Estimation of Physical Activity Intensity Level Based on Heart Rate

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Introduction

This report discusses a method to estimate the intensity level of physical activity based on heart rate. Given a heart rate data point, this method could output the activity level that basically reflect the intensity level. The estimation on top of heart rate is implemented by a KNN classifier, which is trained by a subset of activity monitoring data introduced in [1] [2]. The dataset used for training consists of 22846 rows and three columns: *Timestamp, ActivityID, HeartRate*. 10-fold cross validation is applied to evaluate the performance of KNN classifier and choose the optimal parameter K for KNN classifier.

Intensity Estimation

Three classes, including light effort, moderate effort, and vigorous effort, are defined for different activity intensity levels based on the MET (Metabolic Equivalent) [2]. MET is a way to measure the intensity of aerobic activities based on the energy cost. The 12 different activity labels recorded in the dataset are grouped into the three classes like following, (1). light effort (MET < 3.0): lying, sitting, standing, ironing; (2). moderate effort (3.0<MET<6.0): vaccum cleaning, descending stairs, normal walking, nordic walking, cycling; (3). vigorous effort(MET>6.0): ascending stairs, running, rope jumping.

KNN Classifier

As illustrated in [2], KNN generally outperforms other classifiers in intensity estimation task. Therefore, KNN classifier is chosen for the estimation task. Since different activities need to be grouped into three classes that reflect their intensity level, the first step is to assign new labels that represent intensity level to each data point according to their original activityIDs, and 1, 2, 3 are labels for light effort, moderate effort, vigorous effort, respectively. Then to evaluate the performance of KNN classifier of different parameter K, 10-fold cross validation are utilized to pick up the optimal K. Finally, the classifier can estimate the intensity level of physical activities given a particular heart rate data point.

Performance of KNN Classifier

The best error rate achieved under the chosen optimal parameter K is 8.2%. The dataset is first shuffled in order to fit cross validation technique and achieve better results when applying cross validation since the time series monitoring data is collected following the protocol of data collection, which makes records for light effort tend to be at the beginning of the dataset, and records of vigorous effort at the end of dataset. Since the shuffle process and the instability of quick sort, the optimal K and corresponding error rate fluctuates a little each time as shown in the following three figures. The three figures reflects the results of three executions, and the chosen
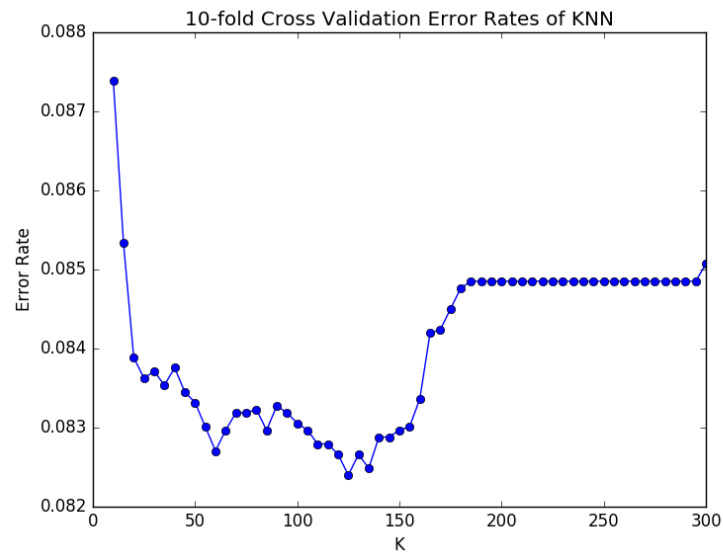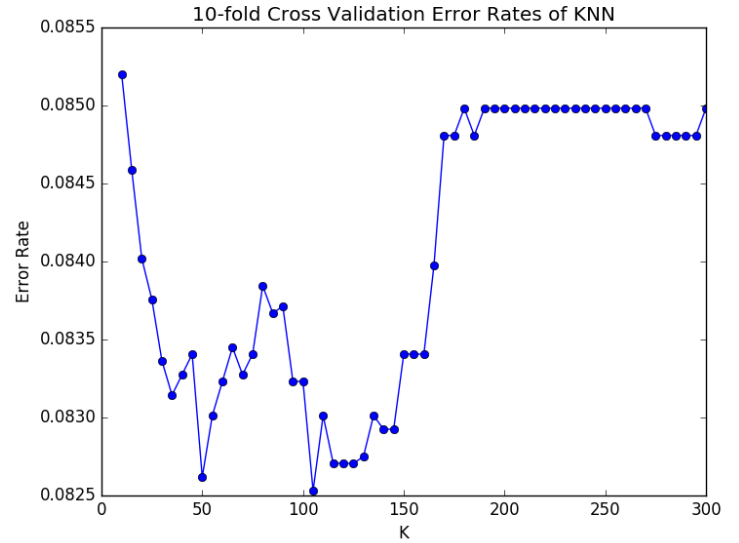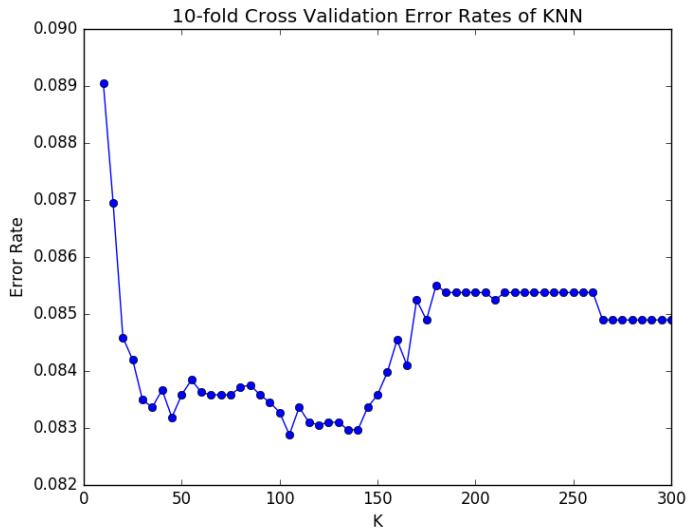
parameter K of KNN classifier and corresponding error rates are, 115 and 0.0827495621716, 105 and 0.082530647986, 125 and 0.0823992994746, respectively.

Reference

[1] A. Reiss and D. Stricker. Introducing a New Benchmarked Dataset for Activity Monitoring. The 16th IEEE International Symposium on Wearable Computers (ISWC), 2012.

[2] A. Reiss and D. Stricker. Creating and Benchmarking a New Dataset for Physical Activity Monitoring. The 5th Workshop on Affect and Behaviour Related Assistance (ABRA), 2012.