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Forming fabric from knitted curves

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Through knitting, yarn, an essentially one-dimensional, curve-like material, is shaped into a lattice of slip-knots to form knitted fabric, a surface-like material. Despite the long history of these materials, modeling their mechanics has proven difficult owing to their complex architecture. To make progress towards this goal, we have developed a geometric framework for simplifying the parameterization of yarn shape. Upon minimizing the total bending energy of yarn, the resulting structures are remarkably realistic, despite the relative simplicity of the yarn model. Thus, we confirm that many of the emergent mechanical properties of knitted fabric can be understood in terms of the geometry of linked space curves. This allows us to not only simplify the representation of yarn within computer simulations, but to make progress towards identifying the key factors that determine how the wide range of mechanical and geometric properties of knitted fabric emerge from a given stitch pattern.