Quantitative Financial Modeling
CA 3

Module Code: B9FT101

Report Presented to: Alan O'Sullivan

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Q4 - Write a brief "technical note" to your team outlining the key features and advantages of a Bayesian inference model. Pay particular attention to the implementation of Bayes theorem and the concept of conditional probability.

Bayesian Interference says that we can have a previous belief about an event but when a piece of new evidence is found the previous belief has to be renewed. So it is a tool that helps us update old beliefs by producing new evidence (*Bayesian Statistics: A Beginner's Guide | QuantStart*, no date). As opposed to frequentist, in Bayesian statistics, the parameters can be assigned and updated using prior beliefs. Bayesian hypothesis testing is carried out based on prior beliefs and probabilities and is updated as per the evidence found during trials. (*An Introduction to Bayesian Statistics*, no date). Hence the Bayesian inference is useful for analysis when previous data is already available or when data is limited.

<u>Bayesian Features:</u>

1) Inclusion Of Prior Knowledge:

    Bayesian inference allows us to incorporate prior knowledge about a hypothesis into our analysis. This is useful in situations where we understand the underlying process or where we have previous sources of information.

2) Intuitive Interpretation:

    Bayesian inference provides a formal framework for representing and quantifying uncertainty. This is achieved using probability distributions, which allow us to observe the change in the degree of belief in various scenarios.

3) Dynamic Update of Beliefs:

    Bayesian inference model can be updated as new data becomes available, providing a continuous learning process. This is done using Bayes' theorem, which provides a mathematical formula for combining prior knowledge with new data to obtain a posterior distribution. (*Advantages vs. disadvantages of Bayesian statistics | LinkedIn*, no date)

Bayes Theorem:

$$\mathbf{P(\theta|D) = P(D|\theta)\, P(\theta) / P(D)}$$

Where,

$P(\theta)$ is prior, the prior belief in the probability of θ

$P(\theta|D)$ is the posterior, the belief in the probability of θ considering the new evidence D

$P(D|\theta)$ is the likelihood, the belief in the probability of D given the belief θ

$P(D)$ is the evidence, the probability of observing D

Here, we can see that the outcome is updated every time we add new evidence to the equation. Baye's theorem helps to update the belief based on the new evidence. In Bayesian inference, Bayes' theorem provides a systematic framework to revise initial probabilities (prior beliefs) into updated probabilities (posterior beliefs) by considering the newly observed evidence.

Conditional probability:

Conditional probability is the likelihood of an event occurring given that another event has occurred.

$$\mathbf{P(A|B) = P(A \cap B)/P(B)}$$

Conditional probability is computed as the probability of both events occurring together $P(A \cap B)$ divided by the probability of B occurring $P(B)$. It is pivotal in computing both the likelihood and posterior probabilities in Bayes' theorem ($P(D|\theta)$ and $P(\theta|D)$ respectively).

References

Advantages vs. disadvantages of Bayesian statistics | LinkedIn (no date). Available at: https://www.linkedin.com/pulse/advantages-vs-disadvantages-bayesian-statistics-miguel-pereira-md-phd/ (Accessed: 27 December 2023).

An Introduction to Bayesian Statistics (no date) *Informatics from Technology Networks*. Available at: http://www.technologynetworks.com/informatics/articles/an-introduction-to-bayesian-statistics-380296 (Accessed: 27 December 2023).

Bayesian Statistics: A Beginner's Guide | QuantStart (no date). Available at: https://www.quantstart.com/articles/Bayesian-Statistics-A-Beginners-Guide/ (Accessed: 27 December 2023).