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IE Decision Systems Engineering Fall '20 Seminar Series

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Inverse Problems in Biomimetic Nanotechnology:

How to design Lego blocks so that you can assemble any structure you want just by shaking the box

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Biography

Dr Petr Sulc has master's degree in Quantum Physics from Ecole Polytechnique in Paris and doctorate in Theoretical Physics from University of Oxford. He worked as a research assistant in Los Alamos National Laboratory and as a Fellow in physics and biology at the Rockefeller University in New York. Since 2018, he has been an assistant professor at School of Molecular Sciences and the Biodesign Institute at Arizona State University. His research broadly focuses on applying high-performance computer simulations and statistical physics methods to biology and nanotechnology. He develops theoretical as well as experimental methods to study and realize DNA and RNA nanotechnology structures and devices.

Abstract

Self-assembly is a process where individual building blocks organize by themselves to assemble into larger more complex structures. This process is ubiquitous in biological systems. For a long time, the field of nanotechnology has looked to biological self-assembly for inspiration for achieving complex behavior at nanoscale level. Despite tremendous progress over the past few decades, it remains a difficult challenge to reliably self-assemble target shape. Here, we present a new solution to the inverse problem, which aims to design building blocks that form a target structure while at the same time avoid all undesired competing structures that the system might be able to form. We show that we can map the inverse design problem to a Boolean Satisfiability Problem. In combination with numerical simulations, we can identify the competing assemblies and use the SAT solvers to design building blocks that can assemble to the target lattice. To demonstrate the versatility of our approach, we show how we can use it to design building blocks that self-assemble some of the most sought-after crystal lattices: pyrochlore, diamond, and clathrate lattices. Our systems are amenable to experimental realization, and we will show some preliminary results of our attempts to realize such lattices using DNA nanotechnology.

Hosted by: Giulia Pedrielli

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