Chapter 6
The Case-Based Reasoning Approach: Ontologies for Analogical Legal Argument

Kevin D. Ashley

6.1 Introduction

This paper addresses the state of the art in ontologies for case-based models of legal reasoning. It attempts to answer the question, "If one were to build a case-based legal reasoning system today, what kind of ontology should one use and what kinds of ontologies or guidance for building them are available?"

Today, one would not develop a system for case-based legal reasoning without considering the need for an ontology. A lesson learned over decades of research designing rule-based legal reasoning systems is the need for an ontology to organize the concepts and manage their interactions. Most likely, the same lesson is true for building a system to reason with legal cases, although the field seems to have learned more about rule-based, rather than case-based, ontologies. It seems hard even to specify what an ontology for case-based legal reasoning should provide.

This paper is an attempt to *demonstrate* what an ontology should provide with an extended example. Section 6.2 defines "ontology," outlines the general roles ontologies serve, and proposes three specific roles for ontologies supporting case-based legal reasoning. Section 6.3 presents the extended example, and Sections 6.4 and 6.5 distill the requirements an ontology needs to model the example's case-based argument. As summarized in Section 6.6, some requirements appear to have been met or nearly so in recent work. Others require considerable further innovation, but the concrete example may help to focus and define appropriate goals.

6.2 Definitions and Roles

By "ontology", we mean "an explicit, formal, and general specification of a conceptualization of the properties of and relations between objects in a given domain (citations omitted)" (Wyner 2008). In order to focus on the level of ontology under

K.D. Ashley (✉)
Learning Research and Development Center, Intelligent Systems Program, and School of Law, University of Pittsburgh, Pittsburgh, PA, USA
e-mail: Ashley@pitt.edu

G. Sartor et al. (eds.), *Approaches to Legal Ontologies*, Law, Governance and Technology Series 1, DOI 10.1007/978-94-007-0120-5_6,

discussion, either abstract and fundamental or specific and applied, it is convenient to distinguish between: (1) an ontological framework that specifies the fundamental types of things that exist for purposes of the system, sets out the relations among these types or concepts, and defines a conceptual syntax for representing more complex concepts; and (2) a domain ontology that specifies objects, predicates, relations, and semantic constraints for a given domain.

Depending on the purpose of the case-based legal reasoning system under development, the ontology might serve a number of general roles, to:

- facilitate exchange and re-use of knowledge and information among knowledge bases and other resources which may be distributed over the Internet and the Web (Breuker et al. 2004).
- make assumptions about concepts explicit so that the program can reason with them and manage relations and distinctions among concept types (Breuker et al. 2004).
- help generate natural language explanations (Wyner 2008).

More specifically, however, since case-based legal reasoning involves drawing inferences by comparing a problem with cases, a CBR ontology should help to:

1. *Support case-based comparisons*: Find relevant cases, compare them with the problem, draw inferences based on the comparisons, and make arguments how to decide the problem.
2. *Distinguish deep and shallow analogies*: Identify cases that are relevant despite superficial dissimilarities or irrelevant despite superficial similarities.
3. *Induce/test hypotheses*: Induce defensible hypotheses about how to decide a problem from a database of suitably represented cases, and evaluate and modify the hypotheses (e.g., using hypothetical reasoning).

The next sections present an extended example to illustrate each role, and discuss recent work on how ontologies can satisfy the role.

6.3 Extended Example

The goal of the new case-based legal reasoning system is to simulate arguments that a law professor and students might reasonably make in discussing a legal case in class. It should generate the kinds of arguments students make in explaining how the case should be decided and that a professor makes in probing those arguments. More specifically, given the facts of a legal dispute, the system outputs an extended argument about how the case should be decided. The arguments include proposing tests or rules for deciding the case, drawing analogies to past cases (i.e., precedents), justifying the analogies in terms of principles and policies underlying the legal domain, challenging the proposed tests by posing hypotheticals and responding, for instance, by modifying the proposed test (Ashley et al. 2008).

Here, a "proposed test" is a rule that advocates or judges might reasonably propose for deciding the case and defend as consistent with past cases and underlying principles and policies. It is a hypothesis about how to decide the case. A "hypothetical" is an imagined situation that involves such a hypothesis (i.e., a proposed test), either exploring its meaning or challenging it as too broad or too narrow.

The example illustrates the intended output for a case drawn from a "family" of cases centered on *Pierson v. Post.* That case deals with an issue of common (i.e., judge-made as opposed to statutory) law: under what circumstances may hunters have property rights in the animals they pursue. Often treated in first year property law courses, *Pierson* and related cases have been a focus of discussion in AI and Law research (Berman and Hafner 1993; Gordon and Walton 2006; Atkinson and Bench-Capon 2007). The problem scenario focused on here is *Popov v. Hayashi*, as introduced in Atkinson and Bench-Capon (2007).

The example is intended to convey an intuitive sense of the kinds of case-based inferences and arguments the system would model. The intended output of the system is an argument presented here as a natural language text in ten parts. Four tables show excerpts of the types of "ammunition" the class participants could employ in making arguments for and against the plaintiff (P), the party that asserts a legal claim in court against the defendant (D), who defends against it. Table 6.1 shows the

Table 6.1 Cases/hypotheticals

Case name	Facts (and factors-side favored)	Decision
Pierson v. Post, 3 Caines R. (N.Y.1805) (C)	D, knowing that the plaintiff was pursuing a fox with horse and hound on open land, intercepted the fox and killed it. (NC-D, OL-D, MCI-P, KCI-P, II-P, N-P)	D
Keeble v. Hickeringill, 103 Eng.Rep. 1127 (K.B. 1706) (C)	P property owner used decoys on his part of the pond to lure ducks. D used guns to scare ducks away. (NC-D, OWL-P, L-P, MCI-P, KCI-P, II-P)	P
Young v. Hitchens, 6 Q.B. 606 (1844) (C)	P commercial fisherman closed net on fish. When the opening was still a few fathoms wide, D went through the opening and caught fish. (NC-D, OL-D, L-P, C-D, MCI-P, KCI-P, II-P)	D
Flushing quail (H)	D, knowing that P was pursuing quail by flushing them out on open land and shooting them, intercepted the quail and killed them. (NC-D, OL-D, L-P, C-D, MCI-P, KCI-P, II-P)	?
Competing school-masters (H)	D school master of competing new school frightens boys on way to old school of P master. (*NC-D*, OL-D,L-P,C-D, *MCI-P*, *KCI-P*, II-P)	?
Escaping boar (H)	D possessed wild boar that escaped and damaged P's crops (NC-D, OWL-P, L-P, *N-D*)	P
Popov v. Hayashi, 2002 WL 31833731 (Cal. Superior, 2002) (H)	When Barry Bonds' record-breaking 73d home run ball was struck into the crowd, P caught it in the upper part of the webbing of his mitt, but was tackled by other fans. D (not one of the tacklers) picked up the ball and put it in his pocket. (*NC-D*, *OL-D*, *MCI-P*, *KCI-P*, *II*-P)	Split proceeds

name, facts, and decision of the *Popov* and *Pierson* cases and other real and hypothetical cases. Table 6.2 lists a variety of principles or policies in this area of property law that courts take into account in deciding such cases. Table 6.3 lists some factors, stereotypical fact patterns that strengthen or weaken a side's claim for property rights. Table 6.4 lists some proposed tests that the arguers (and a court) might plausibly maintain for deciding such a case. We assume that the students would have encountered *Popov* and *Pierson* and some of the other cases in Table 6.1 in reading the part of their casebook dealing with First Possession (See, e.g., Singer 2005).

Example, Part 1. The discussion begins with the facts and plaintiff's claim in the *Popov* case. The plaintiff showed that, when Barry Bonds' record-breaking 73d home run ball was struck into the crowd, plaintiff caught it in the upper part of the webbing of his baseball mitt, but then he was tackled by other fans. In the scuffle, the defendant, who was not one of the tacklers, picked up the ball and put it in his pocket. Plaintiff claimed a property right to the baseball with which the defendant interfered (Table 6.1, Cases/Hypos). A question for the court—and for the class—is

Table 6.2 Principles/policies

Principles or policies	Meaning
Protect fair play	Discourage unsportsmanlike conduct and unfair competition
Reduce nuisance pests	Encourage eradication of deleterious pests
Promote certainty	Maximize rule's ease and clarity of application
Protect livelihood	Protect livelihood of working parties
Avoid property rights on public property	Avoid assigning property rights to things on public property
Promote economic competition	Promote economic competition among businessmen
Protect free enterprise	Protect free enterprise of businessmen
Legally protectable interests	Only protect interests the law recognizes
Protect landowner's rights	Protect the rights of the landowner on his own land

Table 6.3 Factors

Factors	Short name (abbreviation)	Side favored
Animal not caught or mortally wounded	NotCaught (NC)	D
Open land	OpenLand (OL)	D
Own land	OwnLand (OWL)	P
P pursuing livelihood	Livelihood (L)	P
D in economic competition with P	Competes (C)	D
P manifestly closes in on goal	ManifestClosingIn (MCI)	P
D knows P closes in on goal	KnowsClosingIn (KCI)	P
D intentionally interferes physically with P's closing in on goal	Intentional interference (II)	P
Animal is a nuisance pest	Nuisance (N)	D

Table 6.4 Proposed tests (i.e., hypotheses)

Proposed tests	Short name
If plaintiff manifestly intended to gain possession of something of value, and the defendant intentionally interfered causing plaintiff to fail, then he can recover	Manifest Intent
If plaintiff manifestly intended to gain possession of the baseball, and the defendant intentionally interfered causing plaintiff to fail, then he can recover	Manifest-Intent-1
If plaintiff did not gain possession of the baseball (e.g., by catching and securing it), then he cannot recover	Possession
If plaintiff did not gain possession of the quarry (e.g., by catching and securing it), then he cannot recover	Possession-1

the appropriate legal test (if any) for deciding if the plaintiff has such a property right and whether it is satisfied on these facts.

Example, Part 2. A student advocating for the plaintiff proposes a test: "If plaintiff manifestly intended to gain possession of something of value, and the defendant intentionally interfered causing plaintiff to fail, then plaintiff can recover," (Table 6.4, Proposed Tests, Manifest Intent). In order to justify the test, the advocate might argue that it is consistent with underlying principles and past cases: it Protects Fair Play (Table 6.2, Principles/Policies) and is analogous to the *Keeble* case (Table 6.1, Cases/Hypos) in which plaintiff won where the defendant scared away ducks plaintiff had lured to its part of a pond. The student might draw a factual analogy in terms of relevant factors the cases share: Manifest Closing In, Knows Closing In, and Intentional Interference (Table 6.3, Factors).

Example, Part 3. The professor might probe the proposed test as too broad by posing a hypothetical: Suppose a defendant school master of a competing new school frightens boys on their way to the old school of the plaintiff schoolmaster. Should the plaintiff schoolmaster recover? (Table 6.1, Cases/Hypos). If so, would that not contradict the law's goal to promote economic competition? (Table 6.2, Principles/Policies).

Example, Part 4. The pro-plaintiff student might respond by distinguishing the *Popov* case from the Competing Schoolmasters hypothetical (Table 6.1, Cases/Hypos), arguing that the plaintiff and defendant are not in economic competition (Table 6.3, Factors) and thus a pro-defendant factor applied in the hypothetical that does not apply in *Popov*. He might go on to modify his proposed test by making it apply more narrowly to errant "baseballs" rather than to "something of value." (Table 6.4, Proposed Tests, Manifest Intent-1).

Example, Part 5. Another student might respond to the pro-plaintiff student's argument (Part 2) in another way by distinguishing the *Keeble* case, emphasizing any pro-plaintiff factors present in that case not shared in *Popov.* For example the plaintiff in *Keeble* was pursuing his Livelihood on his OwnLand (Table 6.3, Factors). This matters, the student argues, because the court may have aimed to Protect Livelihood and Landowner's Rights (Table 6.2, Principles/Policies). He

might also suggest that Protects Fair Play, although morally relevant, is not a Legally Protectable Interest (Table 6.2, Principles/Policies). Continuing to advocate for the defendant, the student might cite the *Pierson* case where the defendant won (Table 6.1, Cases/Hypotheticals) *despite* the shared facts associated with Manifest Closing In, Knows Closing In, and Intentional Interference (Table 6.3, Factors).

Example, Part 6. If the professor asks for the defendant's advocate's test, the student might propose one like the court in *Pierson* actually employed: "If plaintiff did not gain possession of the baseball (e.g., by catching and securing it), then he cannot recover" (Table 6.4, Proposed Tests, Possession). The student might concede that his test is inconsistent with *Keeble*, but emphasize that applying it in the *Popov* facts would Promote Certainty by discouraging litigants who "almost caught" the ball or "should have had it", and Avoid Property Rights in Public Property (Table 6.2, Principles/Policies), a consideration not present in *Keeble*.

Example, Part 7. Posing a hypothetical based on a real case, the professor might challenge the student's proposed pro-defendant test as too narrow. Suppose the plaintiff were a commercial fisherman, closing his nets on a school of fish, when another fisherman swooped in with a fast boat and scooped up the fish with a smaller net. Wouldn't such a plaintiff fisherman also fail to recover?" (*Young* case, Table 6.1, Cases/Hypos.)

Example, Part 8. In response, the student might broaden his test to cover failing to catch and secure not just baseballs but any quarry including fish (Table 6.4, Proposed Tests, Possession-1). He would justify his proposed result in *Popov* by analogizing *Young* where the defendant won because of a failure to catch or secure the quarry and despite the shared facts associated with Manifest Closing In, Knows Closing In, and Intentional Interference (Table 6.3, Factors).

Example, Part 9. The pro-plaintiff student of Part 2 might object by distinguishing the *Young* case, where the defendant was in economic competition with the plaintiff, a factor that favored defendant in *Young* where there was a policy to promote economic competition that did not apply in *Popov* (Table 6.2: Principles/Policies).

Example, Part 10. The pro-defendant student might respond that while the plaintiff and defendant are not in the business of selling baseballs, they were in economic competition, since Barry Bonds' last home run ball is worth a fortune.

6.4 Requirements for a Case-Based Legal Ontology

The example illustrates ways in which an ontology could address the first specific role for a CBR ontology (Section 6.2): *Support case-based comparisons*, and foreshadows issues raised by the other roles: *Distinguish deep and shallow analogies* and *Induce/test hypotheses.* The requirements for an ontology differ depending on the goals; the behavior in the example could be modeled at various levels of sophistication. As a basic assumption, the system should at least be able to generate a discussion of how to decide any of the cases or hypotheticals in Table 6.1 taken as the problem case, and to incorporate into the discussion as precedents or

hypotheticals any of the other real and hypothetical cases in Table 6.1. Additional assumptions about the system's level of sophistication are discussed below.

6.4.1 For Representing Cases

A basic task for the case-based ontological framework is to specify and organize classes of concepts for representing the Table 6.1 cases and hypos. This includes concepts for representing case Names, Parties, Legal Claims (e.g., to enforce a property right) Decision, etc. but also concepts for representing case facts. Here, much will depend on the nature and grain size of the desired fact representation.

As illustrated in the example, factors have proven to be useful abstractions for representing case facts. A number of CBR programs employ lists of expert-supplied factors to represent legally relevant patterns (e.g., Ashley 1990; Rissland and Skalak 1991; Aleven 2003; Chorley and Bench-Capon 2005; Ashley and Brüninghaus 2006; Wyner 2008). As noted, each factor captures a stereotypical pattern of facts that has legal significance in cases involving a particular claim; each represents a relevant similarity or difference and makes it possible to model comparing cases in terms of set theoretic operations over the sets of factors in each case. This is preferable to using quantitative feature weights, since selecting relevant cases and comparing them in terms of sets of factors facilitates explaining the comparisons in arguments. For instance, using factors, the *Keeble* case is analogized to the problem in Part 2 and distinguished from it in Part 5; also in Part 5, the *Pierson* case is cited as a "trumping" counterexample; it shares all the factors with the problem that *Keeble* does but reaches an opposite result (Ashley 1990; Aleven 2003). For the class of factors, the domain ontology will represent at least the name and side favored by the factor.

Factors will not be sufficient, however. Since the example involves hypothetical cases designed to challenge proposed tests, the domain ontology needs to support a more complex fact representation, especially if the system will pose its own hypothetical scenarios. Cases could be represented in structured formats, composed of facts at least some of which are represented at a finer grain size. As suggested in the Table 6.1 Cases/hypos, the domain ontology will have to represent some fundamental categories of human agency (See Breuker and Hoekstra 2004b) such as:

INTERFERENCE: not interfering, interfering physically with, preventing someone's reaching a goal
INTENTIONALITY: acting unintentionally, negligently, knowingly or intentionally
OBJECTIVENESS OF INTENTION: hiding ones intentions, being ambiguous about them or manifesting them clearly

This domain ontology needs to support analogous activities across the domains covered by the Table 6.1 Cases/hypos. It covers factual classes and values specific

to hunting (or "catching") (The asterisks (*) indicate concepts introduced in order to relate the hunting and fishing domains of the cases fan's to catching a homerun ball in the stands—or a schoolmaster's luring away a tuition-paying student):

HUNTING/CATCHING VENUES: land; pond; ocean; ballpark stands*
RESTRICTIONS ON VENUES: open; privately owned; subject to regulatory restriction; by invitation only*
QUARRY: animals (wild, domestic, edible, nuisance pests, fox, quail); quarry; baseballs*; students*; something of value*; economic goals*
HUNTING/CATCHING STEPS RE POSSESSION: seeking quarry; closing in on quarry; catching and securing quarry (in a mitt*, by killing, in a net hauled in); missing quarry
HUNTING/CATCHING OCCUPATIONS: pursuing livelihood; competing economically; by avocation

With a domain ontology like this, a hypothetical could be created by a coordinated substituting of slot values in the structured case facts or be compared in terms of the corresponding slot values across two cases. The ontology's factor representation could include focal slots whose values are key to the factor's application (Ashley 1990). For instance, the professor's hypothetical in Part 3 substitutes "students" for "baseball" in the quarry slot of the problem and schoolmasters for fans who caught the baseball in an avocational activity. The changes seem small, but they may have significant implications. The Livelihood and Competition factors kick in, a change whose significance is discussed below.

6.4.2 For Explaining Case Decisions

Case decisions need to be explained, and a CBR ontology needs to support those explanations. In the example, the decisions are explained in terms of the proposed test (i.e., legal rule) a decision instantiates, the principles and policies which inform the decision and of which it represents a tradeoff, and the inferences drawn from case comparisons and the reasons why the comparisons matter.

Since tests need to be composed, compared, and modified, it is natural to represent them as logical formulae with concepts drawn from the ontology. This includes factual concepts for case representation such as "quarry" or "baseball" and legal terms or *intermediate legal concepts*. If a rule specifies factual requirements for the application of a particular legal term, and that legal term, in turn, is a requirement in another rule that implies the legal or normative consequences, the legal term is an intermediate legal concept. A concept like "ownership, citizenship, guardianship, trusteeship, possession, etc." "stands as a mediating link between the requirements and the consequences" (Lindahl 2004; See Wyner 2008).

The ontology contains and organizes all of the general factual and intermediate legal concepts for formulating the tests (e.g., possession, manifestly intended, intentionally interfered, causing, and quarry.) A primary task of the ontology is to

coordinate the ordinary and legal institutional descriptions of events and, from the context, to keep track of the factual and legal senses of apparently identical terms. Some intermediate legal concepts may appear the same as general factual concepts. For instance, "causing" may have both an ordinary commonsense and a technical legal meaning as an intermediate legal concept. Such technical legal concepts are open-textured; their meanings are subject to argument.

Typically, ontologies organize concepts according to generality (e.g., fox and fish are animals and also each is a kind of quarry as is a baseball or a tuition-paying student.) Generality, however, is not the only useful ordering criteria. Some orderings characteristic of the "hunting or catching" domain are important, such as certainty of possession (e.g., catching and securing vs. seeking or closing in). Orderings characteristic of the legal domain would also be valuable. Intermediate legal concept classes could be ordered by legal effect or "inclusiveness".

For instance, requiring that an intention's OBJECTIVENESS OF INTENTION be manifest is more stringent than allowing it to be ambiguous or hidden. Similarly, the ordering of the INTENTIONALITY class (i.e., (1) unintentionally, (2) negligently, (3) knowingly or intentionally) corresponds to a legal effect: A rule that penalizes certain actions only if performed knowingly or intentionally is less inclusive than one that penalizes even unintentional actions that have negative consequences.

Since explaining a case decision also involves explaining the extent to which it is consistent with underlying principles, the ontology needs to support reasoning with and about principles. This means categorizing the principles (e.g., arguably, Protects Fair Play is a moral principle, not a Legally Protectable Interest in Part 5).

The ontology should also organize and track hierarchical relationships among the explanatory concepts, including factual concepts, factors, intermediate legal concepts, and principles/policies. Thus, the values of factual concepts in a case or case comparison may trigger the application of factors and intermediate legal concepts which, in turn, trigger the application of principles. For instance, as the value of HUNTING/CATCHING VENUES switches from pond or ocean to ballpark stands and the corresponding values of RESTRICTIONS ON VENUES from privately owned to open or subject to invitation , different factors will apply such as Open Land or Own Land. These, in turn, trigger different principles/policies. Open Land (Table 6.3, Factors) is connected with Avoid Property Rights in Public Property (Table 6.2, Principles/Policies); Own Land relates to Protect Landowner's Rights as employed in explaining the *Keeble* decision and distinguishing it from *Popov*, Parts 5 and 6. Similarly, as the value of QUARRY varies from fish to fox to homerun baseball to tuition-paying students to economic goals, particular factors and their related principles and policies switch on or off: Fox triggers the Nuisance factor and the policy of Reducing Nuisance Pests. Quail triggers Livelihood and the policy of Protect Livelihood. Values for INTENTIONALITY, INTERFERENCE, and OBJECTIVENESS OF INTENTION such as "knowingly interfering physically with a person's manifest attempt to catch a fish" trigger the policy of Protect Fair Play. This makes sense; factors represent similarities and differences and are legally relevant in part because they indicate that different principles and policies are at stake.

Intermediate legal concepts employed in the proposed tests are also implicated by values of factual concepts and relate to factors and principles/policies. For instance, "Intentionally interfered" relates to Intentional Interference (Table 6.3, Factors) and to Protect Fair Play (Table 6.2, Principles/Policies.) "Nuisance pests" connects with Nuisance and Reduce Nuisance Pests. "Possession" is associated with Not Caught and with Promote Certainty.

The ontology has to record and organize these hierarchical relationships in the manner of the Factor Hierarchy in CATO (Aleven 2003) and hierarchical domain model in IBP (Ashley and Brüninghaus 2006). In addition, the ontology must enforce constraints on values and combinations of values. For instance, some venues are subject to private property ownership and some are not. A pond can be privately owned; the ocean cannot be. Sometimes these distinctions will be quite subtle. A ballpark may be privately owned but still open to the public; fans may come in, watch the game, purchase a beer, and even catch a fly ball that strays their way and take it home. They may not take home the seat they are sitting in, however. How to represent such considerations raises design issues; these considerations combine commonsense and legal reasoning and probably should not be dealt with at the ontological level, but that is a design decision based in part on whether the system is aimed at modeling reasoning about them. Finally, the ontology must support translating the values associated with a case or comparison of cases into explanations, probably using explanation-oriented semantic networks that represent the relations among facts and reasons in a more structured way (see, e.g., Falkenhainer et al. 1989; Branting 2003; McLaren 2003; Ashley and McLaren 1995).

6.4.3 For Representing Case-Based Arguments

These explanations will be woven into case-based legal arguments using a set of argument schemes capturing typical, schematic domain-specific inferences (Prakken 2006). The legal inferences based on case comparisons in Parts 2 and 5 are examples of case-based argument schema. The ontology should represent classes of concepts for use in the argument schema to denote features of the case comparisons for purposes of drawing and explaining inferences. For instance, the ontology in Wyner (2008) includes *partitions*, explicit features of the comparison of a pair of cases that capture set-theoretic relationships of the factors in each case and that condition or bias the legal conclusion drawn from the comparison.

6.5 Using the Ontology to Model Arguments with Hypothetical Cases

A recent survey reports a distinction between ontologies designed for models of case-based legal reasoning that focus on rule-extraction versus those that focus on case comparison:

> When cases are considered as authoritative sources of rules (as in the rule extraction method), . . ., the extracted rules are applied, just like other rules. From an ontological point of view, the rule extraction method treats cases basically as sets of rules. In the method of case comparison, cases are considered differently, namely as authoritative sources of arguments and decisions. . . . Ontologically, the case comparison method views cases basically as sets of arguments and decisions. (Roth and Verheij 2004: 635)

The method illustrated in the extended example represents an amalgam of these two conceptions of case-based legal reasoning. Rules may be derived from cases and applied deductively, but the important point is that there are arguments about what the rules mean; the rules can be challenged, changed, and reinterpreted through a process of case comparison. Rather than an authoritative source of a rule, the case is seen as an authoritative result given a set of facts from which a range of rules can be extracted in light of prior decisions and underlying principles/policies. A test is proposed that deductively leads to a desired decision. The test is subjected to a process of interpretive investigation with, among other things, hypothetical examples that tease out the meaning of its terms and assess its fit with the past decisions and principles. The test is applied deductively to the hypothetical and prior case facts, but that is only part of the process.

The result must be assessed in light of underlying domain principles and policies. As the example suggests, the decision of a case is frequently more consistent with some principles and policies than with others. A hypothetical can be used to change the balance in order to demonstrate that a proposed test is too broad or too narrow (Ashley et al. 2008). In turn a proposed test can be modified to ameliorate the over or under breadth.

The case comparison guides that process of modifying the test. As per the model in Ashley et al. (2008) and as illustrated in Part 4, if the test has been challenged as too broad, an advocate can distinguish the hypothetical example from the case at hand, argue that they should have different results, and, guided by the distinction, add a condition or limit a concept definition so that the narrowed test still applies to the current fact situation but does not apply to, or leads to a different result for, the hypothetical example. If the test has been challenged as too narrow, as illustrated in Part 8, an advocate can analogize the hypothetical to the case at hand, concede that the result should be the same in each and, guided by the analogy, eliminate a condition or expand a concept definition so that the test applies to both with the same result.

An ontology that represents the connections among factors, concepts and principles/policies, as described above, could support computationally modeling these phenomena of argument. Hypothetically changing an appropriate fact takes the case out of one policy and into another. For instance, in Part 3, switching the QUARRY from baseball to tuition-paying student and applying the Manifest Intent test suddenly leads to a result that protects fair play but at the expense of discouraging economic competition! This involves commonsense reasoning when judges do it; the switch could be modeled in terms of simple ontological moves. The ontological ordering of terms by abstractness and legal effect or "inclusiveness" also guides comparing or modifying test versions. For instance, "baseball" is substituted for

"something of value" in modifying the Manifest Intent test in Part 4 into Manifest Intent-1 (Table 6.4), thus removing the over breadth. In Part 9, the modification of Possession to Possession-1 with the liberalization of the quarry from baseballs to "baseballs" and "fish" or "quarry" accommodates the hypothetical and is, again, inspired and supported by connections in the ontology.

As presented in Ashley et al. (2008) the model of hypothetical reasoning illustrated in the extended example explains some features of U.S. Supreme Court oral arguments, common law decision making (Eisenberg 1988; Gewirts 1982), and American legal education, but it may apply as well to aspects of civil law legal reasoning especially in the highest courts dealing with constitutional issues (MacCormick and Summers 1997: 528–529).

6.6 Challenges for a CBR Ontology

As a goal, an ontology and computational model that could generate the example represents an advance over existing case-based legal reasoning programs in AI and Law research whose outputted arguments do not include such features as reasoning with proposed tests and hypotheticals and which have tended not to have elaborate ontologies (see, e.g., McCarty and Sridharan 1981; Ashley 1990; Rissland and Skalak 1991; Aleven 2003; Branting 2003; Bench-Capon and Sartor 2003; Chorley and Bench-Capon 2005, Ashley and Brüninghaus 2006). An exception is the recent OWL-based ontology in Wyner (2008). It comes nearest to satisfying the ontological requirements in a program, AS-CATO, that is a reworking of two programs, CATO (Aleven 2003) and IBP (Ashley and Brüninghaus 2006), all of which implement some of the behaviors illustrated in the example. Neither the ontology nor the AS-CATO program address reasoning with proposed tests, hypotheticals or underlying principles and policies.

The two remaining roles of a case-based ontology, distinguishing deep and shallow analogies and inducing/testing hypotheses present challenges that the example helps to frame.

Distinguish deep and shallow analogies. In order to distinguish deep and shallow analogies, the ontology will need to represent classes of claims and issues as well as an explanation of what the court decided. For example, from a superficial viewpoint, given the relevance of the *Pierson* case, the Escaping Boar case (Table 6.1) may also appear relevant. It involves *possession* of a *wild animal* and, like *Pierson*, arguably, even a *nuisance pest.* At a deeper level, however, the scenario, claim, and issue of the Escaping Boar case are quite different; the claim is negligence (or strict liability without fault) and the issue involves whether the defendant possessor of the escaping animal who escaped through (or even absent) the defendant's negligence is liable for injury sustained by his plaintiff neighbors. As suggested in Table 6.5, in order to discriminate among superficially similar cases, the ontology should support representing in a more structured way the relations among the parties, defendant's injuries and the way plaintiff's actions caused them, and the relevant claims and

Table 6.5 Explanation of some cases, issues, claims, factors

Case name	Explanation	Factors
Popov v. Hayashi	Where defendant pocketed a very valuable baseball that plaintiff had caught, plaintiff won a *claim* of interference with property despite the *issue* of possession where plaintiff had not completely secured the ball before being knocked down, but was awarded only half the proceeds of sale of baseball.	*Not caught, open land, manifest closing in, knows closing in, intentional interference*
Young v. Hitchens	Where defendant commercial fisherman caught fish from within the still open nets plaintiff commercial fisherman was closing around the fish, defendant won *claim* of interference with property due to *issue* of plaintiff's possession where plaintiff had not captured the fish.	Not caught, *open land*, livelihood, competes, manifest closing in, knows closing in, intentional interference
Keeble v. Hickeringill	Where defendant used guns to scare away ducks that land owner lured to his part of the pond, plaintiff won claim of interference with property despite issue of possession where plaintiff had not killed or mortally wounded ducks.	Not caught, own land, livelihood, manifest closing in, knows closing in, intentional interference
Pierson v. Post	Where defendant killed a fox, a nuisance pest, that plaintiff hunted for sport, plaintiff lost *claim* of interference with property on *issue* of possession where plaintiff had not killed or mortally wounded the fox.	Not caught, open land, manifest closing in, knows closing in, intentional interference, nuisance
Escaping boar case	Where defendant possessed a wild animal nuisance pest that damaged plaintiff's property, plaintiff won *claim* for negligence/strict liability on *issue* that animal escaped through/without defendant's fault.	Not caught, own land, livelihood, *nuisance*
Competing School masters hypothetical	Where defendant schoolmaster scared away pupils from attending plaintiff's school, plaintiff won?/lost? a *claim* for interference with a property interest where an *issue* involved whether the plaintiff had a property interest in students attending his school.	*Not caught*, *open land*, *livelihood*, *competes*, *manifest closing in*, *knows closing in*, intentional interference

issues. Explanation-oriented semantic networks would be a suitable representation for this type of information (see, e.g., Branting 2003; McLaren 2003; Breuker and Hoekstra 2004a). In order to assess whether cases that share some terms and factors are similar at a deeper level, the program could then map the explanations from one case to another.

By contrast, in the *Popov v. Hayashi* case, as we have seen, the issue re possession in a claim for enforcing a property interest are similar, even though the tackling fans are the only "wild animals" involved: defendant intercepts the "quarry" (in this case a baseball) as plaintiff closes in. The court cited the *Pierson* and *Young* cases because they involved a similar issue of possession.

If the decisions in *Pierson* and *Young* are represented as structured explanations as suggested in Table 6.5, and if the ontology supported matching explanations expressed in increasingly abstract versions, the deeper analogies would be revealed. For one thing, "baseball" would be seen as a kind of quarry like a "fox" or "fish" and "putting in one's pocket" a kind of interference with plaintiff's property interest. Factors would also need to be matched more abstractly. The italicizing of the factor names for the *Popov* case in Tables 6.1 and 6.5 indicates that the *Not Caught*, *Open Land*, *Manifest Closing In*, *Knows Closing In*, and *Intentional Interference* factors all have somewhat different senses in the context of a fan's catching a homerun ball in a baseball stadium's stands versus hunting a fox in a meadow or catching fish in the open sea. A baseball may be caught but will not be mortally wounded. Hunter's close in on their living prey or interfere with one another's attempts in a different way. And, as noted above, a baseball stadium is not Open Land, although fans are invited in and may catch homeruns that come their way. Similarly, the factors in the Competing School Master hypothetical of Part 3, with its human or economic "quarry," are italicized in Tables 6.1 and 6.5 because the case does not involve animal quarry, the venues are not hunting venues in the usual sense, "closing in" has a different connotation, "catching" is metaphorical, and even the manner of ones livelihood and competition is somewhat different from the hunting scenarios.

How can this kind of abstract matching be managed? The factors should be expressed in terms of more abstract schema that deal with closing in on ones goals and being frustrated by external intentional interference (See, e.g., Breuker and Hoekstra 2004b). These could be mapped flexibly to different kinds of scenarios achieving analogical mapping and reuse across multiple legal domains.

The underlying principles/policies associated with factors could also inform the analogies, but they, too, would need to be matched abstractly. For instance, the *Young* case pits the policy of Protecting Livelihood against Promoting Economic Competition, arguably presenting a deeper analogy to the Competing Schoolmasters hypothetical than to the *Pierson* case. "Once the purpose of the rule is understood, analogous cases setting forth the rights of school masters become more relevant than cases dealing with foxes." (Berman and Hafner 1993). If the abstract schema associated with these competing principles or their associated factors (i.e., Livelihood and Competes) are seen abstractly as applying to the *Popov* case with its struggle over a potentially extremely valuable baseball, then a fruitful line of argument is revealed. Of course, the ontologically-supported mapping across cases that are similar at a deeper level despite superficial differences would seem to be a subject for argument itself raising issues similar to ontology alignment (Laera et al. 2006).

Induce/test hypotheses. The remaining role for the ontology is to support the generation and assessment of hypotheses, namely, the proposed tests. Designing systems to induce (or abduce) reasonable legal tests or rules (and other abstractions such as issues and factors) from the decided cases and their facts, suitably represented, has been the focus of research in AI and Law. For instance, the IBP program generated and tested hypotheses predicting a winner based on a logical model of a legal claim, legal issues, and cases represented with factors (Brüninghaus and Ashley 2003). The rules derived in Chorley and Bench-Capon (2005) reflected

value preferences in past cases. Generating legal hypotheses is more challenging than ordinary machine induction, because the tests must be susceptible to being explained in terms of expert legal knowledge: principles/policies, precedents, their facts and decisions, issues and other legal rules.

As illustrated in the extended example, one way to model the kind of incremental, explainable induction that characterizes legal reasoning is to focus on the process of proposing tests and evaluating them with hypotheticals. The hypothetical reasoning process is driven by argument schema applied to problem cases and is supported by the ontology. The primary adaptive mechanism involves substituting facts and concepts from the ontology to make the hypotheticals and modify the tests. This is like case-based adaptation (Kolodner 1993: 7), except the solution is not a case decision alone but includes the test as proposed or modified; the hypothetical case is a case adaptation that helps evaluate if the test is consistent with past cases, underlying principles and policies, and anticipated future cases. A robust computational model of the process would integrate and extend techniques for constructing hypotheticals (Ashley 1990), broadening or narrowing a legal rule (Rissland and Skalak 1991) and for reasoning with values (Atkinson and Bench-Capon 2007; Bench-Capon and Sartor 2003).

A comprehensive ontological organization of the legal and factual concepts to guide substitutions would be essential, but it may not be enough. In fashioning proposed tests and tailoring them to past cases, principles, and policies, human participants in the process, such as advocates, judges, professors, and students, commonly invent new intermediate legal concepts. The extended example does not illustrate the advocates' inventing new legal concepts, but it is interesting to think how an ontological framework and domain ontology might support that commonplace of legal argument. In drawing analogies across cases from different legal domains, concepts employed in rules of abstractly analogous cases could be adapted to the new domain with the assistance of the ontological organization. Alternatively, the ontology might support a process of composing existing terms in its ontological organization. Ontology-based automated combinations of elements have been discussed in the literature, such as causal case explanations in terms of actions and intentions (Breuker and Hoekstra 2004a) and transformation rules (i.e., weak rules of inference abstracting and formalizing procedures empirically discovered in solving cases) (Zarri 2007). It is a matter of determining appropriate guidelines and constraints for the process so that the results can be evaluated.

6.7 Conclusions

In order to help specify what an ontology for case-based models of legal reasoning and argument should provide, this paper has presented an extended example based on a legal classroom discussion the yet-to-be invented CBR system should simulate, supported by an appropriate case-based ontology. The example illustrates three roles for the ontology in supporting case-based comparisons, distinguishing deep and shallow analogies, and inducing and testing hypotheses. The paper has distilled

the ontological requirements for modeling the example's case-based arguments and reviewed current research relevant to meeting those requirements. The first role is nearly within reach of current AI and Law technology; work still needs to be done in modeling the proposing of tests for deciding a case and the role of hypotheticals in evaluating and modifying the test in light of prior cases, principles and policies. The last two roles present challenges that will necessitate advancements in the design of ontologies and the kinds of reasoning they support.

The concrete example helps to define and focus on goals for future developments in designing CBR ontologies. It comprises a family of related, and some unrelated, or apparently unrelated, cases. The cases are almost all based on real legal cases, almost any of which could be used as a problem scenario with the other cases cited as precedents or the seeds of hypotheticals. In this sense, the extended example captures a limited but realistic argument "world" and, thus, might be an appropriate tool for designing and building a working case-based ontology. Such examples can illustrate a wide range of legal reasoning behaviors and domains providing a concrete context for modeling ontological operations. The extended example can be made more complex in an incremental way so that, as new features are built into the ontology, more advanced behavior can be simulated, tested, and accommodated.

References

Aleven, V. (1997). *Teaching Case-Based Argumentation Through a Model and Examples*, Ph.D., University of Pittsburgh.

Aleven, V. (2003). Using Background Knowledge in Case-Based Legal Reasoning. *Artificial Intelligence,* 150(1–2): 183–238.

Ashley, K. (1990). *Modeling Legal Argument: Reasoning with Cases and Hypotheticals* (The MIT Press). Based on (1988) Ph.D. Tech. Rep. No. 88-01 COINS, U. Mass.

Ashley, K., S. Brüninghaus (2006). Computer Models for Legal Prediction. *Jurimetrics Journal*, 46: 309–352.

Ashley, K., C. Lynch, N. Pinkwart, V. Aleven (2008). A Process Model of Legal Argument with Hypotheticals. JURIX 2008. Firenze.

Ashley, K., M. McLaren (1995). Reasoning with Reasons in Case-Based Comparisons. In M. Veloso, A. Aamodt (Eds.) ICCBR-95 LNCS (LNAI) 1010. Springer, Heidelberg, 133–144.

Atkinson, K., T. Bench-Capon (2007). In Proceedings of the Eleventh International Conference on Artificial Intelligence and Law (ICAIL), June 4–8, 2007, Stanford Law School, Stanford, California.

Bench-Capon, T., G. Sartor (2003). A Model of Legal Reasoning with Cases Incorporating Theories and Values. *Artificial Intelligence*, 150: 97–143.

Berman, D., C. Hafner (1993). Representing Teleological Structure in Case-Based Legal Reasoning: The Missing Link. In *ICAIL 1993.* ACM Press, New York, NY, 50–59.

Branting, L.K. (2003). A Reduction-Graph Model of Precedent in Legal Analysis. *Artificial Intelligence*, 150: 59–95.

Breuker, J., R. Hoekstra (2004a). DIRECT: Ontology-Based Discovery of Responsibility and Causality in Legal Cases: In T. Gordon (Ed.) *Proceedings JURIX-2004*. IOS-Press, Amsterdam, 115–126.

Breuker, J., R. Hoekstra (2004b). Epistemology and Ontology in Core Ontologies: FOLaw and LRI-Core, Two Core Ontologies for Law. In *Proceedings of the EKAW04 Workshop on Core Ontologies in Ontology Engineering*, 15–27.

Breuker, J., A. Valente, R. Winkels (2004). Legal Ontologies in Knowledge Engineering and Information Management. *Artificial Intelligence and Law*, 12(4): 241–277 Springer.

Brüninghaus, S., K. Ashley (2003). Predicting the Outcome of Case-Based Legal Arguments. In G. Sartor (Ed.) *Proceedings of the 9th International Conference on Artificial Intelligence and Law* (ICAIL-03) ACM Press, New York, NY, 234–242.

Chorley, A., T. Bench-Capon (2005). AGATHA: Automated Construction of Case Law Theories Through Heuristic Search. In *ICAIL 2005*. ACM Press, New York, NY, 45–54.

Falkenhainer, B., K. Forbus, D. Gentner (1989). The Structure-Mapping Engine: Algorithm and Examples, *Artificial Intelligence*, 41(1): 1–63.

Eisenberg, M. (1988). *The Nature of the Common Law*, vol. 99. Harvard University Press, Cambridge, MA.

Gewirtz, P. (1982). The Jurisprudence of Hypotheticals. *Journal of Legal Education*, 32: 120 f.

Gordon, T.F., D. Walton (2006). Pierson vs. Post Revisited—A Reconstruction Using the Carneades Argumentation Framework. In P.E. Dunne, T. Bench-Capon (Eds.) *COMMA 2006.* IOS Press, Amsterdam.

Kolodner, J. (1993). *Case-Based Reasoning.* Morgan Kaufmann, San Mateo, CA.

Laera L., V. Tamma, J. Euzenat, T. Bench-Capon (2006). Arguing Over Ontology Alignments. In *Proceedings of the First Workshop on Ontology Matching*, Athens, GA, 49–60, URL http://ceur-ws.org/Vol-225/paper5.pdf.

Lindahl, L. (2004). Deduction and Justification in the Law. The Role of Legal Terms and Concepts. *Ratio Juris*, 17: 182–202.

MacCormick, D., R. Summers (Ed.) (1997). *Interpreting Precedents*. Ashgate/Dartmouth, Brookfield, VT.

McCarty, L.T., N.S. Sridharan (1981). *The Representation of an Evolving System of Legal Concepts: II. Prototypes and Deformations*. LRP-TR-11. Lab. for CS Res. Rutgers U.

McGinty, L., B. Smyth (2002). Comparison-Based Recommendation. In S. Craw, A.D. Preece (Eds.) *ECCBR 2002*. LNCS (LNAI), vol. 2416. Springer, Heidelberg, 575–589.

McLaren, B. (2003). Extensionally Defining Principles and Cases in Ethics: An AI Model. *Artificial Intelligence*, 150: 145–182.

Prakken, H. (2006). Artificial Intelligence and Law, Logic and Argument Schemes. In D. Hitchcock, B. Verheij (Eds.) *Arguing on the Toulmin Model.* Springer, Dordrecht.

Rissland, E.L., D.B. Skalak (1991). CABARET: Rule Interpretation in a Hybrid Architecture. *International Journal of Man-Machine Studies*, 34(6): 839–887.

Roth, B., B. Verheij (2004). Cases and Dialectical Arguments. An Approach to Case-Based Reasoning. On the Move to Meaningful Internet Systems 2004: OTM 2004 Workshops. In R. Meersman, Z. Tari, A. Corsaro (Eds.) *WORM'04: The Second International Workshop on Regulatory Ontologies*. LNCS, vol. 3292. Springer, Heidelberg, 634–651.

Singer, J. (2005). *Property Law: Rules, Policies & Practices*, 4th ed. Aspen Press, New York, NY.

Wyner, A. (2008). An Ontology in OWL for Legal Case-Based Reasoning. *Artificial Intelligence and Law*, 16: 361–387.

Zarri, G. (2007). Ontologies and Reasoning Techniques For (Legal) Intelligent Information Retrieval Systems. *Artificial Intelligence and Law*, 15(3): 251–279.