

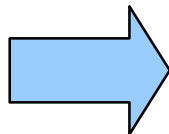
FeNAs: A Fuzzy e-Negotiation Agents System

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Introduction

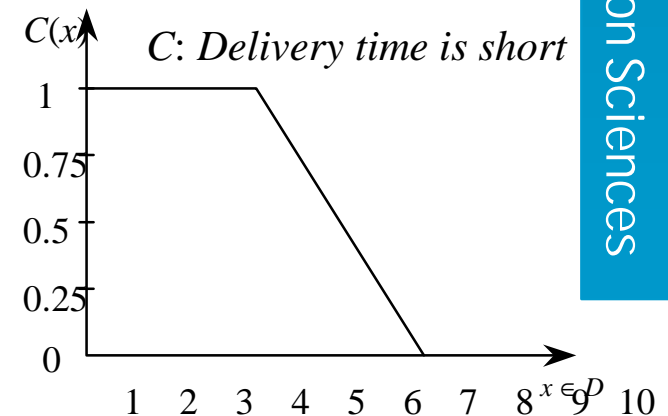
- Software agents in e-commerce trading
 - Product finding, Supplier finding, Product ordering and payment, Delivery monitoring, ...
- Automated negotiation in EC (e-negotiation)
 - Find a mutual agreement on the terms of transactions that satisfies all parties' constraints, preferences and objectives
 - Examples: Kasbah, AuctionBot, Tete-a-Tete
 - Distributive vs integrative negotiations
 - Uncertainty re incomplete information
 - Assume information available is PRECISE
 - E.g. price < \$99, delivery time = 1 day, etc
- Real-world: Imprecise information
 - E.g. low price, high quality, short delivery time, etc



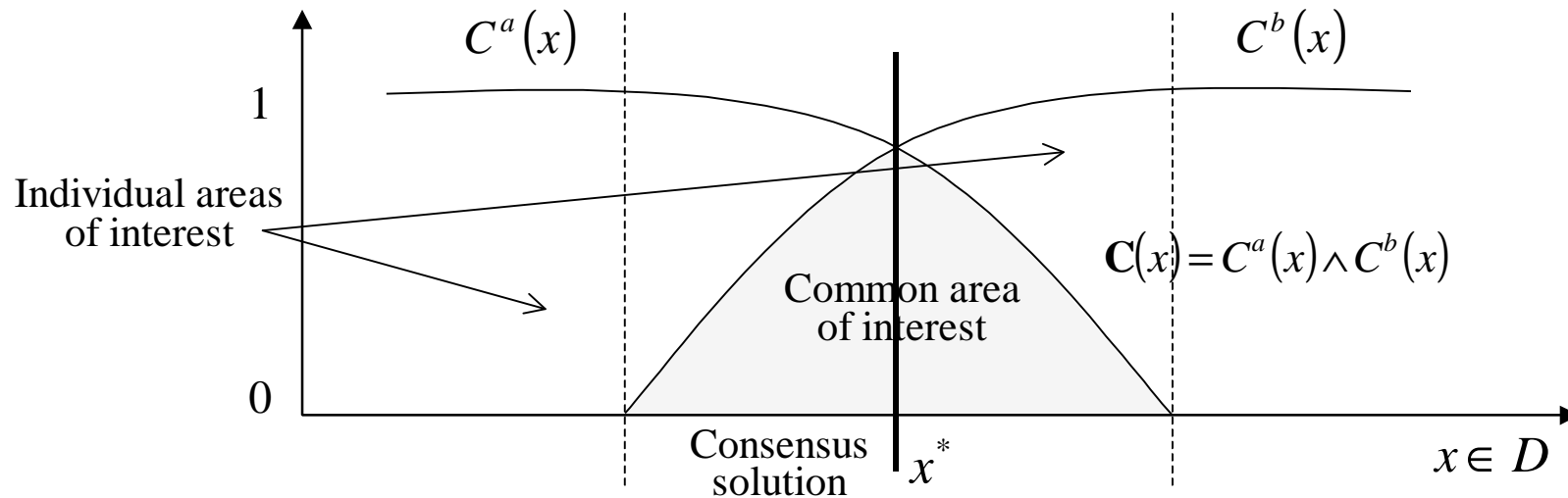
FeNAs: Fuzzy e-Negotiation Agents

FeNAs Approach

- An iterative decision making process of finding an agreement that satisfies all parties
 - evaluating offers
 - relaxing the preferences and constraints
 - making counter-offers
- Preferences/constraints/objectives – soft/imprecise
- Negotiation as a distributed fuzzy CSP (DFCSP)
 - Set of variables with domains
 - negotiation issues
 - Set of fuzzy constraints relating the vars
 - objectives/preferences/constraints on the negotiation issues
 - distributed among the negotiation parties
 - Objective
 - to find a solution (i.e. instantiation of the vars) that maximizes constraint satisfaction of the parties

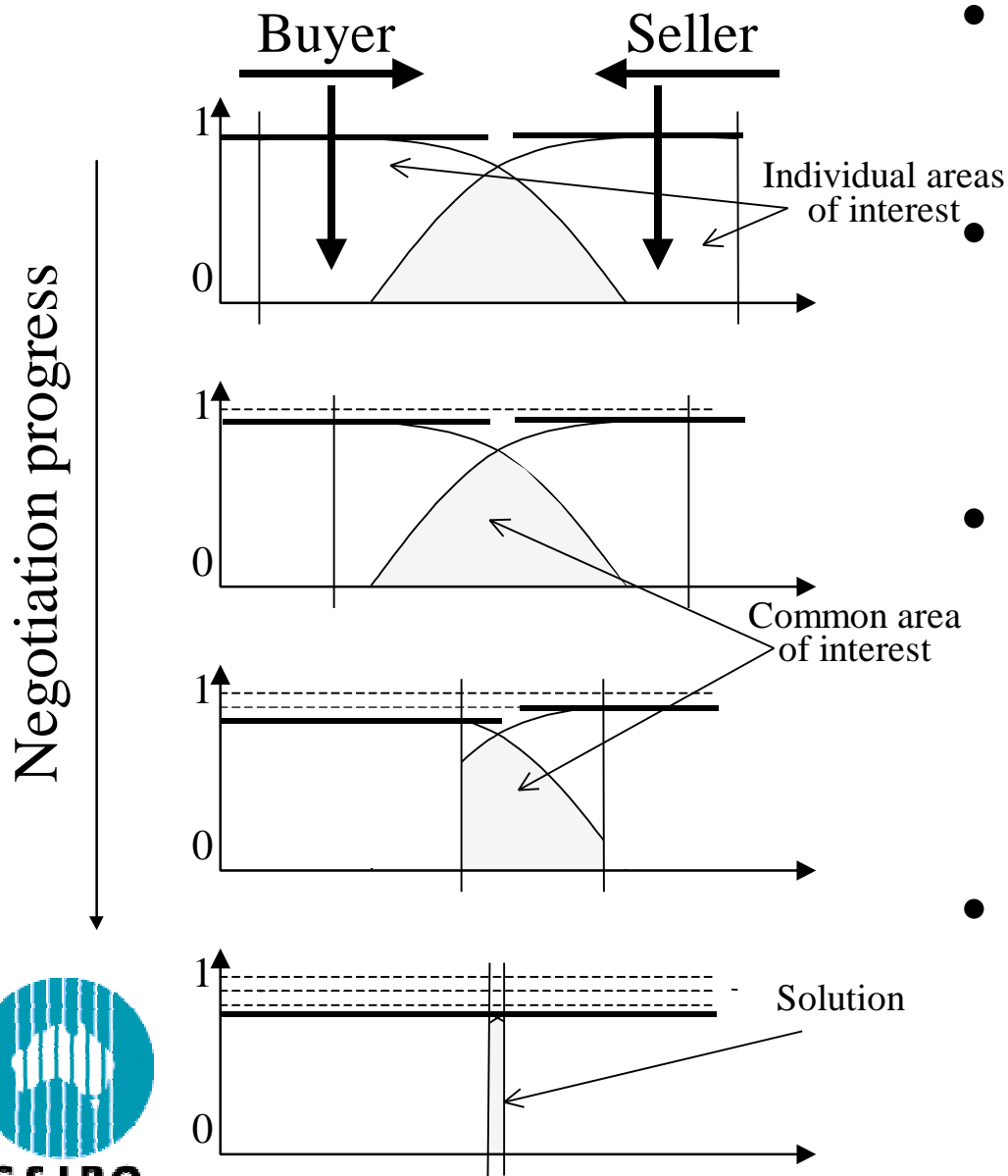


Fuzzy Constraints in Negotiation



- Individual areas of interest of parties a and b
 - private fuzzy constraints
 - a fuzzy set of the preferred solutions $C^a(x)$ $C^b(x)$
 - Common area of interest $C(x)$
 - intersection of individual areas of interest
 - a fuzzy set of potential solutions $C(x) = C^a(x) \wedge C^b(x)$
 - Consensus
 - Solution from $C(x)$ with max joint degree of satisfaction
- But $C(x)$ not known a priori !!!!

Fuzzy constraint-based negotiation



- Move towards and explore potential agreements
- Exchange the preferred solutions as offers until consensus can/cannot be reached
- Negotiation strategies
 - trade-offs – alternative solutions at the same satisfaction level
 - concessions – solutions with lower satisfaction level
- Previous offers act as constraints
 - individual areas of interest (available options) reduce



Offer evaluation

- Utility (value) of offers

$$v(x_1, \dots, x_n) = \sum_{i=1, \dots, n} w_i v_i(x_i), \quad \sum_{i=1, \dots, n} w_i = 1 \quad v(x) \in [0, 1]$$

– a fuzzy constraint on trade-offs

- Fuzzy constraint satisfaction (incl. utility constraint)

$$C(x) = \bigwedge_{i=1, \dots, m} C_i(x) \in [0, 1]$$

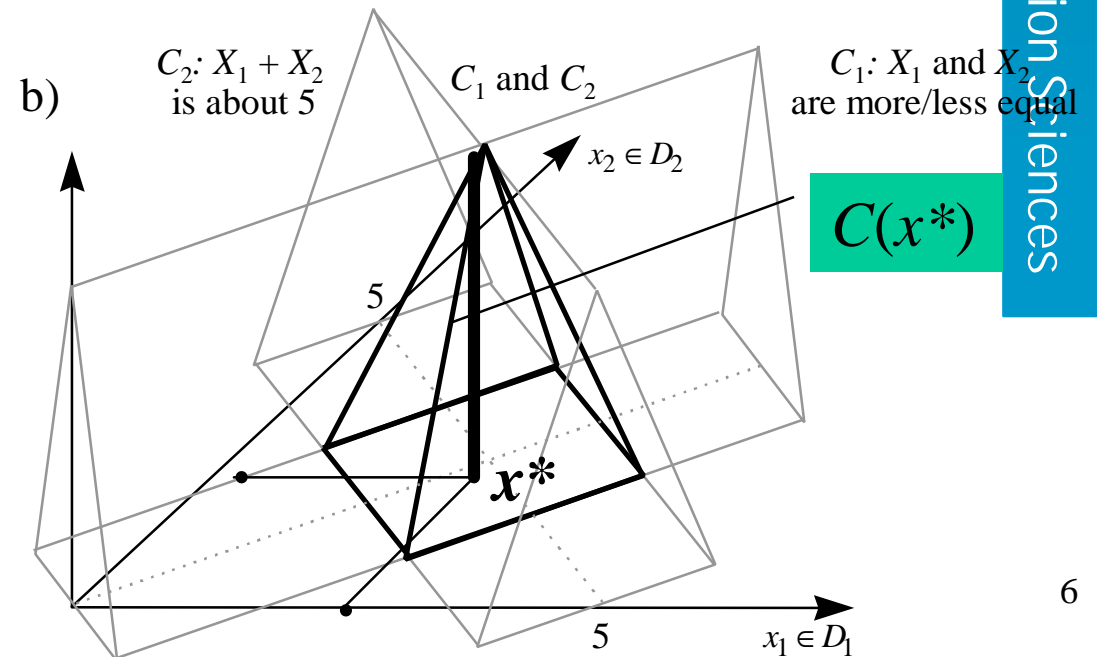
t-norms (e.g. min)

aggregation (e.g. averages, OWA)

– assess the offers

– order options in offer generation

- e.g. offer x^*

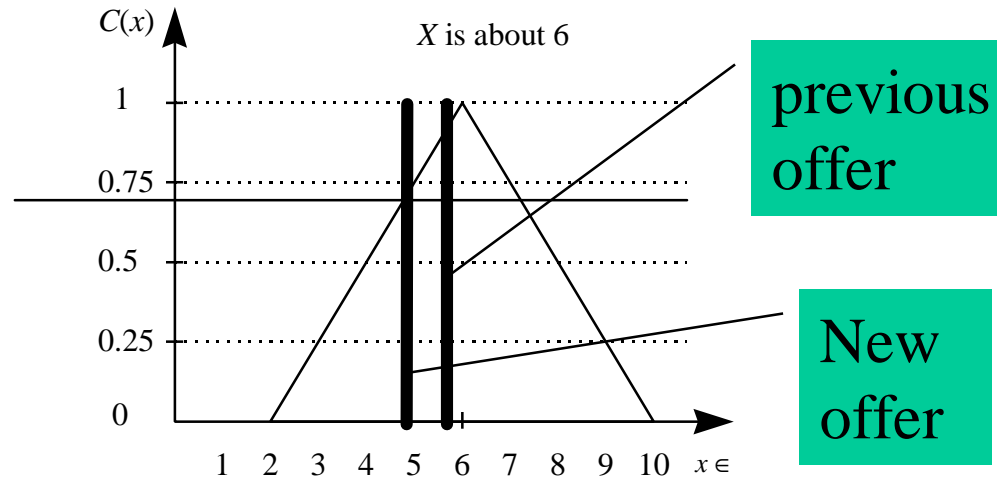


Offer generation

- negotiation strategies
 - select satisfaction
 - find offer values
- concession



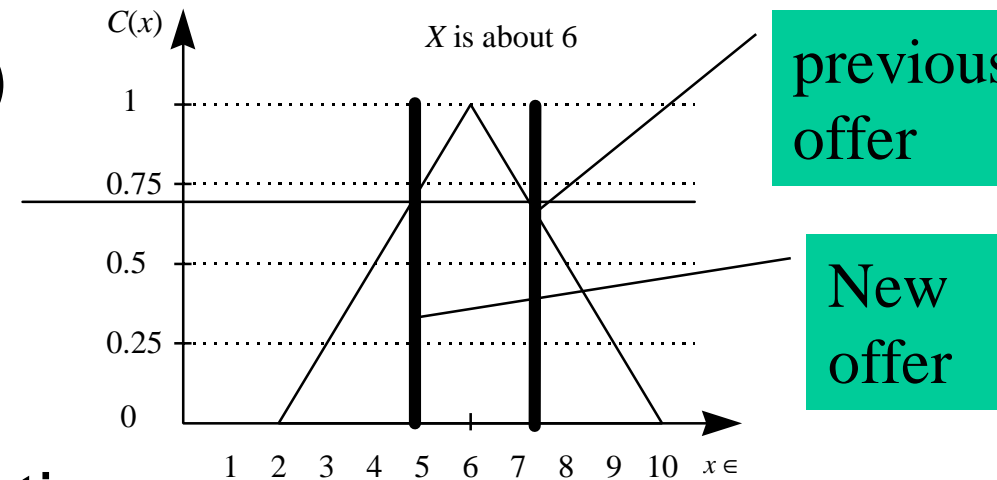
New offer:
 $C' = C - \text{step}$



- trade-offs (on issues)

New offer:
 $C' = C$

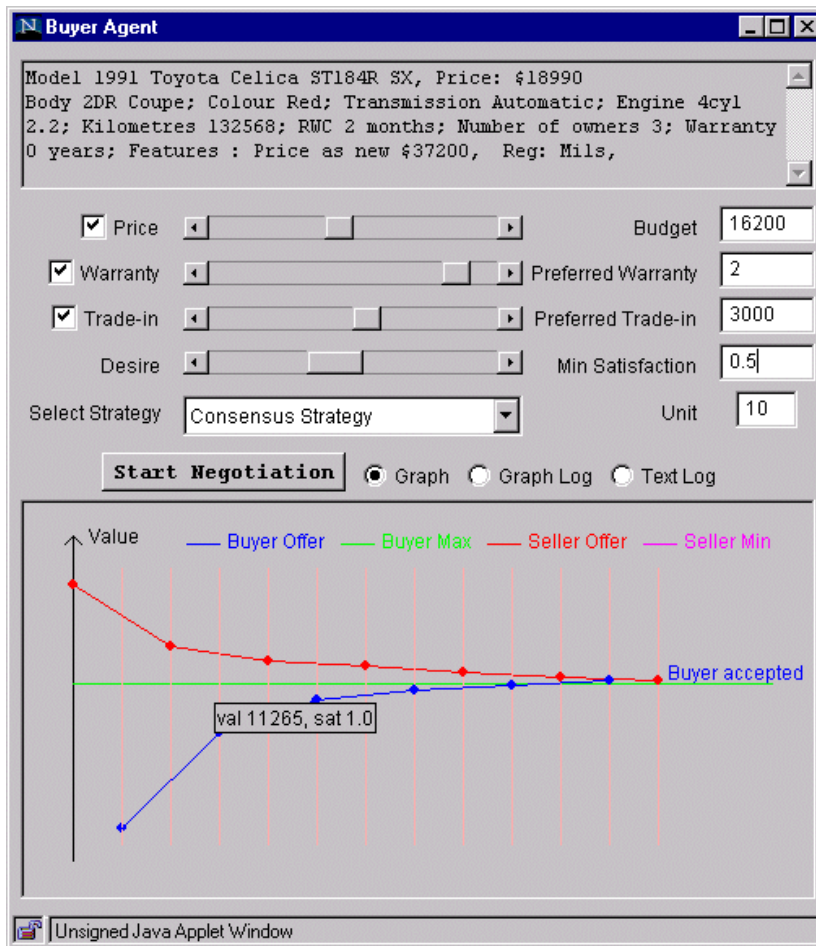
Note: it maybe possible
 to offer higher total C, i.e. $C' \geq C$



- issue values instantiation
 - given $C(x)$ find x – B&B search

FeNAs Example 1: Car Trading

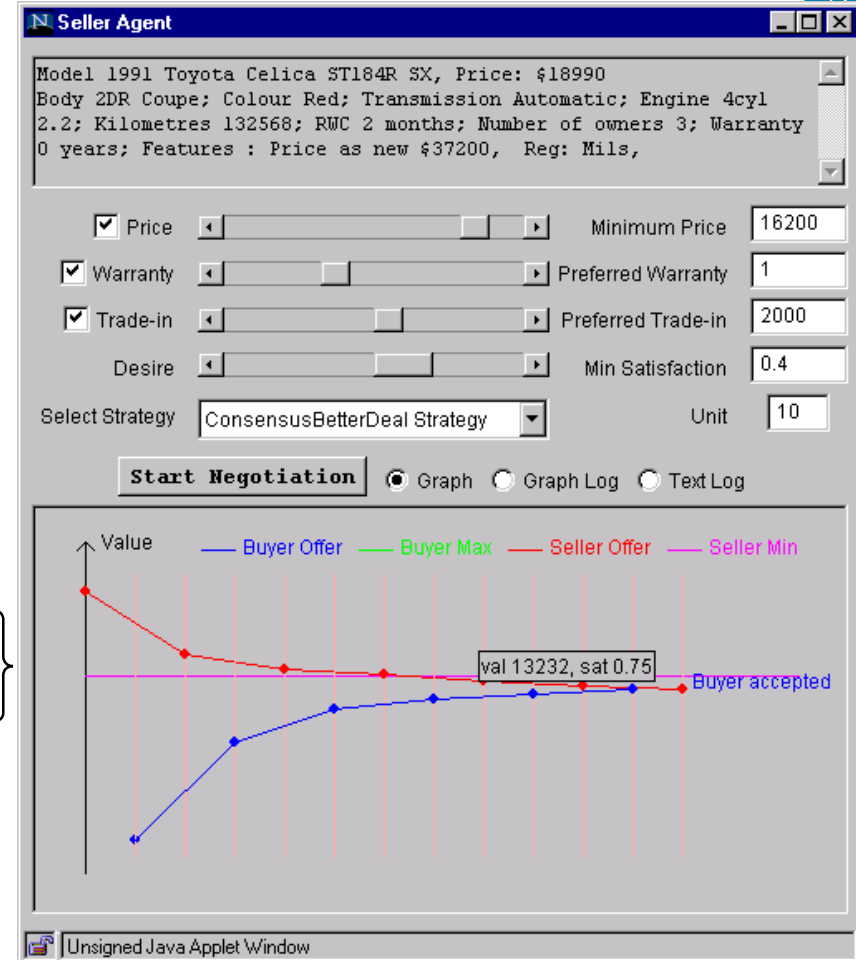
- Issues: price, warranty, trade-in



{ public info }

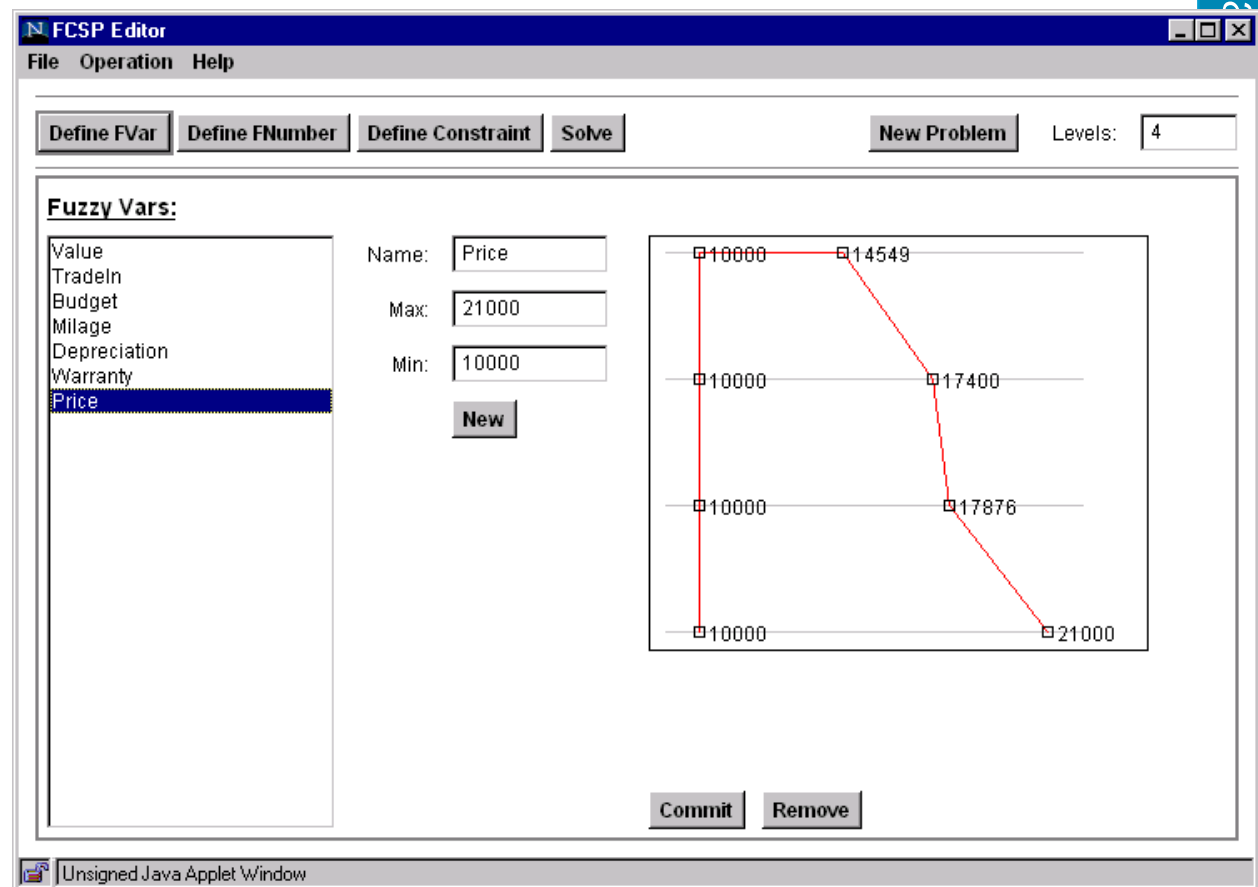
{ private info }

{ neg. progress }



FeNAs Example 1: Car Trading (cont)

- Fuzzy constraint editor
 - variables (incl. negotiation issues)
 - f. numbers
 - f. constraints
- Config file
 - issues
 - constraints
 - utility



FeNAs Example 1: Car Trading (cont)

- Constraint propagation during negotiation
 - Individual areas of interests
 - Available options

The screenshot shows a 'Seller Agent' window with the following details:

- Model:** 1991 Toyota Celica ST184R SX, Price: \$18990
- Body:** 2DR Coupe; **Colour:** Red; **Transmission:** Automatic; **Engine:** 4cyl 2.2; **Kilometres:** 132568; **RWC:** 2 months; **Number of owners:** 3; **Warranty:** 0 years; **Features:** Price as new \$37200, Reg: Mils,

Configuration:

- Price: Minimum Price 16200
- Warranty: Preferred Warranty 1
- Trade-in: Preferred Trade-in 2000
- Desire: Min Satisfaction 0.4
- Select Strategy: ConsensusBetterDeal Strategy
- Unit: 10

Buttons: Start Negotiation, Graph, Graph Log, Text Log

Offer ID	Price	Warranty	Trade-in
12340	2	3000	
15850	2	3000	
17010	2	3000	
17380	2	3000	
17520	2	3000	

Each offer row includes a 'My offer' section with 'price', 'warranty', and 'tradein' sub-sections, each containing a small chart. The 'price' charts show a downward slope, while 'warranty' and 'tradein' charts show horizontal lines.

At the bottom, it says 'Unsigned Java Applet Window'.



FeNAs Example 2: Transl. Services

- Scenario: Document translation services (DEXA e-Negotiation)
 - Issues:
 - TIME [1, 10] (e.g. days)
 - PRICE [500, 1000] (e.g. \$)
 - QUALITY [0, 10] (doc type and complexity, skills required to translate)
 - Customer (Buyer):
 - urgent need (e.g. about 6 days) to translate a quite complex document (requiring high quality of translation, e.g. about 7) and is prepared to pay about \$700 for the translation service.
 - The quality of translation is more important than the constraints on price and time (e.g. company is prepared to pay more for a good quality translation).
 - Provider (Seller)
 - quite busy but very keen to secure a contract
 - has resources available to translate documents with more or less average complexity (e.g. about 5) and the preferred time for the service is about 8 days with the price about \$800.
 - Its preferences are price, time and quality (i.e. it can make other resources available if the price is attractive).

Buyer Agent

Demonstrating how FeNAs can support e-negotiation using the scenario used for DEXA 2000.

ISSUE: time
 Advertise: 10
 Weight: [slider]
 Scale: -100

ISSUE: price
 Advertise: 1000
 Weight: [slider]
 Scale: -1

ISSUE: quality
 Advertise: 6
 Weight: [slider]
 Scale: 100

Desire: [slider] Min Satisfaction: 0.6
 Select Strategy: Simple concession

Start Negotiation Graph Graph Log Text Log

Seller Agent

Demonstrating how FeNAs can support e-negotiation using the scenario used for DEXA 2000.

ISSUE: time
 Advertise: 10
 Weight: [slider]
 Scale: 100

ISSUE: price
 Advertise: 1000
 Weight: [slider]
 Scale: 1

ISSUE: quality
 Advertise: 6
 Weight: [slider]
 Scale: -100

Desire: [slider] Min Satisfaction: 0.4
 Select Strategy: Simple concession

Start Negotiation Graph Graph Log Text Log

Connection to the negotiation engine identified.
 Their offer: time=4 price=500 quality=8

My offer: time=10 price=1000 qual value
 val 8000, sat 1.0
 accVal:5750

Their offer: time=6 price=693 quality=8

My offer: time=8 price=925 qual value
 val 6650, sat 1.0
 accVal:5750

Their offer: time=6 price=502 quality=7

My offer: time=8 price=902 qual value
 val 6512, sat 1.0
 accVal:5750

Their offer: time=6 price=622 quality=7

My offer: time=8 price=900 qual value
 val 6500, sat 1.0
 accVal:5750

Their offer: time=6 price=669 quality=7

My offer: time=7 price=888 qual value
 val 6028, sat 0.75
 accVal:5750

Their offer: Yes

Unsigned Java Applet Window



a win-win consensus (time, price and quality) at (7, 888, 7)

Conclusion and Future Work

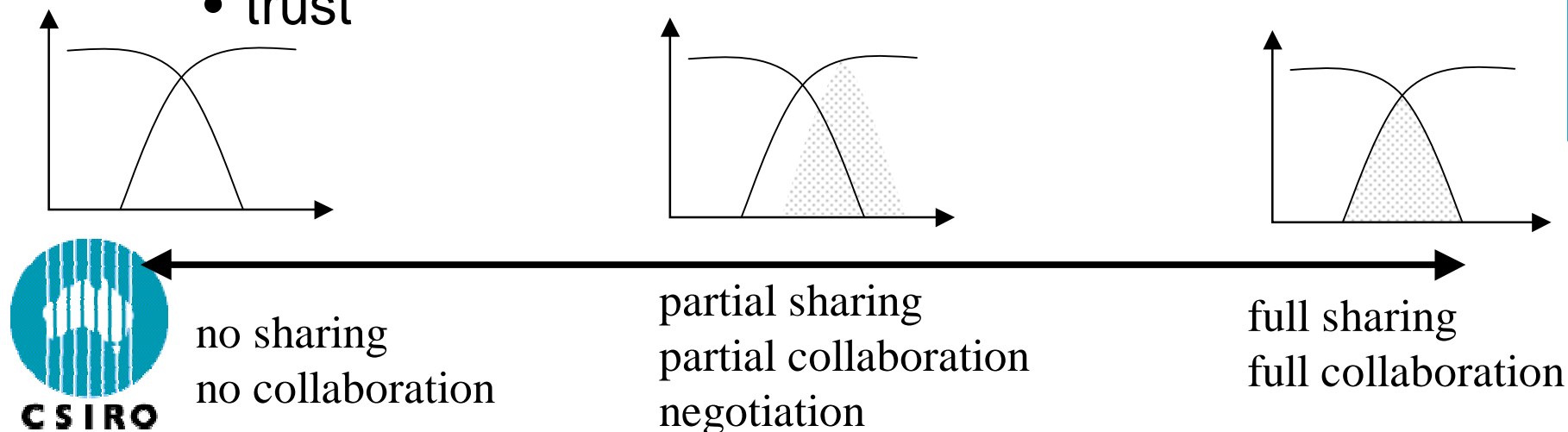
- FeNAs: automated negotiation with imprecise information
- Fuzzy constraint-based representation
 - uniform for all constraints, preferences and objectives, i.e. [0,1]
 - intuitive soft/imprecise constraints (e.g. short delivery time)
 - multi-issue (criteria) aggregation
- Fuzzy constraint-based negotiation process
 - fuzzy constraint propagation (reasoning) to keep track of changing options (incl. value ranges and satisfaction level)
 - flexible constraint relaxation
 - find consensus to maximise agents' utilities at the highest possible level of fuzzy constraint satisfaction (win-win solutions possible)
- Initial experiments promising -> Future/current work
 - negotiation engine
 - aggregation and measures (e.g. possibility/necessity, OWA)
 - negotiation strategies (adaptability, flexibility, optimality – f.game theory)
 - linguistic negotiation (i.e. negotiation with words)
 - other FeNAs capabilities
 - learning from experience (e.g. negotiation strategies)
 - opponent modeling (e.g. reservations/constraints, strategies)
 - dynamic multi-lateral negotiations (many-to-many, markets, organisations)
 - dynamic coalition formation (when, how – negotiation to form a coalition)

Questions ???

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Constraint-based knowledge sharing

- constraints
 - declarative KR
 - decision space (crisp) and landscape (fuzzy)
 - exchange/sharing knowledge (partial, dynamic)
- level of collaboration
 - information shared ~ common knowledge
 - trust



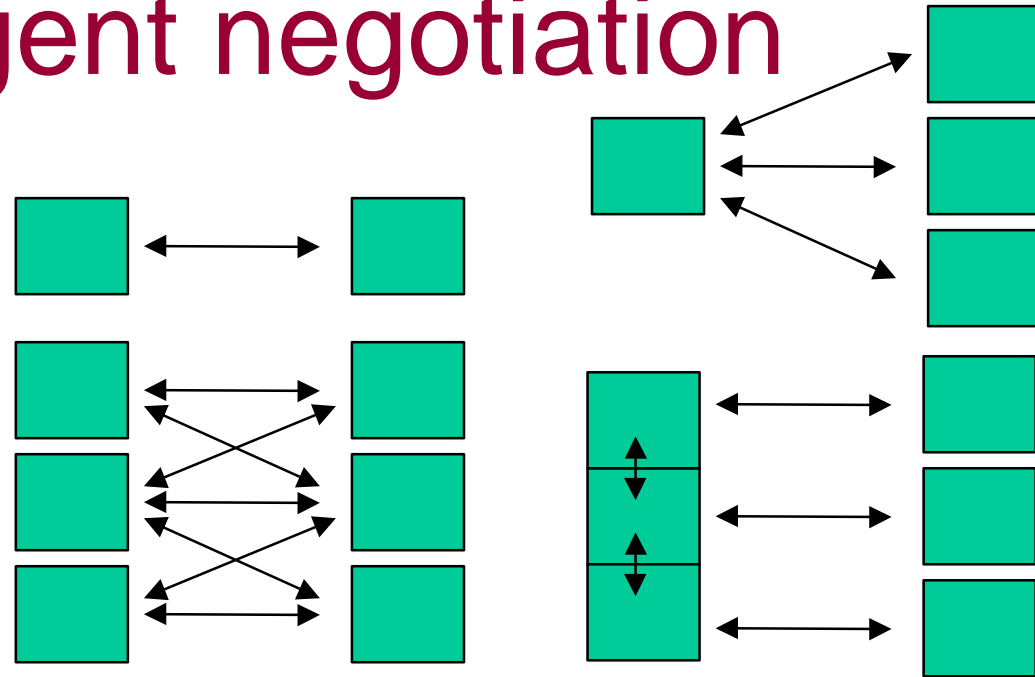
no sharing
no collaboration

partial sharing
partial collaboration
negotiation

full sharing
full collaboration

Multi-agent negotiation

- one2one
- one2many
- many2many



- constraint-based collaboration

- sharing constraints
 $A \leftrightarrow B$
- shared search decision space
- multi-agent neg one2one based

