

Towards Learning of Spatial Triad from Online Text

Jina Kim and Yao-Yi Chiang

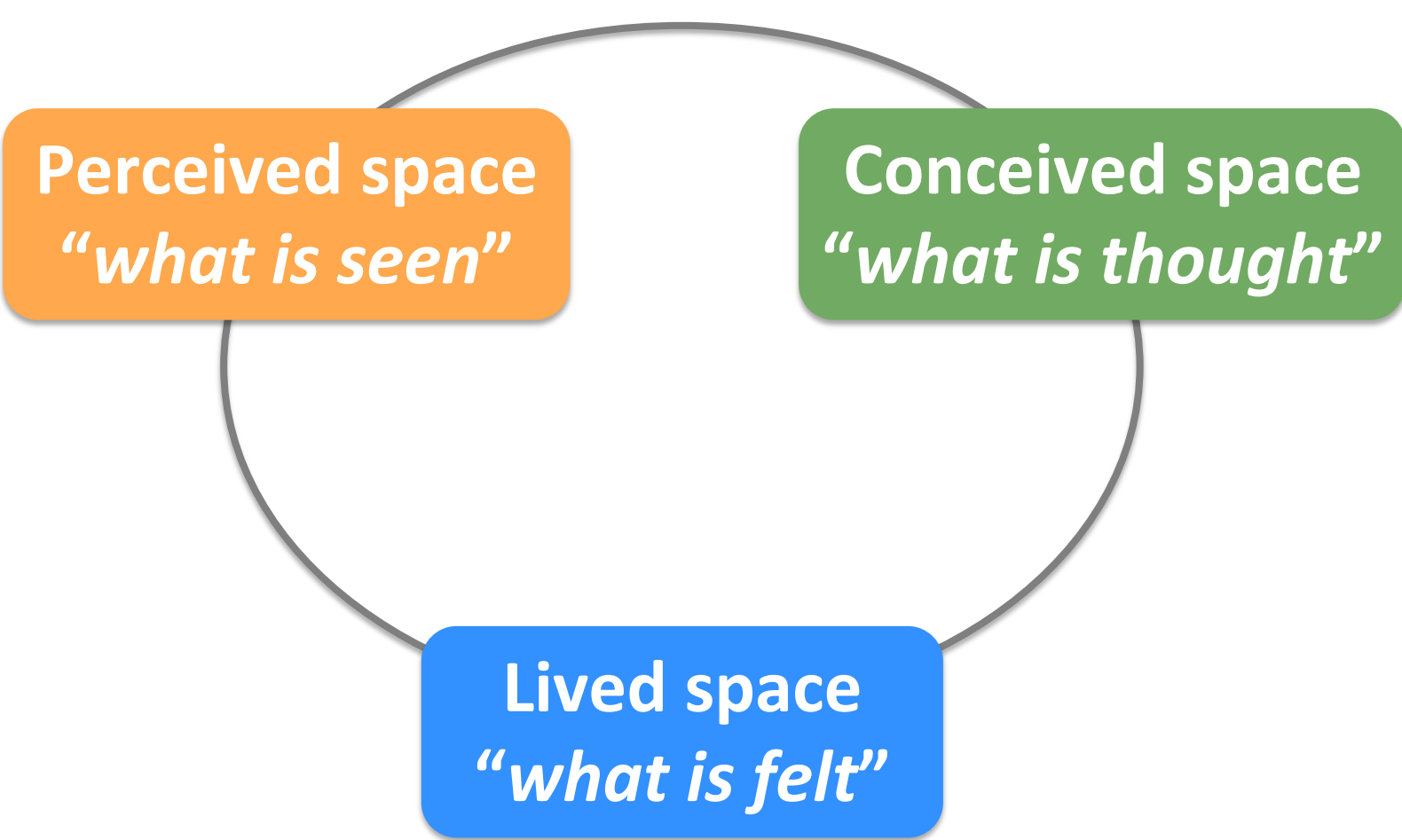
Department of Computer Science and Engineering, University of Minnesota, Minneapolis, USA
kim01479@umn.edu | jina-kim.github.io

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Nov. 15th Lunch

Understanding how humans see, feel, and think about their surroundings promotes human well-being and quality of life (e.g, Zhang et al., 2018)

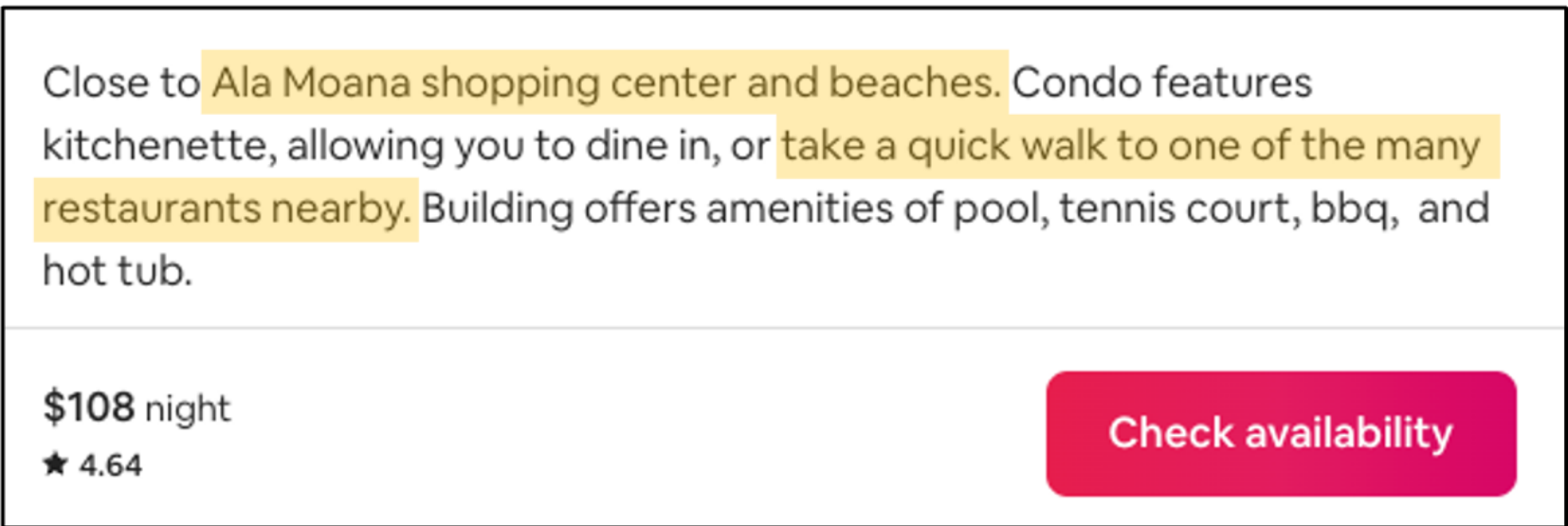


The Spatial Triad (McCann et al., 1999)

Existing Work on Understanding Spaces

- Expensive surveys and interviews (e.g., Bieling et al., 2014; Senlier et al. 2009)
 - Machine learning approaches using **images**
 - Extract objects (e.g., wall, building, tree) from street-level images
 - Predict perceptions of space (e.g., safe, lively, boring) (e.g., Ramírez et al., 2021; Zhang et al., 2018)
 - Learn visual representations of regions from satellite or street-level images
 - Predict socio-economic indicators (e.g., Park et al., 2022; Liu et al., 2023)
- Problems**
- Supervised prediction methods can require large training data when the relationship to learn is complicated (→)
 - Real world data often only have a few data points for training

Can We Use Online Text Reviews, Descriptions for Hotels, Rentals, Real Estates, Travel Blogs



	Satellite Image	Street-level Image	Text with Locations
Spatial Coverage	✓	Limited due to privacy, LMIC	✓
Spatial Triad			

e.g., Koreatown, Los Angeles & Koreatown, Chicago

Things to do #1: Capture shared concepts across documents within same locality

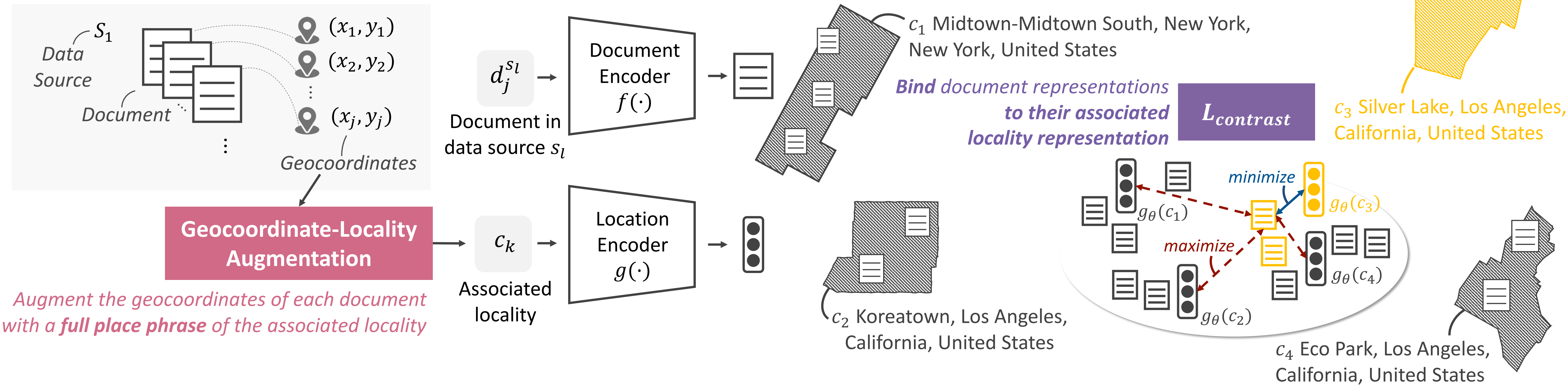
- Supervised topic modeling (e.g., BERTopic - Maarten Grootendorst, 2022)
 - often work on ONLY a few numbers of topics (e.g., 20 NewsGroups)
 - deal with easily distinguishable topics (e.g., transportation, safety)
- But there are subtle differences in locality characteristics*

Things to do #2: Preserve geographic hierarchy of localities and their semantic similarities

- Location encoders taking geocoordinates (e.g., Space2Vec - Mai et al., 2022)
 - useful on learning POI distributions
- But it is highly likely to have similar locality characteristics in same geographic hierarchies (e.g., state, country)*

Approach: Capturing Locality Characteristics from Text with Locations

Goal: Learn shared locality characteristics () across text descriptions within the same locality



Experiments

- Pretrain with Airbnb listing 649,651 descriptions of 179 cities / 167 Los Angeles / 165 New York City neighborhoods

1. Meaningfulness of Locality Representations

- Perform hierarchical clustering on the learned locality representations of a set of cities / neighborhoods



Sampled hierarchical clustering results using pretrained locality representations of LA neighborhoods

Close locality embeddings from our approach

New York and Boston
Silver Lake and Eco Park

Evidence from expert-curated data

'What are your city's twins?' article
'Hipster L.A.' with unique characteristics

Matched!

2. Locality-Related Downstream Tasks

- Perform downstream tasks that require understanding locality characteristics

Results on locality indices prediction for NYC neighborhoods

	Model	RMSE
NYC Open Data	KnowCL-Satellite (Liu et al., 2023)	0.622
	KnowCL-Street-level	0.657
	Our Method	0.142
	KnowCL-Satellite	0.612
Treepedia (Li et al., 2015)	KnowCL-Street-level	0.524
	Our Method	0.183
	Greenness	0.148

- Our method achieved higher performance using only text
- Text descriptions with feelings and thoughts of localities are meaningful

Future Work

- A robust foundation model that **comprehensively defines the Spatial Triad of localities** by incorporating other modalities of data