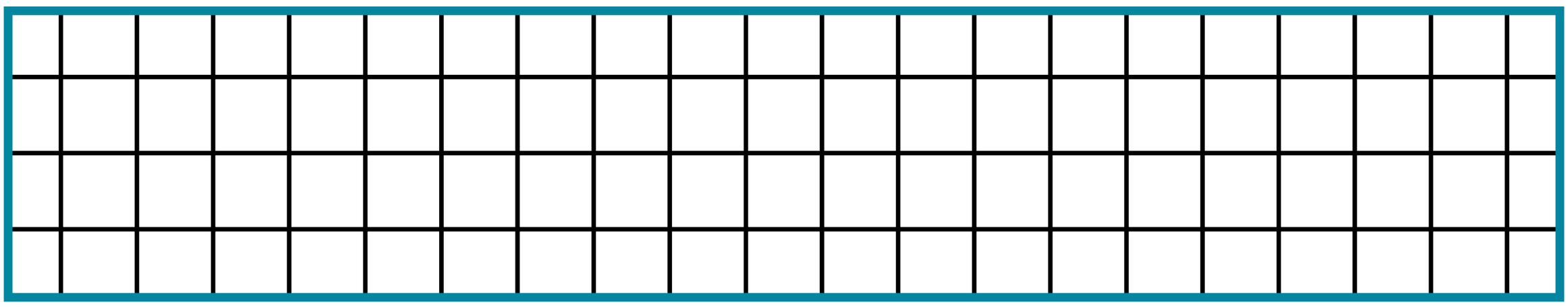
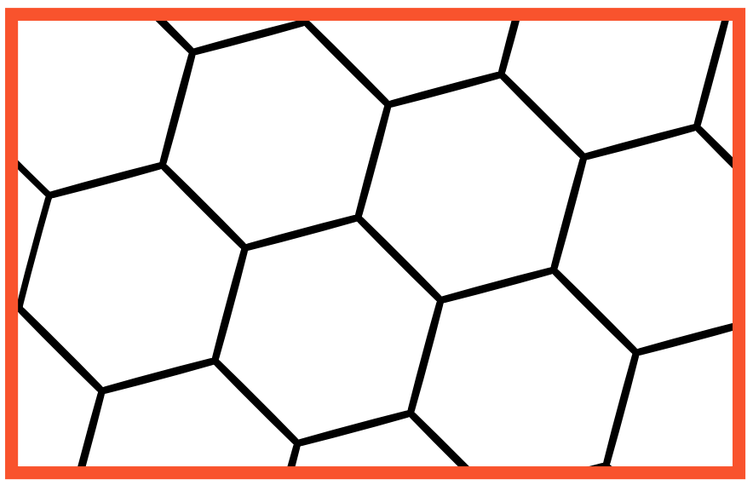
WHAT IS A TILING?

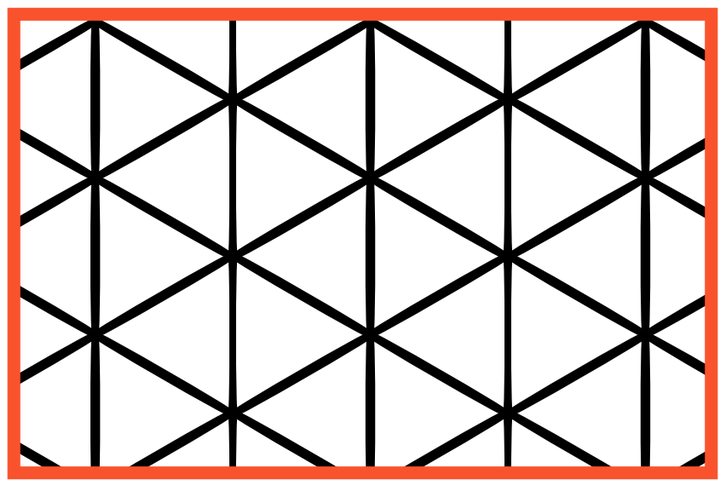
BEACH SPECTRES

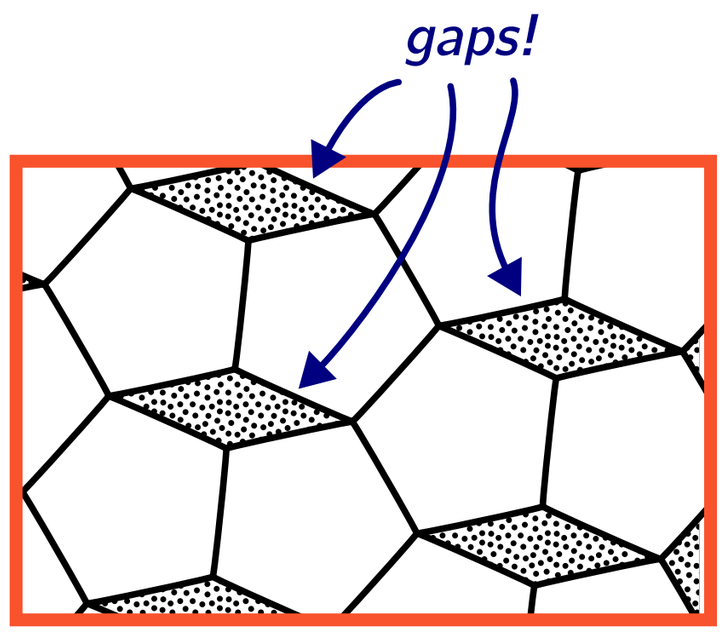
There are many ways to cover a flat surface with shapes and without leaving any gaps between. You could use many copies of the same shape - like a square, which tiles like this:



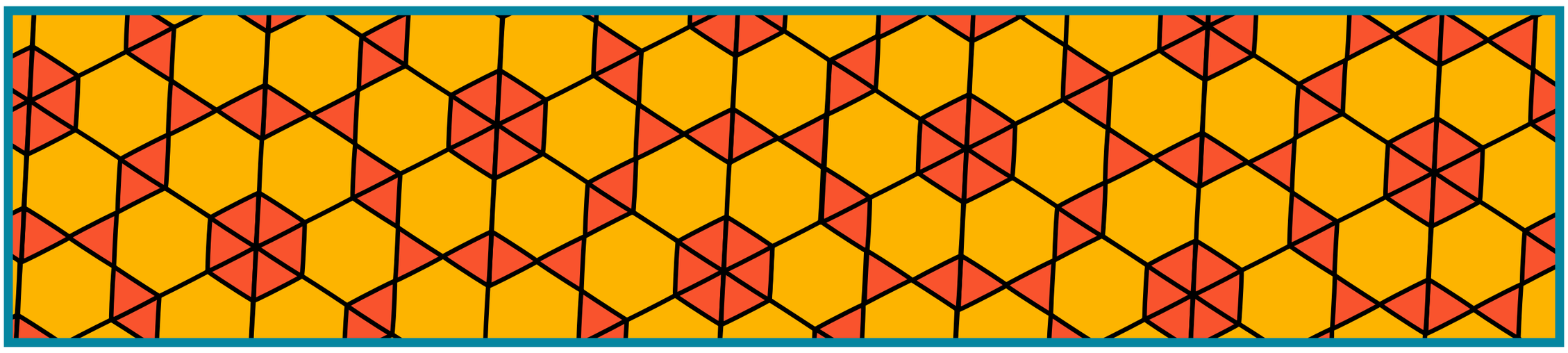
Some shapes can tile like this, and others can't.



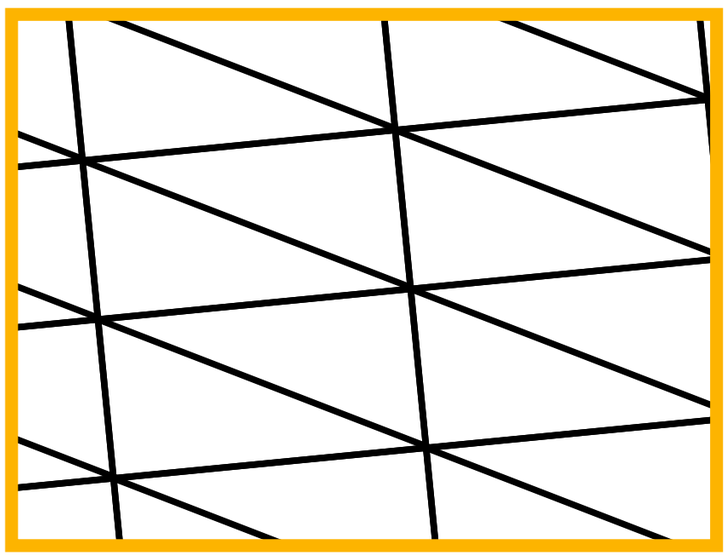


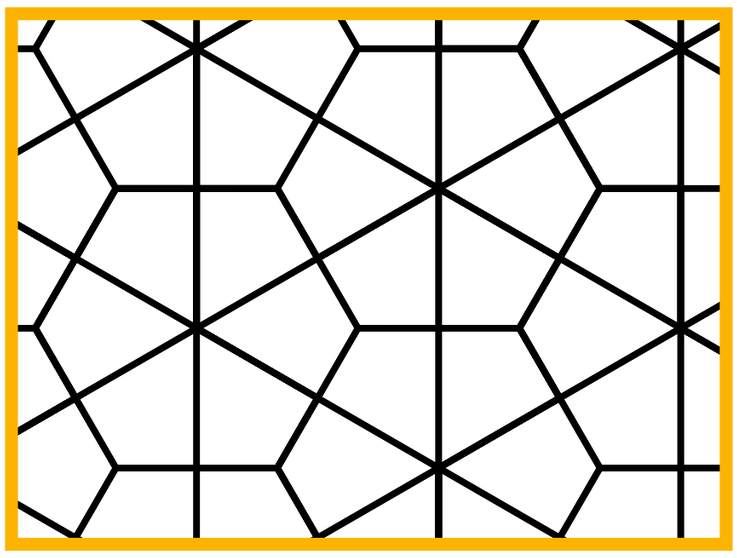


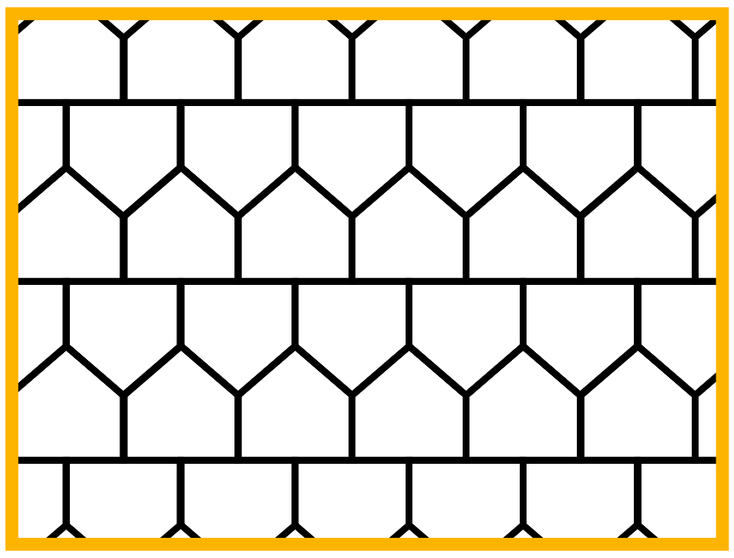
We can also use more than one kind of shape to make a tiling, like these triangles and hexagons:



If a shape can be used to make a tiling just on its own, we call it a **monotile**. Here are some monotiles:







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TILINGS THAT DON'T REPEAT

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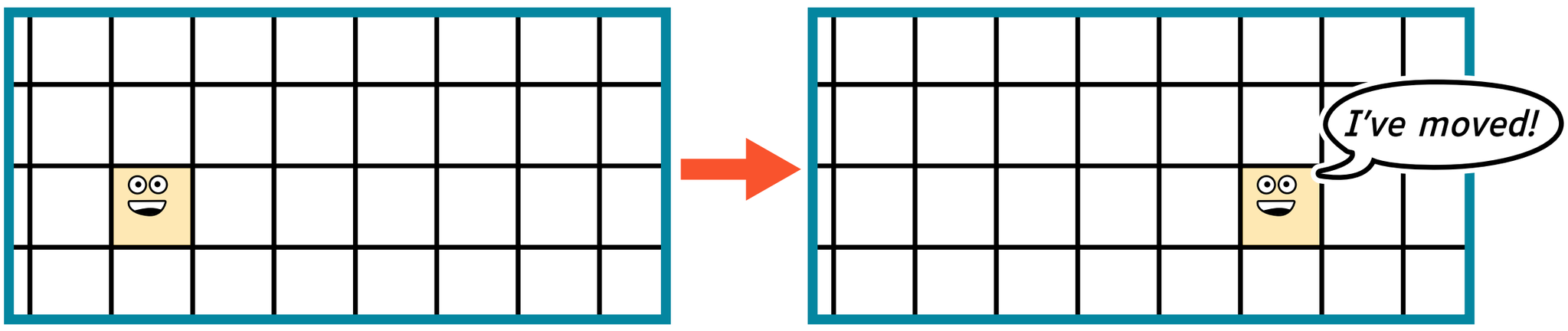
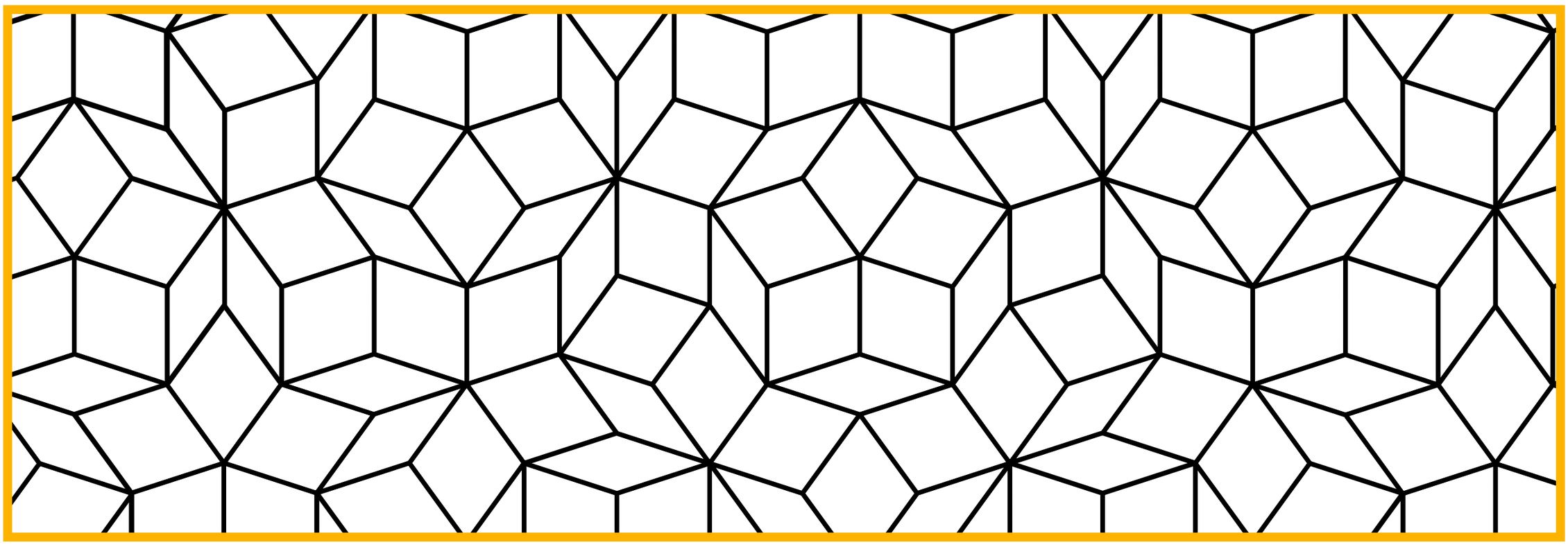
When you tile using shapes like squares or triangles, the tiling has a pattern to it: the same layout, repeating over and over. If we were to slide the whole tiling across or down by the right amount, it would look the same.

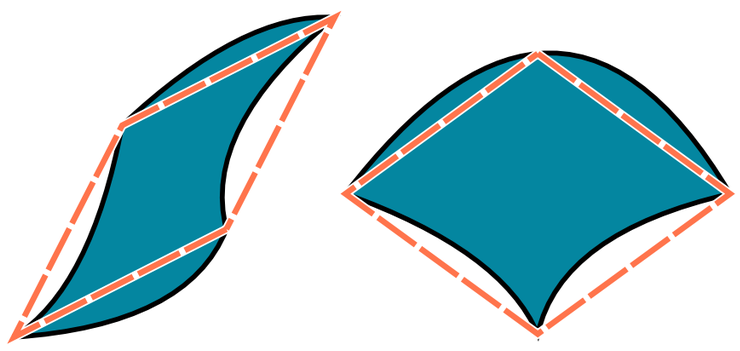


We say a tiling like this is **periodic**.
But is there a way to make a tiling that doesn't repeat like this?

There is: using **aperiodic tiles!**

The Penrose tiling was discovered in the 1960s. It's made from two aperiodic tiles which can be arranged so they never make a periodic pattern. The pattern can be extended forever in all directions, without repeating.





The tiles have to be arranged in a specific way in order to make sure the tiling never repeats. Using curved edges forces the tiles to match up in the right way.

But until recently, nobody had managed to combine both of these ideas: to make a single tile which can only be used to make tilings that go on forever without repeating: an **aperiodic monotile**.

We didn't know if we'd ever find one.

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APERIODIC MONOTILE!

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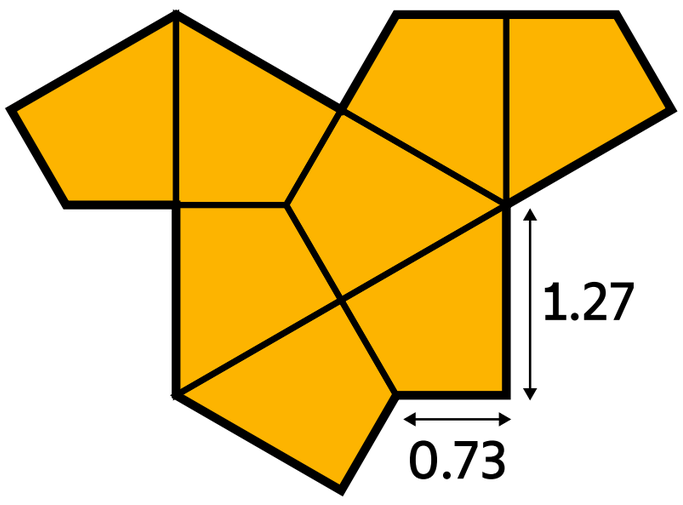
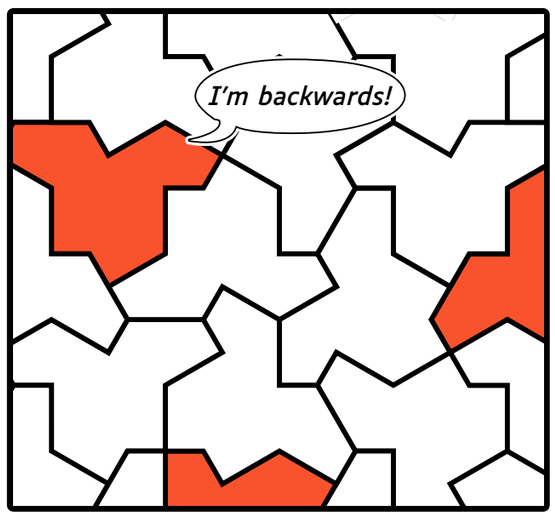
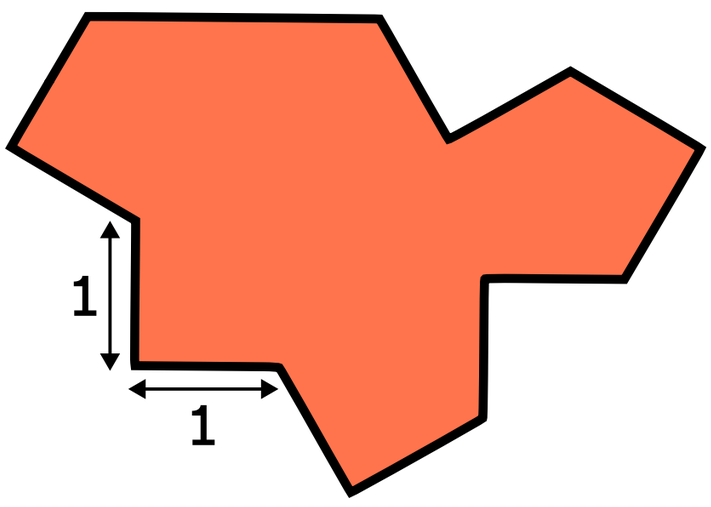
In 2023, an artist called David Smith, who was working on this problem, found some shapes he thought were interesting. He contacted some mathematicians - Joseph Samuel Myers, Craig S. Kaplan, and Chaim Goodman-Strauss, so they could help him check.

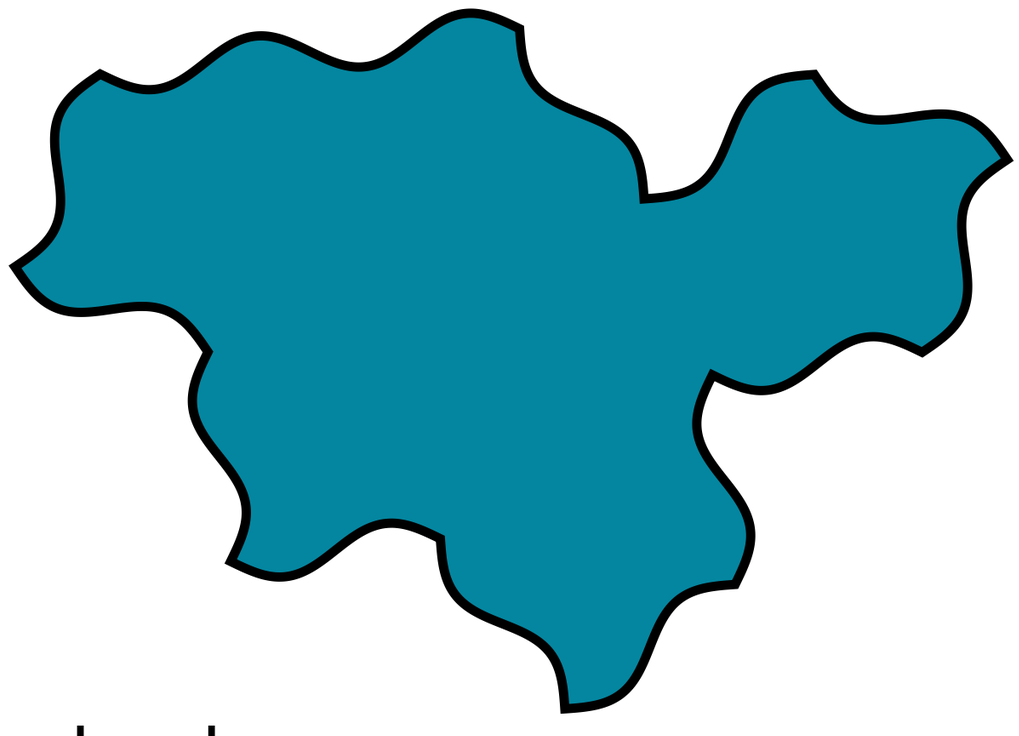
The exciting new discovery was the "hat" monotile, which is made by joining up ten kite-shapes. It can tile the plane without repeating but needs some of the tiles to be flipped over.







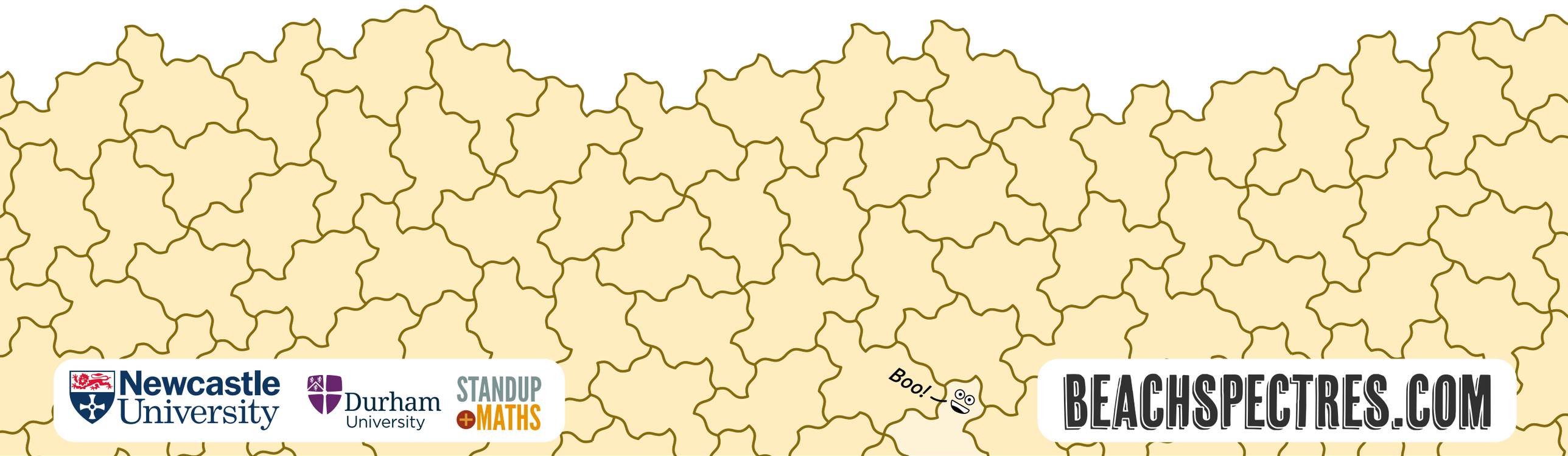
A few months later, they discovered a second tile: it's similar to the hat tile but all the sides are the same length. It doesn't need to be flipped the opposite way, and can create beautiful tilings without repeats.



Like the Penrose tiles, it only makes aperiodic tilings if arranged in the right way. Adding wiggly edges stops the tiling from being periodic. Because the wobbly sides make it look a bit spooky, they called it "the Spectre".

This is the shape we're using today to tile the beach.

No matter how many Spectres we put down, the pattern will never repeat!



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