Student Presentation

Preliminary Results on Predicting Corporate Bankruptcy and Its Systemic Effect using Case Based Reasoning with Financial and Relational Data

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Universitas Indonesia

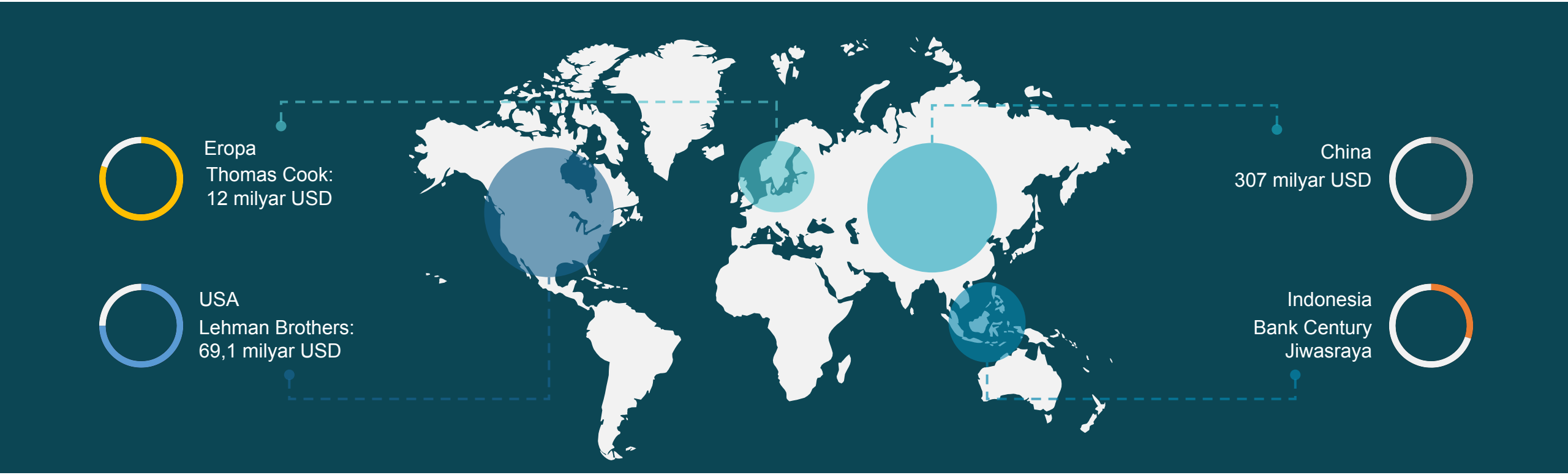
Agenda

- Introduction
- Methodology
- Pre-liminary Result
- Conclusion

Introduction

3

Bankruptcy Cases



01 **Eropa**

Led to an increase in unemployment and a decline in the pace of UK economy

02 **China**

It caused global trust in China to fall

03 **USA**

A systemic effect on the global crisis in 2008

04 **Indonesia**

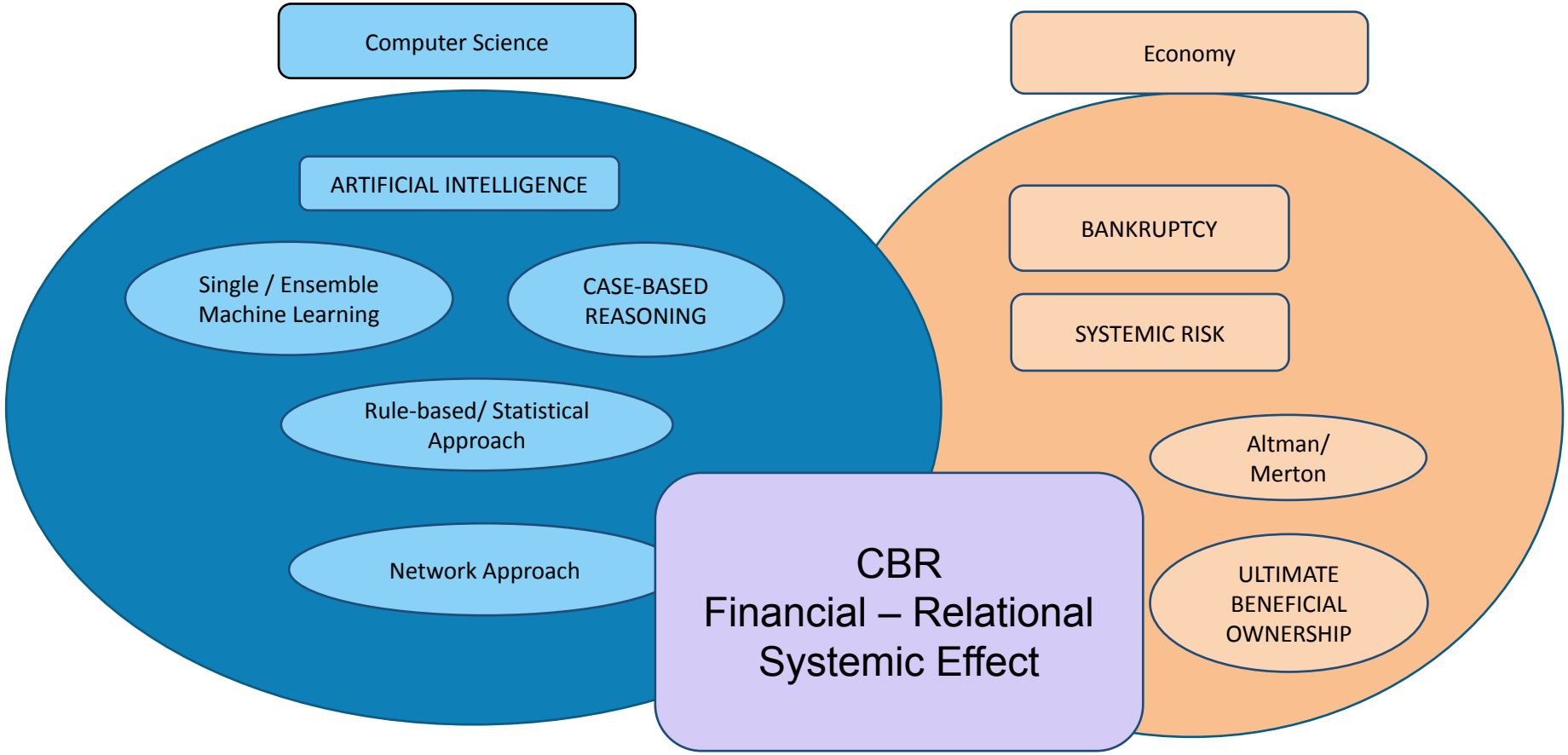
Declared bankruptcy has the potential to cause systemic effects

Systemic Effect of Bankruptcy

Maka, sebelum kebangkrutan terjadi seharusnya kondisi buruk sudah dapat diprediksi dan dicegah

- Economy Stability Crises
- Systemic impact to public trust to the financial system
- Affect to related company (debtor-creditor or group/ conglomerate)
- Corporate bankruptcy– Layoffs disrupt the rate of investment in the same sector

Related Research



Research Question

Predictor Variable

How to determine the financial and non-financial variables that have a significant effect on the prediction results of corporate bankruptcy and its systemic impact?

Building the Model

- How to build a reliable model to predict bankruptcy and its systemic impact?
- How to evaluate the results of bankruptcy prediction and system impact prediction results

Novelty

Bankruptcy prediction using financial and 3 relational variable

Relational variable use in this research: BoD, BoC, and Shareholder

While in Toback, only director/manager was counted

CBR Model for enterprise interconnection variables in predict the bankruptcy and its systemic effect

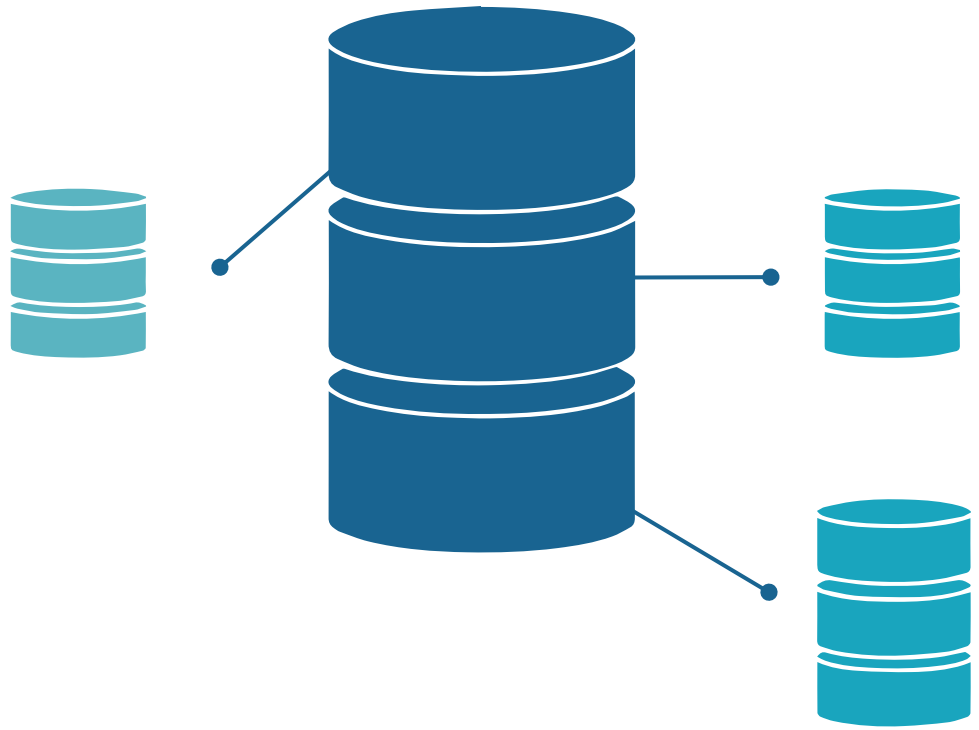
Using the network built from relational variable, the system produce set of company that may be affected by certain company's bankruptcy

Research Methodology

Design Methods, Data Collection and Analysis

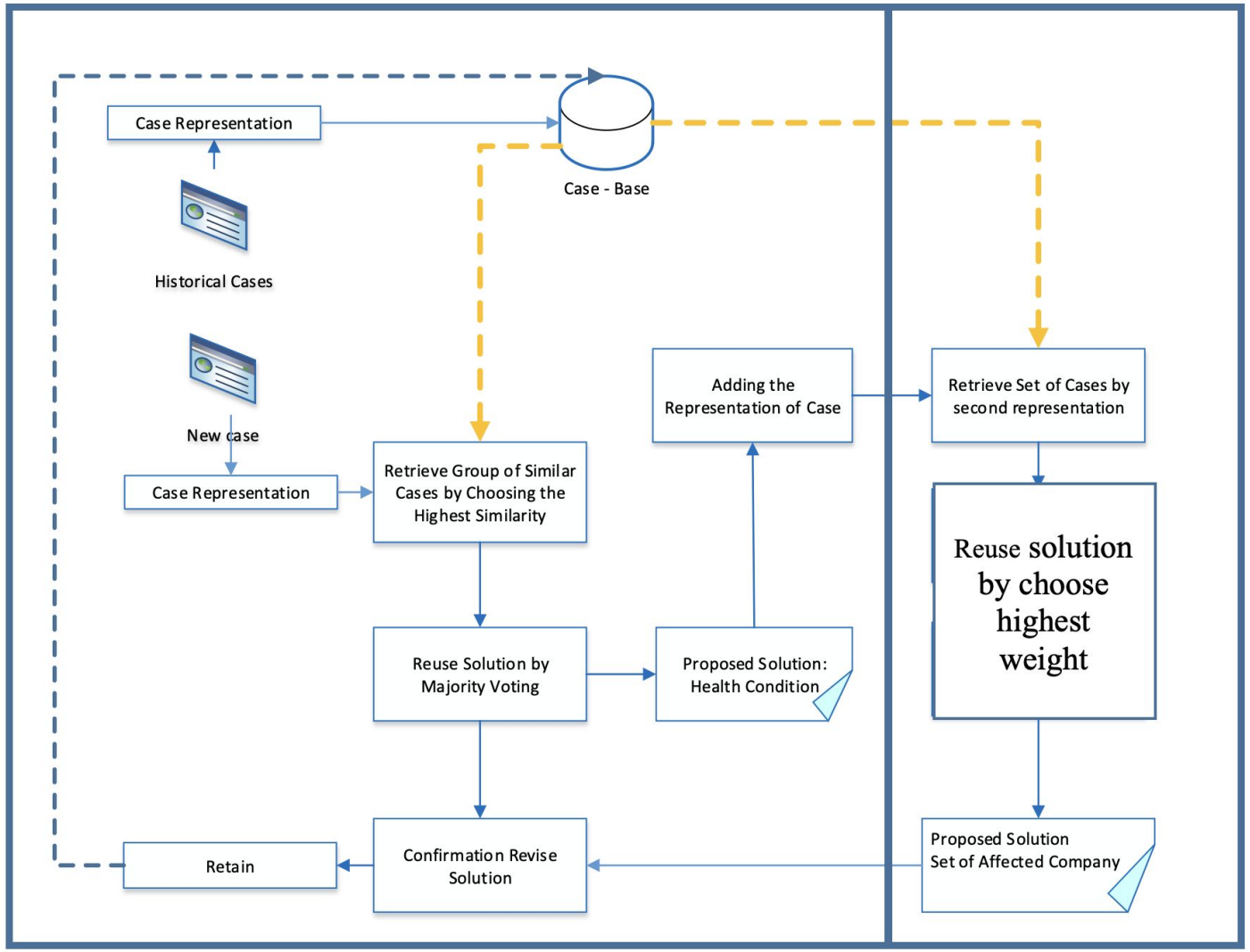
Data

Financial
Financial data is in numerical form, either ratio or original value
Source OJK banking reports, IDX Financial Reports, and TICMI



Timeline
Timeline data is the year when certain variables decrease or increase

Company Relation
The interconnection data consists of the same BoD, BoC, and Shareholders



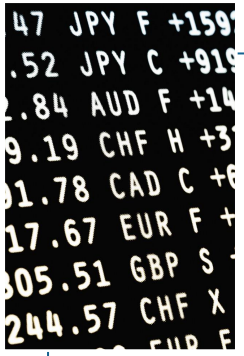
$$C_1 = (variabel\ finansial, kelas)$$

$$C_2 = (variabel\ relasional, kelas)$$

$$C_3 = (variabel\ finansial, variabel\ relasional, kelas)$$

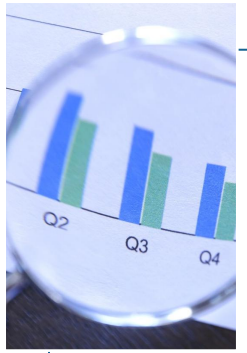
$$C_{ds} = (sumber, [\ target, bobot, kelas\ target])$$

Research Phase



Pre: Building Data Set

- Collecting financial fundamental data
  Collect BoS, BoC and Shareholder data reported in the Company's Annual Report
  Build financial data and relational data separately



RQ1: Determine the Variable Predictor

- Based on literature review
  Cleaning data sets
  feature selection
  Implement on various machine learning methods

RQ2: Building The Model

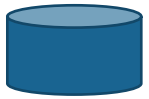
- Building a bankruptcy prediction model with financial data
  Building a bankruptcy prediction model with relational data
  Fusion of the two models
  Generate a list of affected companies

Pre

Building Data Set

How to build a dataset covering the necessary financial and non-financial variables, including information on financial conglomerates in Indonesia, common management involved, and other interconnection variables between companies?

Literature Review: Menentukan variable keuangan dan non-keuangan yang mungkin digunakan pada model prediksi kebangkrutan



Financial data

Managerial and shareholder data

Company Financial and Relational Data for 2010 - 2021

Data Collection

Data Pre-processing

Data Selection

Prev Research: Keywords ”bankruptcy prediction”, “financial distress prediction”, “systemic effect prediction”

Financial data for listed company during 2010 to 2021

Data Board of Director, Board of Commisioner, Auditor, and Shareholder from **company annual report**

Tahun	ode Emite	ama Emit	Sektor	Total Aset(Rp)	Total Utang (Rp)	Total Ekuitas(Rp)	Total Sales(Rp)
2017	BISI	Bisi Inte	1. Ag	2,622,336,000,000	422,226,000,000	2,200,110,000,000	2,310,290,000,

rsih(Rp)	ATO	ROA	ROE	NPM	DAR	DER
87,000,000	0.88100457	15.37892169	18.33031076	17.45612023	0.161011404	0.191911314
29,339,940)	0.879054593	-15.89599155	-67.10630788	-18.08305386	0.763122245	3.221586785
29,000,000	0.694020146	8.476410229	11.40256289	12.21349304	0.256622365	0.345211308
68,764,700	0.285596544	8.366729362	12.07993796	29.29562537	0.307386396	0.443806467
91,000,000)	0.190477507	-1.174343456	-3.097484897	-6.165260539	0.620871935	1.637631165

Kod	AUDCOM	20	20	20	20	20
PNLF	A. Agus Susanto	1	1	1	1	1

Kode	BOD	20	20	20	20
TRAM	A. A. Alit Wiradharma				
BNBR	A. Amri Aswono Putro	1	1	1	1

Kode	BOC	20	20	20	20	20	1
AALI	Angky Utarya Tisnadisastra	1	1	1			
AALI	Anugerah Pekerti				1	1	

Kode	Shareholder	2019	2018	2017	2016	
NFCX	1 Inti Dot Com	7.50%		99.00%	99.00%	
CITY	1st Financial Company Limited	7.78%				
ASRM	A. Winoto Doeriat	19.17%	19.17%	19.17%	21.30%	21.3
IIKP	AAA-JS Multisectoral Fund					
TRAM	AAA-US Multi Sectoral Fund					
NASA	Abadi Usaha Jayaraya	6.65%	7.10%	29.09%	40.00%	
ABBA	Abbey Communications	10.27%	10.27%	10.27%	10.27%	
ARII	Abdi Andre	15.42%	15.41%	15.75%	15.75%	15.7

Data Collection

Data Pre-processing

Data Selection

Prev Research: Keywords ”bankruptcy prediction” and similar term, and “systemic effect prediction”

Library 21/9/20:
Science Direct
IEEE

Filter:
Year > 2014

Manually tabulation variable in previous research

Financial data from Financial Report. There are 25 variables results from manualluy tabulation

Publication title

- [ ] Expert Systems with Applications (17)
- [ ] Decision Support Systems (5)
- [ ] European Journal of Operational Research (5)
- [ ] Journal of Business Research (3)
- [ ] International Review of Financial Analysis (3)
- [ ] Applied Soft Computing (3)
- [ ] Procedia Computer Science (3)
- [ ] Economic Modelling (2)
- [ ] Journal of Retailing and Consumer Services (2)
- [ ] International Review of Economics & Finance (2)

Title
Bankruptcy prediction
OR
Default prediction
OR
Financial failure
OR
Financial distress
OR
Insolvency
OR
Business failure

Data Collection

Data Pre-processing

Data Selection

Data finansial from TICMI for listed company in 2010 - 2021

Manual tabulated financial data is available for 2010 to 2018

TICMI data from 2010 to 2021

Tabulation results data is synchronized with TICMI data, if there is data that is out of sync then manual tabulation results are not used

TICMI: data provider of Indonesia Stock Exchange

ticmi.co.id

Pesan Paket Data Khusus Disini

Daftar data yang tersedia

No	Jenis Data	Format Data	Kolom	Keterangan	Selengkapnya
1	**Paket Khusus**				
	Ringkasan Keuangan, Rasio Keuangan, Market Cap Tahunan, Tanggal Penyampaian Laporan Keuangan (LK), Informasi Pasar, Profil Perusahaan	Excel	Paket N = 100	Multi Years	Klik
		Excel	Paket N = 400	Multi Years	
		Excel	Paket N = 800	Multi Years	
		Excel	Paket N = 1000	Multi Years	
		Excel	Paket All Emiten Kuartal / Tahun	Ringkasan Keuangan	
		Excel		Rasio Keuangan	
		Excel		Informasi Pasar	
		Excel		Informasi Perusahaan	
		Excel		All in One	

Tahun	ode Emite	ama Emit	Sektor	Total Aset(Rp)	Total Utang (Rp)	Total Ekuitas(Rp)	Total Sales(Rp)
2017	BISI	Bisi Inte	1. Ag	2,622,336,000,000	422,226,000,000	2,200,110,000,000	2,310,290,000,
2017	MGNA	Magna I	1. Ag	226,027,673,845	172,486,745,909	53,540,927,936	198,690,664,
2017	AALI	Astra Ag	1. Ag	24,935,426,000,000	6,398,988,000,000	18,536,438,000,000	17,305,688,000,
2017	ANLT	Austind	1. Ag	7,675,266,366,216	2,359,272,469,644	5,315,993,896,572	2,192,029,549,

rsih(Rp)	ATO	ROA	ROE	NPM	DAR	DER
37,000,000	0.88100457	15.37892169	18.33031076	17.45612023	0.161011404	0.191911314
29,339,940)	0.879054593	-15.89599155	-67.10630788	-18.08305386	0.763122245	3.221586785
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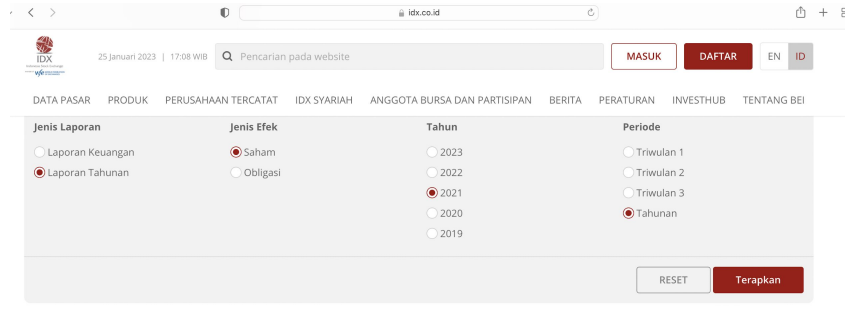
58,764,700	0.285596544	8.366729362	12.07993796	29.29562537	0.307386396	0.443806467
91,000,000)	0.190477507	-1.174343456	-3.097484897	-6.165260539	0.620871935	1.637631165

Data Collection

Data Board of Director, Board of Commisioner, Auditor, and Shareholder from Laporan Tahunan Perusahaan

Stages:

1. Download the 2010 – 2021 Company Annual Report from IDX: idx.co.id
2. If the annual report is not obtained then buy ICMD from TICMI, which contains the necessary information
3. Manual tabulation of each Shareholder and the amount of ownership, Commissioners, Board of Directors, and Audit Committee of each company – each year



Kode	AUDCOM	20	20	20	20	20
PNLF	A. Agus Susanto	1	1	1	1	1

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IIKP	AAA-JS Multisectoral Fund							7.28%
TRAM	AAA-US Multi Sectoral Fund							
NASA	Abadi Usaha Jayaraya	6.65%	7.10%	29.09%	40.00%			
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ARII	Abdi Andre	15.42%	15.41%	15.75%	15.75%	15.75%	15.75%	15.75%

Data Pre-processing

Data Selection

Data Collection

Data Pre-processing

Data Selection

Tahun	ode Emite	ama Emit	sektor	Total Aset(Rp)	Total Utang (Rp)	Total Ekuitas(Rp)	Total Sales(Rp)
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2017	MGNA	Magna I	1. Ag	226,027,673,845	172,486,745,909	53,540,927,936	198,690,664,

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91,000,000)	0.190477507	-1.174343456	-3.097484897	-6.165260539	0.620871935	1.637631165

Kode	BOC	20	20	20	20	20
AALI	Axxxx Uxxxxx Txxxxxxxxx	1	1	1		
AALI	Axxxxxxx Pxxxxxxx				1	1
AALI	Cxxxx Sxx Cxxxxx	1	1	1	1	1
AALI	Dxxxx Bxxxxxxx Txxxxxx	1	1	1		
AALI	Gxxxxxx Gxxxxxxxxxxx					

1.Handling format (text, number, code, space, etc)
2. Handling duplicate data
3. Handling missing value & invalid data

BOC	Kode	20	20	20
Abdul Salam	ASDM			
Abdul Salam	BGTG			
Abdulgani	ABBA		1	1
Abdulgani	GIAA	1	1	

1.Handling format (text, number, code, space, etc)
2. Handling missing value (mean)

	Kode	BRNA	CSAP	DNET	INDF	BCIP	LCGP	ALTO	MIRA	HRUM
0		Kode	SMMT	TAXI	BRNA	CSAP	DNET	INDF		0.0
1	A	Kode	SMMT	TAXI	BRNA	CSAP	DNET	INDF		0
2	A									

	Kode	SMMT	TAXI	BRNA	CSAP	DNET	INDF
0	AALI	0.0	0.0	0.0	0.0	0.0	0.0
1	ABBA	0.0	0.0	0.0	0.0	0.0	0.0
2	ABDA	0.0	0.0	0.0	0.0	0.0	0.0

Pertahun

Transformation into inter-company relations

PRE | Building financial and relational data | Stage 2

Data Collection

Data Pre-processing

Data Selection

2017	MYRX	
2018	MYRX	1
2010	MYRXP	1
2011	MYRXP	8
2012	MYRXP	1
2013	MYRXP	5
2014	MYRXP	5
2015	MYRXP	
2016	MYRXP	8
2017	MYRXP	

Delet invalid data

1. Exxxx Txxxxx
2. Hxxxx Dxxxxx
3. R. Hxxxx Zxxxxxxy
Kxxxxx Wxxxxx
Axxxxxxxi

Sxxxxxxa Sxxxxxxxxn Uxo
Sxxxxxxa S. Uxo

Inconsistent writing (Numbering and Abbreviation)

Mxxxxxx Sxxxxxxxxx			0	0	0	1	1	1	1	1	
Kxxx Sxxxx											1
Maaaaa Sxxxxxxxxxx											1

Merge to one row for Mxxxxxx Sxxxxxxxx

Variable PrevNP:
1. Net profitY-1
2. If data Y-1 not found, then Y-2
3. If Y-1 and Y-2 not found, then Y

Data Collection

Data Pre-processing

Data Selection

```
RangeIndex: 6584 entries, 0 to 6583
Data columns (total 22 columns):
 #   Column              Non-Null Count  Dtype
---  ------              --------------  -----
 0   Tahun               6584 non-null   int64
 1   Kode                6584 non-null   object
 2   Aset Lancar         5419 non-null   float64
 3   Aset Tetap          4874 non-null   float64
 4   Other Asset         3554 non-null   float64
 5   Aset Tidak Lancar   5417 non-null   float64
 6   Total Aset          6559 non-null   float64
 7   Utang Lancar        5413 non-null   float64
 8   Utang Tidak Lancar  5414 non-null   float64
 9   Total Utang         6559 non-null   float64
 10  Total Ekuitas       6559 non-null   float64
 11  Total Sales         6558 non-null   float64
 12  Gross Profit        5377 non-null   float64
 13  EBT                 6559 non-null   float64
 14  TAX                 4874 non-null   float64
```

Literature Review: Fundamental variable

Condition: minimum missing value

```
RangeIndex: 6584 entries, 0 to 6583
Data columns (total 14 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   Tahun           6584 non-null   int64
 1   Kode            6584 non-null   object
 2   Total Aset      6559 non-null   float64
 3   Total Utang     6559 non-null   float64
 4   Total Ekuitas   6559 non-null   float64
 5   Total Sales     6558 non-null   float64
 6   EBT             6559 non-null   float64
 7   Laba Bersih     6559 non-null   float64
 8   ATO             6557 non-null   float64
 9   ROA             6557 non-null   float64
 10  ROE             6557 non-null   float64
 11  NPM             6534 non-null   float64
 12  DAR             6557 non-null   float64
 13  DER             6557 non-null   float64
```


BoD


SH


BoC


Aud

Literature review: Manajerial relation, capital flow

Condition: Significant relation


BoD


SH


BoC

Financial and Relational Data of Company in the Year of 2010 - 2021

PRE | Building financial and relational data | Output

Data Collection

Data Pre-processing

Data Selection

FINANCIAL DATA OF COMPANY IN 2010 - 2021

Variabel Penciri	Variabel Nilai	Variabel Rasio
Tahun	Total Aset	Asset Turnover
Kode Perusahaan	Total Utang	Return on Asset
	Total Ekuitas	Return on Equity
	Total Sales	Net Profit Margin
	Earning before Tax	Debt to Asset
	Laba Bersih	Debt to Equity

RELATIONAL DATA OF COMPANY IN 2010 - 2019

- Board of Director
- Board of Commisoner
- Shareholder

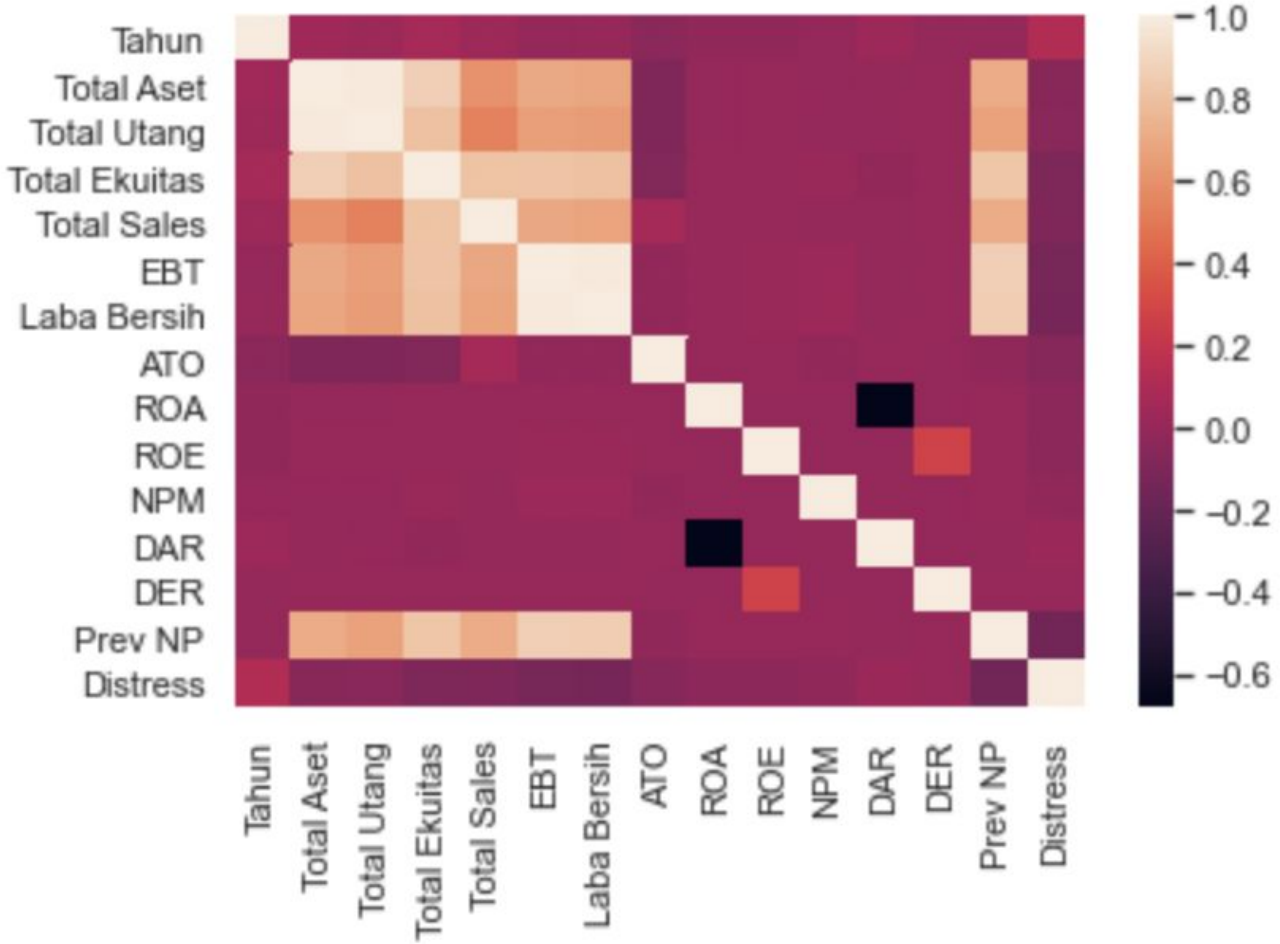
Kode	AAAA	BBBB
AAAA	The number of BOD/ BOC/SH in the same year	
BBBB		

Pre-liminary Result

Predictor Variable and Model

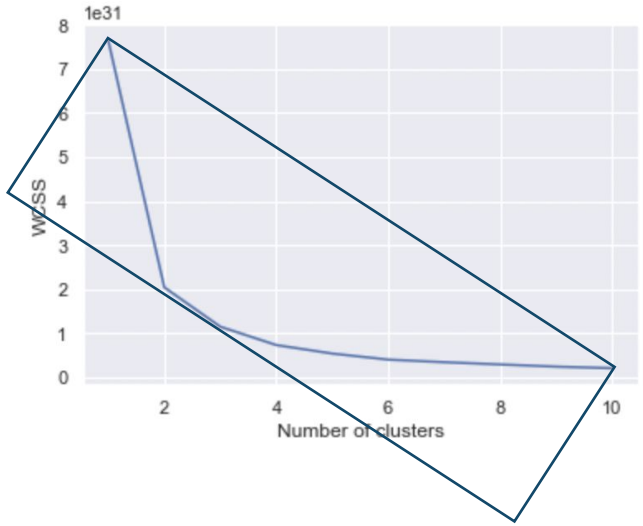
RQ1 | Determine the predictor variable | Correlation Matrix

How to determine the financial and non-financial variables that have a significant effect on the prediction results of corporate bankruptcy and its systemic impact?

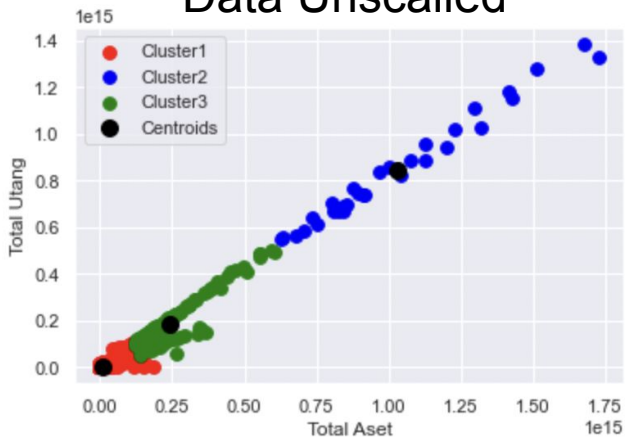


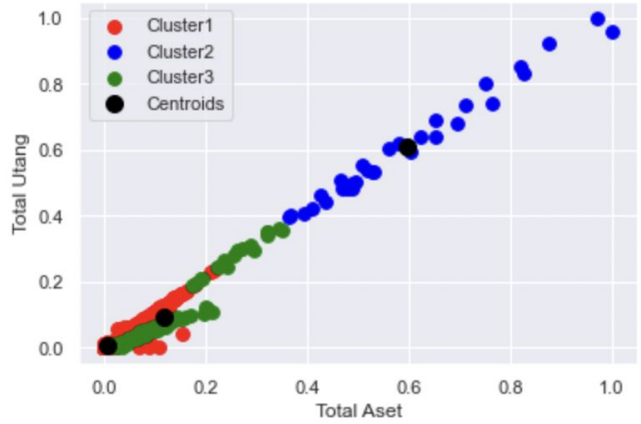
RQ1 | Determine the predictor variable | K-Means Clustering

How to determine the financial and non-financial variables that have a significant effect on the prediction results of corporate bankruptcy and its systemic impact?



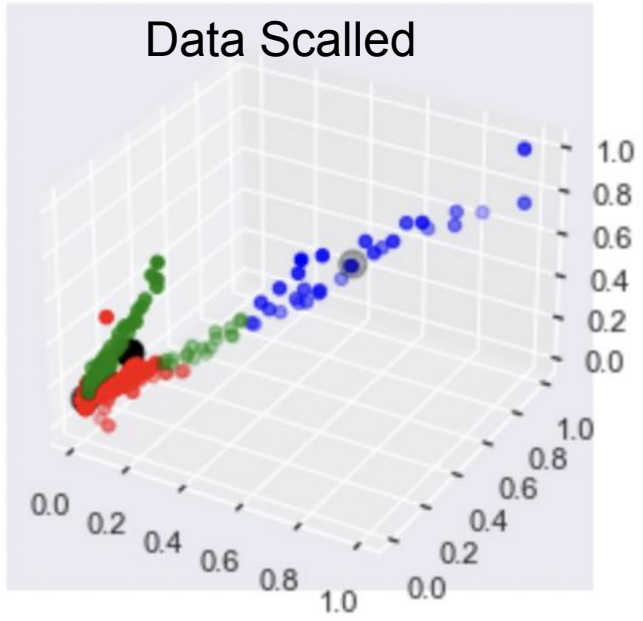
Data Unscalled



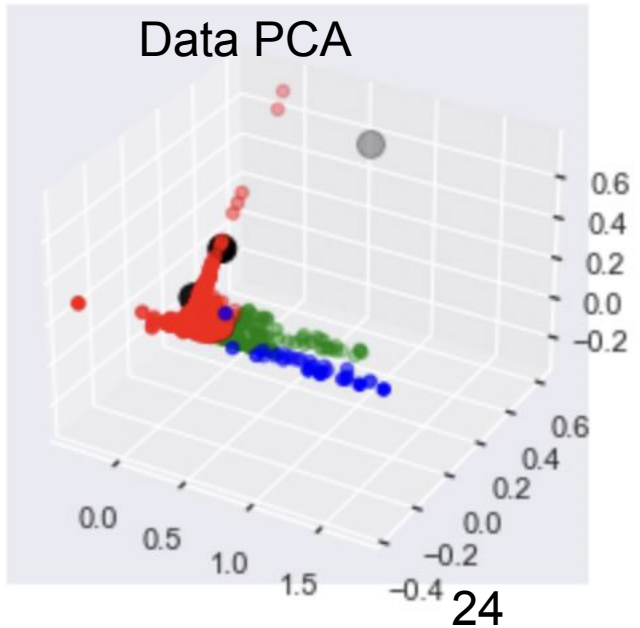


Data Scalled

Data Scalled

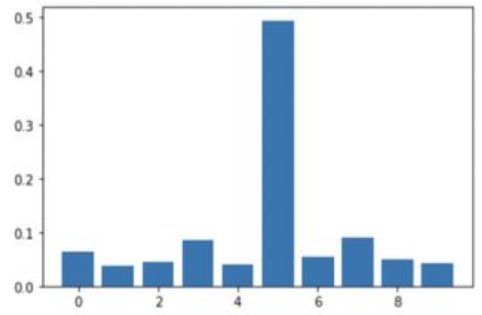


Data PCA

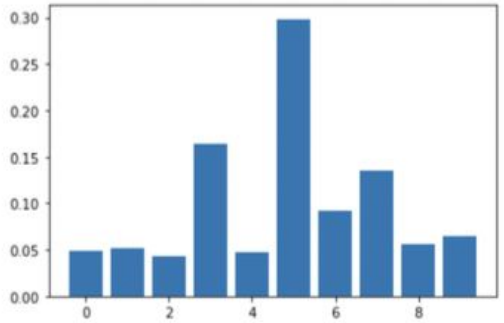


RQ1 | Determine the predictor variable | Variabel Importance

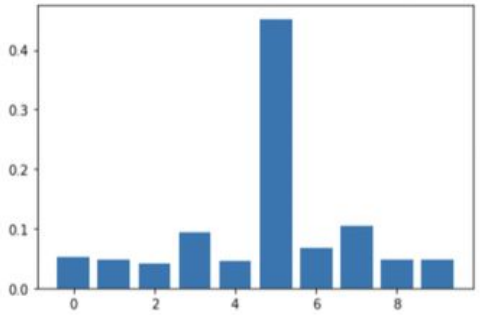
How to determine the financial and non-financial variables that have a significant effect on the prediction results of corporate bankruptcy and its systemic impact?



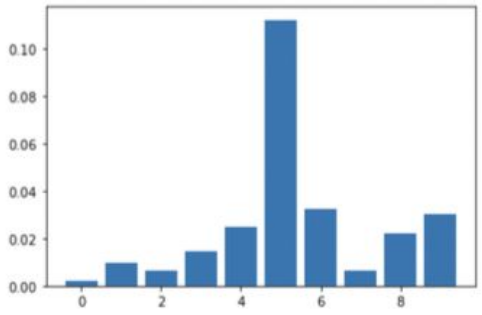
Decision Tree Classifier



Random Forest Classifier



XGBoost Classifier

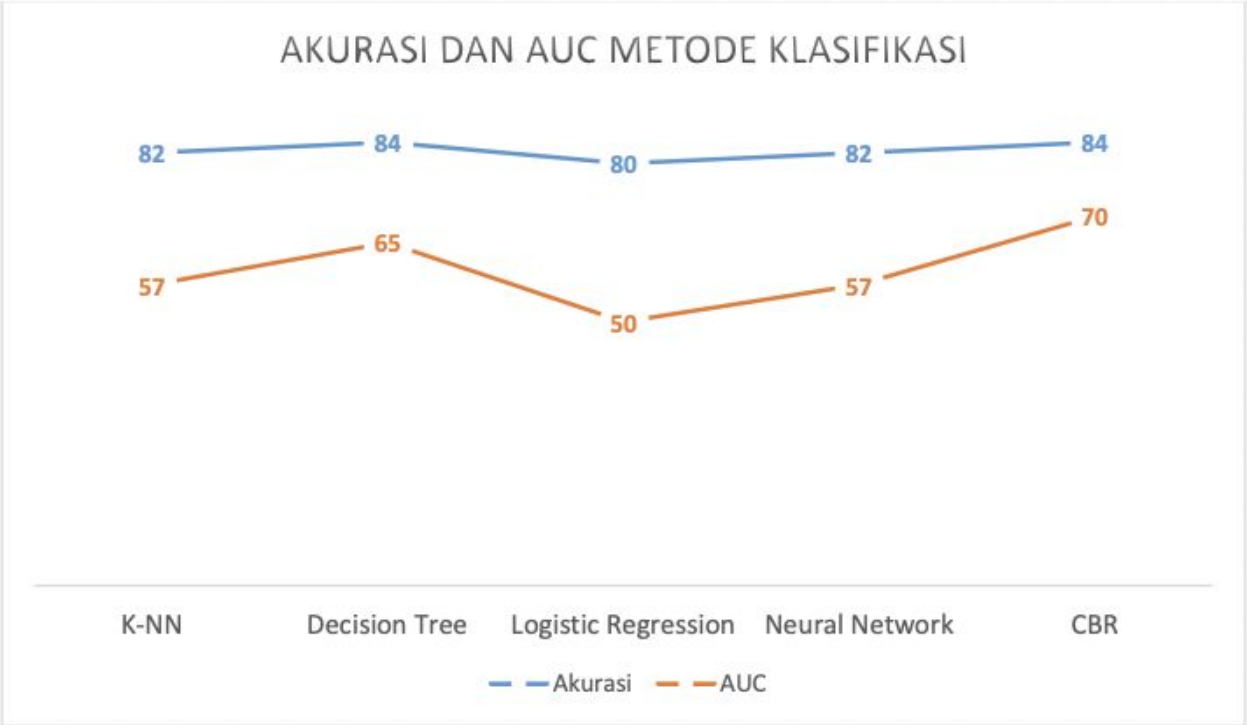


K-NN Classifier

Indeks Variabel:
0 = 'Total Utang'
1 = 'Total Ekuitas',
2 = 'Total Sales',
3 = 'Laba Bersih',
4 = 'ATO',
5 = 'ROA',
6 = 'ROE',
7 = 'NPM',
8 = 'DAR',
9 = 'DER.

RQ1 | Determine the predictor variable | Classifcations

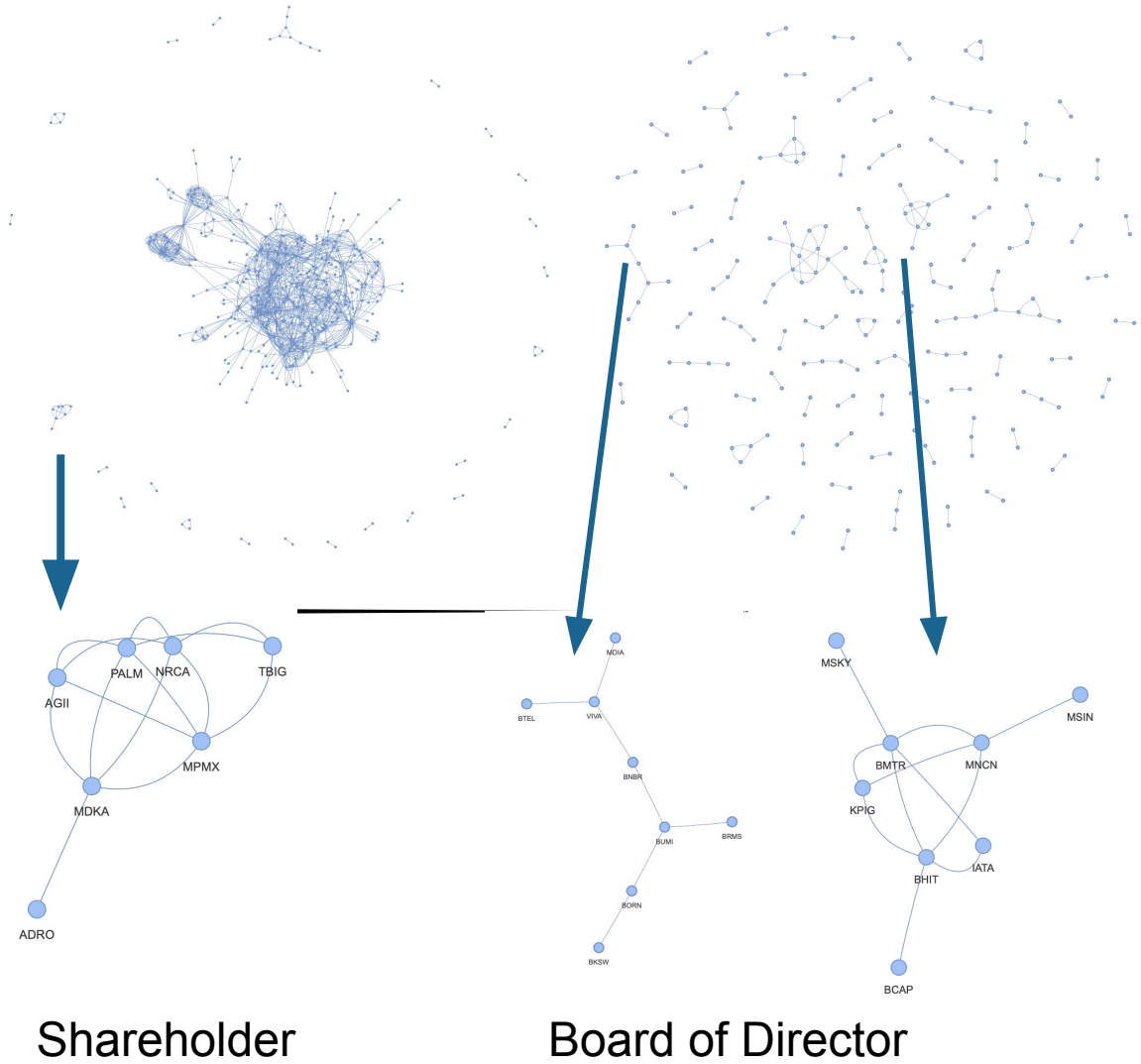
How to determine the financial and non-financial variables that have a significant effect on the prediction results of corporate bankruptcy and its systemic impact?



Gambar 35. Akurasi dan AUC Metode Klasifikasi

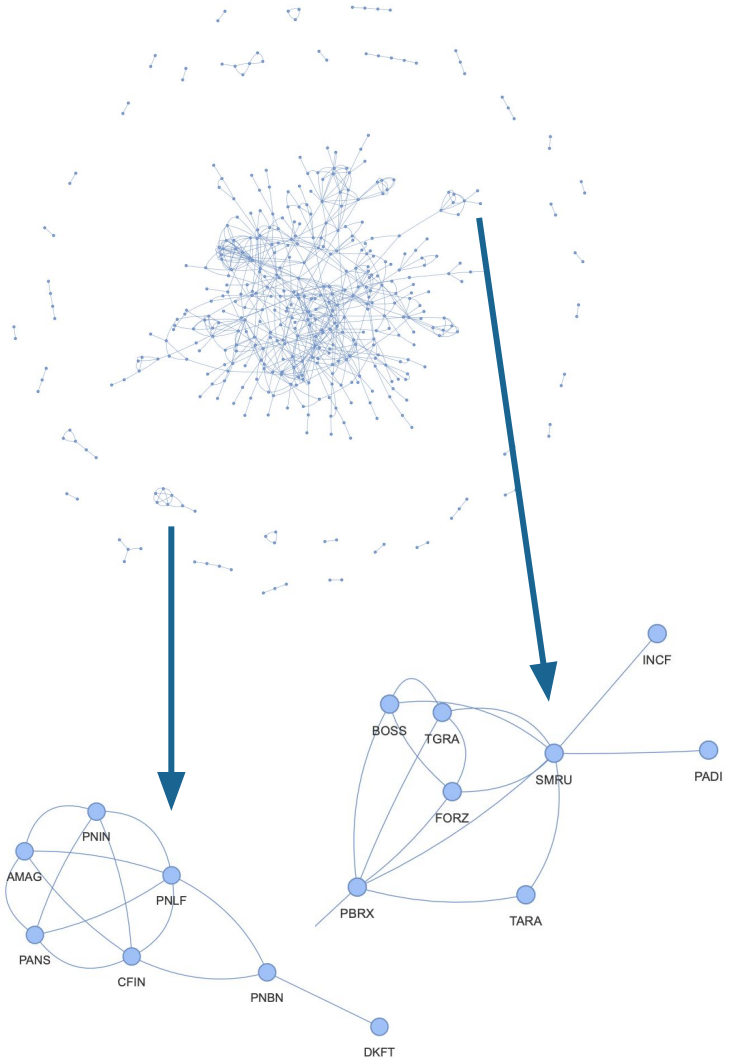
RQ1 | Determine the predictor variable | Understanding variable

How to determine the financial and non-financial variables that have a significant effect on the prediction results of corporate bankruptcy and its systemic impact?

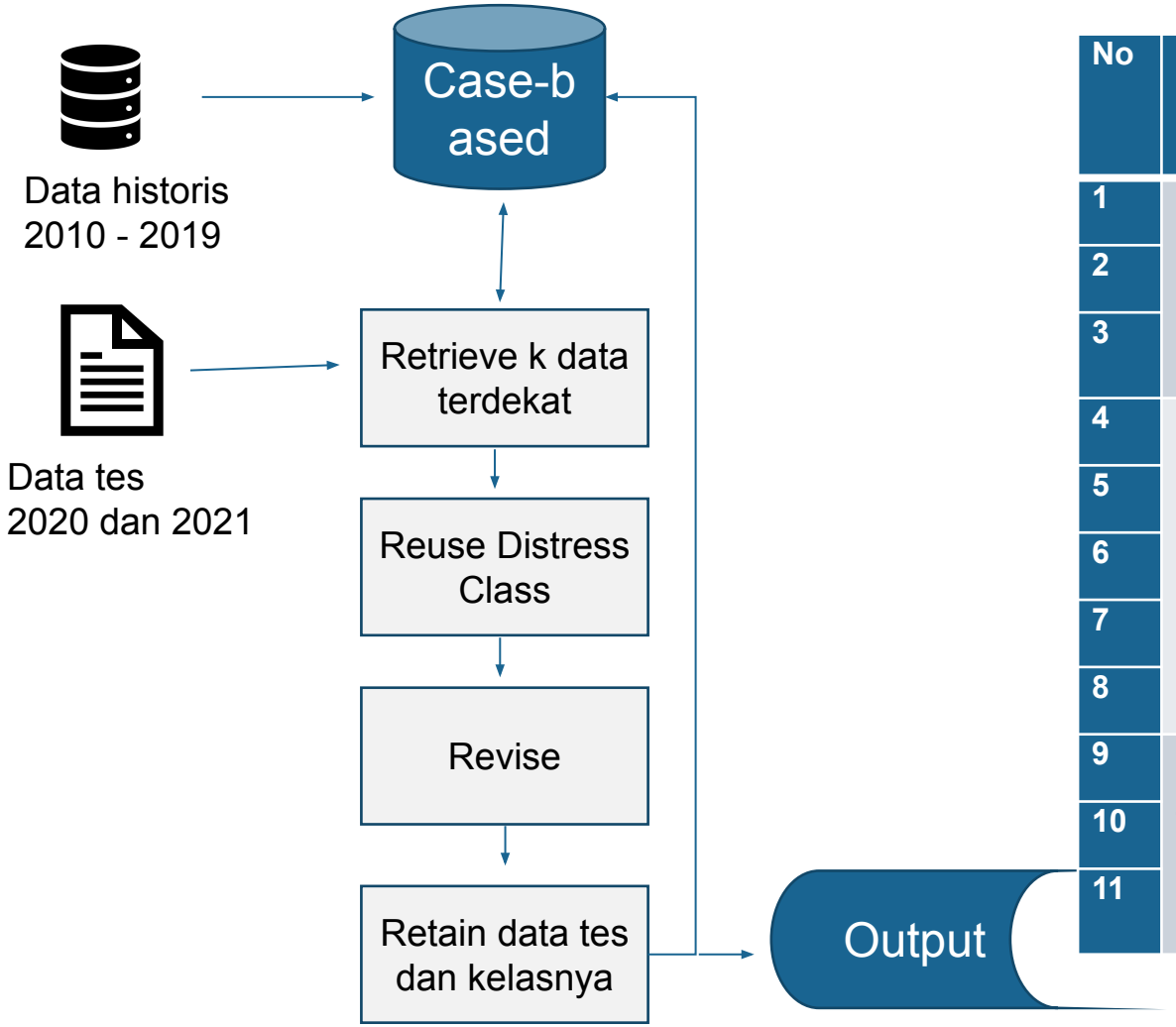


Shareholder

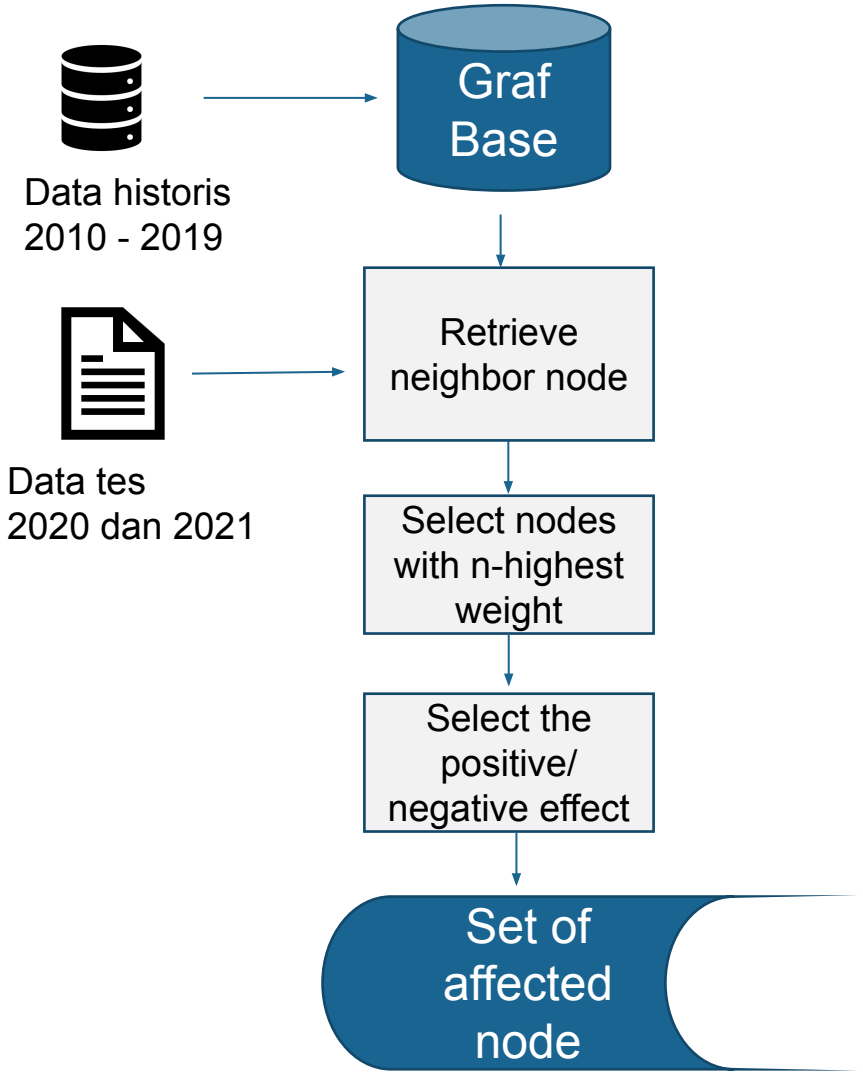
Board of Director



Board of Commissioner



No	Skenario	Variabel	K-NN	Akurasi	AUC
1	Data Finansial	Balance sheet, Activity, Profitability	-	84	70
2			5	84	68
3			10	84	67,9
4	Data relasional	BoC, BoD, SH	-	76	50
5		BoC, BoD, SH	5	74	51
6		BoC	5	78	49
7		BoD	5	80	51
8		SH	5	78	49
9	Data Finansial dan Data Relasional	50 : 50	5	79	54
10		75 : 25	5	81	61
11		Sum	5 dan 10	79 - 80	68



Shareholder

	Index	Kode	edS	Dist	Edge
2194	ZONE	BTEL	2.0	0.700000	1.400000
2195	ZONE	KPIG	2.0	0.000000	0.000000
2196	ZONE	OCAP	2.0	0.526316	1.052632
2197	ZONE	BHIT	1.0	0.000000	0.000000
2198	ZONE	ENRG	1.0	0.200000	0.200000
2199	ZONE	FREN	1.0	0.833333	0.833333
2200	ZONE	VIVA	1.0	0.111111	0.111111

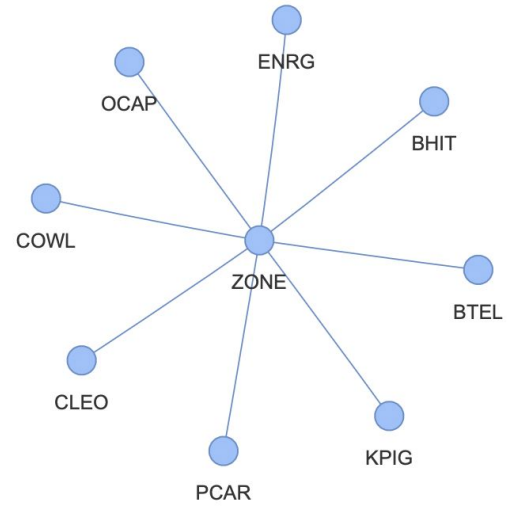
BOC

	Index	Kode	edC	Dist	Edge
1511	ZONE	CLEO	2.0	0.000000	0.000000
1512	ZONE	COWL	2.0	0.300000	0.600000
1513	ZONE	PCAR	2.0	0.333333	0.666667

BOD

Index	Kode	edD	Dist

	Index	Kode	ed	Dist
1211	ZONE	CLEO	2.0	0.000000
1212	ZONE	COWL	2.0	0.300000
1213	ZONE	PCAR	2.0	0.333333
1323	ZONE	BTEL	2.0	0.700000
1324	ZONE	KPIG	2.0	0.000000
1325	ZONE	OCAP	2.0	0.500000
1326	ZONE	BHIT	1.0	0.000000
1327	ZONE	ENRG	1.0	0.200000



Conclusion

1. **The data set has been built** by collecting, pre-processing and analyzing financial and relational data from 2010 to 2021. The financial data was obtained from TICMI, which is a public company data provider listed on the Indonesia Stock Exchange. Relational data is management (directors and commissioners) and shareholder data recorded in the Company's Annual Report from 2010 to 2019.
2. **The first research question is regarding which variables have a significant effect on bankruptcy prediction and their systemic impact.** This research question was answered by measuring the feature importance of the available variables and also conducting experiments with other machine learning classification methods. There are 10 financial variables used in this study, namely Total Debt, Total Equity, Total Sales, Net Income, ATO, ROA, ROE, DAR and DER. In addition, there are 3 relational variables that have an effect on, namely Shareholders, BoD and BoC.

3. **The second research question is about how to build a model with good accuracy.** Some have been answered by building a Case-based Reasoning model. The model can produce up to 85% accuracy and up to 70% AUC. This model is also combined with K-NN which produces not much different accuracy. At the systemic impact prediction stage, the model has been able to recommend predictions of affected companies but has not yet pruned the results.

4. **The limitations of the research found up to this stage are:**

a. It is necessary to explore the measurement of company similarity in terms of financial ratios and also network scores for bankruptcy prediction

b. It is necessary to weigh each type of network according to the level of its importance on systemic impact predictions

c. Expansion of the definition of conglomerate into companies that are related managerially and share ownership


THANK YOU