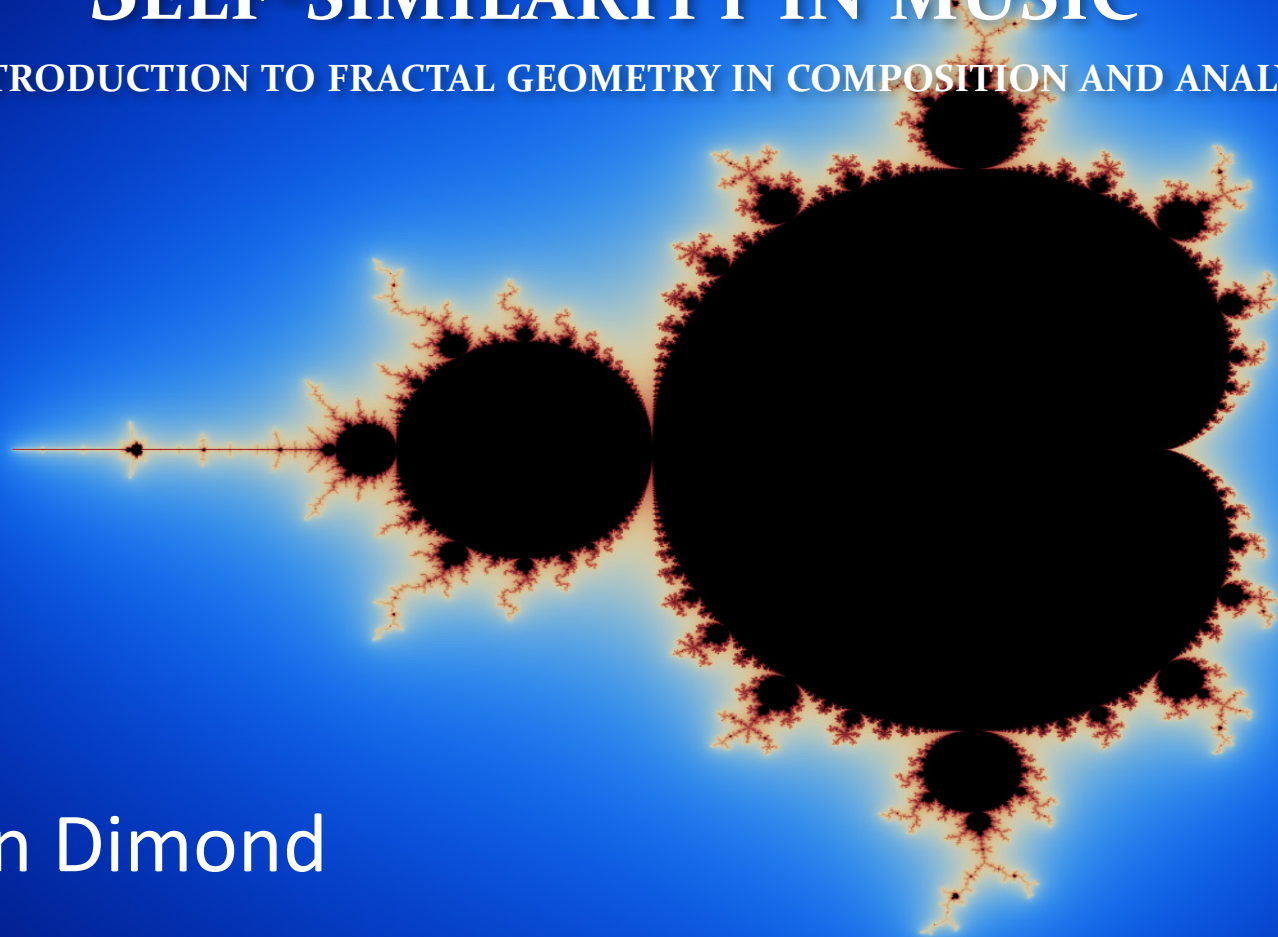


SELF-SIMILARITY IN MUSIC

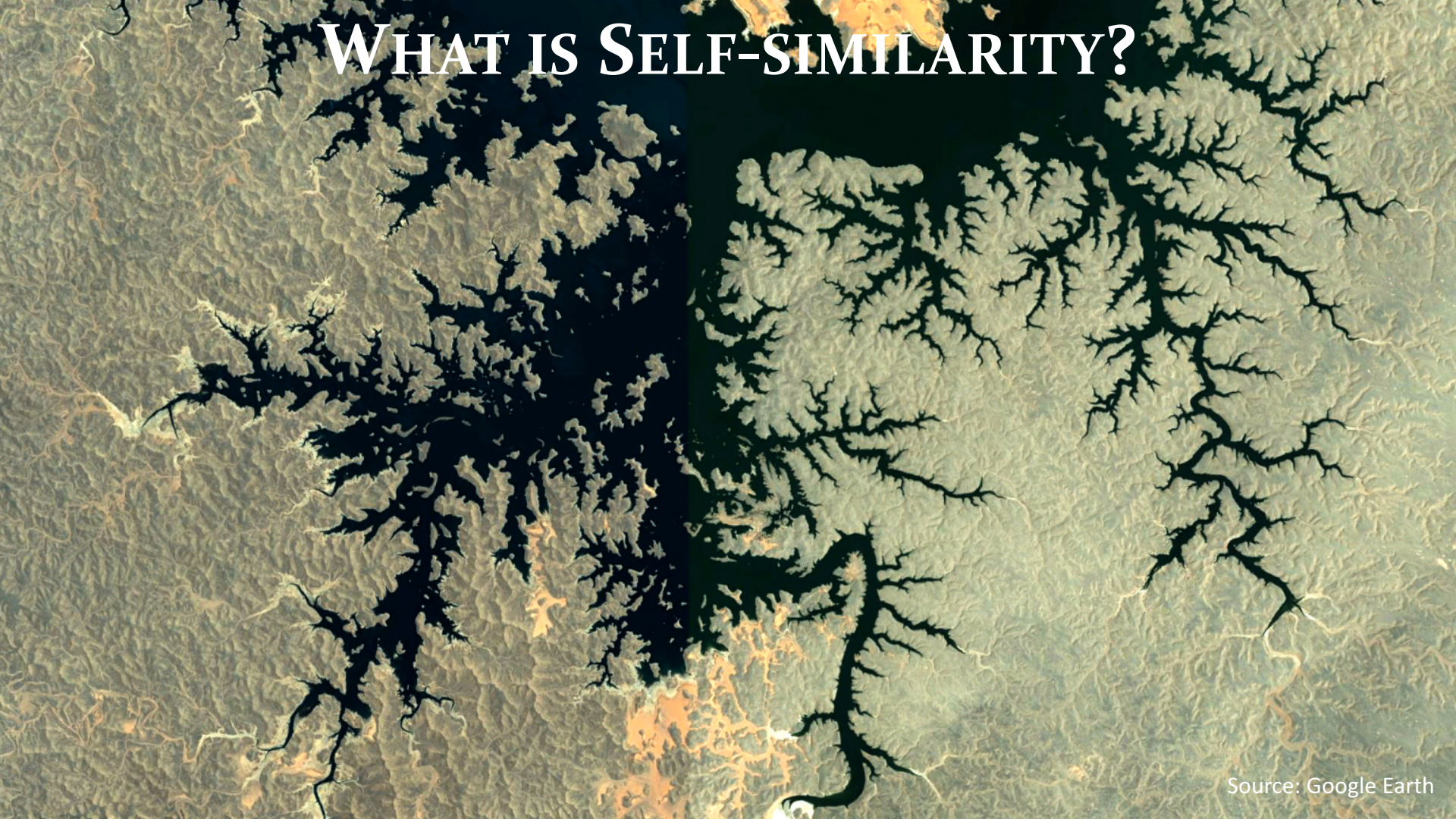
AN INTRODUCTION TO FRACTAL GEOMETRY IN COMPOSITION AND ANALYSIS



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April 2017

WHAT IS SELF-SIMILARITY?

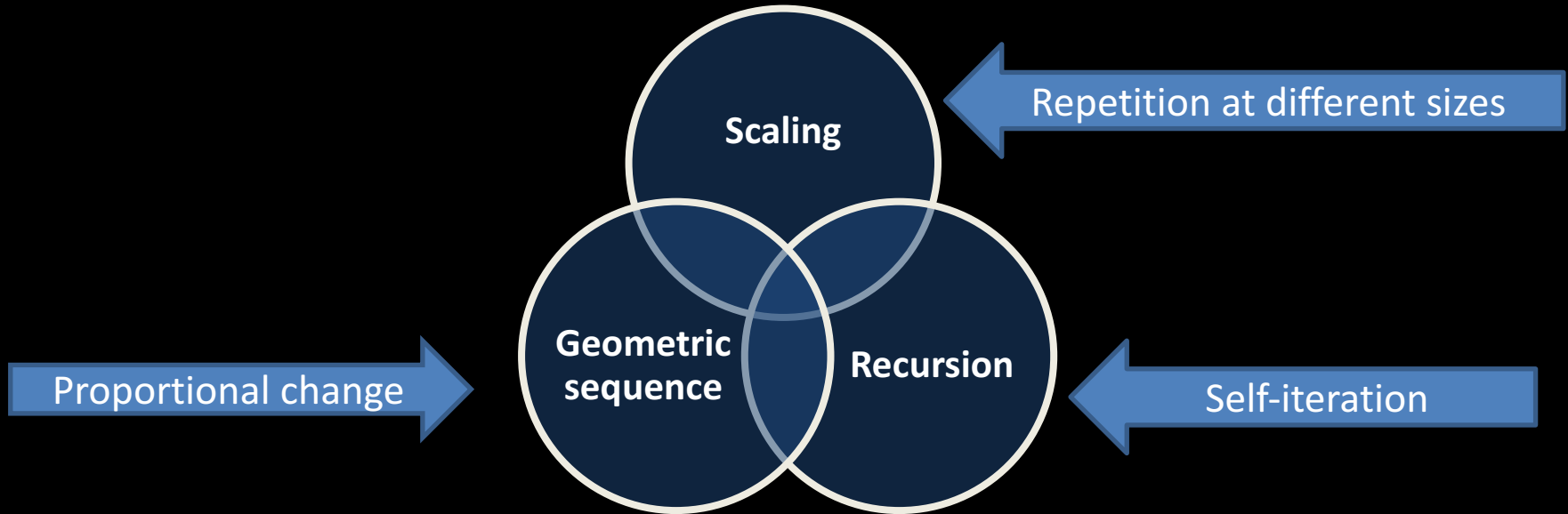


Source: Google Earth

TOWARDS A MUSICAL INTERPRETATION OF SELF-SIMILARITY AND FRACTAL GEOMETRY

Spatial relationships of fractal geometry translate to musical parameters – e.g. pitch and time.

INDICATORS OF SELF-SIMILARITY



LET'S SING...

A musical score for a song titled "LET'S SING...". The score is written on two staves in the key of A major (indicated by three sharps: F#, C#, G#). The first staff begins with a treble clef and a key signature of three sharps. The melody is written in a simple, accessible style, with lyrics underneath. The lyrics are: "Row, row, row your boat gen - tly down the stream". The second staff begins with a treble clef and a key signature of three sharps. The melody continues with lyrics: "mer - ri - ly mer - ri - ly mer - ri - ly mer - ri - ly life is but a dream". The score includes chord markings: "A" above the first staff, "E7" above the second staff, and "A" above the third staff. The score is numbered "5" at the beginning of the second staff.

5

A

Row, row, row your boat gen - tly down the stream

mer - ri - ly mer - ri - ly mer - ri - ly mer - ri - ly life is but a dream

E7

A

THAT SURE WAS FUN...
BUT WAS THAT SELF-SIMILARITY?



LET'S SING...

A

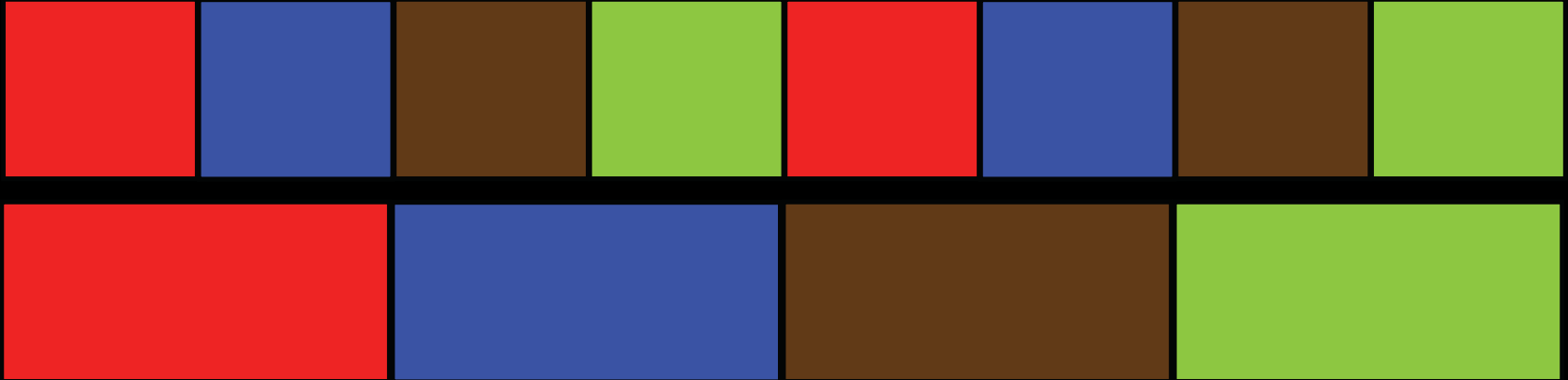
Row, row, row your boat gen - tly down the stream

5

mer - ri - ly mer - ri - ly mer - ri - ly mer - ri - ly life is but a dream

E7 A

THAT SURE WAS FUN...
BUT WAS *THAT* SELF-SIMILARITY?



LET'S SING...

A

Row, row, row your boat gen - tly down the stream

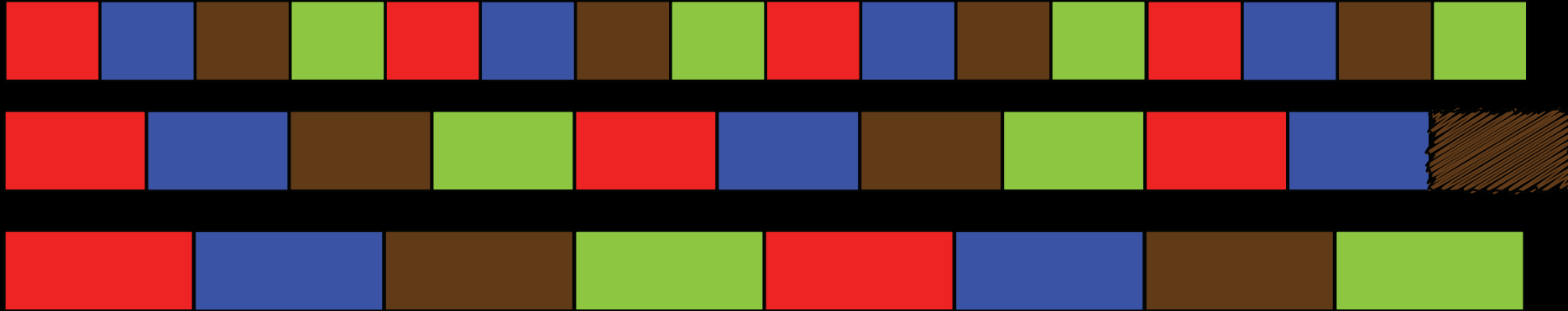
5

mer - ri - ly mer - ri - ly mer - ri - ly mer - ri - ly life is but a dream

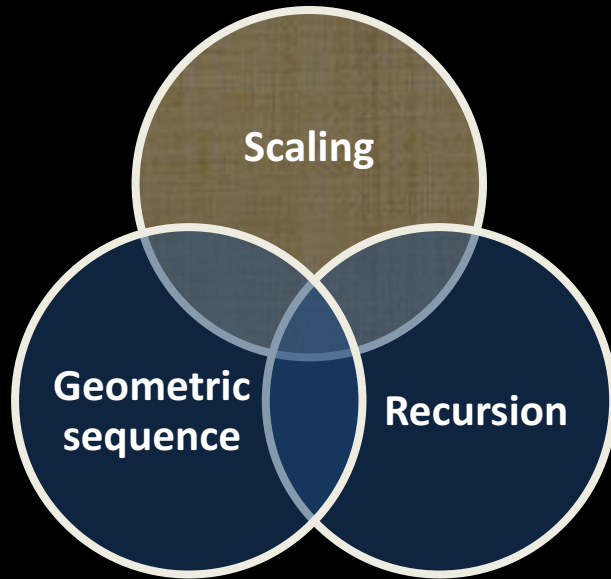
E7

A

THAT SURE WAS FUN...
BUT WAS THAT *ALSO* SELF-SIMILARITY?



SELF-SIMILAR TECHNIQUE: RHYTHMIC AUGMENTATION / DIMINUTION



SELF-SIMILAR TECHNIQUE: INTERVAL SCALING

Interval scaling - proportional (or arithmetic) change in interval size

The image shows a musical staff in 6/8 time with a treble clef. It contains two measures of a 'Motive' and two measures of the motive scaled by a factor of 3. The intervals are indicated by numbers below the notes.

Motive

Intervals: -1, +3, -2, -2

Scaled by +/- 1

Intervals: -2, +4, -3, -3

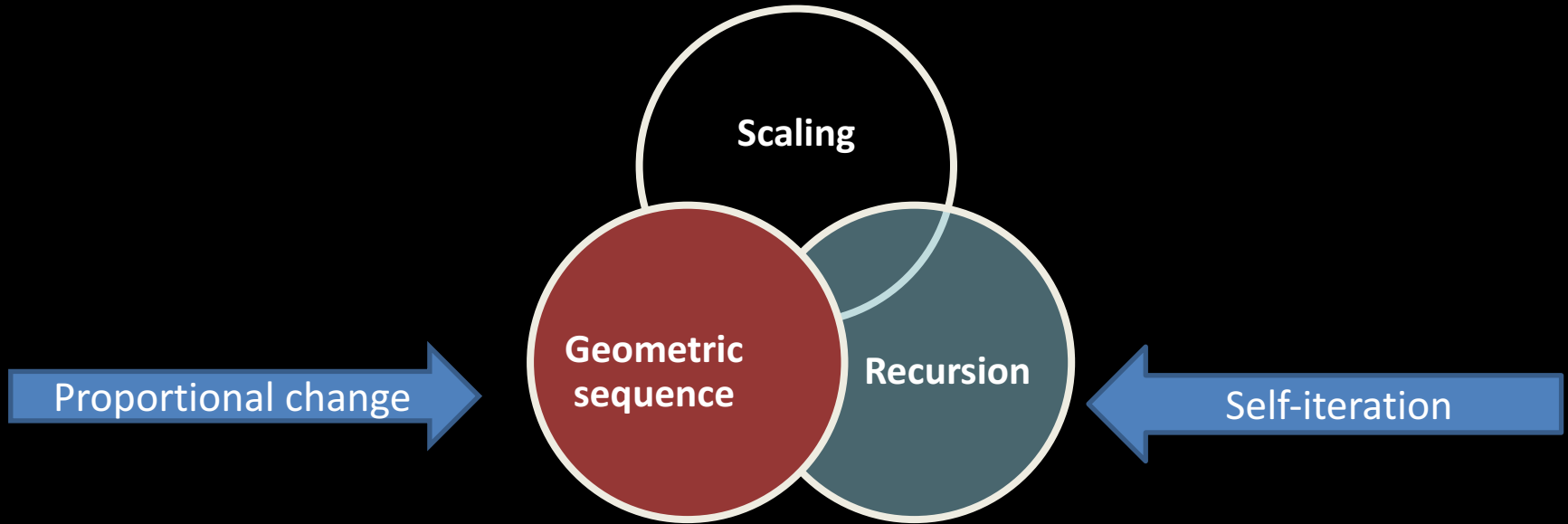
Motive

Intervals: -1, +3, -2, -2

Scaled by factor of 3

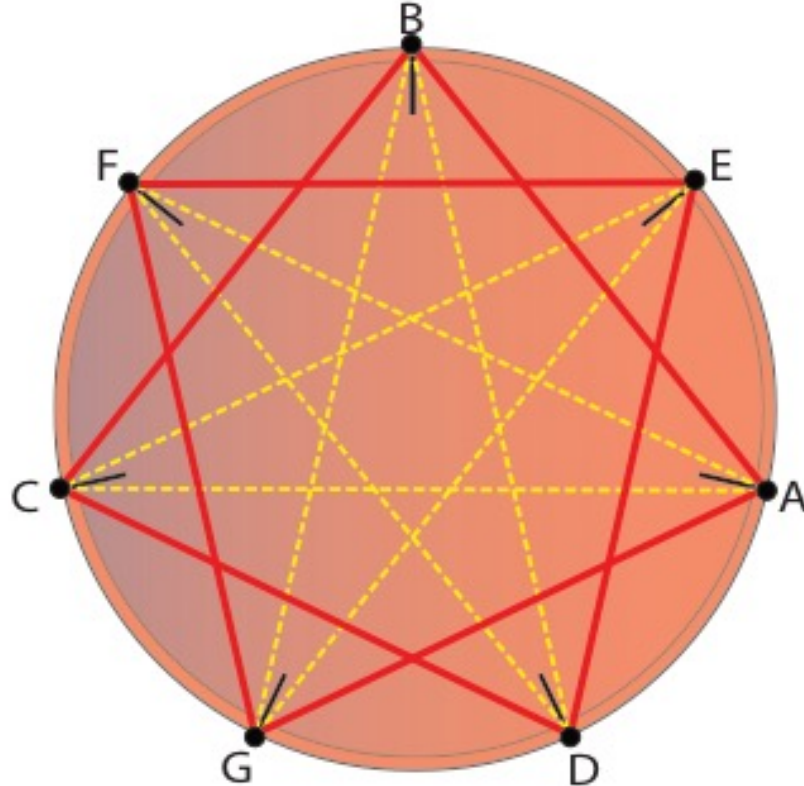
Intervals: -3, +9, -6, -6

FOCUS ON OTHER FEATURES OF SELF-SIMILARITY...



SELF-SIMILAR TECHNIQUE: SELF-SIMILAR SCALES

Self-similar scales – built from reiteration of an interval



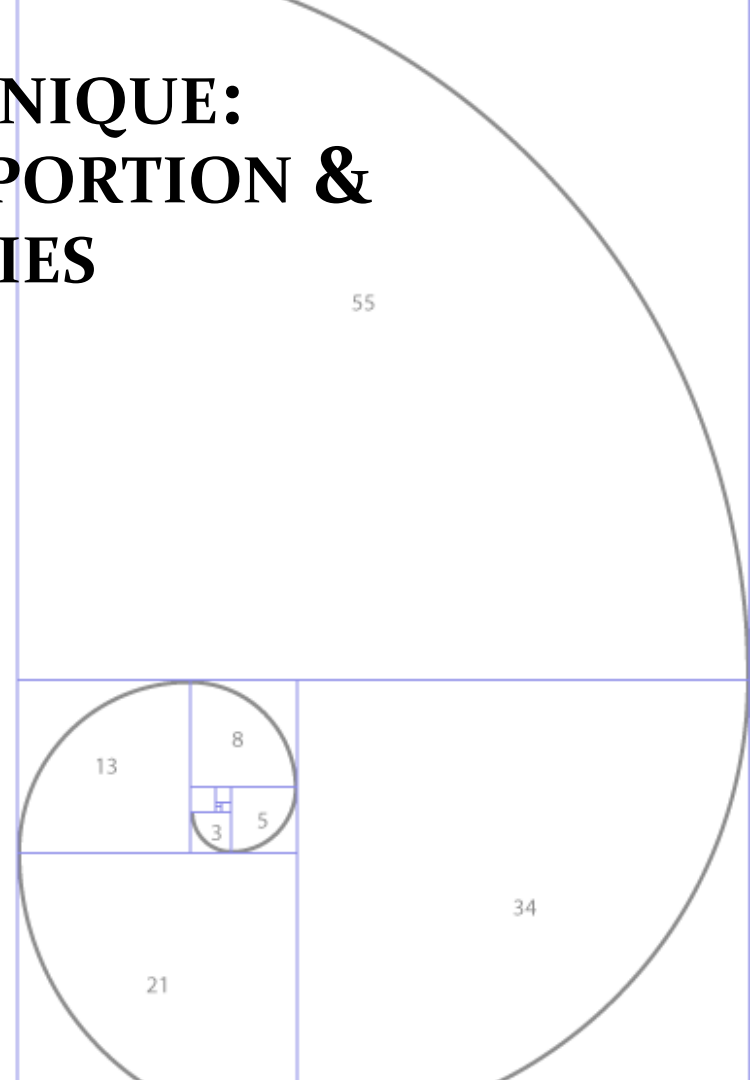
“Well-formed” scale:

Carey and Clampitt

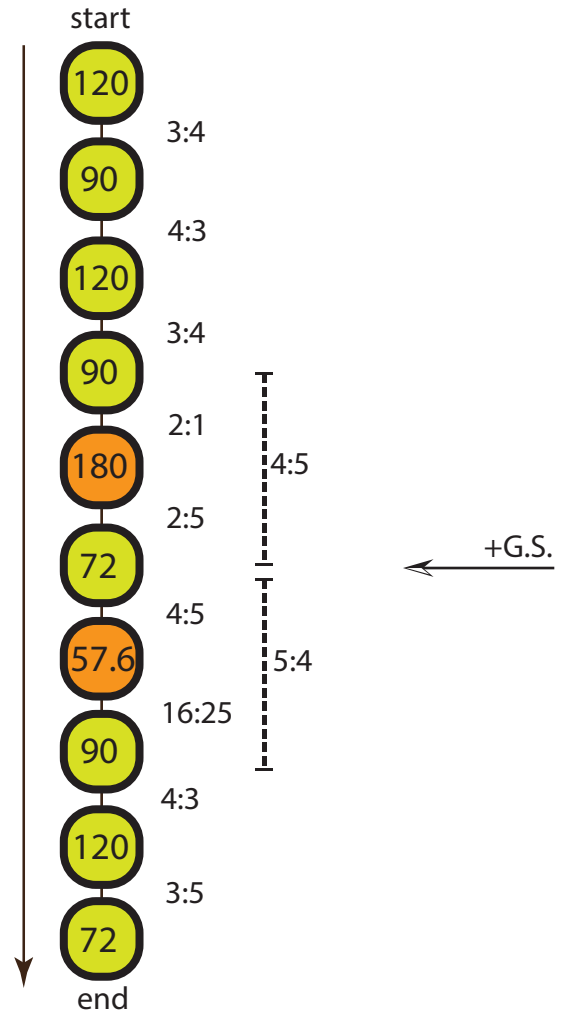
Perspectives of New Music, Summer 1996

SELF-SIMILAR TECHNIQUE: GOLDEN SECTION PROPORTION & FIBONACCI SERIES

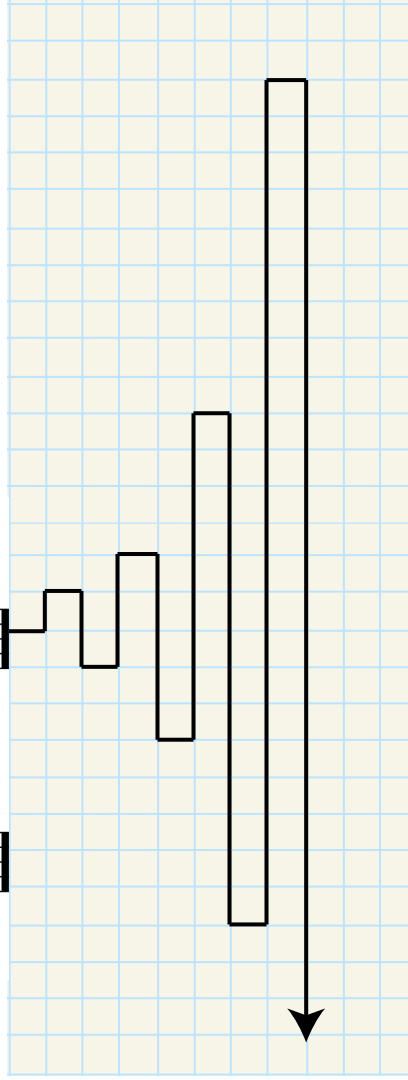
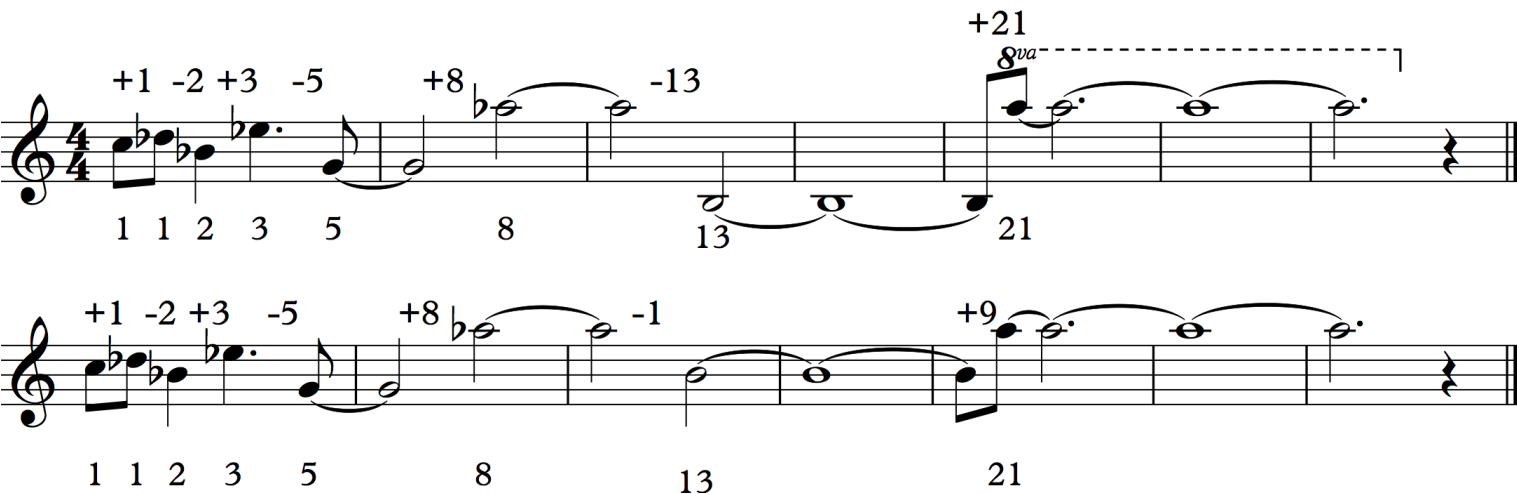
$$\frac{a+b}{a} = \frac{a}{b} = \varphi$$



SELF-SIMILAR TECHNIQUE: GOLDEN SECTION PROPORTION IN STRUCTURE



SELF-SIMILAR TECHNIQUE: GOLDEN SECTION PROPORTION IN MELODIC CONTOUR



SELF-SIMILAR TECHNIQUE: RECURSIVE MELODIES

Built from reiteration of cell idea
May use an automaton

SELF-SIMILAR RECURSIVE MELODY

What types of counting do you know that contain levels, or are “nested”?

- Counting bars rest (1234, 2234, 3234, 4234, ...)
- Simple counting in a base (1, 2, 3, 4, ..., 10, 11, 12, 13, 14, ...)

Let's consider ways of creating self-similar patterns from simple counting

(1, 2, 3, 4, ...)

SELF-SIMILAR RECURSIVE MELODY

Tom Johnson* defines self-similar categories of counting:

Accumulative counting (in the normal counting sequence, 2 becomes 12 and 3 becomes 123, etc)

1

12

123...

*Johnson, Tom. *Self-similar melodies*.

SELF-SIMILAR RECURSIVE MELODY

Accumulative counting is used in South Indian rhythmic patterns called *Yati*.

1
12
123
1234
12345

Srotogata yati

12345
1234
123
12
1

Gopuccha yati

1
12
123
1234
12345
1234
123
12
1

Mridanga yati

SELF-SIMILAR RECURSIVE MELODY

Repetitive counting (in the normal counting sequence,
2 becomes 22 and 3 becomes 333, etc)

1

22

333...

SELF-SIMILAR RECURSIVE MELODY

Two-level self-similar counting.

Repetitive accumulative counting sequence:

1

1 22

1 22 333...

0 1
1

SELF-SIMILAR RECURSIVE MELODY

This musical score illustrates a self-similar recursive melody in 4/4 time, organized into four measures. The score is written on six staves, with the first four staves grouped by a brace on the left. The notation demonstrates how a complex melody is built from simpler, recursive components.

Staff 1 (Treble Clef): Contains the full, complex melody for each measure, composed of many eighth and sixteenth notes.

Staff 2 (Treble Clef): Shows the first iteration of the recursive construction, using only quarter and eighth notes.

Staff 3 (Treble Clef): Shows the second iteration, using only quarter notes.

Staff 4 (Bass Clef): Shows the third iteration, using only half notes.

Staff 5 (Bass Clef): Shows the fourth iteration, using only whole notes.

Staff 6 (Bass Clef): Shows the final iteration, using only whole notes, with a long horizontal line indicating the duration of the notes.

SELF-SIMILAR RECURSIVE MELODY

Thue-morse sequence

Voice 1: 0110 1001 1001 0110 1001 0110 0110 1001

Voice 2: 0 1 1 0 1 0 0 1 1 0 0 1 0 1 1 0 1 0 0 1 ... etc

Voice 3: 0 1 1 0 1 0 0 1 1 0 ... etc

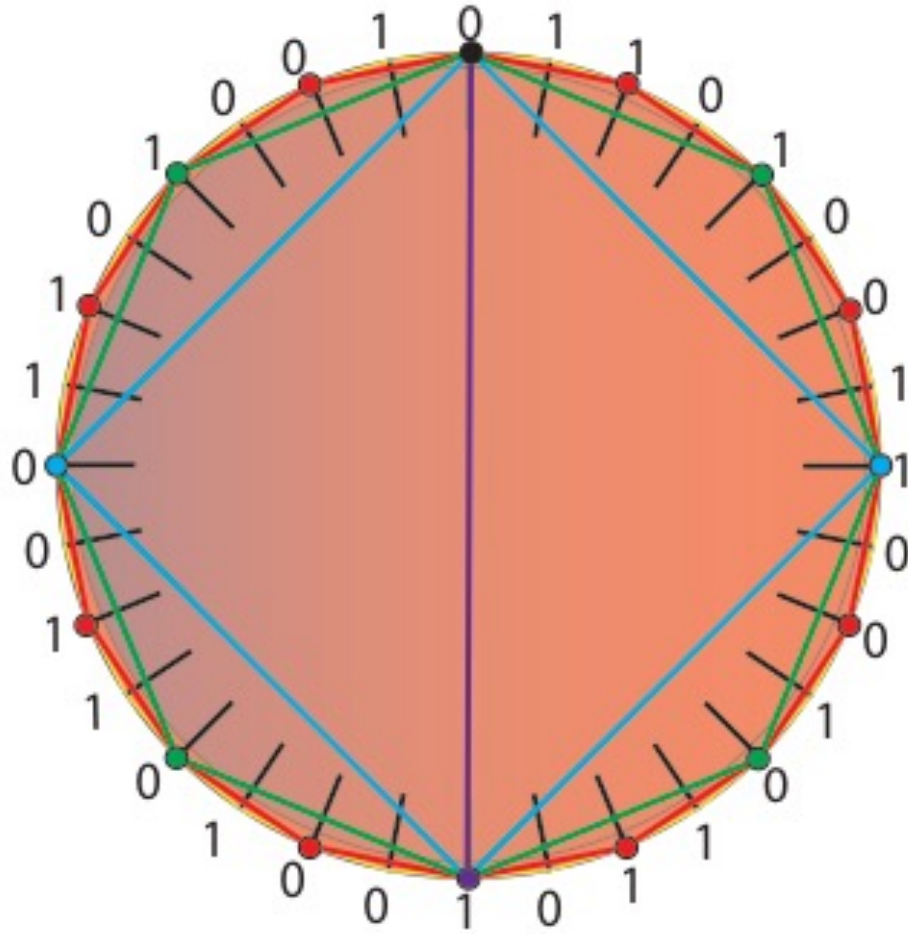
Voice 4: 0 1 1 0 1 ... etc

Voice 5: 0 1 1 ... etc

Voice 6: 0 1 ... etc

Automaton: 0 -> 01 & 1 -> 10 (digit seed of 0)

SELF-SIMILAR RECURSIVE MELODY





Thank you...

*If we contemplate the method of Nature, we see
that everywhere vast results are brought about
by accumulating minute actions.*

Herbert Spencer. *Principles of Sociology* (1896), p.366.