Analysis of Matrices with Turing Machine

Matt Parker - Stand-Up Maths

http://standupmaths.com/

Hypercube, Turing Machine and Pi Videos

Lisa Piccirillo - Solving the Conway Knot

https://en.wikipedia.org/wiki/Lisa_Piccirillo

Moritz Firsching - Unfolding of the Hypercube

https://unfolding.apperceptual.com/

Pascal Michel - Busy Beaver Game (Explanation)

https://webusers.imj-prg.fr/~pascal.michel/

This paper came as a result of thinking about other abstractions that could be made for a Turing State Machine to inspect. This has been with the primary focus to try and look at things that seem uncertain.

For example, we see a lot of symmetry at each layer. However, having a 7 by 8 matrix as a result does not fit well with other layers of symmetry seen. I am also unsure how to string state machines together, if it can be done at all, blocking them together and stitching them together have both been suggested in previous papers.

This paper sets out to inspect how matrices are multiplied together and how this could be abstracted out to Turing State Machines.

Let us use a matrix used to calculate Pi to see if we can get any information out of it…

Matrix Multiplication

Matrix multiplication is done in what is deemed to be an odd order where dot products are the result of multiplying and adding different combinations of rows and columns.

For example:

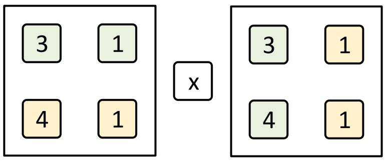


Figure 1.1

This can be represented as dot products.

(3 1) . (3 4) = 3x1 + 3x4

(3 1) . (1 1) = 3x1 + 1x1

(4 1) . (3 4) = 4x1 + 3x4

(4 1) . (1 1) = 4x1 + 1x1

Figure 1.2

Sigma Representation

If we consider the dot products as state machines, we end up with this set of machines.

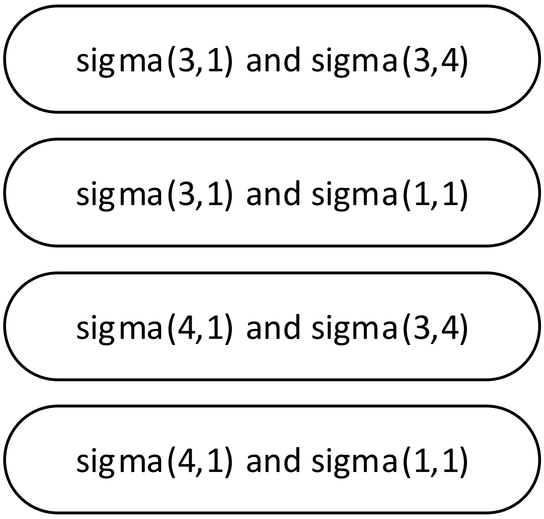

sigma(3,1) and sigma(3,4)
sigma(3,1) and sigma(1,1)
sigma(4,1) and sigma(3,4)
sigma(4,1) and sigma(1,1)

Figure 2.1

We can arrange these into a grid of sorts since we note on inspection that these dot products (or sigma mappings) are symmetrical.

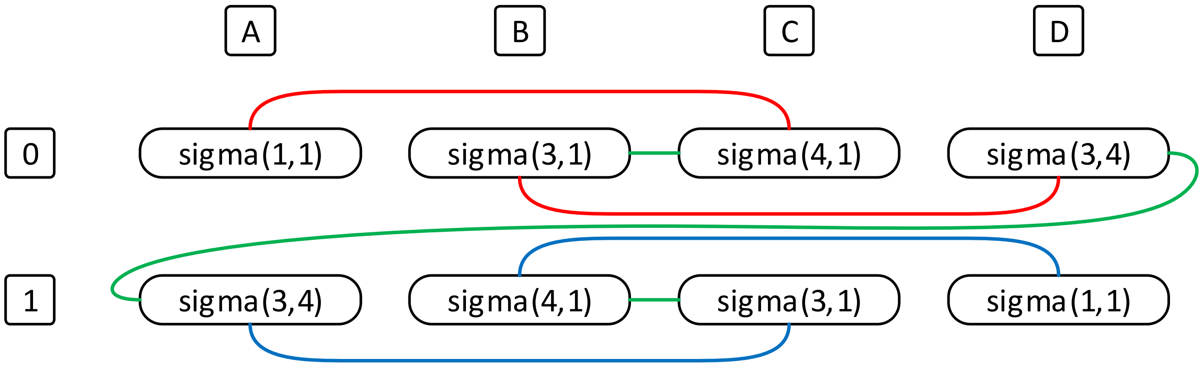


Figure 2.2

This symmetry appears to be very similar to a previous state machine we have run when looking at the 8 node Tree Set 1.

This figure is taken from “Analysis of Hypercube Tree Topology” - Figure 3.2.

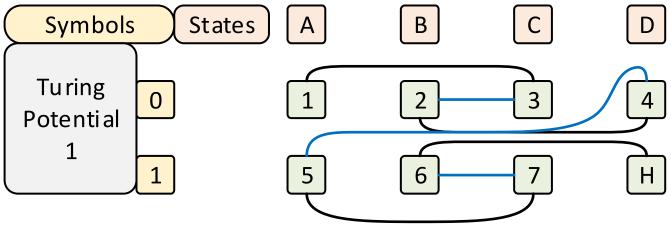


Figure 2.3

Rationalisation

If we consider that through the following papers:

Analysis of Hypercube Tree Topology

Analysis of Conway - Piccirillo Knot with Turing State Machine

Analysis of the Turing State Machine

Analysis of Stacking Sigma

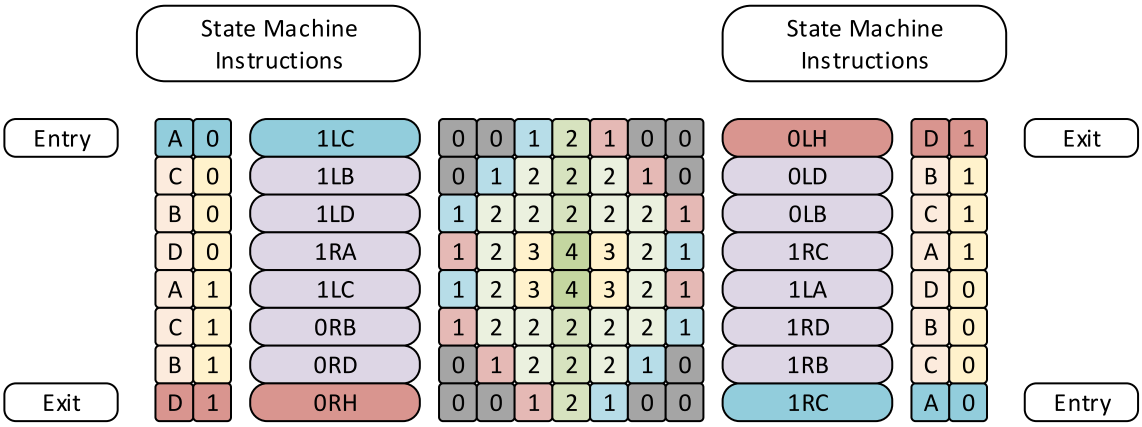
We have shown that there is symmetry in the instruction set itself with the Hypercube and Knot analysis.

We have shown that there is symmetry without instructions.

We have shown that there is symmetry in the sigma themselves outside of the instruction set.

If we consider that the symmetry shown in the pairing of the sigma instructions can be represented the same as the pairing in the instruction set.

The result of the instruction set result from the Hypercube paper is this (taken from Figure 11.1):



			State Machine Instructions								State Machine Instructions			
Entry	A	0	1LC	0	0	1	2	1	0	0	0LH	D	1	Exit
	C	0	1LB	0	1	2	2	2	1	0	0LD	B	1	
	B	0	1LD	1	2	2	2	2	2	1	0LB	C	1	
	D	0	1RA	1	2	3	4	3	2	1	1RC	A	1	
	A	1	1LC	1	2	3	4	3	2	1	1LA	D	0	
	C	1	0RB	1	2	2	2	2	2	1	1RD	B	0	
	B	1	0RD	0	1	2	2	2	1	0	1RB	C	0	
Exit	D	1	0RH	0	0	1	2	1	0	0	1RC	A	0	Entry

Figure 3.1

Indication of Error in Hypercube Tree Analysis

This is an interesting result.

It indicates how the separate tracks should be brought together. It suggests the method used to do this in the Hypercube (and other) paper is close but not quite right.

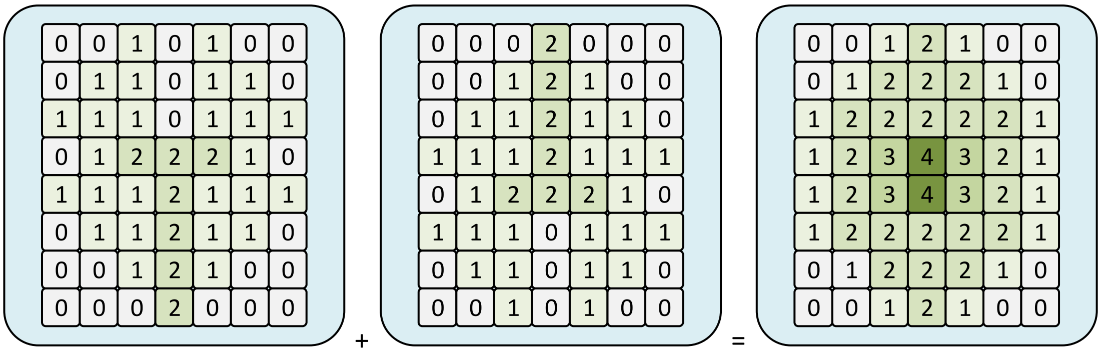
The adjacent tracks that represent the pointer head should stay separate and not be combined. With hindsight this makes sense to get an 8 by 8 result matrix instead of a 7 by 8. Got to start somewhere…

The reason for this:

The numbers used in the Matrix are 3 1 4 1 (first 4 digits of Pi).

We have used the sigma from a known method of calculating Pi with matrices. This would lead us to assume that the resultant pattern would be a circle (or look like a circle - or part of a circle).

We see in the results from previous paper (taken from Figure 6.4):



0	0	1	0	1	0	0
0	1	1	0	1	1	0
1	1	1	0	1	1	1
0	1	2	2	2	1	0
1	1	1	2	1	1	1
0	1	1	2	1	1	0
0	0	1	2	1	0	0
0	0	0	2	0	0	0

+

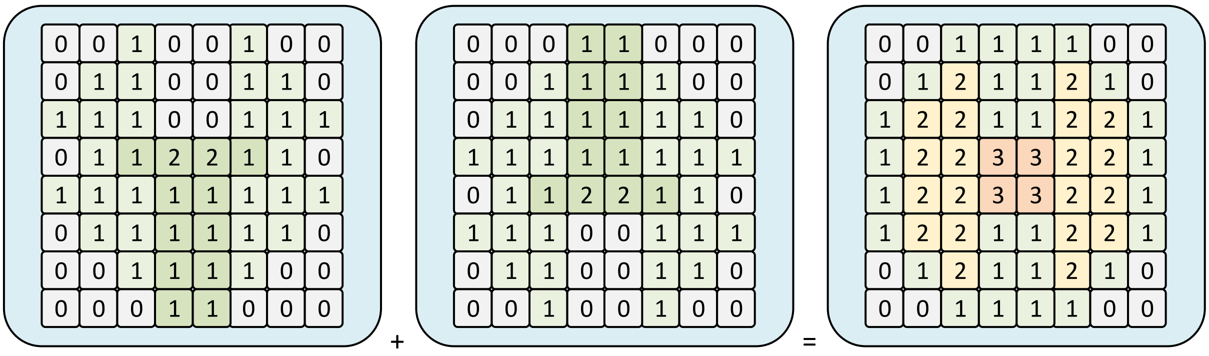
0	0	0	2	0	0	0
0	0	1	2	1	0	0
0	1	1	2	1	1	0
1	1	1	2	1	1	1
0	1	2	2	2	1	0
1	1	1	0	1	1	1
0	1	1	0	1	1	0
0	0	1	0	1	0	0

=

0	0	1	2	1	0	0
0	1	2	2	2	1	0
1	2	2	2	2	2	1
1	2	3	4	3	2	1
1	2	3	4	3	2	1
1	2	2	2	2	2	1
0	1	2	2	2	1	0
0	0	1	2	1	0	0

Figure 4.1

However, having used Pi it would suggest the result is this:



0	0	1	0	0	1	0	0
0	1	1	0	0	1	1	0
1	1	1	0	0	1	1	1
0	1	1	2	2	1	1	0
1	1	1	1	1	1	1	1
0	1	1	1	1	1	1	0
0	0	1	1	1	1	0	0
0	0	0	1	1	0	0	0

+

0	0	0	1	1	0	0	0
0	0	1	1	1	1	0	0
0	1	1	1	1	1	1	0
1	1	1	1	1	1	1	1
0	1	1	2	2	1	1	0
1	1	1	0	0	1	1	1
0	1	1	0	0	1	1	0
0	0	1	0	0	1	0	0

=

0	0	1	1	1	1	0	0
0	1	2	1	1	2	1	0
1	2	2	1	1	2	2	1
1	2	2	3	3	2	2	1
1	2	2	3	3	2	2	1
1	2	2	1	1	2	2	1
0	1	2	1	1	2	1	0
0	0	1	1	1	1	0	0

Figure 4.2

As we see in the answer here now a pattern that matches the sigma output from the dot products in a much better ratio.

Sides of length: 4

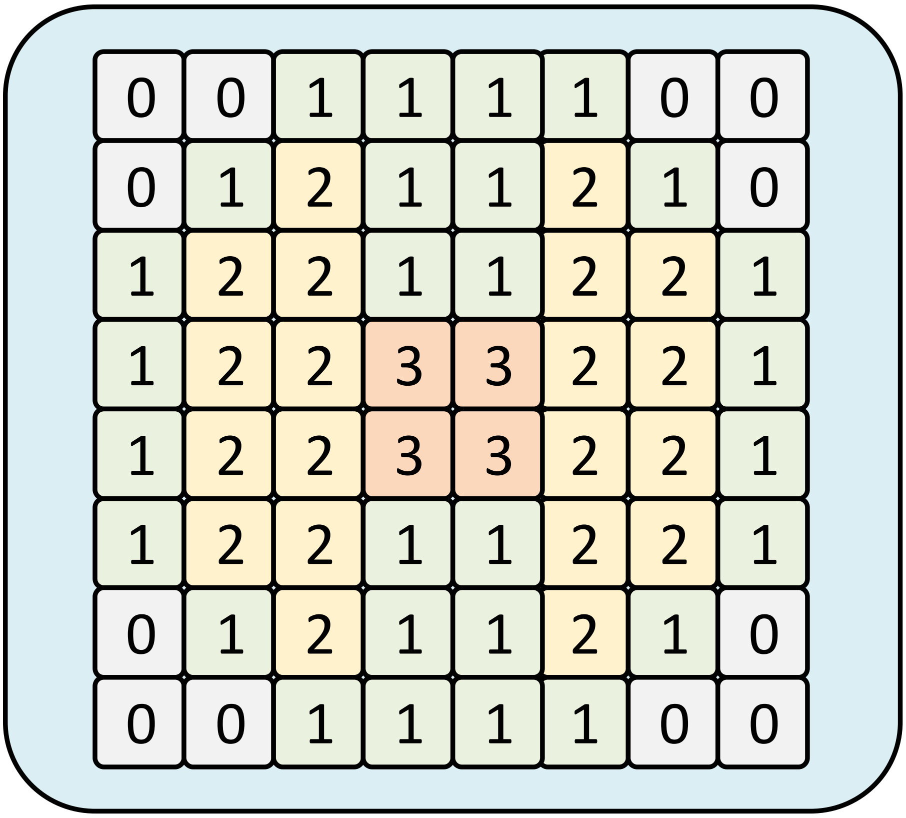
Diagonals of length: 3

There are 4 4's and 4 3's in the sigma instructions that could represent each side of the shape.

The numeric result for the matrix multiplication is 3.14156

It could be said the sigma represent the calculation to only 3.141 (the values initially plugged in prior to the dot product being calculated).

It would mean this is a circle, and it is accurate to 3.141 Pi.



0	0	1	1	1	1	0	0
0	1	2	1	1	2	1	0
1	2	2	1	1	2	2	1
1	2	2	3	3	2	2	1
1	2	2	3	3	2	2	1
1	2	2	1	1	2	2	1
0	1	2	1	1	2	1	0
0	0	1	1	1	1	0	0

Figure 5.1

Observations

Previous papers errors will be corrected, and new diagrams produced for each of the effected sections. It seems sensible to use an 8 by 8 result matrix (as this also provides another layer of symmetry).

Observation #1

Circles appear to be a set of sigma that with each calculation provide back an answer that allows for more granularity into the same pattern.

This granularity is given back in the results (numerically) and can then be recycled back into another matrix to give sigma for larger instructions sets that define sides that are longer length than the previous result giving a better result for a circle.

Observation #2

It does not appear that perfect circles can be defined within this structure.

Observation #3

Pi could be said to be a representation of a string of state machines.

Observation #4

A circle could be part of the hypercube shape.

Observation #5

This seems to suggest how to combine the tracks together along the length of tracks.

However, it does not help with how to stack the results of instructions together, whether building blocks or stitching at the instruction set intersections to make continuous instructions.

Observation #6

The corrections being made in this paper are primarily due to the following:

7 by 8 matrix does not seem to be correct where all other layers of the same structure appear to be otherwise symmetrical.

An 8 by 8 does marry up with the number of quadrants and instructions at other layers better which may make for more layers of symmetry at different intersections of instructions and sigma.

The values in the sigma vs the values on the shape sides.

Observation #7

Is sigma(1,1) an optional HALT?