TuneTrace and the rules of programming

All computers need programs, which are sets of instructions to tell them what to do. Those instructions are written in programming languages. Why a special language? To be sure that the computer will get the instructions right.

In a way, it's like music. If you have ever seen a musical score written out, you'll know music is written in a special language too. Musicians need to know exactly which notes to play, in what order, and for how long. Just using everyday English to describe what a song should sound like wouldn't be precise enough. (If you want to see what we mean, try describing *the tune* of your favourite song to a friend. Can they tell which song you mean?) To make sure the musicians get the song right, a composer writes out all the notes for them using symbols.

Playing with TuneTrace is another way of making music with symbols. The computer takes your doodles and uses them as instructions for what notes to play in what order. Doodles that look different from each other act as different instructions for the computer, which is why they sound different from each other in TuneTrace.

So if playing with TuneTrace is like writing music, and writing music is like programming, playing with TuneTrace is like programming too! Congratulations: if you can draw songs in TuneTrace, you're a programmer.

Activity: can you figure out some of the rules for programming in TuneTrace?

For any set of instructions to work, there needs to be a set of rules to follow to turn the instructions into actions. In written music, those rules are things like playing notes in order from left to right. TuneTrace follows rules to turn your drawings into music, too. Can you work out some of those rules by playing with it?

Warm-up questions

1. Can you draw something that doesn't make any sound? If you can then what is different about the silent drawings?
2. Can you draw something that plays a tune and then stops?
3. Can you draw something that plays a tune that then loops?

Super challenge

- What's the simplest drawing you can find that makes the longest tune without stopping or repeating?

Teacher notes and answers

The rules of TuneTrace

Here are the basic rules that TuneTrace follows to produce sound from drawings. See if your students work them out!

- it's not random
- lights start on every line ending
- length and thickness don't matter, only line endings and crossings (like the tube map)
- lights cannot cross each other on a line
- lights can merge or split but cannot appear or disappear

Answers to questions

Warm-up questions

Q: Can you draw something that doesn't make any sound? If you can then what is different about the silent drawings?
A: Yes. It might be because there are no line endings for the lights to start at. For example a circle, a figure of eight or even a square have no line endings (corners continue a line, they're not treated as ends). Or there may be no line crossings; the lights can't cross each other on a line other, so a single line will have two lights that have nowhere to go. TuneTrace needs a both line endings and crossings before it can make a sound.

Q: Can you draw something that plays a tune and then stops?
A: Yes. TuneTrace makes sounds when the number of stationary or moving lights changes from one step to the next. TuneTrace can reach a balance in which, even if lights are moving back and forth, the number of stationary and moving lights stays the same.

Q: Can you draw something that plays a tune, then loops?
A: Yes. Imagine drawing the board for a game of "snakes and ladders", but with a twist: You knew the player didn't have a dice, they just had the rule to move one square at a time following whatever snakes-down or ladders-up they land on. Depending on how you arranged the snakes and ladders the player would either reach the end or get stuck in a loop. The loop could be simply one snake, or it could be a long journey up and down lots of ladders and snakes. TuneTrace's rules are a bit more complicated but the the result is similar, it depends on the drawing whether the rules will reach a finish or get stuck in a loop.

Super challenge

Q: What's the simplest drawing you can find that makes the longest tune without stopping or repeating?
A: No one knows the answer to this. It’s possible to make very long songs in TuneTrace. The easiest way to do this is to make a very complex drawing, with lots of lines and crossings. Try playing the London tube map in TuneTrace as an example! But making long songs with simple drawings is much more difficult. See which of your students can make a simple drawing that produces a long song (but they should stop the clock if the song stops or begins to loop). Ask them if they had any theories in mind when they made their drawings.