# Support Material Reduction for Fused Filament Fabrication Utilizing Compound Bridging and Constrained Steiner Trees

Austin, Justin (School: Arkansas School for Mathematics, Sciences and the Arts)
McCollum, Wesston (School: Arkansas School for Mathematics, Sciences and the Arts)
Greenway, Stephen (School: Arkansas School for Mathematics, Sciences and the Arts)

In recent years, 3D Printing has become an essential part of technological development, and as such, the standard procedures and algorithms are always changing and improving. This project improves on the standard support algorithms which consume more filament than required. This new solution finds the lowest number of points per layer that require support and supports them, combining support structures using Steiner trees. To find what points need supporting, an algorithm goes through all unsupported points in combinations of increasing numbers, temporarily declaring each point supported, until it finds a combination that allows the layer to be printed. The algorithm then takes in the combination of points, and works out a near optimal constrained Steiner tree using a maximum branch slope of 30°. This is accomplished by looping through the array of points and joining the two points with the minimal required branch length until no more legal connections can be made. With the unsupported points found and Steiner tree developed, the algorithm creates G-code for the Steiner tree. This algorithm was shown to work in testing, reducing the filament used on support structures by up to 45% in some cases. Testing involved constructing trees to 3D points and comparing the amount of filament used.