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# Computer Support for Discussions in Spatial Planning

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# Computer support for discussions in spatial planning

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## 1. Introduction

Spatial planning deals with the problem of distributing the limited resource "space" among different uses and users. It can be highly challenging to find a balanced land-use pattern, for example in urban agglomerations. Different interest groups such as residents, industry, and ecologists will claim different desirable land-uses for a given area. Spatial planning is also about locating unwanted land-use such as waste facilities. In this case, interest groups (e.g. city councils, neighbourhood organizations) and individuals will fight nearby locations. This situation is known as the NIMBY problem: “Not In My BackYard!”

In democratic societies, decisions such as those in spatial planning are made by political representatives in cooperation with public administration and residents. The final decision will usually be based on a number of consecutive prior decisions, or choices, which are made by different groups of stakeholders. At any of these decision levels, there are two important methods to reach a conclusion: consensus finding, or voting. Both will be preceded by more or less intensive discussions and argumentation. The ultimate goal of discussions is to achieve sustainable development by integrating the objectives of diverse stakeholders. Thus, we argue that discussions are a crucial element of spatial planning procedures and are to be integrated with planning and decision support techniques.

Discussions will have diverse formats in different planning projects. For example, the number of participants may vary from only two to hundreds and more; participants may get together or stay separated in space and/or time; discussion may be un-moderated, or moderated and structured. Nevertheless, discussion contributions (statements, messages, arguments, articles) in spatial planning will commonly contain a spatial reference. This does allow to link discussion support to spatially enabled decision support techniques as argued in this chapter.

In section 2, we will review general theories on argumentation and introduce major concepts of computer-supported cooperative work. Next, geographically referenced discourse will be analysed in more detail leading to the argumentation map model (section 3). Section 4 develops use cases for GIS-based discussion support, and section 5 presents some existing applications. Finally, we will speculate about future developments in computer support for discussions in spatial planning (section 6).

## 2. Argumentation theory and CSCW

Argumentation theorists analyse rational human discourse on a variety of levels. According to van Eemeren et al. [1],

> “Argumentation is a verbal and social activity of reason aimed at increasing (or decreasing) the acceptability of a controversial standpoint for the listener or reader, by putting forward a constellation of propositions intended to justify (or refute) the standpoint before a rational judge.”

An important aim of argumentation analysis is structuring discourse. Formal models of argumentation were put forward by Toulmin [2] in “The uses of argument” and Kunz and Rittel [3] in “Issues as elements of information systems”. Both approaches suggest a limited set of types of basic argumentation elements, and a set of relations between these. Toulmin models argumentation elements as *data*, *claims*, or *warrants*. Warrants back claims, which in turn are based on data. Similarly, Kunz and Rittel use *issues*, *positions*, and *arguments*. Root issues are assumed to draw different positions that are supported or opposed by arguments.

While operated manually at the beginning, IBIS have quickly been computerized, e.g. in the *gIBIS* (graphical IBIS) research tool by Conklin and Begeman [4], which was further developed into the commercial *QuestMap* product, and more recently the open source tool *Compendium*, by Jeff Conklin. In general, argumentation models can easily be visualized using graphs if they are composed of elements of different types, and relations between these elements. Nodes in an argumentation graph represent specific argumentation elements while edges in a graph represent relations between the elements. For example, QuestMap uses icons at the nodes of a “dialog map”: question marks, light bulbs, plus and minus signs represent dialog elements of types such as question, idea, pro and con, respectively (see http://www.cognexus.org/index.htm, link to “Dialog Mapping”).

The common Usenet newsgroups (e.g. comp.infosystems.gis) are another example of structured discourse support by (simple) computer visualization. The argumentation structure of newsgroups consists of threads that are initiated by a message with a new subject line. Additional messages within the thread reply to the initial message (at least they should). Visualization of this structure in most newsreader software is achieved through indentation of the subject lines in the overview list of a discussion. The importance of visually representing the structure of discourse is underlined by the recent publication of “Visualizing Argumentation” (Kirschner et al. [5]).

**Table 1:** Examples of discussion settings in spatial planning, and supporting computer tools.

| | **Same time** | **Different time** |
|---|---|---|
| **Same place** | Community meeting:<br><br>*2D, 3D, and animated project visualization; note keeping* | Speaker series, shared Internet access:<br><br>*Video recording, argumentation recording and structuring* |
| **Different place** | Video conference, chat room:<br><br>*Shared text, graphics documents; virtual worlds* | Internet newsgroups, forums, guestbooks:<br><br>*Argumentation recording and structuring, hyperlinking* |

On a more general level, computer support for structured discussions can be subsumed under the label of computer-supported cooperative work (CSCW). CSCW examines the enabling techniques for collaboration in groups. Specific topics include groupware systems, network

technologies, human-computer interaction, and the social implications of computer-supported distributed work environments.

Techniques for CSCW differ due to varying cooperation settings. A helpful distinction can be made between same place or different place, and same time or different time, cooperation (Ellis et al. [6]). This applies to discussions as well: Discussions between people meeting at the same time are called "synchronous" and include community meetings (same place) and video conferences or chat (different place). Discussions over a longer time period (different time, "asynchronous"), in which participants do not respond immediately to each other include speaker series (same place) and Internet newsgroups and forums (different place). Newsgroups can also be used in an asynchronous but same place setting, if common public Internet access points are used by participants.

Table 1 summarizes these examples of distinct discussion settings and adds useful computer tools for the four categories. The different place / different time setting is the focus of the remainder of this chapter as it requires the most generic argumentation support, and generates a natural need for computer and network support for remote and asynchronous discussions.

## 3. Modelling geographically referenced discourse

In order to define the specific aspects involved with discussions in spatial decision-making, we will examine a sample of arguments that came up in a community meeting in a preliminary phase of planning a new office building in the German city of Münster. In the following citations, references to geographical objects identified on maps, plans, in a movie, or memorized, are emphasized by the author:

> Inhabitant (inquiring): "*Our house* on the north side of *the adjacent road* already suffered structural damage when *the existing shopping mall* next to *the planned building* was constructed."
>
> Inhabitant (enraged): "The layout of *the parking entrance* will significantly increase traffic in front of *my living room window*. When I moved here, *this neighbourhood* was designated as a residential area, but it turned out that we have traffic problems already due to the large electronics store in *the mall*."
>
> City planner (balancing, points to schematic road map and landscape photograph): "*This building* has been designed so that the historical silhouette of Münster, which is visible when approaching the city on *this stretch of highway*, will not be occluded. The silhouette will be modified though, because the new building will stick out between the towers of *the cathedral* and *this church*."
>
> Architect (matter-of-factly, displays 3D fly-by movie of building and surrounding streets): "*This project* is designed in a light-weight fashion similar to *our much acclaimed building* in the south of town. The grass-grown ramparts are designed to resemble *the Omnisports centre* in Paris."

Obviously, geographic references do appear in the arguments in urban planning discussion. The most typical case probably is inhabitants referring to their own dwelling and to their

neighbourhood. Stakeholders involved in projects on a job level, instead of a personal level, may tend to refer to wider geographical areas such as to the city as a whole, or to comparable places in other cities. According to the previous section, Internet newsgroups are common instruments to facilitate remote, asynchronous discourse. Thus, it seems natural to seek ways of integrating newsgroups with digital maps and GIS. However, the geographical reference of argumentation elements poses some methodological problems that will be discussed in the sequel.

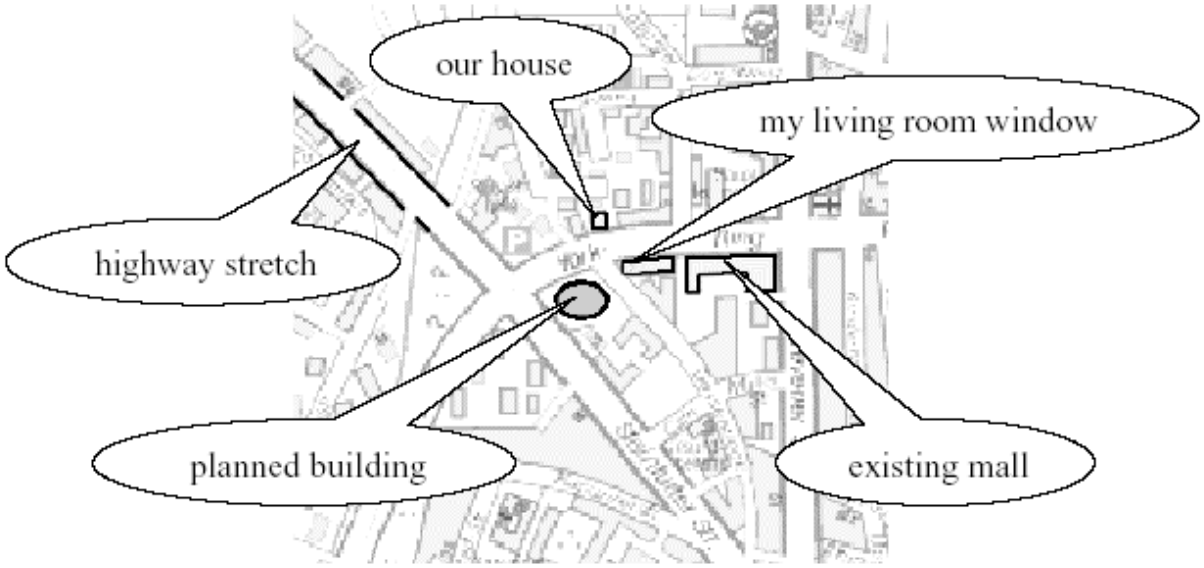


**Figure 1:** Sketch for excerpt of urban planning discussion. Source: Geographical references according to scenario in text. Background map modified from www.muenster.de. With permission.

Figure 1 visualizes some of the geographical references used in the arguments cited above. Additional objects that were referred to, such as the cathedral and a comparable building, are difficult to include on a map in planning scale. Please note that some of the references are likely to be available as geographical objects on a digital planning map (buildings as a whole, road section), while others are part of objects or may best be thought of as coordinate locations (living room window). With respect to the situation sketched in Figure 1, we are going to assess different components involved in modelling geographically referenced argumentation.

Geographic information systems are designed to integrate spatial (geometric) data with thematic (attribute) data. For example, census maps visualize socio-economic data values with reference to enumeration units such as census blocks. Handling arguments as just another attribute of geographic objects in a planning GIS would not accurately represent the “real-world” – an argument is an entity on its own, which can be used independently of a geographical representation, and which can refer to more than one geographical object thus being more than a “flat” attribute.

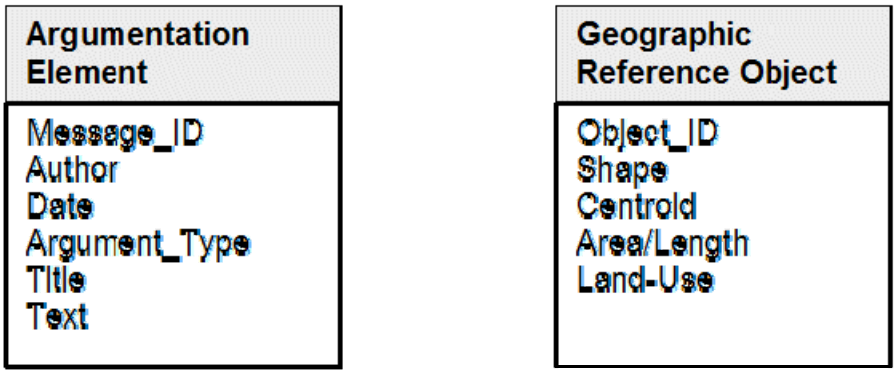


**Figure 2:** Object models for isolated argumentation elements and geographic reference objects.

Figure 2 suggests object models for both, argumentation elements and geographic objects. This model reflects the individual object identities in both, the argumentative and the geographical spaces. However, relationships between the objects have to be added: On the one hand, geographical objects have implicit spatial relations between each other, which may or may not be reflected in GIS data models. We will add a self-reference to the geographic object class to hint at topological relations. On the other hand, arguments in a structured discussion necessarily have (topo)logical relations between each other, e.g. a reply-to relationship. In this modelling approach, argumentation elements preserve a dependency structure according to the argumentation model chosen in a specific application, so that two sets of topological objects are combined.

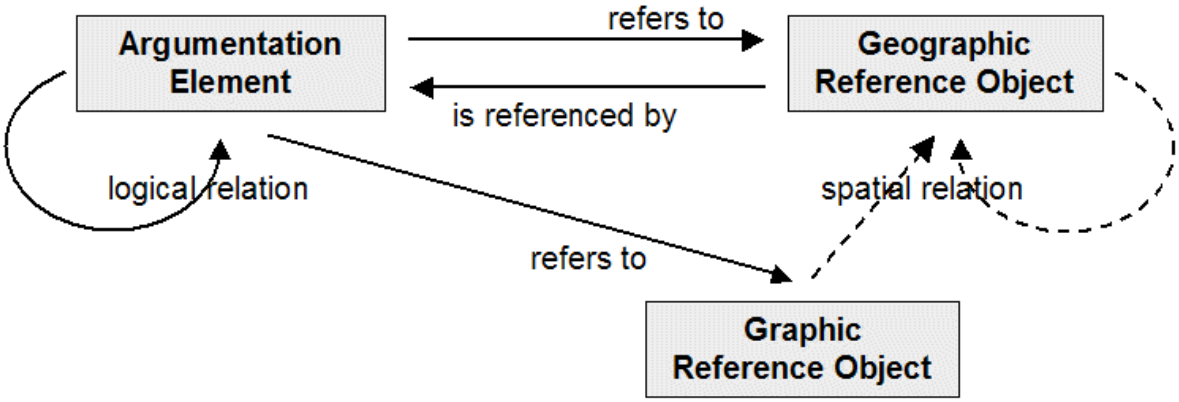


**Figure 3:** The argumentation map model links argumentation elements and geographic objects. Source: Extended from Rinner [7]. With permission.

Figure 3 includes these relations within each object class and, most importantly, the geo-argumentative relations between objects of the two classes: Argumentation elements can refer to one or more geographic objects, while a geographic object can be referenced by one or more arguments. In addition to direct references between arguments and geographical objects, the model in Figure 3 also includes arguments referring to graphical helper objects. This means that

discussants can specify an exact point location as a graphic reference for their contributions. Users also would be allowed to draw features on a map, e.g. a free-form ellipse around an area of concern, and link their argument to this graphic. If a direct reference to a geographic feature such as a street or planning area is missing, the spatial relation to planning features could be re-constructed using standard topological operations in GIS. This is an extension of the argumentation map model originally proposed by Rinner [7]. The following section outlines the potential uses of the model.

## 4. The uses of argumentation maps

The term "argumentation map" describes a conceptual model that relates objects in a computer-supported discourse (argumentation elements) with objects in a geographical database (e.g. within a GIS). Implementations of argumentation maps thus can be used to support spatially referenced discussions. The functionality of argumentation maps can be classified according to typical information system functions such as data input, retrieval, analysis, and presentation. To follow an order of increasing complexity of these functions from a user point-of-view, we will shift the presentation function to the first place in this list (see Table 2).

**Table 2:** Optimal functionality of argumentation map implementations.

| |
|---|
| **Presentation** of spatially referenced discussion |
| **Input** of arguments with geographical reference |
| **Retrieval** of argumentation elements or geographical objects or both |
| **Analysis** of the status of a spatially referenced debate |

The *presentation* of the current status of a spatially referenced discussion naturally involves maps. It is, however, not obvious what should be presented on an argumentation map (in the narrower sense) in addition to the geographic situation, which is at the centre of discussion. In addition to the occurrence of arguments at specific locations or with pre-defined geographical objects such as roads, or land-use polygons, additional attributes of these arguments might be interesting to visualize. For example, to display the spatial pattern of approving vs. objecting arguments, the type of argument (e.g. pro, contra) needs to be represented by colour hue, or shape of a symbol. Also, the display may be limited to subsets of arguments, e.g. those arguments put forward by a single participant, or group of participants. Besides using cartographic maps, presentation of a debate will also require text-based displays of structured argument lists and contents of individual arguments. In the hypermedia setting of a Web-enabled argumentation map, the presentation function will allow users to navigate through discussion-related documents based on cartographic displays.

The *input* function of an argumentation map should support discussants in submitting a new argument together with its spatial reference. This process could be started from either a discussion forum or a mapping component showing the geographical area subject to discussion, but it will eventually involve both of these components. For example, in addition to writing the

text of a discussion element, the participant would be asked to provide at least one spatial reference by clicking a location on the map, or selecting a geographical object. Or, some kind of interaction with a map (e.g. double-clicking a location or geographical object) would open a dialog for the input of a discussion contribution, which would then be related to existing messages in a discussion forum. Text and geo-reference input is the primary function to support active participation in a planning debate.

The *retrieval* functions include querying the discussion for arguments referring to selected geographical object(s) as well as querying the map for objects referenced by selected argument(s). These topological queries should be combinable with each other and with attribute queries. For example, it should be possible to search for messages of a certain author (attribute query) that refer to a selected object (topological query) and all its neighbours (another topological query). Some of these query types use the topology internal to the geographical domain or to the argumentative domain, while at least one part of the query crosses the two domains. The theoretical implications of combined topology are discussed further below.

As the most advanced class of functions of an argumentation map, the *analysis* of geo-referenced discussion uses existing data to generate additional information of use to participants or observers of a discussion. Summary statistics such as counts of arguments with certain characteristics (author, submission date, argument type) or dominant argument type per geographical area might be useful to understand the current state of a debate. Geo-argumentative analysis requires arguments to refer to geographical objects rather than coordinate locations so that arguments referring to the same object can be identified. Alternatively, arguments referring to coordinate locations could be related using GIS analysis such as point-in-polygon to identify those reference locations falling in the same geographical object. The straightforward way of reporting the results of an analysis operation again is visualizing them using some regular cartographic method such as chart maps for counts, or area shading (choropleths) for averages.

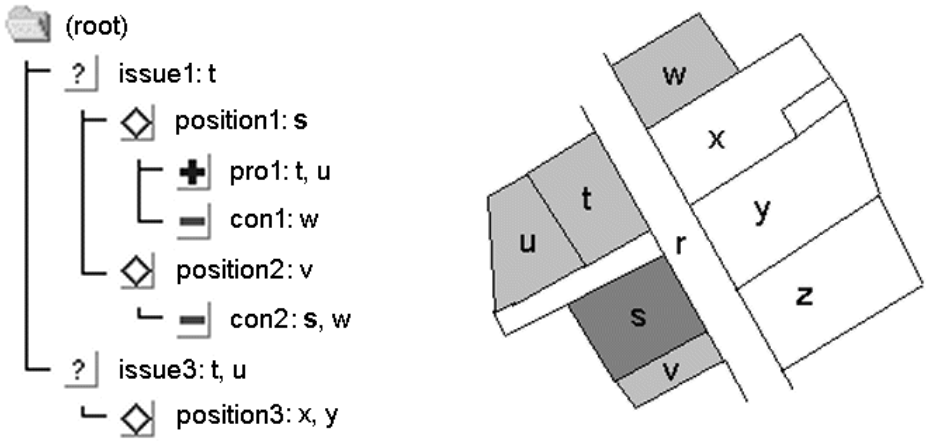


**Figure 4: Geographically** referenced IBIS discussion to demonstrate geo-argumentative relations. Source: Rinner [7]. With permission.

The topological relations within, and between, the two domains involved in an argumentation map have interesting theoretical implications. In particular, if links cross the geographical domain and the argumentative domain twice, formal relations between objects in one domain appear that may be of practical use. For example, object *s* in Figure 4 is linked to argument *position1*, to which *con1* is responding in the discussion structure. *con1* in turn is linked to object *w*. Although *w* is not a neighbour or otherwise directly spatially related to *s*, there seems to be a link between the two objects, at least according to some of the discussion participants. We term such links as "geo-argumentative relations", which allow for defining a distance relation between objects of the geographical domain via the argumentative domain, or vice versa. No other field is known to the author where such connections between objects via "parallel universes" including the geographical domain would be exploited.

## 5. Existing applications

In the past five years or so, several isolated attempts have been made to implement computer tools that would support geographically referenced discourse.

CrossDoc is a research prototype developed by Tweed [8] to visualize argumentation structures by modelling networks of documents. In the planning application described in the paper, the document network includes a planning map and arguments, which are structured according to the issue-based information system (IBIS) framework (Kunz and Rittel [3]). CrossDoc thus provides a fully visual index to the structure and spatial reference of argumentation. The tool was conceived of as a stand-alone, integrated desktop tool for argumentation recording, a "decision journal". It is bound to the Apple Macintosh platform.

A cooperative hypermap is suggested by Rinner [9] to support the online link of planning maps with discussion contributions. A perspective view on an urban development plan is provided together with an input form. Users can create a 3D flag to represent an argument; user input includes the type of argument according to the IBIS model, a link to a message in a discussion forum that would contain the argument, and the spatial reference. The reference is achieved by placing the flag on top of the plan element the message was referring to. The virtual reality modelling language (VRML) is used in conjunction with a Java applet to implement the user interface within a standard Web browser as shown in Figure 5. This prototype version does not include a server component that would be required to store user input. With respect to the argumentation map model outlined above, this application is limited in that it provides only for coordinate-based spatial references, and allows only one-to-one relations between arguments and locations. In the original version, the third dimension was used to represent larger and smaller flags depending on the level of the corresponding argument (e.g. largest for issues in an IBIS model), while the planning map was drawn as a texture on a flat surface. However, a virtual round-table variant was implemented as a student project with the map placed on a table in a virtual planning office showing a more "immersive" environment for discussion support.

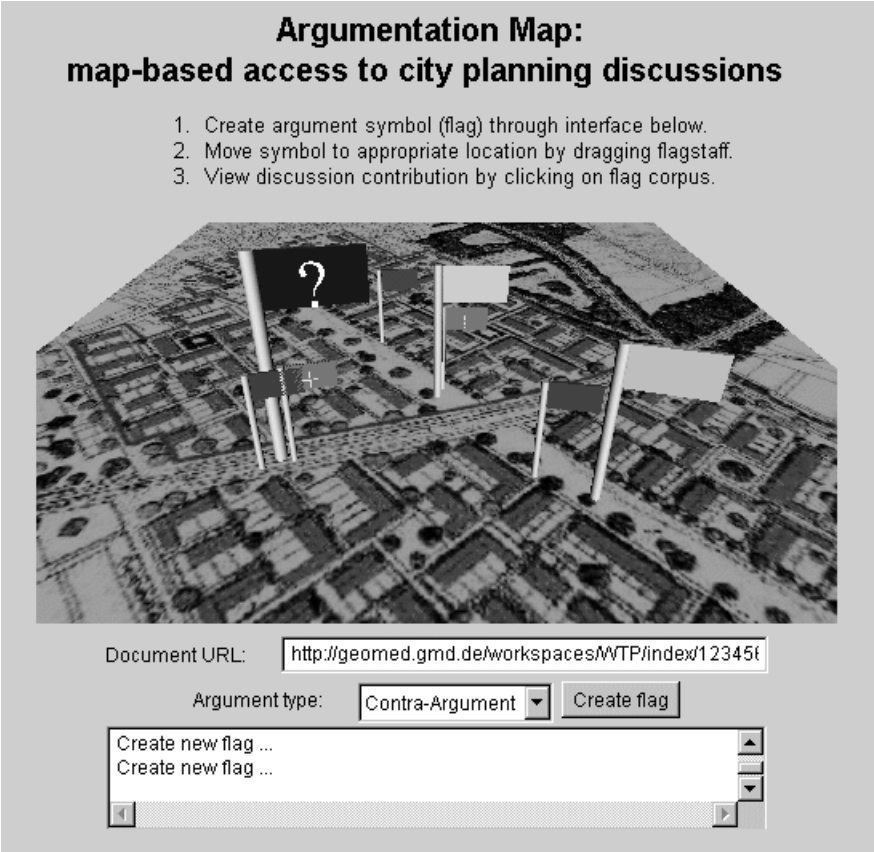


**Figure 5:** VRML-based 3D display of an argumentation map.

VRMLView is presented by Lehmkühler [10] as an experimental combination of a three-dimensional mapping component and a newsgroup component. The 3D scene is developed using VRML as well, and represents a hypothetical planning scene. A mouse click in the scene opens a discussion forum in another Web browser window, which includes an input form for new contributions. This prototype suggests combining standard techniques for (3D) mapping and discussion to achieve an accessible solution for the greatest number of potential users on the Internet. There is, however, no link between individual elements of the planning "map" and the arguments in the discussion forum.

Virtual Slaithwaite is introduced by Kingston et al. [11] as a case study for "virtual" decision-making. In a real-world development effort, residents of a UK village were given the opportunity to discuss local planning issues. Steve Carver and colleagues at the School of Geography, University of Leeds, have studied this environment from different perspectives related to virtual society. The original application provides users with a village map and a comment frame combined in a Web browser window. In the initial version, comments would be placed at coordinate locations on the map and represented by point symbols. Subsequent users thus would get an impression of where there are comments. By clicking on symbols, corresponding comments would be displayed in the comment frame. The current, Java-based version of Virtual Slaithwaite allows the user to select a geographical object to link a comment. The resulting link structure however could not be verified in a recent visit of the site (http://www.ccg.leeds.ac.uk/slaithwaite/). In theory, Virtual Slaithwaite provides a map-based

access to discussion contributions. On the side of the discussion however, neither is argumentation structure supported nor are any display of messages in a list or graph offered.

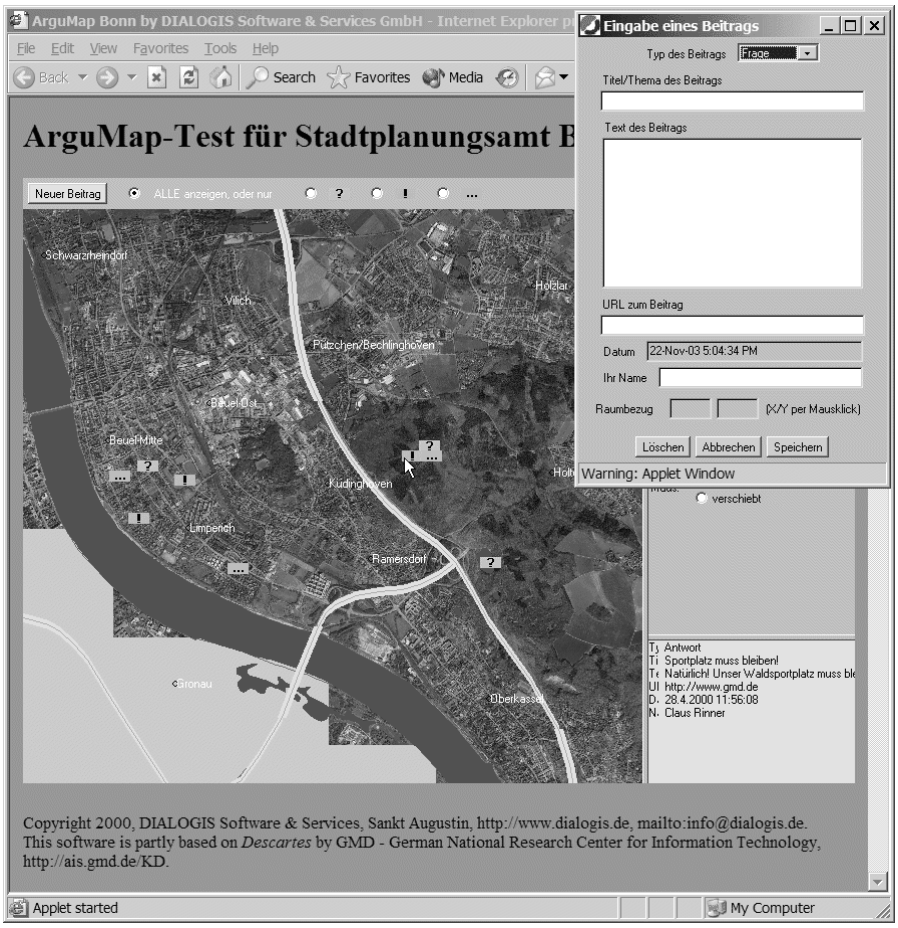


**Figure 6:** ArguMap – prototype of a map-based planning discussion forum. Source: Dialogis GmbH. With permission.

Based on the Descartes thematic mapper (Andrienko and Andrienko [12]) and on the argumentation map concept, Dialogis Software & Services GmbH developed ArguMap, later called NoteMap, a map-based forum for planning communication endorsed by urban planners in Bonn, Germany. The Java applet shown in Figure 6 could display an aerial image of the city together with point symbols representing questions, answers, and comments to planning issues. When published on the city's Web site the application was limited to displaying planners' annotations to selected issues. The reasons include the fear of overwhelming input volume and misuse of the system. No option for discussion of these issues by concerned citizens was included in this version.

Hans Voss and colleagues at the Spatial Decision Support team of Fraunhofer Institute for Autonomous Intelligent Systems (AIS) are working on the arguably most advanced approach to supporting spatial discourse. Coupling two existing software tools in AIS, the Zeno discussion forum, and the Descartes thematic mapper, was first suggested by Rinner [13]. Voss et al. [14] describe the most recent design for integrating structured discourse and spatial analysis and

mapping. Their two systems, now called Dito and CommonGIS, will support many-to-many relations between user comments and geographical objects on maps. In addition to this and other conceptual requirements, the authors put forward recommendations to achieve a consistent graphical user interface. For example, geo-referenced comments should be represented on a special annotation layer. Further requirements refer to technical issues such as performance, synchronisation, and security.

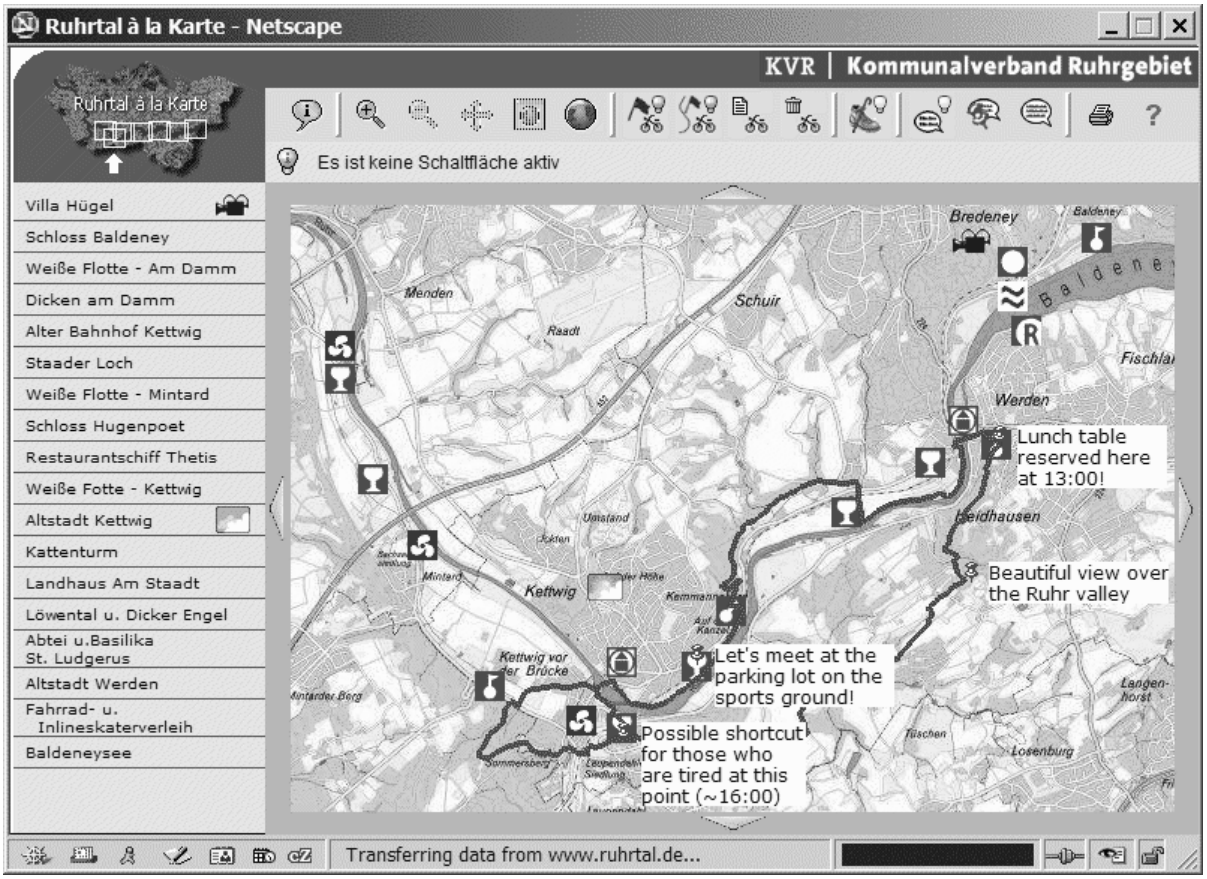


Figure 7: Cooperative Web map. Source: Ruhrtal à la Karte, http://www.ruhrtal.de. With permission.

A typical feature of many argumentation map implementations is the storage of user input on a central server. Kolbe et al. [15] suggest a different approach: They introduce a map annotation tool for bicycle tourists in the Ruhr valley, Germany. Their “cooperative Web map” prototype allows users to add comments, and link pictures, to a centrally stored bike route map. Instead of storing this input on the server, it is built into a complex URL, which can be sent to other users. Recipients of such a URL will view the central Web site augmented by the sender’s annotations, while other visitors of the Web site will not know about the annotations. Using the URL as a container for Web page annotation is implemented such that it does not require any software installation on client computers as long as a modern Web browser is available. The central Web site is realized as a script that will handle annotations if they are provided in the URL. In this case, annotations will be placed in HTML layers on top of the default contents of the page (see

example in Figure 7). If no annotations are provided in the URL, the bike map will appear as it is. This appears to be a highly innovative concept for Web-based, peer-to-peer cooperation, but Kolbe and colleagues also mention possible limitations of their approach. Page annotations made by a user at one point in time may become invalid if the background page on the server changes, which is beyond the user's control. The amount of information contained in a URL is limited by Web browsers in a non-standardized way (e.g. 2048 bytes for Internet Explorer). Finally, the peer-to-peer approach lacks any option to get an overview of comments made on a Web map, which will disqualify it for certain applications that require a public forum rather than fragmented discussion groups.

## 6. The Road Ahead

Integrated computer support for both, map display, and participation in planning debates, is an important milestone on the way to sustainable development, namely in urbanized democracies. But the conceptual peculiarities of geographical information as well as human discourse so far prevented integrated tools from being developed, except for very specific applications. We anticipate that comprehensive computer support for discussions in spatial planning will only be established and widely accepted when popular mapping and discussion tools are combined. This might involve solutions as simple as MapQuest® on the GIS side, and Usenet newsgroups on the argumentation side. This might also require scaling down our expectations with respect to the optimal spatial discourse environment outlined above and by other researchers such as Voss et al. [14].

Nonetheless, investigating the character of geographically referenced argumentation has already contributed to geographic information science in that it poses specific demands on conceptual data models. Arguments as a type of media to be linked to maps are un-common in GIS. The most similar to these are map hyperlinks (or hotlinks), which geo-reference HTML pages, photos, or movies. In the context of digital libraries, Goodchild [16] discusses the generalized concept of geographically referenced "information-bearing objects". In contrast to these, however, arguments typically refer to each other, in addition to having a geo-reference.

Helpful visualizations and analysis functions have been proposed in applications such as those described in the previous section. But computer support for spatial discussions needs to be founded on a theory of geographically referenced information objects. More examples from different application domains (planning, design, business, conservation, etc.) need to be collected, and prototypes be implemented to test which user groups will benefit from this approach.

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