The Inquisitive Turn

—a new perspective on semantics, pragmatics, and logic—

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www.illc.uva.nl/inquisitive-semantics

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Overview

Inquisitive semantics

- Motivation
- Definition and illustration
- Some crucial properties

Inquisitive pragmatics

Inquisitive logic

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Inquisitive semantics

- Motivation
- Definition and illustration
- Some crucial properties

Inquisitive pragmatics

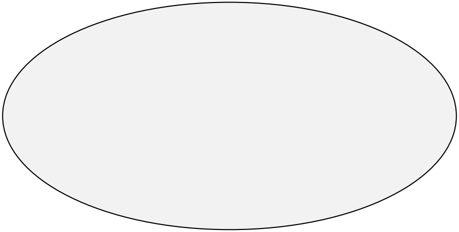
Inquisitive logic

Disclaimer

- Definitions are sometimes simplified for the sake of clarity
- This is all work in progress, there are many open issues, many opportunities to contribute!

The Traditional Picture

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



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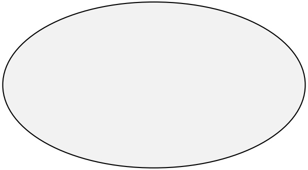

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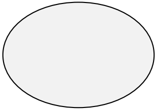

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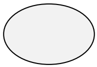

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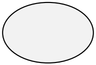
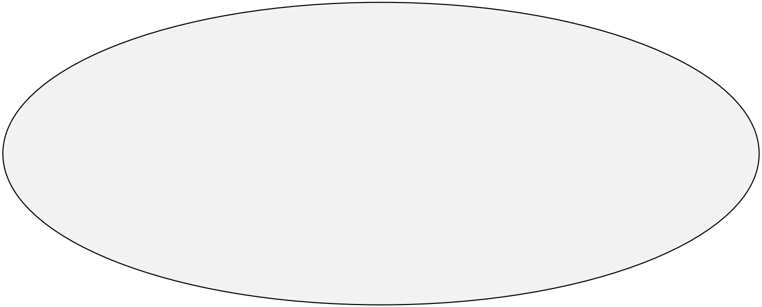


- Captures only one type of language use: providing information
- Does not reflect the cooperative nature of communication

The Inquisitive Picture

- Propositions as proposals
- A proposal consists of one or more possibilities
- A proposal that consists of several possibilities is inquisitive



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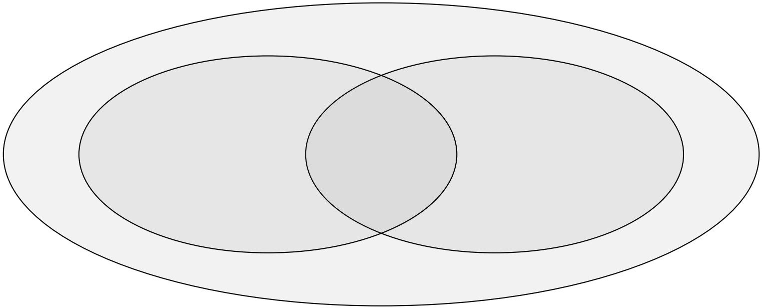

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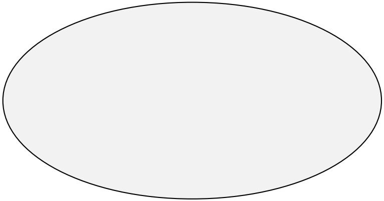

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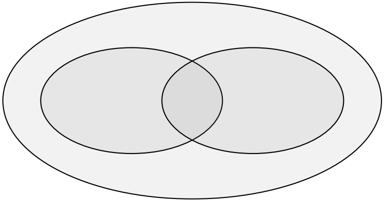

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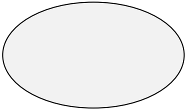


A Propositional Language

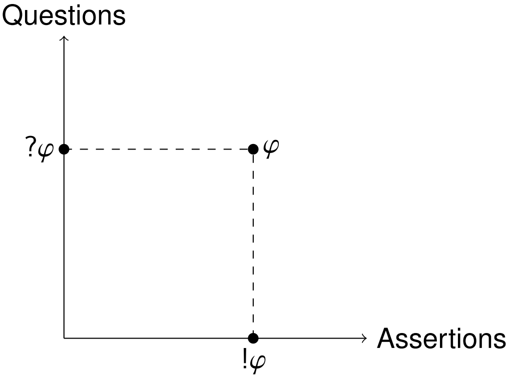
Basic Ingredients

- Finite set of proposition letters $\mathcal{P}$
- Connectives $\bot$, $\wedge$, $\vee$, $\rightarrow$

Abbreviations

- Negation: $\neg\varphi := \varphi \rightarrow \bot$
- Non-inquisitive projection: $!\varphi := \neg\neg\varphi$
- Non-informative projection: $?\varphi := \varphi \vee \neg\varphi$

Projections

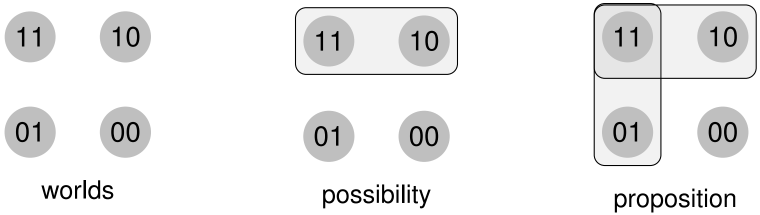


Semantic Notions

Basic ingredients

- Possible world: function from $\mathcal{P}$ to $\{0, 1\}$
- Possibility: set of possible worlds
- Proposition: set of alternative possibilities

Illustration, assuming that $\mathcal{P} = \{p, q\}$



Semantic notions

Basic Ingredients

- Possible world: function from $\mathcal{P}$ to $\{0, 1\}$
- Possibility: set of possible worlds
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Notation

- $[\varphi]$: the proposition expressed by φ
- $|\varphi|$: the truth-set of φ (set of indices where φ is classically true)

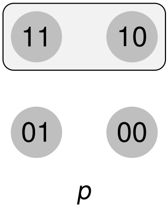
Classical versus inquisitive

- φ is classical iff $[\varphi]$ contains exactly one possibility
- φ is inquisitive iff $[\varphi]$ contains more than one possibility

Atoms

For any atomic formula φ: $[\varphi] = \{ \, |\varphi| \, \}$

Example:



Connectives

In the classical setting

connectives operate on sets of possible worlds:

- negation = complement
- disjunction = union
- conjunction = intersection

In the inquisitive setting

connectives operate on sets of sets of possible worlds:

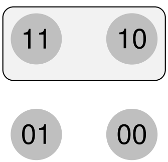
- negation = complement of the union
- disjunction = union
- conjunction = pointwise intersection

Negation

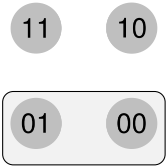
Definition

- $[\neg\varphi] = \{\ \overline{\bigcup[\varphi]}\ \}$
- Take the union of all the possibilities for φ; then take the complement

Example, φ classical:



$[p]$



$[\neg p]$

Negation

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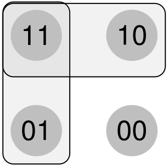
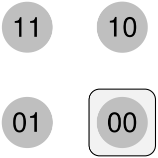
Example, φ inquisitive:



$[\varphi]$



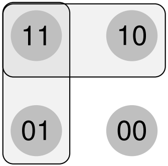
$[\neg\varphi]$

Disjunction

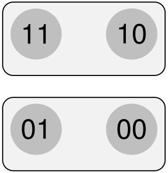
Definition

- $[\varphi \vee \psi] = [\varphi] \cup [\psi]$

Examples:



$p \vee q$



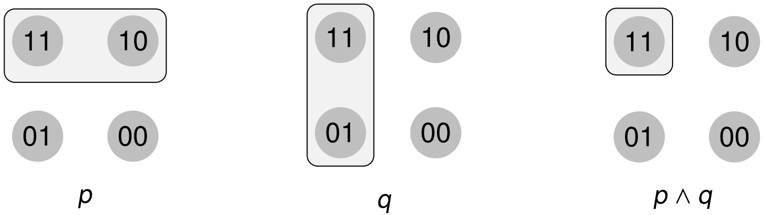
$?p \;\; (:= p \vee \neg p)$

Conjunction

Definition

- $[\varphi \wedge \psi] = [\varphi] \sqcap [\psi]$
- Pointwise intersection

Example, φ and ψ classical:



Conjunction

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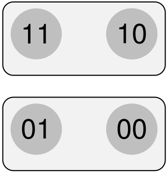
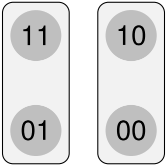
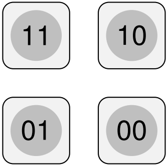
Example, φ and ψ inquisitive:



$?p$



$?q$



$?p \wedge ?q$

Implication

Intuition

$$\varphi \to \psi$$

- Says that if φ is realized in some way, then ψ must also be realized in some way
- Raises the issue of what the exact relation is between the ways in which φ may be realized and the ways in which ψ may be realized

Example

If John goes to London, then Bill or Mary will go as well

$$p \rightarrow (q \vee r)$$

- Says that if p is realized in some way,
  then $q \vee r$ must also be realized in some way

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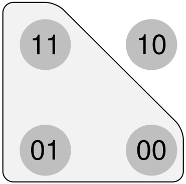
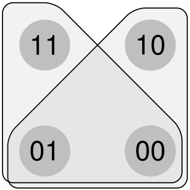
- but $q \vee r$ can be realized in two ways
- Thus, $p \to (q \vee r)$ raises the issue
  of whether the realization of p implies the realization of q,
  or whether the realization of p implies the realization of r
- $[p \to (q \vee r)] = \{\, |p \to q| \,,\, |p \to r| \,\}$

Pictures, classical and inquisitive



$p \rightarrow q$



$p \rightarrow ?q$

If John goes, Mary will go as well.

If John goes, will Mary go as well?

Another way to think about it

Intuition

$$\varphi \to \psi$$

- Draws attention to the potential implicational dependencies between the possibilities for φ and the possibilities for ψ
- Says that at least one of these implicational dependies holds
- Raises the issue which of the implicational dependencies hold

Example

If John goes to London, Bill or Mary will go as well

$$p \rightarrow (q \vee r)$$

- Two potential implicational dependencies:
  - $p \rightsquigarrow q$
  - $p \rightsquigarrow r$
- The sentence:
  - Says that at least one of these dependencies holds
  - Raises the issue which of them hold exactly

A more complex example

If John goes to London or to Paris, will Mary go as well?

$$(p \vee q) \rightarrow ?r$$

- Four potential implicational dependencies:
  - $(p \rightsquigarrow r) \;\; \& \; (q \rightsquigarrow r)$
  - $(p \rightsquigarrow \neg r) \; \& \; (q \rightsquigarrow \neg r)$
  - $(p \rightsquigarrow r) \;\; \& \; (q \rightsquigarrow \neg r)$
  - $(p \rightsquigarrow \neg r) \; \& \; (q \rightsquigarrow r)$
- The sentence:
  - Says that at least one of these dependencies holds
  - Raises the issue which of them hold exactly

Formalization

- Each possibility for $\varphi \to \psi$ corresponds to a potential implicational dependency between the possibilities for φ and the possibilities for ψ;
- Think of an implicational dependency as a function f mapping every possibility $\alpha \in [\varphi]$ to some possibility $f(\alpha) \in [\psi]$;
- What does it take to establish an implicational dependency f?
- For each $\alpha \in [\varphi]$, we must establish that $\alpha \Rightarrow f(\alpha)$ holds

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Implementation

- $[\varphi \to \psi] = \{\gamma_f \mid f : [\psi]^{[\varphi]}\}$ where $\gamma_f = \bigcap_{\alpha \in [\varphi]} (\alpha \Rightarrow f(\alpha))$

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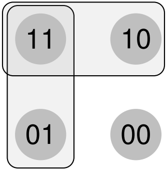
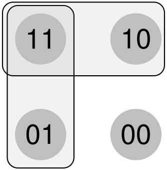
- For simplicity, we usually define $\alpha \Rightarrow f(\alpha)$ in terms of material implication: $\overline{\alpha} \cup f(\alpha)$. But any more sophisticated treatment of conditionals could in principle be plugged in here.

Informativeness and Inquisitiveness



- $p \vee q$ is inquisitive: $[p \vee q]$ consists of more than one possibility
- $p \vee q$ is informative: $[p \vee q]$ proposes to eliminate indices

Informativeness and Inquisitiveness



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- $\bigcup[\varphi]$ captures the informative content of φ

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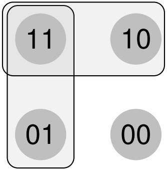
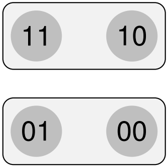


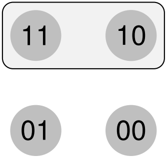
- $p \vee q$ is inquisitive: $[p \vee q]$ consists of more than one possibility
- $p \vee q$ is informative: $[p \vee q]$ proposes to eliminate indices
- $\bigcup[\varphi]$ captures the informative content of φ
- Fact: for any formula φ, $\bigcup[\varphi] = |\varphi|$

  $\Rightarrow$ classical notion of informative content is preserved

Questions, assertions, and hybrids

- φ is a question iff it is not informative
- φ is an assertion iff it is not inquisitive





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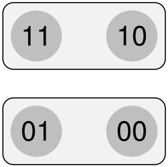
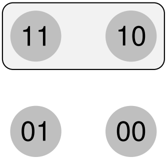
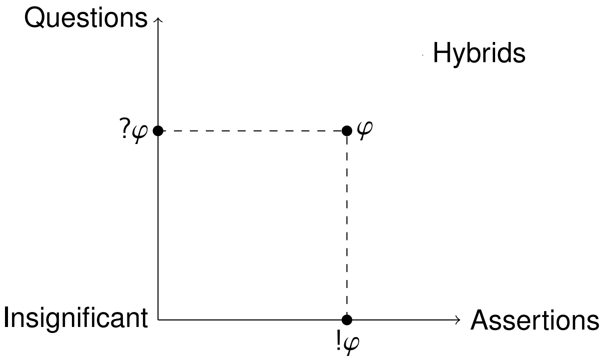




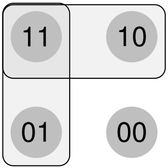
- φ is a hybrid iff it is both informative and inquisitive
- φ is insignificant iff it is neither informative nor inquisitive

Questions, assertions, and hybrids

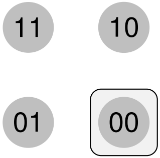


Non-inquisitive closure

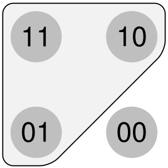
- Double negation always preserves the informative content of a sentence, but removes inquisitiveness



$p \vee q$



$\neg(p \vee q)$



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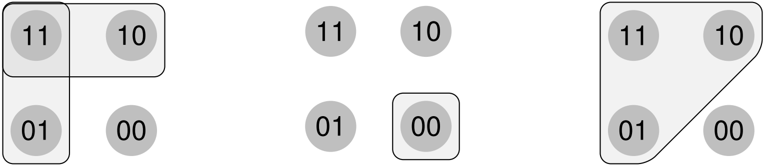


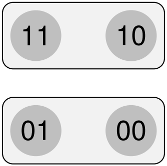
$p \vee q$ $\neg(p \vee q)$ $\neg\neg(p \vee q)$

- Therefore, $\neg\neg\varphi$ is abbreviated as $!\varphi$
- and is called the non-inquisitive closure of φ

Significance and inquisitiveness

- In a classical setting, non-informative sentences are tautologous, i.e., insignificant
- In inquisitive semantics, some classical tautologies come to form a new class of meaningful sentences, namely questions
- Questions are meaningful not because they are informative, but because they are inquisitive

- Example: $?p := p \vee \neg p$



$p \vee \neg p$

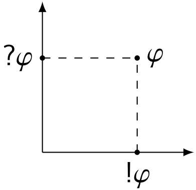
Alternative characterization of questions and assertions

Equivalence

- φ and ψ are equivalent iff $[\varphi] = [\psi]$
- Notation: $\varphi \equiv \psi$

Questions and assertions

- φ is a question iff $\varphi \equiv ?\varphi$
- φ is an assertion iff $\varphi \equiv !\varphi$



Division fact

- For any φ: $\varphi \equiv ?\varphi \wedge !\varphi$

Pragmatics

- specifies how cooperative speakers should use the sentences of a language in particular contexts, given the semantic meaning of those sentences

Classical (Gricean) pragmatics

- identifies semantic meaning with informative content
- is exclusively 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

- Inquisitive semantics enriches the notion of semantic meaning
- This gives rise to a new perspective on pragmatics as well

Inquisitive pragmatics

- based on informative content, but also on inquisitive content
- speaker-oriented, but also hearer-oriented

- Quality: say only what you know, ask only what you want to know
  publicly announce unacceptability of a proposal
- Quantity: say more, ask less
- Relation: be *compliant* $\Rightarrow$ formal notion of relatedness

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, propositions are construed as sets of possible worlds
- there are only three possible relations between two sets of worlds: inclusion, overlap, and disjointness
- these correspond to entailment and (in)consistency
- other relations between sentences cannot be captured

Inquisitive logic

A new perspective

- Inquisitive semantics enriches the notion of semantic meaning
- This gives rise to a new perspective on logic as well

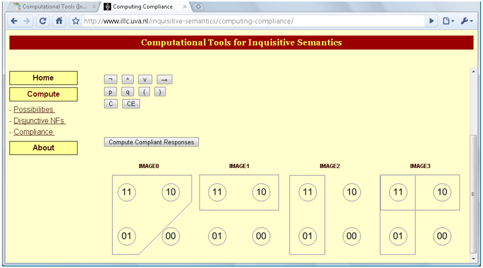
New logical notions

- 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 issue raised by ψ without providing any redundant information.
- Note: classical notions are not replaced, but preserved.

Computational tools and applications

Tools

- sites.google.com/site/inquisitivesemantics/implementation



Applications

- Dialogue systems, question-answer systems, negotiation protocols, ambiguity resolution.

Some references

Inquisitive semantics and pragmatics

Jeroen Groenendijk and Floris Roelofsen (2009) *Stanford workshop on Language, Communication and Rational Agency*

Inquisitive logic

Ivano Ciardelli and Floris Roelofsen (2010)
Journal of Philosophical Logic

Disjunctive questions, intonation, and highlighting

Floris Roelofsen and Sam van Gool (2010) *Logic, Language, and Meaning: selected papers from the Amsterdam Colloquium*

www.illc.uva.nl/inquisitive-semantics