all_steps_activity recognition_final_version_split_cycling_time_segment

January 11, 2021

[1]:
```
from helpers import math_helper
from sensors.activpal import *
from utils import read_functions
from scipy import signal
from sklearn.model_selection import train_test_split, cross_val_score
from sklearn import tree
from sklearn.metrics import f1_score, plot_confusion_matrix, confusion_matrix,␣
 ↪accuracy_score, precision_score, recall_score, confusion_matrix,␣
 ↪classification_report
from sklearn.ensemble import RandomForestClassifier

import pandas as pd
import numpy as np
import statistics
import os
import pickle
import matplotlib.pyplot as plt
```

Adnan Akbas # Feature Extraction

[2]:
```
activpal = Activpal()

features_columns = ['standard_deviation_x', 'mean_x', 'standard_deviation_y',␣
 ↪'mean_y','standard_deviation_z', 'mean_z', 'activiteit']
activity_columns = ['activity_cycling_light', 'activity_cycling_heavy',␣
 ↪'activity_walking', 'activity_running', 'activity_standing',␣
 ↪'activity_sitten']
activities = ['fietsen licht', 'fietsen zwaar', 'lopen', 'rennen', 'staan',␣
 ↪'zitten']

test_users = ['BMR004', 'BMR034', 'BMR097']

# src: https://dbader.org/blog/python-memoization#:~:
 ↪text=In%20Python%2C%20using%20a%20key,the%20cached%20result%20is%20returned.
def memoize(func):
    cache = dict()
```

```
    def memoized_func(*args):
        if args in cache:
            return cache[args]
        result = func(*args)
        cache[args] = result
        return result

    return memoized_func


activpal_read_data = memoize(activpal.read_data)
```

[3]:
```
def extract_features_from_correspondent(correspondent, segment_size=6.4):
    features_df = pd.DataFrame(columns=features_columns, index=pd.
 ↪to_datetime([]))

    # Getting dataset for a correspondent
    activities_df = read_functions.read_activities(correspondent)

    for activity_name in activities:
        activity = activities_df.loc[activity_name]
        if not activity.empty:
            start_time = activity.start
            stop_time = activity.stop
            activpal_df = activpal_read_data(correspondent, start_time,␣
 ↪stop_time)

            # denormalizing dataset
            activpal_df['x'] = math_helper.
 ↪convert_value_to_g(activpal_df['pal_accX'])
            activpal_df['y'] = math_helper.
 ↪convert_value_to_g(activpal_df['pal_accY'])
            activpal_df['z'] = math_helper.
 ↪convert_value_to_g(activpal_df['pal_accZ'])

            date_range = pd.date_range(start_time, stop_time,␣
 ↪freq=str(segment_size) + 'S')

            for time in date_range:
                segment_time = time + pd.DateOffset(seconds=segment_size)
                activpal_segment = activpal_df[(activpal_df.index >= time) &␣
 ↪(activpal_df.index < segment_time)]

                stdev_x =  statistics.stdev(activpal_segment['x']) if␣
 ↪len(activpal_segment['x']) >= 2 else 0
```

```
                mean_x = activpal_segment['x'].mean()

                stdev_y =  statistics.stdev(activpal_segment['y']) if len(activpal_segment['y']) >= 2 else 0
                mean_y = activpal_segment['y'].mean()

                stdev_z =  statistics.stdev(activpal_segment['z']) if len(activpal_segment['z']) >= 2 else 0
                mean_z = activpal_segment['z'].mean()


                features_df.loc[segment_time] = [stdev_x, mean_x, stdev_y, mean_y, stdev_z, mean_z, activity_name]

    return features_df


def extract_features_from_correspondents(correspodents,  segment_size=6.4):
    all_features_df = pd.DataFrame(index=pd.to_datetime([]))

    print("starting extraction of segment_size: ", segment_size)
    for correspodent in correspodents:
        features_df     = extract_features_from_correspondent(correspodent, segment_size)
        all_features_df = pd.concat([all_features_df, features_df])

    print("Ended extraction")

    return all_features_df

def extract_features_from_all_correspondents(exclude_test_correspodent = True, segment_size=6.4):

    exclude_directory = ['output', 'throughput', 'Test data','.ipynb_checkpoints']
    exclude_respodents = ['BMR015','BMR025','BMR027', 'BMR035', 'BMR051', 'BMR054', 'BMR060', 'BMR099', 'BMR100']

    exclude = exclude_respodents + exclude_directory

    if (exclude_test_correspodent):
        exclude = exclude + test_users

    correspodents = []

    for directory in os.walk('../../data'):
```

```
        if directory[0] == '../../data':
            correspodents = directory[1]

    for exclude_item in exclude:
        if exclude_item in correspodents:
            correspodents.remove(exclude_item)

    return extract_features_from_correspondents(correspodents, segment_size)
```

[4]:
```
def get_model_scores_on_segment_size(segment_size):
    test_dataset = extract_features_from_all_correspondents(True, segment_size)

    test_dataset[activity_columns] = 0

    test_dataset.loc[(test_dataset['activiteit'] == 'lopen'),␣
↪'activity_walking'] = 1
    test_dataset.loc[(test_dataset['activiteit'] == 'rennen'),␣
↪'activity_running'] = 1
    test_dataset.loc[(test_dataset['activiteit'] == 'staan'),␣
↪'activity_standing'] = 1
    test_dataset.loc[(test_dataset['activiteit'] == 'zitten'),␣
↪'activity_sitten'] = 1
    test_dataset.loc[(test_dataset['activiteit'] == 'fietsen licht'),␣
↪'activity_cycling_light'] = 1
    test_dataset.loc[(test_dataset['activiteit'] == 'fietsen zwaar'),␣
↪'activity_cycling_heavy'] = 1

    test_dataset.drop('activiteit', axis=1, inplace=True)
    test_dataset.dropna(how='any', inplace=True)

    x = test_dataset[features_columns[:-1]]
    y = test_dataset[activity_columns]

    train_x, valid_x, train_y, valid_y = train_test_split(x,y, test_size=0.2,␣
↪random_state=0)


    #### Quick analysis
    accuracy_scores = []

    n_estimator_numbers = range(10,200,1)
    print(n_estimator_numbers)

    for i in n_estimator_numbers:
        # rfc_t = RandomForestClassifier(n_estimators=i, random_state=0)
        # rfc_t.fit(train_x, train_y)
```

```
    # predictions = rfc_t.predict(valid_x)
     accuracy_scores.append( cross_val_score(␣
↪RandomForestClassifier(n_estimators=i, random_state=0), x, y, cv=5,␣
↪scoring='accuracy').mean())
     accuracy_scores.append(accuracy_score(valid_y, predictions,␣
↪normalize=True))

    np_accuracy_scores = np.array(accuracy_scores)
    number_of_trees = np.argmax(np_accuracy_scores)  + 10




    # validation dataset
    ftc = RandomForestClassifier(n_estimators=number_of_trees, random_state=0)
    ftc.fit(train_x, train_y)

    prediction_y = ftc.predict(valid_x)

    accuracy = accuracy_score(valid_y, prediction_y)
    precision = precision_score(valid_y, prediction_y, average='micro')
    recall = recall_score(valid_y, prediction_y, average='micro')

    #cross validation
    cross_val_accuracy_scores =␣
↪cross_val_score(RandomForestClassifier(n_estimators=number_of_trees,␣
↪random_state=0), x, y, scoring='accuracy')
    cross_val_precision_scores =␣
↪cross_val_score(RandomForestClassifier(n_estimators=number_of_trees,␣
↪random_state=0), x, y , scoring='precision_micro')
    cross_val_recall_scores =␣
↪cross_val_score(RandomForestClassifier(n_estimators=number_of_trees,␣
↪random_state=0), x, y , scoring='recall_micro')

    return [number_of_trees, accuracy , precision, recall,␣
↪cross_val_accuracy_scores.mean(), cross_val_precision_scores.mean(),␣
↪cross_val_recall_scores.mean()]
```

[5]:
```
def plot_stuff(df):
    df.plot(y=['accuracy', 'precision', 'recall'], marker='o', ylabel='scores',␣
↪xlabel='segment size(seconds)', title= 'validation dataset')
    df.plot(y=['cross_val_accuracy', 'cross_val_precision',␣
↪'cross_val_recall'], marker='o',  ylabel='scores',xlabel='segment␣
↪size(seconds)', title = 'cross validation')
```

[6]:
```
## tAdd
```

[15]:
```
score_columns = ['number_of_trees', 'accuracy', 'precision', 'recall',␣
↪'cross_val_accuracy',  'cross_val_precision',  'cross_val_recall']
results_with_trees = pd.DataFrame(columns=score_columns)
segment_sizes = np.arange(6.0, 14.0, 0.1)

for segment_size in segment_sizes:
    results_with_trees.loc[segment_size] =␣
↪get_model_scores_on_segment_size(round(segment_size, 1))
```

```
starting extraction of segment_size:  6.0
Ended extraction
range(10, 200)
starting extraction of segment_size:  6.1
Ended extraction
range(10, 200)
starting extraction of segment_size:  6.2
Ended extraction
range(10, 200)
starting extraction of segment_size:  6.3
Ended extraction
range(10, 200)
starting extraction of segment_size:  6.4
Ended extraction
range(10, 200)
starting extraction of segment_size:  6.5
Ended extraction
range(10, 200)
starting extraction of segment_size:  6.6
Ended extraction
range(10, 200)
starting extraction of segment_size:  6.7
Ended extraction
range(10, 200)
starting extraction of segment_size:  6.8
Ended extraction
range(10, 200)
starting extraction of segment_size:  6.9
Ended extraction
range(10, 200)
starting extraction of segment_size:  7.0
Ended extraction
range(10, 200)
starting extraction of segment_size:  7.1
Ended extraction
range(10, 200)
```

```
starting extraction of segment_size:  7.2
Ended extraction
range(10, 200)
starting extraction of segment_size:  7.3
Ended extraction
range(10, 200)
starting extraction of segment_size:  7.4
Ended extraction
range(10, 200)
starting extraction of segment_size:  7.5
Ended extraction
range(10, 200)
starting extraction of segment_size:  7.6
Ended extraction
range(10, 200)
starting extraction of segment_size:  7.7
Ended extraction
range(10, 200)
starting extraction of segment_size:  7.8
Ended extraction
range(10, 200)
starting extraction of segment_size:  7.9
Ended extraction
range(10, 200)
starting extraction of segment_size:  8.0
Ended extraction
range(10, 200)
starting extraction of segment_size:  8.1
Ended extraction
range(10, 200)
starting extraction of segment_size:  8.2
Ended extraction
range(10, 200)
starting extraction of segment_size:  8.3
Ended extraction
range(10, 200)
starting extraction of segment_size:  8.4
Ended extraction
range(10, 200)
starting extraction of segment_size:  8.5
Ended extraction
range(10, 200)
starting extraction of segment_size:  8.6
Ended extraction
range(10, 200)
starting extraction of segment_size:  8.7
Ended extraction
range(10, 200)
```

```
starting extraction of segment_size:  8.8
Ended extraction
range(10, 200)
starting extraction of segment_size:  8.9
Ended extraction
range(10, 200)
starting extraction of segment_size:  9.0
Ended extraction
range(10, 200)
starting extraction of segment_size:  9.1
Ended extraction
range(10, 200)
starting extraction of segment_size:  9.2
Ended extraction
range(10, 200)
starting extraction of segment_size:  9.3
Ended extraction
range(10, 200)
starting extraction of segment_size:  9.4
Ended extraction
range(10, 200)
starting extraction of segment_size:  9.5
Ended extraction
range(10, 200)
starting extraction of segment_size:  9.6
Ended extraction
range(10, 200)
starting extraction of segment_size:  9.7
Ended extraction
range(10, 200)
starting extraction of segment_size:  9.8
Ended extraction
range(10, 200)
starting extraction of segment_size:  9.9
Ended extraction
range(10, 200)
starting extraction of segment_size:  10.0
Ended extraction
range(10, 200)
starting extraction of segment_size:  10.1
Ended extraction
range(10, 200)
starting extraction of segment_size:  10.2
Ended extraction
range(10, 200)
starting extraction of segment_size:  10.3
Ended extraction
range(10, 200)
```

```
starting extraction of segment_size:  10.4
Ended extraction
range(10, 200)
starting extraction of segment_size:  10.5
Ended extraction
range(10, 200)
starting extraction of segment_size:  10.6
Ended extraction
range(10, 200)
starting extraction of segment_size:  10.7
Ended extraction
range(10, 200)
starting extraction of segment_size:  10.8
Ended extraction
range(10, 200)
starting extraction of segment_size:  10.9
Ended extraction
range(10, 200)
starting extraction of segment_size:  11.0
Ended extraction
range(10, 200)
starting extraction of segment_size:  11.1
Ended extraction
range(10, 200)
starting extraction of segment_size:  11.2
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range(10, 200)
starting extraction of segment_size:  11.3
Ended extraction
range(10, 200)
starting extraction of segment_size:  11.4
Ended extraction
range(10, 200)
starting extraction of segment_size:  11.5
Ended extraction
range(10, 200)
starting extraction of segment_size:  11.6
Ended extraction
range(10, 200)
starting extraction of segment_size:  11.7
Ended extraction
range(10, 200)
starting extraction of segment_size:  11.8
Ended extraction
range(10, 200)
starting extraction of segment_size:  11.9
Ended extraction
range(10, 200)
```
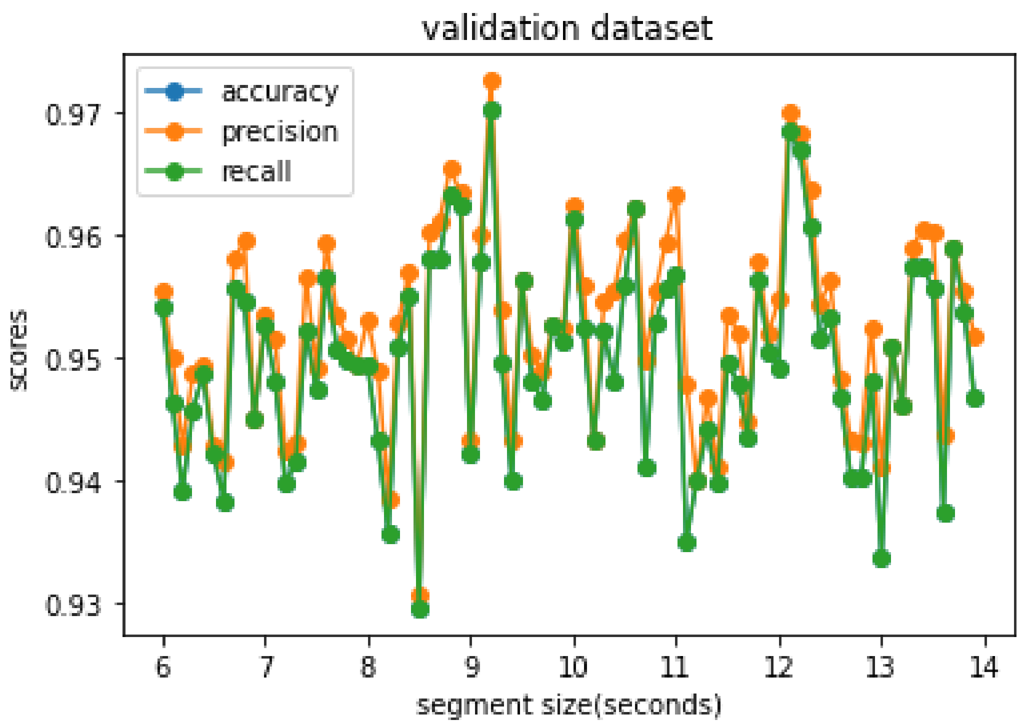
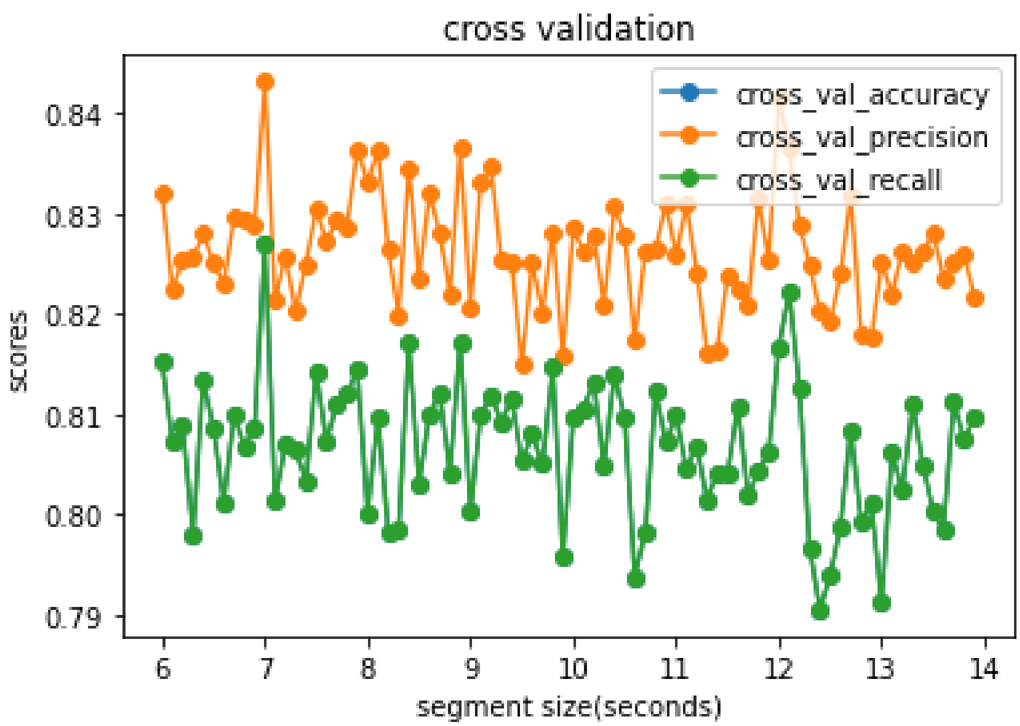

```
starting extraction of segment_size:  12.0
Ended extraction
range(10, 200)
starting extraction of segment_size:  12.1
Ended extraction
range(10, 200)
starting extraction of segment_size:  12.2
Ended extraction
range(10, 200)
starting extraction of segment_size:  12.3
Ended extraction
range(10, 200)
starting extraction of segment_size:  12.4
Ended extraction
range(10, 200)
starting extraction of segment_size:  12.5
Ended extraction
range(10, 200)
starting extraction of segment_size:  12.6
Ended extraction
range(10, 200)
starting extraction of segment_size:  12.7
Ended extraction
range(10, 200)
starting extraction of segment_size:  12.8
Ended extraction
range(10, 200)
starting extraction of segment_size:  12.9
Ended extraction
range(10, 200)
starting extraction of segment_size:  13.0
Ended extraction
range(10, 200)
starting extraction of segment_size:  13.1
Ended extraction
range(10, 200)
starting extraction of segment_size:  13.2
Ended extraction
range(10, 200)
starting extraction of segment_size:  13.3
Ended extraction
range(10, 200)
starting extraction of segment_size:  13.4
Ended extraction
range(10, 200)
starting extraction of segment_size:  13.5
Ended extraction
range(10, 200)
```

```
starting extraction of segment_size:  13.6
Ended extraction
range(10, 200)
starting extraction of segment_size:  13.7
Ended extraction
range(10, 200)
starting extraction of segment_size:  13.8
Ended extraction
range(10, 200)
starting extraction of segment_size:  13.9
Ended extraction
range(10, 200)
```

[16]:
```
plot_stuff(results_with_trees)
```





[17]:
```
results_with_trees['number_of_trees'] = results_with_trees['number_of_trees'] +␣
↪10
```

[18]:
```
results_with_trees.sort_values(by=['accuracy'],ascending=False , inplace=True)
results_with_trees.head(5)
```

[18]:
```
      number_of_trees  accuracy  precision    recall  cross_val_accuracy  \
9.2              73.0  0.970252   0.972477  0.970252            0.811899
12.1             93.0  0.968373   0.969834  0.968373            0.822249
12.2             99.0  0.966817   0.968278  0.966817            0.812574
8.8              71.0  0.963243   0.965330  0.963243            0.804206
8.9             171.0  0.962306   0.963374  0.962306            0.817187

      cross_val_precision  cross_val_recall
9.2              0.834658          0.811899
12.1             0.836513          0.822249
12.2             0.828898          0.812574
8.8              0.822045          0.804206
8.9              0.836683          0.817187
```

[19]:
```
results_with_trees.sort_values(by=['cross_val_accuracy'],ascending=False ,␣
↪inplace=True)
results_with_trees.head(5)
```

[19]:
```
      number_of_trees  accuracy  precision    recall  cross_val_accuracy  \
7.0             203.0  0.952673   0.953509  0.952673            0.827059
12.1             93.0  0.968373   0.969834  0.968373            0.822249
8.9             171.0  0.962306   0.963374  0.962306            0.817187
8.4             141.0  0.954974   0.956978  0.954974            0.817032
12.0             21.0  0.949025   0.954751  0.949025            0.816752

      cross_val_precision  cross_val_recall
7.0              0.843252          0.827059
12.1             0.836513          0.822249
8.9              0.836683          0.817187
8.4              0.834617          0.817032
12.0             0.841591          0.816752
```

It's better to look cross validatio score because it's better representation whaat model does when it's sees something it doesn't recognize. Looking at the results i decided that it's better to take 1 small, 1 medium and one large time segment with somedistance between them.

Seconds : number of trees

7.0 : 203

12.1 : 93

8.9 : 171

[ ]:
```
## Normal
```

[ ]:
```
score_columns = ['accuracy', 'precision', 'recall', 'cross_val_accuracy', 
 ↪'cross_val_precision',  'cross_val_recall']
results = pd.DataFrame(columns=score_columns)
segment_sizes = np.arange(1.0, 14.0, 0.1)

for segment_size in segment_sizes:
    results.loc[segment_size] = 
 ↪get_model_scores_on_segment_size(round(segment_size, 1))
```

[ ]:
```
plot_stuff(results)
```

[ ]:
```
results[results.cross_val_accuracy.max() == results.cross_val_accuracy]
```

[ ]:
```
results.sort_values(by=['accuracy'],ascending=False , inplace=True)
results.head()
```

[ ]:
```
results.sort_values(by=['cross_val_accuracy'],ascending=False , inplace=True)
results.head()
```

[ ]:
```

```