Qualitative Bankruptcy

Inteligência Artificial Aplicada 2015/2016

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Problem Knowledge Area

- The problem chosen is of a social-economic nature.
- A considerable number of companies end up being dragged towards bankruptcy due to financial problems and the economy.
- Data classification remains as one of the most important issues for most business applications.
- Information regarding bankruptcy prediction gathered by experts in this area is still considered quite important due to the subjectivity attached to their predictions.

Figure 1: Bankruptcy issues

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Attributes

Given the problematic nature of this issue the aim here is the prediction of bankruptcy for a given company given a set of qualitative risk factors assessed by experts for that particular company.

- There are 6 different attributes which have the same domain.
- Each attribute can hold one of 3 possible values, **positive (P)**, **average (A)** and **negative (N)**
- The prediction/classification will be either as **bankruptcy (B)** or **non-bankruptcy (NB)**.
- The 6 attributes present are the companies' internal risks, **Industrial Risk (IR), Management Risk (MR), Financial Flexibility (FF), Credibility (CR), Competitiveness (CO)**, and **Operating Risk (OP)**.

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Bayes Network

The Bayes Network for this problem is the following:

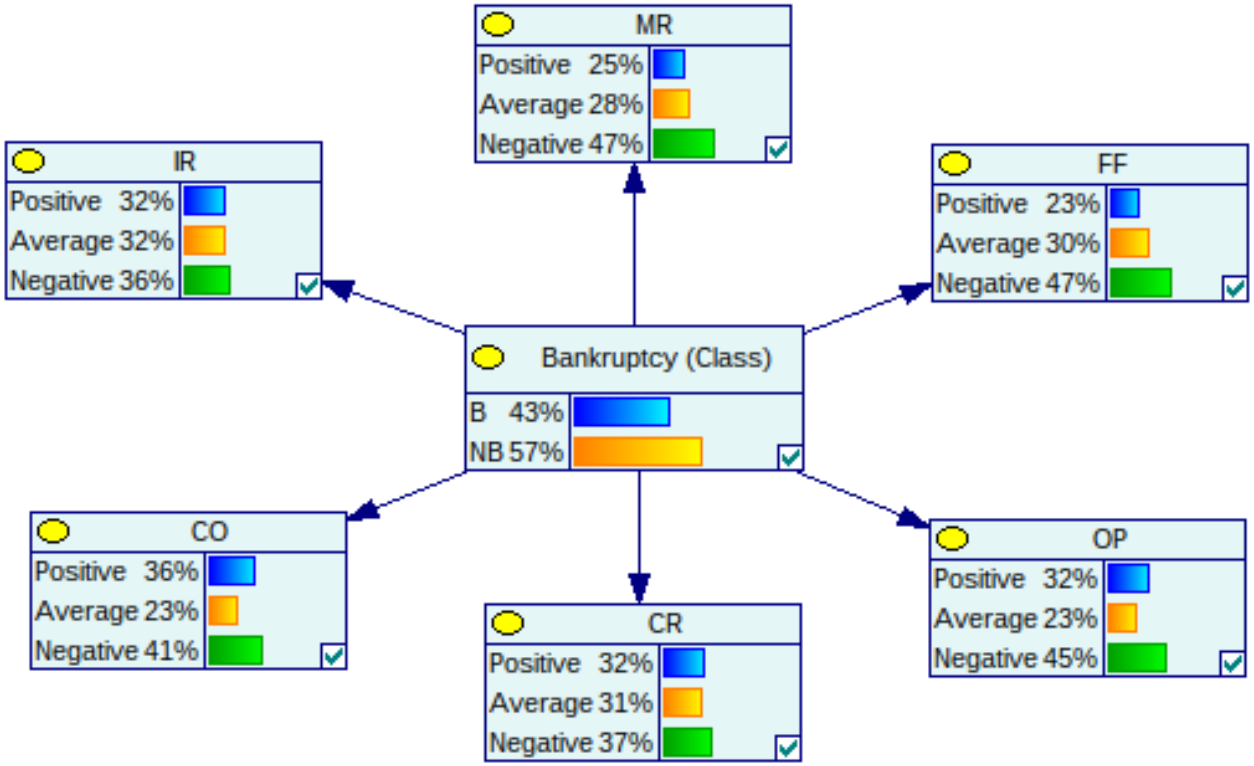

Figure 2: Bayes Network

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Bankruptcy Prediction Probabilities Table

The table for the probabilities of the Bankruptcy prediction node inferred from the data set is the following:

Bankruptcy (class)	
B	0.428
NB	0.572

Table 1: Bankruptcy prediction node probabilities table

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Conditional Probabilities Tables

Bankruptcy (Class)	B	NB
Positive	0.244	0.377
Average	0.263	0.37
Negative	0.493	0.253

Figure 3: Conditional probabilities (IR)

Bankruptcy (Class)	B	NB
Positive	0.106	0.356
Average	0.217	0.322
Negative	0.677	0.322

Figure 4: Conditional probabilities (MR)

Bankruptcy (Class)	B	NB
Positive	0.014	0.391
Average	0.041	0.488
Negative	0.945	0.121

Figure 5: Conditional probabilities (FF)

Bankruptcy (Class)	B	NB
Positive	0.033	0.529
Average	0.161	0.419
Negative	0.806	0.052

Figure 6: Conditional probabilities (CR)

Bankruptcy (Class)	B	NB
Positive	0.005	0.633
Average	0.041	0.363
Negative	0.954	0.004

Figure 7: Conditional probabilities (CO)

Bankruptcy (Class)	B	NB
Positive	0.18	0.419
Average	0.226	0.232
Negative	0.594	0.349

Figure 8: Conditional probabilities (OP)

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Problem Reformulation I

In order to insert the decision and utility nodes in the bayes network the problem had to be reformulated.

A venture capitalist finds a venture he believes to have some potential for investment purposes and wants to decide if it is worth investing. The venture capitalist wants to invest **€850,000** in the venture. Based on qualitative bankruptcy predictions he can guess if the venture is going to be successful.

So there are 2 choices here, investing or not in the venture and 2 different outcomes, the venture is successful or unsuccessful.

- In case the venture capitalist decides to invest:
  - If the venture is indeed **successful**, the venture capitalist will collect an additional maximum amount of **€2,150,000**.
  - On the other hand, if the venture turns out to be **unsuccessful** he looses the initial investment of **€850,000**.
- Should he choose not to invest in the venture and go through a risk-free path he can make a risk-free investment in a bank which which will earn him an additional **€150,000**.

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Problem Reformulation II

The venture capitalist is interested solely in its financial gain. If there are any other factors involved like changes in the value of money or intangible values, they can be represented through means of the utility function.

This utility function will represent the financial gain. So in the end what matters is the decision which brings the maximum amount of financial gain to the venture capitalist.

Given the data provided for the problem the values for the **Financial Gain** Utility function would be the following:

Venture Success	Success		Failure	
Invest?	Invest	DoNotInvest	Invest	DoNotInvest
Value	2150000	150000	-850000	150000

Figure 9: Financial Gain utility function values

The values specified are the respective monetary gain for each combination of values from the **Invest?** and **Venture Success** nodes.

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Decision Network

After the reformulation of the problem and adding the required decision and utility nodes the decision network obtained can be seen in the next figure.

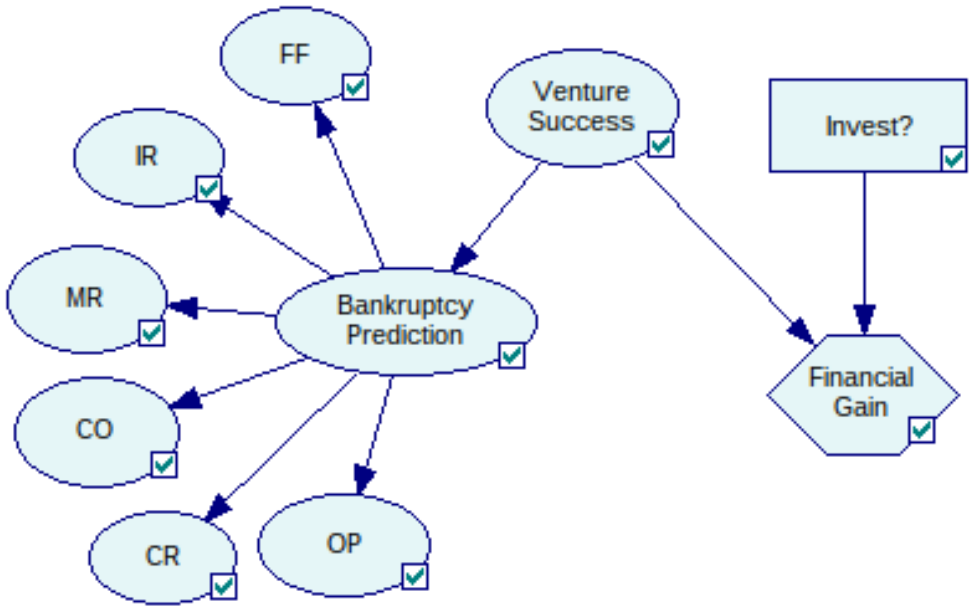

Figure 10: Bayes Decision Network

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Probabilities

The probabilities for the Bankruptcy Prediction node were altered due to the insertion of a new node for the Venture Success Prediction. The Probabilities tables for each can be found in the next figures. The remaining probabilities for the companies internal risk factors remain the same.

Venture Success	Success	Failure
B	0.348	0.552
NB	0.652	0.448

Figure 11: B. Prediction node probabilities

Success	0.381
Failure	0.619

Figure 12: Venture Success node probabilities

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Case 1

If the default probability values were considered for Venture Success node (shown in figure 12) the expected utility values of investing or not investing would be the following:

Expected utilities for different policies:

Invest?	Invest	DoNotInvest
Exp. utility	293000	150000

Figure 13: Expected Utility Values (Example 1)

Given these values the **decision** here would be to invest in the venture.

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Case 2

If the probability values for the venture success node were the following,

Success	0.15
Failure	0.85

Figure 14: Venture Success Probabilities (Example 2)

then the expected utility values of investing or not investing would be the following:

Expected utilities for different policies:

Invest?	Invest	DoNotInvest
Exp. utility	-400000	150000

Figure 15: Expected Utility Values (Example 2)

Given these values the **decision** here would be to not invest in the venture and make a risk-free investment in a bank instead.

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Case 3

If the probability values for the venture success node were the following,

Success	0.65
Failure	0.35

Figure 16: Venture Success Probabilities (Example 3)

then the expected utility values of investing or not investing would be the following:

Expected utilities for different policies:

Invest?	Invest	DoNotInvest
Exp. utility	1100000	150000

Figure 17: Expected Utility Values (Example 3)

Given these values the **decision** here would be to invest in the venture.

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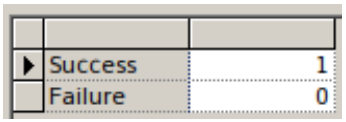
Case 4

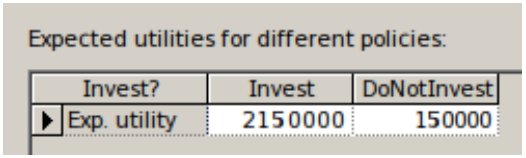
If the probability values for the venture success node were the following,



Success	1
Failure	0

Figure 18: Venture Success Probabilities (Example 4)

then the expected utility values of investing or not investing would be the following:



Expected utilities for different policies:

Invest?	Invest	DoNotInvest
Exp. utility	2150000	150000

Figure 19: Expected Utility Values (Example 4)

Given these values the **decision** here would be to invest in the venture.

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Case 5

If the probability values for the venture success node were the following,

Success	0
Failure	1

Figure 20: Venture Success Probabilities (Example 5)

then the expected utility values of investing or not investing would be the following:

Expected utilities for different policies:

Invest?	Invest	DoNotInvest
Exp. utility	-850000	150000

Figure 21: Expected Utility Values (Example 5)

Given these values the **decision** here would be to not invest in the venture and make a risk-free investment in a bank instead.

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Conclusion

- Taking into account the results here the best result here is to invest in the company unless the probability for Venture success is too low, which is backed by a bigger probability in the prediction of the venture going bankrupt.
- The bankruptcy prediction values can indirectly influence the utility functions' values depending on the difference of probabilities between both predictions.
- In cases like the default one (figure 12 where the probability for success is way less than 50%, but the probability for a Non-Bankruptcy prediction is still higher than average it is still worth investing because the gains will still be higher than those that come from not investing in the venture and making instead the risk-free investment in a bank.

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Conclusion

The End

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