

## *II. Philosophy of frequentism*

### *II-1. Theory of frequentism: comparison with Bayesianism*

Statistical tests which will be explained in several following chapters are based on the logic of frequentism. There are various opinions and situations relating to judgement for probabilistic phenomena, which include possibility of misjudging in real world, because we have to consider benefits of correct judgement and cost by misjudge as well as probability. Mathematically, frequentism and Bayesianism are major logics opposing each other in statistics. From the viewing point of Bayesianists, frequentism includes many unrealistic forced prior conditions. On the other hand, Bayesianism is only a method to express probabilistic phenomena and is not statistical analysis for Frequentists. Traditionally, frequentism was main stream in statistics, though various statistical method based on Bayesianism are commonly used in recent scientific reports using calculating power of computer. Logics and models used in frequentism is complicated and is sometimes difficult to understand for beginners, though calculation is relatively easy and simple. On the contrary, logic of Bayesianism is easy to understand, though we need enormous repetitive calculation in many cases when apply methods based on Bayesianism. There exists development and familiarization of computer in the background of popularization of Bayesianism.

Essentially, the author thinks, term of “Frequentism” is not appropriately expressing the content of frequentism. Objective probability and subjective probability are sometimes used for frequentism and Bayesianism. Those terminologies are also not appropriate and making confusion. The author is overlapping the relation between frequentism and Bayesianism to the relation between heliocentricism (Copernican system) and geocentrism (Ptolemaic system)) in his brain. I think, the explanation that Copernicus deny geocentrism is incorrect or at least imprecise. What Copernicus said is not that earth is moving and sphere is not moving. He did not want to clarify which is moving. What he said is that description of movement changes depending on the selection of inertial system (the system which is hypothesized as it accepts no power from outside and is not accelerated.). Actual data obtained from real world is dropped in a abstract graphic which is drawn for an ideal phenomena which happens perfectly obeying probability model, and statistical judgment is made by the place of the data in the graphic in frequentism. Contrastingly, trivial “truth” is not existing, and probability distribution is drawn from experiences in the real world in Bayesianism. Each obtained data is an experienced fact and is treated as an information. Human beings change their view of the world with their experiences. “Truth” for human beings is drifting in their brain with information. When we accept this statement as “truth”, we

should say that “truth” fluctuates stochastically. This is why the author overlaps the relation between frequentism and Bayesianism with the relation between heliocentricism and geocentrism. The author learned that Thomas Bayes (1702-1761) proposed Bayes’ theorem and he was Presbyterian, though the author does not know who establish Bayesian theory. He is supposing that Bayes may consider that human being can come close to “truth” by honestly facing experiences, but cannot catch the “truth”, because “truth” is always moving in the hand of God, and human being cannot be God. In Bayesianism, frequency distribution is drawn by random sampling of information as fluctuation of observed “truth”. Some said that selection of frequentism or Bayesianism is problem in philosophy and they are mutually exclusive. He does not think so. Buda may say “Human being cannot understand the truth of the world. Do not stand fringe, that is biased viewing position. Use proper method as the situation demand”. This is “upaya” and “PrajnaParamita”. Fundamentalism cannot solve anything.

Fig. 1 and 2 show the ideas of probability distribution in frequentism and Bayesianism diagrammatically.

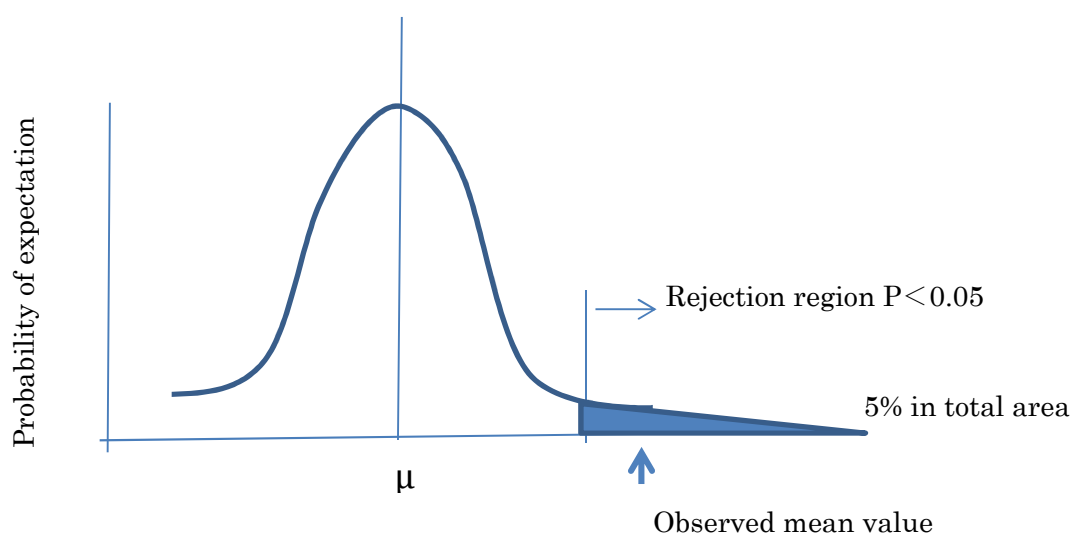


Fig 1. Testing of significance of difference in frequentist...

Heavy line is indicating probability distribution of expected mean by random sampling from “correctly estimated parental population”. Mean and variance of parental population are estimated from data. Probability distribution is drawn assuming normal distribution of parental population. In the case showing in the figure, the average of sample population is different from the average of parent population in 5% risk rate, because observed mean drops rejection region less than 5%.

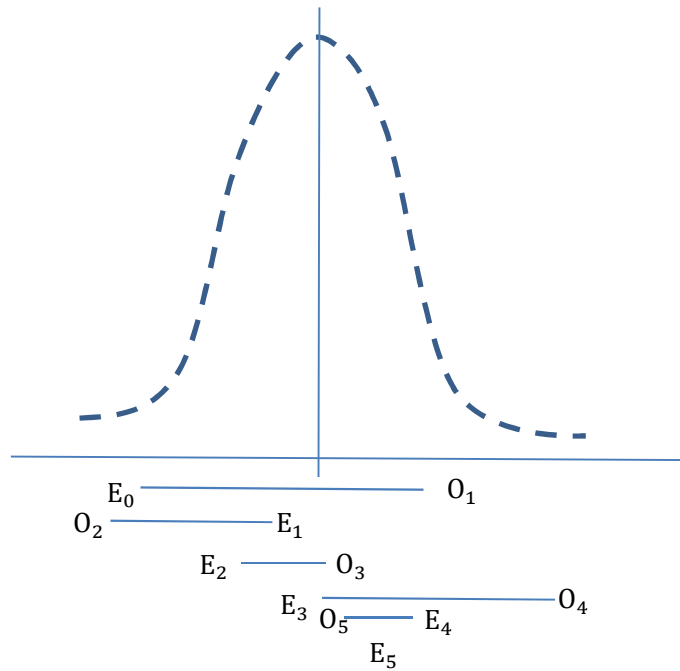


Fig. 2 Basic idea and method of Bayesianism

In Bayesianism, firstly, a value of mean of sample population is determined in a subjective way as prior information ( $E_0$ ), then a data ( $O_1$ ) is randomly selected from sample population and first predictive value ( $E_1$ ) is calculated combining the selected data ( $O_1$ ) and  $E_0$ . And then, second data ( $O_2$ ) is randomly selected and second predictive value ( $E_2$ ) is calculated combining the selected data ( $O_2$ ) and  $E_1$ . In this random selection, result of first random selection should not make any impact to second random selection, in another words, the data selected by random sampling should return to the batch of original sample population (Markov chain). By repeating of this procedure, frequency distribution of predicted value of mean can be drawn. Bayesianists consider the figure as the image of swinging “truth”.