Input

Frame 1 — thumb: 0 1 2 | 3 | index: 4 5 6 | 7 | middle: 8 9 10 | 11 | ring: 12 13 14 | 15 | little: 16 17 18 | 19 | wrist/palm: 20 21 22

Frame 2 — thumb: 0 1 2 | 3 | index: 4 5 6 | 7 | middle: 8 9 10 | 11 | ring: 12 13 14 | 15 | little: 16 17 18 | 19 | wrist/palm: 20 21 22

Frame n — thumb: 0 1 2 | 3 | index: 4 5 6 | 7 | middle: 8 9 10 | 11 | ring: 12 13 14 | 15 | little: 16 17 18 | 19 | wrist/palm: 20 21 22

Dimensi--onality Reduction using PCA

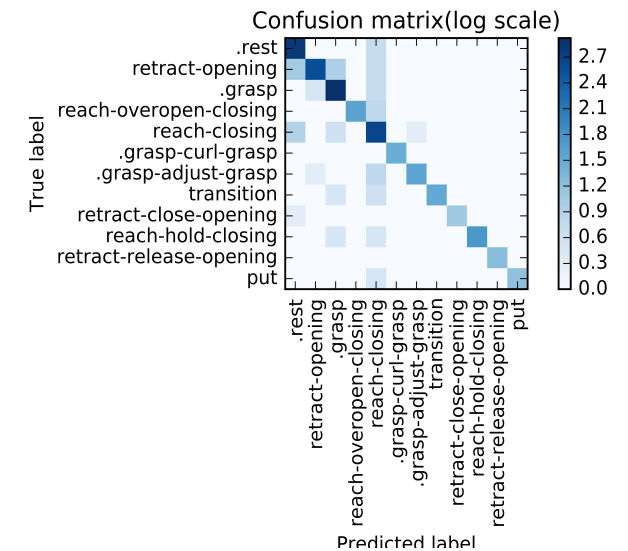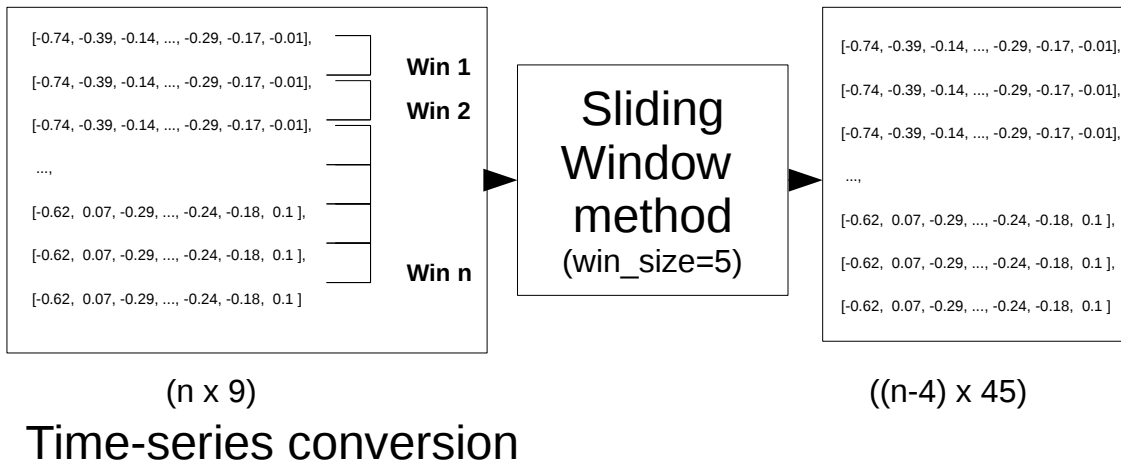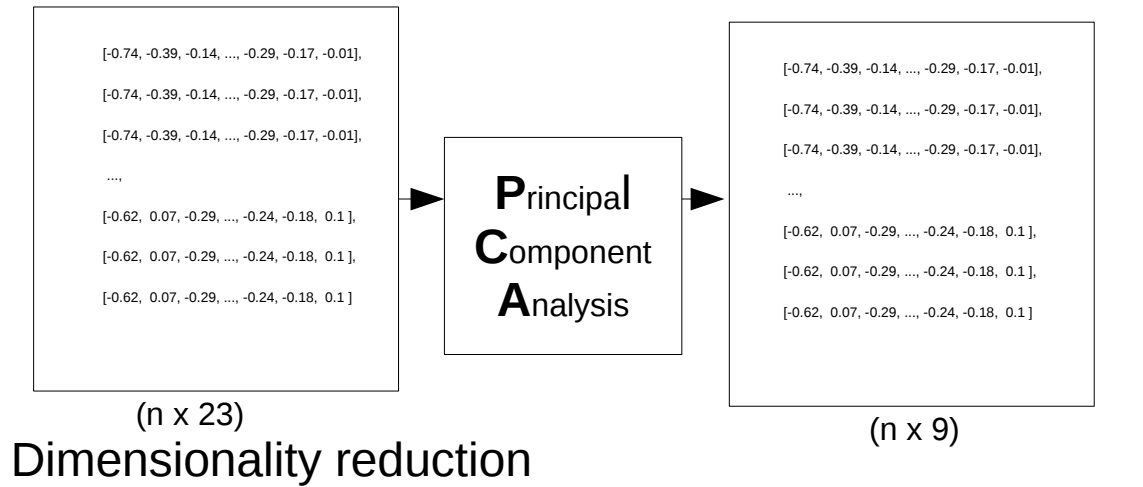Conversion to Time-series data

Classification using SVM

Output

Hand Motion Analysis.

This program finds the hand pose given joint angles of the hand.

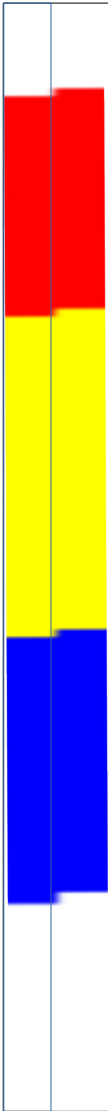**Legend (output - 12 grasp types)**

- .rest
- retract-opening
- .grasp
- reach-overopen-closing
- reach-closing
- .grasp-curl-grasp
- .grasp-adjust-grasp
- transition
- retract-close-opening
- reach-hold-closing
- retract-release-opening
- put

Dimensionality reduction

[-0.74, -0.39, -0.14, ..., -0.29, -0.17, -0.01],
[-0.74, -0.39, -0.14, ..., -0.29, -0.17, -0.01],
[-0.74, -0.39, -0.14, ..., -0.29, -0.17, -0.01],
...,
[-0.62, 0.07, -0.29, ..., -0.24, -0.18, 0.1],
[-0.62, 0.07, -0.29, ..., -0.24, -0.18, 0.1],
[-0.62, 0.07, -0.29, ..., -0.24, -0.18, 0.1]

(n x 23)

Principal **C**omponent **A**nalysis

[-0.74, -0.39, -0.14, ..., -0.29, -0.17, -0.01],
[-0.74, -0.39, -0.14, ..., -0.29, -0.17, -0.01],
[-0.74, -0.39, -0.14, ..., -0.29, -0.17, -0.01],
...,
[-0.62, 0.07, -0.29, ..., -0.24, -0.18, 0.1],
[-0.62, 0.07, -0.29, ..., -0.24, -0.18, 0.1],
[-0.62, 0.07, -0.29, ..., -0.24, -0.18, 0.1]

(n x 9)

Time-series conversion

[-0.74, -0.39, -0.14, ..., -0.29, -0.17, -0.01],
[-0.74, -0.39, -0.14, ..., -0.29, -0.17, -0.01],
[-0.74, -0.39, -0.14, ..., -0.29, -0.17, -0.01],
...,
[-0.62, 0.07, -0.29, ..., -0.24, -0.18, 0.1],
[-0.62, 0.07, -0.29, ..., -0.24, -0.18, 0.1],
[-0.62, 0.07, -0.29, ..., -0.24, -0.18, 0.1]

Win 1
Win 2
Win n

Sliding Window method (win_size=5)

[-0.74, -0.39, -0.14, ..., -0.29, -0.17, -0.01],
[-0.74, -0.39, -0.14, ..., -0.29, -0.17, -0.01],
[-0.74, -0.39, -0.14, ..., -0.29, -0.17, -0.01],
...,
[-0.62, 0.07, -0.29, ..., -0.24, -0.18, 0.1],
[-0.62, 0.07, -0.29, ..., -0.24, -0.18, 0.1],
[-0.62, 0.07, -0.29, ..., -0.24, -0.18, 0.1]

(n x 9)

((n-4) x 45)

Hand motion analysis explained in detail

Confusion matrix(log scale)

Classification using **S**upport **V**ector **M**achine

- **Python library**: sklearn.svm.SVC
- Parameters: kernel: RBF (degree 3)
- **Accuracy: 98.09 %**(with PCA) win_size=5

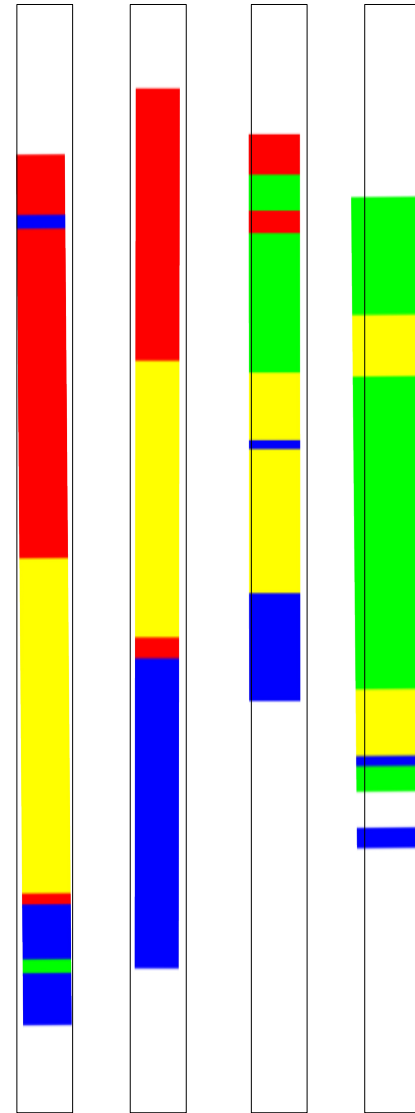Testing on training data shows the wrongly classified data is usually when there is transition from one grasp type to another grasp type.

(1) (2)
(1) Testing on training data
(2) Testing on left out data

Analysis of output

Results on testing data show small patches of "misclassified" grasp types.

3