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Abstract. As governments seek to consult their citizens over matters of policy, it becomes increasingly important that citizens receive the relevant information in a medium that they can, and will, want to use in forming their opinion upon consultative issues. This report presents argumentation support systems and sample eParticipation application scenarios of these systems, in order to assess their potential contribution to the consultation process. The systems presented cover techniques for the presentation of complex information in a thematically arranged format, for identifying those issues that generate a significant response, for collating consultation responses and representing them within an argument structure, and for checking upon the consistency of contributions to a debate. As such, argumentation support systems have something valuable to offer both government and civil society.

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Executive Summary

Argumentation Support Systems are computer software for helping people to participate in various kinds of goal-directed dialogues in which arguments are exchanged. Their potential relevance for eParticipation should be readily apparent, since the goal of eParticipation is to engage citizens in dialogues with government about such matters as public policy, plans, or legislation. Surely argumentation plays a central role in this process. In a public consultation, for example, citizens are given an opportunity to not only make suggestions, but also support these suggestions with arguments.

Typically eParticipation projects make use of generic groupware systems, such as discussion forums and online surveys. These generic groupware systems, however, do not provide specific technical support for argumentation. For example, they provide no way for a citizen to obtain a quick overview of the issues which have been raised, to list ideas which may have been proposed for resolving such issues, to see in one place the arguments pro and con these proposals, or to get an idea about which positions currently have the best support given the arguments put forward thus far in the dialogue. These are just a few of the kinds of services offered by argumentation support systems.

This report provides an introduction to the theory of argumentation; summarizes prior work of the leading research groups on modelling argumentation and supporting argumentation with software tools; describes various prior applications of argument support systems, mostly in research pilot projects; and presents a number of eParticipation application scenarios for argumentation support systems, as a source of ideas for future pilot projects.

A number of argumentation support systems and associated tools are presented. Some of these focus on the visualization of arguments and here the graphical notation and user interface are important features. Others focus on providing analysis of the situation but typically with a more limited graphical user interface. A number of underlying argumentation models are used including those based on Issue-Based Information Systems (IBIS) and the diagramming method developed by Wigmore for mapping evidence in legal cases. In considering their relevance to eParticipation, we need to consider the features needed to support informed debate to support evidence-based policy-making. The systems presented allow users to access various levels of information, to be able to focus on specific information and to have the ability to organize the gathered data to construct an effective argument – all of which are required for eParticipation.

In eParticipation, there is a clear requirement to better understand how technology can support informed debate on issues but there are two main obstacles in achieving this. The first is that the deliberation is typically on complex issues and therefore there are typically a large number of arguments and counter arguments to consider which when presented in linear text can be confusing for the public at large. Secondly, it is not obvious that many people actually have the necessary critical thinking skills to deliberate on issues. It can be seen that the type of argumentation support systems and tools described in this report have the potential to add value to current eParticipation methods. This is explored further in the section on eParticipation scenarios.

As governments seek to consult their citizens over matters of policy, it becomes increasingly important that citizens receive the relevant information in a medium that they can, and will, want to use in forming their opinion upon consultative issues. This report presents sample eParticipation application scenarios of argumentation support systems in order to assess the potential contribution these systems can make to the consultation process. They cover techniques for the presentation of complex information in a thematically arranged format, for identifying those issues that generate a significant response, for collating consultation responses and representing them within an argument structure, and for checking upon the consistency of contributions to a debate. As such, they have something valuable to offer both government and civil society.

1 Introduction

Argumentation Support Systems are computer software for helping people to participate in various kinds of goal-directed dialogues in which arguments are exchanged. Their potential relevance for eParticipation should be readily apparent, since the goal of eParticipation is to engage citizens in dialogues with government about such matters as public policy, plans, or legislation. Surely argumentation plays a central role in this process. In a public consultation, for example, citizens are given an opportunity to comment on draft legislation. These comments will not only contain suggestions for changes, but also support these suggestions with arguments. In some other forms of eParticipation, such as those founded on the ideal of deliberative democracy, other participants are offered an opportunity to view and respond to such arguments with further arguments of their own.

Typically eParticipation projects make use of generic groupware systems, such as discussion forums and online surveys. These generic groupware systems, however, do not provide specific technical support for argumentation. For example, they provide no way for a citizen to obtain a quick overview of the issues which have been raised, to list ideas which may have been proposed for resolving such issues, to see in one place the arguments pro and con these proposals, or to get an idea about which positions currently have the best support given the arguments put forward thus far in the dialogue. These are just a few of the kinds of services offered by argumentation support systems.

The idea of using argumentation support systems for eParticipation is not entirely new. Arguably the idea can be traced back at least to Horst Rittel's pioneering work in the early 1970s on Issue-Based Information Systems (Rittel 1973). Rittel was not a computer scientist but rather a city planner. His idea of an Issue-Based Information System (IBIS) is essentially a visual map of arguments, to help people to collaborate to find solutions to what he called "wicked problems", by which he meant problems which have no algorithmic, scientific or objectively optimal solutions for a variety of reasons, including the lack of consensus among stakeholders about such things as utilities and values. He recognized that city planning, like public policy and legislative development in general, was essentially a social, dialectical process of trying to resolve conflicting goals, values, interests and positions.

One of the first European eParticipation research projects, GeoMed (Geographical Mediation Systems, IE2037), which began in 1996, long before the term "eParticipation" had been coined, aimed to help citizens to participate in city planning by integrating an IBIS-based argumentation support system, Zeno, with a web-based geographical information system (Gordon 1995, Gordon 1996, Gordon 1997). A later version of Zeno served as the technical foundation of the eParticipation platform developed in another European project, DEMOS (Delphi Mediation Online System, IST-1999-20530), which ran from 2000-2004 and was successfully piloted in the cities of Hamburg and Bologna (Gordon 2002, Richter 2002).

The remainder of this report is organized as follows. The next section provides an introduction to the theory of argumentation and an overview of the prior work of leading research groups on modelling argumentation and supporting argumentation with software tools. Next is a section describing various prior applications of argument support systems, mostly in research pilot projects. We then return to the subject of eParticipation by presenting a number of eParticipation application scenarios for argumentation support

systems, as a source of ideas for future pilot projects. Finally, there is a section recapitulating the main conclusions.

2 Overall Description of Technology

Argumentation Support Systems cannot be understood or evaluated without some appreciation of the theory of argumentation. Moreover, software tools should be based on carefully considered computational models of the application domain and its tasks, according to the principles of good software engineering. For these reasons, our description of the technology of argumentation support systems has two parts: the first part outlines the theory of argumentation, primarily from the perspective of the field of philosophy, and introduces various efforts to develop formal, computational models of argumentation within computer science; the following section focuses on more applied computer science research by presenting software tools which have been developed for supporting various argumentation tasks, such as argument visualization and mediation systems.

2.1 Argumentation Theory

In 1962, Carl Adam Petri, the renowned German computer scientist and inventor of Petri Nets, said (Petri 1962): "Now is the time to shift our view of computers from communications medium to negotiation medium, from knowledge processing to interest processing". Considering that the first email systems had just been invented in 1961 and that the ARPANET computer network, the predecessor of the Internet, did not appear until 1969, this was quite a remarkable statement for the time. Petri anticipated that computer networks would not only be used as a communications medium, for transferring data from place to place, but also provide some kind of intelligent support for helping people to resolve conflicts of interest when confronting practical problems.

Practical problems are problems requiring some action to be taken to achieve goals and promote values. Such problems range from the trivial, such as deciding what to cook for dinner, to the global issues of our time, such as how to preserve the environment or prevent the further proliferation of nuclear weapons. Theoretical problems, in contrast, are concerned with how best to acquire and organize our knowledge of the way the world works. Whereas theories can be revised or replaced at any time, practical decisions typically have consequences, once they have been acted upon, which cannot be undone.

Existing information and communications technology is of limited use for helping people to solve practical problems. Algorithms require the problem to be "well-defined" and perfect input data to produce correct results, following the principle of "garbage in, garbage out". Automatic theorem provers are similar; they may be able to tell us if some premises are inconsistent or what conclusions are entailed by the premises, but they provide no support per se for constructing or challenging the premises. Large databases, particularly loosely coupled and distributed databases such as the World-Wide Web, can provide access to enormous amounts of data, but the informativeness of this data can be questionable and it may be practically impossible to find relevant information or determine its quality (c.f. "information overload"). Knowledge-based systems can provide useful support in narrowly-defined technical domains, but are too expensive to build and maintain for helping with everyday problems requiring common sense ("knowledge acquisition bottleneck"). Also, support systems based on decision theory

make strong assumptions about knowledge of the dimensions of the problem space and consensus about the utility curves which are unrealistic for most practical problems.

Typically, when confronted with a practical problem, there is both too much and not enough information, the decision must be made within a limited period of time and other resources such as personnel and money can also be scarce. The expected value of the outcome is usually not high enough to warrant the development of special purpose software. Opinions will differ about the truth, relevance or value of the available information. Arguments can and will be made both for and against and proposed solutions. Reasoning is "defeasible", i.e. further information may require some conclusions to be retracted or make some other solution appear more promising. Value judgments about ethical, legal, political, business or even aesthetic issues are at least as important as objective facts or knowledge about the problem domain. Various stakeholders, with divergent interests, may be affected by the decision. Negotiation may be necessary.

The purpose of Argumentation Support Systems is to support and facilitate the making of practical decisions under such circumstances. The aim is to help assure that the decision-making process is efficient, transparent, open, fair and rational. Not coincidentally, these goals have much in common with the goals of "good governance" and e-participation (Malkia 2004).

The theoretical subfield of computer science which studies the foundations of Argumentation Support Systems is young and goes by many names, such as Computational Models of (Natural) Argumentation or Computational Dialectics. Much work has been conducted as part of Artificial Intelligence, especially in the interdisciplinary field of Artificial Intelligence and Law.

The concepts of dialectic and argumentation are closely related. The ancient Greeks recognized and studied three normative sciences: logic, rhetoric and dialectic. In modern terms, logic is the study of consequence and inference relations between declarative sentences; rhetoric is the study of effective communication and dialectic is the study of norms and methods for resolving conflicting views, ideas and opinions. Argumentation straddles rhetoric and dialectic: whereas rhetoric is concerned with how to select and present arguments, dialectic addresses the question of how to organize the process of exchanging and evaluating arguments in goal-directed dialogues. Whereas the term "argumentation" emphasizes the process of exchanging and evaluating arguments in dialogues, the term "dialectic" emphasizes the process of resolving conflicting arguments (pro v. con), interests (proponent v. opponent) and ideas (thesis v. antithesis). The conflict of interests between two parties can be generalized to dialogues with more than two stakeholders, as is often the case in the context of e-participation.

Thus far our aim has been to introduce the topic of argumentation support systems and demonstrate its relevance for e-participation. In the remainder of this section we present an overview of the modern theory of argumentation, from the field of philosophy, and a summary of computer science research on computational models of argumentation.

This brief overview of the modern philosophy of argumentation is based on Douglas Walton's recent textbook, "Fundamentals of Critical Argumentation" (Walton 2006), beginning with the concept of an argument. An argument links a set of statements, the premises, to another statement, the conclusion. The premises may be labelled with additional information, about their role in the argument. Aristotle's theory of syllogism, for example, distinguished major premises from minor premises. The basic idea is that the

premises provide some kind of support for the conclusion. If the premises are accepted, then the argument, if it is a good one, lends some weight to the conclusion.

The goal of argumentation is often described as discovering or determining the "truth" of some claim, where a claim is a statement which has been asserted by some party in the dialogue. When the claim is about a factual or theoretical issue, this may make sense, at least as an ideal. However, when the issue being discussed is about what action to take in order to solve some practical problem, this characterization of the goal of argumentation is more problematical. If for example, in an e-participation context, the plan of a city to build the airport is being subjected to public review, one would not ordinarily characterize this as being an issue of truth or falsity. The question is not whether the plan is true, but whether it is good, acceptable or well-advised.

For this reason, among others, the goal of argumentation is to determine the acceptability of claims, rather than their truth. In the case of factual claims, ideally only true claims would be acceptable. Given unlimited resources, the argumentation should conclude that a factual statement is acceptable if and only if it is true. But in practice, resources will typically be limited and we will often have to decide whether or not to accept claims with less than complete certainty about their truth. Consider criminal cases, to take a familiar example, where a person can be convicted of having committed a crime when the evidence is conclusive "beyond all reasonable doubt". Although this is a high standard of proof, it does not require complete certainty.

Good arguments provide reasons for accepting their conclusion, the conclusion need not be a logical consequence of the premises. Logical consequences are necessary, by virtue of their form, irrespective of their content. Arguments, in contrast, are substantive and "defeasible". They are substantive because they depend not only on the form of the premises, but also their content and acceptability. And they are defeasible because their conclusions are only plausible, not certain, and may be defeated in various ways by additional information, for example by revealing implicit premises which turn out to be untenable or by bringing forward better counterarguments. In the field of Artificial Intelligence, this property of argumentation is known as "nonmonotonicity", a term borrowed from mathematics.

As just suggested, some premises of arguments may be implicit. For the sake of efficiency, the norms of argumentation do not require all premises to be made explicit, at least not immediately. For example, premises which are thought to be common knowledge, or otherwise already accepted by the other participants, are typically left implicit. "Socrates is a man, therefore Socrates is mortal" to use a standard example, is a perfectly understandable argument, even though the major premise "All men are mortal." has been omitted. Implicit premises can be revealed and possibly challenged during the dialogue as necessary.

There are many different kinds of arguments and much research has gone into discovering and classifying various patterns of argument, based on an analysis of the structure and content of arguments reconstructed from natural language texts. These patterns of argument have come to be called "argumentation schemes". Although they are the result of empirical case studies, they also have a normative side. They are a useful tool both for guiding the reconstructing of arguments put forward by other parties, so as to open them up to critical analysis and evaluation, as well supporting the construction ("invention") of new arguments to put forward in support of ones own claims or to counter the arguments of others.

Argumentation schemes generalize the concept of an inference rule to cover plausible as well as deductive and inductive forms of argument. Argumentation schemes are conventional patterns of argument, historically rooted in Aristotle's "Topics" (Slomkowski 1997). Unlike inference rules, argumentation schemes may be domain dependent. Each scheme comes with a set of "critical questions" for evaluating and challenging arguments which use the scheme. For example, the scheme for argument from expert opinion includes a critical question about whether the expert is biased. Argumentation schemes are useful for several purposes, including reconstructing and classifying arguments, criticizing arguments, and as templates for making new arguments.

Since argumentation schemes may be domain dependent, there are an unlimited number of such schemes. Domain dependent schemes, in fields such as the law, may evolve along with the knowledge of some domain. Many schemes, however, are general purpose. Walton and his colleagues have taken on the project of collecting and classifying general purpose schemes. To date their collection contains about 60 schemes. Examples include Argument from Expert Opinion, mentioned previously, Argument from Popular Opinion, Argument from Analogy, Argument from Correlation to Cause, Argument from Consequence, Argument from Sign and Argument from Verbal Classification.

When evaluating arguments put forth in a dialogue, one issue is the "validity" of the argument. An invalid argument has no weight, i.e. provides no support for its conclusion. But how shall validity be defined? In classical deductive logic, an inference is valid if and only if the conclusion must logically be true if the premises are true. This conception of validity is too stringent for arguments, since these only provide plausible support for their conclusions. Nonmonotonic logics strengthen the consequence relation to support consequences which are only plausible. Consequences in nonmonotonic logics are defeasible: it may be that some consequence of a set of premises is not a consequence of some superset of these premises. That is, additional information may require plausible conclusions to have to be retracted.

Nonmonotonic logics retain however the relational approach of argument validity of classical logic: whether or not an argument is valid depends only on the relationship between the set of premises and the conclusion. Walton's theory of argumentation, however, takes a more contextual, procedural view of argument validity: an argument is "valid" if and only if it furthers the goals of the dialogue in which it is put forward. From this perspective, the validity of an argument can depend on the state and history of the dialogue. To give a practical example: an argument in favor of some proposal made during the brainstorming phase of a deliberation might be valid during the process of selecting some of these brainstorming ideas for a more in-depth evaluation in the next phase of the deliberation, but not valid in this later phase if this particular proposal had not been selected. To sum up: from a dialectical perspective, whether or not an argument is valid depends on how it is used in a dialogue, not merely on the relation between its premises and conclusion.

Whether or not an argument has been used properly or furthers the goals of the dialogue, depends also on the type of dialogue. Walton has developed a taxonomy or "ontology" of dialogue types, as illustrated in Figure 1.

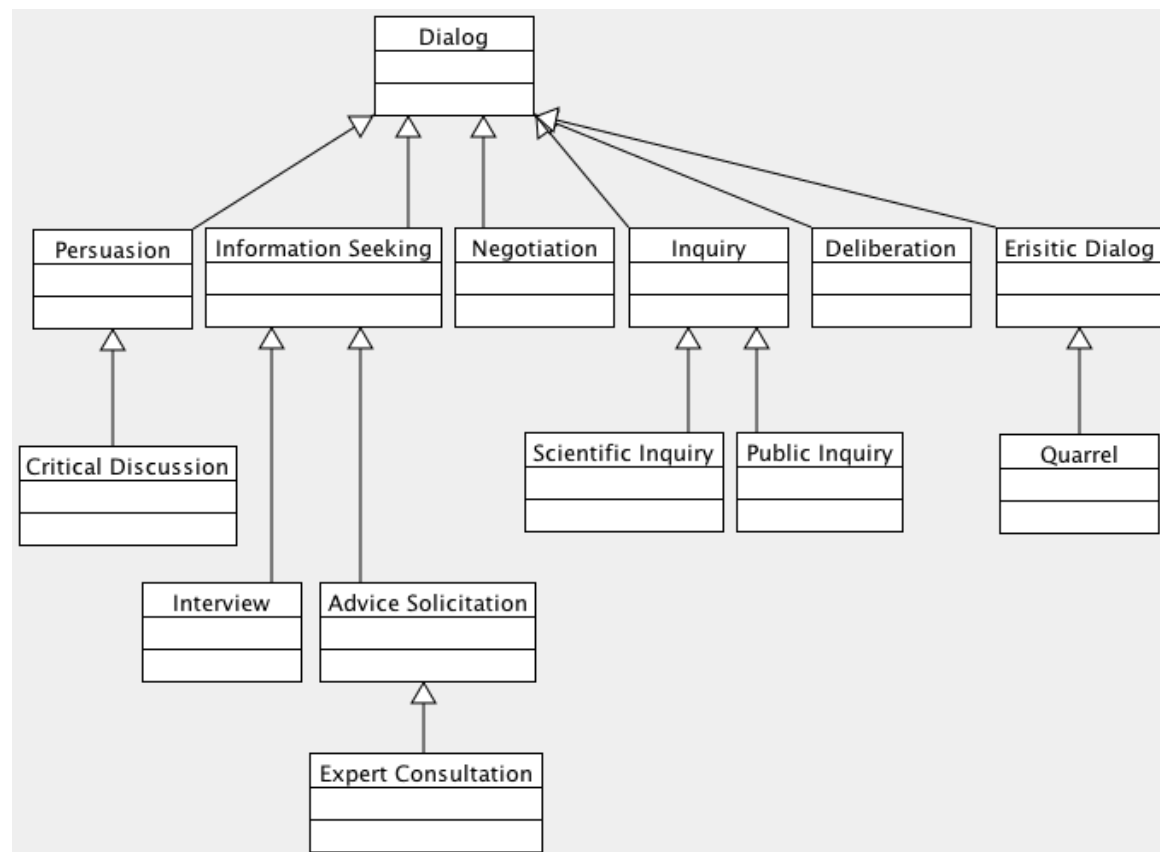


Figure 1: Taxonomy of Dialogue Types

Persuasion dialogues debate the truth of some statement. One party, the proponent, claims that some statement is true. The other party, called the respondent, challenges this claim. There are several subtypes of persuasion dialogues. In a "dispute", the respondent not only challenges the proponent's claim, but also claims some opposing, contradictory statement to be true. The roles in a dispute are symmetric. The proponent and respondent each have a burden of proof, for their respective claims. More common, however, is the "dissent" form of persuasion dialogue, in which the respondent only doubts the proponent's claim, but makes no claim of his own. In a dissent, the proponent has the burden of proof and must produce the stronger arguments. The arguments of the respondent need only be strong enough to cast doubt on the proponent's claim.

Although the dialogue types are usually described as involving two parties, they can be generalized to any number of parties. More important than the number of participants is their roles in the dialogue. Several participants could share a role.

An information seeking dialogue has the goal of seeking advice. The starting point is not the assertion of some claim, as in persuasion dialogue, but rather the asking of a question. Expert consultations, for example with medical doctors or lawyers, are a subtype of information seeking dialogues.

The goal of negotiation dialogues is to make a "deal", i.e. to reach an agreement on how to exchange such things as goods, services or money. The starting point is neither a question nor a claim, but rather an offer. This can be accepted by the other party or modified in a counteroffer.

An inquiry is a methodical investigation of some matter, to explain or understand some observations or data. Scientific inquiries try to explain natural phenomena by developing

hypotheses and constructing, evaluating and comparing scientific theories. Public inquiries investigate such things as accidents or crimes. The starting point of an inquiry consists of the observations in need of explanation. These observations are not being called into question, unlike the claim of a persuasion dialogue. The question is not whether these observations are true, but how best to explain them.

Deliberation dialogues are about choosing some course of action which takes into account the interests of multiple stakeholders. In a deliberation, one of the first tasks is to identify the stakeholders and their interests. They may not all be participants in the dialogue, at least not initially. And it may not be practical for every stakeholder to take part in the dialogue personally. Stakeholders may need to be represented by others. A common mistake in deliberation is for participants to make and try to defend specific proposals at too early a stage in the dialogue. It is usually better to first spend time trying to identify the stakeholders and understand their interests. Brainstorming may come next, in which ideas are freely collected but participants are not supposed to commit themselves yet to particular proposals.

So-called "eristic" dialogues, from the ancient Greek word meaning wrangle or strife, is an emotional kind of dialogue in which the participants vent their anger, frustration or other deep feelings. Eristic dialogues are considered by some to be irrational and to have no other goal than to "argue for the sake of argument". Walton's view, however, is that such dialogues can serve a positive, "cathartic" function and that they are, like the other kinds of dialogues in his typology, guided by norms, even if these norms are quite relaxed compared to the other dialogue types. For example, the basic civility norms requiring participants to do such things as take turns and give each other a fair opportunity to express their views, remain in force.

Actual dialogues may be mixtures of these various types and a dialogue may shift from one type to the other and back. For example, during a negotiation a salesman may make some claims about the product that might be called into question by the customer, causing a temporary shift to a persuasion dialogue. Similarly, in a deliberation, once the stage has been met to evaluate specific proposals, each such evaluation could take the form of a persuasion dialogue.

What kinds of dialogues are relevant for e-participation? The field of e-participation distinguishes various forms or degrees of "citizen-engagement", such as consultation and deliberation. In a consultation, the government publishes draft plans or legislation and provides citizens with an opportunity to submit comments, but not an opportunity to view or discuss each others comments or to engage the government in a true dialogue. These comments may range from merely casting doubt on the government's draft, criticizing it with arguments against the proposal or, at the other extreme, contain proposals for changes to the draft, supported by arguments. Such consultations are probably best classified as information seeking dialogues, in terms of Walton's typology. The government is seeking information from citizens. Deliberative democracy is some form of deliberation dialogue, but the particular characteristics of deliberative democracy, which distinguish it from general-purpose deliberation dialogues, require further study. As for eristic dialogues, surely when open, unmoderated discussion forums are made available for e-participation, there is a risk that some dialogues will be of this type.

Dialogue types are defined along several dimensions: the purpose or goal of the dialogue, the roles of the participants, the speech acts available, the termination criteria, a process model and a "protocol" for regulating this process. Dialogue types in argumentation theory are normative models of communication. If argumentation dialogues are viewed as

games, then the participants are its players, the speech acts its moves, and the protocol defines its rules.

Speech acts are uses of natural language in dialogues, such as asking questions, making claims, putting forward arguments or counterarguments, making concessions or retracting claims. The protocol defines the pre- and postconditions of these speech acts, to regulate when a speech act may be made and, if it is allowed, with what effect. This may depend on the stage of the process and the state of the dialogue, taking into consideration the prior history of the dialogue, i.e. what has already been said.

In addition to defining the preconditions and postconditions of speech acts, the protocol will include rules regulating such things as termination conditions (When is the dialogue finished?), commitments rules (When does a party become committed to some statement?), proof standards (How are the arguments pro and con some statement to be balanced, weighed or otherwise aggregated for each issue?), and finally the distribution of the "burden of proof". There are various kinds of proof burdens to consider: the "burden of questioning" regulates whether some statement can be assumed to be true so long as it has not been called into question; the "burden of production" regulates which party is responsible for producing arguments or evidence suggesting that some presumption may not hold; and the "burden of persuasion" regulates which party must have the stronger arguments when the time comes to make a decision. Usually the same party will have both the burden of production and the burden of persuasion. But this is not always the case. In criminal law, for example, the defense has the burden of production for any exceptions to crimes, such as self-defense in murder cases, but the prosecution has the burden of persuasion, even for such exceptions. Thus, to continue with the murder example, the prosecution has the burden of persuading the court that the killing was not done in self-defense, once the defendant has produced sufficient evidence to meet his burden of production.

2.2 Computational Models of Argumentation

This section provides an overview of computer science research on modeling argumentation. Computational models of argumentation are formal models designed for use in specifications of argumentation support systems. These are mathematical models, using such mathematical tools as set theory and formal logic. What makes such a mathematical model "computational" is its intended use as a foundation for computer applications. Thus, computational properties, such as decidability and computational complexity are relevant. Computational models can also themselves be represented in software, using high-level functional or logic programming languages. These "executable specifications" facilitate the empirical testing and evaluation of the models.

It will be helpful for structuring this presentation of computational models to first take a look at the various kinds of argumentation tasks we would like these models to support. Based on prior analyses of argumentation tasks and their interrelationships (Brewka 1994, Prakken 1995, Bench-Capon 2003), we distinguish the following four layers:

- The "logical layer" is responsible for representing statements and argumentation schemes into order to construct or generate arguments by applying argumentation schemes to a "knowledge base" of statements.

- The "dialectical layer" is responsible for structuring, evaluating and comparing arguments which have been put forward during the dialogue, and informing participants about the status of statements and arguments given these arguments. We also will include the task of "reconstructing" arguments from natural language texts in this level.
- The "procedural layer" is responsible for supporting the process of argumentation, facilitating and guiding the dialogue, to help assure its achieves its normative goals. This layers includes the facilitation tasks of moderators and mediators. One of these tasks is to help participants to obey procedural rules, i.e. the argumentation protocol for the applicable dialogue type. This task in turn requires keeping track of the commitments of the participants in the dialogue.
- Finally, the "rhetorical layer" is responsible for helping participants to "play the game" well. Whereas the procedural layer facilitates the normative goals of the dialogue, this layer provides a private advisor to each participant, analogous to an attorney, to help participants protect and further their own interests. Tasks here include selecting among arguments which could be made and presenting these arguments clearly and persuasively, taking into consideration the intended audience, perhaps using argument visualization techniques. We have also placed the decision-making task of the authority with power to make decisions at this layer.

Figure 2 is a "use case" diagram showing these tasks, divided into the above layers, together with the abstract roles responsible for each task. In concrete situations, one person may have more than one role, some roles may be combined or some roles may need to be distinguished further. For example, in lawsuits the judge may have the moderator role and share the authority role with a jury.

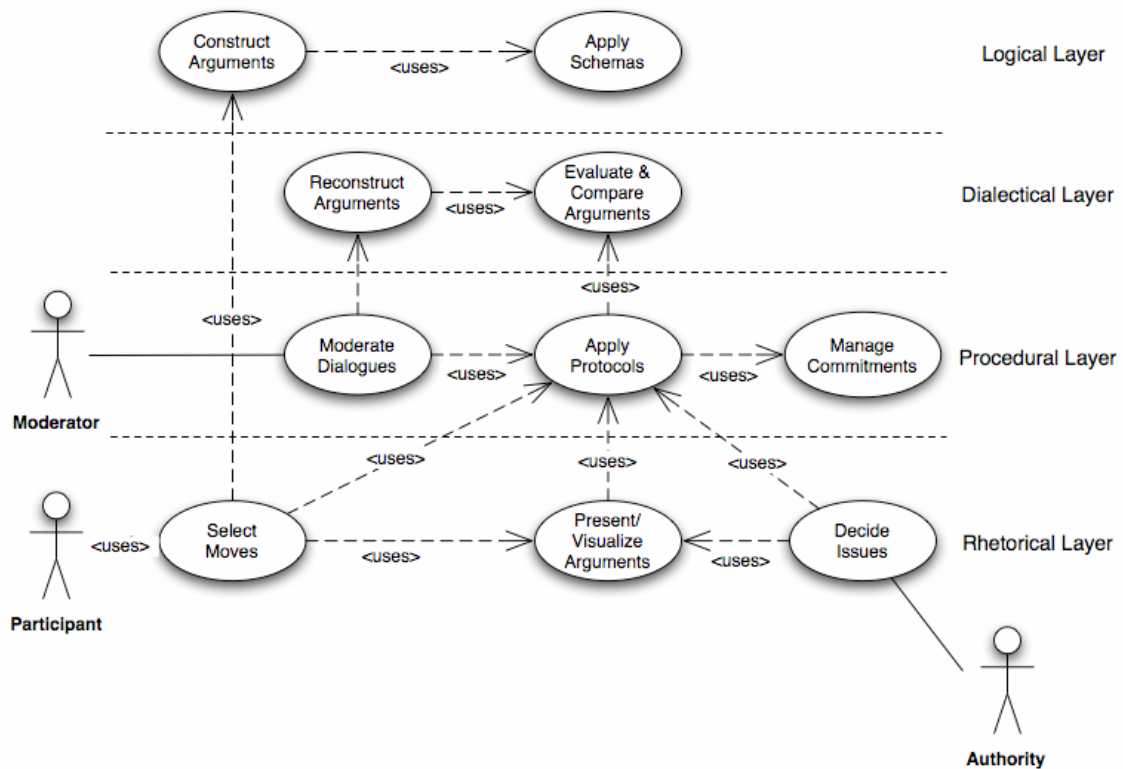


Figure 2: Argumentation Use Cases

Let us now begin our review of computational models of argument, starting with the logical layer. Again, here the task, broadly stated, is to construct arguments by applying argumentation schemas to some representation of evidence, facts or knowledge of the domain. The field of Artificial Intelligence (AI) is relevant here (Russell 2003). In mainstream AI, argumentation schemes have not typically been studied as such, explicitly. But AI research on such topics as knowledge representation, nonmonotonic logics, case-based reasoning, reasoning under uncertainty, and machine learning can all be understood, retroactively, as efforts to construct computational models of various argumentation schemes. Moreover, the theory of argumentation schemes provides a framework for understanding how the seemingly diverse forms of reasoning studied by AI can be combined and integrated. For example, research on computational models of legal reasoning in the field of Artificial Intelligence and Law was long divided between case-based and rule-based approaches. But, increasingly, argumentation theory is seen within AI and Law as a way to synthesize these approaches. Prakken has produced a survey of computational models of various argumentation schemes from the field of Artificial Intelligence and Law (Prakken 2005), which was a helpful reference for the work presented in this section. See also (Bench-Capon 2003; Bench-Capon 2006).

The topic of case-based reasoning in AI can be understood as attempts to construct computational models of the scheme for arguments from analogy and related schemes. The first research on case-based reasoning was probably within the interdisciplinary field of AI and Law, at around the time this field was forming in the late 1970s. McCarty's TAXMAN model (McCarty 1977) was one of the seminal works in the field. McCarty's approach to case-based reasoning, based on the idea of constructing and comparing theories of a line of cases, was much ahead of its time. According to this theory-construction model, the better arguments from cases are the ones based on the better, i.e. more "coherent", explanatory theory of those cases.

Probably the most influential computational model of case-based reasoning is Ashley's HYPO model (Ashley 1990). In HYPO, cases are represented as a set of "dimensions", where each dimension includes information about which party is favoured in each direction of the dimension. For example, in the trade secrets domain, the dimension of disclosure favours the defendant, i.e. the party who allegedly violated a trade secret, the more the plaintiff company has disclosed the (so-called) secret to third parties. HYPO formalized the relation of "on-pointedness". One precedent case is more "on-point" than another precedent case if the first case has more dimensions in common with the current case. Arguments were constructed in HYPO by searching for analogous cases, cases with dimensions in common with the current case, which had been decided in favour of the desired party, plaintiff or defendant. (This depended of course on the role of the party trying to construct the argument.) The other party can then try to construct counterarguments, either by distinguishing the current case from precedent case, i.e. by pointing out differences between the two cases, or by searching for more on-point cases in his favour. HYPO is named after its model of reasoning with hypothetical cases. Hypotheticals are imaginary cases, constructed for the sake of argument. Typically, they are variations of the current case, constructed to test proposed interpretations of legal rules or principles. For example, if a party proposes some rule, perhaps by generalizing the decision of some precedent case, the other party could try to construct a hypothetical case showing that this proposed rule leads to some unintuitive or otherwise undesirable result.

The CATO model of case-based reasoning (Alevan 1997), both simplified and extended the HYPO model. It simplifies HYPO by replacing dimensions by boolean "factors", i.e. propositions which are either true or false in a case. But CATO extends HYPO by organizing these factors into a hierarchy and using this hierarchy to support additional case-based argumentation schemes, in particular schemes for arguments from "downplaying" and "emphasizing" distinctions. A distinction between a precedent case and the current case is downplayed by showing that factors present in both cases have a common ancestor in the hierarchy and arguing that the precedent case is more general, applying to all cases in which this more abstract, common factor is present. For example, if the precedent case involved deception but the current case bribery, one might downplay the distinction between deception and bribery by noting they are both illegal means of obtaining information and arguing the precedent applies to all such illegal means, not just deception.

Other influential models of case-based reasoning in the AI and Law field include GREBE (Branting 2000) and CABARET (Skalak & Rissland 1992). GREBE used semantic networks, the forerunner of ontologies modelled using Description Logic, currently popular in the context of the Semantic Web, in its model of case comparison. CABARET modelled the use of cases to construct arguments about open-textured concepts and included models of argumentation schemes for broadening and narrowing the application of legal rules using cases. Both GREBE and CABARET were early attempts to model an argumentation framework in which argumentation schemes for arguments from both rules and cases could be used together, in an integrated fashion. See also (Prakken & Sartor 1998). Gardner's early model of legal reasoning (Gardner 1987) also needs to be mentioned in this context. Although it was primarily a model of schemes for arguments from rules, it also included scheme for arguments from cases, called interpretation rules, which were applied to open-textured concepts, "when the rules ran out". Loui and Norman (1995) developed a computational model of another case-based argumentation scheme, for arguments from the "rationale" of the case. The scheme exposes

presuppositions of the rationale of a case and then argues that these presuppositions do not apply in the present case. For example, in a precedent case which decided that vehicles are not allowed in public parks, there may be a presupposition that the vehicles in question are privately owned. If in the current case the vehicle is not privately owned, this argumentation scheme could be applied to construct an argument that the precedent does not apply. Finally, Bram Roth developed a model of case-based argumentation which also makes use of rationales, represented as reconstructions of the dialectical structure of the arguments in the published opinions of the cases (Roth 2003). In Roth's account, the arguments in a precedent case are applied to the facts of the current case. If the current facts provide at least as much support for the conclusion of the precedent case, considering its arguments, then the conclusion of the precedent case presumptively also applies to the current case. The scheme modelled by Roth is known as argument "a fortiori" (from the stronger argument).

Next we want to address computational models of schemes for arguments from defeasible rules or, as Walton calls them, defeasible generalizations. In the law, the idea of applying rules, by trying to "subsume" the facts of the case under the legal terms of the rule, is quite basic. In the legal philosophy known as "mechanical jurisprudence", this process was thought to be purely deductive. In some early work in the field of AI and Law, this same insight led to experiments with using theorem provers or rule-based systems to build legal expert systems based on first-order logic (Sergot 1986). This approach is adequate for some application scenarios, especially in public administration, and is the basis for most commercial legal knowledge systems today. But models of rules based on classical logic are not well suited for capturing the defeasibility of arguments from rules, since rules can be subject to exceptions, overridden by others rules, or invalid. Nonmonotonic logics have been developed in AI to model reasoning with defeasible rules, but typically these logics do not address the issue of how to integrate reasoning with defeasible rules with other forms of plausible or presumptive reasoning, such as case-based reasoning. Argumentation-theoretic models of reasoning with defeasible rules can overcome these limitations. One influential argumentation-theoretic model of arguments from rules is Hage and Verheij's "Reason-Based Logic" (Hage 1997; Verheij 1996). Other models of defeasible arguments from rules were developed by Gordon (1995), as part of his Pleadings Game model of legal argumentation, and Prakken and Sartor (1996).

When arguments conflict, some way is needed to resolve these conflicts. Some models of argumentation include a "built-in" method for resolving these conflicts. For example, several models always prefer arguments from cases to arguments from rules (Gardner 1987, Branting 2000, Skalak & Rissland 1992). Similarly, some nonmonotonic logics, such as Conditional Entailment (Geffner 1993) always prefer the more specific argument. A more general solution is to support argumentation about argument priorities or strengths (Gordon 1995; Prakken & Sartor 1996; Hage 1996; Verheij 1996; Kowalski & Toni 1996). These priority arguments may apply higher-level principles, such as *lex superior* (prefer the rule from the higher authority), *lex posterior* (prefer the newer rule) and *lex specialis* (prefer the more specific rule), which may themselves be defeasible.

Computational models of argumentation schemes for reasoning with evidence have long been neglected. One of the first models (Lutomoski 1989), represented a number of argumentation schemes for arguments from statistical evidence in the domain of employment discrimination law, including critical questions. Chris Reed, Douglas Walton and Henry Prakken have more recently been working together on computational models of arguments from evidence (Prakken 2003, Bex et al, 2003, Prakken 2004), based on

John Pollock's work on a scheme for argument from perception and related schemes (Pollock 1987).

In (Bench-Capon 2002), Bench-Capon analyzed the role of purpose ("teleology") when interpreting a body of case law, motivated by the seminal paper by Berman and Hafner (1993), which identified limitations of the HYPO approach to case-based reasoning in the law. Bench-Capon's central idea is that the rules and rule preferences cannot be derived solely from factors in precedent cases, but must also be informed by the purposes of the rules, i.e. by the values promoted by the rules. Shortly thereafter, Bench-Capon, in collaboration with Sartor, developed this basic idea into a theory-construction model of legal argument (Bench-Capon & Sartor 2003). In this model, legal theories are constructed from precedent cases in a process which takes values and value preferences into consideration to derive and order rules, which may then be applied to the facts of cases to reach decisions. This theory construction approach, first advocated in AI and Law by McCarty (1977), can be viewed as a complex argumentation scheme. The scheme is complex compared to other case-based schemes, because it depends not only on the features of a single case, but rather an analysis of a whole line of cases. The idea of the scheme is to construct a theory capable of explaining the decisions in this line of cases and then to apply this theory to the facts of the current case. Of course several competing theories are possible. Thus the scheme can produce several competing arguments. The conflict between these arguments is resolved by comparing these theories: the better the theory, the better the argument. Which theory is better, or most "coherent" can be debatable and thus an issue to be addressed by further argumentation. There are different criteria for evaluating the quality of theories. Bench-Capon and Sartor address the issue of how to define and model coherence in (Bench-Capon & Sartor 2003). And in (Bench-Capon & Sartor 2001), they present quantitative metrics of theory coherence. See also (Hage 2001). Atkinson (formerly Greenwood), Bench-Capon and McBurney (Atkinson 2005) did further work on modelling teleological reasoning in the law, in which they develop a formal model of the argument scheme for practical reasoning, based on Bench-Capon's Value-Based Argumentation Framework (Bench-Capon 2003). Also relevant for the question of how to model arguments from purpose and values, is Bruce McLaren's thesis (McLaren 1999), in which he develops a formal model of ethical arguments from cases.

Before moving on to models of the dialectical layer, let us say a few words about the role of "classical" knowledge representation in AI for argument construction. The mainstream approach to modelling knowledge uses various subsets of first-order logic, sometimes a couple of subsets in combination. Currently popular is to use a decidable subset of first-order logic, such as Description Logic (Baader, 2003), to model terminological knowledge ("ontologies") and to use some complementary, rule-based, subset of first-order logic to handle knowledge which cannot be expressed in the decidable subset used to model terminology (Russell 2003). This is the approach taken by the World Wide Web Consortium with the Web Ontology Language (McGuinness 2004) and the Semantic Web Rule Language (Horrocks 2004). Since argumentation schemes generalize inference rules of deductive logic, in principle inference engines for knowledge bases expressed in first-order logic, or some subset thereof, may be used to construct arguments, where the arguments represents a formal, deductive proof. Although such reasoners, being limited to first-order logic, are not sufficient for modelling defeasible argumentation, they can be used to construct arguments which can then be compared with, and perhaps defeated by, arguments constructed using other argumentation schemes. For example, arguments from two different OWL ontologies could be pitted against each other. If they are two different

versions of the same ontology, the principal of *lex posterior* could be applied to prefer the argument from the newer version. Or some model of theory coherence could be used to prefer the argument from the more coherent ontology.

Recall that the "dialectical layer" is responsible for structuring, evaluating and comparing arguments which have been put forward during the dialogue, and informing participants about the status of statements and arguments given these arguments. The idea of developing a computer model for managing support and justification relationships between propositions goes back to research on truth and reason maintenance systems in AI, beginning with Jon Doyle's Truth Maintenance System (Doyle 1979). Probably the most famous system of this kind is Johann de Kleer's Assumption-Based Truth Maintenance System (de Kleer 1986). Some nonmonotonic logics, those with an argumentation-theoretic semantics, can be viewed as providing the services of the dialectical layer. Examples include Loui's model of defeat among arguments (Loui 1987), Pollock's OSCAR system (Pollock 1987), which includes an explicit model of relationships between propositions and arguments called "inference graphs", Vreeswijk's work on defeasible dialectics (Vreeswijk 1993), the assumption-based model of defeasible argumentation of (Bondarenko 1997), Prakken and Sartors argumentation-based logic with defeasible priorities (Prakken & Sartor 1997), Verheij's DefLog system (Verheij 2003), and the argumentation semantics for Nute's Defeasible Logic (Nute 1994) developed in (Governatori et al. 2004). An overview of logics for defeasible argumentation is provided by (Prakken & Vreeswijk 2002). Dung's abstract model of argumentation frameworks, which defines the acceptability of arguments solely in terms of an attack relation among arguments, has been extremely influential (Dung 1995), in part because he was able to prove how many prior nonmonotonic logics could be reconstructed as instances of his abstract model. Prakken, however, has argued that Dung's abstract model is not capable of modelling distributions of the burden of proof (Prakken 2001). Prakken and Sartor (2006) have shown that it is important to distinguish between three kinds of burdens (the burden of questioning, the burden of production and the burden of persuasion). And the question of who has some burden must be distinguished from the proof standard used to evaluate whether this burden has been met. Freeman and Farley (1996), were the first to model proof standards, based on such legal proof standards as *scintilla* of evidence, preponderance of the evidence and beyond reasonable doubt. The Zeno Argumentation Framework (Gordon & Karacapilidis 1997) included a model of argument graphs which used such proof standards to evaluate the dialectical status of statements. Zeno, however, did not distinguish the three kinds of burdens of proof. A recently developed successor of Zeno, called Carneades, in addition to supporting variable proof standards, on an issue-by-issue basis, uses three kinds of premises (ordinary premises, assumptions and exceptions) and information about the dialectical status of statements (undisputed, at issue, accepted or rejected) to allow the three kinds of burden of proof to be allocated (Gordon & Walton 2006).

The first formal models of the "procedural layer" in philosophy were by Hamblin (1970), Rescher (1977) and Mackenzie (1979), but these were not computational. They formally defined protocols for various kinds of argumentation dialogues, in the form of games. One could also mention Lorenzen and Lorenz's Dialog Logic, which is a formal dialogue game for constructing proofs in intuitionistic logic (1978). (From the viewpoint of argumentation theory, this is rather ironic, since intuitionistic logic is even more strict than classical logic about the inferences it allows.) Krabbe (1985) provides a survey of formal systems of dialogue rules up until 1985. Walton and Krabbe (1995) developed a formal model of commitment rules for dialogues. Commitment is one of the fundamental

concepts which needs to be handled by a model of dialogue. The basic idea is that a party becomes committed to the premises and conclusions of any arguments he puts forward, as well as to any claims of the other party he concedes. In many formal models of dialogue, these commitments are managed in a so-called "commitment store". One issue to be addressed by the model is to what extent a party should become committed to logical consequences of his explicit commitments. One of the first computational models of argumentation dialogues was Gordon's Pleadings Game (Gordon 1995), which is an idealized model of the process of pleading in civil law cases in common law jurisdictions. The pleading phase is the first phase of a law suit, before trial. Essentially, the goal of pleading is to identify the legal and factual issues to be resolved by the court at trial. Other computational models of dialogue followed shortly thereafter, including Hage's procedural model about how to decide hard cases (Hage et al. 1994), Dialaw (Lodder 1999) which is based on Reason-Based Logic (Hage 1997; Verheij 1996), the Toulmin Dialogue Game (Bench-Capon 1998), which as its name suggests is based on Toulmin's argumentation scheme (Toulmin 1958), and Prakken's formal model of Dutch civil procedure (Prakken 2001), which focuses on modeling the allocation of burden of proof and the role of the judge. Also worth mentioning in this context is the Prakken and Gordon's computational model (1999) of Robert's Rules of Order (Robert 1915) for parliamentary assemblies.

Except for the topic of argument visualization, relatively little research has been done on computational models of the rhetorical layer, which is responsible for selecting arguments to put forward and other moves, and presenting arguments clearly and persuasively, taking into consideration the standpoints, values, commitments and beliefs of the intended audience. However, two chapters of the book "Argumentation Machines" (Reed and Norman 2003) address this issue. The first chapter, entitled "The Persuasion Machine" (Gilbert et al. 2003), presents a high-level description of an argumentation support system, based on insights from computational linguistics, which focuses on rhetorical tasks. Although informed by computational linguistics, this work is too abstract to be considered a computational model, and this presumably was not the authors' intention. Rather, it is a high-level sketch of various rhetorical tasks, i.e. a use-case analysis, together with some initial ideas about how to support these tasks using computer systems. The second chapter, entitled "Computational Models of Rhetorical Argument" (Crosswhite et al. 2003) sounds like it might present a survey of prior research on this subject, but actually presents a new computational model of the rhetorical level, based upon the philosophy of argument in "The New Rhetoric" (Perelman & Olbrechts-Tyteca 1969) and using McCarthy and Buvac's Context Logic (1998) to model audiences. This model is contrasted with prior work by Das et al. (1997), which uses rhetorical argument schemas to select arguments. Interestingly, both of these models are from the multi-agent systems community. Bench-Capon's Value-Based Argumentation Framework (2003) also needs to be mentioned here, since it uses a model of the value preferences of an audience in its evaluation of the acceptability of arguments.

One of the first argument visualization methods was developed by Wigmore, for visualizing the evidence in legal cases (Wigmore 1940). The diagramming method Toulmin used in his "Uses of Argument" (Toulmin 1958) has been very influential. But the argument diagramming method developed by Beardsley (1950) and refined by Freeman (1991) has become the de facto standard in the humanities. Conklin's gIBIS system (Conklin 1988), based on Rittel's idea of an issue-based information system (Rittel & Webber 1973), was perhaps the first computational model designed for visualizing arguments. More recently, a number of software applications for visualizing arguments

have been developed, such as Araucaria (Rowe & Reed 2003), some of them as commercial products. Araucaria and other tools for visualizing arguments are covered in more depth in the next section of this report.

2.3 Argumentation Support Tools & Associated Research Groups

Douglas Engelbart, inventor in the 1960s of much of today's interactive personal computing tools, draws attention to the need for tools to tackle the "complex, urgent problems" facing society. Forty years on, he has concluded that central to meeting this challenge are argumentation support systems to help clarify the nature of the problems, and scaffold dialogical negotiation of ways forward (Engelbart, 2003). In this section we describe various examples of argumentation support tools.

Some have been developed as an educational resource, both as a means of delivering information but also as a means of teaching critical thinking skills. The legal domain requires its students to develop critical thinking skills and make effective use of argument, therefore it is not surprising that a large number of tools have their roots in this domain, being developed as 'argumentation assistants' for the legal profession. Others have grown within a commercial domain in response to the demands of arriving at, and presenting, strategic decisions within a large, dispersed business community. However, that is not to say that background determines suitability; for instance, 'Reason!Able' has been employed to resolve a dispute, but is also used for the instruction of critical thinking; similarly, 'Compendium' has been used in an informative role, even though its roots are firmly in commercial real-time problem solving.

Bex, Prakken, Reed and Walton (2003), although focusing on the legal domain, usefully consider two distinct types of argumentation support tools. That is those which contain knowledge about a problem domain and can perform reasoning to suggest solutions to the problem, for example dialogue and mediation tools, and those they term 'sense-making' systems (Kirschner et al, 2003) which do not support reasoning but rather structure the problem typically using visualization and may also support logical computation and communication between users of the system, i.e. argument mapping tools. Graphical visualization, through various forms of argument maps, has the potential to help people to create better arguments and analyses. The majority of the systems in this section can be considered to be of the sense-making type, however, some for the legal domain e.g. CATO and PLAID have associated case bases which can be interrogated.

We do not claim that this is an exhaustive survey but it does indicate the breadth of work being undertaken in the development of argumentation support tools. For each argumentation support tool we provide a general description of the system and, if available, the URL where either the tool can be downloaded from or where further information is available. We then briefly describe each tool by considering: the underlying argumentation model it uses, the type of user interface it presents, the domain it has been predominantly used in.

The systems are listed in alphabetical order.

2.3.1 Argue! and ArguMed

<http://www.ai.rug.nl/~verheij/aaa/index.htm>

Argue! was developed in 1998 by B. Verheij at the University of Groningen, The Netherlands. It can be considered as a sense-making tool. Verheij himself describes it as an ‘argument-assistance system’ which is meant to support, rather than replace, the reasoning process of the user (Verheij 1998). The system was further developed into ArguMed (Verheij 2000). It is an aid in the drafting and generation of arguments, performing such tasks as: administration of the argument process; tracking issues raised and assumptions made; tracking of reasons, conclusions and counterarguments; evaluating the extent to which statements are justified; and checking that users comply with the argument rules.

ArguMed provides graphical structuring for argumentation with a user interface supporting a click and drag metaphor to allow the user to decide whether their input is an assumption, issue, reason or attack. The system then decides whether an issue is justified, not justified or neither. Further details of this work can be found in Verheij (2005).

2.3.2 Araucaria

<http://araucaria.computing.dundee.ac.uk/>

This is an argument mapping tool developed by the University of Dundee, UK (Rowe et al 2003). It is used for analysing arguments where the user is supported in reconstructing and diagramming an argument. There is a simple point-and-click interface. The software supports several different diagramming methods, including Toulmin diagrams and the Beardsley/Freeman "standard" diagramming method.

It provides a user-customisable set of schemes with which to analyse arguments. The latest version of the tool supports Wigmore diagrams, a technique of presenting legal arguments in a diagrammatic form which was introduced into the legal academies in the 1930's (Wigmore 1931). This argumentation scheme provides for ‘propositions’ and ‘assertions’, or relations, such as ‘supports’ and ‘challenges’.

A more recent publication discusses the use of the Araucaria to support the teaching of philosophy students (Rowe et al 2006).

2.3.3 Belvedere

<http://lilt.ics.hawaii.edu/lilt/software/belvedere/index.html>

This is an argument mapping system that has been designed to support problem-based collaborative learning scenarios, using evidence and concept maps, to teach middle and high school students critical enquiry skills. It was originally developed by Dan Suthers while at the University of Pittsburgh. He is now at the University of Hawaii at Manoa where the system has been further enhanced.

Belvedere is an issue-based argumentation system and supports multiple representational views (tables, hierarchies and graphs) on evidence models and provides support for concept maps and causal models. Users can construct ‘inquiry diagrams’ from a ‘palette’ of icons that represent different types of statements – such as ‘hypotheses’ and ‘data’ – and different types of linkages to indicate relationships between statements – such as ‘for’

and ‘against’. The linkages are colour-coded (green indicating a ‘for’ linkage, red indicating ‘against’) and their thickness can be altered to represent level of belief.

In the process of diagram construction, students working together develop social skills necessary for group problem-solving. They can also compare their maps to ‘model solutions’ provided by their teachers.

2.3.4 CATO and CATO-Dial

Both systems were developed by University of Pittsburgh to teach law students about the use of case-based legal argument. The first version of the system, CATO (Case Argument TutOriial), used didactic explanatory dialogue. Students have to develop a position choosing cases presented to them by the system. If they choose a poor example, the system alerts them to the fact and provides an explanation for why that particular case is of no value.

The newer version, CATO-Dial, takes a courtroom simulation approach using dialectic argument, the idea being that students would acquire skills more effectively when engaged in rôle-play, since the learning context would then be more appropriate to those hoping to practice law. The student acts as advocate in a case, selecting argument moves from a menu. The system acts as judge to mediate the proceedings, and as opposing counsel to expose any weaknesses in the student’s argument. It also provides an online help facility for the student to access when their argument goes badly.

CATO is perhaps one of the most popular systems to teach legal argument skills. It is based on previous work of Ashley, i.e. the HYPO model of legal argumentation, which provides an overall framework, argument forms: citation, response and rebuttal and a set of argument moves that can be made within the framework. It has been trailed extensively with law students (Aleven and Ashley, 1994).

2.3.5 Compendium

<http://www.compendiuminstitute.org>

Compendium is an argument mapping system that uses the issue-based information system for indexing and structuring discussions. It has been used for a number of years for commercial real-time problem-solving; originally, applications were concerned with business process re-design. The Compendium tool was designed to overcome some of the known limitations of the QuestMap tool (see below), though it has now grown substantially in scope to include integration with other tools, open source development and generally be more focussed towards use in research..

The system allows for considerable customization of the argument maps by the users and supports outputs in multiple document formats. Elements of a discussion are represented as ‘queries’ and ‘responses’, to which qualifying remarks can be attached indicating ‘support for’, or ‘criticism of’ that contention. Using hyperlinks, users can associate relevant documents with particular nodes to back-up any references. It is also possible to partition the discussion into a series of linked maps, which has the advantage of breaking-down large amounts of data into manageable portions.

Being based upon a MySQL database, users can perform searches upon the information contained in the nodes, thereby facilitating the extraction of information contained in the

maps. Describing the full functionality of Compendium is beyond the scope of this report, however the Compendium website provides extensive information (Selvin, 2003).

2.3.6 Dialaw

<http://cli.vu/~lodder/dialaw/> and <http://cedire.org/>

This is a dialogue game for two players. It is an issue-based system developed by Arno Lodder who is currently at the Computer/Law Institute of the Vrije University Amsterdam (Lodder and Herczog 1995). The idea behind the game is to allow two people to state what they believe about a particular issue under discussion and then see where they agree and disagree. It helps users to understand how to construct logical arguments against opposing claims and also how to defend their own claims. The system allows for users to exchange statements and arguments and this dialogue is then stored and represented in a tree structure. The system supports a procedural model of legal justification.

Basically the game proceeds as follows. A player starts a dialogue (a game) with a claim and then the other player can challenge, make a new claim or concede. The game continues in this fashion with the opportunity for each player to also retract a claim. The system identifies when one player's statements logically imply a claim of the other player, in which case the player then has to concede to the claim or retract one of his statements that led to the implied commitment. The game finishes when no disagreement remains.

Dialaw is discussed, along with Gordon's Pleading Game and other dialogues and mediation systems, by Bench-Capon and Prakken (2006).

2.3.7 Hermes

<http://www.mech.upatras.gr/~nikos/index.html>

This argumentation support tool was developed under the European Commission ICTE-PAN project (Karacapilidis 2005). It is based on the Zeno system (Gordon and Karacapilidis, 1997). Hermes is aimed at supporting online group facilitation between government agencies. The developers argue that the majority of existing collaborative argumentation support systems have been designed to support face to face meetings with a human facilitator whereas what is needed for government to government collaboration is virtual support. Therefore the tool has an issue-based discussion forum with special support for argumentation.

The tool allows for the construction of a diagram of the discourse that is composed of the ideas so far expressed during the discussion. The basic elements are: 'issues' - corresponding to decisions to be made or targets to be met; 'alternatives' - corresponding to potential choices; 'positions' - these are assertions associated with an 'alternative', that provide grounds for following or avoiding that choice; and 'constraints' - these represent preference relations. Users can input their preferences to courses of action through a "position, relation, position" tuple, where an example of a relation is "less important than" or "more important than". Not only does Hermes record the users' arguments, but it also checks for inconsistencies among users' preferences, and automatically updates the discourse status according to the entire set of user input.

2.3.8 GEOMED

http://cordis.europa.eu/search/index.cfm?fuseaction=proj.simpledocumentlucene&HD_ID=1783331&CFID=169260&CFTOKEN=54309717

GeoMed (Geographical Mediation System, IE2037) was a 4th Framework Telematics European project to develop and validate an web-based groupware system to engage citizens in regional and urban planning. GeoMed integrated support for sharing documents, arguing planning issues and accessing geographical information (Schmidt-Belz et al., 1999).

GeoMed began in 1996 and was thus one of the first European eParticipation research projects, long before the term "eParticipation" had been coined. The project aimed to help citizens to participate in city planning by integrating an IBIS-based argumentation support system, Zeno, with a web-based geographical information system (Gordon 1995, Gordon 1996, Gordon 1997). A later version of Zeno served as the technical foundation of the eParticipation platform developed in another European project, DEMOS (Delphi Mediation Online System, IST-1999-20530), which ran from 2000-2004 and was successfully piloted in the cities of Hamburg and Bologna (Gordon 2002, Richter 2002). More information on Zeno can be found in Section 2.3.15 of this report.

2.3.9 Parmenides

<http://cgi.csc.liv.ac.uk/~katie/Parmenides1.html>

The 'Parmenides' system (Atkinson, Bench-Capon and McBurney 2004 and Atkinson 2006) supports consultation. It has a web-based interface to an argumentation support tool designed to facilitate dialogue between government and individuals. The system uses argumentation theory to support deliberation dialogues and helps users to apply the argumentation scheme for practical reasoning within a discussion.

Presently, it features a debate upon the invasion of Iraq as an illustration of its capabilities. The user is presented with a justification of the invasion in the form of a structured argument. They then have the opportunity either to accept the argument, in which case they are taken to a 'farewell' screen, or they are presented with a series of six possible attacks on the argument with which they can agree or disagree. The user is also able to enter a free text comment summarising their view of the debate.

By storing the users' comments on a database, it is possible to identify the strengths and weaknesses of the issue under scrutiny, thereby affording the policy makers an insight into where their views need bolstering, as well as where they can rely upon public support.

2.3.10 PLAID

This argumentation support tool, Proactive Legal Assistance, was developed at the University of Liverpool, UK to teach law students how to develop argument-based briefs as answers to policy questions. (Bench-Capon and Staniford, 1995 and Bench-Capon et al, 1998). PLAID is based on a modified form of the argument schema developed by Toulmin and uses a dialogue game structure. (For more information on dialogue games see Gordon, 1995).

The key features of PLAID are: access to legal sources of information which can be used with minimum adaptation for use by the system; multi-agent based architecture; and a knowledge base to support the development of an argument. The dialogue game is between the user (a law student) who asks for information as part of an argument graph and the computer which holds the entire graph. The system generates a 'brief' for the user, compiled from a number of sources comprising the system's knowledge base; these sources include statutes, leading cases, commentaries, and 'birth, marriage and death' records.

The system agents assist the user by finding information to fill the roles of required by the Toulmin schema – such as 'claim', 'data', 'backing', 'warrant' and 'rebuttal'. When the user is satisfied with their choice, a 'Rapporteur' agent generates a document in English from these arguments. This document can then be edited using a text editor, or by using Plaid's purpose-built editor that allows hypertext documents to be created and manipulated, thereby enabling the cooperative editing of texts.

2.3.11 QuestMap

<http://www.cognexus.org/id17.htm>

QuestMap was based on the gIBIS system (Conklin and Begemann, 1988) and (Conklin, Selvin, Buckingham Shum, and Sierhuis, 2003). Originally QuestMap was developed as an organizational memory and information management tool for collaborative working within a large utilities company in California. It was the company's idea to use it to support group facilitation/deliberation. Therefore, the system supported two different types of applications, supporting asynchronous collaborative information management and supporting group deliberation in face-to-face meetings.

It was based on the IBIS argument notation and provided hypertext and groupware functionality by allowing the user to create IBIS maps and lists. QuestMap used icons, or 'nodes', to represent the IBIS method elements of 'Issues', 'Positions' and 'Arguments' (supporting or contesting statements relative to a position). It was powered by a hypertext engine whose functions were accessed via an interface. The chief features were as follows: the creation of hyperlinks between maps through the copying of one node into another map; a list display of all maps or lists in which a particular node features – clicking on a list element takes the user to the particular instance of that node; additional information could be added to each node by placing text in a 'contents window' – including keyword search terms; and a search engine that could produce lists of nodes containing keywords, where those lists were themselves sets of hyperlinks. A case study on its use is provided by Conklin (2003).

This tool is no longer distributed or supported.

2.3.12 Reason!Able and Rational

<http://www.goreason.com/> and <http://www.philosophy.unimelb.edu.au/reason/>

Both Reason!Able and Rationale are argument mapping tools from the University of Melbourne. Reason!Able supports the development of simple diagrams of complex reasoning, so that the evolving argument can be visualized. The tool was developed to support deliberation through the visualization of arguments. Initially the system was intended to help undergraduate students develop their critical thinking skills, then later

progressed to support group deliberation in the workplace. The system itself does not support any analysis of the arguments but rather supports the construction and modification of argument visualizations. The Reason! project is developing a method for improving reasoning skills which is centred around Computer-Assisted Argument Mapping (CAAM) using the Reason! software learning environment.

Rationale uses colour and position to represent arguments; 'position' boxes, representing the conclusion, are white and placed at the top of the map; 'reason' and 'objection' boxes are green and red respectively, and are positioned beneath the position they support; 'rebuttal' boxes are orange, and represent an objection to an already existing objection. The argument is laid out on three levels; the top level provides the position being debated; the second level presents the reasons and objections that support or refute the position; the third level provides support to second level reasons and objections, thereby reinforcing them but not directly responding to the initial position. Users can judge the strength of an argument by evaluating its elements (whether they think the case is strong, weak or ambivalent, and whether they agree, disagree or are undecided about the position), and these judgements are represented on the map through the thickness of the lines connecting the various boxes.

For further information see van Gelder (2002 and 2003). An application using Reason!Able is presented in the following section.

2.3.13 Risk Agora

<http://www.csc.liv.ac.uk/~peter/downloads/may01/rehgmcb.doc>

This system supports deliberation about potential health and environmental risks of new chemicals among the scientific community (Rehg et al 2004). It is not intended as a real-time tool but rather to formally model and represent debates in the risk domain, as users posit, assert, contest, justify, qualify and retract claims. This activity is represented using Toulmin's model of argumentation within a dialectical framework.

Using a knowledge-base compiled from scientific data, the Agora represents debates for the following purposes: to point-out the logical implications of current scientific belief relating to a particular issue, and the consequences of alternative options; to compare the arguments for and against a particular claim, according to their respective degrees of certainty and cogency; to combine arguments for and against a claim, thereby constructing a case for it; to provide an overview of the debate for the benefit of interested observers; to support group deliberation; and to support government agencies in risk assessment and regulatory determination.

Since regulatory decisions have to be taken regardless of the completeness of the scientific knowledge of a particular issue, it is desirable for regulatory agencies to have a snap-shot of the relevant debate at any time. To enable this, the Agora defines claims according to the arguments presented for and against them. Thus 'Probable' claims are those for which no arguments have been presented that rebut or undercut the claim. Clearly, at any particular time, it is these 'probable' claims that will be of most interest to the relevant agencies.

2.3.14 Room 5

<http://www.cs.wustl.edu/~room5/>

Room 5 is a sense-making tool developed as a game to support computer-mediated defeasible argumentation which is issued-based (Loui et al 1997). It was developed at Washington University in the US, as a testbed for a semi-formal legal argumentation system that could be used by members of the public. Room 5 separates each claim into three parts: the authority for the claim, such as a legal precedent; a paraphrasing of the claim; and a formal statement of the logic behind the claim.

It supports the graphical structuring of argumentation with a rather unusual user interface in that it uses colour codes to distinguish arguments and counter arguments. It also specifically does not use arrows to show linkages but rather uses horizontal and vertical text boxes to represent argument and counter-arguments horizontally and support for arguments vertically.

The tool is primarily aimed at supporting law students and its development is based on past Supreme Court cases. It includes a data mining component to provide access to online legal texts. The law student then has to decide whether the information from previous legal text supports, attacks or re-states evidence in the current case.

2.3.15 Zeno, Dito and Diaglo

<http://zeno8.gmd.de/zeno/>

Dito and its predecessor Zeno provide advanced support for collaborative decision-making using a moderated issue-based discussion forum with special support for argumentation. Diaglo provides a graphical user interface to the systems.

Zeno supports computer-mediated defeasible argumentation (Gordon, 1996). The argumentation model is based on IBIS and aspects of the overall tool are specific to the urban planning domain, e.g. it is integrated with a geographical information system. The basic elements are issues, positions, arguments and preferences. The elements of the IBIS model can be linked together to form various argumentation graphs, for example a dialectical graph. A novel feature of the system is its ability to support inference through 'semantic' labelling of the graphs. As Gordon and Karacapilidis (1997) state:

“It transforms IBIS from a lifeless method to organize and index information into a playing field for stimulating debate. The interested parties can see immediately whether their positions are currently “winning” or “losing”, given the arguments which have been made so far, motivating them to marshal still better arguments in favor of their positions” (p17)

Zeno extended the idea of threaded discussions, in which messages are organized in an outline or tree, to the collaborative construction of more general labelled graphs. Both the nodes and links could be labelled, with labels configured by the moderator. And the graphs were not restricted to trees. Other extensions included the assignment of user defined properties to nodes and attachments, as in email attachments. Gordon and Richter (2002) describe the implemented system towards the end of the DEMOS project.

2.4 Summary

To conclude, in this section we have presented a number of argumentation support systems and associated tools. With regard to the tools, some of these focus on the visualization of arguments and here the graphical notation and user interface are

important features. Others focus on providing analysis of the situation but typically with a more limited graphical user interface. A number of underlying argumentation models are used including those based on IBIS and Wigmore diagrams. In considering their relevance to eParticipation we need to consider the features needed to support informed debate to support evidence-based policy-making. The systems we have presented here allow the users to have access to various levels of information, to be able to focus on specific information and to have the ability to organize the gathered data to construct an effective argument – all of which are required for eParticipation.

In eParticipation there is a clear requirement to better understand how technology can support informed debate on issues but there are two main obstacles in achieving this. The first is that the deliberation is typically on complex issues and therefore there are typically a large number of arguments and counter arguments to consider which when presented in linear text can be confusing for the public at large. Secondly, it is not obvious that many people actually have the necessary critical thinking skills to deliberate on issues. It can be seen that the type of argumentation support systems and tools described in this section have the potential to add value to current eParticipation methods. This will be explored further in the section on eParticipation scenarios.

3 Applications of Argumentation Support Systems

This section provides examples of the practical use of argumentation support systems in five specific domains: business and commerce, education, law, urban planning, and conflict resolution. This is not an exhaustive description of the application of such tools but rather specific applications that have direct relevance to eParticipation.

The first two examples use the Reason!able tool. As discussed in the last section, this can be classed as a sense-making tool that supports the development of argument maps. The tool supports group deliberation in face-to-face meetings and also helps students develop their critical thinking skills.

3.1 Business and Commerce

This is concerned with the pressure to resolve a difference of policy within a company and involves the use of argument mapping system in a face-to-face setting. Van Gelder (2003, pp. 108-114) recounts a case in Australia involving a dispute at a factory. From pursuing a policy of 'one person, one job', the company decided to switch to training their workforce to be able to perform more than one role. This change in working practice divided the employees, and, although discussions were vigorously undertaken, no consensus upon the matter could be reached.

Representatives from throughout the factory participated in a facilitated argument mapping exercise using Reason!Able in an attempt to resolve the impasse. The group were conducted through a map developing exercise based upon the premise that they should continue with the current policy. Once all the representatives' views had been satisfactorily recorded, the resulting map was reviewed. The visualisation clearly presented the group with an irresistible reason for rejecting this premise; if one person is wholly and uniquely responsible for a task, then when that person is unavailable, the job cannot be performed. Consequently, work dependent upon the performance of that task will be unable to continue. Hence the case for multi-skilling appeared unanswerable.

The significance of this result lies in the fact that although the group were aware of this reason all along, visualising the entire debate presented this reason within the context of all other considerations for the first time. With such a complex mesh of reasons for and against, it is too taxing to keep all the points in one's mind together, and too easy to avail oneself of a handy counter argument.

3.2 Education

Argument mapping tools have been used widely to support the teaching of philosophy students. They aim to improve the student's ability to follow arguments in a logical manner and to develop the student's critical thinking.

This example is based on research conducted at Monash University, Australia (Twardy, 2004). Twardy was concerned that the critical thinking skills of undergraduate students at Monash University were not as good as those of students at University of Melbourne. The Melbourne students were taught to map arguments using the Reason!able tool. Therefore Twardy undertook a comparative study of the methods used and to ensure an even comparison of the methods, he himself did the teaching at the two universities. The results provided strong empirical data in favour of the argument mapping method. He concludes: “Despite my own training in analytical philosophy, I feel that mapping helps me with my own thinking”.

Similar research from the Department of Philosophy at Carnegie Mellon University investigated whether using argument mapping could enhance the critical thinking skills of 139 students in an introductory philosophy course. Her research concluded that learning how to construct argument maps significantly improved the student’s critical thinking skills (Harrell 2004).

Critical thinking involves understanding an argument and being able to analyse and evaluate it. With regard to eParticipation, if we wish to develop online deliberation tools to support citizen engagement then we must also ensure that the users have the necessary skills to deliberate, both individually and in groups. Therefore the type of tools that support critical thinking have the potential to also support eParticipation.

3.3 Law

The use of symbols to represent arguments has a long history in the legal domain, going back to Wigmore in 1931 (Wigmore 1931). One important motive for thus representing legal cases was not so much to show the reasoning that led to any particular verdict, but to highlight weaknesses in a chain of argument, thereby making the verdict more or less doubtful. This critical use of argument representation is shared by current researchers in the domain of legal argumentation (for example, Bex et al 2003).

However, the application of Argument Support Systems in law is hampered by the necessity to provide any system with sufficient amounts of information for the task it is expected to perform; in the legal domain, there is simply too much knowledge required for any but the simplest routine jobs. Whilst there appears to be little prospect of overcoming this problem in the near future, it is possible to make the size of the knowledge base more tractable, yet large enough to find useful application. Thus, the ability to present legal argument clearly will be of great benefit in preliminary fact investigation, case management and mediation. It also proves its worth in legal training, not only by helping students familiarise themselves with the structure of cases, but also in teaching them the discipline of legal reasoning. The application to be considered in this sub-section relates to a study of law students using such techniques.

A research project was conducted with the aim of discovering whether or not the use of argument visualisation techniques affects the quality and type of arguments produced by second year law students, both in their course work and a final exam (Carr 2003). In the study, a test group of thirty-three students were given training in and access to a Computer Supported Argument Visualization (CSAV) tool called QuestMap™ – which was a commercial version of Conklin's gIBIS system (Conklin et. al, 1988) – whilst a control group of forty students prepared their work using traditional methods. The

students were set five problems to solve at intervals throughout the semester. A ‘model’ narrative answer was prepared, along with a mapped version that had been approved by the course professor. Using these documents, the students were able to compare their answers with the ‘model’ solution, with the control group using the narrative version and the test group using the map. At the end of the semester all students sat a practice examination.

Assessment of the impact of using QuestMap™ was based upon the measurement of three indicators: the number and types of argument structures present in the student’s answers, as defined by Toulmin’s Model of Argument; the professor’s judgement of the students’ performance in the final exam; the number of nodes created using QuestMap™ throughout the semester, indicating the extent to which skills improved with time (the higher the node count, the greater the depth of the arguments). Tests on the students indicated that there were no significant pre-existing differences between the control and test groups.

A summary of the results are as follows: the arguments of the test group did not get significantly more elaborate over time; the test group did not have a significantly different score from the control group in the practice exam. Two features of this case should be borne in mind; that the students in question were in their second year of Legal Studies and therefore had acquired experience in legal argumentation (which goes to explain why the test group quickly became proficient in using QuestMap™); that the practice exam was held a fortnight before their finals, suggesting that the students may not have spent much effort in preparation.

Whilst these results do not confirm the belief that using CSAV will improve a student’s ability to analyse legal arguments, they do provide a number of valuable insights into the effect such tools can have when used in this context. It is felt that were the same test conducted with first year students, who would be expected to lack argumentation skills, then there would be a marked improvement in those using argument support compared with those who lacked it. As it is, there is arguably a benefit to experienced students, in the sense that the tool provides support to their work, allowing them to create answers more efficiently, as well as serving as a focus for discussion. This facility is not to be underestimated; as noted by Suthers whilst researching CSAV as an aid to teaching (Suthers 1999), visual representations can promote discussion amongst students by showing clearly where openings for counter arguments occur, where the fruits of these discussions appear on the map rather than the discussions themselves. Thus the map’s function is less to record than to stimulate. As Carr says: “The software then becomes a support for the process of argumentation, rather than a representation of it.” (Carr 2003, p.92)

3.4 Urban Planning

In 1997, there was a proposal to create a residential area and high-technology ‘park’ between the cities of Bonn and Sankt Augustin. The land to be developed was reserved for agricultural use, so a change in its status was required by law before any work could proceed. Such a change meant that the plans had to be made available to the general public, and their comments taken into consideration. This provided an opportunity to implement an internet-based support system, ‘GeoMed’ (Geographical Mediation) to facilitate the process (Schmidt-Belz, Gordon & Voss 1999).

Urban and Regional planning may be characterised as having the following features: effective communication and collaboration between interested parties is essential throughout the planning process; representations of space, such as maps, are a necessary feature of the process; negotiation and decision making are crucial phases of each project. With this in mind, GeoMed was designed to make planning processes more transparent; to encourage and oversee public participation; to assist in the resolution or avoidance of conflict; and to support co-operation between planners, experts and communities. Success in these aims would have the beneficial result of making urban planning more efficient, less time-consuming and less-expensive.

To perform this function, GeoMed consists of six components:

- Shared workspaces to which owners define access rights, where members can view or upload documents to share with other members.
- A GIS viewer that allows users to pan, zoom and select layers, as well as add new layers, perform simple editing functions to graphics and annotations.
- A service whereby GIS data can be offered for sale, ordered and paid for.
- Software agents that perform notification services to users of shared workspaces and discussion fora.
- Knowledge-based system applications that allow the plans to be analysed with respect to any special regulations that apply.
- A discussion forum to provide a space for users to present their comments, queries and responses.

These components are represented as a single system that provides a number of integrated services. Thus, users of the discussion forum are able to link their comments to plans made available via the GIS viewer, thereby making any debate about features of the plans easier to comprehend.

The discussion forum employs the 'Zeno Argumentation Framework' (Gordon & Karacapilidis 1997) in order to be able to offer its users more than the simple functions of viewing and responding to messages. 'Zeno' is designed to show dependences between arguments as they emerge in the process of debate, to direct discussion onto solutions that appear to be the most promising. It also assists the moderators of the forum to monitor the propriety of comments by providing them with information on the rights and obligations of participants. Typically, an issue will be raised in the forum – for instance, the benefits of demolishing certain buildings to accommodate a new development – to which contributors will respond, providing comments for, or against. Using Zeno, it is possible to provide diagrammatic views of the issues and their associated positions, providing a clearer view of the relationship between comments. In addition, it shows preference rankings between positions thereby making it possible to judge the relative strengths of the contending solutions. This provides contributors with an immediate view on which positions are currently favoured, thereby motivating those whose opinions are 'losing' to strengthen their arguments, and guaranteeing a robust debate of the issue.

GeoMed was subjected to a two-day validation process, in which two groups were given a scenario, rôles to play and tasks to perform, followed by a discussion on the system's prospective benefits and potentials. Some months later, the opportunity arose to offer it for public use in participating in a planning project. Over a two week period, a GeoMed workspace was made available to citizens containing plans and information; a discussion forum was created where citizens could input their comments.

Some cautious conclusions can be drawn from this experience, always bearing in mind that when this project was conducted in 1997, citizens' familiarity with ICTs was a pale shadow of what it is to-day. An encouraging number of people used the workspace for information, comparing favourably with the numbers attending a public meeting. However, no-one left a comment on the discussion forum or provided feedback on the system to the project team. It is possible that the lack of communication was due to difficulties with the user interface, coupled with the novelty of the system.

Yet, this project provided many valuable points for future work, not only in the field of planning, but any system supporting group co-operation, internet mapping or public participation. These include: introducing complex systems like GeoMed into organisations will be difficult since they will not only have to accommodate novel processes, but do so within the constraints posed by the legal regulations to which regional and urban planning is subject; planning issues involve people performing different rôles, with distinct interests to promote, but if the discussion is to be of any value it not only has to be available to all but also contributions have to be made from all parties in order to provide a balanced and informed debate; systems like GeoMed run in conjunction with traditional methods, which leads to the administrative problems associated with using paper documents and electronic data.

From the experience of the GeoMed project it is evident that the relationships between and within organisations are highly complex. In this respect it is worth briefly describing a recent project, using argumentation systems to facilitate G2G collaboration for public-policy and decision-making (Karacapilidis, Loukis & Dimopoulos 2005). There are four basic discourse elements in the system; issues, alternatives, positions and preferences. 'Issues' correspond to the problems, decisions and goals. Users propose 'alternatives' for each 'issue', which represent potential choices. These choices are supported or contested by 'positions', which may also refer to other 'positions' raised in the debate. 'Preferences' provide a qualitative means by which users can assess the relative strengths of particular courses of action, and consist of the tuple (position, relation, position), where 'relation' can be either 'more important than', 'of equal importance to', or 'less important than'. Any expression of a preference may also be subject to support or criticism. User input is used by the system to construct an illustrative discourse-based knowledge graph, representing the user's arguments and any documents they wish to include supporting their opinion.

The project centred upon the question of whether or not to allow non-state universities in Greece, the outcome of which has significant implications for such institutions as government, education, the municipalities, Chambers of Industry and Commerce, the Church, the private sector, not to mention all the potential students. Four groups were chosen from this collection of interested parties, representing the Ministry of National Education, the University Professors, the Chambers of Industry and Commerce, and owners of existing private educational institutions. All received training in the system and were familiar with using the internet, including the use of electronic fora. The argumentation session was conducted synchronously amongst the fourteen participants.

Evaluation of the session showed that the participants felt that the system was useful and that its basic functions were easy to master. This positive attitude extends to their being prepared to use it again in similar discussions and contexts, with the reservation that some difficulties arose from their being unfamiliar with conducting arguments over the internet rather than face to face. However, whilst online argumentation requires greater effort in the construction and comprehension of arguments when compared with traditional

discussion sessions, it is felt that this will ease significantly as users become familiar with the system; allowing longer training sessions and conducting the debate asynchronously would also alleviate the burden. Overall, this project provides evidence that argumentation systems can support the collaborative understanding of social problems and the development of potential solutions, both within and between organisations, as well as with the citizens who will be affected by policy decisions. The authors conclude that: "...it can contribute to the transparency and openness of the whole public policy making and implementation process, by making the relevant information accessible at a very low cost." (Karacapilidis et al 2005, p. 620)

3.5 Conflict Resolution

The use of argumentation tools to resolve conflicts cuts across three of the applications named above, and warrants a brief entry in this section. The case to be described (Papadopoulos 2004) conjoins the features of dispute, legal intricacy and planning issues.

The Californian community of Graton faced the problem posed by Mexican day labourers using outlying areas of the town as a base for finding employment. Their presence caused concerns about such matters as traffic, litter, personal safety and contamination of the local creek. The Mexicans too were frustrated at there being few dependable job opportunities and a lack of affordable housing. The construction of a day centre for the labourers was proposed as a solution to this problem, but community opinion was divided upon the merits of this scheme.

In November 2002, the North Bay Consensus Council (NBCC), using a technique called 'Conflict Cartography', was hired to bring the various stakeholder groups together in an effort to build consensus and resolve this issue. Argument visualisation tools played two important roles in this task. Maps representing the state of the project were produced at each significant step in the conflict resolution process. These provided an accessible medium for interested parties, by organising the immense amount of data supplied by the stakeholders, which included such diverse material as aerial photographs of suitable sites, planning regulations, expert analysis, and suggestions concerning the layout of the day centre. Maps were also used to stimulate and represent in real time the community feedback upon the progress of the project and its findings. Through a process of negotiation, involving argumentation support systems, the NBCC managed to bring representatives for the stakeholders from an impasse, to the creation of a set of draft agreements and recommendations.

4 eParticipation Application Scenarios of Argumentation Support Systems

This section focuses on eParticipation application scenarios for argumentation support systems and investigates to what extent such systems can be designed to encourage debate and deliberation by citizens on public issues.

Policy making is an iterative process where options to follow have to be discovered over time. The policy solution is such that there is no clear cut right or wrong approach, but instead there are better or worse solutions that need to be debated and where stakeholders hold conflicting views to such an extent that some do not even agree that there is a problem to be solved. The domain involves a large amount of knowledge that must be made explicit in different formats at each stage of the policy-making life cycle. This includes knowledge from many different sources and channels. Where the government has an interest in seeking the public's views on policy, there is an obvious need to supply suitable information upon which particular opinions can be based. As most of this will need to be extracted from this large amount of information, the public are faced with a time-consuming, and thereby off-putting, activity in order to prepare themselves for an informed debate. Additionally, problems of political policy are highly complex, admitting many opportunities for confusion and frustration. Taking all these facts together, they fall within that class of problems classified as 'wicked' (Rittel 1973). As discussed in earlier sections, 'wicked' problems have a number of characteristics that make them both difficult to analyse and resolve.

As we have shown, argumentation support systems are useful both for guiding the reconstruction of arguments put forward by other parties, so as to open them up to critical analysis and evaluation, as well supporting the construction ("invention") of new arguments to put forward in support or one's own claims or to counter the arguments of others. Given that argument maps use icons and arrows to represent the structure of a series of related viewpoints, thereby clarifying the issue under consideration, they have the potential to provide a readily accessible medium by which citizens can follow and join in public debates on policy issues.

In this section we consider the use of argumentation support systems to support the provision of information, consultation and deliberation,- three eParticipation activities identified in D4.1 and D5.1. We particularly focus on the sense-making systems.

4.1 Sense-Making application scenarios for eParticipation

Napier University has been using the Compendium tool, as an example of a sense-making tool, to investigate how they can be used within a political context to support eParticipation (Renton and Macintosh 2005 and 2006).

4.1.1 Supporting provision of information - Representing political debates.

Figure 3 demonstrates how argumentation support tools have the potential to support the provision of information. The map represents a fragment of a parliamentary debate on radio masts from the Scottish Parliament. It concerns the issue of safe usage guidelines. Typically such debates are recorded and where made available electronically on websites are reproduced verbatim without any analysis or structuring, making it very difficult for users to read and comprehend the issues. In the case of this map, the two bulb icons represent the substance of an issue, at a general level (top centre) and as a specific statement (top centre, enclosed in a light blue box). Contributions supporting and contesting this statement are indicated by green 'pluses' and red 'minuses' respectively, attached by arrows. The text beneath these icons is a summary of the comment taken from the verbatim report of the debate. The blue asterisk to the right of the icon indicates the presence of information that can be revealed when the cursor is rolled-over. In the above instance, the text in the mauve box contains the name, political party and constituency of the individuals making the comment.

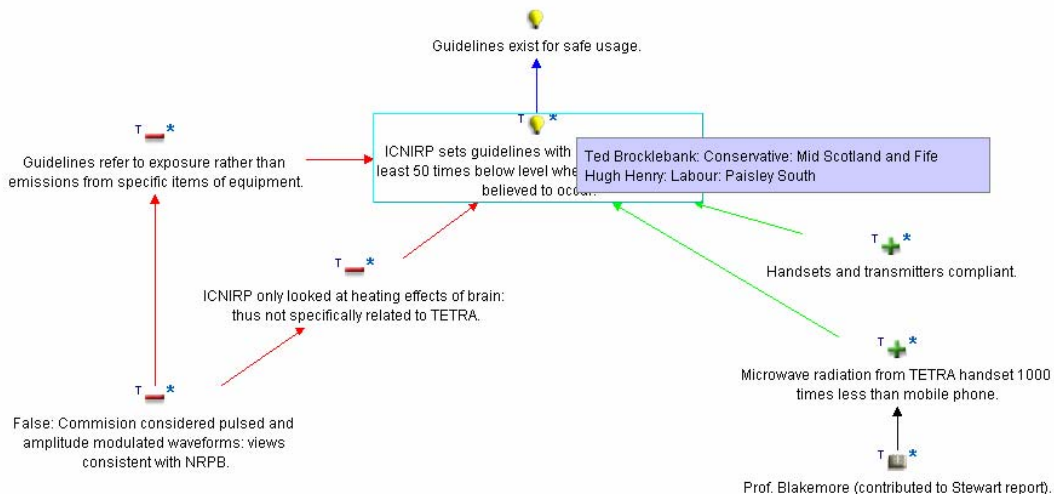
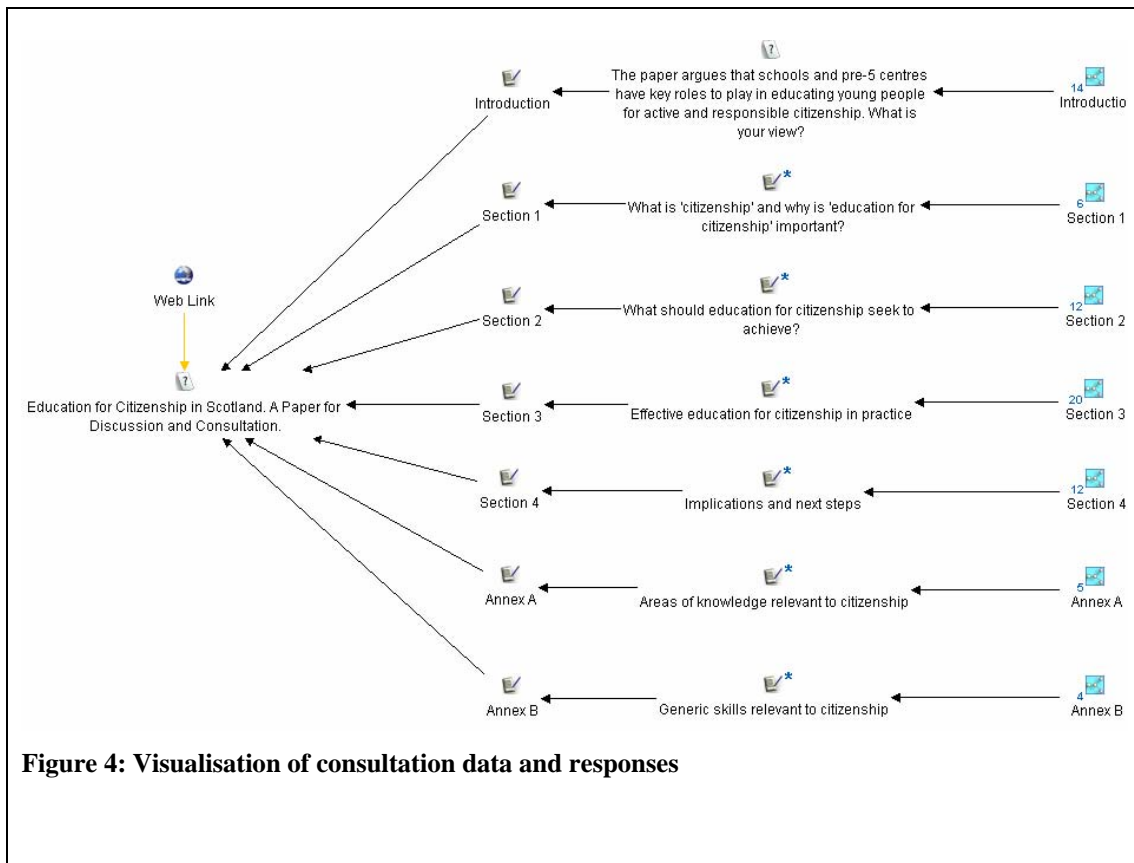


Figure 3: Arrangement of icons representing part of a political debate

4.1.2 Supporting Consultations

Figure 4 shows an alternative way of setting out the responses to an online consultation on a published draft policy document. The globe icon on the left indicates a hyperlink; in this instance, linked to the site containing the consultation paper. The intention is to improve clarity by making all the section topics visible at once. The blue icons on the far right provide links to further visualisations that provide the user with greater detail. Embedding maps permits information to be organised clearly and efficiently over a number of connected pages, rather than attempting to place all the data on one page. The deepest map contains a representation of the replies made to a particular question.



4.1.3 Supporting deliberation

Figure 5 represents a simplified version of consultation responses in the form of an inverted tree. It is designed to allow users to deliberate before making their own conclusions. This process should assist users to see how their convictions on one issue may conflict with other beliefs; thus, one might realise that the principle of 'freedom of choice' clashes with a belief in the duty of employers to protect their employees from harm.

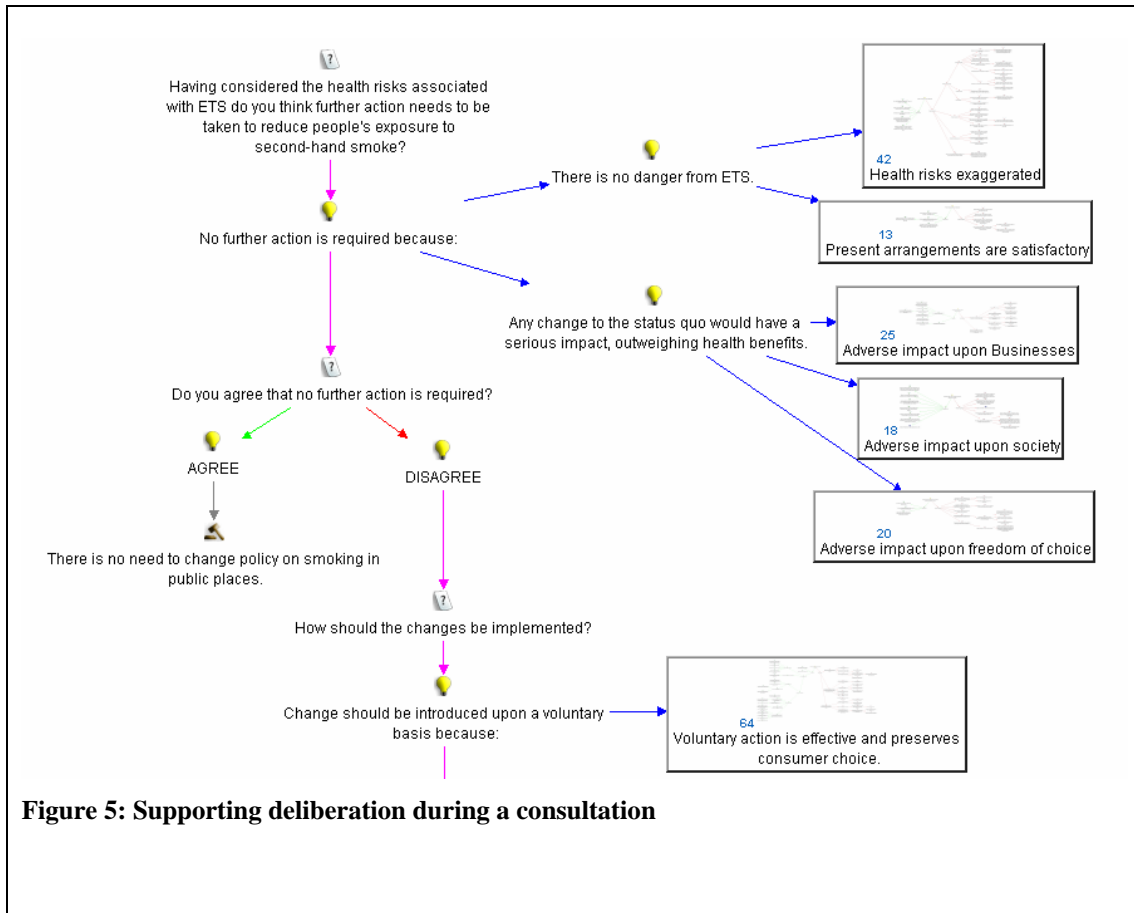


Figure 5: Supporting deliberation during a consultation

4.1.4 Supporting Analysis of a discussion forum

Figure 6 shows an alternative way of displaying the responses to an online consultation. The contributions to an online discussion forum were taken and reproduced verbatim. Although the map provides information in the same way as those above, it was also designed to establish whether or not individual contributors had remained consistent throughout the debate, and therefore could be used to support the analysis and evaluation of the consultation process.

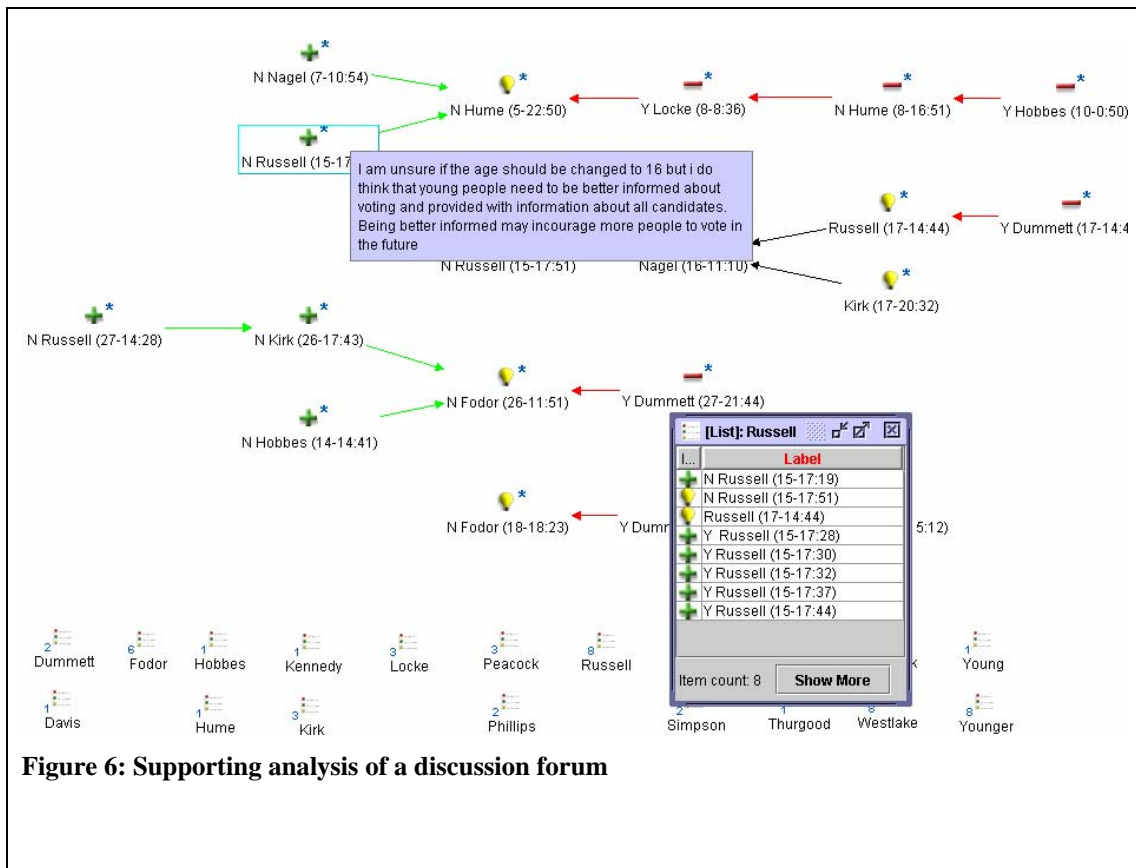


Figure 6: Supporting analysis of a discussion forum

Figure: Example of use of the ‘list’ function to check on consistency¹

4.2 Summary

Currently the creation of maps is largely done manually and thereby is quite time consuming. The corollary of this is that the maps will be expensive to produce as well as there being a lag period between the end of the debate and the appearance of the map. Whilst experiments are underway in using semantic searching to extract text for the maps, the results are unclear and further research involving semantic search and text mining is required.

As governments seek to consult their citizens over matters of policy, it becomes increasingly important that citizens receive the relevant information in a medium that they can, and will, want to use in forming their opinion upon consultative issues. This section has presented sample scenarios in order to assess the potential contribution argument support systems can make to the consultation process. They cover techniques for the presentation of complex information in a thematically arranged format, for identifying those issues that generate a significant response, for collating consultation responses and representing them within an argument structure, and for checking upon the consistency of

¹ Map created using responses to: ‘Should the voting age for the Scottish Parliament be lowered to 16?’ Highland Youth Voice: 28.05.04 – 19.07.04.

contributions to a debate. As such, they have something valuable to offer both government and civil society.

5 Conclusions

Argumentation Support Systems are computer software for helping people to participate in various kinds of goal-directed dialogues in which arguments are exchanged. Their potential relevance for eParticipation should be readily apparent, since the goal of eParticipation is to engage citizens in dialogues with government about such matters as public policy, plans, or legislation. Surely argumentation plays a central role in this process. In a public consultation, for example, citizens are given an opportunity to not only make suggestions, but also support these suggestions with arguments.

Typically eParticipation projects make use of generic groupware systems, such as discussion forums and online surveys. These generic groupware systems, however, do not provide specific technical support for argumentation. For example, they provide no way for a citizen to obtain a quick overview of the issues which have been raised, to list ideas which may have been proposed for resolving such issues, to see in one place the arguments pro and con these proposals, or to get an idea about which positions currently have the best support given the arguments put forward thus far in the dialogue. These are just a few of the kinds of services offered by argumentation support systems.

This report introduced the theory of argumentation; summarized prior work of the leading research groups on modelling argumentation and supporting argumentation with software tools; described various prior applications of argument support systems, mostly in research pilot projects; and presented a number of eParticipation application scenarios for argumentation support systems, as a source of ideas for future pilot projects.

A number of argumentation support systems and associated tools were presented. Some of these focus on the visualization of arguments and here the graphical notation and user interface are important features. Others focus on providing analysis of the situation but typically with a more limited graphical user interface. A number of underlying argumentation models are used by these systems, including Issue-Based Information Systems (IBIS) and the method developed by Wigmore for mapping evidence in legal cases. In considering their relevance to eParticipation, we need to consider the features needed to support informed debate to support evidence-based policy-making. The systems presented allow users to access various levels of information, to be able to focus on specific information and to have the ability to organize the gathered data to construct an effective argument – all of which are required for eParticipation.

In eParticipation, there is a clear requirement to better understand how technology can support informed debate on issues but there are two main obstacles in achieving this. The first is that the deliberation is typically on complex issues and therefore there are typically a large number of arguments and counter arguments to consider which when presented in linear text can be confusing for the public at large. Secondly, it is not obvious that many people actually have the necessary critical thinking skills to deliberate on issues. It can be seen that the type of argumentation support systems and tools described in this report have the potential to add value to current eParticipation methods. This was explored further in the section on eParticipation scenarios.

As governments seek to consult their citizens over matters of policy, it becomes increasingly important that citizens receive the relevant information in a medium that they can, and will, want to use in forming their opinion upon consultative issues. This report presented sample eParticipation application scenarios of argumentation support systems in order to assess the potential contribution these systems can make to the consultation

process. They cover techniques for the presentation of complex information in a thematically arranged format, for identifying those issues that generate a significant response, for collating consultation responses and representing them within an argument structure, and for checking upon the consistency of contributions to a debate. As such, they have something valuable to offer both government and civil society.

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