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Finding the optimal nets for self-folding Kirigami

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Three-dimensional shells can be synthesized from the spontaneous self-folding of two-dimensional templates of interconnected panels, called nets. The yield is maximized following sequentially two design rules: (i) maximum number of vertices with a single-edge cut and (ii) minimum radius of gyration of the net. Previous methods to identify the optimal net are based on random search and thus limited to very simple shell structures and not guaranteeing a unique solution. Here, we show that the optimal net can be found using a deterministic algorithm. We map the connectivity of the shell into a shell graph, where the nodes and links of the graph represent the vertices and edges of the shell, respectively. Applying the design rule (i) corresponds then to finding the set of maximum leaf spanning trees of the shell graph, to which (ii) can be applied straightforwardly. This method allows not only to designing the self-assembly of much larger shell structures but also to apply additional design rules, as a complete catalog of the maximum leaf spanning trees is obtained.