

# The Mathematics of Rhythm



# The Mathematics of Rhythm

*Music & Math Using Supercollider*

*ELLIOTT GRABILL*



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# I. The Mathematics of Rhythm



## THE MATHEMATICS OF RHYTHM

A YouTube element has been excluded from this version of the text. You can view it online here: <https://ubalt.pressbooks.pub/musicandmathsupercollider/?p=39>

The above video contains a demonstration for setting up and playing music on SuperCollider.

First, download this [Rhythm Lesson Worksheet](#).

Then, download SuperCollider: <https://supercollider.github.io/download>

**After you download the Rhythm Lesson Worksheet and SuperCollider, you will also need to download the instrument files linked below.**

[Tom](#)

[Bass Drum](#)

[Cowbell 1](#)

[Cowbell 2](#)

[Tambourine](#)

[Snare](#)

Copy and paste the text below into a blank SuperCollider document. **Replace all of the lines starting with “/Users/elliottgrabill/Documents...”** by clicking and dragging the downloaded audio files (as shown in the above video demonstration).

---

```
//HIGHLIGHT
```

“s.boot” and press

SHIFT + ENTER.

```
s.boot;
```

```
//DOUBLE CLICK to the right of the “(” below. Press SHIFT +  
ENTER.
```

```
(
```

```
//Tom
```

```
  = Buffer.read(s, “/Users/elliottgrabill/Documents/Paper  
  Documents/Math/OER Files/Tom.wav”
```

```
);
```

```
//Bass Drum
```

```
  = Buffer.read(s, “/Users/elliottgrabill/Documents/Paper  
  Documents/Math/OER AudioFiles/Bass Drum.wav”
```

```
);
```

```
// Cowbell 1
```

```
  = Buffer.read(s, “/Users/elliottgrabill/Documents/Paper  
  Documents/Math/OER Files/Cowbell  
  1.wav”
```

```
);
```

```
// Cowbell 2
```



```

    = Buffer.read(s,    "/Users/elliottgrabill/Documents/Paper
Documents/Math/OER AudioFiles/Cowbell 2.wav"
);
//Tambourine
    = Buffer.read(s,    "/Users/elliottgrabill/Documents/Paper
Documents/Math/OERFiles/Tambourine.wav"
);
// Snare
    = Buffer.read(s,    "/Users/elliottgrabill/Documents/Paper
Documents/Math/OER AudioFiles/Snare.wav"
);
SynthDef("normal", {
arg amp = 1, bufnum = 0, rate = 1.066666667, loop = 0, ffreq =
1000, rel = 10; var snd;
var env = Env.new([0, 5, 1, 0], [0.01, 16, 6], [-5, 0, 3]);
var envgen = EnvGen.ar(env, doneAction: 2);
s
n
d
=
p
l
a
y
B
u
f
.
a
r
(
n
u
m
C

```

h  
a  
n  
n  
e  
l  
s  
:  
2  
,  
b  
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n  
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m  
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b  
u  
f  
n  
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m  
,  
r  
a  
t  
e  
:  
r  
a  
t  
e  
,  
l

```

o
o
p
:
l
o
o
p
)
*
e
n
v
g
e
n
*
a
m
p
;
Out.ar([0, 1], snd);
}
).add;
~mySynth = Synth("normal", [\bufnum, a, \amp, 0.1, \rel, 10]);
)
// EXAMPLE 1
~drum = Pbind(
\instrument, "normal",
\bufnum, a,
\dur, Pseq([
1, 0.33333, 0.33333, 0.33333, 1, 2,
1, 2
], 15),
\rate, 1

```

```

).play;
// EXAMPLE 2
~drum = Pbind(
\instrument, "normal",
\bufnum, a,
\dur, Pseq([
2, 2, // MEASURE 1
0.5, 0.5, 2.5, 0.5 // MEASURE 2
], 15),
\rate, 1
).play;
// EXAMPLE 3
// TWO RHYTHMS AT THE SAME TIME
t = TempoClock(144/60);
{
~tambourine = Pbind(
\instrument, "normal",
\bufnum, e,
\dur, Pseq([
1, 0.33333, 0.33333, 0.33333, 1, 2,
1, 2
], 5),
\rate, 1
).play(t);
~drum = Pbind(
\instrument, "normal",
\bufnum, c,
\dur, Pseq([
1.5, 2.5,
1.5, 2.5
], 5),
\rate, 1
).play(t);
}.fork(t);
// EXAMPLE 4
















```

```
// cCHANGING THE TEMPO
t = TempoClock(144/60);
{
  ~tambourine = Pbind(
    \instrument, "normal",
    \bufnum, e,
    \dur, Pseq([
      1, 1, 0.5, 1,
      0.5, 0.5, 0.5, 0.5, 0.5
    ], 5),
    \rate, 1
  ).play(t);
  ~drum = Pbind(
    \instrument, "normal",
    \bufnum, c,
    \dur, Pseq([
      1.5, 1.5,
      1.5, 1.5
    ], 5),
    \rate, 1
  ).play(t);
}.fork(t);
```













# Appendix A: Diagram of Western Musical Notation

KRISTIN CONLIN

| Name                      | Symbol  | Duration | May also look like:   | Comments                    |
|---------------------------|---|----------|---|-----------------------------|
| Whole note                |    | 4        |   |                             |
| Dotted half note          |    | 3        |   |                             |
| Half note                 |    | 2        |   |                             |
| Dotted quarter note       |    | 1.5      |   |                             |
| Quarter note              |    | 1        |   |                             |
| Dotted eighth (8th) note  |    | 0.75     |    | Dotted 8th note + 16th note |
| Eighth note (8th)         |    | 0.5      |    | Two 8th notes               |
| Triplet eighth (8th) note |   | .33333   |   | Three triplet 8th notes     |
| Sixteenth (16th) note     |  | 0.25     |  | Four 16th notes             |
| Thirty-second (32nd) note |  | 0.125    |  | Four 32nd notes             |



# Appendix B: Diagram of Western Musical Notation Rests

| Name                         | Symbol  | Duration |
|------------------------------|---|----------|
| Whole rest                   |    | 4        |
| Dotted half rest             |    | 3        |
| Half rest                    |    | 2        |
| Dotted quarter rest          |    | 1.5      |
| Quarter rest                 |    | 1        |
| Dotted eighth (8th) rest     |  | 0.75     |
| Eighth (8th) rest            |  | 0.5      |
| Triplet eighth (8th) rest    |  | 0.33333  |
| Dotted sixteenth (16th) rest |  | 0.25     |
| Thirty-second (32nd) rest    |  | 0.125    |

# Appendix C: Latin Rhythms

```
s.boot;
(
  //Tom
  a = Buffer.read(s, "/Users/elliottgrabill/Documents/Paper
Documents/Math/OER Files/Tom.wav"
);
  //Bass Drum
  b = Buffer.read(s, "/Users/elliottgrabill/Documents/Paper
Documents/Math/OER Audio Files/Bass Drum.wav"
);
  // Cowbell 1
  c = Buffer.read(s, "/Users/elliottgrabill/Documents/Paper
Documents/Math/OER Audio Files/Cowbell 1.wav"
);
  // Cowbell 2
  d = Buffer.read(s, "/Users/elliottgrabill/Documents/Paper
Documents/Math/OER Audio Files/Cowbell 2.wav"
);
  //Tambourine
  e = Buffer.read(s, "/Users/elliottgrabill/Documents/Paper
Documents/Math/OER Audio Files/Tambourine.wav"
);
  // Snare
  f = Buffer.read(s, "/Users/elliottgrabill/Documents/Paper
Documents/Math/OER Audio Files/Snare.wav"
);
  SynthDef("normal", {
    arg amp = 1, bufnum = 0, rate = 1.066666667, loop = 0, ffreq = 1000,
    rel = 10;
    var snd;
    var env = Env.new([0, 5, 1, 0], [0.01, 16, 6],[-5, 0, 3]);
```

```

var envgen = EnvGen.ar(env, doneAction: 2);
snd = PlayBuf.ar(
  numChannels: 2,
  bufnum: bufnum,
  rate: rate,
  loop: loop
) * envgen * amp;
Out.ar([0, 1], snd);
}
).add;
~mySynth = Synth("normal", [\bufnum, a, \amp, 0.1, \rel, 10]);
)
// EXAMPLE 1
// SIMPLE
~drum = Pbind(
  \instrument, "normal",
  \bufnum, a,
  \dur, Pseq([
    1, 1, 0.5, 0.5, 1,
    2, 1, 1
  ], 15),
  \rate, 1
).play;
// EXAMPLE 2
// CHA CHA
t = TempoClock(120/60);
{
  ~cowbell = Pbind(
    \instrument, "normal",
    \bufnum, e,
    \dur, Pseq([
      1, 1, 1, 1
    ], 5),
    \rate, 1
  ).play(t);

```

```

~drum = Pbind(
  \instrument, "normal",
  \bufnum, c,
  \dur, Pseq([
    1, 0.5, 0.5, 1, 0.5, 0.5
  ], 5),
  \rate, 1
).play(t);
}.fork(t);
// EXAMPLE 3
// RUMBA
t = TempoClock(184/60);
{
  ~cowbell = Pbind(
    \instrument, "normal",
    \bufnum, e,
    \dur, Pseq([
      1, 0.5, 1, 1, 0.5,
      1, 1, 0.5, 1, 0.5
    ], 5),
    \rate, 1
  ).play(t);
  ~drum = Pbind(
    \instrument, "normal",
    \bufnum, c,
    \dur, Pseq([
      1.5, 2, 1.5,
      1, 2
    ], 5),
    \rate, 1
  ).play(t);
  ~bassdrum = Pbind(
    \instrument, "normal",
    \bufnum, b,
    \dur, Pseq([

```

```

1.5, 2.5,
4
], 5),
\rate, 1
).play(t);
}.fork(t);
// EXAMPLE 4
// MAMBO
t = TempoClock(184/60);
{
~cowbell = Pbind(
\instrument, "normal",
\bufnum, e,
\dur, Pseq([
1, 0.5, 1, 0.5, 0.5, 0.5,
1, 1, 0.5, 1, 0.5
], 5),
\rate, 1
).play(t);
~drum = Pbind(
\instrument, "normal",
\bufnum, c,
\dur, Pseq([
1.5, 1.5, 2,
1, 2
], 5),
\rate, 1
).play(t);
~bassdrum = Pbind(
\instrument, "normal",
\bufnum, b,
\dur, Pseq([
1.5, 1.5, 2.5,
1.5, 1,
], 5),

```

```

\rate, 1
).play(t);
}.fork(t);
// EXAMPLE 5
// NEW YORK MOZAMBIQUE
t = TempoClock(184/60);
{
~tambourine = Pbind(
\instrument, "normal",
\bufnum, e,
\dur, Pseq([
1, 1, 0.5, 1, 1,
0.5, 1, 0.5, 1, 0.5
], 5),
\rate, 1
).play(t);
~drum = Pbind(
\instrument, "normal",
\bufnum, c,
\dur, Pseq([
3.5, 2,
1.5, 1
], 5),
\rate, 1
).play(t);
~bassdrum = Pbind(
\instrument, "normal",
\bufnum, b,
\dur, Pseq([
7.5, 0.5
], 5),
\rate, 1
).play(t);
}.fork(t);
// EXAMPLE 6

```

```

// SONGO
t = TempoClock(144/60);
{
  ~tambourine = Pbind(
    \instrument, "normal",
    \bufnum, e,
    \dur, Pseq([
      1, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5
    ], 5),
    \rate, 1
  ).play(t);
  ~drum = Pbind(
    \instrument, "normal",
    \bufnum, c,
    \dur, Pseq([
      1, 1.5, 1, 0.5
    ], 5),
    \rate, 1
  ).play(t);
  ~bassdrum = Pbind(
    \instrument, "normal",
    \bufnum, b,
    \dur, Pseq([
      1.5, 1.5, 1
    ], 5),
    \rate, 1
  ).play(t);
}.fork(t);
// EXAMPLE 7
// NANIGO
t = TempoClock(144/60);
{
  ~tambourine = Pbind(
    \instrument, "normal",
    \bufnum, e,

```

```

\dur, Pseq([
1, 1, 0.5, 1,
0.5, 0.5, 0.5, 0.5, 0.5
], 5),
\rate, 1
).play(t);
~drum = Pbind(
\instrument, "normal",
\bufnum, c,
\dur, Pseq([
1.5, 1.5,
1.5, 1.5
], 5),
\rate, 1
).play(t);
}.fork(t);
// EXAMPLE 8
// MOZAMBIQUE
t = TempoClock(184/60);
{
~tambourine = Pbind(
\instrument, "normal",
\bufnum, e,
\dur, Pseq([
1, 1, 0.5, 1, 1,
0.5, 1, 0.5, 1, 0.5
], 5),
\rate, 1
).play(t);
~cowbell1 = Pbind(
\instrument, "normal",
\bufnum, d,
\dur, Pseq([
1.5, 1.5, 2.5,
1.5, 1

```



```

    ], 5),
    \rate, 1
  ).play(t);
  ~cowbell2 = Pbind(
    \instrument, "normal",
    \bufnum, c,
    \dur, Pseq([
      2, 4,
      2
    ], 5),
    \rate, 1
  ).play(t);
  ~bassdrum = Pbind(
    \instrument, "normal",
    \bufnum, b,
    \dur, Pseq([
      2, 4,
      2
    ], 5),
    \rate, 1
  ).play(t);
}.fork(t);
// EXAMPLE 8
// SALSA
t = TempoClock(108/60);
{
  ~tambourine = Pbind(
    \instrument, "normal",
    \bufnum, e,
    \dur, Pseq([
      0.5, 0.5, 0.25, 0.5, 0.25,
      0.5, 0.25, 0.5, 0.25, 0.25, 0.25
    ], 5),
    \rate, 1
  ).play(t);

```

```

~drum = Pbind(
  \instrument, "normal",
  \bufnum, c,
  \dur, Pseq([
    0.5, 0.5, 1,
    0.75, 0.75, 0.5
  ], 5),
  \rate, 1
).play(t);
~bassdrum = Pbind(
  \instrument, "normal",
  \bufnum, b,
  \dur, Pseq([
    0.75, 2, 0.75, 0.5
  ], 5),
  \rate, 1
).play(t);
}.fork(t);
// EXAMPLE 9
// SAMBA
t = TempoClock(182/60);
{
  ~tambourine = Pbind(
    \instrument, "normal",
    \bufnum, e,
    \dur, Pseq([
      0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5,
      0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5
    ], 5),
    \rate, 1
  ).play(t);
  ~cowbell = Pbind(
    \instrument, "normal",
    \bufnum, c,
    \dur, Pseq([

```

```

1, 1.5, 1, 1,
1, 0.5, 1, 1
], 5),
\rate, 1
).play(t);
~bassdrum = Pbind(
\instrument, "normal",
\bufnum, b,
\dur, Pseq([
1.5, 0.5, 1.5, 0.5,
1.5, 0.5, 1.5, 0.5
], 5),
\rate, 1
).play(t);
}.fork(t);
// EXAMPLE 10
// BOSSA NOVA
t = TempoClock(182/60);
{
~tambourine = Pbind(
\instrument, "normal",
\bufnum, e,
\dur, Pseq([
1, 1, 1, 1,
1, 1, 1, 1
], 5),
\rate, 1
).play(t);
~cowbell = Pbind(
\instrument, "normal",
\bufnum, c,
\dur, Pseq([
1.5, 1.5, 2,
1.5, 1.5
], 5),

```

```

\rate, 1
).play(t);
~bassdrum = Pbind(
\instrument, "normal",
\bufnum, b,
\dur, Pseq([
1.5, 0.5, 1.5, 0.5,
1.5, 0.5, 1.5, 0.5
], 5),
\rate, 1
).play(t);
}.fork(t);
// EXAMPLE 11
// BAI AO
t = TempoClock(182/60);
{
~tambourine = Pbind(
\instrument, "normal",
\bufnum, e,
\dur, Pseq([
1.5, 0.5, 1.5, 0.5,
1.5, 0.5, 1.5, 0.5
], 5),
\rate, 1
).play(t);
~cowbell = Pbind(
\instrument, "normal",
\bufnum, c,
\dur, Pseq([
0.5, 0.5, 1.5, 0.5, 1.5,
0.5, 2, 1
], 5),
\rate, 1
).play(t);
~bassdrum = Pbind(

```

```

\instrument, "normal",
\bufnum, b,
\dur, Pseq([
1.5, 1.5, 1,
1.5, 1.5, 1
], 5),
\rate, 1
).play(t);
}.fork(t);
// EXAMPLE 12
// PARTIDO ALTO
t = TempoClock(108/60);
{
~tambourine = Pbind(
\instrument, "normal",
\bufnum, e,
\dur, Pseq([
0.5, 1.5, 0.5, 0.5, 1,
1, 1, 0.5, 0.5, 1
], 5),
\rate, 1
).play(t);
~cowbell = Pbind(
\instrument, "normal",
\bufnum, c,
\dur, Pseq([
1, 3.5,
2.5, 1
], 5),
\rate, 1
).play(t);
~bassdrum = Pbind(
\instrument, "normal",
\bufnum, b,
\dur, Pseq([

```

```

2.5, 1, 2.5,
1, 1
], 5),
\rate, 1
).play(t);
}.fork(t);
// EXAMPLE 13
// BATUCADA
t = TempoClock(182/60);
{
~tambourine = Pbind(
\instrument, "normal",
\bufnum, a,
\dur, Pseq([
1, 2, 2,
2, 1
], 5),
\rate, 1
).play(t);
~cowbell1 = Pbind(
\instrument, "normal",
\bufnum, b,
\dur, Pseq([
1.5, 0.5, 1.5, 0.5,
1.5, 0.5, 1.5, 0.5
], 5),
\rate, 1
).play(t);
~cowbell2 = Pbind(
\instrument, "normal",
\bufnum, c,
\dur, Pseq([
2, 1.5, 1,
1, 0.5, 2
], 5),

```

```

\rate, 1
).play(t);
~cowbell2 = Pbind(
\instrument, "normal",
\bufnum, e,
\dur, Pseq([
0.5, 0.5, 0.5, 1, 0.5, 0.5, 0.5,
0.5, 0.5, 0.5, 1, 0.5, 0.5, 0.5,
], 5),
\rate, 1
).play(t);
}.fork(t);
// EXAMPLE 14
// BEGUINE
t = TempoClock(144/60);
{
~snare = Pbind(
\instrument, "normal",
\bufnum, f,
\dur, Pseq([
0.5, 1, 1, 1, 0.5
], 5),
\rate, 1
).play(t);
~bassdrum = Pbind(
\instrument, "normal",
\bufnum, b,
\dur, Pseq([
2, 1, 1
], 5),
\rate, 1
).play(t);
~tambourine = Pbind(
\instrument, "normal",
\bufnum, e,

```

```

\dur, Pseq([
1, 1, 1, 1
], 5),
\dur, 1
).play(t);
}.fork(t);
// EXAMPLE 15
// TANGO
t = TempoClock(108/60);
{
~snare = Pbind(
\dur, "normal",
\bufnum, f,
\dur, Pseq([
1, 1, 1, 2,
1, 1, 1
], 5),
\dur, 1
).play(t);
~bassdrum = Pbind(
\dur, "normal",
\bufnum, b,
\dur, Pseq([
1, 1, 1, 1,
2, 1, 1
], 5),
\dur, 1
).play(t);
~tambourine = Pbind(
\dur, "normal",
\bufnum, e,
\dur, Pseq([
3.5, 0.25, 0.25, 3.5, 0.25, 0.25
], 5),
\dur, 1

```



```

).play(t);
}.fork(t);
// EXAMPLE 15
// BOLERO
t = TempoClock(96/60);
{
  ~snare = Pbind(
    \instrument, "normal",
    \bufnum, f,
    \dur, Pseq([
      0.5, 0.166667, 0.166667, 0.166666,
      0.5, 0.166667, 0.166667, 0.166666,
      0.5, 0.5,
      0.5, 0.166667, 0.166667, 0.166666,
      0.5, 0.166667, 0.166667, 0.166666,
      0.166667, 0.166667, 0.166666, 0.166667, 0.166667, 0.166666
    ], 5),
    \rate, 1
  ).play(t);
}.fork(t);
// EXAMPLE 16
// REGGAE
t = TempoClock(120/60);
{
  ~tambourine = Pbind(
    \instrument, "normal",
    \bufnum, e,
    \dur, Pseq([
      0.66667, 0.33333, 0.66667, 0.33333,
      0.66667, 0.33333, 0.66667, 0.33333
    ], 5),
    \rate, 1
  ).play(t);
  2.wait;
  ~bassdrum = Pbind(

```

```
\instrument, "normal",  
\bufnum, b,  
\dur, Pseq([  
4  
, 5),  
\rate, 1  
) .play(t);  
}.fork(t);
```

# Works Cited

Mattingly, Rick. *All About Drums: A Fun and Simple Guide to Playing Drums*. Milwaukee: Hal Leonard Corporation, 2006.

Roberts, Gareth E. *From Music to Mathematics: Exploring the Connections*. Baltimore: Johns Hopkins University Press, 2016.

Ruviero, Bruno. *A Gentle Introduction to SuperCollider*. Licensed under the Creative Commons Attribution-ShareAlike 4.0 International License, 2015 edition.