AI 活用で挑む学問の革新と創成　　2022 年度
2021 年度採択研究代表者　　年次報告書

張 家銘

東京大学 大学院情報理工学研究科
特任講師

Design Thinking for Facilitating Data Annotation and Machine Learning

研究成果の概要

In the 2nd year, I completed three projects (1) **Dual Label** (2) **Dynamic Labeling** and (3) **Speed Labeling**. Dual Labeling project was published in GI 2022 as a full paper. Dynamic Labeling project is completed and will be submitted to HCOMP 2023. Speed Labeling project is completed and it was submitted to UIST 2023 (full paper, under review). These projects were collaborated with Prof. Haoran Xie from JAIST (Japan), Prof. Xi Yang from Jilin University (China), Prof. Xiang 'Anthony' Chen from UCLA (US), and Prof. Takeo Igarashi from The University of Tokyo. I am the 1st author of the three papers.

In addition to the three projects that mainly focused on “image” annotation task on desktop computer. In the end of the 2nd year, I started to investigate different labeling task (e.g., audio/video annotation) on different devices (e.g., smartphone). These will be my 3rd year research goal.

Below shows summary of the three projects:

Project 1: DualLabel: Secondary Labels for Challenging Image Annotation

Non-expert annotators must select an appropriate label for an image when the annotation task is difficult. Then, it might be easier for an annotator to choose multiple “likely” labels than to select a single label. Multiple labels might be more informative in the training of a classifier because multiple labels can have the correct one, even when a single label is incorrect. We present DualLabel, an annotation tool that allows annotators to assign secondary labels to an image to simplify the annotation process and improve the classification accuracy of a trained model. A user study compared the proposed dual-label and traditional single- label approaches for an image annotation task. The results show that our dual-label approach reduces task completion time and improves classifier accuracy trained with the given labels.

Project 2: Dynamic Labeling: A Control System for Labeling Styles in Image Annotation Tasks

Labeling style affects labeling efficiency and quality in image annotation tasks. For example, a "label quickly" style can increase labeling efficiency when the data are easy, and a "label carefully" style can increase label quality when the data are difficult. However, the selection of an appropriate labeling style is difficult as different annotators have different experiences and domain knowledge, affecting their subjective feelings of data difficulties (for example, User 1 feels Data A to be easy, while User 2 feels it difficult). In this paper, we propose "Dynamic Labeling" as a control system for labeling styles used in image-labeling tasks. Our control system analyzes the labeling behaviors of annotators (i.e., label selection time) and dynamically assigns an appropriate labeling style (label quickly or label carefully). We conducted a user study to compare a conventional "non-dynamic" and the proposed "dynamic" labeling approaches for an image-labeling task. The results suggest that Dynamic Labeling increased the label quality and labeling efficiency.

*This study was extended from my 1st year project "Lableing Styles"[1] and it aims to improve the limitation of the previous study.

Project 3: Speed Labeling: Non-stop Scrolling for Fast Image Labeling

This study presents "speed labeling," an image-labeling technique to increase the efficiency of easy binary labeling tasks where an annotator can choose a label instantly. We first conduct a formative study to identify the factors affecting the efficiency of easy image labeling: image layout and image transition. Based on these results, we designed a novel labeling technique using non-stop scrolling. In conventional image labeling, the system moves to the next image only after the user assigns a label to

[1] **Chia-Mingc Chang**, Xi Yang, and Takeo Igarashi. 2022. An Empirical Study on the Effect of Quick and Careful Labeling Styles in Image Annotation. Gl 2022. Paper

the previous image. To maximize efficiency, our technique continuously scrolls images without waiting for the completion of labeling, assuming that the user gives labels at a mostly constant speed. The system dynamically adjusts the scrolling speed based on the labeling speed. Subsequently, we conduct a user study to compare the proposed “non-stop scrolling” technique to the conventional “stop-and-go scrolling” technique in an easy image-labeling task. The results showed that speed labeling requires less time (faster by 7%, 305 more images labeled per man-hour) to complete the labeling task than the conventional technique without a significant increase in errors. In addition, the results showed that speed labeling makes the labeling task more enjoyable for crowd workers and makes them feel more attentive during tasks.

In addition to my own projects, I also supervised students in relevant studies and two student papers were published in HCII222 (as full papers), see below (4) and (5).

【代表的な原著論文情報】

1) **Chia-Ming Chang**, Yi He, Xi Yang, Haoran Xie, and Takeo Igarashi. 2022. DualLabel: Secondary Labels for Challenging Image Annotation. Gl 2022.
2) **Chia-Ming Chang**, Yi He, Xusheng Du, Xi Yang, and Haoran Xie. 2023. Dynamic Labeling: A Control System for Labeling Styles in Image Annotation Tasks. Gl 2023
   [paper submitted, under review]
3) **Chia-Ming Chang**, Yi Tang, Xi Yang, Xiang 'Anthony' Chen, and Takeo Igarashi. 2023. Speed Labeling: Non-stop Scrolling for Fast Image Labeling. UIST 2023.
   [paper submitted, under review]
4) Shugo Miyata, **Chia-Ming Chang** and Takeo Igarashi, 2022, Trafne: A Training Framework for Non-Expert Annotators with Auto Validation and Expert Feedback. HCI International 2022
5) Yi Lu, **Chia-Ming Chang** and Takeo Igarashi, 2022, ConfLabeling: Assisting Image Labeling with User and System Confidence. HCI International 2022