FROM EVERYTHING CALLED CHICAGO SCHOOL TO

THE THEORY OF VARIETIES

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ABSTRACT

A.D.F. Hamlin's Chicago School was rooted in the untrammeled freedom of art in America and offered bold, utilitarian solutions for early skyscrapers with vertical lines rising uninterrupted from the basement to the roof. Thomas Tallmadge responded to Hamlin, but redefined the term, inspired by the great American planes and their horizontal lines. Sigfried Giedion returned to the initial definition and was followed as well as opposed by many later writers. Meanwhile, William James witnessed the birth of a Chicago School of Thought around John Dewey's pragmatist philosophy. Robert Park became the central figure in a Chicago School of Sociology that explored human nature. And in economics, Milton Friedman crusaded for free markets and free choice. Furthermore, there were Chicago Schools of Fiction, Broadcasting, Advertising, and many more. This present dissertation collected, cataloged, and evaluated everything called Chicago School. Based on this data, it is possible to tell from a collective point of view what successful Chicago Schools were. In addition, Sigfried Giedion's school marks a turning point in history. After Giedion's essay was published, multiple schools of thought rose to fame together. Why did this trend only come into action a century after the first mentions of a Chicago School? To understand this delay, I developed a theory based on the variability of definitions and the responsiveness of audiences. Mathematically, the Theory of Varieties builds on equations previously employed in other disciplines. In the Humanities, it may help evaluate the evolution of cultural trends.

CHAPTER 1
INTRODUCTION

Much scholarly, philosophical, and literary work engaged with the proposition that all life is shaped by evolution.[1] However, when applying evolutionary theory to the Humanities, the limitations in record keeping and computational power together with the almost impenetrable complexity arising from the phenomena of semiotics often limited past work to speculation. Barriers to testability were imposed by difficulties in collecting data, the ambiguity of form, the implicit dimensions of meaning, and the problem that form and meaning had to be interpreted under conditions of cultural change. In other words, the evaluation of topics in the Humanities requires corpus building, disambiguation, interpretation, and contextualization. This present dissertation brings together formal and semantic evaluations in the service of understanding cultural change and distributions of importance within the public discourse. After developing a theory based on axioms, the dissertation employs the empirical method of research and tests hypotheses against aggregate, historical data. Judging from the logical structure, the here developed Theory of Varieties has equivalent formulations in the Life Sciences, namely in biology, genetic information theory, and physical chemistry. Furthermore, in the Social Sciences, similar theories are also found in economics and political economy. Thus, the Theory of Varieties bridges Science and Humanities. In the latter, the theory may serve in the systematic and quantitative evaluation of past, present, and future cultural trends.

Besides the theoretical contribution to a newly emerging field of quantitative studies in the Humanities, this present dissertation also offers new historiography for the Chicago School. Separate monographs were dedicated to

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[1]Peter Godfrey-Smith, "Cultural Evolution," *Darwinian Populations and Natural Selection,* Oxford: Oxford University Press, 2009.

W. Brian Arthur, *The Nature of Technology, What It Is and How It Evolves?"* New York: Free Press, 2009.

Steven Johnson, *Where Good Ideas Come From, The Natural History of Innovation,* New York: Riverhead Books, 2010.

Matt Ridley, *The Rational Optimist, How Prosperity Evolves,* Notting Hill, 4th Estate, 2010.

Tim Harford, *Adapt, Why Success Starts with Failure,* New York: Farrar, Straus and Giroux, 2011.

Kevin Kelley, *What Technology Wants,* New York: Penguin, 2011.

Dan Costa Baciu, "Umberto Boccioni Architettura Futurista 1914," Master Thesis, ETH Zurich, 2011.

the Chicago School in sociology, economics, and architecture;[2] but in comparison to past scholarly work, my dissertation offers an ensemble view of the term Chicago School uniting the different disciplines. The research was primarily led by the question what a successful Chicago School was; and this question was answered on the background of the complete history of publication. Deploying methods from Data Science and with the support of a major digital library as well as several research centers and grants, this present dissertation collected over a hundred thousand books and periodicals referencing the Chicago School and disambiguated, interpreted, and contextualized hundreds of lines of thought that entered the public discourse over the last two centuries. As a central part of my work, I gave much attention to Sigfried Giedion who wrote on the Chicago School at a pivotal point of its history. Many of Giedion's elements of narration were also found in the work of other earlier and later authors across the disciplines, but after Giedion's essay was printed and reprinted, the Chicago School found broader audiences than ever before. Most surprisingly, however, multiple Chicago Schools not only co-existed, they were as influential as they were heterogeneous.

This dissertation was partially supported by: the Fulbright Program, the Swiss National Science Foundation, the Swiss American Society, and IIT's College of Architecture. In addition, the scientific support of the HathiTrust Research Center and the Cognitive Computation Group made much of the quantitative work possible in first line. I would like to acknowledge the personal support of my doctoral advisors:[3] Harry F. Mallgrave, Michelangelo Sabatino, Vedran Mimica, Alla Vronskaya, and Jack Snapper; the senior advisors who supported my collaboration with the HathiTrust Research Center: Irina Matveeva, David Van Zanten, Johnathan Mekinda, Michael Golec, Dan Roth; the scientific staff and decision makers of the HathiTrust Research Center: Boris Capitanu, Eleanor Dickson, Ryan Dubnicek, Robert McDolald, J. Stephen Downie, Peter Organisciak; the scientific programmers from the Cognitive Computation Group: Chase Duncan and Mark Sammons; and the fifteen collaborating students from IIT's Department of Computer Science under the lead of Irina Matveeva. I would also like to thank the scholars who accepted my

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[2] Martin Bulmer, *The Chicago School of Sociolog: Institutionalization, Diversity, and the Rise of Sociological Research,* Chicago: University of Chicago Press, 1984.
Jan Van Overtveldt, *The Chicago School: How the University of Chicago Assembled the Thinkers Who Revolutionized Economics and Business,* Chicago: Agate, 2007.
Rolf Achilles, *The Chicago School of Architecture, Building the Modern City 1880-1910,* New York: Shire, 2013.

[3] The names are listed in chronological order of my first contact.

invitation to serve as keynote speakers, respondents, paper session chairs, and committee members to the Chicago Schools graduate student symposium that I co-organized at Illinois Institute of Technology in partnership with the 2017 Chicago Architectural Biennial on the topic of my dissertation. These are, in addition to scholars mentioned above: Gwendolyn Wright, John Zukowsky, Rolf Achilles, Alexander Eisenschmidt, Thomas Leslie, Alison Fisher, Joanna Merwood Salisbury, Christopher Vernon, Eric P. Mumford, Kevin Harrington, Claire Zimmerman, Robert Bruegmann. I would also like to express my dearest gratitude to my parents for their support, and especially thank my father to have served as my first reader.

The Layout of the Dissertation. After this introduction, readers might wonder whether this dissertation is a contribution to historiography or Data Science. The answer is both. First, the work starts by collecting, cataloging, and interpreting the history of the Chicago School. Second, the methods are refined for this given purpose. Finally however, a theory applicable beyond disciplinary boundaries is developed. These three contributions work in concert, but the chapters have nevertheless each its own focus. The numbering starts with one for the introduction. Chapter two sketches and contextualizes the Theory of Varieties. Chapter three goes into the theoretical details and draws the logical connection between small and large-scale phenomena. Chapter four evaluates the Chicago Schools following a selection of themes that were important in other chapters as well, but the format of a more traditional narrative is chosen. Chapter five contains the thematic and theoretical conclusions of the dissertation. Chapter six gives a more detailed overview of the employed methods for those who wish to study the results in more detail. Finally, the dissertation is accompanied by the publication of data for the purpose of replicability. Furthermore, readers may also survey the original, copyrighted records together with our own metadata through Bookworm, HTRC's new, sustainable online interface.

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March 2018, Dan C. Baciu, ORCID 0000-0002-0043-5616

CHAPTER 2
THEORY AND CONTEXT

Varieties of thought permeate all realms of culture. Past and present traditions are built upon multitudes of ideas and philosophies. Search processes yield sweeping lists of results. Rules are circumvented by exceptions and outbreaks. Research questions lead to multiple answers and discoveries. Oftentimes, breadth and open-mindedness prevailed against monotony, control, and restriction. In the late 15th century, Studia Humanitatis earned a leading position at Italian universities when the reading of canonical literature was complemented by the study of rare manuscripts. The unconstrained acceptance of a broad, classical heritage led to the co-existence of competing positions: there were historians and theoreticians, prolific writers and book-hunters, as well as empiricists and idealists. The heterogeneity of themes and narratives set Humanism to the forefront of early modern movements; however, diversity and transformation are inherent to all fields of intellectual pursuit.[4] Scholarly evaluations of terms such as the Beautiful rarely elicit one definition that matches all narratives. Instead, frequent characteristics and overlapping categories are discovered. Individual narratives each borrow from shared thought that critics and historians delineate in painstaking detail. Even aspirations in the search for the Divine lead to multiple types of experience. William James, an American philosopher whom we shall encounter later again in this chapter, cautioned against dogmatism and the one-sided view of the subject. His book, *Varieties of Religious Experience,* gained attention as a pioneering work in the scholarly evaluation of the religious mind. James posited that many characters were alternately of equal importance. Individual experiences drew upon a common storehouse of human emotions.[5] Following the American philosopher Daniel Dennett's book *Elbow Room: The Varieties of Free Will Worth Wanting,* even the belief in free will comes in multiple alternatives. More broadly, in life and culture, everything is variable. Collections

[4] Robert Grudin, "Humanism," *Encyclopedia Britannica*.

[5] William James, "The Varieties of Religious Experience," lecture series, University of Edinburgh 1901-1902, lecture 2.

In James's pragmatist take, Government was equally complex. "One person would define it as authority, another as submission, another police, another army, another assembly, another a system of laws; yet all the while it would be true that no concrete government could exist without all these things, one of which is more important as one point in time and others at another."

of art, music, and architectural plans typically display more variety than actual novelty. In the process of design, intermediary steps result in manifold alternatives and slight rethinking. Markets are flooded by similar and yet different products, and, in economics, market values are believed to arise from small differences between related products, or in technical terms, from marginal utilities. In physical chemistry and biology,[6] varieties are the basis of evolutionary adaptation taking place in any population of plants, animals, cells, or viruses. No matter where we look, varieties abound, and yet, what can we learn from this apparent truism? As an experimental setup, this dissertation deals with almost everything that has been called "Chicago School" in the United States. First, a historical synopsis is drawn from the systematical and critical evaluation of a massive collection of published records. Almost all texts that mentioned the Chicago School in the last two centuries are gathered; and the many unique narratives are categorized into groups of overlapping definitions. Evaluating explicit as well as implicit attributes among those definitions leads us to the observation that our Chicago Schools are a cohesive collection of thought that reveals many alternatives and slight variations. Finally, by subsequent logical deduction and empirical testing, we develop a theory for the interpretation of the collective history of ideas and find its equivalent formulations in the life sciences. In this broader sense, the Theory of Varieties developed in this dissertation may be interpreted as a theory of almost everything.

2.1 Theory: Collecting Everything Called Chicago School

Let us build a corpus containing everything called Chicago School. What would we be able to learn from these records? Literature referencing the Chicago School is found in multiple fields of study and fills hundreds of thousands of pages, making it impossible for a scholar to manually review all of it. One might also fear that variability and transformation makes theory unachievable all together. Conversely, narrowing down the corpus at the beginning of the research might result in objectionable consequences because the research topic is little understood at the beginning of a new project. Despite these challenges, one action is always possible: we can catalog our records. We will find Chicago Schools of *fiction*, of *big city flavor*, of *Jazz*, of *Friedman*… What then is the Chicago School? Some scholars point to remarkable historic high-rises, others attempt to debunk it as a myth. Using methods from Data

[6] As well as information theory in biological fitness landscapes.

Science, and with the support of many remarkable institutions over a three-year period, this present dissertation disambiguated hundreds of lines of thought that entered the public discourse over the last two centuries. These lineages shared historic roots and often iterated a common ethos. A brief synopsis of the Chicago School will soon reveal how ideas were spread, translated, and transformed. However, before we dive into history, let us formulate a hypothesis. Imagine two records that are identical with the only difference that one contains the term Chicago School while the other does not. The first adds a layer of interpretation by building a reference to a larger discourse; a line of criticism is established. However, sustaining this coherence comes to a cost at the narrative's complexity. Mentioning the Chicago School might, for example, require justification or the introduction of some conceptual background. One can readily recognize that creating a lineage complicates reality. In one way or the other, persistent lineages must compensate this incurred cost with some utility to either authors, readers, or both. An obvious question then is why and when lineages are maintained over historic breaks. Logically thinking, breaks at the same time disrupt coherence and challenge previously established utility.

2.2 History: A Synopsis of the Chicago School

Growth, speculation, and the establishment of new standards shaped Chicago's history as early as 1850. The small city of thirty thousand inhabitants was soon to become a busy, dirty metropolis. In consequence to the demographic change, new educational programs rose in the city in lack of trained physicians, but East Coast academics uttered concern. In their eyes, the teaching standards in the Midwest were too loose. Chicagoans in turn defended themselves by claiming that their school reconciled education and public needs. The *Chicago School* offered practical solutions that adapted education to real world problems. It is probable that this reasoning reflects a mere side-note of an interrupted line of thought. The curricula changed few years later, after the enactment of licensing and the acceptance of the germ theory of disease.[7] Nevertheless, the debate illustrates very early uses of the term Chicago School together with the ethos of bridging theory and practice that was later so often iterated beyond disciplinary boundaries.

[7] Thomas N. Bonner, *Medicine in Chicago, 1850–1950: A Chapter in the Social and Scientific Development of a City,* Chicago: University of Illinois Press, 1991. [2nd ed]

Although many records might have vanished, an editorial of the weekly Chicago Times already called for a school of architecture in 1879: “What the city needs are architects who have been reared in what may be termed a Chicago atmosphere,” the editor wrote and continued explaining what “an architect of this school should be.” A decade later, a group of architects was already known as the Chicago School when Henry Van Brunt wrote two articles to endorse his peers.[8] He propounded that a number of contemporary commercial buildings were first signs of a new synthesis that boldly unified academic principles and engineering.[9] Most prominently, this idea was echoed in two books that dominated the architectural discourse for decades. Although each of these publications is unique in its scope, their authors discussed the Chicago School in similar terms. A.D.F. Hamlin, an early Columbia professor, published the first textbook of the history of architecture written in the United States and mentioned the Chicago School in five reprints, from 1900 to 1907.[10] The term referred to a group of Midwestern practitioners that successfully integrated the engineer's work in the façades of their high-rises, as opposed to the Eastern School that focused on artistic expression in the tradition of the Parisian École des Beaux-Arts. In Hamlin’s narrative, the Midwest emanated the aura of a central place in the middle of the continent that amalgamated trends and allowed architects to experiment with new, promising, and useful solutions. Among his contemporaries, Hamlin became known to have opened the eyes to countless students. His book became influential in establishing the study of modern architectural history at American universities.

Three decades later, Sigfried Giedion confirmed the relevance of architectural history for a new generation of practitioners and urbanists that had

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[8] Dan Costa Baciu, “Sigfried Giedion: Historiography and History of Reception on a Global Stage,” editors Iris Aravot and Dana Margalith, *Ar(t)chitecture,* Haifa: Technion Faculty of Architecture and Urban Planning 2016, 40-52.

[9] The discussion in the press can be documented back to 1893 with: John Willis Abbot, “The Makers of the Fair: A Family Paper,” *The Outlook* 48, 18. November 1893. The text contains a full mention of the term “Chicago School of Architecture,” and the content is similar to Van Brunt’s article the same year. These early Chicago School mentions were never included in scholarly bibliographies. They were re-discovered with data mining tools as part of this present research.

[10] Alfred Dwight Foster Hamlin, *A Text-book of the History of Architecture,* New York: Longmans Green and Co, 1895, reprints Oct. 1900, Oct. 1902, Sept. 1904, June 1906, Nov. 1907. Through the architect and program founder William Robert Ware an acquaintance of Van Brunt’s. Hamlin’s Textbook was first published 1896, the same year of Banister Fletcher’s History of Architecture. Publishing in London, Fletcher mentioned a similar set of Chicago buildings, although his argumentation differed and did not reference the Chicago School.

previously attempted to break with the past. Even more frequently than Hamlin, Giedion lectured and wrote on the Chicago School claiming its relevance as the first large synthesis of art and engineering.[11] Giedion's first public talks provided a well-chosen palette of early high-rises. His later lectures often focused on Louis Sullivan's Auditorium Building, a mixed-use theater, hotel, and office block that had already been included in Van Brunt and Hamlin's work. The Auditorium was simultaneously a home for the arts and an early tall building.[12] Art and engineering were physically united. Giedion's Chicago School essay became an often-read part of his most hailed and frequently reprinted book, *Space, Time and Architecture*. Carl Condit, a historian at Northwestern University, made a whole book, and then an expanded book out of Giedion's essay, and Ludwig Hilberseimer, Colin Rowe, and Manfredo Tafuri also continued along those lines. Much of the later work departed from previous historiography by emphasizing the practical aspects of the Chicago School and letting art and engineering drift apart. However, other recent work returned to the older imagery, calling the Chicago School "a marvelous mix of reality and romance."[13]

Reinterpretation is not limited to this example. Generally speaking, in the history of publication, dissemination and transformation went hand in hand from the early beginnings. In 1889 and 1893, when Van Brunt wrote his above-mentioned articles, his ideas assumed a different format with the establishment of architectural education in the city of Chicago. Two institutes, one rooted in the arts, the other focused on engineering, found each other in their venture to unite the two disciplines into one joint program that was named The Chicago School of Architecture. Van Brunt's peers, including Daniel Burnham and Louis Sullivan, went in and out of the school's doors. The density of diverging narratives was certainly visible in 1908 when Thomas Tallmadge, the school's new lecturer in architectural history, redefined the Chicago School, slightly

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[11] Sigfried Giedion, "The Danger and Advantages of Luxury," *Focus* 3 (1939), GTA Archive 43-T-15-1939-1.

—— , lecturer. "America influences Europe: The Chicago School and Frank Lloyd Wright." Charles Eliot Norton Lectures, Harvard University, 1939, GTA Archive, 43-T-13-7-1-8-2.

—— . *Space Time and Architecture.* Boston: Harvard University Press, 1941.

—— . Lectures. GTA Archive, 43-T-13-3-1; 43-T-13-1-5-5; 43-T-13-1-19-4; 43-T-13-7-1-8-2.

[12] In terms of height, the Auditorium building of 1889 with Sullivan's office at the tower's top measured 238 feet (73m). W.W. Boyington's Board of Trade built in 1885 was slightly taller at 320 feet (92m).

[13] Jay Pridmore quoting Renzo Piano in a doctoral methods seminar held at IIT by Michelangelo Sabatino and the author of this dissertation.

departing from all previous work.[14] He mentioned Sullivan as a key figure, but mostly referred to a group of colleagues that built suburban mansions. Although the Auditorium building was mentioned in the essay, it was only considered a precursor for the designs of the Chicago School. Tallmadge's generation became particularly influential in the rise of architectural licensing first established in the state of Illinois in 1898.

As the many Chicago Schools evolved side by side, they kept being identified as counter-movements to the East Coast, or as circles that synthesized theory and practice. In 1903, the realist writer William Dean Howells asserted the existence of a Chicago School of Fiction constructing it around Chicago writers and their literary characters, that were "fine as frank," and whose pure thought flew in fountains of slang.[15] In comparison to Boston, New York, and San Francisco, in Chicago, these commonplace people were rendered "so frankly, so boldly, and yet so delicately defined, so unmistakably shown, so undeniably true." [16] Chicago's writers were leading the way. Independently, a Chicago School of Thought was asserted the same year. University of Chicago celebrated ten years of establishment, and John Dewey dedicated the decennial publication of the Department of Philosophy to William James who in turn responded with an essay that he entitled *The Chicago School.* James lauded Dewey's *Studies in Logical Theory* as "a promising *via media* between the empiricist and transcendentalist tendencies."[17] For Dewey and his Chicago colleagues, Thought made only sense in "readjusting and expanding the means and ends of life." In an approach all too typical for Chicago, solutions were only meaningful as answers to perceivable problems of modern life and society. We shall see towards the end of this chapter how this philosophy was later employed in sociology and economics. Dewey also positioned his pragmatism at the middle ground between other contemporary tendencies, iterating the ethos of Chicago as a melting pot of thought. In the ensuing decades numerous lineages spread from James and Dewey's

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[14] Thomas Eddy Tallmadge, "The 'Chicago School,'" *The Architectural Review* 15.4 (1908), 69-74.

[15] W.D. Howells, "Certain of the Chicago School of Fiction," *The North American Review* 1903, 740.

[16] W.D. Howells, "Certain of the Chicago School of Fiction," *The North American Review* 1903, 740, 746.

[17] William James, "The Chicago School," *Psychological Bulletin* 1, (1904), 1. James wrote on the Chicago School independently from Howells. As Michael Buxton observed in his 1984 essay on James's influence on Dewey, James repeated references to Dewey's new Chicago School in letters dating between March and November 1903. Michael Buxton, "The Influence of William James on John Dewey's Early Work," Journal of the History of Ideas 45, 3 (1984), 462.

intellectual sparks. As one might expect, sociology, economics, and law did not always promote the same values—and among the many undertaken efforts in the city, certainly not all were named Chicago School. Over time, past ideas found new adaptions but, as always, much change was unpredictable.

What then is the Chicago School? At this point, we can only say that it is a set of values that was disseminated, translated and transformed. Although the term sometimes served as a derisory epithet used by East Coast practitioners, in the rise of Midwestern awareness, authors appropriating the term could hope to establish continuity and gain legitimacy in the public discourse on modernization. A phenomenon of coherence, lineages drew upon shared ideas and displayed more variability than actual novelty.

2.3 Theory: Cataloging and Counting the Collected Records

Given that the Chicago Schools were disseminated and transformed in an unplanned manner, a systematic has to be developed to map an initially unknown number of overlapping definitions. This present dissertation developed a bottom-up procedure by relying first on the positions taken by the authors. Aware of the co-existence of multiple Chicago Schools, authors specify their context in 40% of the mentions. Our corpus contains a “Chicago School of Burnham,” “of 1880,” “of 1890,” etc. These and similar expressions have been employed by authors to distinguish their definition of the term Chicago School from other possible variants. Of course, the phrase “Chicago School of 1920” is not a complete definition. The real meaning of any term is mostly implicit. However, given that authors use an attribute such as “1920” as a specific difference to other close variants, we may also use this clue as a first baseline to disambiguate.[18] After this first step, some of our records are still ambiguous. There exist multiple Chicago Schools of 1920, namely in sociology, criminology, and other fields. Therefore, the systematic is refined by further subdividing the records into additional categories as well as merging groups of too similar results. After this iterative process of labeling, we can classify the remaining 60% of the mentions by techniques described in chapter six.

The result obtained from counting the frequencies of occurrence appears somehow familiar. If we enumerate the numbers in decreasing order, we find a

[18] We may assume that authors are mostly well informed about close definitions because they are publishing. Oftentimes, authors copied phrases like the above mentioned from previous work, in which case a lineage is historically given unless referencing and departure from that definition occur at the same time.

power-law probability distribution. Frequently mentioned schools are surrounded by a vast spectrum of rare variants. Ultimately, most schools are mentioned only a couple of times. We can find among them the Chicago School "of Tenors," of "humorous baseball reporters," of "bone breakers," of "speculators in New York." The power laws are often observed empirically, but it remains unclear why they emerge naturally in those different contexts. Technically speaking, power-law probability distributions simply print as straight, falling lines on double logarithmic paper, but the history of their discovery is much more complicated than their shape.

2.4 History: The Pareto Distribution, Zipf's law, and Topic Modeling

Vilfredo Pareto started his work in economics in his forties but his late career proved particularly productive. Pareto optimality, efficiency, principle, and other terminology later chosen in honor of his name is still in common use. Working in a discipline previously dominated by moral philosophy, the trained engineer stood out from his contemporaries by adopting the use of aggregate data. Entire pages of his publications are filled with mathematical equations, graphs, and charts that are almost as diverse as the illustrations of modern-day textbooks.[19] In 1893, after teaching in Italy, Pareto was appointed professor at University of Lausanne, Switzerland, and three years later, he discovered a power-law probability distribution today known as the Pareto distribution.

The pyramid of income is the most straightforward, although not completely accurate metaphor to illustrate the meaning of Pareto's discovery.[20] Slices cut through a pyramid from the top towards the bottom increase following the quadratic function. However, Pareto explained that the sizes of income classes increase in a much more drastic, exponential manner leaving less room for the middle class.[21] Income disparity suddenly became quantifiable.

Multiple political systems and types of data led to the same conclusions.[22] Jean-Baptiste Estoup formulated an application in stenography,

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[19] Benoît Mandelbrot, Richard L Hudson, *The (mis)behavior of markets : a fractal view of risk, ruin, and reward,* New York: Basic Books, 2004, 153.

[20] Pareto already used the pyramid metaphor to illustrate his discovery. It was later also used as a model by the British economist Harold Lydall.

[21] The pyramid would assume the shape more of a circus tent. Pareto wrote, the tip of a spinning top.

[22] Micheline Petrusyewycz, "L'histoire de la loi d'Estoup-Zipf: documents," *Mathématiques et sciences humaines* 44 (1973), 41-56.

and, independently, the law also found its way into the German Avantgarde. There, the Pareto distribution was reformulated by Felix Auerbach, a professor of physics and patron of the arts. Edward Munch painted him a portrait in 1906; and an icon of modern architecture, Walter Gropius built him a house in 1924.[23] Henry van de Velde, Ernst Ludwig Kirchner, Max Bruch, Richard Dehmel were among the frequent guests. Wassily Kandinsky and Paul Klee admired Auerbach's explanation of Albert Einstein's Theory of Relativity. The two book titles, Auerbach's *Space and Time, Matter and Energy* and Giedion's *Space, Time and Architecture* are strikingly similar.[24]

Empirically studying the sizes of cities, Auerbach observed a compelling regularity: in any chosen area, there were few big cities surrounded by many smaller dwellings, villages, and hamlets. If the population numbers were sorted in decreasing order and multiplied by their enumeration rank, Auerbach received a constant value. In other words, Auerbach took the population sizes of the cities, then multiplied the largest number by one, the second by two, the third by three, and so on. From every multiplication, he received the roughly same value. Although Auerbach also rediscovered the validity of this power-law probability distribution for income data, his article of 1913 did not cite Pareto's work.[25] Pareto and Auerbach's descriptions also built on different metaphors. Pareto spoke of pyramids. Auerbach chose to print tables with constant values. Nevertheless, both professors observed the same phenomenon. Only twenty years later, in February 1933, Auerbach suffered a second heart attack and is believed to have committed suicide together with his wife after the Nazi party seized power in Germany. During that period, the Pareto distribution was popularized as Zipf's law in the United States.

After studying in Bonn and Berlin, George K. Zipf obtained the position of Lecturer in German at Harvard University, and, in a series of articles starting with 1932, he further developed the regularity previously observed by Pareto, Estoup, and Auerbach. Zipf first counted word frequencies, but he followed Pareto and Auerbach's line in recognizing that the distribution was found in many other collections of data as well, which led him to an increasing number of socially

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[23] Barbara Happe and Martin S. Fischer, *Haus Auerbach: Von Walter Gropius mit Adolf Meyer/ Of Walter Gropius with Adolf Meyer*, Tübingen: E. Wasmuth, 2003.

[24] Felix Auerbach, *Raum und Zeit, Materie und Energie,* Leipzig: Dürr'sche Buchhandlung, 1921. Quoted from: Ulrich Müller, *Raum, Bewegung und Zeit im Werk von Walter Gropius und Ludwig Mies van der Rohe,* Berlin: Akademie Verlag, 2004.

[25] Felix Auerbach, "Das Gesetz der Bevölkerungskonzentration," *Petermanns Geographische Mitteilungen*, 59, 1913, p. 73-76.

relevant applications. Zipf's distribution became a law that linked geography, society, literature, art, and engineering. Sigfried Giedion was among the readers.[26] In his last published article, Zipf was calling for a scientific analysis of culture, building on a longer tradition that had originated in the Vienna School. Zipf's essay brought together semiotics, psychology, and art history. His aim was to move historiography away from the concept of what he called "holymen," heroes who were thought to dominate the discussion, to empirical and population studies. However, Zipf fell sick and died after three months of agony in February 1950.[27] Giedion was equally interested in the anonymous history of every day life, but he probably remained unconvinced by a theory that was never completed.

Most notably, all attempts to explain the Pareto distribution were unsuccessful. Already 1924, the British statistician Udny Yule had proposed an explanation that was later called Preferential Attachment. Yule's idea was that big groups grew faster than small ones. Following this assumption, rich individuals were more likely to find well-paid jobs, and writers preferred using words that are already frequent. However, if this were the main cause for the Pareto distribution, the same social circles, the same technologies, the same companies would indefinitely keep their previously assumed rank. Such stability is rarely if ever observed. In contrary, culture is constantly changing. Already the German philosopher Immanuel Kant wrote about scientific revolutions in his 1781 book *Critique of Pure Reason.* In the twentieth century, the term "paradigm shift" was coined by Thomas S. Kuhn. Equally well known is Michel Foucault who studied public discourses in his book, *The Order of Things,* and arranged knowledge around changing "epistemes." Today's readers might be even more familiar with online platforms that quantify cultural change such as trends.google.com. Culture is constantly changing.

In comparison to Kuhn and Foucault's philosophies, Yule's theory is a theory of inertia. It says that rich are rich and stay rich. The first we already know; the information was gained from the initially given data. The second might not hold true. Many people actually value novelty over age. Yule's belief in stability did not spring from nowhere. He based his theory on the quantitative work of the botanist John Christopher Willis who counted the number of species

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[26] Martin James, Harry Holtzman, letter to Sigfried Giedion, gta archives ETH Zurich, Sigfried Giedion Estate, 43-K-1949-12-30. Interrelations Art, Architecture, Engineering, scheme of the Article of George K. Zipf attached to the letter.

[27] "Zipf Dies After 3-Month Illness," *Harvard Crimson*, September 27, 1950. [http://www.thecrimson.com/article/1950/9/27/zipf-dies-after-3-month/]

included in various genera and found that the numbers displayed a Pareto distribution. The problem was that, erroneously, Willis and Yule assumed that the oldest genera were also the richest and most heterogeneous ones. Yule's calculations were flawless, but the assumptions were false. It is interesting to note that Yule titled his work *A Mathematical Theory of Evolution.* Ronald Fisher, J.B.S. Haldane, and Sewall Wright formulated such a theory at the time by uniting Darwinian evolution with Mendel's theory of inheritance. We shall encounter their theory again later when discussing fitness landscapes.

Although Yule did not find empirical evidence to successfully support his theory in biology, he proposed it again twenty years later, applying it to language. However, in language the problems are significant enough to be easily brought to light. For example, Yule's theory produces results that are independent of semantics. The equations do not require any information about the meaning or the form of words to predict frequencies of occurrence. However, the latter strongly depend on the first. For example the usage of the words scenery, mountain, hill, and river has changed over the last centuries, and the changes are parallel because the three words signify things that are related. Sceneries, hills, mountains, and rivers were more frequently mentioned in the nineteenth century than they were a century earlier or later. Furthermore, every decade brings dozens of neologisms, words that stand for new types of objects or experiences. With Yule's theory, neologisms would rarely become frequent words; and that process would happen by chance, independently of the individual meaning of each neologism in contemporary society. Internet is a frequent word of the twenty-first century, but with Yule, that frequency is a random effect. The Internet would be a farce devoid of meaning or utility.

Herbert A. Simon, an economist trained at University of Chicago retook Yule's theory in 1955. Simon posited that empirical data in biology, sociology, and economics had nothing in common other than the Pareto distribution. Hence, the explanation of the Pareto distribution had to be a probability mechanism independent of meaning. Benoit Mandelbrot, known today for his work on fractals and chaos theory, immediately criticized Simon's work. Nevertheless, Derek J. de Solla Price applied Yule's theory on books in 1976; and in 1999, Albert-László Barabási and Réka Albert, two Hungarian-American physicists rediscovered Yule's theory and popularized it under the name Preferential Attachment. Their work was especially influential on our present understanding of networks. Many researchers in their line used computers to artificially build networks. If the structural features of the artificial networks were similar on average to those observed in real networks, then it was believed "within the bounds of possibility that the same mechanisms were also operative

in their real-world counterparts."[28] In the networks built by Barabási, Albert and their followers, the number of links per node followed a Pareto distribution. Given that the Pareto distribution made the networks look similar on different scales, the two researchers called their networks scale free. However, already in 2001, Barabási's student Ginestra Bianconi proposed a model based on fitness rather than Preferential Attachment that better reflected reality. Bianconi's fitness model was inspired from Sewall Wright's fitness landscapes and proposed that nodes had actual utilities and that the number of links acquired by every node was only a secondary result of those utilities. In 2016, Thong Pham, Paul Sheridan, and Hidetoshi Shimodaira proposed and evaluated a unified model that brought together Preferential Attachment and Bianconi's fitness model. Studying parts of an online social network however, the team concluded that the network had been primarily shaped by node fitness rather than Preferential Attachment.[29] In addition, the Japanese research also made a step forward in searching for real criteria to infer fitness. Finally in 2018, Anna D. Broido and Aaron Clauset evaluated nearly thousand social, biological and technological networks and found that the vast majority of ninety-six percent offered insufficient or no support for Preferential Attachment because their distributions of links per nodes did not follow the Pareto distribution in first line. This present dissertation will not rule out Preferential Attachment. It is very curious that Preferential Attachment seemed a plausible phenomenon to so many researchers, yet its imprint on empirical data seems less quantifiable than expected. As a solution to this problem, we will later assume that, in culture, the effects of Preferential Attachment are held in check by habituation, a phenomenon that renders audiences unresponsive to repeated messages that are irrelevant to them. The dynamics of the interaction between Preferential Attachment and habituation will appear complex and unpredictable.

Another figure interested in power laws, Benoit Mandelbrot also searched for the mathematical conditions that logically lead to distributions that are shaped similar to Pareto's. Research in Mandelbrot's line contradicted Yule by proposing that the curve was a result of a process of optimization. Building on Zipf's work, Mandelbrot proposed to take into account the shape of the words

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[28] Thong Pham, Paul Sheridan, Hidetoshi Shimodaira, "Joint estimation of preferential attachment and node fitness in growing complex networks" *Nature Scientific Reports,* doi:10.1038/srep32558.

[29] Thong Pham, Paul Sheridan, Hidetoshi Shimodaira, "Joint estimation of preferential attachment and node fitness in growing complex networks" *Nature Scientific Reports,* doi:10.1038/srep32558.

although not their content. Thus, the only point in which Yule and Mandelbrod agree is in the proposition that Pareto's distribution arises independently of meaning or semantics. However, we have already shown that this proposition suffers from obvious limitations. If Mandelbrot were correct that the frequency of occurrence of a word was explainable from its shape alone, then, changes in pronunciation would be the main reason for cultural change. The word “car" would not have become more frequent in the twentieth century because of its meaning and utility, but because of changes in spoken accent. It is certainly true that long, frequently used words such as “automobile” or “Internet,” are often replaced by shorter versions or abbreviations such as “car” or “net.” However, the choice of a short version of the term can be interpreted as a result of its popularity rather than vice versa.

Finally, a third theory incorporated semantics, but proposed that generic terms are more frequent than specific ones. This principle would generate a Pareto distribution if, for example, the word animal would occur as frequently as all members of its class: dogs, cats, horses, etc. Or another example, the word scenery would occur as often as mountains, hills, and rivers together. Manin, who published this theory in 2008, realized that this was by far not the case. We shall see that specific terms tend to be less frequent than generic ones, but this hierarchical phenomenon is only a side effect besides horizontal loss in importance as well as terms that are more generic but nevertheless rarer. Furthermore, the critique that applied to Yule and Mandelbrot, also applies to Manin. If their logic would explain the Pareto distribution in first line, then history would not change the rank of words such as cars, Internet, and other neologisms. Manin’s work is nevertheless groundbreaking in that it also suggested that the importance of terms might depend on their correlations. We shall continue in that direction.

Steven Piantadosi, an American researcher in computation and language, reviewed the Pareto distribution and its explanations in 2015 and came to two important conclusions.[30] First, Pareto and Zipf’s method of collecting data is statistically incomplete, but little previous work had addressed this issue. Estoup’s work might be one of the few exceptions. As a result, the many different collections of data appeared similar to each other simply because of the way in which the data had been collected. Can you always tell the object from the contour of a shadow? Piantadosi found a trick to restore statistical completeness. However second, and more dramatically, Piantadosi's

[30] Steven T. Piantadosi, “Zipf’s word frequency law in natural language: a critical review and future directions,” 2015.

systematical evaluation led to the conclusion that no theory truly explained the law. Past work misapplied effort in looking for categories of mechanisms that lead to power-law probability distributions rather than explaining regularities in human language and culture.[31]

In Piantadosi's evaluation, if one were to apply any of the past theories to natural language, it would emerge that all books have the same frequent terms because the theoreticians did not assume that texts each deal with a chosen set of real-world problems or topics. You would not more frequently find "Wind" in books about sailing and "transportation" in those about urbanization. This very common feature of language is used in Latent Semantic Analysis (LSA), a successful text mining technique that was continuously developed in the industry since 1997. LSA distinguishes categories of documents from each other by assessing co-occurrences of words. Today, LSA's more recent variant, Latent Dirichlet Allocation (LDA) is probably best known as topic modeling.[32] LDA outperformed LSA precisely by adding weight to the assumption that texts contain a limited number of shared topics. Thus, wind is a frequent word in a book about sailing because it is closely related to that topic. A model equivalent to topic modeling was proposed in genetics for the evaluation of population structures just a few years earlier to positive review.[33]

The theoretical framework of topic modeling and those of power laws cannot afford to contradict each other. Developing theory in response to problems observed in the industry was so much of an ethos of the Chicago School that the present work may in part be seen to continue this lineage. In this sense, one of our contributions is to reconcile the theory of power laws with topic modeling. As this chapter already revealed, our approach differs from any previous work by assuming that there is a public discourse. In particular, we will assume that terms have utilities that depend on their relevance within a given discourse. This observation is not only in accord with topic modeling together with its equivalent formulations in the analysis of population structures in genetics, it will also appear to be relevant in the theoretical interpretation of the Pareto distribution.

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[31] Steven T. Piantadosi, "Zipf's word frequency law in natural language: a critical review and future directions," 2015.

[32] Mark Girolami, Ata Kabán, "On an equivalence between pLSI and LDA," *SIGIR* (2003). Chris Ding, Tao Li, Wei Peng, "On the Equivalence between Non-negative Matrix Factorization and Probabilistic Latent Semantic Indexing," *Computational Statistics and Data Analysis* 52 (2008), 3913-3927.

[33] Jonathan K Pritchard, Matthew Stephens, Peter Donnelly, "Inference of population structure using multilocus genotype data," *Genetics* 155 (June 2000), 945–959.

2.5 Theory: Correlations and Utility among Variants

In our experimental setup, we collected all records mentioning Chicago Schools and categorized them. Among the many unique narratives, recurrent definitions were disambiguated and their frequencies were counted. Our next step is to estimate specific differences between any two definitions. Based on this step, we may also estimate utility. Let us first identify in which ways the collected definitions are conceptually related to each other. In the process of writing, when authors develop their Chicago School narratives, they go through a set of choices that others have been faced with before them. Most frequently, their decisions will adhere to their knowledge, often but not necessarily reflected by the tradition they remain within. In this sense, most of their choices coincide with those taken by precursors. Yet, at a certain point, an author may search for alternatives and make a choice that might be artistic and not fully explainable but leads to a conceptually different and potentially useful result. This new choice makes the piece of writing stand out from previous work. Authors who change the meaning of terms are mostly aware of possible confusion; and they might use a modifier to help the reader disambiguate. Expressions such as "the Chicago School of the late 1930s and early 1940s," fulfill precisely the purpose of indicating specific differences. We already used these clues to disambiguate, but in addition, we must also evaluate implicit changes in meaning. For this purpose, it is necessary to interpret the meaning of definitions within their historic context. Individually, every single author might attempt to change existing definitions as little as possible because new choices require justification. Nevertheless, over the course of time, new variants depart from initial definitions by the degree to which new choices are accumulated.

A similar picture can be drawn in retrospect, after the narratives have been written and published. A group of close definitions, in logic also called a Species, are correlated among each other by sharing numerous common attributes, which are referred to as their Genus. Differentia then denominates those specific attributes that distinguish departing variants. Defining by Genus and Differentia dates back to Aristotle. *The Organon*, Aristotle's work on logic, gives a detailed account on the proper use of generic, specific, and accidental attributes. Later, the Linnaean taxonomy and other major systematics were laid out by the logic of Genus and Differentia, Species and Varieties. Towards the end of the Age of Enlightenment, Hegel noticed that logic had remained almost unchanged since antiquity, although it led to dramatic development in the scientific understanding of the world.[34] In addition, Differentia not only served to

[34] Georg Wilhelm Friedrich Hegel, *Wissenschaft der Logik,* 2014, preface. First edition 1812.

disambiguate definitions, it was also used to estimate utility, both in the natural and social sciences. During the second half of the 19th century, Darwin based his theory of evolution on the natural selection of favorable mutations. Darwin's idea was that random, slight variations, although mostly detrimental, might sometimes prove useful. Thus he linked the concept of variation with that of utility. Fitness, as Herbert Spencer popularized it, reflected the suitability of mutations within their changing ecosystem. In the 1930s, the geneticist Sewall Wright proposed laying out genetic sequences next to each other, together with the corresponding slight changes in fitness. Writing about this theoretical construct, he compared it to a landscape with peaks and valleys. Later, Wright called his metaphor a *fitness landscape*.[35] Every geneticist knows the term today. In a sequence space in which all available variants are ordered by their genetic distance, the fitness landscapes indicates zones in which the related genetic sequences display high or low utilities. In the 1970s, the Quasispecies equation expanded this theoretical framework and showed that species collectively climb the slopes of the fitness landscapes in search of local peaks. Biological fitness landscapes may be rugged; and compared to natural landscapes, they are characterized by much higher dimensionality. Nevertheless, recent work showed that even simple statistical methods such as linear regression could be used on fitness landscapes to make accurate, evolutionary predictions.[36]

The word choice *landscape* might potentially be a result of the high popularity of cartography due to the development of aerial photography at the beginning of the twentieth century.[37] For example Auerbach's work on the sizes of cities had started with a nightly balloon flight over Germany. Although it probably is a mere coincidence, it might nevertheless be worthwhile mentioning here that there is a similarity between genetic fitness landscapes and the concept of topics and discourses. The word *topic* stems from the Greek *topos*, meaning *landscape*. Thus, fitness landscapes lay out closely related genetic sequences next to each other and observe peaks and valleys in the big picture. Similarly, topics are groups of similar terms that are relevant within a given discourse. However, fitness landscapes, as a theory, are not only more useful

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[35] Sewall Wright, "The roles of mutation, inbreeding, crossbreeding, and selection in evolution". *Proceedings of the Sixth International Congress on Genetics,* 355–366.

[36]Louis du Plessis, Gabriel E. Leventhal, and Sebastian Bonhoeffer, "How good are statistical models at approximating complex fitness landscapes?" *Molecular Biology and Evolution* 33, 9 [May 2016]. DOI10.1093/molbev/msw097

[37] The word "cultural landscape" was used with high frequency in 1932/33, compared to previous as well as ensuing decades. Source: ngram "cultural landscape" books.google.com.

but also more stringent than the theory of discourses, topics, and terms in that they possess a clearly defined concept of mutation and therefore a systematic for laying out related sequences. This present work develops a suchlike systematic for the evaluation of topics and public discourses.

During the decades in which the concept of gradual, favorable mutations entered evolutionary theory, economists developed a strikingly similar approach to explain regularities of market values. They interpreted prices by slight changes in use and utility. The Austrian Carl Menger maybe most lucidly explained the subjectivity of value and its dependence on the cultural context. A young economic reporter at the time, Menger used the example of tobacco.[38] What would happen if everyone stopped smoking? Cigarettes would loose their values as marketable goods, regardless of the cost to produce them. On the other hand, the price of the farm land used to grow tobacco would not fall to zero, but is valued according to its next best, or marginal use, for instance growing crops.[39] Menger also explained the distribution of wages. In his view, workers were paid off by the increase in value that their work contributed in the process of production. Marginal utility was discovered besides Menger also by other researchers.[40] Léon Walras, Pareto's predecessor at University of Lausanne, and William Jevons employed the metaphor independently, leading to what was later called the Marginal revolution. Today, dividing total value into smaller parts is also performed in Hedonic regression whereby every attribute of an object adds some value to the final product. Similar to fitness landscapes the statistical model of linear regression is deployed to estimate unknown values. Although a unified theory of price landscapes was never consciously formulated in economics,[41] fitness landscapes and marginal utility are similar to each other, in that they assume the possibility of departure and deduce changes in utility from slight variation. Given that these theories are based on the same axioms, many logical deductions are valid in both disciplines alike. For example linear regression yields good estimates because utility is inferred from closely related objects. The merit of our approach then lies in deriving a theory that unifies all fields in which Genus and Differentia are applicable and slight variation may lead to differences in utility.

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[38] Carl Menger, *The Principles of Economics*, Auburn: Ludwig von Mises Institute, 1976, 66.

[39] Mark Skousen, *Vienna and Chicago Friends or Foes*, Washington: Regnery Publishing 2005, 26.

[40] Daniel Bernoulli's expected value theory is a special case of marginal utility formulated already in 1738.

[41] Economists often contend themselves with the image of the invisible hand as an interpretation for large scale regularities and spontaneous order.

2.6 History: The Methodenstreit

Theory helps interpret the regularities of observable phenomena by revealing the logical connections between them. However, why is theory important? Just recently, at the second Chicago Architecture Biennial, a famous historian lost heart over his observation that both life and architecture display too much variability.[42] As a conclusion, making theory was either impossible or made no sense.[43] Philip Ursprung, another professor, historian, and curator participating in a number of related events maintained a different position. Ursprung ascertained that contemporary historians were primarily dealing with two topics, namely urbanism and postmodernism, both of which seemed inadequate as axioms for architectural theory. Although Ursprung asked whether the end of theory had arrived, he hoped for the contrary and later wrote: "Yet we are not certain if theory has actually ended. Perhaps, theory is persisting in latency, hardly visible, building up steam and waiting for its comeback. Or maybe it is already back."[44] Then again, other voices were more critical. "Read Poetry, not Theory" headlined a magazine article summarizing a debate about the end of theory held at ETH Zurich among Jacques Herzog, Peter Eisenman and Kurt W. Foster, three authorities of architectural history and practice.[45]

Given that these and similar encounters are making a comeback, it might be meaningful to remind here that the methodic battle is already surpassed. The Methodenstreit, or in English *the Battle of Methods,* was fought at the end of the late 19th century. German economists of the Historical School held that history displayed too much diversity, which made theory impossible. The Austrian Carl Menger, whom we have already encountered, opposed this view. He used history as a source to discover and elucidate axioms of broad validity. Logical deduction could then be used to derive important consequences and formulate basic principles of economics. "This method of research," Menger explained, "attained universal acceptance in the natural sciences, led to truly great results, and on this account came mistakenly to be called the natural-scientific method.

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[42] Dan Costa Baciu, "Brueckenschaege an der Biennale," *Phoenix* (Nov. 2017), phoenix.blverlag.ch.

[43] Dan Costa Baciu, "Brückenschläge an der Biennale," *Phoenix 12* [December 2017], 26-30.

[44] Philip Ursprung, "The End of Theory?" *e-flux*, October 25, 2017. http://www.e-flux.com/architecture/history-theory/159230/the-end-of-theory/

[45] Andres Herzog, "Lest Poesie, nicht Theorie," *Hochparterre online,* September 29, 2017. Jacques Herzog, Peter Eisenman und Kurt W. Foster philosophierten gestern Abend bei einem imaginären Glas Wein über das Ende der Theorie. Die Fronten waren klar: Der schreibende Architekt mag Worte, der bauende bevorzugt Taten.

It is, in reality, a method common to all fields of empirical knowledge, and should properly be called the empirical method."[46] Ultimately, Menger had discovered marginal utility using this empirical method. When Hermann Heinrich Gossen had proposed a similar theory two decades earlier, he believed to have discovered laws equally important to Copernicus', but his work was overshadowed by the Historical School.[47] The book remained unsold and was soon forgotten. Nevertheless, around the turn of the century, the Austrian School and the Marginal revolution took over, eventually outliving the Historical School.

Despite final victory, the dispute most probably had destructive consequences as well. A possible influence of the historical doctrine, Austrians mostly avoided using aggregate data to test their theories. Later generations became enough radical to proclaim a split between life sciences on one side and social sciences on the other—much in contrary to Menger's creeds. Those later scholars partially returned to the perspective of the German School, holding that human action was governed by subjectivity and uncertainty to an extent that prohibited empirical assessment. Consequently, they circumvented the use of mathematics by resorting to lengthy narratives. As we have already seen, Walras and Pareto's Lausanne School was more open in this respect, and for this reason, it is oftentimes remembered as the Mathematical School.

Most prominently however, the Chicago School pioneered testing theory against empirical data in the second part of the 20th century. The voluminous book, *A Monetary History of the United States* by Milton Friedman and Anna Schwartz persuaded mainstream economists by its use of historical data to test theories.[48] Later, Friedman proposed the existence of a natural rate of unemployment, an idea that had already been formulated by the Noble Prize winning Austrian economist and Chicago professor Friedrich Hayek. However Friedman's success would have been unthinkable without the supporting data. Finally, in his Nobel Prize speech held eight years before Hayek's, Friedman argued that subjectivity and uncertainty existed in natural and social sciences alike. "Of course," the economist explained in a tone similar to Menger's, "the

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[46] Carl Menger, Principles of Economics, Auburn: Ludwig von Mises Institute 1976, 47. [First German edition 1871.]

[47] Hermann Heinrich Gossen, *Entwickelung der Gesetze des menschlichen Verkehrs, und der daraus fließenden Regeln für menschliches Handeln* [Development of the laws of human intercourse, and the rules following therefrom for human action]. Braunschweig: Friedrich Vieweg und Sohn, 1854.

[48] Milton Friedman and Anna J. Schwartz, *A Monetary History of the United States, 1867–1960*, Princeton: Princeton University Press 1963.

different sciences deal with different subject matter, have different bodies of evidence to draw on, find different techniques of analysis most useful, and have achieved different success in predicting the phenomena they are studying. But such differences are as great among, say, physics, biology, medicine, and meteorology as between any of them and economics."[49] This position not only echoes Menger's comment on the empirical method but also John Dewey's pragmatism, the philosophy around which the Chicago School of Thought was asserted in 1903. Other Chicago economists, from George Stigler to Richard Thaler who earned the Nobel Prize in 2017 continued this empirical trajectory with similar successes. The question whether history and theory should be separated has already been answered.

In addition to this accumulated experience, one may realize that bedeviling theory is in itself inconsistent. The statement "theory is impossible" falls into the category of liar's paradoxes. Assuming that statements such as "this sentence is a lie" are either true or false leads to immediate contradiction. One may correct this flaw by specifying: "theory other than this statement is impossible." However, once admitted that the statement already constitutes a theoretical proposition, one may measure its explanatory power against other theories. Following these lines, the question is not whether or not to make theory. Rather, efforts should be applied in discerning good from bad theory; and there are generally accepted ways to do so. First and foremost, replicability stands for the idea that data is provided with the research results, allowing other parties to test intermediary steps. This present dissertation offers the empirical data and intermediary results together with the narrative. In addition, good theoretical frameworks last long and they are open and interactive. This dissertation is accompanied by an implementation of exploratory tools as part of an online portal hosted by North America's greatest network of university libraries. Finally, once we tend to accept a theory, we may also want to search for equivalent formulations in other fields of study and see whether experience acquired from those efforts may help improving our own approach and experiments.

[49] Milton Friedman, "Inflation and Unemployment," Nobel Memorial Lecture, December 13, 1976, 267f.

2.7 The Theory of Varieties[50]

From our experimental setup, we know so far that multiple Chicago Schools evolved side by side although some definitions were more useful than others. We also know that departure takes place, and that the distance between any two variants may be represented by their specific difference. Furthermore, we know that correlations between definitions, and their subjective relationship to the public discourse may influence their utility. The next step is to rephrase these ideas in abstract terms. We assume that *variants* may coexist side by side, although in a given public discourse, some have higher *utility* and are disseminated faster than others. Furthermore, we introduce a probability of *departure*. The number of steps necessary to transform one definition into the other may then represent the *distance* between any two variants. From this set of premises already a great number of conclusions can be drawn. In physical chemistry, a formalism known as *the Quasispecies equation for molecular evolution* was derived from similar premises.[51] A German, Nobel laureate, Manfred Eigen, and his Austrian colleague Peter Schuster developed the equation. Unexpectedly, it proved even more useful in biology. The evolution of populations of virus such as HIV and HBV in the human body has been calculated using this approach and led to the adoption of new successful regimens.[52] Researchers especially valued the model's explanatory power on the level of genetics, and a major recent publication indicated that this was a consequence of the model's origins in chemistry.[53] In contrast to that verdict, this present work suggests that the applicability of the formula depends on the validity of the assumptions. The equivalence is obvious: what is a gene code of a protein if not a definition of that protein encoded in genetic base pairs, what are mutations, if not departure from that definition, and what are mutants if not variants?

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[50] I first derived this theory in my technical report for the HathiTrust Research Center, published September 30, 2017. I subsequently presented results at five conferences between October 2017 and March 2018.

[51] Manfred Eigen, "Selforganization of matter and the evolution of biological macromolecules," *Die Naturwissenschaften* 58, 10 (October 1971), 465–523.

[52] Martin A. Nowak and Robert M. May, *Virus Dynamics: The Mathematical Principles of Immunology and Virology*, Oxford: Oxford University Press, 2000 [first edition].
Esteban Domingo and Peter Schuster, "What is a Quasispecies? Historical Origins and Current Scope," Esteban Domingo, ed., *Quasispecies: From Theory to Experimental Systems,* Berlin: Springer 2016.

[53] Esteban Domingo, ed., *Quasispecies: From Theory to Experimental Systems,* Berlin: Springer 2016.

The Theory of Varieties that we derive from the above premises not only excels by interpreting Genus and Differentia on the scale of populations, or by building on the previous success of special formalisms applied in chemistry and biology, it also explains the evolution of the many definitions of Chicago School, and potentially many other terms such as the Vienna School, the Modern, the Beautiful, the Sublime, the Classical, the Romantic, the Vernacular… The results are easy to illustrate. At the center of the public discourse, we encounter a small number of often-named schools that are most useful and therefore most frequently mentioned. With increasing distance from those schools, the potential number of neighbors grows almost exponentially, although those departing variants might be individually less and less frequently mentioned because they are increasingly distant from the central topics of the public discourse. Using the Quasispecies equation, it is possible to estimate expected distributions.

The next step is testing our model against empirical data collected from a corpus of 105'000 books and periodicals that mentioned the Chicago School. We find hundreds of closely related definitions, and our theory is successful in explaining their frequencies of occurrence. After ordering the results by specific difference, we receive a power-law probability distribution as it was empirically observed in many other types of data, only now, the rank of the individual definitions has been estimated independently from their frequency,[54] and the distribution emerges logically from a set of premises that we might find hard to reject. The present work suggests that Pareto and Zipfian distributions result as a special case of the Theory of Varieties. Mathematically formulating the theory, the present work also interprets fluctuations and slight deviations from the regular case. Already Piantadosi showed for example that fluctuations are most common at the lower end of the Zipfian plot (or the bottom of the pyramid).[55] Our model suggests that this occurs because departure at the bottom leads to the discovery of variants that are very distant from each other and therefore also very heterogeneous.

There are a number of simple, practical conclusions as well. At the time of historic breaks, when the utility of definitions is changing, some become obsolete while others gain relevance. Lineages have little to offer other than continuity and utility, yet both of these properties are simultaneously challenged by sudden historical change. At that point in time, a system based on constant transformation is nevertheless prone to adapt easily, as long as one of the many previously existing variants fits the new historic situation. Variants emerge

[54] Important for statistical validity.

[55] Steven T. Piantadosi, "Zipf's word frequency law in natural language: a critical review and future directions," 2015, 4.

previous to the historic change, in periods of time in which ideas have high utility. Adaptation is expected to emerge more often from the adoption of pre-existent variants that fit the new context rather than the tailored design of wholly new definitions in response to the historic change. This principle was first formulated in biology,[56] but is also found in our textual data. For example Sigfried Giedion wrote about high-rises in 1939, when the term Chicago School was popular in his circles of colleagues. László Moholy-Nagy founded the Chicago School of Design, and Ludwig Mies van der Rohe reformed the Chicago School of Architecture. However, Giedion's essay was published more than a decade before Chicago architects built the modern commercial towers in utilitarian lines reminiscent of the first school, which made his narrative popular.

Another interesting conclusion, groups of mediocre, closely related definitions strive over lone-standing very useful ones. Our records show for example that the Chicago Schools of Architecture lost out against those associated with University of Chicago. The latter were collectively more relevant at that point in time.

The Theory of Varieties assumes limited population sizes and competition among variants, but not does not imply in any way perfectly informed authors, centralized decision-making, or the predictability of the future. Life is full of unexpected events and writers are not omniscient designers who plan everything ahead of time. This observation already led Giordano Bruno to his Nolan philosophy in which an omniscient designer failed to control life because he was challenged by the necessity of making too many decisions at the same time and transferring too much information to the right place. Instead, authors may only vaguely anticipate the future. They compete against each other; and the changing audiences later decide their success. For example the famous A.D.F. Hamlin wrote about the Chicago School 1900-1907, but he did not know that a younger lecturer Thomas Tallmadge was about to redefine the term in 1908 and gain sudden success. In turn, Tallmadge very soon mourned that his group of peers had dissolved while architectural licensing actually kept it together. Later again, two great historians, Hugh Morrison and Henry-Russell Hitchcock independently contacted Tallmadge to help inform their books and exhibitions, which made him regain confidence in his cause just before Giedion returned to Hamlin’s definition of the Chicago School, disregarding a discrediting letter that the National Council of Architectural Registration Boards sent him in 1939, before publication. After the later, unexpected success of

[56] In biology referred to as Bonhoeffer’s Law. Martin A. Nowak and Robert M. May, *Virus Dynamics: Mathematical Principles of Immunology and Virology*, Oxford: Oxford University Press, 2000, 99-100.

Giedion's essay, Carl Condit collected material to substantiate the narrative, but when a whole book came together in 1952, he did not expect that University of Chicago Press would reject his title choice. The *Rise of the Skyscraper* was nevertheless a full success and was translated into multiple languages. Finally in 1964, when Condit's chosen title *The Chicago School of Architecture* was accepted for the second expanded edition, the meanwhile acclaimed professor disregarded that another book with the same title but contradictory content was in print at the same time; and the younger author wished to limit the meaning of the term Chicago School to his own definition, which eventually led to controversy and dispersal. Due to competition of multiple, gifted authors, the fate of each essay and book was individually unpredictable, but the Chicago Schools nevertheless persisted as long as one of the many present narratives found sufficient audiences. In this sense, success is a result of competing varieties of thought in public discourse.

The Theory of Varieties also reveals limitations given by the size of the populations, the rate by which new variants emerge, and the rate of historic change. In many historic cases, cultural change lies just below the thresholds imposed by these factors, but crossing them leads to chaos and disappearance of consensus. In every day life, the Theory of Varieties might help institutions boost their creativity, but the theory might also be used, or misused, to push creativity beyond chaos thresholds at the point at which a population will need mechanisms of self-organization that do not depend on Genus, Differentia and transformation.

2.8 History: Evolutionary Architecture[57]

Nineteenth century evolutionism was supported by the study of fossils. At the same time, ruins have been dubbed the fossils of past cultures. Evolutionary thinking is as old in architecture, as it is in biology. Greek temples often inspired thought about the gradual transformation of form. In archaic columns, capitals bulge out while the shafts are straight or sometimes tapered towards the bottom. In classical columns, the shafts are tapered towards the top, never the bottom, and slightly bulge in the middle while the capitals are proportionately small. Hellenistic temples tend to be slender in all details although they favor rich capitals. Then again, curvature in stylobates and architraves suddenly

[57] My research on which I based this section circulated as research plan already in 2010 finally leading to my start at IIT in 2015.

appeared in classical temples, but was only occasionally present in later examples. The belief that the architectural details of Greek temples underwent an evolutionary process is as old as the temples themselves. Philon of Byzantion, a Hellenistic theoretician, proposed a mechanism for historical transformation that possesses all three axioms of Darwinian evolutionism: replication, mutation, and selection.[58] Also in antiquity, although not in architecture, Lucretius's *De Rerum Natura* held that life had emerged through the same three principles.

Although an old idea, the term Evolution was popularized more recently, and in that context, ancient architecture was important again. Early modern interest in the Greek temples of Paestum[59] gave way to Leroy's,[60] Stuart's[61] and Dumont's [62] publications, leading authors no less than Goethe [63] and Winckelmann[64] to express their beliefs on how Greek architecture had been subject to change.[65] Most importantly however, Henri Labrouste finally re-measured the temples in Paestum and suggested that the details had evolved over time.[66] Thus, in contrary to the idealist philosophy, there was no ideal Greek temple, and maybe no ideal architecture at all. Rather, everything evolved. In Paris however, Antoine Quatremère de Quincy disputed the validity of Labrouste's results, giving rise to the embroilments at the Academy of Fine Arts in 1830.[67] At the same time at the Academy of Sciences, Georges Cuvier and Geoffroy Saint Hilaire debated on evolution in biology.

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[58] Philon made some essential remarks on architecture in his treatise about military devices in: Philon of Byzantion, *Belopoeia*, (late third century B.C),109.

[59] Peter Collins, *The Greek revival,* 1965, 79-80.

[60] Julien-David Leroy, *Les ruines des plus beaux monuments de la grèce*, 1758.

[61] James Stuart and Nicholas Revett, *The antiquities of Athens,* 1762.
This influential work about the monuments in Athens was originally inspired by the antiquities of Paestum.

[62] Gabriel Pierre Martin Dumont, *Sequence de plans, sections etc. de Paestum,* 1764.

[63] Peter Collins,*The Greek Revival,* 1965, 80. Goethe has written an essay about Paestum and translated Knights expedition description into German. The translation became at least as influential as the original. See: Claudia Stumpf, *Richard Payne Knight,* 1986.

[64] Wolfgang Leppmann, *Winckelmann eine Biographie,* 1971.

[65] Peter Collins, *The Greek Revival*, 1965, 83

[66] Marin Bressani, "The Paestum Controversy," Corinne Bélier, Barry Bergdooo, Marc Le Coeur, *Henri Labroutst Sturcture Brought to Light*, New York: Museum of Modern Art, 2012, 88-92.

[67] Martin Bressani, *Controverse autour de Paestum*, Corinne Bélier, Barry Bergdooo, Marc Le Coeur, *Henri Labroutst Sturcture Brought to Light*, New York: Museum of Modern Art, 2012, 90-93.

The Parisian controversies became highly influential on architects such as Eugène Viollet-le-Duc[68] and Gottfried Semper.[69] An outstanding architect and professor, Semper began his career in the Paris of 1830. With his architectural and mathematical background,[70] he analyzed style; and after a series of lectures, he publicized a mathematical treatise, *The Dynamic Origin of Forms.*[71] The book appeared in 1859, the year of Darwin's *Origin of Species*.[72] In comparison to Darwin, Semper considered not only a theoretical, but also a mathematical approach to understanding evolution,[73] an attempt that proved useful in modern genetics.[74] In his later writings, Semper lamented that the natural-scientific models of his days were not advanced enough for successful application in the arts. However, Umberto Boccioni echoed Semper's ideas in his manifesto of architecture written in 1914. The Italian Futurist's formula, *Necessity* = *Speed*, as well as the esthetics of his sculptural masterwork *Unique Forms of Continuity* may owe much to Semper's work.[75] Among the architects active in Chicago, most notably Louis Sullivan and Frank Lloyd Wright inspired themselves in evolutionist thinking. Sullivan's dictum *form follows function* is derived from the concept that evolution selects favorable mutations, or, in other words, those forms that give organs additional functionality within their environments.[76] For Sullivan, design was functional when it enhanced the meaning of artifacts within their cultural context.[77] On the other hand, Wright's organicism is rooted in the idea of designing a building inside-out, relying first on the building's interior purposes, an idea that is also found Semper's theory. Semper's curved opera house facades reflect the interior shape of the halls. Also Van Brunt and Hamlin

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[68] Corinne Bélier, "Affinités et postérité heritage francais," Corinne Bélier, Barry Bergdooo, Marc Le Coeur, *Henri Labroutst Sturcture Brought to Light*, New York: Museum of Modern Art, 2012, 226-229.

[69] Harry Francis Mallgrave, *Gottfried Semper*, New Heaven: Yale University Press, 1996, 27-38.

[70] Semper started initially to study mathematics. Mallgrave 1996, 12-13.

[71] I take here Mallgrave's translation. Mallgrave 1996, p. 224.
Gottfried Semper, *Ueber die bleiernen Schleudergeschosse der alten und über zweckmässige Gestaltung der Wurfkörper im allgemeinen ein Versuch die dynamische Entstehung gewisser Formen in der Natur und in der Kunst nachzuweisen*, Frankfurt am Main 1859.

[72] Charles Darwin, *On the origin of species,* 1859.

[73] Gottfried Semper, *Ueber die bleiernen Schleudergeschosse*, 1859.

[74] From a link between Darwins evolutionism and Mendel's genetics. Stephen J. Gould, *The structure of Evolutionary Theory*, 2002, 212-247. See also: Nowak 2006, 2.

[75] As I suggested in 2011 in my Umberto Boccioni Architettura Futurista. The shapes of Semper's bullets are also similar to the details of Forms of Continuity.

[76] Stephen Eisenman and Corinne Granof, ed. *Design in the Age of Darwin: From William Morris to Frank Lloyd Wright,* Evanston: Northwestern University Press, 2008.

[77] Following Harry Mallgrave's suggestion at a PhD committee meeting, for Sullivan, the environment was Democracy, and the subjective means that mediated between Democracy and architecture was human perception.

wrote about style as something unconsciously unfolding like evolution. Van Brunt compared designs to organisms, as we shall see later, and most notably translated Viollet-le-Duc into English. Furthermore, his 1889 essay already mentioned above propounded that the Midwestern school had resulted as an evolutionary adaptation of inherited European Schools to the American cultural climate.[78] Finally, Hamlin believed that styles evolved as well. In the year in which he edited the term Chicago School into his *Textbook of the History of Architecture* already mentioned above, he also wrote an article tracing changes in public taste by applying statistics to a survey.[79] The style of the early Chicago School that he had also adopted for his own designs emerged from this analysis as the most adaptable to new needs.[80] Thus, in the writings of both Van Brunt and Hamlin, the Chicago School of Architecture was interpreted as the result of collective adaptation to new sets of needs.

Phylogenetic trees inspired architectural historians as well.[81] In 1896, Sir Banister Fletcher's book, *A History of Architecture,* came with an illustration of a family tree of architectural styles. In 1971, Charles Jencks' book, *Architecture 2000: Predictions and Methods,* included an updated version of an "evolutionary tree." Finally, in 1996, a century after Fletcher, Juan Pablo Bonta used computers to evaluate headlines. He attempted a quantitative assessment of architects' names as they were mentioned in book titles. Architects oftentimes used evolutionary analogies as explanatory images for open questions although analogies cannot substitute an understanding of the actual cultural phenomena.[82] To all of this past work, the present dissertation serves as a new, substantiated update in terms of methodology, history, and theory.

2.9 Theory: The Audiences Respond

Searching for trends in our Chicago School corpus, we must sooner or later observe that there are countless, strong fluctuations. However, these sudden peaks are immediately reversed or naturally ebb out over the course of

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[78] See chapter four.

[79] A. D. F. Hamlin, The Ten Most Beautiful Buildings: A Discussion of the Vote by A.D.F. Hamlin," *The Brocure Series of Architectural Illustration* 1 (January 1900), 5-13.

[80] For example his Church built in lower Manhattan, New York City.

[81] Some historians use the term Historicism to refer to that work.

[82] Peter Collins, *The biological analogy,* 1959. Philip Steadman, *The evolution of design biological analogy in architecture and the applied arts*, 1979.
Caroline van Eck, *Organicism in nineteenth-century architecture,* 1994.

time. Let us assume that fluctuations can occur as a result of temporary preferences or lack in coordination. Preferential Attachment would only amplify their effects. However, if a school is repeatedly mentioned in the media without offering anything of interest to audiences, they will eventually get bored of it. In psychology this phenomenon is called habituation. Do you also receive a newsletter that does not mean that much to you and therefore often goes unnoticed? Habituation acts against established ranks of importance and gives a chance to newcomers.

In the presence of fluctuations, Preferential Attachment would lead to chaos because fluctuations would remain unchecked. Small disturbances would increase and turn the world into unrelated schools of nonsense. Imagine one year there were suddenly more books in category A because of previous delays in publishing. With Preferential Attachment, the fluctuation would inspire authors to carelessly favor category A in the upcoming years as well. Editors would keep up with the production of those books, and readers to buy them although category A does not mean anything to anyone at all.

In addition, if we calculate distributions using the Quasispecies equation, the results also show that only minute differences in utility lead to major differences in frequencies of occurrence. For example in cases in which departure does not take place at all, the equations predict that one variant spreads steadily, eventually reaching fixation. People who have the chance to compare multiple variants might feel that they are almost equal, but the dynamics of utility and departure sometimes give rise to palpable differences in frequencies of occurrence. In this sense, audiences have reason enough to get bored of variants that are mentioned too frequently.

Since we observe that fluctuations are reversed or ebb out, we have to account for habituation. Let us assume that habituation is a force that acts against variants that are too frequent in a given cultural context. The more authors, editors, and audiences are flooded with a variant that is meaningless to them, the more their brains end up building automatisms to actively ignore it. Mathematically, these assumptions lead to Lotka-Volterra equations.

Lotka-Volterra—also known as prey-predator equations have been extensively studied in mathematical ecology, biology, and chemistry. In addition, they are also used in economics, where there were most prominently introduced by Richard M. Goodwin, an American-born professor who taught at University of Cambridge, and by Paul Samuelson one of the Nobel Prize laureates of the

Chicago School.[83] Although in some cases, Lotka-Volterra equations predict the extinction of entire populations, in most cases they lead to cyclic behavior. The growth and decline in population sizes looks like waves because the sizes of prey and predator populations alternately outbalance each other. Lotka-Volterra equations can be formulated for two or more species. In the latter case, the dynamics are increasingly rich because the cycles rarely return to the precise initial conditions. Although the equations are deterministic, small changes in the parameters can lead to largely divergent behavior.[84] The precise duration of cycles often remains unpredictable due to chaotic behavior. Nevertheless, the cycles largely depend on how fast the predator population grows in response to growing prey populations, as well as how long the predators continue decimating the prey after their populations already start declining. Prey-predator equations may remain in periodic oscillations, or converge to equilibrium.

Alfred J. Lotka and Vito Volterra discovered the equations independently in the United States and Italy, publishing their results in 1920[85] and 1926, at the time Yule published his theory known today as Preferential Attachment. Lotka and Volterra studied populations of plants and herbivorous animals, as well as predatory fish. In economics, Goodwin applied the model to labor markets that oscillated instead of displaying undisturbed growth. In our case, rising Chicago Schools that only annoy readers play the role of the prey, and habituation the one of predators.

Let us look at a concrete example in the Chicago School corpus. In 1964, three monographs appeared on the Chicago School of Architecture in a short sequence. The books were also broadly reviewed. After that wave of interest, the Chicago School of Architecture strongly oscillated between years that attracted many mentions and years of silence. These oscillations were much stronger than in schools that had grown more slowly and sustainably. The cycle length of periodic oscillations in the Chicago School of Architecture after 1964 and in various other Chicago Schools are similar, and they can be modeled as a

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[83] Richard M. Goodwin, "A Growth Cycle", in C.H. Feinstein, editor, *Socialism, Capitalism and Economic Growth*. Cambridge: Cambridge University Press, 1967.
Giancarlo Gandolfo, "The Lotka-Volterra Equations in Economics: An Italian Precursor," *Economia Politica* 3, 343-348. DOI: 10.1428/25816
In Italy, Giuseppe Palomba used the equations in economics already in 1939.

[84] Chaos theory was popularized by the French-American mathematician Benoit Mandelbrot in the second part of the 20th century. We have encountered Mandelbrot in the section on the Pareto distribution.

[85] Alfred J. Lotka, "Analytical Note on Certain Rhythmic Relations in Organic Systems" *Proceedings of the National Academy of Sciences of the United States of America* 6 (July 1, 1920) 410-415. doi.org/10.1073/pnas.6.7.410

result of the interaction between growth and habituation in a framework of Lotka-Volterra equations. The wavelike behavior is not just an imbalance; it is a driver of evolution. In phases of expansion, varieties become increasingly heterogeneous. In phases of decline, useful variants are selected among the many templates. Did you also try brainstorming and then selecting ideas? It's a similar process.

Besides the phenomenon of oscillations, there is a second consequence that we can draw from this evaluation. There is an asymmetry between spreading varieties of thought and habituation. Given that the oscillations of multiple Chicago Schools are not parallel, we can assume that habituation does not act simultaneously against all schools; rather it acts against each school individually, at least at first. If habituation acted against all schools at the same time, the peaks and valleys of fluctuations would occur in parallel at roughly the same points in time. On the other hand, multiple Chicago Schools can establish joint recognition. Famous Chicago Schools can rehabilitate other, discredited schools. Good Schools have a positive impact on related schools and on anything called Chicago School at large. Habituation and varieties act in asymmetric ways in that multiple Chicago Schools evolve together to establish fame, whereas habituation occurs against each of them individually.

This type of asymmetry was previously observed in evolutionary biology;[86] and it leads to a multiphase growth that is also observable in Chicago Schools. At first, schools co-existed next to each other with habituation acting against each of them individually. During this phase, new schools were popular only as long as they conveyed surprising information. As a consequence, the collective fame of Chicago Schools remained constant and relatively low. Finally however, enough schools were accumulated by the 1950s, reaching a threshold beyond which famous schools effectively impaired habituation against all schools. The tipping point was Sigfried Giedion's and László Moholy-Nagy's Chicago Schools of 1939. After this point, the Chicago Schools started rising together. Habituation was especially ineffective against the schools located at University of Chicago because it still acted against each school individually whereas famous schools legitimated all schools. This phenomenon allowed for a constant rise of the Chicago Schools without constant new contributions from every single school. In architecture, the Symposium of 1972 marks another turning point because historians rejected any kind of Chicago School thus acting against all architecture schools simultaneously.[87]

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[86] Martin A. Nowak & Robert M. May, *Virus Dynamics: Mathematical Principles of Immunology and Virology,* Oxford: Oxford University Press, 2000, 133-134.

[87] The Prairie School Review 9, (1972), 20, 27.

In more abstract terms, the asymmetry between varieties and habituation leads to two main evolutionary phases. At first, decades pass during which varieties may gain little recognition, but suddenly, once there are enough strong variants, all rise together. This trend can be only reversed if numerous, important variants loose their relevance, or habituation starts acting against all variants at the same time.

2.10 History and Theory: The Truth of Different Scales

Studying the Chicago School is enlightening on multiple levels. First, if we evaluate historical details, we are intrigued by events that are as true, as they are transient. Even if repeated, no imaginable event will be ever the same again. The ancient Greek philosopher Herakleitos of Ephesos, known for comparing the universe with an eternal fire, said that one could never step into the same river twice.[88] Historical events have many causes: personal struggle, moments of happiness, play, cooperation, as well as corruption. For instance, J. Carson Webster selected the majority of buildings for an architectural guide and wrote all catalog entries, but University of Chicago Press deliberately chose not to put his name onto the book's cover crediting the photographer as sole editor instead. The consequences were profound on the level of personal interaction first between Webster and his colleagues, and then between colleagues and other colleagues. Tracing historical details, we also encounter other remarkable events. Mies van der Rohe and László Moholy-Nagy, two great figures of the Bauhaus were separated by war, and later reunited in Chicago, much to their reluctance. Mies continued the legacy of the Art Institute and Armour's Chicago School of Architecture, although he reformed the curriculum and changed the name. Moholy-Nagy established the New Bauhaus in Chicago, later also known as the Chicago School of Design. The two schools were eventually united. These events were individually as unpredictable as atoms moving in a liquid.

On the next, larger scale, if we turn our attention to the common characteristics of the Chicago Schools, we find entire treasures of ideas valued by past audiences. Some lineages and schools of thought may still inspire us

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There were many other controversies too, but they were often addressed against one single publication, or one single definition of Chicago School. Compare: Harry F. Mallgrave and David Goodman, *An Introduction to Architectural Theory: 1968 to the Present,* Oxford: John Wiley & Sons, 2011, 50, 51.

[88] ποταμοῖσι τοῖσιν αὐτοῖσιν ἐμβαίνουσιν, ἕτερα καὶ ἕτερα ὕδατα ἐπιρρεῖ Herakleitos of Ephesos, "Fragmet BK 12."

with their creeds. Nevertheless, the schools' conceptual frameworks are necessarily incomplete, and their future is unknown. For example John Dewey's pragmatism really laid the foundations for a new tradition in scientific thinking at University of Chicago. The beauty of his ideas is the way in which they transcended disciplines and departments. However, many other philosophies coexisted with pragmatism, and maybe another one will eventually prove more useful. To return to the previous metaphor, lineages are collective movements. The motion of individual atoms sums up to what we call temperature. An aggregate phenomenon, temperature is not found in individual atoms; and it might change.

Finally, if we attempt to understand the laws of varieties, we find principles of self-organization that are mere theory, but as such, they are potentially rediscovered again and again. Theory cannot be proven right; it can only find more and more supporting data. Furthermore, even if an experiment supports the theory, once the experiment is done, it is already past, and the future remains uncertain. Returning to the physics metatphor, we face the uncertainty of Schrödinger's cat. An Austrian physicist, Erwin Schrödinger dwelled on the fact that experiments required scientists to observe them, but the mere action of observing could influence the outcomes. In other words, everything ever observed might have been altered by observation making theory predictive only in the presence of observers. Theory is uncertain regardless of discipline. Nevertheless, it has the potential to be reapplied and improved, explaining phenomena that might occur over and over again. If broad validity is the middle ground between the two incomplete types of knowledge, history and theory are most effective in unison.