# Automated Model Selection and Hyperparameter Optimization Using Bayesian Optimization

## Design of the Study

The design of this study involves the development and evaluation of a framework that automates the selection of machine learning models and the tuning of their hyperparameters using Bayesian Optimization. The study is structured into the following phases:

1. 1. Data Collection and Preprocessing

Relevant datasets are gathered from open-source repositories. Standard preprocessing steps such as handling missing values, normalization, and encoding categorical features are applied.

1. 2. Model Selection

A pool of candidate machine learning models (e.g., Decision Trees, Random Forests, SVM, XGBoost) is defined. The study leverages Bayesian Optimization to select the most suitable model for a given task.

1. 3. Hyperparameter Optimization

Bayesian Optimization is used to efficiently navigate the hyperparameter space. A surrogate model (Gaussian Process or Tree-structured Parzen Estimator) guides the search, while acquisition functions determine the next points to evaluate.

1. 4. Evaluation Metrics

The performance of models is evaluated using metrics such as accuracy, precision, recall, F1-score, and computation time. Cross-validation is employed to ensure robustness.

1. 5. Comparative Analysis

Results from Bayesian Optimization are compared with traditional optimization techniques (e.g., Grid Search, Random Search) to highlight the advantages of the proposed approach.