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THE CONCEPTS OF "SPATIAL" AND "TEMPORAL" IN THE SCIENCES AND HUMANITIES

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Abstract: This article is about the concepts of "spatial" and "temporal" in the science and humanities. Many disciplines, including science, consider that space and time extend in separate dimensions, are inter-changeable, and form co-equal parts of a larger thing called space-time. We adopt a metaphorical mapping to talk about time with spatial terms that appear to follow a sagittal mental timeline. Program scheduling prior to the conference as well as steps to carry out the program during the conference) when detailing how the event takes place

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Relationships between space and time ewoke fundamental questions in the sciences and humanities. Many disciplines, including science, consider that space and time extend in separate dimensions, are interchangeable, and form co-equal parts of a larger thing called space-time. Our perception of how time operates in relation to space or vice verso influences how we represent space, time, and their relationships. The chosen representation, furthermore, predisposes what questions we can ask and what approaches we can take for analysis and modeling. [2]

There are many ways to think about space, time, and their relationships in science. This article synthesizes five broad categories:

(1) Time is independent of space but relates to space by movement and change; (2) Time collaborates with space to probe relationships, explanations, and predictions;

(3) Time is spatially constructed and constrained;

(4) Time and space are mutually inferable;

(5) Time and space are integrated and co-equal in the formation of flows, events, and processes. [5]

Concepts, constructs, or law-like statements arise in each of the categories as examples of how space, time, and their relationships help frame scientific inquiries in science and beyond.

To Albert Einstein, "time and space are modes by which we think and not conditions in which we live". Geographic Information Science (GIScience) has long adopted the perspective of space and time as reasoning frameworks to conceptualize and represent geographic worlds digitally for comprehension and prediction. Besides the absolute and relative conceptualizations of space and time, Science research delves into the relationships between space and time in cognition, representation, computation, and visualization of geographic information.

Space and time are subject to several conceptual dichotomies. Are they continuous (i.e., with infinite details) or discrete (i.e., with minimum units)? Are they absolute (i.e., existing on their own) or relative (i.e., determined by others)? Are they orthogonal (i.e., independent) or relational (i.e., related, connected, or dependent)? Are they separate (i.e., space and time) or integrated (i.e., space-time)? In Science, these conceptual dichotomies of space and time influence what we can represent, reason, analyze, and model, and consequently, how we may understand the world. Below is an unexhaustive list of the relationships between space and time. Central to the five items is the emphasis on the modes by which we think in science. [4]

While science researchers conventionally use the terms "space-time aquarium" and "space-time cube" interchangeably, the convenience of Space-Time Pattern Mining toolbox readily available in December 2014 quickly popularizes a raster view towards the space-time cube model.

Cognitively and linguistically, many temporal expressions adopt spatial terms. Examples include "the end is near" and "The difficult time is behind us." Although temporal analysis prevails in a much wider range of disciplines than spatial analysis, perception of time is more abstract than space. However, time and space share relational similarities, which allow us to comprehend the abstract concepts of time through spatial metaphors that reflect the relational structure in the more concrete domain of space. The common relational similarities between space and time afford languages to express and reason temporal relations in spatial metaphors. The overlapping relational structure between space and time empowers the use of spatial metaphors of time. [3]

We adopt a metaphorical mapping to talk about time with spatial terms that appear to follow a sagittal mental timeline. English, Arabic, and Spanish follow future-front/past-back mapping, Aymara in the Andes assumes the future-back mapping, and Chinese language consists of both future-front and future-back mapping. Furthermore, the spatial mapping may follow either the ego-moving or time-moving metaphor of time, such as "we are coming up on the New Year" or "the New Year is coming." A comparison of sighted and early blind participants shows that the ego-moving metaphor relies on visuo-locomotor coupling, and the blind participants have no mental representation of time along the sagittal plane.

Galton delimits spatial metaphors of time as "no purely spatial metaphor can capture the transience of time", and as "we only experience time at the time we are experiencing it". Expanding the ego-moving and time-moving metaphors, Moore overcomes the limitation by proposing space-motion metaphors with

(1) imagination-oriented deixis (i.e., the meaning of a word depends on its situation of utterance and reference. For example, the word "now" is "understood relative to an imaginary 'here and now',";

(2) ego- or field-perspective frames of reference for mapping locations;

(3) path configured between a mover (i.e., figure) and a location (i.e., ground) in which "sequence is position". Moore's space-motion metaphor of time is mapping from frames that involve space and time to other frames that involve time only. The space-motion metaphor brings spatial and temporal concepts together to organize temporal concepts effectively. [2]

Instead of being dimensional, time and space are intrinsic properties of flows, events, and processes. Flows are interactions of substances (e.g., air, water, goods, or people) or intangibles (e.g., services, messages, news, or ideas) between locations of origins and destinations. A flow takes time to travel from one location to another, and the time and locations are intrinsic to the existence of the flow. Likewise, events and processes inherit space and time as they initiate. GIS research commonly considers flows as spatial interactions. However, flows may be considered as special cases of events or processes. A mudflow can be a hazardous event. Flows of goods and services substrate urbanization processes.

There is a rich literature on events and processes, but universally accepted definitions of events and processes are lacking. In general, events stress happenings, but processes highlight a series of steps in development. However, an event (e.g., a conference) may become a process (e.g., siting, paper selection, room assignment, and program scheduling prior to the conference as well as steps to carry out the program during the conference) when detailing how the event takes place. Yuan encapsulates the scale dependence of events and processes in a hierarchy to represent components, phases, and life-courses in the development of individual complex geographic phenomena. With their intrinsic properties of space and time, the life-course of a phenomenon can experience contraction, expansion, bifurcation, merger, and dissipation. The hierarchical structure becomes the organization, contextualization, and delivery of geographic information about the evolutions and interactions that phenomena have encountered. Worboys catalyzes event-oriented approaches to support reasoning with temporal logics, situation calculus, event calculus, temporal interval calculus, and process calculi (i.e., formal models of concurrent occurrents).

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