By Degrees

This piece explores the potential effects on performance of varying degrees of controlled notation. I was interested in the differences in results that unconventional notation produces, and set about containing a variety of them in the confines of a single score.

The genesis of the piece was an introduction I received to the probabilistic works of Iannis Xenakis. A piece such as *Achorripsis*, for example, uses three different kinds of probability distributions—linear, exponential and Poisson—to produce pitch, temporal and organisational material by using carefully selected values as inputs. My interest was in this latter fact, particularly in the idea that values could be varied to produce distributions of varying qualities.

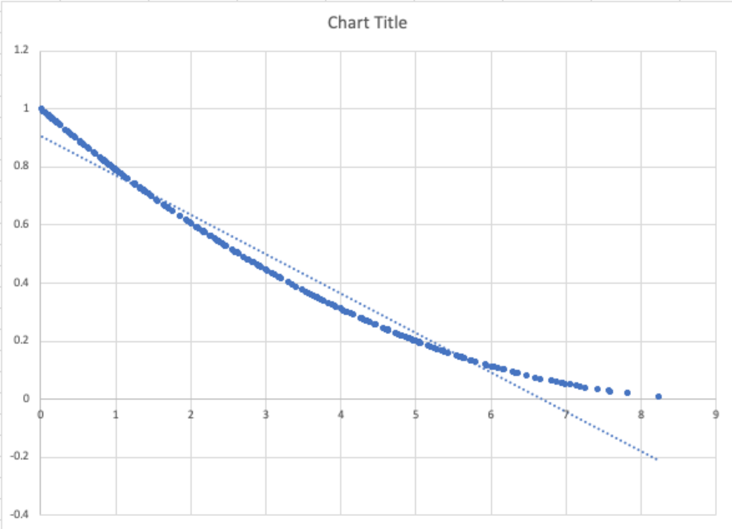
Taking Xenakis' lead, I have mapped values taken from linear distributions (spread fairly equally across a selected range) on to intervallic material, exponential values (in which extreme values occur less frequently than those at the lower end of a range) and Poisson values (which provide *expected* occurrences of an event given a density value) to determine the number of events that occur in a given cell.

Using spreadsheet software and its random number generator function, I was able to devise a means of efficiently producing distributions that could easily be manipulated. Random numbers ensure that values that deviate from the general trend of distributions are possible, which would give me varied material to work with later. Example One shows examples from my sheet of each kind of distribution. Of note is that smaller δ values produce larger values, while larger values produce smaller values. Similarly, linear distributions can be adjusted to produce wider or

Example One: Linear, exponential and Poission distributions generated using random numbers given selected maximum interval, δ and λ values, respectively.

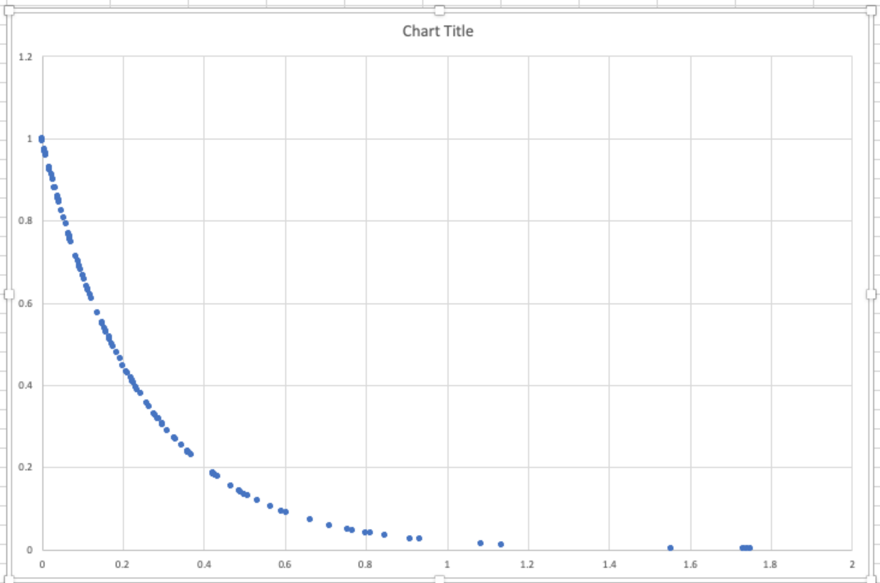
Max. interval size (semitones): 9

3.9008824	0.321
0.3393996	0.926
5.3887675	0.161
5.9479515	0.115
1.5729548	0.681
4.6185619	0.237
0.1634848	0.964
6.3760716	0.085
3.4156469	0.385
1.1179317	0.767
5.742547	0.131
3.0165228	0.442
2.9025415	0.459
4.9750776	0.2
1.8678194	0.628
6.9675138	0.051
3.1951744	0.416
4.4820359	0.252
2.6169756	0.503
6.0975872	0.104
3.8534478	0.327
1.2631402	0.739
0.0451131	0.99
1.9765393	0.609
4.6463808	0.234
0.7219568	0.846
0.8104945	0.828
6.8139076	0.059
0.9400993	0.802
1.4218076	0.709
3.7521433	0.34
5.1710315	0.181
3.5775467	0.363



δ 1.2

Probability	**Unrounded duration**	**Duration**
0.021466389	3.201055733	3.2
0.931126542	0.059466742	0
0.834761655	0.150507532	0.2
0.846308059	0.139059874	0.2
0.879593808	0.10691255	0.2
0.413146502	0.736627519	0.8
0.34542844	0.885808148	0.8
0.508996275	0.562762151	0.6
0.475112032	0.620170538	0.6
0.519049197	0.54646384	0.6
0.073762593	2.172419621	2.2
0.557929784	0.486268467	0.4
0.572973424	0.464096619	0.4
0.579173292	0.45512796	0.4
0.779242136	0.20786121	0.2
0.532708612	0.524817248	0.6
0.407647546	0.747793614	0.8
0.793479192	0.192773302	0.2
0.34353401	0.890390968	0.8
0.978624554	0.018006008	0
0.83848262	0.146801187	0.2
0.049979288	2.496788827	2.4
0.912924309	0.075918587	0
0.20786076	1.30907237	1.4
0.057958166	2.373361503	2.4
0.216092599	1.276706888	1.2
0.872953684	0.113227316	0.2
0.587459138	0.44329049	0.4
0.203228682	1.327852851	1.4
0.252738937	1.146165162	1.2
0.583087424	0.449515124	0.4
0.424756725	0.713532239	0.8
0.429173953	0.704910799	0.8
0.772046091	0.215592522	0.2
0.388770084	0.787305961	0.8
0.438565833	0.686871121	0.6
0.866973472	0.11895575	0.2
0.851773462	0.133695564	0.2



λ:	2.1
No. of cells:	30
blocks:	10
No. of rows:	3

	k		Cells	Columns	Rows
P_0=	0	0.122456	3	0.3	1
P_1=	1	0.257158	8	0.8	2.67
P_2=	2	0.270016	8	0.8	2.67
P_3=	3	0.189011	6	0.6	2
P_4=	4	0.099231	3	0.3	1
P_5=	5	0.041677	1	0.1	0.33
P_6=	6	0.014587	0	0	0
P_7=	7	0.004376	0	0	0
P_8=	8	0.001149	0	0	0

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Column

	Zero	Single	Double	Triple	Quadruple	Quintuple	Sextuple	Septuple
0	7.4	4.5	4.5	5.5	7.4	9	#NUM!	#NUM!
1	2	4	4	2	3	1	0	0
2	1	2	2	2	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
	2.5	**5.5**	**5.5**	**4.5**	**2.5**	**0.9**	**0**	**0**

	Zero	Single	Double	Triple	Quadruple	Quintuple	Sextuple	Septuple	
0	0	0	0	0	0	0	#NUM!	#NUM!	
1	2	4	4	2	3	1	0	0	
2	2	4	4	4	0	0	0	0	
3	0	0	0	0	0	0	0	0	
4	0	0	0	0	0	0	0	0	
5	0	0	0	0	0	0	0	0	
6	0	0	0	0	0	0	0	0	
7	0	0	0	0	0	0	0	0	
	4	**8**	**8**	**6**	**3**	**1**	**0**	**0**	**30**
	3	8	8	6	3	1	0	0	

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Row

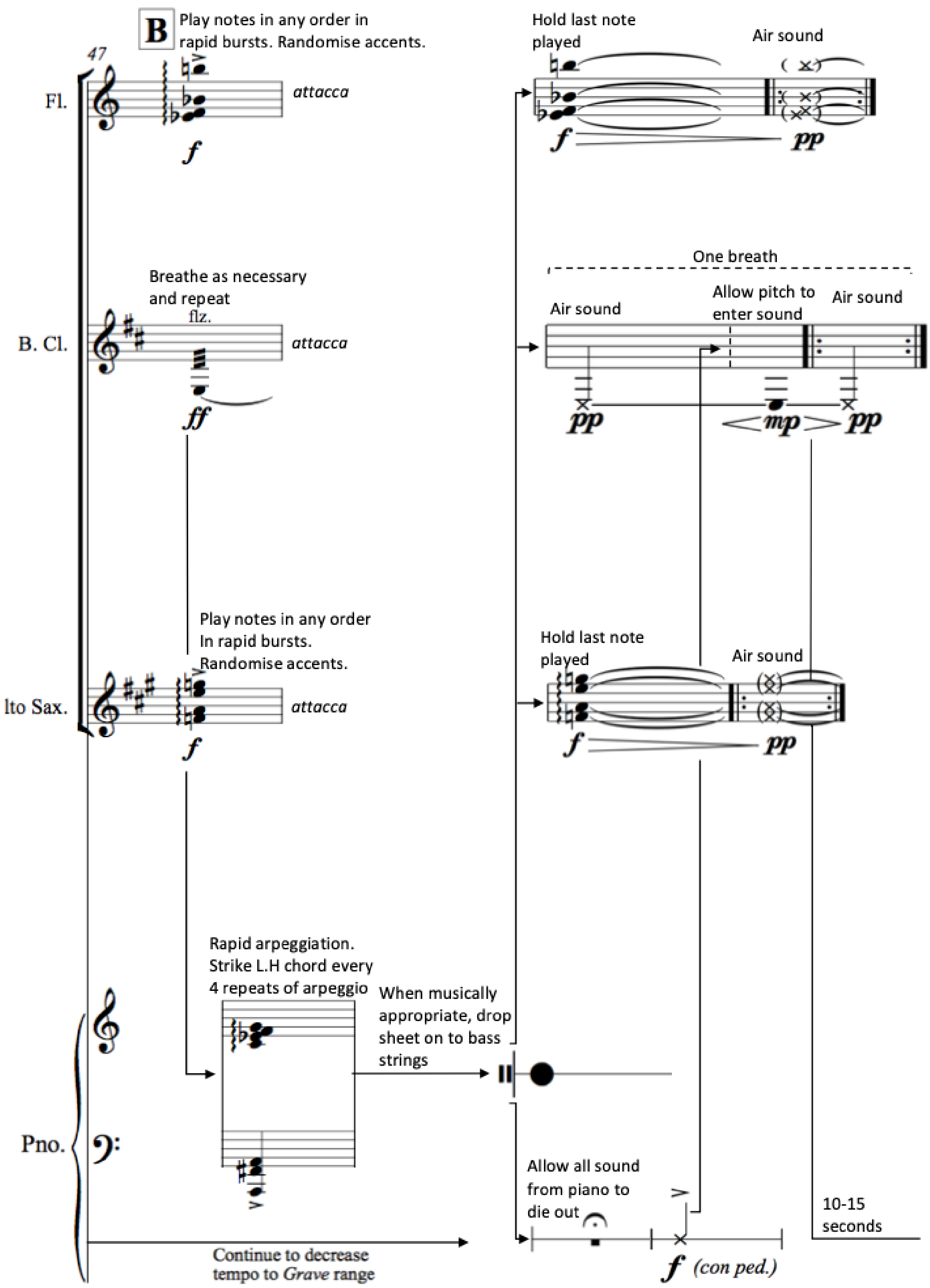
	Zero	Single	Double	Triple	Quadruple	Quintuple	Sextuple	Septuple
0	1.1	0.21	0.21	0.41	1.1	2.16	#NUM!	#NUM!
1	2	0	0	1	3	1	0	0
2	1	2	1	1	0	0	0	0
3			2	1	0	0	0	0
4		1	0	0	0	0	0	0
5		0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0

	Zero	Single	Double	Triple	Quadruple	Quintuple	Sextuple	Septuple
0	0	0	0	0	0	0	#NUM!	#NUM!
1	2	0	0	1	3	1	0	0
2	2	4	2	2	0	0	0	0
3	0	0	6	3	0	0	0	0
4	0	4	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0

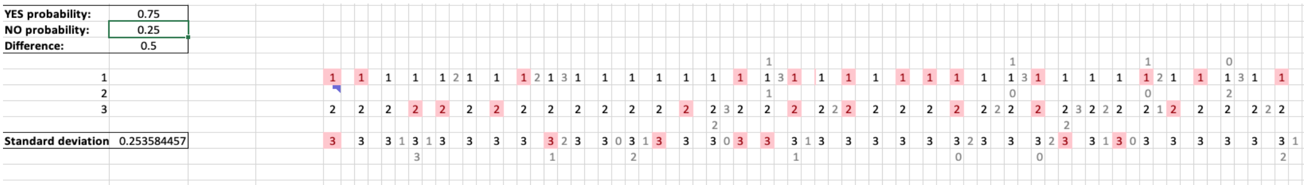
smaller intervals. I found that I could interpret these facts to represent a continuum, wherein smaller, more precise ranges are found at one end and more open values are found at the other. Using δ to provide durations of cells, for example, I could choose to give the performer open segments of time within which to place performance instructions, or produce small units that occur in quick succession.

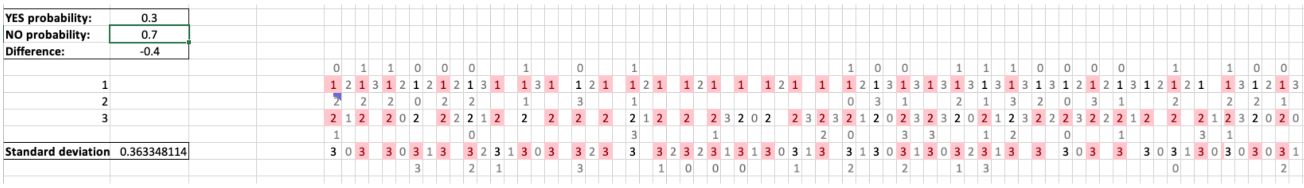
The next stage in the piece's construction came from an interest I have developed in the idea of modular or sequential music. I composed an undergraduate piece in which material proceeds through a series of 'actions', and found that this produced an interesting effect as the way in which performers were required to listen to each other was changed. An extract of this score is shown in Example Two. It also allowed for a degree of aleatoricism to each performance that somewhere between a fixed score and a free improvisation, as material never occurred in precisely the same place in time or in relation to other parts.

Example Two: *Variations* (2017) score, showing sequential/modular notation.



Example Three: Modular section of spreadsheet showing results of two different 'Yes' values.





I sought a way of controlling the degree of precision of this too, and created another spreadsheet which allowed me to determine the amount of modularity and a number of other novel conditions. Example Three shows this spreadsheet. The value 'Yes' gives the probability that a cell will be modular. The score is divided into three instruments, and the intermittent values of one, two and three represent cells. A random number is generated between these cells, and, in the case that the number is smaller than the 'Yes' value, determines whether the proceeding cell will control the cell of another instrument. Zeroes allow for another condition, and a formula is added between rows that generates another random number in the event that a cell becomes modular to allow for the possibility that one cell can control two others. Certain conditions rely on standard-deviation distances from the 'Yes' value to adjust their frequency or infrequency for my desired results, and another random number generator determines whether cells are repeated. Repeated cells are highlighted pink.

The final degree of control related to the notation itself. While my distributions would allow for a degree of control over organisation, there was potential to widen the scope of my inquiry by exploring the control that notation itself has over performance results. I experimented with a number of notation systems, and decided that, for my purposes, I would use a system that ranged from defined note and cell duration and pitch, to one that defined only cell duration and pitch range. By incrementally loosening or tightening restrictions, the choices that performers are required to make about what they play are adjusted, which I believe will make for a performance that continually varies in quality.

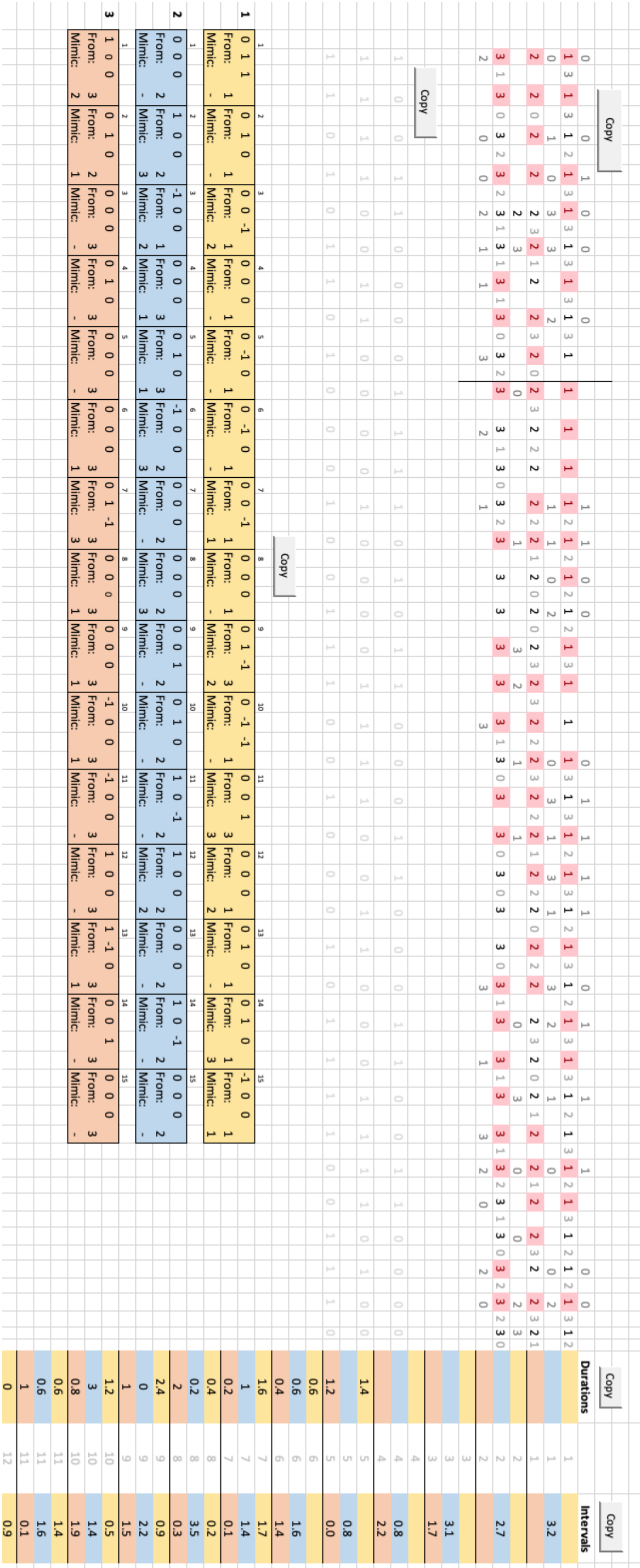
When interpreting my results to make a score, I decided to work on gridded paper to ensure I had a universal way of representing space. A cell read from left to right represents five seconds and can be divided into five one-second cells, which would allow to work with durations of one second upwards. In a treatise on Modular Music, James Saunders explores the thinking on modularity that exists in the engineering world in an attempt to posit parallels that may be made in music, and highlights the important of the distinction between ‘closed’ and ‘open’ modular systems. Closed structures have a limited number of possible formations, whilst open are unlimited, and yield new combinations for as long as they are attempted.[1] Whilst the latter doubtless make for the varied musical results, I wanted to retain a degree of control over the unfolding of a performance, so sought a closed system that nevertheless had a variety of possible performances. For this reason, my score has two possible starting positions: one at the top left of page one (B), and another at the bottom left of page one (A). B begins with loose notation and long durations (δ=0.3), and follows a loose trajectory towards the bottom of page three in which

[1] James Saunders, “Modular Music”, *Perspectives of New Music* 46, no. 1 (Winter 2008), pp. 156–159.

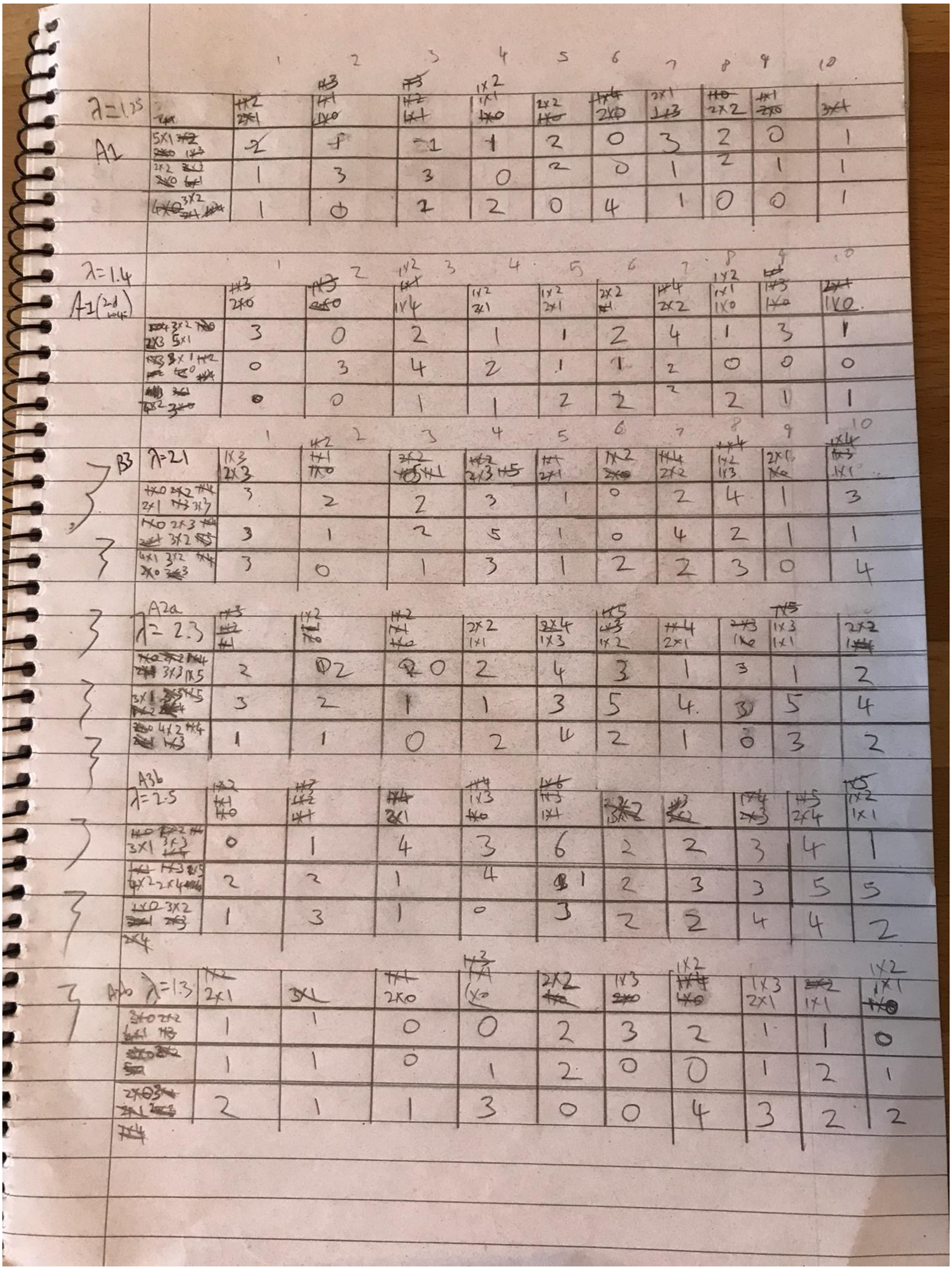
durations become shorter and notation more controlled. With cells at sufficient lengths, the organisational element of cells is negated, and instead become time blocks for near-free improvisation. A follows the inverse, begins with tighter control and short durations. Modularity increases universally across the three pages, from Yes=1 at the left of page one to Yes=0.4 and below by the end of page three, whilst cells toward the middle of each page have the highest λ values and therefore the highest densities where applicable. The final section allows performers themselves to choose the degree of control of their notation, making my own control over this aspect of the score the last thing to be relinquished. The path through modules allows for possible jumps between the two paths, and short, intermediate modules add a frequent organisational that allows performers to signal their choices and position in the score.

Information from my distributions is copied into a separate worksheet. Example Four shows this sheet. The lower table allows me to enter the sequential commands and produces more numbers based on the 'Yes' value to determine whether a cell mimics another, and whether pitch, density or dynamic decrease, increase or remain unchanged, whilst another set of random numbers between one and -1 and 1 allow me to determine whether a pitch rises, falls or remains the same given an interval. Example Five shows examples of various Poisson distribution tables I worked from to calculate density distributions.

Example Four: Worksheet encompassing all data.



Example Five: Poisson distributions for an array of λ values



Bibliography

Saunders, James. “Modular Music.” *Perspectives of New Music* 46, no. 1 (Winter 2008), pp. 152–193.