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GIS FOR POLITICS

Requirements for GIS in Political Decision Making

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GIS are excellent tools to collect spatial data, for example about the environment, but they lack some of the capabilities required to access and analyze the data and produce the information required by the political process for policy making. Systems like MARS[1] in Europe and comparable systems in other countries produce regular analysis of the actual situation of some sector; e.g., agriculture or the land-use, but they are limited to this sector and to a post-fact analysis. They are not well suited to cross data coming from different sources (e.g., remote sensing and administrative data sources) and to answer to information needs of other sectors, even less to extrapolate and to predict future situations. For GIS to gain more attention in the public debate, they must contribute information, which can help to answer the most pressing political question, e.g., the reorganization of the European agricultural market or efforts to stop the degradation of the natural environment. What policy makers need is a tool, which helps them to assess the effects of actions considered and to evaluate different plans. GIS provide the background for such analysis, but they must be extended to include geographic facts in a spatio-temporal context and allow 'what-if' questions, which in turn require functional models and simulation tools. In this paper, we analyze why current GIS are limited to spatial static facts and link this impediment to the mathematical-logical foundation of current GIS. The paper concludes with a list of formal tools, which can be used to build the future dynamic, temporal GIS which model geographic facts and processes.

KEYWORDS: Environment, Interoperability, Functional Models, Simulation, Dynamic GIS, Temporal GIS

INTRODUCTION

GIS are tools to collect and spatially integrate data. They bring together the results of various observations, often based on remote sensing, and promote the integration of data from different sources. The results are detailed descriptions of the current situation of the world.

We observe today that the use of GIS is increasing rapidly – in some countries more than 10% per year -, but not as rapidly as the enormous potential of GIS for administration, policy making and science promises. It was estimated that 80% of human decisions contain a spatial component [2], and thus in most decisions a GIS could contribute to improve the decision or to reduce insecurity. GIS is – despite the rapid growth – seldom used and many areas of decision-making are still going without the benefit of spatial information. This document compares the capabilities of today's commercial GIS and the concepts used for GIS today and compares them with the requirements of administration, science and policy making. The analysis identifies the impediments of today's GIS concepts for widespread use in political decision-making.

The discussion here addresses first very general issues, and situates them within the complex of policy making, especially the agricultural and environmental policies, which are of great practical interest today in Europe, but also in other parts of the world. The impediments, which are discussed, seem to be related to the integration of data, but beyond this integration looms large the static nature of today's GIS. Indeed we will show in the conclusion that the problem of semantic integration and modeling of process are closely related.

Current commercial GIS products are optimized for the management of *static* data about the spatial world and contain increasingly spatial analysis tools. It is possible to build systems which allow the comparison of time series of spatial data [11], but complete integration of temporal and spatial data has not yet been achieved and research efforts are underway (Chorochronos Project, see http://www.dbnet.ece.ntua.gr/~choros/). The collection of spatial data from different sources is – this has been a well-known problem for years – hindered by differences in the format under which data are stored. Data transfer technology [20] and more recent, interoperable systems [6, 17] are to redress this impediment. At the current time, the transfer of data from one system to another is usually not a problem anymore, but the integration of data with different spatial reference system, different level of detail (often described as different scale) and different collection methods is still a confusing issue. National Geographic Infrastructure efforts [7] are focusing on these issues at various levels.

The GIS we have today can answer questions what is in the world; it is the question we ask often when we have to solve mundane problems: where to find a gas station, how to drive to our holiday resort, where to locate a new grocery store, etc. For scientific analysis, we ask questions like 'where are areas used for olive growing',

[1] See: http://www.ais.sai.jrc.it/marsstat/bulletin/index.html

'where are areas with high populations of pigs'. These are static questions.

More engaging are questions, which point to an explanation, questions about future states and, politically most important, questions which link possible actions to future effects. "Do olive growing areas in Spain expand?", "Where are areas where pig populations decrease?" and then the ubiquitous question: "Why?" None of these questions current GIS address well.

The quality of the environment is a high political priority. Environmental GIS are built [15], but today's GIS can at best give a comprehensive picture of the current situation. The public discussion centers around the economic effects of different alternative actions and is often shocked by the cost of corrective actions to recover from environmental sins of the past (several drastic examples are now discovered in the former Soviet Union, see various contributions in the GIS'98 Brno Proceedings [16]). The economic and social cost of environmental degradation is much higher and integrated models are required to assess such cost. Environmental degradation (in a wider sense) is often responsible for the increase in natural hazards. The politicians need to understand the consequences of their decisions and the likely cost to repair the damage of landslides, flooding, and forest fires provoked by thoughtless land cover changes. GIS should provide tools to demonstrate to politicians the effects of agricultural policies, e.g., the resulting increase in fertilizer usage if production is increased, and the secondary effects on the environment, e.g., the elevated nitrate levels in water supplies.

Some GIS are used to collect data about the natural world and its physical properties. Other GIS collect data about the social environment – many administrative systems contain a wealth of social data which can be explored. The integration of these two realms is necessary but hindered by the different traditions of natural and social sciences, which go back to fundamental philosophical differences.

In order to direct future research we have to understand the requirements of society at large. In order for GIS to gain more attention and more resources for its development, we have to show to the public that GIS can contribute to the pressing question of society. Only then, GIS can participate of the limelight of public discussion.

GIS CONTRIBUTION TO POLITICS

What can a GIS contribute to today's eminent political problems? Only if it can contribute to the pressing issues of the day, we can expect that GIS finds the attention of the public and the resources needed for research, data collection and management of GIS and the related technologies.

The question is therefore to analyze the relationship between political action and the interest of politicians with the contributions a GIS can or could make. Politicians are not as irrational and shortsighted as scientists like to caricature them. They have difficult decisions before them, affecting the lives of people in many different ways. They are generally interested in information to support their case. It is our obligation to provide this information in a rational, scientific way.

For this paper, we select an issue of current eminent interest in Europe as a case study. Only if the GIS can contribute to such a case, we can benefit from the public attention, which this issue currently has. In the public TV debate so far, often during prime-time news, I have never heard mentioning the contribution a GIS based study could make. I think it behooves us to analyze the reasons why.

Case Study: European Agricultural Policy

The single issue of major importance for European politics in the next decade selected here as a case study is the reorganization of the agricultural policy (as part of Agenda 2000). Agriculture is a major part of economy for many areas of Europe, and agricultural policy affects therefore the social situation in large parts of Europe. Contribution to the market for agricultural goods amounts to one third of the budget of the European Commission. But agriculture is also identified as a major contribution to environmental pollution and agricultural policy therefore affects the state of the natural environment. Thus in agricultural policy, the interaction with the environment and the social situation must be considered – the environmental questions are linked (through agricultural processes, but this is only one particular example) linked to the social questions. This is a perfect example for the complex environmental questions we have to address in the future and I will concentrate on how GIS can be improved to contribute to solving such problems.

Political Questions

A rational politician confronted with a decision will consider the alternative actions and the effects these actions may have. The outcomes are assessed with respect to his constituency – the people that have elected him – and to his party associates, relevant industry, etc.

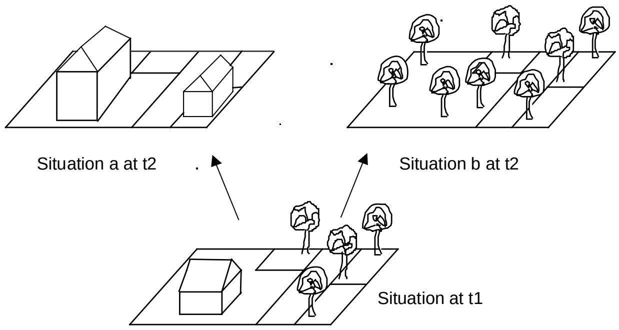

Figure 1: Two different future landscapes at t2, modeled from current situation at t1. GIS visualization allows politicians to evaluate the different possibilities.

The political debate should be about the evaluation of the outcomes for different people with different needs and the political decision should lead to an optimal set of actions which produce maximum benefits (Figure 1). Political debate is, in principle, about the evaluation of the future states; different parties may differ in their evaluation functions. Practical politics is much about strategies to achieve an optimum for one's constituency to be reelected. Mathematical game theory [22] provides a mathematical framework for the analysis of political behavior and strategies (for a more detailed analysis [23]).

Current political debate is not only about the differences in the evaluation of outcomes, but often compound with (1) a debate about the description of the current states and (2) a debate about the likely effects actions have on the current state. This makes political debate more complex and confusing than necessary.

Optimally, science should provide the politicians with an agreed upon description of the facts to reduce the political confusion, and acceptable models to link potential actions to likely outcomes. Then politicians could concentrate on their primary function, namely the political evaluation of outcomes and the selection of the most beneficial one. Unfortunately, GIS cannot provide this today because we do not know (1) how to integrate data to build acceptable databases of facts and (2) GIS do not contain process models, which allow 'what-if' questions to explore the outcomes of potential decisions.

Scientific Questions

Surprisingly, scientists ask very similar questions as politicians. In theory, scientists posit a hypothesis and then formulate an experiment, which either confirms the hypothesis or falsifies it [24]. For scientific work to progress, a detailed description of the state before and after an action is required. The action is then modeled and the predicted outcome of the model compared with the observed outcome. The comparison leads to the acceptance of the model or its rejection.

Interesting Questions to Politicians and Scientists

For the questions politicians ask they need descriptions of states, and models which link current state and actions to future states. This problem can be captured in formulae to construct a framework for the discussion of particular applications. The theory of modeling dynamic systems [26] gives a framework which is often used for the discussion of economic or global environmental scenarios, but seldom applied to environmental issues in a localized (spatially disaggregated) form. Considering a current state *s* and actions *a* which could be carried out. If actions are taken, then the current state is transformed by the function *f* (which represents the complex system, e.g., the environmental, agricultural and social interactions) to become state *s'* (Formula 1). Politicians apply a valuation function ps_i to a state to gain an assessment of the desirability of this state (here described by a value *v*; Formula 2). The valuation function ps_i can be applied to the future state *s'*, which would be achieved after action *a* are applied (Formula 3). The politician's goal must be to select a set of actions, which maximize the outcome for his constituency (leaving the details of the optimality definition to the discussion in the economic theory).

$$f(s, a) = s' \quad (1)$$
$$v = ps_i(s) \quad (2)$$
$$v_i = ps_i(s_i') = ps_i(f(s, a_i)) \quad (3)$$

select a_i for which v_i is max!

The scientists interpretation in the terms used above is: A hypothesis is a function *f*, which links current states *s* and the experiment (an action) *a* with observable outcomes *s'*.

If the observed outcome $\overline{s'}$ is the same as the predicted outcome *s'* then the hypothesis is confirmed, otherwise it is rejected; a single experiment is sufficient to falsify a theory, but all experiments in the world cannot prove a theory – and therefore Popper stresses the importance of falsification for the development of theories.

$s' = f(a, s)$ - for the predicted outcome

$\overline{s'} = \overline{f'}(a, s)$ - is the observed outcome after action *a* applied in state *s*

Very often, scientific theories *f* contain a number of constant parameters. Past observations are used to calibrate the parameters, such that the theory predicts optimally the past observed performance. The theory with the determined parameters can then be used as a predictive theory, technically to extrapolate into the future – assuming that the parameter values will not change.

Commonality

We see that both science and politics are not interested in the current state of the world *per se*, but are interested in models of the world which link the current state and actions with a future state. The GIS today at best provides the description of some aspects of current state, which is useful and valuable for many applications (mostly in the administrative domain) but does not respond to the major challenges of our living environment and the conditions for human live.

Both political and scientific studies work with data with limited accuracy and in consequence accepts result with limited accuracy. Scientists often use statistical tests, to differentiate between the arbitrary random effects and significant effects. Politicians request data which is *fiable* and despise data which can be easily falsified in details by their political adversaries (even if the general trend is correct): the message a politician sends must evoke confidence and if it can be shown to be false in a single detail, the trust the public places in this elected politician is lost. We lack so far an assessment of 'political fiability' which corresponds to the concept of scientific significance.

Common to both, to the scientist and the politician, is that at the end, they are satisfied with a qualitative answer: the hypothesis is confirmed or rejected; the set of actions, which leads to the optimal state, is identified. Both are interested in 'models', which link the current state and actions to future state. The terminology is not uniform, but scientists often call models theories if they are constructed in terms of a supportive science (or more detailed level of the same science).

This very general analysis provides us with a common framework for both scientific analysis and for political and administrative use of GIS. It stresses the importance of the dynamic modeling power of the GIS required.

REQUIREMENTS FOR FUTURE GIS

GIS today manage data which describe the current (or some past) states of the world. In order for GIS to contribute more to the pressing problems of the world, they must be expanded. Two key requirements must be addressed:

- Integration of data, to construct the database to calibrate complex models,
- Description of process, to permit 'what-if' questions

and we will show in this section, how these are interrelated. The next two sections will then discuss the mathematical foundations and the intellectual tools available to address these challenges. Later we will discuss the practical efforts already underway to contribute to them.

Spatial Database Management

GIS as a special, spatial case of data management is of limited interest and limited commercial success to the software vendors. It is clearly visible that increasingly the large DBMS providers include some form of spatial data management tools in their offerings (Oracle: Spatial Data Organization; Informix: Spatial Data Blade). Spatial data management is not the core issue of GIS research any more, as it was some years ago; there is a now regular bi-ennnial conference where mostly computer scientists meet to discuss spatial access methods and related database issues of importance to GIS [28]. The research challenge today is more with the integration of spatial data into regular DBMS with minimal adaptation of the complex kernel of a full-feature, industry-strength DBMS. Proposals for solutions by Abel [1] have been tested and work well.

Integration of Data

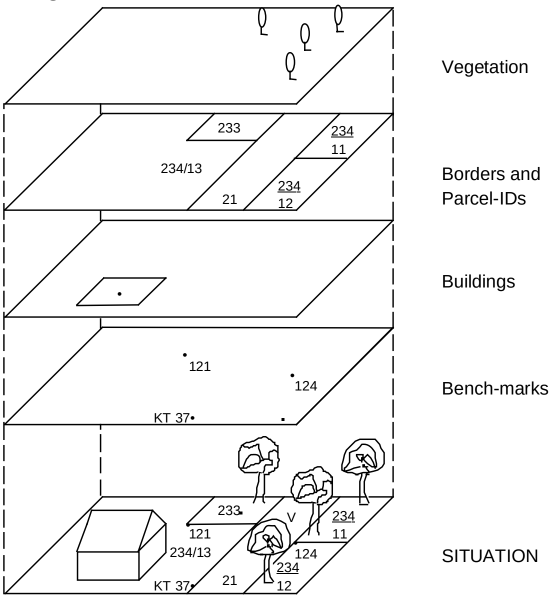

Figure 2: Different thematic representations of the same situation.

The promise of GIS is the integration of data from different sources with respect to location in space, best visualized in the often seen stack of thematic maps (Figure 2).

Practically, GIS has delivered on this promise only partially. We can integrate routinely, i.e., without major expert intervention:

- raster data with comparable resolutions and apply the operations defined by Dana Tomlin [31]
- polygonal data (coverages) if the data is of comparable spatial resolution and precision.

This is a quite limited success; it excludes most interesting data integration tasks politicians and scientists wait for. Integration works do not work automatically; if the data is of different resolution, level of detail, measurement scales etc., then the integration requires very careful analysis of the datasets by experts, is often achieved only with a very time consuming trial and error process and produces results of questionable value.

The seamless integration of raster and polygonal data is a long standing question; in principle, it can be easily resolved by translating all data to a raster format but leaves out linear data which is not easily expressed in a raster data model. The integration of data of different resolutions is theoretically equally simple: either the more detailed data set is aggregated to the level of resolution of the less detailed one or the less detailed is 'blown up' to match the resolution of the more detailed one. The first approach invokes all the known problems of cartographic map generalization [32], which are not yet solved automatically. The second approach produces results, but their interpretation is extremely tricky.

Politicians expect us to relate spatial data from social statistics with data describing the physical environment. Political decisions are made by people for people and the models must contain the assessment of the outcome of actions for people. A common but important example is the association of population counts with the urban area – population counts are collected for administrative subdivisions, which do not coincide with the boundaries of geographic units like urban (built-up) area. Theoretically, the problem is the lack of a uniform system of reference areas. The problem is further aggravated if changes in time are considered: data collected at time t1 for the administrative units are not directly comparable to the data collected at t2 which refer to the administrative units at this time, which are often changed (see [12], in particular the paper by Jostein Ryssevik [27]).

But even if the technical solutions are available to integrate data in a comparable format, other non-technical issues may make the integration difficult. The data may not be available for a number of administrative and legal reasons [19] and if it is available, it might be difficult to decide if it can be used. To assess the semantics and the quality of the data is again a question only experts can answer [14]. Data collected for different purposes – even if supposedly the same phenomena are observed – may differ substantially (e.g., terrain height collected by terrestrial and photogrammetrical methods; population counts from census or from daytime sampling).

Modeling of Process

Scientists and politicians are interested in the processes which change our world, not in simple collections of facts: There are few people who read the phone book with great interest – despite that it is a very extensive collection of facts! For an effective use of spatial data for science and policy making, collections of facts like the census results are important, but modeling of process is essential.

The GIS has never promised to deal with process modeling. The initial view was that GIS would manage the data and other tools would include the process models. There were concepts of systematically organized collections of methods for analytical and other purposes. Unfortunately, this concept did not materialize, because the interface between the process models and the data models were not resolved.

The impediments today are:

- GIS data is essentially static and presents a snapshot of the world;
- Lack of methods to discuss dynamic processes;
- Difficulty to link dynamic process models with the static spatial data collections.

The formal models we use today in GIS (but also in most other geographical sciences) are mostly static and do not include formal, generalized expressions of processes, which change a static situation (see discussion in next section). Simulation tools for 'dynamic modeling' [26], as used in other sciences (electrical engineering, economy etc.) are not widely used in geographical sciences. The lack of theory for the description of the process implies that the integration of process model and data management is complicated and no general-purpose solutions have been found yet.

LOGIC FOUNDATIONS TO HANDLE DATA ARE STATIC

The logical tools developed for the description of data – at least their logical structure – are extensive. There are the universally used concepts of relational databases, with the concepts of relational table, tuples and key, and the operations of selection, projection, join, union and difference, but there as old is the entity-relationship model, with entity and relations as the founding blocks.

These tools are based on and - in essence - do not go beyond their foundation in logic. In a fundamental early paper, Gallaire, Minker and Nicolas [13] gave a clean mathematical connection between databases and first order predicate calculus. It was shown that the logical framework is more powerful than relational algebra (which led eventually to practical extensions to include 'transitive closure' into the relational algebra). It made the knowledge about logical systems and the power they have applicable to the database world (for an extensive discussion of the design space for theories see [4]). The viewpoint spurred a large research effort to use Prolog or extensions of Prolog to explore data.

These efforts pointed out what cannot be modeled in a relational database. The standard logical assumptions in a RDBMS include the so-called 'closed world assumption' [25]. It says that the database is a complete picture of the world, and all things in the database are true, but also – and this is the crux for GIS – that facts which are not in the database are false. The closed world presupposes a complete knowledge of the world – which is achievable in administrative systems, but is never the case for GIS. With the closed world framework, it is not necessary to express negative facts because just leaving out a fact asserts its negation.

Integration of Temporal Aspects in Logic Based Formalizations

Logic is an essentially static system: it describes what is – implying 'at a given time' or sometimes 'always'. This can be extended to systems of temporal logic [33], which describes situations related to a point in time and a calculus can be formed (the 'situation calculus' of McCarthy [18]). Formulae can then express changes from one state to the next, and logical deduction is used to connect these. The so-called 'frame problem', i.e., the need to express that all facts not affected by a change formula remain the same, must be addressed. With these extensions, a predicate calculus based 'situation calculus' has a format and an expressive power, which is quite similar to the algebra based tools described next. This theoretical result has recently been verified by a M.Sc. thesis, where the dynamic characteristics of a land registration system was formalized, once using algebra and once using situation calculus [21].

ALGEBRA-BASED TOOLS CAN MODEL DYNAMIC SITUATIONS

An algebra is a description of a set of connected operations which apply to a set of types. This is the generalized definition of algebra, introduced by Birkhoff as 'universal algebra'. It generalizes the concept of an algebra, for example, the algebra over complex numbers with the operations +, -, *, etc. to situations where the operands of the operation have different type. We give here the well-known example of a stack, to demonstrate the principle.

A stack can accept elements pushed onto it – a simple example is a 'stack of plates' as found in any cafeteria. The operation top return the top element, the operation pop returns a stack with the top element removed (these two operations are usually merged in real computer implementations, but to achieve mathematical clarity and simplicity, they must be separated).

```
class Stack s a where          -- where s a is a
                                  stack of elements a
    new :: -> s a
    push :: a -> s a -> s a
    pop :: s a -> s a
    top :: s a -> a
```

Algebras capture both the notions of the abstraction of objects and the abstraction of operations. The concept of an algebra is therefore fundamental when we attempt to discuss changes as operations (not just as difference between two states). For the stack, the behavior of the operations can be fully explained by a few axioms like:

top (push (a, s)) = a — *- the top element after pushing an element onto the stack is the element which was pushed on.*

pop (push (a,s)) = s — *- the stack returned after pushing something onto a stack and then apply a pop to the result is the same as the stack before the push operation.*

The theory of algebra can be further abstracted to category theory [3]. In category theory, the axiom

pop (push (a,s)) = s

would be written as

pop. push = id,

stating that the combination of a *push* and a *pop* operation is the identity operation (the operation, which does nothing). Both algebra and category theory provide the instruments for the description of semantics without the infinite regress to 'previously defined terms'. They give tools which allow the definition of terms without relying on previously understood terms (which in turn, rely on previously defined terms – leading to an infinite regression). Algebraic tools are therefore useful for the definition of semantics, especially across language and cultural differences in Europe.

Object Orientation Tools

Object Orientation is a trend in software engineering, closely related in the theory to universal algebra and category theory. Object Orientation is seen as the solution for the software crisis, and the concentration on objects and related operations is fundamental for the programming of graphical user interfaces, but also for other code. It is supported by most programming languages currently used.

UML is the new conceptual tool for the designer and a set of programs (Rational Rose) is available [10]. The concepts are high level and have a strong object-oriented flavor. They can be used to design systems, but lead to very large diagrams. Code can be produced.

The current Object Orientation programming languages (e.g., C++) are designed with concentration on the efficiency of the implementations and the continuation of coding practice from previous languages. The languages have the advantages of an algebraic (abstract data type) approach, but they are complex to use and coding is therefore error prone.

Object Orientation and GIS

The advantage of Object Orientation methods for GIS have been seen early [8] and have been extensively discussed [34]. Object Orientation can be used for the design and programming of GIS software; it is expected that this should improve the quality of the code, but is otherwise not relevant for the user. Object Orientation can also be used for the design of the programmers or the user interface and in this respect is highly relevant. New GIS designs – mostly from Europe – are based on object oriented concepts, which are available for the user or the application programmer. A number of research and R&D projects have been exploring different methods of building Object Orientation based interfaces to GIS, some using object oriented databases.

For the user of a GIS it is essentially irrelevant if the program is built with an Object Orientation programming language or not. One might expect that the software would be easier to maintain, but this is not guaranteed. For the designer of applications, it is useful if the application programmer interface has an Object Orientation. The object-oriented design of the GIS can show at the user interface. Several projects (Geo2, Geoworks) have produced consistent sets of specialized GIS operations.

CURRENT EFFORTS TO ACHIEVE THESE GOALS

Activity today concentrates on the integration goal: how to build National Geographic Infrastructures and eventually also how to achieve a European GI. Standardization of data format has been mostly achieved. Lacking are process models.

Integration of Data Using Interoperability

Standardization has progressed, a number of national and international data transfer standards are available and are used in parallel to the standard formats of the major vendors. Data transfer is less desirable, as it transfers a static snapshot of the data – access using the rapidly expanding Internet to the updated data when they are needed is more attractive. The OpenGIS concept [5] and the related standardization allow access over the Internet independent of the software used to data, which is current.

Difficult today is the formalization of the description of the data (metadata), such that a potential user can find it and decide if the data another agency holds can be used to answer his questions. It is necessary to describe the phenomena the data describes, the quality of the data in general terms and the encoding. This is often summarized as meta-data (data describing the data) and closely linked to the semantics (meaning) of the data. It is widely recognized that describing meaning of data is closely related to the automated translation of natural language, which has been an elusive goal. To produce solutions, which can be used practically, solvable sub-problems must be addressed.

The current approaches to metadata, data quality and semantics are based on verbal (natural language) descriptions. Metadata typically takes the perspective of the data producer and describes – for lack of a better approach – the process used to collect the data. This is understandable only to a technically sophisticated potential user and does not lead to automatization required to wholesale integration of data from different sources as needed [30].

To achieve a formalization of metadata, the process of collecting the data and the process of using the data with respect to the real world must be modeled in a single framework. Then the correspondence between the phenomena in the world about which data are collected, and the phenomena in the world about which data are required to make a decision, can be linked and it becomes possible to decide on the fitness for use of the data automatically. This can be done for limited user communities, thus avoiding the need for a general solution of natural language understanding.

Process Models

Dynamic models for processes are widely used in economics but also in environmental studies [29]. Most dynamic models are aggregate models, which model the change in parameters describing accumulated quantities in a system. Current modeling is also either concentrating on the physical aspects of the environment or on economic aspects.

Cellular automata allow models which show spatial distribution of quantities – but these models are typically very small. The University of Utrecht has recently demonstrated quite large and detailed models[2]. Most recently, cellular automata models have been extended to include simplistic movable agents [9], which simulate behavior of human individuals in space.

Rapid advances in the raw computing power allow to increase the level of detail for such models. Missing are the software tools to routinely build and improve such models.

CONCLUSIONS

The current GIS are systems to systematically collect, manage and present static data of the world. They present snapshots of what is. This limitation to a static view of the world limits their usefulness in many cases. It excludes GIS mostly from the limelight of the public debate. To help the politicians with the pressing questions of today, GIS must be extended to include dynamic data and the process models such that 'what-if' questions can be answered.

In order to achieve this, the foundation of GIS must be extended from the current 'logic' based framework of current (static) database management to include processes. Algebraic methods, which coincide with the object-oriented trend in software engineering, are perfect tools to model change and process.

Algebraic methods hold promise to allow the modeling of the semantics of data – at least for limited user groups – based on formal models of data collection and decision (data use) processes.

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[2] See: http://www.frw.ruu.nl/pcraster/exmod/icgintro.html

Roswitha Markwart and Isolde Schlaisich to improve this text.

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