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Recreating the eleventh century musical sequence Victimae paschali laudes using Max
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Recreating the eleventh century musical sequence *Victimae paschali laudes* using Max.

Stace Constantinou, University of Northampton.

This essay shows how the eleventh century musical sequence *Victimae paschali laudes* is recreated in Max using fifteen objects. The programming level is relatively simple. The desired musical outcome was in no need of a more complex programming, as shall be seen.

Before showing how the Max patch works, a contextual exploration of the music of *Victimae paschali laudes* is presented for those readers unacquainted with it. Following this, the reason for using Max to recreate the chant is then given, before a detailed analysis of the Max patch is presented. Finally, a short section on how the audio material is created in the Max patch is put to use in another software programme Logic Pro X.

Brief Contextual Exploration of *Victimae paschali laudes*

The eleventh century musical sequence *Victimae paschali laudes* is ascribed to Wipo of Burgundy (CA. 995-CA. 1050) according to the Norton Anthology of Western Music (Burkholder and Palisca, 2006, p. 31).

Just James Greasby, in his PhD thesis devoted to bringing to light neglected music for Easter, says:

> Victimae paschali laudes was one of the four sequences retained by the Council of Trent of 1545-1563. This sequence, along with the Stabat Mater dolorosa admitted in 1727, is included among the five sequences which are still in use on designated holy days by the Roman Catholic 3 Church today.
> Greasby, J, J., (1972, p. 3).

Victimae paschali laudes is a religious chant often associated with Easter, the most important feast day in the Christian calendar, sung as part of the liturgy at Mass. The Mass includes a number of parts including the following: alleluia, verse, alleluia, sequence (Greasby, 1971, p.3).

Greasby goes on to say of the sequence that it is:

> an embellishment of the liturgy, an insertion between liturgical chants— the Gradual and the Gospel, originating about the eighth century: the sequence is thus an interpolation in the liturgy, but it is not an interpolation in a liturgical text.
> Greasby (1971, p. 15).

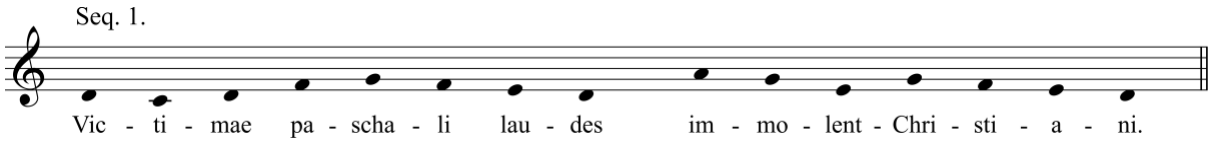
The sequence can be considered independent of the text and only forms meaning when connected with it. The eleventh century saw more creative freedom for those who compose music for the church as well as in certain secular contexts. As a result of such freedoms hundreds of sequences were written during this time. Sequences were widely adopted to be a part of the Mass as well as organised into large collections with specific sequences used for specific days (Greasby, 1971, p. 19). Whilst the history of the sequence is fascinating, there is, however, not the space here to reveal its fuller context. (For further details see the references section at the end of this chapter.)

The text evokes the resurrection of Christ, and the redemption that he will bring to all of humanity according to the Christian religion. In modern chant books the sixth verse is omitted due to its reference to the notion of the deceitful Jews (Burkholder and Palisca, 2006, p. 31). Modern church leaders have apologised for this and have sought to uproot this calamity. The text nor its content was of any concern to me in creating my six-track EP, however. The sequence is separated from its text in my rendition, and as such is therefore devoid of its meaning. I have in fact written my own text for The SAPIAN Trilogy. Thus, by applying my own lyric to the melisma of the chant continue the tradition of such sequence making, the origins of which themselves arose by the practice of adding texts to existing melodies (Greasby, 1971, p. 43).

The chant has musical qualities such that they accord it longevity, according to John Julian, in his book "Origin and History of Christian Hymns of All Ages and Nations, New York, Charles Scribner's Songs"

> This fine Sequence is simple, scriptural, good in rhythm, and embraces in itself various elements which account for its popularity and long extended use. Luther held it in high esteem, especially admiring the terse and vivid picture of the conflict between Death and Life…
> (Julian, 1892, p. 1223)

Similarly, what I find of value in the chant is its musicality. With its Dorian mode, uneven phrase, a range of a twelfth (wide for a plainchant), contour of subtle variation, and its atmosphere. In addition, its exemplary combination of repetition and variation, as can be seen for example in the deployment of descending stepwise melodic patterns at the end of each phrase. Most of the intervals move in step, very few are larger than a second. There are some thirds, occasional fourths and no interval larger than a fifth is applied.



Sequence 1. Victimae paschali laudes ascribed to Wipo of Burgundy (CA. 995-CA. 1050). Source: (Burkholder and Palisca 2006, p. 31).

The above chant is 'one of only five that are retained in the liturgy and standard modern chant books.' (Burkholder and Palisca, 2006, p. 31).

The above chant is the first sequence (Seq. 1.) that then forms the musical basis for the following six sequences. It ends with the notes: G, F, E and D a pattern that occurs on other occasions throughout the music.

Why use Max to recreate an eleventh century sequence?

Chants are very attractive musical materials worthy of study and continual use. They have been bequeathed to us by previous generations. That some chants have survived the intergenerational evolution of cultural norms whilst most have not, in my view, implies that the enduring music has superlative quality that affords them their longevity.

The longevity notion, accurate or not, is however an after-thought. My first instinctive desire was to learn and play it (on my voice and an instrument) for the shear mystifying enjoyment of musicmaking. Then, later it became evident that the chant could be put to good use in my six-track EP *The SAPIAN Trilogy: part 1*.

In 2020 I began writing my six-track *EP The SAPIAN Trilogy*: part 1. The work was initiated as a series of musical exercises made for my students, to show how simple musical ideas can be made into more substansive material with limited software or technical resources. The limitation in this case is the digital audio workstation software Logic Pro X. Having started to become rather fond of some of the musical exercises, I took the decision to develop them into a full-blown work. For more information about the SAPIAN Trilogy please see, [insert text], click here.

Most of the six-track EP is produced using Logic Pro X. A software that offers users a comforting experience. It is user friendly and intuitive to operate. Without much experience of either music or DAW software users

can quickly and relatively easily begin making rudimentary pieces using the wealth of pre-made loops and samples the package delivers. The music made in this way can sound derivative, however. In order therefore to produce music that sounds like it has not come out of the box, so to say, it requires more effort on the part of the user.

As I have been using Logic for many years, and prior to taking it up, used other DAW software, crafting different kinds of music in the programme now seems second nature. The square wave sound in Logic is, however, a bit too easy on the ear, for what I wanted in the EP, so, I made the decision to use Max for this one element. The Max sawtooth and triangle waveforms have a raspier quality than those used in Logic Pro X. And it was this rawer timbral quality I wanted to explore in the composition of *The SAPIAN Trilogy: part 1*.

In total nine Max patches were created named "Seq. 1.maxpat; Seq. 2.maxpat;…Seq. 7.maxpat." then "Seq. metro synch test", and "zSeq. 2 + rev.".

The first seven are straightforward realisations of the chant sequence. With the final two being experiments. In the end only the first seven were used in my EP. The two omitted patches were experiments too far and as such were rejected. (It will be explained later in the chapter why these two experiments were rejected.)

The Construction of the Max Patch

In recreating the eleventh century musical sequence *Victimae paschali laudes* in Max, I used the following fifteen objects:

1. saw~ generates an anti-aliased sawtooth wave.
2. tri~ generates a triangle wave whose component frequencies are resistant to aliasing.
3. gain~ a slider that scales signals. It can also make a smooth transition as you move from one value of the slider to the next.
4. metro Acts as a metronome which outputs bang s at a regular, specified interval. This object uses the Max time format syntax, so the interval that the metro object uses can be either fixed or tempo-relative.
5. gswitch2 Send input to one of two outlets. Switches the right inlet between two output pathways.

6. Bang Output a bang from many outlets. Outputs bang messages out of each outlet (in right-to-left order) when it receives any input. The number of outlets is determined by an argument.
7. toggle Switch between off and on (0/1). When clicked, toggle outputs a 0 when turned off and a 1 when turned on. When giving input, a non-zero number will turn it on, a 0 will turn it off, and a bang will alternate the state of the toggle. All numbers are converted to integer and passed through unchanged.
8. number (integer and non-integer) Display and output a number. Displays, inputs, and outputs integer numbers.
9. kslider Output numbers from an onscreen keyboard. Outputs and displays note and velocity information using an on-screen keyboard.
10. mtof Converts a MIDI note number to frequency. Performs MIDI-note-number to frequency conversion. Frequency is reported in as a float in Hertz (Hz).
11. scope~ Visualize an audio signal. Visualize an audio signal.Use the scope~ object to visualize and audio signal using an oscilloscope-style display.
12. EZDAC
13. Message object (to bang out numbers)
14. Multiplication argument (amending the frequency of the triangle)
15. Division argument (amending the frequency of the triangle).

This simple patch has three main parts: 1) a sequence control mechanism, 2) a pitch generator and a 3) sound source/ timbre (including an audio output).

The sequence control is used to create the number of notes in each sequence, in the correct order. The pitch generator realises the pitches and converts the MIDI notes to frequency. Part 3 uses the sound source of a sawtooth wave, plus two triangle waves to realise the timbre.

The following sections looks in detail at the patch, offering a deeper insight into its workings and rationale.

Part 1: The Sequence Control Mechanism

This part is made by the simple use a metro object that releases a bang into a gswitch 2 with sixteen out gates (one for each note in Seq. 1 of *Victimae paschali laudes*). Each gate outlet is then connected to a number that conjoins to part 2 of the patch. A toggle is used to switch the metro

(and therefore sequence) on/ off and a number object is fed into the righthand inlet of the metro to control the frequency of which the bangs are released. This in effect becomes the tempo control. Each number object, when triggered by the gswitch, sends the corresponding number to the kslider producing a MIDI note aligned to a pitch. To give an example, 50=D natural, 48=C natural.

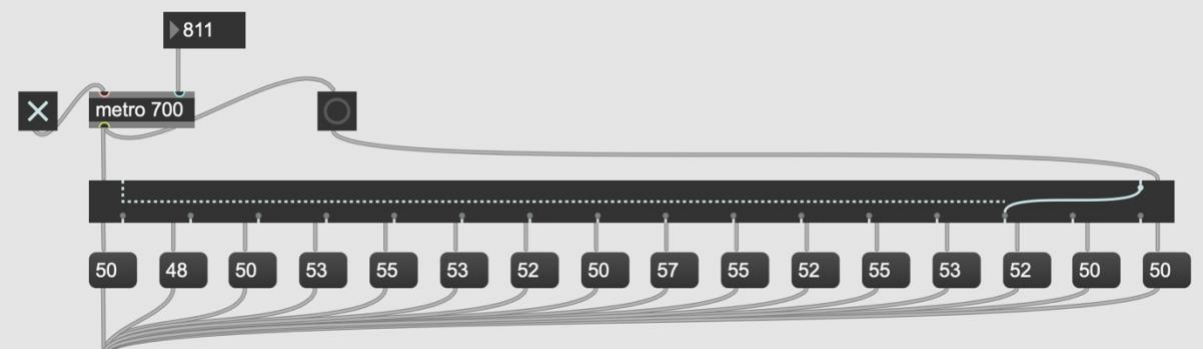


Figure 1: The Sequence Control Mechanism used in the recreation of the first sequence of Victimae paschali laudes.

The metro is set at 700, which means it will output a message every 700 milliseconds. This value was arrived at through a trial and error process of trying different values to hear which one worked best for the musicality of the sequence. The number object connected to the righthand inlet of the metro simply allows for the convenient fast-forwarding through the sequence.

Part 2: The Pitch Generator

The sixteen number objects from the above part 1 feed into the kslider (of part 2) triggering MIDI notes whose pitches are then converted into a frequency in Hertz (Hz) using the mtof object.

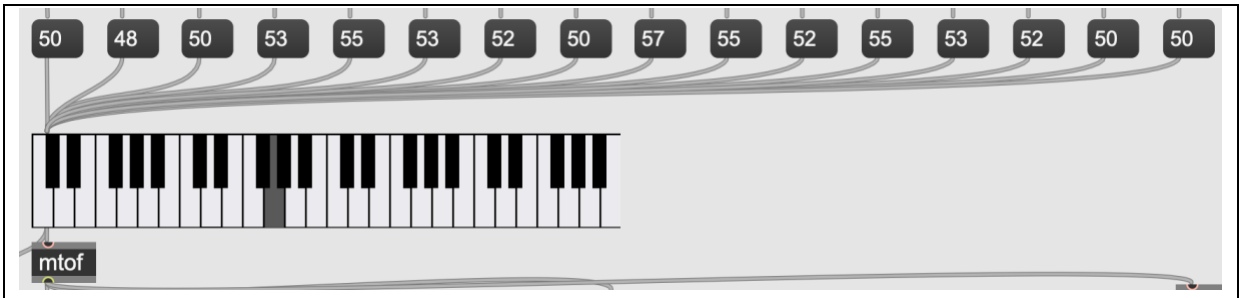


Figure 2: The Pitch Control used in the recreation of the first sequence of Victimae paschali laudes.

Part 3: The Sound Source (timbre)

The sound source is the main reason for using Max as already stated earlier in the chapter. A sawtooth wave and two triangle waves have been combined, in a very simple additive synthesis technique. The sawtooth is used as the fundamental tone. With the first triangle wave adding a harmonic component a fifth above. And the second triangle adding a component a fourth above (below – check).

The electronic sonic clarity of this simple sound source made using three components is what I wanted to achieve in the making tracks: 1b ”Hail Self-Generating Reason” and 2b “The Seven Rules of The Omniverse Ordering of the Artificial Intelligent Vision” of my six-track EP, *The SAPIAN Trilogy*.

Three gain sliders were used to fine-tune the balance between the three harmonic components. The final result is that it has an almost low bit depth quality to it that lends itself well to the theme of the trilogy, a Super Artificial Intelligence order.

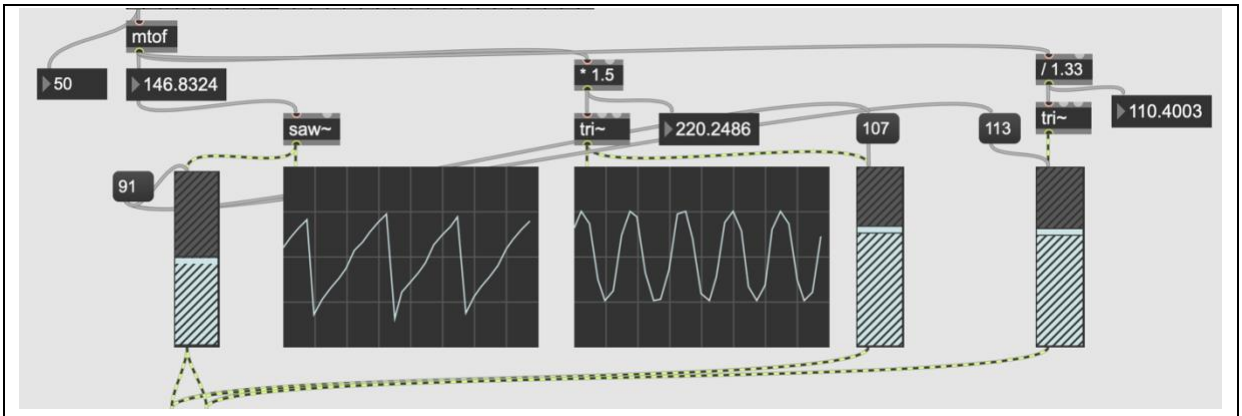


Figure 3: The Sound Source used in the recreation of the first sequence "Seq. 1.maxpat" of Victimae paschali laudes.

It can be observed that there are three message objects, one next to each of the gain~ sliders. Each message object has a different numeric value, starting on the far right: 91, 107 and 113. These determine the relative loudness of each harmonic component. The first message box is connected to the others necessitating, therefore, a simple push of this first message to simultaneously activate the other two, thereby determining the relative amplitudes of the harmonic components and hence the realising the final timbre.

The Whole Patch with Audio Output

The three gain sliders shown in the above figure 3 can also be seen also in figure 4 below, this time connected to the EZDAC, the audio output set to the hardware speakers on my MacBook computer.

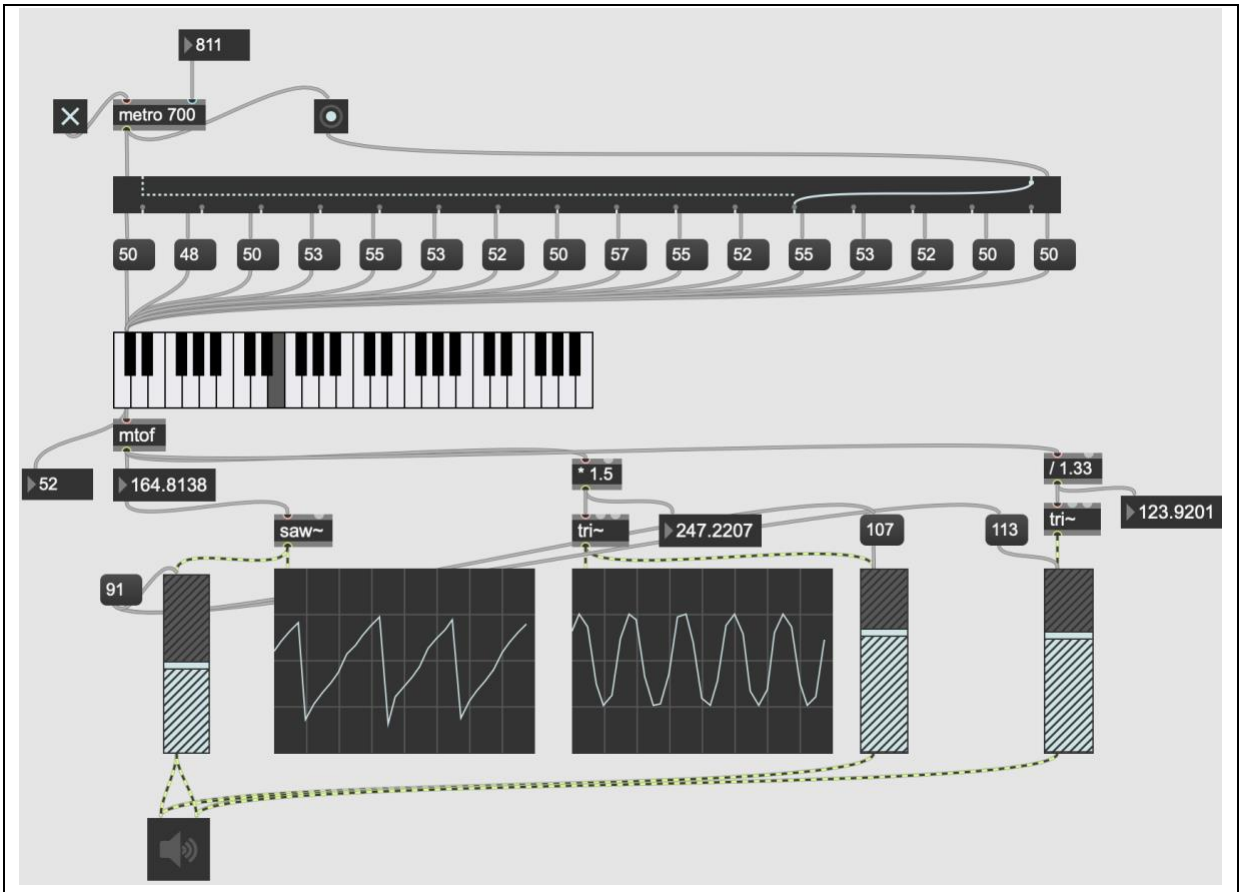
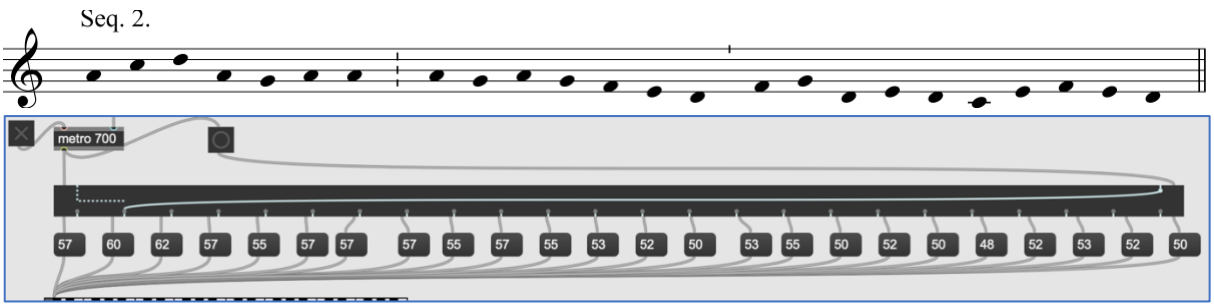


Figure 4: The Whole Patch showing the Audio Output

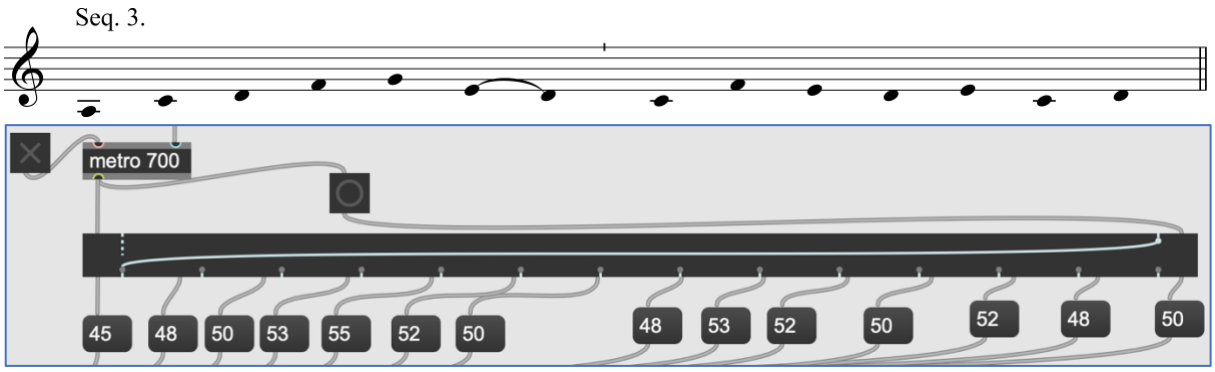
This concludes the Max Patch for Seq. 1 of *Victimae paschali laudes*. The following details each of the patches for the subsequent music of the chant. Given that only part two of the Max Patch is different for sequence 2 to sequence 7, the following therefore gives the details of only the deviations that occur in Part 2 of the Max Patch; the part that deals with the specific sequences of pitched notes.

Seq. 2. The Pitch Control Part 2 element

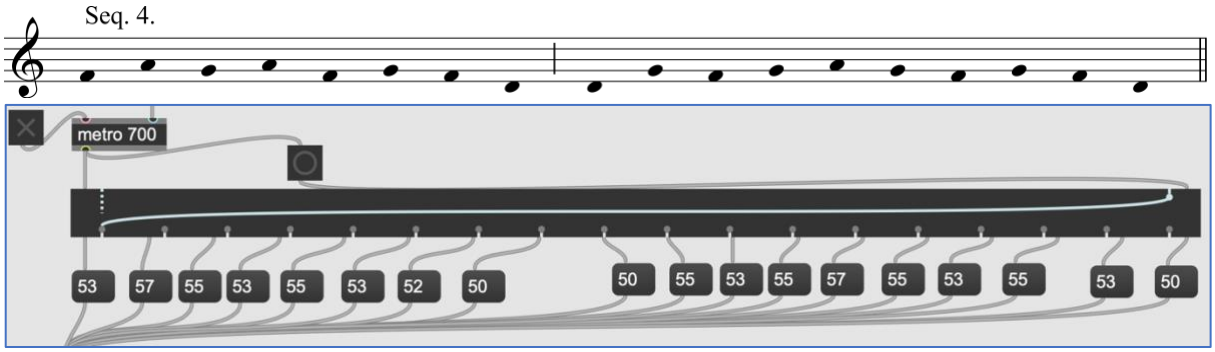
The longest sequence in the series, consisting of twenty-four notes.



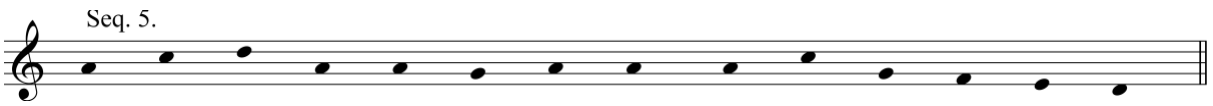
Seq. 3. The Pitch Control Part 2 element
The third sequence consists of fourteen notes.

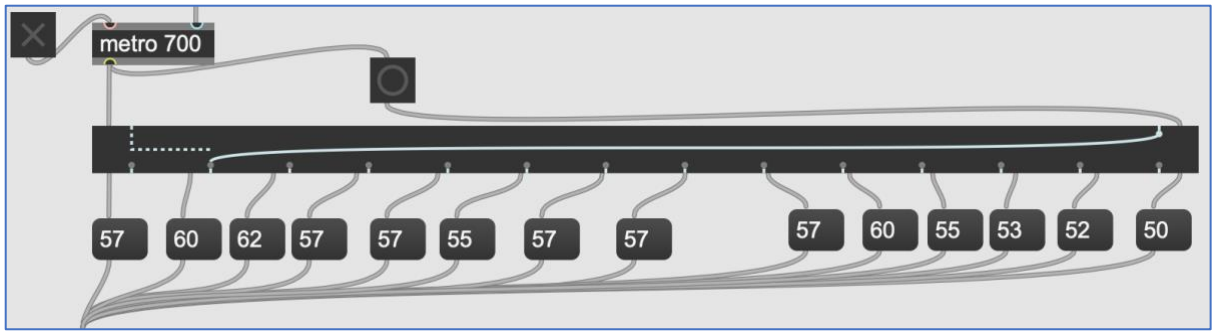


Seq. 4. The Pitch Control Part 2 element
In this eighteen note sequence, it can be seen how the Max patch mirrors the phrasing of the notation, whereby the two D-naturals, steps eight and nine (number object 50) are visually separated. This allowed me to more accurately see where the patch corresponds with the music.

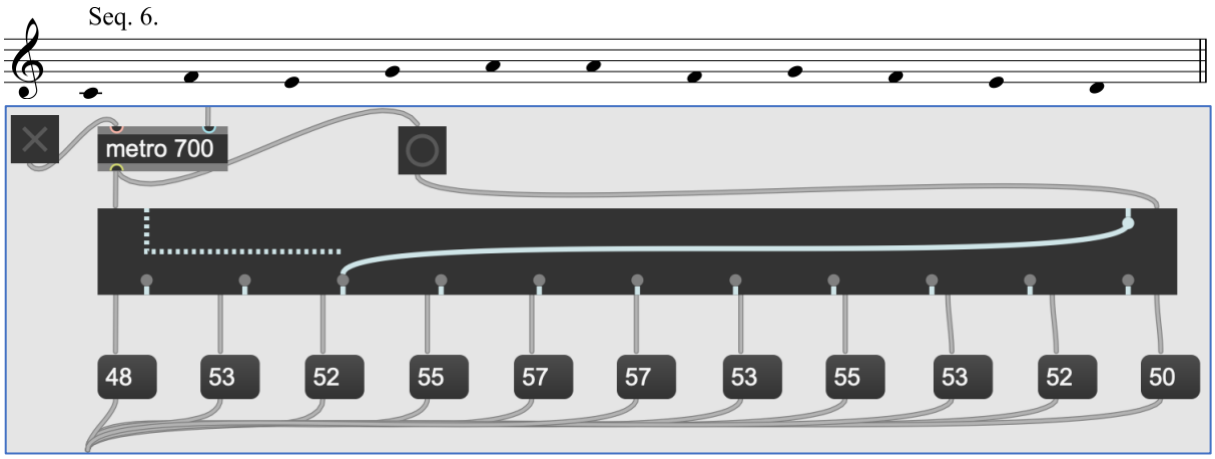


Seq. 5. The Pitch Control Part 2 element
The fourteen notes of sequence five are visually separated at the phrase point, as in the sequence above. This can be seen on number objects 57 steps eight and nine.

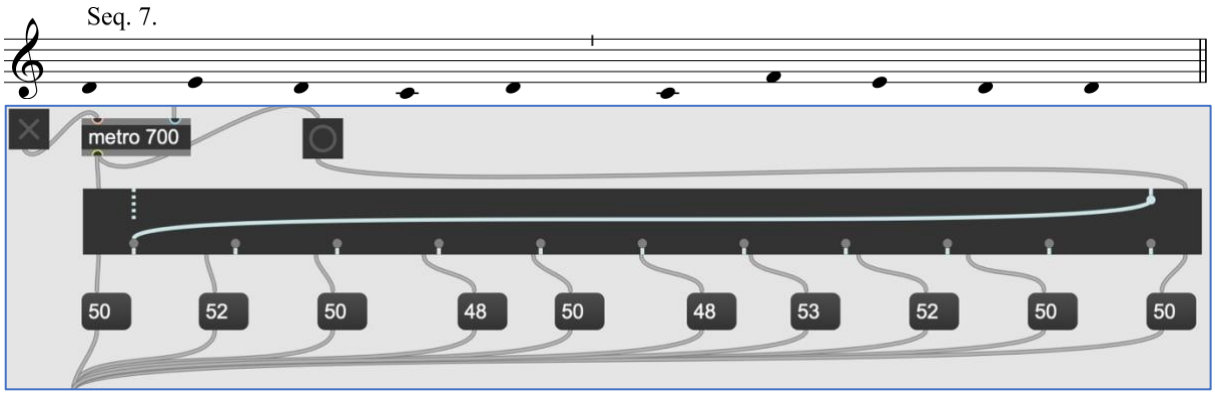




Seq. 6. The Pitch Control Part 2 element
The eleven notes of this sequence are easily visualised in one glance of the Max patch, so there was no need for separation.



Seq. 7. The Pitch Control Part 2 element
In this final, and shortest, sequence the double D-natural is included, unlike in the previous sequence, whereby grace-notes were omitted.



Two rejected patches "Seq. metro synch test" and "zSeq. 2 + rev"
The first rejected patch "zSeq. 2 + rev" includes three additional harmonic components in the shape of triangle waves, with a harmonic intervallic multiplication relative to one another of: / 1.33, / 1.167, / 1.125 and / 1.111. With each of the harmonic components being sent to a reverberation object from the BEAP section of the pre-made Max resources.

The seconds rejected patch "Seq. metro synch test" includes the same harmonic content as the above patch, but also has a feedback loop element, whereby the frequency determined by the mtof object number is multiplied by 1.01 then feed back into the metro, to provide a variable tempo directly related to the pitch step in the sequence. So, for example A=220 Hz gives a metro of 222 milliseconds where C=261.6256 Hz gives a metro of 264 milliseconds.

Sometimes in composition, but not always, more is less. Having made two patches with additional harmonic content as well as reverberation, in the end I simply preferred the rawer, raspier sound of the single sawtooth and two triangle waves. Given I knew the seven sequences would be recorded, turned into audio files, then imported in Logic Pro X, it was decided that it would be more preferable to shape the raw sound in the latter DAW, as will be seen shortly.

Recording the Output to Create Seven Audio Files

Because of the low bit depth quality of sound required, there was no need for sophisticated recording programming or hardware. Instead, the stereo mini-jack output of my MacBook was used to connect to two separate (left and right) quarter inch jack plugs connected to a standard audio interface connected to another computer running Logic Pro X. The signal to noise ratio was carefully analysis by making several versions of the *Seq. 1* to ascertain the optimal output level of the MacBook and input on the audio interface.

Integration of the Audio File into The SAPIAN Trilogy

Logic Pro X was used to firstly record in the raw audio. This provided me with seven audio files of each separate sequence of *Victimae paschali laudes* shown above.

Figure 5: Logic Pro X used to record the seven Max patch parts for Victimae paschali laudes.

Once the seven sequences had been turned into audio files there was no longer any need for Max.

Logic Pro X was then used to further emphasis the digital sonic quality of the audio, by the inclusion of four inline digital process:

- EQ
- Spectral Gate Filter
- Phase Distortion
- Compressor.

In addition, two pre-fade bus channels were used to send the signal simultaneous to two separate reverb digital signal processes. This then forms the musical accompaniment to the spoken word voice parts that recite the lyrics of the track. The spoken vocal part is also coloured using a variety of processes, including pitch-shift down to give the voice a more primal feel.

Five channels are used in total, one for the chant made in Max and four for the spoken word vocals. All are five are sent to the same two reverberation digital signal processes, aforementioned. The stereo master channel uses no additional inserts (DSPs). The exact same settings are

used in both tracks: *1b Hail Self-Generating Reason* and *2b The Seven Rules of The Omniverse Ordering of the Artificial Intelligent Vision* to provide sonic coherence throughout the EP.

Conclusion

This chapter has shown how an eleventh century musical sequence can be realised using simple Max programming techniques.

A brief context of the musical sequence *Victimae paschali laudes* is presented before an exploration of the need to use Max, and how it is used in forming material for my six-track EP The SAPIAN Trilogy.

The raw perhaps raspy sound quality of the Max single sawtooth waveform and two triangle waveforms was the sound I wanted for my The SAPIAN trilogy. In addition, the simple nature of the way in which the gswitch creates the sequence, by switching from one output to the next in step, afforded the sound quality an extra, almost chip-tone like quality.

In total nine Max patches were created, two were reject with seven being used to make audio files that were then used in Logic Pro X to realise the final musical material.

Each of the seven patches can be divided into three parts:
Part 1: The Sequence Control Mechanism
Creates the sequence of notes for each phrase in *Victimae paschali laudes*.

Part 2: The Pitch Generator
Generates the pitches applied to the sequence above.

Part 3: The Sound Source (timbre).
Realises the sequence and notes as a distinct timbre, by applying a single sawtooth waveform and two triangle waveforms, to form a raw, rasp like sound quality.

The simplicity of the Max patch is reflected in its use of only fifteen objects.

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Discography

Victimae paschali laudes: The Passion and Resurrection of Christ in Gregorian chant sung by the monks of Quarr Abbey [CD] Herald AV Publications, HAVPCD 119

Scores

Burkholder, P. J., and Palisca, C, V., (2006) Norton Anthology of Western Music: volume 1: Ancient to Baroque, fifth edition: London, W. W. Norton & Company, Ltd.