# Patrick Xinghua CHENG

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## Research Interests

Machine Learning in Remote Sensing, Multi-modal Remote Sensing Data Fusion, Statistical Thermodynamics, Multispectral LiDAR Point Clouds, Communication Theorems.

## Education

M.S. Geomatics (with distinction) 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 imagery: from Shannon back to Boltzmann
- Grade: A+ **(the first master student supervised by Prof. LI)**
- Advisor: Chair Prof. Zhi-lin LI

B.S. Geographical Information Science (with distinction) Sept 2014 - June 2018
*The Department of Geographical information Science*, Nanjing Normal University, China

- Thesis: Spatial temporal modelling for district: A case study in Nanjing, China
- Grade: A+
- Advisor: Prof. Nan JIANG, Prof. Di HU

## Research Experience

### 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 of remote sensing imagery.**
  - **Investigated the information transmission from multispectral remote sensing image 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 denosing 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 Associate Prof. 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 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 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 manuscript that came out of this project.
  - Investigated the data structures for storing spatial temporal data of district.

### Achievements:

- **Research Paper**
  - **Cheng, X. H**, Li, Z. L., 2021. A Configurational Entropy-based Model for Predicting the Lossless Compression Ratio of Gray Images. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*. (Has been revised)
  - 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 model. *Remote Sensing of Environment* (Has been revised)
  - **Cheng, X. H**, Li, Z. L., Statistical Thermodynamics in Remote Sensing Image Classification: Experimental Demonstration and Verification of Jarzynski Equality. *Remote Sensing of Environment*. (In review).
  - **Cheng, X. H**, Li, Z. L., 2021. An Information-Theoretic Method for Evaluating Lossless Compression Techniques Applied to Remotely Sensed Data. *IEEE Geoscience and Remote Sensing Letters*. (In review).
  - **Cheng, X. H**, Li, Z. L., 2021. Statistical Thermodynamics in Remote Sensing Image Classification: Experimental Demonstration and Verification of Jarzynski Equality. *IEEE Transactions on Geoscience and Remote Sensing Letters*. (In review).
  - Hu, H. Y, Rao, J. M. **Cheng, X. H***, 2021. Visualizing the Spatial Heterogeneity of Accessibility of Metropolitan China with Thermodynamic Entropy. *Environment and Planning A*. (In review).
  - **Cheng X. H**, Hu D., He, H. D, Lv, G. N, Zhu, A. X., 2021. An Automatic Parsing Approach for Acquiring Data Formats of the Inputs and Outputs of Geographic Models. *Environmental Modelling & Software* (In review).
  - **Cheng, X. H**, Li, Z. L., Configurational Entropy for Optimizing the Encryption of Digital Elevation Model Based on Chaos System and Linear Prediction. *Applied Science*, 11(5), pp. 2402, Doi:10.3390/app11052402.
  - **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.

- **Cheng, X. H**, Hu, E. J, Hu, D, Zhu, A. X., Lü, G. N., 2021. Automatic Generation of File Reading Program: A Data-format-description-based Approach. *Computers & Geosciences* (in review).
- **Cheng, X. H**, Hu, D, Zhu, A. X., Lü, G. N., 2021. An Automatic Approach for Acquiring the Inputs and Outputs of Geographical Models. *Environmental Modeling & Software* (in review).
- **Cheng, X. H**, Hu D, Yu, Z. Y, Long, Y, Zhou, R. C., 2017. Modeling spatial temporal object of multi-granularity for district and its implementation by geodatabase. *Journal of Geo-information Science*, vol 19, no. 9, pp. 1228-1237, Doi: 10.3724/SP.J.1047.2017.01228.
- 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.
- 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*.

- **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.

## Work and Teaching Experience

**Research Assistant** Dec 2018 - Feb 2020

**Research Associate** Mar 2020 – 20 Dec 2021 (expected)

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

**Teaching Assistant** Sept 2020-Current

- 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

- 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

**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*, Neveda, 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. "Measung the Srambling Degree of Remote Sensing Imgaes: 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?" *XXIVI 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

- IALE-NA Annual Meeting, (2020 Toronto, Canada).
- XXIV ISPRS Congress 2020, (2020 Nice, Fance).
- 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

- 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

- 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).