

Hierarchical Classification Using ML/DL for Sussex-Huawei Locomotion-Transportation (SHL) Recognition Challenge

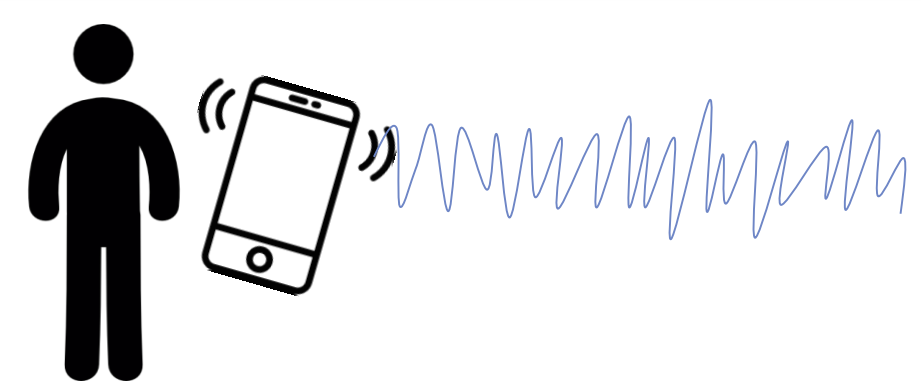
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1. Introduction

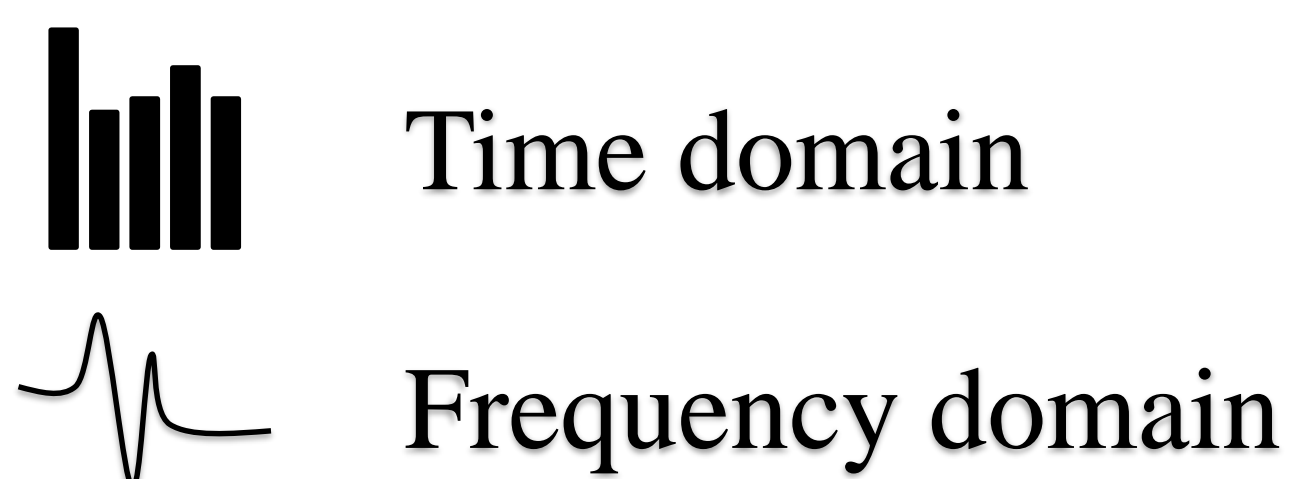
2020 SHL Challenge

- HAR (human activity recognition): identify the mean of posed activities of a person
- SHL dataset: contains sensor data from a smartphone
- Recognition target: still, walk, run, bike, car, bus, train, and subway

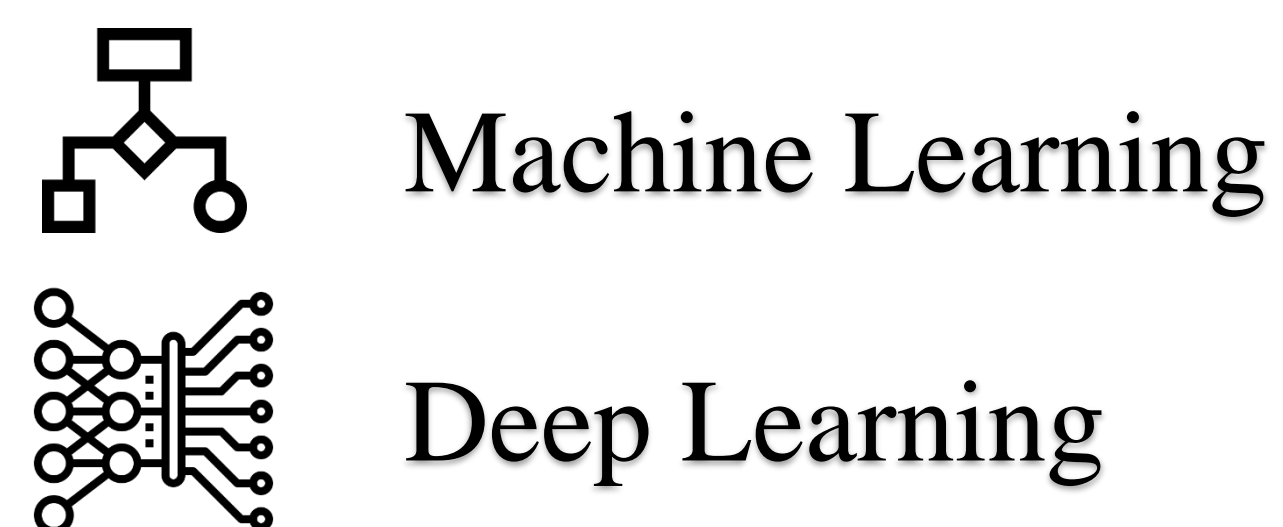
Activity Signal



Feature Extraction



Model Training



Activity Inference

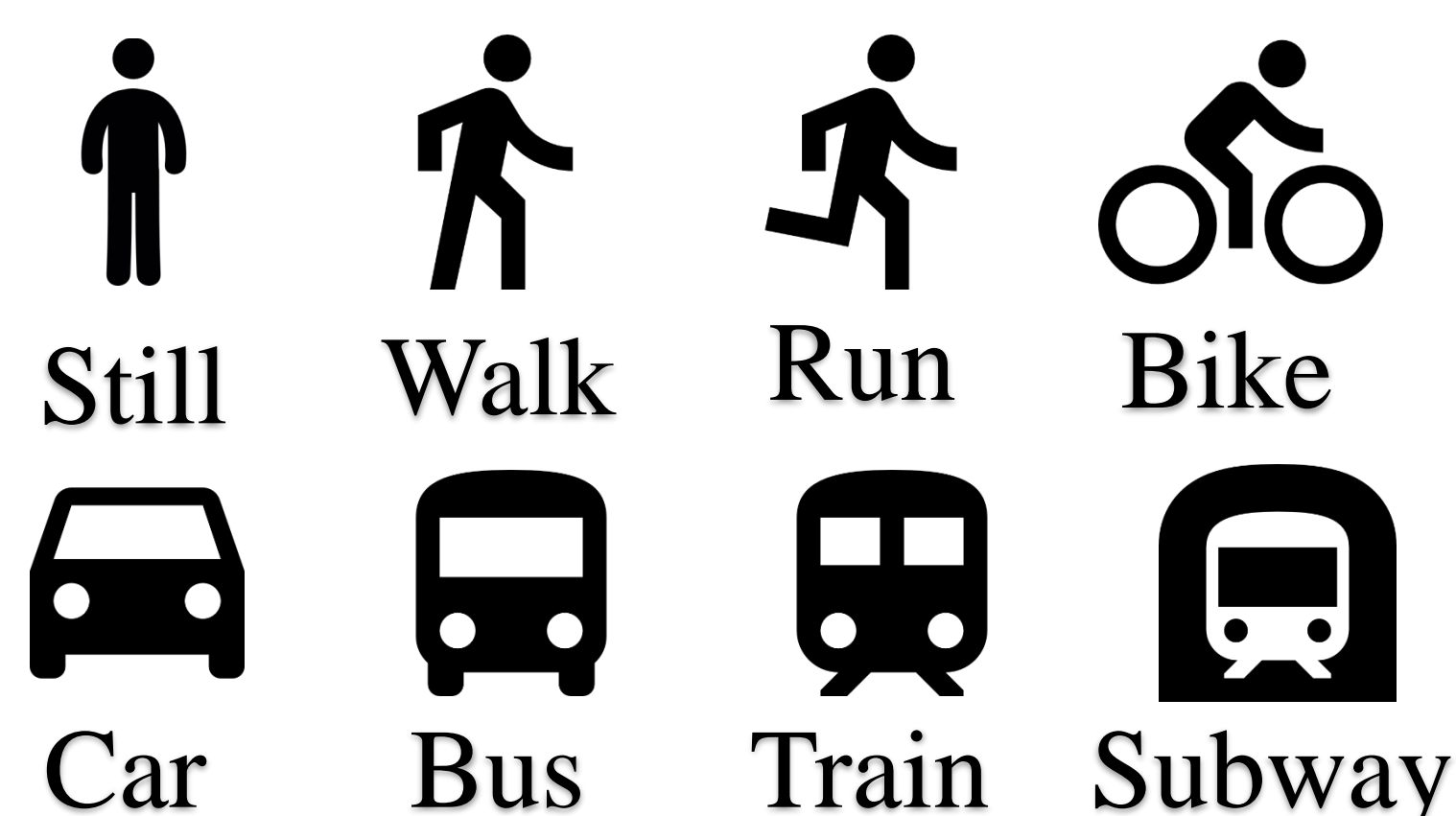


Fig. 1: Overview of HAR

2. Methodology

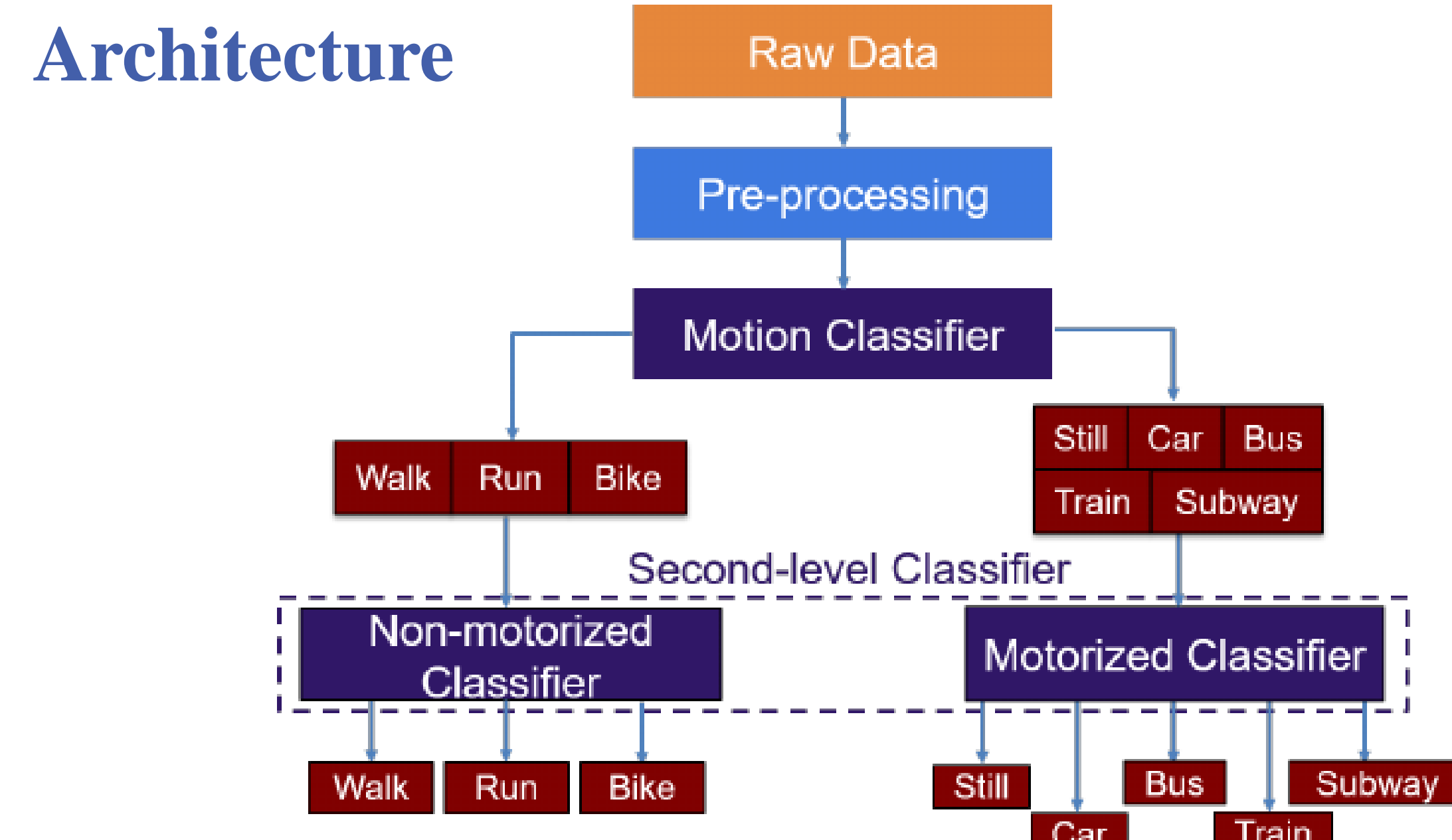


Fig. 2: Overview of proposed hierarchical classifiers.

- 2 levels consisting of 3 models
 - 1st level: Motion Classifier
 - 2nd level: Non-motorized Classifier, Motorized Classifier
- **Motion Classifier**: predicts whether the input data is within walking, running and biking or the rest
 - Model: XGBT
 - Input feature: statistics of acceleration
 - Feature observation: different patterns of acceleration statistics (e.g. Fig. 3)

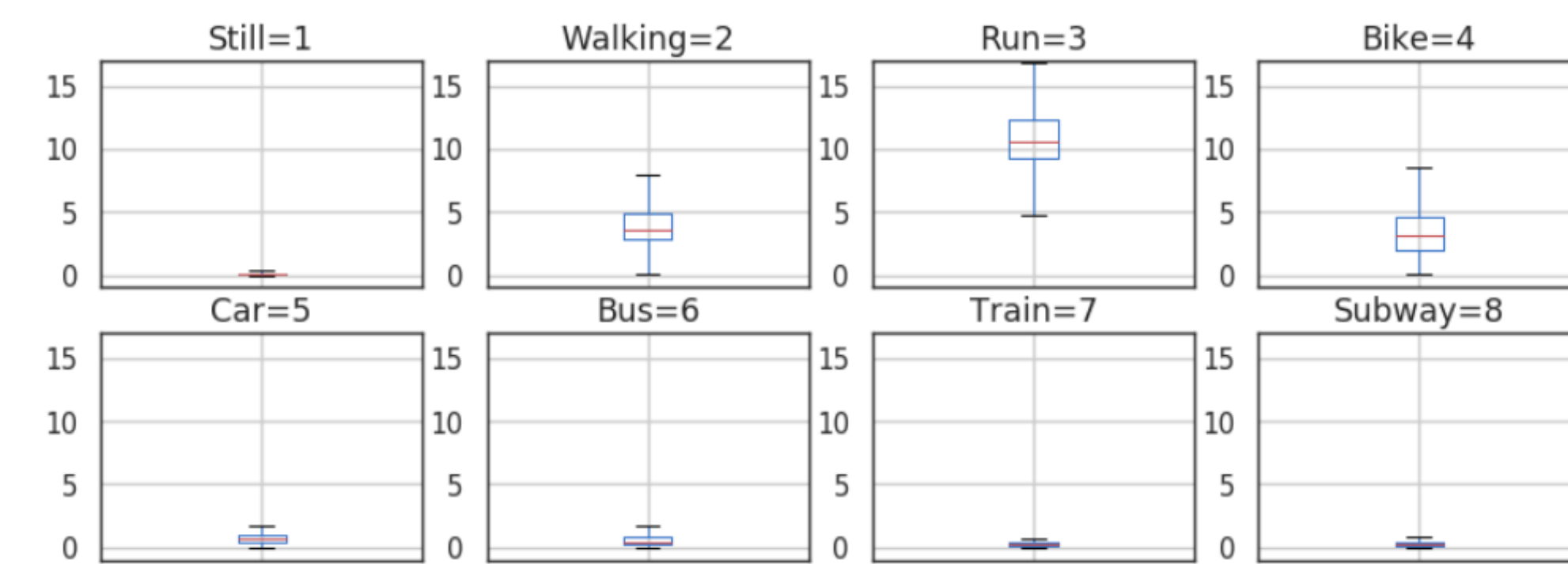


Fig. 3: Boxplots of the standard deviation of acceleration for all classes.

- **Non-motorized Classifier**: classifies within non-motorized labels: walking, running and biking
 - Model: 3-layer MLP
 - Input feature: auto-correlation function of acceleration
 - Feature observation: auto-correlation function of acceleration has different patterns within walking, running and bike (Fig.4)

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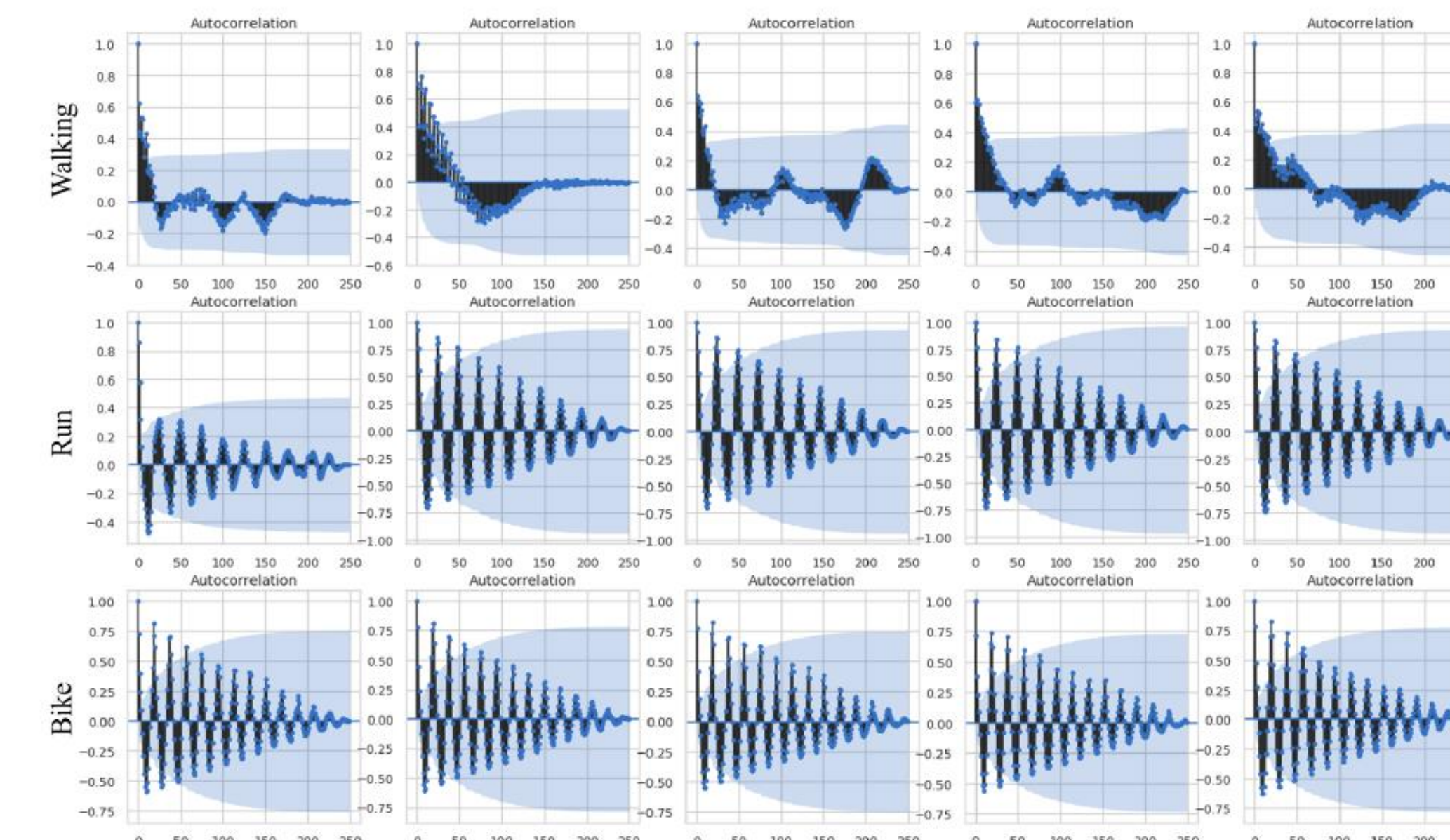


Fig. 4: Auto-correlation function of vertical acceleration while walking, running and biking.

- **Motorized Classifier**: classifies within still and motorized labels, car, bus, train and subway.
 - Model: XGBT
 - Input feature: statistics of measured values of magnetic field and air pressure
 - Feature observation: Fig. 5~Fig. 7

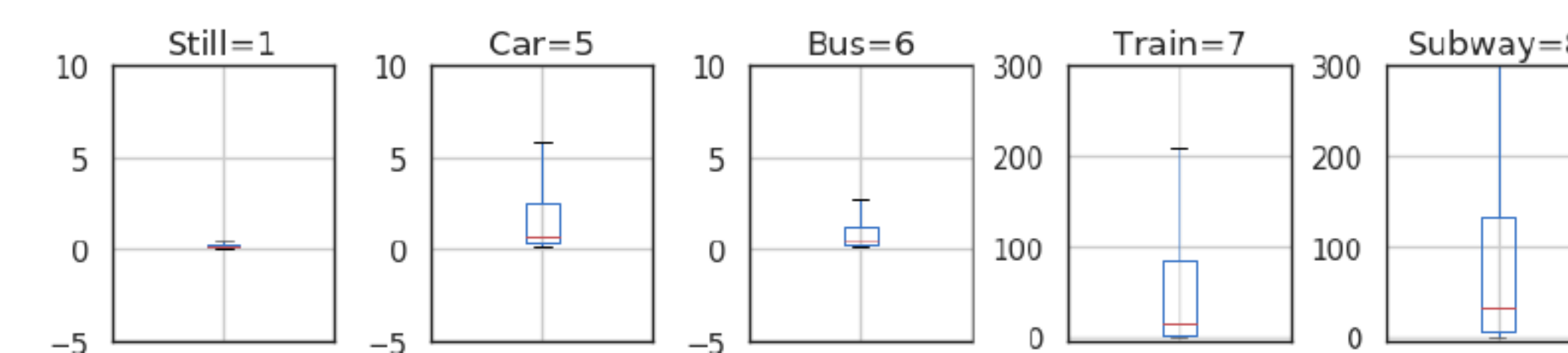


Fig. 5: Boxplots of the variance of magnetic field with labels of still, car, bus, train and subway.

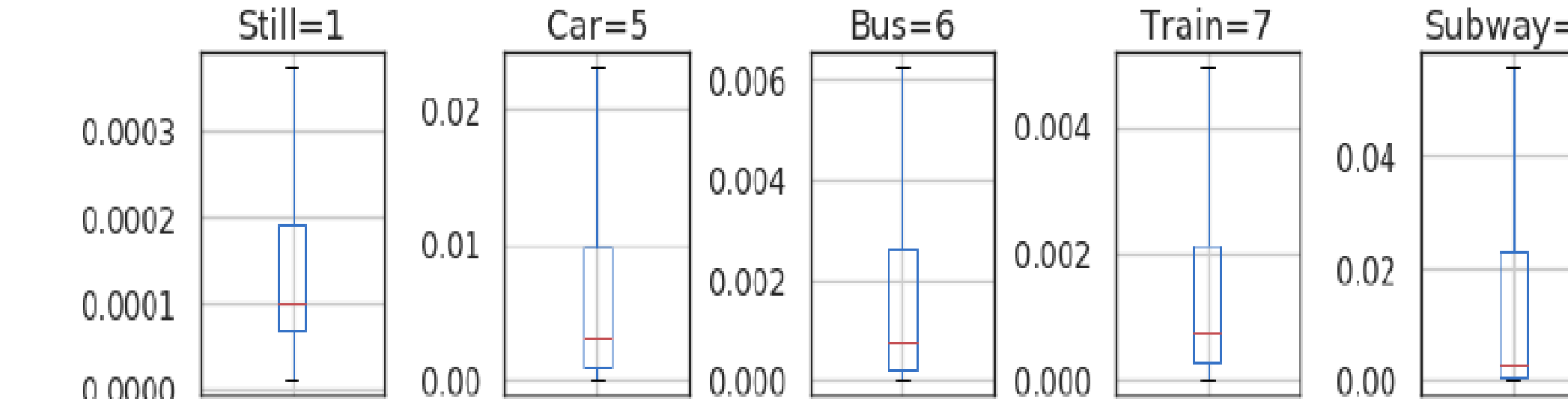


Fig. 6: Boxplots of the variance of pressure with labels of still, car, bus, train and subway.

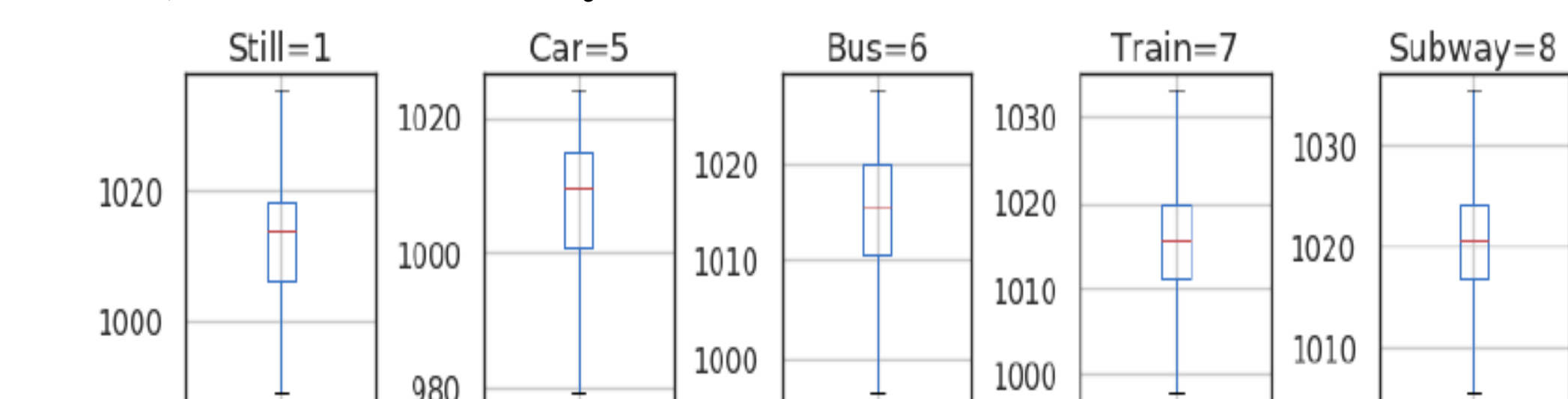


Fig. 7: Boxplots of the average of pressure with labels of still, car, bus, train and subway.

3. Results

Experimental Environment

A PC with a 16-core CPU, 16GB RAM, and an Nvidia GTX 1080 GPU.

Evaluation

Table 1: Performance Metrics

	Precision	Recall	F1-score
Motion classifier	90.1%	89.3%	88.6%
Non-motorized classifier	87.8%	84.3%	84.7%
Motorized classifier	60.2%	60.7%	60.3%
Overall	64.7%	43.4%	49.9%

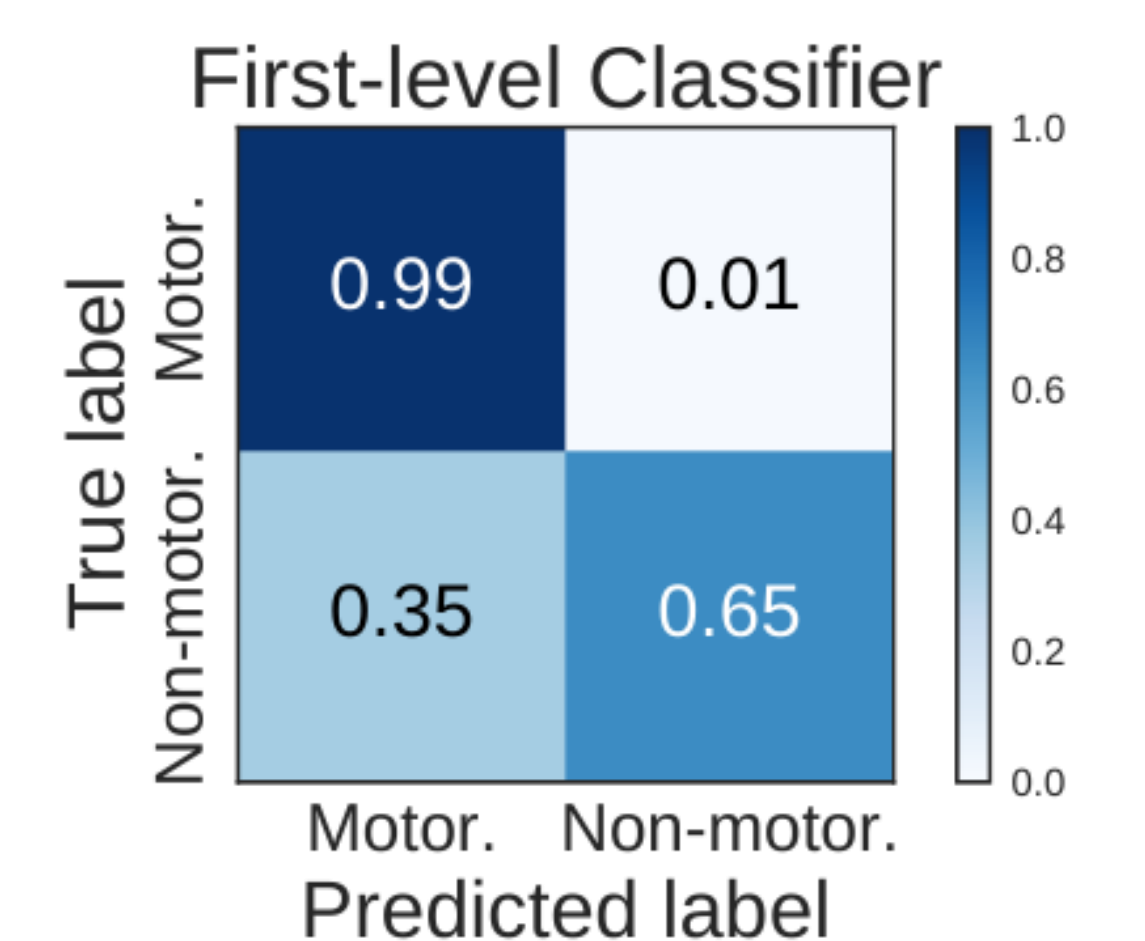


Fig. 8: Confusion matrix of first-level classifier evaluation result.

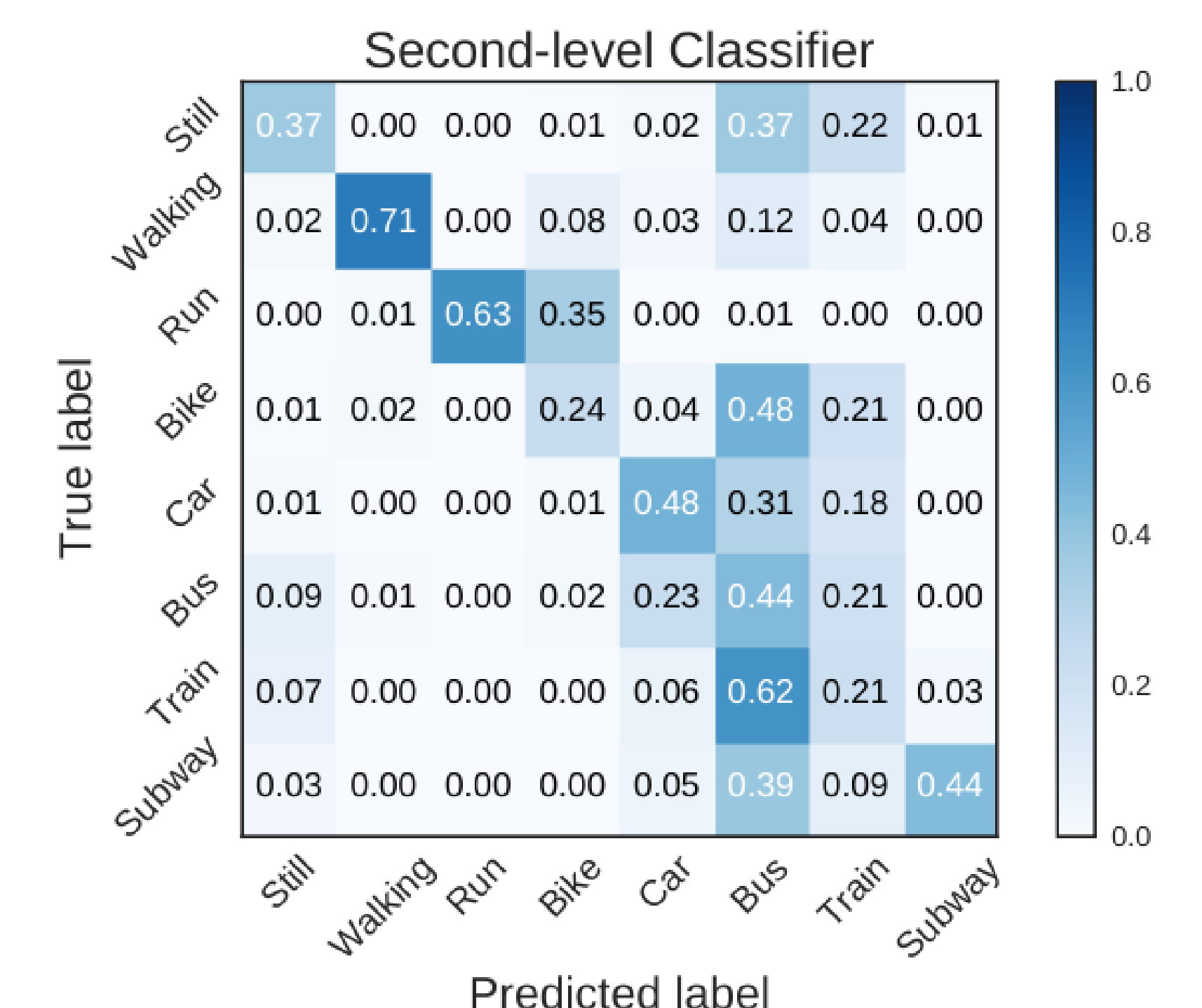


Fig. 9: Confusion matrix of second-level classifier evaluation result.

Acknowledgements

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