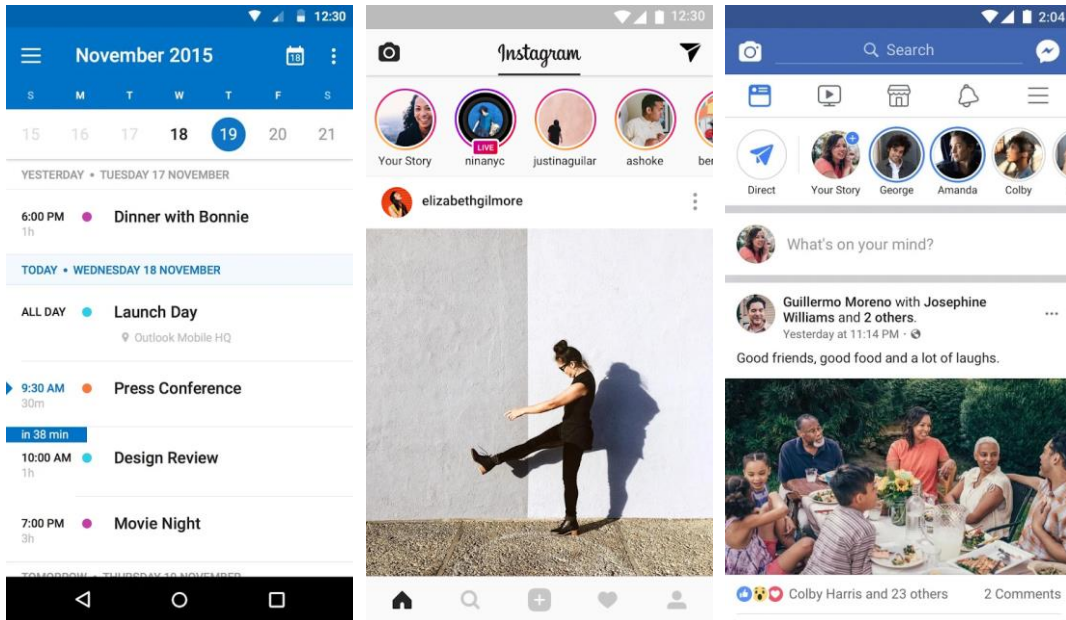# **UI2code**: A Neural Machine Translator to Bootstrap Mobile GUI Implementation

Chunyang CHEN, Ting Su, Guozhu Meng, Zhenchang Xing, Yang Liu

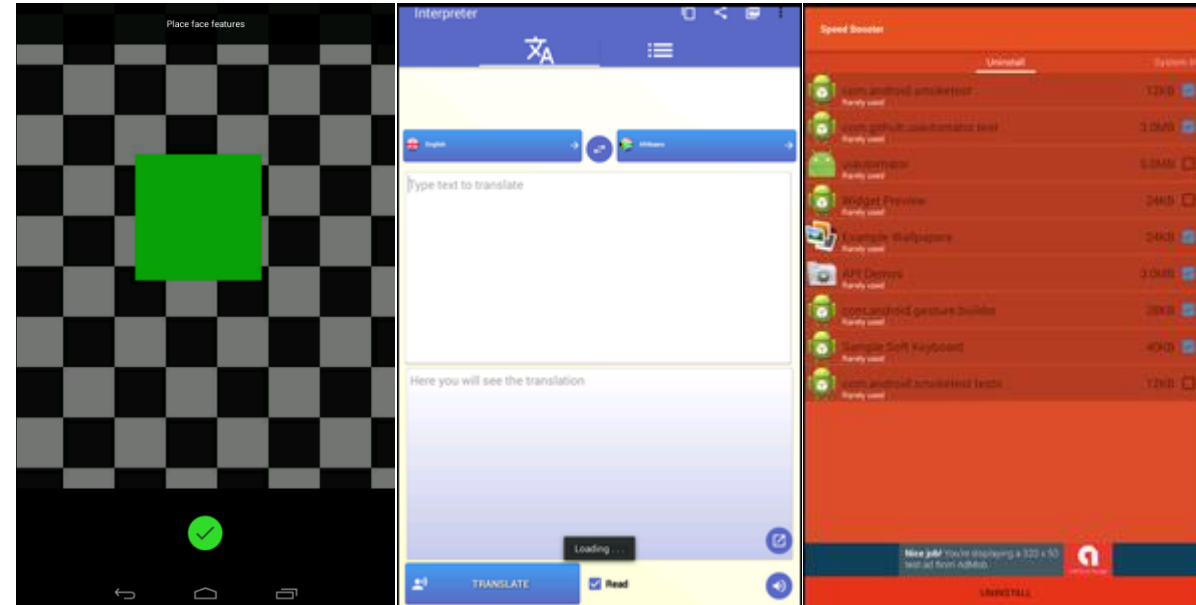Nanyang Technological University, Australian National University

Background

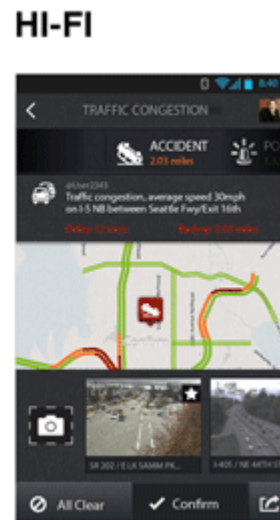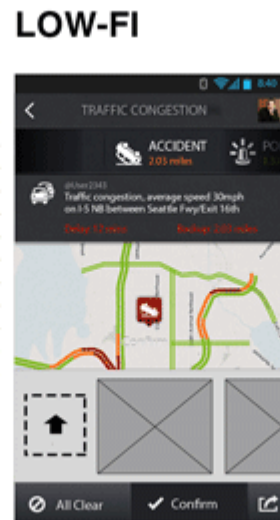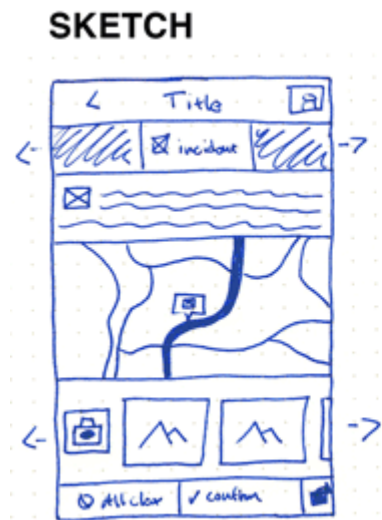▸ UI (User Interface) is crucial for the **success** of the App

Good:

Bad:

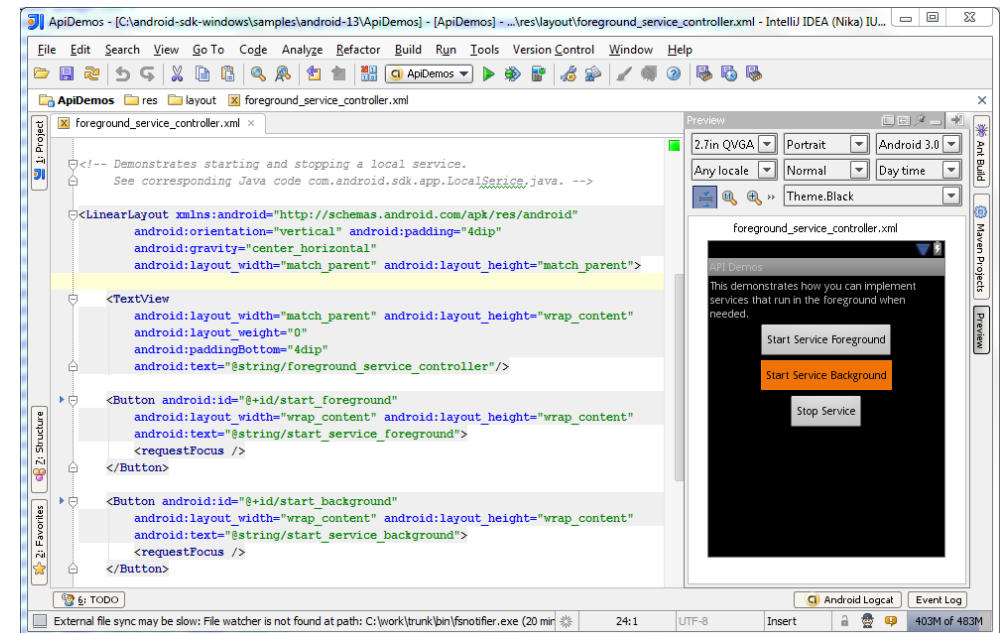# APP UI Development

▸ UI design

  ▸ designer
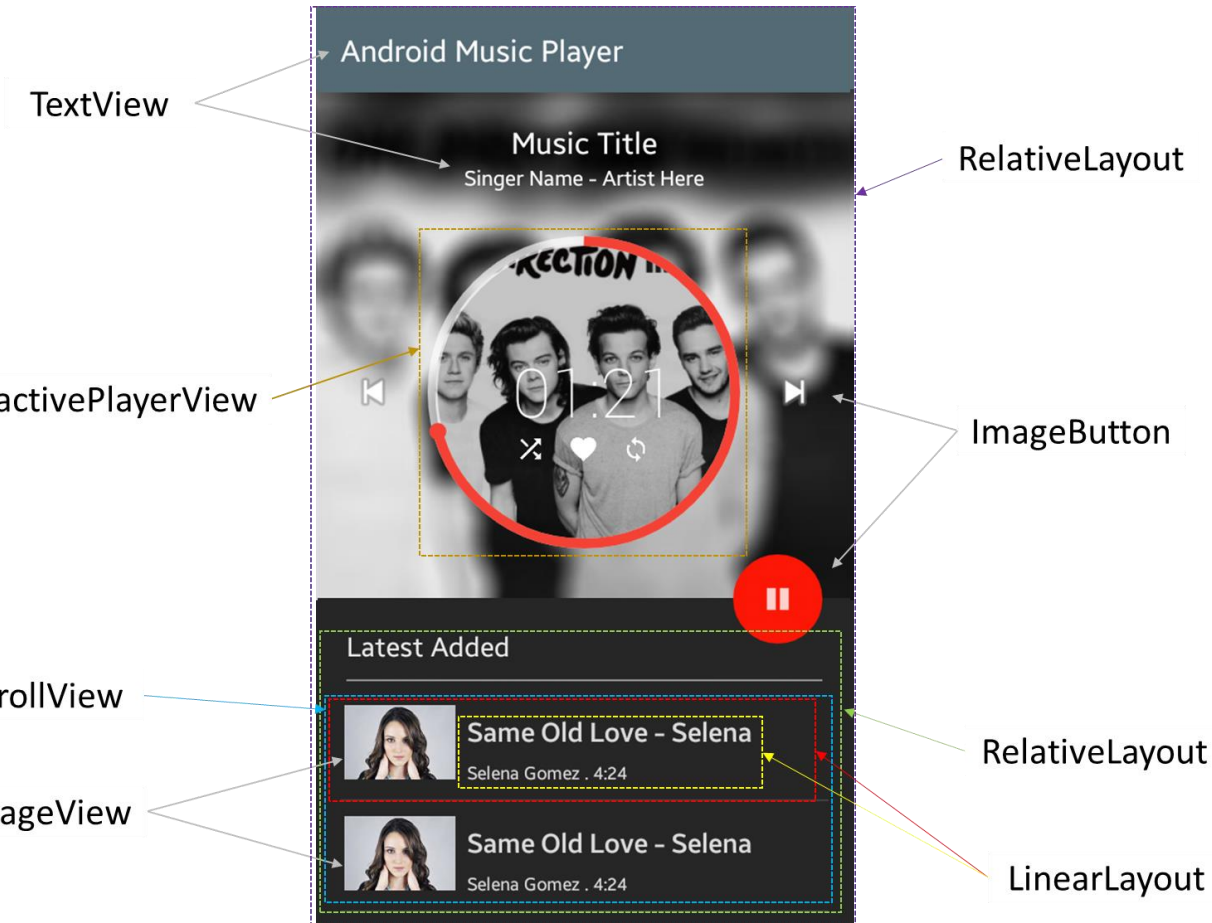
▸ UI implementation

  ▸ 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
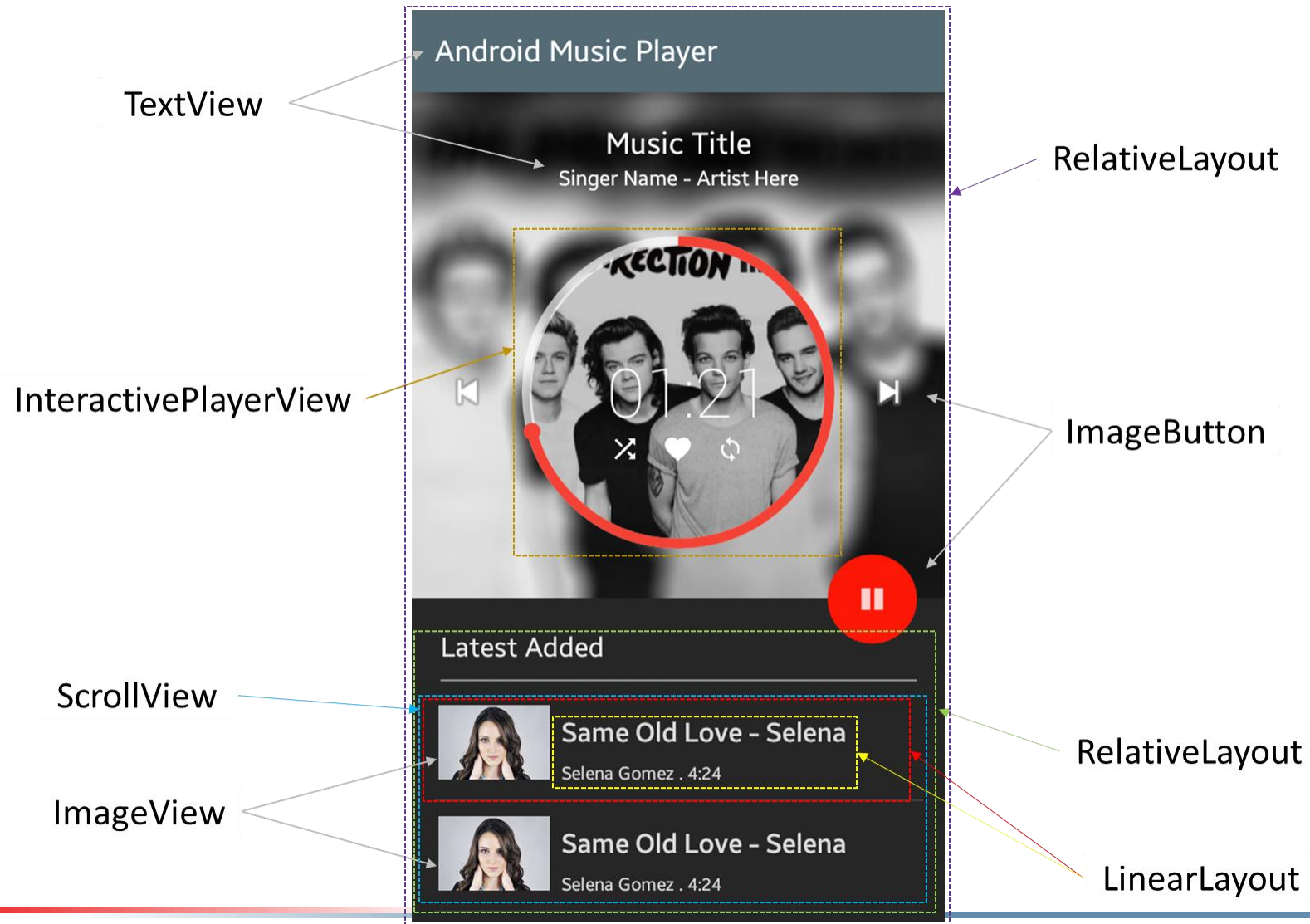
How to Fill in This Gap?

▸ 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

Or You May Wish ...

▸ An "expert" who knows a vast variety of UI designs and GUI skeletons is always available to advise you …

Where are you, "Expert" …

Android Music Player

TextView

Music Title
Singer Name - Artist Here

RelativeLayout

InteractivePlayerView

ImageButton

Latest Added

ScrollView

Same Old Love – Selena
Selena Gomez . 4:24

RelativeLayout

ImageView

Same Old Love – Selena
Selena Gomez . 4:24

LinearLayout

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
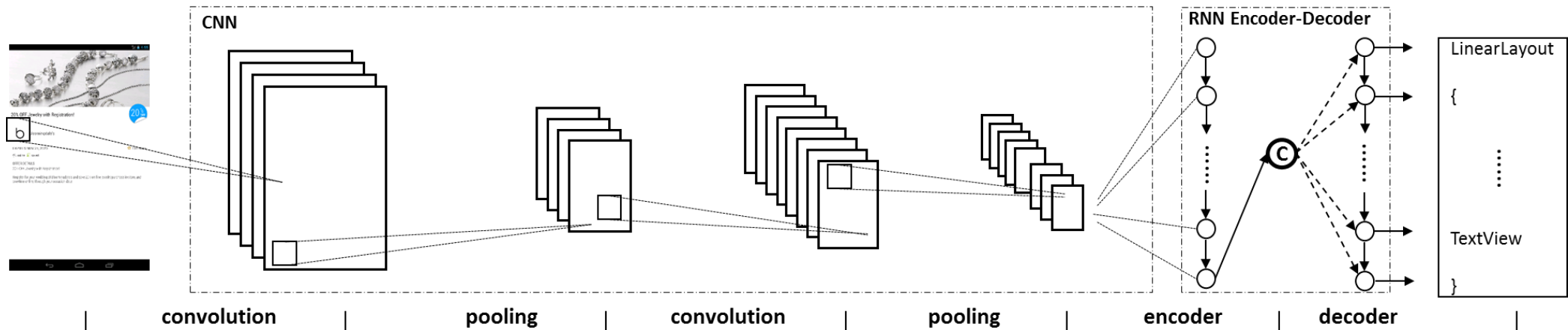
Data Collection

▸ Crawl Apps from Google Play

▸ Automatically Explore App UIs:

    ▸ Action: click, edits, scroll

    ▸ Prioritizing UI exploration:

        ▸ Frequency of action

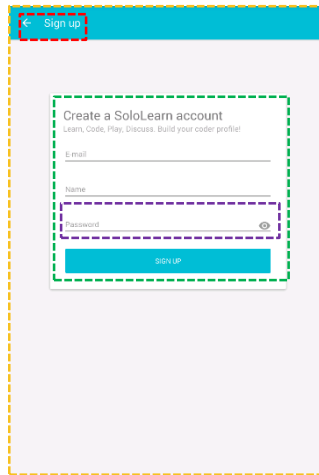   ▸ Number of subsequent UIs

        ▸ Type of action

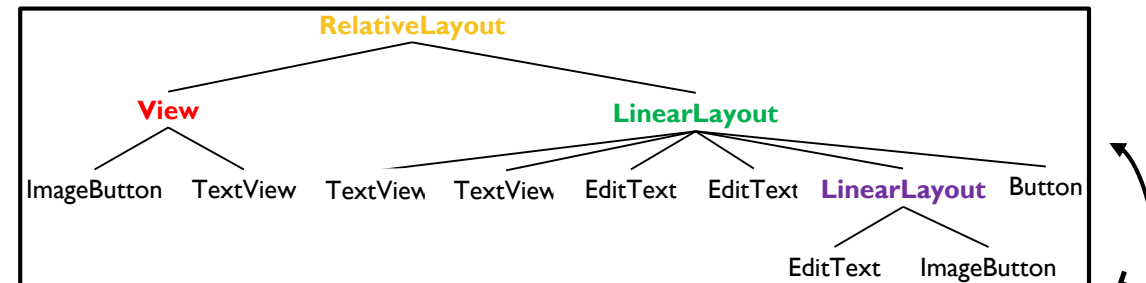$$execution\_weight(a) = \frac{\alpha * T_a + \beta * C_a}{\gamma * F_a}$$
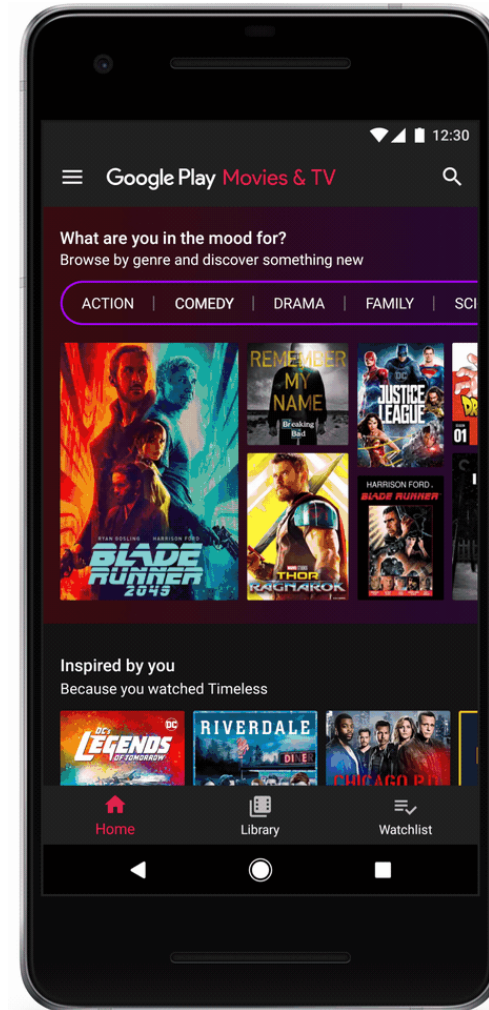
Better show a UI state model after animation.

NANYANG
TECHNOLOGICAL
UNIVERSITY

Data Collection

▸ Collect UI screenshots & GUI Skeleton ~~code~~

Android UI Automator →

RelativeLayout
- View
  - ImageButton
  - TextView
- LinearLayout
  - TextView
  - TextView
  - EditText
  - EditText
  - LinearLayout
    - EditText
    - ImageButton
  - Button

DFT

RelativeLayout{ View{ ImageButton TextView} {LinearLayout { TextView TextView EditText EditText LinearLayout { EditText ImageButton } Button }
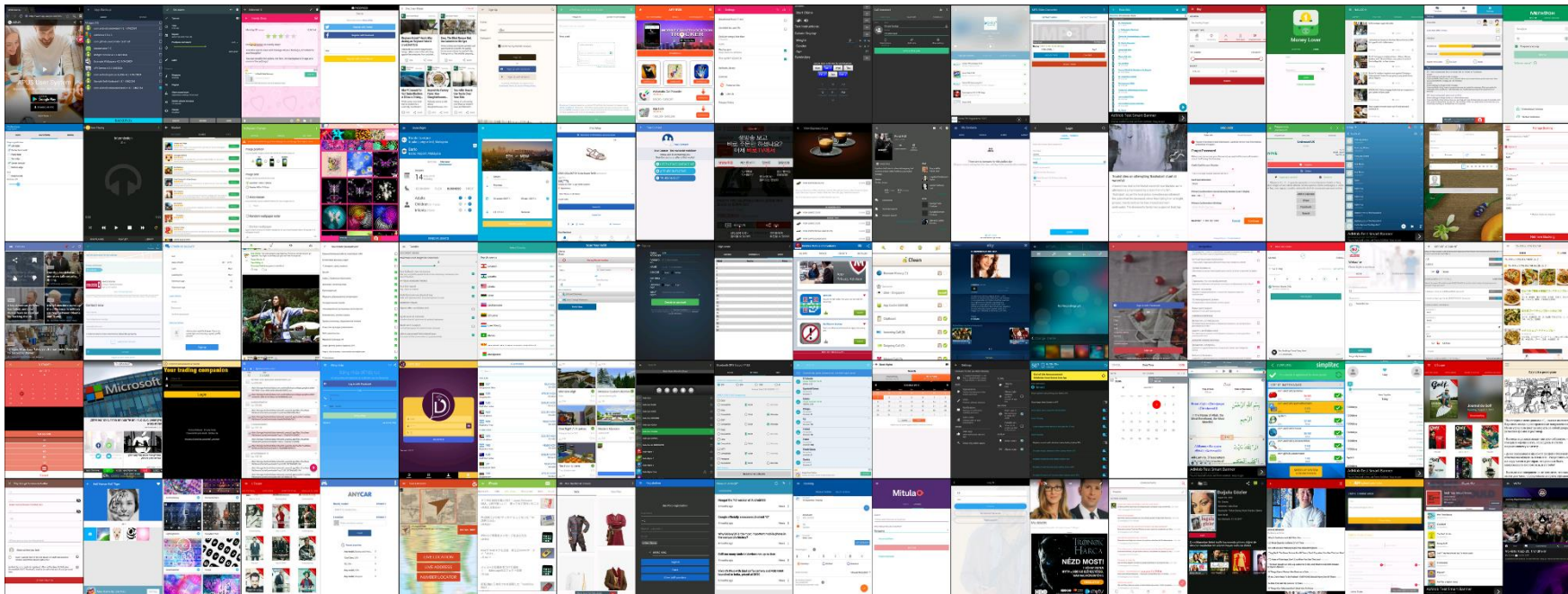
This one has wrong pair of bracket?

RelativeLayout{ View{ ImageButton TextView} LinearLayout { TextView TextView EditText EditText LinearLayout { EditText ImageButton } } Button }

Data Collection

▶ Dataset

 ▶ 5043 apps in 25 categories ?show category barchart in the top-right empty space?

 ▶ 185,227 pairs of UI images and GUI skeleton code

 ▶ 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** ?we use spatial in the paper information

    ▶ Decoder generates the GUI skeleton ~~code~~

  ▶ https://github.com/ccywch/UI2code
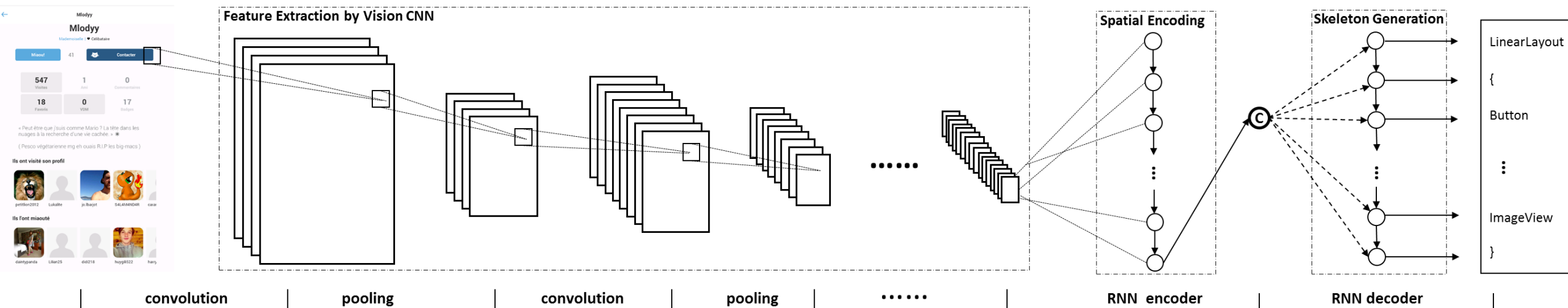
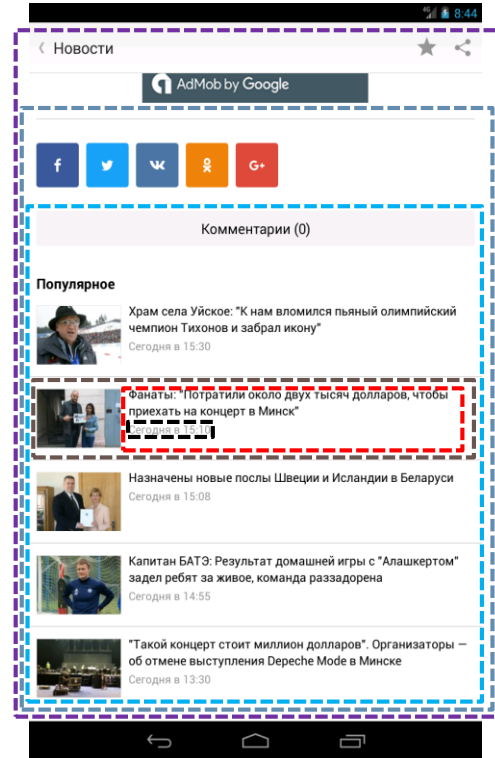# Accurate UI2code Results

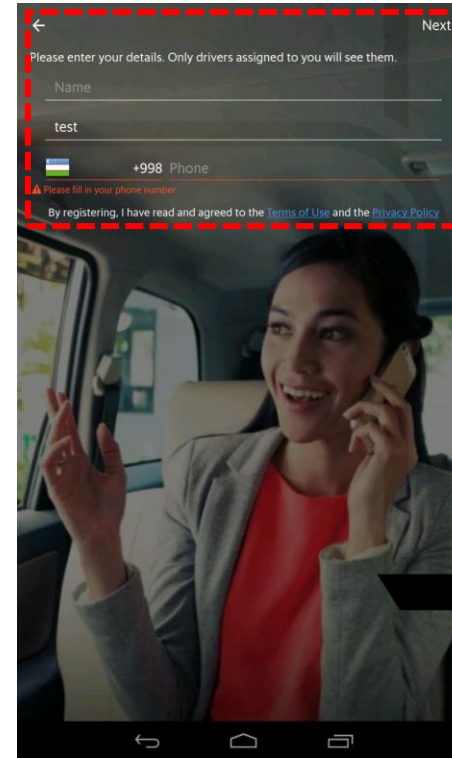▸ 60.28% exact match & 79.09 BLEU score
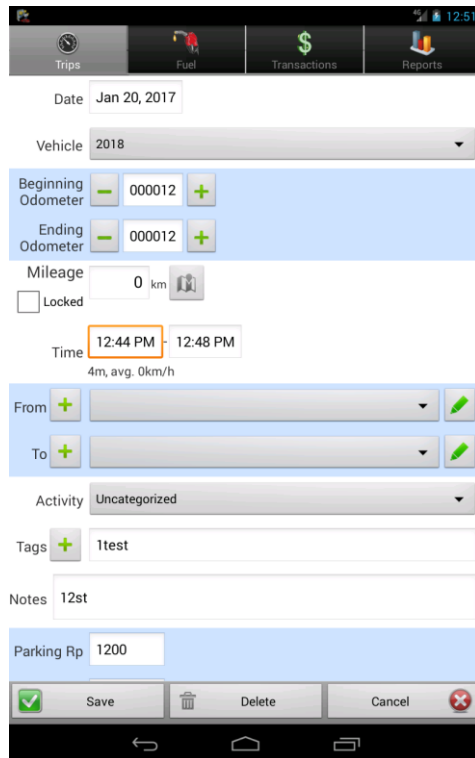
Complex layout   Deep hierarchy   Background image   Text-like image
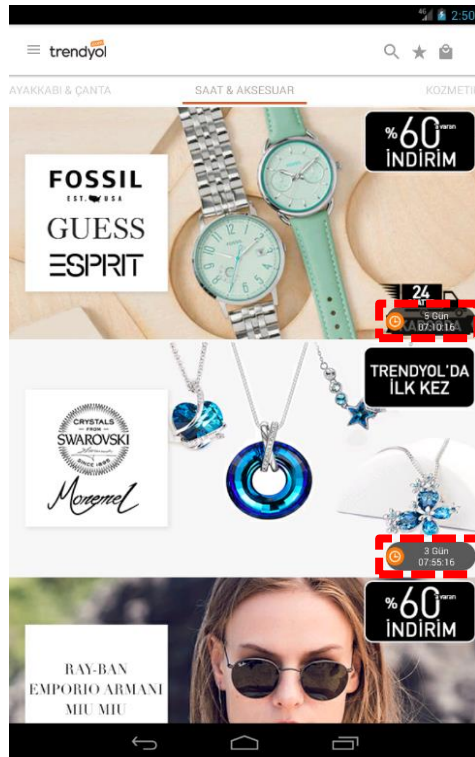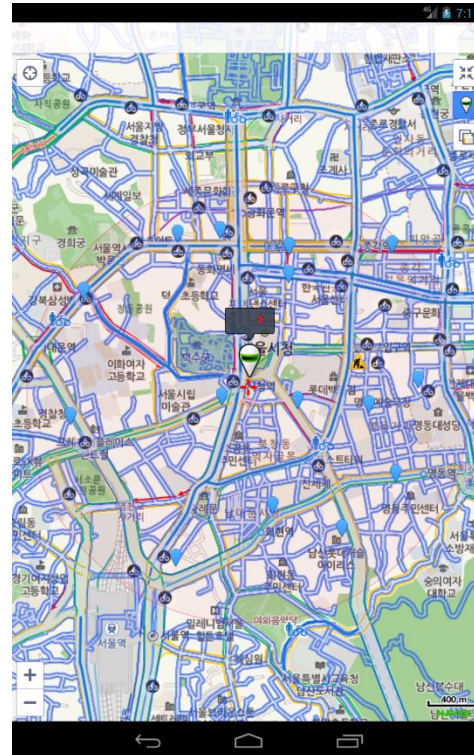
Errors

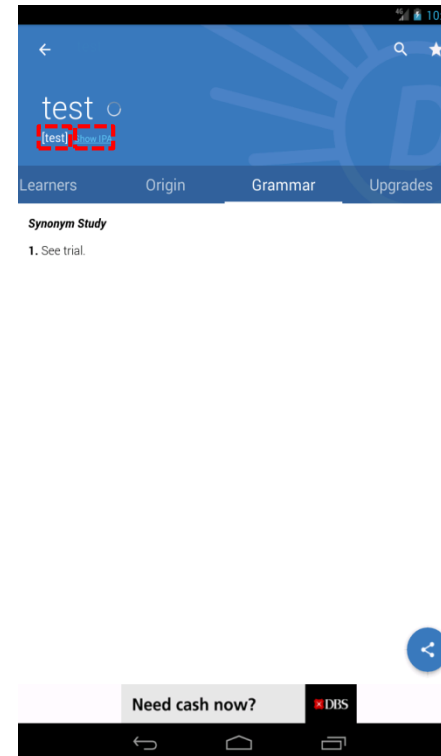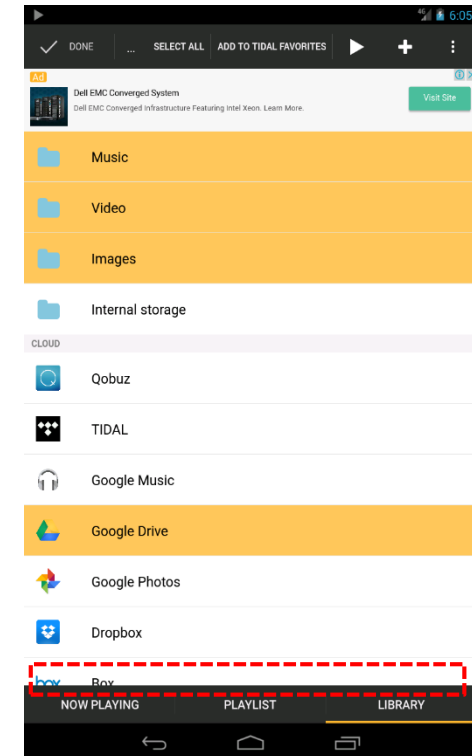- ??add a summary of errors

Image-like UI components

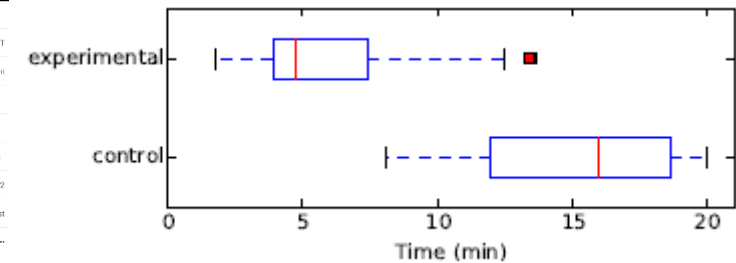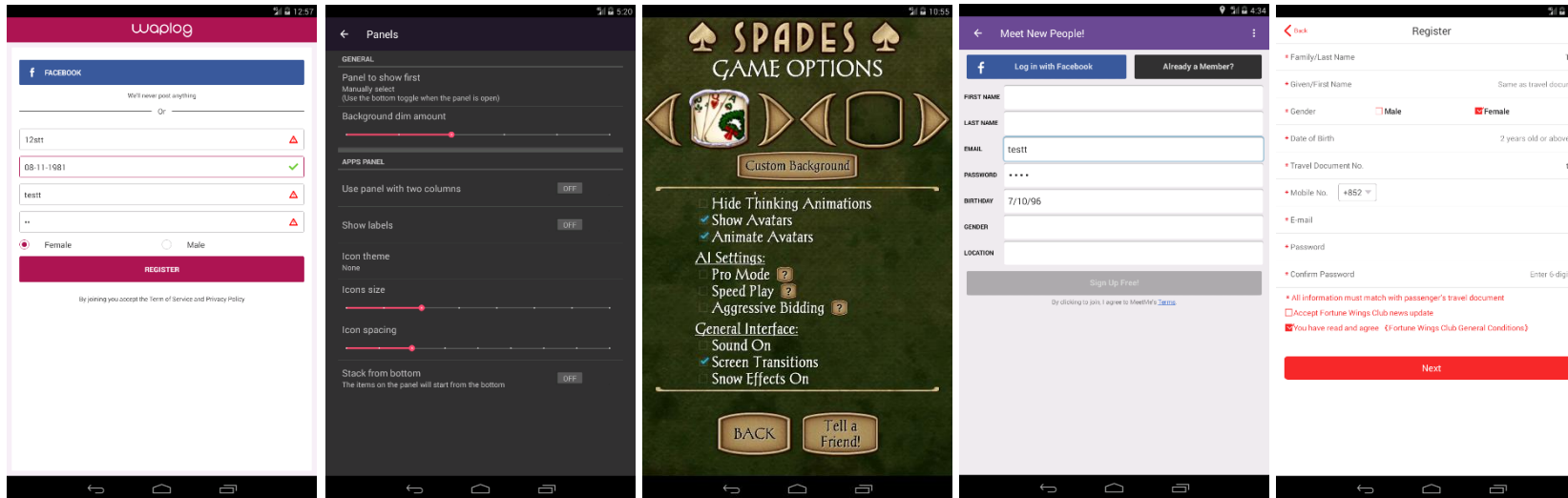Displayed as one

Similar small text

Partially visible elements

User Study

- ▶ 8 participants for developing 5 UI design images
  - ▶ 4 as experimental group, 4 as control group

Add a conclusion of user study

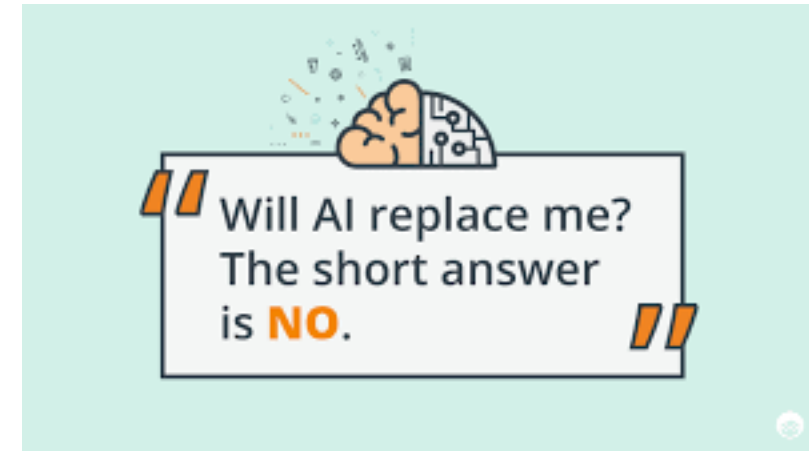| Measures	Control	Experimental
Time (minutes)	15.19	6.13*
Satisfactoriness	3.8	4.9*
Similarity	3.65	4.2**

Wait a Minute. Are We Becoming Replaceable?

AI & Human

▸ Artificial Intelligence
  ▸ ☺ Good for dealing with complex problems efficiently
  ▸ ☹ May not be **reliable** or **interpretable**

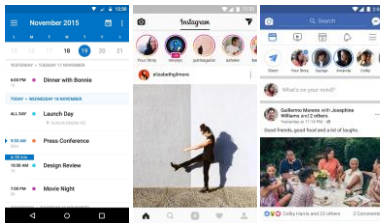"Will AI replace me? The short answer is NO."
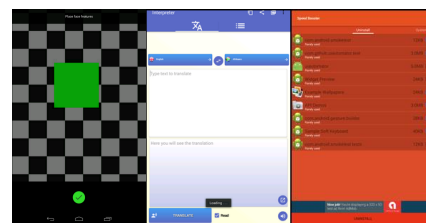

??

!!

Thanks for the listening !

Background

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

Good:
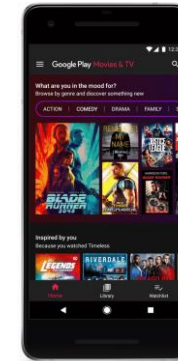
Bad:

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  ▸ Action: click, edits, scroll

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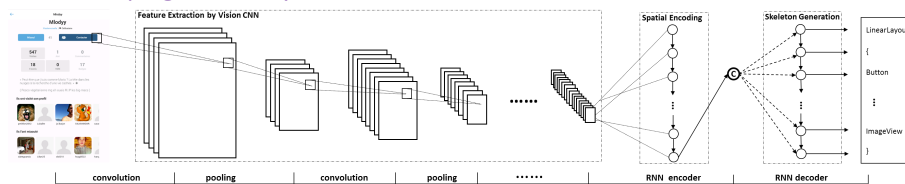
$$execution\_weight(a) = \frac{\alpha * T_a + \beta * C_a}{\gamma * F_a}$$

https://ndrdnws.blogspot.sg/2018/03/google-brings-updates-to-play-movies-tv.html

UI2code approach

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  ▸ https://github.com/ccywch/UI2code

AI & Human

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  ▸ ☹ May not be **reliable** or **interpretable**

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

 or

Chen, Chunyang, Ting Su, Guozhu Meng, Zhenchang Xing, and Yang Liu. "From ui design image to gui skeleton: a neural machine translator to bootstrap mobile gui implementation." In *Proceedings of the 40th International Conference on Software Engineering*, pp. 665-676. ACM, 2018.

Chunyang Chen wchccy@gmail.com