Types for linguistic typologies. A case study: Polarity Items

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Contents

1. The problem

- In formal linguistic literature, one finds examples of theories based on **classifications** of items which belong to the same syntactic category but which differ in some respect. For example,
  - **generalized quantifiers** have been classified considering the different ways of distributing with respect to negation [Beghelli and Stowell'97];
  - **wh-phrases** can be divided considering their sensitivity to different weak-islands strength [Szablosci and Zwarts'97];
  - **adverbs** differ in their order relations [Ernst'01];
  - **polarity items** have been distinguished by the sort of licensors they require for grammaticality [Wouden'94,Giannakidou'97].
- In all these cases, the described typologies are based on semantically motivated **subset relations** holding among the denotations of the involved items.
- **Aim**: to show how categorial type logic can contribute to the study of linguistic typologies, and how this application sheds light on the different role of binary vs. unary operators.

2. Polarity Items

- A **typology** of Polarity Items (PIs) has been described in [Zwarts 1995, Giannakidou 1997] where PIs are considered sensitive to (non-)veridicality.
- In other words, polarity items (syntactic) **distribution** depends on some semantic features, viz. (non-)veridicality, of their licensors.
- Though (non-)veridicality is an **invariant** among natural language expressions, PIs show **different** behavior cross-linguistically. E.g.
  - "Possibly" differs from its Greek counterpart: though they have the same meaning, the Greek version licenses PIs, whereas the English one does not.
- PIs are an interesting phenomena from a **cross-linguistic** perspective: languages differ in the distributional properties of PIs, rather than in their structural occurrence.

3. Non-veridical Contexts

Definition [(Non-)veridical functions] Let f be a boolean function with a boolean argument, a definition of (non-)veridical functions can be given starting from the following basic case: $f \in (t \rightarrow t)$

- f is said to be **veridical** iff $[\![f(x)]\!] = 1$ entails $[\![x]\!] = 1$ (e.g. 'yesterday');
- f is said to be **non-veridical** iff $[\![f(x)]\!] = 1$ does not entail $[\![x]\!] = 1$ (e.g. 'usually');
- f is said to be **anti-veridical** iff $[\![f(x)]\!] = 1$ entails $[\![x]\!] = 0$ (e.g. 'It is not the case').

Note, AV functions form a proper subset of the NV ones, $\mathsf{AV} \subset \mathsf{NV}$

4. Polarity items typology

Based on these distinctions of (non-)veridical contexts, PIs have been classified as follow:

- **positive polarity items** (PPIs) can occur in veridical contexts (V) ('some N');
- **affective polarity items** (APIs) cannot occur in V, i.e. they must occur in non-veridical contexts (NV), (e.g. 'any N');
- **negative polarity items** (NPIs) cannot occur in NV, i.e. they must occur in anti-veridical contexts (AV) (e.g. 'say a word').

Schematicaly, this means that

$$\begin{array}{ll} \mathrm{AV} \circ \Delta\lceil \mathrm{NPI} \rceil & {}^*\mathrm{NV} \circ \Delta\lceil \mathrm{NPI} \rceil, \\ \mathrm{AV} \circ \Delta\lceil \mathrm{API} \rceil & \mathrm{NV} \circ \Delta\lceil \mathrm{API} \rceil, \\ {}^*\mathrm{V} \circ \Delta\lceil \mathrm{NPI} \rceil & {}^*\mathrm{V} \circ \Delta\lceil \mathrm{API} \rceil. \end{array}$$

where $\circ$ is the composition operator, $\Delta\lceil X \rceil$ means that X is in the structure Δ and has wide scope in it, and * marks ungrammatical composition.

5. A concrete example

'Yesterday', 'usually' and 'it is not the case' are all denoted in the domain $D_t^{D_t}$, hence their (syntactic) category is s/s. However,

1. (a) *Yesterday I spoke with anybody I met. $*V \circ \Delta\lceil API \rceil$

   (b) *Yesterday I said a word. $*V \circ \Delta\lceil NPI \rceil$

2. (a) **Usually** I speak with anybody I meet. $NV \circ \Delta\lceil API \rceil$

   (b) *Usually I say a word. $*NV \circ \Delta\lceil NPI \rceil$

Question: How can we account for these differences among items denoted in the 'same' domain?

6. Categorial Type logic

In [Areces, Bernardi and Moortgat] the base logic ($\mathsf{NL}(\Diamond, \cdot^{\mathbf{0}})$) consisting of residuated and Galois connected operators has been studied.

- **Language** Formulas are built from: Atoms, residuated operators: $(\backslash, \bullet, /)$, $(\Diamond\cdot, \Box^{\downarrow}\cdot)$; and unary Galois connected ones: $({}^{0}\cdot, \cdot^{0})$.

- **Models**

  Frames $F = \langle W, R_0^2, R_\Diamond^2, R_\bullet^3 \rangle$

  W: 'signs', resources, expressions

  $R_\bullet^3$: 'Merge', grammatical composition

  $R_\Diamond^2$: 'feature checking', (order preserving)

  R_0^2: 'feature checking' (order reversing)

  Models $\mathcal{M} = \langle F, V \rangle$

  Valuation $V : \mathsf{TYPE} \mapsto \mathcal{P}(W)$: types as sets of expressions

7. Some useful derived properties

Compositions $\Diamond\Box^{\downarrow}A \longrightarrow A \qquad A \longrightarrow \Box^{\downarrow}\Diamond A$

$A \longrightarrow {}^{\mathbf{0}}(A^{\mathbf{0}}) \qquad A \longrightarrow ({}^{\mathbf{0}}A)^{\mathbf{0}}$

(Iso/Anti)tonicity $B \longrightarrow C$ implies $B/A \longrightarrow C/A \qquad A\backslash B \longrightarrow A\backslash C$

$A/C \longrightarrow A/B \qquad C\backslash A \longrightarrow B\backslash A$

In Natural Deduction format, a general inference step we are going to use is the one below. If $B \longrightarrow C$, then

$$\dfrac{\Delta \vdash A/C \quad \dfrac{\Gamma \vdash B}{\Gamma \vdash C}\vdots}{\Delta \circ \Gamma \vdash A}\,[/E]$$

8. The concrete example

1. (a) *Yesterday I spoke with anybody I met. — *V $\circ$ $\Delta\lceil$API$\rceil$
   (b) *Yesterday I said a word. — *V $\circ$ $\Delta\lceil$NPI$\rceil$
2. (a) **Usually** I speak with anybody I meet. — NV $\circ$ $\Delta\lceil$API$\rceil$
   (b) *Usually I say a word. — *NV $\circ$ $\Delta\lceil$NPI$\rceil$

In order to make fine-grained distinctions in the lexical assignments, we can use unary operators.

Lexicon

It is not...	$\in s/({}^{\mathbf{0}}s)^{\mathbf{0}}$	(AV)
Usually	$\in s/({}^{\mathbf{0}}(\Diamond\Box^{\downarrow}s))^{\mathbf{0}}$	(NV)
Yesterday	$\in s/\Box^{\downarrow}\Diamond s$	(V)

The type of a structure is determined by the element having wide scope, viz. in $\Delta\lceil X\rceil$ it is determined by X.

$$api : ({}^{\mathbf{0}}(\Diamond\Box^{\downarrow}s))^{\mathbf{0}} \rightarrow npi : ({}^{\mathbf{0}}s)^{\mathbf{0}} \qquad npi : ({}^{\mathbf{0}}s)^{\mathbf{0}} \not\rightarrow api : ({}^{\mathbf{0}}(\Diamond\Box^{\downarrow}s))^{\mathbf{0}}$$

$$api : ({}^{\mathbf{0}}(\Diamond\Box^{\downarrow}s))^{\mathbf{0}} \not\rightarrow ppi : \Box^{\downarrow}\Diamond s \qquad npi : ({}^{\mathbf{0}}s)^{\mathbf{0}} \not\rightarrow ppi : \Box^{\downarrow}\Diamond s$$

9. Types for PIs and their licensors

Schematically, the needed types are:

$$\begin{array}{ccc} \mathrm{AV} \in A/npi & \mathrm{NV} \in A/api, & \mathrm{V} \in A/ppi \\ api \longrightarrow npi & npi \not\longrightarrow ppi & api \not\longrightarrow ppi. \end{array}$$

Note, $AV : A/npi \longrightarrow NV : A/api \quad \leadsto \quad \mathrm{AV} \subset \mathrm{NV}$

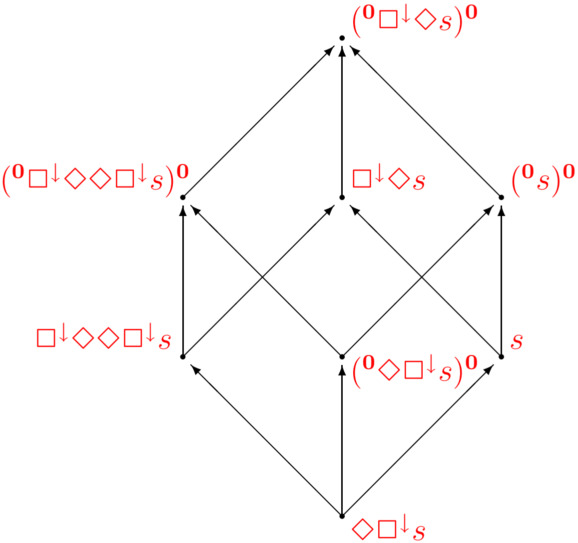
$$\dfrac{\mathrm{AV} \vdash A/npi \quad \begin{array}{c} \Delta\lceil \mathrm{API} \rceil \vdash api \\ \vdots \\ \Delta\lceil \mathrm{API} \rceil \vdash npi \end{array}}{\mathrm{AV} \circ \Delta\lceil \mathrm{API} \rceil \vdash A} \qquad \dfrac{\mathrm{NV} \vdash A/api \quad \dfrac{\Delta\lceil \mathrm{NPI} \rceil \vdash npi}{\Delta\lceil \mathrm{NPI} \rceil \vdash api}*}{{}^{*}\mathrm{NV} \circ \Delta\lceil \mathrm{NPI} \rceil \vdash A}$$

10. The general picture

- Categorial type logic provides a modular architecture to study **constants** and **variation** of grammatical composition:
  - **base logic** grammatical invariants, universals of form/meaning assembly;
  - **structural module** non-logical axioms (postulates), lexically anchored options for structural reasoning.
- Up till now, research on the constants of the base logic has focussed on binary operators. E.g.
  - Lifting theorem: $A \longrightarrow (B/A)\backslash B$;

  While unary operators have been used to account for structural variants.
- We show how **unary operators** can be used
  - to account for **linguistic typologies** encoding the **subset relations** among items of the same syntactic category, and
  - to account for **cross-linguistic** differences.

11. Options for cross-linguistic variation



12. Greek (I)

NPI: **ipe leksi**, API: **kanenan**, FCI: **opudhipote**

1.	**Dhen** idha kanenan. (tr. I didn't see anybody)	Neg > API
2.	**Dhen** ipe leksi oli mera (tr. He didn't say a word all day)	Neg > NPI
3.	*Dhen idha opjondhipote (tr. I didn't see anybody)	*Neg > FCI
4.	Opjosdhipote fititis **bori** na lisi afto to provlima. (tr. Any student can solve this problem.)	Modal > FCI
5.	**An** dhis tin Elena [puthena/opudhipote], . . . (tr. If you see Elena anywhere, . . .)	Cond > API/FCI
6.	**An** pis leksi tha se skotoso. (tr. If you say a word, I will kill you)	Cond > NPI

13. Greek (II)

The data presented above can be summarized as follows:

Greek	FCI	API	NPI	PPI
Veridical	*	*	*	Yes
Negation	*	Yes	Yes	*
Modal verb	Yes	Yes	*	Yes
Conditional	Yes	Yes	Yes	Yes

14. Italian (I)

NPI: **nessuno**, API: **mai**, FCI: **chiunque**

1.	**Non** gioco mai (tr. I don't play ever)	Neg > API
2.	**Non** ho visto nessuno (tr. I haven't seen anybody)	Neg > NPI
3.	***Non** ho visto chiunque (tr. I haven't seen anybody)	*Neg > FCI
4.	Chiunque **puó** risolvere questo problema (tr. Anybody can solve this problem)	Modal > FCI
5.	*Puoi giocare mai (tr. You can play ever)	*Modal > API
6.	*Puoi prendere in prestito nessun libro (tr. You can borrow any book)	*Modal > NPI
7.	**Se** verrai mai a trovarmi, . . . (tr. If you ever come to visit me, . . .)	Cond > API

15. Italian (II)

The data presented above can be summarized as follows:

Italian	FCI	API	NPI	PPI
Veridical	*	*	*	Yes
Negation	*	Yes	Yes	*
Modal verb	Yes	*	*	Yes
Conditional	*	Yes	*	Yes

16. Summing up

- **Semantic** differences among items of the same (syntactic) categories are responsible for different **syntactic** behaviors;
- In $\mathsf{NL}(\Diamond, \cdot^{\mathbf{0}})$ these differences can be encoded in the **lexicon** by means of unary operators;
- The derivability relations governing unary operators and the tonicity properties of $\backslash, /$ give precise **instructions** to encode the semantic subset relations involved;
- Starting from the lexicon, the **logic rules** prove the correct distribution of the different items;
- Cross-linguistic differences are accounted for by building different lexicon, facilitating comparisons among languages.

17. What have we gained?

Assuming a categorial logic perspective on linguistic typologies help

- gain a deeper understanding of the typological classifications proposed in the literature of formal linguistics;
- carry out cross-linguistic comparisons;
- clarify the consequences predicted by the typologies opening the way to further investigations, and
- discover new dependencies between linguistic phenomena.