Maths and music

Generative music investigation

Aim of today: - investigate generative music

Today we will:

- Use computer programming environments to explore rhythmic and melodic generators
- Avoid heavy theory - today is about using computer programming and mathematics as a set of tools to experiment with sound and music

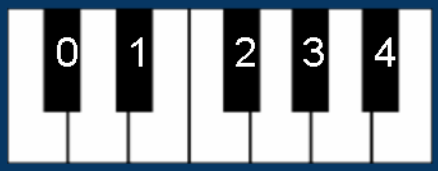
Generative music loosely defined:

- Music created by a system
- Related to algorithmic music, follow a set of rules

- Mathematical constructs determine which notes to play… not a human composer
- The human composes the SYSTEM, not the music

Generating note sequences

- A simple way to apply any number sequence to music is to number the notes on the piano keyboard
- E.G. The black notes on the piano keyboard (C# D# F# G# A#) form a five note (pentatonic) scale



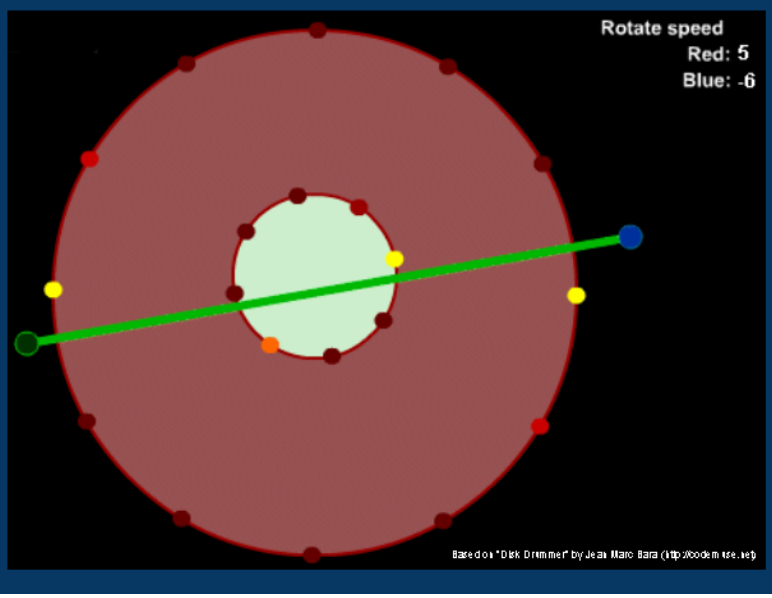
- Any number sequence with range 0 to 4 can then be used as instructions for which notes to play

But, wait!

- What about sequences with range >4?
- Also, without rhythmic instructions, the notes are meaningless

Generating rhythms

- Place pegs around a rotating disk - like a music box
- When a peg crosses the green trigger-line a note is played
- A great variety of rhythms can be generated by altering just a few parameters



Parameters available:

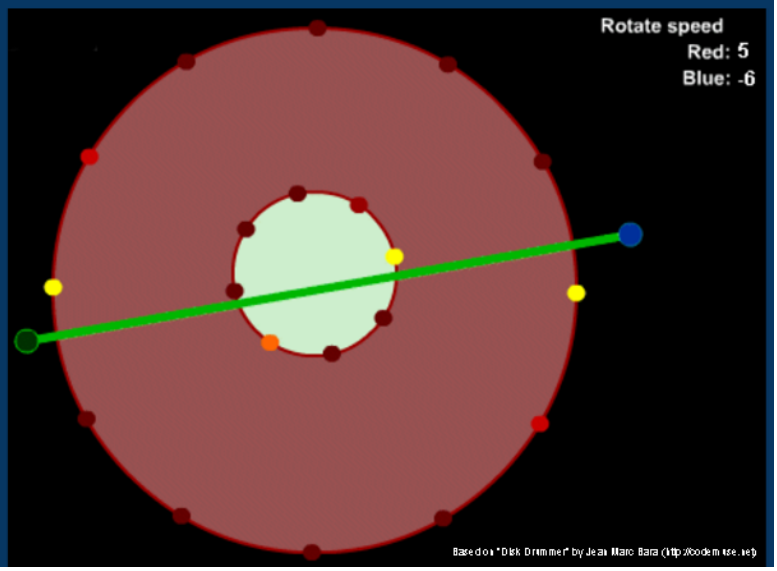
- Speed of each disk
- Direction of each disk
- Number of disks
- Number of pegs per disk
- Size of each disk
- Position of each disk
- Position of trigger-line

Rhythm and notes with rotating disks

- By numbering the pegs from zero we can directly link pegs to notes on a keyboard
- By altering the key numbering we can change the tonality
- Can even generate chords when multiple pegs are triggered (diagram to the right shows 4 simultaneous note triggers)

Chromatic

Pentatonic



Other methods

- Instead of assigning note numbers to pegs directly, take note numbers from a recursive difference equation
- …Like the Pisano sequence

– Pisano sequence is similar to Fibonacci but we “wrap around” using modulo arithmetic

– Quick overview of Fibonacci series (0,1,1,2,3,5,etc…)
  - Take 0 and 1, add them
  - Add the result (1) to the previous number (1) to get 2
  - Add that result (2) to the previous number (1) to get 3
  - ...and so on

Overview - Modulo arithmetic

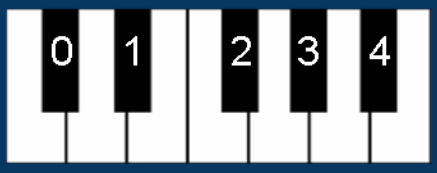
- The modulo operation gives the remainder after division
- A practical analogy is converting 24h time with a 12h clock
  - As you go round the clock: numbers >12 wrap round to 1...
  - … and 12 maps on to 0

- How does this apply to Fibonacci?
  - Fibonacci series is:
    0,1,1,2,3,5,8,13,21,34,55,etc

- In modulo 12 - everything is fine up to 13
- 13 maps to 1,
- 21 maps to 9, and so on

Back to note sequences

– How do we apply Pisano to note sequences?
  - Back to the numbered notes on the piano keyboard
  - (C# D# F# G# A#) with corresponding numbers 0,1,2,3,4



- Compute the Pisano series in modulo 5
  - 0,1,1,2,3,0,3,3,1,4,0,4,4,3,etc...
  - Play the notes corresponding to the numbers
  - C#(0), D#(1), D#(1), F#(2), G#(3), C#(0), G#(3),etc...

Worksheet

Worksheet is divided into 2 sections

- Guided exercises
- Guidelines/starting points for investigation

Read the worksheet fully and avoid skimming!

- The guided examples are designed to help you understand each step, and are therefore quite wordy
- Missing out steps can easily lead to confusion.
- If you have any questions, just ask, we're here to help!