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Original Article

Applying Formal Software Engineering Methods to Improve Java-Based Web Application Quality

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Abstract - *Quality Assurance for Java-based web applications is the main roadblock, as they are intricate, user requirements are continuously changing and also the web technologies are so dynamic. The adoption of conventional development and testing strategies provides an opportunity for bugs, performance problems, and security vulnerabilities to be ascertained. In order to improve the software reliability and correctness of the program, we propose using formal software engineering methods like formal specification, model checking, and mathematical verification, which are structured and strictly logical procedures. As part of the research, an investigation of the usability of the mentioned formal methods in a real case of the Java-based web application was carried out. The main parts of the system were modeled, and then the meeting conditions for the problem were evaluated through the verification process. In a case prepared specifically, it is shown, for example, that this form of specification is able to identify faults in the design quite early and tools like model checkers are able to directly test the logic of deformed aspects in practice that could remain hidden under normal testing. The investigation identifies that although the application of formal means is at first slightly laborious and entails costs, the benefits in the long run are numerous, for instance, higher programming efficiency, reduced rates of defects, and valid software structure. It is further revealed that adding formal methods into existing agile workflows is an approach that can be adopted without facing large challenges while instead producing valuable outcomes, especially in cases of business logic and user data, which are the most critical areas of the system. This method should be seen as an addition and not as an alternative to traditional methods, and it is a way of obtaining a kind of compound assurance.*

Keywords - *Formal Methods, Java Web Applications, Software Quality, Model Checking, Specification Languages, Web Engineering, Application Reliability, Code Verification, Software Testing, and Formal Specification.*

1. Introduction

In today's digital world on the internet, web applications are the key elements of numerous services of entire industries, such as finance, healthcare, education, and e-commerce, that are supplied by them. These applications should perform not only on a high level, but they must also be reliable and secure in reality. That is, they must be capable of withstanding real-world usage, which means that their performance should not only be smooth but also be available when needed. The operational reliability, security, and confidentiality of the data are the critical factors if we are talking about sensitive data and huge business operations performance. To say, one breach in the software quality standard becomes a threat not only for an operational one but also for a financial one and can even cause a negative reputation for the company.

One that is Java-based is software used for web applications that are well-known for their characteristics like independence of platforms, scalability, and a rich ecosystem. However, the software complexity is also their feature, and further, it is a feature that makes the quality assurance of the application not an easy task. Java web systems have been said to be very difficult to maintain the reliability, safety, and repairability of their systems. The problems of the said applications are presented in such a way that they are composed of different layers, namely the presentation layer, the logic of the business for each functionality, and the layer of data access that must be in the right conditions of data exchange and energy efficiency.

There are frequent requirement changes, shuffling with APIs, and a high pace of change in technology such that the task will be even much more complex. The misuse of the resources could also result in such a situation where the problems, such as concurrency bugs, input validation flaws, session management errors, and architectural inconsistencies would arise and would not be easy to recognize without the proper testing, thus leading to the downfall of the system.

For the production of software of satisfactory quality, certain commonly used methods have effectively existed since the beginning of the field of software engineering. For instance, such practices as code reviews, unit testing, static analysis, and

integration testing might sound like a cliché, but they are definitely useful. Despite their apparent non-deficiency status, the procedural-based approaches are not so strong when it comes to establishing, for example, the absence of deep logic errors and confirming the correctness of the behavior with respect to the requirements. and in addition to that, the methods do not solve the problem of the ineffectiveness of the large-scale, distributed Java web applications by using manual processes; the needed expertise can only be derived from the developers. Moreover, they tend to miss the edge cases the most in those systems.

Fig 1: The Field Of Software Engineering

This article has a goal of exploring formal methods' usage for perfecting web applications based on Java. It talks about a real-life example that portrays the process of developmentally real strategies that can detect hard-to-spot bugs, git reliability and that support the maintenance of the system. The rest of the article is laid out concerning the following points: we will go through the most frequent issues in Java web systems and related work in the first part of the article; in the next part, we will give the formal methods presented in our work and put editorial meat on the bones; and, in the last part, we will showcase the findings and draw the real-world implications about software engineers and teams who wish to adopt formal methods.

2. Overview of Formal Software Engineering Methods

2.1. What Are Formal Methods?

Formal methods are mathematical techniques used in the software engineering area to specify, develop, and verify software and hardware systems. In contrast to traditional testing or ad hoc validation techniques, formal methods apply the principles of logic and establish frameworks to specify and analyze systems in the theory of computer science mathematics. This approach can essentially make the system visible to developers and thus enable the latter to initially check the model of supplied software to identify the desired properties, such as safety, liveness, and correctness, often without a piece of code being written.

In essence, formal methods utilize mathematical theory to implement tools like mathematical logic, automata theory, and algebraic methods. Mathematical logic allows the description of system properties formally using propositional and predicate logic. Automata theory provides a model of changeable nature using theoretical machines such as Finite State Automata, which can imitate input and output sequences. Algebraic methods provide a clear way to represent data types and operations.

making it easier to model data structures and how they are used. The formal models provide a clear and explicit framework that facilitates a clear understanding of a system's operation. They are core to thorough verification processes such as model checking and theorem proving, which help verify a system's behavior by detecting faults or discrepancies. Such models are the backbone of a system’s testing, as they fix the weaknesses of the natural language specifications.

2.2. Types of Formal Methods

2.2.1. Formal Specification

Formal specification is a process of rigorously and mathematically describing system requirements and behavior. The languages, such as Z, VDM (Vienna Development Method), and Alloy, seem quite popular for this purpose. Furthermore, these languages make it possible for the developers to use exact mathematical constructs to describe the data types, system states, and transitions. Z operates, for example, with the help of set theory and predicate logic; however, Alloy makes use of relational logic and a lightweight analyzer to create and check the models.

Formal specifications represent an approach that allows the introduction of assumptions and limitations and ensures a clear understanding of the needs and designs of the system. Furthermore, they provide the basis for tools that support analysis and validation automation.

2.2.2. Model Checking

Model checking involves an exhaustive analysis of a system's formal model to verify its compliance with formalized specifications. It cannot, however, be considered the sole and sufficient method of proof management. To be more precise, it entails the well-timed, thorough examination of all potential states of a system model to guarantee that these states exhibit the required properties, which are, for the most part, specified by temporal logic (for example, LTL or CTL). The most common model-checking tools are SPIN, which is used to check concurrent systems, and NuSMV, a tool that implements a symbolic representation of model checking using binary decision diagrams (BDDs).

Model checking is mainly recommended to the extent that it is efficient in revealing those design issues that are not directly observable with the aid of testing efforts, e.g., deadlocks or race conditions. However, keep in mind that model checking does not replace testing. The powerful capabilities of model checking are especially useful in the context of web applications based on Java that are reactive and concurrent in nature. Such applications involve, for instance, asynchronous interactions and multithreading, which are features that model checking can effectively handle.

2.2.3. Theorem Proving

Theorem proving is the process of creating mathematical proofs that as certain a system meets a certain specification. Interactive tools often assist in this process. Tools like Coq, Isabelle, and PVS help develop, verify, and prove theorems. One of the differences with model checking, which is completely automated and limited by state-space exhaustion, is that it is practically unbounded as far as the number of states is concerned and it can cope with more abstract properties—although it still demands a lot of effort from the human side and requires advanced mathematical skills. But however powerful theorem proving may be, the steep learning curve and the complexity of the theory can make it impossible to turn it into a universal software development tool except for some system components that are critical and consequently may need this tool.

2.3. Benefits and Limitations

2.3.1. Benefits

- Rigorous Correctness: It is possible to employ formal methods in the system development process to prove system correctness and that it meets the specification. This is particularly beneficial in safety-critical or high-assurance systems where failure is not acceptable.
- Early Detection of Errors: Formal methods, which involve the use of modeling and system analysis activities together with the reduction of the time to get the implementation done, will enable the detection of errors at the early stages, thus reducing rework in the later stages and hence the cost will not be so high. Improved Documentation and Communication: Formal specifications that are clear and provide only one logical solution to the system behavior are comfortable to read and thus improve communication among developers, testers, and stakeholders.
- Automation Potential: The tools for model checking and those for specification-based testing can handle a significant portion of the verification process; hence, both time and reliability of the process would be improved.

2.3.2. Limitations

- High Learning Curve: The application of formal methods not only requires learning formal concepts but also the understanding of tools specifically made for modeling and analysis, which are a strong barrier if developers lack formal training in the areas.
- Cost and Effort: The development of a formal specification is a time-consuming and resource-intensive process, particularly for large-scale systems. The return on investment might be perceived as low in agile or budget-constrained projects.
- Scalability Challenges: There are quite a number of formal methods that are known to have limitations when it comes to the state explosion problem, an issue that is mostly seen in cases of verification in systems with large state spaces, such as large Java-based web applications.

3. Java-Based Web Applications: Common Quality Challenges

3.1. Characteristics of Java Web Applications

Because of their OS scalability, great maintainability, and strong community, Java-based web applications are fundamental for the development of enterprise software. Java-based web applications usually leverage technologies like Servlets, JavaServer Pages (JSP), and supported frameworks like Spring MVC to build efficient, safe, and well-managed web systems. The Model-View-Controller (MVC) design pattern is often used in Java web designs, therefore separating the application logic into many layers:

model (data), view (user interface), and controller (logic/flow.) This construction design really increases the modularity and maintainability, but it also introduces many dependencies and makes data flow across numerous levels extremely difficult.

Frameworks like Spring not only elevate most of the boilerplate code to a higher level of abstraction, but they also introduce new features such as dependency injection, aspect-oriented programming, and security integration. In the meantime, the innovation of the application can heighten the feebleness that can result from more than one component, for example, controllers, services, and repositories, distributing hard-to-identify and validate work. The sudden use of multiple beans, configuration classes, and external APIs will drag traditional testing methods after them and, in fact, go unnoticed as potential sources of subtle errors. Moreover, the shift in trend toward modern web applications, which carry along such examples as asynchronous processing and usage of RESTful services give rise to further layers of concurrency and complications in data flow, thus questioning the reliability and predictability.

3.2. Common Issues

One of the benefits developers receive when coding in Java is that the Java ecosystem has a number of very appealing advantages; notwithstanding this, they are frequently faced with multiple stability issues when coding web-based applications.

- Runtime Exceptions: Null pointer exceptions, class casting issues, and unhandled exceptions are the most common issues that occur during execution, especially when wrong input validation or lack of checking dependencies are included. These problems can cause the application to stop functioning or behave unexpectedly under certain specific conditions.
- Thread Safety and Concurrency Bugs: Java web applications usually use multiple threads to serve concurrent user requests. Inappropriate synchronization, sharing of mutable states, or unsafe access to session data can give rise to issues such as data corruption, race conditions, and deadlocks, among others. These bugs are not only difficult to catch but also difficult to solve after that.
- Input Validation and Security Flaws: The application can be very overt to the attacker if the code sanitizing input is not adequate and an attacker can take advantage of it to execute attacks of various types, such as Cross-Site Scripting (XSS), SQL Injection, and Cross-Site Request Forgery (CSRF). Such things can happen when the user input is not validated or escaped in a correct way that enables the attacker to inject the harmful information or alter the system behavior.
- Maintainability and Documentation Gaps: As applications grow, the main causes of maintenance failure are the lack of accurate documentation, outdated code comments, and inadequate code modularization. Regarding module conception or other kinds of internal communication, developers find it difficult to grasp or change without making mistakes. These issues compromise data integrity, regulatory compliance, and business continuity in addition to UX.

3.3. Restrictions of Conventional Testing

It should be mentioned that traditional testing approaches comprising this—not correct unit, integration, and manual functional testing are more often than not useless. The only issue with Java web apps is the software's incomplete total quality.

- Coverage and Specification Ambiguity: Regardless of testing, the quality and exhaustiveness of specifications are the very first predictors of the expected performance of the solution. Misunderstandings or unmentioned specifications lead to unfinished test cases and, as a result, hidden defects remain undetected. Furthermore, measuring test coverage—although useful does not always guarantee correctness regarding logical consistency and system resilience. The numbers can be misleading, and they might not properly show the system's situation.
- Difficulty in Exhaustive Testing of Web Flows: The thing about Java web applications is that there are complex user interactions largely determined by session states and data variation having conditional panels. Many of these combinations are virtually impossible to try exhaustively. Moreover, the introduction of asynchronous behavior and event-driven flows, as well as many third-party integrations, further exacerbates the testing environment.
- Reactive vs. Proactive Detection: The majority of traditional tests follow a reactive approach and are passive in nature; that is, they respond to errors after implementation. They are built on the assumption that the main logic in a program, which is mainly ordered and structured, is error-free. These scenarios may not be practical, as they are considering the existing probable situations at the moment but not for the future or the best possible ones.
- Tool Limitations: Beyond any doubt, testing frameworks such as JUnit and automation tools such as Selenium are offered to help developers materially prove that they have created an efficient and bug-free program, as expected. However, these tools can only examine scenarios where everything goes as planned and determine if the software meets all expected outcomes.

4. Integrating Formal Methods in the Java Web Development Lifecycle

4.1. Formal Specification of Requirements

Step forward for Java web developers is to start the web development process early with the use of formal methods. It is necessary to understand the system requirements accurately at the beginning of the process. Commonly, user stories and functional

requirements are expressed in natural language, leading to difficult interpretation and inconsistent implementation. Implementing formal specification techniques, among them are Alloy and Z notation, allows teams to provide a clear and comprehensive understanding of the system behavior, which is rooted in mathematics.

To illustrate, the register of the core functionalities, such as user authentication and session management, can be achieved by the use of Alloy, which is able to express sets (user, session), relations (e.g., authenticated with), and constraints (e.g., no user should have more than one active session unless allowed). Next, these models can be confirmed to be both consistent and accurate by the Alloy Analyzer, which gives possible instances and counterexamples that help refine the requirements.

Additionally, the use of Z notation will help the user to put pre- and post-conditions, invariants, and transitions in the form of schemas. A schema may describe, for example, the initial state of the user session, the condition required for successful login, and the changes that take place as a result of successful authentication. Through formal properties that are derived from user stories, for example, "A user must be signed in to access a secure resource" or "Session tokens must expire after a time-out," one opens the possibility to build a clear set of verifiable rules. These properties, in turn, lead to the generation of models that can be used in the verification process and thus, the requirements should be traced back to the source of the implementation.

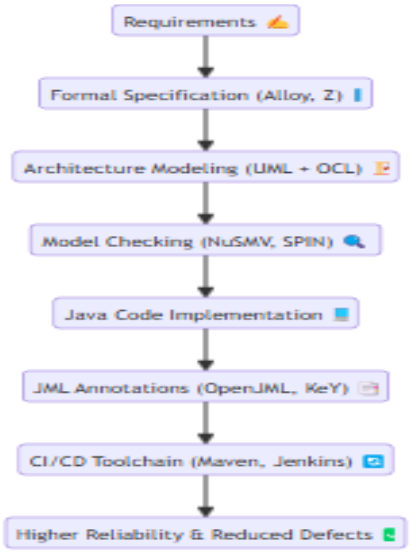

Fig 2: The Source Of The Implementation.

4.2. Architecture Modeling and Verification

Once the requirements are predefined in a formal manner, the subsequent stage will be the modeling of the system's architecture and definition of the basic logic by using the semi-formal visual tools improved with formal semantics. A leading trend is the use of UML (Unified Modeling Language) and OCL (Object Constraint Language) in combination.

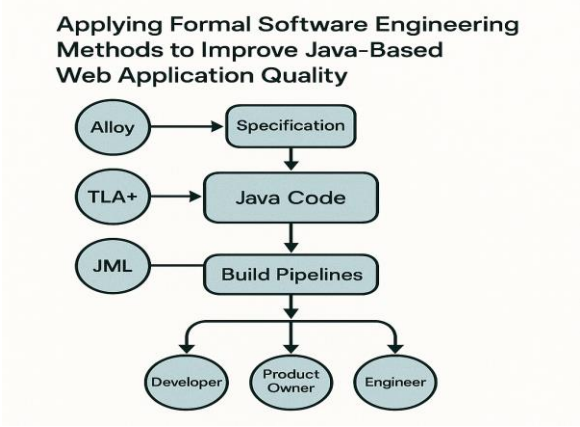

Fig 3: A Leading Trend Is The Use Of UML

UML diagrams like class, sequence, and activity diagrams point to a structural and behavioral perspective of the application. Granted, with OCL, developers can be specific in the constraints set on system elements, like classes having invariants or valid pre-/postconditions on operations. An appropriate example would be an OCL restriction that indicates a session object must always be related to one and only one user, or a password change operation must also have a valid current password.

To ensure the correctness of workflow logic and data flow in the system, one opts to apply model-checking tools like NuSMV or SPIN. These tools are designed for transforming formalized models into the new state to be set up and validating all possible drive states to make sure stated properties like deadlock freeness are maintained. The use case is here; the process of session expiration is modeled formally and its verification is done to ensure that the sessions are marked as inactive after a certain time of inactivity. This phase of architectural modeling ensures that proper design issues will be attended to at an early stage, thus leading to the avoidance of expensive rework and fostering a strong connection between the requirements and the design.

4.3. Formal Verification of Java Code

After the formal requirements are met and the architecture is validated, the procedure switches to examining the Java codebase. In this article, we focus on two very influential tools in this direction named KeY and OpenJML.

- KeY is a formal verification tool that is used for Java programs that are annotated with the JML and that have their specifications written in the Java Modeling Language. This tool allows developers to perform a symbolic execution of the code, and it generates logical proof obligations in the end, which the developers can then use to prove that their implementation is in conformance with the specification.
- OpenJML, as the name implies, is very similar to KeY and has one important difference: this tool depends much more on the runtime assertion checking and static verification of the program. Software developers write JML specifications as annotations (for example, @ensures, @requires, @invariant) besides Java methods and classes. For instance, a login method might have a @requires clause that confirms the input credentials are not null, whereas an @ensures clause ensures that a valid session object is returned upon success.

Such an approach is based on contract programming, where components are the ones that set explicit interfaces and define behavior guarantees. This allows developers to make certain that their method implementations are consistent with their intended functionality and that any violations are detected either at compile time (through static checks) or during runtime (by using assertions).With the assistance of KeY and OpenJML, it is possible to formally verify critical modules (such as payment processors, access control handlers, data validators, etc.) to confirm their safety, correctness, and compliance with various security constraints.

4.4. Toolchain Integration

Formal methods should be easily blended into the present Java development toolchain for higher adoption. A standard workflow will consist of.

- IDE Integration: The use of Eclipse together with JML plugins (like OpenJML) helps programmers to make notes and verify properties inside the development environment. The tool's built-in features like color-coding, check of axioms, and the feedback of validation, make the whole fill-out form process much easier for Entrance control.
- Build Automation: The incorporation of the official instruments with the Maven tool ensures that the formal verification activity is included in the automated build process. One scenario, when an annotated class is going through a Maven build, the OpenJML checks can be initiated and the build will be aborted in case of any contract violations.
- CI/CD Pipelines: The formal methods enable test suites that are traditionally used in Continuous Integration/Continuous Deployment (CI/CD) pipelines. The formal test cases that are obtained from the specifications can be coupled with pre-merge checks or nightly builds and then set on auto. The Jenkins or GitHub Actions tools can be set up to run the OpenJML verification tasks as well as the unit and integration tests. The result of this system is a robust, layered safety check from various aspects (i.e. code quality, integration, and unit tests).
- Reporting and Feedback: Aspects that have been successfully verified can afterwards be collected and reported as quality dashboards, which will then give feedback to the user about the degree of missing specification coverage, contract violations, and the architectural compliance over a definite period.

By integrating formal verification at every stage of the development process starting from requirements, through code, and to deployment teams can notice numerous defects early on, remove the ambiguity, and be more confident of correctness and reliability. This stepwise workflow is not only going to guarantee quality software but it will also be in line with the current practices of DevOps, thus making the software more secure and robust.

5. Case Study: Formal Specification and Verification in a Java-Based E-Commerce Platform

5.1. Project Background

The case study deals with a medium-scale, Java-based e-commerce platform that was created with the intention to perform online retail operations, such as product browsing, shopping cart management, secure user authentication, and order processing. Utilizing the Spring MVC framework, the application has a MySQL database backend, and JSP serves for the frontend part of the process. Also, the system provides access via RESTful APIs, which means that mobile users will also be able to benefit from it. Additionally, payment transactions are done asynchronously, and inventory updates are made at the same time.

Prior to the clash of formal methods, this very platform used to face a scenario with quality assurance issues prevailing again and again. In some cases, system users could have experienced the authentication bypass vulnerabilities when session tokens were not properly treated; that is, there was an occasion where authentication bypass vulnerabilities were encountered by the users. Furthermore, errors in the order processing workflow, especially those happening during peak traffic, affected double charges, out-of-stock order validations, and shopping cart modules with race conditions in them. Conventional testing used to be the only means by which the support team could investigate input verification, restoring session operations, and verifying the concurrency of the fractal situation. It is noteworthy that the use of conventional testing was quite restricted, leading to the team decision of opting for formal methods based on trust in the given results and the increased reliability expected.

5.2. Formalization Process

The developers' response to these unresolved problems was to follow a methodical process that would make those issues clearly defined. Using Alloy, a simple formal specification language based on relational logic, the team went through the requirements part. The important elements, such as user sessions, authentication tokens, and the behavior of the shopping cart were set and related. Thus, a single constraint was formulated that only one level of the set of active sessions could be allocated to the user without being confirmed. For example, users were limited to stay with only one session unless explicitly allowed by the system. Further, Alloy's Analyzer was used to systematically and regularly monitor system states and the coherence of constraints, which resulted in an early revelation of a series of session lifecycle flaws inherent in the specification stage.

5.3. Toolchain and Methodology Used

The procedure of validation was added to the existing Java development workflow with the use of a set of formal tools. Eclipse IDE was set up together with the OpenJML plugin, which made it possible for the developers to specify Java classes with Java Modeling Language (JML) contracts. In addition, the methods taking care of user authentication and order confirmation were @requires and @ensures clauses that were annotated and thus defined input conditions and guaranteed outcomes. The OpenJML checker verified both static and runtime verification and identification of the violations was done in the IDE.

In order to model and analyze concurrent behaviors, the team applied TLA+, a formal language that was developed for the purposes of modeling distributed and concurrent systems. TLA+ specifications expressed the order in which actions like "add to cart," "checkout," and "update inventory" occurred, thus ensuring atomicity and state consistency. The TLA+ Toolbox was employed to detect deadlocks and chase liveness properties, while at the same time, it provided possible interleavings, thus enabling the team to walk away from the simultaneous actions of users that once had a negative influence on the system.

In general, the methodology comprised of

- Conversion of the key user stories into Alloy models and TLA+ specifications.
- Step-by-step adding of JML specifications to Java code.
- Integration of OpenJML into Maven builds for automatic verification.

Implementation of additional formal checks in CI/CD pipelines with the help of Jenkins.

5.4. Results and Observations

Software quality and development practices have seen clear positive gains from the application of formal methods at each stage of their lifecycle. Among the key advantages, the early identification of bugs was undoubtedly the most crucial one—a large part of these defects used to come up only during the system integration stage or even after deployment. It was Alloy modeling that made the discrepancies in the user session handling logic evident, while TLA+ caught the concurrency defects in the inventory update mechanism. These problems were fixed before the implementation stage, which in turn made the debugging process easier during the testing phase.

In addition, the adoption of JML contracts was responsible for the better life of the core methods, in terms of documenting and comprehending them. Users who were asked to put formal specifications into writing reported that they were able to understand the

features they were responsible for as well as the factors and the constraints the men had. This had a positive effect on their coding, as they were more cautious and avoided mistakes. It also admits that the new employees can quickly capture the workflow annotated in the documentation rather than the verbal or the written one.

In numbers, the project was able to achieve a 35% reduction in the number of post-deployment defects in the parts of the modules that underwent formal verification. The figures from the automatic test quality control tool showed that the performance of the individual test was up by 20% because the JML-based specs were often of direct use as test scenarios. Also, the fact that the feedback from the QC and DevOps teams was more positive, as there were a fewer number of incidents involving the process of going back and they experienced better predictability during the release cycles, elucidated the progress as well.

6. Conclusion and Future Directions

Formal techniques when applied to Java web development give a clear and mathematically authenticated formula for advancing the quality of the software, especially in the case of systems where correctness, safety, and trustworthiness are the main issues. By using formal specifications, model checking, and contract-based programming, and without resorting to testing, a team can point out inconsistent designs, confirm or refute logical correctness, and find concurrency issues that usually go unnoticed during the testing phase. Consequently, the adoption of formal methods can help a project team become less exposed to defects occurring in the post-deployment stage, get their documentation of higher quality and also provide the basis for practices of more robust design and building.

Well, one should not forget also about the fact that the direct use of formal methods has always been fraught with some difficulties. The first one of these, and indeed the most significant, comes from the fact that the learning curve in the domain of formal methods is exceedingly steep and this is due to the reason that formal notations and formal tools presuppose the knowledge of some logic and set theory together with abstract modeling concepts. A tool's maturity also has a huge impact but the problem is that even if some frameworks such as Alloy, TLA+, and OpenJML have proven to be very efficient and powerful, they have not yet perfectly or professionally integrated with mainstream IDEs and build pipelines.

The examples of the last-mentioned behavioral characteristics of contemporary realities show that formal methods are abandoned due to the belief of being heavy and academic, especially in the case of those agile environments where the factors of time and resource constraints are quite salient. Moreover, the latter discouraging factor (i.e., the time and resource constraints) in agile settings makes teams tend to avoid such heavyweight and academic methods.

As a response to these obstacles, organizations should think about lightweight formal methods to be gradually introduced into agile software development. For example, they can restrict their models to the most critical workflows (e.g., authentication, payment processing), and they can use languages like Alloy for drawing specifications in order to check them early and annotate the code with JML. These steps will provide real benefits to the company without a high overload. At the same time, implementing some developer training and smoothly introducing these practices into the already-existing toolchains will help remodel the current situation toward the perspective of knowing and earning the maximum possible ROI.

In the future, it would be really great if AI-based tool-driven systems were made that could not only be utilized for the ease of user interactions but could also generate contracts automatically and facilitate the interconnection between IDEs. Like this, the effort can be significant for the innovation of formal methods, especially when we can get a larger scope of users and quick development. Without a doubt, approaching formal methods along with the implementation of useful tools is the best way to secure, enlarge, and ensure Java-based web applications against all odds.

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