ICT Dialogue Manager Tutorial: Lecture 3: Architecture& Representations

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Mind

Intelligent Cognitive Agent

| Dialog Manager | Emotion Model | Task Planner | Body and Affective State Management (e.g., Gaze) |

- Perception
- Natural Language Understanding
- Natural Language Generation

Body

- Vision Recognition
- Speech Recognition
- Non-Verbal Behavior Generator
- Speech Synthesis
- Smartbody Procedural Animation Planner

Environment

- Real Environment
- Rendered Game Engine

Knowledge Management

- Domain Specific Knowledge
- Domain Independent Knowledge
- World State Protocol

2008 VHuman Architecture

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Dialogue Management Tasks

- **Updating Context on observed communication**

- **Deciding what/when to say next**

- **Interface with back-end/task model**
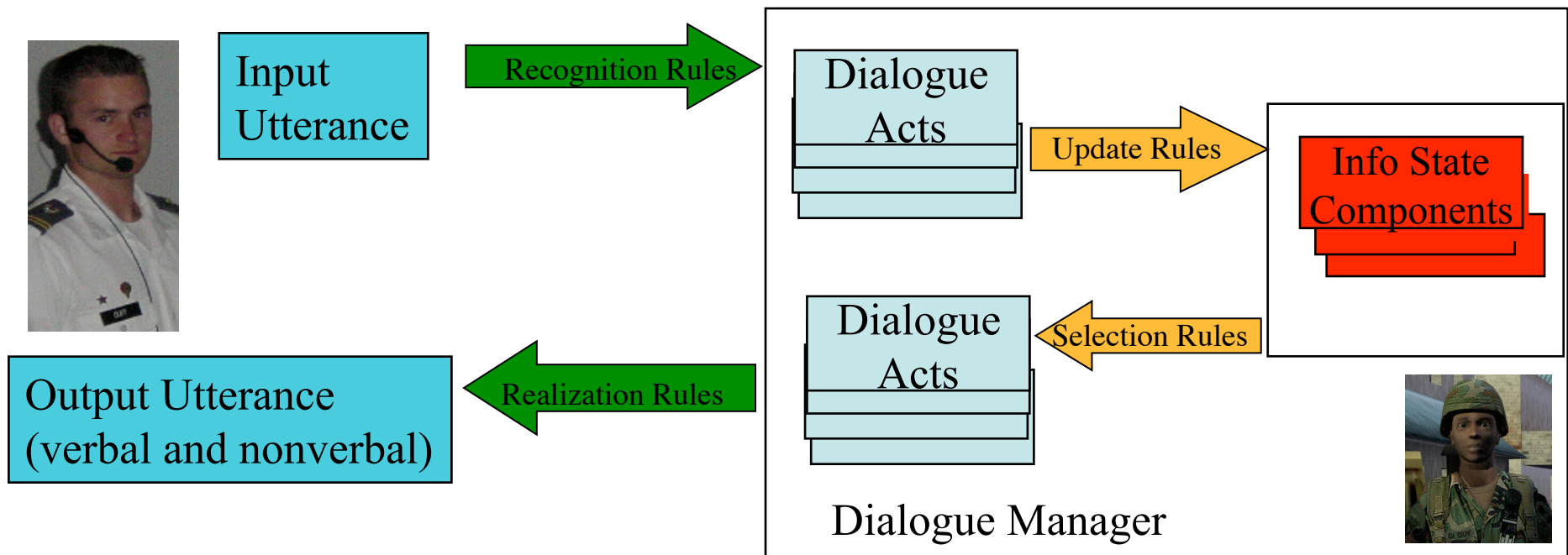
- **Provide expectations for interpretation**

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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)

Input Utterance → Recognition Rules → Dialogue Acts → Update Rules → Info State Components → Selection Rules → Dialogue Acts → Realization Rules → Output Utterance (verbal and nonverbal)

Dialogue Manager

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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

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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, Affilliation, Trust)
  - Social Roles

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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?

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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

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Turn (Novick 88, Traum &Hinkelman 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

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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

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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

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Grounding (Traum & Hinkelman92, Traum 94)

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

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

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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**

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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

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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

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Social Commitments

(Traum & Allen94, 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

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Elements of Dialogue Theory

- **Cooperation**

- **Obligation & Non-cooperative interaction**

- **Grounding**

- **Multiparty interaction**

- **Cooperative Negotiation**

- **Multiparty Non-Cooperative Negotiation**

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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   Committed

    Disparaged   Endorsed

            Mentioned   Strength
                                          Of claim

        Unmentioned

    Expressed desirability

Stances added from Speech acts

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

- **Suggestion:**
  - mentioned

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

- **Rejection:**
  - rejected

- **Counterproposal:**
  - disparaged$_1$
  - endorsed$_2$

- **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

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Negotiation acts

- **General properties**
  - ^action <act>   ^type backward
  - ^addressee <other>   ^speaker <me>
  - ^content <sa>
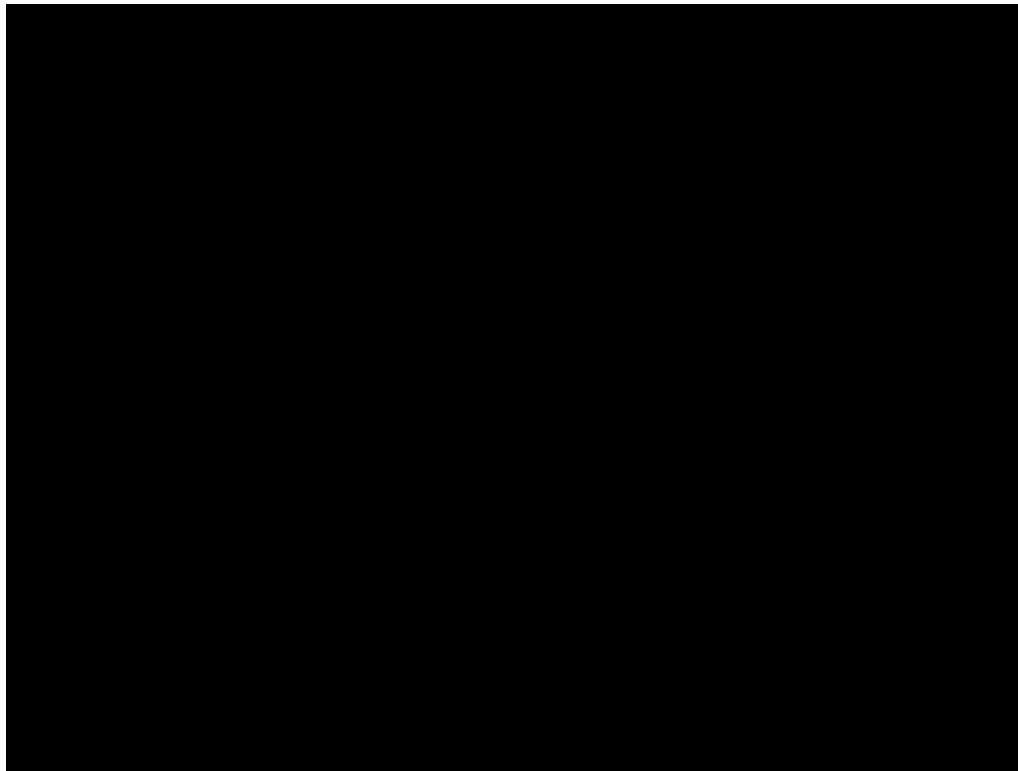
- **Specific Acts (^action slot)**
  - Accept
    - Manner (reluctant, eager)
  - Reject
    - ^reason (no-plan-instance,plan-conflict,goals-satisfied, blocked
  - Counterpropose
    - ^reason (worse-than, precluded)
    - ^counterproposal <act>
  - Redirect
    - Relevant-party <other>
  - Express
    - 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: $disparaged_1$ + $endorsed_2$
  - 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
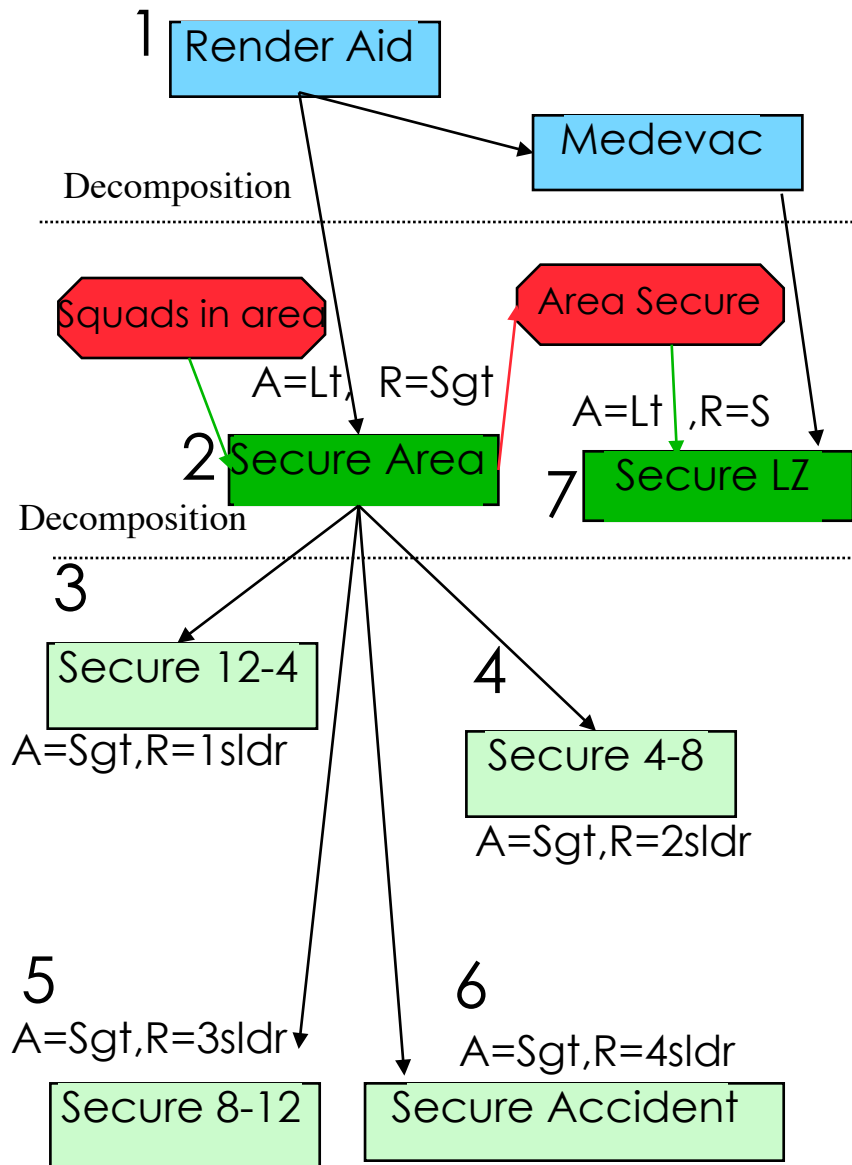 - Plan State: how do I feel about it

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MRE Team-Negotiation Example

Sgt's Negotiation Behavior

1 Render Aid

Medevac

Decomposition

Squads in area

Area Secure

A=Lt, R=Sgt

A=Lt ,R=S

2 Secure Area

7 Secure LZ

Decomposition

3 Secure 12-4

A=Sgt,R=1sldr

4 Secure 4-8

A=Sgt,R=2sldr

5

A=Sgt,R=3sldr

6

A=Sgt,R=4sldr

Secure 8-12

Secure Accident

Focus=1
Lt: U9 "secure a landing zone"
Committed(lt,7,sgt), 7 authorized, Obl(sgt,U9)
Sgt: U10 "first we should secure the assembly area"
Disparaged(sgt, 7,lt), endorsed(sgt,2.lt), grounded(U9)
Lt: U11"secure the area"
Committed(lt,2,sgt), 2 authorized, Obl(sgt,U11),grounded(U10)
Sgt: U12"yes sir"
Committed(sgt,2,lt), grounded(U11), Push(2,focus)
Goal7:Announce(2,{1sldr,2sldr,3sldr,4sldr})
Goal8: Start-conversation(sgt, ,{1sldr,2sldr,...},2)
    Goal8 -> Sgt: U21 "Squad leaders listen up!"
    Goal7 -> Sgt: U22 "I want 360 degree security"
    Committed(sgt,2,{1sldr,2sldr,3sldr,4sldr})
Push(3, focus)
    Goal9:authorize 3
    Goal9 -> Sgt:U23"1st squad take 12-4"
    Committed(sgt,3, {1sldr,2sldr,3sldr,4sldr}), 3 authorized
Pop(3), Push(4)
    Goal10: authorize 4
    Goal10 -> Sgt: U24"2nd squad take 4-8"
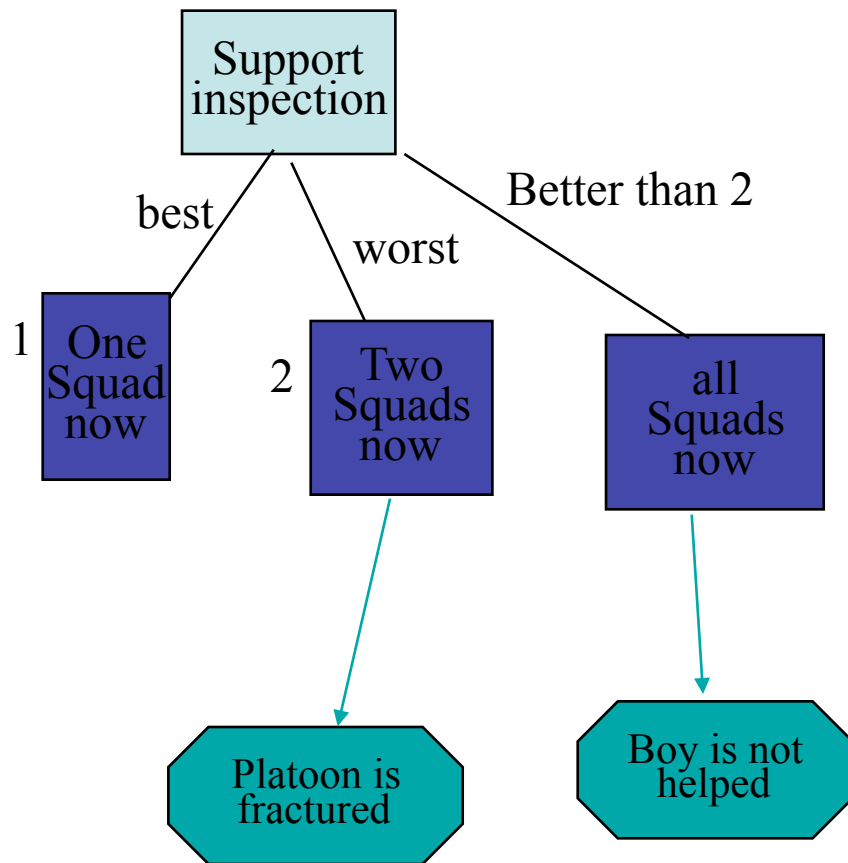   Committed(sgt,4,{1sldr,2sldr,3sldr,4sldr}), 4 authorized
Pop(4)
   ...
    A10: Squads move
    Grounded(U21-U26)
    ends conversation about 2, Happened(2)
Push(7,Focus)

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 reccomendation sir,...**

3' **Lt: Send fourth squad to Celic**
4' **Sgt: Yes sir**

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Elements of Dialogue Theory

- **Cooperation**

- **Obligation & Non-cooperative interaction**

- **Grounding**

- **Multiparty interaction**

- **Cooperative Negotiation**

- **Non-Cooperative Multiparty Non-Cooperative Negotiation**

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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

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Using Trust

- **accept assertions as truth (e.g., Perrault, Cohen & Allen)**

- **Negotiate in good faith**

- **Continue engagement**

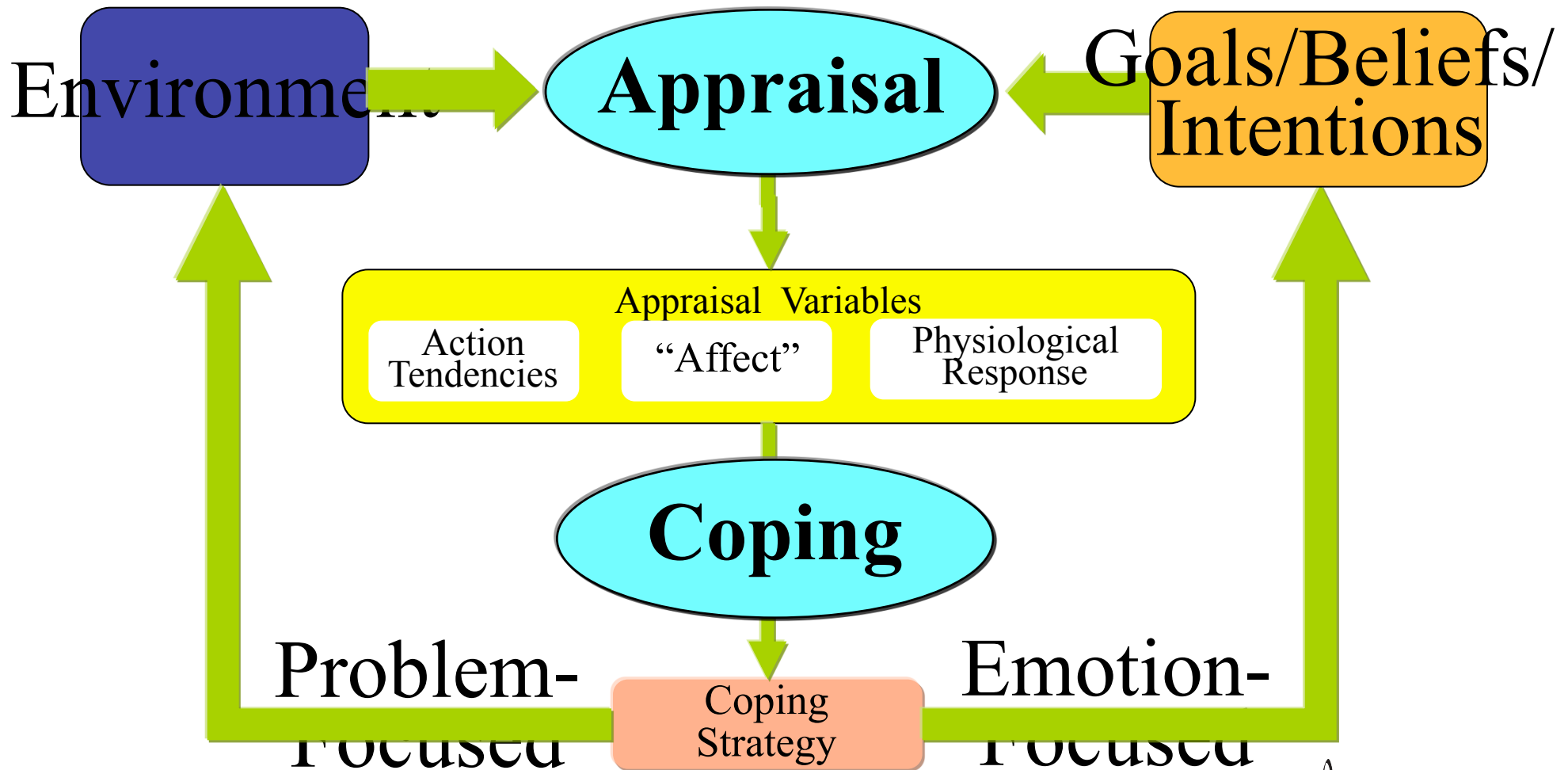- **Acceptance/Rejection of empathy (Martinovksi et al)**

Negotiation Strategies: Appraising the topic

	topic	Control	Utility	Potential	Trust	Commitment
Find issue	--				some	
Avoid		+	--		some	
Attack	+	--	--	--	some	
Negotiate	+	--	--	+	some	
Advocate	+		+		some	
Success	+				moderate	Mutual
Failure	+				Very low	Negative

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Theoretical Perspective on Emotion
(Marsella & Gratch, AAMAS 02, 03)
Smith and Lazarus '91 cognitive-motivational-emotive system

Environment

Appraisal

Goals/Beliefs/ Intentions

Appraisal Variables

Action Tendencies

"Affect"

Physiological Response

Coping

Problem-Focused

Coping Strategy

Emotion-Focused

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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

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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

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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

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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

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