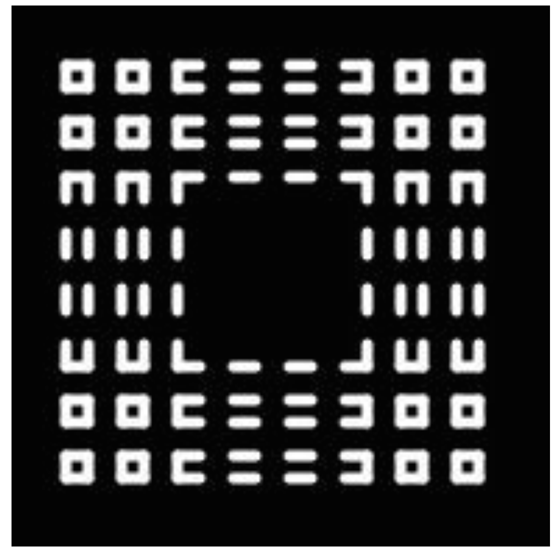
Recursive Distinctioning

By Louis H. Kauffman and Joel Isaacson: Howard Bloom Presentation

Editors' Introduction: Scientist and author Howard Bloom presented at ISDC-2017, in St. Louis, on May 28, 2017, the most recent paper authored by Dr. Louis Kauffman and Dr. Joel Isaacson providing the description and current status of research on Nature's Cosmic Intelligence. The term for that autonomous phenomenon in the universe is *"Recursive Distinctioning (RD)*." See our Editors' Notes at the end of the article for more of the RD Story. *Bob Krone and Gordon Arthur*.

Recursive Distinctioning

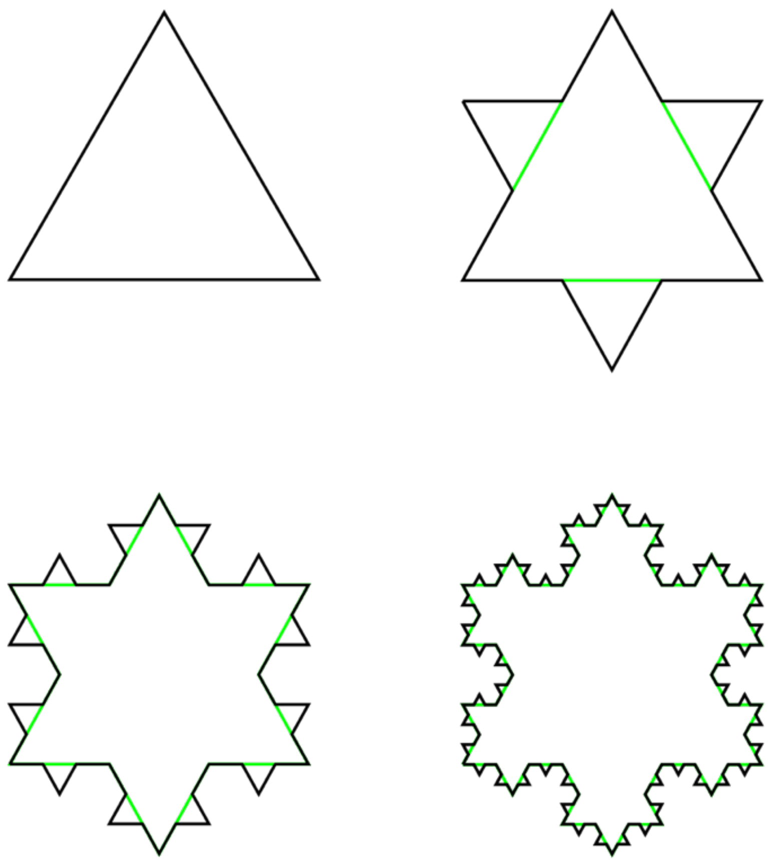
by Louis H. Kauffman and Joel Isaacson



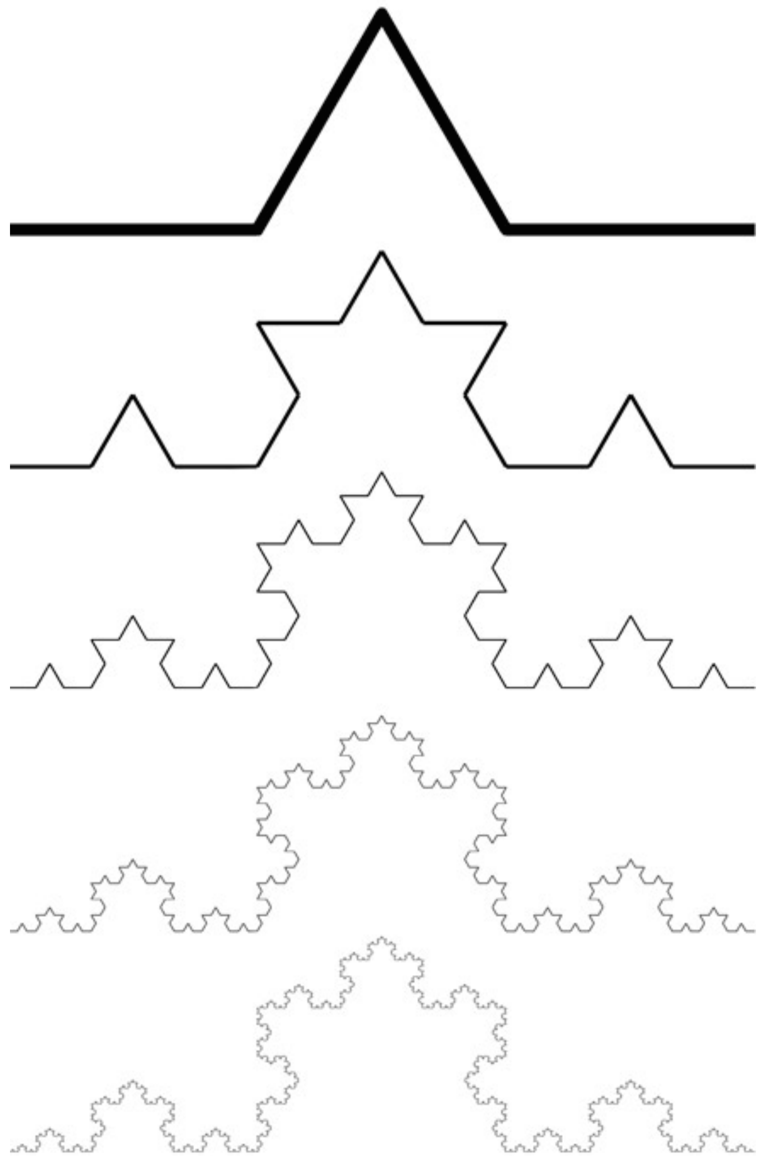
This slide show is based on a paper
"Recursive Distinctioning"
by Joel Isaacson and Louis H Kauffman,
and
joint work with
programming and exploring recursive distinctioning
by
Louis H Kauffman and Dan Sandin.

See
http://homepages.math.uic.edu/~kauffman/
RD.html

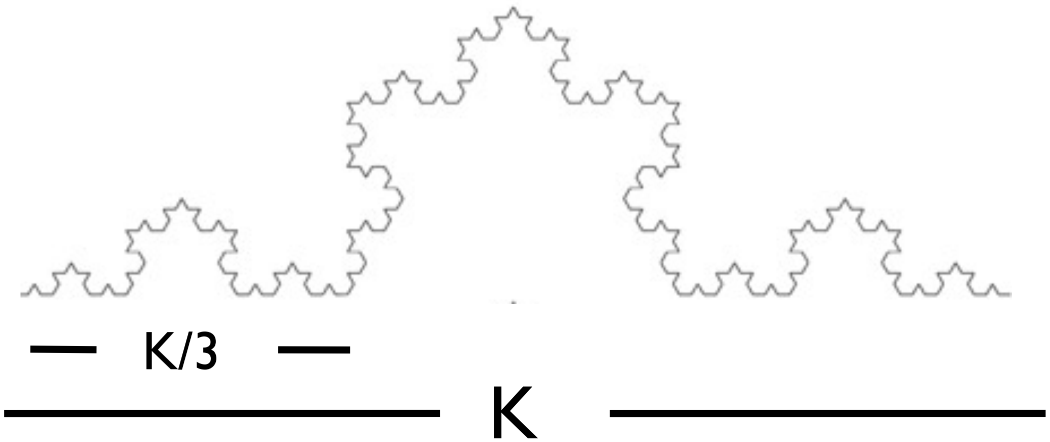
WE HAVE A TALE TO TELL.
And before we start telling it, some ideas are worth discussing.
Lets begin with the famous Koch Snowflake.



Begin by MAKING A DISTINCTION in each edge of the triangle by cutting out the middle third. Replace the middle third by two edges of the same length. The new form has 12 edges. Do this again FOREVER.



If you apply this
RECURSIVE
DISTINGUISHING
PROCESS
(distinguish the
middle third and
construct two
copies of the middle
third to replace it)
to one side of the
triangle, you obtain
the Koch Fractal, a
form that is equal to
FOUR COPIES OF
ITSELF
EACH SHRUNK BY
ONE THIRD.



FOUR COPIES OF
ITSELF
EACH SHRUNK
BY ONE THIRD.

$$K^D = 4 \times (K/3)^D$$

$$3^D = 4$$

$$D = \mathrm{Log}(4)/\mathrm{Log}(3) = 1.26186$$

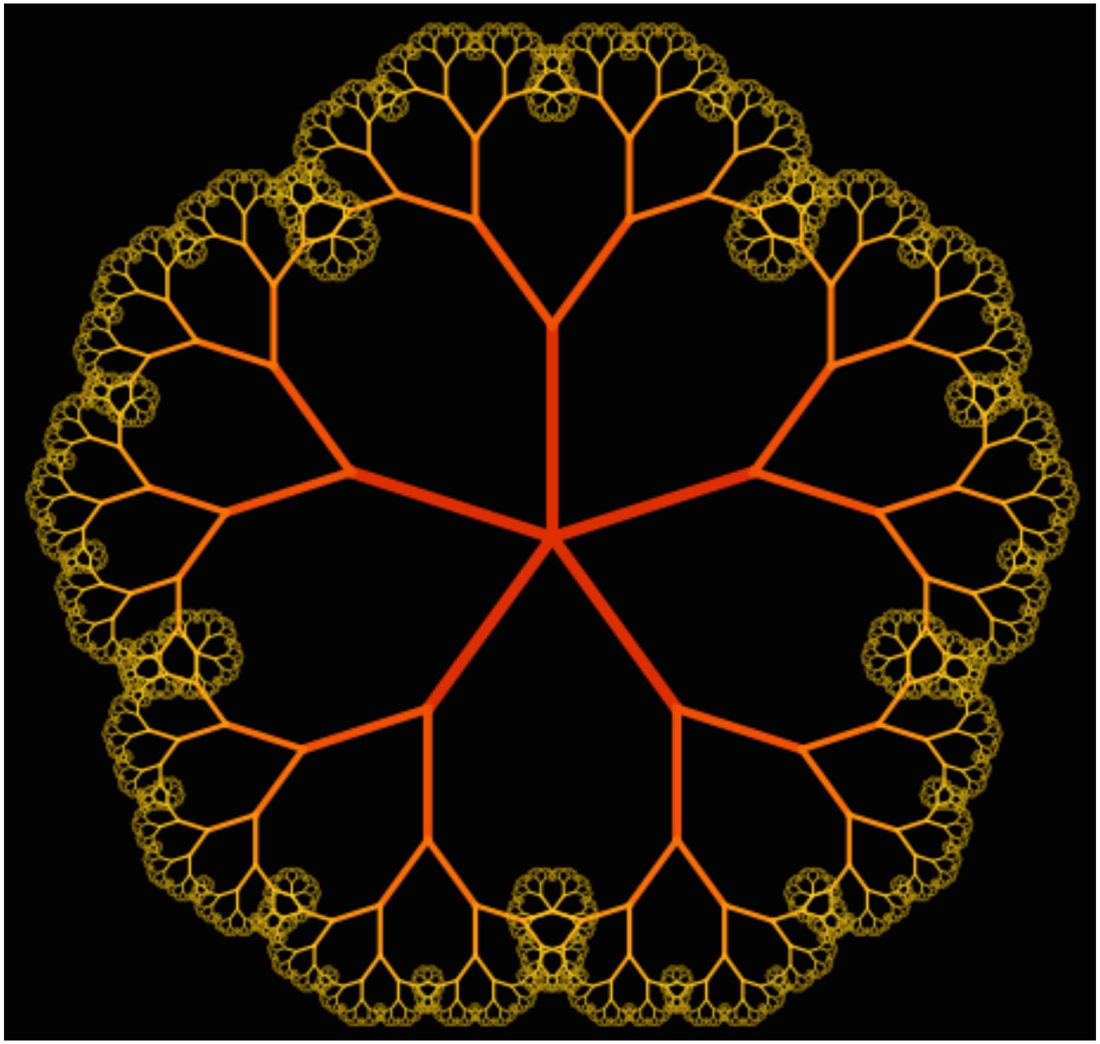
The Koch Fractal has NON-INTEGRAL DIMENSION.

The fractal makes a space of its own that is not one dimensional nor is it two dimensional. The dimension is a measure of the process of recursive distinguishing that has given birth to this recursive form.

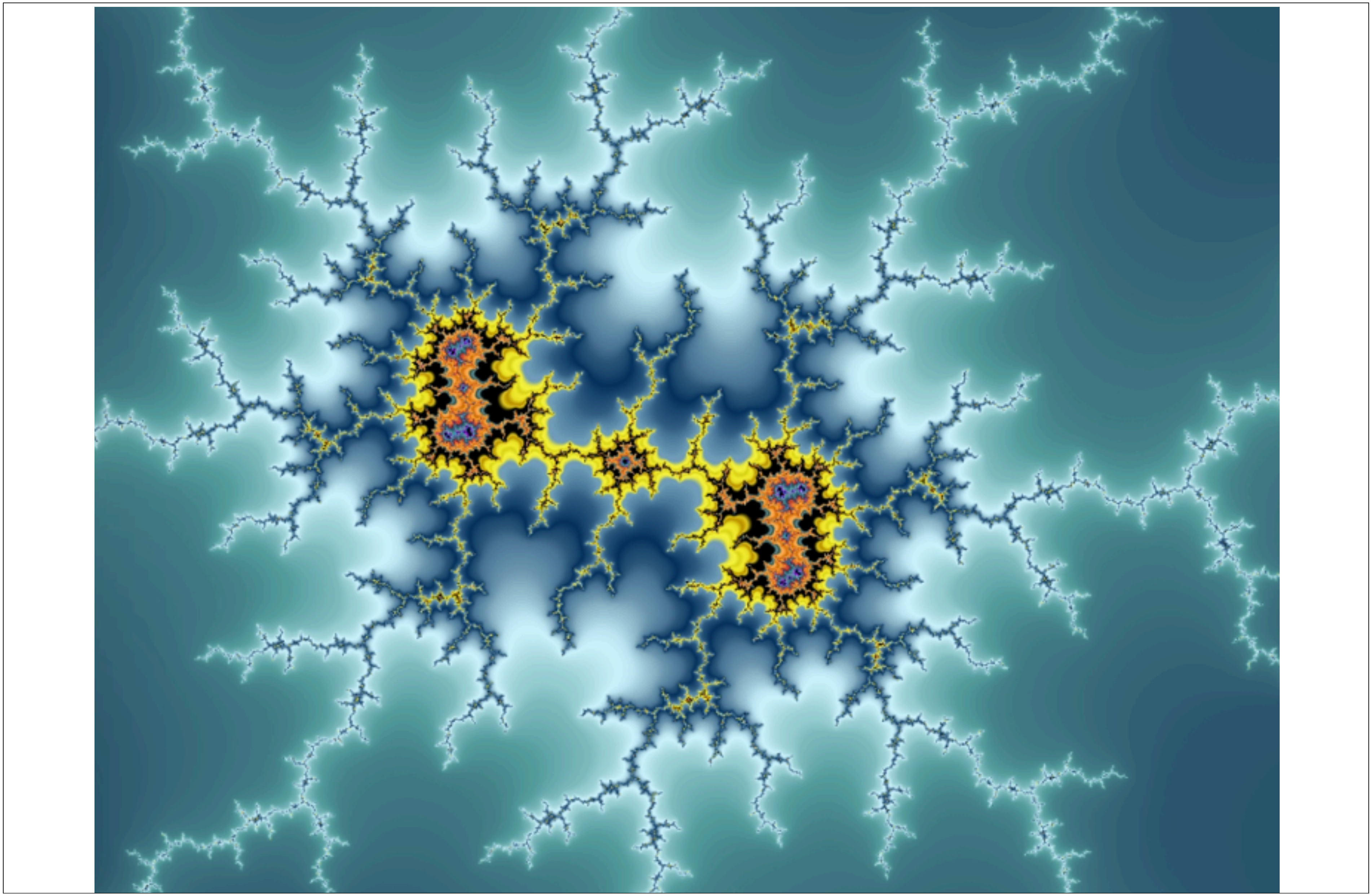
Fractal Spacetime

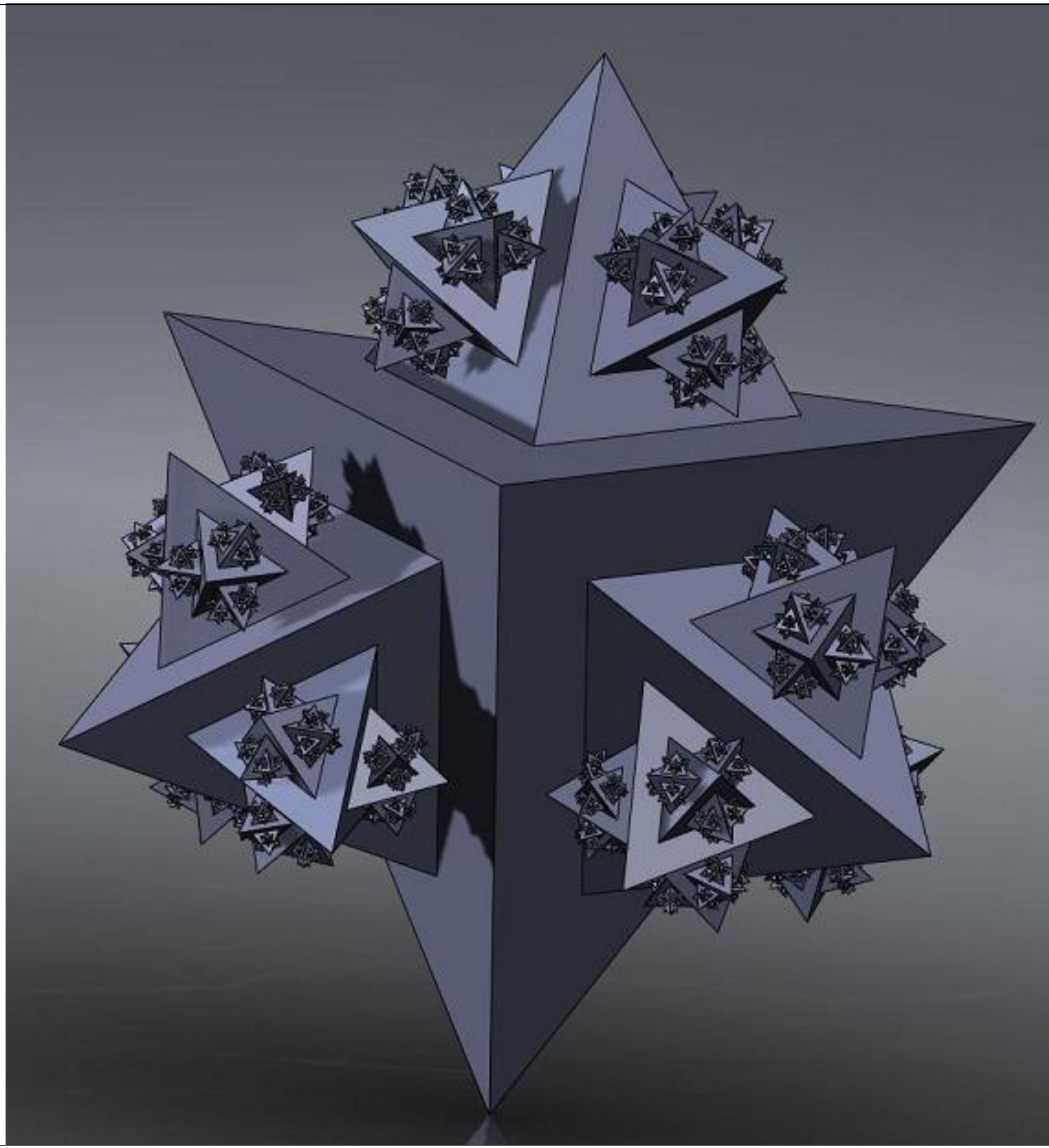
Spacetime itself may be a fractal and the true dimension of spacetime, a fractal dimension, greater than three but less than four! The problems of infinities and renormalization in physics may be resolved by this understanding.

Fractal Spacetime is generated by an Ultimately Simple Process of Recursive Distinguishing.



Beautiful, self-similar geometric forms emerge from the simplest of distinctions and a recursive process in which these distinctions are enfolded.





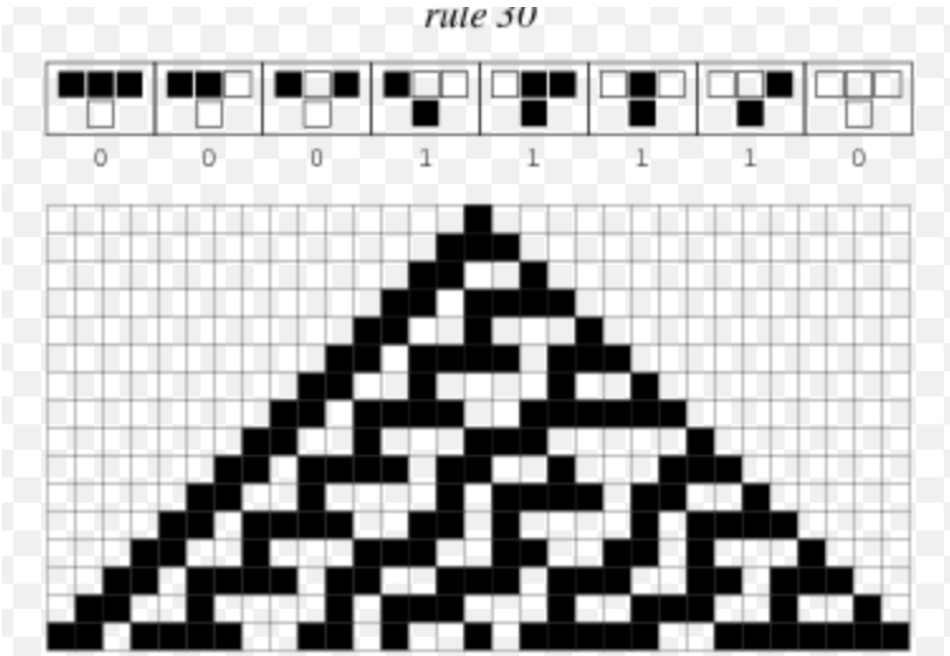
Higher dimensional analogues give us new insight into the nature of space and time.

Space is the distinction we apprehend.

Time is the process by which space becomes what it is now.

Recursive Fractal Distinguishing occurs in Biological Systems.

A simple growth rule, based on an elementary distinction --- and recursion ---
generates a myriad of forms.



Wolfram Rule 30

Cellular Automata, based on very simple rules generate complex, fractal and even undecideable patterns.

Wolfram line automata use a distinction that is based on the different neighbor patterns for a given square. The replacement is a black square or a white square.

In Conway Life the rules apply in two dimensions.

A black cell is born if it has exactly 3 neighbors.

A black cell survives only if it has 2 or 3 neighbors.

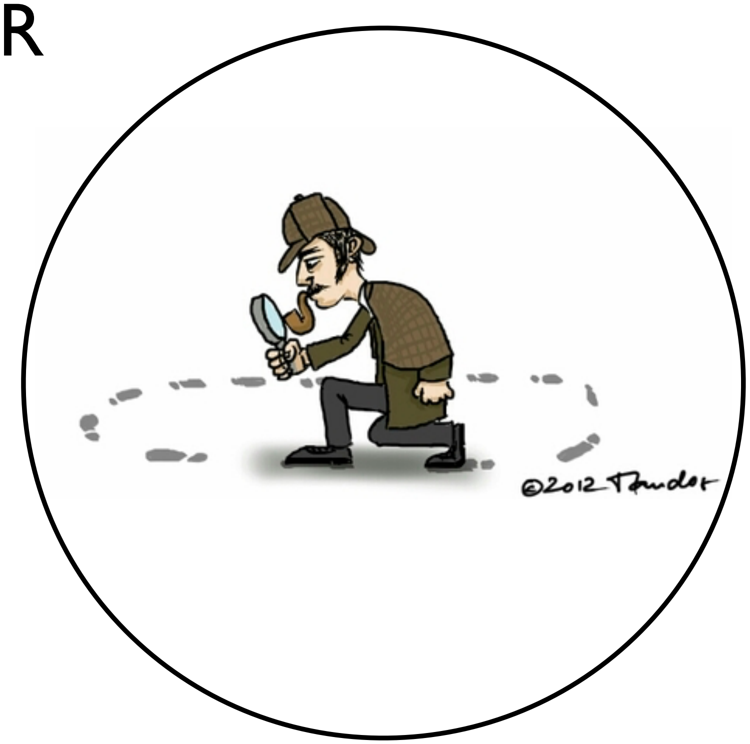
In all these situations, there is a set of distinctions such as black and white cells that are INDICATORS.
And there are rules that are based on distinctions about these indicators.

We ask about such recursive distinguishing:
HOW SIMPLE CAN IT BE?

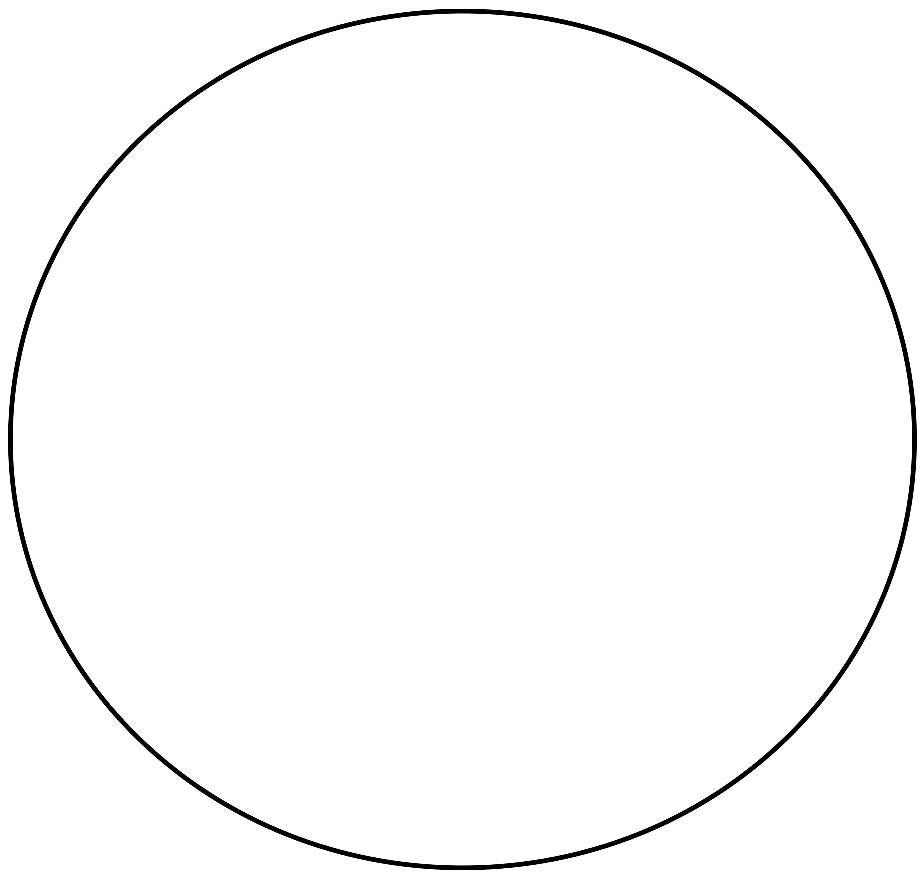
CAN THE RECURSION AND THE LANGUAGE OF INDICATION COME FORTH TOGETHER?

CAN WE ELIMINATE ARBITRARINESS AND KEEP THE DISTINCTIONS AS SIMPLE AS POSSIBLE?

TO MAKE A TRANSITION TO
EXTREME SIMPLICITY
PUTS
EXTRAORDINARY DEMANDS
ON YOU THE LISTENER
AND ON
THE
INVESTIGATOR
AS WELL.



WHAT IS THE NATURE OF A DISTINCTION?



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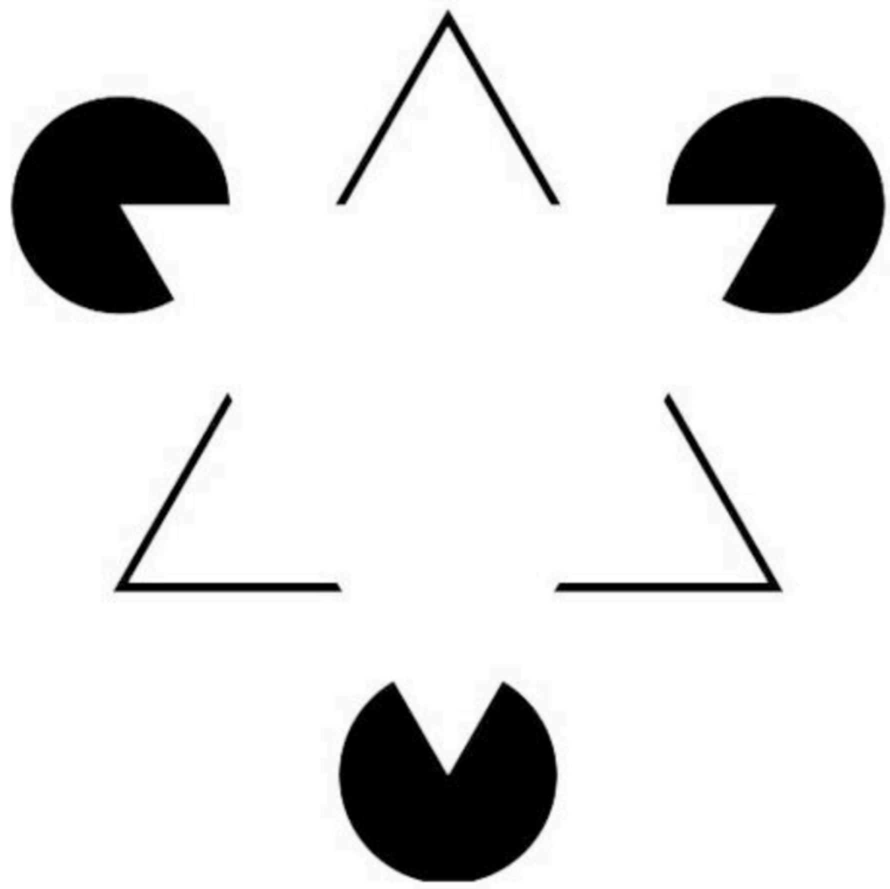

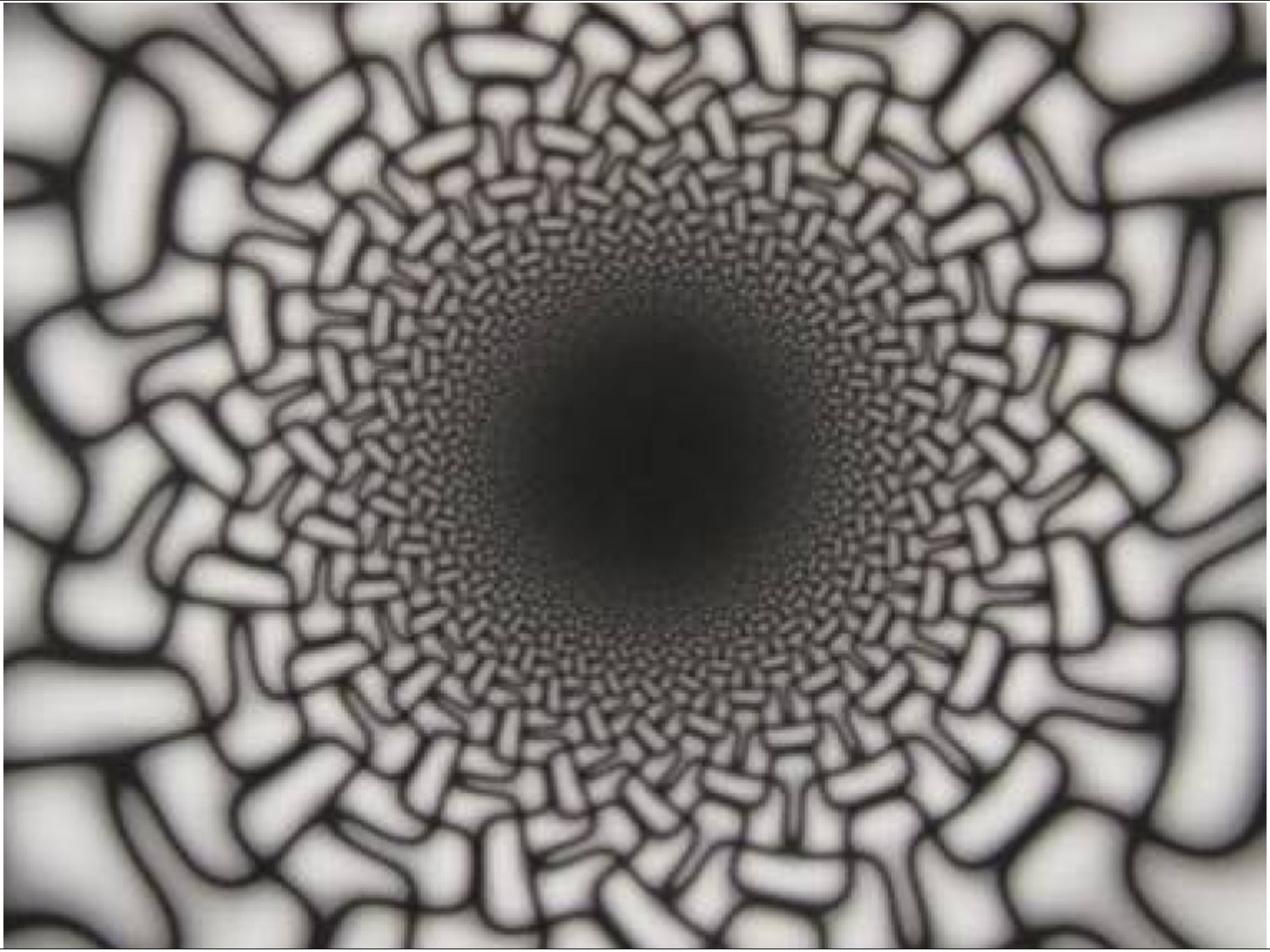

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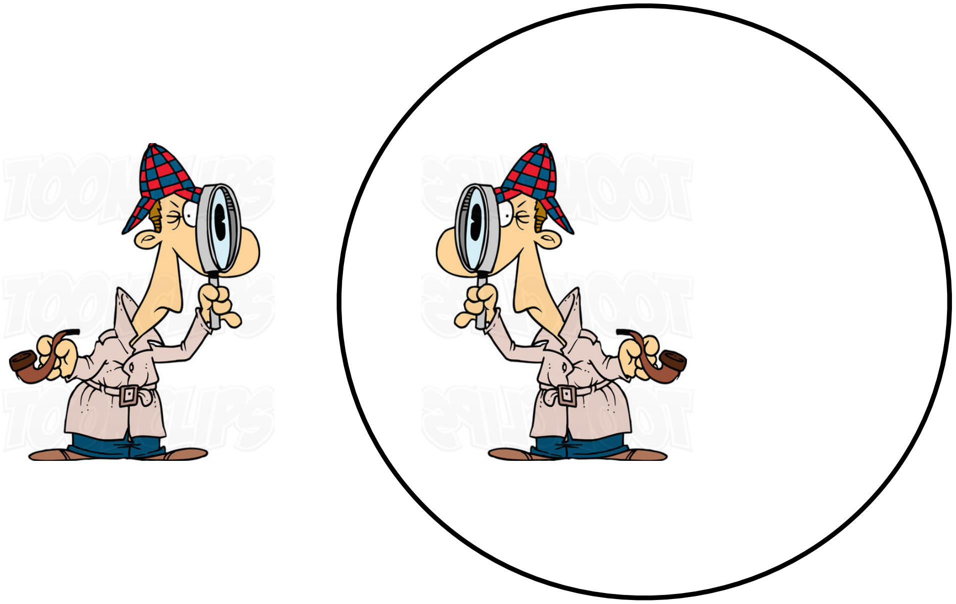
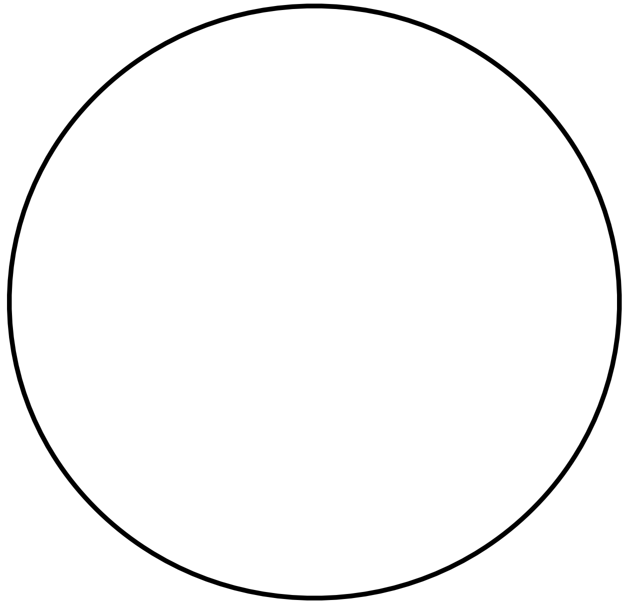


We make distinctions and we are often able to recognize them.

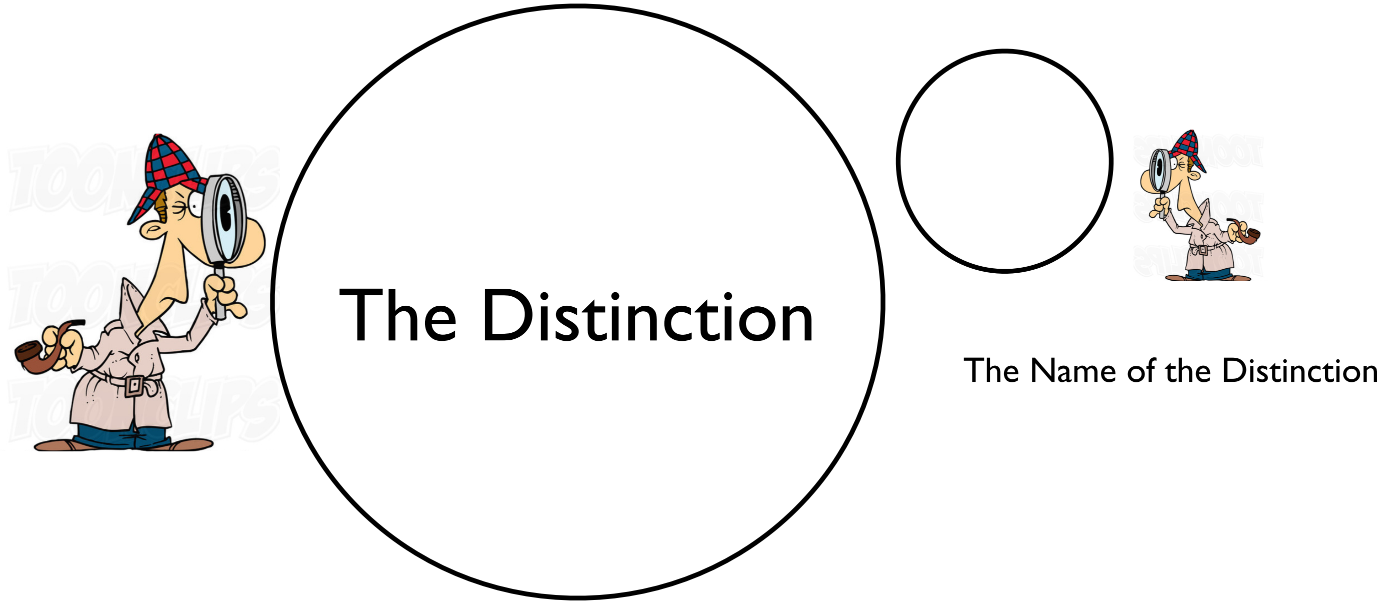
A circle makes a distinction in the plane between its inside and its outside.

We draw a circle and so make a distinction.



Finding a circle, we agree that it is a distinction.
We see that the circle makes a difference between its inside and its outside.
We see that for us the circle indicates a difference between its inside and its outside.
A circle could also be a SYMBOL, standing for a distinction.

A circle could also be a SYMBOL, standing for a distinction.



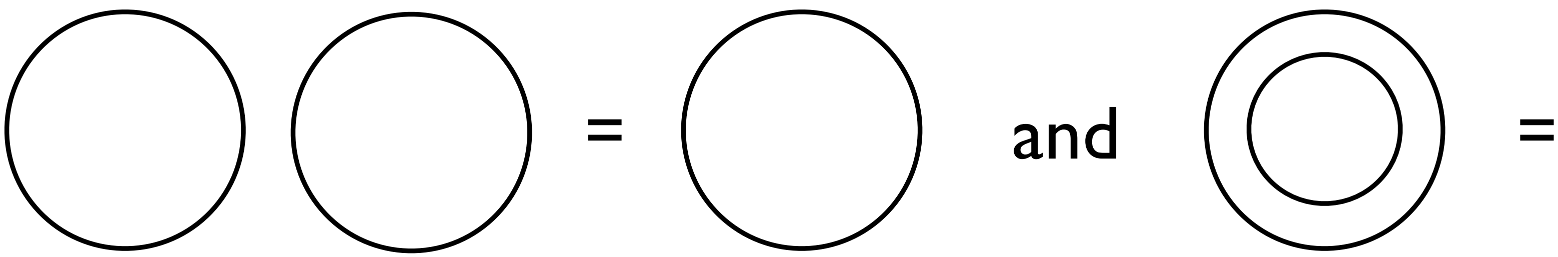
A symbol can MAKE a distinction.

A symbol can be the NAME of a distinction.

In the primordial event of a distinction, the distinction is its own name.

G. Spencer-Brown's Laws of Form

These issues take a very strong direction of the English mathematician and philosopher George Spencer-Brown. Spencer-Brown developed a calculus based on distinctions that is seen to underly the development of logic and boolean algebra. This Calculus of Indications is based on the equations

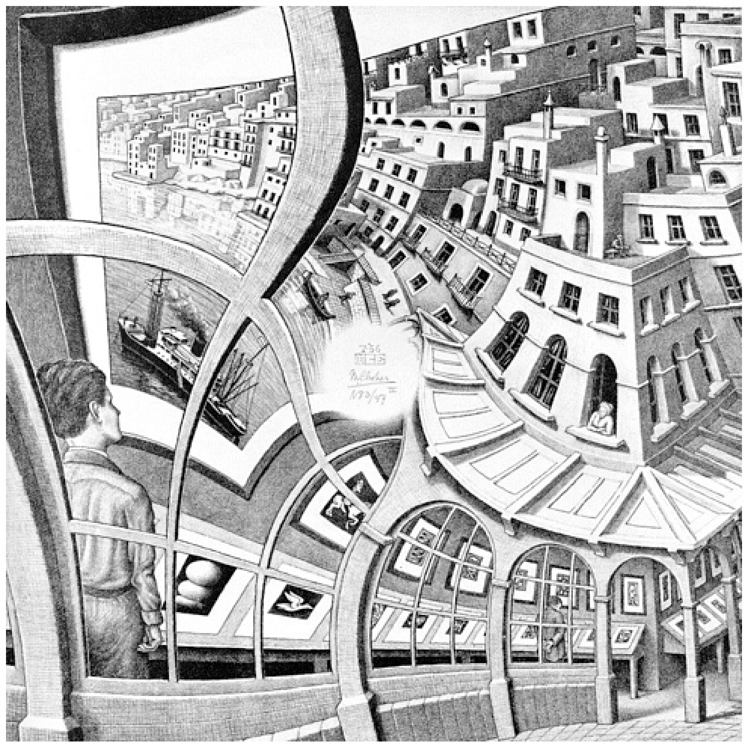


On the left side of the first equation, either circle is the name of the other, and so either can be erased.

In the second equation the two distinctions fit perfectly and so cancel to no distinction at all.

THE PRIMORDIAL DISTINCTION IS ITS OWN NAME.

In the course of recursive distinguishing
the simplest examples will be distinctions
that describe themselves.



As we shall see, we may begin with distinctions that describe other distinctions, but they will soon be describing themselves in endless recursion.

Recursive Distinctioning is what it says.

One has a distinction or a field of distinctions.
Such a field of distinctions can be made specific
by arranging patterns in a line, on a lattice or a graph.

For example, one might have a string of letters
such as
AAAABAAAA

We will describe this pattern with a special
alphabet
{ =, [,], O}

A letter will receive "[" if it is equal to the letter on the right and unequal to the letter on the left.

A letter will receive "]" if it is equal to the letter on the left and unequal to the letter on the right.

A letter will receive "O" if it is unequal to the letter on the left and unequal to the letter on the right.

A letter will receive "=" if it is equal to the letter on the left and equal to the letter on the right.

...A A A A A A A A B A A A A A A A A...

...= = = = = = =] O [= = = = = = =...

...= = = = = =] O O O [= = = = = =...

...= = = = =] O [=] O [= = = = =...

...A A A A A A A A B A A A A A A A A...

...= = = = = = =] O [= = = = = = =...

...= = = = = =] O O O [= = = = = =...

...= = = = =] O [=] O [= = = = =...

A single distinction (the letter B in the row of same A's) has been described and the description itself described two more times.

At the first description, a "protocell"]O[appeared and this cell underwent a "mitosis" in the next two iterations.

In the context of recursive distinctioning, recursive re-description, a simple local distinction gives birth to an entity]O[that can reproduce itself!

...= = = = = =] O [= = = = = = ...

...= = = = =] O O O [= = = = = ...

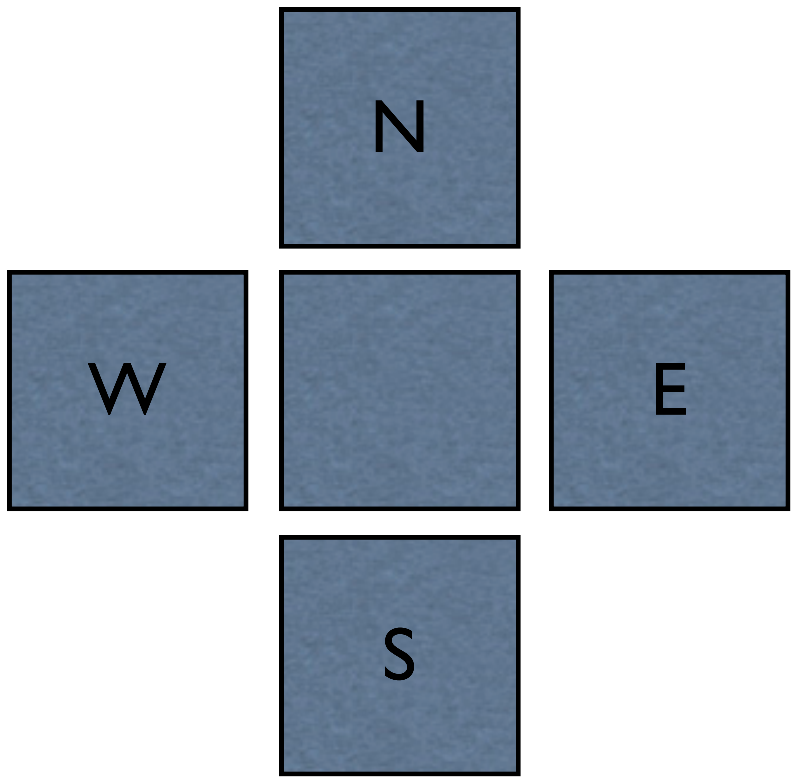
...= = = =] O [=] O [= = = = ...

Philosophically speaking, this is the whole talk. We wish to make the case that the RD process is fundamental and primordial. The fact that it can do something this significant at once, in the simplest case, proves our point.

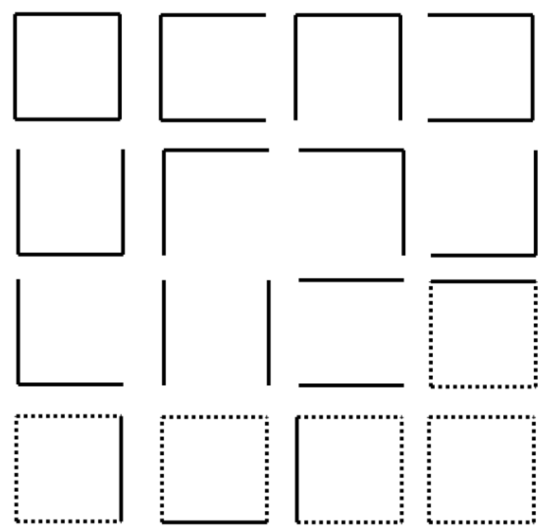
```
*AAAAAAAAAAAAAAAAAAAAAAAAABAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA*
*                        ]O[                              *
*                       ]OOO[                             *
*                      ]O[  ]O[                           *
*                     ]OOOOOOO[                           *
*                    ]O[     ]O[                          *
*                   ]OOO[   ]OOO[                         *
*                  ]O[ ]O[ ]O[ ]O[                        *
*                 ]OOOOOOOOOOOOOOO[                       *
*                ]O[             ]O[                      *
*               ]OOO[           ]OOO[                     *
*              ]O[ ]O[         ]O[ ]O[                    *
*             ]OOOOOOO[       ]OOOOOOO[                   *
*            ]O[     ]O[     ]O[     ]O[                  *
*           ]OOO[   ]OOO[   ]OOO[   ]OOO[                 *
*          ]O[ ]O[ ]O[ ]O[ ]O[ ]O[ ]O[ ]O[                *
*         ]OOOOOOOOOOOOOOOOOOOOOOOOOOOOOOO[               *
*        ]O[                             ]O[              *
*       ]OOO[                           ]OOO[             *
*      ]O[ ]O[                         ]O[ ]O[            *
```

Here is another take on the same process where "=" has been replaced by no marking.

In working with a two dimensional lattice we use a natural sixteen letter alphabet. The letters in this alphabet generalize our small one-dimensional alphabet, and indicate distinctions to the north, south, east and west.



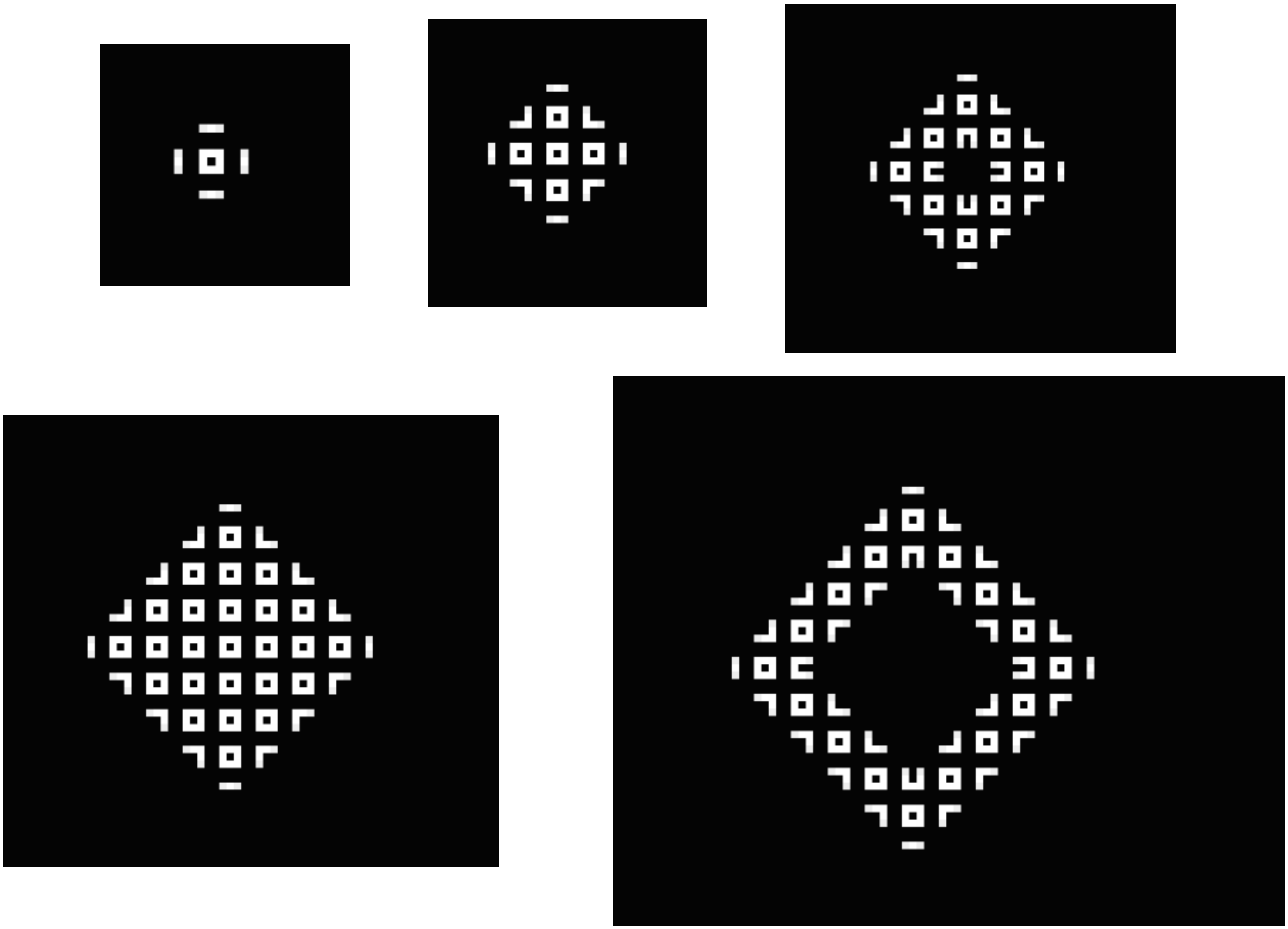
Here is our sixteen letter alphabet.

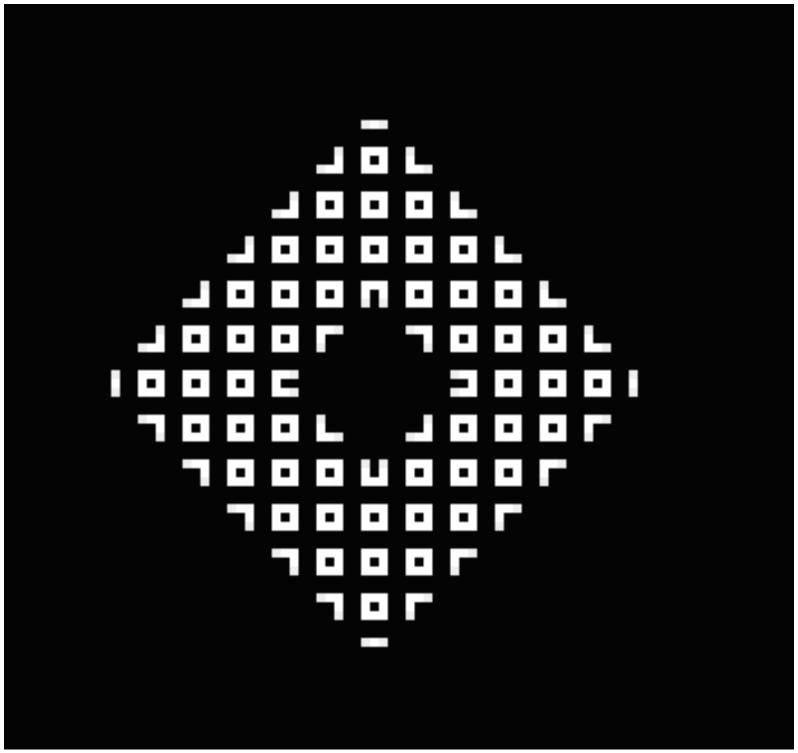


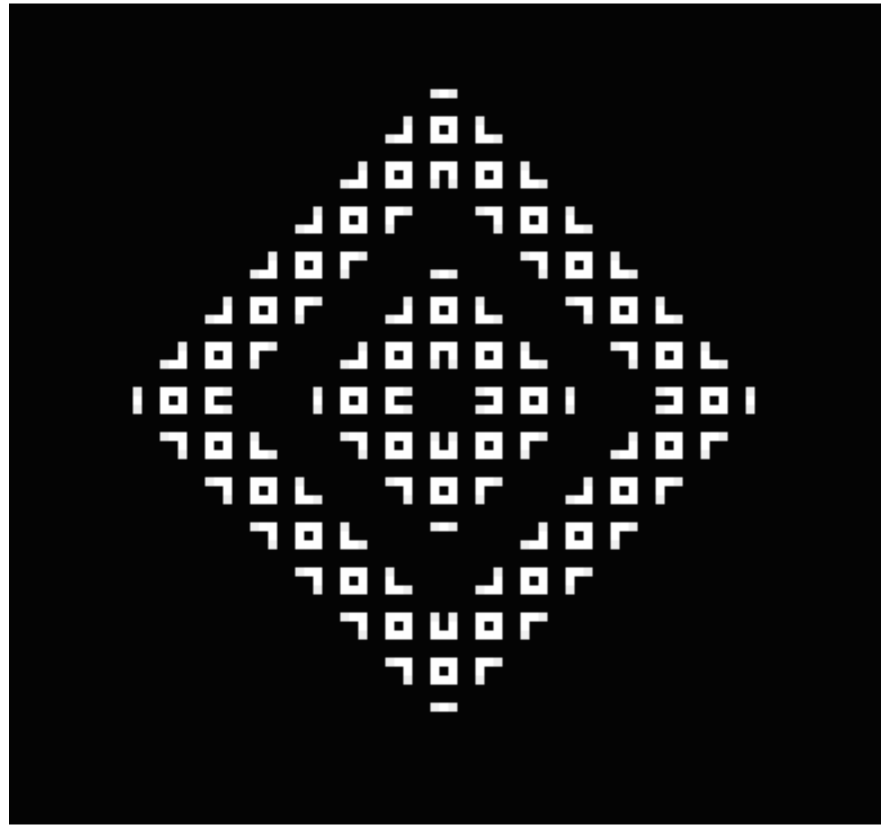
Each icon indicates difference with solid edges and equality with blank or dotted edges.

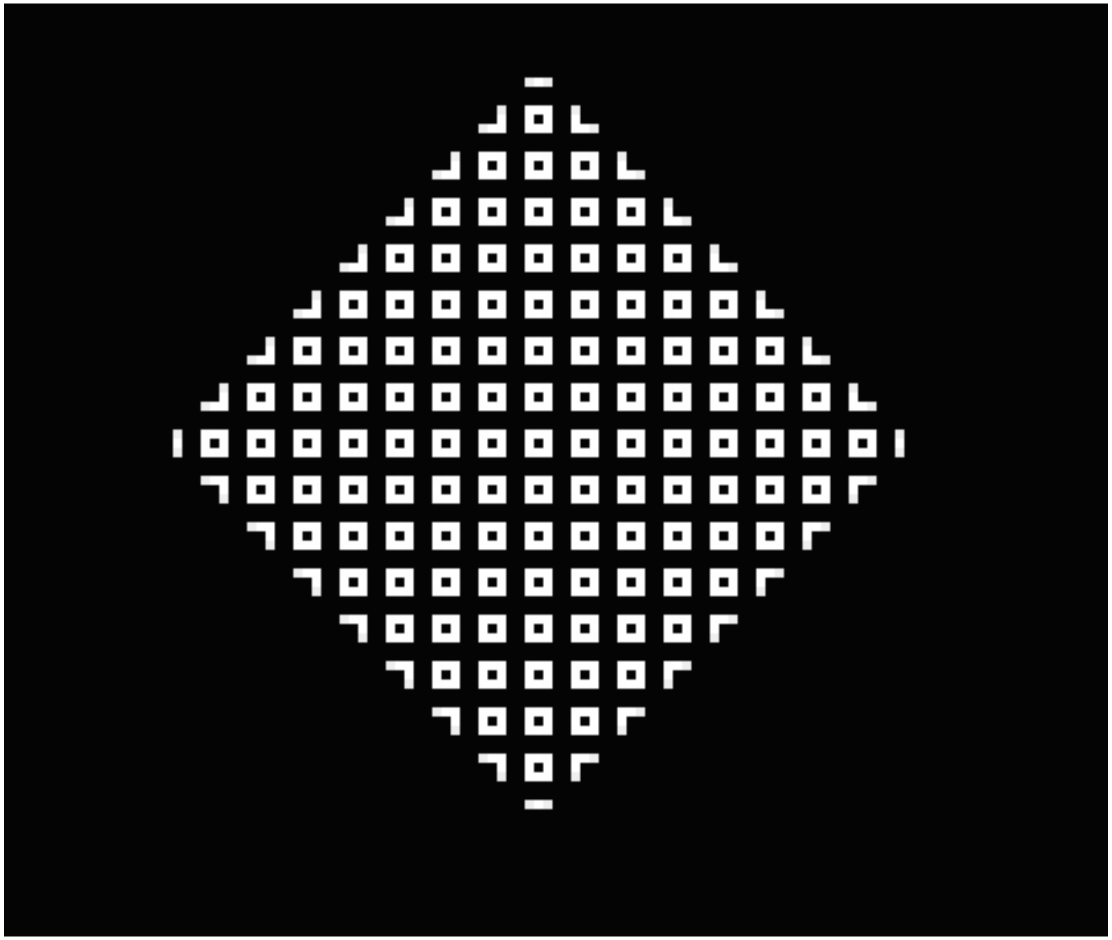
Each icon makes a distinction in that it is different from all the other icons.

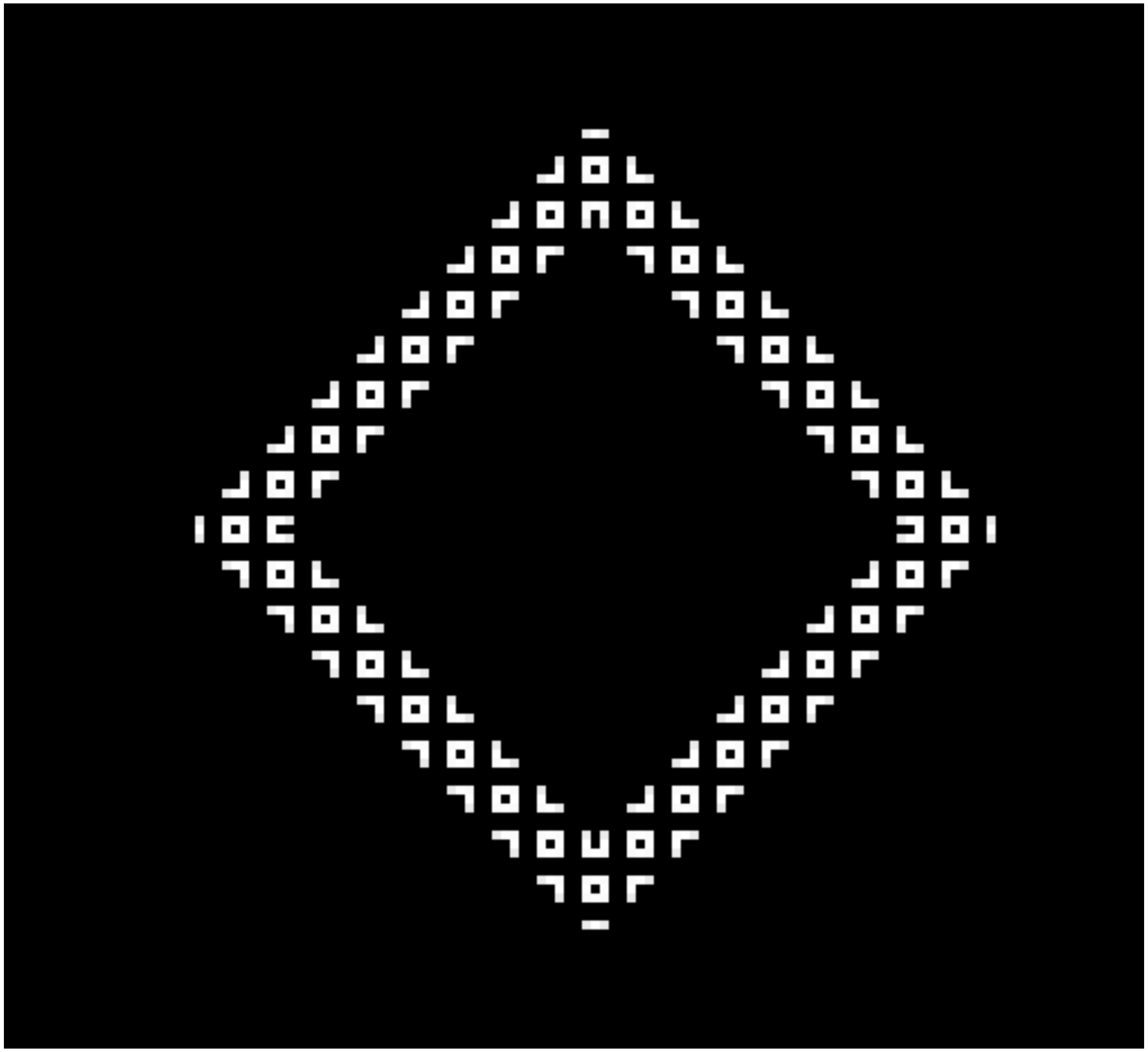
Here is a growing pattern in 2DRD.

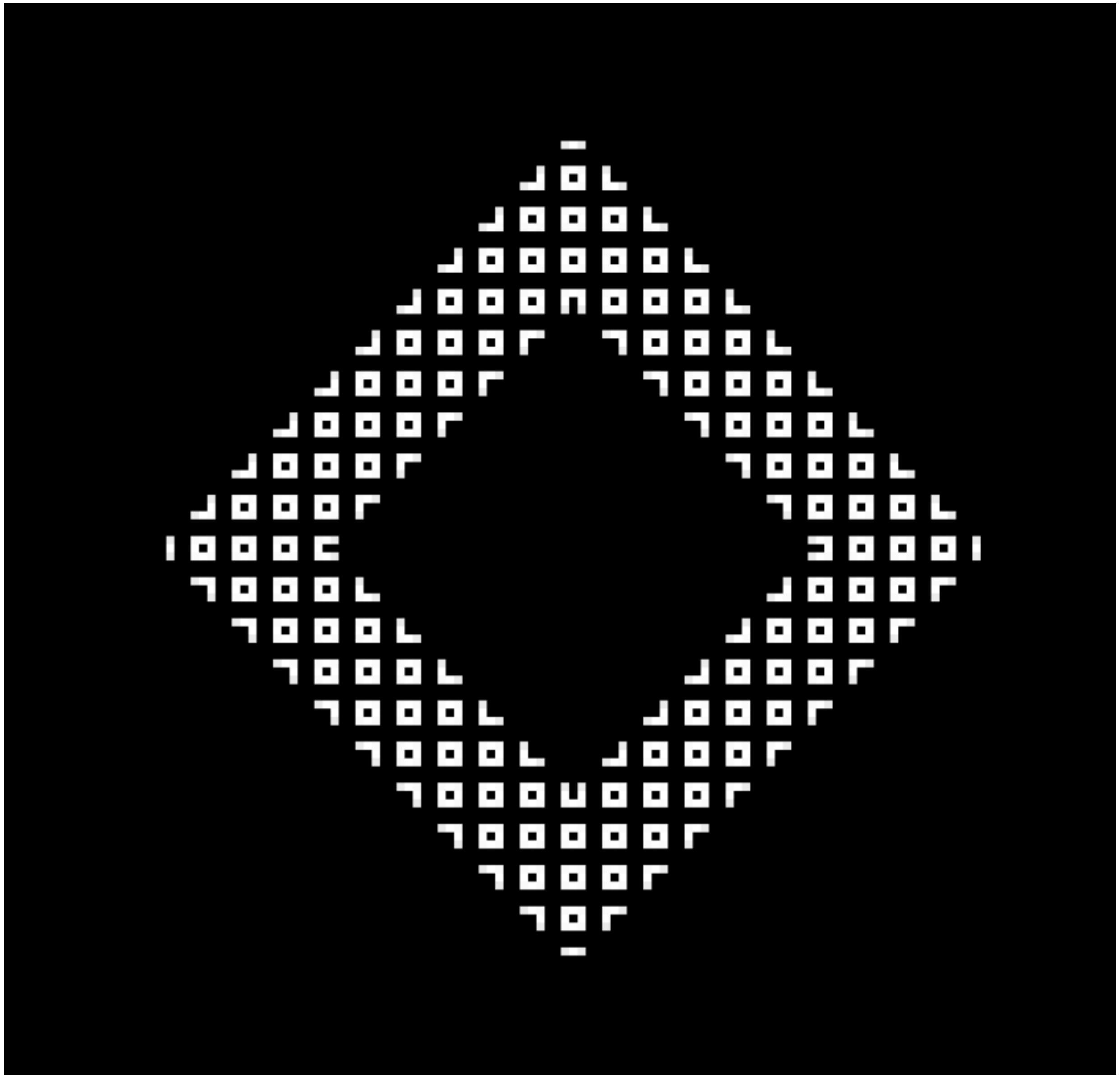


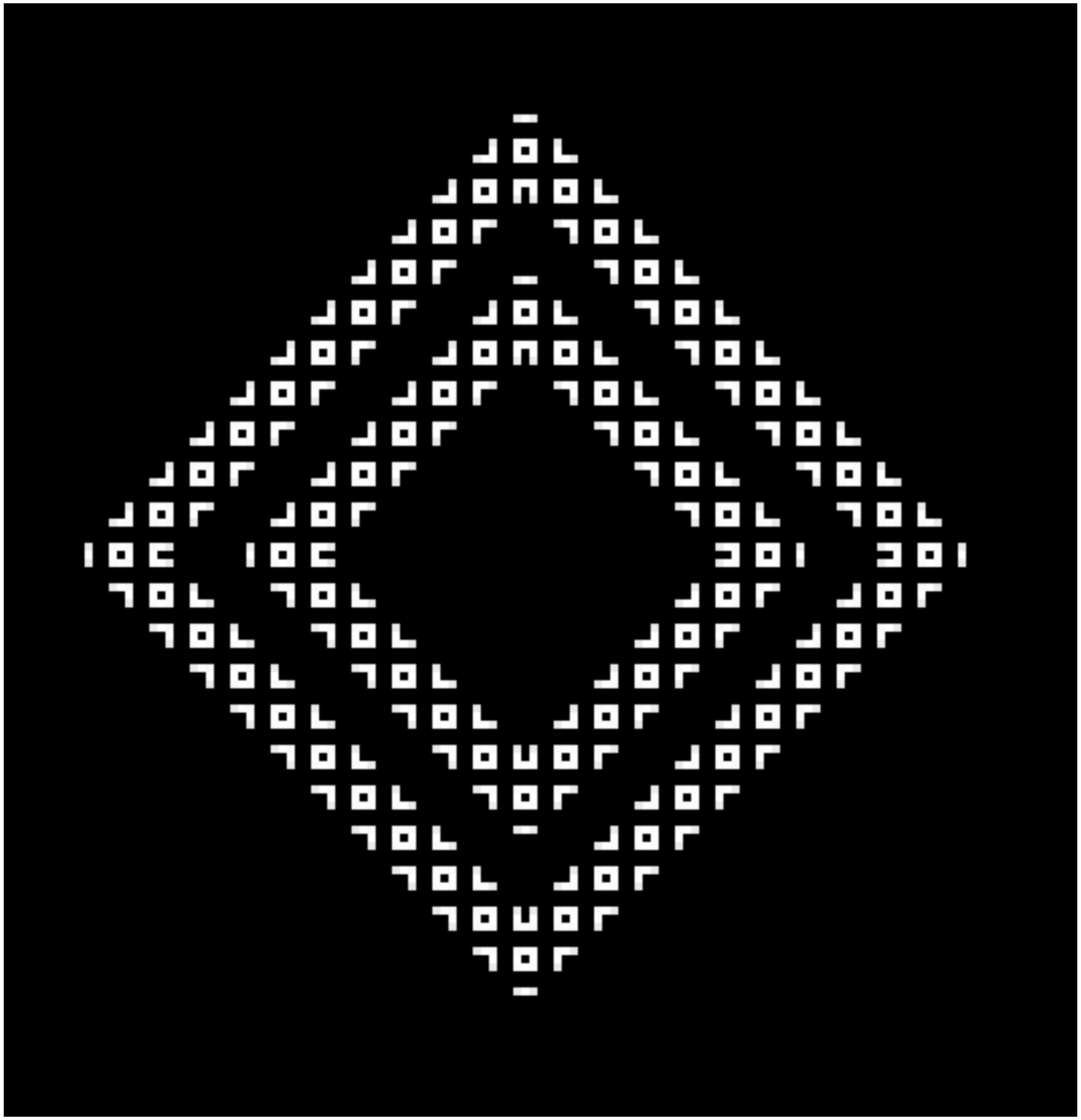


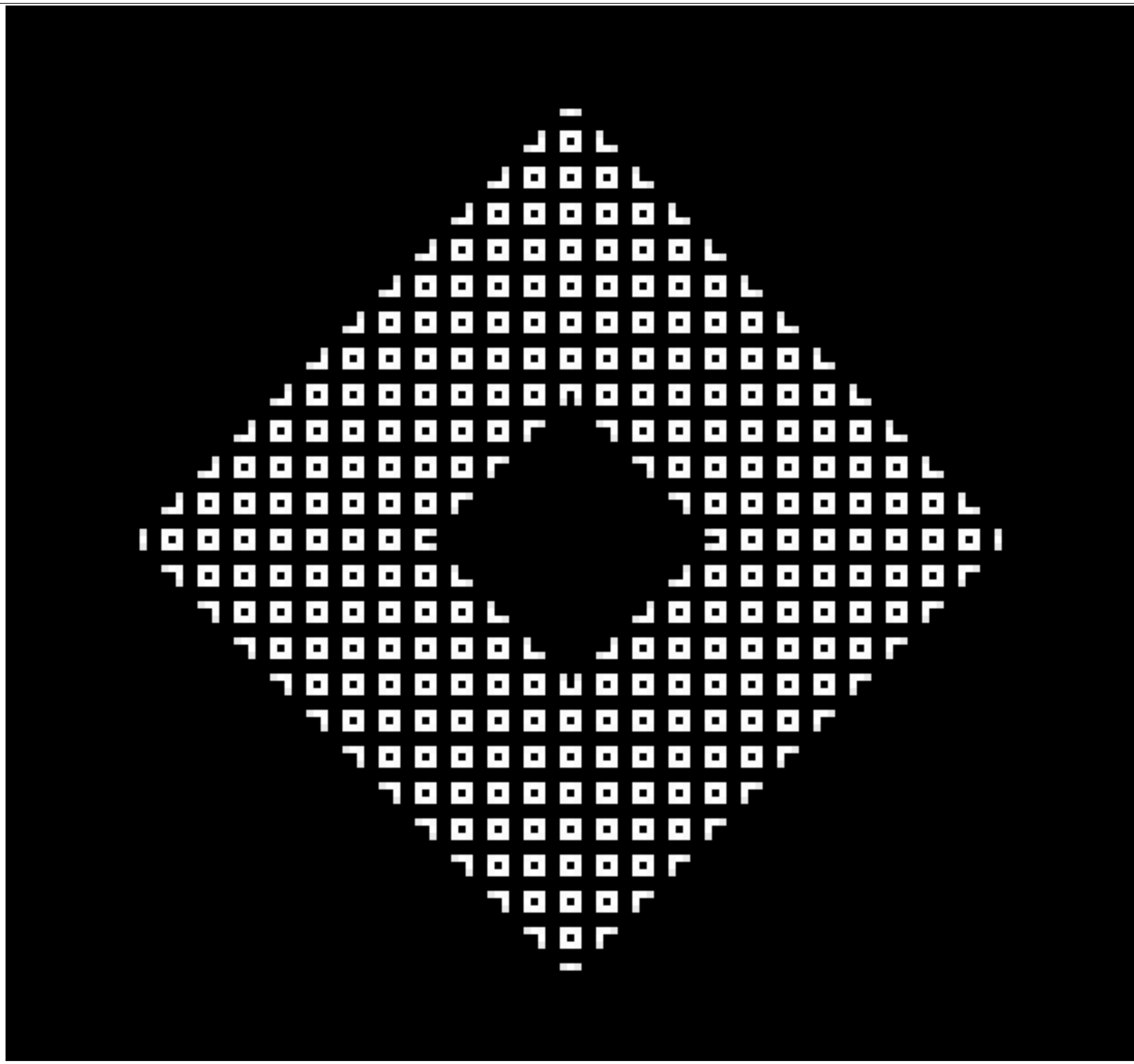


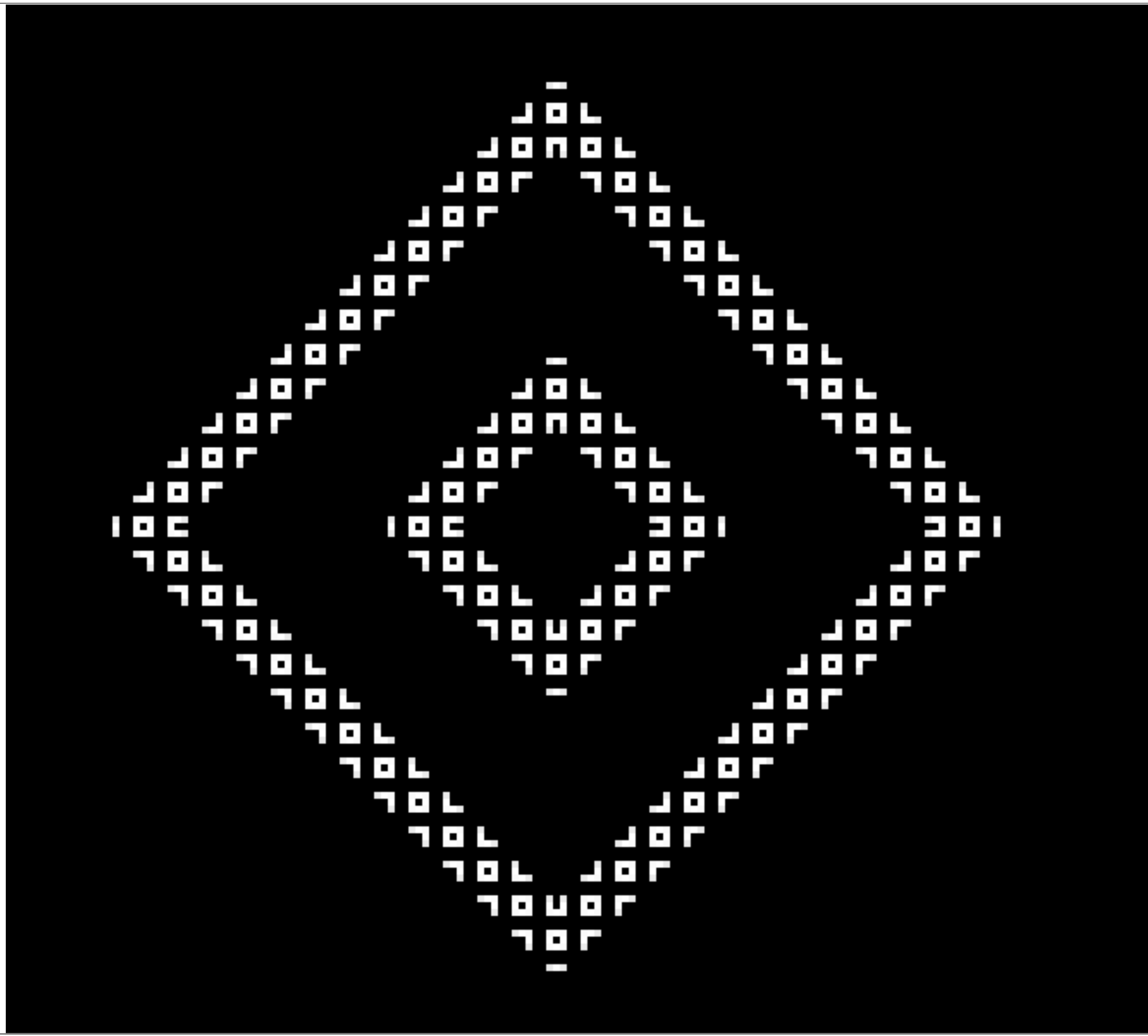


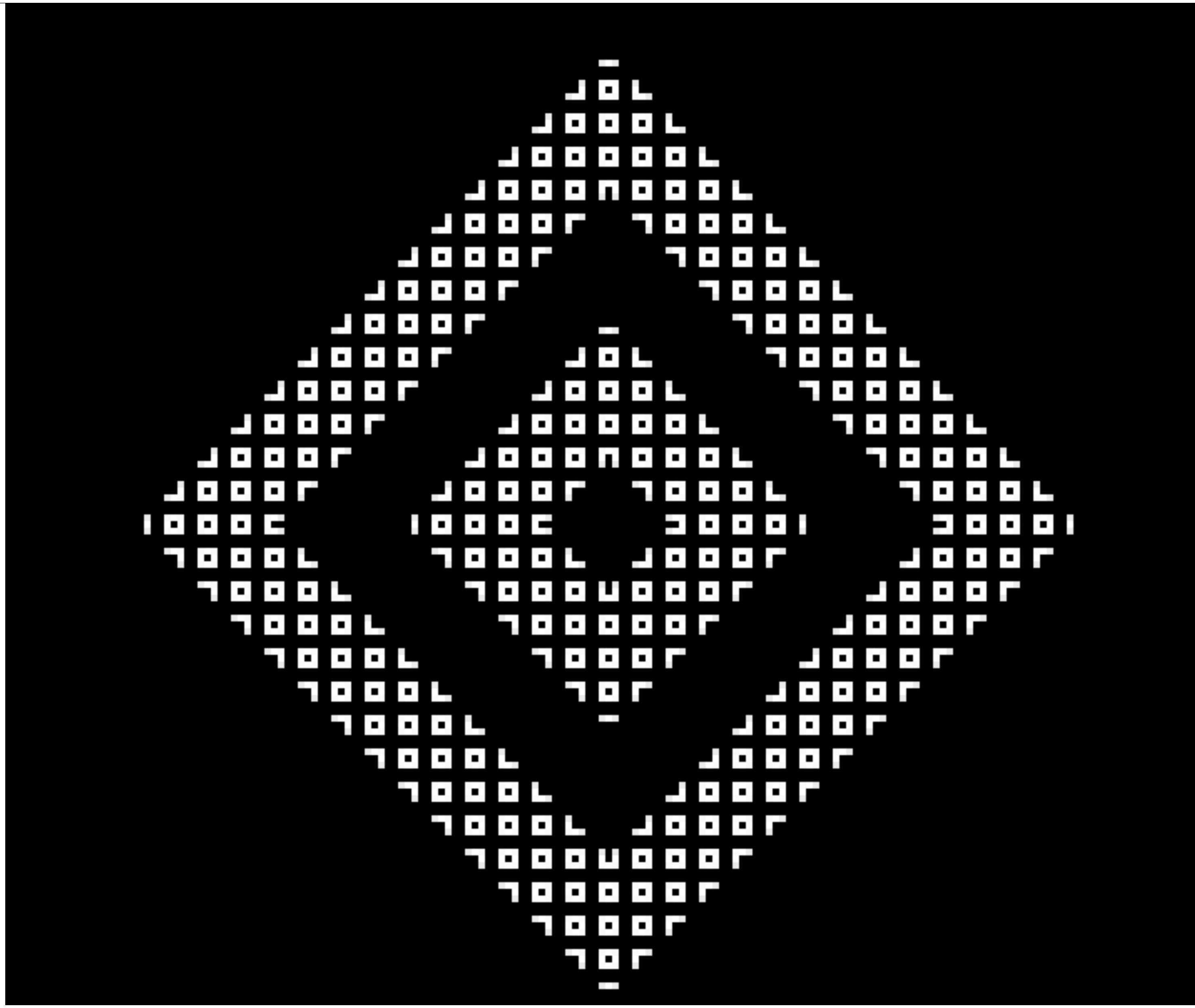


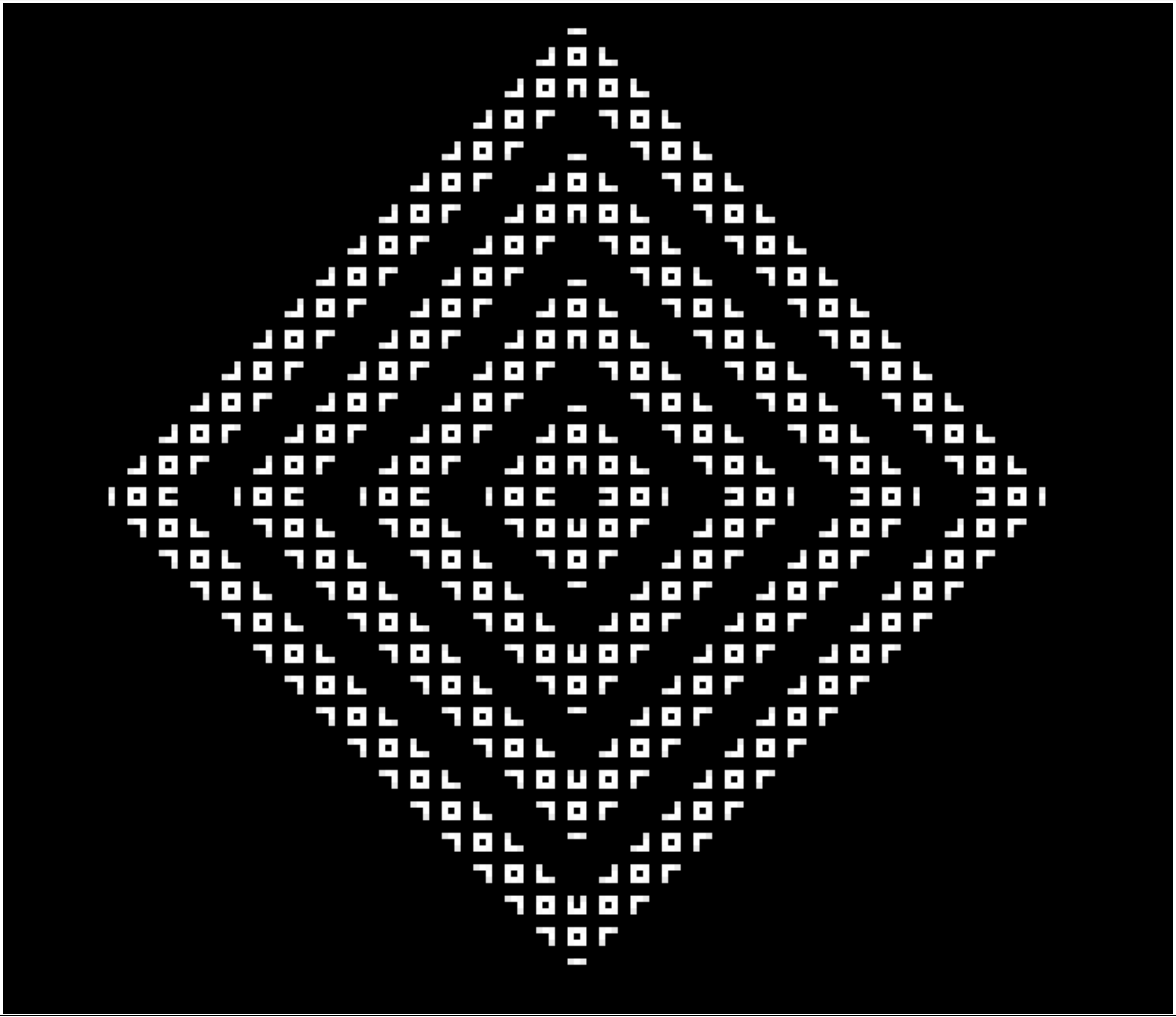


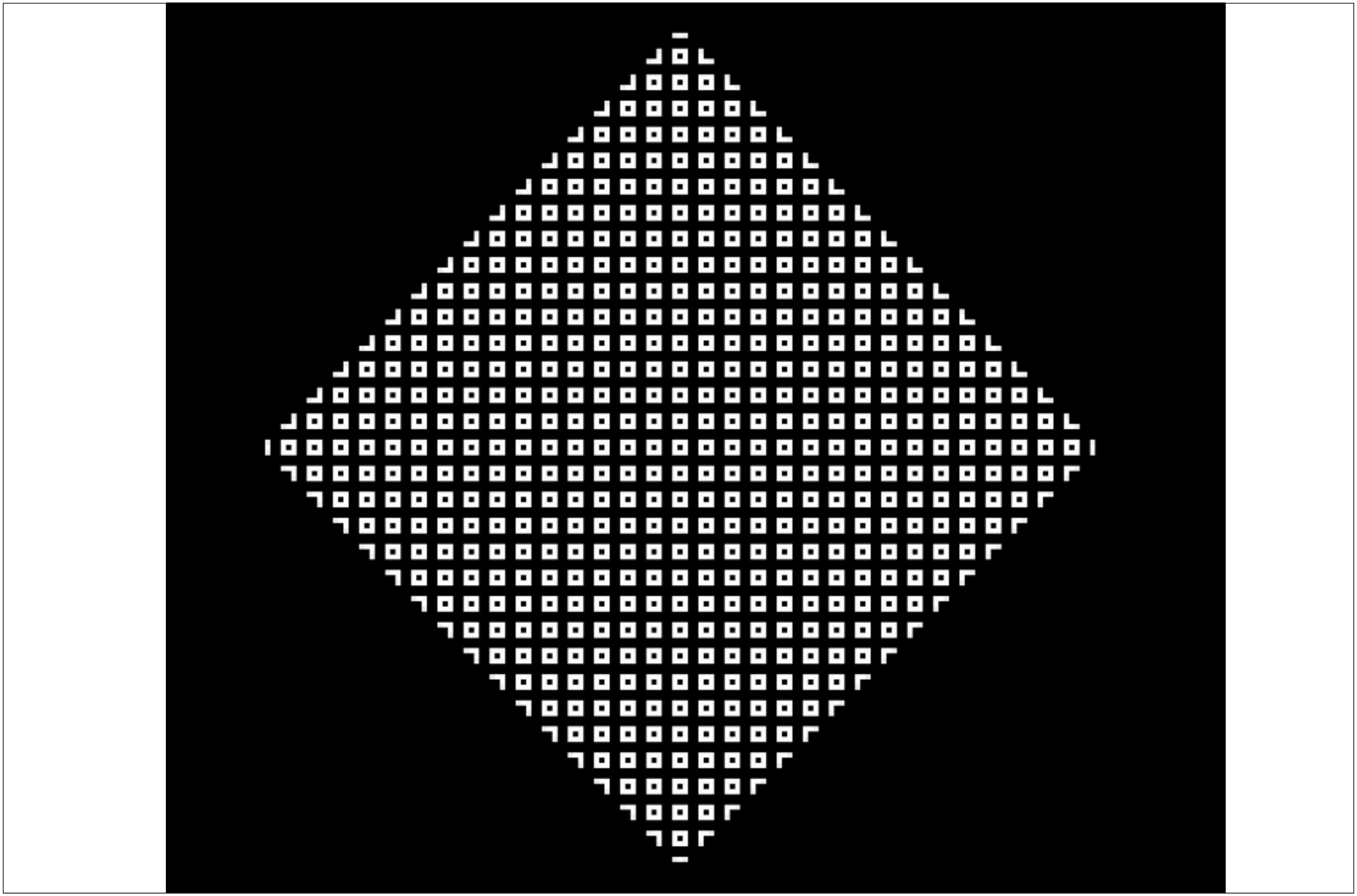












Applications

Here we have studied the simplest examples of recursive distinguishing.
We have kept the examples pure.
The language of distinctions refers to the local distinctions experienced by an occupant of one ‘room’ in the RD lattice.
The new occupants of the lattice are those very elements of language.

We imagine much more complex examples of RD. For example, you can consider any conversation that you have, and how each person transforms the language of the other in a sequence of recursive moves.

So we conclude that the RDs can do elementary mathematical operations, but it may require some extra observations of them to elicit the patterns that are implicit within them.

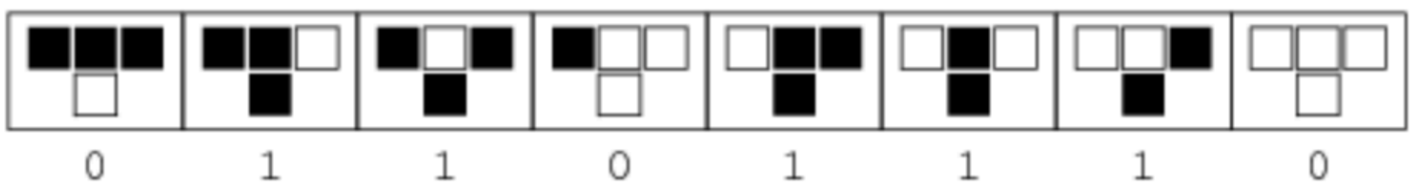
This means that we have to work on this, and use some creativity to figure out how to hook up elementary RDs to make a bigger more conscious entity.

We feel that the balance of language and form that is part of the RD is very important to the design.

But, you say, what about all those cellular automata.
They have a lot of potential applications.
Can you see them as RD?

The answer is YES! Consider the Wolfram Rule 110.

rule 110

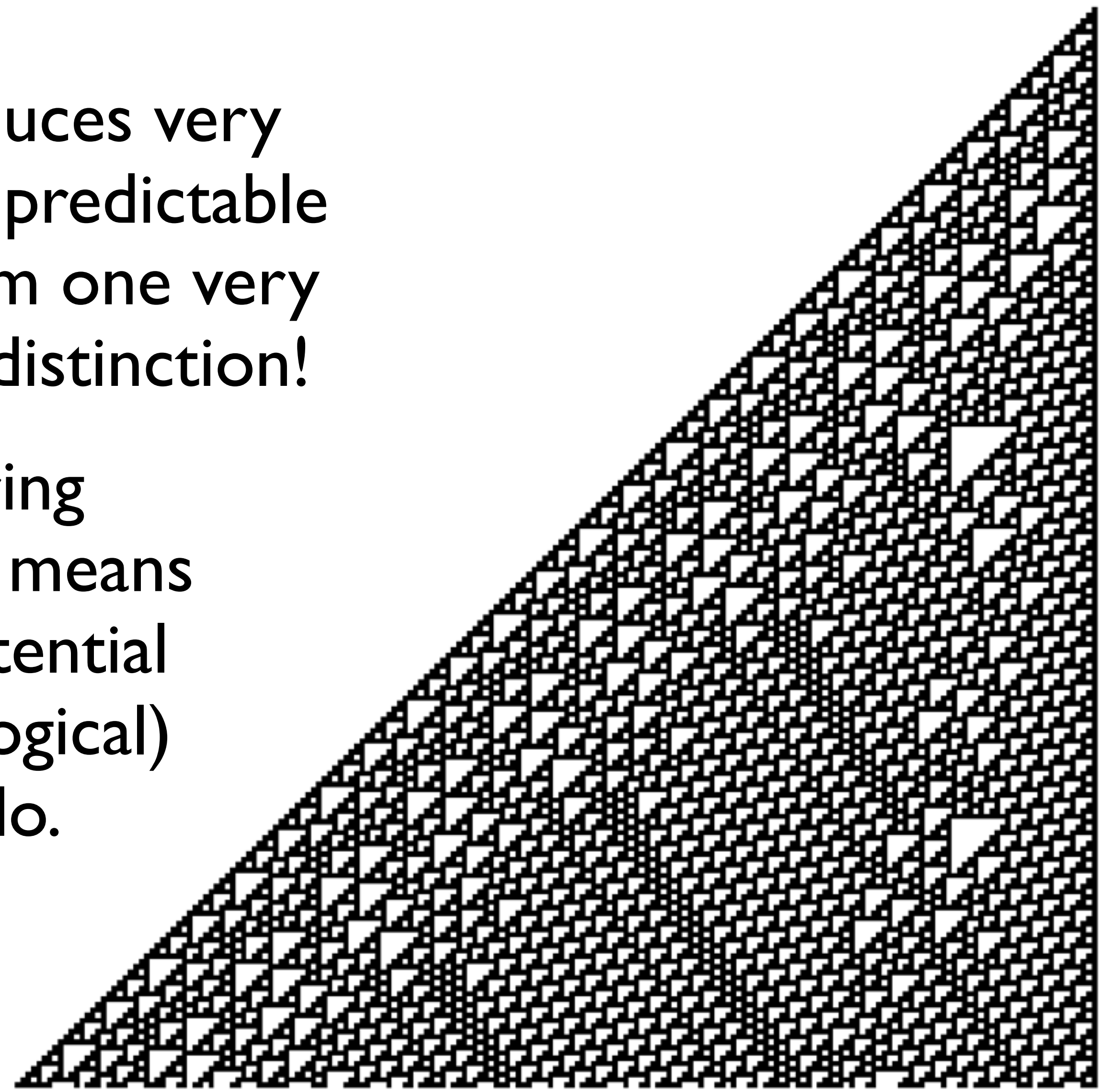


Rule 110 makes a binary distinction on the set of eight binary triples shown above. It assigns 0 to three of them and 1 to the other five.

Once this distinction is in place, one runs this just like our RD except the language is very simple, just 0 and 1, and it always refers to this single distinction.

Rule 110 produces very complex and unpredictable patterns, all from one very assymmetrical distinction!

Rule 110 is Turing Universal, and this means that it has the potential to do what any (logical) machine can do.

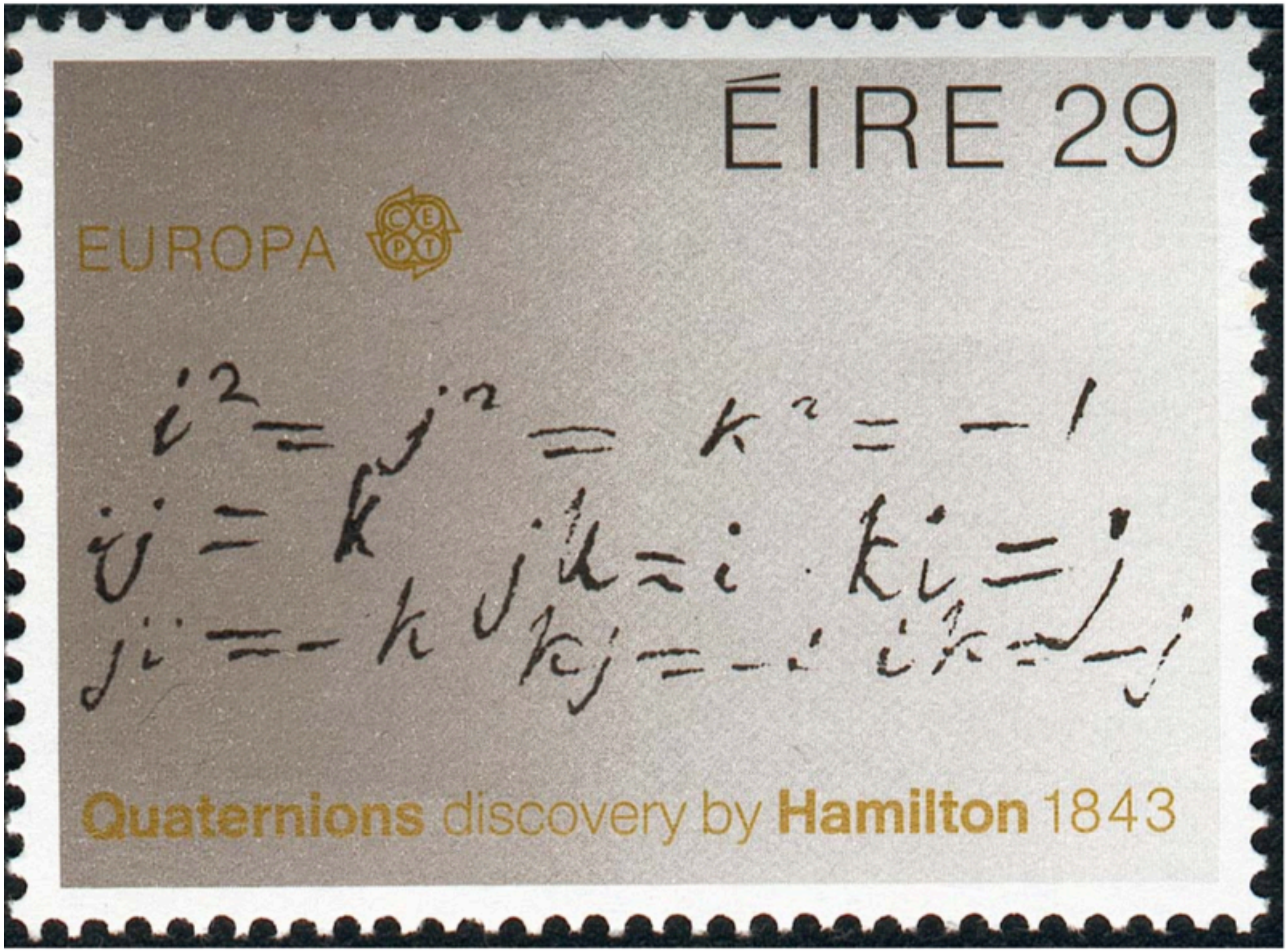


So there is no question that RD has applications.
Many of them already exist but are not often thought about from our point of view.

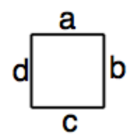
Language $\leftrightarrows$ Distinction

So having found the ground of this way of working, lets get to work!

Quaternions

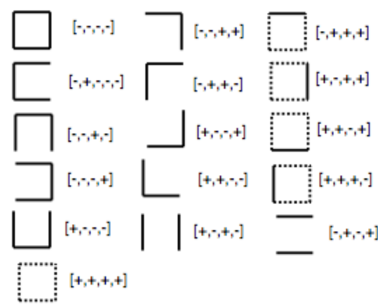


The Logical Underpinnings of the Sixteen Letter Alphabet are related to the structure of SpaceTime and the Quaternions



[a,b,c,d]

Coding and XOR operations for the alphbet.

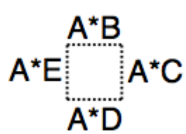


x*y = XOR(x,y) for individual +, - values.
If X and Y are alphabet elements,
let XY denote the XOR of their vectors, and express it as an element of the alphabet.

Then XY is marked exactly when X is different from Y.
Let X*Y denote +1 when X = Y and -1 when X is not equal to Y. Note the -1 corresponds to a dark line.

B
E A C
D

Given this neighbor condition for A in a 2D RD, then A is replaced by the following letter of the alphabet.



In this way, the logical operations determining difference generate this alphabet from the neighbor relations.

It is remarkable that the sixteen-letter alphabet, devised by Isaacson long ago for RD purposes, was rediscovered by Bernd Schmeikal in a spacetime/logic context.

For an account of this (and other references), see the paper

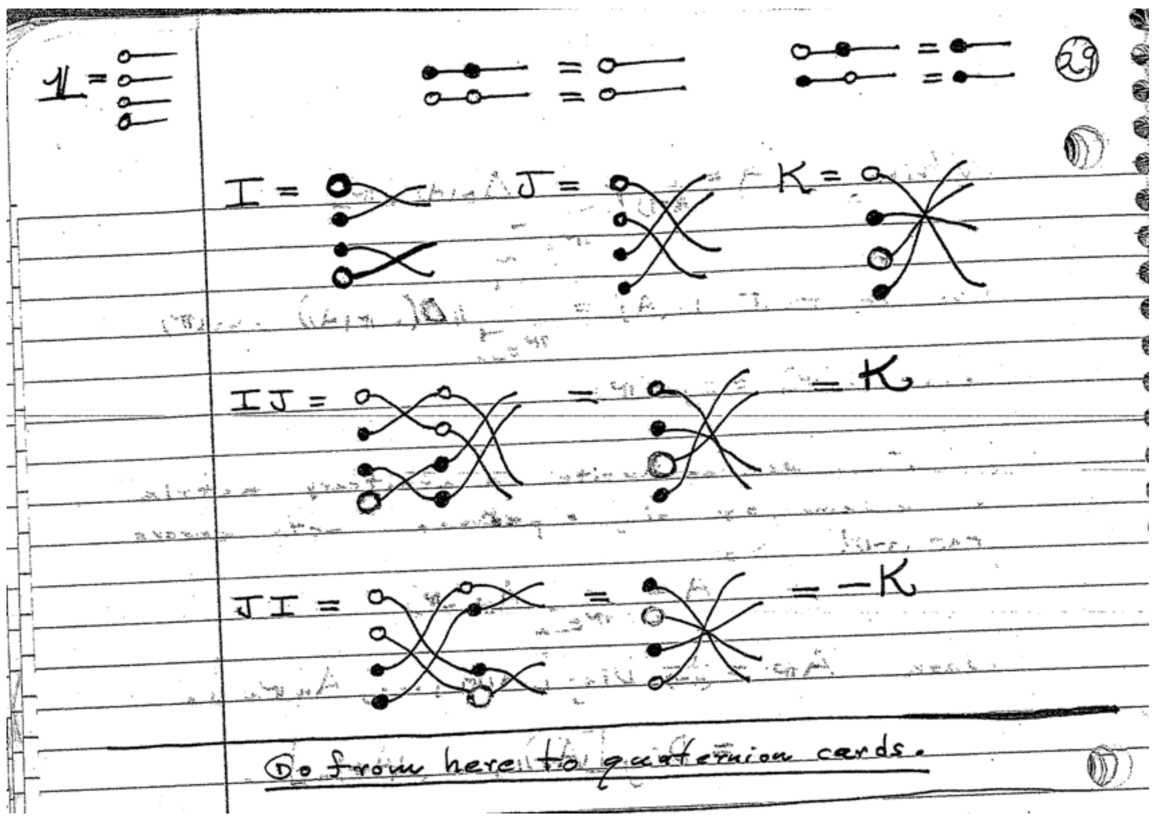
Journal of Space Philosophy 5, no. 1 (Spring 2016)

Basic Intelligence Processing Space By Bernd Schmeikal

The version of the quaternions in relation to the sixteen-letter alphabet shown here is equivalent to an iterant formulation of quaternions due to Kauffman.

Louis H Kauffman, Iterants, Fermions and Majorana Operators. In "Unified Field Mechanics - Natural Science Beyond the Veil of Spacetime," edited by R. Amoroso, L. H. Kauffman, P. Rowlands. World Scientific (2015), pp. 1-32.

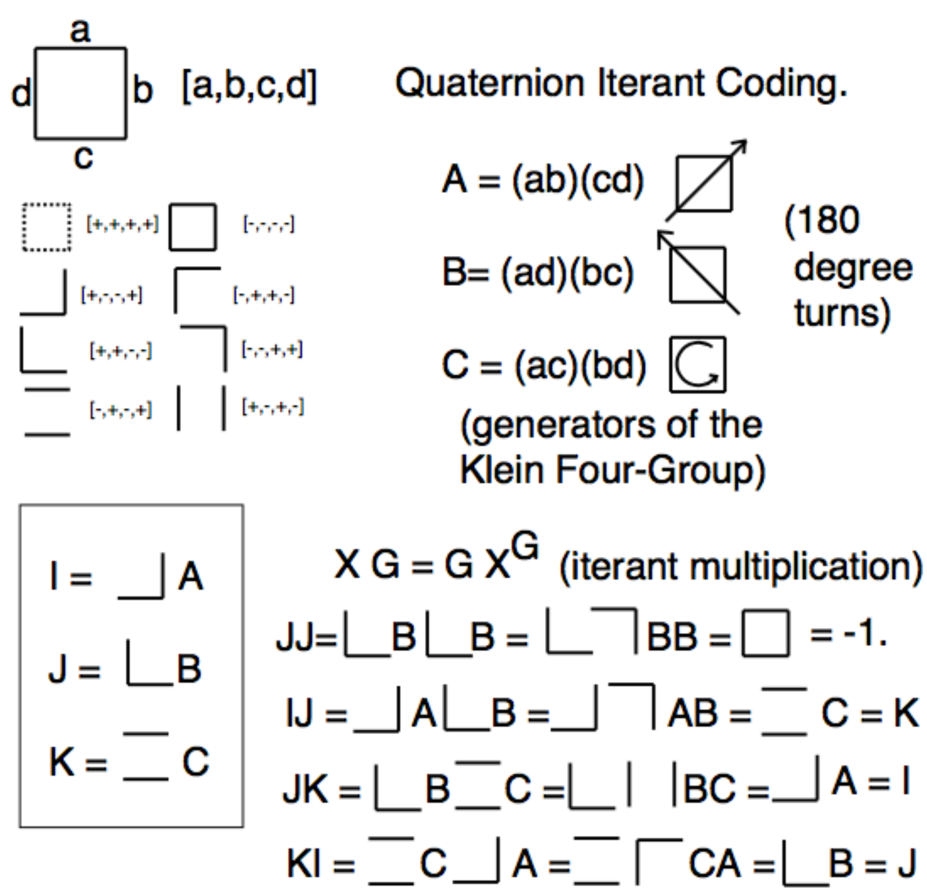
The "Quaternion Card" scheme described here was invented by Kauffman in 1996. See old notes https://dl.dropboxusercontent.com/u/11067256/Hitchlin.pdf



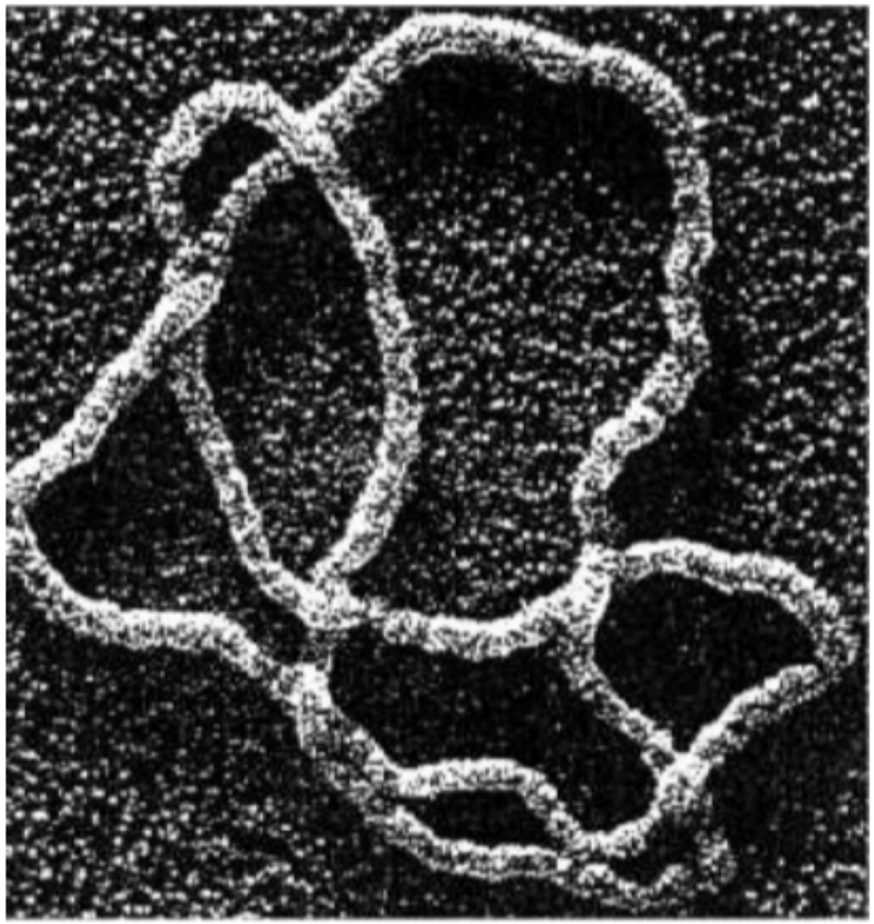
Kauffman made a set of cards with markings at their corners to represent the "iterant" representation of quaternions shown on the previous slide. The idea of using the alphabet was inspired by Isaacson and by Schmeikal.

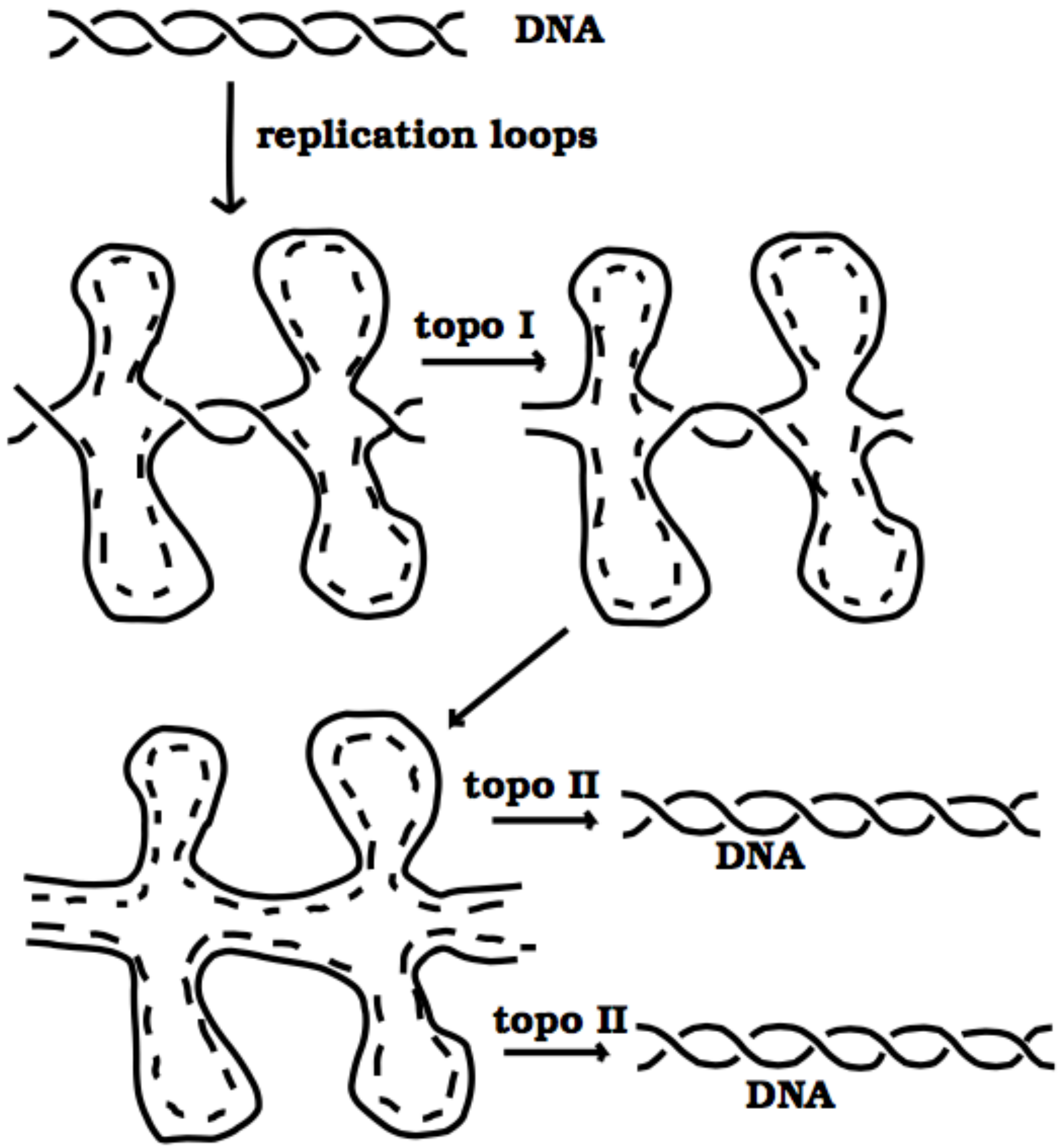
We have the impression that the sixteen-letter alphabet is fundamental and that Bernd Schmeikal's articulation of it in terms of the Clifford algebra of Minkowski spacetime will be significant both for physics and for RD.

This slide shows how the sixteen-letter alphabet can generate the quaternions. We do not explain it here.



DNA Replication and the One-Dimensional Recursive Distinctor




DNA
replication loops
topo I
topo II
DNA
topo II
DNA

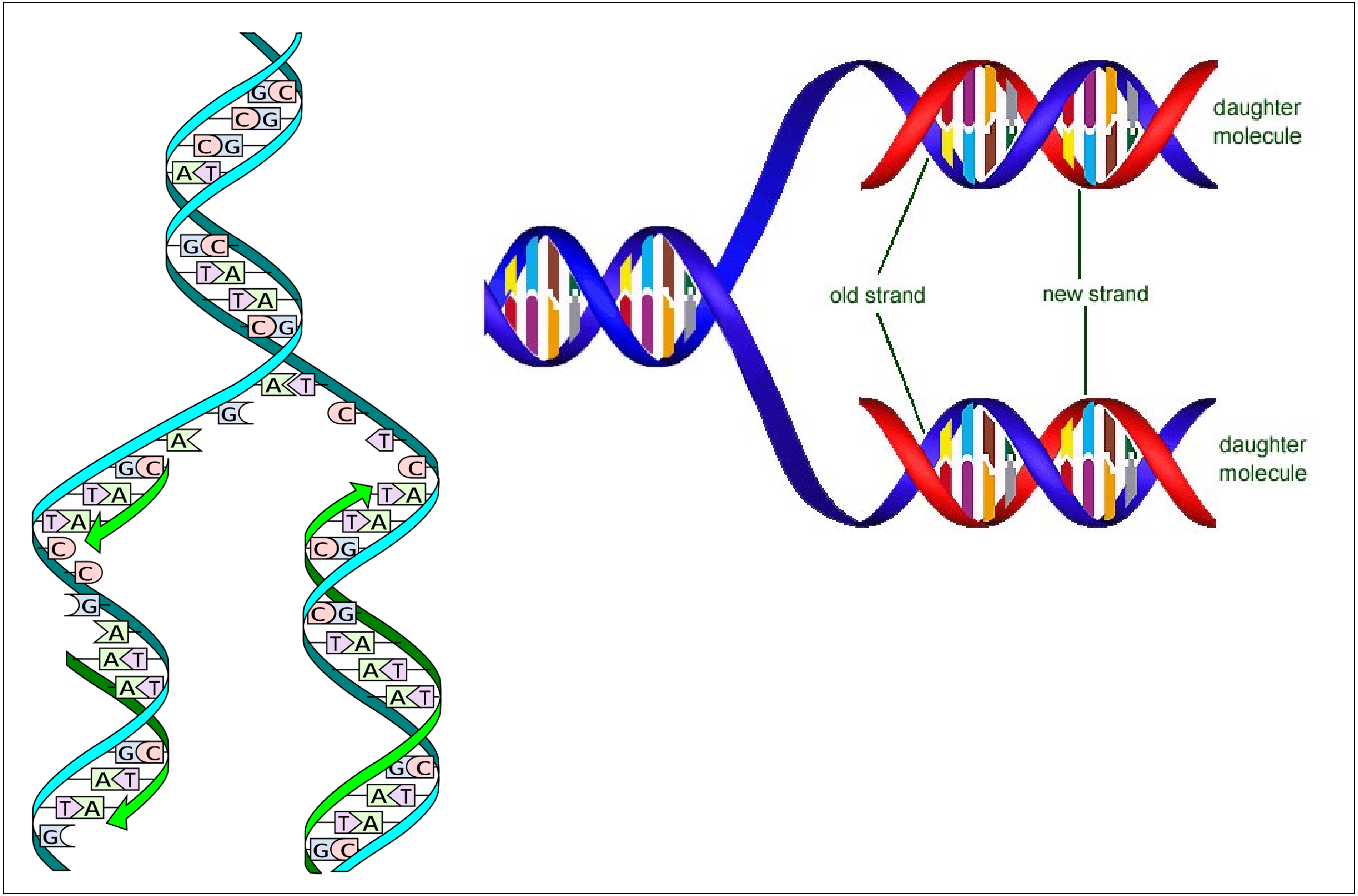
DNA Self-Replication Schema

DNA = |Watson> < Crick|

⟶ |Watson> Environment < Crick|

⟶ |Watson> <Crick| |Watson> < Crick|

⟶ DNA DNA


daughter molecule
old strand
new strand
daughter molecule

RD Self-Replication
is analogous to
DNA Self-Replication.

1. =======]O[======= .

2. ======]OOO[=======

3. =====]O[=]O[======

Recursive distinctioning is a potentially explosive topic whose basic principles apply at all levels of biology, cognition, information science and computation.

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Editors' Notes: Kepler Space Institute (KSI) takes pride in continuing to document the story of Recursive Distinctioning (RD) from its discovery in 1964 by Dr. Joel Isaacson, to his patenting of its characteristics in 1981, to repeated publications in the *Journal of Space Philosophy* beginning with "Nature's Cosmic Intelligence" by Joel Isaacson, in the Fall 2012 issue, followed by the Special Science issue on Recursive Distinctioning, Spring 2015, the Fall 2016 issue, and now this Fall 2017 issue. KSI has sponsored three annual RD conferences by the RD Science Team in 2015, 2016 and 2017.

This article brings readers up to date on the RD presentations at the International Space Development Conference in St. Louis, May 2017. *Bob Krone and Gordon Arthur*.