

# Modeling innovation changes in business networks

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# Innovation Network Performance and Structure

- Actors' choices concerning knowledge sharing with other business actors changes existing network structures resulting in improved overall 'network innovation'
- Actors choose to modify the strength of their connections with the other actors via altering the amount of financial resources or information they share or facilitate with other network actors
- Outcome = network innovation and changes in resources allocation
  - Longitudinal studies
  - Case studies
  - Simulation - however not simply stochastic processes
- Fuzzy sets
- Rapid changes, organisational roles = ambiguous, market boundaries unclear, not exact information, multiple interactions

} limitations

## Dimensions of interest

- Types of Resources
  - Financial
  - Knowledge
  - A-dimensional units (1 to 1 exchange value)  
(resource ties and social bonds are connections of significance)
- Types of Actors - key players in innovation networks
  - Venture Capitalists
  - Manufacturers
  - Research and Development Firms
- Proportion of actors in the network - related to power, opportunities to develop relationships, competition vs mono/oligopolistic behaviours
- Interaction (relational strength encompassing trust, joint activities, closeness of actors, etc.)

## Dimensions of interest - Cont'd

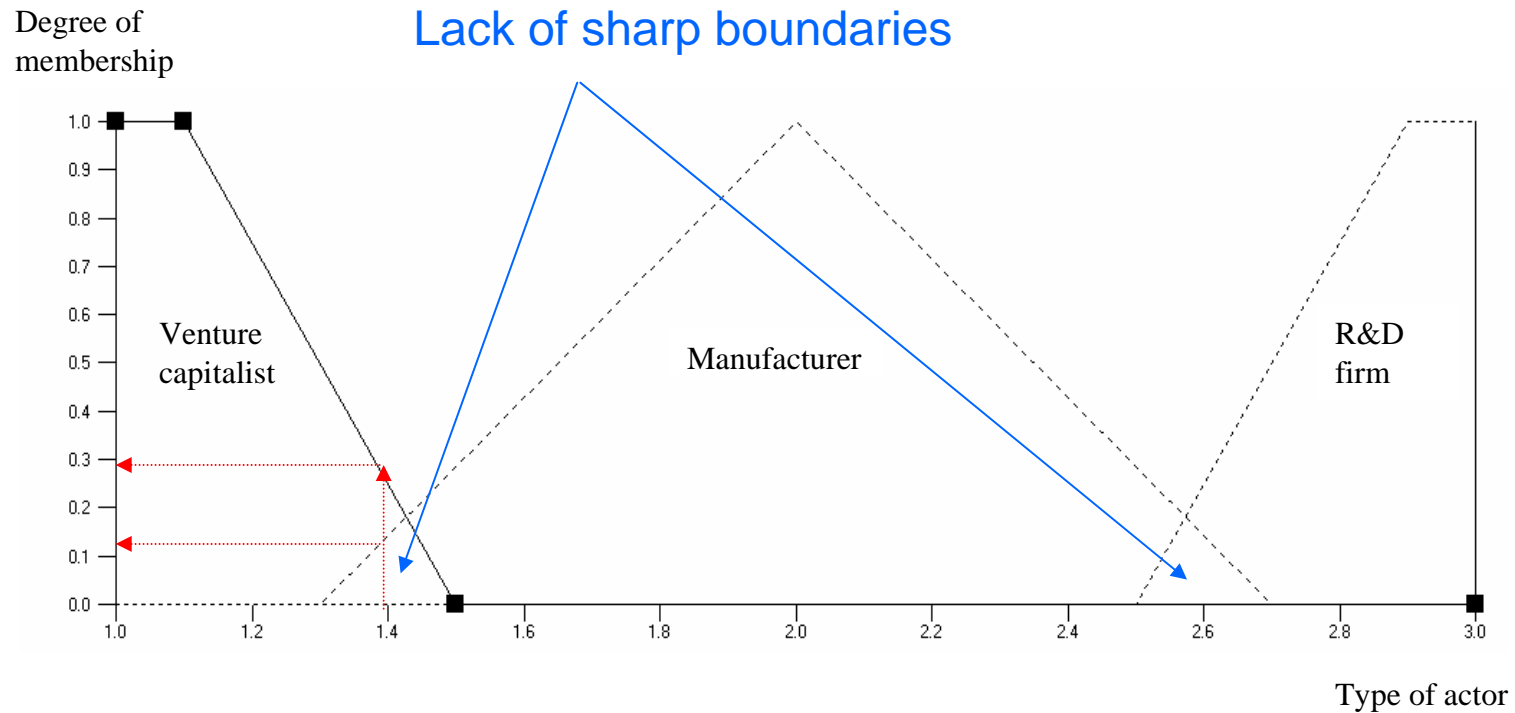
- Relevance of knowledge resources - usefulness
- Determines the parameter for resource growth and decay - highly relevant/specific information likely to decay in a loose ties situation; or highly relevant financial injection likely to multiply in a fertile, strong environment

# Using fuzzy logic

## Rationale

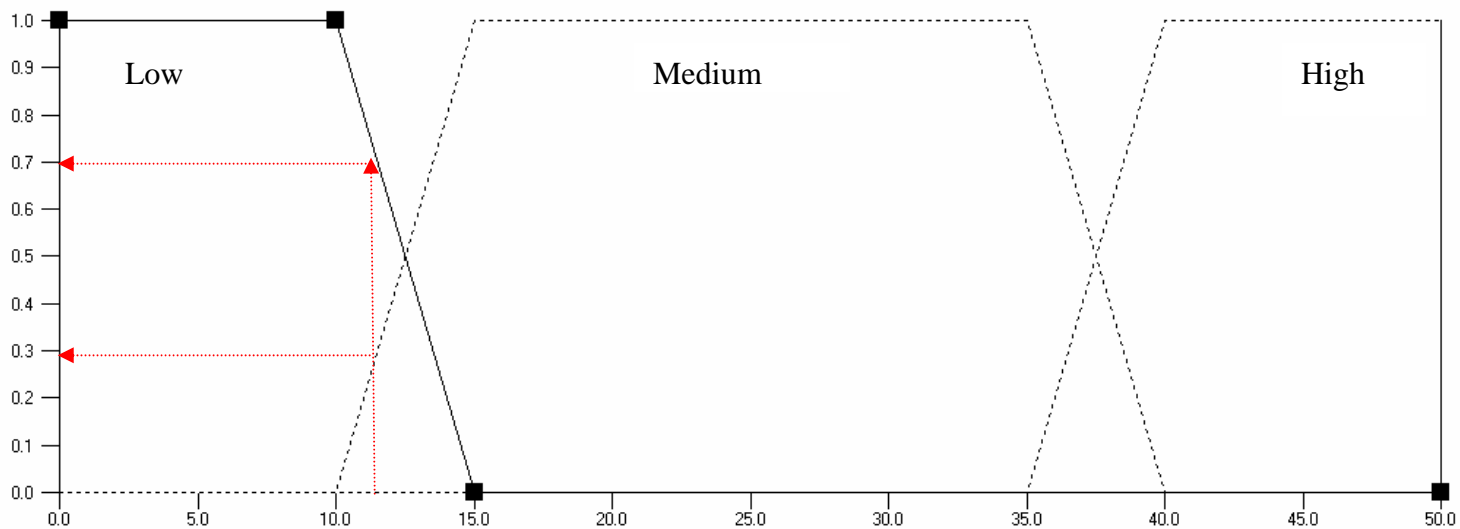
- Subjective/perception of input dimensions - fuzzy not crisp
- Decision rules based on long term experience rather than clear functional forms to be expressed mathematically
- Flexibility in modelling “contradictory” results (e.g., similar conditions may lead to different outcomes depending on the decision rules used by actors)
- Describing changes in the network as a whole entity based on changes occurring in dyadic relations
- Possibility to follow trajectories over time (still under development in the model)

# Fuzzy membership functions



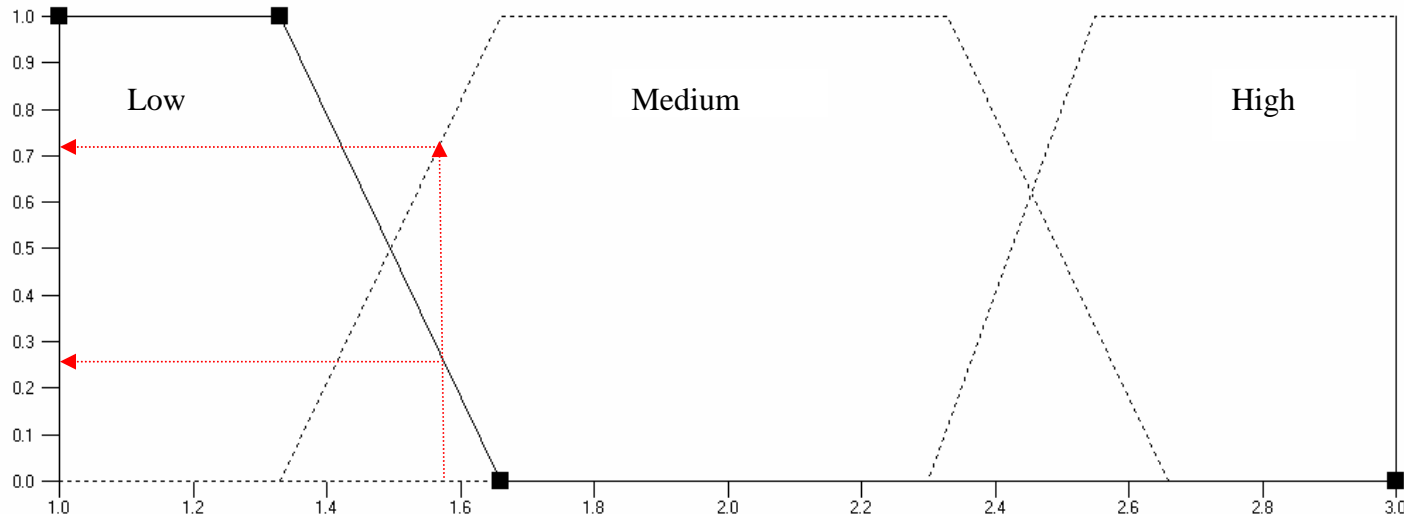
1.4 → VC with 0.3 degree of membership and Manufacturer with 0.12 degree of membership

Degree of membership



Degree of membership

Proportion (%)

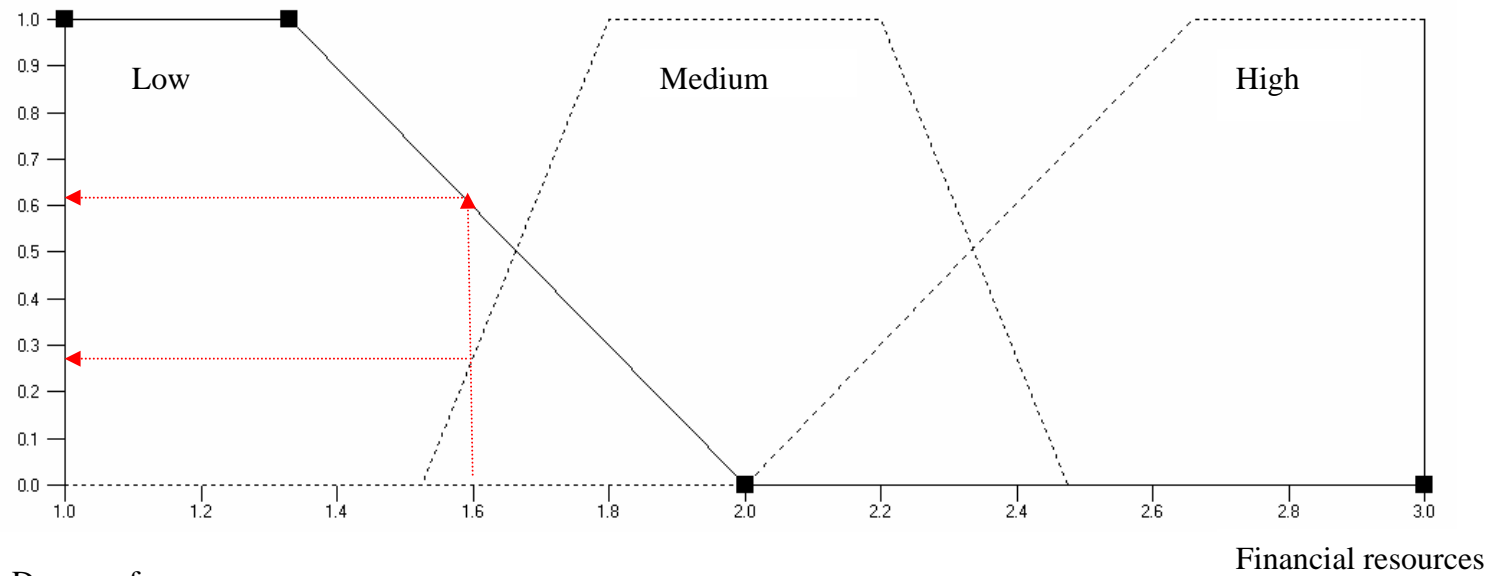


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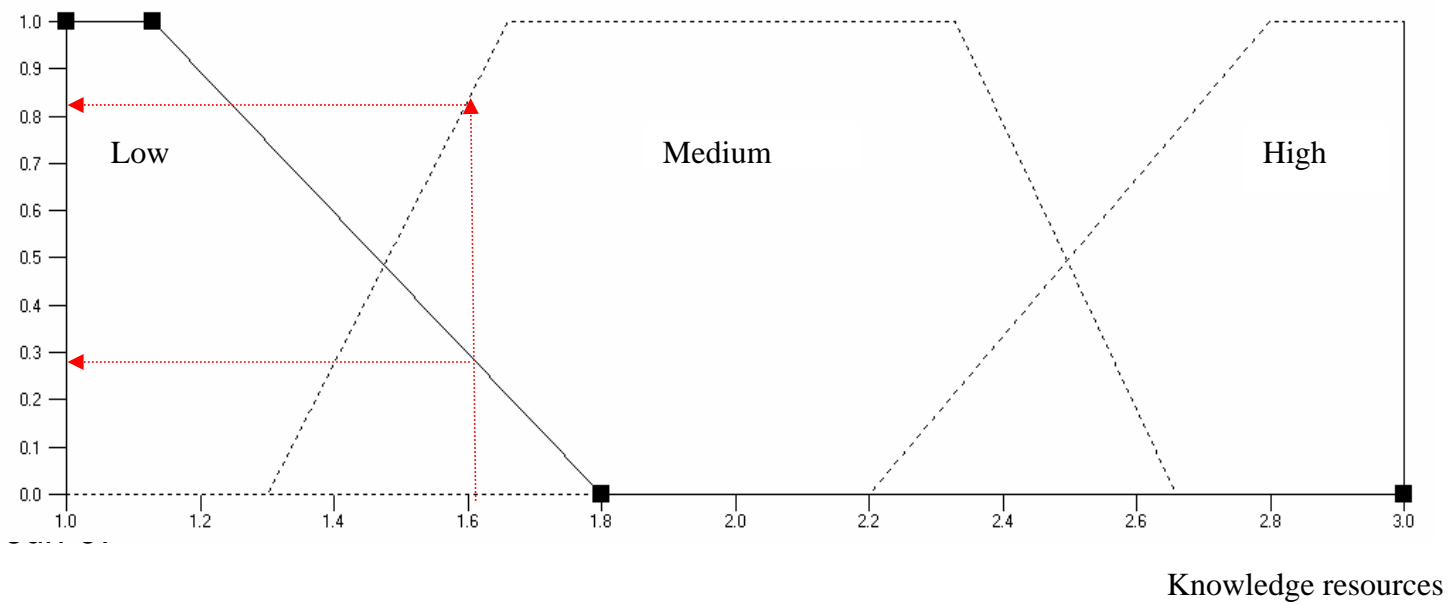
Relational strength



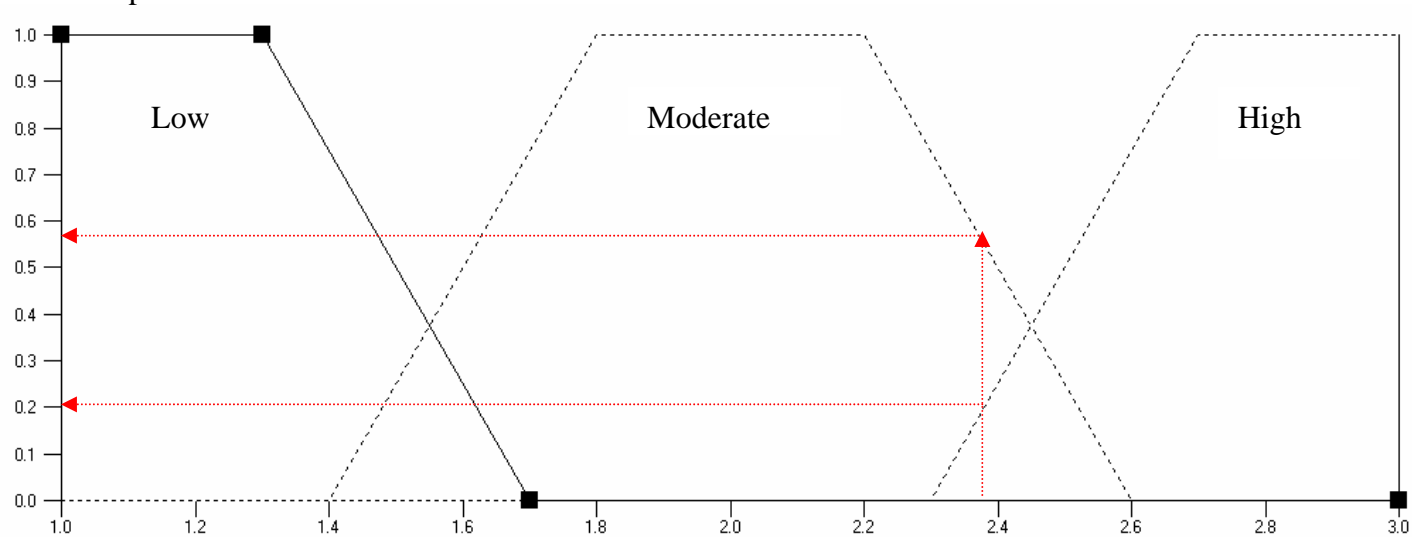
Degree of membership



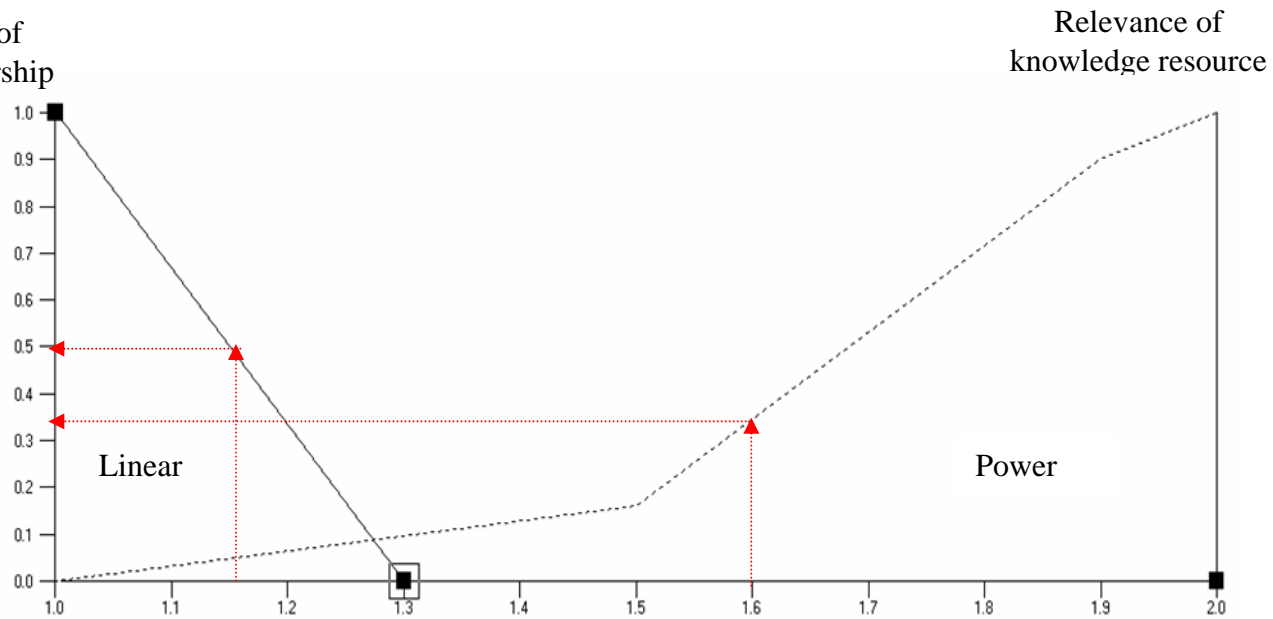
Degree of membership



Degree of membership



Degree of membership

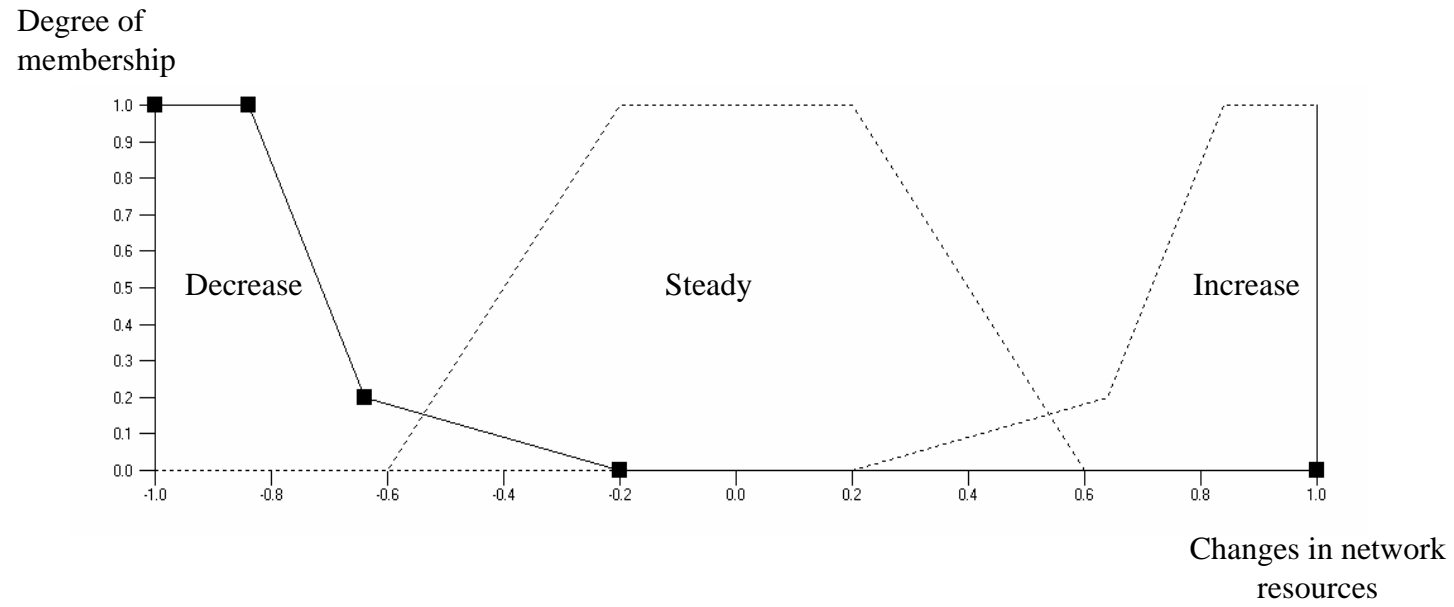


Relevance of knowledge resource

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Growth & decay

# Changes in the network



## Decision Rules

- Full factorial  $3^6 * 2 = 1,458$
- Trimmed down to 324 (eliminate “unbelievable” rules)

## Example

Actor 3 (R&D) Proportion 18% (medium) Financial resources 2  
(medium) Knowledge resources 2.4 (0.72 medium; 0.36 high)  
Relational strength 1.55 (0.35 low; 0.65 medium) Relevance of  
knowledge resources 2.9 ( high) Decay 2 (power)

## Decision rules - Cont'd

- R1 IF (type of actor = "R&D") AND (proportion in the network = "medium") AND (financial resources shared = "medium") AND (knowledge resources shared = "medium" 0.72) AND (relational strength = "low" 0.35) AND (relevance of knowledge resource = "high") AND (growth/decay of resources = "power") THEN changes in network resources = "steady".
- R2 IF (type of actor = "R&D") AND (proportion in the network = "medium") AND (financial resources shared = "medium") AND (knowledge resources shared = "medium" 0.72) AND (relational strength = "medium" 0.65) AND (relevance of knowledge resource = "high") AND (growth/decay of resources = "power") THEN changes in network resources = "steady".
- R3 IF (type of actor = "R&D") AND (proportion in the network = "medium") AND (financial resources shared = "medium") AND (knowledge resources shared = "high" 0.36) AND (relational strength = "medium" 0.65) AND (relevance of knowledge resource = "high") AND (growth/decay of resources = "power") THEN changes in network resources = "increase".
- R4 IF (type of actor = "R&D") AND (proportion in the network = "medium") AND (financial resources shared = "medium") AND (knowledge resources shared = "high" 0.36) AND (relational strength = "low" 0.35) AND (relevance of knowledge resource = "high") AND (growth/decay of resources = "power") THEN changes in network resources = "steady".

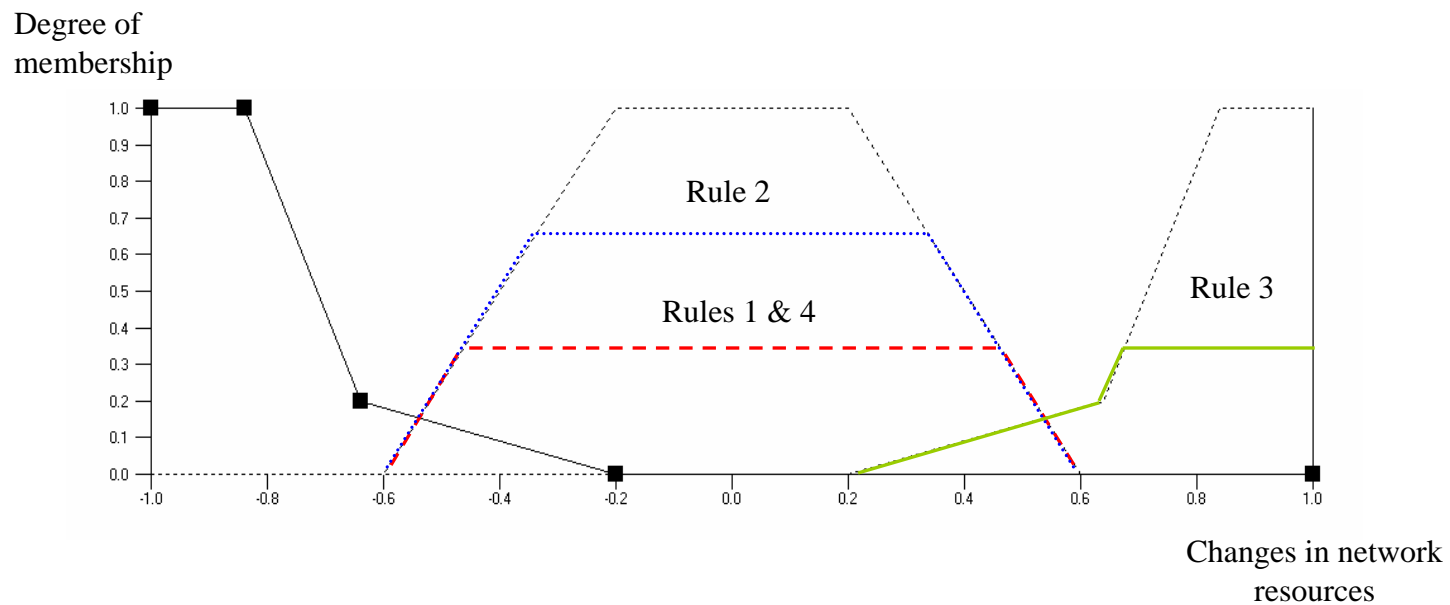
# Fuzzification

R1:  $\min\{1, 1, 1, 0.72, 0.35, 1, 1\} = 0.35$  (no change in the network);

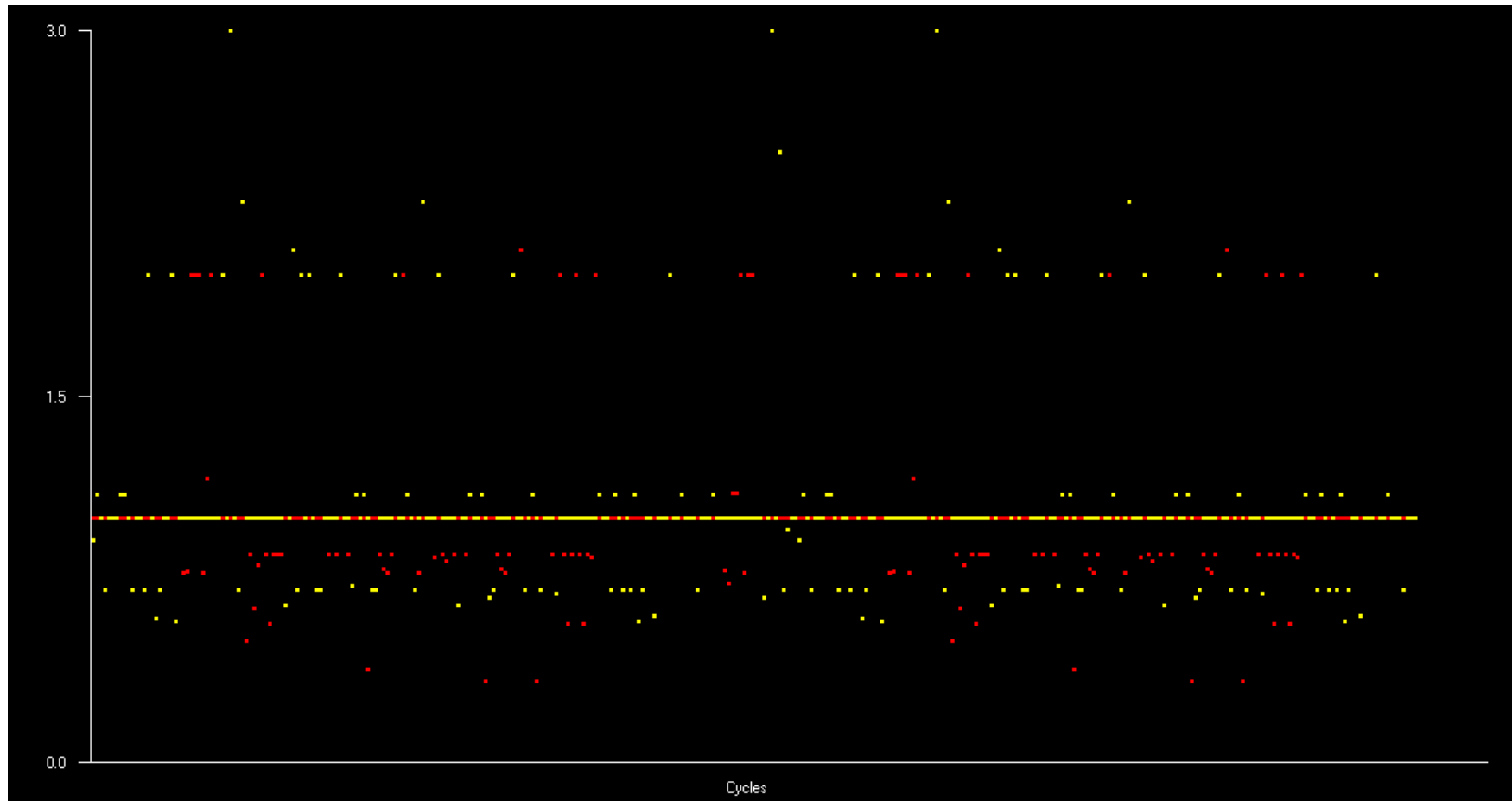
R2:  $\min\{1, 1, 1, 0.72, 0.65, 1, 1\} = 0.65$  (no change in the network);

R3:  $\min\{1, 1, 1, 0.36, 0.65, 1, 1\} = 0.36$  (increased capacity for innovation);

R4:  $\min\{1, 1, 1, 0.36, 0.35, 1, 1\} = 0.35$  (no change in the network);



# Output - Changes in the network (1,000 iterations)



## Clusters of firms based on the network changes

	Groups of firms based on resource growth and decay			
Dimension	“vulnerable”	“steady”	“awesome”	total
relational strength	<b>1.34</b>	1.72	<b>2.58</b>	1.83
financial resource	1.96	1.83	1.82	1.87
knowledge resource	1.805	1.857	<b>1.999</b>	1.878
relevance of resources /information	<b>1.21</b>	2.32	<b>2.72</b>	2.08

Relational strength and relevance of resources = of paramount importance



## Conclusions & future research

- Amount of financial and knowledge resources plays a less important role in the network innovation if not supported by strong ties and relevant/useful resources
- Most of time, steady conditions
- More R&D vulnerable compared to R&D awesome

### Extensions of the model

- Trajectories over time of actors (following their life cycle)
- Zooming in - microscopic level (actor not breed)
- Accounting for changes in the economic environment (boom/recession)

## Conclusions & future research - Methodological

- Fuzzy logic providing a different modelling approach to picture the changes in business networks
- More work necessary to fine tune the model - optimise the structure (fuzzy sets, rules, weights) and draw trajectories in time
- Validation with some real data, especially longitudinal
- Cross-validation with other modelling (&software) paradigms - neural networks, agent based (NetLogo), etc.