Overview of Time Series

and

Prediction

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Time Series – Emphasis on Financial Time Series

-Ref. Financial Time Series, Ruey S Tsay, Wiley

-Skim Ch 1, 2, 3 and pick out some topics to emphasize.

What is a time series?

http://en.wikipedia.org/wiki/Time_series

-Need some sort of structure beyond arbitrary real number for every point in time.

    -Continuity

    -Markov Property

    -Probabilistic Structure

-Random walk example

-Modeling – capable of generating "similar" series.

Properties of Time Series

-Stationarity – Statistical properties don't vary with time.

    -Is random walk stationary?

-Autocorrelation –

    http://en.wikipedia.org/wiki/Autocorrelation

    -look at some examples

Prediction

-Linear Models

-Moving Average Model (MA) - http://en.wikipedia.org/wiki/Moving_average_model

-Auto Regressive Model (AR) - http://en.wikipedia.org/wiki/Autoregressive_model

-run example

-Auto Regressive Moving Average Model (ARMA) - http://en.wikipedia.org/wiki/Autoregressive%E2%80%93moving-average_model

Unit Root Tests

-Time series like GDP or DJIA are non-stationary just like Brownian motion is non-stationary.

-Dickey Fuller test to determine if process acts like Brownian motion. – Unit Root Test

-http://en.wikipedia.org/wiki/Dickey%E2%80%93Fuller_test

-example

-Co-integration

-Two processes that both have unit roots

-there's a linear combination of them that doesn't have unit root

-example GDP and housing starts.

-drunk and dog example

-used in pairs or basket trading.

Predicting Volatility – ARCH and GARCH models

-Securities volatility is more predictable (or more persistent) than securities prices.

-What is volatility

-Black Scholes version of volatility – model for securities price fluctuations

dS/S = u dt + v(t) dB

-(See Mark Joshi's book "Concepts and Practice of Mathematical Finance) for the rest of the derivation of BS eqn.

-Limiting case of Sd(i) (discrete values of securities price spaced Dt apart) (Sd(i) = S(i*Dt))

(Sd(i) – Sd(i-1)) / Sd(i-1) = u Dt + v(i*Dt) * W(i)/$\sqrt{Dt}$

(W is a unit variance Gaussian random sequence)

In this framework, the volatility of a security is the magnitude of the variance term v(t) in the BS eqn.

Other Time Series Approaches

-Gauss Markov models for linear vector difference (or differential) eqns

    -Kalman Filter, Luenberger Observer

-Fractal-based models

    -Singular Spectrum Analysis et. al.