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*Programmable assembly: inverse design of materials from discrete components*

Particles and discrete objects on the scale of nanometres to micrometres, such as colloids, DNA bricks, proteins, transistors, etc, are increasingly being used as building blocks for new materials, with a variety of applications such as in optics, drug delivery, energy harvesting, and nanorobotics. A goal for theory and simulation is to build algorithms and design principles to find the building blocks that assemble into a structure of interest. This is a challenge due to the high-dimensionality of the systems of interest, the presence of strong noise, and the sometimes far-from-equilibrium conditions, making standard optimization algorithms inapplicable and demanding new approaches. I will describe our group's progress on finding optimal conditions for "addressable self-assembly", a system of particles where each building block is distinct and has a specific location in the target structure, and that assembles spontaneously under thermal fluctuations. I will show how using tools derived from machine learning can generate novel solutions for small systems, and will point out challenges in extending these tools to more complex systems.