**SoftwareiTesting**

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1. **ABSTRACTi**

iSoftwareitestingiisitheiprocessiofirunningianiapplicationiwithitheiintentiofifindingisoftwareibugsi(errorsioriotheridefects).iSoftwareidemandihasipusheditheiqualityiassuranceiofidevelopedisoftwareitowardsinewiheights.iItihasibeeniconsiderediasitheimosticriticalistageiofitheisoftwareidevelopmentilifeicycle.iTestingicanianalyzeitheisoftwareiitemitoiidentifyitheidisparityibetweeniactualiandiprescribediconditionsianditoiassessitheicharacteristicsiofitheisoftware.iSoftwareitestingileadsitoiminimizingierrorsiandicutidownisoftwareicosts.iForithisipurpose,iweidiscussivariousisoftwareitestingitechniquesiandistrategies.iThisipaperiaimsitoistudyidiverseiasiwelliasiimprovedisoftwareitestingitechniquesiforibetteriqualityiassuranceipurposes.

1. **INTRODUCTION**

Softwareitestingiisimoreithanijustierroridetection;itestingisoftwareiisioperatingitheisoftwareiundericontrollediconditions,ito

* 1. verifyithatiitibehavesiasispecified;
  2. toidetectierrors,iand
  3. toivalidateithatiwhatihasibeenispecifiediisiwhatitheiuseriactuallyiwanted.
  4. Verificationiisitheicheckingioritestingiofiitems,iincludingisoftware,iforiconformanceiandiconsistencyibyievaluatingitheiresultsiagainstipre-ispecifiedirequirements.i[Verification:iAreiweibuildingitheisystemiright?]
  5. ErroriDetection:iTestingishouldiintentionallyiattemptitoimakeithingsigoiwrongitoidetermineiifithingsihappeniwhenitheyishouldn’tiorithingsidon’tihappeniwhenitheyishould.
  6. Validationilooksiatitheisystemicorrectnessii.e.iisitheiprocessioficheckingithatiwhatihasibeenispecifiediisiwhatitheiuseriactuallyiwanted.

TheidefinitioniofitestingiaccordingitoitheiANSI/IEEEi1059istandardiisithatitestingiisitheiprocessiofianalyzingiaisoftwareiitemitoidetectitheidifferencesibetweeniexistingiandirequirediconditionsi(thatiisidefects/errors/bugs)ianditoievaluateitheifeaturesiofitheisoftwareiitem.iTheipurposeiofitestingiisiverification,ivalidationiandierroridetectioniiniorderitoifindiproblemsianditheipurposeiofifindingithoseiproblemsiisitoigetithemifixed.

MostiCommoniSoftwareiproblems:iInadequateisoftwareiperformance,iDataisearchesithatiyieldsiincorrectiresults.iIncorrectidataieditsi&iineffectiveidataiedits,iIncorrecticodingi/iimplementationiofibusinessirules,iIncorrecticalculation,iIncorrectidataieditsiandiineffectiveidataiedits,iIncorrectiprocessingiofidatairelationship,iIncorrectioriinadequateiinterfacesiwithiotherisystems,iInadequate

performanceiandisecurityicontrols,iIncorrectifileihandling,iInadequateisupportiofibusinessineeds,iUnreliableiresultsioriperformance,iConfusingiorimisleadingidata,iSoftwareiusabilityibyiendiusersi&iObsoleteiSoftware,iInconsistentiprocessing.

**Terminology:**

* + - MistakeiAihumaniactionithatiproducesianiincorrectiresult.
    - Faulti[oriDefect]iAniincorrectistep,iprocess,ioridataidefinitioniiniaiprogram.
    - FailureiTheiinabilityiofiaisystemioricomponentitoiperformiitsiRequiredifunctioniwithinitheispecifiediperformanceirequirement.
    - ErroriTheidifferenceibetweeniaicomputed,iobserved,ioriMeasuredivalueioriconditionianditheitrue,ispecified,ioritheoreticallyicorrectivalueioricondition.
    - SpecificationiAidocumentithatispecifiesiiniaicomplete,iprecise,iVerifiableimanner,itheirequirements,idesign,

**DefinitioniAndiTheiGoaliOfiTestingiProcessioficreatingiaiprogramiconsistsiofitheifollowingiphases**:

* + - 1. definingiaiproblem;
      2. designingiaiprogram;
      3. buildingiaiprogram;
      4. analyzingiperformancesiofiaiprogram,iandi5ifinaliarrangingiofiaiproduct.

Accordingitoithisiclassification,isoftwareitestingiisiaicomponentiofitheithirdiphase,iandimeansicheckingiifiaiprogramiforispecifiediinputsigivesicorrectlyiandiexpectediresults.

Softwareitestingiisianiimportanticomponentiofisoftwareiqualityiassurance,iandimanyisoftwareiorganizationsiareispendingiupitoi40%iofitheiriresourcesionitesting.iForilife-criticalisoftwarei(e.g.,iflighticontrol)itestingicanibeihighlyiexpensive.iBecauseiofithat,imanyistudiesiaboutiriskianalysisihaveibeenimade.iThisitermimeansitheiprobabilityithat

aisoftwareiprojectiwilliexperienceiundesirableievents,isuchiasischeduleidelays,icostioverruns,iorioutrighticancellationiandimoreiaboutithisiin.iThereiareiaimanyidefinitionsiofisoftwareitesting,ibutioneicanishortlyidefineithatias:

Aiprocessiofiexecutingiaiprogramiwithitheigoaliofifindingierrors.iSo,itestingimeansithationeiinspectsibehavioriofiaiprogramioniaifiniteisetiofitesticasesi(aisetiofiinputs,iexecutionipreconditions,iandiexpectedioutcomesidevelopediforiaiparticulariobjective,isuchiasitoiexerciseiaiparticulariprogramipathioritoiverifyicomplianceiwithiaispecificirequirement,iforiwhichivaluediinputsialwaysiexist.

Testingiisianiactivityiperformediforievaluatingisoftwareiqualityiandiforiimprovingiit.iHence,itheigoaliofitestingiisisystematicalidetectioniofidifferenticlassesiofierrorsierroricanibeidefinediasiaihumaniactionithatiproducesianiincorrectiresult,iiniaiminimumiamountiofitimeiandiwithiaiminimumiamountiofieffort.

Figurei1:iTestiInformationiFlow

* + - Gooditesticasesi–ihaveiaigoodichanceiofifindingianiyetiundiscoveredierror;iand
    - Successfulitesticasesi–iuncoversiainewierror.

Aigooditesticaseiisioneiwhich:

* + - Hasiaihighiprobabilityiofifindingianierror;iIsinotiredundant;
    - Shouldibeibestiofibreed;
    - Shouldinotibeitooisimpleioritooicomplex.

1. **iLITERATUREiREVIEW**

iInithisisection,iweiwillioutlineitheipreviousiworksiofiSoftwareiTesting.iAccordingitoi"TheiTheoryiofiSoftwareiTesting",itestingiisitheimeansiofishowingitheipresenceiofierrorsiinitheiprogramiwhichicanieitheribeiperformedimanuallyioriautomatically.iItialsoiincludesitheibasiciterminologyiofitestingisuchiasiautomateditesting,ifailure,itestingiteam,iandiwrongitesticaseiselection.iThisipaperifocusesionitheiprocessithatishouldibeifolloweditoitestitheiperformanceiofinewisoftwareianditheientireisystem.iTheiconclusioniofitheiarticleiisitheicompleteiviewiofisoftwareitesting,ipreliminaryitesting,iandiuseriacceptanceitesting.

1. **TESTINGiMETHODS**

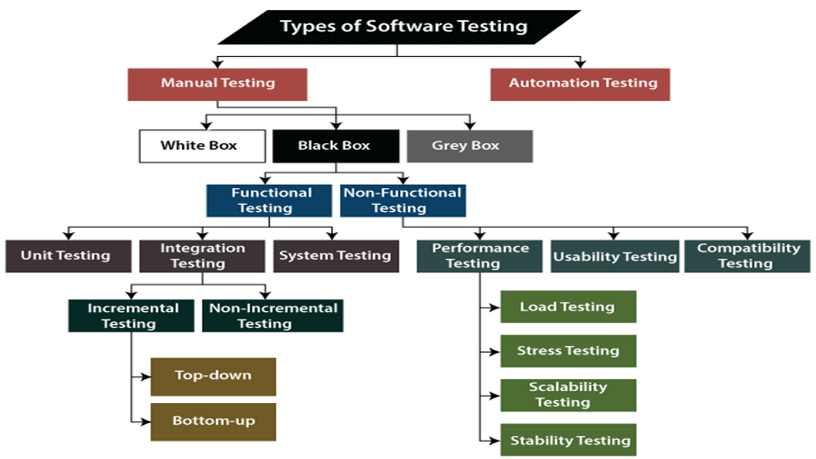
Testicasesiareidevelopediusingivariousitestitechniquesitoiachieveimoreieffectiveitesting.iByithis,isoftwareicompletenessiisiprovidediandiconditionsiofitestingiwhichigetitheigreatestiprobabilityiofifindingierrorsiareichosen.iSo,itestersidoinotiguessiwhichitesticasesitoichose,ianditestitechniquesienableithemitoidesignitestingiconditionsiiniaisystematiciway.iAlso,iifioneicombinesiallisortsiofiexistingitestitechniques,ioneiwilliobtainibetteriresultsiratheriifioneiusesijustioneitestitechnique.

Softwareicanibeitestediinitwoiways,iinianotheriwords,ioneicanidistinguishitwoidifferentimethods:

1. Blackiboxitesting,iand
2. Whiteiboxitesting.

Whiteiboxitestingiisihighlyieffectiveiinidetectingiandiresolvingiproblems,ibecauseibugsicanioftenibeifoundibeforeitheyicauseitrouble.iWeicanishortlyidefineithisimethodiasitestingisoftwareiwithitheiknowledgeiofitheiinternalistructureiandicodingiinsideitheiprogram.iWhiteiboxitestingiisialsoicallediwhiteiboxianalysis,icleariboxitestingioricleariboxianalysis.iItiisiaistrategyiforisoftwareidebuggingi(itiisitheiprocessiofilocatingiandifixingibugsiinicomputeriprogramicodeioritheiengineeringiofiaihardwareidevice,iiniwhichitheitesterihasiexcellentiknowledgeiofihowitheiprogramicomponentsiinteract.iThisimethodicanibeiusediforiWebiservicesiapplications,iandiisirarelyipracticaliforidebuggingiinilargeisystemsiandinetworks.iBesides,iiniwhiteiboxitestingiisiconsiderediasiaisecurityitestingi(theiprocessitoidetermineithatianiinformationisystemiprotectsidataiandimaintainsifunctionalityiasiintended,imethodithaticanibeiuseditoivalidateiwhethericodeiimplementationifollowsiintendedidesign,itoivalidateiimplementedisecurityifunctionality,ianditoiuncoveriexploitableivulnerabilities.

Blackiboxitestingiisitestingisoftwareibasedionioutputirequirementsiandiwithoutianyiknowledgeiofitheiinternalistructureioricodingiinitheiprogram.iInianotheriwords,iaiblackiboxiisianyideviceiwhoseiworkingsiareinotiunderstoodibyioriaccessibleitoiitsiuser.iForiexample,iinitelecommunications,iitiisiairesistoriconnecteditoiaiphoneilineithatimakesiitiimpossibleiforitheitelephoneicompany’siequipmentitoidetectiwheniaicallihasibeenianswerediaiparticularifunction,ibutiinitheifinancialiworld,iitiisiaicomputerizeditradingisystemithatidoesn’timakeiitsirulesieasilyiavailable.iInirecentiyears,itheithirditestingimethodihasibeenialsoiconsideredigrayiboxitesting.iItiisidefinediasitestingisoftwareiwhileialreadyihavingisomeiknowledgeiofiitsiunderlyingicodeiorilogic.Itiisibasedionitheiinternalidataistructuresiandialgorithmsiforidesigningitheitesticasesimoreithaniblackiboxitestingibutilessithaniwhiteiboxitesting.iThisimethodiisiimportantiwheniconductingiintegrationitestingibetweenitwoimodulesioficodeiwrittenibyitwoidifferentidevelopers,iwhereionlyiinterfacesiareiexposediforitest.iAlso,ithisimethodicaniincludeireverseiengineeringitoidetermineiboundaryivalues.iGrayiboxitestingiisinon-intrusiveiandiunbiasedibecauseiitidoesn’tirequireithatitheitesterihaveiaccessitoitheisourceicode.iTheimainicharacteristicsiandicomparisonibetweeniwhiteiboxitestingiandiblackiboxitestingiareifollows.



* 1. BlackiBoxiTestingiVersusiWhiteiBoxiTestingiBlackiBoxiTesting:

Performingitheitestsiwhichiexerciseiallifunctionalirequirementsiofiaiprogram;

Findingitheifollowingierrors:

* + - Incorrectiorimissingifunctions;
    - Interfaceierrors;
    - Errorsiinidataistructuresioriexternalidatabaseiaccess;
    - Performanceierrors;
    - Initializationianditerminationierrors.

Advantagesiofithisimethod:

* + - Theinumberiofitesticasesiareireduceditoiachieveireasonableitesting;
    - Theitesticasesicanishowipresenceioriabsenceioficlassesiofierrors.

WhiteiBoxiTesting:

Consideringitheiinternalilogicaliarrangementiofisoftware;

* + - Theitesticasesiexerciseicertainisetsioficonditionsiandiloops;
    - Advantagesiofithisimethod:
    - Alliindependentipathsiiniaimoduleiwillibeiexercisediatileastionce;
    - Allilogicalidecisionsiwillibeiexercised;
    - Alliloopsiatitheiriboundariesiwillibeiexecuted;
    - Internalidataistructuresiwillibeiexerciseditoimaintainitheirivalidity.

1. **SOFTWAREiTESTINGiSTRATEGIESi**

SoftwareiTestingistrategiesiprovideiaimethodiofiintegratingisoftwareitesticaseidesignimethodsiintoiaiwell-plannediSeriesiofistepsithaticaniresultiinitheisuccessfuliconstructioniofisoftware.iItiprovidesitheiroadimapiforitesting.iTheisoftwareitestingiStrategyishouldibeipliableienoughitoidevelopiaicustomizeditestingiapproach.iTheisoftwareitestingistrategyiisiactuallyiproducedibyiprojectimanagers,isoftwareiengineers,ianditestingispecialists.iThereiareifouridifferentitypesiofisoftwareitestingistrategies:i1)iUnititestingi2)iIntegrationitestingi3)iAcceptance/Validationitestingi4)iSystemitestingi1.iUnititestingiUnitiisitheismallestitestableipart,ii.e.itheimostimodesticollectioniofilinesioficodeiwhichicanibeitested.iUnititestingiisidoneibyitheideveloperiasitheiproperiknowledgeiaboutitheicoreiprogrammingidesigningiisirequired.iGenerally,iunititestingiisiconsiderediasiaiwhite-boxitestingiclassibecauseiitiisipartisanitoievaluateitheicodeiasiimplementediratherithaniassessingiconformanceitoisomeisetiofirequirements.iBenefitsiofiUnitiTesting:i1)iCost-effectiveitestingitechnique.i2)iSimpleitestingitechniqueibecauseitheismallestitestableiunitiofitheicodeiisitestedihere.i3)iIndividualipartsiareitestediwheninecessary,iwithoutiwaitingiforianotheripartiofitheisystem.i4)iUnititestingicanibeiperformediiniparallelibyifixingiproblemsisimultaneouslyibyimanyiengineers.i5)iDetectioniandiremovaliofidefectsiareimuchicosteffectiveicompareditoiotherilevelsiofitesting.i6)iBeiableitoitakeiadvantageiofiseveraliformalitestingiapproachesiavailableiforiunititesting.i7)iClarifyidebuggingibyilimitingitoiaismalliunititheipossibleicodeiareasiiniwhichitoisearchiforibugs.i8)iBeiableitoitestiinternalilogicithatiisinotieasilyireachedibyiexternaliinputsiinitheibroaderiintegratedisystems.i9)iAttainiaihighileveliofistructuralicoverageiofitheicode.i10)iWhenidebuggingisevereiproblems,iitiavoidsilengthyicompile-build-debugicycles.iUnititestingitechniques:iUnititestingiusesiseveralieffectiveitestingitechniques.iTheitestingitechniquesicategorizeiintoithreeitypes:ii.iFunctionaliTestingiii.iStructuraliTestingiiii.iHeuristicioriIntuitiveiTesting

1. **GENERALiCLASSIFICATIONiOFiTESTiTECHNIQUES**

Inithisipaper,itheimostiimportantitestitechniquesiareishortlyidescribed,iasiitiisishowniTechniques

* + - EquivalenceiPartitioningiSummary:iequivalenceiclass

Thisitechniqueidividesitheiinputidomainiofianiprogramiontoiequivalenceiclasses.

Equivalenceiclassesisetiofivalidioriinvalidistatesiforiinputiconditions,iandicanibeidefinediinitheifollowingiway:

* + - 1. Aniinputiconditionispecifiesiairangeioneivalidianditwoiinvalidiequivalenceiclassesiareidefined;
      2. Aniinputiconditionineedsiaispecificivalueioneivalidianditwoiinvalidiequivalenceiclassesiareidefined;
      3. Aniinputiconditionispecifiesiaimemberiofiaisetioneivalidiandioneiinvalidiequivalenceiclassiareidefined
      4. AniinputiconditioniisiBooleanioneivalidiandioneiinvalidiequivalenceiclassiareidefined.

Well,iusingithisitechnique,ioneicanigetitesticasesiwhichiidentifyitheiclassesiofierrors.

* + - BoundaryiValueiAnalysis

Summary:icomplementiequivalenceiPartitioningithisitechniqueiisilikeitheitechniqueiEquivalenceiPartitioning,iexceptithatiforicreatingitheitesticasesibesideiinputidomainiuseioutputidomain.

Oneicaniformitheitesticasesiinitheifollowingiway:

* 1. Aniinputiconditionispecifiesiairangeiboundedibyivaluesiaiandibtiesticasesishouldibeimadeiwithivaluesijustiaboveiandijustibelowiaiandib,irespectively;
  2. Aniinputiconditionispecifiesivariousivaluesitesticasesishouldibeiproduceditoiexerciseitheiminimumiandimaximuminumbers;
  3. Rulesi1iandi2iapplyitoioutputiconditions;

Ifiinternaliprogramidataistructuresihaveiprescribediboundaries,iproduceitesticasesitoiexerciseithatidataistructureiatiitsiboundary.

ComparisoniTestingiSummary:iindependentiversionsiofianiapplicationiInisituationsiwhenireliabilityiofisoftwareiisicritical,iredundantisoftwareiisiproduced.iInithaticaseioneiusesithisitechnique.

FuzziTestingiSummary:irandomiinput

Fuzzitestingiisioftenicalledifuzzing,irobustnessitestingiorinegativeitesting.iItiisidevelopedibyiBartoniMilleriatitheiUniversityiofiWisconsiniini1989.iThisitechniqueifeedsirandomiinputitoiapplication.iTheimainicharacteristiciofifuzzitestingiare:

* + 1. theiinputiisirandom;
    2. theireliabilityicriteria:iifitheiapplicationicrashesiorihangs,itheitestiisifailed;
    3. fuzzitestingicanibeiautomateditoiaihighidegree.

Aitoolicalledifuzzitesteriwhichiindicatesicausesiofifoundedivulnerability,iworksibestiforiproblemsithat

canicauseiaiprogramitoicrashisuchiasibufferioverflow,icross-siteiscripting,idenialiofiserviceiattacks,iformatibugiandiSQLiinjection.iFuzzingiisilessieffectiveiforispyware,isomeiviruses,iworms,iTrojans,iandikeyloggers.iHowever,ifuzzersiareimostieffectiveiwheniareiuseditogetheriwithiextensiveiblackiboxitestingitechniques.

Model-baseditesting

Model-baseditestingiisiautomaticigenerationiofiefficientitestiprocedures/vectorsiusingimodelsiofisystemirequirementsiandispecifiedifunctionality.

Inithisimethod,itesticasesiareiderivediiniwholeioriinipartifromiaimodelithatidescribesisomeiaspectsiofitheisystemiunderitest.iTheseitesticasesiareiknowniasitheiabstractitestisuite,iandiforitheiriselectionidifferentitechniquesihaveibeeniused:

* + 1. generationibyitheoremiproving;
    2. generationibyiconstraintilogiciprogramming;
    3. generationibyimodelichecking;
    4. generationibyisymboliciexecution;
    5. generationibyiusingianievent-flowimodel;

BasisiPathiTestingiSummary:ibasisiset,iindependentipath,iflowigraph,icyclomaticicomplexity,igraphimatrix,ilinkiweight

Ifioneiusesithisitechnique,ioneicanievaluateilogicalicomplexityiofiproceduralidesign.iAfterithat,ioneicaniemployithisimeasureiforidescriptionibasicisetiofiexecutionipaths.

Basedionitheisoftwareiengineersiintuitioniandiexperience:

* 1. AdihocitestingiTesticasesiareidevelopedibasingionitheisoftwareiengineersiskills,iintuition,iandiexperienceiwithisimilariprograms;
  2. ExploratoryitestingiThisitestingiisidefinedilikeisimultaneousilearning,iwhichimeansithatitestiareidynamicallyidesigned,iexecuted,iandimodified.

Specification-baseditechniques:

* 1. Equivalenceipartitioning;
  2. Boundary-valueianalysis;
  3. DecisionitableiDecisionitablesirepresentilogicalirelationshipsibetweeniinputsiandioutputsi(conditionsiandiactions),isoitesticasesirepresentieveryipossibleicombinationiofiinputsiandioutputs;
  4. Finite-stateimachine-basediTesticasesiareidevelopeditoicoveristatesianditransitionsioniit;
  5. Testingifromiformalispecifications

Theiformalispecificationsi(theispecificationsiiniaiformalilanguage)iprovideiautomaticiderivationiofifunctionalitesticasesiandiaireferenceioutputiforicheckingitestiresults;

* 1. RandomitestingiRandomipointsiareipickediwithinitheiinputidomainiwhichimustibeiknown,isoitesticasesiareibasedionirandom.

1. **CONCLUSION**

Softwareitestingiisiaicomponentiofisoftwareiqualityicontroli(SQC).iSQCimeansicontrolitheiqualityiofisoftwareiengineeringiproducts,iwhichiisiconductingiusingitestsiofitheisoftwareisystem.

Theseitestsicanibe:iunititestsi(thisitestingichecksieachicodedimoduleiforitheipresenceiofibugs),iintegrationitestsi(interconnectsisetsiofipreviouslyitestedimodulesitoiensureithatitheisetsibehaveiasiwelliasitheyididiasiindependentlyitestedimodules),iorisystemitestsi(checksithatitheientireisoftwareisystemiembeddediiniitsiactualihardwareienvironmentibehavesiaccordingitoitheirequirements

* + Testingicanishowitheipresenceiofifaultsiiniaisystem;iiticannotiproveithereiareinoiremainingifaults.
  + Componentidevelopersiareiresponsibleiforicomponentitesting;isystemitestingiisitheiresponsibilityiofiaiseparateiteam.
  + Integrationitestingiisitestingiincrementsiofitheisystem;ireleaseitestingiinvolvesitestingiaisystemitoibeireleaseditoiaicustomer.
  + Useiexperienceiandiguidelinesitoidesignitesticasesiinidefectitesting.
  + Interfaceitestingiisidesigneditoidiscoveridefectsiinitheiinterfacesioficompositeicomponents.
  + Equivalenceipartitioningiisiaiwayiofidiscoveringitesticasesi–iallicasesiiniaipartitionishouldibehaveiinitheisameiway.
  + Structuralianalysisireliesionianalysingiprogramiandiderivingitestsifromithisianalysis.
  + Testiautomationireducesitestingicostsibyisupportingitheitestiprocessiwithiairangeiofisoftwareitools.

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