Predicting Boundary-Layer Transition (BLT) using Artificial Intelligence (AI) Causality Inference

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The transition of the boundary layer has been studied through stability analysis and Direct Numerical Simulations; it has also been characterized by methods such as N-Factor and different modes of instabilities. The methods cannot be generalized to all kinds of cases where the failure grows in intermittency and uncertainty. In intermittency, a vital role is played in releasing accumulated energy in fluid flows in unpredictable times and the uncertain generation of chaos. To mitigate the failure of conventional and deterministic methods where chaos always exists based on Lorenz's studies. I propose to enter probabilistic methods where the conditional probability with Do-Calculus probability can be exchanged based on graph operations where the solution based on stochastic processes can be found. The graph can show cause-and-effect relationships based on events that explain why the transition from the boundary layer to higher excitations leads to turbulence. These studies will show previous boundary layer studies, assumptions, the different forms of instabilities, causes, and leading effects to turbulence. In addition, I will provide a better understanding of the current metrics of how to characterize turbulence, the benefits of these studies, where it guides us, and how to generate graphs based on causality inference, which can show us why the flow becomes turbulent based on various causes where we can answer the ultimate question of why.