

The Inquisitive Turn

A new perspective on semantics, logic, and pragmatics

Jeroen Groenendijk and Floris Roelofsen



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www.illc.uva.nl/inquisitive-semantics

Mission statement

Inquisitive semantics

- Meaning is traditionally identified with informative content
- Our main aim is to develop a notion of meaning that captures **both informative and inquisitive content**

Inquisitive logic

- Logic is traditionally concerned with entailment, which rules the validity of argumentation
- We aim to develop logical notions of **relatedness**, which govern the **coherence of conversation**

Inquisitive pragmatics

- Gricean pragmatics specifies rules for providing information
- We aim to develop a pragmatics of **exchanging information**, taking both informative and inquisitive content into account

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Today: a first impression

Semantics

- Propositions as proposals
- Inquisitive algebra
- Attentive content
- Projection operators

Logic

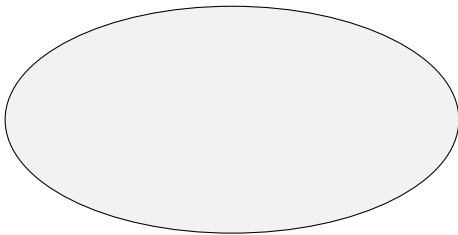
- Informative and inquisitive entailment
- Relatedness, compliance

Pragmatics

- Sincerity, Transparency, Relation

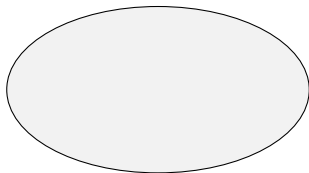
The Traditional Picture

- Meaning = informative content
- Providing information = eliminating possible worlds



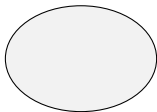
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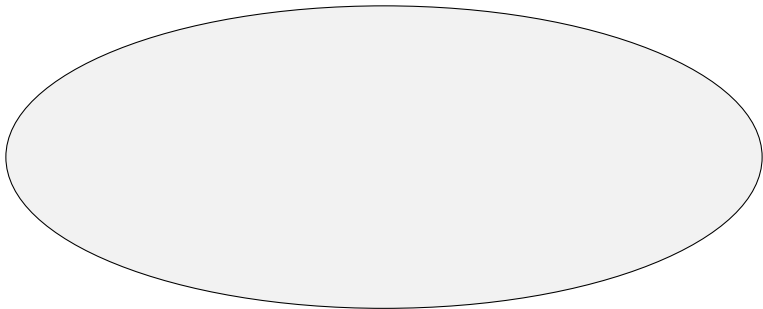
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- Providing information = eliminating possible worlds



- Captures only one type of language use: **providing information**
- Does not reflect the **cooperative** nature of communication

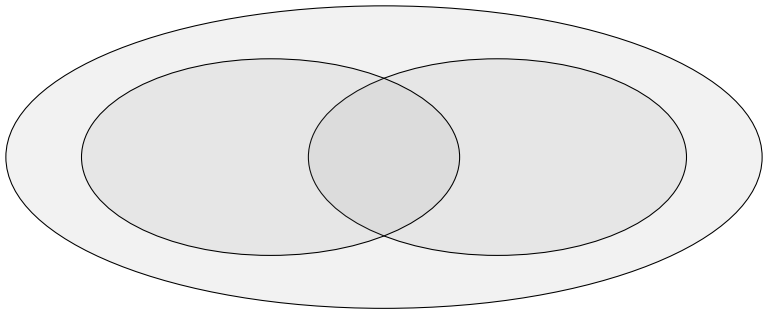
The Inquisitive Picture

- Propositions as **proposals**
- A proposal consists of one or more **possibilities**
- An **inquisitive** proposal offers several alternative possibilities



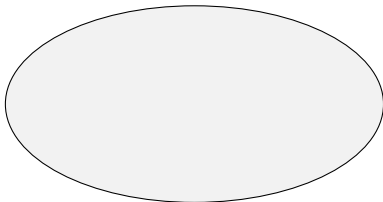
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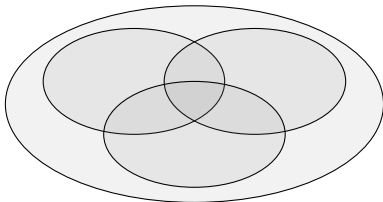
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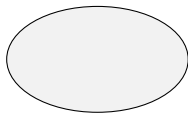
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Worlds, possibilities, and propositions

- Start with a universe of **possible worlds**
- **Possibility**: set of possible worlds
- **Proposition**: set of possibilities

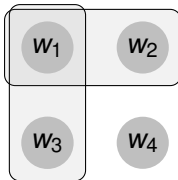
Illustration



worlds



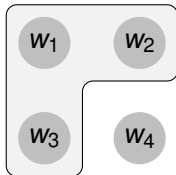
possibility



proposition

How to think of propositions?

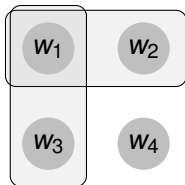
- Traditionally, a proposition is simply a set of possible worlds



- We think of such a proposition A as providing the information that the actual world corresponds to one of the worlds in A

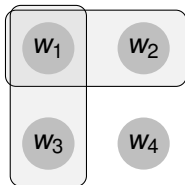
How to think of propositions?

- Now, a proposition is a **set of possibilities**



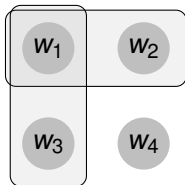
- How should we think of such propositions?
- What is the **information** that they provide?
- Could we think of them as representing **something else** besides informative content? If so, **what exactly?**

Informative and inquisitive content



- We think of a proposition A as representing a proposal to update the common ground in one or more ways
- Each possibility in A embodies one of the proposed updates
- A **provides** the **information** that the actual world is contained in at least one of the possibilities in A
- At the same time, A **requests** a **response** that establishes at least one of the proposed updates

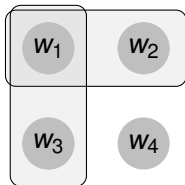
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⇒ a single semantic object embodies both informative and inquisitive content

Informative content

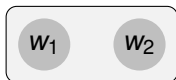


- A proposition A provides the information that the actual world is contained in **at least one** of the possibilities in A
- So, the informative content of A , $\text{info}(A)$, is determined by the **union** of all the possibilities in A :

$$\text{info}(A) = \bigcup A$$

Inquisitive proposals

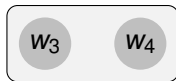
- A proposition A requests a response that establishes at least one of the updates that A proposes
- Sometimes, it suffices to **accept** the information provided by A
- If **additional information** is required, we call A **inquisitive**



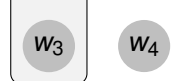
non-inquisitive



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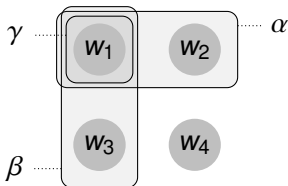


inquisitive



inquisitive

Alternative and residual possibilities



Three possibilities:

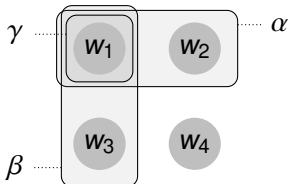
$$\alpha = \{w_1, w_2\}$$

$$\beta = \{w_1, w_3\}$$

$$\gamma = \{w_1\}$$

- Providing the information that at least one of $\{\alpha, \beta, \gamma\}$ contains the actual world is the same as providing the information that at least one of $\{\alpha, \beta\}$ contains the actual world
- Requesting a response that establishes at least one of $\{\alpha, \beta, \gamma\}$ is the same as requesting a response that establishes at least one of $\{\alpha, \beta\}$
- So γ does not play a role in determining the informative or inquisitive content of this proposition

Alternative and residual possibilities



Three possibilities:

$$\alpha = \{w_1, w_2\}$$

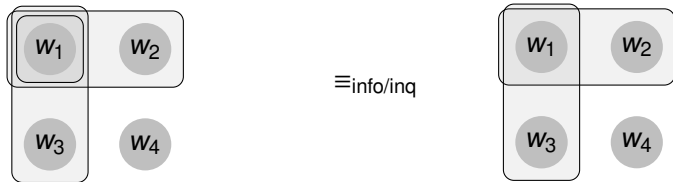
$$\beta = \{w_1, w_3\}$$

$$\gamma = \{w_1\}$$

- In general, for any proposition A , we can distinguish:
- **Alternative possibilities**
 - not properly contained in a maximal possibility in A
 - completely determine **informative and inquisitive content**
- **Residual possibilities**
 - properly contained in a maximal possibility in A
 - do not play a role in capturing **informative/inquisitive content**

Informative + inquisitive content = meaning ?

- Our aim is to develop a notion of semantic meaning that captures both informative and inquisitive content
- In principle, the notion of a proposition as an arbitrary set of possibilities fits this purpose
- However, informative and inquisitive content **do not exhaust** meaning in this setup: different propositions do not necessarily have different informative or inquisitive content



Two ways to go

Restricted inquisitive semantics

- Propositions are defined as **persistent** sets of possibilities
- For every proposition A and every two possibilities α and β :

$$\alpha \in A \text{ and } \beta \subset \alpha \implies \beta \in A$$

- This way, **informative and inquisitive content exhaust meaning**

Unrestricted inquisitive semantics

- Propositions are defined as arbitrary sets of possibilities
- Besides informative and inquisitive content, propositions are taken to represent **attentive content** as well

(Ciardelli, Groenendijk & Roelofsen 2009, 2010)

Restricted inquisitive semantics

Current approach: persistence

- For every proposition A and every two possibilities α and β :

$$\alpha \in A \text{ and } \beta \subset \alpha \implies \beta \in A$$

- **Intuition:** $\alpha \in A$ iff establishing α is enough to **satisfy** the request for information that A embodies.
- Then, if $\alpha \in A$ and $\beta \subset \alpha$, it must also be the case that $\beta \in A$

Earlier approach: alternative possibilities

- In Groenendijk & Roelofsen (2009) and Ciardelli (2009) propositions are defined as sets of **alternative** possibilities
- In a **finite** (propositional) setting this gives the desired result, but in an **infinite** (first order) setting it does not

Overview

Semantics

- Propositions as proposals ✓
- Inquisitive algebra
- Attentive content
- Projection operators

Logic

- Informative and inquisitive entailment
- Relatedness, compliance

Pragmatics

- Sincerity, Transparency, Relation

Algebraic foundations of classical logic

Classical propositions

- Sets of possible worlds
- Embody informative content

Ordering propositions

- Propositions are ordered in terms of informative content
- $A \leq B$ iff A provides at least as much information as B
- Formally: $A \leq B \iff A \subseteq B$

Algebraic foundations of classical logic

Join and meet

- Relative to \leq , every two classical propositions have
 - a **greatest lower bound** (aka their **meet**)
 - a **least upper bound** (aka their **join**)
- The **meet** of two propositions amounts to their **intersection**

$$\text{MEET}(A, B) = A \cap B$$

- The **join** of two propositions amounts to their **union**

$$\text{JOIN}(A, B) = A \cup B$$

- The existence of meets and joins implies that the set of all propositions, Σ , together with \leq , forms a **lattice**

Algebraic foundations of classical logic

Top and bottom

- The lattice has a **bottom element**, \emptyset , and a **top element**, W
- That is, for every proposition A , we have that:

$$\emptyset \leq A \leq W$$

- Thus, $\langle \Sigma, \leq \rangle$ forms a **bounded lattice**

Algebraic foundations of classical logic

Complementation

- For every propositions A , there is another proposition $C(A)$ such that:
 - The **meet** of A and $C(A)$ is the **bottom** element of the lattice, \emptyset
 - The **join** of A and $C(A)$ is the **top** element of the lattice, W
- $C(A)$ is called the **complement** of A
- For every A , $C(A) = \{w \mid w \notin A\}$
- The existence of complements implies that $\langle \Sigma, \leq \rangle$ forms a **complemented lattice**

Algebraic foundations of classical logic

Distributivity

- The meet and join operators **distribute** over each other:

$$A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$$

$$A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$$

- This means that $\langle \Sigma, \leq \rangle$ is a **distributive complemented lattice**
- Such lattices are also called **Boolean algebras**

Algebraic foundations of classical logic

Classical logic

- The **semantic operators** we considered can be associated with **syntactic operators**:
 - $[\neg\varphi] = C([\varphi]) = W - [\varphi]$
 - $[\varphi \wedge \psi] = M([\varphi], [\psi]) = [\varphi] \cap [\psi]$
 - $[\varphi \vee \psi] = J([\varphi], [\psi]) = [\varphi] \cup [\psi]$
- This is how classical propositional logic is obtained
- The approach can be extended to first-order logic as well

Inquisitive algebra

Propositions

- Propositions are **persistent** non-empty sets of possibilities
- For every proposition A and every two possibilities α and β :
 - If $\alpha \in A$ and $\beta \subset \alpha$, then it must also be the case that $\beta \in A$
- Propositions capture both informative and inquisitive content
- So propositions are also **ordered** both in terms of informative and in terms of inquisitive content

Inquisitive algebra

Ordering propositions

- $A \leq B$ if and only if:
 - A **provides** at least as much information as B :

$$\text{info}(A) \subseteq \text{info}(B)$$

- A **requests** at least as much information as B :

$$A \subseteq B$$

Simplification

- If $A \subseteq B$ then also $\text{info}(A) \subseteq \text{info}(B)$
- So $A \leq B$ if and only if $A \subseteq B$

Joins and meets

- As before, relative to \leq , every two propositions have
 - a **greatest lower bound** (aka their **meet**)
 - a **least upper bound** (aka their **join**)
- The **meet** of A and B still amounts to their **intersection**:

$$\text{MEET}(A, B) = A \cap B$$

- The **join** of A and B still amounts to their **union**:

$$\text{JOIN}(A, B) = A \cup B$$

- **Conjunction** and **disjunction** can still be seen as the syntactic counterparts of these semantic operators

$\langle \Sigma, \leq \rangle$ is not a Boolean algebra

- The existence of meets and joins implies that the set of all propositions Σ , together with the order \leq , forms a **lattice**
- Moreover, $\langle \Sigma, \leq \rangle$ has:
 - a **top element**, $\top = \wp(W)$
 - a **bottom element**, $\perp = \{\emptyset\}$
- This means that $\langle \Sigma, \leq \rangle$ forms a **bounded lattice**
- However, $\langle \Sigma, \leq \rangle$ does **not** form a **Boolean algebra**
- That is, not every $A \in \Sigma$ has a **complement** B such that:

$$\text{MEET}(A, B) = \top$$

$$\text{JOIN}(A, B) = \perp$$

$\langle \Sigma, \leq \rangle$ is a Heyting algebra

- We do have that for every two propositions A, B there is a unique weakest proposition C such that $\text{MEET}(A, C) \leq B$
- This proposition C is called the **relative pseudo-complement** of A with respect to B , and is denoted as:

$$A \Rightarrow B$$

- The existence of relative pseudo-complements implies that $\langle \Sigma, \leq \rangle$ forms a **Heyting algebra**
- The (non-relative) **pseudo-complement** of A is defined as:

$$A^* := A \Rightarrow \perp$$

- **Implication** and **negation** can be seen as the syntactic counterparts of \Rightarrow and * , respectively

Algebraic inquisitive semantics

- $[p] = \{\alpha \mid \forall w \in \alpha. w(p) = 1\}$
- $[\neg\varphi] = [\varphi]^*$ pseudo-complement
- $[\varphi \wedge \psi] = [\varphi] \cap [\psi]$ meet
- $[\varphi \vee \psi] = [\varphi] \cup [\psi]$ join
- $[\varphi \rightarrow \psi] = [\varphi] \Rightarrow [\psi]$ relative pseudo-complement

Relevance for natural language semantics

- **Disjunction (MEET)** is a source of inquisitiveness
- This provides the basis for an explanation of the **disjunctive-interrogative affinity** observed cross-linguistically

- (1) We eten vanavond boerenkool **of** hutspot.
We eat tonight boerenkool or hutspot.
'We will eat boerenkool or hutspot tonight.'
- (2) Maria weet **of** we vanavond hutspot eten.
Maria knows or we tonight hutspot eat.
'Maria knows whether we will eat hutspot tonight.'

- See AnderBois (2009, 2010) on Yukatec Maya
and Haida (2009, 2010) on Chadic languages

Relevance for natural language semantics

- Disjunction (MEET) is a source of inquisitiveness
- This facilitates a perspicuous account of sluicing

(3) Fred works for a big software company, I don't remember which.

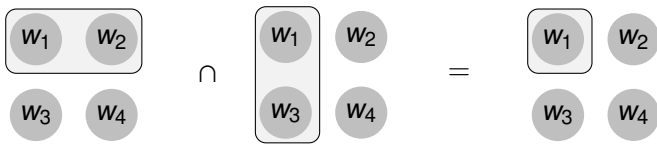
(4) Fred works for Oracle, IBM, or Adobe, I don't remember which.

- See AnderBois (2010)

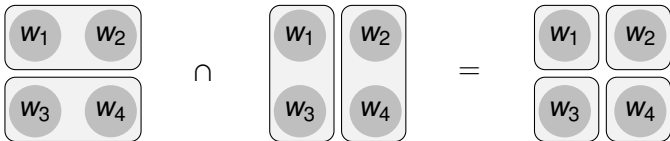
Relevance for natural language semantics

Conjunction (JOIN) applies uniformly to questions and assertions

(5) John speaks Russian and he speaks French.



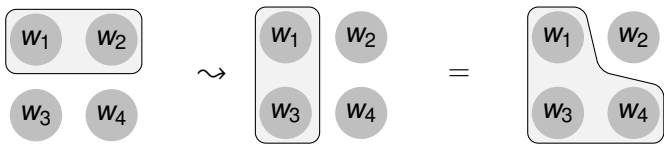
(6) Does John speak Russian, and does he speak French?



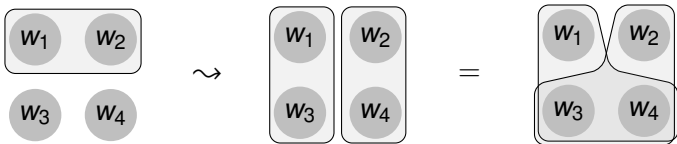
Relevance for natural language semantics

Implication (\leadsto) applies uniformly to questions and assertions

(7) If John will go to the party, Mary will go as well.



(8) If John will go to the party, will Mary go as well?



Relevance for natural language semantics

Conditional questions with disjunctive antecedents

(9) If John or Fred goes to the party, will Mary go as well?

There are **four possibilities** for this sentence, corresponding to the following responses:

- (10)
- a. Yes, if John or Fred goes, Mary will go as well.
 - b. No, if John or Fred goes, Mary won't go.
 - c. If J goes, M will go as well, but if F goes, M won't go.
 - d. If F goes, M will go as well, but if J goes, M won't go.

Overview

Semantics

- Propositions as proposals ✓
- Inquisitive algebra ✓
- **Attentive content**
- Projection operators

Logic

- Informative and inquisitive entailment
- Relatedness, compliance

Pragmatics

- Sincerity, Transparency, Relation

Unrestricted inquisitive semantics

- Propositions are defined as arbitrary sets of possibilities
- Besides providing and requesting information, we also think of a proposition A as **drawing attention** to every possibility in A
- Two propositions that provide and request exactly the same information may still draw attention to different possibilities



Pragmatic thrust of attentive content

Attentive sincerity

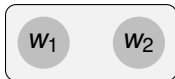
- Cooperative speakers should be **attentively sincere**
- That is, they should avoid drawing attention to possibilities that are inconsistent with their own information state

Licensing / safety

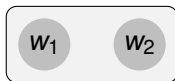
- Thus, drawing attention to a possibility α **licenses** any response that provides just enough information to establish α
- Such responses are **safe**: assuming attentive sincerity, they cannot fail to be consistent with the initiator's information state

Informative, inquisitive, and attentive propositions

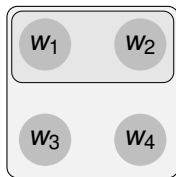
- A is **informative** iff it proposes to eliminate at least one world
- A is **inquisitive** iff it offers at least two alternative possibilities
- A is **attentive** iff it contains at least one residual possibility



purely informative



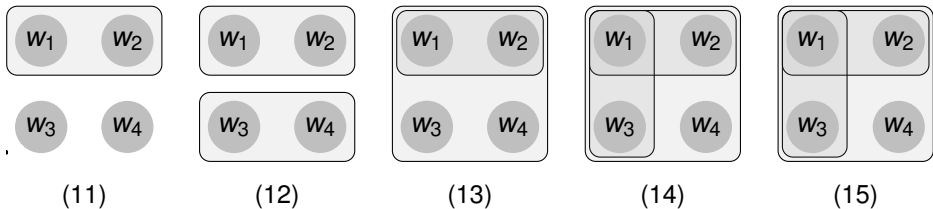
purely inquisitive



purely attentive

Relevance for natural language semantics

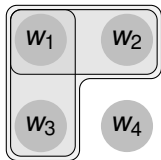
- (11) John speaks Russian. **informative**
- (12) Does John speak Russian? **inquisitive**
- (13) John **might** speak Russian. **attentive**
- (14) John **might** speak Russian **or** he **might** speak French. **attentive**
- (15) John **might** speak Russian **and** he **might** speak French. **attentive**



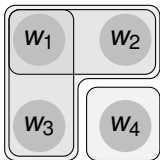
(Ciardelli, Groenendijk & Roelofsen, 2009, 2010)

Relevance for natural language semantics

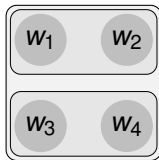
- (16) John speaks Russian or French. **informative & attentive**
- (17) Does John speak Russian-or-French[↑]? **inquisitive & attentive**
- (18) John speaks Russian or he doesn't. **purely attentive**
- (19) John speaks French or he doesn't. **purely attentive**



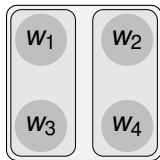
(16)



(17)



(18)

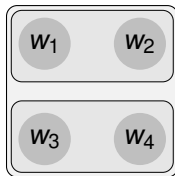


(19)

Relevance for natural language semantics

Romanian oare-questions

- (20) Oare Petru a sosit deja?
oare Peter has arrived already?
'Has Peter arrived already?'



- Farkas & Bruce 2009:
oare-questions are questions in the sense that they do not provide any information, but they differ from default questions in the sense that they **do not require an informative response**
- Similar phenomena in Hungarian (Gärtner and Gyuris, 2009), German (*in subordinate ob*, Truckenbrodt 2004), Danish, ...
- Dubitatives, evidentials, ...

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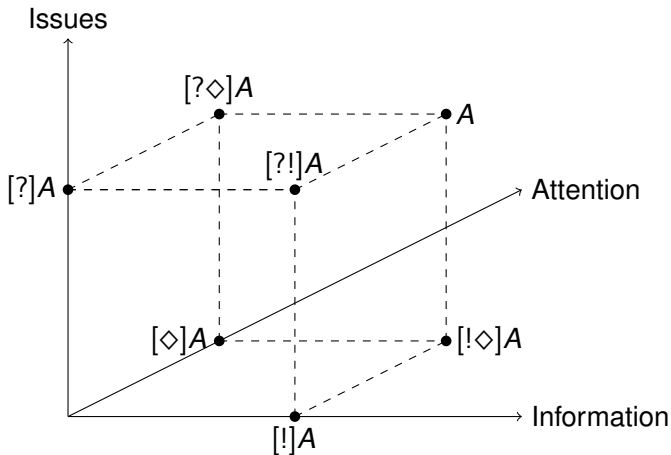
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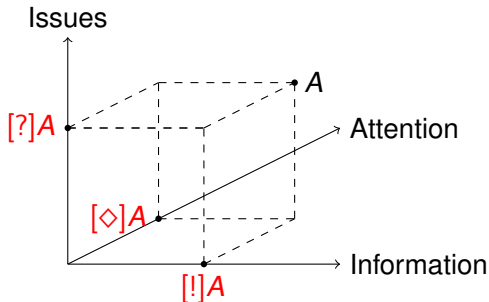
Pragmatics

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Projection operators

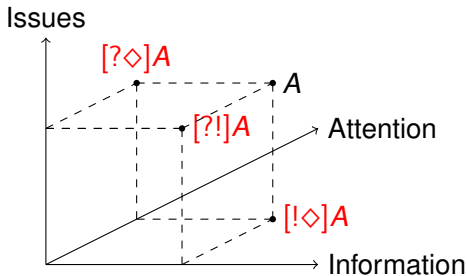


Projections onto the axes



- $[!]A$ purely informative projection
- $[?]A$ purely inquisitive projection
- $[\diamond]A$ purely attentive projection

Projections onto the planes



$[? \diamond]A$ non-informative projection

$[! \diamond]A$ non-inquisitive projection

$[?!]A$ non-attentive projection

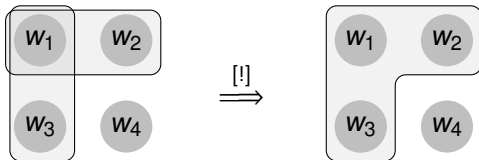
Example: purely informative projection

Requirements

- $[!]\mathbf{A}$ should **preserve** the **informative content** of \mathbf{A}
- $[!]\mathbf{A}$ should be **non-inquisitive**
- $[!]\mathbf{A}$ should be **non-attentive**

Implementation

- $[!]\mathbf{A} = \{\cup \mathbf{A}\}$



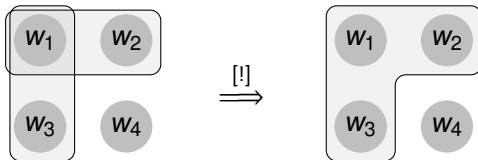
Example: purely informative projection

Requirements

- $[!]\mathbf{A}$ should **preserve** the **informative content** of \mathbf{A}
- $[!]\mathbf{A}$ should be **non-inquisitive**
- $[!]\mathbf{A}$ should be **non-attentive**

Implementation

- $[!]\mathbf{A} = \{\cup \mathbf{A}\}$



\approx 'existential closure' in alternative semantics

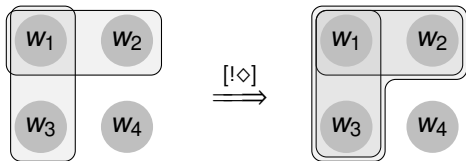
Another example: non-inquisitive projection

Requirements

- $[!\diamond]A$ should **preserve** the **informative content** of A
- $[!\diamond]A$ should be **non-inquisitive**
- $[!\diamond]A$ should **preserve** the **attentive content** of A

Implementation

- $[!\diamond]A = A \cup \{\bigcup A\}$

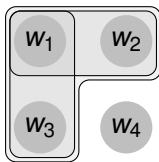


Relevance for natural language semantics

- It makes sense to think of **declarative complementizers** as non-inquisitive closure operators

Earlier example:

(16) C_Q John speaks Russian or French.



- Informative and attentive, but not inquisitive
- Alternatives introduced by **disjunction**, but closed off by C_Q

Overview

Semantics

- Propositions as proposals ✓
- Inquisitive algebra ✓
- Attentive content ✓
- Projection operators ✓

Logic

- Informative and inquisitive entailment
- Relatedness, compliance

Pragmatics

- Sincerity, Transparency, Relation

Logic

Traditionally

- logic is concerned with **entailment** and **(in)consistency**
- given these concerns, it makes sense to identify semantic meaning with informative content

Vice versa

- if semantic meaning is identified with informative content, and propositions are construed as sets of possible worlds
- then there are only three possible relations between two propositions: **inclusion**, **overlap**, and **disjointness**
- these correspond to entailment and (in)consistency
- **other relations between propositions cannot be captured**

Entailment and (in)consistency

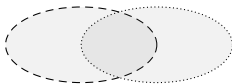
If propositions are construed as sets of possible worlds then two propositions can only be related in one of the following three ways

inclusion



entailment

overlap



consistency

disjointness



inconsistency

Inquisitive logic

A new perspective

- Enriching the notion of semantic meaning leads to a new perspective on logic as well

New logical notions

- Besides classical entailment, we get a notion of **inquisitive entailment**: φ inquisitively entails ψ iff whenever φ is resolved, ψ is resolved as well
(Ciardelli & Roelofsen 2011, Pruitt & Roelofsen 2011)
- We also get logical notions of **relatedness**. In particular, φ is a **compliant** response to ψ iff it addresses the proposal expressed by ψ without providing any redundant information.
(Groenendijk & Roelofsen 2009, Cornelisse et.al. 2009)

Inquisitive logic

A new perspective

- Enriching the notion of semantic meaning leads to a new perspective on logic as well

New logical notions

- Besides classical entailment, we get a notion of **inquisitive entailment**: φ inquisitively entails ψ iff whenever φ is resolved, ψ is resolved as well
- We also get logical notions of **relatedness**. In particular, φ is a **compliant** response to ψ iff it addresses the proposal expressed by ψ without providing any redundant information.

Note: **classical notions are preserved**; the logical agenda is extended, not revised (compare, e.g., with intuitionistic logic)

Pragmatics

Pragmatics specifies how **cooperative** speakers should **use** the sentences of a language, given a particular context and the semantic meaning of those sentences

Classical (Gricean) pragmatics

- identifies **semantic meaning** with **informative content**
- is **speaker-oriented**
- **Quality:** say only what you believe to be true
- **Quantity:** be as informative as possible
- **Relation:** say only things that are relevant for the purposes of the conversation

Inquisitive pragmatics

A new perspective

- Enriching the notion of semantic meaning leads to a new perspective on pragmatics as well

Inquisitive pragmatics

- based on **informative**, but also **inquisitive/attentive content**
- **speaker-oriented**, but also **hearer-oriented**
- **Sincerity**: only say what you know, only ask what you don't know, only draw attention to possibilities compatible with what you know
- **Transparency**: publicly announce unacceptability of a proposal
- **Relation**: compliantly address previous proposals

Summary

- The main purpose of inquisitive semantics is to develop a **new notion of semantic meaning** that captures both informative and inquisitive content
- Propositions are defined as sets of possibilities, representing **proposals to update the common ground in one or more ways**
- These new type of propositions are **ordered** in a natural way, based on their informative and inquisitive content
- This order yields **algebraic operators** like JOIN, MEET, \leadsto , and \sim
- The new conception of propositions also naturally gives rise to **projection operators** like $[?]$ and $[!]$
- These algebraic operators and projection operators could be related to **connectives and complementizers** in formal and natural languages

Summary

- Changing the basic notion of semantic meaning gives rise to a new perspective on **logic**
- Besides informative entailment and consistency, new logical notions like **inquisitive entailment** and **compliance** enter the picture
- Changing the basic notion of semantic meaning also changes our perspective on **pragmatics**
- Speakers should not only be informatively sincere, but also **inquisitively and attentively sincere**
- Responders should be **transparent** and make a contribution that is **related** to previous proposals

Some references

Inquisitive semantics and pragmatics

Jeroen Groenendijk and Floris Roelofsen (2009)

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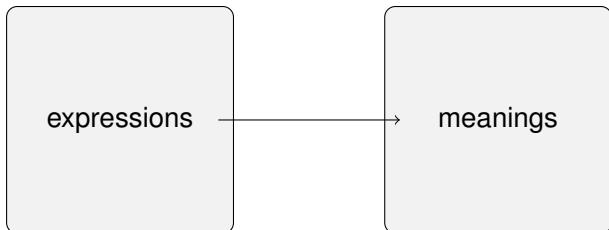
www.illc.uva.nl/inquisitive-semantics



www.illc.uva.nl/inquisitive-semantics

Appendix: framework versus theories

- Natural language semantics seeks to assign appropriate meanings to linguistic expressions in a systematic way



- The work presented here focused on developing a richer space of meanings, and investigating the properties of these meanings, independently of the expressions in natural language that they may be assigned to
- This work suggests a certain semantic treatment of connectives and complementizers

Appendix: framework versus theories

- However, first and foremost, it establishes a **framework** for natural language semantics, leaving many options open as to how the expressions of concrete natural languages should be **mapped** to the enriched meanings
- To illustrate this point, consider the case of *wh*-questions
- **Inquisitive semantics, qua framework, does not make any claims about the proper semantic analysis of *wh*-questions**
- It offers a general framework to capture inquisitive content
- Hamblin's, Karttunen's, and Groenendijk & Stokhof's theories can all be expressed and compared in this framework
- The framework as such does not favor any of these theories