

Seminar: Advanced Dialogue Modeling  
for Practical Applications

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# **Negotiation**

# Motivation(1)

(Source: Wikipedia)

- Negotiation involves:
  - resolving disputes
  - producing an agreement upon courses of action
  - bargaining for individual or collective advantage
  - crafting outcomes to satisfy various interests
- Negotiation occurs everywhere:
  - in business and non-profit organizations
  - government branches and legal proceedings
  - among nations
  - marriage and divorce
  - parenting
  - everyday life

# Motivation(2)

- Negotiation has its own study - negotiation theory
- Professional training for negotiators:
  - union negotiators
  - peace negotiators
  - hostage negotiators
  - diplomats
- Why is negotiation difficult for humans:
  - a lot of facts are to be considered simultaneously
  - time is often short
  - adjustment to other participants is required
- The hope is that computer systems:
  - might do better
  - at least help people become better negotiators

# Sample Systems

- Computer systems for following tasks have been built and tested (not exhaustive):
- System negotiating over the price for a certain service (Source [22]):
  - a lot of different decision variables, both quantitative (price or delivery time) and qualitative (colour)
  - weights of the variables (price is more important than the colour)
- System playing a role in an international crisis (Source [21]):
  - a lot of different options (imposing trade sanctions, reducing pollution, subsidize removal of ships, enforcing rights with military force, different agreement offers)
  - even though mathematically well-defined the time is too short to do the actual calculations (crisis circumstances)
- Virtual human systems which engage human users in order to solve problems (Source [Traum 08][4][5]):
  - analyzing the behaviour is required
  - different tactics and strategies should be applied

# Contents

- + Virtual human systems:
  - + design
  - + strategies
  - + sample conversations
- Dialogue model:
  - rules
  - algorithm for rule application
- Implementation:
  - speech recognition
  - text understanding
  - output generation

# Virtual Humans vs Dialogue Systems

- Dialogue system - a computer system whose purpose is to achieve an application goal through a series of interactions in natural language with a user (Source: LT2 Slides)
- Virtual humans also have knowledge about the task and strategies to solve it, but they
  - don't strive to solve it as efficiently as possible
  - try to produce a human-like dialogue
- Brevity is not necessary an advantage - the longer the conversation the more opportunity for learning

# Virtual Humans

- humanoid body (animated or robots)
- cognitive state (beliefs(not knowledge), goals, intentions, different attitudes)
- embeddedness in the real or virtual world
- Interactivity (ability to manipulate the world, communicate with others, perception of events and communication)
- Virtual humans can play an important role in helping to train skills of interacting with others who have different beliefs, goals and behaviour (e.g. cultural differences, belonging to different groups)

# Negation and Modalities:

- Negotiation as
  - teammates (shared end-goals, strong trust in each other)
  - adversaries (trade-off between one's own goals and the ones of the other party)
  - neutral sides (relationships needed to be developed during the interaction)
- Conversation involving:
  - two participants (teammates, adversaries, neutral)
  - more participants (coalitions, neutral)
- Modalities:
  - speech
  - gestures

# Environment



Dr. Perez(left), elder al-Hassan(right),  
U.S. Army captain(human user)

Dr. Perez - western Doctor, main objective is to treat patients

Elder al-Hassan – middle-eastern man, main objective is to support his village

Captain – objective is to move the clinic near the U.S. camp

Elder and Dr. Perez form a coalition (both don't want the clinic to be moved)

# Task

- Solve Problems:
  - figure out a solution acceptable by all participants.
- Gain Trust:
  - Familiarity (show that you know how to behave in a certain situation)
  - Credibility (stand by own words and promises, say things that are believable)
  - Solidarity (show that you have same goals as other participants and that you want to be cooperative)
- Manage Interaction: react to concerns of the others, control topic progression

# Dialogue model

- Information-state approach:
  - representations used to model dialogue context (task, participants, conversations, roles and relationships, obligations and commitments, speech history)
  - rules for interpreting input, updating(changing) information states, choosing an action for a particular information state, producing output behaviour
  - algorithm that specifies the order and priority of rule application  
(grounding model, initiative model, strategies)

# Strategies(1)

- **Find Issue:**
- Condition - there is a negotiation meeting, but there is no issue to be considered the topic of negotiation.
- Realization - request the topic from another agent (human or virtual), propose topic, propose constraints on topic selection. Signal it non-verbally: e.g. no crossing arms, indicating willingness to participate.
  
- C: Hello Doctor Perez.  
D: Hello.  
C: Very nice to meet you.  
D: What do you want? (Find Issue - requesting C to propose a topic)  
C: I have orders to assist you in moving this clinic to a safer location.

# Strategies(2)

- **Avoid:**
- Condition - there is no topic, there is a topic which is considered undesirable, but avoidable.
- Realization - switch topic to another issue, off-topic e.g. small-talk. Signal it non-verbally with crossed-arms, indicating a defensive position.
- D: You want to move the clinic?  
C: Yes.  
D: This conflict is madness, it is killing people.  
C: It is not safe here we can't protect you.  
D: Protect me? Protect me from what? Are you going to attack?  
(Avoid - switching topic to another issue)

# Strategies(3)

- **Attack:**
- Condition - there is a topic, which is considered undesirable, but not avoidable
- Realization - propose alternatives, attack the persons who are in favour of the current topic. Signal it by a more aggressive, dominant posture.
- D: To move the clinic is not possible, we have too many patients in critical condition.  
C: It is very important to move now!  
D: You are the threat, I need protection from you! (Attack - accusation of the captain)

# Strategies(4)

- **Negotiate:**
- Condition - there is a topic, but the outcome is unclear
- Realization - state flaws of the topic, propose fixes of the flaws. Signal it by a mixed non-verbal posture, e.g. one hand on hip.
  
- D: I can't move all the patients. (flaw of the solution)  
C: We can have locals move you. (possible fix)  
E: We would need to improve the water access in the downtown area. (flaw)  
C: We can dig a well for you. (fix)

# Strategies(5)

- **Advocate:**
- Condition - there is a good reason to believe that the topic will have a good outcome
- Realization - propose solutions and ameliorations to the flaws. Try to convince other participants to agree on the current plan. Signal it with an open relaxed posture.
  
- E: Doctor, I think you should run the clinic downtown.  
(convincing other participants)

# Strategies(6)

- **Success:**
- Condition - successful mutual commitment to an issue.
- Realization - formalise remaining details, disengage friendly from the meeting. Signal it with an open relaxed posture.
  
- D: Very well captain, contact my assistant to make further arrangements.
  
- **Failure:**
- Condition - commitment against an issue.
- Realization - disengage from the meeting. Can have positive or negative emotions.
  
- D: My patients need my attention. I must go now.
  
- E: I must attend to other matters.

# Factors in Strategy Selection

- Topic:
  - if there is none, find-issue and avoid strategies are applicable
- Control:
  - estimated ability to control the discussion. Control is a requirement for successful avoidance.
- Utility:
  - agent's calculation of how good the outcome will be, if current plans will be carried out. Positive utility is a reason for advocate strategy, negative utility for avoid or attack strategies.
- Potential:
  - agent's estimation of how good utility can get. It is a reason for either negotiating about the topic or attacking.
- Trust:
  - agent's reliability on other participants. Negative trust will not increase the probability of success of a plan even if the other side does corresponding commitments.
- Commitments:
  - commitments influence estimations of utility, success and potentials. They are a major requirement that the goal will be achieved.

	topic	control	utility	potential	trust	commitment
find-issue	-				some	
avoid		+	-		some	
attack	+	-	-	-	some	
negotiate	+		-	+	some	
advocate	+		+		some	
success	+				moderate	mutual
failure	+				very low	negative

# Emotion Model

Strategy	Posture
Find Issue	Hands at Side
Avoid	Crossed Arms
Attack	Hands on Hips (Akimbo)
Negotiate	Left Hand on Hip
Advocate	Hands at side
Success	Hands at side
Failure	Arms Crossed in Front

(a) Western Doctor.

Strategy	Posture
Find Issue	Hands at Side
Avoid	Hold Wrist in Front Low
Attack	Hold Wrist behind Back
Negotiate	Hold Wrist in Front High
Advocate	Hands at side
Success	Hands at side
Failure	Hands at side

(b) Middle-Eastern Elder.

- The emotion model is domain-independent (not events trigger reaction, but cognitive processes)

# Models of Other Agents:

- Agents not only calculate ones own beliefs, goals, intentions, utilities of different commitments and outcomes, probabilities for success for certain actions, but also reason about other agents.
- They try to estimate and track:
  - beliefs of the others
  - utilities of the others if certain strategies are followed

# Sample Dialogues(1)

- 1: C Hello gentlemen.
- 2: D Hello captain.
- 3: E Hello captain.
- 4: C I have orders to move this clinic to a camp near the US base.
- 5: D We need to help the victims of the conflict you started.
- 6: C I understand, but it is imperative that we move the clinic out of this area.
- 7: D Do you see that girl over there her mother was killed by American gunfire today.
- 8: C It is not safe here.
- 9: D Look at these people they are injured because of your operations.
- 10: C I have my orders to move you to the camp.
- 11: D Elder I think staying at the market would best.
- 12: E We have many matters to attend to.
- 13: C I understand.
- 14: E We must stop this killing insanity.
- 15: E Captain you would do better to protect the town.
- 16: C We cannot protect you here.
- 17: E I must refuse.
- 18: D I would have to refuse this decision.

# Sample Dialogues(1)

1: C Hello gentlemen.

2: D Hello captain.

3: E Hello captain.

4: C I have orders to move this clinic to a camp near the US base.

[Avoid]

5: D We need to help the victims of the conflict you started.

6: C I understand, but it is imperative that we move the clinic out of this area. [-Solidarity]

[Attack]

7: D Do you see that girl over there her mother was killed by American gunfire today.

8: C It is not safe here. [-Credibility]

[Attack]

9: D Look at these people they are injured because of your operations.

10: C I have my orders to move you to the camp. [-Familiarity]

[Attack]

11: D Elder I think staying at the market would best.

12: E We have many matters to attend to.

13: C I understand.

[Attack]

14: E We must stop this killing insanity.

15: E Captain you would do better to protect the town.

16: C We cannot protect you here. [-Credibility]

[Failure]

17: E I must refuse.

[Failure]

18: D I would have to refuse this decision.

# Sample Dialogues(2)

- 1: C Hello Doctor Perez.
- 2: D Hello captain.
- 3: E Hello captain.
- 4: C Thank you for meeting me.
- 5: E How may I help you?
- 6: C I have orders to move this clinic to a camp near the US base.
- 7: E We have many matters to attend to.
- 8: C I understand, but it is imperative that we move this clinic out of this area.
- 9: E This town needs a clinic.
- 10: D We can't take sides
- 11: C Would you be willing to move downtown?
- 12: E We would need to improve water access in the downtown area, captain.
- 13: C We can dig a well for you.
- 14: D Captain, we need medical supplies in order to run the clinic downtown.
- 15: C We can deliver medical supplies downtown, Doctor.
- 16: E We need to address the lack of power downtown.
- 17: C We can provide you with power generators.
- 18: E Very well captain, I agree to have the clinic downtown.
- 19: E Doctor, I think you should run the clinic downtown.
- 20: D Elder, the clinic downtown should be in acceptable condition before we move.
- 21: E I can renovate the downtown clinic, Doctor.
- 22: D OK, I agree to run the clinic downtown, captain.
- 23: C Excellent.
- 24: D I must go now.
- 25: E I must attend to other matters.
- 26: C Goodbye.
- 27: D Goodbye.
- 28: E Farewell, sir.

# Sample Dialogues(2)

1: C Hello Doctor Perez.

2: D Hello captain.

3: E Hello captain.

4: C Thank you for meeting me. [+Familiarity]

[Find Issue]

5: E How may I help you?

6: C I have orders to move this clinic to a camp near the US base.

[Avoid]

7: E We have many matters to attend to.

8: C I understand, but it is imperative that we move this clinic out of this area.

[Attack]

9: E This town needs a clinic.

10: D We can't take sides

11: C Would you be willing to move downtown?

[Negotiate]

12: E We would need to improve water access in the downtown area, captain.

13: C We can dig a well for you. [+Solidarity]

[Negotiate]

14: D Captain, we need medical supplies in order to run the clinic downtown.

# Sample Dialogues(2)

15: C We can deliver medical supplies downtown, Doctor. [+Solidarity]

16: E We need to address the lack of power downtown.

17: C We can provide you with power generators. [+Solidarity]

18: E Very well captain, I agree to have the clinic downtown.

19: E Doctor, I think you should run the clinic downtown.

[Negotiate]

20: D Elder, the clinic downtown should be in acceptable condition before we move.

21: E I can renovate the downtown clinic, Doctor.

[Success]

22: D OK, I agree to run the clinic downtown, captain.

23: C Excellent.

24: D I must go now.

25: E I must attend to other matters.

26: C Goodbye.

27: D Goodbye.

28: E Farewell, sir.

# Conclusion

- This kind of system is natural, because avoid and attack strategies are very frequent. This leads to the fact that it actually sounds naturally when virtual humans don't directly react to user's input but rather complain about their problems.
- Negotiation model significantly extends the generality and expressiveness of previously existing negotiation models for virtual humans
- Many more factors have to be considered: power, status, interpersonal distance and autonomy.
- Strategies for finding out preferences of other participants have to be implemented (using a series of offers, counter-offers).