UI2code: A Neural Machine Translator to Bootstrap Mobile GUI Implementation

Chunyang CHEN, Ting Su, Guozhu Meng, Zhenchang Xing, Yang Liu
Nanyang Technological University, Australian National University
UI (User Interface) is crucial for the **success** of the App

**Good:**

**Bad:**
APP UI Development

- UI design
  - designer

- UI implementation
  - developer
Convert UI design image to GUI skeleton code

- Implementing This UI Design … Please!
  - Which GUI components to use?
  - How to compose these components?

- Gap between UI designers and developers
How to Fill in This Gap?

- Trial-and-error in GUI builder
  - Too many components and ways of composition

- Search GUI framework tutorials or similar code implementations
  - How to formulate concise, accurate text query of the UI design? (the gap between UI image and natural language)
  - Image search? not supported so far (but I am working on this)

- Ask the community (e.g., Stack Overflow)
  - Well, this depends on the community and luck
An “expert” who knows a vast variety of UI designs and GUI skeletons is always available to advise you …

Where are you, “Expert” …
Dream Comes True

- Automated GUI testing exploration
  - The **first real-world** large scale (185K) dataset of UI-code pairs

- A deep neural network
  - CNN to understand visual features
  - RNN to encode spatial layout and generate the code
Data Collection

- Crawl Apps from Google Play
- Automatically Explore App UIs:
  - Action: click, edits, scroll
  - Prioritizing UI exploration:
    - Frequency of action
    - Number of subsequent UIs
    - Type of action

\[
\text{execution\_weight}(a) = \frac{\alpha * T_a + \beta * C_a}{\gamma * F_a}
\]
Data Collection

- Collect UI screenshots & **GUI** Skeleton code

```
RelativeLayout
   .View
        ImageButton
        TextView
        TextView
    .LinearLayout
        EditText
        ImageButton

This one has wrong pair of bracket!
```

```
RelativeLayout
    .View
        ImageButton
        TextView
    .LinearLayout
        EditText
        ImageButton

RelativeLayout
    .View
        ImageButton
        TextView
    .LinearLayout
        EditText
        ImageButton
```

Android UI Automator → DFT
Data Collection

- **Dataset**
  - 5043 apps in 25 categories
  - Show category bar chart in the top-right empty space
  - 185,227 pairs of UI images and GUI skeleton code
  - [http://tagreorder.appspot.com/ui2code.html](http://tagreorder.appspot.com/ui2code.html)
UI2code Approach

- An UI-specific deep neural network
  - CNN to understand visual features
  - RNN encoder-decoder
    - Encoder further encodes the *structural* information
    - Decoder generates the GUI skeleton code
- [https://github.com/ccywch/UI2code](https://github.com/ccywch/UI2code)
Accurate UI2code Results

- 60.28% exact match & 79.09 BLEU score

- Complex layout
- Deep hierarchy
- Background image
- Text-like image
Errors

- Image-like UI components
- Displayed as one
- Similar small text
- Partially visible elements
8 participants for developing 5 UI design images
- 4 as experimental group, 4 as control group

Add a conclusion of user study

<table>
<thead>
<tr>
<th>Measures</th>
<th>Control</th>
<th>Experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time (minutes)</td>
<td>15.19</td>
<td>6.13*</td>
</tr>
<tr>
<td>Satisfactoriness</td>
<td>3.8</td>
<td>4.9*</td>
</tr>
<tr>
<td>Similarity</td>
<td>3.65</td>
<td>4.2**</td>
</tr>
</tbody>
</table>
Wait a Minute. Are We Becoming Replaceable?
Artificial Intelligence

- 😊 Good for dealing with complex problems efficiently
- 😞 May not be reliable or interpretable

Will AI replace me? The short answer is NO.
Background

- UI (User Interface) is crucial for the success of the App

<table>
<thead>
<tr>
<th>Good</th>
<th>Bad</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Good UI Example" /></td>
<td><img src="image2.png" alt="Bad UI Example" /></td>
</tr>
</tbody>
</table>

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AI & Human

- Artificial Intelligence
  - ☑️ Good for dealing with complex problems efficiently
  - ☐️ May not be reliable or interpretable

UI2code approach

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Chunyang Chen wchccy@gmail.com