Geert-Jan M. Kruijff: A Categorial-Modal Logical Architecture of Informativity

Adriane Boyd

25th April 2005

Outline

Introduction

- Combinations of word order, tune, and morphology are used across and within languages to realize information structure
- Important questions:
  - Where/how is information structure and its realization described?
  - Why/when does a language use certain means to realize information structure?

Kruijff's Theses

- Information structure can be integrated into a theory of grammar at the level representing the linguistically realized meaning of a sentence.
- The way information structure is realized through the possible interaction of word order, tune, and morphological marking can be captured by means of multidimensional linguistic signs and operations on such signs.
- The typification of a language in terms of its morphology and dominant word order patterns determines how a language may realize information structure.

Kruijff's Theses (cont.)

- Typological implications can be used to guide decisions about how to provide a grammar model of the way a language may realize information structure.
- An architecture can be built that models how typologically varied languages may share or differ in aspects of how they realize information structure, based on patterns observed cross-linguistically.
- A compositional account can be given of the relation between the representation of information structure at the level of linguistic meaning, and its realization at the surface form.

Hybrid Logic

- A **hybrid logic** is a modal logic with the ability to
  - refer to states
  - sort atomic symbols

Well-formed formulas

- Propositional symbols: p, r, q
- Modality labels: $\pi\pi'\pi''$
- Nominals: i, j, k (disjoint)
- Well-formed formulas in a basic hybrid multimodal language H(@):
  - $WFF\phi := i|p|\neg\phi|\phi \wedge \psi|\phi \vee \psi|\phi \rightarrow \psi|\langle\pi\rangle\phi|[\pi]\phi|@_i\phi$
- Nominals name unique states
- Nominals are formulas
- i is true in exactly one state: it picks out that state
- $@_i\phi$ is true iff ϕ is true in the state named by i

Sample hybrid logic derivation

1		$\neg @_i(\langle\pi\rangle(p \vee q) \rightarrow \langle\pi\rangle p \vee \langle\pi\rangle q)$	
2		$@_i\langle\pi\rangle(p \vee q)$	$1, \neg \rightarrow$
2'		$\neg @_i(\langle\pi\rangle p \vee \langle\pi\rangle q)$	$1, \neg \rightarrow$
3		$\neg @_i\langle\pi\rangle p$	$2', \neg\vee$
3'		$\neg @_i\langle\pi\rangle q$	$2', \neg\vee$
4		$@_i\langle\pi\rangle j$	$2, \langle\pi\rangle$
4'		$@_j(p \vee q)$	$2, \langle\pi\rangle$
5		$\neg @_j p$	$3,4, \neg\langle\pi\rangle$
6		$\neg @_j q$	$3',4, \neg\langle\pi\rangle$
7	$@_j p$	| $@_j q$	$4', \vee$
	♣ 5,7 ♣	♣ 6,7 ♣	

Functional Generative Description

- Functional Generative Description: linguistic meaning is a relational structure in which dependents modify heads along named dependency relations
  - there is a small, fixed set of dependency relations
  - each argument is assigned one dependency relation

FGD Example

- Modalities are used to represent relations
- A head (identified by i) can only be modified by one dependent in a certain relationship (δ)
  $@_i\langle\delta\rangle j \wedge @_i\langle\delta\rangle k \rightarrow @_j k$
  $@_i\langle ACTOR\rangle j \wedge @_i\langle ACTOR\rangle k \rightarrow @_j k$
- Christopher wrote a letter.
  $(E \wedge @_{act} write \wedge @_{act} ref \wedge \langle P\rangle act \wedge @_{act}\langle ACTOR\rangle(c \wedge Christopher) \wedge @_{act}\langle PATIENT\rangle(l \wedge letter))$
- (E: eventuality nucleus)

Definition of DGL

- Note: using Steedman style notation where resulting category is always on the left
- Valid categories in DGL:
  - any basic category C
  - $C_i\backslash_\mu C_j, C_i/_\mu C_j, C_i \cdot_\mu C_j$
  - $\Diamond_\delta \varpi C$ iff ϖ does not contain $\Diamond_\delta$, where δ is a dependency relation
  - $\Box_\phi \varpi C, \Diamond_\phi \varpi C$, no feature in ϖ would linguistically contravene with ϕ

Dependency relations

- The modes μ in the categories show the head/dependent relationship
- Example: the head of sentence (the verb) remains the head even when a sentence adverb selects it as its argument
  S\S is a sentence adverb $\Rightarrow$ $S\backslash_{*\succ}S$

$$\dfrac{\dfrac{\text{Christopher} \vdash N \qquad \dfrac{\text{greeted} \vdash (S\backslash_{\prec sc}N)/_{c\succ}N \quad \text{Kathy} \vdash N}{(\text{greeted} \circ_{c\succ} \text{kath}) \vdash (S\backslash_{\prec sc}N)}E/_\mu}{(\text{Christopher} \circ_{\prec sc} (\text{greeted} \circ_{c\succ} \text{kath})) \vdash S}E\backslash_\mu \qquad \text{cheerfully} \vdash S\backslash_{a\succ}S}{((\text{Christopher} \circ_{\prec sc} (\text{greeted} \circ_{c\succ} \text{kath})) \circ_{a\succ} \mathit{cheerfully}) \vdash S}E/_\mu$$

Information Structure in the Prague School

- Important components of topic-focus articulation (TFA)
  - topic/focus distinction
  - contextual boundness: a characterization of an individual head's or dependent's informativity
  - communicative dynamism: a relative ordering over heads and dependents that indicates how informative they are relative to one another
- topic and focus are not primary, but derived from contextual boundness

FGD's Topic-Focus Articulation

- the main verb belongs to the focus if it is contextually nonbound and to the topic if it is contextually bound
- the contextually nonbound nodes depending on the main verb belong to the focus, and so do all nodes subordinated to them
- if some of the elements belong to the focus by the first two points, then every contextually bound daughter of the main verb (with its subnodes) belongs to the topic
- if no node fulfills the first two points, then the focus may be more deeply embedded and special rules apply

Topic-focus articulation in DGL (1)

(326) *If a verbal head of the clause is CB, then it belongs to the topic.*
$\mathcal{R}(@_h([\text{CB}](\mathcal{E} \wedge \phi) \wedge \Phi) \mapsto @_h([\text{CB}](\mathcal{E} \wedge \phi) \bowtie \Phi))$

(327) *If a verbal head of the clause is NB, then it belongs to the focus.*
$\mathcal{R}(@_h([\text{NB}](\mathcal{E} \wedge \phi) \wedge \Phi) \mapsto @_h(\top \bowtie [\text{NB}](\mathcal{E} \wedge \phi) \wedge \Phi))$

(328) *If a dependent δ of a verbal head is CB, then δ belongs to the topic (including any nodes it governs).*
$\mathcal{R}(@_h(\Phi \bowtie [\text{CB}]\delta \wedge \Psi) \mapsto @_h([\text{CB}]\delta \wedge \Phi \bowtie \Psi))$

(329) *If a dependent δ of a verbal head is NB, then δ belongs to the focus (including any nodes it governs).*
$\mathcal{R}(@_h(\Phi \bowtie [\text{NB}]\delta \wedge \Psi) \mapsto @_h(\Phi \bowtie \Psi \wedge [\text{NB}]\delta))$

Topic-focus articulation in DGL (2)

(330) *If a CB dependent of type δ is an embedded clause, then it should be placed first (topic proper).*
$\mathcal{R}(@_h(\Phi[[\text{CB}]\langle\delta\rangle(\Gamma[(\mathcal{E} \wedge \pi)])] \bowtie \Psi) \mapsto @_h([\text{CB}]\langle\delta\rangle(\Gamma[(\mathcal{E} \wedge \pi)]) \wedge \Phi \bowtie \Psi)$

(331) *If a NB dependent of type δ is an embedded clause, then it should be placed last (focus proper).*
$\mathcal{R}(@_h(\Phi \bowtie \Psi[[\text{NB}]\langle\delta\rangle(\Gamma[(\mathcal{E} \wedge \pi)])])) \mapsto @_h(\Phi \bowtie \Psi \wedge [\text{NB}]\langle\delta\rangle(\Gamma[(\mathcal{E} \wedge \pi)]))$

(332) *Embedded focus: If in $\Phi \bowtie \Psi$, Ψ contains no inner participants ($\delta \in \{$*ACTOR, PATIENT, ADDRESSEE, EFFECT, ORIGIN*$\}$) whereas Φ does, then a NB modification of a CB dependent is part of the focus:*
$\mathcal{R}(@_h(\Phi[[\text{CB}]\langle\delta\rangle(\Gamma[[\text{NB}]\langle\delta'\rangle(d \wedge \Delta)])] \bowtie \Psi) \mapsto$
$\mapsto @_h(\Phi[[\text{CB}]\langle\delta\rangle(\Gamma[])] \bowtie [\text{CB}]\langle\delta\rangle[\text{NB}]\langle\delta'\rangle(d \wedge \Delta) \wedge \Psi))$

Example of topic-focus articulation in DGL

- goal is: $@_h(T \bowtie F)$, F cannot be empty

The cat ate a SAUSAGE.

i. $@_h([\textsc{nb}](\mathcal{E} \wedge \mathbf{eat}) \wedge [\textsc{cb}]\langle\textsc{Actor}\rangle(c \wedge \mathbf{cat}) \wedge [\textsc{nb}]\langle\textsc{Patient}\rangle(s \wedge \mathbf{sausage}))$

ii. $(327), @_h(\top \bowtie [\textsc{nb}](\mathcal{E} \wedge \mathbf{eat}) \wedge [\textsc{cb}]\langle\textsc{Actor}\rangle(c \wedge \mathbf{cat}) \wedge [\textsc{nb}]\langle\textsc{Patient}\rangle(s \wedge \mathbf{sausage}))$

iii. $(328), @_h([\textsc{cb}]\langle\textsc{Actor}\rangle(c \wedge \mathbf{cat}) \bowtie [\textsc{nb}](\mathcal{E} \wedge \mathbf{eat}) \wedge [\textsc{nb}]\langle\textsc{Patient}\rangle(s \wedge \mathbf{sausage}))$

$\circledast$

Category of Informativity

- Goal: to predict when a language will use particular strategies to realize information structure
- Underlying ideas
  - a language has a dominant word order
  - variability in word order is allowed to different degrees in different languages

Informativity Hypothesis 1

In the unmarked case (unmarked mixed, free word order or unmarked tune), language tend to realize (verbal) contextually bound dependents/heads before contextually nonbound ones, and contextually nonbound dependencies in canonical/systemic ordering.

- holds for many OV languages (Japanese, German)
- SVO languages tend to place focus at the end of the clause
- does not hold for free OV languages (Hungarian, Turkish)

Predicting a focus position

- OV languages have an immediately preverbal focus position
- VO languages have a postverbal focus position
- a language with a rigid word order will rely on tune
- V2 behaves like OV

Focus projection

- most SVO and OV languages tend to project to the left
- in Hungarian, focus can project to the right given canonical word order
- focus can be projected over word groups in canonical order
  - Christopher gave a book [to KATHY]$_F$.
  - Christopher gave Kathy [a BOOK]$_F$.

Information Structure Hypothesis 2 (Marked Realizations)

- the possibility of focus projection may play a role in the realization of information structure
- if a non-canonical focus position is located relative to the canonical position, word order can be used
- if a non-canonical focus position cannot be located relative to the canonical position, predict an interaction between word order and tune

Example of word order variation in DGL

VFinal package

$$
\begin{array}{rcll}
\langle A\rangle^{sub} & \rightarrow & \langle A\rangle^{vfinal} & [Sub\ is\ vfinal] \\
\langle A\rangle^{mtx} & \rightarrow & \langle A\rangle^{vfinal} & [Matrix\ is\ vfinal] \\
A \circ_{<sc} \langle B\rangle^{vfinal} & \rightarrow & A \circ_{<sc} \langle B\rangle^{vhead} & [VFinal0.l(vhead, vfinal)] \\
A \circ_{<dc} \langle B\rangle^{vfinal} & \rightarrow & A \circ_{<dc} \langle B\rangle^{vhead} & [VFinal0.l(vhead, vfinal)] \\
A \circ_{<ic} \langle B\rangle^{vfinal} & \rightarrow & A \circ_{<ic} \langle B\rangle^{vhead} & [VFinal0.l(vhead, vfinal)] \\
\langle A \circ_{<sc} B\rangle^{vfinal} & \rightarrow & A \circ_{<sc} \langle B\rangle^{vfinal} & [VFinal1.p(vfinal, <sc)] \\
\langle A \circ_{<dc} B\rangle^{vfinal} & \rightarrow & A \circ_{<dc} \langle B\rangle^{vfinal} & [VFinal1.p(vfinal, <dc)] \\
\langle A \circ_{<ic} B\rangle^{vfinal} & \rightarrow & A \circ_{<ic} \langle B\rangle^{vfinal} & [VFinal1.p(vfinal, <ic)]
\end{array}
$$

Example derivation using VFinal package

$$
\frac{\text{tverb} \vdash \Box^{\downarrow}_{vhead}(\Box^{\downarrow}_{pat} n \backslash_{<dc} (\Box^{\downarrow}_{act} n \backslash_{<sc} s))}{\langle \text{tverb}\rangle^{vhead} \vdash \Box^{\downarrow}_{pat} n \backslash_{<dc} (\Box^{\downarrow}_{act} n \backslash_{<sc} s)}\ [\Box^{\downarrow}E]
$$

$$
\frac{\text{dobj} \vdash \Box^{\downarrow}_{pat} n \qquad \langle \text{tverb}\rangle^{vhead} \vdash \Box^{\downarrow}_{pat} n \backslash_{<dc} (\Box^{\downarrow}_{act} n \backslash_{<sc} s)}{\text{dobj} \circ_{<dc} \langle \text{tverb}\rangle^{vhead} \vdash \Box^{\downarrow}_{act} n \backslash_{<sc} s}\ [\backslash E]
$$

$$
\frac{\text{subj} \vdash \Box^{\downarrow}_{act} n \qquad \text{dobj} \circ_{<dc} \langle \text{tverb}\rangle^{vhead} \vdash \Box^{\downarrow}_{act} n \backslash_{<sc} s}{\text{subj} \circ_{<sc} (\text{dobj} \circ_{<dc} \langle \text{tverb}\rangle^{vhead}) \vdash s}\ [\backslash E]
$$

$$
\frac{\text{subj} \circ_{<sc} (\text{dobj} \circ_{<dc} \langle \text{tverb}\rangle^{vhead}) \vdash s}{\text{subj} \circ_{<sc} (\text{dobj} \circ_{<dc} \langle \text{tverb}\rangle^{vfinal}) \vdash s}\ [VFinal0.l(vhead, vfinal)]
$$

$$
\frac{\text{subj} \circ_{<sc} (\text{dobj} \circ_{<dc} \langle \text{tverb}\rangle^{vfinal}) \vdash s}{\text{subj} \circ_{<sc} \langle \text{dobj} \circ_{<dc} \text{tverb}\rangle^{vfinal} \vdash s}\ [VFinal1.p(vfinal, <dc)]
$$

$$
\frac{\text{subj} \circ_{<sc} \langle \text{dobj} \circ_{<dc} \text{tverb}\rangle^{vfinal} \vdash s}{\langle \text{subj} \circ_{<sc} (\text{dobj} \circ_{<dc} \text{tverb})\rangle^{vfinal} \vdash s}\ [VFinal1.p(vfinal, <sc)]
$$

$$
\frac{\langle \text{subj} \circ_{<sc} (\text{dobj} \circ_{<dc} \text{tverb})\rangle^{vfinal} \vdash s}{\langle \text{subj} \circ_{<sc} (\text{dobj} \circ_{<dc} \text{tverb})\rangle^{sub} \vdash s}\ [Sub\ is\ vfinal]
$$

$$
\frac{\langle \text{subj} \circ_{<sc} (\text{dobj} \circ_{<dc} \text{tverb})\rangle^{sub} \vdash s}{\text{subj} \circ_{<sc} (\text{dobj} \circ_{<dc} \text{tverb}) \vdash \Box^{\downarrow}_{sub} s}\ [\Box^{\downarrow}I]
$$