

# What is Complexity?

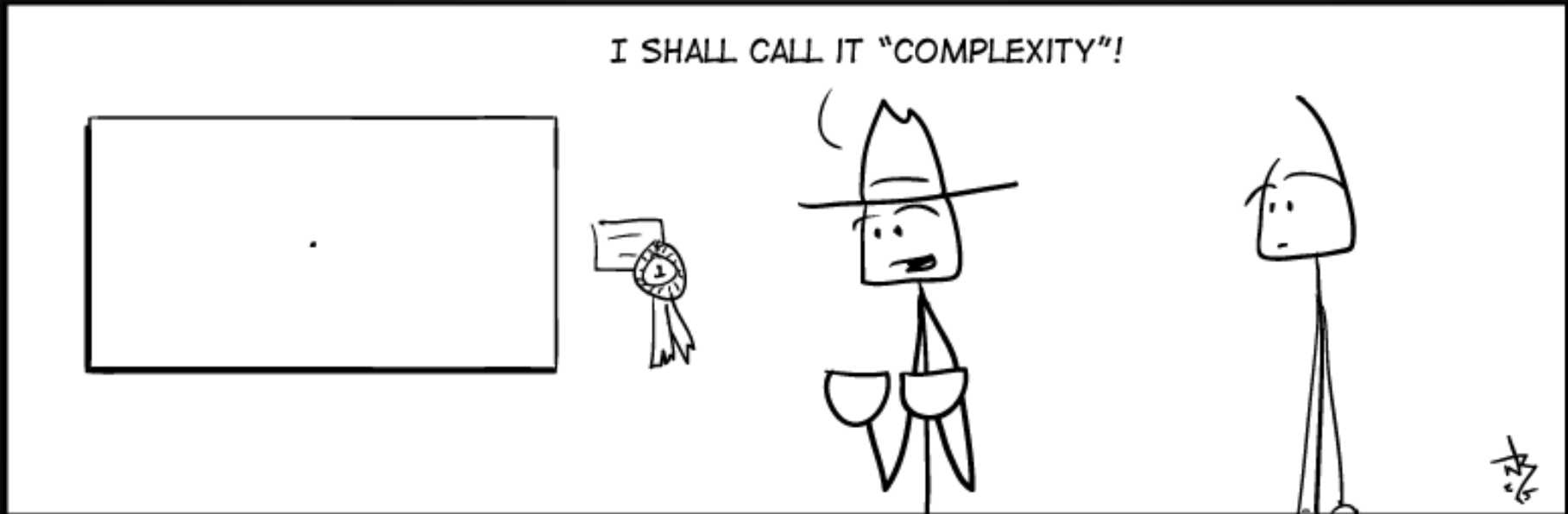
by Murray Gell-Mann

Presenters: Matt Antognoli, Jacob Hobbs, and Nathan Rackley

# Introduction

Defining Complexity

# Defining Complexity



# Measures of Complexity

## Algorithmic Information Content (AIC)

The minimal algorithm to reproduce a set.

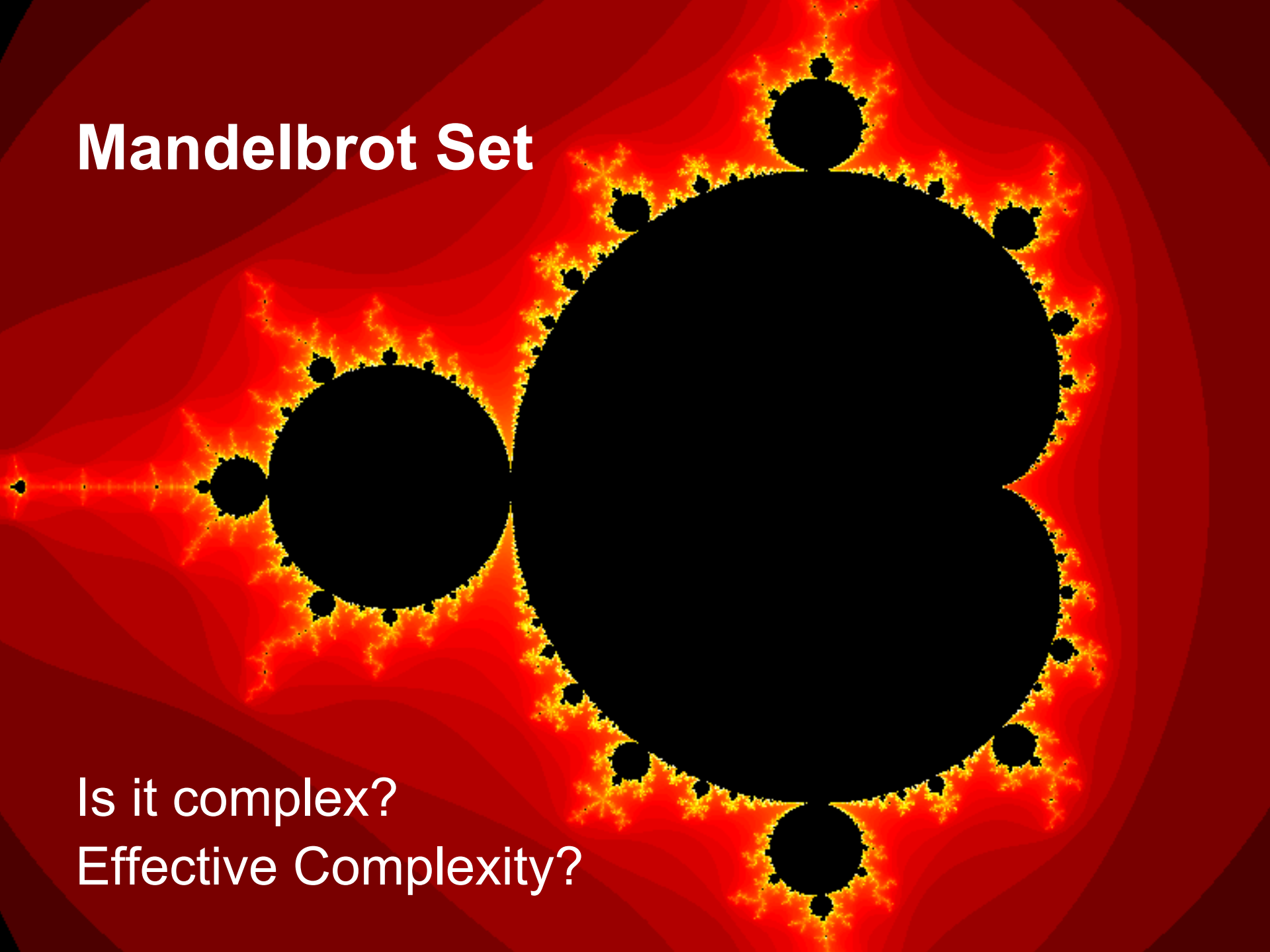
## Computational Complexity

Time and space taken to perform a computation.

## Classes of Regularities

Sets of features by which entities can be grouped together.

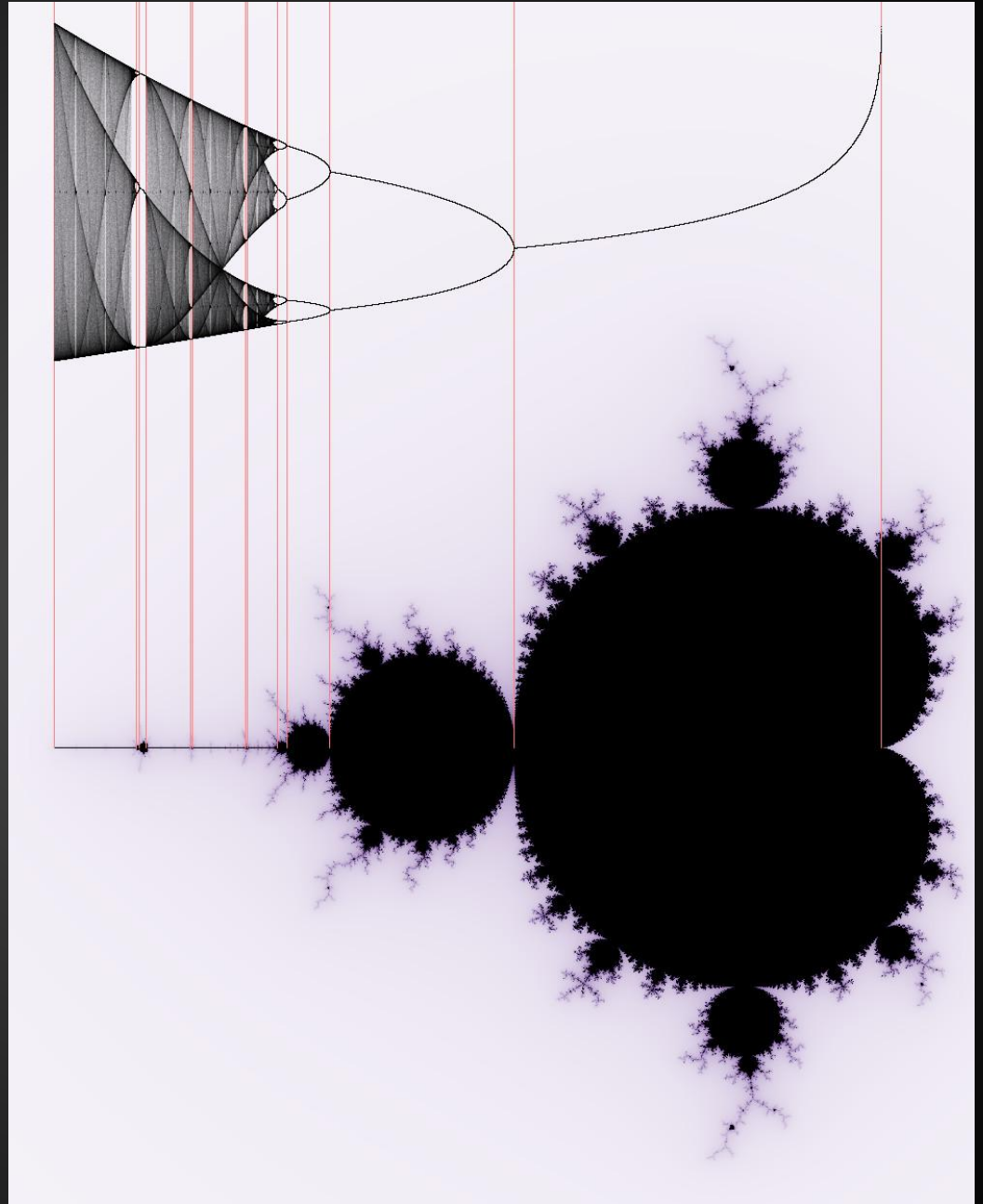
# Mandelbrot Set



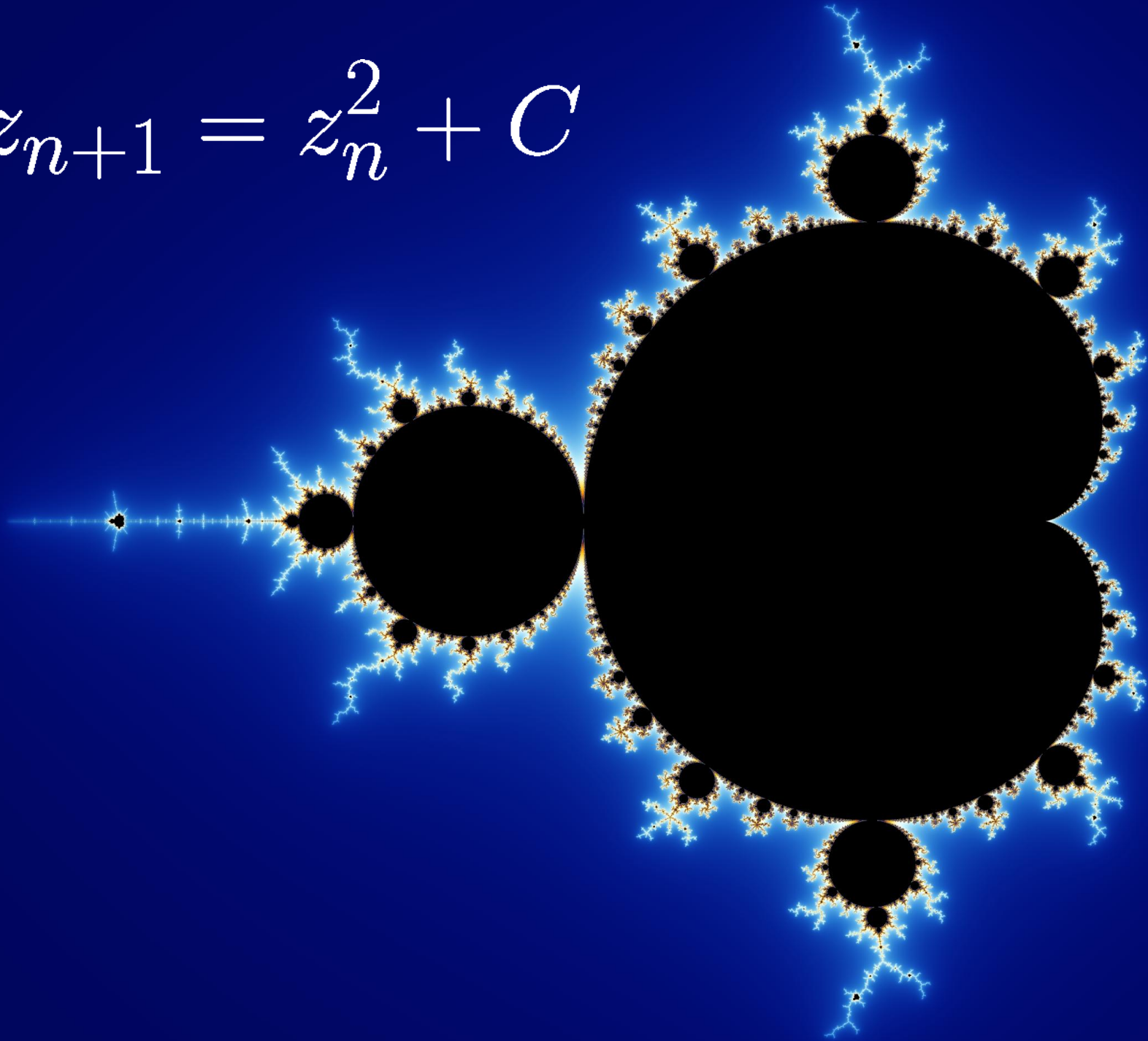
Is it complex?  
Effective Complexity?

# Mandelbrot Set and the Bifurcation Diagram of the Logistic Map

(Source: Wikipedia)



$$z_{n+1} = z_n^2 + C$$



# Effective Complexity

Algorithmic Information Content



# Algorithmic Information Content

"length of the shortest message conveying  
certain information"

10101010101010

# Algorithmic Information Content

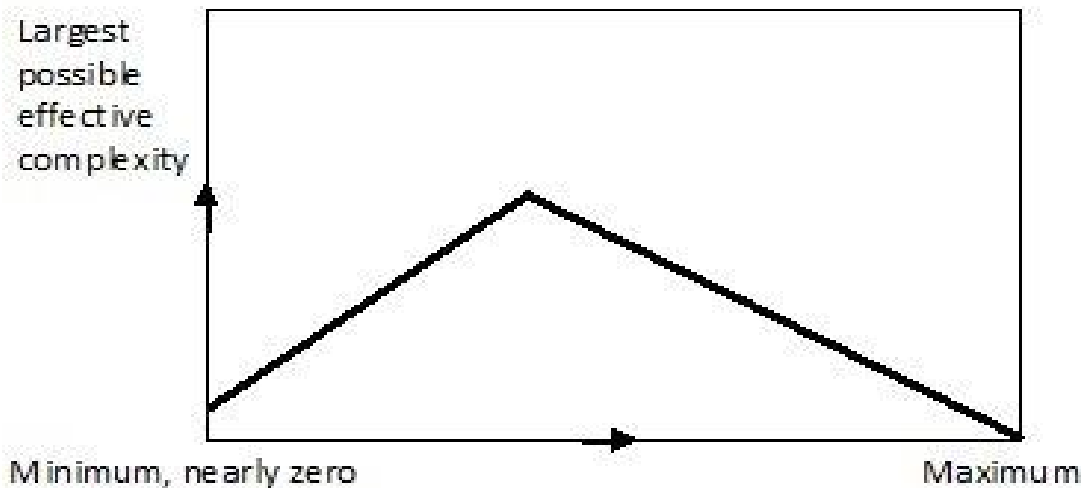
low AIC

1111111111111111

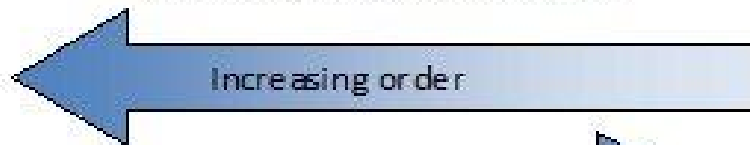
high AIC

110101011101010100

# Algorithmic Information Content



AIC for a given message length



Completely regular

Completely random

# Effective Complexity

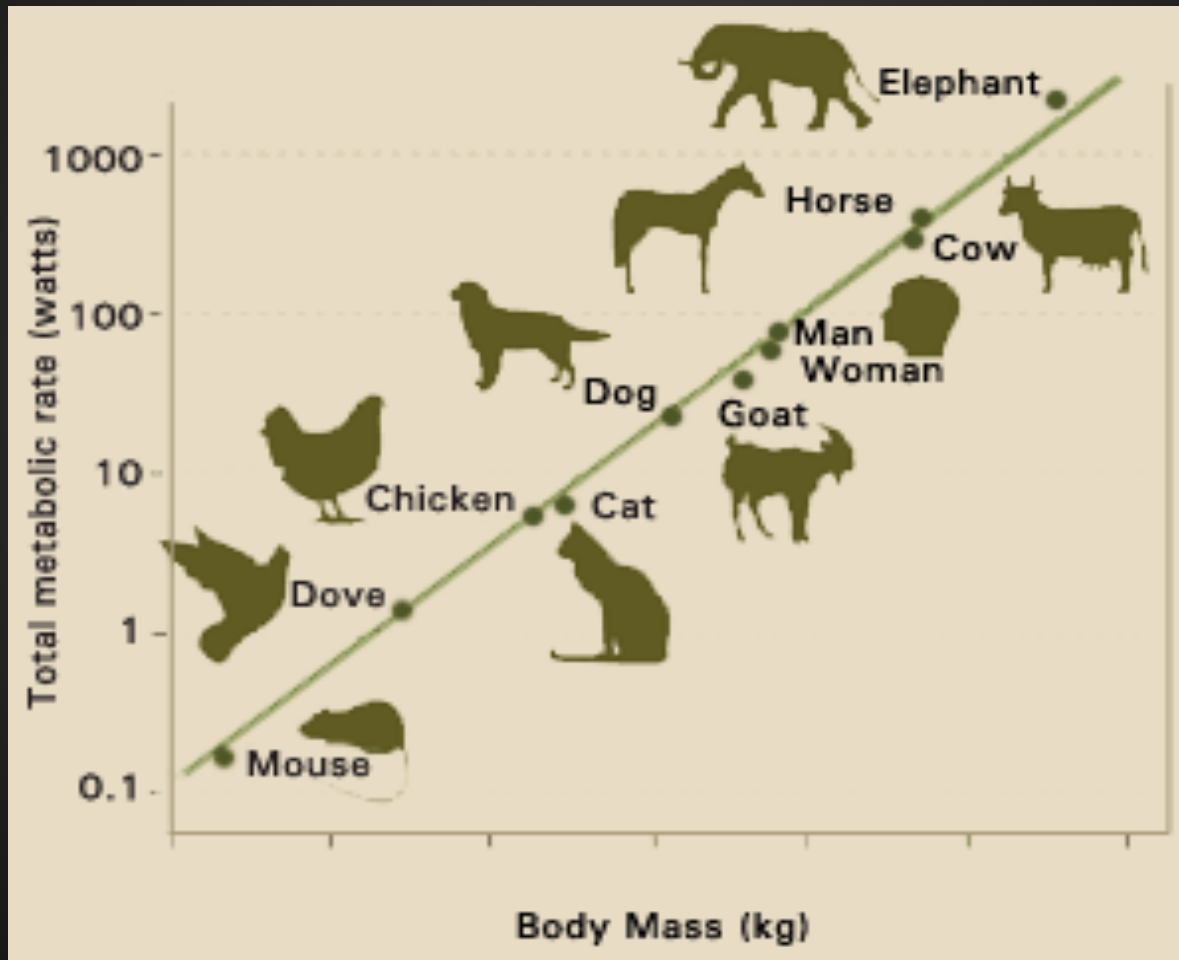
Regularities

# Regularity

"parts of an entity with high mutual information, above some threshold"

"more economical to calculate them together than separately"

# Regularity



# Effective Complexity

$$EC = AIC ( \text{Sum} ( \text{Regularities} ) )$$

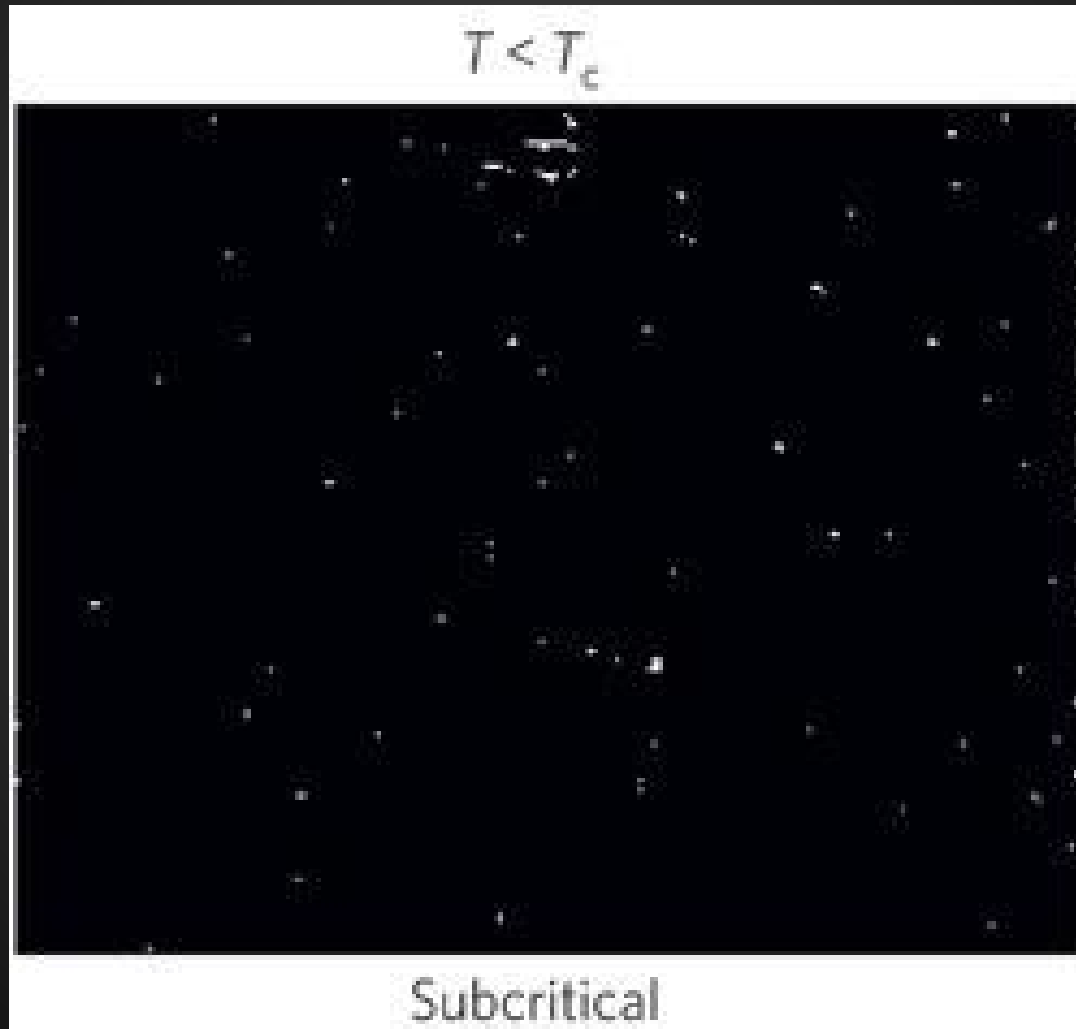
Gibberish as well as simple entities have low  
Effective Complexity

Complex entities have:  
high AIC regularities

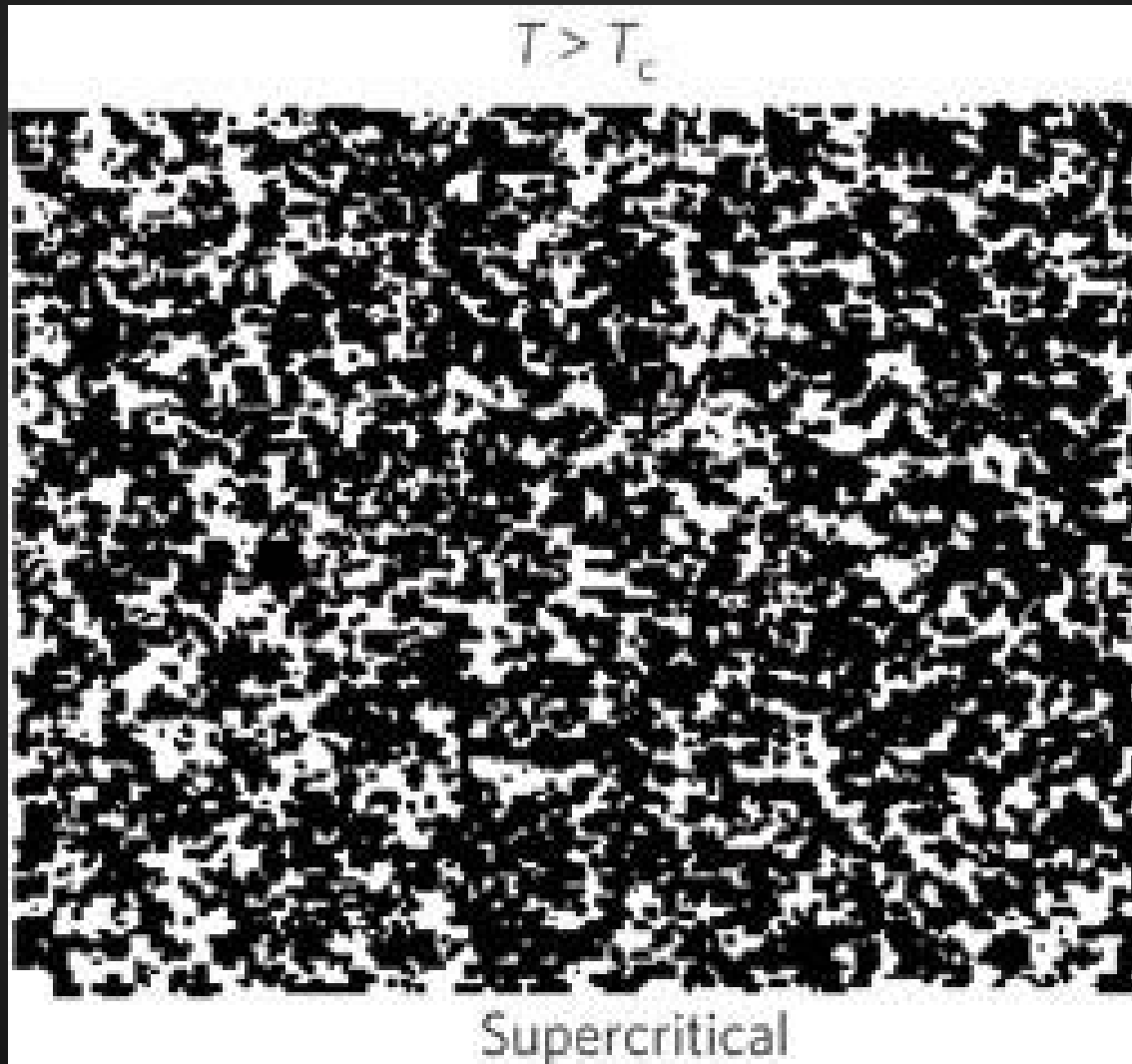
# Related Results



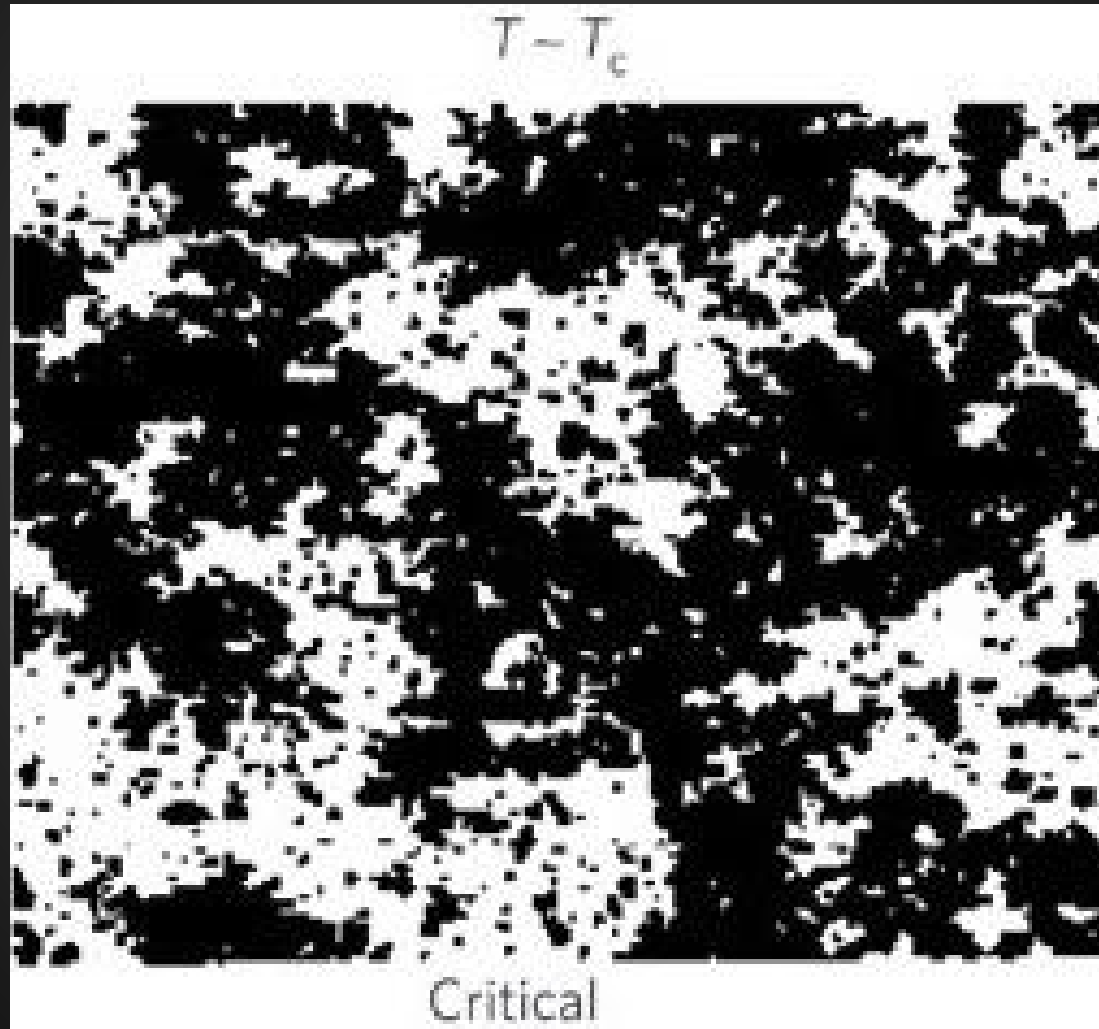
# Ising Model



# Ising Model

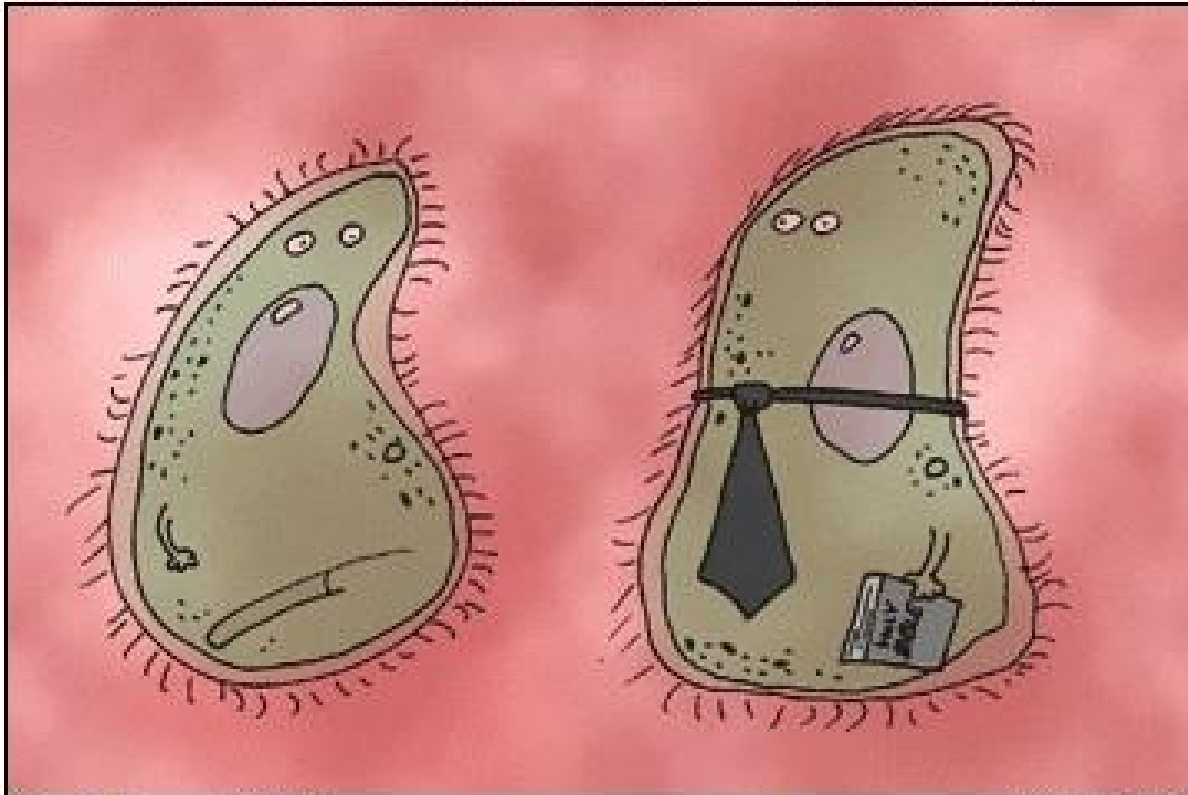


# Ising Model



# Lenski e. coli experiment

REVERENDFUN.COM COPYRIGHT BIBLE GATEWAY



(See Matthew 28:19)

02-18-2004

"You mean if I evolve the ability to digest citrate, I will go extinct?"

# Discussion