Toward Practical Automation for Software Engineering

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George Mason University
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Software Engineering
Software Engineering

The methods and techniques by which developers design, create, test, and manage software
My research goal: Design tailored automated approaches to help facilitate developer needs throughout the software development and maintenance lifecycle.
Blend scientific discovery with practical significance.
PRACTICAL SIGNIFICANCE

Blend *scientific discovery* with *practical significance*
How Can We Design Practical Automation?
How Can We Design Practical Automation?
MINING SOFTWARE REPOSITORIES

GitHub

Bitbucket

Google Play

SourceForge

GitLab
MINING SOFTWARE REPOSITORIES
MINING SOFTWARE REPOSITORIES

- Source Code Files
- Software Documentation
- Screenshots
- Screen Recordings
- Bug Reports
- Design Documents
LEARNING PATTERNS FROM SOFTWARE DATA
LEARNING PATTERNS FROM SOFTWARE DATA

Software Repository Data → Machine Learning → Salient Patterns
SOFTWARE DEVELOPMENT LIFECYCLE

Requirements Analysis

Maintenance

Testing

Design

Implementation
1. A Brief Look into my Research
1. A Brief Look into my Research

- Automatically Prototyping Mobile App GUIs
1. A Brief Look into my Research

- Automatically Prototyping Mobile App GUIs
- Translating Screen Recordings into Replayable Scenarios
1. A Brief Look into my Research
   - Automatically Prototyping Mobile App GUIs
   - Translating Screen Recordings into Replayable Scenarios

2. Overview of other Research Areas & Future Work
A BRIEF LOOK INTO MY RESEARCH
Machine Learning-Based Prototyping of Graphical User Interfaces for Mobile Apps
RESEARCH PROBLEM

UI/UX Design Team

Development Team
RESEARCH PROBLEM

UI/UX Design Team

Development Team
RESEARCH PROBLEM
RESEARCH PROBLEM

Prototype GUI Code

UI/UX Design Team

Development Team
RESEARCH PROBLEM

UI/UX Design Team

Development Team
How does a developer translate a GUI mock-up into code?
FIRST PRINCIPLES

How does a developer translate a GUI mock-up into code?

1. *Detect* or identify GUI-components that exist in a mock-up
FIRST PRINCIPLES

How does a developer translate a GUI mock-up into code?

1. **Detect** or identify GUI-components that exist in a mock-up

2. **Classify** these GUI-components into their constituent types
How does a developer translate a GUI mock-up into code?

1. **Detect** or identify GUI-components that exist in a mock-up

2. **Classify** these GUI-components into their constituent types

3. **Assemble** the GUI-components into a hierarchy and stipulate styles
FIRST PRINCIPLES
Detection
FIRST PRINCIPLES

Detection    Classification
FIRST PRINCIPLES

Detection  Classification  Assembly
FIRST PRINCIPLES

Detection — Classification — Assembly
PHASE 1: GUI-COMPONENT DETECTION

Computer Vision-Based Detection*

Input Image

**Phase 1: GUI-Component Detection**

Computer Vision-Based Detection*

*Input Image

Phase 1: GUI-Component Detection

Computer Vision-Based Detection*

PHASE 1: GUI-COMPONENT DETECTION

Computer Vision-Based Detection*

PHASE 1: GUI-COMPONENT DETECTION

Computer Vision-Based Detection*

**Phase 1: GUI-Component Detection**

Computer Vision-Based Detection*

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PHASE 2: GUI-COMPONENT CLASSIFICATION

Convolutional Layer

Max Pooling

Convolutional Layer

Max Pooling

Fully Connected Layers

Predictions

ImageButton: 0.8
TextView: 0.0
ProgressBar: 0.0
Button: 0.1
EditText: 0.0
Checkbox: 0.1

Feature Extraction

Classification
Phase 2: GUI-Component Classification
PHASE 2: GUI-COMPONENT CLASSIFICATION

Software Repo Miner
Phase 2: GUI-Component Classification

Software Repo Miner → Execution Engine

Github
Bitbucket
Source Forge
Google Play
WWW

GUI Hierarchies
Labeled Images
APPLICATIONS GENERATED BY ReDraw

Textgram

A) Original Application

B) ReDraw App (MockUp)
APPLICATIONS GENERATED BY ReDRAW

Bank of America

A) Original Application

B) ReDraw App (MockUp)
APPLICATIONS GENERATED BY ReDRAW

A) Original Application

B) ReDraw App (CV)

Giphy
STUDY: DEVELOPER UTILITY

9 Screens from 8 Popular Apps

Context

Mobile Front-End Developer
Google

Mobile Designer
HUAWEI

Mobile Researcher
Facebook
STUDY: RESULTS
“It’s a good starting point... From a development standpoint, the thing I would appreciate most is getting a lot of the boilerplate code done [automatically]”
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“There are going to be edge cases for different layouts, but these are easily fixed after the fact”
“It’s a good starting point... From a development standpoint, the thing I would appreciate most is getting a lot of the boilerplate code done [automatically].”

“There are going to be edge cases for different layouts, but these are easily fixed after the fact.”

“The key thing is fast iteration. A developer could generate the initial view [using ReDraw], clean up the layouts, and have a working app. If a designer could upload a screenshot, and without any other intervention [ReDraw] could update the [existing] xml this would be ideal.”
Translating Video Recordings of Mobile Apps into Replayable Scenarios
VIDEO-BASED BUG REPORTING
VIDEO-BASED BUG REPORTING
Our Solution: Video2Scenario (V2S)

Input Screen Recording
**Our Solution: Video2Scenario (V2S)**

Input Screen Recording
OUR SOLUTION: VIDEO2SCENARIO (V2S)

Input Screen Recording

Neural Object Detection & Classification
Our Solution: Video2Scenario (V2S)

Neural Object Detection & Classification

Input Screen Recording

Replay Script
Our Solution: Video2Scenario (V2S)

Accurate Scenario Replay

Replay Script
Our Solution: Video2Scenario (V2S)

Accurate Scenario Replay

Replay Script
Phase 1: Touch Detection
PHASE 1: TOUCH DETECTION
**Accuracy of Replay**

Scenario Replay Precision & Recall

### Controlled Study

### Popular Apps
Overall, precision and recall are ~95% and ~98% respectively.
RQ₃: Accuracy of Replay
RQ3: Accuracy of Replay
Overview of Other Research Areas & Future Work
RESEARCH AREAS & FUTURE WORK
Mobile Software Development
Mobile Software Development

Deep Learning & Software Engineering
RESEARCH AREAS & FUTURE WORK

Mobile Software Development

Deep Learning & Software Engineering

Transforming Bug Reporting
RESEARCH AREAS & FUTURE WORK

Mobile Software Development

Deep Learning & Software Engineering

Transforming Bug Reporting

Improving Software Traceability
RESEARCH AREAS & FUTURE WORK

- Mobile Software Development
- Deep Learning & Software Engineering
- Transforming Bug Reporting
- Improving Software Traceability
- Developer-Centric Software Security
Research Areas & Future Work

- Mobile Software Development
- Deep Learning & Software Engineering
- Transforming Bug Reporting
- Improving Software Traceability
- Developer-Centric Software Security
- Automating Development of Accessibility Features
RESEARCH AREAS & FUTURE WORK

Applied Techniques:

- Machine Learning
- Natural Language Processing
- Computer Vision
- Program Analysis
JOIN THE RESEARCH GROUP!

SWE Research Group

Dr. Kevin Moran
Assistant Professor
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You?

Next Generation
Bug Reporting Systems

You?

NLP for Code
Generation

You?

Computer Vision
for Software Engineering

You?

Software Engineering
for Machine Learning
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You? { Next Generation Bug Reporting Systems

You? { NLP for Code Generation

You? { Computer Vision for Software Engineering

You? { Software Engineering for Machine Learning

Academic Collaborators

[Logos of academic institutions]
JOIN THE RESEARCH GROUP!

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You?

Next Generation Bug Reporting Systems

You?

NLP for Code Generation

You?

Computer Vision for Software Engineering

You?

Software Engineering for Machine Learning

Academic Collaborators

UT DALLAS
WILLIAM & MARY
Georgia Tech
Università della Svizzera italiana

Industrial Collaborators

CISCO
Microsoft Research
facebook
Google

HUAWEI
Thank you!

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Feel free to come chat (virtually)!
ADDITIONAL SLIDES