Vector Plots
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A new method of projecting multi-dimensional data onto a 2-D graph, inspired by Johnson (see References below), is called a *vector plot*. For data with D dimensions or features, D unit vectors are generated at the origin with an angle between each of 180/D degrees. See Figure 1a for a 4-dimensional case. For each example $\boldsymbol{x}$, the length of each vector is multiplied by the corresponding component of $\boldsymbol{x}$, as shown in Figure 1b for $\boldsymbol{x}$ = [1 2 -3 4]. These vectors are then summed together to create the final (x_{vp},y_{vp}) point in the vector plot.

Mathematically, for each example $\boldsymbol{x}$, the corresponding point (x_{vp},y_{vp}) on the vector plot is :

$$x_{vp} = \sum \boldsymbol{x}_i \cdot \cos [180(i-1) / D]$$
$$y_{vp} = \sum \boldsymbol{x}_i \cdot \sin [180(i-1) / D]$$

Where the summations are over i=1..D

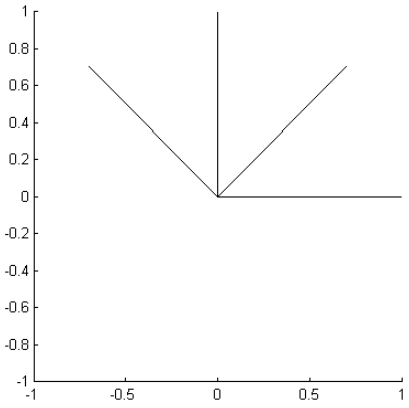

Figure 1a

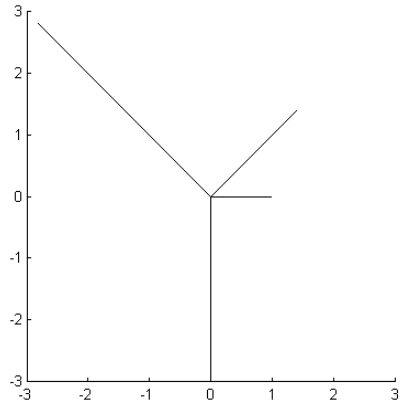

Figure 1b

Vector plots have many desirable properties. The first is that vector plots make no assumptions about the distribution of the data (for example, that it must be Gaussian). Second, for D=2, the resulting plot is identical to the regular plot of the data. Another is that some of the geometry of the original data is preserved, as shown in Figure 2 for a three dimensional spiral. Finally, vector plots have no problems with datasets that have small sample ratios (or "SR", the ratio of the number of examples per class to the number of features per example), since they are transforming the examples without regard to any of their statistics.

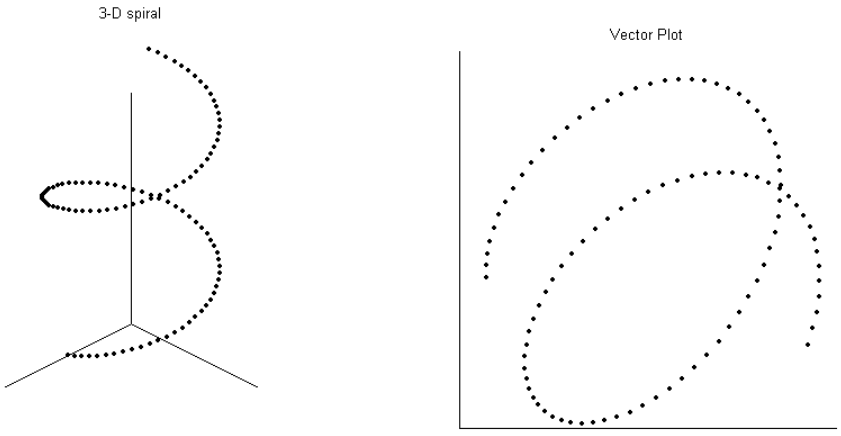

Figure 2

The best two PC's for each class of the 4-dimensional UCI Iris data are shown in Figure 3, and the projection onto the best two LDA directions is shown in Figure 4, while the vector plot for is shown in Figure 5. Comparison with Figures 3 and 4 shows that the overall structure of the data has been retained.

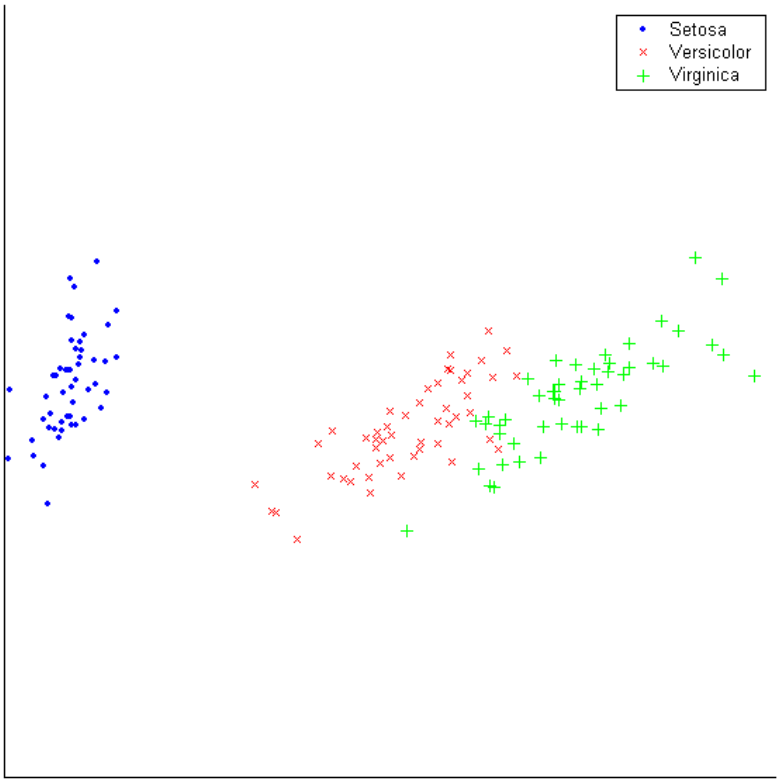

Figure 3 – PCA plot

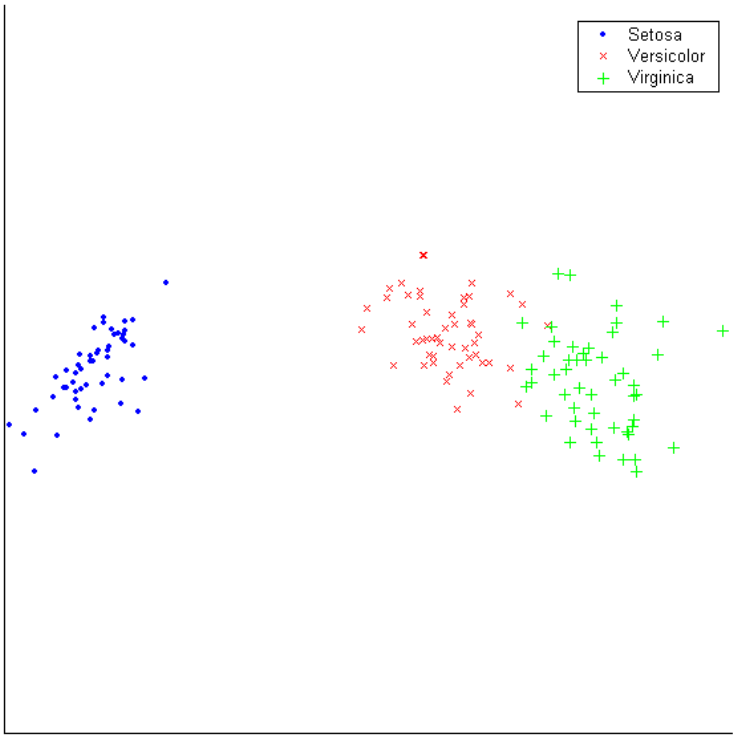

Figure 4 – LDA plot

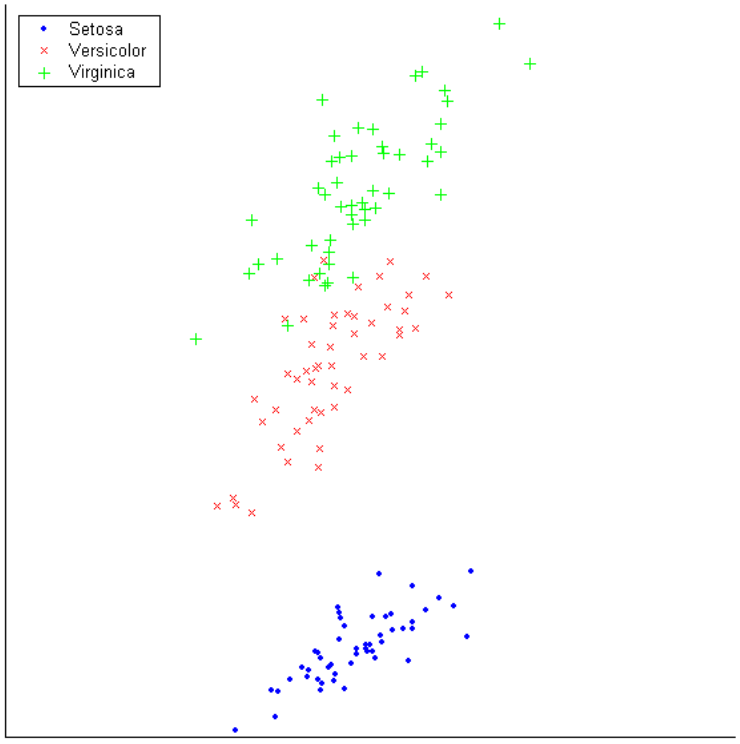

Figure 5 – Vector Plot

References :
Johnson, R.R., “Visualization of Multi-Dimensional Data with Vector-Fusion”, Proceedings of the IEEE Conference on Visualization, Salt Lake City, 2000.