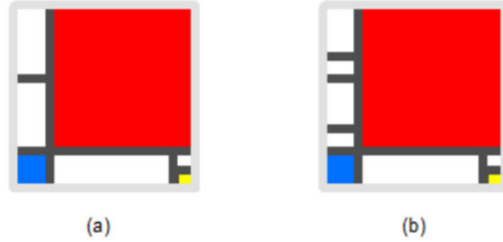


A Map Is a Living Structure with the Recurring Notion of Far More Smalls than Larges

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Which painting is more living?



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Acknowledgement

- AutoCarto 2020 Workshop on Living Structure as a Scientific Foundation of Maps and Mapping.
- Dr. Terry Slocum, the principal author of widely used textbook: *Thematic Cartography and Geovisualization*
- Jiang B. and Slocum T. (2020), A map is a living structure with the recurring notion of far more smalls than larges, *ISPRS International Journal of Geo-Information*, 9(6), 388, <https://www.mdpi.com/2220-9964/9/6/388>

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Axwoman and head/tail breaks

Axwoman	ArcGIS
Living structure view	nonliving structure view
Far more smalls than larges (scaling law)	More or less similar (Tobler's law)
Meaningful things like streets	Meaningless things like points, lines and polygons
Head/tail breaks	Natural breaks
Auto-determined by the data	Partially human determined
Bottom up thinking	Top down thinking
Reflecting scaling law	Reflecting Tobler's law

Jiang B. (2013), Head/tail breaks: A new classification scheme for data with a heavy-tailed distribution, *The Professional Geographer*, 65 (3), 482-494.
Jiang B. (2020), Axwoman in a Nutshell, https://www.researchgate.net/publication/337656401_Axwoman_in_a_Nutshell

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Why this paper?

- The **lagged state** of the art of maps and mapping based on **mechanistic world view** of Descartes, or **absolute and relational views** of space of Newton and Leibniz.
- Some fundamental issues:
 - What is the nature of maps?
 - How do maps work?
 - What does the image of the map look like?
- Some deeper issues:
 - Subjectivity versus objectivity (which is dominated?)
 - Quality of maps (as an opinion or as a fact?)

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What in this paper?

- Living structure as the scientific foundation of maps and mapping.**
- The **third/organic** view of space: space is neither lifeless nor neutral but a living structure capable of being more living or less living.
- The state of the art of maps and mapping.
- Not only the territory but also the maps are a living structure.
- The map is an iterative system, being the map of the map of the map, and so on endlessly.

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So what (implication of this paper)?

- Under the concept of living structure, all small-scale maps can be automatically generated from a single large-scale map or database.
- **Objectivity** should be favored over subjectivity in maps and mapping; and
- Maps are largely about **truth of the underlying living structure** of the territory or the data.
- Goodness of maps is a matter of fact rather than an opinion or personal preference.
- Beyond the maps: goodness of space, goodness of art...

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Two induced facts about a map

- A map has a similar structure to the territory,
- A map is the map of the map of the map, and so on endlessly

Two important characteristics of maps should be noticed. A map is not the territory it represents, but, if correct, it has a similar structure to the territory, which accounts for its usefulness.

Alfred Korzybski

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What is a living structure?

- Both the map and the territory is a living structure.
- A living structure is with far more small substructures than large ones.
- A tree is a living structure, for it has far more small branches than large ones.
- The notion of living structure beyond biology, both a dead and alive thing can be living structure as long as the recurring notion far more smalls than larges retains.



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The notion of far more smalls than larges

- **NOT** just “more smalls than larges”, but
- “Far more smalls than larges”;
- **NOT** just once, “far more smalls than larges”, but
- Multiple times, “far more smalls than larges”.
- So it is the **recurring** notion of **far** more smalls than larges.



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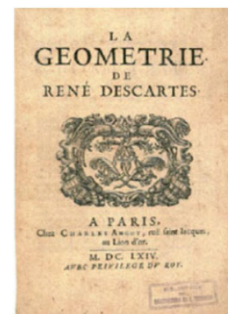
Mechanistic worldview

- *The mechanistic idea of order can be traced to Descartes, about 1640.*
- *If you want to know how something works, you can find out by pretending that it is a machine.*
- *However...*
- *It was because of this kind of Cartesian thought that one was able to find out how things work in the modern sense.*

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Euclidean and analytical geometry



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Leonhard Euler and graph theory

The diagram shows a complex shape with four nodes labeled A, B, C, and D. Node A is at the top, B at the bottom, C on the left, and D on the right. There are multiple edges connecting these nodes, forming a network that resembles a bridge structure. Below the main diagram is a simplified graph with nodes A, B, C, and D and edges connecting them in a specific pattern.

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Space is represented mechanically

The left diagram shows a 2D space divided into colored regions (pink, green, purple, blue) with a yellow path winding through them. The right diagram shows a grid of squares colored in the same pattern, representing a raster approximation of the space.

Vector Source: Psu.edu **Raster**

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Two devastating results of Cartesian world view

- The first was that the “I” went out of our world-picture. The picture of the world as a machine doesn’t have an “I” in it. The “I”, what it means to be a person, the inner experience of being a person, just isn’t part of this picture.
- The picture of the world we have from physics, because it is built only out of mental machines, no longer has any definite feeling of value in it: **value** has become sidelined as a matter of opinion, not intrinsic to the nature of the world at all.

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The third or organic view of space

- Space is neither lifeless nor neutral but a living structure capable of being **more living or less living**.

Alfred Whitehead (1861–1947)

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City as a fractal or living structure

(Hamburg circa 1850)

Johnson S. (2002), *Emergence: The Connected Lives of Ants, Brains, Cities, and Software*, Penguin Books Ltd: London.

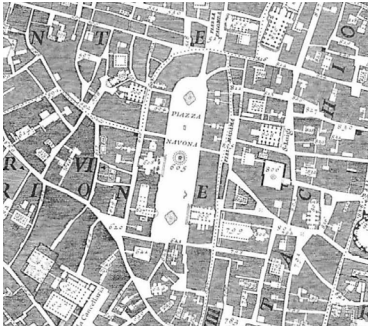
17

Amsterdam – fractal or living structure

Quillien J. (2008), *Delight's Muse on Christopher Alexander's The Nature Of Order: A Summary and personal interpretation*, Culicidae Architectural Press: Ames, Iowa.

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The Nolli Map as a living structure



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Venice – fractal or living structure



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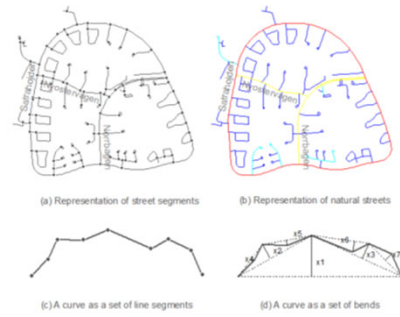
Two camps of thinking on the universe



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Non-living versus living structure views



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The English country garden corner

- The corner is a living structure, which is part of the garden, which is part of the house, which is part of the street, ..., which is part of the universe.

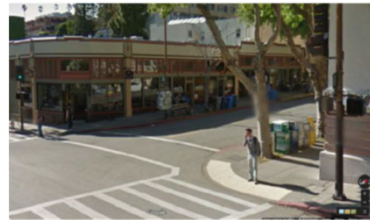


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The Berkeley street corner

- The street corner is a living structure, which is part of the street, which is part of the city, which is part of the Earth, ..., which is part of the universe.



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A ten-city cluster as a living structure

(a) (b) (c)
(d) (e) (f)

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Two papers: with or without a tiny dot

Alexander C. (2002–2005), *The Nature of Order: An essay on the art of building and the nature of the universe*, Center for Environmental Structure: Berkeley, CA.

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Cognition of a paper with a tiny dot

(a) (b) (c) (d)
(e) (f) (g) (h)

Alexander C. (2002–2005), *The Nature of Order: An essay on the art of building and the nature of the universe*, Center for Environmental Structure: Berkeley, CA.

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The structure of these two papers (physics)

Jiang B. (2016), A complex-network perspective on Alexander's wholeness, *Physica A: Statistical Mechanics and its Applications*, 463, 475–484. Reprinted in Ye X. and Lin H. (2019, editors), *Advances in Spatially Integrated Social Sciences and Humanities*, Higher Education Press: Beijing.

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Scaling law – spatial heterogeneity

- There are **far more small things than large ones**, across all scales ranging from the smallest to the largest in geographic space or the Earth's surface or any living structure in general.
- Importantly, the notion of **far more small things than large ones** recurs multiple times rather than just once at different levels of scale.

Jiang B. (2013), The image of the city out of the underlying scaling of city artifacts or locations, *Annals of the Association of American Geographers*, 103(6), 1552–1566.

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Tobler's law – spatial dependence/homogeneity

"everything is related to everything else, but near things are more related than distant things."

- Nearby things tend to be **more or less similar** or related

Walter Tobler in front of the Newberry Library, Chicago, November 2007

(1930–2018)

Tobler W. (1970), A computer movie simulating urban growth in the Detroit region, *Economic Geography*, 46, 234–240.

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These two laws complementary each other

- **Scaling law:**
 - Spatial **heterogeneity**
 - Interdependence
 - Far more **smalls than larges**
 - Available across **all scales**
 - Scale-free, long tailed
 - Disproportion (**80/20**)
 - Complexity
 - Non-equilibrium
- **Tobler's law:**
 - Spatial homogeneity
 - Spatial **dependence**
 - More or less similar things
 - Available in **one scale**
 - With scale, short tailed
 - Proportion (**50/50**)
 - Simplicity
 - Equilibrium

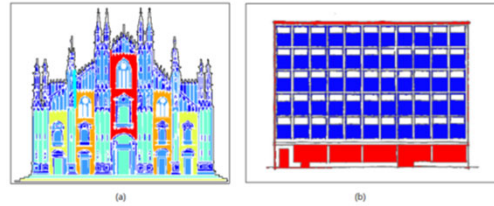
Jiang B. (2019), Living structure down to earth and up to heaven: Christopher Alexander, *Urban Science*, 3(3), 96, <https://www.mdpi.com/2413-8851/3/3/96>

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The left is more beautiful than the right

- The more the substructures, the more beautiful.
- The higher the hierarchy, the more beautiful.



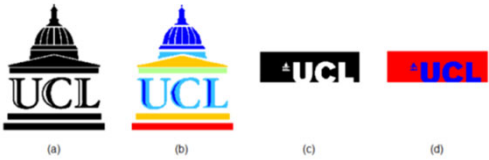
Jiang B. (2019), Living structure down to earth and up to heaven: Christopher Alexander, *Urban Science*, 3(3), 96, <https://www.mdpi.com/2413-8851/3/3/96>

32

32

The left is more beautiful than the right

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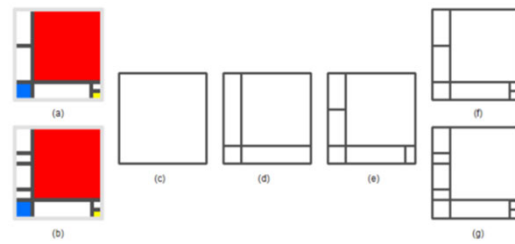


Jiang B. (2019), Living structure down to earth and up to heaven: Christopher Alexander, *Urban Science*, 3(3), 96, <https://www.mdpi.com/2413-8851/3/3/96>

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Why (b) is more beautiful structurally than (a)?



Jiang B. and Huang J. (2020), A new approach to detecting and designing living structure of urban environments, working paper at University of Gävle, Sweden

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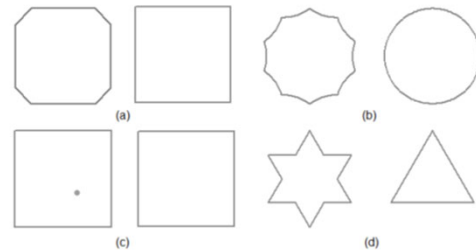
Jackson Pollock's Blue Poles is a living structure



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Goodness of space as a fact rather than an opinion



Jiang B. (2019), A recursive definition of goodness of space for bridging the concepts of space and place for sustainability, *Sustainability*, 11(15), 4091; <https://doi.org/10.3390/su11154091>

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Head/tail breaking a data set [1, 1/2, ..., 1/39]

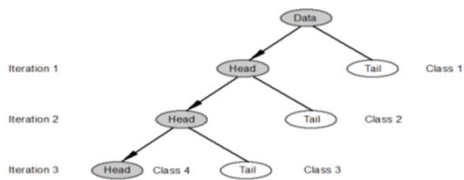


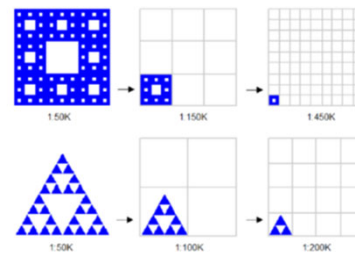
Table 2: Statistics of the head/tail breaks process of the 39 numbers

Number	Mean	# head	# tail	% head	% tail
39	0.11	9	30	23%	77%
9	0.31	3	6	33%	67%
3	0.61	1	2	33%	67%

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Head/tail breaking a pattern

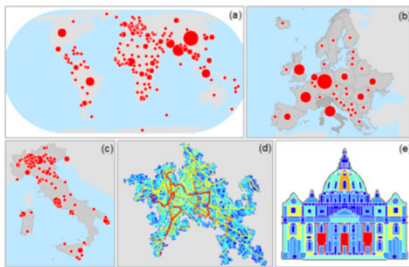


Jiang B. (2015), The fractal nature of maps and mapping, *International Journal of Geographical Information Science*, 29(1), 159–174.

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The Earth's surface is a living structure



Jiang B. (2019), Living structure down to earth and up to heaven: Christopher Alexander, *Urban Science*, 3(3), 96, <https://www.mdpi.com/2413-8851/3/3/96>

39

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More empirical studies and practice

- Jiang B. (2018), Methods, apparatus and computer program for automatically deriving small-scale maps (A granted United States Patent WO 2018/116134, PCT /I B2017 /058073)
- Jiang B. (2017), Line simplification, Richardson D., Castree N., Goodchild M. F., Kobayashi A., Liu W., and Marston R. A. (editors, 2017), *The International Encyclopedia of Geography*, John Wiley & Sons: New Jersey, 4059–4065, DOI: 10.1002/9781118786352.wbieg0005.
- Jiang B., Liu X. and Jia T. (2013), Scaling of geographic space as a universal rule for map generalization, *Annals of the Association of American Geographers*, 103(4), 844–855.

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The eternity of the wholeness

- One of the most renowned reformed pastor evangelists **Dr. Stephen Tong** used to say “**Living God**” while referring to the Lord of the universe.
- One of the most renowned quantum physicists **Dr. David Bohm** died on October 27th, 1992. That day, he was working as usual at Birkbeck College, London. Just before he left his office, he phoned his wife and was quite excited, saying that “**I feel I am on the edge of something...**”.
- I believe now Bohm had reached the eternity or united with the universe or the wholeness or living structure.

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Conclusion

- The living structure exhibits the inherent hierarchy of far more smalls than larges, and it is the **living structure that makes maps and mapping possible**.
- Human cartographers have long been – subconsciously or unconsciously – guided by living structure for map making or map reading, but it is time to explicitly establish **living structure as a formal concept**.
- It is essentially the conventional mode of thinking based on Euclidean geometry and Gaussian statistics that makes **automatic map generalization virtually impossible**.
- Maps **can, should and must** be treated as a scientific product.

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Thank you very much!
(questions and comments?)