Folding Triangular and Hexagonal Mazes

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Abstract

At 5OSME, Demaine et al. (2010) presented an efficient construction to fold orthogonal mazes, computable in polynomial time. The approach was to produce a constant number of fixed gadgets comprising all possible maze intersections in an orthogonal grid, such that compatible orthogonal boundaries of the gadgets match, allowing their combination into arbitrary configurations. In this paper, we present two similar construction approaches to efficiently fold mazes on both triangular and hexagonal grids.

As in the referenced orthogonal maze construction, our constructions are **efficient**, i.e. foldable from paper that is a small scale factor larger than the final maze, **watertight**, i.e. the boundary of the paper maps to the boundary of the model, and **seamless**, i.e. walls and cells of the grid are externally covered by a single, uncreased, visible layer of paper. While a hexagonal maze could be folded using a triangular maze construction, doing so would not maintain the seamless property on cells of the hexagonal grid, so we present both constructions here.

Whereas orthogonal mazes include vertices with maximum degree four, triangular and hexagonal grids have maximum degrees of six and three respectively. So while the orthogonal construction required six distinct intersection gadgets, a triangular grid requires thirteen gadgets up to reflection and rotation, while a hexagonal grid requires only four. Crease patterns for our grid intersection gadgets are shown in Figures 2 and 3. Figure 1 depicts a folding of the MIT logo on a triangular grid.

Similarly to the original orthogonal construction, all of our triangular grid intersection gadgets require only a single pleat of paper to construct a maze wall, not requiring the use of any additional paper. However, we show that if maze walls connect at an angle of more than 90°, additional paper must be used to fold them if the foldings are to remain both seamless and water-tight. Thus, the walls of our hexagonal grid gadgets use additional paper in their construction.

References

Erik D. Demaine, Martin L. Demaine, and Jason Ku. Folding any orthogonal maze. In *Origami*[5]*: Proceedings of the 5th International Conference on Origami in Science, Mathematics and Education (OSME 2010)*, pages 449–454. A K Peters, Singapore, July 13–17 2010.

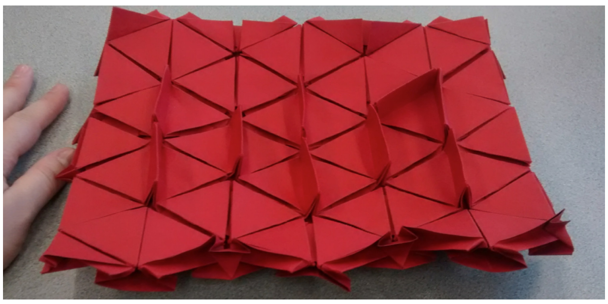

Figure 1: A triangular grid maze representing the letters MIT folded using the gadgets and construction described in this paper.

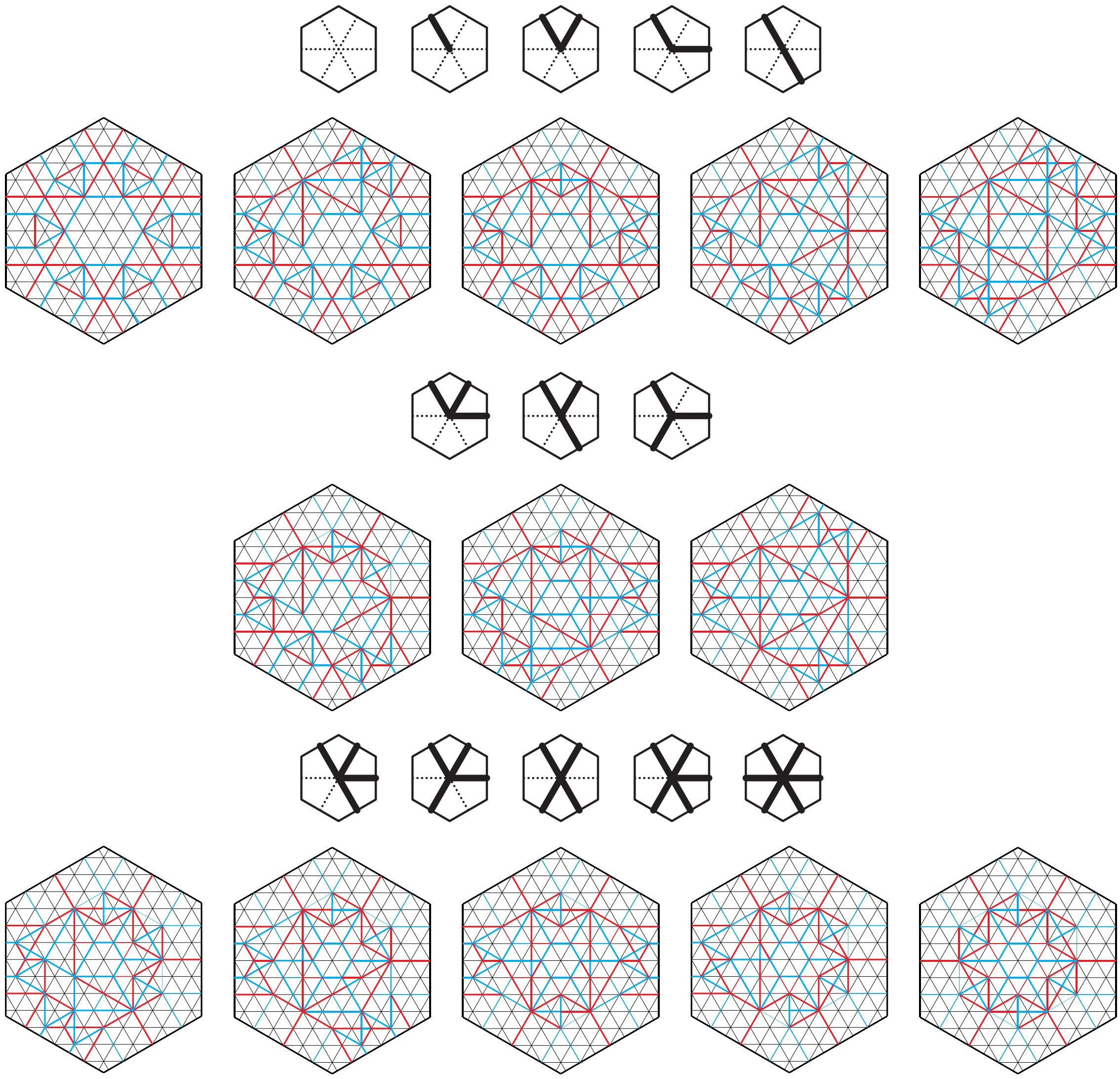

Figure 2: The thirteen triangular grid maze intersection gadgets.

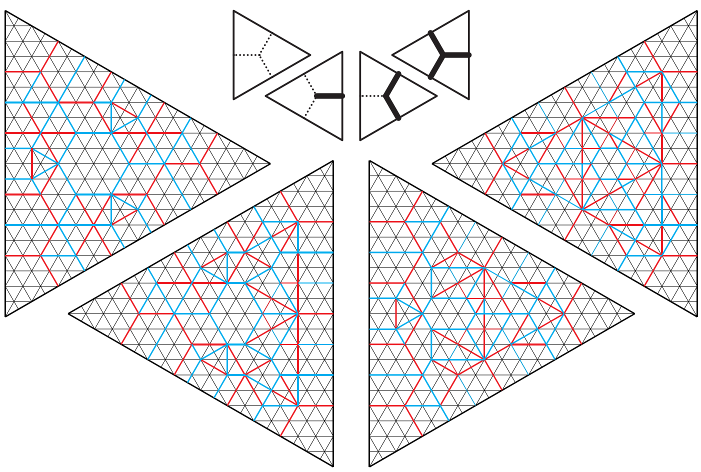

Figure 3: The four hexagonal grid maze intersection gadgets.