**ENVP, another prime number based strategy to encode graphs**

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Abstract: In this paper we show a method to encode graphs with a numerical value that follows unique labeling of each vertex or node and unique labeling of each edge of a graph with unique prime numbers. Each edge is defined as the connectivity between two vertices, therefore two vertices or nodes connected by an edge may be represented by the " edge-nodes value " derived by raising the prime number representing the edge to the product of the primes representing the two nodes that are connected by that edge. Multiplying all the "edge-nodes values" of a single graph will represent a unique number albeit very large in majority of cases. Given this unique number called the "Edge-nodes values product", it is possible to derive the structure of the given graph. This encoding may allow new approaches to graph isomorphism, cryptography, quantum computing, data security, artificial intelligence, etc.

**Results:**

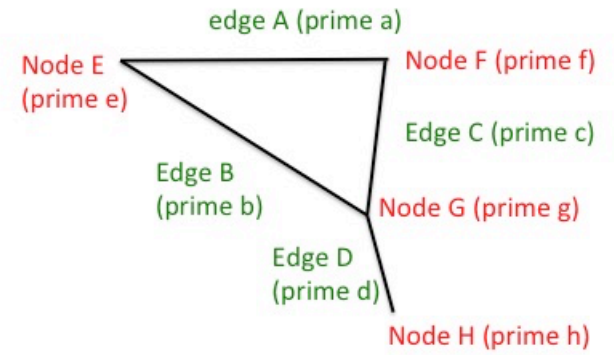
Previously, we have described a prime number based strategy to label the nodes or vertices of a graph and encode its structure as a single numerical value [1]. In this paper, we introduce a new approach to encode a graph by labeling both the edges and the vertices with unique prime numbers. This method may be more compatible with applications than the previous method since just three terms describe each relationship within the graph and product of all such relationships will represent the entire graph. Fewer terms per relationship may be compatible with choice or intelligent labeling to minimize or maximize the product value for the entire graph. Therefore, for a graph with "n" nodes or vertices and "m" edges connecting specific nodes, we would need "n+m" distinct prime numbers to represent each node and each edge of a given graph with a unique prime number.

Figure 1 shows an example graph with four edges A, B, C, D and four nodes E, F, G, H labeled with eight unique primes: a, b, c, d, e, f, g, h respectively.

So consider edge A, (represented by prime number a), that connects node E, (represented by prime number e), and node F, (represented by prime number f). The edge-nodes value for this set of one edge and two nodes is $a^{ef}$. Similarly calculate the edge-nodes value for all edges and their corresponding nodes. The product of all such edge-nodes values will give us a number that uniquely represents the given graph in this approach. We call this product as the Edge-nodes value product or ENVP. However each graph will have "multiple edge-nodes values products" due to the possibility of various alternative prime labelings.

Given the edge-nodes value product or ENVP, it should be possible to reconstruct the entire structure of a given graph. Also, this approach may allow us to calculate the minimum ENVP or an optimum ENVP or a maximum value for ENVP for each

graph for a given choice of prime numbers for labeling and may allow us to compare two given graphs for isomorphism.




"Edge A, node E, node F value" = $a^{ef}$
"Edge B, node E, node G value" = $b^{eg}$
"Edge C, node F, node G value" = $c^{fg}$
"Edge D, node G, node H value" = $d^{gh}$

"Edge nodes value product " = $a^{ef}b^{de}c^{fg}d^{gh}$

**Figure 1: Method to calculate ENVP of a graph**

It may also be possible to extend this method to represent directed graphs by using conventions of +/- in the exponents if the edge is directed between the node with smaller prime to node with greater prime or vice versa respectively.

**References:**

1. A Prime Number Based Strategy to Label Graphs and Represent Its Structure as a Single Numerical Value

http://vixra.org/abs/1512.0222