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Machine-learning-assisting investigation of turbulence anisotropy[1] JUNYI MI, CHAO JIANG, SHUJIN LAIMA, HUI LI, Harbin Institute of Technology — An anisotropy invariant map (AIM) and barycentric map (BMap), which are based the space spanned by invariants of the anisotropic stress tensor, have been playing a crucial role in stress invariant analysis to quantify turbulence anisotropy. However, these methods cannot offer any scale information about the turbulent structures, otherwise the degree of axisymmetry and anisotropy. Only a mingy portion of the turbulent flow in real world can reach the edges or vertices of the AIM or BMap, with which therefore a deeper understanding of flow details about the flow pattern regimes is rarely developed. Here we report an unsupervised machine-learning algorithm (a modified K-means method) as a classifier of flow pattern regimes, with the Reynolds stress tensor instead of their secondary quantities as input features (including the distances from the walls). Tests are performed in duct flows. As a result, (i) there is a consistent one-to-one match between the separation boundaries for different regimes in flow space and the border of stress invariants for this flow itself in the AIM or BMap; (ii) the size of flow regime in coordinate space leads to identifying the scales of turbulent structures. Besides, effects of the aspect ratio and Reynolds number are examined.

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