

A Note on Hierarchical Constraints

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Abstract. In recent years a considerable amount of research has been devoted to formal theories of precedential constraint. In this note I consider a recent paper which explores the use of factor hierarchies in this connection. In that work it was shown both that cases constrained with the use of a hierarchy may be unconstrained if the hierarchy is flattened, and that cases unconstrained with a hierarchy may be constrained when the hierarchy is flattened. I discuss the nature of factor hierarchies and attempt to explain these results.

Keywords. Precedential Constraint, Factors, Issues, Dimensions, Hierarchies

1. Introduction

Giving a formal account of precedential constraint has been a topic in AI and Law since [16], which used the formalism to distinguish between the reason and results models of precedential constraint. The work was developed in a series of papers, summarised in [21]. In [6] it was argued that the constraint should be applied at the issue level, rather than to cases as a whole. This was further developed in [14] to include more intermediate concepts, and so allow a finer granularity of reasoning.

Here I first summarise the accounts of precedential constraint. I then discuss the nature of hierarchies used in reasoning with legal cases, distinguishing those found in CATO [2] from those found in CABARET [25], IBP [13] and VBJP [15], and then consider where the elements of these hierarchies come from.

I then discuss the important result of [14], that cases constrained with the use of a hierarchy may be unconstrained if the hierarchy is flattened, and that cases unconstrained with a hierarchy may be constrained when the hierarchy is flattened. Clearly this raises some questions: in particular whether either approach constrains the cases we believe should be constrained, while allowing choice in cases where choice is appropriate.

2. Factor based Precedential Constraint

In [22] it was shown that precedents represented as sets of factors (i.e the factors present in a case C are $P \cup D$ where P is the set of plaintiff factors and D is the set of defendant factors) could be represented as a set of rules :

r1: $P \rightarrow \pi$

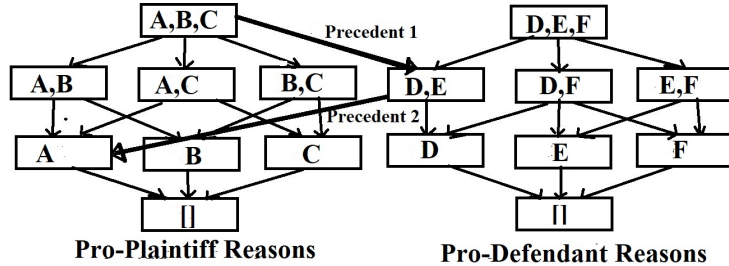


Figure 1. Plaintiff and Defendant lattices with two precedents [5]. Precedent 1 was [A,B,C,D,E] found for plaintiff and Precedent 2 was [A,D,E] found for defendant. A case with [A,B,C,D] cannot be found for the defendant as this would induce a cycle.

r2: $D \rightarrow \delta$

r3: $r1 \succ r2$ or $r2 \succ r1$ depending on the outcome

Prakken and Sartor also noted in [22] that this single step from factors to outcome might fail to represent some important aspects of the reasoning so that “precedents just including consistent, one-step and one-level arguments should be considered as limiting cases of a richer framework.”

In [5] this representation of precedents as rules was exploited to give a rudimentary account of precedential constraint. The plaintiff and defendant factors were arranged into two separate lattices, each representing a partial order on sets of factors for a particular side. Precedents give a preference between a set of plaintiff factors and a set of defendant factors. This can be represented by linking the lattices with a directed edge between the appropriate sets. Given a new case, it is constrained if adding the appropriate edge would induce a cycle; if so, the other direction is forced. Otherwise, either party can win, the new case becomes a precedent, and the edge directed accordingly. An example is shown in Figure 1.

This idea was made more rigorous in [16] and [18]. An important insight was that while [5] represents a *results* model of precedential constraint (as advocated in [3]), it is also possible that a *subset* of the winner’s factors was preferred to the loser’s factors, enabling a stronger constraint. This was termed the *reason* model (advocated in [19]). This work attracted considerable attention and a string of papers followed, offering refinements and improvements, as well as an extension to “factors with magnitude” [17] and dimensions. These developments are summarised and compared in [21].

In [18] and the subsequent work, only single step reasons, from factors to outcome, were used. However, the observation of [22], that sometimes multi-step arguments are necessary, remained apposite. In [6] it was argued that the theory of precedential constraint should be applied to *issues*, not to cases as a whole. The importance of issues was shown in IBP [13]. The issues in IBP formed a logical model which could be represented as an and/or tree. Factor based reasoning was used to resolve the issues, but once the issues had been resolved, the outcome could be deduced using the and/or tree. The importance of issues was shown empirically: while IBP, using issues, achieved 91% accuracy, the case based algorithm without issues achieved only 68% accuracy [13]. The use of issues prevents some cases which should be constrained being distinguished by irrelevant differences, and

allows reasoning with portions of precedents [12] so that cases which match on a particular issue but are elsewhere dissimilar can serve as precedents. Using issues in this way gave rise to two-step arguments:

1. From Factors to Issues using Factor Based reasoning
2. From Issues to Outcome using logical reasoning

As in IBP, [6] went straight from base level factors to issues. In the original factor hierarchy of CATO [2], however, there was a layer of *abstract factors* between issues and the base level factors. The object of CATO had been to assist students in distinguishing cases, and the role of the abstract factors was to group base level factors together to see if any might be used to downplay proposed distinctions by substituting for, or cancelling out, distinguishing factors (see [23] for more on substitution and cancellation). In a recent paper [14], these abstract factors are incorporated into a theory of precedential constraint, allowing extra steps in the arguments and hence finer grained reasoning. In [14] the root of the hierarchy may be an issue or the outcome. If it is an issue, the the outcome is deduced from the resolved issues using a logical model as in [6]. There may be several abstract factors between the base level factors and the root. We therefore have a series of steps in our arguments:

1. From Base Level Factors to Abstract Factors using Factor Based reasoning.
2. From Abstract Factors to Abstract Factors using Factor Based reasoning (0 or more steps).
3. From Abstract Factors to Issues/Outcome¹ using Factor Based Reasoning.
4. If 3 did not reach an Outcome, from Issues to Outcome using logical reasoning.

The paper demonstrated that there were significant differences between using a single step argument from factors to outcome and the hierarchical approach: cases constrained with a hierarchy might be unconstrained without, and cases unconstrained with a hierarchy might be constrained without.²

This raises the question of which is the better account. I will explore this question in the remainder of this paper.

3. Factor Hierarchies

As articulated in [1], there are several different types of statements between outcome and base level factors: issues, intermediate issues and abstract factors. Below these are facts and evidence. Some or all of these are used in the various factor hierarchies available in the literature.

¹Where there is a single issue, the root will be the outcome, as in Figure 3 of [14] and Figures 2 and 4 in this paper.

²A second paper at ICAIL 2023, [26], also discussed hierarchical constraints. A significant difference is that there are no issues in their account (issues in CATO are modelled as abstract factors in [26]), and so there is no stage of logical reasoning. The arguments in [26] comprise the first three steps of those in [14], but always yield an outcome. Although some of my remarks may apply to [26], the focus of my discussion is [14].

The original factor hierarchy of CATO [2] has a separate hierarchy for each issue, five in all. Because the motivation was generating arguments not prediction, there was no need to tie them together to determine the outcome. Thus there are no π and δ nodes in CATO. There are, however, several layers of abstract factors.

In IBP [13] the emphasis changed to prediction. Accordingly the various issues were tied together using the logical model. The hierarchy of IBP (and subsequently VBJP [15]) did not, however, include abstract factors. It did have intermediate issues, but all the factor based reasoning was done in a single step from base level factors to these leaf issues. This is also the hierarchy used in [6].

The hierarchy in [14] has either an issue or an outcome as root and employs factor based reasoning all the way up the hierarchy, from the base level factors through a variable number of abstract factors. Where issues are the root, there is an implicit logical model to deduce the outcome.

3.1. Stages in Reasoning with Cases

The above gives rise to a picture of different stages in legal reasoning as presented in [8]. Once we have moved from evidence to facts and from facts to factors we resolve the issues using factor based precedential constraint. Once the issues have been resolved the outcome can be determined using purely logical reasoning. It is important to distinguish between the logical reasoning required to determine the outcome once the issues have been resolved and the factor based reasoning required to resolve the issues. This has been a fruitful way to look at reasoning with legal cases since the interplay between rules and cases was recognised in CABARET [25]. This distinction between the logical reasoning with issues to determine outcome and factor based reasoning to resolve issues is often ignored, especially in more formal accounts³.

We should now consider where these issues, abstract factors and factors come from.

4. Where Do Issues and Factors Come From?

Issues are typically found in legislation (e.g. [25]), or framework precedents (e.g. [24]) or authoritative commentaries (e.g. [2]). The law is expressed in terms of issues, and judges are obliged to consider and resolve the issues and decide the case by using the and/or tree of issues.

Factors, in contrast, typically do not form part of the law. The factor hierarchies are products of the analysis performed by *knowledge engineers*. They are intended to provide a *descriptive* model of how judges have resolved the issues in past cases. There is *no suggestion* that judges use these hierarchies, or would acknowledge them. They are simply there as part of an effort to model the reasoning of judges.

The base level factors sometimes correspond to commonly used phrases in the legal decisions (such as “information known to competitors”), or may simply

³This includes my own work (e.g. [11] and [18]): my recognition of the importance of issues came later [6].

be used to identify a commonly considered aspect of the cases. The intermediate abstract factors, however, often seem to be entirely a product of the analyst. Their original purpose in [2] was to group together factors that could be considered to substitute for or cancel one another, which was a particular requirement of CATO’s motivation. It may well be that this lack of legal status of abstract factors led to their omission in IBP [13] and VBLP [15], and followed in [6].

Thus courts are not constrained to use a given factor hierarchy. Courts do not use factor hierarchies at all. They are part of the systems analysis, not the legal analysis. This is a strong reason for omitting the abstract factors in [13], [15] and [6], which are concerned with the outcome, not arguing about distinctions. Moreover, if the reasoning of the court does not conform to the model provided by the factor hierarchy, the factor hierarchy needs to be reconsidered, since it is intended to provide a descriptive model of what the courts do. With regard to issues, however, the court is constrained by the statute (and, sometimes by framework precedents) to consider certain issues. The framework of issues (the and/or tree with outcome as root) is fixed in the law [25], but the factor hierarchies used to resolve these issues, although derived from case law, have no legal status.

5. Problem Cases

The results of [14] showed differences between cases constrained under a flat hierarchy (F-constrained), with only an outcome and base level factors, and those constrained under a hierarchy which includes abstract factors (H-constrained). There are four classes of case:

- A: Cases both F-constrained and H-constrained;
- B: Cases F-constrained but not H-constrained;
- C: Cases not F-constrained but H-constrained;
- D: Cases neither F-constrained nor H-constrained.

Type C and Type B cases, where the different approaches constrain different cases can be considered problem cases, since we need to understand which approach is yielding the appropriate constraints.

5.1. Type C cases

An example Type C case⁴ is shown in Figure 2.

In this domain there are six factors. Three are pro-plaintiff, $F1_p$, $F2_p$ and $F4_p$, and three are pro-defendant, $F3_d$ and $F5_d$ and $F6_d$ ⁵.

- The precedent contains $F1_p$, $F4_p$, $F3_d$ and $F5_d$ and was found for plaintiff.
- The current case contains $F2_p$ and $F6_d$.

Since there are no factors in common, the precedent does not F-constrain the current case. However, in the layered case, both cases contain Q_p and R_d and

⁴The example is taken from [14]. Figures 2 and 4 are based on Figure 3 of that paper.

⁵For extra clarity I subscript factors with the party favoured.

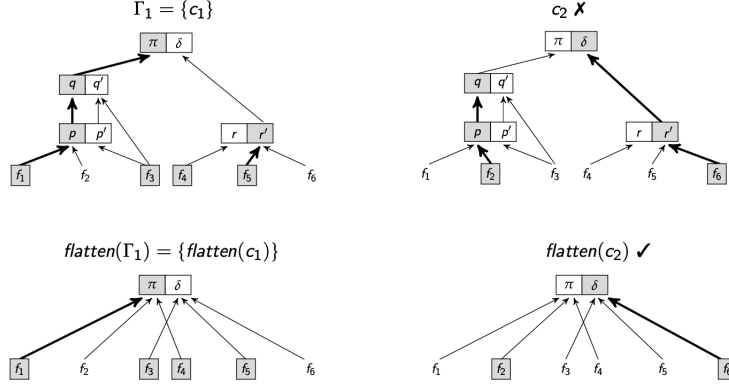


Figure 2. Example Type C cases. Highlighted nodes are accepted.

the decision for π in c_1 turned on the preference $Q_p \succ R_d$ and so the case is H-constrained.

My view is that the case should not be constrained. First, there is no legal status for Q_p and R_d : they are simply posited by the analyst. For this reason I am unsure about applying a constraint in terms of abstract factors which the court may not recognise, having no awareness of the hierarchy shown in Figure 2, which may be entirely a construct of the analyst modelling the domain. For the H-constraint to be applicable, we would need explicit reasoning in the judge’s decision to show that the abstract factors did in fact play a role in the reasoning. For example the judge might argue that $F2_p$ means that Q_p was present in both cases and that both $F5_d$ and $F6_d$ mean that R_d is present, so that R_d is present in both cases, and that the precedent had shown the preference $Q_p \succ R_d$. Without this explicit recognition of the abstract factors, I do not see how we can impose our analysis to create a constraint. Even then the abstract factors are not needed. There are two ways in which such explicit recognition may arise. One is when the meaning of the terms dictates a cancellation. Using the Trades Secrets model in [4], it seems entirely reasonable to reject the abstract factor *ExplicitAgreement* (AF6) even if the defendant had *AgreedNotToDisclose* (F5p) if *Agreement-not-specific* (F4d). So there is a case for having the abstract factor here, if only to improve the explanation. It is not, however, necessary since the analyst could just say $F4d \succ F5p$, and resolve the issue directly, as in [6]. The other possible source is where an analogy has been used. For example it could be that the judge argued that *Brought-Tools* (F7p) was analogous to *Restricted-Materials-Used* (F14p) and use a precedent with F14p to justify the outcome in the case with F7p. Now the analyst *can* group both under the abstract factor *InfoMisuse* (AF3). Again this is legitimate, but unnecessary. Future cases can use the case with F7p as a precedent, with no need of AF3. So, even if abstract factors can be justified, they are not needed to determine the outcomes. I argue that they remain best used for explanation rather than constraint.

The problem causing different behaviours is that factors should only be grouped under the same abstract factor if they are of the same strength. If factors of differing strengths are grouped under the same abstract factor problems arise, as discussed in [10] (Section 4.1), since a weak factor may be treated as if it were

a strong factor, and so be used to cancel a factor that it is unable to cancel. It might well be that $F2_p$ establishes Q_p with sufficient strength to defeat R_d , but that $F6_p$ does not. Thus if it turned out that the case c_2 in Figure 2 was decided for the plaintiff, that might be held to justify the hierarchy used there. But this requires the decision from the court, effectively establishing that $F2_p$ and $F6_p$ can be considered equally strong, with the c_2 as a precedent. The decision could equally have been made for the defendant, establishing that $F6_p$ was not as strong as $F2_p$. Without the decision the assumption of equal strength of the child factors cannot be made, and so the H-constraint should be considered valid only if the F-constraint also holds with appropriate precedents. In all cases where the decision legitimates the hierarchy the legitimating case can become a precedent and used to justify a preference between base level factors.

6. Dimensions

Thinking about factors with different strengths leads to dimensions. I have discussed the relation between dimensions and factors in detail in [6]. I strongly believe, *pace* [17] and [21], that the factor hierarchy should contain factors as usually understood (i.e. either present in a case or absent from that case) [9].

Dimensions are aspects of the case which a judge must consider to determine whether they provide a reason to decide for one or other party, and if so, how strong a reason so to decide. If the dimension does provide such a reason, that means that a particular factor is present in the case. Thus the point on a dimension at which a case lies is a *fact*: factors are ranges on the dimensions for which the dimension supplies a reason to decide for a particular side of a particular strength. Deciding which reasons are provided by dimensions, that is which factors are present, is an important part of reasoning about a case, but is separate from, and prior to, using factors to resolve issues. A reading of decisions in particular cases will show that as well as arguments about the relative merits of the reasons to find for or against the plaintiff, there are also arguments as to whether or not a factor is present [20]. These provide what were termed ascription precedents in [6]. Thus factor ascription should be seen as a separate stage in the reasoning, before the application of factor based precedential constraint to resolve the issues. The process of factor ascription is described in more detail in [7] and [8].

A diagram showing a dimension with three factors partially fixed by precedents is given in Figure 3. Note that a dimension may give rise to several factors favouring the same side, but with different qualitative strengths.

Thus some precedents constrain the ascription of factors, and other precedents constrain how factors resolve issues, but these are two separate mechanisms.

7. Type B cases

The other type of problem cases are of Type B. They are F-constrained, but not H-constrained. An example is shown in Figure 4.

This example uses the same six factors and the same factor hierarchy as the type C example in Section 5.1. In the type B example we have:

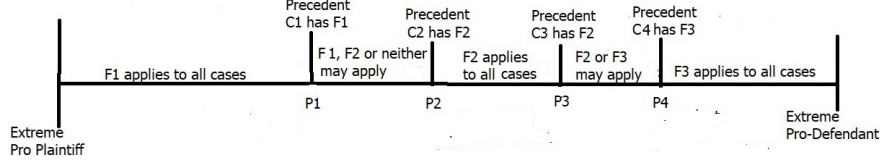


Figure 3. Dimension with three factors; F1 is pro-plaintiff, F2 is weakly pro-defendant and F3 is strongly pro-defendant. P1-4 are points on the dimension occupied by the precedents C1-4. F1 is present in C1, F2 in C2 and C3 and F3 in C4. The factors applicable in ranges P1-P2 and P2-P3 are not determined by C1-4.

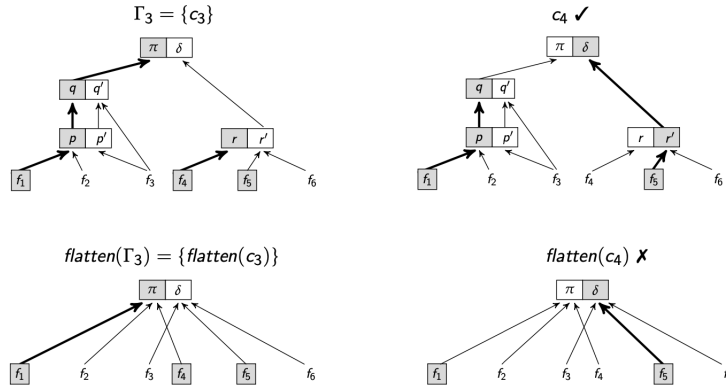


Figure 4. Example Type B cases. Highlighted nodes are accepted.

- A precedent case with pro plaintiff factors $F1_p$ and $F4_p$ and pro defendant factor $F5_d$.
- A current case with pro plaintiff factor $F1_p$ and pro defendant factor $F5_d$.

Given the account of hierarchical constraint in [14], the current case is apparently F-constrained because the reason for deciding for the plaintiff is $F1_p$, the reason for deciding for the defendant is $F5_d$, and the decision for π in c_3 gives the preference $F4_p \succ F5_d$. Thus, when flattened in accordance with [14], we have the preference $F1_p \succ F5_d$ relative to the concern π/δ , so that the current case is F-constrained. However, in the hierarchical setting, when $F4_p$ is absent, as in the current case, R_d is present, and since R_d was absent from the precedent c_3 , there is no preference for Q_p over R_d , and so the current case is not H-constrained.

My view, however, is that the case should *not* be F-constrained. If we apply the reason model as set out in [18] directly to the flatted hierarchy we have three possible reasons;

- (a) $F1_p$ and $F4_p \succ F5_d$: (b) $F1_p \succ F5_d$: (c) $F4_p \succ F5_d$

But now suppose we use the layered hierarchy to explain the reasoning which led to a decision for the plaintiff in c_3 . We can see that it is $F4_p$ that is preferred to, and so neutralises, $F5_d$. $F4_p$, however, does not provide a reason to find for the plaintiff, and so $F1_p$ is required for the decision, and so $F4_p \succ F5_d$ cannot be the reason. There is, however, no comparison in c_3 between $F1_p$ and $F5_d$ and so it would be unsafe to give $F1_p \succ F5_d$ as the reason, because that would ignore the

importance of $F4_p$ in counteracting $F5_d$. This would leave as $F1_p$ and $F4_p \succ F5_d$ the most plausible reason, given the knowledge represented in the hierarchy.

Now, however, c_4 is not constrained by this reason, since $F4_p$ is missing, so that the preference does not apply to c_4 . If, however, c_4 is in fact decided in favour of the plaintiff, we will have our comparison between $F1_p$ and $F5_d$, and we can revise our reason to $F1_p \succ F5_d$. The precedent justifying this reason would be c_4 , however, not the original precedent, c_3 .

Thus I think that the Type B cases may be an artefact of the flattening mechanism in [14], and that directly applying the reason model to a flat hierarchy will not yield such cases. Note, however, that the layered hierarchy could be used to determine which reason should be held to govern the original precedent. This suggests to me that the abstract factors are useful in explaining and justifying a decision, but not in determining constraints. For that F-constraints, as originally proposed in [18], give the appropriate results, although they should be applied to issues, not outcomes, as proposed in [6].

8. Summary

Abstract factors were introduced in CATO [2] to explain why some distinctions were significant and some were not. It was used to supply potential substitutions and cancellations of factors. The strength of the factors was not important in CATO, since the user decided whether substitutes and cancellations were of sufficient strength. For case prediction in [13], [15], however, the abstract factors were removed, suggesting that there is no role for them in prediction. I think that the above discussion confirms this, and precedential constraint is best thought of in terms of a flat hierarchy. The knowledge represented by abstract factors does, however, appear to be useful in selecting which of several candidate reasons should be seen as *the* reason to be taken from a precedent. Thus my conclusions are:

- Factor Hierarchies are used to resolve issues, not cases. The root of a factor hierarchy should be an issue.
- Flat hierarchies are appropriate for precedential constraint. Layered hierarchies have a role in representing domain knowledge useful for the explanation and justification, and deciding which distinctions can be downplayed.
- Dimensions play an important part in legal reasoning. Their role, however, is in *ascribing* factors, and is separate from the use of a factor hierarchy to resolve issues using precedents, which can be done with just factors and preferences between them. Boolean factors are sufficient for this latter purpose, different strengths of reasons being represented by different factors.

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