ABSTRACT

SURVEY ARTICLE

STRUCTURAL AND QUALITATIVE PROPERTIES OF SYSTEMS
—A GRAPH-THEORETIC APPROACH—

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This survey article is intended to present a bird's-eye view of the current status of the researches on systems theory which have been conducted these few decades from the structural and/or qualitative point of view. Samuelson's work on comparative static analysis of a model of national economy [38] may be quoted as an origin of this kind of study, where he raised a problem of finding the direction of change in economic equilibrium induced by a small change of exogenous variables based solely on qualitative information. In engineering field, Lin's work on structural controllability [21] of dynamic systems has been quite influential.

Following these pioneering works, a variety of researches have been done by economists and engineers, as well as by mathematicians. They include refinements and extensions of the earlier results, and also formulation and solution of new problems. A few examples are: structural decouplability and sign-stability of dynamic systems, and structural solvability and decomposability of linear and nonlinear systems of equations.

Especially, the structural analysis of systems of equations has emerged as a new direction of research, as we become more and more frequently involved with large-scale systems. The rapid progress of hardware technology in computing is of course a blessing, but the structural analysis is expected to provide an equally powerful software techniques in such a situation.

This paper therefore surveys the known results in structural and/or qualitative analysis of systems. All these results will be described purely in graph-theoretic terms, with explaining examples. By doing so, it is hoped that this paper serves to introduce OR researchers with some new ideas and viewpoints, and encourage them toward the new applications and possibilities of graph theory.

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