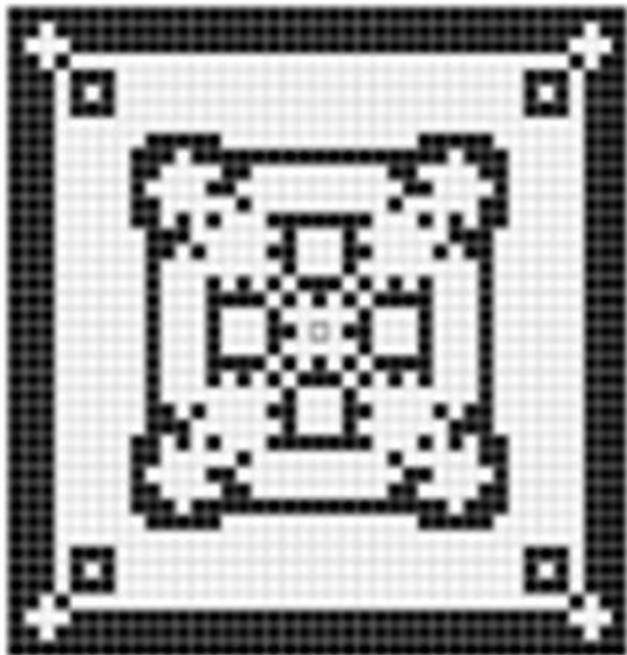
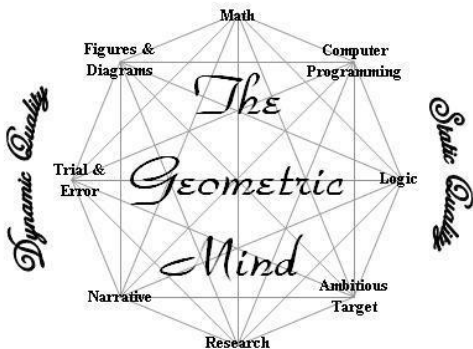


THE GEOMETRIC MIND SERIES  
an *auto*SOCRATIC QUICK-START publication

# *The Game of Life*

An Introduction to John Conway's "Game of Life"





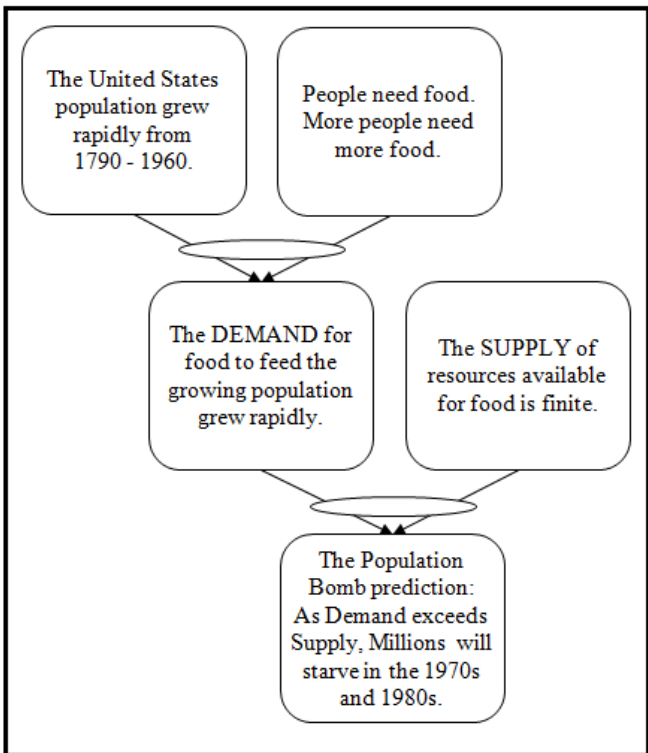
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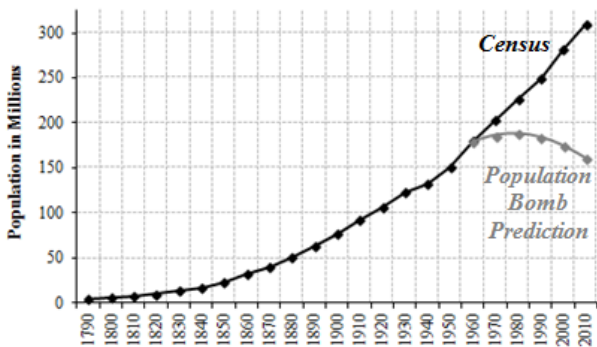
# THE POPULATION BOMB

A 1960s Prediction on Population, Supply and Demand



# THE USA POPULATION

It's Now 2013 ... WHAT HAPPENED?



There was no “Population Bomb”, obviously.

*However ...*

# A NAGGING THOUGHT

Is This ALWAYS How Population Changes Over Time?

The US has shown consistent population growth from 1790 to 2010.

Life expectancy, birth rates, wars, disease, etc., all contribute to, and can change, population totals.

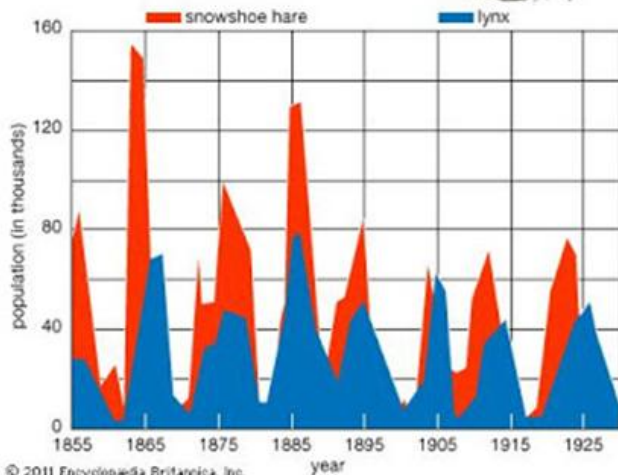
Though our population has always grown, this doesn't have to be the case.

The Hudson Bay Company fur records of Lynx & Snowshoe Hare showed interesting cycles in the 19th century.

PREDATOR / PREY systems might give a good look into the dynamics of population changes.

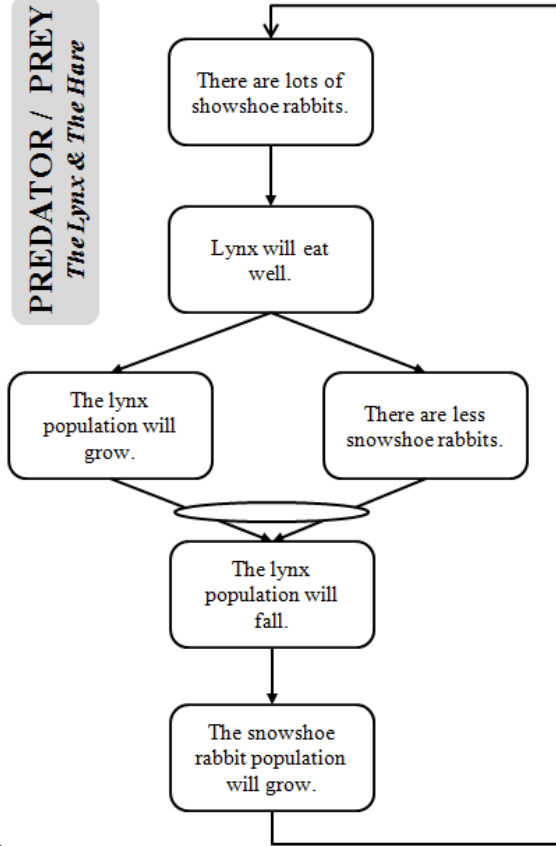
# THE LYNX AND THE HARE

The Ebbs and Flows of Predator / Prey Populations



*What is going on here?*

**PREDATOR / PREY**  
*The Lynx & The Hare*



*And we're right back where we started!*

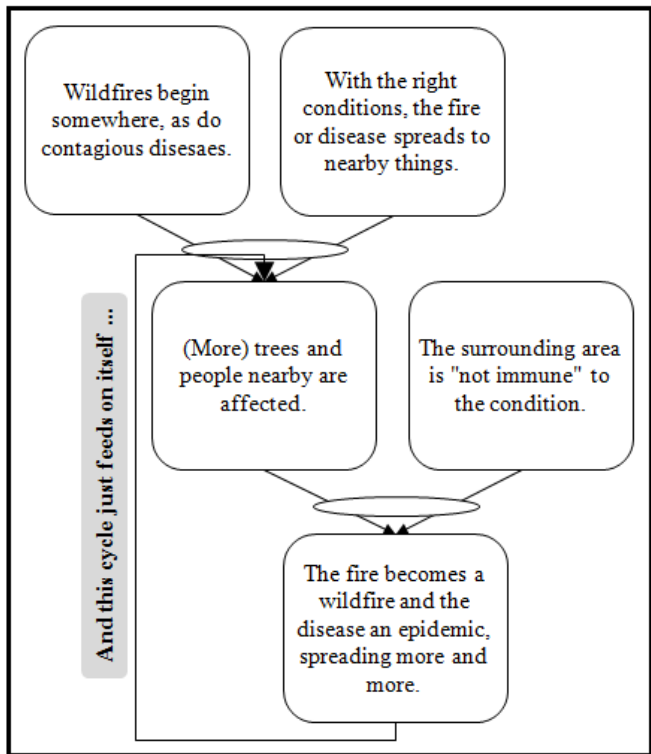
...

*Dynamic Change*  
*A Few More Examples*



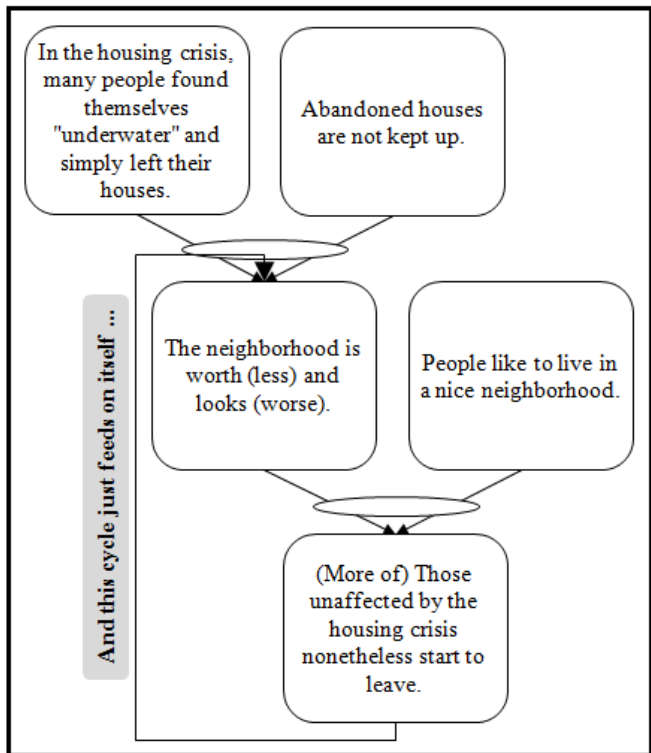
# WILDFIRES AND DISEASES

## How Do Things Spread?



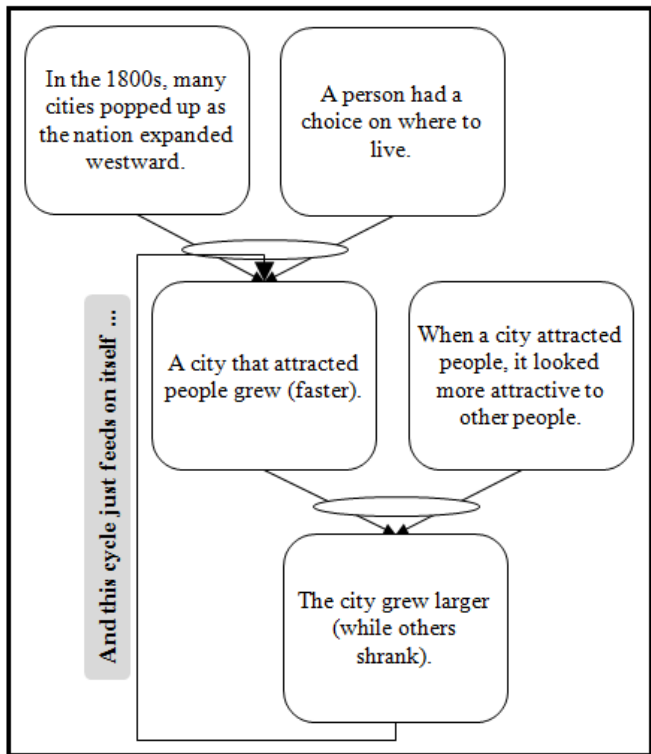
# NEIGHBORHOOD DECLINE

How Does a Neighborhood Become Less a Neighborhood



# A CITY'S DECLINE

## How Does A City Lose Population?



# WHAT IS A GOOD MODEL?

## A Good Model Considers the Dynamic Nature of Change

Population is affected by many factors, any of which can change the demographics.

Forest fires, viruses, city populations, etc., grow (or die) dynamically.

A good model takes into account the dynamics of the system.

One way to consider the dynamics of the system is to look at what's going around you.

"The Game of Life" simulates change by looking at what your neighbors are doing.

*The Game of Life*  
*Simulation of Life – Death – and*  
*Everything In-between*

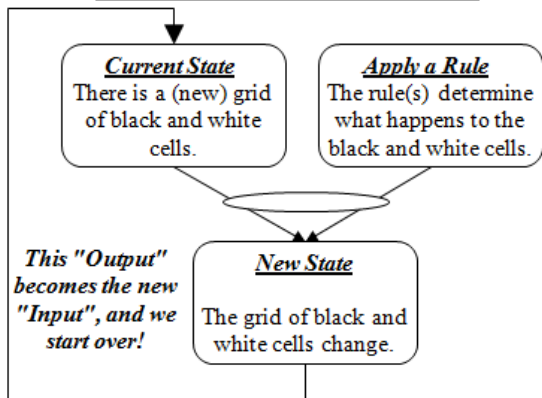
# THE GAME OF LIFE

## An Introduction

Consider this black cell.  
Let's say it's on fire. Every  
cell has eight neighbors.  
*What would happen to  
them?*

	1	2	3	
	8	■	4	
	7	6	5	

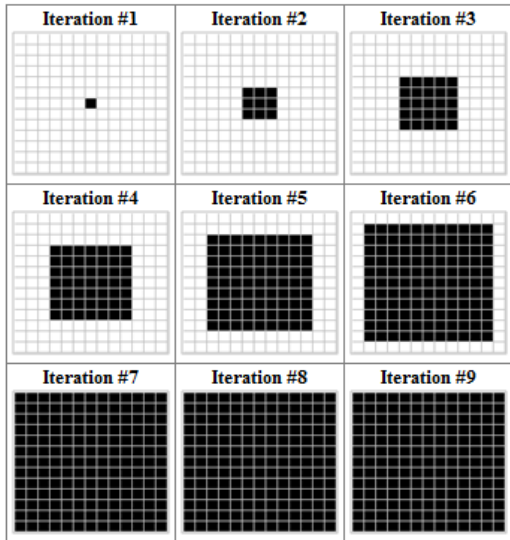
## How the System Changes



# A SPREADING SYSTEM

A Forest Fire or a Disease

FROM A SINGLE SPARK / GERM ...  
*How Do This Change Over Time?*



# A SIMPLE RULE

From a Good Introduction to "The Game of Life"

In the forest fire /  
disease example, the  
condition spread to  
anything it touched.

In most systems, not  
only does spreading  
depend on  
conditions, but  
there's life as well!

The forest fire /  
disease rules were a  
good introduction to  
"The Game of Life"  
and rules.

Reasonable rules  
need to include  
"number of  
neighbors affected",  
in addition to life.

We are ready to  
describe "The Game  
of Life"!



# THE GAME OF LIFE

## How the Game Works ...

I am a black cell, and I have eight possible neighbors ...

	1	2	3	
	8		4	
	7	6	5	

## THE GAME OF LIFE RULES

What happens to me depends on how many neighbors I *actually* have:

IF I HAVE ...	I AM ...	SO I ...
too many neighbors	overcrowded	die
too few neighbors	lonely	die
a reasonable # of neighbors	content	survive
have room to grow	excited	grow

# THE GAME OF LIFE

How the Game Works ...

	1	2	3	
	8	■	4	
	7	6	5	

## IF I'M ALIVE (BLACK CELL)

and I have 4 or more neighbors, then I die of overcrowdedness  
(change to WHITE CELL). ■ → □

and I only have 0 or 1 neighbors, then I die of loneliness  
(change to WHITE CELL) ■ → □

and I only have 2 or 3 neighbors, then I remain alive  
(stay BLACK CELL) ■ → ■

## IF I'M NOT ALIVE (WHITE CELL)

and I have exactly three neighbors, then I come to life  
(change to BLACK CELL) □ → ■

# A SIMPLE EXAMPLE

## The Game of Life

**My Starting Grid**

	a	b	c	d	e
1					
2		■	■	■	
3					
4					
5					

**My Decisions**

cell	neighbors	status	cell	neighbors	status
b2	1	dies	c1	3	grows
c2	2	lives	c3	3	grows
d2	1	dies			

**My Next Grid**

	a	b	c	d	e
1					
2			■		
3			■		
4					
5					

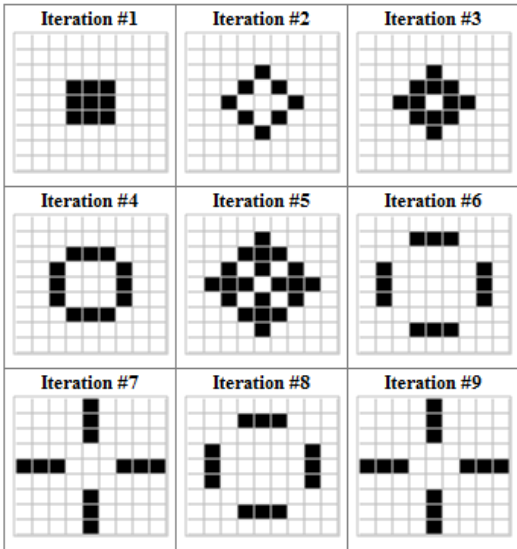
**My Decisions**

cell	neighbors	status	cell	neighbors	status
c1	1	dies	b1	3	grows
c2	2	lives	d1	3	grows
c3	1	dies			

# A 3 x 3 GRID

## The Game of Life

**3 x 3 GRID STARTING POINT**  
*How Does This Change Over Time?*

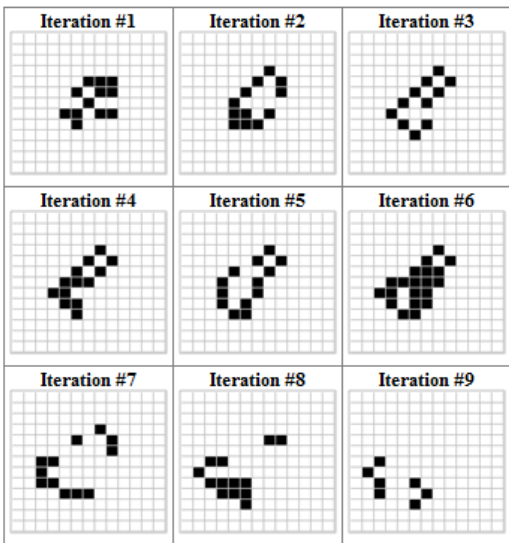


At some point, this becomes a "Blinker", like changing from "heads" to "tails" and back to "heads" again!

# A RANDOM STARTING GRID

## The Game of Life

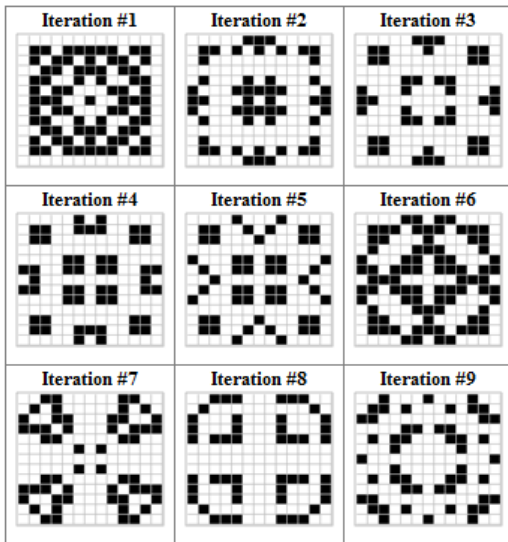
**3 x 3 RANDOMLY FILLED GRID STARTING POINT**  
*How Does This Change Over Time?*



# SYMMETRIC STARTING GRID

The Game of Life

SYMMETRICALLY FILLED GRID STARTING POINT  
*How Do This Change Over Time?*



JOHN CONWAY

# THE GAME OF LIFE

The process described here is a recent development in math. Things like this are now possible – easily – because of the computer.

In 1970, John Conway discussed this structure, called The Game of Life, dealing with individual entities. The movement of the entities – *cellular automata* – spawned a unique structure for possibly understanding the nature and operation of the universe – to be explored in a later issue!

# THE GEOMETRIC MIND

# PROBLEMS

The following three problems each have a CHECK  
(to make sure you've done the problem right).

Once you've confirmed you've done the problem  
right, there's a KEY. The key is necessary to  
unlock the next installment.





# PROBLEM 1

## **PROBLEM 2**

## **PROBLEM 3**

**THE GEOMETRIC MIND**  
**CONCEPT CARD**