Constituent structure and structural ambiguity

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Outline

- Intuitions and tests for constituent structure
- Representing constituent structures
  - Continuous constituents
  - Discontinuous constituents
  - Types of traces
- Structural ambiguity resolution
  - PP attachment
  - Human and computer perspectives
Some words belong together

- Did [the dog] the children like chase the cat?
- Did the [dog the] children like chase the cat?
Do we have evidence for that?

- Did the dog chase the cat?
- Did she chase him?
- Did the dog the children like chase the cat?
- Did the dog they like chase the cat?
- Did she they like chase the cat?
Substitution test

• Replace the constituent with a pro–form
  ✷ The little boy fed the cat.  ➔
    He fed her.
  ✷ The little boy from next door fed the cat without a tail.  ➔
    He fed her.
  ✷ The little boy from next door fed the cat without a tail.  ➔
    * He from next door fed her without a tail.
Substitution test

- Black cats detest green peas. ➞ They detest them.
- These black cats detest those green peas. ➞ They detest them.
- These black cats detest those green peas. ➞ * These they detest those them.

Assumption: only constituents can be substituted with proforms
Pronouns are not the only proforms

- Put it on the table.  ➔  Put it there.
- Put it over on the table.  ➔  Put it over there.
- Put it over on the table.  ➔  Put it there.
- Put it on the table that's by the door.  ➔
  * Put it there that's by the door.
- Put it over on the table that's by the door.  ➔
  * Put it over there that's by the door.
- Put it over on the table that's by the door.  ➔
  * Put it there that's by the door.
• I am very happy, ... ... and Linda is so, too.
• I am very fond of Lukas, ... ... and Linda is so, too.
• I am very fond of my nephew, ... * ... and Linda is so of her niece.
Pro-clause?

• I { know, suspect } that they're invited.
  I { know, suspect } it.
• I { imagine, think } that they're invited.
  I { imagine, think } so.
Moving NPs

- I fed the cats. ➔
  The cats, I fed ___. (The dogs, I didn't.)
- I fed the cats with long, fluffy tails. ➔
  The cats with long, fluffy tails, I fed ___. (The other cats, I didn't.)
  * The cats, I fed ___ with long, fluffy tails.

Assumption: only constituents can be moved
Moving PP, ADJP,

• The cat strolled across the porch with a confident air. ➞ With a confident air, the cat strolled across the porch ___. *With a, the cat strolled across the porch ___ confident air.

• Ali Baba returned from his travels wiser than before. ➞ Wiser than before, Ali Baba returned from his travels ___. *Wiser than, Ali Baba returned from his travels ___ before.
Moving ADVP

- They arrived at the concert hall more quickly than they had expected.

  More quickly than they had expected, they arrived at the concert hall ___.

* More quickly than they, they arrived at the concert hall ___ had expected.
Can it be a sentence fragment in response to a question?

• Noun phrase:
  - What do you like?
    The cats.
    Cats with long, fluffy tails.
    The cats with long, fluffy tails.

• Prepositional phrase:
  - How did the cat stroll across the porch?
    With a confident air.
  - Where did Ali Baba go?
    On a long journey.
    To New York.
Can it be a sentence fragment in response to a question?

- **Adjective phrase:**
  - How did Ali Baba return?
    - Wiser than before.
    - Fairly jeg-lagged.

- **Adverb phrase:**
  - How did they do?
    - Not badly.
    - Surprisingly well.
    - Much better than they had expected.
Ungrammatical with non-constituents

- * What did you feed ___ long, fluffy tails?
  * The cats with.
- * How did the cat stroll across the porch ___ confident air?
  * With a.
- * How did Ali Baba return from his travels ___ before?
  * Wiser than.
- * How did they arrive at the concert hall ___ had expected?
  * More quickly than they.
It cleft focus

• Noun phrase
  ✦ Ordinary cats detest the smell of citrus fruits.
   It is ordinary cats that detest the smell of citrus fruits.

• Prepositional phrase
  ✦ The cat strolled across the porch with a confident air.
   It was with a confident air that the cat strolled across the porch ___.

• Adjective phrase
  ✦ Ali Baba returned from his travels wiser than before.
   It was wiser than before that Ali Baba returned from his travels ___.

• Adverb phrase
  ✦ They arrived at the concert hall more quickly than they had expected.
   It was more quickly than they had expected that they arrived at
Ungrammatical it cleft

- Ordinary cats detest the smell of citrus fruits.
  It is the smell of that ordinary cats detest ___ citrus fruits.
- The cat strolled across the porch with a confident air.
  * It was with a confident that the cat strolled across the porch ___ air.
- Ali Baba returned from his travels wiser than before.
  * It was wiser than that Ali Baba returned from his travels ___ before.
- They arrived at the concert hall more quickly than they had expected.
  * It was more quickly than that they arrived at the concert hall they has expected.
Representing constituent structure

- **Labeled brackets**
  - The label represents the category of the constituent
  - The text string within a bracket represents a constituent
  - Preferred representation scheme in corpus linguistics: bracket bank?

- **Tree diagram**
  - Syntactic constituents are graphically represented as nodes in a tree
  - The nodes are labeled with the syntactic category of the constituent
  - Preferred illustration scheme in papers, textbooks.
Brackets v.s. tree

(S (NP (DT the) (ADJ little) (NN boy)) (VP (VV fed) (NP (DT the) (NN cat))))

(PU .)

A constituent is exhaustively included in a pair of brackets.

A constituent is exhaustively dominated by a node.
Representing discontinuous constituents

• Is there a way of making discontinuous constituents continuous (or alternatively, making long-distance dependencies local)?
• The answer: using trace!
• Believers and doubters of trace
Arthur was attacked by aliens.
Where did you put the book? *T*-1

Localization: Localized!
Relative clause

promises that the president made \*T*-1
This every man contains *T*-4 within them
Cars are tough * to pay for *T*-9
One knows better now who *T*-1 has bone *RNR*-5 and who *T*-2 has jelly *RNR*-5 in his spine.
A young woman *ICH*-9 entered whom she at once recognized *T*-2 as Jane Doe II.
Structural ambiguity

- Wanted: Man to take care of cow that does not smoke or drink.
- Question: how do we represent the interpretation that non-smoking and non-drinking man is sought to take care of cow?
Some examples

- Enraged cow injures farmer with ax
- Teacher Strikes Idle Kids
- Teller Stuns Man with Stolen Check
Teacher strikes idle kids
Teacher strikes idle kids

Tree representation:

- **S**
  - **NP**
    - **NN** Teacher
    - **NNS** strikes
  - **VP**
    - **VBP**
    - **NP**
      - **NNS** idle
      - **NNS** kids
Enraged cow injures farmer with ax
Enraged cow injures farmer with ax
Teller Stuns Man with Stolen Check
Teller Stuns Man with Stolen Check
Categorizing ambiguity

- Part of speech
- Conjunction
- Subordinate clause: higher or lower verbs?
- Prepositional phrase: verb or noun?
The post office will hold out discounts and service concessions as incentives
The post office will hold out discounts and service concessions as incentives.
The post office will hold out discounts and service concessions as incentives.
The post office will hold out discounts and service concessions as incentives
The post office will hold out discounts and service concessions as incentives
Computer ambiguity vs human ambiguity

- Computer: I can’t interpret this. There is so much ambiguity.
- Human: Ambiguity? What ambiguity?
- C: Well, first of all, “will” can be a noun or a modal verb
- H: No Silly, “will” can’t be a noun here.
- C: how do I know that?
- H: You know because there is no such thing as “the post office will hold”.
- C: huh???
How many interpretations?

• The agency sees widespread use of the codes as a way of handling the rapidly growing mail volumes and controlling labor costs
Discussion question

- Should a sentence be annotated with multiple interpretations in a treebank?
Discussion question

- No, unless there is no way to resolve the ambiguity from the context provided in the text. Even then it may be a good idea to just choose one interpretation.
- Machines learn how ambiguities are resolved by examining a large amount of human annotated data and this approach is called **supervised machine learning**.
Discussion question

• Can all semantic dependencies be represented with attachment at the appropriate level?
How do we represent the dependency between the PP and the Noun?

Congress presently toward this matter conduct investigation.  
“The Congress is investigating this matter.”
Penn Treebank representation scheme

- Configurational representation with phrasal labels
- Non-configurational representation with functional tags
- Using empty categories to localize non-local dependencies
PTB Phrasal labels

- S: Simple declarative sentence
- SBAR: Clause introduced by a subordinate conjunction
- SBARQ: Direction question introduced by a wh-word or wh-phrase
- SINV: Inverted declarative sentence
- SQ: Inverted yes-no question
- ADJP: adjective phrase
- ADVP: adverbial phrase
- CONJP: conjunction phrase
- FRAG: fragmentary phrase
- INTJ: interjection phrase
- LST: list
- NAC: not a constituent
PTB Phrasal labels (cont’d)

- NP: noun phrase
- NX: used within certain complex NPs to mark the head of the NP.
- PP: prepositional phrase
- PRN: parenthetical
- PRT: particle
- QP: quantifier phrase
- RRC: reduced relative clause
- UCP: unlike coordinated phrase
- VP: Verb phrase
- WHADJP: Wh–adjective phrase
- WHADVP: Wh–adverb phrase
- WHNP: Wh–noun phrase
- WHPP: Wh–prepositional phrase
- X: unknown, uncertain, or unbracketable
A PTB example

(S (NP–SBJ The Mortgage and equity real estate investment trust)
  (ADVP last)
  (VP (VBD paid)
    (NP a dividend)))
  (PP–TMP (IN on)
    (NP August 1, 1988)))
CTB Phrasal labels

- ADJP: adjectival phrase
- ADVP: adverbial phrase
- CLP: classifier phrase, e.g., 一大帮人
- CP: complementizer phrase
- DNP: 的-phrase, e.g. 我的电脑
- DP: determiner phrase, e.g., 那三个人
- FRAG: fragmentary phrase
- IP: Inflectional phrase
- LCP: localizer phrase, e.g., 那三个人中
- LST: list, e.g., 一，二，三，首先，其次
- NP: noun phrase
- PP: prepositional phrase
- PRN: parenthetical
- QP: quantifier phrase
- UCP: unlike coordinate phrase
- VP: verb phrase
An improvement (?) made in the Chinese Treebank

One grammatical relation per bracket
Complementation (right-headed)
Adjunction

```
XP
  {YP}
  XP
  {ZP}
  VP
    ADVP
    VP
  ADJP
    ADVP
    ADJP
```
Coordination

```
XP
  /  \\
XP  CC  XP
  |
VP
  |
VP  CC  VP
  |
NP
  |
NP  CC  NP
  |
```
One grammatical relation per bracket

(IP (NP–SBJ (DP (CLP (NP–PN (NR 美国))))
  (DEG 的))
(DP (DT 这))
(CLP (M 次))
(NP (NN 军事) (NN 行动))
(VP (PP–DIR (P 对))
  (NP (DP (NP (NP–PN (NR 波斯湾))))
    (NP (NN 地区))
    (CC 和)
    (NP (NN 世界))
    (DEG 的)
  (NP (NN 和平))
    (CC 与)
    (NN 安全)))
(VP (VV 造成))
  (AS 了)
(NP–OBJ (ADJP (JJ 严重))
  (NP (NN 后果))))
Levy and Manning (2003)

- Is it harder to parse Chinese or Chinese Treebank?
- Should theoretical linguistics and corpus linguistics use the same criteria to decide what counts as a good parse and a good representation scheme?
- Should the quality of a corpus be validated by a parser?
References

