Multidisciplinary Modules on Sensors and Machine Learning

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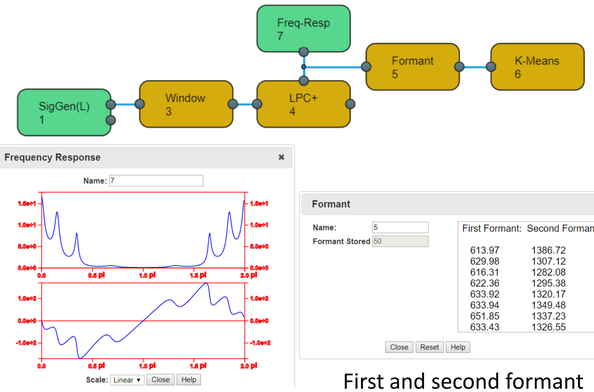
MOTIVATION

- Integrating sensing and machine learning in Internet of Things (IoT) and mobile applications .
- Create modules with online web-based laboratories for training undergraduate students in sensors and machine learning.
- Create modules to help students with visualizing and understanding the inner workings of various machine learning algorithms .
- Microphone sensors were used for acquiring speech signals.

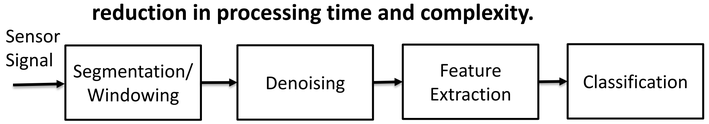


LPC spectral for a frame phoneme 'α' speech signal.

First and second formant frequencies stored within formant block and JDSP-HTML5

FEATURE EXTRACTION FROM SENSORS

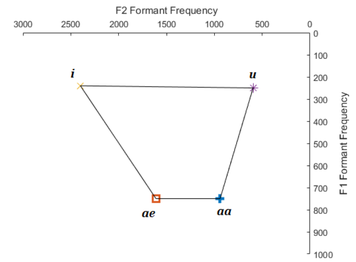
- Acquiring signal data from the sensors.
- Perform pre-processing such as filtering and denoising.
- Reduced dimension of extracted features ensures a great reduction in processing time and complexity.



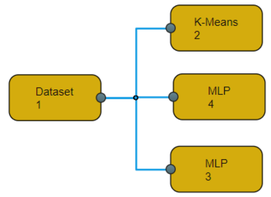
Basic Signal Processing Framework describing feature extraction and classification

FORMANT EXTRACTION FROM SPEECH

- Extract formant frequencies F1 and F2 for four different vowels, namely: */i/, / u/, aa,* and *ae using Linear Predictive Coding.*



Vowel chart showing four different vowels: aa, ae, i, and u.

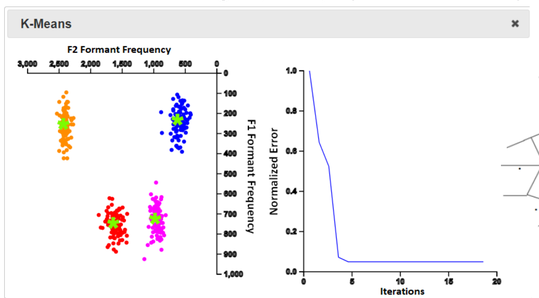


Block diagram for K-means, SVM and Multilayer Perceptron in JDSP-HTML5

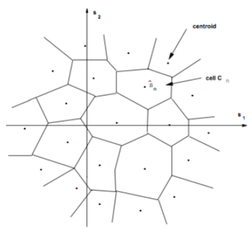
MACHINE LEARNING ALGORITHMS

K-Means

- Euclidean distance is used as a metric and variance is used as a measure of cluster scatter.
- Feature learning in (semi-)supervised or unsupervised training.



K-means algorithm implemented on formant data in JDSP-HTML5



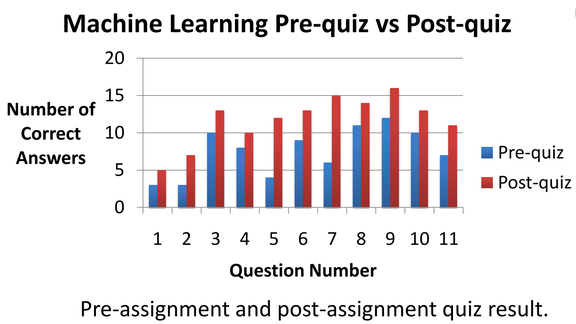
Voronoi Diagram

Support Vector Machine For Classification

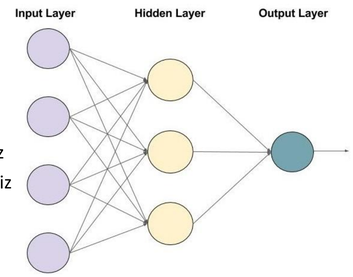
- SVM provides a hyperplane or a boundary of separation which separates positive examples from negative samples.
- Accuracy is much higher compared to other classification algorithms like k-NN or logistic regression.

ASSESSMENT AND EVALUATION

- Pre-assignment quiz based on the K-means algorithm and clustering exercise was given to undergraduate and graduate students.
- Simple multiple-choice questions and True or False based questions were asked .
- Assessment questions related to K-means clustering scheme and mean square error curves were posed.
- A post-quiz was also given to the same class after completion of the exercise.



Pre-assignment and post-assignment quiz result.



Artificial Neural Network with a hidden layers.

- We have seen improvements in some of the questions, particularly those associated with feature extraction
- The basic clustering process seems to have been understood reasonably well before the post quiz, and hence some scores did not have significant difference

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JDSP-HTML5 can be accessed at jdsp.asu.edu
Use this code to visit the link with our work.