Rakamin Academy

# Group 1 - Explorer


Dokumen Laporan Final Project

# Project Team & Role

**Project Manager**

Imam Maghfir Ramadhan

**Tugas**: Leading project and set project timeline

**Data Engineer**

- Nivan Dumatubun
- Syaiful Adri

**Tugas**: Data pre-processing (Cleansing, encoding dll)

**Data Analyst**

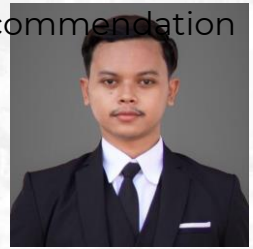
- Putri Sausan
- Puspita Ayu Utami

**Tugas**: EDA, Insight (visualization data distribution), Recommendation

**Data Scientist**

- Marcellinus Putra Wijaya
- Muhamad Zen Fikri

**Tugas**: Modeling and Recommendation



**Business Intelligence**

- Wasis Prasetyo

**Tugas**: Visualization (showing to stakeholder), Recommendation

# 1. Latar Belakang Masalah

Masalah churn pada nasabah kartu kredit merupakan isu yang sangat umum untuk dihadapi lembaga keuangan. **Churn** terjadi ketika nasabah memutuskan untuk **berhenti** menggunakan produk dan layanan dari bank , termasuk kartu kredit. Hal ini **berdampak negatif** terhadap finansial bank karena dapat menyebabkan penurunan pendapatan hingga kerugian kerugian. Selain itu, **biaya untuk mendapatkan nasabah baru cenderung lebih tinggi** dibandingkan mempertahankan nasabah lama.

# Case Study

**Churn rate** pada nasabah kartu kredit di sebuah bank dalam jangka waktu tertentu mencapai sebesar **20,37%.** Bila tidak ditindak, **bank akan mengalami kerugian yang semakin besar**.

# Goal

***Analytical approach*** yang akan dilakukan bertujuan **mengurangi atau menurunkan tingkat churn.**

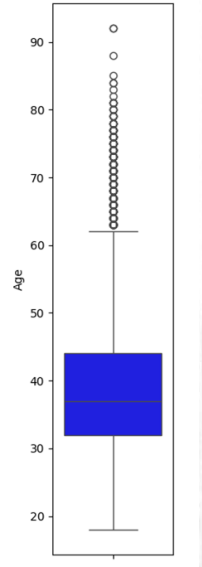
# Objectives

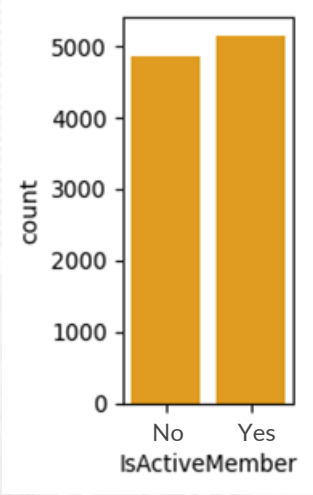
- **Mengidentifikasi faktor-faktor** yang mempengaruhi nasabah untuk churn
- **Membangun model machine learning (ML)** yang akurat yang dapat memprediksi nasabah yang berpotensi churn berdasarkan faktor-faktor yang ada

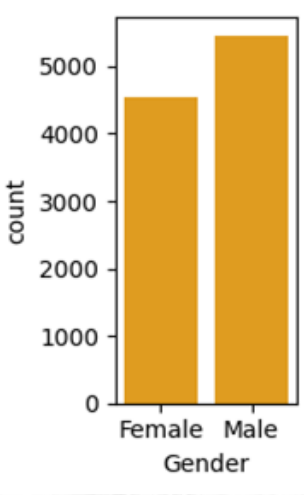
# Business Metric

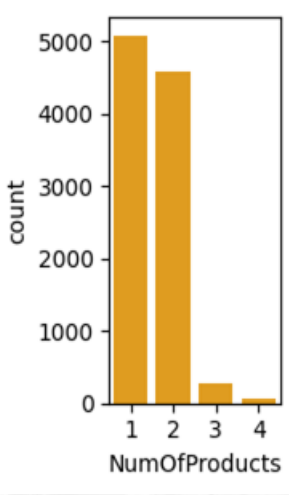
Churn Rate (%)

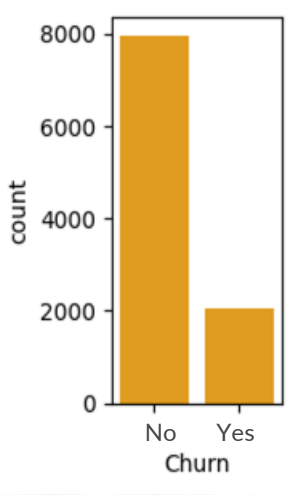
# 2. EDA & Insight




**Analysis**

- Mayoritas nasabah customer yang ada berada pada umur **30 - 40 tahun**
- Mayoritas nasabah bank yang ada merupakan nasabah yang tergolong **aktif,** berjenis kelamin **laki-laki**, dan **memiliki 1 produk**
- Sekitar **2,037 (20.37%) nasabah churn** dari total 10,000 customer yang ada

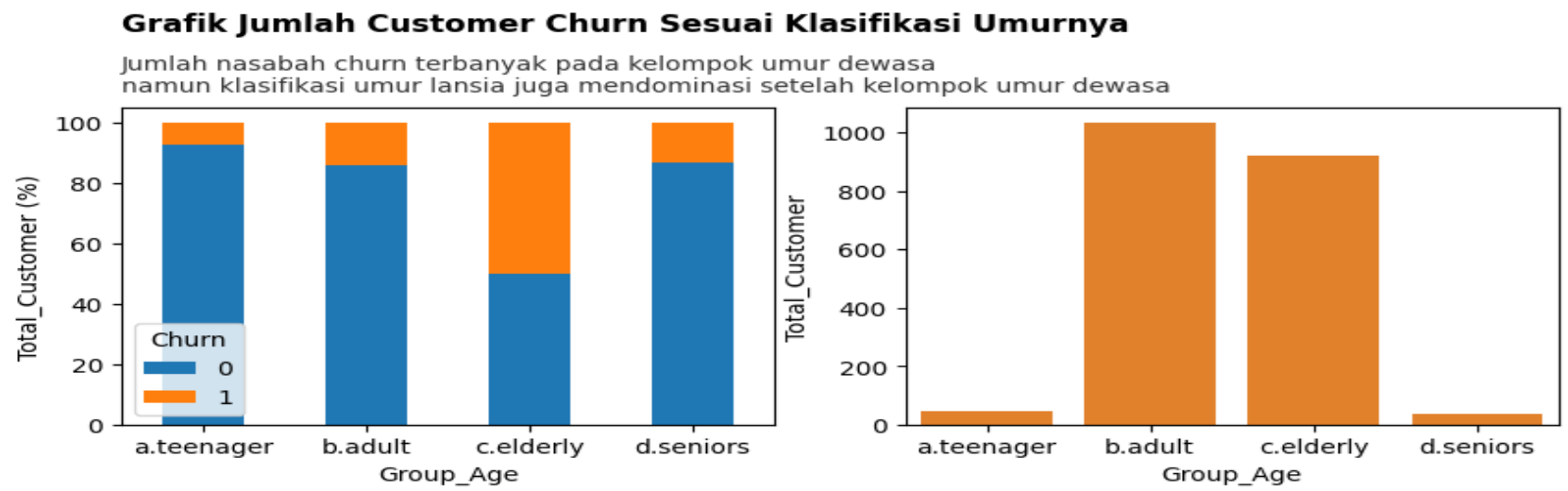
# 2. EDA & Insight

**Kelompok umur manakah yang paling banyak memiliki customer churn?**

Berdasarkan Jurnal Urgensi Revisi Undang-Undang tentang Kesejahteraan Lanjut Usia (http://jurnal.dpr.go.id/index.php/aspirasi/index)

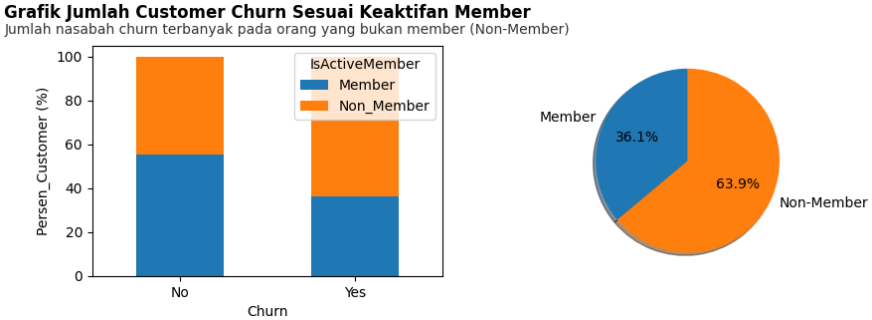
Penentuan range umur dapat dikelompokkan sebagai berikut:

- Umur 12 - 25 = Remaja (teenager)
- Umur 26 - 45 = Dewasa (adult)
- Umur 46 - 65 = Lansia (elderly)
- Umur > 65 = Manula (seniors)



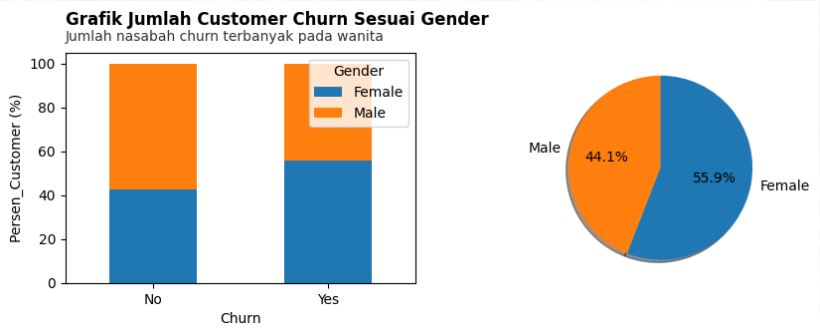

Dari grafik diatas, terlihat bahwa paling banyak customer churn adalah kelompok **Adult** dan **Eldery**

## Customer Bank yang churn berdasarkan keaktifan member



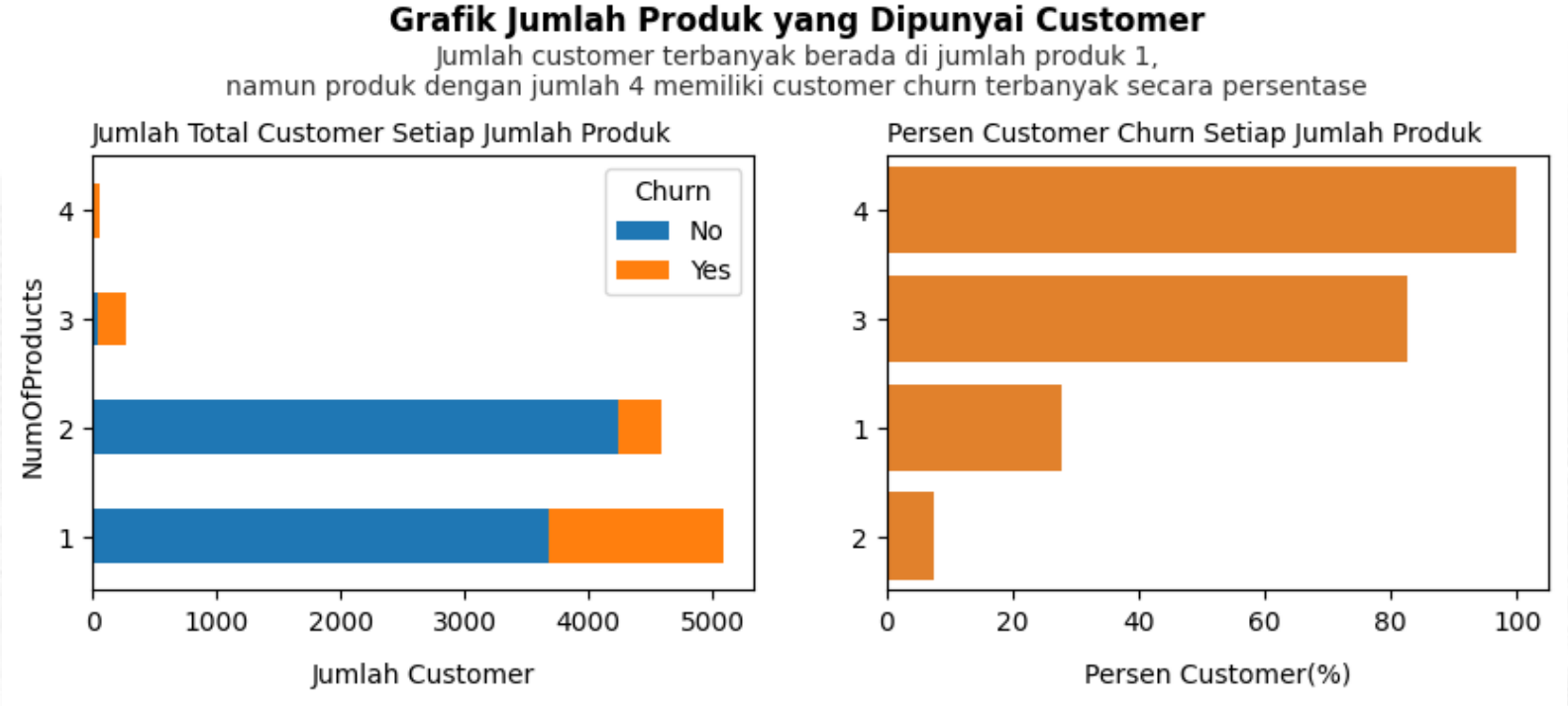

Dari grafik diatas terlihat bahwa **customer yang bukan member aktif** (63,9 %) lebih banyak yang churn dibanding dengan yang **aktif** (36,1 %)

## Customer Bank yang churn berdasarkan gender




Dari grafik diatas terlihat bahwa **customer perempuan (female) sebesar 55,9%** lebih banyak yang churn dibanding laki-laki (male) sebesar 44,1 %

# Customer Bank berdasarkan Kepemilikan Produk




Dari grafik diatas terlihat bahwa paling banyak customer bank memiliki **1 jenis produk** yaitu sebanyak **5.084 customer.** Tetapi untuk presentasi customer bank yang churn paling banyak adalah customer yang memiliki **4 produk.**.

# 3. Pre-processing

## Data Cleansing

- Handle Missing Value
- Handle Duplicated Data
- Handle Outlier

## Feature Engineering

- Feature Selection
- Feature Extraction
- Feature Encoding
- Feature Transformation
- Handle Class Imbalance

# 3.1 Data Cleansing

## Handle Missing Value, Duplicated Data & Outlier

### Handle Missing Value

```
df.isna().sum() # menampilkan jumlah missing value setiap kolom
```

```
RowNumber          0
CustomerId         0
Surname            0
CreditScore        0
Geography          0
Gender             0
Age                0
Tenure             0
Balance            0
NumOfProducts      0
HasCrCard          0
IsActiveMember     0
EstimatedSalary    0
Churn              0
Group_Age          0
dtype: int64
```

Semua tipe data sudah sesuai dan tidak ada data kosong

### Handle Duplicated Data

```
df.duplicated().sum() # check data duplikat
```

```
0
```

Tidak ada data yang duplikat pada dataset

### Handle Outlier

```
perbedaan jumlah data menggunakan z   : 3.19%
perbedaan jumlah data menggunakan IQR : 6.64%
```

Pada kasus ini, outlier kebanyakan terdapat pada kolom age, dimana distribusi dari umur nasabah masih tergolong wajar. Pada model ini outlier removal tidak dilakukan

# 3.2 Feature Engineering

## Feature Selection & Feature Extraction

### Feature Selection

Menghapus kolom 'RowNumber', 'Surname', 'CustomerId' karena tidak penting terhadap target

### Feature Extraction

**Balance_Category** :

Low = 0 - 97199

Medium = 97199 - 127644

High = 127644 - 250898

**CreditScore_Range**:

Poor = 349 - 584

Fair = 584 - 652

Good = 652 - 719

Excellent = 719 - 850

**Tenure_Category**:

Short Term = 0 - 3

Medium Term = 3 - 5

Long Term = 5 - 10

**Salary_Range**:

Low = 0 - 51002

Medium = 51002 - 100194

High = 100194 - 149388

### Feature Tambahan

Menambahkan kolom baru berupa TenureByAge dan CreditScoreGivenAge

# 3.2 Feature Engineering

## Feature Encoding

- **One Hot Encoding**

Dilakukan pada kolom Geography menjadi tiga fitur yaitu France, Germany dan Spain

- **Label Encoding**

Dilakukan pada Gender, Grup Age, Balance Category, CreditScoreRange, dan Salary Range

| Geography_France | Geography_Germany | Geography_Spain |
|---|---|---|
| 1 | 0 | 0 |
| 0 | 0 | 1 |
| 1 | 0 | 0 |
| 1 | 0 | 0 |
| 0 | 0 | 1 |

| Gender | Group_Age | Balance_Category | CreditScore_Range | Tenure_Category | Salary_Range |
|---|---|---|---|---|---|
| 1 | 1 | 0 | 1 | 0 | 2 |
| 1 | 1 | 0 | 1 | 0 | 2 |
| 1 | 1 | 2 | 0 | 2 | 2 |
| 1 | 1 | 0 | 2 | 0 | 1 |
| 1 | 1 | 1 | 3 | 0 | 1 |
| ... | ... | ... | ... | ... | ... |
| 0 | 1 | 0 | 3 | 1 | 1 |

# 3.2 Feature Engineering

## Feature Transformation & Handle Class Imbalance

### Feature Transformation

Menggunakan Standardisasi karena distribusi data relatif normal dan standardisasi lebih robust terhadap outlier

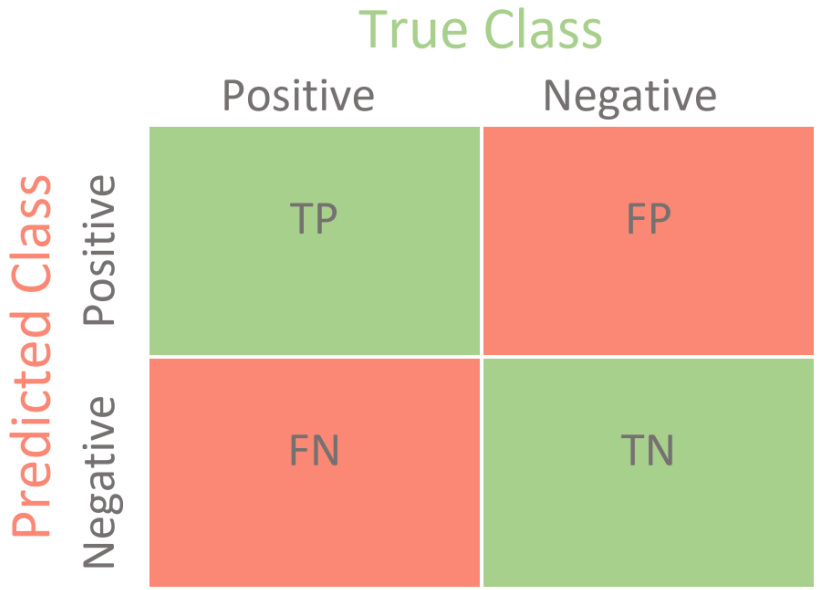
### Handle Class Imbalance

Menggunakan Undersampling karena target prediksi category churn (value=1) lebih sedikit, jika mengunakan oversampling akan menyebabkan bias karena data sintesis yang tergenerate akan lebih banyak

```
Class distribution before oversampling:
0    6356
1    1644
Name: Churn, dtype: int64
```

```
Class distribution after undersampling:
0    1644
1    1644
Name: Churn, dtype: int64
```

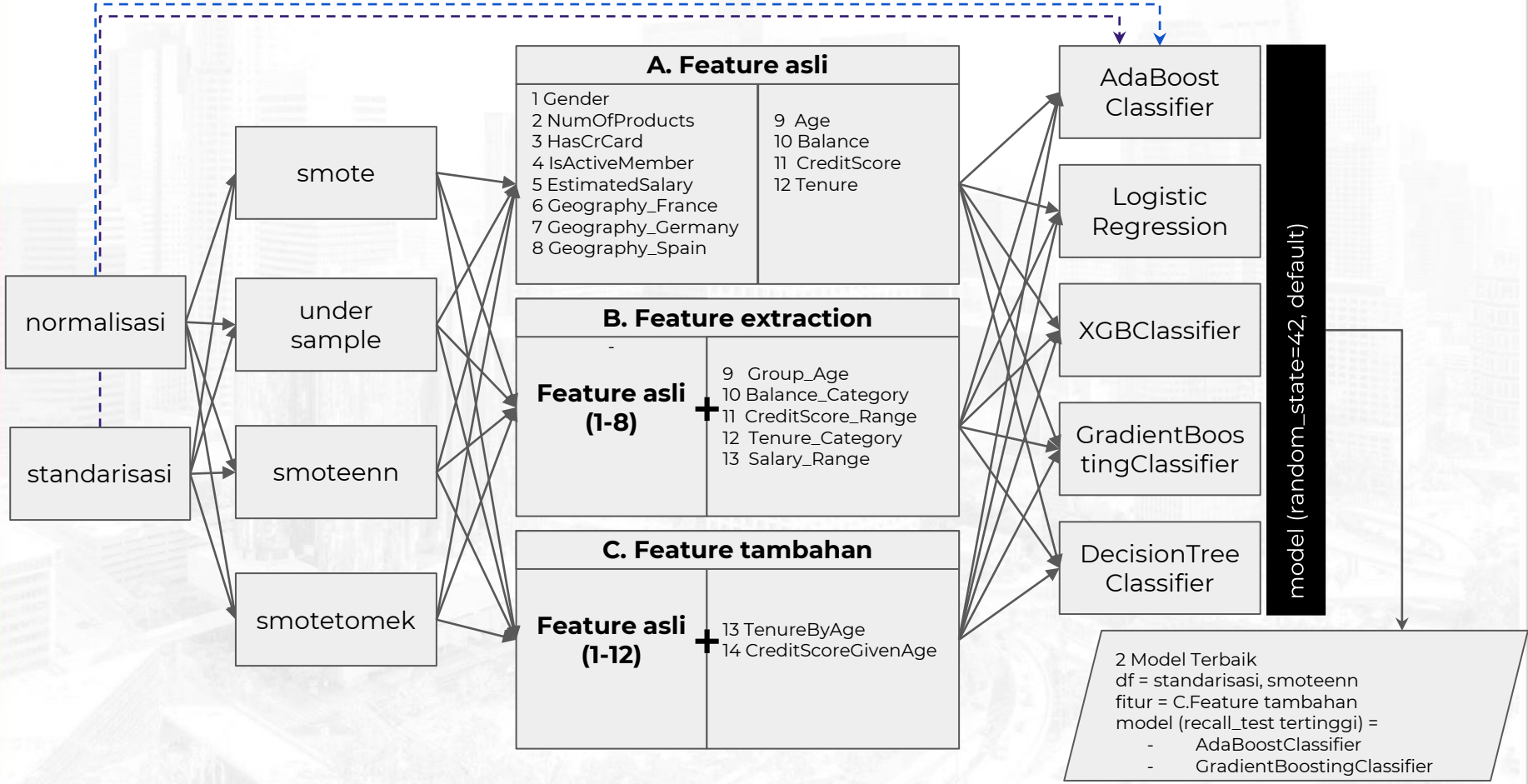
# 4.1 Modelling - Pemilihan Metrik untuk Evaluasi




**Recall**

**Apa alasannya ?**

# 4.2 Modelling - Modelling Experiments



# 4.3 Modelling - Modelling Hypertuning Parameter

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## parameter default

AdaBoostClassifier (random_state=42,default)

| Parameter | Nilai (%) |
|---|---|
| recall train | 90.4 |
| recall test | 82.4 |

GradientBoostingClassifier (random_state=42,default)

| Parameter | Nilai (%) |
|---|---|
| recall train | 93.6 |
| recall test | 81.4 |

Hasil Tuning

| AdaBoost Classifier | Manual | GridSearchCV |
|---|---|---|
| recall train (%) | 88.2 | 90.7 |
| recall test (%) | 84.7 | 86.5 |
| recall train (%) (cross validation) | 83.4 | 78.6 |
| recall test (%) (cross validation) | 83.2 | 78.3 |

| Gradient Boosting | Manual | GridSearchCV |
|---|---|---|
| recall train (%) | 90.1 | 100 |
| recall test (%) | 83.7 | 100 |
| recall train (%) (cross validation) | 84.4 | 87 |
| recall test (%) (cross validation) | 85.1 | 86.2 |

?

## Hypertuning Parameter

- Manual Tuning
- GridSearchCV

| AdaBoost Classifier | Manual | GridSearchCV |
|---|---|---|
| algoritma | SAMME.R | SAMME.R |
| n_estimator | 10 | 200 |
| learning_rate | 0.8 | 0.01 |

| GradientBoosting Classifier | Manual | GridSearchCV |
|---|---|---|
| n_estimator | 12 | 10 |
| learning_rate | 0.2 | 0.01 |
| max_depth | 3 | 3 |
| min_samples_leaf | 65 | 1 |
| min_samples_split | default | 2 |
| subsample | default | 0.8 |

# 4.3 Modelling - Modelling Hypertuning Parameter (Lanjutan)

AdaBoostClassifier Hypertuning (manual)

report test :

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| 0 | 0.95 | 0.69 | 0.80 | 1607 |
| 1 | 0.40 | 0.85 | 0.54 | 393 |
| accuracy | | | 0.72 | 2000 |
| macro avg | 0.67 | 0.77 | 0.67 | 2000 |
| weighted avg | 0.84 | 0.72 | 0.75 | 2000 |

report train :

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| 0 | 0.84 | 0.83 | 0.83 | 4111 |
| 1 | 0.87 | 0.88 | 0.88 | 5531 |
| accuracy | | | 0.86 | 9642 |
| macro avg | 0.86 | 0.86 | 0.86 | 9642 |
| weighted avg | 0.86 | 0.86 | 0.86 | 9642 |

GradientBoostingClassifier Hypertuning (GridSearchCV)

report test :

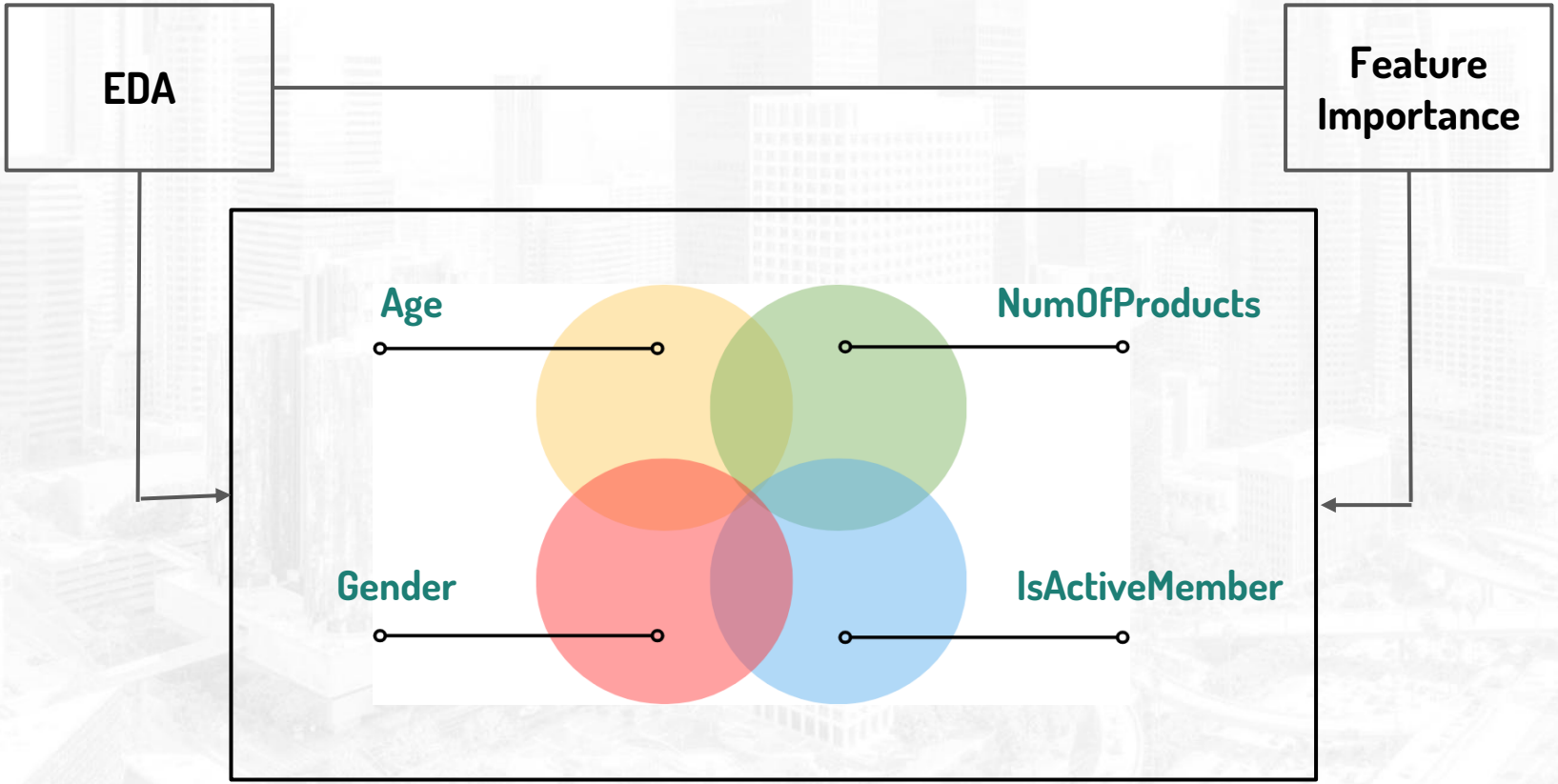
| | precision | recall | f1-score | support |
|---|---|---|---|---|
| 0 | 0.00 | 0.00 | 0.00 | 1607 |
| 1 | 0.20 | 1.00 | 0.33 | 393 |
| accuracy | | | 0.20 | 2000 |
| macro avg | 0.10 | 0.50 | 0.16 | 2000 |
| weighted avg | 0.04 | 0.20 | 0.06 | 2000 |

report train :

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| 0 | 0.00 | 0.00 | 0.00 | 4111 |
| 1 | 0.57 | 1.00 | 0.73 | 5531 |
| accuracy | | | 0.57 | 9642 |
| macro avg | 0.29 | 0.50 | 0.36 | 9642 |
| weighted avg | 0.33 | 0.57 | 0.42 | 9642 |

Model terbaik adalah dengan menggunan AdaBoostClassifier
Alasan : setelah dibandingkan dengan GradientBoosting, Gradient Boosting memiliki recall yang tinggi namun, recall 0 bernilai 0%. Artinya bahwa gradient boosting memprediksi banyak nasabah yang churn walaupun sebenarnya nasabah tersebut tidak churn

# 5. Executive Summary & Recommendation



# 5.1 Actionable Insights

1

**Age**
Umur Customer

**Observasi**

- Kelompok umur Elderly 46-65 tahun memiliki tingkat churn yang tinggi

**Survei Khusus**

Menyesuaikan produk dan layanan yang relevan dengan kebutuhan dan preferensi Customer

# 5.1 Actionable Insights

2

**NumOfProducts**
Jumlah Produk yang digunakan Customer

**Observasi**

- Customer dengan 1 produk memiliki jumlah churn paling banyak
- Customer dengan 4 produk memiliki persentase/tingkat churn paling tinggi

**Program Loyalitas**

Memberikan insentif (tambahan manfaat) untuk penggunaan lebih banyak produk

# 5.1 Actionable Insights

3

**IsActiveMember**
Nasabah yang aktif menggunakan produk dan layanan

**Observasi**

- Customer yang tidak aktif memiliki tingkat churn tinggi

**Notifikasi Rutin**

- Memberikan reward penggunaan produk kembali
- Memberikan poin untuk setiap transaksi

# 5.1 Actionable Insights

4

**Gender**
Jenis Kelamin Customer

**Observasi**

- Customer wanita memiliki tingkat churn tinggi

**Evaluasi Produk dan Layanan**

Mengembangkan produk dan layanan khusus yang lebih relevan dengan kebutuhan dan preferensi customer wanita

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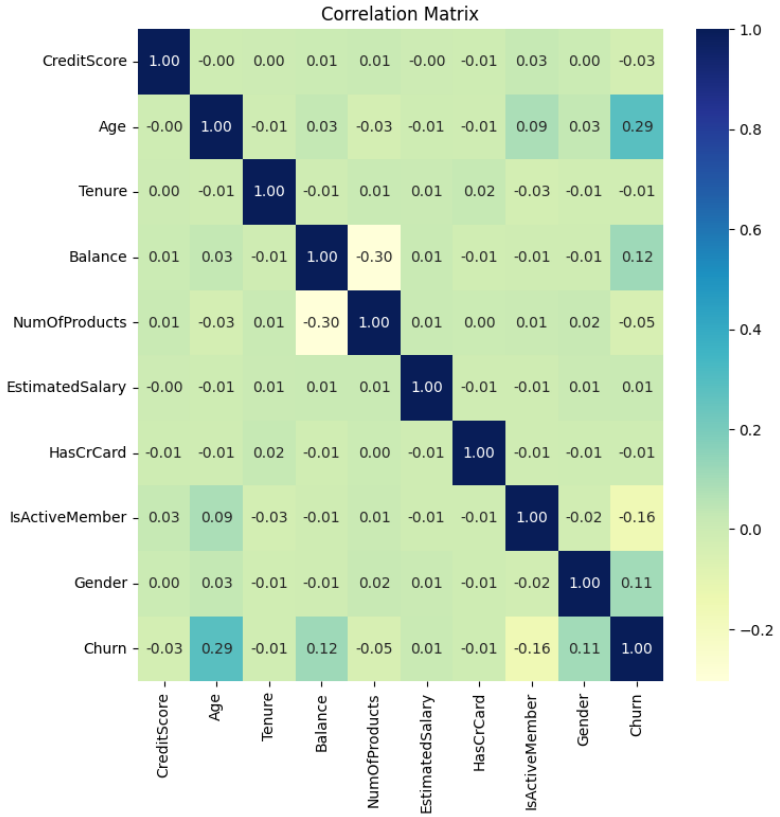
# TERIMA KASIH!

# 2.1 Exploratory Data Analysis (EDA)




## Multivariate Analysis

- **Feature to Feature**
  - ‘Balance’ dan ‘NumOfProducts’ berkorelasi negative (korelasi = -0.30)
- **Feature to Label (“Churn”)**
  - Korelasi positive:
    - ‘Age’ (korelasi = 0.29)
    - ‘Balance’ (korelasi = 0.12)
    - ‘Gender’ (korelasi = 0.11)
  - Korelasi negative:
    - ‘IsActiveMember’ (korelasi = -0.16)

# Fitur Asli

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| | data | list_method | prec_train | prec_test | recall_train | recall_test | AUC_train | AUC_test |
|---|---|---|---|---|---|---|---|---|
| 0 | df9_x_train | AdaBoostClassifier | 90.254 | 43.801 | 90.418 | 82.697 | 96.084 | 84.729 |
| 1 | df7_x_train | LogisticRegression | 80.729 | 32.242 | 84.405 | 80.153 | 85.866 | 77.819 |
| 2 | df9_x_train | GradientBoostingClassifier | 93.615 | 46.244 | 93.582 | 79.898 | 98.049 | 86.166 |
| 3 | df9_x_train | LogisticRegression | 80.465 | 33.018 | 82.661 | 79.898 | 85.592 | 77.877 |
| 4 | df6_x_train | GradientBoostingClassifier | 83.119 | 50.000 | 78.771 | 79.389 | 89.995 | 86.823 |
| 5 | df4_x_train | GradientBoostingClassifier | 83.119 | 50.000 | 78.771 | 79.389 | 89.995 | 86.823 |
| 6 | df7_x_train | GradientBoostingClassifier | 92.900 | 46.837 | 93.834 | 79.135 | 97.818 | 86.334 |
| 7 | df7_x_train | AdaBoostClassifier | 90.315 | 44.556 | 91.292 | 79.135 | 95.958 | 84.638 |
| 8 | df6_x_train | AdaBoostClassifier | 77.968 | 46.341 | 74.696 | 77.354 | 85.885 | 84.409 |
| 9 | df4_x_train | AdaBoostClassifier | 77.968 | 46.341 | 74.696 | 77.354 | 85.885 | 84.409 |
| 10 | df6_x_train | XGBClassifier | 98.960 | 45.706 | 98.358 | 75.827 | 99.898 | 84.625 |
| 11 | df4_x_train | XGBClassifier | 98.960 | 45.706 | 98.358 | 75.827 | 99.898 | 84.625 |
| 12 | df9_x_train | XGBClassifier | 99.764 | 52.788 | 99.530 | 72.265 | 99.992 | 85.552 |
| 13 | df3_x_train | AdaBoostClassifier | 83.674 | 50.536 | 84.346 | 72.010 | 92.116 | 84.278 |
| 14 | df6_x_train | LogisticRegression | 70.900 | 38.897 | 69.951 | 71.756 | 77.251 | 78.110 |
| 15 | df7_x_train | XGBClassifier | 99.677 | 53.935 | 99.469 | 71.501 | 99.989 | 85.433 |
| 16 | df3_x_train | LogisticRegression | 71.312 | 38.943 | 70.359 | 71.247 | 77.590 | 78.121 |
| 17 | df8_x_train | LogisticRegression | 71.637 | 38.997 | 70.676 | 71.247 | 77.945 | 78.128 |

# Fitur Extraction

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| | data | list_method | prec_train | prec_test | recall_train | recall_test | AUC_train | AUC_test |
|---|---|---|---|---|---|---|---|---|
| 0 | df9_x_train | AdaBoostClassifier | 88.704 | 40.293 | 90.436 | 77.099 | 95.300 | 82.292 |
| 1 | df7_x_train | LogisticRegression | 78.450 | 30.101 | 80.250 | 75.827 | 81.761 | 73.467 |
| 2 | df9_x_train | LogisticRegression | 77.857 | 30.512 | 78.828 | 74.300 | 80.991 | 73.457 |
| 3 | df7_x_train | AdaBoostClassifier | 91.194 | 45.928 | 90.969 | 71.756 | 95.894 | 82.361 |
| 4 | df6_x_train | AdaBoostClassifier | 76.451 | 43.012 | 71.290 | 70.483 | 82.916 | 81.235 |
| 5 | df4_x_train | AdaBoostClassifier | 76.451 | 43.012 | 71.290 | 70.483 | 82.916 | 81.235 |
| 6 | df9_x_train | GradientBoostingClassifier | 94.299 | 49.104 | 92.406 | 69.720 | 97.565 | 82.484 |
| 7 | df6_x_train | XGBClassifier | 92.467 | 39.000 | 89.599 | 69.466 | 97.604 | 78.788 |
| 8 | df4_x_train | XGBClassifier | 92.467 | 39.000 | 89.599 | 69.466 | 97.604 | 78.788 |
| 9 | df6_x_train | GradientBoostingClassifier | 80.000 | 45.777 | 73.236 | 68.957 | 86.164 | 82.025 |
| 10 | df4_x_train | GradientBoostingClassifier | 80.000 | 45.700 | 73.236 | 68.957 | 86.164 | 82.025 |
| 11 | df7_x_train | GradientBoostingClassifier | 94.155 | 50.482 | 92.297 | 66.667 | 97.670 | 82.642 |
| 12 | df4_x_train | DecisionTreeClassifier | 100.000 | 32.952 | 99.392 | 65.903 | 99.998 | 66.502 |
| 13 | df6_x_train | DecisionTreeClassifier | 100.000 | 32.700 | 99.392 | 65.649 | 99.998 | 66.239 |
| 14 | df4_x_train | LogisticRegression | 70.968 | 35.989 | 64.234 | 64.377 | 73.786 | 73.756 |
| 15 | df9_x_train | DecisionTreeClassifier | 100.000 | 41.653 | 99.873 | 64.122 | 100.000 | 71.067 |
| 16 | df5_x_train | LogisticRegression | 70.475 | 35.806 | 65.308 | 63.868 | 73.457 | 73.768 |
| 17 | df10_x_train | LogisticRegression | 70.649 | 35.857 | 65.524 | 63.868 | 73.638 | 73.761 |

# Fitur Tambahan

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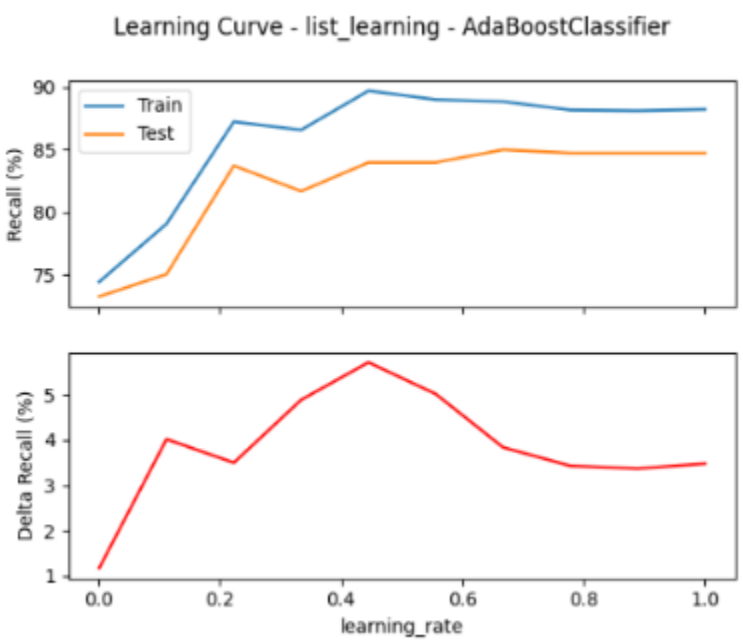
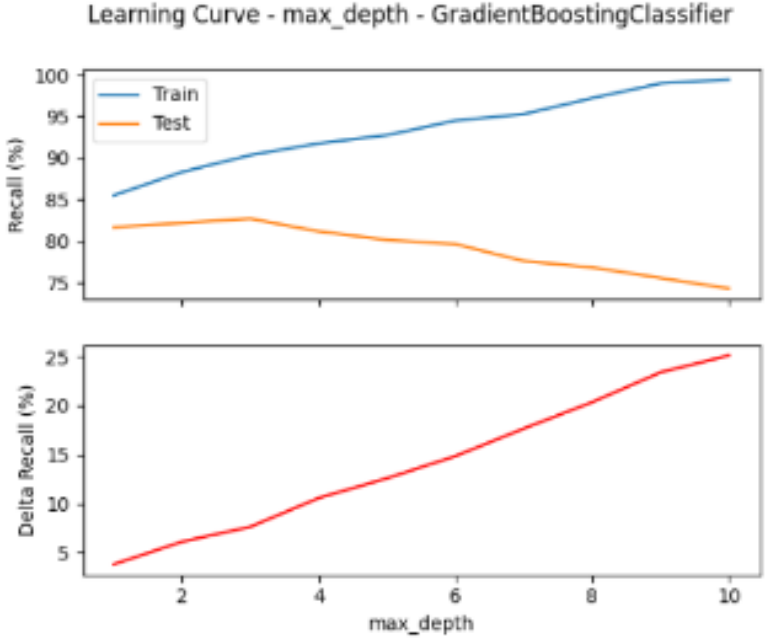
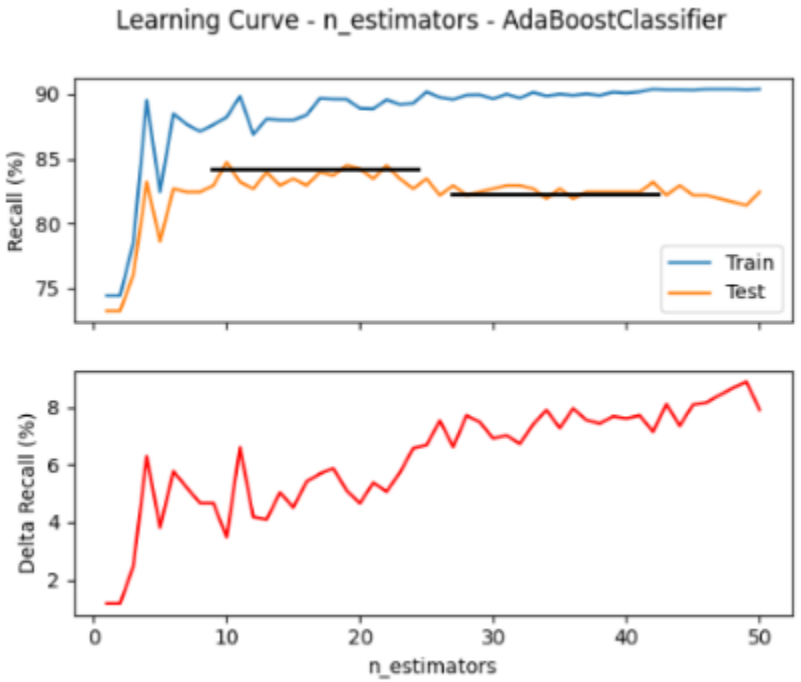
| | data | list_method | acc_train | acc_test | prec_train | prec_test | recall_train | recall_test | AUC_train | AUC_test |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | df9_x_train | AdaBoostClassifier | 88.965 | 75.35 | 90.396 | 43.316 | 90.363 | 82.443 | 96.187 | 85.097 |
| 1 | df9_x_train | GradientBoostingClassifier | 92.709 | 77.50 | 93.716 | 45.911 | 93.564 | 81.425 | 98.051 | 86.315 |
| 2 | df7_x_train | LogisticRegression | 78.634 | 61.75 | 79.986 | 31.511 | 84.462 | 80.662 | 86.044 | 77.851 |
| 3 | df9_x_train | LogisticRegression | 78.117 | 62.55 | 79.681 | 31.874 | 83.023 | 79.644 | 85.847 | 77.941 |
| 4 | df6_x_train | GradientBoostingClassifier | 81.569 | 80.20 | 83.614 | 49.761 | 78.528 | 79.389 | 90.291 | 86.478 |
| 5 | df7_x_train | GradientBoostingClassifier | 92.141 | 78.10 | 92.922 | 46.637 | 93.644 | 79.389 | 97.758 | 86.211 |
| 6 | df4_x_train | GradientBoostingClassifier | 81.569 | 80.25 | 83.614 | 49.840 | 78.528 | 79.389 | 90.291 | 86.481 |
| 7 | df7_x_train | AdaBoostClassifier | 89.223 | 76.55 | 90.315 | 44.556 | 91.292 | 79.135 | 95.958 | 84.638 |
| 8 | df6_x_train | AdaBoostClassifier | 77.342 | 77.50 | 78.324 | 45.714 | 75.608 | 77.354 | 85.982 | 84.381 |
| 9 | df4_x_train | AdaBoostClassifier | 77.342 | 77.50 | 78.324 | 45.714 | 75.608 | 77.354 | 85.982 | 84.381 |
| 10 | df6_x_train | XGBClassifier | 99.179 | 75.50 | 99.209 | 42.836 | 99.148 | 73.791 | 99.963 | 84.476 |
| 11 | df4_x_train | XGBClassifier | 99.179 | 75.50 | 99.209 | 42.836 | 99.148 | 73.791 | 99.963 | 84.476 |
| 12 | df5_x_train | LogisticRegression | 70.839 | 71.35 | 70.380 | 38.064 | 71.963 | 73.028 | 77.885 | 78.216 |
| 13 | df4_x_train | LogisticRegression | 70.620 | 71.50 | 70.348 | 38.184 | 71.290 | 72.774 | 77.254 | 78.132 |
| 14 | df6_x_train | LogisticRegression | 70.803 | 71.05 | 70.652 | 37.731 | 71.168 | 72.774 | 77.308 | 78.168 |
| 15 | df10_x_train | LogisticRegression | 71.000 | 71.50 | 70.550 | 38.184 | 72.095 | 72.774 | 78.109 | 78.231 |
| 16 | df9_x_train | XGBClassifier | 99.751 | 81.80 | 99.873 | 52.690 | 99.693 | 72.265 | 99.997 | 85.567 |

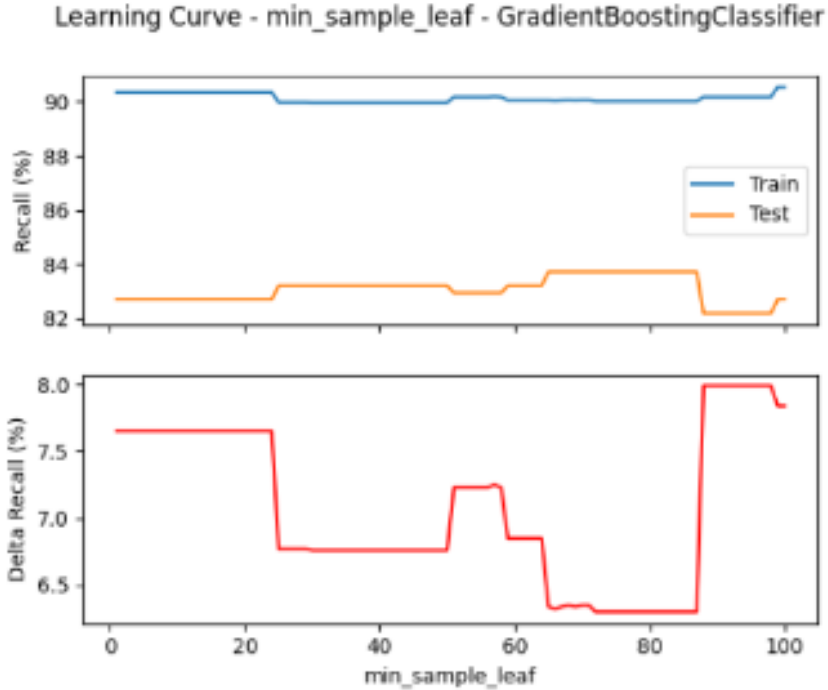
# Sampel Learning Curve



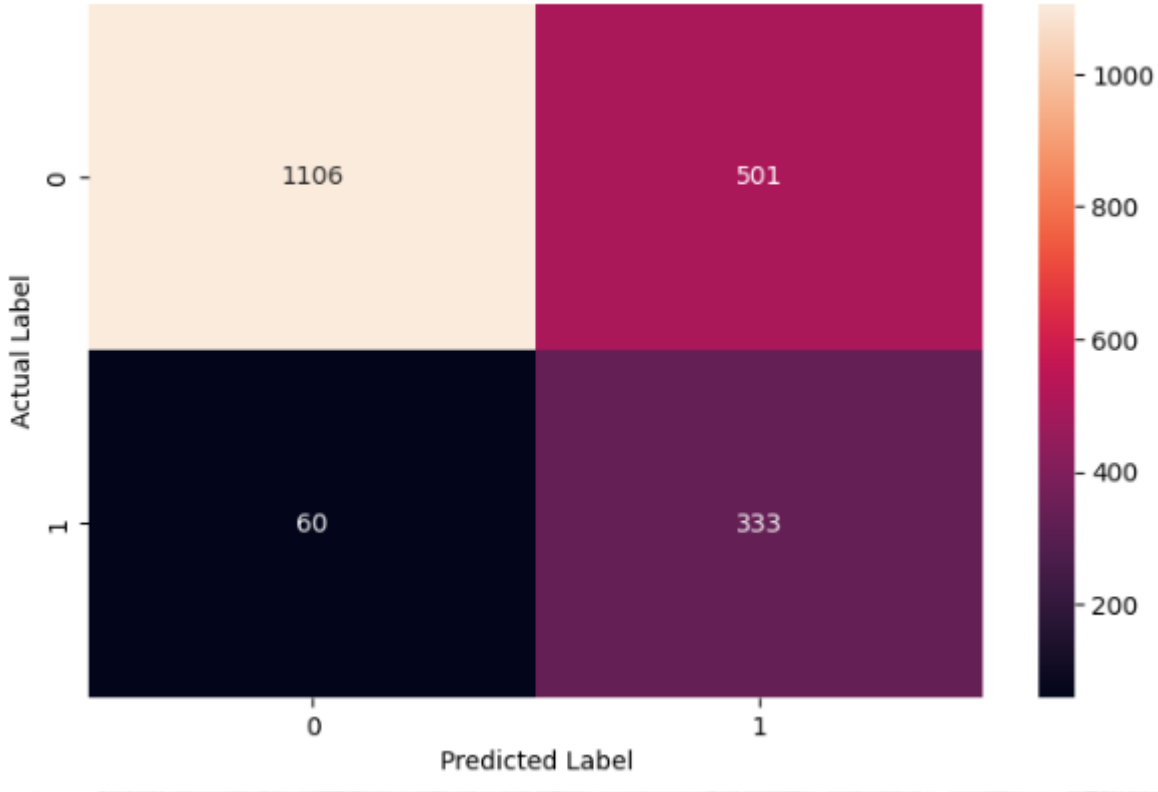



# Sampel Learning Curve



# Confusion Matrix



# 5. Executive Summary & Recommendation