Zero-Shot Character Identification and Speaker Prediction in Comics via Iterative Multimodal Fusion

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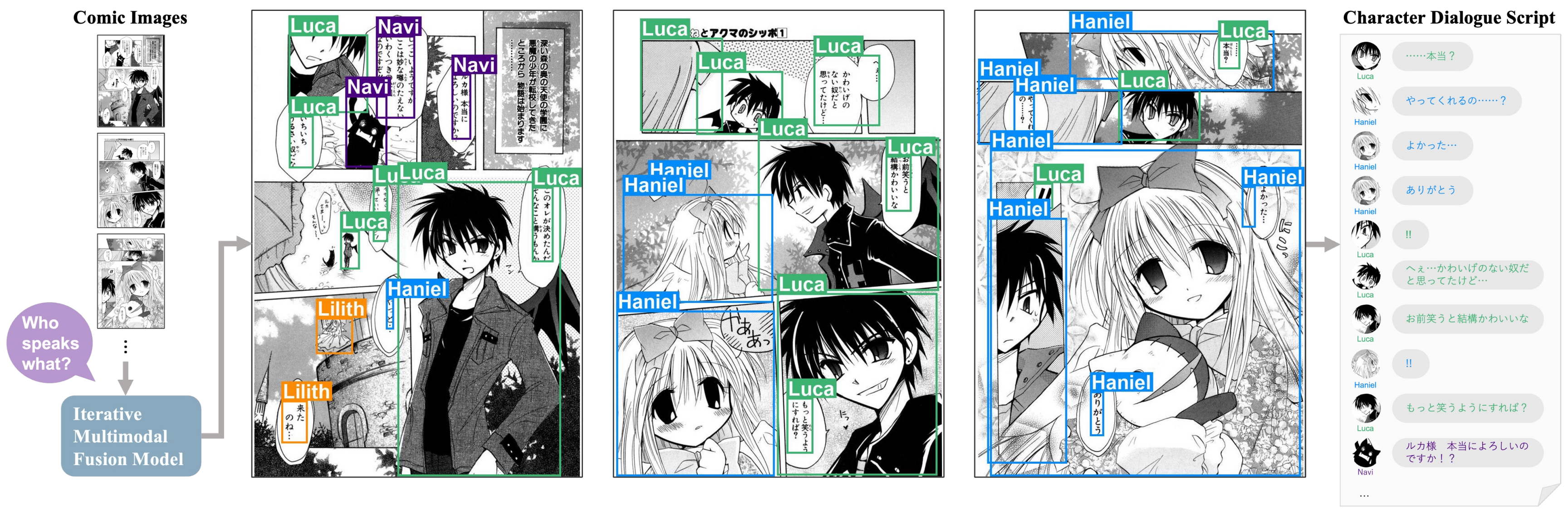
Introduction

Novel task

- Identify characters and predict speakers of unseen comics ***only from images***



Courtesy of Kiriga Yuki

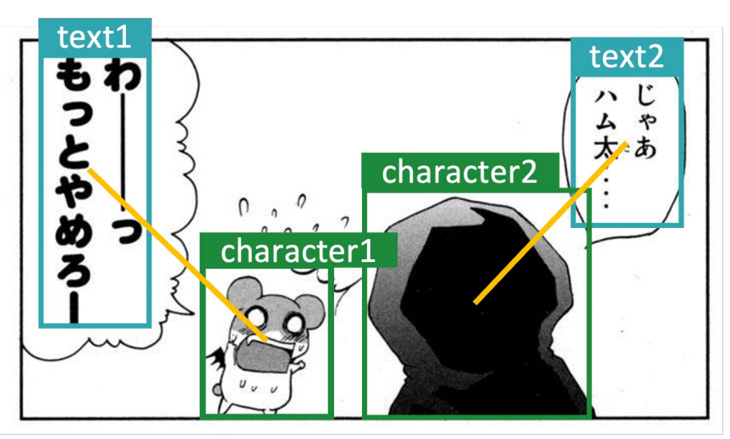
Applications

- Automatic character assignment for audiobooks
- Automatic translation according to characters' personalities
- Inference of character relationships and stories
- ...

Motivation

Limitations of previous studies

- **Speaker prediction:** Focused only on predicting the correspondence [1]
- **Character identification:** Required annotations and specific classifiers for each comic title [2]



Courtesy of Arai Satoshi

Research focus

- Predict character names for both text and character regions
- Tackle ***zero-shot*** tasks without requiring any annotations
- Enhance real-world applicability

Approach

Iterative multimodal fusion

- Leverage large language models (LLMs)
- Merge text-based LLM predictions with image-based classifiers
- Alternately refine each module using results from the other

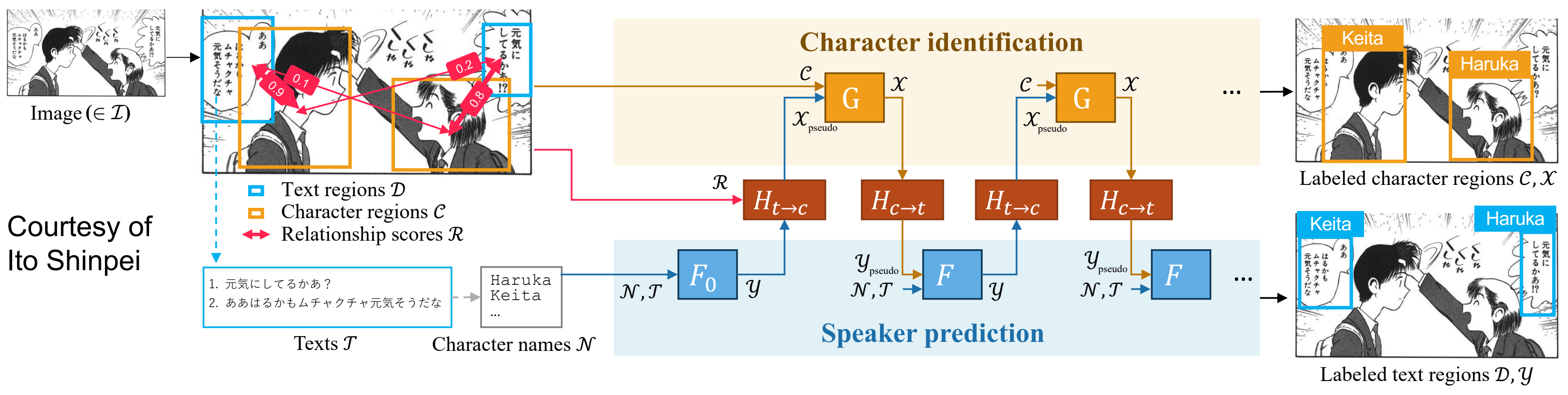


Image ($\in \mathcal{I}$)
Text regions $\mathcal{D}$
Character regions $\mathcal{C}$
Relationship scores $\mathcal{R}$
0.9
0.1
0.2
0.8
1. 元気にしてるかあ？
2. あははるかもムチャクチャ元気そうだな
Texts $\mathcal{T}$
Haruka
Keita
...
Character names $\mathcal{N}$
Character identification
$\mathcal{C}$
$\mathcal{X}$
$\mathcal{X}_{\text{pseudo}}$
G
$\mathcal{R}$
$H_{t\to c}$
$H_{c\to t}$
$\mathcal{N},\mathcal{T}$
F_0
$\mathcal{Y}$
$\mathcal{Y}_{\text{pseudo}}$
F
Speaker prediction
Keita
Haruka
Labeled character regions $\mathcal{C},\mathcal{X}$
Labeled text regions $\mathcal{D},\mathcal{Y}$

Courtesy of Ito Shinpei

Data preprocessing

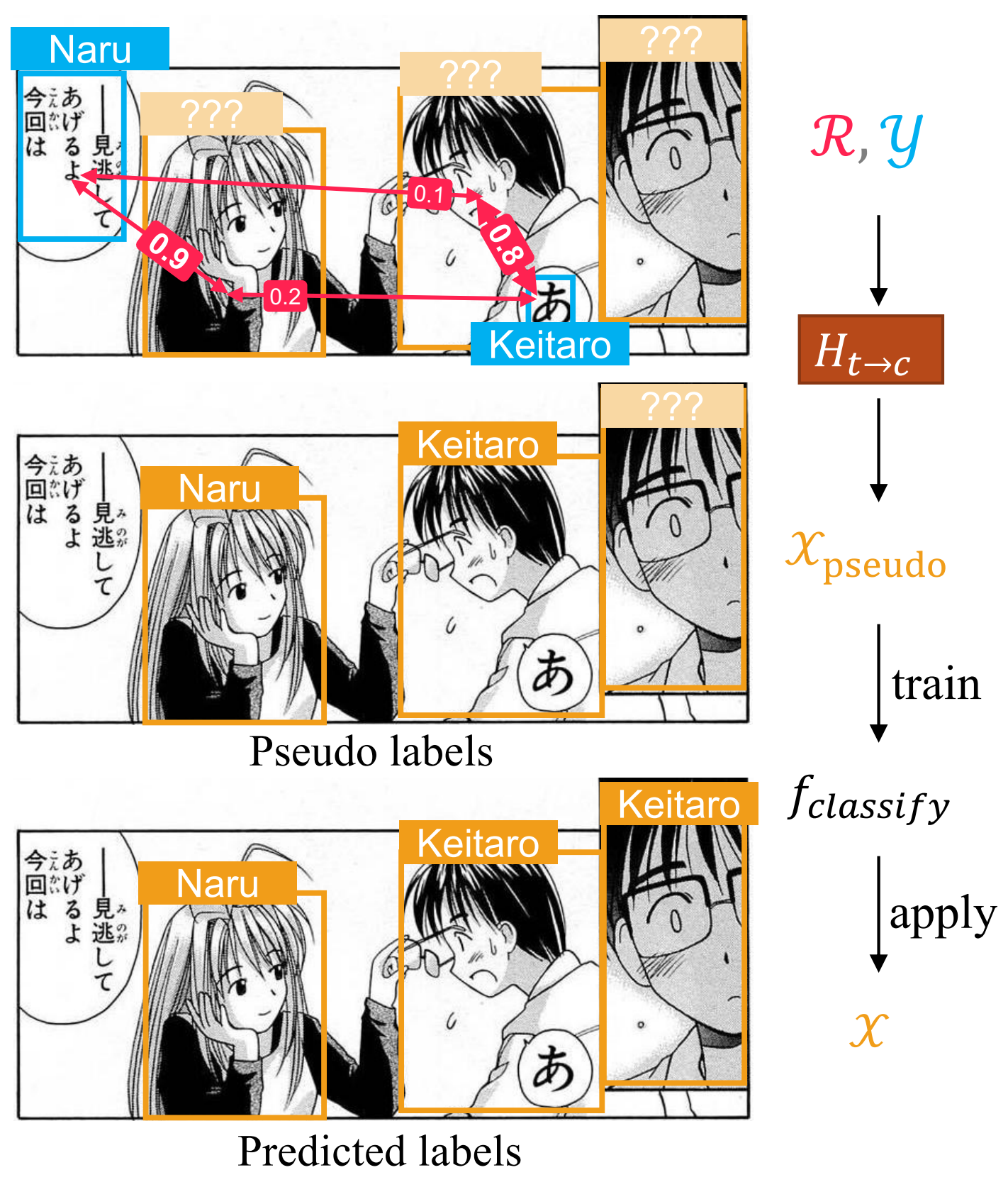
- Object detection: $\mathcal{I} \mapsto \mathcal{C},\ \mathcal{D}$
- Relationship prediction: $\mathcal{I},\ \mathcal{C},\ \mathcal{D} \mapsto \mathcal{R}$
- OCR: $\mathcal{I},\ \mathcal{D} \mapsto \mathcal{T}$
- Character name extraction: $\mathcal{T} \mapsto \mathcal{N}$

Main pipeline: Three modules

- Speaker prediction module (***F***)
- Character identification module (***G***)
- Label propagation module ($H_{t\to c}$, $H_{c\to t}$)

Initial speaker prediction: $\mathcal{T},\mathcal{N} \longrightarrow \boxed{F_0} \longrightarrow \mathcal{Y}$

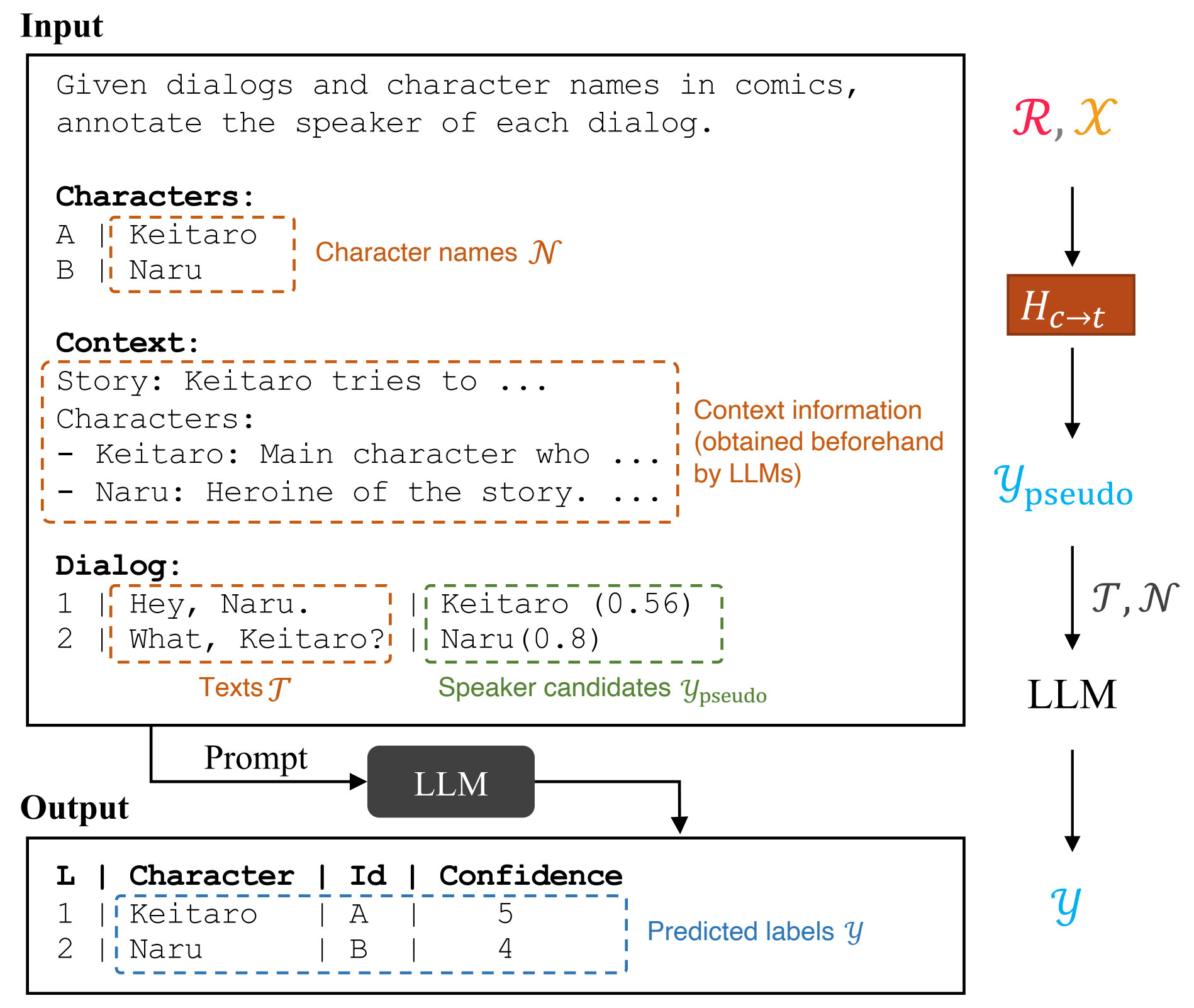
Iterative character identification



Pseudo labels

Predicted labels

Iterative speaker prediction



Input

```
Given dialogs and character names in comics,
annotate the speaker of each dialog.

Characters:
A | Keitaro
B | Naru

Context:
Story: Keitaro tries to ...
Characters:
- Keitaro: Main character who ...
- Naru: Heroine of the story. ...

Dialog:
1 | Hey, Naru.     | Keitaro (0.56)
2 | What, Keitaro? | Naru(0.8)
```

Character names $\mathcal{N}$

Context information (obtained beforehand by LLMs)

Texts $\mathcal{T}$

Speaker candidates $\mathcal{Y}_{\text{pseudo}}$

Prompt

LLM

Output

```
L | Character | Id | Confidence
1 | Keitaro   | A  |      5
2 | Naru      | B  |      4
```

Predicted labels $\mathcal{Y}$

$\mathcal{R},\mathcal{X}$
$H_{c\to t}$
$\mathcal{Y}_{\text{pseudo}}$
$\mathcal{T},\mathcal{N}$
LLM
$\mathcal{Y}$

Experiments

Main results

- **Dataset**
  - **Annotations:** Manga109 [3] + Manga109Dialog [1]
  - **Test set:** 23 volumes that were unseen in the training set
- **Task settings**
  - Set object regions ($\mathcal{C},\ \mathcal{D}$), texts ($\mathcal{T}$), and the name list ($\mathcal{N}$) to known
- **Baselines**
  - **Character identification:** Clustering + mapping clusters to ground truth*
  - **Speaker prediction:** Previous approaches + character identification results
- **Data division**
  - Divided the test set into *Easy* and *Hard* by the difficulty of relationship prediction
  - ***Easy***: 11 volumes with an accuracy of relationship prediction over 75%

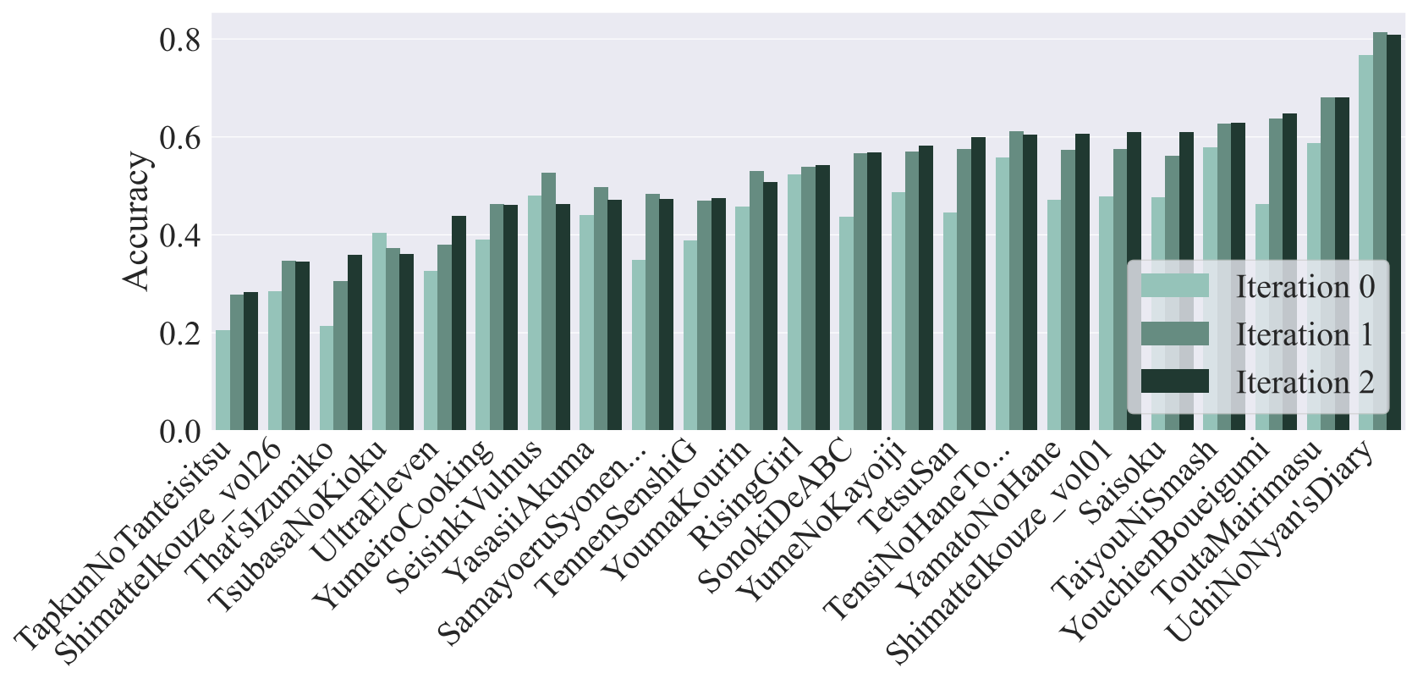
	iter	text	img	Speaker pred.			Character id.		
				Easy	*Hard*	*Total*	*Easy*	*Hard*	*Total*
Baseline									
K-means+Distance	-		✓	34.5*	31.8*	33.1*	37.0*	36.7*	36.8*
K-means+SGG	-		✓	36.7*	34.8*	35.7*	37.0*	36.7*	36.8*
Proposed									
LLM only	0	✓		41.8	45.1	43.6	-	-	-
Multimodal	1	✓	✓	51.0	51.2	51.1	45.8	39.6	42.4
	2	✓	✓	52.4	**51.3**	**51.8**	48.5	**40.3**	**44.0**
	3	✓	✓	**53.5**	49.8	51.6	**48.9**	37.7	42.8

(a) Results on different test sets. * indicates that the baseline method used the ground truth to map clusters into labels, as explained in the experimental setup.

	iter	Speaker pred.	Character id.
Baseline			
K-means+GT	-	42.0*	36.8*
Proposed			
LLM only	0	43.6	-
Multimodal	1	60.2	53.9
	2	63.4	55.5
	3	**63.8**	**56.6**

(b) Results using the ground truth relationships.

- **Speaker prediction accuracy of each comic title**



- **Zero-shot results**

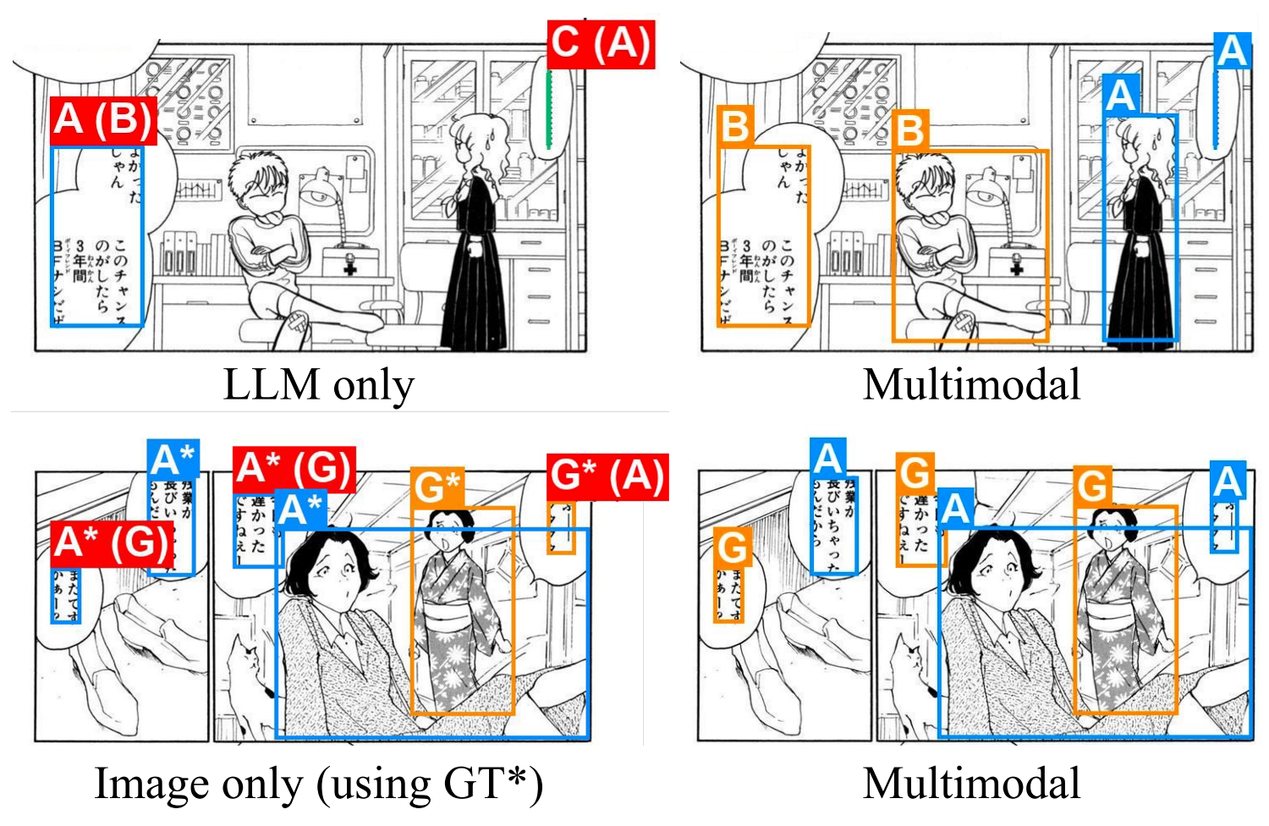
	iter	Speaker pred.	Character id.
LLM only	0	34.1	-
Multimodal	1	37.7	**35.6**
	2	**38.7**	35.0
	3	37.9	33.8
Upper bound	-	67.3	63.9

Correct prediction: The region was detected with an IoU > 0.5 and was correctly labeled

Upper bound: Accuracy under ideal conditions (when all labels of extracted names are perfectly predicted)

Qualitative results

- **Unimodal vs. Multimodal**



LLM only

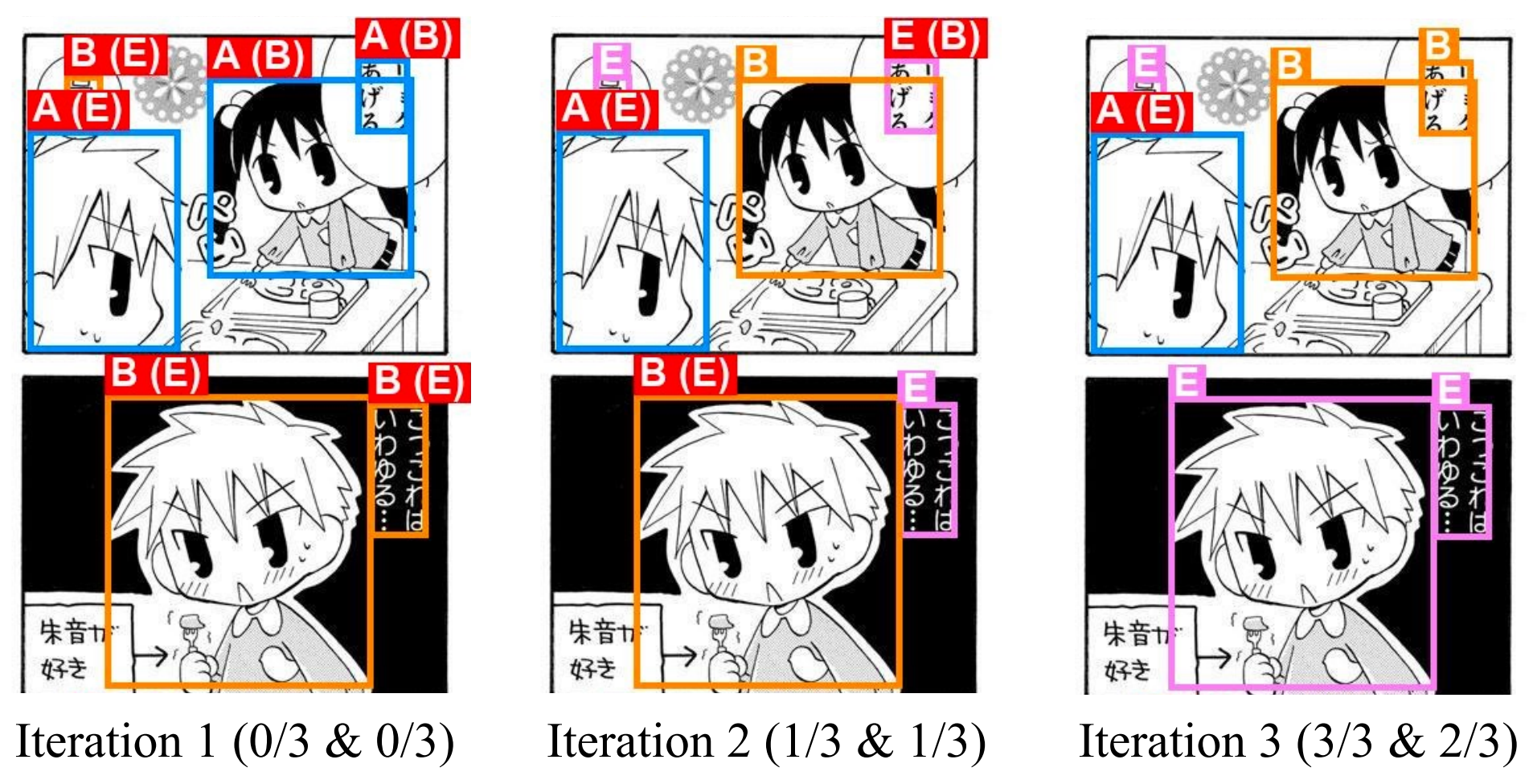
Multimodal

Image only (using GT*)

Multimodal

- **One-step vs. Iterative**

Courtesy of Tashiro Kimu, Hikochi Sakuya, Tenya



Iteration 1 (0/3 & 0/3)

Iteration 2 (1/3 & 1/3)

Iteration 3 (3/3 & 2/3)

Reference
[1] Manga109Dialog: A large-scale dialogue dataset for comics speaker detection. Li et al. ICME 2024.
[2] Cartoon face recognition: A benchmark dataset. Zheng et al. ACMMM 2020.
[3] Building a manga dataset “manga109” with annotations for multimedia applications. Aizawa et al. IEEE MultiMedia 2020.

Conclusion

New tasks

- First to integrate the tasks of character identification and speaker prediction in comics
- First to tackle zero-shot tasks with direct applications in real-world scenarios

Iterative multimodal fusion

- Revealing the significant potential of LLMs for comics analysis
- First approach to use both text and image information for character identification and speaker prediction

Our work has been accepted for ACM Multimedia 2024 (Oral)!

Paper on OpenReview

Project page