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There has been healthy debate in the past decade about GI systems versus GI science. Today the debate is over and there is consensus about the requirement to use both in tandem. Read on to know more

GIS: A TOOL OR SCIENCE?

It is now over 45 years since Roger Tomlinson first introduced the term Geographic Information System (GIS) to describe the hardware, software, data, procedures and people that he and his colleagues had created for the Canada Land Inventory (Tomlinson 1998). Throughout the intervening years the field has developed beyond even the imagination of the early pioneers and has exhibited a high degree of dynamism with constant adoption, adaption and evolution. In the early years the concern was very much on the development of key information handling methods, tools and technologies (Coppock and Rhind 1991, Foresman 1998). Today, GI systems are able to deal with vast amounts of geographic information about the Earth and have quite sophisticated rules, relationships and processes encoded in the logic of the software used in the systems. Geographic information processing is now both effective and reasonably efficient.

But, what information should be used, how should it be processed, what is the most appropriate way to depict it, and what can we say about the results obtained? In the 1990s, Michael Goodchild suggested an alternative decoding of the GIS three letter acronym as Geographic Information Science (Goodchild 1992). This approach highlights the need to consider the fundamental principles that lie behind the use of system technologies and draws attention to the importance of considering the processes and methods that are used to sample, represent, manipulate and present information about the world. GI Science provides an overarching framework for using information theory, spatial analysis and statistics, cognitive understanding, and cartographic principles (Mark (2003) and Longley et al (2005)).

There has been healthy debate in the past decade or so about GI Systems versus GI Science (or as Wright et al (1997) called it: tool or science?). Today the debate is over and there is consensus about the value of both GI Systems and GI Science and a requirement to use both in tandem. GI Science allows us to consider the philosophical, epistemological and ontological contexts of geographic information and GI Systems provide the infrastructure, tools and methods for tackling real world problems within acceptable timeframes. It is possible to undertake GI science without GI Systems thinking and technology (for example using a pencil and paper, or a calculator), but it is very inefficient and unproductive. Similarly, using GI Systems without a clear understanding of the scientific context and key scientific methods will produce results which are suspect at best and may even be wholly inappropriate or even incorrect.

Throughout history many of the key developments in science across many disciplines have been closely linked with advancements in technology (McClellan and Dorn 2006). Today, a number of physicists are eagerly awaiting the early results from operation of the Large Hadron Collider in Switzerland so that they can model the science of sub-atomic particles and the origins of the universe. In the modern era all sciences are dependent to a greater or lesser extent on technology, tools and systems. Geographic information (GI) scientists also have their tools – GI systems – for storing data that describe the form of the Earth and for analysing and modelling the processes that explain how our planet functions. GI systems are a fundamental and integral part of pursuing GI science for without them it is not possible to manage and process the required volumes of data, and create the scientific visualisations, analyses and models that scientists need to pursue their work.

Longley et al (2005) outline the well used ordered support infrastructure for decision making: data, information, evidence, knowledge and wisdom. GI Systems can be used to turn data into information using the many tools and geoprocessing methods common to today's systems. GI science provides the underlying principles and contextual understanding of when to use the tools, how they work and the way to interpret the resulting information. More importantly, GI science gives us a framework and a workflow for allowing us to turn information into evidence and then knowledge. By applying knowledge successfully over multiple years, we can build our wisdom about the world. GI scientists are interested in examining the fundamental principles that underlie GIS, that is to say the basic models, methods and generally held tenants of geography and geographic information. They are also interested in using GI Systems in scientific investigations to create new geographic knowledge. Just as our understanding of GI Systems is developing at pace so too is our conceptualisation of GI science. In spite of its popular

Image Credit: Intellectual property of Tan Hua Seng Jimmy image as a provider of explanation and truth, science is a conquest that is fraught with intellectual, methodological, and practical difficulties and uncertainties. Even in hard-core sciences, there is debate about the overarching philosophy and validity of the objectivity of science and the method used. The so called 'science wars' of the 1990s (Ashman and Barringer 2001) in which scientists and critical theorists clashed head on flushed out a number of important issues that now form scientific foundational fabric.

There is of course not one science, but rather modern science is a compendium of sometimes closely juxtaposed and sometimes apparently divergent subjects and academic disciplines. Beyond the experimental branch of science to which reference has already been made, where empirical methods are used to discover knowledge, there is the theoretical branch in which mathematics and logic encode theories and are used to test proofs. A recent third branch has been added to the mix which is concerned with using computational methods to build and sustain a body of knowledge (Wolfram 2002).

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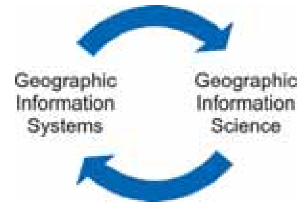
Computational science brings together three important elements: models, algorithms and simulations for investigating important problems; scientific software that is used to represent and manipulate scientific domain objects, relationships and processes; and computer and information science that advances the infrastructure of hardware, software, networks and data management for problem solving. GI science can be considered a branch of computational science that is developing and applying computational science approaches within the geographic domain.

To be considered 'scientific', geographic information processing methods must pass the general science tests of being objective, transparent, reproducible and verifiable by others using independent means. Fotheringham (2006:241) asserts that we need to accrue 'sufficient evidence on which to base a judgment about reality that most reasonable people would find acceptable.' There is no concrete here, but there must be a body of work that is robust enough to stand up to detailed scrutiny in the form of the peer review process. Only then can we establish a platform which both acts as a basic reference and a starting point for further scientific work and discussion.



Science itself is not static but is also evolving a pace and across the sciences a new organisational paradigm is taking shape that is changing the way science is being conducted and the way scientists are operating. In an interesting contribution to the way science has evolved in the modern era, Gibbons et al (1994) refer to existing ('old') science as Mode 1 and 'new' science as Mode 2. The timescales for developing and reporting scientific progress are decreasing, first from decades to years, and now with Web publishing on the rise, to months and weeks. Ideas about the central and singular importance of so-called 'blue-skies' research which is driven by curiosity are being challenged, and there is a call for more strategic, applied science that is relevant to society and able to generate economic value and impact.

There is a feeling also that the world needs not just critical thinkers who can break things down, but also adept problem solvers and designers that can build things up.

What type of GIS are we working with then? For some it is important to be clear about the camp in which they have pitched their tent: those preferring the high ground and intellectual satisfaction of dealing with scientific principles and methods call themselves GI scientists; those who have grown up with the field, are at ease with technological considerations, and who use or build software are more concerned that they are on the firm ground provided by effective and efficient GI Systems. The debate about GI Systems and GI Science really says more about scholarly interests and approaches to problem solving than it does about the need to subdivide the discipline. A concern with describing, explaining and predicting the patterns and processes on the surface of the Earth using whatever means are necessary and appropriate is perhaps a more noble subject for debate. ■