# Forcasting and nowcasting

## Towards predicting the next financial crisis

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"Data modeling is where art meets science. It requires the precision of a mathematician, the creativity of an artist, and the judgment of an experienced craftsman to transform raw data into valuable insights.“

Gepetto di Firenze

# Data exploration

Mixed frequency data (daily, monthly, quarterly):

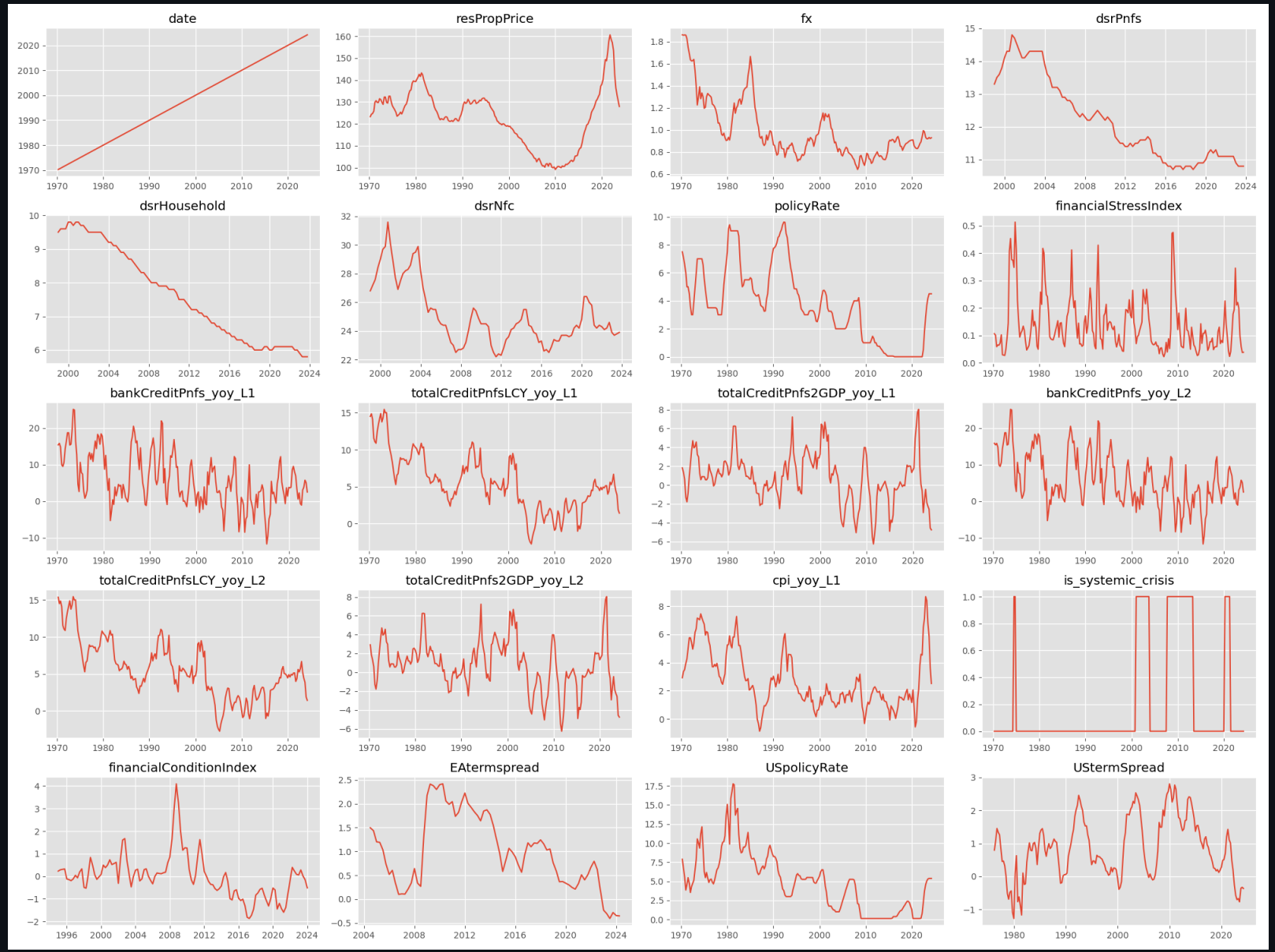
- Global Liquidity Indicators
- Bank Loans
- Real Residential Property Prices
- Consumer Prices
- Bank Credit to PNFS
- Total Credit to PNFS
- Debt service ratio
- Policy Rate
- Yield Curve data
- Exchange rates

# Data preperation pipeline

```
COUNTRY = 'DE'
FILE = './data/data_input_quarterly.csv'
TIME_INTERVALL = "quarterly"

df = read_data(FILE, COUNTRY)
df = get_processed_df(df, COUNTRY,TIME_INTERVALL, verbose=True)
df = subselect_data(df)
```

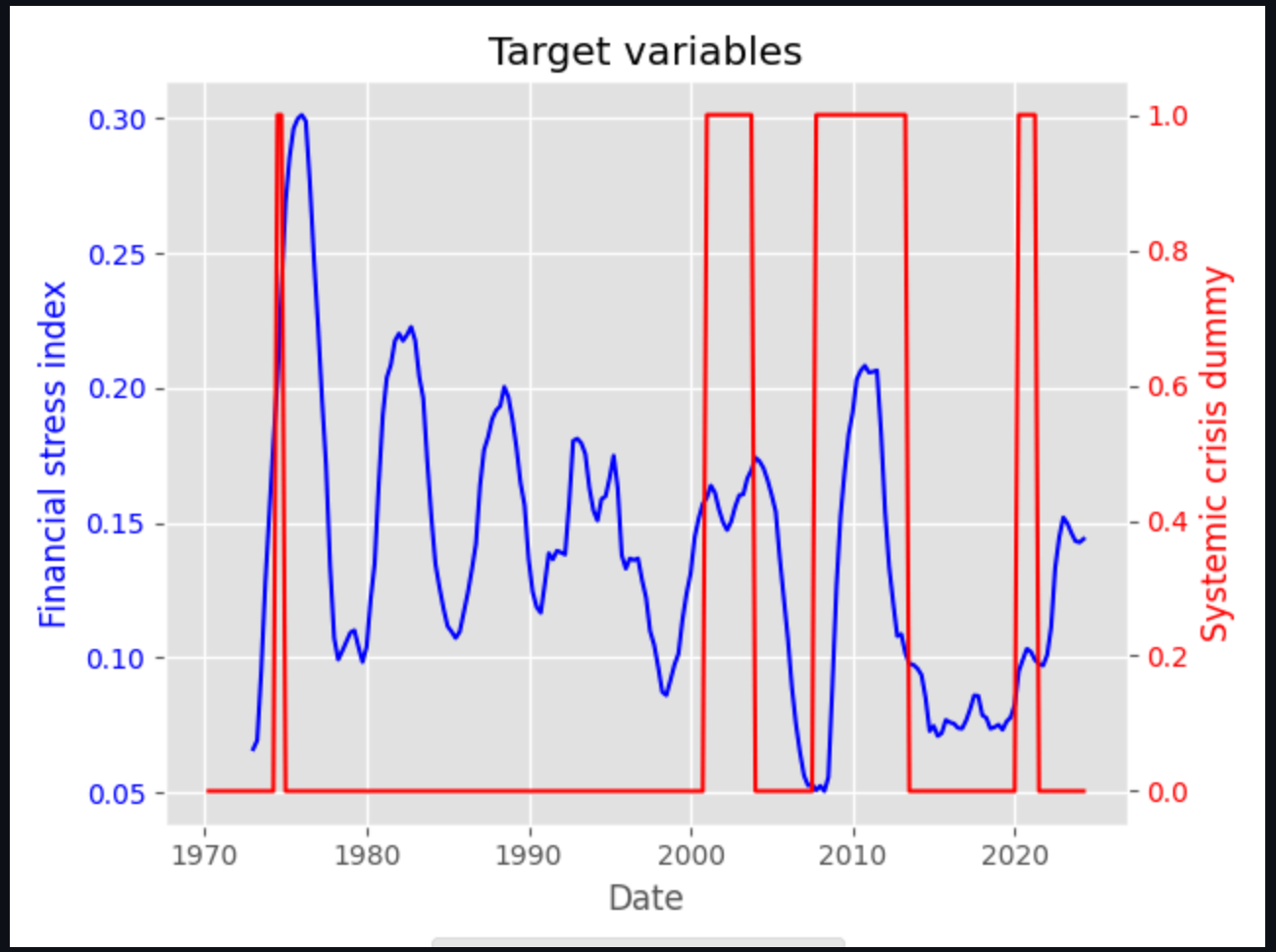
# Data preperation pipeline

```
df = give_sliding_window_volatility(df, 4, "fx")
df = calculate_growth_rates(df, yoy_variables)
df = get_lagged_variables(df, 2, lag2_variables)
df = add_missing_variables(df, country)
df = add_systemic_risk_dummy_with_df(df, df_dummies, country)
```


date
resPropPrice
fx
dsrPnfs
dsrHousehold
dsrNfc
policyRate
financialStressIndex
bankCreditPnfs_yoy_L1
totalCreditPnfsLCY_yoy_L1
totalCreditPnfs2GDP_yoy_L1
bankCreditPnfs_yoy_L2
totalCreditPnfsLCY_yoy_L2
totalCreditPnfs2GDP_yoy_L2
cpi_yoy_L1
is_systemic_crisis
financialConditionIndex
EAtermspread
USpolicyRate
UStermSpread

# Target value

- Systemic crisis *(dummy)*
- Systemic stress *continuous*
- Inflation *?*


Target variables
Financial stress index
Systemic crisis dummy
Date
0.30
0.25
0.20
0.15
0.10
0.05
1.0
0.8
0.6
0.4
0.2
0.0
1970
1980
1990
2000
2010
2020

# Benchmarking (with MLflow)

- define train and test datasets
- define forecast horizon
- define set of regressors

## Models

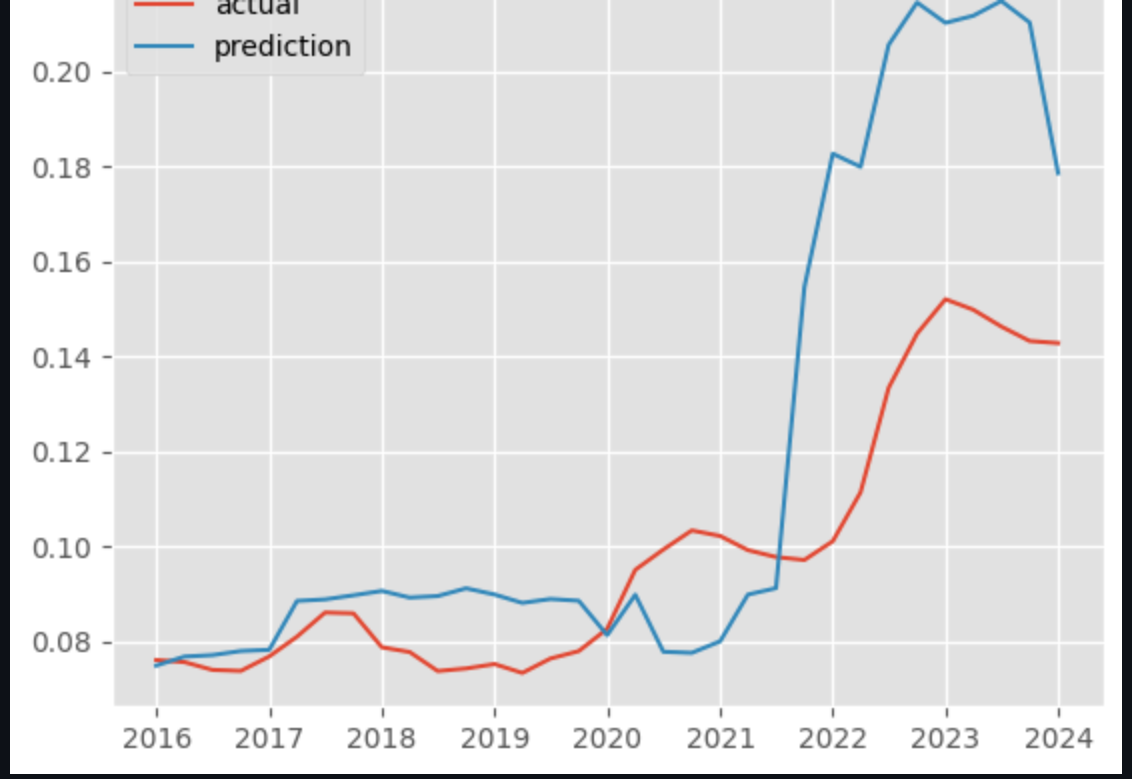
- OLS
- Random Forest
- Ridge
- XGBoost
- Logistic Regression

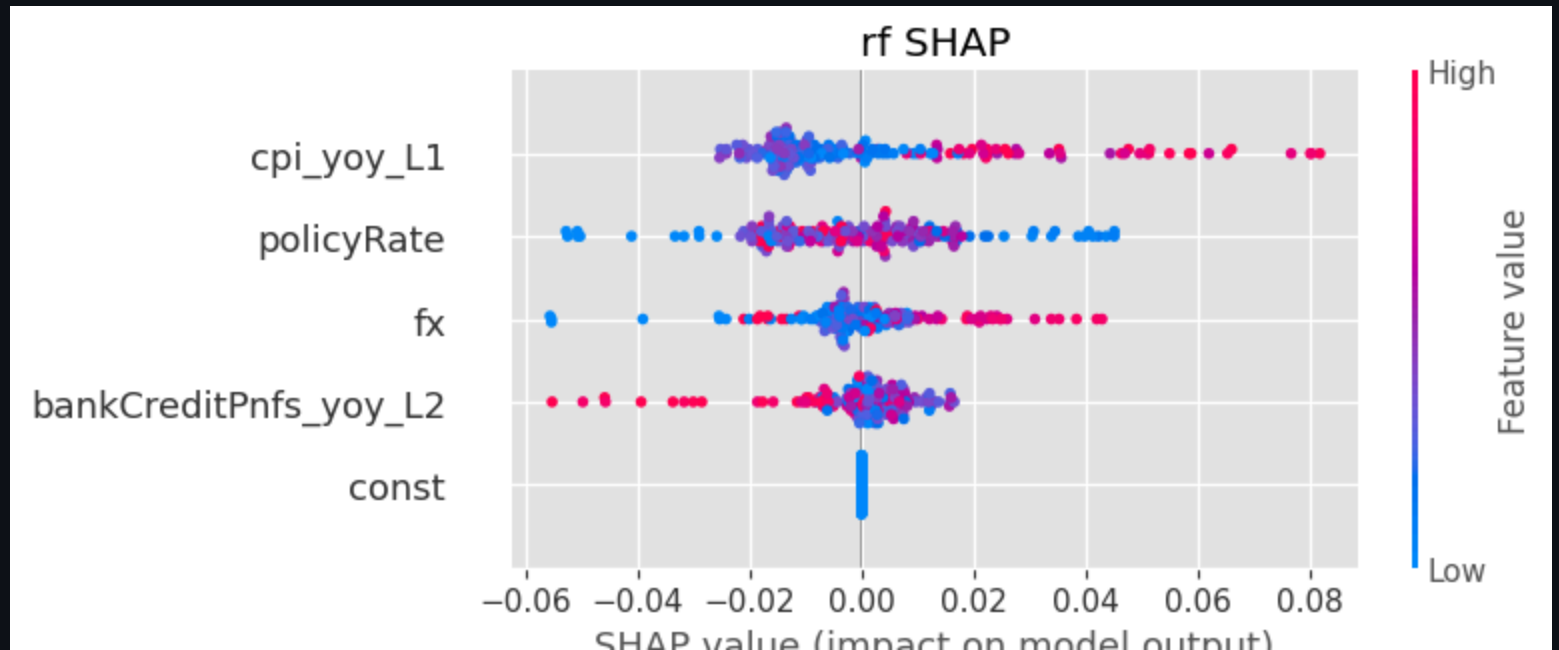
# Hyperparameters tuning

- GridSearchCV with TimeSeriesSplit

# Model interpretability and evaluation

- Shapley values
- Permutation importance
- RMSE
- F1-score
- ROC AUC
- R-squared (pseudo)


actual
prediction
0.20
0.18
0.16
0.14
0.12
0.10
0.08
2016
2017
2018
2019
2020
2021
2022
2023
2024


rf SHAP
cpi_yoy_L1
policyRate
fx
bankCreditPnfs_yoy_L2
const
−0.06
−0.04
−0.02
0.00
0.02
0.04
0.06
0.08
SHAP value (impact on model output)
High
Feature value
Low

# PCA intuition

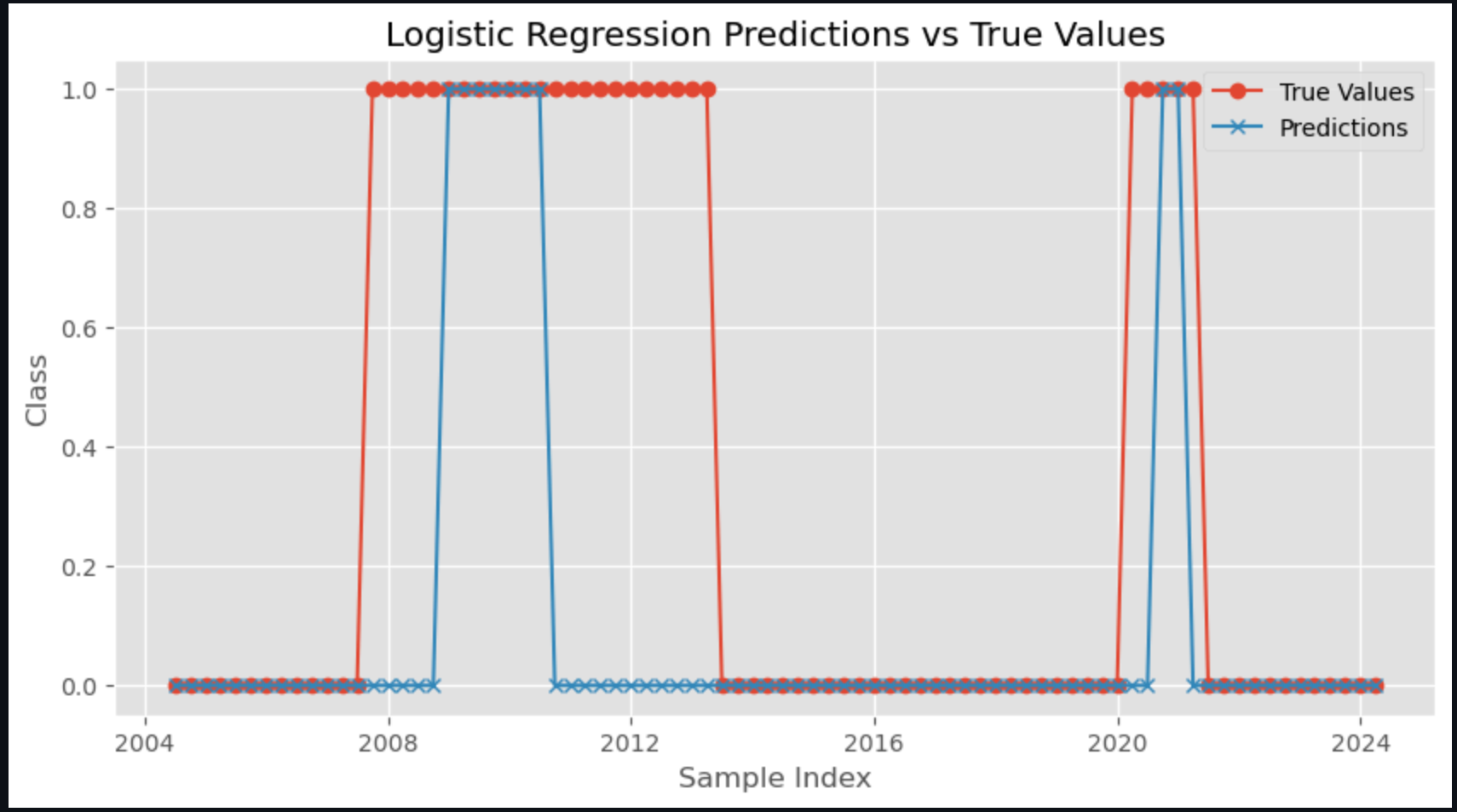
- Principal component analysis (PCA) reduces the number of dimensions in large datasets to principal components
- Retain original information.
- Tansforming potentially correlated variables into a smaller set of variables, called principal components.

(between us: just let Sklearn do the magic)

# PCA Pipeline

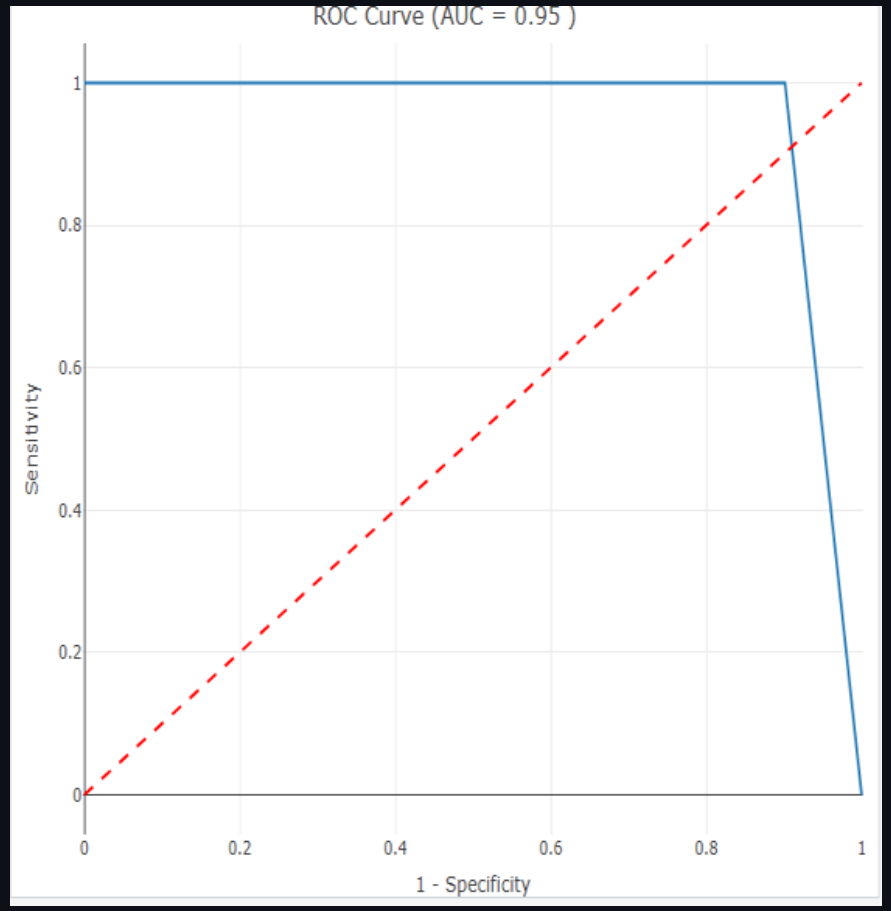
```
from sklearn.decomposition import PCA

pca = PCA()
principalComponents = pca.fit_transform(X_SCALED)
PCA_components = pd.DataFrame(principalComponents)

explained_variance_ratio = pca.explained_variance_ratio_
_target_variance = 0.80
_current_variance = 0.0
_num_features = 0

while _current_variance < _target_variance:
    _current_variance += explained_variance_ratio[num_features]
    _num_features += 1
```

# PCA - preprocessed result




It seems to be too late, however, COVID-19 is exogenous and could not have been predicted. However, result is stable

Out of the 5 models observed, it was built an ensemble of them all having an optimisation function that applies different weights in order to get a better RMSE for the ensemble built




In general, an AUC of 0.5 suggests no discrimination (i.e., ability to diagnose patients with and without the disease or condition based on the test), 0.7 to 0.8 is considered

# Next steps

- Expand country coverage
- Try aggregate model
- Increase data frequency
- Try different forecast horizons
- Improve feature selection process
- Benchmark against commercial forecast (eg Bloomberg, Turnleaf)
- Improve model interpretability
- Public GIT repo to share knowledge amongst institutions