Basics of Fluid Construction Grammar

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Tutorial on Fluid Construction Grammar
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What do you want to know about FCG?

Everything

Are you crazy?

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Issue (1): The world does not become nicely segmented and labeled

Issue (2): Not all meaning is expressed explicitly

Semiotic cycle
Representing meaning:
**predicate calculus (first order)**

- Objects (table, Paul, paper, towel)
  - $\rightarrow$ symbols
  - e.g. $O_1$, $O_2$, ..., $O_n$
- Predication = fact about certain objects
- Using properties (wooden, paper, small)
  - $\rightarrow$ Unary predicates: $p(o)$
  - e.g. wooden($O_1$), paper($O_2$), small($O_2$), table($O_1$)
- Using relations (on, moves)
  - $\rightarrow$ N-ary predicates: $p(o_1,o_2,...)$
  - e.g. on($O_1$, $O_2$), moves-away-from($O_1$, $O_2$)

**Representing meaning:**
**predicate calculus (second order)**

Properties and relations can be objects as well
- Examples of properties:
  - wooden($P_1$, $O_1$), paper($P_2$, $O_2$),
  - small($P_3$, $O_2$), table($P_4$, $O_1$)
- Examples of relations:
  - on($R_1$, $O_1$, $O_2$),
  - moves-away-from($R_2$, $O_1$, $O_2$)
- Intensional relations:
  - Believes ($R_3$, $P$, $R_2$)
Representing meaning: prefix list-notation
Predication is written as a list without comma’s
First element is always the predicate
(wooden P-1 O-1) ; wooden(p-1, o-1)
(paper P-2 O-2) ; paper(p-2, o-2)
(on R-1 O-1 O-2) ; on(r-1,o-1,o-2)
(moves-away-from O-1 O-2)

Representing meaning: typed predicate calculus
Predicate is decomposed into type (attribute) and value
(material wooden P-1 O-1)
(physobj table P-2 O-1)
(spatial on R-1 O-1 O-2)
(moving away R-2 O-1 O-2)

Representing meaning: explicit arguments
Arguments are themselves represented as predicates
(spatial-relation on R-1)
(on-arg1 R-1 O-1)
(on-arg2 R-1 O-2)
(moving away R-2)
(mover-moving-away R-2 O-1)
(moving-away-from R-2 O-2)

Representing meaning: graphical notation
Nodes in the graph are predicates
Links between arguments: if there is a co-reference relation

12/06/15
Exercise

Try to represent:

1. (the) ball on (the) block

2. (the) ball on (the) block on (the) table

Semiotic cycle
The wooden table seen by Paul. The table the paper towel is on. Paul sees that the paper towel is on the table ...

**Lexicon lookup speaker**

Representing meaning:

variables

Variables are written as symbols with question-mark:

?table-1, ?O-2, ?X, ?on-relation-5, ...
Interpretation

Compare meaning derived from words against situation model derived from perception using UNIFICATION

MATCH: Variables get bound in a matching process
Variables can be bound to other variables
BINDING-LIST: associations between variables and their bindings {(v1 . O1) (v2 . ?table-1) ...}

Interpretation

(material paper ?o4) => (material paper o1)
((?o4 . o1))

(size small ?o6) => (size small o1)
((?o4 . o1) (?o6 . o1))

?o4 and ?o6 are co-referential
Exercise: construct binding-list

```
(\textcircled{o-1} \ . \ o-1)
(\textcircled{o-2} \ . \ o-2)
(\textcircled{o-3} \ . \ o-3)
(\textcircled{o-4} \ . \ o-1)
(\textcircled{o-5} \ . \ o-2)
(\textcircled{o-6} \ . \ o-1)
(\textcircled{o-7} \ . \ o-2)
(\textcircled{o-8} \ . \ o-1)
)
```

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**Basic assumptions**

**Bi-directional mapping**

```
meaning \leftrightarrow form
```
(1) Grammar is meaningful

- Grammar provides cues on how the meaning of individual words combine
  - what co-referential links exist between the arguments
- Grammar may also provide additional meaning
  - “The wind blew the small paper towel off the wooden table”
  - X blows Y off Z
  - X action-on Y cause-state Z

(2) Grammar works through intermediary of syntactic and semantic categorizations

- Lexical categories (noun, adjective, adverb...)
- Phrasal categories (noun phrase, verb phrase, ...)
- Functional categories (subject, modifier, ...)
- Agreement features (number, gender, ....)
- Case (nominative, accusative, dative, ...)
- Information structure (topic, comment)
- Tense, aspect, mood, modality ....
- Sem-cats: Phys object, animate/inanimate, ...
- Semantic roles (agent, patient, recipient ...) ...
(3) Mappings are organized as constructions
A construction is a usage pattern associating meaning and form through the intermediary of syntactic and semantic categorizations

- Lexical constructions (words, morphemes)
- Grammatical constructions
- Constructome = set of all constructions

(4) Constructions are computationally ‘real’
A construction schema is a data structure representing information relevant for a particular construction:

- meaning + form
- syntactic + semantic categorizations

We call it also a construction for short

Contrast
In a minimalist approach to grammar, "the notion of grammatical construction is eliminated, and with it, the construction-particular rules. Constructions such as verb phrase, relative clause, and passive remain only as taxonomic artifacts, collections of phenomena explained through the interaction of the principles of UG (Universal Grammar), with the values of the parameters fixed." (Chomsky, 1993:4)
(5) Language processing = problem solving process

- Speaker starts from meaning to be expressed and builds utterance
- Hearer starts from utterance and reconstructs the meaning
- On the way they both construct a variety of syntactic and semantic structures

Problem solving

- Initial state
- Goal state
- Operators transforming states
- Search organization (e.g. Depth first)

Fluid Construction Grammar

1. How to represent the current state of processing a particular utterance?
   - > transient structures
2. How to represent a construction?
   - > construction schemas
3. What is the basic machinery for applying constructions?
   - > match+merge
4. How can the application process be organized?
   - > heuristic depth-first search

Construction grammar cuts the pie in vertical slices (as opposed to horizontal ones)
Feature structures: units

- Semantic pole: groups everything related to meaning
  - Meaning (= set of predications)
  - Referent
  - Semantic categorizations
- Syntactic pole: groups everything related to form
  - Form (= set of predications)
  - Syntactic Categorizations

Poles

Set of units relevant for parsing/producing a particular utterance

Transient structure (ts)

Represent information at any level of linguistic structure (pragmatics, semantics, syntax, morphology, phonology, phonetics, prosody, gestural)
Lock and key model

Construction (schemas)

- Lock + Key model
  - Lock = specifies what has to be there
    - Production lock
    - Comprehension lock
  - Key = transient structure

[1] NP \rightarrow \text{art} \text{ noun}
[2] \text{art} \rightarrow \text{the}
[3] \text{noun} \rightarrow \text{girl}

NP \vdash \text{art} \text{ noun} \vdash \text{“the” noun} \vdash \text{“the girl”}

“the girl” \vdash \text{art} “girl” \vdash \text{art noun} \dashv \text{NP}
More info on the right hand side

```plaintext
shell
form: {string(the-unit-1, "the"),
string(girl-unit-1, "girl"),
meets(the-unit-1, girl-unit-1)}

shell
referent: obj-6
predicates:
(male-person(obj-17),
bake(obj-6),
baker(obj-6, obj-17),
baked(obj-6, obj-16))
```
Constructions in FCG

Bottom-up production
Construction application

Further references


http://www.fcg-net.org/