Value-based decision model for renewal processes in software maintenance

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This work is based on a retrospective analysis of a renewal process applied to a very aged, highly degraded software system. Some parts of the results are generalized to define a method for determining the technical and economic qualities of software system components. The work also presents a decision model for identifying the most suitable renewal process to be applied, based on the quality of the components and the aims of the renewal process. With the model presented, decision-making on the renewal process is specialized to each component of the software system, thus ensuring greater benefits from the process as a whole. The same model can be used to monitor software system quality decay and thus avoid the need to use the most costly renewal processes.

1. Introduction

The semantics underlying some key words used in this work needs to be established right from the start. A software system is described as a legacy system if it is one of an organization’s assets and works to support some of its business functions. A legacy system is termed aging when its economic returns or quality are lower than expected; thus the concept of aging has nothing to do with the chronological age of the system.

To rejuvenate an aging system, one or more types of renewal process are used. For instance: reverse engineering analyzes a subject system to identify its components with their inter-relationships, and to create a representation of the system in another form or at a higher level of abstraction; restructuring improves the structure of a program automatically, without taking the program purpose into account; restoration improves the structure of programs, and of data according to their meaning in the programs; reengineering examines and alters a subject system to reconstitute it in a new form with improved quality. This may include modifications with respect to new requirements not met by the original system; rehosting refers to migration of the system to a different architecture; migration involves changing the software environment the legacy system runs on, Chifosky [1990].

On the basis of the above definitions, software system aging has both economic and qualitative explanations. Assessment of a legacy system must therefore focus on
both aspects and must support decisions on what type of renewal process is best able to attain the improvement targets that have been set.

Owing to their importance in software maintenance environments, the above problems have been much studied and an exhaustive list of references on this topic would take up too much space. We shall therefore confine to mentioning Sneed [1995], Ransom et al. [1998], Favaro and Pfleeger [1997], works produced in communities with different characteristics and nearest in approach to the present work.

These works represent the components of a legacy system on a plane with two axes: technical quality and economic value of the components. Each axis has a threshold separating acceptable values from unacceptable ones for each of the two parameters. The two thresholds divide the plane into four quadrants (figure 2): I, low quality, low value; II, low quality, high value; III, high quality, high value; IV, high quality, low value. All authors conclude that it is possible to decide whether to subject each component of the legacy system to one of the renewal processes or else to rewrite it, according to which quadrant it belongs to.

Apart from Sneed [1995], who provides more detail on how to score the software components, the others leave this decision to the decision-maker. In particular, in [Sneed 1995] some business value components (market value, contribution to profit, data significance) are identified, which must each be given a score in each program by an expert.

All these works leave the definition of the thresholds on each of the axes entirely up to the decision-maker. For the authors, the decision is unrelated to the business organization, and is the same for all the components in each quadrant.

In this work, on the other hand:

1. Guidelines are provided for calculating the quality and economic scores for each component. These can be reused in other projects, although they can and must also be continually refined with use.

2. A model for determining the thresholds on each axis is defined; the model depends on the quality and economics policy adopted by the organization intending to renew the legacy system.

3. A decision process is included, which helps to establish which renewal process should be carried out for each component; this process may differ for components belonging to the same quadrant and depends on the targets the organization intends to attain with the renewal process.

The present work is based on generalization of the results of a retrospective analysis of the data obtained with a real renewal project carried out on a banking software system [Visaggio 1997, 1999b] with 653 programs for 1.5 million instructions, observed over about 2 years. It includes: a description of the model for determining the thresholds on the two axes, an example of application of the model to the real system studied, and use of the model to assess the benefits that can be obtained by applying it to an aging system (section 2); discussion, which contrasts the model with