FROM MANUAL TESTING TO COGNITIVE TEST AUTOMATION
Presented by Alexis Despeyroux
From manual testing to cognitive test automation

- Where are we today?
- Evolution of Software Testing
  - Manual testing
  - Test Script Capture/Replay
  - Testing Frameworks Keyword Driven
  - Test Models
  - Model Based testing
- Future of testing
  - Cognitive Test Automation
Most of Today’s Testing Is Still Done Manually

What percentage of your test execution is automated?*

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 80%</td>
<td>10%</td>
</tr>
<tr>
<td>Between 41% and 80%</td>
<td>12%</td>
</tr>
<tr>
<td>Between 20% and 40%</td>
<td>15%</td>
</tr>
<tr>
<td>Less than 20%</td>
<td>56%</td>
</tr>
<tr>
<td>We do not automate</td>
<td>7%</td>
</tr>
</tbody>
</table>

*From an Enterprise IT Poll in Europe*
Test Requirements Coverage Is So-So to Poor

What is your current requirement coverage?*

<table>
<thead>
<tr>
<th>Requirement Coverage</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 81%</td>
<td>27%</td>
</tr>
<tr>
<td>Between 61% and 80%</td>
<td>35%</td>
</tr>
<tr>
<td>Less than 60%</td>
<td>28%</td>
</tr>
<tr>
<td>Not Sure ... yikes</td>
<td>10%</td>
</tr>
</tbody>
</table>

*From an Enterprise IT Poll in Europe*
Software Defects Permeate Every Industry

• National Health Service (UK)
  • Over 300,000 heart patients received incorrect prescriptions due to software error leading to multiple deaths

• State of Michigan Unemployment Insurance Agency
  • 20,000 people were mistakenly accused of fraud, lost their benefits & faced fines up to $100K due to faulty software system

• WorldPay
  • Payment processing firm that processes 36 million payments PER DAY was crippled for 3 weeks due to software fail

• Southwest Airlines
  • Experienced a 12-hour website outage during a holiday week, forcing the cancellation of 2,300 flights & losing an estimated $54 million in revenue

It is estimated that over one trillion dollars in assets were affected by software bugs in 2016!
There Is too much to test & not enough time

Then...

• One computer platform
• One OS
• One app
• One browser
• One release per year

Now...

• Many platforms
  PC, tablet, phone, cloud, watch, voice interface ...
• Multi OS
  Windows, iOS, Android, Chrome, legacy, ...
• More connected apps
• Multiple browsers
  Chrome, IE, Firefox ...
• Multiple releases
  Every month or sooner
Today's Problems

• Greater complexity
• Faster Time to market
• Lower cost
• High competition
Manual Testing Can’t Solve Today’s Problems

Is it possible to solve the convergence of 3 conflicting issues all at once?

- Manual test design can’t keep up with fast changes
- Manual test execution is too slow and/or too simplified
- Manual testing tends to be error prone & costly

**Manual Testing Was Designed for a Simpler Time**
Evolution of Software Testing

1. Manual Testing
2. Test Scripts
3. Testing Frameworks
   - Keyword Driven
4. Test Models
5. MBT

Improved Testing Efficiency
Manual Testing

- Manual testing should be understood as a technology
- For exploratory testing
- For systems that are hard to automate
- Manual Testing will not die! (Yet?)
Test Scripts and Capture Replay

- Capture/Replay is still manual testing
- Interactions have to be manually performed
- A small change in SUT requires re-recording
Keyword Driven Testing Frameworks

- Adds layer of abstraction for the tester
  - Example:
    - Login(Username,Password)
    - StartVehicle()
- Easier to manage than capture/replay
- Need an automation team for keyword implementation
Graphical Modeling - why?

(1911) - A picture is worth a thousand words

One Look Is Worth A Thousand Words--

One look at our line of Republic, Firestone, Miller and United States tires can tell you more than a hundred personal letters or advertisements.

WE WILL PROVE THEIR VALUE BEFORE YOU INVEST ONE DOLLAR IN THEM.

Ever consider buying Supplies from a catalog?

What’s the use! Call and see what you are buying. One look at our display of automobile and motorcycle accessories will convince you of the fact.

THAT WE HAVE EVERYTHING FOR THE AUTO

Piqua Auto Supply House

133 N. Main St.—Piqua, O.

Article 1913 - Piqua Auto Supply House of Piqua, Ohio.
Test Model

- Test Cases

  - Can be generated from test plans
  - You need to think about the tests you want
  - Complex to manage
  - New Test generation based on your TC
  - Documentation generation
  - Script generation

- Model generated from merging optimized tests:
• Don't model test cases; Model the system.

When you Model the system you can create systems capable of generating everything about test cases. It is a much smaller task, since all the possible test cases is very large and changes behind your back, which means test cases models will become obsolete the moment they are made.

Model Based testing

• SUT description based on modeling language
• Graphical view of the data flows
• Complexity easier to manage graphically
• Test generation
• Documentation generation
• Script generation
• And more!
Evolution Model Based Testing

- Standards
- Test Process
- Test Generation
- Modeling

1970 1980 1990 2000 2010 ...

- People
  - ISTQB Foundation Level Certified Model-Based Tester

- Technology
  - SDLC Tool Integrations
    - modeling, ALM, test execution, CI
  - Automated Test Design
    - combined algorithms
    - symbolic state space exploration
    - constraint solving
  - Model Generation
    - asset reuse

- General Purpose Languages
  - graphical + code

- Domain Specific Languages
  - fully graphical

- Algorithms
  - graph traversal, pairwise

- Programming
  - code
MBT 1.0 Hurdle(s): Modeling Notations

From functional programming (10+ years ago)...

..via some graphical & a lot of general purpose programming (~7 yrs ago) ...

```java
public class GarageDoorController extends StateMachine {
    /** The default constructor. */
    public GarageDoorController() { }

    public void startMotor(String direction) {
        MotorStart start;
        start.direction = direction;
        out.send(start);
    }

    public void stopMotor() {
        MotorStop stop;
        out.send(stop);
    }

    public void reverseMotor() {
        MotorReverse reverse;
        out.send(reverse);
    }
}
```

```csharp
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Threading.Tasks;
using Microsoft.MDL.Modeling;

namespace Example1 {
    public static class Accumulator utilisAClass {
        public static Int32 accumulator = 0;

        [RuleAction("Add(x)")]
        public static void AddRule() {
            Condition.IsTrue(x > 0);
            accumulator += x;
        }

        [RuleAction("ReadAndReset(x)")]
        public static void ReadAndResetRule() {
            Condition.IsTrue(x == accumulator);
            return oldValue;
        }
    }
}
```

```lisp
(define quotient
    (lambda (a b)
        (let ((c (/ a b)))
            (if (> c 0)
                (floor c)
                (calling c)))))

(define remainder
    (lambda (a b)
        (- a (* (quotient a b) b)))))
```

```ocn
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Threading.Tasks;
using Microsoft.MDL.Modeling;

namespace Example1 {
    public static class Accumulator utilisAClass {
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            accumulator += x;
        }

        [RuleAction("ReadAndReset(x)")]
        public static void ReadAndResetRule() {
            Condition.IsTrue(x == accumulator);
            return oldValue;
        }
    }
}
```
Planning and Searching

Constructs tests from the explored part of the state space by selecting paths that leads to testing goals

Test generation algorithm searches the state space for testing goals, defined by the end user

Model behavior implies typically infinite state space
Reasoning and Problem Solving

Technology reasons about the unspecified input and derive a concrete values for the inputs

Technically, a custom built constraint solving algorithm is used to handle unspecified input

Models describe the expected external behavior of the system under test

Models interact with an unspecified environment via message passing
Finding Important Tests

- Predict the ways the system might fail
- Combine large set of heuristics
  - Boundary value analysis
  - Combinatorial testing
  - Mutation testing
  - And more...
- Risk based testing
Searching and Optimization

- Symbolic state space explorer typically finds huge (impractical) number of tests
- An optimized subset needs to be selected
- Use combinatorial optimization method for test selection
Today we use Domain Specific Modeling

- Easier to describe in your own language
- Easier automation
- Better documentation
- Better integrations
MBT 2.0: Test Process Automation

ALM / Requirements Management

Repository

Documentation

ALM / Test Management

Automatic Test Execution

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Still – Each New Project Starts Like This
Automatic Model Capture

- Manual model creation is time consuming and potentially error prone activity
- Create a model automatically from existing assets
MBT 3.0: Reverse engineering

ALM / Requirements Management

Documentation

ALM / Test Management

Automatic Test Execution

Existing Assets

Repository

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MBT 3.0: Reverse engineering

Multiple Assets reuse
- BPM
- Gherkin
- Flowchart
- Manual tests
- Test plans
- UI/Mainframe/SOAP/REST
- And more

Never start from scratch!

- Gherkins Files
- Manual test
- others

- Generated Gherkins
- Files
- Documentation
- Test Script

Import - Generate

Graphical representation
[ALM] Test Plans: Excel as Input to MBT

- **Import & Refine**
- **Generate Tests**
- **Execute!**
Feature: Shopping with esd.conformiq.com
Scenario: Successful shopping
Given a user has logged in successfully
When user adds 1 item(s) of "CQ0003"
Then shopping basket contains 1 item(s)

Scenario: Bad product id
Given a user has logged in successfully
When user adds 3 item(s) of "123"
Then application displays invalid entry

Scenario: Remove item
Given a user has logged in successfully
When user adds 1 item(s) of "CQ0003"
Then shopping basket contains 1 item(s)
When user clicks Remove all button for item "CQ0003"
Then shopping basket contains 0 item(s)

See also separate talk / video
Automation Assets: Web Pages as Input to MBT

Scan & Import

Refine Flows

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Automation Assets: Schema as Input to MBT

Also REST web services:
- WADL/JSON
- OpenAPI/XSD/JSON
- RAML/JSON
Cognitive test automation

Star Wars
The Terminator
Ex Machina
Artificial Intelligence

- AI is intelligence exhibited by a machine
- Term AI is applied when a machine mimics a cognitive function such as learning and problem solving
- Central problems in AI research include reasoning, planning, knowledge, learning, and natural language processing
### 100 STARTUPS USING ARTIFICIAL INTELLIGENCE TO TRANSFORM INDUSTRIES

#### CONVERSATIONAL AI/ BOTS
- MindMeld
- Joynt
- Maluuba
- Mobiware
- KITT.AI
- Snips
- Clara
- Automat
- X

#### VISION
- clarifai
- Chronocam
- Orbitool Insight
- Pilot.AI
- Captricity
- GrokStyle
- Nexar

#### AUTO
- NuTonomy
- Drive.AI
- AMotive
- Nauto
- Dispatch

#### ROBOTICS
- UBTech
- Anki
- Rokid
- Shift
- Technology

#### CYBERSECURITY
- Cylance
- Sift Science
- SparkCognition
- DeepInstinct
- Darktrace

#### BUSINESS INTELLIGENCE & ANALYTICS
- DataRobot
- Trifacta
- RapidMiner
- Tamr
- SIGOPT
- Paxata
- Oc text
- Relevant
- Dataminr
- CrossPower
- Logz.io

#### CORE AI
- Affectiva
- Petuum
- Algorithmia
- H2O
- Loop
- Seldon
- Commons
- Numenta
- Skymind
- Vicarious
- Digital Reasoning
- Ayasdi

#### TEXT ANALYSIS/ GENERATION
- Textilo
- Fido.AI
- Cortical.io
- Narrative Science

#### IOT/IIOT
- Nanit
- Konux
- Veridigris
- Right Machine

#### COMMERCE
- Bloomreach
- Mode.ai

#### FINTECH & INSURANCE
- Cape Analytics
- KenSch
- Numerai
- Alphasense
- Kasisto

#### HEALTHCARE
- Freenome
- CloudMedX
- Zebra
- Enlitic
- TwoAR
- BenevolentAI
- Lunit

#### AD, SALES, CRM
- TalkIQ
- Deepgram
- Persado
- Appier
- Chorus
- InsideSales.com
- Drawbridge
- Digital Genius
- Resci

#### OTHER
- Gigster
- Prospera
- Citrine
- Blue River Technology
- Ross
- Zymogen
- Descartes Labs
- Gradescope

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• Don't model the World; Model the Mind.

When you Model the Mind you can create systems capable of Learning everything about the world. It is a much smaller task, since the world is very large and changes behind your back, which means World Models will become obsolete the moment they are made. The only hope to create intelligent systems is to have the system itself create and maintain its own World Models. Continuously, in response to sensory input.

• Monica Anderson, working on (Language) Understanding Machines and Deep Learning since 2001 and classical AI for decades (https://www.quora.com/)
Bots are already here today but they are stupid! Really?
Image Recognition

Vision Error Rate

- Algorithms
- Human
Speech Recognition
Word Error Rate

- July 2016: 8.5%
- Oct 2016: 6.8%
- Dec 2016: 6.1%
- Current: 4.9%

US English only.
Will your job still exist?

“Tester” will still exist but we will not do the same job.
Testing in the future will be about

- Creativity
- Planning
- AI management
- AI Training
- And more!
Let's try to imagine how will be cognitive test automation in 5 years?
Change in our relationship with work

- More social time
- Less time at work
- Massive impact in every day life

Hello Eva!

How looks my day today?

You have a conference called UCAAT. from 9AM to 18PM
Automatic Test execution report and analyse

- Automatic analyze and report.
- Understanding of the not understood
- Human involvement when needed

The result was that 90% of the SUT was covered as planned. 9% failed based on the last updates and I need you for the 1%. I sent in you agenda a meeting request to take a look on your findings.
Understanding our limitation

- Complexity will still improve
- Human will rise to the level of their incompetence
- AI will use databased based of +1000x design and experience “type”
- Human will take the decision
AI and Human Communication

- Review of autogenerated model
- Graphical representation will become the standard
Creativity will be part of our Job

- Data integration
- New user profile management
- AI training
- “Think out of the box”
How to prepare for cognitive testing?

- Start to build your knowledge base
- What can be use?
- Think more “global”
  - Data
  - Design
  - Marketing info..
- Be more flexible
Tester, Cognitive testing will come, so be prepare

- Build your competence
  - Never stop learning!
- Your job will change. Drive it!
- Don’t be afraid your next job need to be invented!
Thanks!