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Constructal flow of constructal thinking

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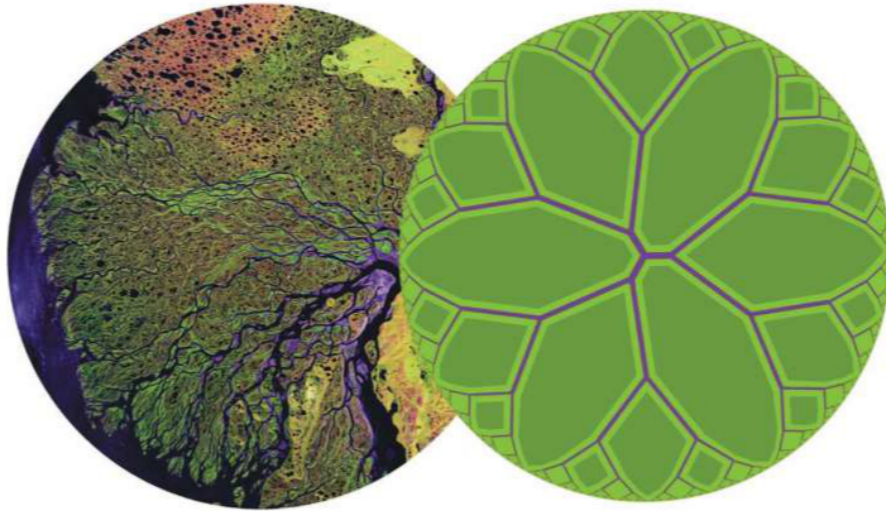
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Constructal flow of constructal thinking

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Abstract

The constructal law was first formulated at Duke University in 1996 [Bejan 1996]. Since then, it has spread around the world. Thousands of researchers have written about the constructal law, and many more have heard about it. This process of dissemination and reception can be interpreted as a point-to-area flow. The point of origin is Duke, while the area of destination is the entire world. Here, we study this point-to-area flow through computer-aided textual analysis. We identify hotspots of constructal thinking, we study their evolution in time, and we reveal active channels of communication between them. The point-to-area flow that we are able to quantify and visualize can be interpreted as a constructal point-to-area flow. We therefore decide to call it a constructal flow of constructal thinking. Our results presented in this extended abstract are preliminary.

Keywords: Geospatial analysis, Geospatial discovery, Constructal thinking.

1. Introduction

The term “constructal” was coined by Adrian Bejan in the mid 1990s [Bejan 1996]. Since then, it has gained increasing popularity. It is used in phrases such as “constructal law”, “constructal approach”, “constructal design”, “constructal evolution”, “constructal principle”, “constructal method”, “constructal tree”, or “constructal theory”. All of these phrases are part of a larger body of constructal

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thinking that has kept growing over almost three decades. We call this larger body of thought “constructal thinking”. The overall growth of constructal thinking is quantifiable for example through Google Books Ngrams, 2019 English corpus. Our main interest is to explore how constructal thinking has spread geographically. Here we present preliminary insights. Other researchers have reported insights similar to ours in a previous study, which was performed in 2017 based on a smaller dataset [Razera, Errera, Dos Santos, Isoldi, Rocha, Proc. Rom. Acad. Ser. A 2018, 105-110]. Our work replicates those earlier findings independently and with a larger and more recent dataset.

2. Materials and Methods

To study how constructal thinking has spread around the world, we begin by collecting 6,785 publications. This corpus is generated through an advanced search for the term “constructal” in the Scopus database.

We proceed by geocoding author affiliations as well as textual content taken from the abstracts. For the latter, we employ a self-developed method of geographic information retrieval published elsewhere. After removing all records that have no geocodable material, we remain with 6,619 documents.

To study geographical distributions, we employ an interactive interface that we previously developed for other research. This interface is designed to help us identify hotspots of research activity and discover and visualize active channels of communication between them.

In our visual, we draw each publication as a gradient line on the map. The line starts white in the place of the first institution that the publication is affiliated with. It then continues through all institutions that follow, becoming gradually darker. Finally, the line becomes green and goes through all geocodable content from the abstracts. Only little geocodable content was found in the abstracts, specifically. An interactive visual is available at bit.ly/constructallaw.

3. Results

Our five main preliminary insights are visualized in the five following figures.



Figure 1. Constructal thinking has spread all over the world, including India,Australia, Asia, South America, and Sub-Saharan Africa. The visual speaks for itself.

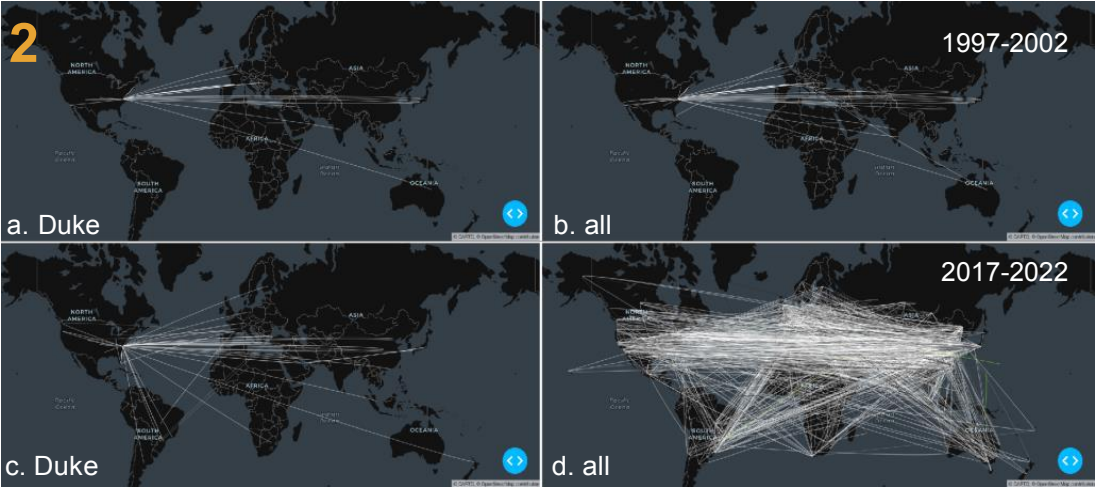


Figure 2. Constructal thinking has started at Duke University. Initially, most activity was seen at Duke, but the activity outside Duke has grown very much faster.

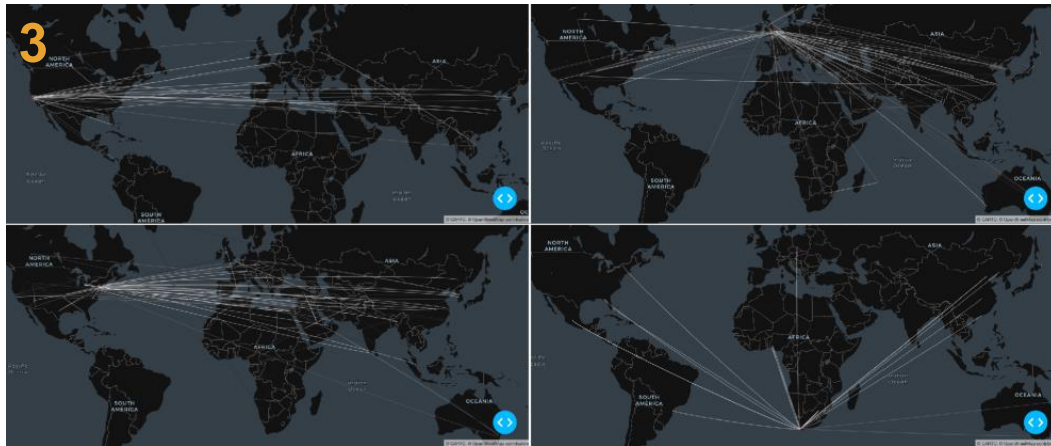


Figure 3. There are highly active centers of activity. The visual shows: San Francisco, New York, Cambridge, and Cape Town (50 km selection window around each).

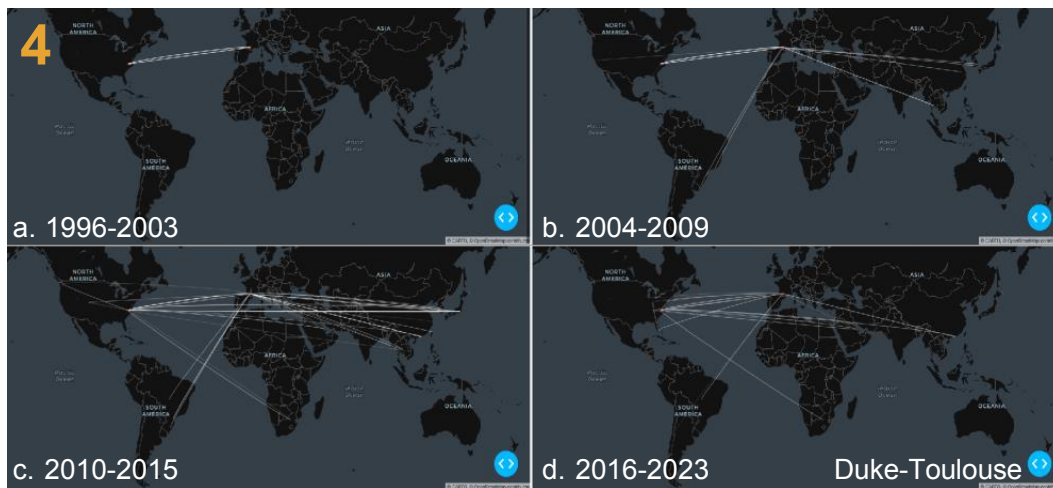


Figure 4. There are highly active paths of communication. The visual shows Duke-Toulouse, which has stayed active since the 1990s, reaching a peak in 2010-2015.



Figure 5. There may be breakaway groups. For example, from the many publications affiliated with Beijing none are affiliated with either Duke or Toulouse.

4. Discussion

Constructal thinking brings authors together, uniting them in an evolving network. As the network evolves, hierarchies with highly active centers of research and highly active paths of communication become increasingly apparent. These hierarchies may help authors gain increasing access to the information that flows through the network. At the same time, the shape of the network branches out to allow for an increasing amount of freedom. This evolution towards both clearly pronounced hierarchies and increasing freedom is what the constructal law has been formulated to describe [Bejan 1996, 2019, 2023]. Thus we can say that we observe a constructal flow of constructal thinking.