Bedhaya Guthrie/ Bedhaya Sadra for Voices, Kemanak, Melody Instruments, and Accompanimental Javanese Gamelan

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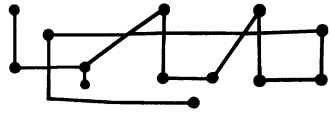


Larry Polansky

For the Astra Choir

Introduction

Bedhaya Guthrie/Bedhaya Sadra is a set of computer-generated transformations of two melodies, Woody Guthrie's "Rangers' Command" and a melody written by the Indonesian composer I Wayan Sadra. The work is a study in the mutation of one melody to another by means of simple melodic or morphological mutation functions.

I asked I Wayan Sadra to write a pelog melody with the same rhythmic structure as the Guthrie melody but which would present interesting possibilities for transformation. He generously wrote several such melodies, one of which is used in this piece.

Versions

The score consists of twelve *versions.* Each version consists of one full rendition (ten verses, including the introduction and close) of the lyrics to "Rangers' Command." The text is the same for each version. The first and last lines of each version are the *Guthrie* (*G*) or *Sadra* (*S*) melodies (depending on the form of the version). The eight other melodies, labelled *a* through *h*, are melodic transformations (called *mutations*) from *G* to *S*, or from *S* to *G*.

Each version is a different melodic transformation between the Guthrie and Sadra melodies. Performance of the piece consists of any combination, or subset, in any order, of the twelve versions given in the score. The ensemble should select the particular combination of versions (from only one, to all twelve) for a given performance. Any version might be repeated.

In performance, there is no pause between versions. The *kemanak introduction* to each version should serve as the only transition, and it should begin immediately at the gong of the previous version. The piece is modular: each of the four *kemanak versions* may be used with any of the vocal versions. The kemanak parts are subsidiary to the vocal ones: a version is not distinguished by using a different kemanak version. The ensemble should construct the performance primarily on the basis of the vocal versions, and add the kemanak accompaniment to that "arrangement."

Versions Vb, VIb, VIIb, and VIIb are alternates of V, VI, VII, and VII. The *mutation parameters* (trajectory, type of mutation used, and so on) are the same for V and Vb, but since the mutation function used in these versions has some stochastic elements I have included two possibilities for each. See the *Theoretical Background* for more information on this.

Instrumentation and Performance Notes

Bedhaya . . . is for solo singer(s), small mixed choir, or any combination of voices; three kemanak players, melody instruments, and gamelan accompaniment (kenong, gong, slenthem, and optional gendér and kendhang). The melody instruments may double and ornament the vocal lines or be soloists themselves, replacing the singing for a given version. All singing is in unison or octaves.

ORCHESTRATION OF THE DIFFERENT VERSIONS

A different vocal or melody instrument combination can be used for each version. One version might be for solo female voice, another for solo male voice with clarinet ornamentation, a third a duet for flute and two voices, and so on.

Other instruments may ornament the melody *ad libitum* in each version. These instruments might play the main melody in one version and in another freely improvise around the melody. The style of improvisation is up to the performers, as is the way the improvisation relates to the tuning, melodic configuration, and rhythm of the melody.

If Western instruments are used, they may play in the pelog tuning of the gamelan, or deviate from that in interesting ways. The singers should always sing in pelog.

The orchestration of the piece is determined by the ensemble. Careful thought should be given to the overall form of the orchestration with respect to the number of versions sung. For example, melody instruments might alternate with voices in a manner similar to the performance by Gamelan Son of Lion in the piece's New York premiere (1990):

Version 1. Vocal trio (two females, one male)

Version 2. Solo clarinet

Version 3. Vocal solo (female) with clarinet ornamentation

Version 4. Solo clarinet with suling ornamentation

Version 5. Vocal trio (two females, one male) with clarinet ornamentation.

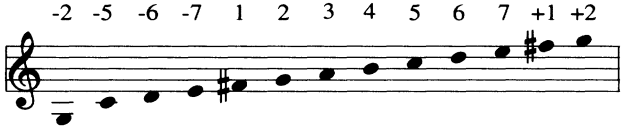
KEMANAK

Javanese kemanak should be used, if possible, tuned to three distinct pitches (for example, pelog 1, 7, and 6). In the absence of kemanak, any other metal percussion instrument with three distinct pitches could be used, such as tuned cowbells, bonang pots, small brake drums, and so forth. Since each kemanak requires two hands to play, three performers are needed for this part, although these performers might sing as well. If some other percussion instruments are used, like cowbells, which do not require both hands, one player might suffice for the part.

VOCAL STYLE AND SCORE

Bedhaya should be sung as naturally as possible, without any unnecessary inflection or elements of the vocal styles of either "cowboy" or Central Javanese music. The singer(s) should use a comfortable vocal style and normal accent (their own).

The vocal and kemanak parts are in Central Javanese cipher notation. Western staff notation is not used because the tunings of various pelog gamelan will not necessarily correspond to specific Western pitches. The pelog pitches used in ***Bedhaya*** may be roughly approximated by the Western pitches (or some transposition) shown in Example 1.



EXAMPLE 1

TUNING

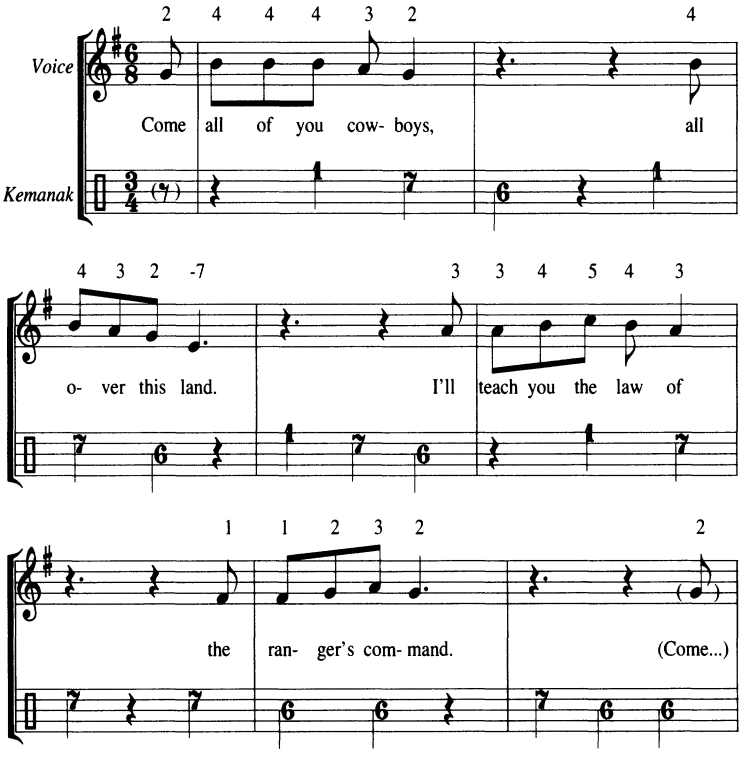
The melodies should be sung in pelog, not equal temperament, with the gamelan instruments providing the reference. Any pelog tuning may be used, either Indonesian or non-Indonesian. It is possible that some pelogs will closely approximate Western equal temperament.

The singers may add ornamentation to the basic melodies, since this work was inspired in part by the Central Javanese music and dance form ***Bedhaya***. All ornaments must be completely in unison, agreed upon beforehand, and should not significantly alter the melodies. If Western melodic instruments are used the performers may ornament freely in any style.

TEMPO

The piece should be performed at a moderate tempo. If the vocal part is considered to be in 6/8 meter, a reasonable tempo range is dotted-quarter-note equal to between mm. 60 and mm. 84. This means that the

kemanak part would be somewhere between 45 to 63 for the quarter note. There is a hemiola relationship between the kemanak part's four-beat pattern in 3/4 and the vocal part in 6/8. The tempo of the vocal part should allow for a clear and regular kemanak part. Example 2 shows the relationship between the kemanak and vocal parts in an approximate Western notation.



EXAMPLE 2

The slenthem plays the second and last note of each melodic group; it is joined by the kenong on the last note of each verse (rhymed couplet of text). Example 3 shows the slenthem and kenong parts from *a* of ***Version I*** (slenthem with single parenthesis, kenong with double parentheses).

2 3) 3 5 4 2) 3 5) 4 3 1)
4 4) 4 4 3 2) -7 -7) 2 2 (2)

EXAMPLE 3

The gong plays the last note of every version. Rebab, kendhang, and gendér are optional, and should freely improvise in an understated and auxiliary role. The players may invent ***cengkok*** (patterns) to fit with the melodies. The slenthem, kenong, and gong play in every version; rebab, kendhang, and gendér do not have to. The choice of how to employ rebab, kendhang, and gendér is left to the ensemble.

NOTE ON CIPHER NOTATION

The range of the vocal part is from pelog low 2 (-2, ***"ro" besar*** or ***gedhe***) to pelog high 2 (+2, ***ro kecil*** or ***cilik***).[1] For typographical reasons low notes are written with a minus (-) before them (equivalent to the dot below in standard Central Javanese *Kepatihan* notation). High notes are written with a plus (+) before (the dot above in *Kepatihan* notation).

SOURCE MELODIES: SADRA AND GUTHRIE

Melody from I Wayan Sadra (S).
S: 2 1 3 5 6 2 3 5 7 6 +2 7 6 4 2 1 -5 -6 -6 2 1 2

Melody from Woody Guthrie (G).
G: 2 4 4 4 3 2 4 4 3 2 -7 3 3 4 5 4 3 1 1 2 3 2

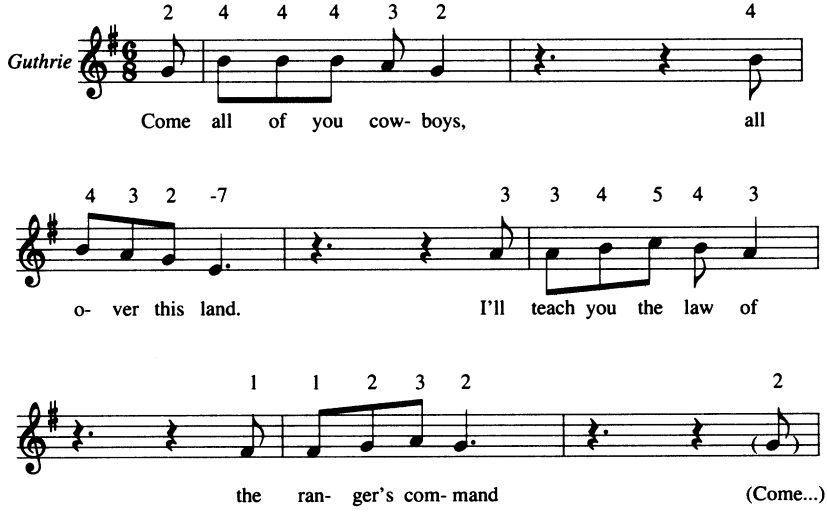
RHYTHMIC REALIZATION

The rhythm for all versions is the same, although the performers may agree on their own variations. Each verse consists of a six-beat phrase, a five-beat phrase, a six-beat phrase, and a final five-beat phrase. Rests of either six or seven beats follow each melodic phrase (totalling twelve beats). The relationship of the vocal part to the kemanak is the same for each verse. With a little bit of practice the piece becomes quite simple to sing.

Example 4 shows the rhythm for the Sadra and Guthrie melodies, first in cipher and then in Western notation with corresponding cipher numbers above each "pitch."

Guthrie Melody:

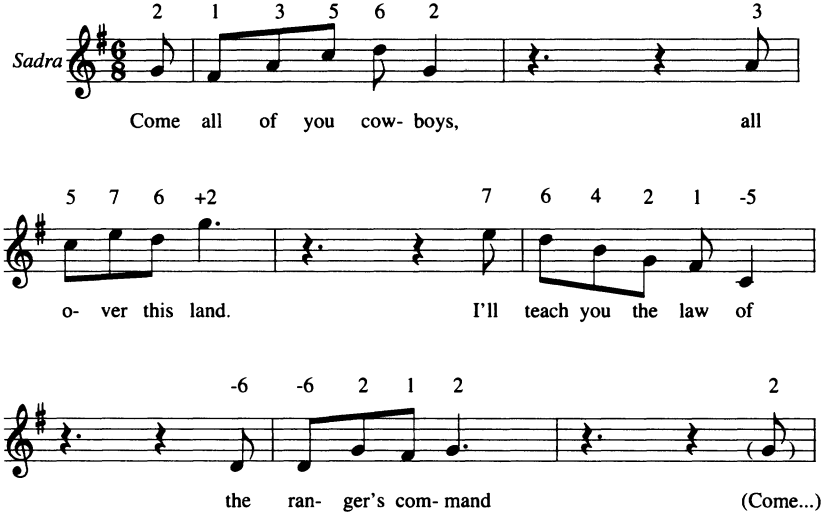
```
                                    (. . . . 2)
                                    "Come
4 4 4    3 2 . . . . . 4
all of you  cowboys,        All
4 3 2    -7 . . . . . 3
ov-er this  land            I'll
3 4 5    4 3 . . . . . 1
teach you the  law of       The
1 2 3    2 . . . . . (2)
Rangers' Command"
```



EXAMPLE 4

Sadra Melody:

(. . . . . 2)
"Come
1 3 5 6 2 3
all of you cowboys, All
5 7 6 +2 7
ov-er this land I'll
6 4 2 1 -5 . . . . . -6
teach you the law of The
-6 2 1 2 . . . . . .(2)
Rangers' Command"



EXAMPLE 4 (CONT.)

INTRO:

Come all of you cowboys, all over this land,
I'll sing you the law of the Rangers' Command

VERSES

(*a*) Come all of you cowboys, all over this land,
I'll sing you the law of the Rangers' Command.

(*b*) To hold a six-shooter, and never to run,
As long as there's bullets in both of your guns.

(*c*) I met a fair maiden, whose name I don't know,
I asked her to the round-up, with me would she go.

(*d*) She said she'd go with me to the cold round-up,
And drink her hard liquor from a cold bitter cup.

(*e*) We started for the round-up in the fall of the year,
Expecting to get there with a herd of fat steer.

(*f*) The rustlers broke on us in the dead hour of night,
She rose from her warm bed, a battle to fight.

(*g*) She rose from her warm bed, (with) a gun in each hand,
Saying "Come all of you cowboys, and fight for your land."

(*h*) Come all of you cowboys, and don't ever run,
As long as there's bullets in both of your guns.

CLOSE

Come all of you cowboys, all over this land,
I'll sing you the law of the Rangers' Command.

Variations:

—"When the rustlers came on us in the dead of the night" (*f*)
—"I'll teach you the law of . . ." (intro, *a*, close)
—"And drink that hard liquor . . ." (*d*)

Cipher Notation Versions

The first words of the lyrics for each verse are included in the notation for *Version I* as an example of how performers might annotate their parts once the text is memorized. Each version uses the same lyrics.

VERSIONS I–IV. UNIFORM SIGNED INTERVAL MAGNITUDE (USIM)

Version I. G→S→G Uniform Signed Interval Magnitude (USIM).

G	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2	
	Come all of you cowboys . . .				
(*a*)	2 3 3 5 4 2	3 5 4 3 1	4 4 4 4 3 2	-7 -7 2 2 2	
	Come all of you cowboys . . .				
(*b*)	2 3 3 5 4 2	3 5 5 4 4	5 5 4 3 2 1	-7 -7 2 2 2	
	To hold a six-shooter . . .				
(*c*)	2 2 3 5 5 2	3 5 6 5 6	6 5 4 3 2 -6	-6 -6 2 1 2	
	I met a fair maiden . . .				
(*d*)	2 1 3 5 6 2	3 5 7 6 +1	7 6 4 2 1 -5	-6 -6 2 1 2	
	She said she'd go with me . . .				
(*e*)	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2	(*S*)
	We started for the roundup . . .				
(*f*)	2 2 3 5 5 2	3 5 6 5 7	6 5 4 3 2 -7	-7 -7 2 2 2	
	The rustlers fell on us . . .				
(*g*)	2 2 3 5 5 2	3 5 5 4 4	5 4 4 4 3 1	-7 -7 2 2 2	
	She rose from her warm bed . . .				
(*h*)	2 3 3 5 4 2	3 5 4 3 2	4 4 4 4 3 2	-7 -7 2 2 2	
	Come all of you cowboys . . .				
G	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2	
	Come all of you cowboys . . .				

Version II. S→G→S Uniform Signed Interval Magnitude (USIM).

S	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2	
(*a*)	2 2 4 4 5 2	4 4 6 5 +1	6 5 4 3 2 -6	-7 -7 2 2 2	
(*b*)	2 2 4 4 5 2	4 4 5 4 5	5 4 4 4 3 -7	-7 -7 2 2 2	
(*c*)	2 3 4 4 4 2	4 4 4 3 3	4 4 4 4 3 2	1 1 2 3 2	
(*d*)	2 4 4 4 3 2	4 4 3 2 1	3 3 4 5 4 3	1 1 2 3 2	
(*e*)	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2	(*G*)
(*f*)	2 3 4 4 4 2	4 4 4 3 2	4 4 4 4 3 1	-7 -7 2 2 2	
(*g*)	2 3 4 4 4 2	4 4 5 4 5	5 5 4 3 2 -7	-7 -7 2 2 2	
(*h*)	2 2 4 4 5 2	4 4 6 5 7	6 5 4 3 2 -6	-7 -7 2 2 2	
S	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2	

Version III. G→S Uniform Signed Interval Magnitude (USIM).

G	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2
(*a*)	2 3 3 5 4 2	3 5 4 3 1	4 4 4 4 3 2	-7 -7 2 2 2
(*b*)	2 3 3 5 4 2	3 5 4 3 2	4 4 4 4 3 2	-7 -7 2 2 2
(*c*)	2 3 3 5 4 2	3 5 5 4 3	5 4 4 4 3 1	-7 -7 2 2 2
(*d*)	2 3 3 5 4 2	3 5 5 4 4	5 5 4 3 2 -7	-7 -7 2 2 2
(*e*)	2 2 3 5 5 2	3 5 5 4 5	6 5 4 3 2 -7	-7 -7 2 2 2
(*f*)	2 2 3 5 5 2	3 5 6 5 6	6 5 4 3 2 -6	-6 -6 2 1 2
(*g*)	2 2 3 5 5 2	3 5 6 5 7	6 6 4 2 1 -6	-6 -6 2 1 2
(*h*)	2 1 3 5 6 2	3 5 7 6 +1	7 6 4 2 1 -5	-6 -6 2 1 2
S	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2

Version IV. S→G Uniform Signed Interval Magnitude (USIM).

S	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2
(*a*)	2 2 4 4 5 2	4 4 6 5 +1	6 5 4 3 2 -6	-7 -7 2 2 2
(*b*)	2 2 4 4 5 2	4 4 6 5 7	6 5 4 3 2 -6	-7 -7 2 2 2
(*c*)	2 2 4 4 5 2	4 4 5 4 6	5 5 4 3 2 -7	-7 -7 2 2 2
(*d*)	2 2 4 4 5 2	4 4 5 4 5	5 4 4 4 3 1	-7 -7 2 2 2
(*e*)	2 3 4 4 4 2	4 4 5 4 4	4 4 4 4 3 1	-7 -7 2 2 2
(*f*)	2 3 4 4 4 2	4 4 4 3 3	4 4 4 4 3 2	1 1 2 3 2
(*g*)	2 3 4 4 4 2	4 4 4 3 2	4 3 4 5 4 2	1 1 2 3 2
(*h*)	2 4 4 4 3 2	4 4 3 2 1	3 3 4 5 4 3	1 1 2 3 2
G	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2

VERSIONS V–VIII. LINEAR CONTOUR MUTATION (LCM)/IRREGULAR UNSIGNED INTERVAL MAGNITUDE (IUIM)

Version V. G→S→G LCM/IUIM.

G	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2	
(*a*)	2 4 4 4 3 2	4 4 3 2 -7	3 6 4 2 4 3	-6 1 2 3 2	
(*b*)	2 4 4 4 3 2	4 5 7 2 4	3 3 4 2 -7 3	1 -6 2 1 2	
(*c*)	2 -7 3 5 6 2	4 4 7 2 +2	7 6 4 2 1 -5	-6 -6 2 3 2	
(*d*)	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2	
(*e*)	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2	(*S*)
(*f*)	2 1 3 5 3 2	3 5 3 6 +2	7 6 4 5 1 6	1 -6 2 1 2	
(*g*)	2 1 4 4 3 2	3 5 7 6 -7	3 6 4 2 -7 1	1 -6 2 3 2	
(*h*)	2 4 4 4 6 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2	
G	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2	

Version Vb. G→S→G LCM/IUIM (alternate).

G	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2	
(*a*)	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2	
(*b*)	2 1 4 4 3 2	3 5 7 2 -7	7 6 4 2 3 3	-6 1 2 3 2	
(*c*)	2 1 4 5 3 2	4 5 7 6 -2	7 3 4 2 1 -5	-6 -6 2 1 2	
(*d*)	2 3 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2	
(*e*)	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	1 -6 2 1 2	(*S*)
(*f*)	2 1 3 5 3 2	4 4 3 2 -2	7 3 4 2 4 1	-6 1 2 3 2	
(*g*)	2 1 3 4 6 2	4 4 3 2 -7	3 3 4 2 4 3	1 -6 2 3 2	
(*h*)	2 -7 4 4 3 2	4 4 7 2 -7	3 3 4 5 4 3	1 1 2 3 2	
G	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2	

Version VI. S→G→S LCM/IUIM.

S	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2	
(*a*)	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	1 1 2 1 2	
(*b*)	2 -7 3 4 3 2	3 5 7 2 +2	3 3 4 2 4 -5	-6 1 2 1 2	
(*c*)	2 4 3 4 3 2	3 4 3 6 4	3 3 4 2 -7 -5	1 1 2 3 2	
(*d*)	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2	
(*e*)	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 2 4 3	1 1 2 3 2	(*G*)
(*f*)	2 4 4 5 6 2	4 5 3 2 +2	7 3 4 5 4 3	-6 -6 2 3 2	
(*g*)	2 1 3 5 6 2	4 5 3 2 -2	7 6 4 5 3 1	-6 -6 2 1 2	
(*h*)	2 1 3 4 3 2	3 5 7 6 +2	3 6 4 2 -7 -5	-6 -6 2 1 2	
S	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2	

Version VIb. S→G→S LCM/IUIM (alternate).

S	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2	
(*a*)	2 1 3 5 6 2	4 4 7 6 +2	7 6 4 2 1 6	-6 -6 2 1 2	
(*b*)	2 1 3 5 6 2	3 5 7 2 +2	7 3 4 2 1 1	-6 -6 2 3 2	
(*c*)	2 1 3 4 6 2	4 5 7 2 4	3 3 4 2 4 3	1 1 2 3 2	
(*d*)	2 4 3 5 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2	
(*e*)	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 1 2	(*G*)
(*f*)	2 4 4 4 3 2	4 4 7 2 -2	7 3 4 2 3 1	-6 1 2 3 2	
(*g*)	2 4 3 5 3 2	3 5 7 2 4	7 3 4 2 3 -5	1 -6 2 1 2	
(*h*)	2 1 3 5 3 2	4 5 3 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2	
S	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2	

Version VII. G→S LCM/IUIM.

G	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2
(*a*)	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 -6 2 3 2

(*b*)	2 -7 4 4 6 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2
(*c*)	2 4 4 5 3 2	3 4 3 6 -7	3 6 4 2 4 3	1 1 2 3 2
(*d*)	2 -7 4 4 6 2	3 5 3 2 +2	7 6 4 2 4 1	1 -6 2 1 2
(*e*)	2 4 3 4 3 2	4 5 3 6 -7	3 6 4 5 4 6	1 -6 2 1 2
(*f*)	2 1 3 5 6 2	3 5 7 6 -7	7 3 4 2 1 -5	-6 -6 2 1 2
(*g*)	2 3 3 5 6 2	3 5 7 2 4	7 6 4 2 1 -5	1 1 2 1 2
(*h*)	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2
S	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2

Version VIIb. G→S LCM/IUIM (alternate).

G	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2
(*a*)	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 4 6	1 1 2 3 2
(*b*)	2 3 4 4 3 2	4 4 3 2 4	3 3 4 2 4 3	1 1 2 1 2
(*c*)	2 3 4 4 3 2	3 4 3 2 -2	3 6 4 5 3 3	1 1 2 3 2
(*d*)	2 -7 4 4 3 2	4 4 3 6 4	7 3 4 2 4 3	-6 -6 2 1 2
(*e*)	2 -7 3 4 6 2	4 4 3 6 +2	3 6 4 2 1 6	-6 -6 2 1 2
(*f*)	2 -7 4 5 6 2	3 4 7 2 -2	7 3 4 2 4 3	-6 -6 2 1 2
(*g*)	2 -7 3 4 6 2	4 4 7 2 4	7 6 4 2 -7 -5	-6 -6 2 3 2
(*h*)	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 1	-6 -6 2 1 2
S	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2

Version VIII. S→G LCM/IUIM.

S	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2
(*a*)	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2
(*b*)	2 1 3 5 6 2	3 5 7 2 +2	7 6 4 2 3 1	1 -6 2 1 2
(*c*)	2 1 3 5 6 2	4 5 7 6 4	7 3 4 2 1 -5	-6 -6 2 1 2
(*d*)	2 3 4 5 3 2	3 4 7 6 4	3 6 4 5 1 -5	1 1 2 1 2
(*e*)	2 3 4 4 3 2	4 5 3 2 -7	3 3 4 5 3 6	-6 -6 2 1 2

(*f*)	2 1 4 4 3 2	3 5 7 2 4	3 3 4 5 -7 6	-6 -6 2 3 2
(*g*)	2 -7 3 4 3 2	4 5 3 2 -7	3 3 4 5 4 3	1 1 2 3 2
(*h*)	2 4 3 4 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2
G	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2

Version VIIIb. S→G LCM/IUIM (alternate).

S	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 -5	-6 -6 2 1 2
(*a*)	2 1 3 5 6 2	3 5 7 6 +2	7 6 4 2 1 6	1 -6 2 1 2
(*b*)	2 -7 3 5 6 2	3 5 7 6 -2	7 6 4 2 -7 -5	-6 -6 2 3 2
(*c*)	2 1 4 5 6 2	4 5 7 2 +2	7 6 4 2 -7 -5	-6 1 2 1 2
(*d*)	2 -7 3 4 3 2	4 5 3 2 4	3 6 4 2 -7 6	-6 1 2 1 2
(*e*)	2 1 3 5 6 2	4 4 7 2 4	7 3 4 5 3 3	1 1 2 1 2
(*f*)	2 -7 3 4 6 2	4 4 7 6 -2	3 3 4 5 -7 6	-6 1 2 1 2
(*g*)	2 -7 4 4 3 2	4 5 3 2 -7	3 3 4 2 4 1	1 1 2 3 2
(*h*)	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 3 3	1 1 2 3 2
G	2 4 4 4 3 2	4 4 3 2 -7	3 3 4 5 4 3	1 1 2 3 2

Kemanak Notation

Each kemanak part begins with one complete "cycle" of the first kemanak pattern for that version. This is equal in length to one complete verse. Thus, each kemanak version actually consists of eleven verses as opposed to ten in the vocal part. Note also that each kemanak "beat" is twice as long as each vocal "beat." Each verse is thus twenty-two kemanak "beats" (equal to forty-four vocal beats).

In the following notation, double spaces between the kemanak groups indicate where verses fall, and the letter to the right is the corresponding verse in the vocal part. Each kemanak pattern may be thought of (and played) as a four-beat pattern under the triplet time of the melodies.

The parenthetical "ternary triplets" to the left may be ignored by the performer. This is a shorthand description of the *contour* of the kemanak patterns, used to generate them. It is for theoretical reference purposes only (see the Appendix to this article called "Theoretical Notes").

SAMPLE KEMANAK REALIZATION

Example 5 is a sample realization of one possible kemanak part in cipher notation for one verse (*V*: voice; *K*: kemanak). For example, this would be the beginning of vocal versions II, IV, VI, or VII, and kemanak versions I and III. Note that the kemanak basic rhythm pattern (. 1 7 6) consists of four beats (the first always a rest), equal to eight beats of the vocal part, and "cycles" twice for each verse, so that each new half of each verse starts at the "beginning" of the kemanak pattern. The kemanak part, for the sake of clarity, is written in "half-time" with respect to the vocal part. As stated above, one "beat" of the kemanak part equals two "beats" of the vocal part.

```
K:  {.   1    7    6    .    1
K:  7    6    .    1    7    6
K:  .    1    7    6    .    1

V:                   (.  .  .  .  .  2)
K:  7    6    .    1    7    6  }

V:  1  3 5  6 2  .  .  .  .  .  .  3
K:  .    1    7    6    .    1

V:  5  7 6  +2 .  .  .  .  .  .  .  7
K:  7    6    .    1    7    6

V:  6  4 2  1 -5 .  .  .  .  .  .  -6
K:  .    1    7    7    .    7

V: -6 2  1  2  .  .  .  .  .  .  .  (2)    . . . etc.
K:  6    6    .    1    6    6          . . . etc.
```

EXAMPLE 5: ONE COMPLETE KEMANAK "CYCLE" FOR THE BEGINNING OF EACH VERSION

KEMANAK VERSION I (176→671)

(Intro.)					
	.1 7	6 . 1	7 6 .	1 7 6	(000)
	.1 7	6 . 1	7 6 .	1 7 6	
(*S* or *G*)					
	.1 7	6 . 1	7 6 .	1 7 6	(000)
	.1 7	7 . 1	7 7 .	6 6 1	(001)
(*a*)	.7 6	6 . 1	6 6 .	1 6 6	
	.1 6	7 . 1	6 7 .	1 6 7	(002)
(*b*)	.7 6	7 . 7	6 7 .	1 7 1	(012)
	.1 7	1 . 1	6 1 .	1 6 1	
(*c*)	.7 6	1 . 7	6 1 .	7 6 1	(022)
	.7 7	6 . 7	7 6 .	1 1 7	(100)
(*d*)	.1 1	7 . 1	1 6 .	1 1 6	
	.1 1	1 . 1	1 1 .	7 7 7	(111)
(*e*)	.7 7	7 . 6	6 6 .	6 6 6	
	.6 6	7 . 6	6 7 .	6 6 1	(122)
(*f*)	.6 6	1 . 7	7 1 .	7 7 1	
	.7 1	6 . 7	1 6 .	7 1 6	(200)
(*g*)	.7 1	7 . 7	1 7 .	6 7 6	(210)
	.6 7	6 . 6	1 6 .	6 1 6	
(*h*)	.6 1	7 . 6	1 7 .	6 1 7	(220)
	.6 7	7 . 6	7 7 .	7 1 1	(221)
(*S* or *G*)	.7 1	1 . 6	1 1 .	6 1 1	
	.6 7	1 . 6	7 1 .	6 7 1	(222)

KEMANAK VERSION II (671→176)

(Intro)					
	.6 7	1 . 6	7 1 .	6 7 1	(222)
	.6 7	1 . 6	7 1 .	6 7 1	
(*S* or *G*)	.6 7	1 . 6	7 1 .	6 7 1	
	.6 1	1 . 6	1 1 .	7 1 1	(221)
(*a*)	.7 1	1 . 6	7 7 .	6 7 7	
	.6 1	7 . 6	1 7 .	6 1 7	(220)

(*b*)	.6 1	6 .6	1 6 .	6 7 6	(210)
	.6 7	6 .7	1 7 .	7 1 7	
(*c*)	.7 1	6 .7	1 6 .	7 1 6	(200)
	.7 7	1 .7	7 1 .	6 6 1	(122)
(*d*)	.6 6	1 .6	6 7 .	6 6 7	
	.6 6	6 .6	6 6 .	7 7 7	(111)
(*e*)	.7 7	7 .1	1 1 .	1 1 1	
	.1 1	6 .1	1 6 .	1 1 7	(100)
(*f*)	.1 1	7 .7	7 6 .	7 7 6	
	.7 6	1 .7	6 1 .	7 6 1	(022)
(*g*)	.1 6	1 .1	6 1 .	1 7 1	
	.1 7	1 .7	6 7 .	7 6 7	
(*h*)	.1 6	7 .1	6 7 .	1 6 7	(002)
	.1 6	6 .1	6 6 .	7 6 6	(001)
(*S* or *G*)	.7 6	6 .1	7 7 .	1 7 7	
	.1 7	6 .1	7 6 .	1 7 6	(000)

KEMANAK VERSION III (176→671→176)

(Intro.)					
	.1 7	6 .1	7 6 .	1 7 6	(000)
	.1 7	6 .1	7 6 .	1 7 6	
(*S* or *G*)	.1 7	7 .7	6 6 .	1 6 6	(001)
	.1 6	7 .1	6 7 .	7 6 7	(002, 012)
(*a*)	.1 7	1 .1	6 1 .	7 6 1	(012, 022)
	.7 6	1 .7	7 6 .	1 1 7	(022, 100)
(*b*)	.1 1	6 .1	1 1 .	7 7 7	(100, 111)
	.6 6	6 .6	6 7 .	6 6 1	(111, 122)
(*c*)	.7 7	1 .7	1 6 .	7 1 6	(122, 200)
	.7 1	7 .6	7 6 .	6 1 6	(210)
(*d*)	.6 1	7 .6	1 7 .	6 7 7	(220, 221)
	.7 1	1 .6	1 1 .	6 7 1	(221, 222)
(*e*)	.6 7	1 .6	1 1 .	7 1 1	(222, 221)
	.6 7	7 .6	1 7 .	6 1 7	(221, 220)

(*f*)	.6 1	6 .6	7 6 .	7 1 7	(210)
	.7 1	6 .7	1 6 .	7 7 1	(200, 122)
(*g*)	.6 6	1 .6	6 7 .	6 6 6	(122, 111)
	.7 7	7 .1	1 1 .	1 1 6	(111, 100)
(*h*)	.1 1	7 .7	7 6 .	7 6 1	(100, 022)
	.7 6	1 .1	6 1 .	1 7 1	(022, 012)
(*S* or *G*)	.7 6	7 .1	6 7 .	1 6 7	(012, 002)
	.1 6	6 .7	6 6 .	1 7 7	(001)

KEMANAK VERSION IV (671→176→671)

(Intro)					
	.6 7	1 .6	7 1 .	6 7 1	(222)
	.6 7	1 .6	7 1 .	6 7 1	
(*S* or *G*)	.6 1	1 .7	1 1 .	6 7 7	(221)
	.6 1	7 .6	1 7 .	6 1 6	(220, 210)
(*a*)	.6 7	6 .7	1 7 .	7 1 6	(210, 200)
	.7 1	6 .7	7 1 .	6 6 1	(200, 122)
(*b*)	.6 6	7 .6	6 6 .	7 7 7	(122, 111)
	.1 1	1 .1	1 6 .	1 1 7	(111, 100)
(*c*)	.7 7	6 .7	6 1 .	7 6 1	(100, 022)
	.1 6	1 .1	7 1 .	7 6 7	(022, 012)
(*d*)	.1 6	7 .1	6 7 .	1 6 6	(002, 001)
	.7 6	6 .1	7 7 .	1 7 6	(001, 000)
(*e*)	.1 7	6 .1	7 7 .	7 6 6	(000, 001)
	.1 6	6 .1	6 7 .	1 6 7	(001, 002)
(*f*)	.7 6	7 .1	7 1 .	1 6 1	(002)
	.7 6	1 .7	6 1 .	7 7 6	(022, 100)
(*g*)	.1 1	7 .1	1 6 .	1 1 1	(100, 111)
	.7 7	7 .6	6 6 .	6 6 7	(111, 122)
(*h*)	.6 6	1 .7	7 1 .	7 1 6	(122, 200)
	.7 1	6 .7	1 7 .	6 7 6	(200, 210)
(*S* or *G*)	.6 1	6 .6	1 7 .	6 1 7	(210, 220)
	.6 7	7 .7	1 1 .	6 1 1	(221)

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Appendix

Theoretical Notes

Bedhaya Guthrie/Bedhaya Sadra is based on a theory of ***morphological mutation functions*** developed by the composer. There are many such functions, and each one has several different parameters that may be changed. The mutations create a ***morphology*** (motive, shape, melody) that is some distance between a source and a target morphology (in this case the Sadra and Guthrie melodies). They mutate one morphology, or melody, into another on the basis of some combination of perceptual and morphological features (contour, interval magnitude).

A morphology can be thought of, in general, as any ordered list. The intervals between elements in this list (however they are defined) are the material for the mutation functions.

Each version in ***Bedhaya*** is distinguished by two things:

(1) the ***trajectory*** of the mutation

(2) the ***mutation*** used

TRAJECTORIES

Only two trajectories are used; a ***straight line*** from one melody to the other and an ***arch*** from one to the other and back again. By combining these two trajectories with the possibility of starting on either the Sadra or Guthrie melody, four combinations are possible:

$$G \rightarrow S$$

$$S \rightarrow G$$

$$G \rightarrow S \rightarrow G$$

$$S \rightarrow G \rightarrow S$$

These trajectories define the path from target to source by some melodic distance measure over the course of the version. This distance is called the ***mutation degree***, and varies from 0 (the source is unchanged) to 1 (some characteristic of the source, like its contour, is exactly the same as the same characteristic of the target). For example, in $G \rightarrow S$, the Guthrie

melody gets steadily changed into the Sadra melody. Each new melody is "further" from the Guthrie melody and "closer" to the Sadra melody. In $G \rightarrow S \rightarrow G$, this same process happens (twice as fast) and is then reversed, returning to the Sadra melody.

MUTATION FUNCTIONS

Each mutation function is of the general form:

$$M = mut(S, T, \Omega)$$

where S is the source melody, T is the target melody, M is the mutated melody, and Ω is the desired distance, or mutation degree, between 0 and 1, from S to M.

$mut(S, T, \Omega)$ transforms from S to T through M by some "inverse metric," or notion of distance. In general, metrics have corresponding mutation functions. Another way to describe this is:

$$S + \Omega(\Delta(S, T)) = M$$

that is, the value of the source, plus the mutation degree times some difference (Δ) between S and T equals the mutation. If $\Omega = 1$, then $M = T$ by the given mutation function. If $\Omega = 0$, then $M = S$ by the given mutation function. It is important to point out that the mutations often quantize the distance between two morphologies. This is certainly the case in *Bedhaya*.

Mutations generally operate on *intervals* in the source and target melodies. These intervals are taken between two elements in a melody, and are notated $\Delta(M_i, M_j)$ where M_i denotes the ith note of the melody M. Many interval functions Δ can be used, and not all are metrics. The simplest example of an interval (which is not a metric, because it can return a negative value) is that of the signed difference between two pitches represented as integers:

$$\Delta(M_i, M_j) = (M_i - M_j)$$

Another example (which is a metric), which preserves some notion of "inversion," takes the absolute value of that difference,

$$\Delta(M_i, M_j) = |M_i - M_j|$$

Mutations which operate on intervals transform a given source melody interval $\Delta(S_i, S_j)$ by some percentage (Ω, the mutation degree) into the interval $\Delta(T_i, T_j)$. For example, consider two three-element melodies represented as integers: $T = \{4, 10, 18\}$ and $S = \{5, 7, 11\}$. Δ can be defined, for a given melody (S) as:

$$(S_{i+1} - S_i)$$

or

$$S_{sgn} * S_{abs}$$

where S_{sgn} is the sign of the interval, and S_{abs} is the absolute interval magnitude

$$|S_{i+1} - S_i|$$

This definition of Δ retains the sign and magnitude of the interval. It is negative, or "goes down," if the second note is lower in pitch than the first, and positive, or "goes up" if the first note is lower in pitch than the second.

If the mutation degree $\Omega = .5$, the elements of M can be calculated as follows:

$$M_{i+1} = M_i + (S_{sgn} * (S_{abs} + \Omega * |T_{abs} - S_{abs}|))$$

Where $i = 1$, this equation yields:

$$M_2 = 5 + 2 + .5 * (1 * (6 - 2)) = 7 + 2 = 9$$

or half of the difference between the interval in the source and target.

The example above is only one type of mutation function, called the *Uniform Unsigned Interval Magnitude* (*UUIM*) mutation. This mutation retains the sign of the source interval but uses some percentage (Ω) of the difference in magnitude of the source and target intervals. Many variations of this general principle are possible, including mutations that use:

(1) the sign of the target, but the magnitude of the source

(2) the sign and magnitude of the target

and several others.[2]

Two different mutation functions are used to generate *Bedhaya*, called *Uniform Signed Interval Magnitude* (*USIM*) and *Linear Contour Mutation* (*LCM*)/*Irregular Unsigned Interval Magnitude* (*IUIM*). The following is a brief description of each.

The *Uniform Signed Interval Magnitude* (*USIM*) mutation mutates the *magnitude* of every interval in a source melody to be some portion of the corresponding interval in the target melody (corresponding to order of occurrence in the melody). It uses the direction (or sign) of the target interval. The source intervals are thus "stretched" or "compressed" gradually to equal those of the target. For example, if the source interval is 6, and the target 12, and the mutation degree at a given point of the piece is .5, the new interval in the mutated melody will be half the distance from the source interval to the target, added to the source interval, or 9. When used in its simplest way this mutation is just a *crossfade* between two melodies.

This mutation is sensitive to the sign of the target melody, or intervallic direction (or "contour"). In the situation above if the source interval is 6, and the target −6 (that is, the source interval is ascending, and the target descending), the new interval will be 0, or half the distance between +6 and −6, added to the source ("in the direction of the target," so actually subtracted). If this process were "animated" one would see the source melody's intervals gradually expand and contract into the intervals of the target, even changing direction as they passed through the zero point (if necessary).

The *USIM*, in other words, mutates each interval by sign (direction) and value every time but each interval is only mutated a percentage of the distance between source and target intervals. The equation for the *USIM* is:[3]

$$M_i = S_{int} + \Omega * (T_{int} - S_{int})$$

where, S_{int}, T_{int}, are

$$S_{int} = S_{sgn} * S_{abs}$$
$$T_{int} = T_{sgn} * T_{abs}$$

The *Linear Contour Interval* (*LCM*)/*Irregular Unsigned Interval Magnitude* (*IUIM*) is a concatenation of two mutations, one applied to the result of the other:

$$M = LCM(IUIM(S, T, \Omega))$$

The outer mutation (*LCM*), applied second, alters the direction, or contour of the intervals mutated first by the inner (*IUIM*) mutation, which makes some percentage (dependent on the index, Ω) of the intervals in the source to be the same absolute magnitude as the corresponding intervals of the target.

The *Linear Contour Mutation* (*LCM*) mutation changes the direction of a certain percentage of the intervals in the source to be the same as the direction of the corresponding intervals in the target. The "percentage" is given by the current value of the mutation degree trajectory, or Ω. In the *LCM* the intervals of the resultant mutated melody retain the absolute value of the magnitude of the respective intervals in the source (as in the conventional notion of melodic inversion). For example, if an interval in the source was −6, and the corresponding target interval was +3, the new interval (if changed) will be +6. In a simple application of this mutation intervals change quite radically. The general equation for the *LCM* is:

$$M_i = M_j + (T_{sgn} * S_{abs})$$

when the interval is changed. In the version of the LCM used in this piece, if Ω = .5, every other interval will be changed. This is called an *irregular* mutation function, since not every interval is changed at each mutation.

In the more general mutation theory, the way changed intervals are distributed in the melody in irregular mutations is called *clumping* (∂).[4] Higher clumping values tend to group the mutated intervals closely together rather than distributing them evenly. For example, with a clumping value of 1 (the highest possible), and a mutation index of .5, the first half of the melody will be mutated and the second half will be identical to the source.

In *Bedhaya* the decision to change an interval or not is made stochastically on the basis of the mutation degree. Since the mutation degree always moves on a trajectory from 0 to 1 (and sometimes back to 0), at the "top" of the trajectory, all the intervals will be changed, and at the "bottom," none of the intervals will be changed. This is equivalent, in effect, to using only one *clumping value* for the piece: 0, or most even distribution of the mutation degree (which is approximated by a uniform stochastic function). The two mutations (*LCM* and *IUIM*) make independent stochastic choices about which intervals to mutate, so there are many possible versions with this concatenated mutation.

The *Irregular Unsigned Interval Magnitude* (*IUIM*) changes some percentage of the intervals in the source to be exactly the same in

absolute value as the intervals in the target. These intervals don't "bend" to the new intervals, but jump to them in absolute difference. Like the *LCM*, the *IUIM* has unusual and surprising results. For example, a small descending interval can jump immediately to a large descending interval. The general equation for the *IUIM* is the "inverse" of the *LCM*:

$$M_i = M_j + (S_{sgn} * T_{abs})$$

when the interval is changed. With an index of 1 for both mutations, if first the *IUIM* is applied to an interval (change its magnitude to be that of the target) and then the *LCM* is applied (change its direction), the resulting interval will be the same as the target, and the same as applying the *USIM* (with an index of 1).

The important difference between the *USIM* and *LCM/IUIM* is that even though with a mutation degree of 1 they both yield the same result, the "form" or "shape" of the change (morphogenesis) is very different, musically and perceptually. The first mutation (*USIM*) changes *each interval by some degree every time*, and is perceptually quite smooth. It effects a gradual transition from source to target. The second pair of mutations (*LCM/IUIM*) selects *some percentage of the number of intervals* to be mutated and the resulting morphogenesis will be perceptually "jagged."

By applying the *LCM* to the results of the *IUIM* many possibilities of change are created. Since the interval selection process is stochastic, the same interval in the source will not be necessarily changed by both the *IUIM* and *LCM*. For example, in the *LCM/IUIM*, with a mutation degree of .5, half of the intervals will be changed completely to the target by each of the mutations, in either direction or magnitude, but not necessarily the same intervals.

These two mutations are taken from a continually evolving library of mutation and metric functions which attempt to describe the ways that forms (morphologies) relate to each other along certain perceptual and musical axes. In *Bedhaya*, simple mutations are used which deal with the perception of *contour* and *intervallic magnitude*. However, many other types of mutation are possible, as well as many interesting variations of these basic principles. *Bedhaya Guthrie/Bedhaya Sadra* is intended as a first study in this area.

The kemanak part is derived from a simple notion of *the number of possible combinatorial contours* (CC_n) for a given set of elements. In this case the number of elements is three, and the number of such contours is 13. In general, the formula for the number of possible contours of a set of length n is:

$$\sum_{k=1}^{n} k!\, S(n, k)$$

where $S(n, k)$ is a *Stirling number of the second kind.*

Each of the kemanak versions is simply a list of these contours, often with various "versions" of the contour. For example, 771, 661, and 667 all have the same contour, which I call {122}.[5] (Note that 1 is assumed to be the highest note, as is usual with kemanak). Each kemanak version starts at one end of the list (e.g 671, or {222}), and proceeds through a gradual transformation of contour to the other end of the list (e.g 176, or {000}). The four kemanak versions are the result of combining each of the "triangle and straight line trajectories" with the two possibilities of starting at either end of the list.

Notes

1. "Ro" is derived from the Javanese *loro*, or the number 2; *besar* and *gedhe* mean large in Indonesian and Javanese, respectively, and *kecil* and *cilik* mean small.

2. A more general theory of these mutations and their associated morphological metrics (the distance functions from which they are derived) has been described in more detail in the articles "Morphological Mutation Functions: Applications to Motivic Transformation and a New Class of Cross-Synthesis Techniques," by the composer and Martin McKinney, *ICMC Proceedings*, Montreal, 1991, and "Spectral Mutation in Soundhack," by the author and Tom Erbe, *Computer Music Journal*, forthcoming.

3. By restricting the interval measure used, and by requiring that the first elements be the same in S and T, the general equation above can be simplified to represent a point-by-point crossfade between two melodies.

4. For a slightly more extended discussion of clumping, see my article "More on Morphological Mutations," in the *ICMC Proceedings*, San Jose, 1992.

5. In this notation, a three-digit ternary number indicates the *combinatorial contour* of the three notes, with 0 indicating descension, 2 ascension, and 1 equality. For example, in the three-note triplet 771, the first element is equal to the second {1}, ascends to the third {2}, and the second element ascends to the third {2}, giving the three-digit ternary number {122}. For more on this notion of combinatorial contour, see my article with Richard Bassein, "Possible and Impossible Melody: Some Formal Aspects of Contour," *Journal of Music Theory* 36, no. 2 (Fall 1992).