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Dynamics GIS: Recognizing the dynamic nature of reality

Dr. Tambe Sudhir Tukaram
Head of Department, Geography, Hon Balasaheb Jadhav Arts, Commerce & Science College, Ale, Junnar, Pune, Maharashtra, India

Abstract
Many countries have an abundance of geographic data for analysis, and governments often make GIS datasets publicly available. Map file databases often come included with GIS packages; others can be obtained from both commercial vendors and government agencies. Some data is gathered in the field by global positioning units that attach a location coordinate (latitude and longitude) to a feature such as a pump station. GIS maps are interactive. On the computer screen, map users can scan a GIS map in any direction, zoom in or out, and change the nature of the information contained in the map. They can choose whether to see the roads, how many roads to see, and how roads should be depicted. Then they can select what other items they wish to view alongside these roads such as storm drains, gas lines, rare plants, or hospitals. Some GIS programs are designed to perform sophisticated calculations for tracking storms or predicting erosion patterns. GIS applications can be embedded into common activities such as verifying an address. From routinely performing work-related tasks to scientifically exploring the complexities of our world, GIS gives people the geographic advantage to become more productive, more aware, and more responsive citizens of planet Earth.

Keywords: geographic, map, earth, interactive, positioning

Introduction

Making decisions based on geography is basic to human thinking. Where we go, what will it shall be like, and what shall we do when we get there are applied to the simple event of going to the store or to the major event of launching a bathysphere into the ocean's depths. By understanding geography and people's relationship to location, we can make informed decisions about the way we live on our planet. A geographic information system (GIS) is a technological tool for comprehending geography and making intelligent decisions. GIS organizes geographic data so that a person reading a map can select data necessary for a specific project or task. A thematic map has a table of contents that allows the reader to add layers of information to a baseman of real-world locations. For example, a social analyst might use the base map of Eugene, Oregon, and select datasets from the U.S. Census Bureau to add data layers to a map that shows residents' education levels, ages, and employment status. With an ability to combine a variety of datasets in an infinite number of ways, GIS is a useful tool for nearly every field of knowledge from archaeology to zoology. A good GIS program is able to process geographic data from a variety of sources and integrate it into a map project. Many countries have an abundance of geographic data for analysis, and governments often make GIS datasets publicly available. Map fi le databases often come included with GIS packages; others can be obtained from both commercial vendors and government agencies. Some data is gathered in the field by global positioning units that attach a location coordinate (latitude and longitude) to a feature such as a pump station. GIS maps are interactive. On the computer screen, map users can scan a GIS map in any direction, zoom in or out, and change the nature of the information contained in the map. They can choose whether to see the roads, how many roads to see, and how roads should be depicted. Then they can select what other items they wish to view alongside these roads such as storm drains, gas lines, rare plants, or hospitals. Some GIS programs are designed to perform sophisticated calculations for tracking storms or predicting erosion patterns. GIS applications can be embedded into common activities such as verifying an address. From routinely performing work-related tasks to scientifically exploring the complexities of our world, GIS gives people the geographic advantage to become more productive, more aware, and more responsive citizens of planet Earth.

Reality is dynamic. In fact, dynamics is so essential to reality that a static world is diffi cult to imagine. Space and time penetrate physical, biological, social, and humanistic inquiries. The accumulative nature of sensing and knowing our world arises through spatiotemporal experiences and interpretations. Some disciplines, such as geography and landscape ecology, emphasize the spatial dimension of world knowledge, and other disciplines, such as history and climatology, take time centric approaches to organize evidences of reality. However, it is the space-time integration that provides the explanatory power to understand and predict reality. In this article, I advocate for the concept of dynamics GIS to fundamentally rethink the role of geographic information science as a means to improve our understanding of reality and, through that understanding, to develop geographic information systems that enhance our ability to formulate interpretations, make informed decisions, and develop adaptation strategies for this ever-changing world. Before continuing, I would like to clarify my use of dynamics

GIS instead of dynamic GIS. The emphasis refers to the fact that a GIS can represent, analyze, and model geographic dynamics, not that a GIS is dynamic.

From a different angle, Gerald M. Weinberg's book entitled An Introduction to General Systems Thinking, published by Wiley in 1975, suggests three types of systems:

Small-number simple systems

The behaviors of elementary units can be accounted for individually by mathematical means or qualitative descriptors. Examples are the solar system and a class of students.

Large-number simple systems

Collective characteristics can be considered through statistics. The large number of elementary units in a system ensures that statistical parameters (means, variances, etc.) are representative of general characteristics in the system, due in part to central limit theory. That is, when we collect a large number of independent observations from a population, the means of independent samples from these observations (which are also representative of the population mean) will approach a normal distribution. Examples are the heights of individuals and the property values in a region. In these systems, phenomena are sums of a large number of independent random effects and hence are approximately normally distributed by the central limit theorem.

Middle-number complex systems

The number of members is too small to make statistical measures representative but is too large to account for individuals. Therefore, middle number complex systems require attention to members both individually and collectively.

Embedding Dynamics in a GIS

Now we can consider how dynamics may be embedded in a GIS. In the framework of general system theory and hierarchy theory, we need to consider wholes and parts and apply system concepts to develop GIS data models. We can start with a whole, and then identify its parts. Alternatively, we can start with elementary units to recognize wholes. The concepts of aggregation and disaggregation apply well here. The use of aggregation and disaggregation tools is becoming more and more common in GIS analysis for up scaling and downscaling geospatial data from local to regional (such as spatial interpolation) or from global to regional (such as multivariate spatial allocation). What has not been common is to store the data objects and their associations across spatial and temporal scales in ways that correspond to the proper underlying processes. In addition, we should be attentive to additional properties that emerge through aggregation, not just grouping points, lines, or polygons together. Systems or objects formed by aggregation should be characterized with additional properties appropriately.

Conclusion

In contrast to aggregation and agglomeration, narration produces narratives that play out a story in space and time. A narrative system connects geospatial lifelines via spatial and temporal markers to tell us what has happened, how it happened, and what could have happened. Constructing narratives from spatial and temporal data is very challenging, but its potential for understanding dynamics cannot be underestimated. Storytelling is said to be one of the most effective ways of learning, sense making, and communication, and some consider humans the only species with the intelligence to construct narratives. Regardless of the validity of these claims, maps-as the most popular communication means of geographic information-can be greatly enriched with narratives (perhaps semiotic forms) to add dynamics that shape reality. When a GIS is able to capture and handle information about geographic dynamics, we are empowered to study the world not just spatially or temporally but holistically from a system's perspective. A dynamics GIS needs to make the connections across multiple themes and scales through spatiotemporal integration and summarize discourses and mechanisms by which dynamics manifest and narratives unfold. Think about a GIS not only to show where things are but how geographies become.

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