~~Data Analyst Portfolio Project~~

Forage Task-2

Role:
- Use GenAI tools to delop predictive model.
- justify best approach
- Define plan to evaluate model performance

* Predictive modeling:
↳ using historical data to forecast future outcomes

Use GenAI for predictive modeling

How GenAI helps?

① Selecting the right model type:

models use
- Decision trees - good for explaining why prediction was made
- logistic regression - useful for predicting binary outcomes (eg:- delinquent vs non-delinquent)
- Neural Networks - Effective for complex patterns but harder to interpret.

② Generating model code without coding:

③ Evaluating model performance:

Gen AI can
- Suggest evaluation metrics (eg, accuracy, precision, recall).
- Interpret results and suggest improvements
- Highlight potential bias.

* logistic Regression :-

predicts probability of an event occuring, whether a customer will or won't become delinquent. It assigns a probability score (0 to 1), where a threshold (eg:- 0.5) determines classification.

- Works well with structured data
- Great for binary predictions.

* Neural Networks:-
  ↳ powerful for complex patterns but harder to interpret.
  ↳ they detect complex relationships b/w variables
  ↳ their decision making is less transparent (black box).

- More accurate on large datasets
- Uncover deep patterns
- can predict long term trends.

* Evaluating Model Performance:
evaluating model accuracy & reliability considering bias, explainability & fairness.

(1) Key Metrics for Model evaluation:

(a) Accuracy - Measures overall correctness of model by dividing correct predictions by the total number of cases.

(b) Precision (positive predictive value) - Evaluates how many of the customers predicted to be delinquent actually are

(c) Recall (Sensitivity) - Measures how many actual delinquent customers were correctly identified by the model. High recall is important when missing a delinquent customer could result in financial loss.

1. Key metrics for model evaluation

Each metric provides a different perspective on model effectiveness. It's important to use multiple metrics together rather than relying on a single score:

- **Accuracy** – Measures the overall correctness of the model by dividing correct predictions by the total number of cases.
- **Precision (positive predictive value)** – Evaluates how many of the customers predicted to be delinquent actually are.
- **Recall (sensitivity)** – Measures how many actual delinquent customers were correctly identified by the model. High recall is important when missing a delinquent customer could result in financial loss.
- **F1 score** – A weighted balance between precision and recall. It is useful when both false positives and false negatives are costly.
- **AUC-ROC curve (area under the receiver operating characteristic curve)** – Assesses how well the model distinguishes between delinquent and non-delinquent customers. A score close to 1 means the model is highly effective at ranking risk levels, while a score near 0.5 suggests the model is no better than random guessing.
- **Confusion matrix** – A visual breakdown of actual vs. predicted classifications. It helps diagnose specific types of errors and determine whether the model is favoring one outcome over another.

2. What to do if model performance is poor

If your model is not performing well, there are several ways to improve it:

- **Feature engineering** – Adjust the dataset by adding or removing variables that may be impacting model predictions. For example, including customer tenure or past delinquency trends may enhance predictive power.
- **Rebalancing the dataset** – If the dataset is highly skewed (e.g., 95% non-delinquent, 5% delinquent), oversampling delinquent cases or undersampling non-delinquent cases can improve results.
- **Trying different models** – Some algorithms work better with certain data structures. If logistic regression is underperforming, a decision tree may provide better results.
- **Hyperparameter tuning** – Fine-tuning model parameters, such as adjusting the threshold for delinquency classification, can improve precision and recall scores.

Bias

Bias occurs when a model **systematically favors or disadvantages certain groups**, often due to historical inequalities or imbalanced data.

Common causes of bias:

- **Historical bias** – If past lending decisions were unfair, the model may replicate those patterns.
- **Selection bias** – If the dataset does not represent all customer demographics equally, predictions may be inaccurate for some groups.
- **Proxy bias** – Certain variables (e.g., ZIP code) may unintentionally act as proxies for protected characteristics like race or gender.

Explainability

Explainability ensures that decision-makers can understand and justify a model's predictions.

- **Decision trees and logistic regression** are more interpretable and show clear decision paths.
- **Neural networks** are highly complex and function as "black boxes," making explainability difficult.
- Analysts use tools like **SHAP (Shapley Additive Explanations)** to break down how different factors contribute to predictions.

Fairness

A fair model should:

- **Avoid systematic disadvantages** for certain demographic groups.
- **Be tested for disparate impact** to ensure fairness.
- **Use diverse and representative training data** to prevent reinforcing biases.

Utilizing GenAI tools to generate model code and refine predictions

1. How GenAI assists in model development

- **Generating a model framework** – A user can request a **logistic regression model for predicting delinquency**, and GenAI will provide an initial code structure. *However, it is essential to review, test, and refine the code to ensure correctness and efficiency.*
- **Feature selection assistance** – GenAI can recommend **which variables** to include based on the dataset. *However, analysts must verify that these selections do not introduce bias or proxy discrimination.*
- **Hyperparameter tuning** – Analysts can optimize model performance by asking for parameter adjustments. *While GenAI can suggest modifications, empirical testing and expert judgment are necessary to validate improvements.*

2. Refining and improving model predictions

After generating a model, it's crucial to **refine predictions** to ensure accuracy and fairness. GenAI tools can:

- Suggest modifications to improve precision and recall.
- Evaluate model outputs and identify overfitting or biases.
- Generate alternative models to compare performance.