Examples

April 17, 2018

```
In [1]: %load_ext autoreload
        %autoreload 2
        %matplotlib inline
        from ipywidgets import FloatProgress
        from IPython.display import display

        import numpy as np
        import time

        from sklearn.ensemble import BaggingClassifier
        from sklearn.model_selection import cross_val_score
        from collections import defaultdict


        from pypf.tree import ShapeletTreeClassifier
        from sklearn.ensemble import BaggingClassifier

        from pypf._utils import print_tree

        from pypf.sliding_distance import matches, min_distance
        import matplotlib.pylab as plt
```

```
In [2]: def transform_shape(s, x, i, theta):
            x_match = x[i:(i + s.shape[0])]
            v = x_match - s
            norm_v = np.linalg.norm(v)
            if norm_v == 0:
                return s
            else:
                return s - v / norm_v * theta
```

```
In [3]: train = np.loadtxt("data/InsectWingbeatSound_TRAIN", delimiter=",")
        x = train[:, 1:]
        y = train[:, 0]

        test = np.loadtxt("data/InsectWingbeatSound_TEST", delimiter=",")
        x_test = test[:, 1:]
        y_test = test[:, 0]
        print(x.shape)
```

```
(220, 256)
```

```
In [4]: tmp = defaultdict(list)
        for i, label in enumerate(y):
            tmp[label].append(i)

        label_index = {label:np.array(arr) for label, arr in tmp.items()}
```

```
In [5]: tree = ShapeletTreeClassifier(n_shapelets=100, scale=False, min_shapelet_size=0, max_sh
        bag = BaggingClassifier(base_estimator=tree, random_state=10, n_estimators=100, n_jobs=
        bag.fit(x, y)
```

```
Out[5]: BaggingClassifier(base_estimator=ShapeletTreeClassifier(max_depth=2147483648, max_shape
                    min_samples_leaf=2, min_shapelet_size=0, n_shapelets=100,
                    random_state=<mtrand.RandomState object at 0x7f0f6f2fdca8>,
                    scale=False),
                 bootstrap=True, bootstrap_features=False, max_features=1.0,
                 max_samples=1.0, n_estimators=100, n_jobs=8, oob_score=False,
                 random_state=10, verbose=0, warm_start=False)
```

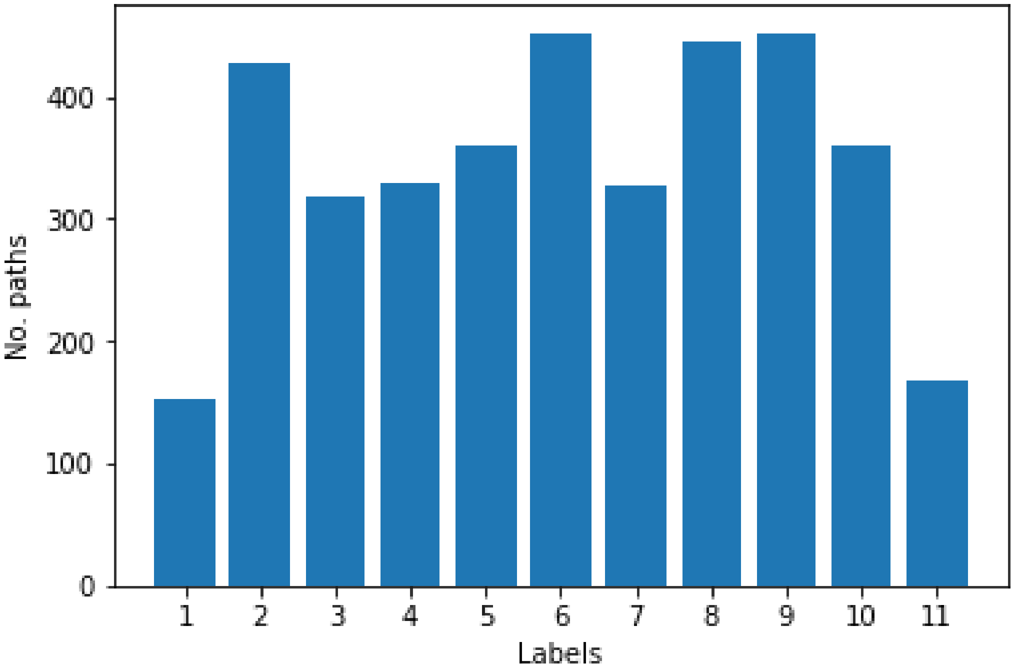
```
In [6]: bag.score(x_test, y_test)
```

```
Out[6]: 0.6196969696969697
```

```
In [7]: def extract_paths(node, d, classes_, path):
            if node.is_leaf:
                d[classes_[np.argmax(node.proba)]].append(path)
            else:
                left_path = path.copy()
                left_path.append(("<=", node.shapelet.array, node.threshold))
                extract_paths(node.left, d, classes_, left_path)

                right_path = path.copy()
                right_path.append((">", node.shapelet.array, node.threshold))
                extract_paths(node.right, d, classes_, right_path)
```

```
In [8]: paths = defaultdict(list)
        for base_estimator in bag.estimators_:
            extract_paths(base_estimator.root_node_, paths, bag.classes_, [])
```

```
In [9]: label, p_count = zip(*[(label, len(path)) for label, path in paths.items()])
        plt.bar(label, p_count)
        plt.xlabel("Labels")
        plt.xticks(label)
        plt.ylabel("No. paths")
        plt.show()
```



```
In [10]: def transform_with_path(x, path, epsilon=0.05):
             steps = []
             for direction, shapelet, threshold in path:
                 if direction == "<=":
                     distance, location = min_distance(shapelet, x, return_index=True)
                     if distance > threshold:
                         impute_shape = transform_shape(shapelet, x, location, threshold - eps
                         x[location:(location+len(shapelet))] = impute_shape
                         steps.append(x.copy())
                 else:
                     locations = matches(shapelet, x, threshold)
                     if len(locations) > 0:
                         for location in locations:
                             impute_shape = transform_shape(shapelet, x, location, threshold +
                             x[location:(location + len(shapelet))] = impute_shape
                             steps.append(x.copy())
             return x, steps
```

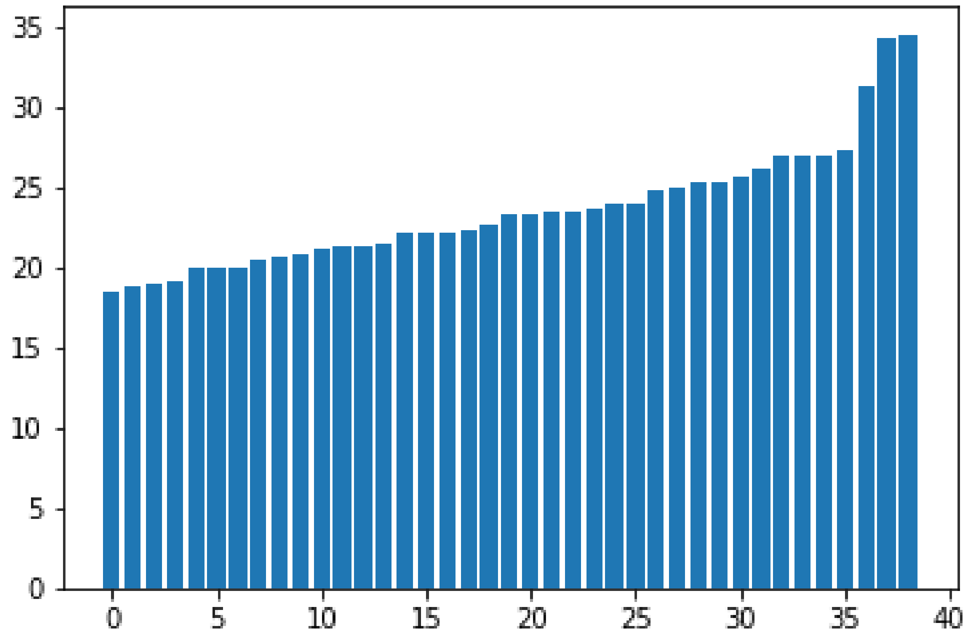
```
In [11]: to_label = 5
         from_label = 1
         example = label_index[from_label][-1]
         x_i = x[example, :]
         min_cost = np.inf
         min_i = -1
         x_prime = None
```

```
        print("Convert", example, "from", y[example], "to", to_label)
        path_list = paths[to_label]

        f = FloatProgress(min=0, max=len(path_list))
        display(f)
        x_prime = np.empty([len(path_list), x.shape[1]])
        step_prime = np.empty(len(path_list), dtype=object)
        for i, path in enumerate(path_list):
            x_i_prime, steps = transform_with_path(x_i.copy(), path, epsilon=0.05)
            x_prime[i, :] = x_i_prime
            step_prime[i] = steps
            f.value = i

        y_prime = bag.predict(x_prime)
        x_prime = x_prime[y_prime == to_label]
        step_prime = step_prime[y_prime == to_label]
        cost = np.linalg.norm(x_prime - x_i, axis=1)
        min_cost_i = np.argmin(cost)
        min_x = x_prime[min_cost_i, :]
        min_cost = cost[min_cost_i]
        if min_cost_i >= 0:
            print("Path", min_cost_i, "has lowest cost:", min_cost )
            plt.bar(np.arange(cost.shape[0]), np.sort(cost))
        else:
            print("No possible transformation")
```

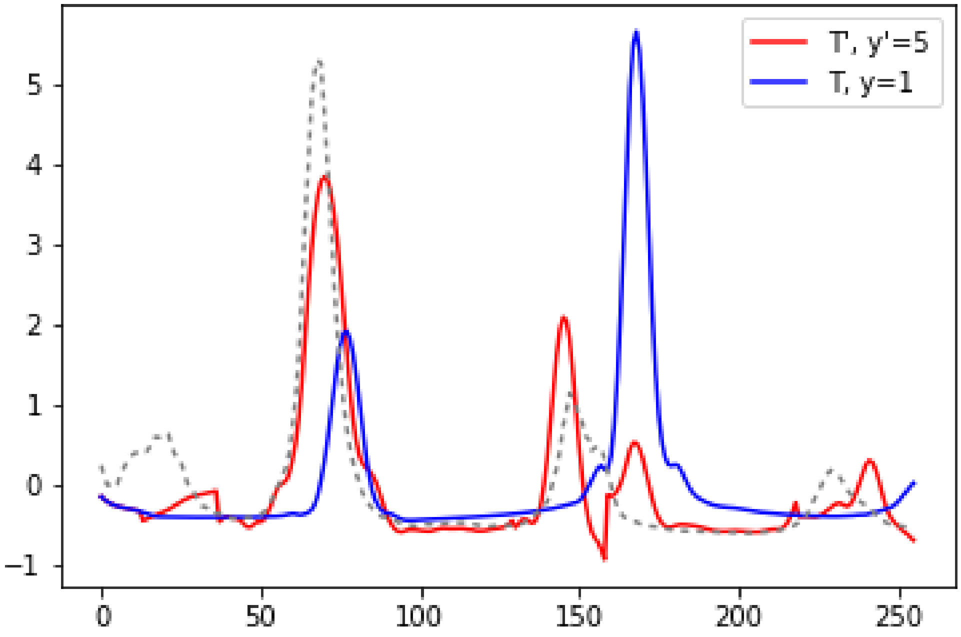
```
Convert 218 from 1.0 to 5
```

```
FloatProgress(value=0.0, max=360.0)
```

```
Path 26 has lowest cost: 18.514059436417767
```

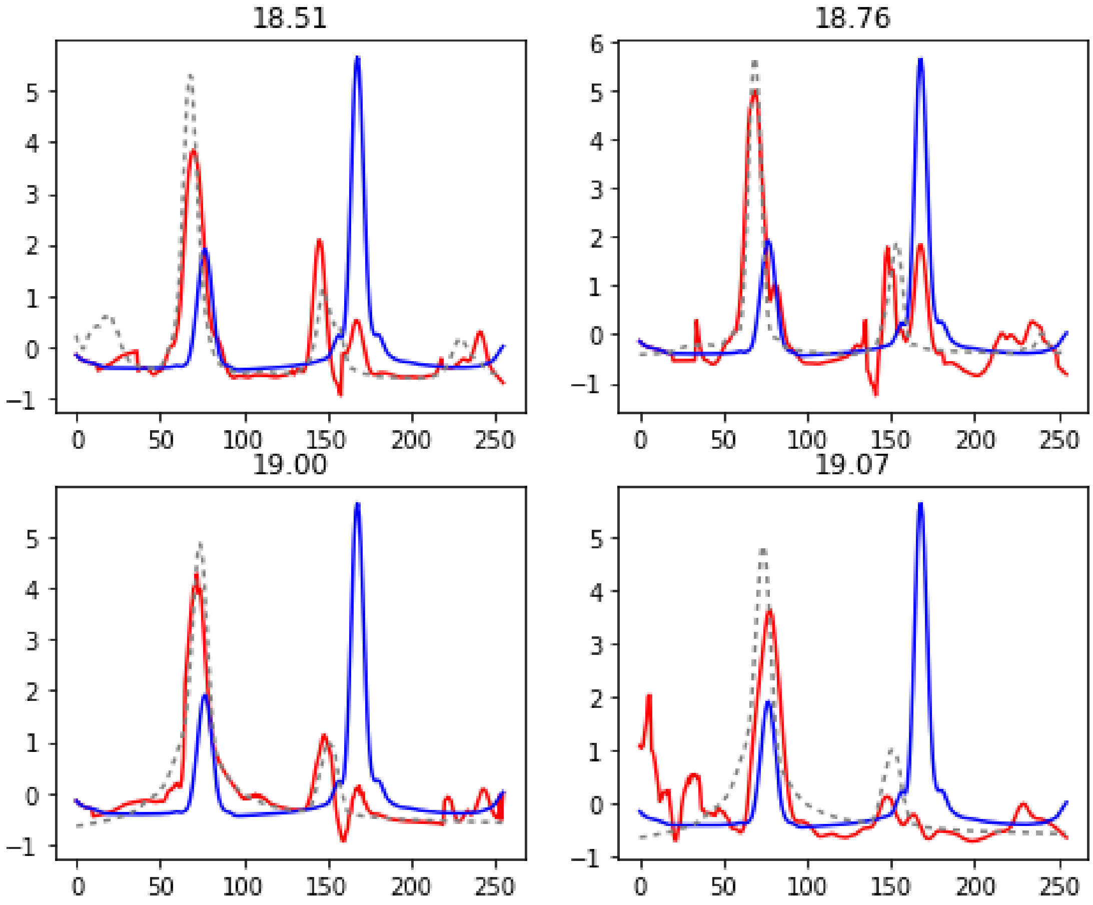


```
In [12]: from sklearn.neighbors import NearestNeighbors
         neigh = NearestNeighbors(1)
         neigh.fit(x[y == to_label])

Out[12]: NearestNeighbors(algorithm='auto', leaf_size=30, metric='minkowski',
                   metric_params=None, n_jobs=1, n_neighbors=1, p=2, radius=1.0)

In [13]: def plot_example(ax, x_i, min_x, closest):
             ax.plot(min_x, c="red", label="T', y'={}".format(to_label))
             ax.plot(x_i, c="blue", label="T, y={}".format(from_label))
             for i in range(closest.shape[1]):
                 ax.plot(x[y == to_label][closest[0, i]], c="gray", dashes=[2, 2])

         closest = neigh.kneighbors(min_x.reshape(1, -1), return_distance=False)
         fig, ax = plt.subplots(1)
         plot_example(ax, x_i, min_x, closest)
         plt.legend()
         plt.savefig("figure/example1.pdf")
```

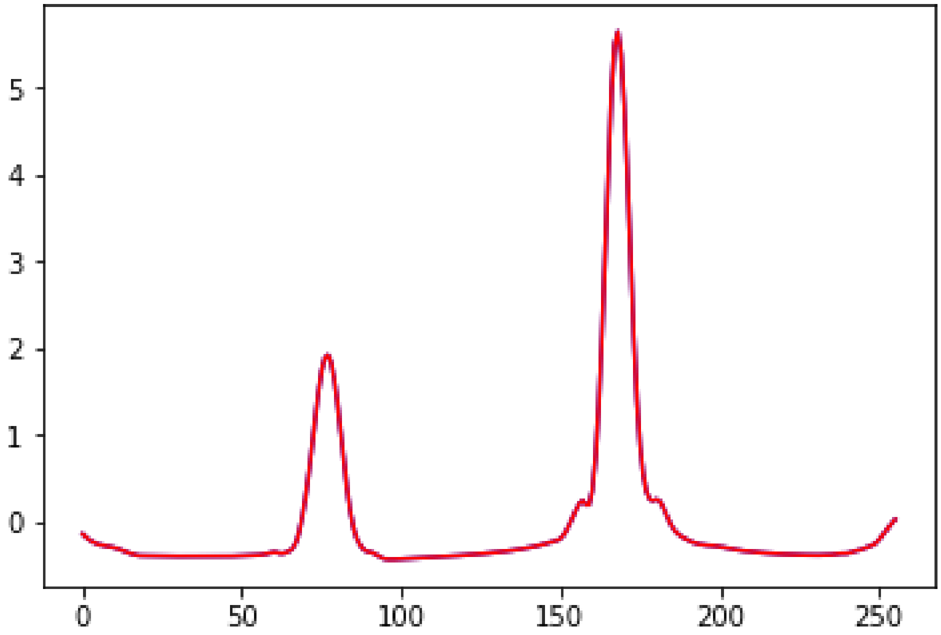


```
In [14]: cost_sort = np.argsort(cost)
```

```
In [15]: fig = plt.figure(figsize=(8, 6.5))
         ax = fig.subplots(2, 2)
         for i, a in enumerate(ax.reshape(-1)):
             x_cost_i = x_prime[cost_sort[i], :]
             closest = neigh.kneighbors(x_cost_i.reshape(1, -1), return_distance=False)
             plot_example(a, x_i, x_cost_i, closest)
             a.set_title("{:.2f}".format(cost[cost_sort[i]]))
         fig.savefig("figure/example2.pdf")
```



```
In [16]: steps = step_prime[cost_sort[0]]
         plt.figure()
         plt.plot(x_i, c="blue")
         plt.plot(x_i, c="red")
         for step in steps:
             plt.figure()
             plt.plot(x_i, c="blue")
             plt.ylim([np.min(x_i)-np.std(x_i), np.max(x_i)+np.std(x_i)])
             plt.plot(step, c="red")
```


5
4
3
2
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0
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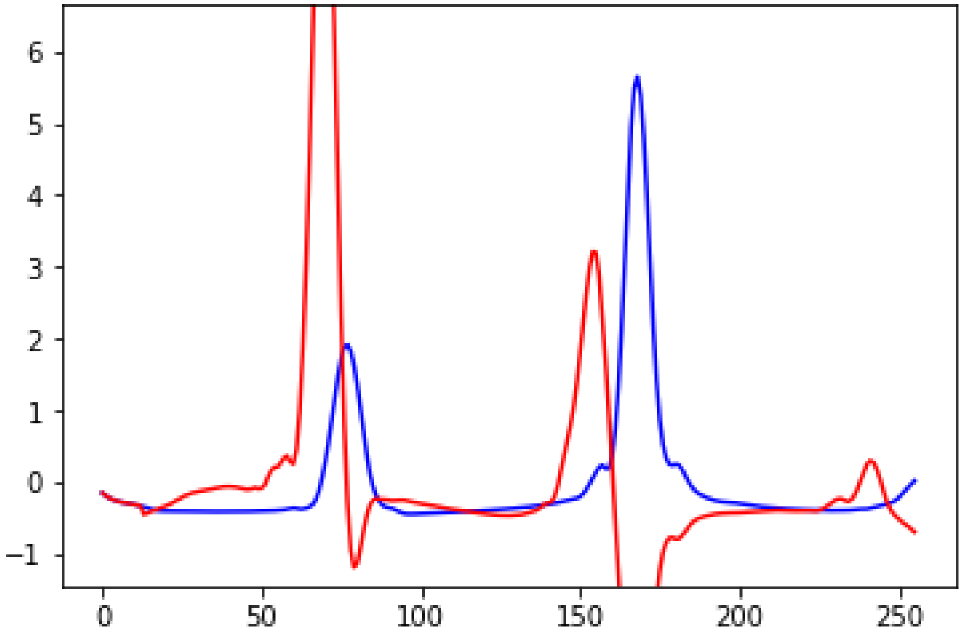
150
200
250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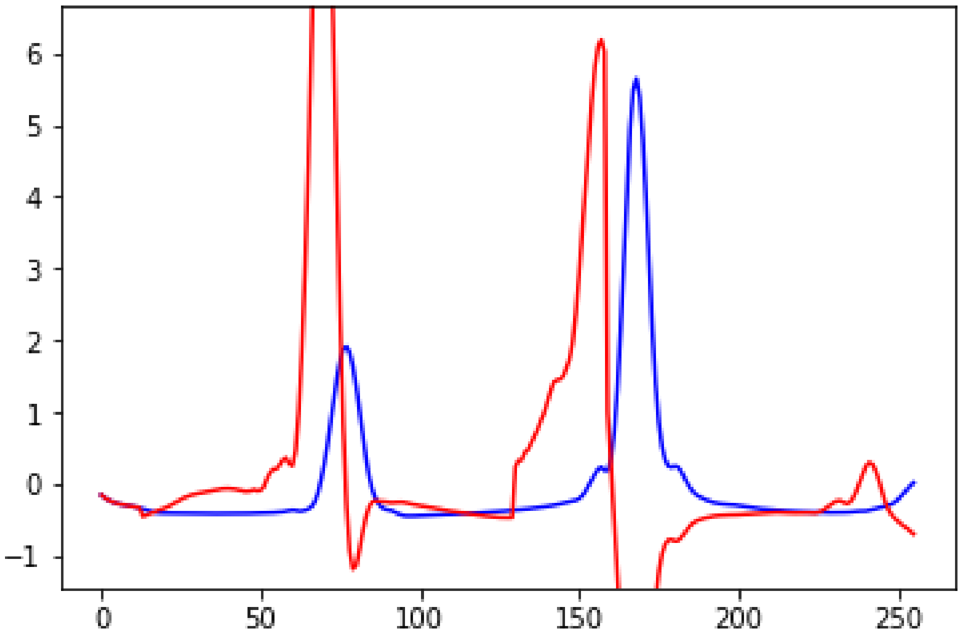
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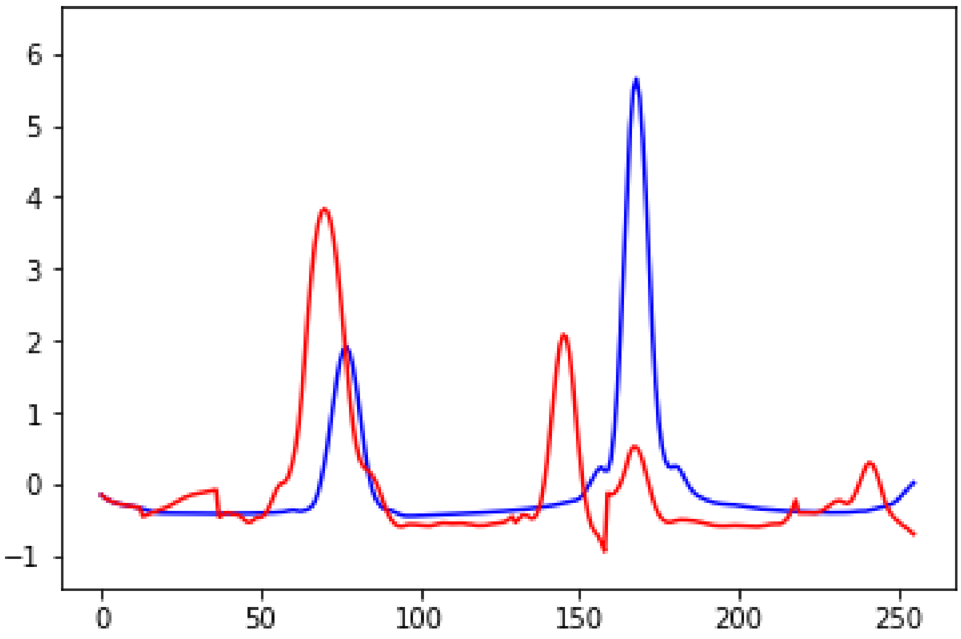
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