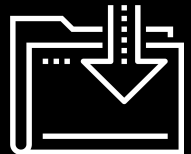


Time Series Statistical Models

FinTech
Lesson 10.2



Class objectives

By the end of today's class you will understand:



Stationary vs Non-stationary data



Augmented Dickey-Fuller Test



Autoregressive Moving Average Model (ARMA)



AutoRegressive Integrated Moving Average (ARIMA)

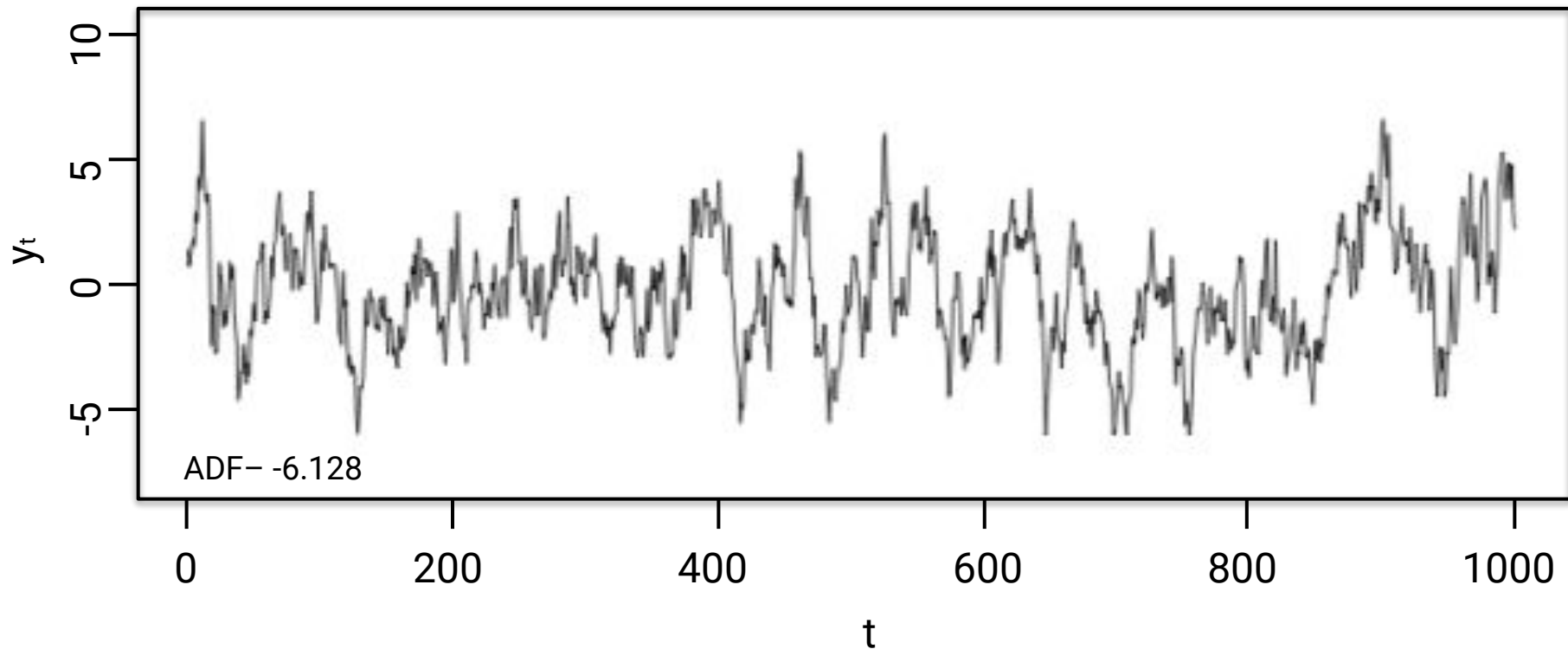


Generalized Autoregressive Conditional Heteroskedasticity (GARCH)

Stationarity

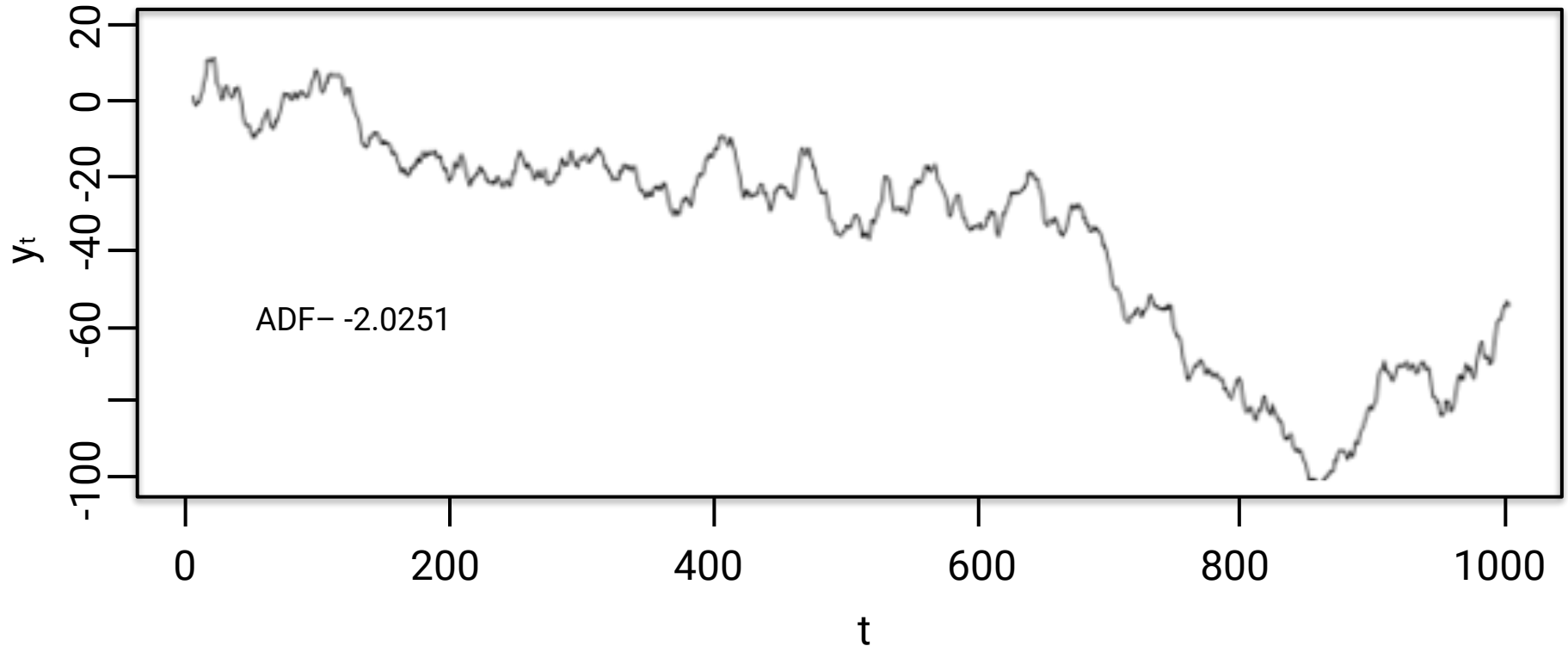
Stationarity

In a stationary process, the mean and variance are constant across time.



Non-stationary

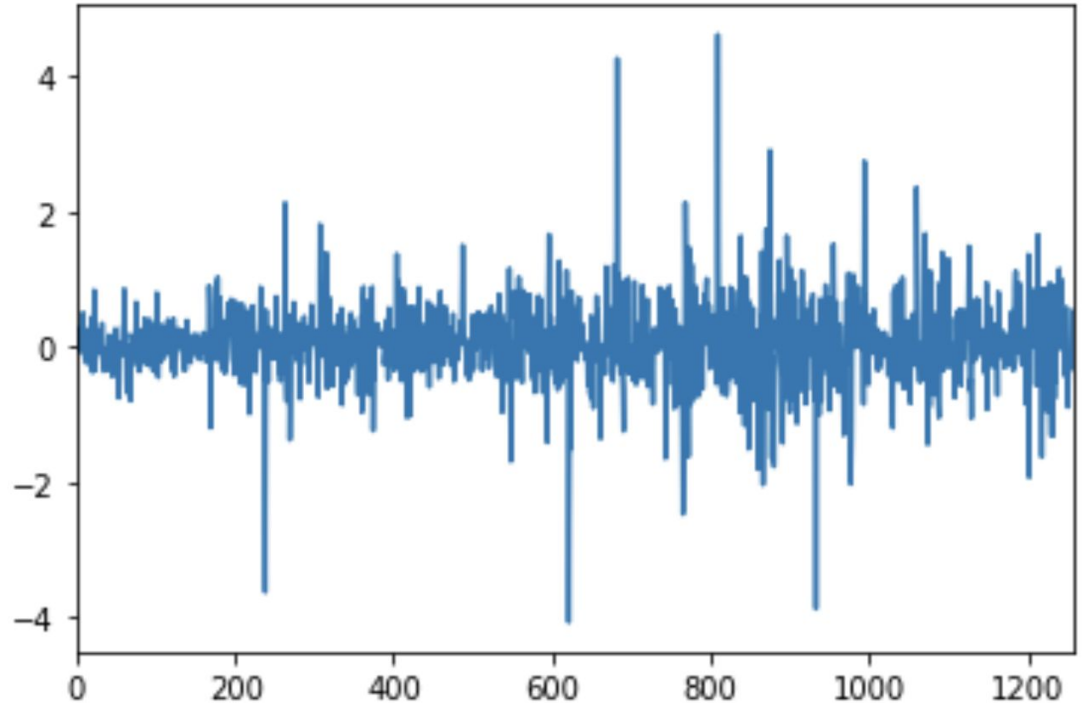
A time series with an upward or downward trend is **not stationary**.



Stationarity

Important in selecting a time series model.
Makes data easier to model.

There are strategies to transform a non-stationary time series into a stationary one.





ARMA

Auto-Regressive Model

$$y_t = \mu + a_1 y_{t-1} + \epsilon_t$$

Auto-Regressive (AR) Models

01

Past values are used to predict future values.

02

Therefore assumes some degree of auto-correlation.

03

An AR model may have one significant lag, or it may have multiple.

Second-order AR model

$$y_t = \mu + a_1 y_{t-1} + a_2 y_{t-2} + \epsilon_t$$

AR Model Summary

An AR model predicts future values based on:

01

Past values at a specified lag.

02

The number of significant lags.

Moving Average Model

$$y_t = m\epsilon_{t-1} + \epsilon_t$$



Past **errors** (plus current error) are used to predict future values.



ARIMA

ARIMA Model

$$y_t = \mu + a_1 y_{t-1} + a_2 y_{t-2} + m \epsilon_{t-1} + \epsilon_t$$



Combines features of AR and MA models.



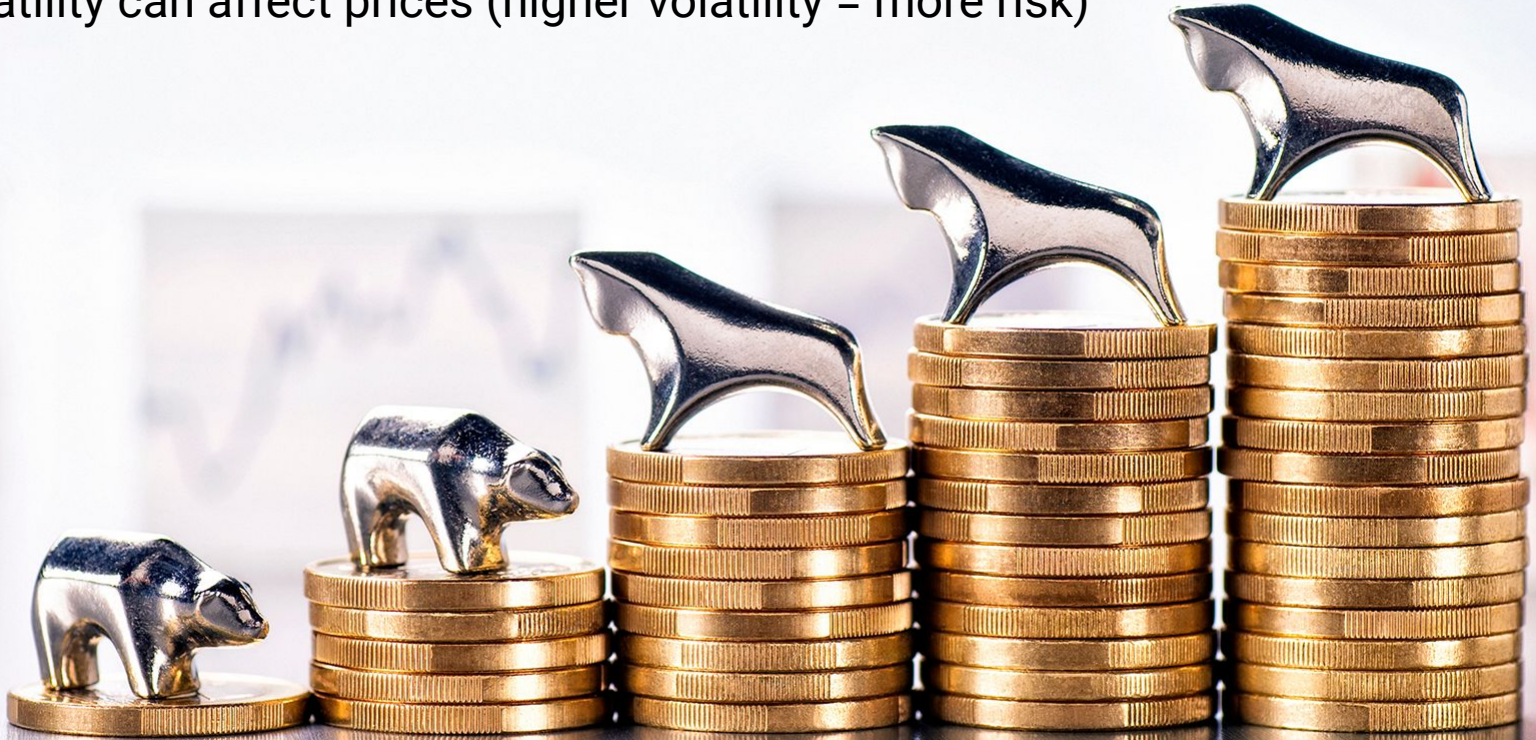
Past values and errors are used to predict future values.



Why is Volatility Important to Understand?

Higher volatility = More Risk

High volatility can affect prices (higher volatility = more risk)



Diversified Portfolio


By understanding volatility of individual assets (stocks bonds etc), a more diversified portfolio can be constructed



Derivatives

Some assets are particularly sensitive to volatility, e.g. derivatives.



The background of the image is a blurred financial chart. It features a grid with various data points and lines. A hand is visible, holding a pen and pointing at a smartphone screen. The chart includes several numerical values, some positive and some negative, representing financial data. A dark blue circle is overlaid on the left side of the image, containing white text.

Volatility
can beget
volatility,
i.e. cluster.

AIC & BIC



Akaike Information Criterion, Bayesian Information Criterion.



Assess how well a model fits the data (goodness of fit), and complexity.



Higher-order models are penalized for complexity.



Lower scores are better.



GARCH

ARMA

Auto-Regressive component:

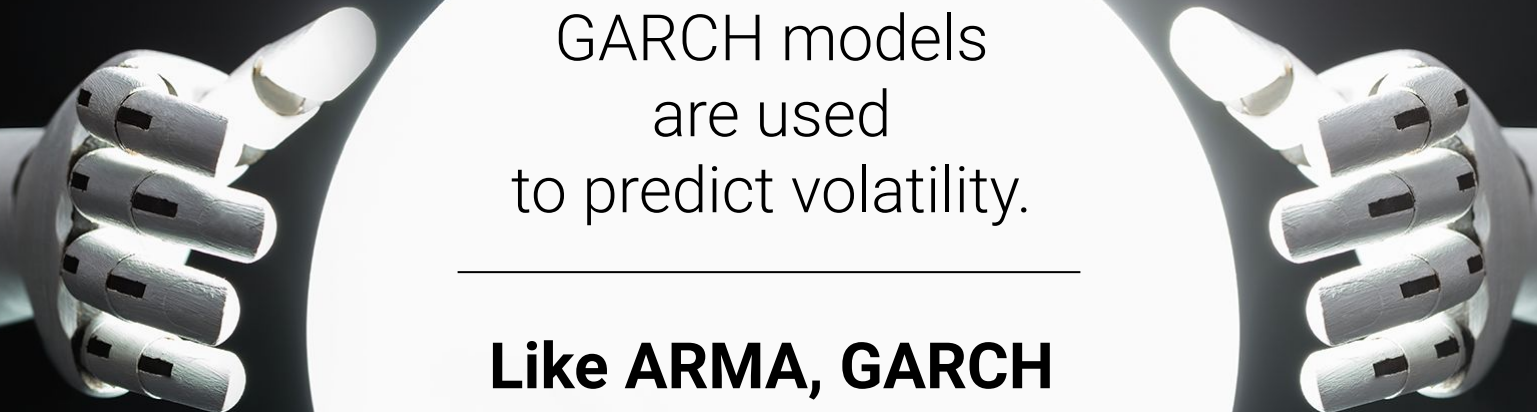
Future values predicted
based on **past values**.

Moving Average component:

Future values predicted based
on **past errors**.



GARCH



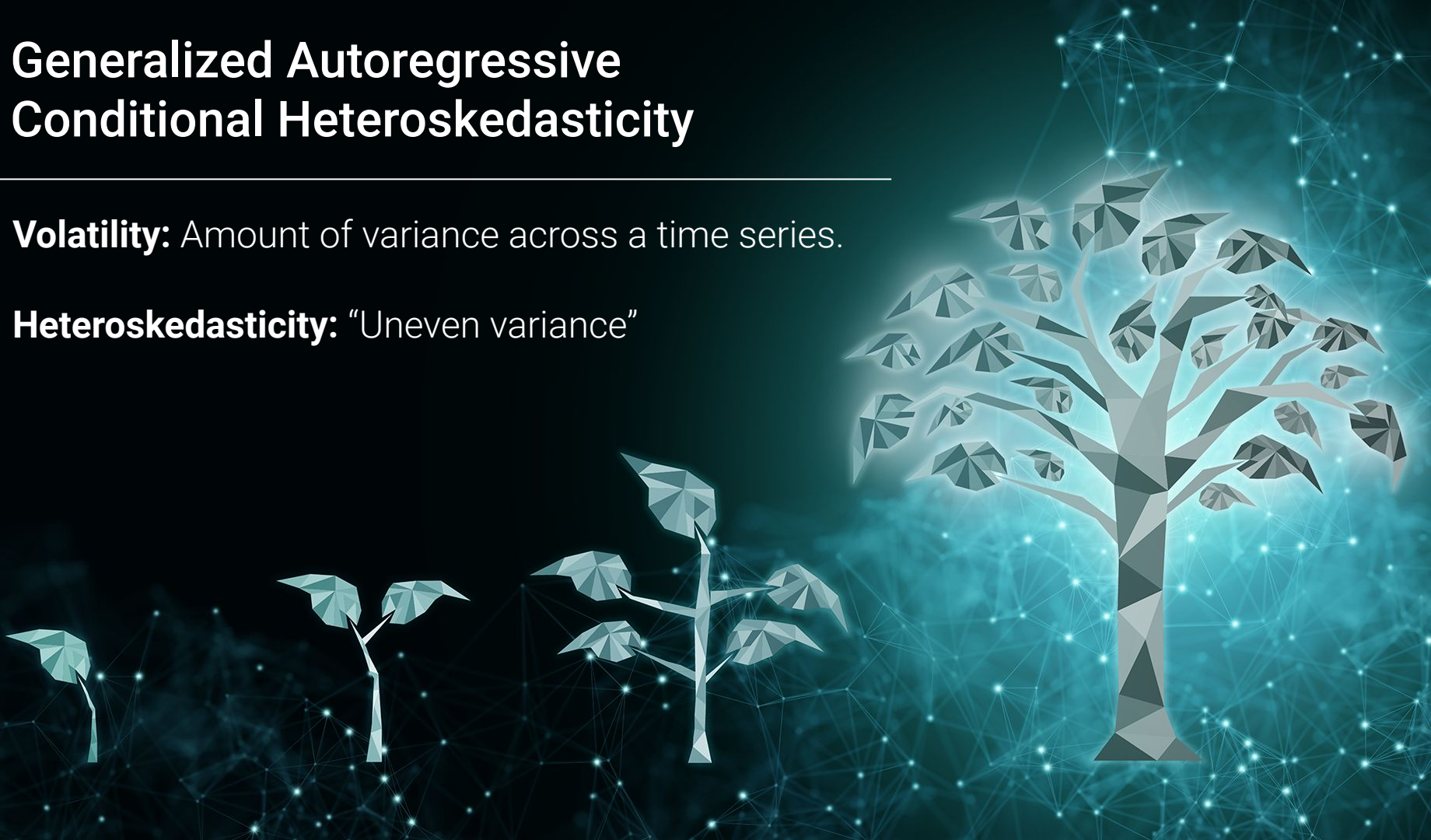
GARCH models
are used
to predict volatility.

**Like ARMA, GARCH
also has auto-regressive
and moving average
components.**

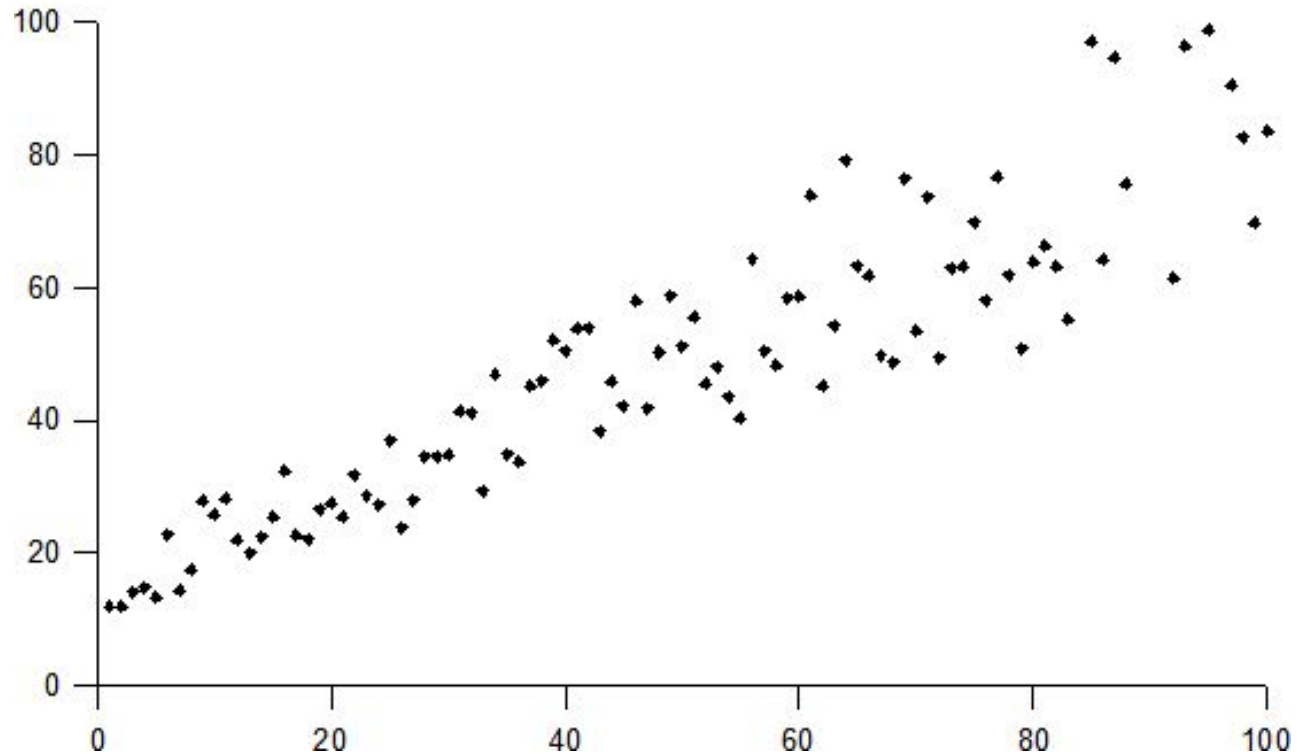
Generalized Autoregressive Conditional Heteroskedasticity

Volatility: Amount of variance across a time series.

Heteroskedasticity: “Uneven variance”



Heteroskedasticity



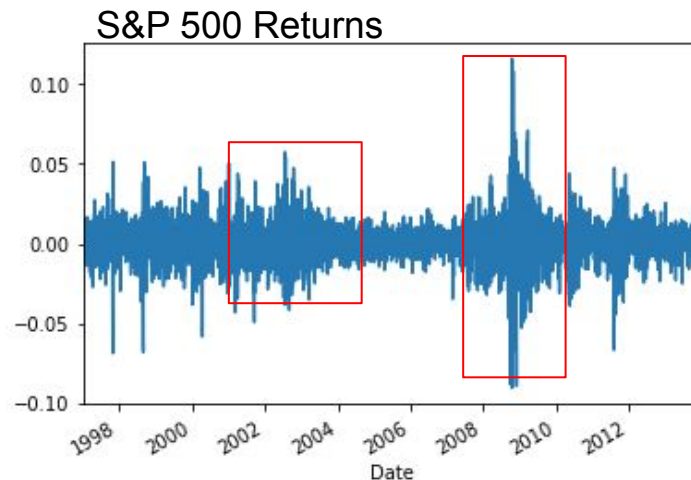
Volatile Periods in the US Stock Market



Volatility and returns tend to cluster.



GARCH is a model designed to take specific advantage of that.





Questions?