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Foundations of Geographic Information Science

International Conference, COSIT 2001
Morro Bay, CA, USA, September 2001
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Preface

The 5th International Conference on Spatial Information Theory, COSIT 2001, took place at the Inn at Morro Bay, California, USA, September 19-23, 2001. COSIT grew out of a series of workshops/NATO Advanced Study Institutes/NSF Specialist Meetings during the 1990s concerned with theoretical and applied aspects of representing large-scale space, particularly geographic or environmental space (this history is elaborated in the prefaces of previous COSIT proceedings). These are spaces in which (and on which) human action takes place, and which are represented and processed in digital geographic information systems. In these early meetings, the need for well-founded theories of spatial information representation and processing was identified, particularly theories based on cognition and on computation. This concern for theory provided an early foundation for the newly emerging field of geographic information science.

COSIT is not backed by any particular scientific society but is organized as an independent enterprise. The conference series was established in 1993 as an interdisciplinary biennial European conference on the representation and processing of large-scale spatial information after a successful international conference on the topic had been organized by Andrew Frank et al. in Pisa in 1992 (frequently referred to as "COSIT 0"). After two successful European COSIT conferences with strong North American participation (COSIT '93: Island of Elba, Italy; COSIT '95: Semmering, Austria), COSIT '97 moved across the pond to the United States, and was held in the Laurel Highlands, Pennsylvania. COSIT '99 returned to Europe, being held in Stade, Germany. The 2001 site of Morro Bay, on the central coast of California, continued the COSIT tradition of holding the conference at somewhat remote but accessible sites. The participants stay together for the full period of the meeting to promote intensive interactions without distractions.

The aim of COSIT is to bring together researchers from different disciplines for an intensive scientific exchange. This aim is facilitated by the presentation and discussion of a restricted number of papers in a single-track meeting format to ensure that all conference participants can get involved in the discussions of the papers. As has been typical, COSIT 2001 had about 100 participants, including

university professors, university and industry researchers, and students (including doctoral candidates). COSIT is very *multi*disciplinary, and as it has evolved, has become increasingly *inter*disciplinary, with researchers increasingly sharing methods and concepts across disciplines. COSIT attracts a great variety of disciplines. The most strongly represented have been different specializations within geography, computer science, and psychology, but contributions have also come from anthropology, architecture, biology, cartography, design, earth science, economics, engineering, history, law, linguistics, mathematics, philosophy, planning, and surveying and geodesy. This pattern occurred again in 2001. The continued vitality of the COSIT program in the future will be signaled by increasing disciplinary diversity and increasing disciplinary integration.

The conference program was determined by thorough peer-review of over 70 submitted full manuscripts by an international and interdisciplinary Scientific Committee. The reviews of the Scientific Committee were managed and evaluated by members of a Program Committee; in borderline cases, their judgments were in turn subjected to criteria of relevance, innovation, accessibility, and intellectual diversity by the Program Committee Chair. This interactive and time-consuming process was intended to equitably identify the highest quality scientific contributions, effectively communicated, that would provide a balanced and spirited intellectual basis for the meeting that took place. Undoubtedly this process led to the rejection of worthy contributions and perhaps the expression of implicit biases of the COSIT community. As Chair of the Program Committee, I take final responsibility for these unfortunate shortcomings.

To kick the conference off, a two-day workshop on Spatial Vagueness, Uncertainty, and Granularity took place at the Inn at Morro Bay on September 17-18. Organized by Matteo Cristani and Brandon Bennett, the workshop featured a series of papers on various aspects of this very important topic in geographic information science. COSIT proper started with a day of state-of-the-art tutorials on September 19. The tutorials were intended to help bridge boundaries between different disciplines involved in the conference. Tony Cohen presented "Qualitative Spatial Representations and Reasoning"; Mary Czerwinski and George Robertson presented "Navigating Information Spaces"; Jonathan Raper presented "Everything You Wanted to Know About GIS, But Were Afraid to Ask!"; and Jack Loomis and Andrew Beall

presented "Virtual Reality as a Research Tool for Studying Spatial Cognition". The second to fourth days of the conference were dedicated to the formal presentations and discussions of the research papers, including one invited Keynote Address by an eminent scientist each morning. On the fifth and final day, the "Doctoral Colloquium" was held. This was a forum for doctoral students to present and discuss their research with one another and with experienced research advisors. The goal of the colloquium was to give students experience presenting research in a public forum, and to give them feedback on their research and presentations. It also provided an opportunity for students and faculty to share insights on how to do a Ph.D. in an interdisciplinary field.

Science is a social process too. The exchange of ideas and cementing of collaborations do not occur just in formal sessions. At COSIT 2001, these social activities included coffee breaks and lunches, a welcoming reception on the 19th, "birds-of-a-feather" dinner on the 20th, an afternoon expedition to Hearst Castle in San Simeon on the 21st, and a banquet that evening. The organizers hope that other occasions during the five days were found suitable for the social intercourse that plays such an important yet informal role in the advance of knowledge.

I thank all members of the program, scientific, and organizing committees for making the meeting and this volume a success. Thanks also to the tutorial presenters for four stimulating and popular tutorials. The continued support of Springer-Verlag is gratefully acknowledged. The staff and setting of the Inn at Morro Bay made for an appealing week. The generosity of our sponsors is also appreciated. Finally, the core of any such enterprise is the participants and contributors. Their effort and enthusiasm made this worthwhile for me.

July 2001 Daniel R. Montello

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A Geographer Looks at Spatial Information Theory

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Abstract. Geographic information is defined as a subset of spatial information, specific to the spatiotemporal frame of the Earth's surface. Thus geographic information theory inherits the results of spatial information theory, but adds results that reflect the specific properties of geographic information. I describe six general properties of geographic information, and show that in some cases specialization has assumed other properties that are less generally observed. A recognition of the distinction between geographic and spatial would allow geographic information theory to achieve greater depth and utility.

1 Introduction

The term *geographic* might be said to refer to features and phenomena at or near the surface of the Earth, and if so, geographic information is information about such features and phenomena. More formally, geographic information might be defined as consisting of atomic pairs of the form <**x**,**z**> where **x** is a location in space-time, and **z** is a set of properties of that location [10]; or of information that is reducible to such pairs. Thus *geographic* refers to a spatial domain consisting of the Earth's surface and near-surface, and times extending forwards and backwards from the present. The term also implies a certain range of spatial resolution, from perhaps 1cm to 10km, that excludes any quantum or relativistic effects and is thus rigidly Newtonian.

In this sense geographic is a subset or specialization of *spatial*, which by extension refers to any spatiotemporal frame, and any spatial resolution, and also includes non-Cartesian spaces. The spaces defined by the human body, or an automobile, or the universe are instances of *spatial*. A spatial frame may contain the geographic frame, as in the case of the universe, but the geographic frame may also contain spatial frames that may move within it. Thus a human sees the geographic frame as a rigid and fixed structure, and other spaces as variously embedded within it. From this perspective the term *geospatial* is essentially identical to and redundant with *geographic*.

While *geographic* inherits many of its properties from *spatial*, it also adds new ones, and thus specializes the definition. If "spatial is special", as many have suggested [1], [13], then geographic should be even more special, and a theory of geographic information should be distinct from a theory of spatial information, inheriting all of the generality of the latter, but adding its own specifics. Thus when a geographer looks at spatial information theory, he or she logically asks not whether