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Credit risk early warning system using fuzzy expert systems

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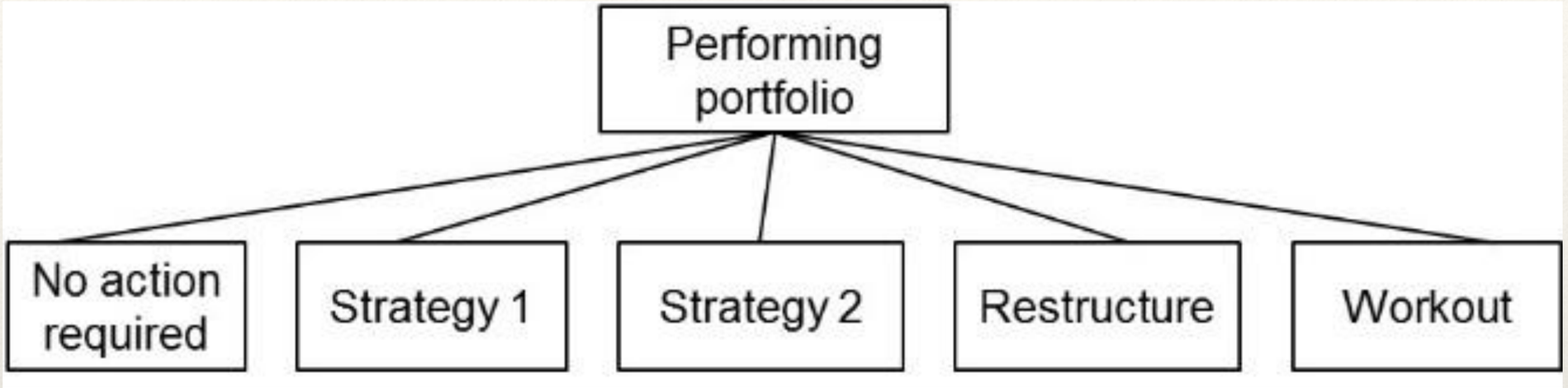
Context

- Recent financial crisis revealed major issues with the ability of financial institutions to recognize increases in credit risk early enough
- Main causes were identified:
  - Too much focus on underwriting and compliance
  - Lack of a dedicated organizational unit and personnel
  - Lack of interdepartmental and intragroup communication
  - Poor data quality
  - Inadequate IT systems

Goal of the Early Warning System

- Differentiate between clients who can be saved from default by taking appropriate actions and clients whom the bank would like to divorce
- Minimize losses by taking appropriate actions early on
- Proactively manage the client's financials
- First lender to identify a high risk client will collect more than others
- First lender to identify a troubled client which can be saved can win him over

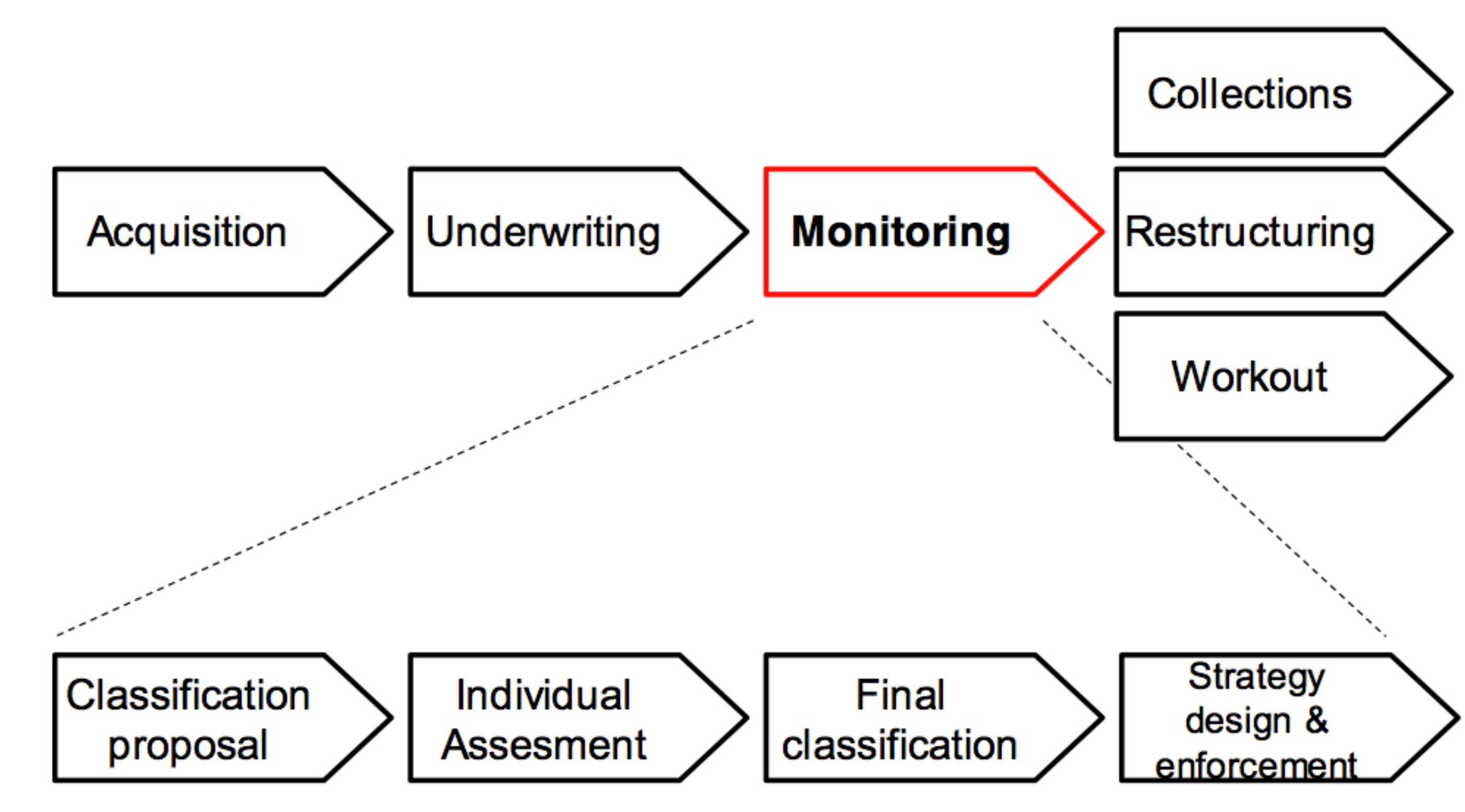
A Classification Problem



	Real status	
Classification	Performing	Default
No action required	Well done	Type 2 error
Monitor	Type 1 error	Well done

- Type 1 error reduces efficiency
- Type 2 error reduces effectivness
- Resources are modeled as a constraint, goal is to minimize errors

Monitoring Process



Signal Data Sources

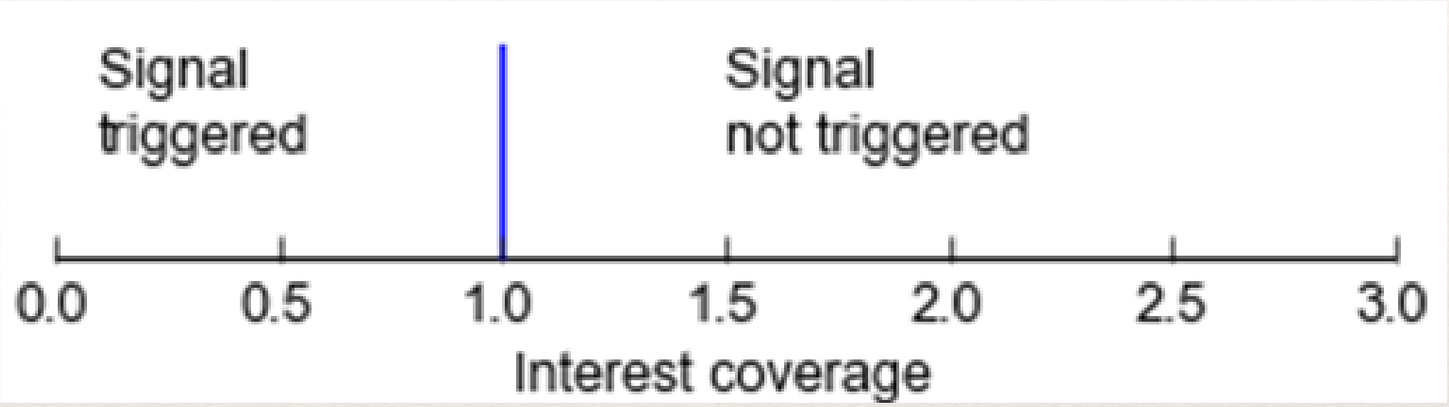
- Internal data (CRM, collateral database, ...)
- Group data (leasing, insurance, factoring, ...)
- Financial statements
- Macroeconomic and industry analyses
- Credit bureau
- Capital markets
- Government databases (land registry, subsidies, official papers, ...)
- Media
- Payment transactions
- Network analysis

Signal Evaluation

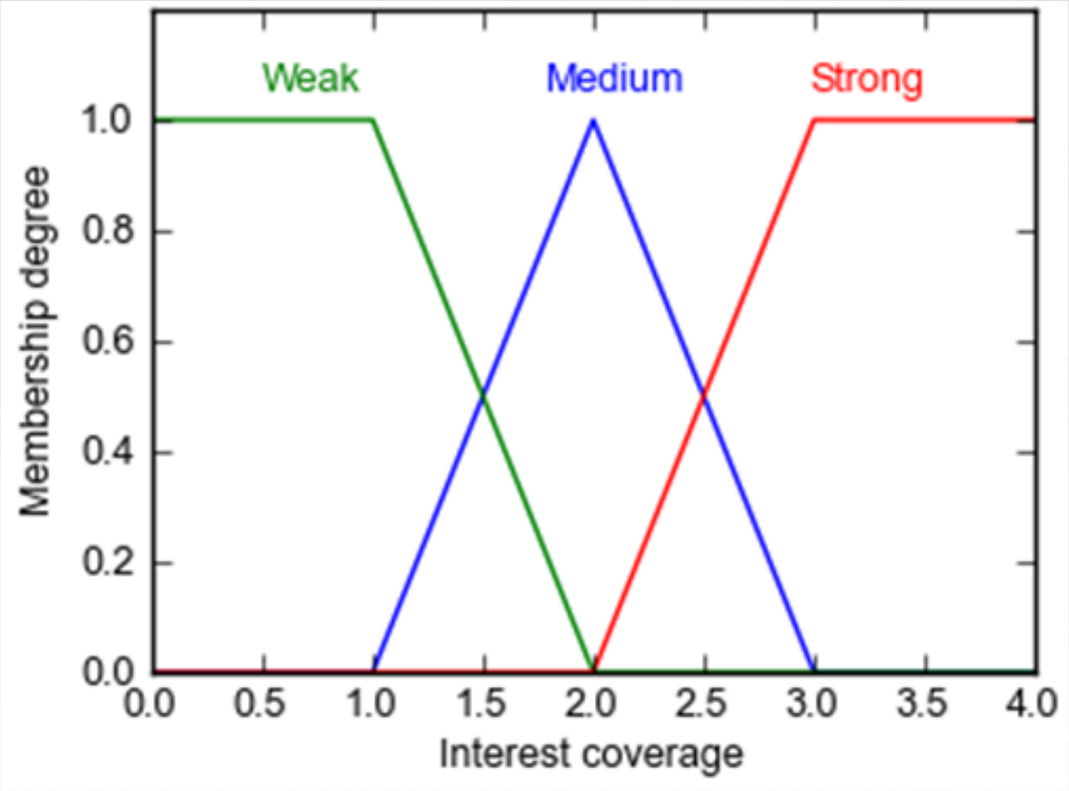
- Precision = number of defaulted clients with signal / total clients with signal
- Coverage = number of defaulted clients with signal / total defaulted clients
- Workload = number of clients with signal
- Time to default = average time between first occurance of the signal and actual default

Fuzzy Logic

- Traditional logic



- Fuzzy logic

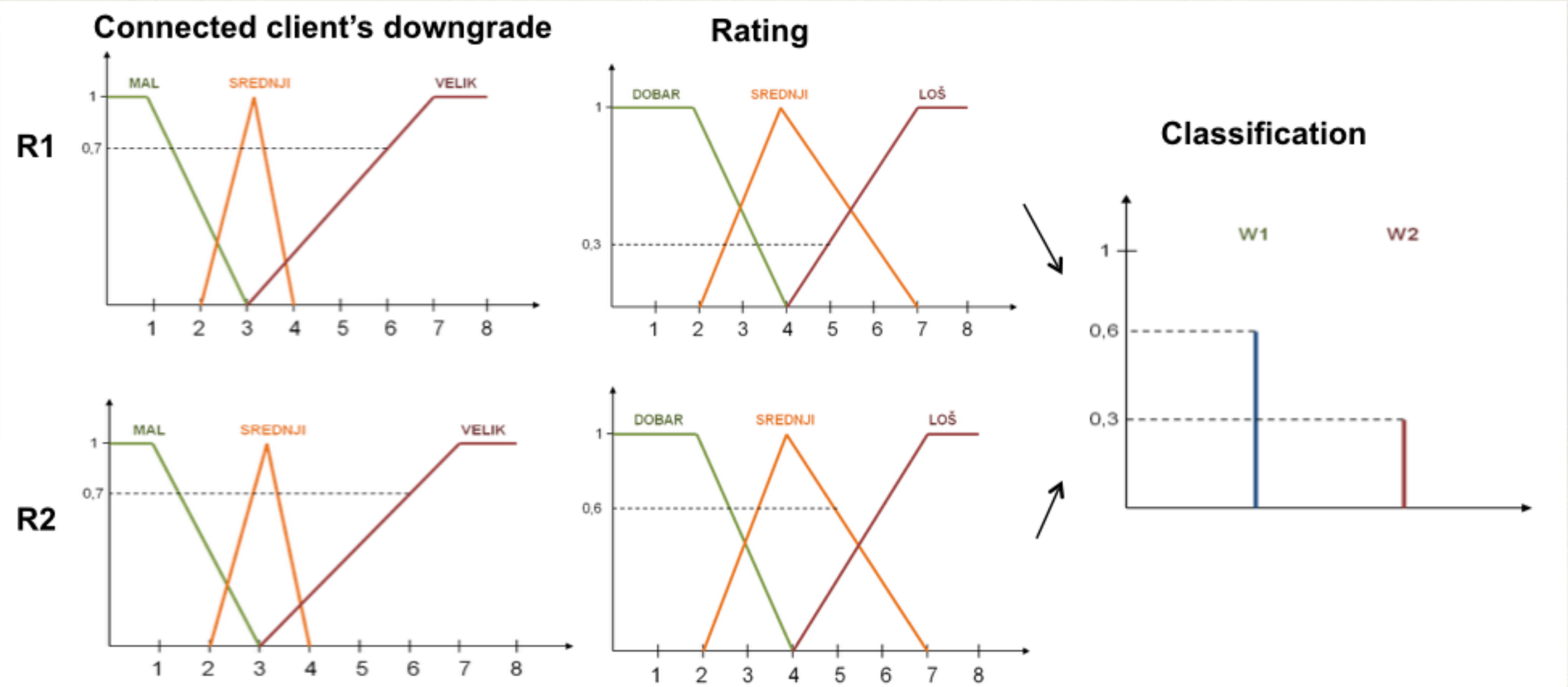


Fuzzy Expert System

- Rules are defined using linguistic variables
- Signals can be combined with auxiliary variables (segment, industry, exposure, ...)
- All rules for which at least one signal is triggered are fired simultaneously
- Rules can have weights making them more or less important
- System is easily tuned for available capacity by adjusting the minimal membership degree treshold of output variables

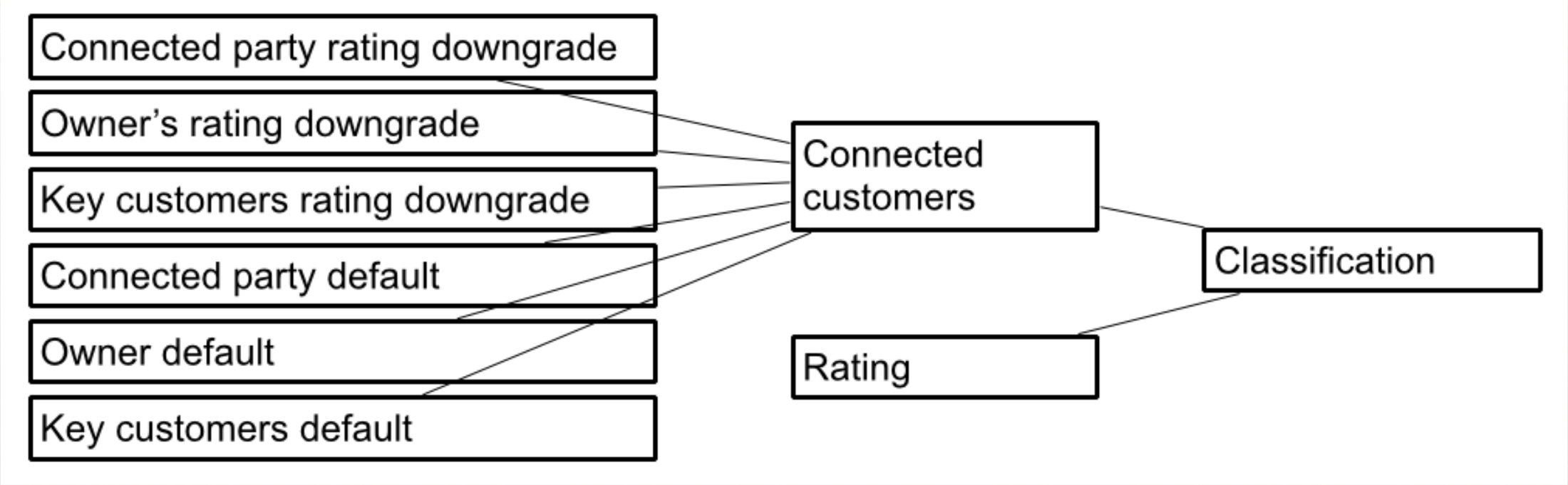
An Example

- Rule 1: If connected client's rating downgrade is large and rating is weak than monitoring class is W2
- Rule 2: If connected client's rating downgrade is large and rating is medium than monitoring class is W1
- Connected client's rating downgrade = 6 notches, client rating = 5



Handling Model Complexity

- Rule blocks

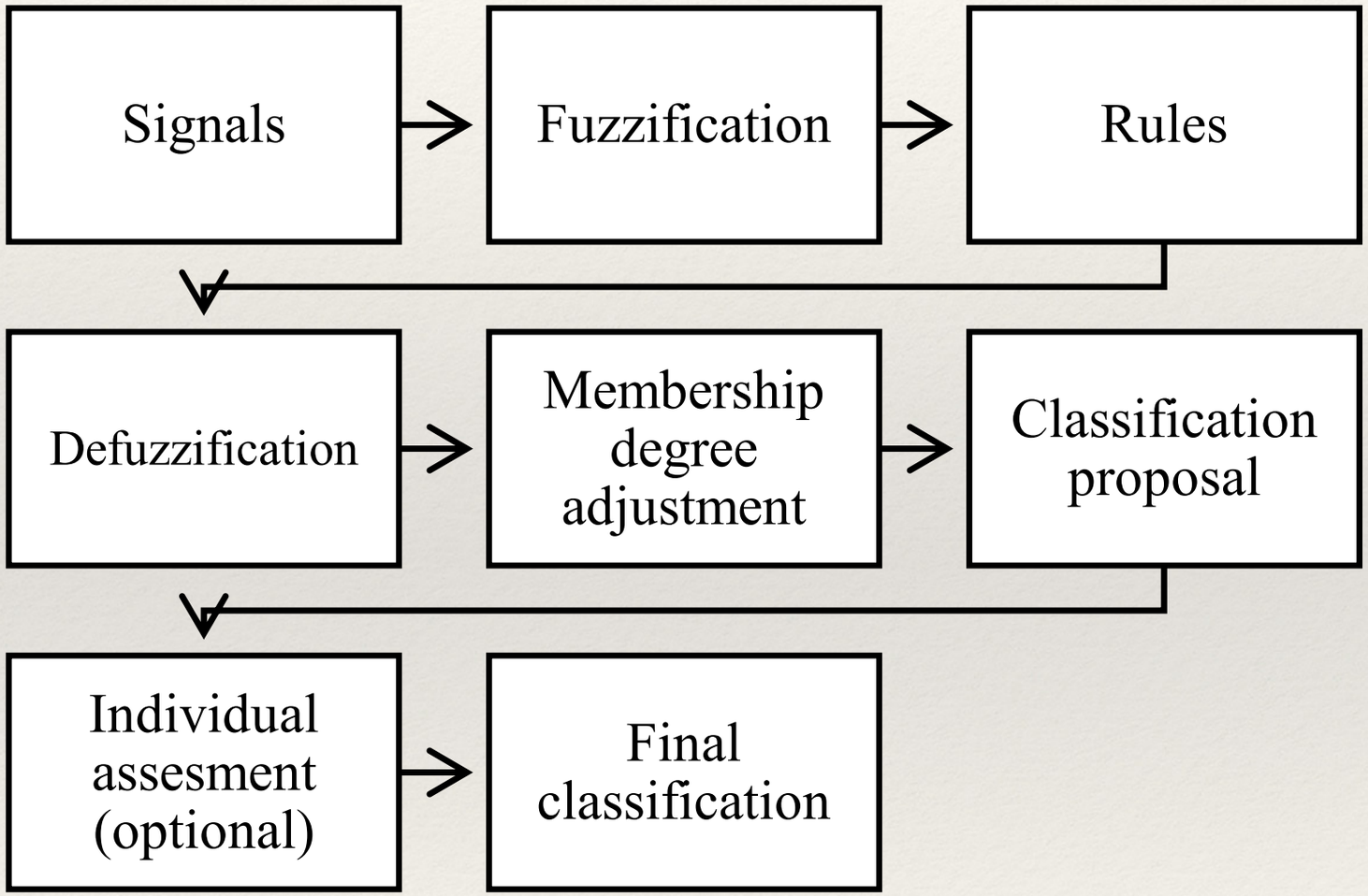


- Adjusting membership degrees
  - High quality collaterals
  - Clients previously in monitoring, restructuring or workout

Auto tuning

- Each rule can have a weight corresponding to its importance / predictive power
- Rules can be fuzzy as well
- Rule weights can be adjusted automatically using new data
- Weights for rules which are declining in predictive power can be automatically decreased and vice versa

System Architecture



Validation

Test case	Model outcome at N-th month prior to default				Domain experts' remarks
	3m	6m	12m	24m	
Case 1	R	R	S1	S1	Correct & timely
Case 2	S1	NA	NA	NA	Too late
Etc.					

Conclusion

- Fuzzy expert system proved to be a better option compared to traditional statistical techniques in terms of predictive power, robustness, interpretability, etc.
- Validation continues to be an issue
- Future research:
  - Model auto-tuning
  - Social Network Analysis