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Geometric Nonlinear Computation of Thin Rods and Shells[1]

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We develop simple, fast numerical codes for the dynamics of thin elastic rods and shells, by exploiting the connection between physics, geometry, and computation. By building a discrete mechanical picture from the ground up, mimicking the axioms, structures, and symmetries of the smooth setting, we produce numerical codes that not only are consistent in a classical sense, but also reproduce qualitative, characteristic behavior of a physical system—-such as exact preservation of conservation laws—-even for very coarse discretizations. As two recent examples, we present discrete computational models of elastic rods and shells, with straightforward extensions to the viscous setting. Even at coarse discretizations, the resulting simulations capture characteristic geometric instabilities. The numerical codes we describe are used in experimental mechanics, cinema, and consumer software products.

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