Using artificial intelligence to augment and accelerate software testing
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As businesses prepare for the digital age, and as they offer more to their customers through digitization, they face growing complexity in the use, scale and deployment of software. Critical bugs, if missed, have ever-more catastrophic consequences. But traditional testing approaches are becoming prohibitively expensive—almost as costly as writing code—while simultaneously proving less reliable in a world of rapid deployment and faster time to market.

Automation is an obvious solution to this growing complexity and cost. And, while previous automation initiatives haven’t always fully delivered on their potential, the latest cutting-edge techniques change the game. By embedding intelligence into their method, new technologies can closely mimic human behavior, allowing self-learning mechanisms to develop new data-based insights.

The future of testing is therefore set to be dominated by novel and insight-driven methods that employ a suite of efficient and modern machine learning, artificial intelligence and statistical modelling algorithms and offer solutions over the whole testing lifecycle, from planning to design and execution. This is, in short, the world of precision testing.

“In today’s world, time to market is critical and hence Precision testing can become a key imperative.”

Kishore Durg
Lead for Accenture Global Testing Services
THE BUSINESS NEED: ADDRESSING CRITICAL ISSUES EARLY

Leading organizations increasingly face challenges in using traditional software testing models that focus only on verification and validation, and are looking for solutions that meet the performance and efficiency demands of the digital age.

What are the business needs?

1. SHRINK TIME TO MARKET WITH PRESCRIPTIVE MODELS

Disruption across numerous industries is fueling a race to shrink time to market in product development. Technologies like prescriptive analytics are increasingly being adopted as a solution that can deliver rapid decision making and implementation. Compellon 20/20, for example, is a prescriptive analytics solution that uses artificial intelligence to shrink the time and effort required to guide strategic and tactical action. It identifies critical focus areas that maximize impact for a business, such as the most valuable customer segment to address or which individuals to target with new offers. Its combination of software and services can in this way not only save money, but accelerate time to action.¹

Figure 1: Traditional testing models do not match demands of digital applications.

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¹ Figure 1: Traditional testing models do not match demands of digital applications.
Prescriptive analytics are also ideally suited to a modern testing environment, where the technology offers capabilities in analyzing historical data, suggesting corrective actions, and saving development time.

2. CLOSE THE COVERAGE GAP WITH SELF-ADAPTIVE SYSTEMS

Learning mechanisms are an essential component of modern testing models. To date, most of these tools have required large amounts of data and extended periods of time to function effectively. But companies are now finding new and faster solutions, using Bayesian methods for data modelling and analysis. One recent example is Uber’s acquisition of AI start-up Geometric Intelligence, which specializes in areas other than machine learning, and will be critical in improving Uber’s services through the rapid development of new algorithms.2

Testing models that can learn from new data are especially important because complexity increases exponentially as new features interact with existing applications. In traditional models, test coverage grows linearly because test cases can only be added one at a time (or are tied to the number of testers available). In the early stages of a project, this might be enough to keep up with feature development, but coverage and functionality will inevitably diverge over time leading to a coverage gap. AI-driven testing models that learn and adapt over time are therefore of vital importance.

Figure 2: AI-driven testing promises to address feature complexity of future applications.3
3. ADDRESS QUALITY ISSUES THROUGH HUMAN-LIKE AUTOMATION

Deep learning, a technique which mimics human-like functionalities to enable intelligent automation, is a cutting-edge field. Stanford University is working on enhanced computer vision and natural language processing to detect credit card fraud, for example. Illumina, which develops sequencing and array technologies for life science research, translational and consumer genomics, and molecular diagnostics, is researching gene prediction to identify the parts of the genome that encode certain functions. And Snapchat recently acquired startup Cimagine to benefit from its computer vision, real-time image processing and 3D display technologies.

In a testing environment, human-like automation can identify application failures quickly and systematically with far fewer executions than alternative techniques. Deep learning based advances in computer vision mean machines can now observe and test applications in the way humans do—but with far greater speed and accuracy.

4. IMPROVE ACCURACY AND OUTCOMES BY AUGMENTING THE TESTER

Leading businesses around the world are using virtual agents to share their human analysts’ workloads. The Royal Bank of Scotland’s Luvo is an artificially intelligent chatbot that assists contact center agents by answering simple queries or routing customers to the correct channel. Freed from these basic tasks, agents are able to focus on more complex customer queries, at a huge saving for the business.

There is enormous potential to apply similar technologies in a testing environment, where a virtual assistant that identifies potential performance issues and offers relevant test cases from its repository could transform a human tester’s workload.
Accenture’s Precision Testing is a solution that brings these capabilities together to meet the needs of businesses in the digital age. It enables a shift away from the static, lower-quality, non-learning, process-driven models of the past. At its core is ‘intelligent design’, which is characterized by four key dimensions:

1. **PRESCRIPTIVE.** Its trained models predict the future state of a system in order to prescribe the right action to be taken.

2. **SELF-ADAPTING.** Its machine learning algorithms are trained on past projects and updated as new data emerges.

3. **AUTOMATED.** Its automated execution methods and supervised learning techniques mimic human users to make creating and maintaining test scripts far easier.

4. **AUGMENTED.** Its intelligent virtual assistant seamlessly orchestrates applications, provides relevant data to human testers and bootstraps new testers through a single, conversational interface.

**Figure 3:** Precision testing addresses the efficiency demands of digital applications.
INNOVATING FOR THE FUTURE
Accenture’s Precision Testing

Accenture Labs and Accenture Global Testing Services has co-innovated with a US based financial services client to evolve its model of Precision Testing to meet the business needs of new age applications and overcome the challenges associated with traditional testing models. The technique brings into practice the principles of precision testing described in earlier sections. Accenture’s Precision Testing solution offers the following innovative capabilities:

PREDICTIVE ANLYTICS USING BAYESIAN STATISTICS

The solution uses data from the results of test scripts completed in each test cycle to learn and predict future priorities through the use of predictive analytics. It can therefore guide a business in prioritizing its testing effort, predicting whether scripts will pass or fail, and assessing overall testing efficiency.

“The solution’s capacity to learn from past data is driven by Bayesian methods—techniques that infer future probabilities from past data—and test failures are predicted using machine learning. It enables efficiency to be visualized over numerous test cycles so that test managers can concentrate on components with a higher likelihood of bugs.

A Bayesian mechanism continuously updates the learnt model parameters of the solution as new test execution results come in. In this way, the model is a self-adapting system.

“More than 50% of software development effort is spent on testing and Machine Learning can help to reduce that significantly.”

Sanjay Podder
Lead Software Engineering R&D, Accenture Labs, Bangalore
TEST MANAGEMENT THROUGH SIMILARITY ANALYTICS

Traditional testing often involves redundancies, bloated test suites and difficulties in managing costs and effort, which can distract testers from the real question: whether a test is yielding deep insights. In contrast, precision testing:

• **learns** from past defect logs and test suites;

• **identifies** duplicates and semantically related tests and defects using similarity analytics; and

• **visualizes** central problem areas, their coverage and interrelatedness.

The approach eliminates redundancies, brings deeper insights, and makes intelligent recommendations for effective test management with reduced costs and effort. The system uses unsupervised machine learning based on similarity analytics and can analyze and **prescribe** relevant actions to improve testing efficiency.

TEST AUTOMATION THROUGH COMPUTER VISION

Manual test scripts written in a natural form of language, such as English, are relatively easy for a human tester to create, maintain and execute, as the tester interacts with the application visually. Automation tools, however, have to date all required implementation details in order to execute test scripts. This additional need is down to the fundamental difference between what a human ‘sees’ and what a machine ‘sees’ when carrying out a test, and can be so severe that projects often find little or no benefit from test automation.
Accenture’s precision testing now bridges this gap between human and machine. Its Domain Specific Language (DSL) allows a tester to create scripts in a simple English-like language. These steps are parsed into actions and web elements, enabling automated tests to execute without any further implementation details. Leveraging a deep neural network to locate the co-ordinates of the elements specified in a test, the machine performs the requested test actions on the identified elements. This method has the potential to significantly advance test automation by allowing machines to mimic humans.

**Figure 4:** Bridging the gap between human and computer vision is the key to automation.
AN INTELLIGENT TESTING ADVISOR

To date, little has been done to support the needs of human testers through the testing lifecycle, and testers still largely rely on their individual skills, training and productivity. Accenture’s intelligent advisor now offers a means of plugging this gap. It assists a tester throughout a project lifecycle by offering project-specific knowledge, as well as AI-based decision and diagnostic support, through a natural, intuitive conversational interface.

The intelligent advisor offers three capabilities in particular:

• it enables the tester to prioritize test cases and arrive at decisions by making **backend analysis accessible**;

• it **bootstraps new testers** by acting as a buddy, designed to significantly reduce the learning curve; and

• it provides **active assistance**, including progress reports to the test lead, **throughout the entire software testing lifecycle**—this is unique to Accenture’s solution and is a key differentiator in the market.

The ease of use of the intelligent advisor and its role as a technical buddy are designed to **augment** a human tester for a faster and more accurate outcome.

**CONVERSATIONAL INTERFACE AS A DECISION ADVISOR**

<table>
<thead>
<tr>
<th>Knowledge Advisor that bootstraps new testers</th>
<th>Decision advisor through Predictive and similarity analytics</th>
<th>Diagnostic Advisor through similarity analytics</th>
</tr>
</thead>
</table>

Rhea: Hi John. What can I do for you today.

John: please suggest the next set of test cases to execute

Rhea: There are 3 modules: Excel Reader, Grammar, and Scope Resolution which have high business criticality and high fault prediction. I suggest that you start testing these modules.

John: show me the test cases of the ExcelReader.

Rhea: The ExcelReader module has 25 test cases. Displaying the details.

**Figure 5:** The intelligent advisor enables testers to perform tasks efficiently.
CASE STUDY
Pilot with a large financial services company

Accenture’s precision testing solution was piloted with a large financial services client in the United States. The results were extremely successful.

The client benefited from:

• An 80 percent reduction in manual effort in identifying the redundant test cases for regression testing.

• A 10 percent regression test suite optimization by eliminating test cases that did not yield defects.

• A 5-10 percent reduction in test execution effort by not running redundant test cases.

• A 50 percent reduction in schedule delays by prioritizing test executions.

• A 10 percent test suite compaction by consolidating duplicate and similar test cases.

• A 5-10 percent reduction in SME time by resolving new-joiner queries through the virtual agent.

Precision Testing was piloted with a large financial services client and the results were extremely successful.
CONCLUSION

These results demonstrate the power of Accenture’s Precision Testing model. Its intelligent design enables it to be self-adapting and prescriptive, meaning it can predict the future state of a system and prescribe actions to be taken. It is augmented with an intelligent advisor that assists human testers through the entire lifecycle of a project, offering easy access to backend analysis and bootstrapping new testers into the project. And it offers test script automation through its supervised learning technique, bridging the gap between machine and human testing.

The solution thus overcomes the challenges associated with traditional testing models, namely coverage, redundancy, maintenance, debugging, and human–computer interaction:

<table>
<thead>
<tr>
<th>ISSUES IN TRADITIONAL TESTING</th>
<th>HOW CAN ‘PRECISION TESTING’ HELP</th>
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<tbody>
<tr>
<td><strong>MAXIMUM COVERAGE</strong></td>
<td>Only a small percentage of the bugs are truly critical, yet a significant amount of time is spent testing modules which are known to be stable.</td>
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<td></td>
<td>Statistical modelling techniques that look at the past data and identify vulnerable components. Further, Precision Testing can predict whether a test script is going to pass or fail.</td>
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<tr>
<td><strong>ELIMINATE REDUNDANT TEST CASES</strong></td>
<td>New test cases that have been added may turn out to be redundant where the scenarios have already been covered by other test cases.</td>
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<tr>
<td></td>
<td>Precision testing analyses the test descriptions, test steps and other natural language text to identify semantically similar test cases, putting them into clusters.</td>
</tr>
<tr>
<td><strong>SIMPLIFY MAINTENANCE</strong></td>
<td>Many projects have found little or no benefits from automation as large amount of manual effort is needed to create and maintain an automation script.</td>
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<tr>
<td></td>
<td>Precision Testing uses advances in computer vision techniques to mimic human like automation where the test automation scripts can be created and maintained with ease.</td>
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<tr>
<td><strong>ML DEBUGGING</strong></td>
<td>Poorly executed debugging and root cause analysis tend to cause defects to re-appear.</td>
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<td></td>
<td>Machine learning based solution that can help identify potential root causes for a defect. The solution looks through the defects that have occurred in the past and how they have been fixed.</td>
</tr>
<tr>
<td><strong>HUMAN-COMPUTER INTERACTION</strong></td>
<td>The fundamental theme of HCI is to make the interaction as ‘natural’ as possible. However, reports &amp; data are often difficult to consume and interpret.</td>
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<tr>
<td></td>
<td>The intelligent agent has the ability to engage a tester through speech, assist the tester with respect to the various tasks and help bootstrap a new tester in a project by providing FAQs and relevant documentation.</td>
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</table>
Most importantly, the precision testing model explicitly recognizes and addresses the issue of exponential application complexity growth over time. This is its key differentiator over traditional testing approaches, which often fail to keep pace with feature development in the later stages of a project.

Through its use of artificial intelligence and self-learning, Precision Testing is a forward-looking solution for the rapid deployment of superior quality software. It’s a solution that meets the demands of a modern business environment. It’s a solution for a business that wants to thrive in the digital age.

END NOTES

2. BI Intelligence, Uber’s new AI acquisition, Dec 2017.
5. Business Insider, Snapchat acquires AR startup Cimagine.

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The precision testing model explicitly recognizes and addresses the issue of exponential application complexity growth over time.
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