Spring School on Artificial Intelligence and Law

Invited graduate course
at Central South University, Changsha

Floris Bex, Enrico Francesconi, Bart Verheij, April 2019

中南大學
CENTRAL SOUTH UNIVERSITY

Organisers: Juan Li, Minghui Xiong

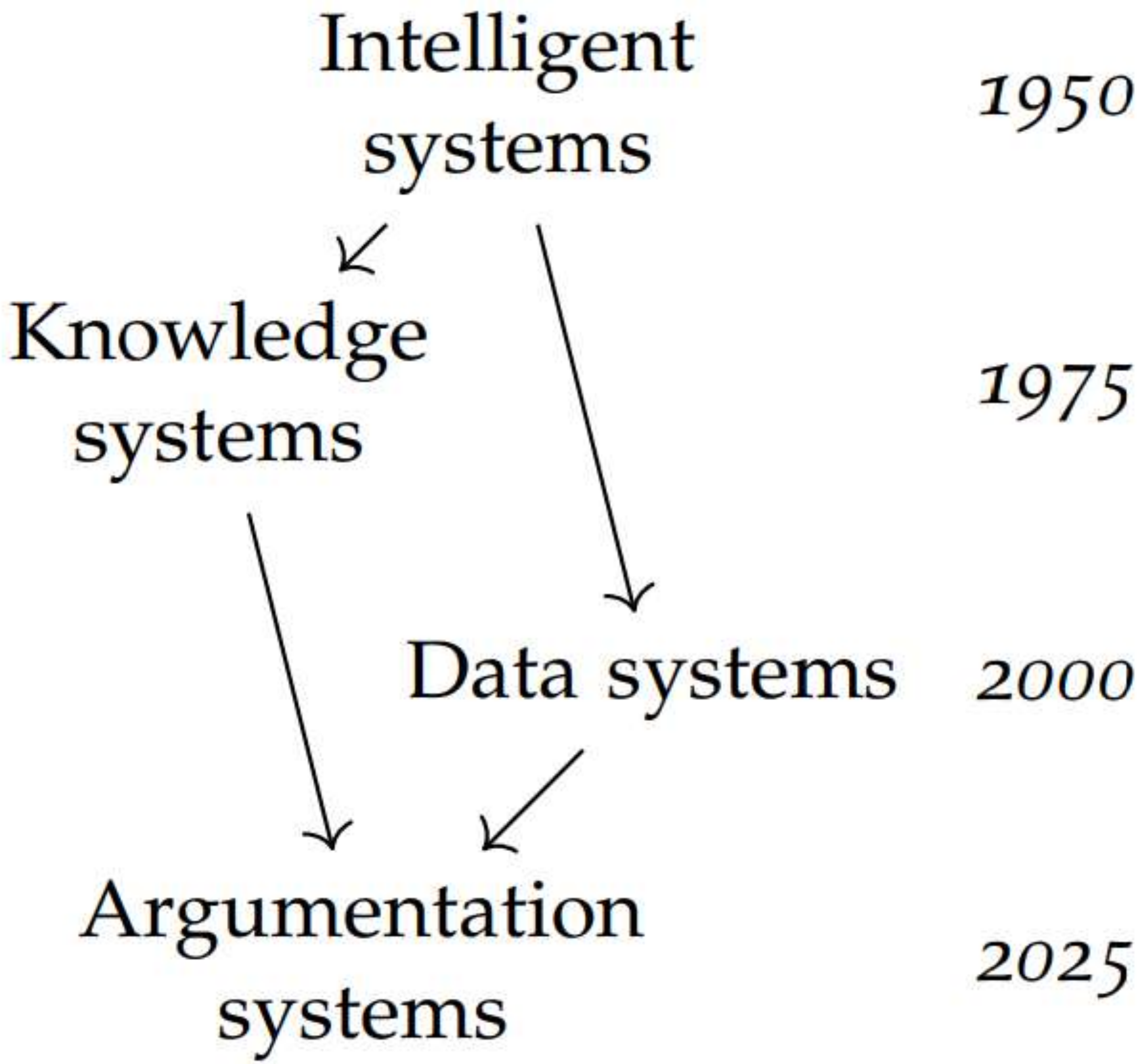
Day 2 Monday April 15

8:30	AI & Law - Modeling Legal Knowledge (Enrico Francesconi)
10:00	*Break*
10:30	Arguments, Rules and Cases in AI & Law (Bart Verheij)
12:00	*Break*
14:30	Argument and Story Strength - Bayesian vs. Qualitative Approaches (Floris Bex)
16:00	*Break*
16:30	Discussion
17:30	

The two faces of Artificial Intelligence

Expert systems	Adaptive system
Business rules	Machine le
Open data	Big d
IBM's Deep Blue	tson
Complex structure	ptive structure
Knowled	**Data tech**
Fou	Foundation:
	probability theory
Explainability	Scalability

Argumentation technology


Intelligent systems
1950
Knowledge systems
1975
Data systems
2000
Argumentation systems
2025

The law can be enhanced by artificial intelligence

Access to justice, efficient justice

Artificial intelligence can be enhanced by the law

Ethical AI, explanatory AI

Formalizing Arguments, Rules and Cases

Bart Verheij
Artificial Intelligence, University of Groningen
bart.verheij@rug.nl

ABSTRACT

Legal argument is typically backed by two kinds of sources: cases and rules. In much AI & Law research, the formalization of arguments, rules and cases has been investigated. In this paper, the tight formal connections between the three are developed further, in an attempt to show that cases can provide the logical basis for establishing which rules and arguments hold in a domain. We use the recently proposed formalism of case models, that has been applied previously to evidential reasoning and ethical systems design. In the present paper, we discuss with respect to case-based modeling how the analogy and distinction between cases can be modeled, and how arguments can be grounded in cases. With respect to rule-based modeling, we discuss conditionality, generality and chaining. With respect to argument-based modeling, we discuss rebutting, undercutting and undermining attack. We evaluate the approach by developing a case model of the rule-based arguments and attacks in Dutch tort law. In this way, we illustrate how statutory, rule-based law from the civil law tradition can be formalized in terms of cases.

CCS CONCEPTS

• Computing methodologies → Artificial intelligence; • Theory of computation → Logic; • Applied computing → Law;

KEYWORDS

Argumentation, Rule-based reasoning, Case-based reasoning

ACM Reference format:

Bart Verheij. 2017. Formalizing Arguments, Rules and Cases. In *Proceedings of ICAIL '17, London, United Kingdom, June 12-16, 2017*, 10 pages.
https://doi.org/10.1145/3086512.3086533

1 INTRODUCTION

Legislation and precedents are primary sources for the backing of legal arguments, and each of these two kinds is typically associated there can be an exception to an applying rule, and in case-based reasoning, adherence to a matching case can be overruled by another case that is a better match.

In Artificial Intelligence and Law, such defeasible reasoning backed by rules and cases has productively been modeled in terms of arguments for and against possible conclusions. Formal and computational models have been proposed that investigate relations between arguments, rules and cases in various ways. For instance, cases have been studied as the source of hypothetical arguments (Aleven and Ashley 1995; Ashley 1990; Rissland and Ashley 1987), rules and cases have been studied for the construction of explanations of decisions (Branting 1991, 1993), rules and cases have been used for the construction of arguments (Prakken and Sartor 1996, 1998), and cases and the values they promote have been used to establish rules (Bench-Capon and Sartor 2003).

This and related work has shown that the formal and computational relations between arguments, rules and cases are close. The present paper aims to further develop the close formal relations between arguments, rules and cases.

For this aim, we use the recently proposed case model formalism that was previously applied to evidential reasoning and ethical system design (Verheij 2016a,b, 2017). The case model formalism was developed in an attempt to answer the semantics and normative questions for reasoning with presumptive arguments (Verheij 2016a): How are presumptive arguments grounded in interpretations; and when are they evaluated as correct? In that work, the case model formalism is shown to have equivalent qualitative and quantitative characterizations, connecting to classical logic and probability theory. Hence the formalism is simultaneously 'with and without numbers', and the case model formalism could be applied to evidential reasoning, involving arguments, scenarios and probabilities (Verheij 2014, 2017). In contrast with Bayesian network approaches connecting arguments, scenarios and probabilities that require the specification of a full probability distribution (Fenton et al. 2013; Hepler et al. 2007; Timmer et al. 2017;

http://www.ai.rug.nl/~verheij/publications/icail2017.htm

Introduction

Argumentation semantics

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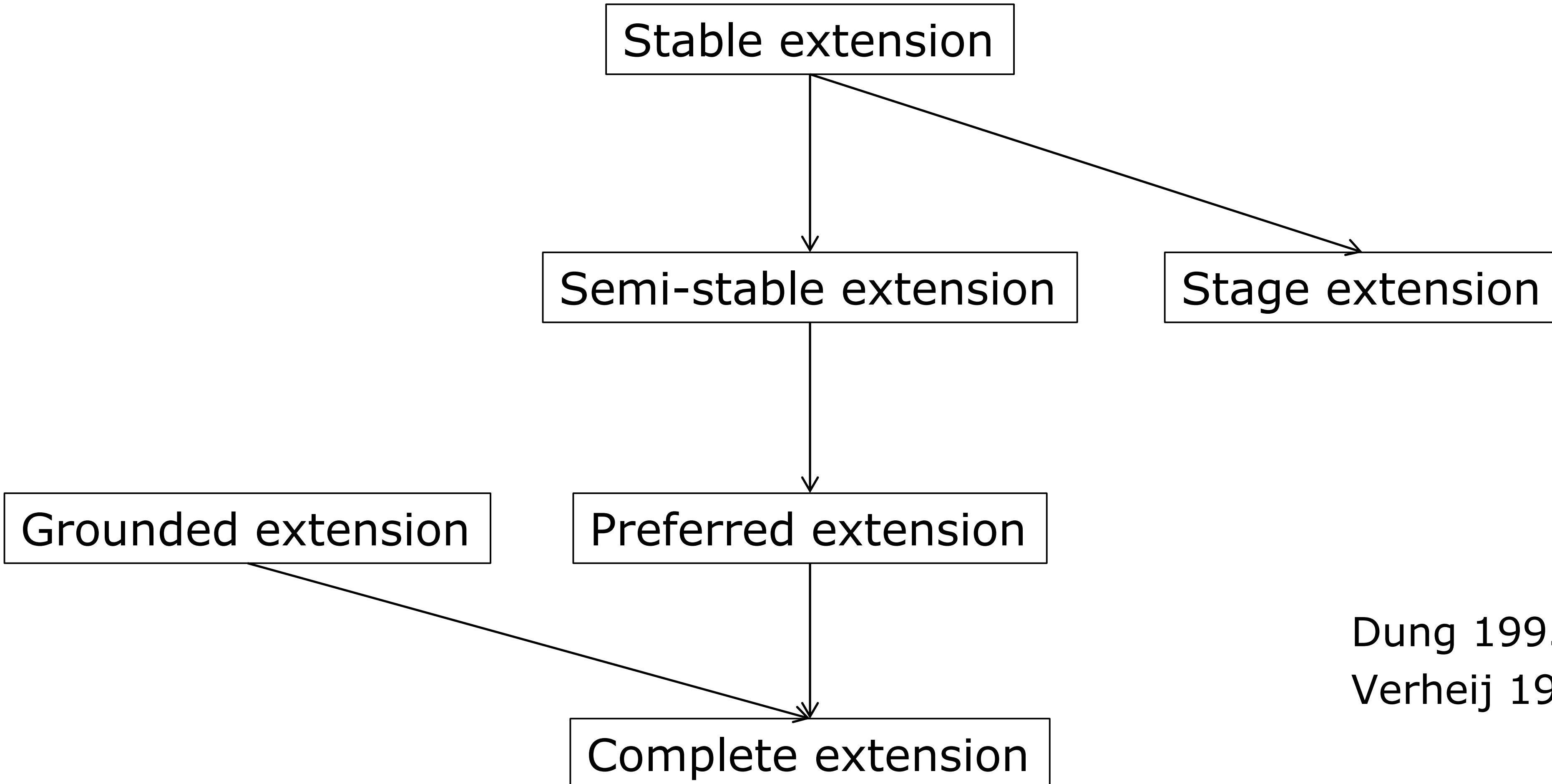
Tort law (damages and unlawful acts)

AI&Law

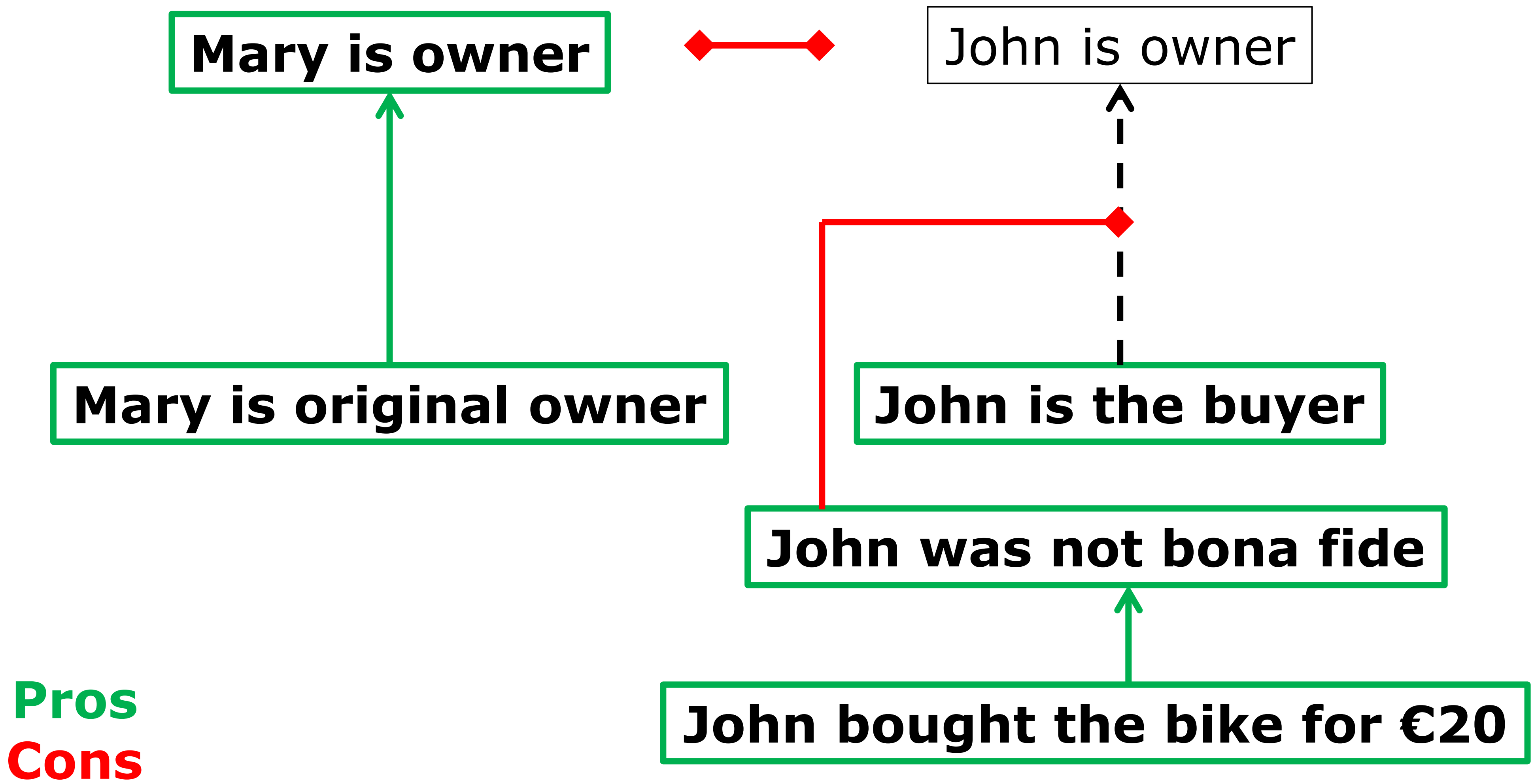
Abstract argumentation semantics (1996)



Dung 1995

Verheij 1996

Set theoretic and labeling semantics


Mary is owner
John is owner
Mary is original owner
John is the buyer
John was not bona fide
John bought the bike for €20
Pros
Cons

Combining support and attack

Starting with attack graphs, there are two ways to add support:

1. ***The abstract argumentation approach***

   Treat nodes in an attack graph as abstactions of support structure

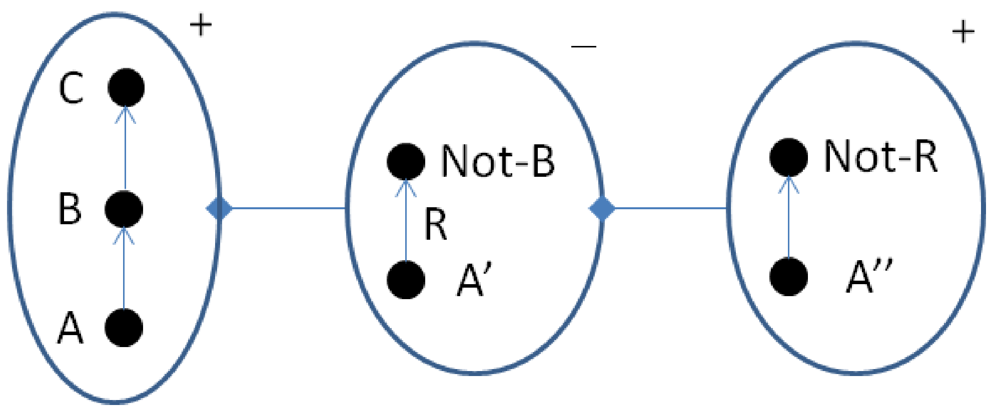
2. ***The reason-based approach***

   Use two kinds of links, one for attack (con-reasons), one for support (pro-reasons)

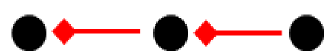
Combining support and attack

Approach 1:

Dung's abstract arguments have internal structure



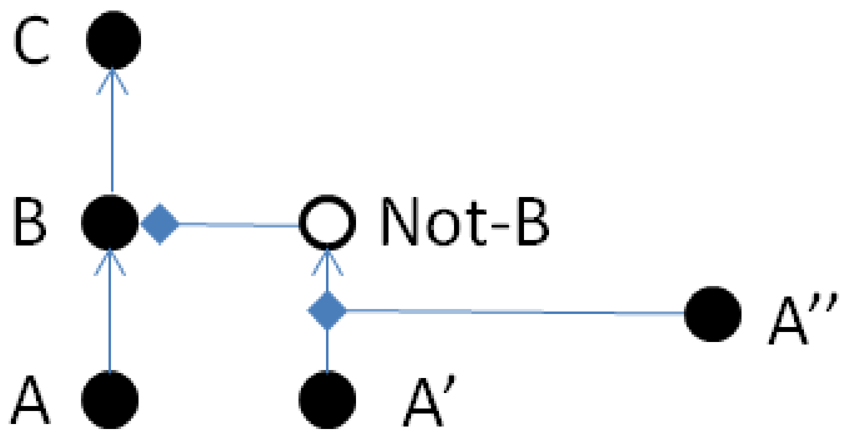
Abstract version:



Combining support and attack

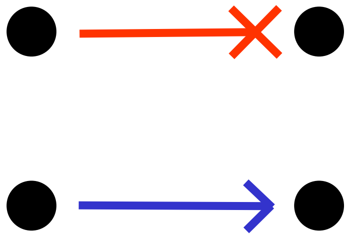
Approach 2:

Arguments can attack or support



Focus on attack

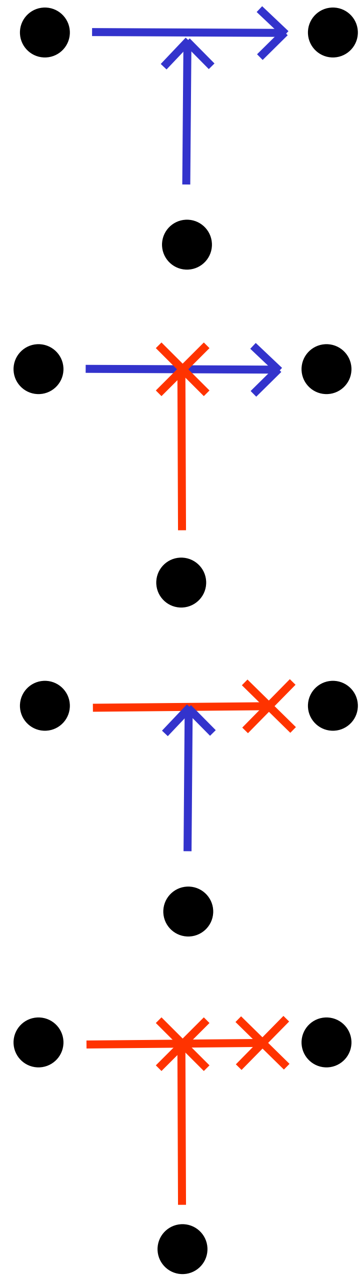
Dung 1995



Also support

$\varphi \sim\mathrm{x}\ \psi$

$\varphi \sim> \psi$



With nesting

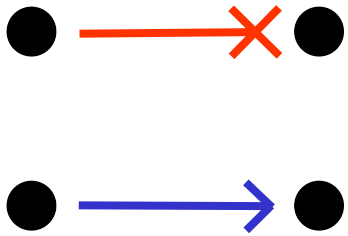
$\varphi \sim> (\psi \sim> \chi)$

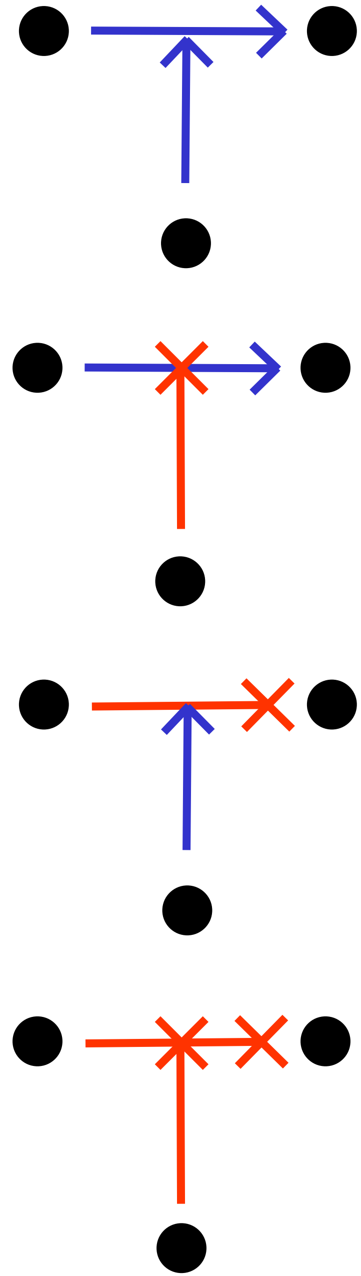
$\varphi \sim\mathrm{x}\ (\psi \sim> \chi)$

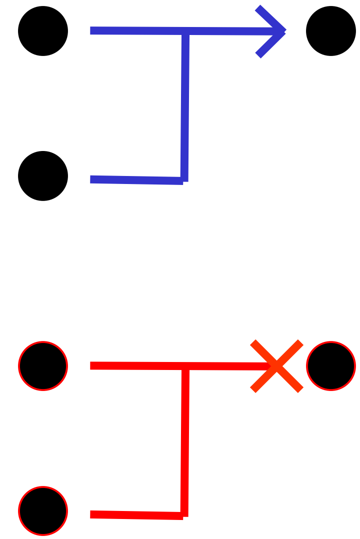
$\varphi \sim> (\psi \sim\mathrm{x}\ \chi)$

$\varphi \sim\mathrm{x}\ (\psi \sim\mathrm{x}\ \chi)$

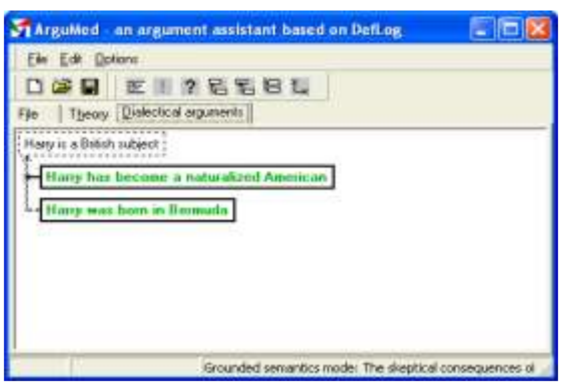
Verheij DefLog 2000, 2003





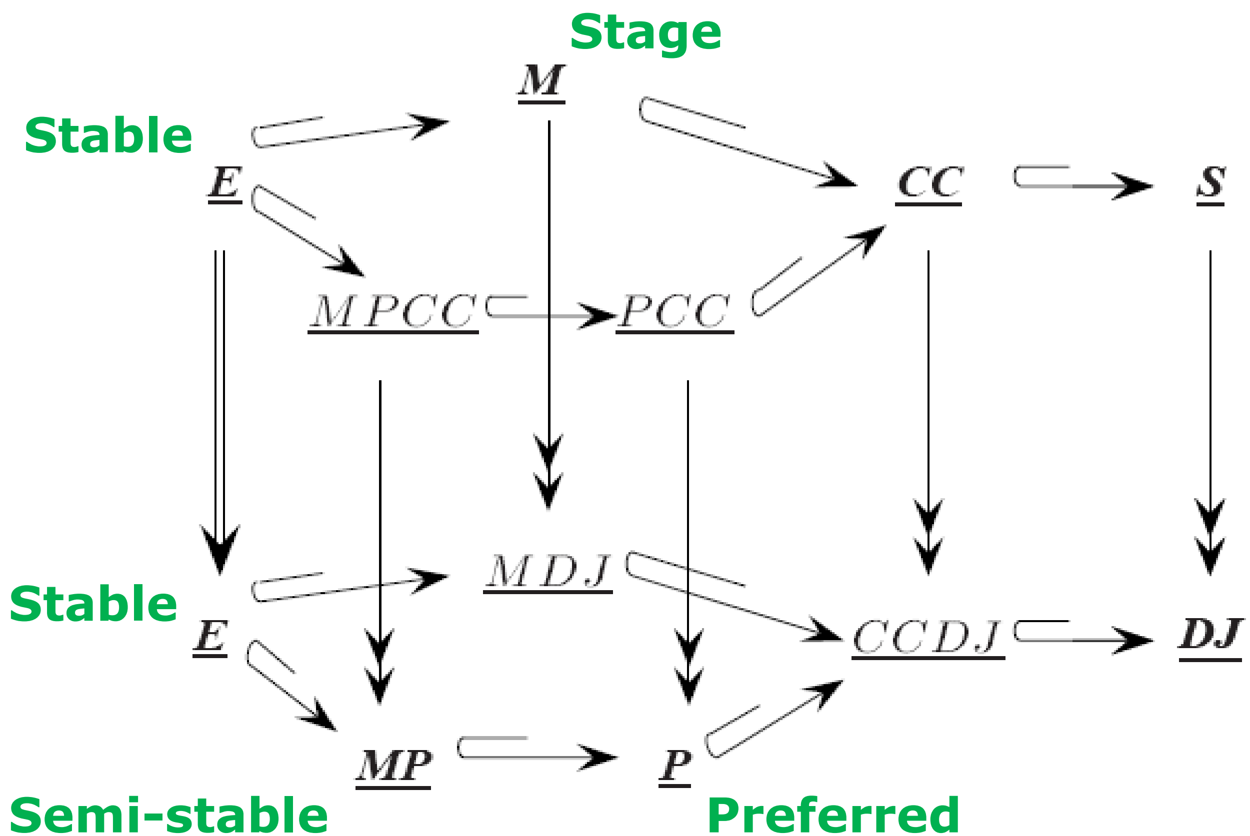


Composite conditions



Verheij ArguMed 2003, 2005

Argumentation semantics (2003)



DefLog Verheij 2003

Set theoretic and labeling semantics

Correct Grounded Reasoning with Presumptive Arguments

1. **The semantics question.** How are presumptive arguments grounded in interpretations? This question is about *grounded argumentation*.

2. **The normative question.** When are presumptive arguments evaluated as correct?
   This question is about *correct argumentation*.

Verheij, B. (2016). Correct Grounded Reasoning with Presumptive Arguments. *Logics in Artificial Intelligence. 15th European Conference, JELIA 2016, Larnaca, Cyprus, November 9-11, 2016, Proceedings*. Berlin: Springer.

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AI&Law

Legislation and precedents

Legislation and precedents are primary sources for the backing of legal arguments.

Each is associated with a specific style of reasoning:

- legislation with rule-based reasoning, and
- precedents with case-based reasoning.

Legal traditions

- Civil law

  History: Eastern Roman empire, 6th century, Codex Justinianus

  Emphasis: codified law

  Primary source: legislation

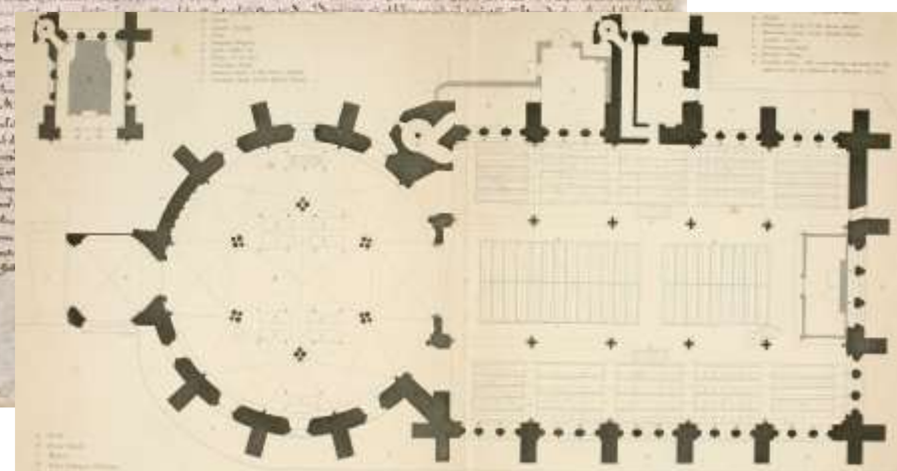
- Common law

  History: England, Middle Ages, Magna Carta

  Emphasis: judge-made law

  Primary source: precedents

Magna Carta Libertatum 1215



Kinds of reasoning

In *rule-based reasoning*, rules backed by legislation are followed when they apply in the current case.

In *case-based reasoning*, cases with precedential authority are adhered to when they match the current case.

Defeasibility

Both kinds of reasoning are defeasible.

In rule-based reasoning, there can be an exception to an applying rule.

In case-based reasoning, adherence to a matching case can be overruled by another case that is a better match.

Artificial Intelligence and Law

Defeasible reasoning backed by rules and cases has been modeled in terms of arguments for and against possible conclusions.

Formal and computational models have been proposed that investigate relations between arguments, rules and cases in various ways. Such work has shown that the formal and computational relations between arguments, rules and cases are close.

The ICAIL 2017 paper aims to further develop the close formal relations between arguments, rules and cases.

Artificial Intelligence and Law

- Cases have been studied as the source of hypothetical arguments (Rissland, Ashley, Aleven).
- Rules and cases have been studied for the construction of explanations of decisions (Branting).
- Rules and cases have been used for the construction of arguments (Prakken, Sartor).
- Cases and the values they promote have been used to establish rules and decision-making (Bench-Capon, Sartor, Atkinson).

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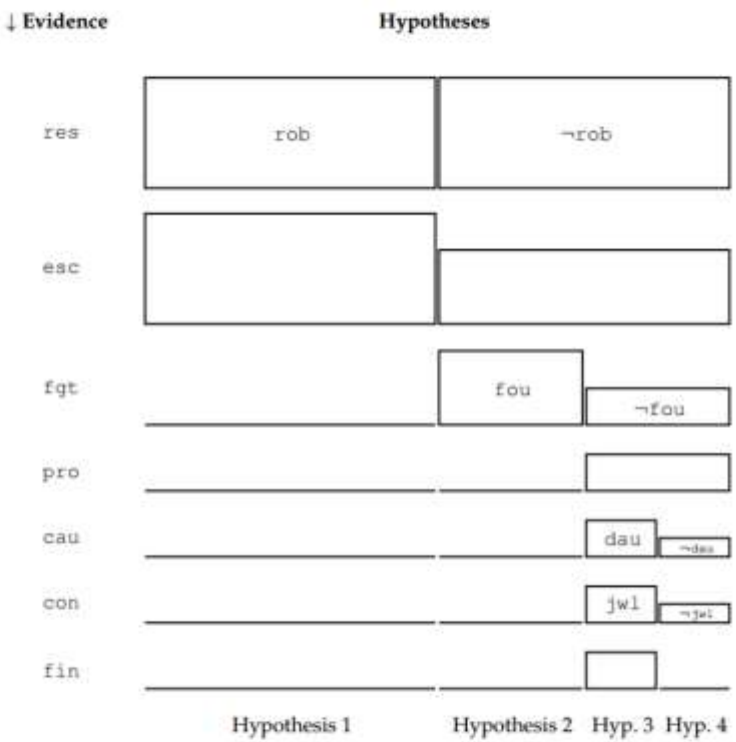
Case models

We use the recently proposed *case model formalism*, previously applied to evidential reasoning and ethical systems design.

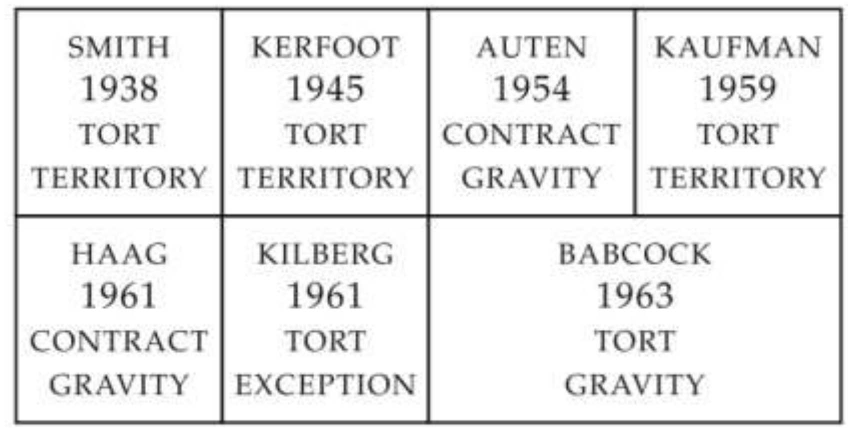
The case model formalism was developed in an attempt to answer the *semantics and normative questions* for reasoning with presumptive arguments:

- How are presumptive arguments grounded in interpretations?
- When are they evaluated as correct?

Case models



Alfred Hitchcock's
'To Catch A Thief'



A series of New York tort cases about car accidents (Hafner, Berman)

ICAIL 2017 paper

We discuss themes in case-based, rule-based and argument-based modeling, all using the same case model formalism.

- With respect to *case-based modeling*, we discuss the themes of analogies, distinctions and argument grounding.
- With respect to *rule-based modeling*, we discuss conditionality, generality and chaining.
- With respect to *argument-based modeling*, we discuss rebutting attack, undercutting attack and undermining attack.

The proposal is evaluated by modeling Dutch tort law. That is an example domain from the rule-based, civil law tradition, and we model it in terms of the case model formalism.

Common law and civil law

Comparative law research has shown that the roles of legislation and precedents as sources of arguments are closely connected in different legal systems, both in common law and in civil law (MacCormick & Summers).

By developing the formal relations between arguments, rules and cases, we contribute to the explanation of this fact.

Case models

Case models consist of a set of sentences and an ordering relation.

The cases in a case model are sentences that must be logically consistent, mutually incompatible and different; and the comparison relation must be total and transitive (a total preorder).

Arguments are interpreted in case models. Three kinds of argument validity are distinguished: coherence, presumptive validity and conclusiveness.

Definition 1. A *case model* is a pair $(C, \geq)$ with finite $C \subseteq L$, such that the following hold, for all φ, ψ and $\chi \in C$:

1. $\not\models \neg\varphi$;
2. If $\not\models \varphi \leftrightarrow \psi$, then $\models \neg(\varphi \wedge \psi)$;
3. If $\models \varphi \leftrightarrow \psi$, then $\varphi = \psi$;
4. $\varphi \geq \psi$ or $\psi \geq \varphi$;
5. If $\varphi \geq \psi$ and $\psi \geq \chi$, then $\varphi \geq \chi$.

Kinds of argument validity

Coherent arguments

$(C, \geq) \models (\varphi, \psi)$ if and only if $\exists \omega \in C$: $\omega \models \varphi \wedge \psi$.

Conclusive arguments

$(C, \geq) \models \varphi \Rightarrow \psi$ if and only if $\exists \omega \in C$: $\omega \models \varphi \wedge \psi$ and $\forall \omega \in C$: if $\omega \models \varphi$, then $\omega \models \varphi \wedge \psi$.

Presumptively valid arguments

$(C, \geq) \models \varphi \rightsquigarrow \psi$ if and only if $\exists \omega \in C$:

1. $\omega \models \varphi \wedge \psi$; and
2. $\forall \omega' \in C$: if $\omega' \models \varphi$, then $\omega \geq \omega'$.

Case models

Case 1: $\neg p$

Case 2: $p \wedge q$

Case 3: $p \wedge \neg q$

Case 1 > Case 2 > Case 3

Case models

Case 1: $\neg p$

Case 2: $p \wedge q$

Case 3: $p \wedge \neg q$

Case 1 > Case 2 > Case 3

p: unlawful

q: duty to repair

Case models

Case 1: $\neg p$

Case 2: $p \wedge q$

Case 3: $p \wedge \neg q$

Case 1 > Case 2 > Case 3

p: unlawful

q: duty to repair

Coherent arguments:

(p, q), $(p, \neg q)$

Presumptively valid arguments:

$(true, \neg p)$, (p, q)

Conclusive arguments:

$(\neg p, \neg p)$, (q, p)

Case models

Case 1: $\neg p$

Case 2: $p \wedge q$

Case 3: $p \wedge \neg q$

Case 1 > Case 2 > Case 3

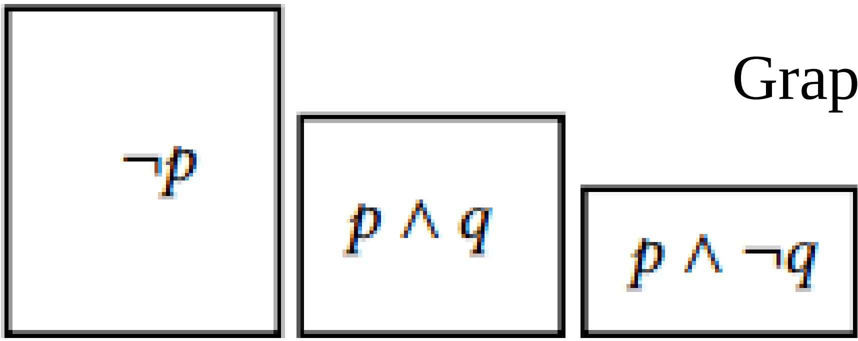
p: unlawful

q: duty to repair

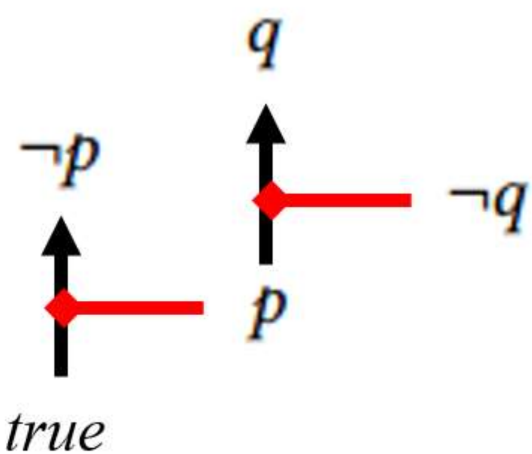
Presumptively valid arguments:

$(true, \neg p)$ has defeating circumstances p

(p, q) has defeating circumstances $\neg q$



Graphical representation of the case model



Graphical representation of the arguments

black arrows: presumptively valid

red arrows: defeating circumstances

Case models

The case model approach has equivalent qualitative and quantitative representations.

The approach has been applied to evidential reasoning for the modeling of argumentative, scenario and probabilistic analyses.

The approach has been applied to decision making for the modeling of value-guided choices (ethical systems design).

Definition 1. A *case model* is a pair $(C, \geq)$ with finite $C \subseteq L$, such that the following hold, for all φ, ψ and $\chi \in C$:

1. $\not\models \neg\varphi$;
2. If $\not\models \varphi \leftrightarrow \psi$, then $\models \neg(\varphi \wedge \psi)$;
3. If $\models \varphi \leftrightarrow \psi$, then $\varphi = \psi$;
4. $\varphi \geq \psi$ or $\psi \geq \varphi$;
5. If $\varphi \geq \psi$ and $\psi \geq \chi$, then $\varphi \geq \chi$.

$\boxed{\geq \textbf{ is a total preorder}}$

i.e., a relation representable by a numeric function

Definition 1. A *case model* is a pair $(C, \geq)$ with finite $C \subseteq L$, such that the following hold, for all φ, ψ and $\chi \in C$:

1. $\not\models \neg\varphi$;
2. If $\not\models \varphi \leftrightarrow \psi$, then $\models \neg(\varphi \wedge \psi)$;
3. If $\models \varphi \leftrightarrow \psi$, then $\varphi = \psi$;
4. $\varphi \geq \psi$ or $\psi \geq \varphi$;
5. If $\varphi \geq \psi$ and $\psi \geq \chi$, then $\varphi \geq \chi$.

$\geq$ is a total preorder

With and without numbers

Kinds of argument validity

Coherent arguments $p(\psi \mid \varphi) > 0$

$(C, \geq) \models (\varphi, \psi)$ if and only if $\exists \omega \in C$: $\omega \models \varphi \wedge \psi$.

Conclusive arguments $p(\psi \mid \varphi) = 1$

$(C, \geq) \models \varphi \Rightarrow \psi$ if and only if $\exists \omega \in C$: $\omega \models \varphi \wedge \psi$ and $\forall \omega \in C$: if $\omega \models \varphi$, then $\omega \models \varphi \wedge \psi$.

Presumptively valid arguments $p(\psi \mid \varphi) > t$

$(C, \geq) \models \varphi \rightsquigarrow \psi$ if and only if $\exists \omega \in C$:

1. $\omega \models \varphi \wedge \psi$; and
2. $\forall \omega' \in C$: if $\omega' \models \varphi$, then $\omega \geq \omega'$.

Properties of presumptive validity

Proposition 8 *Let* $(C, \geq)$ *be a case model. For all* φ, ψ *and* $\chi \in L$*:*

(LE) *If* $\varphi \mid\!\sim \psi$, $\models \varphi \leftrightarrow \varphi'$ *and* $\models \psi \leftrightarrow \psi'$, *then* $\varphi' \mid\!\sim \psi'$.
(Cons) $\varphi \not\mid\!\sim \bot$.
(Ant) *If* $\varphi \mid\!\sim \psi$, *then* $\varphi \mid\!\sim \varphi \wedge \psi$.
(RW) *If* $\varphi \mid\!\sim \psi \wedge \chi$, *then* $\varphi \mid\!\sim \psi$.
(CCM) *If* $\varphi \mid\!\sim \psi \wedge \chi$, *then* $\varphi \wedge \psi \mid\!\sim \chi$.
(CCT) *If* $\varphi \mid\!\sim \psi$ *and* $\varphi \wedge \psi \mid\!\sim \chi$, *then* $\varphi \mid\!\sim \psi \wedge \chi$.

Proposition 13 *Let* $(C, \geq)$ *be a case model, and* $L^* \subseteq L$ *the closure of* C *under negation, conjunction and logical equivalence. Writing* $\mid\!\sim^*$ *for the restriction of* $\mid\!\sim$ *to* L^*, *we have, for all* φ, ψ *and* $\chi \in L^*$*:*

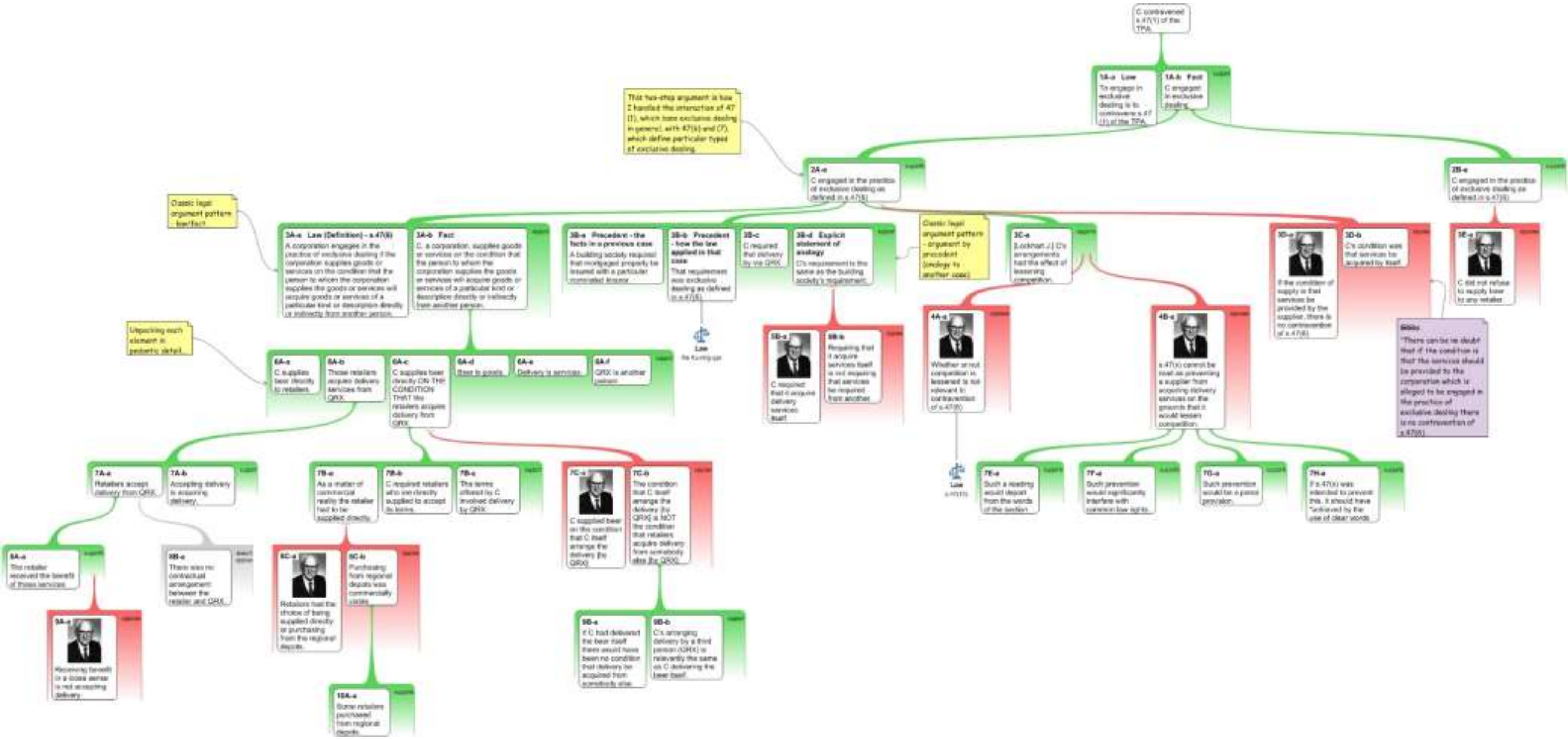
(Coh) $\varphi \mid\!\sim \varphi$ *if and only if* $\exists \varphi^* \in L^*$ *with* $\varphi^* \not\models \bot$ *and* $\varphi^* \models \varphi$;
(Ch) *If* $\varphi \mid\!\sim^* \varphi$ *and* $\psi \mid\!\sim^* \psi$, *then* $\varphi \vee \psi \mid\!\sim^* \neg\varphi \wedge \psi$ *or* $\varphi \vee \psi \mid\!\sim^* \varphi \wedge \psi$ *or* $\varphi \vee \psi \mid\!\sim^* \varphi \wedge \neg\psi$;
(OC) *If* $\varphi \vee \psi \mid\!\sim^* \varphi$ *and* $\psi \vee \chi \mid\!\sim^* \psi$, *then* $\varphi \vee \chi \mid\!\sim^* \varphi$.

Case models

Can case models represent more complex argument structure as is typical in rule-based reasoning?

Challenge:

> Construct a case model for a domain with a complex argument structure



https://timvangelder.com/

Introduction

Argumentation semantics

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Tort law (damages and unlawful acts)

AI&Law

Tort law (The Netherlands)

Art. 6:162 BW. 1. A person who commits an unlawful act toward another which can be imputed to him, must repair the damage which the other person suffers as a consequence thereof.

2. Except where there is a ground of justification, the following acts are deemed to be unlawful: the violation of a right, an act or omission violating a statutory duty or a rule of unwritten law pertaining to proper social conduct.

3. An unlawful act can be imputed to its author if it results from his fault or from a cause for which he is answerable according to law or common opinion.

For instance, if you bump into another car while parking, you typically must pay for the damages incurred.

Tort law (The Netherlands)

As specified in Art. 6:162.1 BW, a **duty to repair** someone's damages can be established when four conditions are fulfilled:

1. *Someone has suffered **damages** by someone else's act.* For instance, the car parked into has a dent in a door panel.
2. *The act committed was **unlawful**.* In the example, the unlawfulness follows from the ownership of the damaged car.
3. *The act can be **imputed** to the person that committed the act.* In the example, it can be said that causing damages because of bumping into another car is your own fault.
4. *The act **caused** the suffered damages.* The door panel was pristine, and now has a dent.

Tort law (The Netherlands)

Three kinds of **unlawful acts** are distinguished (Art. 6:162.2 BW):

1. *The act is a violation of someone's **right***. In the example, the car owner's right to ownership was violated.
2. *The act is a violation of a **statutory duty**.* Examples are acts that are punishable in the sense of the Dutch criminal code or other statutes.
3. *The act is a violation of **unwritten law** against proper social conduct.* Supreme Court of the Netherlands, January 31, 1919, NJ 1919 (Lindenbaum-Cohen).

Tort law (The Netherlands)

Art. 6:162.2 BW explicates an exception to unlawfulness: the existence of **grounds of justification**.

Examples: Force majeure, in particular a conflict of duties as they can occur in a life-endangering situation; commands by an authority such as a police officer.

This exception is phrased as applying to each of the three kinds of unlawfulness, but doctrine often takes it that it only applies to the first two (rights, statutory duties).

Tort law (The Netherlands)

$$\mathrm{dmg} \wedge \mathrm{unl} \wedge \mathrm{imp} \wedge \mathrm{cau} \leadsto \mathrm{dut}$$
$$\mathrm{vrt} \leadsto \mathrm{unl}$$
$$\mathrm{vst} \leadsto \mathrm{unl}$$
$$\mathrm{vun} \leadsto \mathrm{unl}$$
$$\mathrm{ift} \leadsto \mathrm{imp}$$
$$\mathrm{ila} \leadsto \mathrm{imp}$$
$$\mathrm{ico} \leadsto \mathrm{imp}$$

Tort law (The Netherlands)

$\mathrm{dmg} \wedge \mathrm{unl} \wedge \mathrm{imp} \wedge \mathrm{cau} \leadsto \mathrm{dut}$

Four conditions
for duty to repair

$\mathrm{vrt} \leadsto \mathrm{unl}$

$\mathrm{vst} \leadsto \mathrm{unl}$

$\mathrm{vun} \leadsto \mathrm{unl}$

Three kinds
of unlawfulness

$\mathrm{ift} \leadsto \mathrm{imp}$

$\mathrm{ila} \leadsto \mathrm{imp}$

$\mathrm{ico} \leadsto \mathrm{imp}$

Three kinds
of imputability

Tort law (The Netherlands)

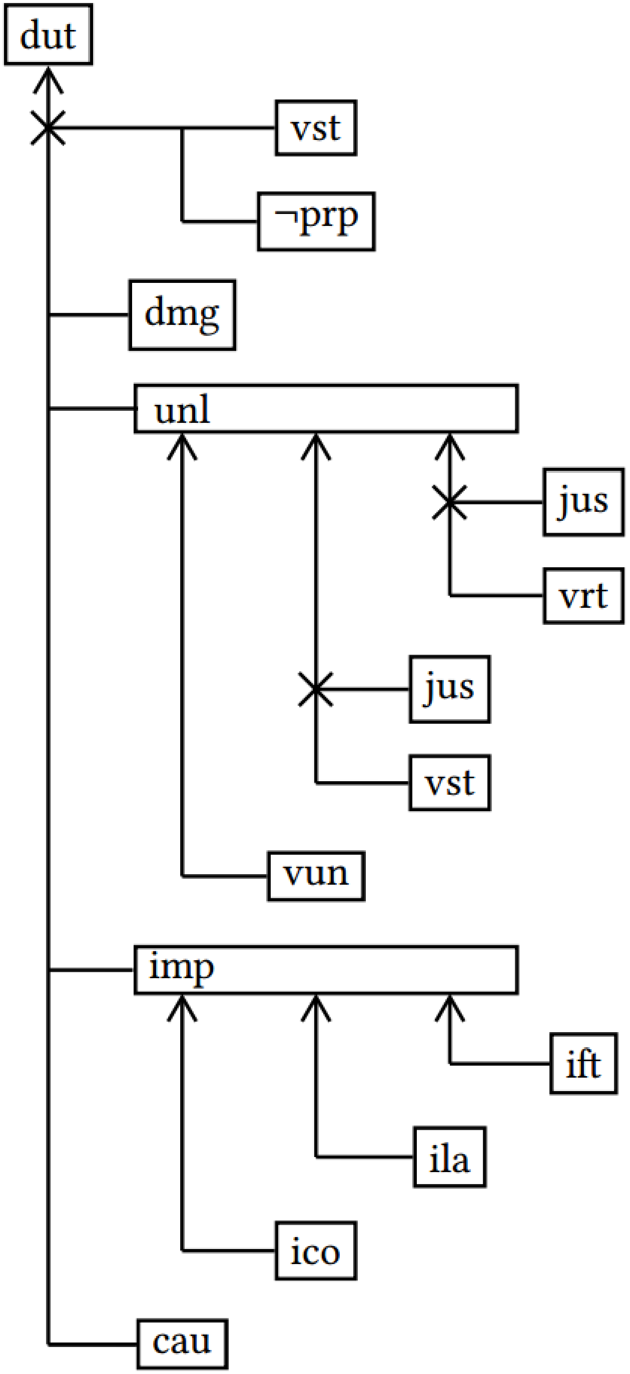
$$\text{dmg} \wedge \text{unl} \wedge \text{imp} \wedge \text{cau} \rightsquigarrow \text{dut} \times \text{vst} \wedge \neg\text{prp}$$
$$\text{vrt} \rightsquigarrow \text{unl} \times \text{jus}$$
$$\text{vst} \rightsquigarrow \text{unl} \times \text{jus}$$
$$\text{vun} \rightsquigarrow \text{unl}$$
$$\text{ift} \rightsquigarrow \text{imp}$$
$$\text{ila} \rightsquigarrow \text{imp}$$
$$\text{ico} \rightsquigarrow \text{imp}$$

Tort law (The Netherlands)

Defeating circumstances
(Art. 6:163 purpose)

$$\mathrm{dmg} \wedge \mathrm{unl} \wedge \mathrm{imp} \wedge \mathrm{cau} \leadsto \mathrm{dut} \times \mathrm{vst} \wedge \neg \mathrm{prp}$$
$$\mathrm{vrt} \leadsto \mathrm{unl} \times \mathrm{jus}$$
$$\mathrm{vst} \leadsto \mathrm{unl} \times \mathrm{jus}$$
$$\mathrm{vun} \leadsto \mathrm{unl}$$
$$\mathrm{ift} \leadsto \mathrm{imp}$$
$$\mathrm{ila} \leadsto \mathrm{imp}$$
$$\mathrm{ico} \leadsto \mathrm{imp}$$

Defeating circumstances
(grounds of justification)



dut	There is a duty to repair someone's damages
dmg	Someone has suffered damages by someone else's act.
unl	The act commited was unlawful.
imp	The act can be imputed to the person that commited the act.
cau	The act caused the suffered damages.
vrt	The act is a violation of someone's right.
vst	The act is a violation of a statutory duty.
vun	The act is a violation of unwritten law against proper social conduct.
jus	There exist grounds of justification.
ift	The act is imputable to someone because of the person's fault.
ila	The act is imputable to someone because of law.
ico	The act is imputable to someone because of common opinion.
prp	The violated statutory duty does not have the purpose to prevent the damages.

Case models

Can case models represent more complex argument structure as is typical in rule-based reasoning?

Challenge:

Construct a case model for a domain with a complex argument structure

A case model for Dutch tort law

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	¬dut	¬dut	¬dut	dut	dut	dut	dut	dut	dut	dut	dut	dut	¬dut	¬dut	¬dut
¬dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg
	¬unl	unl	unl	unl	unl	unl	unl	unl	unl	unl	unl	unl	¬unl	¬unl	unl
		¬imp	imp	imp	imp	imp	imp	imp	imp	imp	imp	imp			imp
			¬cau	cau	cau	cau	cau	cau	cau	cau	cau	cau			cau
	¬vrt			vrt	vrt	vrt	¬vrt	¬vrt	¬vrt	¬vrt	¬vrt	¬vrt	vrt	¬vrt	
	¬vst			¬vst	¬vst	¬vst	vst	vst	vst	¬vst	¬vst	¬vst	¬vst	vst	vst
	¬vun			¬vun	¬vun	¬vun	¬vun	¬vun	¬vun	vun	vun	vun			
		¬ift		ift	¬ift	¬ift	ift	¬ift	¬ift	ift	¬ift	¬ift			
		¬ila		¬ila	ila	¬ila	¬ila	ila	¬ila	¬ila	ila	¬ila			
		¬ico		¬ico	¬ico	ico	¬ico	¬ico	ico	¬ico	¬ico	ico			
				¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	jus	jus	
				prp	prp	prp									¬prp

$1 > 2 > 3 > 4 > 5 \sim 6 \sim 7 \sim 8 \sim 9 \sim 10 \sim 11 \sim 12 \sim 13 > 14 \sim 15 \sim 16$

A case model for Dutch tort law

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	¬dut	¬dut	¬dut	dut	dut	dut	dut	dut	dut	dut	dut	dut	¬dut	¬dut	¬dut
¬dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg
	¬unl	unl	unl	unl	unl	unl	unl	unl	unl	unl	unl	unl	¬unl	¬unl	unl
		¬imp	imp	imp	imp	imp	imp	imp	imp	imp	imp	imp			imp
			¬cau	cau	cau	cau	cau	cau	cau	cau	cau	cau			cau
	¬vrt			vrt	vrt	vrt	¬vrt	¬vrt	¬vrt	¬vrt	¬vrt	¬vrt	vrt	¬vrt	
	¬vst			¬vst	¬vst	¬vst	vst	vst	vst	¬vst	¬vst	¬vst	¬vst	vst	vst
	¬vun			¬vun	¬vun	¬vun	¬vun	¬vun	¬vun	vun	vun	vun			
		¬ift		ift	¬ift	¬ift	ift	¬ift	¬ift	ift	¬ift	¬ift			
		¬ila		¬ila	ila	¬ila	¬ila	ila	¬ila	¬ila	ila	¬ila			
		¬ico		¬ico	¬ico	ico	¬ico	¬ico	ico	¬ico	¬ico	ico			
				¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	jus	jus	
				prp	prp	prp									¬prp

1 > 2 > 3 > 4 > 5 ~ 6 ~ 7 ~ 8 ~ 9 ~ 10 ~ 11 ~ 12 ~ 13 > 14 ~ 15 ~ 16

Case 1: There are no damages

A case model for Dutch tort law

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	¬dut	¬dut	¬dut	dut	dut	dut	dut	dut	dut	dut	dut	dut	¬dut	¬dut	¬dut
¬dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg
	¬unl	unl	unl	unl	unl	unl	unl	unl	unl	unl	unl	unl	¬unl	¬unl	unl
		¬imp	imp	imp	imp	imp	imp	imp	imp	imp	imp	imp			imp
			¬cau	cau	cau	cau	cau	cau	cau	cau	cau	cau			cau
	¬vrt			vrt	vrt	vrt	¬vrt	¬vrt	¬vrt	¬vrt	¬vrt	¬vrt	vrt	¬vrt	
	¬vst			¬vst	¬vst	¬vst	vst	vst	vst	¬vst	¬vst	¬vst	¬vst	vst	vst
	¬vun			¬vun	¬vun	¬vun	¬vun	¬vun	¬vun	vun	vun	vun			
		¬ift		ift	¬ift	¬ift	ift	¬ift	¬ift	ift	¬ift	¬ift			
		¬ila		¬ila	ila	¬ila	¬ila	ila	¬ila	¬ila	ila	¬ila			
		¬ico		¬ico	¬ico	ico	¬ico	¬ico	ico	¬ico	¬ico	ico			
				¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	jus	jus	
				prp	prp	prp									¬prp

1 > 2 > 3 > 4 > 5 ~ 6 ~ 7 ~ 8 ~ 9 ~ 10 ~ 11 ~ 12 ~ 13 > 14 ~ 15 ~ 16

Case 5: There are damages because of an unlawful right violation

A case model for Dutch tort law

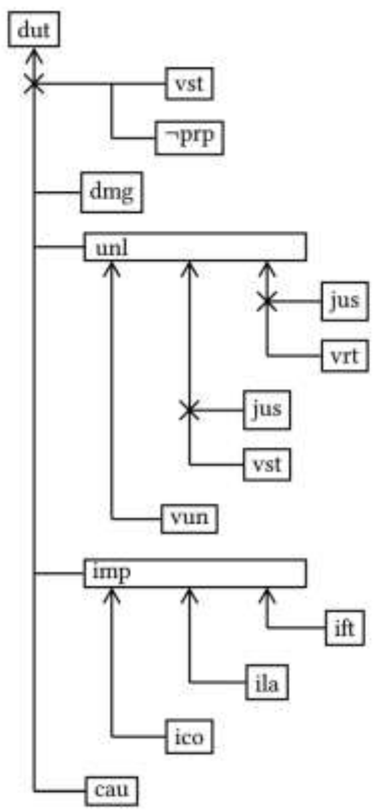
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	¬dut	¬dut	¬dut	dut	dut	dut	dut	dut	dut	dut	dut	dut	¬dut	¬dut	¬dut
¬dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg
	¬unl	unl	unl	unl	unl	unl	unl	unl	unl	unl	unl	unl	¬unl	¬unl	unl
		¬imp	imp	imp	imp	imp	imp	imp	imp	imp	imp	imp			imp
			¬cau	cau	cau	cau	cau	cau	cau	cau	cau	cau			cau
	¬vrt			vrt	vrt	vrt	¬vrt	¬vrt	¬vrt	¬vrt	¬vrt	¬vrt	vrt	¬vrt	
	¬vst			¬vst	¬vst	¬vst	vst	vst	vst	¬vst	¬vst	¬vst	¬vst	vst	vst
	¬vun			¬vun	¬vun	¬vun	¬vun	¬vun	¬vun	vun	vun	vun			
		¬ift		ift	¬ift	¬ift	ift	¬ift	¬ift	ift	¬ift	¬ift			
		¬ila		¬ila	ila	¬ila	¬ila	ila	¬ila	¬ila	ila	¬ila			
		¬ico		¬ico	¬ico	ico	¬ico	¬ico	ico	¬ico	¬ico	ico			
				¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	jus	jus	
				prp	prp	prp									¬prp

1 > 2 > 3 > 4 > 5 ~ 6 ~ 7 ~ 8 ~ 9 ~ 10 ~ 11 ~ 12 ~ 13 > 14 ~ 15 ~ 16

Case 14: There is a ground of justification

A case model for Dutch tort law

$$(C, \geq) \models \mathrm{dmg} \wedge \mathrm{unl} \wedge \mathrm{imp} \wedge \mathrm{cau} \rightsquigarrow \mathrm{dut} \times \mathrm{vst} \wedge \neg \mathrm{prp}$$
$$(C, \geq) \models \mathrm{vrt} \rightsquigarrow \mathrm{unl} \times \mathrm{jus}$$
$$(C, \geq) \models \mathrm{vst} \rightsquigarrow \mathrm{unl} \times \mathrm{jus}$$
$$(C, \geq) \models \mathrm{vun} \rightsquigarrow \mathrm{unl}$$
$$(C, \geq) \models \mathrm{ift} \rightsquigarrow \mathrm{imp}$$
$$(C, \geq) \models \mathrm{ila} \rightsquigarrow \mathrm{imp}$$
$$(C, \geq) \models \mathrm{ico} \rightsquigarrow \mathrm{imp}$$



Case models

Can case models represent more complex argument structure as is typical in rule-based reasoning?

Challenge:

Construct a case model for a domain with a complex argument structure

Yes we can!

Kinds of defeat (Pollock)

Rebutting attack Rebutting attack is a special kind of attack. Rebutting attack occurs when an argument is attacked, while supporting the opposite conclusion.

Definition 5.2. When circumstances χ successfully attack presumptively valid argument (φ, ψ), the circumstances are *rebutting* when $(\varphi \wedge \chi, \neg\psi)$ is presumptively valid.

Undercutting attack Undercutting occurs when the attacking circumstances are not rebutting.

Definition 5.5. When circumstances χ successfully attack presumptively valid argument (φ, ψ), and are not rebutting, the circumstances are *undercutting*.

Artificial Intelligence and Law

- Cases have been studied as the source of hypothetical arguments (Rissland, Ashley, Aleven).
- Rules and cases have been studied for the construction of explanations of decisions (Branting).
- Rules and cases have been used for the construction of arguments (Prakken, Sartor).
- Cases and the values they promote have been used to establish rules and decision-making (Bench-Capon, Sartor, Atkinson).

ICAIL 2017 paper

We discuss themes in case-based, rule-based and argument-based modeling, all using the same case model formalism.

- With respect to *case-based modeling*, we discuss the themes of analogies, distinctions and argument grounding.
- With respect to *rule-based modeling*, we discuss conditionality, generality and chaining.
- With respect to *argument-based modeling*, we discuss rebutting attack, undercutting attack and undermining attack.

The proposal is evaluated by modeling Dutch tort law. That is an example domain from the rule-based, civil law tradition, and we model it in terms of the case model formalism.

Checking the validity of rule-based arguments grounded in cases: a computational approach

Heng ZHENG [a,1], Minghui XIONG [b] and Bart VERHEIJ [a]
[a] *Artificial Intelligence, University of Groningen, The Netherlands*
[b] *Institute of Logic and Cognition, Sun Yat-sen University, Guangzhou, China*

Abstract. One puzzle studied in AI & Law is how arguments, rules and cases are formally connected. Recently a formal theory was proposed formalizing how the validity of arguments based on rules can be grounded in cases. Three kinds of argument validity were distinguished: coherence, presumptive validity and conclusiveness. In this paper the theory is implemented in a Prolog program, used to evaluate a previously developed model of Dutch tort law. We also test the theory and its implementation with a new case study modeling Chinese copyright infringement law. In this way we illustrate that by the use of the implementation the process of modeling becomes more efficient and less error-prone.

Keywords. Artificial Intelligence and Law, Rule-based Reasoning, Case-based Reasoning, Argumentation Modeling, Prolog

Introduction

Argumentation semantics

Legal sources: legislation and precedents

Case models

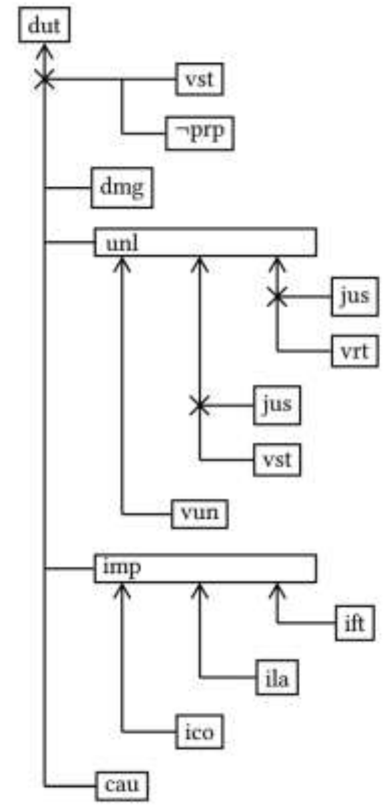
Tort law (damages and unlawful acts)

AI&Law

Artificial Intelligence and Law

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	¬dut	¬dut	¬dut	dut	dut	dut	dut	dut	dut	dut	dut	dut	¬dut	¬dut	¬dut
¬dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg
	¬unl	unl	unl	unl	unl	unl	unl	unl	unl	unl	unl	unl	¬unl	¬unl	unl
		¬imp	imp	imp	imp	imp	imp	imp	imp	imp	imp	imp			imp
			¬cau	cau	cau	cau	cau	cau	cau	cau	cau	cau			cau
	¬vrt			vrt	vrt	vrt	¬vrt	¬vrt	¬vrt	¬vrt	¬vrt	¬vrt	vrt	¬vrt	
	¬vst			¬vst	¬vst	¬vst	vst	vst	vst	¬vst	¬vst	¬vst	¬vst	vst	vst
	¬vun			¬vun	¬vun	¬vun	¬vun	¬vun	¬vun	vun	vun	vun			
		¬ift		ift	¬ift	¬ift	ift	¬ift	¬ift	ift	¬ift	¬ift			
		¬ila		¬ila	ila	¬ila	¬ila	ila	¬ila	¬ila	ila	¬ila			
		¬ico		¬ico	¬ico	ico	¬ico	¬ico	ico	¬ico	¬ico	ico			
				¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	jus	jus	
				prp	prp	prp									¬prp

1 > 2 > 3 > 4 > 5 ~ 6 ~ 7 ~ 8 ~ 9 ~ 10 ~ 11 ~ 12 ~ 13 > 14 ~ 15 ~ 16



Artificial Intelligence and Law

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	¬dut	¬dut	¬dut	dut	dut	dut	dut	dut	dut	dut	dut	dut	¬dut	¬dut	¬dut
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		¬imp	imp	imp	imp	imp	imp	imp	imp	imp	imp	imp			imp
			¬cau	cau	cau	cau	cau	cau	cau	cau	cau	cau			cau
	¬vrt			vrt	vrt	vrt	¬vrt	¬vrt	¬vrt	¬vrt	¬vrt	¬vrt	vrt	¬vrt	
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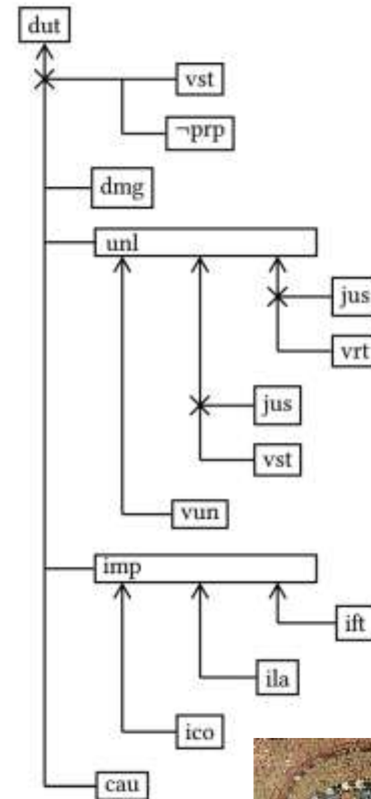
	¬vun			¬vun	¬vun	¬vun	¬vun	¬vun	¬vun	vun	vun	vun			
		¬ift		ift	¬ift	¬ift	ift	¬ift	¬ift	ift	¬ift	¬ift			
		¬ila		¬ila	ila	¬ila	¬ila	ila	¬ila	¬ila	ila	¬ila			
		¬ico		¬ico	¬ico	ico	¬ico	¬ico	ico	¬ico	¬ico	ico			
				¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	jus	jus	
				prp	prp	prp									¬prp

$1 > 2 > 3 > 4 > 5 \sim 6 \sim 7 \sim 8 \sim 9 \sim 10 \sim 11 \sim 12 \sim 13 > 14 \sim 15 \sim 16$

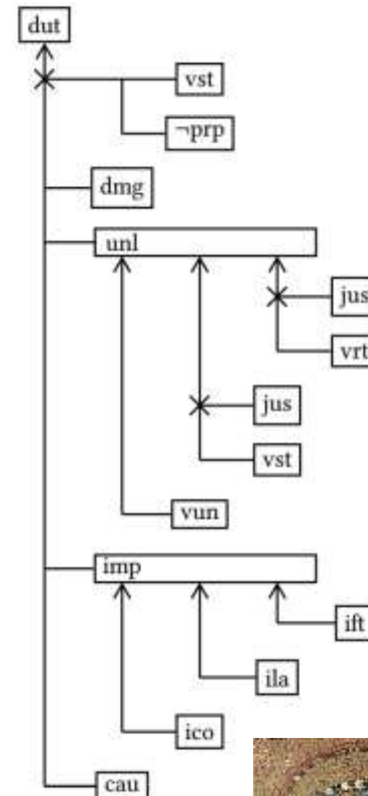


Artificial Intelligence and Law

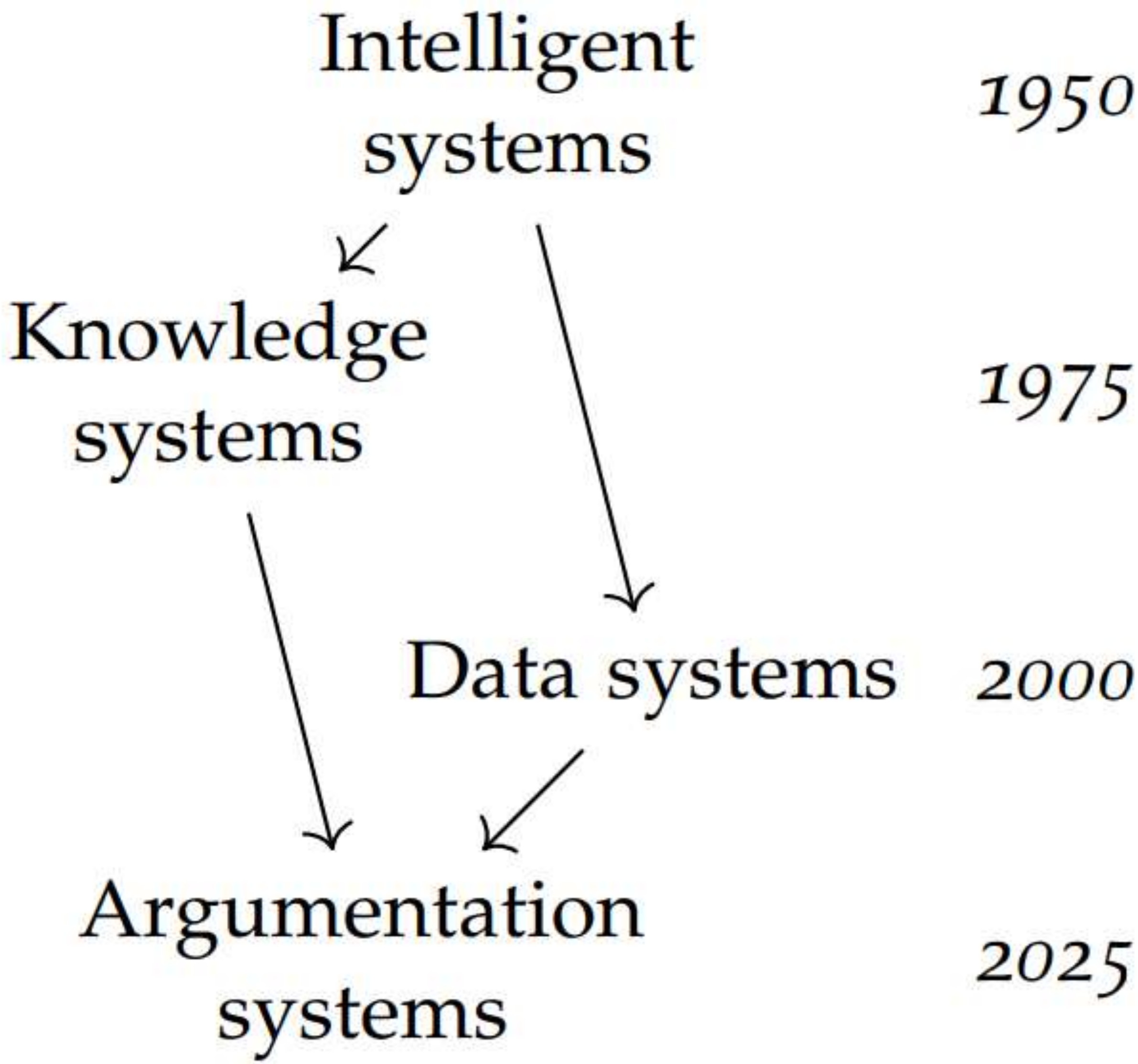
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	¬dut	¬dut	¬dut	dut	dut	dut	dut	dut	dut	dut	dut	dut	¬dut	¬dut	¬dut
¬dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg	dmg
	¬unl	unl	unl	unl	unl	unl	unl	unl	unl	unl	unl	unl	¬unl	¬unl	unl
		¬imp	imp	imp	imp	imp	imp	imp	imp	imp	imp	imp			imp
			¬cau	cau	cau	cau	cau	cau	cau	cau	cau	cau			cau
	¬vrt			vrt	vrt	vrt	¬vrt	¬vrt	¬vrt	¬vrt	¬vrt	¬vrt	vrt	¬vrt	
	¬vst			¬vst	¬vst	¬vst	vst	vst	vst	¬vst	¬vst	¬vst	¬vst	vst	vst
	¬vun			¬vun	¬vun	¬vun	¬vun	¬vun	¬vun	vun	vun	vun			
		¬ift		ift	¬ift	¬ift	ift	¬ift	¬ift	ift	¬ift	¬ift			
		¬ila		¬ila	ila	¬ila	¬ila	ila	¬ila	¬ila	ila	¬ila			
		¬ico		¬ico	¬ico	ico	¬ico	¬ico	ico	¬ico	¬ico	ico			
				¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	¬jus	jus	jus	
				prp	prp	prp									¬prp

$1 > 2 > 3 > 4 > 5 \sim 6 \sim 7 \sim 8 \sim 9 \sim 10 \sim 11 \sim 12 \sim 13 > 14 \sim 15 \sim 16$

Data



Knowledge


Intelligent systems
1950
Knowledge systems
1975
Data systems
2000
Argumentation systems
2025

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