![ITEA3 logo]

Project Results

The TESTOMAT Project

The value of investments in test knowledge

EXECUTIVE SUMMARY

The ITEA TESTOMAT Project pushes the state-of-the-art in test automation towards agile development, allowing companies to identify their own 'next level' through a Test Automation Improvement Model while optimising their testing with dozens of open-source tools.

PROJECT ORIGINS

In software development, reliability and agility often seem like opposing forces. This issue is exacerbated by the increasing complexity of software and the constant drive towards faster release cycles for maximum market impact. Manual testing cannot meet these challenges, yet many safety-critical and hardware-oriented companies believe that test automation is irrelevant to them. SMEs, meanwhile, may miss out due to a lack of awareness or investments in automated agile testing. To strike the perfect balance between quality and speed, a new approach to automation is needed.

In the TESTOMAT Project - The Next Level of Test Automation, companies do not buy a result; they invest in knowledge. This 'next level' differs per organisation and depends on factors such as sector, size and practices. Many automation-related variables are unknown to the organisation, so the TESTOMAT Project focuses on providing software teams with personalised roadmaps for improving their automated testing in a cost-efficient manner. The consortium has also developed and enhanced over 40 tools in areas ranging from test scheduling to simulation-based testing, allowing software teams to pick and choose the most relevant innovations for their own agile automated development process.

TECHNOLOGY APPLIED

The TESTOMAT Project's technological innovations began with the Test Automation Maturity Survey, which was completed by 151 respondents in 101 organisations and 25 countries. This provided the consortium with the status of test automation and key issues worldwide. On this basis, a Test Automation Improvement Model (TAIM) was developed to define measurable steps for improvement. The TAIM web interface is open source to ensure maximum usage, aided by two handbooks on Test Automation. Continuous integration tools and logs provide quantitative data on the actual development and test execution, minimising potential flaws of human interpretation.

Success in the TESTOMAT Project is measured in terms of test effectiveness, test optimisation and quality and standards in testing. Effectiveness refers to ability to find bugs and maintain the test suites. A specific test method yielding success has been to deploy mutation testing, through e.g. the open-source TESTURA tool, which provides local and cloud support for C# testing, or the Dextool Mutate used in a safety-critical environment. Test optimisation, means selecting only relevant test cases for regression testing from the millions created through automation. One element of this is clone detection and similarity analysis, which enable the maintenance of much larger suites. Finally, quality and standards address non-functional aspects such as security and performance testing. Here, the TESTOMAT Project has worked to bring automation into standards that previously focused on manual testing and has also contributed to standard extensions and to the release of a completely new standard: UML Testing Profile 2.0.

To demonstrate the project's versatility, its ten use-cases can broadly be grouped into the following categories: trains, planes and telecoms; forestry, machines, robotics, banking, wind turbine maintenance with drones and port integration

technologies. The results are too numerous to list but include test visualisation with Epimetheus that compares test results; MBTCreator, a prototype web-based tool for model-based testing in CI and sOrTES tool for test scheduling. 11 tools are already available via GitHub and an average Technology Readiness Level (TRL) of 3.43 has been achieved for over 90 key targets.

MAKING THE DIFFERENCE

The TESTOMAT Project's great strength is its customised nature, which guarantees promising results regardless of the level of automation already found within a company. For those using fully manual testing, an average improvement of 60-80% can be gained in their time to market. It should be noted that improvements are highly variable due to enormous differences across companies: Ponsse, for instance, improved its unit testing and requirements coverage by 64% whereas Prodevelop managed a 220% increase in test efficiency. At the other end of the spectrum, Ericsson already carried out completely automatic testing but still saw a 29% improvement in product quality. Likewise, Saab uncovered 48 test issues (despite initially believing they had none) and also increased their number of product users by 440%. For already-automated companies, 15-30% fewer faults are predicted.

The true impact, however, should be viewed in terms of the TESTOMAT Project's influence on the software community as a whole. Software is becoming increasingly complex, but widespread dissemination of the project's results can counter this. So far, the TESTOMAT Project has released 80 publications with over 146 presentations and demonstrations, created 25 workshops and established 23 university courses on test automation. 22 industry-academia transfers have been reported (as well as 27 new employees within the consortium). A key focus is on long-term promotion through YouTube videos, which have helped drive over 144,000 visits to the website.

Subsequent large-scale uptake of the project's innovations will have enormous knock-on effects in society. One example should be increased safety in transportation, as the project clearly demonstrates the importance of safety-critical techniques for even the biggest companies like Saab. Another aspect is quality of life, as society relies on quality software, from automatic maintenance to better patient treatment through healthcare optimisation. Finally, optimised manufacturing and mobility means better resource management and fewer emissions, helping to meet the grand challenge of the energy transition. Through these combined factors, the TESTOMAT Project is likely to touch every corner of our daily lives.

MAJOR PROJECT OUTCOMES

Dissemination
- More than 80 publications (e.g. ACM SIGSOFT, IEEE SANER, STVR, APSEC, JSS, ESEM, IEEE ETFA, IEEE/ACM AST, ICSOFT, IEEE AITESTING, IFAC/EAAI, ACM MaLTeSQuE, IEEE Software).
- 133 presentations at conferences/fairs (e.g. dvcon, mtvcon, SAM, IWSF/SHIFT, RCIS, ISOLA, AUTOMATION, EKA, ICCSA, REFSQ, VVIoT, INSTA) and 25 workshops organised.

Exploitation (so far)
- Oxygen, a tool that empowers the user to convert the results of any testing tool or framework to Robot Framework's reporting to consolidate all test reporting (EfiCode).
- Web based tool for MBT in CI includes features for semi-automated requirements formalisation as well as automated test generation, prioritisation and test execution (AKKA, IFAK & EKS Tech).
- Testura, a mutation testing tool for C# .NET, which is a code wrapper around the Roslyn API and used for generation, saving and compiling C# code (System Verification & RISE).
- Dextool Mutate, a Clang based tool for mutation testing of C/C++ projects (Saab).
- Testar tool and videos for automated scriptless GUI testing (The Open University of the Netherlands).
- Cityscape test visualisation using Unity3D (RISE & Verifyter).

Standardisation
- Charter of OMG UTP 2.2 RTF, which includes chairing the UML Task force.
- Contribution of Release of UML Testing Profile 2.1.
- Extended UTP2 with cascading arbitrations, which enables UTP2 to be used for verdict arbitration in situations were functional arbitration is not sufficient such security or fault-tolerance testing.

TESTOMAT Project
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Partners

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Ericsson
KTH
Mälardalen University
RISE
Saab
System Verification Sweden
Verifyter

Turkey
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October 2017

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