AlgoRhythm

A Library for Algorithmic Music Composition

Joris ten Tusscher, Cas van der Rest, Orestis Melkonian

April 5, 2018

Universiteit Utrecht

Music DSL

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

Focus on Generation, Ignore Analysis

Generation

genState, selectors, diatonic improv, etc...

Dynamic Performance

k-means, etc...

Grammars: Properties

(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
    ...
```

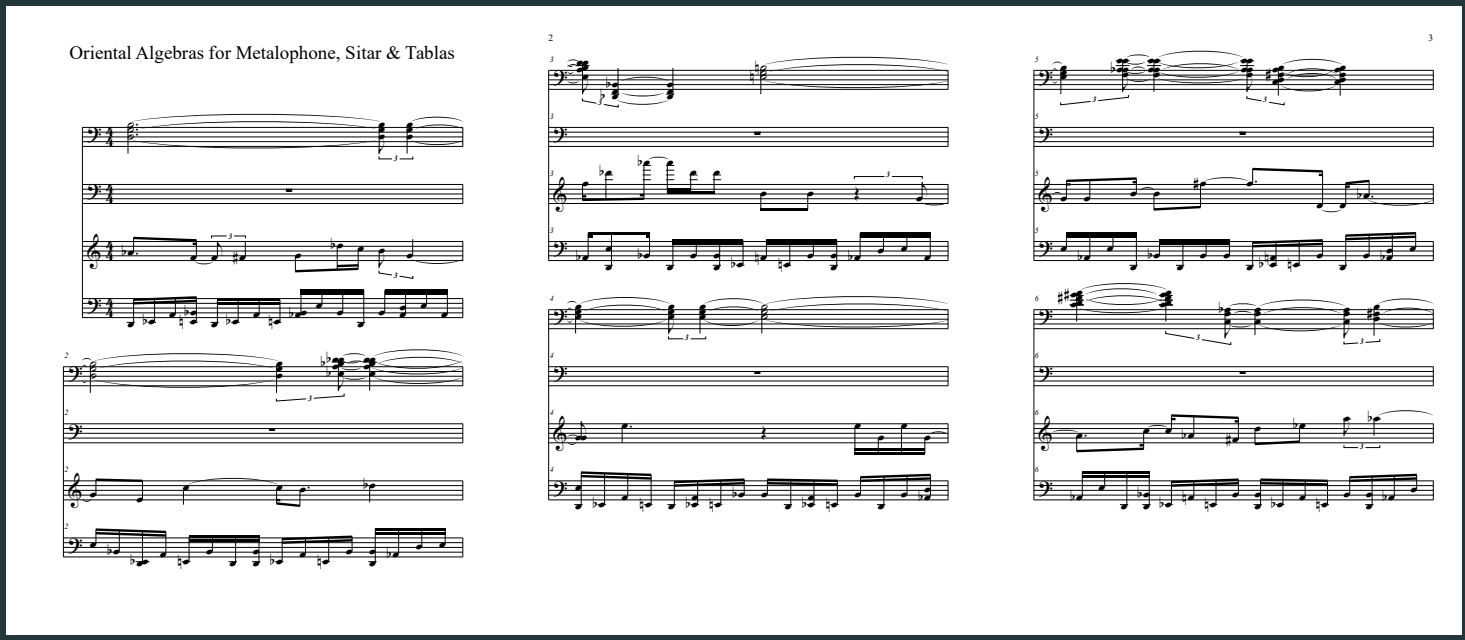
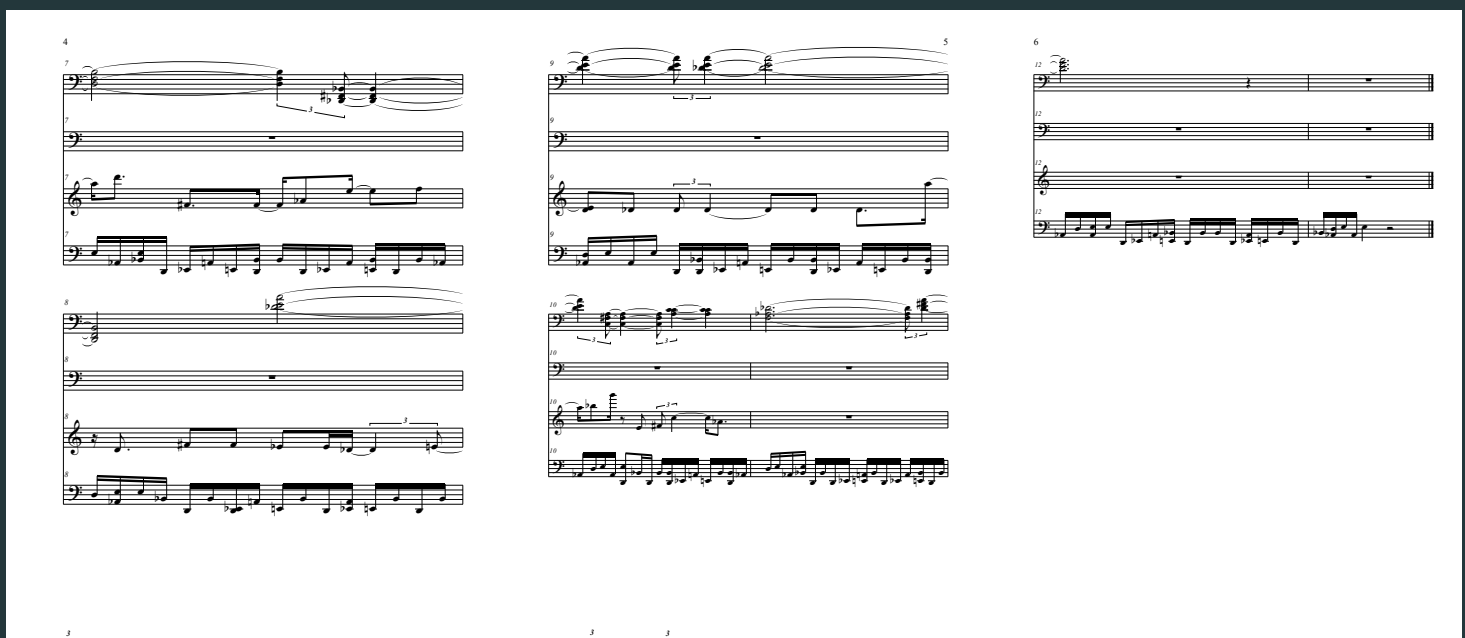
Grammars: Tonal Harmony

```
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