Musical variations from a chaotic mapping

Written by Diana S. Dabby
Presented by Ching-Hua Chuan
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Outline

- Introduction
  - Author, paper's goal, background
- The chaotic mapping
- Results and analysis
  - Three variations on Bach's prelude No. 1
  - A variation on Gershwin's prelude
  - *Islamorada* and the variation
  - Remarks on parameter settings
- Conclusion

The Author

- Diana S. Dabby
  - Associate Professor of Electrical Engineering and Music in Olin college
  - Concert pianist, composer, Ph.D. from MIT
  - Developed unique synthesis of art and engineering she hopes will help revolutionize music
  - "Crazy about" electric trains
  - Loves downhill biking, hates uphill biking
  - Believes engineering helps her as musician and vice versa.
  - Life philosophy: "I like reaching people, whether as a composer, performer or teacher."

Introduction

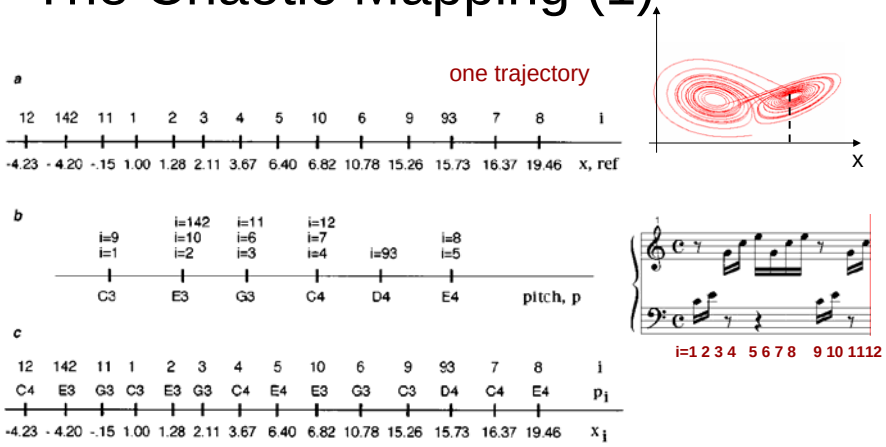
- Goal
  - Apply chaotic mapping to generate musical variations.
  - Variation: changed but still recognized as the same piece.
  - Inspire composers from the generated ideas.
- History of science and music
  - Math, physics, and stochastic v.s. music
- Chaotic dynamics
  - Output is converted to notes, attack envelopes, loudness levels, texture, timbre…etc.

Chaotic Theory

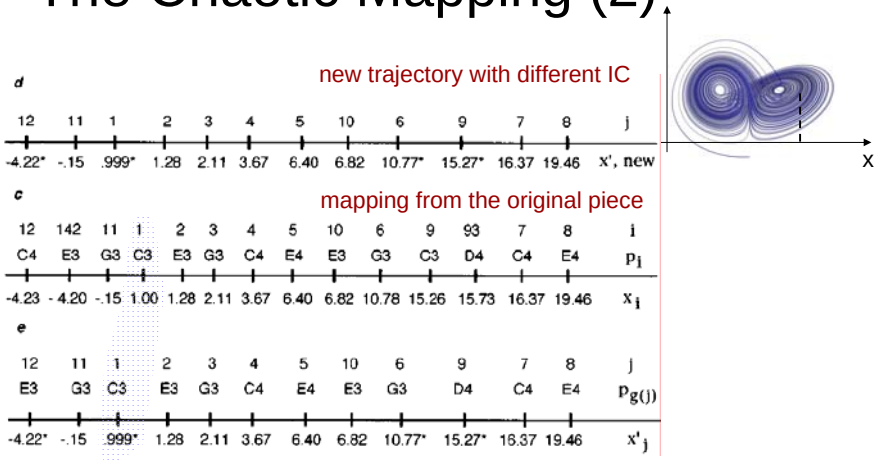
- In mathematics and physics, **chaos theory** describes the behaviour of certain nonlinear dynamical systems that under certain conditions exhibit a phenomenon known as **chaos**.
- A dynamical system is chaotic if:
  - Sensitive to initial condition (IC)
  - Topologically mixing
  - The periodic orbits must be dense
- Lorenz attractor: a chaotic map

$$\frac{dx}{dt} = \sigma(y - x)$$
$$\frac{dy}{dt} = x(\rho - z) - y$$
$$\frac{dz}{dt} = xy - \beta z$$

The Chaotic Mapping (1)



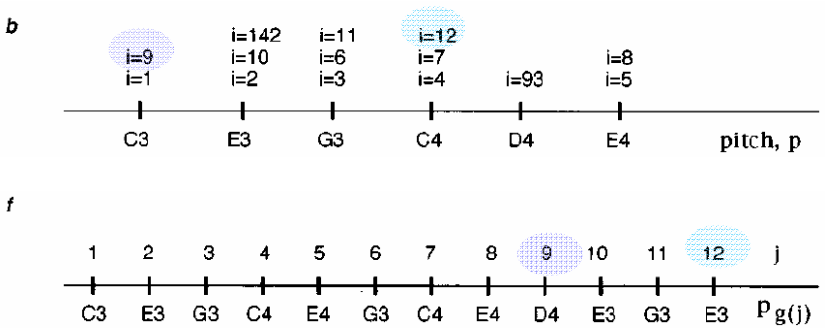
The Chaotic Mapping (2)



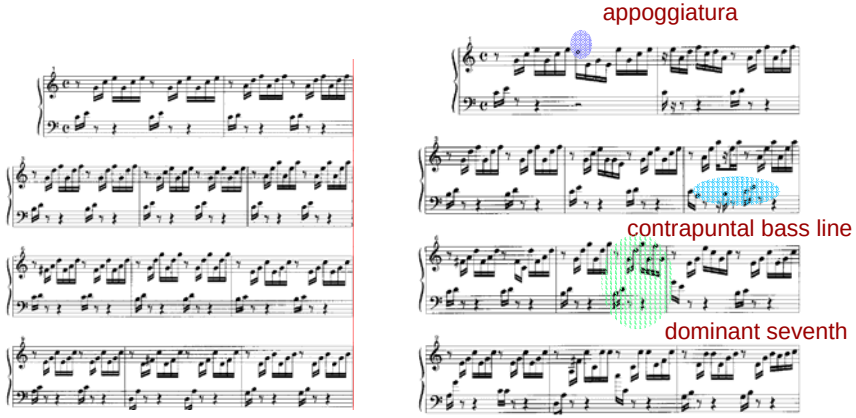
g(j): i of the smallest x_i wherer $x_i \geqq x_j'$

The Chaotic Mapping (3)

After the mapping…

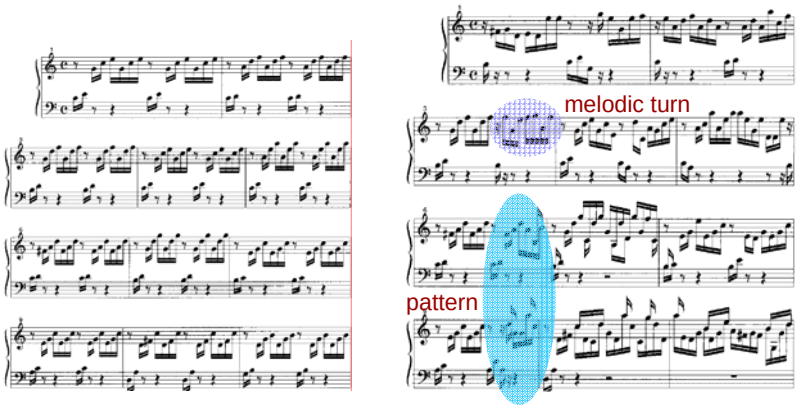


Variation 1 on Bach's



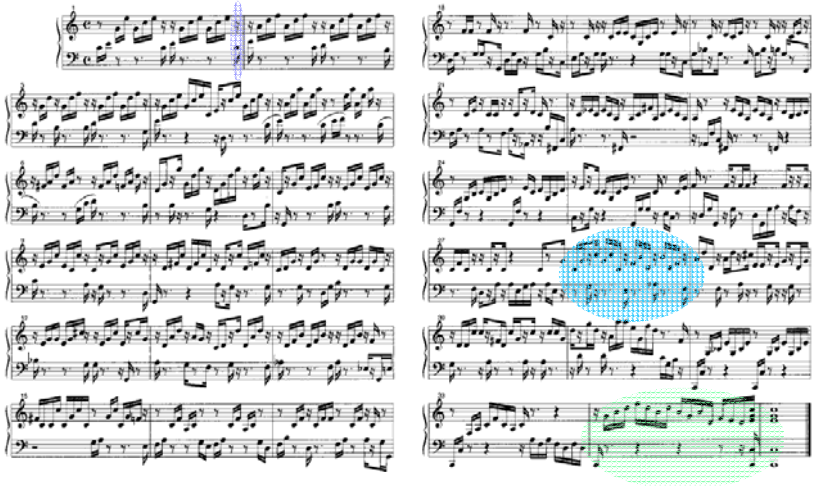
Original Variation 1

Variation 2 on Bach's

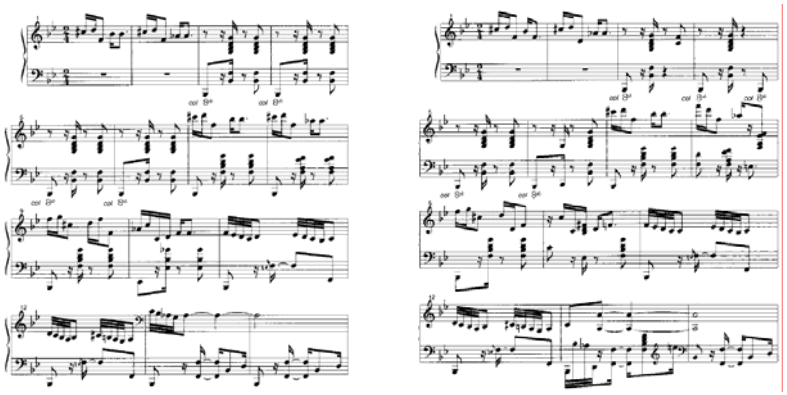


Original Variation 2

Variation 3 on Bach's



Variation 1 on Gershwin's



Original Variation 1

Islamorada and the variation

- *"Islamorada*, a concerto for piano and percussion, captures a small town in the Florida Keys. The work opens with percussion alone, followed by the entrance of the piano, left hand alone. The pianist's left hand plays as a solo instrument for the first 2 ½ minutes, after which the right hand enters by crossing over the left hand and reinventing an earlier motive."
- Variation.

Remarks on Parameter Settings

- Step size
  - Too big or too small, eliminates the track ability.
- Initial condition
  - The degree of variation should be proportional to IC.
- Infinite length of mapping
  - Linear, not periodic
- Rounded number
  - Increase the probability of different notes in variation.
- Other chaotic systems
  - Lorenz's another system and Rössler system

Conclusion

- Chaotic v.s. variation.
- The generated examples sound good.
- Potential problems
  - Chords are harder to handle.
  - It needs an original piece first. The quality of the resulting variation depends highly on the original piece.

References

- Diana S. Dabby, http://www.olin.edu/faculty_staff/faculty_profiles.asp
- Sound examples in the presentation, http://dsp.ece.olin.edu/music/
- Chaotic theory, http://en.wikipedia.org/wiki/Chaos_theory
- Lorenz attractor, http://en.wikipedia.org/wiki/Lorenz_attractor