Cyclic Patterns of Movement Across Weaving, Epiplokē and Live Coding

Feature Article

Alex McLean   Giovanni Fanfani   Ellen Harlizius-Klück
Deutsches Museum (GE)

Abstract

This article hosts an interdisciplinary exploration of cyclic rhythmic structures, bringing together historical references to ground understanding of algorithmic electronic dance music, and in particular the algorave movement. The role of pattern in uniting dance, music and language is investigated in the ancient practice of weaving, in ancient Greek choral lyric, and contemporary live coding. In this context the TidalCycles environment is introduced, with some visual and audio examples. Cyclic metrical patterns in ancient Greek are then explored in detail, particularly the metrical transformations of Epiplokē. Finally, this jump between contemporary and ancient practice leads us to consider algorave itself as a Luddite movement, its proponents engaged in an unravelling of technology.

Keywords: epiplokē; pattern; live coding; weaving; algorave

Alex McLean is researcher and live coder, working as post-doc in the ERC project *PENELOPE: A Study of Weaving as Technical Mode of Existence*. He completed his thesis "Artist Programmers and Programming Languages for the Arts" in 2011, in Goldsmiths, University of London. He has performed live coded music widely since the year 2000 and organised well over a hundred electronic art and music events, including AlgoMech Festival. Alex cofounded the algorave and TOPLAP movements, as well as the international conferences on Live Coding and Live Interfaces. Web: <https://penelope.hypotheses.org/alex-mclean> <http://slab.org>

Giovanni Fanfani is a classical philologist and post-doc, also working in the PENELOPE project, where he explores the relevance of ancient weaving technology for the poetics of archaic Greek literature. He received his PhD at the University of Bologna with a thesis on the intertextuality of Euripides' Trojan Women. His research focuses on weaving imagery in Greek poetry, and on the interaction of lyric and tragedy. Web: <http://penelope.hypotheses.org/giovanni-fanfani>

Ellen Harlizius-Klück is Principal Investigator in the PENELOPE project, funded by an ERC Consolidator Grant and hosted at Deutsches Museum, Munich. She was international Co-Investigator in the *Weaving Codes—Coding Weaves* Project, funded by a Digital Transformations Amplification Award of the Arts & Humanities Research Council (UK), and Marie-Curie Research Fellow at the Centre for Textile Research, University of Copenhagen. The philosophy and technology of ancient textile production and its impact on early scientific thinking is her main interest. Web: <https://penelope.hypotheses.org/ellen-harlizius-kluck>

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Introduction

A typical musical performance at an algorave, sees a live coder on stage (Collins et al. 2003) writing code. As they type, their computer interprets their code as sonic, musical structure, with immediate, physical results—in particular electrical impulses being sent to loudspeakers, where they are translated into soundwaves. These air pressure waves propagate across the room, hitting audience members, experienced by them as sound and as music. If they are not dancing too much, they may also read the code on the performer's screen, which is generally projected in the venue (see fig. 1). The performer responds to the audience in deciding what to type next.

Figure 1. ALGOBABEZ performing at Blue Dot festival 2016, photo Dan Hett.

This journey from discrete symbols to physical movement and back creates a whole experience, encompassing musical action and reaction, formal language, and physical movement. As time is counted out by the performer, through driving repetitions in the music, they make changes to their code that are well timed to play with expectations, feeding or delaying anticipation in the listener. As the audience responds, and the performer responds to the audience in turn, they link physical movements with the abstract structures they are building inside the computer.

All of this relates to pattern—patterns in language, in sound, in music and in movement. At a microscopic level, patterns run through the operation of a computer, for example through bitwise shifting operations, boolean logic, modulos and the procedural dance of sorting algorithms. If mathematics is the science of patterns, then computing (as applied mathematics) is the performance of pattern. Live coding then is an act of opening up these hidden computational performances, and manipulating them into musical performances. So we have patterns of code, structured into patterns of music, and therefore into patterns of movement, felt by the musician who feeds it back again into code.

Algorave, as a dance party driven by abstract computer language, seems other-worldy, and it would be too easy to treat it as science fiction made real. In the following article, we instead turn to ancient history to look for cultural precursors that throw a different light on our understanding of algoraves. In particular, we find analogous culture in Ancient Greece, where pattern also connected text with music and dance. To understand this patterning across the senses, we refer to another artform present in Ancient Greece—weaving at the warp-weighted loom—which we consider to be ancient apparatus for producing digital (and indeed algorithmic) art. Weaving will help us for its explanatory power both as a ubiquitous metaphor for intermingled flows of force, and as a practice in its own right; weaving itself unites pattern, mathematics and the body.

The following section provides a short introduction to some practical and philosophical aspects of weaving, and to concepts of pattern and weaving in ancient Greek thought and song-culture. We then turn our attention to the modern day technology of TidalCycles (referred to by its shorter name "Tidal"), and its particular approach to musical pattern, representing patternings of repetition, symmetry, interference and glitch as a function of time. We then return to ancient Greece to explore ways in which the notion of *epiplokē* works as a pattern operator in rhythmical design, generating cyclic structures of metrical sequences in a comparable way to Tidal. We then conclude to consider the more recent history of the industrial revolution, relating the practice of live coding to the Luddite movements of the early 19th century.

Textility of Weaving, as Metaphor and as an Ancient Digital Artform

An underlying topic running through this article is the ancient technology of *weaving*. We examine patterns recurring across weaving, live coding, and ancient Greek poetry. In this we look to demonstrate that weaving patterns were an important reference for archaic and classical Greek sung-and-danced poetry, both in terms of its design and performance. The fact that the song, the movements of the dancers, and the rhythmical sequences of the poem are all conceptualized in terms of weaving invites us to explore whether this points to a mode of pattern generation that is comparable to live coding of music.

While live coding is becoming more widely known (e.g. Kretowitz 2017), it is difficult to define, and perhaps a textile-grounded metaphor can help us. We can say that live coding is a community of practice, interested in changing rules while they are followed (Ward et al. 2004). This puts forward live coding as a heavily improvisatory practice, where the performer changes the underlying rules of a performance on-the-fly, seemingly taking control of the rules, but at the same time giving up control; by manipulating rules the performer finds unexpected results. This connects live coding to the recent approach of Bruno Latour as "one of those beings that teach you what you are when you are making it" (Latour and Porter 2013: 230). Here Latour meets with Tim Ingold (2010) and his idea of the *textility of making* that includes a criticism of the concept of art where an idea is *imposed* on matter. In contrast, to Ingold "the forms of things arise within fields of force and flows of material" (2010: 91). Likewise, Latour claims that we should not situate "the origin of an action in a self that would then focus its attention on materials in order to carry out and master an operation of manufacture in view of a goal thought out in advance" (Latour and Porter 2013: 230).

Accordingly, for us the promise of live coding is to reject the predominant goal-driven notion of technological development, and to offer instead an approach that responds to the living moment. Here we consider the textility of live code, as a flow of force that we respond to in the process of working upon it. Emma Cocker coined the term *kairotic practice* for this complex approach to notation and rules implied in live coding, where the ancient Greek term *kairos* here denotes an opportunity to seize, a fruitful moment, a chance to grasp (Cocker 2014): “A *kairotic* practice is not one of ‘scripting’ in advance or designing from a distance; Kairos involves the making of the situation at the same time as deciding how to act” (Cocker 2017: 135).

Kairos is not only related to time in the sense of a reappearing possibility. It also denotes a part of the ancient warp-weighted loom (see fig. 2), namely the shed-bar that divides the series of vertical threads into a binary alternation: every other thread is in front or behind that bar which is fixed on the loom. The opening that is provided by this device (*kairos*) is called the natural shed. Another rod, the *kanōn*, carries heddles to which all the threads lying behind the *kairos* are attached. When pulled in front of the *kairos*, it will produce a so-called artificial shed. The alternation of natural and artificial shed provides the two openings into which the shuttle and weft thread are inserted to produce a fabric.

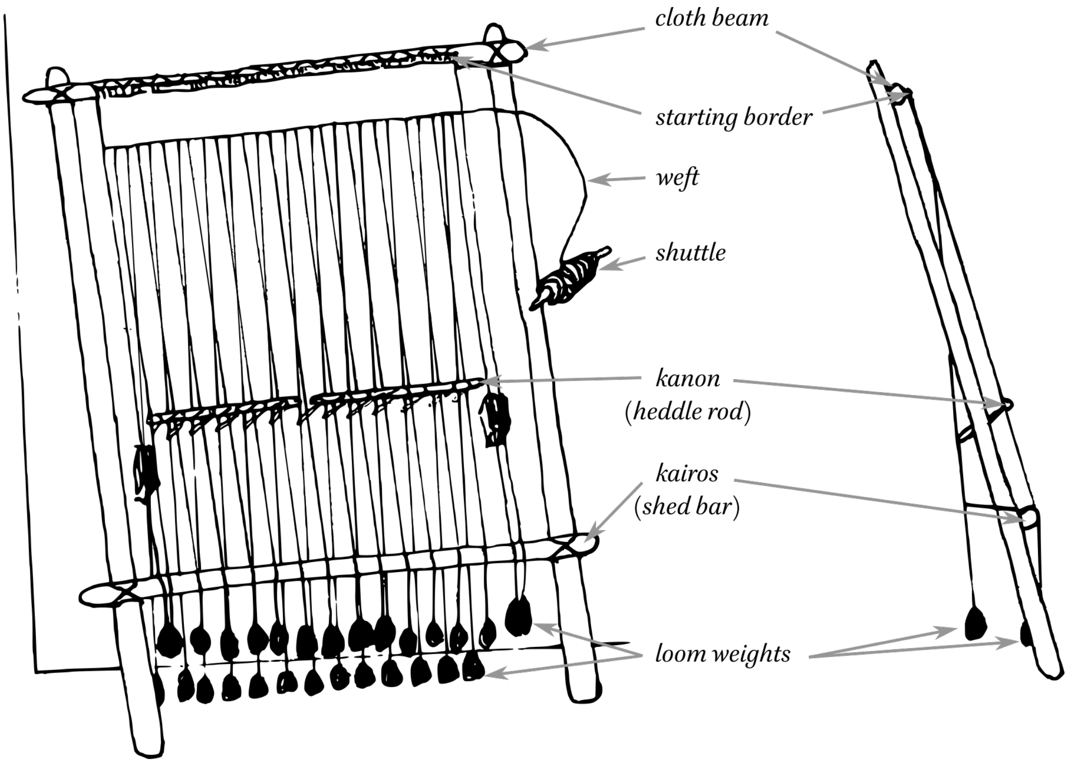


Figure 2. The Components of a Warp-weighted Loom, as used in Ancient Greece.

Weaving patterns on an ancient loom is an *abstract* and *binary* operation in very much the same way as contemporary computer programming. The patterns defining warp and weft colours, heddle configurations, and the operation of shafts each interact to create the end result in ways that are sometimes impossible for a layperson to predict. A loom and a weaver work together to form a digital mechanism, following an algorithmic procedure to create visual patterns on the surface of the resulting woven cloth, that are the result of a sequenced operation on discrete, numerical elements.

There is a strong similarity between ancient weaving and contemporary computer programming here, which we explored in a research project entitled "Weaving Codes—Coding Weaves" where Dave Griffiths and FoAM Kernow developed a tangible device for programming weave patterns called the *pattern matrix*.[1] But the technological connection between rhythm, dance and weaving explored in such work is not as recent an idea as it might seem.

Epiplokē, a Greek term explicitly grounded in textile technology and that we could translate as weaving together or interweaving of metrical sequences, denotes a particular mechanism of Greek lyric versification that we see as a sort of pattern operator at the level of rhythm. In ancient Greek metrical theory, *epiplokē* refers to a modality of combination/interlacement of sequences within rhythmically homogeneous meters, through the addition and subtraction of one quantity from one end of a meter to the beginning of the other, or metathesis (transposition) of quantities within the meter. A recent re-examination of *epiplokē* by Thomas Cole repositions the concept as a fundamental principle and operator of rhythmical modulation within recurrent cyclic patterns; to quote his words about the relevance of the weaving idea in the mechanism of *epiplokē*, "rhythm is a single fabric in which rise and fall are constantly being interwoven through a pattern of alternating or cyclical recurrence" (Cole 1988: 3). Through *epiplokē,* cyclic structures are generated in ways that invite comparison with the mode of manipulating patterns within the live coding software *Tidal*, as we shall see later in this article.

Just as contemporary computation and music are brought together in an algorave by live coded patterns, it is interesting therefore to see how the ancient digital art of weaving connects to archaic Greek dance culture, particularly within the genre of choral lyric.[2] This is effected through both the conceptualization of the performance in terms of weaving, and the rhythmical structure of binary elements that, though characterizes Greek meter as a whole, shows in the metrical patterns of choral songs a distinctive complexity. Such a binary nature, as we shall see, is evident in particular through the alternation/opposition/combination of long and short quantities in meter, and of *arsis* and *thesis* in rhythm, i.e. of lifting and lowering the foot literally (in the steps of the dancing chorus) and metaphorically (the metrical foot).

Algorithmic Pattern as Ordered Structure in Early Greek Thought: The Case of Weaving

The centrality of the concept of pattern for the emergence of early Greek reflections on nature and the cosmos should be set against the broader notion of *technē*, a term whose semantic domain encompasses art, craft and technology: cosmic order (*kosmos*) is conceived of as embodying "the pattern discovered, or allowed to appear, through making" by the craftsman (McEwen 1993: 42). At the beginning of Greek architecture, mathematics, harmonics, astronomy and science of nature—closely-related and interacting domains of investigation in much of Presocratic philosophy, in particular early Pythagoreanism—seems to lie the idea of an ordered and harmonic structure of elements that invests (and projects as cosmological principles) the perceived nature of numbers, their properties and their ratio. Philolaus of Croton (5th century BC), a Pythagorean thinker who cultivated interests in arithmetic, harmony and cosmology, classifies numbers in a binary (or in ancient Greek terms: dyadic) way by dividing them into odd, even and even-odd, a mixture of the other two genres probably referring to the unit. The scanty fragments of Philolaus seem to grant numbers an epistemological role, as they provide the knowledgeability of the sensible world: we can know things as far as we are able to grasp the structure of numerical relationships that they possess.[3] Possessing numbers (Greek *arithmon echein*) here refers to an ordered plurality (see Huffman 1993: 173–76), potentially a pattern. This would fit well with the practice of arranging odd and even numbers in patterns of pebbles, as Eurytus, a disciple of Philolaus, is reported to be doing by Aristotle and Theophrastus (fragments 45 2-3 D.-K.), assigning to each number a corresponding concept according to the number shape/pattern.[4]

One especially powerful and flexible technological instrument for pattern-generation in antiquity is the warp-weighted loom in use in ancient Greece (see fig. 2 above). Weaving is digital in nature, in that every in-woven geometrical or figurative element made to appear on the fabric is generated by a structure of crossing threads, arranged and ruled by discrete numerical relationships, rather than being a design imposed on a surface. Furthermore, as the weaver follows a procedure to create such a woven structure, this practice of weaving is therefore algorithmic. Ellen Harlizius-Klück has demonstrated that the logic of pattern construction in ancient weaving provides ground for the dyadic arithmetic that surfaces in the fragments of early Pythagoreans and in Plato, and is later formalized as a coherent theory of odd and even numbers in Euclid's *Elements*.[5] Ancient weaving employs a concept of number that is not about counting but about possibilities of form, of arrangements of elements that "possess" number and are appositions of binary components by nature (namely dyadic elements of either odd or even).

Ranking among the earliest technologies developed by humans, weaving (and the related techniques of plaiting, braiding, and stringing) has been shown to bear a broad range of symbolic associations in classical antiquity, spanning a number of human domains (politics, sexuality, poetics).[6] Our focus in this paper is rather on the logic of ancient weaving, and on the patterns of thought that this technology seems to generate: among these is an algorithmic approach to creating complex structures that are reflected and integrated into the archaic Greek view of the cosmos and of poetic composition and performance. Early accounts of cosmic weaving and the doctrine of the Atomists seem to project onto the (macro- and micro-) structure of the universe the logic of the woven pattern as an ordered interlacement of threads. The papyrus fragments of a cosmogony written by Pherecydes of Syros, reported by a strand of ancient doxography to be the first Greek prose book, describe how god Zeus generates the cosmos as a pattern-woven fabric.[7] The recurrent conceptualization of the process of composing and performing poetry/song (and even dancing in a chorus) in terms of weaving may point to an analogy that invests the deep level of the primary structural elements of the poetic medium–in our case, that is, the metrical and rhythmical units of ancient Greek lyric, a dyadic system based on the opposition of short and long quantities.[8]

Encoded Weaving Patterns in Song?

One factor that may have played a role in the widespread literary association of weaving and song in antiquity is the tradition of songs at/to the loom, i.e. rhythmical sung sentences or rhymes used by weavers as mnemonic devices representing weave patterns. Anthony Tuck (2006) has put forward the fascinating hypothesis that the metrical sequences of archaic Greek poetry (and, more broadly, the early corpus of Indo-European metrical poetry) might have originally encoded numerical information related to weaving patterns, used in the process of fabric-making. Tuck draws this hypothesis based on two sets of comparative evidence. One is the practice, still documented for traditional weavers in certain areas of India and Central Asia, of committing to memory through worksong the count sequences of patterns they are producing—one may even say performing.[9] The other is the pervasive association, in the repertoire of metrical poetry of ancient Indo-European literatures (notably the Old-Indian sacred hymns *Rig Veda* and archaic Greek poetry), of weaving while singing, and of the "weaving a hymn/song" motif. Tuck (2006: 543) suggests that "information embedded within narrative structures, tonal shift, or rhythmical changes, all in association with song, could provide the framework" for the memorization of pattern, and indeed that this "pattern-encoding" could be the origin of Proto Indo-European recited or sung metrical poetry.

Distinctions of poetic genre are important though: while the *Rig Veda* and Homeric epics, two poetic corpora that ground much of Tuck's hypothesis, present a metrical texture based on the repetition of a single-verse sequence, the metrical-rhythmical patterns of Greek choral lyric respond to different principles. They are composed by units (metra, lit. "meters") combined in cola ("members", recurring sequences of metra) structured in systems of larger stanzas (strophe, from Greek *strophē* denoting the turn of the dancing chorus); an antistrophe ("turn in the opposite direction") usually follows each strophe, and bears an identical rhythmical design; a final sequence called epode normally closes the strophic system, which is thus called triadic. Repeating AAB/strophe-antistrophe-epode triads make the structure of a large part of our corpus of choral lyric poetry. The complexity of verse patterns in Greek choral song, and the crucial fact that the genre of choral lyric featured together music, singing and dancing in a synchronized performance, add further layers to, and probably complicate the picture envisaged by Tuck of weaving-related pattern information coded in metrical sequences of poetry.[10]

But how are we to imagine the rhythmical patterns governing the performance of a choral song? The initial impulse for this article arose from perceiving potential analogies in the ways in which cycles of recurring rhythmical patterns are generated and manipulated in two—seemingly very disparate—domains: the live coding environment Tidal, and the ancient mechanism of *epiplokē* in Greek choral poetry. Rather than presenting a systematic comparison of the two, we have opted for a juxtaposition that better reflects the experimental nature of our approach to this analogy and provide a detailed treatment of how rhythmical cycles ground the structure of Tidal, and how the metrical and rhythmical architecture of a significant sample of ancient Greek lyric can be analysed in terms of *epiplokē*.

Tidal Patterns: A Brief Introduction

TidalCycles, or *Tidal* for short, is a live coding environment (McLean 2014), which approaches algorithmic music in terms of pattern, on multiple levels. It is a kind of programming language, but many people using it would self-identify as musicians rather than professional programmers. Tidal therefore falls within the research field of End-User Programming (Blackwell 2006). It has been primarily created as a system for making music, but is used to pattern a wide range of media such as live video, light control, choreography, and fixed images. Tidal is a Domain Specific Language (DSL), implemented as a library within the *Haskell* programming language. Haskell has a reputation for being difficult to learn, due to its basis in lambda calculus and strict type systems, but is a remarkably warm host to musical pattern. We have already explored pattern in a historical context, as a particular approach to creating structure. This is somewhat against normal use of the word in electronic and computer music communities, where *pattern* often simply refers to any discrete sequence. However, by looking deeper into the structure of musical pattern we connect with this wider sense, referring to processes inherent in the *making* of sequences. From this perspective, pattern is not about sequences, but computational functions that, just like the weaver at their loom, transform and combine sequences. Transformations of musical patterns may be grouped into categories, for example Laurie Spiegel (1981) provides a list of twelve high-level groupings. In the following we put forward just four high-level categories to help address different levels of pattern transformation, namely *repetition*, *symmetry*, *interference* and *deviation*, relating each of these categories to Tidal's representation of music.

Repetition

Patterns generally feature repetitions, often on multiple scales. Accordingly, Tidal's representation of time is based on repetition, with the primary reference point being the metric cycle rather than any fixed beat duration, an approach inspired by the work of Bernard Bel (2001) in formalising Tabla rhythms from Indian Classical Music. Because time is primarily structured by cycles, and not notes or other discrete steps, Tidal breaks from the usual notion of time *signature*, used in much Western music and music software. This results in a metrical fluidity, where cycles can be composed of subcycles with differing temporal structures. Furthermore, time can be stretched, compressed and otherwise manipulated in a variety of ways, meaning that while the cycle is the reference point, metrical structure can vary wildly from one cycle to the next. This allows support for polyrhythm, complex meters, and both flowing (continuous) and grid-based (discrete) patterns, subdividable to arbitrary levels of complexity.

Symmetry

Symmetrical forms are also common to many patterns, for example as reflection, conceived in music in various ways including inversion. With Tidal's cyclic notion of time, there is also the possibility of *rotational* symmetry, where events are moved forward and backwards in time.

Interference

Interference patterns occur in Tidal where two or more patterns can be combined to create a new one, or a pattern combined with a transformed version of itself, creating complex higher-order patterns out of simple parts. As already discussed above in the context of weaving, resulting interference patterns often bear little or no resemblance to the source material. Another familiar example of a visual interference is the *moire* patterning seen when netting overlaps. Tidal provides a multitude of methods for combining patterns (thanks in large part to Haskell's healthy range of type constructs for composing well-defined elements together), and these methods may in turn be combined (again, thanks to Haskell's functional nature) to create new methods, providing a very large number of possibilities to explore.

Deviation

Where we create recognisable patterns, we set up expectations for what comes next, creating a musical sense of anticipation. Of course, musicians then purposefully break those expectations. Interestingly, the effects of anticipation and deviation is present even when a listener is very familiar with a piece of music; the anticipation is still perceived as musical structure (Huron 2006). With Tidal we can break expectations through chance operations, using pseudo-random number generators—mathematical processes useful for taking arbitrary choices. Such deviation allows a musician to forego making a decision by making a random choice, or add glitches and imperfections as an aesthetic choice in its own right.

In exploring these different flavours and levels of patternings, it quickly becomes clear that they are rarely independent. For example how many different kinds of symmetry can you add to a pattern before they begin to interfere with each other? How much deviation or interference can you add before the sense of repetition breaks down? How long can a repetitive cycle last before you stop perceiving it as such? There is much music to be found on these boundaries.

Tidal does not make sound itself, but as a pattern engine sends messages to synthesisers (hardware or software) to make sound. By default, Tidal is used with *SuperDirt*, a synthesis framework designed for use with Tidal and implemented in the SuperCollider environment. We will begin however with patterns of colour, in sympathy with the present medium.

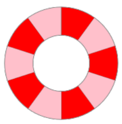
Transforming Sequences

Tidal really comes in two parts, a little language for describing sequences, and a library of functions for transforming them as patterns. The little language for sequences is denoted with double quotes:

```
"red pink"
```

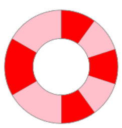
The above and following figures should be read clockwise, beginning at the top. The above pattern is rendered in a circle, in order to put Tidal's central notion of cyclic pattern in visual form—the end of one cycle is also the beginning of the next. There is much that we can do inside these double quotes to describe complex sequences, but first, lets introduce a simple way to transform this sequence using the fast function to speed it up:

```
fast 5 "red pink"
```



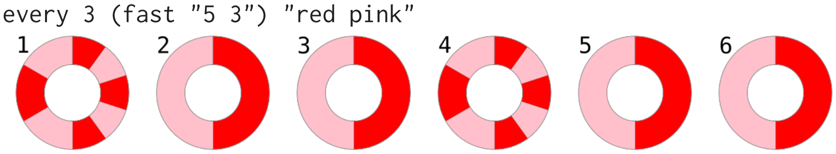
Now we can see five repetitions of red and pink within a single cycle. It is worth noting that the number `5`, as a parameter to fast in the above, is itself a pattern. When we give a pattern as a bare number like this, it simply repeats that number, once per cycle. The below gives a sequence of two numbers to fast instead, so that the first half of each cycle is sped up by a factor of five, and the second half by a factor of three:

```
fast "5 3" "red pink"
```



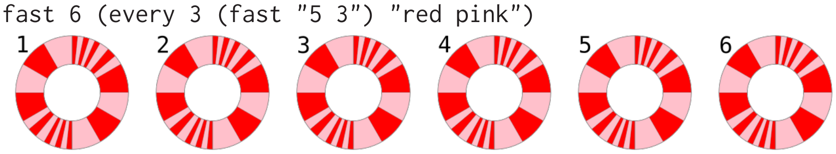
In the above, the `fast` function takes two patterns as input, and combines them to return a new pattern. Pattern transformations tend to operate relative to cycles, but that does not mean that successive cycles are identical. For example in the following, `every 3` is used to apply the function `fast "5 3"` to `"red pink"` as above, but only every third cycle. The first six cycles of the resulting pattern are shown below, so that you can see this change over time:

```
every 3 (fast "5 3") "red pink"
```



We can also squeeze the above six cycles into one, again by speeding it up, so that each cycle is identical once more:

```
fast 6 (every 3 (fast "5 3") "red pink")
```



Already we can see a strong part of Tidal's flexibility; it is highly *composable*. Functions like `fast 6` take a pattern as input, and return a new pattern as output, so that it is straightforward to compose multiple functions together into more complex transformations, as we have done above. Furthermore, we did not have to write any code to align `"5 3"` with `"red pink"`; in conventional terms, Tidal is *declarative*, in the sense that it takes care of the mechanics of pattern composition for us.

An Aside: Imperative, Declarative and Kairotic Programming

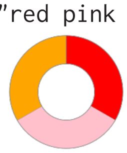
Different techniques in programming are generally classified into either imperative or declarative programming. Imperative programming is where we describe a procedure in terms of how it is done. The usual everyday example of such a program is a cake recipe. Instead of describing a cake, a recipe gives a step-by-step procedure for combining different elements, where a cake is the (hopeful) result. In declarative programming, we instead describe *what* we want, and leave the job of *how* this is achieved to the computer. From the point of view of pattern-making, this distinction is already problematic in itself, in that *how* we make something is part of what it *is* (McLean 2011: 75–77).

Reflecting on Emma Cocker's work described earlier, here we suggest that *Kairotic coding* is a third approach that sits between both declarative and imperative programming. This is akin to answering neither *how* or *what* questions, but instead focussing on programmers asking a question themselves: *what if*? This is where a programmer changes to the structure of code, perceives the end result, and then makes their next change to the code in response. This kairotic approach, where the programmers enter the timeline of their code, has become embedded in the practice-led design of Tidal.

Event Time in Polyphonic and Polymetric Sequencing

We have already learned the standard unit of time in Tidal is the cycle. One impact of this is that if you add additional steps to a sequence, the steps will become shorter in duration, so that they are contained exactly within a single cycle:

```
"red pink orange"
```



```
"red pink orange blue lightblue"
```

In the musical domain, this means that the more events you add to a pattern, the faster they will be played, in order to fit them into a cycle:

```
sound "bd cp sd"
```

```
sound "bd cp sd mt lt"
```

In other words, timing in Tidal is not based around a notion of a fixed beat duration, but on higher level cycles. This lends metrical flexibility, so for example it is possible to break down individual steps into subcycles, using square brackets:

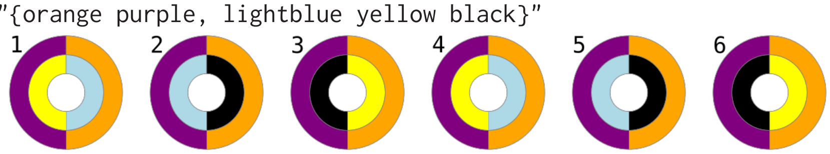
```
"red [orange green] blue [lightblue yellow black]"
```

It is also possible to place more than one subcycle inside a single step:

```
"[orange purple, lightblue yellow black]"
```

In the above we can see that `lightblue yellow black` fills the same span as `orange purple`. It is not significant that one subcycle is placed on the outside of the other; in musical terms this simply indicates that they form a polyphony, happening at the same time. We can change this behaviour by instead using curly brackets to denote the subsequences:

```
"{orange purple, lightblue yellow black}"
```



We can see that the *steps* rather than cycles now align, so that orange purple lines up with lightblue yellow in the first cycle. We can also see what it means to be a subcycle, as the subcycle continues where it left off, over successive cycles. From `lightblue yellow black`, only the first two colours are used in the first cycle to match with the two colours in orange purple, so on the second cycle it continues with black, cycling back to lightblue for its second value. We end up with a structure that repeats every third cycle.

Let's listen to the equivalent in the sound domain, listening to a two-step bass drum (`bd`) - clap (`cp`) sequence against a low (`lt`) - mid (`mt`) - high tom (`ht`) sequence:

```
sound "[bd cp, lt mt ht]"
```

```
sound "{bd cp, lt mt ht}"
```

Subcycles can be placed within subcycles. The following contains a subcycle with three steps (with a span of one third of a cycle each), of which the middle step is broken down further into two substeps (one sixth of a cycle each):

```
"red [orange [black green] brown] blue"
```

Rests, Gaps and Stretches

Silence is of course central to music, and in Tidal sequences you can insert empty gaps with the ~ character:

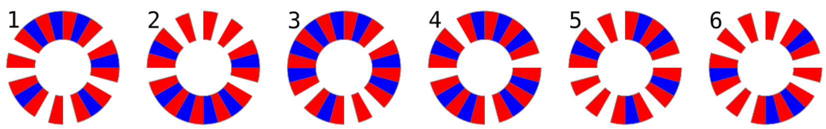
```
"red blue ~ orange [purple ~] green"
```

Alternatively a _ character will stretch the previous step:

```
"red blue _ orange [purple ~] green"
```

You can also use a ? character to replace a step with silence around 50% of the time, varying from one cycle to the next:

```
fast 12 "red blue?"
```



Manipulating Time

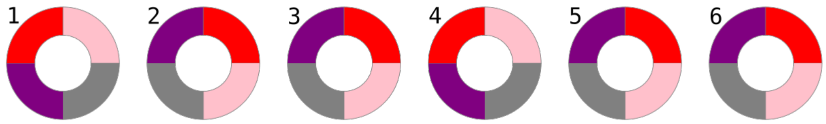
Music is of course a time-based artform, and in Tidal, time is malleable—it both flows in cycles, and develops over time. It can be reversed, shifted forward into the future or back into the past, expanded and contracted, chopped up and rearranged, and subdivided to practically any depth.

We have so far focussed on sequences, but there is much more to pattern. Let us move on to explore different kinds of patterning, all of which take existing patterns and transform them. Of course, everyone listens differently, and so a pattern is not necessarily a puzzle to be solved, but an environment to be explored. The pattern transformation might be perceivable by the listener, or it might only give them a sense of order amongst chaos, but because there is a clear structure in the creation of pattern, the sonic environment that results has the possibility to be an engaging place, explored through the process of listening.

Many computer music systems represent music as *lists* of events, an approach which certainly has its advantages. However, Tidal instead represents music as a pure, mathematical *function*, with a timespan as input and returning events active within that timespan as output. Each event consists of a value, and a timespan during which the event is active. This approach, a form of Functional Reactive Programming (Hudak 1999), allows the temporal structure of Tidal patterns to be efficiently manipulated without being calculated, either as a discrete or continuous signal, and separately from the events which are represented within the signal (McLean 2014). Time is represented as a rational number, lending itself to precise subdivision. It is not important to understand Tidal's inner representation of time in detail, but worth noting that much of the flexibility seen in the following stems from Tidal's focus on composing together functions of time, rather than linear procedures over data.

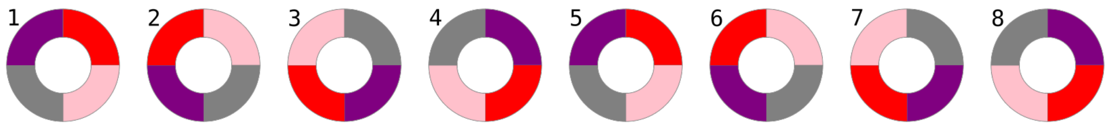
We have already seen the `fast` function for speeding up a pattern. The <~ and ~> operators manipulate time a different way, by moving patterns backwards and forwards in time. With Tidal's cyclic notion of time, in practice this results in *rotating* a pattern. The following pattern shows a quarter rotation, every third cycle:

```
every 3 (0.25 <~) $ "red pink grey purple"
```



The `iter` function also shifts time, but keeps shifting it from one cycle to the next, until the cycle returns back to where it started. This takes place over a given number of cycles, which in the following is four:

```
iter 4 "red pink grey purple"
```



Let's hear some sound-based examples of <~ and iter:

```
iter 4 $ sound "lt mt sd cp"
```

```
every 3 (<~ 0.25) $ sound "lt mt sd cp"
```

For a complete introduction to the pattern transformations available in Tidal, refer to the website: <http://tidalcycles.org>.

Patterning Multiple Dimensions of Sound

In terms of how it is perceived, sound is multi-dimensional. A modern synthesiser may have a keyboard providing a pitch dimension, but will also have a plethora of knobs and sliders for exploring further timbral dimensions. Accordingly, Tidal allows different aspects of sound to be patterned independently. The following example demonstrates independent patterning of the `legato` (relative duration) and `lpf` (low pass filter) parameters, where the structure is defined by the `n` (note) rather than `sound` parameter:

```
off 0.125 (|+| n “-12”) $
  jux rev $ n (off “<1%8 1%4>“ (+ chord “<major minor major>“)
               (palindrome $ “<c(3,8) f(3,8) g(3,8) c6(3,8)>“))
  # sound “superpiano”
  # legato (scale 0.5 2 saw)
  # lpf “<300 [1000 700] 2000>“
  # lpq 0.2
```

The above presents only a small part of Tidal's language for exploring pattern. To get a broader impression of its creative possibilities, please refer to the live performances and demonstrations on the official website: <http://blog.tidalcycles.org/video/>

Dance, Music and Song: Archaic Greek Choral Lyric as a Multi-Layered Performance

A central concern of this article is to suggest a comparison between, on the one hand, ways in which patterns of recurring rhythmic cycles are created and manipulated in Tidal, and, on the other hand, the extent to which rhythmic recurrence can be recognized as a structural feature of archaic and classical Greek lyric verse through the mechanism of *epiplokē*. As already anticipated, the nature of this comparison is largely experimental, and a methodological caveat is required before introducing some basic notions of metre and rhythm in ancient Greek poetry. As a concept created by Hellenistic and later Greek metrical theory in order to make sense of the rhythmical patterns of archaic and classical lyric (a poetry written and performed a few centuries earlier), *epiplokē* is not originally a notion born in the song-culture context where choral lyric was produced—though the idea that the interlacement (Greek *plekein*) of a few rhythmical types generates every possible metrical sequence surfaces as early as Plato (*Republic* 400a4-5) and possibly earlier (Lomiento 2004). In a similar fashion, the recent re-conceptualization of *epiplokē* as a principle of rhythmic modulation by Thomas Cole is an interpretative tool that is largely arbitrary, and has not met with universal scholarly consensus (see Haslam 1991). That said, we think that both the weaving idea at the core of the ancient notion of *epiplokē* and the novel approach to ancient Greek rhythmic patterns in terms or recurring cycles are capable of directing our attention to key modes of ancient Greek versification—modes that present striking similarities with Tidal's approach to rhythm.

The shipwreck of the largest part of ancient Greek poetry has been especially severe in regards to music and dance, two fundamental dimensions of both cultic-civic and dramatic choral lyric. The orchestic movements of the choristers in circular, processional, or rectangular formations, and the melodies of the songs to the accompaniment of the lyre or the pipe are completely lost to us with the exception of a few papyri containing fragments of lyric passages provided with musical notation. In short, we are left with three typologies of textual evidence that somewhat reflect the performance of choral lyric poetry: a) intra-textual self-referential utterances by the choral persona describing the actual dancing or the musical features of the on-going performance; b) the metrical and rhythmical patterns of the poem as far as we can reconstruct them from the textual tradition; c) ancient scholarship on meter, rhythm and music commenting on features of archaic or classical choral performances.

While some scholars entertain the possibility that different musical and verbal rhythmical levels interacted in the actual performance of sung Greek poetry (e.g. Gentili and Lomiento 2003: 3–4 and passim) it is probably more practical to think of a single rhythmical pattern, with different yet complementary layers and realizations. From this viewpoint: a) the steps of the dancers; b) the down beat (*thesis* "beating") and the up beat (*arsis* "lifting") of the musical sequences and; c) the metrical sequences of the text, represent three layers of the overarching rhythmical texture of the poem/song. Interference patterns are generated by verbal demarcation, i.e. the sequence of word-ends which occur in certain (fixed or not) positions within the metrical design (e.g. caesura and diaeresis), thus creating an interplay of different structural levels.[11] Furthermore, since ancient Greek had a musical accent, the natural pitch of accented syllables represented a further element that interacted with the musical melody.

ANCIENT GREEK METER AND RHYTHM: A BRIEF INTRODUCTION

Ancient Greek is a quantitative language with tonal accent. Metrical structures are built through the opposition of long (-) and short (⏑) elements (corresponding to syllables), combined into metrical sequences (Battezzato 2009). Conventionally, a long element corresponds in length to two short ones: in many cases a long element may be substituted with two shorts (known as resolution), and two shorts substituted by a long (known as contraction). Depending on their position within the internal structure of a metrical sequence, certain elements may be realized as either short or long syllable (anceps, denoted by ×).

The fundamental metrical units are known as metra (singular metron) and are composed by two to six elements: among the metra mentioned in this article figure dactlyl (-⏑⏑), cretic (-⏑-), iamb (×-⏑-), trochee (-⏑-×), ionic *a minore* (⏑⏑--), ionic *a maiore* (--⏑⏑), anapaest (⏑⏑-), and choriamb (-⏑⏑-). Larger sequences generated by the combination of metra are called cola (singular colon), single metrical phrases of around 12 syllables (usually reduplicating metra in dimeters and trimeters), which the poet may demarcate through word-end (caesura). A combination of cola generates the verse or period, the fundamental self-contained structure in metrical composition. A period is marked off and framed by a metrical pause that must coincide with word-end, and that makes the last element before the pause metrically indifferent. In the layout of lyric poems transmitted by papyri and medieval manuscripts (called colometry), periods are generally longer than a single line. The strophe is generated by a number of periods, and in choral lyric it recurs throughout the poem (in responsion with the antistrophe in triadic structure, i.e. in the sequence strophe-antistrophe-epode), and it probably corresponded to a musical unit, repeated in the course of the song. As Martin West points out while tracing the prehistory of Greek rhythm, the basic rhythmical movements are a pair of symmetrical sequences, ...-⏑⏑-⏑⏑-... and ...-⏑-×-⏑-..., and a combination of them in asymmetrical ones, ...-⏑⏑-×-⏑-... and ...-⏑-×-⏑⏑-... (West 1982: 19).

Greek lyric has strong regional characterizations: the Aeolic meters and rhythms represent the older stratum of Greek versification, and they have been shown to share structural features with the meters of an ancient Indian religious poem, the *Rig Veda*. Characteristic of Aeolic meters is the freedom of the first two quantities (××), called Aeolic base, which can be realized as two short syllables (⏑⏑), two long (--), or one short and one long (-⏑ or ⏑-). One of the fundamental rhythmical and metrical units of the Aeolic system is the glyconic (××-⏑⏑-⏑-); a shorter variant of this colon, where the final syllable is omitted, is called pherecratean (××-⏑⏑--). The colon resulting from cutting off the Aeolic base from a glyconic is called dodrans (-⏑⏑-⏑- *dod*). An expanded form (-⏑⏑-⏑⏑-⏑- *dod*^{d}), and a reversed one (-⏑-⏑⏑- *dod*$^{\ddot{}}$), are also common Aeolic cola. Metrical periods are generated through the combination of these cola with iamb (×-⏑-) or cretic (-⏑-) as suffix or prefix, or with internal expansion of glyconic (e.g. choriambic expansion *gl*^{cho} ××-⏑⏑-⏑⏑-⏑-).

Choral lyric use of Aeolic rhythms in larger strophic systems shows complex patterns of repetition and modulation within strophe, with each period/verse developing elements of the preceding one. What results is often the alternation between dominant sequences and others that "seem to be adaptations or inversions of these common sequences. How to code these patterns is one of the greatest challenges facing metrical theory" (Rutherford 2001: 447). Following West (1982: 66) a strophe from a choral poem by Simonides (542.21-30 *Poetae Melici Graeci*) may illustrate this point:

τοὔνεκεν οὔ ποτ᾽ ἐγὼ τὸ μὴ γενέσθαι δυνατὸν	*dod*^{d} + *dod*¨	- ◡◡-◡◡-◡- ◡--◡◡-
διζήμενος κενεὰν ἐς ἄ-	iamb + ◡◡-◡-	◡-◡- ◡◡-◡-
πρακτον ἐλπίδα μοῖραν αἰῶνος βαλέω,	glyconic + iamb‖	-◡-◡◡-◡- --◡-
πανάμωμον ἄνθρωπον, εὐρυεδές ὅσοι	◡◡-◡- + glyconic	◡◡-◡- -◡-◡◡-◡-
καρπὸν αἰνύμεθα χθονός·	glyconic	-◡-◡◡-◡-
ἐπὶ δ᾽ ὔμὶν εὑρὼν ἀπαγγελέω.	◡◡-◡- + *dod*¨	◡◡-◡- -◡-◡◡-
πάντας δ᾽ ἐπαίνημι καὶ φιλέω,	iamb + *dod*¨	--◡- -◡-◡◡-
ἑκὼν ὅστις ἔρδῃ	2 catalectic iambs	◡-- ◡--
μηδὲν αἰσχρόν· ἀνάγκᾳ δ᾽	pherecratean	-◡-◡◡--
οὐδὲ θεοὶ μάχονται	ithyphallic ‖|	-◡----

Rhythm is considered by ancient scholarship as the "ordered disposition of musical quantities", resulting in different patterns obtained by the opposition of *thesis* and *arsis* (not necessarily equal in length) according to the ratio between them (2:2, 2:1, 3:2). The early reflection on rhythm poses as the two fundamental rhythmical categories (genus, from Greek *genos*) the even genus (ratio 2:2) and the double genus (1:2 and 2:1). This division between even and double genus is already theorized in 5th century BC by the sophist Damon, teacher of Socrates, whose doctrine surfaces in a passage of Plato's *Republic* (400a-c). Here, Damon seems not to distinguish between the two metra (dactyl -◡◡ and anapaest ◡◡-) of the even genus (2:2), nor between the two (trochee -◡-◡ and iamb ◡-◡-) of the double genus (2:1 and 1:2).[12] This implies that a long sequence of … -◡◡-◡◡-◡◡-◡◡- … may be in abstract marked off in both dactylic and anapaestic segments, and the same goes for a sequence … -◡-◡-◡-◡-◡-◡ … (trochaic and iambic segments). The rhythmical affinity between the members of each pair of antithetical metra (one falling, with initial long, and one rising, with initial short or double short) was also recognized by ancient metricians.

Epiplokē in Context: From Variegation in Metre to Pattern Operator of Rhythmical Cycles

According to the ancient metrical theory, one of the modalities through which metra are generated is a mechanism of inter-weaving (*epiplokē*), whose superseding principle is affinity/likeness (*suggeneia*, lit. "kinship");[13] within a single rhythmical type genus, each meter is created through the transference (initial addition and subtraction, or internal transposition) of a quantity from one to the other of a given pair. In fact, however, one type of ancient *epiplokē* encompasses four metra of six quantities: choriamb (-◡◡-), ionic *a minore* (◡◡--), antispast (◡--◡), and ionic *a maiore* (–◡◡). Subtracting the initial syllable in a series of choriambs, a sequence of ionic *a minore* is generated, and so on:

-◡◡--◡◡--◡◡--◡◡--◡◡--◡◡-	choriambs
◡◡--◡◡--◡◡--◡◡--◡◡--◡◡--	ionics *a minore*
◡--◡◡--◡◡--◡◡--◡◡--◡◡--◡	antispast
--◡◡--◡◡--◡◡--◡◡--◡◡--◡◡	ionic *a maiore*

Again, in a theoretically infinite sequence in *epiplokē* -◡◡--◡◡--◡◡--◡◡--◡◡--◡◡- one may mark off either a series of choriambs, or ionics *a minore*, or antispasts, or ionics *a maiore*, depending where one decides to start. In this sense, *epiplokē* has been aptly defined as "a sort of matrix from where you could hack out" different segments (Dale 1968: 70).

While ancient metricians were mainly concerned with providing a mechanical and abstract explanation for the genesis of the nine fundamental metra of Greek versification, the concept of *epiplokē* as a pattern of rhythmical interweaving invites an analysis that goes beyond the theoretical frame of metrical segmentation into discrete units (or, employing a fitting analogy, of musical bars), and thus beyond the simple phase-shifting rotation that the above diagram may seem to imply.

Ancient *epiplokē* provides us with an interpretative tool to recognize instances of alternation/variegation and modulation in lyric versification (*poikilia* in Greek), especially in cases where ancient colometry seems to reflect such a principle. Particularly in the choral lyric sections of drama, alternating sequences of rhythm in *epiplokē* (e.g. a dactylic passage followed by anapaests) tend to be regularized by modern editors, who often build series of identical cola out of the *poikilia* transmitted by the ancient editions, and restore an alleged (and arbitrary) regularity and rhythmical coherence.[14] A broadened perception of *epiplokē* as a key concept of versification, and a tool to reconsider rhythmical continuity and modulation in archaic and classical Greek lyric sustains the work of Thomas Cole on pattern analysis of metrical sequences. Against the horizontal model of metrical segmentation and demarcation represented by the system of metra, Cole proposes to think of a cyclical movement—the circumference of a clock face being an apt image for it—of "undemarcated recurrence" (Cole 1988: 4). A given cycle of *epiplokē*, that is, "partakes simultaneously of the movements that it comprises" (Haslam 1991: 232). Regardless of the pattern of verbal demarcation or rhetorical division, a word-end recurring at certain intervals within the verses/periods should be seen as a potential way of structuring a rhythmical sequence, rather than fixed points or sorts of musical bars. Thus, a sequence like ˥-˪⏑⏑-⏑-⏑-˥-˪⏑⏑-⏑-⏑-˥-˪⏑⏑-⏑-- occurring at Aristophanes' *Knights* 553-555 (strophe, with ˥ denoting colon and line division; see fig. 3 for visualization) and 583-585 (antistrophe, ˪ colon and line division), shows a remarkably different verbal articulation in strophe and antistrophe.[15] That is, dividing the sequence into eight-syllable cycles in the strophe word-ends occur so as to suggest a iambo-choriambic colon (choriamb + iambic metron -⏑⏑-×-⏑-), while in the antistrophe the pattern of word-ends shifts a syllable, thus producing an anacreontic (a metre of the ionic family: ⏑⏑-×-⏑--).[16] The *epiplokē* of choriambic and ionic (also contemplated by the ancient doctrine), acting in the context of strophic responsion, should be seen as a continuous rhythmical cycle with interweaving demarcations and encompassing both the metra (˥-˪⏑⏑-×-⏑-˥-˪⏑⏑-×-⏑-˥-˪⏑⏑-⏑--), rather than being disambiguated as featuring either one or the other meter. What is missing is precisely the point of junction between different cola (Haslam 1991: 232).

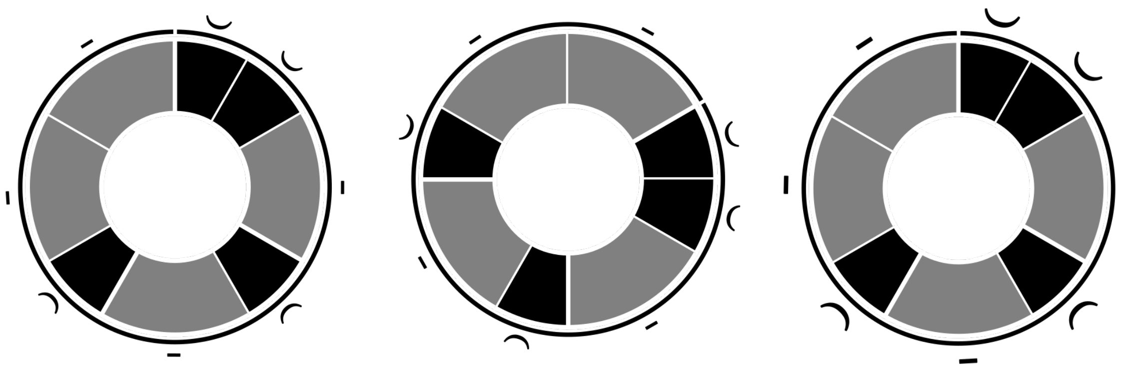


Figure 3. Aristophanes' *Knights* 553-555 (strophe) 585-585 (antistrophe) can be interpreted and represented as a cycle of iono-choriambic *epiplokē* of eight syllables. A switch in the starting point of the cycle determines the alternating demarcation of strophe and antistrophe.

A passage from a choral ode in Sophocles' *Philoctetes* (strophe 686-690 = antistrophe 702–706) shows a cycle of iono-choriambic *epiplokē*, in this case within internal responsion. In the colometry below, we have chosen to visualize the pattern of alternating catalectic ionic dimeters (in the form ⏑⏑-⏑-⏑-) and hypercatalectic choriambic dimeters (-⏑⏑-⏑-⏑--). Most modern editors, in fact, prefer a colometry that is either consistently choriambic or ionic, with a sequence of 4 choriambic dimeters (-⏑⏑-⏑-⏑-, the fourth catalectic, whereas in the ionic colometry there would be a series of 3 anacreontic, with a typical clausola) following an acephalous choriambic dimeter (⏑⏑--⏑⏑-).[17] The two alternative colometries are shown in the table:

τόδε δ᾽ αὖ θαῦμά μ᾽ἔχει,	⏑ ⏑ - - ⏑ ⏑ -	τόδε δ᾽ αὖ θαῦμά μ᾽ ἔχει,	⏑ ⏑ - - ⏑ ⏑ -
πῶς ποτε πῶς ποτ᾽ ἀμφιπλήκτων	- ⏑ ⏑ - ⏑ - ⏑ - -	πῶς ποτε πῶς ποτ᾽ ἀμφιπλή-	- ⏑ ⏑ - ⏑ - ⏑ -
ῥοθίων μόνος κλύων,	⏑ ⏑ - ⏑ - ⏑ -	κτων ῥοθίων μόνος κλύων,	- ⏑ ⏑ - ⏑ - ⏑ -
πῶς ἄρα πανδάκρυτον οὕτω	- ⏑ ⏑ - ⏑ - ⏑ - -	πῶς ἄρα πανδάκρυτον οὔ-	- ⏑ ⏑ - ⏑ - ⏑ -
βιοτὰν κατέσχεν	⏑ ⏑ - ⏑ - -	τω βιοτὰν κατέσχεν	- ⏑ ⏑ - ⏑ - -

The mechanism of *epiplokē* encourages us to see these sequences as a cycle of interwoven ionic-choriambic dimeters rather than as segmented cola, with rhythmical ambiguity as a meaningful part of the poetic design: -⏑⏑-×-⏑--|⏑⏑-×-⏑-⌉-⌊⏑⏑-×-⏑--|⏑⏑-×--.

A further application of *epiplokē* takes place within the structure of a single verse where rhythmical shifts are mediated by modulating sequences common to both metrical types (often ⏑ -). As it has been aptly noted, "rhythmics, like harmonics (music theory), is much concerned with modulation, μεταβολή" (Haslam 1991: 233). In the sequence ×-⏑--⏑⏑-×-⏑-, an iambic-trochaic *epiplokē* ×-⏑- frames a ionic-choriambic *epiplokē* ⏑--⏑⏑-, with the sequence ⏑- functioning as modulating device. Coles' repositioning of *epiplokē* as a principle of rhythmical continuity proves indeed very effective in cases of ambiguity of rhythmical patterns. Such ambiguity is in fact an integral aspect of *epiplokē* and, within this view, cyclically recurrent patterns are at the root of archaic and classical verse design. In particular, Coles questions the ancient metrical theory and practice of colometry, as this implies a large recourse to the category of catalexis, acephaly and the like (i.e. metra shortened of a final quantity at the end or at the beginning of a verse) in order to resort to sequences of cola of a standard length. The cyclical element introduced by *epiplokē* changes the paradigm, and invites us to think of different points at which the cycle may begin. Metrical demarcation is thus superseded by the different principle of rhythmical continuity. Patterns of verbal demarcations within verses, sometimes in contrast with the apparent rhythmical cycle, invite us also to reflect on the complex interaction of layers in the performance of a choral lyric poem: the musical rhythm (recurring in strophe and antistrophe, which we have seen sometimes display different demarcations within cycles), the metrical patterns interfering with verbal demarcation (word-end marked by caesura and diaeresis), and the lost choral schemata (maybe regulated by the beating of the feet in correspondence of the *thesis* within cola). If *epiplokē* in its original designation was meant to bring to mind the character of pattern generation through a dyadic system of elements typically a feature of ancient weaving technology, a closer look at how the mechanism works in context may reflect as well a further distinctive feature of weaving on the warp-weighted loom—the possibility to effect pattern connections and variations within (and in the course of) the overall fabric design, rather than stitching together different pieces already woven.[18]

Algorave as a Luddite Movement

Algorave might at times be presented as sci-fi made real, as an outcome of progress. We argue that a better approach is to take a longer view, looking for historical connections which help us understand algorave in relation to wider human culture, and might give clues about its future. We consider algorave as a reaction to technological progress, rather than as an outcome from it.

Today, general purpose computing is becoming as ubiquitous as woven fabric, and is maintained and developed by a global industry of software engineers. While the textile industry developed out of worldwide practices over millennia, deeply embedded in culture, the software industry has developed over a single lifetime, the practice of software engineering literally constructed as a military operation. Nonetheless, the similarity between weavers and programmers is stark if we consider weaving itself as a technology. Here we do not refer to the inventions of the industrial age, but the fundamental, structural crossing of warp and weft, with its extremely complex, generative properties to which we have become largely blind since replacing human weavers with powerlooms and Jacquard devices. It is clear that weaving has been a digital art from the very beginning (Harlizius-Klück 2017).

Software engineers are now threatened with job loss under strikingly similar circumstances, thanks to breakthroughs in Artificial Intelligence (AI) and "deep learning" methods, taking advantage of the processing power of industrial-scale server farms. Jen-Hsun Hu, chief executive of NVIDIA who make some of the chips used in these servers is quoted as saying that now, "Instead of people writing software, we have data writing software" (Standage 2016).

One question is what to do with all the software engineers, if their jobs were to disappear. But another important question is what to do with all the programming languages? Consider that with the arrival of powerlooms and knitting machines, many craftspeople continued hand weaving and knitting in their homes and social clubs for pleasure, rather than out of necessity. This was hardly a surprise, as people have always made fabric, and indeed in many parts of the world handweaving has remained the dominant form of fabric making. Through much of the history of general purpose computing however, any cultural context for computer programming has remained behind its industrial and military contexts. There has of course been a hackerly counter-culture from the beginning of modern-day computing, but consider that the celebrated early hackers in MIT were funded by the military while war flared in Vietnam, and the renowned early Cybernetic Serendipity exhibition of electronic art included presentations by General Motors and Boeing, showing no evidence of an undercurrent of political dissent (Usselmann 2003). In a sense, computer programming culture has not yet happened at scale. Looking forward, we therefore see great possibilities.

All the young people now learning how to write code for industry may find that the industry has disappeared by the time they graduate, and that their programming skills give no insight into the workings of deep learning networks. But the good side is that it seems that the scene is set for programming to be untethered from necessity. The activity of programming, free from a military-industrial imperative, may become dedicated almost entirely to cultural activities such as music-making and sculpture, augmenting human abilities to bring understanding to our own data, breathing computational pattern into our lives. Programming languages could slowly become closer to natural languages, simply by developing through use while embedded in culture. Perhaps the growing practice of live coding over the past two decades is a precursor to this. Our hope is that we will begin to think of code and data in the same way as we do of knitting patterns, weaving block designs and the Greek poetic metre discussed above, because in essence, they are one and the same: languages with structures intricately (and literally) woven into our lives.

So perhaps the algorave movement should take lessons from the Luddites. Because they were not just agents of disruption, but also agents against disruption, not campaigning against technology, but for technology as a positive cultural force.

Conclusion

The activity and site of algorave is increasingly distant from that of contemporary software engineering, in that notions of quality control, test suites, and client relationships are sidelined, replaced with programming as creative, live interaction, where errors and failures are embraced as musical imperatives. This does not mean that the fundamentals of computer science are discarded, indeed the focus on pattern and mathematics brings these fundamentals to the fore, where the creative possibilities of strict type systems are plumbed with great enthusiasm, as we have seen with Tidal.

One motivation for this article has been that in order to understand the place of algorithms in electronic dance music, we must take a longer comparative view, placing algorave on long line of cultures engaging shared experience of discrete patterns and movement. Taking ancient Greek culture as our starting point, we have considered the then contemporary technology of the warp-weighted loom for its binary nature, relating the cyclic patterns of weave with the cyclic metrical patterns evident in ancient Greek choral lyric, including the metrical transformations of *epiplokē*. The ancient technology of weaving functions as a pervasive paradigm for conceptualizing pattern generation in early Greek thought and poetics. At the same time, the interference of warp and weft also brings useful perspective to the interferences explored through Tidal.

There is much to separate Tidal and *Epiplokē*, the first being a system for creating metrical sequences, the latter only employed as a system for analysing them (due to the loss of the original music). But there are also fascinating comparisons to be drawn, such as the cyclic structures at play, the cyclic modulations and transformations, the disregarding of established metrical subdivisions, and the notion of pattern that unites music, dance and language.

By looking for ancient perspectives on emerging technology, we find alternative narratives, which provide extremely rich seams of history to explore for understanding.

Notes

1 We also employed this device to live code musical patterns in a performance at the Art Areal Festival in Munich 2015. A second version of this device, enhanced by an augmented reality layer to provide dynamic feedback was tried out by Dave Griffiths at the Algomech algorave in Sheffield 2017 as part of a performance with Alexandra Cardenas and Alex McLean.

2 As a pervasive practice of ritual, religious and civic participation in every Greek polis, choral dancing was the distinctive element in the complex, multimedia performance that was Greek choral lyric—a genre of poetry that we experience today only as what remains: written texts, sometimes only in fragments. The fact that choristers were mostly non-professional dancers implies the exposure and participation of the average citizen to a significant number of choral activities.

3 See fragment 44 B4 D.-K.: "And certainly everything that is known possesses number. For it is not possible either to think or to know anything without this". For a comprehensive investigation of Pythagorean arithmetic and weaving with reference to Plato see Harlizius-Klück (2004).

4 For more on dyadic arithmetic, see: <http://www.praetexta.de/psephoi/e_psephoi_01.html>.

5 Odd and even numbers are theorised in Euclid's *Elements* in two sections: the definitions opening book 7 and the propositions 21–36 in book 9, whose nucleus is commonly traced back to Pythagorean mathematics.

6 The reference work on weaving as both a symbol and a conceptual metaphor (a myth in the authors' terminology) in Greece and Rome is Scheid and Svenbro (1996). See as well Fanfani, Harlow and Nosch (2016).

7 See Pherecydes of Syros (6th century BC) fr. 76, (Schibli 1990). Lucretius' *De Rerum Natura* (1st century BC) surely drew on Greek sources (namely 5th century BC Atomists, Leucippus and Democritus). As for the concept of atomic bonding and conglomerates, these are illustrated throughout the whole didactic poem through a sustained use of weaving metaphors, where atoms are defined as *primordia*. These are literally "first-threads", where the root *ordior* ("to warp") brings in as

well the idea of order and a reference to the starting-border of the weave. See Fanfani and Harlizius-Klück (2016).

8 The metapoetics of craftsmanship uses literary imagery, notably metaliterary metaphors, to illustrate the quality, structure and modes of performance of a poem in terms of a given craft. Weaving (and related textile techniques like plaiting, braiding, stringing) is a favourite conceptual vehicle for the generation/composition of the poem/song already in Old Indian sacred hymns (the *Rig Veda*). Archaic Greek literature appropriates this device in a rather genre-specific fashion. It is mainly choral lyric (ritually marked performances of sung and danced poems executed by a chorus) that provides the richest repertoire of weaving metaphors for song-making. Here, through the poetic 'I' (more often referring to the chorus than to the poet/composer), the imagery of weaving/plaiting/stringing invests explicitly the performance of the song. A further ramification of weaving imagery in archaic Greek poetics can be observed at the level of terminology: a number of key words designating the poem/song itself, or structural features of it, are etymologically or conceptually grounded on elements or mechanisms of weaving technology (see Fanfani and Harlizius-Klück 2016).

9 Referring to rug production in contemporary Afghanistan, Tuck (2006: 540) observes that "weavers reduce images to numerical grids that are then remembered and communicated throughout the course of production in the form of a chantlike song". Perhaps more interestingly for the purpose of this article, Tuck proceeds to exemplify the numerical sequences of a few traditional woven patterns, noting that in case of bichrome threads, "complex patterned textiles would call for long strings of number sequences, all of which would require not only memorization of repeating patterns of numbers along the horizontal axis of a loom's warp but also the correct relationship of a given line of numbers to that which proceeds and follows it in sequence. The songs thus appear to be mnemonic devices communicating this information".

10 Interestingly enough, the strand of Greek poetic imagery that associates weaving with choral lyric invests the element of dance in a distinctive way: instances of the image of "weaving/plaiting/stringing together a chorus of dancers" (collected by Calame 1997: 34–35 fn. 63) are often significantly connected to circular choruses. Circularity is a primary morphological feature of the lyric chorus, often in ritual context. (The dithyrambic chorus, linked to the cult of Dionysus, is probably the best-known example of circular dance in agonistic context. In a competition between tribes, 1000 Athenian citizens performed dithyrambs in circular formation annually at the Greater Dionysia festival). The act of weaving/plaiting together the dancers is usually the province of the chorus leader, the choregos. In a number of cases, the image of weaving a dance is associated with mixed choruses of young boys and young girls in the context of wedding or courtship rituals. (For an instance of circular dance, refer to the aetiological myth of the crane dance led by Theseus in the scholia AB to Homer's *Iliad* 18.590. For an instance of movement in a row, refer to the necklace dance described by Lucian, *On dance* 12).

11 In traditional metrical terminology, caesura designates word-end within a metron (the primary metrical unit), while diaeresis marks word-end coinciding with metron-end.

12 It bears noting that rhythmical terminology precedes reflection on meter. Our oldest attestations present terminology for rhythmical patterns rather than for individual meters. This has been elaborated at a later stage, when metricians in Alexandrian (Hellenistic) period made the effort of extending rhythmical terminology as to include nine fundamental metra, the combination of which could describe every verse (period).

13 For a comprehensive overview of ancient sources (both Greek and Latin) on *epiplokē* see Palumbo Stracca (1979: 90–107).

14 In the context of the Summer School of Greek metrics and rhythmics at the University of Urbino, 4–8 September 2017, several scholars have shown how the mechanism of *epiplokē* may in fact highlight significant thematic motifs within a given choral ode through alternating, modulating, and responding combinations of metra in *epiplokē*.

15 In other words, the pattern of word-ending in the strophe is coincident with the iambo-trochaic colon, while in the antistrophe it seems to be following the anacreontic cola.

16 See Cole (1988: 5–6): "For metrists and colometrists, of course, Aristophanes' rhythm must be either iambo-choriambic or Anacreontic, not both; and this leads to a dilemma: one or the other set of demarcations must be selected as basic—a series of colon or metron diaereses (divisions) separating rhythmical units—and the other dismissed. . . . Epiploke provides the simplest and most natural way of avoiding the dilemma in passages of this sort, and as such it deserves a place in any discussion of the rhythmical procedures used in Greek poetry".

17 But, as Dale (1968: 147) points out tentatively, "where there is no doubt as to colometry and it is merely the attribution to ionic or aeolic (i.e. choriambic) which is uncertain, a decision is perhaps not of great importance. Choriambic series and ionic series are in ἐπιπλοκή, and perhaps the best we can do is to call such passages aeolo-ionic, whether this be taken merely as a confession of our ignorance or (as I believe) as a valid indication that such ἐπιπλοκή was objectively present in the actual choral rendering of the passage in question".

18 Some observations on these features of ancient weaving, and its reflection in archaic terminology for poetics have been proposed by two of us in an online publication (Harlizius-Klück and Fanfani 2017).

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