Zekun Li

Website | GitHub | LinkedIn

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Computer Science & Engineering, UMN Twin Cities

Research Interests

computer vision & **natural language processing**. I have worked on text detection on historical maps, and extracting general-purpose representations of geo-entities for toponym recognition and toponym linking tasks. Currently, I am working on building a vision-language model for map image VQA.

Technical Skills

DL Frameworks	:	**Pytorch**, Keras, Tensorflow, Theano, Caffe, CNTK
Languages	:	**Python**, C++, C, Java, MATLAB, JavaScript, PHP
Databases	:	PostgreSQL, MySQL
OS Systems	:	Linux, MacOS, Windows, Raspbian

Education

University of Minnesota, Twin Cities (UMN) 09/2021 - present
Ph.D. of Computer Science *College of Science & Engineering*

University of Southern California (USC) 08/2016 - 08/2021
Ph.D. of Computer Science *Viterbi School of Engineering*

University of Southern California (USC) 08/2014 - 05/2016
Master of Computer Science *Viterbi School of Engineering*

Chongqing University (CQU) 09/2010 - 06/2014
Bachelor of Engineering *College of Computer Science*

Publications

GeoLM: Empowering Language Models for Geospatially Grounded Language Understanding. [Link]
Zekun Li, Wenxuan Zhou, Yao-Yi Chiang and Muhao Chen.
Accepted to EMNLP 2023

The Best Protection Is Attack: Fooling Scene Text Recognition with Minimal Pixels. [Link]
Yikun Xu, Pengwen Dai, **Zekun Li**, Hongjun Wang and Xiaochun Cao.
IEEE Transactions on Information Forensics and Security (TIFS) 18 (2023): 1580-1595.

SpaBERT: Pretrained Language Models on Geographic Data for Geo-Entity Representation. [Link]
Zekun Li, Jina Kim, Yao-Yi Chiang and Muhao Chen.
In *Findings of the Association for Computational Linguistics: EMNLP (2022): 2757–2769.*

ACE: Anchor-free corner evolution for real-time arbitrarily-oriented object detection. [Link]
Pengwen Dai, Siyuan Yao, **Zekun Li**, Sanyi Zhang and Xiaochun Cao.
IEEE Transactions on Image Processing 31 (2022): 4076-4089.

Combining remote-sensing-derived data and historical maps for long-term back-casting of urban extents. [Link]
Johannes H. Uhl, Stefan Leyk, **Zekun Li**, Weiwei Duan, Basel Shbita, Yao-Yi Chiang, and Craig A. Knoblock.
Remote Sensing, 13 (18), 3672.

Synthetic Map Generation to Provide Unlimited Training Data for Historical Map Text Detection. [Link]
Zekun Li, Runyu Guan, Qianmu Yu, Yao-Yi Chiang, and Craig A. Knoblock.
ACM SIGSPATIAL Workshop on AI for Geographic Knowledge Discovery (2021): 17-26.

ChartOCR: Data Extraction from Charts Images via a Deep Hybrid Framework. [Link]
Junyu Luo, **Zekun Li**, Jinpeng Wang and Chin-Yew Lin.
IEEE/CVF Winter Conference on Applications of Computer Vision (WACV) (2021): 1917-1925.

An Automatic Approach for Generating Rich, Linked Geo-Metadata from Historical Map Images. [Link]
Zekun Li, Yao-Yi Chiang, Sasan Tavakkol, Basel Shbita, Johannes H. Uhl, Stefan Leyk and Craig A. Knoblock.
ACM SIGKDD International Conference on Knowledge Discovery & Data Mining (2020): 3290-3298.

Generating Historical Maps from Online Maps. **Zekun Li**. [Link]
ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems (2019): 610-611.

Weighted Feature Pooling Network in Template-Based Recognition [Link]
Zekun Li, Yue Wu, Wael Abd-Almageed, and Prem Natarajan.
Asian Conference on Computer Vision (ACCV) (2019): 436-451.

Presentations & Talks

Zekun Li and Yao-Yi Chiang, **The mapKurator System: A Complete Pipeline for Extracting and Linking Text from Historical Map** *Big Ten Academic Alliance (BTAA) GIS Conference 2023*

Zekun Li and Yao-Yi Chiang, **mapKurator: Revolutionizing Historical Map Analysis through Automatic Text Extraction and Entity Linking** *Center for GIScience and Geospatial Big Data (CeGIS) Research Meeting*

Jina Kim, Zekun Li and Yao-Yi Chiang, **Map Understanding Model: Generating GeoSpatial Linked Data from Map Images** *American Association of Geographers (AAG23)*

Yao-Yi Chiang, Jina Kim, Leeje Jang, Zekun Li, Yijun Lin and Min Namgung, **The mapKurator System: Extracting and Linking Text from Large Numbers of Historical Map Scans** *American Association of Geographers (AAG23)*

Yijun Lin, Jina Kim, Zekun Li and Yao-Yi Chiang, **SynMap: A Synthetic Dataset for Text Spotting in Scanned Historical Maps** *American Association of Geographers (AAG23)*

Malcolm Grossman, Yao-Yi Chiang and Zekun Li, **Linking WHG: An analysis of SpaBERT's performance on WHG** *American Association of Geographers (AAG23)*

Zekun Li, **Geospatial Data Understanding: A Peek into Historical Maps and Contemporary Geospatial Databases** *SIAM International Conference on Data Mining (SDM23)*

Zekun Li, Weiwei Duan, Yijun Lin, Fandel Lin, Tanisha Shrotriya, Yao-Yi Chiang and Craig Knoblock **Unearthing Hidden Treasures: Detecting Critical Minerals from Historical Maps.** *MSI Research Exhibition 2023*

Valeria Vitale , Katherine McDonough, Yao-Yi Chiang, Jina Kim, Zekun Li, Deborah Holmes-Wong and Rainer Simon, **Machines Reading Maps: unlocking historical maps with machine learning and semantic web technologies.***Spatial Humanities 2022*

Blogpost

Chris Fleet, Zekun Li, Katie McDonough, and Valeria Vitale, **Maps with a sense of the past: what are synthetic maps, and why do we love them?** on the *National Library of Scotland* blog [Link]

Research Projects

Geo-entity Feature Representation on Geographic Data *Research Assistant* Paper | Code | Slides | Video

- Developed a novel spatial language model called SpaBERT for characterizing geographic entities based on their surrounding entities in geospatial data
- Extended BERT to capture linearized spatial context and incorporated a spatial coordinate embedding mechanism to preserve spatial relations of entities in 2-dimensional space
- Pretrained SpaBERT with masked language modeling and masked entity prediction tasks to learn spatial dependencies. The learnt general-purpose representations can achieve better results on the **geo-entity typing** and **geo-entity linking** tasks compared to SOTA pretrained language models

mapKurator System for Scanned Historical Map Understanding *Project Lead* Paper | Code | Slides | Docs

- Designed and implemented an end-to-end automatic machine learning system called **mapKurator**, which incorporated state-of-the-art techniques for text spotting, image coordinate to geo coordinate conversion, PostOCR, and entity linking modules to process scanned historical maps.
- Successfully processed a **large volume** of historical map images, approximately **57K** from the David Rumsey Map Collection, showcasing strong technical proficiency in handling big data.
- Integrated mapKurator with the user-friendly **web interface** Recogito, allowing users to easily interact with the system and leverage its capabilities.

Generating Historical Maps from Open Street Maps *Research Assistant* Paper1 | Paper2 | Slides | Demo

- Synthesized historical maps in Ordnance Survey map style from Open Street Map tiles with a conditional **generative adversarial network**
- Leveraged the synthesized historical maps as the base-map and automatically place text labels on them to provide a **unlimited amount** of training data for text detection models
- Demonstrated that text detection models can achieve better performance after training on synethtic map dataset comparing with training on general-domain datasets (e.g. ICDAR15

Weighted Feature Pooling Network for Template-based recognition *Research Assistant* Paper | Poster

- Generated template-level representations given templates that contain **various number** of images
- Built an end-to-end neural network to extract image-level features and produce template-level features using **attention mechanism**, where attention scores indicate the quality of features in the same template
- Surpassed the state of the art performance on multiple tasks such as object classification, face recognition and action recognition with CIFAR, IJB-A/IJB-B and UCF101 datasets

Work Experience

Face Mesh and Gaze Prediction May 2021 - Aug 2021
Amazon Alexa AI *Applied Scientist Intern II*

- Designed a **joint model** to predict the 3D face mesh and the eye gaze direction in real time
- Used clustering-based method to select representative samples from real face images in order to fine-tune the models trained on synthetic face datasets.
- Adopted the **moving average loss** normalization technique to automatically up-weight/down-weight the two tasks and balance the training of the mesh prediction and gaze prediction

Synthetic Face Generation for Facial Landmark Detection May 2020 - Aug 2020
Amazon Alexa AI *Applied Scientist Intern*

- Built a robust pipeline to generate synthetic face images along with landmark annotations using 3D modeling application **Makehuman** and rendering application **Blender**
- Generated more than **204K synthetic images** based on **3000** 3D Makehuman models, with various pose, expression, camera rotation, lighting condition and backgrounds. Implemented the mapping of the vertices from 3D mesh into the image space to obtain facial landmarks for synthetic face images.
- Demonstrated that the **2D landmark detection** task and the **3D mesh prediction** task can both benefit from the large amount of generated synthetic images

Automated Visual Data Extraction from Chart Images May 2019 - Aug 2019
Microsoft Research Asia *Research Intern*

- Built a pipeline to automatically infer numerical values for **column chart images**
- Applied **trident-net** to extract the chart object heights. Designed a ruler encoding module to interpret the y-axis information to convert the objects from pixel-space to ruler space to generate reading

Media Coverage

University of Minnesota's Knowledge Computing Lab turns location data into time-saving tools *UMN News* [Link]

Academic Services

- **UMN COGS Grant Reviewer** Year 2023
- **Assistant Session Chair** - SIAM International Conference on Data Mining (SDM) Year 2023
- **Reviewer** - European Conference on Computer Vision (ECCV) Year 2022
- **Reviewer** - ACM SIGSPATIAL International Conference on Advances in GIS Year 2019-2023
- **Reviewer** - International Conference on Pattern Recognition (ICPR) Year 2020-2021
- **Reviewer** - Asian Conference on Computer Vision (ACCV) Year 2020-2021
- **Reviewer** - IEEE Winter Conference on Applications of Computer Vision (WACV) Year 2019-2022
- **Guest Speaker** - Spatial Enabled Artificial Intelligence *Introduction to PyTorch* Year 2022 Spring
- **Teaching Assistant** - Spatial Enabled Artificial Intelligence Year 2022 Spring
- **Teaching Assistant** - Foundations and Applications of Data Mining Year 2020, 2021 Spring
- **Mentor** - USC WiSE PhD Program Year 2020 Fall
- **Guest Speaker** - Advanced Spatial Computing: *Introduction to PostGIS* Year 2019 Fall

Honors & Awards

- SIAM International Conference on Data Mining (SDM) - Best Poster Award, Year 2023
- SIAM International Conference on Data Mining (SDM) - Student Travel Award, Year 2023
- **First-place** in DARPA AI for Critical Mineral Assessment Competition (**$10,000** prize), Year 2022
- British Cartographic Society / **Ordnance Survey Award**, Year 2022
- SIGSPATIAL Student Travel Grant , Year 2018 & 2019
- University Academic Scholarship (consecutively **6 semesters**) , Year 2011-2014
- Merit Graduate Student of Chongqing Universtiy , Year 2014
- **National Academic Scholarship** , Year 2013
- First Prize Winner, QianFang- Optoelectronics Innovation Contest , Year 2012
- QiuShi-LiuBiRu Scholarship, Year 2012
- Merit Student of Chongqing University , Year 2011