Knowledge System Construction and Knowledge Creation in HWMSE

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ABSTRACT[·]

The target of Hall for Workshop of Meta-synthetic Engineering (HWMSE) is to organically combine the human expert systems, machine systems and knowledge systems so as to realize meta-synthesis. It is a human-centered man-machine-net cooperation system for information processing, knowledge creation and wisdom integration. The availability of HWMSE embodies in the capabilities of knowledge using and knowledge creation. There exist two classes of knowledge systems: general knowledge system and object knowledge system. A highly strong and continually accumulated object knowledge system is essential for complex system problem solving. Systematic study of objective system is the foundation for knowledge system construction in HWMSE, and the abilities to define experiences and utilize the defined case knowledge make CBR a promising tool. A case of knowledge system construction in the HWMSE Supporting Macroeconomic System Policy Making is discussed. It is important to design the knowledge system as a whole for system research while at the meanwhile open for accumulation through utilization.

Keywords: Meta-syntheses, HWMSE, Knowledge System, Case reasoning

1.INTRODUCTION

Sciences of compelx systems and comlexity are in the ascendant. Scientists have studied complexity from diverse views and understandings, constucted complex system models using vious methods. Relevant concepts and methods often incude chaos, fractal, self-organization, emergence, complex adaptive systems(CAS), cellular automata(CA), neural networks, genetic algorithms (GA), artificial life, agent based system modeling and its supporting platform such as swarm, etc.

In China, at the end of 80s of 20 century, Qian advanced Meta-synthesis from Qualitative to Quantitative[1]. It is a kind of systematic methodology for OCGS (Open Complex Giant System), to deal with issues of complex system with not only natural attributions but also social and human attributions. Meta-synthesis takes thinking science as one of its theory basis. The source of human creativity is creative thinking combining both logic and imagenery thinking. Qian thus advanced the practical form of Meta-syntheses ---- Hall for Workshop of Meta-synthetic Engineering (HWMSE)[2]. The working pattern of HWMSE is human-centered man-machine cooperation so as to bring into full play the intelligence of man and machine. Then one of the key tasks to build a HWMSE is the construction of knowledge creation environment and knowledge system. This paper focuses on knowledge system constrcution for complex system problem solving in HWMSE and discusses the characteristics of the knowledge system. Then the knowledge system of HWMSE for macroeconomic policy making is discussed as a case.

2.ROLES OF EXPERTS AND MACHINES IN HWMSE

From viewpoints of thinking science, there are two ways of human thinking, thinking in logic and thinking in images. Considering the way of information process, logic thinking belongs to quantitative and micro way of information process, imagery thinking belongs to qualitative and macro way of information process. Human creativeness is come from creative thinking which is the artful use of both thinking in logic and thinking in images, or that the organic combination of quantitative and qualitative, macro and micro thinking.

Computer has strong capabilities in quantitative processing, such as logic reasoning, computation, rapid and precise information processing, expression & illustration, storage and searching, etc. Thus apart of mental work function related to logical thinking can be instead of by computers to a great extent, and with the rapid development of modern computer technologies, some kinds of imagery thinking may also be supported by computers. However, there still are intelligent capabilities of human being that could not be instead of by computers, such as intuitive thinking in images, association of ideas to bring forward new ideas,

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inspiration and creativity. Since the cognitive power is highly related to thinking patterns, man-computer cooperation is a compensative approach.

Figure 1. Thinking Pattern and Cognitive Power

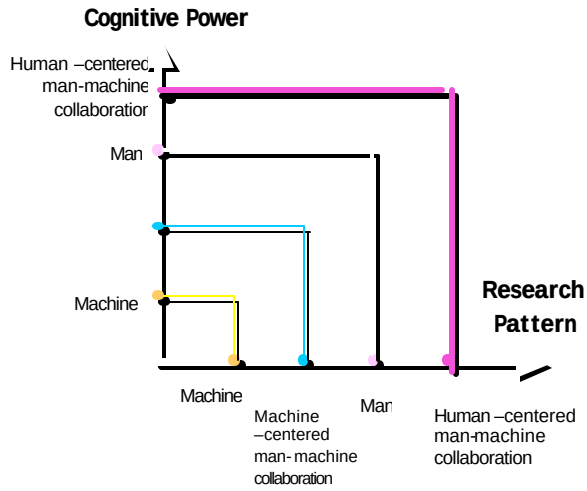

Figure 1 shows the relationship of cognitive power and the research patterns. Since that the strong imagery thinking and the group intelligence emerged in experts group exchange and mutual learning play crucial roles in complex system cognition and problem solving, and computers could hardly simulate the kinds of qualitative intelligence till now, the cognitive power of computers only should be the lowest one. Machine – centered man-machine collaboration pattern pays good attention to giving the computers strong capabilities to do works for human being who is set as a "user". This kind of system may have strong logic thinking capabilities but the imagery thinking capabilities are limited. Man-man cooperation pattern has been proved always significant for ideas inspiration and knowledge creation, in modern times in this pattern computers may also be used very popularly but in most time separately, not for expert group working. Human-centered man machine collaboration means to sufficiently apply expert's abilities of intuitive thinking in imagery, transfer the experiences and feelings to heuristic knowledge. The quantitative intelligence could be largely supplemented by computer systems which are designed mainly for expert collaboration. Thus the key point should be human-centered.

That's just the target of HWMSE, to realize meta-synthetic system approach from qualitative to quantitative through man-man and man-machine collaboration to deal with complex system problems. Essentially, it consists of three parts: a computer system which is an integration of advanced high and new technologies as well as data fusion; a human expert system grouping experts from related disciplines and with different roles; and a knowledge system for problem solving

As mentioned above, strong capabilities of logic thinking, computing and illustration of computers along with advanced communication and network technologies make machine system very useful to deal with complex system. For machine system in HWMSE, important elements include environment for collaboration, abundant resources, methods and tools. A distributive, interactive network and hierarchy structure is used to build HWMSE[3]. It should build a common cooperation platform for experts to work together with available environment, methods and tools for consensus reaching and synthesis making. It also should provide rich sharable supporting resources of information, knowledge and methods. It has integral online apperceiving and real time collaboration. It is problem-oriented and highly customized. Visualization methods and tools are also play significant roles in HWMSE, such as illustration of different forms of information, expert knowledge cluing and the visualization of expert opinions and thinking processes, etc.

Experts play leading roles in HWMSE for their judgments, experiences, particular information, their individual knowledge, methods and models, their capabilities of knowledge using, mutual learning and inspirational thinking.

Knowledge system consists of information, theories, methods and tools, models, practices, experiences, individual knowledge and knowledge of group decision-making, etc. Machine system and experts system are the carriers of knowledge system. The main tasks of machine system are to carry out structural and formalized works while human experts mainly concentrate on unstructured works. These two kinds of works are interlaced and complemented each other during the process of meta-syntheses. Successful application of HWMSE depends on giving full play to the synergistic advantages of the system that man or machine could not have separately.

3、KNOWLEDGE SYSTEM IN HWMSE

3.1 Two Classes of Knowledge systems

The availability of HWMSE embodies in capabilities of knowledge using and knowledge creation. Knowledge system in HWMSE may be classed as general

knowledge and object system knowledge. General knowledge system includes knowledge, methods, tools, processes for group discussion and opinion consensus reaching, data mining, process and method for general problem solving and policy making, knowledge visualization methods, etc. General knowledge system is useful for various HWMSE to provide a opinion exchanging platform for experts, various kinds of methods and tools could be applied to analyze and lead the processes of expert discussion, gaming and to form a group thinking supporting knowledge environment.

However, while general knowledge system is important to construct the platform and support knowledge creation in HWMSE, a highly strong and continually accumulated field knowledge system is essential for complex system problem solving. There are two aspects of reasons. In one aspect, the research object of HWMSE is complex system which has huge knowledge accumulation itself and special research methods system. General methods should be united with the particular methods of object system. In another aspect, the target of HWMSE is to provide a cooperation environment but for just a place for discussion. In fact, the efficacy of "discussion" workshops for problem solving is limited in reality. For example, in China several kinds of workshops on macroeconomic situation are hold to provide a chance for researchers to exchange opinions and to promote the economic analysis and forecast works. But the function of such workshops is limited. Participants may get some particular information from each other. Experts may release similar or conflicting results but usually have no much common bases for further discussion. The policy suggestions cannot but be scattered and it is difficult to use for reference by each other. Divarication comes from information limitation, partial understanding of economic reality, depending on certain theory excessively, etc. Limitations also include that these kinds of experts cooperations always being locally, temporary and scattered [4]. So that while the machine system with only general knowledge environment may provide good functions for opinion processing and integrating, it still could not be regarded as the high place for collaboration. Strong object system knowledge system guarantees the availability of HWMSE. Object system knowledge consist data and information, theories and methods for the object system, system models, practical cases, field–related problem solving process and method, field–related process and methods of policy making, etc. Obviously the two classes of knowledge systems should be organically united in HWMSE.

3.2 Construction and Evolvement of Object Knowledge System

The HWMSE is highly customized, means that HWMSE should be constructed based on object system knowledge. For complex object system, there should be huge knowledge accumulation from trans-disciplines and from different viewpoint; Its knowledge system may have complex structure, with multi-dimensions, multi-hierarchies and multi-profiles ; Object system knowledge may be widely distributed and highly dynamic. It would consist different types of knowledge such as structured and unstructured, tacit and explicit perceptual and rational, etc. Finally, which is remarkable, various kinds of methods and tools are often developed for different targets and under different constrains. And all these give the good reasons to build an integral knowledge environment. Thus the important characteristics of HWMSE should be systematic, dynamic and synergetic.

Therefore there are several rules to be followed for object knowledge system formation. The knowledge system should be designed as a whole for object system but than limited to only one or two current issues, to set an open and dynamic developing environment for knowledge accumulation. This is a process from whole to part. However, to the other aspect, the accumulation is a process from part to whole. Knowledge of HWMSE are accumulated from solving one or several problem, with the paths of the evolvement of object system, evolvement of object system knowledge, and quite important, evolvement with the practices and experiences of HWMSE, enrich its capability to support studies on interrelated problem of the system gradually and improve the performance through the test of the real world practices. So the process of knowledge system construction is also a process to systematically associate the multi-disciplines knowledge of object system in an integral frame, to interosculate the isolated knowledge

It is deduced that systematic study of object system is the foundation for knowledge system construction in HWMSE, including studies such as system description, system states, inner and outside environment, system regulation and the function of experts in system regulation, etc.

3.3 Knowledge Formation and Discovery

The construction and application of HWMSE is also a process to mine out the tacit knowledge and make the extrinsic knowledge associated, systematized and visualized.

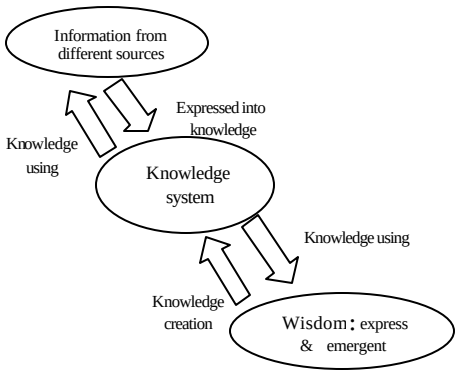

Figure 2 Knowledge system formation

As an integral system of information, knowledge and wisdom, in HWMSE there exists following processes: 1). Information processed into knowledge. The distributed, growing huge amount information should be obtained, filtered, developed and organized according to different utilities. And the processes are extensible and customized for experts. Methods and tools include internet-based information searching, information recommendation [5], knowledge mining, etc. 2). Formation of knowledge net. Since knowledge are from different resources, for different purposes, with different natures and are used in multi ways, there forms a evloving complex knowledge net and the connectivity and efficiency of knowledge use are very important. 3). Emergence and visulization of expert wisdom. Various kinds of methods and tools are designed and used for this purpose to promote the creation of knowledge. There include visualization environment and methods for experts intercommunion, such as ECB (Electronic Common Brain)[6], GAE (Group argumentation Environment)[7]; methods and tools for opinions consensus such as NG, AHP, ECB, path maker; methods and tools for general and particular problem solving pattern formation; methods and tools for thinking process recording and simulation such as CBR(Case-Based Reasoning), etc.

And system modeling based on system analyses is of great significence for complex system description and problem sovling. Models supplement with each other for different purposes in application. In fact, the process of problem solving in HWMSE is a process of different knowledge linked in complementary use, and the knowledge associations are fulfilled through utilization to a great extent. It is also important to understanding the thread of thinking in the process of knowledge using.

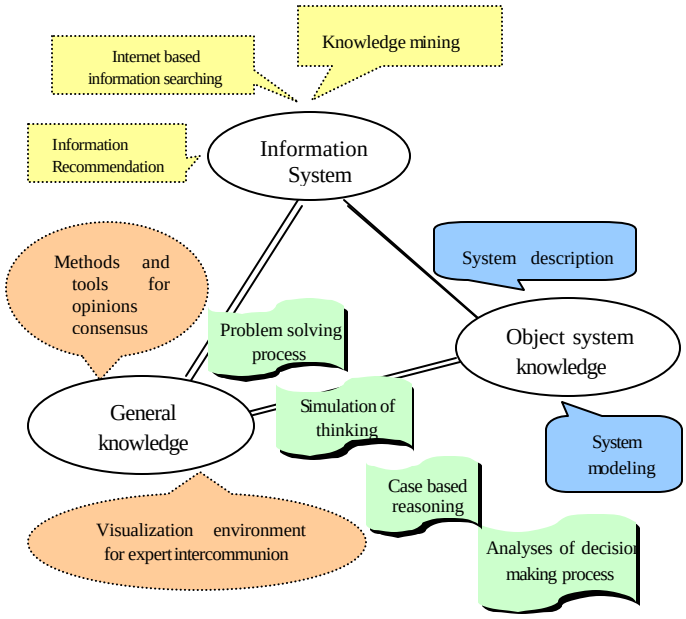

Figure 3 Relevant tasks for knowledge formation

3.4 CBR In HWMSE

The abilities to define experiences and utilize the defined case knowledge make CBR a promising tool. Case-based reasoning has enjoyed tremendous success as a technique for solving problems related to knowledge reuse. One of the key factors in ensuring this success is its ability to define experiences and utilize the defined case knowledge, particularly when a relatively small core of cases is available in a case base [8].

For HWMSE, two mayor classes of CBR could be set: 1). One is CBR for particular problem solving and policy-making. It may include following elements: problem description, description of system states, environment description, object description, evaluation, solution & countermeasures, practical results and verification of conclusions. The whole process would be recorded and traced all the time along. The historic cases for problem solving could be used for reference and it is helpful to correct errors, especially the cases of which the decisions have been tested or proved by practices. 2). The other is CBR for group discussion, which is formed as a discussion-supporting case base consists of expert discussion instances. It may comprise three kinds of case bases, namely Group Case Base including former group discussion examples, Individual Case Base for each expert respectively, and Coordination Case Base which provides supporting

cases for the president to organize the discussion process. Activities of experts could be recorded as cases, patterns could be compared by expert, and the development history of individual expert could be compared as well, this is quite useful for group work and also for expert himself in system analyses and problem solving.

To sum up, as records of experience knowledge, cases may consist of historical practices, policies and effectiveness, expert personal knowledge using (works of expert in or out the visual workshop) and that for group decision-making. Obviously these case bases are very helpful for the evolvement of knowledge system and for expert self-learning.

Consequently, HWMSE is designed to form an integration gaming framework for expert group working to fulfil the process of meta-syntheses, which is to integrate qualitative and quantitative analyses and syntheses, solve the unstructured problem through a series of structured approaches. And the whole process is just a process of knowledge discovery.

4. OBJECT KNOWLEDGE SYSTEM IN HWMSE FOR MACROECONOMIC POLICY MAKING

In the NSFC project "Research on HWMSE for Macroeconomic Policy Making" our sub group contributes to that study the meta-synthetic workshop from the viewpoint of macroeconomic problem solving. Here after the object knowledge system is discussed.

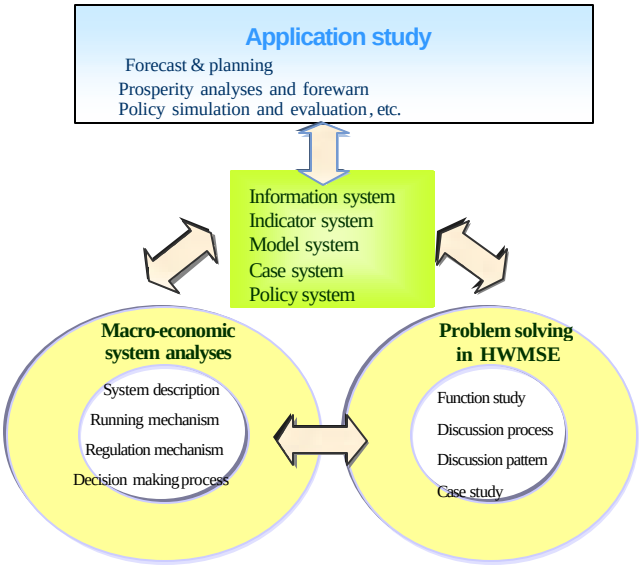

Figure 4 Framework of object knowledge system

As show in Figure 4, two parts of studies, macroeconomic system analyses and macroeconomic problem solving in HWMSE are connected, to set up an open framework for object knowledge system formation.

For macroeconomic system analyses, the complexity and complex adaptability of macroeconomic system are studied as bases. The running mechanism, regulation mechanism and decision making of macroeconomic system should be studied as well. Then, from the perspectives of system description, analysis and system control, macroeconomic information system, indicator system, model system, policy system and case system are established as the embodiment of knowledge of related fields. Emphases are paid on model system and case system.

Based on macro economic system analyses, the problem solving patterns for several special issues and tasks are abstracted and simulated as well. In this part studies are focused on the discussion patterns, problem solving process and possible programs, and the organization and utilization patterns of economic system knowledge under HWMSE. Then basing on the fundamental studies on targets, needed resources, tools, methods of different macroeconomic tasks, discussion and cooperation templates of different tasks are designed, including that for macroeconomic forecast, evaluation, economic prosperity analysis, policy simulation and model construction, etc. Each step there exist man-machine cooperation.

Furthermore, taking real macroeconomic issues as background, some experiments are carried out together with other collaborative research groups to simulate and validate the methods and platform of HWMSE, such as the experiment on "Macroeconomic situation and policy analysis of China under SARS", which is collaborated with researchers from ISS and IA, CAS and Qinghua University.

And all these works are application oriented and are practically used in macroeconomic analyses.

5、CONLUSION

HWMSE is a human-centered man-machine-net cooperation system for information processing, knowledge creation and wisdom integration. The construction of HWMSE itself needs the collaboration of trans-discipline experts, especially experts who are engaged in the research of the object system. The HWMSE is evolving in utilization, the formation of

HWMSE is a process of self learning, self organization and knowledge growing

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