

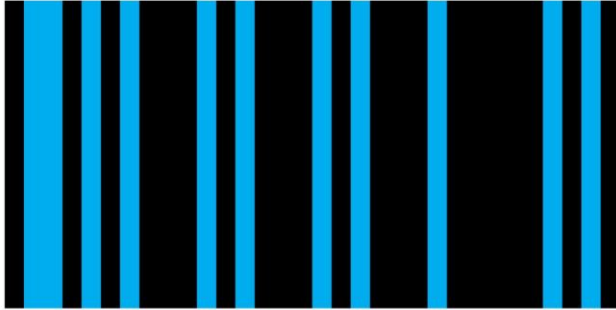
Crating the Snake and Releasing the Geese

Margaret Kepner

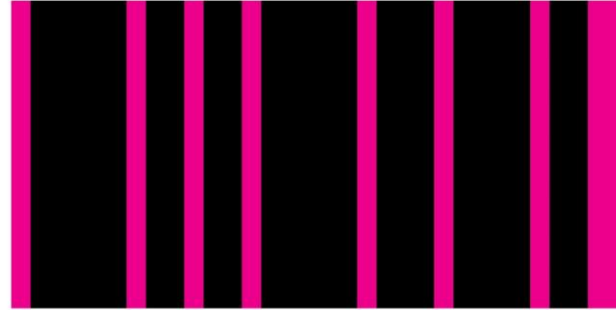
Second Acts

Snake in a Crate - At Bridges 2018, I exhibited a “snake” book, consisting of a long strip of printed paper, which can be coiled up for compactness. The subject matter of the book is the distributions and overlaps of four integer sequences from 1 up to 512, as expressed in colored stripes. Recently, I investigated ways to pack the content of the striped snake book into a 2D square box (or crate), while preserving mathematical integrity and creating visual interest.

Prime



Happy



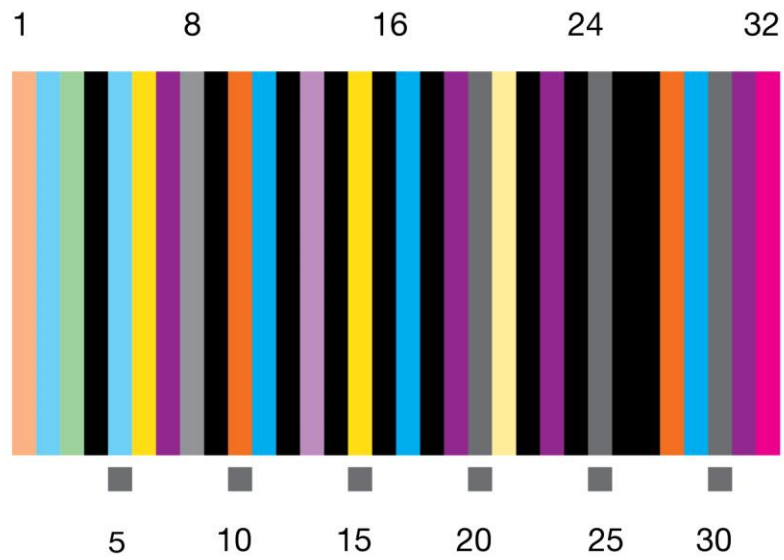
Triangular



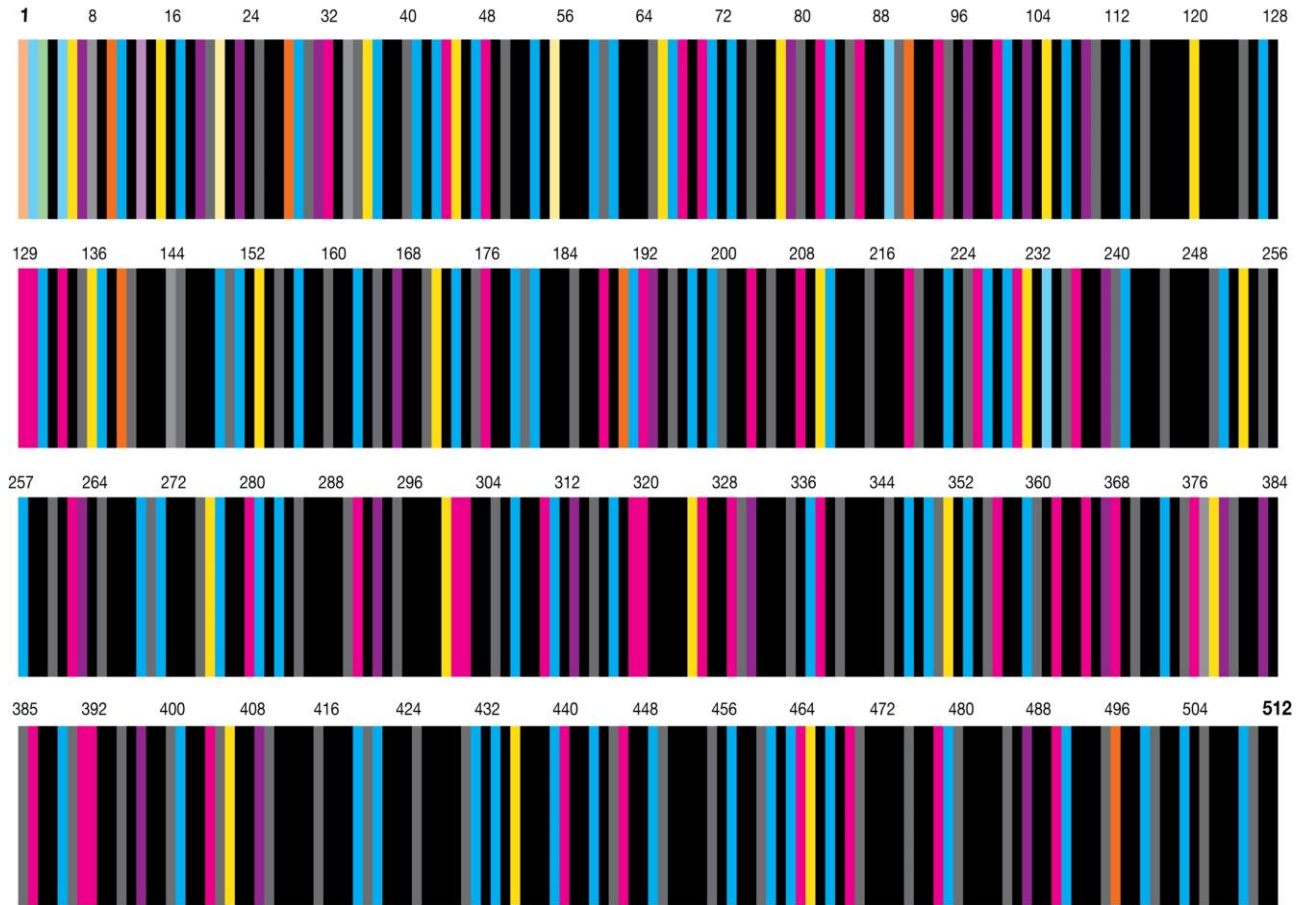
Fibonacci



Four Integer Sequences from 1 to 32



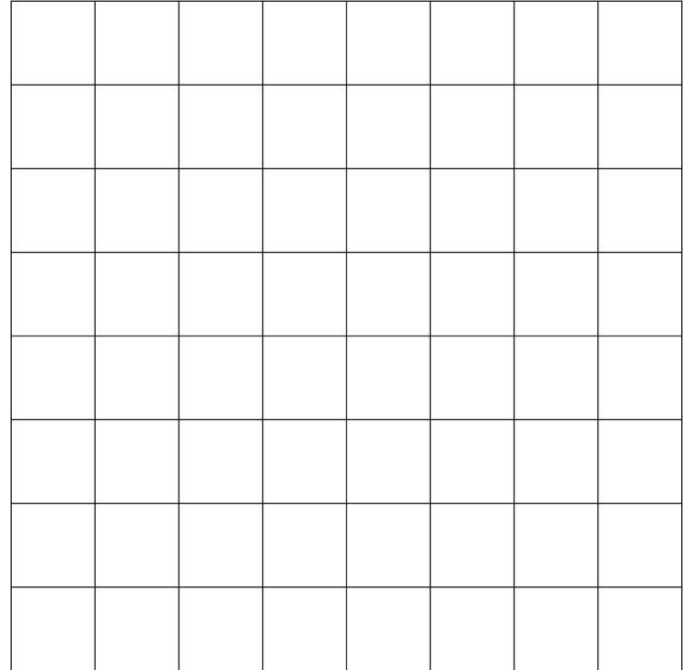
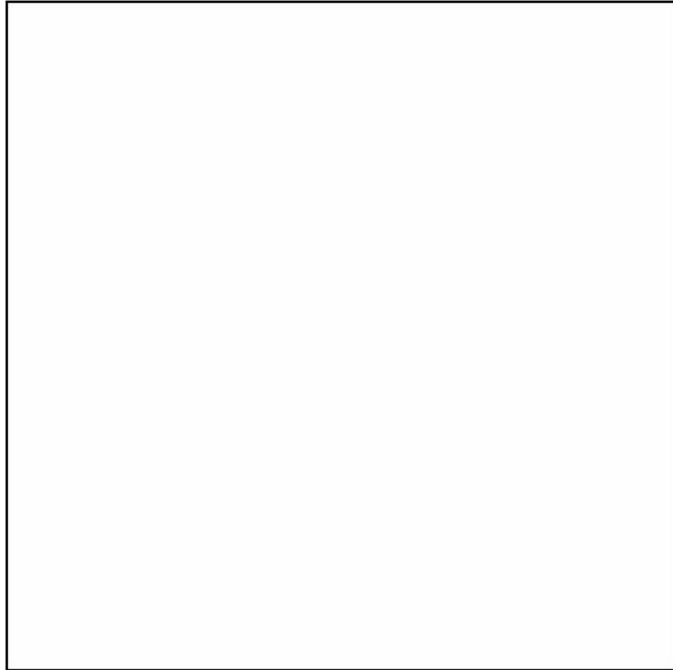
Four Integer Sequences Combined (from 1 to 32)



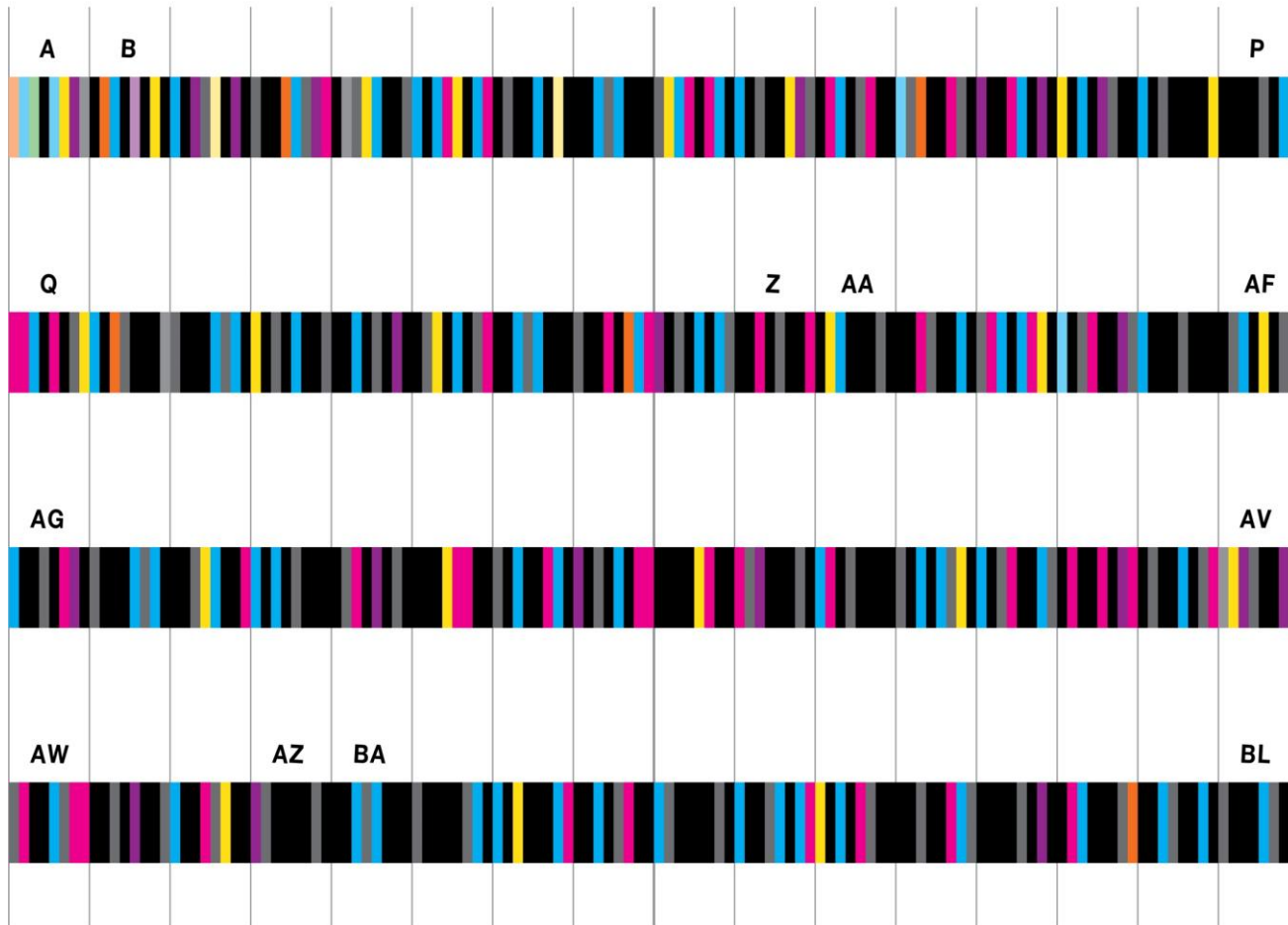
Four Integer Sequences Combined (from 1 to 512)



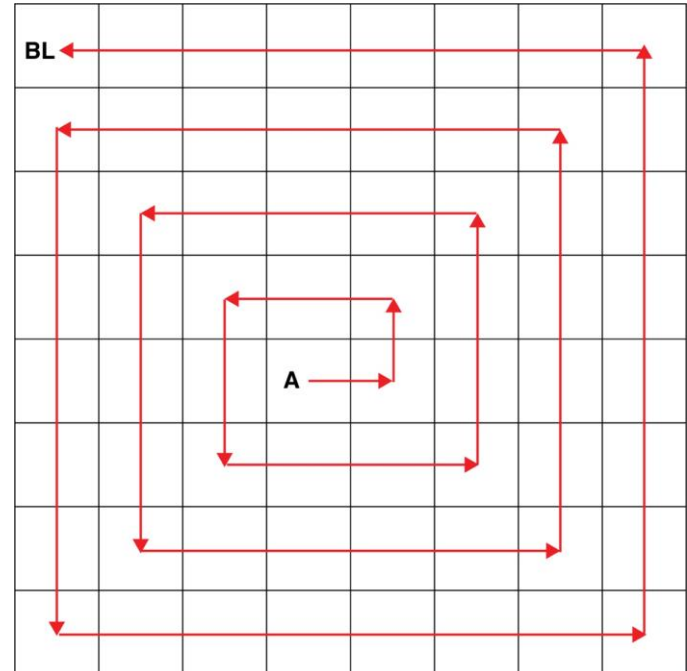
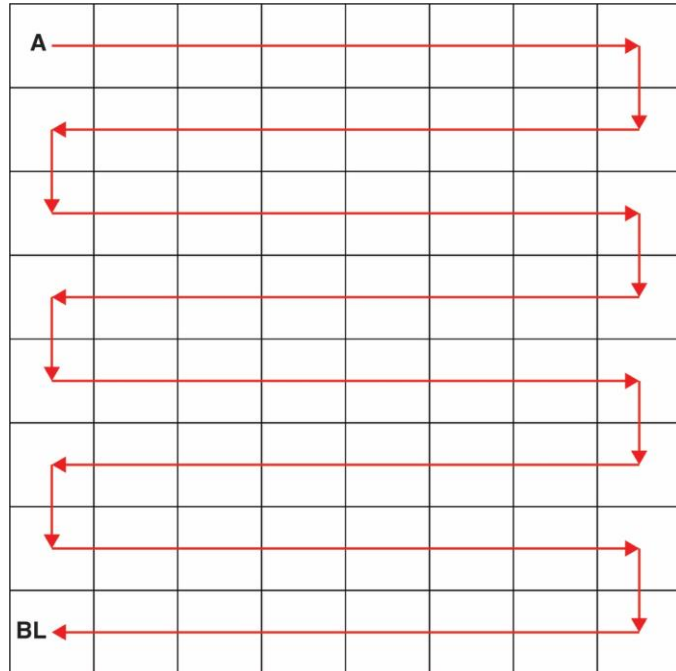
Gene Sequencing, Artist's Book, Bridges 2018



Crate and Subdivided Crate



Four Integer Sequences Combined (from 1 to 512), Scaled and Sliced



Two Path Layouts from Square A to Square BL

AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX
AK	AK	AK	AK	AK	AK	AK	AK	AK	AK	AK	AK	AK
AO	AO	AO	AO	AO	AO	AO	AO	AO	AO	AO	AO	AO
AM	AM	AM	AM	AM	AM	AM	AM	AM	AM	AM	AM	AM
AK	AK	AK	AK	AK	AK	AK	AK	AK	AK	AK	AK	AK
AL	AL	AL	AL	AL	AL	AL	AL	AL	AL	AL	AL	AL
AM	AM	AM	AM	AM	AM	AM	AM	AM	AM	AM	AM	AM
AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN
AO	AO	AO	AO	AO	AO	AO	AO	AO	AO	AO	AO	AO
AP	AP	AP	AP	AP	AP	AP	AP	AP	AP	AP	AP	AP
AQ	AQ	AQ	AQ	AQ	AQ	AQ	AQ	AQ	AQ	AQ	AQ	AQ
AR	AR	AR	AR	AR	AR	AR	AR	AR	AR	AR	AR	AR
AS	AS	AS	AS	AS	AS	AS	AS	AS	AS	AS	AS	AS
AT	AT	AT	AT	AT	AT	AT	AT	AT	AT	AT	AT	AT
AU	AU	AU	AU	AU	AU	AU	AU	AU	AU	AU	AU	AU
AV	AV	AV	AV	AV	AV	AV	AV	AV	AV	AV	AV	AV
AW	AW	AW	AW	AW	AW	AW	AW	AW	AW	AW	AW	AW
AX	AX	AX	AX	AX	AX	AX	AX	AX	AX	AX	AX	AX
AY	AY	AY	AY	AY	AY	AY	AY	AY	AY	AY	AY	AY
AZ	AZ	AZ	AZ	AZ	AZ	AZ	AZ	AZ	AZ	AZ	AZ	AZ
BA	BA	BA	BA	BA	BA	BA	BA	BA	BA	BA	BA	BA
BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB
BC	BC	BC	BC	BC	BC	BC	BC	BC	BC	BC	BC	BC
BD	BD	BD	BD	BD	BD	BD	BD	BD	BD	BD	BD	BD
BE	BE	BE	BE	BE	BE	BE	BE	BE	BE	BE	BE	BE
BF	BF	BF	BF	BF	BF	BF	BF	BF	BF	BF	BF	BF
BG	BG	BG	BG	BG	BG	BG	BG	BG	BG	BG	BG	BG
BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH	BH
BI	BI	BI	BI	BI	BI	BI	BI	BI	BI	BI	BI	BI
BJ	BJ	BJ	BJ	BJ	BJ	BJ	BJ	BJ	BJ	BJ	BJ	BJ
BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK
BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL	BL

Square Spiral Layout from Square A to BL

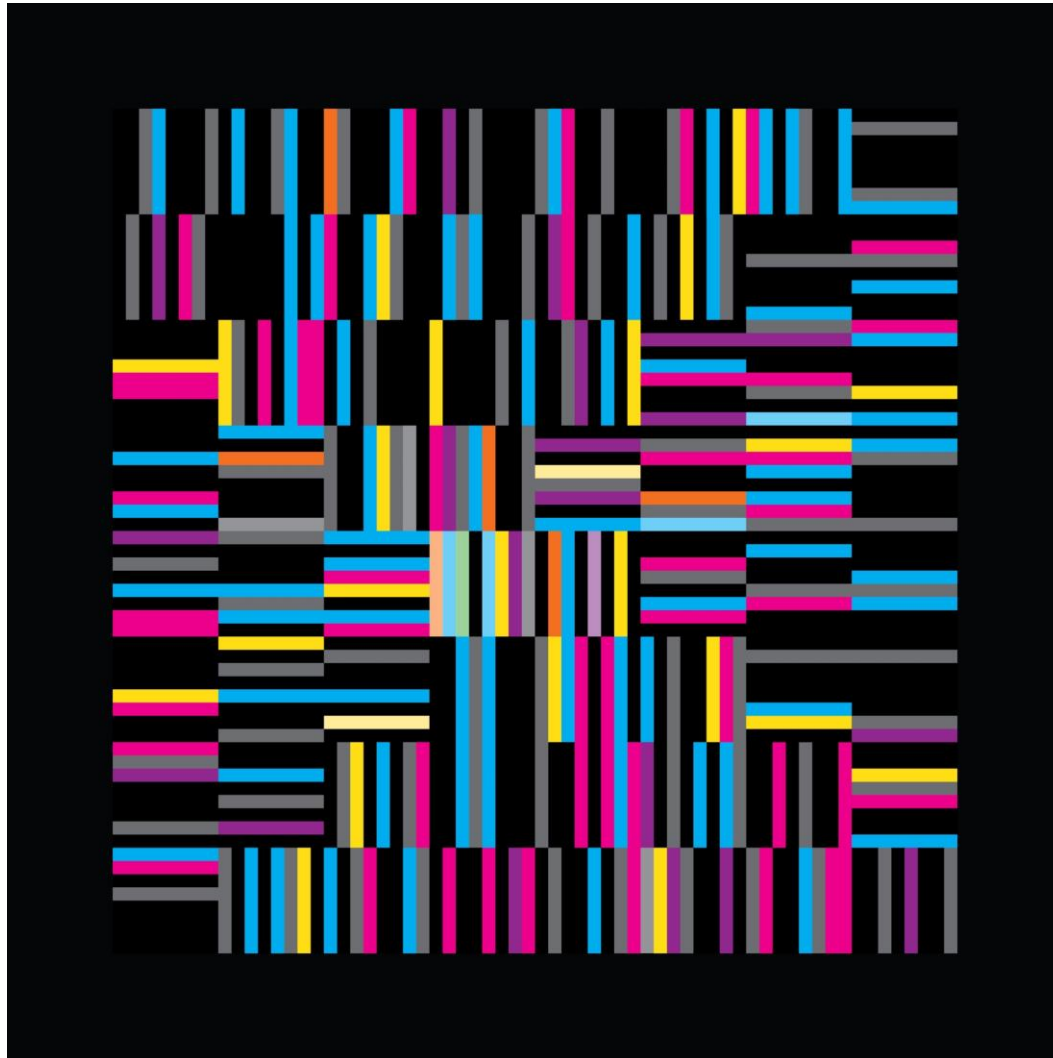
RL	BK	BL	BI	BH	BG	BF	BE
RK	LK	AK	AH	AG	AF	AE	BD
AL	LO	PO	NO	NZ	MZ	AD	BC
AM	RL	RE	RO	CO	LI	AC	BB
AN	SL	FL	VL	KL	AB	AB	BA
AQ	TL	BL	HL	KL	AA	AA	AZ
AP	UL	VL	WL	XL	YL	ZL	AY
AQ	AR	AS	AT	AU	AV	AW	AX

RL	BK	BL	BI	BH	BG	BF	BE
RK	LK	AK	AH	AG	AF	AE	BD
AL	LO	PO	NO	NZ	MZ	AD	BC
AM	RL	RE	RO	CO	LI	AC	BB
AN	SL	FL	VL	KL	AB	AB	BA
AQ	TL	BL	HL	KL	AA	AA	AZ
AP	UL	VL	WL	XL	YL	ZL	AY
AQ	AR	AS	AT	AU	AV	AW	AX

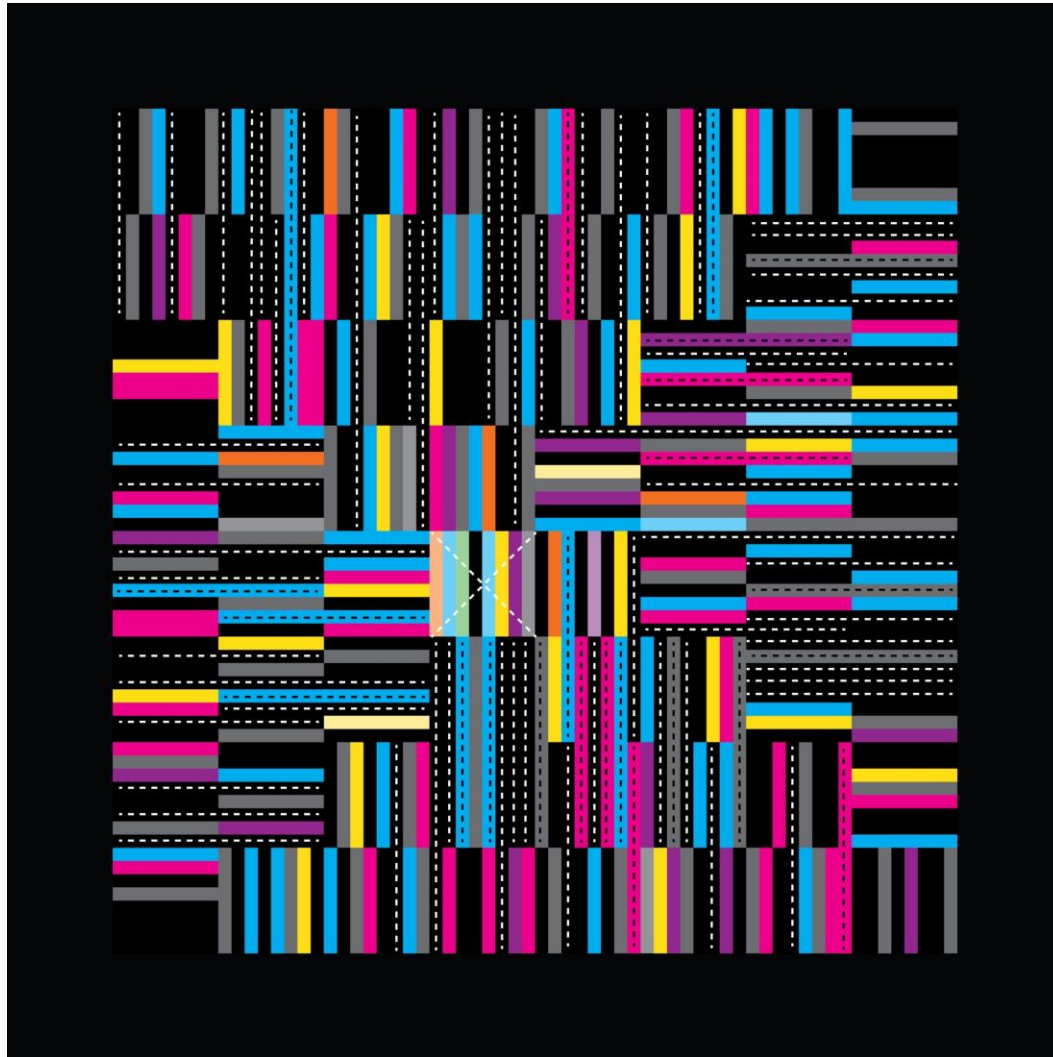
RL	BK	BL	BI	BH	BG	BF	BE
RK	LK	AK	AH	AG	AF	AE	BD
AL	LO	PO	NO	NZ	MZ	AD	BC
AM	RL	RE	RO	CO	LI	AC	BB
AN	SL	FL	VL	KL	AB	AB	BA
AQ	TL	BL	HL	KL	AA	AA	AZ
AP	UL	VL	WL	XL	YL	ZL	AY
AQ	AR	AS	AT	AU	AV	AW	AX

RL	BK	BL	BI	BH	BG	BF	BE
RK	LK	AK	AH	AG	AF	AE	BD
AL	LO	PO	NO	NZ	MZ	AD	BC
AM	RL	RE	RO	CO	LI	AC	BB
AN	SL	FL	VL	KL	AB	AB	BA
AQ	TL	BL	HL	KL	AA	AA	AZ
AP	UL	VL	WL	XL	YL	ZL	AY
AQ	AR	AS	AT	AU	AV	AW	AX

Square Spiral Layout from 1 to 512



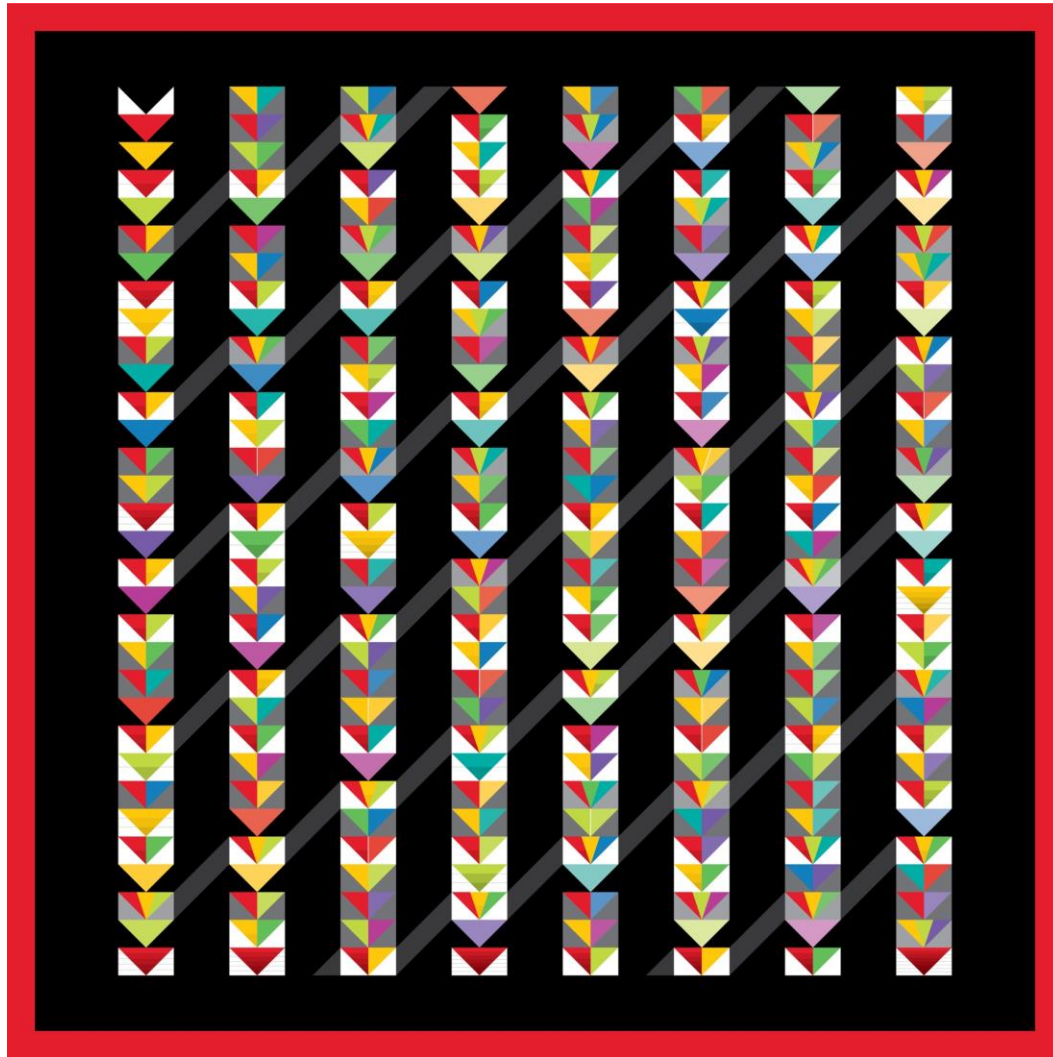
Snake in a Crate, JMM 2026



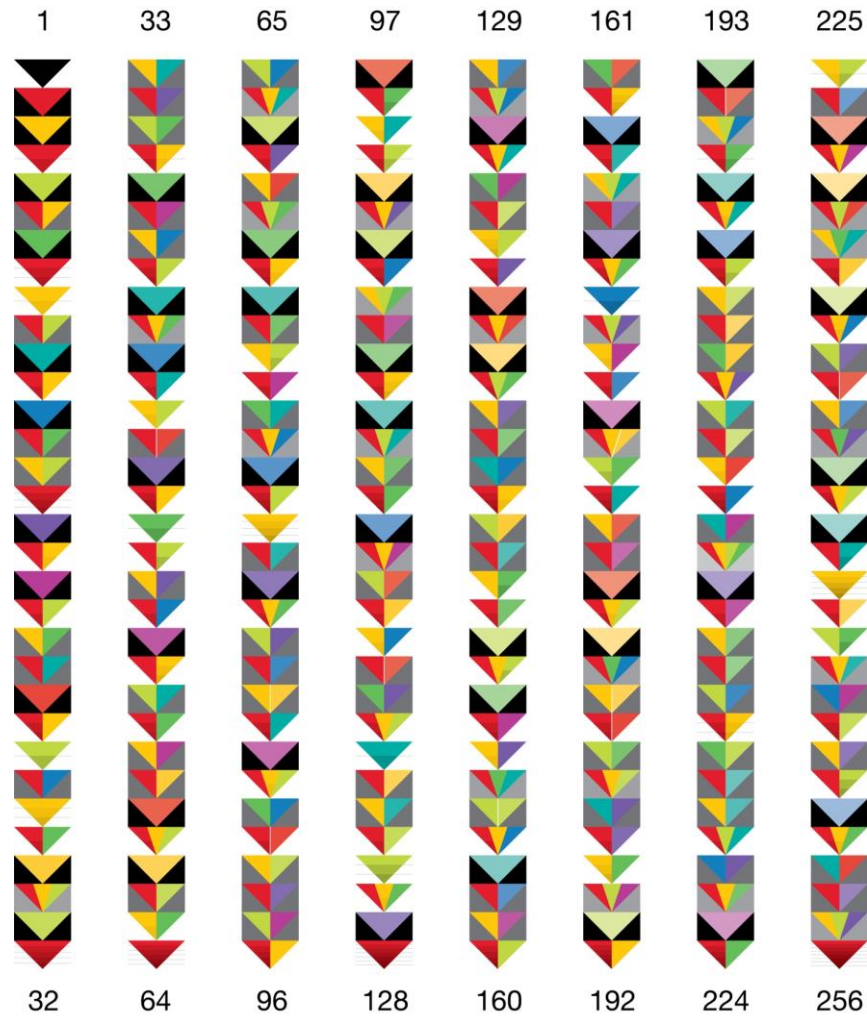
Snake in a Crate with Top Stitching

Second Acts (continued)

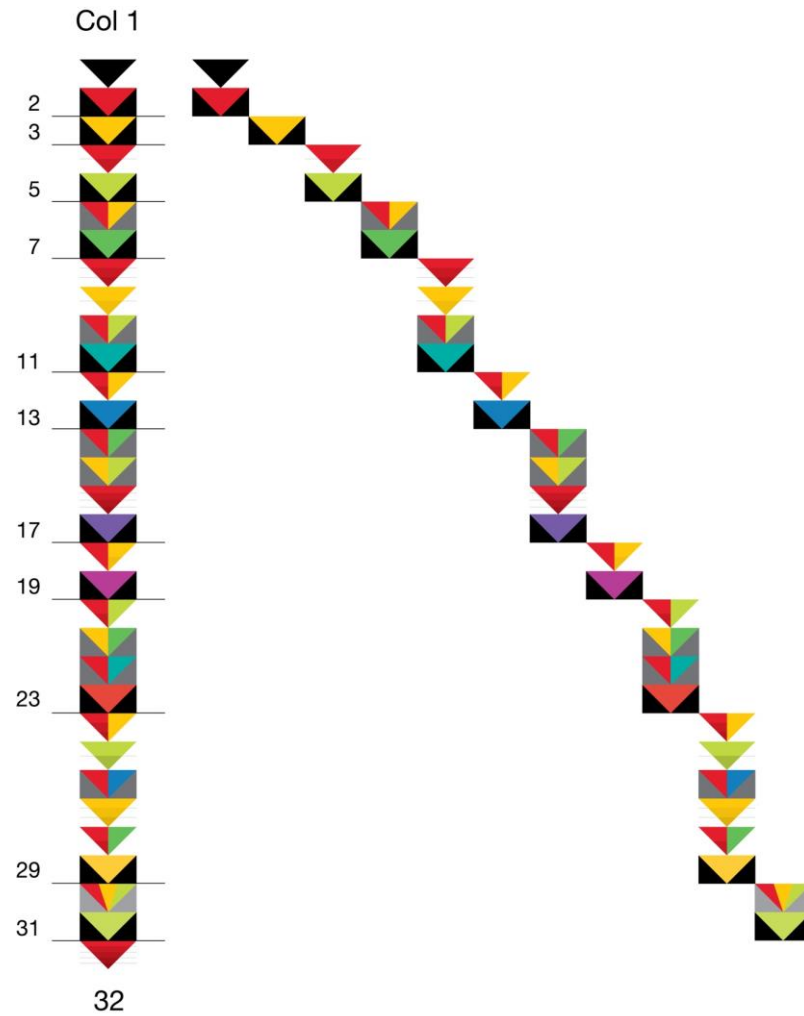
Release the Geese - For this piece, I began with an artwork that was shown at Bridges 2011. In the original design, right triangles are displayed in eight columns echoing the format of a traditional “Wild Goose Chase” quilt. Each right triangle (or goose) represents an integer from 1 to 256, and shows the decomposition of the integer into prime factors using sub-shapes and color coding. I explored what happens if I let the primes themselves determine the layout. In a surprise to me, the geese took off!



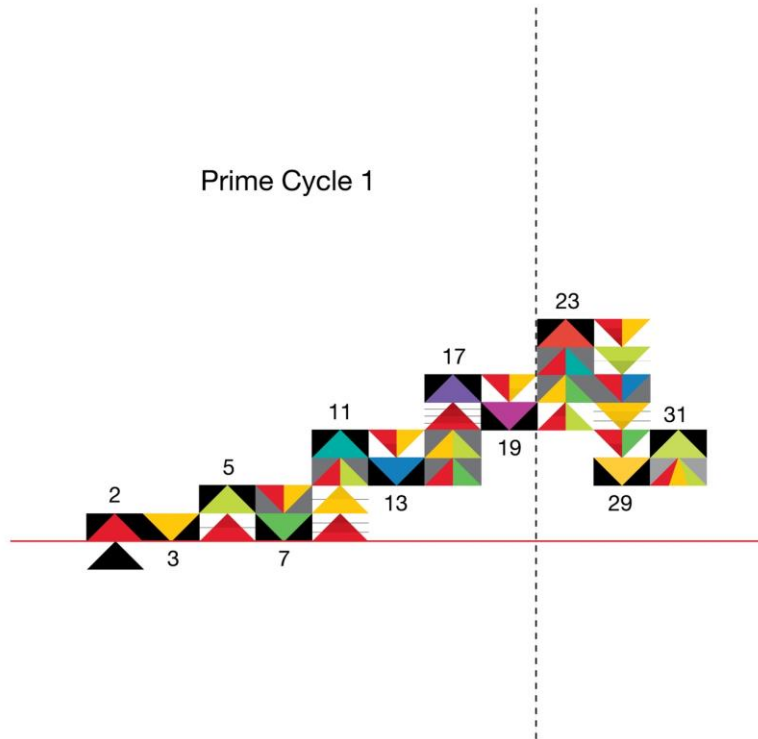
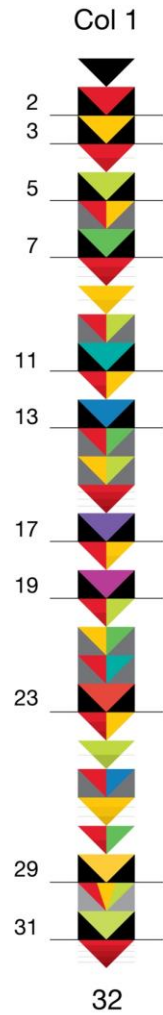
Prime Goose Chase, Bridges 2011



Columns from **Prime Goose Chase**

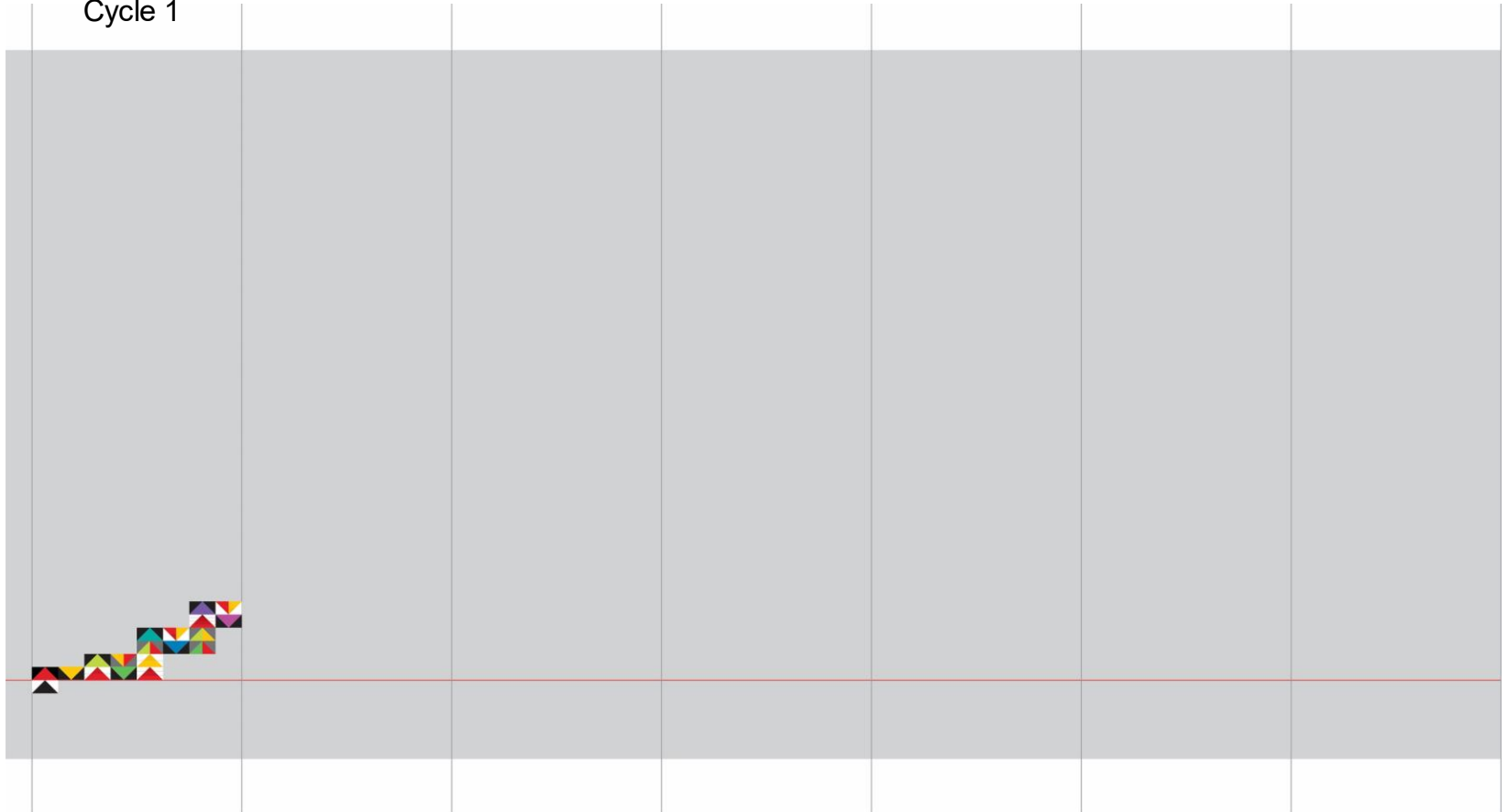


Column 1 from **Prime Goose Chase**

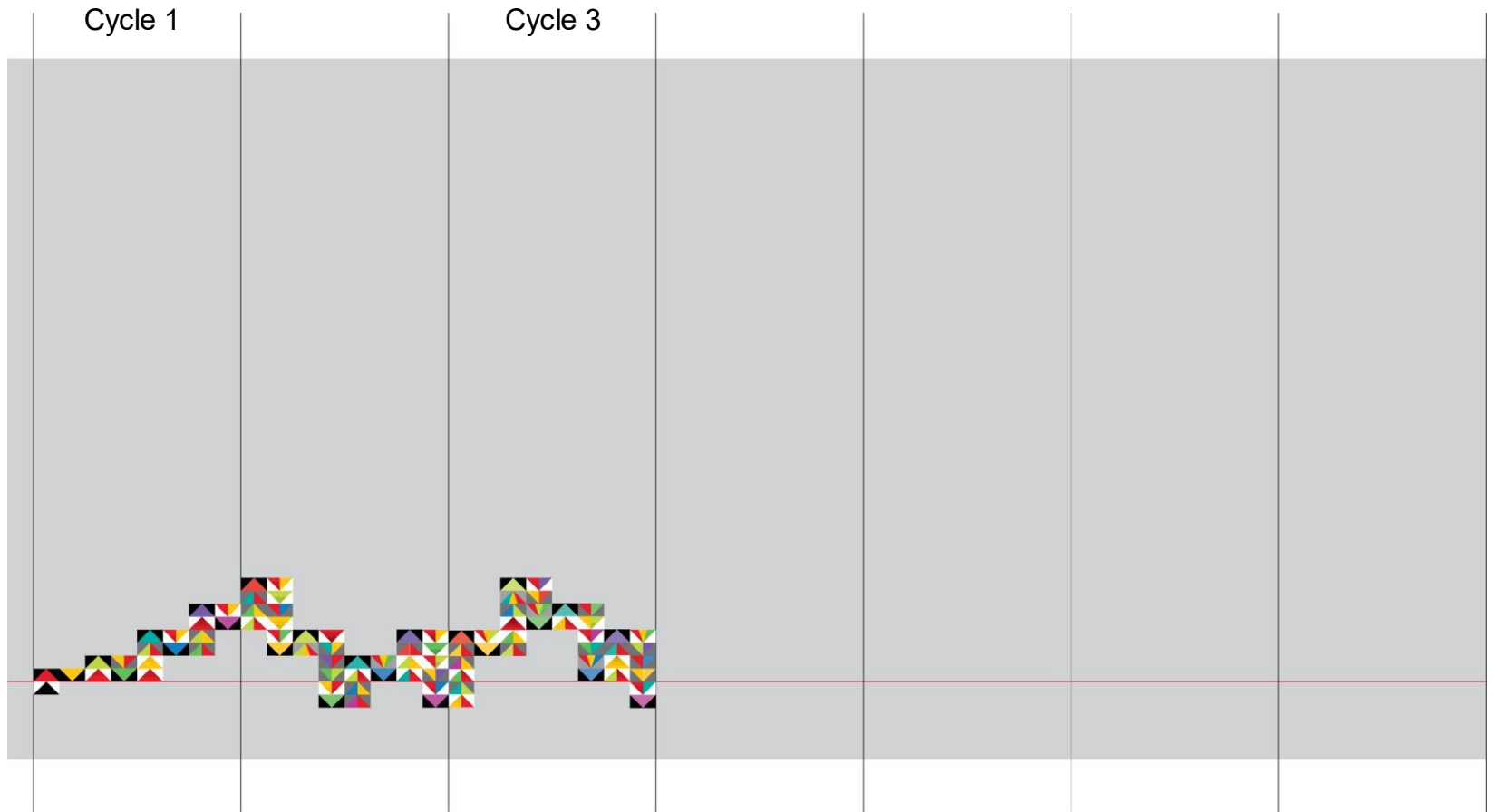


Column 1 from **Prime Goose Chase**, Sliced and Reassembled

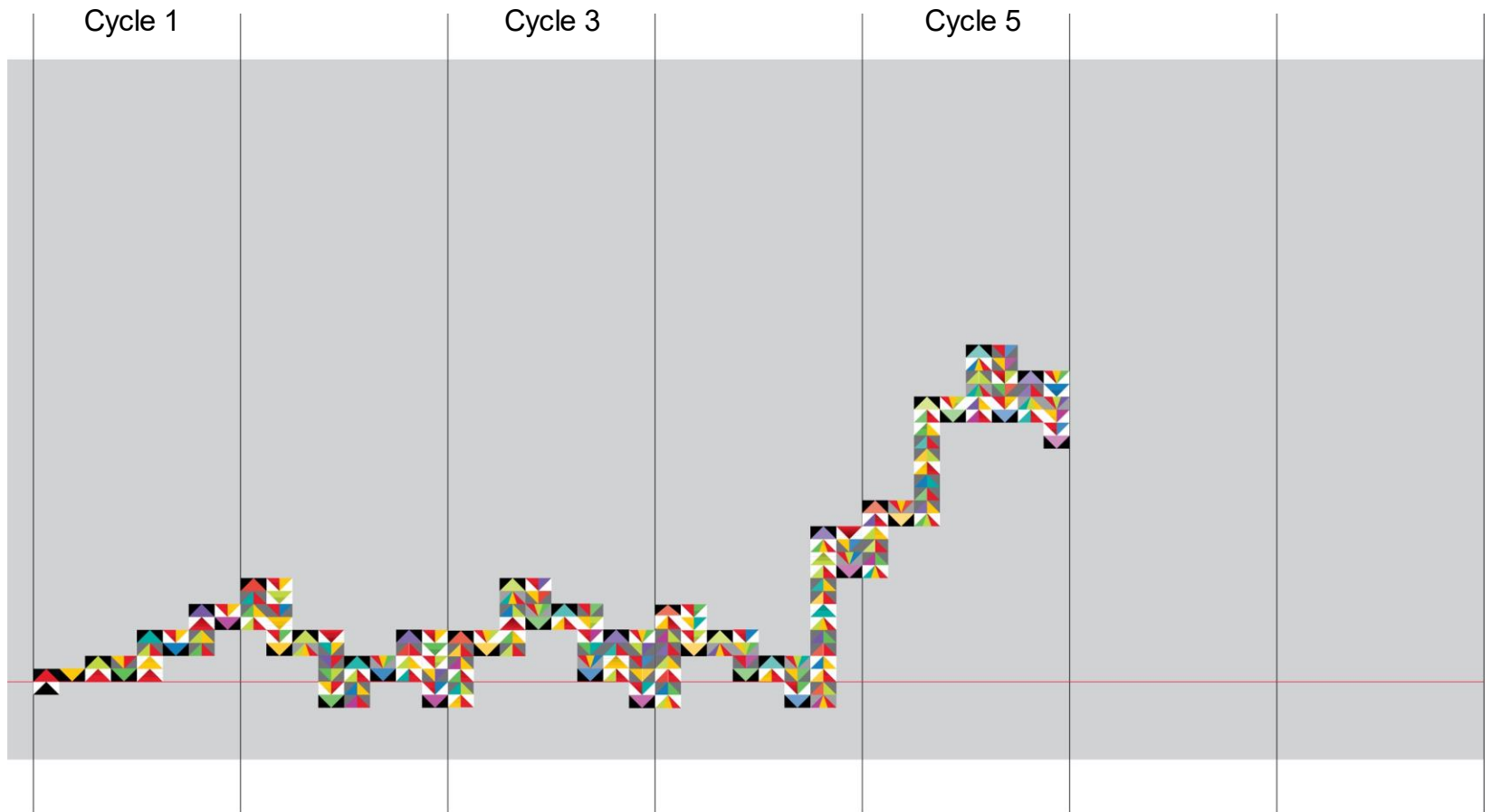
Cycle 1



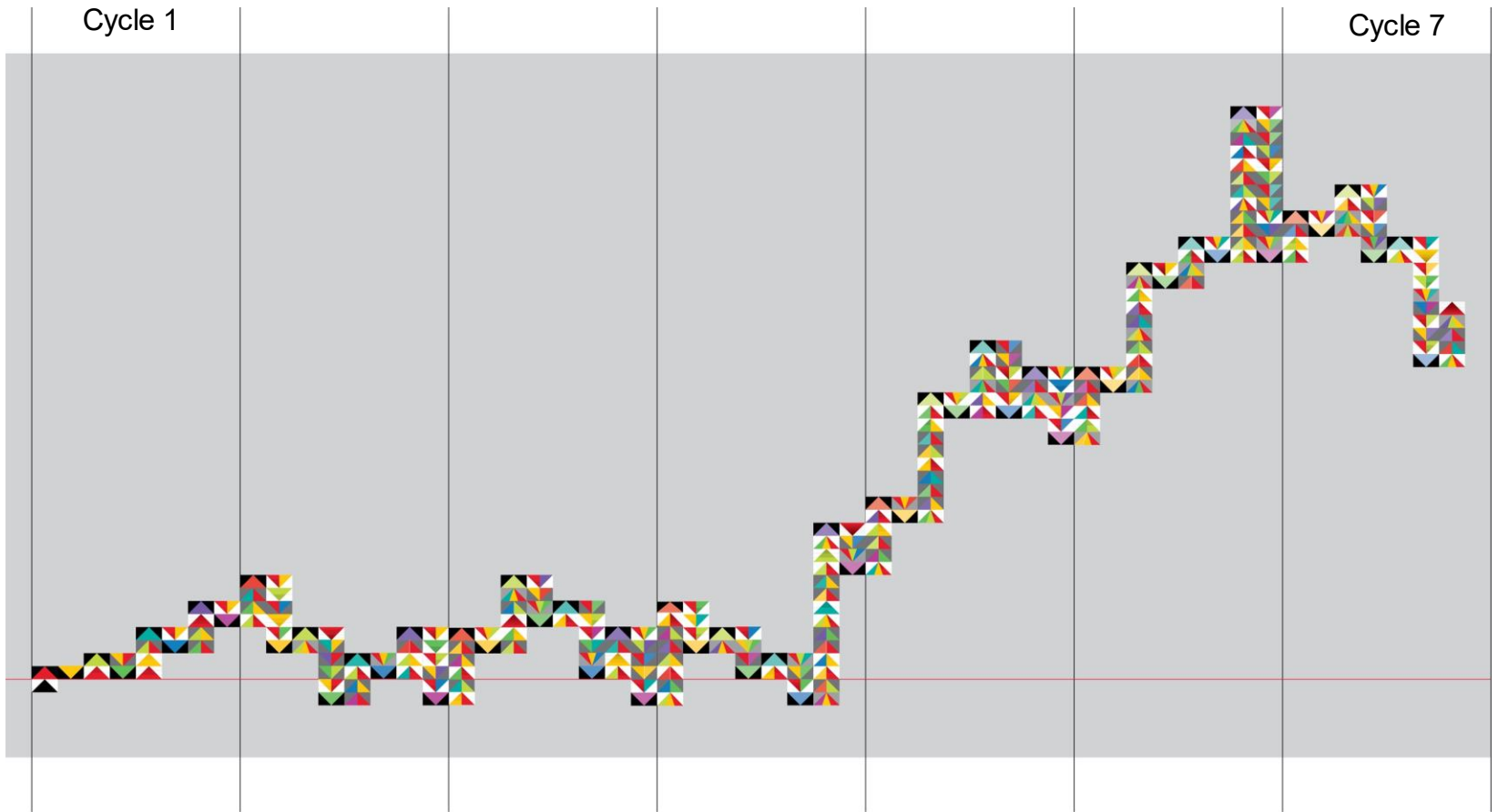
Reassembled Pieces up to 8th Prime [19]



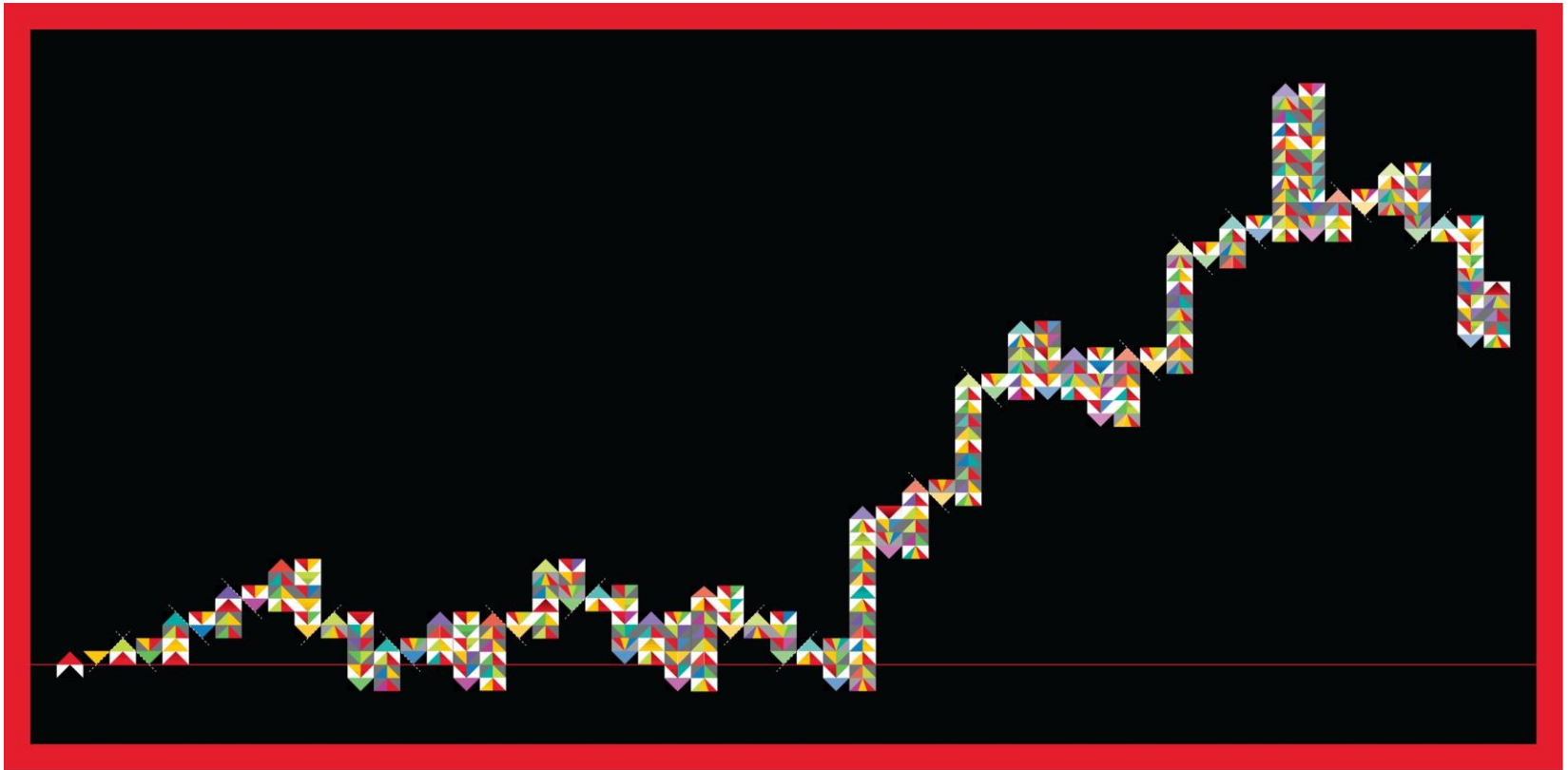
Reassembled Pieces up to 24th Prime [89]



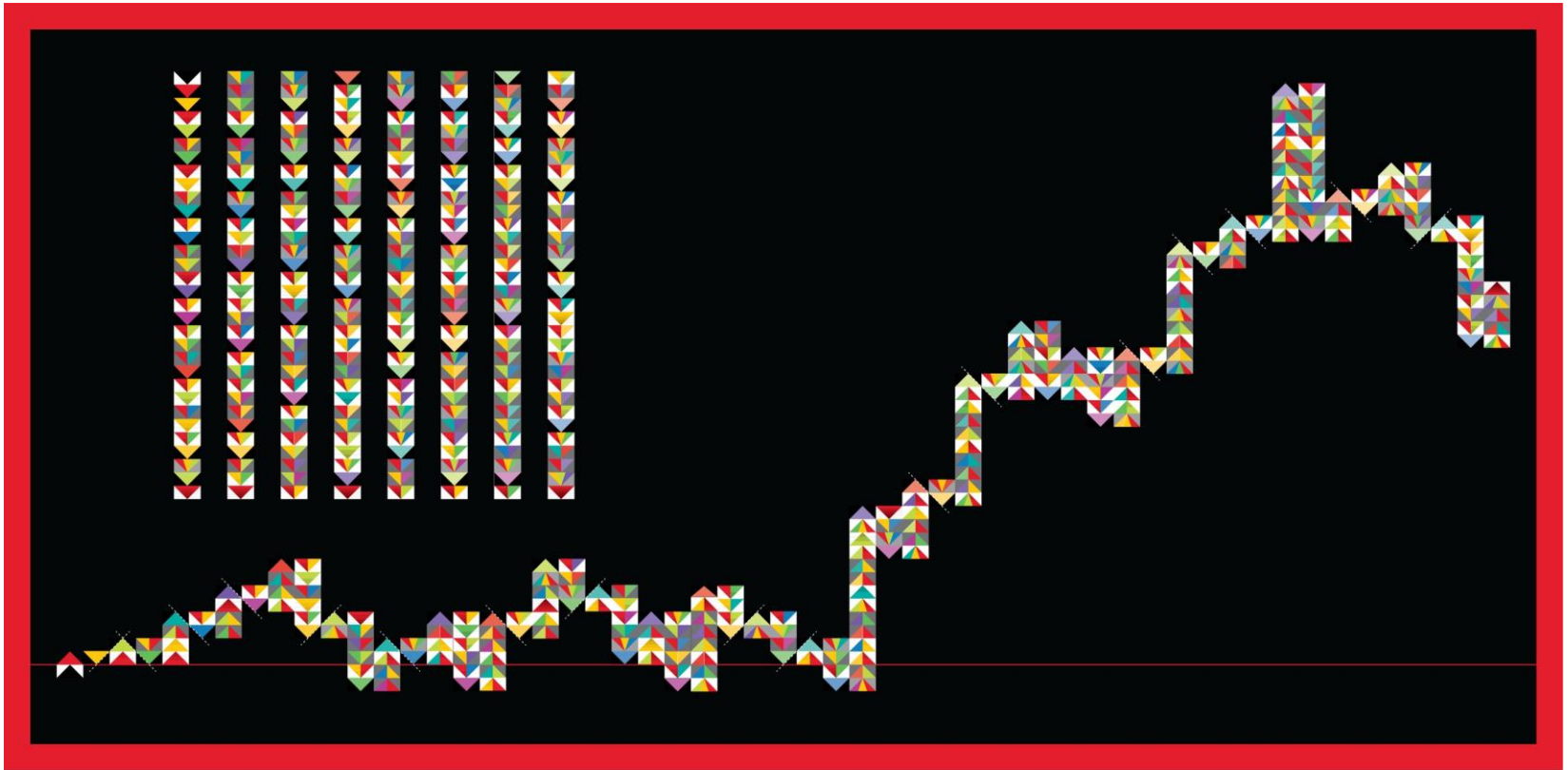
Reassembled Pieces up to 40th Prime [173]



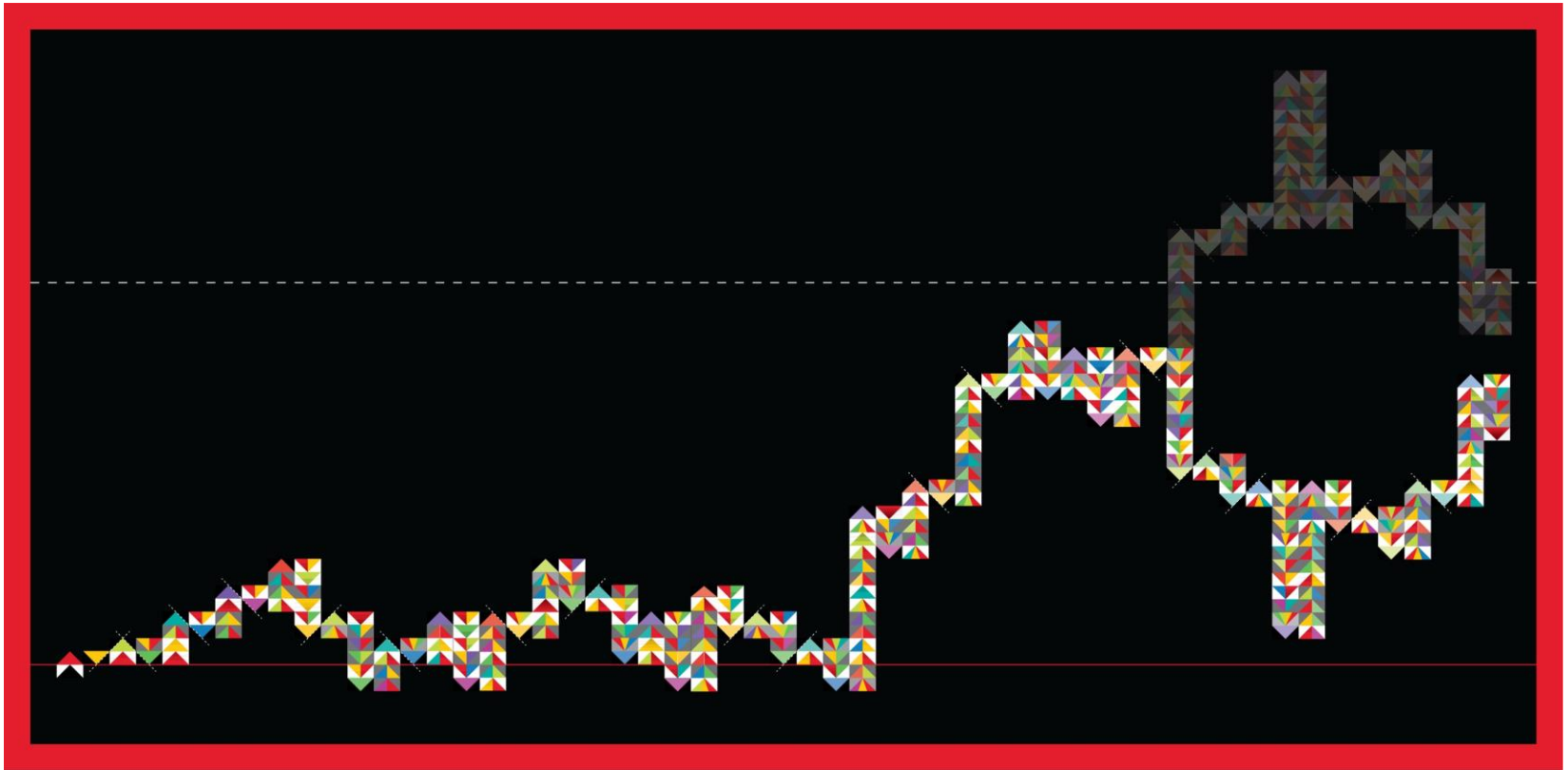
Reassembled Pieces up to 256



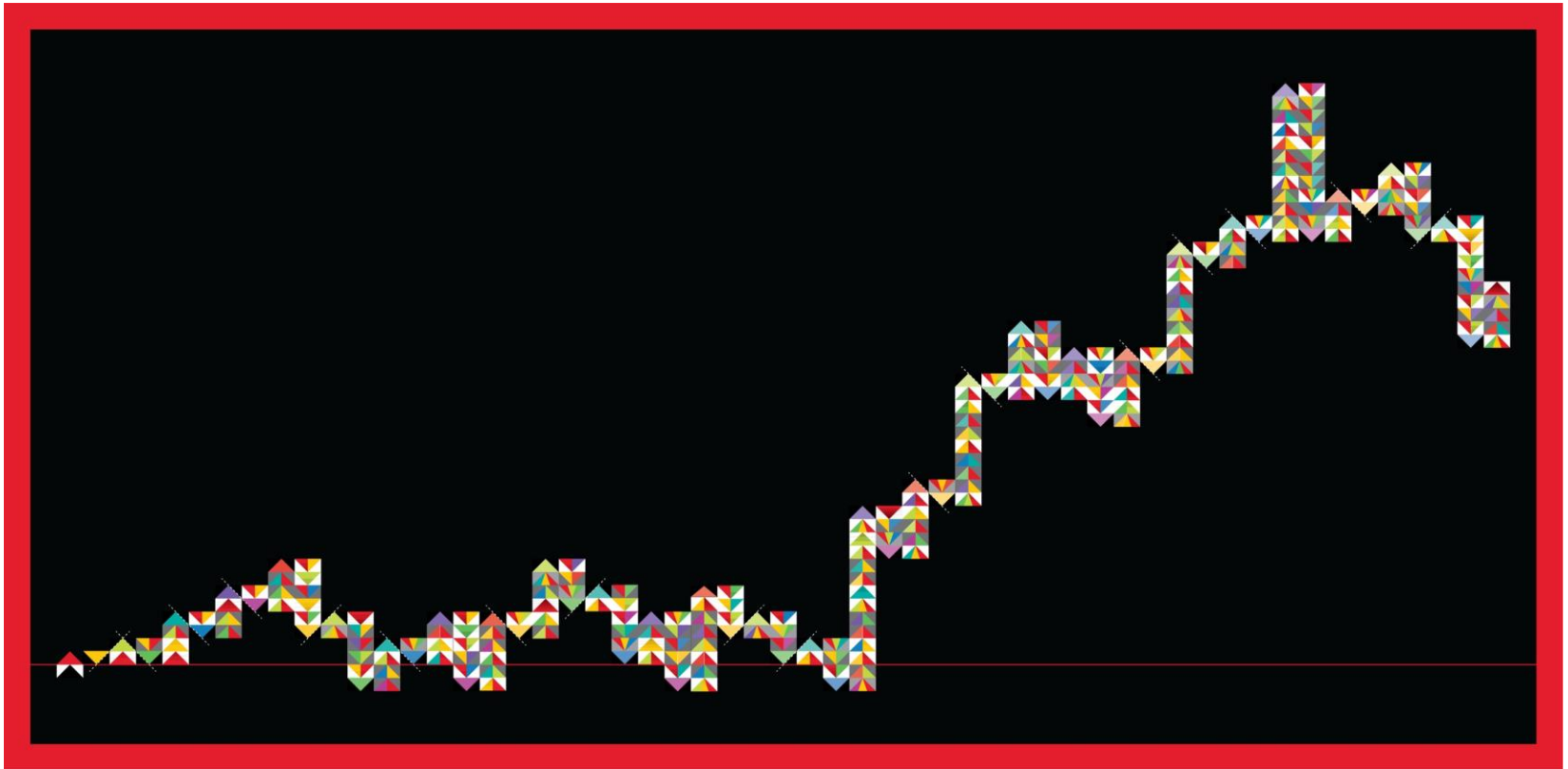
Release the Geese, JMM 2026



Release the Geese with a “Patch”



Release the Geese with a Guardrail Reflection



Release the Geese, JMM 2026

What's the Future of the Released Geese?

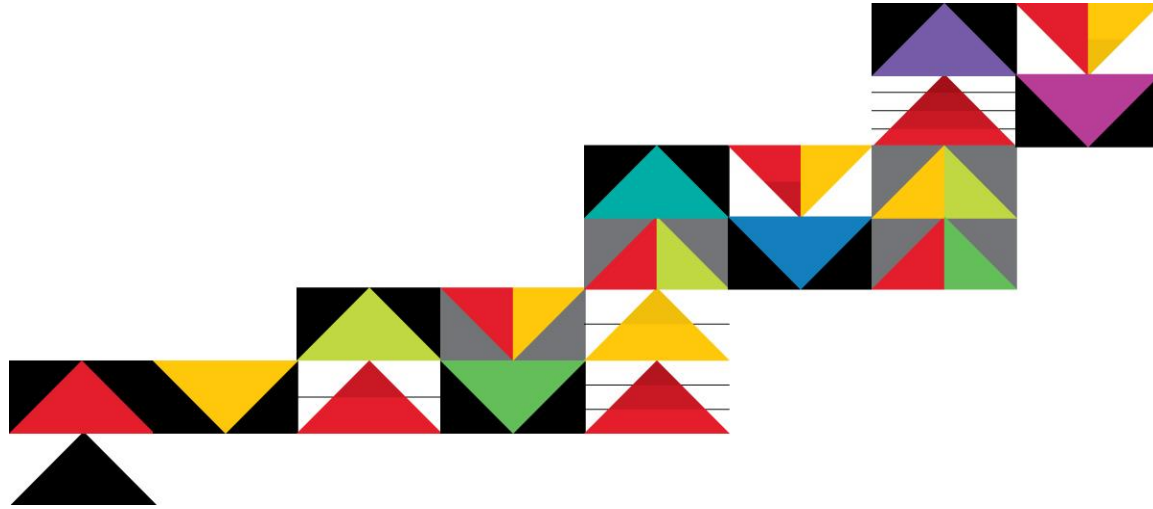
Up to the 54th prime [251], the maximum height for the geese is 44

By the 96th prime [503], the maximum height for the geese is 66

By the 146th prime [839], however, their height has fallen to -3

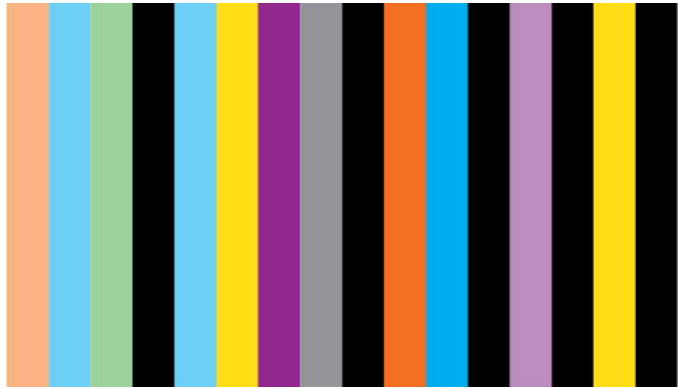
But then the height of the geese starts to climb up again

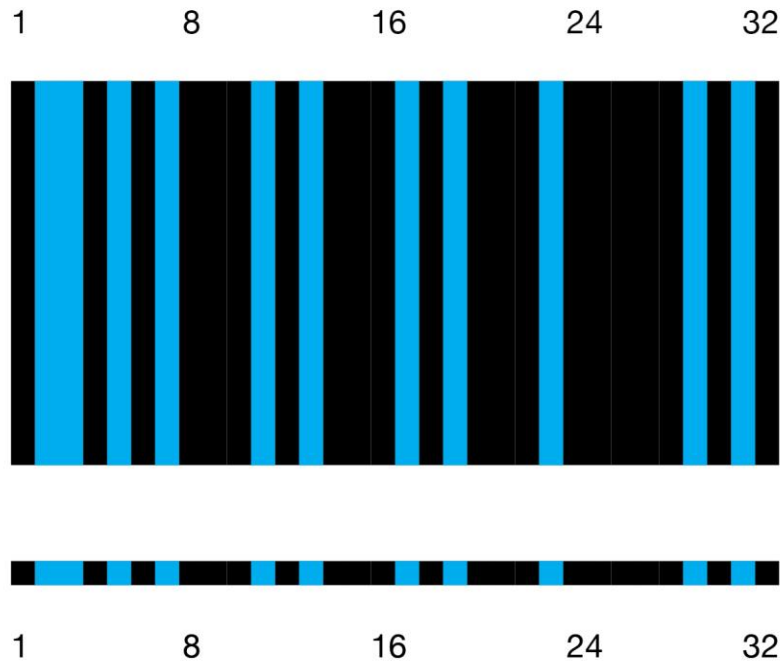
A topic for future work!



THANK YOU!

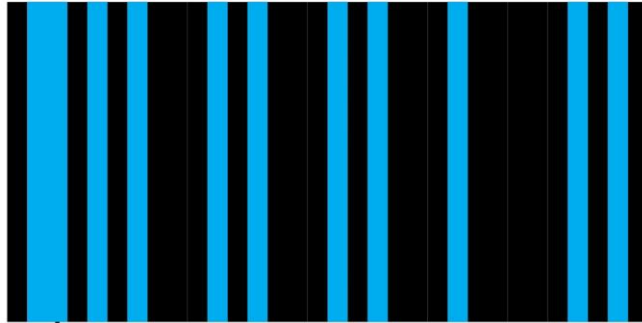
Margaret Kepner
mekvisuals.net
renpek1010@gmail.com



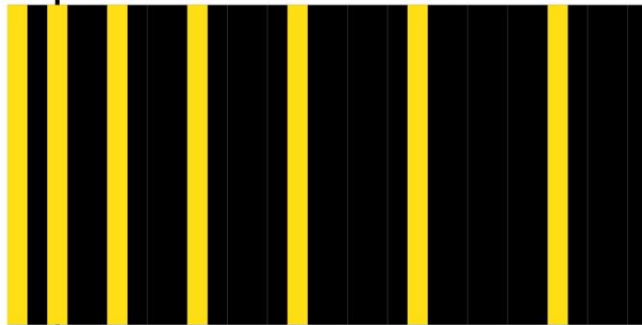


Prime numbers from 1 to 32

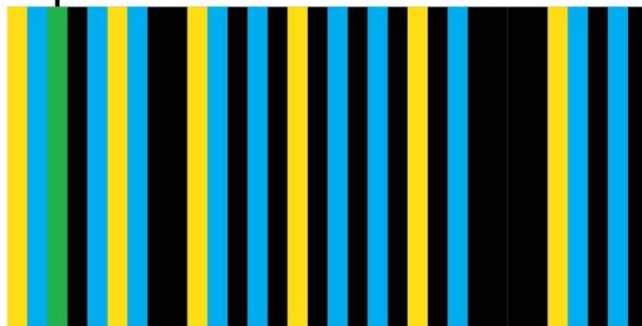
1 3 8 16 24 32



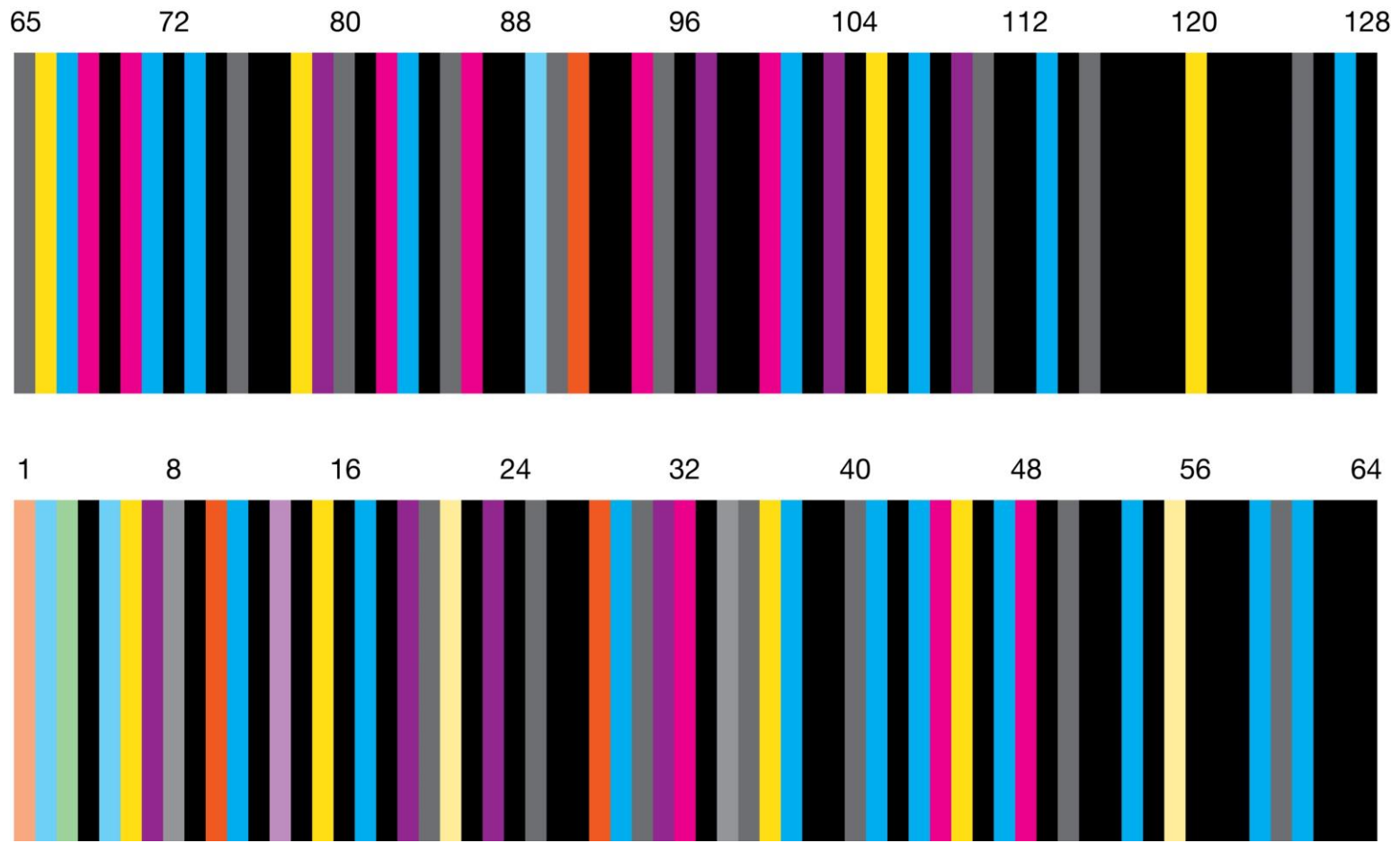
Prime Numbers



Triangular Numbers



Combination



Four Integer Sequences Combined, from 1 to 128

BE ↗	BF ↖	BG ↖	BH ↖	BI ↖	BJ ↖	BK ↖	BL ↖
BD ↗	AE ↖	AF ↖	AG ↖	AH ↖	AI ↖	AJ ↖	AK ↖
BC ↗	AD ↖	M ↖	N ↖	O ↖	P ↖	Q ↖	AL ↖
BB ↗	AC ↖	L ↖	C ↖	D ↖	E ↖	R ↖	AM ↖
BA ↗	AB ↖	K ↖	B ↖	A ↖	F ↖	S ↖	AN ↖
AZ ↗	AA ↖	J ↖	I ↖	H ↖	G ↖	T ↖	AO ↖
AY ↗	N ↖	Y ↖	X ↖	W ↖	V ↖	U ↖	AP ↖
AX ↗	AW ↖	AV ↖	AU ↖	AT ↖	AS ↖	AR ↖	AQ ↖

Square Spiral Layout from Square A to BL

Introduction

- **Integer sequences** are ordered lists of integers defined explicitly (they can be generated by a formula) or implicitly (through a relationship or process).
- The **prime numbers** are a familiar integer sequence, consisting of positive integers that cannot be expressed as the product of two smaller positive integers. The sequence begins: 2, 3, 5, 7, 11, 13, 17, 19, . . .
- The **triangular numbers** relate to objects arranged in a triangular format. The k th one is the sum of the integers from 1 to k , and an explicit formula exists. The sequence begins: 1, 3, 6, 10, 15, 21, 28, 36, . . .
- The **On-Line Encyclopedia of Integer Sequences** (OEIS) contains more than 250,000 integer sequences, and provides a wealth of information on each one.
- I have been exploring **the patterns contained within integer sequences** by displaying them in various visual formats and employing color. Combining several sequences produces interesting images, some of which resemble pieces of modern art.

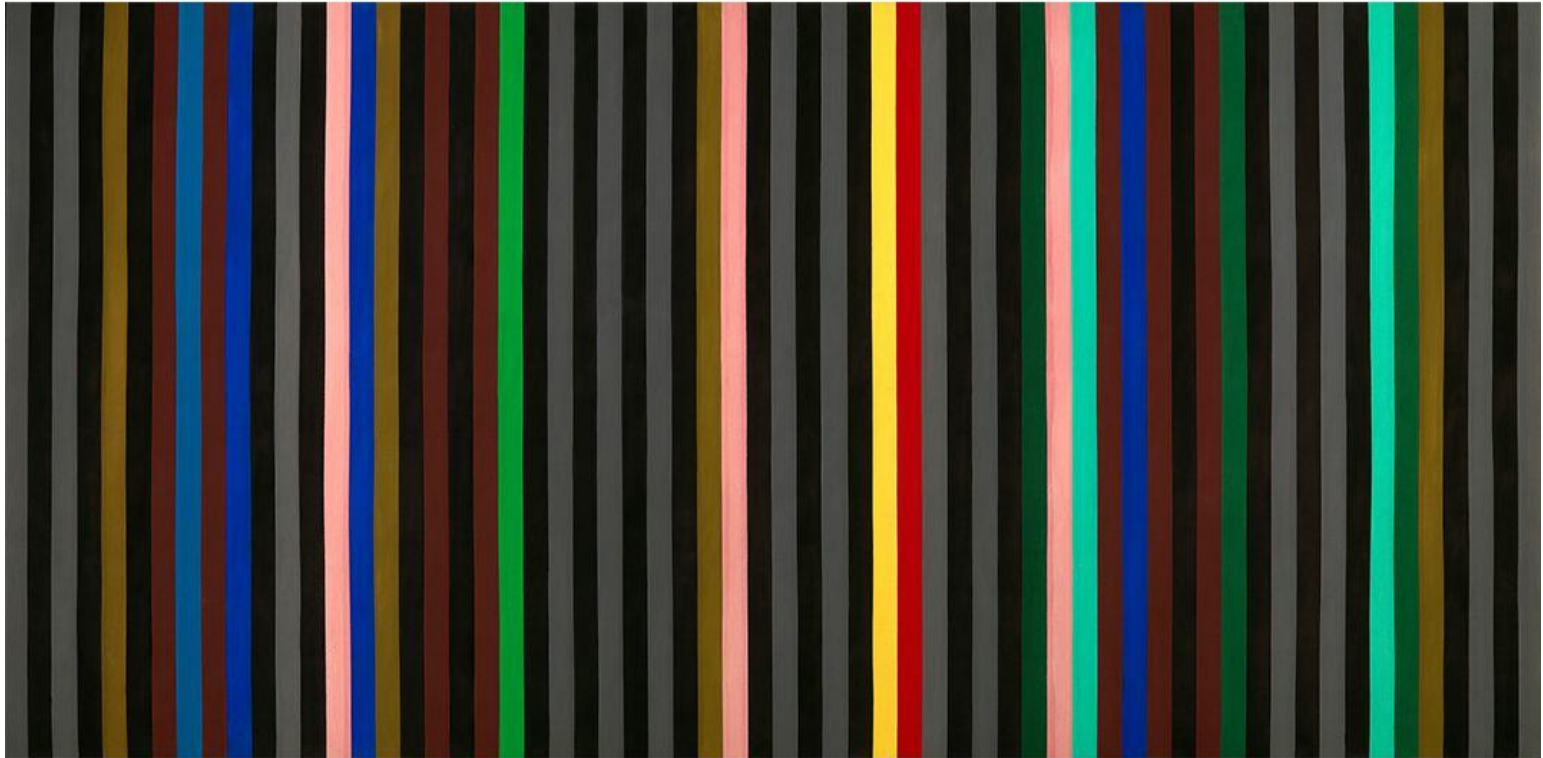
More Sequences

- The first two terms of the **Fibonacci sequence** are 0 and 1. Thereafter, each term is the sum of the two preceding ones. Hence, the sequence becomes 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, . . . The Fibonacci numbers are related to the Golden Ratio and certain biological growth patterns.
- The **happy numbers** are defined through a computational rule. Starting with any positive integer, sum the square of its (base 10) digits. Take this integer result and repeat the process. A number for which the chain of calculations ends in a “1” is defined as **happy**. Applying the process to other (unhappy) numbers eventually leads to a repeating cycle that can never reach “1.”

For example, 7 is a happy number: $7 \rightarrow 49 \rightarrow 97 \rightarrow 130 \rightarrow 10 \rightarrow 1$.

But 4 is unhappy: $4 \rightarrow 16 \rightarrow 37 \rightarrow 58 \rightarrow 89 \rightarrow 145 \rightarrow 42 \rightarrow 20 \rightarrow 4$.

- The sequence of happy numbers (base 10) begins: 1, 7, 10, 13, 19, 23, 28, 31, 32, 44 . . .



Gene Davis, **Black Grey Beat**, 1964

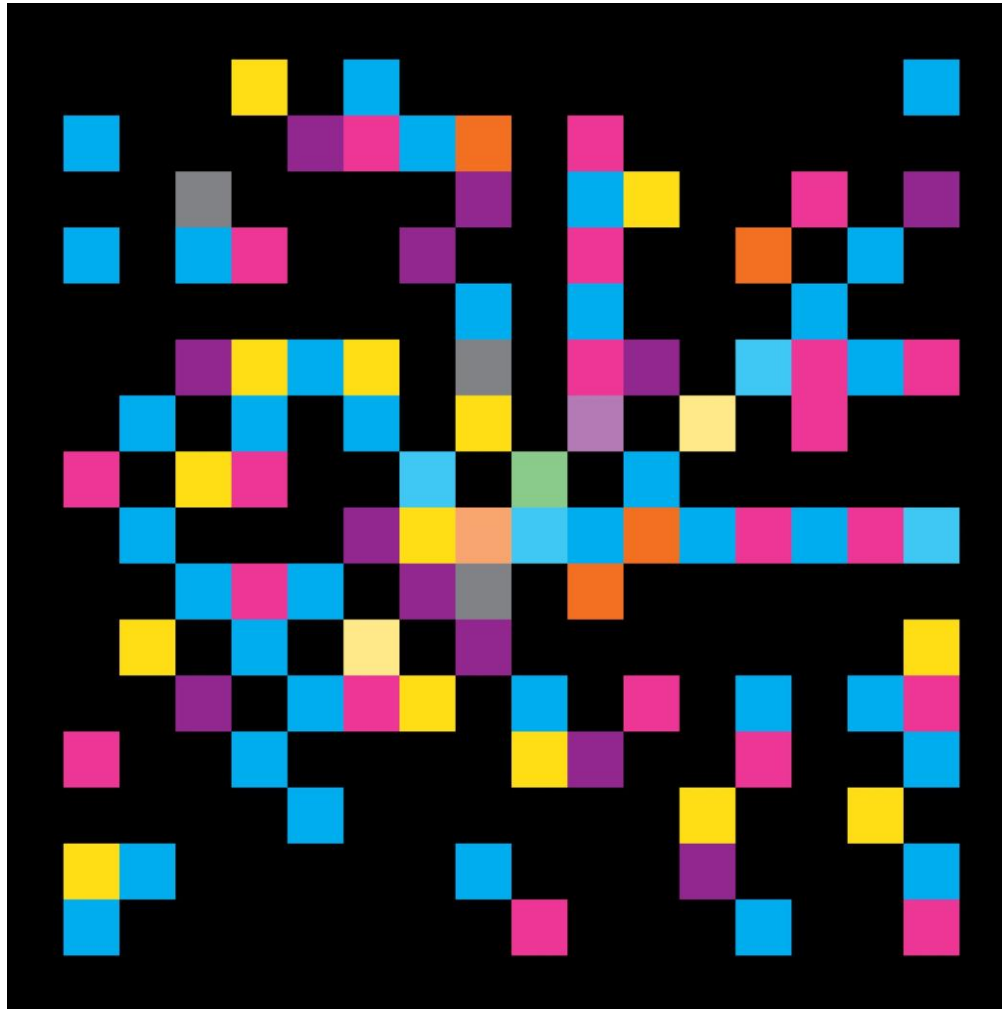


Gene Davis, **Phantom Tattoo**, 1965

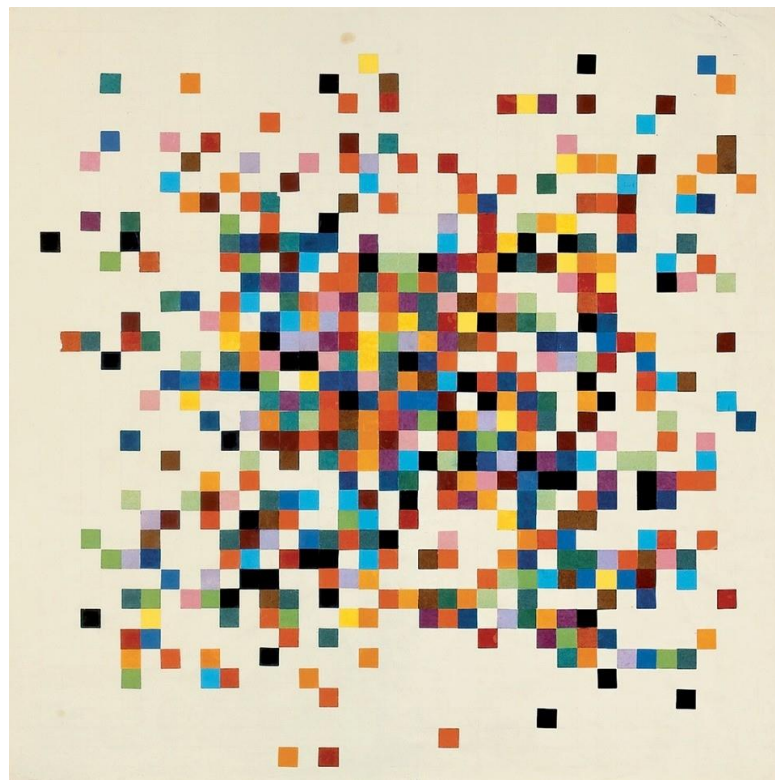
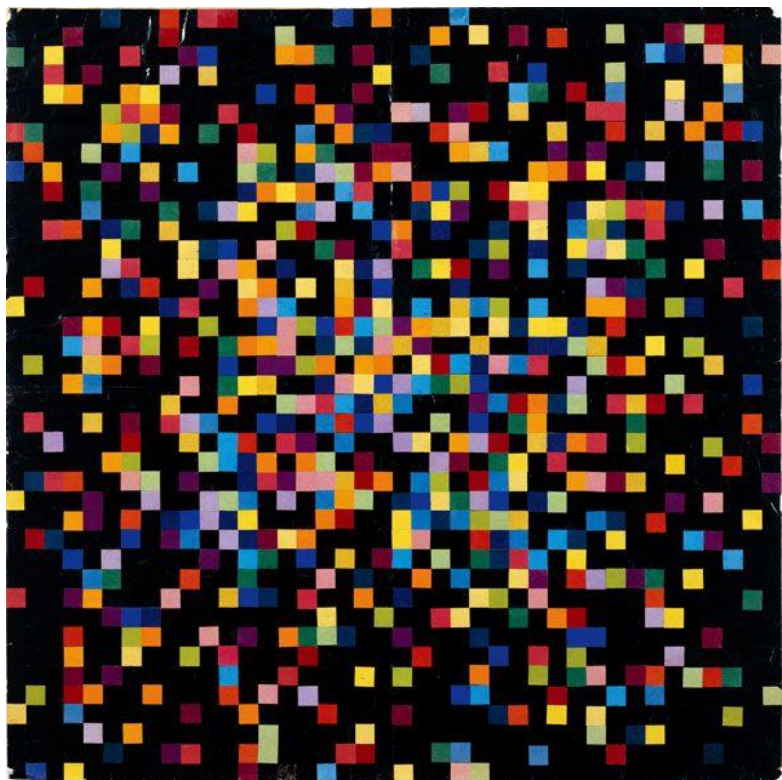
←	36	35	34	33	32	31	
	17	16	15	14	13	30	
	18	5	4	3	12	29	
	19	6	1	2	11	28	
	20	7	8	9	10	27	
	21	22	23	24	25	26	

	36	35	34	33	32	31	
	17	16	15	14	13	30	
	18	5	4	3	12	29	
	19	6	1	2	11	28	
	20	7	8	9	10	27	
	21	22	23	24	25	26	

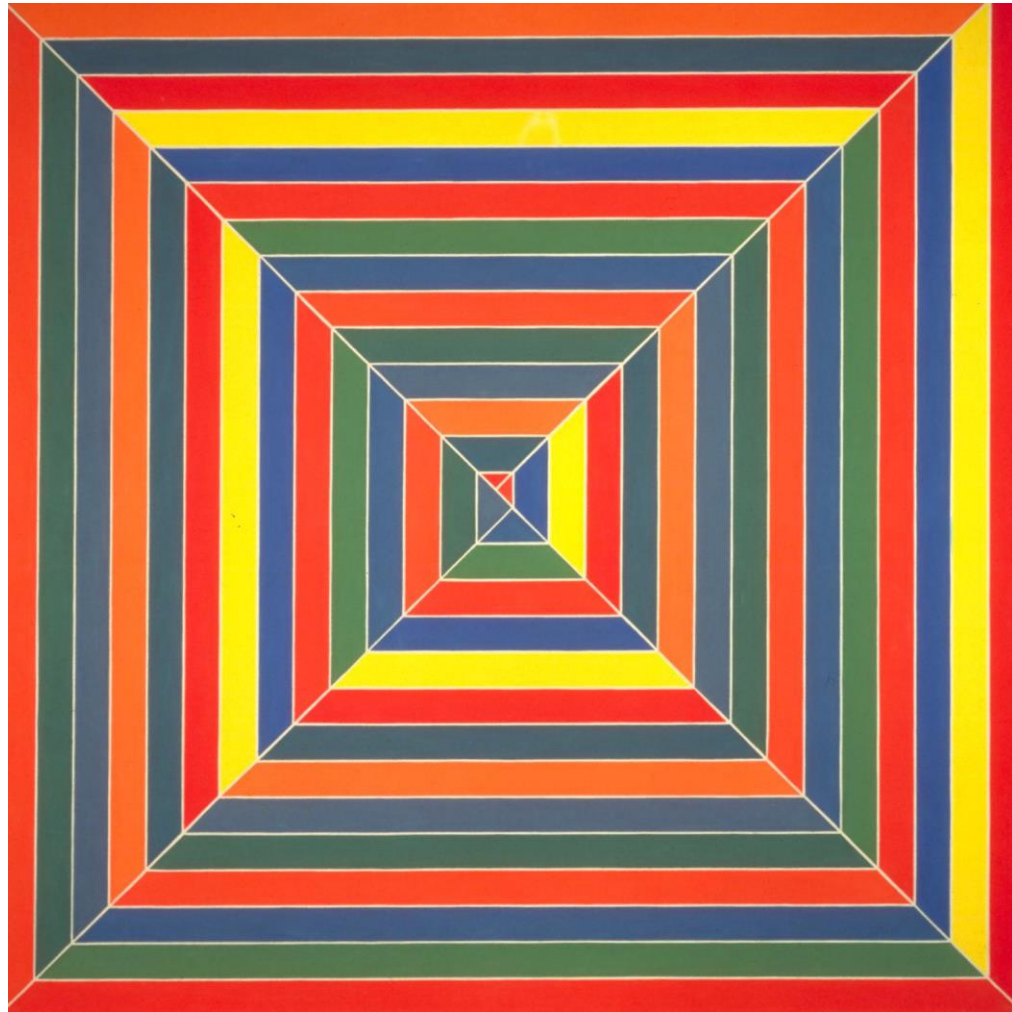
Square Spiral Path on a Grid [36], with Primes



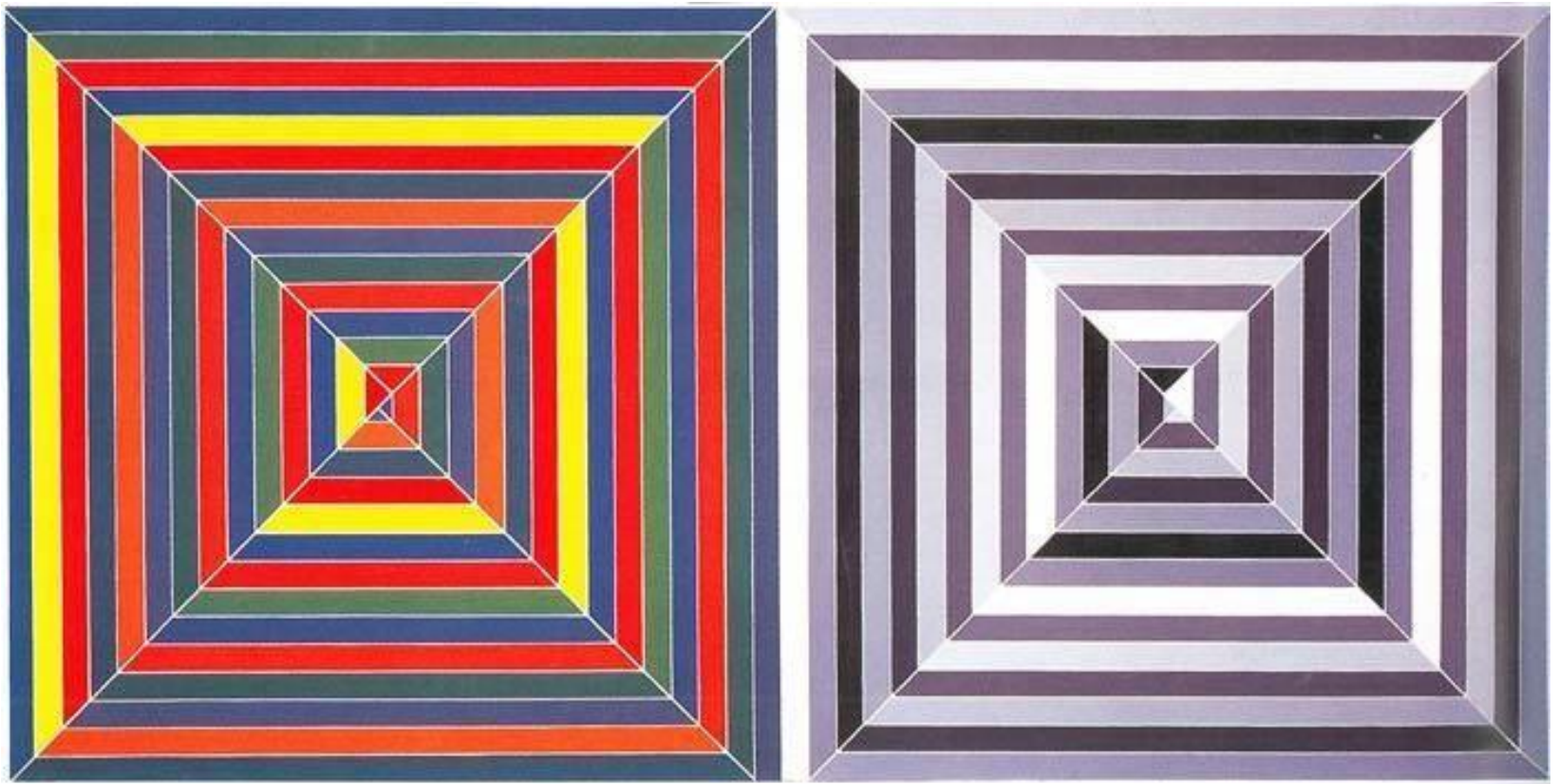
Square Spiral Path on Grid [256] with Prime, Happy, Triangular, and Fibonacci Numbers



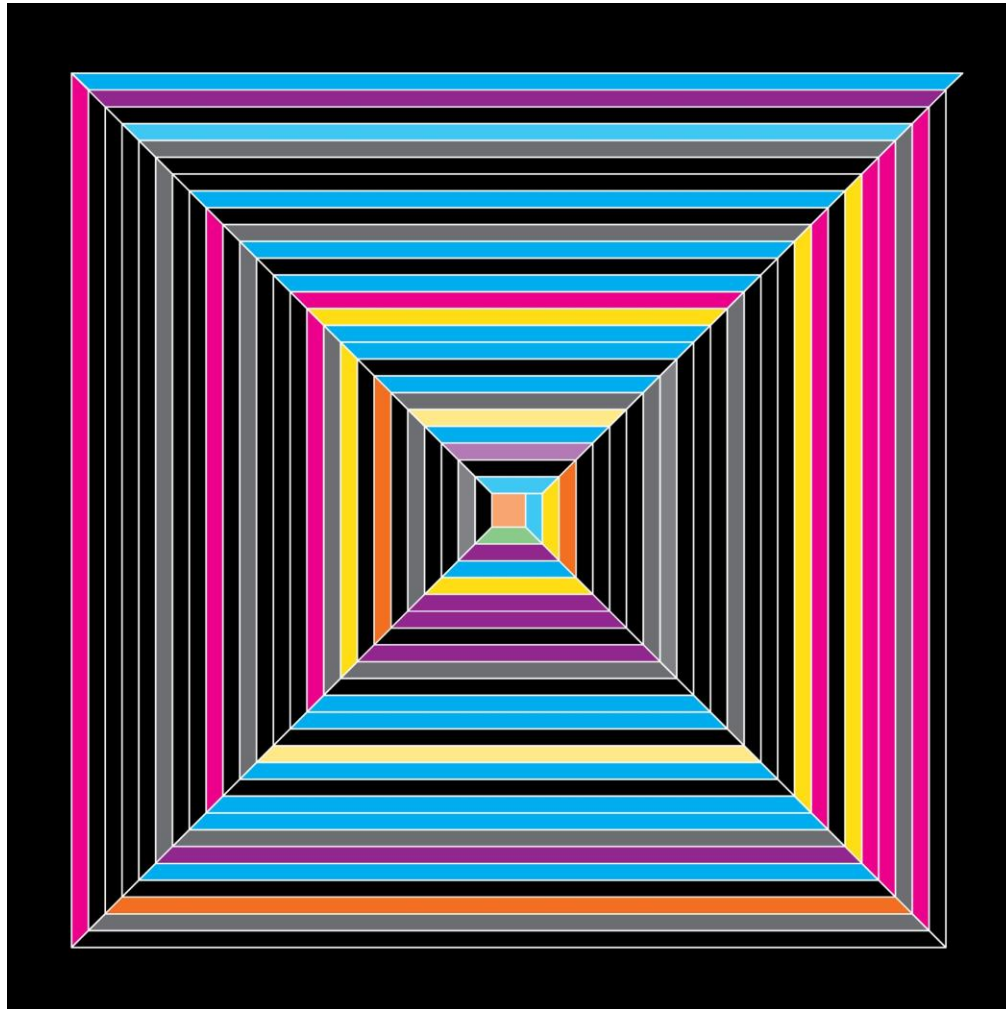
Ellsworth Kelly, **Spectrum Colors Arranged by Chance Series**, 1951 - 1953



Frank Stella, **Hyena Stomp**, 1962



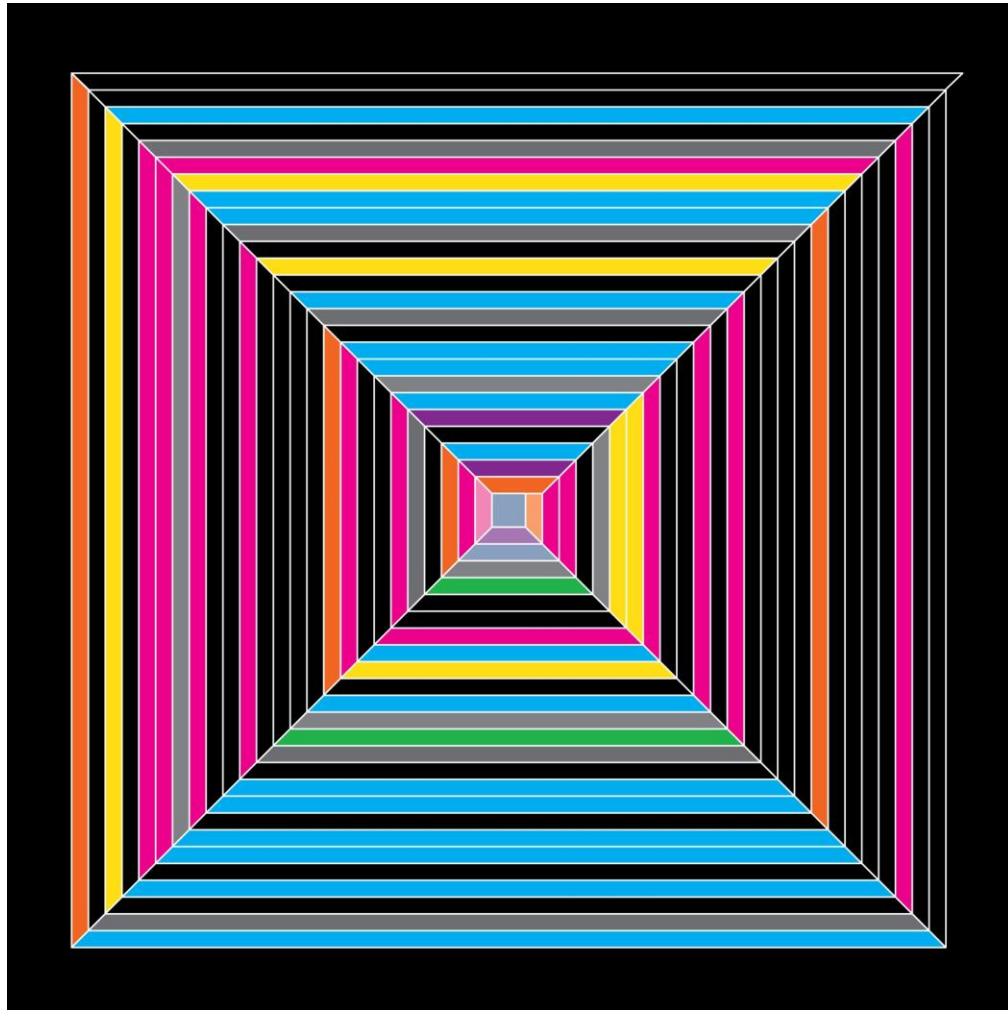
Frank Stella, **Jasper's Dilemma**, 1962



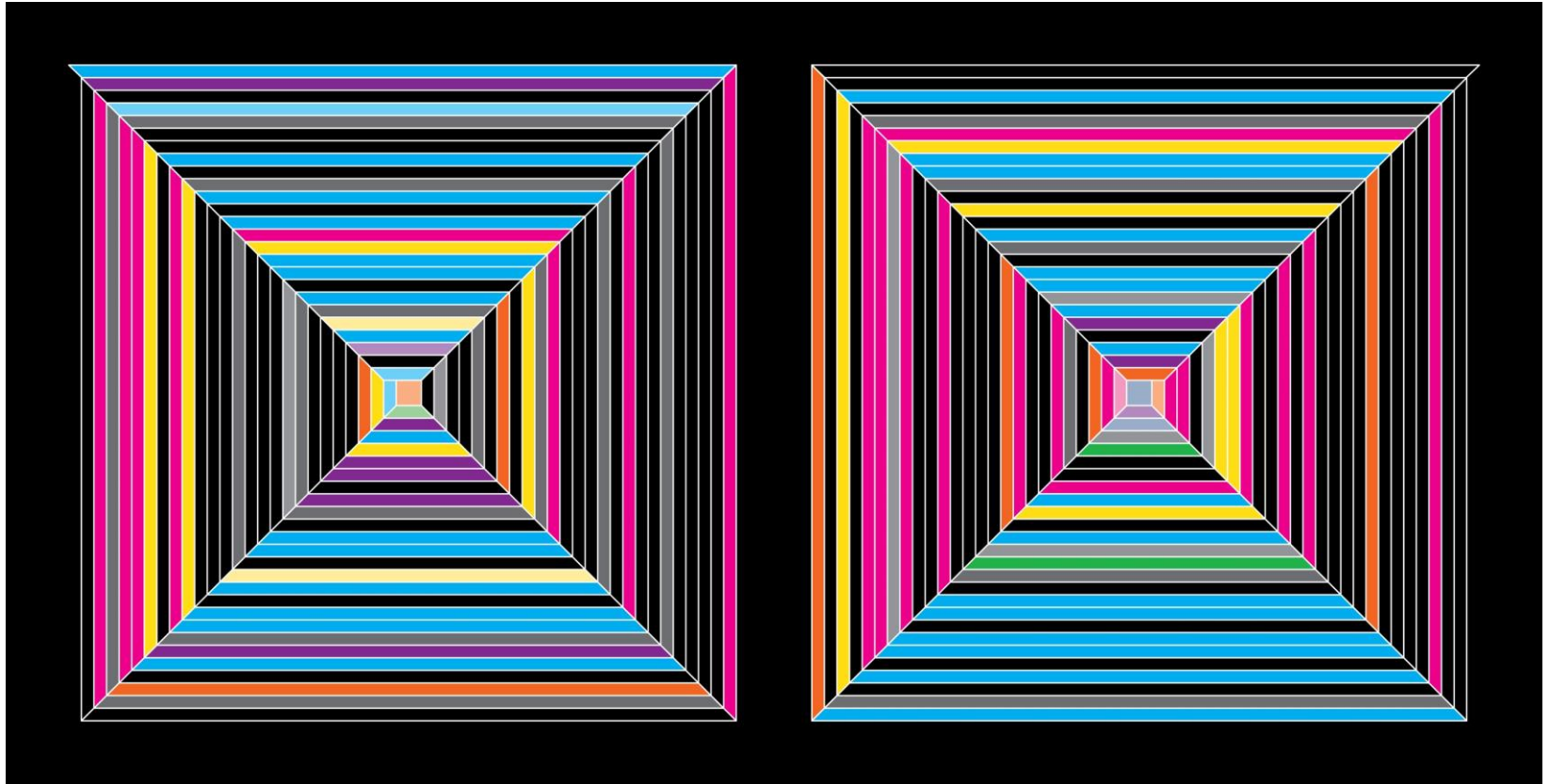
Square Spiral Structure [101] with Prime, Happy, Triangular, and Fibonacci Numbers

Even More Sequences

- Similar to the primes, the **lucky numbers** can be defined by a sieve method. The first few are: 1, 3, 7, 9, 13, 15, 21, 25, . . . They are all odd.
- The **harshad (or Niven) numbers** are defined by a computational rule. They are numbers for which the sum of their digits divides evenly into the number. For example, 12 is a harshad number (base 10), since 3 (= 1 + 2) divides 12 evenly. The number 16 is not, since 7 does not divide 16 evenly. The harshad sequence (in base 10) begins 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 18, 20, 21, 24, 27, . . .
- The pentagonal numbers are figurate numbers based on pentagonal diagrams composed of dots. The **generalized pentagonal numbers** are derived through an extension of the formula for pentagonal numbers. The first few are: 1, 2, 5, 7, 12, 15, 22, 26, 35, . . .
- The **Lucas numbers**, which are similar to the Fibonacci numbers, are generated by a recursive process summing the preceding two terms. The first terms in the Lucas sequence are (2, 1), however, not (0, 1). The resulting Lucas numbers are: 2, 1, 3, 4, 7, 11, 18, 29, 47, . . .



Square Spiral Structure [101] with Lucky, Harshad, Generalized Pentagonal, and Lucas Numbers



Dueling Spirals 101, Digital Print, JMM 2019

