

Equilibrium rules

204	108 (201)	105	54 (147)	51
	156 (198)	150 60 (102, 153, 195)	57 (99)	

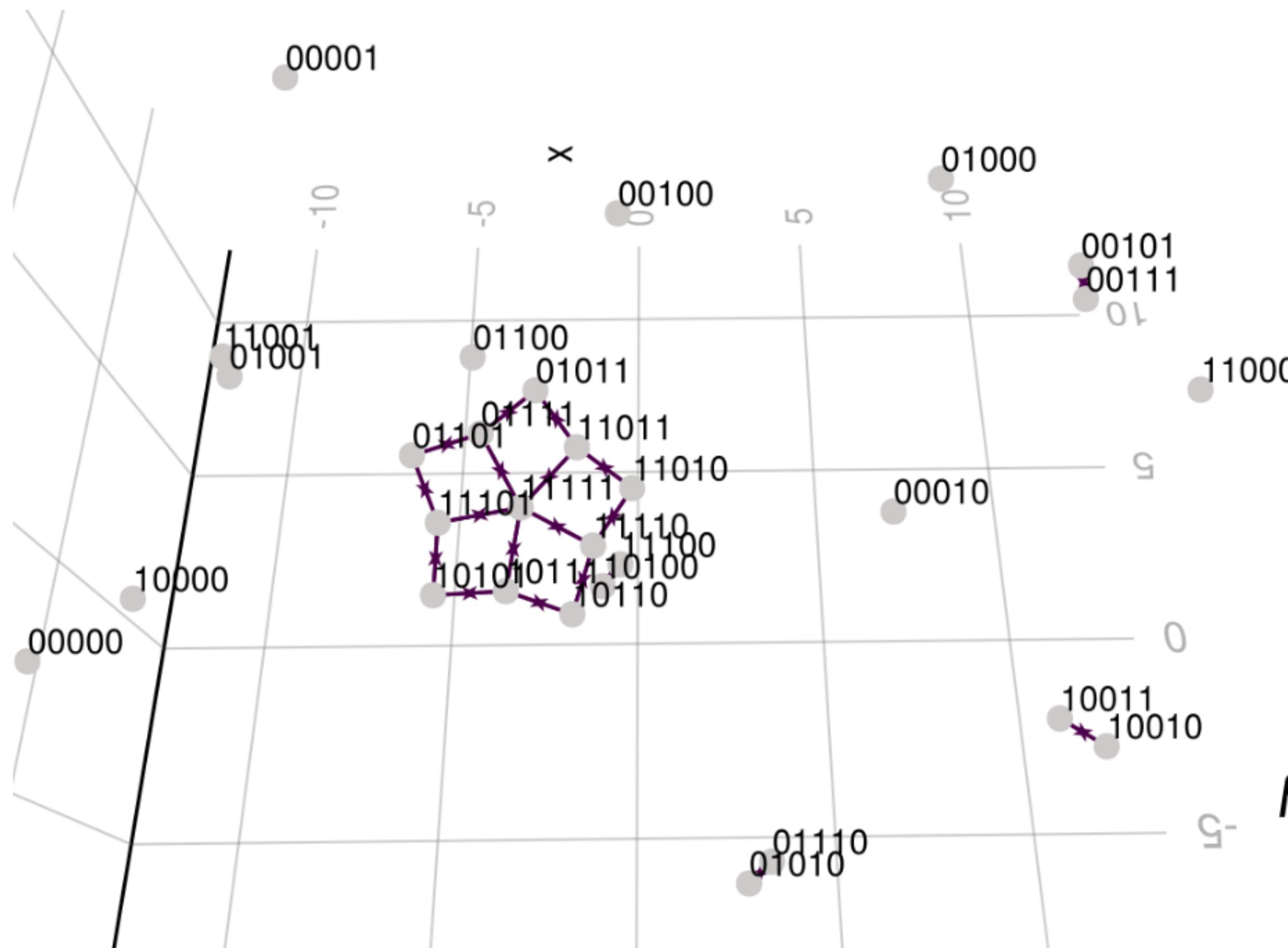
Rules 204, 51 are obvious and boring

E_g rule 108

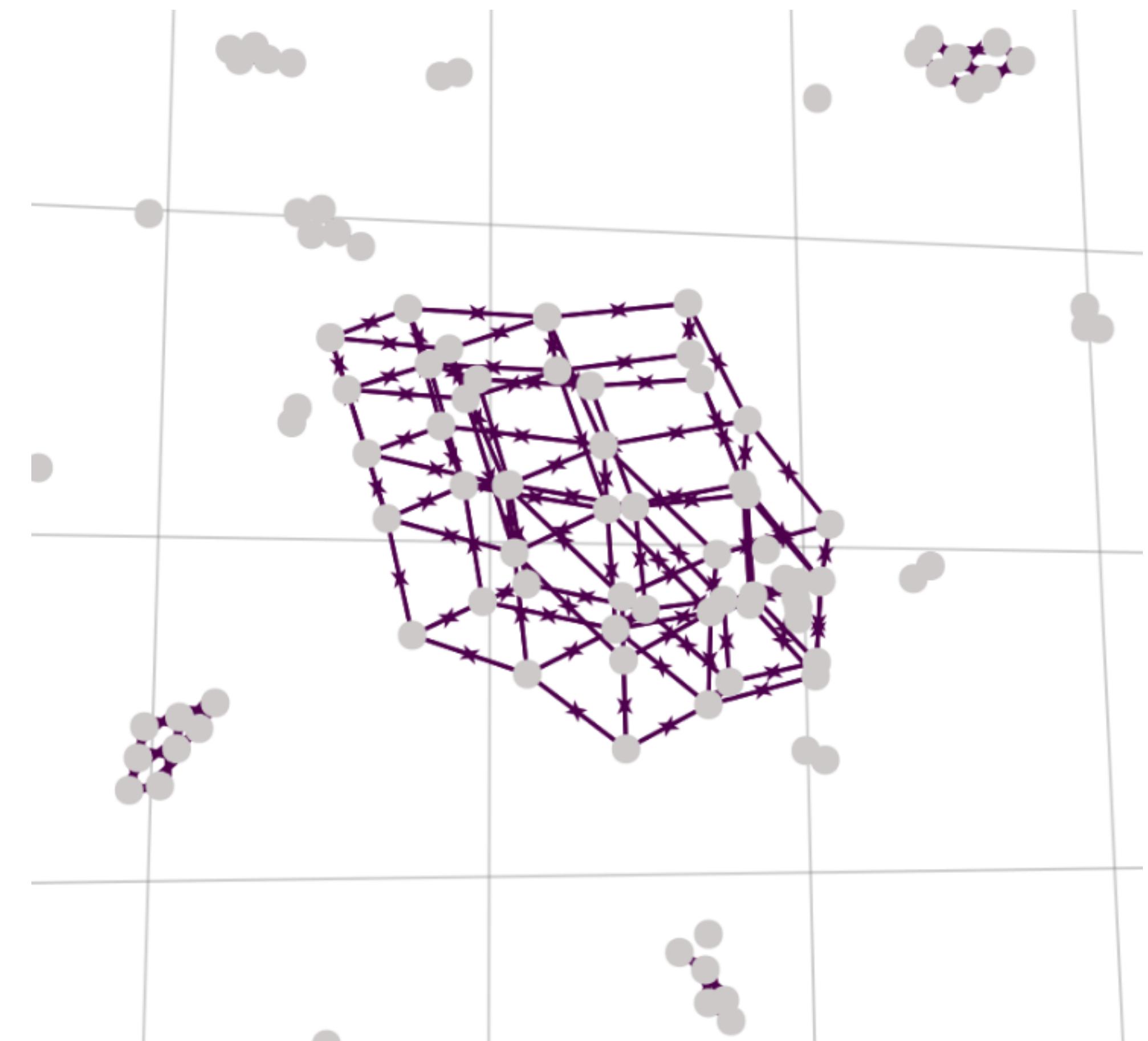
0000
0101

Creates complex structures around states with domains of λ , in particular the cells of state
gather into all isolated states

$$N = 5$$

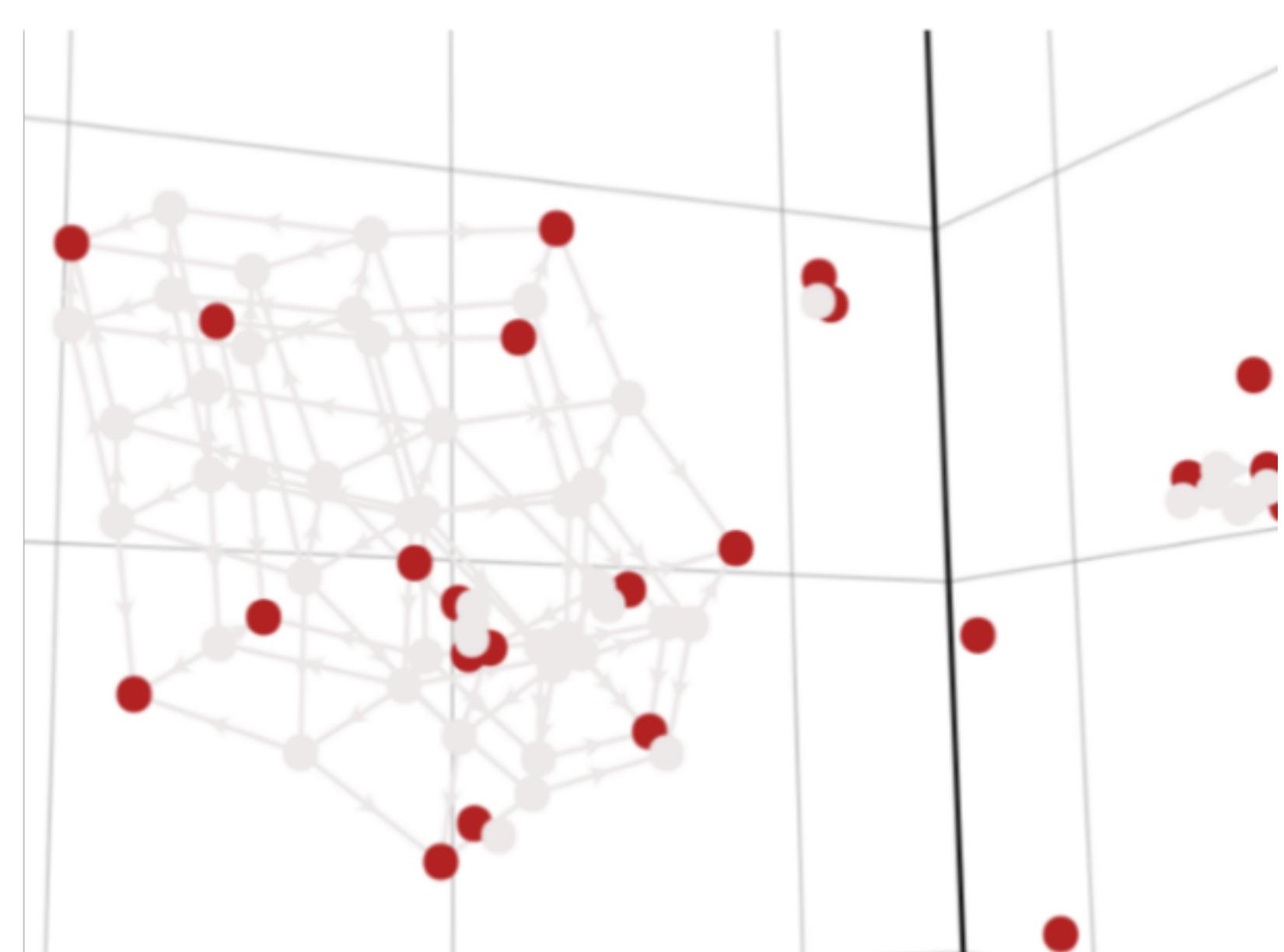


$$\tau \approx 8$$



Non eq Subrules

76 - domains of 1s can be irreversibly broken,
only single ccs, there are multiple
acs around the edges of the structures



236 - domains can be completed but not
broken - every structure has 1
single ac

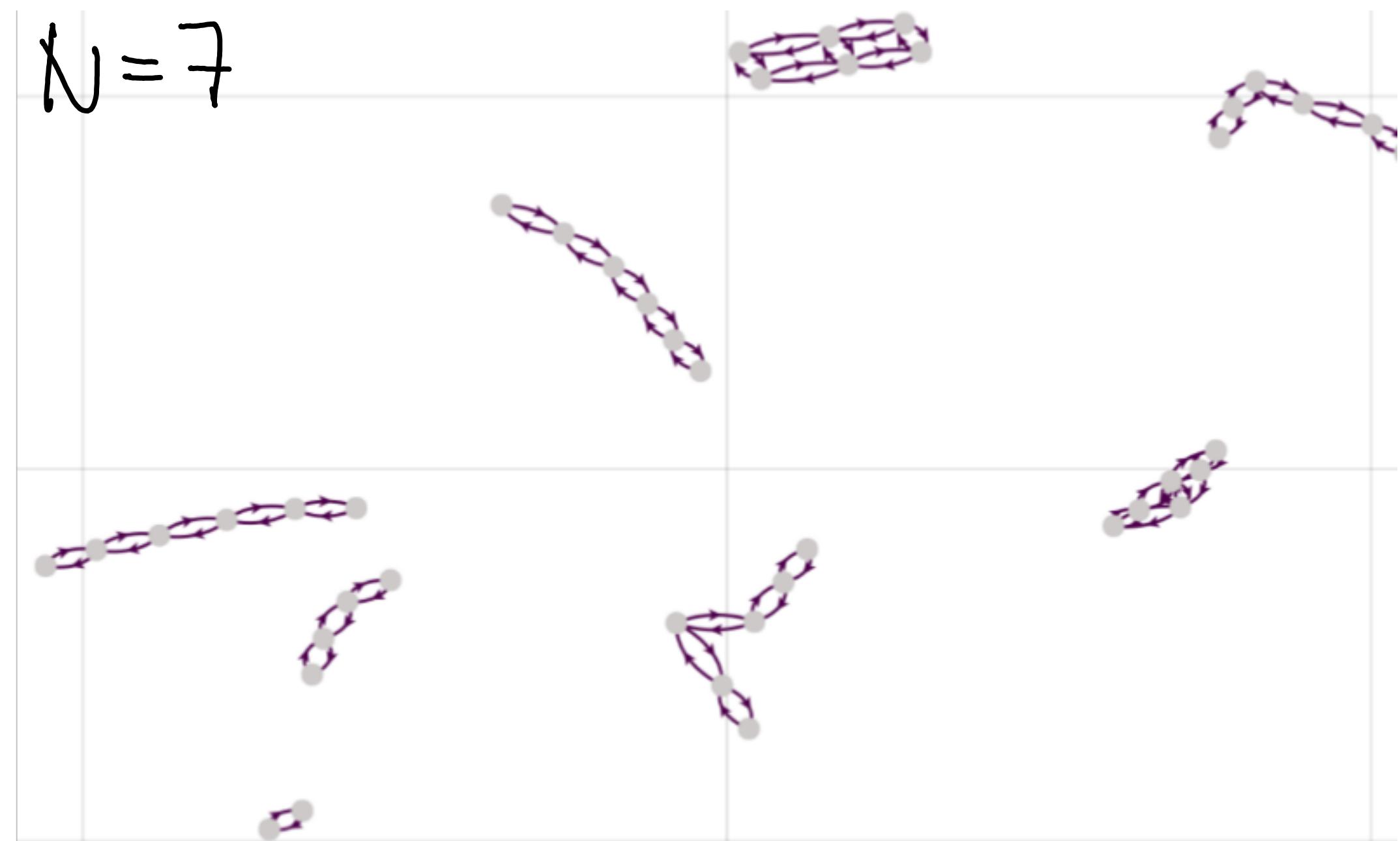
E₉ rule 156

00 00
10 10

Boundaries can grow/shrink on one side but not propagate?

We see many single state lines of states and at higher N
also their "cartesian products"

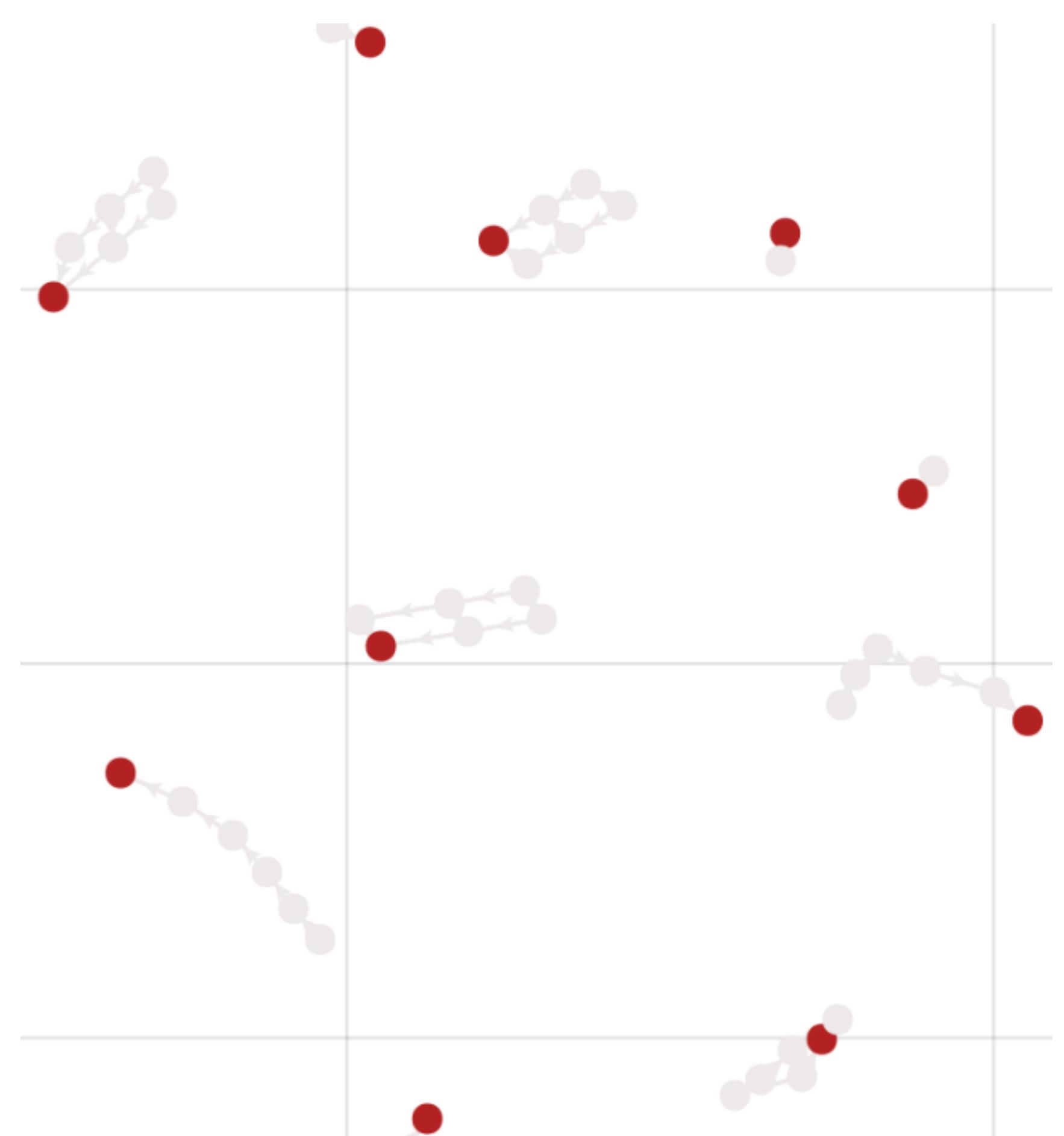
N=7



Only 1 substrate

140 - Biased towards one side, naturally

00 00
00 10
results in 1 single ac at the end
or side of each group



E_g rule 105

10 10
01 01

All domains can be seeded and completed and while they cannot move directly, we get a 2 step move by \vec{P}

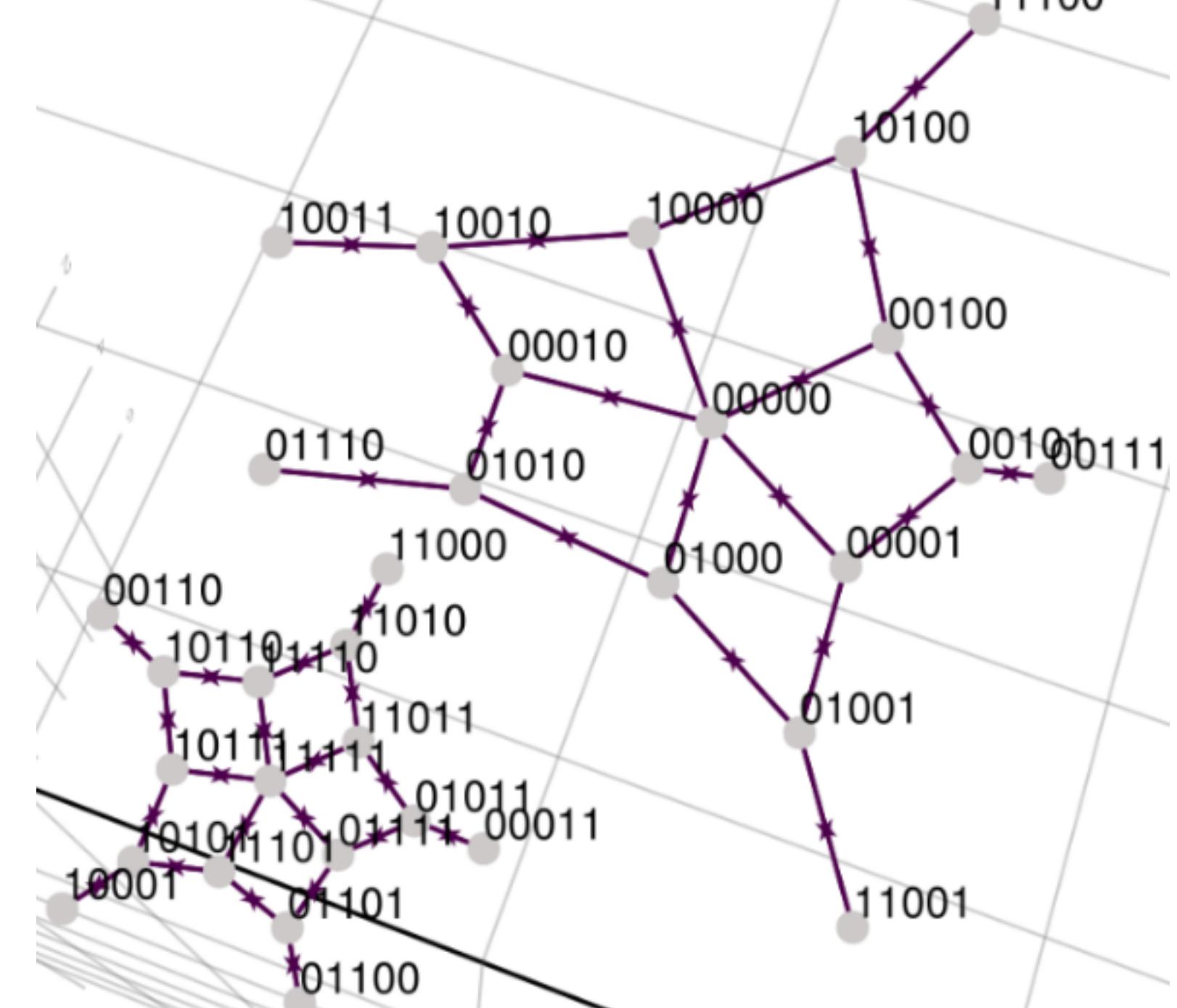
... 00011 ... \rightarrow ... 01011 ... \rightarrow ... 01111 ...

\vec{P}
0

Hence we get much more connections

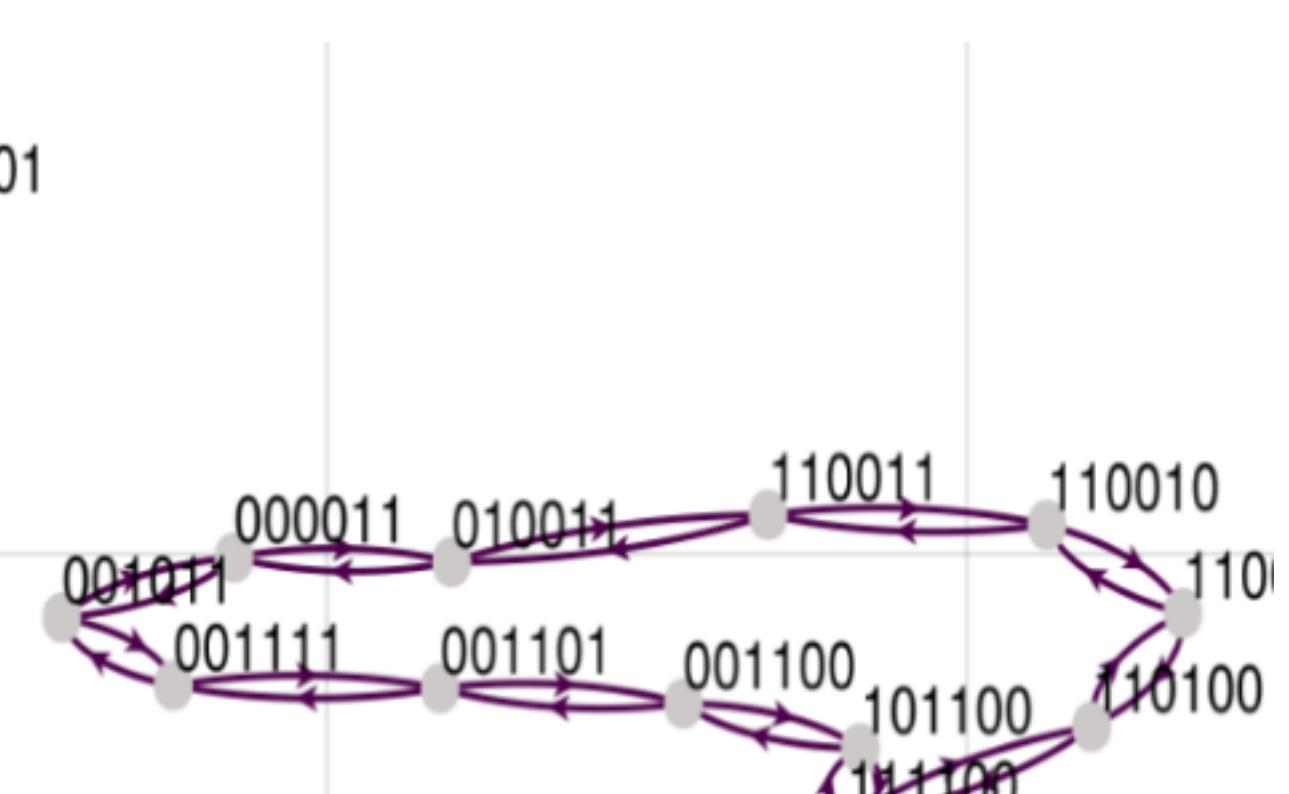
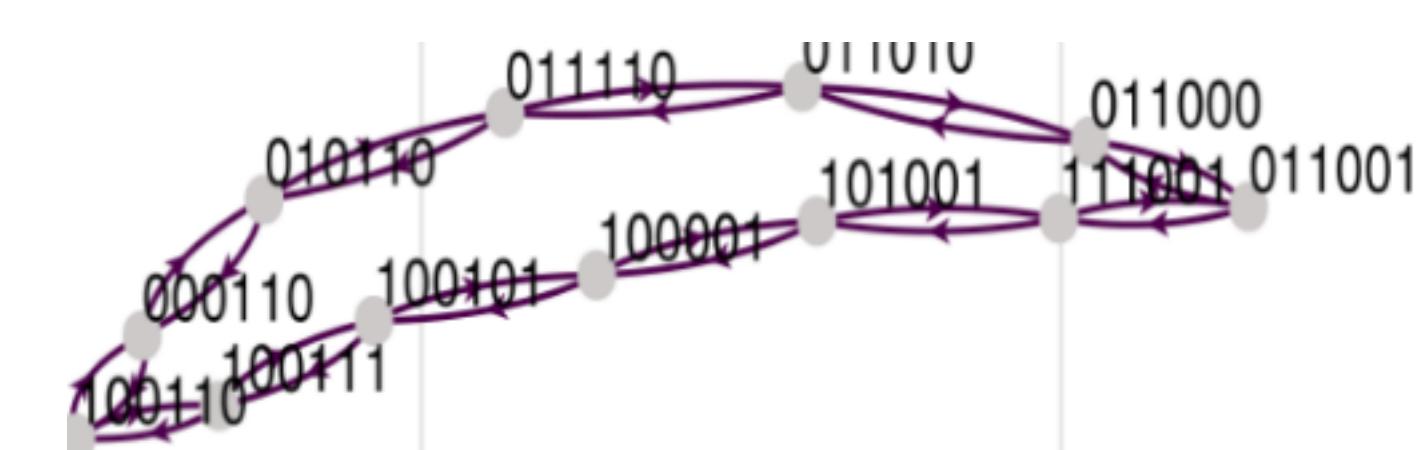
- **Odd N** we get 2 components one around all 0s and one around all 1s

(they are roughly plane-like)

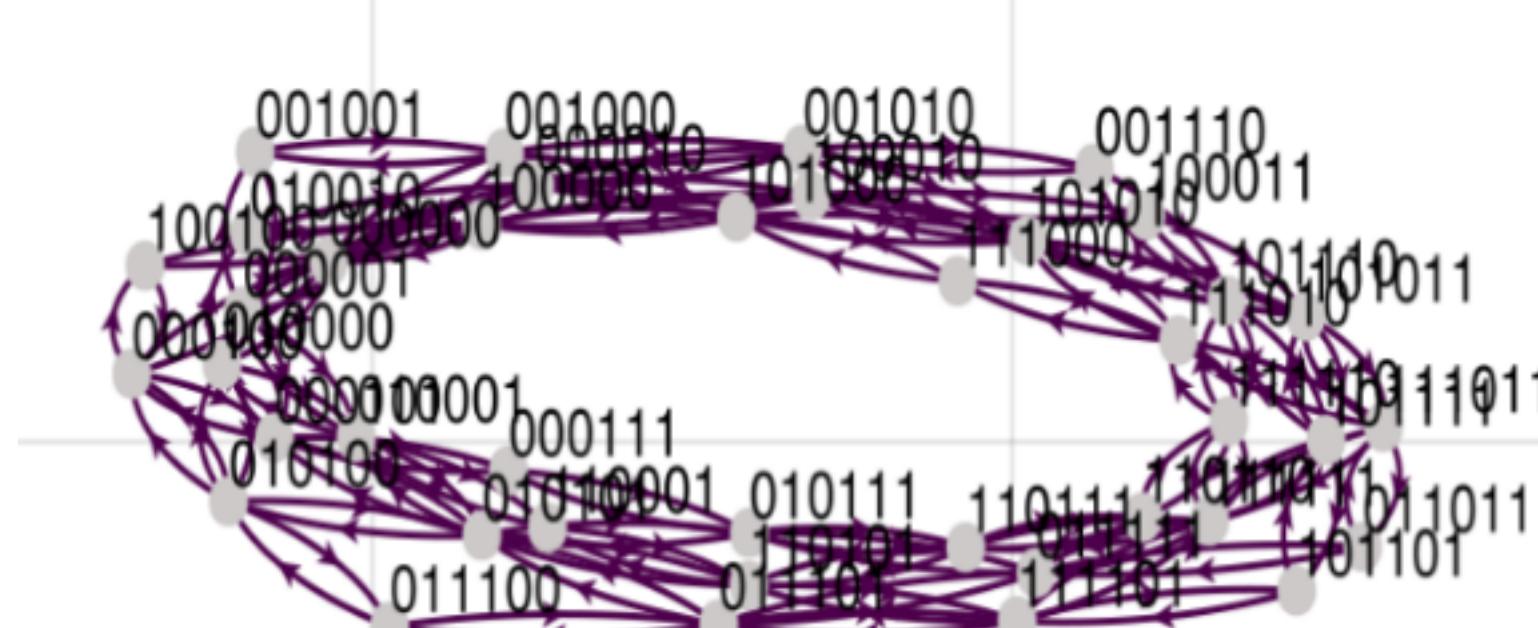


- **Even N** We get loops, all states are in loops besides $\overline{0011}$ which only happen in N divisible by 4

There is always one loop containing both all 0s and all 1s

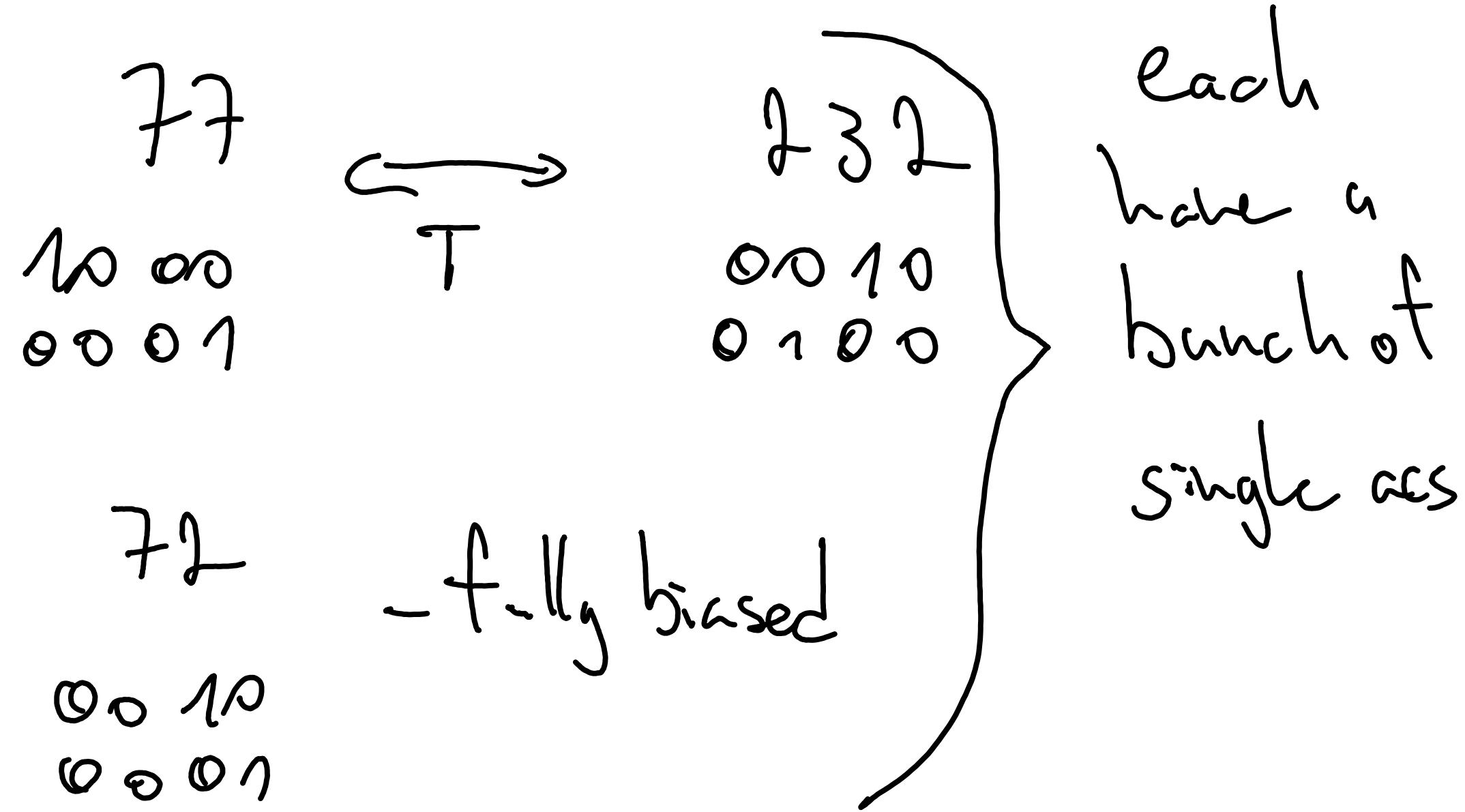


The rest seem to mostly rely on the 2 step propagation mechanism described above



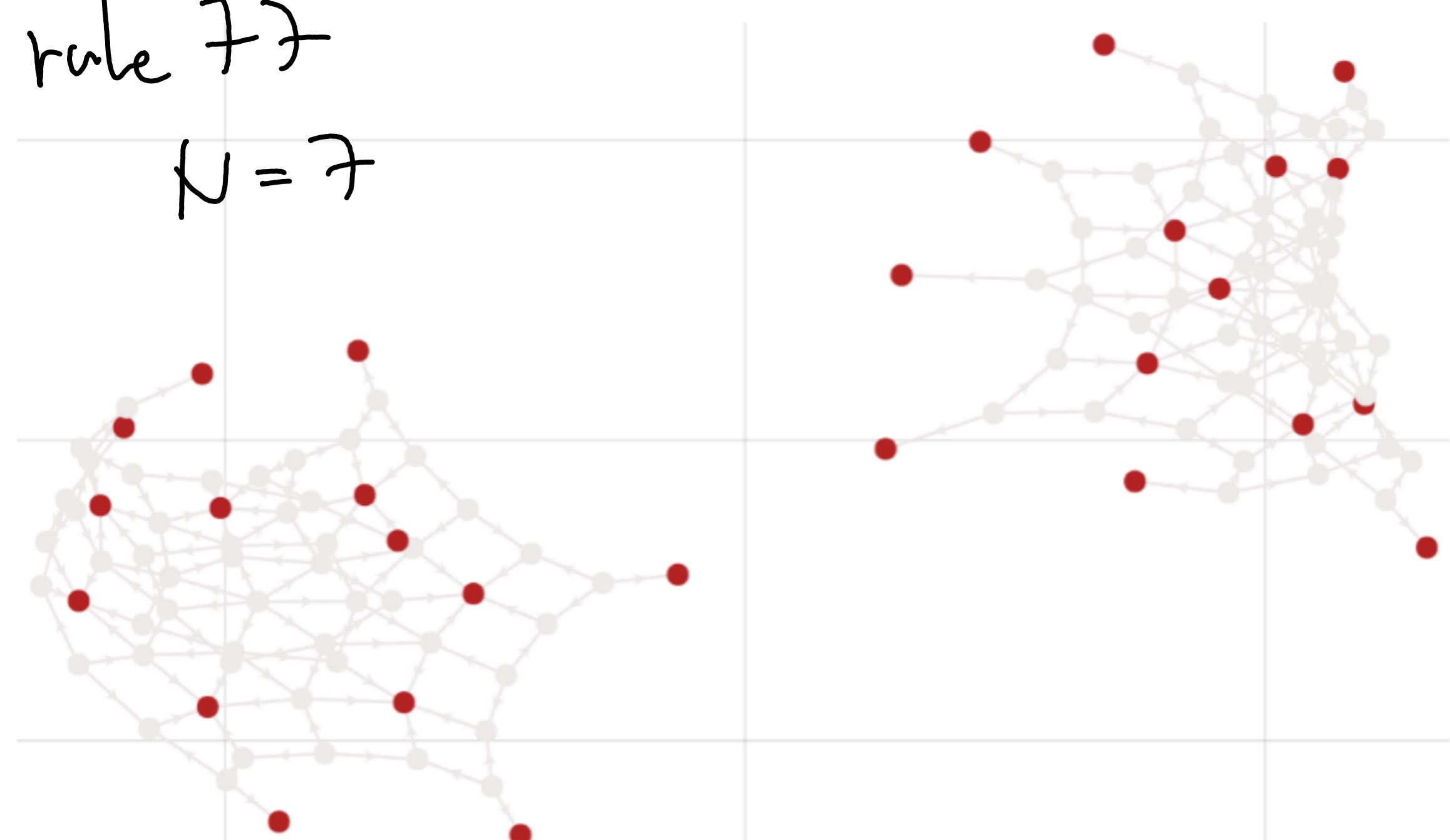
$N=6$
more complex but still [loop] begin

2 enzyme subunits

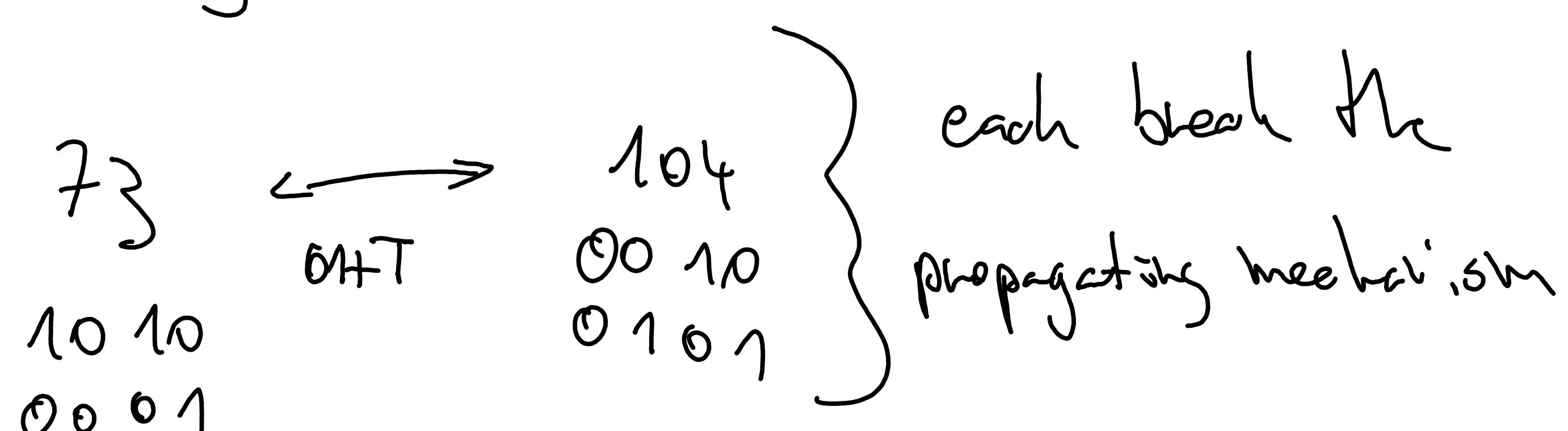


rule 77

$N = 7$

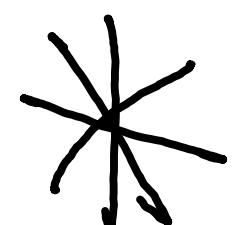


3 enzyme subunits

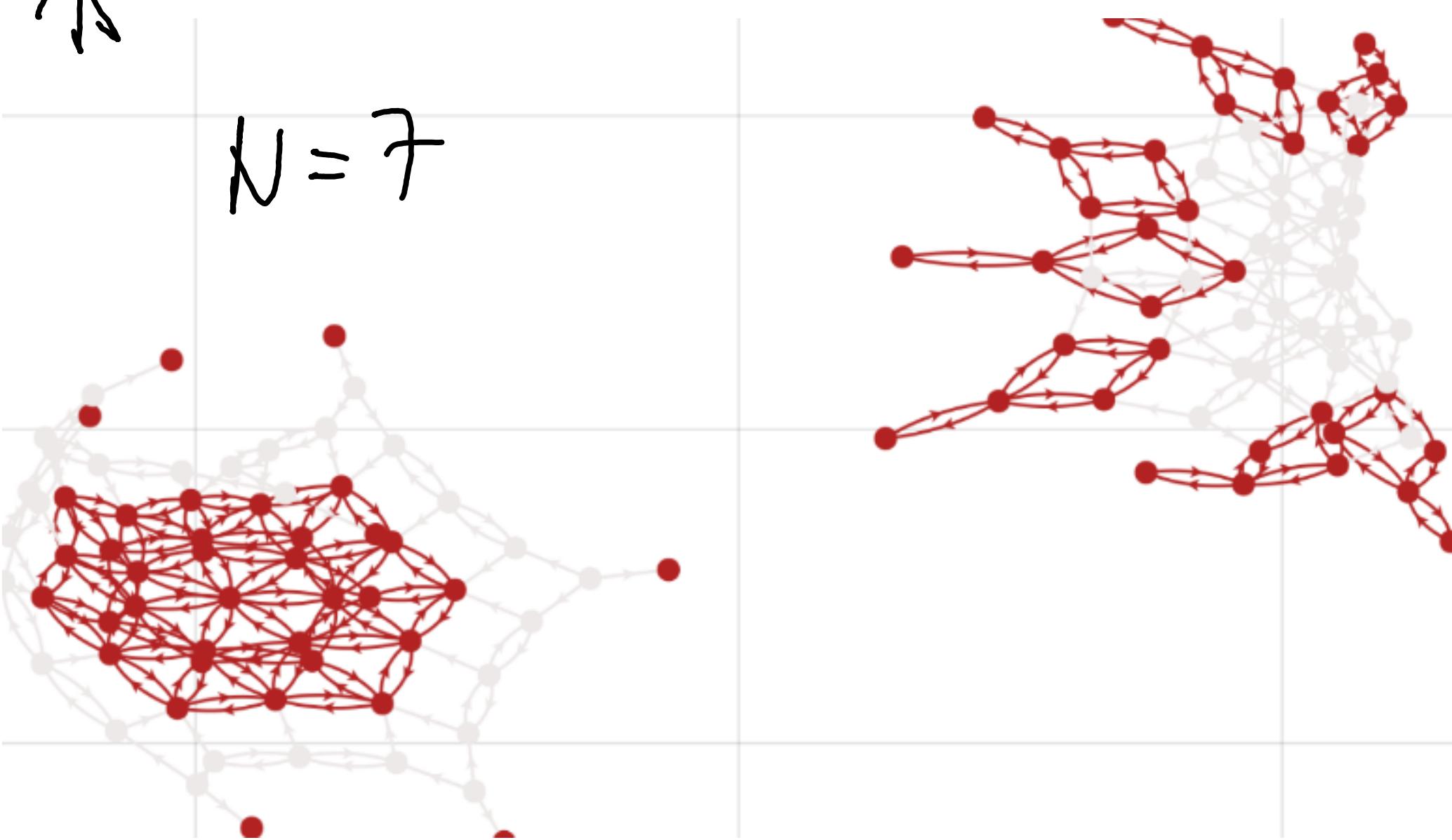


$\begin{matrix} 104 \\ 00\ 10 \\ 01\ 01 \end{matrix}$ - cannot seed 1s and hence gets stuck at either all 0s or products of ...0110...

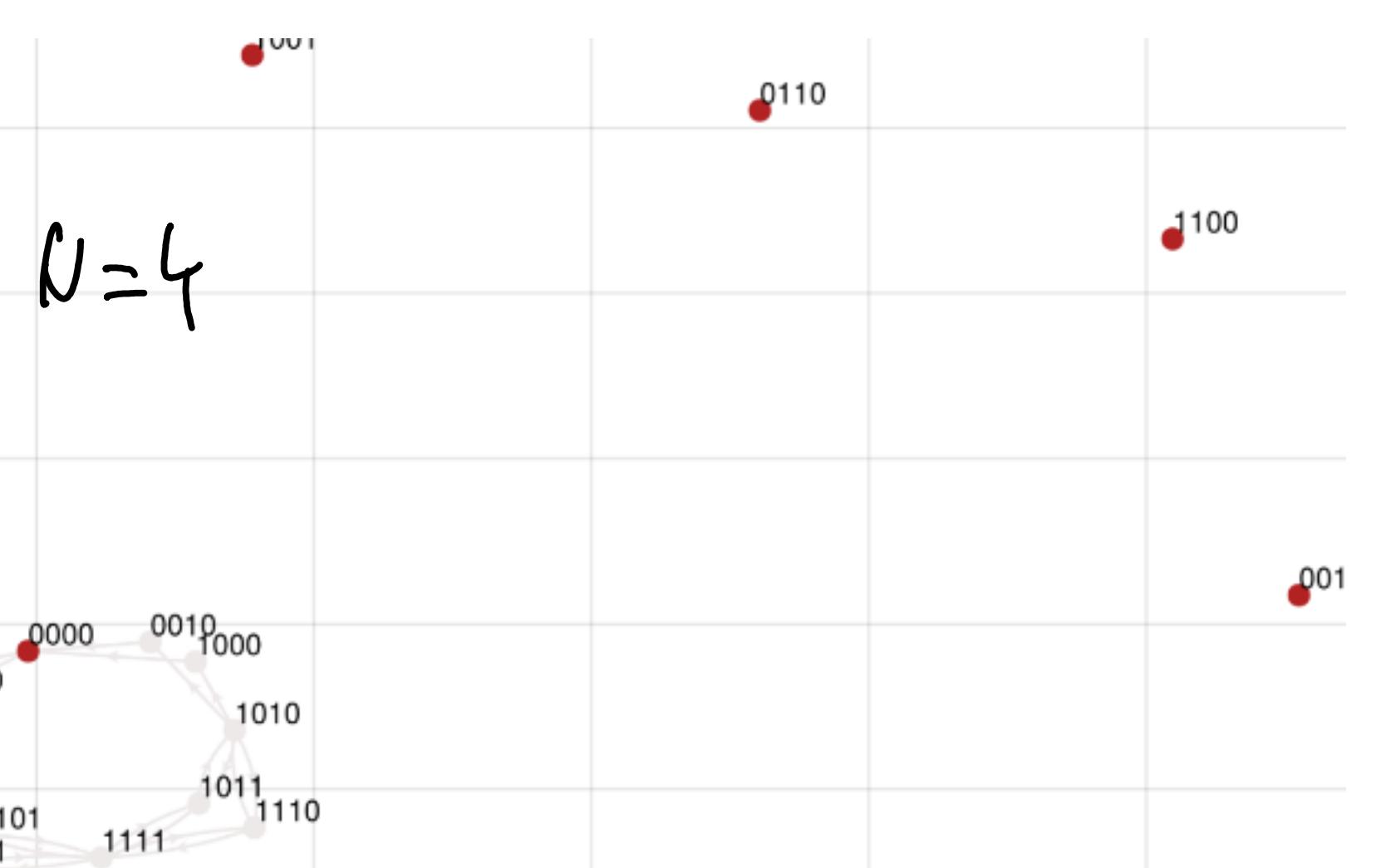
$\begin{matrix} 73 \\ 10\ 10 \\ 00\ 01 \end{matrix}$ - cannot complete 1s but has non-single diffusive ACS!



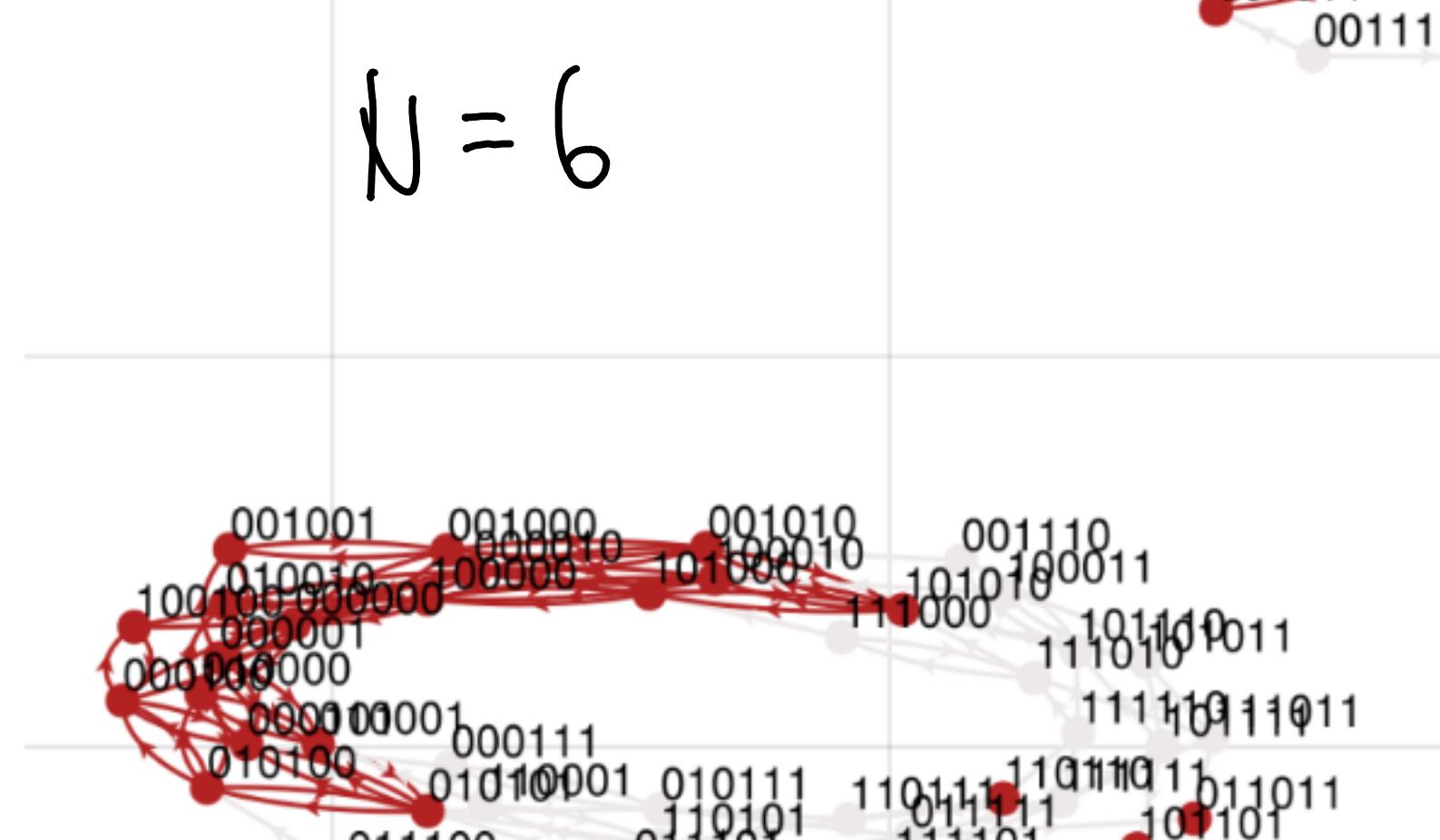
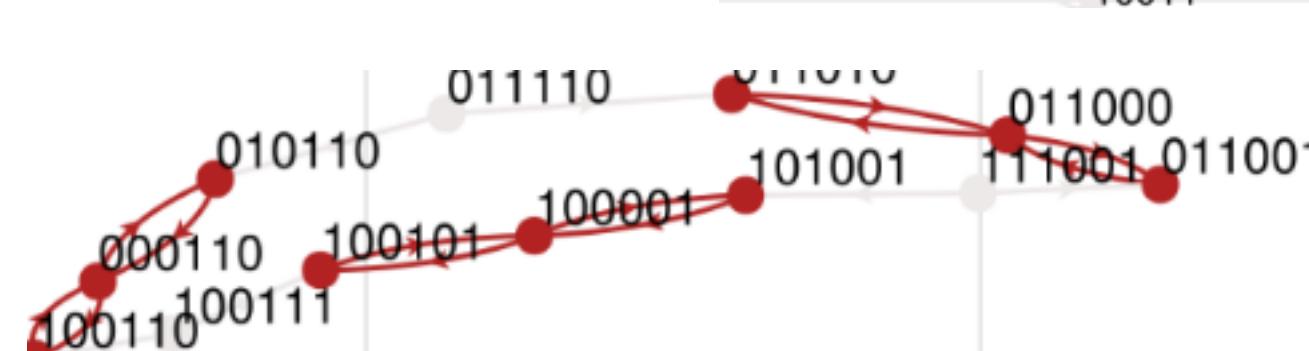
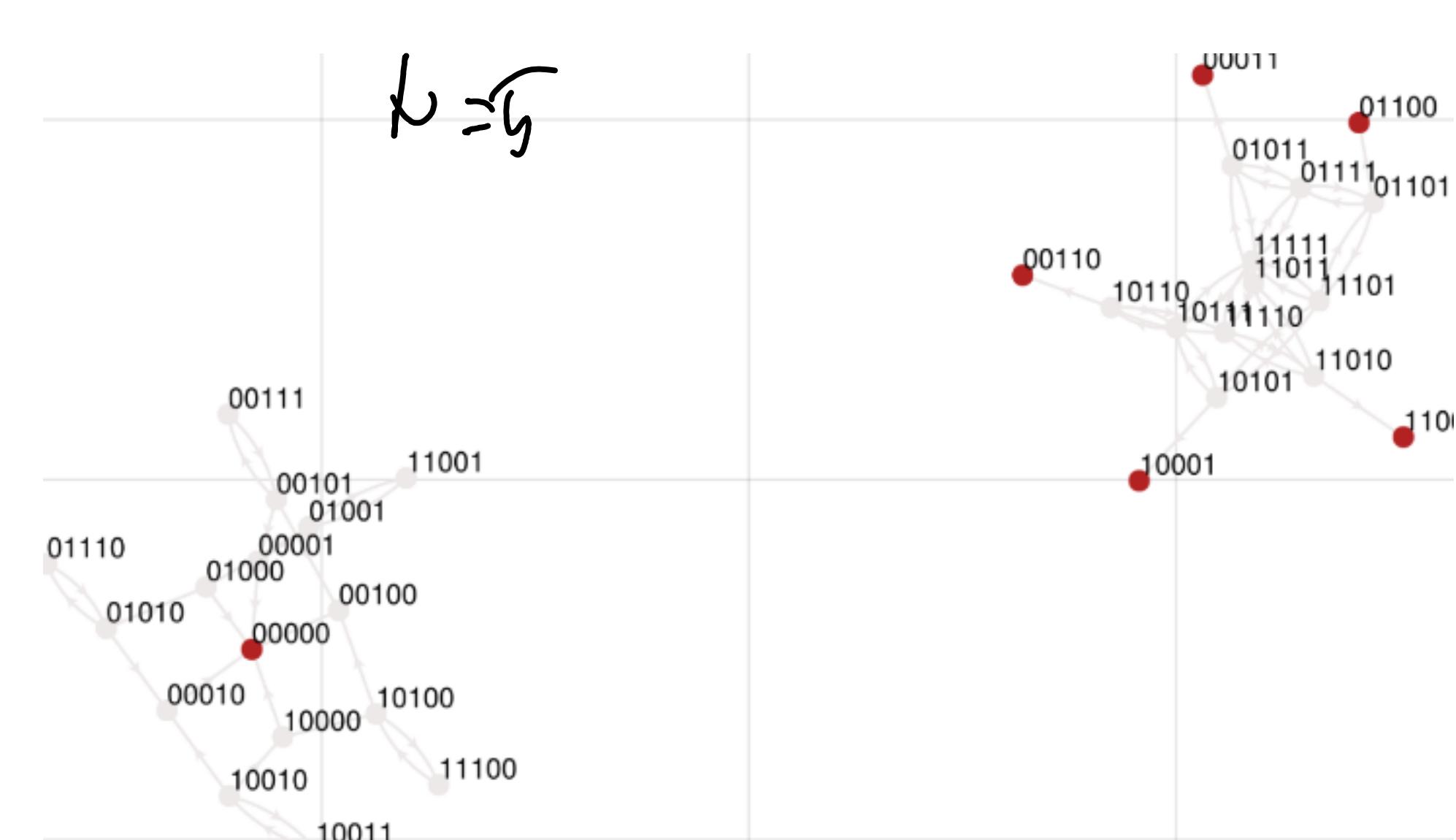
$N = 7$



$N = 6$



$N = 5$



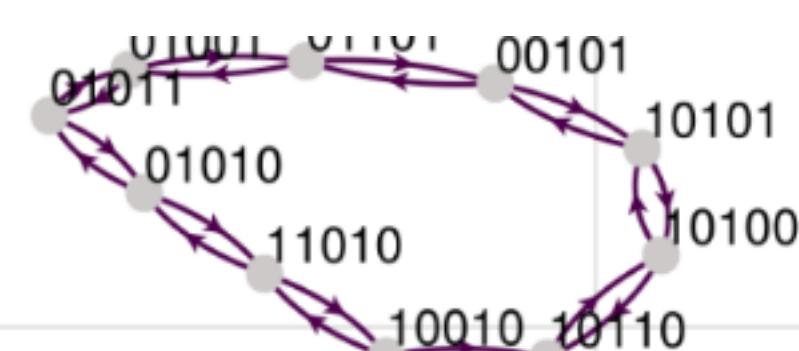
Eq rule 150

01 01
10 10

all boundaries can move both ways but
no seeding/completion

"canonical" loops where a wave moves around
gets isolated all 0s and all 1s and also alternating if they exist
most loops branch but if N is odd there's always
1 single state loop

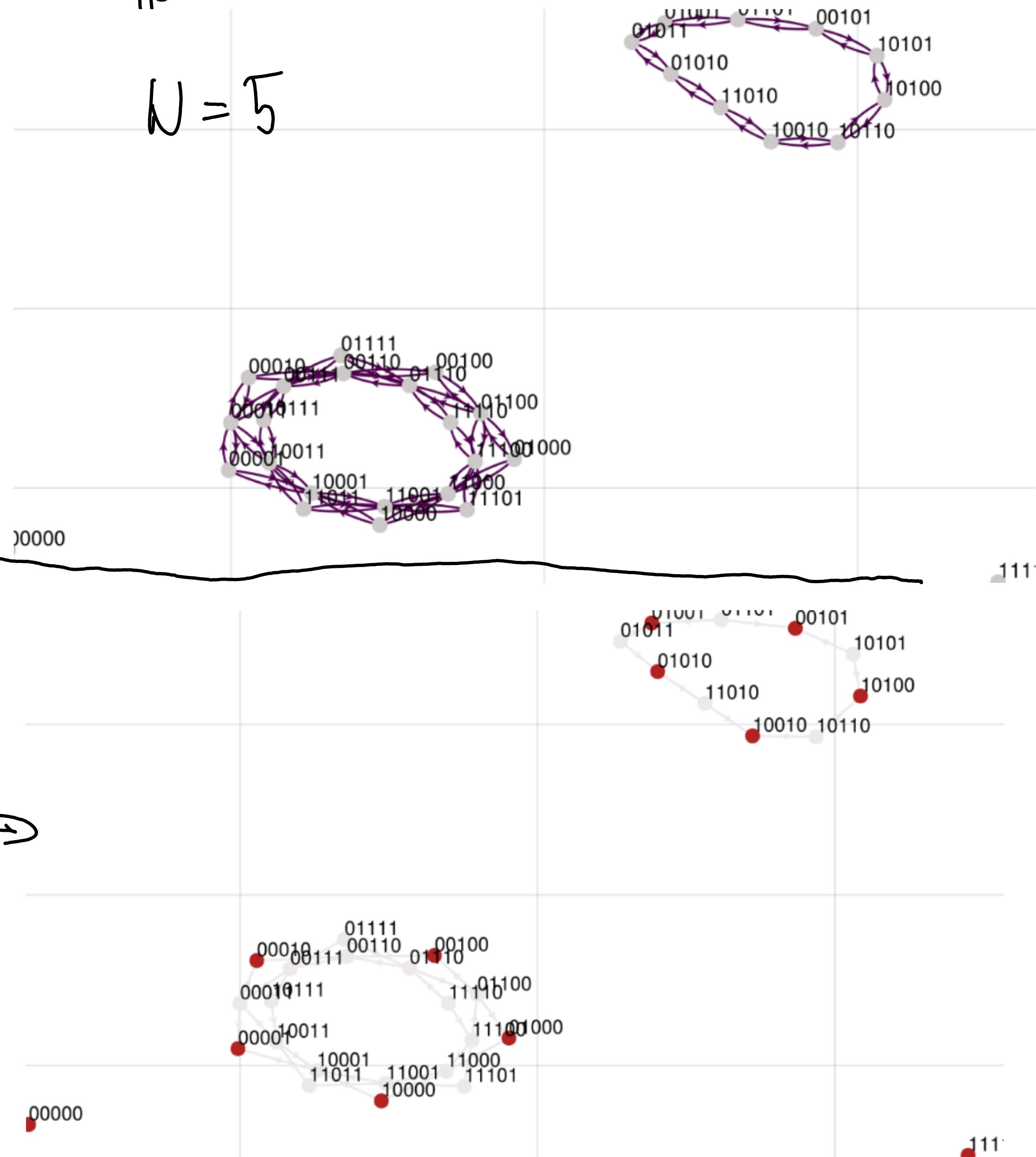
$N = 5$



Lengigne subrules

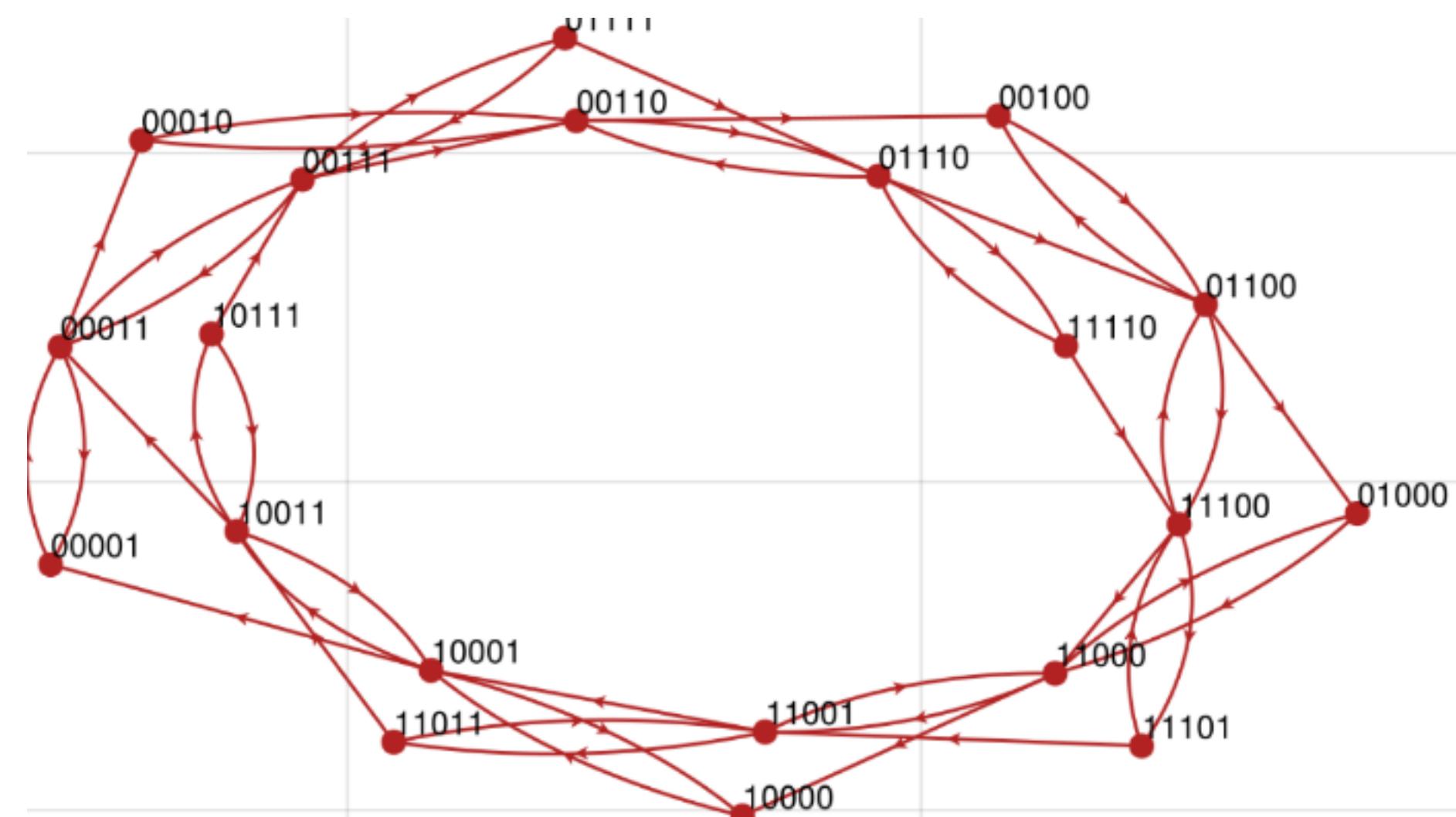
142 - directed moving
wave of all arrows
directed

137 - breaks apart the
acs into single states! →
00 01
00 10



3engigne subrules

134 - partially directed loops,
every other arrow is
directed, works even
for branched loops

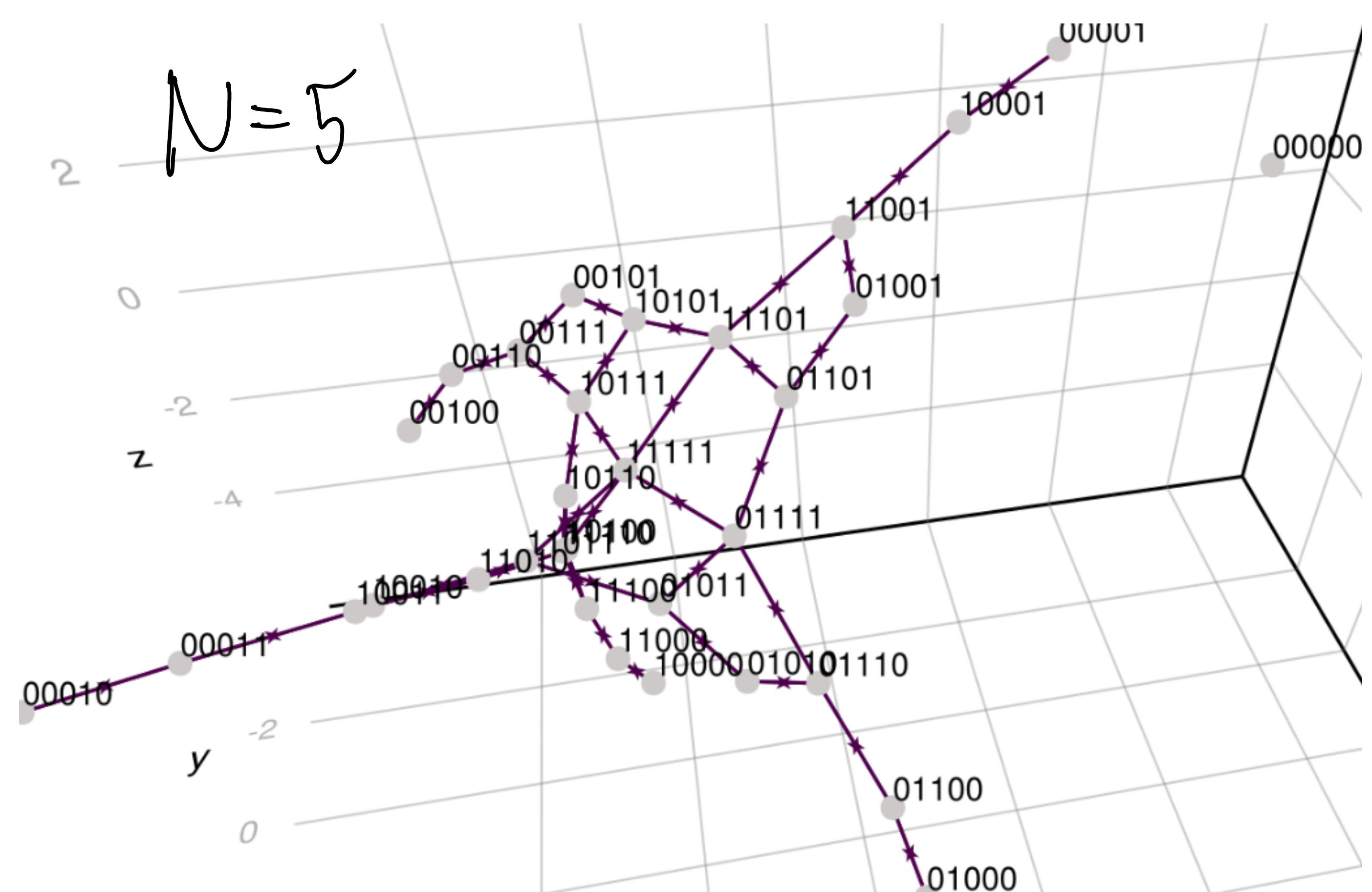


Eq rule 60

Forms "nets" expanding from all 1s (all 0s is isolated)

00 00
11 11

the net having distinct "tips" each ending
in a state with one isolated 1



Lengme subrules

12 \leftrightarrow 252
00 00 T 00 00
00 11 11 00

strongly biased, all single acs

252 only acs are all 1s and all 0s

12 acs are interspersed and include network tips

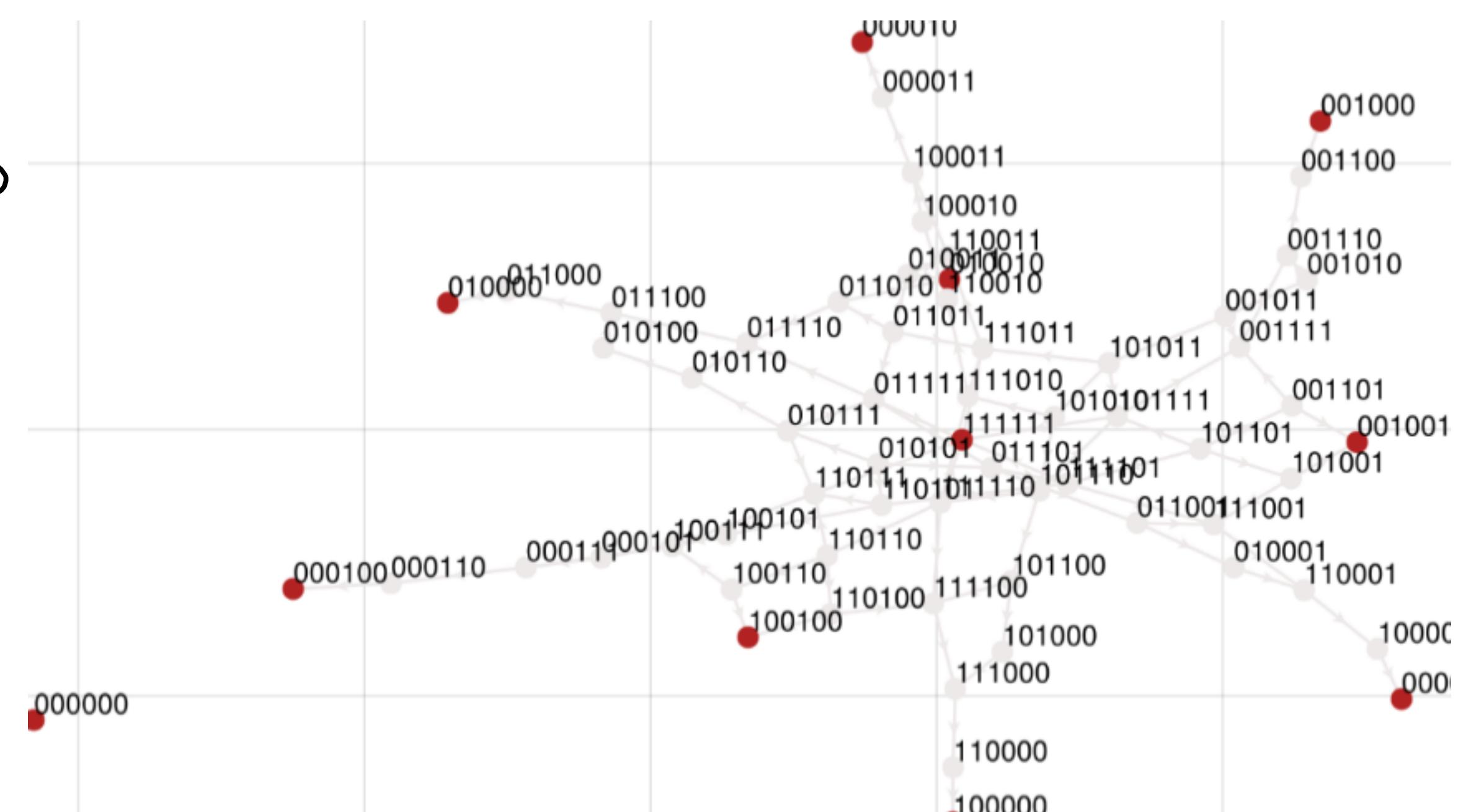
172 \leftrightarrow 92
00 00 T 00 00
01 10 10 01

also only single acs

92 interspersed close to middle

172 always all 0s, all 1s and tips

N = 6

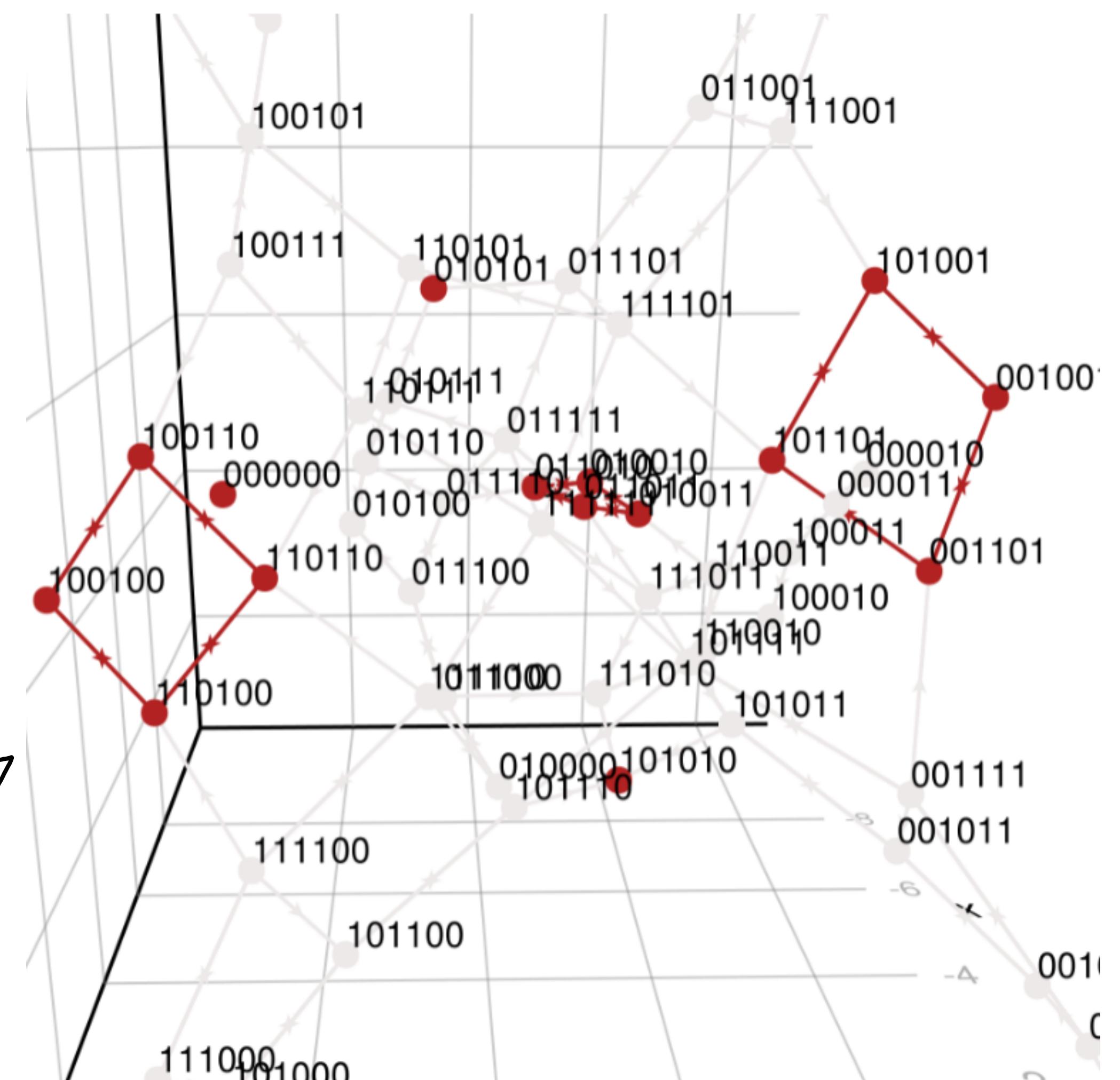


3rd regime subhalos

188 - all 1s and all 0s only
 $\begin{matrix} 00 & 00 \\ 11 & 10 \end{matrix}$
 the accs

$\downarrow T$

28 - has many small diffusive
 $\begin{matrix} 00 & 00 \\ 10 & 11 \end{matrix}$
 non-single accs due to
 a 1100 boundary shifting
 back and forth

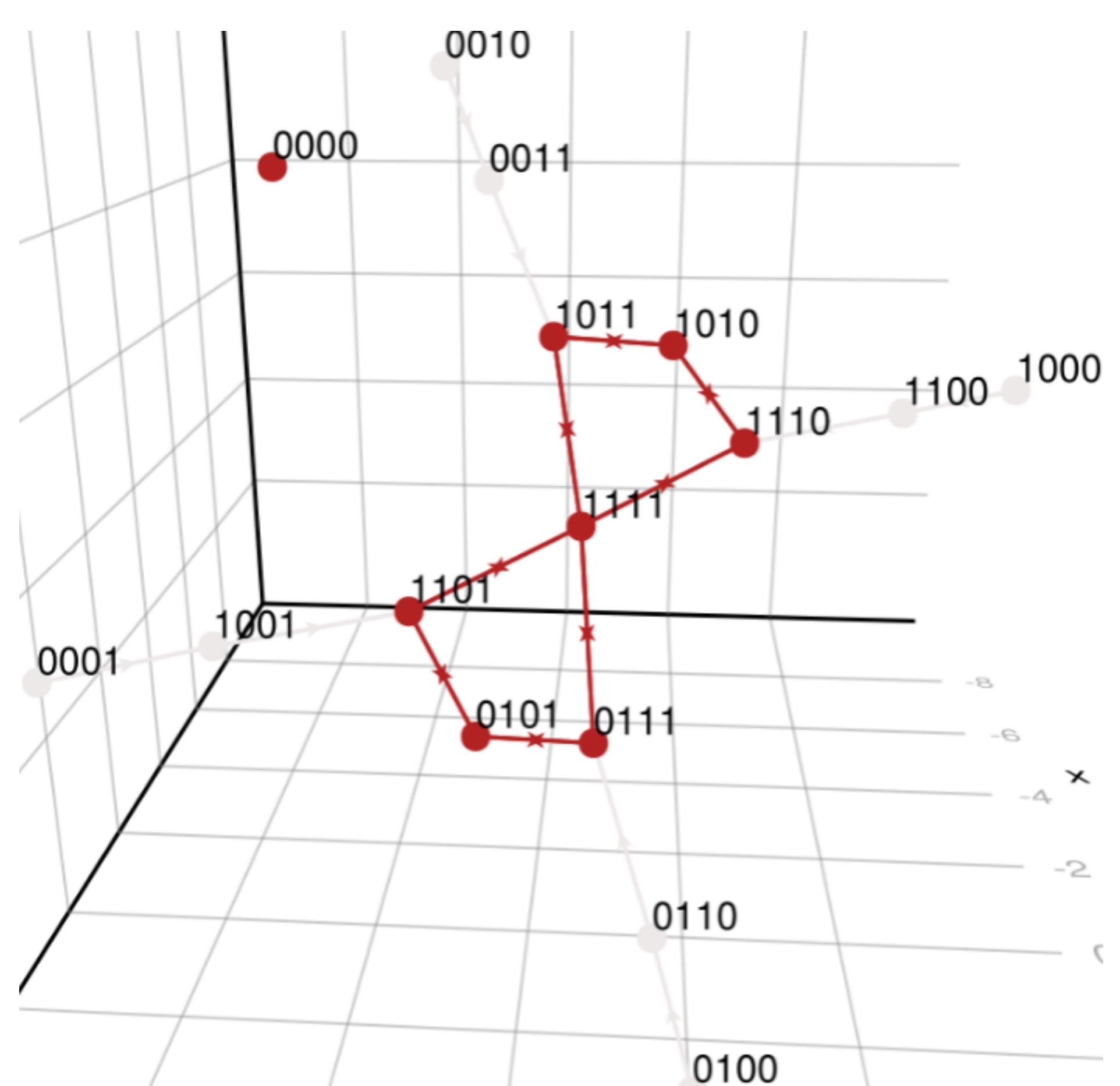
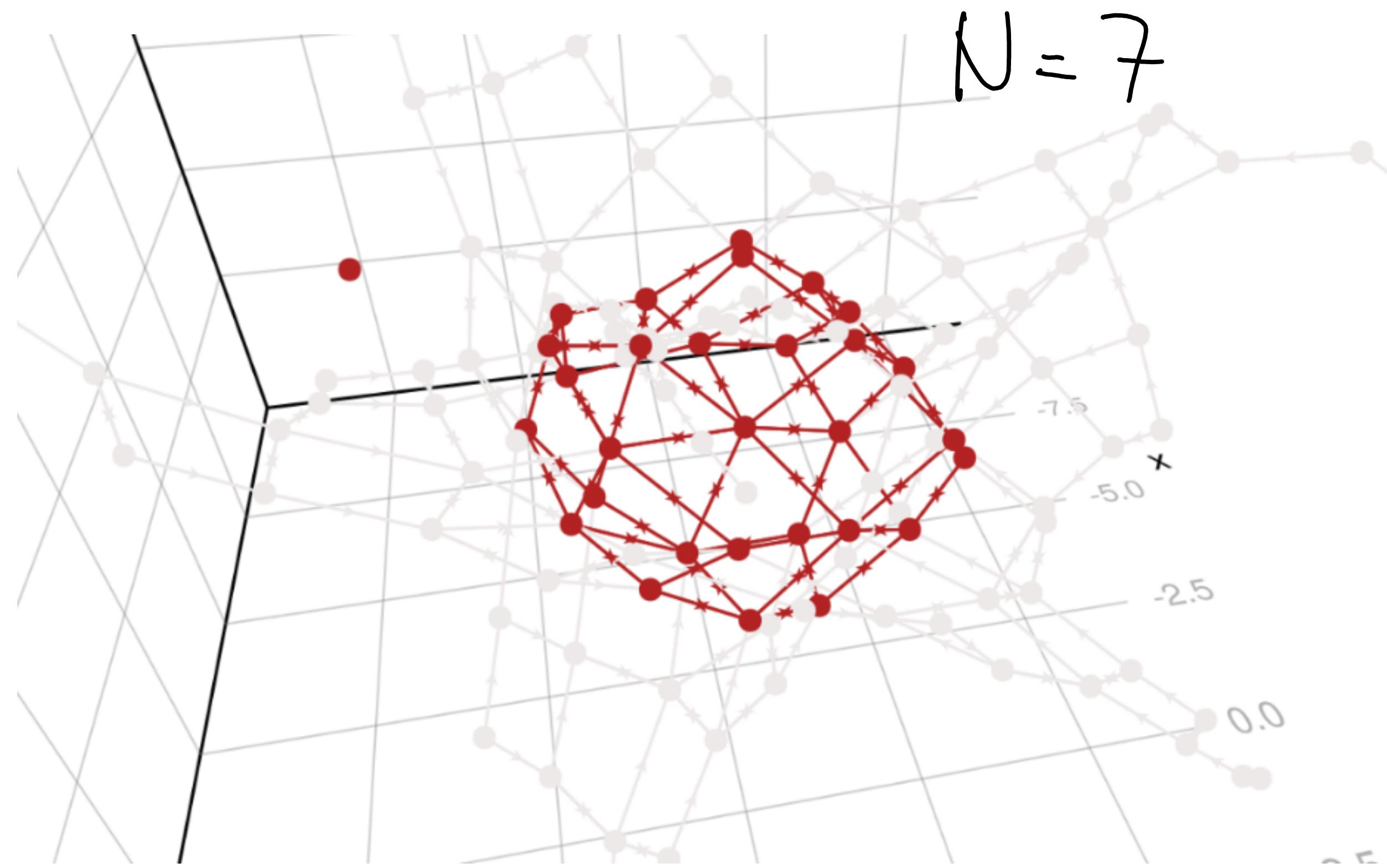


44 - bunch of single accs
 $\begin{matrix} 00 & 00 \\ 01 & 11 \end{matrix}$
 including the vert tips

\downarrow

124 - has a diffusive lensing
 $\begin{matrix} 00 & 00 \\ 11 & 01 \end{matrix}$
 acc around all 1s

$N = 7$

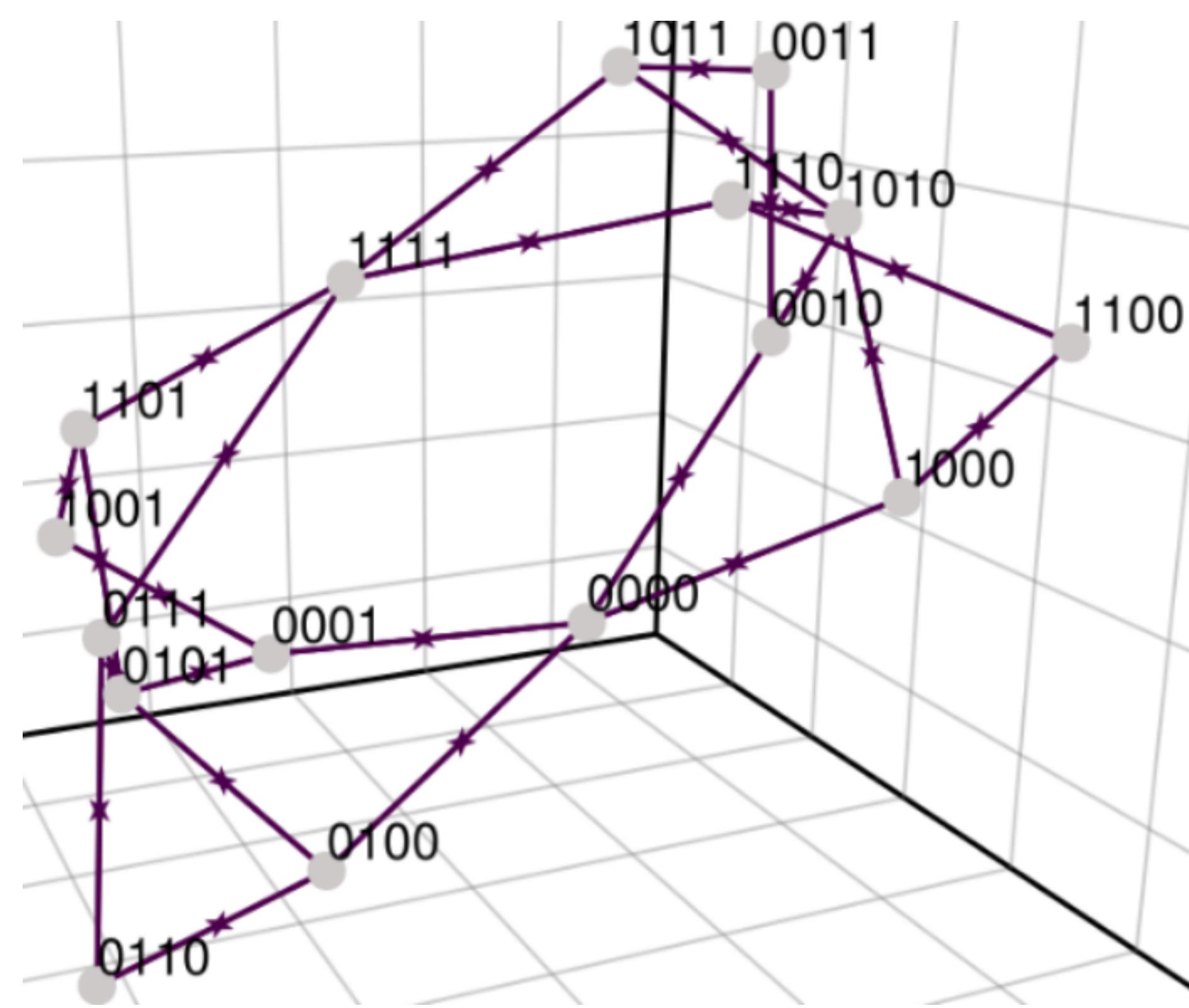


E_9 rule 57

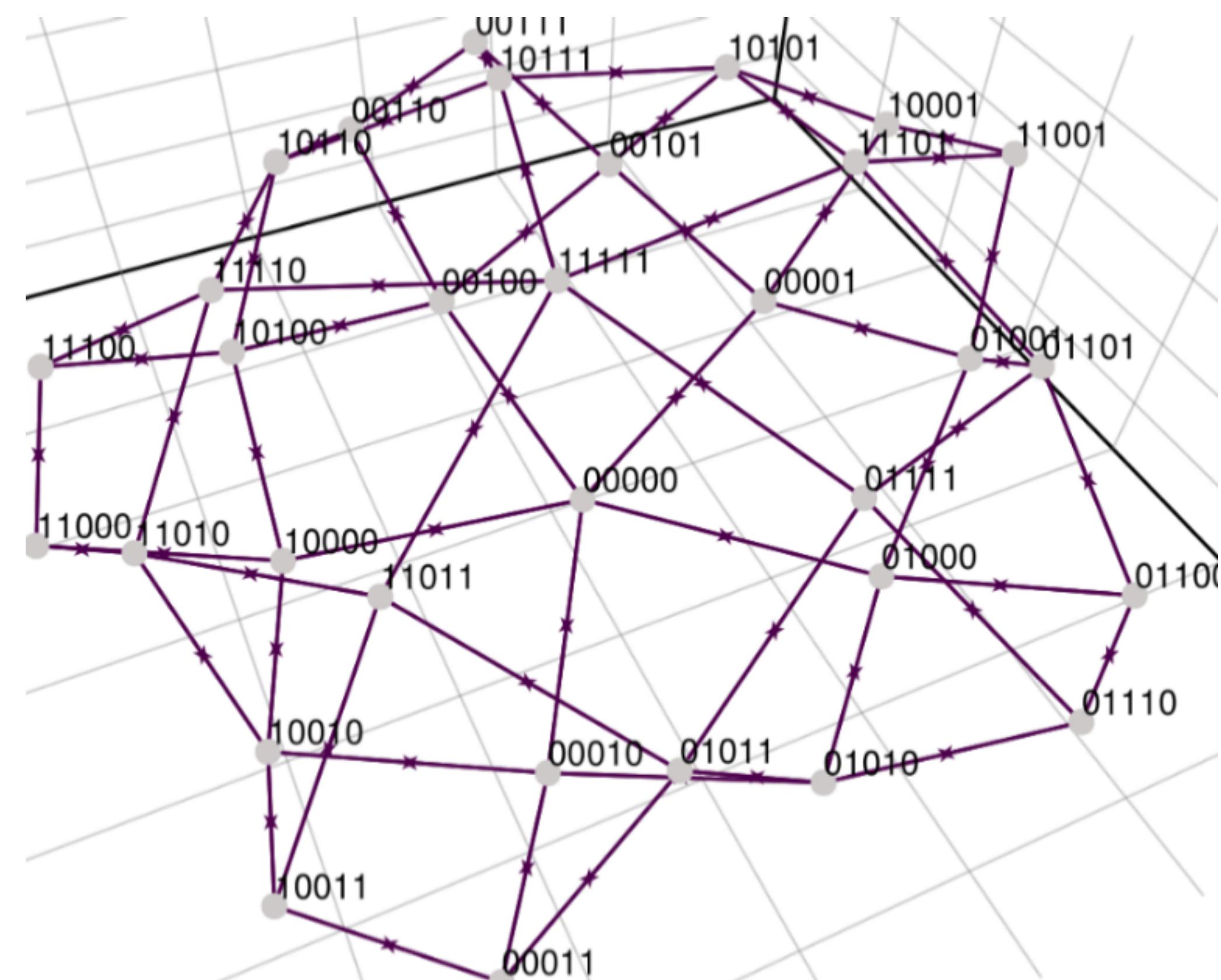
$\begin{smallmatrix} 10 & 10 \\ 11 & 11 \end{smallmatrix}$ - everything but moving a ..0011.. boundary

Forms very pretty symmetrical structures with all 0s and all 1s "opposite"

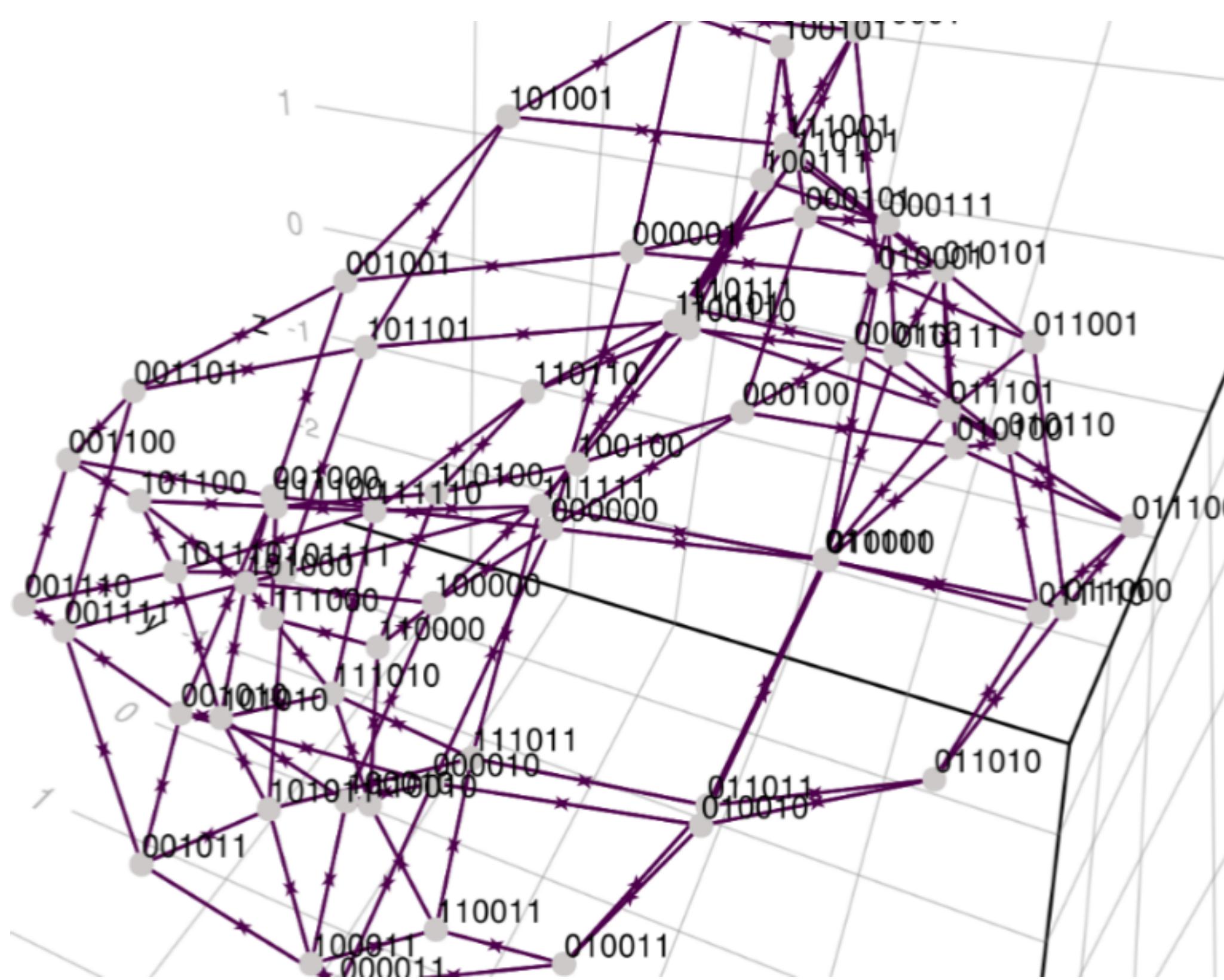
$n=4$



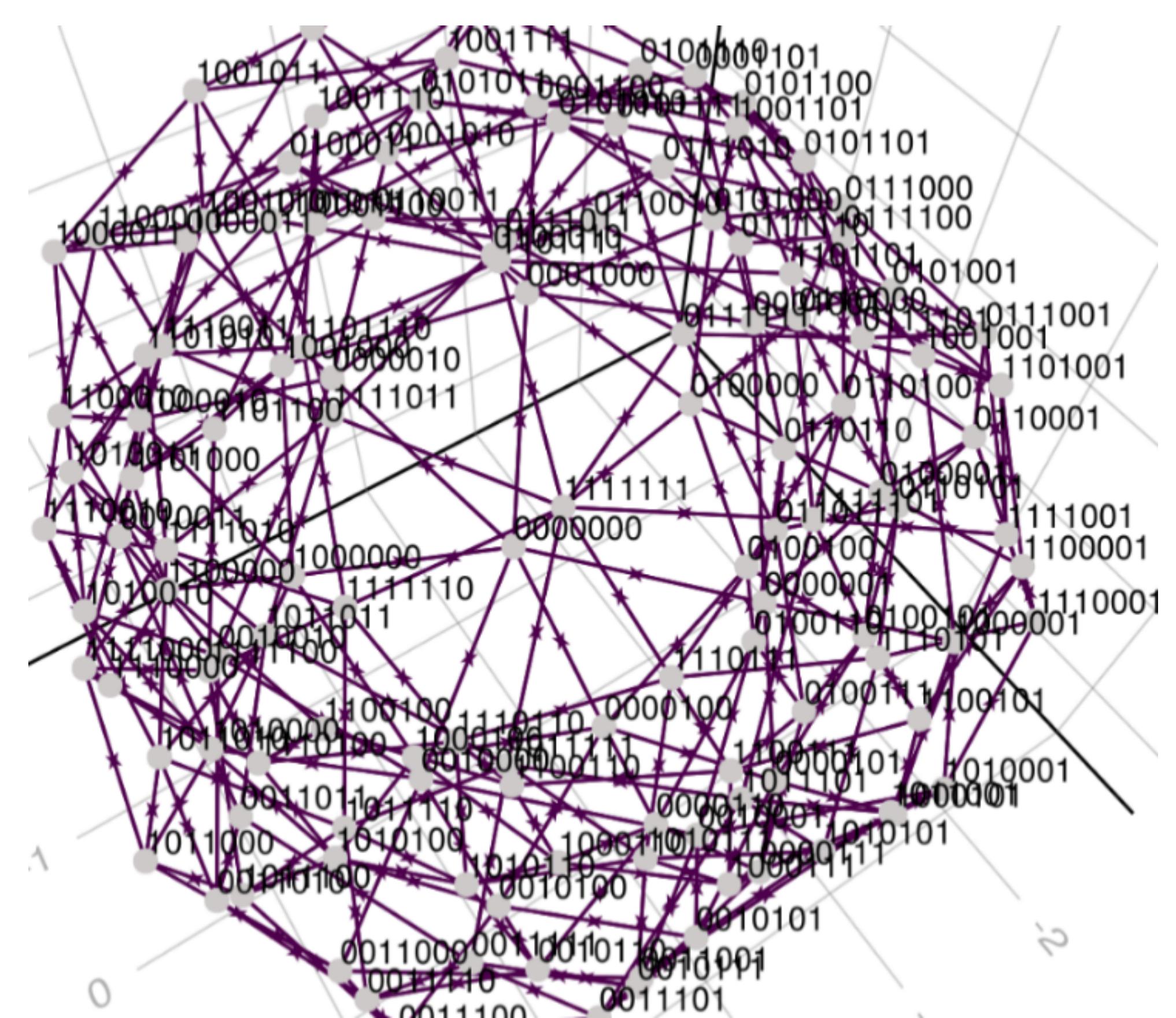
$N=5$



$N=6$

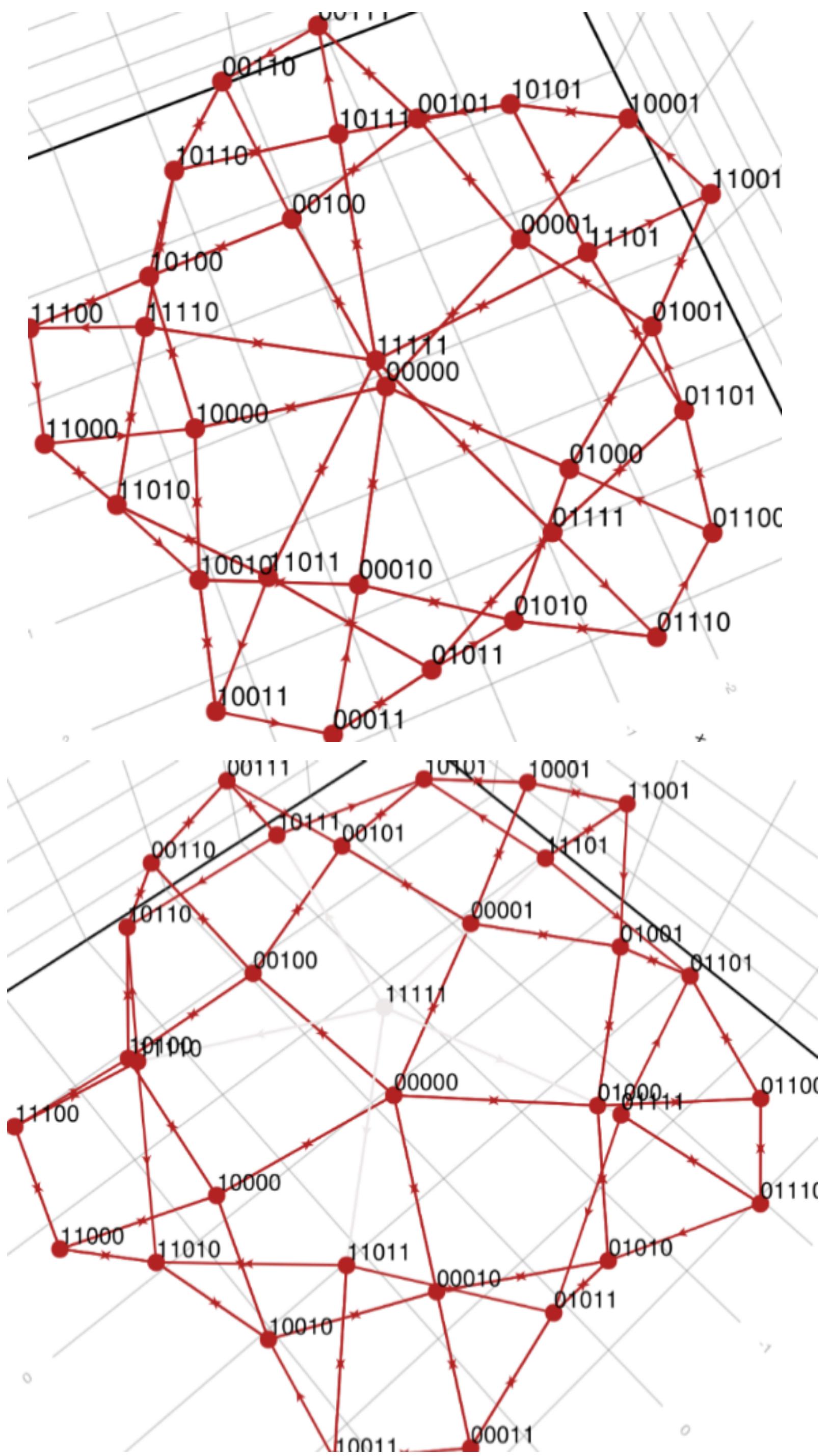


$N=8$



5 enzyme subunits

41 - biased towards all 0s
 $\begin{matrix} 1 & 0 \\ 1 & 1 \end{matrix}$ (as 0 domains cannot shrink)
 $\begin{matrix} 0 & 1 \\ 1 & 1 \end{matrix}$ but remains a single large ac



56 - makes all 0s inescapable

$\begin{matrix} 0 & 0 \\ 1 & 0 \end{matrix}$ all 0s is only ac

$\begin{matrix} 1 & 1 \\ 1 & 1 \end{matrix}$

$$\downarrow T + 01 + LR$$

25 - somewhat similar to 41, has 1 ac but there are some directed arrows, this time toward all 1s which cannot be reached



3 enzyme subunits

B - all 0s only ac

$\begin{matrix} 0 & 0 \\ 0 & 1 \end{matrix}$

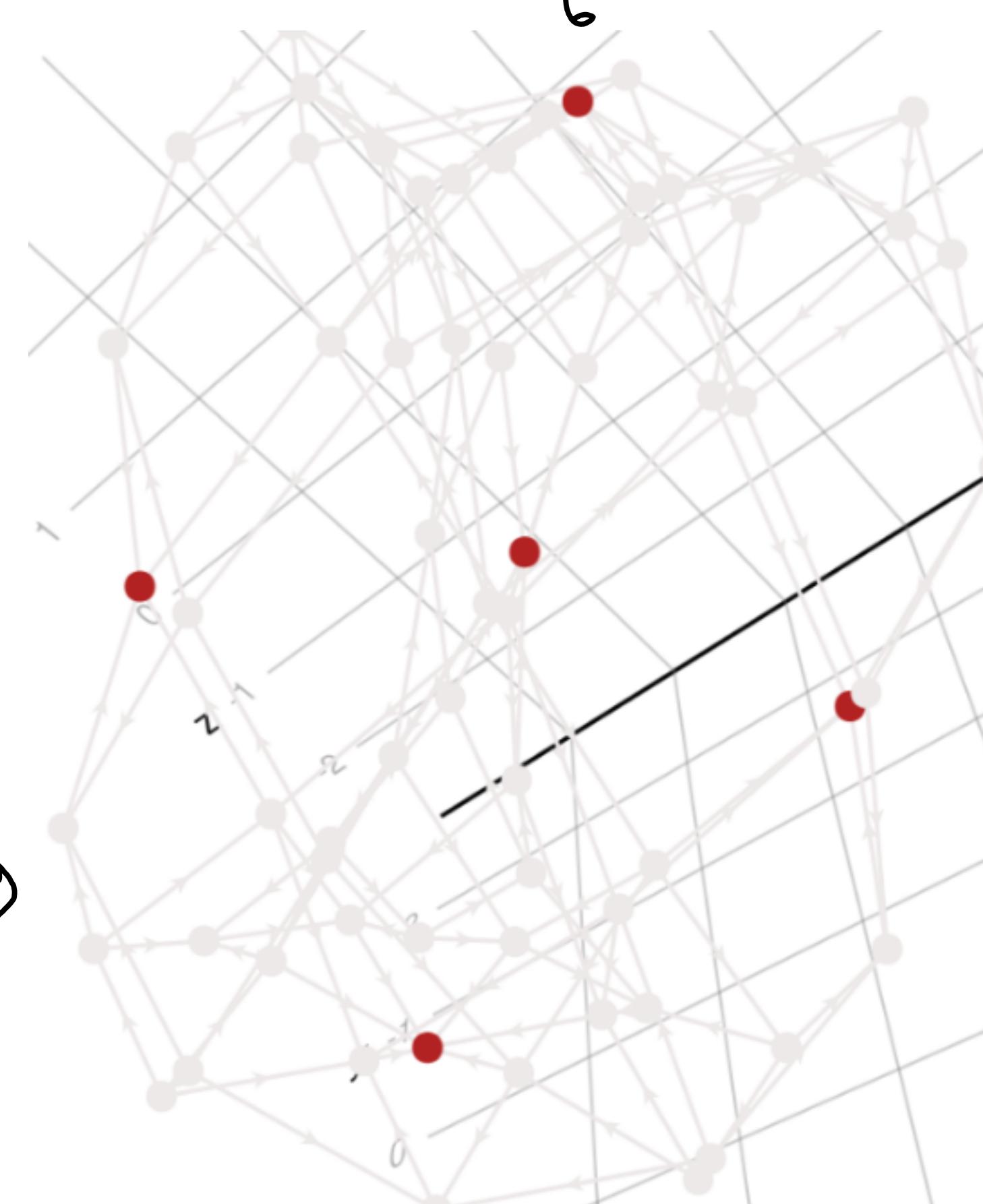
88 - all 0s + if $N \text{ div. by } 3$

$\begin{matrix} 0 & 0 \\ 1 & 0 \end{matrix}$ also repeats of $\overline{110}$

13 - always a couple of clusters dispersed acs

$$\downarrow T + 01 + LR$$

168 - all 0s and all 1s are always the only f acs



longime subrules

40 - all 0s only ac
 00 10
 01 11
 } T++

9 - 1 complex diffusive
 ac around all 0s

24 - all 0s only ac
 00 10
 10 11

120 - all 0s only ac

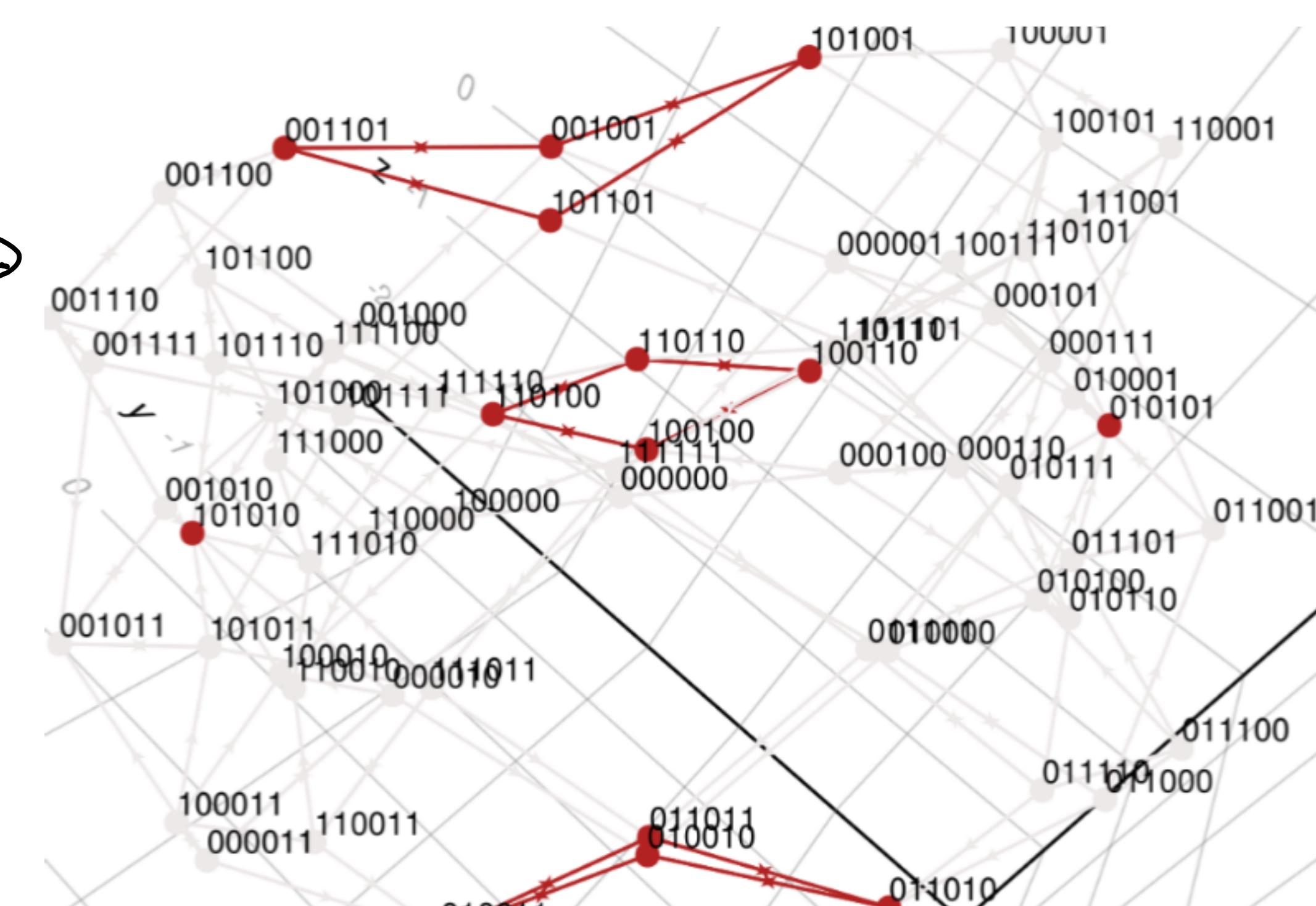
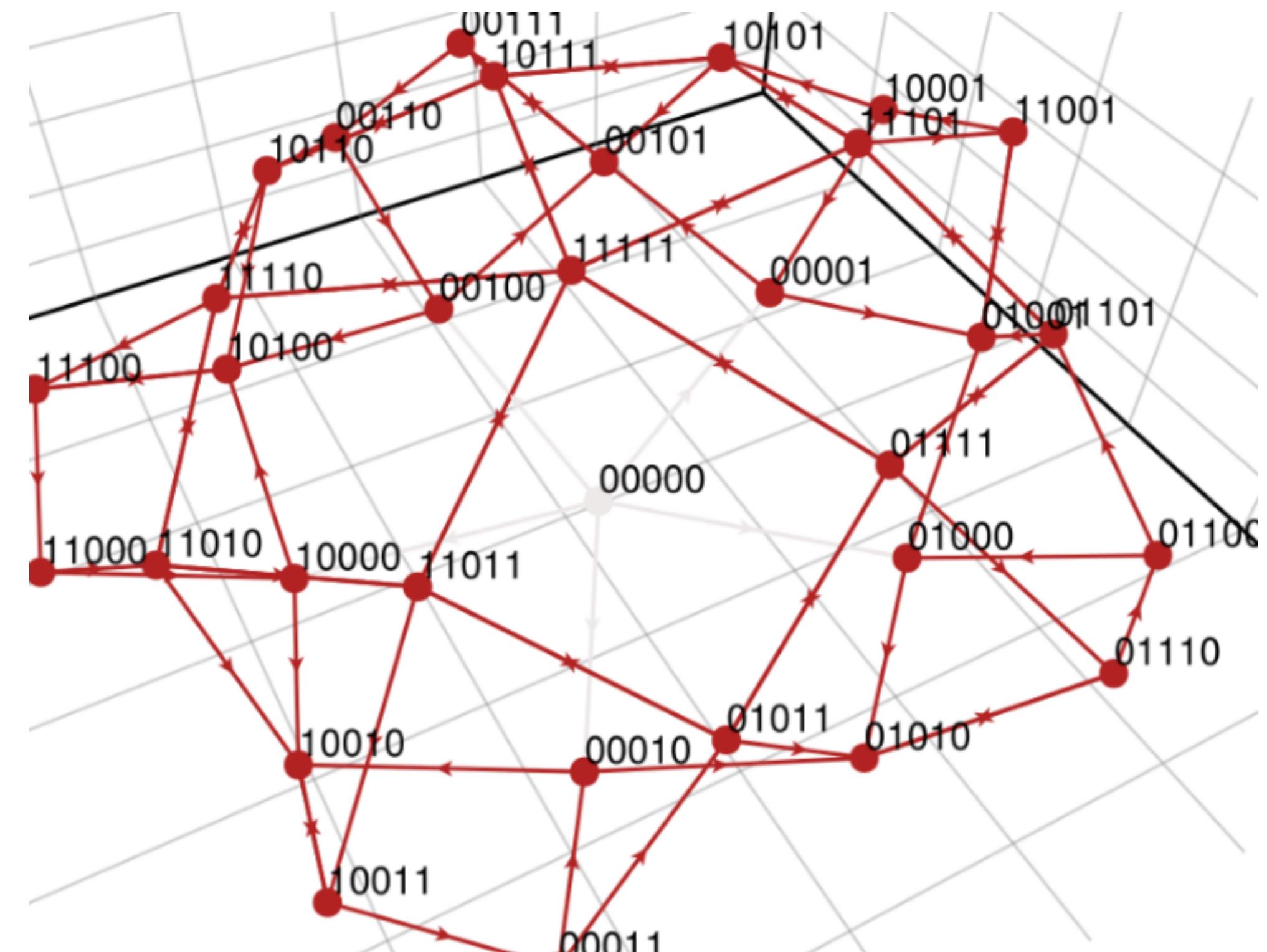
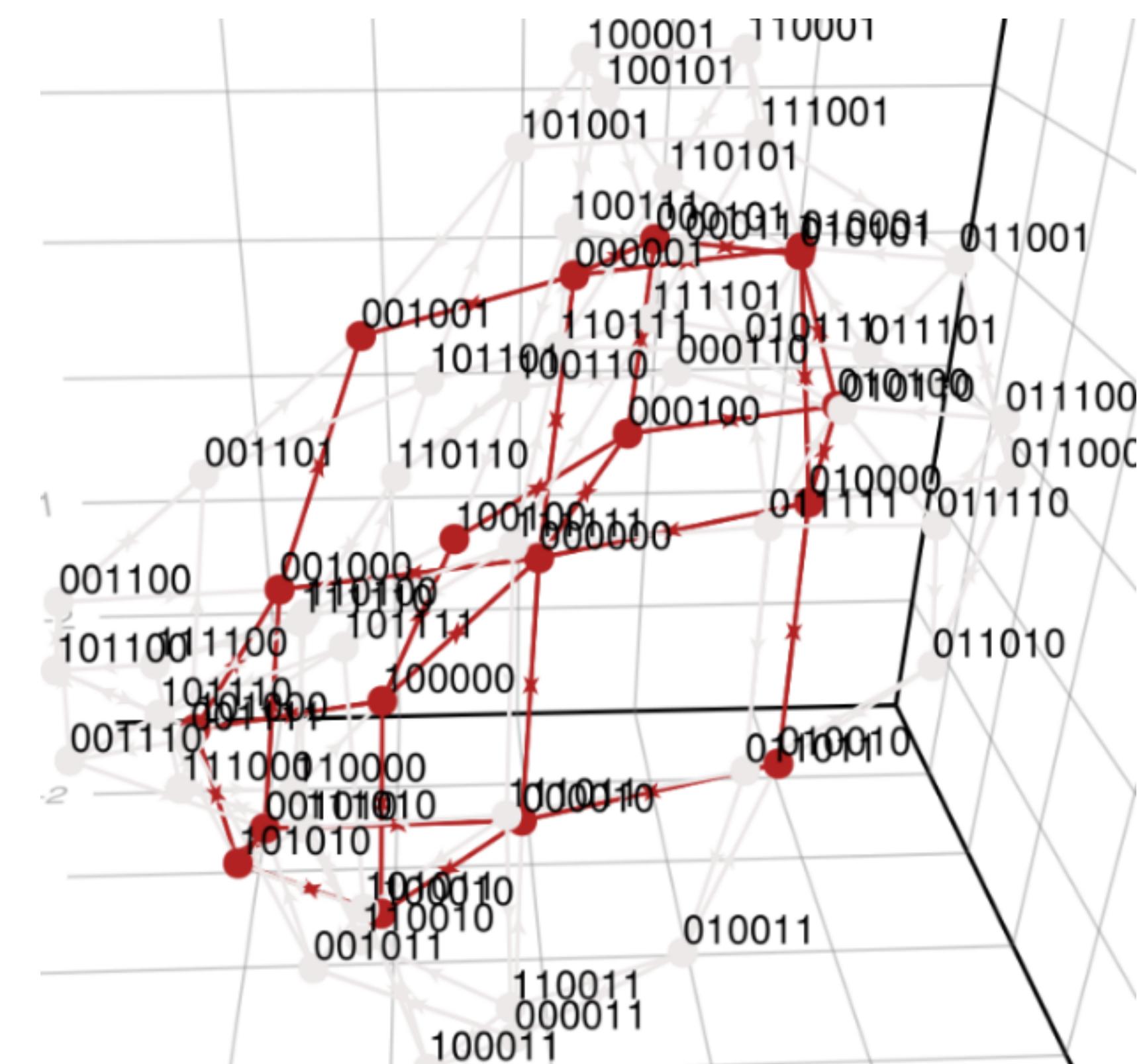
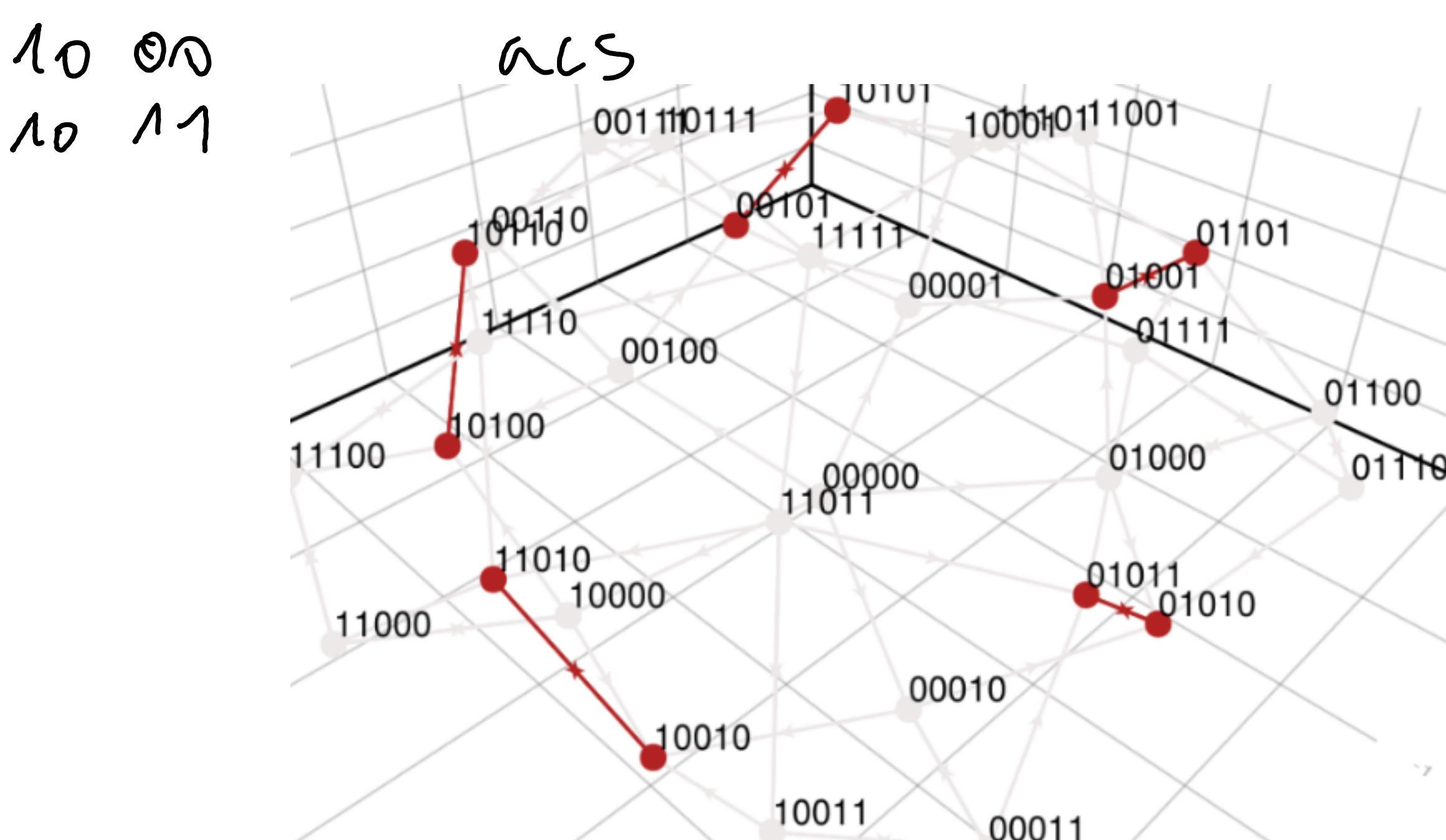
00 10
 11 01
 } T

45 - only ac is everything
 except all 0s unless N div by 3 → then gets stuck at $\overline{001}$

184 - all 0s and all 1s
 only acs

↑ T
 ↓ T

29 - multiple small diffusive
 acs



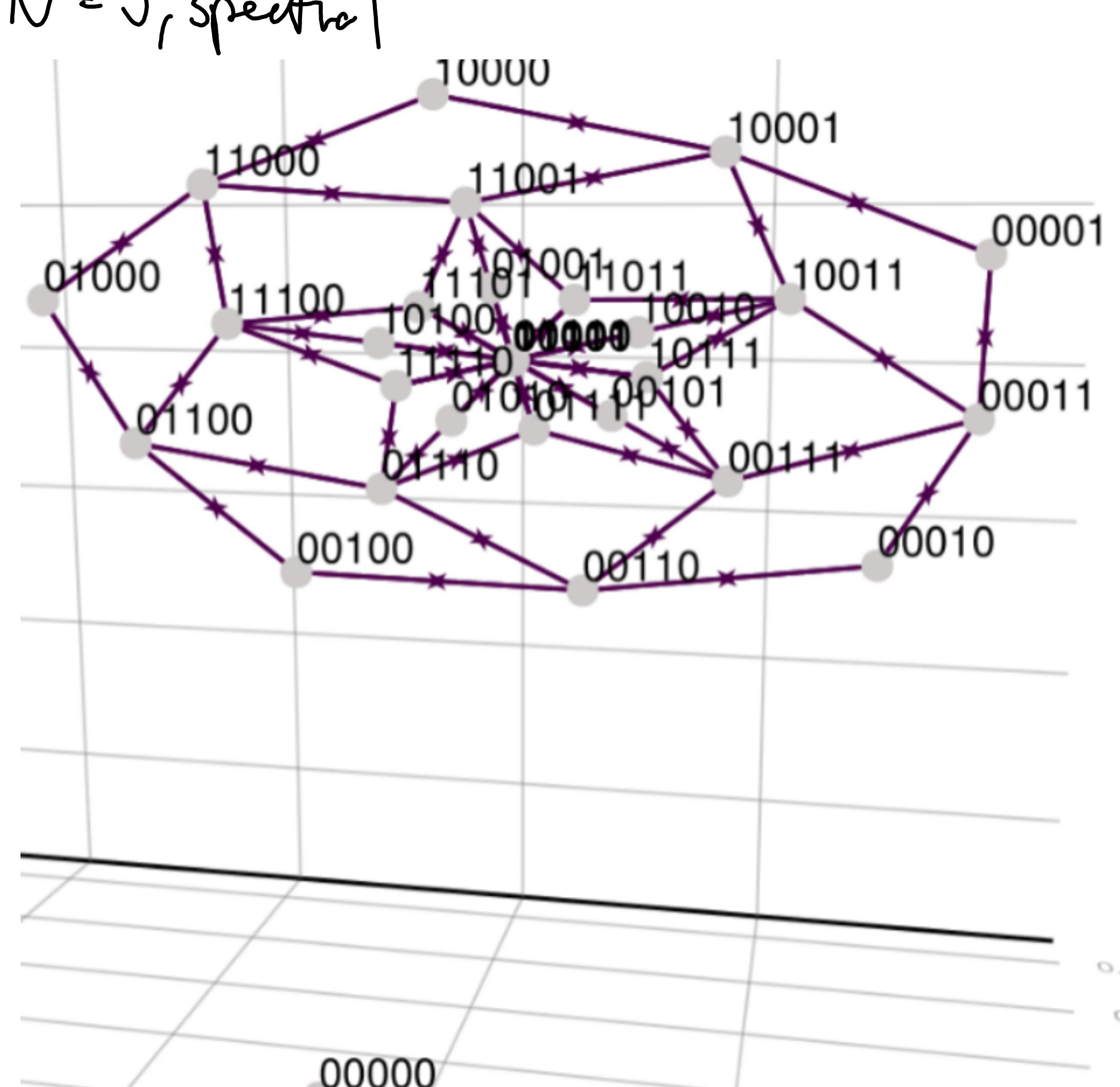
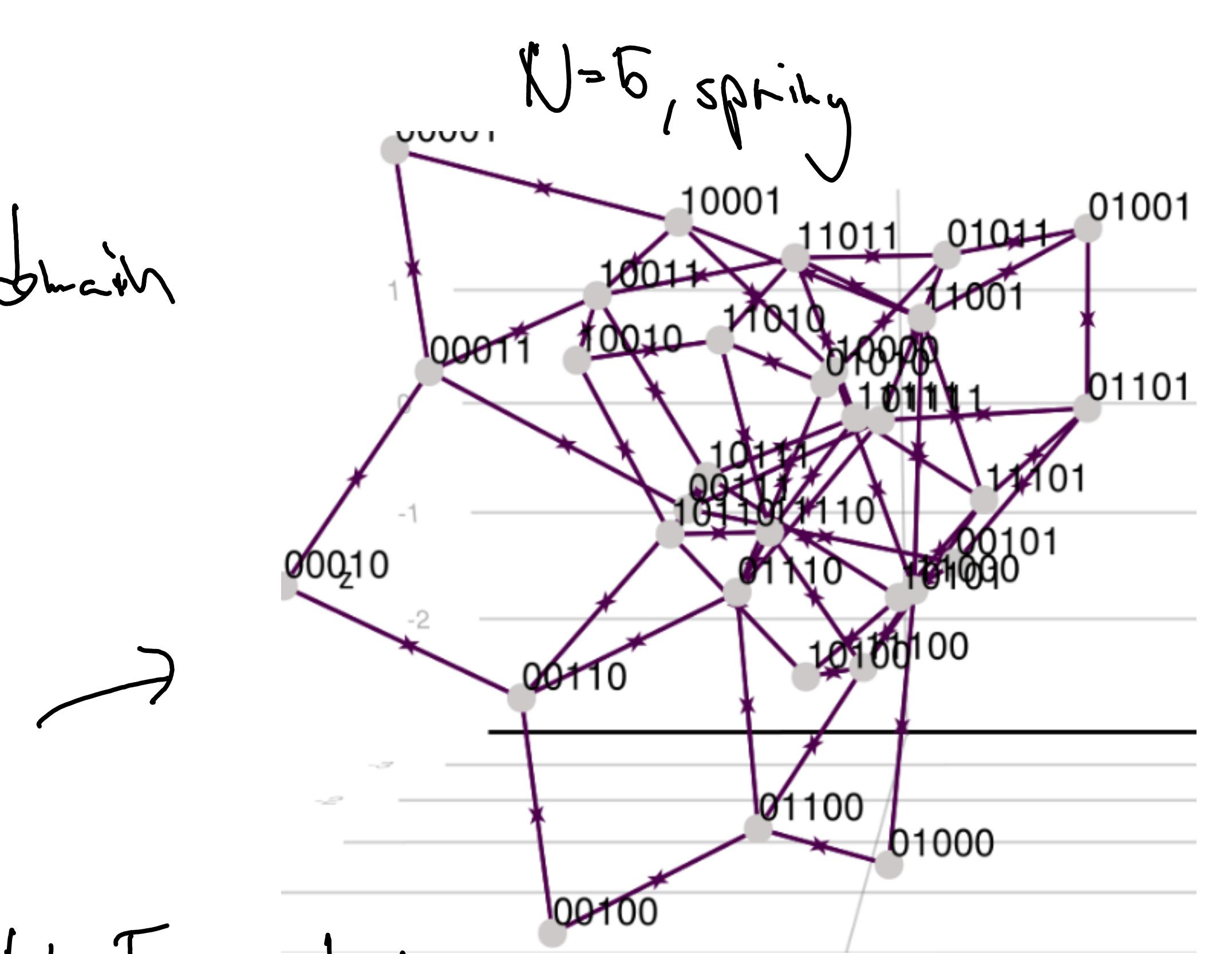
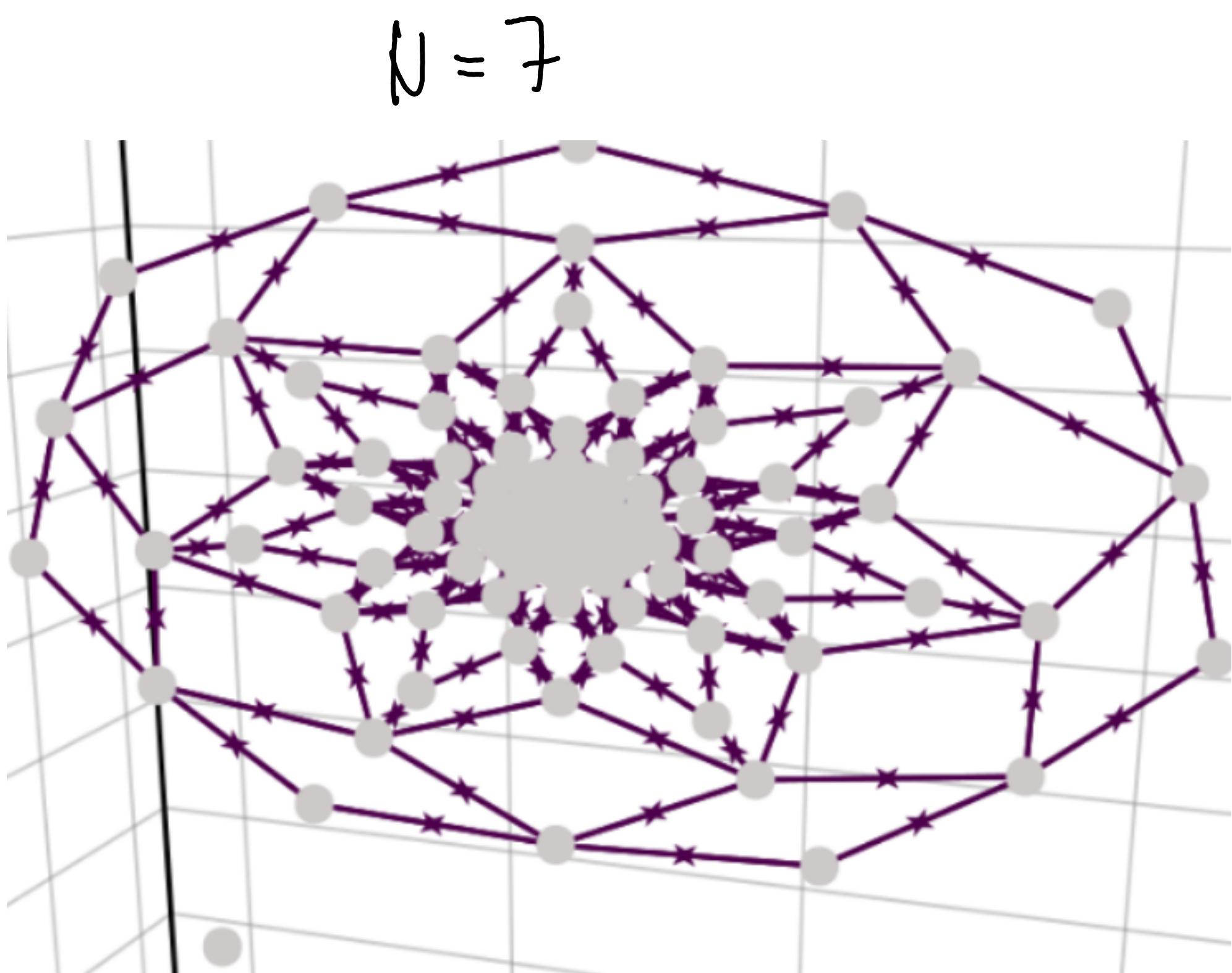
Eg rule 54

$01\ 01$ ~ cannot seed or complete a 0 chain
 $11\ 11$

all 0's is always isolated

in Spring it looks like a structured blob

Spectral always gives a star/dish shape $N=5$, spectral



5 enzyme subrules

182 - all 0s and all 1s

$\begin{matrix} 0 & 1 \\ 1 & 0 \end{matrix}$
 $\begin{matrix} 1 & 1 \\ 1 & 0 \end{matrix}$
only acs

$\uparrow T$

22

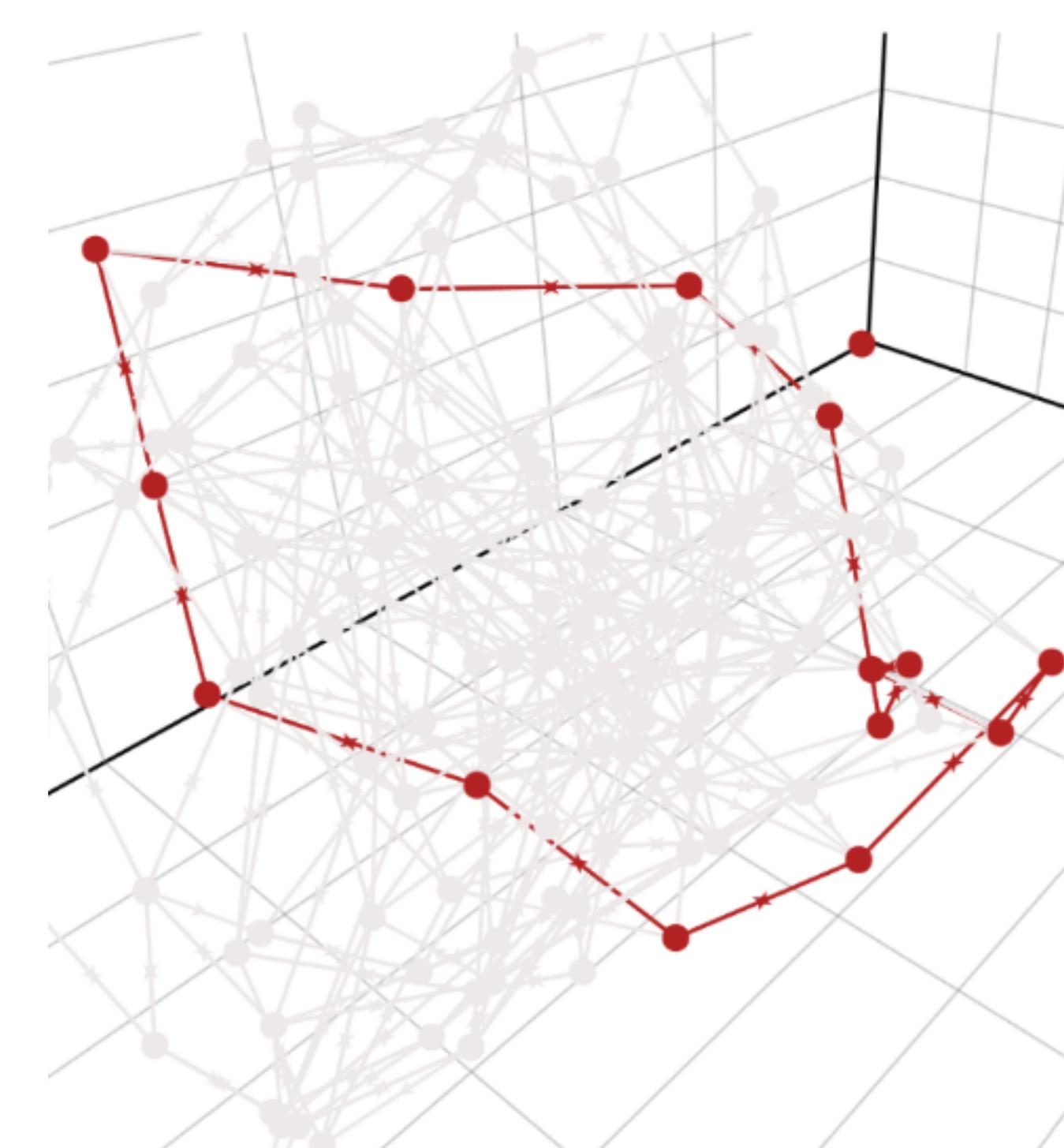
$\begin{matrix} 0 & 1 \\ 1 & 0 \end{matrix}$
 $\begin{matrix} 1 & 0 \\ 1 & 1 \end{matrix}$

- loops At odd N has

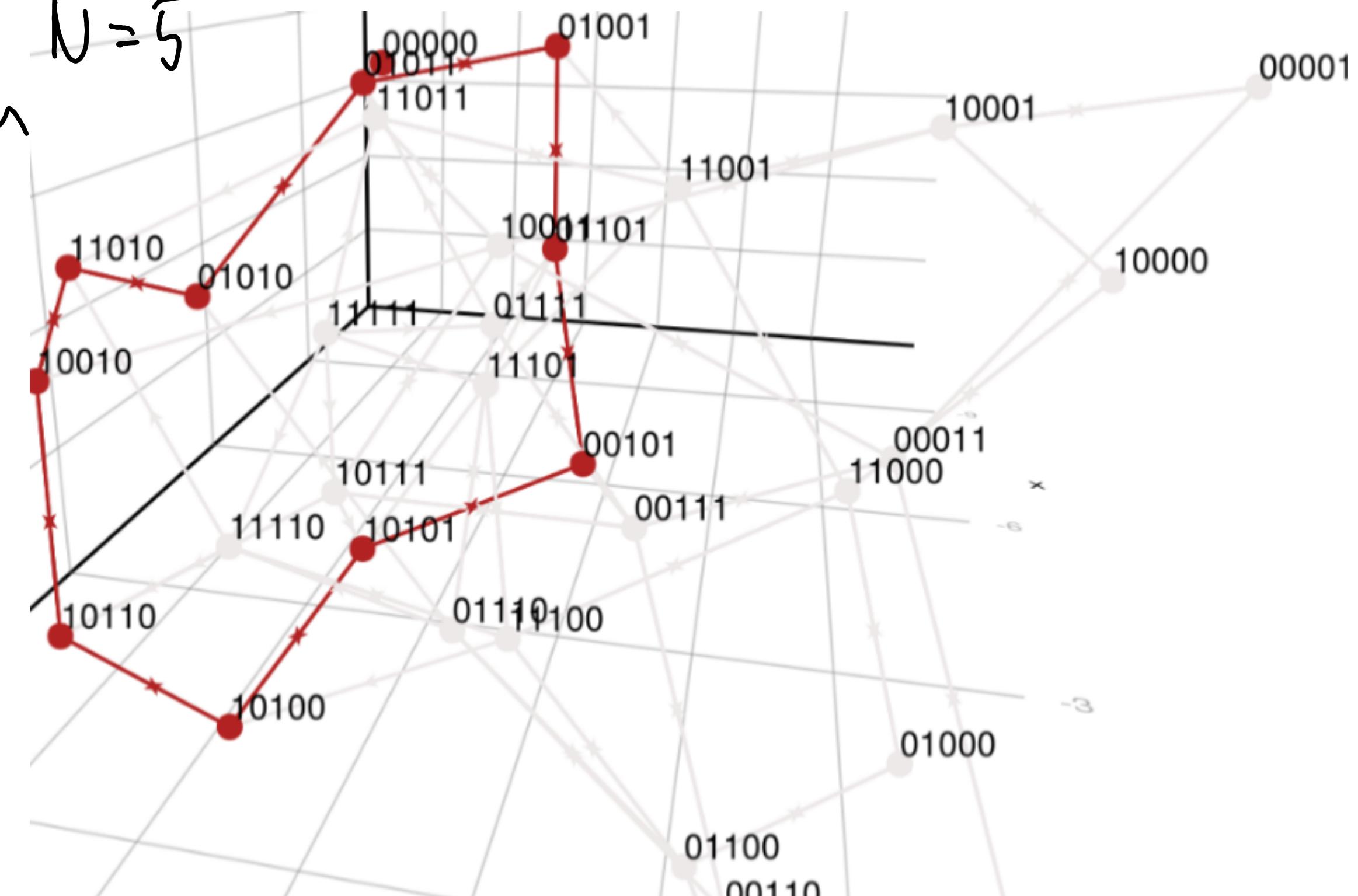
one non-single ac which
is a single state loop

At even N gets stuck
in $\overline{01}$ states

$N=2$



$N=5$



38

$\begin{matrix} 0 & 1 \\ 0 & 1 \end{matrix}$
 $\begin{matrix} 0 & 1 \\ 1 & 1 \end{matrix}$

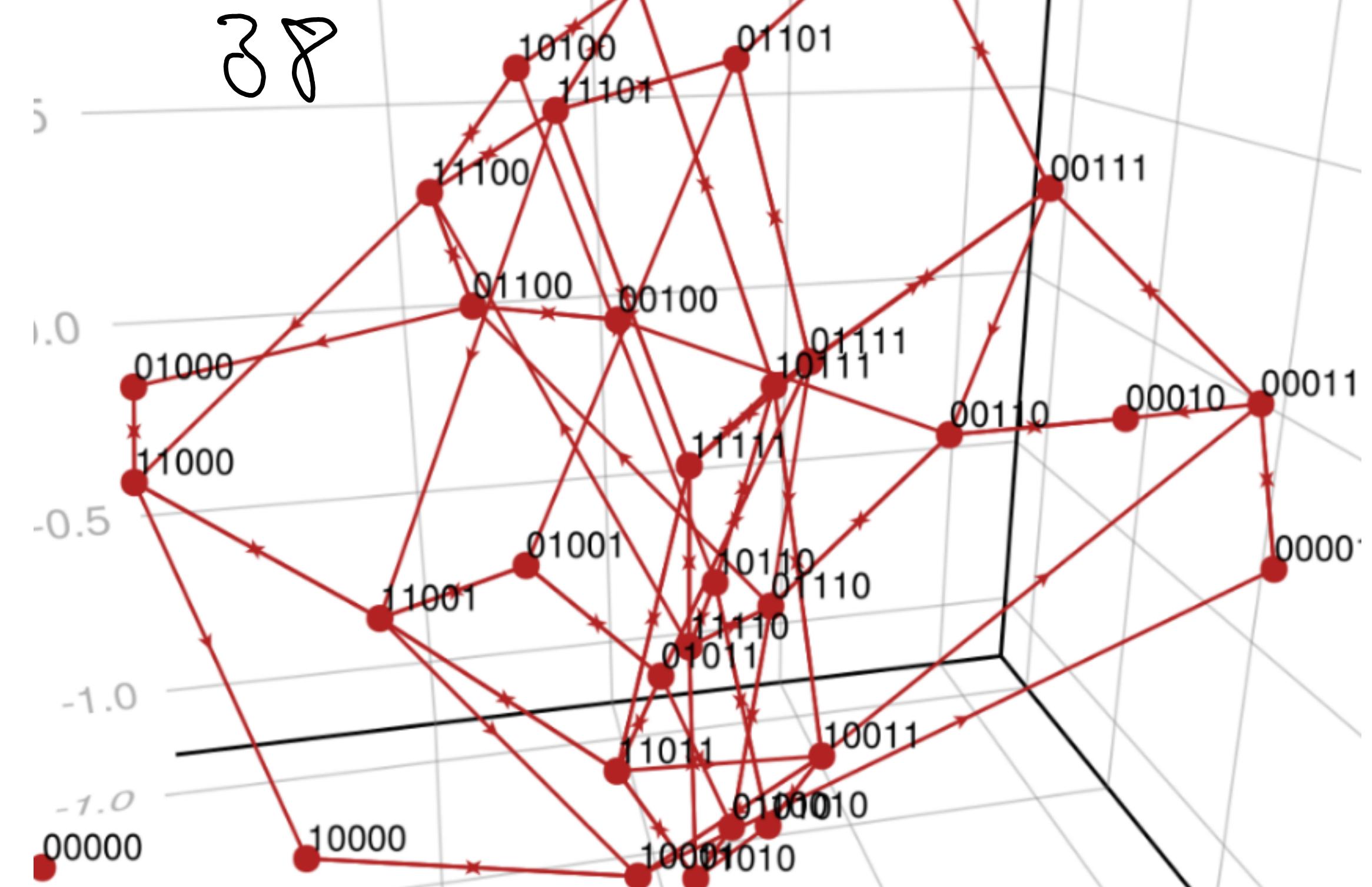
$\uparrow T+LR$

62

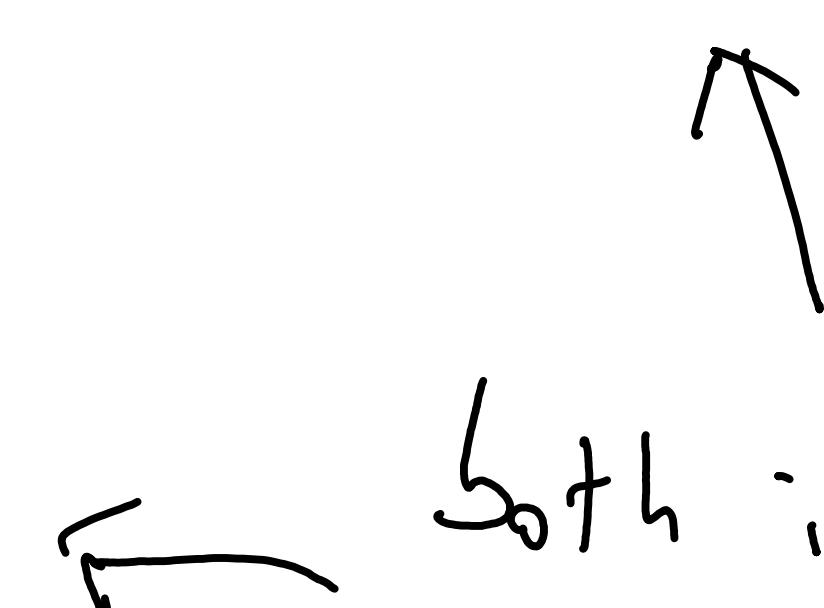
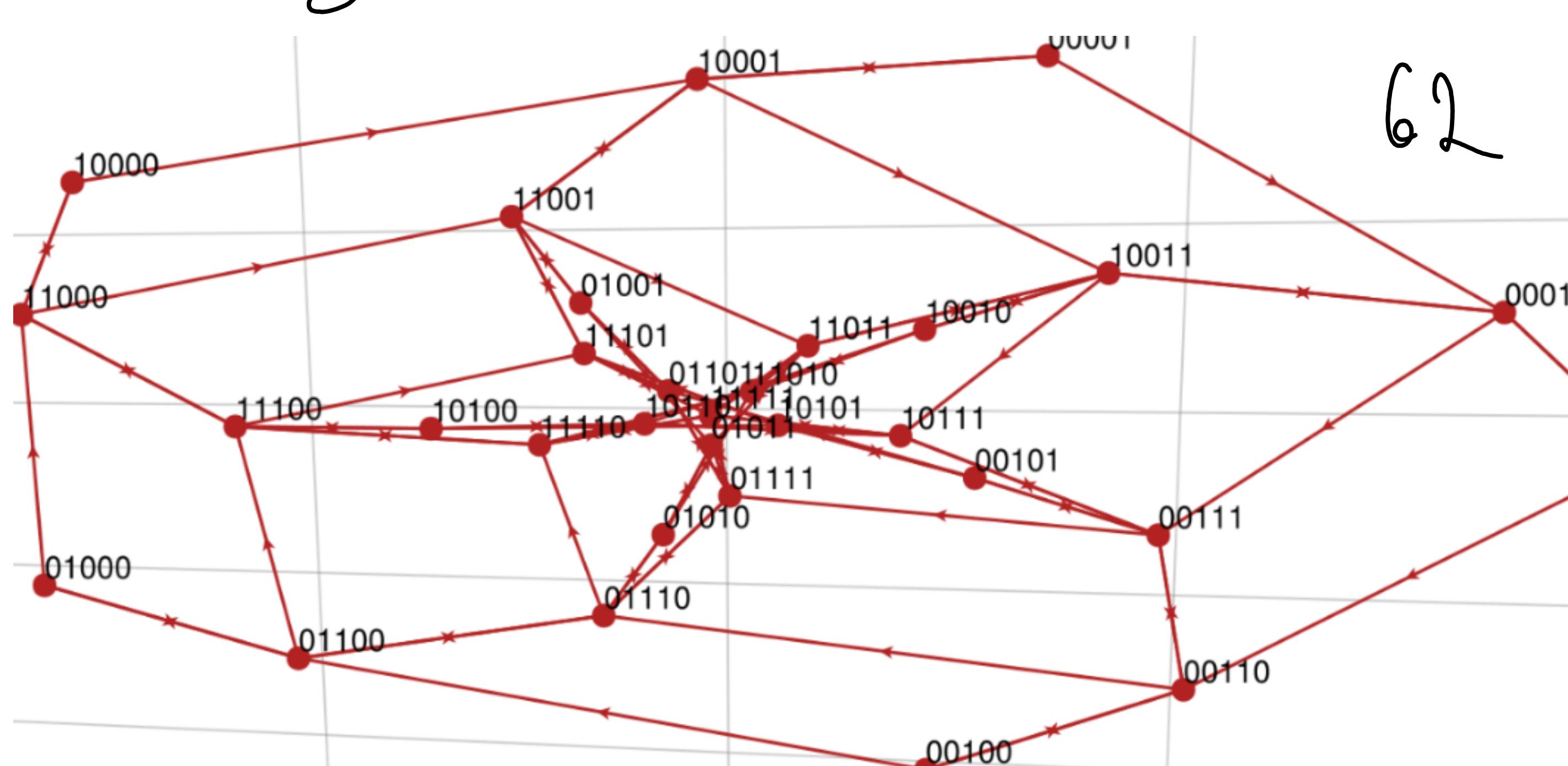
$\begin{matrix} 0 & 1 \\ 1 & 0 \end{matrix}$
 $\begin{matrix} 1 & 1 \\ 1 & 1 \end{matrix}$

both keep the
entire structure
as one complex
bc but looking
at ss makes it
clear there are
bices

38



62

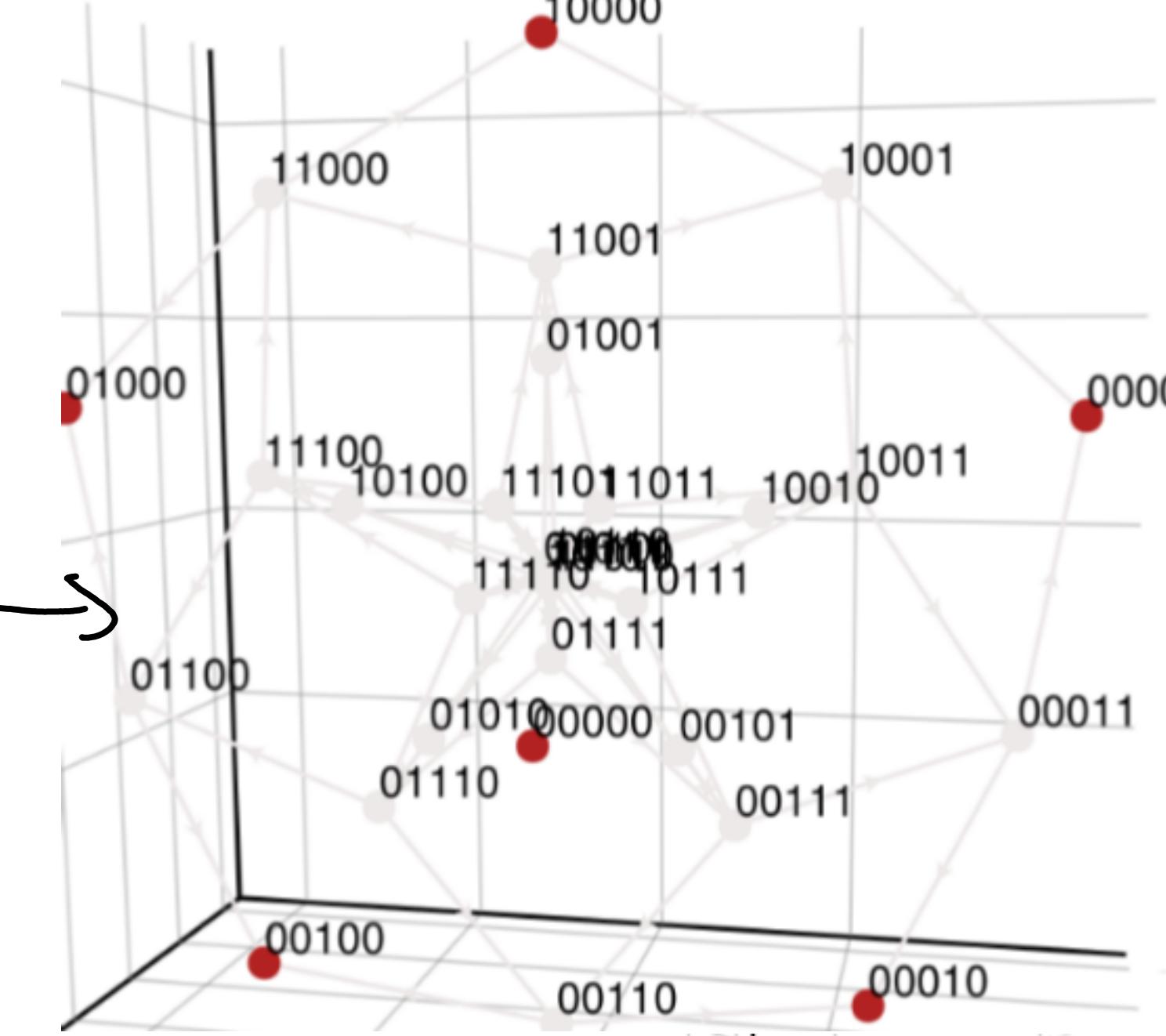


both in Spectral

enzyme subrules

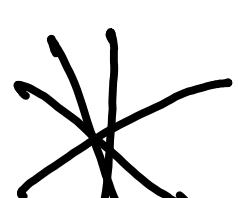
3_b
 00 01
 01 11
 ↓ T

- multiple, symmetric single acs all with isolated 1s eg "...00100..."

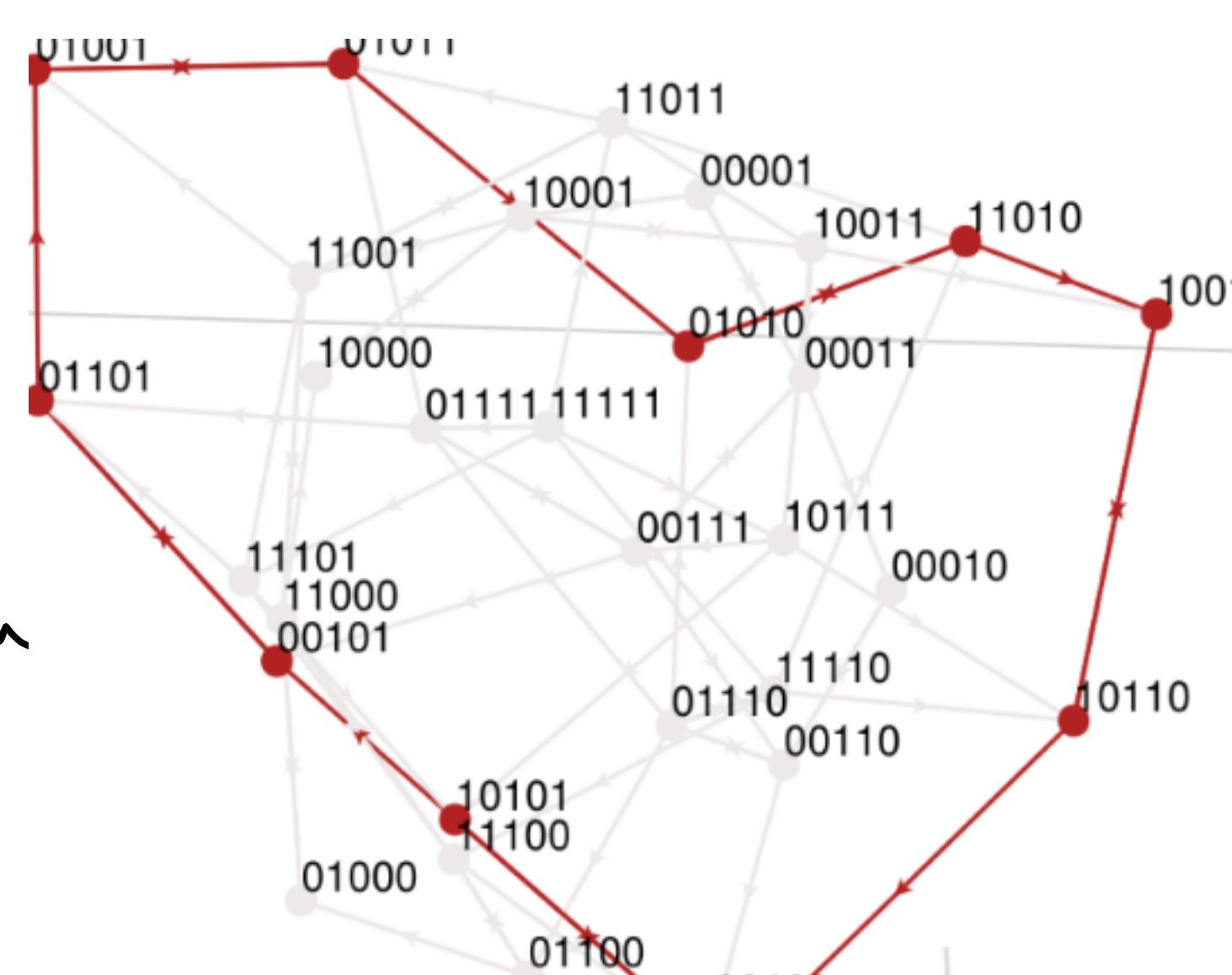


12_b
 01 00
 11 01
 ↓ T

- similar, 1 diff. ac all one step away from all 1s, so isolated 0s

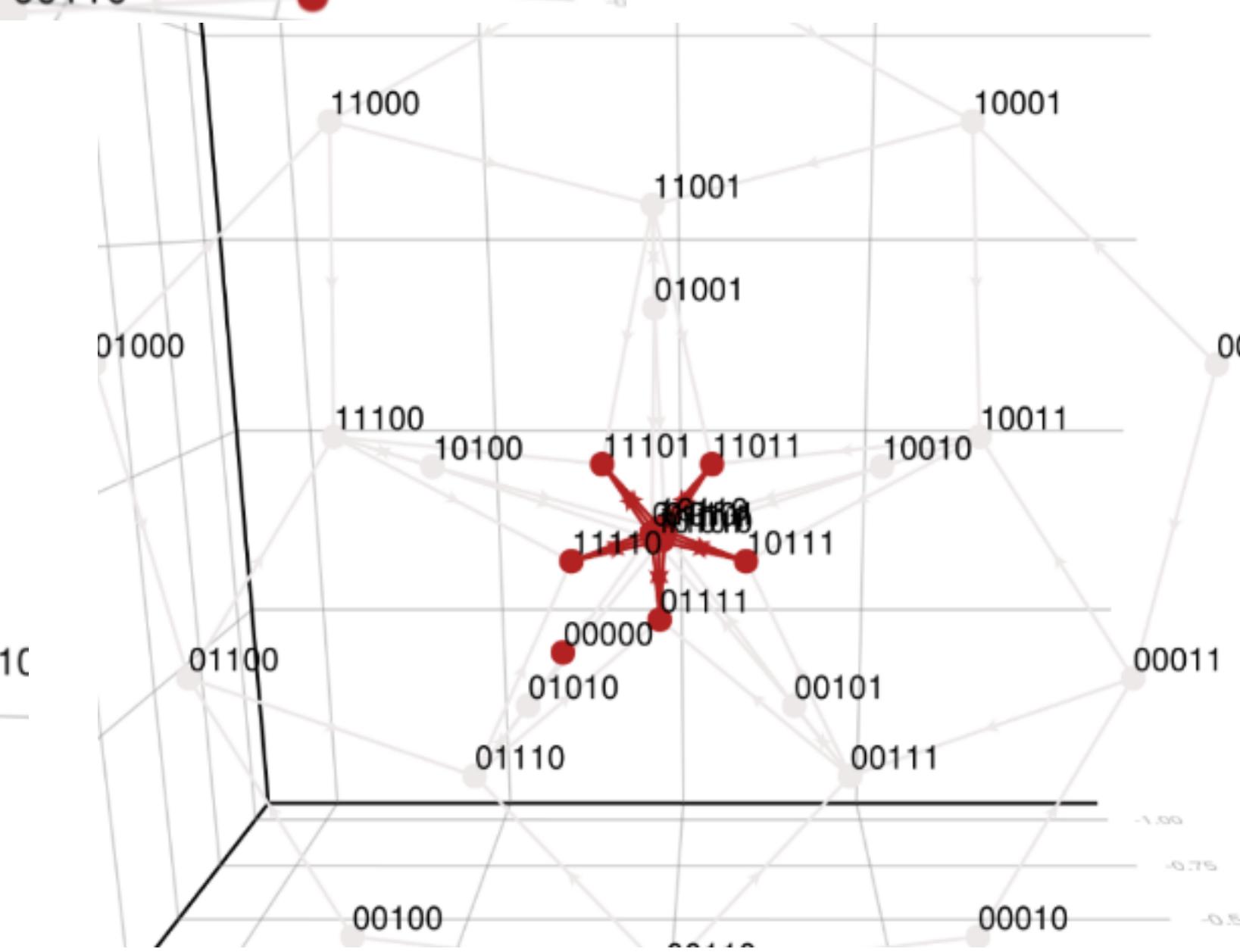


- loops at odd N at even N gets stuck at $\overline{01}$ states

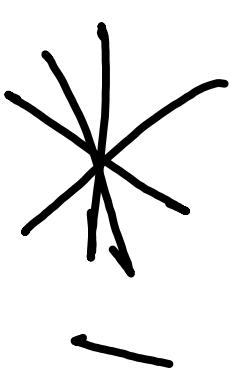


6
 01 01
 00 11
 ↓ T+

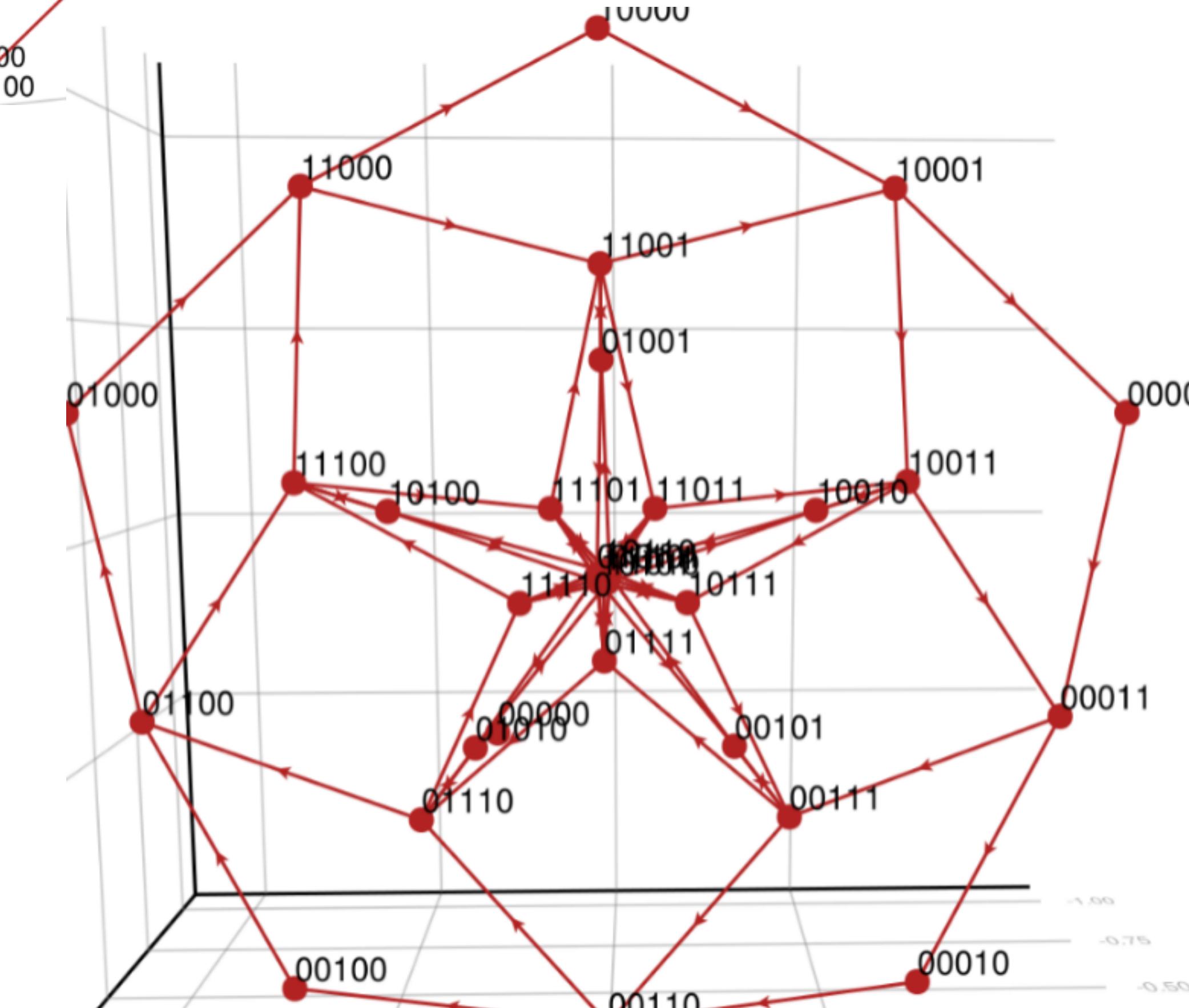
- all 1s and all 0s only acs



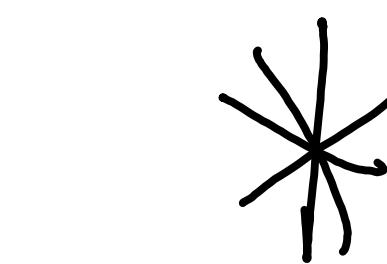
14_b
 01 00
 11 10
 ↓ T+



- all states remain in one complex ac which is however clearly directed



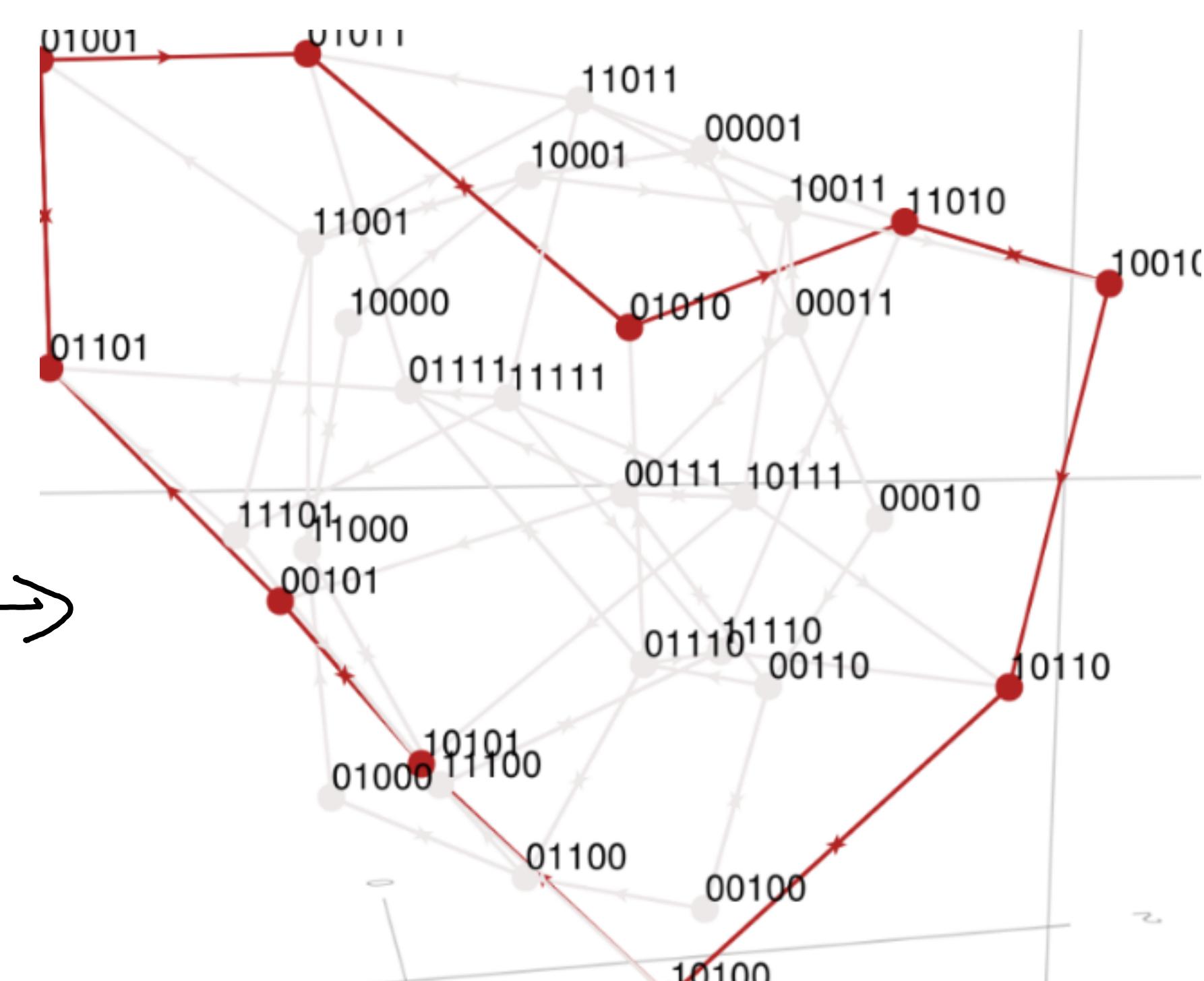
16_b
 01 01
 01 10
 ↓ T+



- all 1s and all 0s only acs



- same loops as 4b but the other arrows are directed



30
 01 00
 10 11
 ↓ T

3 enzyme subunits

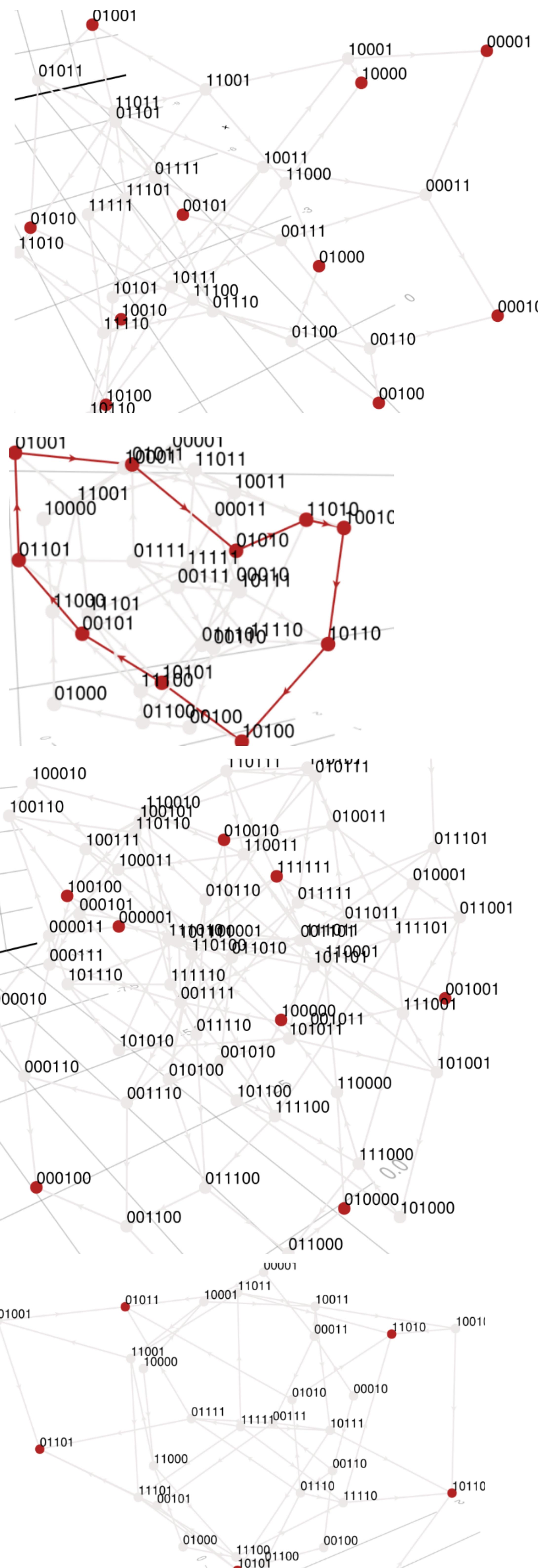
4 - many single state acs,
 $\begin{matrix} 00 & 01 \\ 00 & 11 \end{matrix}$ can only go towards 0s
 $\downarrow T$ but gets stuck at isolated 1s

254 - all 0s and all 1s
 $\begin{matrix} 01 & 00 \\ 11 & 00 \end{matrix}$ only acs

14 - at odd N has the
 $\begin{matrix} 01 & 00 \\ 00 & 11 \end{matrix}$ same loops as 6, 30 but
 $\downarrow T++$ all arrows are directed
at even N gets stuck at $\overline{01}$

174 - all 0s and all 1s
 $\begin{matrix} 01 & 00 \\ 01 & 10 \end{matrix}$ only acs
only 0 domains can spread
but cannot be completed
- but 1 domains cannot be
broken either - many
short acs include all 0s,
all 1s and isolated 1s

164
 $\begin{matrix} 00 & 01 \\ 01 & 10 \end{matrix}$
 $\downarrow T$
94
 $\begin{matrix} 01 & 00 \\ 10 & 01 \end{matrix}$ 1s can be broken but
can't ever shrink, bunch
of single acs each pixel
of isolated 0s

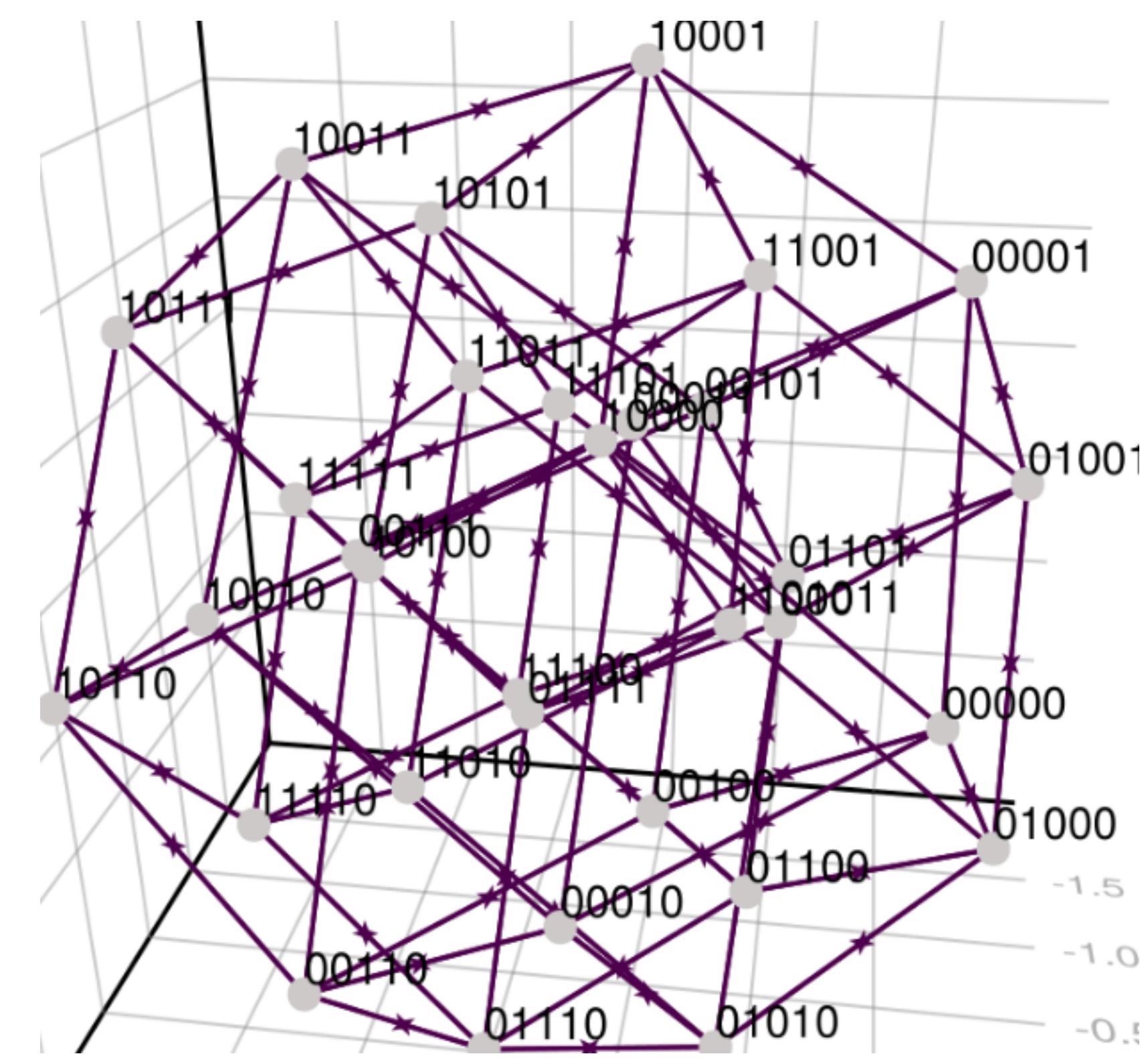


Eg rule 51

1111
1111

- not much to say,
everything is allowed

Spring
layout
Spectral
Tools
Similar



Fengmei subrules

50

- all 0s only cc,
makes sense as cannot
be escaped

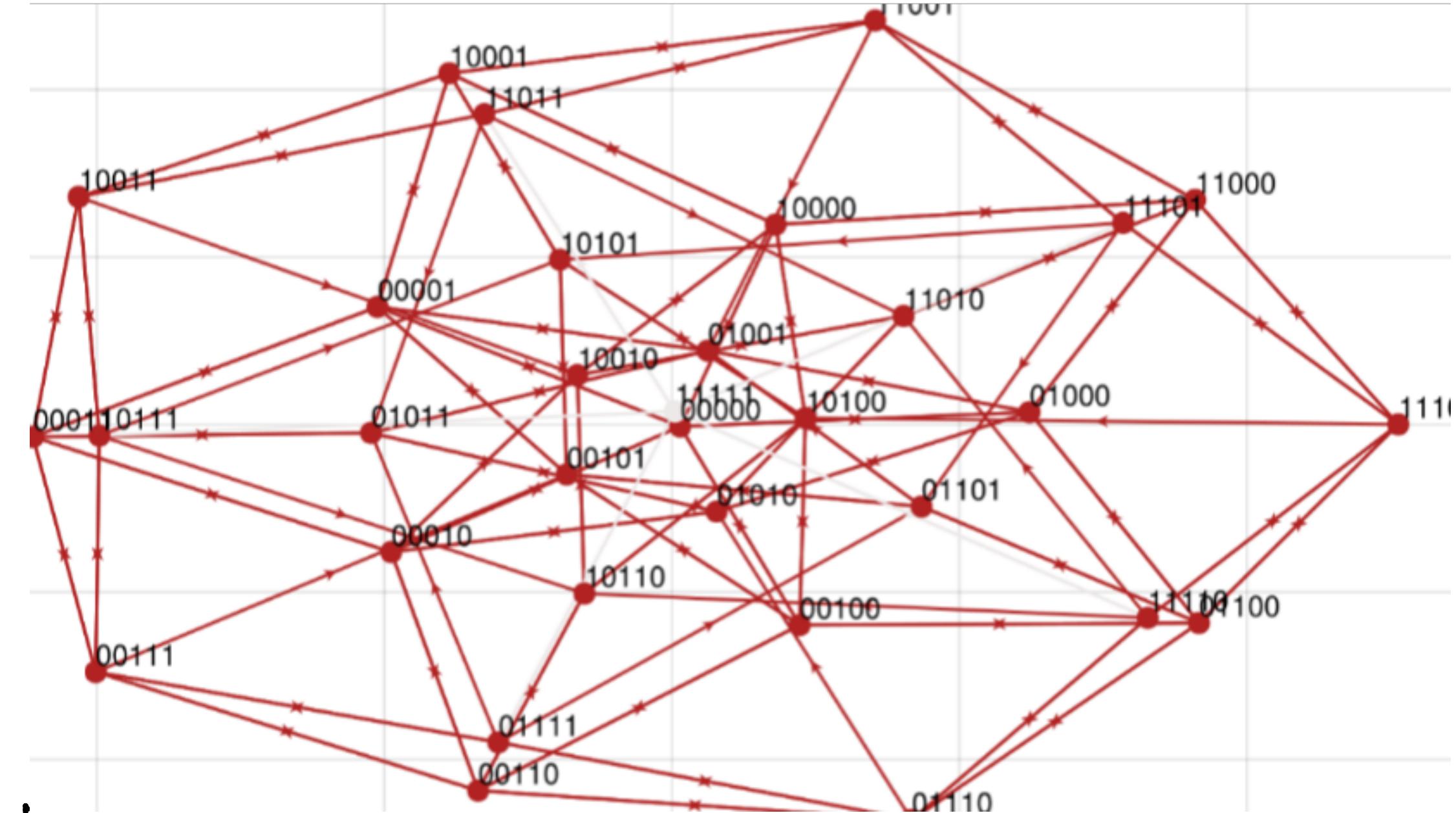
61 11
11 11

↑ T++

19

1111
1011

- all except all 1s Ts in one big cc,
note that cc is not fully diff.
as it is biased towards 0s



35
11 11
01 11

- all the big cc biased (but only partly) towards 0s
and seemingly somewhat chiral

