# Research Methodology

**Keywords** , Automation Tools, Analysing Tools, Cloud Computing, Heuristic Search, A\*, Fuzzy Logic, Web Testing, Web Driver, Mobile Testing, Browser Testing, Automation Framework, Python, Java, Performance Testing, Functional Testing, Unit Testing, Integration Testing, System Testing, Acceptance Testing

# Questionnaires

1. Work and Responsibilities in Organization in Software Development, Software Testing, Quality Engineering and Software Integration and Deployment
2. Describe the methods of development and Testing used in organization
3. Describe the methodologies and status of manual testing
4. Problems associated with manual testing
5. Problems used with manual testing tools
6. Repositories used for Test Cases
7. Uses of Cloud storage in Development and Testing Environment
8. Methodologies of using Dynamic Storage in Software Environment
9. Opinion of using automated testing as a solution coming with manual testing.
10. Factors needed to be considered before implementation of automation.
11. What should be the process of implementing automation?
12. As per the current situation is there any automated process carrying out doing software build, Testing and Delivery?
13. Opinion and suggestions implementing Adaptive Automation with Storage
14. Challenges of implementing adaptive automation?
15. Algorithms used for adaptive software testing tools development in dynamic environment with large cloud storage.
16. Overcoming the challenges of implementing adaptive automation using tools and techniques
17. Level of satisfaction after implementing adaptive automation in System development, System Testing, Thereafter Integration and Delivery.

# Automation Tools for Software Systems Testing

As per the response and data collected from questionnaires, following tools are listed for study and practical implementation to check the behaviour of adaptive automation. These are some tools and technologies available to achieve results on run time dynamic adaptive automation testing (RTDAA) with cloud storage networks. These automation tools has specific features to offer in addressing the growing challenges of software automation in the years ahead. They provide capabilities for continuous testing and integration, management, and reporting. These tools supports continuous increasing automation needs for Web and Mobile testing. Intelligent verification and smart analytics for adaptive and heterogeneous environments are to be desired for automation tools and technologies. We will discuss about Open Source/Free and Commercial Tools and methods to choose right tools.

## List of RTDAA Tools

* Selenium
* TestComplete
* QMetry Automation Studio
* HP QTP/UFT
* Testim.io
* HP Quality Center (HP ALM)
* TestComplete
* Test Studio
* Katalon Studio
* IBM Rational Functional Tester
* Ranorex
* Appium
* Robotium
* Cucumber
* EggPlant
* SilkTest
* Watir
* Sauce labs
* Sahi Pro
* Sikuli
* IBM Performance Tester
* Apache JMeter
* BlazeMeter
* HP LoadRunner
* WAPT by SoftLogica
* NeoLoad
* Perfecto Mobile
* WebLOAD
* Test Anywhere
* Visual Studio Test Professional
* FitNesse
* TestingWhiz
* Tosca Testsuite
* WatiN
* SoapUI

## Open Source Tools

### Selenium WebDriver

Selenium is an open source library with bindings in multiple languages (Java, C#, Python, etc.) that allows an engineer to write code that is then translated into human-like interactions with various browsers and mobile devices.   At its core Selenium spins up a lightweight server on a machine that sends commands in the JSON format to a browser or device.  These JSON commands typically include information such as the action to be performed (click, enter text, submit form, etc.) as well as information about how to identify the element for the action to be performed on.

These pieces of identifying information are based on the Document Object Model (DOM) or a web page or app and, for all intents and purposes, can be thought of as the HTML of a page.

### Selenium

It is test automation framework for Web applications. Selenium is an automation framework of choice for Web automation engineers, particularly for those who possess advanced programming and scripting skills. Selenium become a core framework for other open-source automation tools such as Katalon Studio, Watir, Protractor, and Robot Framework. Selenium supports multiple operating systems (Windows, Mac, and Linux) and multiple browsers (Chrome, Firefox, IE, and Headless browsers). And it can be programmed with scripts can be written in various programming languages such as Java, Groovy, Python, C#, PHP, Ruby, and Perl. Engineers have flexibility with Selenium, can write complex and advanced test scripts to meet various levels of complexity, it requires advanced programming skills and effort to build automation frameworks and libraries for specific testing needs.

It is the most popular automation testing tool for web applications. Selenium can be run in multiple browsers and operating systems**.** It is compatible with other automation testing frameworks.

With selenium, a browser-centered automation test scripts can be created which are scalable across different environments. Scripts can be created using Selenium that is of great help for prompt reproduction of bugs, regression testing, and exploratory testing.

### Katalon Studio

This is a powerful test automation solution for web application, mobile, and web services. This is built on top of the Selenium and Appium frameworks. This supports different levels of testing skills. Manual Testing Engineers can find it easy to start an automation testing, while automation engineers can save time from building new libraries and maintaining their scripts. Katalon Studio can be integrated into CI/CD processes and works with tools in the QA process including qTest, JIRA, Jenkins, and Git. It offers a feature called Katalon Analytics which provides users comprehensive views of test execution reports via dashboard including metrics, charts, and graphs.

### Watir

It is an open-source testing tool for web automation testing based on Ruby libraries. It supports cross browser testing including Firefox, Opera, headless browser, and internet explorer. It supports data-driven testing and integrates with BBD tools Cucumber, and Test/Unit.

### Robot framework

Robot Framework implements the keyword-driven approach for acceptance testing & acceptance test-driven development (ATDD). Test capability can be extended by implementing additional test libraries using Python and Java. Selenium WebDriver is an external library in Robot Framework. Test engineers can leverage Robot Framework as an automation framework for web testing as well as for Android and iOS test automation. Robot Framework can be easy to learn for engineers who are familiar with keyword-driven testing.

### [JBehave](http://jbehave.org/)

JBehave is an open source BDD (Behavior Driven Development) library that allows users to write their test cases in plain English and have them automatically translated into chunks of Java code to be executed.

JBehave allows someone like a product owner or scrum master to write test cases, hand them off to automation engineers and have those engineers write the automation scripts.

JBehave also creates easily digestible and human readable reports after execution, including information such as what test cases were run, how many test cases passed/failed and provides screenshots for any failed test cases.

Everything in JBehave is customizable and flexible, giving each team the power to define their own test runs and even create custom reports.

### [RestAssured](http://rest-assured.io/)

RestAssured is an open source framework that allows for easy and flexible testing of API based applications.

### [PhantomJS](http://phantomjs.org/)

An extension of Selenium WebDriver that allows users to run tests on their local machine in a headless state, meaning they do not have to have a particular browser installed to run a test against it.

### [Docker](https://www.docker.com/)

Docker is an open source tool that allows users to "containerize" applications and environments.

Using a simple Docker image and 1-2 commands a user can instantly deploy an environment on their local machine with a set of predefined conditions such as installed browsers with specific versions, specific applications installed or preconfigured network settings.

### [TestNG](http://testng.org/doc/)

TestNG is a lightweight testing framework in between JUnit and JBehave/Cucumber.  TestNG is ideal for teams that don't want to deal with the overhead of configuring BDD frameworks or are writing tests (such as API level) that do not lend themselves to BDD concepts such as stories or features.

### Cucumber

Cucumber is another commonly used BDD library.  It is very similar to JBehave but will be more familiar to those coming from a non-Java coding background.

It is designed over the concept of BDD (Behavior-driven development). It performs the automated acceptance testing by running the stories that best describe the behaviour of the application. It gets a single up-to-date living document that is having both specification and test documentation.

Cucumber is scripted in Ruby. It also supports Java and.NET. It also has cross-platform OS support.

### Sikuli

It works on image recognition and has the capability of automating anything that is seen on the screen. Currently, it supports desktop apps which run on windows, Mac or Unix/Linux. This tool is good at reproducing bugs and its users have reported it to be very useful as compared to other tools when are going to automate an application which is not web-based.

### Apache JMeter

It is Java desktop application designed for load testing. It mainly focuses on web applications. This tool can be used for unit testing and limited functional testing.

Its architecture is centered on plugins with the help of which JMeter provides a lot of out of box features. It supports many types of applications, servers and protocols like Web, SOAP, FTP, TCP, LDAP, SOAP, MOM, Mail Protocols, shell scripts, Java objects, and database. It also include Test IDE, dynamic reporting, command line mode, portability, multithreading, caching of test results and highly extensible core. It supports many types of applications, servers and protocols like Web, SOAP, FTP, TCP, LDAP, SOAP, MOM, Mail Protocols, shell scripts, Java objects, and database.

### BlazeMeter

You can easily create load and performance tests. It is compatible with JMeter tool. JMeter tests compatible with BlazeMeter as well. With BlazeMeter, API tests can be setup easily, to do user interactive website testing, perform scalable load testing using virtual user traffic and do a lot more. This tool supports native as well as mobile web apps.

### Appium

This Test automation framework is intended for mobile applications, and automation of native, hybrid and mobile web applications built for iOS and Android. This tooluses vendor-provided automation frameworks and is based on client/server architecture. Appium is easy to install and use.

### Robotium

It is an open-source test automation framework primarily meant for Android UI testing? It supports both native and hybrid applications. Using Robotium, time-saving, readable and easy to use automated gray box UI tests intended for android apps can be written. System testing, functional testing, and user acceptance testing over Android-based apps with the help of Robotium can be performed.

### Katalon Studio

It is a powerful test automation solution for mobile, Web, and API testingit provides a comprehensive set of features for test automation, including recording actions, creating test cases, generating test scripts, running tests, reporting generated results, and integrating with other tools in the software development lifecycle.

Katalon Studio runs on **Windows** and **MacOS**, also supporting automated testing of **iOS** and **Android apps, web applications** on all modern browsers, and API services. This tools can be integrated with tools such as JIRA, qTest, Kobiton, Git, and Slack.

### Watir

It is an abbreviation for Web Application Testing in Ruby. It is a light-weight tool for automating web application testing. It supports web application regardless of considering over which technology, app is designed. With this, simple, flexible, readable and easily maintainable automated tests can be designed. Companies that use Watir includes SAP, Oracle, Facebook, etc.

### WatiN

Name of this tool signifies Web Application Testing in .NET. This test automation framework supports IE & FF browsers, and for UI & functional testing of Web apps.

### SoapUI

This is a functional testing tool which provides complete API Test Automation Framework for SOAP and REST.

## Commercial Tools

### [Perfecto Mobile](https://www.perfectomobile.com/)

Perfecto Mobile is a third party cloud provider that gives “run time dynamic adaptive automation “ users access to hundreds of real mobile devices to test against.

Any Organization has access to the Perfecto public cloud as well as a secure private cloud.  The private cloud can be updated/customized as needed, giving us flexibility to test against specific device/os combinations from physical locations in any country like India, Australia and China.

Additionally, Perfecto supports a private repository where apps can be stored as “.apk” or “.ipa” files and dynamically loaded onto a device at runtime and cleared after execution.

### [BrowserStack](http://www.browserstack.com/)

BrowserStack is a third party cloud provider that gives RTDAA users access to thousands of OS/Browser/Version combinations.

When a user makes a request to BrowserStack they provide an OS (Windows XP - 10, OSX Snow Leopard - El Capitan), browser (Chrome, Firefox, Safari, Opera, Yandex, IE, Edge) and a browser version.

BrowserStack spins up a Virtual Machine (VM) in their private cloud with these specifications and the automation scripts are executed against them as if they were the users local desktop.

This allows Mac users to test on IE, Windows 10 users to test old versions of Chrome, etc.

### [AppliTools Eyes](https://applitools.com/)

AppliTools Eyes is a visual automation tool allowing users to test the look and feel of an application in a way that Selenium by itself is not capable of.  A user takes a screenshot of an application at various points in the test and creates "gold standard" images of what they expect it to look like.

In subsequent runs engineers will put "checkpoints" into their code where they take another screenshot and send it to AppliTools for comparison against the "gold standard" image.  Using the Eyes, AppliTools can tell you whether a logo is out of place or missing, if the layout of a page is messed up or anything in between.  AppliTools Eyes allows for an incredible amount of flexibility in the comparison and allows the user to tweak the algorithm for each image.  Users can choose to ignore certain areas of the image (for example, if Google Ads are present and always changing) and set the comparison type (pixel to pixel, layout, etc.).

### [Page Object Model](https://github.com/SeleniumHQ/selenium/wiki/PageFactory)

The Page Object Model is an industry standard best practice for writing test automation scripts that allows the user to represent a page's functionality in a highly intuitive, readable format.

Page Objects allow engineers to define an application's behaviour in single place and reuse it throughout their tests.  The model allows for easy and efficient updating of automation scripts as the application UI changes.  RTDAA provides utilities that assist in writing these objects and take care of many of their commonly pain points users experience with them.

### UFT

**Unified** Functional Testing (UFT) is a commercial testing tool for functional testing. It provides a feature set for API, web services, and GUI testing of desktop, web, and mobile applications across platforms. This tool has advanced image-based object recognition feature, reusable test components, and automated documentation. UFT uses Visual Basic Scripting for testing processes and object control. UFT can be integrated with Mercury Business Process Testing and Mercury Quality Center. This supports CI with Jenkins. It was previously known as QuickTest Professional (QTP).

It brings developers & engineers coming together under one umbrella and provides high-quality automation testing solutions. It makes functional testing less complex and cost-friendly. Its features include **Cross browser & multi-platform compatibility,**Optimized distributed testing, multiple testing solutions, image-based object recognition and canvas, visual test flows.

### IBM Rational Functional Tester

IBM RFT is a data-driven testing platform. It supports applications such as .Net, Java, SAP, Flex, and Ajax. RFT uses VB, .Net and Java as programming languages. RFT has a feature called as Storyboard testing in which users’ actions on AUT are recorded and visualized in a storyboard format through application screenshots. It can be integrated with IBM Jazz application lifecycle management systems such as IBM Rational Team Concert and Rational Quality Manager.

This tool is intended for**automated functional testing & regression testing.** It allows to perform data-driven and GUI testing. The automated testing is based upon script assure technology which highly improves the efficiency of testing and provides easy script maintenance. This tool does automated performance testing over web and server based apps. It has RCA capabilities to remove performance bottleneck. It provides real-time reporting and test data customizations. It also offers load and scalability testing.

### TestComplete

Environment Supported are web, mobile, and desktop testing. Programming/scripting languages support: JavaScript, VBScript, Python, and C++Script. Testing performed: keyword-driven and data-driven testing with Test Complete offers easy-to-use record and playback feature. Like UTF, TestComplete’s GUI object recognition capability can automatically change with UI objects which helps reduce the effort to maintain test scripts when the AUT is changed. It can be integrates with Jenkins in a CI process. This tool works for desktop, mobile and web applications. With TetComplete, Functional UI tests can be built and run via robust record & replay capabilities or by scripting in your favorite languages, including Python, JavaScript, VBScript With support for applications, such as .Net, and native and hybrid iOS and Android apps, along with regression, parallel, and cross-browser testing capabilities.

### TestPlant

This is an image-based automated functional testing tool, enables engineers to interact with application under test. Here User’s point of view is put rather of the test scripts view often seen by engineers. This allows engineers with less programming skills to learn and apply test automation intuitively. This tool supports platforms like Web, mobile, and POS systems. Lab management and CI integration can be done with this tool.

### Tricentis Tosca

This is a model-based test automation tool which provides a broad feature set for continuous testing including dashboards, analytics, and integrations to support agile and DevOps methodologies. This helps users to optimize the reusability of test assets. It supports a range of technologies and applications such as web, mobile, and API. This has features for integration management, risk analysis, and distributed execution.

### Ranorex

Ranorex is a quite automation tool for web, mobile, and desktop testing. The tool features for GUI recognition, reusable test scripts, and record/playback. Codeless test creation is a feature that allows new automation engineers to learn and apply test automation to their projects. The tool does Selenium integration for web application testing. Engineers can distribute the execution of their tests across platforms and browsers using Selenium grid.

### [Domo](https://www.domo.com/)

Domo is an analytics dashboard allowing teams to aggregate data such as test results, sonar scans, test coverage, etc. into a single, easily readable and digestible dashboard that can give an instantaneous overview of a product's health.

### QMetry Automation Studio

This is a leading software automation tool built on Eclipse IDE and leading open source frameworks, Selenium and Appium. It brings structure, efficiency, and reusability to automation efforts. The studio supports advanced automation strategy with coded automation and enables manual teams to transition into automation seamlessly with script less automation methods. In addition to test authoring, QAS provides a unified solution for an Omni channel, multi-device, and multi-locale scenario by supporting the web, mobile native, mobile web, web services, and micro-services components. This helps the enterprise to scale automation thereby eliminating the need for special purpose tools. This is a part of the Artificial Intelligence enabled QMetry Digital Quality Platform, one of the most comprehensive software quality platforms offering test management, test automation, quality analytics in a single suite.

### Testim.io

This tool leverages machine learning for the authoring, execution, and maintenance of automated test cases. Uses dynamic locators and learn with every execution/repetition of Steps**.** This produces super-fast authoring and stable tests that learn, thus eliminating the need to continually maintain tests with every code change. Companies like Netapp, Verizon Wireless, and Wix.com run over 300,000 tests using Testim.io every month. Testim, a Heavy bit portfolio company, has dual offices in San Francisco and Israel (R&D) and is backed by Spider Capital (Appurify, PagerDuty), Foundation Capital and other U.S. based investors.

### HP Quality Center

HP Quality Center software standardizes testing. It is an integrated IT quality management software application. Automated testing is one of its key features which constantly allows to test earlier and quicker. Sharing with reusability allows HP QC to have bug-free and reliable applications.

### Telerik Test Studio

Is acomprehensive test automation solution**.** It is for GUI, performance, and API testing. It allows to test desktop, mobile and web applications. Its features include Point-and-click test recorder, support for real coding language, central object repository and continuous integration with source control.

### Ranorex

It is flexible, all in one GUI testing tool where you can execute automated tests flawlessly throughout all environments and devices. It has super smart object recognition feature that automatically detects any change in the UI and keeps the test going. Other significant features of Ranorex include reusable code modules, early bug finding, and seamless integration with other tools, simple test recording and easy to use the editor.

### Eggplant

EggPlant is (By TestPlant) primarily aimed for application testing and GUI testing. For engineers, Eggplant offers a variety of test automation tools using which different types of testing can be performed. This has two components, Eggplant functional for functional testing and eggplant performance for performance, load and stress testing.

EggPlant works on image-based approach instead object-based approach. Using a single script, testing on multiple platforms like Windows, Mac, Linux, Solaris, can be performed.

### Silk Test

It is a licensed product of [Micro focus](https://www.microfocus.com/) aims at automated functional and regression testing. It does cross-browser support and unified test automation for a variety of applications including desktop apps, mobile apps, web apps, rich-client applications and enterprise applications. It enables efficient, speedy and high-quality automation testing.

### Sauce Labs

This is a selenium cloud-based concepts that offers automated testing over cross-browsers and multiple platforms. It works with mobile and desktop apps. It is known for significantly accelerating test cycles. Companies includes Yahoo, Zillow, and OpenDNS have certified that they have reduced testing time by a huge extent with the help of SauceLabs.

### Sahi

It is a tester centric web automation tool. This cross-browser/platform tool comes with features, such as smart accessory identification, record and playback on any browser, no ajax timeout issues, end to end reporting, powerful scripting and inbuilt excel framework.

### HP Load Runner

This is again an automated load and performance testing tool provided by [Hewlett Packard](http://www8.hp.com/in/en/home.html). It works in different environments and over different types of applications. It supports mobile and cloud testing as well. HP Load Runner measures system performance, allows to do the RCA and fix the bugs before the application is released to live environment.

### Neoload

**It** is also very popular and automated performance testing tool. It replicates user activities and finds out the system bottlenecks. It supports both mobile and web apps. This supports both mobile and web apps.

### Perfecto

This automated application testing over cross browsers and mobile devices. It can be plugged with other test automation frameworks.

### WebLoad

This is a load, performance, and stress testing tool for mobile and web applications. It integrates with testing tools like Selenium, Perfecto mobile, etc.  It provides dashboards to give clear picture of tests run.

### Test Anywhere

It is a tool for frontend automated testing tool that replicates the real user actions and do not need to write any code.

### Visual Studio Test Professional

This tool provides exploratory browser-based testing**.** This tool for streamlining quality and continuous delivery. It has the free trial available as well.

### TestingWhix

It is a licensed tool which offers automation solutions for regression testing, web testing, mobile testing, cross-browser testing, web services testing and database testing. It has architecture which supports continuous integration very well.

### Tosca Testsuite

It is an automated tool for performing functional testing, regression testing. And business dynamic steering.

# Tools used for Cross Platform Testing

* 1. Browserstack: this is based on cloud and tests websites on multiple browsers and OS combinations. Trial version may be tested and thereafter fee need to be paid as number of users licenses.
  2. Testize: This tool works on standards and analyze websites identifying issues in performance, site rendering and compatibility.
  3. Test Plant: This is cross browser testing automation tool to test Websites in different Operating system environments and configurations.
  4. Browser shots: this is a free Open source tool which creates screenshots of website to run on different browsers. These screenshots are tests n real browser on different operating systems.

# Approach and Steps of Study/Analysing Right Tool

1. Market Research: I have done Search for tool available whether Free Open Source, Community versions or Paid one fit in the requirements. To study open source automated tools and based design algorithm and methodologies and simulation of code base libraries of adaptive nature intelligent enough to understand their execution environment.
2. Experts View: Get feedback from the users and experts or from Forum of experts to get experiences on the features of tools. To take input from the users for their feedback to make the algorithm in a way so that it simulates itself as per the nature of protocol and requirements
3. Personal Experience: As per my personal work experience working with tools I have done research shortlisted best tools that best suits requirements and affordability of adaptive tools.
4. I Prepared comparison chart and done SWOT Analysis to select the best tool works on the principle of Run Time Dynamic Adaptive Automation. Studied the level of satisfaction/experience of users before using automated (adaptive design and test pattern algorithm) Build and Test of software applications. Then Study the level of satisfaction of users after using automated (adaptive) software applications.
5. As per the comparison and study of tools and methodologies find problems in application of Adaptive Software in Technical Organizations and designed an engineering algorithm in terms of model and methods for assembling software systems that can dynamically adapt to context and can ‘account for them-selves’ specific to run time dynamic environment.
6. Then done minimizing tools for the requirements fits exactly we have to get through above mentioned guidelines.

# Study on Cloud Computing Terms (Types and Definition, services)

There are few concepts those need to be addressed if cloud computing been used for Dynamic Run Time Adaptive Automation and Data Access/Storage.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  | | --- | |  | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | **Definition of "cloud computing"** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | As per definition provided by NIST (National Institute of Standards and Technology) which is summarized as follows: Cloud computing model is for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be provisioned/released with minimal effort or service provider interaction.  The full definition and explanation can be found in [this](http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf) public NIST document. Additionally, NIST has published a final version of cloud computing technology roadmap. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | **Different types of clouds and distinction between them.‎** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | | | | | | | | | | | | | | | | | | |  | | | | | | | | | | | | | | | | | | | | | | |  | | | | | | | | | | | | | | | | | | | | | | | There are four kinds of cloud deployment models: private clouds, community clouds, public clouds, and hybrid clouds.  A private cloud infrastructure is provisioned for exclusive use of organizations. It’s owned, managed, and operated by organizations, by third parties, or combination of them. It may exist on or off organizations premises.  A community cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It can be owned, managed, and controlled by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises. A public cloud infrastructure is open to use by the public. A public cloud may be owned, managed, and operated by a business, academic organization, or government organization (or some combination of the three). The infrastructure for this type of cloud exists on the premises of the cloud provider.  A hybrid cloud is a combination of two or more separate cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology which enables data and application portability (e.g., cloud bursting for load balancing between clouds). | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | **Definition of “SaaS” or “PaaS”. And a "Service" with respect to cloud.** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  |  |  |  |  | |  | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | ​A service is something that provides “value” to the organization’s lines of business. There are mainly three basic service models: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). Another service model (that is not officially defined by the National Institute of Standard and Technology) is Database as a Service (DaaS). | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | **Different types of service models**. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  |  |  |  |  |  |  | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | Software as a Service, or SaaS, is the delivery of applications that are developed and hosted by the SaaS vendor. The end user accesses the applications over the Internet.  Unlike traditional packaged applications the SaaS vendor owns the software and runs it on computers in its data centre. The customer does not own the software but can rents it, usually for a scheduled time fee.   Platform as a Service, or PaaS, is a model in which the user creates an application or service using tools and/or libraries from a provider. The provider provides the networks, servers, storage, operating systems, and other services that are required to host the consumer’s application or service.  Although less established and not as widely available as compared to SaaS and IaaS offerings, ready-to-use application platforms offer great promise for organizations that aren’t compelled to own and manage the underlying infrastructure. A well-known platform that uses the PaaS model is Google App Engine.   Infrastructure as a Service, or IaaS, is the virtualized processing, storage, and networking services along with automation and management capabilities in this area offer the most flexible level of services in the cloud computing model.  A well-known platform that uses the IaaS model is Amazon Elastic Compute Cloud.  Database as a Service, or DaaS, is a cousin of SaaS. It is a physical data management strategy for managing an on-site private cloud made up of several different database architectures.  These architectures can provide varying degrees of database service to an application based on business requirement’s related to availability, scalability and performance.  The main objective of the DaaS strategy is to provide a high-quality database service while maximizing ROI on database software/hardware and supporting agile development efforts through faster service delivery. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# Patterns/Algorithms for Adaptive System Design, Development and Test

As per the data collected from questionnaires with regards to adaptive algorithms, A study is done and resulted with a simulated adaptive algorithm based on Search Algorithms, Informed Heuristic Search strategies and Fuzzy Logic. These approaches mentioned in algorithms can be used to develop adaptive software and tools for analysing and doing run time decision based on adaptive simulation and learning from environment and feedback mechanism.

**Informed (Heuristic) Search Strategies**

To solve big problems with number of possible states, problem-specific knowledge function must be added to increase the performance of search strategy algorithms.

**Heuristic Evaluation Functions**

Calculates the total cost of optimal path between two states of nodes/set. For example, A heuristic function for sliding-tiles games is processed by calculating number of moves that every tile makes from its goal state and then summing up all.

**Pure Heuristic Search**

It counts heuristic values for every node then expands them in the order. In this process two lists are created, a closed list for the expanded nodes and an open list for the defined but unexpanded nodes.

Then In each iteration, a node having minimum heuristic value is expanded, and all its child nodes are created/placed in the closed list. Then, the heuristic function is applied to the child nodes to place them in the open list according to their heuristic value. And in the End the shorter paths are saved, and the longer ones are disposed.

**A \* (Best First) Search**

It is form of Best First search because it avoids expanding paths that are already expensive but expands most promising/optimized paths first.

The function for A\* Search is defined as follows

f(n) = g(n) + h(n), where

* g(n) the cost (so far) to traverse the node
* h(n) expected cost to get from the node to the result
* f(n) estimated total cost of path through n to result. priority queue is used to implement same by increasing f(n).

**Greedy Best First Search**

It expands/executes the nodes that is estimated to be closest to goal. It expands nodes based on f(n) = h(n). It is implemented using priority queue and only estimated cost to get from the node to the goal is calculated.

**Disadvantage** − It can get stuck in loops. It is not optimal.

**Fuzzy Logic**

Fuzzy Logic Systems (FLS) gives acceptable but definite output even if incomplete, ambiguous, distorted, or inaccurate (fuzzy) input is given.

**What is Fuzzy Logic?**

Fuzzy Logic (FL) is a way of reasoning that resembles human understanding. The approach of FL concludes the way of decision making in humans that involves all interim possibilities between digital values YES and NO.

The conventional logic block takes precise input and produces a definite output as TRUE or FALSE, which is equivalent to human’s YES or NO.

The inventor of fuzzy logic, Lotfi Zadeh, observed that, the human decision making is different from computers which includes a range of possibilities between YES and NO, such as −

|  |
| --- |
| CERTAINLY YES |
| POSSIBLY YES |
| CANNOT SAY |
| POSSIBLY NO |
| CERTAINLY NO |

Hence the fuzzy logic works on the different levels of possibilities of input data to get the definite output.

**Implementation**

* It’s suitable for systems with various sizes and capabilities from small microprocessors to large, networked, workstation-based control systems also include networked storage cloud.
* It can be implemented in hardware, software, or in embedded systems.

**Need of Fuzzy Logic?**

It is useful for many commercial and practical purposes.

* It can control machines and consumer products.
* It may not produce accurate reasoning, but acceptable reasoning to get the work done.
* Fuzzy logic helps to deal with the uncertainty in engineering design and execution by working on the set of acceptable defined data.

**Fuzzy Logic Systems Architecture**

It has four main parts as shown −

* **Fuzzification Module** − It converts the inputs, which are defined numbers, into fuzzy sets and splits the input signal x into five steps may be defined as

|  |  |
| --- | --- |
| **LP** | x is Large Positive construct |
| **MP** | x is Medium Positive construct |
| **S** | x is Small construct |
| **MN** | x is Medium Negative construct |
| **LN** | x is Large Negative construct |

* **Knowledge Base** − It creates IF-THEN rules provided by system designers.
* **Inference Engine** − It defines and simulates the human understanding process by making fuzzy inference on the inputs and IF-THEN rules, combining.
* **Defuzzification Module** – It processes the fuzzy set obtained by the inference engine and transformed into an exact value.

The **membership functions work on** fuzzy sets of variables and Input.

**Membership Function**

Membership functions quantify linguistic term and presents a fuzzy set diagrammatically. A **membership function** for a fuzzy *set A* on the universe of X is defined as μA:X → [0,1].

Each element of fuzzy set is mapped to a data between 0 and 1. This is called **degree of membership**. Membership Function quantifies the degree of membership of the element in *X* to the fuzzy set *A*.

* x axis represents the universe of discourse.
* y axis shows the degrees of membership in the interval.

multiple membership functions can be defined applicable to fuzzify a numerical value. Hence simple membership functions are used because use of complex functions does not add more precision in the output.

All membership functions are shown as below in graph diagram.



The triangular membership function shapes are more frequent among various other membership function shapes.

**Algorithm**

* Define linguistic variables and terms.
* Construct membership functions for them.
* Construct knowledge base of rules.
* Convert scattered data into fuzzy data sets with functions. (fuzzification)
* Evaluate rules in the rule base. (Inference Engine)
* Combine results from each rule. (Inference Engine)
* Convert output data into non-fuzzy values. (defuzzification)

**Logic Development**

**Step 1: Define linguistic variables and terms**

Linguistic variables are input/output variables may be in the form of known words or sentences to form simple constructs. For example, room temperature, may be categorized as, cold, warm, hot, etc.

Temperature (t) = {very-cold, cold, warm, very-warm, hot}

Every component of this defined set is a linguistic term which can cover some part of overall temperature values.

**Step 2: Construct membership functions for them**

The membership functions of temperature are represented as below.



**Step3: Construct knowledge base rules**

To construct knowledge-based rules a matrix of room temperature values versus target temperature values is created that an air conditioning system is expected to have.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **RoomTemp. /Target** | **Very\_Cold** | **Cold** | **Warm** | **Hot** | **Very\_Hot** |
| Very\_Cold | No\_Change | Heat | Heat | Heat | Heat |
| Cold | Cool | No\_Change | Heat | Heat | Heat |
| Warm | Cool | Cool | No\_Change | Heat | Heat |
| Hot | Cool | Cool | Cool | No\_Change | Heat |
| Very\_Hot | Cool | Cool | Cool | Cool | No\_Change |

Build a set of procedure or regulations into the knowledge defined construct in the form of conditional IF-THEN-ELSE structures.

|  |  |  |
| --- | --- | --- |
| **Sr. No.** | **Condition** | **Action** |
| 1 | IF temp= (Cold OR Too\_Cold) AND target=Warm THEN | Heat |
| 2 | IF temp= (Hot OR Too\_Hot) AND target=Warm THEN | Cool |
| 3 | IF (temp=Warm) AND (target=Warm) THEN | No\_Change |

**Step 4: Obtain fuzzy value**

Fuzzy set operations perform evaluation of rules. The operations used for OR/AND are Maximum and Minimum. Combining all results of outcome to get a result. This result is a fuzzy value.

**Step 5: Perform defuzzification**

Then Defuzzification is performed according to membership function with output variable.



**Advantages of FLSs**

* Within fuzzy reasoning Mathematical concepts are simple to understand.
* FLS can be modified by altering rules due to flexibility of fuzzy logic.
* Fuzzy logic Systems can also consider imprecise, distorted, noisy input information.
* FLSs are easy to construct and understand.
* Fuzzy logic is a solution to complex problems in all fields of life, specifically run time dynamic systems as it works on the concepts of human reasoning and decision making.

**Disadvantages of FLSs**

* Lacking systematic approach to fuzzy system designing.
* are understandable only when defined in easy terminologies.
* Suitable for the systems which do not need high accuracy as output.

# 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.

Stop 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 optimised 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 defuzzification)

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.

# References

http://www.seleniumhq.org/

<https://www.katalon.com/>

<http://www.robotframework.org/>

<http://watir.com/>

<https://software.microfocus.com/fr-ca/software/uft>

[https://www.ibm.com/](https://www.ibm.com/us-en/marketplace/rational-functional-tester)

[https://smartbear.com/](https://smartbear.com/product/testcomplete/overview-b/)

<https://www.testplant.com/>

https://www.tricentis.com/

<https://www.ranorex.com/>

https://en.wikipedia.org/wiki/Software\_testing

https://en.wikipedia.org/wiki/Debugging

[Mastering Mobile Test Automation,](https://www.amazon.in/Mastering-Mobile-Automation-Feroz-Pearl/dp/1782175423/ref=sr_1_3?s=books&ie=UTF8&qid=1539171133&sr=1-3&keywords=automation+testing+tools" \o "Mastering Mobile Test Automation)11 May 2015

By Feroz Pearl Louis and [Gaurav Gupta](https://www.amazon.in/Gaurav-Gupta/e/B00J65JPNI/ref=sr_ntt_srch_lnk_3?qid=1539171133&sr=1-3)

[Software Automation Testing Tools for Beginners,](https://www.amazon.in/Software-Automation-Testing-Tools-Beginners/dp/1619030454/ref=sr_1_2?s=books&ie=UTF8&qid=1539171133&sr=1-2&keywords=automation+testing+tools" \o "Software Automation Testing Tools for Beginners) 26 April 2012

By Rahul Shende

[Test Automation Using HP Unified Functional Testing: Explore Latest Version of QTP,](https://www.amazon.in/Automation-Using-Unified-Functional-Testing/dp/0992293502/ref=sr_1_21?s=books&ie=UTF8&qid=1539172399&sr=1-21&keywords=automation+testing+tools" \o "Test Automation Using HP Unified Functional Testing: Explore Latest Version of Qtp) 1 August 2013

By MR Navneesh Garg

[Test Complete Cookbook,](https://www.amazon.in/TestComplete-Cookbook-Gennadiy-Alpaev-ebook/dp/B00HD0ZMH6/ref=sr_1_29?s=books&ie=UTF8&qid=1539172399&sr=1-29&keywords=automation+testing+tools" \o "TestComplete Cookbook)16 December 2013

By Gennadiy Alpaev

[Foundations of Software Testing ISTQB Certification,](https://www.amazon.in/Foundations-Software-Testing-ISTQB-Certification/dp/8131526364/ref=sr_1_1?s=books&ie=UTF8&qid=1539173989&sr=1-1&keywords=Testing" \o "Foundations of Software Testing ISTQB Certification) February 2015

By [Rex Black](https://www.amazon.in/Rex-Black/e/B001I9QBYQ/ref=sr_ntt_srch_lnk_1?qid=1539173989&sr=1-1) and Erik van Veenendaal

[Stop Coding, Learn to test automate without coding and get that automation testing job,](https://www.amazon.in/Stop-Coding-automate-without-automation-ebook/dp/B07B74V474/ref=sr_1_3?ie=UTF8&qid=1539174045&sr=8-3&keywords=automation+software+testing" \o "Stop Coding: Learn to test automate without coding and get that automation testing job)

By Ajamo Adams