Collatz Conjecture - The Prime Solutions

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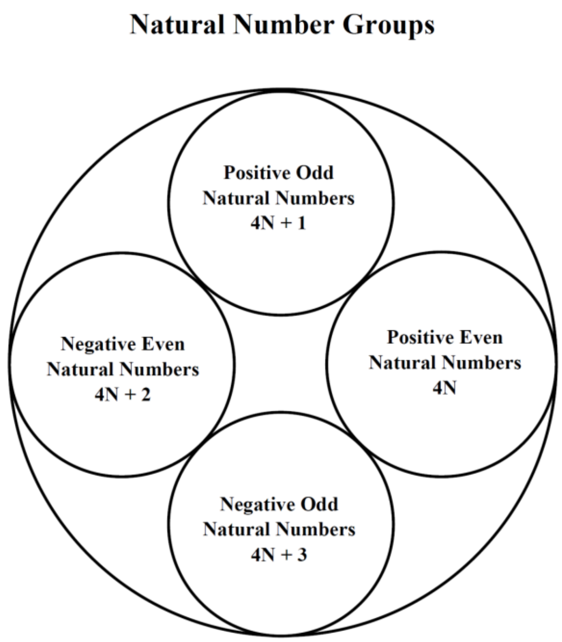

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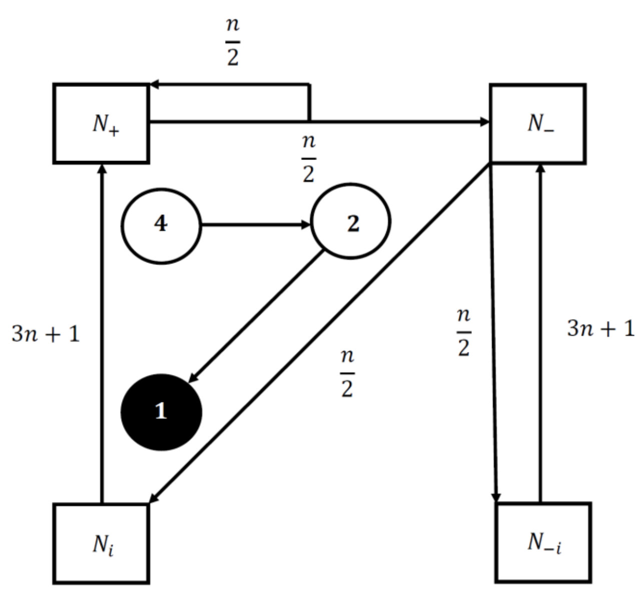


Contents

Natural Numbers

Euler's Formula

$$e^{i\theta} = cos\theta + i\ sin\theta$$

θ (degrees)	θ (radians)	$e^{i\theta}$
0°	0	1
90°	$\frac{\pi}{2}$	i
180°	π	-1
270°	$\frac{3\pi}{2}$	-i

Four Quadrants

$$e^{i(N+4)} = \cos(N+4) + i\sin(N+4)$$

Axes	Unit Values $e^{i(N+4)}$	Number Sets N
Positive Real Axis	1	0, 4, 8, 12, 16
Positive Imaginary Axis	i	1, 5, 9, 13, 17
Negative Real Axis	-1	2, 6, 10, 14, 18
Negative Imaginary Axis	-i	3, 7, 11, 15, 19

Natural Numbers Nomenclature

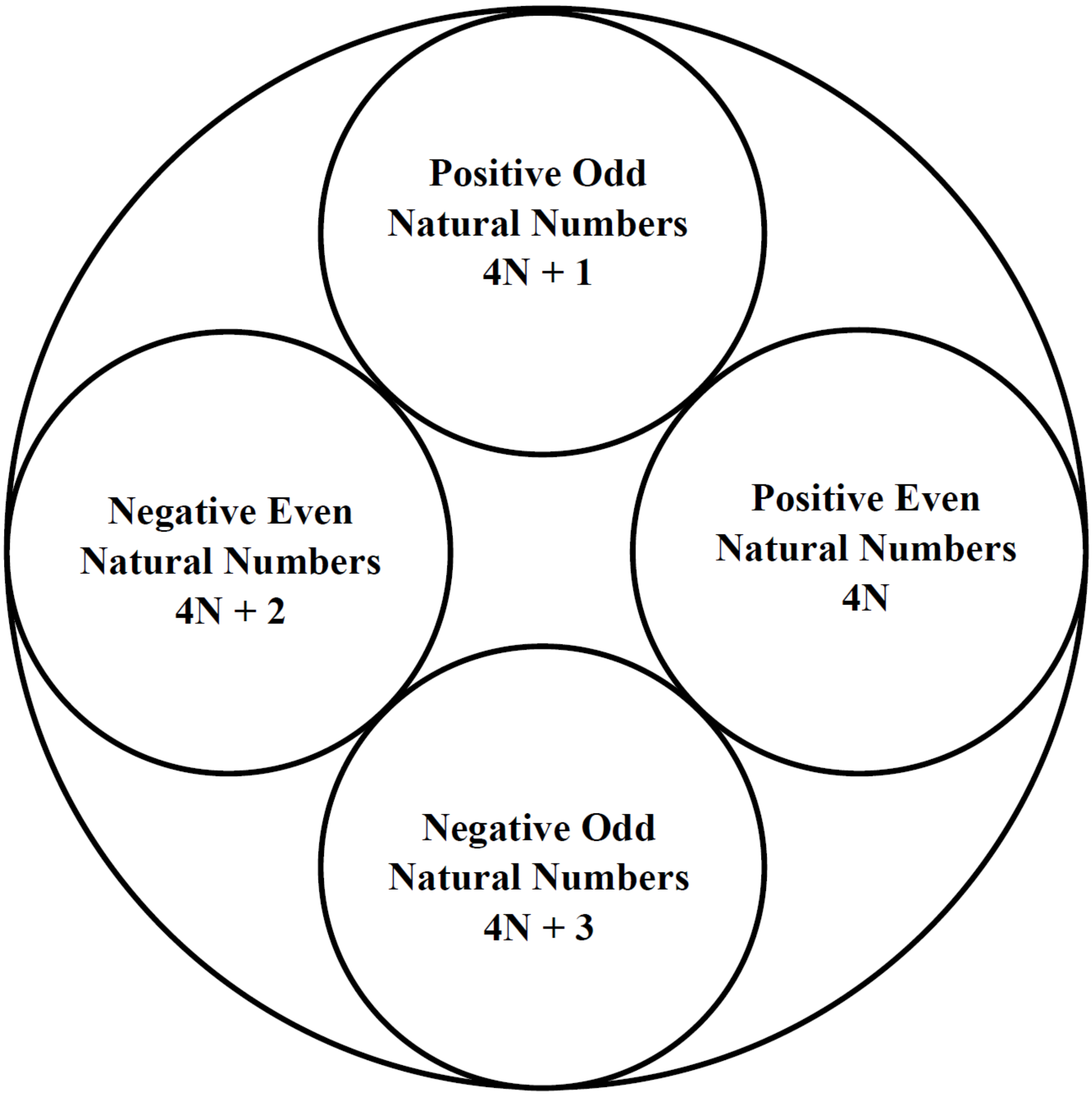
Positive Even Numbers $N_+ = 4N \ \in \{0, 4, 8, 12, 16 \ldots\}$
or Positive Even-Even Numbers $N_+ = 2(2N)$

Positive Odd Numbers $N_i = 4N + 1 \ \in \{1, 5, 9, 13, 17 \ldots\}$

Negative Even Numbers $N_- = 4N + 2 \ \in \{2, 6, 10, 14, 18 \ldots\}$
or Negative Even-Odd Numbers $N_- = 2(2N + 1)$

Negative Odd Numbers $N_{-i} = 4N + 3 \ \in \{3, 7, 11, 15, 19 \ldots\}$

Natural Number Groups



Theorem One: *Arithmetic addition of positive even numbers* (N_+) *must produce a positive even number value* (N_+):

$$Z = X_+ + Y_+$$

$$e^{iZ} = e^{i(X_+ + Y_+)}$$

$$e^{iZ} = e^{iX_+}e^{iY_+}$$

$$e^{iZ} = 1.1 = 1$$

Theorem Two: *Arithmetic addition of a positive odd numbers* (N_i) *must produce a negative even number value* (N_{-}):

$$Z = X_i + Y_i$$

$$e^{iZ} = e^{i(X_i + Y_i)}$$

$$e^{iZ} = e^{iX_i} e^{iY_i}$$

$$e^{iZ} = i.i = -1$$

Theorem Three: *Arithmetic addition of negative even numbers* (N_{-}) *must produce a positive even number value* (N_{+}):

$$Z = X_{-} + Y_{-}$$

$$e^{iZ} = e^{i(X_{-} + Y_{-})}$$

$$e^{iZ} = e^{iX_{-}} e^{iY_{-}}$$

$$e^{iZ} = -1. -1 = 1$$

Theorem Four: *Arithmetic addition of negative odd numbers* (N_{-i}) *must produce a negative even number value* (N_{-}):

$$Z = X_{-i} + Y_{-i}$$

$$e^{iZ} = e^{i(X_{-i} + Y_{-i})}$$

$$e^{iZ} = e^{iX_{-i}} e^{iY_{-i}}$$

$$e^{iZ} = -i. -i = -1$$

Theorem Five: *Arithmetic addition of a positive even number* (N_+) *and a positive odd number* (N_i) *must produce a positive odd number value* (N_i):

$$Z = X_+ + Y_i$$

$$e^{iZ} = e^{i(X_+ + Y_i)}$$

$$e^{iZ} = e^{iX_+} e^{iY_i}$$

$$e^{iZ} = 1.i = i$$

Theorem Six: *Arithmetic addition of a positive even number* (N_+) *and a negative even number* (N_-) *must produce a negative even number value* (N_-):

$$Z = X_+ + Y_-$$

$$e^{iZ} = e^{i(X_+ + Y_-)}$$

$$e^{iZ} = e^{iX_+} e^{iY_-}$$

$$e^{iZ} = 1. -1 = -1$$

Theorem Seven: *Arithmetic addition of a positive even number* (N_+) *and a negative odd number* (N_{-i}) *must produce a negative odd number value* (N_{-i}):

$$Z = X_+ + Y_{-i}$$

$$e^{iZ} = e^{i(X_+ + Y_{-i})}$$

$$e^{iZ} = e^{iX_+} e^{iY_{-i}}$$

$$e^{iZ} = 1. -i = -i$$

Theorem Eight: *Arithmetic addition of a positive odd number* (N_i) *and a negative even number* (N_{-}) *must produce a negative odd number value* (N_{-i}):

$$Z = X_i + Y_{-}$$

$$e^{iZ} = e^{i(X_i + Y_{-})}$$

$$e^{iZ} = e^{iX_i} e^{iY_{-}}$$

$$e^{iZ} = i. -1 = -i$$

Theorem Nine: *Arithmetic addition of a positive odd number* (N_i) *and a negative odd number* (N_{-i}) *must produce a positive even number value* (N_+):

$$Z = X_i + Y_{-i}$$

$$e^{iZ} = e^{i(X_i + Y_{-i})}$$

$$e^{iZ} = e^{iX_i} e^{iY_{-i}}$$

$$e^{iZ} = i. -i = 1$$

Theorem Ten: *Arithmetic addition of a negative even number* (N_{-}) *and a negative odd number* (N_{-i}) *must produce a positive odd number value* (N_i):

$$Z = X_{-} + Y_{-i}$$

$$e^{iZ} = e^{i(X_{-} + Y_{-i})}$$

$$e^{iZ} = e^{iX_{-}} e^{iY_{-i}}$$

$$e^{iZ} = -1. -i = i$$

Arithmetic Additive Rules

Addition	$\mathbf{N_+}$	$\mathbf{N_i}$	$\mathbf{N_-}$	$\mathbf{N_{-i}}$
$\mathbf{N_+}$	N_+	N_i	N_-	N_{-i}
$\mathbf{N_i}$	N_i	N_-	N_{-i}	N_+
$\mathbf{N_-}$	N_-	N_{-i}	N_+	N_i
$\mathbf{N_{-i}}$	N_{-i}	N_+	N_i	N_-

Theorem Eleven: *Arithmetic multiplication of positive even numbers* (N_+) *must produce a positive even number value* (N_+):

$$Z = X_+Y_+$$

$$Z = 4n4m$$

$$Z = 4(4nm)$$

Theorem Twelve: *Arithmetic multiplication of positive odd numbers* (N_i) *must produce a positive odd number value* (N_i):

$$Z = X_i Y_i$$

$$Z = (4n + 1)(4m + 1)$$

$$Z = 16nm + 4n + 4m + 1$$

$$e^{iZ} = e^{i(16nm+4n+4m+1)}$$

$$e^{iZ} = e^{i16nm} e^{i4n} e^{i4m} e^{i}$$

$$e^{iZ} = 1.1.1.\, i = i$$

Theorem Thirteen: *Arithmetic multiplication of negative even numbers* (N_{-}) *must produce a positive even number value* (N_{+}):

$$Z = X_{-}Y_{-}$$

$$Z = (4n + 2)(4m + 2)$$

$$Z = 16nm + 8n + 8m + 4$$

$$Z = 4(4nm + 2n + 2m + 1)$$

Theorem Fourteen: *Arithmetic multiplication of negative odd numbers* (N_{-i}) *must produce a positive odd number value* (N_i):

$$Z = X_{-i}Y_{-i}$$

$$Z = (4n + 3)(4m + 3)$$

$$Z = 16nm + 12n + 12m + 9$$

$$e^{iZ} = e^{i(16nm+12n+12m+9)}$$

$$e^{iZ} = e^{i16nm}e^{i12n}e^{i12m}e^{i9}$$

$$e^{iZ} = 1.1.1.i = i$$

Theorem Fifteen: *Arithmetic multiplication of positive even number* (N_+) *and positive odd number* (N_i) *must produce a positive even number value* (N_+):

$$Z = X_+Y_i$$

$$Z = 4n(4m + 1)$$

Theorem Sixteen: *Arithmetic multiplication of positive even number* (N_+) *and negative even number* (N_-) *must produce a positive even number value* (N_+):

$$Z = X_+ Y_-$$

$$Z = 4n(4m + 2)$$

Theorem Seventeen: *Arithmetic multiplication of positive even number* (N_+) *and negative odd number* (N_{-i}) *must produce a positive even number value* (N_+):

$$Z = X_+ Y_{-i}$$

$$Z = 4n(4m + 3)$$

Theorem Eighteen: *Arithmetic multiplication of positive odd number* (N_i) *and negative even number* (N_-) *must produce a negative even number value* (N_-):

$$Z = X_i Y_-$$

$$Z = (4n + 1)(4m + 2)$$

$$Z = 16nm + 8n + 4m + 2$$

$$e^{iZ} = e^{i(16nm+8n+4m+2)}$$

$$e^{iZ} = e^{i16nm} e^{i8n} e^{i4m} e^{i2}$$

$$e^{iZ} = 1.1.1.-1 = -1$$

Theorem Nineteen: *Arithmetic multiplication of positive odd number* (N_i) *and a negative odd number* (N_{-i}) *must produce a negative odd number value* (N_{-i}):

$$Z = X_i Y_{-i}$$

$$Z = (4n + 1)(4m + 3)$$

$$Z = 16nm + 12n + 4m + 3$$

$$e^{iZ} = e^{i(16nm+12n+4m+3)}$$

$$e^{iZ} = e^{i16nm} e^{i12n} e^{i4m} e^{i3}$$

$$e^{iZ} = 1.1.1. -i = -i$$

Theorem Twenty: *Arithmetic multiplication of negative even number* (N_{-}) *and negative odd number* (N_{-i}) *must produce a negative even number value* (N_{-}):

$$Z = X_{-}Y_{-i}$$

$$Z = (4n + 2)(4m + 3)$$

$$Z = 16nm + 12n + 8m + 6$$

$$e^{iZ} = e^{i(16nm+12n+8m+6)}$$

$$e^{iZ} = e^{i16nm}e^{i12n}e^{i8m}e^{i6}$$

$$e^{iZ} = 1.1.1.-1 = -1$$

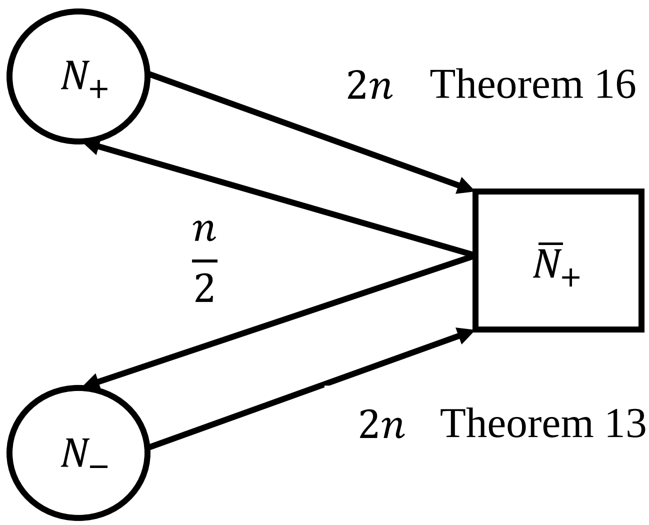
Arithmetic Multiplicative Rules

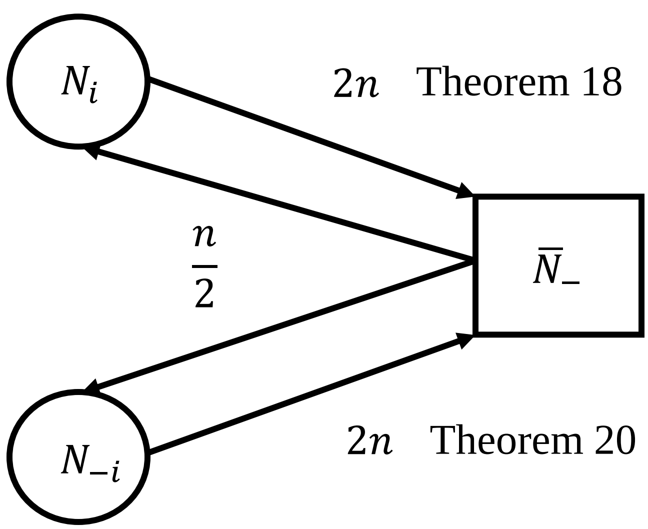
Multiplication	$\mathbf{N_+}$	$\mathbf{N_i}$	$\mathbf{N_-}$	$\mathbf{N_{-i}}$
$\mathbf{N_+}$	N_+	N_+	N_+	N_+
$\mathbf{N_i}$	N_+	N_i	N_-	N_{-i}
$\mathbf{N_-}$	N_+	N_-	N_+	N_-
$\mathbf{N_{-i}}$	N_+	N_{-i}	N_-	N_i

Collatz Conjecture

Even Operations

$$f(n) = \frac{n}{2} : n \text{ is even}$$





Odd Operations

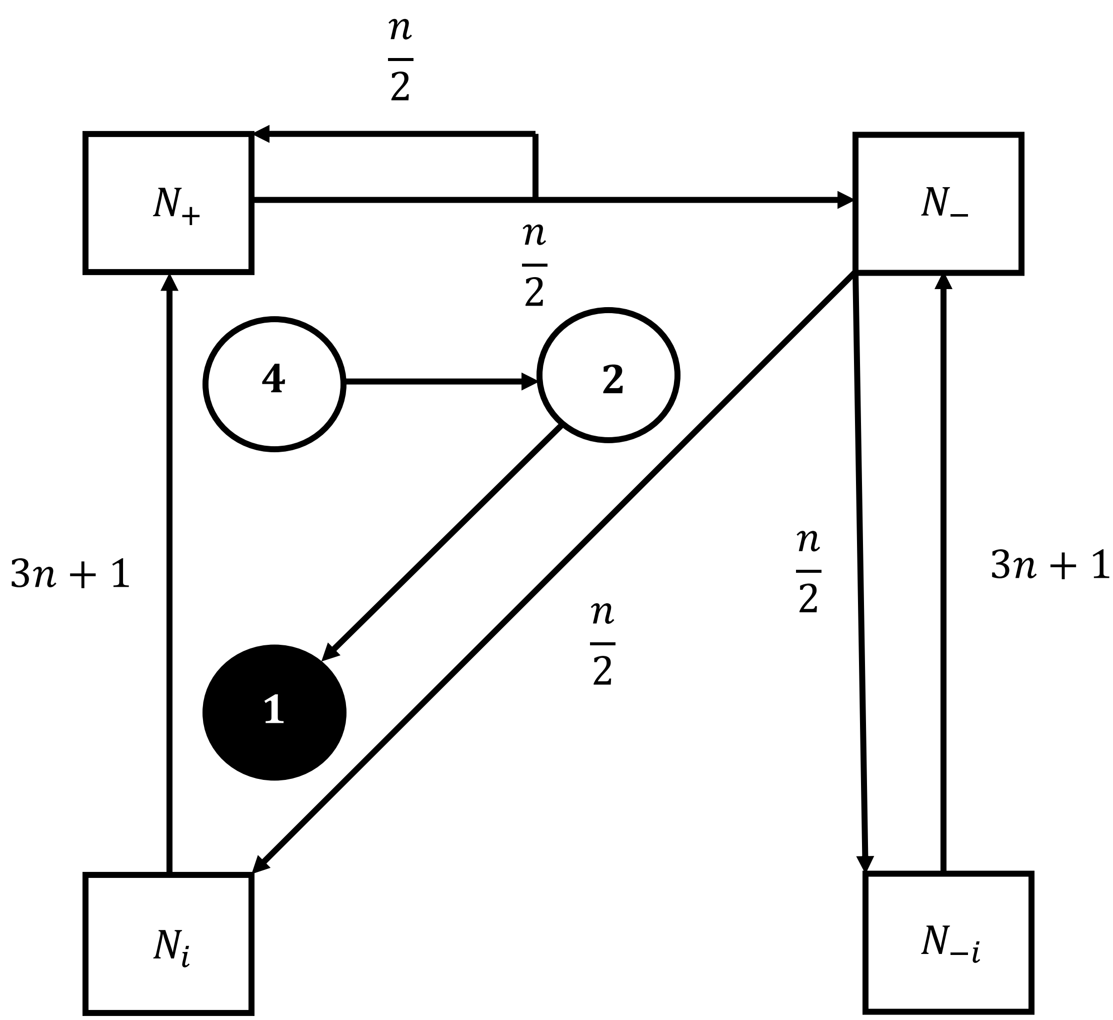
$$f(n) = 3n + 1 : n \text{ is odd}$$

$$N_i \xrightarrow[\text{Theorem 19}]{3n} N_{-i} \xrightarrow[\text{Theorem 9}]{3n+1} N_+$$

$$N_{-i} \xrightarrow[\text{Theorem 14}]{3n} N_i \xrightarrow[\text{Theorem 2}]{3n+1} N_-$$

Target Operations

$$f(n) = 1$$



Composite Numbers

Odd Composite Numbers:

$$C_{\pm i} = (2N+1) = \prod P_{\pm i}$$

$$C_{\pm i} = (2n+1)(2m+1)\dots(2x+1)(2y+1)$$

$$C_{\pm i} = P_{\pm i}\bar{C}_{\pm i}$$

$$P_{\pm i} = (2n+1)$$

$$\bar{C}_{\pm i} = (2\overline{N}+1) = (2m+1)\dots(2x+1)(2y+1)$$

Even Composite Numbers:

$$C_{\pm} = 2M(2N+1) = \prod 2 \prod P_{\pm i}$$

Prime Numbers

Even Prime Number:

$$P_{-} = 2$$

$$P_{-} = C_{\pm} = 2M(2N + 1)\ with\ M = 1, N = 0$$

Odd Prime Numbers:

$$P_{\pm i} = 2n + 1$$

$$P_{\pm i} = C_{\pm i} = P_{\pm i}(2\overline{N} + 1)\ with\ \overline{N} = 0$$

Positive Even Numbers

$N_+(4n)$	Primes	Composition
0	0	N_+
4	2.2	P_-P_-
8	2.2.2	$P_-P_-P_-$
12	2.2.3	$P_-P_-P_{-i}$
16	2.2.2.2	$P_-P_-P_-P_-$
20	2.2.5	$P_-P_-P_i$
24	2.2.2.3	$P_-P_-P_-P_{-i}$
28	2.2.7	$P_-P_-P_{-i}$
32	2.2.2.2.2	$P_-P_-P_-P_-P_-$
36	2.2.3.3	$P_-P_-P_{-i}P_{-i}$

Even operations $n/2$ on positive even numbers (N_+) will divide out all the even primes ($P_- = 2$) leaving only positive odd primes (P_i) and negative odd primes (P_{-i}). Since positive even numbers ($N_+ = 4n$) is an infinite series ($n \rightarrow \infty$), then the infinite number of even operations ($n/2$) must generate an infinite products of positive odd primes (P_i) and negative odd primes (P_{-i}):

$$f_+(n \rightarrow \infty) = \frac{N_+}{2} \rightarrow \prod_0^\infty P_i \prod_0^\infty P_{-i}$$

Hence the infinite even operations $n/2$ on the infinite series of positive even numbers (N_+) will generate all possible odd composite numbers ($C_{\pm i}$) including all positive odd (N_i) and negative odd (N_{-i}) numbers.

Negative Even Numbers

$N_-(4n+2)$	Primes	Composition
2	2	P_-
6	2.3	P_-P_{-i}
10	2.5	P_-P_i
14	2.7	P_-P_{-i}
18	2.3.3	$P_-P_{-i}P_{-i}$
22	2.11	P_-P_{-i}
26	2.13	P_-P_i
30	2.3.5	$P_-P_{-i}P_i$
34	2.17	P_-P_i
38	2.19	P_-P_{-i}

Even operations $n/2$ on negative even numbers (N_-) will divide out the even prime ($P_- = 2$) leaving only positive odd primes (P_i) and negative odd primes (P_{-i}). Since negative even numbers ($N_- = 4n + 2$) is an infinite series ($n \to \infty$), then the infinite number of even operations ($n/2$) must generate an infinite products of positive odd primes (P_i) and negative odd primes (P_{-i}):

$$f_-(n \to \infty) = \frac{N_-}{2} \to \prod_0^\infty P_i \prod_0^\infty P_{-i}$$

Hence the infinite even operations $n/2$ on the infinite series of negative even numbers (N_-) will generate all possible odd composite numbers ($C_{\pm i}$) including all positive odd (N_i) and negative odd (N_{-i}) numbers.

Positive Odd Numbers

$N_i(4n+1)$	**Primes**	**Composition**
1	0	N_i
5	5	P_i
9	3.3	$P_{-i}P_{-i}$
13	13	P_i
17	17	P_i
21	3.7	$P_{-i}P_i$
25	5.5	P_iP_i
29	29	P_i
33	3.11	$P_{-i}P_{-i}$
37	37	P_i

Odd operations $(3n+1)$ on positive odd primes (P_i) generates positive even numbers (N_+):

$$3P_i + 1 = P_{-i}P_i + N_i \to N_+$$

Odd operations $(3n+1)$ on negative odd primes (P_{-i}) generates negative even numbers (N_-):

$$3P_{-i} + 1 = P_{-i}P_{-i} + N_i \to N_-$$

Since positive odd numbers $(N_i = 4n+1)$ is an infinite series $(n \to \infty)$, then the infinite number of odd operations $(3n+1)$ must generate all possible even composite numbers $(C_\pm)$ including all positive even (N_+) and negative even (N_-) numbers.

Negative Odd Numbers

$\boldsymbol{N_{-i}(4n+3)}$	**Primes**	**Composition**
3	3	P_{-i}
7	7	P_{-i}
11	11	P_{-i}
15	3.5	$P_{-i}P_i$
19	19	P_{-i}
23	23	P_{-i}
27	3.3.3	$P_{-i}P_{-i}P_{-i}$
31	31	P_{-i}
35	5.7	P_iP_{-i}
39	39	P_{-i}

Odd operations $(3n+1)$ on positive odd primes (P_i) generates positive even numbers (N_+):

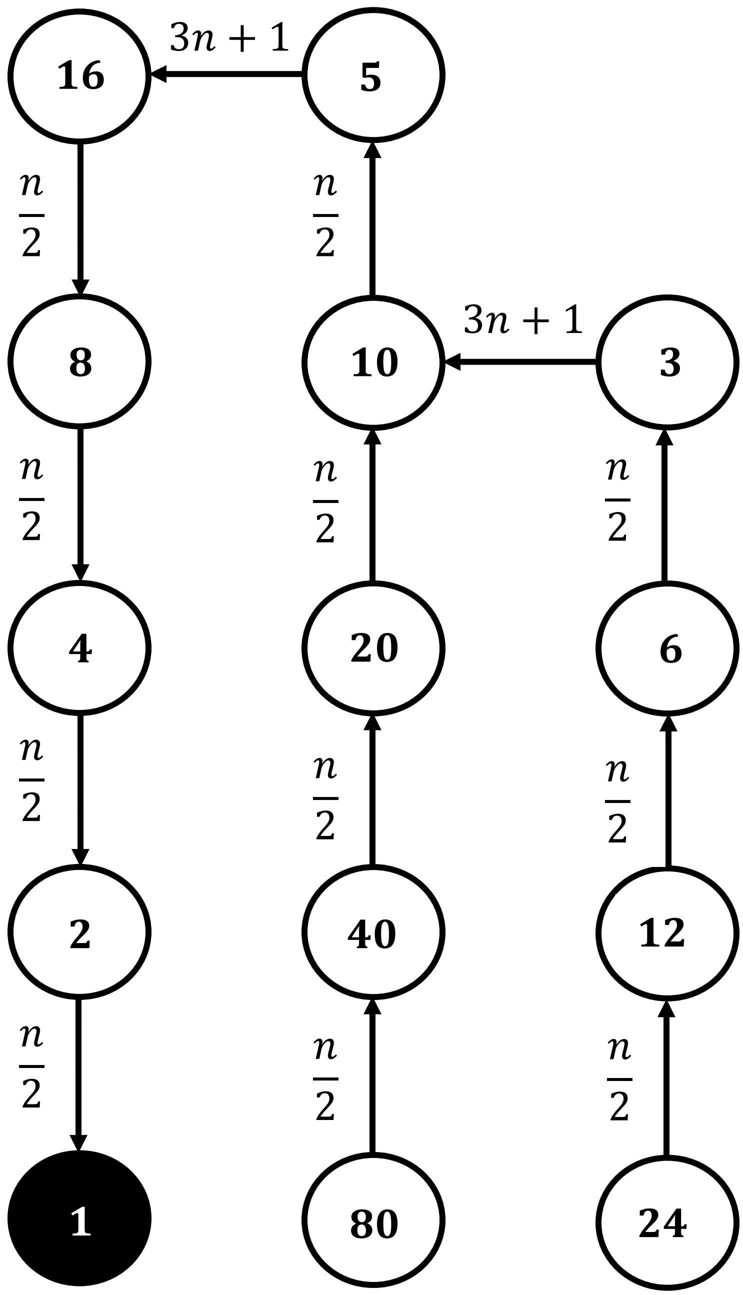
$$3P_i + 1 = P_{-i}P_i + N_i \rightarrow N_+$$

Odd operations $(3n+1)$ on negative odd primes (P_{-i}) generates negative even numbers (N_-):

$$3P_{-i} + 1 = P_{-i}P_{-i} + N_i \rightarrow N_-$$

Since negative odd numbers $(N_{-i} = 4n+3)$ is an infinite series $(n \rightarrow \infty)$, then the infinite number of odd operations $(3n+1)$ must generate all possible even composite numbers $(C_\pm)$ including all positive even (N_+) and negative even (N_-) numbers.

Convergence



Nodes

Level One Nodes:

- Applications of single even operator $(n/2)$
- Convergence values of level one nodes are $n_1 = 2^n$
- Examples of infinite numbers associated with level one nodes are:

$\boldsymbol{n}$	**Nodes $\boldsymbol{n_1}$**	**Operators**
1	2	$n_1/2 = 1$
2	4	$n_1/2 = 2$
3	8	$n_1/2 = 4$
4	16	$n_1/2 = 8$

Level Two Nodes:

- Applications of two operations: even $(n/2)$ and odd $(3n + 1)$
- Convergence values of level two nodes are $n_1 = 3n_2 + 1$
- Examples of infinite numbers associated with level two nodes are:

$$n_2 = \frac{2^n - 1}{3}$$

$\boldsymbol{n}$	**Nodes $\boldsymbol{n_2}$**	**Operators**
4	5	$3n_2 + 1 = 16 \rightarrow n_1/2 = 8$
6	21	$3n_2 + 1 = 64 \rightarrow n_1/2 = 32$
8	85	$3n_2 + 1 = 256 \rightarrow n_1/2 = 128$
10	341	$3n_2 + 1 = 1024 \rightarrow n_1/2 = 512$

Level Three Nodes:

- Applications of three operations: even-odd-even
- Convergence values of level three nodes are $n_2 = n_3/2$
- Examples of infinite numbers associated with level three nodes are:

$$n_3 = \frac{2^{n+1} - 2}{3}$$

$\boldsymbol{n}$	**Nodes $\boldsymbol{n_3}$**	**Operators**
4	10	$n_3/2 = 5 \rightarrow 3n_2 + 1 = 16 \rightarrow n_1/2 = 8$
6	42	$n_3/2 = 21 \rightarrow 3n_2 + 1 = 64 \rightarrow n_1/2 = 32$
8	170	$n_3/2 = 85 \rightarrow 3n_2 + 1 = 256 \rightarrow n_1/2 = 128$
10	682	$n_3/2 = 341 \rightarrow 3n_2 + 1 = 1024 \rightarrow n_1/2 = 512$

There are an infinite number of converging nodes, and because each level of operating nodes $(n_1, n_2, n_3 \dots n_\infty)$ are uniquely defined, then there exists no closed loops for the series of infinitely converging numbers going through the infinite number of uniquely defined even and odd sequential operating nodes. With no closed loops, then all natural numbers (N_+, N_i, N_-, N_{-i}) will cycle through the infinitely unique operating nodes and eventually converges down to 1.