PANSYSTEMS THEORY AND AUTOMATIC CAUSALITY REASONING IN SYSTEM DYNAMICS

Zhang Qinling **Zhang Baoping**

Tianshui Teachers College, Tianshui, 741000. P. R. China.

Tel: 0938 214147

Abstract: Researches for complex systems become more and more important in modern science. System dynamics has done its significant work for the integration of System Theory and Computer Science in this field. Each dynamic system forms a complex causality network. Now we can use the panweighted network in Pansystems Theory for the dynamic system modeling, and further perform the automatic reasoning on this model. This new idea may be developed into a deep seated issue in AI. In this article, the method of both modeling and automatic reseasoning on a panweighted network in dynamic systems will be introducted together with a simple and typical example in System dynamics. The further extention of this new method will be discussed in other articles.

Key words: Dynamic system, Panweighted network, Automatic Causality Reasoning, Prolog Prolog Clauses.

I. Intrduction

One of the most significant researches in modern science is on large complex systems such as ones in society, economy and nature. For this research, many knowlege about qualitive or quantitative approaches, analysis or modeling and also about ones from logic or methodology to various concrete techniques are needed. J. W. Forrester (1961, 1968) created system Dynamic [2,3] (SD for short) which has got more and more achievements in many science fields now. SD firstly observe and analyzes the dynamics informations about the system structure, and then solve the system problems of controling and policy — making with techniques of the causality network analysis and the computer simulation. But there are still two further work we must do. Firstly, SD ought to not only work on the numeral or function's network, but also on one of logic, fuzzy or semiquantity [4]. Secondly, instead of DYNAMO, a logic computer language is needed to support the automatic causality reasoning in SD. and the expert system for controling and policy—making can be formed [5]. In this article, a new modeling method on the panweighted network for all causality relations in SD is got to perform the automatic reasoning, and further work can be done with other automatic reasonings.

Ⅱ. panweighted networks of relations in SD.

In System Theory, a complex system can be represented by the structure formed by its elements and all relations between them. In pansystems Theory, it is represented symbolic by GS—(H,S)[1,6], here H is a generalized set and called the hardware of GS, and S contains all relations on H and called the software of GS. And these relations are such as mathematical, dynamic, logic, fuzzy relations or their compounds and transformations.

As to a dynamic system, its structure is mainly represented by various causality relations in its behaviours. These relations work on the feedback mechanism of SD. With GS—(H,S), a dynamic system has it H with the dotes in the causality relations chains which form it's S. By mathenatical method, these relations can be represented by the Descartes product of H. And the causality chains can be represented by the most typical binary relation $DD \subseteq H^2$. If we put the generalized weight set W such a functions set. Logic predicates set and fuzzy set onto H^2, then $DW \subseteq H^2 \times W$ is called a weighted network, which is an extention of mathematical weighted network. In SD these panweight set can contain I/Os, flows, levels and rates. Now we have got a new model on panweighted network for SD. and next further work is to perform the automatic reasoning on it .

Ⅲ. Automatic causality reasoning in SD

In a dynamic system with a complex causality network, one change in a causality chain will result in a series of changes. To simulate these causality changes and produce their control mechanisms is a deep—seated issue of AI. because (1) In logic, it concerns with a real—time or a concrete logic system. And there for a cooperational logic reasoning model is required urgently. (2) For the artificial simulation of a dynamic system, an expert system of control and policy—making is needed. If we are able to perform the automatic reasoning , next work to construct an expert system will be easy. As to a dynamic system, the automatic reasoning will solves two kind questions;

1. Forward reasoning (a) Reasoning of the system goal; that is to make the system reach its required state by changing a certain cause; (b) complete reasoning : that is calculation to predict all behaviours of the system.

2. Backward reasonimg. That is the reasoning from a result to its cause.

Following is the automatic reasoning method based on the panweighted causality network to fulfil the system goal with prolog program.

1. The causality panweighted network: Let H = (Vi | Vi is a dote in causality chains) and w = ПWi: here wi is a generalized weight set. $D \subseteq H^2 \times W$ is called the causality panweighted network of the system.

2. The computer simulation model: Let W_p = (p | p is a clause in prolog). $D_p = D_w \times W_d$ is called a simulation model of the system. And this model will give out two ideas: a) Mathematical form of a dynamic, and futher discuss will be another artical.

b) combining the date flows and controling flows in the system behaviours to perform the automatic reasoning.

3. Automatic reasoning algorithm:

Step 1 Init and Halt, that is to presuppose the intial and the halt state of the system.

Step 2 Goal, that is so set up the control goal of the system.

Step 3 Dote operation: P (V,Goal) ⊢ Goal, P (V,V′ ,w), not (Halt),Op (V′ , Goal), here P (V,V′,W) is a clause on Dw.

Step 4 Automatic reaoning: Rs ⊢ Init, Op (Goal, V)

IV. The fulfilment of a simple example in SD

As Fig. is a simple example feedback control system of a stock. Now we practice the automatic reasoning algorithm to perform the stock balance.

1. Causality panweighted network is simplized as :

D_p = { (MB, CC, P(MB, CC) ⊢ CC=MB−KC), (KC,CC,P(KC,CC) ⊢ CC=MB KC).

(CC,DH,P(CC,DH) ⊢ DH = CC/TZ), (DH, KC, P (DH, KC) ⊢ KC=2DH+KC),

(TZ,DH, P(TZ, DH) ⊢ DH= CC/TZ)}.

2. Control algorithm of automatic balance in the stock:

Init ⊢ MB is 6000, TZ is 5, KC iS 1000.

Halt ⊢ CC is 10.

Op ⊢ P(V,V′), not (Halt), Op (V′).

Rs ⊢ Init, Op (KC).

To execute the program from this algrithm will make the stock automatically reach its balance.

References

(1). Wu xuemou, The pansystems view of the world. Chinese people University Press, 1990.

(2). J. W. Forresster, Principles of systems. Wright Allen Press, 1972.

(3). Khalid saeed, David Andersen and Jos Machuca (eds.), system Dynamics' 91, system Dynamics society, 1991.

(4)Levary R R. 1990, systems Dynamics with Fuzzy Logic. International Journal of systems Science, 8 (21).

(5). Mihran Markarian and Roman Koziol, Taming Expert Systens in the Business world, Proceedings of the 1991 International Systems conference, 1991.

(6). Tan Ting Quan, Interdiscinlinary Research: Applied systems Analysis, Gansu science and Technology Press, 1989.

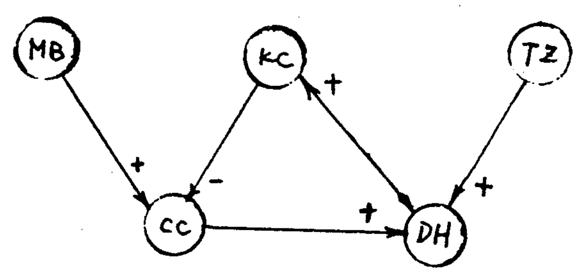

Fig. A simple automatic controling system