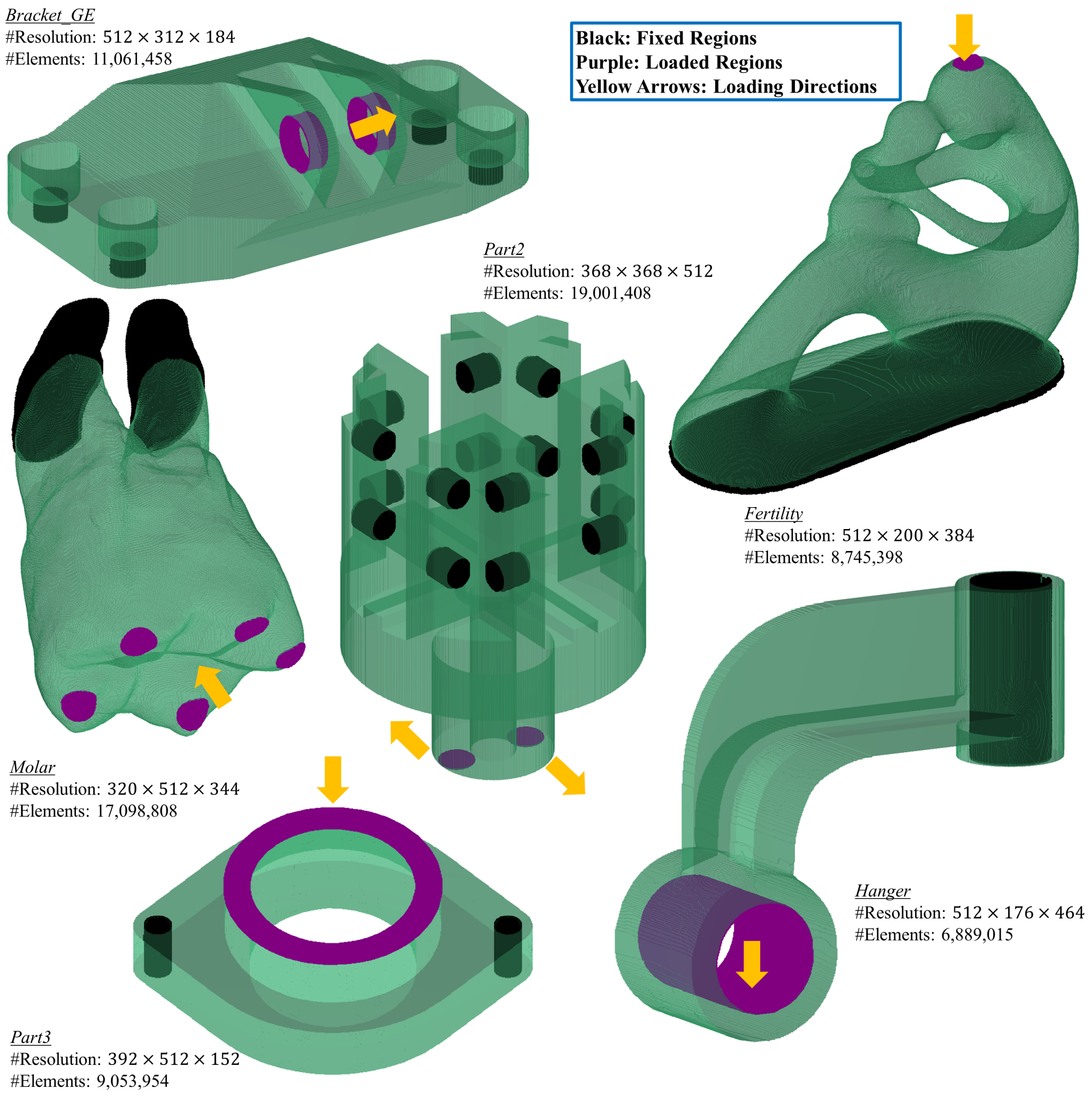
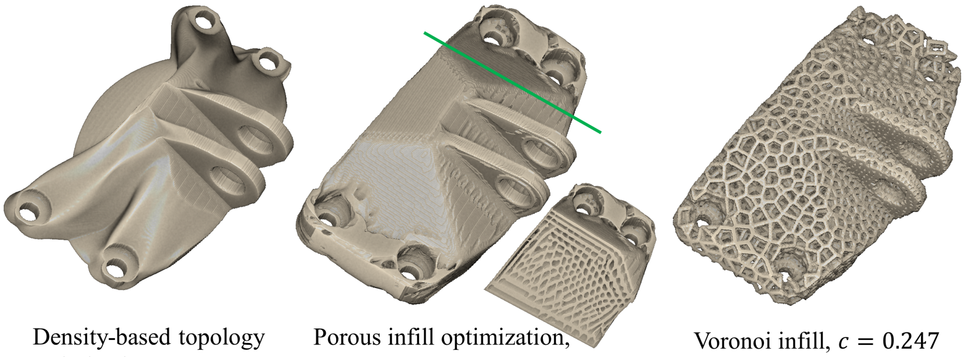
SGLDBench:
A Benchmark Suite for Stress-Guided Lightweight 3D Designs
Supplemental Material

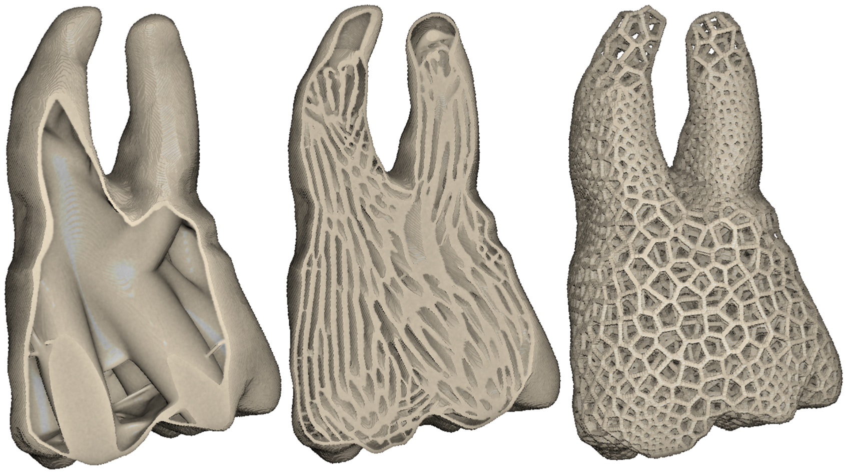
Six additional datasets are considered to demonstrate the usability of SGLDBench. First, the boundary conditions used for optimization are shown. Then, the results of the lightweight design methods supported by SGLDBench using the same material budget are compared. The solid boundaries of all infills, except topology optimization and porous infill optimization, are omitted to reveal the interior structures.



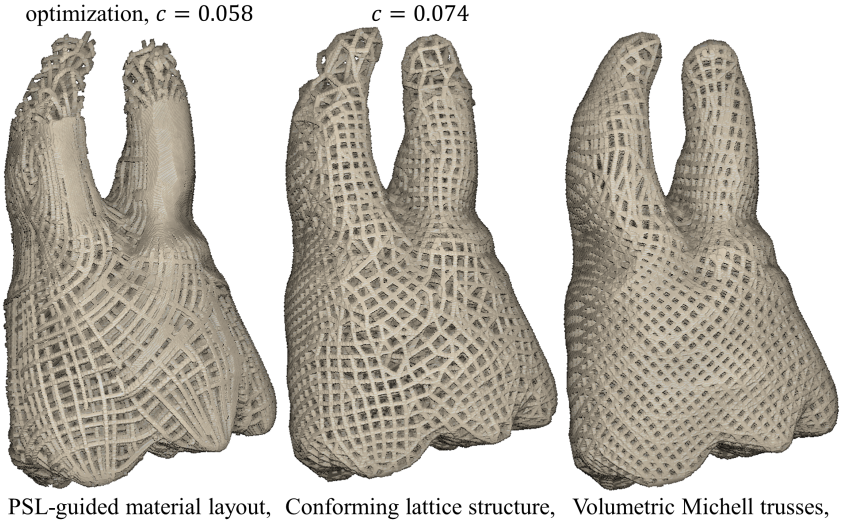


Density-based topology optimization, $c = 0.148$ | Porous infill optimization, $c = 0.191$ | Voronoi infill, $c = 0.247$

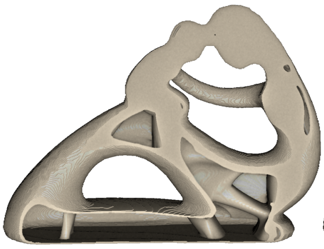
PSL-guided material layout, $c = 0.378$ | Conforming lattice structure, $c = 0.289$ | Volumetric Michell trusses, $c = 0.380$



Density-based topology optimization, $c = 0.058$ | Porous infill optimization, $c = 0.074$ | Voronoi infill, $c = 0.089$

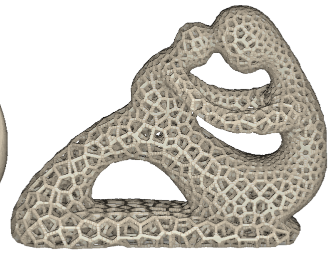


PSL-guided material layout, $c = 0.086$ | Conforming lattice structure, $c = 0.116$ | Volumetric Michell trusses, $c = 0.151$

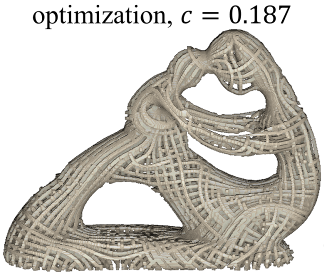


Density-based topology optimization, $c = 0.187$

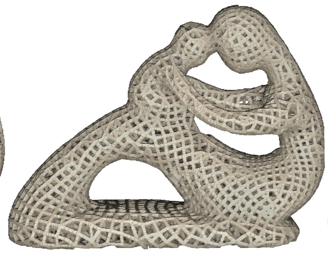
Porous infill optimization, $c = 0.252$



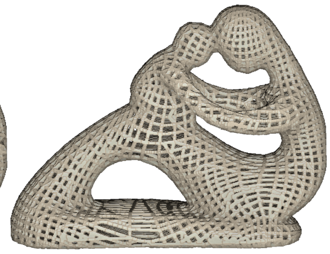
Voronoi infill, $c = 0.263$



PSL-guided material layout, $c = 0.317$



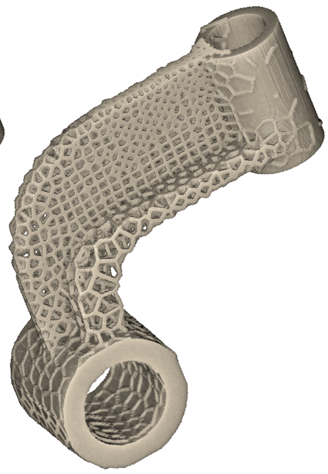
Conforming lattice structure, $c = 0.307$



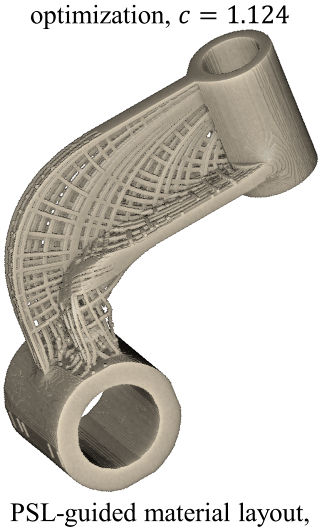
Volumetric Michell trusses, $c = 0.410$

Density-based topology optimization, $c = 1.124$

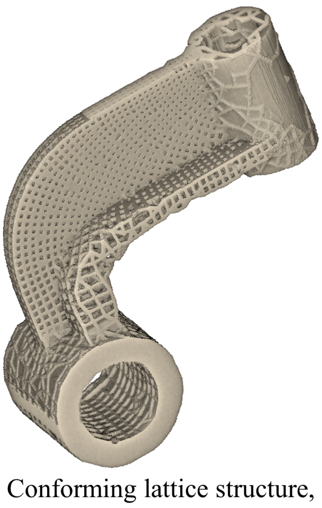
Porous infill optimization, $c = 1.349$



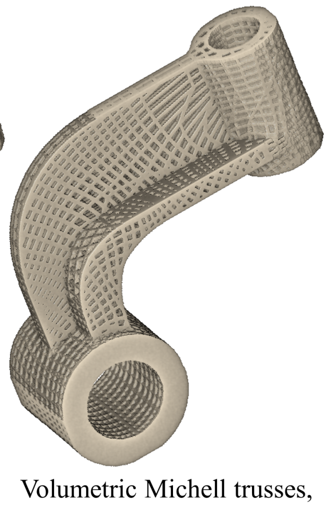
Voronoi infill, $c = 1.706$



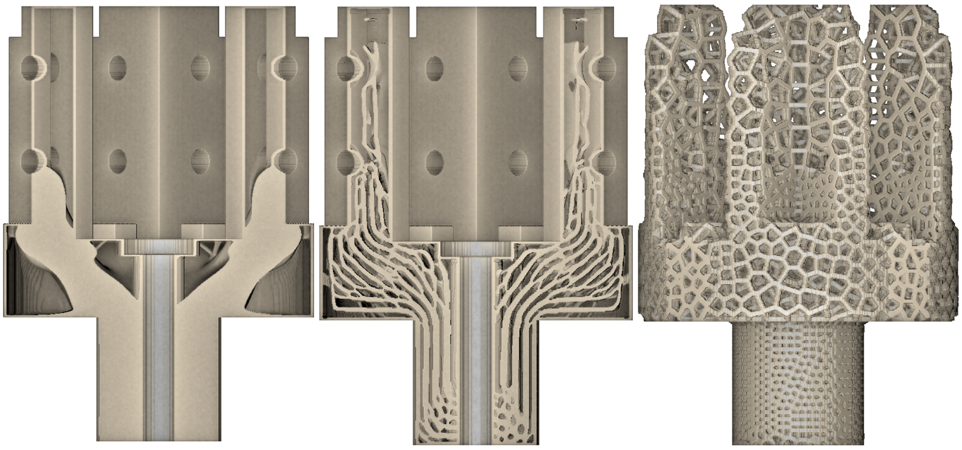
PSL-guided material layout, $c = 1.578$



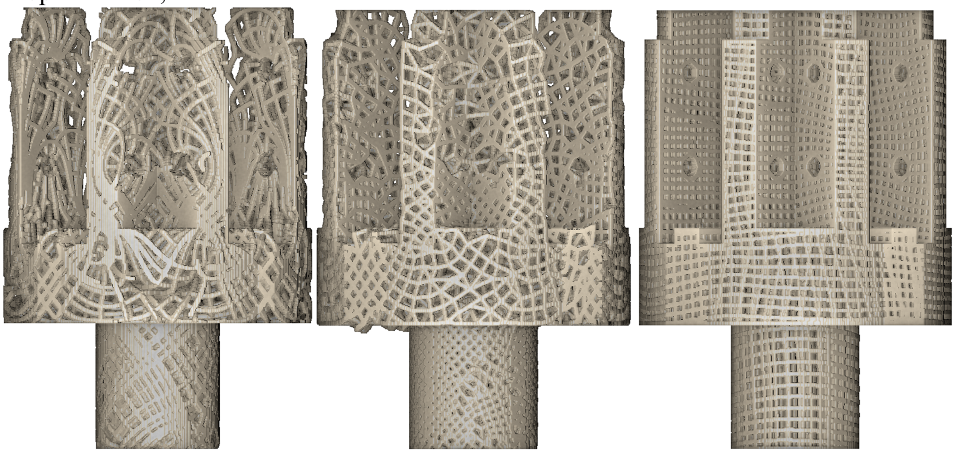
Conforming lattice structure, $c = 1.859$



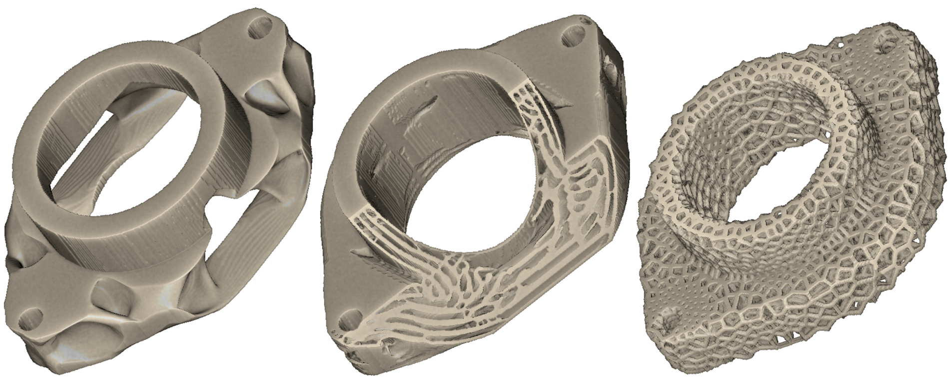
Volumetric Michell trusses, $c = 2.343$



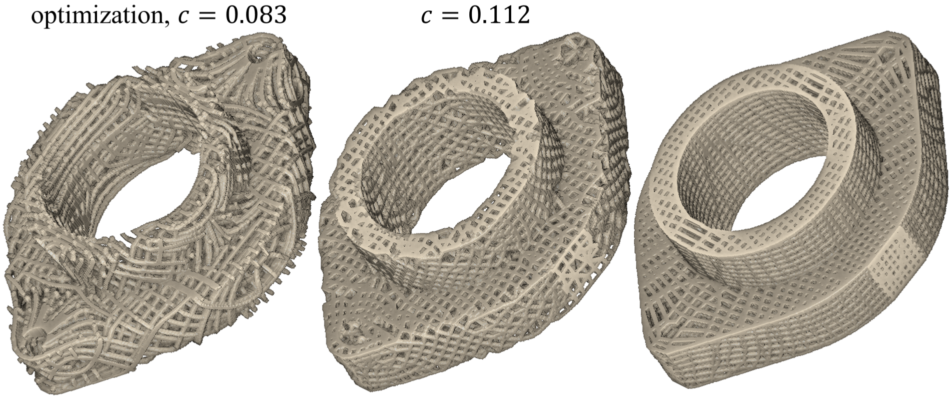
Density-based topology optimization, $c = 0.182$ | Porous infill optimization, $c = 0.261$ | Voronoi infill, $c = 0.255$



PSL-guided material layout, $c = 0.215$ | Conforming lattice structure, $c = 0.380$ | Volumetric Michell trusses, $c = 0.676$

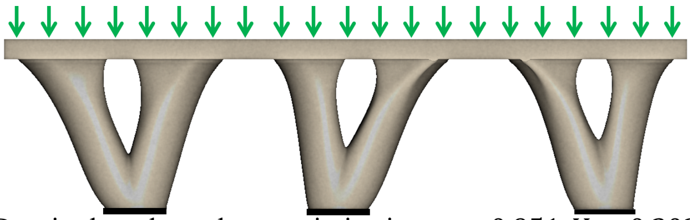


Density-based topology optimization, $c = 0.083$ | Porous infill optimization, $c = 0.112$ | Voronoi infill, $c = 0.141$



PSL-guided material layout, $c = 0.136$ | Conforming lattice structure, $c = 0.153$ | Volumetric Michell trusses, $c = 0.312$

We further demonstrate the capability of SGLDBench to create lightweight infills in the interior of a topology-optimized shape. In this case, the user first runs topology optimization to obtain the optimized shape, then extracts the isosurface of the design from the voxel volume and resubmits the surface to SGLDBench to compute a new infill in the surface's interior. Therefore, the isosurface is reconstructed via MATLAB's built-in functionality, to obtain a conforming triangular surface mesh. The corresponding functionality is integrated into the topology optimization panel of SGLDBench. The figure below first shows the applied boundary conditions and the result of topology optimization, followed by the infill designs using the optimized shapes as domain boundaries for porous infill optimization, Voronoi infill, PSL-guided material layout, conforming lattice structure, and volumetric Michell trusses. Topology optimization has been performed on a cuboid domain with resolution $1024 \times 192 \times 256$, which involves $50,331,648$ simulation finite elements corresponding to $152,523,075$ degrees of freedom. A uniformly distributed force acts downward onto the top of the design domain, and three circular regions at the bottom are fixed.

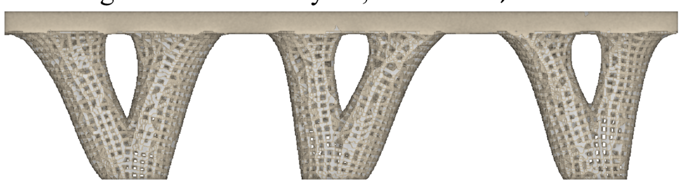


Density-based topology optimization, $c = 0.951, V = 0.302$

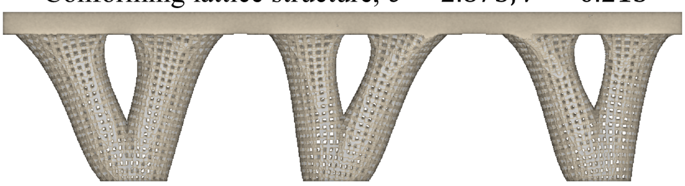
Porous infill optimization, $c = 1.339, V = 0.230$

Voronoi infill, $c = 2.890, V = 0.218$

PSL-guided material layout, $c = 1.708, V = 0.224$



Conforming lattice structure, $c = 2.873, V = 0.215$



Volumetric Michell trusses, $c = 2.129\ , V = 0.222$