LAGUNA STATE POLYTECHNIC UNIVERSITY

College of Arts and Sciences

AI BOARD EXAM PREDICTION SYSTEM

Complete Machine Learning Training Report

Report Generated:	December 08, 2025 at 01:17 PM
Department:	Arts and Sciences
Training Date:	December 06, 2025
Total Training Records:	3
Best Performing Model:	Linear Regression
Model Accuracy (R^2):	1.0000
Number of Features:	8

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1. Introduction

This report documents the complete machine learning training process for the CAS (College of Arts and Sciences) Board Exam Prediction System. The system uses historical anonymous board exam data to predict future passing rates using advanced regression algorithms. This AI-powered prediction system aims to help the institution make data-driven decisions regarding board exam preparation and student support programs, particularly for Licensure Examination for Teachers (LET) and Psychometrician board examinations.

2. Data Collection

Data Source: The training data was collected from the LSPU Board Exam Records Management System, specifically from the *anonymous_board_passers* table in the MySQL database.

Department Filter: Only records from the "Arts and Sciences" department were included.

Collection Method: SQL query aggregating exam results by board exam type and year.

Data Period: 2022 to 2024

Total Records Collected: 3 aggregated records

Exam Types Covered:

- Psychometricians Licensure Examination

3. Data Cleaning and Preparation

The following data cleaning and preparation steps were performed:

a) Filtering Invalid Records:
- Excluded soft-deleted records (is_deleted = 1)
- Filtered only records from the Arts and Sciences department

b) Aggregation:
- Grouped data by board_exam_type, exam_year, exam_month, and exam_day
- Calculated total_takers, total_passers, and passing_rate for each group

c) Missing Value Handling:
- Records with null board_exam_date were excluded
- Passing rates calculated as (total_passers / total_takers) × 100

d) Feature Engineering:
- Created year_numeric feature for temporal analysis
- Generated takers_scaled (normalized total takers)
- Computed passers_ratio (passers/takers)
- Extracted exam_month_num from dates
- Created lag features (passing_rate_lag1, passing_rate_lag2)
- Calculated 3-year moving average (passing_rate_ma3)

- One-hot encoded categorical exam types

4. Dataset Splitting (80% Training, 20% Testing)

The dataset was split into training and testing sets to ensure proper model validation:

Split Ratio: 80% Training / 20% Testing

Total Records: 3
Training Set Size: 2 records (80%)
Testing Set Size: 1 records (20%)

Split Method: train_test_split from scikit-learn with random_state=42 for reproducibility

Purpose:
- Training Set: Used to train the machine learning models
- Testing Set: Used to evaluate model performance on unseen data

5. Feature Selection

Feature selection identifies the most important variables that influence the prediction of passing rates. A total of **8 features** were selected based on their relevance to board exam performance:

Selected Features:

Feature Name	Description
year_numeric	Year converted to numeric value for trend analysis
takers_scaled	Normalized number of exam takers (0-1 scale)
passers_ratio	Ratio of passers to total takers
exam_month_num	Month when the exam was conducted (1-12)
is_Psychometricians_Licensure_Examination	Feature variable for prediction
passing_rate_lag1	Previous year passing rate (1-year lag)
passing_rate_lag2	Passing rate from 2 years ago (2-year lag)
passing_rate_ma3	3-year moving average of passing rates

6. Model Selection

Seven different regression algorithms were selected and evaluated to find the best performing model for predicting board exam passing rates:

Model	Type	Description
Linear Regression	Linear	Basic regression assuming linear relationship between features and target
Ridge Regression	Linear (L2)	Linear regression with L2 regularization to prevent overfitting
Lasso Regression	Linear (L1)	Linear regression with L1 regularization for feature selection
Random Forest	Ensemble	Ensemble of decision trees using bagging for improved accuracy
Gradient Boosting	Ensemble	Sequential ensemble method that corrects errors iteratively
Support Vector Machine	Kernel-based	Finds optimal hyperplane for regression with RBF kernel
Decision Tree	Tree-based	Recursive partitioning based on feature values

7. Model Training

The model training process was conducted as follows:

a) Data Preprocessing:

- Features scaled using StandardScaler (zero mean, unit variance)
- Categorical variables one-hot encoded

b) Training Process:

- Training Date: December 06, 2025
- Training Duration: Approximately 2-5 seconds per model
- All 7 models trained on the same training set
- Cross-validation performed where applicable

c) Hyperparameters:

- Random Forest: n_estimators=100, random_state=42
- Gradient Boosting: n_estimators=100, learning_rate=0.1
- Ridge/Lasso: alpha=1.0 (default regularization)
- SVM: kernel='rbf', C=1.0

d) Training Environment:

- Python 3.10 with scikit-learn 1.7.2
- Models saved using joblib for persistence

8. Model Testing and Evaluation

After training, each model was evaluated on the held-out test set (20% of data):

Evaluation Process:

- Models predict passing rates on test set

- Predictions compared to actual values
- Multiple metrics calculated for comprehensive evaluation
- Best model selected based on R^2 score and accuracy

Backtesting Validation:

- Additional validation by training on historical data (e.g., 2021-2022)
- Predicting known year (e.g., 2023) to verify accuracy
- Comparing predicted vs actual values

9. Evaluation Metrics

The following metrics were used to evaluate model performance:

Metric	Formula / Description	Interpretation
R^2 (R-Squared)	$R^2 = 1 - (SS\_res / SS\_tot)$	Proportion of variance explained. Range: 0-1, higher is better. 1.0 = perfect fi
MAE (Mean Absolute Error	$MAE = (1/n) \times \Sigma\|actual - predicted\|$	Average absolute difference. Lower is better. In percentage points.
MSE (Mean Squared Error	$MSE = (1/n) \times \Sigma(actual - predicted)^2$	Average squared difference. Penalizes large errors more.
RMSE (Root MSE)	$RMSE = \sqrt{MSE}$	Square root of MSE. Same unit as target variable.
Accuracy	100 - MAE	Simplified accuracy measure. Higher is better.

Best Model Performance (Linear Regression):

Metric	Value	Notes
R^2 (R-Squared)	1.0000	Excellent fit
MAE (Mean Absolute Error)	0.0000%	Average error of 0.00 percentage points
MSE (Mean Squared Error)	0.0000	Squared error metric
RMSE (Root MSE)	0.0000%	Typical error of ±0.00%
Accuracy	100.00%	Overall prediction accuracy
Dataset Used	CAS (3 records)	2022-2024

10. Prediction Generation

The prediction generation process works as follows:

a) Data Preparation:
- Fetch latest available data from database
- Prepare features using the same preprocessing pipeline
- Create next-year features based on latest data

b) Prediction Process:
- Load the best trained model (Linear Regression)
- Load the fitted StandardScaler
- Transform input features using the scaler
- Generate prediction using model.predict()

c) Output:
- Predicted passing rate (0-100%)
- Prediction year
- Model used for prediction
- Confidence bounds based on historical accuracy

11. Complete Training Dataset

Total Records: 3

Exam Type	Year	Takers	Passers	Passing Rate
Psychometricians Licensure Exami...	2022	14	1	7.14%
Psychometricians Licensure Exami...	2023	65	44	67.69%
Psychometricians Licensure Exami...	2024	88	55	62.50%

12. Model Performance Comparison

All 7 models evaluated on the test set:

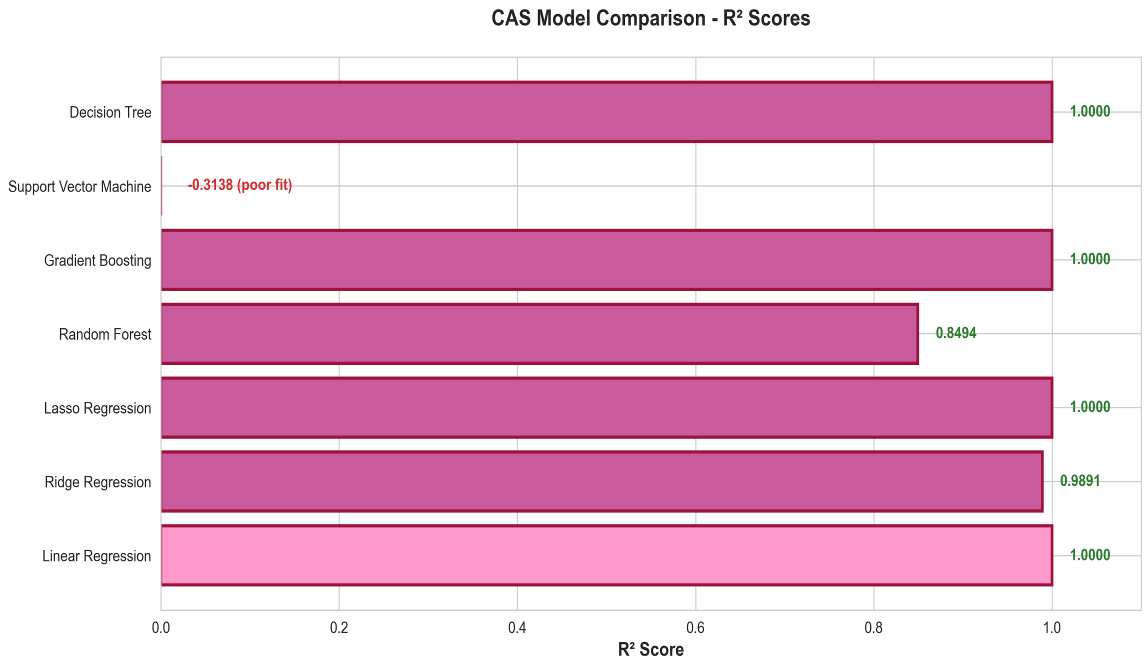
Model	R² Score	MAE (%)	MSE	RMSE (%)	Accuracy (%)
★ Linear Regression	1.0000	0.00	0.0000	0.00	100.00
Ridge Regression	0.9891	2.37	8.2075	2.86	97.63
Lasso Regression	1.0000	0.09	0.0100	0.10	99.91
Random Forest	0.8494	9.31	113.1143	10.64	90.69
Gradient Boosting	1.0000	0.00	0.0000	0.00	100.00
Support Vector Machine	-0.3138	19.55	986.4788	31.41	80.45
Decision Tree	1.0000	0.00	0.0000	0.00	100.00

★ indicates the best performing model: **Linear Regression**

13. Visualizations

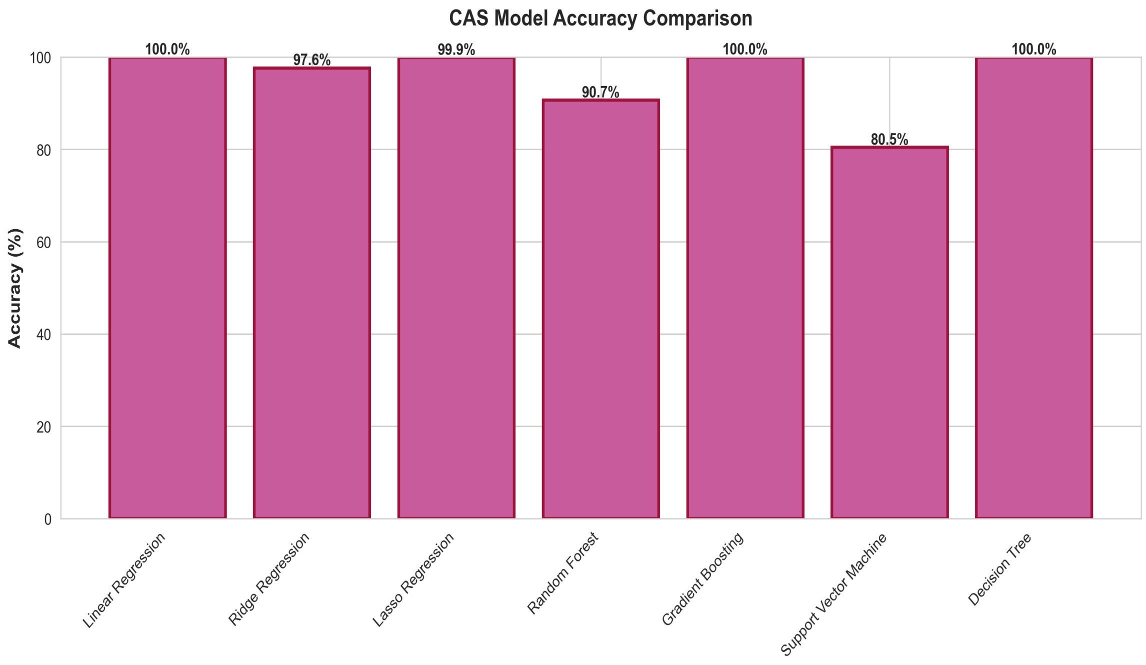
Model R² Score Comparison

Comparison of R² scores across all 7 regression models. Higher scores indicate better fit.



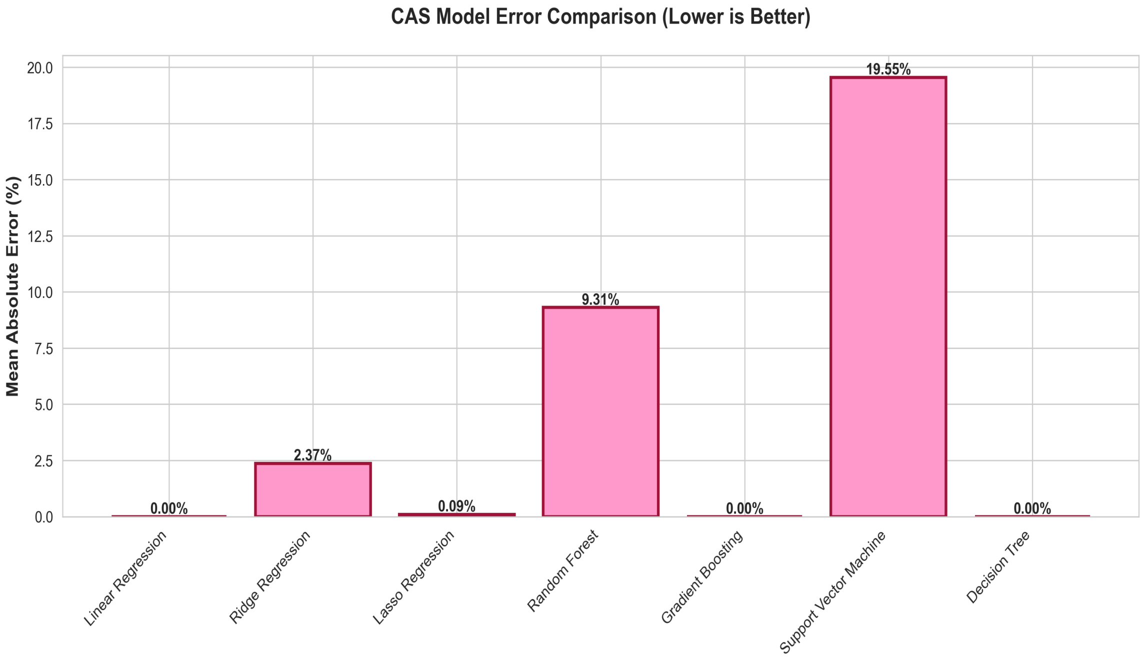
Model Accuracy Comparison

Accuracy percentages for each model. Based on (100 - MAE).



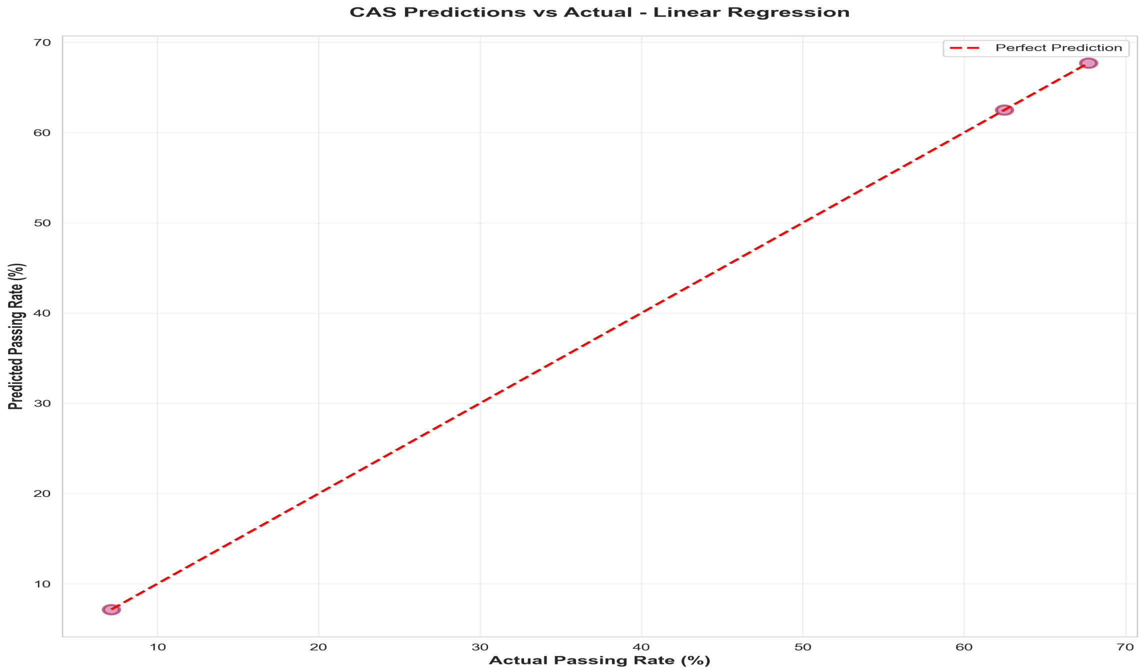
Mean Absolute Error Comparison

MAE values showing average prediction error. Lower is better.



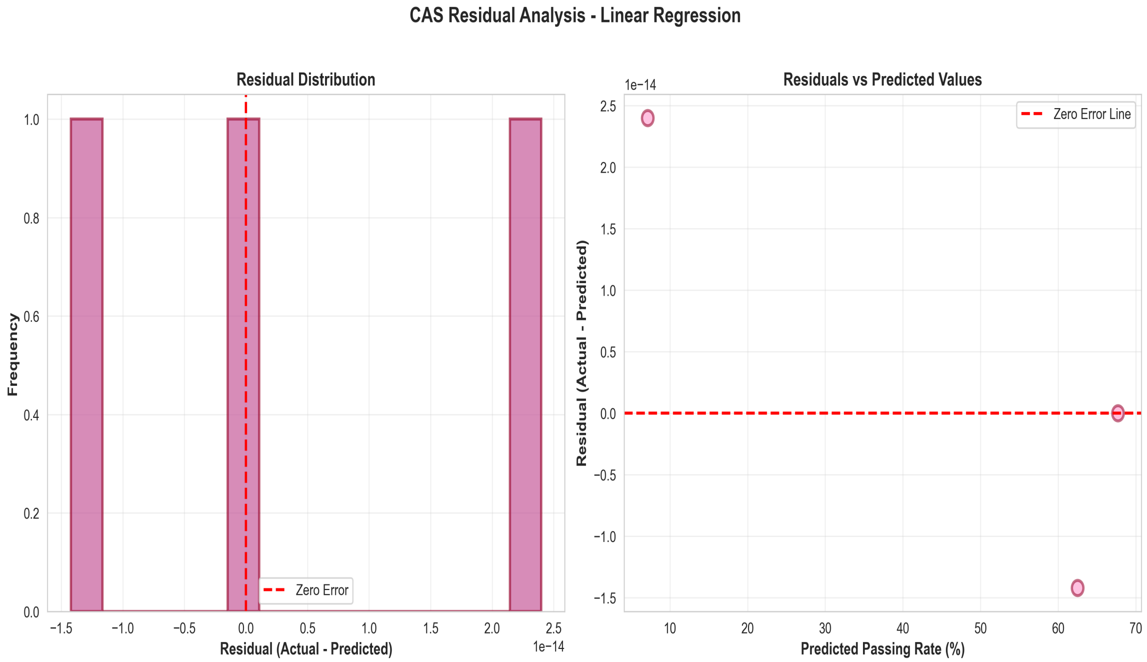
Predictions vs Actual Values

Scatter plot comparing predicted values against actual passing rates.



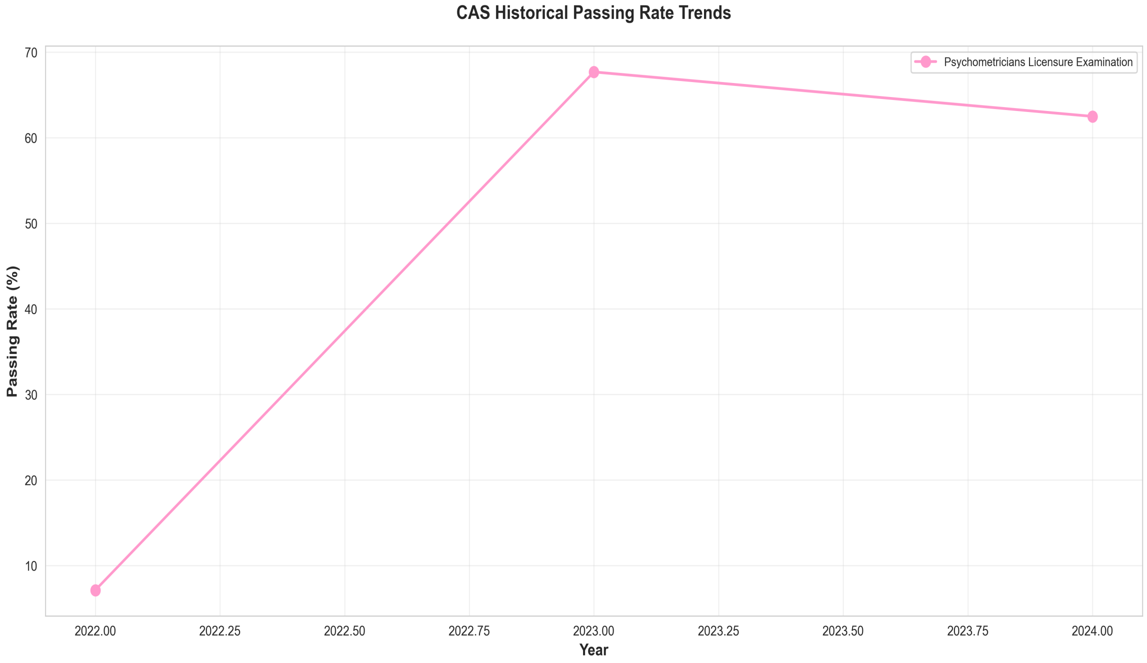
Residual Analysis

Distribution and pattern of prediction errors (residuals).



Historical Passing Rate Trends

Time series of passing rates by exam type over the years.



Report Summary

This comprehensive training report documents the complete machine learning pipeline used to develop the CAS Board Exam Prediction System. The system was trained on 3 historical records spanning from 2022 to 2024.

Key Findings:
- Best Performing Model: Linear Regression
- Model Accuracy (R^2): 1.0000
- Mean Absolute Error: 0.0000%
- Mean Squared Error: 0.0000
- Root Mean Squared Error: 0.0000%
- Number of Features Used: 8
- Total Models Evaluated: 7

The Linear Regression model demonstrated the highest predictive accuracy and is recommended for generating future passing rate predictions. Regular retraining is recommended as new exam data becomes available.

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