Recursive Adjectival Modification in CLLRS

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A glimpse of adjectival modification

(1) a. pink unicorn
b. invisible pink unicorn

(2) a. invisible unicorn
b. occasionally invisible unicorn
c. occasionally entirely invisible unicorn

(3) a. blond artist
b. skillful programmer
c. former senator
d. alleged president

(4) a. blond artist
b. potentially blond artist

Structure of the talk

- Modification in HPSG: Kasper (1997)
- Modification in (CL)LRS
- Representation and meaning
- Analysis in LRS with implementation in CLLRS
- Concluding thoughts

Kasper (1997) and modification in HPSG

- Kasper's observation:
  - classical HPSG: representation of head-adjunct phrases comes from adjunct daughters
  - in *blond artist*, representation at blond says: an *x* that is blond and an artist
  - in *potentially blond artist*, *potentially* then modifies: an *x* that is blond and an artist (and the entire representation is in *potentially*)
  - but: *x is* an artist who is potentially blond!
- Kasper's solution in classical HPSG format:
  - distinguish inherent content of lexical items from combinatorics
  - distinguish inherent content from its use in different constructions
  - project the combinatorial behavior from the lexical head
  - uniform semantic principle for all head-modifier structures
  - analysis for operator/intersective meaning and attributive/predicative use of adjectives (and other modifiers)

Doing it in (CL)LRS

- focus in LRS on:
  - scope underspecification
  - quantifiers, polyadic quantifiers, content raising
  - concord phenomena
  - semantics for idiomatic expressions
  - NPI licensing
  - plural semantics, Skolem functions
  - $\rightarrow$ semantics of modification is a new area of application
- combination of analysis with implementation in CLLRS, and with development of CLLRS
- reasoning architecture with higher-order logic

A representation for adjectives

Starting point for the representation of adjectives:

$\lambda P_{\langle s\langle et\rangle\rangle}\lambda w_s\lambda x_e.tall_{\langle s\langle\langle s\langle et\rangle\rangle\langle et\rangle\rangle\rangle}(w, P, x)$

Motivation:

Uniform syntactic form for intersective, subsective, privative and other types of adjectives. Meaning postulates guarantee the intended inferential behavior.

- *blond student* (intersective)
- *successful student* (subsective)
- *fake student* (privative)
- *alleged student*

Representations for adjectival modification

(5)

a. (i) controversial plan

(ii) $controversial'(w, (\lambda w_2 \lambda y.(plan'(w_2, y))), x)$

b. (i) invisible pink unicorn

(ii) $invisible'(w, (\lambda w_2 \lambda y.(pink'(w_2, (\lambda w_3 \lambda z.(unicorn'(w_3, z))), y))), x)$

c. (i) potentially controversial plan

(ii) $(potential'(controversial'))(w, (\lambda w_2 \lambda y.(plan'(w_2, y))), x)$

d. (i) occasionally entirely invisible unicorn

(ii) $(occasional'(entire'(invisible)))(w, (\lambda w_2 \lambda y.(unicorn'(w_2, y))), x)$

Meanings for adjectives: Meaning postulates

Classes of adjectives are characterized by the inferences they license. For an adjective α:

1. intersective adjectives: *blond, Scandinavian, Irish, British, female, male*
   $\exists P^1_{\langle s\langle et\rangle\rangle} \forall w_s \forall P^2_{\langle s\langle et\rangle\rangle} \forall x_e (\alpha(w, P^2, x) \leftrightarrow (P^1(w, x) \wedge P^2(w, x)))$
2. subsective, non-intersective adjectives: *genuine, skillful, successful, interesting, large, small, fat, tall, blue*
   $\forall P_{\langle s\langle et\rangle\rangle} \forall x_e \forall w_s (\alpha(w, P, x) \rightarrow P(w, x))$
3. privative adjectives: *fake, former*
   $\forall P_{\langle s\langle et\rangle\rangle} \forall x_e \forall w_s (\alpha(w, P, x) \rightarrow \neg P(w, x))$
4. *alleged*
   $\forall P_{\langle s\langle et\rangle\rangle} \forall x_e \forall w^1_s (alleged(w^1, P, x) \leftrightarrow$
   $allegedly(w^1, (\lambda w^2 P(w^2, x))))$

Words: Attributive adjective

An adjective: *pink*, type $\langle s\langle\langle s\langle et\rangle\rangle\langle et\rangle\rangle\rangle$

$$\left[\begin{array}{l} \textit{word} \\ \text{PHON}\ \langle \textit{pink} \rangle \\ \text{SYNSEM LOC}\ \left[\begin{array}{l} \text{CAT HEAD MOD} \ldots \text{CONT MAIN}\ \psi \\ \text{CONT}\ \left[\begin{array}{ll} \text{DR} & \boxed{\text{X}} \\ \text{MAIN} & \text{pink}' \end{array}\right] \end{array}\right] \\ \text{SEM}\ \left[\begin{array}{l} \textit{lrs} \\ \text{EXCONT}\ (\alpha)\ (\boxed{\text{W}}, \lambda\boxed{\text{W}}\lambda\boxed{\text{X}}.\beta, \boxed{\text{X}}) \\ \text{INCONT}\ \boxed{1}\ \text{pink}' \\ \text{PARTS}\ \left\langle \begin{array}{l} \text{pink}', \alpha(\boxed{\text{W}}), \alpha(\boxed{\text{W}},\gamma), \\ \alpha(\boxed{\text{W}},\gamma,\boxed{\text{X}}), \lambda\boxed{\text{X}}.\beta, \lambda\boxed{\text{W}}\lambda\boxed{\text{X}}.\beta \end{array} \right\rangle \end{array}\right] \end{array}\right] \;\&\; \boxed{1} \triangleleft \alpha \;\&\; \psi(\boxed{\text{W}},\boxed{\text{X}}) \triangleleft \beta$$

CLLRS: ^(([{pink′}]) (W, λWλX. [ψ(W, X)], X))

Words: Adverbial modifier

An adverbial modifier: *potentially*,
type $\langle\langle s\langle\langle s\langle et\rangle\rangle\langle et\rangle\rangle\rangle\langle s\langle\langle s\langle et\rangle\rangle\langle et\rangle\rangle\rangle\rangle$

$$\left[\begin{array}{ll} \textit{word} & \\ \text{PHON} & \langle \textit{potentially} \rangle \\ \text{SYNSEM LOC} & \left[\begin{array}{l} \text{CAT HEAD MOD} \ldots \text{CONT MAIN } \boxed{2} \\ \text{CONT MAIN potential}' \end{array}\right] \\ \text{SEM} & \left[\begin{array}{ll} \textit{lrs} & \\ \text{EXCONT} & \alpha\,(\beta) \\ \text{INCONT} & \boxed{1}\ \text{potential}' \\ \text{PARTS} & \langle \text{potential}', \alpha(\beta) \rangle \end{array}\right] \end{array}\right] \;\&\; \boxed{1} \triangleleft \alpha \;\&\; \boxed{2} \triangleleft \beta$$

CLLRS: ^(([{potential′}]) ([2]))

Words: Count noun

A count noun: *unicorn*, type $\langle s \langle et \rangle \rangle$

$$\left[\begin{array}{ll} \textit{word} & \\ \textsc{phon} & \langle \textit{unicorn} \rangle \\ \textsc{synsem loc cont} & \left[\begin{array}{ll} \textsc{dr} & \boxed{X} \\ \textsc{main} & \text{unicorn}' \end{array}\right] \\ \textsc{sem} & \left[\begin{array}{ll} \textit{lrs} & \\ \textsc{excont} & \ldots \alpha \ldots \\ \textsc{incont} & \boxed{1}\ \text{unicorn}'(\boxed{W},\boxed{X}) \\ \textsc{parts} & \langle \text{unicorn}', \text{unicorn}'(\boxed{W}), \text{unicorn}'(\boxed{W},\boxed{X}) \rangle \end{array}\right] \end{array}\right] \quad \& \quad \boxed{1} \lhd \alpha$$

CLLRS: ^[{unicorn′(W, X)}]

LRS Projection Principle

In each *phrase*,

1. the EXCONT values of the head and the mother are identical,
2. the PARTS value contains all and only the elements of the PARTS values of the daughters,

3a. if it's not a head-adjunct phrase,
the INCONT values of the head and the mother are identical,

3b. if it is a head-adjunct phrase,
the EXCONT value of the non-head daughter and the INCONT value of the mother are identical.

Semantics Principle

Clause for (adverbial) adjectival modification

In a *head-adjunct* phrase with an adjective or and adverbial modifier of adjectives as non-head daughter ([HEAD *adj_adv* $\vee$ *adjective*]), the INCONT value of the head daughter is a subterm of an argument of the INCONT value of the non-head daughter.

Adjective-noun combinations

Analysis of *pink unicorn*:

pink:
adjunct daughter: ^(([{pink′}]) (W, λWλX. [ψ(W, X)], X))

unicorn:
head daughter: ^[{unicorn′(W, X)}]

lexical restriction by *pink*:
^(([{pink′}]) (W, λWλX. [unicorn′(W, X)], X))

restriction by Semantics Principle:
pink′(...[unicorn′(W, X)]...)

pink unicorn:
^[{pink′ (W, λWλX. [unicorn′(W, X)], X)}]

Adverbial modifiers of adjectives

Analysis of *potentially pink*

potentially:
adjunct daughter: ^(([{potential′}]) ([2]))

pink:
head daughter: ^(([{pink′}]) (W, λWλX. [ψ(W, X)], X))

lexical restriction by *potentially*:
^(([{potential′}]) ([pink′]))

restriction by Semantics Principle:
potential′ (. . . [pink′] . . .)

potentially pink:
^(([{potential′(pink′)}]) (W, λWλX. [ψ(W, X)], X))

New representations in CLLRS

Underspecification of functors in type-logical representations:

- specification in a Montague Grammar format:
  $\lambda P \lambda w \lambda x.\mathit{controversial}'(w, P, x)$
- specification in HPSG, possible underspecification of arguments:
  $\mathit{controversial}'(w, P, x)$
- specification in LRS, needed in CLLRS:
  $\rightarrow ([\mathit{controversial}'])@(w, P, x)$
- unabbreviated CLLRS specification:
  $\rightarrow ((([\mathit{controversial}'])@w)@P)@x$

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Next steps

- integration of meaning postulates
- predicative adjectives: *Few unicorns are (entirely) pink.*
  ^(([{pink′}]) (W, entity, X))
- observation: predicative nominals obtain an analogous treatment
  Alice is a (potentially pink) unicorn.
- adverbial modifiers of adverbial modifiers:
  [[very occasionally] invisible] unicorn
- adverbials in the verbal domain: type polymorphism

Conclusions

- revisiting Kasper's guiding intuitions in LRS:
  - LRS by design distinguishes lexical content from combinatorics
  - combinatorics is lexically determined by resources, external content and internal content of the word
  - one clause of SEMANTICS PRINCIPLE for head-adjunct structures
  - attributive/predicative adjectives are systematically related
- unified representation for different classes of adjectives
- LRS analysis and CLLRS implementation go hand in hand
- behavior of inferences under modification (*apparently British artist, allegedly fake student*)
- more adjectival and adverbial constructions (Huddleston & Pullum 2002, chapter 6)