CS5228 Project Report

Group 17 - Workload Distribution

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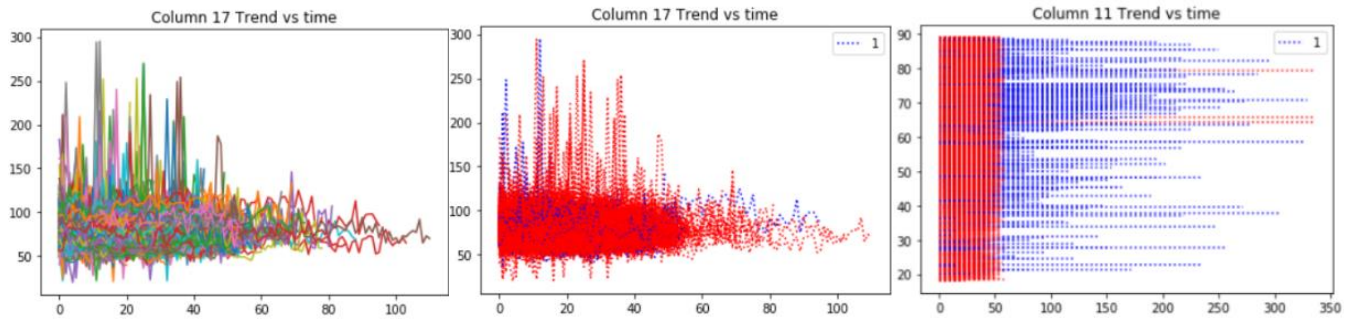
Key Words

Column: The column of the given data loaded from .npy.
Feature: Characteristics of the data.

Data Exploration

P1: Trend vs Time – Each column is investigated, and each column has different features that could contribute to the predictions. For example, column 17 data has high variations and column 11 is sensitive to time length.



P2: Non-Nan rate – Correlation between columns which is not all NaN and expected label – We found out that when some columns have value which is not NaN, the expected label tends to be 1.

Column	Label 0	Label 1	Difference
5	30.78%	63.54%	-32.76%
13	46.68%	77.08%	-30.40%
18	50.74%	78.18%	-27.44%
2	48.72%	77.04%	-28.32%

Data Preprocessing

NaN Handling – We set all the NaN to the average value for the column across all the training data. We tried setting all the NaN to 0 but it yields worse result as shown in the table below.

Column	Fill NaN	Preprocessing	Feature Selection	Tuning	Model	Public Score
5	0	TSFresh	None	None	Gradient Boosting	0.88856
5	**Average**	**TSFresh**	**None**	**None**	**Gradient Boosting**	**0.89372**

Features Extraction

TSFresh library is used to extract features of time series data. Given a multivariable time series, TSFresh will return many time series characteristics. Based on P1, each column has many different features that contribute to the predictions, TSFresh enables us to consider more characteristics of the time series data. TSFresh considers characteristic including standard deviation, variance, mean, count above mean.

We used extract_features to get the features and used select_features to remove irrelevant features. The output results are stored as parquet(.gzip) files for model training later.

Features Selection

Column Selection

We believe that if an irrelevant column is removed, the model will have better performance. As trying all combination of the columns would cost very long time (2^40 combinations), we started by trying with features that seems important

based on P2. Later, we employ random search technique with a fixed validation set. However, most result is inconsistent because most of the combinations that score well in the validation set, score worse in Kaggle Public Score. Thus, in this report, we are showing only Kaggle Public Score.

Removing column 18 consistently give a good result (shown below), thus it is chosen in the final submission.

Column	Fill NaN	Preprocessing	Feature Selection	Tuning	Model	Public Score
18	Average	TSFresh	None	None	Gradient Boosting	0.90419
22	Average	TSFresh	None	None	Gradient Boosting	0.91283
18, 22	Average	TSFresh	None	None	Gradient Boosting	0.91187
All	Average	TSFresh	None	None	Gradient Boosting	0.93715
All but 18	**Average**	**TSFresh**	**None**	**None**	**Gradient Boosting**	**0.94368**

Feature Selection Technique

The features extracted by TSFresh might be irrelevant for the data. Therefore, feature selection techniques are employed to increase the model AUC. Several feature selection techniques were tried including Sklearn Variance Threshold, Sklearn SelectFromModel and some feature selection techniques from Skfeature. SelectFromModel using ExtraTreesClassifier was found to have good performances, thus it is chosen to select individual features in most of the submissions.

Column	Fill NaN	Preprocessing	Feature Selection	Tuning	Model	Public Score
All but 18	Average	TSFresh	None	None	Gradient Boosting	0.94368
All but 18	**Average**	**TSFresh**	**Extra Tree Classifier**	**None**	**Gradient Boosting**	**0.95056**

We tried running feature selection on individual feature as well as running feature selection on combined data.

Column	Fill NaN	Preprocessing	Feature Selection	Tuning	Model	Public Score
All but 18	**Average**	**TSFresh**	**Extra Tree Classifier**	**Hyperopt**	**LightGBM**	**0.96169**
All but 27	Average	TSFresh	Extra Tree Classifier Select For Each Column	Hyperopt	LightGBM	0.95909

Model Training

We compared the performance of Gradient Boosting with Neural Network. Gradient Boosting performs better.

Column	Fill NaN	Preprocessing	Feature Selection	Tuning	Model	Public Score
22	**Average**	**TSFresh**	**None**	**None**	**Gradient Boosting**	**0.91283**
22	0	None	None	None	Tensorflow Neural Network	0.89307
22	0	None	None	None	Tensorflow Neural Network	0.8971
22	0	None	None	None	Tensorflow Neural Network	0.84987

Next, LightGBM, XgBoost, Sklearn Gradient Boosting are compared. LightGBM yields the best result.

Column	Fill NaN	Preprocessing	Feature Selection	Tuning	Model	Public Score
All but 18	Average	TSFresh	Extra Tree Classifier	None	Gradient Boosting	0.95056
All but 18	**Average**	**TSFresh**	**Extra Tree Classifier**	**None**	**LightGBM**	**0.96069**
All but 18	Average	TSFresh	Extra Tree Classifier	None	XGBoost	0.95403

Model Tuning

Sklearn Random Search CV and Hyperopt are experimented. Hyperopt is chosen due to its speed performance. The best parameters found by Hyperopt is {'boosting_type': 'dart', 'metric': 'auc', 'colsample_bytree': 0.7912493015275733, 'learning_rate': 0.1825037992404684, 'min_child_samples': 95, 'num_leaves': 48, 'reg_alpha': 0.5753421176471192, 'reg_lambda': 0.6231841891673146, 'subsample_for_bin': 20000}.

Column	Fill NaN	Preprocessing	Feature Selection	Tuning	Model	Public Score
All but 18	Average	TSFresh	Extra Tree Classifier	None	LightGBM	0.96069
All but 18	**Average**	**TSFresh**	**Extra Tree Classifier**	**Hyperopt**	**LightGBM**	**0.96169**

Final Model

The final model is chosen based on the highest Public Score and is shown in the table below.

Column	Fill NaN	Preprocessing	Feature Selection	Tuning	Model	Public Score	Private Score
All but 18	**Average**	**TSFresh**	**Extra Tree Classifier**	**Hyperopt**	**LightGBM**	**0.96169**	**0.94081**

References

tsfresh. (n.d.). Retrieved from https://tsfresh.readthedocs.io/en/latest/.
LightGBM. (n.d.). Retrieved from https://lightgbm.readthedocs.io/en/latest/.
Pedregosa et al. (2011). Scikit-learn: Machine Learning in Python, JMLR 12, pp. 2825-2830.
Bergstra, J., Yamins, D., Cox, D. D. (2013) Making a Science of Model Search: Hyperparameter Optimization in Hundreds of Dimensions for Vision Architectures. To appear in Proc. of the 30th International Conference on Machine Learning (ICML 2013).

Appendix – Important experiments

Only Kaggle Public Score is recorded as Kaggle Public Score is a better indicator in our case:

Column	Fill NaN	Preprocessing	Feature Selection	Tuning	Model	Public Score	Private Score
All but 18	**Average**	**TSFresh**	**Extra Tree Classifier**	**Hyperopt**	**LightGBM**	**0.96169**	**0.94081**
All but 18, 27	Average	TSFresh	Extra Tree Classifier	None	LightGBM	0.95695	0.9365
All but 27	Average	TSFresh	Extra Tree Classifier Select for Each Feature	Hyperopt	LightGBM	0.95909	0.93639
All but 18	Average	TSFresh	Extra Tree Classifier	None	LightGBM	0.96069	0.93373
All but 27	Average	TSFresh	Extra Tree Classifier Select for Each Feature	None	LightGBM	0.96063	0.93336
All but 18	Average	TSFresh	Extra Tree Classifier	None	XGBoost	0.95403	0.93057
All but 18	Average	TSFresh	Extra Tree Classifier	None	Gradient Boosting	0.95056	0.92814
All but 27	Average	TSFresh	Extra Tree Classifier	None	LightGBM	0.95609	0.92755
All but 18	Average	TSFresh	None	None	Gradient Boosting	0.94368	0.9187
All	Average	TSFresh	None	None	Gradient Boosting	0.93715	0.91264
All but 2 and 18	Average	TSFresh	None	None	Gradient Boosting	0.93338	0.90609
5, 22	Average	TSFresh	None	None	Gradient Boosting	0.91056	0.87796
18, 22	Average	TSFresh	None	None	Gradient Boosting	0.91187	0.87456
22	Average	TSFresh	None	None	Gradient Boosting	0.91283	0.87368
22	Average	TSFresh	None	None	XGBoost	0.90624	0.86369
18	Average	TSFresh	None	None	Gradient Boosting	0.90419	0.86143
5, 13	Average	TSFresh	None	None	Gradient Boosting	0.90916	0.86097
5	0	TSFresh	None	None	Gradient Boosting	0.88856	0.85067
5, 33	Average	TSFresh	None	None	Gradient Boosting	0.89429	0.84817
5	Average	TSFresh	None	None	Gradient Boosting	0.89372	0.84773
13	Average	TSFresh	None	None	Gradient Boosting	0.85919	0.80678
33	0	TSFresh	None	None	Gradient Boosting	0.84482	0.78877
26	Average	TSFresh	None	None	Gradient Boosting	0.8261	0.78346
0	Average	TSFresh	None	None	Gradient Boosting	0.82475	0.78263
2	0	TSFresh	None	None	Gradient Boosting	0.82657	0.77792
35	Average	TSFresh	None	None	Gradient Boosting	0.8246	0.77493
11	0	TSFresh	None	None	Gradient Boosting	0.82215	0.7724
All	Average	TSFresh	FCBF	None	Gradient Boosting	0.77254	0.25281
2,3,6,8,11,12,13,15,17,18,22,24, 26,29,31,33,35,37,39	0	None	None	None	Tensorflow Neural Network	0.90039	0.85684
22	0	None	None	None	Tensorflow Neural Network	0.89307	0.83614
22	0	None	None	None	Tensorflow Neural Network	0.8971	0.86794
22	0	None	None	None	Tensorflow Neural Network	0.84987	0.80797
22	Average	TSFresh	None	Random Search Optimization	LightGBM	0.8483	0.8206