Available online at www.sciencedirect.com
ScienceDirect
Mathematical and Computer Modelling 46 (2007) 926–934
MATHEMATICAL AND COMPUTER MODELLING
www.elsevier.com/locate/mcm

Parallels between the analytic hierarchy and network processes (AHP/ANP) and fractal geometry

Claudio Garuti, Isabel Spencer*

Fulcrum Engineering Ltd., Luis Thayer Ojeda 0180 Of.1004, Providencia Santiago, Chile

Received 28 November 2006; accepted 14 March 2007

Abstract

The aim of this work is to show the parallelisms and analogies that exist in modeling and measuring of dependence and feedback processes, in physical and in decision making processes, that is, to compare among the scales of measurement of the physical world (geometry) and the scales of measurement of the human being's internal decision process, in other words, the brain's internal generation of a relative measure scale.

Keywords: ANP; Fractals; System representations; Parallelisms; History

1. Introduction

Concerning the phrase:"... the brain's internal generation of relative measure scales" in the Abstract above, we can quote the following from Saaty [1]: *"Trading off is the human form of doing things. Nature even makes tradeoffs in the human body by setting up hormones that operate on compensation principles. The brain is empowered to supervise equilibrium by ordering or blocking the secretion of one substance or another to orchestrate the workings of the entire body. I believe that the brain itself must operate on a relative principle, as it has no stored scales of measurement to determine the absolute amount of each substance needed to maintain balance"*.

As an example of this we can add that the values described as "normal" in the medical literature for lipoproteins represent a range defined by the statistical average for a population; therefore, individuals may exist with levels in the lower bound of the accepted range, and others in the upper bound, still being physiologically healthy with differences up to 50% in their values. Any intent of modifying these values in a pharmacological way or by means of diet may result in overcompensation that shows up by driving hormonal responses into a variety of other pathological symptoms (hyperglycemia or hypoglycemia, variations in the triglycerides, etc.).

Indeed, from the work of Saaty [1] *"the creative mind, (it) is driven by the imagination and our ability and reasoning ability. Imagination is fragmentary and needs purpose and cohesion unity. In science, imagination always precedes unity. Synthesizing its creations takes time. A long-standing and troubling observation to me has been the*

* Corresponding author.
E-mail addresses: claudiogaruti@fulcrum.cl (C. Garuti), isabelspencer@fulcrum.cl (I. Spencer).

0895-7177/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.mcm.2007.03.029

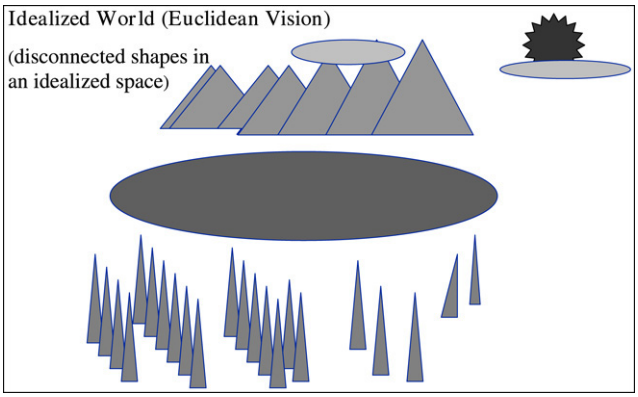

Fig. 1. The Euclidean vision; an idealized world vision.

fragmentary and evanescent nature of our knowledge. This is due both to the diversity of our experience and to an absence of goal-oriented thought structures – hierarchies – needed to link knowledge from one set of goals to a higher set and ultimately for our survival.".

As an intermediate objective of this work, we examine the basic concepts of measurement interpretation and quantification, and their development in history (Euclidean, Cartesian and fractal geometry) [4]. Metric concepts and their interpretation in the physical world (for example, the concept of distance), and in the decision-making world, are examined and we point out the analogies between metric axioms and the Analytic Hierarchy Process (AHP) axioms.

This work also considers some of the mathematical parallelisms that exist in the representation of reality by both systems (ANP & fractal geometry) and in the modeling processes used in both systems such as: limits, convergence, stability, attractors, and still others like errors, randomness, consistencies and their physical interpretations, all of which are shown in a graphical way with simple explanations and interpretations.

2. Basic concepts of geometry in history

2.1. Basic concepts of interpretation and quantification of measures, and their development in human history

The first measurement principles with an appropriate logical structure appeared in human history in ancient Greece, mainly with the great Euclid and his principles of representative geometry, where the objects were idealized (like in Plato's vision), and represented geometrically as stand-alone abstract figures with no connection between them and reality, as illustrated in the landscape of Fig. 1.

Two thousand years later a new vision of the world was generated which affected our way of understanding and measuring the world. This time the famous French philosopher and mathematician René Descartes (1596–1650) was the first to offer a new representation of geometry, the now well-known Cartesian coordinate linear system with an absolute point of reference at (0, 0). Here the idea is to connect all the elements to each other by means of a mesh of invisible points which share a common origin point (0, 0). This makes it possible to generate relative measurements among the elements, and even more important, to generate an absolute measurement system able to assign a length (an absolute measurement length) for any point in relation to the origin.

Descartes' vision, used even today as the standard or normal form of reality representation, can be graphically represented as shown in Fig. 2.

At this point, we would like to make a parenthetical observation just to highlight the relationship between the open ancient Greek culture with its world vision of Euclid and Plato as an abstract and idealistic world, and the absolutist culture of the XVII century with its focus on religious dominance and the inquisition with Descartes' grid vision of the world.

This grid representation is the way people interpreted the world at that time: everything should be related to an origin, most of the time a religious one. History, philosophy and science would only make sense if connected to a divine origin. This way of thinking was carried to an extreme when it became acceptable to burn people to death because their beliefs did not agree with the truth the current religion had established.