MS-C1001

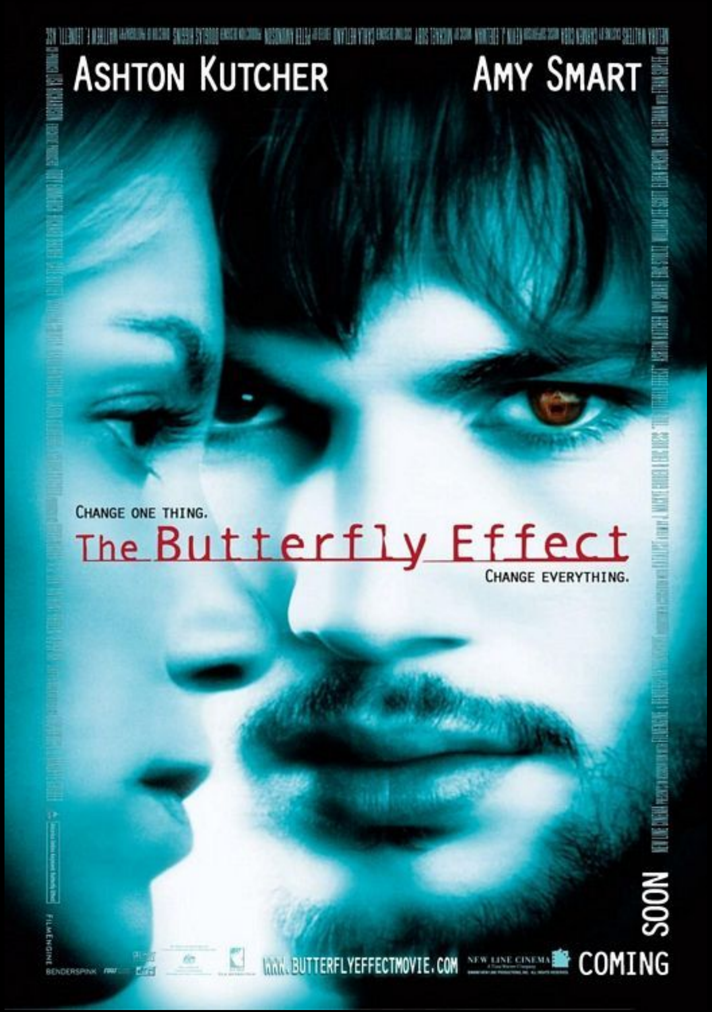
Shapes in Action

Butterfly Effect:

*“Does the **Flap of a Butterfly’s Wings in Brazil** Turn Off my sauna **in Helsinki**?”*

Aalto University

SIGNS OF MATHEMATICS


ASHTON KUTCHER
AMY SMART
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NEW LINE CINEMA
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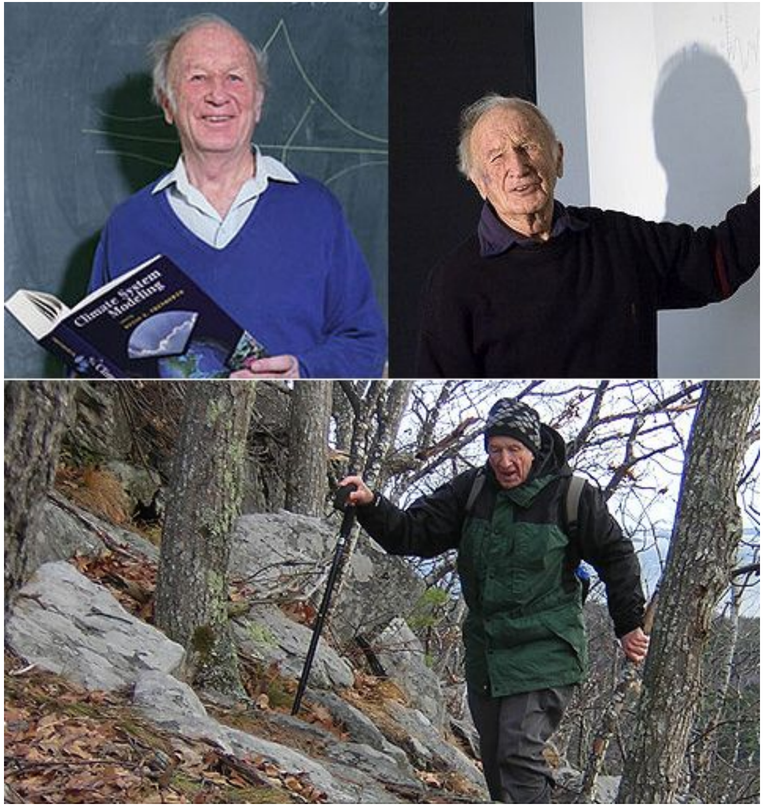
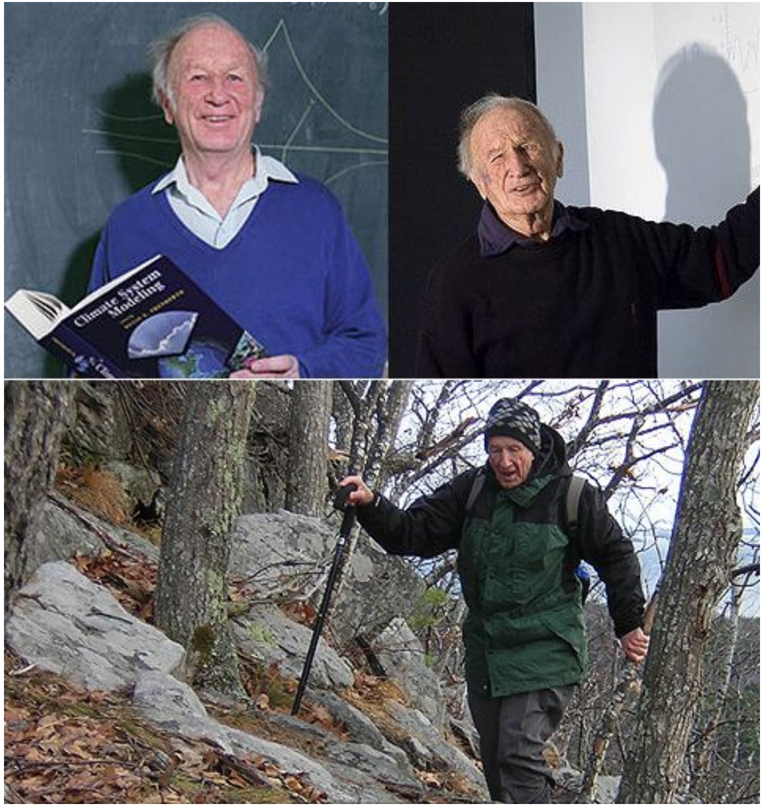

Climate System Modeling

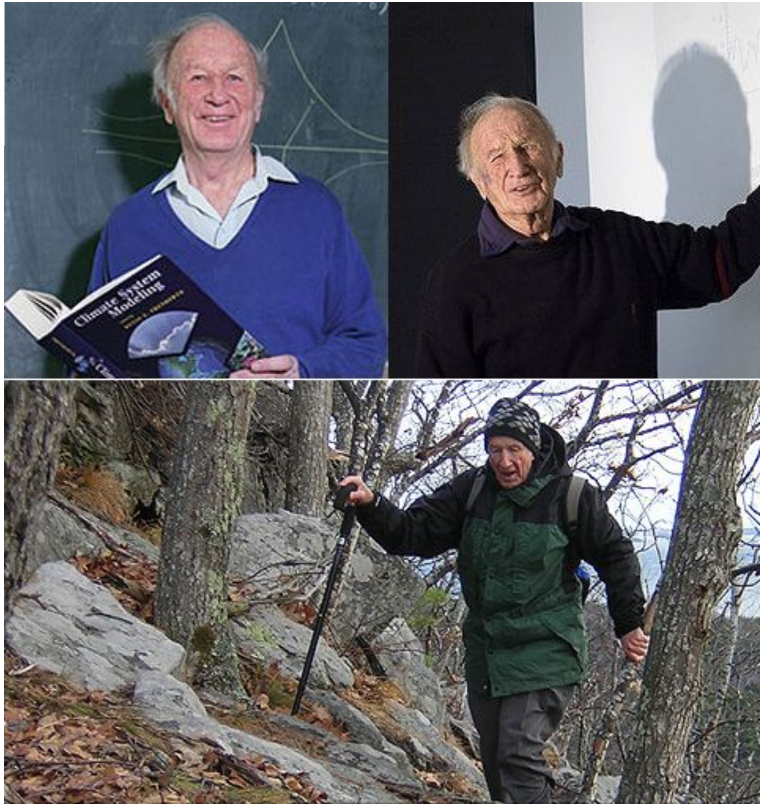
Edward Lorenz

(1917-2008)



Lorenz equations

$$\frac{dx}{dt} = -\frac{2}{3}x + 8y$$
$$\frac{dy}{dt} = -9xz + 5x - 3y$$
$$\frac{dz}{dt} = -z - \frac{1}{9}xy$$



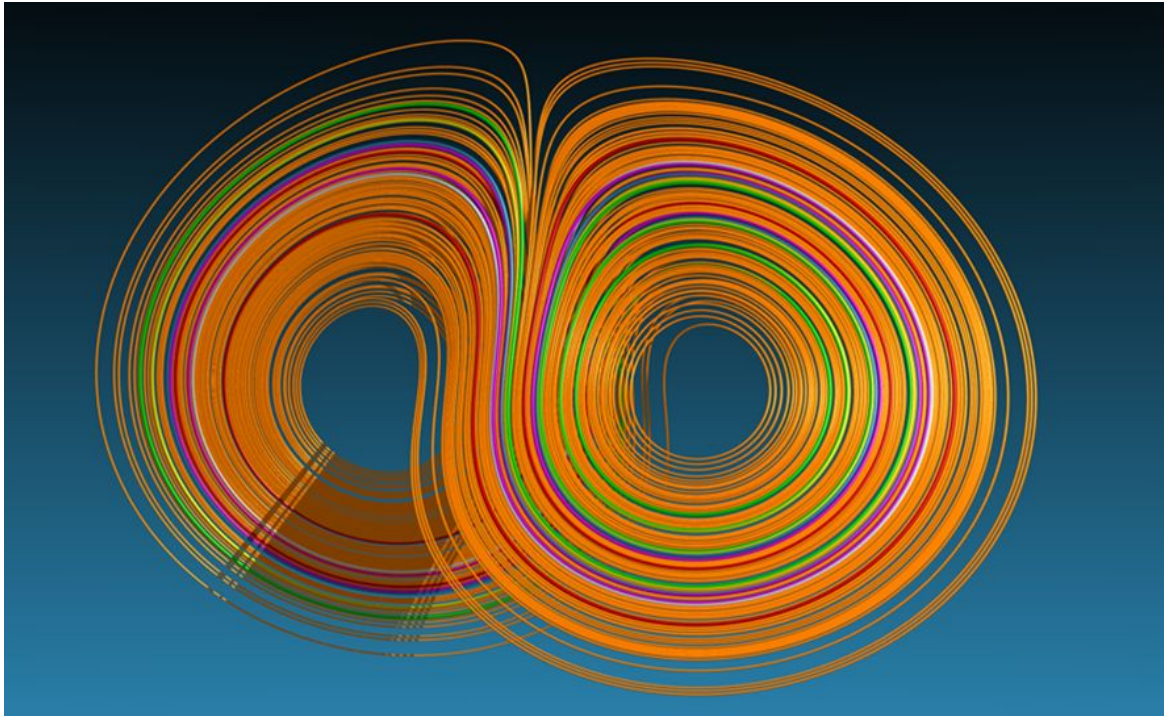


Image: Jos Leys

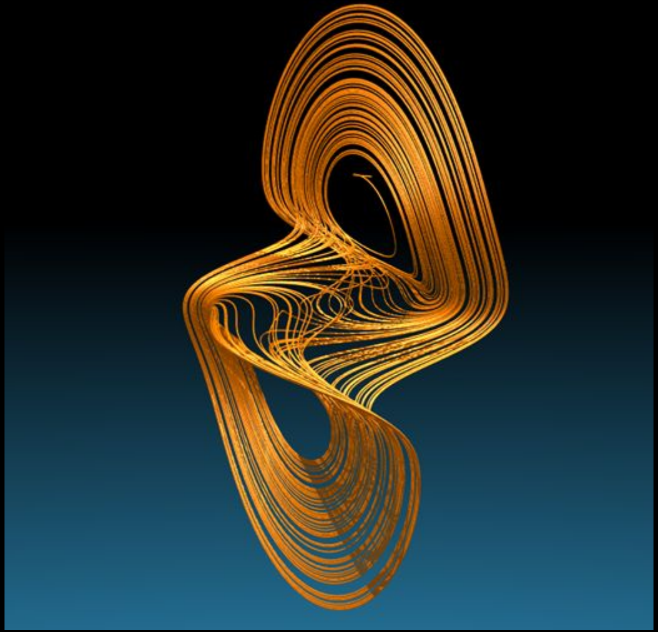


Image: Jos Leys

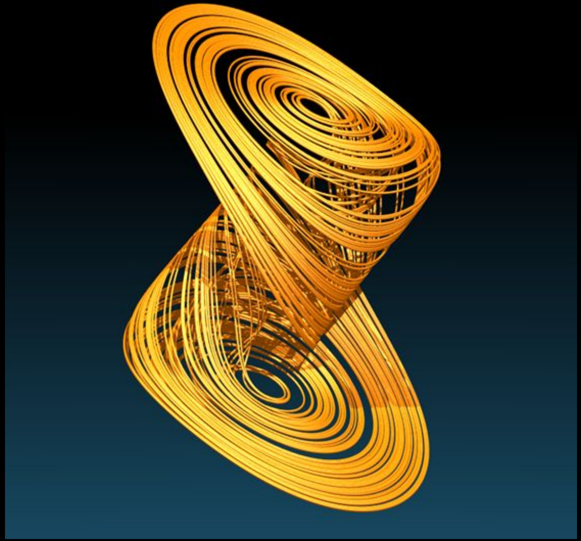


Image: Jos Leys

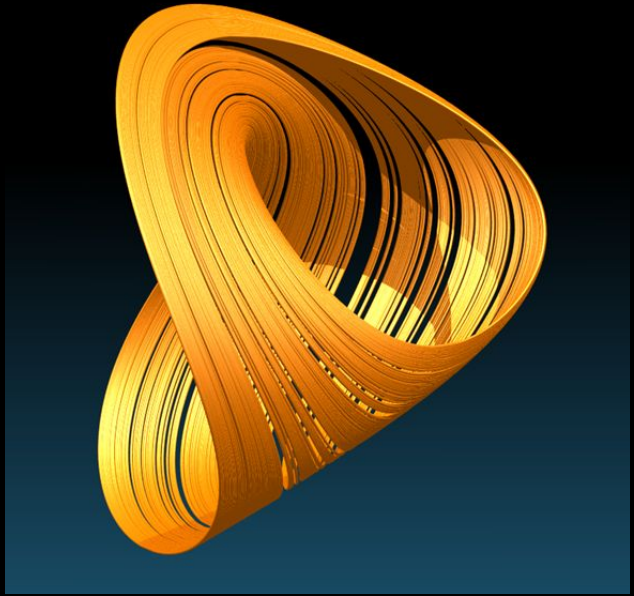
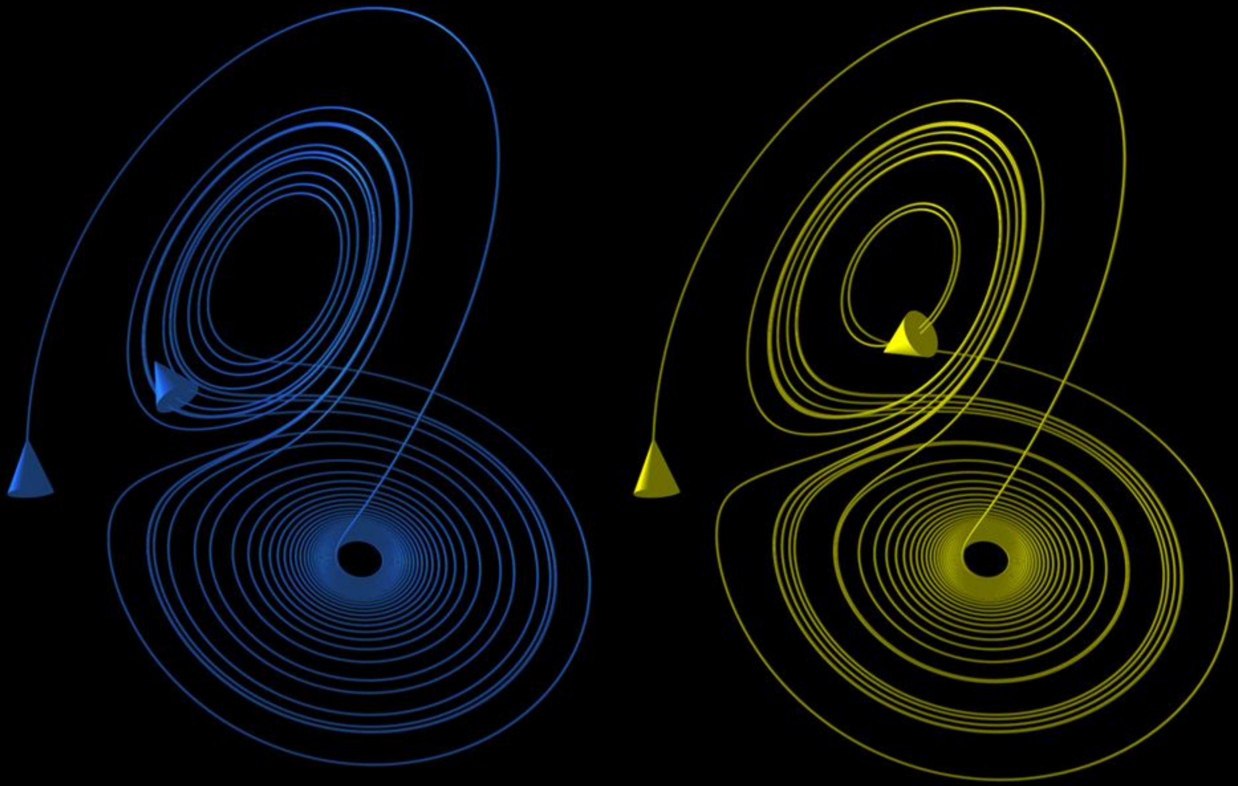
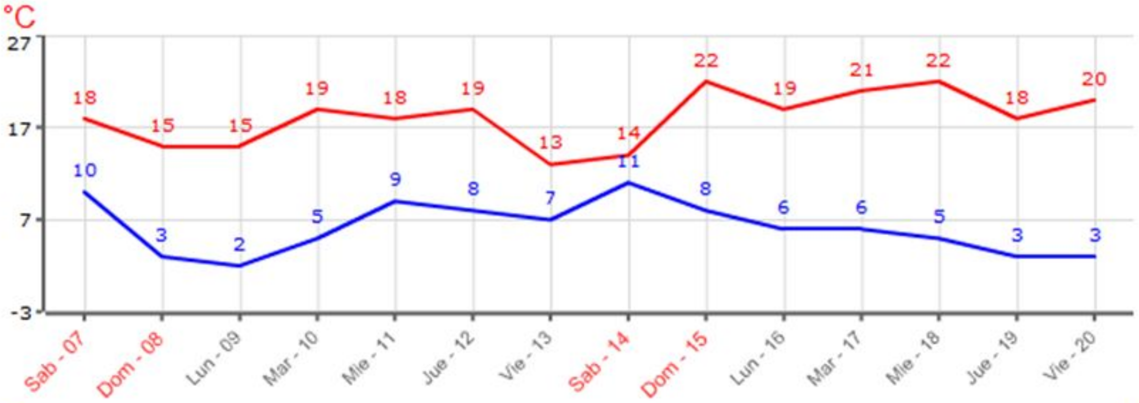


Image: Jos Leys

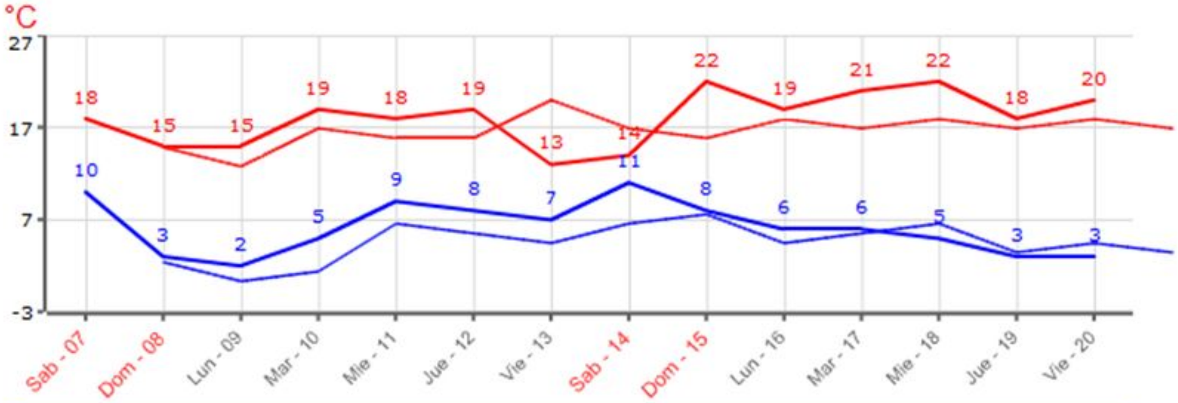


Temperature massime e minime Chart

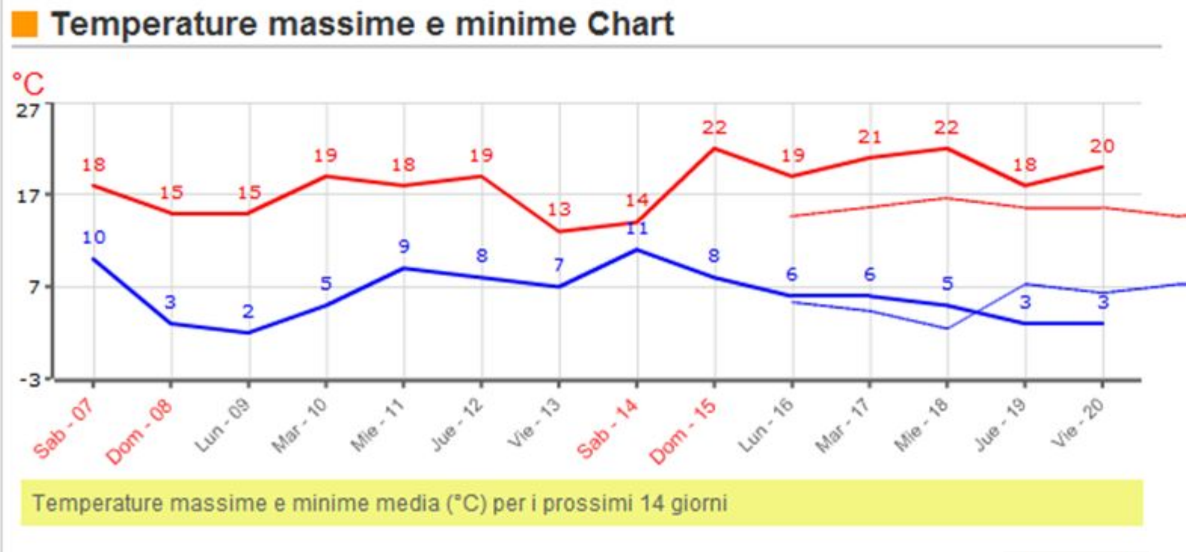


Temperature massime e minime media (°C) per i prossimi 14 giorni

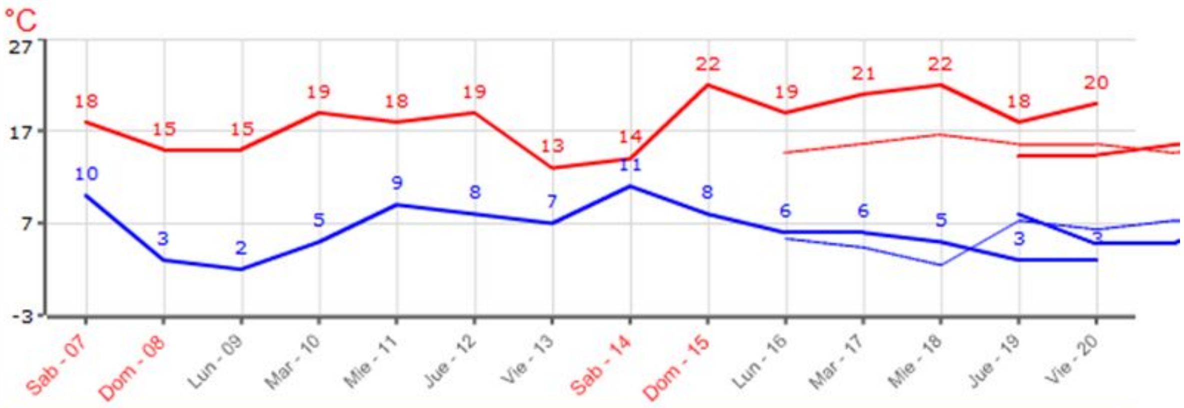
Temperature massime e minime Chart



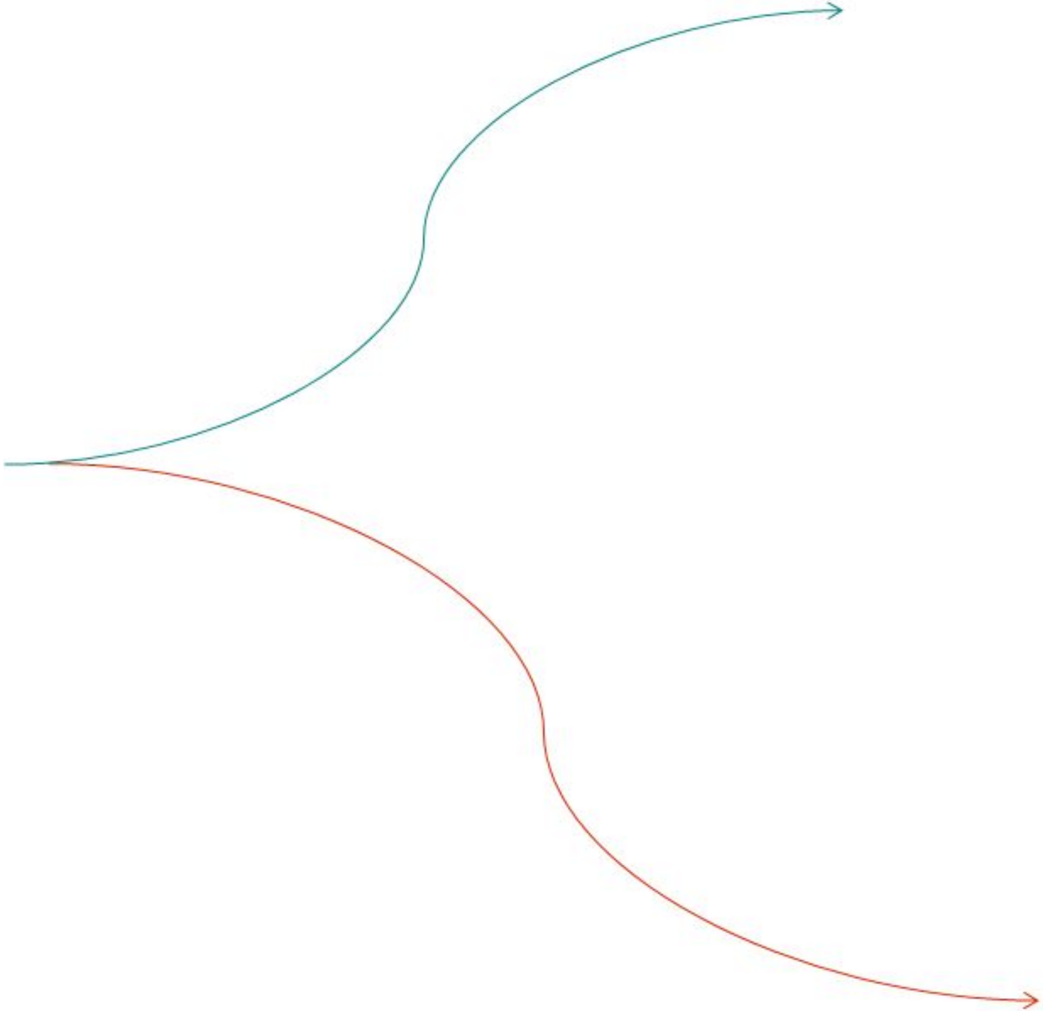
Temperature massime e minime media (°C) per i prossimi 14 giorni


Temperature massime e minime Chart
°C
27
17
7
-3
18
15
15
19
18
19
13
14
22
19
21
22
18
20
10
3
2
5
9
8
7
11
8
6
6
5
3
3
Sab - 07
Dom - 08
Lun - 09
Mar - 10
Mie - 11
Jue - 12
Vie - 13
Sab - 14
Dom - 15
Lun - 16
Mar - 17
Mie - 18
Jue - 19
Vie - 20
Temperature massime e minime media (°C) per i prossimi 14 giorni

Temperature massime e minime Chart



Temperature massime e minime media (°C) per i prossimi 14 giorni



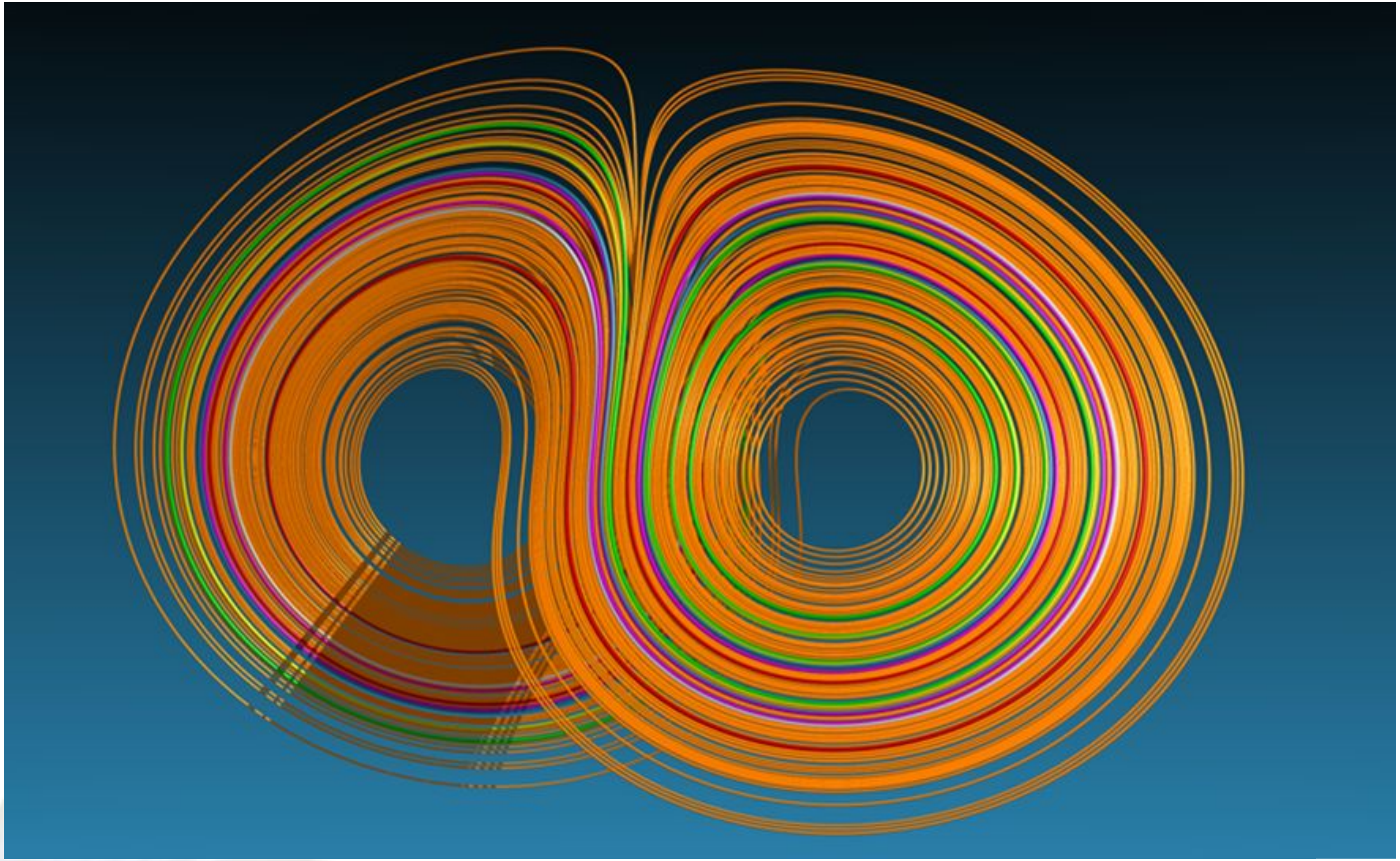
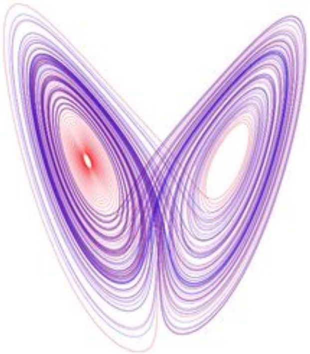


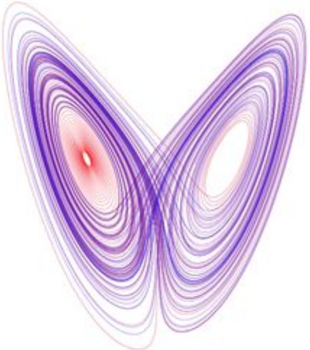
Image: Jos Leys

Philip Merilees



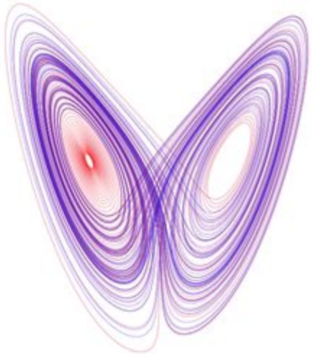
Philip Merilees

(1940-2018)



Philip Merilees (1972)

*"Does the **Flap of a Butterfly's Wings in Brazil** Set Off a **Tornado in Texas**?"*



Always my man, all in a hand
To celebrate you is greater

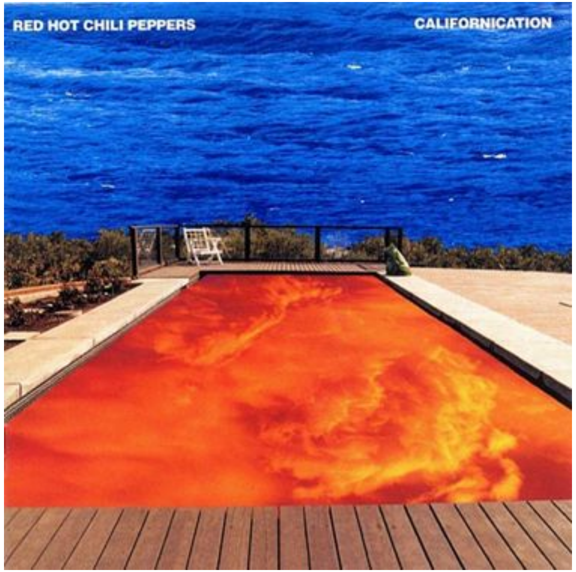
Now that I can, always my man
Now you see what I came for

No one here is to blame for
Misunderstand, all in a hand
Just like you 'cause you made me
All that I am, all in a hand

A butterfly that flaps its wings
Affecting almost everything
The more I hear the orchestra

The more I have something to bring
And now I see you in a beautiful
And different light

He's just a man and any damage done
Will be all right
Call out my name
Call and I came



Savoir

Red Hot Chili Peppers

A Butterfly in **A** *generates a catastrophe* in **B**

Brésil – Texas (tornade) E. Lorenz, AAAS, 29.12.72

Brésil – Floride (tornade) Le Figaro 3.94

Notre Dame de Paris - Paris C. Allègre, Le Point 18.6.94

Forêt amazonienne – Chicago (tempête) R. Lewin, La Complexité, 94

Sumatra – Angleterre (ouragan) J. Schwartz, The Creative Moment, 92

Le jardin de ma tante – Manille (cyclone) Science et Vie Junior

Baie de Sidney – Jamaïque (cyclone) Les Echos, 18.4.90

Pékin – Côte ouest des Etats-Unis La Recherche, 10.90

Rio – Australie (tempête) Explora, 12.88

Pékin – New York (tempête) J. Gleick, La Théorie du Chaos, 87

Pékin – New York M. Crichton, Le parc jurassique, 92

Mer de Chine – Caraïbes (ouragan)

Havana – Sidney (dragonfly) Pollack

A Butterfly in **A** *generates a catastrophe* in **B**

Brésil – ?? E. Brézin, Pour la Science, avril 92

Rio – San Francisco H. Reeves, Dernières nouvelles du cosmos, 94

Forêt amazonienne – Bangladesh (cyclone) R. Chaboud, France-Inter, 6.93

Rio – Japon (tornade) Explora 89 ?

Muraille de Chine – Paris Actuel, 90

Honolulu – New York (pluie) ??

Brésil – Texas A. Boutot, L'invention des formes, 94

Amazonie – Mexique (raz-de-marée) J. E. Hallier, Le Nouvel Observateur, 6.94

Philippines – Californie J. F. Kahn, 94

Tokyo Brésil – I. Stewart, The Collapse of Chaos, 93

Brésil – Londres (orage) Sunday Times, 31.1.93

A Butterfly in **A** *generates a catastrophe* in **B**

Pékin – New York Libération, 7.7.93

Rio – Chicago S. Kaufmann, Scientific American, 8.91

Martinique – Chine L'Evénement du Jeudi,24.2.94

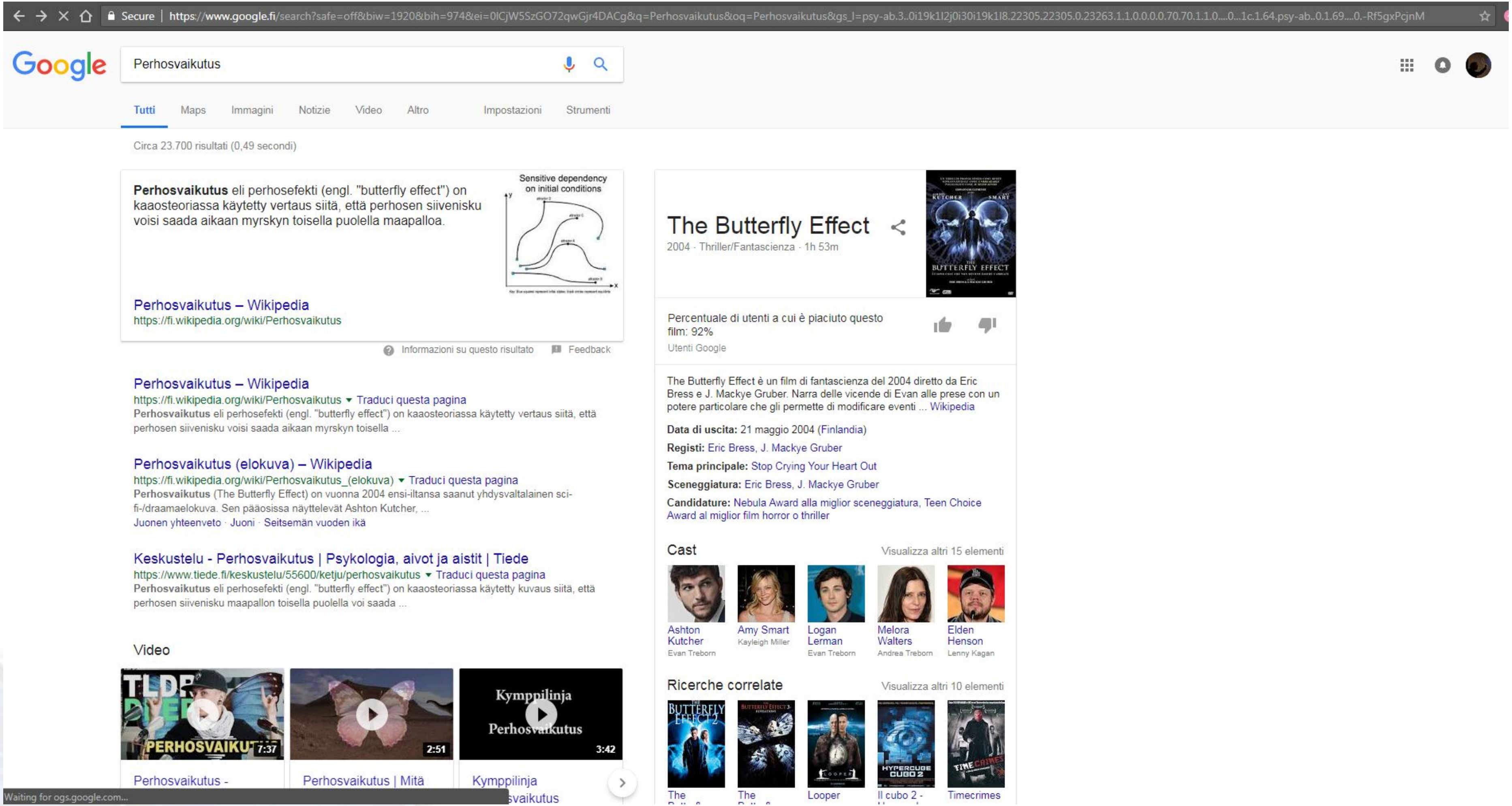
Pékin – New York G. Mélenchon

Afrique – Jamaïque P. Tambourin, France-Culture, 9.11.94

… … …

Brazil – Pisa (straighten the leaning tower) La Limonaia, 15.04.2012

Brazil – Helsinki (turn off a Sauna) Shapes in Action, 28.09.2018


Secure | https://www.google.fi/search?safe=off&biw=1920&bih=974&ei=0lCjW5SzGO72qwGjr4DACg&q=Perhosvaikutus&oq=Perhosvaikutus&gs_l=psy-ab.3..0i19k1l2j0i30i19k1l8.22305.22305.0.23263.1.1.0.0.0.0.70.70.1.1.0....0...1c.1.64.psy-ab..0.1.69....0.-Rf5gxPcjnM
Google
Perhosvaikutus
Tutti
Maps
Immagini
Notizie
Video
Altro
Impostazioni
Strumenti
Circa 23.700 risultati (0,49 secondi)
Perhosvaikutus eli perhosefekti (engl. "butterfly effect") on kaaosteoriassa käytetty vertaus siitä, että perhosen siivenisku voisi saada aikaan myrskyn toisella puolella maapalloa.
Sensitive dependency on initial conditions
Perhosvaikutus – Wikipedia
https://fi.wikipedia.org/wiki/Perhosvaikutus
Informazioni su questo risultato
Feedback
Perhosvaikutus – Wikipedia
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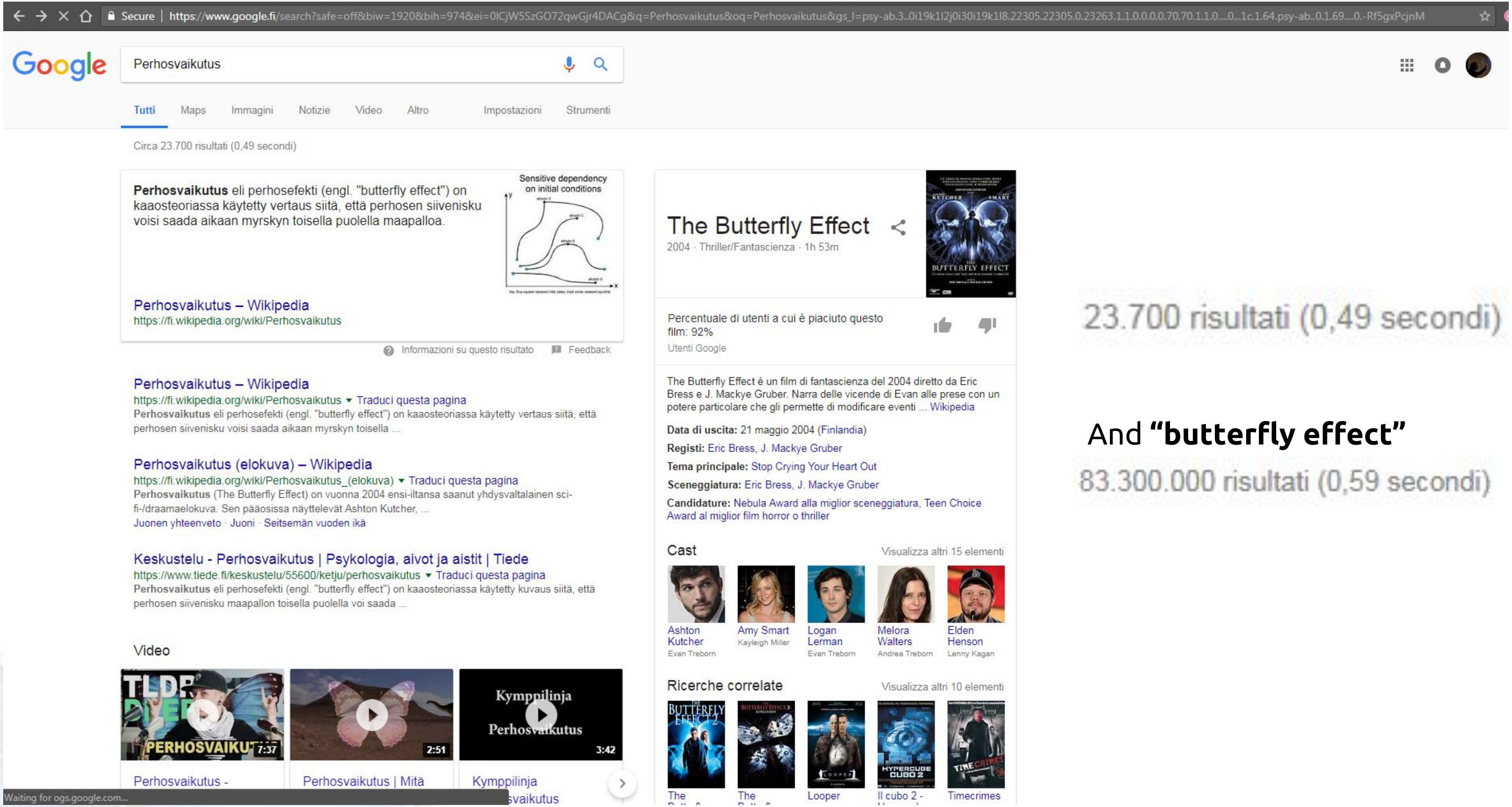
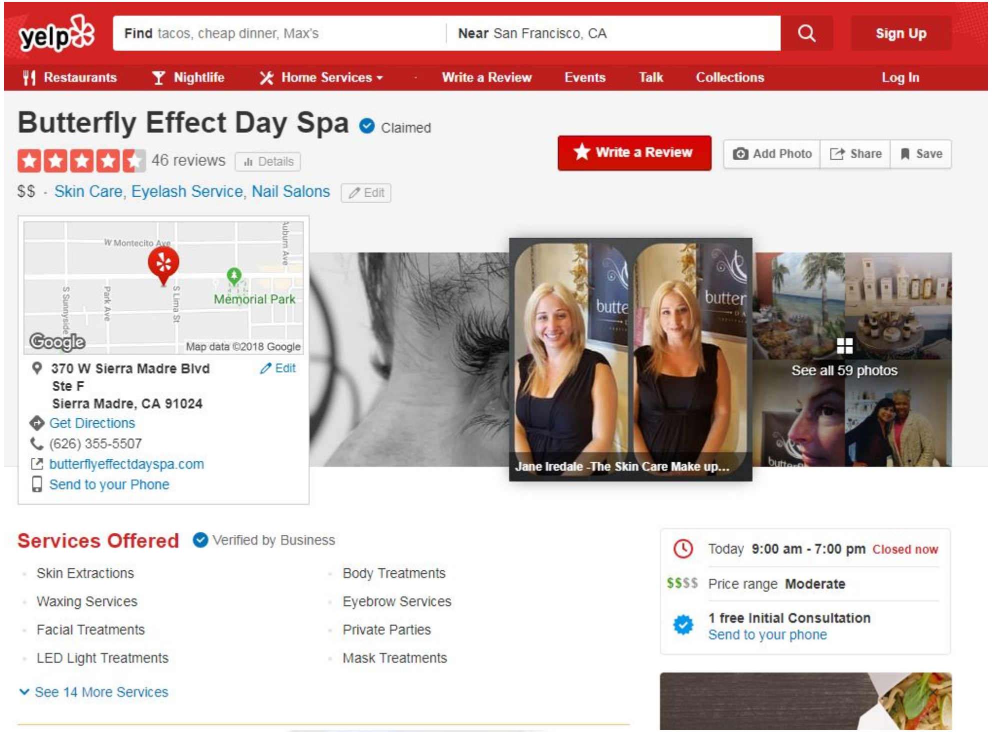
Perhosvaikutus eli perhosefekti (engl. "butterfly effect") on kaaosteoriassa käytetty vertaus siitä, että perhosen siivenisku voisi saada aikaan myrskyn toisella ...
Perhosvaikutus (elokuva) – Wikipedia
https://fi.wikipedia.org/wiki/Perhosvaikutus_(elokuva) ▾ Traduci questa pagina
Perhosvaikutus (The Butterfly Effect) on vuonna 2004 ensi-iltansa saanut yhdysvaltalainen sci-fi-/draamaelokuva. Sen pääosissa näyttelevät Ashton Kutcher, ...
Juonen yhteenveto · Juoni · Seitsemän vuoden ikä
Keskustelu - Perhosvaikutus | Psykologia, aivot ja aistit | Tiede
https://www.tiede.fi/keskustelu/55600/ketju/perhosvaikutus ▾ Traduci questa pagina
Perhosvaikutus eli perhosefekti (engl. "butterfly effect") on kaaosteoriassa käytetty kuvaus siitä, että perhosen siivenisku maapallon toisella puolella voi saada ...
Video
PERHOSVAIKU
7:37
2:51
Kymppilinja
Perhosvaikutus
3:42
Perhosvaikutus -
Perhosvaikutus | Mitä
Kymppilinja
svaikutus
Waiting for ogs.google.com...
The Butterfly Effect
2004 · Thriller/Fantascienza · 1h 53m
KUTCHER
SMART
THE BUTTERFLY EFFECT
Percentuale di utenti a cui è piaciuto questo film: 92%
Utenti Google
The Butterfly Effect è un film di fantascienza del 2004 diretto da Eric Bress e J. Mackye Gruber. Narra delle vicende di Evan alle prese con un potere particolare che gli permette di modificare eventi ... Wikipedia
Data di uscita: 21 maggio 2004 (Finlandia)
Registi: Eric Bress, J. Mackye Gruber
Tema principale: Stop Crying Your Heart Out
Sceneggiatura: Eric Bress, J. Mackye Gruber
Candidature: Nebula Award alla miglior sceneggiatura, Teen Choice Award al miglior film horror o thriller
Cast
Visualizza altri 15 elementi
Ashton Kutcher
Evan Treborn
Amy Smart
Kayleigh Miller
Logan Lerman
Evan Treborn
Melora Walters
Andrea Treborn
Elden Henson
Lenny Kagan
Ricerche correlate
Visualizza altri 10 elementi
BUTTERFLY EFFECT 2
BUTTERFLY EFFECT 3
LOOPER
HYPERCUBE CUBO 2
TIMECRIMES
The
The
Looper
Il cubo 2 -
Timecrimes



23.700 risultati (0,49 secondi)

And **"butterfly effect"**

83.300.000 risultati (0,59 secondi)


yelp
Find tacos, cheap dinner, Max's
Near San Francisco, CA
Sign Up
Restaurants
Nightlife
Home Services
Write a Review
Events
Talk
Collections
Log In
Butterfly Effect Day Spa
Claimed
46 reviews
Details
Write a Review
Add Photo
Share
Save
$$ · Skin Care, Eyelash Service, Nail Salons
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Memorial Park
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370 W Sierra Madre Blvd
Ste F
Sierra Madre, CA 91024
Edit
Get Directions
(626) 355-5507
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Jane Iredale -The Skin Care Make up...
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Services Offered
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Skin Extractions
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Facial Treatments
LED Light Treatments
Body Treatments
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Private Parties
Mask Treatments
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$$$$ Price range Moderate
1 free Initial Consultation
Send to your phone

This job and the impact of the butterfly effect | Uber Drivers Forum
https://uberpeople.net › Community › Stories ▾ Traduci questa pagina
27 mag 2018 - I just want to say that when doing **Uber**/Lyft I "feel" closer to the **butterfly effect** then I have any other point in my life. In any large market there are ...

The butterfly effect | Uber Drivers Forum
https://uberpeople.net › US Cities › Atlanta ▾ Traduci questa pagina
18 ott 2017 - its either my phone or surge but nothing seems to make sense... I get surge requests on white screen and non-surge requests when its orange.

The Butterfly Effect in Dating | Delvin Randle | Pulse | LinkedIn
https://www.linkedin.com/.../butterfly-effect-dating-delvin-randl... ▾ Traduci questa pagina
30 set 2015 - I no longer want to even casually **flirt** with someone unless she makes me as stupidly excited as the sight of my first crush did when I was 12 ...

The Butterfly Effect in Retirement Planning | Flirting with Models
https://blog.thinknewfound.com/.../butterfly-effect-retirement-pl... ▾ Traduci questa pagina
5 set 2017 - Examining the significant impact of changes in assumptions, including spending and return assumptions, on retirement planning analysis.

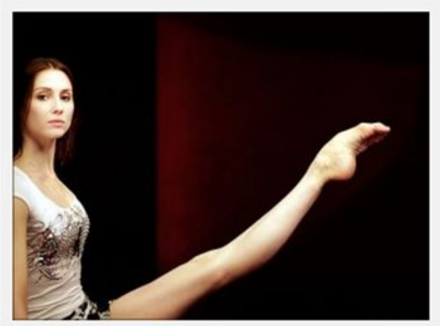
Small details consisting changes

piccolezze e altre amenità

← Considerato che si finisce per leggere sempre le stesse cose
Dio non gioca a dadi con l'universo e nemmeno con il tennis →

L'effetto farfalla della danza classica: il collo del piede

Postato il 2 gennaio 2009 da Fabrizio Brascugli



Basta osservare con attenzione per rendersi conto che la vita che ci circonda è piena di piccole condizioni innate che possono permettere di aprire carriere. Nella disciplina della danza classica l'estensione del collo del piede è una di queste condizioni, che permette a chi nasce già con una buona estensibilità di poter lavoraci su per migliorarla e poter raggiungere livelli di eccellenza. Chi non

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- 372,100 da ottobre 2007

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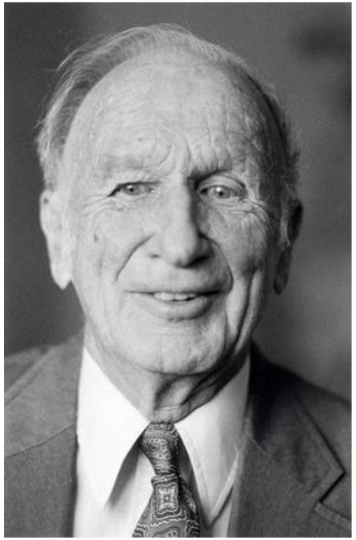
La mano di Rod il tennis e le scienze del caos. Laurum Editrice. ISBN 978-88-87346-82-4. Euro 15


HD



Deterministic Nonperiodic Flow[1]

EDWARD N. LORENZ

Massachusetts Institute of Technology

(Manuscript received 18 November 1962, in revised form 7 January 1963)

ABSTRACT

Finite systems of deterministic ordinary nonlinear differential equations may be designed to represent forced dissipative hydrodynamic flow. Solutions of these equations can be identified with trajectories in phase space. For those systems with bounded solutions, it is found that nonperiodic solutions are ordinarily unstable with respect to small modifications, so that slightly differing initial states can evolve into considerably different states. Systems with bounded solutions are shown to possess bounded numerical solutions.

A simple system representing cellular convection is solved numerically. All of the solutions are found to be unstable, and almost all of them are nonperiodic.

The feasibility of very-long-range weather prediction is examined in the light of these results.

1. Introduction

Certain hydrodynamical systems exhibit steady-state flow patterns, while others oscillate in a regular periodic fashion. Still others vary in an irregular, seemingly haphazard manner, and, even when observed for long periods of time, do not appear to repeat their previous history.

These modes of behavior may all be observed in the familiar rotating-basin experiments, described by Fultz, *et al.* (1959) and Hide (1958). In these experiments, a cylindrical vessel containing water is rotated about its axis, and is heated near its rim and cooled near its center in a steady symmetrical fashion. Under certain conditions the resulting flow is as symmetric and steady as the heating which gives rise to it. Under different conditions a system of regularly spaced waves develops, and progresses at a uniform speed without changing its shape. Under still different conditions an irregular flow pattern forms, and moves and changes its shape in an irregular nonperiodic manner.

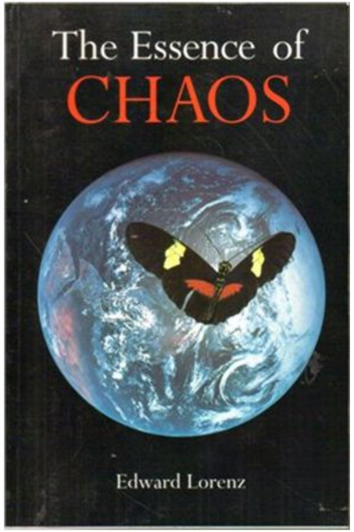
Lack of periodicity is very common in natural systems, and is one of the distinguishing features of turbulent flow. Because instantaneous turbulent flow patterns are so irregular, attention is often confined to the statistics of turbulence, which, in contrast to the details of turbulence, often behave in a regular well-organized manner. The short-range weather forecaster, however, is forced willy-nilly to predict the details of the large-scale turbulent eddies—the cyclones and anticyclones—which continually arrange themselves into new patterns. Thus there are occasions when more than the statistics of irregular flow are of very real concern.

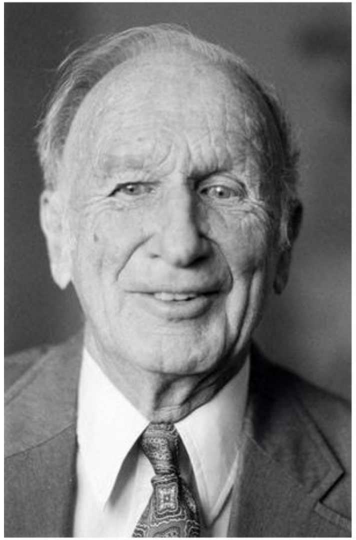
In this study we shall work with systems of deterministic equations which are idealizations of hydrodynamical systems. We shall be interested principally in nonperiodic solutions, i.e., solutions which never repeat their past history exactly, and where all approximate repetitions are of finite duration. Thus we shall be involved with the ultimate behavior of the solutions, as opposed to the transient behavior associated with arbitrary initial conditions.

A closed hydrodynamical system of finite mass may ostensibly be treated mathematically as a finite collection of molecules—usually a very large finite collection —in which case the governing laws are expressible as a finite set of ordinary differential equations. These equations are generally highly intractable, and the set of molecules is usually approximated by a continuous distribution of mass. The governing laws are then expressed as a set of partial differential equations, containing such quantities as velocity, density, and pressure as dependent variables.

It is sometimes possible to obtain particular solutions of these equations analytically, especially when the solutions are periodic or invariant with time, and, indeed, much work has been devoted to obtaining such solutions by one scheme or another. Ordinarily, however, nonperiodic solutions cannot readily be determined except by numerical procedures. Such procedures involve replacing the continuous variables by a new finite set of functions of time, which may perhaps be the values of the continuous variables at a chosen grid of points, or the coefficients in the expansions of these variables in series of orthogonal functions. The governing laws then become a finite set of ordinary differential

[1] The research reported in this work has been sponsored by the Geophysics Research Directorate of the Air Force Cambridge Research Center, under Contract No. AF 19(604)-4969.





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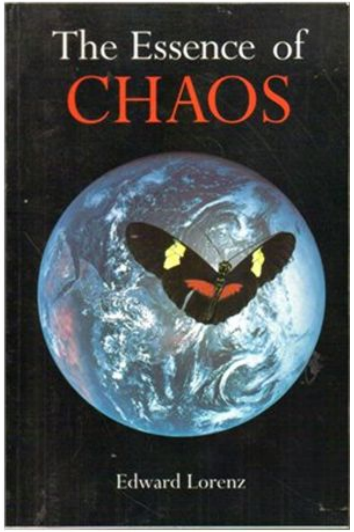
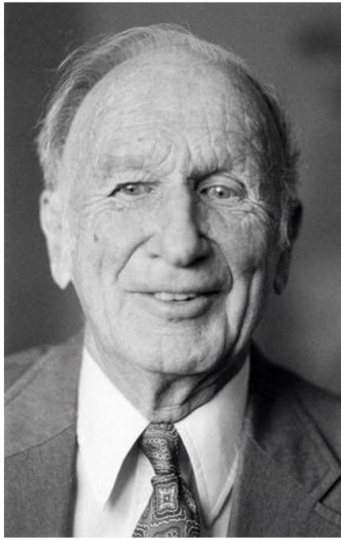
[1] The research reported in this work has been sponsored by the Geophysics Research Directorate of the Air Force Cambridge Research Center, under Contract No. AF 19(604)-4969.

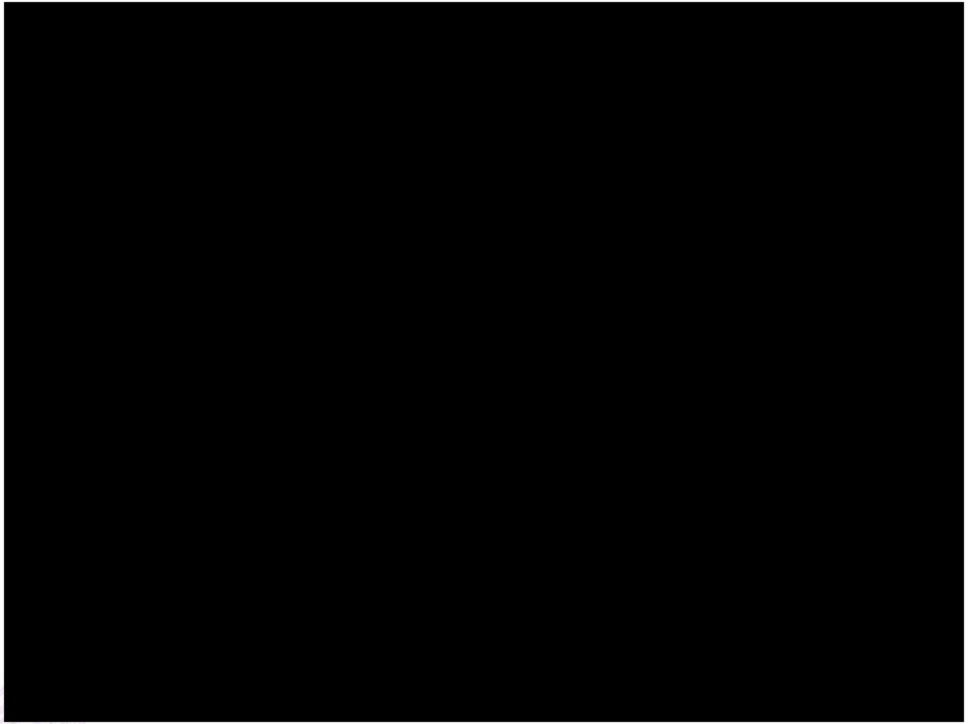


Is *“Butterfly effect”* only a “mathematical phenomena” or it can also be observed in physics?

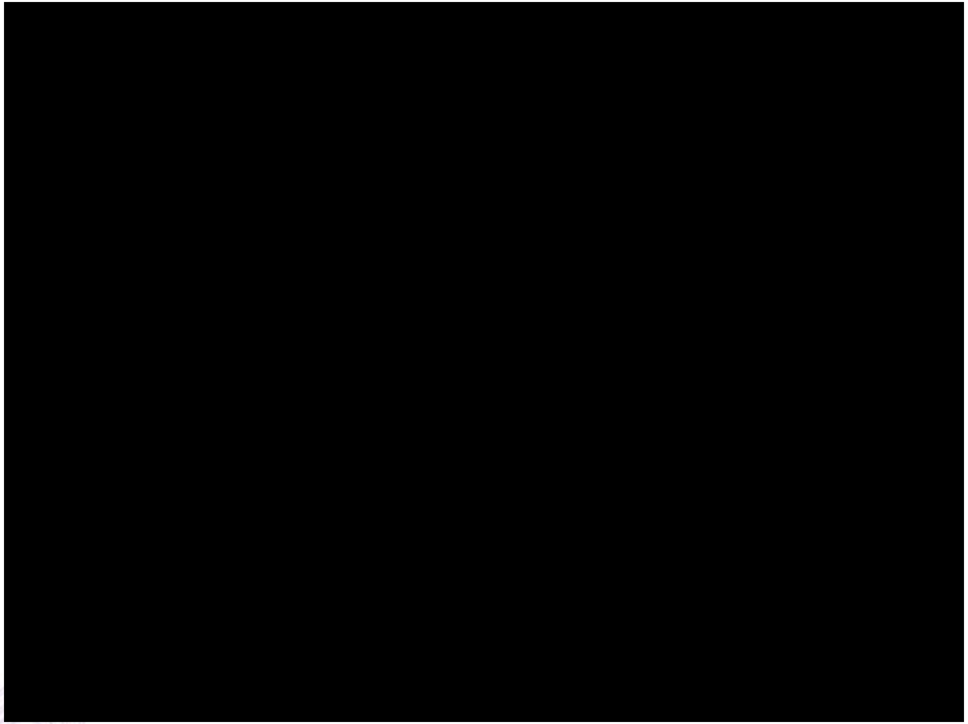
“There remains the question as to whether our results ***really apply to the atmosphere****. One does not usually regard the atmosphere as either deterministic or finite, and the lack of periodicity is not a mathematical certainty, since the atmosphere has not been observed forever.”*



Physical model (Lorenz’s Water Wheel)
Attributed to Willem Malkus and Lou Howard



Étienne Ghys, Jos Leys — «Le moulin à eau de Lorenz» — Images des Mathématiques, CNRS, 2009



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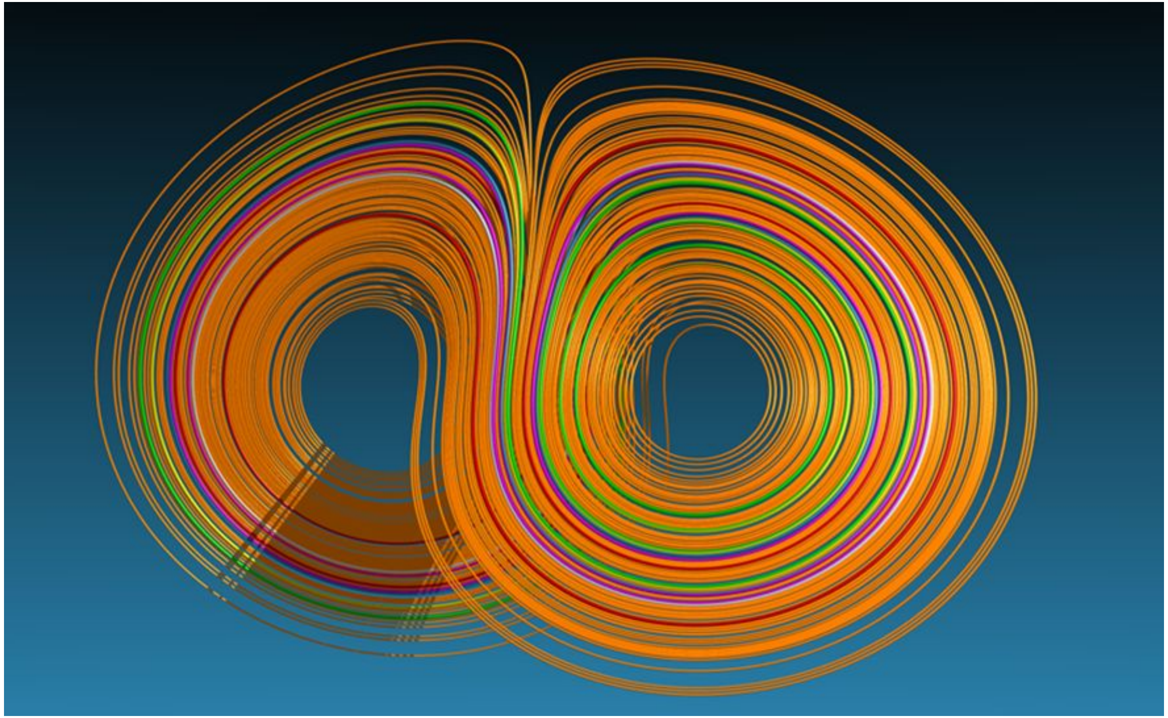

Image: Jos Leys

Understanding the two faces of *Butterfly Effect*

We know that the **present may determine the future**, but we also know that an imperfect knowledge on the present - *as it is almost always the case* - makes the possibility of prediction of the future **illusory**.

Understanding the two faces of *Butterfly Effect*

Edward Lorenz (1972 conference) on sensitivity to initial conditions:

> *“If a single flap of a butterfly's wing can be instrumental in generating a tornado, so all the previous and subsequent flaps of its wings, as can the flaps of the wings of the millions of other butterflies, not to mention the activities of innumerable more powerful creatures, including our own species..”*

Understanding the two faces of *Butterfly Effect*

Edward Lorenz ideas goes much further:
(but this second aspect was unnoticed by media)

"More generally, I am proposing that over the years minuscule disturbances neither increase nor decrease the frequency of occurrence of various weather events such as tornados; the most they may do is to modify the sequence in which these events occur."

Understanding the two faces of *Butterfly Effect*

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*"More generally, I am proposing that over the years minuscule disturbances neither increase nor decrease the **frequency of occurrence** of various weather events such as tornados; the most they may do is to **modify the sequence in which these events occur**."*

Galton Board Experiment

Galton Board Experiment

IFA.tv - A Random Walker, Probability Machine, Galton Board, Quincunx Index
https://www.youtube.com/watch?v=AUSKTk9ENzgwww.youtube.com/watch?v=AUSKTk9ENzg

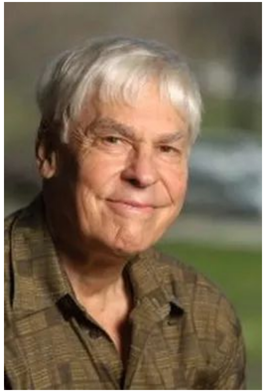
Summary: two faces of Butterfly Effect to keep in mind

The Butterfly effect:

- manifests with a **sensitivity to the initial conditions**: a small change at the present can significantly change the evolution for the future.
- manifests with **insensitivity to the initial conditions**: the frequency of manifestation of future events, measured over large periods of time, are not affected by small errors on the initial conditions.

Science is build by a community

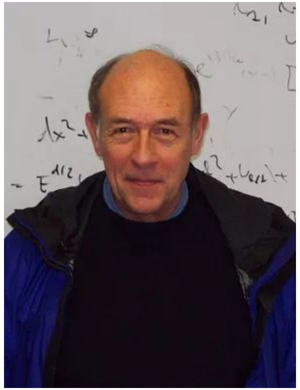
Henri Poincaré
(1828–1892)



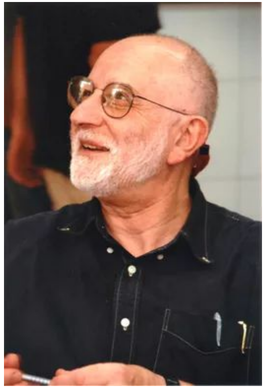
Stephen Smale
(1930–)

Jacob Palis
(1940–)

George D. Birkhoff
(1884–1944)



David Ruelle
(1935–)



Michael Berry
(1941-)

Aalto University

AALTO MATH&ARTS

SIGNS OF MATHEMATICS

“The mind, once stretched by a new idea, never returns to its original dimensions.”

Ralph Waldo Emerson

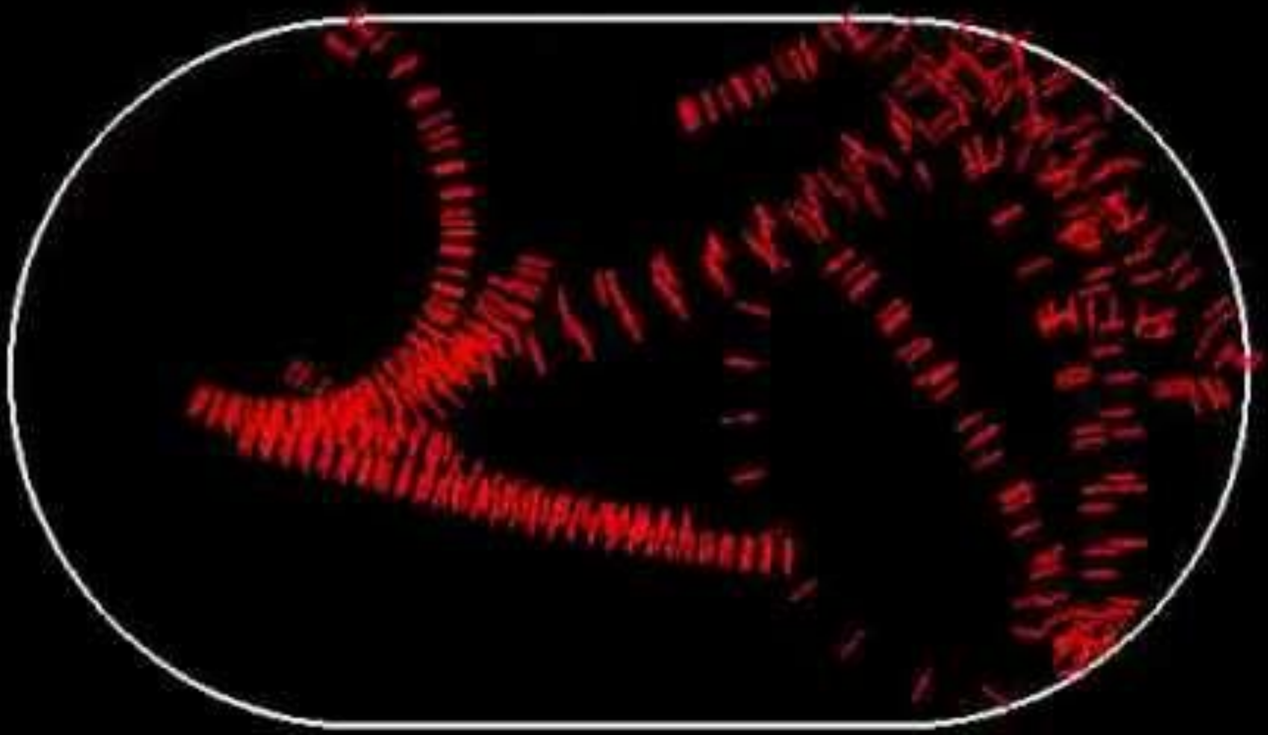
“The mind, once stretched by a new idea, never returns to its original dimensions.”

Ralph Waldo Emerson

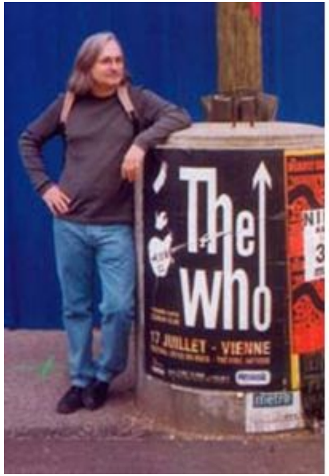
More about visit Signs of Mathematics exhibition and our website: http://jyu.fi/somath/

Examples: Magnetic Pendulum

Examples: Billiards



This talk is inspired by a series of works of



Etienne Ghys
ENS-Lyon

Jos Leys
Mathematical imagery

Thank you!

UNIVERSITY OF JYVÄSKYLÄ
JYVÄSKYLÄN YLIOPISTO

"The mind, once stretched by a new idea, never returns to its original dimensions."

Ralph Waldo Emerson

SofM
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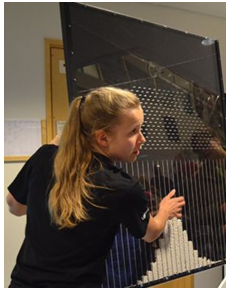
Tuomo


Ville


Terhi


Timo


Elina


Markus

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