Linear Dynamical Systems for Price Prediction

Inaugural UCL Algorithmic Trading Conference

June 11, 2010

UCL

Chris Bracegirdle

PhD Financial Computing Department of Computer Science

Overview

- > Linear Dynamical Systems
- > Inference & Learning
- > Future Work

Linear Dynamical Systems

- Generative model for time-series
- > 'Hidden Markov Models with continuous variables'
- > Trained model permits price prediction
- > Interesting variations
 - Switching systems (Markov regime-switching)
 - Resetting systems (changepoint models)
 - Autoregressive variations

Linear Dynamical Systems

> Gaussian Resetting Autoregressive LDS



with dynamics $v_t = \hat{\mathbf{v}}_{t-1}^{\top} \mathbf{a}_t + \epsilon_v^{c_t}$, where

$$\hat{\mathbf{v}}_{t-1} = \begin{pmatrix} v_{t-1} \\ \vdots \\ v_{t-n} \end{pmatrix}, \quad \mathbf{a}_t = \begin{cases} A \mathbf{a}_{t-1} + \epsilon_a^0 & c_t = 0 \\ \epsilon_a^1 & c_t = 1 \end{cases}$$

Inference & Learning

- > Classical inference problems
 - Filtering (inferring the present)
 - Smoothing (inferring the past)
 - Prediction (inferring the future)

$$p(h_t | v_{1:t}) \\ p(h_t | v_{1:T}) \\ p(h_{t+1} | v_{1:t})$$

- > For Resetting LDS, inference is tractable
- Expectation Maximisation increases likelihood by learning parameter values iteratively

Example Data – Generated

1.20

1.15

1.10

1.05

1.00

0.95

0.90



Example Data – Crude Oil Futures

















Future Work

- > Approximate inference to improve speed
- Resetting systems with multiple underlying generating systems (Reset-HMM)
- > Decision engine for trading strategies