Aleatorio no es azaroso

Pedro Miramontes

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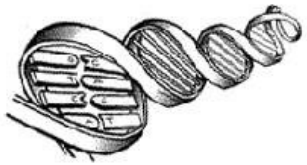

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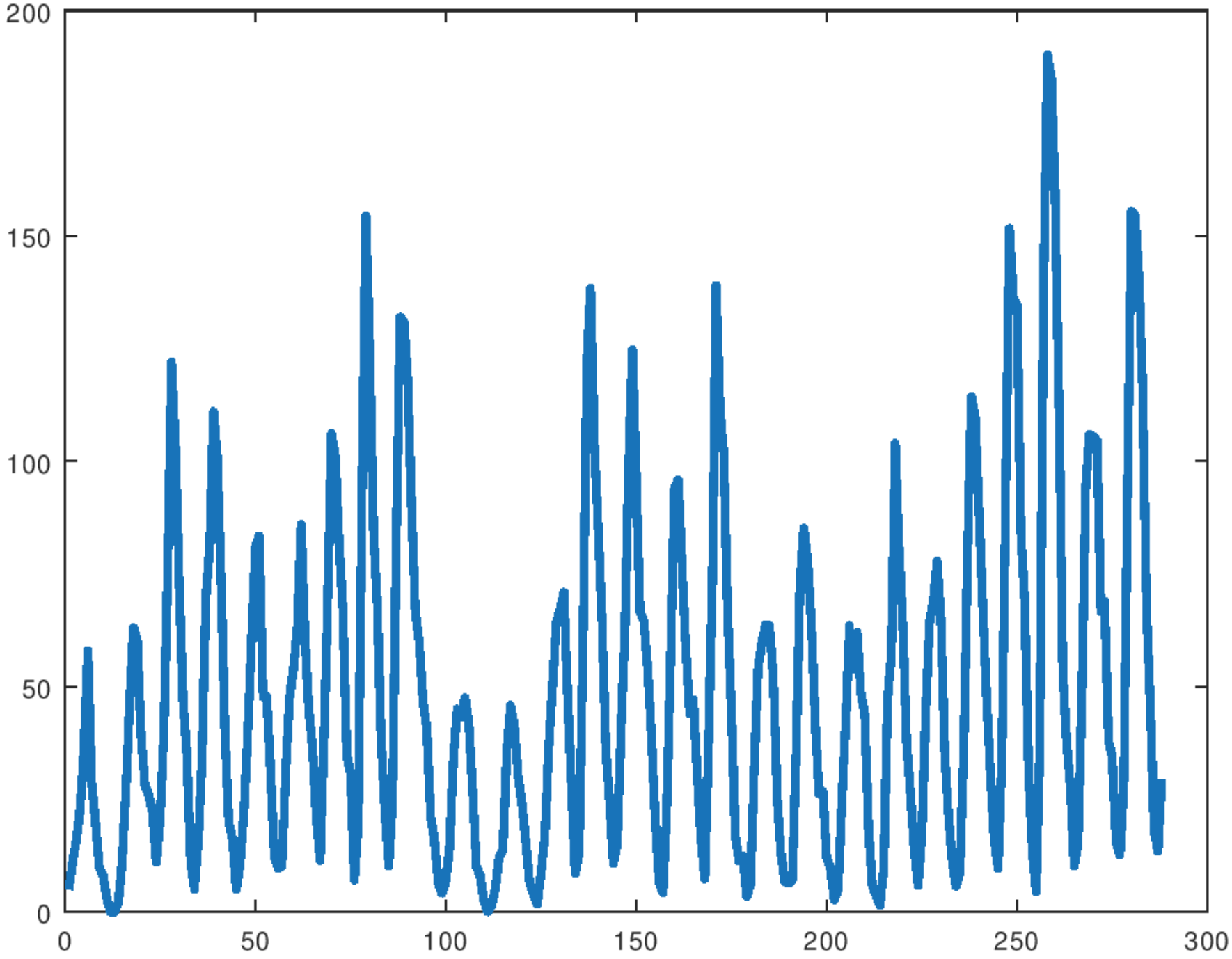
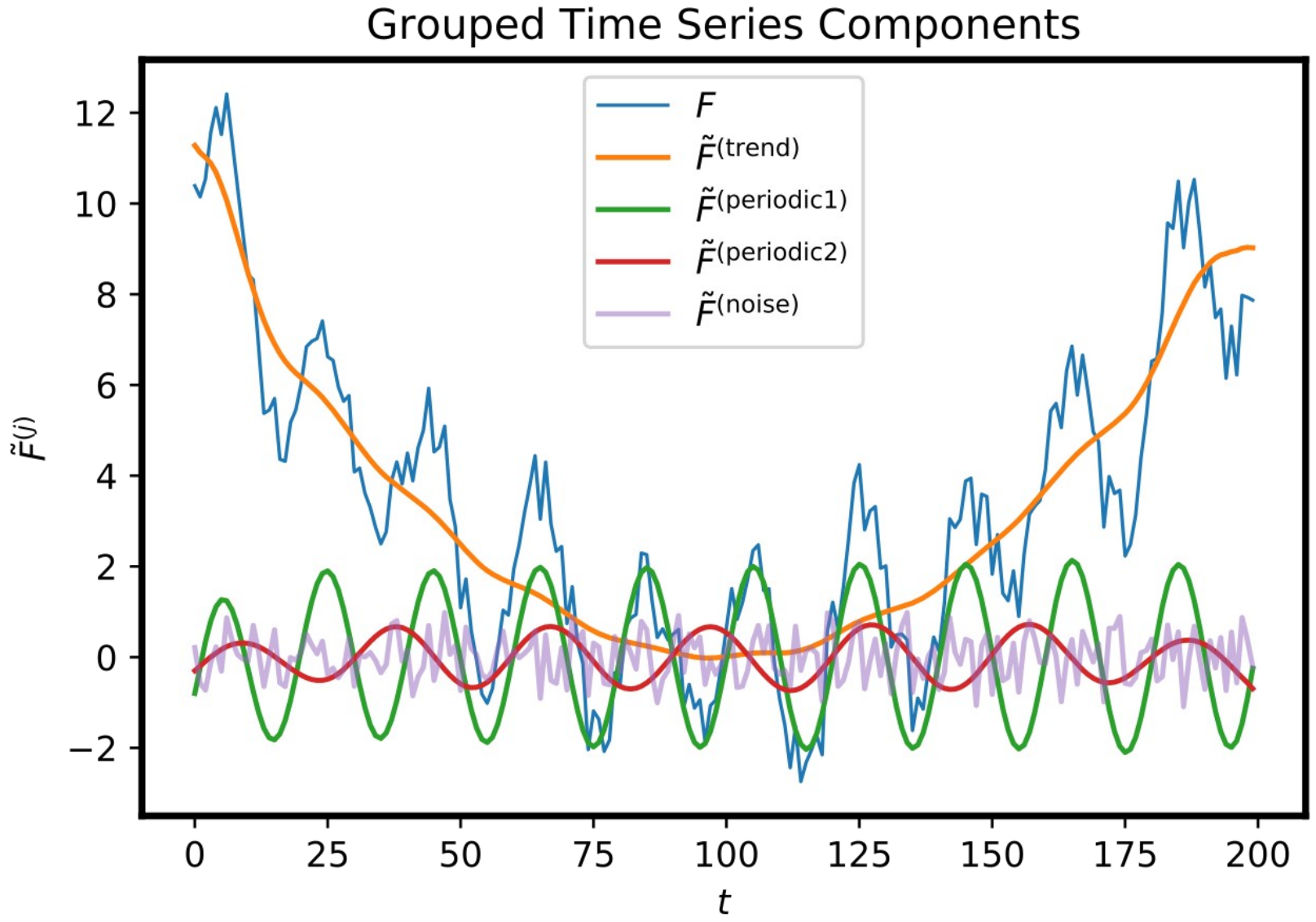
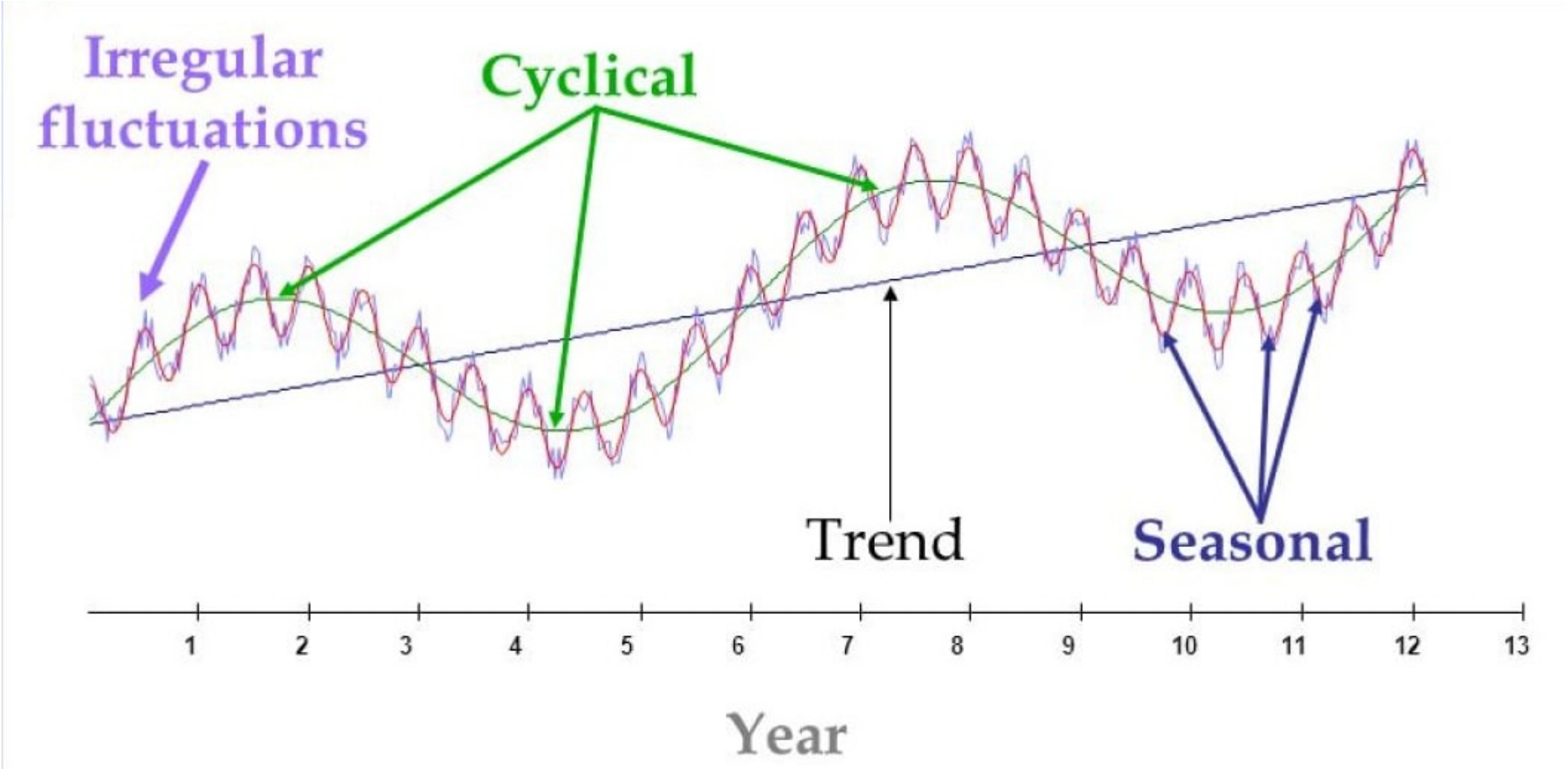

200
150
100
50
0
0
50
100
150
200
250
300

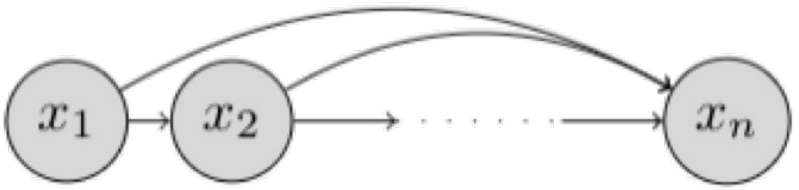

Grouped Time Series Components
F
$\tilde{F}$(trend)
$\tilde{F}$(periodic1)
$\tilde{F}$(periodic2)
$\tilde{F}$(noise)
$\tilde{F}(j)$
12
10
8
6
4
2
0
−2
0
25
50
75
100
125
150
175
200
t

$$\{X_t\}_{t=1}^{n}$$


Irregular fluctuations
Cyclical
Trend
Seasonal
1
2
3
4
5
6
7
8
9
10
11
12
13
Year

$$X_t = X_{t-i} + \epsilon_t$$

$$X_t = c + \sum_{i=1}^{p} \phi_i X_{t-i} + \epsilon_t$$

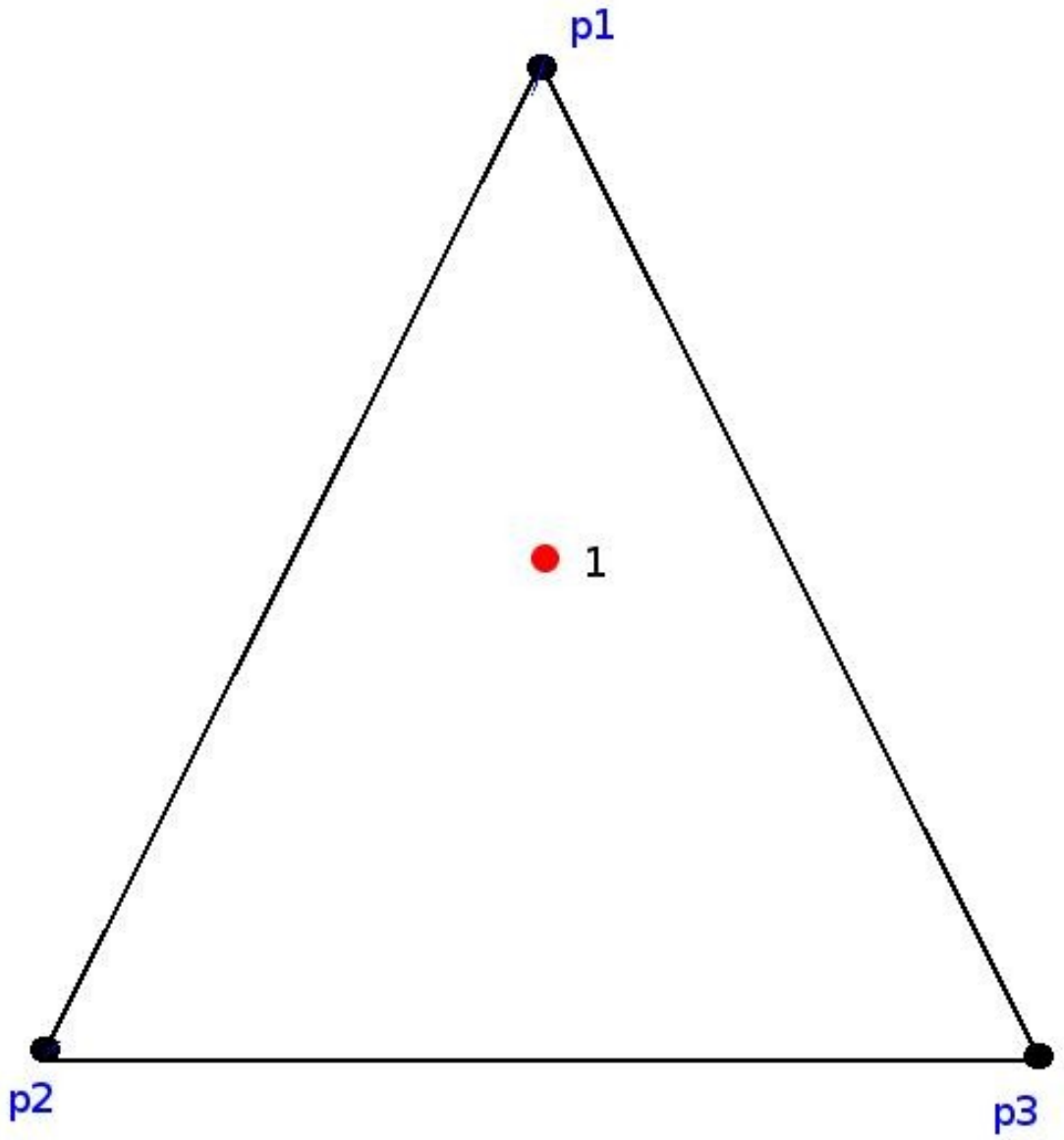


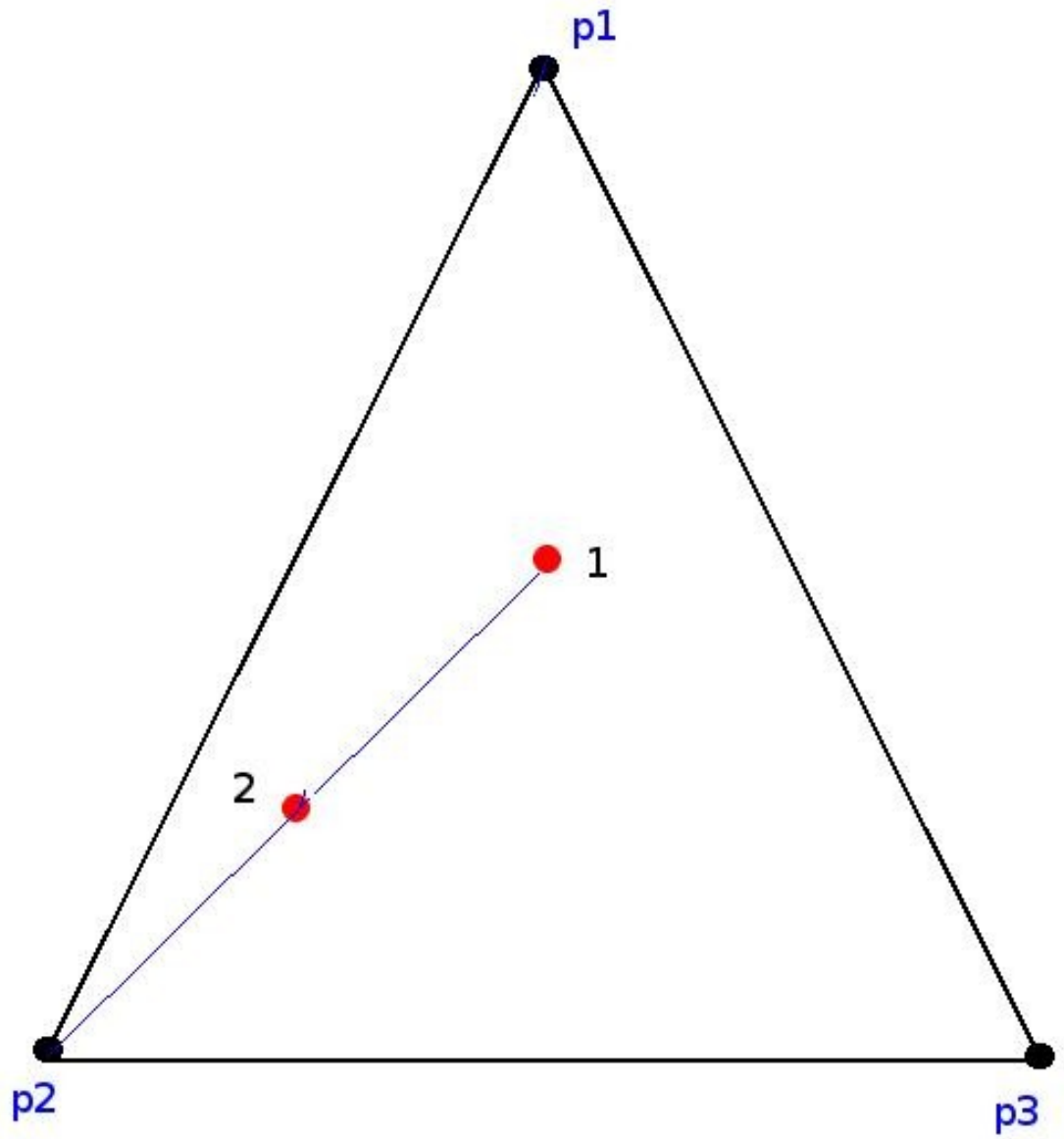
¿Qué es el azar?

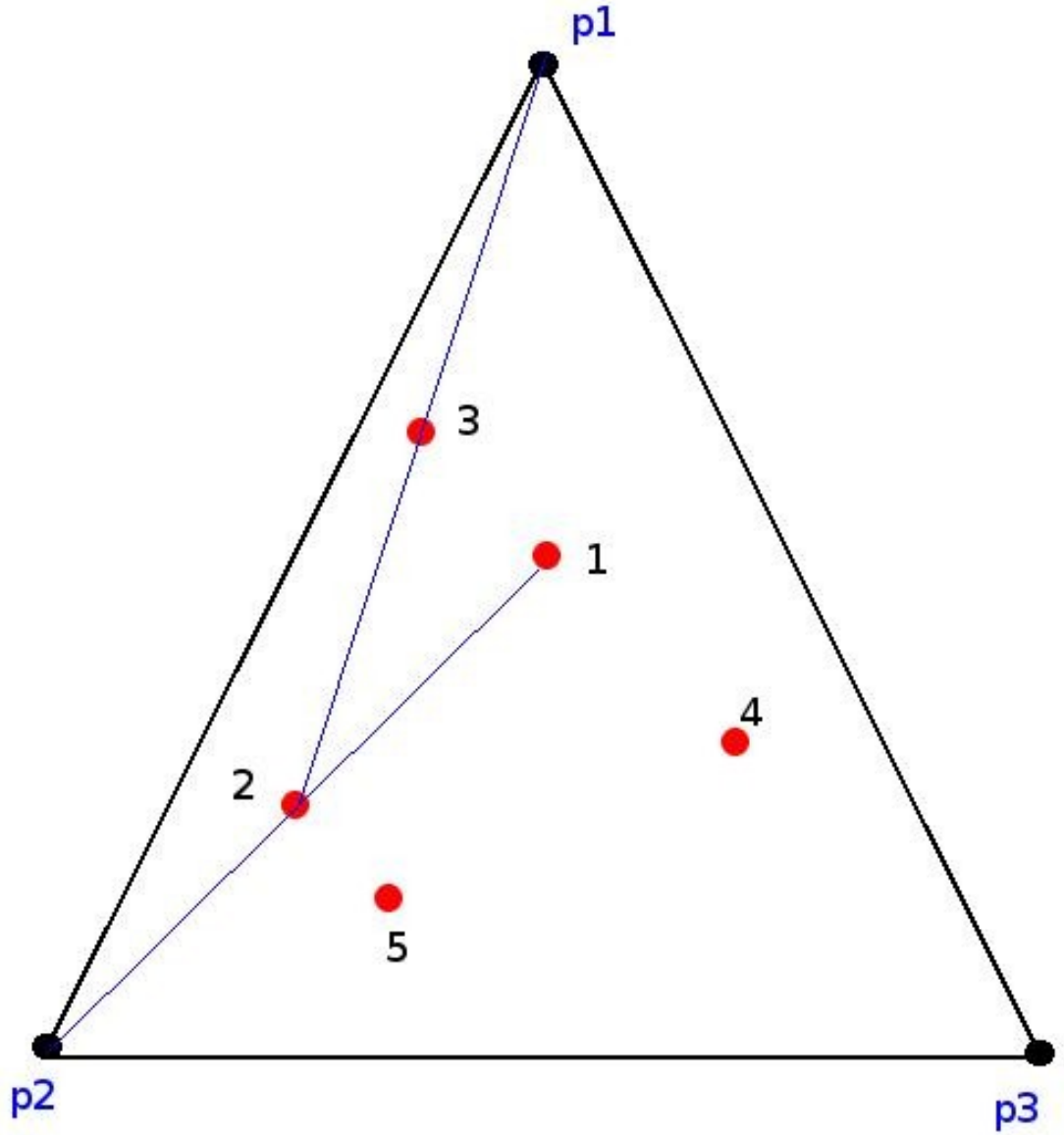
Randomness is only apparent, not fundamental;
beneath it lies a deeper order

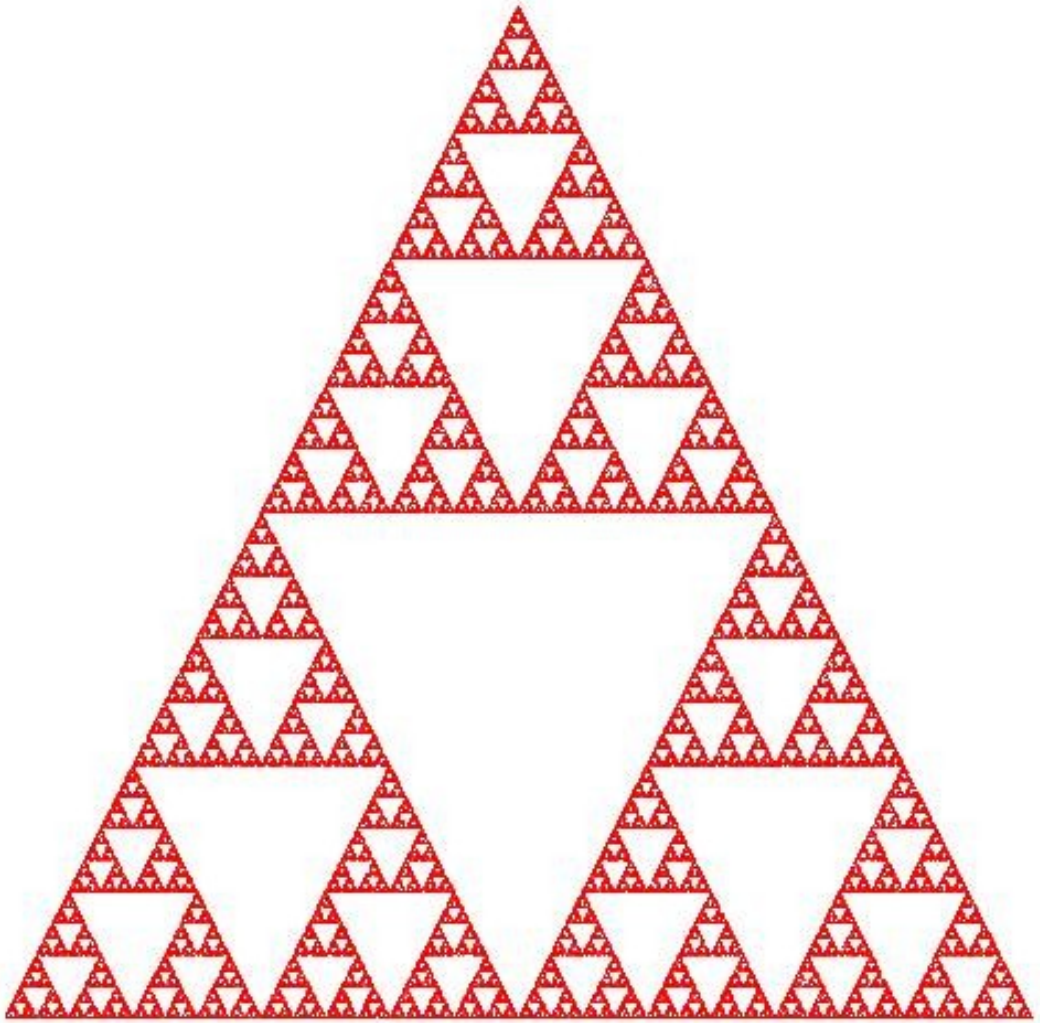
David Bohm

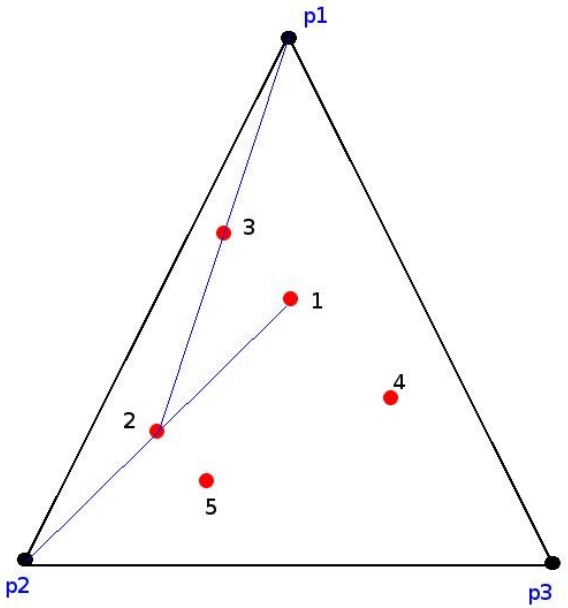
Lo que no es

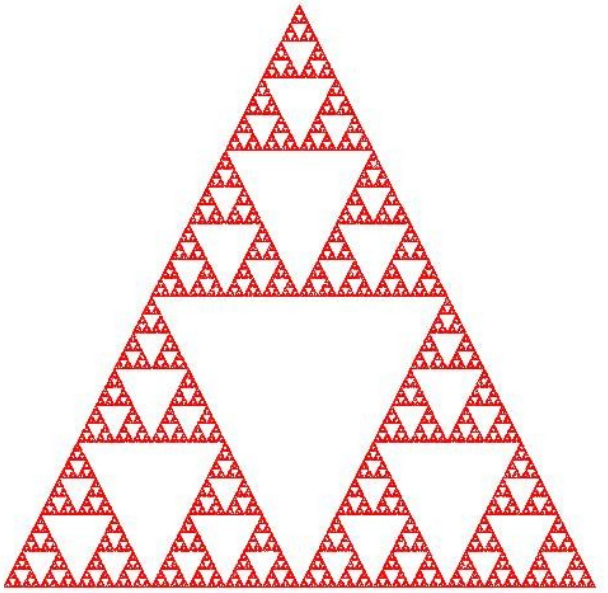

p1
1
p2
p3

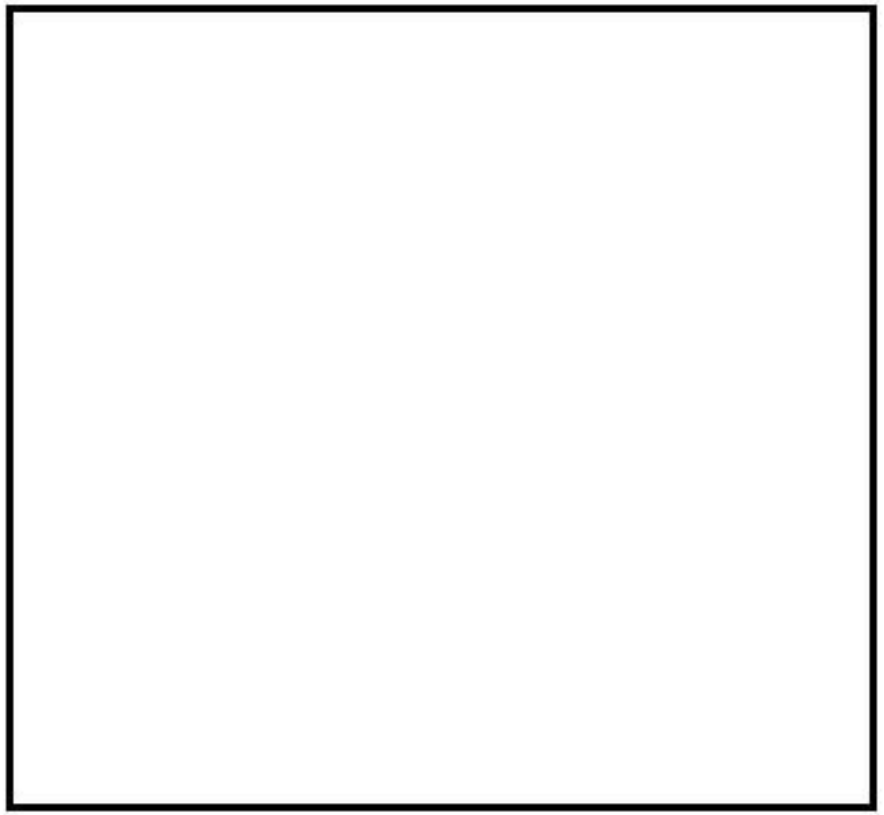

p1
1
2
p2
p3

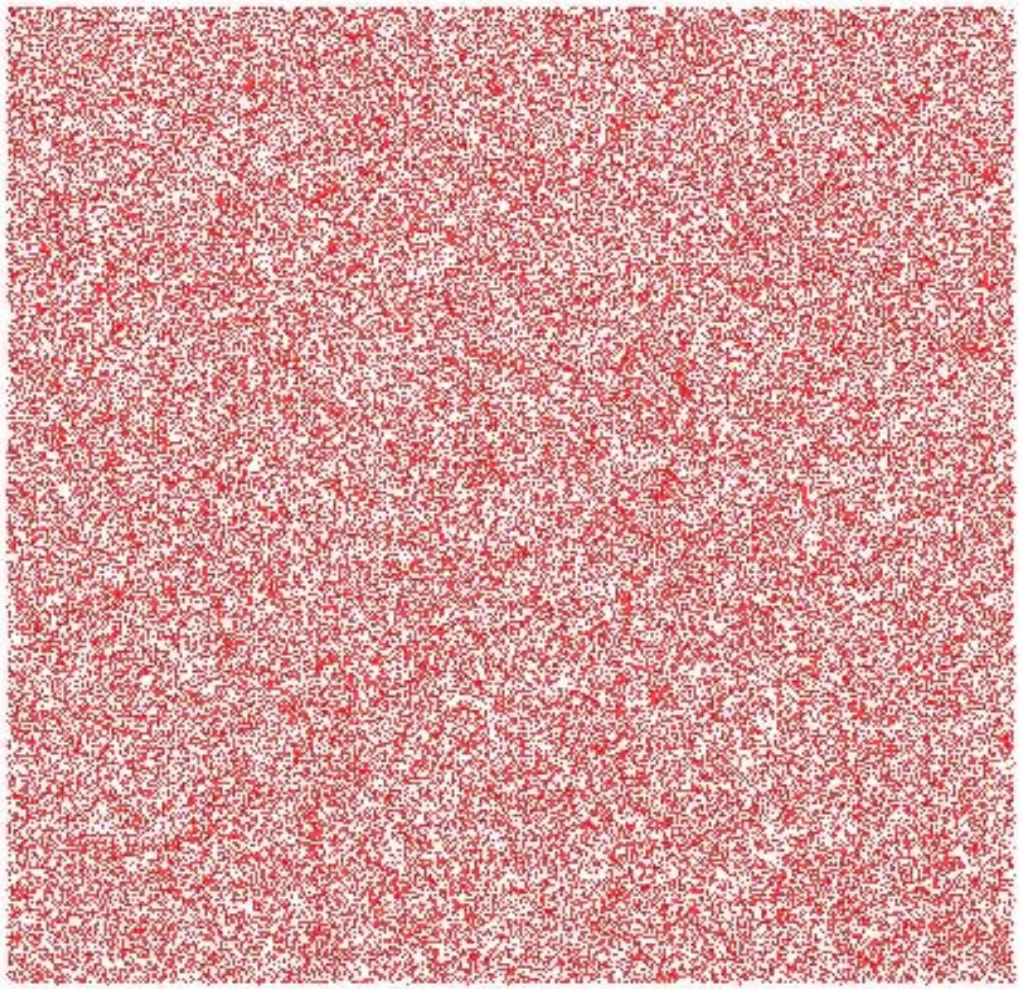

p1
3
1
4
2
5
p2
p3

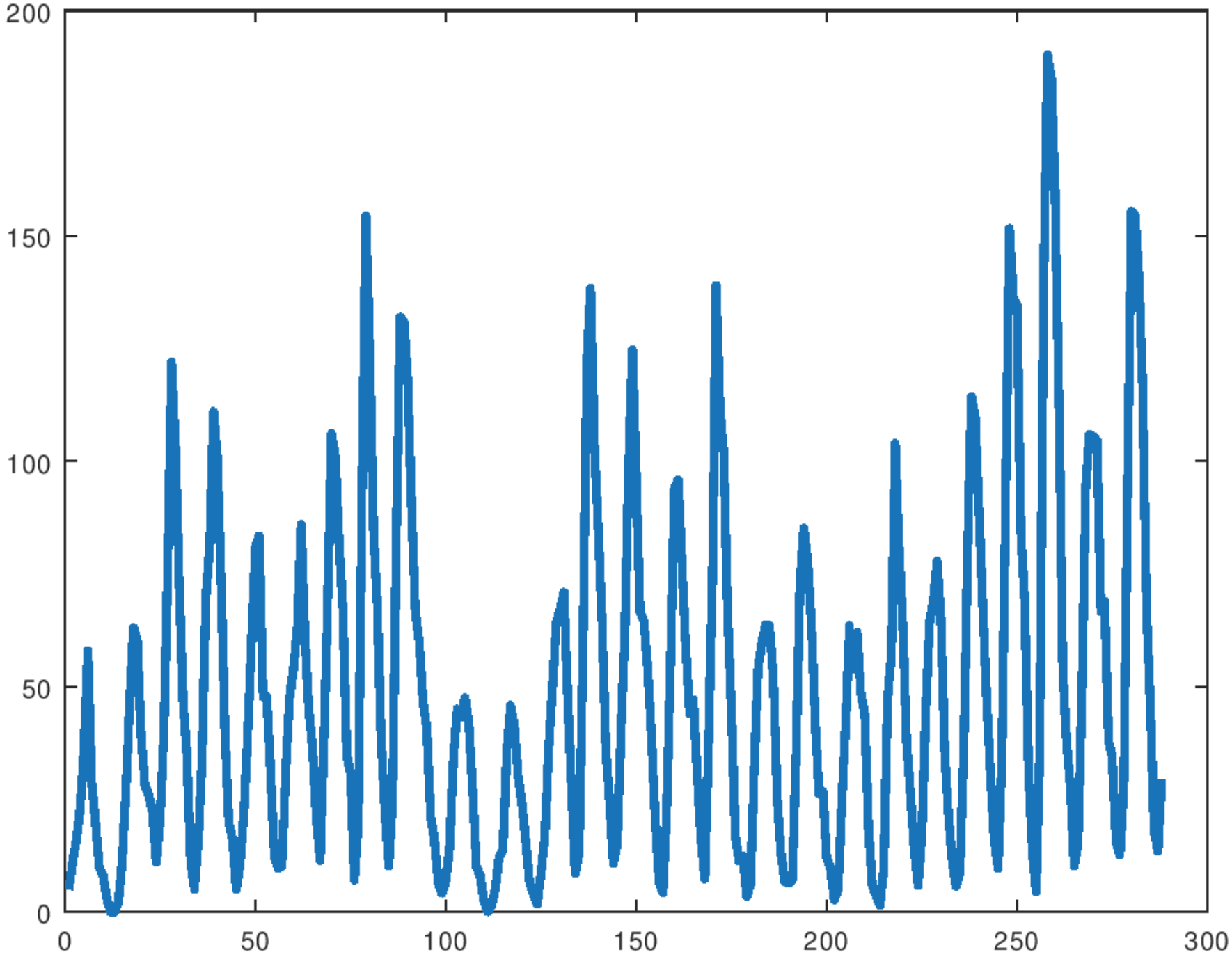



p1
3
1
4
2
5
p2
p3





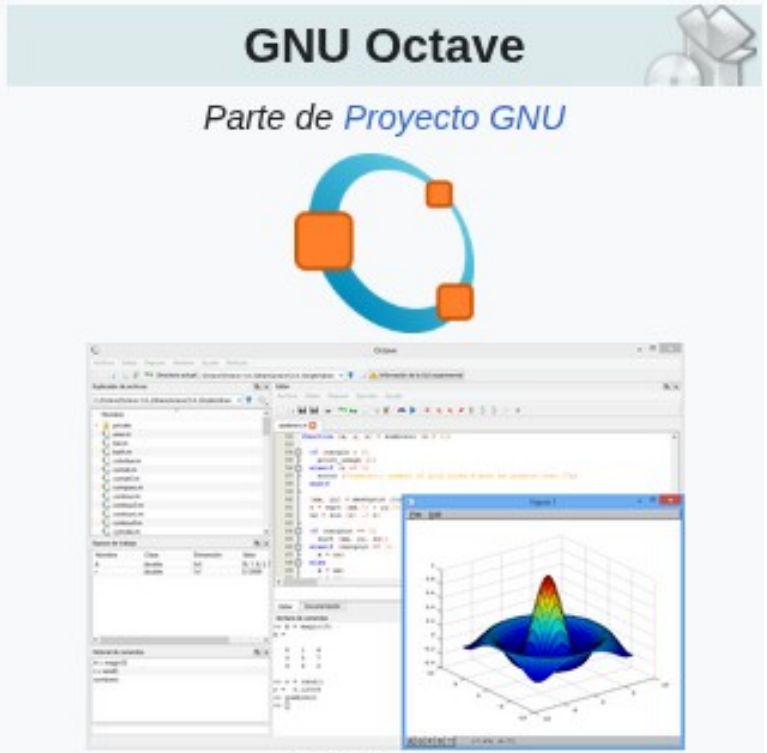



200
150
100
50
0
0
50
100
150
200
250
300

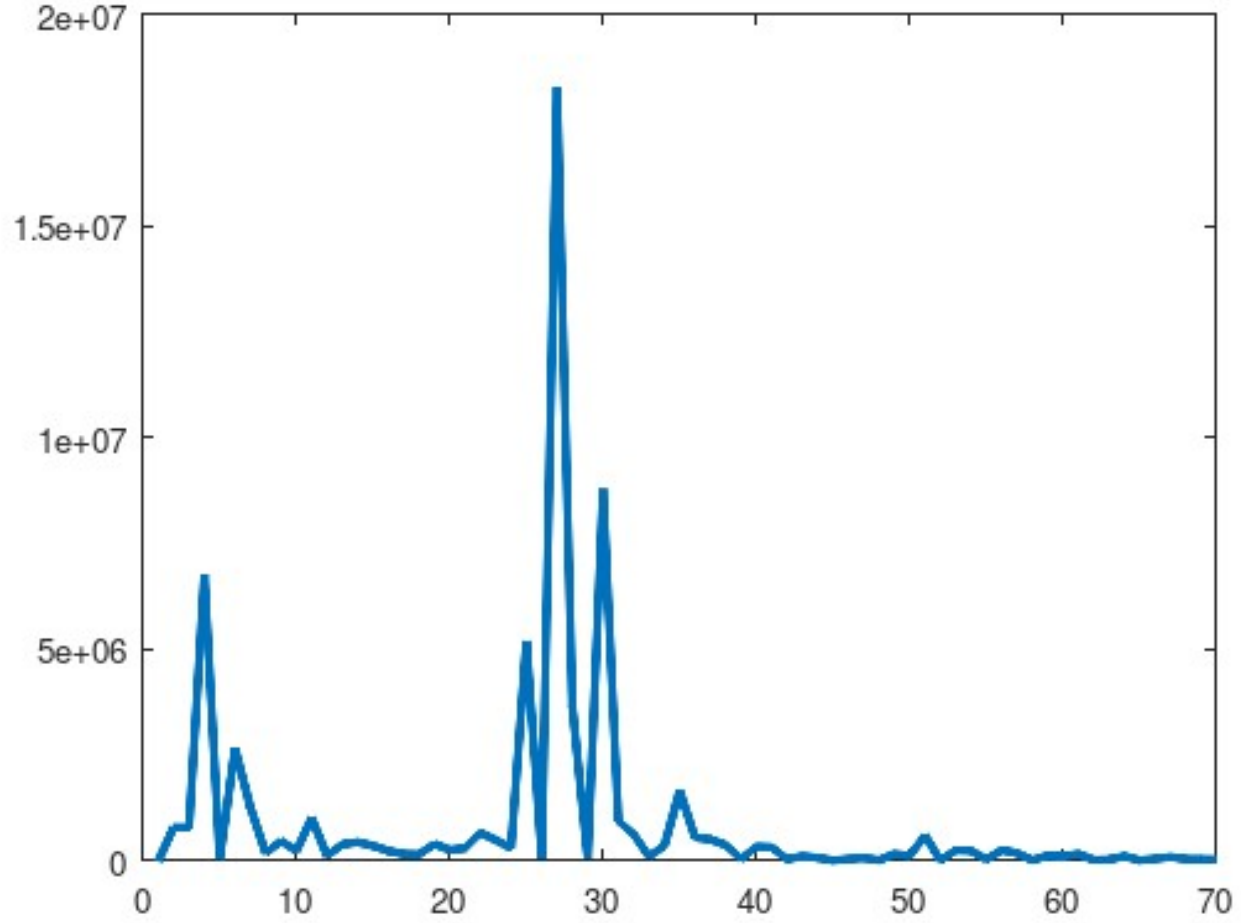
Aproximación de funciones

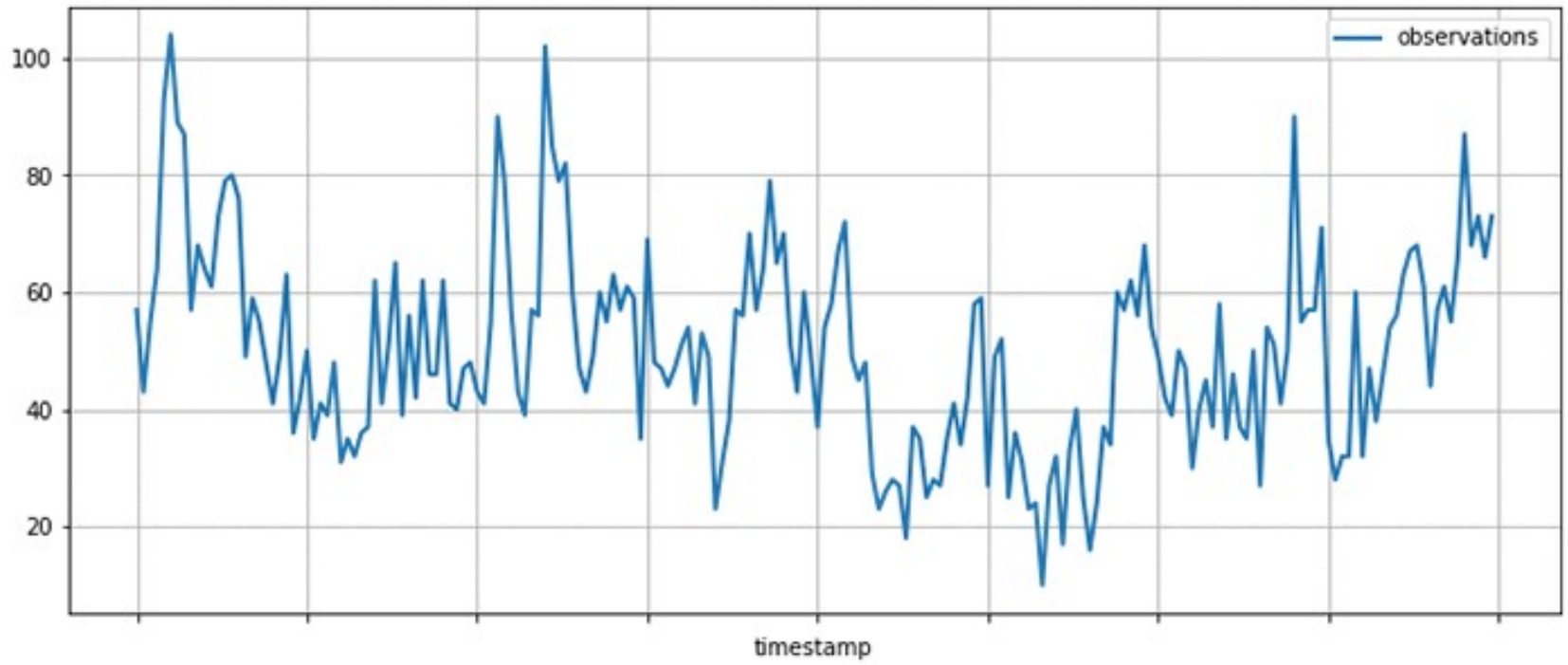
Joseph Fourier (1768-1830)

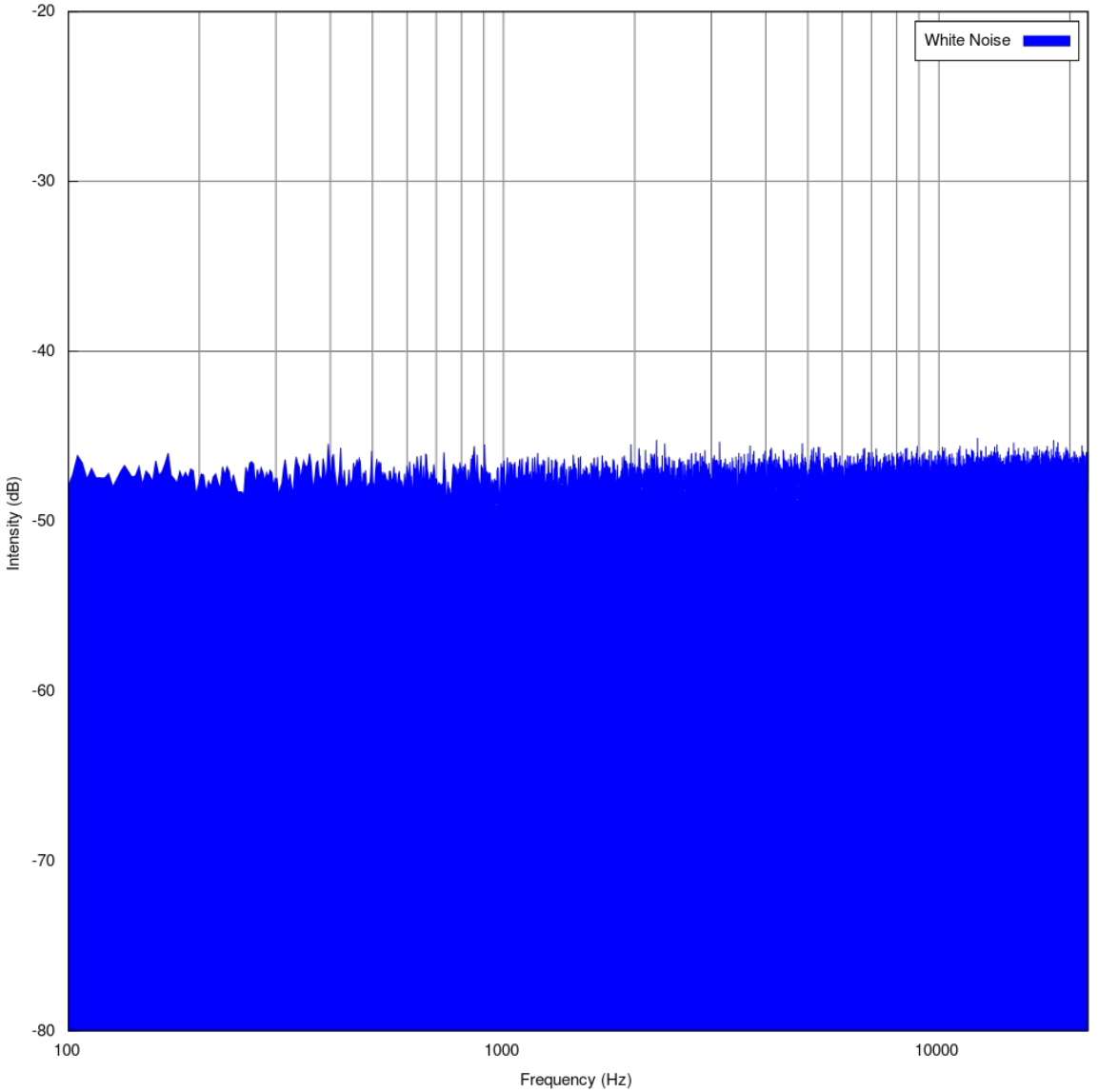
```
>>
>> load 'sunspot.dat'
>> s=sunspot(:,2);
>> f=fft(s);
>> f=abs(f);
>> f=f.*f;
>> f(1)=0;
>> plot(f(1:70),"linewidth",3)
>>
>>
```

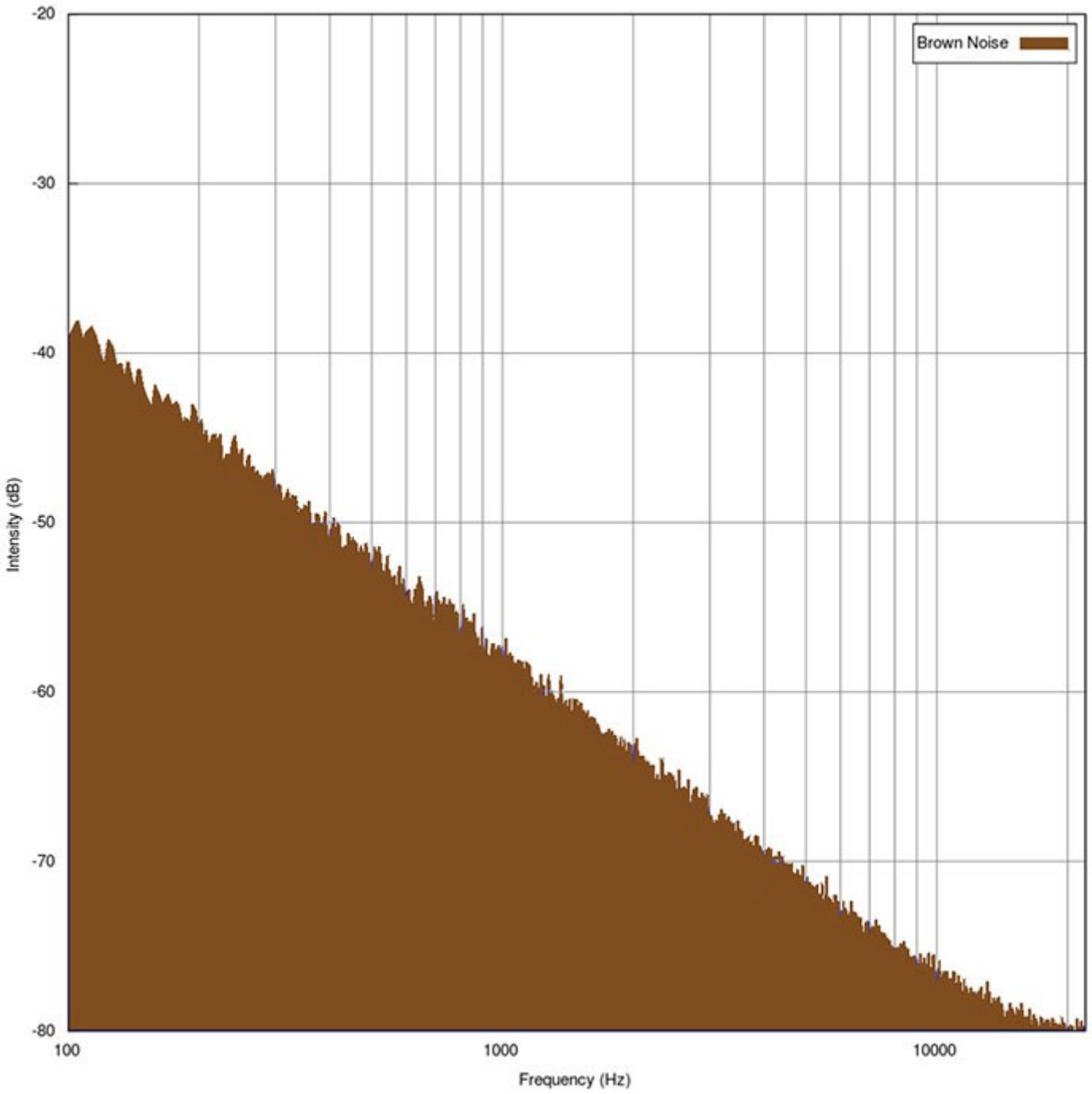


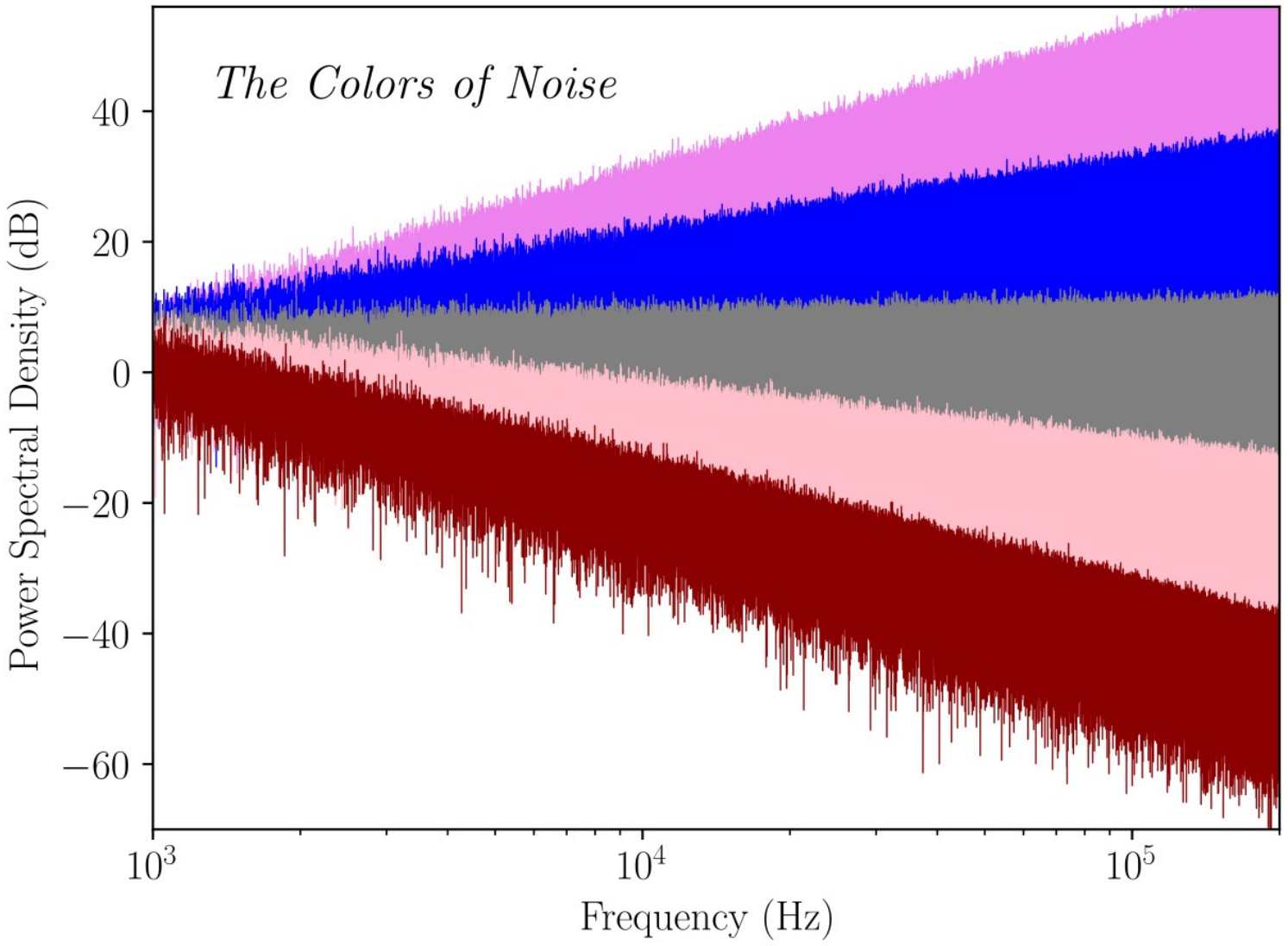
GNU Octave

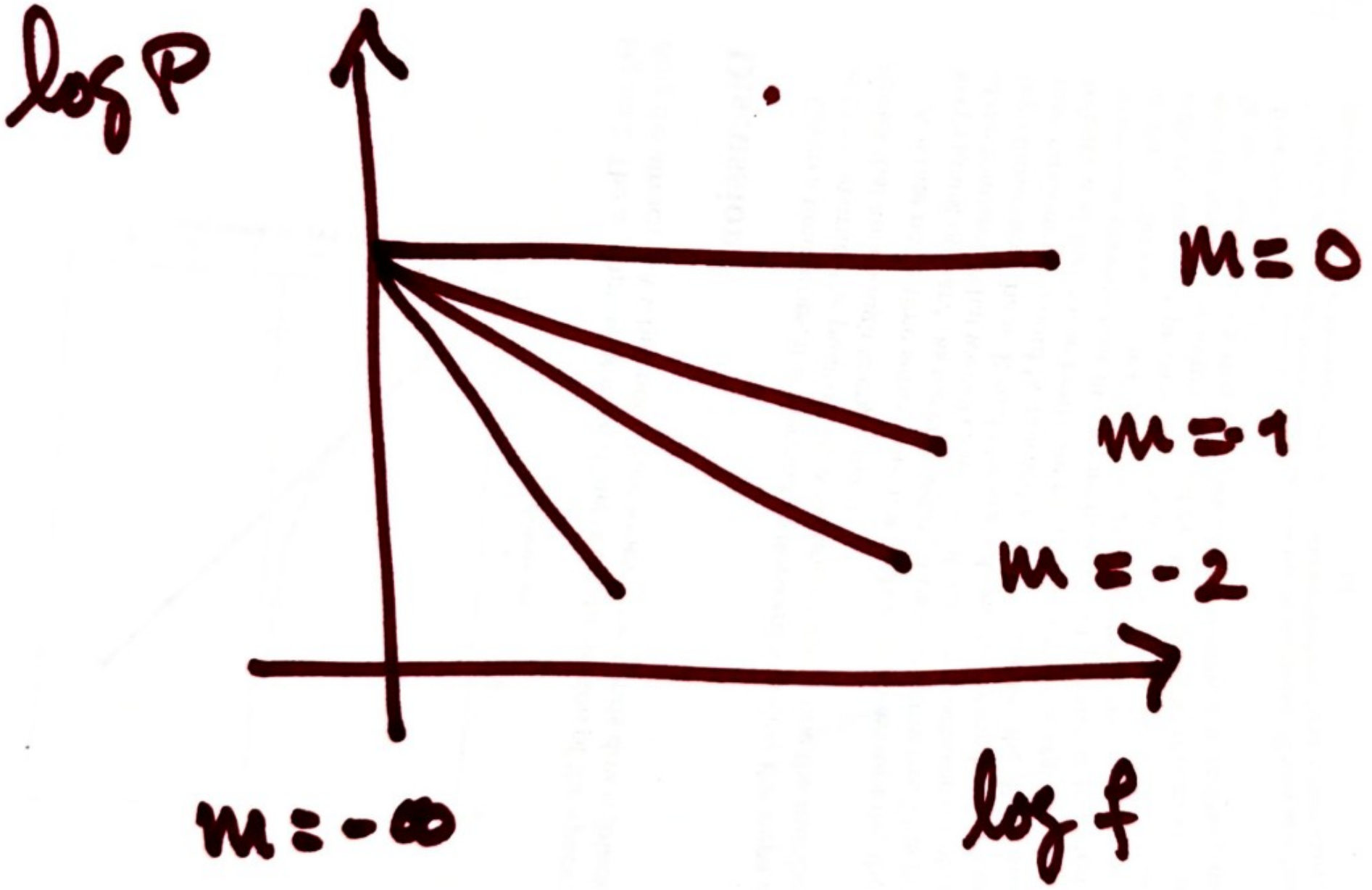

2e+07
1.5e+07
1e+07
5e+06
0
0
10
20
30
40
50
60
70

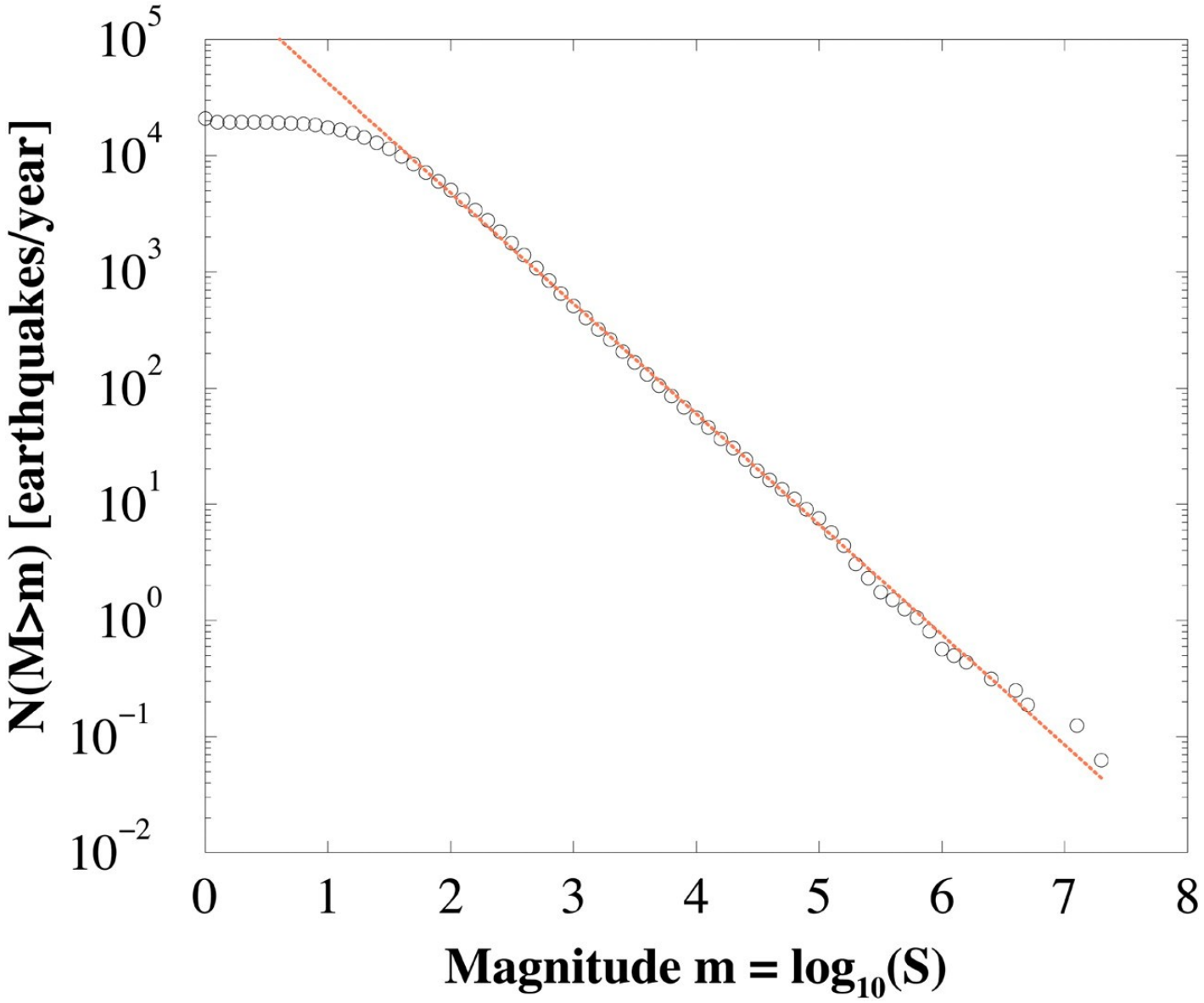

observations
100
80
60
40
20
timestamp


White Noise
-20
-30
-40
-50
-60
-70
-80
Intensity (dB)
100
1000
10000
Frequency (Hz)


Brown Noise
-20
-30
-40
-50
-60
-70
-80
Intensity (dB)
100
1000
10000
Frequency (Hz)


The Colors of Noise
Power Spectral Density (dB)
40
20
0
−20
−40
−60
10^3
10^4
10^5
Frequency (Hz)


log P
m = 0
m = -1
m = -2
m = -∞
log f


N(M>m) [earthquakes/year]
10^5
10^4
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
0
1
2
3
4
5
6
7
8
Magnitude m = $\log_{10}$(S)

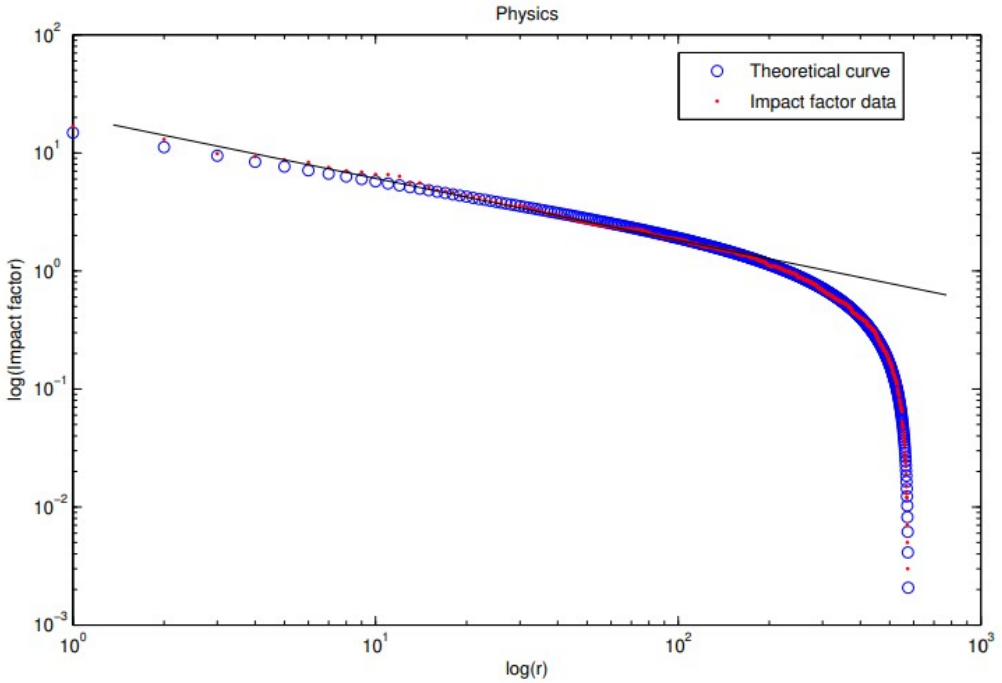
$$f(x) = ax^{-k}$$

$$f(cx) = a(cx)^{-k}$$

$$= c^{-k} f(x)$$


Pedro Miramontes
Río
de
TIEMPO
y agua

El ruido correlacionado no es azar



$$f(r) = K\frac{(N+1-r)^b}{r^a}$$

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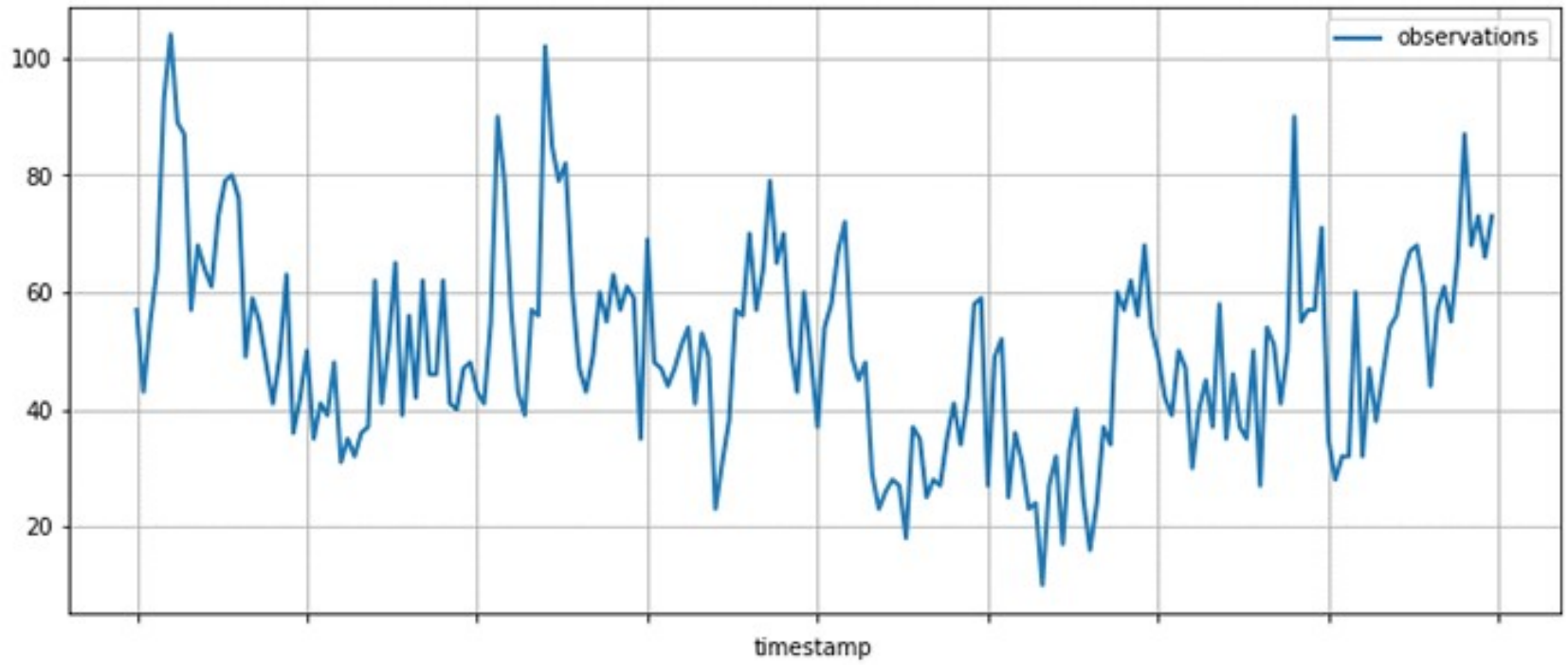
Volume 1, Issue 2, April 2007, Pages 155-160

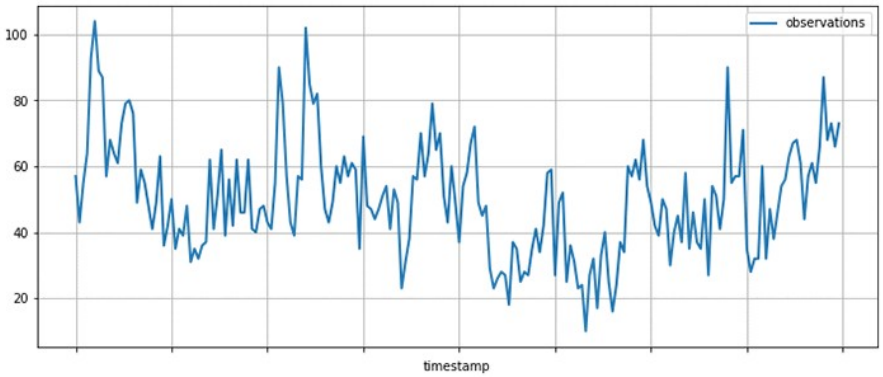
On the behavior of journal impact factor rank-order distribution

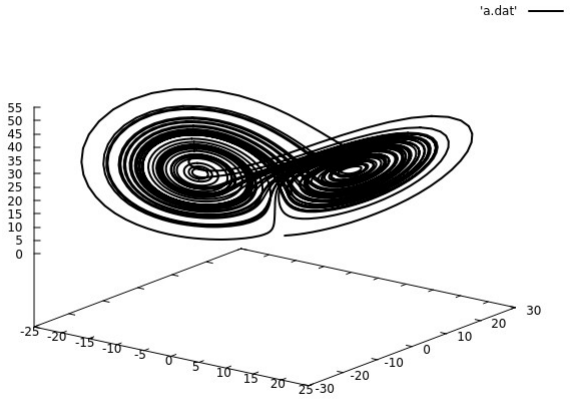
R. Mansilla [a], E. Köppen [a], G. Cocho [b], P. Miramontes [c]

Show more

Caos y series de tiempo


observations
100
80
60
40
20
timestamp





Método de Takens

$$\{x_i\}_{i=1}^{n}$$

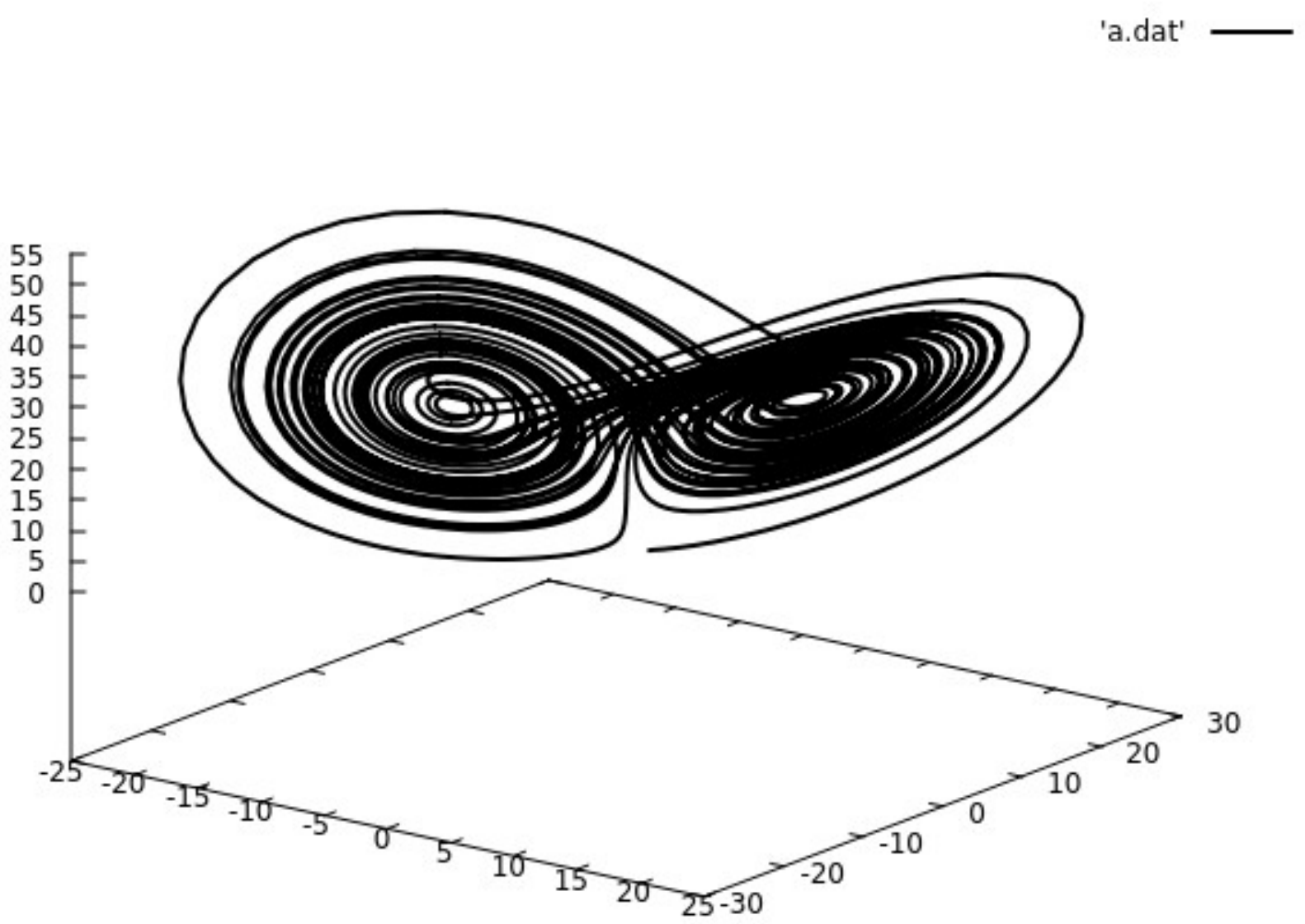
$$x_i \mapsto (x_i, x_{i+\tau})$$

$$x_i \mapsto (x_i, x_{i+\tau}, x_{i+2\tau}, \ldots, x_{i+n\tau})$$

$$\frac{\mathrm{d}x}{\mathrm{d}t} = \sigma(y - x),$$

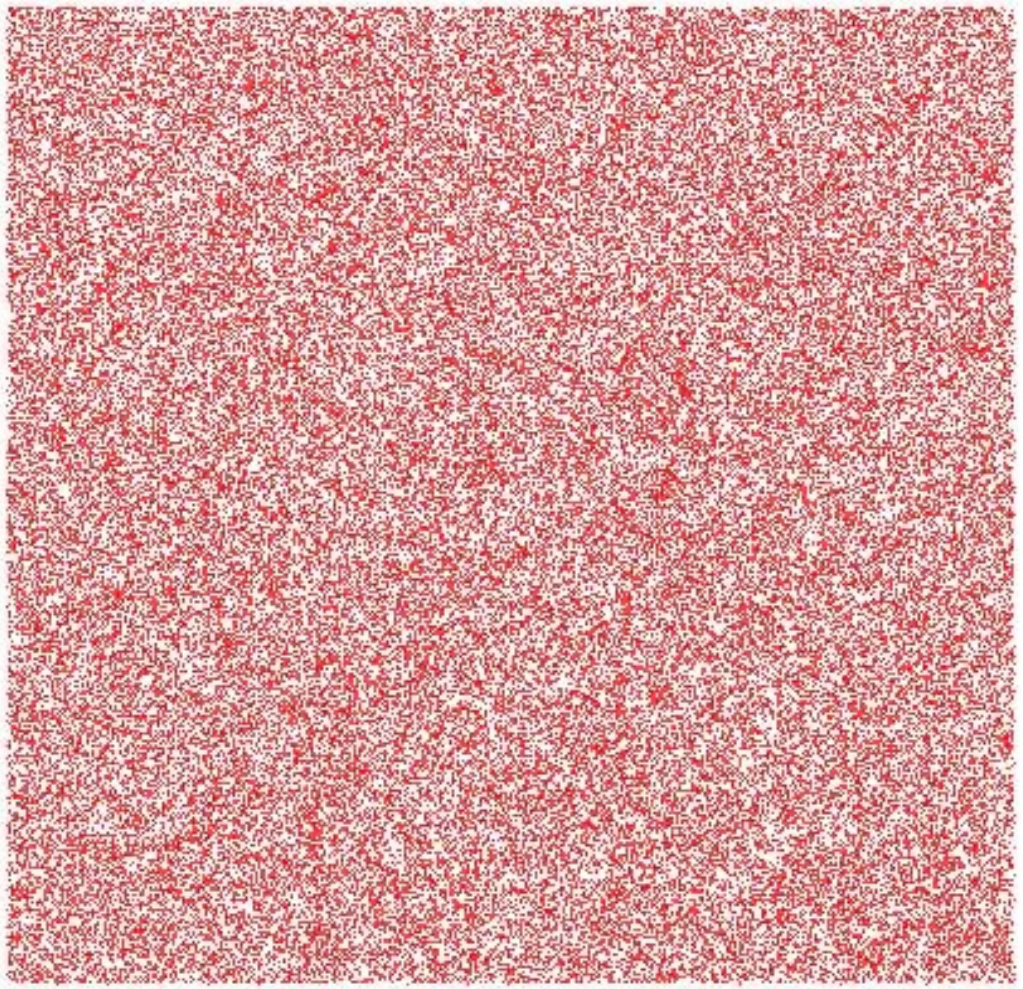
$$\frac{\mathrm{d}y}{\mathrm{d}t} = x(\rho - z) - y,$$

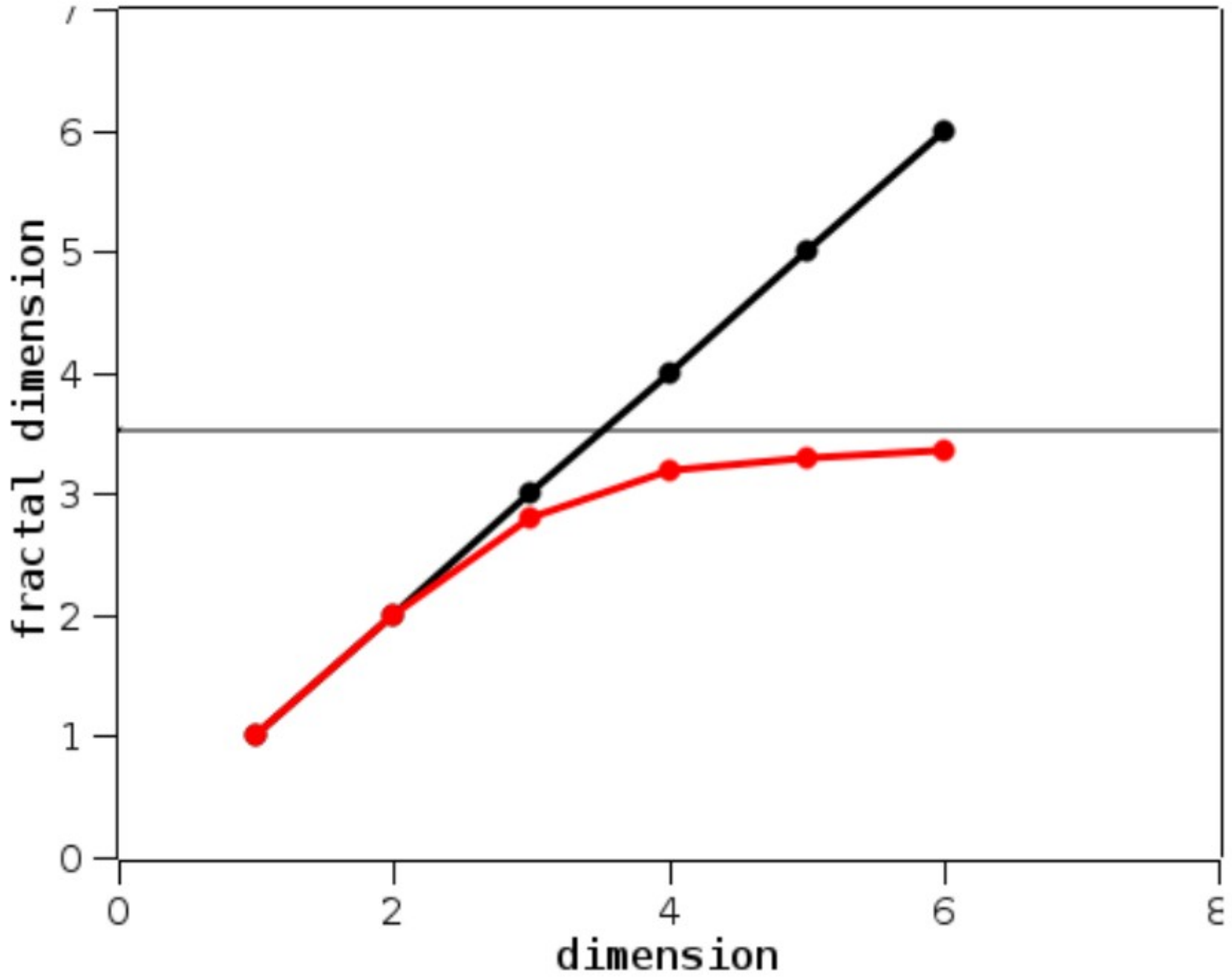
$$\frac{\mathrm{d}z}{\mathrm{d}t} = xy - \beta z.$$


'a.dat'
55
50
45
40
35
30
25
20
15
10
5
0
-25
-20
-15
-10
-5
0
5
10
15
20
25
-30
-20
-10
0
10
20
30

$$C(r) = \frac{1}{N(N-1)} \sum_{i \neq j} H(r - |\vec{x}_i - \vec{x}_j|)$$

$$C(r) \sim r^d$$




fractal dimension
0
1
2
3
4
5
6
0
2
4
6
dimension

El Azar es Caos de alta dimensión


No sea Maje, use
Linux