Recognizing Head and Shoulders Pattern in Time Series Data Using Self-Organizing Maps

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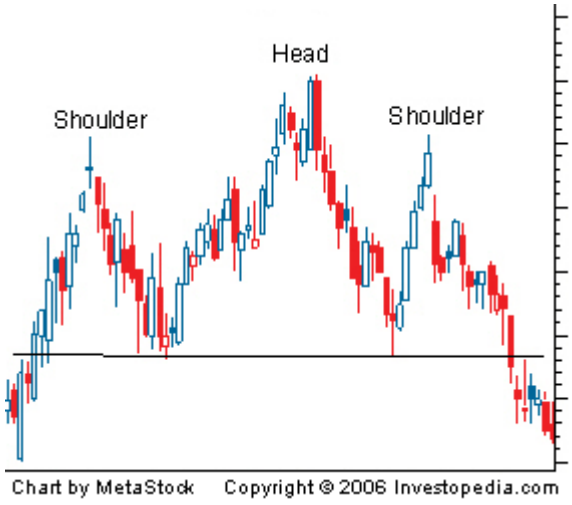
MOTIVATION



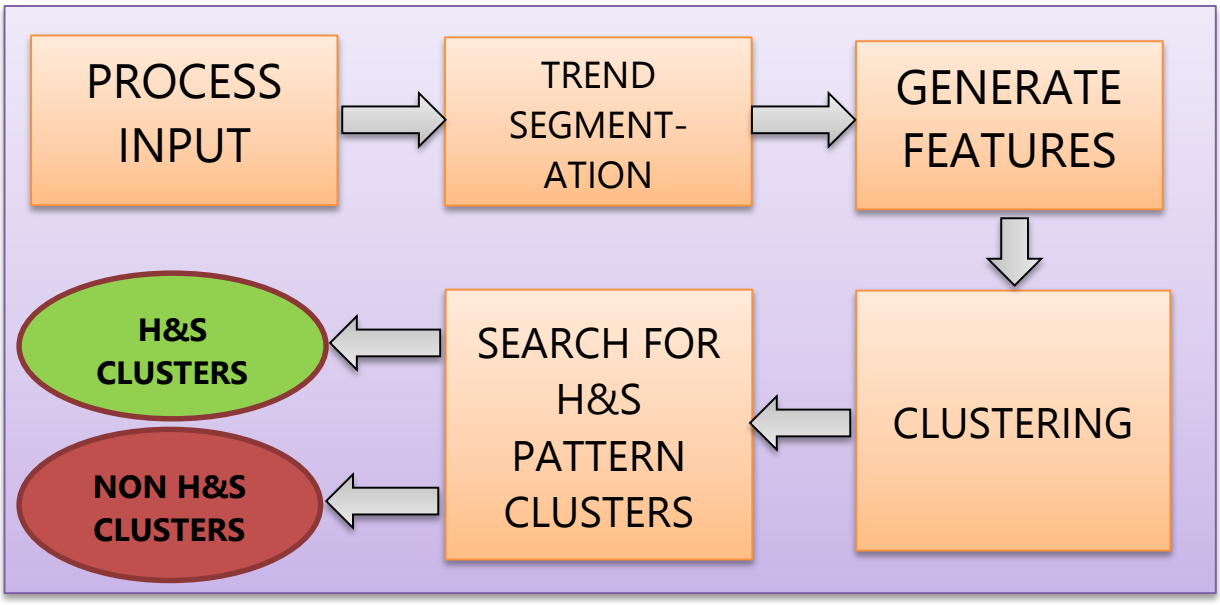
The Head and Shoulders (H&S) Pattern is a commonly occurring, highly reliable pattern in stock and futures markets indicating **price reversal**. A bullish (upward) stock trend will become bearish (downward) after an H&S pattern and vice-versa. If we are able to automatically detect H&S patterns, financial traders can make better informed decisions, thereby **increasing profits** and **decreasing losses.**

As our data is unlabeled, we use ***unsupervised learning*** [Self-Organizing Maps (SOM)] to detect patterns.

OBJECTIVE

- To experiment and identify the best SOM for H&S pattern recognition by f-measure accuracy.

DESIGN



Modular View of the System

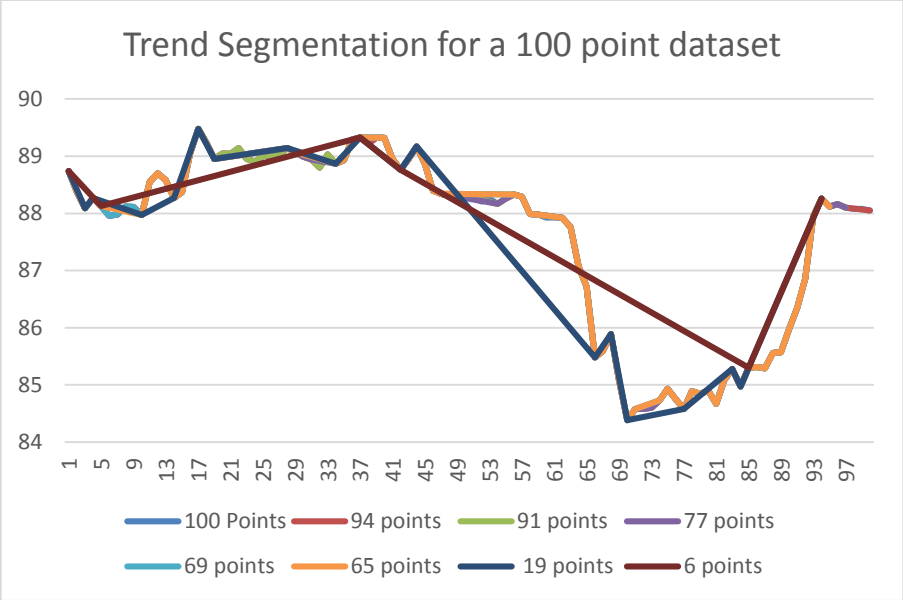
- We use a five-module system to recognize top and bottom H&S patterns in time series data.
- We use a sliding window approach with window size = 7 price points.
- We determine the SOM cluster size by trial-and-error.

IMPLEMENTATION

Our dataset contains 10,000 price-points from crude oil futures.

TREND SEGMENTATION AND MERGING

We use trend segmentation to represent the data using reduced number of points (8000, 6000, 4000, 2000, 1000, 500, 250 points). We achieve this by merging similar-trending adjacent segments and ignoring minor fluctuations. By adjusting the average segment length, this technique allows us to capture even long-range H&S patterns using a fixed window size.



FEATURES

We use six features to represent each sample of seven price points. The the features and price points are named *f1->f6* and *y1->y7* respectively.

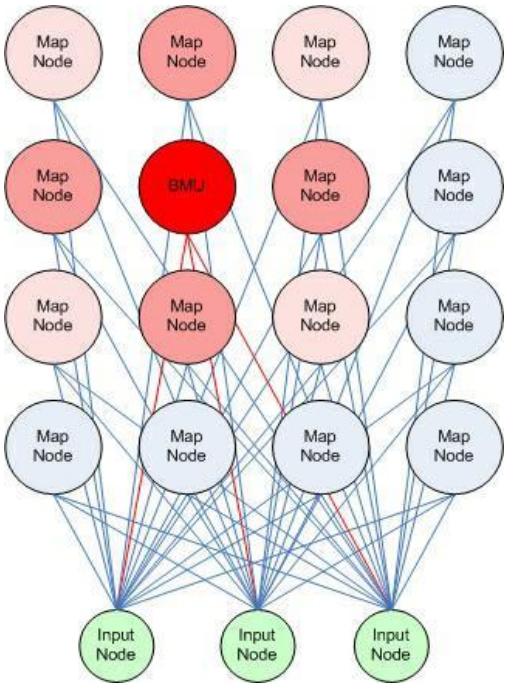
$f1 = y2 - y1$ and $f(i) = [y(i+1) - y(i)]/[y(i) - y(i-1)]$ for i = 2,3,4,5,6.

If the sign of *f2 –>f6* is positive, it means that the trend (increasing/decreasing) in the previous segment continues. If it is negative, the trend reverses with respect to the previous segment.

CLUSTERING

We use a Self-Organizing Map with randomly initialized weights to cluster the input data. A SOM is an artificial neural network that maps inputs from a high-dimensional input space to a low-dimensional map

space. In a SOM, neurons compete to win input samples. Only one neuron can win a sample. Upon winning, the weights of the neuron and its neighbors are modified to more resemble the input sample. Over multiple training epochs, the neurons weights adjust themselves such that between them, they can represent the entire input spectrum and similar samples are grouped together. We survey square-shaped SOMs with row size ranging from 10 to 18.



SEARCH FOR H&S CLUSTERS

Once the weights of the neurons have stabilized, the system searches for H&S clusters. The search condition is derived from the structure of the H&S pattern. The system searches for weights that match the template **[+/-A, -B, -C, -D, -E, -F]** where A->F are $\boldsymbol{R}^{+}$, C > 1, 0 < E < 1. Due to the similarity-grouping characteristic of SOM, the system predicts all samples in the matched clusters to be H&S patterns.

RESULTS

		SAMPLE SIZE				
		245	***495***	***995***	***1495***	***1995***
Probability of detecting H&S pattern	***Random Guessing***	0.06	0.03	0.04	0.03	0.03
	SOM	0.36	0.45	0.52	0.23	0.4

The SOM of dimensions **16 x 16** was the best-performing SOM with highest, lowest and mean accuracies of 52%, 23% and 39.2%. The accuracy of the SOM technique (unsupervised) was consistently higher than that of random guessing – despite both methods having the same amount of knowledge about the input. This accuracy can be improved by better clustering, more trials and modified learning parameters.