On Limit Analysis of Trusses

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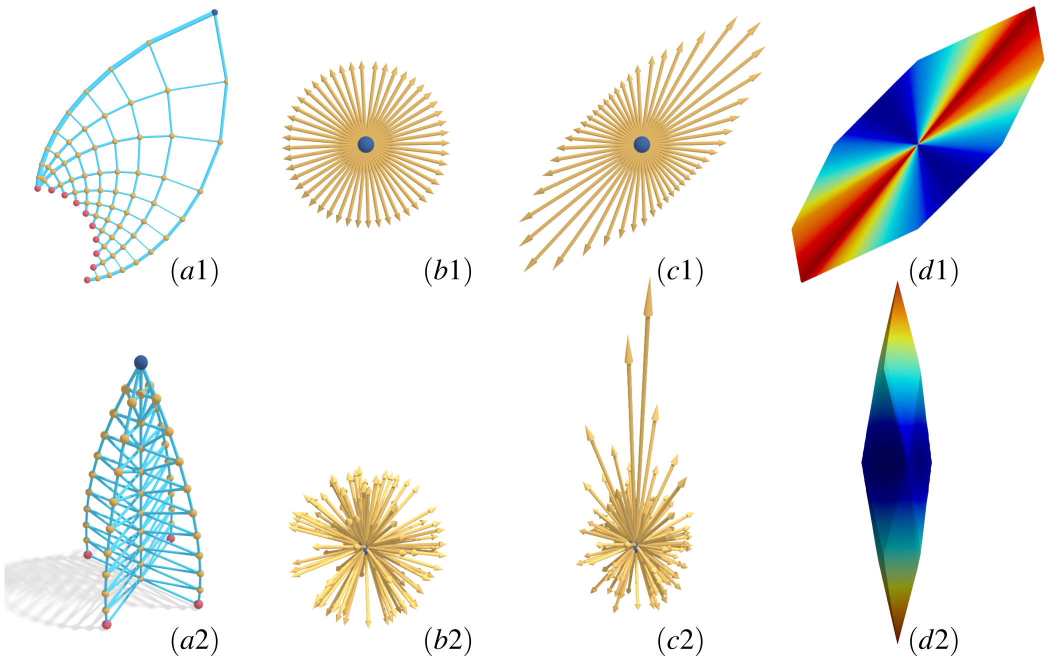

Figure 1: Limit Analysis of given trusses. The upper row is for a 2D truss and the lower one is for a 3D truss. From left to right, (a1) and (a2) show the input trusses with given joint positions, topologies and cross-sections of bars, the trusses are supported at the red joints and external forces are applied at the blue joints, (b1) and (b2) illustrate different sampled external force directions, (c1) and (c2) show the maximum magnitude of external forces that the given trusses can afford, and (d1) and (d2) show the color coding of the magnitude, here the magnitude increases from blue to red. Note that the boundary curve of 2D shape in (d1) and the surface of 3D shape in (d2) are the so called ultimate bearing capacity curve and surface which are convex polygon and polyhedra.

Abstract

Truss as a fundamental structure has been studied in the filed of civil engineering for decades. We introduce an effective way of limit analysis on the bearing capacity of given 2D plane and 3D spatial trusses. To illustrate the maximum external forces that a truss can carry along different directions, we propose the concept of ultimate bearing capacity curve and surface for 2D and 3D trusses respectively. We provide an efficient algorithm to calculate the ultimate bearing capacity curve and surface by solving LP problems and prove that the ultimate curves and surfaces are always convex. This important property could be used in truss design and optimization in the case of bearing dynamic external forces. Two examples of ultimate bearing capacity curve/surface and their convexity are shown in Figure 1.