# Automatic Fuzzy Rules Generation for the Deadline Calculation of a Seller Agent

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# Outline

- Introduction
- Market entities
- Buyer-Seller Interaction
- Seller Behavior
- Fuzzy Approach
- Results

# Introduction

- Intelligent Agents
  - Autonomous Software Components
  - Represent users
  - Learn from their owners
- Information Markets
  - Virtual places where entities negotiate for the exchange of information goods

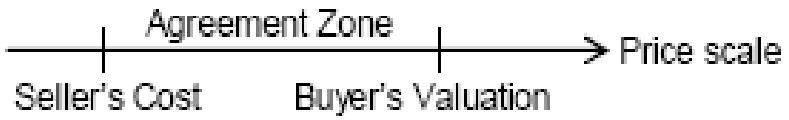
# Market Member Roles

- Buyers
- Sellers
- Middle entities (matchmakers, brokers, market entities)

➔ Intelligent Agents may represent each of these entities

# Buyer-Seller Interaction

- Can be modeled as a finite horizon Bargaining Game (BG)
- No knowledge about the characteristics of the opponent (i.e., the other side) is available
- The buyer aims to buy the product at the lowest possible price while the seller aims to sell the product at the highest possible price
- The buyer has a specific valuation for the product
- The seller has a specific production cost
- The two players have specific deadlines to conclude the transaction




# Seller Behavior (1/3)

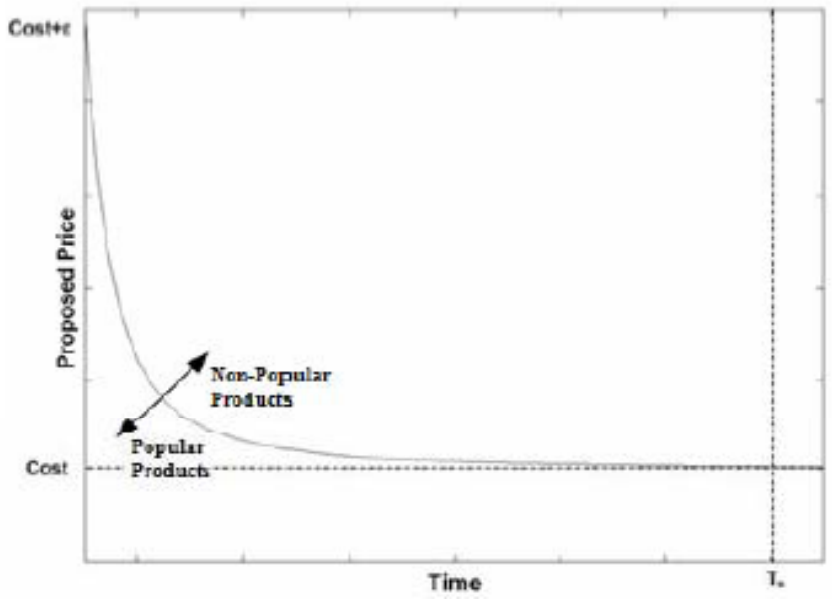
- The seller stays in the game for a specific number of rounds
- Profit
  - A Utility Function is used
  - Profit = price – production/retrieval cost
  - The greater the price is the greater the profit becomes
- Pricing Policy
  - It is based on: the cost (c), an amount of profit (ε), the proposal's sequence number (x) and the popularity measure (q):

$$p^s(x) = \frac{\varepsilon}{x^{q+1}} + c, \quad x = 1,2,....$$

  - The popularity measure is calculated through the Zipf Law

# Seller Behavior (2/3)

- Pricing Policy (continued)
  - Popular products are delivered to interested parties many times
  - The products are classified according to their popularity
  - The seller concludes rapidly the game for popular products
  - The seller does not sell the product below its cost



# Seller Behavior (3/3)

- Deadline calculation
  - Based on its pricing function a deadline value could be defined if:

$$\lim_{x \to \infty} \left[ \frac{-\varepsilon \cdot (\mathrm{q}+1)}{x^{q+2}} \right] = 0$$

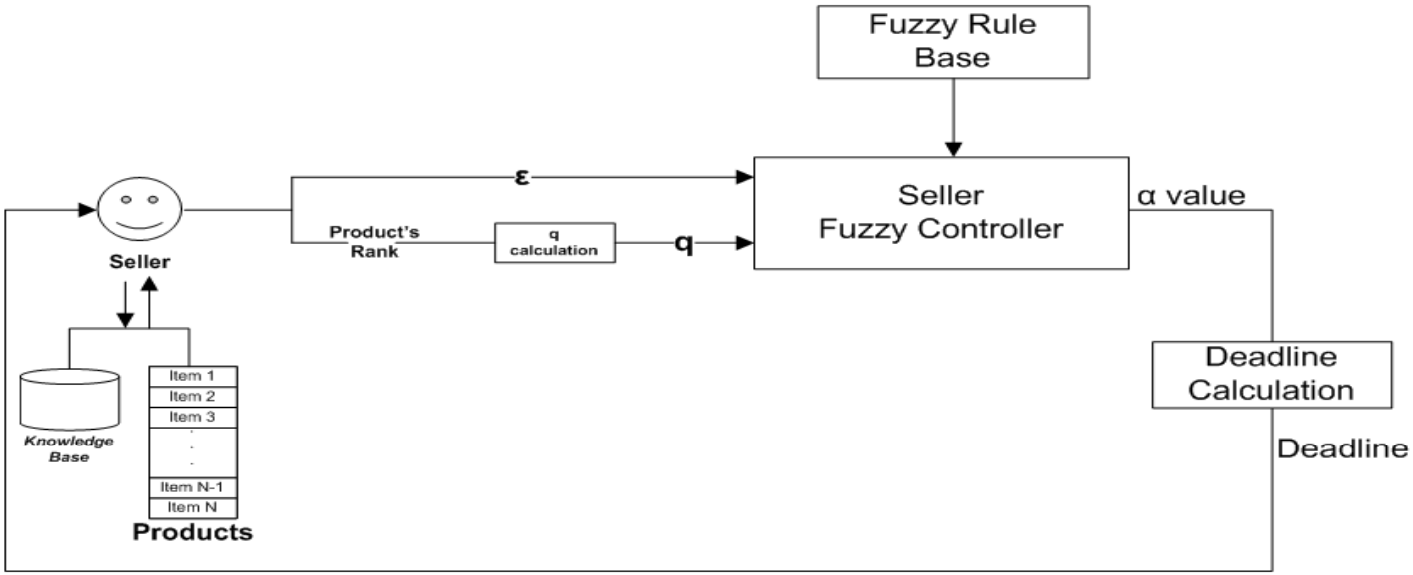
  - therefore

$$x^{q+2} \approx \alpha \cdot \varepsilon \cdot (\mathrm{q}+1) \rightarrow T_s \approx (\alpha \cdot \varepsilon \cdot (\mathrm{q}+1))^{\frac{1}{\mathrm{q}+2}}$$

  - Variable α is the patience factor of the seller
    - is based on the policy of the seller
    - indicates the patience of the seller
    - The greater the factor is the more time the seller spends in the game
    - indicates until when the game is meaningful for the seller

# Fuzzy Logic Controller

- It deals with:
  - The product rank (q)
  - The desired profit (ε)
- Output: an appropriate value for the α parameter



# Fuzzy Rule Base

- It is the most important part of the FL controller
- It describes the seller knowledge base
- It contains If – Then rules
- Rules involve popularity measure q and profit ε
- Rules utilize parameters' membership functions
- Rules result the appropriate value for parameter α

# Rules Generation

- The definition of specific fuzzy rules is a complex task
- We need an automatic method
- Automatic generation using data defined by experts and clustering techniques
  - Subtractive Clustering
  - Fuzzy C-Means Clustering

# Training Data

- Describe the policy of the seller concerning its deadline
- We use 90 datasets
- Each row contains data for q, ε and α
- Every cluster represents a rule

# Results

- The automatic FL rules generation provides an efficient and fast way for the rule base definition
- Our model provides more fine grained deadline values
- Clustering techniques improve the behavior of the seller

| Profit (ε) | Popularity Ranking measure *q* | $T_s$ for $\alpha$ = 50 (without FL) | Fuzzy approach using specific FL rules | | Subtractive clustering technique | | Fuzzy C-Means technique | |
|---|---|---|---|---|---|---|---|---|
| | | | $\alpha$ value | $T_s$ | $\alpha$ value | $T_s$ | $\alpha$ value | $T_s$ |
| 1 | 0.2 | 6 | 588 | 20 | 999 | 25 | 430 | 17 |
| 1 | 1 | 5 | 89.4 | 6 | 168 | 7 | 152 | 7 |
| 10 | 0.2 | 18 | 588 | 56 | 511 | 53 | 396 | 47 |
| 10 | 1 | 10 | 89.4 | 12 | 116 | 13 | 118 | 13 |
| 50 | 0.2 | 38 | 588 | 117 | 109 | 54 | 246 | 79 |
| 50 | 1 | 17 | 15.8 | 12 | 1 | 5 | 1 | 5 |
| 100 | 0.2 | 52 | 275 | 113 | 117 | 77 | 58.2 | 56 |
| 100 | 1 | 22 | 15.8 | 15 | 1 | 6 | 1 | 6 |

# Thank you!

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