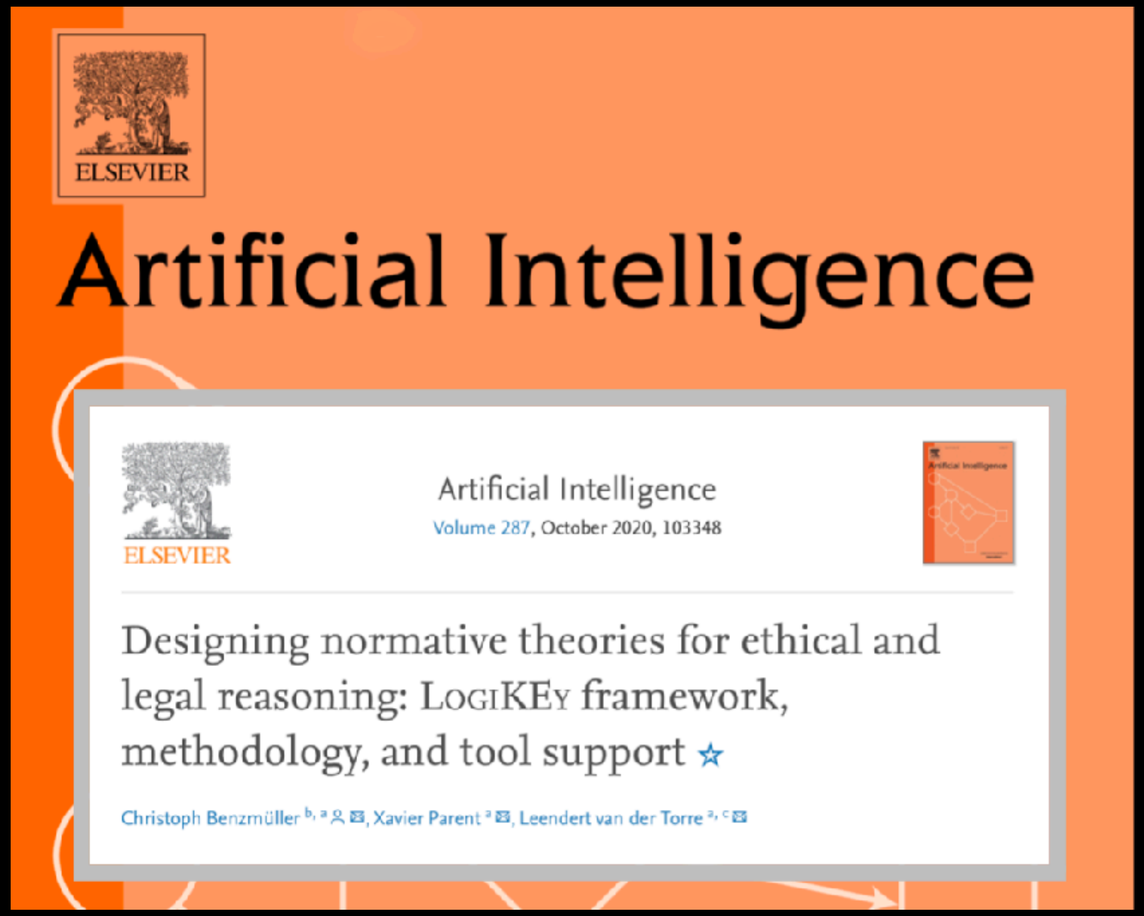
Latest Extensions to LogiKEy

Christoph Benzmüller
Freie Universität Berlin

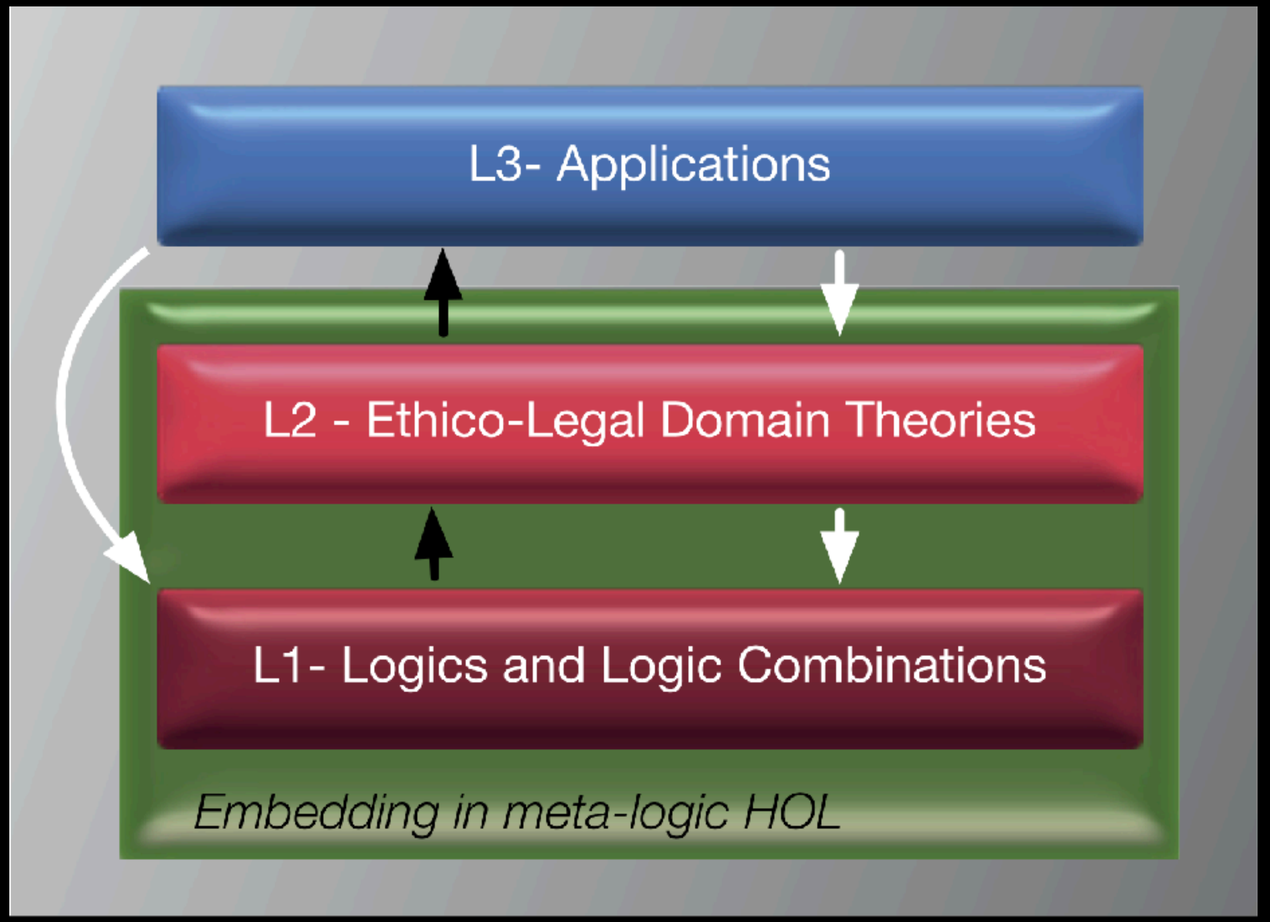
jww many collaborators



DELIGHT (Deontic Logic for Epistemic Rights), Kick-off Workshop, U Luxembourg, Dec 1, 2021

LogiKEy

- Automation of logics (combinations)
- Example: quantified deontic logics
- Flexible and pluralistic
- Embeddings in classical HOL
- Reuse of provers for HOL

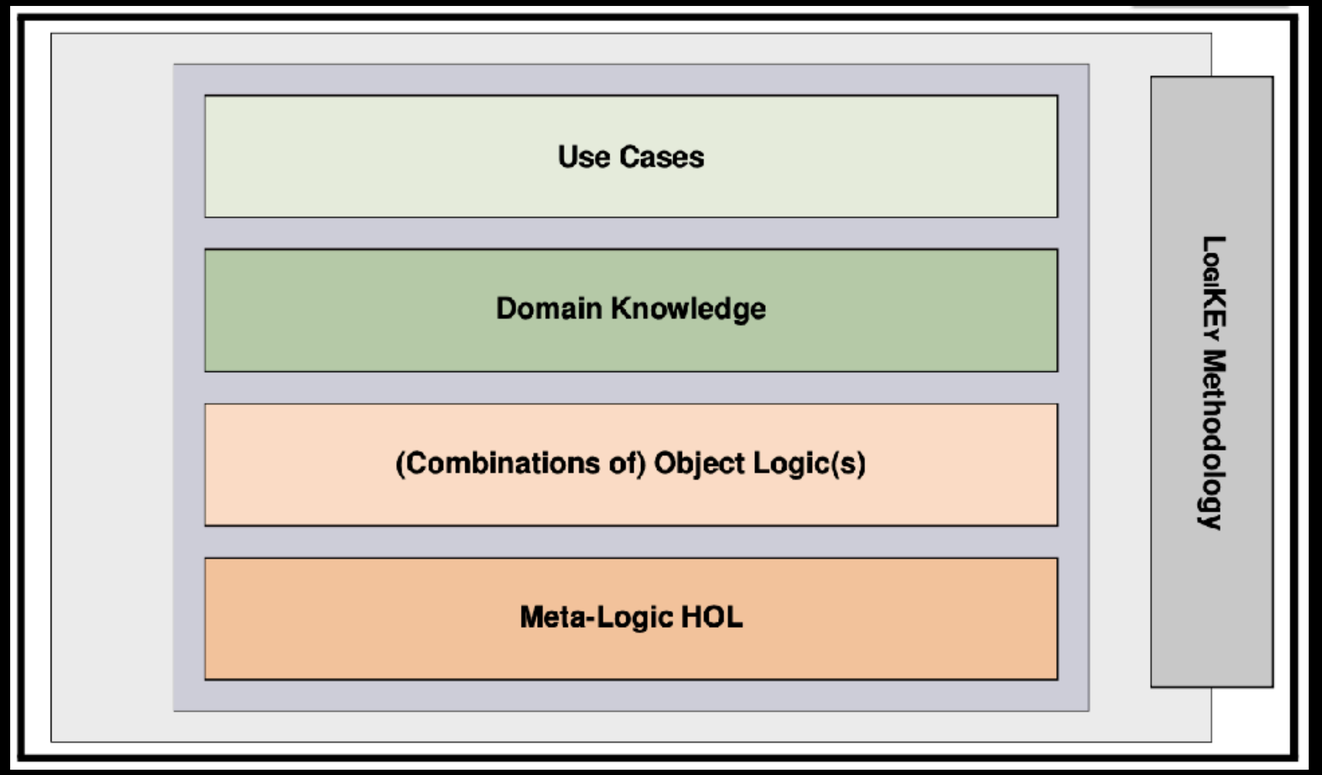


Simultaneous modeling at various layers

LogiKEy bridges between different communities:
KR&R, DEON, Deduction Systems, Formal Ethics

LogiKEy

- Automation of logics (combinations)
- Example: quantified deontic logics
- Flexible and pluralistic
- Embeddings in classical HOL
- Reuse of provers for HOL



Simultaneous modeling at various layers

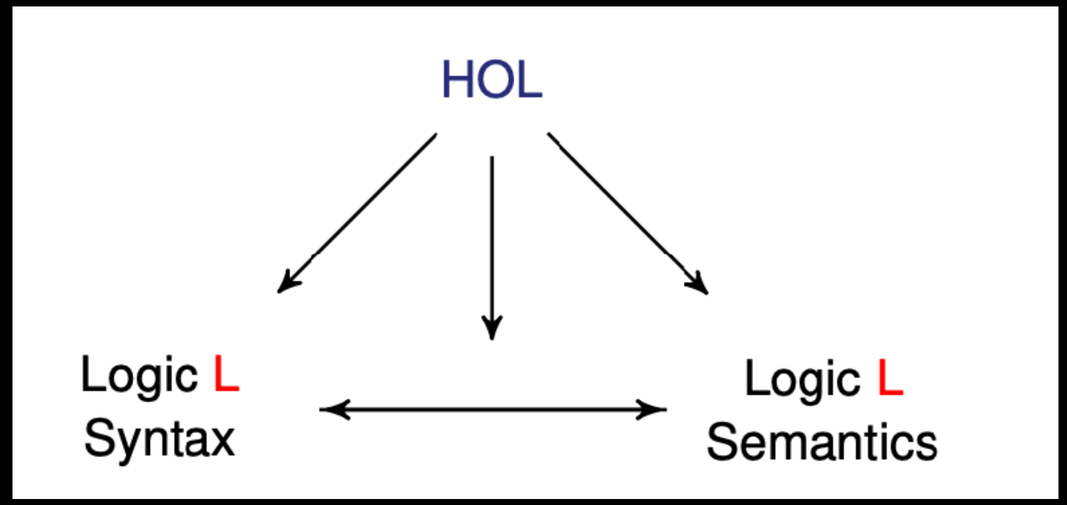
LogiKEy bridges between different communities:
KR&R, DEON, Deduction Systems, Formal Ethics

Universal (Meta-)Logical Reasoning

via Semantical Embeddings in Higher-Order Logic (HOL)

"If we had it [a *characteristica universalis*], we should be able to reason in metaphysics and morals in much the same way as in geometry and analysis."

(Leibniz, 1677)



SpringerLink Search Log in

Published: 27 May 2012

Quantified Multimodal Logics in Simple Type Theory

Christoph Benzmüller & Lawrence C. Paulson

Logica Universalis **7**, 7–20 (2013) | Cite this article

204 Accesses | **26** Citations | Metrics

ELSEVIER

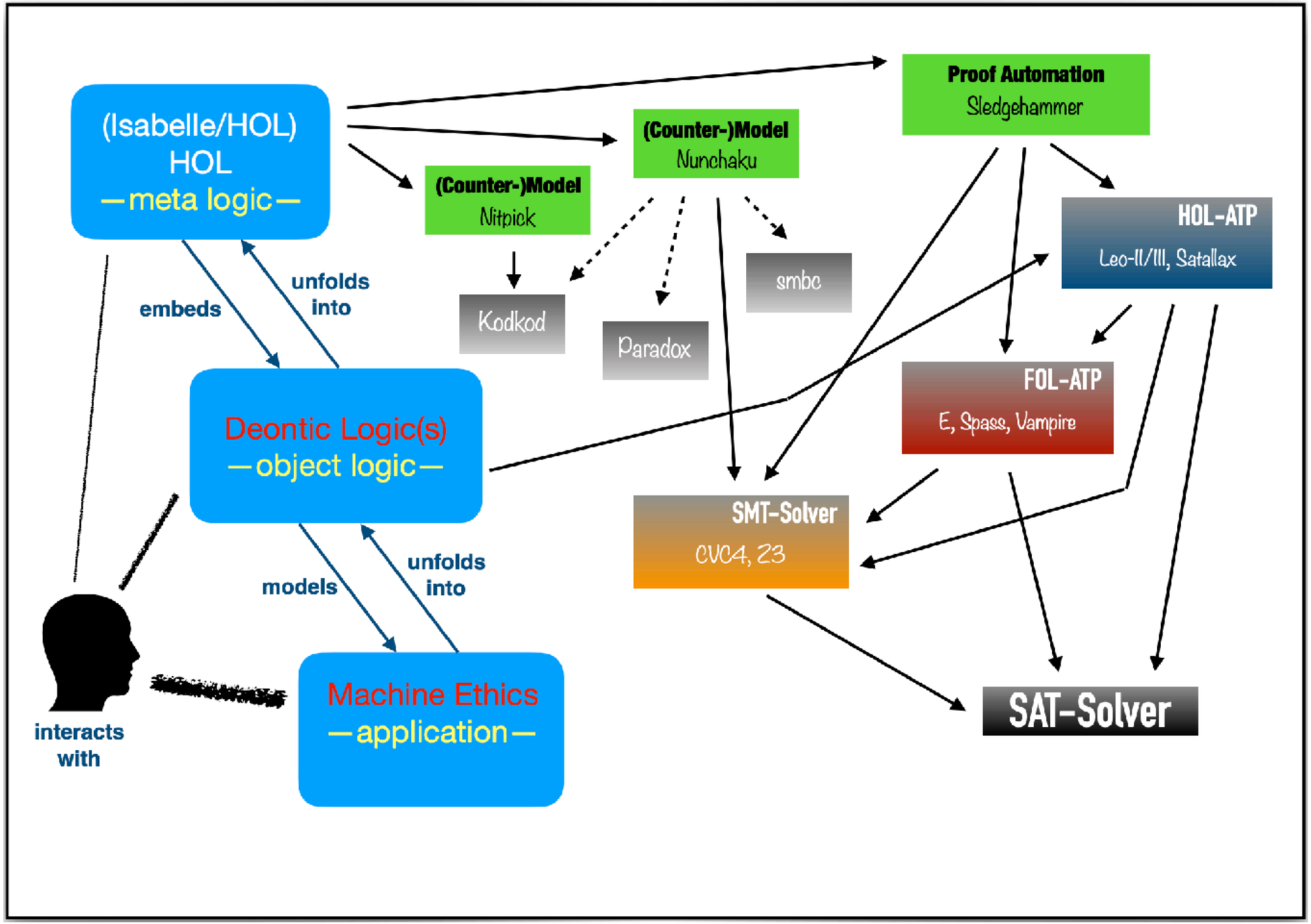
Science of Computer Programming

Volume 172, 1 March 2019, Pages 48-62

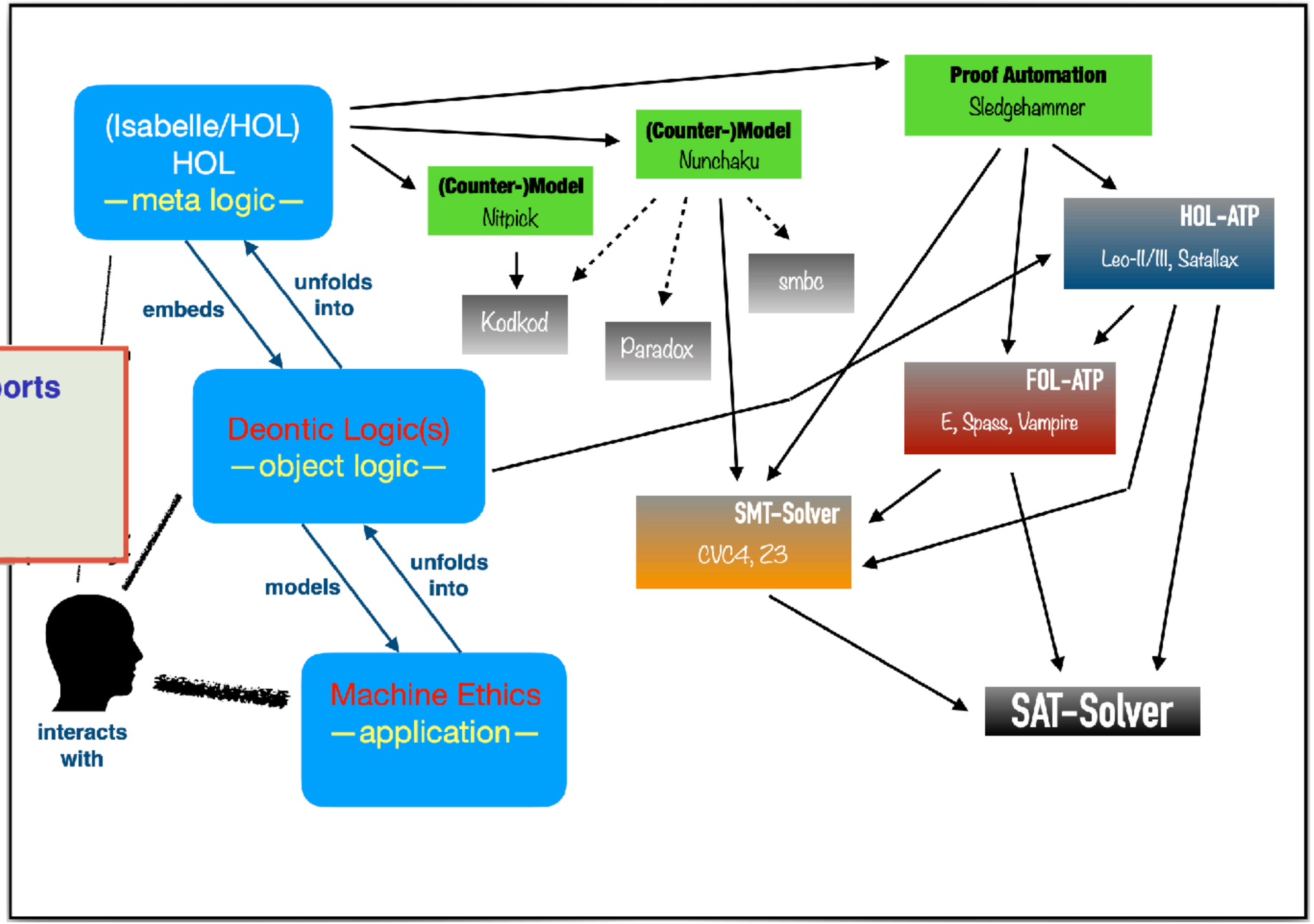
Universal (meta-)logical reasoning: Recent successes ☆

Christoph Benzmüller [a, b]

Universal (Meta-)Logical Reasoning Framework [SCP, 2019], [Open Philosophy,, 2019]



Universal (Meta-)Logical Reasoning Framework [SCP, 2019], [Open Philosophy,, 2019]



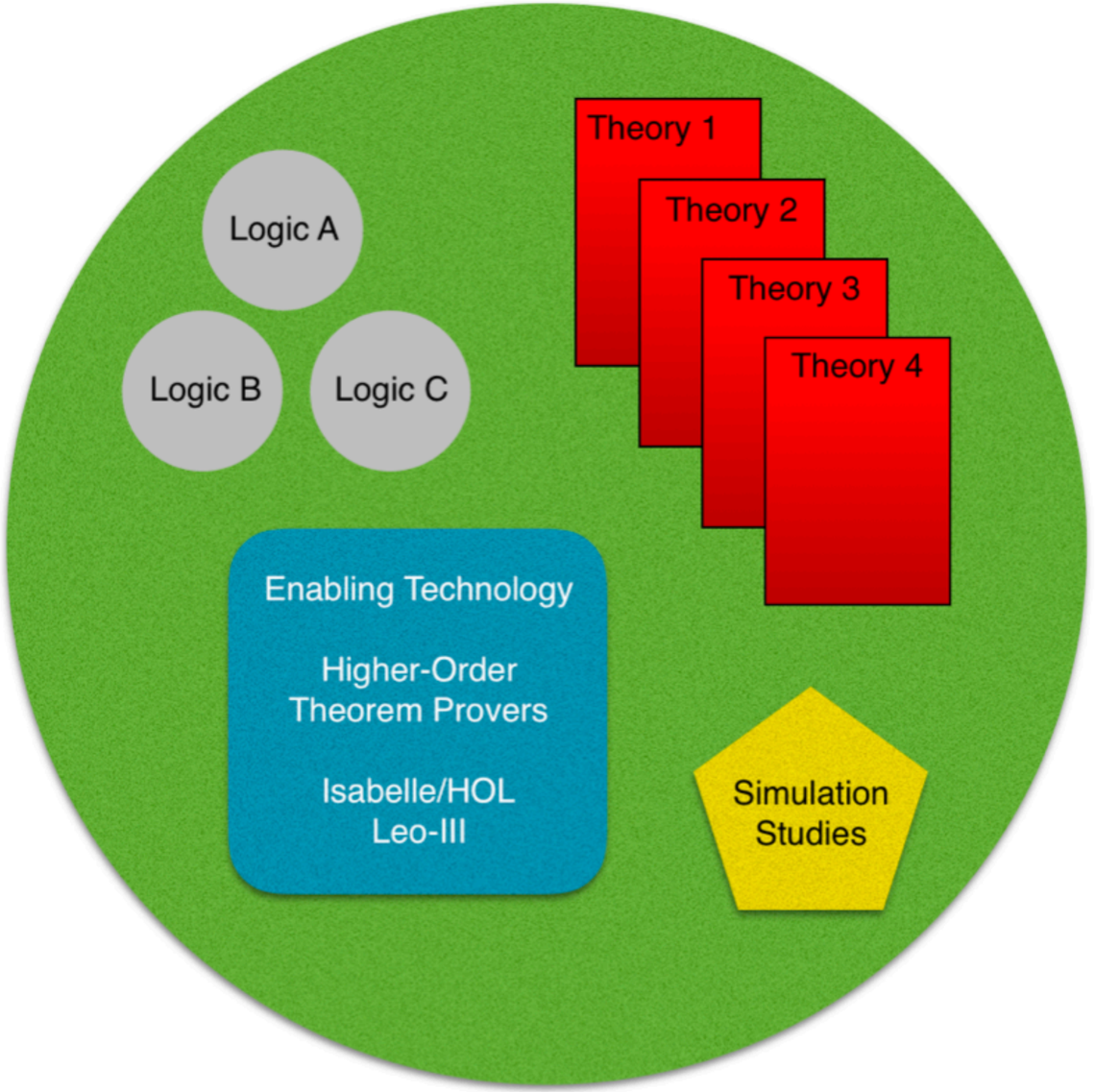
Uniformly supports

- research
- education
- application

Normative Reasoning Experimentation Framework

(proposed in 2018 DEON keynote and much further developed since then)

[AIJ (2020) vol. 287], [Data in Brief (2020) vol. 33], `www.logikey.org`



Recent Extensions to LogiKEy (Selection)

- Combining Argumentation and Reasoning in HOL / LogiKEy
  - ➡ (Alexander Steen & David Fuenmayor) — see talk by Alex
- Value-Oriented Ethico-Legal Reasoning in LogiKEy
  - ➡ (jww David Fuenmayor & Bertram Lomfeld)
- Dynamic Epistemic Logics in LogiKEy
  - ➡ (jww Sebastian Reiche)
- (Very Large) Foundational Metaphysical Theory in LogiKEy
  - ➡ (jww Daniel Kirchner & Edward Zalta)
- Categorical Foundations of Maths in LogiKEy
  - ➡ (jww Jonas Beyer, Lucca Tiemens, Aleksey Gonus, Dana Scott)
- Paraconsistent and Paracomplete Logics in LogiKEy
  - ➡ (David Fuenmayor) — David should have presented?

Value-Oriented Ethico-Legal Reasoning in LogiKEy

(jww David Fuenmayor & Bertram Lomfeld)

Application to Legal Balancing

Wild Animal Court Cases — see our recent paper at [MLR-WS@KR (2020)]

Post, a fox hunter, was chasing a fox through public land when Pierson came across the fox and, knowing it was being chased, killed the fox and took it away. Post sued Pierson for damages against his possession of the fox. Post argued that giving chase to the fox was sufficient to establish possession.

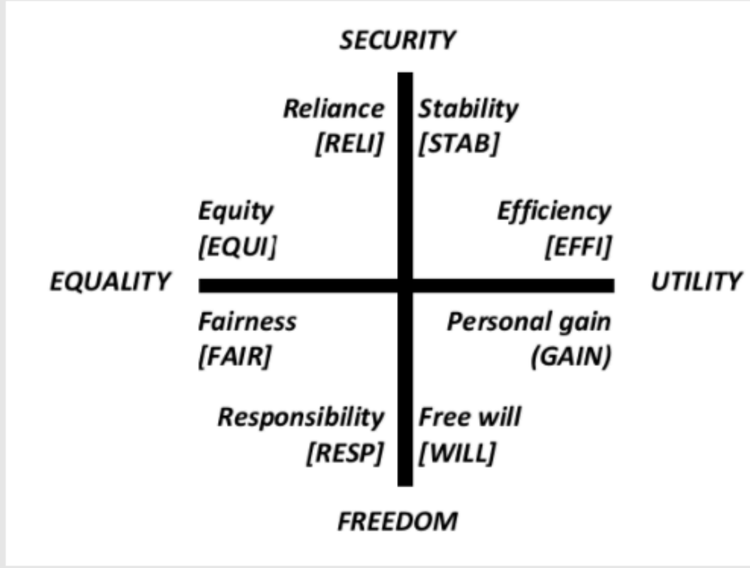
- A local court first ruled in favour of Post; Pierson appealed, decision was changed
- Decision in favour of Pierson implies: legal **STAB**ility outweighs the **WILL** to possess

STAB > **WILL**

Chester, a parrot owned by the ASPCA (animal shelter), escaped and was recaptured by Conti. The ASPCA found this out and reclaimed Chester from Conti.

- Here the court ruled in favour of the ASPCA
- **STAB** > **WILL** doesn't apply in this context
- For a **domestic animal** it is sufficient that the owner did not give up the **RESP**onsability for its maintenance and the **RELI**ance in the animals property

(**RESP**&**RELI**) > **STAB**

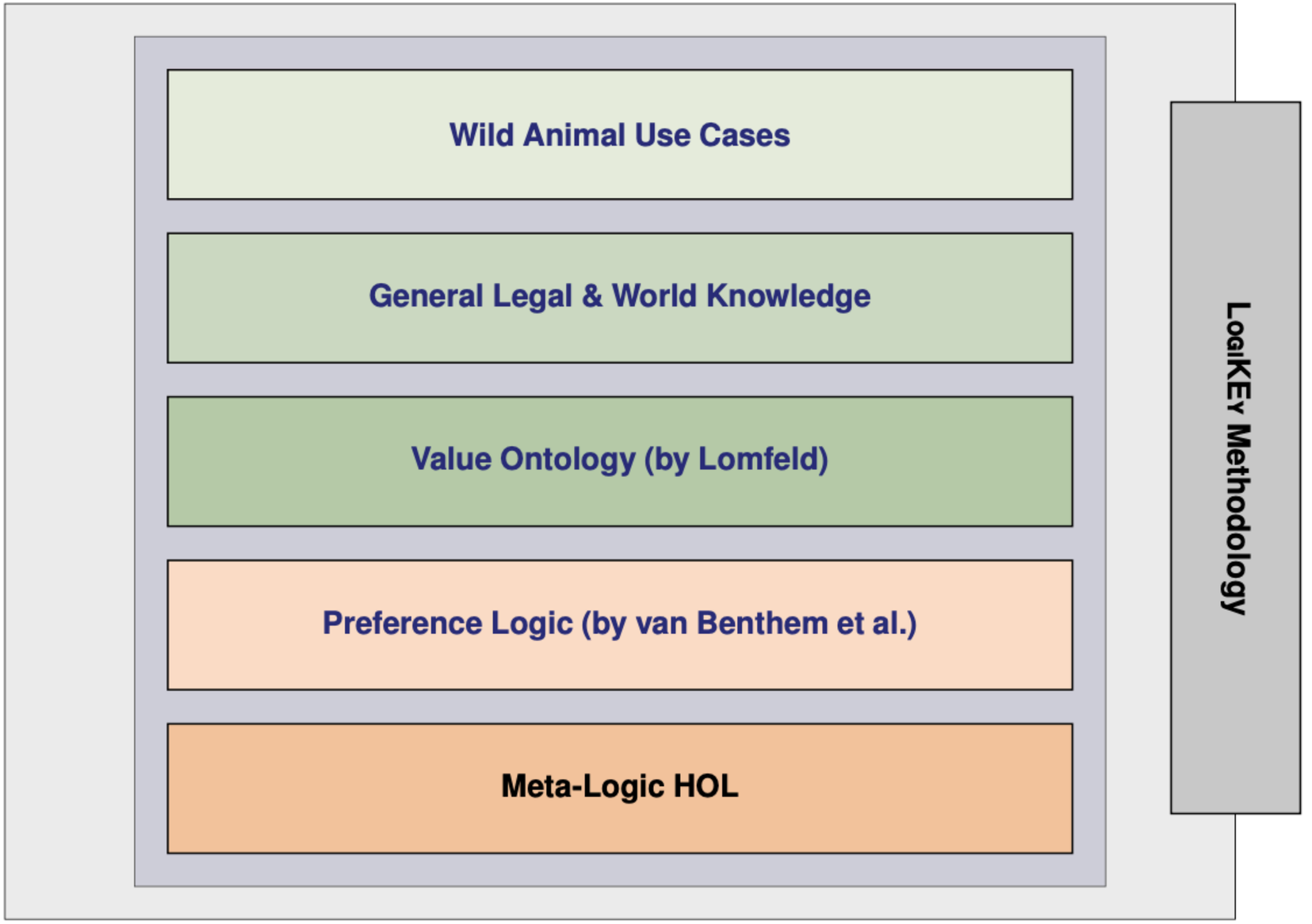


Value Ontology [Lomfeld (2019)]

```
(*LWK: (prima facie) value preferences for kinds of situations*)
axiomatization where
 R1: "⌊appAnimal ⟶ ([STABᵖ] ≺ [STABᵈ])⌋" and
 R2: "⌊appWildAnimal ⟶ ([WILLˣ⁻¹] ≺ [STABˣ])⌋" and
 R3: "⌊appDomAnimal  ⟶ ([STABˣ⁻¹] ≺ [RELIˣ⊕RESPˣ])⌋"
```

```
 (*decision for plaintiff (Post) can be proven automatically*)
theorem Post: "p_theory ⟶ ⌊p_facts ⟶ □¬For p⌋"
  by (smt F1 F3 ForAx tBR SBR_def other.simps)
 (*decision for defendant (Pierson) can be proven automatically*)
theorem Pierson: "d_theory ⟶ ⌊d_facts ⟶ □¬For d⌋"
  by (smt F1 F3 ForAx R2 W5 W7 other.simps tSBR)
 (*decision for plaintiff (ASPCA) can be proven automatically*)
theorem ASPCA: "p_theory ⟶ ⌊p_facts ⟶ □¬For p⌋"
  by (smt F3 F4 F5 ForAx R3 W6 W8 tBR SBR_def other.simps(1))
```

Adaptation of LogiKEy



Further Reading

Value-oriented Legal Argumentation in Isabelle/HOL (Christoph Benzmüller, David Fuenmayor), *In International Conference on Interactive Theorem Proving (ITP), Proceedings (Liron Cohen, Cezary Kaliszyk, eds.)*, Schloss Dagstuhl - Leibniz-Zentrum für Informatik, LIPIcs, volume 193, number 23, pp. 23:1-23:18, 2021. (Preprint: https://dx.doi.org/10.13140/RG.2.2.21514.80320) [bibtex] [doi]

Encoding Legal Balancing: Automating an Abstract Ethico-Legal Value Ontology in Preference Logic (Christoph Benzmüller, David Fuenmayor, Bertram Lomfeld), *In Workshop on Models of Legal Reasoning, hosted by 17th Conference on Principles of Knowledge Representation and Reasoning (KR 2020)*, 2020. (Preprint: https://arxiv.org/abs/2006.12789 or https://www.researchgate.net/publication/342380027) [bibtex]

Dynamic Epistemic Logics in LogiKEy

(jww Sebastian Reiche)

old

Universal Logical Reasoning

Kripke Style Semantics (propositional modal logic K)

$M, g, s \models P$ if and only if $s \in g(P)$

$M, g, s \models \neg \varphi$ if and only if $M, g, s \not\models \varphi$

$M, g, s \models \varphi \vee \psi$ if and only if $M, g, s \models \varphi$ or $M, g, s \models \psi$

$M, g, s \models \Box \varphi$ if and only if for all t with sRt we have $M, g, t \models \varphi$

Idea: Modal Propositions are mapped to Predicates (= truth-sets) in HOL

- $\mathsf{P} = P_{i \to o}$
- $\neg = \lambda \varphi_{i \to o}\ \lambda w_i\ \neg(\varphi w)$
- $\vee = \lambda \varphi_{i \to o}\ \lambda \psi_{i \to o}\ \lambda w_i\ \varphi w \vee \psi w$
- $\Box = \lambda \varphi_{i \to o}\ \lambda w_i\ \forall v_i\ Rwv \to \varphi v$

Validity

- $[\varphi_{i \to o}] = \forall w_i\ \varphi\ w$

Modal Logic (in fact, Hybrid Logic) as a Fragment of HOL

Kripke Style Semantics (adding quantifiers)

$M, g, s \models \forall x\ \varphi$ if and only if for all $d \in D$ we have $M, ([d/x]g), s \models \varphi$

This Idea can be extended for Quantifiers

- remember: $\forall x_\alpha\ s$ is shorthand for $\Pi_{(\alpha \to o) \to o}(\lambda x_\alpha\ s)$ —no binder needed!!!
- $\Pi = \lambda \Phi_{\alpha \to (i \to o)}\ \lambda w_i\ \Pi_{(\alpha \to o) \to o}(\lambda x_\alpha\ \Phi x w)$

Dynamic Epistemic Logics in LogiKEy

(jww Sebastian Reiche)

old

Universal Logical Reasoning

Kripke Style Semantics (propositional modal logic K)

$M, g, s \models P$ if and only if $s \in g(P)$

$M, g, s \models \neg \varphi$ if and only if $M, g, s \not\models \varphi$

$M, g, s \models \varphi \vee \psi$ if and only if $M, g, s \models \varphi$ or $M, g, s \models \psi$

$M, g, s \models \Box \varphi$ if and only if for all t with sRt we have $M, g, t \models \varphi$

Idea: Modal Propositions are mapped to Predicates (= truth-sets) in HOL

- $\mathsf{P} = P_{i \to o}$
- $\neg = \lambda \varphi_{i \to o}\ \lambda w_i\ \neg(\varphi w)$
- $\vee = \lambda \varphi_{i \to o}\ \lambda \psi_{i \to o}\ \lambda w_i\ \varphi w \vee \psi w$
- $\Box = \lambda \varphi_{i \to o}\ \lambda w_i\ \forall v_i\ Rwv \to \varphi v$

Validity

- $[\varphi_{i \to o}] = \forall w_i\ \varphi\ w$

Modal Logic (in fact, Hybrid Logic) as a Fragment of HOL

Kripke Style Semantics (adding quantifiers)

$M, g, s \models \forall x\ \varphi$ if and only if for all $d \in D$ we have $M, ([d/x]g), s \models \varphi$

This Idea can be extended for Quantifiers

- remember: $\forall x_\alpha\ s$ is shorthand for $\Pi_{(\alpha \to o) \to o}(\lambda x_\alpha\ s)$ —no binder needed!!!
- $\Pi = \lambda \Phi_{\alpha \to (i \to o)}\ \lambda w_i\ \Pi_{(\alpha \to o) \to o}(\lambda x_\alpha\ \Phi x w)$

Dynamic Epistemic Logics in LogiKEy

(jww Sebastian Reiche)

new

Definition 3.2 (Truth at world w). Given an epistemic model $\mathcal{M} = \langle W, \{R_i\}_{i \in \mathcal{A}}, V \rangle$. For each $w \in W, \varphi$ *is true at world* w, denoted $\mathcal{M}, w \models \varphi$, is defined inductively as follows:

$$
\begin{array}{lll}
\mathcal{M}, w \models p & \text{iff} & w \in V(p) \\
\mathcal{M}, w \models \neg\varphi & \text{iff} & \mathcal{M}, w \not\models \varphi \\
\mathcal{M}, w \models \varphi \vee \psi & \text{iff} & \mathcal{M}, w \models \varphi \text{ or } \mathcal{M}, w \models \psi \\
\mathcal{M}, w \models K_i\varphi & \text{iff} & \text{for all } v \in W, \text{ if } wR_iv \text{ then } \mathcal{M}, v \models \varphi
\end{array}
$$

Definition 3.3 (Public Announcement). Suppose that $\mathcal{M} = \langle W, \{R_i\}_{i \in \mathcal{A}}, V \rangle$ is an epistemic model and φ is a formula (in the language of our base logic). After φ is publicly announced, the resulting model is $\mathcal{M}^{!\varphi} = \langle W^{!\varphi}, \{R_i^{!\varphi}\}_{i \in \mathcal{A}}, V^{!\varphi} \rangle$ where $W^{!\varphi} = \{w \in W \mid \mathcal{M}, w \models \varphi\}$, $R_i^{!\varphi} = R_i \cap (W^{!\varphi} \times W^{!\varphi})$ for all $i \in \mathcal{A}$, and $V^{!\varphi}(p) = V(p) \cap W^{!\varphi}$ for all $p \in \mathcal{P}$.

To say that "ψ *is true after the announcement of* φ" is represented as $[!\varphi]\psi$. Truth for this new operator at world w in $\mathcal{M}$ is defined as:

$$\mathcal{M}, w \models [!\varphi]\psi \text{ iff } \mathcal{M}, w \not\models \varphi \text{ or } \mathcal{M}^{!\varphi}, w \models \psi$$

Dynamic Epistemic Logics in LogiKEy

(jww Sebastian Reiche)

new

```
(*In HOL the transitive closure of a relation can be defined in a single line.*)
definition tc::"α⇒α" where "tc R ≡ λx y.∀Q. transitive Q ⟶ (sub_rel R Q ⟶ Q x y)"

(* Lifted HOMML connectives for PAL *)
abbreviation patom::"σ⇒τ" ("ᴬ_"[79]80) where "ᴬp ≡ λW w. W w ∧ p w"
abbreviation ptop::"τ" ("⊤") where "⊤ ≡ λW w. True"
abbreviation pneg::"τ⇒τ" ("¬_"[52]53) where "¬φ ≡ λW w. ¬(φ W w)"
abbreviation pand::"τ⇒τ⇒τ" (infixr"∧"51) where "φ∧ψ ≡ λW w. (φ W w) ∧ (ψ W w)"
abbreviation por::"τ⇒τ⇒τ" (infixr"∨"50) where "φ∨ψ ≡ λW w. (φ W w) ∨ (ψ W w)"
abbreviation pimp::"τ⇒τ⇒τ" (infixr"→"49) where "φ→ψ ≡ λW w. (φ W w) ⟶ (ψ W w)"
abbreviation pequ::"τ⇒τ⇒τ" (infixr"↔"48) where "φ↔ψ ≡ λW w. (φ W w) ⟷ (ψ W w)"
abbreviation pknow::"α⇒τ⇒τ" ("K_ _") where "K r φ ≡ λW w.∀v. (W v ∧ r w v) ⟶ (φ W v)"
abbreviation ppal::"τ⇒τ⇒τ" ("[!_]_") where "[!φ]ψ ≡ λW w. (φ W w) ⟶ (ψ (λz. W z ∧ φ W z) w)"

(* Validity of τ-type lifted PAL formulas *)
abbreviation pvalid::"τ ⇒ bool" ("⌊_⌋"[7]8) where "⌊φ⌋ ≡ ∀W.∀w. W w ⟶ φ W w"

(* Agent Knowledge, Mutual Knowledge, Common Knowledge *)
abbreviation EVR::"ϱ⇒α" where "EVR G ≡ big_union_rel G"
abbreviation DIS::"ϱ⇒α" where "DIS G ≡ big_intersection_rel G"
abbreviation agtknows::"α⇒τ⇒τ" ("K_ _") where "Kᵣ φ ≡  K r φ"
abbreviation evrknows::"ϱ⇒τ⇒τ" ("E_ _") where "E_G φ ≡  K (EVR G) φ"
abbreviation disknows :: "ϱ⇒τ⇒τ" ("D_ _") where "D_G φ ≡ K (DIS G) φ"
abbreviation prck::"ϱ⇒τ⇒τ⇒τ" ("C_(_|_)")
  where "C_G(φ|ψ) ≡ λW w. ∀v. (tc (intersection_rel (EVR G) (λu v. W v ∧ φ W v)) w v) ⟶ (ψ W v)"
abbreviation pcmn::"ϱ⇒τ⇒τ" ("C_ _") where "C_G φ ≡  C_G(⊤|φ)"
```

Dynamic Epistemic Logics in LogiKEy

(jww Sebastian Reiche)

new

```
(*In HOL the transitive closure of a relation can be defined in a single line.*)
definition tc::"α⇒α" where "tc R ≡ λx y.∀Q. transitive Q ⟶ (sub_rel R Q ⟶ Q x y)"

(* Lifted HOMML connectives for PAL *)
abbreviation patom::"σ⇒τ" ("ᴬ_"[79]80) where "ᴬp ≡ λW w. W w ∧ p w"
abbreviation ptop::"τ" ("⊤") where "⊤ ≡ λW w. True"
abbreviation pneg::"τ⇒τ" ("¬_"[52]53) where "¬φ ≡ λW w. ¬(φ W w)"
abbreviation pand::"τ⇒τ⇒τ" (infixr"∧"51) where "φ∧ψ ≡ λW w. (φ W w) ∧ (ψ W w)"
abbreviation por::"τ⇒τ⇒τ" (infixr"∨"50) where "φ∨ψ ≡ λW w. (φ W w) ∨ (ψ W w)"
abbreviation pimp::"τ⇒τ⇒τ" (infixr"→"49) where "φ→ψ ≡ λW w. (φ W w) ⟶ (ψ W w)"
abbreviation pequ::"τ⇒τ⇒τ" (infixr"↔"48) where "φ↔ψ ≡ λW w. (φ W w) ⟷ (ψ W w)"
abbreviation pknow::"α⇒τ⇒τ" ("K_ _") where "K r φ ≡ λW w.∀v. (W v ∧ r w v) ⟶ (φ W v)"
abbreviation ppal::"τ⇒τ⇒τ" ("[!_]_") where "[!φ]ψ ≡ λW w. (φ W w) ⟶ (ψ (λz. W z ∧ φ W z) w)"

(* Validity of τ-type lifted PAL formulas *)
abbreviation pvalid::"τ ⇒ bool" ("⌊_⌋"[7]8) where "⌊φ⌋ ≡ ∀W.∀w. W w ⟶ φ W w"

(* Agent Knowledge, Mutual Knowledge, Common Knowledge *)
abbreviation EVR::"ϱ⇒α" where "EVR G ≡ big_union_rel G"
abbreviation DIS::"ϱ⇒α" where "DIS G ≡ big_intersection_rel G"
abbreviation agttknows::"α⇒τ⇒τ" ("K_ _") where "Kᵣ φ ≡  K r φ"
abbreviation evrknows::"ϱ⇒τ⇒τ" ("E_ _") where "E_G φ ≡  K (EVR G) φ"
abbreviation disknows :: "ϱ⇒τ⇒τ" ("D_ _") where "D_G φ ≡ K (DIS G) φ"
abbreviation prck::"ϱ⇒τ⇒τ⇒τ" ("C_(_|_)")
  where "C_G(φ|ψ) ≡ λW w. ∀v. (tc (intersection_rel (EVR G) (λu v. W v ∧ φ W v)) w v) ⟶ (ψ W v)"
abbreviation pcmn::"ϱ⇒τ⇒τ" ("C_ _") where "C_G φ ≡  C_G(⊤|φ)"
```

Dynamic Epistemic Logics in LogiKEy

(jww Sebastian Reiche)

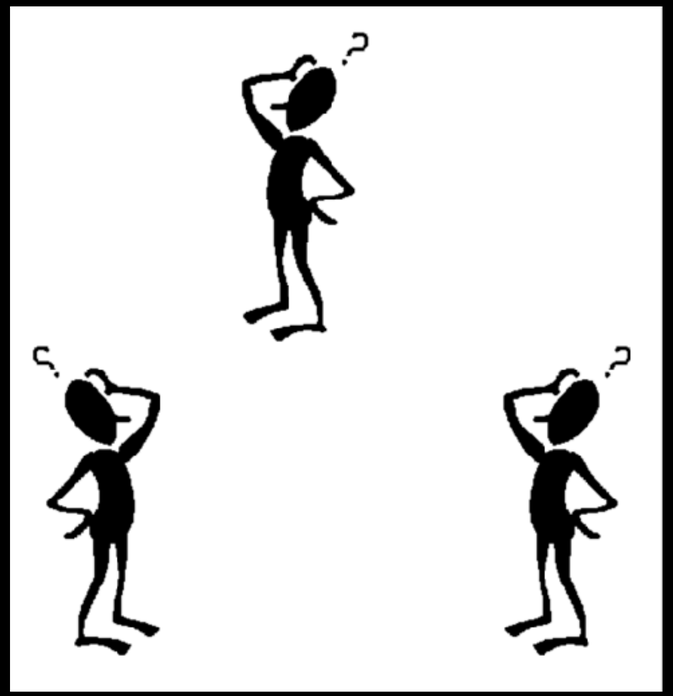
new

```
(*** Encoding of the wise men puzzle in PAL ***)
consts ws::"α⇒σ"
axiomatization where WM1: "⌊C𝒜 (Aws a ∨ Aws b ∨ Aws c ∨ Aws d)⌋"

axiomatization where
  (* Common knowledge: If x not has a white spot then y know this *)
  WM2ab: "⌊C𝒜 (¬(Aws a) → (Kb (¬(Aws a))))⌋" and
  WM2ac: "⌊C𝒜 (¬(Aws a) → (Kc (¬(Aws a))))⌋" and
  WM2ad: "⌊C𝒜 (¬(Aws a) → (Kd (¬(Aws a))))⌋" and
  WM2ba: "⌊C𝒜 (¬(Aws b) → (Ka (¬(Aws b))))⌋" and
  WM2bc: "⌊C𝒜 (¬(Aws b) → (Kc (¬(Aws b))))⌋" and
  WM2bd: "⌊C𝒜 (¬(Aws b) → (Kd (¬(Aws b))))⌋" and
  WM2ca: "⌊C𝒜 (¬(Aws c) → (Ka (¬(Aws c))))⌋" and
  WM2cb: "⌊C𝒜 (¬(Aws c) → (Kb (¬(Aws c))))⌋" and
  WM2cd: "⌊C𝒜 (¬(Aws c) → (Kd (¬(Aws c))))⌋" and
  WM2da: "⌊C𝒜 (¬(Aws d) → (Ka (¬(Aws d))))⌋" and
  WM2db: "⌊C𝒜 (¬(Aws d) → (Kb (¬(Aws d))))⌋" and
  WM2dc: "⌊C𝒜 (¬(Aws d) → (Kc (¬(Aws d))))⌋"


(* Automated solutions of the Wise Men Puzzle with 4 Agents*)

theorem whitespot_c_1: "⌊[!¬Ka(Aws a)]([!¬Kb(Aws b)]([!¬Kc(Aws c)](Kd (Aws d))))⌋"
  using WM1 WM2ba WM2ca WM2cb WM2da WM2db WM2dc
  unfolding Defs
  by (smt (verit))
```



Further Reading

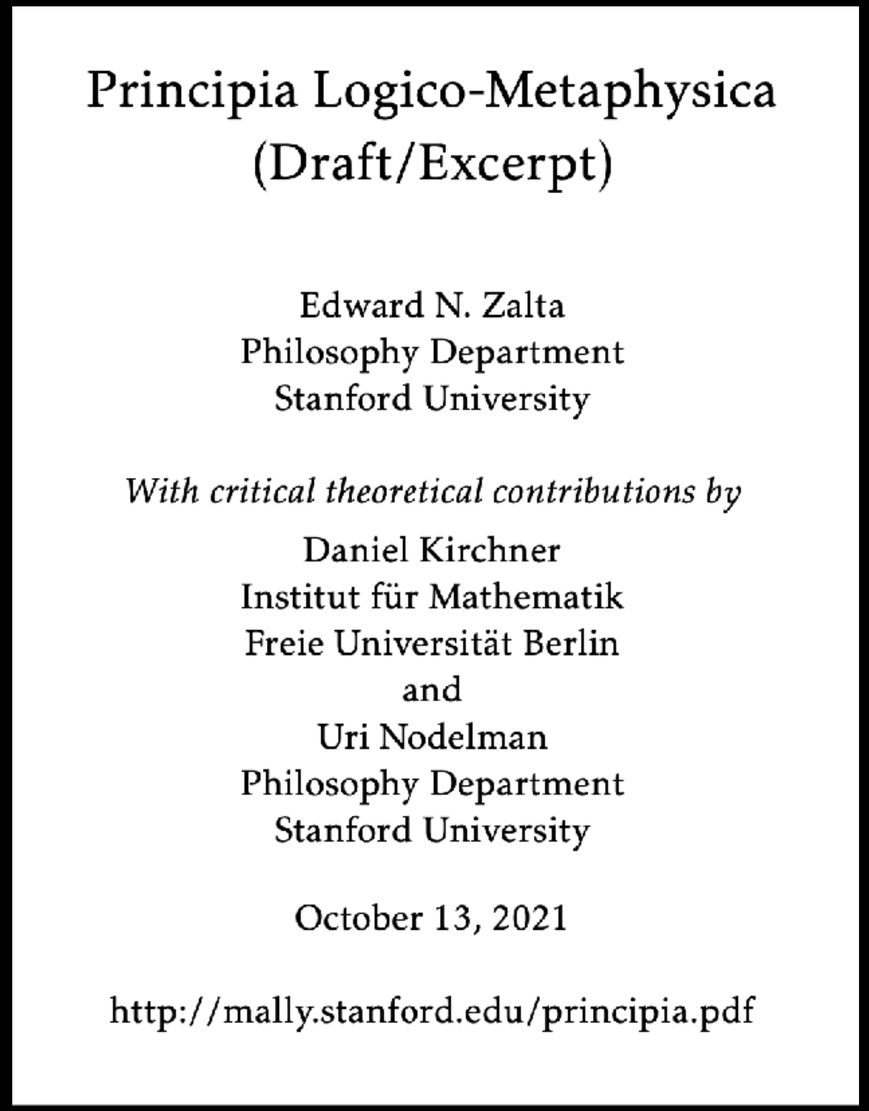
Modeling and Automating Public Announcement Logic with Relativized Common Knowledge as a Fragment of HOL in LogiKEy (Christoph Benzmüller, Sebastian Reiche), Technical report, CoRR, number arXiv:2111.01654, 2021. (https://arxiv.org/abs/2111.01654) [bibtex] [url]

Automating Public Announcement Logic and the Wise Men Puzzle in Isabelle/HOL (Christoph Benzmüller, Sebastian Reiche), *In Archive of Formal Proofs*, pp. 1-5, 2021. (Note: data publication) [bibtex] [url]

Public Announcement Logic in HOL (Sebastian Reiche, Christoph Benzmüller), *In Dynamic Logic. New Trends and Applications. DaLi 2020 (Manuel A. Martins, Sedlár Igor, eds.)*, Springer, Cham, Lecture Notes in Computer Science, volume 12569, 2020. (Preprint: https://arxiv.org/abs/2010.00810) [bibtex] [doi] [url]

Large Foundational Metaphysical Theory in LogiKEy

(jww Daniel Kirchner & Edward Zalta)



Principia Logico-Metaphysica
(Draft/Excerpt)

Edward N. Zalta
Philosophy Department
Stanford University

With critical theoretical contributions by

Daniel Kirchner
Institut für Mathematik
Freie Universität Berlin
and
Uri Nodelman
Philosophy Department
Stanford University

October 13, 2021

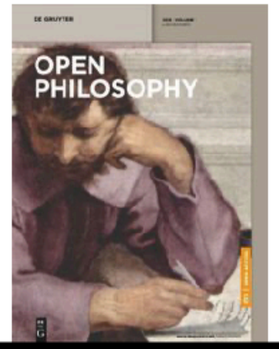
http://mally.stanford.edu/principia.pdf

- >1200 pages of foundational metaphysics
- formalised in Isabelle/HOL
  - >20000 (26027) loc
  - using SSE technique underlying LogiKEy

- paradox detected and fixed
- significant influence on the latest theory
- difficulty: comprehension principles

- new: *empirical methods* exploited for theory exploration in metaphysics!!!
- in DELIGHT: … analogous …

Further Reading

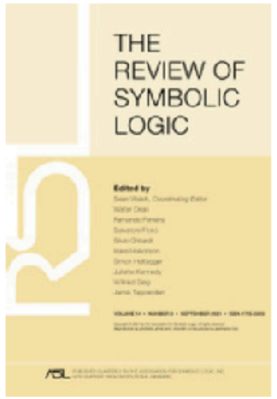


ARTICLE Open Access

Computer Science and Metaphysics: A Cross-Fertilization

Open Philosophy

Daniel Kirchner, Christoph Benzmüller, Edward N. Zalta August 23, 2019



MECHANIZING *PRINCIPIA LOGICO-METAPHYSICA* IN FUNCTIONAL TYPE-THEORY

Published online by Cambridge University Press: **12 July 2019**

DANIEL KIRCHNER, CHRISTOPH BENZMÜLLER and EDWARD N. ZALTA

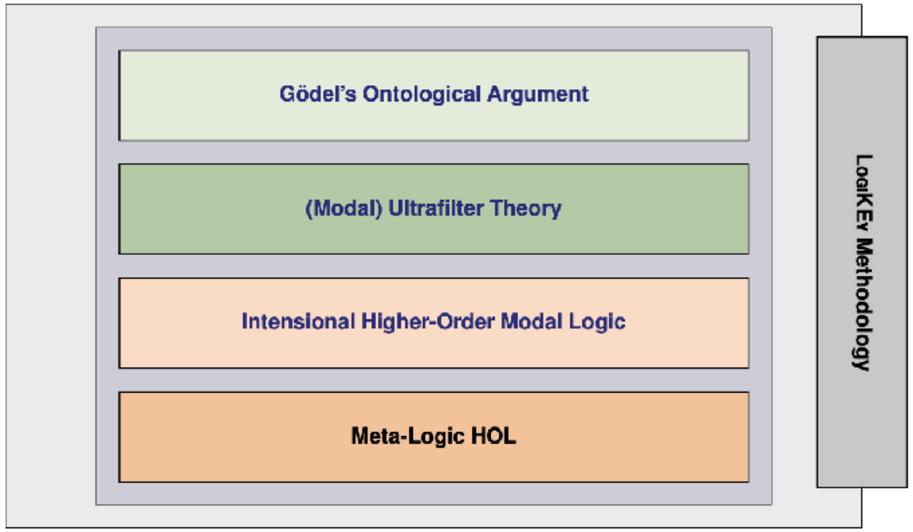
Show author details

PhD thesis of Daniel Kirchner:
will be submitted in December …

More recent *empirical works* in Metaphysics!

Universal Logical Reasoning & LogiKEy Methodology

[Artificial Intelligence (2020) vol. 287]



Different Layers — Flexibility (except HOL) — Parallel & Cyclic Development

Exploring Simplified Variants of Gödel's Ontological Argument in Isabelle/HOL

Title:	Exploring Simplified Variants of Gödel's Ontological Argument in Isabelle/HOL
Author:	Christoph Benzmüller
Submission date:	2021-11-08
Abstract:	Simplified variants of Gödel's ontological argument are explored. Among those is a particularly interesting simplified argument which is (i) valid already in basic modal logics K or KT, (ii) which does not suffer from modal collapse, and (iii) which avoids the rather complex predicates of essence (Ess.) and necessary existence (NE) as used by Gödel. Whether the presented variants increase or decrease the attractiveness and persuasiveness of the ontological argument is a question I would like to pass on to philosophy and theology.
BibTeX:	`@article{SimplifiedOntologicalArgument-AFP, [...]`
License:	BSD License

Categorical Foundations of Maths in LogiKEy

(jww Jonas Beyer, Lucca Tiemens, Aleksey Gonus, Dana Scott)

FREIE UNIVERSITÄT BERLIN

BACHELOR'S THESIS

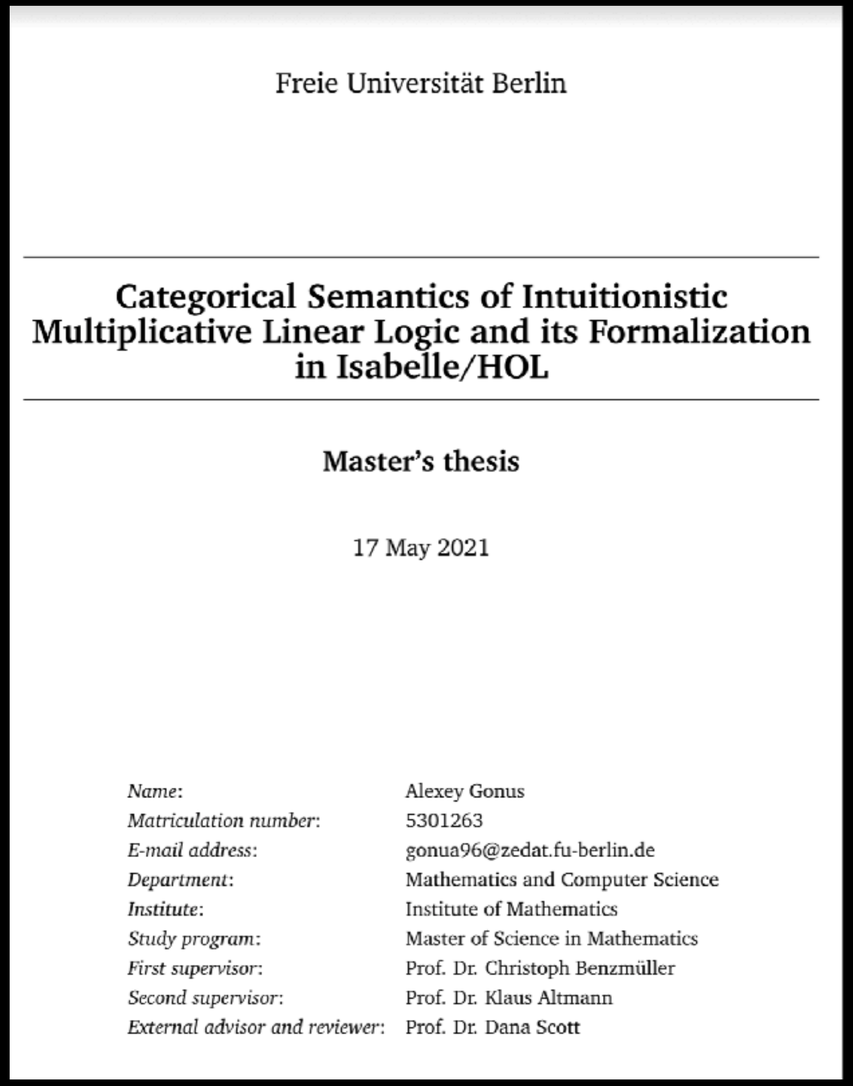
Exploring categories, formally

JONAS BAYER

FIRST ASSESSOR Prof. Dr. Christoph Benzmüller
SECOND ASSESSOR Prof. Dr. Ralf Kornhuber

EXTERNAL ADVISOR AND REVIEWER Prof. Dana S. Scott

September 6, 2021



Freie Universität Berlin

Categorical Semantics of Intuitionistic Multiplicative Linear Logic and its Formalization in Isabelle/HOL

Master's thesis

17 May 2021

Name:	Alexey Gonus
Matriculation number:	5301263
E-mail address:	gonua96@zedat.fu-berlin.de
Department:	Mathematics and Computer Science
Institute:	Institute of Mathematics
Study program:	Master of Science in Mathematics
First supervisor:	Prof. Dr. Christoph Benzmüller
Second supervisor:	Prof. Dr. Klaus Altmann
External advisor and reviewer:	Prof. Dr. Dana Scott

Paraconistent and Paracomplet Logics in LogiKEy

(David Fuenmayor)

Cornell University

the Si

arXiv.org > cs > arXiv:2104.04284

Search...

Help | Advar

Computer Science > Logic in Computer Science

[Submitted on 9 Apr 2021]

Topological semantics for paraconsistent and paracomplete logics in Isabelle/HOL

David Fuenmayor

We encode a topological semantics for paraconsistent and paracomplete logics enriched with recovery operators, by drawing upon early works on topological Boolean algebras (by Kuratowski, Zarycki, McKinsey & Tarski, etc.). This work exemplarily illustrates the shallow semantical embedding approach using Isabelle/HOL and shows how we can effectively harness theorem provers, model finders and "hammers" for reasoning with quantified non-classical logics.

Cornell University

W

the Simon

arXiv.org > math > arXiv:2003.09522

Search...

Help | Advanced

Mathematics > Logic

[Submitted on 20 Mar 2020 (v1), last revised 20 May 2021 (this version, v4)]

Logics of Formal Inconsistency enriched with replacement: an algebraic and modal account

Walter Carnielli, Marcelo E. Coniglio, David Fuenmayor

Regarding Dov's earlier comment: yes, I agree, our (conception of the) world and law is highly paraconsistent …

… but due to David Fuenmayor's recent work LogiKEy is also prepared for this

To appear in
Review in Symbolic Logic

Conclusion

LogiKEy seems prepared for DELIGHTful Applications

Regarding Dov's earlier comment:
yes, I agree, our (conception of the) world and law seem highly paraconsistent …
… but due to David Fuenmayor's recent work (with Carnielli & Coniglio) LogiKEy is also prepared for this