



[Course](#) > [Unit 5 Bayesian statistics](#) > [Statistics](#) > [Lecture 17: Introduction to Bayesian](#) > [3. Introduction to the Bayesian Framework](#)

3. Introduction to the Bayesian Framework

Frequentist vs Bayesian Approaches

The Bayesian approach



- ▶ In many practical contexts, we have a *prior* belief about θ^*
- ▶ Using the data, we want to update that belief and transform it into a *posterior* belief.

▶ 8:48 / 8:48

▶ 1.50x



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Frequentist vs. Bayesian I

1/1 point (graded)

Which of the following are aspects of **Bayesian** modeling approach, as opposed to the **frequentist** modeling approach? (Choose all that apply. Refer to the slides.)

☒ In Bayesian statistics, the true parameter is modeled as a random variable, or at the very least, the uncertainty regarding the true parameter is modelled as such.

☐ In most practical applications of Bayesian statistics, we are trying to estimate the true parameter only from the observation data and our chosen model.

☒ In Bayesian statistics, we use the data to update our prior belief about a parameter and transform it into a posterior belief, which is reflected by a posterior distribution.



Solution:

We examine the choices in order.

- The first choice "**In Bayesian statistics, the true parameter is modeled as a random variable, or at the very least, the uncertainty regarding the true parameter is modelled as such**" is correct. In the Bayesian set-up, we model the true parameter as a random variable and update its distribution as we receive more data.
- The second choice "**In most practical applications of Bayesian statistics, we are trying to estimate the true parameter as accurately as possible as possible only from the observation data and our chosen model.**" is incorrect. In the Bayesian set-up, we do not even assume that there exists a true parameter, or at least we model it as a random variable to represent our uncertainty. This is rather the approach of frequentist statistics.
- The third choice "**In Bayesian statistics, we use the data to update our prior belief about a parameter and transform it into a posterior belief, which is reflected by a posterior distribution.**" is correct. Our prior belief is captured by the prior distribution on the parameter, and we can use Bayes' formula to update the prior distribution as we receive more data.

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i Answers are displayed within the problem

Factors that Can be Specified in the Frequentist View

1/1 point (graded)

Suppose that we have some background information about our statistical problem, say from intuition or existing literature. We want to stick to a frequentist approach, but wish to specify our problem so that the outcome would be more in line with what we know so far. Which of the following components are we allowed to specify? (Choose all that apply.)

☒ The set Θ possible parameters

☒ The probability model \mathbb{P}_θ

☐ A distribution $\pi(\theta)$ by which we weight the likelihood

☒ The procedure by which we would infer or estimate the true parameter based on the observations and model. (MLE, method of moments, M-estimator, etc.)




Solution:

- The first choice "**The set Θ possible parameters**" is correct, as it is part of the statistical model that can be specified regardless if we are in the frequentist or the Bayesian setting.
- The second choice "**The probability model \mathbb{P}_θ** " is correct, as it is also part of the statistical model for the observations.
- The third choice "**A distribution $\pi(\theta)$ by which we weight the likelihood function**" is incorrect. Having a prior belief independent of the model or the observations, to be used as weights, is the core of the Bayesian approach.
- The fourth choice "**The procedure by which we would infer or estimate the true parameter based on the observations and model**" is correct as frequentist inference or estimation procedures treat the parameter as a fixed, true value, not as a random variable as is done in the Bayesian approach.

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