Adding Dimensions and Facts to ADF Representation of Legal Cases

Latifa AL-ABDULKARIM, Katie ATKINSON, Trevor BENCH-CAPON
Department of Computer Science, The University of Liverpool, UK

Abstract.
Previous work has shown that theories representing a body of case law can be represented as Abstract Dialectical Frameworks (ADF) but that it is desirable to represent degrees of presence of factors, rather than as simply considering factors as present or absent, as is currently standard. This requires consideration not only of factors, but also of the facts on which their attribution to cases is based. In this paper we revive the use of dimensions, from which factors developed, to mediate between facts and factors so as to achieve a structured and transparent representation of degrees of presence of factors. We will illustrate our exploration using the much discussed wild animal cases.

Keywords. case based reasoning, dimensions, factors, facts.

1. Introduction

Previous work has shown that theories representing a body of case law can conveniently be represented as Abstract Dialectical Frameworks (ADF) [2]. ADFs [15] are a recent development in computational argumentation in which nodes are used to represent statements and each node is associated with its own acceptance condition that determines its acceptability in terms of whether its children are acceptable. ADFs can represent a variety of attack and support relations, unlike standard abstract Argumentation Frameworks (AFs) [18] whose only relationship between nodes is that of defeat: the relation between standard AFs and ADFs has been shown in [14]. The suitability of ADFs for representing a domain of case law was shown empirically in [2]. In [3] it was argued that it is sometimes essential to represent degrees of presence of factors if we are to captuare all the nuances of a case. This requires consideration not only of factors, but also of the facts on which their attribution to cases is based. In this paper we will revive the notion of dimensions ([5], [10]) to achieve a structured and transparent representation of degrees of presence of factors. We will illustrate our exploration of making explicit the role of facts in the assignment of factors by using the well known wild animals and *Popov v Hayash*i cases (see, e.g., [6]), of which we now provide a brief overview.

The wild animals cases concern plaintiffs chasing wild animals when their pursuit was interrupted. Post was chasing a fox for sport, but Pierson killed the

fox before he could catch it. Keeble was hunting ducks, but Hickeringill scared them away from his pond. Young was sea fishing, but Hitchens entered his nets and took the fish before Young could land them. Ghen harpooned a whale, but the line broke, Ellis found the whale washed up on a beach and sold it to Rich. Keeble, Young, Hitchens, Ghen and Rich were all in pursuit of their livelihoods. *Popov v Hayashi* concerned disputed ownership of a baseball (valuable because it had been hit by Barry Bonds to break a home run record). Popov was attempting to complete his catch when he was assaulted by a mob of fellow spectators, and Hayashi (who had not taken part in the assault) ended up with the baseball when it rolled free. The wild animals cases were cited when considering whether Popov's efforts had given him possession of the ball.

Thirteen, base-level, factors were identified in [11]. These were formed in [1] (together with appropriate abstract factors) into a factor hierarchy, to form the basis of the node and link structure of an ADF. Some adaptations from [11] were made: for example a factor *Res* (Residence Status) was added to indicate the attachment of the animals to the land, since it appears to make a difference in some other cases (e.g. *Kleepe v New Mexico*, discussed in [9]) whether they are on the land permanently, seasonally, habitually, occasionally, or whatever. As our starting point we will use the 2-regular ADF (a normal form in which every non-leaf node has exactly two children [3]) given in the Appendix of [1]. The 27 associated base-level factors are shown in Table 1.

Table 1. Base Level Factors for *Popov* Cases

1	OwnsLand	8	Residence	15	Nuisance	22	DefNoFault
2	Whaling	9	FrequentVisitor	16	PPleasure	23	DLivelihood
3	Baseball	10	StartedPursuit	17	PLivelihood	24	DOpportune
4	PhysicalPossess	11	Assault	18	POpportune	25	DSport
5	CertainCapture	12	DefOnLand	19	PSport	26	DAltruism
6	HotPursuit	13	PMalice	20	PAltruism	27	DPleasure
7	Vermin	14	Impolite	21	DMalice		

We next need to relate these base level factors to a set of *dimensions* [5], aspects of the case which, if applicable, range from an extreme pro-plaintiff point, through a set of intermediate points to an extreme pro-defendant point. The key idea is that the factors represent a *range* on the dimension, and the degree of presence of a factor will be given by the position of the particular case within that range as determined by the particular facts of the case.

2. Dimensions for the Popov cases

Factors were developed in Aleven's CATO [4] from the dimensions of HYPO [5]. A factor can be seen as a point, or, more a generally, range, on a dimension. The idea in CATO was to map the facts of the case which indicated that a dimension was applicable to the case, and which determined the point on the dimension at which the case should be placed, directly to one of these factors. A key point is that whereas dimensions range from extreme pro-plaintiff to extreme pro-defendant,

and it is undecided which side is favoured by intermediate points, factors favour a particular side. Thus the conversion effectively draws a line across the dimension, with pro-plaintiff factors on one side and pro-defendant factors on the other. But it may be unclear as to where the line should be drawn: and, as discussed in [10], the outcome of the case may depend on where this line is drawn. It has been argued that *Pierson v Post*, the starting point of the animal cases in [13], was such a case: with social usefulness suggesting that the line be drawn more favourably for the plaintiff and legal clarity that it be drawn more favourably for the defendant. Dimensions were discussed in [11], but the emphasis there was very much on factors. Dimension points were also used to represent facts in [17] and [7]. Here we too will use dimensions to bridge between factors and facts so that we can transparently ascribe degrees of presence on the basis of the facts. In this section we will consider the dimensions required to accommodate the base level factors. Not every interesting point of the dimensions is represented in the limited number of cases we use in our analysis, so that there will be some additional dimension points. We will, however, assume that all the dimensions we need will relate to one or more of the 26 factors shown in Table 1.

In [11] after some discussion four dimensions were identified: *possession*, *inteferenceIllegal*, *defendantBehaviour* and *activityToEncourage*. The findings of [1], however, lead us to rethink these. In [1] possession is an abstract factor identifying a range on a dimension indicating how close to capturing the quarry the plaintiff was, and we need to capture antisocial as well as strictly illegal acts. Thus we see *inteferenceIllegal* as a range on a larger dimension relating to the nature of the act. The dimension *defendantBehaviour* partly relates to the nature of the act, and partly to the defendant's role in that act, and we will split this across two dimensions. Finally the encouragement to be given to the activity is absorbed into the effect of the motives of the plaintiff and defendant, the authority followed and the nature of the quarry, which determines how close the pursuit needs to be to count as possession. We will therefore identify our own dimensions, driven by the need to account for the 26 factors of Table 1.

OwnsLand is a factor present only to *Keeble*. But this factor is the subject of a lengthy discussion of the related dimension in [10], and *OwnsLand*, if we think of the hypothetical cases we may wish to consider, is best seen as the extreme pro-plaintiff point of a dimension which should range through to ownership by the defendant. For example, some precedent cases where the plaintiff did own the land were distinguished in *Pierson v Post*. Thus we should use a dimension *landOwnership* (LO). The range of points of this and the other dimensions will be shown in the summary towards the end of this section.

Whaling and *Baseball* relate to the particular conventions governing behaviour in two of the cases and these conventions are referred to in the decisions. We are interested in conventions because they can say what counts as possession of the quarry. Thus in whaling "the iron holds the whale" and in baseball catching a baseball which has left the field is enough to give possession. Amongst fox hunters, starting a fox is probably enough to give the right to pursue it to the death, but this is not a universally accepted convention. Thus we use the *facts* relating to the area of activity, the closeness of pursuit and the degree of acceptance of the convention to determine the appropriate point of the *dimension*

ApplicableConvention (AC). The decisions seem to suggest that currently the law will uphold only a universally accepted convention (i.e. whaling and baseball, but not fox hunting).

Factors 4,5,6 and 10 relate to how close the pursuer had come to capture: this was also discussed in [10] and was the main bone of contention in *Pierson v Post*. We relate these factors on a dimension *ClosenessOfPursuit* (COP).

The factor *Vermin* describes the nature of the quarry in *Pierson v Post*, and is intended to justify the pursuit of the fox in terms of social usefulness: we consider that vermin is not a dimension point, but a fact indicating that foxes are pursued for social rather than economic reasons. In other cases the pursuit can be justified in terms of the value of the quarry, be they ducks, fish or a special baseball. Other quarries (e.g. common species of insects) might have no commercial value at all. We therefore have a dimension *QuarryValue* (QV).

Factors 8 and 9 relate to the degree of association of the animal with the land. In so far as land ownership gives a right to the animal, the animal needs to be connected with the land, and the closeness of its connection may be reflected in the way ownership of the land affects ownership of the animal. This is a point in *Keeble*, and arises also in the burros cases discussed in [9]. We therefore need a dimension *QuarryLandConnection* (QLC).

A number of factors (11,14,15 and 22) relate to the act which interrupted the pursuit. This can range from the actually criminal, such as assault and trespass, through varying degrees of anti-social behaviour such as nuisance and impoliteness, to acceptable. We therefore have a dimension *NatureOfAct* (NOA).

We next need to consider the motives of the plaintiff and the defendant. These can be laudable, mercenary or even dishonest. We need to consider the plaintiff and the defendant motives separately since their motives may differ and both may have good (or bad) motives. We therefore have two dimensions *PlaintiffMotive* (PM) and *DefendantMotive* (DM).

We also need to say something about the degree of responsibility of the defendants. Were they acting alone or in concert with others? Was it an accident? Was the defendant innocent of any wrong doing? We reflect this in a dimension *DefendantRole* (DR).

We have now related all 26 base level factors to 9 dimensions, each with a number of points ranging from extreme pro-plaintiff to extreme pro-defendant.

We also need to reflect the degree of difference between adjacent dimension points. The difference between a criminal act such as trespass and a social nuisance is greater than the difference between nuisance and simple discourtesy. We will adapt the proposal of [17], described in detail in [16], for mapping factors to numbered points on a structured dimension. In [16] each dimension is seen as 21 slots, with 1 as the most pro-plaintiff and -1 as the most pro-defendant. In [16] the CATO analysis in [4] tells us whether the dimension point corresponding to the factor should be positive or negative, but here the dimension point may favour either side. Therefore we will assign each point an integer from 10 to 0, with 10 extreme pro-plaintiff and 0 extreme pro-defendant. The numbers are chosen by the knowledge engineer and are assigned not to necessarily reflect specifics of the real world, but more to make explicit the ordering of, and distance between, the dimension points. They are required in order to enable the computation, and are

justified by how well the behaviour of the program accords with our understanding of the theory formed from the cases. The ordering of the points on the dimension does, however, provide structure, and the determination of the particular point on the dimension by the facts of the case provides transparency. Moreover, the effect of using different numbers can be explored using the interface described in section 5. The line between plaintiff and defendant can then be drawn at any point on this scale. A summary of our dimensions, some important points and suggested associated numbers are shown below. Some of the points are taken from our cases, some from previous discussions and some supplied by us to fill out the dimension. New cases may identify additional points, which can be inserted as appropriate.

1. **LandOwnership** (LO): p-freehold (10), p-leasehold (8), p-rent (7), common (5), other-owner (4), d-rent (3), d-leasehold(2), d-freehold (0).
2. **ApplicableConvention** (AC): FullPossession (10), InformalExclusiveRight(5), SocialPreference (3), None (0).
3. **ClosenessOfPursuit** (COP): PhysicalPossession (10), MortalWounding (8), CertainCapture (7), HotPursuit (5), Chasing (3), StartedPursuit (1), None (0).
4. **QuarryValue** (QV): MarketValue (10), SocialValue (7), DomesticPet (6), PersonalValue (3), None (0).
5. **QuarryLandConnection** (QLC): Resident (10), FrequentVisitor (8), RegularVisitor (6), OccasionalVisitor (4), Transient (2), OnceOnly (0).
6. **NatureOfAct** (NOA): ViolentlyIllegal (10), Illegal (8), Nuisance (5), Impolite (3), ActOk (0).
7. **PlaintiffMotive** (PM): Livelihood (10), Opportunistic (8), Altruism (6), Pleasure (4), Impulse (2), Malice (0).
8. **DefendantMotive** (DM): Livelihood (10), Opportunistic (8), Altruism (6), Pleasure (4), Impulse (2), Malice (0).
9. **DefendantRole** (DR): Innocent(10), JointlyResponsible (7), IgnorantOfTheLaw (6), Accident (3), SolelyResponsible (0)

The cases are represented as sets of facts. We use these to produce a vector of nine numbers ($\langle$LO,AC,COP,QV,QLC,NOA,PM,DM,DR$\rangle$). In seven of the dimensions, the dimension points are single facts: so that the fact gives the number immediately. For example, for COP:

```
IF PhysicalPossession THEN COP = 10. IF MortalWounding THEN COP = 8.
IF CertainCapture THEN COP = 7. IF HotPursuit THEN COP = 5. etc
```

But for two (AC and NOA) we need rules such as the following to map from facts to numbers:

```
IF whaling and harpooned THEN AC = 10.
IF baseball and catchCompleted THEN AC = 10.
IF baseball and snowConeCatch THEN AC = 5.
IF foxhunting and startedPursuit THEN AC = 3.
IF assault then NOA = 10. IF trespass then NOA = 8.
IF anti-social and malicious then NOA = 5.
```

The defaults for all dimensions are 0. Applying these rules yields the following case vectors to our program.

Pierson v Post: [5,3,5,7,8,3,6,2,0][1].
Keeble v Hickergill: [8,0,7,10,8,5,10,0,0].
Young v Hitchens: [5,0,7,10,10,3,10,10,0].
Ghen v Rich: [5,10,8,10,10,0,10,8,6].
Popov v Hayashi: [4,5,5,10,10,10,8,8,10].

3. Applying the Dimensions to the ADF

We now relate the dimensions to a 2-regular ADF given in [1] by replacing the base level factors (leaf nodes) with the appropriate dimension. Where both children relate to the same dimension, the children can be pruned and the dimension replaces the parent. This pruning leaves us with the 12 abstract factors discussed below. When we instantiate the framework to a particular case, we replace the dimensions with the appropriate number. The acceptance conditions associated with each node in the ADF are then be used to propagate these numbers up the tree, assigning numbers to the various abstract factors, and finally arriving at a number for *FindForPlaintiff*. We will consider the acceptance conditions for each abstract factor in turn. For conjunction and disjunction we will use the fuzzy logic approach (minimum and maximum respectively) [20] as our default. We will consider the abstract factors[2] working down the tree.

FindForPlaintiff involves consideration of two independent issues: whether the plaintiff owned the animal, and whether he had the right to pursue it. Either can be the basis of finding for the plaintiff: we therefore take the *maximum* of the two factors.

Ownership can likewise be from having captured the quarry, or through some right given by ownership of the land or by some convention. Again we take the *maximum* of the two abstract factors.

ConsequentRight can be acquired either by land or by convention. It again takes the *maximum* of these two abstract factors.

ByLand requires *both* that the land be owned and that the quarry be associated with the land. A threshold is set for the degree of ownership (perhaps if the land is rented, animals on the land belong to the landlord not the tenant). If the land is not appropriately owned (i.e the *LandOwnership* dimension is $<$ *OwnershipThreshold*), ByLand is 0: otherwise it takes the *minimum* of the *LandOwnership* and *QuarryLandConnection* dimensions.

ByConvention: As noted above, whaling and baseball are facts which are used in rules which determine points on the *ApplicableConventions* dimension. This node simply takes its value from that dimension.

[1] Some of the facts might be debatable. For example Post's motive is as argued by his counsel, and the defendant might have argued altruism if it had appeared necessary to do so. Equally Pierson's motive may have been malicious arising from some kind of class resentment, as suggested in [12].

[2] Towards the top of the tree we arrive at what might be termed issues. In this paper, we ignore the difference between issues and abstract factors.

CapturedQuarry is intended to indicate a range on the *ClosenessOfPursuit* dimension. This range is normally narrowly drawn towards the pro-plaintiff end of the dimension, but might be modified in the case of certain quarries, depending on the authority followed. This is reflected in a threshold to determine how close the pursuit needs to be, set according to the authority, and perhaps other conditions. This threshold we call *PursuitThreshold*, and the pseudo code below sets it in accordance with the majority opinion in *Pierson v Post*. If the threshold is reached, CapturedQuarry is 10, otherwise it is the value of *ClosenessOfPursuit*.

RightToPursue is acquired by having a pre-possessory interest which is frustrated by a culpable act. This means that the defendant must be blameworthy in some way, and so, as a conjunction, it takes the *minimum* of its two abstract factors, *Pre-possessoryInterest* and *DefBlameworthy*.

Pre-possessoryInterest is established on the basis of being a favoured pursuer, and there being no other legitimate competitors. As a conjunction of *Favoured-Pursuer* and *ExclusiveRight*, it takes the *minimum* of the two values.

FavouredPursuer can be established either through ownership of the land, or by actual pursuit. It therefore takes the *maximum* of the *LandOwnership* and *ClosenessOfPursuit* dimensions.

ExclusiveRight requires both that the plaintiff be acting from an acceptable motive, and that there is no legitimate competitor. In order for there to be an exclusive right, we require that *PlaintiffMotive* must be greater than the possible exception, FairCompetition. If this is so the value of *PlaintiffMotive* is passed up, otherwise *ExclusiveRight* is given the value 0.

FairCompetition: This involves consideration of the two motive dimensions, and is set according to what is seen to be the concern of the law. This can be drawn strictly so that competition is seen as applicable only to business, or more loosely to allow any gainful activity, or even social pursuits. This is reflected in a flag which can be LitigateBusiness, LitigateGain or LitigateSocial. The flag is set according to precedent and authority: *Young v Hitchens* suggests 10, but Livingston might well argue for a lower threshold, so that hunters for pleasure could be in competition with one another.

DefBlameworthy will apply to the extent that an illegal act was committed, unless the defendant was innocent of the act. We calculate its value by subtracting *NoFault* from the *NatureOfAct* dimension and then ensuring that it is $>= 0$.

While in earlier work criminal acts and anti-social acts have been seen as independent factors, we view them as ranges on the *NatureOfAct* dimension, determined on the basis of the facts using rules as discussed in section 2.

The above give conditions enable the calculation of the degree of acceptance of the parents in terms of their children, while leaf nodes are taken from the case-dimension vector. The value of *FindForPlaintiff* can be calculated by propagating numbers from the leaf nodes up the tree, as shown by the pseudo-code in the next section. Table 2 shows the results for each case.

4. Implementation

It is a straightforward matter to implement the equations required to propagate the numbers up the tree. Pseudo-code is given below.

```
READ case vector from file
% Set flags to select authority, interpreation of ownership, and scope
Authority = Justinian. Ownership = Standard. Litigate =Business.
% Set Thresholds, by saying where each authority drew their lines.
IF Authority = Justinian THEN PursuitThreshold  = 10
     ELSEIF Authority = Pufendorf THEN PursuitThreshold  = 8
        ELSEIF Authority = Barbeyrac THEN PursuitThreshold  = 7
           ELSEIF Authority = Livingston and QV >= 7
                          THEN PursuitThreshold  = 5
% Livingston sets a low threshold to encourage the pursuit of vermin

IF Ownership = Strict THEN OwnershipThreshold =10
    ELSEIF  Ownership = Standard THEN Threshold = 7

IF Litigate = Business THEN MatterForLaw = 10
    ELSEIF Litigate = Gain  THEN MatterForLaw = 8
       ELSEIF Litigate = Social THEN MatterForLaw = 6

IF Min(PM,DM) >= MatterForLaw THEN FairCompetition = Min(PM,DM)
                              ELSE  FairCompetition = 0
IF  PM > FairCompetition  THEN  ExclusiveRight = PM ELSE ExclusiveRight = 0
FavouredPursuer = max(LO,COP)
Temp = NOA - DR.  DefBlameworthy = max(0, Temp).
Pre-possessoryInterest = min(ExclusiveRight, FavouredPursuer)
RightToPursue = min(Pre-possessoryInterest, DefBlameworthy)
IF COP >= PursuitThreshold THEN CapturedQuarry=10 ELSE CapturedQuarry = COP
ByConvention = AC
IF LO <= OwnershipThreshold THEN ByLand = 0 ELSE ByLand = min(LO, QLA)
ConsequentRight = max(ByLand, ByConvention)
Ownership = max(ConsequentRight, CapturedQuarry).
FindForPlaintiff = max(Ownership, RightToPursue)
```

The code is given an interface such as that shown in Figure 1. The idea is that we set the parameters required through drop down menus (only authority is shown in Figure 1: MatterForLaw and OwnershipThreshold are taken as fixed). We then load a case which supplies an initial position for each of the 9 sliders (one per dimension). The value of *FindForPlaitiff* is shown on the dial. We can then explore hypothetical cases by moving the sliders. Rollovers indicate the various dimension points on the sliders. This interface allows exploration of hypotheticals along each dimension, and shows immediately the effect of the overall decision.

5. Concluding Remarks

Current work on reasoning with legal cases has suggested a need to represent degrees of presence of factors. Our contribution is to show how these degrees of presence can be systematically and transparently related to the facts of a case

Table 2. Application to cases using Justinian as Authority

	Pierson	Keeble	Young	Ghen	Popov
LO	5	8	5	5	4
AC	3	0	0	10	5
COP	5	7	7	8	5
QV	7	10	10	10	10
QLA	8	8	10	10	10
NOA	3	5	3	0	10
PM	6	10	10	10	8
DM	2	0	10	8	8
DR	0	0	0	6	10
FairCompetition	0	0	10	0	0
ExclusiveRight	6	10	0	10	8
FavouredPursuer	5	10	7	8	5
DefBlameworthy	3	5	3	6	0
Pre-possessory Interest	5	10	0	8	7
RightToPursue	3	5	3	0	0
SufficientPursuit	5	7	7	8	5
CapturedQuarry	5	7	7	8	7
ByConvention	3	0	0	10	5
ByLand	0	8	0	0	0
ConsequentRight	3	8	0	10	5
Ownership	5	8	7	10	7
FindForPlaintiff	5	8	7	10	7

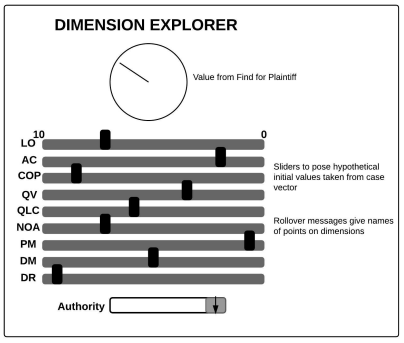

Figure 1. Interface: slider points are not for any particular case

by reviving the idea of dimensions (from which factors originally derived). By seeing factors as ranges on dimensions, typically covering several points, we can use rules to establish how far along the dimension the case is on the basis of its facts, and provide a number accordingly. The dimensions thus mediate between the facts and the factors. We have illustrated this with the wild animals and *Popov* cases to facilitate comparison with other work on representing cases ([8], [19], [6]), identifying a set of dimensions covering the set of factors required. Facts

are either points on these dimensions, or determine points on the dimensions via specific rules. A GUI is specified for use to allow exploration of hypotheticals to go beyond the limited number of cases on which the theory is based.

References

[1] L. Al-Abdulkarim, K. Atkinson, and T. Bench-Capon. *Evaluating an Approach to Reasoning with Cases Using Abstract Dialectical Frameworks*. Technical Report ULCS-15-002, Department of Computer Science, University of Liverpool, 2015.

[2] L. Al-Abdulkarim, K. Atkinson, and T. Bench-Capon. Evaluating the use of abstract dialectical frameworks to represent case law. In *Proceedings of the Fifteenth International Conference on Artificial Intelligence and Law*, pages 156–60, 2015.

[3] L. Al-Abdulkarim, K. Atkinson, and T. Bench-Capon. Factors, issues and values: Revisiting reasoning with cases. In *Proceedings of the Fifteenth International Conference on Artificial Intelligence and Law*, pages 3–12, 2015.

[4] V. Aleven. *Teaching case-based argumentation through a model and examples*. PhD thesis, University of Pittsburgh, 1997.

[5] K. Ashley. *Modelling Legal Argument: Reasoning with Cases and Hypotheticals*. Bradford Books/MIT Press, Cambridge, MA, 1990.

[6] K. Atkinson. Introduction to special issue on modelling Popov v. Hayashi. *Artificial Intelligence and Law*, 20(1):1–14, 2012.

[7] K. Atkinson, T. Bench-Capon, H. Prakken, and A. Wyner. Argumentation schemes for reasoning about factors with dimensions. *Proceedings of 26th International Conference on Legal Knowledge and Information Systems (JURIX 2013)*, 2013.

[8] K. Atkinson, T. J. M. Bench-Capon, and P. McBurney. Arguing about cases as practical reasoning. In *Proceedings of The Tenth International Conference on Artificial Intelligence and Law*, pages 35–44, 2005.

[9] T. Bench-Capon. Representation of case law as an argumentation framework. In *Proceedings of Jurix 2002*, pages 103–112. IOS Press, 2002.

[10] T. Bench-Capon and E. Rissland. Back to the future: dimensions revisited. In *Proceedings of JURIX 2001*, pages 41–52. IOS Press, 2001.

[11] T. J. M. Bench-Capon. Representing Popov v Hayashi with dimensions and factors. *Artif. Intell. Law*, 20(1):15–35, 2012.

[12] B. R. Berger. It's not about the fox: The untold history of pierson v. post. *Duke Law Journal*, 55(6):1089–1143, 2006.

[13] D. Berman and C. Hafner. Representing teleological structure in case-based legal reasoning: The missing link. In *Proceedings of the Fourth International Conference on Artificial intelligence and Law*, pages 50–59, 1993.

[14] G. Brewka, P. Dunne, and S. Woltran. Relating the semantics of abstract dialectical frameworks and standard afs. In *Proceedings of the 22nd International Joint Conference on Artificial Intelligence*, pages 780–785, 2011.

[15] G. Brewka and S. Woltran. Abstract dialectical frameworks. In *Principles of Knowledge Representation and Reasoning: Proceedings of the Twelfth International Conference*, 2010.

[16] A. Chorley. *Reasoning with Legal Cases Seen as Theory Construction*. PhD thesis, University of Liverpool, 2007.

[17] A. Chorley and T. Bench-Capon. An empirical investigation of reasoning with legal cases through theory construction and application. *Artif. Intell. Law*, 13(3-4):323–371, 2005.

[18] P. M. Dung. On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming, and n-person games. *Artif. Intell.*, 77:321–357, 1995.

[19] T. F. Gordon and D. Walton. Pierson vs. Post revisited - A reconstruction using the carneades argumentation framework. In *Proceedings of COMMA 2006*, pages 208–219, 2006.

[20] L. A Zadeh. Fuzzy sets. *Information and control*, 8(3):338–353, 1965.