

# ALGORHYTHM

A LIBRARY FOR ALGORITHMIC MUSIC COMPOSITION

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Joris ten Tusscher, Cas van der Rest, Orestis Melkonian

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Universiteit Utrecht

music representation (Music, MusicCore, Scale, Chord, etc...  
music manipulation (transpose, retrograde, time-scale, etc...

FOCUS ON GENERATION, IGNORE ANALYSIS



**YOU SHALL NOT PARSE!**

genState, selectors, diatonic improv, etc...

k-means, etc...

(Generative) *context-free grammars*, with a few extra features:

- **Temporal:** Rules are parametric to duration
- **Probabilistic:** Rules can be assigned weights
- **Graph:** Allow node sharing (using *let*-expressions)

## GRAMMARS: DEFINITION

```
data Grammar meta a =  
  a | : [Rule meta a]  
data Rule meta a =  
  (a, Weight, Dur -> Bool) :-> (Dur -> Term meta a)  
data Term meta a =  
  a %: Dur  
  | Term meta a :-: Term meta a  
  | Aux Bool meta (Term meta a)  
  | Let (Term meta a) (Term meta a -> Term meta a)  
  
(a, w) -| f = (a, w, f) :-> (a %:)  
a | -> b = a :-> const b  
a |--> b = (a, 1, always) | -> b  
($:) = Aux False  
(|$:) = Aux True
```

## GRAMMARS: GENERATION

```
gen :: (Eq a, Eq meta, Expand input meta a b)
    => Grammar meta a -> input -> Dur -> Music b
gen gr i t = rewrite gr t >>> unlet >>> expand i >>> toMusic
```

1. Given an initial duration, rewrite until fixpoint

```
rewrite :: (Eq a, Eq meta)
        => Grammar meta a -> Dur -> Term meta a
```

2. Unfold *let*-expressions

```
unlet (Let x f) = f x
unlet x         = x
```

3. Expand auxiliary wrappers

```
class Expand input meta a b | input meta a -> b where
    expand :: input -> Term meta a -> Term () b
```

4. Convert to music

```
(:~:) ~> (<|)
(:-:) ~> (:+:)
```



## GRAMMARS: TABLA RHYTHM

```
tabla :: Grammar () Syllable
tabla = S | :
  [ S | --> TE1 :-: XI
  , XI | --> TA7 :-: XD
  , XD | --> TA8
  , XG | --> TB2 :-: XA
    ...
  , TE4 | --> Ti :-: Rest :-: Dha :-: Ti
  , TC2 | --> Tira :-: Kita
  , TB3 | --> Dha :-: Tira :-: Kita
  , TD1 | --> Rest
    ...
  ]
instance ToMusicCore Syllable where
  ...
```

## GRAMMARS: TONAL HARMONY

```
harmony :: Grammar Modulation Degree
harmony = I | :
[ -- Turn-arounds
  (I, 8, (> wn)) :-> \t ->
    Let (I%:t/2) (\x -> x :-: x)
  , (I, 6, (> hn) /\ (<= wn)) :-> \t ->
    II:%:t/4 :-: V:%:t/4 :-: I:%:t/2
  , (I, 2, (> hn) /\ (<= wn)) :-> \t ->
    V:%:t/2 :-: I:%:t/2
  , (I, 2) -| (<= wn)
  -- Modulations
  , (V, 5, (> hn)) :-> \t -> Modulation P5 $: I:%:t
  , (V, 3) -| always
  , (II, 2, (> hn)) :-> \t -> Modulation M2 |$: I:%:t
  , (II, 8) -| always
]
```

instance Expand Config Degree Modulation SemiChord where  
...

```
voiceLead :: Music SemiChord -> IO (Music Chord)
```

## GRAMMARS: JAZZ IMPROVISATION

```
melody :: Grammar () NT
melody = MQ | :
  [ -- Abstract Rhythm { MQ ~> Q }
    (MQ, 1, (== qn)) |-> Q:%:qn
    , (MQ, 25, (> (hn^.))) :-> \t -> Q:%:hn :-: MQ:%:(t - hn)
    ...
    -- Concrete Rhythm { Q ~> MN }
    , (Q, 47, (== wn)) |-> MN:%:qn :-: Q:%:hn :-: MN:%:qn
    , (Q, 6, (== hn)) |->
      MN:%:(qn^^^ ) :-: MN:%:(qn^^^ ) :-: MN:%:(qn^^^ )
    ...
    -- Abstract Melody { MN ~> N }
    , (MN, 1, (== wn)) |-> N:%:qn :-: N:%:qn :-: MN:%:hn
    , (MN, 1, (== qn)) |->
      N:%:(en^^^ ) :-: N:%:(en^^^ ) :-: N:%:(en^^^ )
    ...
    -- Concrete Melody { N ~> NT }
    , (N, 50, (== qn)) |-> ChordTone:%:qn
    , (N, 45, (== qn)) |-> Rest:%:qn
    , (N, 1, (== en)) |-> ApproachTone:%:en
    ...
  ]

mkSolo :: Music SemiChord -> Music NT -> IO Melody
```

## DEMO: CODE

```
orientalAlgebras = do
  let ?config = MusicConfig
    { basePc      = A
    , baseOct     = Oct3
    , baseScale   = arabian
    , chords      = equally allChords
    , scales      = equally allScales
    , octaves     = [(20, Oct4), (15, Oct5), (5, Oct6)]
    , restWeight  = 0, ...
    , tempo       = 6%5
    , instruments = [Piano, Sitar, Tabla]
    , beat        = sn
    }
  let t = 12 * wn
  har <- voiceLead <$> runGrammar harmony t
  mel <- mkSolo har <$> runGrammar melody t
  rhy <- runGrammar tabla t
  writeToMidiFile "out.mid" (dyn (har == mel == rhy))
```

# DEMO: MUSIC SCORE

## Oriental Algebras for Metalophone, Sitar & Tablas



System 1 of the musical score, measures 1-3. It features three staves: a top staff with a treble clef and a key signature of one flat, a middle staff with a treble clef, and a bottom staff with a bass clef. The music is in 4/4 time. The top staff has a whole note chord in measure 1, followed by a half note in measure 2, and a quarter note in measure 3. The middle staff has a half note in measure 1, followed by a quarter note in measure 2, and a quarter note in measure 3. The bottom staff has a continuous eighth-note pattern throughout the system.



System 2 of the musical score, measures 4-6. It features three staves: a top staff with a treble clef and a key signature of one flat, a middle staff with a treble clef, and a bottom staff with a bass clef. The music is in 4/4 time. The top staff has a half note in measure 4, followed by a quarter note in measure 5, and a quarter note in measure 6. The middle staff has a half note in measure 4, followed by a quarter note in measure 5, and a quarter note in measure 6. The bottom staff has a continuous eighth-note pattern throughout the system.



System 3 of the musical score, measures 7-9. It features three staves: a top staff with a treble clef and a key signature of one flat, a middle staff with a treble clef, and a bottom staff with a bass clef. The music is in 4/4 time. The top staff has a half note in measure 7, followed by a quarter note in measure 8, and a quarter note in measure 9. The middle staff has a half note in measure 7, followed by a quarter note in measure 8, and a quarter note in measure 9. The bottom staff has a continuous eighth-note pattern throughout the system.



System 4 of the musical score, measures 10-12. It features three staves: a top staff with a treble clef and a key signature of one flat, a middle staff with a treble clef, and a bottom staff with a bass clef. The music is in 4/4 time. The top staff has a half note in measure 10, followed by a quarter note in measure 11, and a quarter note in measure 12. The middle staff has a half note in measure 10, followed by a quarter note in measure 11, and a quarter note in measure 12. The bottom staff has a continuous eighth-note pattern throughout the system.



System 5 of the musical score, measures 13-15. It features three staves: a top staff with a treble clef and a key signature of one flat, a middle staff with a treble clef, and a bottom staff with a bass clef. The music is in 4/4 time. The top staff has a half note in measure 13, followed by a quarter note in measure 14, and a quarter note in measure 15. The middle staff has a half note in measure 13, followed by a quarter note in measure 14, and a quarter note in measure 15. The bottom staff has a continuous eighth-note pattern throughout the system.



System 6 of the musical score, measures 16-18. It features three staves: a top staff with a treble clef and a key signature of one flat, a middle staff with a treble clef, and a bottom staff with a bass clef. The music is in 4/4 time. The top staff has a half note in measure 16, followed by a quarter note in measure 17, and a quarter note in measure 18. The middle staff has a half note in measure 16, followed by a quarter note in measure 17, and a quarter note in measure 18. The bottom staff has a continuous eighth-note pattern throughout the system.