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Title of presentation:
Low-dimensional modeling and control of shear flows using cluster analysis

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Abstract:
This talk presents a data-driven approach for low-dimensional modeling and control using cluster analysis. The proposed cluster-based reduced-order modeling (CROM) strategy assumes a probabilistic viewpoint taking advantage of the linearity of the evolution equation for the probability while including nonlinear actuation dynamics.
Cluster analysis is employed to partition snapshot data into a small number of representative flow states. Then, the transitions between these states are dynamically modelled as a Markov process. CROM has potential applications for the systematic identification of physical mechanisms of complex dynamics, for the identification of precursors to desirable and undesirable events, and for flow control design exploiting nonlinearities. The framework is applied to a range of fluid dynamical benchmark problems.
A CROM-based feedback control approach is exemplified for a separating flow over a smooth ramp. The controller is based on the best open-loop frequency and turns the actuation on or off depending on the applicable cluster. The CROM-based control is compared to the complete ensemble of control laws demonstrating the capabilities and challenges of cluster-based control.