

On Grounded Language Generation in Intelligent Agents

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Outline

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Introduction

- Intelligent behavior
 - problem solving, navigation, perception, learning
- Grounded Language
 - Words, sentences depend on agents processing, perceptions, belief, intentions
- Motivation
 - Human collaboration in domains like search-and-rescue
 - Learning with Instruction



Soar

- Architecture
 - Rule based production system for agent design
 - Preconditions, application
 - Inspired by functional components of the human intelligence
 - Semantic Memory, Episodic Memory, Working Memory, Reinforcement Learning
 - Used in past to design robust, intelligent agents for many domains
- Agents
 - Very similar to planning agents
 - State - Action (Operators in Soar) - State
 - Episodic Store: store all state-action pairs

SimpleNLG

- Simple Java API for lexicalization, realization
- System includes
 - Lexicon/morphology system
 - Realiser
 - Microplanning (simple aggregation)
- Available here - <http://www.csd.abdn.ac.uk/~ereiter/simplenlg/> at University of Aberdine, UK

Generating Language

- Typical language generation problem has two logically distinguishable parts
 - *Tactical Generation*: making appropriate linguistic choices given semantic information
 - Soar's production memory, perceptions
 - *Realization*: building a syntactic representation, morphological transformation, linearization
 - SimpleNLG

Grammar

S → NP VP

NP → (DET) (ADJP) Noun

ADJP → (PRE-MOD)* Adjective (POST-MOD)*

VP → (ADVP) Verb (COMPLEMENT)
(INDIRECT-OBJECT) (PP-PHRASE)

COMPLEMENT → NP

INDIRECT-OBJECT → NP

PP-PHRASE → preposition NP

ADVP → (PRE-MOD)* Adverb (POST-MOD)*

- Combining NP with conjunctions
- Combining clauses with co-ordinate/subordinate conjunctions
- Converting a clause/sentence into wh-questions/yes-no question

Examples

1. The dog chased George.
2. The dog will not chase George.
3. Will the dog chase George?
4. (How/why/when) will the dog chase George?
5. A cat and the dog chased Mary and George.
6. The cruel dog chased George.
7. The very cruel dog chased George.
8. The cruel dog chased George in the park.
9. George quickly ran.
10. The dog chased George and George quickly ran.
11. George quickly ran, because the dog chased George.

Conceptual Knowledge and Language

- Ace Framework (Paul S. Jacob, 1987)
- Language provides information about semantic concepts
 - Concept of *transaction* will involve a *giver* and a *givee*
 - *selling* is a kind of a transaction
 - The word *sell* is indicative of the concept *transaction* and has corresponding subject and verbs.
 - Relationship is many-to-many
 - Hierarchical structures
- Leads to a unified theory of semantic and lexical knowledge

State, Action and Language

- State: objects and predicates that represent the relationship between objects

`ontop(A,B), ontop(C,table),
ontop(B,table),
isclear(A), isclear(C)`

- Action: causes a change in the predicates

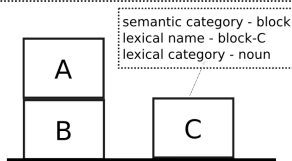
`move(A,C)`

- similar predicates/actions will share similar linguistic structure

- difference arises due to objects in the instantiation of a predicate

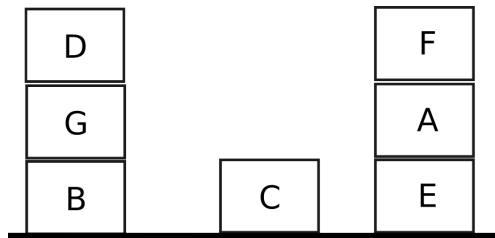
`ontop(<x>,<y>) -lexical equivalent-> <x> is on <y>`

conceptual - `ontop(x,y)` where x and y are blocks
lexical - verb is, requires subject x and pp-complement "on y"



Scene Description in Blocks World

F-block is on A-block,
G-block is on B-block,
C-block is on table,
B-block is on table,
E-block is on table,
A-block is on E-block,
D-block is on G-block,
F-block is clear and
D-block is clear.



Commentary in Missionaries and Cannibals

Agent : There were 3 missionaries and 3 cannibals on the left-bank and there were 0 missionaries and 0 cannibals on the right-bank.
Agent : I moved 2 missionaries from the left-bank to the right-bank.



Limitations

- Not coherent

F-block is on A-block, G-block is on B-block,
C-block is on table, B-block is on table,
E-block is on table, A-block is on E-block,
D-block is on G-block, F-block is clear and
D-block is clear.

- Not fluid because lacks knowledge that similar predicates can be grouped together

- Incomplete grammar

There were a missionary and 3 cannibals on the left-bank
and there were 2 missionaries and 0 cannibals on
the right-bank.

- Learning, categorization

Conclusions

- Asserted that natural language can be used to convey information about the state/beliefs/intentions/perceptions of the agent
 - might be useful for the human indicating with the agent
- Proposed a method to generate language about the activities of an agent
 - lexical knowledge stored is consistent with conceptual knowledge/perceptions about the environment.
- SimpleNLG is good.

Future Work

- Selective information - what to communicate
 - internal state of the agent
 - shared environment with the human/agent
- Explanation - why I did a particular action
- Categorization, inheritance of the lexical characteristics