FEATURE-BASED TEST ORACLES TO CATEGORIZE IMAGES

This briefing reports scientific evidence on the use and efficiency of an approach that automates test oracles to categorize synthetic 3D and 2D images blood vessels through the similarity between features.

FINDINGS

The aim of this paper was to describe and analyze the efficiency of an approach that automates test oracles to categorize synthetic 3D and 2D images blood vessels through the similarity between features.

- **Proposal:** this study presents a strategy to support automated testing activities in complex-output systems is the design based on test oracles.

- **Case study:** the strategy is demonstrated through a case study that aims to automatically categorize synthetic images of blood vessels in 3D and 2D models from the similarity between features.

- **Methodology:** initially, we generated synthetic images of blood vessels in 3D models. Next, we identified relevant features to extract from the images that may be source of information for the automated oracle.
  The images are categorized into four groups, based on the similarity between the number of features. The feature extractors and the similarity function are adapted to the context of the framework O-FIm/CO, which implements the concepts designed by feature-based test oracles.

- **Extension case study:** aiming at extending the study, we generated images in 2D models using screeshots of the 3D images taken with the BioImage Suite Tool. After that, we created test oracles to assess the categorization of the images in 3D and 2D models, aiming at evaluating the accuracy of the test oracle in the judgment of similarity between the images.

- **Compare method:** additionally, we compared the categorization performed by the test oracle with random algorithms, demonstrating that the test oracle has a statistically significant difference in comparison with the random algorithms.

From conducted a case study, the following results were obtained

- Regarding the categorization of 3D images, the automated oracle presented an average (AVG) of 77% for precision, 100% for recall, and 88% for specificity.

- The automated oracle presented results with high accuracy in most 3D images. The AVG of 77% precision for 3D images means that the oracle has categorized most of the images as positive in the expected categories.

- Regarding the categorization of 2D images, the automated oracle presented an AVG of 72% for precision, 81% for recall, and 93% for specificity.

- The automated oracle in 2D images had a low recall value. This may have occurred because of the threshold value used. Furthermore, for images with larger numbers of features, the automated oracle presented low numbers of precision and recall.

- Regarding the random classifier, the tests performed shown that by conventional criteria, test oracle versus random (p-value = 0.0109) has reached a difference considered to be statistically significant.

Through of the results obtained, we identified some points that can be revisited in the next version of the study, such as:

- As future works, we plan to increase the number of images in our dataset by varying the number of categories and include images with larger numbers of features.

- Regarding extractors features, we plan to identify and develop more feature extractors, offering a larger dataset as the source of information for the test oracle.

- The study offers several gaps that can be explored with the purpose of performing empirical studies that validate synthetic images of blood vessels.

Based on the process applied when conducting the study, we observed that medical images in 3D model are complex and allow a more detailed analysis of the image.

The development of feature extractors is less complex for 3D images. On the other hand, 2D images are limited, and the extractors development process is more complex.

Feature-based test oracles approach can be used as a promising strategy to automate validation activity of complex objects, specifically synthetic images of blood vessel in 3D and 2D models.

Keywords

Software Testing
Test Oracles
Synthetic Vascular Networks

Who is this briefing for?

Software engineering practitioners who want automate test oracles in the process of validating 3D and 2D medical images.

Where the findings come from?

All findings of this briefing were extracted from the use of the feature-based test oracles approach to describe and analyze the development of automated test oracles for 3D and 2D medical images. conducted by JUNIOR, M. C et al.

What is included in this briefing?

The main findings on the use of the feature-based test oracles approach.

Evidence characteristics through a description of an case study, identifying positive aspects and limitations in the approach.

What is not included in this briefing?

Information about a proposed approach to automate test oracles for 3D and 2D medical images.

To access other evidence briefings on software engineering:

http://www.lia.ufc.br/~cbsoft2017

ORIGINAL RESEARCH REFERENCE

JUNIOR, M. C, OLIVEIRA, R. A. P. ; VALVERDE, M. A. G. ; JACKOWSKI, M. P. ; NUNES, F. L. S. ; DELAMARO, M. E.; Feature-Based Test Oracles to Categorize Synthetic 3D and 2D Images of Blood Vessels. In Proceedings of the 2nd Brazilian Symposium on Systematic and Automated Software Testing (SAST) @ VIII Brazilian Conference on Software: Theory and Practice (CBSoft 2017), Fortaleza, 2017.