

Dr. Varun Chandola

CONTACT INFORMATION

Assistant Professor
Computer Science & Engineering
University at Buffalo
The State University of New York
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Buffalo, NY 14260 USA

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RESEARCH INTERESTS

I focus on using **Machine Learning**, **Data Mining**, and **High Performance Computing** for decision oriented knowledge discovery from massive data sets. I develop methods for identification of anomalous events from big data sets. My research encompasses the entire spectrum of decision enabling knowledge discovery, from designing algorithms for critical event detection, scaling them for big data problems in varied domains, and creating deployable solutions for the benefit of broad scientific and research community.

EDUCATION

University of Minnesota, Twin Cities, MN

Ph.D., **Computer Science**, September 2009

- Thesis Topic: *Anomaly Detection for Symbolic Sequences and Time Series Data*
- Adviser: Professor Vipin Kumar
- Co-adviser: Professor Arindam Banerjee
- Thesis Committee: Professor Jaideep Srivastava, Professor Xiaotong Shen

Indian Institute of Technology Madras, Chennai, India

B.Tech., **Computer Science and Engineering**, May 2002

- Thesis Topic: *A Flexible Content Management System Using Semi-structured Data Model*
- Adviser: Professor P. Sreenivas Kumar

PROFESSIONAL EXPERIENCE

University at Buffalo, SUNY
Assistant Professor (*Tenure track*)
Computer Science & Engineering

August 2013 to present

Oak Ridge National Laboratory
Research Scientist
Computational Sciences and Engineering Division

May 2011 to August 2013

Oak Ridge National Laboratory
Postdoctoral Research Associate
Computational Sciences and Engineering Division

October 2009 to April 2011

NASA Ames Research Center
Visiting Researcher
Intelligent Data Understanding Group

March 2009 to July 2009

RESEARCH GRANTS

NSF: Awarded \$960K for 4 Years.

TWC: Medium: Collaborative: Data is Social: Exploiting Data Relationships to Detect Insider Attacks.

Co-Principal Investigator.

October 1, 2014 to September 30, 2018.

Microsoft Azure: \$20K for 1 Year.

Microsoft Azure Research Award.

Principal Investigator.

Nov. 1, 2014 to Oct. 31, 2015.

Amazon Web Services: \$5K for 1 Year.

AWS Machine Learning Research Grant.

Principal Investigator.

March 1, 2014 to February 29, 2016.

ORNL Laboratory Directors R&D Funds: Awarded \$200K for 1 Year.

CoNNECT for Real-Time Building Energy and Grid Management.

Co-Principal Investigator.

October 1, 2012 to September 30, 2013. *Future funding anticipated.*

Center for Medicare & Medicaid Services: Awarded \$20M for 2 Years.

Knowledge Discovery Infrastructure for Healthcare.

Investigator and Task Lead (Beneficiary Call Center Use Case).

October 1, 2011 to May 31, 2013.

National Geospatial Intelligence Agency: Awarded \$350K for 1 Year.

Multi-disciplinary GEOINT Analysis, Project #266 (World Factbook Analysis).

Investigator and Data Mining Task Lead.

June 1, 2012 to May 31, 2013.

AWARDS AND
HONORS

- NASA Worldwind Europa Challenge, second prize in the University category, 2014.
- ORNL Significant Achievement Award for developing the Settlement Mapper Technology, 2013.
- ACM Computing Survey article on “Anomaly Detection: A Survey” listed as 4th Most Cited Publication in Computer Science/Data Mining in last 5 years (Microsoft Academic Search).
- Special Recognition for contributions to “Knowledge Discovery for Health Care” project at ORNL, 2012.
- Awarded Best LDRD Project titled - “Spatiotemporal Data Mining Framework for Monitoring Biomass at Regional and Global Scales”, under the ORNL Laboratory Director’s Research and Development Program, 2011.
- Selected one of the best 6 papers at NASA CIDU conference, 2010.
- Doctoral dissertation nominated for ACM Best Dissertation award from Computer Science Department, 2009.
- Recipient of Student Travel Awards at ICDM 2005, ICDM 2008, and SDM 2009.
- Research Excellence Award by Department of Computer Science, University of Minnesota, 2005.
- Best student paper award at 5th International Conference on Data Mining (ICDM), November 2005.

- J8. Rumor Tagging in Crisis Microblogs: A Case of Boston Bombings. Rohit Valecha, Ankit Sultania, **Varun Chandola**, Manish Agrawal and Raghav Rao. *Transactions on Information Systems, Under Review*, 2015.
- J7. A Reference Based Analysis Framework for Understanding Anomaly Detection Techniques for Symbolic Sequences. **Varun Chandola**, Varun Mithal and Vipin Kumar. *Data Mining and Knowledge Discovery, Springer*. 2014.
- J6. Image Based Characterization of Formal and Informal Neighborhoods in an Urban Landscape. Jordan Grasser, Anil Cheriyyadat, Ranga R. Vatsavai, **Varun Chandola**, Jordan Long, and Edward Bright. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*. 2012.
- J5. GX-Means: A model-based divide and merge algorithm for geospatial image clustering. Ranga R. Vatsavai, Christopher T. Symons, **Varun Chandola**, and Goo Jun. *Procedia Computer Science*. 2011.
- J4. A Scalable Gaussian Process Analysis Algorithm for Biomass Monitoring. **Varun Chandola** and Ranga R. Vatsavai. *Statistical Analysis and Data Mining*. 2011.
- J3. Anomaly Detection for Discrete Sequences - A Survey. **Varun Chandola**, Arindam Banerjee, and Vipin Kumar. *IEEE Transactions on Knowledge and Data Engineering (TKDE)*. 2011.
- J2. Anomaly Detection - A Survey. **Varun Chandola**, Arindam Banerjee, and Vipin Kumar. *ACM Computing Surveys (CSUR)* (h-index = 148, 4th ranked journal in Computer Science.). 2009.
- J1. Summarization - Compressing Data into an Informative Representation. **Varun Chandola** and Vipin Kumar. *Knowledge And Information Systems Journal (KAIS)*. 2007.

- C15. Modeling Graphs Using a Mixture of Kronecker Models Suchismit Mahapatra and **Varun Chandola**. *Proceedings of the 3rd IEEE International Conference on Big Data, 2015*.
- C14. Surface Reconstruction from Intensity Image using Illumination Model based Morphable Modeling. Zhi Yang and **Varun Chandola**. *Proceedings of 10th International Conference on Computer Vision Systems (ICVS)*, 2015.
- C13. Bringing Big Data from Space to Desktop. **Varun Chandola** and Patrick Hogan. *Proceedings of the 2014 conference on Big Data from Space (BiDS'14)*, 2014.
- C12. Knowledge Discovery from Massive Healthcare Claims Data. Varun Chandola, Sreenivas R. Sukumar, and Jack C. Schryver. *Proceedings of the 19th International ACM SIGKDD Conference on Knowledge Discovery and Data Mining*. 2013.
- C11. Large Scale Remote Sensing Data Mining for Biomass Monitoring: Recent Advances and Future Challenges. Ranga R. Vatsavai, **Varun Chandola**, and Budhendra Bhaduri. *Proceedings of 7th International Conference on Geographic Information Science (GIScience)*. 2012.
- C10. iGlobe: An Interactive Visualization and Analysis Framework for Geospatial Data. **Varun Chandola**, Budhendra Bhaduri, and Ranga R. Vatsavai. *Proceedings of 2nd International Conference and Exhibition on Computing for Geospatial Research and Application (COM. Geo)*. 2011.

- C9. Machine Learning Approaches for High-resolution Urban Land Cover Classification. Ranga R. Vatsavai, **Varun Chandola**, Anil Cheriyyadat, Edward Bright, Bhaduri Budhendra, and Jordan Grasser. *Proceedings of 2nd International Conference and Exhibition on Computing for Geospatial Research and Application (COM. Geo)*. 2011.
- C8. Rapid Damage Assessment using High-resolution Remote Sensing Imagery: Tools and Techniques. Ranga R. Vatsavai, Mark Tuttle, Budhendra Bhaduri, Edward Bright, Anil Cheriyyadat, and **Varun Chandola**. *Presented at International Geoscience and Remote Sensing Symposium (IGARSS) (h-index = 31)*. 2011.
- C7. A Gaussian Process Based Online Change Detection Algorithm for Monitoring Periodic Time Series. **Varun Chandola** and Ranga R. Vatsavai. *Proceedings of SIAM International Conference on Data Mining (SDM) (h-index = 44)*. 2011.
- C6. Multi-temporal Remote Sensing Image Classification - A Multi-view Approach. **Varun Chandola** and Ranga R. Vatsavai. *Proceedings of NASA Conference on Intelligent Data Understanding*. 2010.
- C5. Scalable Time Series Change Detection for Biomass Monitoring Using Gaussian Process. **Varun Chandola** and Ranga R. Vatsavai. *Proceedings of NASA Conference on Intelligent Data Understanding (CIDU)*. 2010. (**Selected as one of the top 6 best papers at the conference.**)
- C4. A Framework for Exploring Categorical Data. **Varun Chandola**, Shyam Boriah, and Vipin Kumar. *Proceedings of 2009 SIAM Data Mining Conference (h-index = 44)*. 2009.
- C3. Comparative Evaluation of Anomaly Detection Techniques for Sequence Data. **Varun Chandola**, Varun Mithal, and Vipin Kumar. *Proceedings of 8th International Conference on Data Mining (ICDM) (h-index = 56)*. 2008.
- C2. Similarity Measures for Categorical Data: A Comparative Evaluation, Shyam Boriah, **Varun Chandola** and Vipin Kumar. *Proceedings of 8th SIAM Data Mining Conference (SDM) (h-index = 44)*. 2008.
- C1. Summarization - Compressing Data into an Informative Representation. **Varun Chandola** and Vipin Kumar. *Proceedings of 5th International Conference on Data Mining (ICDM) (h-index = 56)*. 2005. (**Awarded one of the top 3 best student papers at the conference.**)
- TUTORIALS
- T3. Anomaly Detection: Theory and Practice. **Varun Chandola** and Sanjay Chawla. *IEEE International Conference on Data Mining (ICDM)*. 2011.
- T2. Data Mining for Anomaly Detection. Arindam Banerjee, **Varun Chandola**, Aleksandar Lazarevic, Vipin Kumar, and Jaideep Srivastava. *ECML PKDD Conference*. 2008.
- T1. Anomaly Detection: A Tutorial. Arindam Banerjee, **Varun Chandola**, Aleksandar Lazarevic, Vipin Kumar, and Jaideep Srivastava. *SIAM Data Mining Conference (SDM)*. 2008.
- REFEREED
WORKSHOP
PROCEEDINGS
- W9. A Big Data Approach to Rumor Mitigation in Twitter Microblog: A Case of Boston Bombings. Rohit Valecha, Ankit Sultania, **Varun Chandola**, Manish Agrawal and H. Raghav Rao. *Proceedings of the 13th Workshop on e-Business (WeB)*, 2015.

- W8. Development of a computational and data-enabled science and engineering Ph.D. program. Paul T. Bauman, **Varun Chandola**, Abani Patra and Matthew Jones *Proceedings of SC EduHPC Workshop*, 2014.
- W7. Spatiotemporal Data Mining in the Era of Big Spatial Data: Algorithms and Applications. Ranga R. Vatsavai, **Varun Chandola**, Scott Klasky, Auroop Ganguly, Anthony Stefanidis, Shashi Shekhar. *Proceedings of 1st International Workshop on Analytics for Big Geospatial Data (BigSpatial)*. 2012.
- W6. Implementing a Gaussian Process Learning Algorithm in Mixed Parallel Environment. **Varun Chandola** and Ranga R. Vatsavai. *Proceedings of Super computing (SC) Workshop on Latest Advances in Scalable Algorithms for Large-Scale Systems (Scala)*. 2011.
- W5. Using Time Series Segmentation for Deriving Vegetation Phenology Indices from MODIS NDVI Data. **Varun Chandola**, Dafeng Hui, Lianhong Gu, and Ranga R. Vatsavai. *Proceedings of 1st ICDM Workshop on Knowledge Discovery from Climate Data: Prediction, Extremes, and Impacts*. 2010.
- W4. An In Depth Scalability Analysis of a Gaussian Process Training Algorithm. **Varun Chandola** and Ranga R. Vatsavai. *Proceedings of Super Computing (SC) Workshop on Latest Advances in Scalable Algorithms for Large-Scale Systems (Scala)*. 2010.
- W3. Scalable Hyper-parameter Estimation for Gaussian Process Based Time Series Analysis. **Varun Chandola** and Ranga R. Vatsavai. *Proceedings of 4th SIGKDD Workshop on Large-scale Data Mining: Theory and Applications (LDMTA)*. 2010.
- W2. A Reference Based Analysis Framework for Analyzing System Call Traces. **Varun Chandola**, Shyam Boriah, and Vipin Kumar. *Proceedings of 6th Annual Cyber Security and Information Intelligence Research Workshop (CSIIRW)*. 2010.
- W1. DDDAS/ITR: A Data Mining and Exploration Middleware for Grid and Distributed Computing. Jon B. Weissman, Vipin Kumar, **Varun Chandola**, Eric Eilertson, Levent Ertoz, Gyorgy Simon, Seonho Kim, and Jinoh Kim. *Proceedings of Workshop on Dynamic Data Driven Application Systems - DDDAS*. 2007.
- BOOK CHAPTERS R4. Analyzing Big Spatial & Big Spatiotemporal Data: A Case Study of Methods and Applications. **Varun Chandola**, Ranga R. Vatsavai, Devashish Kumar, and Auroop Ganguly. *Big Data Analytics*, eds. *Vijay Raghavan, Calyumpadi R. Rao and Venu Govindaraju*, Elsevier Publications, 2015.
- R3. Fraud Detection in Healthcare. **Varun Chandola**, Sreenivas R. Sukumar, and Jack C. Schryver. *Healthcare Data Analytics*, eds. *Chandan Reddy and Charu Aggarwal*. 2014.
- R2. Data Analysis for Real Time Identification of Grid Disruptions. **Varun Chandola**, Omिताomu Olufemi and Steve N. Fernandez. *Computational Intelligent Data Analysis for Sustainable Development*, eds. *Ting Yu, Nitesh Chawla, and Simeon Simoff*, Taylor and Francis. 2012.
- R1. Data Mining for Cyber Security. **Varun Chandola**, Eric Eilertson, Levent Ertoz, Gyorgy Simon and Vipin Kumar. *Data Warehousing and Data Mining Techniques for Computer Security*, ed. *Anoop Singhal*, Springer. 2006.

INVITED ARTICLES A2. Virtualization of Evolving Power Grid. Olufemi Omitaomu, **Varun Chandola**, and Alexander Sorokine. *IEEE Smart Grid Newsletter*. 2012.

A1. Knowledge discovery from sensor data (SensorKDD). **Varun Chandola**, Olufemi Omitaomu, Auroop Ganguly, Ranga R. Vatsavai, Nitesh Chawla, Joao Gama, and Mohamed Gaber. *SIGKDD Explorations Newsletter*. 2011.

EDITED
WORKSHOP
PROCEEDINGS

E4. Third ACM SIGSPATIAL International Workshop on Analytics for Big Geospatial Data (BigSpatial). **Varun Chandola** and Ranga Raju Vatsavai. *Workshop Proceedings, 22nd International Conference on Advances in Geographic Information Systems (SIGSPATIAL 2014)*, 2014.

E3. Second ACM SIGSPATIAL International Workshop on Analytics for Big Geospatial Data (BigSpatial). **Varun Chandola** and Ranga Raju Vatsavai. *Workshop Proceedings, 21st International Conference on Advances in Geographic Information Systems (SIGSPATIAL 2013)*, 2013.

E2. Fifth International Conference on Knowledge Discovery from Sensor Data (SensorKDD11). **Varun Chandola**, Olufemi Omitaomu, Auroop Ganguly, Ranga R. Vatsavai, Joao Gama, Mohamed Gaber, and Nitesh Chawla [Proceedings Editors and Workshop Organizers] *Workshop Proceedings, 17th International Conference on Knowledge Discovery and Data Mining (KDD)*. 2011.

E1. Fourth International Conference on Knowledge Discovery from Sensor Data (SensorKDD10). **Varun Chandola**, Olufemi Omitaomu, Auroop Ganguly, Ranga R. Vatsavai, Joao Gama, Mohamed Gaber, and Nitesh Chawla [Proceedings Editors and Workshop Organizers] *Workshop Proceedings, 16th International Conference on Knowledge Discovery and Data Mining (KDD)*. 2010.

TECHNICAL
REPORTS

R6. Non-parametric Depth Estimation for Images from a Single Reference Depth. Zhi Yang and **Varun Chandola**. *UB CSE Technical Report 2014-01*. 2014.

R5. Knowledge Discovery from Massive Healthcare Claims Data. **Varun Chandola**, Sukumar R. Sreenivas, Jack Schryver. *ORNL Technical Report ORNL/TM-2013/83*. 2013.

R4. Detecting Anomalies in a Time Series Database. **Varun Chandola**, Deepthi Cheboli, and Vipin Kumar. *CS Technical Report 09-004, Computer Science Department, University of Minnesota*. 2009.

R3. Understanding Anomaly Detection Techniques for Symbolic Sequences. **Varun Chandola**, Varun Mithal, and Vipin Kumar. *CS Technical Report 09-001, Computer Science Department, University of Minnesota*. 2009.

R2. Understanding Categorical Similarity Measures for Outlier Detection. **Varun Chandola**, Shyam Boriah, and Vipin Kumar. *CS Technical Report 08-008, Computer Science Department, University of Minnesota*. 2008.

R1. A Multi-Step Framework for Detecting Attack Scenarios. Mark Shaneck, **Varun Chandola**, Haiyang Liu, Changho Choi, Gyorgy Simon, Eric Eilertson, Yongdae Kim, Zhi-li Zhang, Jaideep Srivastava, and Vipin Kumar. *CS Technical Report 06-004, Computer Science Department, University of Minnesota*. 2008.

REFEREED
WORKSHOP
PRESENTATIONS

- P5. Improving Quality of Care Using Data Science Driven Methods. Jialiang Jiang, Jessica Castner, Sharon Hewner and **Varun Chandola**. *Poster presented at UNYTE Scientific Session on Hitting the Accelerator: Health Research Innovation through Data Science*, 2015.
- P4. Spatio-temporal Analysis for Identifying Grid Disruptions. **Varun Chandola**, Olufemi Omitoumu, and Steven Fernandez. *Presented at 1st International Workshop on Analytics for Cyber-physical Systems (ACS-2012)*. 2012.
- P3. Open Source, Interactive, Real-Time Visualization and Analysis Framework for Geospatial Data. Uwe Rosebrock, Tisham Dhar, Patrick Hogan and **Varun Chandola**. *Presented at OzViz Conference*. 2011.
- P2. iGlobe: Interactive Visualization and Analysis Framework for Geospatial Data. Patrick Hogan, **Varun Chandola**, Ranga R. Vatsavai, Tisham Dhar and Alexandru Babescu. *Presented at American Geophysical Union Fall Meeting (AGU)*. 2011.
- P1. A Comparative Study of Vegetation Phenology Using MODIS and AmeriFlux Data. Dafeng Hui, **Varun Chandola**, Lianhong Gu, and Ranga R. Vatsavai. *American Geophysical Union Fall Meeting (AGU)*. 2010.

INVITED TALKS

18. Accelerating Gaussian Process Based Statistical Methods for Spatio-temporal Analysis. *International Indian Statistical Association Conference*, December 2015, Pune, India.
17. Scaling Gaussian Process Analysis for Big Spatiotemporal Data. *10th International Workshop on Spatial and Spatiotemporal Data Mining (SSTDM)*, November 2015, Atlantic City, NJ.
16. iGlobe: Bringing Big Data from Space to Desktop. *36th Annual Symposium on Remote Sensing of the Environment, ISRSE*, May 2015, Berlin, Germany.
15. Large Scale Machine Learning for Massive Remote Sensing Data: A Case Study in Biomass Monitoring. *ASPRS Annual Meeting*. March 2013, Baltimore, MD.
14. iGlobe: Bridging the Gap Between Weather and GIS. *NASA World Wind Department of Defense Apps Meeting*. October 2012, Washington, DC.
13. iGlobe: Bringing Weather to WorldWind for Interactive Analysis. *NASA World Wind Department of Defense Apps Meeting*. March 2012, Mountain View, CA.
12. High Performance Spatiotemporal Data Mining. *US Department of Energy Fall Creek Falls Meeting*. October 2010, Memphis, TN.
11. Anomaly Detection for Symbolic Sequences. *NASA Conference on Intelligent Data Understanding*. September 2008, Washington, D.C.

PATENTS

Detection of Multi-step Computer Processes such as Network Intrusions. **Varun Chandola**, Eric Eilertson, Haiyang Liu, Mark Shaneck, Changho Choi, Gyorgy Simon, Yongdae Kim, Vipin Kumar, Jaideep Srivastava, and Zhi-li Zhang. *US Patent Published Application No. 20080276317*. 2008.

SOFTWARE

iGlobe: An open source tool for interactive analysis and visualization of climate data. <http://www.cse.buffalo.edu/~chandola/iglobe/iglobe.html>.
NASA Tech Brief - <http://www.techbriefs.com/component/content/article/13850>.

Sequence Anomaly Detection (SQUAD): A package of anomaly detection techniques for sequences. <http://www.cse.buffalo.edu/~chandola/software.html>

Minnesota Anomaly Detection System (MINDS): A data mining based intrusion detection software package. <http://www.cs.umn.edu/research/MINDS>.
NSF Press Release - http://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=100488.

TEACHING	<i>CSE 474/574</i> - Introduction to Machine Learning	Spring 2015
	<i>CSE 740</i> - Large Scale Machine Learning and Big Data	Fall 2013
	<i>CSE 474/574</i> - Introduction to Machine Learning	Spring 2014
	<i>CSE 740</i> - Large Scale Machine Learning and Big Data	Fall 2014

SERVICE **Panelist**

- Panelist for NSF IIS, NSF SaTC, and DOE ASCR.

Mentor Service

- Mentor for “Data Science for Social Good” summer fellowship at University of Chicago, June – August, 2014.
- Mentor in the SUNY Louis Stokes Alliance for Minority Participation (SUNY-LSAMP) program, June – August, 2014.

Editorial Service

- Guest Editor for special issue: “Big Spatial Data”, *Geoinformatica*.
- Coordinating Editor for “Information Systems Frontiers”, Springer.
- Guest Associate Editor for special issue: “Information Fusion, Data Analysis, and Knowledge Discovery in Hybrid Networks”, *Journal of Computer Networks and Communications*.

Referee Service

- ACM Computing Surveys
- ACM Transactions on Knowledge and Data Discovery
- IEEE Transactions on Knowledge and Data Engineering
- SIAM Statistical Analysis and Data Mining
- Springer Machine Learning
- Data Mining and Knowledge Discovery
- Knowledge and Information Systems
- International Journal of Geographical Information Science
- Pattern Recognition
- Journal of Artificial Intelligence Research
- IEEE IET Information Security
- IEEE Systems, Man and Cybernetics, Part B
- Applied Stochastic Models in Business and Industry
- Journal of Aerospace Information Systems

Organization Committees

- ICDM 2015 (*Sponsorship Chair*)

- BigSpatial 2012, BigSpatial 2013, BigSpatial 2014, BigSpatial 2015 (*Workshop Co-chair*)
- ACS 2012, ACS 2013 (*Workshop Co-chair*)
- SensorKDD 2010, SensorKDD 2012, SensorKDD 2013 (*Workshop Co-chair*)
- PDAC 2011, PDAC 2012, PDAC 2013 (*Publicity Chair*)
- SSTDM 2011, SSTDM 2012, SSTDM 2013 (*Government, Industry, and Publicity Chair*)
- KDCloud 2014 (*Workshop Co-chair*)
- KDCloud 2011, KDCloud 2012, KDCloud 2013 (*Government, Industry, and Publicity Chair*)

Senior Program Committees

- SDM 2012, SDM 2014

Program Committees

- CIKM 2014, CIKM 2015
- IT-OT Analytics 2015
- HINA 2015
- BigData 2013
- SDM 2013
- ICRA 2012, ICRA 2013
- CIDU 2012
- PAKDD 2012
- Clim-KD 2011

PROFESSIONAL MEMBERSHIPS

- Association for Computing Machinery (ACM), Member, 2010–present
- Society for Industrial and Applied Mathematics (SIAM), Member, 2012–present

STUDENTS

- *Past:* Zhi Yang (First appointment: Continental Vision)
- *Current:* Suchismit Mahapatra, Dinh Tran, Duc Thanh Anh Luong, Niyazi Sorkunlu, Jialiang Jiang (PhD Students)