When it stays in bull state there is 7.4% of return. Then when it shifts to bear state it gives negative return of -7.4%.
Again when it shifts to Bull state it gives a return of 6.8%.
When it stays in Bull state (5^{th} transition) with a shock of -0.7, it gives 3.6% return.

This is Markov Regime Switching Model (MRS) which allows us to understand the dynamic changes in the behaviour by switching between different regimes.

BAYESIAN REASONING:-

Bayesian reasoning is a probabilistic approach to inference, where we update our beliefs based on new evidence using Bayes theorem. Bayesian reasoning is widely used in finance for risk assesment, portfolio optimization, asset pricing, and fraud detection. It allows investors and analysts to update their beliefs about financial markets as new information becomes available.

Bayes' Theorem: The foundation of Bayesian Reasoning

Bayes' Theorem describes how to update probabilities when new evidence is introduced. It is given by:-

$$\boxed{P(A|B) = \frac{P(B|A) \cdot P(A)}{P(B)}}$$

where:

$P(A|B)$ = Posterior Probability (Probability of event A given evidence B).

$P(B|A)$ = Likelihood (Probability of evidence B if A is true).

$P(A)$ = Prior probability (Initial belief about A).

$P(B)$ = Marginal Probability (Total probability of evidence B)

Example:-

A certain disease affects 1% of a population. A diagnostic test detects the disease 90% of the time when a person has it (true positive rate). However, the test incorrectly identifies 5% of healthy individuals as having the disease (false positive rate). If a person tests positive, what is the probability that they actually have the disease?

Solution:-

Step 1:- Define Given Probabilities

$P(D) = 0.01 \rightarrow$ Prior Probability of having disease.

$P(\sim D) = 0.99 \rightarrow$ " " " not having disease.

$P(T|D) = 0.90 \rightarrow$ Probability of testing positive if diseased.

$P(T|\sim D) = 0.05 \rightarrow$ Probabily of testing positive if healthy (false positive rate).

$P(T) \rightarrow$ Total Probability of testing positive.

Step 2:- Compute the Total Probability of Testing Positive.

$$P(T) = P(T/D)\,P(D) + P(T|\sim D).P(\sim D)$$
$$= (0.90 \times 0.01) + (0.05 \times 0.99)$$
$$= 0.009 + 0.0495$$
$$\boxed{P(T) = 0.0585}$$

Step 3:- Compute Posterior Probability Using Bayes' Theorem:

$$P(D|T) = \frac{P(T|D)P(D)}{P(T)}$$
$$= \frac{0.90 \times 0.01}{0.0585} = \frac{0.009}{0.0585} \boxed{= 0.154 = 15.4\%}$$

If a person tests positive, the probability that they actually have the disease is 15.4% (not 90% as one might initially assume).

Example: 2

An investor wants to decide whether the stock market will rise (H) given that the GPD growth rate has increased. The prior belief is that the stock market rise is 60%. When the stock market rises, there is an 80% chance that

GPD growth was positive. 70% of time the GPD growth is positive. Find the updated probability that the stock market will rise given that GPD growth was positive.

P(H) → Probability that stock market rise is 60% → 0.6.

P(D|H) → 0.8

P(D) → Overall GPD growth Probability → 0.7.

Compute the posterior probability:

$$P(H|D) = \frac{P(D|H) \cdot P(H)}{P(D)}$$

$$= \frac{(0.8 \times 0.6)}{0.7} = \frac{0.48}{0.7}$$

$$\boxed{= 0.6857 = 68.57\%}$$

The probability that stock market will rise given that GPD growth has increased from 60% to 68.57%.

Applications of Bayesian Reasoning in Finance:

(1) Asset Pricing and Risk Management:

* Bayesian models helps to update the risk of assets based on new economic or company-specific information.
* Example:- If a company reports strong earnings, the probability of its stock price increasing can be updated dynamically.

(2) Fraud Detection and Credit Scoring:

* Banks use Bayesian Networks to credit risk.
* Example: If a borrower misses one payment, Bayesian updating recalculates the probability of default.

(3) Algorithm Trading and Market Predictions:

* Bayesian inference helps in quantitative finance to adjust trading strategies based on real-time market news.
* Example:- A Bayesian model can predict whether a stock price will go up/down based on past price movements and news sentiment.