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Department of
Mechanical Engineering
The University of Hong Kong



Tam Wing Fan
Inno Wing Two

FACULTY OF ENGINEERING

SEMINAR

Machine-learning-based asymptotic homogenisation/localisation and design of spatially-varying lattice configurations

Date: 16 February, 2024 (Friday)
Time: 3:30 pm – 4:30 pm
Venue: Tam Wing Fan Innovation Wing Two
G/F, Run Run Shaw Building, HKU



Speaker: Professor Yichao Zhu
School of Mechanics and Aerospace Engineering
Dalian University of Technology
China

Moderator: Professor David Srolovitz

Abstract:

In this talk, we introduce a general framework, with the use of traditional asymptotic homogenisation approaches and the emerging machine learning tools, for the (CAD-inspired) representation, (CAE-inspired) analysis and (CAD-CAE integrated) design of smoothly-varying lattice configurations. Asymptotic analysis serves to identify the expressions for key quantities of interest, such as the (nonlinear) overall compliance, the sites and the magnitude of the maximum tensile stress, etc., in a scale-separated manner. Machine learning method is employed to embody those implicit interrelationships that are confirmed with asymptotic analysis. A number of simulation examples will be presented to show the balanced accuracy and efficiency of the proposed method. The presentation concludes with mathematical analogy to generalise the method used for analysing the behaviour of other multiscale systems.

References:

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- [3] Li, S. S., Zhu, Y. C., and Guo, X., "Optimisation of spatially varying orthotropic porous structures based on conformal mapping", *Comput. Methods Appl. Mech. Engrg.*, **391**, 114589 (2022).
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- [6] Zhou, Z. C., Zhu, Y. C., and X. Guo, X., "Machine learning based asymptotic homogenization and localization: Predictions of key local behaviors of multiscale configurations bearing microstructural varieties", *Int. J. Numer. Meth. Eng.*, **124**(3), 639-669 (2023).
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- [8] Pan, X. W., Zhou, Z. C., Ma, C., Li, S. S., and Zhu, Y. C., "Machine-learning-based asymptotic homogenisation and localisation considering boundary layer effects", *Int. J. Numer. Meth. Eng.*, **125**, e7367 (2024).

Biography:

Dr. Yichao Zhu is now a full professor based in the School of Mechanics and Aerospace Engineering at Dalian University of Technology (DUT). Dr. Zhu got his Bachelor degree on applied mathematics from Fudan University, and his PhD on applied mathematics from University of Oxford. Dr. Zhu's major research interest lies in the modelling and simulations of multiple-scale problems that arise in physics, engineering and materials science, and he is now devoting efforts to re-vitalising traditional asymptotic homogenisation/localisation techniques with the use of machine learning. Dr. Zhu also bears strong interests in projects, where mathematical tools can be used by all means to solve industrial problems. Dr. Zhu has published more than 40 peer-reviewed articles. He sits in the junior editorial board of *Acta Mechanica Solidia Sinica*, and serves in the administrative panel on mechanics of soft materials underneath the Chinese Society of Theoretical and Applied Mechanics.

ALL INTERESTED ARE WELCOME