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Self-reference as a principal indicator of complexity

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Abstract

Self-reference, the ability of a system to refer to itself, is a necessary condition for complexity, and can indeed form the basis for a definition of complexity.   When a part of the system can refer to the whole of the system, there indeed have to be deeper complex structures and processes than those that only superficially appear. Examples of the centrality and essentialness of self-reference to complexity can be found in many fields of study, including mathematics, system of system architecture, and systems engineering processes.

Keywords: self-reference; complexity; indicator; feedback; principle

1. Introduction

The inspirational origin of self-reference resides in natural cases and phenomena that are difficult to characterize, but from which is drawn the idealized abstract principle of self-reference. Self-reference can form the basis for a complexity index when it is possible to count discrete occurrences of self-reference by identifiable actors. An application of the index to a simple network example is given.

In the examples below, self-reference will be illustrated in the situation where a part of the system actually refers to the whole of the system. A highly related and more complex situation exists where each part of the system bears some undeniable relation to the whole of the system. The examples avoid the simpler situation where a part only refers to another part of the system.

Kauffman (1987) illustrated the concept of self-reference with mathematical and cybernetic connections:

"A very simple discussion of the meaning of self-reference … unfolds into many ideas. Not surprisingly, we encounter wholes and parts, distinctions, pointers and indications, local-global, circulation, feedback, recursion, invariance, self-similarity, re-entry of forms, paradox, and strange loops. But we also find topology, knots and weaves, fractal and recursive forms, infinity, curvature and imaginary numbers! A panoply of fundamental mathematical and physical ideas relating directly to the central turn of self-reference" (Kauffman, 1987, p. 53).

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2. Self-Reference versus Hierarchy

View and Viewpoints. ANSI/IEEE 1471 (2000) emphasizes views and viewpoints, indicating that "Viewpoint and view are just abstractions of familiar geometric ideas," with "view" defined as "what you see," and "viewpoint" defined as "where you look from." Thus, through a viewpoint and view, the viewer attempts to refer to the whole of the system.
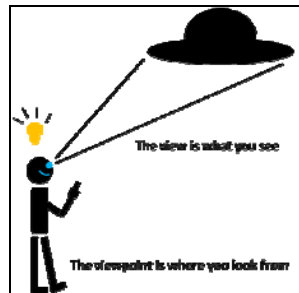

Figure 1: Viewpoint and view (ANSI/IEEE, 2000)

Corporate example. Corporations are legally independent entities that have no way of acting except through corporate participants such as shareholders, directors, officers and agents. Many participants in a corporation continually refer to a centralized map that is constantly being updated. The map is formed by the corporate bylaws, the corporate charter, or the spirit of the corporation as defined in by the founders, mission, and culture, as well as current events which change the total definition of the corporation. Actually, for practical reasons, participants will only be able to refer to approximations to the corporate definition – if 'the' definition even exists. The figure below illustrates the attempted self-reference of the totality of the corporation to itself through corporate actors.
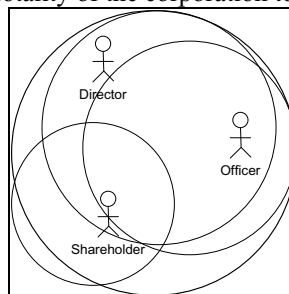

Figure 2: Self-reference in a corporation

Cohesiveness is demonstrated in the corporate example, as all fiduciary actors (ideally) direct their efforts toward the benefit of the corporation.

Self-Organization arises in the corporate example, because when different actors evolve their view of the corporation in a beneficial way, the other actors respond by adopting and supporting a modified view of the corporation (Luhmann, 1995).

Scope and Decomposition. Buede (2000) indicates that, once a system boundary is defined, it becomes possible to decompose a system by progressively bounding elements in the next level down. This process is made possible be a continual reductionist application of an exterior view. Reference from one outside viewpoint allows exact decomposition, while self-reference from an interior viewpoint produces uncertainty as to the delineation of system elements and boundaries.
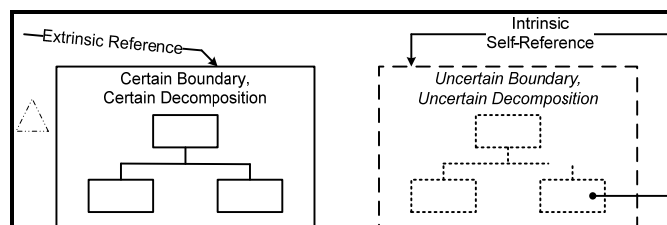

Figure 3: One exterior viewpoint compared an interior viewpoint