Sonic Pi

Lesson 5

Concurrency

Designed by
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Concurrency

If we want to make some meaningful and interesting musical structures we need to learn some meaningful and interesting programming structures. In this lesson we will

Learning Objectives	Computers can multitask i.e. do many things at once.
	A simple program has one flow of control i.e. one thread of execution.
	Programs can have multiple threads of execution.
	Multiple threads work at the same time i.e. concurrently

Teaching Progression

For the majority of the lesson, it is suggested that work is carried out in pairs. Each pair should have access to the standard equipment described below. In addition, is suggested that you have your own setup connected with a speaker for the demonstration sections.

Sonic Pi Equipment

- A Raspberry Pi with the Sonic Pi software installed per pair;
- A keyboard and mouse connected to the RPi per pair;
- A monitor connected to the RPi per pair;
- A headphone splitter connected to the RPi audio jack per pair;
- A pair of headphones connected to the splitter per pupil.

Equipment

- Computational cards with thread statements.

Lesson Summary

- Overview of the role of the control card and control flow.
- Introduction to threads.
- Using threads to play sounds at the same time.

Starter

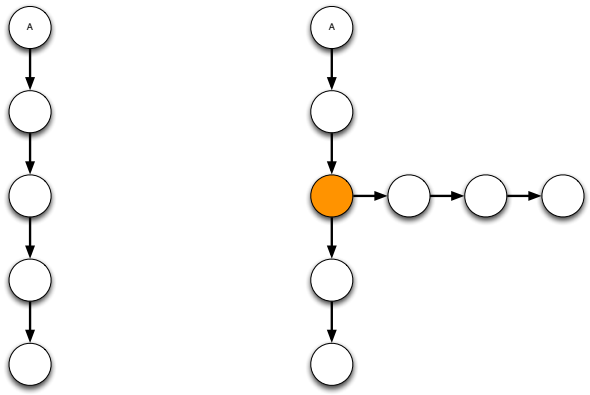
Pupils are first invited to set up and connect their Raspberry Pi hardware.

Main/development

1. Pupils are asked to form a simple line with the original computation cards and act out the program. Ensure that the control card is correctly handed down the line like a relay baton. An example program might be:

```
beep
sleep 1
whoosh
sleep 0.5
ping
sleep 2
boop
```

2. Once they have acted this out, invite them to talk about the structure of this code. Lead them into seeing the clear linear structure - they are standing in a line. Also point out that the control card represents control flow. It represents where the computer is in the program. Ask them to discuss the main limitation of only having one control card - only one thing can happen at once. What if we wanted a bass line to play at the same time as a melody?
3. Explain that we're going to introduce a way of having more than one control card in the same program which will mean more than one thing can happen at the same time. In the programming world, we call this concurrency. The following figure shows how we can move the line of pupils from a single threaded program to a multi-threaded program. The plain circles represent the standard program cards we've used so far (whoosh, ping, sleep, etc) and the orange circle represents one of the thread cards. Organise the pupils into such a form - one main line as before, but with a threaded branch. Remind them that this is similar to the conditional branch in the previous less. However, rather than just one of the branches being taken *both* will be taken! Start the program as normal with the first person (denoted by A in the diagram) having the control card, performing the action, and then passing the control card on to the next person as normal. However, when the control card reaches the person holding the thread card, pass the holder of the thread card *another* control card and ask them to pass one each to both branches. Now execution happens concurrently and independently.



4. Simple linear program

Multi-threaded program
(orange denotes in_thread command)

5. Now invite the pupils to write the following code:

```
in_thread do
  10.times do
    play 60
    sleep 0.25
  end
end

play 60
sleep 0.5
play 62
sleep 0.5
play 64
sleep 0.5
play 65
sleep 0.5
play 67
sleep 0.5
play 69
sleep 0.25
play 72
```

6. Explain that this code works exactly like the system they just acted out. The code within the `in_thread` block gets its own control flow and therefore runs at the same time as the `play` & `sleep` code below.

Plenary

Pupils are invited to play around with the constructs of this less in addition to everything they've learned so far to design simple a musical program.

All students are able to...	Know that computers can do multiple things at once. Use an `in_thread` block.
Most students are able to...	Use multiple `in_thread` blocks in the same program.
Some students are able to...	Understand that threads have a separate flow of control.