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A Novel Human Opinion Dynamics Based Optimization for Software Cost Estimation

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ABSTRACT

Software is exploited in most of the fields today and plays an important role in both economic and social development. Mature software industries rely on early software cost estimation. Accuracy in estimations allows the company to develop appropriate time plan and estimate the most feasible budget for the project. A major cause of failure of many software projects is the lack of accurate and early cost estimation. However, irrespective of great deal of importance, estimating the time and development cost accurately is still a challenge in software industry. Barry Boehm proposed Constructive Cost Model also known as, COCOMO Model which used basic regression formula with parameters derived from historical project data and characteristics of the current project for estimating the cost of software. This model is a high risk due to low accuracy and lack of reliability. This is where the need of optimization comes in. Various approaches like Genetic Algorithm have already been applied for tuning of the parameters of COCOMO in order to increase its accuracy and reliability. Regardless, that humans are the most intelligent social animals**,** an approach based on crowd dynamics, opinion dynamics, language dynamics is seldom used for optimization. Interaction between humans gives rise to different kind of opinions in a society. The process of opinion formation evolves from collective intelligence emerging from integrative forces of social influence with disintegrative effects of individualization. Opinion dynamics leads to efficient decision making and so, we propose an approach based on human opinion dynamics for effective and accurate software cost estimation.

Keywords

COCOMO, Opinion Dynamics, Cost Estimation, Social Structure, Social Influence

1. INTRODUCTION

Accurate software cost estimation has a great significance for both software development team and customers involved in the project. Estimating the effort, time plan and staffing levels required to develop a software project is referred as software cost estimation. Standish group reported, in U.S 53% of software projects ran over 189% of the original estimate due to lack of early estimation. But, estimation is definitely not enough, the key lies within accurate estimation. The Constructive Cost Model (COCOMO) first used in 1981, laid a more calculative foundation towards cost estimation but at last suffered lack of accuracy and reliability. Several approaches are already endorsed inspired from agglomeration is physical and behavioral space like Ant Colony Optimization, Particle Swarm Optimization etc for effective estimations. Collective patterns emerging from as simple as, bacterial colonies to as complex as, humans always been an inspiration to solve complex optimization problems. As, human opinion is one of those parameters which help humans to make effective and smart decisions throughout their life so it becomes evident, that it also provides a stable base for solving such practical optimization problem like software cost estimation.Opinion can be defined as nothing but degree of preference of an individual towards a particular phenomenon in

real or imagined presence of other individuals.Opinion dynamics is a complex and difficult approach because of it's evolutionary nature and impacts of social influence and individualization. Decision making on the basis of human opinion and social structure is referred as opinion concensus.Opinion formation isn't a piece of cake to have,and suffers two major challenges.Firstly,opinion can be modeled as binary states or it may also take continous values and secondly, the decision is continuously influenced from each neighbouring individual. Mathematically opinion can be a variable or set of variables but the difficulty lies in deciding adequate set of mechanisms which explains the process of evolution and formation.However, opinion dynamics once modeled and deployed successfully can become revolutionary for solving complex mathematical optimization problems.

2. PROBLEM FORMULATION

Understanding and calculation of software cost estimation based on historical data set is difficult because of complex and related attributes which may change at any given time and may differ for different development environments.To overcome these difficulties a new approach is required which leads software cost estimation to accuracy. So,out of all algorithmic models,COCOMO model is taken in account for the study and the parameters used by this will be tuned on the basis of human opinion dynamics.This technique will be validated using NASA project data.

3. PROPOSED SOLUTION

3.1 The COCOMO

Developed by Barry Boehm in 1981, The Constructive Cost Model (COCOMO), is the most widely used algorithmic model which used regression formula with parameters for software cost estimation. The model defines the mathematical relationship between the software development time, the effort in person-months and the maintenance effort. COCOMO reflects three models on the basis of complexity namely, the Basic Model, the Intermediate Model and the Detailed Model which operates in three different modes namely, Organic, Semi-Detached and Embedded. In all these a few parameters are used namely, a,b,c and d which take different values for different modes and helps in software cost estimation. The major drawback of COCOMO is that it doesn't meet the development environment of recent times. For that purpose the parameters of COCOMO are to be tuned so that the estimates of this model, tends to accuracy.

3.2 Human Opinion Dynamics Algorithm

The study of opinion dynamics and formations is an important area of social physics.Human opinion dynamics algorithm is complex to implement but equally effective too.The four pillars of this algorithm are- Social Structure, Opinion Space,Social Influence and Updating rule.

Social structure lies between individuals or group of individuals.It portrays the way of interaction of individuals from other individuals in their neighbourhood.It is a network which ties a number individuals within one structure and reflects a stable pattern of relationship between the entities.A social graph is formed within a social structure in which the individuals forms the nodes of the graph and the neighbouring set of individuals from which each individual interact is defined with the edges of the graph.

The second pillar of the algorithm is the opinion space. Each individual within a social graph has it's own opinion space.Opinion space can be discrete or continous, where discrete opinions can be as {0,1) continous opinions can take any real value. Each individual *i* is associated with an opinion vector O(t) at any given time which allows us to search in a multidimensional space.

Social Infulence plays a huge role in opinion dynamics. Decision making process is influenced by one's own considerations as well as social beliefs in the structure. Disintegrative tendencies of individualization go hand in hand with integrative tendencies of socialization. However, for the sake of simplicity, only local dynamics is taken in account for representing social influence.Therefore, Social influence is formulated using the Social Rank and the distance between the two nodes in the social graph. Social rank is determined from the fitness values which are the output from the objective function that is to be minimized, lesser the fitness value higher will be the social ranking.Distance is actually the

Euclidean Distance between the two nodes.The social influence wij(t) of individual j on individual i is given by equation

$$w_{ij}(t) = \frac{SR_j(t)}{d_{ij}(t)} \quad (1)$$

where dij this the Euclidean distance among the two nodes.

The last but not the least is the Updating rule.Update Rule is of great significance in this algorithm because as stated earlier opinions may change at any given time and so the position of the individuals in the search space.This change in position is determined by the Update Rule which is given as :-

$$\Delta o_i = \frac{\sum_{j=1}^{N} (o_j(t) - o_i(t)) w_{ij}(t)}{\sum_{j=1}^{N} w_{ij}(t)} + \xi_i(t), j \neq i \quad (2)$$

Where, $o_j(t)$ is the opinion of neighbours of individual *i*, *N* is the no. of neighbours, $w_{ij}(t)$ represents social influence and $\xi_i(t)$ is a normally distributed random noise with standard deviation $\sigma_i(t)$ which is given as:-

$$\sigma_i(t) = S \sum_{j=1}^{N} e^{-f_{ij}(t)} \quad (3)$$

where, *S* denotes the strength of disintegrating forces in the society and $f_{ij}(t)$ denotes the modulus of difference in fitness values of individual *i* and individual *j* at time *t*. The higher the value of $\sigma_i(t)$, the higher is the tendency of an individual towards individualization[2].

3.3 COMBINED IMPLEMENTATION APPROACH

An opinion space is formed as the search space for each parameter in the social structure with domain D=[ai,bi] for (i=1,2,…n).We want to optimize function having n-parameters f(o1,o2,…on) where ai belongs to di and given that it is a positive function.Candidate solutions will be defined as n-dimensional opinion vectors given as o1,o2,….on in the opinion space.Social influence of each individual is calculates from the social rank and the distance between the two nodes.Social Rank is determined from the fitness value which is the output of the objective function which is to be minimized i.e lesser the fitness value higher will be the social ranking and the distance is given as Euclidean Distance between the two nodes in the social graph.Once the social influence is determined an update rule comes into action.Social influence is calculated and the update rule is implemented iteratively until a final value is reached.These final values are expected to take the estimation obtained from standard COCOMO parameters towards accuracy.

4. CONCLUSION

A new approach is proposed to estimate the software cost for projects sponsored by NASA using human opinion dynamics. However, availability of good historical data used by COCOMO coupled with an efficient algorithm like human opinion dynamics algorithm can generate better results. The performance of the developed model will be tested on NASA software project data. The developed model is expected to provide good estimation capabilities.

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