

A network graph with orange circular nodes of varying sizes connected by thin orange lines, forming a complex web structure across the entire slide.

# It's not all about the money

Bankruptcy prediction using  
relational data

Credit Scoring and Credit Control XIV conference 2015

University of Edinburgh

Ellen Tobback

A map of Italy is shown in a light gray color against a darker gray background. Two orange rectangular text boxes are overlaid on the map. The first box is in the upper left, and the second is in the lower right.

**€112 billion** outstanding  
debt to non financial firms

**About 1 out of 80** firms  
went bankrupt in 2014



bankruptcy prediction



Scholar

Ongeveer 56.300 resultaten (0,03 sec)

Artikelen

Mijn bibliotheek

Elke periode

Tip: alleen in het **Nederlands** zoeken. U kunt uw zoektaal bepalen in [Instellingen voor Scholar](#).

**A neural network model for bankruptcy prediction**

[MD Odom](#), [R Sharda](#) - 1990 IJCNN International Joint Conference on ..., 1990 - infona.pl

A neural network model is developed for **prediction of bankruptcy**, and it is tested using financial data from various companies. The same set of data is analyzed using a more

A Google Scholar search on “bankruptcy prediction” lists **56,300** hits.

Most of them use financial and accounting variables.



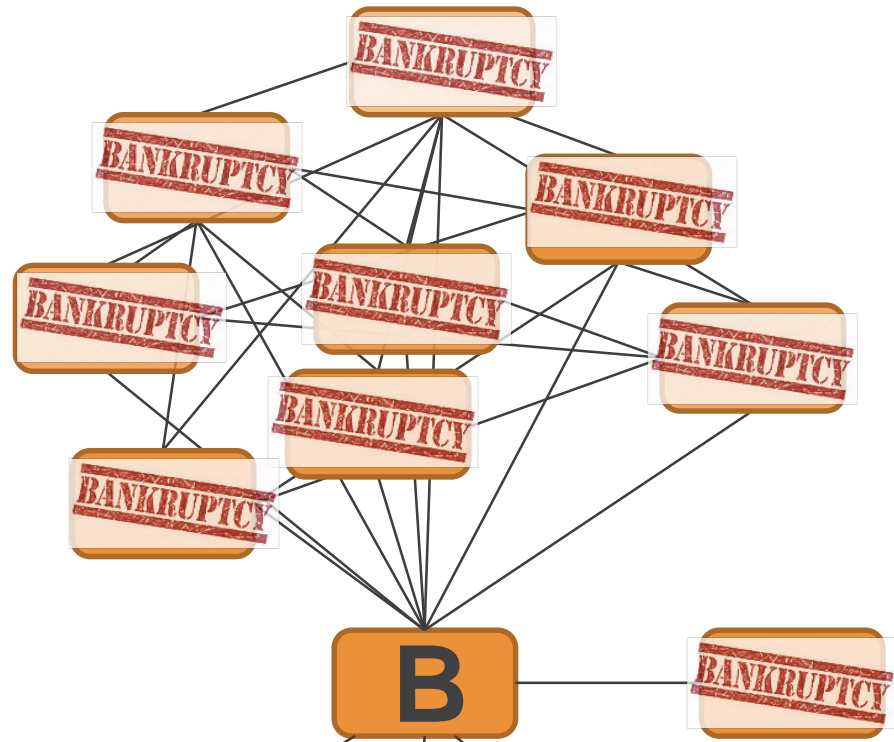
**80%** of the bankruptcy cases are caused by **mismanagement** and **incompetence**.\*

More than 5 % of the active Belgian SMEs have **at least one** manager or board member that was involved in a **previous bankruptcy**.

\* According to a Belgian survey



If company A and B are linked through the same manager and company A fails, will company B have a **higher probability of failure**?



Is company B the next one to **fail**?





# Data set in numbers

+ 400,000

Belgian SMEs

2012-2013

Training and validation period

2014

Test period

1%

Event rate in each set

+5%

“Bad link” rate



# Prediction models

- ① Base model
- ② Network model
- ③ Ensemble model



# Base model



## Financial Variables

- Return on Assets
- Return on Equity
- Current Ratio
- Debt to Total Assets
- Cash Flow to Equity
- Profit/Loss



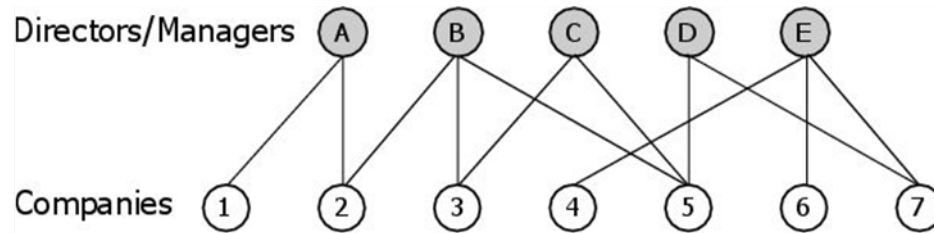
## Dummy Variables

- Missing Values
- Small or Large?
- Newly Founded?

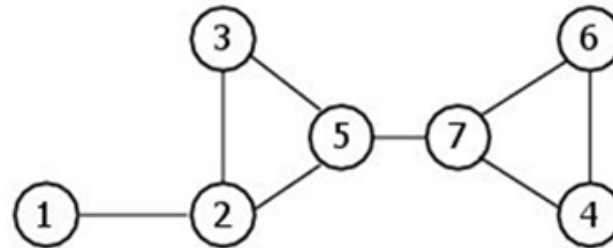
## Linear SVM model



# Network model



From a  
bigraph



To a  
unigraph

How do we **quantify** the links?

Bottom Node Projection

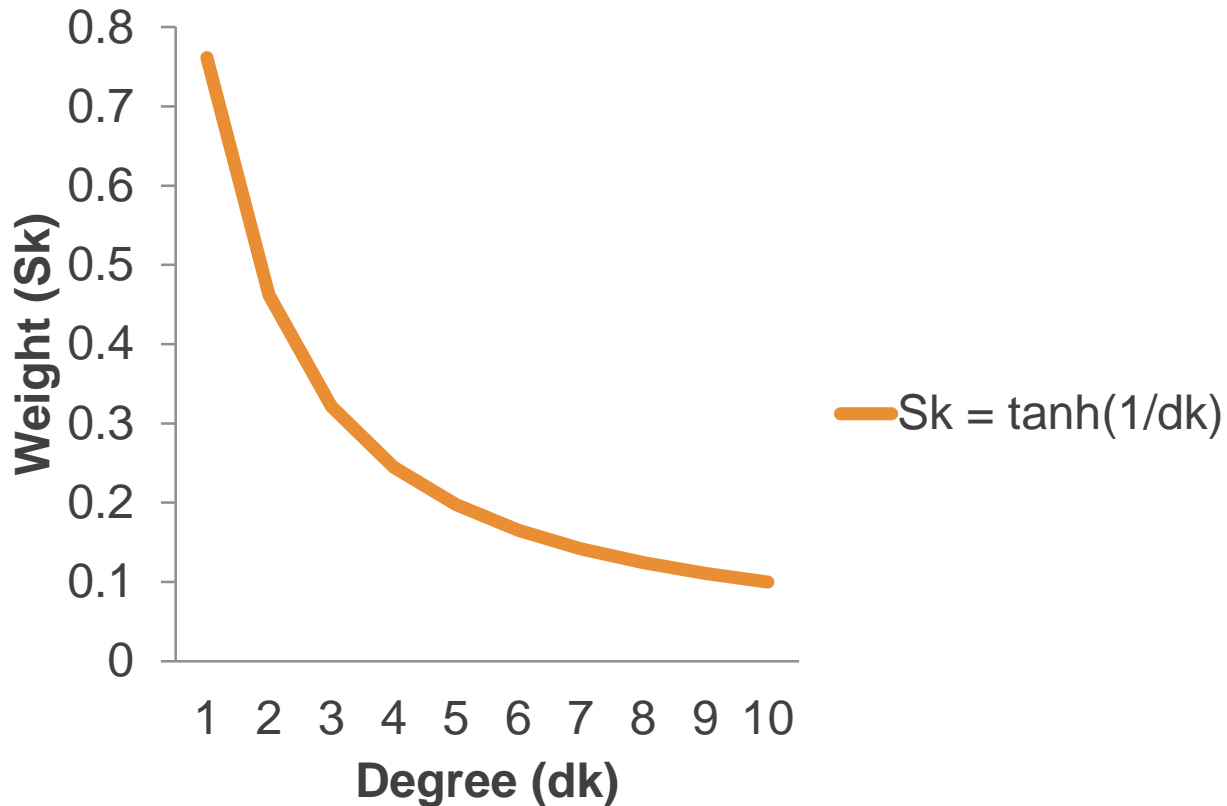
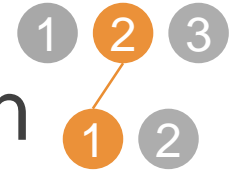
How do we get a **prediction**?

Weighted vote Relational Neighbour

# Bottom node projection

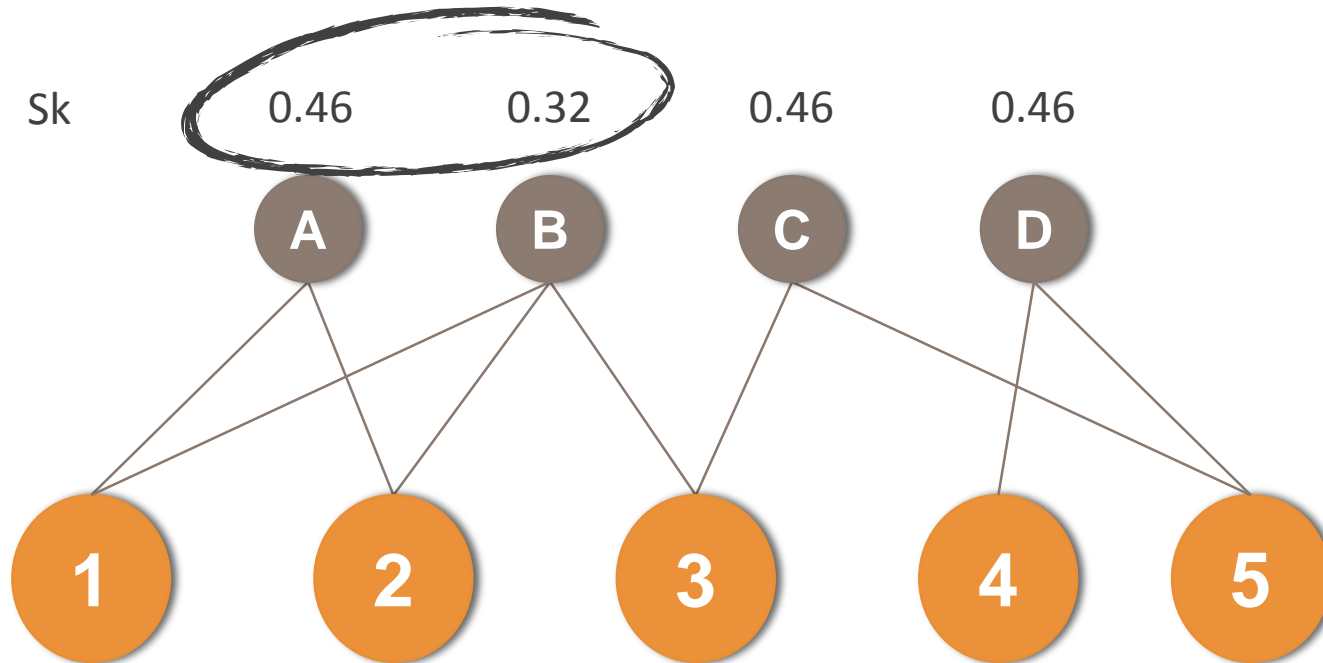
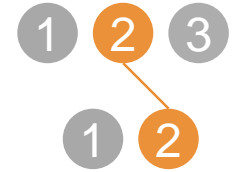
- 1 Hyperbolic Tangent Function
- 2 Sum of Shared Nodes

# Hyperbolic Tangent Function



Downweight managers that are part of many firms

# Sum of Shared Nodes



Company 1 and 2 have A and B in common.  
The weight of the link between 1 and 2 is  
 **$0.46 + 0.32 = 0.78$ .**

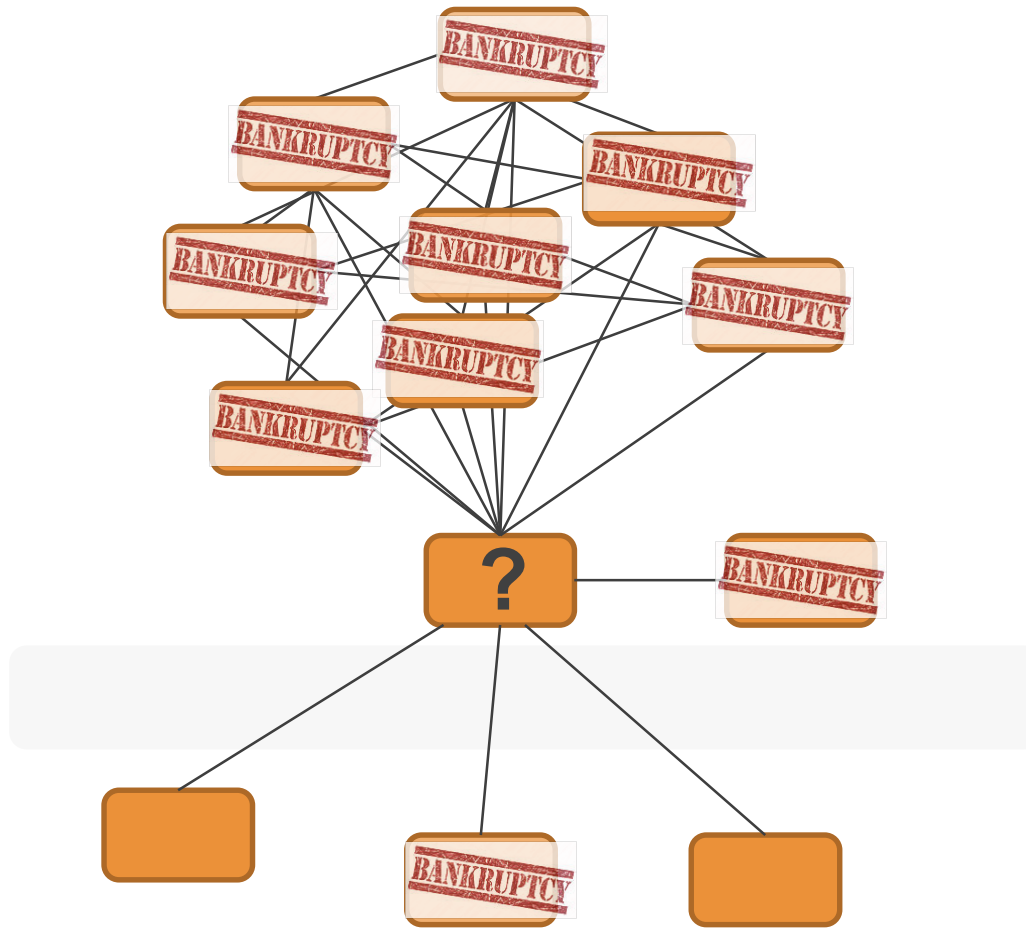
How do we **quantify** the links?

Bottom Node Projection

How do we get a **prediction**?

Weighted vote Relational Neighbour

# Weighted vote relational neighbour



$$W P(B = \text{bankrupt} | N_B) = \frac{1}{Z} \sum_{\text{Vertex } j \in N_i} w_{i,j} * P(J = \text{"Bankrupt"} | N_j)$$

# Ensemble model



## Financial Variables

- Return on Assets
- Return on Equity
- Current Ratio
- Debt to Total Assets
- Cash Flow to Equity
- Profit/Loss



## Dummy Variables

- Missing Values
- Small or Large?
- Newly Founded?



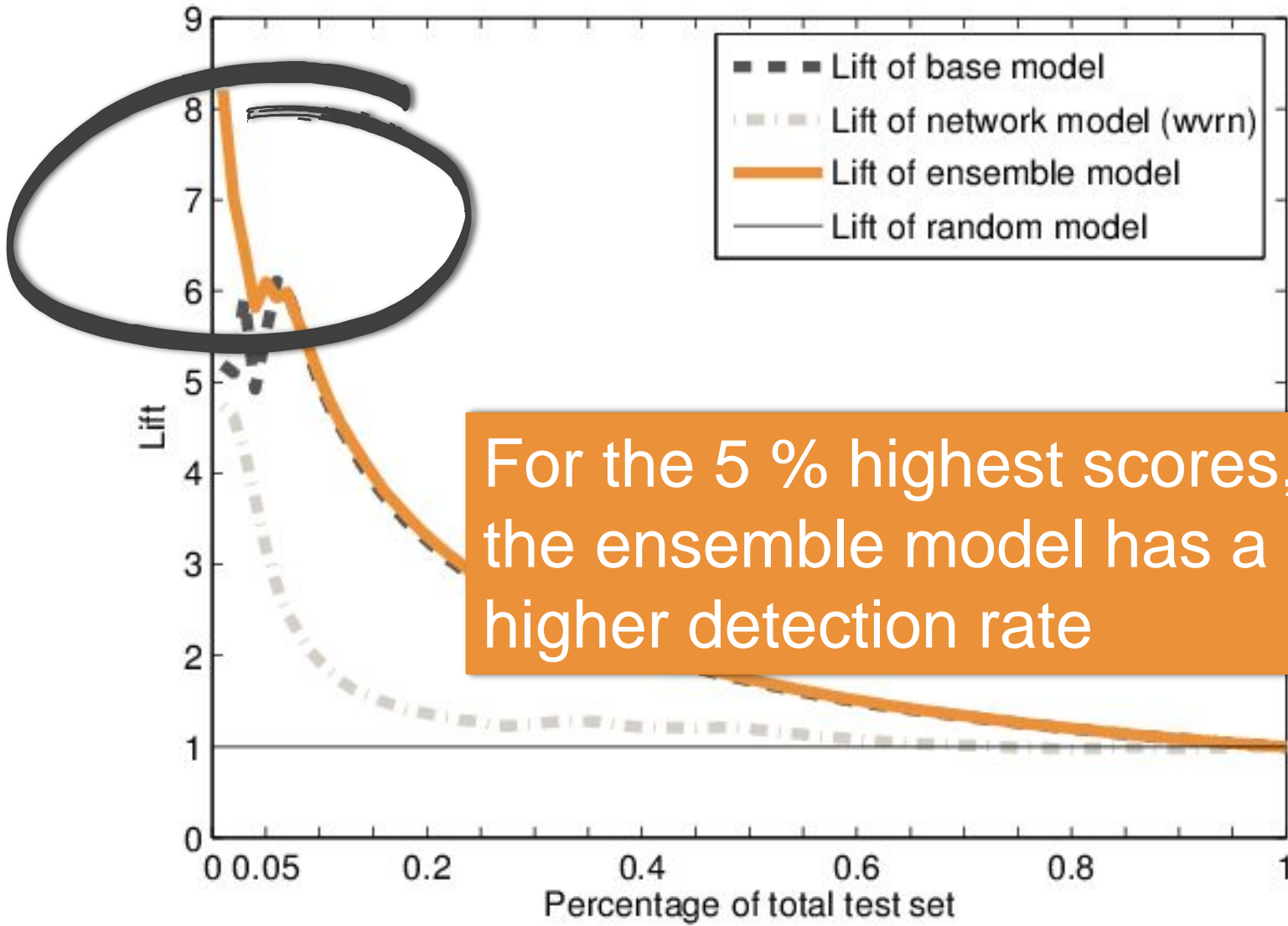
## Network score

- wvRN

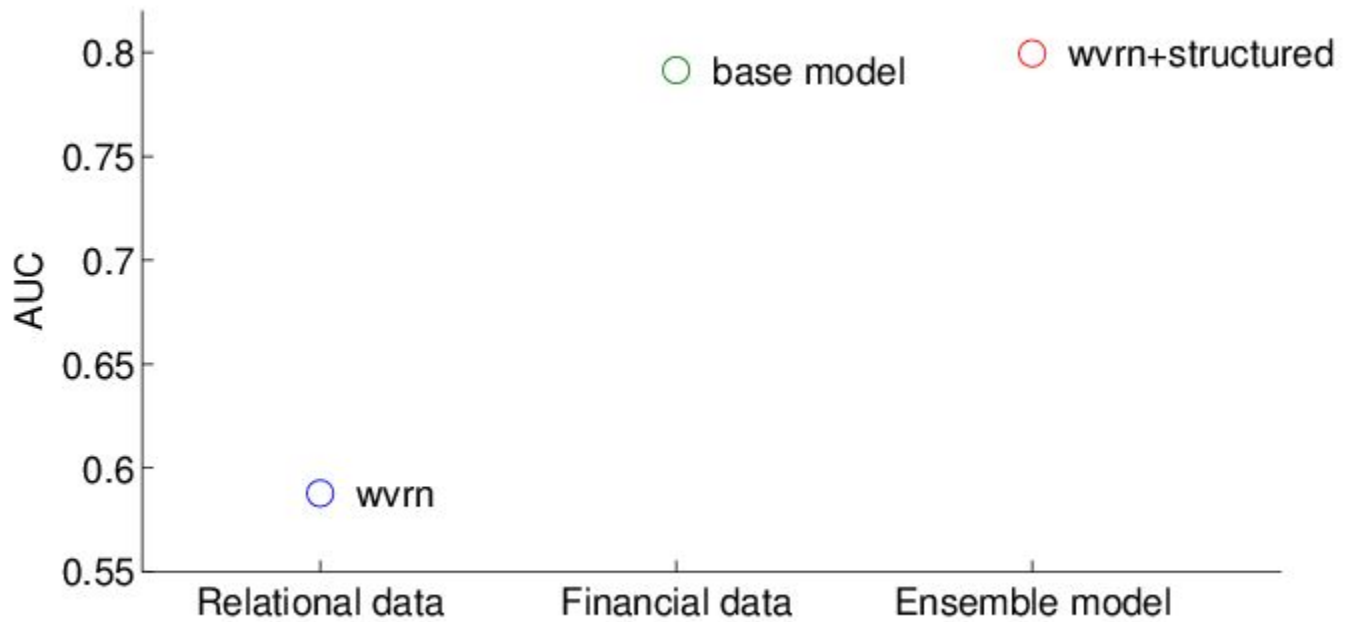
Linear SVM model

# Performance assessment

- ① Lift Curve
- ② AUC Performance
- ③ Predictors analysis



For the 5 % highest scores, the ensemble model has a 58% higher detection rate



The AUC-value is **not** significantly higher



## Base Model

## Ensemble model

+

Missing ROE  
Missing Equity Ratio  
Missing ROA

Network scores  
Missing ROE  
Missing Equity Ratio

-

Newly Founded  
Equity Ratio  
Profit(+)/Loss(-)

Newly Founded  
Equity Ratio  
Profit(+)/Loss(-)



Three conclusions to take home



Companies linked to many (or only) bankrupt firms have a **higher probability of bankruptcy**, especially when they find themselves ***in a bad financial position***.

# 2

Combining the network scores of the relational model with the financial data results in a **better detection** of the companies that are more likely to fail.



***Being related to healthy firms*** only **does not compensate for a bad financial situation** and does not lower your probability of failure.

