Topology meets mechanics: predicting the response to compression in metallic porous materials using Fourier-based computational approaches and topological data analysis

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Metallic porous materials are used in wide-ranging practical applications, from lightweight metal structures to medical implants. However, their use in a given application depends on obtaining the desired mechanical properties, such as Young's modulus and yield stress. Advances in 3D printing enable creating a wider choice of prescribed structures than ever before. However, to take ad- vantage of this opportunity one must predict which structures will exhibit the desired mechanical properties. Instead of testing each candidate structure di- rectly using the computationally expensive simulation methods, our strategy rests on using Fast Fourier Transform-based computational methods to create a database of sample structures that will be used to build predictive models based on variables defined by topological data analysis (TDA) whose results can be extrapolated to a wider space of possible structures.