

*LogICCC Launch Conference*

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## LoMoReVI

### Logical Models of Reasoning with Vague Information

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## Vagueness and Logic — Cats and Dogs?

- (A) LogICCC involves many researchers.
- (B) If a single researcher ceases to be a member of a LogICCC project (A) is still true.

Therefore – by repeated application of *modus ponens*:

- (C) Even if only one researcher remains involved (A) is still true.

*Whoever undertakes to scrutinize logical arguments conducted outside mathematics cannot but wince at the flighty conduct of words . . .*

Jean van Heijenoort, *Frege and Vagueness* (1985)

## More than a century after Frege ...

- ▶ many logical approaches to reasoning under vagueness
- ▶ dozens of competing 'solutions' to the *sorites paradox*
- ▶ 'fuzzy logic' is explicitly motivated by vagueness phenomena
- ▶ vagueness is just one form of 'imperfect information'

### Summarizing:

- ▶ contemporary logic is ready to address vagueness

### However:

- ▶ foundational challenges still loom large ...

## The big challenge

- ▶ Phenomena of vagueness are studied in various disciplines ranging from philosophy, linguistics, psychology, to logics, computer science, and engineering.
- ▶ In particular: competing 'theories of vagueness' are vigorously debated in analytic philosophy. (Epistemicism, pragmatism, degree based theories, supervaluation, contextualism, . . . )
- ▶ It is not easy (and not always possible) to separate vagueness from related phenomena, like uncertainty, truthlikeness, incomplete and inconsistent knowledge.

Can one find a common framework for discussing the relevant questions and for modelling reasoning under vagueness?

Our credo:

Contemporary logic provides flexible tools to meet the challenge!

## Aims, objectives, and methods

General aim: a comprehensive formal framework ('toolbox') for the integration of various approaches to reasoning under vagueness.

Particular objectives and methodology:

- ▶ Find translations and connections between degree based, supervaluational, epistemic, and contextualist theories of vagueness.
- ▶ Develop t-norm based fuzzy logics as an information based model, including higher order formalisms and modal extensions.
- ▶ Explore the role of game theory in modeling vagueness and define corresponding logical games.
- ▶ Investigate relations to other forms of imperfect information.
- ▶ Explore applications to knowledge extraction.

## A side remark on 'fuzzy logic'

'Fuzzy Logic' has quite different connotations and meanings.



## 'Fuzzy logic' in a broad and a narrow sense

- ▶ **Broad sense:** Theory and practice of graded concepts. (Fuzzy set theory, fuzzy controlling, 'fuzzification' of mathematical concepts, 'gradual switch' technology . . .)
- ▶ **Narrow sense:** deductive logic(s) based on 'degrees of truth'

We are (mainly) concerned with the later.

**Vigorous debates** on the adequateness of fuzzy logic (e.g., viz-a-viz probability theory) accompanied the field long time.

Corresponding **conceptual confusions** are largely clarified now.

While fuzzy logic still has a rather **bad reputation** among many mathematicians and scientists, **modern mathematical fuzzy logic** adheres to highest technical standards and is – by know – recognized as a **rich and mature subfield of mathematical logic**.

## Who are we?

Three research teams ('small is beautiful' !)

### Barcelona:

Lluís Godo (*IIIA-CSIC Artificial Intelligence Research Institute*)

T. Alsinet (CS), F. Bou (Log,Math), P. Dellunde (Log,Phil),  
F. Esteva (Math,Log), E. Marchioni (Log), C. Noguera (Math,Log)

### Prague:

Petr Hájek (*Institute of Computer Science, ASCR*)

L. Běhounek (Log), M. Bílková (Log), P. Cintula (Log),  
Z. Haniková (Math), M. Holeňa (CS), R. Horcík (Math),  
I. Kramosil (CS), O. Majer (Phil), M. Peliš (Phil)

### Vienna:

Chris Fermüller (*TU Vienna, Theory and Logic Group*)

M. Baaz (Log,Math), A. Ciabattoni (Log), R. Kosik (Math),  
Ch. Roschger (CS), F. Slivovsky (Phil,CS)



## Constituent projects – Barcelona

### LoCoMoTion – Logics for combining models of reasoning under imperfect information

#### Objectives:

- ▶ investigation of **epistemic modal logics** extending t-norm based fuzzy logics
- ▶ logical of **uncertainty about ‘vague events’**
- ▶ integration of various **belief and approximation modalities**
- ▶ **argumentation and inconsistency handling** over graded propositions
- ▶ **temporal aspects** in logics of vagueness
- ▶ **fuzzy description logics**

## Constituent projects – Prague

### Fuzzy logic as a basis for a common framework for reasoning under vagueness

#### Objectives:

- ▶ extend deductive fuzzy logics to higher order systems
- ▶ investigate modal extensions of fuzzy logics with an eye on applications in philosophy of language and linguistics
- ▶ explore game theoretical approaches to a logic of vagueness
- ▶ combine models of uncertainty in a uniform framework
- ▶ develop different forms of ‘fuzzy knowledge extraction’

## Vienna

### Contextualism, supervaluation, and fuzzy logic

#### Objectives:

- ▶ embed fuzzy logics into a wider semantic framework that includes conversational contexts and precisification spaces
- ▶ develop dialogue games and corresponding proof systems for various logics of vagueness
- ▶ extract degrees of truth and truth functions from models based on supervaluation and contextualism
- ▶ study connections with Brandom's 'incompatibility semantics'
- ▶ create a logical dialogue game laboratory for the interactive exploration of theoretic concepts

## Cooperation with other CRPs

Joint activities, beyond mere exchange of information are planned with FP010 - Vagueness, Approximation, and Granularity (**VAAG**). In particular:

- ▶ A jointly organized **conference on vagueness** (2010?) should provide a forum for discussing different facets of and approaches to vagueness

Potential collaborations on particular topics envisaged with

- ▶ FP004 - Dialogical Foundations of Semantics (**DiFoS**)
- ▶ FP005 - The Logic of Causal and Probabilistic Reasoning in Uncertain Environments (**LcpR**)

## Potential benefits to other CRPs

(Beyond obvious mutual benefits for **VAAG**, **DiFoS**, and **LcpR**)

If we succeed in providing a **powerful, flexible, robust toolbox** for modeling various aspects of **reasoning under vagueness**, corresponding tools might be applied to **further LogI CCC topics**.

Some speculations:

- ▶ **Logic for Interaction:** interactions, in particular conversations between human agents, are often based on **vague information** and **loose (vague) coordination**
- ▶ **Foundations of Social Choice:** logically complex combinations of **vague (fuzzy/graduated) preferences** might be considered
- ▶ **Social software for elections:** new allocation concepts might arise from considering '**fuzzy constraints**' and **vague preferences**

## Why I am excited about the project?

- ▶ **Joining forces:**  
collaboration among researchers from different background and expertise **matching the complexity of the topic**
- ▶ **Foundational research:**  
in particular serious **interaction** between **mathematical logic**, **informatics** and **philosophy**
- ▶ **Wider perspectives:**  
prospect of cooperating with **other topical LogICCC projects**, in particular on **other aspects of vagueness** and **dialogue games**