Zeno Revisited: Representation of Persuasive Argument

Katie Atkinson [a,1] and Trevor Bench-Capon [a]

[a] *Department of Computer Science, University of Liverpool, Liverpool, UK.*

Abstract. In this paper we explore and contrast different forms of dispute representation from the present and past literature. In particular, we examine the Zeno Framework, which represents disputes as dialectical trees, and compare this to other abstract systems for argument representation. We discuss the merits of each method and show how the example argument first represented in Zeno can be transformed into a more concise representation whilst retaining its desirable features.

Keywords. Argumentation, Persuasion, Values, Dispute Resolution, e-Democracy.

Introduction

Persuasion through argument plays a crucial role in many areas addressed by AI and Law, such as dispute resolution, e-democracy and deciding legal cases. In this paper we will examine an influential approach to persuasion through argument [10], in the light of recent developments in work on argumentation. This is necessary since a frequent question asked of approaches based on these developments, such as the author's Parmenides system [4], is how they relate to work such as [10].

The Zeno system [10], which is in a tradition going back to the IBIS (Issue Based Information System) of Rittel and Weber [11] represents a deliberation between two individuals (in the example given there a husband and wife) as to an issue (in the example as to what car to buy). The dispute is represented as a dialectical graph. This graph contains two kinds of node, *positions* and *issues*. If a position is disputed, it gives rise to an issue, and then reappears in the graph as a choice with respect to that issue. Positions may either be *factual statements* ("Porsches are fast cars") or *preference expressions*, in which one position is preferred to another ("Porsches are fast cars" is more important than "Porsches are expensive cars"). Edges are of one of four types: the children of issues are either *choices* (factual positions) or *constraints* (preference expressions), while the children of positions are either *pros*, supporting the position, or *cons*, attacking the position. An argument is a pair of positions, one of which is a pro or con of the other. Given such a graph, it is possible to calculate the status of an issue, with respect to a range of *proof standards*, running from *scintilla of evidence* to *beyond a reasonable doubt*.

This approach satisfies a number of intuitively desirable requirements for representing persuasive argument:

---

[1]Correspondence to: Department of Computer Science, University of Liverpool, L69 3BX, UK. Tel.: +44 (0)151 795 4243; Fax: +44 (0)151 795 4235; E-mail: katie@csc.liv.ac.uk

- It distinguishes issues from positions, thus differentiating between the questions under consideration and the considerations which influence the answers to them;
- In organises issues into a sequence, so as to exhibit dependencies between them;
- It allows both reasons for and against a position to be represented;
- It allows preferences to account for the often subjective nature of the choice of resolution of an issue;
- It allows preferences to be themselves the subject of argument;
- It allows the status of positions and issues to be computed according to a variety of different standards of proof.

In contrast much recent work on argumentation has its basis in the abstract Argumentation Frameworks (AFs) introduced by Dung [8]. These frameworks also have a graphical interpretation, but there the nodes are of single type (*arguments*) and the directed edges are also of a single type (called *attacks* in [8], but which we will call *defeats* to distinguish from a later notion). These AFs are then used to identify sets of arguments which are admissible, according to a variety of semantics, most notably *grounded*, *preferred* and *stable*, and arguments can be said to be either *credulously* (roughly scintilla of evidence upwards) or *sceptically* (beyond a reasonable doubt) acceptable.

Dung's framework is a very elegant and flexible structure, and has proved a fruitful basis on which to explore issues of non-monotonic logic and the computational properties of argument systems. Clearly, however, moving to this level of abstraction has removed some of the distinctions which Zeno is able to express:

- No distinction is made between issues and positions. In practice this distinction is not always a comfortable one in Zeno, since positions can be made into issues, and when this happens the position must appear twice, once as a pro, con or constraint, and once more as a choice with respect to its own issue. This suggests that the distinction may not be as clear as at first appeared.
- There is no notion of supporting a position: the only relation in an AF is defeat. Some efforts have been made to add a notion of support to Dung's AFs, e.g. [2].
- There is no notion of preference: an attack on an argument always succeeds. Efforts have been made to address this through preference based AFs [1] and through value based AFs [5].
- Even in these extensions, however, discussion about which preferences/values should be adopted is not possible.
- Computation of status allows only for sceptical (complete) acceptance and credulous (everything weaker down to complete rejection) rather than the finer grained distinctions offered in [9] and [10].

In this paper we will attempt to address these apparent deficiencies. We will first discuss in Section 1 the representation of a Zeno dialectical tree in the basic AF of [8]. We will then relate the components of the dialectical tree to the argument scheme for practical reasoning developed in [3]. This will allow us to represent the debate as arguments associated with values, the purposes and interests that give force to the arguments motivating actions, so that they can be organised into a Value Based Argumentation Framework (VAF) [5]. This approach grounds the Parmenides systems for e-democracy [4]. In Section 2 we discuss the proof standards given this representation. We will illustrate our discussion with consideration of a legal case in Section 3, and finish with some concluding remarks in Section 4.

1. Graphical Representations of Disputes

1.1. The Zeno Framework

Figure 1 below shows the dialectical tree for the example used in [10]. The top issue (I1) is which car to buy: a Porsche (P1) or a Volvo (P2). A Volvo is safe (P6) but boring (P5). A Porsche is fast (P3) but expensive (P4). Whether Volvos are safe is disputed (I2), on the grounds of a survey (P8) and defended by advertising claims (P7). It is asserted (P11) that the survey is more reliable than the advertising. It is also asserted that the disadvantages of a boring car outweigh expense (P10). Whether speed or safety is more important (P9) is disputed (I3). In favour of speed is prestige (P12), against is that they have children to consider (P13), and this is held more important (P14).
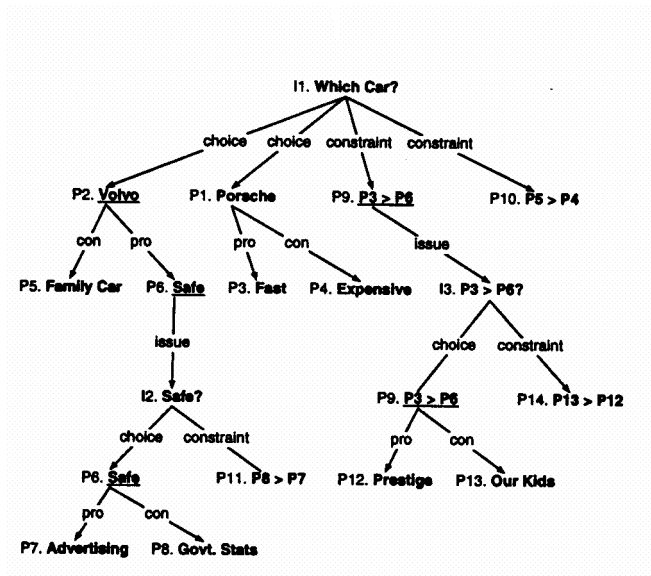

Figure 1. Dialectical Tree from Zeno

1.2. Dung Style Argumentation Frameworks

The previous dispute translates into a basic AF as shown in Figure 2.
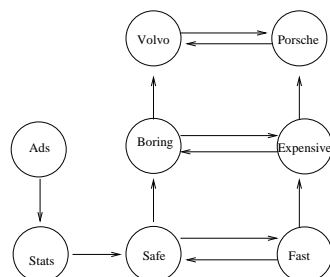

Figure 2. Argumentation Framework Version

Points to note are:

- A position has become a chain of three arguments - the position, attacked by the con, which is in turn attacked by the pro.
- An issue becomes a set of nodes representing the choices, all attacking one another.
- Preferences and issues relating to preference expressions are not represented. Pros and cons of preference expression choices are not represented. Note, however, that as well as the two cycle forming the issue, there are two other two cycles between Boring and Expensive and between Safe and Fast. These cycles, which give rise to a set of alternative preferred extensions in Dung's framework are places where preference needs to be expressed, and are reflections of preference expressions in the dialectical graph of Zeno.

1.3. Value-Based Argumentation Frameworks

The problems with the AF of Figure 2 arise from the entirely abstract nature of the conception of argument. Since arguments have no properties, other than the arguments they defeat, there is nothing on which to base a preference. Moreover, since the arguments are without structure, they do not capture the notion of argument expressed in Zeno, where an argument is a relation between two nodes. In order to address these problems we will recast the AF as a VAF, to enable us to represent preferences. In order to provide the required degree of structure we will make use of the argumentation scheme for practical reasoning developed in [3]. That scheme (called AS1) stated there was:

In R (the current state of affairs)
Do A (a possible action choice)
To reach S (a new state of affairs)
To realise G (a goal)
To promote V (a value).

The initial states, and those reached by action are not explicitly stated in Zeno's dialectical tree, but the action A correspond to positions labelled with choice, goals are the pros and cons of choices and values are the pros and cons of positions relating to preference expressions. Thus there is a good correspondence between AS1 and the elements of the dialectical graph.

We can also see the relation between these arguments as coming from the process of critical questioning developed in [3]. The argument scheme presented above has sixteen different critical questions associated with it which enable parts of the justification to be attacked. These attacks question the validity of the various elements of the argument scheme and the connections between them, and additionally there may be alternative possible actions, and side effects of the proposed action. Examples of such critical questions are: "Are the circumstances as described?", "Does the goal promote the value?", "Are there alternative actions that need to be considered?". The full list of critical questions can be found in [3]. Thus the critical questions can attack both factual claims (the objective elements of the justification) as well as arguments about values (the subjective elements of the justification). Pros and cons of positions present factual information about the issue, typically goals achieved by the action at issue, whereas values provide the *reasons* for one goal to be preferred to another. Thus we can see values as being the

pros and cons of choices relating to issues where the position under consideration is a preference expression. The constraints for such issues is an ordering of values. Where the issues to be resolved rest upon factual information, the choices for these issues are themselves factual. Conflicts regarding factual issues are resolved analogously to a VAF, but using a preference order over sources rather than over values.

Returning now to our example, we can take the arguments involved in the debate and instantiate the argument scheme with the following two justifications for action, each of which proposes a different action. The first instantiation endorses the action of buying a Porsche (note that for clarity we label the arguments with the labels ascribed in [10]):

P1/3: We wish to buy a car, we should buy a Porsche, because Porsches are fast cars, owning a fast car promotes the value of prestige.

The second instantiation of the argument scheme proposes a different action plus justification of it:

P2/6: We wish to buy a car, we should buy a Volvo, because Volvos are safe cars, owning a safe car promotes the value of care for family.

The above instantiations represent the issue to be resolved in the debate: whether to buy a Porsche or a Volvo. As the arguments propose incompatible actions (we cannot afford two cars), they can be seen to be attacking each other, through the application of a particular critical question (CQ11 in [3]). This attack is made if an action precludes some other action which is more desirable from the standpoint of the person proposing the argument. In addition to the attack that these arguments pose against each other, there are further attacks against both arguments that can be posed through the application of the critical questions, beginning with P4 as follows:

P4: We wish to buy a car, we should not buy a Porsche, because Porsches are expensive, (no value stated)[1].

The above instantiation of AS1 represents an application of a different critical question (CQ9): that the action has undesirable side effects. This argument attacks P1/3.

Looking to argument P2/6, we have the following attack on it:

P5: We wish to buy a car, we should not buy a Volvo, because Volvos are boring cars, owning a boring car demotes the value of prestige.

This argument also poses CQ9 to state that the action of buying a Volvo has side-effects that demote another value, namely Prestige. This argument is also in conflict with P4, this time through the application of CQ11, which states that each action precludes another more desirable one.

Furthermore, there are two arguments in the debate that concern factual information. The first of these attacks the claim that Volvos are safe cars, but this is countered by an

---

[1]As we are modelling the arguments as they are used in [10], not all justifications here will include all elements of the argument scheme, where these are implicit in the original paper.

attack stating that there is a TV advertisement which claims that Volvos are in fact safe cars. These arguments do not involve all elements of the argument scheme (i.e., they are arguments about facts as opposed to values), nor do they propose any alternative actions. Thus, they do not instantiate the full argument scheme but rather question certain elements of the justifications concerned. The first attack, providing survey evidence that Volvos are not in fact safe cars, poses another critical question (CQ2), which disputes the consequences of the action, as follows:

P8: buying a Volvo does not achieve the goal of owning a safe car, according to Government survey results.

The attack on P8 counters the argument also by posing CQ2, as follows:

P7: buying a Volvo does achieve the goal of owning a safe car, according to a TV advertisement.

We can now take all the above arguments and attacks and represent the dispute as a VAF, as shown in Figure 3.
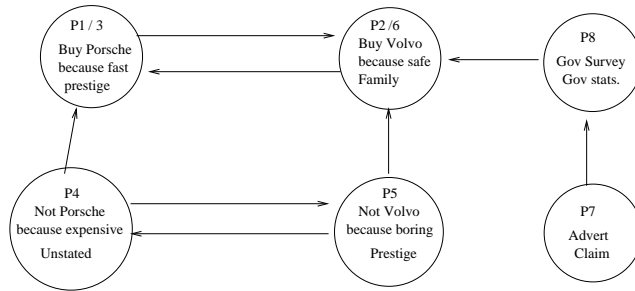

Figure 3. VAF Version.

This must be combined with a representation of the (partial) preference orders, expressed as a binary relation on values, *valuePref({(family, prestige)})*, and a binary relation on sources, *sourcePref({(Government stats., Advert claim)})*. These relations will be expanded if more preferences are added.

Now the status of the arguments in the VAF will be determined by the ordering placed on the values (constraints in preference issues) and, for factual claims, the confidence in the sources. In the example, Government Statistics is preferred to unsourced claim so, P8 resists the attack of P7. P2/6 is thus defeated (in VAFs, facts always defeat value based arguments). However, although it is accepted by both parties that Family Responsibilities must come before Prestige, since P2/6 is defeated, P1/3 is no longer attacked on this score. The debate is therefore resolved by the claim that avoiding a boring car is worth the expense. There is no issue as to this, and so the values relating to P4 and P5 are not stated, but it is reasonable to assume that the boring car is not wanted for reasons of prestige. If we suppose that the value of P4 is family responsibility (perhaps because the money saved will buy shoes for the children), then since the priority of this value has been conceded, P4 will defeat P5 and P1/3. Note, however, that, unlike in the original example, this will not mean that we should buy a Volvo, since our reason for

wanting to do so, the safety basis of P2/6, has been shown to be factually incorrect. This is a difference between this account and Zeno: defeating the pro of a position now defeats the position as well, by defeating the argument which gave the *prima facie* case for accepting it. We would claim this to be an advantage.

Another important point is the attack between P4 and P5, included to correspond to P10 of the Zeno diagram. This attack exists because Volvo and Porsche are seen as a dichotomy, so that Volvo can be substituted for not Porsche and Porsche for not Volvo. This attack disappears if we introduce another option. Again we see this as essential, although it is not clear that it would be so in Zeno.

Given the above situation, what is to be done? It appears that we can buy neither a Porsche nor a Volvo. Either we must introduce another argument for a Porsche, which is able to resist that attack of P4, the currently acceptable argument, or we must find an argument for a Volvo, perhaps the car commended by the Government survey. Perhaps the survey found all orange cars were safe: we could now refine P2/6 to 'Buy an orange Volvo' because it is safe. Now P8 does not attack P2/6. Note that the same move cannot be made with an orange Porsche, because such a car remains expensive.

Figure 3, with the associated preferences already captures the debate expressed in the Zeno dialectical tree of Figure 1. We believe it does so in a more elegant way, that the framework is better understood and more easily related to other current work on argumentation, and that the relation with the argument scheme gives a means of generating as well as recording arguments (e.g., as shown in [3]).

We can now see that there is a case which does not feature in the example, namely the justification of a constraint on an issue relating to a preference expression. Suppose in the example P14, that P13 is preferred to P12 became an issue. On our account this is a question as to the appropriate ordering of values, so that the choice would be a particular ordering of values. What would be the pros and cons of such a choice? It is clear that this is not comfortably accommodated in a VAF, and so represents some kind of appeal to a metalevel. We will not discuss the nature of the metalevel reasoning here, but will note that although some work on determining value orders has been done [7], integrating this smoothly with the above framework is still a matter for research.

2. Proof Standards

A feature of Zeno was the possibility of a number of proof standards. So far we have shown only that the status of an argument can be determined with respect to a particular ordering on values and sources ([5] calls such orderings *audiences*).

Let us consider the diagram in Figure 3 without assuming a particular ordering, and that the value of P4 is family. Since we have two values and two sources, there are four potential audiences. The preferred extensions for these audiences are shown in Table 1.

In [5] four classes of acceptability were identified. *Sceptically objectively acceptable* arguments are acceptable irrespective of ordering on values or sources. *Credulously objectively acceptable* arguments are acceptable irrespective of value order for a given order on sources. *Sceptically subjectively acceptable* arguments are acceptable irrespective of source order for a given order on values. *Credulously subjectively acceptable* arguments are acceptable for some order on sources and some order on values.

Table 1. Preferred Extensions for all Audiences

	Government stats. > Advert claim		Advert claim > Government stats.	
Preference	F > P	P > F	F > P	P > F
Preferred Extension	P4 P7 P8	P1/3 P5 P7 P8	P2/6 P4 P7	P1/3 P5 P7
P1/3	O	I	O	I
P2/6	O	O	I	O
P4	I	O	I	O
P5	O	I	O	I
P7	I	I	I	I
P8	I	I	O	O

In the example: P7 is sceptically objectively acceptable: P8 is credulously objectively acceptable; P1/3, P4 and P5 are sceptically subjectively acceptable, and P2/6 is credulously subjectively acceptable.

Does this categorisation relate to the six Zeno standards in any way? In Zeno there were five standards of proof. *Scintilla of Evidence*, where the choice has some pro. *Preponderance of Evidence*, where the pros outweigh the cons given the preference expressions. *No Better Alternative*, where no choice is preferred on the basis of the preference expressions. *Best Choice*, where it is preferred to every alternative choice on the basis of the preference expressions. *Beyond a Reasonable Doubt*, where no con is reason against it, and no pro is reason for an alternative.

First we should note that these do not necessarily form a scale. *Scintilla of Evidence*, and *Beyond a Reasonable Doubt* relate to pros and cons, *No Better Choice* and *Best Choice* relate to preference expressions and *Preponderance of Evidence* requires a judgement to be taken about contending facts: so some of the standards relate to facts and others to genuine choices. We should therefore expect the first two to relate to source order and the second two to value order, and *Preponderance of Evidence* to preferences about facts.

We might then see scintilla of evidence as relating to credulous acceptance and beyond a reasonable doubt as relating to sceptical acceptance, while no better choice corresponds to subjective acceptance and best choice to objective acceptance. Where does this leave preponderance of evidence? Since this requires a balancing of pros and cons, it requires that some preferences have been expressed. In our framework this would in turn assume that the required ordering had been justified at the metalevel. Again justification at the metalevel could be seen as forcing acceptance (justified), or merely establishing an arguable case (arguably). Preponderance of evidence relates to sources, but similar considerations could be given to the value order.

We can then see four degrees of justification for both the order of sources and the order of values: true in all, true in a particular justified order, true in a particular defensible order, or true in some order. Combining these gives rise to sixteen possible degrees of justification. The strongest, sceptically objective acceptance, represents *the best choice beyond a reasonable doubt* whereas the weakest represents a position which cannot be refuted but has nothing particular to commend it. We thus feel that we are able to accommodate a variety of proof standards, capturing much of the intuition present in Zeno.

3. Legal Example

This far we have couched our discussion in terms of the example used in [10]. We now briefly consider a small legal example. We shall use Pierson v Post, which has been much discussed since it was introduced to the AI and Law community in [6]. It is useful both because of its small size, and because of its wide familiarity. The facts are undisputed: Post was chasing a fox on open land but had not caught it when Pierson shot and made off with it. Post demanded compensation from Pierson. The court found in favour of Pierson, with Tomkins giving the majority decision and Livingston the dissent. We can summarise the arguments as an informal discussion of the kind used to motivate Zeno.

Livi: We should find for Post (P1). He put a good deal of effort into chasing the fox (P3).
Tom: But he hadn't actually caught it, so it was not really his (P4). That's what matters (P5). We need to be able to draw a clear line (P6).
Livi: But chasing foxes is to be encouraged. It is socially useful (P7).
Tom: I think it is more important to be clear. There would be far too many disputes if the courts took that view (P8).

This dispute can be represented as a Zeno style dialectical tree and as a VAF, as in Figures 4 and 5 respectively. In the VAF there is a clear disagreement turning on the relative importance of the values. This issue also ends the dialectical tree.
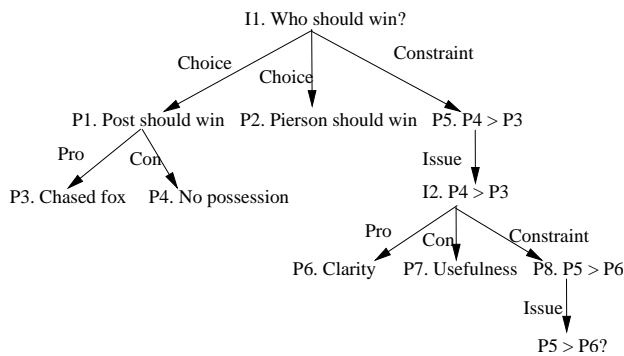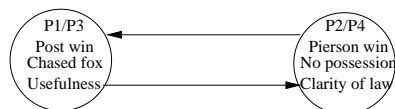

Figure 4. Dialectical graph for Pierson v Post.

Figure 5. VAF for Pierson v Post.

Here some kind of metalevel arguments for the disputed value ordering is needed. No such arguments were advanced in the actual case, since it seemed that Tomkins and Livingston relied on the intuitive appeal of their values, and perhaps their rhetorical expression of these values to persuade. We could, however, imagine that Tomkins might use some version of a slippery slope argument, working through a series of hypotheticals to demonstrate the trivial nature of the disputes that might arise if the law intervened in this kind of matter. Alternatively he might cite some precedents, to show that the law had not found for the plaintiff in such circumstances, and that successful plaintiff cases in

this area turned on different matters (e.g. "the case of Keeble provides no precedent since the plaintiff was on his own land".) We will not attempt to represent this new level of reasoning here, but it looks like an important and intriguing area for future investigation.

4. Concluding Remarks

We believe that by recasting the dialectical tree of Zeno in terms of a VAF with arguments structured according to our argument scheme for practical reasoning, we have captured the several good features of Zeno, but in a better defined framework, and one in which the points of contention are more explicit.

- Moving pros and cons inside the argument nodes excludes unsupported claims and provides prospects for the generation of arguments;
- The structure allows us to decide in a principled way whether an argument is a pro of one choice or a con of another, which is sometimes arbitrary in Zeno;
- Distinguishing between contention as to the facts and contention as to choices based on values provides a clearer account of when disagreement is rational and when it should be capable of resolution;
- We can distinguish arguments that depend on preferences from those that must be accepted on a given view of the facts, or according to a given value order;
- Use of audiences separates the dialectical structure from particular choices, and distinguishes reasoning about value priorities, fact priorities and the consequences of particular orderings.

References

[1] L. Amgoud and C. Cayrol. Inferring from inconsistency in preference-based argumentation frameworks. *Journal of Automated Reasoning*, 29(2):125–169, 2002.

[2] L. Amgoud, C. Cayrol, and M. C. Lagasquie-Schiex. On the bipolarity in argumentation frameworks. In *Proc. of the 10th workshop on Non-Monotonic Reasoning*, pages 1–9, 2004.

[3] K. Atkinson. *What Should We Do?: Computational Representation of Persuasive Argument in Practical Reasoning*. PhD thesis, Dept. of Comp. Sci., University of Liverpool, UK, 2005.

[4] K. Atkinson, T. Bench-Capon, and P. McBurney. Parmenides: Facilitating deliberation in democracies. *Artificial Intelligence and Law*, 2005. *In press*.

[5] T. Bench-Capon. Persuasion in practical argument using value based argumentation frameworks. *Journal of Logic and Computation*, 13 3:429–48, 2003.

[6] D. H. Berman and C. D. Hafner. Representing teleological structure in case-based legal reasoning: the missing link. In *Proc. of the 4th ICAIL*, pages 50–59. ACM Press, 1993.

[7] S. Doutre, T. Bench-Capon, and P. Dunne. Determining preferences through argumentation. In *Proc. of the 9th IAAI*, pages 98–109, 2005.

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

[9] A. M. Farley and K. Freeman. Burden of proof in legal argumentation. In *Proc. of 5th International Conference on AI and Law*. ACM Press, 1995.

[10] T. F. Gordon and N. I. Karacapilidis. The Zeno argumentation framework. In *Proc. of 6th International Conference on AI and Law*, pages 10–18. ACM Press, 1997.

[11] H. W. J. Rittel and M. M. Webber. Dilemas in a general theory of planning. *Policy Sciences*, pages 155–169, 1973.