Designing 3D Printed Diatom-Biomimicking Materials Using Unsupervised Machine Learning

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This study explores the intersection between unsupervised machine learning with bio-inspired material design. The goal of this project was to design a new procedure to simply and intuitively create a bio-inspired material mimicking the structure of diatoms—a type of algae that live in marine ecosystems and have cell walls made of glassy silica—starting with only microscopic images of these fascinating single-cell organisms. In this study, a 3D-printed material was designed with the goal of mimicking the structure of diatom frustules (cell walls), one of the strongest bio-materials in the world. The fabrication process was intuitive, yet novel to the fields of unsupervised machine learning and bio-inspired materials. The procedure uses four distinct steps; unsupervised machine learning, which is when a machine learning model learns a task without labeled data; image processing; three-dimensional tomographic reconstruction, or layering cross-sections on top of each other to create a material; and 3D printing. In this study, high-quality materials that mimicked the internal microstructure of diatoms were successfully printed. The printed materials serve as a proof of concept of the validity and potential of this method to change the way that researchers develop their own bio-inspired materials. Untapped potential also lies in continuing to improve the diatom-inspired material, since the diatom cell wall is one of the strongest biomaterials on our earth.

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