

Resource Grammars and Language Learning and Evolution

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Resources for building (formal) languages (with Aarne Ranta)

Language learning and evolution (with Staffan Larsson)

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Natural and formal languages in 20th century linguistics

- ▶ languages as sets of strings and early transformational grammar

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- ▶ interpreted languages as sets of string-meaning pairs
- ▶ Montague in 'Universal Grammar':

There is in my opinion no important theoretical difference between natural languages and the artificial languages of logicians; indeed I consider it possible to comprehend the syntax and semantics of both kinds of languages within a single natural and mathematically precise theory.

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- ▶ a basis for much computational processing of language

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 - ▶ abstract or theoretical concepts like democracy or meaning

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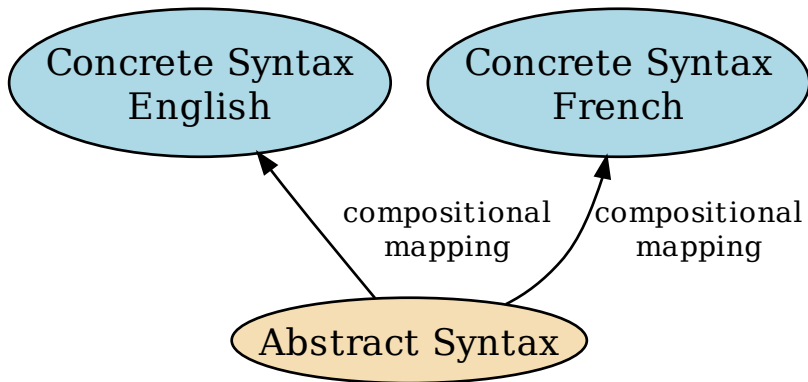
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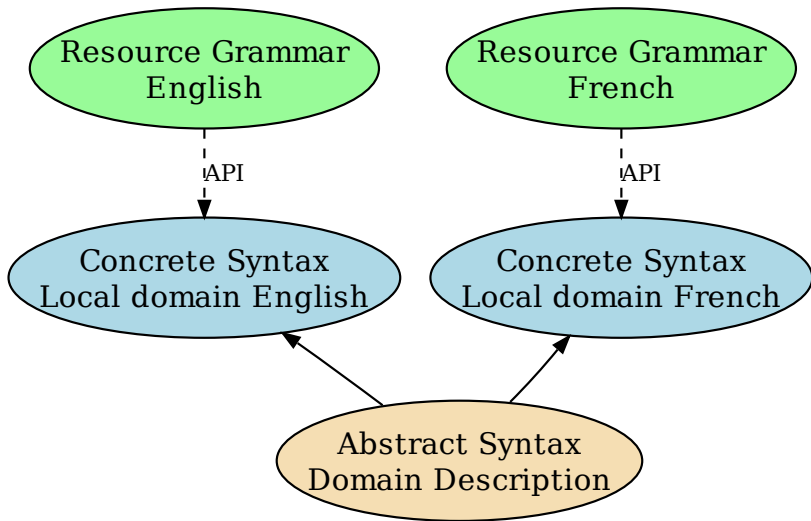
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- ▶ speakers of natural languages are constantly in the process of creating new language to meet the needs of novel situations in which they find themselves
- ▶ A corpus of natural language data (even a single dialogue) is not required to be consistent either in terms of grammaticality or in terms of meaning since it represents output based on a collection of related grammars rather than a single grammar.

Scaling up to multilingual grammar the GF way



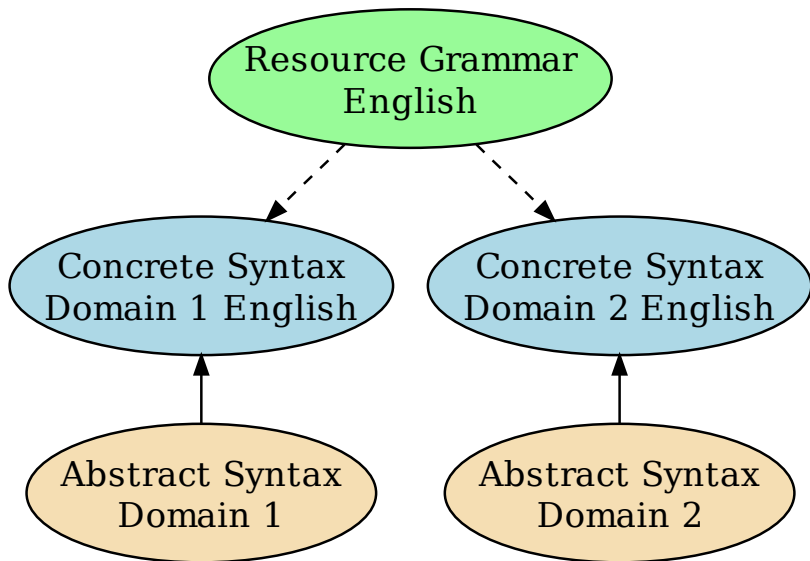
Scaling up/down to local domain grammars the GF way



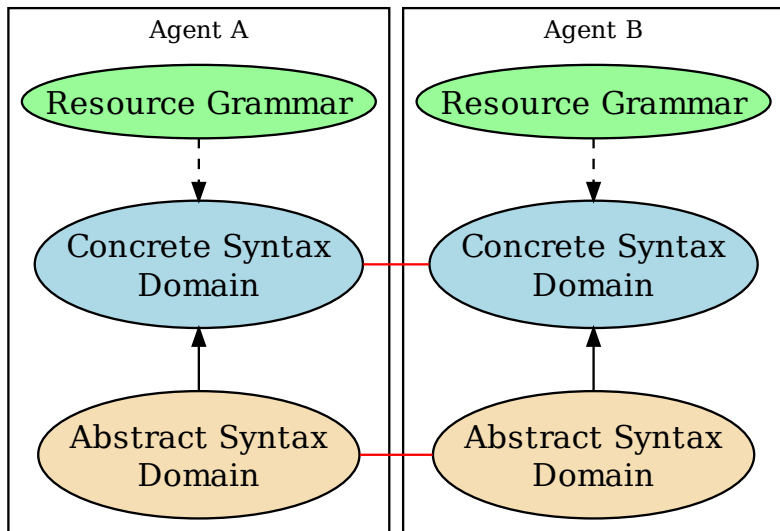
API = Application Programming Interface

Importation of definitions

Reusing the resource grammar in GF



Coordination



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Requirements for a theory of semantic coordination

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 - ▶ dynamic representations of concepts which can be modified in various ways (Type theory with records, TTR)
- ▶ pragmatics: an account of how meanings (and concepts) are coordinated in dialogue and how dialogue moves governing coordination are related to semantic updates
 - ▶ a description of dialogue strategies involved in semantic coordination (Information State Update, ISU)

Corrective feedback

A frequent pattern in corrective feedback is the following:

original utterance A says something

innovative utterance B says something parallel to A's utterance,
containing a use which is innovative for A

learning step A learns from the innovative use

In-repair

Abe: I'm trying to tip this over, can you tip it over? Can you tip it over?

Mother: Okay I'll turn it over for you.

- ▶ **offer-form:in-repair**("turn", "_ it over")
- ▶ **offer-form**("turn", "tip")

Clarification request

Adam: Mommy, where my plate?

Mother: You mean your saucer?

- ▶ **offer-form:cr**(“saucer”, “[poss] - ”)
- ▶ **offer-form**(“saucer”, “plate”)

Explicit replace

Naomi: Birdie birdie.

Mother: Not a birdie, a seal.

- ▶ **offer-form:explicit-replace**("seal", "birdie")
- ▶ **offer-form**("seal", "birdie")

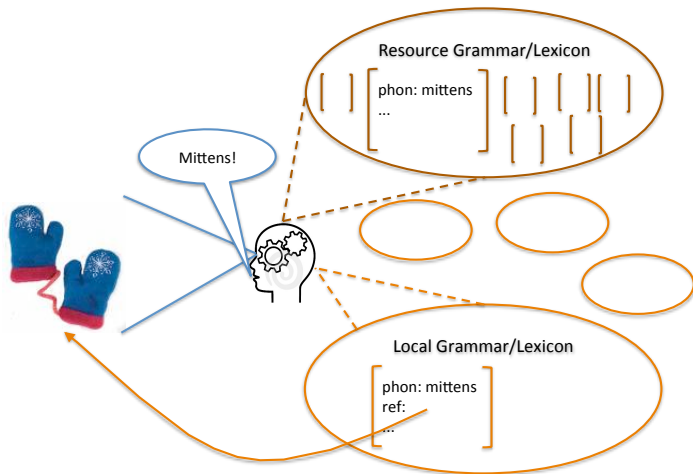
Bare correction

Naomi: mittens.

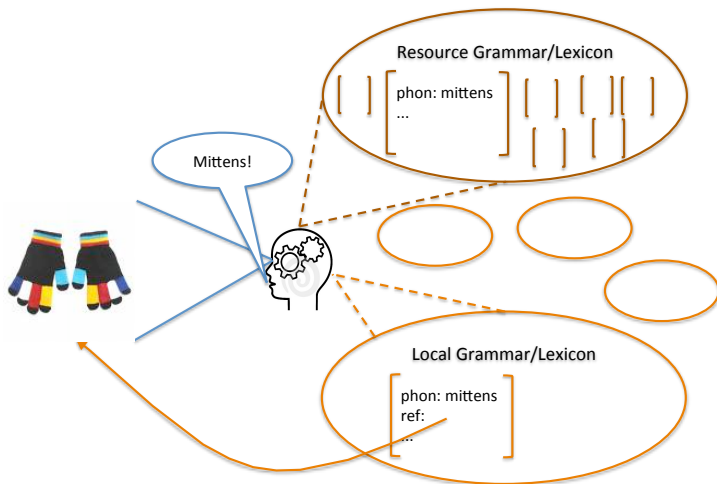
Father: gloves.

- ▶ **offer-form:bare**(“gloves”)
- ▶ **offer-form**(“gloves”, “mittens”)

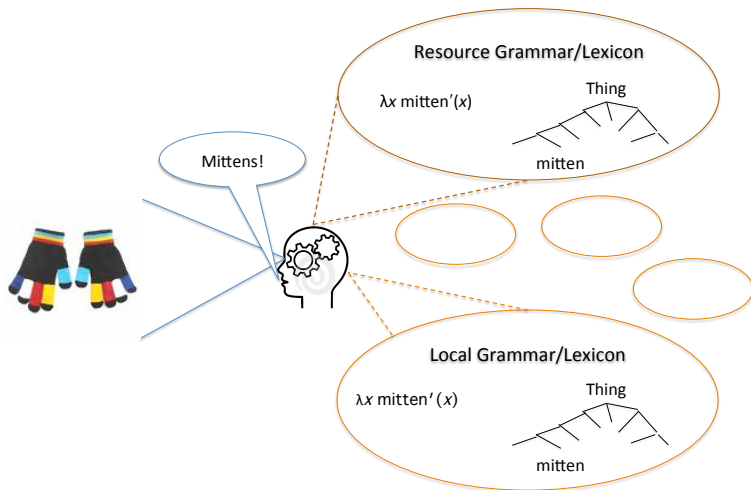
Talking about mittens



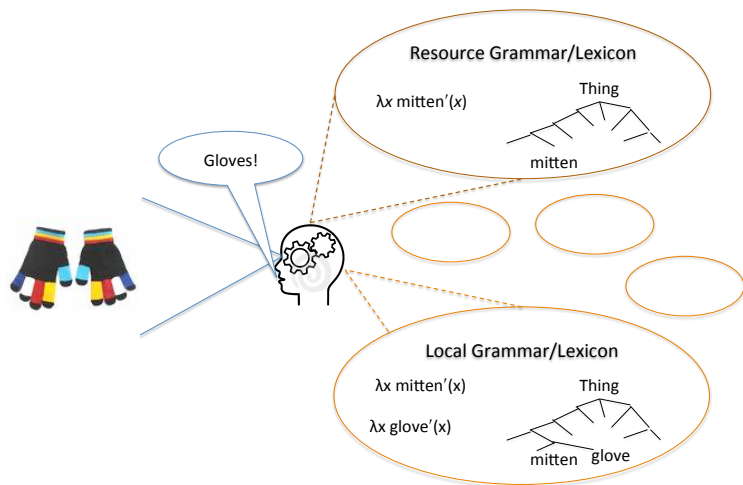
Talking about gloves (when you only know about mittens)



Compositional and ontological semantics



Enriching the local lexicon



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- ▶ dialogue moves associated with information state updates
- ▶ semantic coordination updates involve linguistic resources (grammar, lexicon, semantic interpretation rules, ...), i.e. *not* the standard conversational scoreboard
- ▶ agents construct local resources for sublanguages used in specific situations

Generic and domain resources

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- ▶ this will not be the case in general, e.g. *black hole* in physics not a black hole in the general sense, variables in logic and experimental psychology

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- ▶ $[c]_s^A$ may be anchored to the specific objects under discussion in s

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- ▶ $c' \in [c]^A$, i.e. part of a domain independent generic resource

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- ▶ positive or negative feedback obtained when using the pairing in a communicative situation

Representing concepts using TTR

Type Theory with Records

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- ▶ feature structure like properties are important for developing similarity metrics on meanings and for the straightforward definition of meanings modifications involving refinement and generalization
- ▶ logical aspects are important for relating our semantics to the model and proof theoretic tradition associated with compositional semantics

Records and record types

Record type $\left[\begin{array}{l} \text{ref} \quad : \quad \text{Ind} \\ \text{size} \quad : \quad \text{size}(\text{ref}, \text{MuchBiggerThanMe}) \\ \text{shape} \quad : \quad \text{shape}(\text{ref}, \text{BearShape}) \end{array} \right]$

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Record $\left[\begin{array}{l} \text{ref} \quad = \quad \text{obj123} \\ \text{size} \quad = \quad \text{sizesensorreading85} \\ \text{shape} \quad = \quad \text{shapesensorreading62} \\ \text{colour} \quad = \quad \text{coloursensorreading78} \end{array} \right]$

Types containing manifest fields

```
[ ref=obj123  :  Ind  
  size       :  size(ref, MuchBiggerThanMe)  
  shape     :  shape(ref, BearShape) ]
```

Type hierarchies

[ref : Ind
size : size(ref, MuchBiggerThanMe)]

is a subtype of

[ref : Ind]

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is a subtype of

$$\left[\text{ref} \quad : \quad \text{Ind} \right]$$

as is also

$$\left[\text{ref=obj123} \quad : \quad \text{Ind} \right]$$

The panda

A: That's a nice bear

B: Yes, it's a nice panda

offer-form:in-repair("panda", "is a nice _")

offer-form("panda", "bear")

A's concept "bear" in the "zoo" domain

We assume that, before B 's utterance, A has a single concept of "bear" in a domain called "zoo", that is, a unique member of the collection $[\text{bear}]_{\text{zoo}}^A$.

ref	:	Ind
phys	:	phys-obj(ref)
anim	:	animate(ref)
size	:	size(ref, MuchBiggerThanMe)
shape	:	shape(ref, BearShape)
bear	:	bear(ref)

A's take on the communicative situation

A's dialogue information state at the time of *B*'s utterance (much simplified)

$$\left[\begin{array}{l} \text{domain} : \text{zoo} \\ \text{shared} : \left[\begin{array}{l} \text{foo} = \text{obj123} \\ \text{com} = \left[\begin{array}{l} c_1 : \text{nice}(\text{foo}) \\ c_2 : \text{bear}(\text{foo}) \end{array} \right] \end{array} \right] \end{array} \right] \begin{array}{l} : \text{Ind} \\ : \text{RecType} \end{array} \end{array} \right]$$

A creates a local “panda”-concept

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- ▶ assuming the principle of contrast (Clark), find a way in which pandas differ from bears
- ▶ create first a local situated interpretation $[\text{panda}]_s^A$ based on $[\text{bear}]_{\text{zoo}}^A$

[panda]_s^A

```
[ ref=obj123 : Ind  
  phys       : phys-obj(ref)  
  anim       : animate(ref)  
  size       : size(ref, MuchBiggerThanMe)  
  shape      : shape(ref, BearShape)  
  colour     : colour(ref, BlackAndWhite)  
  panda      : panda(ref) ]
```

[bear]_s^A

A refines the local “bear”-concept corresponding to the newly formed local “panda”-concept

ref	:	Ind
phys	:	phys-obj(ref)
anim	:	animate(ref)
size	:	size(ref, MuchBiggerThanMe)
shape	:	shape(ref, BearShape)
colour	:	colour(ref, Brown)
bear	:	bear (ref)

A's updated dialogue information state

$$\left[\begin{array}{l} \text{domain} : \text{zoo} \\ \text{shared} : \left[\begin{array}{l} \text{foo} = \text{obj123} \\ \text{com} = \left[\begin{array}{l} \text{c}_1 : \text{nice}(\text{foo}) \\ \text{c}_2 : \text{panda}(\text{foo}) \end{array} \right] \end{array} \right] \end{array} \right] : \begin{array}{l} \text{Ind} \\ \text{RecType} \end{array} \end{array} \right]$$

A dereferenced panda-concept

```
[ ref      : Ind  
  phys    : phys-obj(ref)  
  anim    : animate(ref)  
  size    : size(ref, MuchBiggerThanMe)  
  shape   : shape(ref, BearShape)  
  colour  : colour(ref, BlackAndWhite)  
  panda   : panda(ref) ]
```

Available for use as $[\text{panda}]_{\text{ZOO}}^A$, and for progression through the meaning hierarchy.

Further reading

- ▶ <http://www.ling.gu.se/~cooper/records>
- ▶ http://www.flov.gu.se/english/research/Semantic_Coordination_in_Dialogue/