International Science Group

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IV

INTERNATIONAL SCIENTIFIC AND PRACTICAL CONFERENCE "SCIENCE, THEORY AND PRACTICE"

Tokyo, Japan
October 12-15, 2021

ISBN 978-1-63972-064-4

DOI 10.46299/ISG.2021.II.IV

SCIENCE, THEORY AND PRACTICE

Abstracts of IV International Scientific and Practical Conference

Tokyo, Japan
October 12 – 15, 2021

Library of Congress Cataloging-in-Publication Data

UDC 01.1
The IV International Science Conference «Science, theory and practice», October 12 – 15, 2021, Tokyo, Japan. 477 p.

ISBN - 978-1-63972-064-4
DOI - 10.46299/ISG.2021.II.IV

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RESEARCH OF REGRESSION AND MODULAR TESTING OF WEB APPLICATIONS

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Regression testing is a type of testing that aims to verify changes made to an application or software environment (bug fixes, code merges, migration to another operating system, database, web server, or server applications) to confirm the fact that pre-existing functionality still works.

Both functional and non-functional regression tests can be performed. Typically, regression testing uses test cases written in the early stages of development and testing. This ensures that changes to the new version of the program do not damage existing functionality.

It is recommended to automate regression tests to speed up the further testing process and detect defects in the early stages of software development [1].

The main task of the regression testing stage is to implement a systematic process of processing changes in the code. After each modification of the program it is necessary to make sure that the functionality of the program was not affected by the modified code. If such an effect is detected, talk about a regression defect.

During regression testing, functionality that was not planned to change uses previously developed tests.

One of the purposes of regression testing is to ensure that, according to the code coverage criterion used (e.g., operator flow or data flow coverage criterion), the same level of coverage is guaranteed as when the program is fully retested. To do this, you need to run tests related to the changed areas of code or functionality [2].

Another goal of regression testing is to make sure that the program works according to its specification and that the changes do not lead to new errors in the previously tested code. This goal can always be achieved by re-running all regression set tests, but it is more promising to weed out tests in which the original data of the modified and old program do not differ [3].

Testing coincide with the types of conventional testing. We can talk, for example, about modular regression testing or functional regression testing. Another way to classify the types of regression testing relates them to the types of support, which in turn are determined by the types of modifications. There are three types of maintenance:

– Corrective maintenance, usually called error correction, is performed in response to the detection of an error that does not require a change in the specification of

requirements. When corrective maintenance is performed, diagnostics and correction of defects in the software are carried out in order to keep the system in working order;

– Adaptive maintenance is carried out in response to changes in the data or runtime environment. It is used when the existing system is improved or expanded and the specification of requirements is changed in order to implement new functions;

– Improving (progressive) maintenance includes any processing to improve the efficiency of the system or the effectiveness of its maintenance.

Consider an example of regression testing where two new button names (buttonName) were added to a web page as button elements, using the JS programming language and the Cypress framework (the application responsible for implementing test cases) to see if you can see them and whether you can click on them:

```
switch (buttonName) {
  case 'buttonName1':
    cy.get(this.button).contains(buttonName1).should('be.visible').click()
    break;
  case 'buttonName2':
    cy.get(this.button).contains(buttonName2).should('be.visible').click()
    break;
  default:
    console.log('No buttons available')
    break;
}
```

The check takes the buttonName as a parameter and for each of the two options checks whether there is a data button as a parameter, text as a name on the web page and whether it can be clicked.

The "this.button" constructs looks for a button on a button-unique HTML selector on a web page; the "break" construct allows you to exit the validation cycle of each parameter and move on to the next.

If neither of the first two conditions is done, the base condition with the text "No button data" will be implemented, indicating that the regression check failed and, as a result, the web application developers must check the correctness of the changes.

Modular testing – testing, the purpose of which is to check the performance of individual modules (functions or classes) [4].

Modular testing is the most common type of testing in testing small electronic systems.

Traditional definition of the concept of module from the point of view of testing: "module-component of the minimum size which can be independently tested in the course of verification of system" [5].

The main purpose of modular testing is to make sure that the requirements for a single module of the software system are met before integrating into the entire system. The modular testing solves four main tasks [6].

The modules to be tested are usually small in size, so modular testing is considered the simplest but very time consuming step of testing the entire system. However, despite the simplicity of implementation, modular testing has two main problems:

– Differences in the interpretation of the concept of modular testing;

– There are no uniform principles for defining a single module.

Thus, modular testing helps the tester to easily refactor at each stage of testing and at any time to analyze each of the modules for functionality.

For an example of implementing modular testing in program code, consider a case in which an automated test should check the ability to enter text in a text field and check its display in the field, then clear the field and check that the text has been deleted and then enter numbers and check that they are not displayed (the field can only accept letters). The program code is implemented using the JavaScript programming language and the Cypress framework.

Modular testing script using the program code:

```
function fillTextInput () {
cy.get(this.textInput). fill ('Hello, world');
cy.get(this.textInput).contains('Hello, world').should('be.visible');
cy.get(this.textInput).clear();
cy.get(this.textInput). fill ('12345');
cy.get(this.textInput). contains ('12345').should('not.be.visible')
}
```

This software code implements a modular test of the ability of a text field to accept valid characters and not display invalid ones, which is a full-fledged test of a text field as a module.

For an example of the implementation of regression testing, it is possible to consider the following web applications:

– In applications that build models that can make the right decisions in terms of incomplete and unclear information and their use in computer systems [7];

– In applications that implement information preparation for decision-making on the construction of educational institutions in an area of high demand and developed infrastructure and provide an opportunity to determine the optimal and rational location of the required spatial objects [8, 9], and implement integrated data relevance criteria based on these calculated values;

– In computer vision applications that implement statistical estimation models in determining and classifying image relevance and implement integrated data relevance criteria based on these calculated values [10, 11].

Advantages of regression testing:

– The ability to track short-term changes in the application through regression tests;

– The ability to cover a significant part of the functionality in a relatively short period of time;

– The ability to find problems that lead to errors elsewhere in the system.

Disadvantages of regression testing:

– The need to run a full set of test cases after making changes to the application;

– The need for constant updating of test cases in accordance with minor changes in the functionality of the application;

– The possibility of test-dependent test cases.

Positive unpredictable results of modular testing include small changes in the application, which in the future, when adding new functionality can lead to significant errors. In this case, modular testing helps to quickly identify and eliminate future difficulties in the operation of the system.

Negative unpredictable results include the inability to adapt a set of test cases to significant changes in the application, which will require the writing of new software code.

Modular testing can be performed on many web applications:

– Geographic information web applications. Geographic information system is a new system of orientation in time and space; it includes modern methods of information processing and, at the same time, is accessible to most people. The use of geographic information systems allows at a qualitatively new level to provide an information base for almost all services and on this basis to provide solutions to technical, economic and a number of other problems. Geographic information system is widely used in the development and management of real estate [12];

– Web applications related to image recognition. The problem of recognizing structural images is relevant. This is a promising way to assess the similarity of objects. This approach provides simplicity of design and high reliability of decision-making. The main problem of effective description of characteristic features is the distortion of fragments of the analyzed objects. The reasons for changing the input data can be the action of geometric transformations, the influence of the background or noise. The problem of ensuring high-quality recognition requires the introduction of effective means of image processing. Methods of statistical modeling, granulation of data and fuzzy sets, detection and comparison of key points in the image, classification and grouping of data and simulation are used [13, 14].

– Web applications related to modeling of complex objects based on the rules of interpretation of the developed model using a tool for modeling and analysis of interacting processes [15, 16].

Advantages of modular testing:

– Breaking the system into small parts, which contributes to a deeper structural analysis;

– A short time to test a single module;

– In the process of modular testing, shortcomings in the integration of modules can be found and structural changes.

Disadvantages of modular testing:

– High probability of testing complex code;

– The expected test result is only approximate;

– Integration errors complicate the process of selecting modules as separate parts.

Unpredictable results in modular testing can be as follows:

– A positive unpredictable result can be found to improve the integration logic in order to increase the convenience of implementing a holistic system. Also, a positive

unpredictable result can be found when you need to add or remove certain modules to improve the system;

– A negative unpredictable result may be unrealistic expectations from testing modules, which lead to the formation of unrealistic test cases. Also a negative result can be a complex integration logic, which leads to the impossibility of separating individual modules.

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