Go gamedev: XM music

quasilyte 2024

My Go gamedev story

- I create games with Ebitengine
- I make libraries for gamedev in Go
- I write talks and articles about gamedev in Go
- t.me/go_gamedev (Russian-speaking) creator

I’m using Ebitengine for around 2-3 years now

Roboden

Press ENTER to continue

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Desktop: Linux, Windows, MacOS

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Mobile: Android

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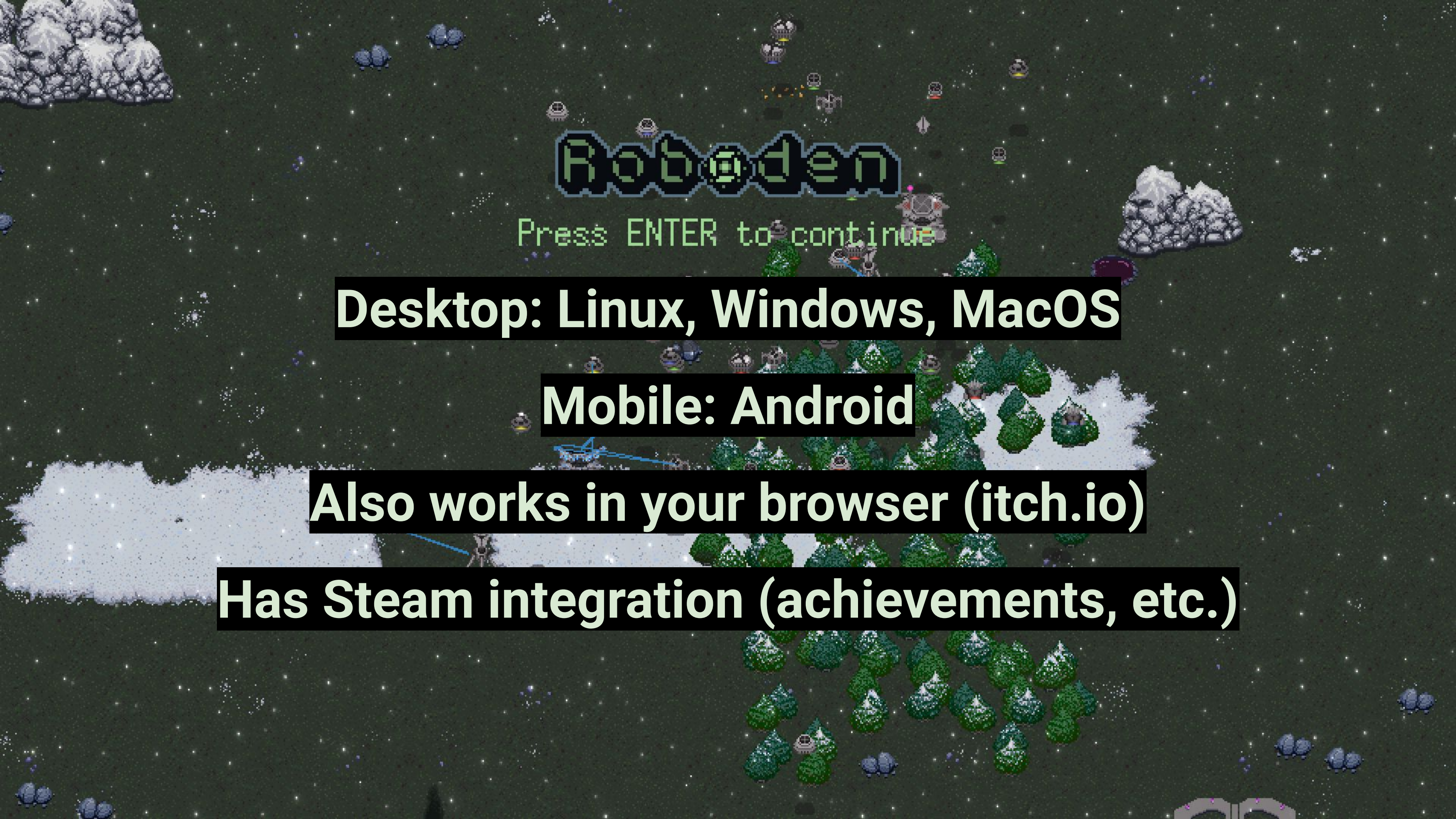
Also works in your browser (itch.io)



Desktop: Linux, Windows, MacOS

Mobile: Android

Also works in your browser (itch.io)

Has Steam integration (achievements, etc.)

Ebitengine audio for music

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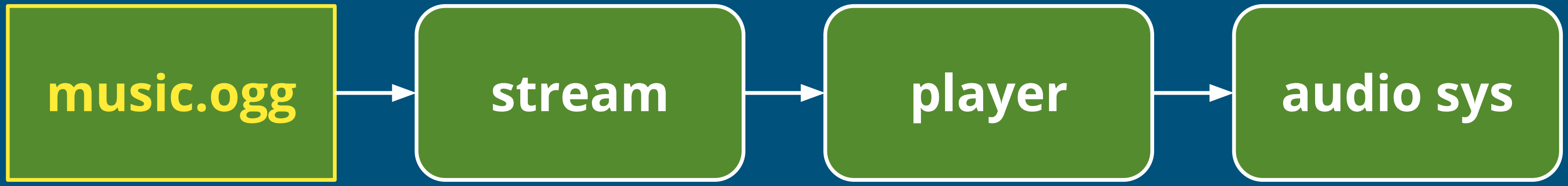
- Your own stream reader implementation is possible
- Works with 16-bit 2-channel PCM LE streams
- Works well on every platform I tested my games on

Stereo 16-bit PCM Little Endian

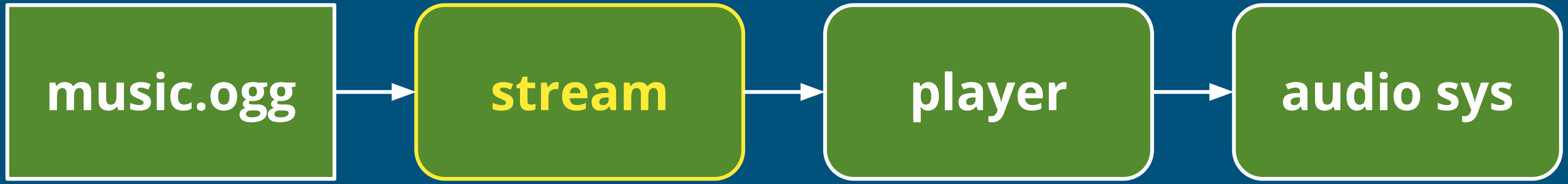
- PCM are given to the audio driver as a final step
- OGG and MP3 formats allow compact storage
- A ~4 min PCM data can have a size of ~50MB

This is why most players “decode” OGG/MP3 into PCM on-the-fly, so you can avoid this large memory overhead.



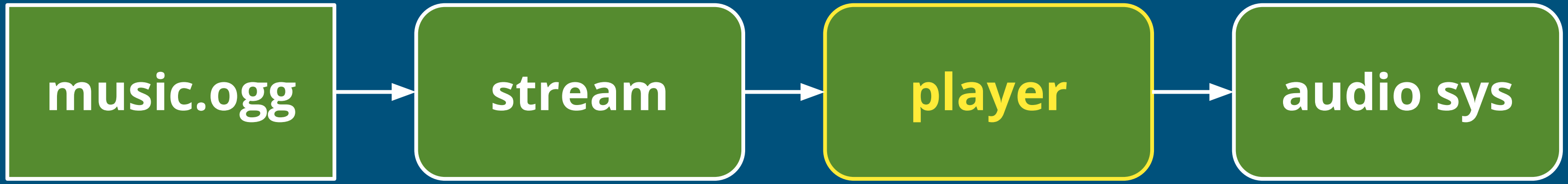
music.ogg

Contains the Vorbis-encoded music data.



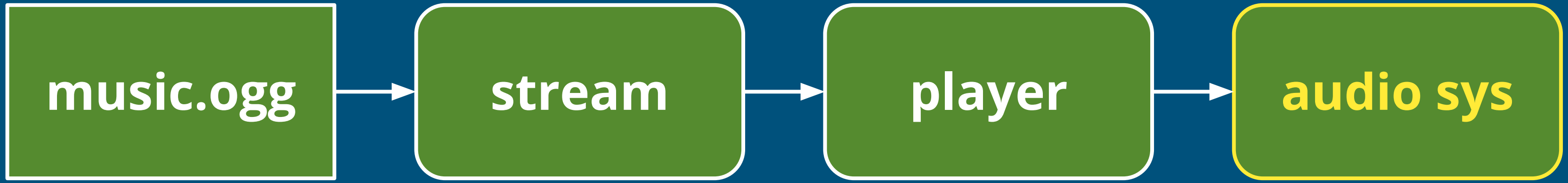
Stream

Reads OGG data and turns them into the 16-bit PCM LE bytes the player expects to get.



(audio) Player

This is your audio system API object. It’s a bridge between your stream implementation and the underlying audio system. Players are reusable, they wrap a single stream at a time. You can create tons of Player objects in your game.



Audio system

This part is usually unseen for a game developer. We can assume that it’s some kind of a low-level library that speaks to the audio systems on different platforms.

Why XM?

Roboden music story

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At some point, the game archive became quite big for a web build.

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- Lack of the “sources” (they’re also “lossy”)
- Harder to do dynamic fancy stuff with the sound

Let’s go one step back

The “source” of my music (Drozerix tracks) is XM.

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XM file size: 71 KB

Converted OGG file size: 1.8 MB (~1843 KB)

It’s about x25 times smaller!

Roboden web archive size

With OGG music: ~18 MB

With XM music: 9 MB

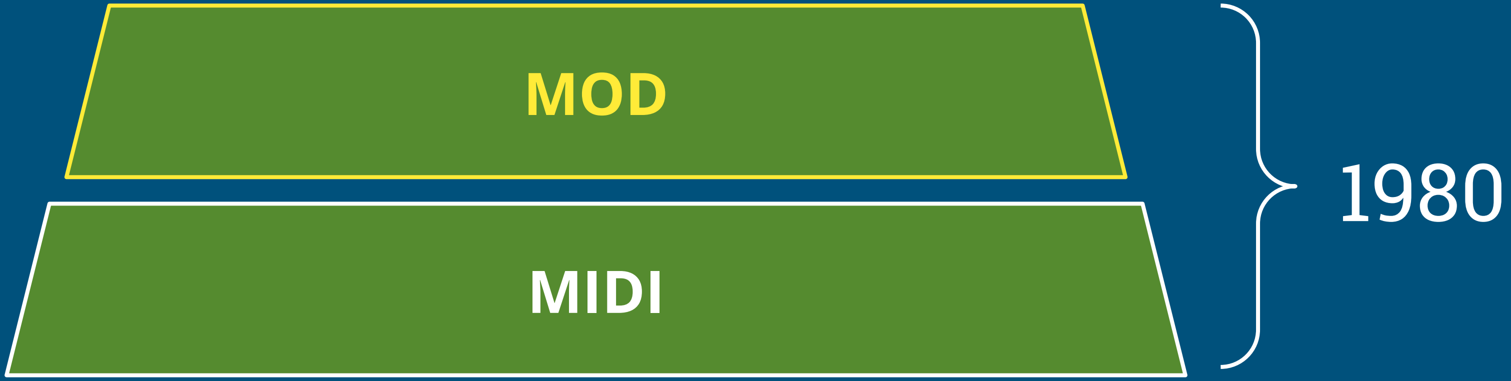
The modular music

- Smaller file size
- The music file itself is a source
- Almost the “code is data” approach

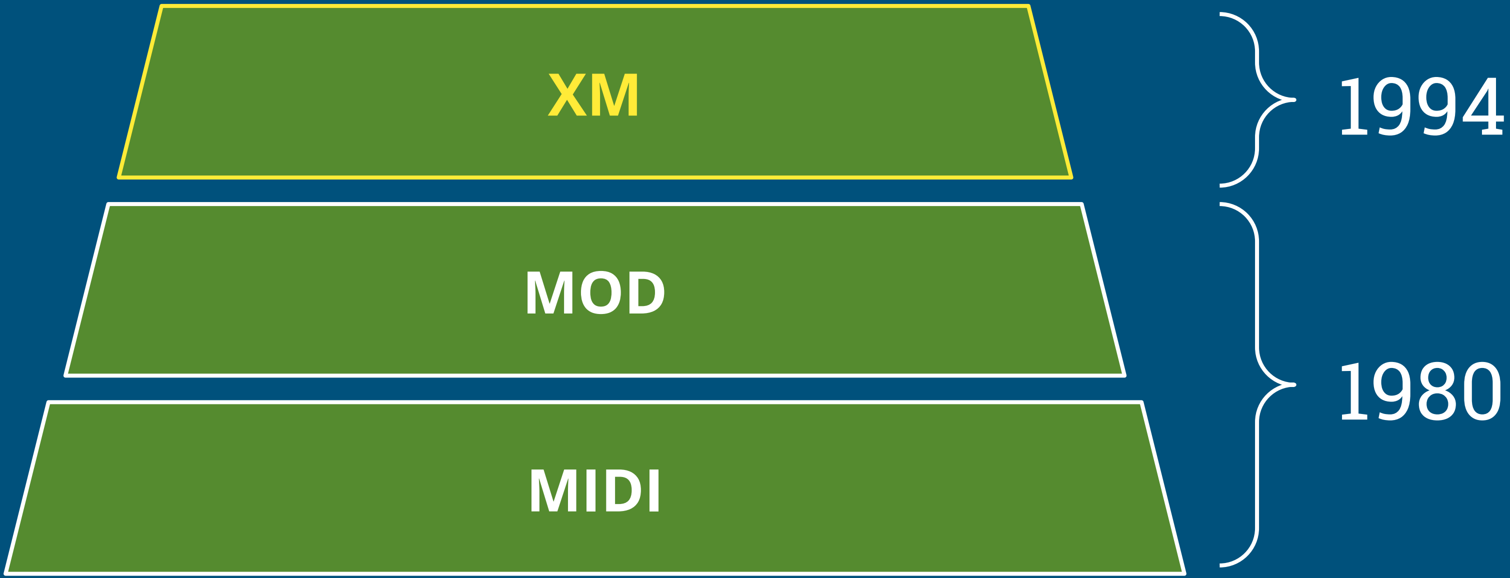
The modular music

MIDI

The modular music



The modular music



XM

MOD

MIDI

1994

1980

Some games that used modular music

- Deus Ex (2000, IT format)
- Unreal Tournament (1998, IT format)
- Age of Wonders (1996, IT format)
- Star Control 2 (1992, MOD format)
- Several first Final Fantasy games (MOD format)

…most modular formats can be converted to XM

XM music format

Stands for “Extended MOD”.

It’s like MOD, but better (it’s even more compact thanks to the simple compression scheme).

OGG	XM
Stores the compressed music track data	Stores the instructions about how to play the music and samples data

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Avg. size is 3-7 MB	Avg. size is 50-500 KB

Comparing XM, IT, S3M

- All of them are modular music formats

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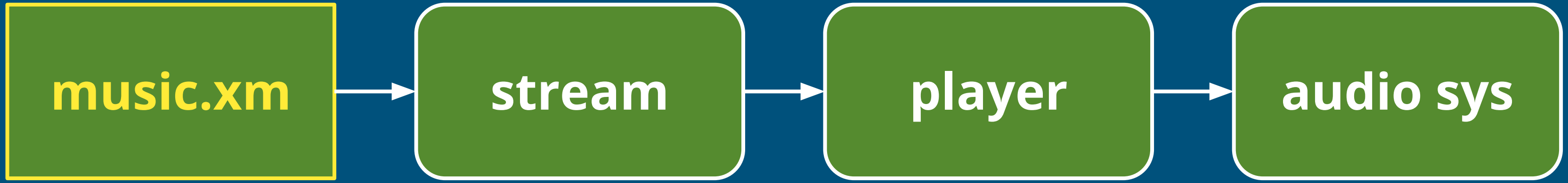
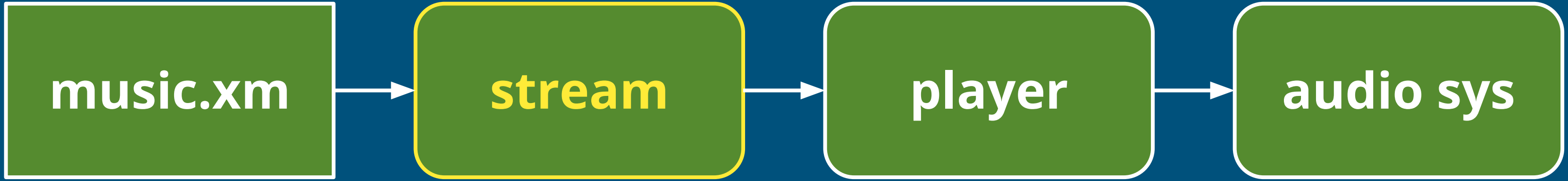
- XM is more popular than the other two nowadays
- MilkyTracker can convert IT and S3M to XM



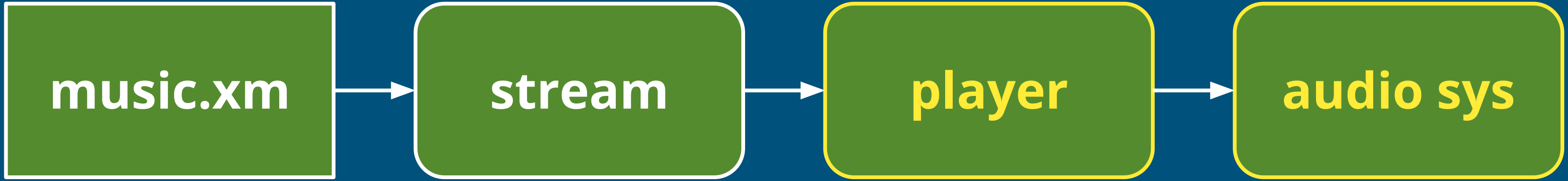
music.xm

Contains the instructions for an XM-player. Also stores the necessary samples data inside the XM file.



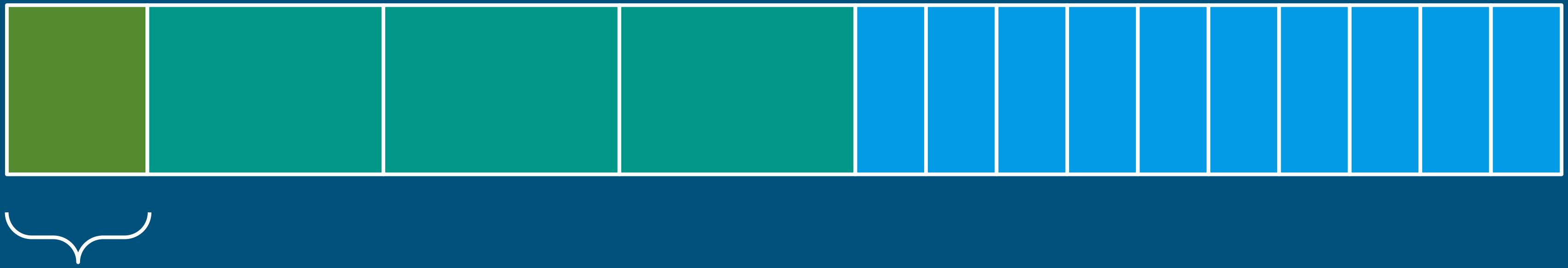
Stream

Plays a role of an XM-player. It evaluates the XM instructions and produces the output PCM bytes.



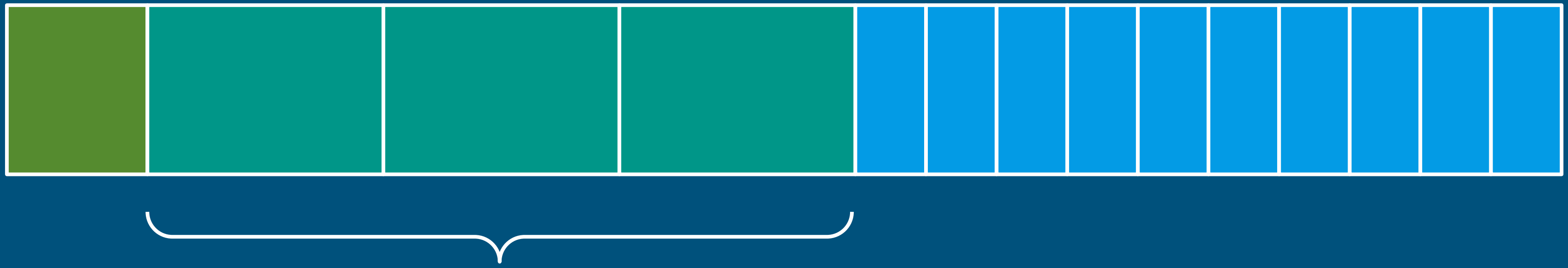
[same as with OGG]

XM file layout



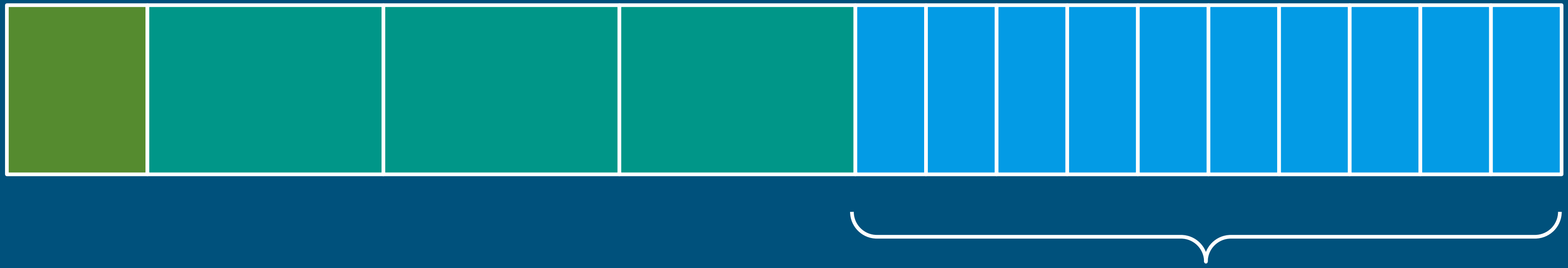
Header with metadata, etc.

XM file layout



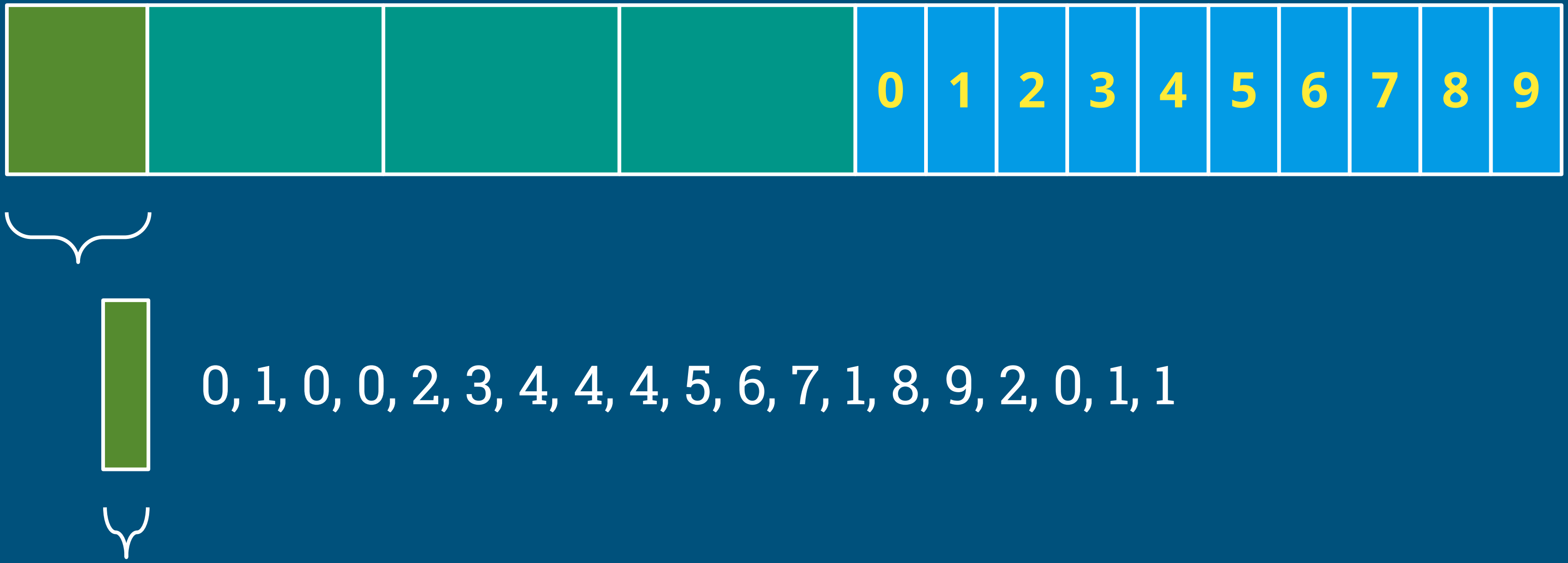
Samples

XM file layout



Patterns (rows, notes)

XM file layout



0, 1, 0, 0, 2, 3, 4, 4, 4, 5, 6, 7, 1, 8, 9, 2, 0, 1, 1

Pattern order (just an array of indexes)

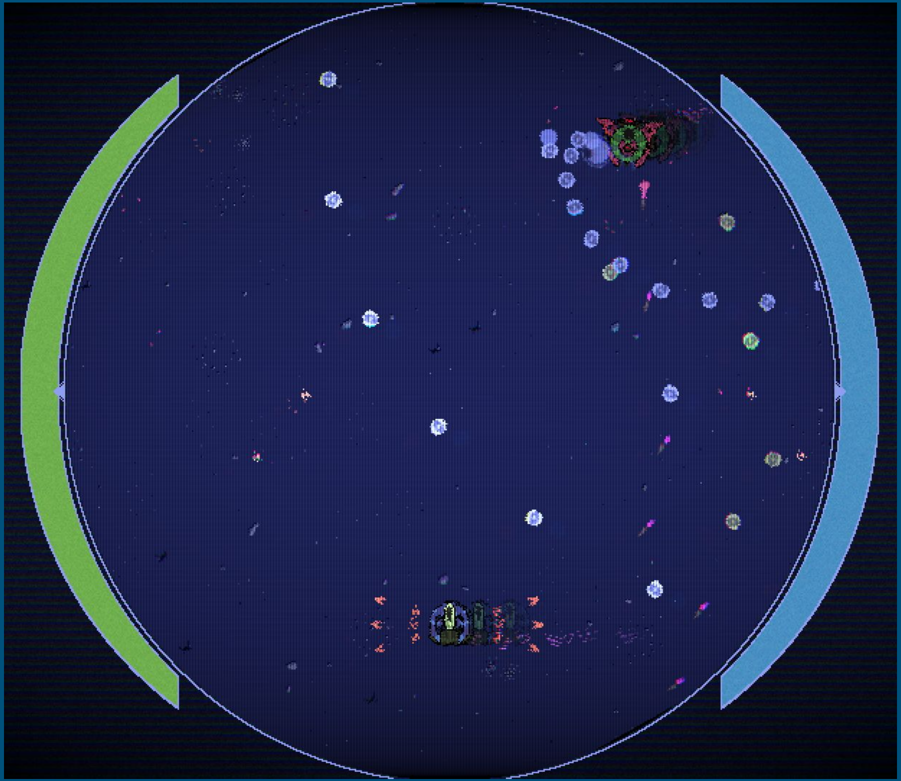
XM player for Go (Ebitengine-compatible)

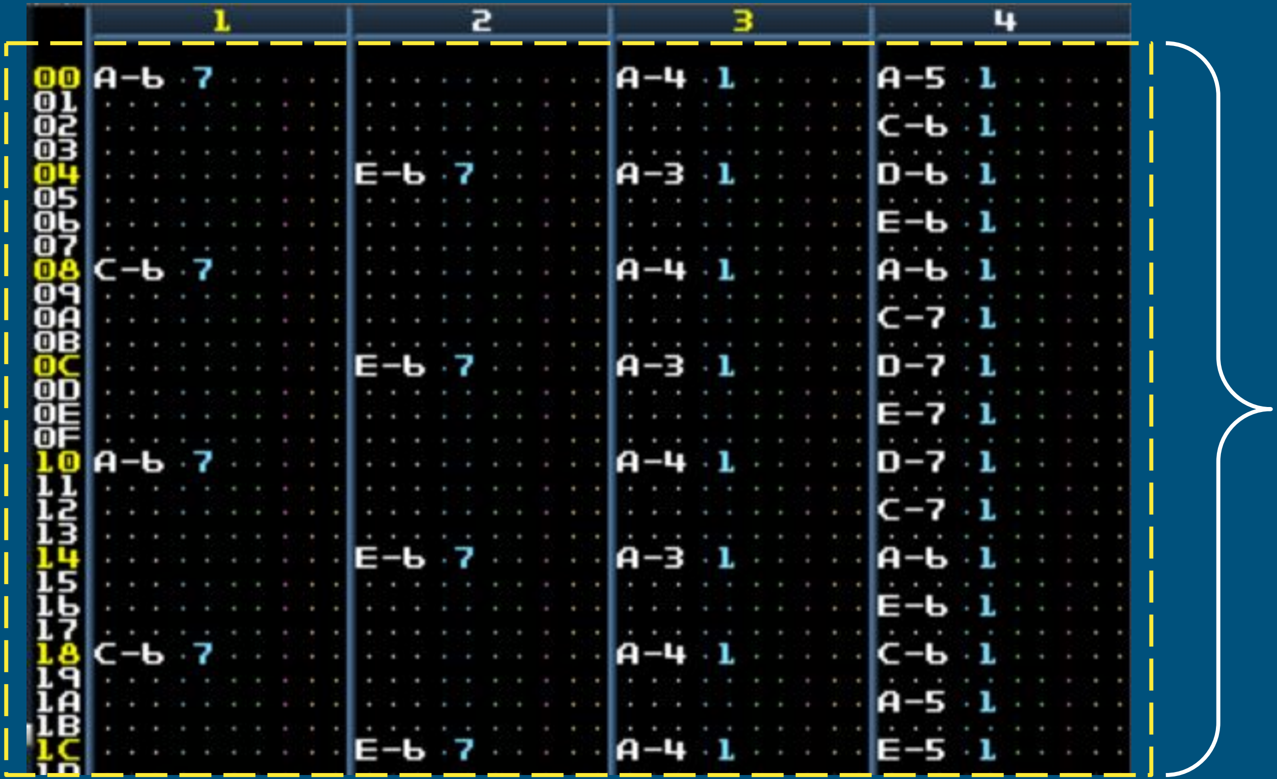
github.com/quasilyte/xm

Used in Roboden and some other games of mine

XM-powered games

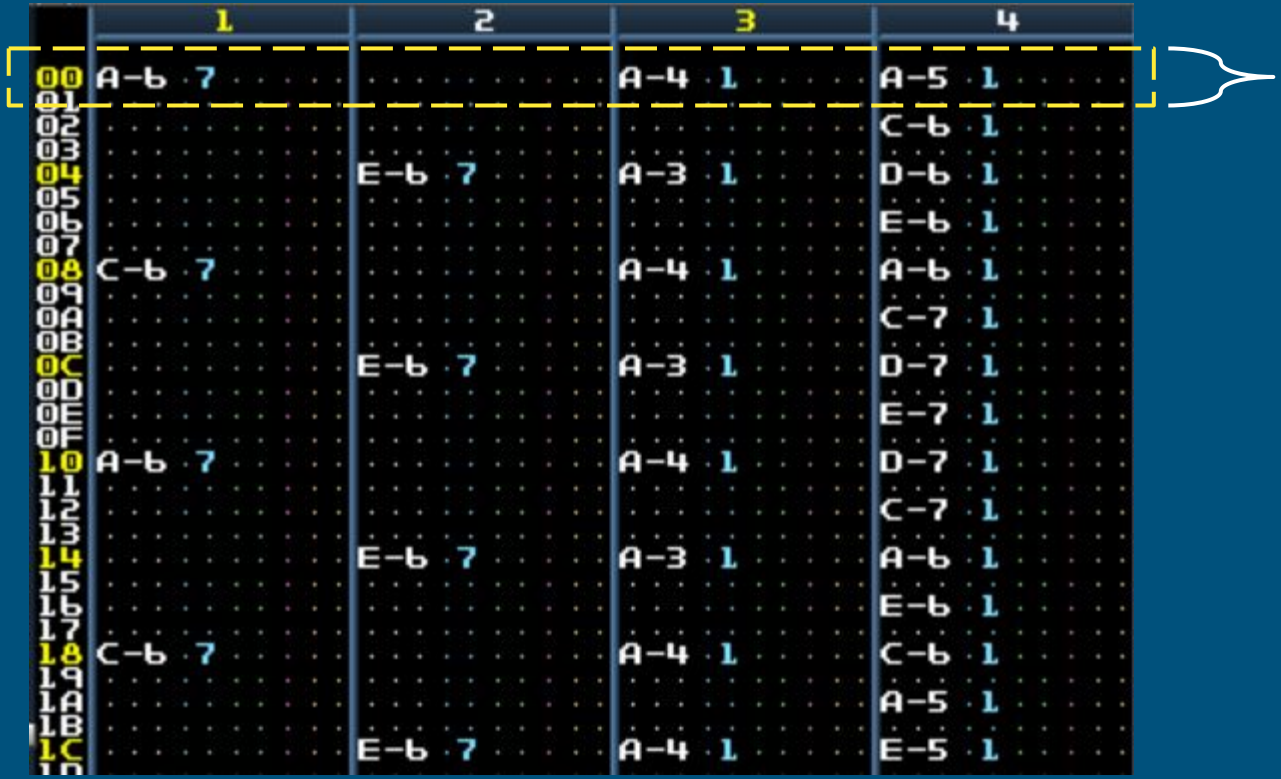
TuneFire game (GameOff 2023)





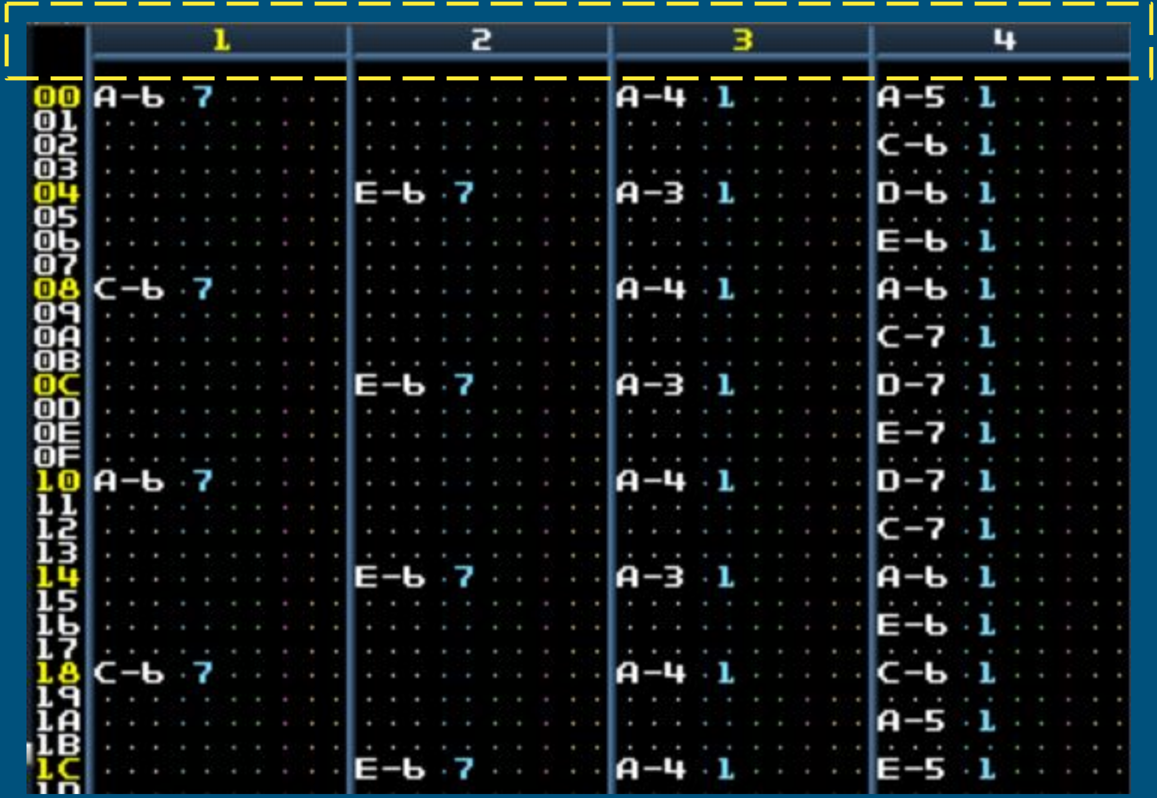
```
   1              2              3              4
00 A-6 .7 .. ...  ... .. .. ...  A-4 .1 .. ...  A-5 .1 .. ...
01 ... .. .. ...  ... .. .. ...  ... .. .. ...  ... .. .. ...
02 ... .. .. ...  ... .. .. ...  ... .. .. ...  C-6 .1 .. ...
03 ... .. .. ...  ... .. .. ...  ... .. .. ...  ... .. .. ...
04 ... .. .. ...  E-6 .7 .. ...  A-3 .1 .. ...  D-6 .1 .. ...
05 ... .. .. ...  ... .. .. ...  ... .. .. ...  ... .. .. ...
06 ... .. .. ...  ... .. .. ...  ... .. .. ...  E-6 .1 .. ...
07 ... .. .. ...  ... .. .. ...  ... .. .. ...  ... .. .. ...
08 C-6 .7 .. ...  ... .. .. ...  A-4 .1 .. ...  A-6 .1 .. ...
09 ... .. .. ...  ... .. .. ...  ... .. .. ...  ... .. .. ...
0A ... .. .. ...  ... .. .. ...  ... .. .. ...  C-7 .1 .. ...
0B ... .. .. ...  ... .. .. ...  ... .. .. ...  ... .. .. ...
0C ... .. .. ...  E-6 .7 .. ...  A-3 .1 .. ...  D-7 .1 .. ...
0D ... .. .. ...  ... .. .. ...  ... .. .. ...  ... .. .. ...
0E ... .. .. ...  ... .. .. ...  ... .. .. ...  E-7 .1 .. ...
0F ... .. .. ...  ... .. .. ...  ... .. .. ...  ... .. .. ...
10 A-6 .7 .. ...  ... .. .. ...  A-4 .1 .. ...  D-7 .1 .. ...
11 ... .. .. ...  ... .. .. ...  ... .. .. ...  ... .. .. ...
12 ... .. .. ...  ... .. .. ...  ... .. .. ...  C-7 .1 .. ...
13 ... .. .. ...  ... .. .. ...  ... .. .. ...  ... .. .. ...
14 ... .. .. ...  E-6 .7 .. ...  A-3 .1 .. ...  A-6 .1 .. ...
15 ... .. .. ...  ... .. .. ...  ... .. .. ...  ... .. .. ...
16 ... .. .. ...  ... .. .. ...  ... .. .. ...  E-6 .1 .. ...
17 ... .. .. ...  ... .. .. ...  ... .. .. ...  ... .. .. ...
18 C-6 .7 .. ...  ... .. .. ...  A-4 .1 .. ...  C-6 .1 .. ...
19 ... .. .. ...  ... .. .. ...  ... .. .. ...  ... .. .. ...
1A ... .. .. ...  ... .. .. ...  ... .. .. ...  A-5 .1 .. ...
1B ... .. .. ...  ... .. .. ...  ... .. .. ...  ... .. .. ...
1C ... .. .. ...  E-6 .7 .. ...  A-4 .1 .. ...  E-5 .1 .. ...
```

Pattern



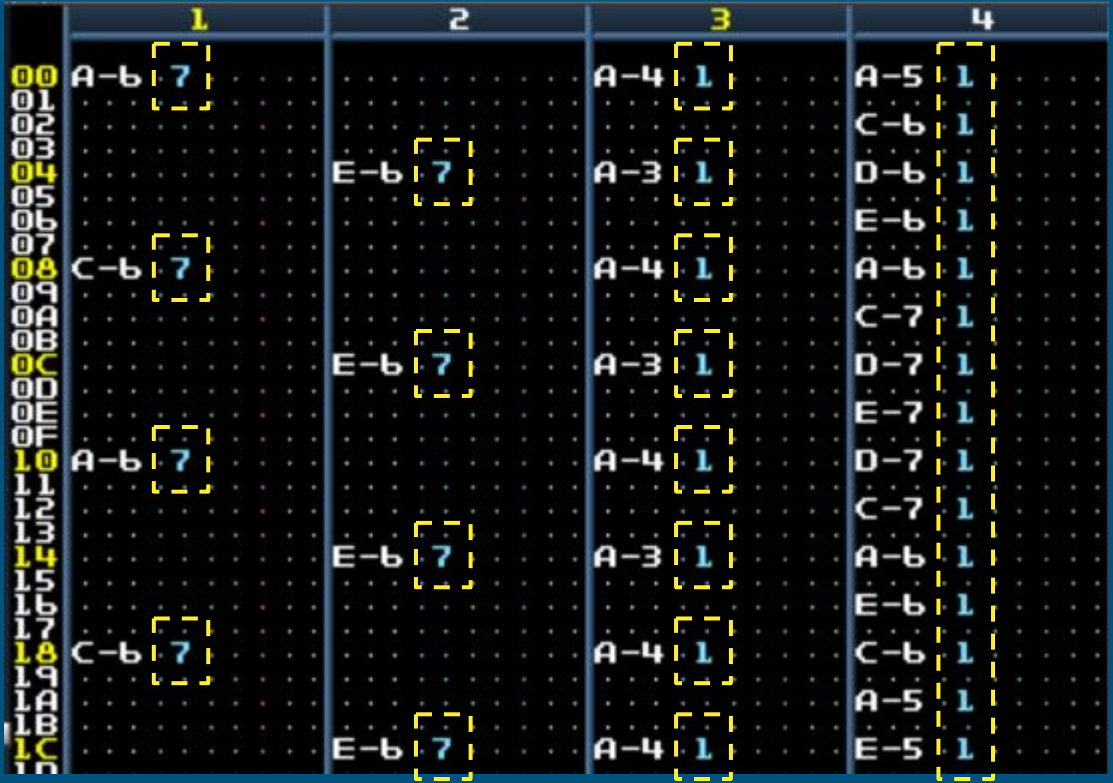
```
        1            2            3            4
00 A-6 7 .....  ... .. .....  A-4 1 .....  A-5 1 .....
01 ... .. .....  ... .. .....  ... .. .....  ... .. .....
02 ... .. .....  ... .. .....  ... .. .....  C-6 1 .....
03 ... .. .....  ... .. .....  ... .. .....  ... .. .....
04 ... .. .....  E-6 7 .....  A-3 1 .....  D-6 1 .....
05 ... .. .....  ... .. .....  ... .. .....  ... .. .....
06 ... .. .....  ... .. .....  ... .. .....  E-6 1 .....
07 ... .. .....  ... .. .....  ... .. .....  ... .. .....
08 C-6 7 .....  ... .. .....  A-4 1 .....  A-6 1 .....
09 ... .. .....  ... .. .....  ... .. .....  ... .. .....
0A ... .. .....  ... .. .....  ... .. .....  C-7 1 .....
0B ... .. .....  ... .. .....  ... .. .....  ... .. .....
0C ... .. .....  E-6 7 .....  A-3 1 .....  D-7 1 .....
0D ... .. .....  ... .. .....  ... .. .....  ... .. .....
0E ... .. .....  ... .. .....  ... .. .....  E-7 1 .....
0F ... .. .....  ... .. .....  ... .. .....  ... .. .....
10 A-6 7 .....  ... .. .....  A-4 1 .....  D-7 1 .....
11 ... .. .....  ... .. .....  ... .. .....  ... .. .....
12 ... .. .....  ... .. .....  ... .. .....  C-7 1 .....
13 ... .. .....  ... .. .....  ... .. .....  ... .. .....
14 ... .. .....  E-6 7 .....  A-3 1 .....  A-6 1 .....
15 ... .. .....  ... .. .....  ... .. .....  ... .. .....
16 ... .. .....  ... .. .....  ... .. .....  E-6 1 .....
17 ... .. .....  ... .. .....  ... .. .....  ... .. .....
18 C-6 7 .....  ... .. .....  A-4 1 .....  C-6 1 .....
19 ... .. .....  ... .. .....  ... .. .....  ... .. .....
1A ... .. .....  ... .. .....  ... .. .....  A-5 1 .....
1B ... .. .....  ... .. .....  ... .. .....  ... .. .....
1C ... .. .....  E-6 7 .....  A-4 1 .....  E-5 1 .....
```

Pattern’s row



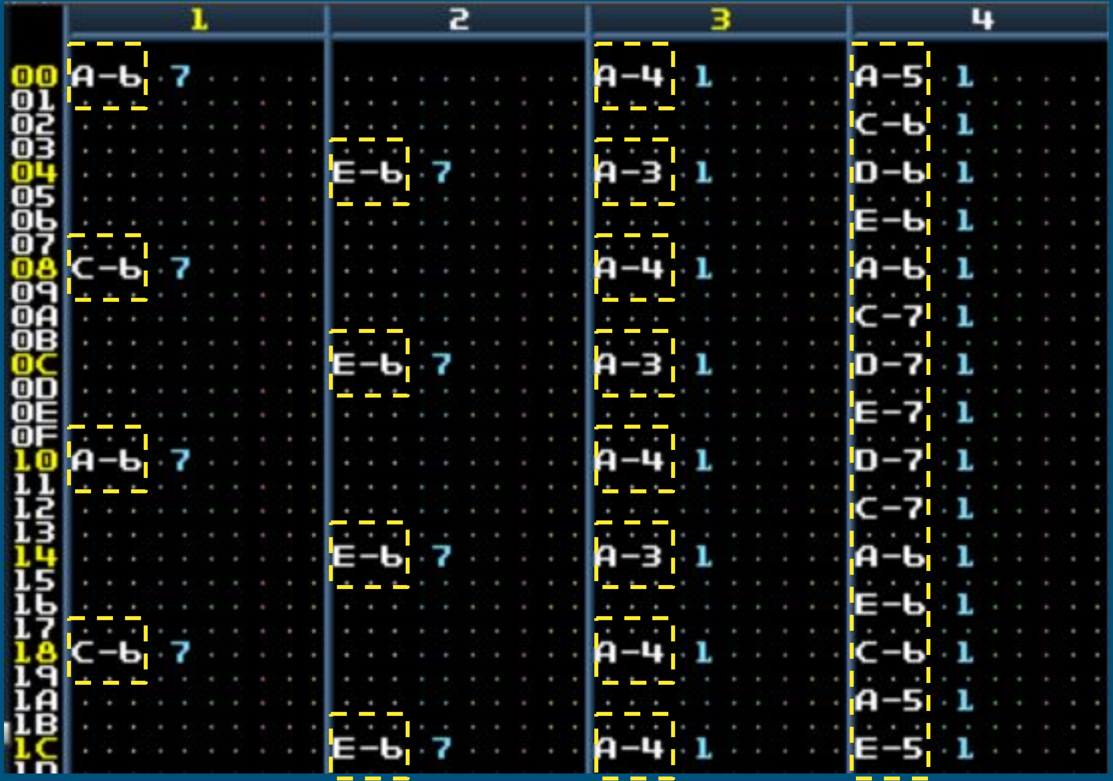
```
         1           2           3           4
00 A-6 7 ..... ........... A-4 1 ..... A-5 1 .....
01 ........... ........... ........... ...........
02 ........... ........... ........... C-6 1 .....
03 ........... ........... ........... ...........
04 ........... E-6 7 ..... A-3 1 ..... D-6 1 .....
05 ........... ........... ........... ...........
06 ........... ........... ........... E-6 1 .....
07 ........... ........... ........... ...........
08 C-6 7 ..... ........... A-4 1 ..... A-6 1 .....
09 ........... ........... ........... ...........
0A ........... ........... ........... C-7 1 .....
0B ........... ........... ........... ...........
0C ........... E-6 7 ..... A-3 1 ..... D-7 1 .....
0D ........... ........... ........... ...........
0E ........... ........... ........... E-7 1 .....
0F ........... ........... ........... ...........
10 A-6 7 ..... ........... A-4 1 ..... D-7 1 .....
11 ........... ........... ........... ...........
12 ........... ........... ........... C-7 1 .....
13 ........... ........... ........... ...........
14 ........... E-6 7 ..... A-3 1 ..... A-6 1 .....
15 ........... ........... ........... ...........
16 ........... ........... ........... E-6 1 .....
17 ........... ........... ........... ...........
18 C-6 7 ..... ........... A-4 1 ..... C-6 1 .....
19 ........... ........... ........... ...........
1A ........... ........... ........... A-5 1 .....
1B ........... ........... ........... ...........
1C ........... E-6 7 ..... A-4 1 ..... E-5 1 .....
```

- Channel number



```
         1             2             3             4
00  A-6 7 ...     ...           A-4 1 ...     A-5 1 ...
01  ...           ...           ...           ...
02  ...           ...           ...           C-6 1 ...
03  ...           ...           ...           ...
04  ...           E-6 7 ...     A-3 1 ...     D-6 1 ...
05  ...           ...           ...           ...
06  ...           ...           ...           E-6 1 ...
07  ...           ...           ...           ...
08  C-6 7 ...     ...           A-4 1 ...     A-6 1 ...
09  ...           ...           ...           ...
0A  ...           ...           ...           C-7 1 ...
0B  ...           ...           ...           ...
0C  ...           E-6 7 ...     A-3 1 ...     D-7 1 ...
0D  ...           ...           ...           ...
0E  ...           ...           ...           E-7 1 ...
0F  ...           ...           ...           ...
10  A-6 7 ...     ...           A-4 1 ...     D-7 1 ...
11  ...           ...           ...           ...
12  ...           ...           ...           C-7 1 ...
13  ...           ...           ...           ...
14  ...           E-6 7 ...     A-3 1 ...     A-6 1 ...
15  ...           ...           ...           ...
16  ...           ...           ...           E-6 1 ...
17  ...           ...           ...           ...
18  C-6 7 ...     ...           A-4 1 ...     C-6 1 ...
19  ...           ...           ...           ...
1A  ...           ...           ...           A-5 1 ...
1B  ...           ...           ...           ...
1C  ...           E-6 7 ...     A-4 1 ...     E-5 1 ...
```

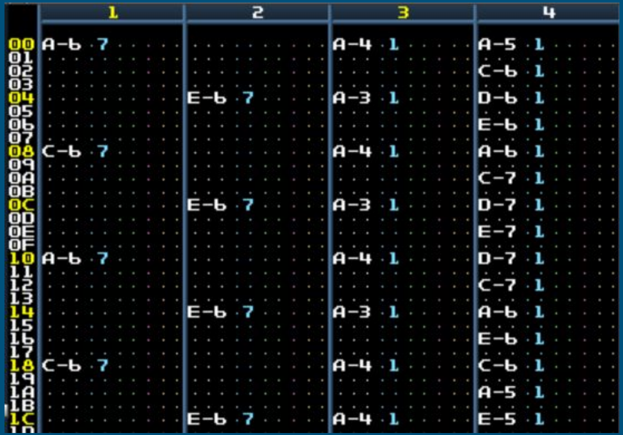
- Channel number
- Instrument ID



```
          1              2              3              4
00  A-6 7 . . . .  . . . . . . .  A-4 1 . . . .  A-5 1 . . . .
01  . . . . . . .  . . . . . . .  . . . . . . .  . . . . . . .
02  . . . . . . .  . . . . . . .  . . . . . . .  C-6 1 . . . .
03  . . . . . . .  . . . . . . .  . . . . . . .  . . . . . . .
04  . . . . . . .  E-6 7 . . . .  A-3 1 . . . .  D-6 1 . . . .
05  . . . . . . .  . . . . . . .  . . . . . . .  . . . . . . .
06  . . . . . . .  . . . . . . .  . . . . . . .  E-6 1 . . . .
07  . . . . . . .  . . . . . . .  . . . . . . .  . . . . . . .
08  C-6 7 . . . .  . . . . . . .  A-4 1 . . . .  A-6 1 . . . .
09  . . . . . . .  . . . . . . .  . . . . . . .  . . . . . . .
0A  . . . . . . .  . . . . . . .  . . . . . . .  C-7 1 . . . .
0B  . . . . . . .  . . . . . . .  . . . . . . .  . . . . . . .
0C  . . . . . . .  E-6 7 . . . .  A-3 1 . . . .  D-7 1 . . . .
0D  . . . . . . .  . . . . . . .  . . . . . . .  . . . . . . .
0E  . . . . . . .  . . . . . . .  . . . . . . .  E-7 1 . . . .
0F  . . . . . . .  . . . . . . .  . . . . . . .  . . . . . . .
10  A-6 7 . . . .  . . . . . . .  A-4 1 . . . .  D-7 1 . . . .
11  . . . . . . .  . . . . . . .  . . . . . . .  . . . . . . .
12  . . . . . . .  . . . . . . .  . . . . . . .  C-7 1 . . . .
13  . . . . . . .  . . . . . . .  . . . . . . .  . . . . . . .
14  . . . . . . .  E-6 7 . . . .  A-3 1 . . . .  A-6 1 . . . .
15  . . . . . . .  . . . . . . .  . . . . . . .  . . . . . . .
16  . . . . . . .  . . . . . . .  . . . . . . .  E-6 1 . . . .
17  . . . . . . .  . . . . . . .  . . . . . . .  . . . . . . .
18  C-6 7 . . . .  . . . . . . .  A-4 1 . . . .  C-6 1 . . . .
19  . . . . . . .  . . . . . . .  . . . . . . .  . . . . . . .
1A  . . . . . . .  . . . . . . .  . . . . . . .  A-5 1 . . . .
1B  . . . . . . .  . . . . . . .  . . . . . . .  . . . . . . .
1C  . . . . . . .  E-6 7 . . . .  A-4 1 . . . .  E-5 1 . . . .
```

- Channel number
- Instrument ID
- Notes (pitch)

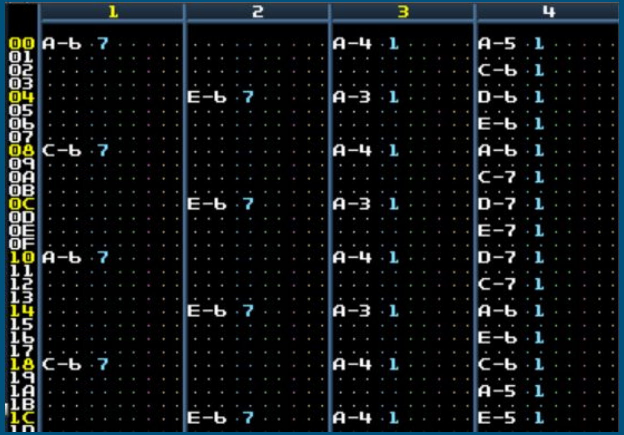
Using music data as gameplay elements



```
    1         2         3         4
00  A-6 7               A-4 1     A-5 1
01
02                                C-6 1
03
04            E-6 7     A-3 1     D-6 1
05
06                                E-6 1
07
08  C-6 7               A-4 1     A-6 1
09
0A                                C-7 1
0B
0C            E-6 7     A-3 1     D-7 1
0D
0E                                E-7 1
0F
10  A-6 7               A-4 1     D-7 1
11
12                                C-7 1
13
14            E-6 7     A-3 1     A-6 1
15
16                                E-6 1
17
18  C-6 7               A-4 1     C-6 1
19
1A                                A-5 1
1B
1C            E-6 7     A-4 1     E-5 1
```

- Channel number
- Weapon type

Using music data as gameplay elements

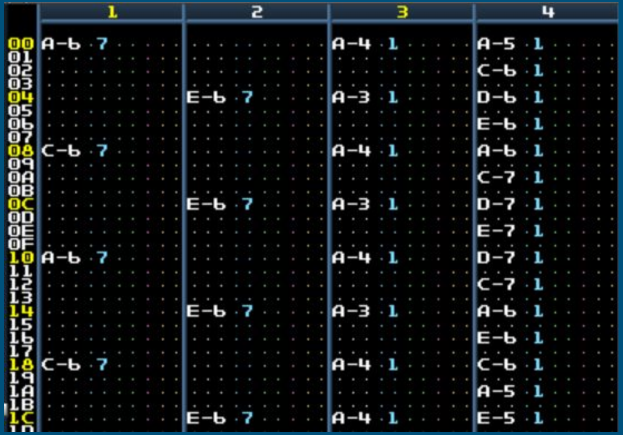


```
       1        2        3        4
00   A-6 .7   ... ..   A-4 .1   A-5 .1
01   ... ..   ... ..   ... ..   ... ..
02   ... ..   ... ..   ... ..   C-6 .1
03   ... ..   ... ..   ... ..   ... ..
04   ... ..   E-6 .7   A-3 .1   D-6 .1
05   ... ..   ... ..   ... ..   ... ..
06   ... ..   ... ..   ... ..   E-6 .1
07   ... ..   ... ..   ... ..   ... ..
08   C-6 .7   ... ..   A-4 .1   A-6 .1
09   ... ..   ... ..   ... ..   ... ..
0A   ... ..   ... ..   ... ..   C-7 .1
0B   ... ..   ... ..   ... ..   ... ..
0C   ... ..   E-6 .7   A-3 .1   D-7 .1
0D   ... ..   ... ..   ... ..   ... ..
0E   ... ..   ... ..   ... ..   E-7 .1
0F   ... ..   ... ..   ... ..   ... ..
10   A-6 .7   ... ..   A-4 .1   D-7 .1
11   ... ..   ... ..   ... ..   ... ..
12   ... ..   ... ..   ... ..   C-7 .1
13   ... ..   ... ..   ... ..   ... ..
14   ... ..   E-6 .7   A-3 .1   A-6 .1
15   ... ..   ... ..   ... ..   ... ..
16   ... ..   ... ..   ... ..   E-6 .1
17   ... ..   ... ..   ... ..   ... ..
18   C-6 .7   ... ..   A-4 .1   C-6 .1
19   ... ..   ... ..   ... ..   ... ..
1A   ... ..   ... ..   ... ..   A-5 .1
1B   ... ..   ... ..   ... ..   ... ..
1C   ... ..   E-6 .7   A-4 .1   E-5 .1
```

- Channel number
- Instrument ID

- Weapon type
- Weapon owner

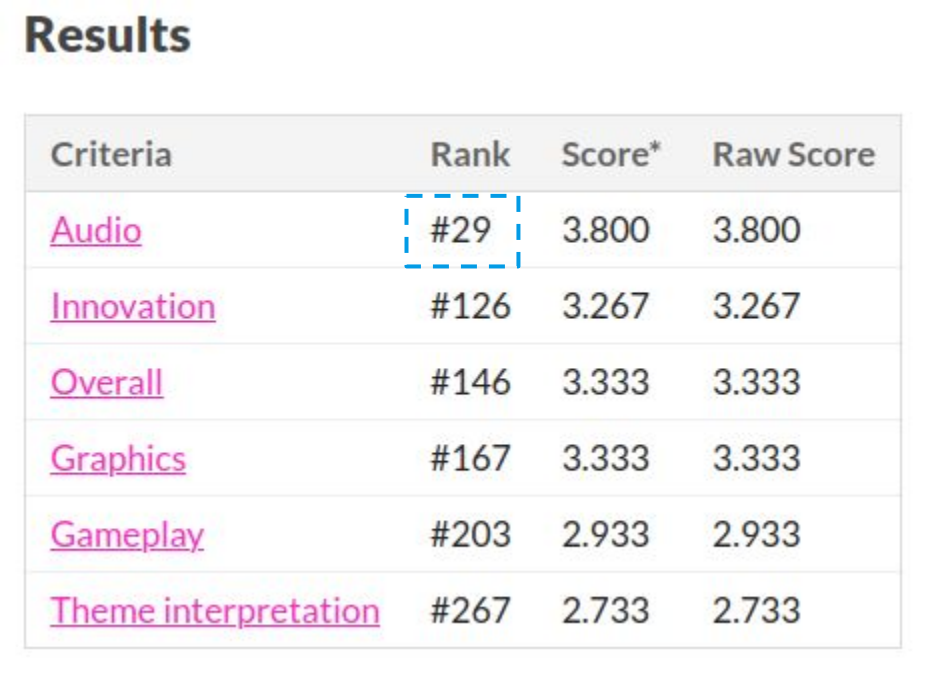
Using music data as gameplay elements



	1	2	3	4
00	A-6 7		A-4 1	A-5 1
01				
02				C-6 1
03				
04		E-6 7	A-3 1	D-6 1
05				
06				E-6 1
07				
08	C-6 7		A-4 1	A-6 1
09				
0A				C-7 1
0B				
0C		E-6 7	A-3 1	D-7 1
0D				
0E				E-7 1
0F				
10	A-6 7		A-4 1	D-7 1
11				
12				C-7 1
13				
14		E-6 7	A-3 1	A-6 1
15				
16				E-6 1
17				
18	C-6 7		A-4 1	C-6 1
19				
1A				A-5 1
1B				
1C		E-6 7	A-4 1	E-5 1

● Channel number	● Weapon type
● Instrument ID	● Weapon owner
● Notes (pitch)	● Projectile power

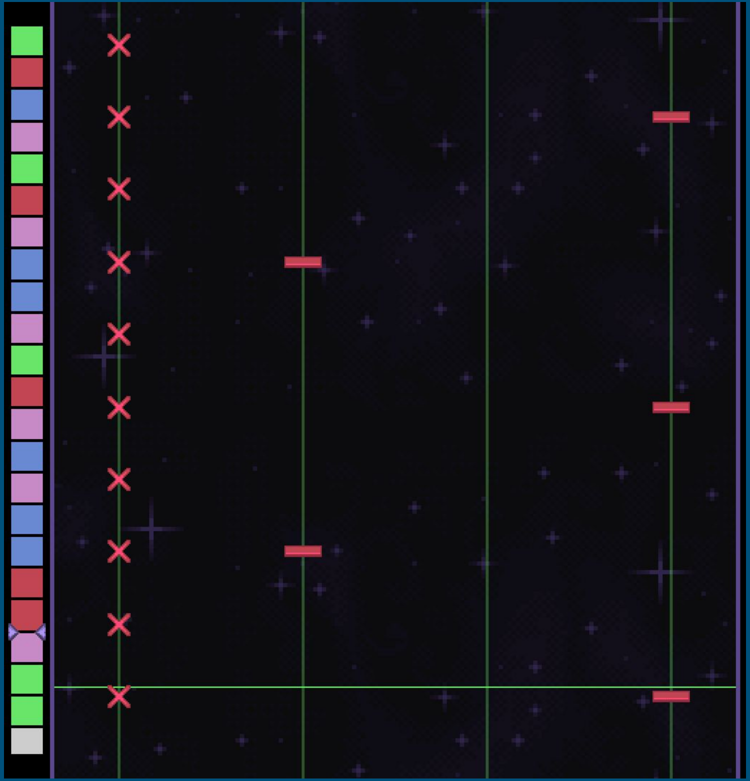
TuneFire game (GameOff 2023)



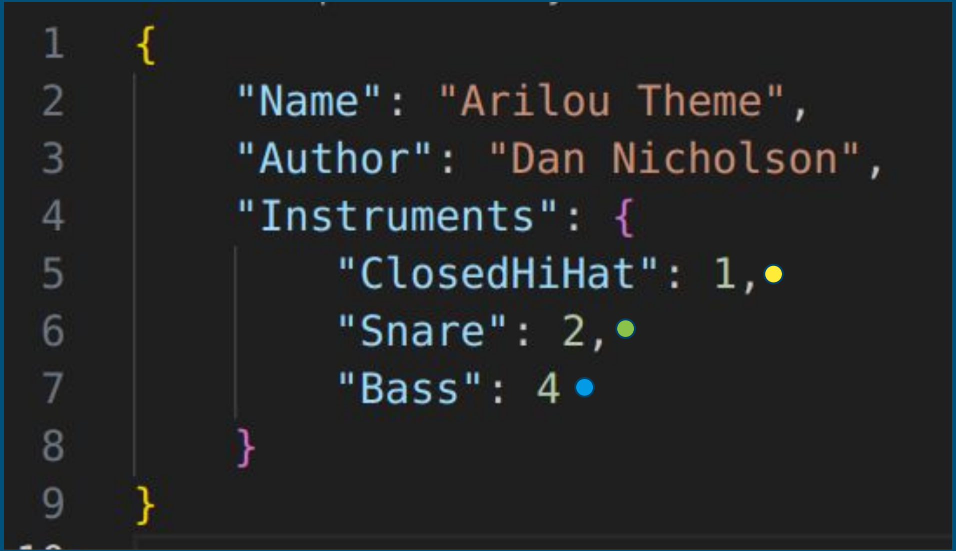
Results

Criteria	Rank	Score*	Raw Score
Audio	#29	3.800	3.800
Innovation	#126	3.267	3.267
Overall	#146	3.333	3.333
Graphics	#167	3.333	3.333
Gameplay	#203	2.933	2.933
Theme interpretation	#267	2.733	2.733

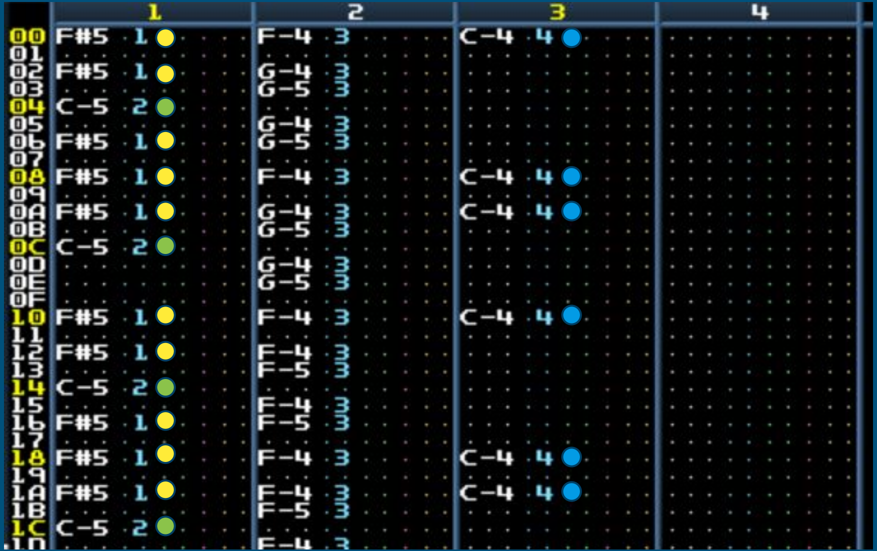
Drum Hero (WIP)



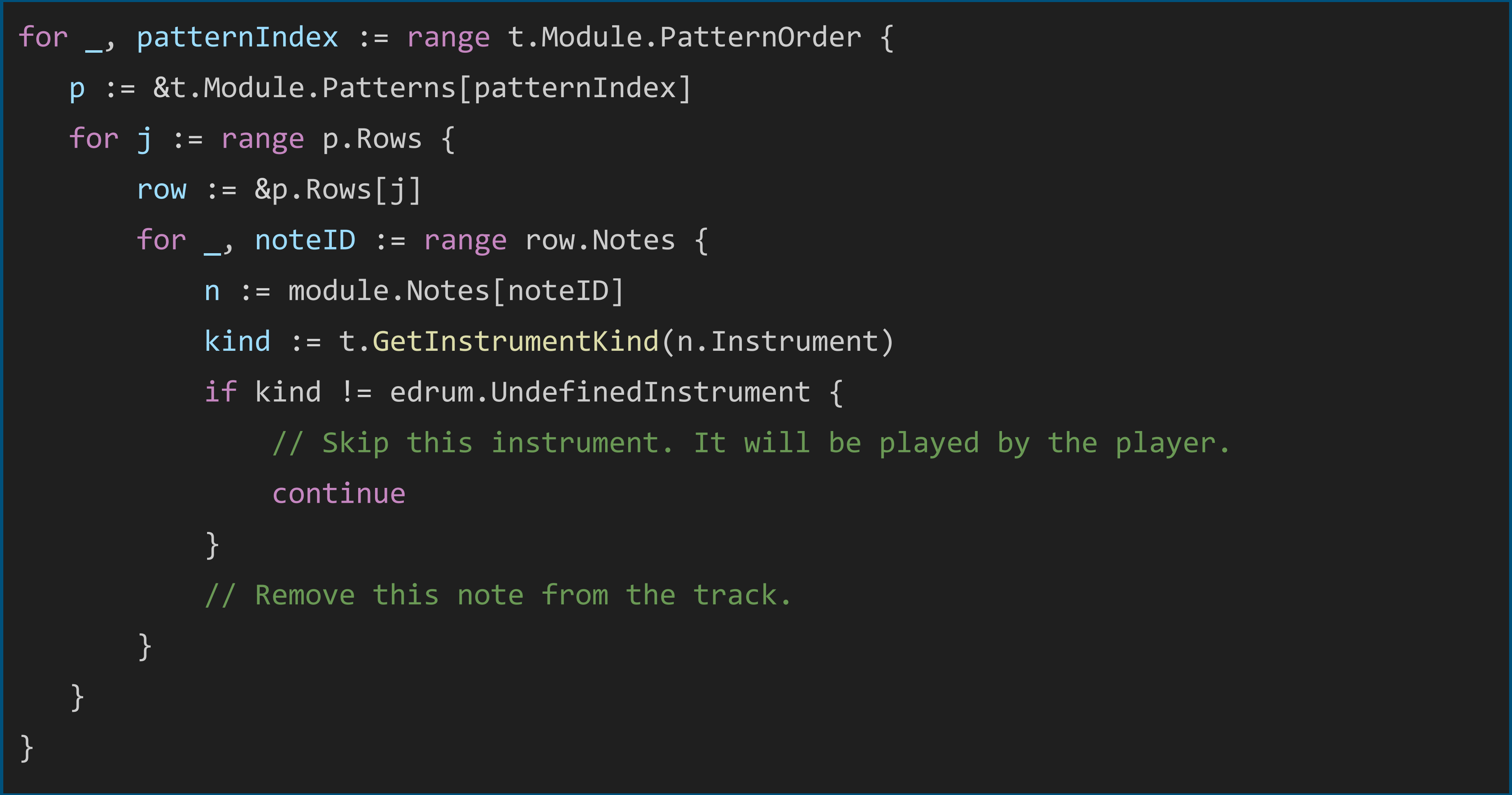
Step 1: remove drums from the track



```
{
    "Name": "Arilou Theme",
    "Author": "Dan Nicholson",
    "Instruments": {
        "ClosedHiHat": 1, ●
        "Snare": 2, ●
        "Bass": 4 ●
    }
}
```



	1	2	3	4
00	F#5 1 ●	F-4 3	C-4 4 ●	
01				
02	F#5 1 ●	G-4 3		
03		G-5 3		
04	C-5 2 ●			
05		G-4 3		
06	F#5 1 ●	G-5 3		
07				
08	F#5 1 ●	F-4 3	C-4 4 ●	
09				
0A	F#5 1 ●	G-4 3	C-4 4 ●	
0B		G-5 3		
0C	C-5 2 ●			
0D		G-4 3		
0E		G-5 3		
0F				
10	F#5 1 ●	F-4 3	C-4 4 ●	
11				
12	F#5 1 ●	F-4 3		
13		F-5 3		
14	C-5 2 ●			
15		F-4 3		
16	F#5 1 ●	F-5 3		
17				
18	F#5 1 ●	F-4 3	C-4 4 ●	
19				
1A	F#5 1 ●	F-4 3	C-4 4 ●	
1B		F-5 3		
1C	C-5 2 ●			
1D		F-4 3		



```go
for _, patternIndex := range t.Module.PatternOrder {
    p := &t.Module.Patterns[patternIndex]
    for j := range p.Rows {
        row := &p.Rows[j]
        for _, noteID := range row.Notes {
            n := module.Notes[noteID]
            kind := t.GetInstrumentKind(n.Instrument)
            if kind != edrum.UndefinedInstrument {
                // Skip this instrument. It will be played by the player.
                continue
            }
            // Remove this note from the track.
        }
    }
}
```

Step 2: extract selected instrument samples

Can be done programmatically or manually via Tracker software (like MilkyTracker).

Step 3: create a note map

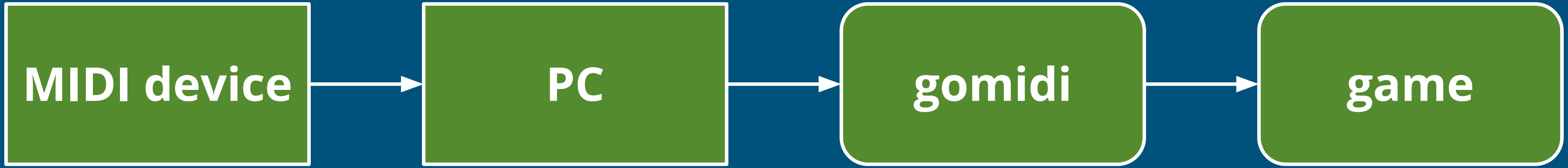
For every note “removed” from the track, remember its timings and other info like instrument type.

Render these note bars to the players when they need to play them.

Step 4: read the MIDI stream

For every MIDI “play note” event play instrument’s associated sample.

gitlab.com/gomidi/midi/



Summary

- The track is played without drums

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- The track is played without drums
- There is an interactive drum notes map
- The drum will play original samples
- Every drum stroke is /real/ and affects the song

What else can we do?

- Collect player stats, like rhythm consistency
- Create tab sheets for an XM track automatically
- Play XM tracks at different speed and effects
- This is not limited to drums-only, any MIDI-device will do
- Record the player and build a combined XM track
- Build colored sound wave based on inst&chan index

My XM player library for Go

- High performance (zero-alloc repeated plays)
- Sample interpolation & volume ramping support
- Dependency-free
- Ebitengine-compatible
- Exports XM files and parsers

github.com/quasilyte/xm

XM Performance

XM playback

There are two main aspects to it:

1. Evaluating the effects/notes for a “tick”
2. Rendering the PCM bytes for the given tick

(1) is XM-specific, (2) is what any player would do

Rendering the PCM dominates the run time: 90-95%

Benchmarks

We’ll be comparing two libraries:

1. XM: github.com/quasilyte/xm
2. OGG: github.com/jfreymuth/vorbis

Benchmarks

We'll be using 3 different tracks:

1. Industrial Porn (Drozerix)
2. Old Bulls (Aruan); a MOD file converted to XM
3. Crush (Drozerix)

OGG player uses the converted XM->OGG file

Benchmarks

There are 2 main parts of playing the music:

- Loading the file (preparing it to be played)
- Streaming the PCM bytes (playing the music)

Benchmarks: decoding (ns/op)

Benchmark	OGG	XM	XM (lerp)
Decode1	6.27 ms	3.30 ms	3.46 ms
Decode2	4.95 ms	1.56 ms	3.58 ms
Decode3	5.03 ms	4.45 ms	4.98 ms

Benchmarks: decoding (ns/op)

Benchmark	OGG	XM	XM (lerp)
Decode1	slowest	~90% faster	~80% faster
Decode2	slowest	~317% faster	~38% faster
Decode3	slowest	~13% faster	~same

Benchmarks: playing (ns/op)

Benchmark	OGG	XM	XM (lerp)
Play1	4245 ms	1235 ms	Same as previous
Play2	4292 ms	540 ms	Same as previous
Play3	2609 ms	1627 ms	Same as previous

Benchmarks: playing (ns/op)

Benchmark	OGG	XM	XM (lerp)
Play1	slowest	~343% faster	Same as previous
Play2	slowest	~795% faster	Same as previous
Play3	slowest	~160% faster	Same as previous

Benchmarks: playing (allocs/op)

Benchmark	OGG	XM	XM (lerp)
Play1	444097	0	0
Play2	447999	0	0
Play3	163519	0	0

Benchmarks: conclusion

- XM players are not slow
- XM players can be zero alloc

If XM-style music fits your game, use it directly instead of converting it to OGG (or MP3)

XM lib internals

Stages separation

- Decoding: compile the XM module
- Playback: generate PCM bytes from the module

Compilation happens only once.

A module can be played multiple times.

This library favors the playback efficiency (zero alloc).

Sample loops

A sample can “loop”:

- Forward loop
- Ping-pong loop (bidirectional)

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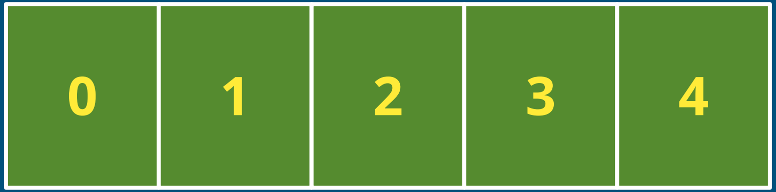
We can unify all of them (for branchless performance)

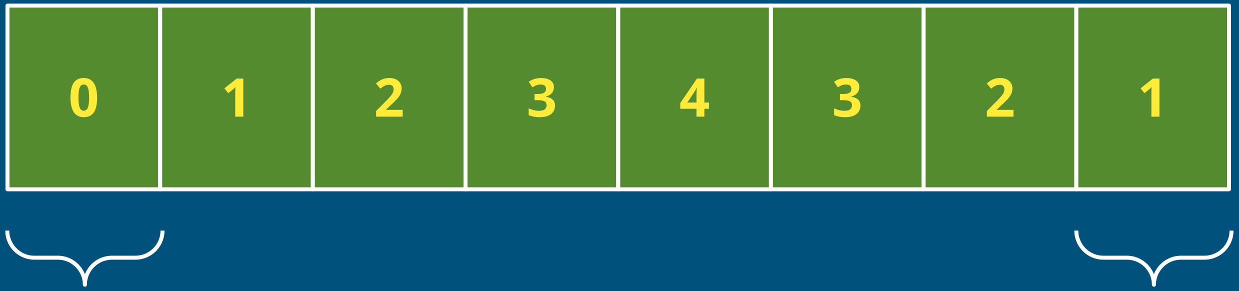
Ping-pong loop



0	1	2	3	4

Played as 0, 1, 2, 3, 4, 3, 2, 1, ...

Unrolled ping-pong loop



0	1	2	3	4	3	2	1

Loop start

Loop end

Now we only have “forward” loops

Sample interpolation (lerp, etc.)

There are (at least) two ways:

- A genuine interpolation during a playback
- A precomputed subsamples approach

My library uses the latter

Precomputed subsamples

- Injects subsamples during the track compilation

Precomputed subsamples

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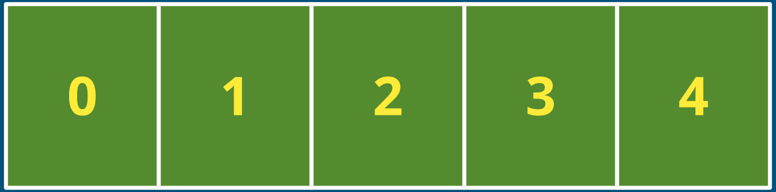
Precomputed subsamples

- Injects subsamples during the track compilation
- Requires more memory due to the extra samples
- Has zero CPU cost during the playback
- Can be sample-size dependent (adaptive)

Original sample



0	1	2	3	4

With 1 sub-sample injected

0	0.5	1	1.5	2	2.5	3	3.5	4

Volume ramping

Only a few first bytes of the “tick” require ramping.

Process “tick” in two loops: with and without ramping.

```
n := s.module.bytesPerTick
const rampBytes  = 2 * 2 * numRampPoints

for i := 0; i < rampBytes; i += 4 {
   // ... generate PCM with ramping
}

// 80-90% of bytes don’t need ramping:
for i := rampBytes; i < n; i += 4 {
   // ... generate PCM without ramping (super fast)
}
```

Closing Words

Using other modular music formats

These formats can be converted to XM easily:

- MOD -> XM (I use MilkyTracker for this conversion)
- S3M -> XM (MilkyTracker and modplug)
- IT -> XM (MilkyTracker)

Amiga frequencies can be converted to linear too.

Links

- XM file format overview
- A tiny XM player implementation in C
- MilkyTracker sources (implements XM as well)
- Modarchive (modular music collection)
- My XM library for Go
- Ebitengine Discord channel (international)

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- Game development in Go is a thing (try it out!)
- Modular music (esp. XM) is still relevant
- You can play the XM music in Ebitengine directly
- Modular music can sound cool (Deus Ex OST, Drozerix)
- XM players are not slow (see benchmarks)

Go gamedev: XM music

quasilyte 2024