The Modeling and Optimization of Software Engineering Processes

Alexandr Harchenko[1], Ihor Bodnarchuk[2], Vasyl Yatcyshyn[2]

Abstract – **The using of the method of insertion programming and Saaty Analytic Hierarchy Process (AHP) is described for formalization and optimization of software engineering processes. The procedure of formalized representation of requirements specification for software system (SWS) is shown, and the algorithm of optimal selection of SWS architecture in case of large quantity of quality parameters is presented too.**

Key words – **software system, requirements specification, formalization, Analytic Hierarchy Process, base protocols, architecture.**

I Introduction

The creation of SWS is enough laboriousness and expensive process caused of insufficient using of mathematical modeling methods. It is concerned especially to processes of design, analysis and communication of specifications requirements, architecture design, evaluation of quality [1].

The requirements formalization and verification are grounded on the model of base protocols. This gives possibility to formalize requirements specifications, to use automation means for their verification.

The modified Analytic Hierarchy Process (AHP) is proposed to use for the architecture design of SWS.

II. Using of logic programming for development of requirements specification

Requirement specification – is a set of properties, what the performance of SWS must satisfy to. These properties can be formalized as mathematical logic expressions, and can be represented as base protocols grounded on logical language [2].

The base protocol is written as following: $\forall x(\alpha \to \langle u \rangle \beta)$, here x – the list of parameters; α i β – precondition and postcondition of base protocol; u – the process of protocol.

The system $S(p)$, which realizes base protocols, is defined such, that its initial state can be any condition α of base language. The model of system, initialized via the parameters of base language, is represented as following: $S(p,\alpha) = \sum_{\beta \to \alpha} S_\beta(p)$, here β – such initial states, that $\beta \to \alpha$.

Such formalized system defines the abstract representation of SWS realization. It can be used for the exploration of system performance in different situations, and it allows creation of automation means for requirements verification.

III. The design of SWS architecture based on modified Analytic Hierarchy Process

Using of design patterns is a most often used method of SWS architecture design. The essence of this method is a selecting among alternative variants the optimal according to the set of quality requirements [3].

The SWS quality (and quality of its architecture too) is a hierarchical structure according to ISO 25010. It has levels of characteristics (subcharacteristics), and attributes. So the problem of selecting of optimal architecture among the set of alternatives based on complex of quality criteria is a problem of multicriteria optimization on a hierarchical structure.

The Analytic Hierarchy Process is most acceptable for solving of such problem [4]. But it good fits for small quantity of criteria ($k \le 7 \pm 2$), and has significant inconsistency of coefficients in the matrix of pairwise comparisons. They are used to get weight multipliers w_i. If the coefficients of matrix of pairwise comparisons are consistent, then the following is true: $\gamma_{ij} = w_i / w_j$, $w_i = \gamma_{ij} \cdot w_j$, here w_i – the weight multipliers of i^{th}, γ_{ij} – the coefficient of superiority of i^{th} criterion over j^{th}.

But the inconsistencies of coefficients of pairwise comparisons matrix are essential (20–30%) in a case of significant quantity of criteria is presence. It does not allow getting acceptable solution. It is proposed to find w_i as a solution of inconsistency minimization problem to overcome this disadvantage. One of possible variant of such problem is following: $\min_{\{w_i\}_{i=\overline{1,n}}} \sum_{i=1}^{n} \sum_{j=1}^{n} \left(w_i - \gamma_{ij} \cdot w_{ij}\right)^2 \quad (i \ne j)$,

$$a \le w_i \ge 1, \quad i = \overline{1,n},$$

here a – some given number.

The solution of this problem allows to get acceptable values of w_i, if inconsistencies of $\|\gamma_{ij}\|$ are significant.

IV Conclusion

So the using of methods of mathematical formalization and methods of optimization gives possibility to solve more effectively software engineering problems, dealt with development and verification of SWS requirements and architecture design. Using of formal methods is a base of automation of these processes.

References

[1] .Харченко О.Г., Яцишин В.В.,Райчев І.Е., Інструментальний засіб розробки та комунікації вимог якості до програмних систем./ Інженерія програмного забезпечення.-К.НАУ,2010-№2.-с. 29-34.

[2] Letichevsky A.,Kapitonova J.,Letichevsky A.Jr. Basic Protocols, Message Sequence Charts./ISSRE WITUL.,Rennes,4 November 2005. 2004.

[3] Saaty T.,Vargas L. Decision Making with theAnalitic Network Process.- N.Y.:Springer,2006.-278p.

[4] Павлов А.А.,Лищук Е.И.КутВ.И.,Математические модели оптимизации для нахождения весов объектов в методе парних сравнений./ Системні дослідження та інформаційні технології.-К.:ІПСА, 2007.-№2.-с.13-21.