Rules, Cases and Arguments
in Artificial Intelligence and Law

Heng Zheng, Bart Verheij

*Department of Artificial Intelligence, Bernoulli Institute of Mathematics, Computer Science
and Artificial Intelligence, Faculty of Science and Engineering,
University of Groningen, The Netherlands*

Abstract In this chapter, three styles of legal reasoning are discussed as they have been
studied in the field of Artificial Intelligence and Law: rule-based reasoning, case-based
reasoning and argument-based reasoning. In rule-based reasoning, conclusions are drawn
when the rule conditions are fulfilled, unless there is an exception to the rule. In case-based
reasoning, the decision of a precedent case is followed in the current case when it is
analogous to the precedent, but there can be relevant distinctions. In argument-based
reasoning, a conclusion follows when it is supported by an argument that is not defeated by a
counterargument. Rule-based, case-based and argument-based reasoning are illustrated using
tort law in the Netherlands as example. The chapter ends with suggestions for further reading
in Artificial Intelligence and Law research.

1. Introduction

Artificial Intelligence and Law is an interdisciplinary field of research that goes at least
back to the 1970s with academic conferences starting in the 1980s.[1] In the field, complex
problems are addressed on the computational modeling and automated support of legal
reasoning and argumentation. Scholars in this field have different backgrounds, and progress
is driven by insights from lawyers, judges, computer scientists, philosophers and others. The
community investigates and develops Artificial Intelligence techniques applicable in the legal
domain, in order to enhance access to law for citizens and to support the efficiency and
quality of work in the legal domain, aiming to promote a justice society.

Since it is the core of many activities in the legal domain, the structure and process of
legal reasoning has gained much attention in AI & Law research. Three major styles of
modeling legal reasoning are studied, namely rule-based reasoning, case-based reasoning and
argument-based reasoning. These are the focus of this text and will be introduced in the
following sections. As we will see, the styles of modeling legal reasoning are related to one
another, and there is much work investigating relations. We use the example domain of
Dutch tort law (Section 2) to illustrate the rule-based, case-based and argument-based styles
of modeling the structure and process of legal reasoning (Sections 3 to 5, respectively).

2. Tort law in the Netherlands

Tort law handles situations in which someone causes damages to someone else and has
the legal duty to repair those damages, typically by financial compensation. Consider for
instance the case of John who visits Mary in her house, and accidentally, by a sudden clumsy
move, bumps into a small Chinese vase decorating Mary's home, which falls and breaks.

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[1] The biennial International Conference on Artificial Intelligence and Law (ICAIL) had its first edition in 1987.
The annual International Conference on Legal Knowledge and Information Systems (JURIX) in 1988. The
journal *Artificial Intelligence and Law* started in 1992.

Though the emotional value cannot be repaid, by law, John has the duty to repair the damages by paying (typically via his liability insurance) Mary the amount of 900 euros, the estimated value of the antique vase.

The core articles related to tort law in the Netherlands are Art. 6:162 and 6:163 of the Dutch Civil Code (in Dutch: Burgerlijk Wetboek, or BW, for short). Here we use the English version of these two articles translated by Betlem (1993) (see also Verheij et al., 1997):

> **Art. 6:162 BW.** 1. A person who commits an unlawful act toward another which can be imputed to him, must repair the damages 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.
> **Art. 6:163 BW.** There is no obligation to repair damage when the violated norm does not have as its purpose the protection from damage such as that suffered by the victim.

According to Art. 6:162.1 BW, the issue whether someone has a duty to repair someone's damages can be established depending on four cumulative conditions:

1. Someone has suffered damages by someone else's act; and
2. the act committed was unlawful; and
3. the act can be imputed to the person that committed the act; and
4. the act caused the suffered damages.

In the Chinese vase example, Mary's damages consist of the broken vase (condition 1), by John's unlawful act (2), imputable to him (3) and causing the damages (4).

Art. 6:162.2 BW specifies which kinds of acts can be considered as unlawful:

1. The act is a violation of someone's right; or
2. the act is a violation of a statutory duty; or
3. the act is a violation of unwritten law against proper social conduct.

There is an exception in Art. 6:162.2 BW: the existence of grounds of justification makes that a prima facie unlawful act is not unlawful after all. John's act was unlawful, for instance since it violated Mary's property right (condition 1). There are no grounds of justification.

Art. 6:162.3 BW lists the three situations that an act can be imputed to someone:

1. The act is imputable to someone because of the person's fault; or
2. the act is imputable to someone because of law; or
3. the act is imputable to someone because of common opinion.

Art. 6:163 BW provides an exception to the general rule in Art. 6:162.1 BW, namely that, if the violated statutory duty does not aim for preventing the damages occurred, then there is no obligation to repair damages.

The violation of unwritten law against proper social conduct (condition 3 in Art. 6:162.2 BW) is an example of an open norm, which leaves much room for interpretation when applied. The Supreme Court has provided a number of guiding factors for determining

whether the condition holds (in the cellar hatch case, discussed below, HR 5 november 1965, NJ 1966/136; see Asser-Hartkamp 1998):

1. The nature and scale of the feared damages.
2. The probability that these damages occur because of certain behaviour.
3. The nature and the benefits of the activity or the goal striven for.
4. The difficulty of taking precautionary measures.

When deciding a case, these four factors are assessed by judges using the facts of the case in order to determine unlawfulness by a violation of proper social conduct.

For ease of reference, Table 1 lists key propositions for Dutch tort law, with abbreviations. The symbol ¬ stands for negation.

dut	There is a duty to repair someone's damages.
dmg	Someone has suffered damages by someone else's act.
unl	The act committed was unlawful.
imp	The act can be imputed to the person that committed 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.

Table 1 Key propositions in Dutch tort law; with abbreviations

We discuss three well-known cases of Dutch tort law, with examples of violations of unwritten law. Analyses of the cases in terms of the key propositions (Table 1) are provided in Table 2. From the table we can find all three cases contain the same key propositions.

Lindenbaum-Cohen. Both Lindenbaum and Cohen had a printing company in Amsterdam. In order to gain more benefits, Cohen bribed one of Lindenbaum's employees to seek for commercially relevant information. Lindenbaum then claimed for compensation by Cohen as he suffered damages caused by Cohen. The court of first instance rejected Lindenbaum's claim as at that time only violations of rights and statutory duties counted as unlawful. However, in the Supreme Court's final decision, Cohen's behaviour was regarded as an unlawful act, because it was a violation of unwritten law against proper social conduct. (HR 31-01-1919; NJ 1919/161)

Spitfire. A military airplane damaged a power line of an electricity company. It was not at issue that the State had to repair the electricity company's damages as the State violated the company's property right, a straightforward basis for unlawfulness. However, the plaintiff of this case was a textile factory that had also suffered damages caused by the power failure. Since what the airplane damaged is the property of the electricity company, in this case the violated statutory duty does not have the purpose to prevent the damages of the textile factory. The court still considered that the State should compensate the textile factory because of the act of the State is a violation of unwritten law against proper social conduct, since the State

created a dangerous situation causing the power failure, which the State should have prevented. (HR 14-3-1958; NJ 1961, 570).

Cellar hatch. A Coca-Cola company employee had opened a cellar hatch door without taking precautionary measures when he delivered goods in a café in Amsterdam. A customer, Duchateau, from Maastricht, fell into the cellar on his way to the restrooms. The Dutch Supreme Court listed the relevant factors discussed above (nature and scale of feared damages, etc.) and, upon weighing these factors, decided that the Coca-Cola company had acted unlawfully and should have considered the possibility of careless bar guests and taken measures accordingly. Damages were shared 50-50 between Coca-Cola and Duchateau since a part of the damages were caused by Duchateau's own fault (HR 5-11-1965; NJ 1966, 136).

Lindenbaum-Cohen	
Cohen has a duty to repair Lindenbaum's damages.	dut
Lindenbaum has suffered damages by Cohen's act.	dmg
Cohen's behaviour was regarded as an unlawful act.	unl
Cohen's behaviour was a violation of unwritten law that against proper social conduct	vun
The act can be imputed to Cohen.	imp
The act is imputable to Cohen because of his fault on seeking commercial information.	ift
The act caused Lindenbaum suffered damages.	cau
Spitfire	
The State has the duty to repair the textile factory's damages on power failure.	dut
The factory has suffered damages by the State's act.	dmg
The State's behaviour was regarded as an unlawful act.	unl
The State's behaviour was a violation of the electricity company's property which caused the factory's damages.	vst
The State's behaviour was a violation of unwritten law that against proper social conduct.	vun
The act can be imputed to the State.	imp
The act is imputable to the State because of their fault to not prevent the dangerous situation.	ift
The act caused the factory suffered damages.	cau
The statutory duty that the State violated does not have the purpose to prevent the factory's damages.	¬prp
Cellar hatch	
The Coca-Cola company has the duty to repair the customer's damages.	dut
The customer has suffered damages by the act committed by the employee from the Coca-Cola company.	dmg
The company's act in this case was regarded as an unlawful act.	unl
The company hasn't considered the possibility of careless bar guests, therefore their act was a violation of unwritten law that against proper social conduct.	vun
The act can be imputed to the Coca-Cola company	imp
The act is imputable to the company because of their fault on taking measures to protect careless bar guests.	ift
The act caused the customer of the bar suffered damages.	cau

Table 1 Analysis of the cases in terms of key propositions

3 Rule-based reasoning

Rule-based reasoning is based on the application of rules. When the conditions of a rule apply, the rule conclusion follows. Figure 1 shows the structure of the main rule underlying Art. 6:162.1 BW with four cumulative conditions and a conclusion.

In the following, we discuss four structures related to reasoning with rules: different rules with the same conclusion; rules with the condition of another rule as a conclusion; rules with exceptions; rules with opposite conclusions.

Rules with the same conclusion Different rules can have the same conclusion. For example, Figure 2 shows the three kinds of unlawful acts (expressed in Art. 6:162.2 BW) as three single condition rules.

Rules with the condition of another rule as a conclusion One rule's conclusion can be another rule's condition. For instance, Figure 3 shows this kind of linked structure between rules in Dutch tort law: the main rule of Art. 6:162.1 BW has `The act committed was unlawful' as a condition, while Art. 6:162.2 BW has this statement as its conclusion.
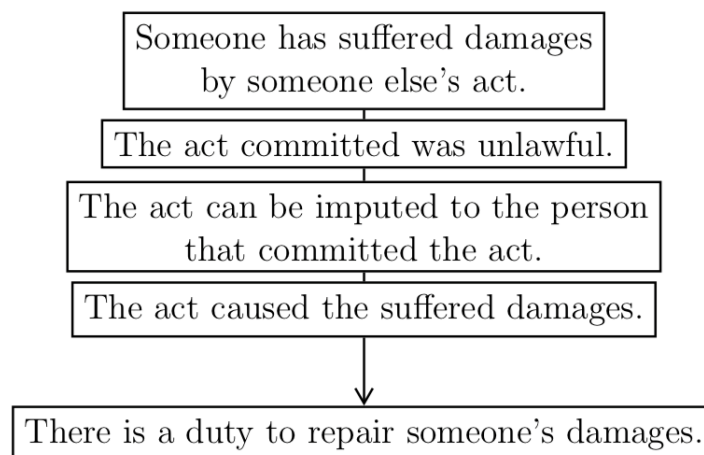

Figure 1 A rule with four cumulative conditions and a conclusion (based on Art. 6:162.1 BW)

Rules with exceptions In rule-based reasoning, a rule's conclusion does not always follow from the conditions, as there can be exceptions. For instance, Figure 4 shows the occurrence of grounds of justification as an exception to the rule that violations of a right are unlawful.

Rules with opposite conclusions Legal rules can have opposite conclusions. For instance, the main tort rule in Art. 6:162.1 BW has conclusion `There is a duty to repair someone's damages.', which is the opposite of the conclusion of Art. 6:163 BW expressing the exception based on the purpose of a statutory duty.
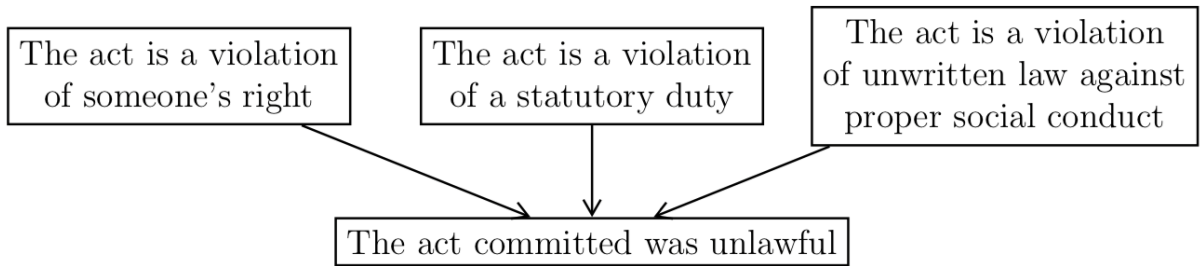
Figure 2 Three rules with the same conclusion

4 Case-based reasoning

Case-based reasoning is based on adherence to an analogous precedent. When the current case shares all elements relevant for a conclusion with a precedent, the precedent's conclusion follows in the current case too. The elements of a case can be graphically shown as in Figure 6. The elements shown correspond to each of the three cases discussed in Section 2 and analyzed in Table 2 and include the cases' intermediate conclusions (here `unl' and `imp', derived from `vun' and `ift', respectively) and final decision (`dut', derived from `dmg', `unl', `imp' and `cau').
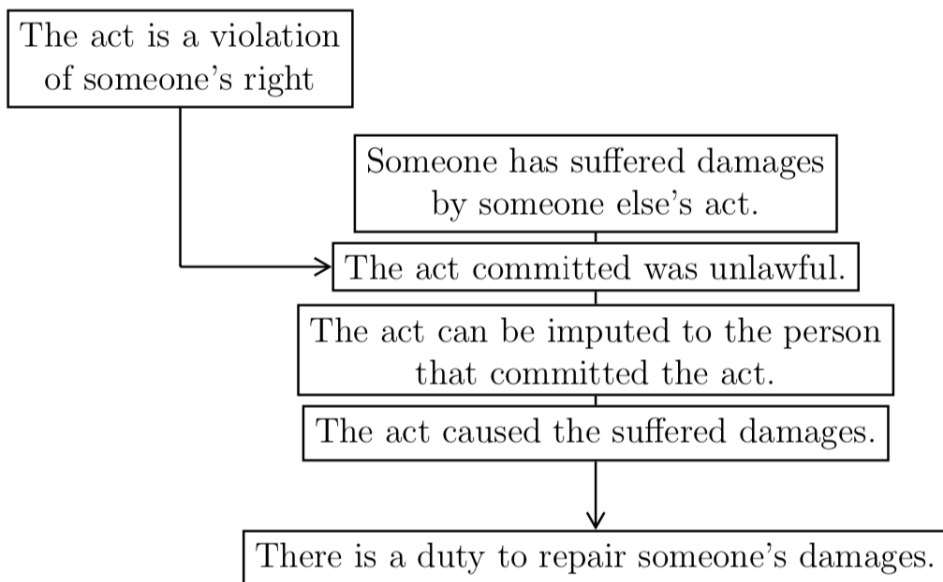
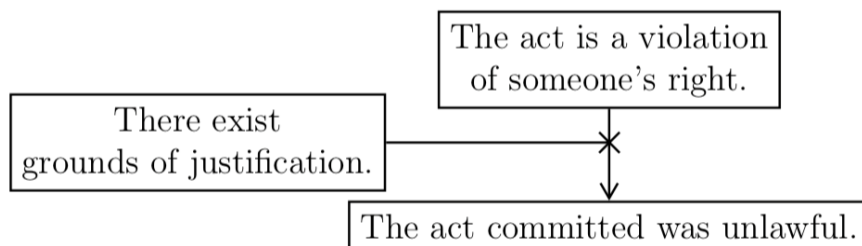Figure 3 A rule with a condition that is another rule's conclusion
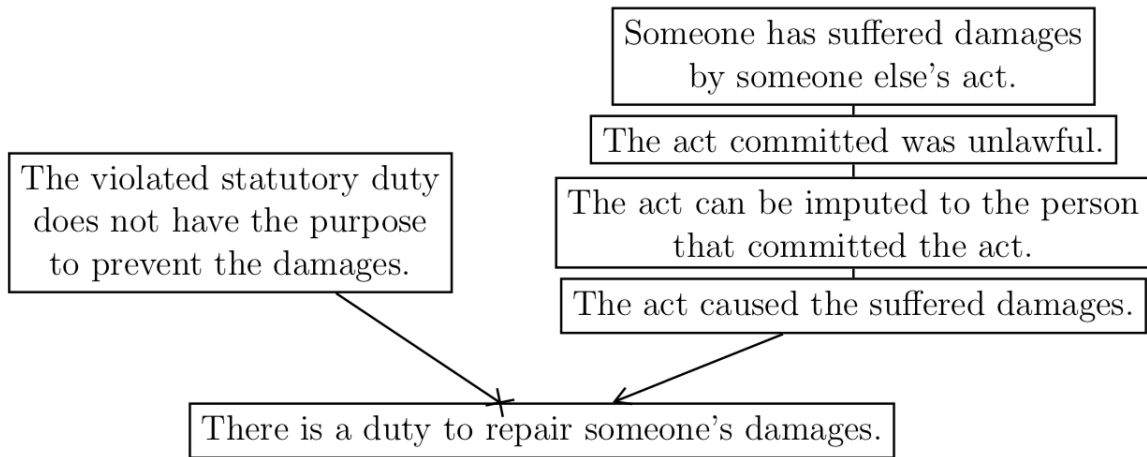

Figure 4 A rule with an exception
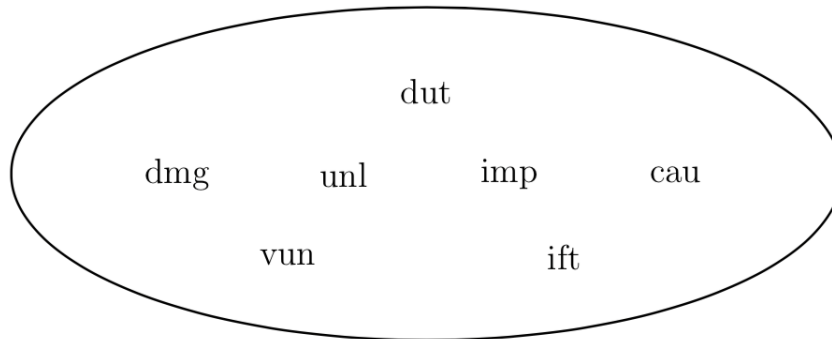
Figure 5 Rules with opposite conclusions

Figure 6 The elements of a decided case, including intermediate conclusions and decision

Analogy and distinction Cases can share more or less elements. Consider for instance the two cases in Figure 7. The case on the left has been decided for a duty to repair (`dut'), the case on the right against such a duty (`¬dut', where ¬ stands for negation). The cases share that there were damages, unlawfulness by violation of unwritten law (`vun') and causality, but not imputability. In the case on the left, there was imputability, because their was a fault (`ift'), on the right there was no imputability because there was no fault (`¬ift'). The shared elements express the analogy between the two cases, and the non-shared elements their distinction.
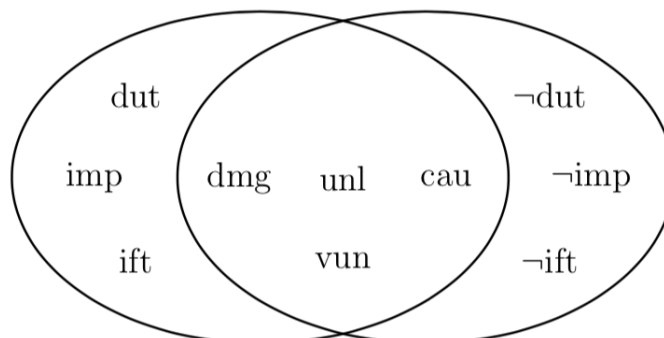

Figure 7 Two decided cases with opposite conclusions

Decided cases can stand in different relations with an undecided case. Consider for instance an undecided case with elements `dmg', `vun', `ift' and `cau'. This undecided case shares all its elements with the decided case on the left of Figure 7, but not with the decided case on the right as the undecided case has `ift' instead of `¬ift'. The decided case on the left

is more on point with respect to the undecided case than the case on the right. In fact, by the analogy `vun', it can be concluded that the case is unlawful (`unl'), and by `ift' imputability (`imp'). Hence all elements relevant for the duty to repair are available (`dmg', `unl', `imp', `cau') and the decision of the decided case can be followed in the undecided case.

Case elements with sides The elements of a case can have a side in the sense that they support one side of the legal issue. For instance, the element `The act caused the suffered damages' supports `There is a duty to repair someone's damages', whereas the element `There exist grounds of justification' supports the opposite side `There is no duty to repair someone's damages'. Most key propositions listed in Table 1 support a duty to repair damages; only the exceptions of grounds of justification (`jus') and purpose of a statutory duty (¬prp') support that there is no duty to repair damages (see Table 3, where for completeness also `dut' is listed). In Figure 7, the elements `¬imp' and `¬ift' also support that there is no duty to repair damages.

dut	dmg	unl	imp	cau	vrt	vst	vun	jus	ift	ila	ica	¬prp
+	+	+	+	+	+	+	+	-	+	+	+	-

Table 3 Sides of key propositions: + supporting a duty to repair damages; - supporting the opposite

The side of an element influences the relevance of an analogy or a distinction. Consider for instance the three decided cases in Figure 8 and an undecided case with elements `dmg', `unl', `vst', `imp', `ift' and `cau': there are damages, the act is inlawful by a violation of a statutory duty, there is imputability because of fault and the damages are caused by the act. The three cases shown all share exactly these elements with the current case. Suppose now that Case 1 is suggested as a case to follow in the current case. Indeed the shared elements provide an analogy between Case 1 and the current case, and all these elements support that there is a duty to repair damages, as was decided in Case 1. Now it turns out that in the current case the violated statutory duty did not have the purpose to protect against the damages (`¬prp'), an element supporting that there is no duty to repair damages. As a result, Case 1 has a relevant distinction with the current case, in the sense that the current case has an element supporting the opposite of the decision of Case 1. Case 2 has a more on point analogy with the current case than Case 1, suggesting that there is no duty to repair damages as decided in Case 2. If we now assume that in the current case there was still a violation of unwritten law (`vun'), Case 2 can again be relevantly distinguished, as there is an element in the current case supporting the opposite of Case 2's decision. Now Case 3 has a more on point analogy with the current case, suggesting the decision that there is a duty to repair after all. The Spitfire case discussed above (Section 2) has elements as in Case 3.
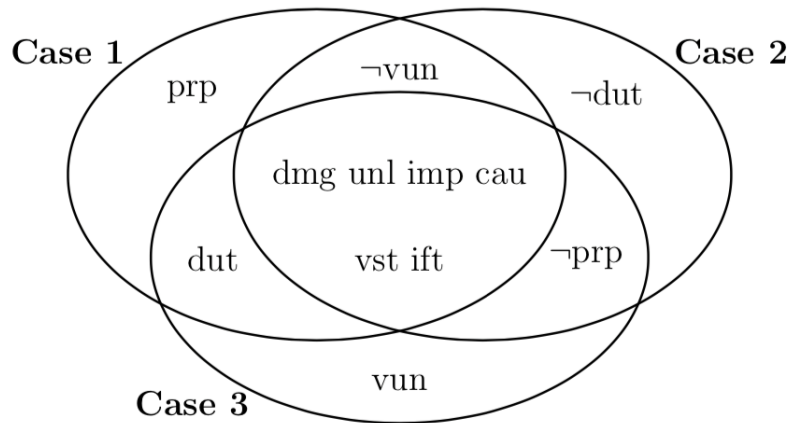
Figure 8 Three decided cases

A hierarchy of elements In case-based reasoning, the hierarchical relations between case elements can be relevant. For instance, the violation of a statutory duty, of a right and of unwritten law (`vst', `vrt', `vun') indirectly support the duty to repair (`dut') since they support the unlawfulness of the act (`unl'), which in turn supports the duty to repair. Figure 9 shows the hierarchy of the key propositions as they appear in the Tables 1 and 3. The analysis of sides of key propositions (as in Table 3) can be regarded as a flattened version of the hierarchy.
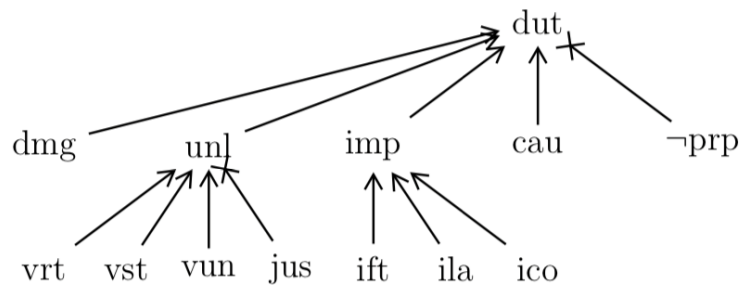

Figure 9 The hierarchy of elements in Dutch tort law

Figure 10 shows three decided cases that can be distinguished from one another in terms of their elements. Case 1 is a case of violation of a right (`vrt), Case 2 of a statutory duty (`vst'), and Case 3 of unwritten law (`vun'). However, for determining whether there is a duty to repair damages, the hierarchy of elements can be used to downplay these distinctions as irrelevant since all are cases in which the committed act was unlawful (`vun'). In the hierarchical structure of tort law, the distinctions between the three cases occur at a level below what is relevant for the legal issue whether there is a duty to repair damages.

Dimensions Until now, we focused on elements of a case of a binary nature: they either hold or do not hold in a case. For instance, a statutory duty is violated or not in a case. However, case elements can also have a degree, or dimension. The cellar hatch case discussed in Section 2 provides examples. For instance, the nature and scale of feared damages can be smaller or larger.
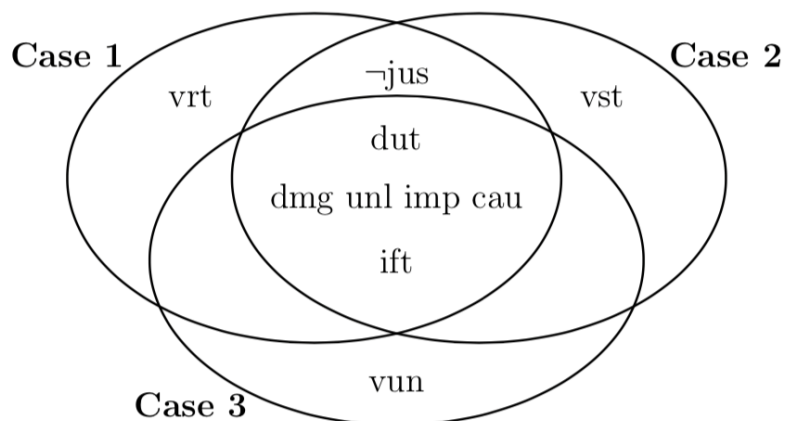
Figure 10 Three cases with different kinds of unlawfulness

Figure 11 shows three decided cases with the dimensional elements listed in the cellar hatch case: the nature and scale of the feared damages (`nsd'), the probability that these damages occur because of certain behaviour (`prd'), the nature and the benefits of the activity or the goal striven for (`nba'), and the difficulty of taking precautionary measures (`dpm'). The dimensional elements have been evaluated on a five point scale (very small, small, normal, large, very large, abbreviated as $--$, $-$, 0, +, ++). The acts in two cases are decided as unlawful, hence there is a duty to repair damages (Cases 1 and 2), one case as not unlawful, hence there is no duty to repair damages (Case 3). Looking at the dimensional elements, Case 1 points more strongly in the direction of unlawfulness than Case 2 for each of the elements: feared damages are larger, the probability that they arise are larger, the benefits of the activity are smaller, and the difficulty of taking precautions is smaller. Similarly, Case 2 (decided for unlawfulness) points more strongly in the direction of unlawfulness than Case 3 (decided for lawfulness). Apparently the tipping point between unlawfulness and lawfulness is somewhere between Case 2 and Case 3.
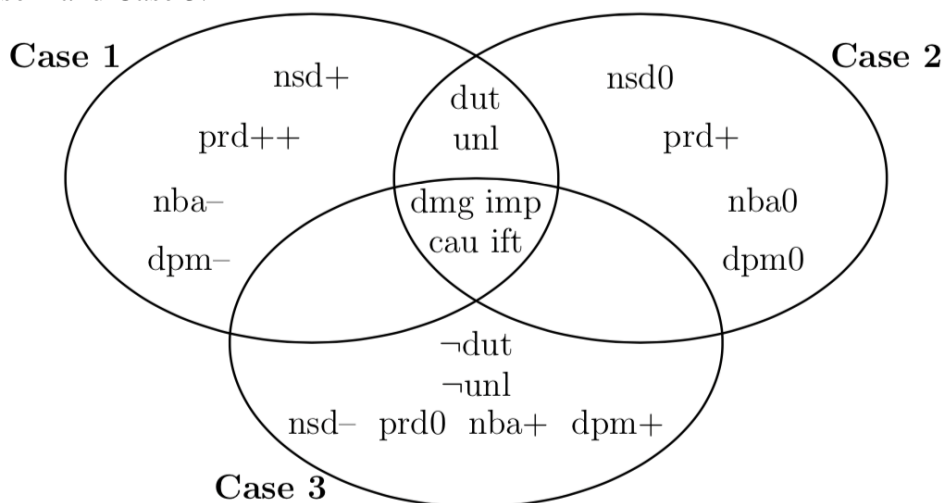

Figure 11 Decided cases with dimensional elements

These decided cases with dimensional elements can be used to evaluate new cases. For instance, consider a case with the following evaluation of the dimensional elements: nsd+, prd+, nba–, dpm0. In terms of the evaluation of the elements, this case falls somewhere between Cases 1 and 2: feared damages and benefits are scored as in Case 1, probability of damages and difficulty of precautions as in Case 2. This suggests that by case-based reasoning also in this case, as in Cases 1 and 2, the decision can be for unlawfulness and a duty to repair. In another case, where the elements are scored nsd–, prd+, nba0, dpm+, the

situation is unclear: here the scoring is in between those of Cases 2 and 3. As the tipping point is somewhere between these cases, case-based reasoning cannot suggest an answer.

5 Argument-based reasoning

In argument-based reasoning, the focus is on the reasons for and against conclusions, as they can be put forward in a discussion about an issue. For instance, the statement `The act is a violation of someone's right' is a reason for the conclusion `The act was unlawful', and the statement `There exists grounds of justification' is a reason against that conclusion.

Supporting reasons In legal arguments, supporting reasons come in different kinds of combinations. In multiple support, reasons that each support their conclusion are combined.
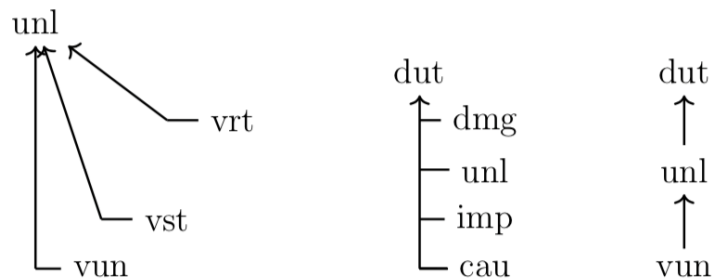
Figure 12 Multiple reasons (left); coordinated reasons (middle); subordinated reasons (right)

For instance, since there are three kinds of unlawful acts, there are three kinds of reasons to support the conclusion `The act committed was unlawful', that can be combined as multiple supporting reasons (Figure 12, left). Coordinated reasons appear when they support their conclusion in conjunction. Figure 12 (middle) shows an example of support by coordinated reasons. The conclusion `There is a duty to repair someone's damages' has four reasons that only in combination support the conclusion. Subordinated reasons appear when a conclusion of a reason is itself the reason for another conclusion. For instance, as Figure 12 (right) shows the reason `The act committed was unlawful' that supports the conclusion `There is a duty to repair someone's damages' and is itself supported by another reason `The act is a violation of unwritten law against proper social conduct'.

Attacking reasons A reason put forward in an argument can also attack a conclusion. For instance, the argument from `The act is a violation of someone's right' (`vrt')) to `The act committed was unlawful' (`unl') can be attacked by the reason `There exist grounds of justification' (`jus') (Figure 13, left). This is an example of what is called rebutting attack, since the attacking reason supports the opposite conclusion that the act committed is not unlawful. An example of undercutting attack is shown in the middle of the figure. As a reason for a duty to repair the damages (`dut'), it is claimed that there is a duty to repair damages. However the argument is attacked now that the violated statutory duty does not have the purpose to prevent the damages (`¬prp'). In this case, the opposite conclusion that there is no duty to repair damages is not supported, since there can be another ground for a duty to repair the damages. An undercutting defeater only attacks the connection between a reason and its conclusion. A third kind of attacking reason (referred to as undermining attack) occurs when a supporting reason is itself attacked. An example is in Figure 13 on the right. As a reason for unlawfulness it is claimed that the act is a violation of unwritten law (`vun'), which in turn is attacked by the reason that it is very difficult to take precautionary measures (`dpm++')
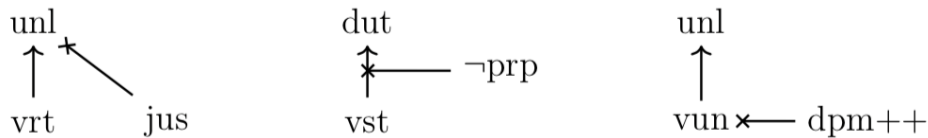
Figure 13 Rebutting attack (left); undercutting attack (middle); undermining attack (right)

Composite arguments The kinds of supporting and attacking arguments can be combined in larger, composite arguments. For instance, the arguments in Dutch tort law can be combined as in Figure 14. Here attacks have been indicated as attacks of the connections between reasons and their conclusions.

Argument evaluation In legal reasoning, an argument successfully support its conclusion in the beginning, but after new information is added—for instance an exception to a rule or an attacking reason—, the argument may become defeated. For instance, a duty to repair damages (`dut') can be successfully supported by a violation of a statutory duty (`vst') (Figure 15, left). But the argument is defeated when it is claimed that the statutory duty did not have the purpose to protect against the damages (middle). The conclusion can become reinstated when it is argued that there was a violation of an unwritten norm after all (right).

Arguments, rules and cases There are close connections between arguments, rules and cases as they are used in legal reasoning. For instance, supporting arguments can be constructed by applying rules, and attacking arguments can arise from exceptions to rules. For instance, the example rule and exception in Figure 4 is closely related to the example of rebutting attack in Figure 13 (left). Also cases are a source for the construction of arguments. For instance, the example of arguments and reinstatement in Figure 15 was based on the cases in Figure 8, their analogies and distinctions.

6 Conclusion

In this chapter, we introduced three key approaches to the modeling of legal reasoning as studied in the AI and Law community, namely rule-based reasoning, case-based reasoning and argument-based reasoning. We illustrated each of them by applying these approaches to the Dutch tort law. Although rule-based, case-based and argument-based reasoning focus on different components of legal reasoning, connections between them are abundant, as can be seen from the examples discussed. It is natural to continue investigating hybrid approaches, in which rule-based, case-based and argument-based methods are combined. Also rules and their exceptions can be considered as knowledge structures that can be applied to, discovered in and adapted by cases using argument-based theory construction methods. This provides a promising way to combine knowledge-based and data-driven approaches in AI.
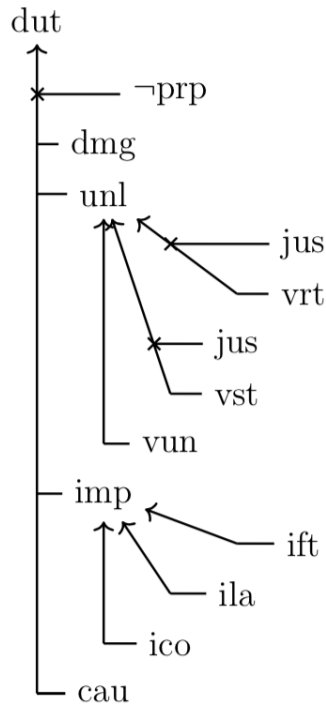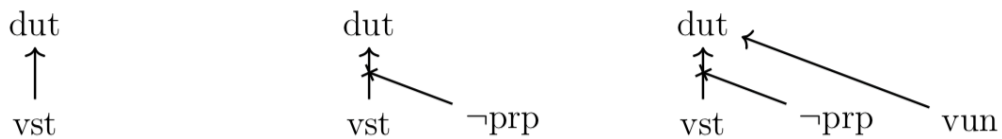
Figure 14 Composite argument structure

Figure 15 Reinstatement

Further reading

Rissland et al. (2003) give an overview of the field of AI & Law aimed at AI researchers. A concise introduction to AI & Law research is given by Sartor and Rotolo (2013). Bench-Capon et al. (2012) provide a variety of examples, using discussions of papers presented at the ICAIL conference series. Ashley (2017) is a recent textbook length overview of the field. Prakken and Sartor (2015) discuss much AI & Law research with a focus on the logic of argumentation. An overview of AI and other information technology aimed at the legal profession is given by Lodder and Oskamp (2006). An early discussion of AI & Law and the modeling of legal reasoning is provided by Gardner (1987). Legal knowledge has been modeled using logic programming (Sergot et al. 1986, Bench-Capon et al. 1987). Hage (1997) provides an analysis of legal reasoning in terms of rules and reasons. Prakken and Sartor propose analyses of rule-based and case-based arguments (1996, 1998). Rissland and Ashley (1987) develop a model of case-based reasoning with factors (close to the case elements with sides discussed in this chapter) and dimensions, further developed by Ashley (1990). Aleven and Ashley (1995) use a hierarchy of factors in their approach to case-based arguments. Roth proposed an entangled factor hierarchy with nested support and attack (Roth 2003, Roth and Verheij 2004). Branting (1991) analyzes the interplay between rules and cases in legal argument. Skalak and Rissland (1992) provide a model combining case-based

and rule-based elements. Verheij (2017) uses case models as a formal semantics for rule-based arguments. Berman and Hafner (1995) model how case-based arguments change over time. McCarty (1997) discusses rule-based and case-based argument modeling. Gordon (1995) and Hage, Leenes and Lodder (1993) provide a dialogue approach to the modeling of legal reasoning. Loui and Norman (1995) model the rationale underlying legal argument. Bench-Capon and Sartor (2003) study case-based argumentation with values. Verheij (2005) presents a formal argument diagramming format compliant with Dung's (1995) abstract argumentation. Atkinson and Bench-Capon (2006) model case-based argument as a kind of practical reasoning. Horty and Bench-Capon (2012) treat case-based argument in terms of reasons. Čyras and colleagues (2016) build on Dung's abstract argumentation (1995) in their approach to case-based reasoning. Walton, Reed and Macagno (2008) list argument schemes and their critical questions relevant for the modeling of legal reasoning.

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