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AN OVERVIEW OF THE ADOPTION OF FORMAL METHODS IN SOFTWARE ENGINEERING IN NIGERIA

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Abstract

Despite the prominence of formal method in academic research over the years, formal method is still in a state of obscurity in the industrial sector. The reasons range from difficult mathematical bases, inadequate tools, incompatibility with other software and rigor in training users. In Nigeria the situation is even worse as the use of Formal Methods can barely be found in most sectors. The paper is set out to x-ray Formal Methods, its benefit and level of adoption especially in software engineering in Nigeria industrial sector.

Keywords: Formal Methods, Software Engineering, Nigeria, Adoption

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1.0 Introduction

We live in world today where computers and computer related device practically support all forms of human activities and at the heart of this development are software- programs that manipulate these devices. Systems are increasingly dependent on software components, Complexity of systems with embedded software has increased rapidly. In situation like this, the role of software that is efficient and reliable should be of utmost important to security of property, finance and even human life. Since the reliance on these devices is growing to a near absolute confidence level, the need to reduce faults in software codes is of the essence. A major goal of software engineering is to enable developers to construct systems that operate reliably despite their complexity. One way of achieving this goal is by using formal methods which are mathematically based languages, techniques, and tools for specifying and verifying such systems (Edmund et al., 1996). Formal methods consist of writing formal descriptions, analyzing those descriptions and in some cases producing new descriptions. This method ensures that inconsistencies, ambiguities, and incompleteness that might otherwise go undetected are spotted and corrected before implementation.

Despite the vital role of formal method, they are hardly applied to majority of software systems (Plat, Katwijk and Toefenel, 1992).

This paper examines formal methods and its benefit and looks at reasons for its slow adoption in software system in Nigeria. The paper listed recommendations that will promote application of formal method in Nigeria.

2.0 Literature review

2.1 *Formal methods*

According to Wing (1990), formal methods are mathematically based techniques for describing both hardware and software systems. Formal methods can also describe any approach which utilizes a formal specification language and species the role of that formal specification during the software development process (Burgess, 1995). The word Formal is used in sense that such a method has a sound mathematical base. This provides the means to precisely define notions such as consistency, correctness, specification and implementation (Plat et al., 1992). They provide framework for inspecting the completeness of specifications for proving the correctness of an implementation of a system and for proving properties of system without the need to have executable representation of the system. The representation used in formal methods is called a formal specification language.

2.2 *Types of formal methods*

- Abstract state machines (ASM) – ASM strategy is a logically surely understood and handy programming building idea. The idea of ASM is given by Yuri Gurevich in the mid of 1980s. ASM was the change of Turing postulation which expresses that “every algorithm is simulated by an appropriate Turing machine.” Yuri Gurevich later proposed the ASM postulation which expresses that "every algorithm, no matter how abstract, is step for-step emulated by an appropriate ASM."
- B-Method- B-Method is a formal method which is utilized for the advancement of the project code given by the unique machine notations. B-method was proposed by Jean Raymond Abrial. B-method is connected with Z notation which backings the advancement of using so as to programming code determinations. B-method is firmly identified with

article arranged demonstrating and in later past years B-Method gave some other usage apparatuses (or tools) like: Atelier-B, Pro B, BRILLIANT, and Rodin Tool.

•Z-notation- Z- Notation is a formal specification language utilized for demonstrating and portraying computer based system. Z-notations are likewise proposed by Jean-Raymond Abrial. It is normally utilized when the particular of the computer system is cleared. Z in view of the first-order predicate logic and set theory where states are characterized by numerical structures like sets, relations and functions.

•Vienna Development Method (VDM) - VDM is also one of formal method used for the development of computer based system. It was developed in the 1970's at IBM Vienna laboratory. After VDM's commendable growth it includes additional tools and techniques to support formal specification language which is called VDM-specification language (VDM-SL). VDM-SL is an extension of VDM++ which depends on object - oriented modeling and concurrent systems.

•Unified Modeling Language (UML) - provides system architect with one consistent language for specifying, visualizing, constructing, and documenting the artifacts of software systems.

•Spark Ada is a code level formal method tool, adopted by Altran Praxis for their correctness by correction approach. It is a subset of the standard Ada programming language designed to be susceptible to static proof of correctness. The SPARK tool set is designed to insure high levels of system correctness.

2.3 *Benefit of Formal Methods*

The following are some of the benefits realizable from effective applications of Formal Methods:

- Formal Methods help find defects and also causes more defects to be detected than would otherwise be the case and in certain circumstances guarantees the absence of certain defects.
- Formal specifications allow defects in requirements and designs to be detected earlier than they would be otherwise and greatly reduce the incidence of mistakes in interpreting and implementing correct requirements and designs and invariably reduce the overall cost of the project.
- Subjective reason is limited but with the use of formal methods, formalized statements can always be analyzed and their consequences calculated with the use of proof methods such as model checking and theorem proving which are based on sound mathematics (NASA, 1995).
- Formal methods can provide confidence and increase in trust in industries where its application is publicized. This is so in heavily regulated industries such as aviation, military and aeronautics. They demonstrate responsible engineering and give solid reasons for trust in the product (Hall, 2005).

2.4 *Related Works*

In a research paper, F. A. Kasali, Y. A. Adekunle, A. A. Izang, O. Ebiesuwa, O. Otusile evaluated the usage of Formal methods among the student of Babcock University Illishan. The aim of the evaluation was to create awareness on the importance of Formal Method in the design and implementation of reliable and efficient software and also to bridge the gap between academic research and application of formal methods in the industry.The sample of survey was basically Computer Science students, the total population of Computer Science students both at the Undergraduate and Post graduate level are about for example 37.4% of

the sample surveyed say they find it easy to learn formal methods concepts and tools which means that with a confidence interval of 7.59, this implies that between 29.81% and 44.99% of the entire population find it easy to learn formal methods concepts and tools which is not even up to half of the entire population surveyed.

J.B. Collins presented a paper that addressed The Role of Formal Methods in Soft ware Engineering Education and Industry. The paper outlines some of the benefits of including formal methods as part of the degree curriculum in University education. He deduced at the end that the use of formal methods in real industrial projects is increasing, but is still a small percentage of the total number of project undertaken.

Musa and Rahman (2015) in their research on "Formal Methods of Software Development in the 2000s: A case study of Nigeria" in order to find the present state of formal method usage in IT organisation in Nigeria, conducted a survey among different professionals of information technology and computing sciences in the country. A quantitative study with the option of questionnaire was adopted. 250 respondents comprising of male and female professionals with knowledge of computing were selected, 45% of them have a first degree as their highest qualification. 27% of the respondents have a master's degree as their highest qualification. 9.7% of the respondents are PhD holders. Those with diploma as their highest level qualification constitutes were 7%. The remaining 8.1% of the respondents claim to have other qualifications different from the ones stated on the questionnaire. The result of the study indicated that 83.3% have never applied FM in real life and only 1.6% has actually applied it in real time. They concluded that most IT professionals have a poor knowledge of FM and that FM is not part of the education curriculum of computer science in most higher institutions in the country.

3.0 Causes of Slow Adoption of Formal Methods

Despite academics and industrial claim that the use of formal methods in software development would lead to better software process and increased software quality, there exists a general lack of acceptance of formal methods (Burgess, 1995). In Nigeria, the adoption of formal Method is extremely very low and almost non existence. From various research and studies, the reasons for this can be traced to the following:

1. Formal methods are not part of most undergraduate curriculum in Nigeria higher educational system. Early adoption of FM in our educational system could spark early interest in this filed.
2. Educational system in Nigeria is theoretically based. Therefore application of FM which is rooted in practical application is suffering in attention.
3. Software development is at the infant state in Nigeria. Majority of software and applications being used in the country are imported.
4. Availability of research materials of formal methods in the country is still limited. This might be the reason why the IT professionals in the country have poor knowledge of the said methods.
5. Technological transfer is issue that stands between developed and underdeveloped nations. Most error critical software are still managed or contracted to foreign partners.

4.0 Conclusion

Even though the practical application of Formal Methods has not matched its popularity in academic research, formal methods and its intents are still very essential in producing error free software, especially in this era of information and communication technology where security, finance and even human life depends on the application of software.

If Nigeria IT professionals want to be reckoned with globally in the development of software that is safe, economically viable and globally standard, we must embrace the practical principles of Formal methods in pursuit of our software development.

5.0 Recommendation

Having noted the problem militating against the adoption of Formal Method in Nigeria, I wish to propose the following solution:

1. Early introduction and awareness of principle of Formal Method in our higher educational system may kindle the interest of would be professionals.
2. Practical approach to the teaching of Formal Methods will increase interest in its benefits.
3. Encouragement of local software and application development will lead to increase in the usage of formal methods.

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