Pattern, Code and Algorithmic Drumming Circles, A Report

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ABSTRACT

A report on Pattern + Code, a project working with primary school children to explore codes through both textiles and musical code, creating an audio/visual installation and live performance. The project came in three parts: *Knot Coding*, hiding messages in string, inspired by Andean Quipu, *Algorithmic Drumming Circles*, live coding percussive, cyclic music in groups of eight, and finally a live coding quartet performance. The paper concludes by considering how knot coding and live coding could be brought together in the future.

1 Introduction

This project was developed and executed by myself (Alex) during an arts residency in collaboration with primary school pupils, resulting in an art installation for the Playgrounds exhibition in Sheffield, Yorkshire UK. I chose the theme *Pattern + Code* for the activity and installation, a continuation of my interests in understanding coding through both traditional and contemporary cultural practices. I wanted to bring together two activities: *knot coding* inspired by the ancient Andean practice of Quipu (Urton 2017), and contemporary, collaborative *live coding* musical practice (Collins et al. 2003).

I worked with two classes full of Y4 (8-9 year old) children on the installation. In addition I worked with three Y8 (12-13 year old) pupils for more focussed work leading to a group performance. Ten days were available to develop the whole activity.

In the following section I will briefly introduce knot coding, before describing the activity that is the focus of the present paper, algorithmic drumming circles. I will conclude by reflecting on these activities, and how I plan to bring them closer together in the future.

2 Knot coding

Quipu is the ancient pre-Columbian practice of recording information using yarn, used in the Andean region to keep records during the Inka empire (Urton 2017). This practice did not survive the Spanish conquest, and the Quipus that remain have only partially been decoded. We do however know that a decimal system of knots was used to record numbers, and that other information was recorded with binary properties such as the spin direction of yarn, the orientation of hitches, as well as the colours of threads.

Inspired by this ancient practice, I worked with Y8 children in Wybourn Community Primary in Sheffield, on hiding messages in knots tied into yarn. The aim was to get the children thinking about how information can be represented using discrete (i.e., digital) knots in string. My motivation was to introduce digital art in a way that was grounded in human cultural practice, rather than contemporary demands of the information economy.

The first step was to make Quipu-like strands to work with. This involved taking a length of alpaca wool, tying a lollypop stick to one end, and standing on the stick while twisting the other end. When the twist in the wool gets tight, the two ends are brought together (i.e., the wool is folded in half), and the twist in the wool causes it to 'self-ply', i.e. twist back on itself to create a new thread that is around half the length and twice the thickness. Importantly, the strand is not only thicker, but has a loop at one end where the original thread was folded in half. In Quipus, this loop is used to hitch one strand onto another, creating a non-cyclic tree structure of main cord, pendant strands, sub-pendants and so on, the structure of which can be easily adjusted later.

Having each created a Quipu-like strand to work with, we then looked at how Inka Quipu-makers recorded numbers with knots. Being a decimal system, knots are arranged into units, tens, hundreds and so on up the strand, with one being a

Figure 1: Quipu-like structure created with Wybourn Community Primary pupils. Photo (c) Jon Harrison.

simple overhand knot (or figure 8 knot in the unit position), and other numbers represented by the number of turns in a "long knot".

The children were then set the task to hide messages in string, given additional ready-made Quipu-like strands to work with as well as elastic bands and beads. After a half-day session with each class, the resulting works were hitched on to a single main cord, creating a Quipu-like structure for the exhibition, shown in Figure 1.

3 Algorithmic drumming circles

Working with Quipus set the scene for the focus of the present paper: algorithmic drumming circles. Faced with the challenge of working with two classes full of children, and limited time, I formed a plan to work with groups of eight children. It was important for the harmony of the school that no children were left out, so this meant having seven sessions, over the two days available.

By chance, the children had already partipated in drumming circles with real drums earlier in the school year, and so were familiar with the concept of playing rhythms together. They were on the whole less familiar with coding, although perhaps the earlier knot coding activity gave them some ideas about discrete representation and pattern.

Each group of eight children was arranged in a circle on the floor, each child with their own computer and speaker. They used the TidalCycles [McLean (2014); tidal for short] live coding environment to make music together. Each session only lasted one hour, during which I gave them a short presentation on the practice of both drumming circles and live coding, teached them how to live code with tidal, and recorded a drumming circle performance for the installation. Despite the apparent impossibility of this task, in two cases there was time to record two performances to include in the exhibition. Some sessions could not be recorded due to lack of parental consent, and in the end five recorded performances were kept, of around 10 minutes each. For safeguarding reasons I am not able to share these videos online, but here is a link to a drumming circle with six adults, to demonstrate how the system works: https://photos.app.goo.gl/HKKvexgiXXdcvwa18.

3.1 Hardware

Eight Raspberry Pi computers (version 2) were used, with high quality audio outputs from Phat DAC add-on boards, and 7" screens donated by sponsor Pimoroni. In addition eight speakers (four pairs of Fostex PM0.3d) were used, with a speaker placed under each computer and screen, creating an eight-channel drumming circle where each pupil could hear their own contribution clearly. I had originally planned to use cheaper Pi Zero Ws, but could not obtain them in time for the workshops, and had ready access to Pi 2s. The computers had keyboards, but not mice.

In order to support accurate time synchronisation and tempo coordination, and take a live backup of the children's code, an ethernet network was used. As well as recording the code, a high definition video recording was taken of the circle from the top-down by Jon Harrison, by fixing a camera with wide lens to the ceiling. The camera also took an audio recording for reference purposes. Rather than recording the eight-channel audio, keypresses by the children were recorded so that they could be replayed, thereby reconstructing the audio perfectly.

3.2 Software

I used the *TidalCycles* environment, with a newly developed, tightly integrated text-based editor *FeedForward*, written in the same language as TidalCycles; Haskell. This project gave significant impetus to develop this editor so that it was stable enough for use by eight year olds. In the event, the children were the first people to use it aside apart from myself. Feedforward features include automatic labelling of separate patterns (so the usual d1, d2 functions are not required), so that individual pattern can be easily muted and unmuted with hotkeys. Furthermore, each pattern is given a VU meter, giving a visual cue of the audio produced by it.

Importantly for this project, FeedForward records keypresses with accurate timestamps, allowing performances to be recorded and played back with very high precision, and minimal space requirements. These data were sent over the network to my laptop, so that they could be stored together for later processing, and also as a live backup.

I also added software features to TidalCycles itself in the form of the optional Sound.Tidal.Simple module, mainly to reduce the amount of typing needed to make live music, to a level acceptable to non-touch typists. This involved developing Tidal's overloaded string feature, so that a sequence will default to being a pattern of sounds. This is in addition to automatic inference of separate patterns, so rather than typing d1 $ sound "kick snare" for a minimal kick-snare pattern, only "kick snare" is required.

I also added a number of shorthand pattern transformation functions to Sound.Tidal.Simple, which all take a single pattern as input and return a pattern as output. These additional functions are listed in the below table:

name	effect
crunch	apply bit crush
scratch	chop each sample into 32 grains and play them backwards
louder	increase the gain
quieter	decrease the gain
mute	replace the pattern with silence
jump	skip forward in time by a quarter cycle
higher	increase playback rate
lower	decrease sample playback rate
faster	increase sample playback rate and play the pattern faster
slower	decrease sample playback rate and play the pattern slower

I have since found myself using these 'simple' features during my own performances.

As well as the above unary pattern transformations, I also introduced the children to two of Tidal's higher order functions, every and sometimes. Even these two functions ad a great deal of variety to the overall rhythm, allowing them to patterns such as every 3 faster "hi*2 ~ lo lo". I also showed them how to add additional transformations on top, such as sometimes crunch $ every 3 faster "hi*2 ~ lo lo", explaining that the $ operator is used for 'glueing together' transformations.

3.3 Instruction and sound

I had a few different approaches to the drumming circle to try out with the first couple of groups of children (who did not have parental permission for filming). For example, I had printed example patterns onto stickers, which I stuck onto playing cards, and then dealt out to the children. These stickers had different colours to denote whether they were drum pattern sequences, or functions to transform those sequences.

However, it quickly became clear that any such intervention was a distraction from what is most important in a drumming circle: trying things out, listening to each other, and responding. So rather than handing out cards, I simply showed them

Figure 2: Algorithmic drumming circle installation in-situ, showing video and on-screen code playback of the children working, which was synched with the audio. Photo (c) Jon Harrison.

how to make pattern sequences and transformations on-screen, and gave them time to experiment with each example hands-on.

I gave each child only two samples each, named hi and lo, to denote the high and low tone of many hand drums. Each child had a different pair of sound samples, taken from a variety of hand drums, to help them differentiate their own patterns from those of the rest of the group, creating a rich percussive emsemble. My original intention was to use these at the beginning, but then give them additional sounds to play with, printed on cards. However as mentioned earlier, I found limiting the children to only two sounds each provided constraints leading them work creatively with the patterns.

4 Installation

The installation was live during the week-long Playgrounds exhibition in Millennium Gallery in Sheffield, taking place as part of the Childrens' Media Conference. As shown in Figure 2, the computers were set up on the floor of the exhibition, as they were in the school, only without keyboards, creating a non-interactive installation. The videos originally taken from a camera attached to the ceiling in the school were projected back onto the computers from a projector suspended above, so that ghostly images of the children could be seen moving around and working at the computers. Their keypresses were simultaneously replayed in synchrony with the video, so visitors to the exhibition could see the children, see what they were typing, and hear the rhythms produced from the code they were typing from the individual speakers. The knot-coded quipu-like structure was installed next to the drumming circle, with photographs of the children making them. Small booklets were made explaining how the project worked, and its motivations.

The projection could have been a little brighter, and the acoustics of the room a little dryer, but in my opinion the children made amazing music, and this came through well in installation form. The children themselves visited the gallery, and reports are that they enthusiastically enjoyed re-watching their drumming circles (and stepping on each other's projected forms).

5 Live performance

I also worked with three older pupils, this time 12-13 year olds from Crofton Academy school in Wakefield, also in Yorkshire UK. This was in collaboration with the Wakefield sensory support service there, with a view to exploring tactile interfaces to live coding through participatory design, but the visual impairments of the participants was not a factor in the present project. We had around five hours of learning and practice over two sessions together, allowing a much wider exploration of Tidal's functions and sounds. We also recorded new sounds for the children to use. I joined them in the performance, forming a live code quartet, to a large audience, the majority of which were pupils from another local primary school. The young live coders did brilliantly, causing the whole audience to spontaneously stand up and dance.

6 Conclusion

This project was developed as an arts residency, and no attempt was made to evaluate it as a piece of research at this stage. The eight-year olds were not surveyed for qualitative or quantitative responses, however they all engaged fully with the activity throughout, and to my own ears, the musical results were great, fluctuating between polyrhythmic grooves and extreme noise, with each drumming circle group having a distinct musical character. It was particularly good to see children at several points hear something interesting one of their friends was making, run round to have a look at how it was done, and then run back to try it out themselves.

Further development is ongoing towards a follow-on installation. As well as having more time with future groups, and I am particularly keen to make the next iteration interactive, providing an additional computer or two allowing visitors to join in with the live code being played back. I have plans to work with another school in the region, but am also keen to work with adult and family groups. The first of these will take place at RODEO festival of dance and theatre during October 2018, where some visitors will work on algorithmic drumming, while others will control dancing robots created by Dave Griffiths.

More fundamentally, I am keen to explore how Quipu-like textile structures could be used as an interface to live coding. Both Quipu and computer lanugage is structured as a syntactical tree, and being able to describe computational, musical patterns through such textile structures appears to be an area ripe with possibilities. It is easy to forget that historical technologies such as Quipus perished through external factors and not necessary through any lack. The practice of quipu-making was developed and refined over a far longer period than contemporary silicone-based technology, and so we must surely a great deal to learn from it.

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References

Collins, Nick, Alex McLean, Julian Rohrhuber, and Adrian Ward. 2003. "Live Coding in Laptop Performance." *Organised Sound* 8 (03): 321–30. https://doi.org/10.1017/s135577180300030x.

McLean, Alex. 2014. "Making Programming Languages to Dance to: Live Coding with Tidal." In *Proceedings of the 2nd ACM SIGPLAN International Workshop on Functional Art, Music, Modelling and Design*. https://doi.org/10.1145/2633638.2633647.

Urton, Gary. 2017. *Inka History in Knots: Reading Khipus as Primary Sources*. Austin: University of Texas Press.