This document is intended for notes on the strategies we are developing.

1 Numerical Data Techniques

1.1 DMD

1.2 PCA

1.3 Approximate Difference Scheme (ADS)

Consider a time series $f_j = f(t_j)$ for uniformly spaced grid, $t_j = j\Delta t + t_0$, $j = 0, \ldots, N_t$. We wish to obtain f_j for $j > N_t$. We suppose that the time series approximately obeys the difference equation:

$$a_0 f_j + a_1 f_{j-1} + ... + a_M f_{j-M} \approx 0, \quad j = M, \ldots, N_t. \tag{1}$$

Let $\mathbf{f}_j = [f_j, f_{j-1}, \ldots, f_{j-M}]$, then we want to find a vector $\mathbf{a}$ approximately orthogonal to $\mathbf{f}_j$ for $j = M, \ldots, N_t$. Combine into a matrix equation

$$\mathbf{F}\mathbf{a} = [\mathbf{f}_M, \mathbf{f}_{M+1}, \ldots \mathbf{f}_{N_t}]\mathbf{a} \approx 0. \tag{2}$$

Take the SVD of $\mathbf{F}$,

$$\mathbf{F} = \mathbf{U}\mathbf{\Sigma}\mathbf{V}^*. \tag{3}$$

Since

$$\mathbf{F}\mathbf{v}_i = \sigma_i \mathbf{u}_i, \tag{4}$$

the vector that is most closely in the null space of $\mathbf{F}$ is the last column of $\mathbf{V}$, which corresponds to the smallest singular value. The smaller the singular value, the better the approximation is. In a scenario like the stock market, we will know a piece of information for each day and may want to predict what will happen to the information during the next day. Let $\hat{f}$ be the predicted values. The prediction for the next day, $j = N_t + 1$, is given by

$$\hat{f}_j = -\frac{1}{a_0} \sum_{i=1}^{M} a_i f_{j-i}. \tag{5}$$

See `approximateDifferenceSchemeTest.m`.

2 Stock Price Prediction Techniques

2.1 Smooth-Extrapolate-Unsmooth (SEUS)

1. Stock data is very noisy, first smooth the data so our algorithms will work better. For example use a trailing average

$$\tilde{f}_j^M = \frac{1}{M} \sum_{i=0}^{M-1} f_{j-i}, \tag{6}$$

where $\tilde{f}$ is the smoothed variable.

2. Use a predictive algorithm to extrapolate $\tilde{f}_{j+1}$ (ADS).

3. If possible, find f_{j+1} given $\tilde{f}_{j+1}$. One quantity of interest is the predicted percent increase, given by

$$\hat{p}_{j+1} = \frac{\hat{f}_{j+1} - f_j}{f_j} \tag{7}$$

See `analyzeStock.m`

3 Validation Metrics

3.1 Win Loss Ratio

The win-loss ratio is calculated by

$$w/l = \left(\sum_{j,\ p_j > 0} p_j \right) \Big/ \left(\sum_{j,\ p_j < 0} p_j \right). \tag{8}$$

This is for the simplified scenario where the investor sells the day after a buy and buys the same principle amount each time. If the win loss ratio is 2, then the investor looses a dollar on every 2 dollars of profit. The higher the win-loss ratio, the more confident the investor will be in the strategy. For stocks that are held for a long time, a typical win-loss ratio may be around 1.5 due to high volatility.