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A Survey on Early Size Estimation Techniques

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Abstract— Estimations play a very crucial role in the efficient termination of the task in software development life cycle (SDLC). Incorrect estimations hamper the progress of the project. As software estimation plays a critical role to control the project failures rate, estimation in the beginning of the software life cycle turns out to be very important goal for the software engineering community. For the effective development of the software project, early size estimation is considered an important parameter as it is essential for estimating the cost and total development effort. Earlier estimation leads to better project management .The main objective of this article is to explore the present literature with an intention to gain familiarity with the situation to examine the software estimation model and techniques. These estimation model and techniques helps in estimating the software size during the early phase of SDLC and acknowledge the gaps in the literature for future directions.

Keywords—SDLC,UML,Metrics,Early Size estimation

I. INTRODUCTION

Estimations are the important issues of software engineering. Incorrect estimations are the major causes of weak management, which often drive the projects out of hand [1] .The outcomes of the projects are usually overdue and overbudget, resulting in failure to deliver any outcome by any means. Numerous estimation techniques are available but, these estimation techniques are still adjudged as "inadequate" by numerous individuals. The present metrics and techniques are depreciated by means of the common dilemma for the estimation method at the early stages of the estimation science used for the software engineering [2, 3]. Significant challenges can be represented as:

1. Ambiguous hypothetical foundation
2. Inadequacy of principles on schemes
3. Inadequate validation of metrics
4. Conflicting development stage
5. Product scope of the estimation models
6. Early estimation of project size

Early estimation of project size is considered as major issue. To draw a significant and timely estimate, one has to gain a moderate knowledge and proper understanding regarding the project. Product appraisal or estimates ought to be performed during the initial stage of SDLC.This is essential to provide a capacity to react to the contracts and plan a head of times. This task has to be executed even though some adequate points of interest are not yet known regarding the problem. It is known as size estimation anomaly [4, 5, 6]. Size measurement is an important issue due to non-availability of sufficient and necessary data and estimation strategies at the early phase of software engineering. Actually, the majority of the current researches have focus on comparatively subsequent stages of software Development such as Preliminary design phases or software requirements specification. As stated by Kotonya and Sommerville [3], the phase of requirements engineering can be broadly classified into four interspersed processes. These processes consist of Requirements Elicitation, Requirements Analysis and Negotiation, Requirements Documentation and Requirements Validation. Fig.1. represents the requirements engineering process [3]. Prior estimation improves the project management. The significance of prior estimation is introduced when it is obligate to fill a tender for project or focus on an agreement between a client and a developer. The prior software size estimation is performed at that stage when the particulars of the problem are not yet known This is known as size estimation mystery [2].

In order to conduct the survey we focus on the following research questions.

- Which estimation and modelling techniques help in investigating the early estimation of project size in the literature?
- Analyze the different estimation and modelling techniques that help in investigating the early estimation of project size in the literature Organization of the paper is as follows.

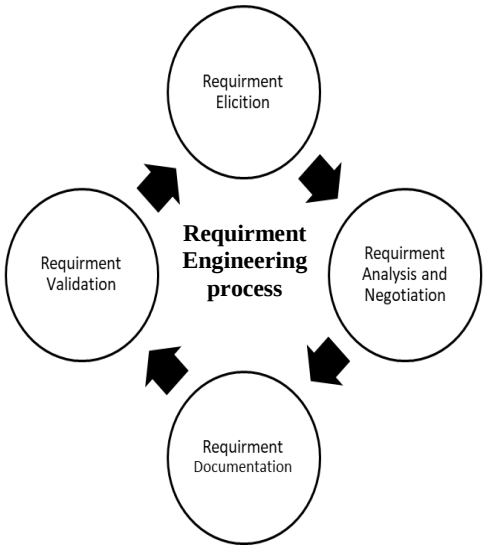

Figure 1. Requirement engineering process

Section 1 represents the introductory part which describes the key aspects of the SDLC. Section 11represents the background study. Section 111 represents the research methodology used in the paper. Section 1V contains the results. Section V contains the conclusion and future directions

II. BACKGROUND STUDY

Estimating resources are very important issue in software engineering and information technology. Planning is very important if you want to deliver the project, according to expectation. We cannot plan properly if we do not have idea about underlying dependencies and estimates. In this section we introduce previous literature studies that are related to the subject to identify their weaknesses and strengths Hasting and Rajeev [7] This paper suggests a vector size measure (VSM) that simultaneously considers problem complexity and functionality in an equitable and perpendicular style. In a vector prediction model (VPM) the VSM is utilized as the input which helps to assess the development effort in the beginning of SDLC. VSM and VPM principles can be practically applied to unified modelling language (UML). Ronchetti et al.[8] Early estimation of software size is very important for these, authors pursue two proposals from a software organization to predict, is there any attribute of the review object may possibly forecast the definite size of the software. Still authors depended to lines of code for measuring the size of the project. Lot of research is required to be done in this field. Pendharkar 2010[9] this paper highlighted a probabilistic neural network (PNN) method for con-currently assessing the estimate of software development attributes either software size or software effort. Data has been collected with real-facts of software engineering datasets and V-fold sampling. The author performs the comparison between the PNN method and the chi-squared automatic interaction detection (CHAID) method and concludes that the PNN method executes same as the CHAID method, however the former delivers better probability estimation. In this research parameter, cost of misclassification is ignored.Wilkie et al. [10] this paper highlights the utility of function point method within a business software development organization. The aim of the paper is to evaluate the cost/benefit which functional sizing methods are able to carry toward the project development and organization of software projects in a small-to-medium level software development corporation. The employ of software sizing methods gives an important contribution which would supplement, however not substitute, the business's current cost estimation approach.

III. RESEARCH METHODOLOGY

This review uses a systematic literature review (SLR) strategy presented by Kitchenham et al [11] in the direction of the estimation techniques which helps to predict the early estimation of software size. According to Kitchenham et al [11] a SLR is a method used for recognizing, assessing as well as demonstrating the entire accessible research associated towards a specific subject, idea, or theme. The SLR protocol contains distinct significant stages as represented by figure. 2.

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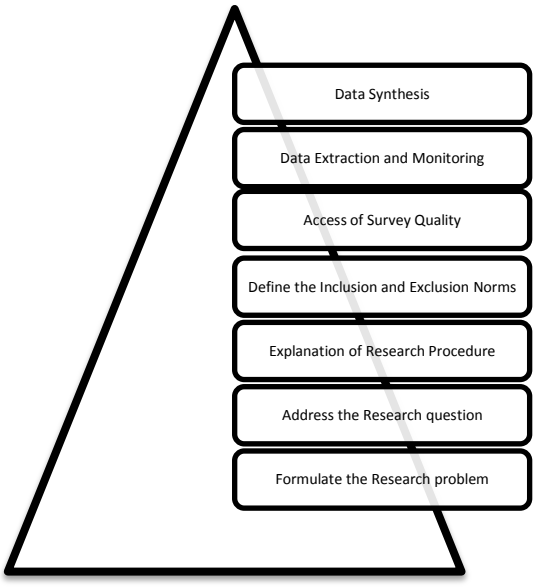

Figure 2. Phases of SLR protocol

Table 1 List of E-Resources

Publisher's Name	Source
• ELSEVIER SCIENCE DIRECT • IEEE XPLORE • IET DIGITAL LIBRARY • SPRINGER LINK • SCIENCE DIRECT • AMC DIGITAL LIBRARY • TAYLOR AND FRANCIS • WILLEY BLACKWELL PUBLISHING • BUSINESS SOURCE PREMIER • GOOGLE SCHOLAR	• SCI(Science citation index) • SCIE(Science citation index expanded) • Scopus • Scimago • Inspect • ICI (Indian Citation Index)

A. Formulate the Research Problem

Various research papers present many estimation techniques that cover several projects peculiarities determining the effort estimation. However estimation of the software size at the beginning of the SDLC is yet a major challenge [1,2,3,4,,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,39,40 ,41,42,43,44,45,46,47,48,49,50]. Main objective of this work is to perform a SLR that gives attention on the pragmatic research papers in the accessible literature keeping in mind to know the status of the research on the software estimation techniques that helps in the early estimation of the software size, and recognize the holes and open doors for future directions.

B. Research Questions

The research queries considered for this survey are listed as follows:

Which estimation and modelling techniques help in investigating the early estimation of project size in the literature?

Analyze the different estimation and modelling techniques that help in investigating the early estimation of project size in the literature.

C. Explanation of Research Procedure

Electronic database presented by Chen et.al [22] can be selected on the basis of earlier research practice, proposal and references. The databases selected for this survey paper comprise publisher's name and source. Table 1 list of E-Resources shows the listing of selected publisher's name and source. We go for various searches and observe distinct outcomes with the aim of improving the search string that can be employed in lieu of succeeding inclusive search. The search string that was created in accordance with our research questions consists of keywords and auxiliary words. The keywords and their auxiliary words are selected from existing literature in connection with early size estimation model and techniques [23, 24, 25, 26, 27]. List of prime keywords and their auxiliary words are mentioned into Table 2.Search strings can be build up by concatenating these keywords and their auxiliary words applying Boolean 'AND' or 'OR' operators. Following search strings are used to select the databases: 'software size estimation' OR 'early estimations' OR 'size metrics' OR 'code size' OR 'software product metrics') AND ('models' OR 'techniques' OR 'methods' OR 'processes') AND ('SLOC' OR 'source line of code' OR 'software size' OR 'software metrics' OR 'COCOMO' OR 'early estimate checker OR 'functional size measurement' OR' approximate software sizing methods' OR 'probabilistic forecasting' OR 'software product metrics) AND ('size measurement'' OR 'software measurement' OR 'software engineering' OR 'object oriented systems' OR 'software engineering'

D. Description of Inclusion and Exclusion Norms

With the support of research questions and objectives, we establish the following inclusion and exclusion norms for the publication selection.

Inclusion Norms: We considered publications which are based on estimation methodology of software effort and size. It was mandatory that the published publications were accessible in English language and available in full text article. These publications should be a part of some book, articles, journals and conference proceedings. Only those publications were included that consist of empirical studies and scrutinize the results by means of quantitative methods, such as statistical analysis methods. By including the studies that focus on estimation methodology of software effort and size, we focused on enhancing the survey and sustain our conclusions for formulating from the literature. Chosen publications are represented in Appendix1

Exclusion Norms: The studies which ambiguously discussed the estimation methodology of software effort and size had been excluded. Moreover the removals of those papers had been done that didn't offer critical points of interest about effort, cost and size model. Replicate entries which are the outcomes of the exploration, of diverse E-database had been abolished to keep a record of exclusive articles

*Primary Studies Selection***:** Doing the process of primary studies selection, we came across numerous papers. We used

Table2 Prime Keywords and Auxiliary Words

Prime Keywords	Auxiliary Words
Software size estimation	Early size estimation
S/W Metrics	Early estimation, Size metrics, Code size, Software product metrics
UML.	Unified Modelling Language
OOPS	Object Oriented Programming

tollgate strategy presented by Afzal et al. [28] for filtering the election procedure.Tollgate strategy consists of five stages illustrated by Fig. 3. Explanation of tollgate strategy is described by Table 3.As using the first step of the tollgate strategy, an aggregation of 200 publications was short-listed from the whole database. Publications were selected subject to inclusion norms. When we applied second stage of the tollgate strategy, we short-listed154 publications after removal of duplicates from multiple electronic libraries. At third stage the selection process matched the paper's title and abstract with the keywords associated with the research questions. At the end of third stage, 86 papers were selected. At the fourth step, the papers were selected by giving attention on 'introduction and conclusion'. In this stage we included articles, technical background of those associated with the early estimations in software engineering. By employing this stage, 50 publications were chosen. At the last stage, articles were filtered on the basis of full text. At this step, those papers were chosen, which were primarily associated to the early estimations of size, effort and cost of software projects. Overall 31 publications were filtered out for the primary study of this research. The result shows that most of the papers related to early estimation of software size are selected from Science direct, IEEE XPLORE and Springer link. Appendix1 represented the research paper considered for primary publications were filtered out for the primary study of this research. The result shows that most of the papers related to early estimation of software size are selected from Science direct, IEEE XPLORE and Springer link. Appendix1 represented the research paper considered for primary study.

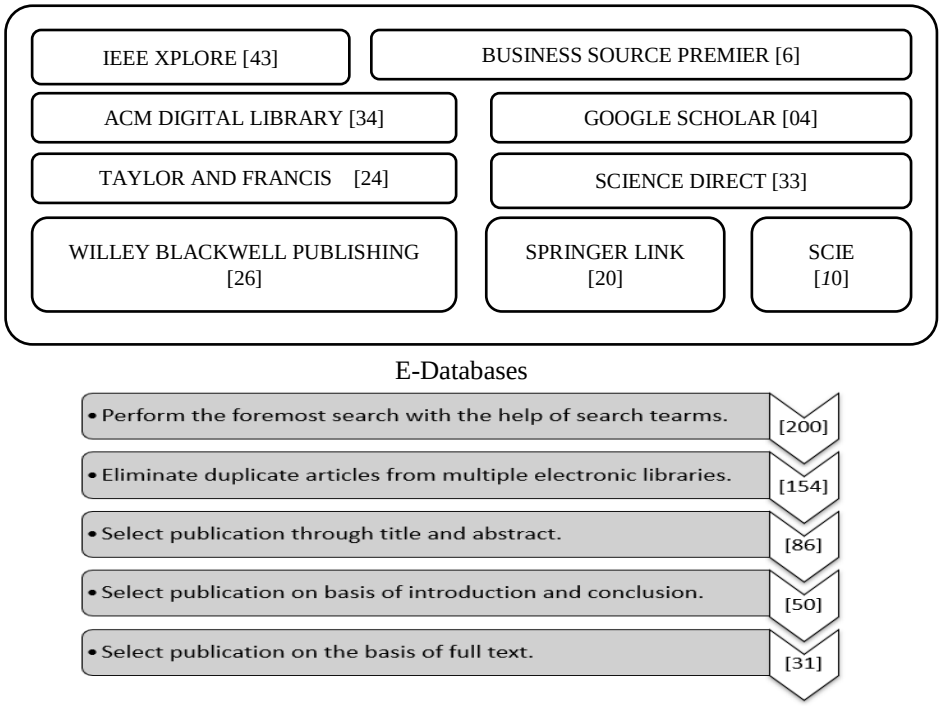

Figure3.Tollgate approach

Table 3 Publication selection through tollgate approach

E-Databases	Foremost search with the help of search terms	Eliminate duplicate publication	Select publication through title and abstract	Select publication through Introduction and conclusion	Select publication on basis of full text
IEEE XPLORE	43	17	31	26	07
SPRINGER LINK	20	15	12	7	07
SCIENCE DIRECT	33	30	14	7	09
AMC DIGITAL LIBRARY	34	31	7	5	03
TAYLOR AND FRANCIS	24	22	4	0	00
WILLEY BLACKWELL PUBLISHING	26	23	6	0	00
SOURCE PREMIER	6	4	4	0	00
GOOGLE SCHOLAR	04	2	2	2	02
SCIE BUSINESS	10	10	6	3	3
Total no of articles:	200	154	86	50	31

Assessment of the Survey Quality: To investigate the quality of short-listed papers the survey quality assessment standards were devised. The quality evaluation was done along the footing of check-list presented in Table 4 and 5. The check-list was generated according to the procedure in [28, 29, 30, 31, 37, 38]. Such papers are considered which answer the research question provided in the quality check-list. We are also assigned points to the papers which are considered. We have assigned 1 point to such papers which unambiguously accomplished the quality assessment research questions. We provide 0.5 points to such papers that communicates partial information relating to the quality assessment research questions. Papers which have not answered the questions were awarded 0 marks. After the selection of such quality standards 31 papers were included in the primary studies.

Data Extraction and Monitoring: In the data extraction phase information had been taken out using 31 primary studies dedicated to this methodical survey. Authors analyzed the different estimation techniques and models discussed in the primary studies incorporated into this methodical survey. We found that we contrasted excessively in what we really extricated for independent extraction to be significant. As an outcome, all information from every prime studies were monitored and collected by both the authors at concurrent meetings. Appendix1 shows the complete list of 31 articles selected in the primary studies.

Data Synthesis: At this stage, the results we obtained fetched were together and both questions were absolutely assessed against the results. We discussed different estimation techniques and models which help in investigating the early estimation of project size, identified from 31 publications.

Table 4 Quality assessment research questions

Questionnaire
Does the context of study unambiguously talk about the paper?
Does the study clearly focus on an early estimation of size and effort in software engineering?
Does the adopted research methodology in the paper clearly depict the research questions?
Does the data collection strategy depict in the paper?
Are the result shown in the paper appropriate to answer the research question?

Table 5 Grading of publications

SCORE	DESCRIPTION
1	Studies that have unambiguously accomplished the quality assessment research queries.
0.5	Papers which communicate limited knowledge relating to the quality assessment research queries.
0	No information.

IV. RESULTS

This phase represents the results and analysis on research questions stated in the Section 3.

A. Different Estimation Techniques andModels

The main aim of Q1is to select different estimation techniques and models which are associated with software size and effort and Q 2 to analyze the different metrics which help in predicting the early estimation of software

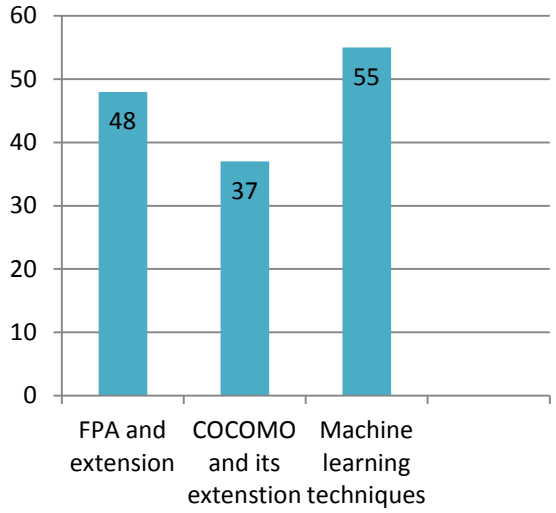

Figure.4. Frequency distribution of estimation techniques and models

size. Frequency distribution of estimation techniques and model is shown in Fig.4.

Function Point Analysis and Extension: In this study, 48% papers used function point analysis and its extensions to predict the software size in the preliminary stage of software life cycle. Concept of Function point analysis is introduced by Alan Albrecht in 1979. His main aim was to overcome the challenges associated to SLOC as a measure of software size, and to help in building up a method to forecast effort related to SDLC. Function point analysis is independent of technology because it accessed the system from a functional viewpoint. The count of function point for the system will not be differed by adopting the different languages, hardware platform or development methods.*vieridelbinaco et .al* [RT14] uses cosmic size measure to estimate the early estimation of software size which gives more accurate size estimation results than function point analysis.Sanaesadaoui *et.al* [RT13] uses the Common Software Measurement International Consortium Full Functional point, measurement (COSMIC_FFP) methodology to approximate the functional size of software. F.G Wilkie *et.al* [RT12] uses' Estimated nesma' tool which is considered to be the general suitable means for bringing into play in size estimation for the corporation. Deliberate.kennethet.al [RT10] represents in what way to use Common Software Measurement International Consortium Functional Size Measure meant for size assessment point. T.E.Hastings *et.al* [RT8] proposed a vector size measure which integrates together problem complexity and functionality to predict the software size at the early phase of software life cycle

COCOMO and Its Extension: In this study, percentage of papers which uses COCOMO model and its extension is 37 % VuNgugyen [RT15] conducted a study which proposes the improvement to the COCOMO model for estimating size and effort .j.kaczmarek et al [RT11] surveys the present strategies for early size estimation and discover their wholes and open doors. Jaimes bielak [RT6] attempts to build up strategy for recovering size estimates through investigating the sum of programming elements which might assist in predicting the code's absolute size.

Machine Learning Techniques: In this analysis 55% paper used machine learning techniques to estimate the software size during the initial stage of SDLC. For estimating the parameter like software effort and software size simultaneously, probabilistic neural network (PNN) approach was proposed by Parag c.pendharkar [RT2] This paper compares and contrasts V-fold sampling technique with the chi-squared automatic interaction (CHAID) technique .PNN approach provides better probability estimates. Yuming zhou et.al. [RT3] used different modelling technique for estimating the accuracy of different metrics to estimates the SLOC .modelling techniques are linear model, rule tree based model, nonlinear model and instance based model. Paper concluded that ordinary least square regression along with a logarithmic transformation generates the best SLOC estimation model. P. G. Kjeldsberg et.al [RT23]. Prototype of computer aided design mechanism has been proposed which consist of requirement assessment and optimization strategy for main portion of the storage space with the help of illustrative function demonstrators, this paper clarifies how tool and technology are capable of efficiently assisting the design engineer to attain a altered derive by using minimum storage space requirement.

V. CONCLUSION AND FUTURE DIRECTION

This survey paper has observed the prominent gap area in the successful implementation of techniques for estimating the software size during the early phase of SDLC. Despite hypothetical claims on accessibility of reverse discharge strategies, there is minimal sign of real utilization of some

benchmark to changing over software size starting with one measure then onto the next, over the business association. There exist some drawbacks and technical problems in changing data related to early software sizing from SLOC to FP or other way around. In addition to this, one more phase of these estimations that affects the size is the issue of complexity which may increase or decrease the size that adds up one more constituent of bias, resulting in size measures fault-prone. As there are visible gaps in the previous research there is scope for refinement and enhancement. Research work can be carried out to fill in these gaps with relevant solutions. It might also help in resolving various issues related to software size estimation at the initial stage of software life cycle. As the innovation is driving towards another period of advancement, thus customary strategies which we have discussed in study for estimating the total size of project won't be extremely powerful here. There are several new algorithms that can be chosen. It is the need of time that research work should be carried out for estimating the size at the initial stage of software life cycle by means of sophisticated mechanism surfing through the unpredictable designs of code. In this survey, 31 papers were selected out of 200 papers. We can extend this survey by adding more papers in the prime study.

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Appendix1

Sr.no	Title of Research Paper
[RT1]	Early Estimation of Software Size in Object-Oriented Environments A Case Study In CMM Level 3 Software Firm
[RT2]	Probabilistic Estimation of Software Size and Effort
[RT3]	Source Code Size Estimation Approach for Object Oriented Systems from UML class Diagrams: A Comparative Study
[RT4]	Estimation Tools and Techniques
[RT5]	AREION: Software effort estimation based on multiple regressions with adaptive recursive data partitioning
[RT6]	improving Size Estimates Using Historical Data
[RT7]	Managerial Use of Metrics for Object – Oriented Software: An Exploratory Analysis
[RT8]	A Vector –Based Approach of Software Size Measurement and Effort Estimation
[RT9]	ClassPoint: An Approach for the Size Estimation of Object-Oriented Systems
[RT10]	A Practical Approach to Size Estimation of Embedded Software Components
[RT11]	Size and Effort Estimation for Application Written in Java
[RT12]	The Value of Software Sizing
[RT13]	Experiment with COSMIC V3.0: Case Studies
[RT14]	'Model-based early and rapid estimation of COSMIC functional size – An experimental evaluation
[RT 15]	Improved Size and Effort Estimation Models for Software Maintenance
[RT16]	Function point analysis using NESMA: simplifying the sizing without simplifying the size
[RT17]	An experimental study on the conversion

	between IFPUG and UCP functional size measurement units
[RT18]	A historical compilation of software metrics with applicability to NASA's Orion spacecraft flight software sizing
[RT19]	Employing use cases to early estimate effort with simpler metrics
[RT20]	Source code size prediction using use case metrics: an empirical comparison with use case points
[RT21]	An Empirical Study of Static Program Slice Size
[RT22]	Conceptual Data Model-Based Software Size Estimation for Information Systems
[RT23]	Storage Requirement Estimation for Optimized Design of Data Intensive Applications
[RT24]	A Comparison of Size Estimation Techniques Applied Early in the Life Cycle
[RT25]	Towards an Early Software Estimation Using Log –Linear Regression and a Multilayer Perceptron Model
[RT26]	Probabilistic size proxy for software effort prediction: A framework
[RT27]	Fast &&Serious :A UML Based Metric for Effort Estimation
[RT28]	Software Cost Modelling and Estimation Using Artificial Neural Networks Enhanced by Input Sensitivity Analysis
[RT29]	Consistency Checking in Early Software Product Line Specifications - The VCC Approach
[RT30]	An Interactive Design Pattern Selection Method
[RT31]	Neural network models for software development effort estimation: a comparative study

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