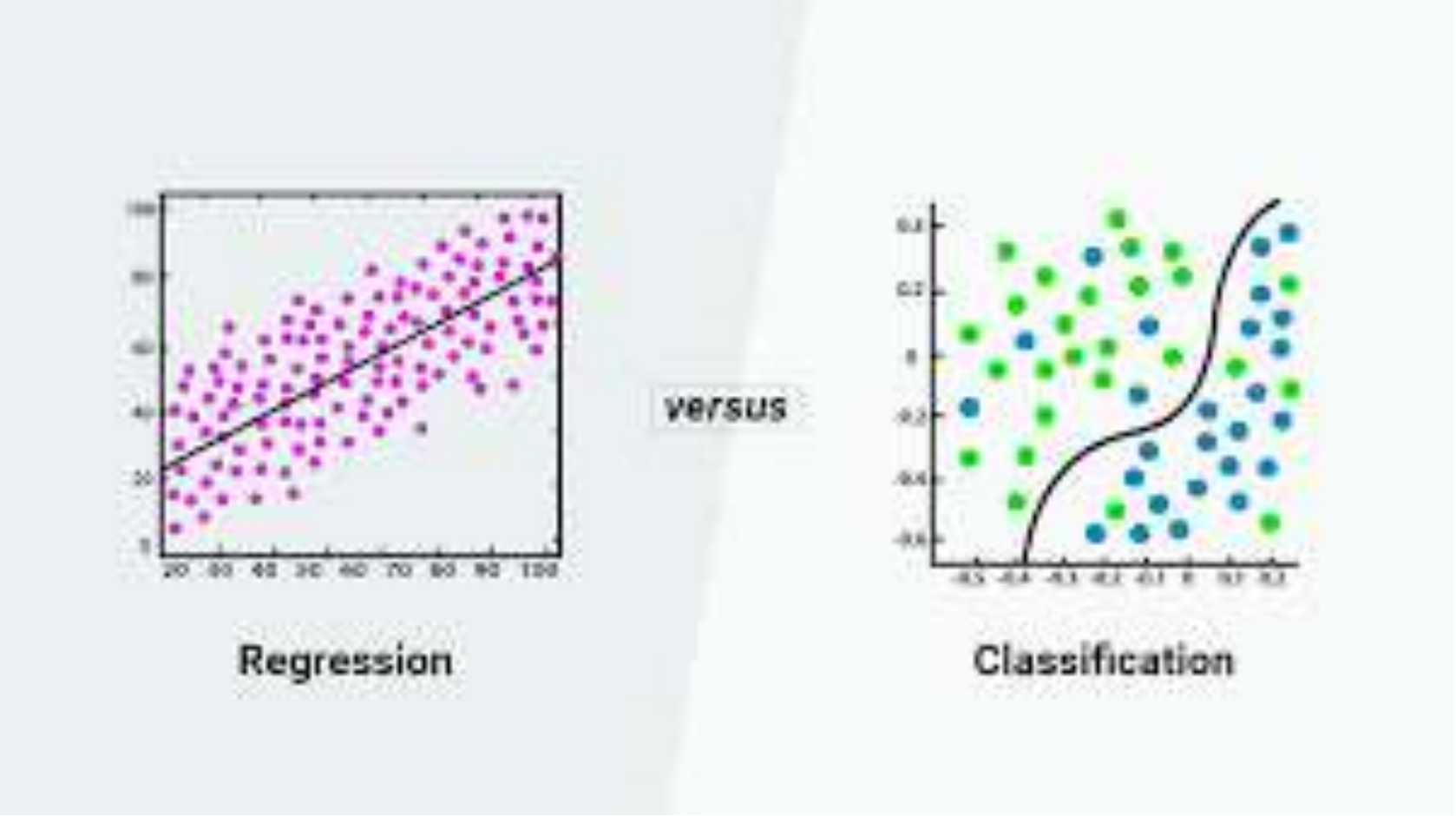
Bayesian Linear Regression

Regression is a Machine Learning task to predict continuous values (real numbers), as compared to classification, that is used to predict categorical (discrete) values.



Linear Regression

Linear Regression is a very simple machine learning method in which each data points is a pair of vectors: the input vector and the output vector.

In the simplest case linear regression assumes that the k'th output vector was formed as some linear combination of the components of the k'th input vector plus a constant term, and then Gaussian noise was added.

Classical linear regression can then be used to identify, based on the data, the best fitting linear relationship between the inputs and outputs.

It turns out that this is an efficient process because it simply involves building two matrices from the data and then solving a DxD system of linear equations where D is (the number of inputs).

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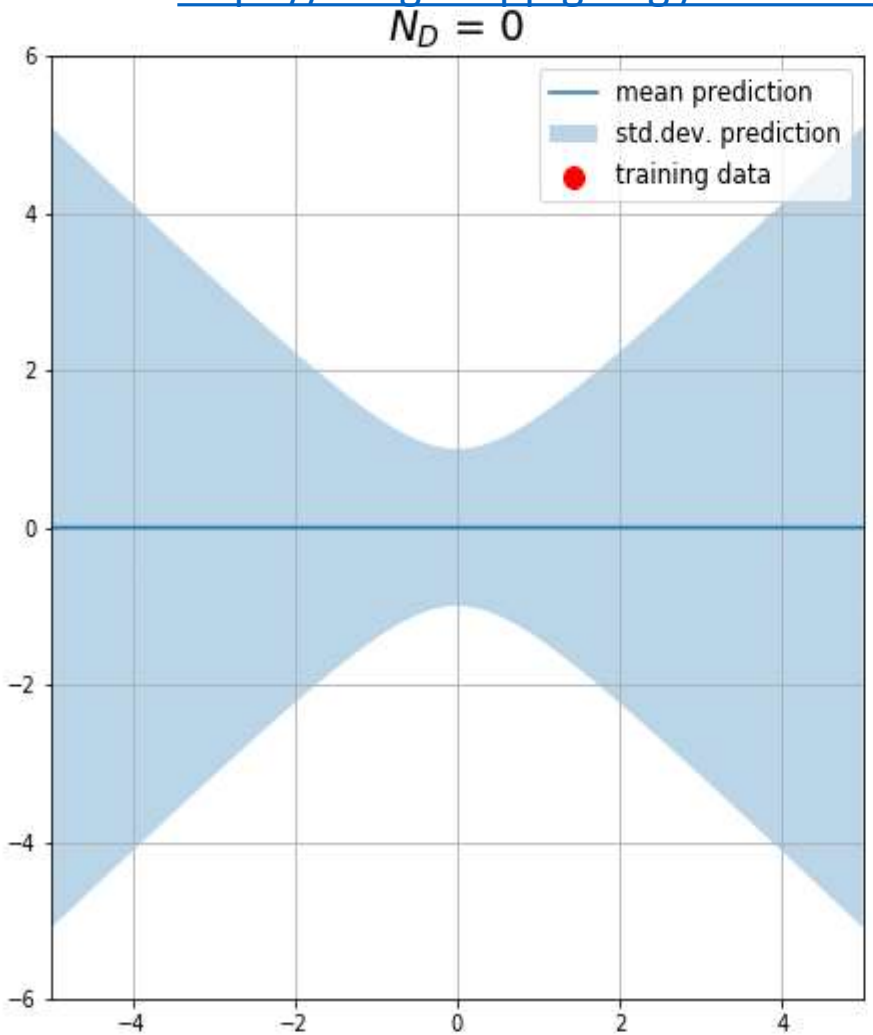
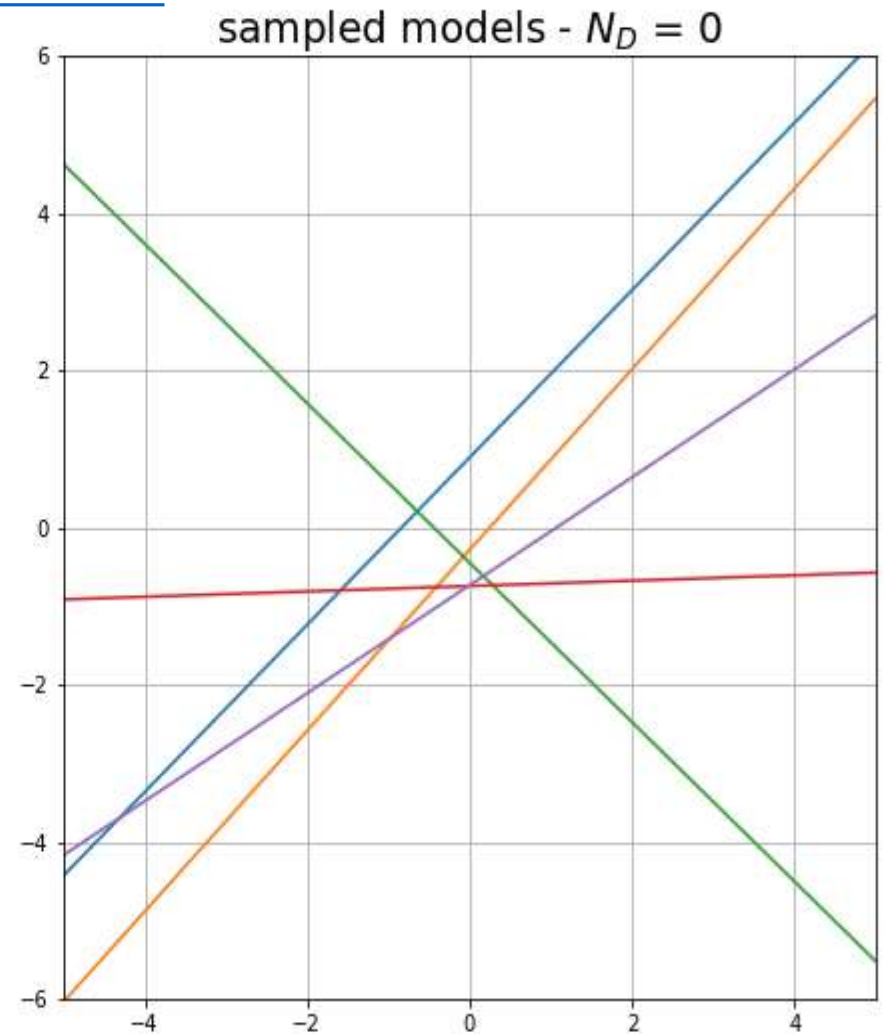




Bayesian Regression methods is a very powerful method because they provide us with the entire distribution over regression parameters.

In order to calculate inadequate data or unequal distributed data, Bayesian Linear Regression provides a natural mechanism.

Statistical analysis is conducted under the conditions of Bayesian interface in Bayesian linear regression in statistics.

The output is achieved from a probability distribution, rather than usual regression techniques.

The goal of Bayesian linear regression is to find Posterior instead of model parameters.

Model parameters are supposed to occur from a distribution.

The posterior expression is

Posterior= (Likelihood*Prior)/Normalization

where

- **Posterior:** It is the probability of an event to occur; say, H, given that another event; say, E has already occurred. i.e., P(H | E).
- Prior: It is the probability of an event H has occurred prior to another event. i.e., P(H)
- Likelihood: It is a likelihood function in which some parameter variable is marginalized.

The above equation is similar to Bayes' Theorem, which is

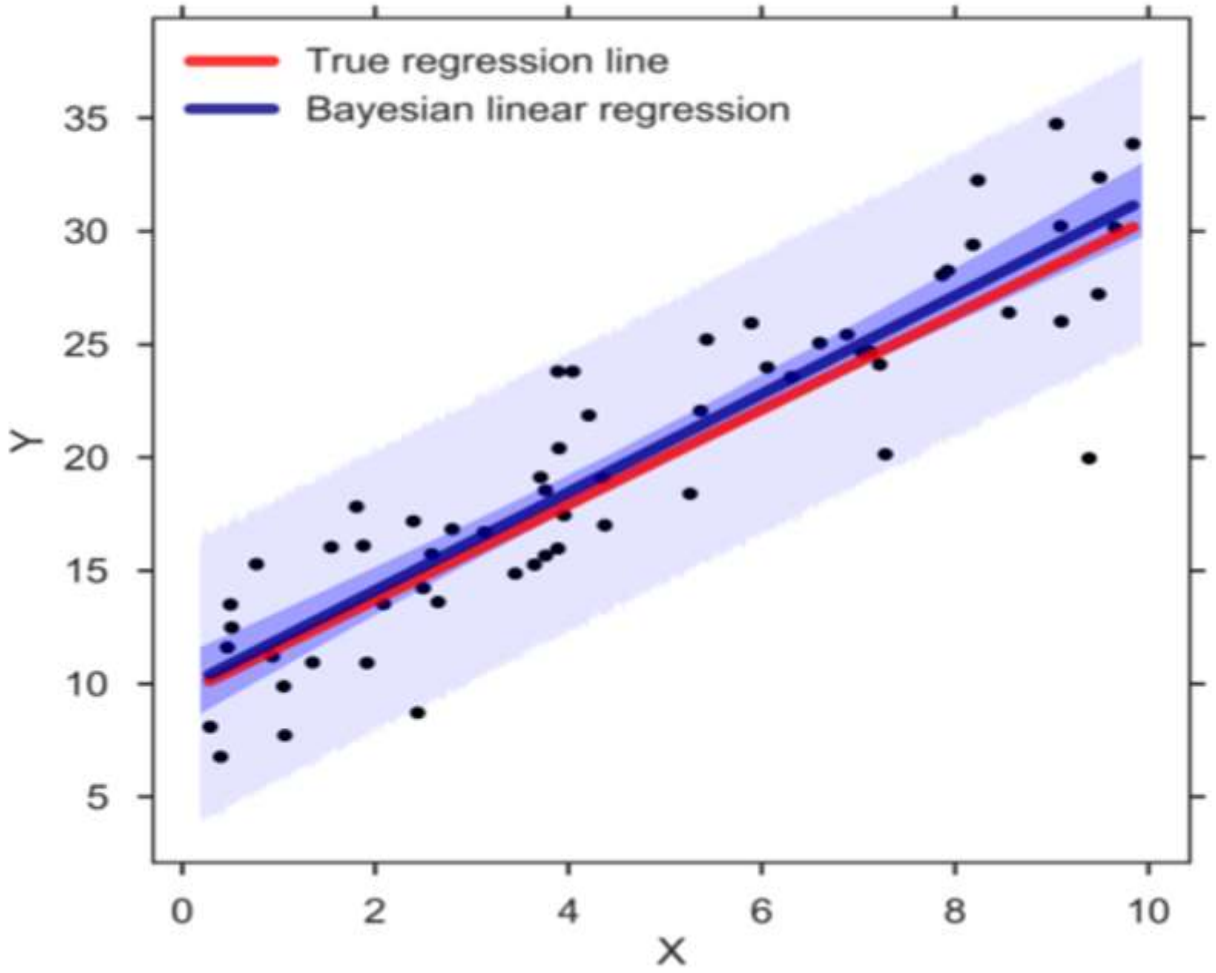
$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

where

A and B are events,

P(A) is the probability of occurrence of A, and P(A|B) is the probability of A to occur given that event B has already occurred.

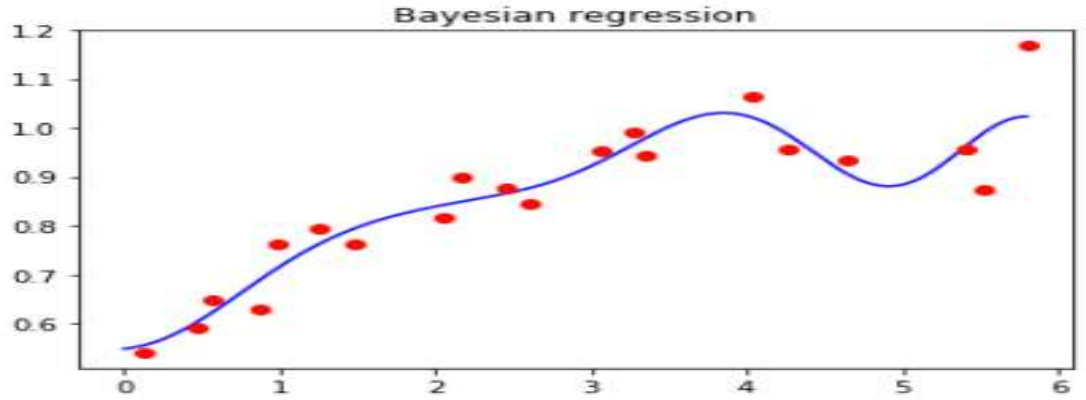
P(B), the probability of event B occurring cannot be 0 since it has already occurred.

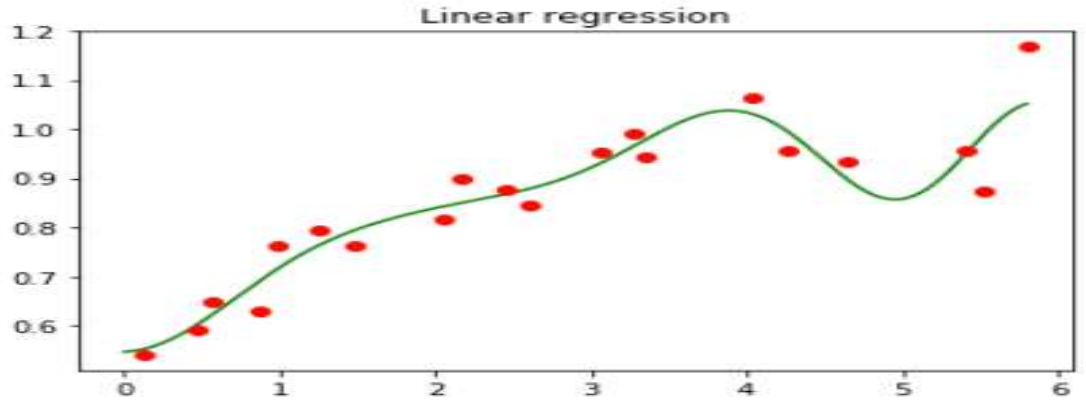


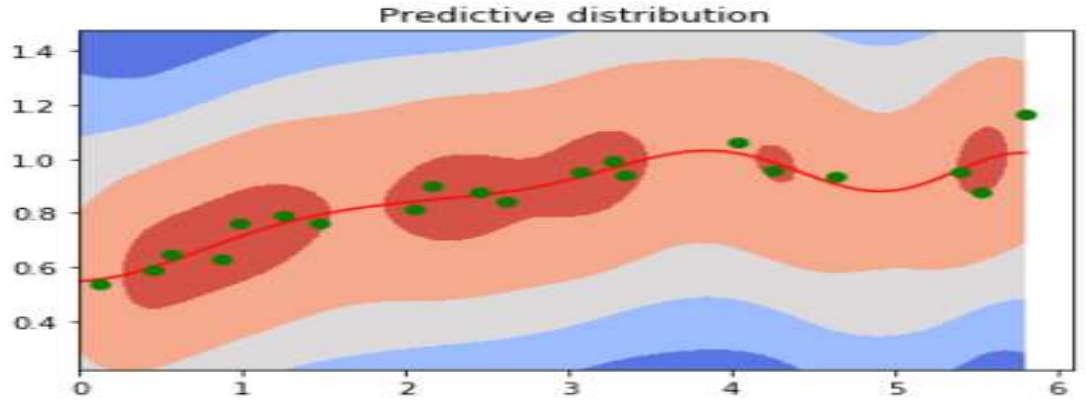
Real-life Application Of Bayesian Linear Regression

According to the graphs,

Linear regression and Bayesian regression can generate the same predictions.







Advantages of Bayesian Regression:

With the help of Bayesian processing, we can retrieve the complete variety of inferential solutions instead of a point estimate.

It works efficiently with the small size of the dataset.

It is very suitable for the online form of learning, whereas, in the form of batch learning, we have the whole dataset.

It is a very powerful and tested approach.

Disadvantages of Bayesian Regression:

It does not work efficiently if the dataset contains a huge amount of data.

The conjecture of the model can be time-consumin