Natural Language Generation

Generating Referring Expressions

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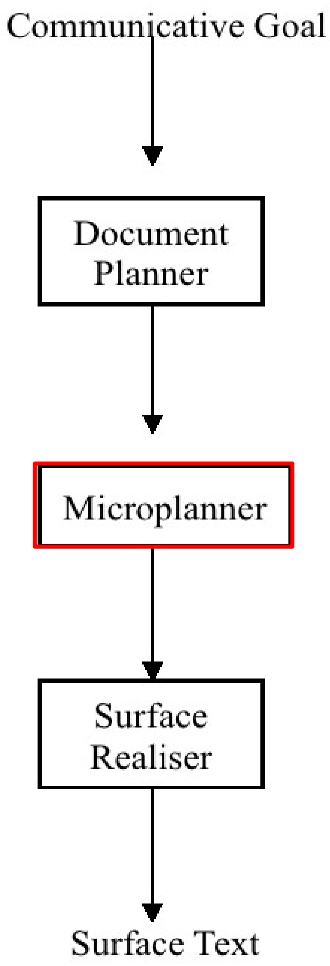
Microplanning



[Reiter and Dale, 2000]

Two-stage model of a NLG system

- **Document Planner** - *what to say*

  text content and structure

- **Surface Realizer** - *how to say it*

  sentence-level syntax and morphology

Microplanner: fine-grained decisions

- **Lexicalisation** – particular words, syntactic constructs
- **Aggregation** – distribution of messages across sentences (order, length, number of sentences)
- **Referring Expression Generation (REG/GRE)** – phrases to use to identify particular domain entities

REG/GRE Problem

(Dale, Reiter 1995)

Domain of objects

D = { d1, d2, d3 }

Attributes

A = { type, gender, shape, clothing, position,...}

Goal: find attribute-value pairs (**property**), so that the conjunction is true of the target but not of any of the other domain objects

d_1 d_2 d_3

Can you describe d1?

As a normal sentence? As a set of attribute-value pairs?

REG/GRE Problem

(Dale, Reiter 1995)

Domain of objects

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Attributes

A = { type, gender, shape, clothing, position,...}

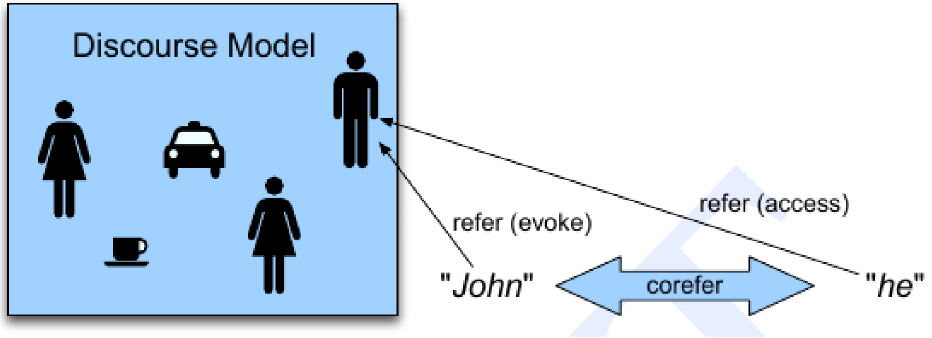
Goal: find attribute-value pairs (**property**), so that the conjunction is true of the target but not of any of the other domain objects

d_1 d_2 d_3

1. *{<gender, man>, <clothing, wearing suit>}*
2. *{<gender, man>, <position, left>}*
3. *{<gender, man>, <clothing, wearing suit>,<position, left>}*

Reference Resolution

- What entity is being referred to?
  - one **referent**
  - multiple **distractors**
- referring expression



- paradigm: distinguishing description = „definite description whose primary purpose it is to identify the referent and rule out distractors"

- **Coreference resolution** - linking expressions that refer to the same entity

  {Victoria Chen, Chief Financial Officer of Megabucks Banking Corp since 1994, her, the 37-year-old, the Denver-based financial-services company's president, She}

- **Pronominal anaphora resolution** - finding the antecedent for a pronoun

  It has been ten years since *she* came to Megabucks.

Incremental Algorithm

- most influential basic algorithm (1995)
- „preference“ for attributes (fixed order) → based on experimental data
- polynomial complexity

`r` referent
`D` domain
`Pref` list of ordered attributes

referring expression

list of open distractors

IncrementalAlgorithm $(\{r\}, D, \mathit{Pref})\{$
$L \leftarrow \emptyset$
$C \leftarrow D - \{r\}$
for each A_i in list Pref **do**
    $V = \mathsf{Value}(r, A_i)$
    if $C \cap \mathsf{RulesOut}(\langle A_i, V \rangle) \neq \emptyset$
    then $L \leftarrow L \cup \{\langle A_i, V \rangle\}$
        $C \leftarrow C - \mathsf{RulesOut}(\langle A_i, V \rangle)$
    endif
    if $C = \emptyset$
    then return L
    endif
return failure $\}$

`RulesOut(<.,.>)` returns the set of objects which have a different value for that attribute than the referent

Too simple?

Which simplifications are made to the REG task?

What limitations does the IA have? Why is the IA not suitable for interactive tasks and dialogue systems?

- produces reference to a single referent (no sets of objects)
- predefined simple attributes
- no backtracking if a better description is found, includes redundant properties (is this a problem?)
- Closed World Assumption
- no vague property descriptions (height = large vs. height = 180cm)
- no relations between objects *„The girl left to the woman in the dress.“*
- objects are assumed to be equally salient
- no multimodal reference (intonation, gaze, gestures)

Dialogue Systems

Produce human-like referring expressions

- Simplicity is not everything
  - negations, relations, quantifiers
- Complex content does not require a complex form
  - break down information into smaller chunks over dialogue turns
- Overspecification
  - humans tend to overspecify
- Favorize fixed attributes (colour) over relative attributes (size)
- Include different modalities
  - spatial visual context, movement

Taking the adressee into account (adressee modelling)

- Lexical Entrainment (Alignment)
  - adapt to the dialogue partners' preferences and to the domain setting
  - frequency gives information about preference → requires data
  - dialogue history
- Account for differing domain views

Referability

1. Form of reference (deictic pronoun "*that one*" or full description "*the chair with the armrests*")
2. Attribute Selection
3. Surface Realization

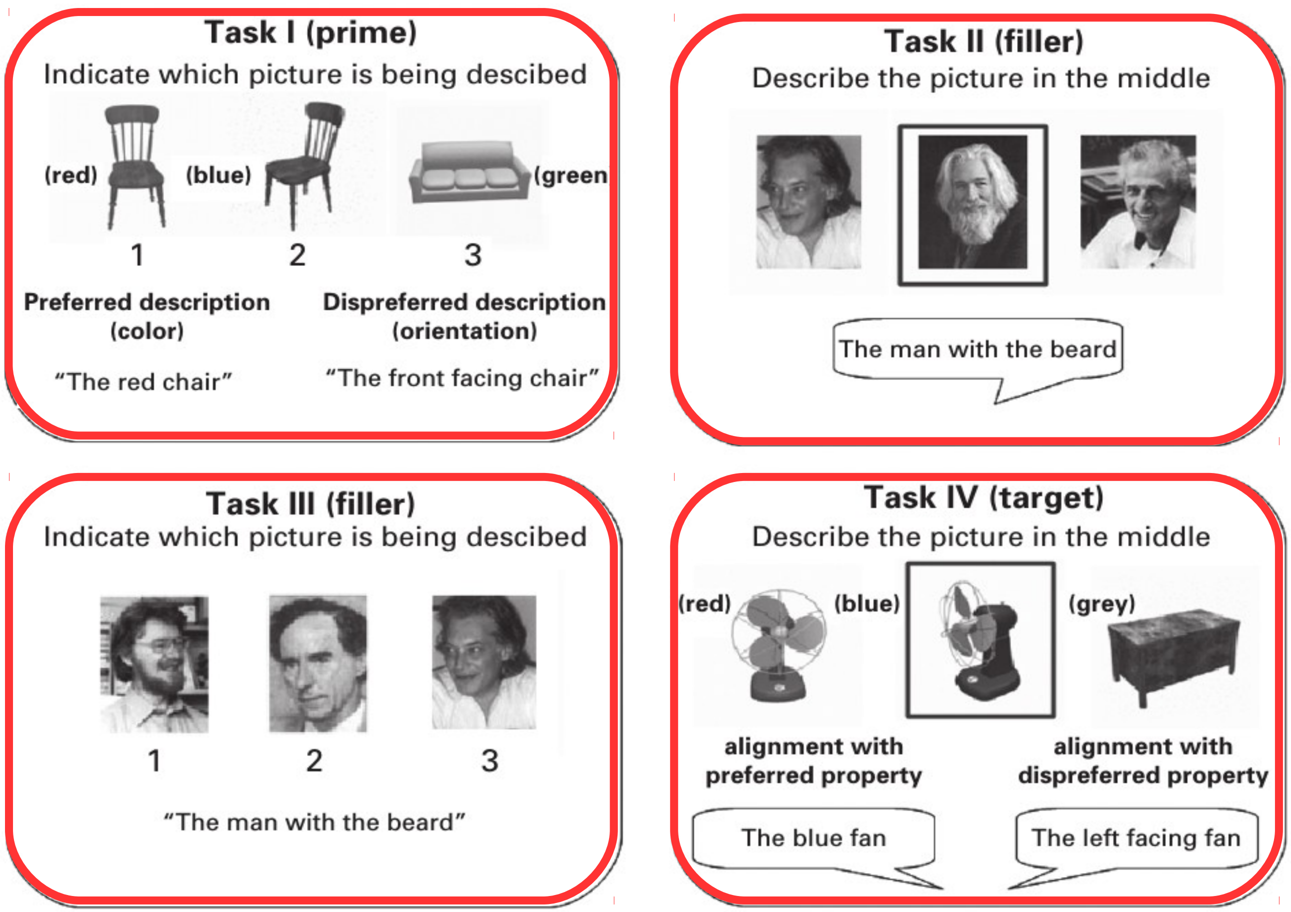
Experiments: How do people refer to objects?

- TUNA Corpus
  - Furniture Domain colour
  - People Domain wearing glasses
- Experiments on Adaption and Interaction in Interactive Setting
  - Inherent preferences for certain properties in a given domain
  - Tendency to adapt to references produced by the dialogue partner

Experiment I

how adaption influences attribute selection
preferred vs. dispreferred

find referent



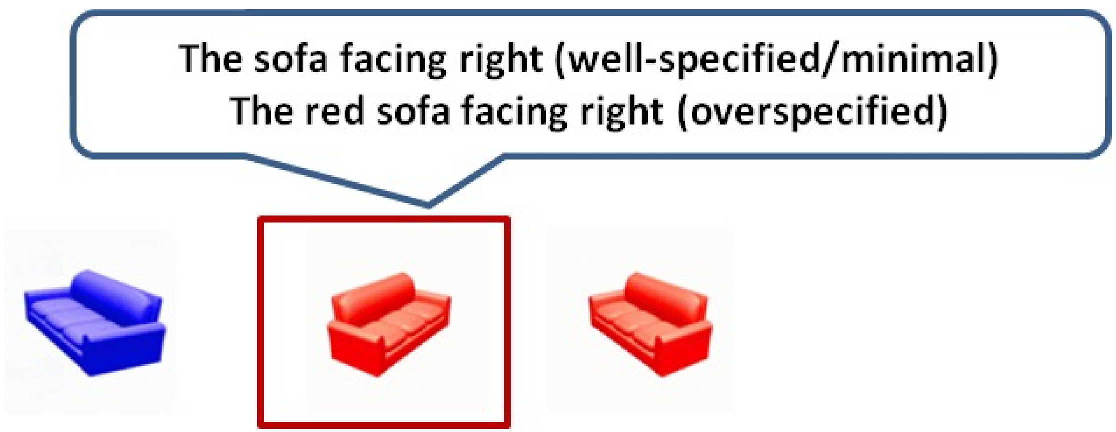
create referring expression

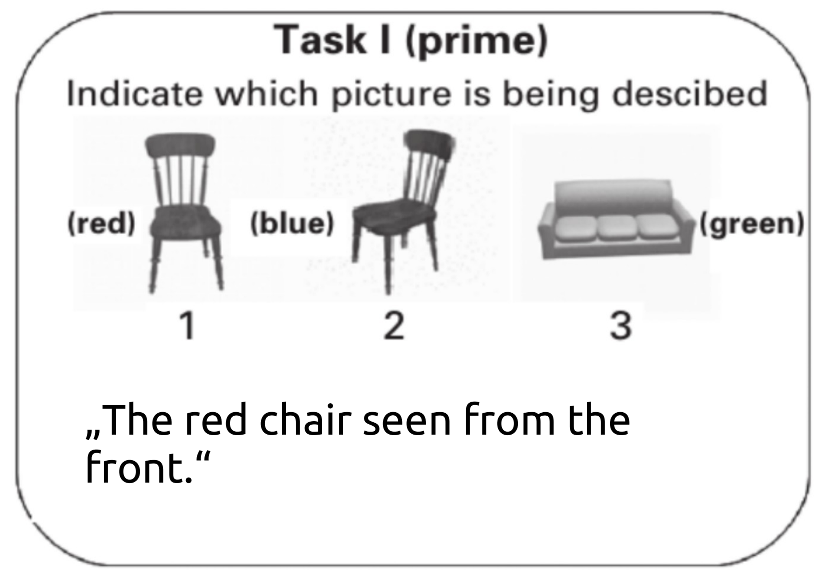
Results: preferred attributes used more often, dispreferred attributes used significantly more if primed, more alignment in the furniture domain

Experiment II

priming of overspecification

- overspecified referring expressions in the prime turn
  - two attributes in addition to the type attribute
  - one preferred and one dispreferred
  - both sufficient to uniquely describe the referent



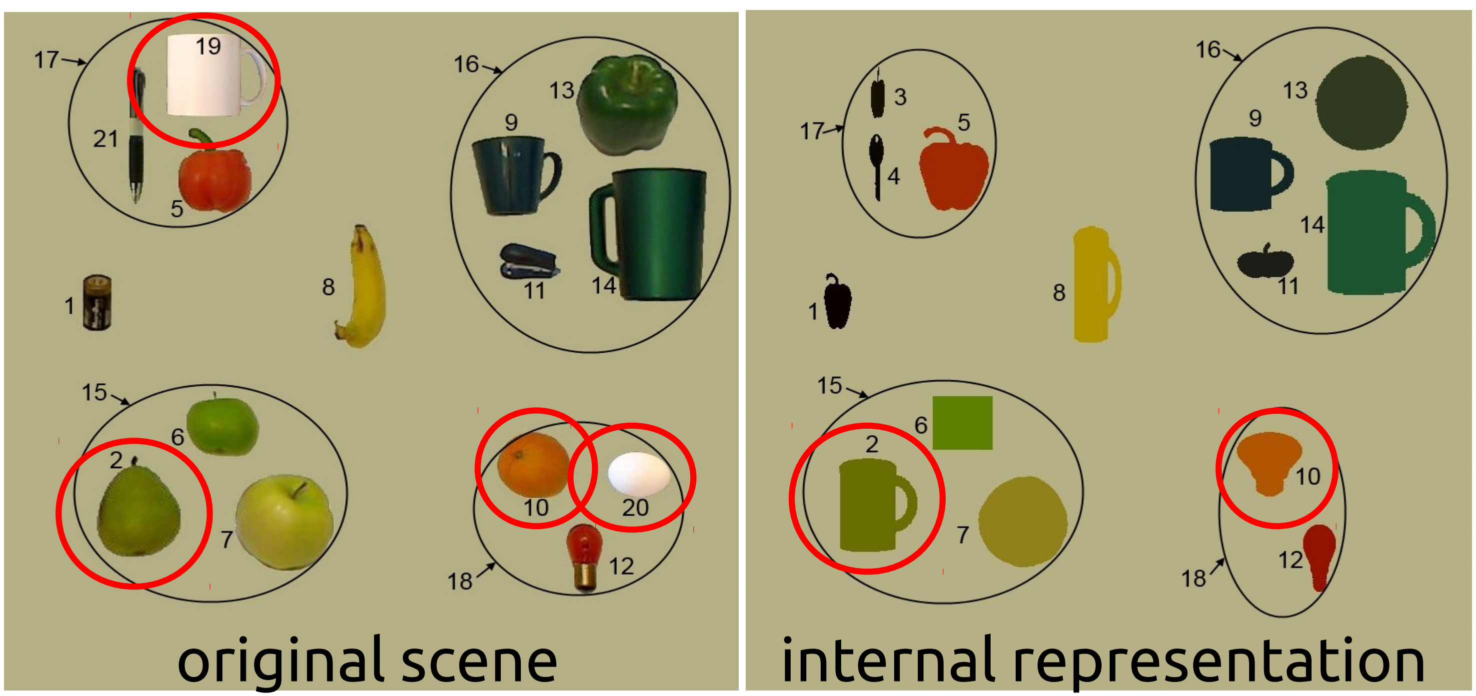


Results: over 50% chose overspecification after being primed
(compared to 10% of overspecifications in Experiment I)

Collaborative Models in Situated Dialogue

[Fang et al., 2014]

- assumption: perceptual basis between human and agent (dialogue system) differs
- generate multiple small expressions that gradually lead to the target object
- reinforcement learning through human feedback

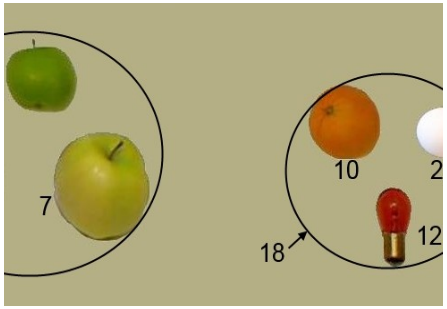


Collaborative Models in Situated Dialogue

[Fang et al., 2014]

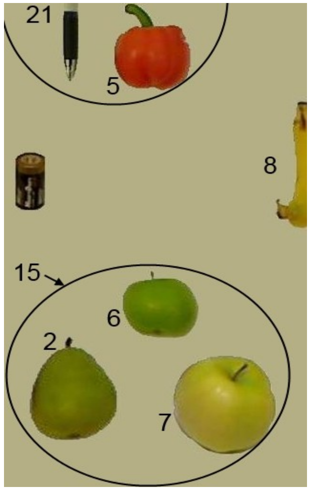
- **Episodic description**
  - sequence of smaller noun phrases that lead to the target

A: below the orange, next to the apple, it's the red bulb.



- **Installment description**
  - waits for explicit feedback from the partner
  - iterative process

A: under the pepper we just talked about.
B: yes.
A: there is a group of three objects.
B: OK.
A: there is a yellow object on the right within the group.



Collaborative Models in Situated Dialogue

[Fang et al., 2014]

- **Episodic model**
  - Branch-and-Bound & Graph Search → find path to the target with the lowest cost
  - nodes = objects + concatenation of describing attributes (type, color, type with color, etc.) and their preference cost
- **Installment model**
  - landmark object („current“ object confirmed by user)

<u>Action:</u> Object + RE + SP
RE = generation strategy (describes type, color, size, group)
SP = spacial location wrt. the landmark

<u>Transition Function:</u> updates landmark

<u>Reward:</u> 100 is target is reached and identified, 10 for correct intermediate steps, -1 else

Adapting to User Knowledge in Spoken Dialogue Systems

[Janarthanam, Lemon, 2010]

- reinforcement learning framework (hierarchical SARSA)
- technical support dialogue → set up home broadband connection
- learn to chose the appropriate referring expressions based on user's domain expertise

Jargon: Please plug one end of the `broadband cable` into the `broadband filter`.
Descriptive: Please plug one end of the `thin white cable with grey ends` into the `small white box`.

Adapting to User Knowledge in Spoken Dialogue Systems

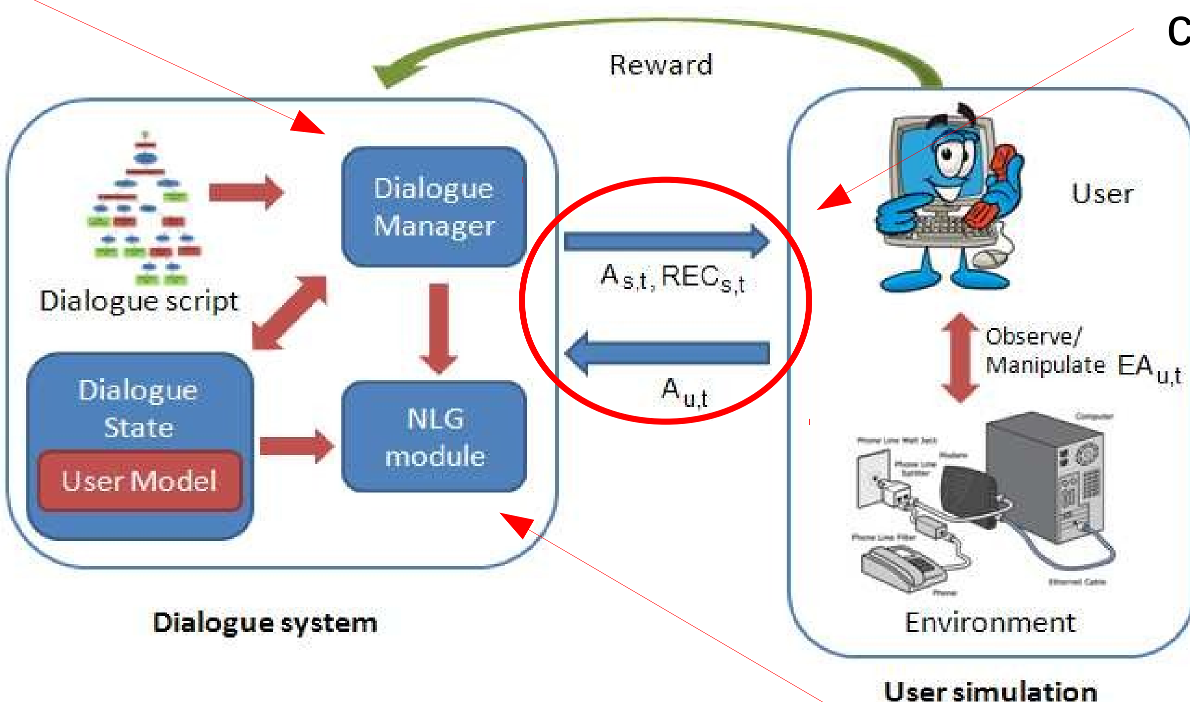
[Janarthanam, Lemon, 2010]

instruction based on
dialogue management policy

observation

manipulation

action and
referring expression
choices (REC)



initial domain knowledge

jargon referring expression x

`user_knows_x = yes/no/not_sure`

REG module

Jargon

Descriptive

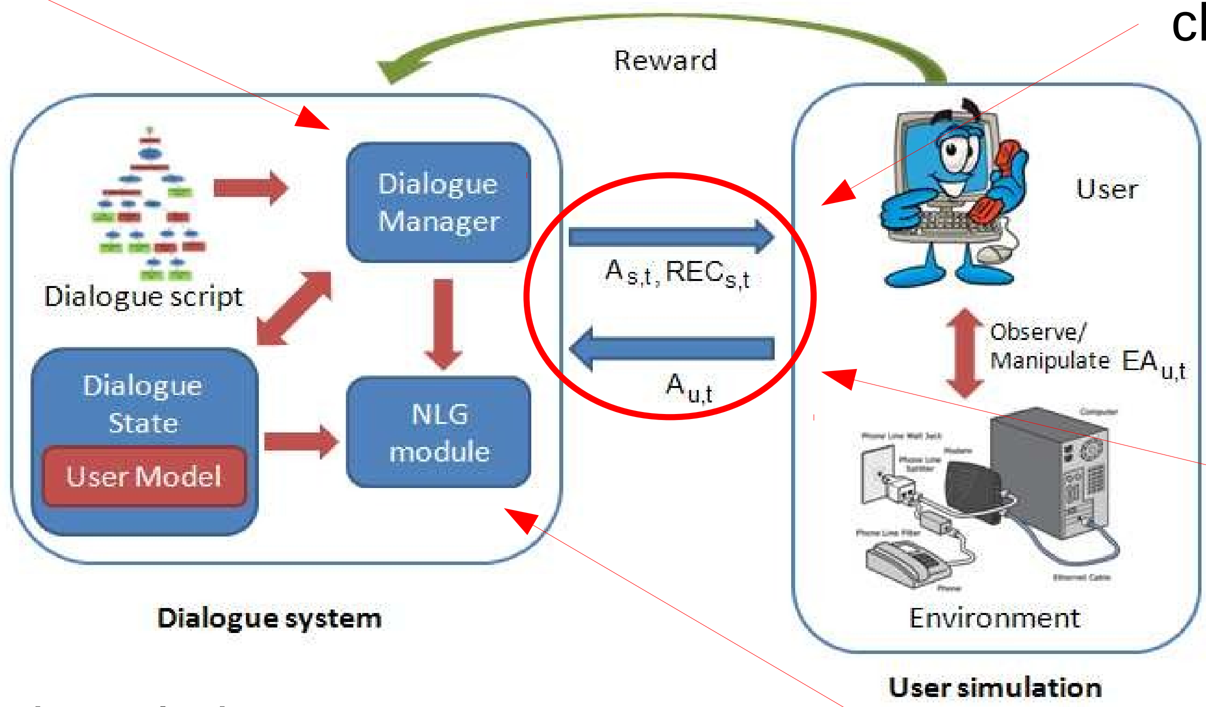
Adapting to User Knowledge in Spoken Dialogue Systems

[Janarthanam, Lemon, 2010]

instruction based on dialogue management policy

$$AA = \frac{1}{r} \sum_r \frac{|appropriate\ expr(r)|}{|instances(r)|}$$

action and referring expression choices (REC)



clarification request

instruction response

initial domain knowledge

users' domain knowledge updated dynamically

REG module

REG policy: User Model → REC

Conclusion

- generate a referring expression
- Incremental Algorithm is too restricted
- attributes and overspecification can be primed
- Dialogue Systems need to produce
  - human-like referring expressions
  - a model of the dialogue partner
- Applications:
  - collaborative models
  - adapt to user-knowledge

References

Books

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General

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Application

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