

# Dialogical Foundations of Semantics (DiFoS)

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# Questions

- What are the big research questions driving this CRP?
- What is innovative?
- What do we find most exciting?
- What are the open problems shared with other CRPs?
- Do we see any opportunities how research can be of use to other CRPs and vice versa?
- Do we have suggestions for cooperation within and / or beyond LogICCC?

# The big research question

What is logic?

More specifically: What is logical inference?

The answer is crucial to

- science
- argumentation
- the dealing with any sort of “why”-question

Logic is needed for argumentative interaction.

# Logic for interaction

- Logic as the **basis** of (argumentative) interaction
- Logic as a **tool** for modelling interaction

We are rather interested in:

## Interactive foundations of logic

i.e., logic as rooted in interaction,

i.e., **interaction as the basis of logic.**

# Dialogical Foundations

Initiated at the end of the 1950s by Lorenzen as an alternative approach to rule-based semantics: “**Dialogical logic**”

Rival approach by Hintikka: “**Game-theoretic semantics**”

Idea: Propositions are the subject of a disputation between two agents. Validity is given by a **winning strategy** of one agent against any move of the opposed agent.

# Logical archaeology?

1958 – 2008

“What is innovative about your proposed approach?”

“What do you yourself find most exciting about the project?”

Answer: We investigate dialogical foundations of logic in a **radically different environment.**

1958:

- Central issue: Foundations of mathematics
- Constructive vs. classical (platonist) foundations

## Fifty years later

- Mathematics no longer dominating logic
  - neither mathematical applications
  - nor foundations of mathematics
- Logic facing new technologies
  - Logic in computer science
  - Computerized logic
- Boundaries between different logical disciplines becoming increasingly irrelevant
  - Example: model theory vs. proof theory
  - Much more communication between different camps
- Logic has become a genuine tool of philosophy outside philosophy of science



## Fifty years later

- Growing interest in the history and philosophy of logic
  - modern history
  - ancient and medieval logic
- The epistemic turn in logical foundations
  - From language to cognition
  - logical dynamics — dynamic logic
- Logical Frameworks
  - Anti-foundationalism, anti-justificationism
  - Different logics for different applications (“logical pluralism”)
    - type theories
    - substructural logics
- etc.

# General topics

- Technical
  - Reasoning format (type of calculus: sequent, natural deduction)
  - Uniform frameworks for game rules
  - Notions of “proof” and “strategy”
- Philosophical
  - Why play (adversarial) games at all?
  - Why are particular rules preferable to others?
  - What comes first: Games, strategies or proofs?
  - How to show that a winning strategy is available?

# Some special problems

- Proof-theoretic vs. dialogical semantics
- Negation
  - Denial
  - Absurdity
  - Change-of-roles
- Logic Programming
  - Incorporation of negation
  - Extended Logic Programming
- Protocols
  - cryptographic
  - zero-knowledge
- Mathematical proofs
  - Dialogues and mathematical arguments

## Two basic problems

The *strategy* problem

- Following a strategy: What does that mean?
- How to prove that there is a strategy?

The *frame rules* problem

- What are the proper frame rules for dialogues?

## Further open problems shared with other CRPs?

- Logic for interaction vs. interaction in logic
- Dialogues and cognition
- Relationship to equilibrium based game theory
- Non-monotonicity vs. uncertainty / probabilistic reasoning

	<b>Tübingen</b>	<b>Lisbon</b>	<b>Amsterdam</b>
	<i>Proof-theoretic vs. dialogue semantics</i>	<i>Dialogues and computer-aided proofs</i>	<i>Historical roots of dialogical and game-based reasoning</i>
	<i>Master projects</i>		
M-1	Technical aspects of dialogue semantics		
M-2	Philosophical foundations of dialogue semantics		
	<i>Collaborative projects</i>		
C-LA		Dialogues and arguments in mathematical proofs	
C-TA	Negation, duality and denial in dialogue semantics		Negation, duality and denial in dialogue semantics
C-TL	Zero knowledge proofs		
	Extended logic programming		
	<i>Local projects</i>		
L-T1	Lorenzen's case for dialogical logic		
L-T2	Definitional reasoning and dialogue semantics		
L-T3	Propositions-as-types-of-strategies in linguistics		
L-L		Interaction in computer-aided theorem proving	
L-A			Medieval theories of <i>obligationes</i> in relation to dialogue semantics

# Historical roots

- The understanding of the historical roots is intrinsic to the understanding of a subject.
- Lorenzen explicitly related dialogical logic to Greek origins (“Logik und Agon”, 1958)
- Logic is rooted in **rhetoric**
- More can be said about the historical roots of dialogues in logic, in particular about its **medieval roots**.
- The individual work by the Amsterdam site is devoted to the medieval roots of dialogical semantics.

# The medieval theory and practice of *obligationes*

Formal dialogues deal with *obligations* players enter when claiming a proposition.

- Obligations related to the content of a proposition
- Obligations related to the frame rules of the game

There is a medieval theory and practice of *obligationes* that deals with dialectical disputations regulated by formal rules.

It is only natural to study them on the background of modern developments.



# Dialogue games before Lorenzen: A brief introduction to *obligationes*

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# Games and logic

**Dialogue games** in logic have a history going back to the Middle Ages.

*The links between logic and games go back a long way. If one thinks of a debate as a kind of game, then Aristotle already made the connection; his writings about syllogism are closely intertwined with his study of the aims and rules of debating. Aristotle's viewpoint survived into the common medieval name for logic: dialectics. In the mid twentieth century Charles Hamblin revived the link between dialogue and the rules of sound reasoning, soon after Paul Lorenzen had connected dialogue to constructive foundations of logic [Hodges, SEP, "Logic and games"]*

**Obligationes** are a game-like disputation, conceptually very similar to Lorenzen's dialectical games.

The name derives from the fact that the players are "obliged" to follow certain formal rules of discourse.

## Different types of *obligationes*

- ▶ *positio*.
- ▶ *depositio*.
- ▶ *dubitatio*.
- ▶ *impositio*.
- ▶ *petitio*.
- ▶ *rei veritas / sit verum*.

## Authors who wrote on *obligationes*

- ▶ Nicholas of Paris (fl. 1250)
- ▶ William of Shyreswood (1190–1249)
- ▶ Walter Burley (or Burleigh) c. 1275–1344)
- ▶ Roger Swyneshed (d. 1365)
- ▶ Richard Kilvington (d. 1361)
- ▶ William Ockham (c. 1285–1347)
- ▶ Robert Fland (c. 1350)
- ▶ Richard Lavenham (d. 1399)
- ▶ Ralph Strode (d. 1387)
- ▶ Peter of Candia (late 14th C)
- ▶ Peter of Mantua (d. 1399)
- ▶ Paul of Venice (c. 1369–1429)

## Recent research on *obligationes*

- ▶ The origin of *obligationes* is unclear, as is their purpose.  
Uckelman, 2008. “What is the point of *obligationes*?”, talk presented at Leeds Medieval Congress, July 2008:  
<http://staff.science.uva.nl/~suckelma/latex/leeds-slides.pdf>
- ▶ First treatises edited in the early 1960s; “real” start in the late 1970s.
- ▶ Few treatises currently translated out of Latin; not very accessible to non-medievalists.

## Positio according to Burley

- ▶ Two players, the **opponent** and the **respondent**.
- ▶ The **opponent** starts by positing a *positum*  $\varphi^*$ .
- ▶ The **respondent** can “admit” or “deny”. If he denies, the game is over.
- ▶ If he admits the *positum*, the game starts. We set  $\Phi_0 := \{\varphi^*\}$ .
- ▶ In each round  $n$ , the **opponent** proposes a statement  $\varphi_n$  and the **respondent** either “concedes”, “denies” or “doubts” this statement according to certain rules. If the **respondent** concedes, then  $\Phi_{n+1} := \Phi_n \cup \{\varphi_n\}$ , if he denies, then  $\Phi_{n+1} := \Phi_n \cup \{\neg\varphi_n\}$ , and if he doubts, then  $\Phi_{n+1} := \Phi_n$ .

## *Positio* according to Burley.

- ▶ We call  $\varphi_n$  **pertinent** (relevant) if either  $\Phi_n \vdash \varphi_n$  or  $\Phi_n \vdash \neg\varphi_n$ . In the first case, the **respondent** has to concede  $\varphi_n$ , in the second case, he has to deny  $\varphi_n$ .
- ▶ Otherwise, we call  $\varphi_n$  **impertinent** (irrelevant). In that case, the **respondent** has to concede it if he knows it is true, to deny it if he knows it is false, and to doubt it if he doesn't know.
- ▶ The **opponent** can end the game by saying *Tempus cedit*.

## An example of *positio*

### Opponent

I posit that Cicero was the teacher of Alexander the Great:  $\varphi^*$ .

The teacher of Alexander the Great was Greek:  $\varphi_0$ .

Cicero was Greek:  $\varphi_1$ .

### Respondent

I admit it.  $\Phi_0 = \{\varphi^*\}$ .

I concede it. Impertinent and true  $\Phi_1 = \{\varphi^*, \varphi_0\}$ .

I concede it. Pertinent, follows from  $\Phi_1$ .



## Another example (“order matters!”)

### Opponent

I posit that Cicero was the teacher of Alexander the Great:  $\varphi^*$ .

The teacher of Alexander the Great was Roman:  $\varphi_0$ .

Cicero was Roman:  $\varphi_1$ .

### Respondent

I admit it.

I deny it.

I deny it.

$\Phi_0 = \{\varphi^*\}$ .

Impertinent and false;  $\Phi_1 = \{\varphi^*, \neg\varphi_0\}$ .

Pertinent, contradicts  $\Phi_1$ .

## Properties of Burley's *positio*.

Provided that the *positum* is consistent,

- ▶ no disputation requires the **respondent** to concede  $\varphi$  at step  $n$  and  $\neg\varphi$  at step  $m$ .
- ▶  $\Phi_i$  will always be a consistent set.
- ▶ it can be that the **respondent** has to give different answers to the same question.
- ▶ The **opponent** can force the **respondent** to concede everything consistent.

### References:

Dutilh Novase, Catarina. 2005. *Formalizations après la lettres*, Ph.D. thesis, Universiteit Leiden.

Spade, Paul V. 2008. "Medieval theories of *obligationes*", *Stanford Encyclopedia of Philosophy*,

<http://plato.stanford.edu/entries/obligationes/>.

## An example of this fact

Suppose that  $\varphi$  does not imply  $\neg\psi$  and that  $\varphi$  is known to be factually false.

### Opponent

I posit  $\varphi$ .

$\neg\varphi \vee \psi$ .

$\psi$

### Respondent

I admit it.

I concede it.

I concede it.

$\Phi_0 = \{\varphi\}$ .

Either  $\varphi$  implies  $\psi$ , then the sentence is pertinent and follows from  $\Phi_0$ ; or it doesn't, then it's impertinent and true (since  $\varphi$  is false);  $\Phi_1 = \{\varphi, \neg\varphi \vee \psi\}$ . Pertinent, follows from  $\Phi_1$ .

## Two broad classifications

### *responsio antiqua*

Walter Burley

William of Shyreswood

Ralph Strode

Peter of Candia

Paul of Venice

### *responsio nova*

Roger Swyneshed

Robert Fland

Richard Lavenham

- ▶ **Walter Burley**, *De obligationibus*: Standard set of rules.
- ▶ **Roger Swyneshed**, *Obligationes* (1330–1335): Radical change in one of the rules results in a distinctly different system.

## *positio* according to Swyneshed.

- ▶ All of the rules of the game stay as in Burley's system, except for the definition of *pertinence*.
- ▶ In Swyneshed's system, a proposition  $\varphi_n$  is **pertinent** if it either follows from  $\varphi^*$  (then the **respondent** has to concede) or its negation follows from  $\varphi^*$  (then the **respondent** has to deny). Otherwise it is impertinent.

## Properties of Swyneshed's *positio*.

Provided that the *positum* is consistent,

- ▶ no disputation requires the **respondent** to concede  $\varphi$  at step  $n$  and  $\neg\varphi$  at step  $m$ .
- ▶ The **respondent** never has to give different answers to the same question.
- ▶  $\Phi_i$  can be an inconsistent set.

## *positio* according to Kilvington

- ▶ *Sophismata*, c. 1325.
- ▶ *obligationes* as a solution method for sophismata.
- ▶ He follows Burley's rules, but changes the handling of impertinent sentences. If  $\varphi_n$  is impertinent, then the **respondent** has to concede if it **were true if the *positum* was the case**, and has to deny if it **were true if the *positum* was not the case**.

## *Impositio*

- ▶ In the *impositio*, the **opponent** doesn't posit a *positum* but instead gives a definition or redefinition.
- ▶ **Example 1.** “In this *impositio*, *asinus* will signify *homo*”.
- ▶ **Example 2.** “In this *impositio*, *deus* will signify *homo* in sentences that have to be denied or doubted and *deus* in sentences that have to be conceded.”

Suppose the **opponent** proposes “*deus est mortalis*”.

- ▶ If the **respondent** has to deny or doubt the sentence, then the sentence means *homo est mortalis*, but this is a true sentence, so it has to be conceded. Contradiction.
- ▶ If the **respondent** has to concede the sentence, then the sentence means *deus est mortalis*, but this is a false sentence, so it has to be denied. Contradiction.
- ▶ An *impositio* often takes the form of an insoluble.



## Dubitatio

In *dubitatio*, the **respondent** must **doubt** the statement that the **opponent** puts forward (called the *dubitatum*).

### Rules:

- ▶ if  $\varphi$  or  $\neg\varphi$  is equivalent with the *dubitatum*,  $\varphi$  must be doubted.
- ▶ if  $\varphi$  implies the *dubitatum*, it must be doubted or denied.
- ▶ if  $\varphi$  is implied by the *dubitatum*, it must be doubted or accepted.
- ▶ if  $\varphi$  is irrelevant, the **respondent** should accept if he knows  $\varphi$  is true, deny if he knows  $\varphi$  is false, and doubt if he does not know either.
- ▶ the exercise cannot be terminated (!)
- ▶ world-knowledge does not change (“all responses must be directed to the same instant”).

**Reference:** Uckelman, Maat, Rybalko, “The art of doubting in *Obligaciones Parisienses*”, forthcoming in Kann, Löwe, Rode, Uckelman, eds., *Modern Views of Medieval Logic*.

## DiFoS research goals concerning *obligationes*

Main goals of DiFoS:

- ▶ Describe the **foundational value** of Lorenzen's dialogical logic.
- ▶ Embed it into a **modern scientific context** taking into account its **historical roots**.
  - ▶ Formal relations between modern interactive approaches, Lorenzen's dialogical semantics, and *obligationes*: formalizations, consistency proofs, winning strategies.
  - ▶ Connections between dialogue and proof (in medieval logic and mathematics)
  - ▶ Investigation of the epistemic underpinnings of, e.g., *dubitatio*.
  - ▶ Interactive website for *obligationes*:

<http://www.illc.uva.nl/medlogic/obligationes/>



# obligationes

## What Are Obligationes?

**O**bligatio (or "obligations") is a formal disputation form that was widespread in medieval Europe. The earliest writings on obligations date from the beginning of the thirteenth century, but the theoretical roots can probably found much earlier, assumably in Aristotle's *"Topics"*. Obligatio can be viewed as a game between two players, the opponent (*opponens*) and the respondent (*respondens*). The opponens puts forward some hypothesis and the respondent decides whether he denies or admits the hypothesis. In the first case the game doesn't start, in the latter case the game is on it's way. The opponens puts forward questions (propositions) that may or may not relate directly to the hypothesis. The respondent answers these questions with 'I concede', 'I deny' or 'I doubt it'. This is where the name of the game comes in: both players *oblige* to a very strict set of rules that determine how a question should be answered according to both the hypothesis, the propositions already put forward and the real world. When the respondent follows these rules closely, he or she can maintain a consistent 'world' that follows logically from the original hypothesis. The goal for the opponens is to trick the respondent in 'responding badly' within the game time that the players agreed upon. When the game time is up or when the respondent has responded badly, the opponens ends the game by saying "*cedat tempus*".

**O**ne interesting aspect of this logical game, is that ,while it is clear that obligationes were widespread and heavily debated from the thirteenth century on, the actual purpose of the game remains unclear.

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