



Hybrid Intelligence in Negotiation Processes

CATHOLIJN M. JONKER



Our Future with Artificial Intelligence

Potential & benefits of AI

- Empower autonomy
- Expand experience
- New activities
- Strengthen democracies

Misuse & side-effects of AI

- Reduce autonomy
- Replace experience
- Redundant
- Endanger democracies



Artificial Intelligence → Hybrid Intelligence

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Misuse & side-effects of AI

- Reduce autonomy
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Align AI with human & social values & create Hybrid Intelligence

Hi

Meaningful human control & Hybrid Intelligence



Negotiation (Support) Systems



Why negotiation is difficult for humans



- Leaving money on the table (sub-optimal outcomes for both)
- Bounded rationality (outcome space is too big)



- Slowly discover what they want while negotiating (preference elicitation)
- Satisficing (rationalising your intuitions)
- Position bargaining vs understanding underlying concerns
- Self-reinforcement (proud of the outcome)



- And the usual ...
- Laziness (... preparation)
- Emotions (... negative effect on rationality)

SWOT analysis (2007)



Human

Understands natural language

Recognizes emotions

Has emotions

General knowledge

NSS

Good at calculating (bids)

Keeps overview

Stays calm

Negotiation knowledge

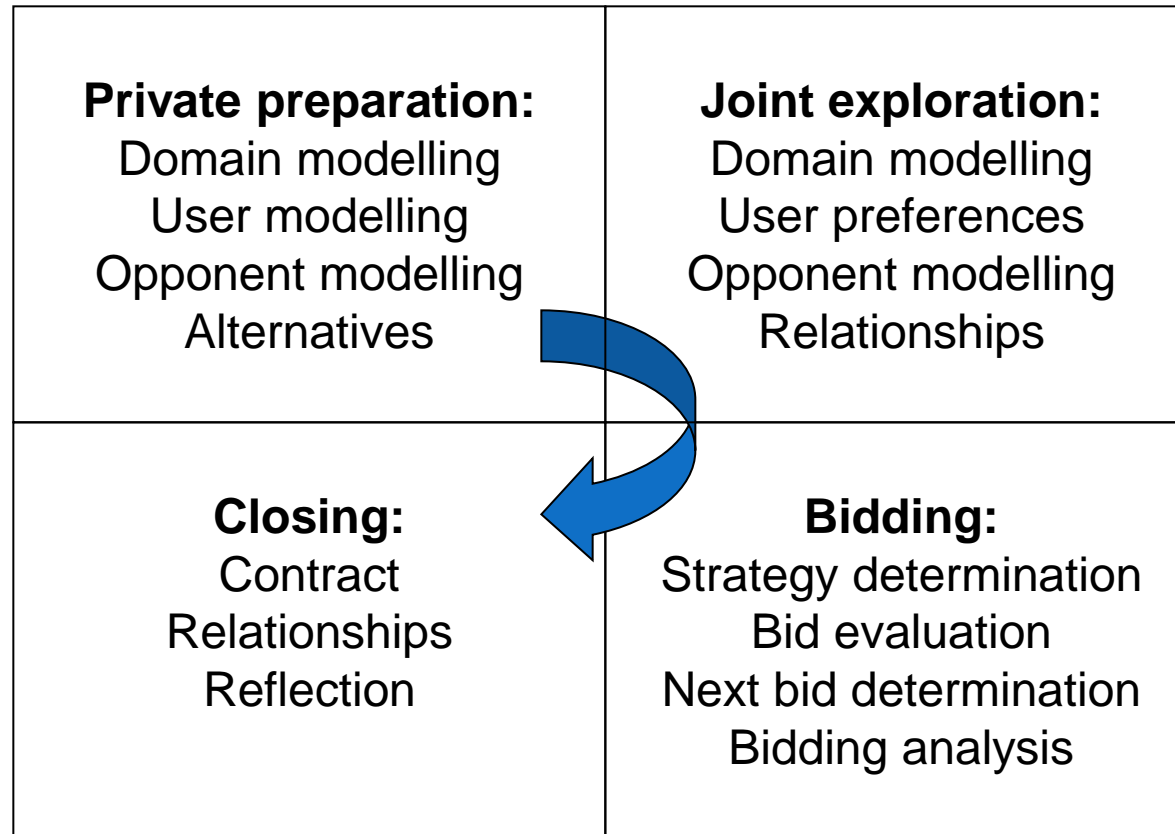
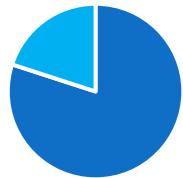
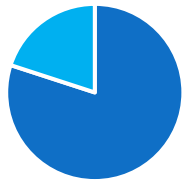


combining the strengths of machine and human

The Pocket Negotiator Project:

development of a next generation negotiation support system

Phases of Negotiation: Potential for AI (2007)



■ Human ■ Symb.AI



Introduction



Prepare & Explore



Strategic info



My interests



My preferences



Other's interests



Other's preferences



Bidding



Closure

Bidding (round 8/10)



1 My bid

salary

4000

fte

1.0

work from home

0

lease car

yes

permanent contract

yes

career development opportunities

medium

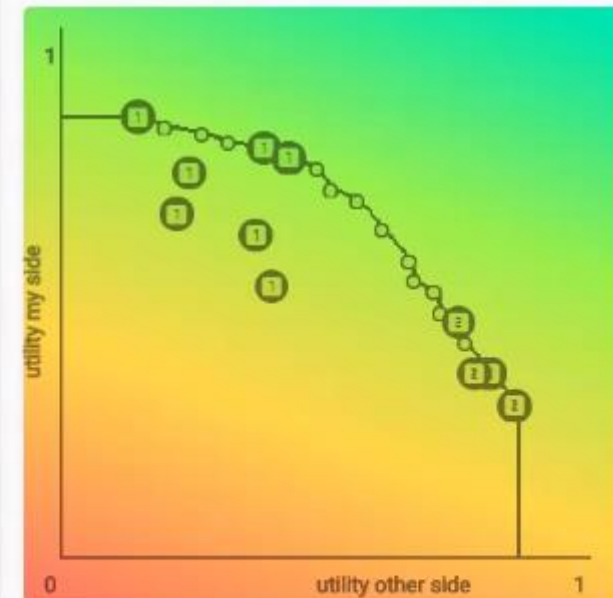
Enter my bid

Suggest bid

Good for me



Good for other

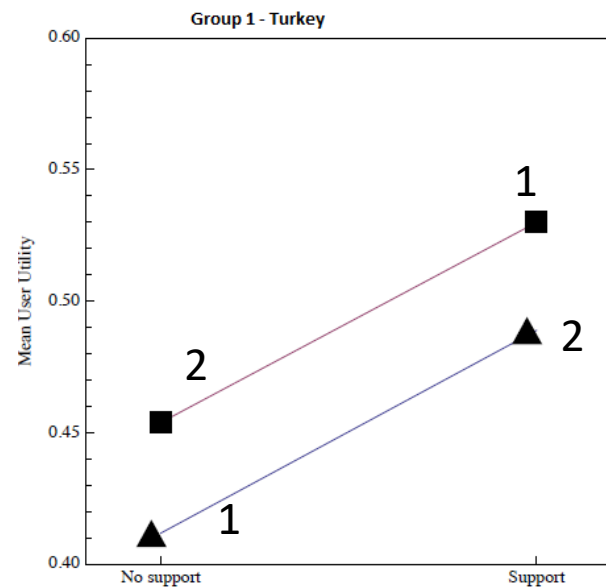


Accept current bid

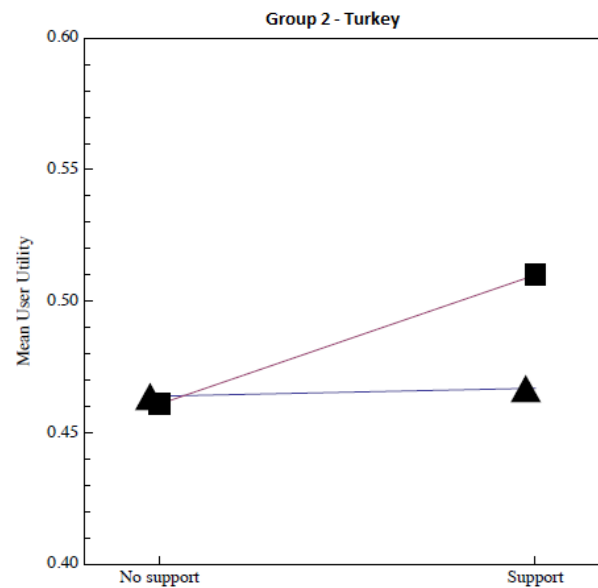


End negotiations

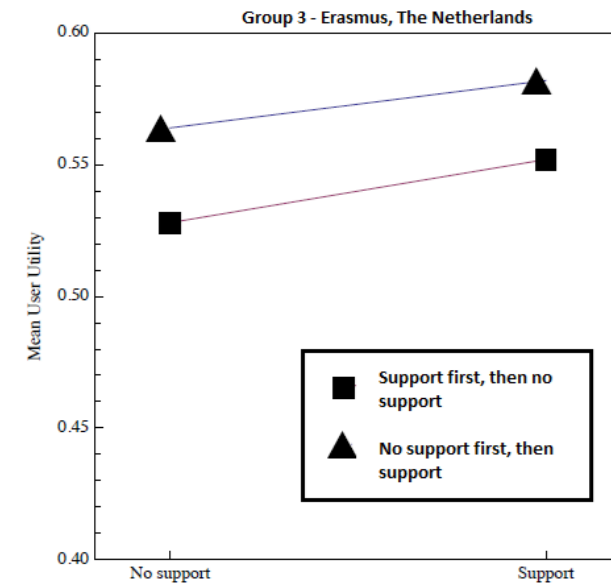
Computer science



Industrial Engineering



Business



Pocket Negotiator increases outcome utility ($p < 0.01$)

Some people manage quite well on their own

Pareto Optimality

Not significant



significant
also per group

All groups	NS-S	S-NS
S-Pareto	5.5	6.2
NS-Pareto	2.2	2.6

The average number of Pareto Optimal bids over all groups split out according to support- and starting conditions.

Average number of bids made per negotiation: 10

What support was used?

Groups	Bids	Pareto Optimality	Pareto Clicks	Suggestions
Computer science students	10	7	8.5	1
Design students	9.6	3.6	4.9	1.1
Business students	11.1	6.4	6.7	3.8
All	10.3	5.9	6.7*	2.2

*: In the Support-condition: Significant correlation between the number of bids on the Pareto Frontier and the type of support used by the participants: Spearman's Rho = 0.61, $p < 0.01$

Bidding (round 8/10)



1 My bid

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fte
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0

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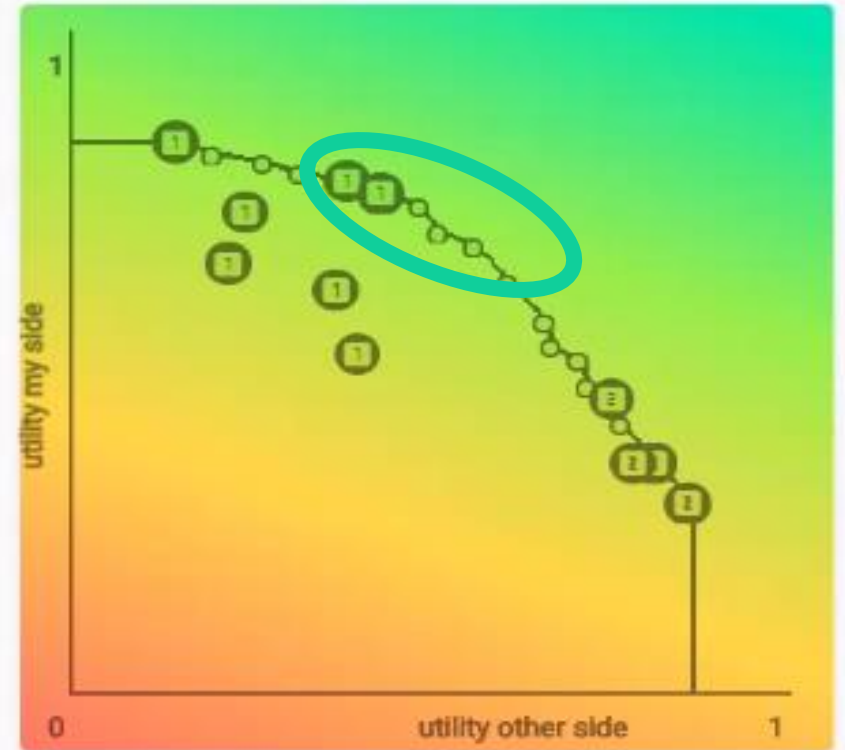
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Good for me

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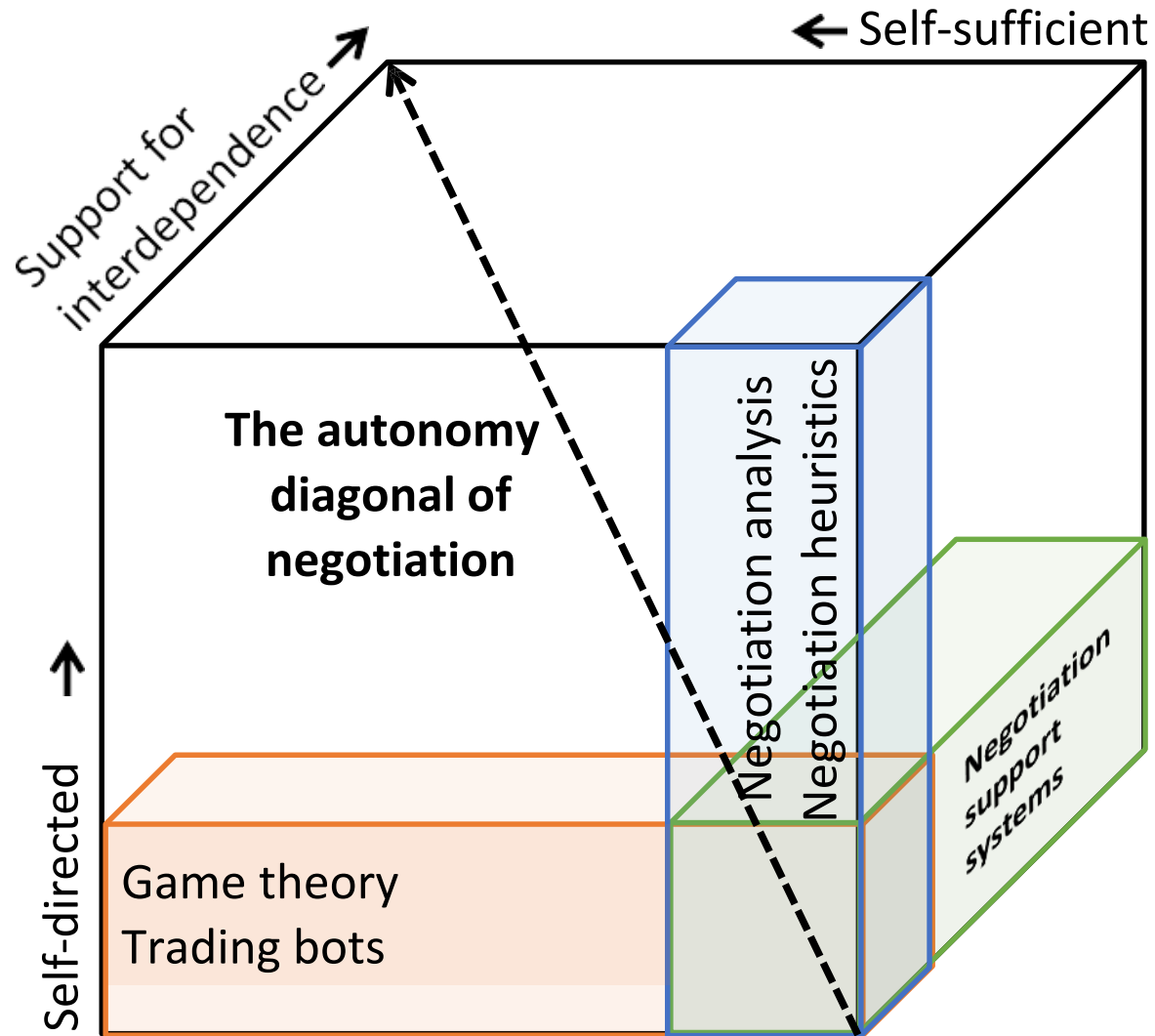
Other's interests

Other's preferences

Bidding

Closure

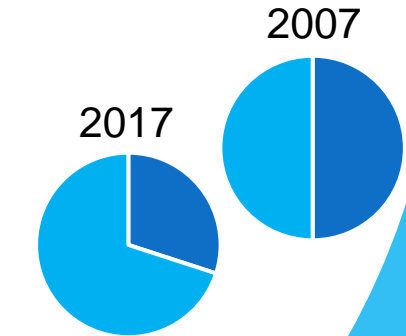
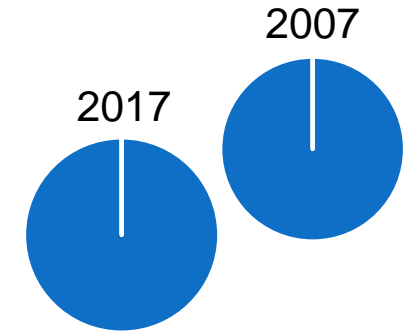
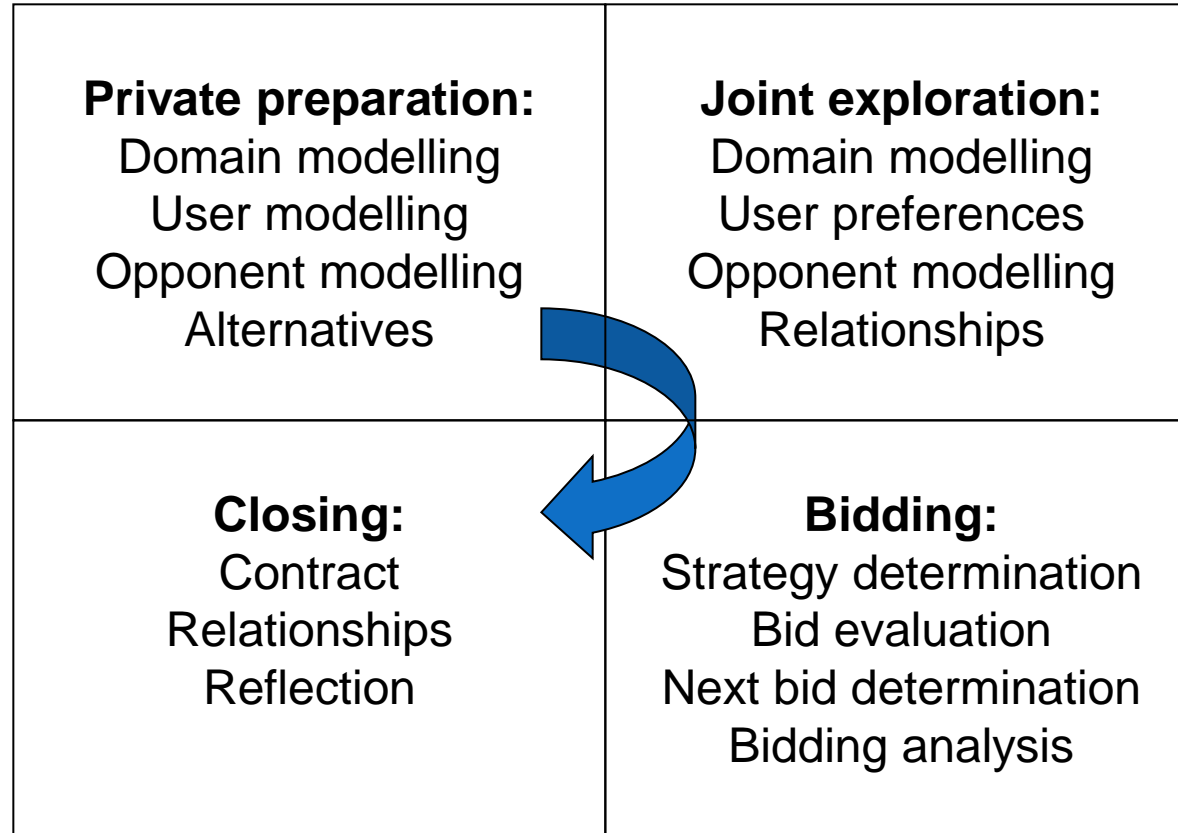
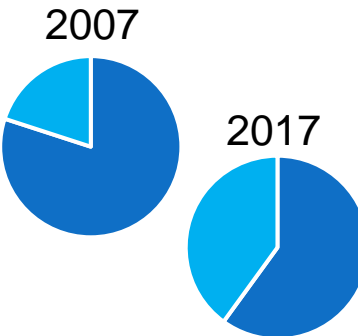
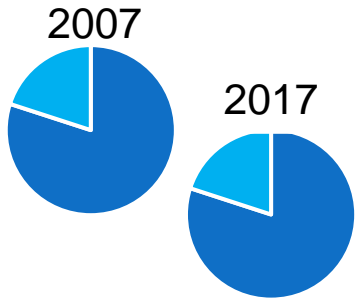
SWOT (2017) & Research Agenda



Research agenda

1. Domain knowledge and preference elicitation
2. Long-term perspective
3. User trust and adoption
4. Learning strategies

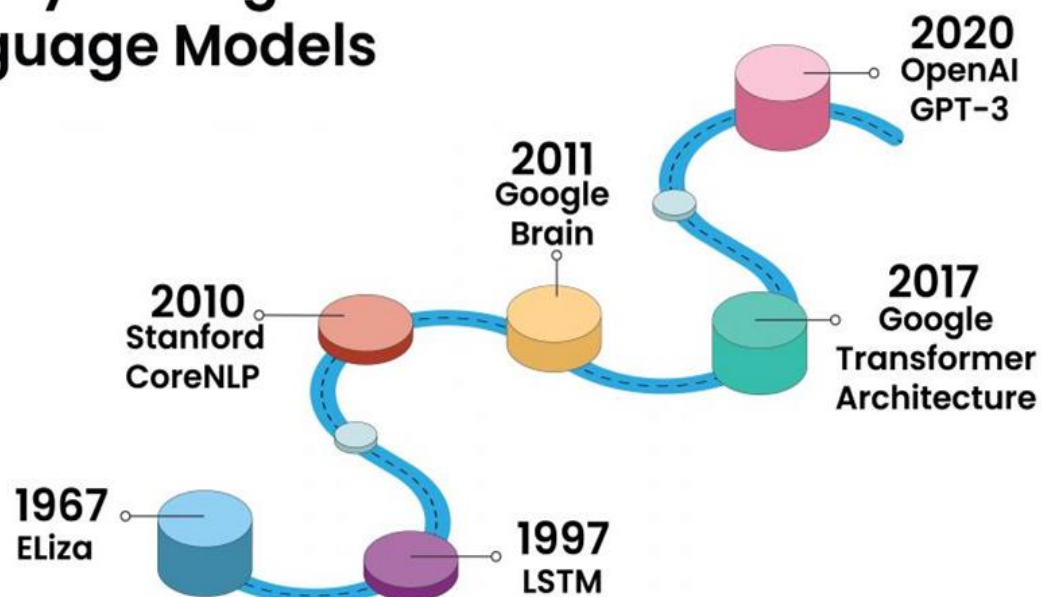
Phases of Negotiation: Potential for AI (2017)



■ Human ■ Symb.AI

SWOT (2024) & Research Agenda

History of Large Language Models



From the 2017 Research agenda

1. Domain knowledge and preference elicitation
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What opportunities offer LLMs?

- Negotiation Support
- Automated Negotiating Agents

Picture from



SWOT (2024) & Research Agenda



The Negotiator

By ChatGPT

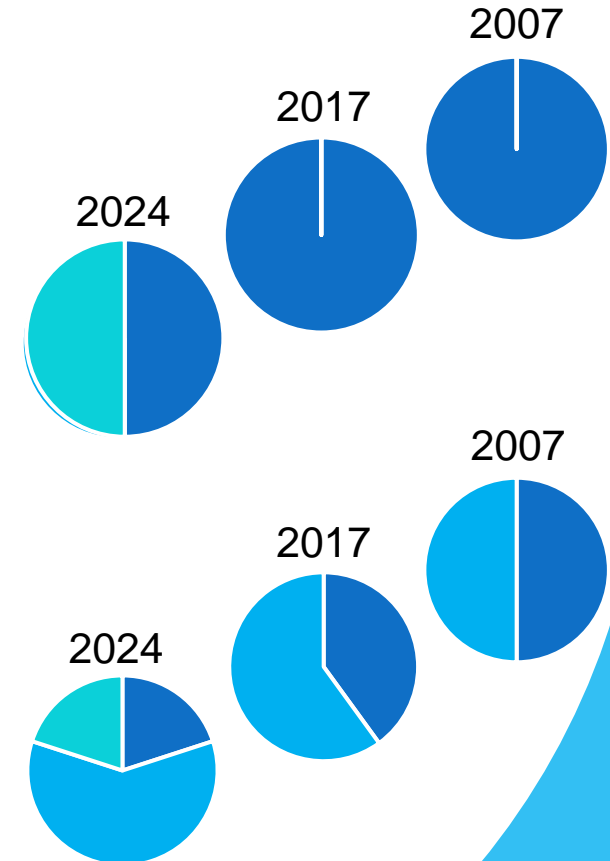
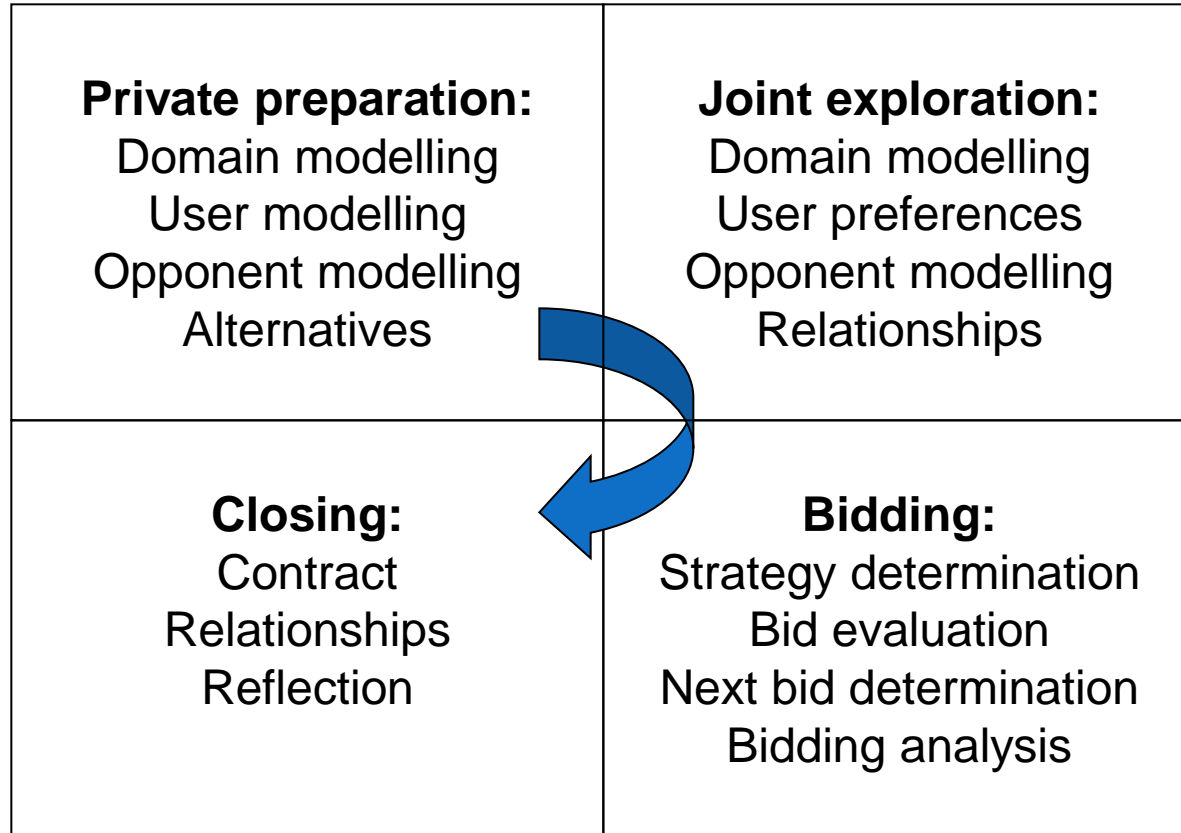
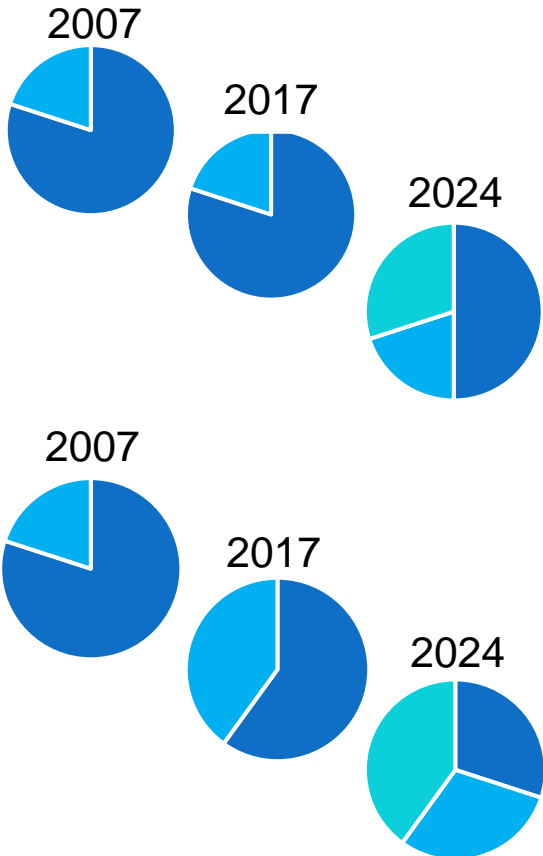
I'll help you advocate for yourself and get better outcomes.

Become a great negotiator.

From the 2017 Research agenda

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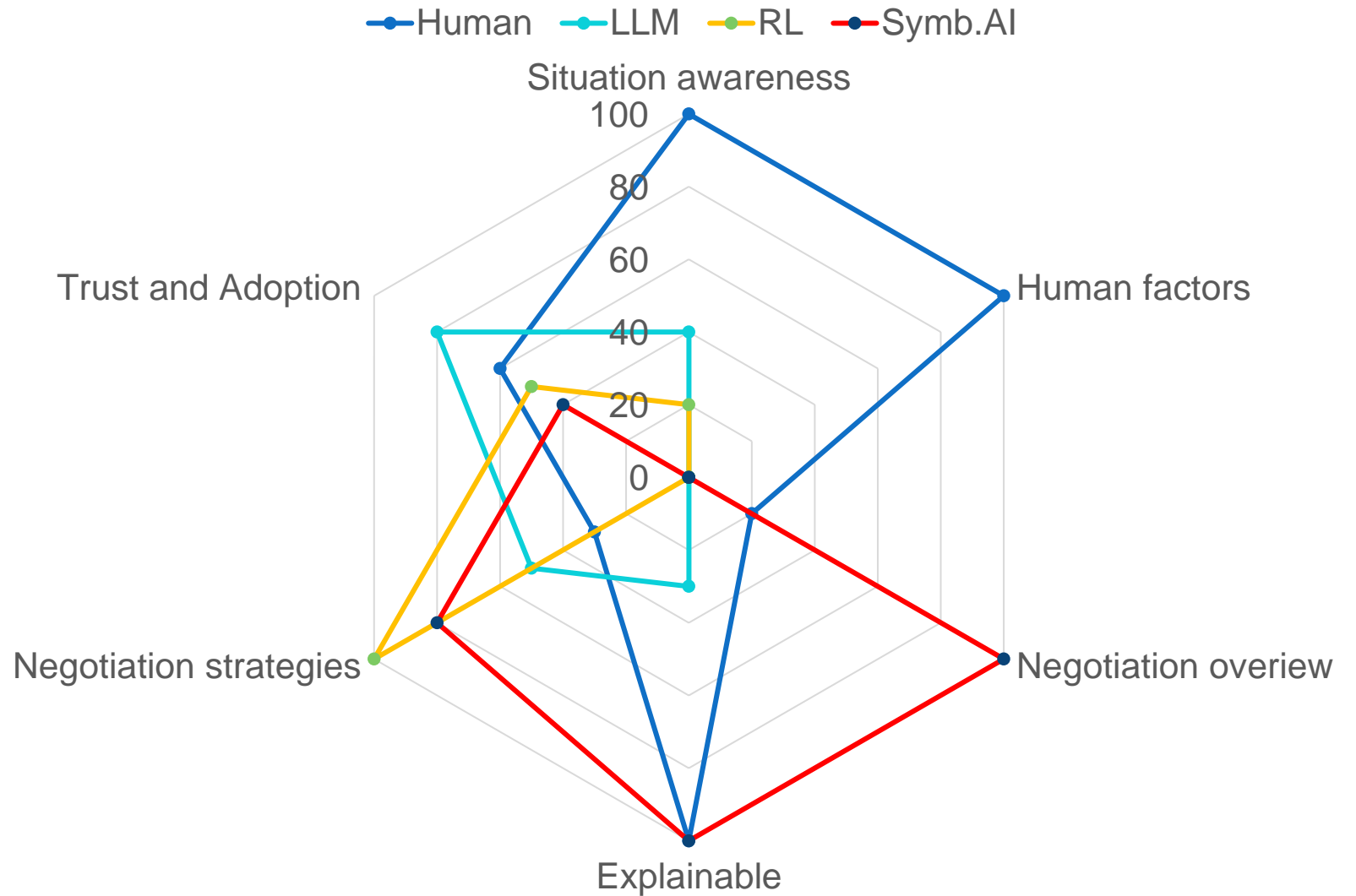
Phases of Negotiation: Potential for AI (2024)



■ Human ■ Symb.AI ■ LLMs

SWOT 2024

AI potential for negotiation



The way forward

- LLMs instrumental for usability
- Reinforcement Learning for solidity
- Symbolic AI (explainability, causal learning)
- Hybrid Intelligence is the way forward

