A COMPUTATIONAL MODEL OF POWER IN COLLABORATIVE NEGOTIATION DIALOGUES

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Plan

1. Context & related work
2. Computational model of collaborative negotiation
3. Negotiation based on power
4. Evaluation
5. Conclusion and future work

Context: Conversational agents

Companion

AlwaysOn
Sidner *et al, 14*

Smith *et al, 10*

Tutor

SimSensei
DeVault *et al, 14*

SimCoach
Rizzo *et al, 11*

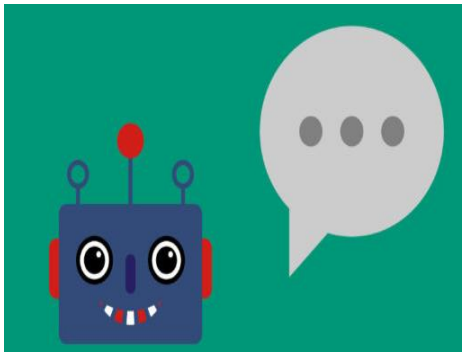
Partner

REA
Bickmore *et al, 02*

Louise
Davi

Collaboration User/Agent

Collaboration in dialogue



Collaborative Negotiation

Expertise

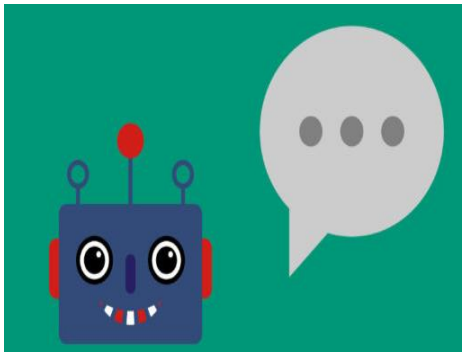
Preferences

Expertise

Preferences

Collaborative negotiation
trade-of which best satisfies the interests of **both participants**, instead of maximizing **one participant's interest**. (Chu-Caroll & Carberry, 95)

Collaboration in dialogue



Collaborative Negotiation

Expertise

Preferences

Social Relation

Expertise

Preferences

Impact of the social relation on the negotiation strategy

Social aspects in negotiation (Broekens et al, 10)

Dominance

- Ability to express behavior of power *(Burgoon & Dunbar 98)*
- Control attempts by one individual *are accepted* by the interactional partner *(Burgoon & Dunbar 98)*

Power

Ability to influence the behavior of another person *(Burgoon et al 98)*

Social aspects in negotiation

- Non-verbal behaviors:

(Bee, André *et al, 10*)
Gaze and posture

(Gebhard *et al,14)*
Head tilts
raised head associated to a dominant behavior

Social aspects in negotiation

➢ Verbal behaviors

- **Linguistic style** (Bradac & Mulac, 1984)
  - Dominant behavior is associated with more assertive style.

- **Lead of the conversation** *(Dedreu and VanKleef, 04; Burgoon98)*
  - High-power individuals tends to make the first move
  - Control of the flow of the conversation
  - Dictating topic changes

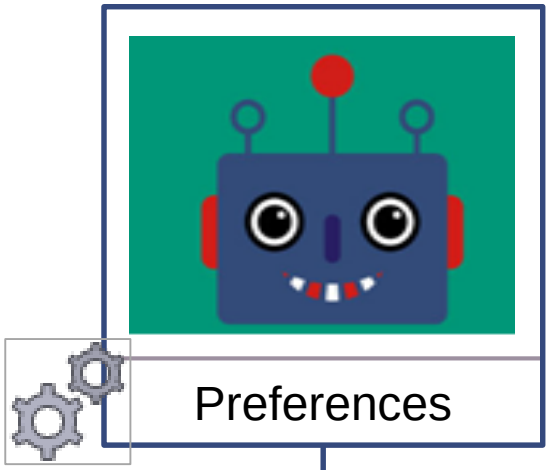
- **Strategic behaviors** *(Dedreu and VanKleef, 04)*
  - Self centeredness
  - Level of demand and concessions

Plan

1. Context & related work
2. Computational model of collaborative negotiation
   1. Model of preferences
   2. Model of communication
3. Negotiation based on power
4. Evaluation
5. Conclusion and future work

Model of negotiation of preferences

Mental state



Goal choose an option (ex : Restaurant).

Domain model

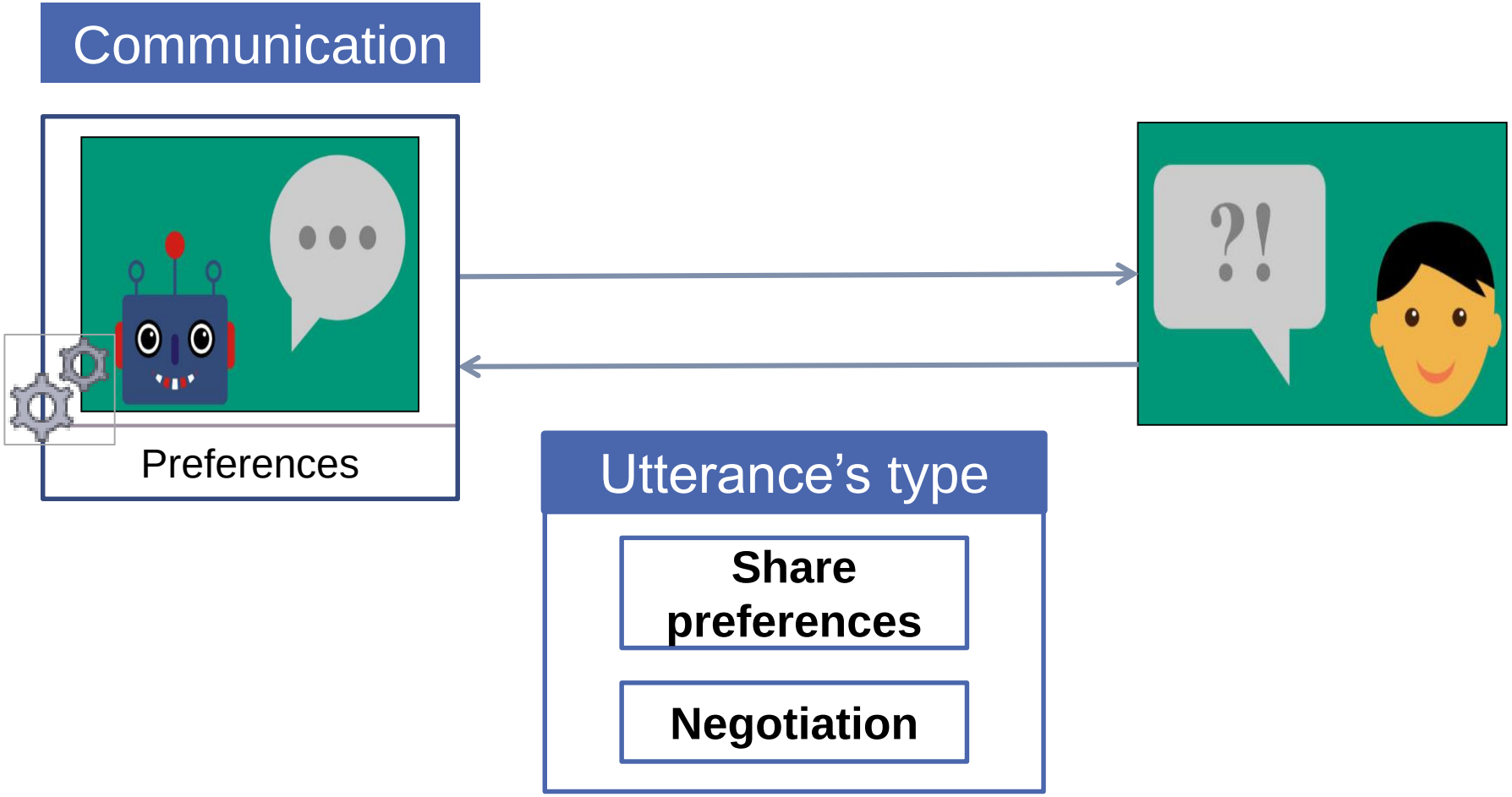
Option = {criterion_1, …, criterion_n}

- Ex : Restaurant = {cuisine, Price, ambiance}

+ Partial order.
+ Score of satisfaction
Inverse of the number of ancestors

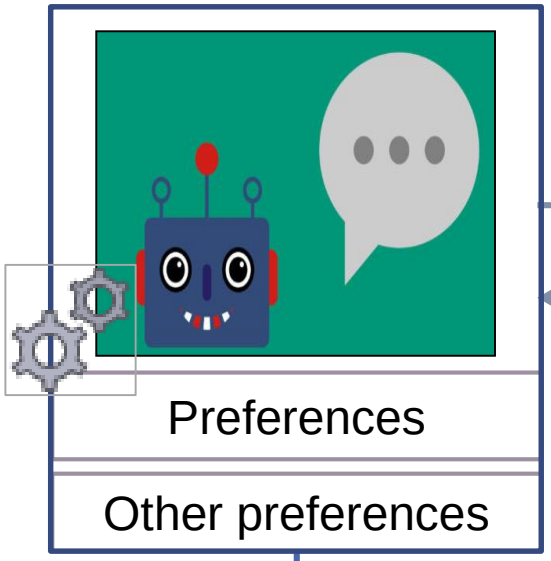
$$sat_{self}(v, \prec_i) = 1 - \left(\frac{|\{v' : v' \neq v \ \wedge \ (v \prec_i v')\}|}{(|C_i| - 1)} \right)$$

Model of negotiation of preferences



Model of negotiation of preferences

Communication



Preferences

Other preferences

Share preferences

Share a preference
State Preference(X)

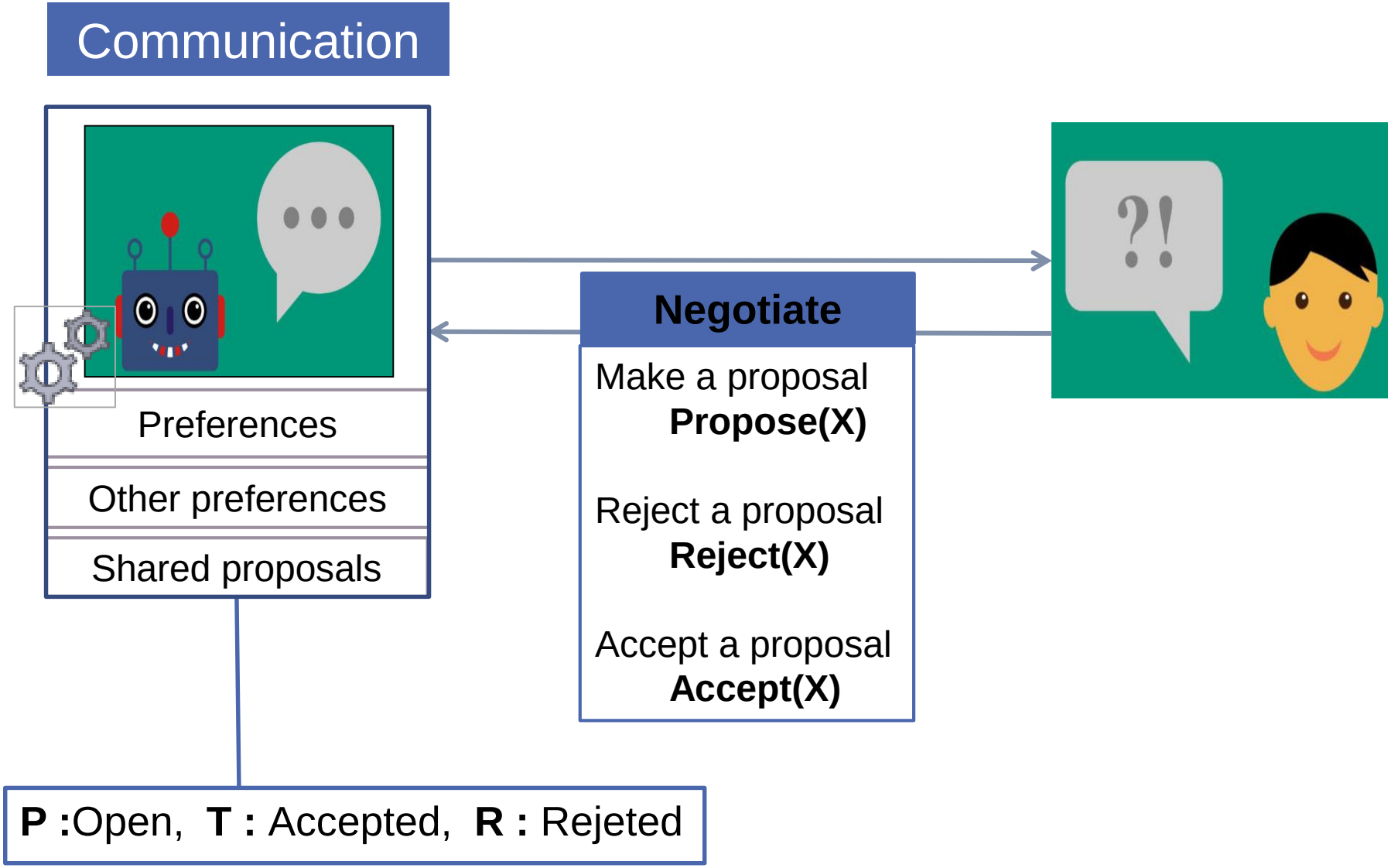
Ask for a preference
Ask Preference(X)

$$sat_{other}(v) = \begin{cases} 1 & \text{if } c \in A_i \\ 0 & \text{if } c \in U_i \\ 0.5 & \text{otherwise} \end{cases}$$

I like v

I don't like v

Model of negotiation of preferences



Plan

1. Context & related work
2. Computational model of collaborative negotiation
3. Negotiation based on power
   1. Behaviors related to power in social psychology
   2. Computational model of decision based on power
4. Evaluation
5. Conclusion and future work

Model of negotiation based on power

- **Principle 1: Level of demand and concession** *(Dedreu et al 95)*
  - Power is associated to a high level of demand and a low level of concessions

- **Principle 2: Self *vs* other** *(Fiske 93, DeDreu et al 95)*
  - High-power individuals are self-centered and only interested in satisfying their own preferences.

- **Principle 3: Lead of the negotiation** *(Dedreu,VanKleef, 04)*
  - High-power individuals tends to make the first move
  - Control of the flow of the negotiation

Model of negotiation based on power

Principle 1: Power is associated to a high level of demand and a low level of concessions

- **Implementation:** Conditions to accept a proposal

Level of demand

Acc: Define if a value is acceptable

Ex: Accept(Chinese) / Condition : acc(Chinese) = True

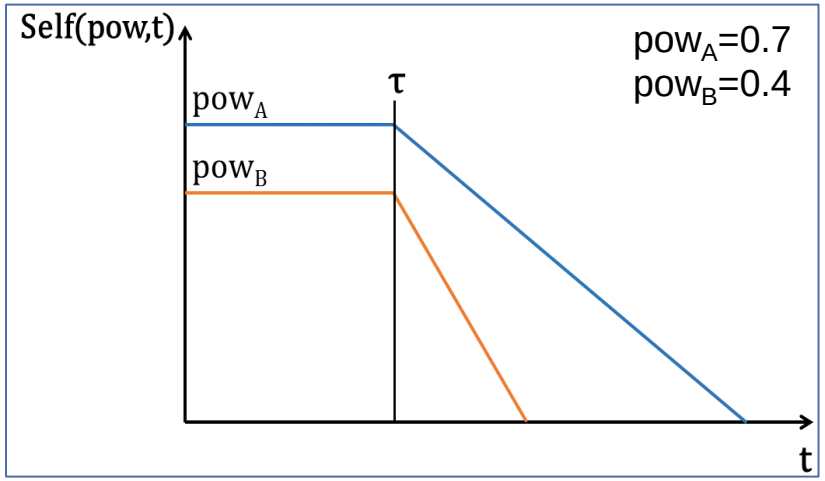
Self : Function representing the value of **pow** over time

Concessions

- Lower the level of demand.
- Self decreases over time.
- t = nb of non accepted prop

$$acc(v) = sat_{self}(v) \geqslant (\beta \cdot self(t))$$

$$self(t) = \begin{cases} pow & \text{if } (t \leqslant \tau) \\ \max(0, pow - (\frac{\delta}{pow} \cdot (t - \tau))) & \text{otherwise} \end{cases}$$



Model of negotiation based on power

Principle 2: High-power individuals are self-centered

- **Implementation:** Choose the value of a proposal

+ Choose a proposal by taking into account **self preferences** and **other preferences**

+ The higher ***self(t)*** is, the more an agent gives **weight** to its preferences

$$\mathrm{tol}(v) = \mathrm{self}(t) \cdot \mathrm{sat}_{\mathrm{self}}(v) + (1 - \mathrm{self}(t)) \cdot \mathrm{sat}_{\mathrm{other}}(v)$$

Model of negotiation based on power

Principle 3: High-power agent leads the negotiation

- **Implementation:** Choose the next utterance

- Decision rules
- Define a priority in the choice of the utterance
  - **High-power:** Negotiation acts (Propose, Reject, Accept).
  - **Low-power:** Statement acts (StatePreference, AskPreference

Example of dialogue

Pow(A) = 0.9, Pow(B) = 0.4

A: "Let's go to a Chinese restaurant."

B: "I don't like Chinese restaurants, let's choose something else."

A: "Let's go to the Shanghai. It's a quiet, cheap Chinese restaurant on the south side."

B: "Do you like Italian restaurants?"

A: "I don't like Italian restaurants."

B: "Do you like French restaurants?"

A: "Let's go to the Shanghai. It's a quiet, cheap Chinese restaurant on the south side."

B: "Do you like French restaurants?"

A: "I don't like French restaurants."

B: "Do you like Korean restaurants?"

A: "Let's go to a cheap restaurant."

B: "Okay, let's go to a cheap restaurant."

A: "Let's go to a restaurant on the south side."

B: "Okay, let's go to a restaurant on the south side."

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B: "Okay, let's go to the Shanghai restaurant.“

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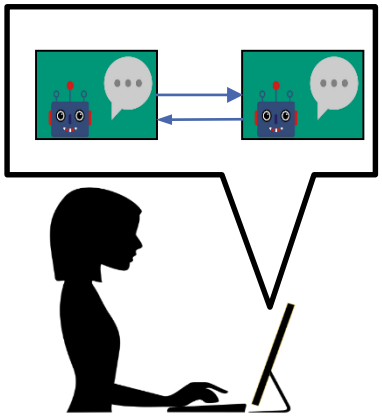
Evaluation of the model

- Evaluate the perception of behaviors related of power.

Conditions

- Agent preferences.
  - **Similar** preferences
  - **Different** preferences
- Init of power
  - Pow(A) = 0.9, Pow(B) = 0.4
  - Pow(A) = 0.7, Pow(B) = 0.4
  - Pow(A) = 0.7, Pow(B) = 0.4



Procedure

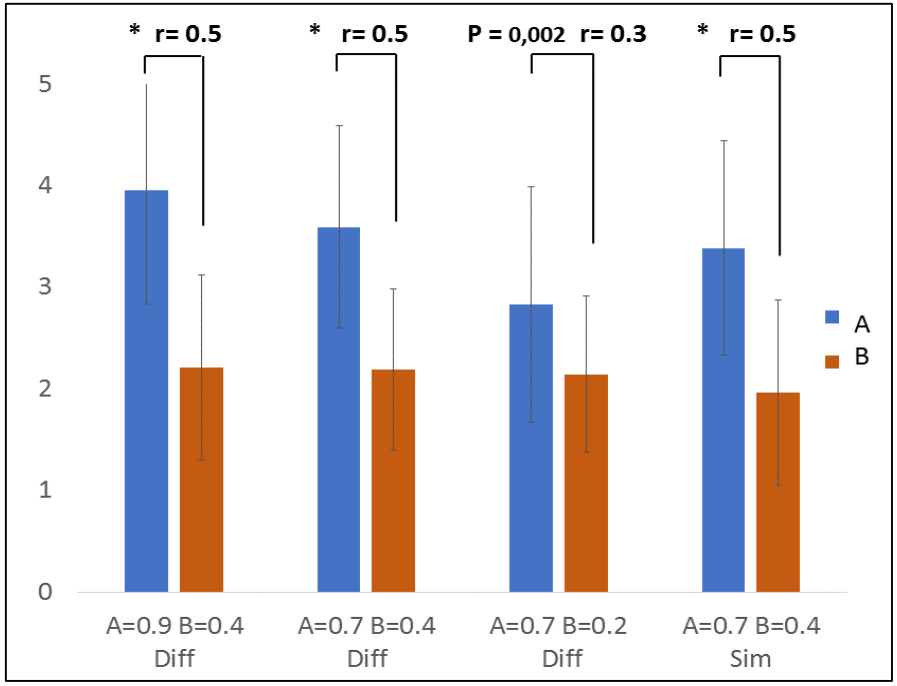
- External judges evaluate both agent behaviors during their negotiation.
- A between-subject study on the online site *CrowdFlower.com*.
- Agents described as two friends negotiating about restaurant where to have dinner.
- Total participants: 120

Evaluation of the model

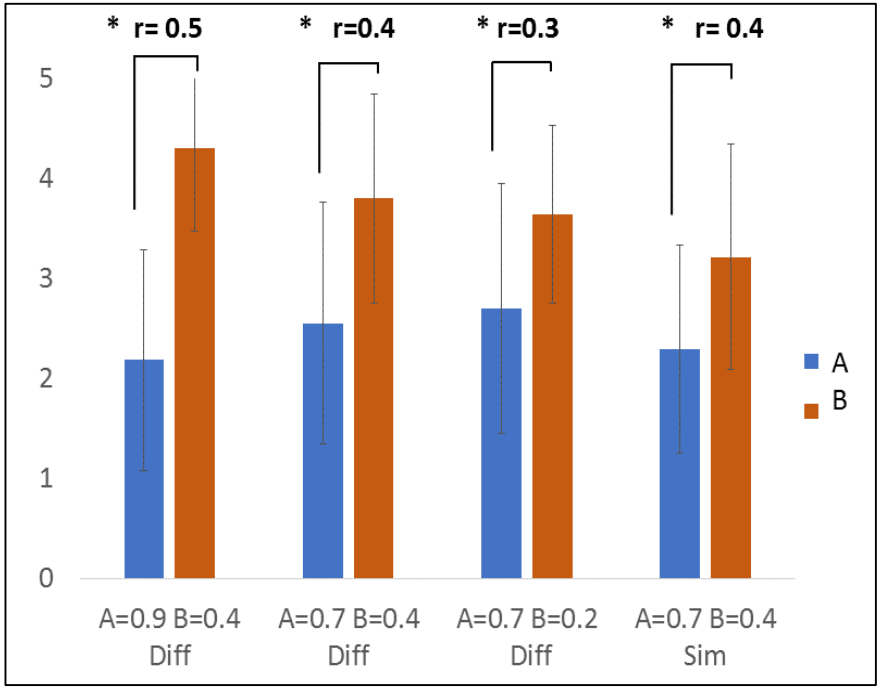
- Hypotheses
  - H1 The higher-power agent will more strongly be perceived as self-centered than the lower-power agent
  - H2 The lower-power agent will be more strongly perceived as making larger concessions than the higher-power agent
  - H3 The higher-power agent will more strongly be perceived as demanding than the lower-power agent
  - H4 he higher-power agent will more strongly be perceived as taking the lead in the negotiation than the lower-power agent

Evaluation of the model

H1: Self centeredness



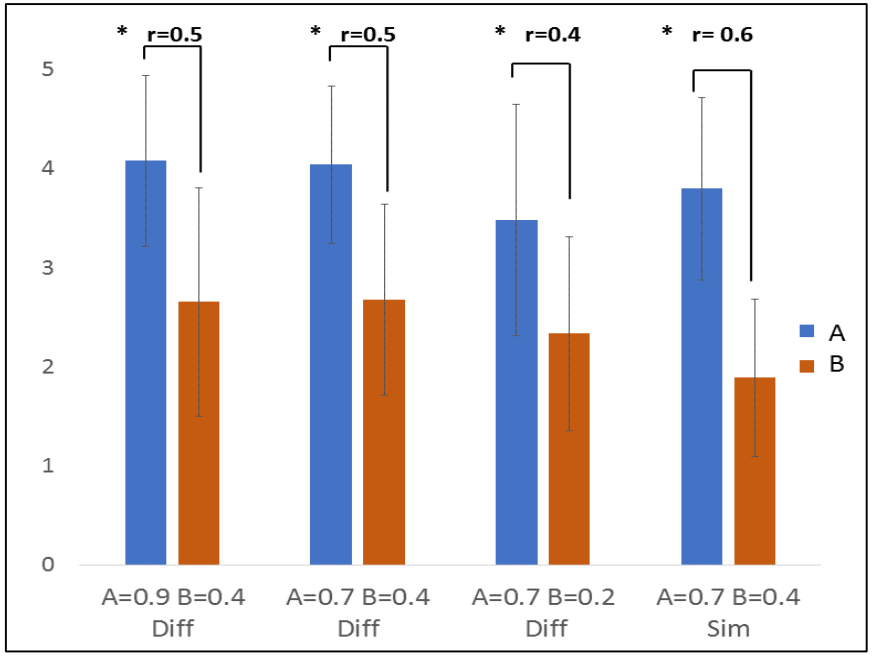
H2: Concessions



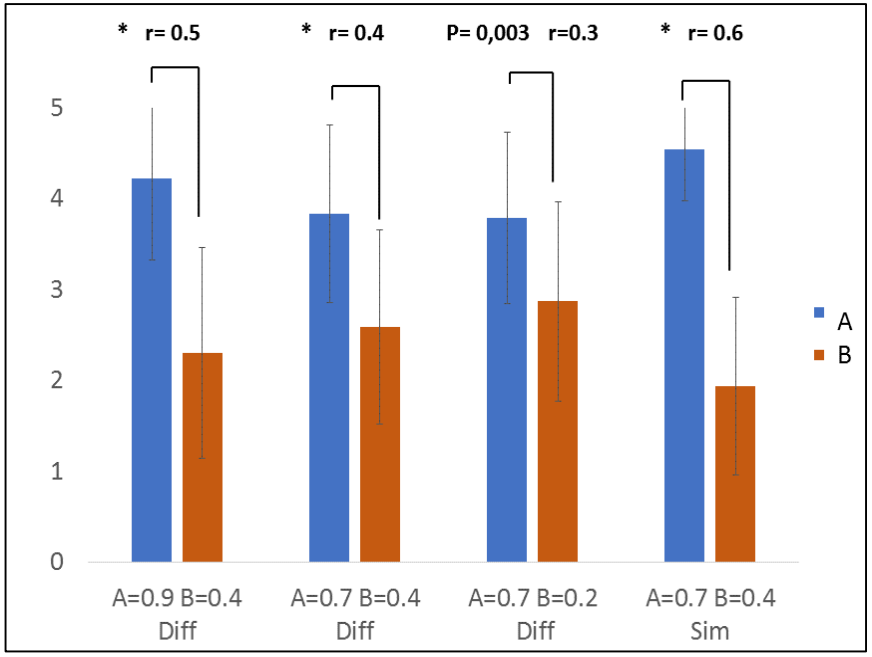
- Agent A is more self-centered and makes less concessions.
- Agent B tries to find the best trade-off for both parties, and is able to make larger concessions.

Evaluation of the model

H3: Level of demand



H4: Lead of the dialogue



- Agent A is more demanding than agent B.
- Agent A is the one who leads the dialogue.

Conclusion

Goal: Impact of dominance on the negotiation strategies.

1. Identify 3 principles of behaviors related to power
2. Computational model of collaborative negotiation
3. Decision model based on power
4. Validation of behaviors of power by external judges
5. Validation of the model in HMI
6. Build the relation of dominance during the negotiation
   i. Adapt the agent to the user behavior
7. Validate the model in the context of HMI

Thank you for your attention