CHAPTER 8

CONCLUSION

# 8.1 Summary

Adaptive Lifecycle Management is a structured methodology geared toward ensuring successful implementation of automated testing. The ALM approach mirrors the benefits of modern rapid application development efforts, where such efforts engage the user early in the development cycle. The user of the software product is actively involved throughout analysis, design, development, and test of each software build, which is delivered in an incremental fashion may be called as beta versions.

Many organizations have adopted the ALM. Many companies have adopted the ALM as their company standard for automated software testing. Others believe that industry automated tool vendors will soon be incorporating the ALM’s structured methodology within their tools. Instead of performing the entire test lifecycle haphazardly, software managers will use an ALM-compliant test tool that automatically supports (and possibly enforces) the ALM's sound building-block approach to the test effort. In ALM, we need to finalize the decision to automation and expectations from the automated testing. But before that a significant automated plan should be generated and test tool should be selected in such a way that one tool should fit for most of the requirements. These should be concrete benefit of selecting and working with automated tools.

There should be proper use of adaptive test automation design patterns while doing automated testing. It includes Adaptive Life Cycle which is made of following steps (*speculate*, *collaborate*, and *learn*). As An adaptive software test and development approach is based on observation, so it is best-suited for projects with uncertainty and focuses should be on the rapid creation and evolution of software systems. Complex Adaptive System Theory which talks about differences of behavior, style, and culture with Management Techniques, Strategies and Understanding of adaptive software. There are two perspective of Adaptive Software Development (ASD): Conceptual perspective and Practical Perspective. CAS concept also talks about emergence, complexity and quality. RAD practices includes characteristics, those are mission-focused, feature-based, iterative, time boxed, risk driven and change tolerant. Adaptive management policies also works as passive and active adaptive management mode.

Almost all of the modern cloud or API applications are developed in the new micro-services architecture, there are certain factors or requirements the application should closely adhere to make sure it is cloud ready or can be used to easily expand and change services/behaviours as per market demand. These standards help us achieve applications to be in sync with the cloud computing definition from NISTas closely as possible to be used and deployed on a cloud infrastructure.

There been study of cloud storage networks, which is of mainly of software as a service and platform as a service, and infrastructure as a service. Storage devices are categorized as Primary and Secondary storage device, which is further divided in Magnetic, Optical and Flash storage devices. As there are different types of storage hence it is necessary to have particular usages. So in data centres, storage devices with larger capacity should be used. Those may be direct attached, networked attached or storage area network, based on storage and networking protocols. But now a days most importantly cloud based file storage is used frequently.

In dynamic storage we need to first know about storage protocols for high speed data transfer, includes SCSI, FC, CIFS, NFS and HTTP/S. Storage networking protocols includes iSCSI, FCoE, and TCP/IP stack. Now a days Storage Virtualization technologies are being used mainly in cloud computing.

There are some tools and technologies available to achieve results on Run Time Dynamic Adaptive Automation Testing (RTDDA). These tools are mainly divided in two categories Free/Open Source Tools and Commercial Tools. There are some tools used for cross platform testing, Hence in the list of many tools there should be strategy to choose right tools on the basis of Market research, Experts View and Personal Experience. Sometime if required tools may be developed in-house.

After doing thorough study of tools which are used to automate the process and Test the application in run time dynamic adaptive environment. The most important is Selenium, which supports doing Web Automation by using Java, Python, C# and Other Scripting Languages.

JMeter is most commonly used Tool to Bench Mark Web Performance Testing. Junit and TestNG are Unit Test Automation Frameworks. Hence it completes the ecosystem from Unit Test Automation to functional test automation and then Performance Testing Automation.

A Practical implementation of Adaptive automation system by setting up Automated Build System with Continuous Integration and Continuous delivery is demonstrated using setting up (deploying) Free/Open source Software (Jenkins) over cloud for accomplishing multiple tasks such as triggering software build as soon as check-ins made in repo, or then running unit tests, Code Coverage and Static Code Analysis and parsing code for bugs, running integration tests etc. As there are many plugins freely available, if configured properly it encompasses (approaches to) adaptive learning as per environment and schedule.

As Jenkins takes care of automating task from Code Check-ins into repository to Unit Test, Code Coverage, Code Analysis, Build, Generates Reports, and does Code Integration with Delivery. Hence it’s an end to end solution and by using intelligent Plugins and using scripts process can be made continuously better and better. And here everything happens over cloud server irrespective of geographical location. This whole system can be configured in one Master and multiple Slave Nodes to get better performance in forms of distributed computing.

This research continue demonstrating patterns used in adaptive automation testing. It includes continuously Learning, Speculate and Collaborate, Spiral model have Plan, Build and Revise continuously. It can be understood with Complex Adaptive Systems Theory. It includes Adaptive Software Development with conceptual perspective and particle perspective. CAS has concepts of Emergence, Complexity and Quality.

Rapid Application Development can be used for adaptive development because it’s iterative, time boxed and change tolerant.

Adaptive S/W development management has polices namely Passive and Active Management and Leadership-Collaboration Management. Adaptive Automation Testing have some patterns named as Data Patterns, Technical Patterns, Proxy Patterns, Business Patterns, Page Object Patterns, Façade Patterns, Factory Patterns, and Singleton Patterns.

A study of Adaptive Algorithm is done used to develop adaptive software algorithms and tools mainly categorized in Heuristic Strategy and Fuzzy Logic and concluded.

# 8.2 Customized Adaptive Algorithm for Taking Decision in Run Time Dynamic Networked Cloud Storage Environment.

Step 1: Collect maximum possible parameters or variables (System Environment) need to run/execute the system.

Step 2: Define set for variables, based on components and functionalities.

Step 3: Collect the variables in Set or arrange them in group.

Step 4: As there will be large number of set, and different states of variables so apply Heuristic Evaluation Functions to calculate the cost of optimal path between two states.

Step 5: Every set will become a node so apply pure heuristic search, in which nodes will be expanded as per their heuristic values. This step will result a list of unique shortest paths between nodes and dispose long paths.

Step 6: Now apply Best First search to get the cost of path with cost of goal. By using priority queue, it will return optimized weighted cost.

Step 7: As nodes in networked dynamic cloud storage environment has various sizes and capabilities; hence next fuzzy logic will be applied which works on the levels of possibilities of input to achieve the definite output.

Step 8: To get acceptable reasoning and overcome the uncertainties, covert node values in fuzzy sets called a fuzzification.

Step 9: Convert/arrange fuzzy sets into logical constructs, decision making statements.

Step 10: Evaluate and combine results with the help of (Inference Engine).

Step 11: Then output data need to be converted back into non-fuzzy values. (Called as de-fuzzification)

Step 12: Repeat Step 7 to 11 for all data sets.

Step 13: Repeat Step 4 and 5 if required and there is a larger set of data.

Step 14: Go to step 2 to check if any data/functionality is remaining. Follow step 3 onwards if necessary.

Step 15: End of execution of Adaptive Algorithm in dynamic environment.

# 8.3 Recommendations

This research worked on broad area of automation but focus is adaptive automation for High Speed Storage and that itself should be in dynamic, run time environment. This is possible with the algorithms able to work in environment in High Performance and High Speed but sufficient transportation of data storage should be there.

Present era is an era of information and vast information is lying over servers worldwide. This information is accessed using various Internetworking technologies, protocols and search engines.

Here the nature is always dynamic and processing of information is done on need basis. This all information is managed with various data centres. Hence every Big organization manages and runs Data Centres where high speed storage networking protocols are used. Then this information is travels over Internet using TCP/IP stack and application Layer protocols mainly in a secure manners. This research opens the scope of study of secure data storage, access and transfer in cloud network, i.e. the uses of https (Transport Level Security), and various cryptography and security algorithms.

Hence this research can be taken further with other areas of Information Security, Cyber Intelligence and Solutions and Neural networks and Artificial Intelligence Solutions. Where data is processed dynamically to conclude decision at run time. Hence this research plays a significant role in added technologies.

We head of today about Data Science, Data Engineering and Data Analytics a lot. This is an emerging field where concepts of statistics and computing are sued together and cloud is been involved. This research is also been used in this area to take the Data Analysis and Performance ahead.

Artificial Intelligence some time called as machine learning are based on the techniques of Deep Learning.

Machine Learning is about to fit data in functions to have a group such that it may give predictions of future outcomes.

Deep Learning takes this approach ahead with chained layers (densely or loosely), such that output from one layer is feed into next layer and parameters being fitted are the weights of those connections.

This is really used in pattern recognition and statistical fitted to enormous amounts of data.

The most algorithms with deep learning (AI) are Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and Reinforcement Learning (RL).

The most common algorithm is Reinforcement Learning which is used in the area of Adaptive automation development, as adaptive automation is tightly connected to Dynamic decision in complex run time storage environment.

Artificial intelligence is on everyone’s thought. In the meetings with consumers, colleagues, industry experts, educators, academicians and reporters. Invariably, every conversation turns at some point into Artificial Intelligence and scope of the opportunities, threats, limitations, and the future of same in parallel to other cutting edge technologies.

AI systems have been around since the 1950s in some other developing forms. There were always overhyped expectations but those could not be met that time but grows over time.

Artificial intelligence is now extending abilities through technology is what we do normally. It is who we are. It’s not to stop with the invention of algorithms/tools to give greater intelligence, but rather move on to create external intelligence, should not be a surprise.

Today we celebrate Artificial Intelligence systems with incredible abilities and superhuman abilities in many ways. Systems that can operate vehicles autonomously, diagnose illnesses on medical images, translate accurately between languages, detect credit card fraud, guide customer relationships, and run entire data centres.

This approach of AI is to make use of the most of the information available to us. And then to build on algorithms trained on this information based on analytics. This extends the area of adaptive automation.

An algorithm is a methodological recipe to transform one larger concept into another step by step procedures or functions. It is how small software ingredients turn into a big application, or how light photons are processed in the dark visual cortex of the brain which transformed into images of the world in our eyes. Algorithms are expressed through if-then-else programming logic, through connections and weights in an artificial neural network, through reactions and neurological processes, or through other means as may be discovered or implemented.

The algorithms that expedite the artificial intelligence are derived from processing data through analytics and being processed in different steps which trains a neural network layers. Training a deep neural network means finding an acceptable solution in an over parameterized nonlinear system, iteratively improving from a set of starting values by reducing the discrepancy between the solution and the collected data while finding a solution that generalizes to other data. Fundamentally, this is no different than finding the solution to a logistic regression problem or finding the optimal split values and pruning depth of decision trees in a random forest.

As deep learning and reinforcement learning in Adaptive Automation are just a small tip in the analytic toolbox of the AI builder, analytics of all stripes are used to derive algorithms from data and to drive decisions. The successful AI systems are based on advanced analytics and its extensions, turning data points into decisions and actions.

As per continuous evolvement of living being on earth it can be understood and sensed that quality assurance system is natural selection. Automation and Adaptive algorithms are a very recent invention. Yet they are getting increasingly sophisticated and complex, solving more and more difficult problems that were thought to be impossible few decades back.

AI algorithms are also advancing much faster and progress can be measured in couple of days and that comes in terms of idea to accept that intelligence no longer requires a brain.

Human vision is much more complex than computer vision, but an algorithm trained to identify objects is still highly capable and can augment humans because it checks things differently. AI algorithms should not be compared as human being in understands language and communicates in context, but more flexible than human being in translating between languages. Algorithms do not have to overcome human being at everything to be impactful and transformational.

As a research discipline, it’s a continuous process to automate the quality assurance and test systems, application based on adaptive and deep learning algorithms.

The QA system for artificial intelligence is not only for making sure the algorithms and software work. But also to make sure that algorithmic decisions are understood, transparent, and unbiased. It is about developing/building the technical infrastructure with engineering discipline that supports autonomous decision making by machines. Realizing autonomous data transfer and access, at scale will require a complex traffic control system, more complex than the current traffic control system.

**The Future Ahead**

Researcher recommend to be reactive in research strategy. Should invent first, then we learn from mistakes. First the Problems and Domains, then the solutions. For example, First the Algorithms, Programming, then the Computing Devices and then Software Applications.

Adaptive Automation is a fundamental concept integrated with Heuristics Strategy and Deep Machine Learning, collectively called as Artificial Intelligence.

This research opens the scope of add-on researching further with distributed computing, storage devices and storage networking protocols, Cloud Storage and Cloud Computing and area of further research to make software more intelligent.

There are always a scope of further add-On and continuity of research,

To go further research, there are a number of ways add-on research can be done in the area of adaptive automation. Most importantly to capture involvement of application of Adaptive Automation in whole research process from initial design through to dissemination in cutting edge technology. There should be far more potential case studies in principle, and those should be included related to automation in various industries, so that there will be a greater choice of which to proceed with once study began in earnest.

Involvement of case studies from the application stage to capture the important early involvement of research studies in the initial design period. It might be preferable to research a smaller number of case studies related to adaptive automation, allowing a more in-depth approach. This might require a brief screening exercise of a larger group of People on their attitudes to and experience of technology involvement. Hence a proper questioner on involving technology should be made.

The technology evaluation in Adaptive Automation in dynamic environment was challenging in a number of ways, particularly in seeking to obtain completed resource from participating research involvement technologies and software tools. Keep a data collection period should be broad field such as dynamic involvement, where activity may be very episodic and infrequent. Thus, collecting run time data alongside other case study data in a more integrated way, and particularly with interviews and more ethnographic observation of software tools practical activities, might be advantageous.

The new budgeting and free, open source tools developed by a useful resource for future technical evaluations.

It’s been learning from the involvement of practical applications works over cloud in my research project and, although many aspects of my approach worked well, there are few things can be done differently in future. Even though I included substantial resources for research involvement in all aspects of research, I underestimated how time-consuming the full involvement would be.

Researchers perhaps ambitious in trying to ensure such full involvement with the number of practical data and the number and complexity of the case studies. I was also perhaps naive in expecting all the Tools and applications to play the same role in the research goal; different research partners came with different experiences and skills, and, like most of case studies, should be better to be less prescriptive and allow the roles to develop more organically within the project.

If one of the objectives of R&D goal is to increase the extent and effectiveness of practical tools and data involvement in research, then a key implication of research is the importance of influencing technologies to value hardware and software application involvement in research or to delegate to other. Keeping training with upcoming related technologies is unlikely to be the key mechanism.

Researchers are much more likely to be influenced by peers or by their personal experience of the technology involvement. Researchers may be shape themselves by training and learning new technologies but again learning and culture may be more influential. For those researchers skeptical or agnostic about adaptive automation involvement, the requirement of researcher is a key factor that is likely to make them engage with the involvement agenda. Researchers need to scrutinize the track record of research idea on expert’s involvement to ascertain whether there is any evidence of further use in society.

One of the findings of the research analysis in the area of adaptive automation was that it was also notable that there was sometime a degree of variation in the real data getting from technology involvement and that effective involvement is necessarily always required used to analyze the deviation. Different models of involvement incur different study data and researchers need to be made aware of the costs and benefits of these different options.

One methodological conclusion was the impact that conducting research had reflection on the impact of number of tools and applications involvement. Particularly for research candidates, the questions asked sometimes made them reflection upon what is being done and change aspects of approach to involvement. Virtualization is the most important and recommending technology in managing development operations. Reporting, audit and other forms of evaluation can be built on the impact of technology involvement directly into processes, the more likely such questioning might stimulate similar reflection and may give further data and idea of another research.