Prevarication in Dispute Protocols

Paul E. Dunne
Dept. of Computer Science
University of Liverpool
Liverpool L69 7ZF, UK
ped@csc.liv.ac.uk

ABSTRACT

Models of persuasion, argument, and reasoning motivated by analogies from Law and legal process are now accepted formalisms supporting multi-agent discourse in applications such as contract negotiation and resolving disputed claims. A number of non-classical Logics and proof theories within these have been proposed specifically to deal with the special circumstances wherein propositional theories are not best suited to address modeling issues arising in legal contexts: e.g. exceptions and defaults are treated in a variety of so-called *non-monotonic* logics; similarly concepts of *credulous*, *cautious* and *sceptical* belief have been developed, partly to reflect differing forms of 'burden of proof' that may apply in various judicial contexts. Our concern in this paper is to consider one aspect of legal argument that appears to have been largely neglected in existing work concerning agent discourse protocols – particularly so in the arenas of persuasion and dispute resolution – the use of *legitimate* procedural devices to defer 'undesirable' conclusions being finalised and the deployment of such techniques in seeking to have a decision over-ruled. Motivating our study is the contention that individual agents within an 'agent society' could (be programmed to) act in a 'non-cooperative' manner: thus, contesting policies/decisions accepted by other agents in the 'society' in order to improve some notional 'individual' utility. Using Dung's argumentation framework, we present various settings in which the use of 'legitimate delay' can be rigorously modeled, formulate some natural decision questions respecting the existence and utility of 'prevaricatory tactics', and, finally, illustrate within a greatly simplified schema, how carefully-chosen devices may greatly increase the length of an apparently 'straightforward' dispute.

KEYWORDS: Argumentation and Persuasion, Dialogue Protocols, Locution Selection.

1. INTRODUCTION

That the pronounced agenda of Algorithmics and Computational Complexity Theory should appear driven by the Olympic ideal, is perhaps understandable: to obtain higher lower bounds, discover stronger proof techniques, develop faster algorithms, must, inevitably, form the cornerstones of a theoretical discipline whose long-term objectives are directed toward discerning the fundamental limits of effective computational process. As a programme with which to embrace *every* aspect of 'potentially automatable' principles, these agenda are, however, inadequate: in numerous domains of human activity the impact and appreciation of a process are assessed not through its brevity but, rather, through its qualified postponement of a resolution. Thus one finds in the narrative aspects of arts such as Literature, Drama, Cinema, etc. the device of '*suspense*' employed to maintain an observer's involvement, and although the extreme form this takes in, say, Scott's *Ivanhoe*[1] is, nowadays, rare, the careful pacing of incident and event is a crucial skill in heightening effect and retaining interest in any narrative medium: one does not read the last chapter of a crime thriller first, attend only the final scenes of a play; ignore all but the concluding reel of a film. In more mundane activities such as preparing a menu, the timing and order of particular dishes is of importance, not how quickly these can be eaten. Even in music, arguably the most abstract of forms, can be found many examples whereby interest is engaged through delaying aural expectations rather than satisfying these immediately: the return of the first-subject in classical sonata-form; the larger-scale effects of so-called 'progressive tonality' in works such as Nielsen's 4th symphony – a piece whose argument, directed toward establishing a single 'dominant' key, is resolved only in its concluding pages. In total the artful employment of 'legitimate' 'delaying techniques' is a vital skill in many spheres of activity.

Undoubtedly, as regards popular perceptions, in no field are such devices more clearly apparent than that of the practice of Law. The common stereotypical view of legal process is that it is lengthy and expensive; that what appear (to a lay observer at least) to be clear-cut, incontrovertible decisions by one court are, more often than not, subjected to appeal and counter-appeal until confirmed or overturned at the highest judicial authority empowered to do so; that lawyers are more concerned with exploiting technicalities, discovering loop-holes, unearthing suitable precedents, and exploring all manner of legal avenues in order to achieve their (client's) ends, than they are concerned with the 'right decision' being reached: possibly the most reiterated clichés regarding judicial and legal procedure are that 'justice' (as determined by courts) and 'right' (in some 'ethical' sense) are two entirely different concepts; that due regard for the 'rights of alleged wrong-doers' is of greater significance than the grievances of injured parties.

Nor are these views of legal practice recent phenomena: Dickens' *Bleak House* (1852-3) centres on a case (*Jarndyce vs. Jarndyce*)

[1]Wherein a substantial and seemingly unrelated narrative separates the entry of a character at the conclusion of one chapter from the identification of that character as the eponymous hero several chapters later.

of a will disputed over several generations and the effect on the families involved of the protracted legal proceedings in the court of Chancery; Zola in *La Bête Humaine* (1890) portrays criminal investigators interpreting material in order to fit a preconceived (and politically helpful) theory together with the collusion of senior legal officers in first suppressing and later destroying evidence challenging this; nearly four centuries ago Shakespeare, in the person of Hamlet, numbered the slow nature of legal process among life's irritations; and, later, had the same character inveigh against the increasing contemporary use of over-precise logic.[2] Almost two thousand years ago, St. Paul castigated the church in Corinth for resorting to law suits in settling disputes.[3] Earlier yet, the playwright Aristophanes, lampooned the Athenian judicial process – its costs and susceptibility to corrupting influence – and, elsewhere, satirised the growing popularity of Logic and Rhetoric as studies directed toward justifying 'wrong' arguments.[4]

As is usually the case with stereotypes, such views are, of course, a considerable exaggeration, and indeed, distortion, of actual practice. For example, the assertion regarding legal conduct in pursuit of a client's case, fails to take into account that lawyers may consider themselves *ethically bound* to act as such: to take just one series of guidelines (among many), [14, DR-7-101 (1200.32)],

A. A lawyer shall not intentionally:

1. Fail to seek the the lawful objectives of the client through reasonably available means permitted by law . . ..

[14, DR-7-102 (1200.33)] stipulates that lawyers should not,

1. File a suit, assert a position, conduct a defense, delay a trial, or take other action on behalf of the client when the lawyer knows or when it is obvious that such action would serve merely to harass or maliciously injure another.

2. Knowingly advance a claim or defense that is unwarranted under existing law, except that the lawyer may advance such claim or defense if it can be supported by good faith argument for an extension, modification, or reversal of existing law.

Thus, lawyers are required "zealously to represent the interests of their clients within the bounds of the law": that such representation may *appear* 'over-zealous' to external observers does not, in terms of the code quoted, excuse practitioners from its observance.

Nevertheless, such extreme views of legal process as 'unnecessarily' protracted, have arisen partly in consequence of several cases. Thus, Dickens in his preface to *Bleak House* observes,

> . . . there is a suit before the Court which was commenced nearly twenty years ago: in which from thirty to forty counsel have been known to appear at one time; in which costs have been incurred to the amount of seventy thousand pounds;[5] which is a *friendly suit*; and which is (I am assured) no nearer to its termination now than when it was begun. There is another well-known suit in Chancery, not yet decided, which was commenced before the close of the last century, and in which more than double the amount of seventy thousand pounds has been swallowed up in costs.

More recently we have such examples as, in the U.S. the "ENIAC Patent" dispute (pre. 1962–1973) concluding in the judgment in Honeywell Inc. vs. Sperry Rand[6] that "Eckert and Mauchly did not first invent the automatic digital electronic digital computer. . ."[7]; and, in the U.K., the most recent ruling in the case *Regina vs. Hanratty*,[8] relating to the trial, conviction, and subsequent execution of James Hanratty (January-April, 1962): concerns regarding the case had been submitted for consideration at intermittent intervals in the succeeding forty year period.[9] Following the formation, in April 1997, of the Criminal Cases Review Commission further review of the case commenced in March 1999, ultimately leading to the ruling issued in May 2002.[10]

An important feature of the "ENIAC Patent" dispute is the considerable time and expense devoted to case preparation: the legal team acting for Honeywell commenced amassing documentation (resorting, on occasion, to subpoena) from early 1968 – three years prior to the formal opening of the case in June 1971. That this was necessary reveals a common link with the stages in the Hanratty case and indicates an important component in models of 'decision contention' process: it is not possible continually to re-hear cases on the basis of *the same* evidence. Thus, the ENIAC Patents had been ruled valid in 1962 when Bell Labs. were deemed not to have shown "sufficient evidence of prior use": much of Honeywell's pre-trial work was invested in obtaining 'new' *relevant* evidence; each call for review (whether successful or not) of *Regina v. Hanratty* was based on new evidence or procedural points.

The requirement to 'say something new' in contesting a decision is one method of preventing circular argumentation. This, however, does not necessarily mean the introduction of new 'procedural' or 'evidential' matter: an alternative is to seek re-interpretation of arguments. Among the best examples of this type concern the grounds on which the U.S. Supreme Court has either denied or upheld appeals against capital sentences, many of which hinge on readings of the 8th Amendment.[11] The interpretation of the phrase '*cruel and unusual*' is central to the decision in *Atkins v. Virginia* (USSC, No. 00-8452, June 2002) and reverses the 1989 decision of *Penry v. Lynaugh* (492 U.S. 302).[12] In addition to the cases men-

[2] *Hamlet*, Act III, Sc. i, l.73; Act V, Sc. i, ll. 139-44, *vide* also ll. 99–111, of the latter scene in its view of lawyers.

[3] cf. 1 *Cor.* 6:1,7

[4] e.g.*The Wasps*, (422 B.C.), l.1426: "*I want neither law suits nor other troubles*", (the implication being that these are time-consuming and expensive). The caricature of the 'New Learning' ("Unjust Logic" in the text) a year earlier in *The Clouds*, is not an attack on the figure of Socrates, himself, but on the 'misuse' of dialectic techniques, cf. ll. 1179–1200, to defraud a creditor; ll. 1331–1450 to justify physical assault on a parent.

[5] Recall this is written in 1853, an equivalent sum would exceed twenty million pounds in present-day terms: forty pounds *per annum* affording an acceptable living standard in Dickens' era.

[6] Civil Action, U.S. District Court, District of Minnesota, Fourth Division, File No. 4-67 Civ. 138 (19th October, 1973; given by U.S. Federal Judge Earl R. Larson)

[7] *ibid.* Findings of Fact, Conclusions of Law and Order of Judgment, p.47, para. 3.1.2.

[8] Supreme Court of Judicature Court of Appeal (Criminal Division), Case No: 1999020010 S2 (10th May 2002)

[9] e.g. applications for an enquiry to be held were considered in 1963, 1967, 1969, 1971, and 1972; that conducted in 1974 reported the conviction as 'safe' in 1975.

[10] This upholds the conviction and sentence, but is open to challenge in the European Court. Grounds mooted for such, question the use of current technology – DNA evidence – to refute the alibi defence: although acknowledging procedural irregularities in the original trial (para. 213), the DNA evidence was seen to have "made what was a strong case even stronger" (para. 211).

[11] Excessive bail shall not be required, nor excessive fines imposed, nor cruel and unusual punishments inflicted.

[12] Both cases concern the 8th Amendment in respect of the execution of mentally-retarded criminals. The decision in *Atkins v. Virginia* rules that this is unconstitutional.

tioned above, the 8th Amendment has been proposed as prohibiting capital sentences: in *any* circumstances;[13] for particular offences;[14] by particular methods; where its application could be interpreted as racially motivated;[15] and, when an initial attempt to execute sentence has failed.[16]

The examples outlined over the last few paragraphs, serve to indicate the importance of mechanisms for contesting decisions as part of legal argumentation. In total we can identify three general requirements that a decision appeal ought to satisfy: the substance (evidential, procedural, interpretative) should be '*original*', i.e. it should 'say something new'; it must be '*relevant*' to the matter contested; and, finally, it must be '*timeous*', i.e. many appeal processes will not consider particular grounds after a certain limit and/or where these could have been but were not brought at an earlier stage: e.g. alternative defence grounds – say diminished responsibility by reason of insanity instead of alibi – cannot be introduced mid-trial, courts of appeal beyond a certain level will not consider new evidential matter (in the first instance, the U.K. Court of Criminal Appeal considers procedural issues, such as misdirection or admission of contested evidence during the course of a trial); similarly in *Gomez v. US District Court, Northern District of California*, (503 U.S. 653) (1992) (USSC), among the grounds listed for revoking the stay of execution that had been granted to one Robert Alton Harris was the fact that it had been given pending decision on the claim that California's use of lethal gas violated the 8th Amendment, even though no similar claim had featured in four prior appeals.

In this paper, we are concerned with the modeling and efficacy of what we shall term '*prevaricating*' locutions inspired by the legal processes of appeal and counter-appeal within the context of so-called '*agent societies*'. A number of models and properties of such systems have been studied in previous work. For example, Artikis *et al.*[1] examine these from the viewpoint of E-markets and negotiation protocols with respect to questions of distinguishing valid from invalid actions, specifying constraints on the use of actions, and means for dealing with 'anti-social' behaviour. Central to the concept of such societies are the mechanisms by which members *communicate*. Such mechanisms have been studied at length under the general heading of '*dialogue*' or *discussion protocols*. Studies include taxonomies of dialogue types[25]; formalisms for describing and reasoning about protocols[17, 18, 19]; protocols for argumentation[20, 22]; and applications in legal reasoning[2, 3, 11, 15, 21]. In [12, 13] dialogue formulations of argumentation in the setting of Dung's argumentation frameworks[6] are considered. Dung's formalism also underpins the credulous reasoning dialogue game – TPI–dispute – advanced in [24] and extensively analysed in [7]. In contrast to the analysis presented in [10] which deals with structural descriptions of a particular form of prevaricating tactic – so-called 'stone-walling' non-cooperation dialogues – we are primarily interested in how 'successful' prevarication can be in an abstract setting and in the possibility of synthesising prevaricating strategies.

In particular we wish to consider strategies that seek to challenge positions seen as 'unfavourable' in such a way that the process of negotiation and arbitration continues until such a time as one party is 'satisfied' with an arbitrated decision or has no option but to accept the current status. One aspect of such strategies is that a contesting party may attempt to *prolong* the discussion: i.e. in the absence of a 'victorious' outcome, an agent can at least avoid 'losing'. We note four situations in which such a strategy may be beneficial:

a. In compensation cases, a plaintiff seeking damages as a result of incurring a terminal illness, may be encouraged to accept a less generous 'out of court' settlement offered by the defendants who will otherwise use (legitimate) measures to prolong the action.

b. Where limitation devices are an issue, a contesting agent may attempt to continue argument until these take effect, e.g. if a capital sentence has not been carried out after some length of time, this might be argued as violating the 8th Amendment.[17]

c. In order to exploit the availability of 'unlimited' resources to the contesting parties.

d. In the hope that the parties will decide that further argument is counter-productive, e.g. minor offences may be handled by a lay magistrates court without a jury and limited sentencing powers. A defendant can, in some cases, insist on the case being heard in a Crown Court (with a jury empanelled). Although such courts have greater sentencing powers the option of seeking trial in a higher court has two advantages: a jury may be 'more likely' to acquit (or at worst be unable to reach a verdict); it may be decided not to pursue the case because of the additional expense.

Rather than present an abstract setting of the problems we address using a generic formalism for defining dialogue protocols, such as that of [8], we concentrate on one class of persuasion methods – the TPI-protocol of [24]. This and the argument system framework of [6] are reviewed in the next section. In Section 3 we formulate some natural decision problems within this model and in Section 4, illustrate, albeit with a very simplified series of examples, how decision contention may be used within these settings to delay significantly the resolution of a dispute. Section 5 presents a case study involving effective use of prevaricatory methods. Discussion and conclusions occupy the final sections.

2. DIALOGUE PROTOCOLS

As a concrete example we focus on the TPI-protocol of [24] in the setting of *finite* argument systems[6].

DEFINITION 1. *An* argument system *is a pair* $\mathcal{H} = \langle \mathcal{X}, \mathcal{A} \rangle$*, in which* $\mathcal{X}$ *is a set of* arguments *and* $\mathcal{A} \subset \mathcal{X} \times \mathcal{X}$ *is the* attack relationship *for* $\mathcal{H}$*. Unless otherwise stated,* $\mathcal{X}$ *is assumed to be* finite*, and* $\mathcal{A}$ *comprises a set of ordered pairs of* distinct *arguments.*

[13] Most notably, in *Furman v. Georgia*, 408 U.S. 238 (1972) (USSC), *Gregg v. Georgia*, 428 U.S. 153 (1976) (USSC); the latter ruling: "The punishment of death for the crime of murder does not, under all circumstances, violate the Eighth and Fourteenth Amendments."

[14] cf. *Coker v. Georgia*, 433 U.S. 584 (1977) (USSC).

[15] A factor in, e.g. *McCleskey v. Kemp*, 481 U.S. 279 (1987) (USSC): "The Baldus study does not demonstrate that the Georgia capital sentencing system violates the Eighth Amendment.". The Baldus study investigated racially disproportionate imposition of capital sentences.

[16] e.g. *Louisiana ex rel. Francis v. Resweber*, 329 U.S. 459 (1947) (USSC): Willie Francis had been prepared for execution on 3rd May 1946 and although subjected to electric shock, survived. A challenge to the enactment of a second death warrant was made on the grounds that this violated the 5th ("...nor shall any person be subject for the same offence to be twice put in jeopardy of life or limb;...") and 8th Amendments: the appeal was denied.

[17] Despite the many cases of individuals awaiting execution for over twenty years, it appears that such claims have yet to be considered by the U.S. Supreme Court.

A pair $\langle x, y\rangle \in \mathcal{A}$ is referred to as 'y is attacked by *x' or 'x* attacks *(or* is an attacker of*) y'. For R, S subsets of $\mathcal{X}$ in $\mathcal{H}(\langle \mathcal{X}, \mathcal{A}\rangle)$, we say that*

a) $s \in S$ is attacked *by R if there is some $r \in R$ such that $\langle r, s\rangle \in \mathcal{A}$.*

b) $x \in \mathcal{X}$ is acceptable with respect to *S if for each $y \in \mathcal{X}$ attacking x there is some $z \in S$ attacking y.*

c) S is conflict-free *if no argument in S is attacked by any other argument in S.*

d) A conflict-free set S is admissible *if every argument in S is acceptable with respect to S.*

DEFINITION 2. *The decision problem* Credulous Acceptance *(*CA*) takes as an instance: an argument system $\mathcal{H} = \langle \mathcal{X}, \mathcal{A}\rangle$ and an argument $x \in \mathcal{X}$. The result true is returned if and only if* at least one *admissible set S of $\mathcal{X}$ contains x. If* $\text{CA}\langle \mathcal{H}, x\rangle)$ *holds then x is said to be* credulously accepted *in $\mathcal{H}$.*

The *Two Party Immediate Response* or TPI-protocol is a sound and complete mechanism for deciding if a given argument, x, of $\mathcal{H}(\mathcal{X}, \mathcal{A})$ is credulously accepted. We view a TPI-dispute as a sequence of instantiated locutions (utterances) involving elements of the set $\{p : p \in \mathcal{X}\} \cup \{p \hookrightarrow q : \langle p, q\rangle \in \mathcal{A}\}$. Utterances alternate between two protagonists: the Proposer (P) who seeks to demonstrate that x is credulously accepted; and the Challenger (C) who disputes this claim. The first move is made by P. As a dispute, δ, progresses $\Sigma(\delta)$ – the dispute 'state' – contains a subset of $\mathcal{X}$ that P is attempting to build into an admissible set containing x the disputed argument. The set of locution types in TPI-disputes is {ASSERT,COUNTER,BACKUP,RETRACT}.[18] In a TPI-dispute in which P seeks to convince C that x is credulously accepted, the first move is the utterance $\text{A}(x)$. The dispute proceeds with moves of the form $\text{C}(y)$ where y is an 'available' attack on the most recent argument advanced by the opposing player. In the first instance an argument is 'available' to C if is not attacked by any argument in $\Sigma(\delta)$. If no such arguments are present then C is forced to start a 'new line of attack' (z) on the most recent open argument, y, put forward by P using the utterance $\text{B}(z \hookrightarrow y)$. If there are no available arguments and C cannot open a new line of attack then C loses. For P an argument, z, is 'available' if it does not conflict with any of the arguments in $\Sigma(\delta)$ and the set $\{z\} \cup \Sigma(\delta)$ has not already been shown inadmissible: if P can play $\text{C}(y)$ after δ, then $\Sigma(\delta \cdot \text{C}(y)) = \Sigma(\delta) \cup \{y\}$. If there is no available argument for P, then the utterance $\text{R}()$ is played provided that $\Sigma(\delta) \neq \{x\}$, with $\Sigma(\delta \cdot \text{R}()) = \{x\}$. It should be noted that $\Sigma(\delta)$ is not changed following an utterance by C.[19]

A TPI-dispute, δ, is *partial* if the player whose turn it is has a valid utterance with which to continue δ; it is *terminated* when this player has no available utterance. We use $|\delta|$ to denote the total number of utterances in the dispute δ.

3. PREVARICATING CHALLENGES

Consider the argument system of Figure 1. The argument labelled x is credulously accepted being contained in the admissible set $\{x, u, w\}$. Suppose P wishes to argue that x is admissible but

[18] These are abbreviated to A, C, B and R subsequently.

[19] A full formal semantics for TPI-disputes is given in [7]: this employs an optimisation to the form in [24], that has, independently, been noted by [4].

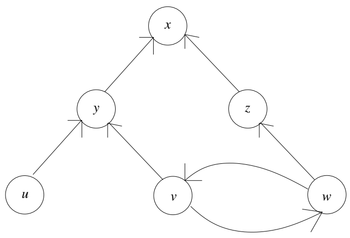

Figure 1: Example Argument System

has no knowledge of the set $\{x, u, w\}$; C claims that x is not acceptable, however 'knows' this position to be untenable since C is aware of the admissible set containing x. Attempts may be made by C to adopt a line of argument that prolongs the dispute in the hope that P will 'give up'. Ideally, C would prefer the dispute

$$\text{A}(x) \cdot \text{C}(y) \cdot \text{C}(v) \cdot \text{B}(z \hookrightarrow x) \cdot \text{R}() \cdot \text{C}(y) \cdot \text{C}(u) \cdot \text{B}(z \hookrightarrow x) \cdot \text{C}(w)$$

to the alternative

$$\text{A}(x) \cdot \text{C}(z) \cdot \text{C}(w) \cdot \text{B}(y \hookrightarrow x) \cdot \text{C}(u)$$

Thus for this example it is clear that C's 'best' move is to attack x with y which leaves open the possibility that P will choose the 'wrong' defence (v) rather than to attack using z, after which all moves are forced, i.e. there is a unique valid continuation. Of course, if P knows that the set $\{x, u, w\}$ is admissible, then C is powerless to prevent a 'minimum' length dispute.[20]

In general, where systems of greater complexity than that of Figure 1 arise, C will at each stage have a choice of arguments with which to challenge the most recent argument put forward by P: in seeking to prolong the dispute, C tries to select attacks that present the 'greatest scope' for P to make a mistake. Thus we have the following elements:

1. An argument system $\mathcal{H}(\mathcal{X}, \mathcal{A})$ and argument $x \in \mathcal{X}$.
2. A partial TPI-dispute $\delta = \text{A}(x) \cdot \mu_2 \cdots \mu_{2k-1}$.
3. An admissible set $S \subseteq \mathcal{X}$ with $x \in S$.

The set S is known by C but not by P. In conducting the dispute both protagonists must employ some *argument selection* process, i.e. there are functions σ_P and σ_C that take a partial dispute δ and return the next utterance – $\text{C}(y)$, $\text{B}(y \hookrightarrow z)$, or $\text{R}()$ – that would be played by P or C respectively.

We now have defined sufficient elements to introduce the *Prevaricating Utterance Problem* (PUP) (for TPI-disputes).

DEFINITION 3. *An instance of the* Prevaricating Utterance Problem *(*PUP*) for* TPI*-disputes comprises:*

1. An argument system $\mathcal{H}(\mathcal{X}, \mathcal{A})$.

2. An argument $x \in \mathcal{X}$.

3. An admissible set $S \subseteq \mathcal{X}$ with $x \in S$.

4. A partial TPI*-dispute, $\delta = \text{A}(x) \cdot \mu_2 \cdots \mu_{2k-1}$.*

5. An argument selection policy, σ_P used by P.

6. A positive integer $K \geq 2k$.

[20] This is proved in [7]: formally if there is an admissible set of size k containing x then there is a TPI-dispute won by P of length $2k-1$ proving this.

An instance is accepted if there is a possible continuation,

$$\eta = \delta \cdot \mu_{2k} \cdot \mu_{2k+1} \cdots \mu_K$$

of δ *such that* $\mu_{2(k+i)+1} = \sigma_P(\delta \cdots \mu_{2(k+i)})$ *for each* $i \geq 0$*. If no such continuation exists the instance is rejected.*

Informally, PUP asks whether C can select its next utterance in such a way that P following its argument selection policy results in the total dispute length being at least K.

We could, of course, formulate Definition 3 in terms of persuasion protocols other than TPI. Nevertheless, some general points of interest can be raised even within the limits of TPI-disputes. We note first that the problem models situations in which, ultimately, C cannot win: the argument x disputed *is* credulously accepted in $\mathcal{H}(\mathcal{X}, \mathcal{A})$ as witnessed by the admissible set S. So despite the fact that C has access to significant data – an admissible set containing x, the argument selection process used by P – there is a limit on how far a dispute could be prolonged even with the most 'naive' selection strategy in use by P. In addition, the underlying presumption being made in seeking a dispute over a certain length (the value K) is that the given parameter in a sense represents a limit on P's 'patience': if a dispute continues for at least this length of time then P, while not necessarily conceding defeat, will cease striving to persuade C that the disputed thesis holds. Regarding 'time' as a resource limited by the number of moves made does not, however, fully account for 'reasonable' ways in which P may become 'exhausted'. Consider the following argument selection strategies that might be used by P:

s1. Given a choice of counter-arguments, choose one which attacks the greatest number of arguments.

s2. Given a choice of counter-arguments, choose one which has fewest attackers.

s3. Given a choice of counter-arguments, choose one of these uniformly at random.

s4. Prior to playing $\mathrm{A}(x)$, construct from $\mathcal{H}(\mathcal{X}, \mathcal{A})$ any admissible set, R, containing x. In response to any attack using $z \notin R$ by C, choose any argument in R that attacks z.

There is a significant difference between the strategies (s1–s3) and that given by (s4): the former group can all be realised *efficiently*; the latter, although leading to minimal length disputes, is unlikely to be efficiently realisable.[21] In implementing (s4) P is, potentially, committed to investing significant preparatory effort in order to nullify employment of prevaricating tactics by C. It may well be the case, however, that P has limited resources and is not in a position to use (s4).

In order to model the concept of 'limited resource' for P, the natural mechanisms to use involve associating a *cost function* with the argument selection policy employed and, instead of formulating PUP in terms of forcing a dispute of a certain length K, introduce an overall 'resource limit' for P, so that the C's aim is to prolong a dispute to the point where P's resources are exhausted. We note that in this framework we assume C possesses 'unlimited' resources, cf. the 'effective' position of Honeywell's legal team in the "ENIAC Patent" disputes cited earlier.

We thus have,

DEFINITION 4. *The* Prevaricating Utterance Problem with Limited Resource *(PUPLR) for* TPI*-disputes, takes as an instance,*

1. *An argument system* $\mathcal{H}(\mathcal{X}, \mathcal{A})$.
2. *An argument* $x \in \mathcal{X}$.
3. *An admissible set* $S \subseteq \mathcal{X}$ *with* $x \in S$.
4. *A partial* TPI*-dispute,* $\delta = \mathrm{A}(x) \cdot \mu_2 \cdots \mu_{2k-1}$.
5. *An argument selection policy,* σ_P *used by* P.
6. *A* cost function
$$\chi \ : \ \{\eta = \mathrm{A}(x) \cdots \mu_{2m} : \eta \textit{ is a partial dispute}\} \rightarrow \mathbf{N}$$
7. *A* resource limit, $M \in \mathbf{N}$.

An instance is accepted if and only if there is a possible continuation of δ

$$\eta = \delta \cdot \mu_{2k} \cdot \mu_{2k+1} \cdots \mu_{2(k+t)-1}$$

with $\mu_{2(k+i)+1} = \sigma_P(\delta \cdots \mu_{2(k+i)})$ *for each* $i \geq 0$ and

$$\sum_{i=0}^{t-1} \chi(\delta \cdot \mu_{2k} \cdots \mu_{2(k+i)}) \ \geq \ M$$

Thus in PUPLR C's aim is to engineer a partial dispute, η, with the property that P cannot afford to continue arguing since the process of constructing η has exhausted such resources as it had available.

While classifying the computational complexity of PUP and PUPLR is a problem of some interest, we note that there are a number of technical considerations with respect to the formulation that would require detailed treatment in order to deal properly with these issues.[22] Given this, we do not, in this paper, address the issue of computational complexity further. Instead, in the next section, we present a sequence of examples illustrating that for the 'efficient' strategies (s1–s3), C can always[23] adopt arguments that exhaust P limited to 'reasonable' resources.

4. PREVARICATION TO AVOID LOSING

In this section we consider the strategies (s1–s3) in more depth. We describe a *sequence* of argument systems $\langle \mathcal{G}_n \rangle$ each of which contains an admissible argument, Φ, around which disputes are centred. The systems $\langle \mathcal{G}_n \rangle$ have the following properties:

1. There is a unique minimal admissible set U_m in $\mathcal{G}_n$ that contains Φ.
2. The size of U_m is exactly $m + 1$, with $m = O(n)$.
3. The number of arguments in $\mathcal{G}_n$ is $O(n^2)$.
4. If σ_P – the argument selection strategy for P – chooses counter-arguments on the basis any of (s1–s3) then, there is a strategy for C to choose prevaricating utterances under which a partial dispute δ having
$$|\delta| \ \geq \ 2^{n^c} \text{ for some constant } c > 0$$
results ('almost certainly' in the case of s3).

[21]The precomputation in building the strategy, effectively decides that P's 'belief' in x is justified, i.e. proves that x is credulously accepted. This decision problem is, however, NP–complete, cf. [5].

[22]These concern, among others, how the functions σ_P and χ are represented in instances.

[23]For the strategy s3 which involves a randomised choice, 'always' is taken to mean 'with high probability'.

One consequence of these systems is that, even assuming each invocation of its selection function costs P a *single unit* of its resources, if the total resource, M, is bounded above by n^k (for some constant k) after some point in the sequence of systems $\langle \mathcal{G}_n \rangle$ the strategies s1–s3 all will lead to C exhausting the resource available to P before the dispute terminates with C losing.

Central to our construction is the following:

THEOREM 1. *([7, Corollary 1, Thm. 5]) There are (infinite) sequences of argument systems with arguments $\Psi \in \mathcal{X}$ not credulously accepted but with the number of moves in any* TPI*-dispute establishing such exponential in $|\mathcal{X}|$.*

In informal terms, Theorem 1 can be interpreted as follows. There are constants c, d (both greater than 0) and a sequence of argument systems $\{\mathcal{F}_n(\mathcal{Y}_n, \mathcal{A}_n)\}$ satisfying for each $n \in \mathbf{N}$: $|\mathcal{Y}_n| = dn$; there is a distinguished argument, $\Psi \in \mathcal{Y}_n$ that is *not* credulously accepted; and if $\delta = \mathrm{A}(\Psi) \cdot \eta$ is a terminated TPI-dispute concerning Ψ then $|\delta|$ is at least 2^{n^c}.

The proof of Theorem 1 is 'semi-constructive', i.e. although it does not present *explicit* systems with these properties, the manner of its proof allows such systems to be built from *known* explicit constructions, we refer the reader to [7, 23] for further details.

Rather than present three separate constructions – one for each of the strategies (s1–s3) – we present a *single* construction that has the properties desired with respect to each of these. Although the system may appear rather involved, the basic idea underpinning it is quite simple: to 'embed' the argument system $\mathcal{F}_n(\mathcal{Y}_n, \mathcal{A}_n)$ within it in such a way that P is forced by its selection strategy to attempt to defend the argument Ψ: since this is not admissible such defences will fail, however, before this is realised, P will have exhausted all of its available resource.

We present the details of the construction first and then describe the ideas behind it.

Given any $n \in \mathbf{N}$, the argument system $\mathcal{G}_n(\mathcal{Z}_n, \mathcal{B}_n)$ consists of the following set of arguments:

Z1 A set of $5n$ arguments

$$\begin{array}{l} Q_n = \{q_1, \ldots, q_n\}\ ;\ \bar{Q}_n = \{\bar{q}_1, \ldots, \bar{q}_n\} \\ R_n = \{r_1, \ldots, r_n\}\ ;\ \bar{R}_n = \{\bar{r}_1, \ldots, \bar{r}_n\} \\ S_n = \{s_1, \ldots, s_n\} \end{array}$$

Z2 A set of n^2 arguments,

$$D = \{d_{i,j}\ :\ 1 \leq i \leq n,\ 0 \leq j \neq i \leq n\}$$

Z3 A set of n arguments,

$$E = \{e_i\ :\ 1 \leq i \leq n\}$$

Z4 The arguments $\mathcal{Y}_n$ of $\mathcal{F}_n(\mathcal{Y}_n, \mathcal{A}_n)$.

Z5 Arguments Φ and t.

The attack relationship, $\mathcal{B}_n$, in $\mathcal{G}_n$ comprises,

B1

$$\begin{array}{l} \{\langle q_i, \bar{q}_i\rangle,\ \langle \bar{q}_i, q_i\rangle\ :\ 1 \leq i \leq n\} \\ \{\langle r_i, \bar{r}_i\rangle,\ \langle \bar{r}_i, r_i\rangle\ :\ 1 \leq i \leq n\} \\ \{\langle r_i, \bar{q}_i\rangle,\ \langle \bar{r}_i, q_i\rangle\ :\ 1 \leq i \leq n\} \\ \{\langle t, s_i\rangle\ :\ 1 \leq i \leq n\} \end{array}$$

B2

$$\begin{array}{l} \{\langle d_{i,j}, \Phi\rangle\ :\ 1 \leq i \leq n,\ 0 \leq j \neq i \leq n\} \\ \{\langle e_i, \Phi\rangle\ :\ 1 \leq i \leq n\} \end{array}$$

B3 The set of attacks $\mathcal{A}_n$ of $\mathcal{F}_n(\mathcal{Y}_n, \mathcal{A}_n)$.

B4

$$\begin{array}{l} \{\langle q_i, e_i\rangle :\ 1 \leq i \leq n\} \\ \{\langle \bar{q}_{i+1}, e_i\rangle :\ 1 \leq i \leq n-1\} \\ \{\langle \bar{q}_1, e_n\rangle\} \\ \{\langle q_i, d_{i,0}\rangle :\ 1 \leq i \leq n\} \\ \{\langle s_k, d_{i,0}\rangle :\ 1 \leq k \leq n, 1 \leq i \leq n\} \\ \{\langle \bar{q}_i, d_{i,j}\rangle :\ 1 \leq i \leq n, 1 \leq j \neq i \leq n\} \\ \{\langle q_j, d_{i,j}\rangle :\ 1 \leq i \leq n, 1 \leq j \neq i \leq n\} \\ \{\langle s_k, d_{i,j}\rangle :\ 1 \leq i \leq n, 1 \leq j \neq i \leq n, 1 \leq k \neq i \leq n\} \end{array}$$

B5 The attack $\langle \Psi, t\rangle$ for $\Psi \in \mathcal{Y}$ as in Theorem 1.

Before we consider the properties of $\mathcal{G}_n(\mathcal{Z}_n, \mathcal{B}_n)$ in more detail, we give an overview of its construction. Notice that the arguments of $\mathcal{G}_n$ can be considered as ordered into six distinct 'levels': the argument Φ which attacks no other arguments; the sets D and E each argument in which attacks Φ; the arguments in Q_n, $\bar{Q}_n$ and S_n which attack arguments in $D \cup E$; the arguments in R_n and $\bar{R}_n$ that interact with Q_n and $\bar{Q}_n$; the argument t that attacks each argument in S_n and is attacked by a single argument; and, finally, the system $\mathcal{F}_n(\mathcal{Y}_n, \mathcal{A}_n)$ the inadmissible argument Ψ of which is the only attacker of t, (Fig. 2)

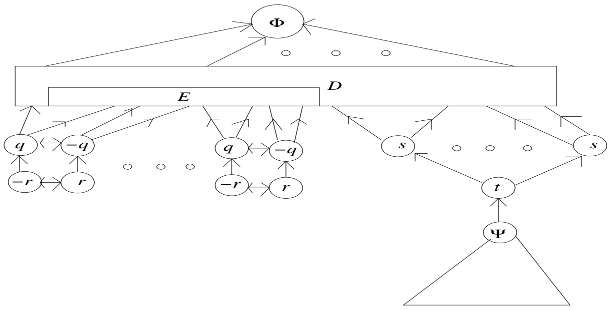

Figure 2: The System $\mathcal{G}$

Consider a TPI-dispute in $\mathcal{G}_n$ that opens with the utterance $\mathrm{A}(\Phi)$. If, C responds with $\mathrm{C}(d_{i,j})$ for some $d_{i,j} \in D$, then P must choose an argument from

$$\begin{array}{lll} \{q_i\} \cup S_n & \text{if} & j = 0 \\ \{\bar{q}_i, q_j\} \cup S_n/\{s_i\} & \text{if} & j \neq 0 \end{array}$$

Faced with these alternatives, C 'hopes' that P will play $\mathrm{C}(s_k)$ for some $s_k \in S_n$, for in this case, C can only respond $\mathrm{C}(t)$ after which P is forced to counter with $\mathrm{C}(\Psi)$: C, however, can show (after exponentially many, in n, moves) that Ψ is not admissible, thus compelling P to play $\mathrm{R}()$ conceding that the set $\{\Phi, s_k\}$ is not a subset of any admissible set. If, however, P's resources are sufficiently limited, then this point will never be reached: P will have exhausted its resource while trying to defend Ψ. We observe that for C *always* to respond $\mathrm{C}(e_i)$ only helps P: 'at worst' P might respond $\mathrm{C}(\bar{q}_{i+1})$, but this will not 'significantly' impede the progress of a dispute: if C never attacks Φ using any $d_{i,j} \in D$, then $O(n)$ utterances will suffice to terminate the dispute with a win for P.

We introduce the following notation: for an argument, x in some system $\mathcal{H}(\mathcal{X}, \mathcal{A})$,

$$\begin{array}{l} \gamma^+(x) = |\{y\ :\ \langle x, y\rangle \in \mathcal{A}\}| \\ \gamma^-(x) = |\{y\ :\ \langle y, x\rangle \in \mathcal{A}\}| \end{array}$$

THEOREM 2. *In the argument system $\mathcal{G}_n(\mathcal{Z}_n, \mathcal{B}_n)$:*

a. The set, $U_m = \{\Phi\} \cup Q_n \cup R_n$ is the unique minimal subset of $\mathcal{Z}$ that is admissible and contains Φ.

b. For all $1 \leq i \leq n$,

$$\begin{array}{lll} \gamma^+(q_i) = n+2 & ; & \gamma^-(q_i) = 2 \\ \gamma^+(\bar{q}_i) = n+1 & ; & \gamma^-(\bar{q}_i) = 2 \\ \gamma^+(s_i) = n^2 - n + 1 & ; & \gamma^-(s_i) = 1 \end{array}$$

PROOF. For (a), first observe that each argument $d_{i,j} \in D$ is attacked by q_i (if $j = 0$) or by q_j (if $j \neq 0$). Furthermore q_i attacks e_i. Thus the set Q_n attacks all of the attacks on Φ. The argument q_i is itself attacked only by $\bar{q}_i$ and $\bar{r}_i$, however the argument r_i provides counterattacks to both of these. It follows that the set U_m is an admissible set containing Φ. To see that U_m is minimal, observe that the set $U_m/\{r_i\}$ has no argument with which to counter the attack by $\bar{r}_i$ on q_i; on the other hand the set $U_m/\{q_i\}$ contains no argument which can be used to counter the attack by $d_{i,0}$ on Φ. It remains to show that U_m is the unique set of size at most $2n+1$ that contains Φ. Consider any admissible set V with $\Phi \in V$. If $Q_n \subset V$ then $|V| \geq |U_m|$ with equality if and only if $V = U_m$. So we can assume, without loss of generality, that $q_1 \notin V$. In this case, one of the arguments in S_n must be in V (in order to provide an attack on $d_{1,0}$). No argument in S_n is admissible: $s_i \in V$ implies that $\Psi \in V$ (in order to provide an attack on t), however, the construction of $\mathcal{G}_n$ ensures that Ψ is not admissible.

Part (b) is a simple counting argument from the definition of $\mathcal{B}_n$. We omit the details. $\Box$

THEOREM 3. *For $n \geq 3$, let*

$$\begin{array}{lll} \kappa(n) & = \min & \{|\delta|: \delta \text{ is a terminated TPI-dispute} \\ & & \text{over } \Psi \text{ in } \mathcal{F}_n(\mathcal{Y}_n, \mathcal{A}_n)\} \\ & \geq & 2^{n^c} \text{ for some } c > 0 \end{array}$$

and

$$\begin{array}{lll} \tau(\sigma_P, \sigma_C, n) & = \min & \{|\delta|: \delta = \text{A}(\Phi) \cdot \eta \text{ is a terminated} \\ & & \text{TPI-dispute over } \Phi \text{ in } \mathcal{G}_n(\mathcal{Z}_n, \mathcal{B}_n) \\ & & \text{when } P \text{ uses } \sigma_P \text{ and } C \text{ uses } \sigma_C\} \end{array}$$

For the strategies, (s1–s3), there are strategies, σ_C for C such that

a) $\tau(s1, \sigma_C, n) \geq n\, \kappa(n)$
b) $\tau(s2, \sigma_C, n) \geq n\, \kappa(n)$
c) $\text{Prob}[\tau(s3, \sigma_C, n) \geq \kappa(n)] \geq 1 - \exp(-n \log n)$
d) $\mathbf{E}[\tau(s3, \sigma_C, n)] \geq (n - \log n)\kappa(n)$

In the strategy (s4), i.e. that producing minimum length defences of Φ.

e) $\tau(s4, \sigma_C, n) = 4n + 1 \quad \forall\, \sigma_C$

PROOF. When σ_P is conducted according to (s1) or (s2), C responds $\text{C}(d_{1,0})$ to $\text{A}(\Phi)$. Without loss of generality the dispute is then forced to continue via

$$\text{A}(\Phi) \cdot \text{C}(d_{1,0}) \cdot \text{C}(s_1) \cdot \text{C}(t) \cdot \text{C}(\Psi) \cdot \eta \cdot \text{R}()$$

where $1 + |\eta| \geq \kappa(n)$, since η results in the argument Ψ being shown inadmissible. The utterance, $\text{R}()$ concluding this partial dispute only determines that the set $\{\Phi, s_1\}$ is not a subset of any admissible set. Thus, C can repeat $\text{C}(d_{1,0})$ on n separate occasions – each of which results in some set $\{\Phi, s_i\}$ being eliminated – before the 'correct' attack (q_1) is chosen by σ_P. This suffices to prove parts (a) and (b).

For (c), C advances the arguments $\langle d_{1,0}, d_{2,0}, \ldots, d_{n,0}\rangle$ in turn. The only way in which P avoids eventually playing $\text{C}(\Psi)$ is if it attacks $d_{i,0}$ with q_i on each occasion. The probability that this happens (assuming possible counter attacks are selected uniformly at random) is $(n+1)^{-n}$, which suffices to prove (c). Part (d) is obtained by analysing the strategy in which C plays $\text{C}(d_{1,0})$ until P finds the 'correct' response $\text{C}(q_1)$: we omit the details. Finally, part (e), follows from Theorem 2(a) and the upper bound proved in [7]. $\Box$

There are a number of points of detail concerning our construction of $\mathcal{G}_n$ which, perhaps, merit further comment. One possible objection is that – within the context of $\mathcal{G}_n$ – the selection policies (s1–s3) are rather naive: repeated evaluation of $\text{C}(\Psi)$ might be avoided by P noting that since all paths into s_i must go through Ψ and t, having dealt with one case, P would avoid playing $\text{C}(s_i)$ in response to $\text{B}(d_{1,0} \hookrightarrow \Phi)$ should this occur: in effect, after its first instantiation, the sequence $\text{C}(t) \cdot \text{C}(\Psi)$ 'says nothing new'. In addition, were σ_P to consider the 'depth' that any counter-attack might develop to within $\mathcal{G}_n$ then opting to play $\text{C}(q_i)$ or (at worst) $\text{C}(\bar{q}_j)$ appear to be better alternatives. In fact it is not difficult to modify $\mathcal{G}_n$ in such a way that neither of these options help: instead of a single argument t attacking each s_i we could introduce n distinct t_i with $\langle t_i, s_i\rangle \in \mathcal{B}_n$ and use n different 'copies' of the system $\mathcal{F}(\mathcal{Y}, \mathcal{A})$ whose inadmissible argument Ψ_i attacks t_i, so that $\text{C}(t_i) \cdot \text{C}(\Psi_i)$ constitutes 'new evidence'; secondly we can replace the arguments r_i and $\bar{r}_i$ by argument systems having 'nearly identical' structures to $\mathcal{F}$ *but* with the distinguished argument Θ in these being *admissible*.

We note that our analyses of (s1–s3) simply provide very basic lower bounds on the extent to which C can prolong the dispute. It is possible that these bounds can be increased by considering strategies in which, e.g. $\text{A}(\Phi) \cdot \text{C}(e_1) \cdot \text{C}(q_1) \cdot \text{B}(d_{2,0} \hookrightarrow \Phi)$ forms the opening dialogue fragment: the eventual retraction that results will be of the subset $\{\Phi, q_1, s_k\}$ rather than $\{\Phi, s_k\}$. Thus by carefully interplaying attacks on Φ using arguments in E with attacks using arguments in D, C may be able to force up to n^2 analyses of the argument Ψ.

These, however, are largely points of purely combinatorial interest. In Section 6 we consider in general terms to what extent the model presented is 'realistic'. Prior to this we briefly present, one example of 'successful' prevarication as a case study.

5. CASE STUDY

The case we examine is from French Civil proceedings and concerns the attempt by an association (formed in October 1951) to obtain compensation in consequence of illness occasioned by eating contaminated food. The final finding in favour of the association was given on January 21st 1965. Our discussion is summarised from the detailed account of this case and its history reported in the study by Fuller[9].

5.1 Background

On August 16th 1951 a bakery in the town of Pont-Saint-Esprit supplied its clientele with bread that was subsequently discovered to have been made with contaminated flour provided by Union Meuniere – a private monopoly. Within a few days its consumers developed severe psychological trauma[24] necessitating committal of

[24]Among which: seizures and physical convulsions; vivid hallucinations of being attacked by wild animals, snakes, and fireballs; monomania - one victim spending almost three weeks repeatedly counting the panes of glass in a window; cataleptic trances, delusions of being able to fly; and insomnia that did not respond to powerful sedatives.

the worst afflicted to psychiatric institutions. Several hundred people were affected and five deaths resulted. The official enquiry blamed the outbreak on accidental contamination of some flour sacks by a mercury-based fungicide. A number of medical experts who witnessed and treated the victims disputed this, finding instead strong evidence of the cause being ergot in a rare variant whose properties were similar to lysergic acid: in effect, the victims had been subjected to considerable doses of LSD. An association was formed to seek redress from Union Meuniere using as a test case one of the surviving victims.

5.2 Significant Factors

French judicial process prevents the instigation of any civil case while there are any outstanding criminal proceedings to be settled: this factor delayed the point at which any civil action could be started until August 1954. In French Civil Law the vendor has an implied contractual obligation to gaurantee their product – the bread in this instance – is uncontaminated, even if such contaminants may have been unknowingly inherited from other suppliers, e.g. the flour used. While the Civil Code distinguishes concepts of 'good/bad faith' these do not extend so far as separating liability: in both cases the vendor is responsible for the damages resulting from the product's use. In consequence the civil code did not permit Union Meuniere directly to be sued: the process required the association to seek damages from the baker who sold the contaminated bread and he, in turn, would have to seek redress from Union Meuniere. Although both actions were dealt with simultaneously, the Union Meuniere defence team could argue that their client should only be held responsible for those cases in which a direct link between the flour supplied and the symptoms resulting was established: the official finding of the cause being a mercury-based fungicide was strongly backed by Union Meuniere (since traces of this could be argued as having arisen from containers) whereas the ergot theory was disparaged as this would imply negligent quality control of the flour distributed.

The conflict between the official findings and medical opinions suited Union Meuniere's case, but that such a disagreement should arise seems (from a present-day viewpoint) surprising. Several difficulties were faced by the proponents of ergotism: outbreaks were extremely rare – the most recent medical studies available dated from the late 19th century; ergot derivatives had been adapted for clinical use but the study of their properties was a highly-specialised field with only a handful of individuals aware of contemporary research. The lack of knowledge of current work created what turned out to be the major difficulty in defending ergotism as a cause of the outbreak: for the symptoms resulting, given its known properties ergot mould would have to be present in such quantities as to render bread clearly inedible. The research of Hoffman and Stoll whereby lysergic acid was obtained from an active agent in ergot was not widely known of in the early 1950s: the fact that minute traces of lysergic acid would be sufficient to occasion the outbreak witnessed was never seriously considered during the official enquiry.[25]

The association bringing the action was funded by member subscription (and a small number of private donations). Financing the legal costs was a constant problem throughout the case history. More significantly the symptoms suffered improved considerably over the course of several years. By 1960 very little evidence remained of these and furthermore symptoms consistent with mercury poisoning were never evident whereas those only explicable by ergotism had been: the active chemical agent in ergot, however, was extremely unstable and even if administered in large quantities rapidly became almost undetectable.

The trial at which the liability of the Union Meuniere was assessed did not start until October 10th 1957 with judgment given against them in April 1958. An appeal court confirmed this ruling two years later, with the supreme court concurring with this finding in January 1965. Despite these no compensation was ever paid by Union Meuniere to any of those affected.

5.3 Aims and Strategy

In defending the action three aims were pursued with the ultimate intention of exhausting both the funds and stamina of the association members: to deny any responsibility for the outbreak; to promote the findings of the official enquiry; and, if needed, to force independent medical assessments of damages.

A number of legal devices were employed to delay the eventual verdict. In the criminal proceedings two Union Meuniere suppliers were under investigation: the legal team succeeded in having the two granted bail but did nothing to expedite the criminal enquiry which, in consequence, did not deliver its findings until 1954. The civil case - originally scheduled to start in May 23rd 1957 - was delayed by almost six months: an objection lodged on the 16th May challenging the court's jurisdiction and requesting more time to prepare creating the delay. The court decision reached in April 1958 effectively ruled Union Meuniere were liable to pay damages to all affected by the outbreak. Intending to appeal, the monopoly refused to pay the procedural costs necessary for the judgment to be finalised. Thus, the association in order to move the legal process forward had to meet these costs itself: the ruling could not be enforced or the appeal heard until these were settled. The appeal hearing in 1960, although superficially confirming the 1958 findings, added one significant qualification: that Union Meuniere should only indemnify damages paid to victims whose symptoms were consistent with mercury poisoning as assessed by a medical tribunal. The costs of the clinical tests were to be borne in the first instance by those seeking compensation. A deadline was set by which to register for these, however, on its expiry in February 1962 not a single association member had complied. A final appeal by Union Meuniere was dismissed in the French Supreme Court in early 1965 by which time only the single test case had been settled: the baker required to pay compensation having had the expense covered by his professional guild.

6. DISCUSSION

Our model uses a scenario whereby one agent endeavours to 'exhaust' the limited resources of another, whilst itself possessing 'unlimited' resource. In such 'civil suits' where the penalty of losing a case may considerably outweigh the potential expenditure of pursuing it, we might argue that this scenario is reasonable: thus, the cost to Honeywell (and other computer manufacturers) had Sperry-Rand's patent claim been endorsed would have vastly exceeded the cost invested in their pre-trial preparation.

In fact we may give examples of situations where one agent makes a *deliberate* judgment to pursue a 'questionable' course of action employing the following informally phrased strategy:

[25] Hoffman and Stoll's accidental synthesis of LSD via an ergot-based alkaloid and their investigation of its properties had taken place in the late 1940s at a Swiss pharmaceutical company. On reading contemporary reports of the events in Pont-Saint-Esprit both had considered the possibility of their laboratory synthesis occuring naturally and subsequently contacted medical teams investigating the outbreak. Due to intransigence on the part of the local authorities, flour and bread samples were not provided for analysis until late 1952 by which time ergot derived agents would no longer have been traceable.

> "I wish to carry out action X since this will benefit me. Although X may be challenged – and is likely to be deemed invalid – the cost of mounting such an attack is prohibitively expensive, is *not guaranteed* to be successful in the first instance, and it is 'well-known' that I have sufficient resources at my disposal to appeal against any unfavourable ruling. I can therefore proceed to perform action X, since no party is 'likely' to question it in these circumstances."

Thus, under this process, an agent is making an assessment of 'risk' before proceeding. We note the superficial similarity of this tactic to the concept of '*cheap talk*', cf. Matthews[16], in the setting of economic models of rational debate: one player promotes a position by a threat to act in a particular manner if this position is not adopted, e.g. an upper legislative chamber indicates it will block all bills passed by a lower chamber unless particular measures in its interest are established. In this latter setting the threat may contain an element of bluff and as such may not be enacted. In the strategy outlined earlier, however, the protagonist intends to proceed with a 'hostile' action. One can cite several examples of this in practice. In the U.K., where the media do not enjoy protection similar to that provided in the U.S. through the 1st Amendment, but where rights to privacy are not as extensive as, for example, under French jurisdiction, editors are often faced with deciding whether to publish an article that could be regarded as libellous by its subject: reasons for not proceeding with publication concern the notoriously high damages and costs that have recently been awarded by U.K. juries finding against newspapers; reasons for publishing the story are, of course, to increase sales. In deciding whether to proceed with publication a key factor is the likelihood of the 'libelled' individual taking action: thus, if the story, concerned someone known to have significant financial means and who was 'sensitive' about their public image, it is probable that publication would be put off; on the other hand, if it concerned an individual with 'limited' resources, publication might well go ahead.[26]

These interpretations of 'limited resource' are given in terms of 'financial limits': thus, recognising that instantiating and preparing legal proceedings are costly activities so that an agent with significantly greater resource at its disposal may seek to exploit such to the detriment of those less well-off. There is, in addition, an implication that the conduct of a dispute may develop over several levels of appeal, counter-appeal etc. It is worth noting, however, another class of instances where 'enforcing' a 'protracted dispute' may prove beneficial to an agent even when it contends with another possessing equal (or, indeed, more extensive) resources. In contrast to our examples above, arising from 'civil cases', the relevant examples for these come from the sphere of criminal proceedings. It is a requirement in many judicial codes that prosecuting agents must prove their case 'beyond reasonable doubt': if a verdict of guilty is to be returned by a jury (under English Law) the prosecuting counsel's case must convince at least ten out of twelve jurors 'beyond reasonable doubt' of the defendant's culpability. This requirement can, in certain types of case, be exploited by skilled defence counsel to increase the chance of their client being acquitted or, at worst, forcing a re-trial since the jury cannot agree a verdict.

In cases where evidential matter involves great technical complexity proof 'beyond reasonable doubt' can create two significant problems for prosecutors: a jury will almost certainly have no specialist familiar with the area at issue, thus unless the case is made in detail using non-technical language, may fail to understand or appreciate the prosecution points; on the other hand, such a presentation is likely to be lengthy and may antagonise jurors (if they feel they are being 'talked down' to) or bore them. For example, one reason given by prosecuting authorities for failing to obtain any convictions following the collapse of the Maxwell business empire, was that the jury had failed to understand the complexities of a case presented over a trial lasting a number of weeks; similar reasons were advanced for the acquittal verdicts in the first prosecutions brought under the 1990 Computer Misuse Act. A notable example of how such complexities have been used is the late George Carman's defence of the popular British entertainer Ken Dodd on charges of tax evasion: Carman has commented that the prosecution case, although presented with great skill, came close to losing the jury's interest as it ran on for over three weeks; in contrast the defence was completed in a matter of days, deliberately set out to be 'entertaining', and resulted in acquittal.[27]

These two mechanisms exploit 'limited resources' in rather different ways from that underlying the structures considered earlier: in the former a potentially 'indefensible' action is executed predicated on the *assumption* that, since its executor's ability to exhaust limited resources has been 'advertised', no agent will (be in a position to) challenge; in the latter, by requiring an agent to present each significant aspect of its case in detail, the intention is to 'exhaust' the limited resource (patience, interest etc) of some *arbitrating* party. Within our setting using Dung's argument systems and the procedural device of TPI-disputes, it is possible (albeit, somewhat naively) to accommodate this by considering multi-agent 'societies' in which some members are distinguished as 'arbiters', for the purpose of determining the outcome of *partial* disputes. Certainly one would not 'realistically' expect such agents to have unlimited 'patience', i.e. to be dedicated to reviewing partial disputes of 'excessive' length, and thus not only the structure of a partial dispute itself but also its length may prejudice the opinion of some arbiters. In such settings, it would be of interest to examine a number of issues concerning how overall decisions are determined, e.g. by simple majority (as available to juries under Scots Law) or by minimal level majority (as in English Law) and the strategies that agents might adopt in trying to influence the adjudication of partial disputes.

As one final collection of issues we note that in the agent 'society' context the scenarios outlined over the preceding pages are concerned with strategies that might be employed by '*argumentative*' agents. Taking the example class of argument systems $\mathcal{G}_n$ discussed above, in the case of two agents 'co-operating' in the discussion over Φ, an 'altruistic' Challenger would be more disposed always to advance $e \in E$ as a potential attack on Φ but would (particularly if aware of the inadmissibility of Ψ) avoid asserting $d_{i,j} \in D$. Given the aim of attempting to exhaust an opponent's resources, the strategies described within the proof of Theorem 3 can, in a more general sense, be thought of as 'entrapment' techniques: manipulating the proponent of a thesis into adopting a line of defence that benefits the challenging agent.

7. CONCLUSIONS AND FURTHER WORK

In this article our principal aim has been to outline a framework for the conduct of persuasion dialogues in which one party attempts to use legitimate techniques in order to prolong the discussion of

[26]It should be noted that, in the U.K., 'legal aid' is not available to pursue actions for libel, nor, currently, can such cases be accepted on the basis of 'no win, no fee' arrangements.

[27]Significantly, this defence did not contest any of the *factual detail* that had concerned the prosecution, concentrating on instead on arguing that no intentional conspiracy to defraud existed by creating a picture of the defendant's naive and chaotic approach to financial matters.

a disputed thesis. Our motivation ultimately derives from the exploitation of such methods in legal process. While we have concentrated on the TPI-protocol of [24] within the argument systems of [6] in order to provide a concrete setting for the ideas discussed, we note that similar instantiations could be defined for other persuasion formalisms. We have presented a number of examples whereby a challenging agent – armed with sufficient knowledge of the proposer's defence strategy – can prolong a 'lost' dispute to the point where the proposer exceeds some defined limit for its resources. We conclude by briefly reviewing some aspects of the ideas developed that may merit further study.

In addition to the purely combinatorial question of how great a gap can result between the optimal length dispute and that resulting through following a particular argument selection strategy, the main analytic questions of interest concern the computational complexity of PUP and PUPLR. We noted earlier that in order for such issues to be dealt with sensibly, some care is needed with respect to the exact formulation of these decision problems. It would be of interest, however, to answer these questions even with respect to a *single* 'well-defined' argument selection strategy, e.g. the mechanisms s1 or s2 dealt with above. Of greater interest, however, is the following. Our analysis has focused on demonstrating (constructively) the existence of prevaricating challenge strategies for a certain class of argument systems, but the issue of approaches to synthesising such strategies in general is important regarding how effective such methods could be in practice. Of relevance to these issues is how the *number* of 'distinct' admissible sets containing a given argument affects disputes: an important feature of the construction $\mathcal{G}_n$ in Section 4 is that there is exactly one minimal subset containing the argument Φ, thus C's choices can be seen as engineering a dispute through which P's selection strategy avoids adding elements of this unique set to its 'commitment' state, $\Sigma(\delta)$. Where there are 'multiple' defences of an argument, one would expect the ability of C to prevaricate to be greatly reduced. The issues above, represent just a small selection of questions of interest regarding the concerns of this paper: more detailed analysis of these will be the subject of future work.

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