N-Dimension Visualization in 2-Dimension Space and Prime Numbers Distribution on N-Side Shape and Higher Dimension

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Abstract

A Higher Dimensionality means more complexity for your system and its visual representation. In this paper, we will be talking about a simpler way to visualize an N-Side Shape in N-Dimension space into a 2-Dimension space. We will do this by memorizing the visual representation of the movement of an N-Side Shape in N-Dimension while it is going through the 2-Dimension Space.

Then we will use this Flatten Visualization in the 2-Dimension space to reveal more about complex systems like Prime number Distribution in a higher Dimensionality as an application for this concept.

Keywords: N-Dimensionality, Visualization in 2D, Prime Numbers, Composite Prime Numbers, Prime Number Distribution

1. Introduction

1.1 Introduce the Problem

The dimensionality of a system is one of the complexity measures for any system and the Human brain may find it difficult to visualize anything in dimension higher than 3-Dimensions. So, if we have a visualization for a higher dimensionality in a lower dimension than the human brain can process may help us understand complex systems easier. Prime number distribution is one example of these complex systems. So, we will use Prime numbers distribution as an example in this paper to explain and demonstrate how this dimensionality reduction may revile more relationships inside any system.

In Previous Paper [Step Pyramid Distribution for Prime Numbers][1] we started this concept of reduction in dimensionality visualization.

we started with a 2D triangle and extended it into 3D but flattened it in 2D. for example if we have a pyramid and we need to visualize it in 2D will be as shown in Figure 1.

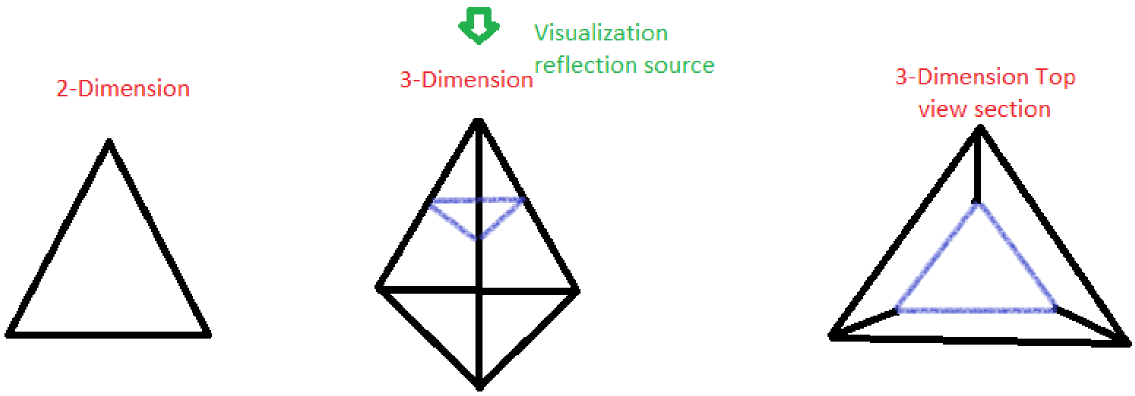

Figure 1. Top View Section for 3D Pyramid

We can see that this sectional top view cut into the pyramid can be repeated as many times as the height of the pyramid. And the top view will only reveal 2-D different sizes of triangles inside each other.

For Example, In Figure 2., This increase in Dimensionality from 2D into 3D, from the Top view cut it is only seen as a change in size in 2D as 3D moves through the 2D, if we memorized all these moves in 2D we get its 2D Flatten Visualization. for example, if we reflect 3D pyramid into 2D we can represent it as triangles inside each other's if we memorize all the moves of that pyramid going through the 2D (triangles) as shown in Figure2.

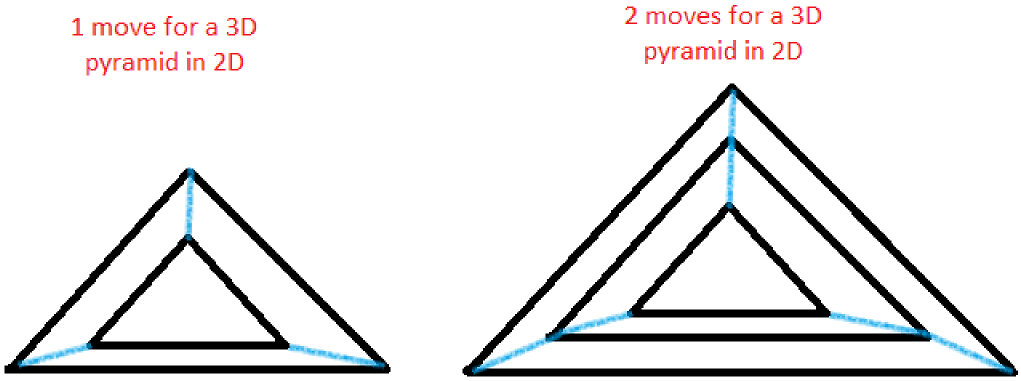

Figure 2. Memorize 3D object (pyramid) move inside a 2D

So, any 3D pyramid can be represented in 2D as an infinite number of different triangle sizes inside each other.

We can extend this concept to all objects. for example, a sphere can be memorized in 2D as an infinite number of different sizes Circles inside each other's. and a cube can be memorized in 2D as an infinite number of squares of a different size inside each other.

In Figure 3., we show how a 3D pyramid can be flattened in 2D as different sizes of its 2D shape by memorizing its moves in 2D.

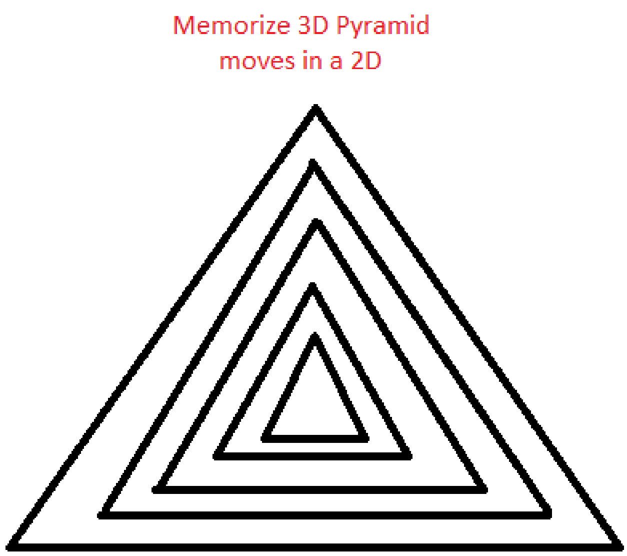

Figure 3. Visualize a 3D object (pyramid) inside a 2-Dimension by memorizing its moves inside the Dimension

Example 1: - Consider we have a Cube, sphere, and pentahedron. In Figure 4., This is how they will be visualized in 2-Dimension Space as flattened shapes by memorizing their moves through the 2D space.

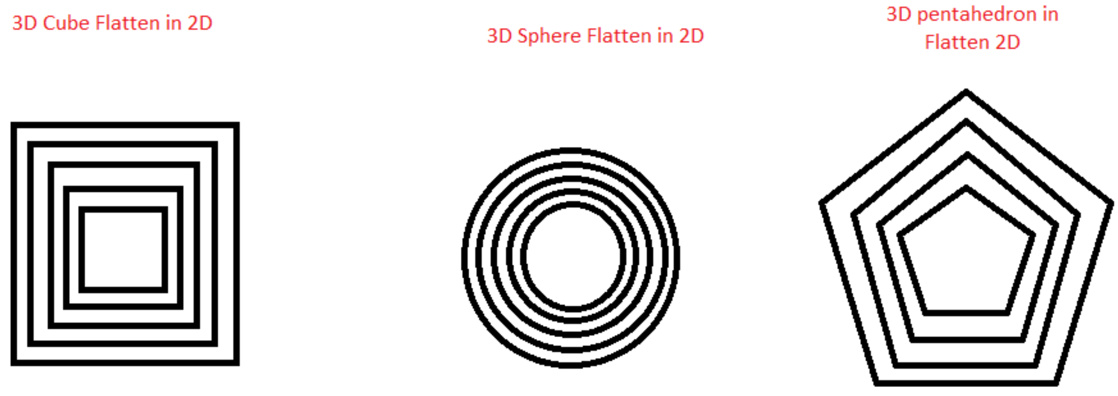

Figure 4. Visualize any 3D object inside a 2-Dimension by memorizing its 2D shape moves through the 2-Dimension

2. Applications for this Dimensionality reduction concept

In the Previous paper [Step Pyramid Distribution for Prime numbers][1] we used the pyramid 2D shape memorization to get a better representation of the prime number's distribution.

In this paper, we will extend this concept to use a hexahedron (6-Side Shape) to see how Prime numbers distribute on the vertex of this 6-side shape in higher dimensions represented in a 2-Dimension.

As you see in Figure 5., each one of this 6 vertex (1,2,3,4,5,6) will have one number and all following numbers with a difference or distance of 6 between each number and its next number in each one of the vertexes of the shape.

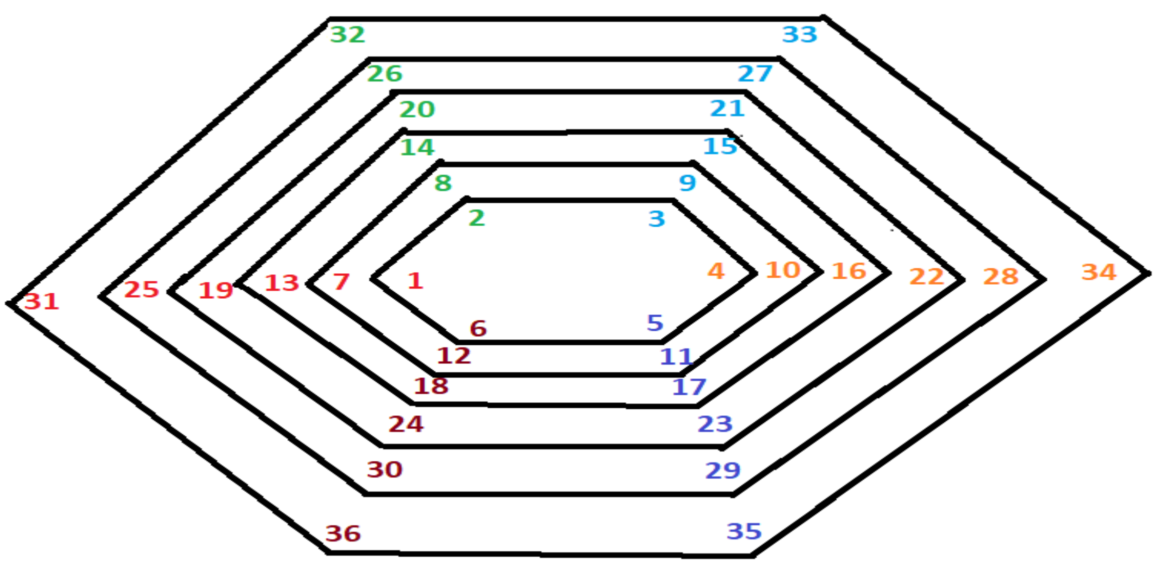

Figure 5., Visualize a 6-side object inside a 2-Dimension by memorizing its 2D shape moves.

1- In 3- Side shape in 3-Dimension (Pyramid) representation we had only one vertex that separated all natural numbers that are divisible by 3 (the shape in 2D was triangle) as we saw in a previous paper.

2- In 4-Side shape in 3-Dimension, only one vertex will separate all natural numbers that are divisible by 4 in one vertex of the 4 vertices.

3- In a 5-side shape in 3-Dimension, only one vertex will separate all natural numbers that are divisible by 5 in one Vertex of the 5 vertices.

4- In the 6-side Shape, it is very clear that prime numbers will be only in the vertex (5 and 7) all the other 4 vertexes will even have an even number or odd number divisible by 3.

Note: - This is a unique feature for a 6-side shape in higher Dimension and Natural numbers.

As in Figure 6., The rest of all N-Side shapes will have only one vertex that will separate an N number and it's divisible from all other numbers. As you see only on the vertex (9 vertexes will have a clear cut for all the numbers that are divisible by 9).

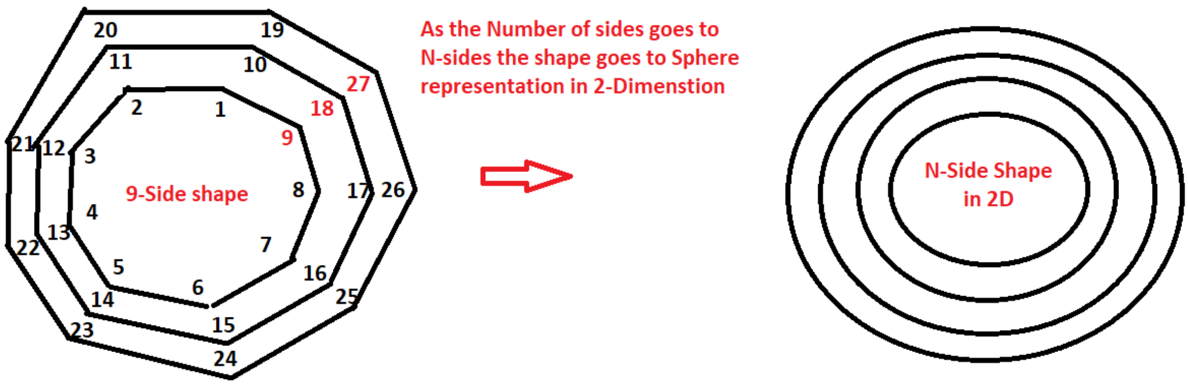

Figure 6., Visualize an N-side object inside a 2-Dimension by memorizing its 2D shape moves.

Figure 5 Summary: -

1- Vertex 2 will have all the natural numbers that are even (divisible by 2) And the difference between each number in each 2D plane move representation and next move representation is 6.

2- Vertex 3 will have all the natural numbers that are divisible by 3 And the difference between each number in each 2D plane move representation and next move representation is 6.

3- Vertex 4 will have all the natural numbers that are even (divisible by 4) And the difference between each number in each 2D plane move representation and next move representation is 6.

4- Vertex 5 and vertex 1, are the only vertices in this shape that will have Prime numbers. And the difference between each number in each 2D plane move representation and next move representation is 6.

Table 1. [6-Side Shape] Movement in 2D and Prime numbers Distributions

ID = 6-Shape Movement in 2D	Vertex 1	Vertex 5
0	1	5
1	7	11
2	13	17
3	19	23
4	25	29
5	31	35

6	37	41
7	43	47
8	49	53
9	55	59
10	61	65
11	67	71
12	73	77
13	79	83
14	85	89
15	91	95
16	97	101
17	103	107
18	109	113
19	115	119
20	121	125
21	127	131
22	133	137
23	139	143
24	145	149
25	151	155
26	157	161
27	163	167
28	169	173
29	175	179
30	181	185
31	187	191
32	193	197
33	199	203
34	205	209
35	211	215
36	217	221
…	…	…

Table 1. Summary

1- Numbers in each row will be = [Numbers in the previous row] + 6.
2- Number in column vertex 5 = [Numbers in column vertex 1] – 4.
3- Any Number, X at Row ID = Y, will have another number Z in the same vertex column that is divisible by this number X, such that this Number Z will be located at movement ID = X + Y.
4- For any number X, the next number in its vertex column will be after X rows in the same vertex.
5- (Any Number X1 in column vertex 1) * (any Number X5 in column vertex 5) will be in at movement ID = [Number X1 * (movement ID of Number X5)] + 1.

For Example: -

Number 11 in column vertex 5 & Number 19 in column vertex 1 at movement ID = 3. Therefore, 11 will have a (11*19 = 209) at movement ID = (11 * 3) +1 = 34.

3. Results

Using this concept of dimensionality reduction in visualization, we were able to represent and visualize very complex systems and shapes in a much simpler way. This concept helped us to study those complex systems in a simpler space (2-dimension space) instead of studying these systems in Higher Dimensions. We did this in a 2-Dimension space by memorizing all the movement of the N-Side Shape going through our 2-Dimension space. Which gave us a simpler way to represent N-Side shapes in Higher dimensions using only one variable the size of the 2-Dimension shape for this N-Side Shape. As an application for this concept, we presented a very simple way to see the distribution of the Prime number in the natural number space more simply.

References

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