Centre for Logic and Philosophy of Science
Centrum voor Logica en Wetenschapsfilosofie

UNIVERSITEIT GENT

FACULTY OF ARTS AND PHILOSOPHY

An Adaptive Logic for the Formal Explication of Scalar Implicatures.

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Outline

1. Scalar Implicatures
2. The Deductive Background
3. *Step 1*: The Logic $\mathbf{CL}^{\mathbf{u}}_{\exists\mathbf{10}}$
4. *Step 2*: The Logic $\mathbf{CL}^{\mathbf{s}}_{\exists\mathbf{10}}$
5. The Cookie Conversation
6. Conclusion

Scalar Implicatures

The Gricean Maxims

Instead of thinking about them as rules (or rules of thumb) or behavioral norms, it is useful to think of them as primarily inferential heuristics which then motivate the behavioral norms. (Levinson, 2000, p. 35)

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  $\neq$ deductive derivations

  = pragmatic derivations

  $\Rightarrow$ Defeasible !!

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  EXAMPLES $\langle \mathit{and}, \mathit{or} \rangle$, $\langle \mathit{all}, \mathit{most}, \mathit{many}, \mathit{some} \rangle$, $\langle \mathit{succeed}, \mathit{try} \rangle$, $\langle \mathit{book}, \{\mathit{chapter}1, \mathit{chapter}2\} \rangle$,...

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    EXAMPLE "John ate *some* of the cookies" implicates that "John didn't eat *all* of the cookies"

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    $=$ The way hearers make use of scalar implicatures!

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    - $\neq$ The diagnostics of linguistic scales
    - $\neq$ The psychology of linguistic scales
    - $=$ The way hearers make use of scalar implicatures!
      - $\Rightarrow$ The information available to a hearer in a conversational context is a couple $\langle \Gamma^u \cup \Gamma^{bk}, \Gamma^{ls} \rangle$, with
        - Γ^u = utterances made by the speaker
        - Γ^{bk} = shared background knowledge
        - Γ^{ls} = linguistic scales available to the hearer

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$\Rightarrow$ The information available to a hearer in a conversational context:

- Γ^u only contains utterance–sentences
- Γ^{bk} only contains standard sentences

The Deductive Background

The Cookie Conversation

MOTHER	Did John eat something this afternoon?
NANNY	Yes, he ate some cookies.
	IMPLICATES THAT John didn't eat many cookies.
	IMPLICATES THAT John didn't eat all cookies.
NANNY	In fact, he ate many.
	FORCES WITHDRAWAL OF John didn't eat many cookies.
MOTHER	He didn't eat them all, did he?
NANNY	No, he didn't.

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- The deductive background is captured by the logic $\mathbf{CL}^{\mathbf{u}}_{\exists\mathbf{10}}$.
- The scalar implicatures occurring in the cookie conversation are captured by the logic $\mathbf{CL}^{\mathbf{s}}_{\exists\mathbf{10}}$, i.e. an *adaptive logic* based on $\mathbf{CL}^{\mathbf{u}}_{\exists\mathbf{10}}$.

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Step 1: The Logic $\mathbf{CL}^{\mathbf{u}}_{\exists\mathbf{10}}$

- Language Schema

  = the language schema of classical logic +

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    MEANING There are at least ten objects in the domain for which something is the case.

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\begin{aligned}
(\mathtt{All}_\alpha)(A_\alpha, B_\alpha) &=_{df} (\forall_\alpha)(A_\alpha \supset B_\alpha)\\
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    - ★ *Many* is arbitrarily taken to be *at least ten*.
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- the non–standard logical symbols $\dot{\neg}, \dot{\wedge}, \dot{\vee}, \dot{\supset}, \dot{\equiv}, \dot{\exists}, \dot{\exists}^{10}, \dot{\forall}, \dot{=}$
- the defined generalized quantifiers $\dot{\mathtt{All}}$, $\dot{\mathtt{Many}}$, and $\dot{\mathtt{Some}}$

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  = The axiom system of classical logic +

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- $(A_{\beta_1} \wedge \ldots \wedge A_{\beta_{10}} \wedge \neg(\beta_1 = \beta_2) \wedge \neg(\beta_1 = \beta_3) \wedge \ldots \wedge \neg(\beta_9 = \beta_{10})) \supset (\exists^{10}_{\alpha})A_{\alpha}$
  $(\exists^{10}_{\alpha})A_{\alpha} \supset (\exists_{\alpha_1})\ldots(\exists_{\alpha_{10}})(A_{\alpha_1} \wedge \ldots \wedge A_{\alpha_{10}} \wedge \neg(\alpha_1 = \alpha_2) \wedge \neg(\alpha_1 = \alpha_3) \wedge \ldots \wedge \neg(\alpha_9 = \alpha_{10}))$

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$\dot{\neg} A \supset A$	$\dot{\neg}\dot{\neg} A \supset A$
$(A \dot{\wedge} B) \supset (A \wedge B)$	$\dot{\neg}(A \dot{\wedge} B) \supset (\dot{\neg} A \vee \dot{\neg} B)$
$(A \dot{\vee} B) \supset (A \vee B)$	$\dot{\neg}(A \dot{\vee} B) \supset (\dot{\neg} A \wedge \dot{\neg} B)$
$(\alpha \dot{=} \beta) \supset (\alpha = \beta)$	$\dot{\neg}(\alpha \dot{=} \beta) \supset \neg(\alpha = \beta)$
$(\dot{\exists}_\alpha)A_\alpha \supset (\exists_\alpha)A_\alpha$	$\dot{\neg}(\dot{\exists}_\alpha)A_\alpha \supset (\forall_\alpha)\dot{\neg} A_\alpha$
$(\dot{\exists}^{10}_\alpha)A_\alpha \supset (\exists^{10}_\alpha)A_\alpha$	$\dot{\neg}(\dot{\exists}^{10}_\alpha)A_\alpha \supset \neg(\exists^{10}_\alpha)A_\alpha$
$(\dot{\forall}_\alpha)A_\alpha \supset (\forall_\alpha)A_\alpha$	$\dot{\neg}(\dot{\forall}_\alpha)A_\alpha \supset (\exists_\alpha)\dot{\neg} A_\alpha$

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- Important Theorem

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For Γ the set of standard sentences corresponding to the utterance–sentences in Γ^u and for A a standard sentence:

$$\Gamma^u \cup \Gamma^{bk} \vdash_{\mathbf{CL}^{\mathbf{u}}_{\exists 10}} A \text{ iff } \Gamma \cup \Gamma^{bk} \vdash_{\mathbf{CL}_{\exists 10}} A$$

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$\Rightarrow$ The hearer is able to derive all standard deductive consequences from the utterances made by the speaker!

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- Adaptive Logics are formal logics that were developed to explicate dynamic (reasoning) processes (both monotonic and non–monotonic ones).

  FOR EXAMPLE Induction, abduction, default reasoning,...

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- The *standard format* of adaptive logics
  - a lower limit logic
  - a set of abnormalities Ω
  - an adaptive strategy

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The Logic $\mathbf{CL}^{\mathbf{s}}_{\exists\mathbf{10}}$ is an adaptive logic!

- The general idea

$$\Gamma \vdash_{\mathbf{CL}^{\mathbf{s}}_{\exists\mathbf{10}}} A \text{ iff } \Gamma \vdash_{\mathbf{CL}^{\mathbf{u}}_{\exists\mathbf{10}}} A \vee Dab(\Delta) \textit{ and } \Gamma \nvdash_{\mathbf{CL}^{\mathbf{u}}_{\exists\mathbf{10}}} Dab(\Delta)$$

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  - The logic $\mathbf{CL}^{\mathbf{u}}_{\exists\mathbf{10}}$ is the lower limit logic of $\mathbf{CL}^{\mathbf{s}}_{\exists\mathbf{10}}$

    REMARK THAT all $\mathbf{CL}^{\mathbf{u}}_{\exists\mathbf{10}}$–consequences of Γ are $\mathbf{CL}^{\mathbf{s}}_{\exists\mathbf{10}}$–consequences of Γ as well.

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  - *Dab*(Δ) is a *disjunction of abnormalities* (i.e. elements of Ω)

    $\Rightarrow$ Adaptive logics try to falsify as many abnormalities as possible!

    $\Rightarrow$ Additional consequences representing the consequences obtained by applying scalar implicatures.

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  - Abnormalities that occur in *Dab*–consequences cannot all be falsified

    DEF $Dab(\Delta)$ is a *Dab*–consequence in case $\Gamma \vdash_{\mathbf{CL}^{\mathbf{u}}_{\exists 10}} Dab(\Delta)$.

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    DEF $Dab(\Delta)$ is a *Dab*–consequence in case $\Gamma \vdash_{\mathbf{CL}^{\mathbf{u}}_{\exists 10}} Dab(\Delta)$.

    $\Rightarrow$ The adaptive strategy provides the guideline to handle with those abnormalities

    IN CASU The adaptive strategy of $\mathbf{CL}^{\mathbf{s}}_{\exists 10}$ is the *normal selections strategy*.

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  - $\{(\dot{\mathtt{Some}}_\alpha)(A_\alpha, B_\alpha) \wedge (\mathtt{Many}_\alpha)(A'_\alpha, B'_\alpha) \mid A, B$ only contain utterance–symbols; A', B' are obtained from respectively A and B by replacing all utterance–symbols by the corresponding standard symbols$\}$
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The Cookie Conversation

- The information available to John's mother is represented as follows:
  - $\Gamma^{u} = \{(\dot{\texttt{Some}}_\alpha)(C_\alpha, E_{j\alpha}), (\dot{\texttt{Many}}_\alpha)(C_\alpha, E_{j\alpha}), \dot{\neg}(\dot{\texttt{All}}_\alpha)(C_\alpha, E_{j\alpha})\}$
  - $\Gamma^{bk} = \{(\texttt{Many}_\alpha)C_\alpha\}$
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  - $\Gamma^{bk} = \{(\mathtt{Many}_\alpha)C_\alpha\}$
  - $\Gamma^{ls} = \{\langle \mathtt{All}, \mathtt{Many}, \mathtt{Some}\rangle\}$

- The formula $(\dot{\mathtt{Some}}_\alpha)(C_\alpha, E_{j\alpha})$ yields two scalar implicatures:
  - $\Gamma \vdash_{\mathbf{CL}^{\mathbf{u}}_{\exists 10}} \neg(\mathtt{Many}_\alpha)(C_\alpha, E_{j\alpha}) \vee ((\dot{\mathtt{Some}}_\alpha)(C_\alpha, E_{j\alpha}) \wedge (\mathtt{Many}_\alpha)(C_\alpha, E_{j\alpha}))$
  - $\Gamma \vdash_{\mathbf{CL}^{\mathbf{u}}_{\exists 10}} \neg(\mathtt{All}_\alpha)(C_\alpha, E_{j\alpha}) \vee ((\dot{\mathtt{Some}}_\alpha)(C_\alpha, E_{j\alpha}) \wedge (\mathtt{All}_\alpha)(C_\alpha, E_{j\alpha}))$

The Cookie Conversation

- The information available to John's mother is represented as follows:
  - $\Gamma^u = \{(\dot{\texttt{Some}}_\alpha)(C_\alpha, E_{j\alpha}), (\dot{\texttt{Many}}_\alpha)(C_\alpha, E_{j\alpha}), \dot{\neg}(\dot{\texttt{All}}_\alpha)(C_\alpha, E_{j\alpha})\}$
  - $\Gamma^{bk} = \{(\texttt{Many}_\alpha)C_\alpha\}$
  - $\Gamma^{ls} = \{\langle \texttt{All}, \texttt{Many}, \texttt{Some}\rangle\}$

- The formula $(\dot{\texttt{Some}}_\alpha)(C_\alpha, E_{j\alpha})$ yields two scalar implicatures:
  - $\Gamma \vdash_{\mathbf{CL}^{\mathbf{u}}_{\exists 10}} \neg(\texttt{Many}_\alpha)(C_\alpha, E_{j\alpha}) \vee ((\dot{\texttt{Some}}_\alpha)(C_\alpha, E_{j\alpha}) \wedge (\texttt{Many}_\alpha)(C_\alpha, E_{j\alpha}))$
  - $\Gamma \vdash_{\mathbf{CL}^{\mathbf{u}}_{\exists 10}} \neg(\texttt{All}_\alpha)(C_\alpha, E_{j\alpha}) \vee ((\dot{\texttt{Some}}_\alpha)(C_\alpha, E_{j\alpha}) \wedge (\texttt{All}_\alpha)(C_\alpha, E_{j\alpha}))$

- One of them has to be withdrawn though:
  - $\Gamma \vdash_{\mathbf{CL}^{\mathbf{u}}_{\exists 10}} (\dot{\texttt{Some}}_\alpha)(C_\alpha, E_{j\alpha}) \wedge (\texttt{Many}_\alpha)(C_\alpha, E_{j\alpha})$
  - $\Gamma \nvdash_{\mathbf{CL}^{\mathbf{u}}_{\exists 10}} (\dot{\texttt{Some}}_\alpha)(C_\alpha, E_{j\alpha}) \wedge (\texttt{All}_\alpha)(C_\alpha, E_{j\alpha})$

Conclusion

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I have provided a formal explication of how scalar implicatures are applied in conversation by speakers in order to get at the intended meaning of uncooperative utterances.

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Further Research

- Can the approach be extended to other implicatures?
  = non–scalar implicatures!

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- Can the approach be extended to other implicatures?

  $=$ non–scalar implicatures!

- How to capture the prioritized case?

  $\Rightarrow$ by means of *prioritized adaptive logics*?

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