

Kuldeep Ramchandra Kurte, Ph.D.

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Experience

2018—2019: Post-Doctoral Research Associate at Oak Ridge National Laboratory (ORNL)

Mentor: Dr. Jibonananda Sanyal

Projects:

Accelerated Global Human Settlement Discovery (PI: Dr. Jibonananda Sanyal, ORNL)

The main objectives of the project include developing of a scalable deep-learning model-based end-to-end workflow for identifying man-made structures from remote sensing imagery and identify the challenges for such large-scale (image) object detection tasks. My contributions in this project include benchmarking various modules in this workflow, implementing load-balancing and checkpoint-restart strategies to address the unbalanced workload and to prevent the data loss due to the runtime failures. Using this workflow, a remote sensing image dataset with a spatial resolution of 0.31m and is comprised of 685,675 km² of area of the Republic of Zambia was processed in under six hours using 5426 nodes of the Titan supercomputer.

The workflow was used to detect swimming pools in Texas, US. During this task, 4106 remote sensing images (2.0 GB – 12 GB each) were processed under 10 minutes. My contributions in this specific task are developing a GPU version of the index-based swimming pool detection algorithm using CUDA and executing a large job on Titan supercomputer to detect swimming pools in Texas. This algorithm can handle any size of remote sensing image irrespective of GPU version.

Urban Exascale Computing Project (UrbanECP) (PI: Dr. Charlie Catlett, Argonne National Lab)

This is a multi-DOE lab project. The objective of this collaborative effort is to build a coupled multi-scale models such as weather models, transportation simulations, building energy to simulate the interdependencies of these different systems in the urban environment. One of my contributions to this project includes the development of a capability to execute large number of transportation simulation models on Titan supercomputer using a high-performance workflow management system called Swif-t. As a part of this effort I have carried out a spatio-temporal study of the impact of the inclement weather on the transportation system of the City of Chicago and its overall energy footprint. The results of these analysis are being used to generate various scenarios for transportation simulation model. Currently, I am working on developing predictive models to predict traffic characteristics based on weather condition. Here, the task is to develop a capability that can fetch the daily weather information and can generate transportation scenario, and further execute the simulation model and perform this at a scale for multiple years.

Scalable Load Management using Reinforcement Learning (PI: Dr. Helia Zandi, ORNL)

The goal of this project is to develop a cost-effective load management system that can be used in existing homes with minimal effort to enable load flexibility to save money for the homeowners and to improve resiliency for the power grid. My ongoing contribution in this project is to develop reinforcement learning (RL) based optimization techniques to enable data-driven observation,

prediction, and control dispatch of the end-use devices such as HVAC, water heater. Currently, I am working on developing a deep Q-learning model to optimize the cost of HVAC for summer period.

Large-scale Hypergraph Analytics (PI: Dr. Neena Imam, ORNL)

Phoenix is a high-performance distributed streaming graph analytics framework under the Durmstrang project that focused on enabling concurrent utilization of online and offline graph analysis. The framework implemented a high-performance in-memory data structure for streaming property graphs over which both the online and offline queries are supported. The current framework does not support hypergraph generation and processing capability. My major ongoing contribution to this project is implementing a hypergraph's in-memory tensor representation and tensor decomposition capability for Phoenix.

Education

2011—2017 M.Tech + Ph.D. Dual degree

Indian Institute of Technology Bombay, Mumbai, India

Department: Centre of Studies in Resources Engineering

CPI (Cumulative performance index out of 10): 9.33

Dissertation: *Semantics enabled framework for spatial image information mining of linked earth observation data* (Supervisor: Dr. Surya S. Durbha)

Developed a framework for spatial image information mining from Earth Observation (EO) data repository which uses a novel Linked data-based approach to store EO data. A Spatial Semantic Graph (SSG) and sub graph isomorphism-based approach were used to model complex spatial relationships among image regions.

Developed and integrated a rapid Big Data process chain for Spatial Image Information Mining (SIIM) using a hybrid High Performance Computing (HPC) approach, to reduce the processing time of the large data.

Proposed and developed a Dynamic Flood Ontology (DFO) and integrated with the SIIM ontology to enable spatio-temporal queries on EO data.

Master's thesis work (M.Tech.): Developed a rapid parallelized k -medoid clustering algorithm using C/CUDA and tested its performance against non-parallelized version.

2006—2010 B.E. (Bachelor of Engineering) in Computer Engineering

Mumbai University, India

Percentage: 70.03%

Key Research Interests

Machine Learning: Supervised and unsupervised image classification, Support Vector Machines, spatial clustering, Deep learning, Reinforcement learning.

Image Information Mining: Image retrieval from large image archives, Spatial relations modelling for more intuitive image retrieval, Spatio-Temporal image mining, Content-Based Image Retrieval (CBIR), Region-Based Image Retrieval (RBIR).

High Performance Computing (HPC): Accelerating Big-data processing using HPC technologies such as Message Passing Interface (MPI), CUDA, MPI+GPU based hybrid computing, GPU optimization; Exploring Single Instruction Multiple Data (SIMD) architecture to accelerate various computationally intensive algorithms; applications of HPC technology in real-world scenarios such as flood disaster.

Semantic Web (Web 3.0): Linked data representation of geospatial data, Resource Description Framework (RDF) modeling, Knowledge representation through domain Ontology, Geospatial Ontologies development, Rule reasoning for knowledge extraction, SPARQL query, Reasoning, Semantic Web Rule Language (SWRL).

Interoperability and Geospatial standards and semantics: Open Geospatial Consortium (OGC) web

services, OGC Geospatial Sensor Web framework, Sensor Model Language (SensorML), Sensor Observation Service (SOS), Sensor Alert Service (SAS), Geospatial applications development using Service Oriented Architecture (SOA) and Sensor Web Enablement (SWE).

Internet of Things (IoT): Accelerating various algorithms of IoT in the domains of agriculture, disaster etc. using GPU enabled embedded platforms such as NVIDIA Jetson TK1, R-Pi etc. for location-based services, semantics enabled location-based services.

Peer Reviewed Journals

1. **K. R. Kurte**, J. Sanyal, A. Berres et al., "Performance analysis and optimization for scalable deployment of deep learning models for country-scale settlement mapping on Titan supercomputer," *Concurrency Computation Practice and Experience*, May 2019. doi: <https://doi.org/10.1002/cpe.5305>.
2. **K. R. Kurte**, S. S. Durbha, R. L. King, N. H. Younan and R. Vatsavai, "Semantics-Enabled Framework for Spatial Image Information Mining of Linked Earth Observation Data," *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, vol. 10, no. 1, pp. 29-44, Jan. 2017.
3. S. S. Durbha, **K. R. Kurte**, U. M. Bhangale, "Semantics and High-Performance Computing Driven Approaches for Enhanced Exploitation of Earth Observation (EO) Data: State of the Art", *Proceedings of the National Academy of Sciences, India Section A: Physical Sciences*, Nov. 2017.

Peer Reviewed Conferences

1. A. Berres, P. Im, **K. R. Kurte**, M. Allen-Dumas, G. Thakur, and J. Sanyal, "A Mobility-Driven Approach to Modeling Building Energy", In 5th IEEE Workshop on Big Data Analytics in Supply Chains and Transportation at 2019 IEEE International Conference on Big Data (Big Data 2019) .
2. **K. R. Kurte**, A. V. Potnis, Surya Durbha, "Semantics-enabled Spatio-Temporal Modeling of Earth Observation Data: An application to Flood Monitoring", In 2nd ACM SIGSPATIAL International Workshop on Advances on Resilient and Intelligent Cities (ARIC'19), November 5–8, 2019, Chicago, IL, USA. ACM, New York, NY, USA, 10 pages. <https://doi.org/10.1145/3356395.3365545>.
3. O. Kotevska, **K. R. Kurte**, J. Munk et al., "RL-HEMS: Reinforcement Learning-Based Home Energy Management System for HVAC Energy Optimization," *2020 ASHRAE Winter Conference*.
4. **K. R. Kurte**, S. Ravulaparthi, A. Berres et al., "Regional-scale Spatio-Temporal Analysis of Impacts of Weather on Traffic Speed in Chicago using Probe Data," *The 9th International Conference on Sustainable Energy Information Technology (SEIT'19)*.
5. **K. R. Kurte**, A. V. Potnis, Surya Durbha, Rajat Shinde, "Semantic framework for spatial query reformulation for disaster monitoring applications," *2019 IEEE International Geoscience and Remote Sensing Symposium*.
6. A. V. Potnis, R. Shinde, S. S. Durbha, **K. R. Kurte**, "Multi-class segmentation of urban floods from multispectral imagery using deep learning," *2019 IEEE International Geoscience and Remote Sensing Symposium*.
7. A. V. Potnis, S. S. Durbha, **K. R. Kurte**, "A Geospatial Ontological Model for Remote Sensing Scene Semantic Knowledge Mining for The Flood Disaster", *2018 IEEE International Geoscience and Remote Sensing Symposium*.
8. **K. R. Kurte**, S. S. Durbha, R. L. King, N. H. Younan and A. V. Potnis, "A Spatio-Temporal Ontological Model for Flood Disaster Monitoring", *2017 IEEE International Geoscience and Remote Sensing Symposium (IGARSS)*.
9. **K. R. Kurte**, S. S. Durbha, "Spatio-Temporal Ontology for Change Analysis of Flood Affected Areas Using Remote Sensing Images", *9th International Conference on Formal Ontology in Information Systems (FOIS 2016)*. (**One of the top three finalists for Ontology Competition track**)
10. **K. R. Kurte**, U. M. Bhangale, S. S. Durbha, R. L. King and N. H. Younan, "Accelerating Big Data processing chain in Image Information Mining using a hybrid HPC approach," *2016 IEEE International Geoscience and Remote Sensing Symposium (IGARSS)*, Beijing, 2016, pp. 7597-7600. (**considered for NVIDIA innovation award at HIPC 2016**)
11. U. M. Bhangale, **K. R. Kurte**, S. S. Durbha, R. L. King and N. H. Younan, "Big data processing using hpc for remote sensing disaster data," *2016 IEEE International Geoscience and Remote Sensing Symposium (IGARSS)*, Beijing, 2016, pp. 5894-5897.

12. U. Bharambe, S. S. Durbha, R. L. King, N. H. Younan and **K. Kurte**, "Use of geo-ontology matching to measure the degree of interoperability," *2016 IEEE International Geoscience and Remote Sensing Symposium (IGARSS)*, Beijing, 2016, pp. 7601-7604.
13. **K. R. Kurte**, S. S. Durbha, "Graphics processing units-based region clustering for region-based image retrieval in image information mining", *National Conference on Application of Geoinformatics in Rural, Urban & Climatic Studies (Geomatrix14)*, pp. 319-322, Mumbai, 6-7 June 2014 (**Best poster award**).
14. **K. R. Kurte**, S. S. Durbha, "High resolution disaster data clustering using Graphics Processing Units", *IEEE International Geoscience and Remote Sensing Symposium (IGARSS'13)*, vol., no., pp.1696,1699, 21-26 July 2013.
15. U. Bharambe, S. S. Durbha, **K. R. Kurte**, N. H. Younan, R. L. King, "Pareto optimization for multi-objective matching of geospatial ontologies", *IEEE International Geoscience and Remote Sensing Symposium (IGARSS'13)*, pp.1159-1162, Melbourne, 21-26 July 2013.

Technical Reports

H. Zandi, M. Starke, J. Munk, C. Winstead, O. Kotevska, **K. R. Kurte**, T. Kuruganti, "Field Evaluation Plan for Multi-year Experiment," ORNL/SPR-2019/1127.

Other Publications/Posters/Presentations/Talks

1. A. Berres, P. Im, **K. R. Kurte** et al., "A Data-Driven Urban Scale Mobility Model for Estimating Building Occupancy for EnergyPlus," *Accepted for the presentation during 2019 ASHRAE Building Performance Analysis Conference*, Denver, USA, 2019.
2. **K. R. Kurte**, A. Berres, G. Thakur et al., "Performance Analysis and Optimization Challenges in Scaling a Transportation Simulation," *Presented a poster during Exascale Computing Project (ECP) Meeting*, Huston, Texas, US, 2019.
3. A. Berres, **K. R. Kurte**, M. Allen et al., "Coupled Urban Modeling: The Big Data Challenge in Exascale Computing," *Presented a poster during Exascale Computing Project (ECP) Meeting*, Huston, Texas, US, 2019.
4. L. Yang, D. Lunga, M. Coletti et al., "Accelerated Global Human Settlement Discovery," *Presented a poster during Oak Ridge Leadership Computing Facility (OLCF) user meeting*, May 2018.
5. M. Coletti, J. Weaver, A. Berres, et al., "Preliminary results for optimizing a building footprint detection deep learner's hyper-parameter with an evolutionary algorithm," *Presented a poster during Oak Ridge Leadership Computing Facility (OLCF) user meeting*, May 2018.
6. M. Coletti, J. Weaver, A. Berres, et al., "Size Matters — Evolving Misbehaving Deep Learner Kernel and Batch Sizes," *Presented at the Urban Dynamics Institute Lunch and Learn talk*, April 2018.

Awards and Recognitions

1. One of the top three finalists in Ontology Competition track held during a conference on Formal Ontology in Information Science (FOIS'16), France, 2016.
2. Grant from IEEE Geoscience and Remote Sensing Society to attend IGARSS, 2016.
3. Best poster award in the national conference on geospatial technologies (Geomatrix'14), India, 2014.
4. Awarded the Junior Research Fellowship (JRF) and the Senior Research Fellowship (SRF) by MHRD, Govt. of India for pursuing the Ph.D. at IIT Bombay, 2013—2017.
5. Awarded the GATE scholarship by MHRD, Govt. of India to pursue M. Tech. at IIT Bombay, 2011—2013.
6. Secured 1st rank in the first year of M.Tech, at CSRE, IIT Bombay with CPI 9.33, 2011—2012.
7. Awarded the certificate from Indian Space Research Organization (ISRO) for successfully clearing a distance learning course exam on *Hyperspectral Remote Sensing* at IIT, Bombay. 2012.
8. Silver Medal winner in Science quiz competition (Taluka level) at Vasai, Maharashtra, India. 2000.

Invited Talks/Workshops

1. Invited session on Python during workshop on Tools and Techniques to Start with HPC at ORNL, 2018.

2. Delivered a guest lecture on *Data Analytics with Python and R* at Shah & Anchor Kutchhi Engineering College, University of Mumbai, 2018.
3. Invited two-day workshop on QGIS during Geoweek, 2017. (Fergusson college, Pune), 2017.
4. Invited lecture on *Parallel Computing* at Vidyalankar Institute of Tech., University of Mumbai, 2017.
5. Invited lecture on *High Performance Computing* during Short Term Training Program (STTP) organized by Vidyalankar Institute of Technology, University of Mumbai, 2017.
6. A talk on *Rapid Image Information Mining for flood disaster* at de-HPC' 16, IIT Bombay, 2016.
7. Delivered a talk on *Big data processing in remote sensing* at Embedded Supercomputing meetup, IIT Bombay 2015.

Positions of Responsibilities

Teaching Assistantship: Conducted lecture sessions for the subject “Advances in Geospatial Standards, Interoperability and Knowledge Discovery”, Conducted GIS lab for the class of 20 students in autumn semester. 2012—2017.

Organizing Committee Member of de-HPC'16 conference: Distributed & Embedded-High Performance Computing (de-HPC), 2016 held at IIT Bombay. Overall coordinator of the event. Organized and lead the team of volunteers to ensure the smooth functioning of the various teams such as, publicity, sponsorship, hospitality.

Member, Sponsorship Team, Geomatrix'12 and Web Team Geomatrix'14

Active participant in sponsorship team of Geomatrix'12, International Conference on Geospatial Technologies held in February 2012 at IIT Bombay.

Coordinated a web team of Geomatrix'14, National Conference on Geospatial Technologies, 2014, held in IIT Bombay.

Mentoring

1. Mentoring one Science Undergraduate Laboratory Internships (SULI) student and one high-school student during summer 2019.
2. Conducted C tutorial sessions for beginners as a pre-placement activity, CSRE, IIT Bombay, 2012.

Professional Memberships

IEEE Membership.

IEEE Young Professionals.

IEEE Geoscience and Remote Sensing Society Membership (GRSS).

IEEE Computer Society.

ACM Membership.

ACM SIGSPATIAL Membership.

Student member of Resources Engineers Association (REA).

Service

Program committee ACM SigSPATIAL workshop “GeoAI2019”, “GeoAI2018”.

Program committee SEIT2020.

Program committee MobiSPC2020.

Technical committee EarthVision2020 workshop

Reviewer of EarthVision2020 workshop.

Reviewer of IEEE International Geoscience and Remote Sensing Symposium (IGARSS'20), 2020.

Reviewer of IEEE Transaction on Parallel and Distributed Systems (TPDS), 2020.

Reviewer of Journal of Supercomputing, 2020.

Reviewer of Journal of Indian Society of Remote Sensing, 2020.

Reviewer of International Journal of Natural Hazard, 2019.

Reviewer for SigSPATIAL workshop GeoAI [2018], [2019].

Reviewer for the International Journal of Geographical Information Science, 2018.

Reviewer for the journal GeoInformatica, 2018.
Reviewer for the journal of Earth Science Informatics, 2018.
Reviewer for ORPA symposium, 2018.

Summer School/ Workshops Attended

Third Interdisciplinary School on Applied Ontology (ISAO 2016). Organised by The International Association for Ontology and its Appli. (IAOA) and the Free University of Bozen. June 27- July 1, 2016.

Academic Projects

Ph. D: Semantics enabled framework for spatial image information mining of linked earth observation data, (2013 – 2017)

- Developed a framework for spatial image information mining from Earth Observation (EO) data repository.
- Demonstrated a Linked data based novel approach to store EO data.
- Developed a Spatial Semantic Graph (SSG) and sub graph isomorphism-based approach for complex spatial relationships-based querying for image information mining from EO repositories.
- Developed and integrated a rapid Big Data process chain for Spatial Image Information Mining (SIIM) using a hybrid High Performance Computing (HPC) approach, to reduce the processing time of the large data.
- Proposed and developed a Dynamic Flood Ontology (DFO) and integrated with the SIIM ontology to enable spatio-temporal queries on EO data.

M.Tech. Thesis: GPU Driven Geospatial Data Processing (*C, CUDA*)(2012-13)

- Objective is to improve various classification algorithms using computing horsepower of GPU.
- *k*-means classification algorithm is implemented and compared its performance with CPU version.
- NVIDIA's GeForce and Tesla GPU are used for this purpose.

B.E. Major Project: Robot Path Follower (*C, Assembly Language, 8051 Microcontroller*), 2010

- A robotic vehicle was implemented which follows the user specified path.
- With the help of various sensors robot can be used as spy vehicle.

B.E. Minor Project: Mailing System (*ASP, Javascript*), 2009

- Developed a web site which sends messages to the person provided he/she has account.
- Web site provides *inbox, outbox, send message* functionalities.

Course projects (2011—2012)

Simulation of Bus Movement (*Java, Ms Access*): Movements of the buses in IIT Bombay campus are simulated by using Java multithreaded approach. *Subject: Geographical Information System.*

Integration of Heterogeneous Geospatial Information (*Java, Ajax, SPARQL*): Developing AJAX-driven web client interface to access geospatial data from web server using *Google Web Toolkit* and Geoserver as backend. *Subject: Advances in Geospatial Standards, Interoperability and Knowledge Discovery.*

Calculation of NDVI, Band Ratio, Band Difference for Satellite Image (*Java*): Normalized Differential Vegetation Index for given area was calculated using *Infra-red* and *Red* band of satellite data. *Subject: Satellite Image Processing.*

Binary Classification of Image Using Neural Network (*Java*): Implemented single layer perceptron model using back-propagation training algorithm. *Subject: Advance Satellite Image Processing.*

Dam-site Selection and Its Environmental Impact Assessment (*Matlab*): Implemented Region Growing Segmentation algorithm to select optimal locations for dam construction using various spatial information. *Subject: Spatial Databases.*

Course Seminars (2011—2012)

Particle Swarm Optimization (PSO): Presented a comparison of PSO with Genetic algorithm and its applications in various areas like *Neural Network Training*.

Dynamic Tunneling Approach to Improve Training Method of Neural Network: Studied an approach to improve the back-propagation training algorithm.

Technical Skills

Languages/Software: C/C++, Java, Python, R, HTML, XML, Ajax, Protégé, Weka Data Miner Tool, ArcGIS, ERDAS, Apache Tomcat, Matlab, ASP, Javascript, PHP, VB 6.0

High Performance Computing: Programming GPUs, CUDA, open-MPI, openMP, openACC

Database Technologies: PostGreSQL, PostGIS, Ms-Access, MySQL

Semantic Web: Allegrograph RDF triplestore, DL-Reasoner, SPARQL, Geo-SPARQL, OWL, RDF

Key Courses: Spatial Databases, Geographical Information System (GIS), Satellite Image Processing, Machine Learning, Remote Sensing, Natural Resource Potential Modelling, Advances in Geospatial Standards, Interoperability and Knowledge Discovery.

Extra Curriculars

Technical

Finalist of *CSI project showcase* in college techfest OPUS at VCET, Vasai, 2010.

First Runner-up in *Codexterity* coding competition in college techfest ORION at VCET, Vasai, 2009.

Cultural

Enacted in *Street Play* drama competition for two consecutive years in B.E. (2009—2010)

Performed in Group Dance Event of PG-Cult IIT, Bombay, 2012.

Sports

Performed *Military Rope Stunts* in college festival ZEAL at VCET, Vasai, (2009—2010).

Participated in *Football, Cricket, Carrom* competitions in PG-Sports at IIT, Bombay, (2011—2012).

References

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Dr. Jibonananda Sanyal

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