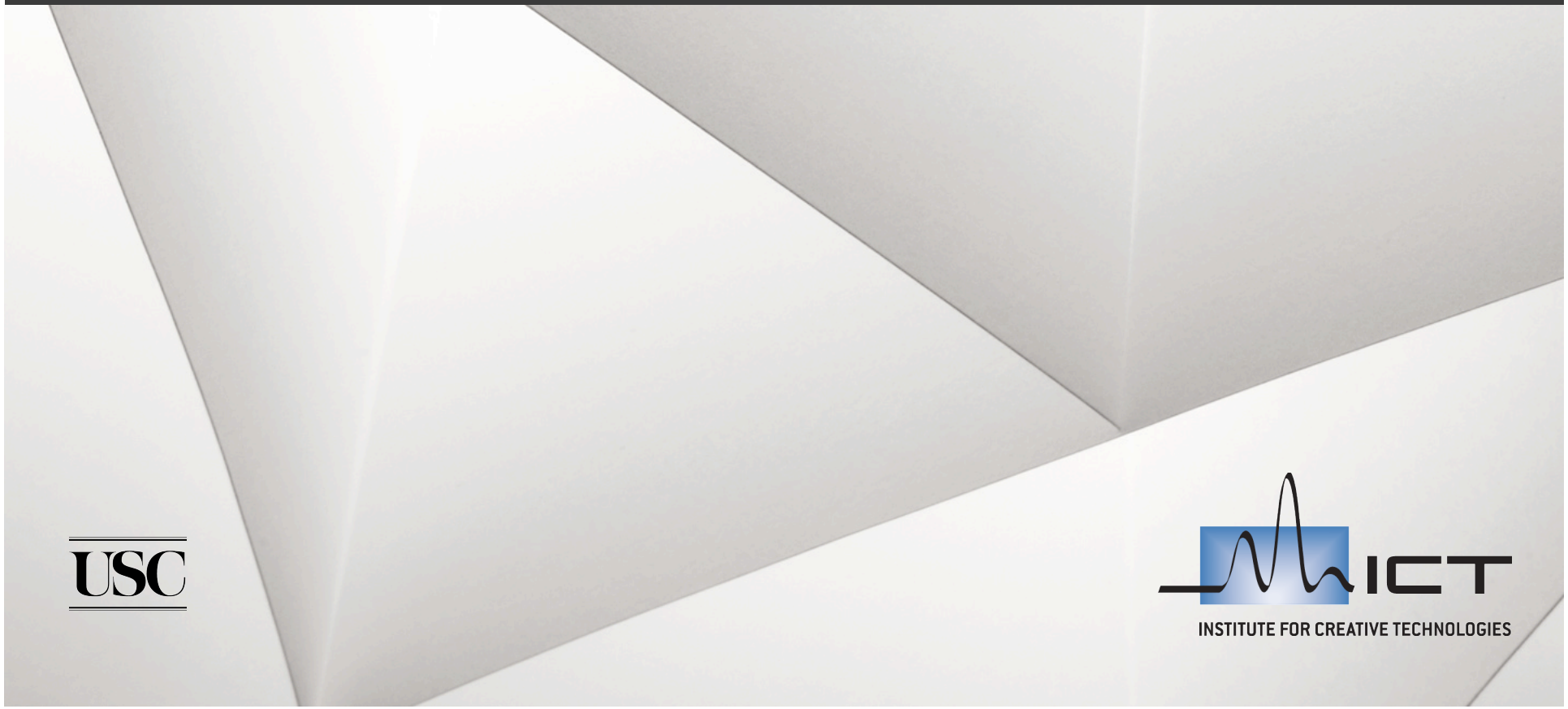
ICT Dialogue Manager Tutorial: Session 5: Implementation in Soar (II)



Outline

- **Review**
  - Soar basics
  - Dialogue Information State
  - Dialogue Processing Cycles
  - Code overview
- **Content and Dialogue Act Representations**
- **Stepping through the system**
- **Code viewing**
- **Q&A**

Implementation: SOAR (7.3)

- **Information state (Working Memory)**
- **Production rules**
  - Elaborate state rules
  - Operator Proposal rules
  - Operator application rules
- **Processing cycles**
  - Elaboration cycle
    - Invoke all rules that apply, change WM preferences
    - Calculate WM changes based on preference arbitration
  - Deliberation cycle
    - Choose operator
    - Input processing
    - Elaboration cycle+ (until no more rules apply)
    - Output processing

Example Elaboration Rule (inference.soar)

```
sp {top-ps*elaborate*task*belief*intend*true
   (state <s> ^problem-space.name top-ps
              ^agent-name <me>
              ^plan <task>)
   (<task> ^intend true
           ^responsibility <me>
           ^authorized yes)
   -->
   (<task> ^belief true)
}
```

Example Proposal Rule (nlu.soar)

```
sp {top-state*propose*operator*update-dialogue-state
  (state <s> ^name top-state
             ^speech-event-history <ss>)
  (<ss>    ^speech-input <si>)
  (<si> ^processed-by understand-speech
      -^processed-by update-dialogue-state)
  -->
  (<s> ^operator <o> + =)  ;# "indifferent" preference
  (<o> ^name update-dialogue-state
      ^speech-input <si>
      ^priority-class listen)
}
```

Example Operator Application Rule (nlu.soar)

```
sp {top-state*apply*operator*understand-speech*gesture-processed
 (state <s> ^name top-state
            ^operator <o>)
 (<o> ^name understand-speech
      ^speech-input <si>
      ^gesture <new>)
 (<si>     ^processed-by understand-speech)
 (<new> ^type gesture
        ^unprocessed yes)
 -->
 (<new> ^unprocessed yes -)
}
```

Main Aspects of Dialogue Context

- **Persistent State**
  - Social State
  - Lexicon
  - Ontology
  - Speech-event-history
- **Transient**
  - Conversation(s)
  - Social Planning
  - Participants
  - Task model
    - Causal-history, current-state
    - Plan,next-step
    - Task focus
  - Emotion Model
    - Emotional state
    - Coping strategies

Dialogue Processing Cycles

- **Dialogue Inference**
  - Elaborate-state rules
- **Language Interp Stages**
  - ASR: 4 message types (speech in, timing/text out)
  - NLU: semantic interpretation(s)
  - Perception: integrated un(der) interpreted speech
  - SOAR Understand Speech Operator
  - SOAR Update Dialogue State Operator
  - SOAR Coping Focus Operator
- **Language Production Stages**
  - Output Speech proposal (desire)
  - pre NLG Output Speech operator (intention)
    - NLG Sub-state Operators
  - ✦ External NLG
  - ✦ String look-up
  - XMLify/vrExpress call
  - NVBG
    - Beavin
  - SBM
  - TTS
    - Festival
  - GameEngine
  - Post-NLG message passing/ callbacks

Communication Paths

- **Language Interpretation**
  - ASR:
  - Message format (human messages):
  - vrSpeech start <id> <speaker>
  - vrSpeech interp <id> <interp-id> <conf> <intonation> <surface>
  - vrSpeech finished-speaking <id>
  - vrSpeech asr-complete <id>

Understand Speech Operator

- **Triggered by complete speech input event**
  - Human (ASR,NLU)
  - Agent (vrSpeech,vrNLU)
  - Self (autonomous “event” from generation)
- **Main Purposes:**
  - Adjust semantic interpretation using soar-internal context (task, language and situation specific)
  - Reference resolution (pick out acts, entities, concepts mentioned)
  - Detect uninterpretable or ambiguous/underspecified content
  - Recognize dialogue acts

Update Dialogue State Operator

- **Triggered by Interpreted Speech Input**
- **Purpose:**
  - Update context by calculating effects of dialogue acts

Example: Soar Update rule

```
sp {top-state*apply*operator*update-dialogue-state*csa*order
  (state <s> ^name top-state          ^operator <o>)
  (<o> ^name update-dialogue-state      ^speech-input <si>)
  (<si> ^speaker <speaker>       ^interpretation <i>)
  (<i> ^conversation <c>      ^speech-act <csa>)
  (<c> ^grounding <cgu>)
  (<cgu> ^dialogue-history <csa>)
  (<csa> ^action order       ^content <sem>       ^addressee <addr>)
   -->
  (<cgu>  ^obligation <obl> + &)
  (<obl>  ^type obligation              ^holder <addr>
          ^obligated-to <speaker>        ^deadline asap
          ^sanction order          ^action <sem>)
```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NLG Approach

- **Asynchronous Communicative Goal Proposal**
- **Selection of Goal**
- **Content planning**
- **Realization: Hybrid Approach**
  - External Generator (GNLG, RNLG, ANLG, DNLG)
  - Hand-crafted prompts
    - Rapid-prototyping
  - Selection of detailed sentences plans
    - Emotional impact, natural expression
  - Generic case frames
    - Broad domain coverage
  - Template generation (discussion of emotions)

Selecting Acts to Perform

- **Considerations:**
  - The turn
  - Obligations to ground
  - Obligations to repair
  - Degree of understanding of prior utterances
  - (potential) obligations to address info-request
  - Beliefs about true answers

Output Speech Operator

- **Triggered by (successful) desire to speak**
- **Main Purposes**
  - Deliberation over how to achieve communication goal
  - Content planning
    - Sentence planning
  - Realization
  - Selection
  - Produce speech & wait for callback

Example Output Speech Rule

```
sp {top-state*propose*operator*output-speech*accept-obligation-to-act
  (state <s> ^name top-state  ^agent-name <me>  ^conversation <c>
             ^social-planning <sp>)
  (<sp>  ^my-potential-obligation <obl>)
  (<obl> ^obligated-to <other>        ^action <a>
        ^dialogue-state needs-discussion   ^relevant-party <me>
        ^plan-state << good considered-good not-in-coa >>)
  (<c>  -^turn <other>        ^grounding <cgu1>
        ^participant <me>     ^participant <other>)
  (<cgu1> ^dialogue-history <order>)
  (<order> ^action << order request >>        ^actor <other>
         ^addressee <me>        ^content <a>)
   -->
  (<s> ^operator <o> + =)
  (<o> ^name output-speech     ^priority-class respond
      ^conversation <c>       ^goal <b>)
  (<b> ^action accept
      ^type backward
      ^addressee <other>
      ^speaker <me>
      ^content <order>)
}
```

Example Output Speech Rule: take initiative

```
sp {top-state*propose*operator*output-speech*take-initiative-agenda-no-strategy
      (state <s> ^name top-state          ^agent-name <me>
                 ^social-planning <sp>    ^conversation <c>
                 ^social-state <ss>       -^plan-status update-needed)
     -(<c> -^turn <me>     -^turn *none*)
      (<sp> ^agenda <ag>      ^take-initiative yes)
      (<ag> -^strategy.strategy << delay negative >>     ^next <item> )
  -->
    (<s> ^operator <o> + = <)
    (<o> ^name output-speech    ^priority-class advance-task   ^agenda
   <item>)}
```

Task Model: Basic Types

- **States**
  - Object-id
  - Attribute
  - Value
  - Polarity

  E.g.: :object-id boy :attribute health-status
  :value critical-injuries :polarity positive

- **Tasks**
  - Pre, Add , Delete (states)
  - Case roles (event, agent, patient, location, source, destination,instrument, path)
  - E.g.: secure-lz { :agent sgt :patient lz
    :event secure :instrument 3rd-sqd
    :pre {3rd-sqd-at-aa}
    :add {lz-secure lz-marked 3rd-sqd-at-lz}
    :del {3rd-sqd-at-aa}

Task Model: Plans

- **Task Model: Set of steps and relations**
- **Step**
  - Primitive or abstract
    - Subtasks, decomposition
  - Roles (for group task)
    - Responsibility
    - Authority
- **Links**
  - Ordering constraints
  - Causal links
  - Threat relations
- **Indirect action**
- **Partial Order Planning Algorithm**
  - **Updated as world changes**

Alternative Courses of Action

- **Hierarchical tasks representing mutually exclusive recipes**
- **Relevant vs intended**
  - All subtasks in COA marked
  - Alternative COAs not intended
- **No threat from elements of alternative COA**
- **Identification of salient positive and negative consequences (side effects)**
- **Preferences based on utility**
  - best, better than, worst

Proposition and Questions

- **Duran is in the landing zone.**
  - (P1 ^attribute location ^object-id 3s1 ^polarity positive ^time present ^type state ^value lz)
- **Is Duran in the landing zone?**
  - (Q1 ^q-slot polarity ^prop (P2 attribute location ^object-id 3s1 ^time present ^type state ^value lz) ^type question)
- **Where is Duran?**
  - (Q2 ^q-slot value ^prop (P3 attribute location ^object-id 3s1 ^polarity positive ^time present ^type state) ^type question)
- **Who is in the landing zone?**
  - (Q3 ^q-slot object-id ^prop (P4 attribute location ^polarity positive ^time present ^type state ^value lz) ^type question)

Dialogue Acts (1): Core Speech acts (CSA): Forward

- (A1 ^action info-req ^actor <speaker> ^addressee <adr>* ^content <Q> ^type csa)
- (A2 ^action assert ^actor <speaker> ^addressee <adr>* ^content <P> ^type csa)
- (A2 ^action order ^actor <speaker> ^addressee <adr>* ^content <P> ^type csa)
- (A2 ^action request ^actor <speaker> ^addressee <adr>* ^content <P> ^type csa)
- (A2 ^action thank ^actor <speaker> ^addressee <adr>* ^type csa)
- (A2 ^action greeting ^actor <speaker> ^addressee <adr>* ^type csa)
- (A2 ^action closing ^actor <speaker> ^addressee <adr>* ^type csa)

Dialogue Acts (2): Core Speech acts (CSA): Backward

- (A3 ^action answer ^actor <speaker> ^addressee <adr>* ^answer <CSA-or-param-or-obj> ^question <Q> ^type backward)
- (A3 ^action divert ^actor <speaker> ^addressee <adr>* ^response <CSA> ^question <Q> ^type backward)
- (A3 ^action accept ^actor <speaker> ^addressee <adr>* ^content <CSA> ?^style <param> ? ^manner <param> ^type backward)
- (A3 ^action hold ^actor <speaker> ^addressee <adr>* ^content <p-or-csa> ^style <param> ^type backward)
- (A3 ^action check ^actor <speaker> ^addressee <adr>* ^context <CSA>
- ^num-candidates <integer> ^type backward)
- (A3 ^action reject ^actor <speaker> ^addressee <adr>* ^content <CSA> ^reason <obj-or-param> ^type backward)
- (A3 ^action counterpropose ^actor <speaker> ^addressee <adr>* ^content <CSA> ^conversation <c> ^reason <param> ^counterproprosal <p> ^type backward)
- (A3 ^action express ^actor <speaker> ^addressee <adr>* ^content <CSA> ^express <param> ^act ?^role < role> ?^issue <param> ^type backward)
- (A3 ^action redirect ^actor <speaker> ^addressee <adr>* ^content <CSA> ^relevant-party <agent> ^type backward)
- (A4 ^action clarify-parameter ^cand <cand>* ^context <SA> ^num-candidates <integer> ^parameter <slot> ^candidate <val>* ^type backward)

Dialogue Acts (3): Grounding

- **Grounding**
  - (A8 ^type initiate ^actor <speaker> ^cgu <cgu> ^content <SA>* ^conversation <CON>*)
  - (A8 ^type continue ^actor <speaker> ^cgu <cgu> ^content <SA>* ^conversation <CON>*)
  - (A7 ^type acknowledge ^actor <speaker> ^cgu <cgu> ^content <SA>* ^conversation <CON>)
  - (A5 ^type repair ^actor <speaker> ^cgu <cgu> ^content <SA>* ^context <SA2>* ^conversation <CON> ^parameter <slot> ^value <filler> ?^confirm <sa3> ?^remove <sa4>)
  - (A6 ^type request-repair ^actor <speaker> ^cgu <cgu> ^content <SA2>* ^conversation <CON>)
  - (A7 ^type cancel ^actor <speaker> ^cgu <cgu> ^conversation <CON>)

Dialogue Acts (4): Conversation and Turn-taking

- **Conversation**
  - (A8 ^action start-conversation ^speaker <speaker> ^addressee <addr> ^mode <param> ^conversation <CON>*)
  - (A8 ^type confirm-start ^actor <speaker> ^conversation <CON>*)
  - (A8 ^type deny-start ^actor <speaker> ^conversation <CON>*)
  - (A8 ^type identify-topic ^actor <speaker> ^conversation <CON>* ^addressee <addr> ^topic <param>)
  - (see also closing in forward acts)
- **Turn-taking**
  - (A8 ^type take-turn ^actor <speaker> ^conversation <CON>*)
  - (A8 ^type hold-turn ^actor <speaker> ^conversation <CON>*)
  - (A7 ^type assign-turn ^actor <speaker> ^assignee <agent> ^conversation <CON>)
  - (A5 ^type release-turn ^actor <speaker> ^conversation <CON>)
  - (A6 ^type request-repair ^actor <speaker> ^cgu <cgu> ^content <SA2>* ^conversation <CON>)
  - (A7 ^type cancel ^actor <speaker> ^cgu <cgu> ^conversation <CON>)

Team 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

Dialogue Code Files Overview: Austin/DIALOGUE.config

- **coresteve**
  - General Dialogue
    - dialog-init.soar
    - inference.soar
  - Understanding & update
    - nlu.soar
    - reference.soar,
    - ref-candidate.soar
    - Expectations.soar
    - feedback.soar
  - Generation
    - nlg.soar
    - output-strings.soar
    - Initiative.soar
    - test-nlg.soar
  - Conversations and Dialogue acts (understand and update)
    - conversation.soar (also nlg)
    - csas.soar
    - grounding.soar
    - turn-taking.soar
    - negotiation.soar
- **Saso-EN-doctor-perez**
  - Domain-specific
    - Saso-en-dialogue.soar
    - Lexicon.soar
    - Saso-en-output-strings{-negative/positive}.soar

Dialogue Code Files (1) Overview: Austin/DIALOGUE.config

- **coresteve**
  - dialog-init.soar (general initializations)
    - Ontology object, social-state object, social-planning, speech-event history, nlp-flags, things-i-said
  - reference.soar, ref-candidate.soar
    - perform (task-related) reference resolution
  - inference.soar
    - (general inference rules,e.g. relating location of group to individual)
  - csas.soar
  - grounding.soar
  - turn-taking.soar
  - negotiation.soar
    - Collaborative negotiation

Reference Resolution

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