

# Selective Regression Testing on Node.js Applications

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**Abstract**—Node.js is one of the most popular frameworks for building web applications today. As software system becomes mature, the cost of performing the retest-all regression test becomes significant. A technique of reducing running time is Selective Regression Testing (SRT). By rerunning a subset of tests based on code change, selective regression testing can detect software failures more efficiently. However, previous studies mainly focused on standard desktop applications. The Node.js applications are considered hard to perform test reduction because its asynchronous, event-driven programming model and JavaScript is a loosely typed, dynamic programming language. In this paper, we present NodeSRT, a Selective Regression Testing framework for Node.js applications. By performing static and dynamic analysis, NodeSRT gets relationship between changed method and their relationships with each test, then reduce the whole regression test suite to only tests that are affected by change, which would improve the execution time of the regression test suite. To evaluate our selection technique, we applied NodeSRT to two open-source projects: Uppy and Simorgh, then compared our approach with retest-all strategy and current industry used SRT technique: Jest OnlyChange option. The results demonstrate that NodeSRT correctly selects affected tests based on changes and is 457.94% more precise than the Jest OnlyChange option. NodeSRT is also 2.72 times faster in high code coverage project.

**Index Terms**—JavaScript, Selective Regression Testing, Node.js Application, Static Analysis, Dynamic Analysis

## I. INTRODUCTION

With the continuous growth of web applications, Node.js has become one of the most popular frameworks for web application development [2]. Since JavaScript is a loosely typed, dynamic language, test selection on JavaScript projects is hard. Besides, modern web applications are usually composed of different kinds of components; running unit tests only does not judge the overall behaviour of the web application [3].

Generally, there are two phases involved in test selection. The first phase is to select tests based on change and test dependency graph generated by static or dynamic analysis. The second phase is to run selected tests. There are four levels of granularity for test selection techniques: statement, method, file, module. The common two are method-level and file-level. File-level granularity analysis builds relationship between tests and files in the program and selects tests that reflect changed files. Method-level analysis builds relationship between tests and methods and selects tests that reflect changed method. Since method-level selection is more complicated than file-level selection, file-level selection runs faster in phase one. However, file-level selection selects more tests than needed.

Therefore it is less precise than method-level selection and runs slower in phase two.

Current industry used SRT technique: Jest OnlyChange uses file-level granularity, which selects tests to be rerun based on file changes in the Git repository. As it is safe and the most light-weighted approach. Although fast, this approach may not be precise enough for some test suites. Therefore, our research starts from a question: “*Can we find a more effective test selection technique for Node.js Applications?*”

To evaluate effectiveness of test selection technique, Rothermel et al. [1] proposed four metrics: Inclusiveness, Precision, Efficiency, Generality. Inclusiveness measures the extent to which SRT technique chooses tests that are affected by the change. Precision measures the ability that SRT technique omits tests that are not affected by the change. Efficiency measures the time and space required. Generality measures its ability to function in a comprehensive and practical range of situations. We say a selection technique is safe if it achieves 100% inclusiveness.

Our intuition for reducing the total running time is to improve the granularity of the selection technique to improve precision so that less tests are required to run in phase two. We also evaluated our selection technique by performing an empirical study on two open source Node.js projects in different size and code coverage.

## II. APPROACH OVERVIEW

### III. RELATED WORK

There are several techniques proposed for standard desktop applications [1, 6, 7, 9, 10, 11, 13, 14, 15, 16], not much study focused on Node.js web applications. For JavaScript projects, Mutandis [19] is a generic mutation testing approach that guides the mutation generation process. It works by leveraging static and dynamic program analysis to guide the mutation generation process a-priori towards parts of the code that are error-prone or likely to influence the program’s output. Tochal [20] is a DOM-Sensitive change impact analysis tool for JavaScript. Through dynamic code injection and static analysis, this approach incorporates a ranking algorithm for indicating the importance of each entity in the impact set. This approach focused on frontend DOM changes, rather than the whole frontend backend interaction.

For test selection in different levels of granularity, Gligoric et al. [4] showed that file-level granularity analysis runs

32% faster than the method-level granularity analysis in large scale Java programs. [12] also shows tool implemented with approach "DejaVu" [11] is 16% worse when it comes to realistic code-coverage-based test suites. This is because there are two phases required for SRT. The first step is to select tests based on change and test dependency graph generated by static or dynamic analysis. The second phase is to run selected tests. For some project, if the running time of selecting tests plus the running time of executing selected tests is greater than the running time of executing the whole test suite, applying the selection technique is meaningless. This is the reason of current industry used approach only use file-level granularity static analysis as this is the most light-weight, simple approach.

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Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, ac, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

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equations with commas or periods when they are part of a sentence, as in:

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##### E. Some Common Mistakes

- The word "data" is plural, not singular.
- The subscript for the permeability of vacuum  $\mu_0$ , and other common scientific constants, is zero with subscript formatting, not a lowercase letter "o".
- In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)

- A graph within a graph is an “inset”, not an “insert”. The word alternatively is preferred to the word “alternately” (unless you really mean something that alternates).
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- In your paper title, if the words “that uses” can accurately replace the word “using”, capitalize the “u”; if not, keep using lower-cased.
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An excellent style manual for science writers is [7].

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Headings, or heads, are organizational devices that guide the reader through your paper. There are two types: component heads and text heads.

Component heads identify the different components of your paper and are not topically subordinate to each other. Examples include Acknowledgments and References and, for these, the correct style to use is “Heading 5”. Use “figure caption” for your Figure captions, and “table head” for your table title. Run-in heads, such as “Abstract”, will require you to apply a style (in this case, italic) in addition to the style provided by the drop down menu to differentiate the head from the text.

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a) *Positioning Figures and Tables:* Place figures and tables at the top and bottom of columns. Avoid placing them in the middle of columns. Large figures and tables may span

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TABLE I  
TABLE TYPE STYLES

Table Head	Table Column Head		
	Table column subhead	Subhead	Subhead
copy	More table copy <sup>a</sup>		

<sup>a</sup>Sample of a Table footnote.



Fig. 1. Example of a figure caption.

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity “Magnetization”, or “Magnetization, M”, not just “M”. If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write “Magnetization (A/m)” or “Magnetization {A[m(1)]}”, not just “A/m”. Do not label axes with a ratio of quantities and units. For example, write “Temperature (K)”, not “Temperature/K”.

#### ACKNOWLEDGMENT

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression “one of us (R. B. G.) thanks ...”. Instead, try “R. B. G. thanks...”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

#### REFERENCES

Please number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use “Ref. [3]” or “reference [3]” except at the beginning of a sentence: “Reference [3] was the first ...”

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Unless there are six authors or more give all authors’ names; do not use “et al.”. Papers that have not been published, even if they have been submitted for publication, should be cited as “unpublished” [4]. Papers that have been accepted for publication should be cited as “in press” [5]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

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