COLLEGE OF ENGINEERING
MECHANICAL ENGINEERING
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Mechanical Engineering Seminar Series

Some Applications of Machine Learning Based Flow Classification

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Professor

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and is jointly appointed as Professor in the Department of Physics and Astronomy
Johns Hopkins

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ME Seminar Zoom link (QR Code below)

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Abstract
In this talk we will discuss the challenges associated with distinguishing laminar from turbulent flow regions and how machine learning can be applied to this task. We describe an unsupervised machine learning approach to classify a transitional boundary layer over a smooth flat plate into laminar and turbulent regions. As a first application, we use the approach to determine turbulent spots and their area-volume relationship. Remarkably, we find power-law behavior indicative of fractal scaling over nearly 5 decades of spot volume. The resulting fractal dimension is compared to values known from classical turbulent/nonturbulent interface data at much higher Reynolds numbers, as well as a phenomenological scaling relation based on Kolmogorov theory. As a second application, we use the approach in the context of wall-modeled Large Eddy Simulations to enable improved predictions of transitional boundary layer flows. The work is in collaboration with Dr. Zhao Wu, Mr. Ghanesh Narasimhan and Prof. T. Zaki, and was supported by the Office of Naval Research.

Bio
Charles Meneveau is the Louis M. Sardella Professor in the Department of Mechanical Engineering, is Associate Director of the Institute for Data Intensive Engineering and Science (IDIES) and is jointly appointed as Professor in the Department of Physics and Astronomy at Johns Hopkins. He received his B.S. degree in Mechanical Engineering from the Universidad Técnica Federico Santa María in Valparaíso, Chile, in 1985 and M.S, M.Phil. and Ph.D. degrees from Yale University in 1987, 1988 and 1989, respectively. During 1989/90 he was a postdoctoral fellow at the Center for Turbulence Research at Stanford. He has been on the Johns Hopkins faculty since 1990. His area of research is focused on understanding and modeling hydrodynamic turbulence, and complexity in fluid mechanics in general. The insights that have emerged from Professor Meneveau's work have led to new numerical models for Large Eddy Simulations (LES) and applications in engineering and environmental flows, including wind farms. He also focuses on developing methods to share the very large data sets that arise in computational fluid dynamics. He is Deputy Editor of the Journal of Fluid Mechanics and has served as the Editor-in-Chief of the Journal of Turbulence. Professor Meneveau is a member of the US National Academy of Engineering, a foreign corresponding member of the Chilean Academy of Sciences, a Fellow of APS, ASME, AMS and recipient of the Stanley Corrsin Award from the APS, the JHU Alumni Association's Excellence in Teaching Award, and the APS' François N. Frenkiel Award for Fluid Mechanics.

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