Pairwise GUI Dataset Construction Between Android Phones and Tablets

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Motivation

Automated GUI Immigration/Development:

1. To conquer the market, one app is often available on multiple platforms.

2. Platform-specific versions of one app have highly similar Graphical User Interfaces (GUIs) and functionalities, e.g., YouTube.

3. Reusing GUI designs and functionality implementations can significantly minimize the developer's engineering effort.

4. The field of automatic GUI development is still in a research bottleneck, lacking breakthroughs and widely recognized tools, methods and datasets.

Phone

Conversion

Conversion

Tablet

TV
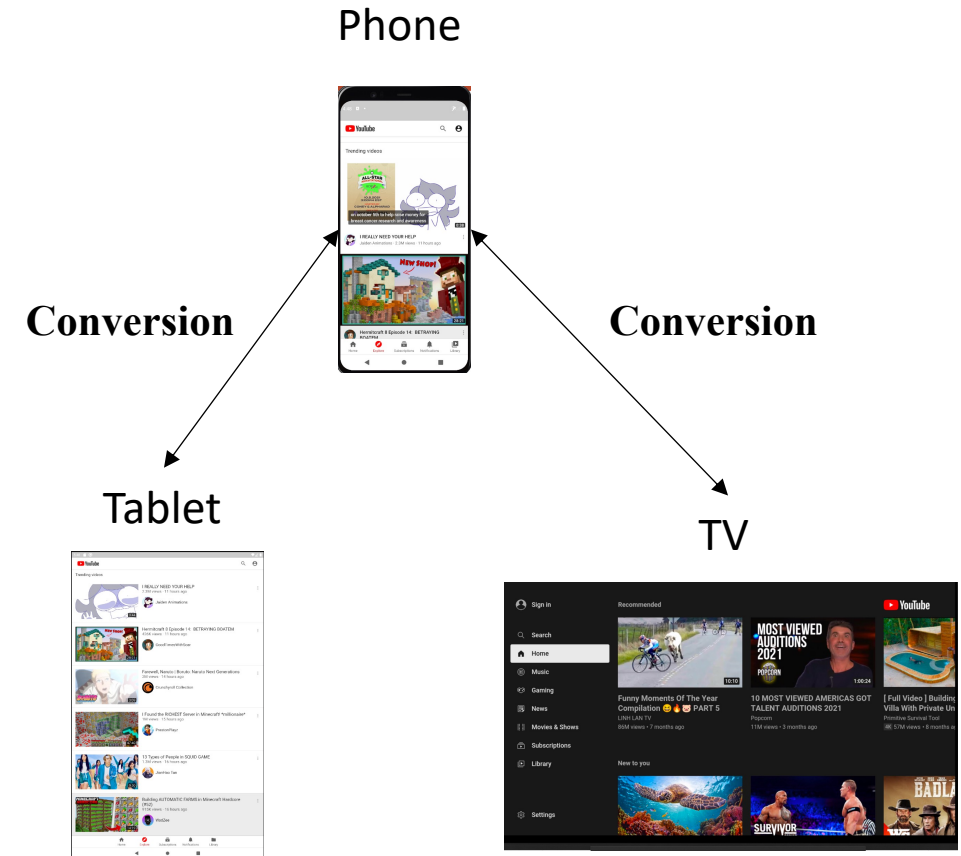
Challenges

1. **Lack of Pairwise GUI Dataset:** There's no existing tool that automatically pairs mobile GUI elements

2. **Alignment Challenges:** It's difficult to automatically align GUI content between phone and tablet interfaces.

3. **Visual Mismatches in GUI Datasets:** Current datasets show mismatches between GUI screenshots and metadata, due to limitations in traditional GUI collection tools.
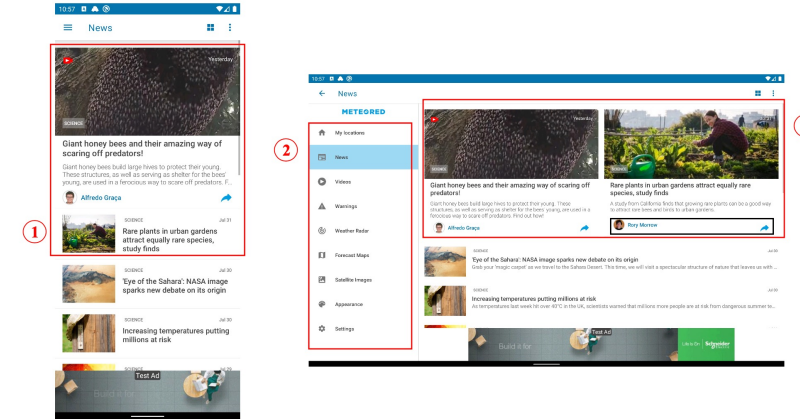

Figure 1: An example of a phone-tablet GUI pair of the app 'BBC News'. The GUI on the left is from the phone, while the GUI on the right is from the tablet.
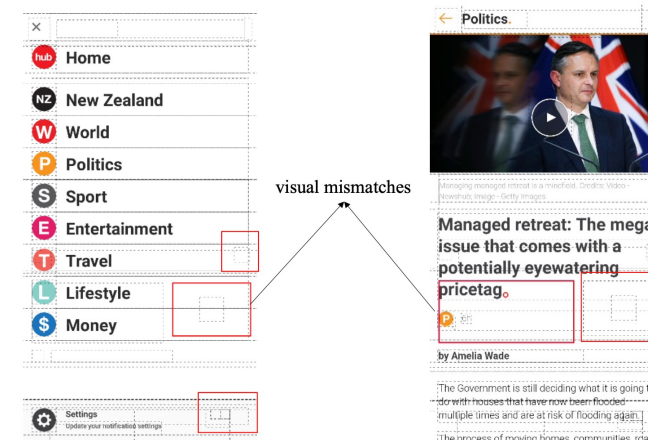

Figure 6: Examples of visual mismatches in current GUI datasets.

Papt dataset

10,035 pairwise phone-tablet GUI pairs.

Each pair contains:
(1) A screenshot of phone GUI page and its metadata file
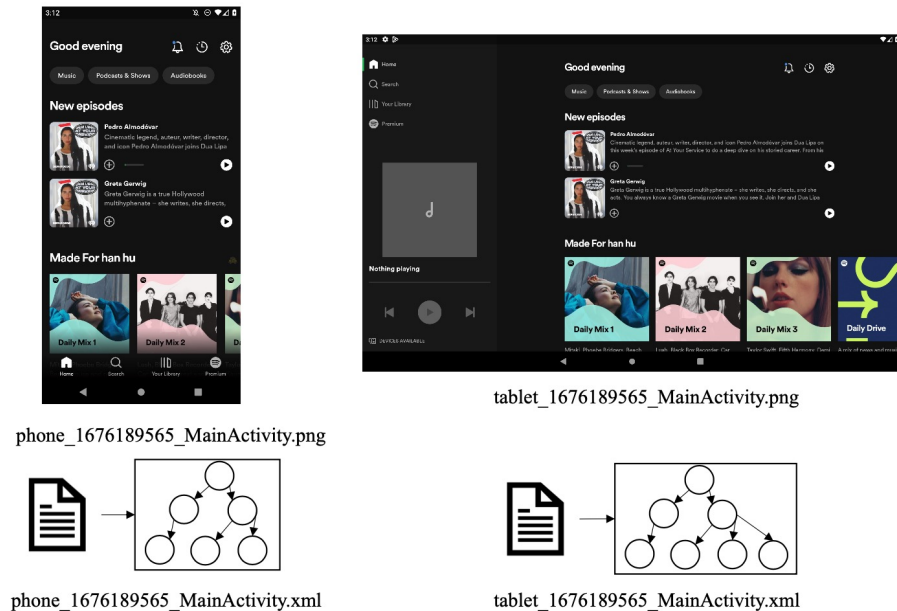(2) A screenshot of tablet GUI page and its metadata file

phone_1676189565_MainActivity.png

tablet_1676189565_MainActivity.png

phone_1676189565_MainActivity.xml

tablet_1676189565_MainActivity.xml

Figure 5: An example GUI pair in Spotify

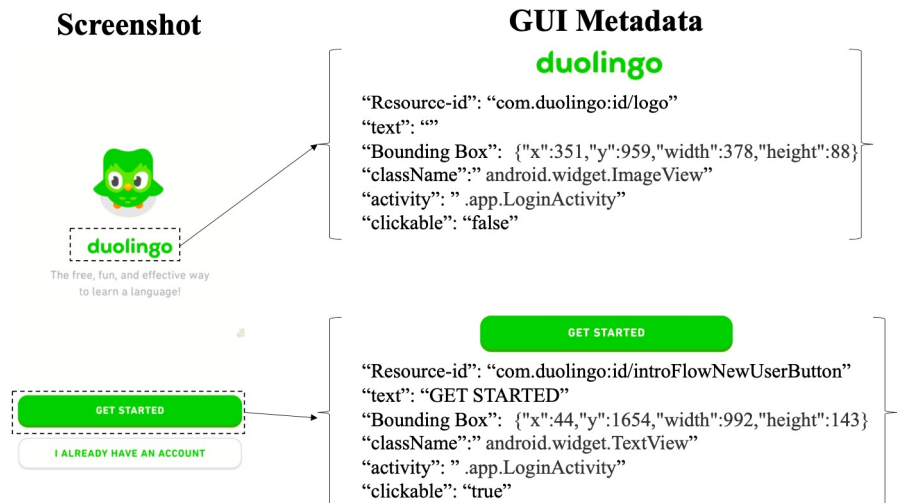The metadata of a screenshot contains the UI properties, UI layout and hierarchy of the whole GUI page.

Screenshot   GUI Metadata

"Resource-id": "com.duolingo:id/logo"
"text": ""
"Bounding Box": {"x":351,"y":959,"width":378,"height":88}
"className":" android.widget.ImageView"
"activity": " .app.LoginActivity"
"clickable": "false"

"Resource-id": "com.duolingo:id/introFlowNewUserButton"
"text": "GET STARTED"
"Bounding Box": {"x":44,"y":1654,"width":992,"height":143}
"className":" android.widget.TextView"
"activity": " .app.LoginActivity"
"clickable": "true"

Figure 4: A screenshot of a GUI and its part UI metadata

Papt dataset

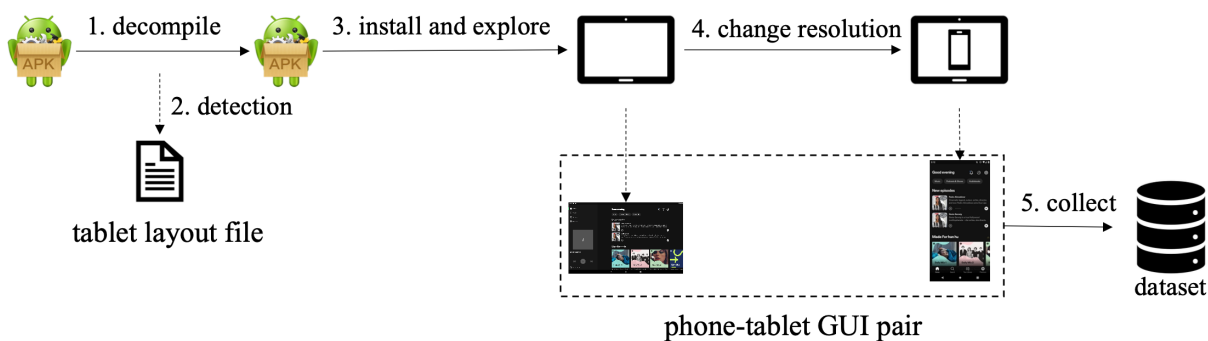**Two Data Collection Approaches:**

Figure 2: Pipeline of dynamically adjusting the resolution for GUI pairing

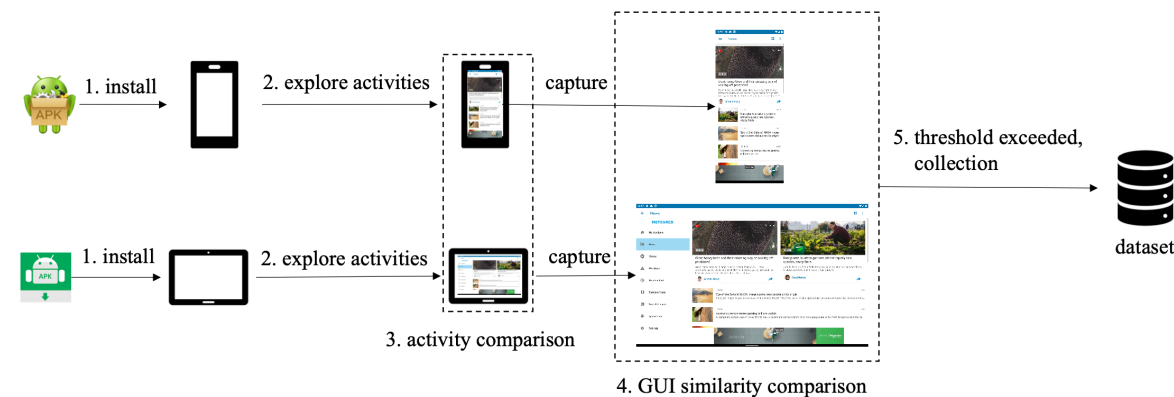(1) Data Collection via Resolution Adjustment in Devices

Figure 3: Pipeline of similarity-based GUI pairing

(2) Data Collection via GUI Similarity Comparison

Papt dataset

10,035 pairwise phone-tablet GUI pairs.

The data source is from diverse app category and UI types

The similarities between the GUIs of phones and tablets in most phone-tablet GUI pairs are between 0.5 and 0.7

Table 1: Top 15 categories of source apps.

Category	#Count	P (%)
Entertainment	496	8.87
Social	394	7.04
Communication	326	5.83
Lifestyle	318	5.69
Books & Reference	286	5.11
Education	279	4.98
News & Magazines	271	4.85
Shopping	270	4.83
Sports	267	4.78
Music & Audio	266	4.76
Weather	265	4.73
Finance	262	4.68
Bussiness	261	4.67
Travel & Local	255	4.57
Medical	254	4.54
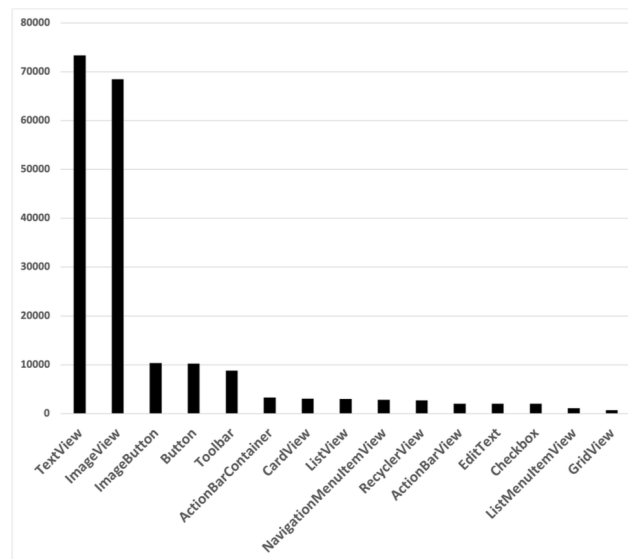
Figure 1: Distribution of top 15 UI view types in the dataset.
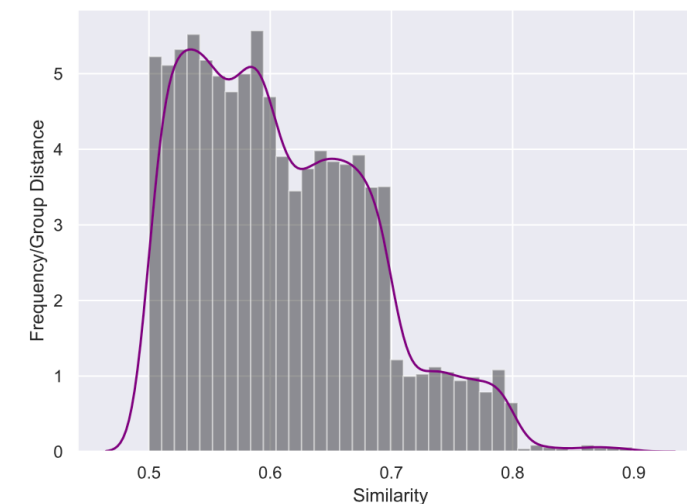

Figure 2: The frequency histogram of GUI similarity of collected pairs

Papt dataset

10,035 pairwise phone-tablet GUI pairs.

Comparison between our dataset and other GUI datasets
(1) Broader applicable tasks
(2) Data accuracy

Table 1: Comparison between our dataset and other GUI datasets

Dataset	GUI Platform	#GUIs	#Paired GUIs	#Data Source App	Latest Updates	Mainly targeted tasks
Rico [14]	Phone	72,000	0	9,700	Sep. 2017	UI Component Recognition, GUI completion
UI2code [10]	Phone	185,277	0	5,043	June. 2018	UI Skeleton Generation
Gallery D.C. [11]	Phone	68,702	0	5,043	Nov. 2019	UI Search
LabelDroid [13]	Phone	394,489	0	15,087	May. 2020	UI Component Prediction
UI5K [12]	Phone	54,987	0	7,748	June. 2020	UI Search
Enrico [28]	Phone	1,460	0	9,700	Oct. 2020	UI Layout Design Categorization
VINS [9]	Phone	2,740	0	9,700	May. 2021	UI Search
Screen2Words [45]	Phone	22,417	0	6,269	Oct. 2021	UI screen summarization
Clay [29]	Phone	59,555	0	9,700	May. 2022	UI Component Recognition, GUI completion
Papt	Phone, Tablet	20,070	10,035	11,186	Jan. 2023	UI Component Recognition, GUI completion, GUI conversion, GUI search

Preliminary Experiments

Table 2: Automatic evaluation results on the test set.

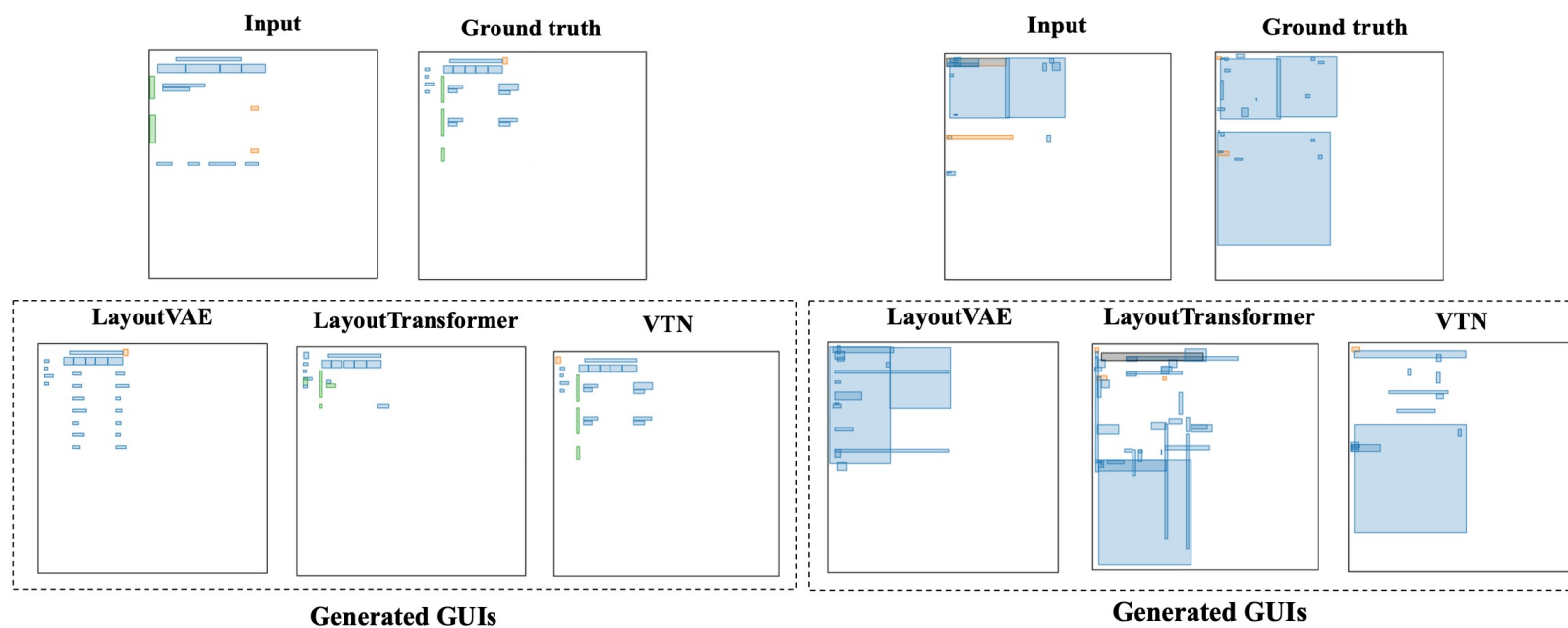| Model	mIoU $\downarrow$	Overlap $\downarrow$	W class $\downarrow$	W bbox $\downarrow$	# Unique matchces $\uparrow$	Matched rate $\downarrow$
LayoutVAE	0.10	0.23	0.29	0.012	356	0.13
LayoutTransformer	0.12	0.32	0.31	0.024	445	0.15
VTN	0.13	0.35	0.37	0.026	541	0.19

Figure 7: Two examples of generated GUIs by selected approaches

Thanks for listening

Questions?