

RECORDED MUSIC | 6.30-9p
Fractal Music in Honor of
Benoît Mandelbrot
(1924–2010)

PERFORMANCE | 8p
Music for Pieces of Wood,
by Steve Reich | Performed by
the Yale Percussion Group

Welcome Reception | Music Program
Peabody Museum of Natural History
Yale University
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ScienceWriters2010

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In the visual domain, the eye can quickly guide us in identifying fractal structure. Looking at the Mandelbrot set, we instantly examine its boundary rather than the interior. On the other hand, a glimpse of the Sierpinski triangle draws us not to its outer boundary, but directly to its gasket-like interior. Sometimes we discern multiple possibilities for measurement, as in the case of a tree: we can investigate the structure of its branches, root system, canopy, or perhaps its mass distribution; the view from a distance might suggest assessing its relation to the forest as a whole.

As with graphics, to find fractal structure in music we must first decide what characteristic we wish to examine. However, given music's ephemeral nature, it is more difficult for the ear to guide us in identifying potentially fractal structure. Musical compositions can indeed manifest a wide variety of the power-law relationships that form the foundation of fractal geometry. Echoing the self-similarity of cloud-like structures, these relationships often arise in a statistical sense that requires careful measurement. The following types of fractal scaling are represented in this evening's recorded music:

- Pitch scaling: The distribution of pitches is statistically self-similar.
- Duration scaling: The distribution of durations is statistically self-similar.
- Melodic interval scaling: The distribution of melodic intervals (changes in pitch) is statistically self-similar.
- Melodic moment scaling: The distribution of the changes in melodic intervals is statistically self-similar.
- Motivic scaling: A melodic or rhythmic motif is repeated simultaneously at different time scales.
- Event density scaling: The distribution of note activity as measured by onset and release times is statistically self-similar.
- Structural scaling: An aspect of the compositional structure follows a recursive form.

To be clear, music can also exhibit other types of scaling, some based on the properties of audio signals. However, the selection of music you will hear this evening was chosen because it shows strong evidence of fractal structure with respect to some aspect of the written score. Here, we are interested the intentional, or more often, unintentional design of the composer.

>> Over for compositions being played tonight >>

For further information, visit: www.brotherstechnology.com/math/fractal-music.html

Music for Pieces of Wood, by Steve Reich

Performed by the Yale Percussion Group

About the Yale Percussion Group

Founded in 1997 by Robert van Sice, the Yale Percussion Group has been called “something truly extraordinary” by composer Steve Reich. It is composed of talented and dedicated young artists who have come from around the world for graduate study at the Yale School of Music. Members of the YPG have gone on to form the acclaimed quartet So Percussion and to perform with Lincoln Center’s Chamber Music Two, the Carnegie Hall Academy Ensemble, the Oslo Philharmonic, and the Orpheus Chamber Orchestra. Yale percussion students and graduates have recently won the Linz (Austria) International Marimba Competition and the Concert Artist Guild Competition. Recent alumni teach at institutions such as Cornell University, Dartmouth College, Michigan State University, SUNY Stony Brook, UMass Amherst, Baylor University, and the Conservatoire de Genève (Switzerland).

About the music

“*Music for Pieces of Wood* grows out of the same roots as *Clapping Music*: a desire to make music with the simplest possible instruments. The claves—cylindrical pieces of hard wood—used in the piece were selected for their particular pitches (A, B, C-sharp, D-sharp, and D-sharp an octave above), and for their resonant timbre. This piece is one of the loudest I have ever composed, but uses no amplification whatsoever. The rhythmic structure is based entirely on the process of rhythmic “build-ups” or the substitution of beats for rests, and is in three sections of decreasing pattern length: 6/4, 4/4, 3/4.” (Adapted from Steve Reich’s notes for “Steve Reich @ 70” at Carnegie Hall [<http://bit.ly/dlQ8yA>])

About the composer

Steve Reich has recently been called “our greatest living composer” (*The New York Times*), “America’s greatest living composer” (*The Village Voice*), “. . . the most original musical thinker of our time” (*The New Yorker*), and “. . . among the great composers of the century” (*The New York Times*). From his early taped speech pieces *It’s Gonna Rain* (1965) and *Come Out* (1966) to his collaboration with video artist Beryl Korot on the digital video opera *Three Tales* (2002), Reich’s path has embraced not only aspects of Western Classical music, but the structures, harmonies, and rhythms of non-Western and American vernacular music, particularly jazz. “There’s just a handful of living composers who can legitimately claim to have altered the direction of musical history and Steve Reich is one of them,” says *The Guardian*. In April 2009 Reich was awarded the Pulitzer Prize in music for his composition *Double Sextet*. (Adapted from steverreich.com)

Recordings played tonight

Agnus Dei II from *Missa L’homme Armé Super Voces Musicales*, by Josquin des Prez (1440–1521), Motivic scaling

Allemande from *Cello Suite No. 1, BWV 1007*, by Johann Sebastian Bach (1685–1750), Interval & moment scaling

Go for Baroque, by Harlan Brothers (Contemporary), Duration scaling

Sarabande from *Partita for Solo Flute, BWV 1013*, by Johann Sebastian Bach, Interval & moment scaling

Country Dance, by Harlan Brothers, Pitch & duration scaling

Bourrée I from *Cello Suite No. 3, BWV 1009*, by Johann Sebastian Bach, Structural scaling (form: AAB)

Polonaises, Op. 40: No. 1, by Frédéric Chopin (1810–1849), Event density scaling

Art of Fugue, Contrapunctus IX, BWV 1080, by Johann Sebastian Bach, Interval scaling

Reel One, by Harlan Brothers, Structural scaling (form: AABA)

Stretch, by Harlan Brothers, Motivic scaling

Anemona, by Dmitry Kormann (Contemporary), Structural scaling (based on Golden Ratio)

Le Tombeau de Couperin (Forlane), by Maurice Ravel (1875–1937), Event density scaling

Study No. 31—Canon 21/24/25, by Conlon Nancarrow (1912–1997), Motivic scaling

Funky Cantor, by Harlan Brothers, Structural scaling (form: AABA)

Monkey Run, by Harlan Brothers, Motivic scaling (percussion part)

Brecker 8, by Harlan Brothers, Interval scaling

Giant Steps, by John Coltrane (1926–1967), Interval & moment scaling (saxophone solo)

Benoît Mandelbrot endlessly extolled the virtue and power of the eye in discerning mathematical truth. It guided him relentlessly through an eclectic array of natural, cultural, and scientific phenomena where issues of scaling, texture, and roughness arise. He always had a strong sense that music, too, shared something of these qualities in a measurable sense.

During a discussion at Yale in 2003, Benoît suggested I explore exactly what it means to say that a given piece of music is fractal. The simple sincerity of his request profoundly influenced the course of my life.

This evening’s music is dedicated to Benoît and his boundless legacy.

— Harlan J. Brothers ©2010