The Design and Realization of Comprehensive Evaluation in the Meta-synthetic Integrated Environment of Stratagem Research

Chu Juntian, Wei Ji-cai, Cui Hao, Lv Shao-qing, Zhao Wei, Dong Jie

Abstract: When conducting researches upon stratagem problems under the meta-synthetic integrated environment of stratagem research (SR) with the combination of qualitative and quantitative methods, we have designed comprehensive evaluation service which takes the argumentation and evaluation procedure as its framework and establishes an analytical model for evaluation based on an evaluation index system to do data acquisition and mining among various evaluation resources, all of which helps realize the practical purpose of providing auxiliary information for quantitative decision making in the stratagem researches.

Key words: Complex System, Environment, Evaluation, Meta-synthetic, Stratagem

I. INTRODUCTION

Stratagem researches under the meta-synthetic integrated environment of stratagem research (SR) mean to make use of relative data, models, information and knowledge in the environment to fulfill certain research tasks. Modeling and Simulation On-Demand for the Meta-Synthetic Integrated Environment of SR is adopted for quantitative calculation, the results of which can’t be the direct source of useful information for the stratagem researches but need to be further analyzed and synthesized and then may be able to provide decision-making information for the stratagem researches according to relative experts’ judgment. Therefore, comprehensive evaluation service is designed to meet applied demands of the stratagem researches in different fields (politics, economics, military and foreign affairs, etc.) through the establishing, running, processing and displaying of data acquisition and evaluation models.

II. THE APPLIED DEMANDS OF COMPREHENSIVE EVALUATION SERVICE

Strategic issues make a typical complex system that is chronologically evolving and spatially diversified due to their relations with various fields including politics, economics, military and foreign affairs.[2],[3] From the time dimension, stratagem researches may study “strategic issues” of the present and the future on basis of the past and the “results” may furnish the process of making strategic policies with auxiliary information. And from the spatial dimension, stratagem researches provide “virtual” strategic environments including the external and internal environments of politics, economics, military and foreign affairs, all of which consist of the research environment for researchers to study the trend and management of strategic issues. Stratagem researches always get various fields and numerous elements involved and there is a large amount of data and information for use in each relative field, which makes significant difference in the applicability, credibility and certainty of the information supporting strategic decisions of the stratagem researches at different fields and different stages, thus it is necessary to synthesize all the information from different sources that may be constantly evolving and not exactly accurate or complete to go through data pre-processing and mining to finally work out a conclusion of comprehensive evaluation for stratagem researches in accordance with the features and needs of stratagem researches at different fields and different stages.

To be specific, according to different objectives of strategic decisions, the evaluation under the meta-synthetic integrated environment of stratagem research (SR) may be classified as follows:

(1) Comprehensive evaluation of different fields under particular strategic environment.
(2) Comprehensive evaluation of different fields under uncertain future strategic environment.
(3) Comprehensive evaluation of particular fields under particular conditions.
(4) Comprehensive evaluation of strategic issues.

Different approaches may be adopted in accordance with different applications of evaluation. Generally speaking, comprehensive evaluation of stratagem researches, on basis of different applicable information, may possibly choose from the following methods:

(1) Subjective judgment taking no account of norms;
(2) Qualitative comparison taking norms into account;
(3) Simple matrix of quantitative comparison;
(4) Value-centered decision analysis;
(5) Analytic Hierarchy Process (AHP)[4];
(6) Simulation;
(7) Multi-attribute decision making[5],[6],[7];
(8) Strategy-to-task analysis. Evaluation models are correspondingly set up on basis of the above approaches to provide auxiliary information for decision making process under comprehensive evaluation environment.

III. THE SOFTWARE STRUCTURE OF COMPREHENSIVE EVALUATION ENVIRONMENT

Comprehensive evaluation environment, subject to the meta-synthetic integrated environment of stratagem research (see Figure 1), utilizes low-level databases via DOD (database on demand) to provide comprehensive evaluation results for different parties in the research deduction environment (the Red, the Blue and the Director), and the next-up comes the introduction to its software structure and functions.

![Figure 1. The Schematic Diagram of the Meta-synthetic Integrated Environment of Stratagem](image)

**Meta-synthetic Integrated Environment of Stratagem Research (SR)**

The software structure of comprehensive evaluation service can be seen in Figure 2. It consists of analytical tools for evaluation, index constitutional tools, data pre-processing and evaluation model development, among which analytical tools for evaluation are supposed to finish the modeling, running, result generating and other auxiliary functions of analytical models for evaluation and compatible with the analytical process of evaluation by the combination of the analysis and the simulation or that of the qualitative and the quantitative. Besides, for the evaluation system of strategic issues, it makes use of the acquired data or the data in hand to evaluate it in compliance with the established evaluation index system and display the evaluation results by different ways of charts, tables and literal presentation and help generate an evaluation report.

![Figure 2. The Schematic Diagram of the Software Structure of Comprehensive Evaluation Environment](image)

**Index Constitutional Tools**

Index constitutional tools assist users to finish the establishment and management of the evaluation index system and set the attributes of indexes. Data pre-processing, via DOD, assists users to pre-process the necessary data to make them meet the requirements of the evaluation and store the processed results. Evaluation model development means to set up new evaluation models according to the demands of the evaluation and store them in a model base for future modeling. It boasts flexible expandability, fulfilling the integration, utilization and deploy of evaluation models.

IV. THE SOFTWARE DESIGNING FOR COMPREHENSIVE EVALUATION ENVIRONMENT

For standardization to design the Software Designing for Comprehensive Evaluation Environment. The Computer Software Configuration Item(CSCI) was adopted in order to show the structure of software, function and API(Application Programming Interface) (see Figure 3). Class diagrams are designed for each part of the structure and here index constitutional tools are taken as example to elaborate the designing process [8],[9].

A. The Workflow of Index Constitutional Tools

Before designing the index constitutional tools, it is necessary to specify its workflow (see Figure 4), according to which CSCI class diagrams are then designed.

B. CSCI Class Diagrams of Index Constitutional Tools

On basis of the index workflow and requirements, CSCI class diagrams are designed for index constitutional tools, among which user interfaces can be seen in Figure 5 and data types in Figure 6.
In Figure 5, PanePropertypGrid refers to display and edit index attributes; CriterionViewer refers to display index system;MainFrame refers to the main frame of index system tools; Search refers to search tools; CriterionBuilderDoc refers to texts; and CChildFrame refers to subclasses.

In Figure 6, Criterion is designed to store the index system and is also able to delete, cut, copy and insert indexes; PanePropertypGrid is about index attributes and available for manual entry and modification of index attributes; ValueFunction is used to acquire detailed information of indexes; and Markup is to analyze the index system out of xml-file documents.

V. SOFTWARE IMPLEMENTATION OF COMPREHENSIVE EVALUATION ENVIRONMENT

Following the design of software CSCI is programming with VC Language in order to finally realize the software development of comprehensive evaluation environment, and the running home interface of the finalized comprehensive evaluation software is like Figure 7. Click the icon “Index Constitutional Tools” and the software is started, the running interface of which can be seen in Figure 8. It provides a graphical modeling environment of index system where users are allowed to set the constitution of index system, index attributes and acquirement methods of index values to realize such editing functions as displaying, modifying, creating and saving within the evaluation index system. Here, the index attributes may be given different utility functions if necessary or user-defined, and Figure 9 is the running software interface with a curve utility function while Figure 10 is the running software.
interface with a user-defined utility function. After evaluation analysis, the evaluation results may be displayed with texts, tables and diagrams and Figure 11 is the three-dimensional display diagram of a certain evaluation result.

Figure 7. The Running Home Interface of Comprehensive Evaluation Software

Figure 8. The Running Interface of Evaluation Analytical Tools

Figure 9. Curve Utility Function

Figure 10. User-defined Utility Function

Figure 11. Three-dimensional Display Diagram of Evaluation Results
VI. INSTRUCTIONS FOR KEY TECHNOLOGIES

During the process of developing comprehensive evaluation environment, it is necessary to standardize the software development management in accordance with the demands of evaluation by software engineering management; visualization may be introduced into the index constitution; and for the development and operation of models, software module designing may help realize recombination and reuse. Due to the diversity of strategic problems, new requirements have been raised in terms of evaluation methodology and the realization process of comprehensive evaluation environment is the exactly how to solve the above problems.

A. The Structuring Process of Evaluation Index System

It is a must to primarily specify the objectives of the evaluation, only on basis of which can an evaluation index system be possibly structured. To structure the evaluation index system is also a presentation of researchers’ wisdom and reflects their subjective concepts regarding indexes, index hierarchy design as well as measurement norms of indexes. A good evaluation index system shall be the effective combination of subjective experience and objective reality. To better reflect this point, when collecting value measurement criteria for evaluation indexes, we have installed internally the regular linear utility function, polygonal utility function and curve utility function with which users may set values for the key points of indexes and correspondingly inside tools will automatically draw the utility curves of those indexes which facilitates users to better understand the utility functions and revise the utility curves in response. Except for setting function for the above three utility functions, evaluation index constitutional tools also provide “user-defined utility function”, a more flexible method structuring index utility curves. User-defined utility function allows users to set the values at several points of a single index, which assists users to structure more complex index utility curves.

At supporting to acquire decision makers’ preference to evaluation indexes, the system allows users to not only directly enter the weights of every index but also provide the visual method of “additive delegation”. For all the sub-indexes subject to a single father node, users may drag the slider block to change the weight of a certain index and accordingly the weights of other indexes at the same class will change proportionally. The sum of the weights of all indexes always remains at 1 automatically by tools. Therefore, users do not necessarily pay any attention to the worry whether the sum of all weights remains 1 and enjoy a more visualized recognition of the weights of all indexes.

B. Evaluation Data Pre-processing

A stratagem research usually takes various approaches plus various systems to get the work done. The large amount of data in different types produced by these systems and approaches can not be directly utilized for evaluation but needs to go through a “pre-processing” stage, the major task of which is to make the result data applicable for solving evaluation indexes after statistics and transformation. Consequently emerges pre-processing technology of evaluation samples based on “equation editing” which actually attempts to let users edit pre-processing equations to flexibly establish the relationship between leaf-node indexes and the result data within evaluation index system, and then “run” the equation to solve the leaf-node index values of the evaluation index system.

C. Visualized, Modularized and Wizard Modeling for Evaluation Models

To support casual tracing analysis of evaluation results, the models for evaluation index solving should be transparent to the maximum extent to facilitate the model checking by evaluation analysts; additionally, to coordinate the changing of scenarios, models, projects and objectives, the models for evaluation index solving are supposed to be as flexible as possible. Therefore, the analytical system for evaluation should adopt a visualized, modularized and standardized evaluation model and operation mechanism[10],[11],[12],[13].

To realize the expandability of the evaluation analytical methods, plug-in models are adopted to capsule them. The structural diagram of the models can be seen in Figure 12, in which the models capsule the internal behavior and only expose the I/O units which can be simply taken as one class of program designing. Models can form function models in the form of model tree via the data interface relationships.

![Figure 12. The Structural Diagram of the Models](image_url)

Out of every evaluation analytical method draws its input and output and capsules its specific operation procedure from users’ visibility. And then model plug-ins are described and deployed with a particular format. All the evaluation analytical methods are developed in compliance with the same criterion and are accessible to the same interface, so a uniform model running engine may possibly be designed to accomplish all the necessary functions with the executions and interoperations of its scheduling model.

D. The Multimode Compatible with Evaluation, Analysis and Forecast

The essence of evaluation is not to simply solve evaluation indexes and get the evaluation results of each project, but to analyze the influencing factors concealed behind problems and more often analyze the factors that exert greater influence on evaluation factors so as to optimize the projects. To make this come true, comprehensive evaluation environment raise the
objective of the multimode compatible with evaluation, analysis and forecast application modes. The evaluation mode tends to make use of both simulation data and experts’ empirical data with certain algorithms to solve the corresponding index values separately, the purpose of which is to make rankings for the projects in terms of their applicability in response to evaluation demands. The analysis mode means to analyze the influencing factors in order to identify the key factors that exert great influence over the changes of indexes. And the forecast mode attempts to use the available data samples to fit the quantitative Approximate Mathematical Model between the factors and the indexes and with which to analyze the untouched factor space in order to better understand the problems of the ongoing researches.

E. Software Engineering Management

To ensure software’s quality for reusing and flexible structuring, the software development of the comprehensive evaluation environment is conducted strictly in compliance with software engineering procedures. The whole process of software development is defined, standardized, managed and controlled, making each link or activity of the project in an orderly fashion. It ensures the progress and quality of software development, strengthens the software’s maintainability, cuts the development costs and meanwhile improves the success ratio and production efficiency of the software development.

REFERENCES


Chu Juntian, The birth place is Shan Dong Province China and birth date is 1959.11. The educational background was system engineer and awarded Doctor degree in 2001. The major field of study is Complex Systems Simulation in the Science and Technology on Complex Systems Simulation Laboratory.

Wei Jicai, The birth place is Shan Dong Province China and birth date is 1973.1. The educational background was system engineer, system simulation and modeling and awarded Doctor degree in 2003. The major field of study is Complex Systems Simulation in the Science and Technology on Complex Systems Simulation Laboratory.

Cui Hao, The birth place is Shan Dong Province China and birth date is 1973.6. The educational background was system engineer, and awarded Doctor degree in 2007. The major field of study is strategy.

Lv Shao-qing, The birth place is Shan Dong Province China and birth date is 1972.6. The educational background was system engineer, and awarded Doctor degree in 2006. The major field of study is strategy.

Zhao Wei, The birth place is Beijing China and birth date is 1978.6. The educational background was system engineer, and awarded Master degree in 2004.

Dong Jie, The birth place is Shan Dong Province China and birth date is 1978.6. The educational background was system engineer, and awarded Master degree in 2005.

Address: Post Box. 9702#19, Beijing China, 100101

Beijing Institute of System Engineer Science and Technology on Complex Systems Simulation Laboratory China

Tel +86 13611209303 Wei Ji-cai