

# Patrick Xinghua Cheng

Dept. of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University

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## Research Interests

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Information Theory, Remote Sensing Image Processing, Thermodynamic Entropy, Machine Learning.

## Education

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M.S. Geomatics (**first-class honor**)

Sept 2018 - Feb 2020

*The Department of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University*

- Thesis: Entropy-based models for predicting lossless compression ratio of remote sensing images: from Shannon back to Boltzmann
- Grade: A+
- Advisor: Chair Prof. Zhi-lin Li

B.S. Geographical Information Science (**first-class honor**)

Sept 2014 - June 2018

*The Department of Geographical Information Science, Nanjing Normal University, China*

- Thesis: Spatial-temporal modelling for the district: A case study in Nanjing, China
- Grade: A+
- Advisor: Profs. Nan Jiang and Di Hu

## Academic Achievements

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### ● Research Articles

- **Cheng, X. H.**, Li, Z. L., 2021. Predicting the Lossless Compression Ratio of Remote Sensing Images with Configurational Entropy. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, vol 14, pp. 11936 – 11953. Doi: [10.1109/JSTARS.2021.3123650](https://doi.org/10.1109/JSTARS.2021.3123650). (IF: 3.78).
- Li, S. J., Hu, G. H., **Cheng, X. H.**, Xiong, L. Y., Tang G. N., Josef S., Integrating topographic knowledge into deep learning for the voids filling of digital elevation models. *Remote Sensing of Environment*, vol 269 Doi: [10.1016/j.rse.2021.112818](https://doi.org/10.1016/j.rse.2021.112818). (IF: 10.16).
- **Cheng, X. H.**, Li, Z. L., 2021. Configurational Entropy for Optimizing the Encryption of Digital Elevation Model Based on Chaos System and Linear Prediction. *Applied Sciences*, 11(5), pp. 2402, Doi:10.3390/app11052402. (IF: 2.68).
- **Cheng X. H.**, Hu D., He, H. D., Lv, G. N., Zhu, A. X., 2021. Parsing Data Formats of the Inputs and Outputs of Geographic Models with Code Analysis. [Preprint at arXiv preprint](#).
- **Cheng X. H.**, Hu E.J., Hu D. 2021. Integrating Structural Description of Data Format Information into Programming to Auto-generate File Reading Programs. [Preprint at arXiv preprint](#).
- **Cheng, X. H.**, Hu D., Yu, Z. Y., Long, Y., Zhou, R. C., 2017. Modelling spatial-temporal object of multi-granularity for district and its implementation by geodatabase. *Journal of Geo-information Science*, 19, (9), pp. 1228-1237, Doi: 10.3724/SP.J.1047.2017.01228. (In Chinese with English abstract).
- Hu, H. Y., Hu, D., **Cheng, X. H.** and Wang, Q. R., 2018. Design and Implementation of a Public-Facing Three Kingdoms Historical WebGIS. *Journal of Nanjing Normal University (Engineering and Technology Edition)*, vol 18, no. 1, pp. 71-78, Doi: 10.3969/j.issn.1672-1292.2018.01.010. (In Chinese with English abstract).

- **Book Chapter**

- Hu, D, **Cheng, X. H**, Lü, G. N, Wen, Y. N, Chen, M., 2020. The Chinese Family Tree Geographical information system. In: Ye, X.Y, Lin, H. eds. Spatial Synthesis: Computational Social Science and Humanities. Switzerland: Springer Nature, pp. 13-17, Doi: 10.1007/978-3-030-52734-1\_3.

- **Conference paper**

- **Cheng, X. H**, Li Z. L., 2020. How Does Shannon's source coding theorem Fare in prediction of image compression ratio with current algorithms? In ISPRS Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Doi: 10.5194/isprs-archives-XLIII-B3-2020-1313-2020.
- **Cheng, X. H**, Li, Z. L., 2020. Using Boltzmann Entropy to Measure Scrambling Degree of Grayscale Images. In *Proc. the 2021 IEEE 5th International Conference on Cryptography, Security and Privacy (CSP 2021)*, Zhuhai, China, pp. 181-185, Doi: 10.1109/CSP51677.2021.9357492.
- Zhou, R. C, Lu, K., Long, Y., Lu, J. Y, **Cheng, X. H**, Hu, D. and Gu, Y.H., 2017. A survey on social image understanding. In *Proc. 2017 IEEE International Conference on Behavioral, Economic, Socio-cultural Computing (BESC)*, Krakow, Poland, pp. 1-5 Doi: 0.1109/BESC.2017.8256394.

- **Papers in preparation**

- **Cheng, X. H**, Li, Z. L., A Generalized Law of Energy Conservation for Mapping from Multispectral Remote Sensing Imagery. (In preparation).
- **Cheng, X. H**, Li, Z. L., 2021. An Information-Theoretic Method to Evaluating Lossless Compression Techniques Applied to Remotely Sensed Data. (In review at *IEEE GRS letters*).

## Research Experience

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### Research Associate at department of land surveying and geo-informatics, HK PolyU

Advisor: Chair Prof. Zhi-lin LI

(<https://scholar.google.com.hk/citations?user=rUJycAoAAAAJ&hl=en>)

- **Project title: Development of Boltzmann-entropy-based image approaches for remote sensing image analysis** (*supported by a grant from the research grant council of Hong Kong Special Administrative Region*)
  - Responsible for developing novel and powerful methods of calculating Boltzmann entropy.
  - Engineered Boltzmann entropy-based models for predicting lossless image compression ratio.
  - Investigated the information transmission from multispectral remote sensing images to land cover maps with a statistical thermodynamics-based approach.
  - Surveyed the statistical thermodynamics in remote sensing image classification
  - Responsible for the development of statistical thermodynamics-based deep learning approaches for remote sensing image analysis.

Advisor: Dr. Yan Wei Yeung

(<http://www.lsgi.polyu.edu.hk/people/academic/yan-wai-yeung/index.asp>)

- **Project title: The next-generation global land cover map: a multispectral LiDAR approach** (*supported by a grant from the research grant council of Hong Kong SAR*)
  - Addressed the issue of measuring the information loss for point clouds denoising with an information-theoretic approach.
  - Development of information fusion approaches of multispectral point clouds and remote sensing images for land cover mapping.

### Research Assistant in “Yangtze River Delta Science Data Center, National Earth System Science Data Sharing Infrastructure” (June 2016 - June 2018)

Advisor: Prof. Nan Jiang and Dr. Di Hu

- **Project title: A Spatial-Temporal Framework Construction and Service of Nanjing over the Past Hundred Years** (*supported by a grant from the Jiangsu provincial bureau of surveying mapping and geoinformation, China*).
  - Participated in the development of web platform of service of Nanjing.
  - Analyzed the changes of the Nanjing district over the past century.
- **Project title: Spatial-Temporal Modeling and Positioning Approach of Historical Geographic Information** (*supported by a grant from the national science foundation of the People's Republic of China*).
  - Screened data for preliminary studying of spatial-temporal modeling.
  - Engineered two approaches for positioning historical geographic information.
- **Project title: Multi-granularity Spatial-Temporal Object Expression Model** (Sub-Topics of Pan-spatial Information System and Intelligent Facilities Management, *supported by a grant from the national science foundation of People's Republic of China*)
  - Responsible for district-based spatial-temporal modeling, and for the writing of portions of the manuscript that came out of this project.
  - Investigated the data structures for storing spatial-temporal data of the district.

## Work and Teaching Experience

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**Research Assistant** Dec 2018 - Feb 2020

**Research Associate** Mar 2020 – Present

- Affiliation: The Department of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University.

**Teaching Assistant** Sept 2020- Now

- Course Name: LSGI3242A Digital Terrain Modelling (Sept 2020-Dec 2020)
  - Instructor: Dr. Yan Wai Yeung
  - Responsibility: Lab Teaching, Assignments Marking
- Course Name: LSGI3244A\_535\_20202\_A Spatial Data Analysis and Mining (Jan 2021- May 2021)
  - Instructor: Dr. Xiao-lin ZHU
  - Responsibility: Lab Teaching, Assignments Marking

## Society Membership

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- North American Regional Association of the International Association for Landscape Ecology (IALE-NA) Student Membership.
- International Society for Photogrammetry and Remote Sensing (ISPRS)
- AAG (American Association of Geographers) Graduate Student Membership.
- Institute of Electrical and Electronics Engineers (IEEE) Geoscience and Remote Sensing Student Membership.

## Oral Presentation

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**Cheng, X. H.**, Li, Z. L. “Effects of Upscaling Functions on Calculating Thermodynamic Entropy of Numerical Raster Data: A Case Study on Aggregation”. In *T-08: Modeling, North American Regional Association of the International Association for Landscape Ecology (IALE-NA) Annual Meeting*, Nevada, USA, April 8-16, 2021. (Online).

**Cheng, X. H.**, Li, Z. L. “Boltzmann-entropy-based Optimization of Encryption and Decryption of DEM with Logistic Map”. In *Special Symposia-07: Entropy for landscape ecology: models, computation, and applications, North American Regional Association of the International Association for Landscape Ecology (IALE-NA) Annual Meeting*, Toronto, Canada, May 10-14, 2020. (Online).

**Cheng, X. H.**, Li, Z. L. "Using Boltzmann Entropy to Measure Scrambling Degree of Grayscale Images". In *2021 IEEE 5th International Conference on Cryptography, Security and Privacy (CSP 2021)*, Zhuhai, China, January 8-10, 2021.

**Cheng, X. H.**, Li, Z. L. "Measuring the Scrambling Degree of Remote Sensing Images: A Perspective from The Second Law of Thermodynamics". In *2020 International Graduate Workshop on Geoinformatics*, Wuhan, China, December 16-18, 2020.

**Cheng, X. H.**, Li, Z. L. "How Does Shannon's source coding theorem Fare in prediction of image compression ratio with current algorithms?" *XXIV International Society for Photogrammetry and Remote Sensing (ISPRS) Congress 2020*, Nice, France, June 14-20, 2020.

**Cheng, X. H.**, Hu, D., He, H. Y., Wang, Q. R. "Publicly-oriented Historical Geographical Information System of Three Kingdoms". *Digital Humanities: Academic Frontiers and Explorations in the Big Data Era" Symposium*, Nanjing, People's Republic of China, July 1-3, 2017.

<https://digitalhumanities.nju.edu.cn/meeting/5d8e0e1a3e22dbed8f/>.

## Academic Conference Experience

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- IALE-NA Annual Meeting, (2020 Toronto, Canada).
- XXIV ISPRS Congress 2020, (2020 Nice, France).
- The Second International Conference on Urban Informatics (2019 Hong Kong, China).
- ESRI China Developer Summit (2017 Beijing, China).
- The Eighth National Conference of Cartography and Geographical Information System (2016 Nanjing, China).
- ISPRS Geospatial Week (2017 Wuhan, China).

## Honor & Awards

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- LSGI Scholarship for Outstanding Academic Performance, The Hong Kong Polytechnic University (2018-2019).
- Nomination of Entry Scholarship of Faculty of Construction and Environment, The Hong Kong Polytechnic University (2018-2019).
- Outstanding Undergraduate Thesis of Nanjing Normal University, Sept 2018.
- Third-class Scholarship for Excellent Student, Nanjing Normal University, 2015
- Award of Pacemaker to Merit Student, Nanjing Normal University, December 2015.
- Third-class Scholarship for Excellent Student, Nanjing Normal University, 2016
- Second-class Scholarship for Excellent Student, Nanjing Normal University, 2017.
- Third-class Scholarship for Excellent Student, Nanjing Normal University, 2018
- Second Prize in the 5th National GIS Skills Competition (Qingdao, China), November 2016.
- Second Prize in the Mapping Group of Nanjing Normal University Campus Invitational Tournament of the 14th National University GIS Competition, Sept 2016.

## Professional Skills

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- Programming Languages: Python, R, C, C#, C++, Java, HTML5, JavaScript, Matlab
- Deep Learning Frameworks: Tensorflow, PyTorch.
- Operating System: Windows families, MacOS, Linux families.
- Databases: Oracle, Mysql, SQLite, PostgreSQL, SqlServer, ESRI Geodatabase.
- Software and Tools: Android Studio, MATLAB, Visual Studio, Eclipse, IntelliJ, ArcGIS, ENVI, Smart3D, AutoDesk 3ds Max, Level, Total Station, GPS, Theodolite, DJ UAV (Unmanned Aerial Vehicle).