ICT Dialogue Manager Tutorial: Lecture 3: Architecture & Representations
Dialogue Management Tasks

- Updating Context on observed communication
- Deciding what/when to say next
- Interface with back-end/task model
- Provide expectations for interpretation
Dialogue Processing

- Interactive programming (Lisp): Read -> Eval -> Print cycles
- Standard Dialogue System: Listen -> Process -> respond
- Our approach:
  - no pipelining
    - Perception
    - Cognition
    - Action
  - Possible serialization, but arbitrary nestings
    - Flexible turn-taking and initiative
    - Multi-utterance turns for all participants
Dialogue Approach: Layered Information State

- **Layer captures coherent aspect of communicative interaction (e.g., turn, grounding, obligations)**
- **Layer consists of**
  - Information State components (state of interaction)
  - Dialogue Acts (Packages of changes to information state)
MRE-SASO Dialogue Management

- Multi-layer Information State
- Asynchronous Processing Phases
  - Interpretation: ASR, NLU, Understand Speech Operator
  - Updates: Update Dialogue State Operator
  - Selection & Generation: Output Speech operator, realization & rendering
Dialogue Levels & Dialogue Acts

- **Contact** (make, break)
- **Attention** (show, request, accept)
- **Conversation** (begin, join, leave, end)
  - Turn-taking (take, hold, release, assign)
  - Initiative (take, assign, release)
  - Utterance
    - Main Function (assert, request, suggest, order, offer, promise, info-request, ...)
    - Relational (answer, accept, reject, avoid, hold, ...)
    - Features: speaker, addressee, overhearer, referent, content
      - Polarity (positive, negative)
  - Grounding (initiate, continue, acknowledge, repair, request repair, ...)
  - Topic (set topic, set subtopic, close topic)

- **Social**
  - Obligations & Commitments
  - Relationships (Face, Status, Affiliation, Trust)
  - Social Roles
Non-verbal Behavior & communicative functions

Behavior
- Orientation/Gaze
- Pointing
- Head-nod
- Head-shake

Addressee
- Turn
- Referent
- Affiliation
- Grounding
- Answer
  - Polarity-positive
  - Polarity-negative
Social Commitments
(Traum & Allen94, Allwood 94, Matheson et al)

- **IS**
  - Obligations to act
  - Social Commitments to Propositions
  - Conditionals

- **Actions**
  - Order
  - Request
  - Suggest
  - Promise
  - Offer
  - Statement
  - Question
  - Accept
Contact (Allwood et al, Clark, Dillenbourg et al)

- **IS:**
  - Who is accessible
  - Modality (visual, audio[shout, normal, whisper], radio)
  - Send vs Receive

- **Actions**
  - Make contact (turn on radio, walk over)
  - Break contact (walk out of hearing, turn off radio/channel, turn out of view or behind something)

- **Issues**
  How much is needed, for what?
Attention (Novick 88)

- **IS: who is attending to what, how**
  - (visually, radio, audio)

- **Actions:**
  - Self
    - Give attention (gaze, verbal feedback)
    - Withdraw-attention (gaze away, attend to other)
  - Other
    - Request attention (call, arm waving)
    - Direct attention (pointing, “look”)
    - Release attention (look away, dismissal)

- **Issues:**
  - How frequently monitored/maintained?
  - How many objects? Cross-modality?
  - Relation to attentional conversational structure
Turn (Novick 88, Traum & Hinkelma 92, Cassell et al. 94, ...)

- **IS: holder**

- **Actions:**
  - Take-turn (start to talk)
  - Release-turn (gaze, stop, rising intonation)
  - Assign-turn (gaze, name)
  - Hold-turn (filled pause, gaze away)
  - Request-turn (hands in gesture space, raise hands in class)

- **Issues**
  - Negotiation for contentious turns
  - Continuous vs. discrete signals
Turn-taking

- **Turn-assigned with specific signals**
  - Question

- **Turn-kept with other signals**
  - Filled pause

- **Underspecified in some cases**
  - Assertion
  - Use of context
    - Initiative holder keeps/takes turn
  - Gaze at end of utterance determines hold/assign turn
Initiative (Whitaker & Walker, Chu-Carroll & Brown,...)

- **IS: holder**

- **Actions**
  - Take (un-prompted contribution)
  - Hold (evocative utterances)
  - Release (open offers)

- **Issues**
  - How many kinds of initiative?
  - Non-verbal behaviors?
Taking Initiative

- **What to communicate**
  - Task model
  - Emotion model
  - Special domain-specific rules

- **When to communicate**
  - Response only
  - Too much silence
  - Too much misunderstanding
  - Too much irrelevance
  - Directed by other

- **How to communicate**
  - Questions
  - Hints
  - Suggestions
  - Performances
Grounding (Traum & Hinkelmann92, Traum 94)

- **IS: stack of CGUs**
  - CGU:
    - Initiator, Responder
    - State
    - Contents
    - Effects

- **Acts**
  - Initiate
  - Continue
  - Repair
  - Request Repair
  - Acknowledge
  - Request Acknowledge
  - Cancel
  - Display
Recognizing Grounding Acts

- **Initiate**: core acts, no ungrounded CGU
- **acknowledge**: evidence of understanding (backward act, explicit, follow-up)
- **Request-repair**: clarify-parameter, or repetition request
- **Repair**: providing changing or solicited info
Grounding Act Updates

- **initiate:**
  - New CGU, state -> 1, obligation to ground

- **continue:**
  - New content added to CGU

- **Request-repair**
  - State -> 2, obligation to repair

- **Repair**
  - State-> 1, change content

- **Acknowledge**
  - State -> F, content effects

- **Cancel**
  - State -> D, remove CGU from ^grounding, recent-cgus, remove grounding obligations for CGU
Topic/Purpose/Focus (Grosz & Sidner,...)

- **IS**
  - Hierarchical, complex
  - Focus: Pointer into structure

- **Actions**
  - Start topic (cue words, head movements)
  - Continue topic (same head movement)
  - End topic (posture shift)

- **Issues**
  - How fine-grained?
  - Stack-based accessibility?
  - Prosody & Information Structure
Social Roles

- **IS**
  - Status (e.g., Military Rank)
    - Superior
    - equal
    - subordinate
  - Activity roles (e.g., forward observer, pilot)
  - Action-performance roles
    - Actors of parts of complex actions
    - Responsibility (team leadership)
    - Authority

- **Action Effects**
  - Authorize action
  - Perform action
  - Take-up, drop role
Social Commitments
(Traum & Allen 94, Allwood 94, Matheson et al 00)

- **IS**
  - Obligations, Social Commitments to Propositions

- **Actions**
  - Order, Request, Suggest
  - Promise, Offer
  - Statement, Question
  - Accept,..

- **Effects are to Obligations & Commitments**
  - Belief updates based on inference, not speech act effects
Virtual Human Task Model  
(Traum et al AAMAS 2003)

- **Basic Types**
  - **States**
    - Object-id
    - Attribute
    - Value
    - Polarity
    - Concerns
    - Belief
    
    E.g.: 
    
    - object-id: clinic
    - attribute: location
    - value: market
    - polarity: positive
  
  - **Tasks**
    - Pre, Add, Delete (states)
    - Case roles (event, agent, theme, location, source, destination, instrument, path)
    
    E.g.: 
    
    - move-clinic {
      - agent: captain
      - theme: clinic
      - source: market
      - event: move
      - instrument: locals
      - destination: camp
      - pre: {clinic-at-market}
      - add: {clinic-at-camp}
      - del: {clinic-at-market}
    }

- **Reasoning**
  - Goals
  - Plans
  - Intentions
  - Alternative Courses of Action
Elements of Dialogue Theory

- Cooperation
- Obligation & Non-cooperative interaction
- Grounding
- Multiparty interaction
- Cooperative Negotiation
- Multiparty Non-Cooperative Negotiation
Negotiation Model

- **Information State:**
  - set of tasks annotated with negotiation objects

- **Negotiation Object Components:**
  - Agent
  - Action
  - Audience
  - Time
  - Reason
  - Stance
    - Committed,
    - endorsed,
    - mentioned,
    - not mentioned,
    - disparaged,
    - rejected
Negotiation Stances

Rejected

Disparaged

Mentioned

Unmentioned

Committed

Endorsed

Expressed desirability

Strength Of claim
Stances added from Speech acts

- **command, promise, request, or acceptance:**
  - committed

- **Suggestion:**
  - mentioned

- **Offer:**
  - mention (conditional commitment)

- **Rejection:**
  - rejected

- **Counterproposal:**
  - disparaged
  - endorsed

- **Justification:**
  - endorsed or disparaged (depending on direction)

- **Retract stance**
Producing Negotiation Stances

1. **Assessment factors**
   - Plan state
   - Dialogue state
   - Relevant party

2. **Act proposal**

3. **Act selection**

4. **Verbal and non-verbal generation**

5. **Realization/rendering**
Factors for selecting negotiation moves

- **Relevant Party (who needs to agree)**
  - Authorizing or Responsible Agent

- **Dialogue State (have I/ do I need to present a stance)**
  - unmentioned
  - discussed
  - needs-discussion

- **Plan State (what do I think about the action)**
  - good (intended and next-step)
  - considered-good (intend unknown, relevant, and best)
  - considered-bad (intend unknown, relevant, other is better)
  - not-in-coa (intend unknown, but not in coa)
  - evaluate (world changed, need to deliberate about plan)
  - premature (the action is intended but not a next-step)
  - goals-satisfied (not a next-step and end-goals-satisfied)
  - bad (the action is not intended or considered relevant)
  - unknown (can't find a task for this action)
  - conflict (irreconcilable preferences for task identification)
Conditions for Negotiation Moves

- **Accept**
  - relevant-party me
  - plan-state
    - good
    - considered-good
    - not-in-coa
  - dialogue-state needs-discussion
  E.g. “yes sir”

- **Accept (reluctantly)**
  - relevant-party me
  - plan-state considered-bad
  - dialogue-state discussed
  E.g., “against my recommendation”

- **Counterpropose**
  - plan-state
    - considered-bad
    - premature
  - dialogue-state needs-discussion
  E.g., “instead we should …”

- **Reject**
  - plan-state
    - bad
    - unknown
    - conflict
    - goals-satisfied
  - dialogue-state needs-discussion
  E.g., “no sir”,
  “that’s done”
  “I don’t know how to do that”

- **Delay**
  - Plan-state evaluate
  E.g., gaze avert

- **Redirect**
  - Relevant-party <other> <> me
  E.g., “<other> can do that for you”

- **Express-discussed**
  - dialogue-state discussed
  E.g., “we already talked about that”
Negotiation acts

- **General properties**
  - \(^\text{action} \ <\text{act}>\) \(^\text{type} \ \text{backward}\)
  - \(^\text{addressee} \ <\text{other}>\) \(^\text{speaker} \ <\text{me}>\)
  - \(^\text{content} \ <\text{sa}>\)

- **Specific Acts** (\(^\text{action} \ \text{slot}\))
  - Accept
    - Manner (reluctant, eager)
  - Reject
    - \(^\text{reason} \ \text{(no-plan-instance,plan-conflict,goals-satisfied, blocked)}\)
  - Counterpropose
    - \(^\text{reason} \ \text{(worse-than, precluded)}\)
    - \(^\text{counterproposal} \ <\text{act}>\)
  - Redirect
    - Relevant-party \(<\text{other}>\)
  - Express
    - Express (discussed, role-unknown)
Negotiation (Traum et al AAMAS 2003)

- **IS: task (&CGU) annotated with negotiation objects**
  - Components: Agent, Action, Stance, audience, reason
    - Stances: Committed, endorsed, mentioned, not mentioned, disparaged, rejected

- **Action effects:**
  - Suggestion: mentioned
  - command, promise, request, or acceptance: committed
  - Rejection: rejected
  - Counterproposal: disparaged₁ + endorsed₂
  - Justification: endorsed or disparaged (depending on direction)
  - Offer: mention (conditional commitment)
  - Retract stance

- **Factors:**
  - Relevant Party: Authorizing or Responsible Agent
  - Dialogue State: who has discussed
  - Plan State: how do I feel about it
MRE Team-Negotiation Example
Example Negotiation Strategy

1. LT: Send two squads forward
2. Sgt: Sir that’s a bad idea. We shouldn’t split our forces. Instead we should send fourth squad to recon forward
3. Lt: Send two squads forward
4. Sgt: Against my recommendation sir,…

3’ LT: Send fourth squad to Celic
4’ Sgt: Yes sir
Elements of Dialogue Theory

- Cooperation
- Obligation & Non-cooperative interaction
- Grounding
- Multiparty interaction
- Cooperative Negotiation
- Non-Cooperative Multiparty Non-Cooperative Negotiation
SASO-EN Multiparty Negotiation

- Set of Strategies
- Multiparty
  - Each agent has strategy
  - Trust toward each party
- Multi-issue
  - Appraisal for each alternative
    - Potential strategy for each
  - Topic tracking
    - Strategy for current topic is active

Negotiation Considerations
- Trust
  - If too low, disengage
- Plan Assessment
  - Appraisal variables
  - Flaws
  - Relative utility
- Dialogue Assessment
  - Topic
  - Control
  - Commitments
SASO VHuman Trust Model
(Traum et al, IVA 2005)

- **Represented as Variable**
  - 0 (no trust) to 1 (full trust)
  - Initial value can be set

- **Trust as function of multiple factors:**
  - Familiarity - can I expect someone to behave properly
  - Solidarity - to what extent does other have shared purpose with me
  - Credibility - does agent make (only) claims that
    - Are believable
    - Are verifiably true
    - Turn out to be true

- **Trust dynamically computed**
  - Displays of solidarity/opposed goals
  - Credible/incredible statements
  - Show empathy, polite behavior, behave according to conventions
Using Trust

- accept assertions as truth (e.g., Perrault, Cohen & Allen)
- Negotiate in good faith
- Continue engagement
- Acceptance/Rejection of empathy (Martinovksi et al)
## Negotiation Strategies: Appraising the topic

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<th>topic</th>
<th>Control</th>
<th>Utility</th>
<th>Potential</th>
<th>Trust</th>
<th>Commitment</th>
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<tr>
<td>Avoid</td>
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<td>--</td>
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<td>some</td>
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<td>+</td>
<td>--</td>
<td>--</td>
<td>some</td>
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<tr>
<td>Negotiate</td>
<td>+</td>
<td>--</td>
<td>--</td>
<td>+</td>
<td>some</td>
</tr>
<tr>
<td>Advocate</td>
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<td></td>
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<td>some</td>
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<td>Failure</td>
<td>+</td>
<td></td>
<td></td>
<td>Very low</td>
<td>Negative</td>
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Theoretical Perspective on Emotion

(Marsella & Gratch, AAMAS 02, 03)

Smith and Lazarus ‘91 cognitive-motivational-emotive system

Environment → Appraisal → Coping → Emotion-Focused

Appraisal Variables:
- Action Tendencies
- "Affect"
- Physiological Response

Goals/Beliefs/Intentions

Problem-Focused → Coping Strategy

Coping

Physiological Response

USC Institute for Creative Technologies
Implementing Negotiation Strategies

- **Orientations result from appraisal of negotiation**
  - Reified negotiation “task”
  - Interactions with goals and plans

- **Strategies chosen as part of coping**
  - Entry & exit conditions

- **Strategies associated with communicative behavior**
  - Base posture and gesture set
  - Choice of dialogue moves
    - Speech act and realization
    - Initiative, topic selection, and type of grounding feedback
    - Affective tone
  - Aspects of interpretation
    - Charitability of interpretation
    - Assumptions vs clarification
Behaving according to Strategies

- **Find Issue**
  - Find topic

- **Avoid**
  - Change topic
  - Try to leave

- **Attack**
  - State flaws
  - Propose better alternatives
  - Ad hominem

- **Negotiate**
  - State flaws
  - Propose solutions
  - Offer bargains

- **Advocate**
  - Propose actions
  - Address flaws
  - Offer commitment

- **Success**
  - Move on

- **Failure**
  - Move on
3-party negotiation Dialogue: Not very cooperative

C: hello gentlemen
D: hello captain
E: hello captain
C: thank you for meeting me
E: how may I help you?
C: i have orders to move this clinic to a camp near the US base
D: we need to help the victims of this conflict you started
C: i understand but it is imperative that we move the clinic out of this area
D: do you see that girl over there her mother was killed by American gunfire today
C: it is not safe here
D: look at these people they are injured because of your operations
C: i have my orders to move you to the camp
D: elder i think staying at the market would be best
E: we have many matters to attend to
C: i understand
E: captain you would do better to protect the town
C: we cannot protect you here
E: we must stop this killing insanity
E: i must refuse
D: i would have to refuse this decision
E: i must leave thank you
D: i must go now
How to Win Friends and Influence Virtual People

- **Gain Trust**
  - Familiarity
    - Do the right things
    - Show you know how to behave
  - Credibility
    - Say believable things
    - Stand by your word
  - Solidarity
    - Want the right things
    - Show alignment in goals

- **Manage Interaction**
  - Don’t lose control
  - Set the agenda
  - React to what they are saying

- **Solve Problems**
  - Offer resources
  - Commit to important actions
  - Remove obstacles
  - Consider alternatives
  - Win-win situations