

# **FROM COMPLEXITY TO PEACE**

**Carlos E. Puente**

Department of Land, Air and Water Resources  
University of California, Davis

Davis, October 20, 2005

## **Thesis**

We humans, with a soul,  
may learn from recent advancements  
regarding natural complexity  
in order to find peace...

## Outline

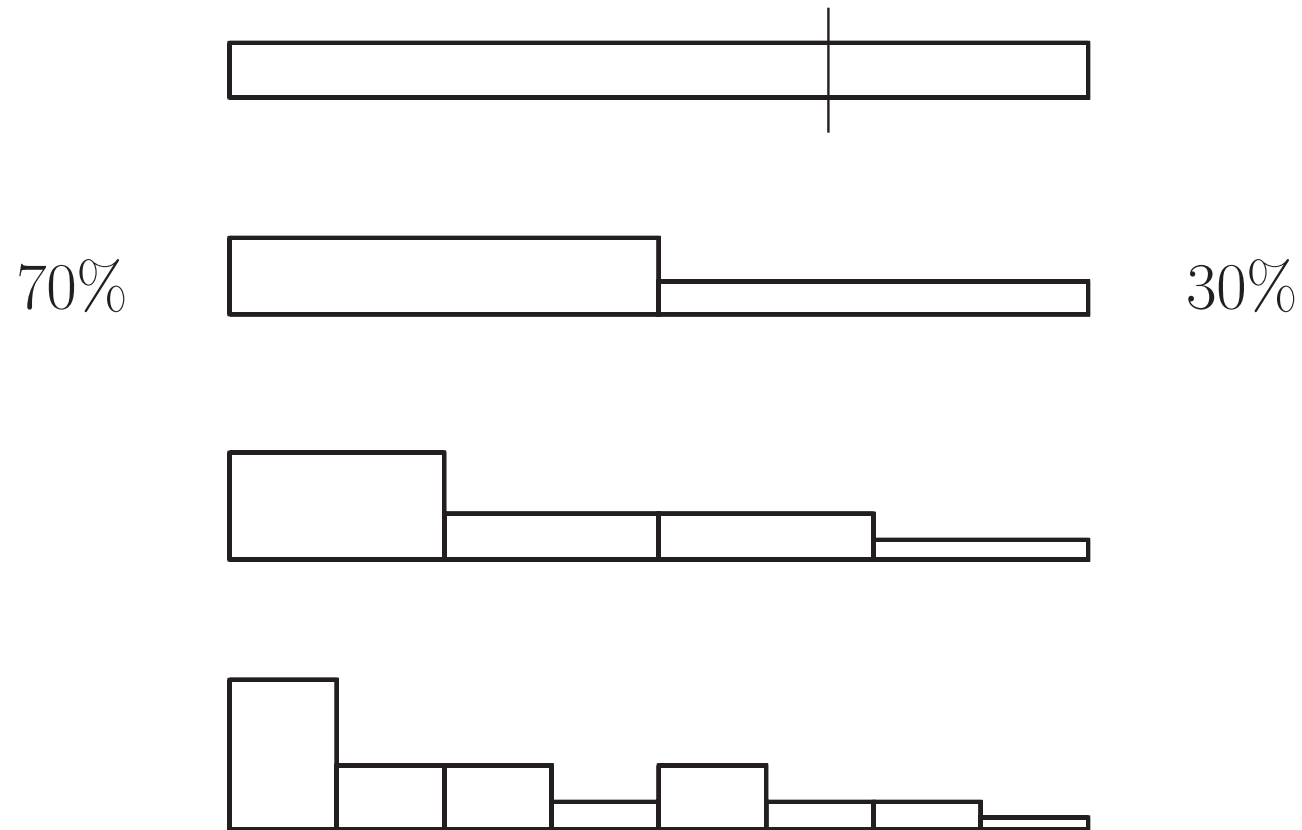
Lessons from turbulence

Lessons from chaos

Lessons from normality

## Lessons from turbulence

# A multiplicative cascade



# A multiplicative cascade

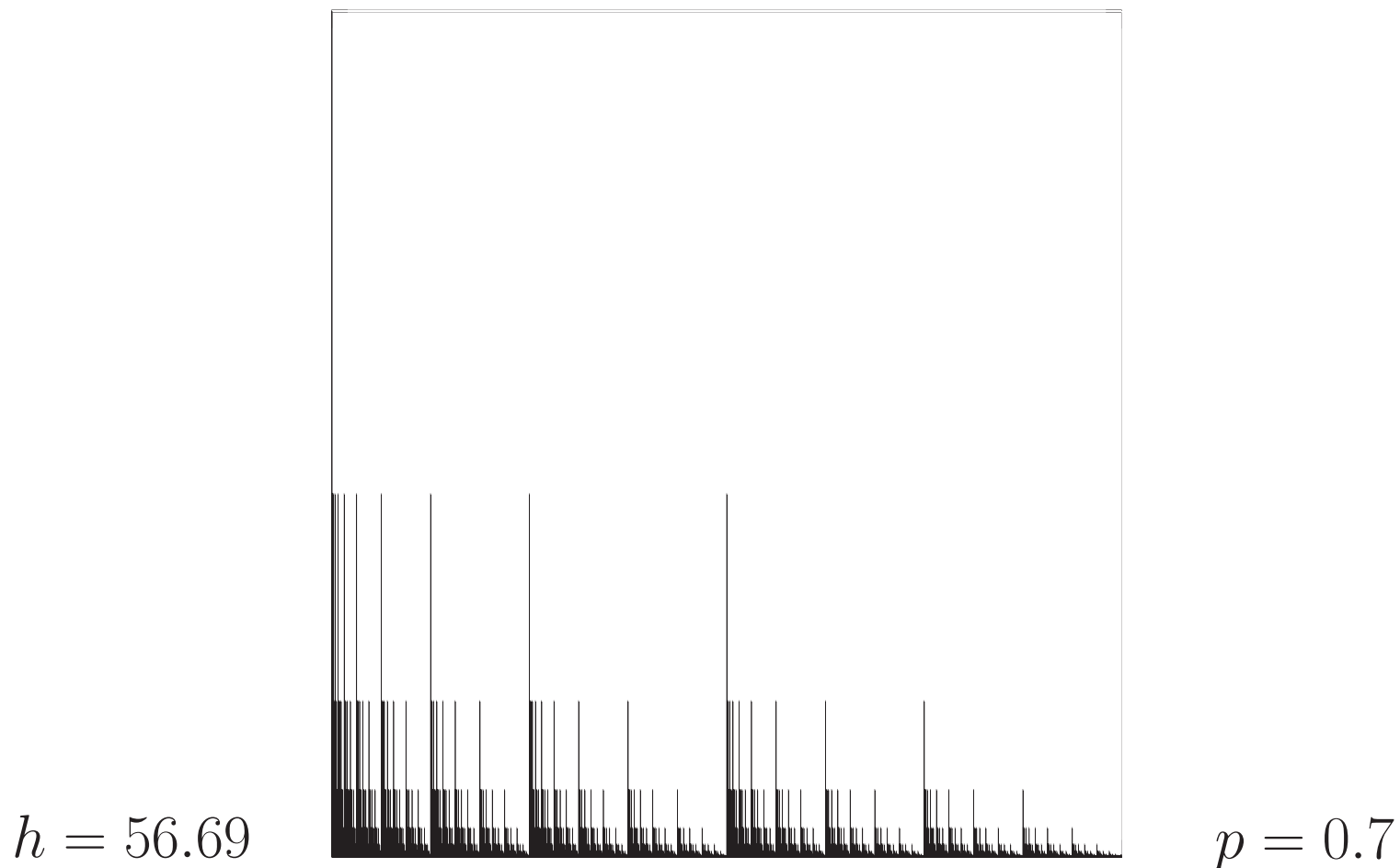


$$(p + q)^n$$



$$\begin{array}{cccc} & & 1 & \\ & 1 & & 1 \\ & 1 & 2 & 1 \\ 1 & 3 & 3 & 1 \end{array}$$

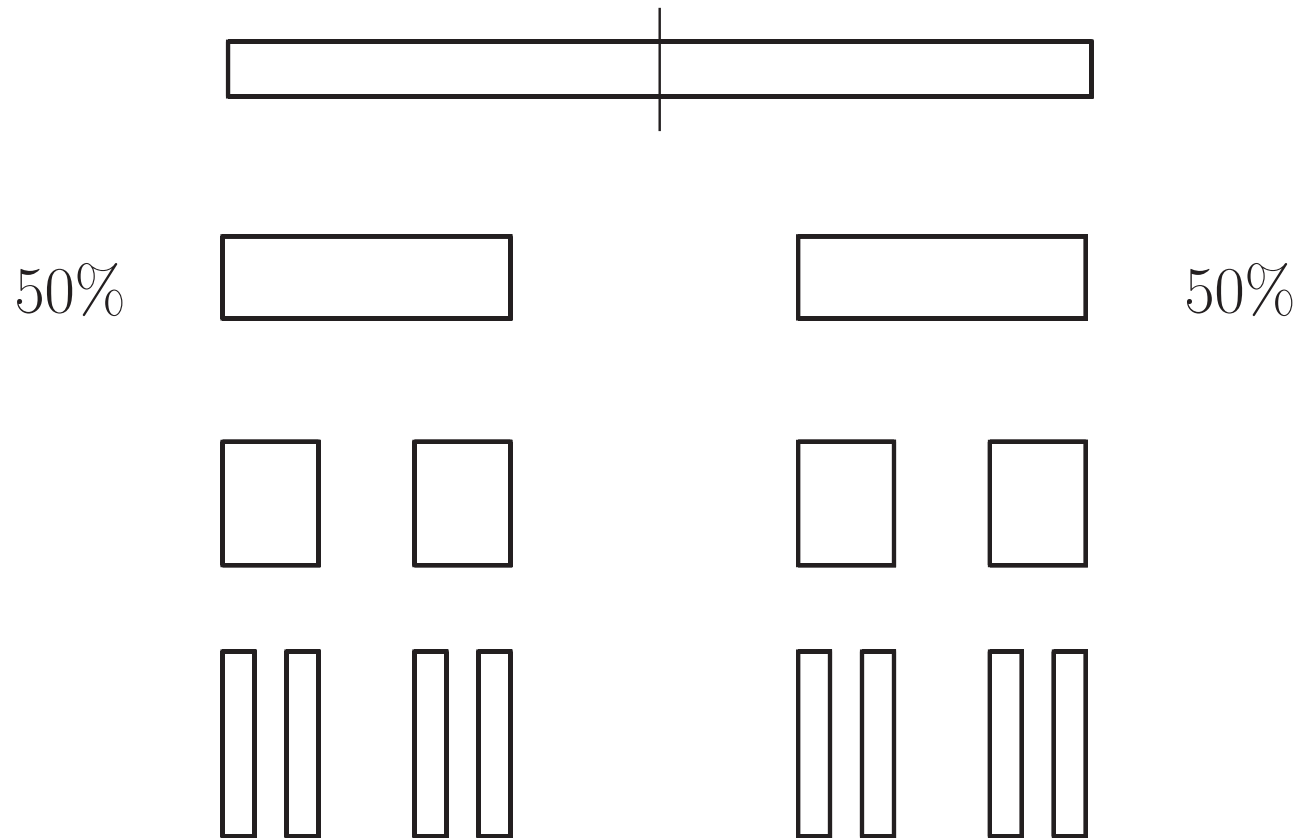
After  $n = 12$  levels



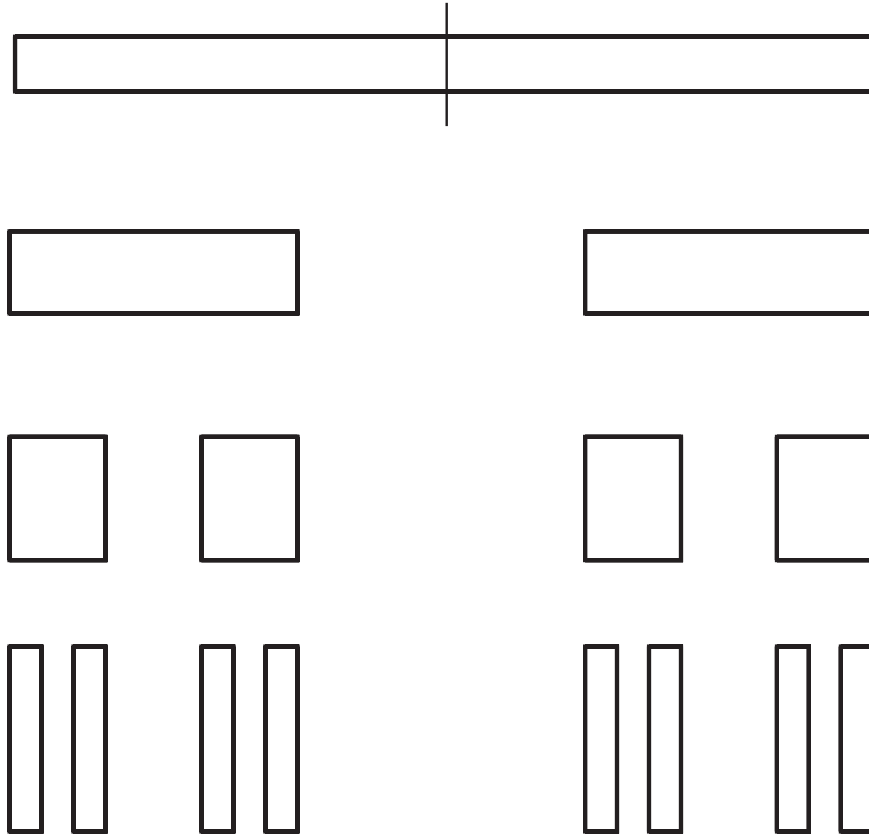
A **multifractal** measure

Intertwined layers of **thorns** having distinct densities

## Another divisive cascade



## Another divisive cascade

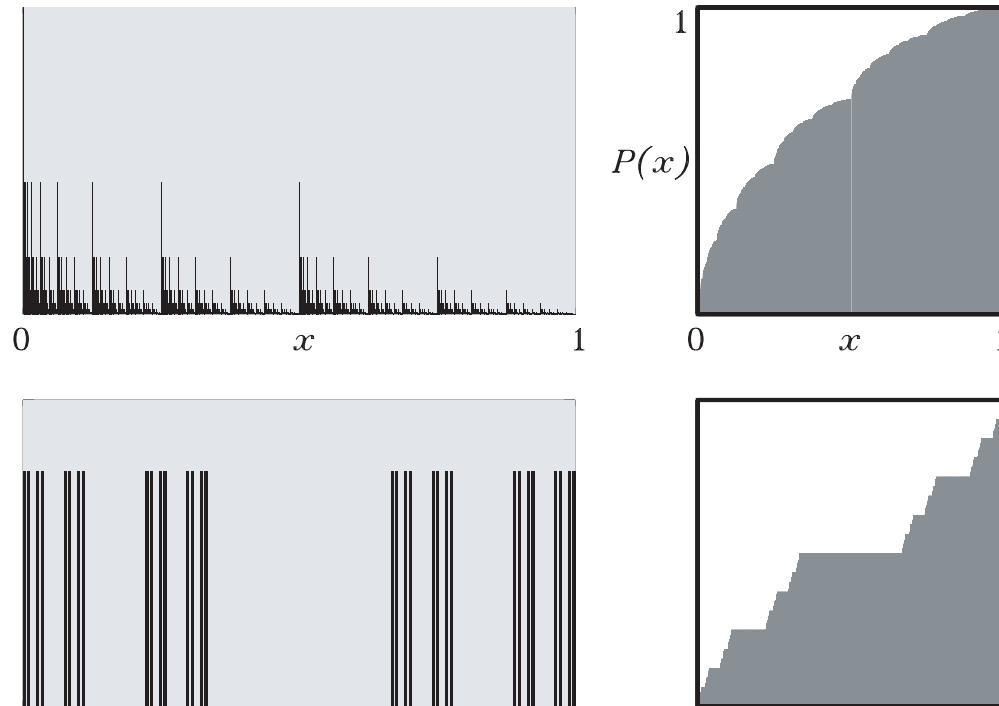


Disjoint equal **thorns** over Cantor **dust**

As found inside layers of first cascade by varying hole size

The two cascades are inherently **related** to one another

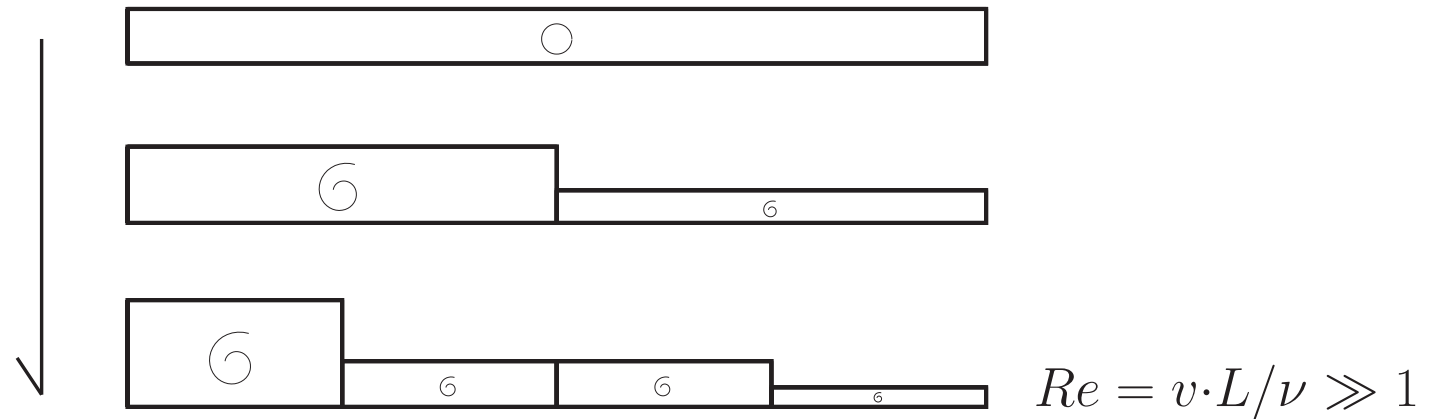
# Cumulative distributions



Locally flat and without derivatives  
**Devil's staircases** having maximal lengths  
 $d\{(0, 0), (1, 1)\} = 2, \quad p \neq 1/2, \quad h \neq 0$

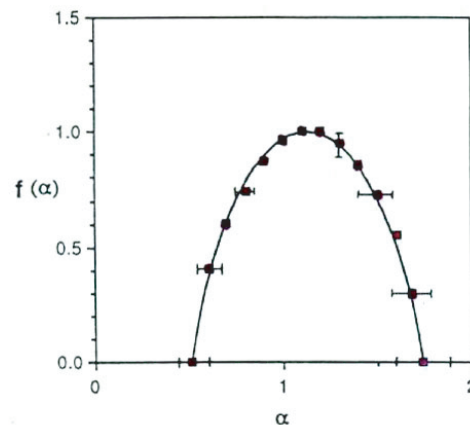
# Fully developed turbulence

(Meneveau and Sreenivasan, 1987)



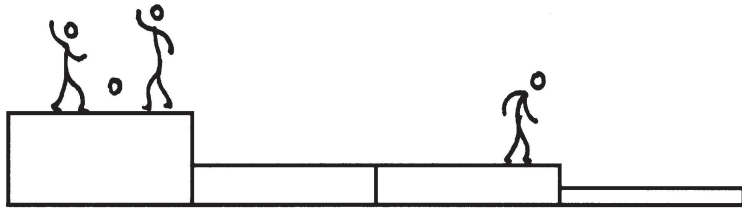
Layers in one-dimensional turbulence as in first cascade:  
boundary layer, atmospheric, wake of a cylinder...

$$p = 0.7$$



**universal**

# Our turbulent times



inequities

competition

disparities



discriminations

forced equality

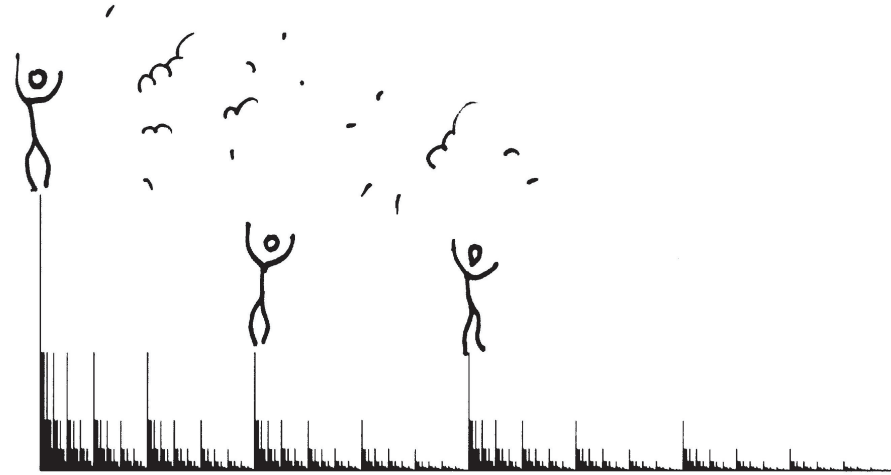
fear

**2/3** of the world under **poverty**

6,000 kids **die** a day for lack of **water**

**violence** and **terror**

## An optimal system?



$$p = 0.7$$

$$n = 20$$

5, 10, 20 and 40% largest thorns have  
57, 70, 84 and 95% of the mass

This is quite close to **USA**: 59, 71, 84 and 95%

**Warning:** both cascades are **dissipative**:  
if we ride them, they lead us to “bite the dust”

## Common sense solution

Run cascade in reverse to **mend** what is broken  
“Cut mountains and fill valleys” to restore **unity**  
Live at low Reynolds numbers to avoid violence

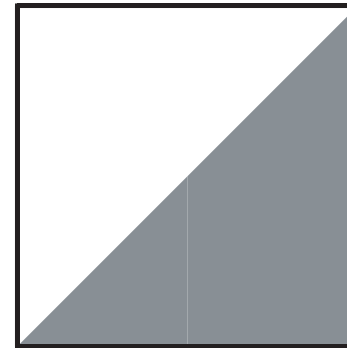
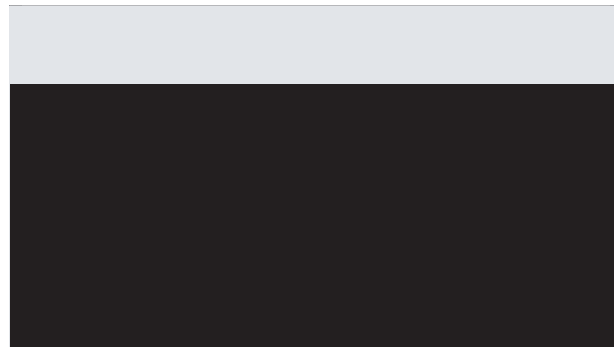
## Common sense solution

Run cascade in reverse to **mend** what is broken

“Cut mountains and fill valleys” to restore **unity**

Live at low Reynolds numbers to avoid violence:

50-50



$$d = \sqrt{2}$$

No holes

A **unique** solid solution without thorns and dust

The **hypotenuse** is the pathway of **peace**!

**Moral:** love everyone to find the **origin**!

# THE HYPOTENUSE

*Carlos E. Puente*

Two options before us  
two pathways ahead,  
the one is the longest  
the other straight.

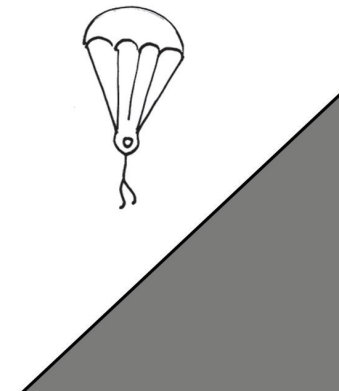
We journey directly  
or go by the legs,  
we follow intently  
or end up in pain.

By walking the flatness  
or hiking the spikes,  
we travel in lightness  
or take serious frights.



The incentive is unity  
and the call proportion,  
the key is forgiveness  
and the goal true notion.

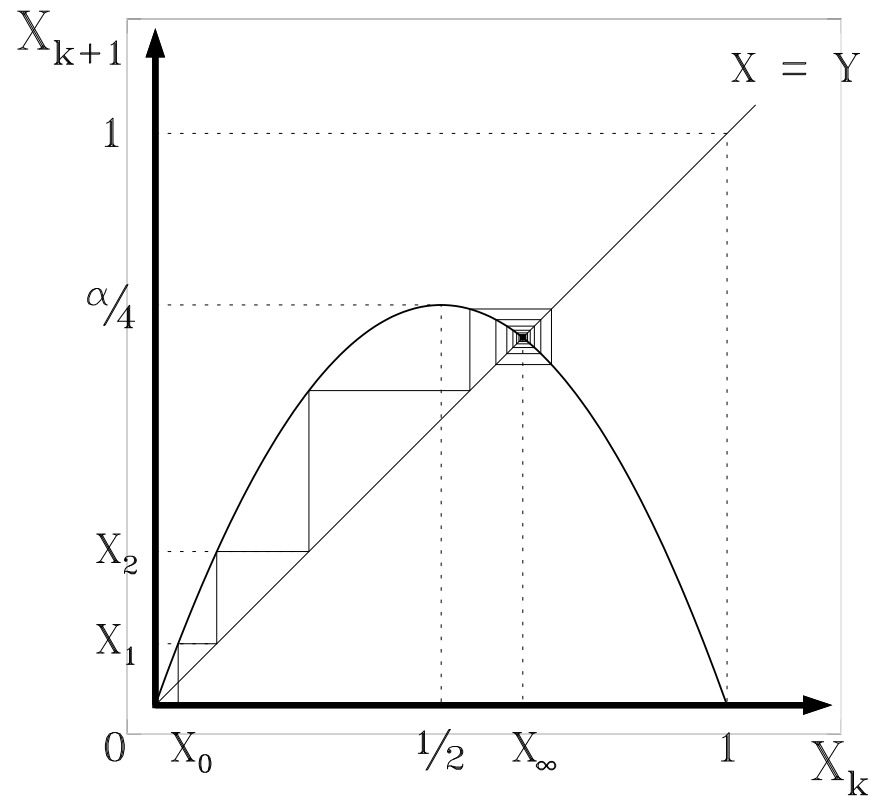
In wandering wickedness  
there is never fruit,  
but in ample humbleness  
one encounters the root.



# Lessons from chaos

## The logistic parabola

$$X_{k+1} = \alpha X_k(1 - X_k), \alpha \in [0, 4]$$

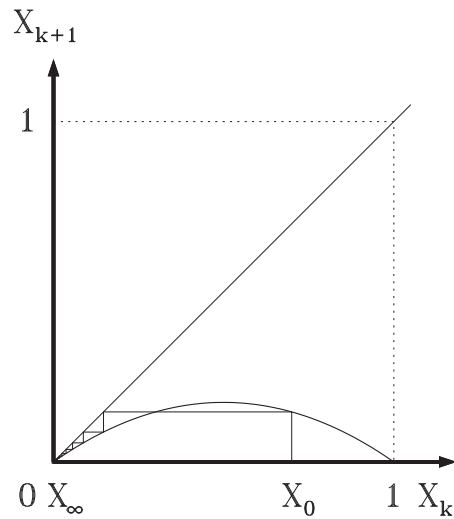


...say population of rabbits as a function of time  
different cases depending on  $\alpha$ ...

# From the origin to bifurcations

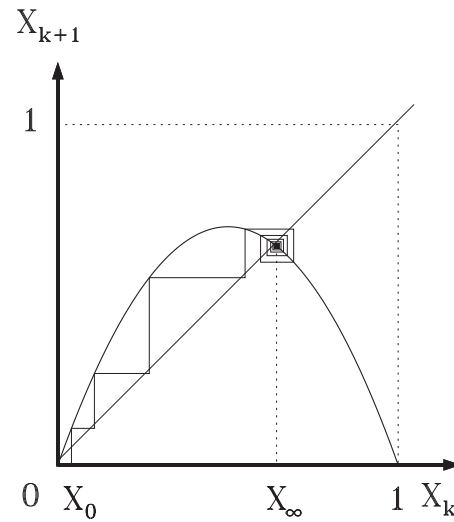
$$0 < \alpha \leq 1$$

$$X_{\infty} = 0$$



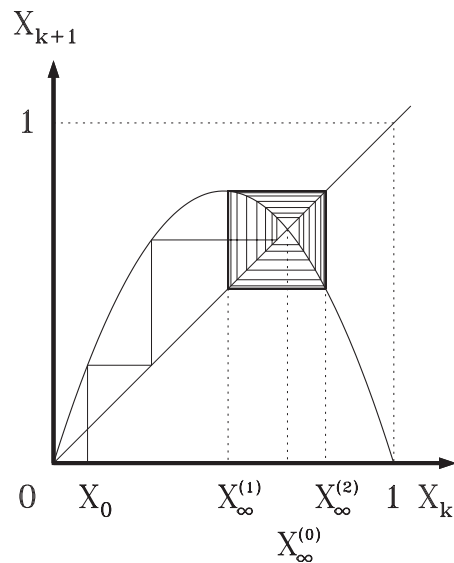
$$1 < \alpha \leq 3$$

$$X_{\infty} = (\alpha - 1)/\alpha$$



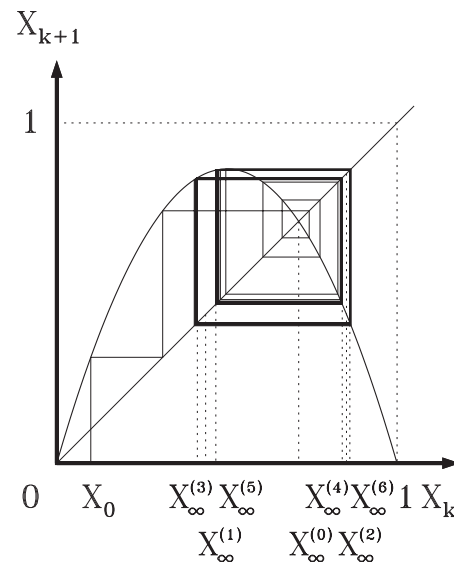
$$\alpha = 3.2$$

$$\text{period 2}$$



$$\alpha = 3.46$$

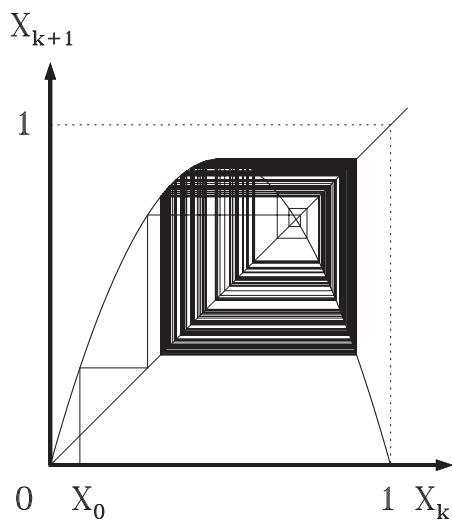
$$\text{period 4}$$



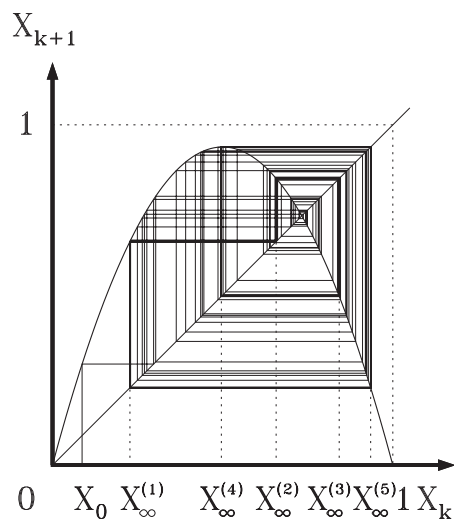
# Periodicities and chaos intertwined

$$(\alpha > \alpha_\infty \approx 3.5699)$$

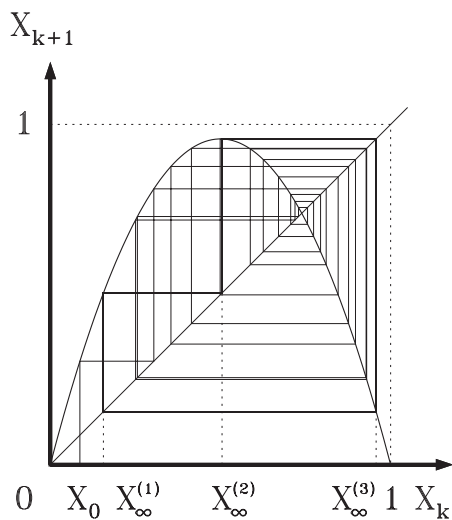
$\alpha = 3.6$   
aperiodic



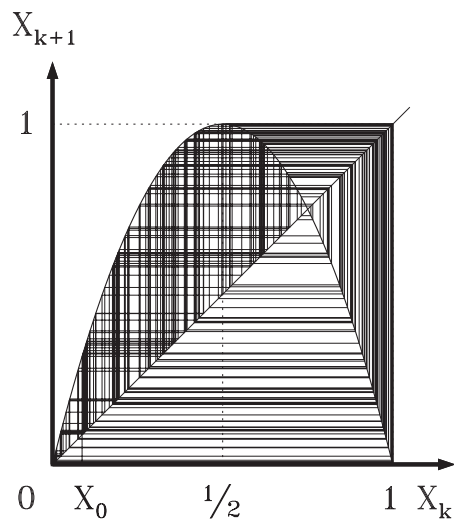
$\alpha = 3.74$   
period 5



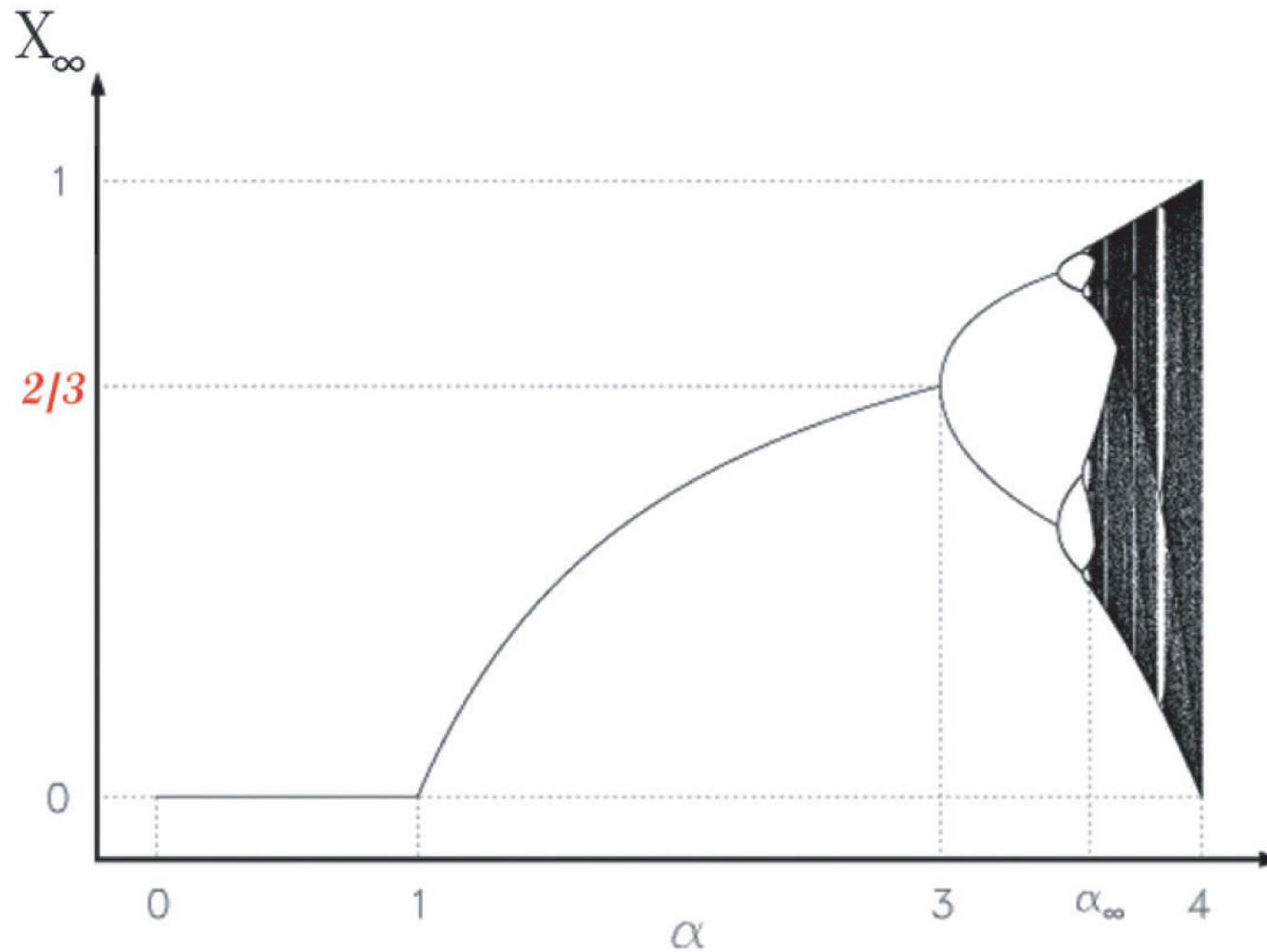
$\alpha = 3.83$   
period 3



$\alpha = 4$   
aperiodic

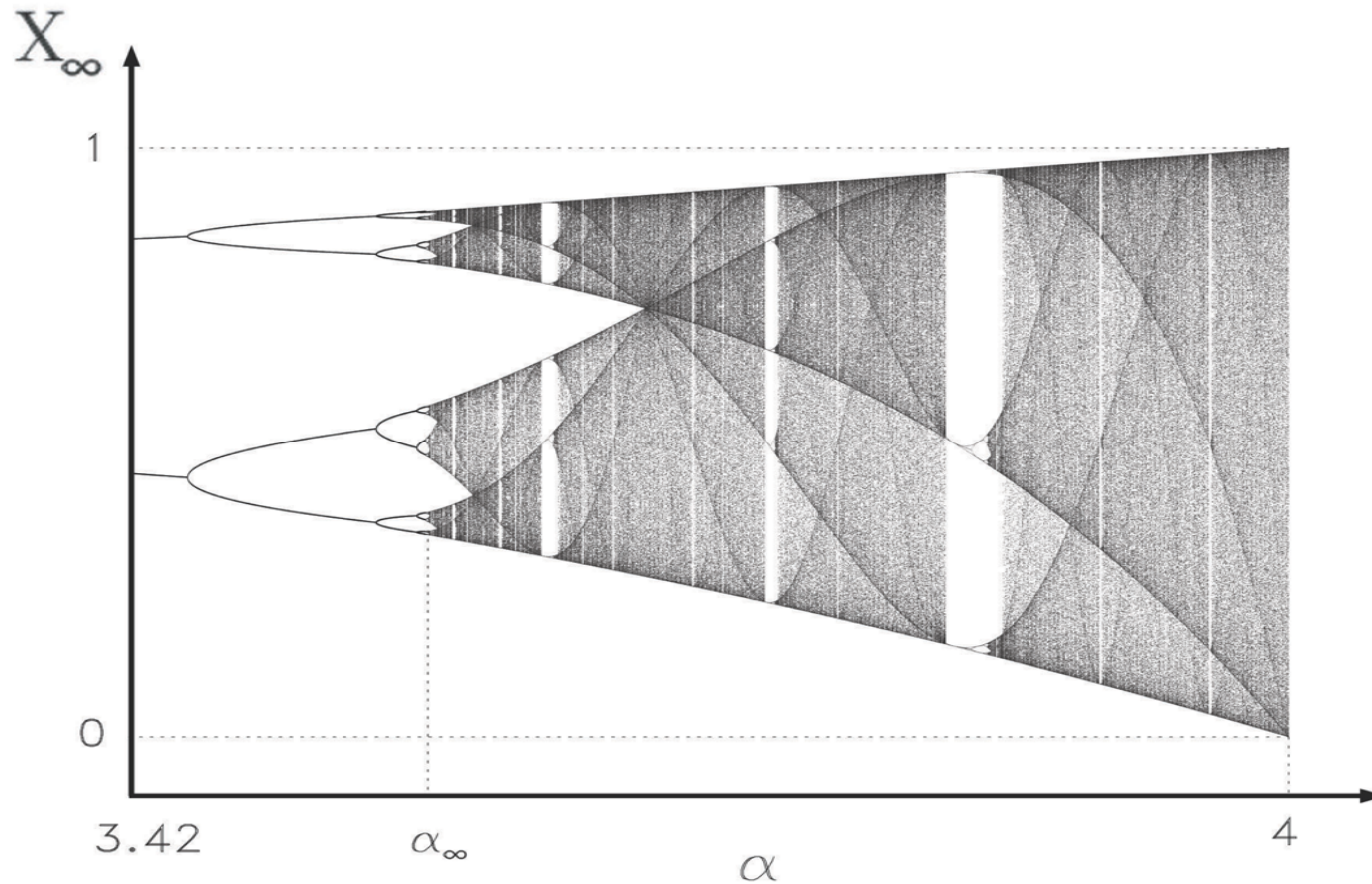


# Bifurcations diagram



Periodic behavior for any number is found in the tree!

## Dust galore and self-similarity

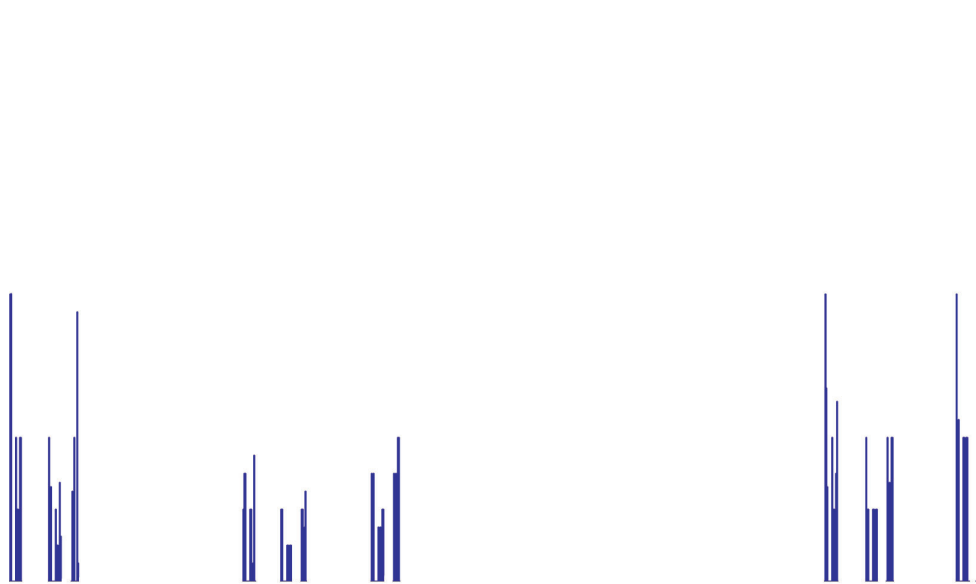


After  $\alpha_\infty$ , **dusty** “strange attractors” are common  
Expansion of periodic **buds** gives small copies of tree!

## Thorns galore

The tree contains many **multifractal** measures

The first one occurs at  $\alpha_\infty$ :

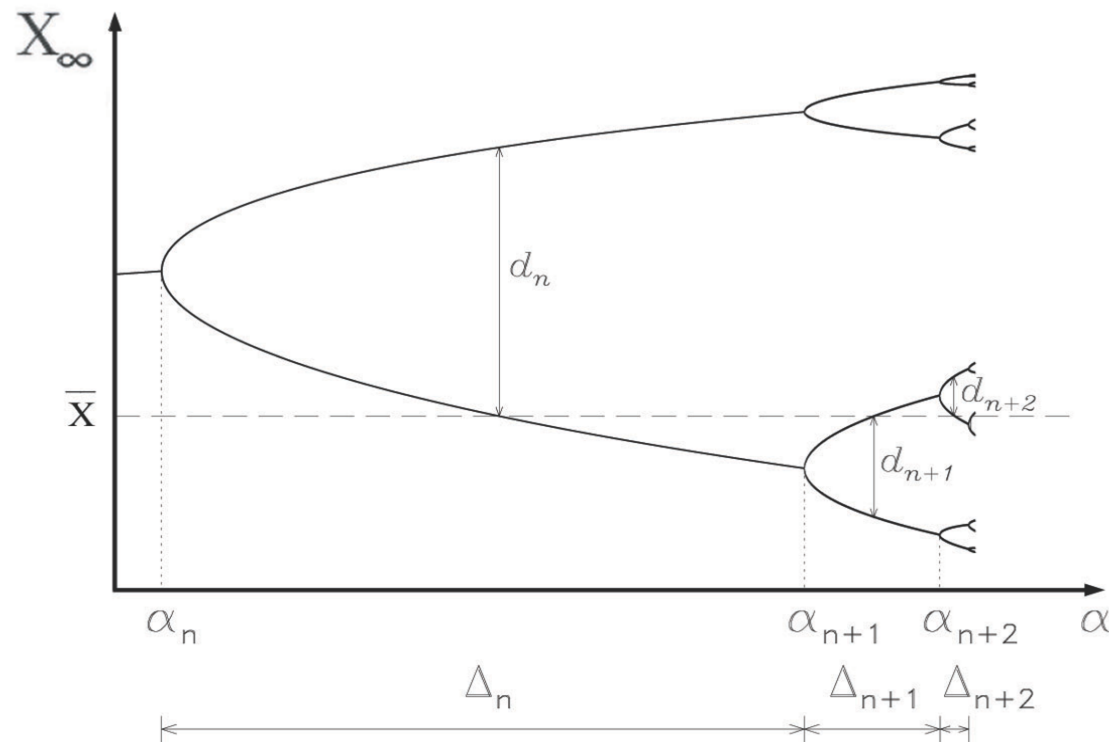


Others happen at accumulation points of buds for all periods

# Universality on Fig Tree

(Mitchell Feigenbaum, 1978)

Bifurcations happen in an **orderly** fashion:

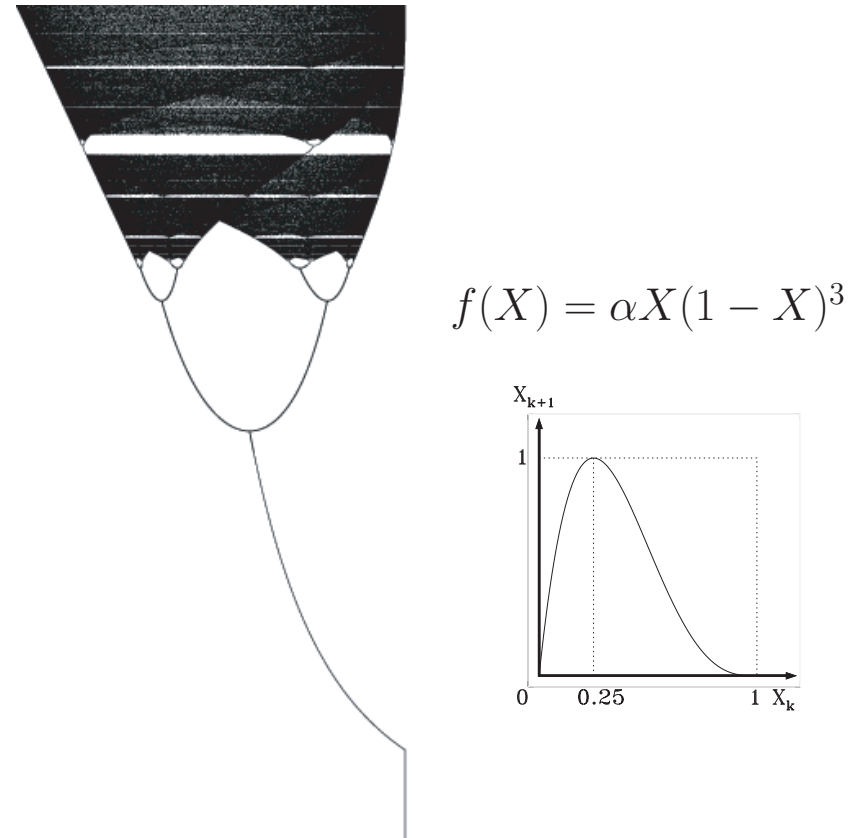
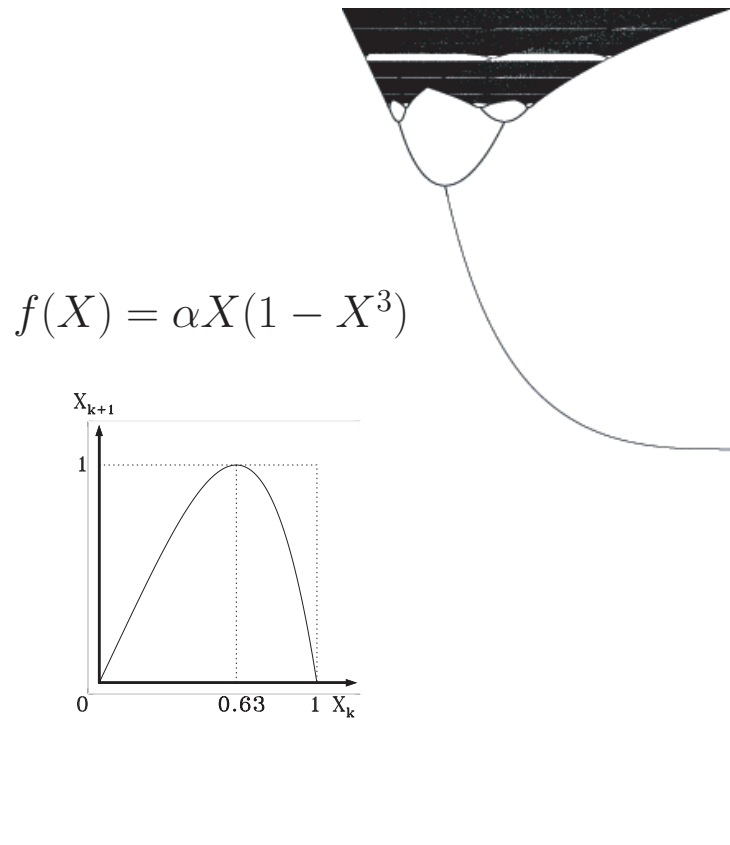


$$d_n/d_{n+1} \longrightarrow \mathcal{F}_1 = -2.50 \dots$$

$$\Delta_n/\Delta_{n+1} \longrightarrow \mathcal{F}_2 = 4.669 \dots$$

## Also universality on other trees

straight root, tender branch, branches, dust (“fig leaves”)



Relevant in Ecology, Chemistry, Physics and Economics  
Dynamics of **convection** are reproduced if  $\alpha$  is **heat**

## More common sense

As with turbulence, it is best:

to lower our **heat** to avoid violence

to tame non-linearities to bypass **thorns** and **dust**

not to amplify the troubles we face ( $\alpha \leq 1$ )

to live **slowly** and in **humility**

not to cross the **threshold**,  $X = Y$ , the **hypotenuse**

to come down the tree to find the **root**

to arrive at the **origin**:  $X_\infty = 0$  (O my rabbits!)

Being trapped in an strange attractor at high heat is **hell!**

## FEIGENBAUM'S PARABEL

*Carlos E. Puente*

Foliage of disorder  
trapped in empty dust,  
jumps astir forever  
enduring subtle thrust.

Crossing of the outset  
leaving faithful root,  
looming tender offset  
failing to yield fruit.

Cascade of bifurcations,  
increasing heat within,  
inescapable succession  
of branches bent by wind.

Sprouting of dynamics  
attracted to the strange,  
oh infinity reminding  
at the origin: the flame.

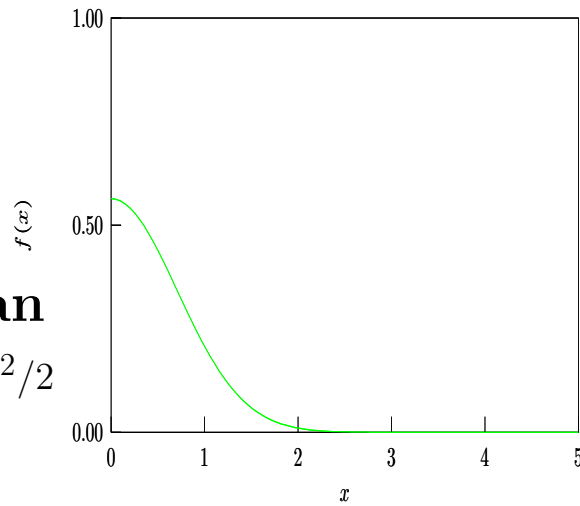


## Lessons from normality

# Bells and power-laws

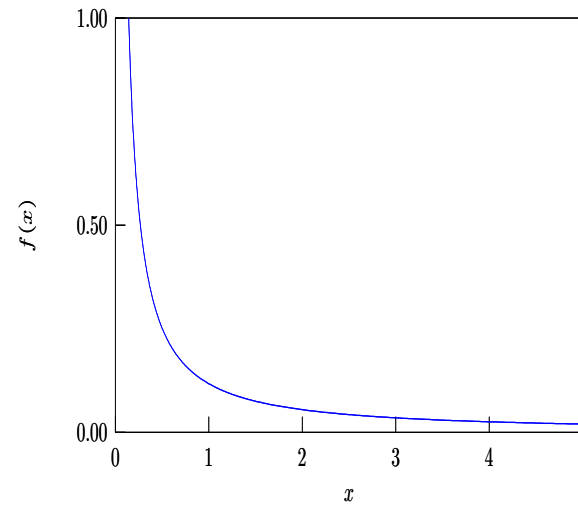
**Gaussian**

$$f(x) \sim e^{-x^2/2}$$

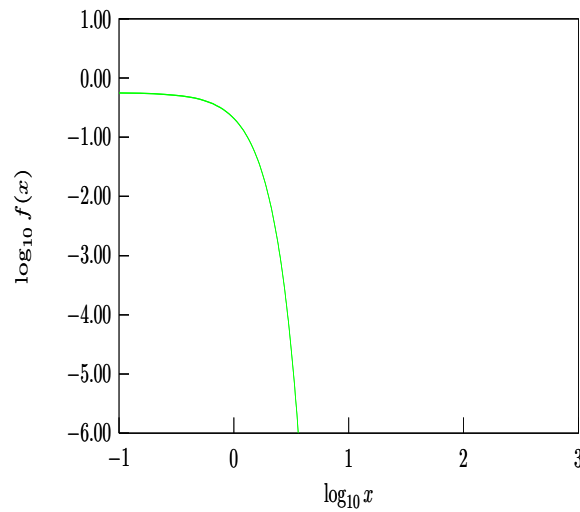


**Pareto**

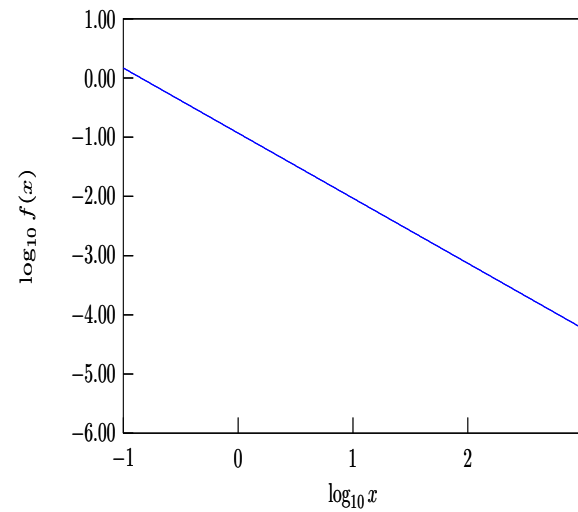
$$f(x) \sim 1/x^{a+1}$$



**CLT**

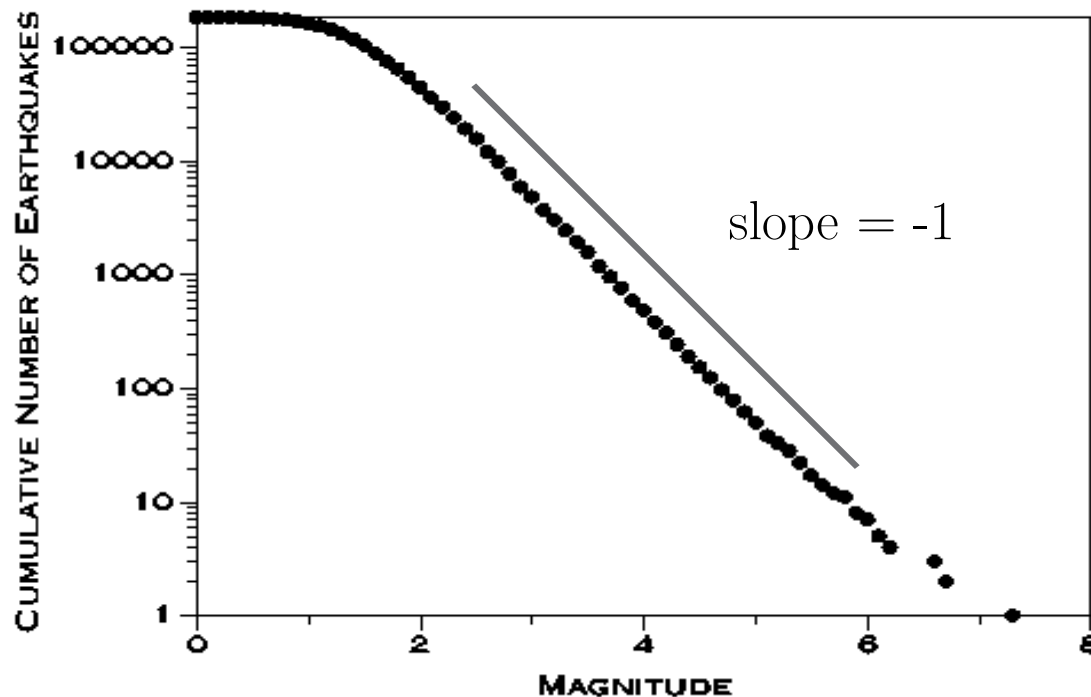


**scale free**  
**“heavy tails”**



# Power-laws and natural complexity

$$P[X \geq x] \sim x^{-c}$$



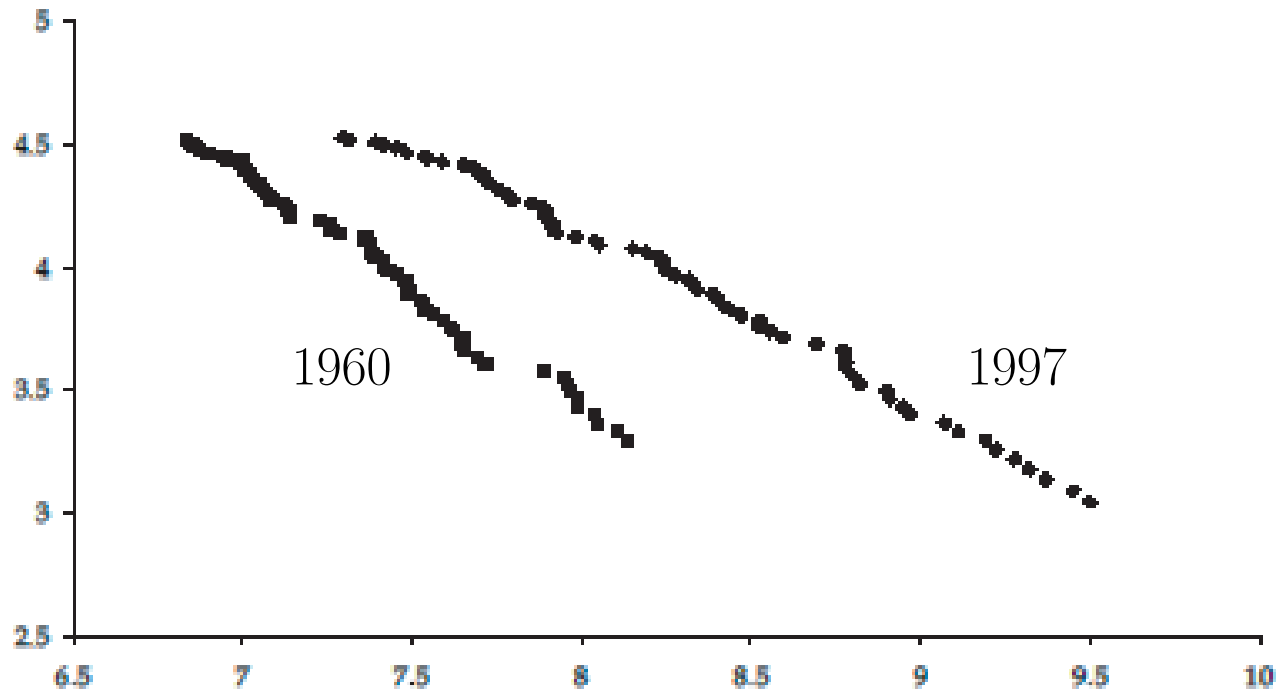
earthquakes, avalanches, hurricanes, floods,  
volcanic eruptions, forest fires...

**utter violence**

# Power-laws and inequalities

(Vilfredo Pareto, 1896)

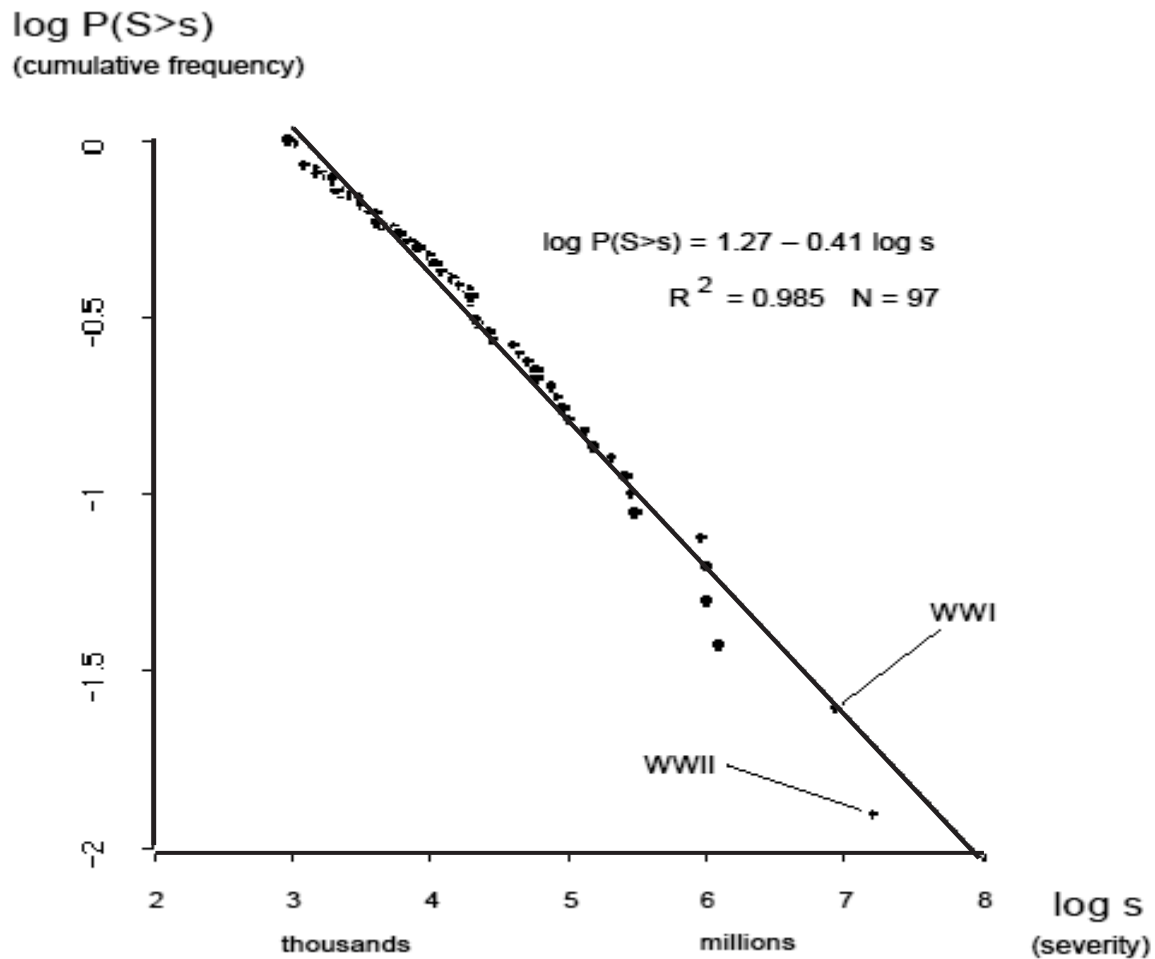
$$\log N(x) = \log A + m \cdot \log x$$



30th to 85th percentiles of world income distribution  
(After Di Guilmi et al., 2003)

# Power-laws and wars

(Lewis Fry Richardson, 1960)



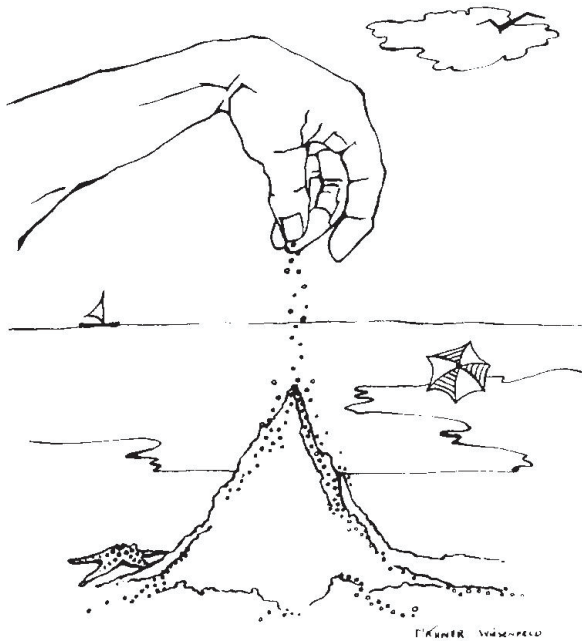
(After Cederman, 2003)

## More on common sense

As **violence** is related to power-laws  $\Rightarrow$  study the mechanisms that produce them and avoid such in order to find **peace**

## More on common sense

As **violence** is related to power-laws  $\Rightarrow$  study the mechanisms that produce them and avoid such in order to find **peace**:



(After Bak, 1996)

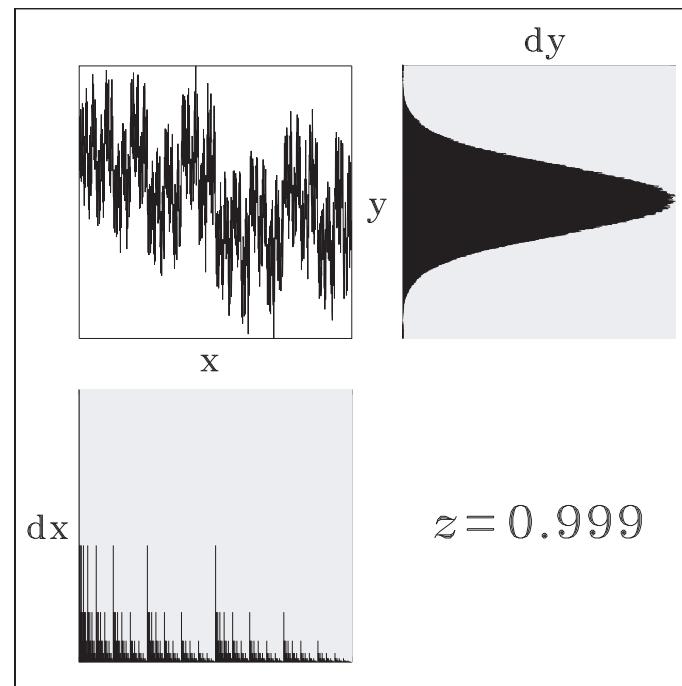
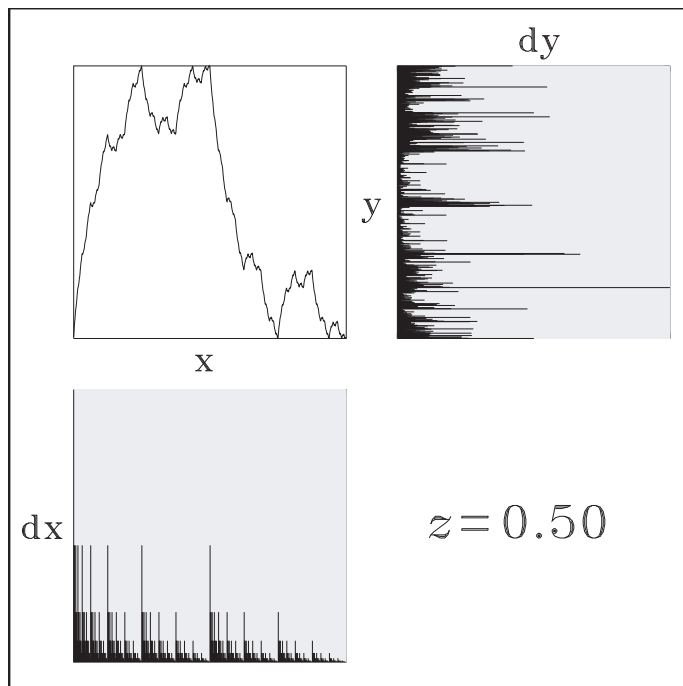
- multiplicative cascades
- preferential attachments
- highly optimized tolerance
- self-organized criticality...

“Scale free humans” misuse their power to yield power-laws  
There is no “**invisible hand**” but our own...

## A pathway to normality via iterations

$$w_1(x, y) = (x/2, x + z \cdot y), w_2(x, y) = (x/2 + 1/2, 1 - x - z \cdot y)$$

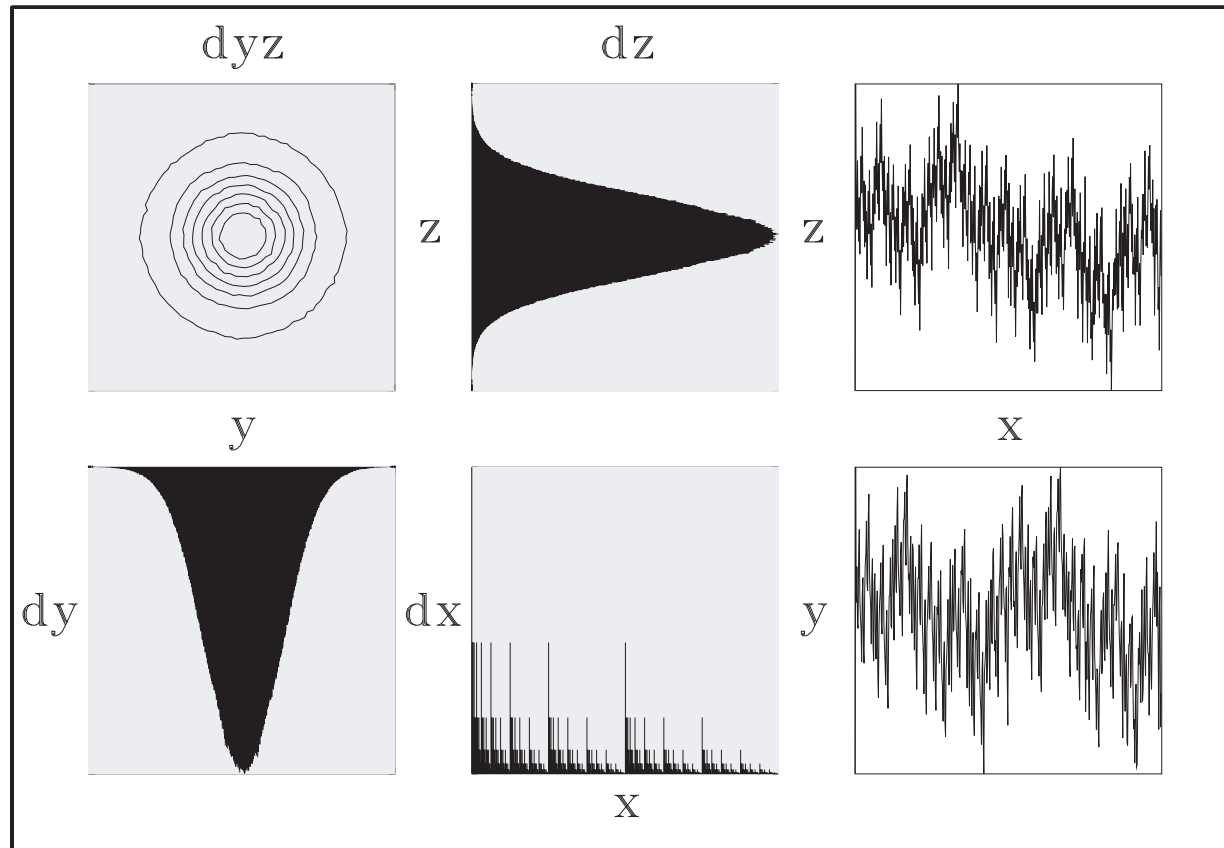
(Puente, 2003)



From a multifractal to a realistic natural set

From **any** multifractal to a limiting **bell**

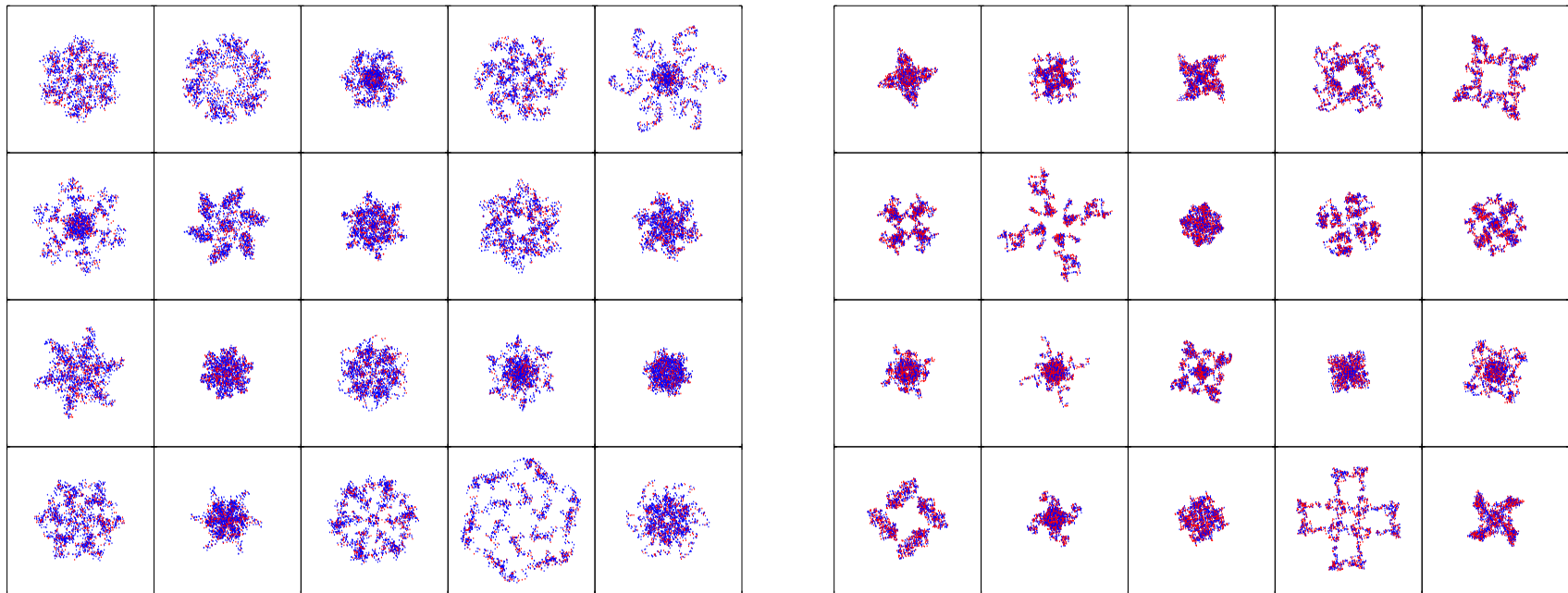
# Bells in higher dimensions



From **thorns** and **dust** to **harmony**  
via a space-filling transformation

# The exquisite decompositions of the bell

(Puente, 2003)

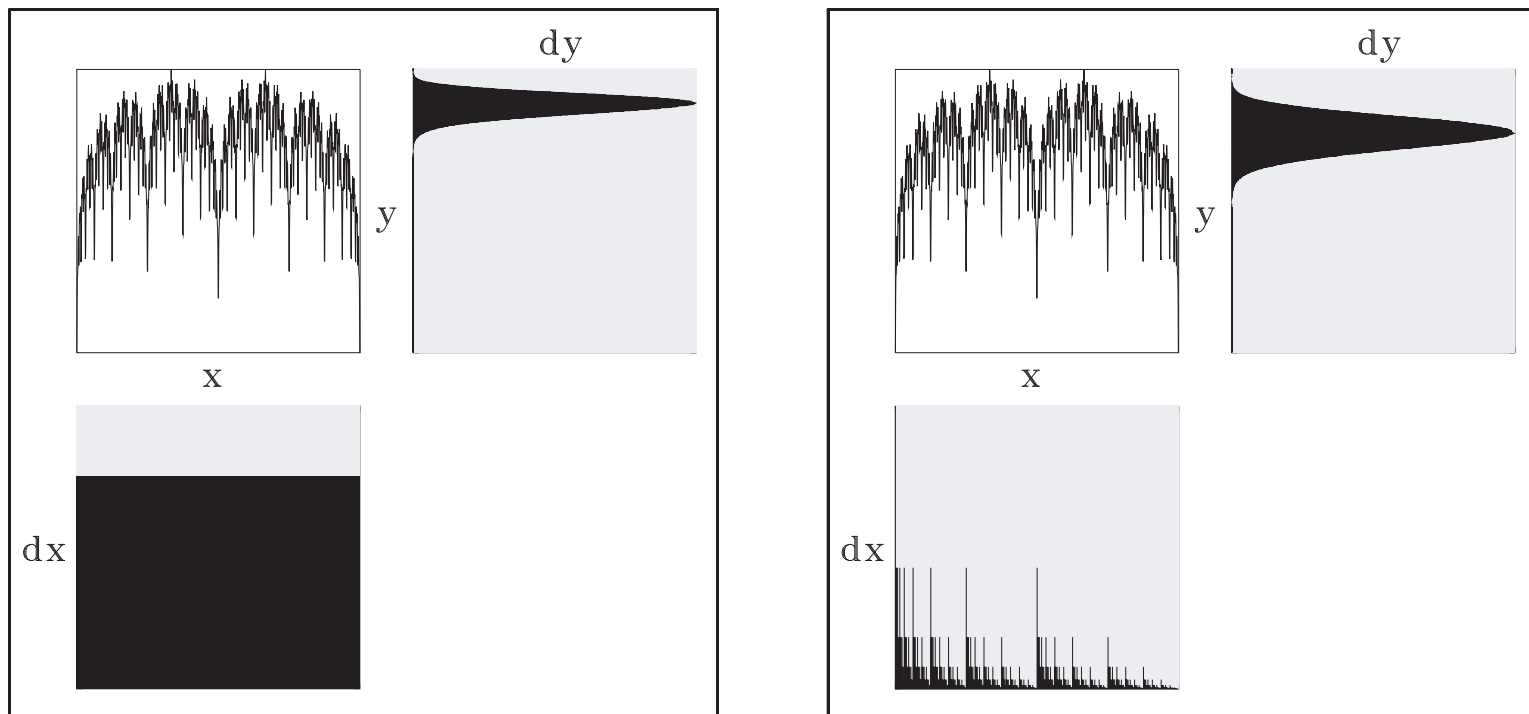


Hidden **order** in chance in the **limit**  
All is **beauty** inside the bell  
ice crystals and biochemical rosettes inside the bell

## A rather special case

$$w_1(x, y) = (x/2, x + z \cdot y), w_2(x, y) = (x/2 + 1/2, 1 - x + z \cdot y)$$

always **positive**,  $z \rightarrow 1$



A bell concentrated at **infinity**!  
A universal **filter** of any type of disorder!

# THE AMAZING BELL

*Carlos E. Puente*

*By the mystery of science  
graciously shines a state,  
an all-embracing alliance  
adding liberty a shape.*

*One day, as if by chance,  
boldly there was such gem,  
as the shadow off a wire  
that fills completely space.*

*As the ideas hint above  
enduring a lasting zest,  
here is probable code  
in the ever precious bell.*

The bell peals silent, oh oh  
reflecting its peace,  
and inside it gathers  
lovely masterpiece.

Symmetric pure beauty, oh oh  
oh mighty delight,  
this limit in fullness  
stores life's designs.

Such vessel contains, oh oh  
alephs of all tastes,  
diatoms and crystals  
including DNA.

But there is a case, oh oh  
reason to this song:  
the forward selection  
that raises it all.

There is clear choice  
that rotates the 8.

**By loving sincerely  
we surely converge.**

Notice, this is cogent:  
the bell's central theme.

**By living in freedom  
one fulfills the dream.**

There is transformation  
that kindles the heart.

**By loving in plenitude  
we become smart.**

For love mends the spiky  
and takes to the clouds.

**By living the present  
one joins blessed crowd.**

Oh see, this is truthful:  
the plus all the way.

**By loving the enemy  
we learn how to play.**

Dimensional growth,  
oh essence of life.

**By living in harmony  
one nails normal plan.**

Oh notice the symbols,  
oh irrational might.

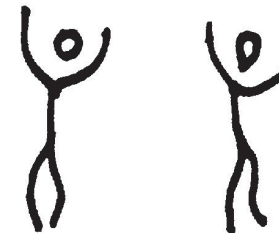
**By loving simplicity  
we experience the light.**

Oh listen, you colleague,  
let's go out the cave.

**By living in unity  
we all shall prevail.**

Oh notice, my friend,  
the plea from a bell.

**By loving and loving  
joy will have no end...**



# CONCLUSIONS

**Simplicity** is far better than **complexity**

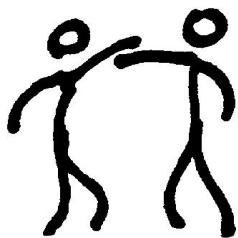
Refrain from what is “**natural**” and do what is “**normal**”

When needed reclaim inherent **scale** by **rectifying**:

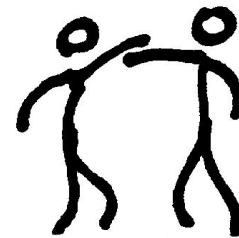
Avoid accumulation of energies living in **equilibrium**  $p = 1/2$

Do not cross appointed thresholds staying at the **root**  $\alpha \leq 1$

Satisfy the central limit theorem being always **positive**  $z \rightarrow 1$



Peace be with you!



<http://puente.lawr.ucdavis.edu/peace.htm>