

## **Discussion and Analysis of Classification Results**

In this analysis, we evaluated the performance of several machine learning algorithms on a dataset containing information about student performance in a variety of educational contexts. The goal was to predict the final class label of students based on various features such as gender, nationality, level of parental involvement, and academic engagement indicators like raised hands in class, resources visited, announcements viewed, and participation in discussions.

### **Performance Metrics:**

We used a variety of performance metrics to evaluate the performance of each algorithm. These metrics included accuracy, sensitivity (true positive rate), specificity (true negative rate), precision, recall (true positive rate), and F1-score. These metrics provide a comprehensive understanding of how well each algorithm is performing in terms of both overall accuracy and its ability to correctly classify instances from each class.

### **Decision Tree:**

The Decision Tree algorithm achieved an accuracy of approximately 65% on both the training and testing sets. While this accuracy is decent, it suggests that the Decision Tree model may be struggling to capture the underlying patterns in the data effectively. The confusion matrix shows that the model is particularly struggling with the 'H' class, where it misclassifies several instances.

### **Random Forest:**

The Random Forest algorithm performed slightly better than the Decision Tree, achieving an accuracy of around 74% on both the training and testing sets. Random Forests are known for their ability to reduce overfitting and improve generalization performance by combining multiple decision trees. However, there is still room for improvement, as evidenced by the confusion matrix, which shows misclassifications across multiple classes.

### **Bagging:**

Bagging, which is an ensemble method similar to Random Forest, achieved an accuracy of approximately 68% on both the training and testing sets. While Bagging did improve over the base Decision Tree model, it still falls short of Random Forest in terms of performance. The confusion matrix reveals that Bagging struggles with misclassifications, similar to the Decision Tree and Random Forest algorithms.

### **Boosting:**

Boosting, specifically AdaBoost, achieved an accuracy of around 61% on both the training and testing sets. Boosting algorithms work by iteratively training weak learners and focusing on instances that were misclassified in previous iterations. Despite its adaptive nature, Boosting did not perform as well as Random Forest or Bagging in this analysis. The confusion matrix shows significant misclassifications across multiple classes.

**Support Vector Machine (SVM):**

SVM, a powerful supervised learning algorithm, achieved an accuracy of approximately 61% on both the training and testing sets. SVM aims to find the hyperplane that best separates the classes in the feature space. However, in this analysis, SVM did not perform as well as expected. The confusion matrix highlights misclassifications across multiple classes, indicating that SVM may not be capturing the underlying patterns effectively.