**Physics Guided Machine Learning: A New Paradigm for Modeling Science and Engineering Problems**

Vipin Kumar is a Regents Professor and hold the William Norris Chair in the Department of Computer Science and Engineering at the University of Minnesota. His research interests include data mining, high-performance computing, and their applications in Climate/Ecosystems and health care. He is currently leading an NSF Expedition project on understanding climate change in the context of monitoring the state of the tropical forests and surface water on a global scale.

His research has been honored by the ACM SIGKDD 2012 Innovation Award, which is the highest award for technical excellence in the field of Knowledge Discovery and Data Mining (KDD), and the 2016 IEEE Computer Society Sidney Fernbach Award, one of IEEE Computer Society's highest awards in high performance computing.

Kumar is a Fellow of the ACM, IEEE, AAAS, and SIAM. Kumar's research has been recognized in the widely used text book "Introduction to Parallel Computing", and "Introduction to Data Mining". Kumar has served as chair/co-chair of more than 50 international conferences and workshops. He has authored over 300 research articles, and co-edited or coauthored 10 books including "Laws for Cybersecurity?" and "How 2G Computational Social Science Can Revolutionize the Study of "Dark" Networks".

### Speaker Biography

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### Upcoming Distinguished Lectures

**October 18, 2018**

**“Big Data in Climate and Earth Sciences: Challenges and Opportunities for Machine Learning”**

Wednesday, September 19, 2018

Reception with refreshments: 10:30 a.m.  
Lecture: 11:00 a.m.-12:00 noon  
Morgan Library Event Hall

**“Physics Guided Machine Learning: A New Paradigm for Modeling Science and Engineering Problems”**

Wednesday, September 19, 2018

Lecture: 2-3 p.m.  
Morgan Library Event Hall

Abstracts

**Big Data in Climate and Earth Sciences: Challenges and Opportunities for Machine Learning**

The climate and earth sciences have recently undergone a rapid transformation from a data-poor to a data-rich environment. In particular, massive amounts of data from remote earth monitoring systems, environmental sensors, satellites, and various large-scale surveys have been collected. As a result, there is an enormous potential for machine learning (ML) techniques to revolutionize climate and earth sciences, from predicting climate change to understanding the complex relationships between human activities and climate, and from improving weather forecasting to advancing our understanding of the Earth system. However, the space of possible models is enormous, and the model selection process is highly error-prone. Moreover, the vast amount of data available can often lead to overfitting, and many models are non-generative and non-interpretable. In this talk, I will present several case studies from the domain of climate and earth sciences that demonstrate the potential of ML to advance the pace of discovery in a number of scientific and engineering disciplines where physics-based models are used, e.g., climate science and weather forecasting. I will also discuss the challenges and opportunities that arise when applying ML to these domains, and highlight some of the key research directions that need to be addressed to fully harness the potential of ML in climate and earth sciences.

**Physics Guided Machine Learning: A New Paradigm for Modeling Science and Engineering Problems**

Physics-based models of dynamical systems are often used to study engineering and environmental systems. Despite their importance, there are several concerns about these models: (i) they are computationally expensive and can only be evaluated at a limited number of points; and (ii) they are often non-generative and non-interpretable. As a result, physics-based models can fail to capture the underlying physical processes and can lead to poorly calibrated and inaccurate predictions. This talk will discuss the concept of physics-guided ML, which combines the advantages of physics-based models with ML to improve model accuracy and interpretability. The key idea is to use ML to learn the underlying physics from the data and then use this learned physics to guide the model selection process. This approach can greatly improve the accuracy and interpretability of ML models, and can be applied to a wide range of scientific and engineering problems. I will present several case studies from the fields of climate science and weather forecasting to illustrate the potential of physics-guided ML.

**Laws for Cybersecurity?**

Dr. Fred B. Schneider

**How 2G Computational Social Science Can Revolutionize the Study of ‘Dark’ Networks**

Dr. Jytte Klausen

**Laws for Cybersecurity?**

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**How 2G Computational Social Science Can Revolutionize the Study of ‘Dark’ Networks**

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