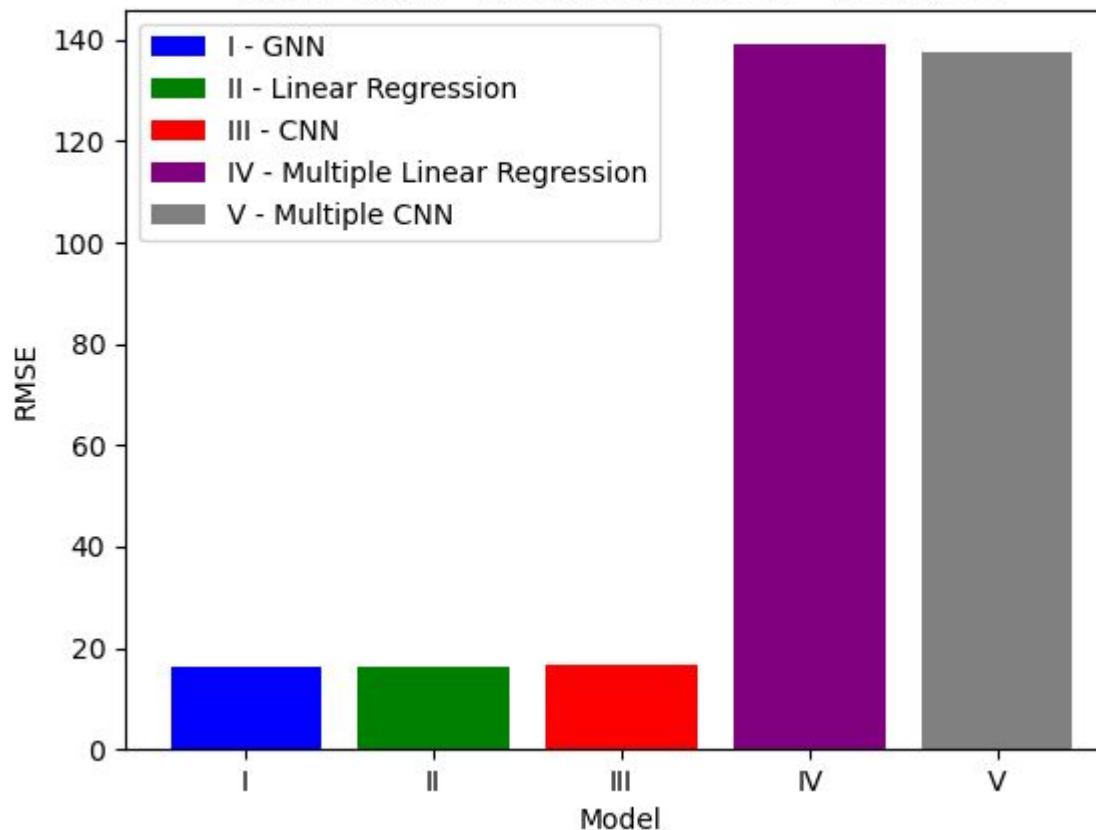
Teste de Comparação de Modelos

- Utilizou-se apenas 1/8 do dataset citado (mês de janeiro)
 - O restante do dataset serviu para maior precisão na interpolação dos dados faltantes
-

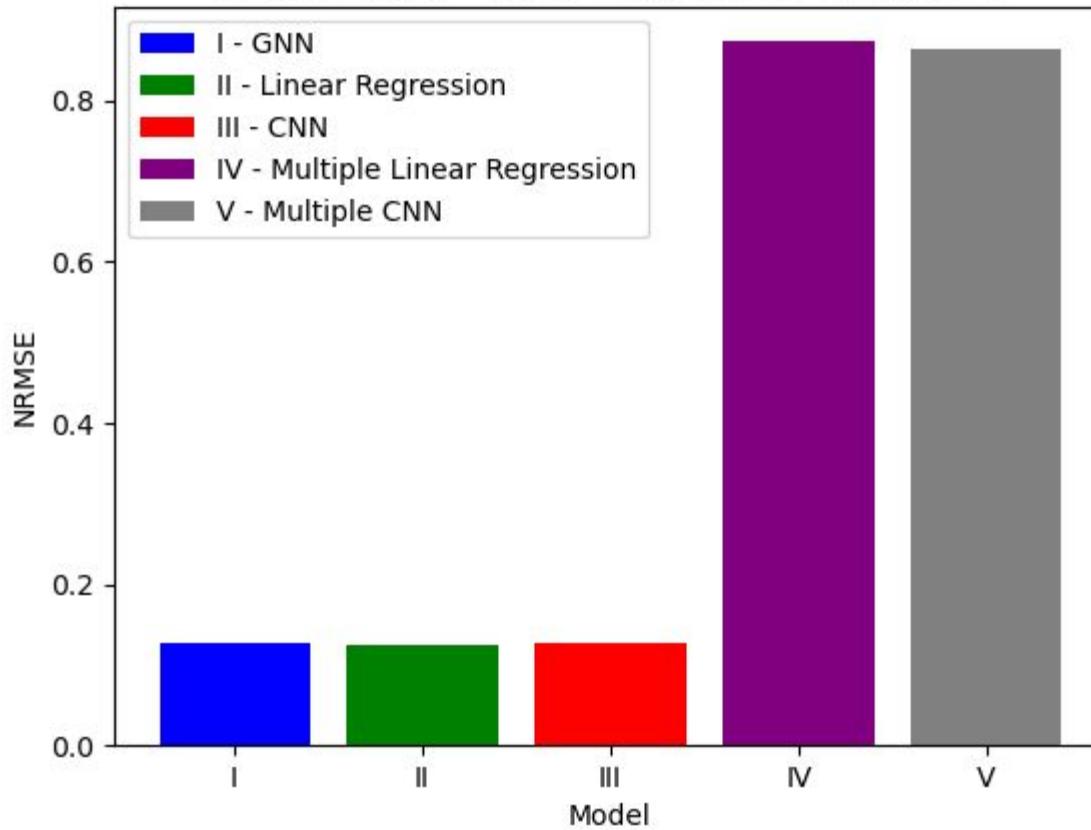
MAE Graph - Model Comparison - Testing Set



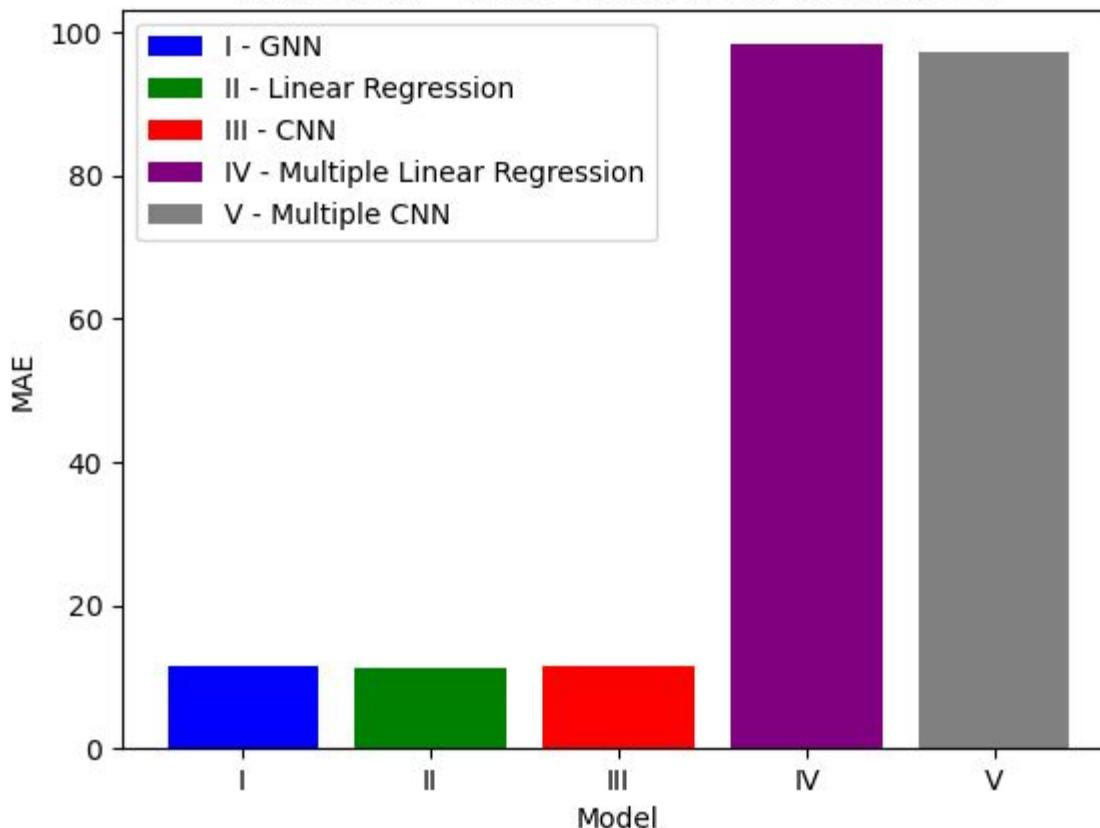
RMSE Graph - Model Comparison - Testing Set



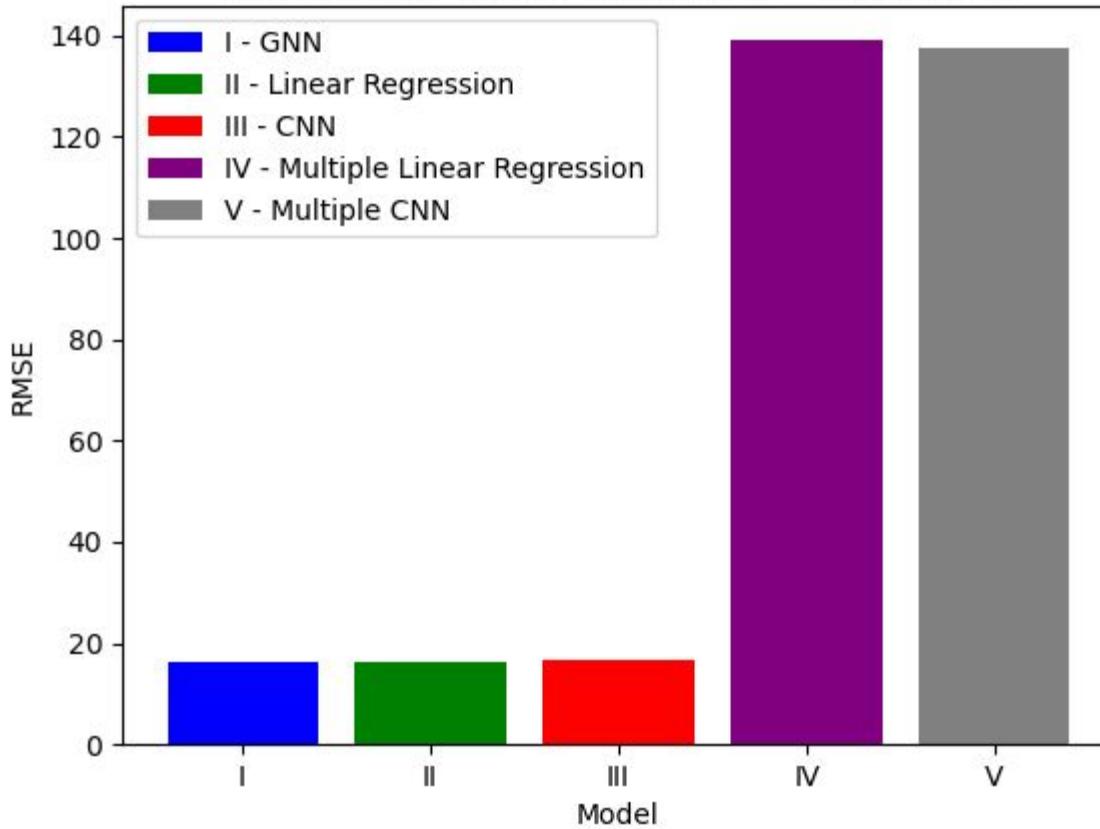
NRMSE Graph - Model Comparison - Testing Set



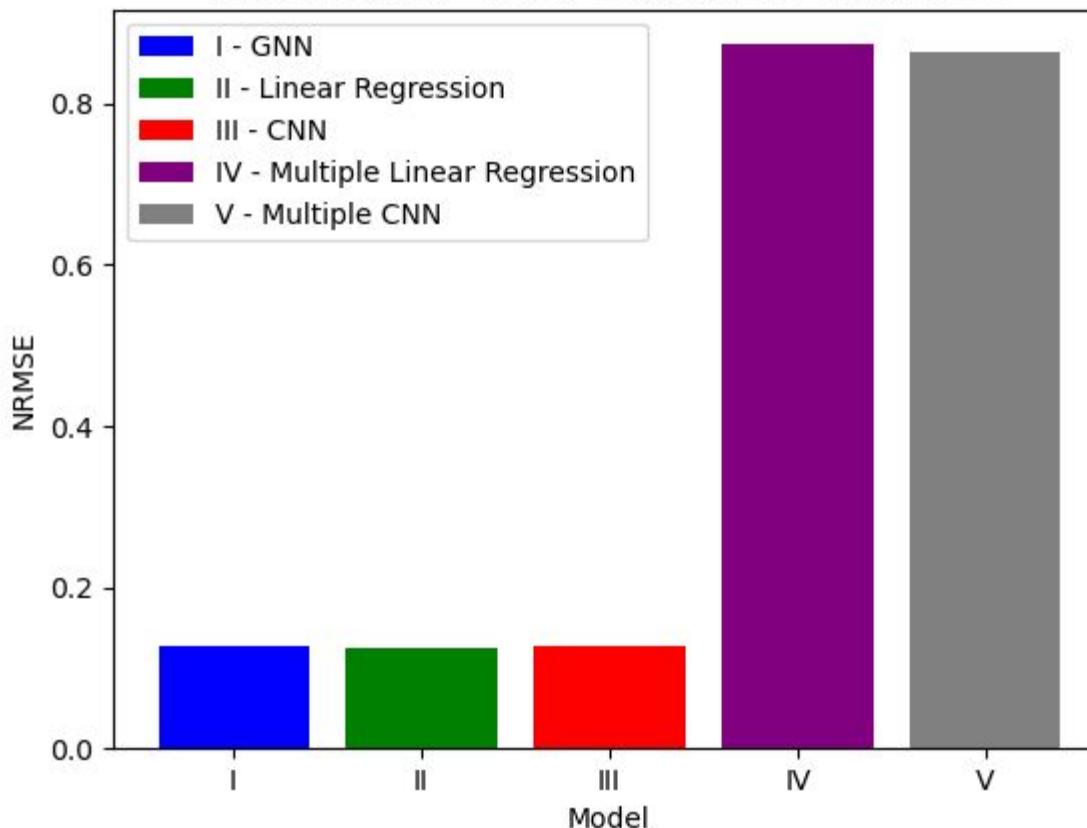
MAE Graph - Model Comparison - Training Set



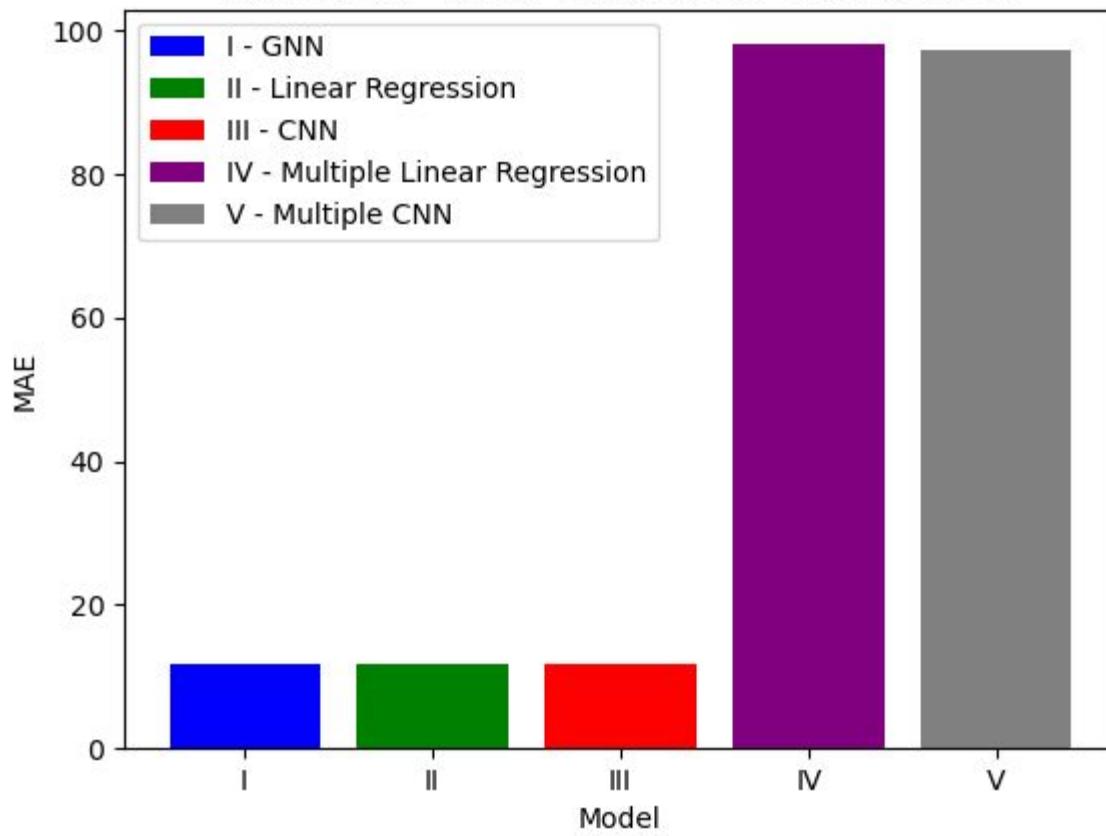
RMSE Graph - Model Comparison - Training Set



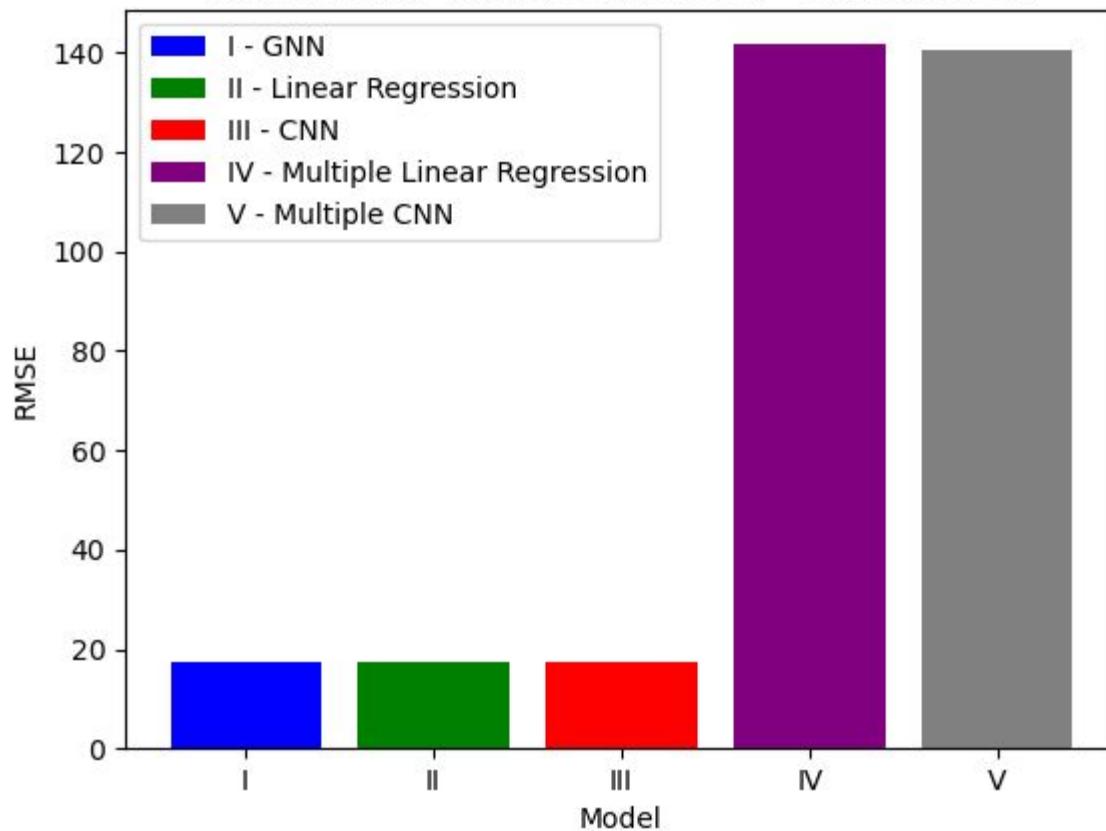
NRMSE Graph - Model Comparison - Testing Set



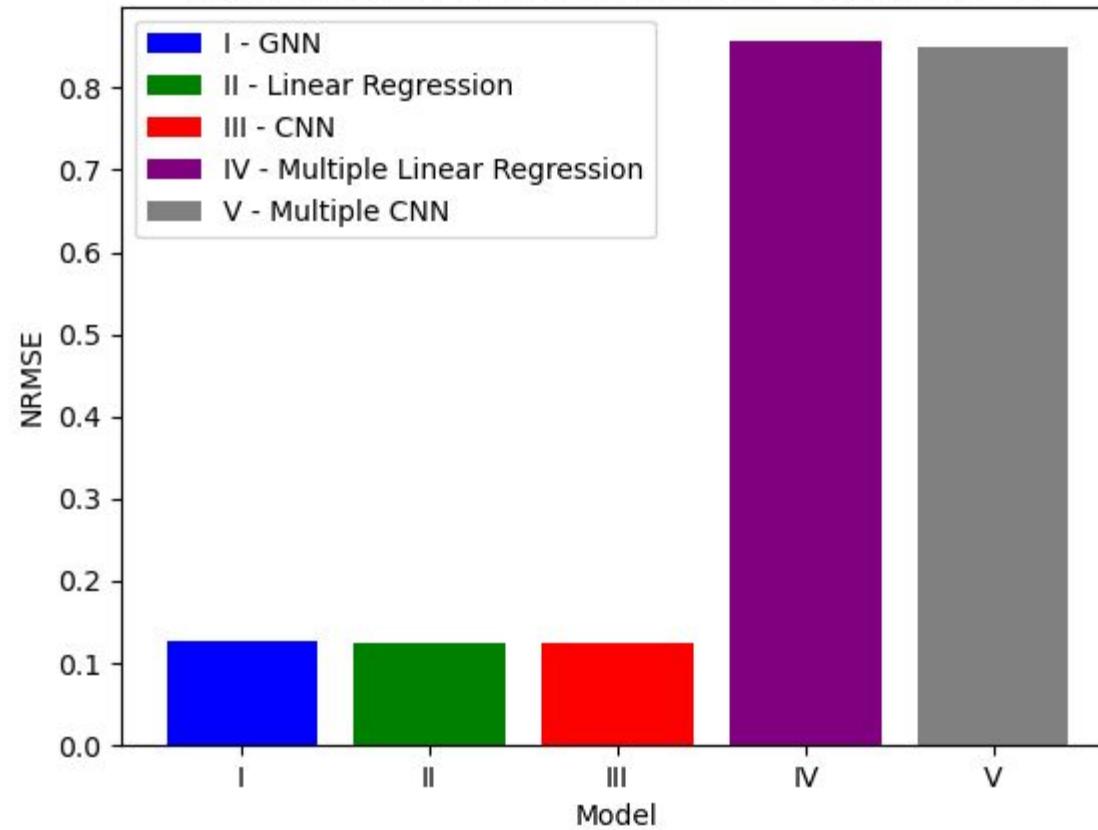
MAE Graph - Model Comparison - Validation Set



RMSE Graph - Model Comparison - Validation Set



NRMSE Graph - Model Comparison - Validation Set



Teste de Sensibilidade Espacial

Explicação do Teste

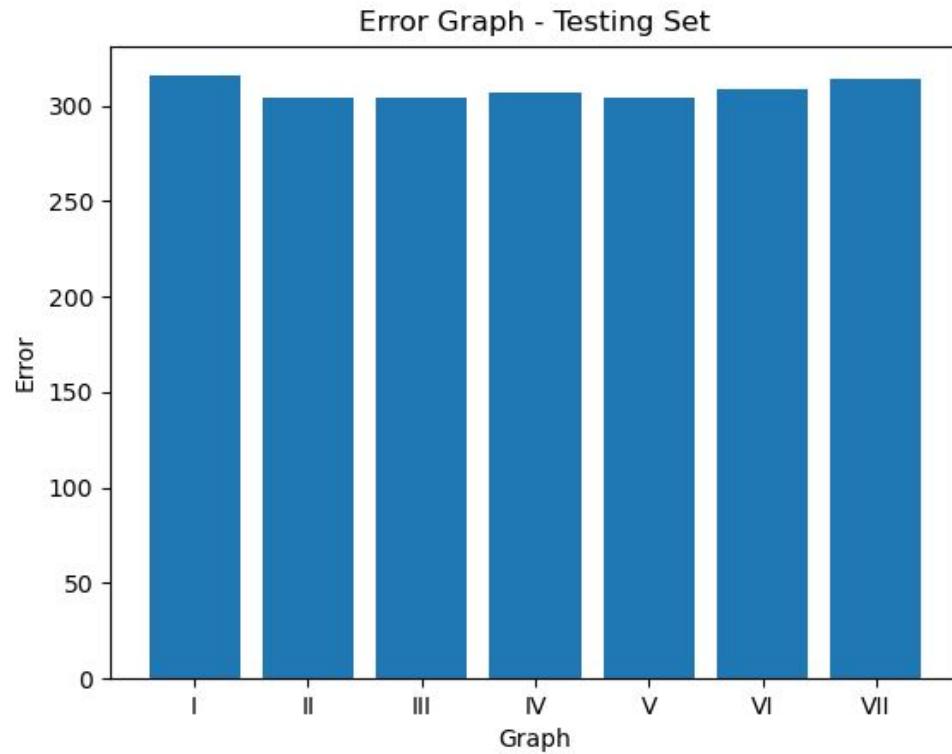
1. Para este teste utilizou-se os dados de fluxo do dataset PEMSD3 (somente $\frac{1}{8}$ do dataset, ou, em outras palavras, somente dados de janeiro de 2023).
2. Comparou-se os resultados ao trocar o grafo original por grafos genéricos

Grafos Utilizados

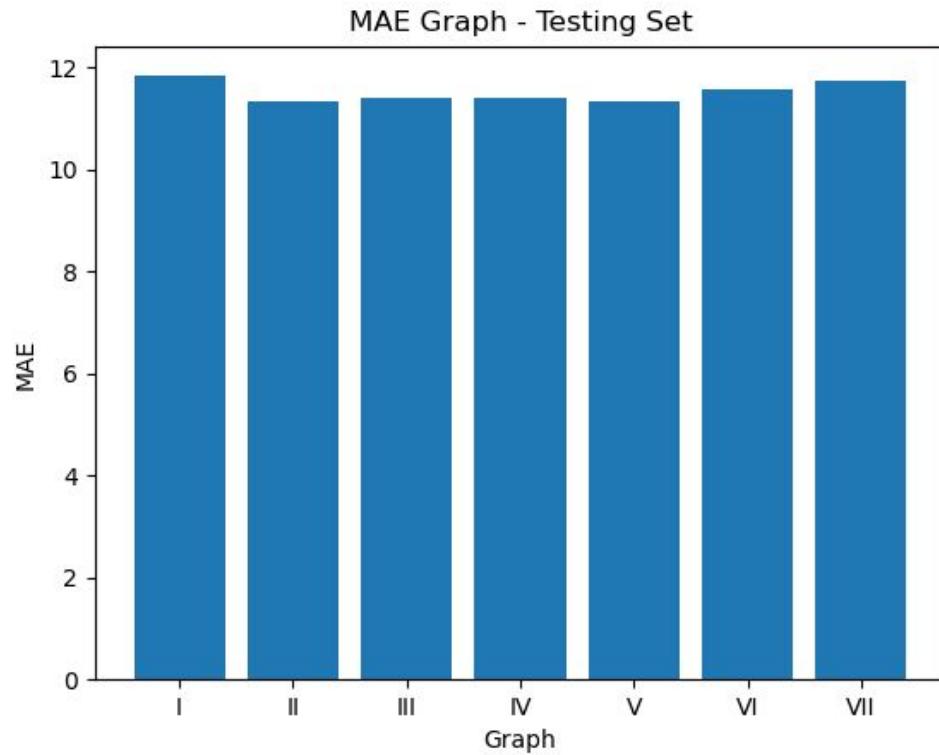
Utilizou-se os seguintes grafos:

- I: Grafo original do dataset
- II: Grafo totalmente desconexo, ou seja, um grafo em que não há arestas entre vértices diferentes
- III: Grafo linear, ou seja uma linha reta de vértices
- IV: Grafo circular, ou seja, um grafo onde todos os vértices fazem parte de um único ciclo
- V: 2 Grafos lineares desconexos
- VI: 2 Grafos circulares desconexos
- VII: Malha quadrada fortemente conexa, uma malha quadrada sem vértices de entrada e saída, porém com alguns vértices retirados para chegar ao número esperado de vértices

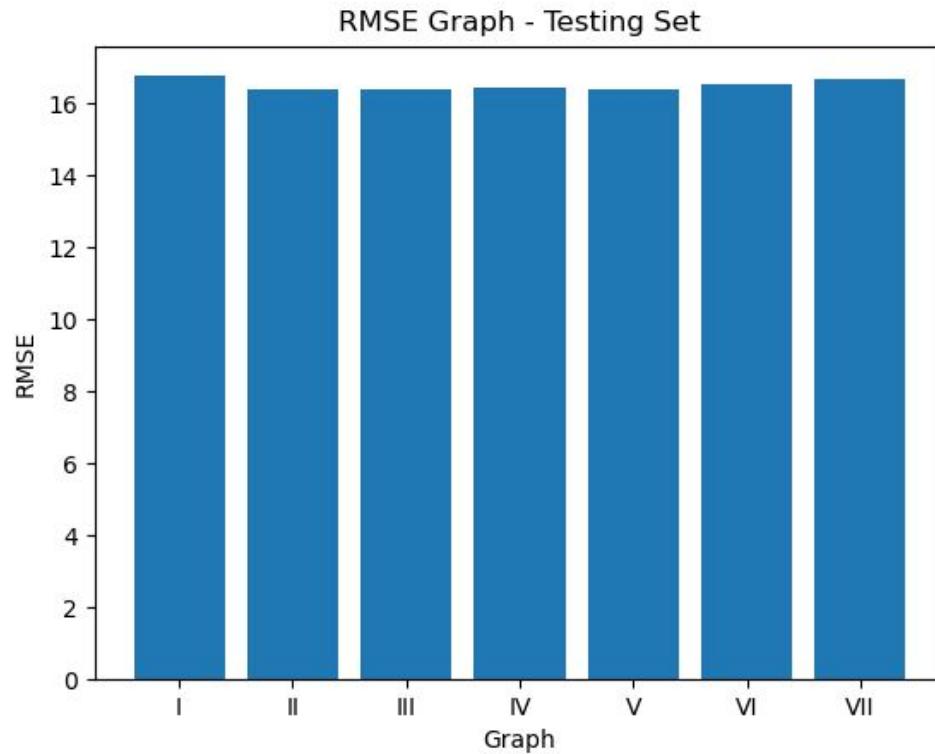
Resultados



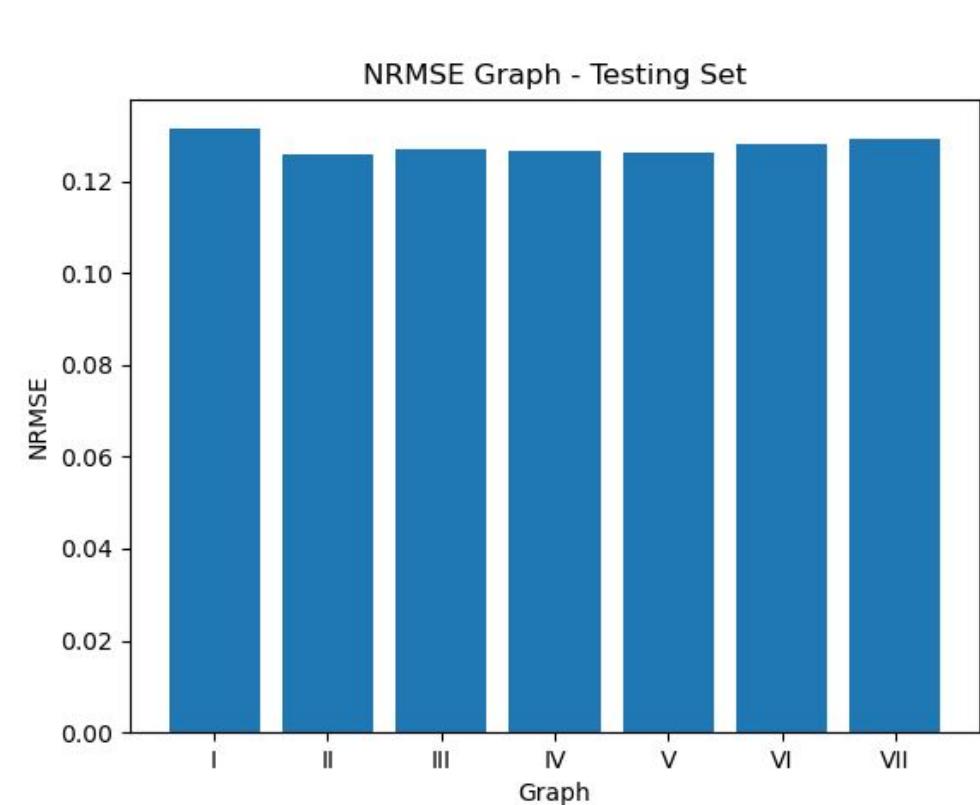
Resultados



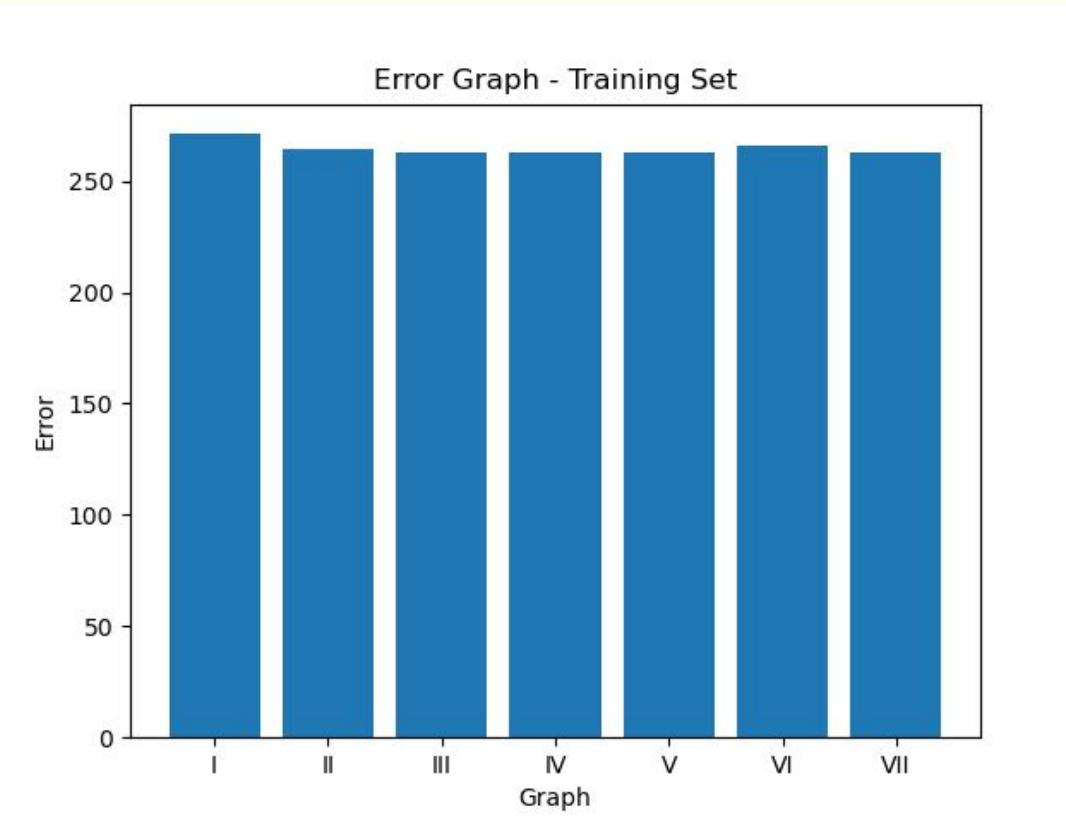
Resultados



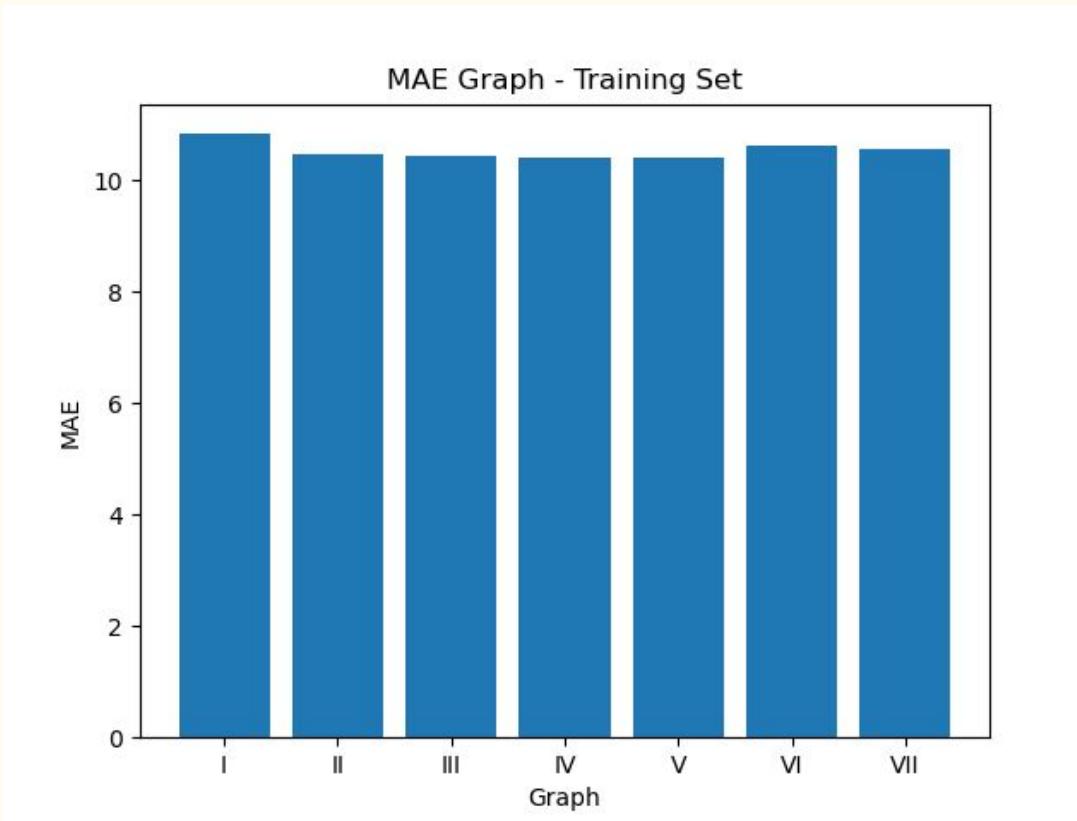
Resultados



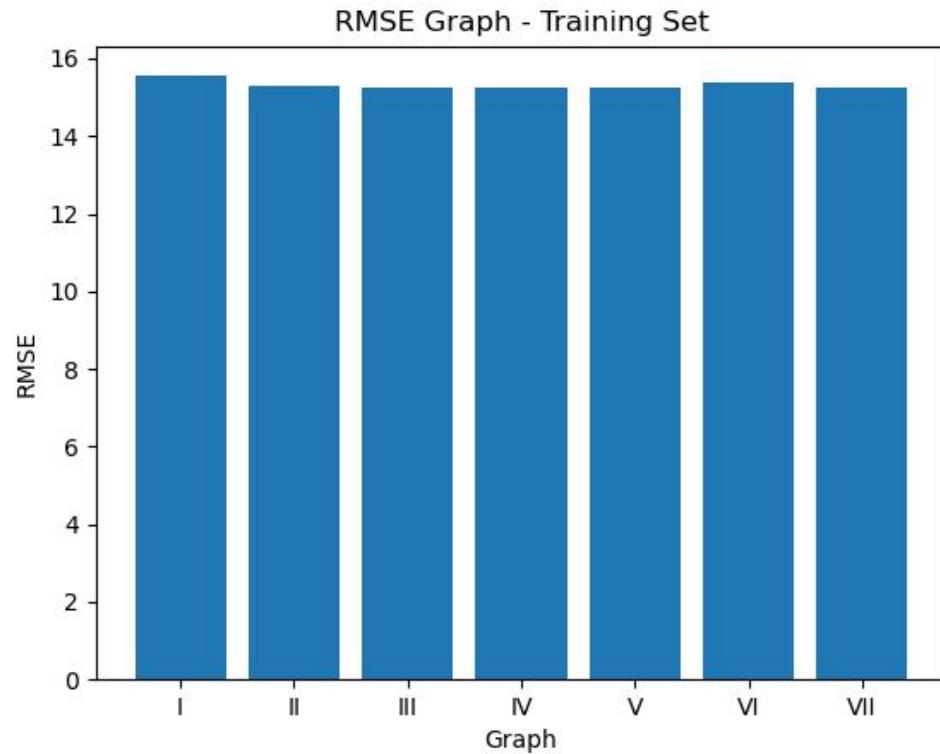
Resultados



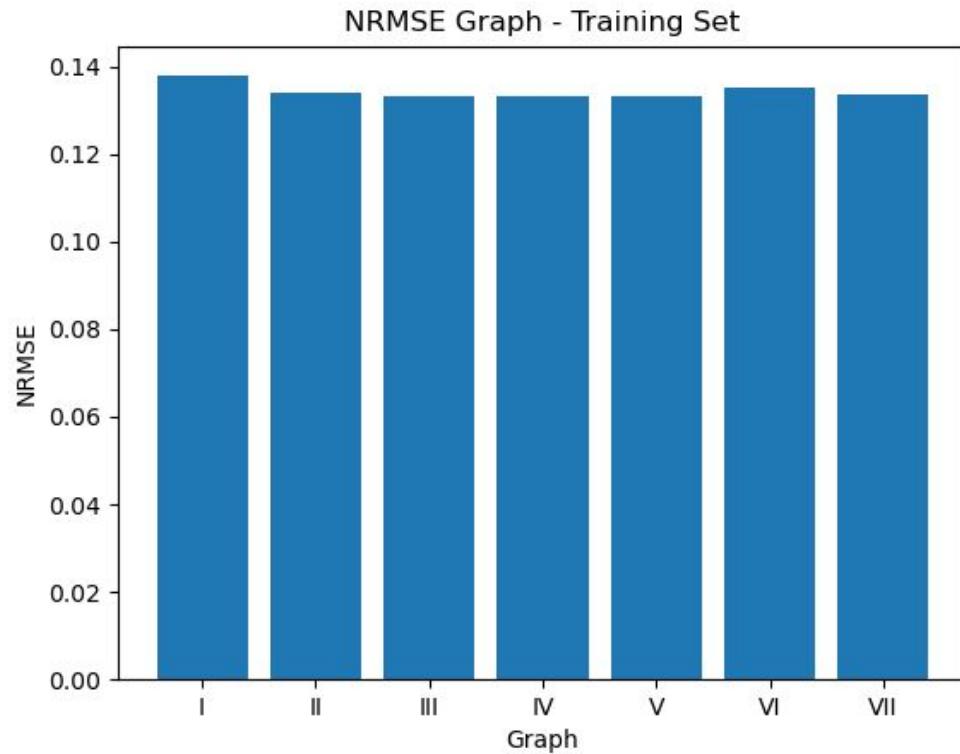
Resultados



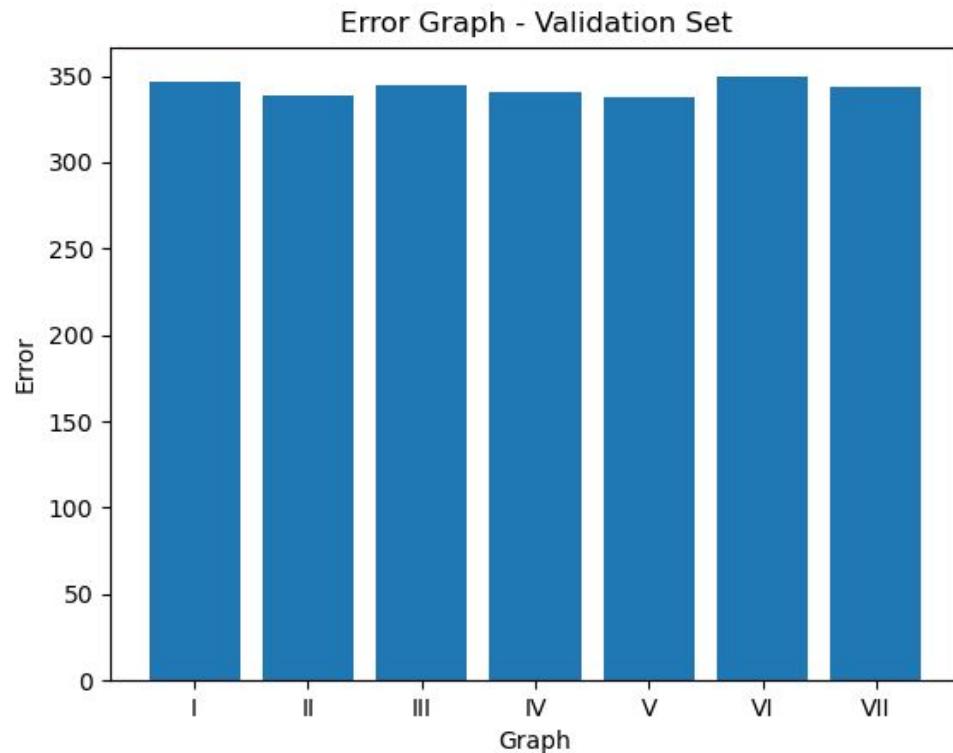
Resultados



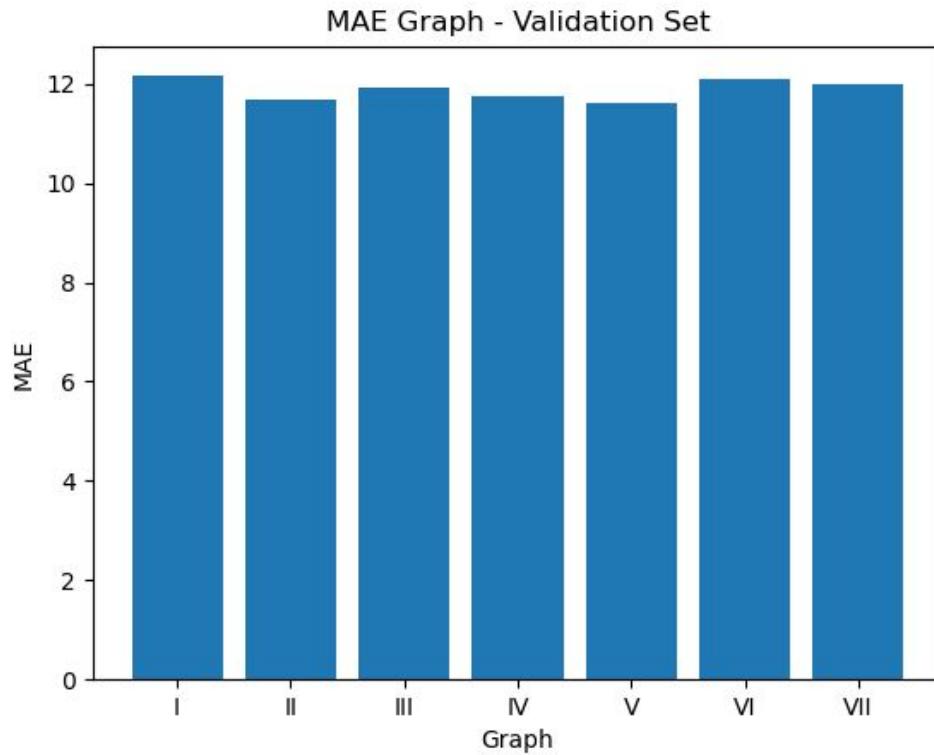
Resultados



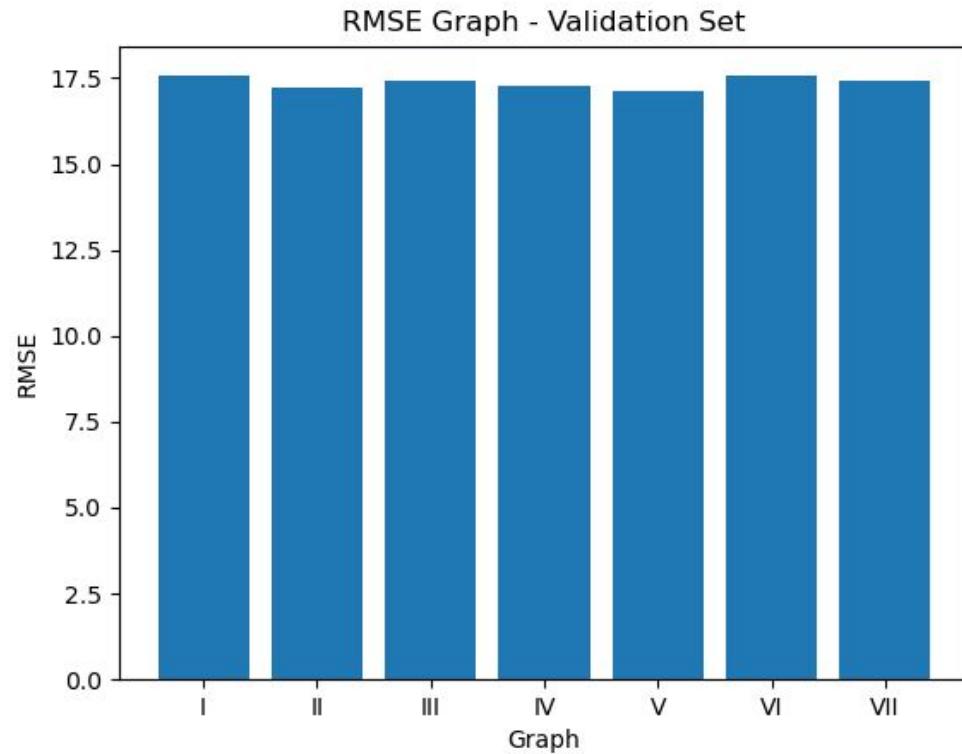
Resultados



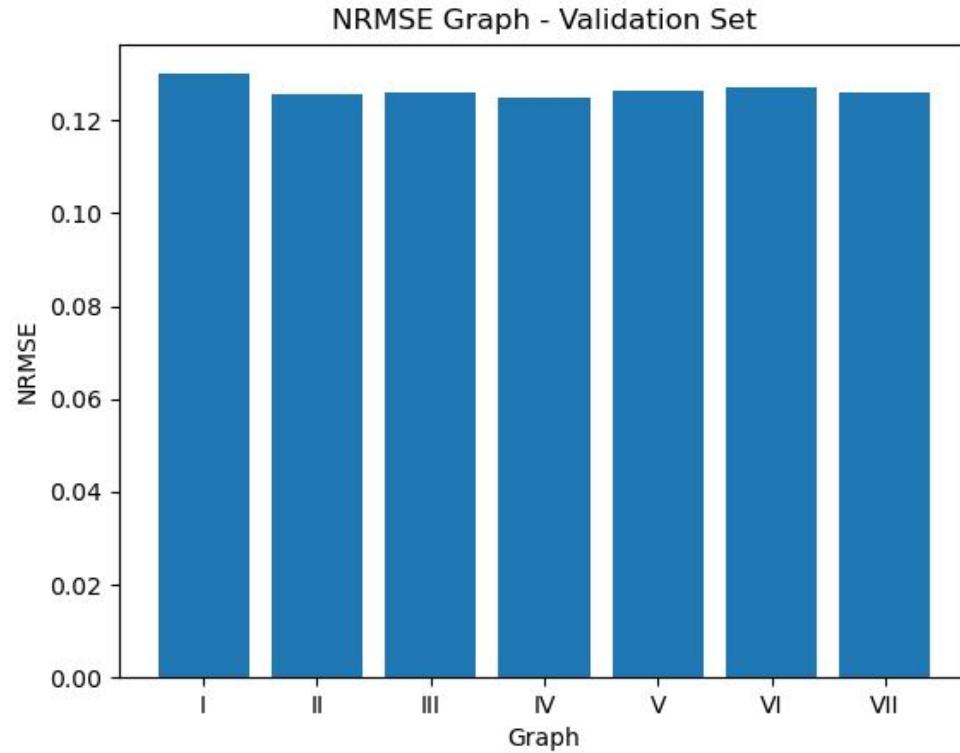
Resultados



Resultados



Resultados



Análise dos Testes

Conclusões

Analisando os resultados dos testes pode-se concluir em relação às características espaciais que:

- Ou o modelo de GNN é pouco sensível às características espaciais
- Ou os dados devem possuir características de correlação que refletem as características espaciais
- Ou a matriz de correlação também não influencia nas características espaciais
- Ou o modelo considera mais as características espaciais contidas na série temporal pois a regressão linear atinge os mesmos resultados porém sem utilizar o grafo correspondente

Conclusões

Analisando os resultados dos testes de esparsidade geográfica pode-se concluir que:

- A pouca diferença entre os resultados pode estar mais relacionada a exclusão da série temporal do que pela degradação do grafo
- Esta observação é apoiada pelos resultados do teste de sensibilidade espacial o qual indica uma variação muito pequena ao variar o grafo

Conclusões - Sensibilidade Espacial

Analisando os resultados do teste de sensibilidade espacial pode-se concluir que:

- Utilizando aqueles dados o modelo foi pouco sensível a variações espaciais
- A pequena diferença de resultado pode estar relacionada também a variação nos parâmetros do modelo devido aos diferentes treinamentos

Conclusões - Características dos Dados

Comparando o modelo de GNN e a regressão linear, na maioria dos testes observou-se que os resultados foram quase idênticos o que indica que os dados utilizados são lineares e portanto a utilização de um modelo mais sofisticado não é necessário

Conclusões - Interpolação

Os resultados dos testes de interpolação mostram um comportamento linear com o aumento da quantidade de dados interpolados, o que fornece informações de como o modelo de GNN reage a esse tipo de dado.

- Os dados interpolados são gerados de modo linear

Conclusões - Esparsidade Temporal

- O tamanho dos datasets decrescem exponencialmente com o aumento linear da medida de esparsidade temporal
- Com o dataset PEMSD3 o resultado observado é um crescimento aproximadamente linear com o aumento da esparsidade
- Em datasets sem periodicidade temporal, este teste mostra um resultado constante com o aumento da esparsidade