

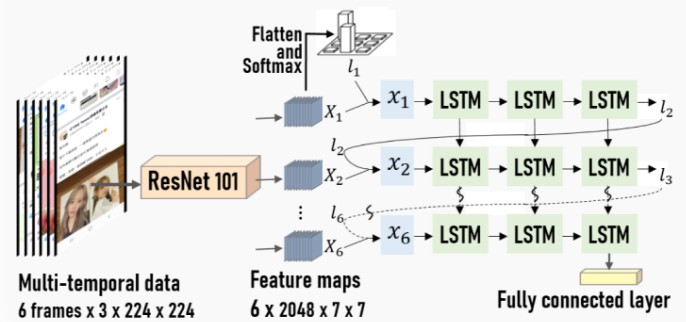
Introduction

- Finding good moments to deliver interruptions has drawn research attention. Killing-time is considered one such a kind of moment, since users are considered to have attention surplus at these moments. However, detection on killing-time has been underexplored.
- We propose a screenshot-based killing-time detection using deep learning. Our model achieves an accuracy 79.71%, recall 90.24%, precision 84.51%, and AUROC 65.50%. This suggests that using screenshots for detecting users' killing time on smartphones is a promising approach



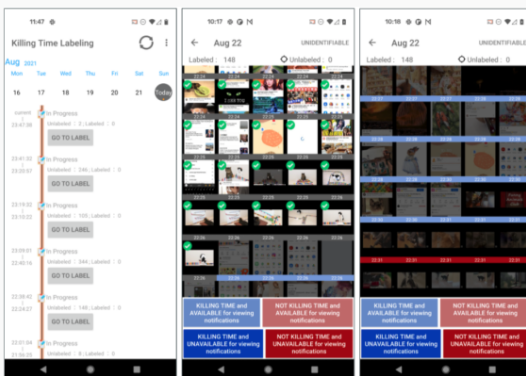
Model Description

- We build up a deep neural network for predicting the user's killing-time from 6 temporally consecutive screenshots, which are resized into 224x224 pixels.
- Our network extracts the feature map of size 7x7x2048 from each screenshot via a ImageNet-pretrained Resnet-101 backbone, where the feature maps are sequentially taken as input for a 3-layer long short-term memory (LSTM) model to reach the final output of killing-time detection.
- The dimensionalities of the hidden state, cell state, and the hidden layer of our LSTM model are set to 512, 512, and 256, respectively.



Data Collection

- We develop an Android app that automatically collects screenshots and phone sensor data every 5 seconds.
- Users can easily select a group of screenshots to for labeling that, at the moment when screenshots were taken, 1) whether the user was killing time and 2) whether he/she was available for viewing notifications.



- Our dataset in total consists of 215,807 screenshots from six users (3 females and 3 males; 22-32 years old; 3 students and 3 employed) recruited via social media.
- 77.7% of the screenshots are labelled as "killing time".
- All of them participated in data collection for fourteen days, and were paid NT\$1200 for collecting labeled screenshots.

Experiment

- The dataset is split into two parts – first part (80%) used for our model training and the second part (20%) used for evaluation; we adopt 5-fold cross-validation to produce the experimental results.
- The model achieves an accuracy of 79.71%, recall 90.24%, precision 84.51%, F1 86.88% and AUROC 65.50%.

		Predicted sign	
		not killing time	killing time
True sign	not killing time	0.41	0.59
	killing time	0.10	0.90

Conclusion

- We employed deep learning to detect when users are killing time on smartphones using their screenshots.
- In a two-weeks study with six participants, the model achieves an accuracy of 79.71%, recall 90.24%, precision 84.51%, F1 86.88% and AUROC 65.50%.
- These results show that using screenshots for detecting users killing time is promising.
- We believe the results will improve when the dataset grows. And we will also further improve the model, including add fusion of sensor data and screenshots.