# Bankruptcy Detection Model

4 859,22 12 341,59 9 558,37 555,33 2 234,43 228,99 173,27 4,85 90

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# **CONTENTS**

- Who am I?
- Bankruptcy and Covid
- Reasons for Bankruptcies
- Model and Analysis
- Conclusions and Recommendations





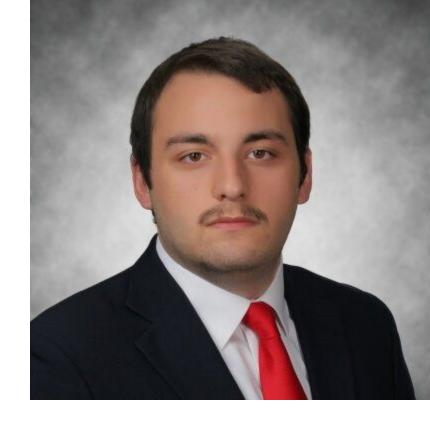
# Getting to know me

## **Background:**

- Bachelors of Arts in Economics from Michigan State University
- Data Scientist with experience working with financial and business data
- Knowledge of American business industries and practices

### Why Bankruptcies:

- Over 35,000 business bankruptcies in the U.S. per year
- 2020/2021 have been awkward years financially for many firms





# What was the impact?

Covid 19 had an impact on many businesses both large and small, both in and without the U.S.

Some of the hardest hit industries were:

- Travel
  - AeroMexico, Flybe, Hertz, Nok Air
- Restaurants
  - Friendly's, Sizzler, Ruby Tuesdays, California Pizza Kitchen, Chuck E. Cheese,
- Fitness
  - o 24 Hour Fitness, Gold's Gym, GNC
- Clothing
  - JCPenney, Ann Taylor, J.Crew, Brooks Brothers, Lord
     & Taylor, True Religion, Men's Wearhouse
- Others
  - Cirque Du Soleil, Remington Arms, Intelsat,
     Whittington Petroleum





# The Data

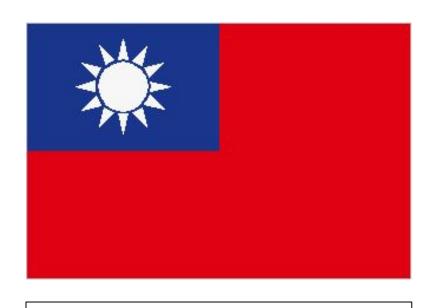
Two datasets from Kaggle.com:

### First dataset:

- from Taiwan (1999-2009)
- looks at 6819 companies
- over 90 features mostly focused on attributes about the companies stock

### Second data:

- from Poland (2000-2012)
- looks at over 42,000 companies
- 64 features mostly focused on the companies financial data



# The Data Distribution

Despite being from two completely different countries, the ratio of bankruptcies to no bankruptcies was near identical

### Taiwan:

- 96.77% non bankruptcies
- 3.23% bankruptcies

### Poland:

- 97.83% non bankruptcies
- 2.17% bankruptcies



# Problems with the Data

Despite the large number of features for both datasets, there was very little correlation between any of the features and bankruptcies

Studies suggest that the best predictors of bankruptcies are :

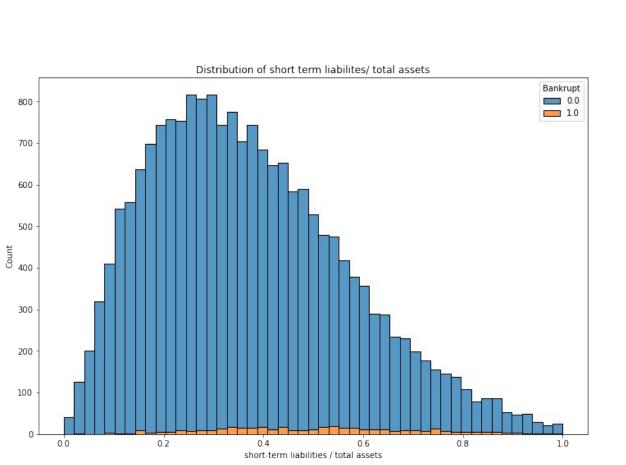
- The companies financials
- It's economic environment
- It's qualitative features

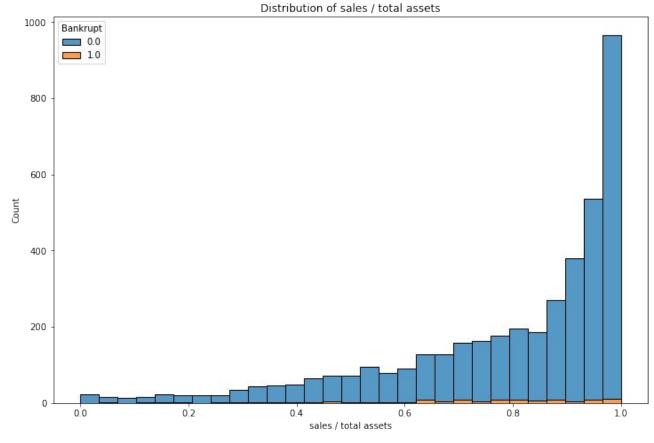


https://www.researchgate.net/publication/235643766\_Bankruptcy\_prediction\_models\_How\_to\_choose\_the\_most\_re\_levant\_variables

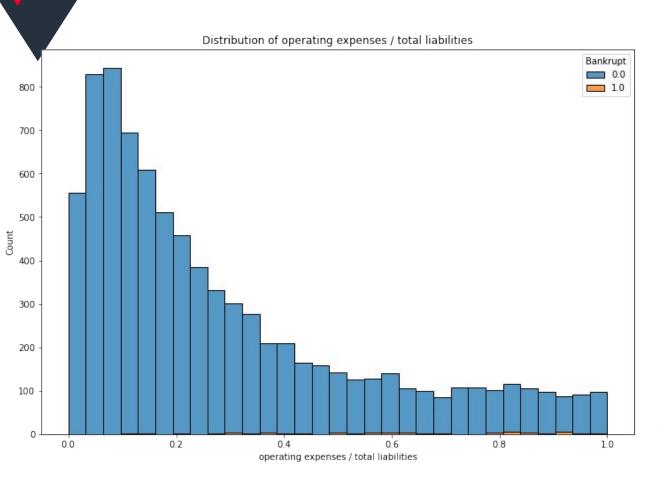
https://www.researchgate.net/publication/2340186 Choosing the Best Set of Bankruptcy Predictors

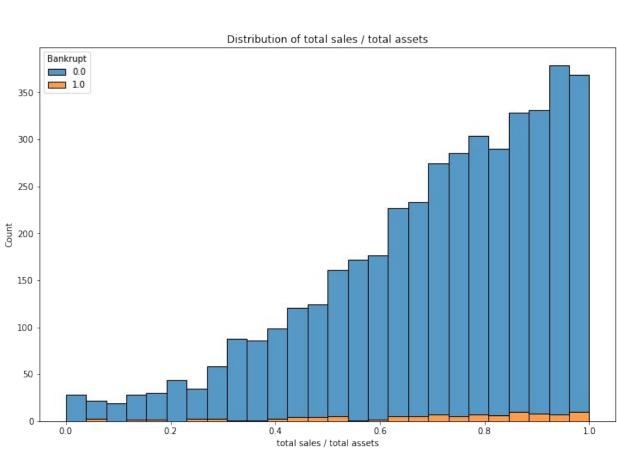
# Polish Data Distribution



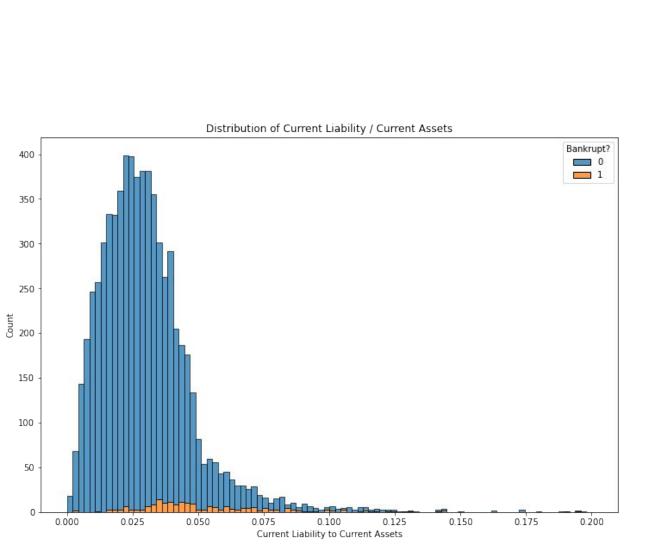


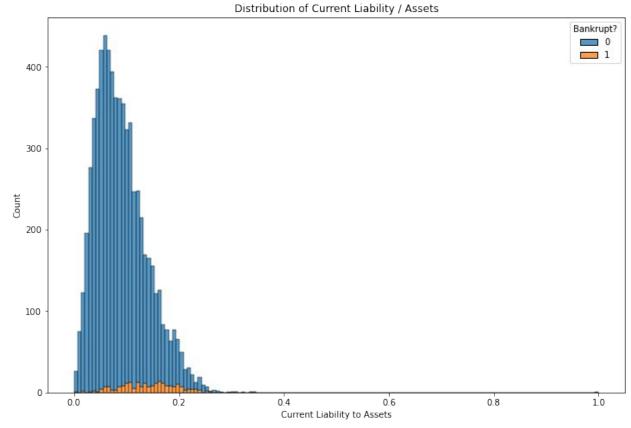
# Polish Data Distribution



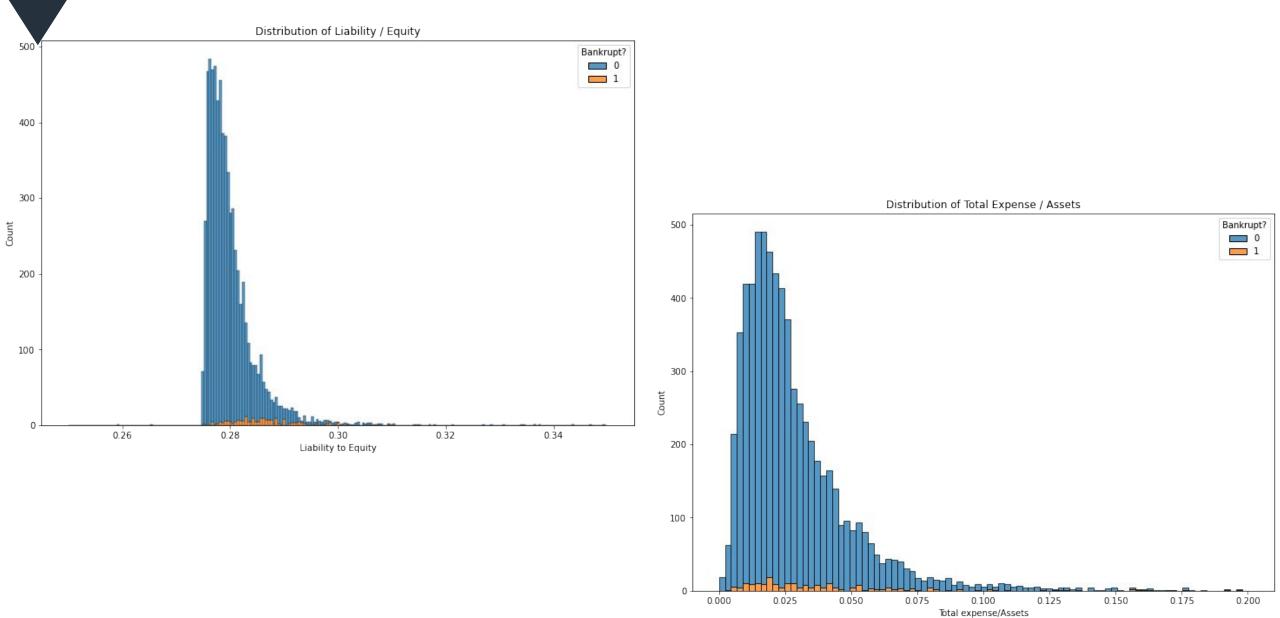


# Taiwanese Data Distribution





# Taiwanese Data Distribution



# Polish Data Correlation Heat Map

	Heat Map of Polish Financial Data
profit on sales / total assets -	-0.089
working capital / total assets -	-0.075
profit on operating activities / total assets -	٠٥.066
total assets / total liabilities -	-0.054
current assets / total liabilities	-0.051
sales / short-term liabilities	-0.039
operating expenses / short-term liabilities	-0.032
net profit/ total assets -	-0.024
current assets / short-term liabilities -	-0.023
working capital -	-0.019
equity / total assets -	-0.012
profit on sales / sales -	-0.0083
gross profit / sales -	-0.0059
sales / receivables	-0.0057
net profit / sales -	-0.0055
profit on operating activities / sales -	-0.0055
sales / inventory	-0.0037
gross profit / total assets -	-0.0034
profit on operating activities / financial expenses	-0.0015
total costs /total sales -	0.0014
working capital / fixed assets -	-0.00086
net profit / inventory	0.00028
long-term liabilities / equity -	0.0017
sales / fixed assets -	0.0076
total liabilities / total assets	0.011
total sales / total assets -	0.016
operating expenses / total liabilities -	0.043
sales / total assets -	0.05
short-term liabilities / total assets	0.095
Bankrupt -	1

Bankrupt

- 0.50

- 0.25

- 0.00

- -0.25

- -0.50

- -0.75

# Taiwanese Data Correlation Heat Map

	•
	Heat Map of Taiwanese Financial Data
Net Income to Total Assets	-0.32
Retained Earnings to Total Assets	-0.22
Working Capital to Total Assets	0.19
Working Capital/Equity	0.15
Cash/Total Assets -	0.1
Gross Profit to Sales	0.1
Equity to Liability	-0.083
Cash Flow to Equity -	-0.059
Current Assets/Total Assets	-0.045
Current Liability to Liability	-0.021
Current Liabilities/Liability -	<b>-0.021</b>
Total income/Total expense	-0.0071
Inventory/Working Capital	-0.0019
Cash Flow to Sales	0.00048
Long-term Liability to Current Assets	0.00078
Inventory/Current Liability -	0.00082
Fixed Assets to Assets -	0.066
Cash/Current Liability	0.078
Equity to Long-term Liability -	0.14
Total expense/Assets	0.14
Current Liability to Equity -	0.15
Current Liabilities/Equity -	0.15
Liability to Equity -	0.17
Current Liability to Current Assets	0.17
Current Liability to Assets -	0.19
Bankrupt? -	i i

Bankrupt?

- 0.75 - 0.50 - 0.25 - 0.00



# The Modeling Process

### The Goal:

- Using Several Machine Learning Techniques (such as Logistic Regression, Random Forest, Gradient Boosting, Extra Trees and Neural Networks), create a model to outperform our very high baselines
- 2. Create a model that produces the lowest number of false negative classifications (optimizing for sensitivity)



# The Best Model

The best performing model was the Gradient Boosting Classifier:

### Poland:

Accuracy: 99.91%

Sensitivity: 99.9%

### Taiwan:

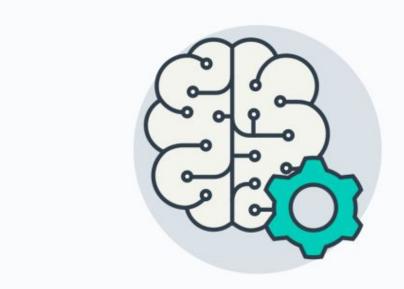
Accuracy: 97.57%

• Sensitivity: 99.45%

### Baseline:

 $\bullet$  P = 97.83%

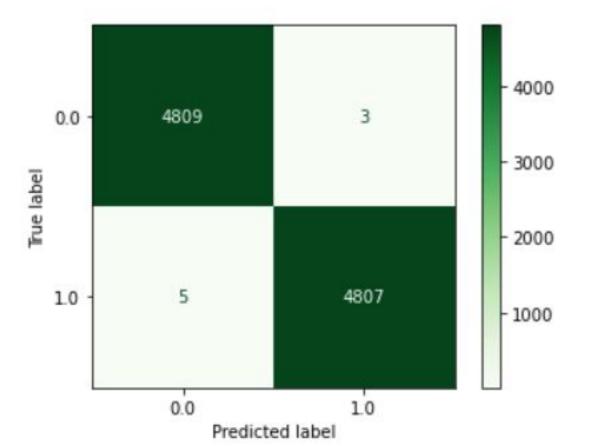
• T = 96.77%



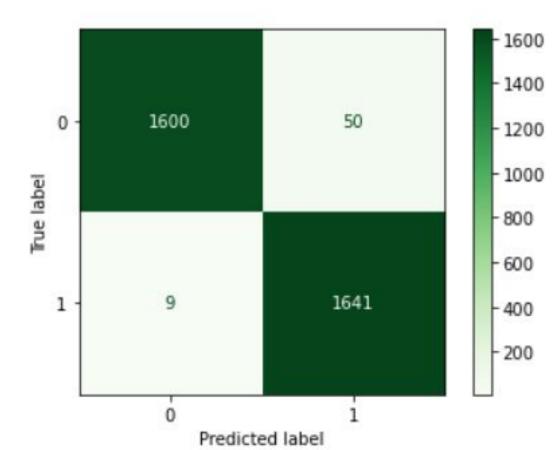


# The Model Visualized

### **Poland Confusion Matrix**



### **Taiwan Confusion Matrix**





# What We Learned

Using the model, we can accurately predict bankruptcies, while also reducing the risk of providing potential dangerous information

A Lot of what can affect the possibility of a company going bankrupt is dependent on harder to quantify metrics and events outside of a company's control



# The Next Steps



# What to do if your company is in financial trouble:

- Pay minimum amount to creditors
- Cut spending
- Find minimum cost level
- Re-negotiate what you can
- Create short term cash flow
- Establish a business plan
- Utilize tax loopholes/ reforms
- Employe a financial advisor



# THANK YOU

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