A Systematic Review of Software Reliability Studies

Apoorva Singhal[1], Ankur Singhal[23]
[1]*Department of Information Technology*
University School of Information Technology, Guru Gobind Singh Indraprastha University, Delhi
apoorva_singhal@yahoo.co.in

[2]*Department of Computer Science*
Harcourt Butler Technological Institute, Kanpur
[3]*Uttar Pradesh Technical University, Lucknow*
ankur.1.singhal@gmail.com

Abstract- **This paper aims to provide a basis for the improvement of software reliability research through a systematic review of previous works. The review identifies 141 papers on software reliability in 34 journals and classifies the papers according to research topic, research approach, and study context. The review results combined with other knowledge provide the support for recommendations for future research on software reliability, including 1) increase the breadth of the search for relevant studies, 2) search manually for relevant papers within a carefully selected set of journals when completeness is essential, and 3) conduct more studies on reliability methods commonly used by the software industry.**

Keywords- **software reliability models, approaches, analysis**

1. Introduction

This study reviews journal articles on software reliability with the goal of supporting and directing future reliability researches. Our review has the following elements:

- *Different goal*: While the main goal of this review is to direct and support future reliability researches, the other reviews principally aim at introducing software practitioners or novice reliability researchers to the variety of formal reliability models. This difference in goal leads to a different focus. For example, our review focuses on research methods and does not include a comprehensive description of different software reliability methods.

- *More comprehensive and systematic review*: We based the analysis on a systematic search of journal papers, which led to the identification of 141 journal papers from 34 journals. We did not find any such review describing a systematic selection process or state clear criteria for inclusion or exclusion.

- *Classification of studies*: We classified the software reliability papers with respect to research topic, research approach, and study context.

Based on what we believed were interesting issues to analyze, we posed five research questions described in Table 1. The underlying motivation for all questions was our goal of improvement of the software reliability researches. These research questions guided the design of the review process.

The remaining part of this paper is organized as follows: Section 2 describes the review process. Section 3 reports the review results. Section 4 summarizes the main recommendations for future researches on Software Reliability.

2. Review process

2.1 Inclusion criteria

The main criterion for including a journal paper in our review is that the paper describes research on software reliability models. Papers related to Software Reliability are only included if the main purpose of the studies is to improve Software Reliability process. We excluded pure discussion/opinion papers.

There were examples of papers describing, essentially, the same study in more than one journal paper. Fortunately, the number of such cases was small and would not lead to important changes in the outcome of our analysis. We, therefore, decided not to exclude any paper for that reason.

TABLE 1
RESEARCH QUESTIONS

Research Question	Main Motivation
RQ1: Which and how many journals include papers on Software Reliability?	Support Software Reliability researchers with a list of journals with potentially relevant papers.
RQ2: To what extent are Software Reliability researchers aware of the breadth of potential Software reliability sources?	Identify possible shortcomings of Software Reliability researchers' searches for related work.
RQ3: How easy is it to identify relevant Software Reliability journal papers?	Identify possible shortcomings of internet and library based searches to identify Software Reliability papers.
RQ4: What are the most investigated Software Reliability search topics and methods and how has this changed over time?	Identify the trends and possible shortcoming / opportunities for research topic and method focus.
RQ5: What are the most frequently applied research methods, and in what study context? How has this changed over time?	Identify the trends and possible shortcoming / opportunities for the use of research methods.

2.2 Identification of papers

The search for papers was based on an issue-by-issue, manual reading of titles and abstracts of all published papers, written in English in various journals published in IEEE Xplore, Springer, ACM, Wiley, Elsevier, Questia and Sage. The journals were identified through reading the reference list of software reliability papers, searching on internet for previously not identified, relevant journals. Both authors constructed a list of potentially relevant journals independently. These two journals were merged together. In spite of the good number of identified journals, it is possible that there are, e.g. national or company-specific journals with papers on software reliability that we have missed.

Papers that were potential candidates for inclusion in our review were read more thoroughly to decide whether to include them or not. In total, 141 relevant papers were found in 34 journals. These 34 journals and 141 papers are listed in, respectively, Appendices A and C. The search was completed in May 2011.

2.3 Classification of papers

For the purpose of our analysis, i.e., addressing the research questions, we have classified the papers according to the properties and categories listed in Table 2. The categories are explained in Appendix B. The categories are adapted to the needs of our analysis. In particular, the classification aims at answering the research questions RQ4, and RQ5. The classification schema was developed for the purpose of our review and is not intended to be a general-purpose classification of software reliability studies. We believe, however, that the classification may be useful for other researchers searching for relevant papers on, for example, a particular reliability approach. Note that most of the categories are nonexclusive, e.g., a paper may focus on more than one reliability approach and apply more than one research model. The robustness of the classification schema and process was evaluated by testing a random sample of papers. The classification test showed that several of the initial descriptions of categories were vague. Most of the disagreements were due to recurring issues, e.g., different interpretations regarding how much review of previous studies a paper should include to be classified as a review paper. In other words, the main problem was the clarity of the descriptions and not so much the initial classification itself. We therefore decided that the initial classification had a degree of accuracy sufficiently high for the purpose of this paper, given that we: 1) clarified the descriptions that led to disagreements, and 2) reclassified the papers that belonged to the problematic categories. In spite of this effort to improve the reliability of the classification, it is likely that several of our classifications are subject to discussion, that the descriptions could be improved further, and that some of the papers are classified incorrectly. However, we believe that on the whole, the current classification is of sufficiently high quality to serve the purpose of our analysis.

TABLE 2
CLASSIFICATION OF PAPERS

Property	Categories
Research topic	Model, Analysis, Use of statistics, Test Plan, Approach, Others
Research approach	Survey, Theory, Experiment, Case Study, Review, Simulation
Study context	Students and/or Professors, Professional and/or Industrial software projects, Not relevant

2.4 Analysis

The classification of research papers provided a general picture of the characteristics of the software reliability research. This general picture served as a starting point for deeper investigation of findings that seemed, from our perspectives, to suggest important shortcomings in reliability research and possibilities for improvement.

2.5 Threats to validity

The main threats to the validity of our review, we have identified, are these:

Publication bias: The exclusion of conference papers and reports is based mainly on practical concerns, including workload, e.g., the problems of identifying all relevant papers and the amount of analysis needed to handle the fact that many journal papers are improvements of previously published conference papers. However, we are interested mainly in properties of the research into software reliability. The main bias of our inclusion of journal papers is simply one toward papers with high scientific quality. We probably have excluded a major source of information about the software industry's experience in using different reliability approaches. Our analyses and recommendations try to reflect this bias. Another potential publication bias is that which might result from not publishing reliability research that has no significant results, results that did not yield the desired outcome, company-confidential results, or results that were conducted on topics that do not fit into the common software engineering journals. Also, only those papers were included which were available free of cost and paid papers were excluded. The size and effect of the potential publication biases would be interesting to study but would require a study design different from ours. *Vested interest of the authors:* We are not aware of the biases we may have had when categorizing the paper. It is possible that the recommendations we make are affected by our interests and opinions.

Unfamiliarity with other fields: Clearly, reliability is a topic that is relevant to many fields; thus, it is possible that we have overlooked essential work and relevant journals published in another discipline, e.g. medical science.

3. RESULTS

3.1 Relevant Software Reliability Research Journals (RQ1)

We found papers on software reliability in as many as 34 journals, i.e., the total number of journals with such papers are higher than we expected. The 34 journals are listed in Appendix A. The name of the journal with five or more papers on software reliability is also displayed in Table 3, together with the corresponding number, proportion and cumulative proportion of papers. These six journals include two-thirds (65.90%) of all identified journal papers on software reliability. Reading only the top five most relevant journals means that important results may be missed.

TABLE 3

MOST IMPORTANT SOFTWARE RELIABILITY JOURNALS

Rank	Journal	Number of Relevant Papers Found	Proportion	Cumulative Proportion
1	IEEE Transactions on Software Engineering	41	29.07%	29.07%
2	Software IEEE	21	14.89%	43.97%
3	Journal of Systems and Software	15	10.63%	54.53%
4	Electronics and Communications in Japan	6	4.25%	58.80%
5	Annals of Software Engineering	5	3.55%	62.35%
5	Empirical Software Engineering	5	3.55%	65.90%

3.2 Researcher Awareness of Relevant Journals (RQ2)

We were interested in the degree to which software reliability researchers were aware of and systematically searched for related research in more than a small set of journals. An indication of this awareness was derived through a random selection of 15 software reliability journal papers (above 10% of the journal). These papers are

marked with (S) in Appendix C. The reference lists of each of these papers were examined. From this examination, we found that:

- The typical (median) software reliability study relates its work to and/or builds on Software Reliability studies found in only few different journals, esp. in IEEE TSE. 12 out of 15 (80%) of the selected papers referred to this journal, for example, in paper "Analyzing and Improving Reliability: a tree based approach", 37.50% paper referred were from IEEE TSE. 33.33% selected papers also referred to IBM Journal of Research and Development. We examined the topics of the papers and found that some of the papers did not referred to previously published, seemingly relevant, papers on the same research topic. For example, "A sequential Bayesian generalization of the Jelinski–Moranda software reliability model" by Alan Washburn, published in 2006 in Naval Research Logistics (NRL) journal by Wiley did not mentioned the name of the journal paper "A Bayesian modification to the Jelinski–Moranda software reliability model" by Bev Littlewood and Ariela Sofer, published in journal paper Software Engineering Journal in 1987 by IEEE Xplore. This indicates, we believe, that many papers on Software Reliability are based on information derived from a rather narrow search for relevant papers.
- The most referenced journal, with respect to related Software reliability work, was the IEEE Transactions on Software Engineering (IEEE TSE) and it contained maximum number of papers (29.07%). Reliability papers from this journal were referred to in as many as 80 percent of the papers. There were surprisingly many references (33.33%) to IBM Journal of Research and Development. 20 percent papers also referred to Journal of System and Software.
- Few papers referred to papers published outside the software community like "Estimation of Software Reliability by Stratified Sampling" and "Software Reliability Models: Assumptions, Limitations, and Applicability" referred to "Estimating software reliability from Teat Data" by E.N. NELSON, published in *Mircroelectron* in 1978 and "A Sequential Bayesian Generalization of the Jelinski–Moranda Software Reliability Model" referred to journals like "American Institute of Aeronautics and Astronautics" and "IEEE Trans Aerospace 2".
- Also, some journals outside computer science field also published paper on reliability improvement and referred to papers from IEEE TSE. Paper "Improving the Reliability of Medical Software by Predicting the Dangerous Software Modules" was published in the Journal of Medical Systems.

The above evidence indicates that several authors use narrow criteria when searching for relevant software reliability papers. The most important issue, however, is whether papers on software reliability miss prior result that would improve its study. This can not be derived from our view alone. Our impression, however, based on the review presented in this paper, is that the major deviation from what we assess as the best research practice is the lack of identification and integration of results outside the computer science domain.

3.3 Identification of Relevant Software Reliability Research Journal Papers (RQ3)

Our search for software reliability papers was, as described earlier, based on a manual issue-by-issue search from the journal. This is, we believe, an accurate method of identifying relevant research papers, given that the people conducting the search possess sufficient expertise. It does, however, require much effort and, if possible, it should be replaced with more automated search and identification methods. The main tool for this is the use of digital libraries. To indicate the power of the digital libraries we conducted the following evaluation:

1. The search term: "software reliability" was applied in many journals. Wider searches would, obviously, lead to more complete searches. The number of "false alarms" would, however, also increase strongly and the benefit of automatic search may easily disappear.
2. The papers identified by using the above searches were compared with the set of papers from our manual search.

The main conclusion from this simple test was that the use of the search facilities of digital libraries to search for common software reliability terms is not sufficient for the identification of all relevant software reliability research papers. The search in many journals missed a substantial part of relevant papers.

A closer examination of the titles and abstracts of the journal papers not identified suggests that the most typical reasons for non-identification in our test were:

- When we typed "software reliability", all papers, around 314, appeared, as "software" appeared

on each paper in the journal "IEEE Transactions on Software Engineering", out of only 41 were relevant, which were found by manual issue-by-issue search.

- A variety of substitutes for the term "reliability," e.g., "fault tolerable", etc were used.
- A variety of terms used instead of "software," e.g., "system," "project," and "program", etc.
- Use of more specific terms derived from particular reliability methods, e.g., "Bayesian analysis," instead of more general reliability terms like "Enhancing software reliability".
- Studies dealing with specific reliability topics, e.g., "Reliability estimation for a software system with sequential independent reviews" may not use the general "reliability" term.

In many cases, a software reliability researcher will use more specific terms when searching for relevant papers. This may reduce the effect of the last two of the above reasons and higher coverage rates can be expected. However, there remains the problem that a number of synonyms are used for the terms "reliability" and "software." A wider search, e.g., the search ("software" AND ("reliability") identified the paper. In addition, if we had used variants of the terms, e.g., "reliable" instead of "reliability," we would not have identified the paper in spite of a very wide search. It is evident that searches in digital libraries that are sufficiently wide to identify relevant software reliability estimation research can easily lead to higher workload than purely manual search processes.

Manual searches do not guarantee completeness, either. It is easy to make errors and to miss relevant journals. The current situation, with a lack of standardized terminology, may require a manual search of titles and abstracts in a carefully selected set of journals to ensure the proper identification of relevant research on software cost estimation. In the longer term, enforcing a more standard scheme of classification for software reliability or a more standardized use of keywords should be an important goal for digital libraries and researchers on software reliability.

3.4 Distribution of Research Topics (RQ4)

Table 4 shows the distribution of topics for three periods and in total. The distribution in Table 4 suggests that:

- The most common research topic, with 42.85% of the papers, is the "analysis" of various models and trends in Software Reliability.
- The distribution of topics over time is quite stable, with a few exceptions. Papers on the "analysis" were more common before 1990 (about 55%) indicating that before 1990's, as study of software reliability was in its nascent stage, less studies were conducted then (13% only of overall studies) and it was simply of analyzing, in nature, of models proposed by others, relatively few by researchers(15%).
- Though, more models were proposed in later period (14.35%), but their analysis by others increased significantly (42.85%) , it shows that researchers are less interested in proposing new things, rather, they either relied upon examining old thing or improving it.
- There is also huge increase in number of different approaches proposed for Software reliability in the three decades, from 15% of total studies before 1990 to 32.90% of total studies after 2000 contributing to overall of 29.22% of total papers examined, which directly links to increase in number of analysis as more and more people were analyzing other's work so after that, they proposed improvements on them.

Table 4 indicates that the most papers on software reliability are of "analysis" in nature, analyzing various software reliability models and effects of other theories on software reliability, etc. Also, using Statistical techniques declined after 1990. Publisher-wise distribution of data is given in Appendix D (of IEEE Xplore, Elsevier, Wiley, Springer, Questia, ACM, and Sage).

TABLE 4
RESEARCH TOPICS

Research topics	~1989	1990-1999	2000-2011	Total
Models	3(15.00%)	8(13.79%)	12(15.78%)	23(14.35%)
Analysis	11(55.00%)	24(41.37%)	31(40.78%)	66(42.85%)
Use of Statistics	2(10.00%)	0(0%)	0(0%)	2(1.30%)
Test plans	0(0%)	5(8.620%)	4(5.26%)	9(5.84%)
Approaches	3(15.00%)	17(25%)	25(32.90%)	45(29.22%)
Others	1(5.00%)	4(29.31%)	4(5.26%)	9(5.84%)

One paper may discuss more than one topic.

3.5 Research Approach and Study Context (RQ5)

Table 5 shows the distribution of papers applying different research approaches, per period, and in total.

Table 5 suggests that:

- Even now, major portion of studies in this area is theoretical in nature, for example, studying models, describing and analyzing them and/ or proposing an improvement over them, etc. (63.08%).
- Excluding theoretical studies, major papers evaluate software reliability using through case studies (16.77%) and after that comes experiments (13.51%), in the form of mathematical derivation, investigation, and/or implementation, and reviews (11.40%) and very few uses simulation techniques (2.68%).

In short, there seems to be a lack of in-depth practical studies on the actual use of software reliability method/ models which were published as journal papers. Moreover, about 63.08% of total studies conducted are still theoretical in nature, which basically analyzes other's studies models and/or proposes an improvement or alternate way to them, and there is still lack of experimental studies (only 13.51%). Publisher-wise distribution of data is given in Appendix D (of IEEE Xplore, Elsevier, Wiley, Springer, Questia, ACM, and Sage).

TABLE 5
RESEARCH APPROACHES

Research approach	~1989	1990-1999	2000-2011	Total
Survey	0(0%)	0(0%)	2(2.94%)	2(1.34%)
Theory	12(54.54%)	41(69.50%)	41(60.20%)	94(63.08%)
Experiment	3(13.63%)	9(15.25%)	13(19.11%)	25(13.51%)
Case study	2(9.09%)	4(6.77%)	1(1.47%)	7(16.77%)
Review	5(22.72%)	3(5.08%)	9(0%)	17(11.40%)
Simulation	0(0%)	2(3.38%)	2(13.23%)	4(2.68%)

One paper may apply more than one approach

Table 6 shows the distribution of papers applying different study contexts per period and in total.

Table 6 suggests that the study context is usually done by students or university professors (63.46%) and not much by industries (21.40%), thus, it is more of theoretical in nature than that of realism in nature. In fact, studies conducted at industry level (21.40 %) are almost one-third of the studies conducted in universities. More over before 2000, substantial number of studies were conducted at industry levels but it declined after 2000 (11.48%). It can also be concluded that out of the total publication in software reliability, the contribution by universities (either by student or professor or both) has increased drastically and enjoys a dominant share of overall studies.

TABLE 6
STUDY CONTEXTS

Study context	~1989	1990-1999	2000-2011	Total
St	9(47.36%)	54(52.42%)	109(73.64%)	172(63.46%)
Pr	8(42.10%)	33(32.03%)	17(11.48%)	58(21.40%)
Nr	3(15.78%)	16(15.53%)	22(14.86%)	41(15.13%)
The abbreviations used are: St: students and/or professors, Pr: professional and/or industrial software projects, Nr: not relevant				

One paper may apply more than one study context

4. CONCLUSION

This paper reviews software reliability papers published in journals classified according to research topic, research approach, and study context. Based on our, to some extent subjective, interpretation of the review results and other knowledge, we recommend the following changes in reliability research:

- **Increase the breadth of the search for relevant studies**: Software reliability research studies seem, on average, to be based on searches for relevant previous studies that use few sources. If the goal is to find relevant research on software

reliability, it is not sufficient to conduct searches in digital libraries or manual searches of the most important software engineering journals. We identified as many as 34 journals with studies on software reliability, several software reliability papers that would have been hard to find through searches in digital libraries, and many journals from other domains that contained relevant results.

- **Search manually for relevant papers in a carefully selected set of journals when completeness is essential**: There is a lack of standardized use of terms pertaining to software reliability. We believe that such a lack makes it is easy to miss important papers when relying on automatic searches in digital libraries or getting more than required papers. The search term "software reliability" for example, identified more than thousands of papers on software reliability by using automatic search. We are aware of the practical limitations related to the use of manual search process, e.g., the required search effort. In cases where completeness is not essential, a combination of manual search of the most relevant journals and use of digital libraries to cover the other journals may be sufficient.
- **Conduct more studies on reliability methods commonly used by the software industry**: In spite of the fact that formal reliability models have being in existence for many years, the dominant reliability method is based on expert judgment. Further, available evidence does not suggest that the reliability prediction accuracy improves with use of formal reliability models. Also, as majority of these papers analyzed are of theoretical in nature relating to analysis or approach and are conducted at university level. This shows that maximum of these papers may be written just for formality, either by students for obtaining their degree or by faculties for their promotion, etc. Despite these factors, current research, which is industry specific or of practical use, is relatively sparse and we believe that this area deserves more research effort.

We cannot claim, based on empirical evidence, that adherence to our recommendations actually leads to better software reliability predictions. However, adherence to these recommendations will, we believe, increase the probability that future reliability research builds on existing knowledge, is relevant for the software industry and is easier to generalize to other contexts. This in turn, we think, will increase the probability of better reliability predicting methods and reliability practices.

References

[1] A. Goel and K. Okumoto, "Time-Dependent Error-Detection Rate Model for Software Reliability and Other Performance Measures," *IEEE Trans. Rel.*, vol. R-28, no. 3, 206 -211, 1979.

[2] Z. Jelinski and P. B. Moranda, "Software Reliability Research," *Statistical Computer Performance Evaluation*, W. Freiberger, Ed. New York: Academic, 485-502, 1972.

[3] M. Shooman, "Probabilistic Models for Software Reliability and Prediction," in *Statistical Computer Performance Evaluation*, W. Freiberger, Ed. New York: Academic, 485-502, 1972.

[4] R.H. Hou, S.Y. Kuo, and Y.P. Chang, "On a Unified Theory of Some Nonhomogenous Poisson Process Models for Software Reliability," Proc. *1998 Int'l Conf. Software Eng., Education & Practice (SEEP '98),* 60-67, Jan. 1998

[5] D.R. Miller, "Exponential Order Statistic Models of Software Reliability Growth," *IEEE Trans. Software Eng.,* vol. 12, no. 1, 12-24, Jan. 1986.

[6] M. Trachtenberg, "A General Theory of Software-Reliability Modeling," *IEEE Trans. Reliability,* vol. 39, no. 1, 92-96, Jan. 1990.

Appendix A

(The numbers of papers identified in each paper are in (). The titles of journals with more than five papers appear in italic.)

Annals of Software Engineering (5) - rank 5
Applied Stochastic Models in Business and Industry (2)
Automation and Remote Control (1)
Cybernetics and Systems Analysis (1)
Electronics and Communications in Japan (6) - rank 4
Empirical Software Engineering (5) - rank 5
IBM Journal of Research and Development (1)
IBM systems Journals (2)
IEE Proceedings Software (1)
IEEE Transactions on Software Engineering (41) - rank 1
Information and Software Technology (3)
Innovations in Systems and Software Engineering (4)
International Journal of Automation and Computing (2)
International Journal of Systems Assurance Engineering and Management (3)
Journal of Applied Mathematics and Computing (1)
Journal of Computer Science and Technology (1)
Journal of Mechanical Engineering Science (1)
Journal of Medical Systems (1)
Journal of Risk and Reliability (1)
Journal of Shanghai University (English Edition) (1)
Journal of Systems and Software (15) - rank 3
Journal of the ACM (JACM) (1)
Journal of the American Statistical Association (1)
Naval Research Logistics (NRL) (1)
Programming and Computer Software (1)
Quality and Reliability Engineering International (2)
Sadhana (1)
Software Engineering Journal (4)
Software IEEE (21) - rank 2
Software Quality Journal (1)
Software Testing, Verification and Reliability (3)
The American Statistician (2)
Transactions on Software Engineering and Methodology (TOSEM) (2)
Wuhan University Journal of Natural Sciences (4)

APPENDIX B

CLASSIFICATION DESCRIPTIONS

Category: Research topic

1. Models: Studies of various software reliability models, simple theoretical studies only.
2. Analysis: Studies dealing with impact of various factors on software reliability or criteria for model comparisons, etc.
3. Use of statistics: Studies dealing with statistical inferences made or statistical estimation done on software reliability.
4. Test plans: Studies dealing with test plans for inferences on software reliability
5. Approaches: Studies proposing various new/alternate approaches to improve software reliability process
6. Other topics: Unclassified topics.

Category: Research approach

1. Survey: Survey-based studies, e.g., questionnaire and interview-based surveys of industry practice.
2. Theory: studies dealing with theoretical description/evaluation of properties of various software reliability models and/or proposing new models or approach.
3. Experiment: Studies dealing with criteria for assessments and model comparisons, experiment-based studies, mathematical derivations, systematic investigations and/or practical implementations of some models, etc.
4. Case study: Case-based studies, e.g. in-dept study of processes of one or more projects.
5. Review: Studies that review other software reliability papers/ models.
6. Simulation: Simulation-based studies. This category relates to the research method, e.g., the evaluation method

Category: Study context

1. Students: Studies where the subjects are students, professors and/or student projects.
2. Professionals: Studies where the subjects are software professionals and/or industrial software projects.
3. Not relevant: Studies where the study context is not relevant.

APPENDIX C

JOURNAL PAPERS ON SOFTWARE

Software Reliability and Testing Time Allocation: An Architecture-Based Approach,
Pietrantuono, R.; Russo, S.; Trivedi, K.S.;
Software Engineering, IEEE Transactions on
Volume: 36 , Issue: 3 Digital
Object Identifier: 10.1109/TSE.2010.6
Publication Year: 2010 , Page(s): 323 – 337
Publisher: IEEE Xplore

Uncertainty Analysis in Software Reliability Modeling by Bayesian Analysis with Maximum-Entropy Principle,
Yuan-Shun Dai; Min Xie; Quan Long; Szu-Hui Ng;
Software Engineering, IEEE Transactions on
Volume: 33 , Issue: 11
Digital Object Identifier: 10.1109/TSE.2007.70739
Publication Year: 2007
Publisher: IEEE Xplore

Nonparametric Analysis of the Order-Statistic Model in Software Reliability,
Simon P. Wilson; Francisco J. Samaniego;
Software Engineering, IEEE Transactions on
Volume: 33 , Issue: 3
Digital Object Identifier: 10.1109/TSE.2007.27 ,
Publication, Year: 2007 , Page(s): 198 – 208
Publisher: IEEE Xplore

A simulation approach to structure-based software reliability analysis
Gokhale, S.S.; Michael Rung-Tsong Lyu;
Software Engineering, IEEE Transactions on
Volume: 31 , Issue: 8 Digital Object Identifier: 10.1109/TSE.2005.86
Publication Year: 2005 , Page(s): 643 – 656
Publisher: IEEE Xplore
Evaluating Web software reliability based on workload and failure data extracted from server logs,
Tian, J.; Rudraraju, S.; Zhao Li;
Software Engineering, IEEE Transactions on
Volume: 30 , Issue: 11
Digital Object Identifier: 10.1109/TSE.2004.87
Publication Year: 2004 , Page(s): 754 – 769
Publisher: IEEE Xplore

A unified scheme of some Nonhomogenous Poisson process models for software reliability estimation,
Chin-Yu Huang; Lyu, M.R.; Sy-Yen Kuo;
Software Engineering, IEEE Transactions on
Volume: 29 , Issue: 3
Digital Object Identifier: 10.1109/TSE.2003.1183936
Publication Year: 2003 , Page(s): 261 – 269
Publisher: IEEE Xplore

Modular operational test plans for inferences on software reliability based on a Markov model,
Rajgopal, J.; Mazumdar, M.;
Software Engineering, IEEE Transactions on
Volume: 28, Issue: 4
Digital Object Identifier: 10.1109/TSE.2002.995424
Publication Year: 2002, Page(s): 358 – 363
Publisher: IEEE Xplore

Reliability estimation for a software system with sequential independent reviews,
Rallis, N.E.; Lansdowne, Z.F.;
Software Engineering, IEEE Transactions on
Volume: 27, Issue: 12
Digital Object Identifier: 10.1109/32.988707
Publication Year: 2001, Page(s): 1057 – 1061
Publisher: IEEE Xplore

Planning models for software reliability and cost,
Helander, M.E.; Ming Zhao; Ohlsson, N.;
Software Engineering, IEEE Transactions on
Volume: 24 , Issue: 6
Digital Object Identifier: 10.1109/32.689400
Publication Year: 1998, Page(s): 420 - 434
Publisher: IEEE Xplore

Total variance approach to software reliability estimation,
Adams, T.;
Software Engineering, IEEE Transactions on
Volume: 22, Issue: 9
Digital Object Identifier: 10.1109/32.541438
Publication Year: 1996, Page(s): 687 – 688
Publisher: IEEE Xplore

Integrating time domain and input domain analyses of software reliability using tree-based models,
Tian, J.;
Software Engineering, IEEE Transactions on
Volume: 21 , Issue: 12
Digital Object Identifier: 10.1109/32.489071
Publication Year: 1995 , Page(s): 945 – 958
Publisher: IEEE Xplore

No special schemes are needed for solving software reliability optimization models (S)
Sarper, H.;
Software Engineering, IEEE Transactions on
Volume: 21 , Issue: 8
Digital Object Identifier: 10.1109/32.403793
Publication Year: 1995 , Page(s): 701 – 702
Publisher: IEEE Xplore

Software reliability trend analyses from theoretical to practical considerations
Kanoun, K.; Laprie, J.C.;
Software Engineering, IEEE Transactions on
Volume: 20 , Issue: 9
Digital Object Identifier: 10.1109/32.317434
Publication Year: 1994 , Page(s): 740 – 747
Publisher: IEEE Xplore

Software reliability model with optimal selection of failure data
Schneidewind, N.F.;
Software Engineering, IEEE Transactions on
Volume: 19 , Issue: 11
Digital Object Identifier: 10.1109/32.256856
Publication Year: 1993 , Page(s): 1095 – 1104
Publisher: IEEE Xplore

Compound-Poisson software reliability model
Sahinoglu, M.;
Software Engineering, IEEE Transactions on
Volume: 18 , Issue: 7
Digital Object Identifier: 10.1109/32.148480
Publication Year: 1992 , Page(s): 624 – 630
Publisher: IEEE Xplore

Prediction of software reliability using connectionist models
Karunanithi, N.; Whitley, D.; Malaiya, Y.K.;
Software Engineering, IEEE Transactions on
Volume: 18 , Issue: 7
Digital Object Identifier: 10.1109/32.148475
Publication Year: 1992 , Page(s): 563 – 574
Publisher: IEEE Xplore

The estimation of parameters of the hypergeometric distribution and its application to the software reliability growth model
Tohma, Y.; Yamano, H.; Ohba, M.; Jacoby, R.;
Software Engineering, IEEE Transactions on
Volume: 17 , Issue: 5
Digital Object Identifier: 10.1109/32.90450
Publication Year: 1991 , Page(s): 483 – 489
Publisher: IEEE Xplore

An approach to the reliability optimization of software with redundancy
Belli, F.; Jedrzejowicz, P.;
Software Engineering, IEEE Transactions on
Volume: 17 , Issue: 3
Digital Object Identifier: 10.1109/32.75419
Publication Year: 1991 , Page(s): 310 – 312
Publisher: IEEE Xplore

Reliability analysis of large software systems: defect data modeling
Levendel, Y.;
Software Engineering, IEEE Transactions on
Volume: 16 , Issue: 2
Digital Object Identifier: 10.1109/32.44378
Publication Year: 1990 , Page(s): 141 – 152

Software complexity and its impact on software reliability
Lew, K.S.; Dillon, T.S.; Forward, K.E.;
Software Engineering, IEEE Transactions on
Volume: 14 , Issue: 11
Digital Object Identifier: 10.1109/32.9052
Publication Year: 1988 , Page(s): 1645 – 1655
Publisher: IEEE Xplore

Fault-Tolerant Software Reliability Modeling
Scott, R.K.; Gault, J.W.; McAllister, D.F.;
Software Engineering, IEEE Transactions on
Volume: SE-13 , Issue: 5
Digital Object Identifier: 10.1109/TSE.1987.233463
Publication Year: 1987 , Page(s): 582 – 592
Publisher: IEEE Xplore

Software Reliability Models: Assumptions, Limitations, and Applicability (S)
Goel, A.L.;
Software Engineering, IEEE Transactions on
Volume: SE-11 , Issue: 12
Digital Object Identifier: 10.1109/TSE.1985.232177
Publication Year: 1985 , Page(s): 1411 – 1423
Publisher: IEEE Xplore

Bayesian Extensions to a Basic Model of Software Reliability
Jewell, W.S.;
Software Engineering, IEEE Transactions on
Volume: SE-11 , Issue: 12
Digital Object Identifier: 10.1109/TSE.1985.231890
Publication Year: 1985 , Page(s): 1465 – 1471
Publisher: IEEE Xplore

Statistical Estimation of Software Reliability
Ross, S.M.;
Software Engineering, IEEE Transactions on
Volume: SE-11 , Issue: 5
Digital Object Identifier: 10.1109/TSE.1985.232487
Publication Year: 1985 , Page(s): 479 – 483
Publisher: IEEE Xplore

Software Reliability Growth Modeling: Models and Applications
Yamada, S.; Osaki, S.;
Software Engineering, IEEE Transactions on
Volume: SE-11 , Issue: 12
Digital Object Identifier: 10.1109/TSE.1985.232179
Publication Year: 1985 , Page(s): 1431 – 1437
Publisher: IEEE Xplore

Assessment of Software Reliability Models (S)
Troy, R.; Moawad, R.;
Software Engineering, IEEE Transactions on
Volume: SE-11 , Issue: 9
Digital Object Identifier: 10.1109/TSE.1985.232543

Publication Year: 1985 , Page(s): 839 – 849
Publisher: IEEE Xplore

Criteria for Software Reliability Model Comparisons
Iannino, Anthony; Musa, John D.; Okumoto, Kazuhira; Littlewood, Bev;
Software Engineering, IEEE Transactions on
Volume: SE-10 , Issue: 6
Digital Object Identifier: 10.1109/TSE.1984.5010297
Publication Year: 1984 , Page(s): 687 – 691
Publisher: IEEE Xplore

Software Reliability—Status and Perspectives
Ramamoorthy, C.V.; Bastani, F.B.;
Software Engineering, IEEE Transactions on
Volume: SE-8 , Issue: 4
Digital Object Identifier: 10.1109/TSE.1982.235728
Publication Year: 1982 , Page(s): 354 – 371
Publisher: IEEE Xplore

Theories of Software Reliability: How Good Are They and How Can They Be Improved?
Littlewood, B.;
Software Engineering, IEEE Transactions on
Volume: SE-6 , Issue: 5
Digital Object Identifier: 10.1109/TSE.1980.230790
Publication Year: 1980 , Page(s): 489 – 500
Publisher: IEEE Xplore

A Summary of the Discussion on "An Analysis of Competing Software Reliability Models"
Goel, A.L.;
Software Engineering, IEEE Transactions on
Volume: SE-6 , Issue: 5
Digital Object Identifier: 10.1109/TSE.1980.230791
Publication Year: 1980 , Page(s): 501 – 502
Publisher: IEEE Xplore

A User-Oriented Software Reliability Model
Cheung, R.C.;
Software Engineering, IEEE Transactions on
Volume: SE-6 , Issue: 2
Digital Object Identifier: 10.1109/TSE.1980.234477
Publication Year: 1980 , Page(s): 118 – 125
Publisher: IEEE Xplore

An Analysis of Competing Software Reliability Models (S)
Schick, G.J.; Wolverton, R.W.;
Software Engineering, IEEE Transactions on
Volume: SE-4 , Issue: 2
Digital Object Identifier: 10.1109/TSE.1978.231481
Publication Year: 1978 , Page(s): 104 – 120
Publisher: IEEE Xplore

Optimization models for reliability of modular software systems
Berman, O.; Ashrafi, N.;
Software Engineering, IEEE Transactions on
Volume: 19 , Issue: 11
Digital Object Identifier: 10.1109/32.256858
Publication Year: 1993 , Page(s): 1119 - 1123
Publisher: IEEE Xplore

An experimental evaluation of software redundancy as a strategy for improving reliability
Eckhardt, D.E.; Caglayan, A.K.; Knight, J.C.; Lee, L.D.; McAllister, D.F.; Vouk, M.A.; Kelly, J.P.J.;
Software Engineering, IEEE Transactions on
Volume: 17 , Issue: 7
Digital Object Identifier: 10.1109/32.83905
Publication Year: 1991 , Page(s): 692 - 702
Publisher: IEEE Xplore

Software reliability allocation based on structure, utility, price, and cost
Zahedi, F.; Ashrafi, N.;
Software Engineering, IEEE Transactions on
Volume: 17 , Issue: 4
Digital Object Identifier: 10.1109/32.90434
Publication Year: 1991 , Page(s): 345 - 356
Publisher: IEEE Xplore

A method for software reliability analysis and prediction application to the TROPICO-R switching system
Kanoun, K.; de Bastos Martini, M.R.; de Souza, J.M.;
Software Engineering, IEEE Transactions on
Volume: 17 , Issue: 4
Digital Object Identifier: 10.1109/32.90433
Publication Year: 1991 , Page(s): 334 - 344
Publisher: IEEE Xplore

Recalibrating software reliability models
Brocklehurst, S.; Chan, P.Y.; Littlewood, B.; Snell, J.;
Software Engineering, IEEE Transactions on
Volume: 16 , Issue: 4
Digital Object Identifier: 10.1109/32.54297
Publication Year: 1990 , Page(s): 458 - 470
Publisher: IEEE Xplore

Statistical inference for general-order-statistics and nonhomogeneous-Poisson-process software reliability models
Joe, H.;
Software Engineering, IEEE Transactions on
Volume: 15 , Issue: 11
Digital Object Identifier: 10.1109/32.41340
Publication Year: 1989 , Page(s): 1485 – 1490
Publisher: IEEE Xplore

An extended domain-based model of software reliability
Weiss, S.N.; Weyuker, E.J.;
Software Engineering, IEEE Transactions on
Volume: 14 , Issue: 10
Digital Object Identifier: 10.1109/32.6196
Publication Year: 1988 , Page(s): 1512 - 1524
Publisher: IEEE Xplore

Effects of field service on software reliability
Baker, C.T.;
Software Engineering, IEEE Transactions on
Volume: 14 , Issue: 2
Digital Object Identifier: 10.1109/32.4642
Publication Year: 1988 , Page(s): 254 - 258
Publisher: IEEE Xplore

Software Reliability: The Stopping Rule Problem
Ross, S.M.;
Software Engineering, IEEE Transactions on
Volume: SE-11 , Issue: 12
Digital Object Identifier: 10.1109/TSE.1985.231891
Publication Year: 1985 , Page(s): 1472 – 1476
Publisher: IEEE Xplore

Using Software Reliability Growth Models in Practice
Almering, V.; van Genuchten, M.; Cloudt, G.; Sonnemans, P.J.M.;

Software, IEEE
Volume: 24 , Issue: 6
Digital Object Identifier: 10.1109/MS.2007.182
Publication Year: 2007 , Page(s): 82 - 88
Publisher: IEEE Xplore

Software-reliability engineering: technology for the 1990s
Musa, J.D.; Everett, W.W.;
Software, IEEE
Volume: 7 , Issue: 6
Digital Object Identifier: 10.1109/52.60588
Publication Year: 1990 , Page(s): 36 - 43
Publisher: IEEE Xplore

Applying reliability models more effectively [software]
Lyu, M.R.; Nikora, A.;
Software, IEEE
Volume: 9 , Issue: 4
Digital Object Identifier: 10.1109/52.143104
Publication Year: 1992 , Page(s): 43 - 52
Publisher: IEEE Xplore

The virtues of assessing software reliability early
Cukic, B.;
Software, IEEE
Volume: 22 , Issue: 3
Digital Object Identifier: 10.1109/MS.2005.79
Publication Year: 2005 , Page(s): 50 - 53
Publisher: IEEE Xplore

Determining the cost of a stop-test decision [software reliability]
Ehrlich, W.; Prasanna, B.; Stampfel, J.; Wu, J.;
Software, IEEE
Volume: 10 , Issue: 2
Digital Object Identifier: 10.1109/52.199726
Publication Year: 1993 , Page(s): 33 - 42
Publisher: IEEE Xplore

A generalized technique for simulating software reliability
Tausworthe, R.C.; Lyu, M.R.;
Software, IEEE
Volume: 13 , Issue: 2
Digital Object Identifier: 10.1109/52.506464
Publication Year: 1996 , Page(s): 77 - 88
Publisher: IEEE Xplore

Why software reliability predictions fail
Lanubile, F.;
Software, IEEE
Volume: 13 , Issue: 4
Digital Object Identifier: 10.1109/52.526841
Publication Year: 1996 , Page(s): 131 - 132
Publisher: IEEE Xplore

New ways to get accurate reliability measures [software]
Brocklehurst, S.; Littlewood, B.;
Software, IEEE
Volume: 9 , Issue: 4
Digital Object Identifier: 10.1109/52.143100
Publication Year: 1992 , Page(s): 34 - 42
Publisher: IEEE Xplore

Planning and certifying software system reliability
Poore, J.H.; Mills, H.D.; Mutchler, D.;
Software, IEEE
Volume: 10 , Issue: 1
Digital Object Identifier: 10.1109/52.207234
Publication Year: 1993 , Page(s): 88 - 99
Publisher: IEEE Xplore

Operational profiles in software-reliability engineering
Musa, J.D.;
Software, IEEE
Volume: 10 , Issue: 2
Digital Object Identifier: 10.1109/52.199724
Publication Year: 1993 , Page(s): 14 - 32
Publisher: IEEE Xplore

Focus on software reliability engineering
Moore, M.M.;
Software, IEEE
Volume: 18 , Issue: 3
Digital Object Identifier: 10.1109/MS.2001.922734
Publication Year: 2001 , Page(s): 98
Publisher: IEEE Xplore

Qualitative and quantitative reliability assessment (S)
Kanoun, K.; Kaaniche, M.; Laprie, J.-P.;
Software, IEEE
Volume: 14 , Issue: 2
Digital Object Identifier: 10.1109/52.582977
Publication Year: 1997 , Page(s): 77 - 87
Publisher: IEEE Xplore

Trends in reliability and test strategies
Varadan, G.S.;
Software, IEEE
Volume: 12 , Issue: 3
Digital Object Identifier: 10.1109/52.382175
Publication Year: 1995
Publisher: IEEE Xplore

Analyzing and improving reliability: a tree-based approach (S)
Tian, J.; Palma, J.;
Software, IEEE
Volume: 15 , Issue: 2
Digital Object Identifier: 10.1109/52.663793
Publication Year: 1998 , Page(s): 97 - 104
Publisher: IEEE Xplore

Reliability measurement: from theory to practice
Sheldon, F.T.; Kavi, K.M.; Tausworthe, R.C.; Yu, J.T.; Brettschneider, R.; Everett, W.W.;
Software, IEEE
Volume: 9 , Issue: 4
Digital Object Identifier: 10.1109/52.143095
Publication Year: 1992 , Page(s): 13 - 20
Publisher: IEEE Xplore

Are we testing for true reliability?
Hamlet, D.;
Software, IEEE
Volume: 9 , Issue: 4
Digital Object Identifier: 10.1109/52.143097
Publication Year: 1992 , Page(s): 21 - 27
Publisher: IEEE Xplore

Applying reliability measurement: a case study
Ehrlich, W.K.; Lee, S.K.; Molisani, R.H.;

Software, IEEE
Volume: 7 , Issue: 2
Digital Object Identifier: 10.1109/52.50774
Publication Year: 1990 , Page(s): 56 - 64
Publisher: IEEE Xplore

Reliability testing of rule-based systems
Avritzer, A.; Ros, J.P.; Weyuker, E.J.;
Software, IEEE
Volume: 13 , Issue: 5
Digital Object Identifier: 10.1109/52.536461
Publication Year: 1996 , Page(s): 76 – 82
Publisher: IEEE Xplore

Reliability through consistency
Birman, K.P.; Glade, B.B.;
Software, IEEE
Volume: 12 , Issue: 3
Digital Object Identifier: 10.1109/52.382182
Publication Year: 1995 , Page(s): 29 - 41
Publisher: IEEE Xplore

Using neural networks in reliability prediction
Karunanithi, N.; Whitley, D.; Malaiya, Y.K.;
Software, IEEE
Volume: 9 , Issue: 4
Digital Object Identifier: 10.1109/52.143107
Publication Year: 1992 , Page(s): 53 - 59
Publisher: IEEE Xplore

Reliability and safety of real-time systems
Everett, W.W.; Honiden, S.;
Software, IEEE
Volume: 12 , Issue: 3
Digital Object Identifier: 10.1109/52.382177
Publication Year: 1995 , Page(s): 13 - 16
Publisher: IEEE Xplore

Measurement and continuous improvement of software reliability throughout software life-cycle
Jeff Tian
Journal of Systems and Software,
Volume 47, Issues 2-3, 1 July 1999, Pages 189-195
Publisher: Elsevier

A criticism on the capture-and-recapture method for software reliability assurance
Sadahiro Isoda
Journal of Systems and Software,
Volume 43, Issue 1, October 1998, Pages 3-10
Publisher: Elsevier

Optimal resource allocation for cost and reliability of modular software systems in the testing phase
Chin-Yu Huang, Jung-Hua Lo
Journal of Systems and Software,
Volume 79, Issue 5, May 2006, Pages 653-664
Publisher: Elsevier
Cost-reliability-optimal release policy for software reliability models incorporating improvements in testing efficiency
Chin-Yu Huang
Journal of Systems and Software,
Volume 77, Issue 2, August 2005, Pages 139-155
Publisher: Elsevier

Neural-network-based approaches for software reliability estimation using dynamic weighted combinational models
Yu-Shen Su, Chin-Yu Huang
Journal of Systems and Software,
Volume 80, Issue 4, April 2007, Pages 606-615
Publisher: Elsevier

Reliability assessment and sensitivity analysis of software reliability growth modeling based on software module structure
Jung-Hua Lo, Chin-Yu Huang, Ing-Yi Chen, Sy-Yen Kuo, Michael R. Lyu
Journal of Systems and Software,
Volume 76, Issue 1, April 2005, Pages 3-13
Publisher: Elsevier
Enhancing and measuring the predictive capabilities of testing-effort dependent software reliability models
Chu-Ti Lin, Chin-Yu Huang
Journal of Systems and Software,
Volume 81, Issue 6, June 2008, Pages 1025-1038
Publisher: Elsevier

Software reliability prediction by soft computing techniques
N. Raj Kiran, V. Ravi
Journal of Systems and Software,
Volume 81, Issue 4, April 2008, Pages 576-583
Publisher: Elsevier

Exploratory analysis of environmental factors for enhancing the software reliability assessment
Xuemei Zhang, Mi-Young Shin, Hoang Pham
Journal of Systems and Software,
Volume 57, Issue 1, 27 April 2001, Pages 73-78
Publisher: Elsevier

Impartial evaluation in software reliability practice
Wen-Kui Chang, Shuen-Lin Jeng
Journal of Systems and Software,
Volume 76, Issue 2, May 2005, Pages 99-110
Publisher: Elsevier

On-line prediction of software reliability using an evolutionary connectionist model
Liang Tian, Afzel Noore
Journal of Systems and Software,
Volume 77, Issue 2, August 2005, Pages 173-180
Publisher: Elsevier

A stochastic software reliability model with imperfect-debugging and change-point
Huan-Jyh Shyur
Journal of Systems and Software,
Volume 66, Issue 2, 15 May 2003, Pages 135-141
Publisher: Elsevier

Some successful approaches to software reliability modeling in industry
Daniel R. Jeske, Xuemei Zhang
Journal of Systems and Software,
Volume 74, Issue 1, 1 January 2005, Pages 85-99
Publisher: Elsevier

On the neural network approach in software reliability modeling
Kai-Yuan Cai, Lin Cai, Wei-Dong Wang, Zhou-Yi Yu, David Zhang
Journal of Systems and Software,
Volume 58, Issue 1, 15 August 2001, Pages 47-62
Publisher: Elsevier

Software architecture reliability analysis using failure scenarios
Bedir Tekinerdogan, Hasan Sozer, Mehmet Aksit
Journal of Systems and Software,
Volume 81, Issue 4, April 2008, Pages 558-575
Publisher: Elsevier

Quantitative assessment models for software safety/reliability (S)
Shigeru Yamada, Koichi Tokuno and Yu Kasano
Electronics and Communications in Japan (Part II: Electronics)
Volume 81, Issue 5, May 1998, Pages: 33–43,
Article first published online : 7 DEC 1998, DOI: 10.1002/(SICI)1520-6432(199805)81:5<33::AID-ECJB5>3.0.CO;2-5
Publisher: Wiley

Software reliability growth modeling based on testing-skill characteristics: Model and application
Takaji Fujiwara and Shigeru Yamada
Electronics and Communications in Japan (Part III: Fundamental Electronic Science)
Volume 84, Issue 6, June 2001, Pages: 42–49,
Article first published online : 23 FEB 2001,
DOI: 10.1002/1520-6440(200106)84:6<42::AID-ECJC5>3.0.CO;2-X
Publisher: Wiley

Software reliability demonstration testing with consideration of damage size of software failures
Kiyoshi Sawada and Hiroaki Sandoh
Electronics and Communications in Japan (Part III: Fundamental Electronic Science)
Volume 82, Issue 5, May 1999, Pages: 10–21,
Article first published online : 29 JAN 1999, DOI: 10.1002/(SICI)1520-6440(199905)82:5<10::AID-ECJC2>3.0.CO;2-M
Publisher: Wiley

A software reliability assessment method based on neural networks for distributed development environment
Yoshinobu Tamura, Shigeru Yamada and Mitsuhiro Kimura
Electronics and Communications in Japan (Part III: Fundamental Electronic Science)
Volume 86, Issue 11, November 2003, Pages: 13–20, Article first published online : 21 MAY 2003, DOI: 10.1002/ecjc.10092
Publisher: Wiley

An infinite server queuing model for assessment of the software reliability
Toshiaki Matsuoka and Shunji Osaki
Electronics and Communications in Japan (Part III: Fundamental Electronic Science)
Volume 85, Issue 3, March 2002, Pages: 43–51, Tadashi Dohi,
Article first published online : 8 NOV 2001, DOI: 10.1002/ecjc.1078
Publisher: Wiley

An estimation of software reliability models based on EM algorithm
Hiroyuki Okamura, Yasuhiro Watanabe, Tadashi Dohi and Shunji Osaki
Electronics and Communications in Japan (Part III: Fundamental Electronic Science)
Volume 86, Issue 6, June 2003, Pages: 29–37,
Article first published online : 4 FEB 2003, DOI: 10.1002/ecjc.10058
Publisher: Wiley

Test workload measurement and reliability analysis for large commercial software systems
Jeff Tian and Joe Palma
Annals of Software Engineering
1997, Volume 4, Number 1, Pages 201-222
Publisher: Springer

Evaluating software architectures for real-time systems
Rick Kazman, Mark Klein and Paul Clements
Annals of Software Engineering
1999, Volume 7, Numbers 1-4, Pages 71-93
Publisher: Springer

A time/structure based software reliability model
Swapna S. Gokhale and Kishor S. Trivedi
Annals of Software Engineering
1999, Volume 8, Numbers 1-4, Pages 85-121
Publisher: Springer
A Measurement-Based Framework for Software Reliability Improvement
Programs for software reliability improvement based on measurements require the collection and analysis of comprehensive...
Karama Kanoun
Annals of Software Engineering
2001, Volume 11, Number 1, Pages 89-106
Publisher: Springer

A comparative analysis of hardware and software fault tolerance: Impact on software reliability engineering
Hany H. Ammar, Bojan Cukic, Ali Mili and Cris Fuhrman
Annals of Software Engineering
2000, Volume 10, Numbers 1-4, Pages 103-150
Publisher: Springer

Guest editorial: Special issue on software reliability engineering
Laurie Williams
Empirical Software Engineering, 2010,
Volume 15, Number 4, Pages 321-322
Publisher: Springer

An Empirical Method for Selecting Software Reliability Growth Models
C. Stringfellow and A. Amschler Andrews
Empirical Software Engineering, 2002,
Volume 7, Number 4, Pages 319-343
Publisher: Springer

A replicated empirical study of a selection method for software reliability growth models
Carina Andersson
Empirical Software Engineering, 2007,
Volume 12, Number 2, Pages 161-182
Publisher: Springer

A binomial software reliability model based on coverage of structural testing criteria
Adalberto Nobiato Crespo, Mario Jino, Alberto Pasquini and José Carlos Maldonado
Empirical Software Engineering, 2008,
Volume 13, Number 2, Pages 185-209
Publisher: Springer

Another viewpoint on “evaluating web software reliability based on workload and failure data extracted from server logs”
Toan Huynh and James Miller
Empirical Software Engineering, 2009,
Volume 14, Number 4, Pages 371-396
Publisher: Springer

Empirical measurement of the software testing and reliability
Feng-zhong Zou and Ren-zuo Xu
Wuhan University Journal of Natural Sciences, 2004,

Volume 9, Number 1, Pages 23-26
Publisher: Springer

Singularity of some software reliability models and parameter estimation method (S)
Xu Ren-zuo, Zhou Rui and Yang Xiao-qing
Wuhan University Journal of Natural Sciences, 2000,
Volume 5, Number 1, Pages 035-040
Publisher: Springer
Investigation on relationship between cost and software reliability
Xu Ren-zuo, Han Yi-fan, Huang Can and Yao Jun-feng
Wuhan University Journal of Natural Sciences, 2005,
Volume 10, Number 1, Pages 9-12
Publisher: Springer

Singularity of software reliability models LVLM and LVQM
Xu Ren-zuo, Zhou Rui and Yang Xiao-qing
Wuhan University Journal of Natural Sciences, 2000,
Volume 5, Number 2, Pages 150-154
Publisher: Springer

Reliability estimation from appropriate testing of plant protection software
May, J.; Hughes, G.; Lunn, A.D.;
Software Engineering Journal
Volume: 10 , Issue: 6
Publication Year: 1995 , Page(s): 206 - 218
Publisher: IEEE Xplore

PERFIDE: an environment for evaluation and monitoring of software reliability metrics during the test phase
Mainini, M.T.; Billot, L.;
Software Engineering Journal
Volume: 5 , Issue: 1
Publication Year: 1990 , Page(s): 27 - 32
Publisher: IEEE Xplore

A Bayesian modification to the Jelinski-Moranda software reliability growth model (S)
Littlewood, Bev; Sofer, Ariela;
Software Engineering Journal
Volume: 2 , Issue: 2
Digital Object Identifier: 10.1049/sej:19870005
Publication Year: 1987 , Page(s): 30 - 41
Publisher: IEEE Xplore

A software reliability growth model for an error-removal phenomenon
Kapur, P.K.; Garg, R.B.;
Software Engineering Journal
Volume: 7 , Issue: 4
Publication Year: 1992 , Page(s): 291 - 294
Publisher: IEEE Xplore

Finding the optimal parameters for a software reliability model
Norman F. Schneidewind
Innovations in Systems and Software Engineering, 2007,
Volume 3, Number 4, Pages 319-332
Publisher: Springer

Predicting shuttle software reliability with parameter evaluation
Norman F. Schneidewind
Innovations in Systems and Software Engineering, 2007,
Volume 3, Number 3, Pages 181-191
Publisher: Springer

Software reliability engineering process (S)
Norman Schneidewind
Innovations in Systems and Software Engineering, 2006,
Volume 2, Numbers 3-4, Pages 179-190
Publisher: Springer

Analysis of object-oriented software reliability model development
Norman F. Schneidewind
Innovations in Systems and Software Engineering, 2009,
Volume 5, Number 4, Pages 243-253
Publisher: Springer

Integrating testing with reliability
Norman Schneidewind
Software Testing, Verification and Reliability
Volume 19, Issue 3, September 2009, Pages: 175–198,
Article first published online : 15 JUL 2008, DOI: 10.1002/stvr.395
Publisher: Wiley

A contribution to the evaluation of the reliability of iterative-execution software
Andrea Bondavalli, Silvano Chiaradonna, Felicita Di Giandomenico and Lorenzo Strigini
Software Testing, Verification and Reliability
Volume 9, Issue 3, September 1999, Pages: 145–166,
Article first published online : 9 SEP 1999, DOI: 10.1002/(SICI)1099-1689(199909)9:3<145::AID-STVR179>3.0.CO;2-B
Publisher: Wiley

A non-parametric order statistics software reliability model
May Barghout, Bev Littlewood and Abdalla Abdel-Ghaly
Software Testing, Verification and Reliability
Volume 8, Issue 3, September 1998, Pages: 113–132,
Article first published online : 8 JAN 1999, DOI: 10.1002/(SICI)1099-1689(1998090)8:3<113::AID-STVR159>3.0.CO;2-8
Publisher: Wiley

Reliability analysis and optimal version-updating for open source software (S)
Xiang Li, Yan Fu Li, Min Xie, Szu Hui Ng
Information and Software Technology,
In Press, Corrected Proof, Available online 23 April 2011
Publisher: Elesvier

Optimal and adaptive testing for software reliability assessment
Kai-Yuan Cai, Yong-Chao Li, Ke Liu
Information and Software Technology,
Volume 46, Issue 15, 1 December 2004, Pages 989-1000
Publisher: Elesvier

Does software reliability growth behavior follow a non-homogeneous Poisson process
Kai-Yuan Cai, De-Bin Hu, Cheng-Gang Bai, Hai Hu, Tao Jing
Information and Software Technology,
Volume 50, Issue 12, November 2008, Pages 1232-1247
Publisher: Elesvier

Multi up-gradation software reliability growth model with imperfect debugging
P. K. Kapur, Ompal Singh, A. S. Garmabaki and Jagvinder Singh
International Journal of Systems Assurance Engineering and Management, 2010,
Volume 1, Number 4, Pages 299-306
Publisher: Springer

A note on software reliability monitoring by moving-average method based on a bootstrap scheme
Mitsuhiro Kimura and Takaji Fujiwara
International Journal of Systems Assurance Engineering and Management, 2010,
Volume 1, Number 4, Pages 293-298
Publisher: Springer

Development of software reliability growth model incorporating enhancement of features and related release policy
P. K. Kapur, R. B. Garg, Udayan Chanda and Abhishek Tandon
International Journal of Systems Assurance Engineering and Management, 2010,
Volume 1, Number 1, Pages 52-58
Publisher: Springer

Software reliability analysis
Misra, P. N.;
IBM Systems Journal
Volume: 22 , Issue: 3
Digital Object Identifier: 10.1147/sj.223.0262
Publication Year: 1983 , Page(s): 262 - 270
IBM Journals
Publisher: IEEE Xplore

On reliability modeling and software quality [Technical note]
Watkins, A. J.;
IBM Systems Journal
Volume: 33 , Issue: 1
Digital Object Identifier: 10.1147/sj.331.0220
Publication Year: 1994 , Page(s): 220 - 222
IBM Journals
Publisher: IEEE Xplore

On the Maximum Likelihood Estimates for the Goel-Okumoto Software Reliability Model
Daniel R. Jeske, Hoang Pham;
The American Statistician,
Vol. 55, 2001
Publisher: Questia

Assessing the Reliability of Statistical Software: Part II
B. D. Mccullough;
The American Statistician,
Vol. 53, 1999
Publisher: Questia

A study of the exponential smoothing technique in software reliability growth prediction
M. Xie, G. Y. Hong and C. Wohlin
Quality and Reliability Engineering International
Volume 13, Issue 6, November/December 1997, Pages: 347–353,
Article first published online : 4 DEC 1998, DOI: 10.1002/(SICI)1099-1638(199711/12)13:6<347::AID-QRE116>3.0.CO;2-O
Publisher: Wiley

A model for Bayesian software reliability analysis
Romulo I. Zequeira
Quality and Reliability Engineering International
Volume 16, Issue 3, May/June 2000, Pages: 187–193,
Article first published online : 16 JUN 2000,
DOI: 10.1002/1099-1638(200005/06)16:3<187::AID-QRE316>3.0.CO;2-R
Publisher: Wiley

Calibrating software reliability models when the test environment does not match the user environment
Xuemei Zhang, Daniel R. Jeske and Hoang Pham
Applied Stochastic Models in Business and Industry
Volume 18, Issue 1, January/March 2002, Pages: 87–99,
Article first published online : 18 FEB 2002, DOI: 10.1002/asmb.453
Publisher: Wiley

A non-parametric approach to software reliability
Axel Gandy and Uwe Jensen
Applied Stochastic Models in Business and Industry
Volume 20, Issue 1, January/March 2004, Pages: 3–15, Article first published online : 10 FEB 2004, DOI: 10.1002/asmb.510
Publisher: Wiley

Estimation of software reliability by stratified sampling (S)
Andy Podgurski, Wassim Masri, Yolanda McCleese, Francis G. Wolff, Charles Yang
Transactions on Software Engineering and Methodology (TOSEM) ,
Volume 8 Issue 3 July 1999
Publisher: ACM

Using failure cost information for testing and reliability assessment
Elaine J. Weyuker
Transactions on Software Engineering and Methodology (TOSEM) ,
Volume 5 Issue 2, April 1996
Publisher: ACM

Estimation of reliability and cost relationship for architecture-based software
Hui Guan, Wei-Ru Chen, Ning Huang and Hong-Ji Yang
International Journal of Automation and Computing, 2010,
Volume 7, Number 4, Pages 603-610
Publisher: Springer

Considering the fault dependency concept with debugging time lag in software reliability growth modeling using a power function of testing time
V. B. Singh, Kalpana Yadav, Reecha Kapur and V. S. S. Yadavalli
International Journal of Automation and Computing, 2007,
Volume 4, Number 4, Pages 359-368
Publisher: Springer

Software reliability analysis models (S)
Ohba, Mitsuru;
IBM Journal of Research and Development
Volume: 28 , Issue: 4
Digital Object Identifier: 10.1147/rd.284.0428
Publication Year: 1984 , Page(s): 428 - 443
IBM Journals
Publisher: IEEE Xplore

Reliability-oriented software engineering: design, testing and evaluation techniques
Lyu, M.R.;
Software, IEE Proceedings -
Volume: 145 , Issue: 6
Digital Object Identifier: 10.1049/ip-sen:19982439
Publication Year: 1998 , Page(s): 191 - 197
Publisher: IEEE Xplore

Using Bayesian networks to predict software defects and reliability
N Fenton, M Neil, and D Marquez
Proceedings of the Institution of Mechanical Engineers, Part O: Journal of Risk and Reliability, December 1, 2008;

vol. 222, 4: pp. 701-712.
Publisher: Sage

System reliability modelling: The current capability and potential future developments
J Andrews
Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science, December 1, 2009; vol. 223, 12: pp. 2881-2897.
Publisher: Sage

Bayesian Computation for Nonhomogeneous Poisson Processes in Software Reliability
Lynn Kuo, Tae Young Yang;
Journal of the American Statistical Association,
Vol. 91, 1996
Publisher: Questia

A sequential Bayesian generalization of the Jelinski–Moranda software reliability model (S)
Alan Washburn
Naval Research Logistics (NRL)
Volume 53, Issue 4, June 2006, Pages: 354–362,
Article first published online : 9 MAR 2006, DOI: 10.1002/nav.20148
Publisher: Wiley

Software reliability via run-time result-checking
Hal Wasserman, Manuel Blum
Journal of the ACM (JACM) , Volume 44 Issue 6 November 1997
Publisher: ACM

Stretching the paradigm for software reliability assurance
W. W. Everett and M. Tortorella
Software Quality Journal
1994, Volume 3, Number 1, Pages 1-26
Publisher: Springer

Software Reliability Experimentation and Control
Kai-Yuan Cai
Journal of Computer Science and Technology, 2006,
Volume 21, Number 5, Pages 697-707
Publisher: Springer

Reliability of application software
I. N. Molchanov
Cybernetics and Systems Analysis, 1997,
Volume 33, Number 1, Pages 145-148
Publisher: Springer

Truncated software reliability growth model
D. R. Prince Williams and P. Vivekanandan
Journal of Applied Mathematics and Computing, 2002,
Volume 9, Number 2, Pages 591-599
Publisher: Springer

A Hybrid Approach to Enhancing the Reliability of Software
A. M. Frolov
Programming and Computer Software, 2004,
Volume 30, Number 1, Pages 18-24
Publisher: Springer

Quasi-Bayesian software reliability model with small samples
Jin Zhang, Jun-xiang Tu, Zhuo-ning Chen and Xiao-guang Yan
Journal of Shanghai University (English Edition), 2009,
Volume 13, Number 4, Pages 301-304
Publisher: Springer

Improving the Reliability of Medical Software by Predicting the Dangerous Software Modules (S)
Vili Podgorelec, Marjan Heričko, Matjaž B. Jurič and Ivan Rozman
Journal of Medical Systems, 2005,
Volume 29, Number 1, Pages 3-11
Publisher: Springer

New interval Bayesian models for software reliability based on non-homogeneous Poisson processes
L. V. Utkin, S. I. Zatenko and F. P. A. Coolen
Automation and Remote Control, 2010,
Volume 71, Number 5, Pages 935-944
Publisher: Springer

Sequential Bayesian technique: An alternative approach for software reliability estimation
S. Chatterjee, S. S. Alam and R. B. Misra
Sadhana, 2009,
Volume 34, Number 2, Pages 235-241
Publisher: Springer

APPENDIX D

PUBLISHER-WISE DISTRIBUTION OF DATA

Category: Research topic

IEEE XPLORE

Research topics	~1989	1990-1999	2000-2011	Total
Models	3(15.00%)	6(14.63%)	2(18.18%)	11(15.27%)
Analysis	11(55.00%)	17(41.46%)	4(54.54%)	32(44.44%)
Use of Statistics	2(10.00%)	0(0%)	0(0%)	2(2.77%)
Test plans	0(0%)	3(7.31%)	1(9.09%)	4(5.55%)
Approaches	3(15.00%)	11(26.82%)	2(18.18%)	16(22.22%)
Others	1(5.00%)	4(9.75%)	2(18.18%)	7(9.72%)

One paper may discuss more than one topic.

ELSEVIER

Research topics	~1989	1990-1999	2000-2011	Total
Models	0(0%)	0(0%)	1(5.88%)	1(5.26%)
Analysis	0(0%)	1(50.00%)	8(47.05%)	9(47.36%)
Use of Statistics	0(0%)	0(0%)	0(0%)	0(0%)
Test plans	0(0%)	0(0%)	1(5.88%)	1(5.26%)
Approaches	0(0%)	1(50.00%)	7(41.17%)	8(42.10%)
Others	0(0%)	0(0%)	0(0%)	0(0%)

One paper may discuss more than one topic.

WILEY

Research topics	~1989	1990-1999	2000-2011	Total
Models	0(0%)	1(25.00%)	3(23.07%)	4(23.52%)
Analysis	0(0%)	1(25.00%)	3(23.07%)	4(23.52%)
Use of Statistics	0(0%)	0(0%)	0(0%)	0(0%)
Test plans	0(0%)	1(25.00%)	1(7.70%)	2(11.76%)
Approaches	0(0%)	1(25.00%)	6(46.15%)	7(41.17%)
Others	0(0%)	0(0%)	0(0%)	0(0%)

One paper may discuss more than one topic.

SPRINGER

Research topics	~1989	1990-1999	2000-2011	Total
Models	0(0%)	1(16.66%)	6(19.35%)	7(18.91%)
Analysis	0(0%)	3(50.00%)	14(45.16%)	17(45.94%)
Use of Statistics	0(0%)	0(0%)	0(0%)	0(0%)
Test plans	0(0%)	1(16.66%)	1(3.22%)	2(5.40%)
Approaches	0(0%)	1(16.66%)	8(25.80%)	9(24.32%)
Others	0(0%)	0(0%)	2(6.45%)	2(5.40%)

One paper may discuss more than one topic.

QUESTIA

Research topics	~1989	1990-1999	2000-2011	Total
Models	0(0%)	0(0%)	0(0%)	0(0%)
Analysis	0(0%)	2(100.00%)	1(100.00%)	3(100.00%)
Use of Statistics	0(0%)	0(0%)	0(0%)	0(0%)
Test plans	0(0%)	0(0%)	0(0%)	0(0%)
Approaches	0(0%)	0(0%)	0(0%)	0(0%)
Others	0(0%)	0(0%)	0(0%)	0(0%)

One paper may discuss more than one topic.

ACM

Research topics	~1989	1990-1999	2000-2011	Total
Models	0(0%)	0(0%)	0(0%)	0(0%)
Analysis	0(0%)	0(0%)	0(0%)	0(0%)
Use of Statistics	0(0%)	0(0%)	0(0%)	0(0%)
Test plans	0(0%)	0(0%)	0(0%)	0(0%)
Approaches	0(0%)	3(100.00%)	0(0%)	3(100.00%)
Others	0(0%)	0(0%)	0(0%)	0(0%)

One paper may discuss more than one topic.

SAGE

Research topics	~1989	1990-1999	2000-2011	Total
Models	0(0%)	0(0%)	0(0%)	0(0%)
Analysis	0(0%)	0(0%)	1(100.00%)	1(33.33%)
Use of Statistics	0(0%)	0(0%)	0(0%)	0(0%)
Test plans	0(0%)	0(0%)	0(0%)	0(0%)
Approaches	0(0%)	0(0%)	0(0%)	0(0%)
Others	0(0%)	0(0%)	2(0%)	2(66.66%)

One paper may discuss more than one topic.

.**Category: Research approach**

IEEE XPLORE

Research approach	~1989	1990-1999	2000-2011	Total
Survey	0(0%)	0(0%)	0(0%)	0(0%)
Theory	12(54.54%)	27(64.28%)	6(50.00%)	45(59.21%)
Experiment	3(13.63%)	6(14.28%)	2(16.66%)	11(14.47%)
Case study	2(9.09%)	4(9.52%)	1(8.33%)	7(9.21%)
Review	5(22.72%)	3(7.14%)	2(16.66%)	10(13.15%)
Simulation	0(0%)	2(4.76%)	1(8.33%)	3(3.94%)

One paper may discuss more than one topic.

ELSEVIER

Research approach	~1989	1990-1999	2000-2011	Total
Survey	0(0%)	0(0%)	1(6.25%)	1(5.55%)
Theory	0(0%)	1(50.00%)	9(56.25%)	10(55.55%)
Experiment	0(0%)	1(50.00%)	3(18.75%)	4(22.22%)
Case study	0(0%)	0(0%)	0(0%)	0(0%)
Review	0(0%)	0(0%)	2(12.50%)	2(11.11%)
Simulation	0(0%)	0(0%)	1(6.25%)	1(5.55%)

One paper may discuss more than one topic.

WILEY

Research approach	~1989	1990-1999	2000-2011	Total
Survey	0(0%)	0(0%)	0(0%)	0(0%)
Theory	0(0%)	4(80.00%)	7(77.77%)	11(78.57%)
Experiment	0(0%)	1(20.00%)	2(22.22%)	3(21.42%)
Case study	0(0%)	0(0%)	0(0%)	0(0%)
Review	0(0%)	0(0%)	0(0%)	0(0%)
Simulation	0(0%)	0(0%)	0(0%)	0(0%)

One paper may discuss more than one topic.

SPRINGER

Research approach	~1989	1990-1999	2000-2011	Total
Survey	0(0%)	0(0%)	1(50.00%)	1(20.00%)
Theory	0(0%)	2(66.66%)	0(0%)	2(40.00%)
Experiment	0(0%)	1(33.33%)	1(50.00%)	2(40.00%)
Case study	0(0%)	0(0%)	0(0%)	0(0%)
Review	0(0%)	0(0%)	0(0%)	0(0%)
Simulation	0(0%)	0(0%)	0(0%)	0(0%)

One paper may discuss more than one topic.

QUESTIA

Research approach	~1989	1990-1999	2000-2011	Total
Survey	0(0%)	0(0%)	0(0%)	0(0%)
Theory	0(0%)	2(100.00%)	1(100.00%)	3(100.00%)
Experiment	0(0%)	0(0%)	0(0%)	0(0%)
Case study	0(0%)	0(0%)	0(0%)	0(0%)
Review	0(0%)	0(0%)	0(0%)	0(0%)
Simulation	0(0%)	0(0%)	0(0%)	0(0%)

One paper may discuss more than one topic.

ACM

Research approach	~1989	1990-1999	2000-2011	Total
Survey	0(0%)	0(0%)	0(0%)	0(0%)
Theory	0(0%)	3(100.00%)	0(0%)	3(100.00%)
Experiment	0(0%)	0(0%)	0(0%)	0(0%)
Case study	0(0%)	0(0%)	0(0%)	0(0%)
Review	0(0%)	0(0%)	0(0%)	0(0%)
Simulation	0(0%)	0(0%)	0(0%)	0(0%)

One paper may discuss more than one topic.

SAGE

Research approach	~1989	1990-1999	2000-2011	Total
Survey	0(0%)	0(0%)	0(0%)	0(0%)
Theory	0(0%)	0(0%)	2(100.00%)	2(100.00%)
Experiment	0(0%)	0(0%)	0(0%)	0(0%)
Case study	0(0%)	0(0%)	0(0%)	0(0%)
Review	0(0%)	0(0%)	0(0%)	0(0%)
Simulation	0(0%)	0(0%)	0(0%)	0(0%)

One paper may discuss more than one topic.

ABOUT THE AUTHORS:

Apoorva Singhal : Mr Singhal is a final year M.Tech (Information Technology) student from Guru Gobind Singh Indraprastha University, Kashmere Gate. He obtained his B.Tech from Galgotias College of Engineering and Technology, Greater Noida in Computer Science branch. He a GATE qualified student, was also associated with HCL as a software engineer after completion of his graduation. Beside Neural Networks, his other areas of interests are Expert system, compiler technology, principles of programming language, Vaastu Shastra and medical science. He developed an expert system on Vaastu shastra as his final year B.Tech project in CLIPS. Currently, he is working on implementation of disease diagnosis system using Neural Network.

Ankur Singhal: Mr. Singhal is a final year B-Tech student of prestigious institute HBTI Kanpur. Since the very beginning of his academic career, he has been focusing on the various technologies in computer science field. He is very keen in implementation of these technologies into real life projects. He is well versed with various programming languages like C, C++, JAVA, MATLAB, LISP etc. He is simultaneously working on a number of different projects. Apart from 'Dental Implant Simulation Software', he has also worked upon the optimization of Ad-hoc routing protocols by adding link prediction algorithm for quality improvement and added the code in the Network Simulator-2 software