An example of steganography in New York state voter rolls

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Abstract

Voter rolls for the state of New York contain strong evidence of steganographically-concealed data. Voter records are designed to identify each voter, their residence, the election districts they belong to, and other election-related information. The records are publicly accessible. If any person or organization wanted to conceal information about voters within the voter rolls, it would have to be done using steganography, by concealing it in plain sight. An in-depth examination of New York's voter rolls proves this has occurred.

The steganographically-concealed information is hidden beneath at least 6 layers of obfuscation in an apparent effort to camouflage its presence and purpose. If the obfuscation layers are penetrated, a distinctive matrix is revealed within the data. The matrix is the product of an algorithm that assigns unique State Board of Elections Identification (SBOEID) numbers. The goal of assigning SBOEID numbers via a sophisticated algorithm is unknown but it could easily allow the clandestine insertion, tracking, and manipulation of "phantom voters" within the voter rolls. Voter rolls for all 62 New York counties contain evidence of steganographically-concealed information.

Introduction

Steganography is a form of cryptography, designed to conceal information in plain sight. In cryptography, a message is written in code to prevent disclosure to unauthorized recipients. Cryptographic messages do not conceal that they are ciphers, though the message itself is concealed by the encoding process. Steganography conceals both message and the fact that there is a message. For instance, publishers of music and filmed entertainment now use steganography to conceal copyright information and serial numbers in music CDs and film DVDs [1]. One can listen to a music CD or watch a DVD movie without detecting hidden information within them.

To be effective, any steganographic method must be:

- embedded within the host media so that it may not be removed
- cannot create perceptible artifacts that would compromise the integrity of the public-facing data
- cannot be perceived without knowledge of the hidden data and the key needed to extract it
- computational cost must be low enough to prevent detectible performance impact
- the data must be recoverable without access to the original data source
- the media must be public so that security depends on access to the key, not the media it resides on [2].

One early example of steganography illustrates its utility in a political context. In it, Demaratus, a king of Sparta, warned his countrymen of a Greek invasion by concealing a message under a layer of wax. The wax tablets were apparently blank and attracted no notice. More recent examples include hiding messages in digital images [3] and other digital media, usually for the purpose of protecting intellectual property rights. Voter rolls, however, are an atypical place to find an example of steganography. Unlike other modern examples, no obvious commercial purpose is at stake in a state's voter rolls. Voter rolls are inherently political, making them more similar to the wax tablets of Demaratus than a music CD.

Context on the potential utility of steganography in New York's voter rolls is provided by events surrounding the 2020 General Election.

On November 3, 2020, a General Election was held in the United States for the offices of president, vice-president, and many other positions in federal, state, and local government. The contest between incumbent President Donald Trump and challenger Joseph Biden was particularly vitriolic for an American election. There were dozens of riots, protests, lawsuits, and other forms of unrest throughout the country. Then-President Trump warned voters that "There is NO WAY (ZERO!) that Mail-in Ballots will be anything less than substantially fraudulent"[4]. Many politicians and media personalities objected to Trump's warnings as baseless. For instance, in an April 10, 2020 article, Jane C. Timm of NBC News raised the following points to rebut Trump's claim:

> *"Richard Hasen, an election law expert…found just 491 incidents of alleged absentee voter fraud [over] more than a decade of elections"*
>
> *"Election officials in mail voting states say they don't have problems with fraud."*
>
> *Republican Secretary of State (WA) Kim Wyman stated that "We're not seeing the rampant fraud that the president talked about"[5].*

On election day and in the weeks, and months following, many thousands of voter and election fraud accusations were made by prominent attorneys Sidney Powell, Lin Wood, and Rudy Giuliani, researchers Bobby Piton, Dr. Douglas Frank, and Captain Seth Keshel, as well as hundreds of individual witnesses [6]. Each of these parties and many others claimed to have evidence of fraud at either the voter level or among those responsible for conducting the election [7]. The claims were brought to several state legislatures in public hearings and to various courts of law in lawsuits. Many of the cases were dismissed on procedural grounds without hearing evidence. Not all of the cases were dismissed [8], as has been reported, nor did all of the remaining cases lose [9], as has also been reported.

It is in the context of these competing claims of fraud and a fraud-free election that New York's voter rolls were examined. The goal was to determine the truth of some of the claims regarding the 2020 election.

In cooperation with the citizen group New York Citizens Audit (NYCA), I obtained access to the New York state voter rolls. Among many other anomalies found in the rolls, one stood out as particularly striking.

A single individual with an address in Brooklyn was assigned a total of 11 unique State Board of Elections Identification (SBOEID) numbers on 2 consecutive days, February 19 and 20, 2020. According to the 2020 New York state election law, at least 10 of those registrations are illegal [10]. Regulation § 6217.2 of the 2020 election law rules and regulations states that a "unique identifier" (SBOEID number) is assigned to a voter only after "all duplicate registration issues have been resolved". To do this, registrations are first collected from counties. County clerks are required by law to check their database for existing registrations before processing a pending application to register. This is to "ensure that the application is not a new registration and is an update or change to an existing record within the county" [11, §6217.10]. If an existing registration is found, the application must be rejected. If an application is approved, it is processed and sent to the New York State Board of Elections (NYBOE). Those registrations must be checked again for duplicate registrations "within the integrated statewide voter registration list". The reason duplicates must be resolved is that in New York state, each voter is allowed only one SBOEID number for their "voting life" [§ 6217.610].

For privacy reasons, the voter with 11 SBOEID numbers is anonymized in this article by changing his name to "Chaim Metzner". Metzner's SBOEID numbers followed an unusual pattern (table 1). The numbers used in the table are masked but they accurately represent the pattern observed. Chaim Metzner's 11 records led to the discovery that a steganographic process was utilized to assign SBOEID numbers in New York State.

Table 1 Chaim Metzner's (Masked) SBOEID and County ID (CID) numbers

Registration Date	CID (Masked)	CID gap to previous	SBOEID (Masked)	SBOEID gap to previous	Status	Registration Source
2/20/2020	6593		45171		ACTIVE	MAIL
2/20/2020	6594	1	45172	1	ACTIVE	MAIL
2/20/2020	6595	1	45173	1	ACTIVE	MAIL
2/20/2020	6596	1	45174	1	ACTIVE	MAIL
2/20/2020	6597	1	45175	1	ACTIVE	MAIL
2/20/2020	6598	1	45176	1	ACTIVE	MAIL
2/20/2020	6599	1	45177	1	ACTIVE	MAIL
2/20/2020	6600	1	45178	1	ACTIVE	MAIL
2/19/2020	7375	775	53691	8513	ACTIVE	MAIL
2/19/2020	7376	1	53695	4	ACTIVE	MAIL
2/20/2020	7497	121	53783	88	ACTIVE	MAIL

Table 1 shows Chaim's SBOEID numbers sorted from smallest to largest. In New York, voters are given County Identification (CID) numbers in addition to their unique New York State (NYS) SBOEID number. Voters are allowed to have multiple CID numbers to accommodate moves to different counties within the state.

Serial numbers normally ascend as they are assigned. In Chaim's case, they do this for the first 8 numbers but then they skip 8,513 numbers, then 4, then 88. This might be explained by the fact that the numbers weren't assigned on the same day but 2 numbers with high values were assigned the day before 8 numbers with lower values. These numbers were not assigned in serial order.

The questions raised by Chaim's 11 SBOEID numbers are: "How were these 11 specific numbers assigned to this individual?" And, "why were these numbers assigned to this individual on 2 consecutive days?"

The questions become more important in the context of other records in the rolls. New York's voter rolls contain no less than 622,973 unique SBOEID numbers assigned to 299,920 individuals identified as an exact match for name, address, and birth date. A fuzzy search of similar names found thousands of additional suspicious records. Counting these is difficult because some require canvassing for verification. All appear to be illegal registrations manufactured by cloning existing registrations. A smaller number of registrations, between about 50,000 – 100,000 records, appear to be subtly altered duplicates of existing records (Table 2). In total, there appear to be a minimum of between 350,000-400,000 illegally cloned records contained within the NYS voter rolls.

The names used in Table 2 are altered for privacy but accurately represent data found in the NYS voter rolls.

Table 2 Fuzzy and exact match cloned record search result types

Record type	First Name	Last Name	DOB	Address	Registration Date	SBOEID
Exact match 1	Chaim	Metzner	12/16/1958	1234 11th St.	2/20/2020	45171
Exact match 2	Chaim	Metzner	12/16/1958	1234 11th St.	2/20/2020	45172
Hyphen removed 1	Isadore	Metzner-Cahill	12/16/1958	1234 11th St.	2/20/2020	45173
Hyphen removed 2	Isadore	Metzner Cahill	12/16/1958	1234 11th St.	2/20/2020	45174
Spelling alteration 1a	Grace	Metzner	12/16/1958	1234 11th St.	2/20/2020	45175
Spelling alteration 2b	Grazia	Metzner	12/16/1958	1234 11th St.	2/20/2020	45176
Spelling alteration 1b	Chaim	Metzner	12/16/1958	1234 11th St.	2/20/2020	45177
Spelling alteration 2b	Chaim	Metzr	12/16/1958	1234 11th St.	2/20/2020	45178
Maiden/Married 1	Isadore	Metzner	12/16/1958	1234 11th St.	2/20/2020	53691
Maiden/Married 2	Isadore	Cahill	12/16/1958	1234 11th St.	2/20/2020	53695
Name swap 1	Chaim	Metzner	12/16/1958	1234 11th St.	2/20/2020	53783
Name swap 2	Metzner	Chaim	12/16/1958	1234 11th St.	2/20/2020	45182

Illegal registrations contained in the NY voter rolls create the potential to validate fake ballots by assigning those ballots to illegally-generated SBOEID numbers. To do it, illegal registrations must be

well-hidden from anyone who is unaware of the scheme. At the same time, the accounts must be readily accessible to those who would make nefarious use of them. Steganography allows both.

Pattern obfuscation

The NYBOE voter rolls obtained by NYCA in November of 2021 contain 20,765,242 records. Excel can only load slightly over 1,000,000 records. For this reason, I created a Filemaker Pro database to examine the records. However, the version I used could only load 8,480,000 records. To access the remainder, I obtained assistance from members of the NYCA research team, who used SQL queries to search the full database without opening it.

Below are the obfuscation methods used to conceal the presence of steganographically-introduced data within the NYBOE voter rolls.

Obfuscation method 1: State partitions

SBOEID numbers are 20 digits long. They start with the characters “NY” for “New York”, continue with 10 leading zeroes, and end with 8 digits used to produce unique numbers (Figure 1). This means that the total numbers available within current constraints is 99,999,999. That is 4.81 times the current size of the NYBOE voter rolls. The 99,999,999 available numbers are the “number space” used by the NYBOE to assign SBOEID numbers.

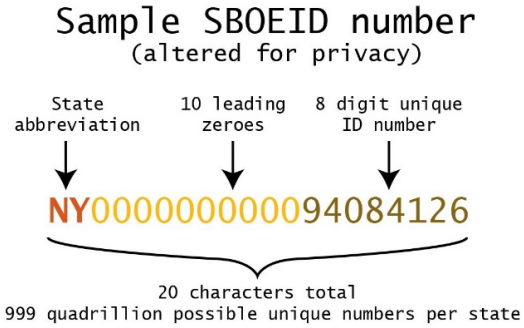


Figure 1 structure of SBOEID number

The number space is divided into 3 primary partitions: 1 “in-range” and 2 “out of range” partitions on either side of the in-range partition. In-range numbers are consecutive SBOEID numbers assigned to the same county. Out of range numbers are non-consecutive numbers either below the lowest in-range number or above the highest in-range number (Figure 2).

The in-range partition assigns SBOEID numbers to counties in 62 sub-partitions. The out of range partitions blend SBOEID numbers from all counties together. The in-range partition contains an average of about 70.0% of all county registrations. The out of range partition contains all remaining registrations. The existence of these partitions is invisible to any normal user of the NYBOE voter roll database. There are no fields to allow its discovery.

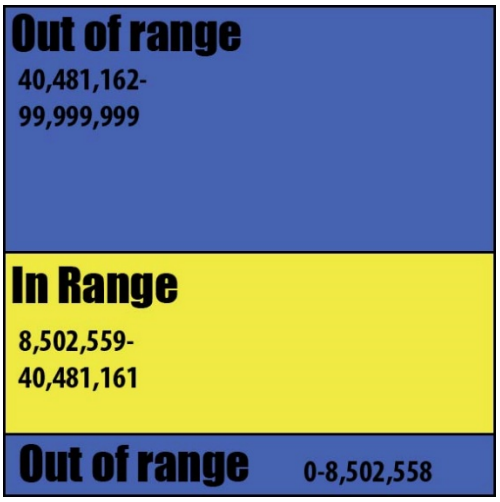


Figure 2 In and out of range SBOEID numbers

Obfuscation method 2: County ranges

In New York, all counties are assigned a "county code". The county code is a 2 digit number, from 01-62, that represents each of New York's 62 counties in alphabetical order, from Albany (county 01) to Yates (county 62). Chaim Metzner's registrations are all in Kings County, county 24. Because the voter roll database is large, it makes sense to filter the results by county code to reduce the memory load. To do that, one simply types "24" into the 'countyCode" field to see all the registrations for Kings County. That simple and logical step obfuscates the county range partitions. The reason is that almost half of the SBOEID numbers assigned to New York's 5 counties, including Kings, are in the out of range partition.

In-range numbers account for 8,763,593 of New York's 14,880,938 registered voters (58.89%) [10]. In-range SBOEID numbers had 4,732,165 votes attached to them, or 56.2% of the total votes cast. The out of range partition is divided into 2 sections, one above and one below the in-range partition. The in-range partition is divided into 67 sections. These are broken down into 2 types: "Buffers" and "Counties". There are 62 county sections and 5 buffer sections (Figure 3). None of the numbers contained within the buffers have been assigned. Almost all of the SBOEID numbers available in the county sections have been assigned.

It is essential to be aware of the in-range, out of range, and county partitions to discover the steganographic SBOEID number assignments.

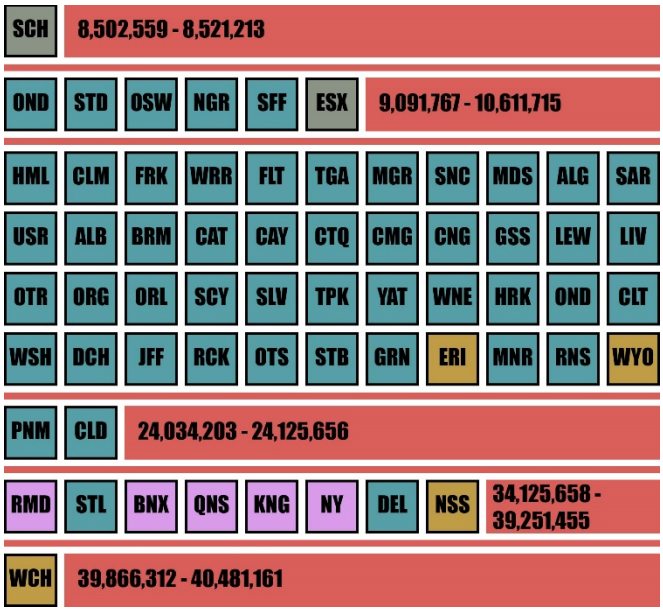


Figure 3 the in-range partition, broken down by county and buffer sections

Obfuscation method 3: 2 number margin

A defining characteristic of the in-range county sections is that all but 3 have 1 unassigned value at the start and end of each county range. This creates a 2 number boundary between each pair of adjacent counties[i]. The effect of the 2 number margin is that new registrations are limited to the few unassigned numbers within each county range or the out of range partitions. Otherwise, the margin between counties is eroded and numbers must be confiscated from adjacent counties. Records can be "deleted" by removing voter information from any given number but if this is done, the steganographic pattern is altered.

A secondary effect of the margin is that it links counties in a non-alphabetical sequence. By scrambling the order of county ranges, more manual labor is required to define the ranges and identify where each county belongs relative to other counties (Appendix 1).

Obfuscation method 4: SBOEID/CID incongruence

If a voter moves from one county to another and registers to vote in the new county, he is assigned a new CID number. The voter then has 2 records in the NYS voter rolls. Both will have the same SBOEID number, name, DOB, and other personal information. The CID numbers will be different, as is the address. Votes can be attached to any CID but can only be counted once per unique SBOEID. Therefore, the two CID numbers in the hypothetical example above cannot be used to vote twice. Chaim Metzner's 11 SBOEID numbers, on the other hand, can be used to vote 11 times.

In-range SBOEID numbers identify the county of origin based on which county is assigned those numbers (Figure 4). This means that if a person first registers to vote in Yates County, his SBOEID number (if it is in-range) will be between the values 21,704,366 – 21,718,821 inclusive. If the same person moves to Albany, his SBOEID remains the same but he is given a new CID for Albany.

	A	B	C	D	E	F	G	H
1	County	County ID	Votes cast (SoS)	DIFF in range records to SoS votes	MIN SBOEID	MAX SBOEID	Gap to previous	MIN to MAX size
40	Yates	62	10,788	-1,301	21,704,366	21,718,821	2	14456
41	Wayne	59	45,031	-2,911	21,718,823	21,775,896	2	57074
42	Herkimer	22	29,565	259	21,775,898	21,816,803	2	40906
43	Oneida	33	102,587	5,448	21,816,805	21,942,752	2	125948
44	Clinton	10	35,637	7,994	21,942,754	21,993,496	2	50743
45	Washington	58	28,256	-1,033	21,993,498	22,030,574	2	37077
46	Dutchess	14	151,889	-19,027	22,030,576	22,201,830	2	171255
47	Jefferson	23	44,129	7,719	22,201,832	22,261,962	2	60131
48	Rockland	44	151,381	-8,627	22,261,964	22,437,102	2	175139
49	Otsego	39	28,223	-2,414	22,437,104	22,472,255	2	35152
50	Steuben	51	46,516	1,909	22,472,257	22,530,584	2	58328
51	Greene	20	25,320	-3,616	22,530,586	22,561,813	2	31228
52	Erie	15	476,913	123,825	22,561,815	23,362,226	2	800412
53	Monroe	28	383,499	19,554	23,362,228	23,808,701	2	446474
54	Rensselaer	42	79,962	-8,085	23,808,704	23,914,045	3	105342
55	Wyoming	61	19,483	2,627	23,914,047	23,952,246	2	38200
56	Buffer 3			0	23,952,247	24,034,202	1	81,956
57	Putnam	40	55,320	-18,069	24,034,203	24,096,076	1	61874
58	Cortland	12	21,893	-1,604	24,096,078	24,125,656	2	29579
59	Buffer 4			0	24,125,657	34,125,657	1	10,000,001
60	Richmond	43	217,899	5,289	34,125,658	34,377,091	1	251434
61	St.Lawrence	50	45,267	8,303	34,377,093	34,439,638	2	62546

Figure 4 County section SBOEID number ranges

The effect of keeping an SBOEID number "for life" but changing CID numbers depending on moves to different counties, is that some voters have mismatched SBOEID and CID numbers. They also have multiple records in the NYS voter roll database. These records are distinct from the 11 records in Chaim Metzner's name because those records have the same address and county code but different SBOEID numbers. From the perspective of the NYBOE, Chaim's 11 SBOEID numbers represent 11 distinct individuals. Multiple CID numbers attached to the same SBOEID number are counted as one individual.

In combination with the out of range partitions, which do not respect county boundaries, mismatched SBOEID and CID numbers are sufficient to thoroughly mask the existence of partitions within the state and county sections. The ranges assigned to individual counties also become very difficult to find (Figures 5 and 6).

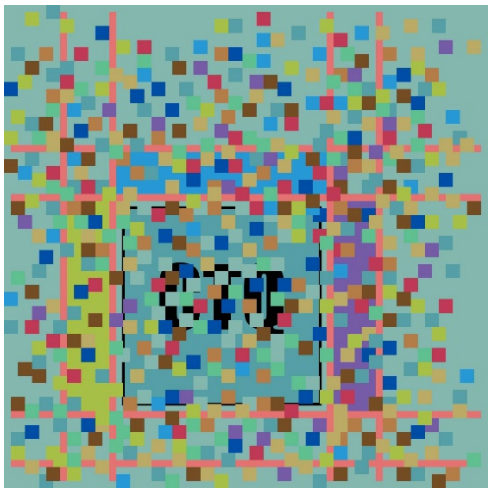


Figure 5 Chautauqua County partition, masked by out of range and mismatched SBOEID numbers

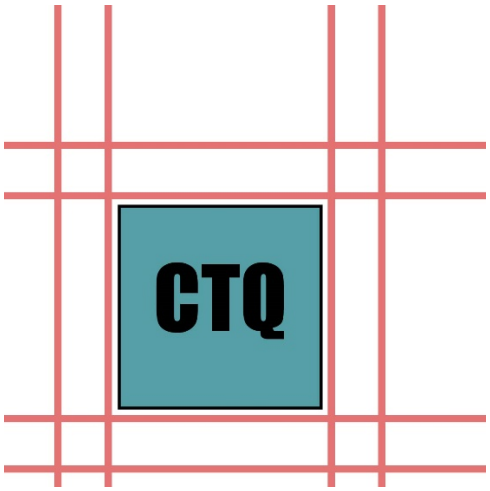


Figure 6 Chautauqua County partition, filtered by county range with mismatched SBOEID/CID numbers removed

Obfuscation method 5: Sort order

The algorithm-generated pattern in the NY voter rolls is absolutely dependent on correct filtering and sort order. The first step toward making the pattern visible is to filter SBOEID numbers by county range. This is impossible unless the county range is known, which in turn is impossible of the existence of in range and county range partitions are unknown. Second, SBOEID numbers must be filtered again by county code. This step removes SBOEID/CID incongruences. Third, the found set must be sorted by CID numbers (Table 3). However, the pattern will remain invisible until another step is taken.

Table 3 SBOEID numbers sorted alphabetically by last name (left) and by CID (right)

Alpha sort	
SBOEID	CID
20298357	380
20299357	400
20299134	397
20298801	390

CID sort	
SBOEID	CID
20298357	380
20298468	386
20298579	387
20298690	388

20298912	391	20298801	390
20298579	387	20298912	391
20299245	399	20299023	395
20299023	395	20299134	397
20298468	386	20299245	399
20298690	388	20299357	400

Obfuscation method 6: Calculation

The last step required to make the pattern visible is to add a column to the database and perform a simple calculation. Each SBOEID number must be subtracted from the next, in the sequence created by all the previous steps. This reveals the pattern (Figure 6). The gap between each pair of SBOEID numbers is a “Gap Unit”.

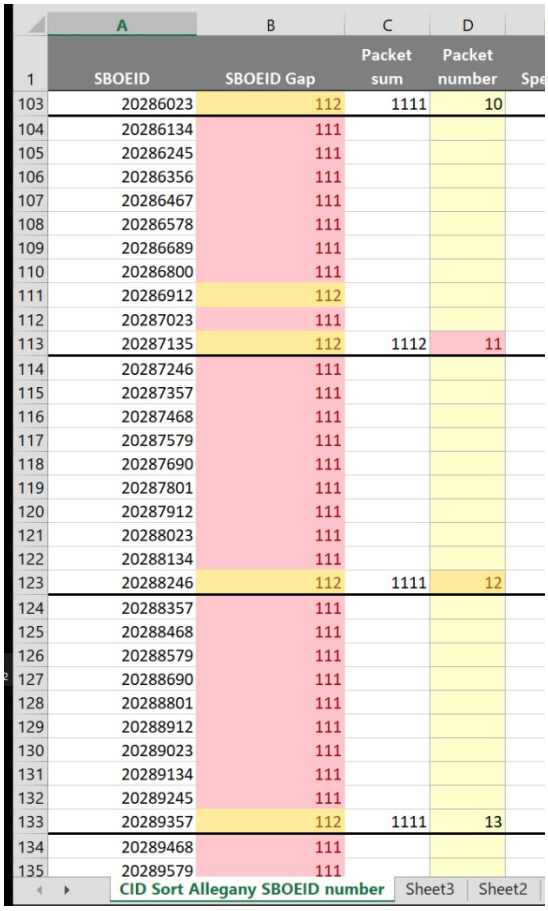
SBOEID	CID	SBOEID Gap	SUM
20288218	23	1111	
20289329	25	1111	
20290440	26	1111	
20291551	27	1111	
20292662	31	1111	
20293773	33	1111	
20294884	36	1111	
20295995	37	1111	
20297106	38	1111	
20298218	**39**	1112	**11111**

Figure 7 Ten rows demonstrating the SBOEID pattern found within the Allegany County voter rolls

The pattern is far more complicated than is visible in Figure 7. What it shows is 10 SBOEID numbers organized into one packet comprised of the numbers “1111” and “1112”, where 1111 is the body of the packet and 1112 defines the end of the packet. These are in turn organized in groups of 10 packets (100 SBOEID numbers). The number 1,111 is known as a “repunit”, or “repeating unit.”

A “repunit” is a number that is composed of nothing but the same number. For instance, the numbers “11”, “111”, “1,111”, “11,111”, and “111,111” are all repunits[12]. The first group of 10 packets uses the repunit “1,111” punctuated by “1,112” to define the first and last packets in its range (Figure 8). However, the constants of the pattern are not the numbers “1,111” and “1,112”, but repunits based on the number “1” or the same repunit +1, which creates a product ending with the number “2”. In this way, each group of 10 SBOEID numbers is bounded by a repunit that ends in 2. Another quality of this grouping is that 10 repunits comprised of 1’s will not equal the next higher order of repunit. However, 10 of these repunits plus 1 does equal the next order of repunit. For instance, 10 times 111 equals

1,110. Add 1 and the sum is 1,111. This is why the tenth number in each of these sequences is counted as a repunit +1 instead of 1,112.



	A	B	C	D
1	SBOEID	SBOEID Gap	Packet sum	Packet number
103	20286023	112	1111	10
104	20286134	111		
105	20286245	111		
106	20286356	111		
107	20286467	111		
108	20286578	111		
109	20286689	111		
110	20286800	111		
111	20286912	112		
112	20287023	111		
113	20287135	112	1112	11
114	20287246	111		
115	20287357	111		
116	20287468	111		
117	20287579	111		
118	20287690	111		
119	20287801	111		
120	20287912	111		
121	20288023	111		
122	20288134	111		
123	20288246	112	1111	12
124	20288357	111		
125	20288468	111		
126	20288579	111		
127	20288690	111		
128	20288801	111		
129	20288912	111		
130	20289023	111		
131	20289134	111		
132	20289245	111		
133	20289357	112	1111	13
134	20289468	111		
135	20289579	111		

CID Sort Allegany SBOEID number | Sheet3 | Sheet2

Figure 8 the start of the first sequence of 10 packets on row 111, with the addition of "112" within a packet, denoting the end of 100 SBOEID numbers contained within 10 packets of 10 numbers

Pattern characteristics

The SBOEID sort order patterns found within the Allegany voter rolls follow a mathematical logic bounded by well-defined rules. They are the product of algorithmic manipulation. For that reason, the word "pattern" in this article is used to describe the product of the algorithm and "algorithm" is used to describe the process used to create the pattern.

The algorithm assigns SBOEID numbers to specific CID numbers to produce the desired gap unit pattern without ever overlapping previously assigned numbers. This is not a trivial task from a mathematics or programming perspective.

Repunits

Gap units in the Allegany voter rolls contain the 5 repunits "11,111", "1,111", "111", "11" and "1". It also contains the 4 modified repunits "1,112", "112", 12", and "2". These 9 numbers are referred to as "special numbers" for the remainder of this article. The 9 special numbers collectively appear 27,633

times out of 27,847 total gap units. The remaining 214 numbers generally do not repeat unless they are a multiple of 11, such as “22” and “33” (Table 4). Another type of number that appears is any one of the repunits added to the number “12”, such as “23” (11+12) and “123” (111+12). These numbers are referred to as “compound units”.

Table 4 Allegany repunit count and characteristics

value	count	multiplied	start row	end row	gap	range
11111	1	11111	4	4		
1111	21	23331	6	29	2	24
111	223	24753	31	284	2	254
11	2228	24508	286	2824	2	2539
1	21919	21919	2826	27847	2	25022
Totals	24392	105622				
value	count	multiplied	start row	end row	gap	range
11112	0	0				
1112	2	2224	13	23		11
112	27	3024	33	275	10	243
12	278	3336	295	2819	20	2525
2	2934	5868	2827	27843	8	25017
	3241	14452				

Quarter Repunits

If any repunit is divided by 4, it yields a “quarter repunit” (Table 5). Quarter repunits and multiples of quarter repunits, are found throughout in-range SBOEID gap values when sorted by CID numbers. The first, a full quarter repunit, always appears in row 3. The second appears in row 5 as 3 quarter repunits. Between them is a full repunit that is the sum of the 2 quarter repunits it is bracketed by. The most common quarter repunits in the county patterns is a single quarter repunit (2,777.75) and a triple quarter repunit (8,333.25). Together, they equal a full repunit (11,111).

Table 5 Repunits and quarter repunits

CONSTANTS	1	2	3	4	5	6
RepUnit	1	11	111	1,111	11,111	111,111
RepUnit +1	2	12	112	1,112	11,112	111,112
RepUnit /4	0	3	28	278	2,778	27,778
Diff to prev	0	3	25	250	2,500	25,000
RepUnit /4 *2	1	6	56	556	5,556	55,556
Diff to prev	0	5	50	500	5,000	50,000
RepUnit /4 *3	1	8	83	833	8,333	83,333
Diff to prev	0	8	75	750	7,500	75,000
RepUnit /4 *5	1	14	139	1,389	13,889	138,889

Repetition

Each of the special numbers repeats as many times as it can within the county range of numbers without intruding on numbers needed to assign all remaining SBOEID numbers. In Allegany, the total range of numbers allows for 28,068 unique SBOEID numbers. Of that range, 222 numbers (another repunit) are unassigned.

The number 11,111 appears only once the Allegany rolls. The number 11,111 is low enough to appear twice within the Allegany county range but not if it is to allow room for other numbers. Because 11,111 only appears once, it is not bounded by “11,112” at the end of each sequence. In contrast, Kings County has more than 1,000,000 in-range records. The highest repunit value found there is 111,111 and it appears 5 times. The 5 Kings county 111,111’s are separated by one 111,112 (Table 6).

Table 6 Kings County special number count (Note that the Kings County pattern is slightly different than Allegany)

Number	Count	Value
1,111,111	0	0
111,111	5	555,555
11,111	92	1,022,212
1,111	936	1,039,896
111	9,219	1,023,309
11	40,660	447,260
1	804,046	804,046
Subtotal	854,958	
111,112	1	111,112
11,112	11	122,232
1,112	116	128,992
112	1,149	128,688
12	5,061	60,732
2	159,413	318,826
Subtotal	165,751	
Total	1,020,709	97.34%

Position

The Allegany algorithm begins each sequence with the highest number first. Once it has used as many numbers as will fit within the range without obstructing other gap units, it removes the first digit from the special numbers. For instance, “11,111” becomes “1,111”. It then continues until it has used up its allotment of the current number and then drops another leading digit, and so on (Figure 9). The angles generated by these values becomes progressively shallower as the numbers decrease.

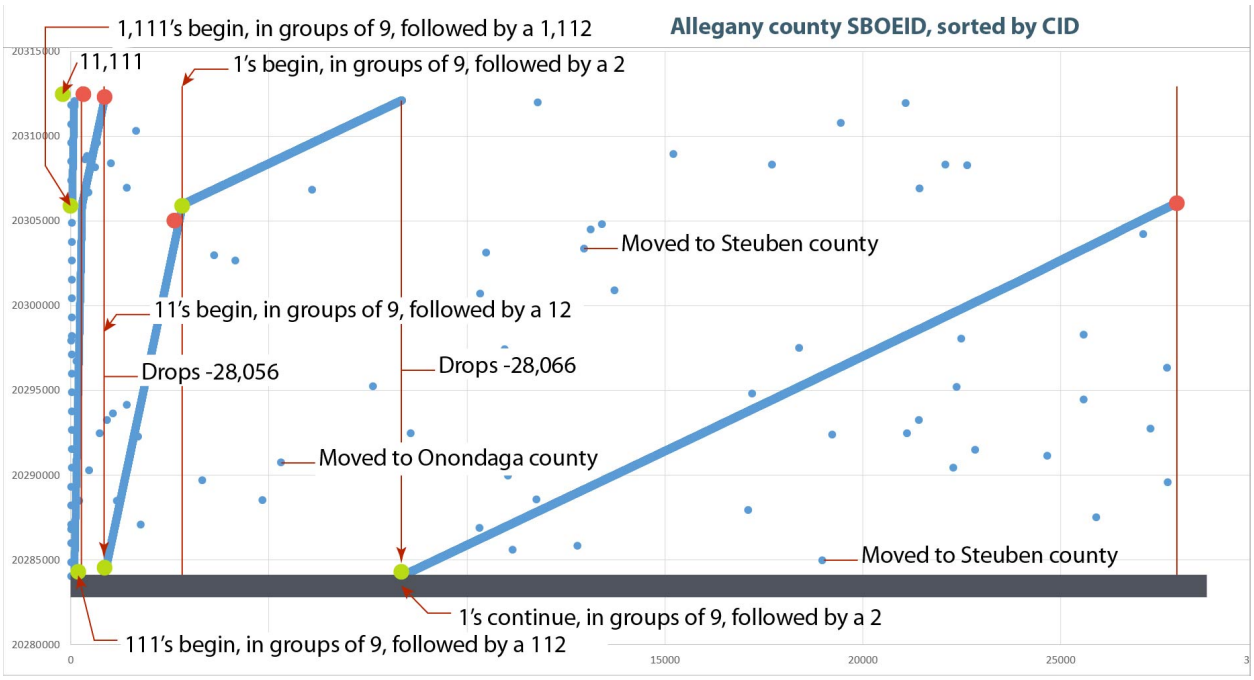


Figure 9 Allegany SBOEID numbers (Y axis) sorted by CID number (X axis) with unfiltered strays

Obfuscation method 7: Interference

Of some interest, the first repunit, 11,111, appears near the maximum limit of the county range. As each repunit approaches the ceiling allowed by the county range, it drops near to the bottom of the range. These drops create regular interference in the pattern. It is not the only form of interference that appears but one of many. Each interference type offsets the numbers in the series unless handled appropriately, and disrupts the pattern. In these cases, the interference is insufficient to camouflage the presence of the pattern but is sufficient to change the values so that any data encoded by the algorithm is affected (Table 7). Note the symmetry of the value changes from one drop value to the next and the row spacing between each occurrence of a number in the series. There is a symmetrical relationship where one value is increased by a factor of 10 as the other number also increases by a factor of 10.

Table 7 Allegany County drop value series

ROW	Value	Diff	spacing
11	-26956		
86	-27956	-1000	75
845	-28056	-100	750
8355	-28066	-10	7500

The way to deal with intrusive numbers that are not special or compound special numbers is to count them as a normal row (figure 9).

1	SBOEID	Flagged	SBOEID Gap	Gap transform	ACTION	Count 1112 groups	Count 1111 groups	Gap	Frame	Count by 100	Count 75, 750, 7500	CID Number	CID gap
2	20284051				End UNK		1	1	1	91		1	
3	20286829		2778		GAP		2	2	2	92		2	1
4	20297940		11111		Start/End 11,111		3	3	3	93		4	2
5	20306285		8345		GAP			1	4	94		7	3
6	20307396		1111		Start 1,111		1	2	5	95		8	1
7	20308507		1111				2	3	6	96		9	1
8	20309618		1111				3	4	7	97		10	1
9	20310729		1111				4	5	8	98		15	5
10	20311840		1111				5	6	9	99		16	1
11	20284884		-26956				6	7	10	100		17	1
12	20285995		1111				1	8	11	1	1	19	2
13	20287107		1112		Start 1,112	1	2	9	12	2	2	20	1
14	20288218		1111			2	3	10	13	3	3	23	3
15	20289329		1111			3	4	11	14	4	4	25	2
16	20290440		1111			4	5	12	15	5	5	26	1
17	20291551		1111			5	6	13	16	6	6	27	1
18	20292662		1111			6	1	14	17	7	7	31	4
19	20293773		1111			7	2	15	18	8	8	33	2
20	20294884		1111			8	3	16	19	9	9	36	3
21	20295995		1111			9	4	17	20	10	10	37	1
22	20297106		1111			10	5	18	21	11	11	38	1
23	20298218		1112		End 1,112	11	6	19	22	12	12	39	1
24	20299329		1111				1	20	23	13	13	42	3
25	20300440		1111				2	21	24	14	14	44	2
26	20301551		1111				3	22	25	15	15	46	2
27	20302662		1111				4	23	26	16	16	47	1
28	20303773		1111				5	24	27	17	17	48	1
29	20304884		1111		End 1,111		6	25	28	18	18	50	2
30	20305979		1095		GAP			26	29	19	19	51	1
31	20306090		111		Start 111		1		30	20	20	52	1
32	20306201		111		GAP		2		31	21	21	53	1
33	20306313		112		Start 112		3		32	22	22	55	2

Figure 10 the first 33 rows of the Allegany County pattern

Another form of interference are numbers that are divisible by repunits. When these numbers appear as gap values, they must be counted as a number of rows equal to the product of the calculation *n*/current repunit. Therefore, the number 22 in a row signifies that the row must be counted as 2 rows to complete the 9x1, 1x2 10 row packet structure. In the same way, the numbers “33” and “3” are used numerous times toward the end of the series to count as 3 rows. Repunit multiples like these may be the product of deleted records or abfuscation.

Structure

The algorithm is based on 2 values: the minimum SBOEID number in a county range and the total number of values between and including the minimum and maximum value for each county’s range. For instance, the lowest SBOEID number (MIN) assigned to the in-range portion of Schenectady County is 9,382,494. The MIN value is always the first number after the header (Row 2) after sorting by CID. The sum of the 3rd through 10th rows (9,474,884) is equal to the MAX SBOEID number (9,477,662) minus the highest quarter repunit (2,778). The total range (95,169) is equal to the gap between each of four drop values plus 1. The MAX SBOEID is located at Row 82,885 (a triple quarter repunit). Directly below it is the second-lowest SBOEID number. Using only the MAX SBOEID, the start, end, and total range for each county can be determined by comparing it to the previous row.

Table 8 MAX SBOEID value and MIN +1, Schenectady County

Row	CID	Short ID	SBOEID Gap	Dist to MIN	Dist to MAX
82885	382786	9477662	1	95168	0
82886	382787	9382495	95167	1	95167

The MAX SBOEID is the 5th and last "Drop Value" in Schenectady County. Drop values are spaced at regular but uneven intervals of 75, 750, 7,500, and (in large counties) larger number of rows, each increasing by a power of 10. Drop values are used to reduce a number from just below the maximum assigned number to near the minimum assignable value. These are used as often as needed to keep SBOEID numbers within the county range. Quarter repunits serve a similar purpose: they ensure that SBOEID numbers never repeat.

The total list of SBOEID numbers is arranged as follows (Appendix 2):

1) MIN SBOEID
2) Next 8 rows = highest repunit in county, sum =MAX SBOEID –highest quarter repunit
3) Next row (Row 11) Drop Value 1 (added to previous row = total range
4) Row 13, first lower order repunit +1 ends first packet of 10 rows started at row 4
5) Row 14-23 = second packet of 10 rows, continues until next drop unit
6) Row 111 = End first 100 packet counter (an additional repunit +1 inserted within a 10 row packet), continues every 100 rows
7) Drop 2, repunits drop to next lowest order (1,111 to 111, etc)
8) Drop 3, repunits drop to next lowest order (111 to 11, etc)
9) Last drop unit (also a triple quarter repunit) = MAX

New York State

Algorithms in every county

After the Allegany work was complete, the task of checking other NY counties was handed off to NYCA. They found the presence of algorithm-produced patterns in all 62 counties. They produced scatterplots of SBOEID numbers sorted by CID numbers to visualize the patterns. A few are presented below to provide an idea how consistent they are (Figures 10-12.

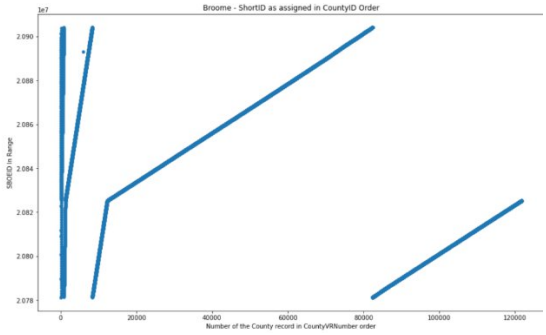


Figure 11 Broome County SBOEID numbers, sorted by CID numbers

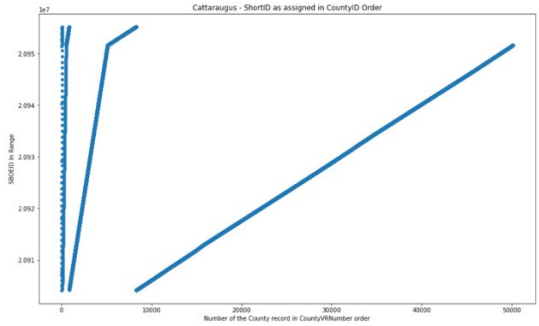


Figure 12 Cattaraugus County SBOEID numbers, sorted by CID numbers

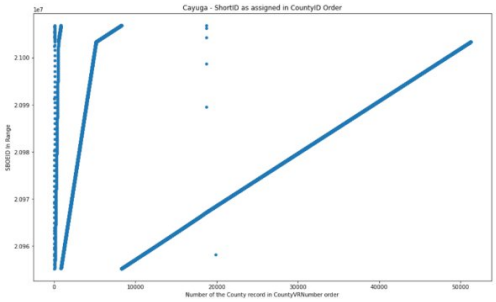


Figure 13 Cayuga County SBOEID numbers, sorted by CID numbers

4 Algorithms

In total, 5 algorithms are found in New York's 62 counties. Each of the 5 algorithms was named based on their properties as follows: "Spiral", "Inverse Spiral", "Metronome", "Motion Blur" and "Tartan". The Allegany algorithm is an example of the Spiral pattern. The 5 counties of New York City (Kings, Queens, New York, Bronx, and Richmond) use the Inverse Spiral algorithm (Figure 13). This algorithm is the same as the Spiral pattern but inverted by sorting CID numbers in descending order instead of ascending.

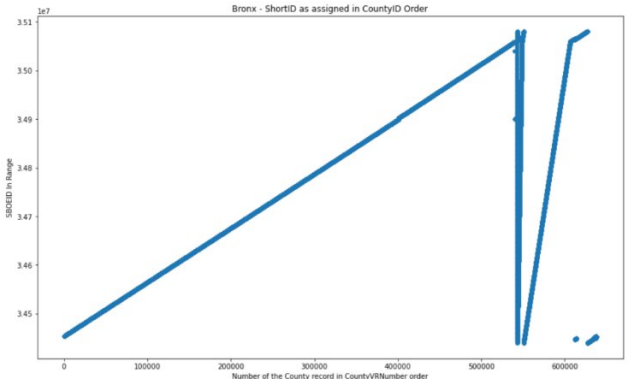


Figure 14 Bronx algorithm, "Inverse spiral"

The Metronome pattern starts in the center of a county's range. It then assigns numbers to the extreme high end of the range followed by the extreme low end, and then swings back and forth between either extreme, assigning numbers on either side and near the center as it traverses the range. The final effect is of a solid brick of blue dots in a scatterplot. The metronome pattern is more visible in a detail plot of

any small section of the range (Figures 14-16). One expert consulted on these findings described the pattern as the product of a “Pachinko Algorithm”.

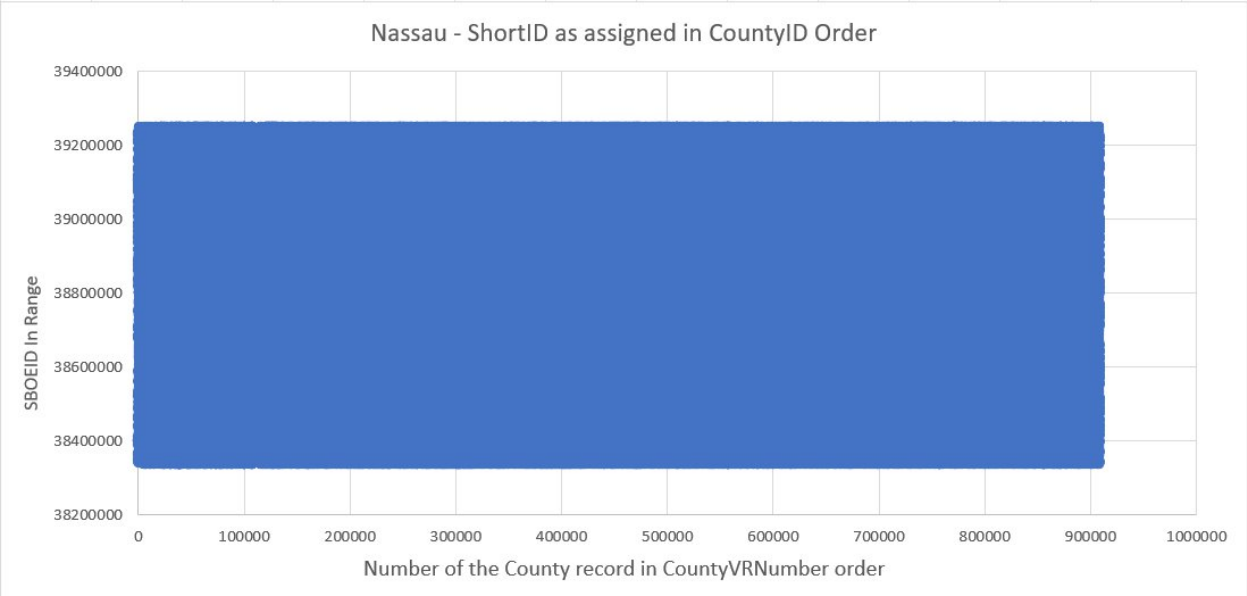


Figure 15 Nassau County scatterplot of SBOEID numbers sorted by CID numbers; "Metronome" pattern

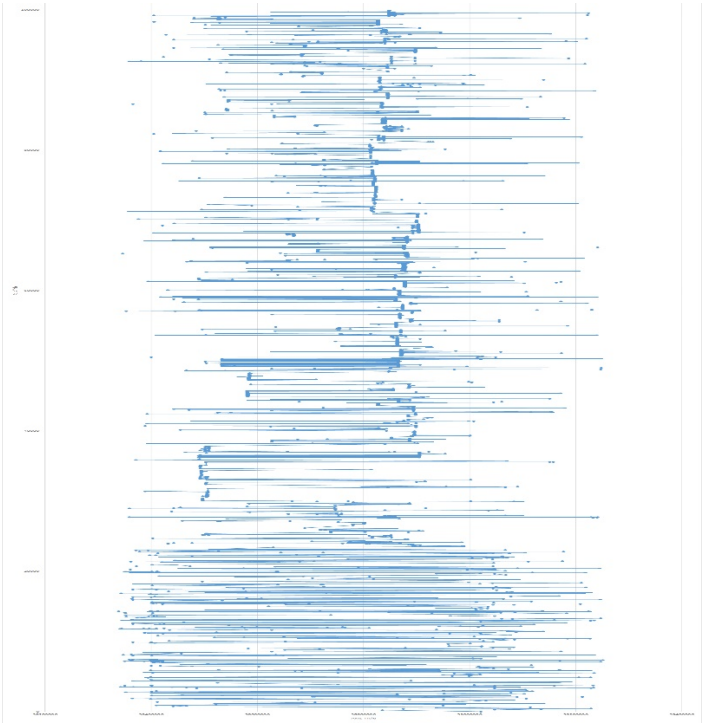


Figure 16 Detail, Nassau County Metronome scatterplot

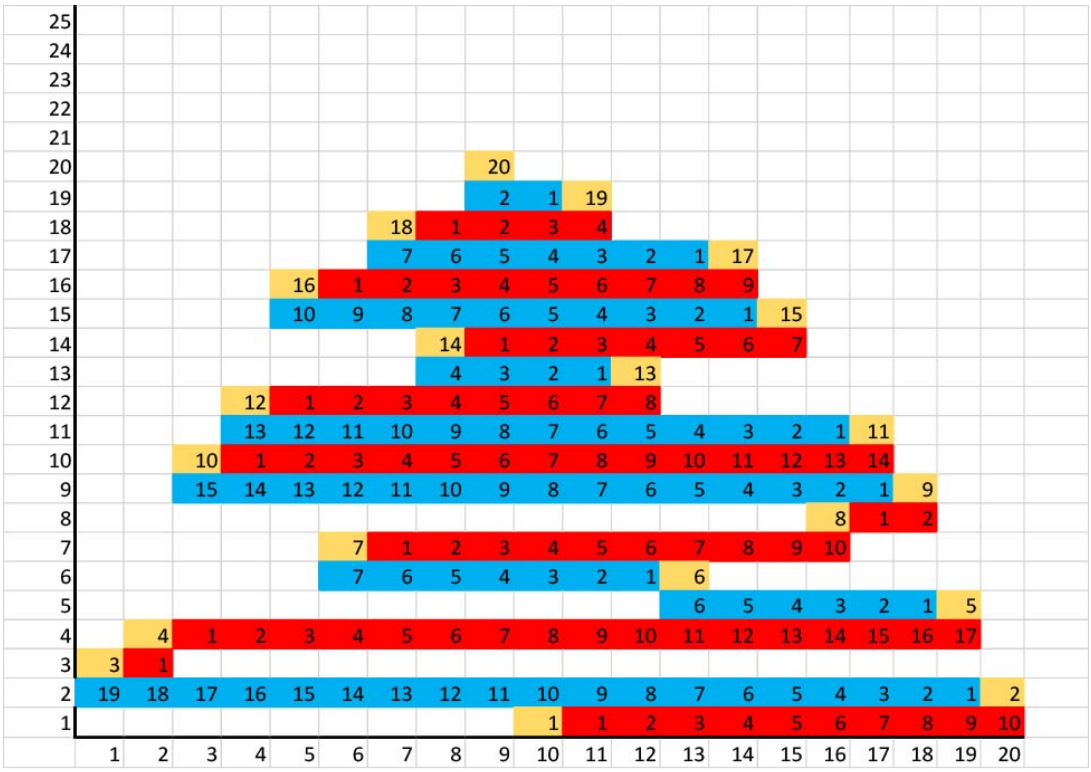


Figure 17 Metronome number assignment pattern, Yellow = number/order of assignment, Red=Positive direction, Blue= Negative direction

The Motion Blur algorithm resembles the Spiral but has significant offsets to create a “blur” effect.

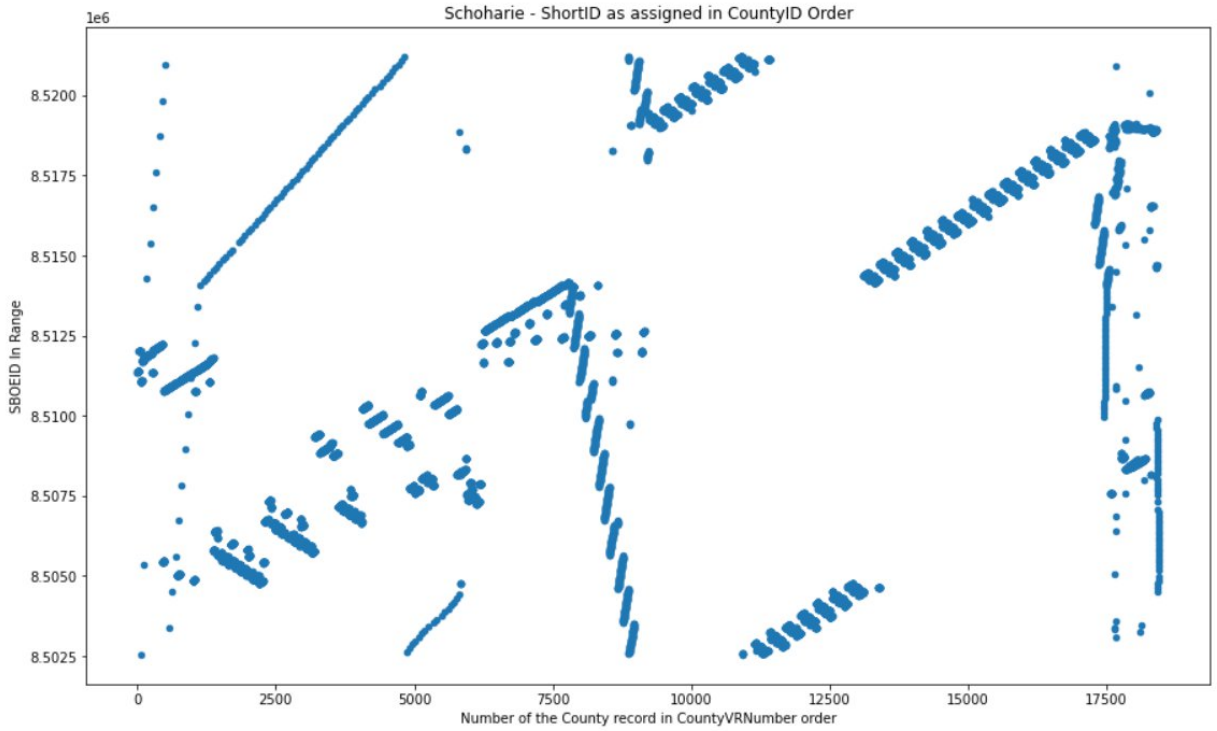


Figure 18 Schoharie "Motion Blur" algorithm

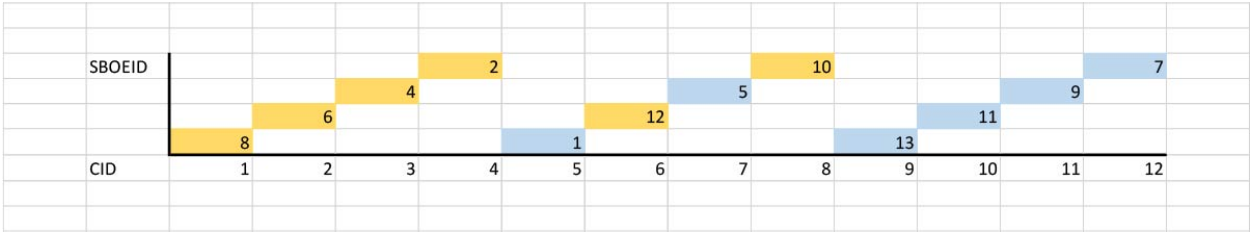


Figure 19 Schematic of Blur pattern, close-up view; Yellow=Even numbers, Blue=Odd Numbers

The following county voter roll records contained patterns produced by these 4 algorithms:

Spiral (52 counties): Albany, Allegany, Broome, Cattaraugus, Cayuga, Chautauqua, Chemung, Chenango, Clinton, Columbia, Cortland, Delaware, Dutchess, Essex, Franklin, Fulton, Genesee, Greene, Hamilton, Herkimer, Jefferson, Lewis, Livingston, Madison, Monroe, Montgomery, Niagara, Oneida, Onondaga, Ontario, Orange, Orleans, Oswego, Otsego, Putnam, Rensselaer, Rockland, Saratoga, Schenectady, Schuyler, Seneca, St. Lawrence, Steuben, Suffolk, Sullivan, Tioga, Tompkins, Ulster, Warren, Washington, Wayne, and Yates.

Reverse spiral (5 counties): Bronx, Kings, New York, Queens, and Richmond (collectively, “New York City”)

Metronome (4 counties): Erie, Nassau, Westchester, Wyoming

Motion blur (1 county): Schoharie

A member of the NYCA research team pointed out that counties using each of the 4 algorithms had been previously identified as groups based on distinctive behavior found in other research. For instance, the five counties of New York City have more discrepancies between vote counts provided by Secretary of State and the state board of elections than any other counties. Those discrepancies are significantly out of proportion to their population and the populations of other counties. For instance, there are 345,990 registered voters in Richmond County, one of the 5 New York City counties. Onondaga County has 329,306 registered voters but the number of vote count discrepancies in their county barely registers in a graph comparing all 62 counties (Figure 19).

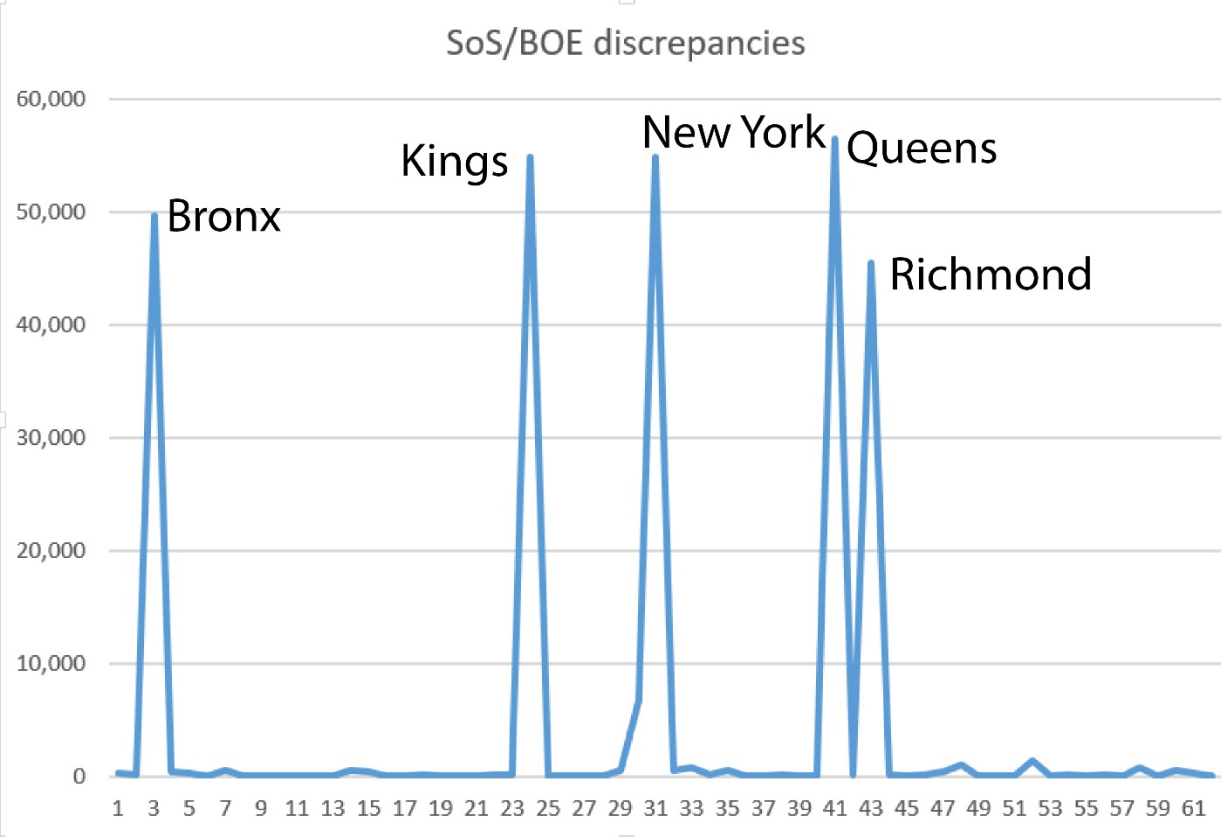


Figure 20 NYC vote count discrepancies

Another grouping characteristic, this time found in “Metronome” counties, are extraordinarily high registration rates relative to other counties (Figure 20).

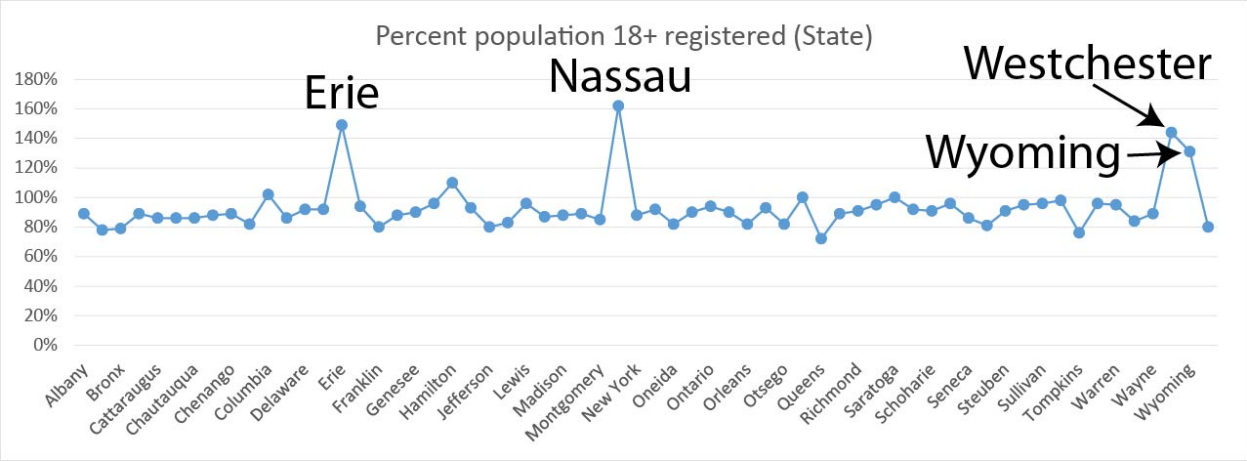


Figure 21 Registered population in Metronome counties exceeds all other counties

Schoharie County stands out for having very low fraud indications relative to other counties. In most categories, they either have no known examples or the number is within the lowest 5 values for the state.

The fifth pattern identified in New York to date is the “Tartan” pattern. The Tartan appears in the out of range partition for all counties. It is characterized by a grid-like structure composed of “Lines”, “Squares”, and “Gradients” (Figure 21).

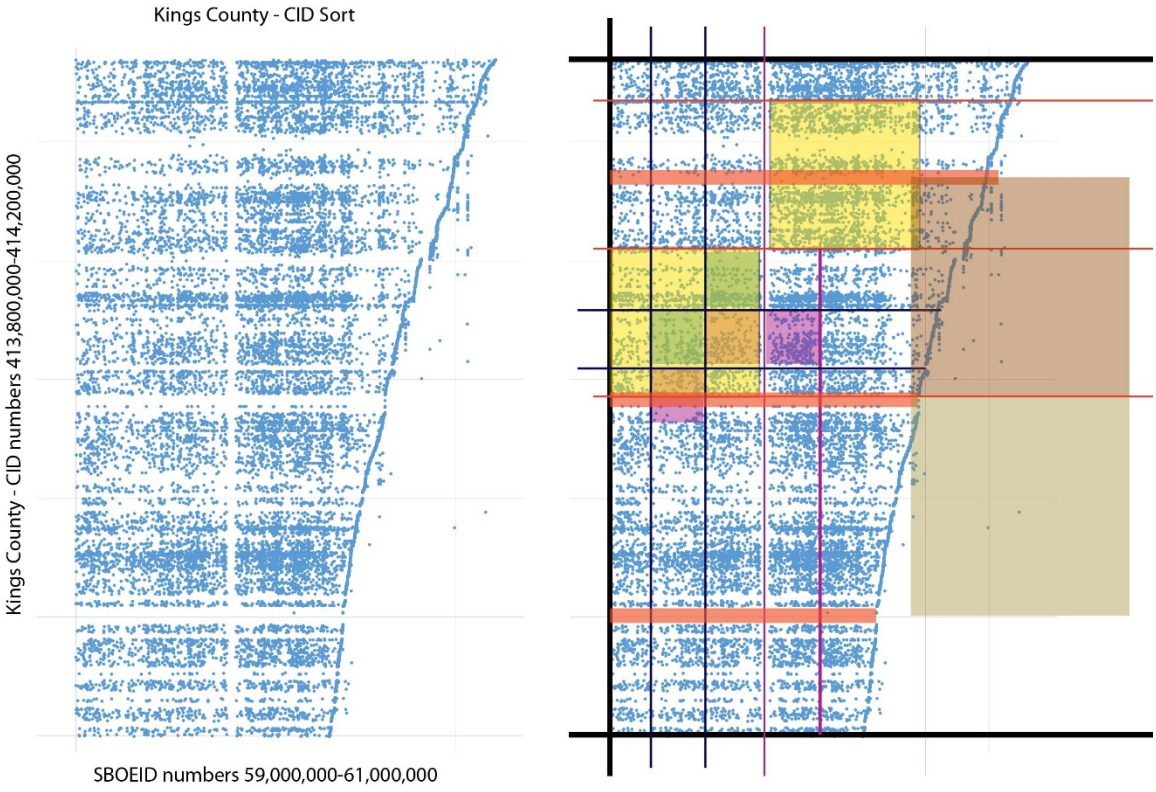


Figure 22 Kings County out of range section illustrates the "Tartan" pattern

The two most distinctive characteristics of the Tartan pattern are: 1) squares divided by lines and 2) gradients between and within lines. The gradients are formed by a concentration of one county's SBOEID numbers on one side of a square or line, blended with a concentration of another county's numbers from the other side (Figure 22).

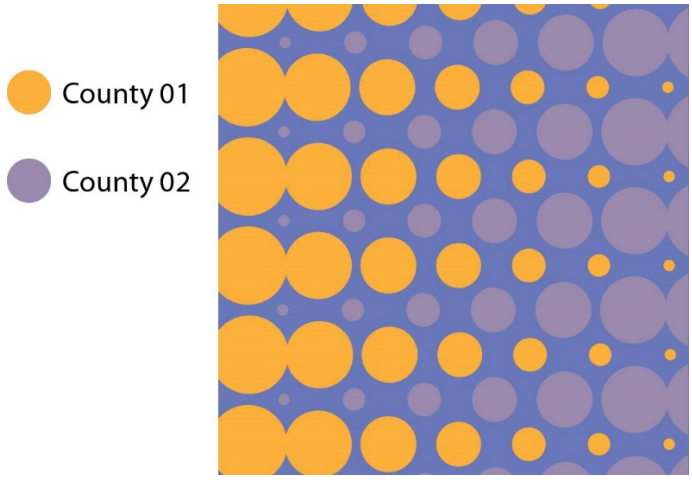


Figure 23 Out of Range gradient

Numbers assigned to out of range regions adhere to a county-specific structure. Ranges for counties in this area are defined as shapes rather than a range defined by minimum and maximum values. For instance, In the Kings County chart, vertical and horizontal white lines are visible. These areas have no numbers assigned to them from Kings. However, other counties are assigned numbers within those ranges, thus allowing them to fill in the lines. Another characteristic of the Tartan pattern is that it makes "gradients" out of the numbers. It first creates vertical and horizontal "walls" and then it assigns numbers near the walls first, then farther away, then farther than that. The result looks akin to dripping water or paint (Figure 22).

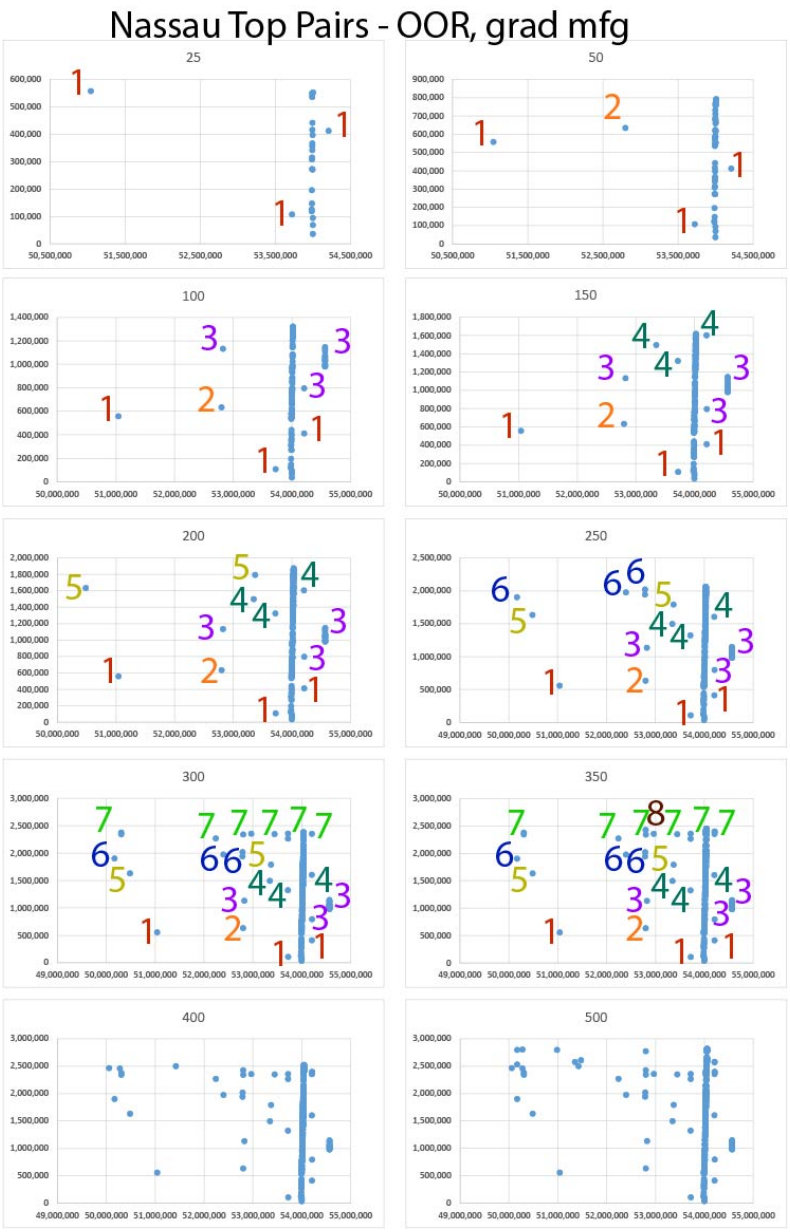


Figure 24 Nassau County; SBOEID distribution over time

Out of Range

Preliminary work on the high out of range partition reveals a complex algorithm that links SBOEID numbers from different counties in a carefully interlaced pattern. This pattern resembles a tartan, or Scottish plaid. One quality of the Tartan region is that most of the known phantom SBOEID numbers are found here. Phantom SBOEID numbers appear in segregated sections of the tartan region. For instance, a scatterplot of Erie voters shows a “staircase” pattern of shingle-like shapes (Figure 24). The yellow values in the plot have been flagged for various reasons, and the black values are high confidence phantom SBOEID numbers. The density of phantom SBOEID numbers in the upper right portion of the staircase is striking, as is the fact that the entire staircase is made of flagged SBOEID numbers. Non-flagged numbers appear elsewhere in the grid portion of the pattern.

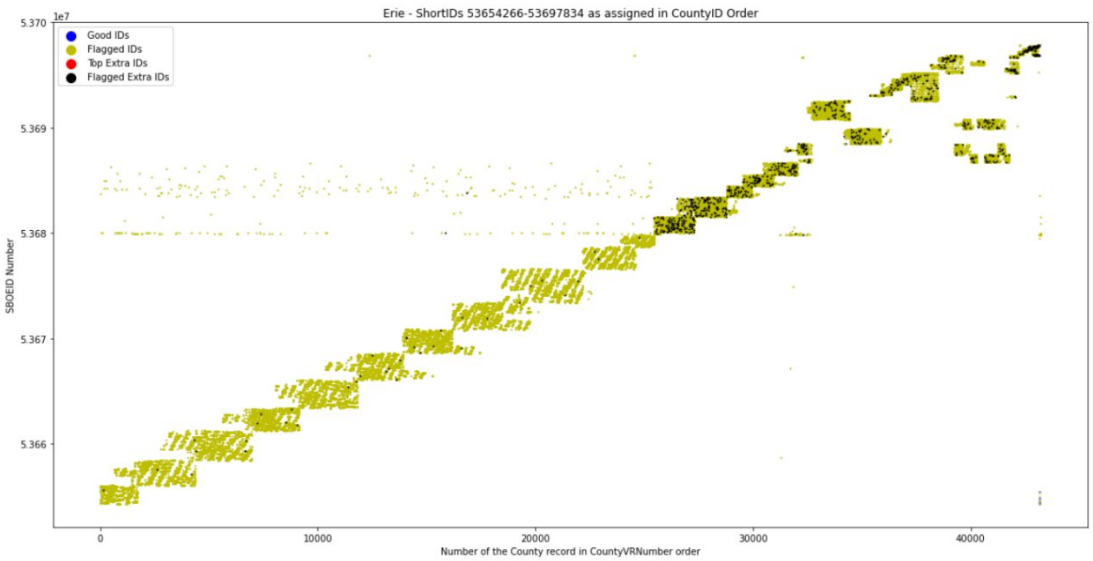


Figure 25 Erie County "shingle" pattern in Out of Range section, phantom SBOEIDs in black.

Another example comes from the low Out of Range region. In this chart, most high confidence phantom SBOEID numbers appear close together and apart from other values (Figure 25).

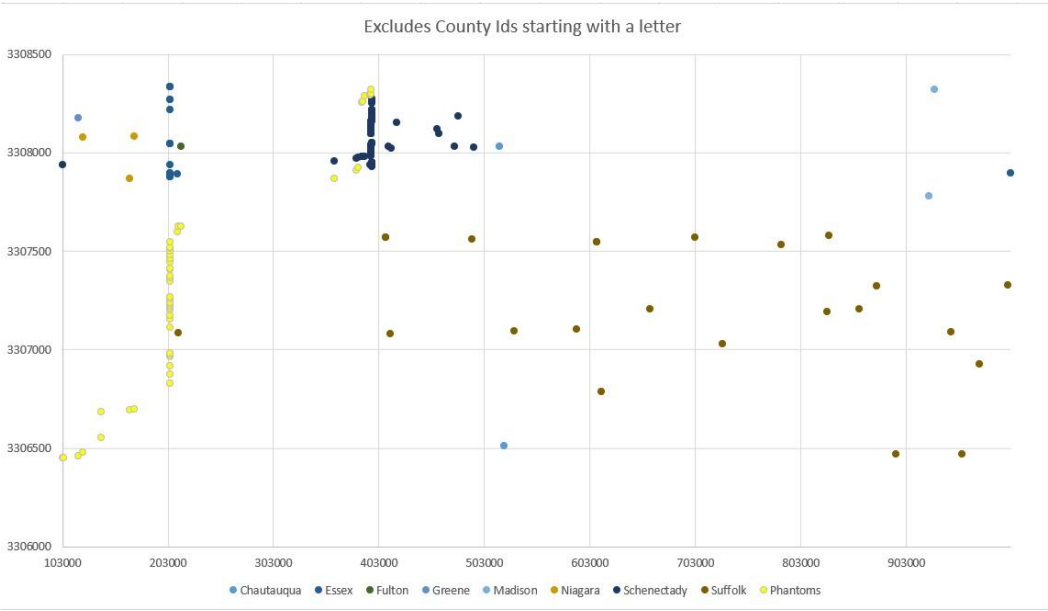


Figure 26 Low Out of range SBOEID numbers, with phantom cluster on lower left

The implication of these findings is that high confidence phantom SBOEID numbers are segregated from other numbers within the voter rolls.

Algorithms in other states

The NYCA team looked for signs of algorithm use in voter roll and election-related data from Pennsylvania, Ohio, Idaho, Oklahoma, and Texas. In Pennsylvania, the team found examples of the Metronome pattern used in mail-in voting and in their voter rolls. A chart of walk-in vs. mail-in ballot

identification numbers arranged by precinct has distinct patterns for each category. Walk in voters appear in an ascending line, mail-in ballots appear as a solid blue brick, easily recognizable as an example of the Metronome pattern (Figure 26). The same phenomenon is visible in charts for Colorado and Florida.

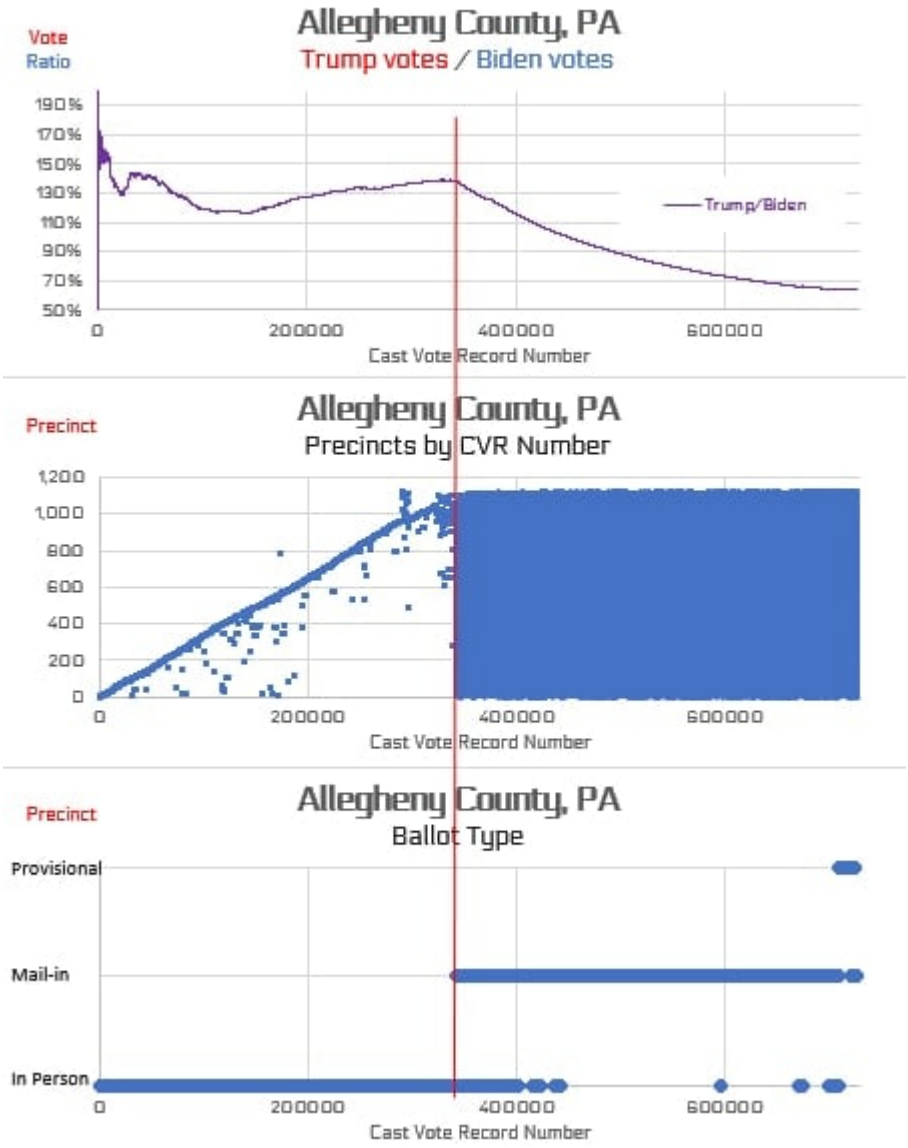


Figure 27 The Metronome pattern in Allegheny County Pennsylvania mail-in votes

Ohio's voter rolls were the most similar to New York's, because they used both CID and SBOEID numbers, unlike some states. All but one of the Ohio counties reviewed by NYCA appeared to have the Tartan algorithm hidden in their voter rolls (Figure 27).

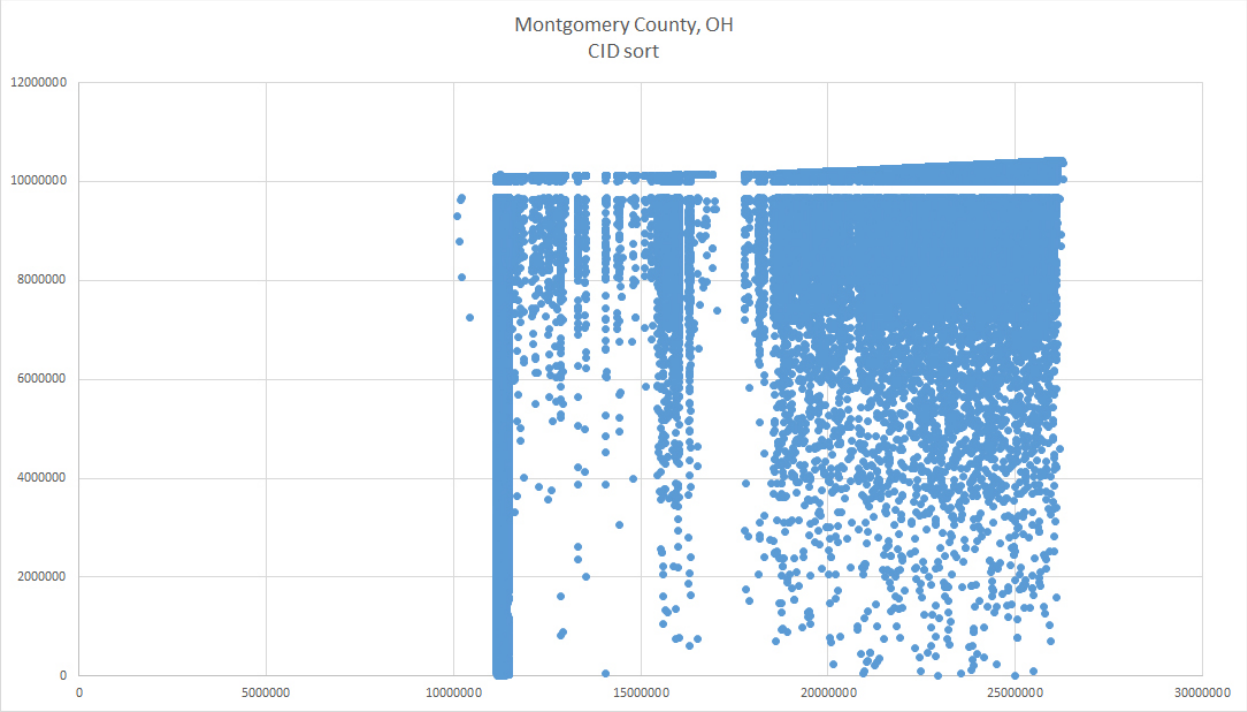


Figure 28 Montgomery County, Ohio, example of Tartan pattern.

On closer examination, a secondary pattern is visible in the Ohio and out of range New York scatterplots: series of quarter arcs. These arcs are rotated at different angles and appear to be part of the method used to create the appearance of evenly-distributed SBOEID numbers. When a cryptography expert was shown this chart, he described it as an example of a “Pachinko Algorithm”. The Pachinko Algorithm is based on a gambling machine popular in Japan, known as Pachinko. Pachinko resembles a vertical pinball board wherein ball bearing are dropped from the top of the table and then bounce in random fashion off of brass pins embedded in the play surface. The pins are often arranged in quarter arcs designed to protect certain portions of the play field.

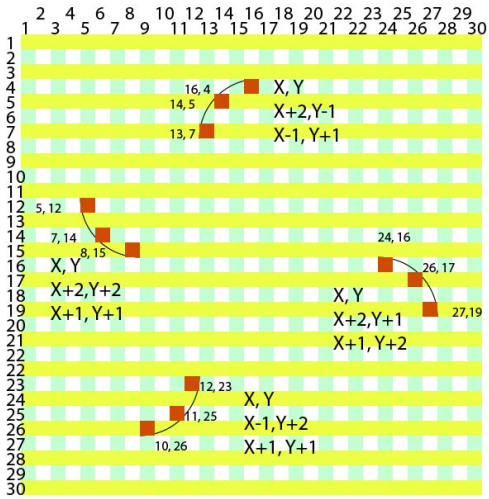


Figure 29 "Pachinko" arcs found in Ohio and out of range New York

Discussion

New York State's voter rolls contain SBOEID numbers assigned by an algorithm. The algorithm links CID numbers to SBOEID numbers in a manner designed to produce a specific SBOEID sort order when records are sorted by CID number. The dependency between CID and SBOEID numbers requires that county ranges are fixed, or the sort order would be disrupted. That sort order makes it possible to perform a simple calculation on all SBOEID numbers in most counties to produce a coherent and logical series of numbers[1]. The series of numbers thus produced creates a 1 unit, 10 unit, and 100 unit grouping structure, or "matrix". The matrix reorganizes SBOEID numbers based on the algorithm used. The groups thus produced are hidden from any user who is unaware of the algorithm and the several steps needed to reveal it.

The obfuscation techniques utilized to hide the SBOEID matrices is a combination of 2 techniques known as "data masking" and "data shuffling" in the Information Security (IS) industry. Data masking is used to disguise the existence of county ranges and the need to perform a calculation to reveal the pattern. Data shuffling is used to provide access to specific SBOEID numbers via a specific but hidden calculation.

Another way to look at the grouping structure is as identity units. The algorithm sorts SBOEID numbers into packets that resemble File Transfer Protocol (FTP) packets. Each of these is segregated from the others by their packet number. These packet numbers, or the SBOEID number's ordinal position within each packet, can be used to identify records of interest. For instance, the 10 SBOEID numbers in every third packet, or the third SBOEID in each packet. The purpose of using an algorithm to accomplish this task appears to be clandestine. Otherwise, it would be simpler and more efficient to add a field to the record and use it to flag the same files.

The reason why the algorithms were used to do this is unknown. However, it is peculiar that the algorithm appears to have been designed to accomplish a task of great importance to anyone involved in election fraud. That task is to identify phantom voters.

"Phantom voters" are false registrations placed in the voter rolls to accommodate false votes, such as those distributed via ballot harvesting operations. If a ballot harvester deposits 10 illegitimate votes in a ballot box, they will be counted. However, if the number of voters counted by the board of elections is significantly different from the number of ballots counted, there is a serious risk of discovery. To reduce the risk, phantom registrations may be inserted into the voter rolls. Then, provided the number of illegitimate votes is known, a corresponding number of phantom registrations are marked to indicate that a vote was cast in the name appearing on those records.

The problem with phantom voters is that they are useless if anyone knows they are there and can be differentiated from legitimate registrations. Thus, the phantom voters must be hidden. That presents another problem. If the phantom voters are hidden in a sizable database, such as the NYS voter rolls, it would be impossible for any person connected to the fraud to utilize those records unless they had a way to easily identify them.

Therefore, a tool that can clandestinely mark voter roll records as phantom voters would have great value to any person with intent to commit election fraud. The patterns seen in the voter rolls examined

[1] The Spiral and Reverse Spiral algorithms are solved at this time. The Metronome and Motion Blur patterns are not. Therefore, whether a "simple" calculation is required to reveal their pattern is unknown for now.

to date are clandestine and they reorganize the data in such a way that any number of software solutions could be used to directly extract or interact with specific records of interest. The algorithms used in New York are examples of “in-band steganography”, the practice of hiding information in plain sight, in this case by utilizing an existing structure.

It remains to be seen whether the algorithms have been used to flag phantom voters. To discover whether this is true, more research is needed. However, it is known that the NYS voter rolls contain at least 320,000 records that can be described as “phantom voters”, including at least 10 of the 11 records assigned to Chaim Metzner. The presence of these records, and an unknown number yet to be discovered, is enough to reasonably expect that whatever person or persons placed them there would have a compelling reason to access those records clandestinely.

It is peculiar that data obfuscation techniques would be utilized to disguise group membership of numbers that are public. Data obfuscation is normally used to conceal sensitive information. Sensitive information such as credit card numbers, Social Security numbers, and Driver’s license numbers, are private. Laws exist to prevent their public disclosure. On the other end of the spectrum of “sensitive information”, laws exist to designate voter roll records, including SBOEID numbers, as public. Any citizen who requests a county’s voter rolls, given certain easily satisfied conditions, is allowed to have them. By law, the SSN and Driver’s license numbers contained in those records must be redacted or deleted. The rolls received by NYCA are an example of this. Every county and the state deleted SSN and Driver’s license numbers from the voter rolls they provided but all of them included SBOEID and CID numbers.

This study has more ground to cover but it has already revealed the clandestine presence of steganography at work in the NYS voter rolls.

Appendix

County codes

Table 9 County code sort order and county range sort order compared

	County Code	County range order	County Code	County Range ID
Albany	1	Out of range 0		1
Allegany	2	Schoharie	47	1.01
Bronx	3	Buffer 1		2
Broome	4	Onondaga	34	2.01
Cattaraugus	5	Schenectady	46	2.02
Cayuga	6	Oswego	38	2.03
Chautauqua	7	Niagara	32	2.04
Chemung	8	Suffolk	52	2.05
Chenango	9	Essex	16	2.06
Clinton	10	Buffer 2		3
Columbia	11	Hamilton	21	3.01
Cortland	12	Columbia	11	3.02
Delaware	13	Franklin	17	3.03
Dutchess	14	Warren	57	3.04
Erie	15	Fulton	18	3.05
Essex	16	Tioga	54	3.06
Franklin	17	Montgomery	29	3.07
Fulton	18	Seneca	49	3.08
Genesee	19	Madison	27	3.09
Greene	20	Allegany	2	3.1
Hamilton	21	Saratoga	45	3.11
Herkimer	22	Ulster	56	3.12
Jefferson	23	Albany	1	3.13
Kings	24	Broome	4	3.14
Lewis	25	Cattaraugus	5	3.15
Livingston	26	Cayuga	6	3.16
Madison	27	Chautauqua	7	3.17
Monroe	28	Chemung	8	3.18
Montgomery	29	Chenango	9	3.19
Nassau	30	Genesee	19	3.2
New York	31	Lewis	25	3.21
Niagara	32	Livingston	26	3.22
Oneida	33	Ontario	35	3.23
Onondaga	34	Orange	36	3.24
Ontario	35	Orleans	37	3.25
Orange	36	Schuyler	48	3.26
Orleans	37	Sullivan	53	3.27

Oswego	38	Tompkins	55	3.28
Otsego	39	Yates	62	3.29
Putnam	40	Wayne	59	3.3
Queens	41	Herkimer	22	3.31
Rensselaer	42	Oneida	33	3.32
Richmond	43	Clinton	10	3.33
Rockland	44	Washington	58	3.34
Saratoga	45	Dutchess	14	3.35
Schenectady	46	Jefferson	23	3.36
Schoharie	47	Rockland	44	3.37
Schuyler	48	Otsego	39	3.38
Seneca	49	Steuben	51	3.39
St. Lawrence	50	Greene	20	3.4
Steuben	51	Erie	15	3.41
Suffolk	52	Monroe	28	3.42
Sullivan	53	Rensselaer	42	3.43
Tioga	54	Wyoming	61	3.44
Tompkins	55	Buffer 3		4
Ulster	56	Putnam	40	4.01
Warren	57	Cortland	12	4.02
Washington	58	Buffer 4		5
Wayne	59	Richmond	43	5.01
Westchester	60	St.Lawrence	50	5.02
Wyoming	61	Bronx	3	5.03
Yates	62	Queens	41	5.04
		Kings	24	5.05
		New York	31	5.06
		Delaware	13	5.07
		Nassau	30	5.08
		Buffer 5		6
		Westchester	60	6.01
		Out of Range 1		7
		Out of Range 2		8
		Out of Range 3		9
		Out of Range 4		10
		Out of Range 5		11
		Out of Range 6		12

Table 10 Schenectady SBOEID analysis, first 33 rows and rows 82,885 and 82,866

Row	CID	Short ID	SBOEID Gap	SBOEID Sum	Dist to MIN	Dist to MAX
2	3	9,382,494			0	95,168
3	4	9,397,107	14,613		14,613	80,555
4	10	9,408,218	11,111		25,724	69,444
5	11	9,419,329	11,111		36,835	58,333
6	13	9,430,440	11,111		47,946	47,222
7	28	9,441,551	11,111		59,057	36,111
8	29	9,452,662	11,111		70,168	25,000
9	39	9,463,773	11,111		81,279	13,889
10	40	9,474,884	11,111		92,390	2,778
11	55	9,390,827	-84,057		8,333	86,835
12	56	9,396,273	5,446		13,779	81,389
13	57	9,397,385	1,112	278	14,891	80,277
14	79	9,398,496	1,111		16,002	79,166
15	80	9,399,607	1,111		17,113	78,055
16	82	9,400,718	1,111		18,224	76,944
17	92	9,401,829	1,111		19,335	75,833
18	105	9,402,940	1,111		20,446	74,722
19	133	9,404,051	1,111		21,557	73,611
20	136	9,405,162	1,111		22,668	72,500
21	165	9,406,273	1,111		23,779	71,389
22	190	9,407,384	1,111		24,890	70,278
23	191	9,408,496	1,112	11,111	26,002	69,166
24	215	9,409,607	1,111		27,113	68,055
25	216	9,410,718	1,111		28,224	66,944
26	247	9,411,829	1,111		29,335	65,833
27	260	9,412,940	1,111		30,446	64,722
28	261	9,414,051	1,111		31,557	63,611
29	308	9,415,162	1,111		32,668	62,500
30	309	9,416,273	1,111		33,779	61,389
31	313	9,417,384	1,111		34,890	60,278
32	339	9,418,495	1,111		36,001	59,167
33	352	9,419,607	1,112	11,111	37,113	58,055
82,885	382,786	9,477,662	1		95,168	0
82,886	382,787	9,382,495	-95,167		1	95,167

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[i] There is a 3 number gap between Livingston and Ontario counties, Monroe and Rensellaer counties, and New York and Delaware counties.