592 Project Report

Philipp Beer

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Clustering M4 Daily Data for Forecasting

https://552dlimages.s3-eu-west-1.amazonaws.com/unic_logo.png
Philipp Beer
Gradudate Program Data Science, UNIC
COMP-501DL Research
Prof. Spyros Makridakis & Prof. Ioannis Katakis

Introduction

M4 Competition Forecasting

- say something here

Machine Learning in time series forecasting

- regularly outperformed by M4 competition benchmark
- high computational costs
- few data points for time series

Grouping similar time series

- combine series - more data to learn from
- ts with similar properties
- less complex learning task

Can it improve forecast performance

Time Series Properties

Feature Representation

- shape-, feature-, model-based
- extraction via Python software package tsfresh

Clustering

- unsupervised learning technique
- learn from data without or minimal input

Philosophical view

- segmentation
- finding groups
- means to find distinction

K-Means

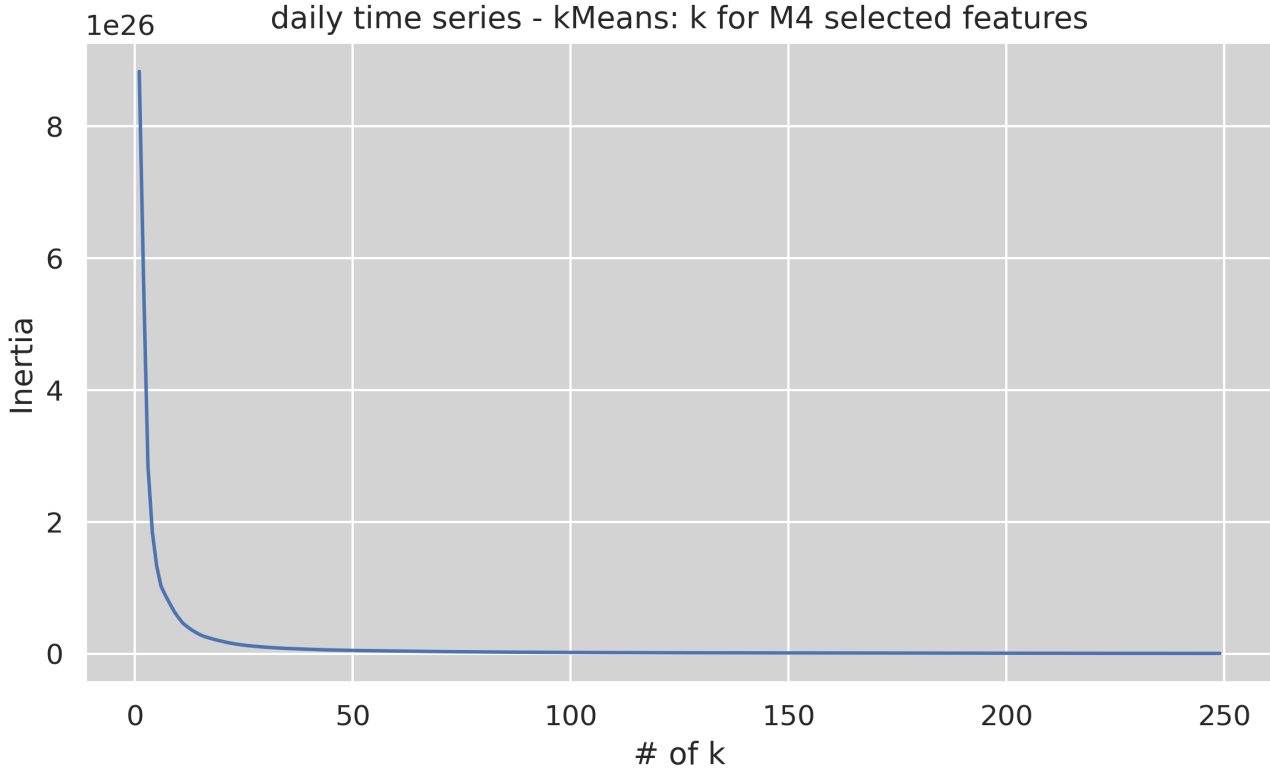
- grouping unlabeled data into predetermined number of groups
- random starting point of points
- iterative adjustment

Deciding k

Inertia

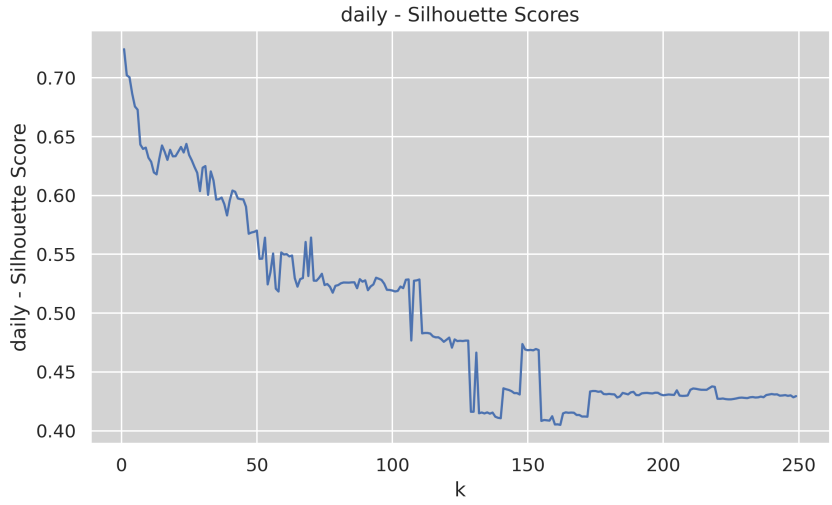
goal: minimize within cluster sum-of-squares

$$\sum_{i=0}^{n} \min_{\mu_j \in C} (||x_i - \mu_j||^2)$$

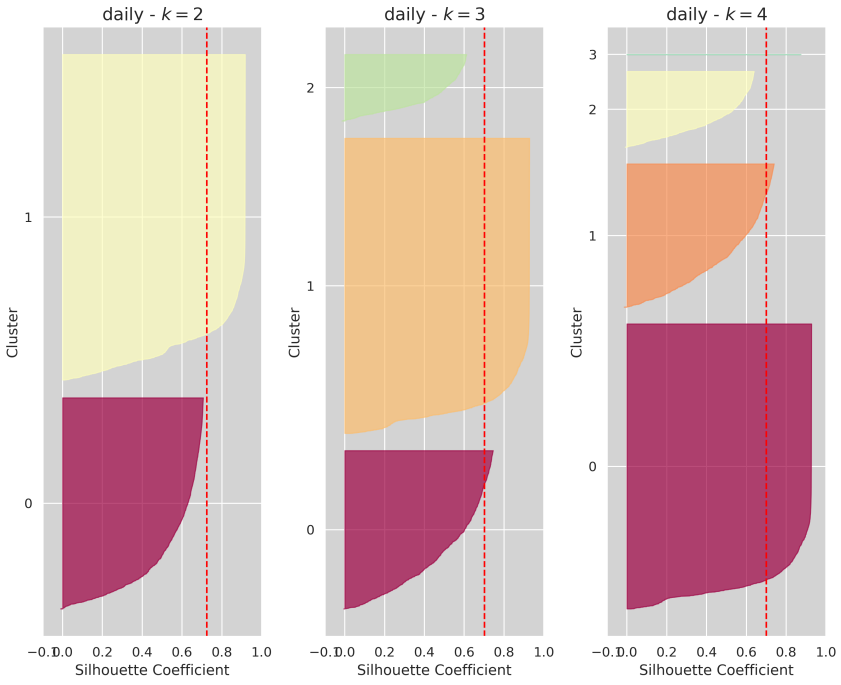


Silhouette score

$$s(i) = \frac{b(i) - a(i)}{\max\{a(i), b(i)\}}$$



Silhouette Diagrams



Forecasting

Neural Network

- 3 hidden layers
- features - lags 1 - 7
- loss: MSE

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2$$

Approach

- full dataset
- clustered datasets
- equivalent random datasets

Cross-Validation

- increase certainty about the error that is encountered in the training
- limit effects of particularities in the data on error metrics

Benchmarking

M4 Accuracy Metrics

$$SMAPE = \frac{100}{n}\sum_{t=1}^{n}\frac{F_t - Y_t}{(|F_t| + |Y_t|)/2}$$

$$MASE = mean\left(\frac{|e_j|}{\frac{1}{T-1}\sum_{t=2}^{T}|Y_t - Y_{t-1}|}\right)$$

Challenges

Data Preprocessing

- data format - wide vs. long format
- Min-Max feature scaling with cross validation with neural networks
- information leakage

Feature extraction and selection

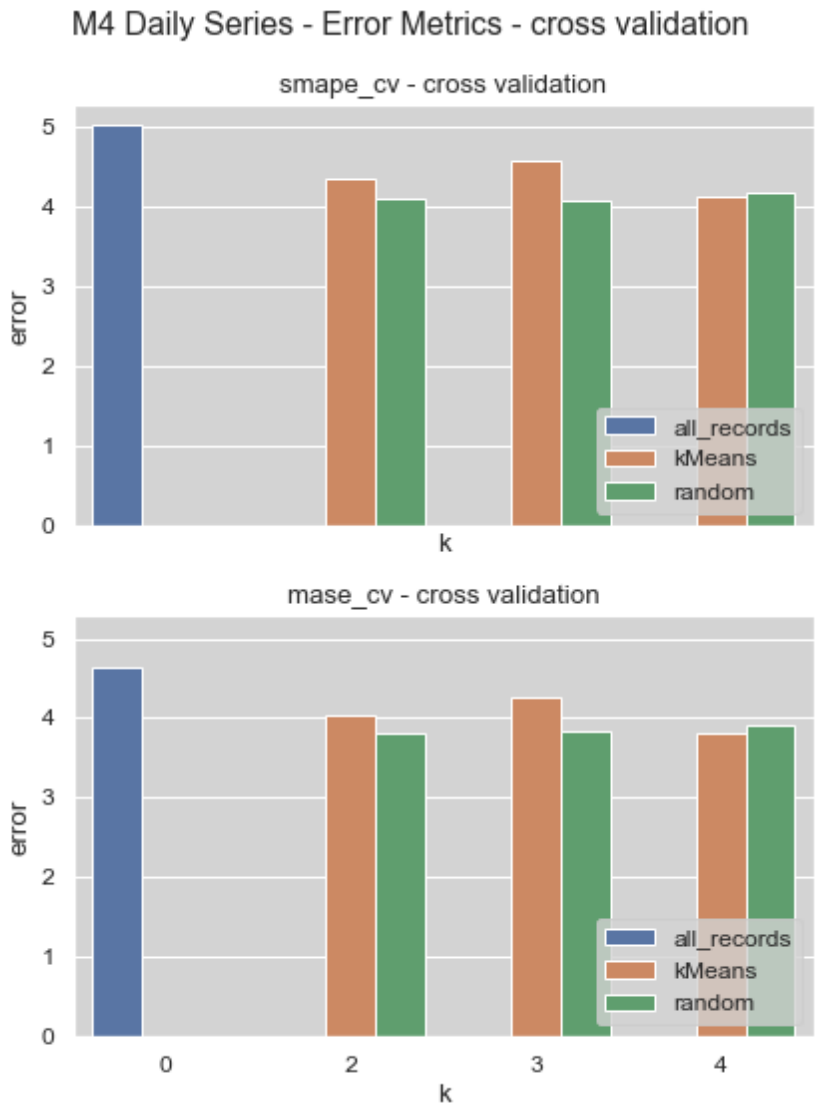
- tsfresh - 800 metrics
- comprehensive vs. efficient

Computational Costs

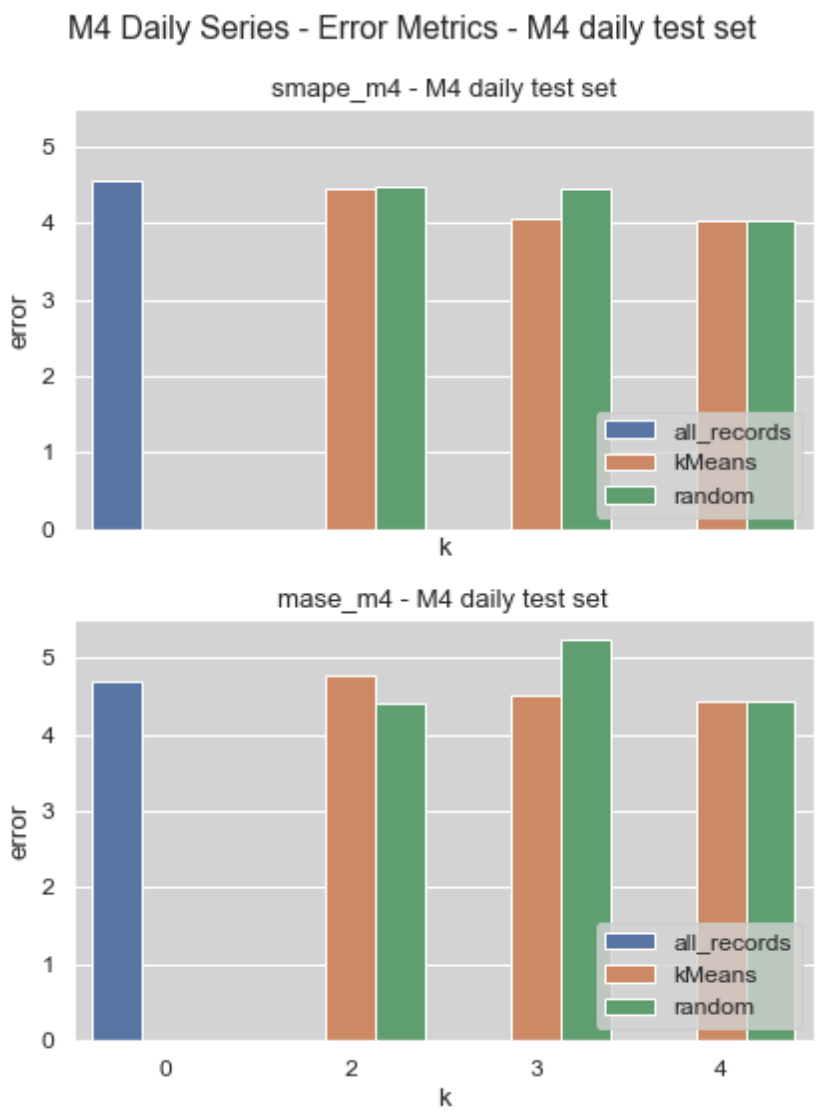
- 6 vCPU / 32GB RAM
- feature extraction and selection (reason for daily only)
- neural network with cv

Results

Cross validation



M4 results



Conclusion

- clustering results not better than random

features vs lags for NN

- possibly better results
- increase of neural network size
- how meaningful are efficient features

Approach to cross validation

- less folds
- MinMax scaler

Uncertainty in the clustering

- reduced uncertainty in the data clustered data
- indication in MASE (higher in test results compared to cv)

Complexity of problem definition

- many moving parts
- M4 Clustering on Github

Outlook

Algorithm

- hierarchical and density and grid-based methods

Feature Choice

- ranking of features