Efficiency of Spiral Model by applying Genetic Algorithm

[1] Sachin Sharma, [2]Anupriya Jain, [3]Seema Sharma, [4]Sonia Duggal
[1,2,3,4]Dept. of Computer Applications, Manav Rachna International University, Faridabad, Haryana, India.

Abstract
The Role of software engineering is to provide a model and process that lead to the protection of well documented software in a manner that is predictable. For a mature process it should be possible to determine in advance, how much time and efforts will be required to produce the final product. Spiral model is a model which was presented in 1986 to incorporate the project risk factor into a life cycle model. The focus is the identification of the problem and the classification of these into different levels of risks, the aim being to eliminate the problems before they threaten the software cost. This paper presents a method to improve efficiency of software spiral model by applying Genetic Algorithm. Genetic Algorithm is based on natural evolution. Through a method of inversion in Genetic Algorithm, it will optimize and reduce the complexity of risk analysis of Spiral Model.

Keywords
Spiral, Genetics, Inversion, Mutation.

I. Introduction

To solve actual problems in an industry setting [1], a s/w engineer or a team of engineers must incorporate a development strategy that encompasses the process, methods and tools layers. This strategy is often referred to as a Process model or an s/w engineering paradigm. A variety of different process models for s/w engineering are presented here. Each represents an attempt to bring order to an inherently chaotic activity. It is important to remember that each of the models has been characterized in a way that assists in the control and coordination of real software. Among them, Spiral Model is one. This model integrates the characteristics of Waterfall model [4] and Prototype model. Each iteration of the prototype represented as a cycle in the Spiral [5]. It is applicable to projects where the projects are very difficult and where new technology is used. Spiral model helps in Risk Management [6]. The developers describe the properties that have high priority and develop a prototype. This prototype is tested and changed if needed. Although consisting many advantages, even then there are some loop holes, such as cost is high and further explanation of projects in breakthrough, blueprints etc. when we evaluate the risk, the cost may be higher than cost for building the spiral model. Through the Genetic Algorithm we can minimize the problem that is faced when evaluating the risk.

Genetic Algorithm is based on natural adaptation. It produces more effective problem [3] solutions. Genetic Algorithm is most widely used in applied problem solving as well as Scientific Models. The members which adapt will all be selected for mating and reproduction. The offspring from better performer inherit the traits from both their parents. In second generation, the members who are good performer are selected for mating. Poor performer dies off without leaving any offspring. There are a number of generic operators that produce offspring having feature of the parents. 1. Crossover 2. Inversion 3. Mutation.

In this paper we apply inversion operation. It is applied to the single data structure. We focus the most important risk, and select a position of risk randomly, after applying inversion operation the tail became head and head became tail. Through this way we can minimize the cost factor in spiral model.

Now we apply 80/20 rule and find the most important risk factor that should be considered first. The 80/20 rule is established in 1897 by Italian Vel Frado Pareto in England. This law states that 20% of something is always responsible for 80% of the result.

The steps for generating the Pareto Principle [2] are as follows

1. We generate a table that lists the causes and their occurrence as percentage.
2. Sort the above table in decreasing order of importance of the cause.
3. Calculate the cumulative percentage of the frequency for the above table.
4. Plot a curve by taking causes on x-axis and cumulative frequency on y-axis and on the same graph, we again draw a Bar Graph taking percent frequency on y-axis and x-axis remains same. .
5. Draw a line at 80% on y-axis parallel to x-axis. Drop the line at the point of intersection with the curve on x-axis. This point on the x-axis separates the important causes on the left and less important causes on the right.

II. Problem Statement

We consider an example of Medical Stock Inventory System which accepts the medicine from the vendor and issues them to the customer. There is a requirement for Stock Management and checking of medicines for Expiry date. This process can be elaborated as follow:
When medicines are supplied by the vendor, the proper stock verification is done and inventory of the store is maintained. Whenever any medicine is issued to the customer, Stock Updation is done and at the day end multiple reports are generated. For new entry of medicine a proper requirement is framed based on SDE or ABC Analysis. The main focus for a medical store is to properly check items below shelf life and maintain specific status report to reduce the wastage.

The following points are important for managing any medical stock inventory system:
1. New Entry in a list
2. Vendor List
3. XYZ Analysis
4. Product List Updation
5. Cross Verification
6. ABC Analysis
7. SDE Analysis
8. Shelf Life
9. List of item below recorder
10. VED Analysis

III. Discussions and Results:

The detailed implementation of the steps with the problem is as follows

A. Firstly we generate a table

Table 1: (List of Causes with Frequencies)

S.No	Causes	Occurrences	%age
1	New Entry	5	33.3
2	Vendor List	2	13.3
3	XYZ	7	46.6
4	Product List	1	6.6
5	Cross Verification	1	6.6
6	ABC	1	6.6
7	SDE	2	13.3
8	Shelf Life	14	93.3
9	List of items below	12	80
10	VED Analysis	7	46.6

B. Now we sort the table according to the frequency.

Table 2: (Sorted table)

S.No.	Causes	%age
8	Shelf Life	93.3%
9	List of Items	80%
10	VED	46.6%
3	XYZ	46.6%
1	New Entry	33.3%
2	Vendor List	13.3%
7	SED	13.3%
6	ABC	46.6%
4	Product List	6.6%
5	Cross Verification	6.6%

C. Now we will calculate the cumulative frequency of the above table.

Table 3: (Sorted table with the Cumulative Frequency)

S.No	Causes	%age	CF
8	Shelf Life	93.3%	93.3
9	List of Items	80%	173.3
10	VED	46.6%	219.9
3	XYZ	46.6%	266.5
1	New Entry	33.3%	299.8
2	Vendor List	13.3%	313.1
7	SED	13.3%	326.4
6	ABC	46.6%	373
4	Product List	6.6%	379.6
5	Cross Verification	6.6%	386.2

Next is we draw the bar graph by taking causes at X axis of frequency on Y axis and draw the curve by taking causes at X-axis and cumulative frequency at Y-axis.

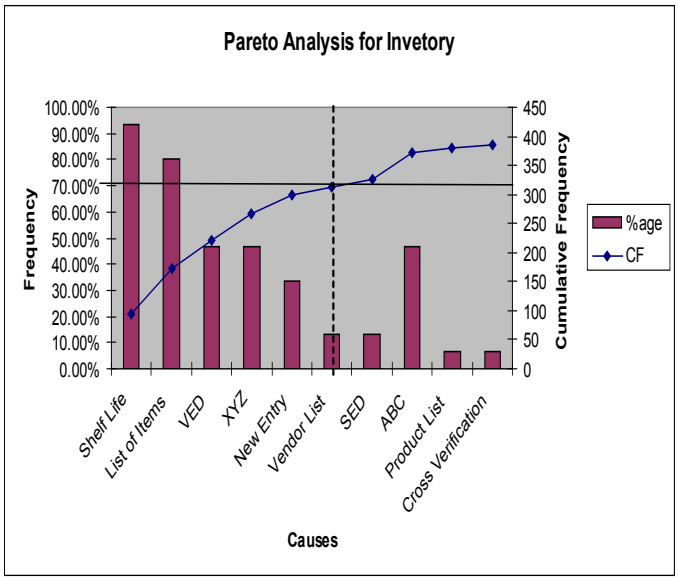

Fig. 1

Now we draw the line at 80% of cumulative frequency draw the perpendicular from the line of intersection.

Now that we have got the most important factors that are to be considered are Shelf Life, List of Items, VED, XYZ and New Entry.

D. Application of Inversion Process

The actual sequence of causes is as shown in table 1 that is 1,2,3,4,5,6,7,8,9,10. In the inversion operation one position is selected at random and after applying this operation, the tail (last process) becomes head (first process) and vice-versa. Let us suppose Inversion operation is applied at position 7. Upon application of Genetic Algorithm, we get the new sequence as 8,9,10,1,2,3,4,5,6,7. If we analyze the above generated sequence, the most important causes come at the beginning that is 8,9,10,1,2 which has also been realized by 80/20 rules. So, application of Genetic Algorithm in Spiral Model becomes efficient as all the top most priority risk factors which have to be considered come at the beginning.

IV. Conclusion

In spiral model at every cycle, there is a requirement for risk analysis which is time consuming and expensive (adds to the cost of project). So if we can deduce a method where we could prioritize the important risk at one go, the model becomes efficient and cost effective.

Using the above said approach, we have applied Pareto's 80/20 rule and Genetic algorithm's inversion operation to identify the most important risk and analyze them at the beginning to reduce the overall cost of system development.

References

[1] Pressman, R., S., "Software Process Improvement. In: Software Engineering – A Practitioner's Approach", Fourth Edition, Software Project Management. p.26. McGraw- Hill Companies Publication, Inc. USA

[2] "Pareto Analysis Step by Step", By Duncan Haughey, PMP

[3] George F Luga, "Artificial Intelligence", V Edition, Pearson Education

[4] [Online] Available: http://www.buzzle.com/articles/spiral-model-advantages-and-disadvantages.html
[5] [Online] Available: http://www.softdevteam.com/Spiral-lifecycle.asp
[6] [Online] Available: http://www.zimbio.com/Internet+Explorer/articles/66/SDLC+SDLC+models+Advantages+disadvantages

Sachin Sharma is currently working as Asstt Professor in Computer Science, Manav Rachna International University, Faridabad, India. He is working towards his Ph.D in Operations Research at MDU, Rohtak, India. His qualifications are M.Tech(IT), M.Phil (Computer), MCA and M.Sc(Operations Research). He has 12+ years experience of teaching undergraduate and post graduate students. He has published 5 research papers in International conferences and participated in many National/ International Conferences. His research interests are in the areas of Software Engg, Data Structures and Operations Research. He has also written various books on "Basics of Data Structure" for BCA, MCA students, "Computer Architecture" for MCA and "Programming in C" for GJU, Hisar. He is also a reviewer member of IJCST.

Anupriya Jain is currently working as Asstt Professor in Computer Science, Manav Rachna International University, Faridabad, India. Her qualifications are M.Tech (IT), M.Phil (Computer) and DOEACC B Level. She has 9+ years experience of teaching undergraduate and post graduate students. She has published 5 research papers in International conferences and participated in many National/ International Conferences to her credit. Her research interests are in the areas of Software Engg and Computer Organization. She has also written two books on "Basics of Data Structure" for BCA, MCA students and "Computer Architecture" for MCA.

Seema K. Sharma is currently working as Asstt Professor in Computer Science, Manav Rachna International University, Faridabad, India. Her qualifications are M.Phil(Computer) and MCA. She has 5+ years experience of teaching undergraduate and post graduate students She has published 5 research papers in International conferences and participated in many National/ International Conferences. Her research interests are in the areas of Software Engg, Data Structures and Java. She has also written books on "Basics of Data Structure" for BCA, MCA students, "Computer Architecture" and Computer Fundamentals & IT Tools" for MCA.

Sonia Duggal is currently working as Asstt Professor in Computer Science, Manav Rachna International University, Faridabad, India. Her qualifications are M.Phil(Computer) and MCA. She is also pursuing M.Tech in Information Technology. She has 5+ years experience of teaching undergraduate and post graduate students She has participated in many National/ International Conferences. Her research interests are in the areas of Software Engg, Digital Electronics.