AI-Driven Test Generation
Machines Learning from Human Testers

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Agenda

Motivation
AI/Machine Learning
Applying AI to Testing
State of the Art
Breaking into AI
Web Automation

Expensive
Lacks generality
High maintenance
Model-Based Testing

Semi-automated

Build model, generate tests. Generality?

Model maintenance.

https://graphwalker.github.io/
Machine vs. Human Testing

How do we...

Enable Learning?

Mimic Humans?

Support Generality?
AI and Machine Learning

**AI** - A branch of CS dealing with simulation of intelligent behavior in computers.

**Machine Learning** - Science of getting computers to act without being explicitly programmed. Data!
AI and Machine Learning

Training Data ➔ ML Algorithm ➔ Model ➔ Input Data ➔ ML Algorithm ➔ Predict

Evaluate

Input Data ➔ ML Algorithm ➔ Model ➔ Predict

Evaluate

Evaluation indicates whether the model is accurate or needs improvement.
Neural Networks

Features

Propagate

Answer
AI ⇔ Testing

Test Inputs

Training

Actual vs. Expected
Applying AI to Testing

Object Recognition

Text Generation
Research: Object Recognition

Different types of problems:
Research: Object Recognition

Image pixels are input into an ML algorithm

28 x 28
784 pixels
Applying: Object Recognition

Recognize webpage components

Steps:
Collect Examples
Label Examples
Train Model
Predict
Applying: Object Recognition

Complex example
Applying: Object Recognition

ML-based element selection raises level of abstraction

Test scripts are reusable across applications

Self-healing test scripts that are resilient to styling changes to SUT
Object Recognition: Getting Started!

Keras

scikit-learn

TensorFlow
Can Detect Objects, Now What?

Having the ability to detect objects using ML is a step in the right direction

Bug classification

But, how do we capture how these objects interact?
Research: Text Generation

Text Generation with LSTM Recurrent Neural Nets
Jason Brownlee, Ph.D.
machinelearningmastery.com
Research: Text Generation

Sentences are generated by training an ML system to predict “next words”: 

Step 1:

Seed sequence of words:
the  man  is  walking

Predicted word:
down

Step 2:

Seed sequence of words:
the  man  is  walking  down

Predicted word:
the

Step 3:

Seed sequence of words:
the  man  is  walking  down  the

Predicted word:
street

Step 4:

Seed sequence of words:
the  man  is  walking  down  the  street
Applying: Text Generation
Can we model testing as a “sequence”? (Test Flow)
Applying: Text Generation

Can we model these sequences (test flows) using a language?

Observe Required TextBox FirstName  Input BLANK FirstName Click Commit  Observe ErrorMessage
Applying: Text Generation
Can we apply ML techniques to generate test flows?

Observe Required Textbox FirstName Try VALID FirstName Click Commit NotObserve ErrorMessage

TRAIN

PREDICT
Applying: Text Generation

Observe Screen ShoppingCart
Focus Product In Collection
Try Click Delete Product
Observe Product Not In Collection

Observe Screen ShoppingCart
Focus Product In Collection
Try Increase Product Quantity
Observe Increase In Total Price
Applying: Text Generation

Train ML system to generate strings in language

Generated strings represent test flows
AI-Driven Test Generation

Web classifier trained by human testers

Test flow generator trained by human testers

Test flows refer to web elements via labels (reusable across SUTs)

Language grammar is used to convert generated flows to executable test cases
AI-Driven Test Generation (Demo)
Agenda

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State of the Art
Breaking into AI
State of the Art

http://test.ai

http://applitools.com

http://mabl.com

http://eggplant.io
State of the Art
Automatic system exploration
State of the Art
Automatic human-readable test case generation

Navigating to the Create New Task page.

Setting **Estimated money budget (in dollars)** text field to 0.0
Clicking **Create Task** button

Verifying application is at the Create New Task page.

✓ Verify error message is present, or commit button is greyed out
State of the Art

Human-trainable knowledge base for domain rules

<table>
<thead>
<tr>
<th>ID</th>
<th>Value</th>
<th>Operator</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jasper O.</td>
<td>has a</td>
<td>Car</td>
</tr>
<tr>
<td>2</td>
<td>Oliver M.</td>
<td>is never a</td>
<td>STE</td>
</tr>
<tr>
<td>3</td>
<td>Mia J.</td>
<td>has one</td>
<td>Car</td>
</tr>
</tbody>
</table>
Open Challenges

Despite the progress that has been made...

How do we reliably generate meaningful test inputs for the infinitely possible combinations?

For deeper domain-specific knowledge, how do we train the bots to know what to expect of a system?

How do we create systems capable of autonomously learning and comparing behavior for intra-domain SUTs?

One step at a time... together.
Important Problems

AI TESTING

TOOLS

METHODS

DESIGNS

SELF-TESTING

TESTING AI

AISTA
aitesting.org
Breaking into AI (MOOCs)

Machine Learning

About this course: Machine learning is the science of getting programmed. In the past decade, machine learning has given recognition, effective web search, and a vastly improved understanding of learning is so pervasive today that you probably use it dozens

More

Created by: Stanford University

Deep Learning Specialization

Master Deep Learning, and Break into AI

NANODEGREE PROGRAM

Become a Machine Learning Engineer

In this program you will master Supervised, Unsupervised, Reinforcement, and Deep Learning fundamentals. You will also complete a capstone project in your chosen domain.
Breaking into AI (Books)

- *Deep Learning with Python* by François Chollet
- *Deep Learning* by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
Breaking into AI (Presentations)

Jason Arbon, “AI and Machine Learning for Testers”, PNSQC 2017


Paul Merrill, “Machine Learning & How It Affects Testers”, Quality Jam 2017

Geoff Meyer, Keynote “What’s Our Job When the Machines Do Testing?”, StarEast 2018

Angie Jones, Keynote “The Next Big Things: Testing AI and Machine Learning Applications”, StarEast 2018

Jason Arbon and Tariq King, “Artificial Intelligence and Machine Learning Skills for the Testing World”, StarEast 2018
Closing Remarks

The Bots Are Here
Ripe New Intersection
Break Into AI, and Get Involved!
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