



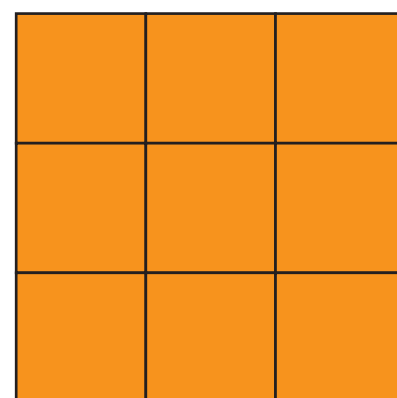
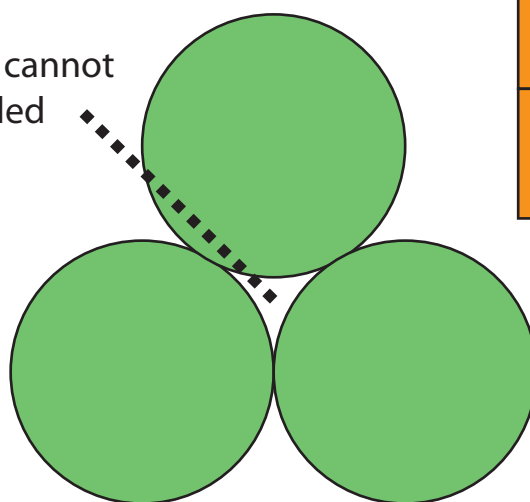
What shapes fill the plane?

If I give you some shapes can you tell me whether they can tile the whole plane?

Easy Examples

For some collections of shapes the answer is easy. For example circles cannot fill the plane without leaving gaps, whereas squares fit together exactly.

Hole that cannot be filled

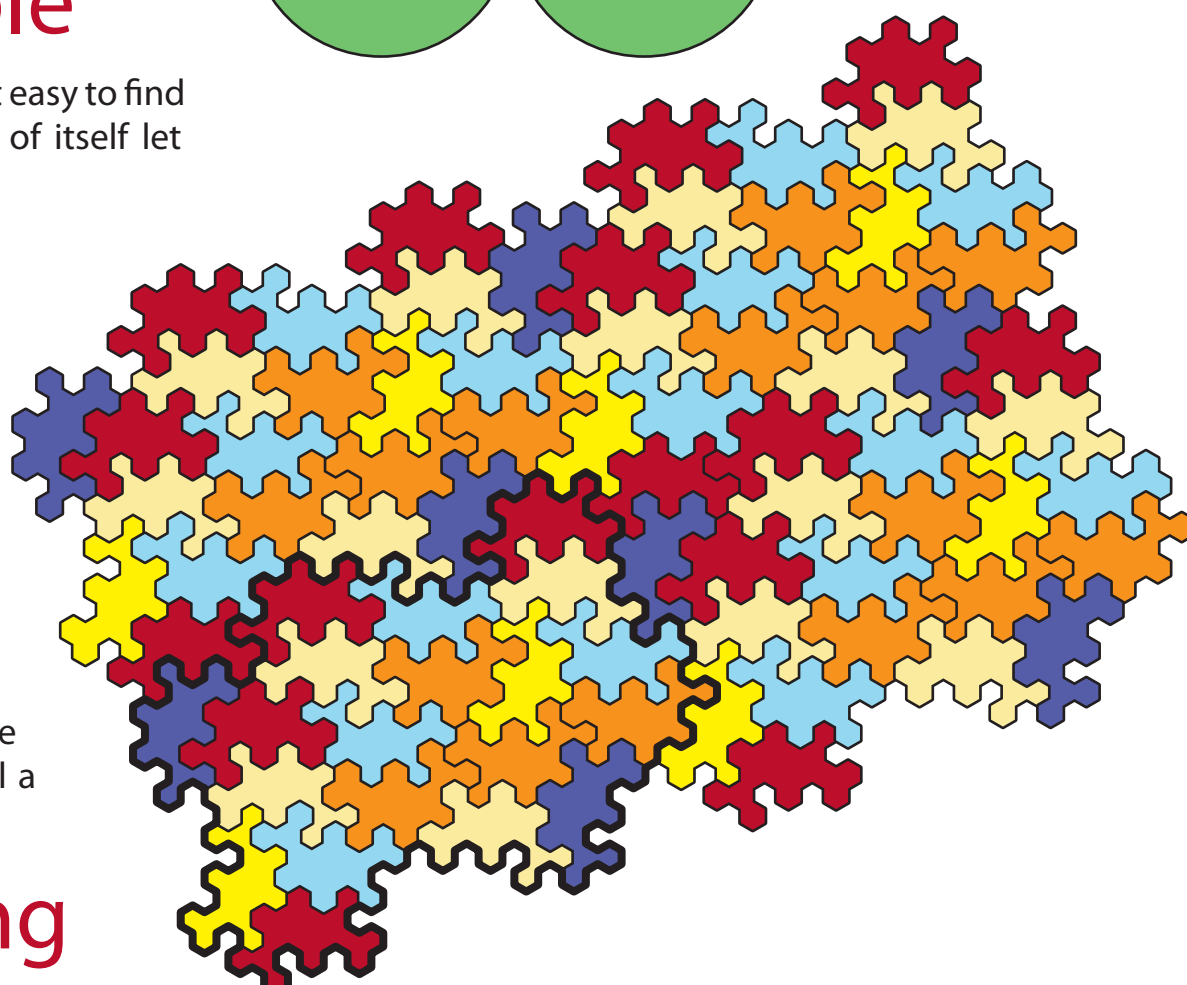


Harder Example

This shape, the Myers tile, is harder, it is not easy to find ways that it can fit together with copies of itself let alone fill the plane.



In fact it can tile the plane as shown on the right. Could you have found this tiling just from the tile?

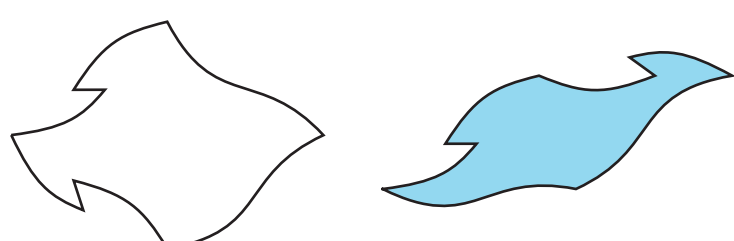


Periodic Tiling

Both the square tiling and the Myers Tiling are called *periodic*. For the square, a single tile gives a region that repeats. The Myers Tiling is more complicated, but still a region of tiles is simply repeated.

Aperiodic Tiling

Can all collections of shapes that can fill the plane produce a periodic tiling? The answer is NO! There are strange sets of *Aperiodic* shapes that can fit together to fill the plane, but never periodically. An example are the two Penrose tiles:



As you can see from the last poster these can fit together to cover a large area.

Monotile Problem

All known aperiodic sets of tiles have at least two shapes. Is there a single aperiodic tile? No one knows!

Undecidability

Aperiodic tiles are an example of how tilings can start to get complicated. In fact things can get a lot wilder. The question of whether a set of shapes can fill the plane can be answered in many cases, however no computer algorithm can say YES or NO for every collection of shapes. In this way it is an example of an *undecidable* problem, beyond the power of computers.

Alan Turing 1912-1954

Alan Turing FRS was a British mathematician and pioneering computer scientist. During the second world war he was instrumental in breaking German codes at Bletchley Park. With the theory of Turing machines he established the foundations and limits of computer Science. He also devised the Turing test to decide whether a machine displays intelligence.



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