

not

CHAOS

within



*i
s*

of



RANDOM:

Exploring

Disorder



the

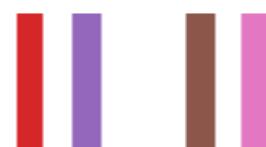


MATHEMATICS

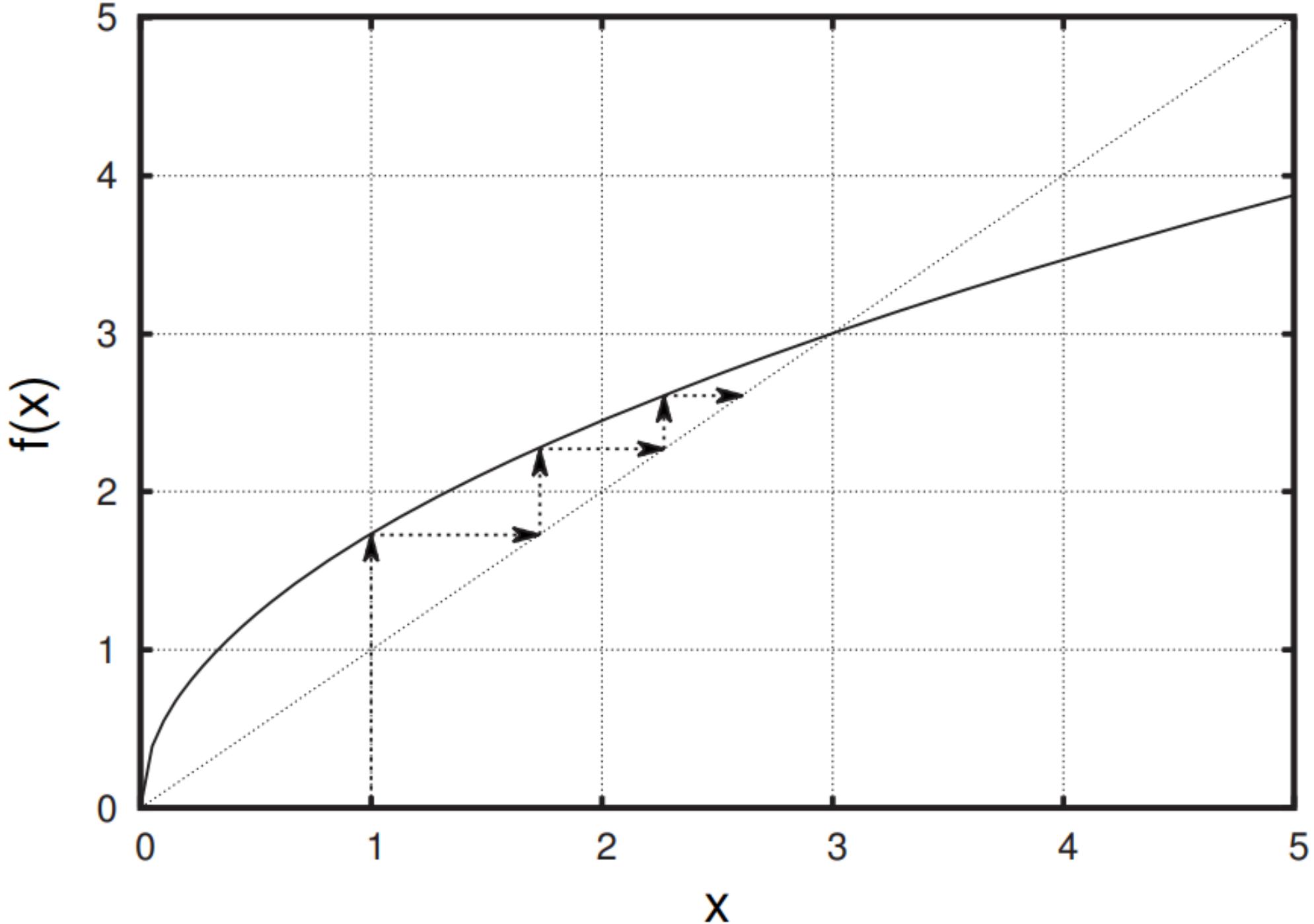
Order



Babel Barm - with Dr. Xiang Wan - Loyola University Chicago 2024



- ITERATING
- ORBIT
- FIXED POINT



CAN

THINGS

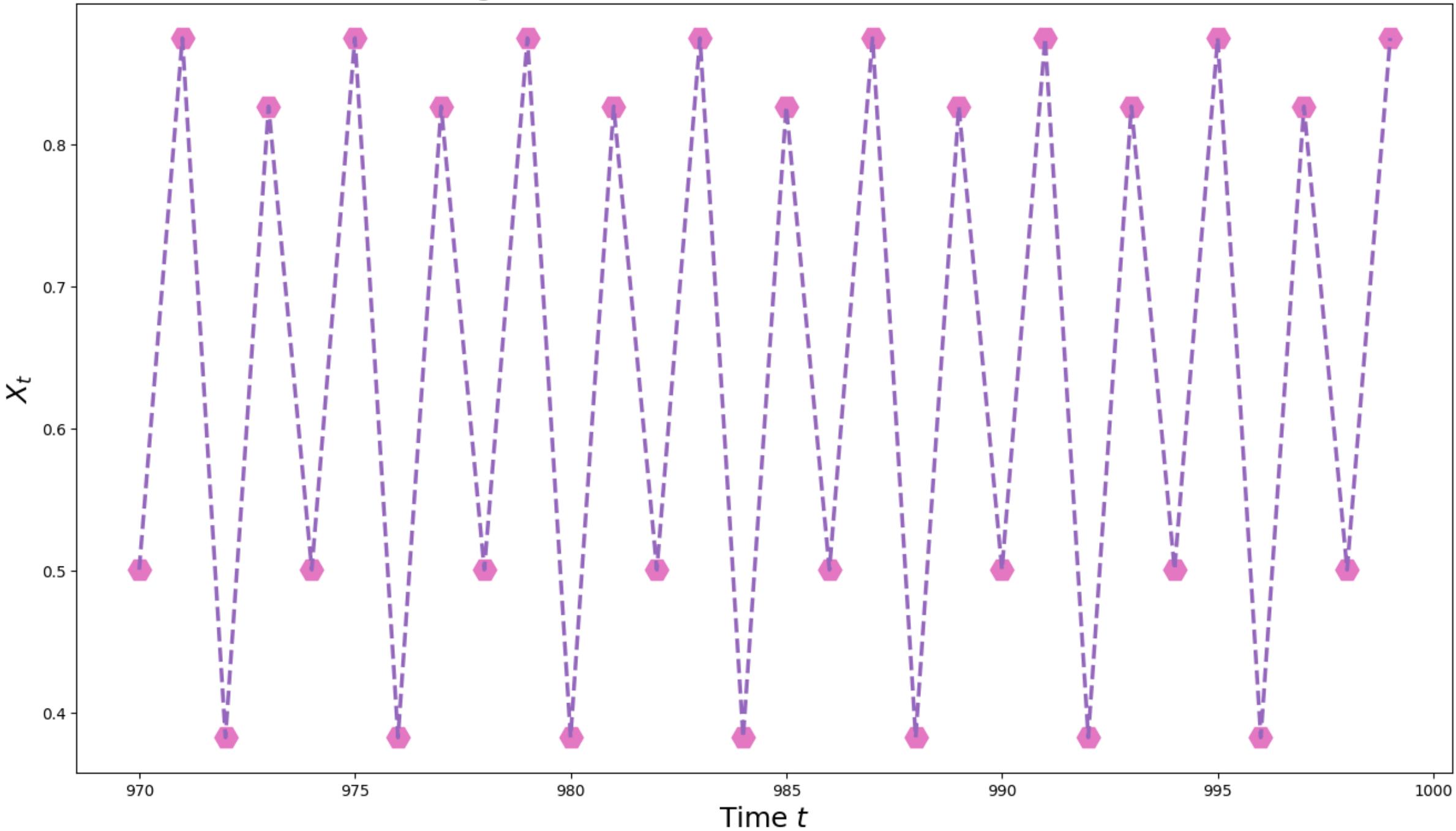
GET

WORSE?

The Logistic Equation

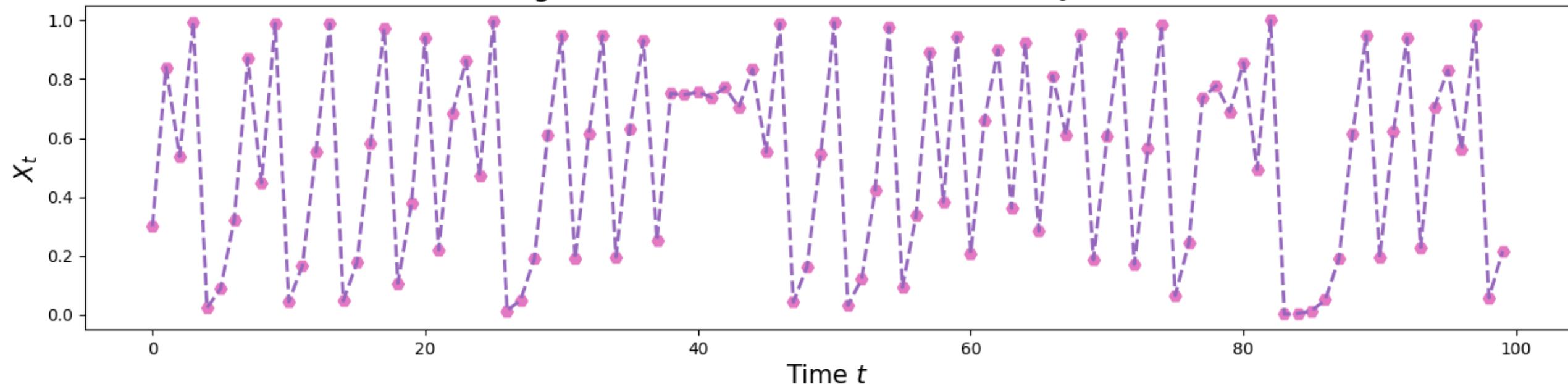
$$f(x) = rx(1 - x)$$

Logistic Time Series, with $r = 3.5$ and $x_0 = 0.3$

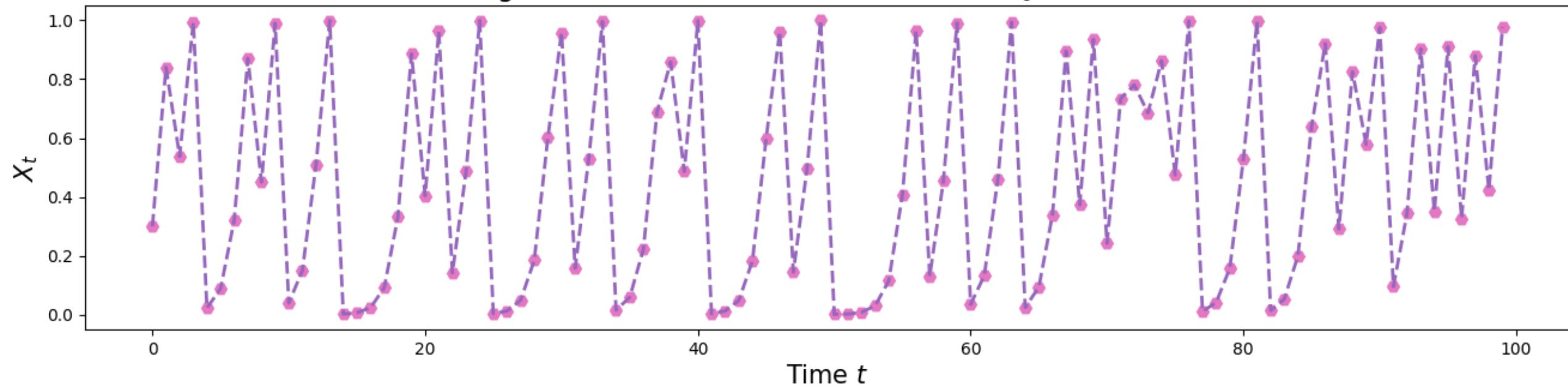


CAN
THINGS
GET
EVEN
WORSE?

Logistic Time Series, with $r = 4.0$ and $x_0 = 0.3$



Logistic Time Series, with $r = 4.0$ and $x_0 = 0.30001$



Chaos Features

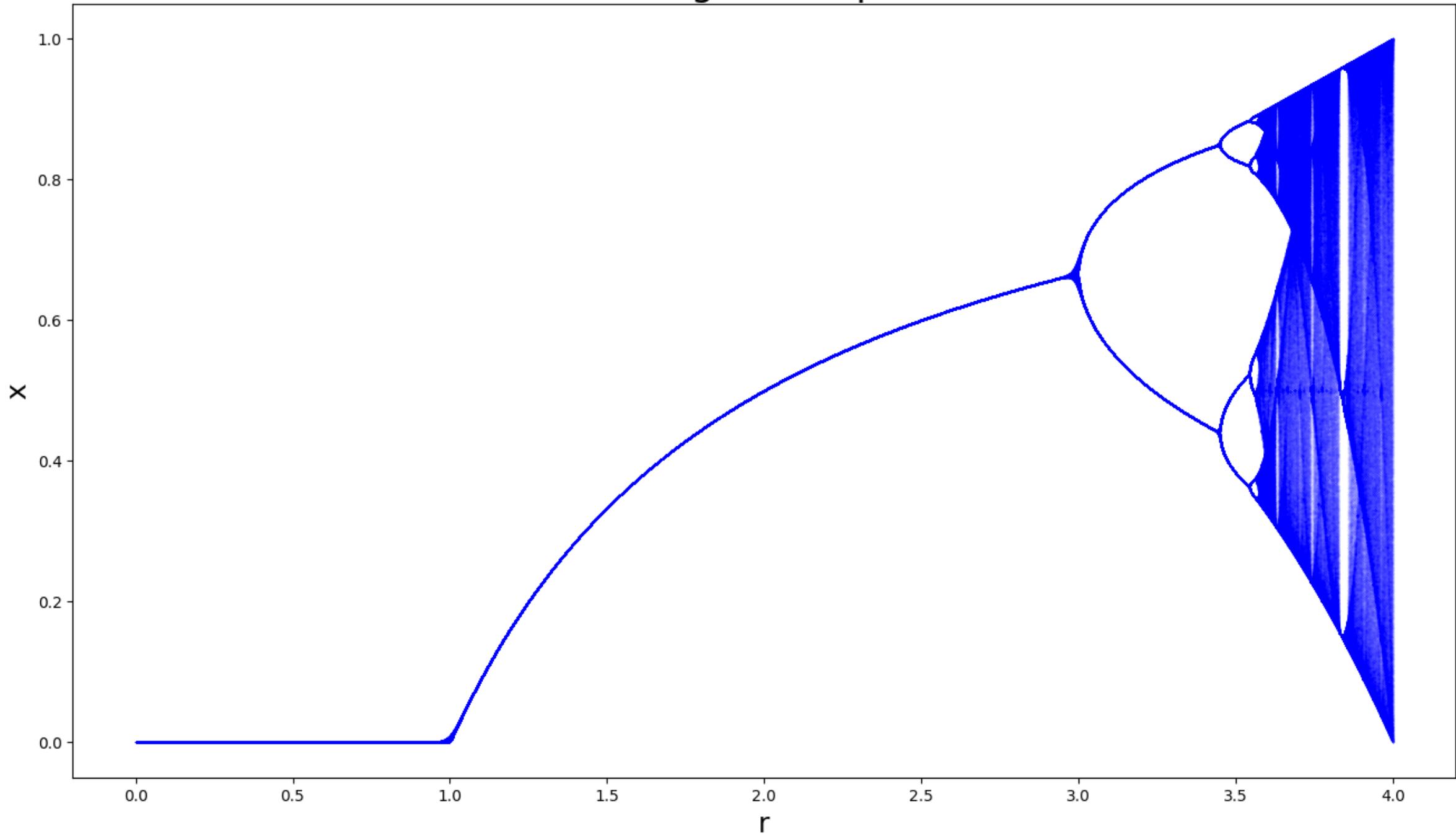
- Bounded
- Aperiodic
- Deterministic
- SDIC



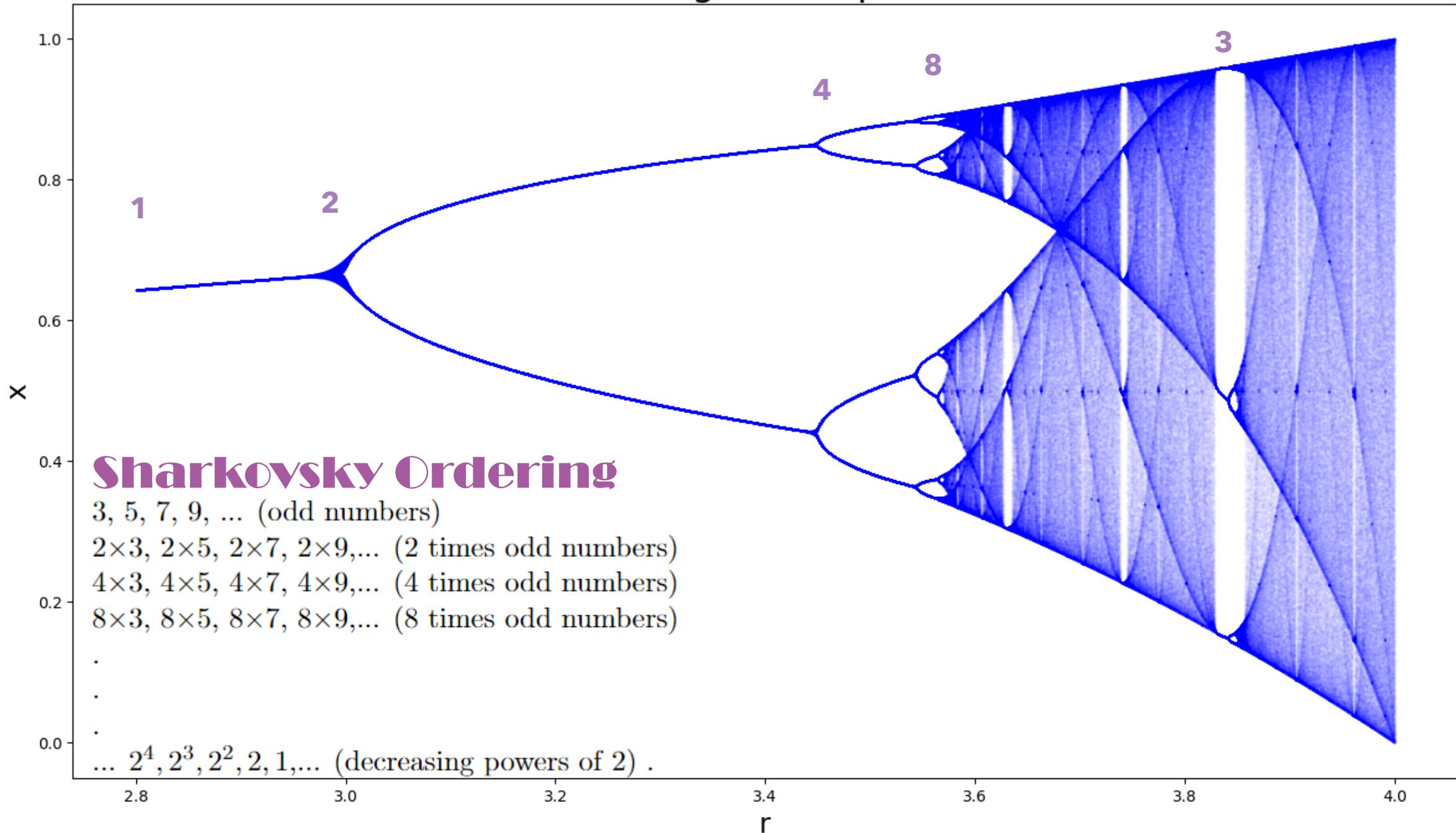
i
t

But JUST
is all Random?

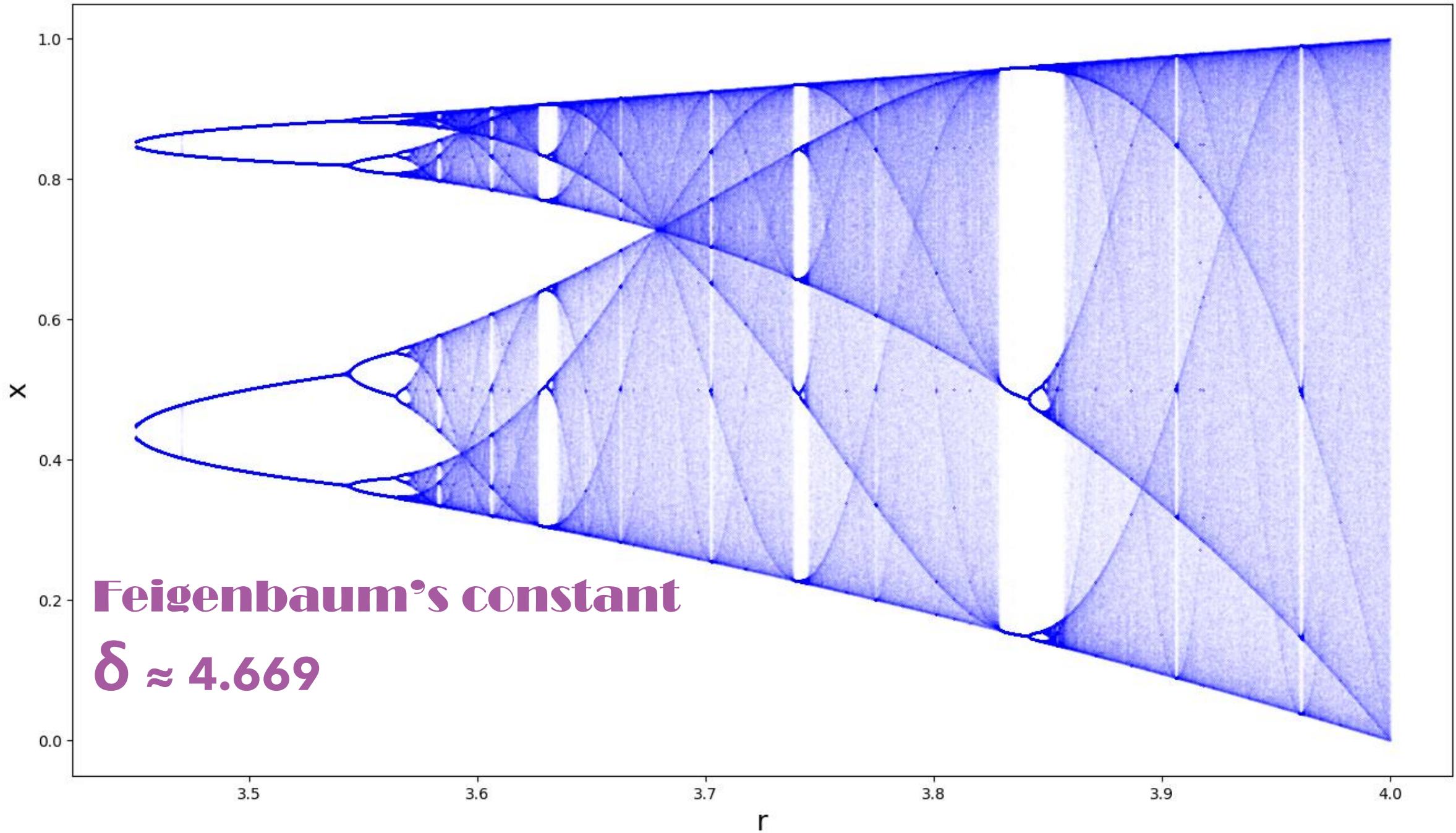
Logistic Map



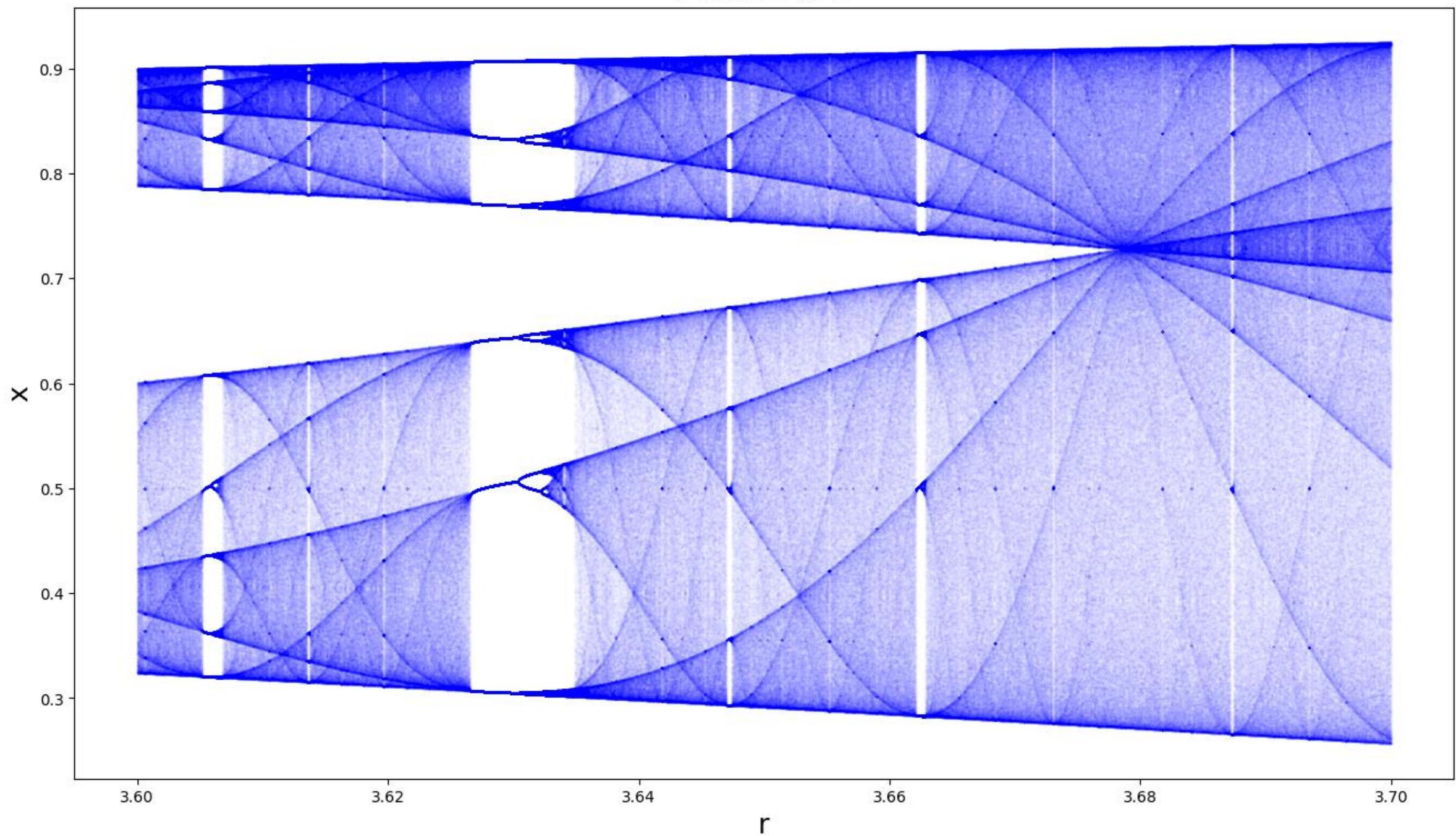
Logistic Map



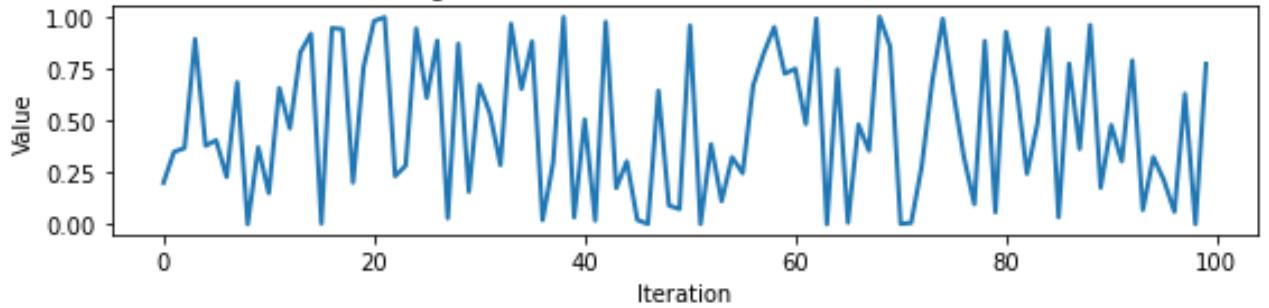
Zoom x 1



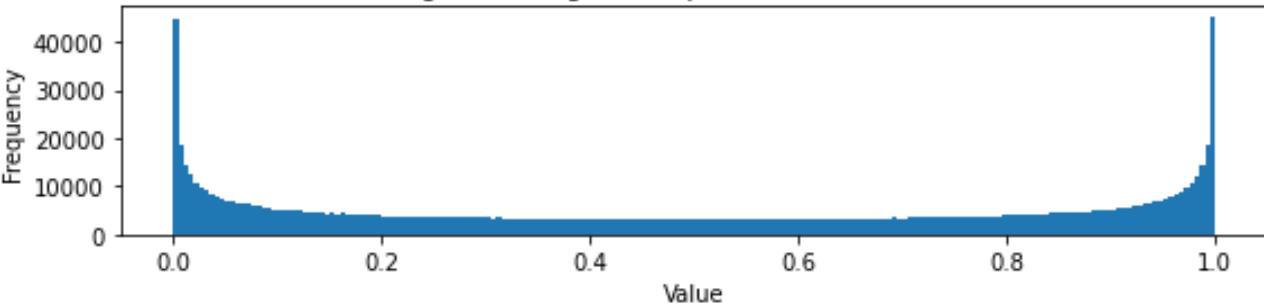
Zoom x 2



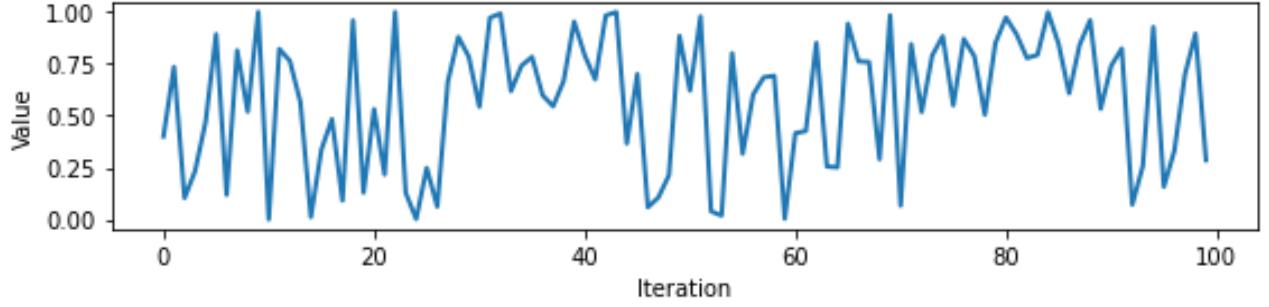
Logistic Time series with $r = 4$, seed = 0.2



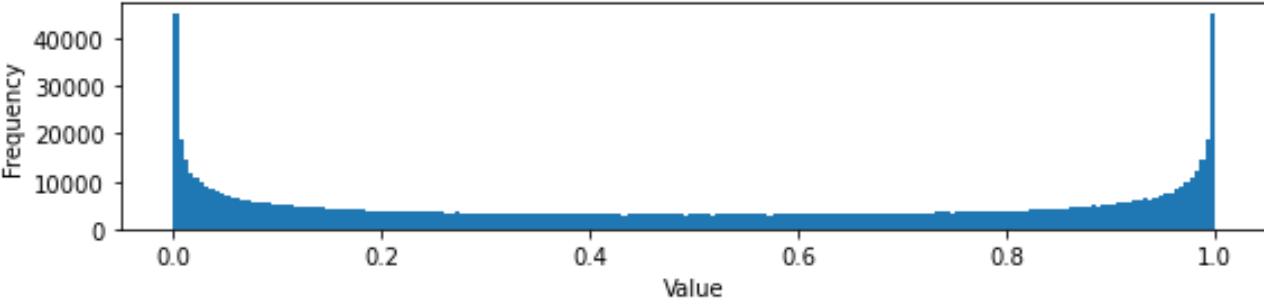
Histogram of Logistic Map with 1000000 Iterations



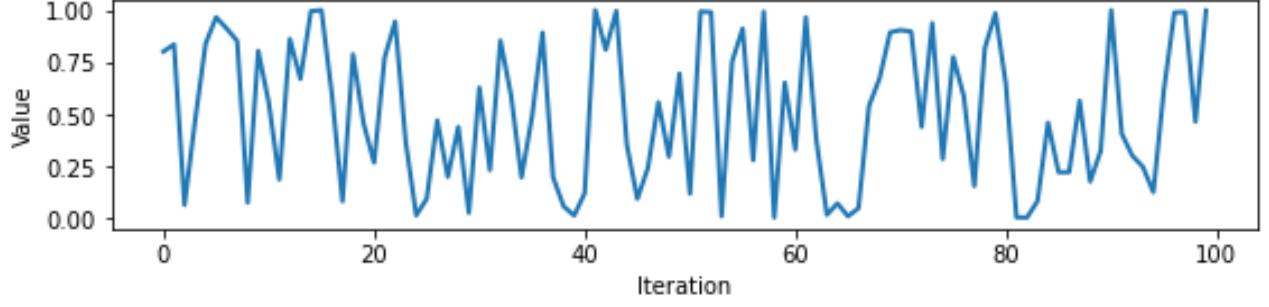
Logistic Time series with $r = 4$, seed = 0.4



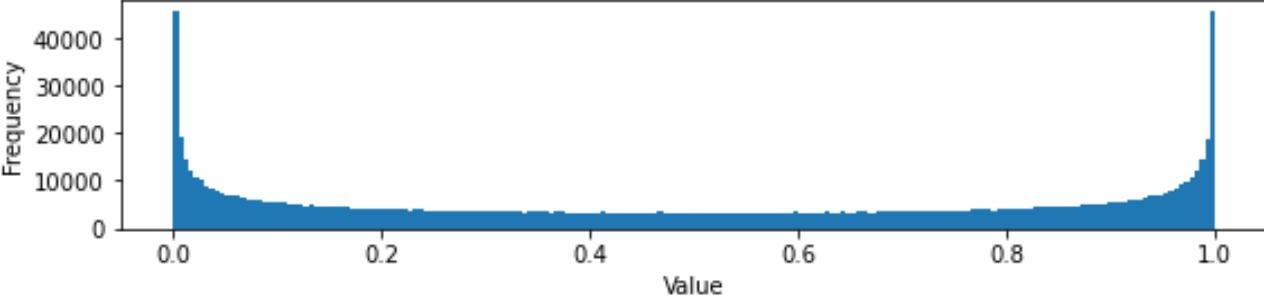
Histogram of Logistic Map with 1000000 Iterations



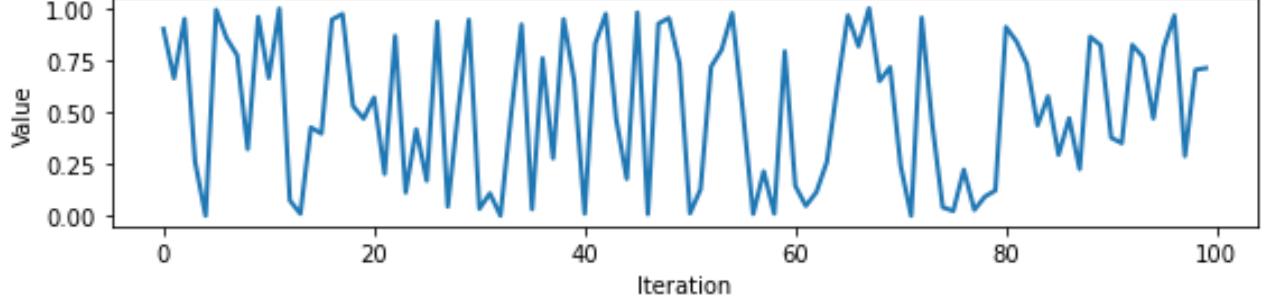
Logistic Time series with $r = 4$, seed = 0.8



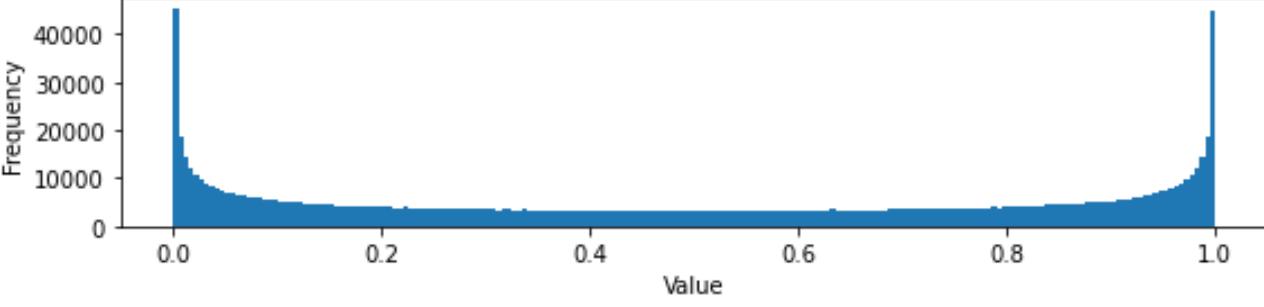
Histogram of Logistic Map with 1000000 Iterations



Logistic Time series with $r = 4$, seed = 0.9

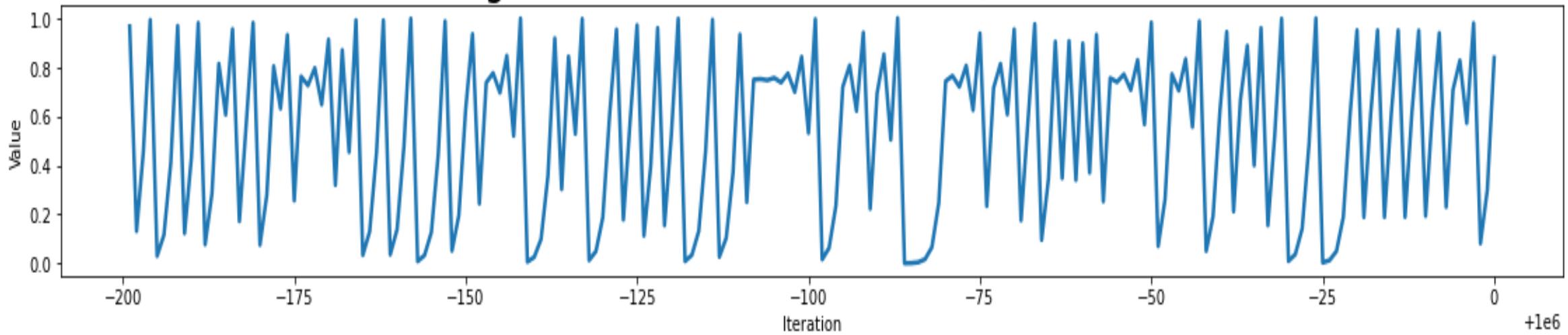


Histogram of Logistic Map with 1000000 Iterations

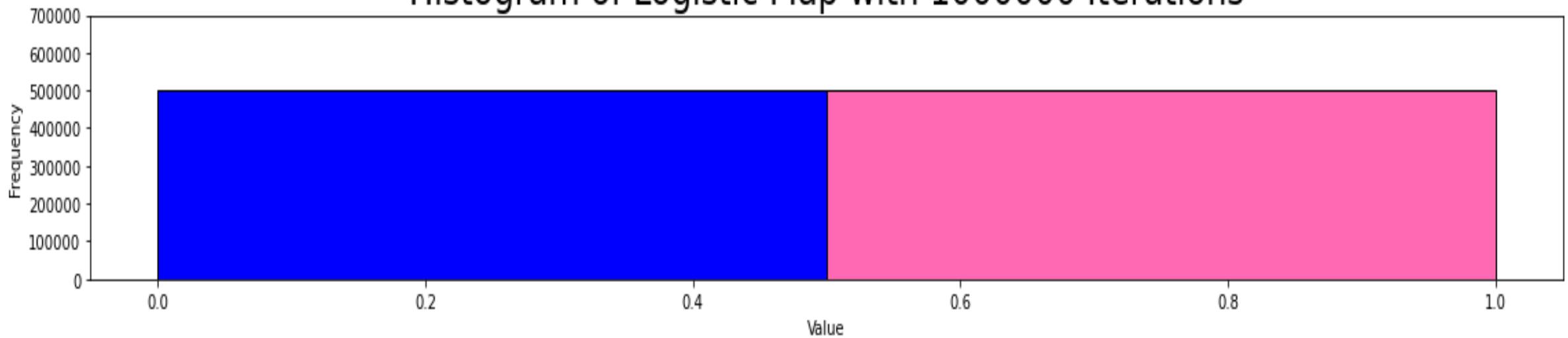


Pseudo-Random Number Generators (PRNG)

Logistic Time series with $r = 4.0$, seed = 0.2



Histogram of Logistic Map with 1000000 Iterations



Seed = 0.8:

The total PRN generated are 1000000; the last 20 psuedo random numbers are:
[1 0 0 0 0 1 1 0 1 0 1 1 0 1 0 1 1 1]
The density of 1 is: 50.0163%.

Seed = 0.8001:

The total PRN generated are 1000000; the last 20 psuedo random numbers are:
[0 1 1 1 0 1 0 1 1 0 1 1 0 1 1 1 1 0 0 1]
The density of 1 is: 50.0038%.

Seed = 0.800001:

The total PRN generated are 1000000; the last 20 psuedo random numbers are:
[0 1 1 0 1 0 1 1 1 0 1 0 1 0 0 0 0 0 0 1]
The density of 1 is: 49.89890000000005%.

Seed = 0.8000001:

The total PRN generated are 1000000; the last 20 psuedo random numbers are:
[1 1 1 1 1 0 1 0 0 0 0 1 1 0 1 0 0 1 1 1]
The density of 1 is: 50.0053%.

**For any Pseudo-Random
Number Generator, in *any
programing language*, you can
assign any seed. Different seeds
will give you random numbers,
but using the same seed will
always give you the same
random sequence.**

Future Considerations:

- Chaotic Equations
- PRNGs

**Thank you to USRE for funding this research, Mr. Peña,
Dr. Putonti, and of course thank you to Dr. Xiang Wan!**

