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CONNECTIVITY MATRIX REPRESENTATION OF GRAPHS OBTAINED BY GRAPH OPERATIONS ON COMPLETE BIPARTITE GRAPHS

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The connectivity matrix is an adjacency matrix with the property that each cell representing the connection between two nodes receives a value of one. Each cell that does not represent a direct connection gets a value of zero. Connectivity matrices are used in real-world applications such as finding the network tolerance of a network and brain connectivity. Our study mainly focuses on obtaining simple matrix representations for resulting graphs of finite summation and multiplication of $K_{m,m}$. In our previous work, we have shown that the resulting graph of the product of n copies of complete bipartite graphs $\left(K_{m,m}\right)^n$ is also a complete bipartite graph, and the number of edges adjacent to each vertex is given by $2^{n-1} \times m^n$ and the summation of n copies of $K_{m,m}$ is not a complete bipartite graph, and the number of edges adjacent to one vertex is given by $m(2n-1)$. These resulting graphs are complicated. In our work, we have shown that the matrix representation of $K_{m,m}$ is the $m \times m$ square matrix (M_m) with all entries equal to M, where $M = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$ which is the matrix representation of $K_{1,1}$. Matrix representation of $\left(K_{m,m}\right)^n$ is a square matrix of order $\left(2^{n-1}m^n \times 2^{n-1}m^n\right)$ with all entries equal to M and this result is proved by mathematical induction where m is the number of vertices in one partite set or degree of one vertex and n represents the number of copies of $K_{m,m}$. The matrix representation of the graph obtained by adding n copies of $K_{m,m}$ is, $\begin{bmatrix} M_m & J_{2m} & \cdots & J_{2m} \\ J_{2m} & \ddots & \cdots & J_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ J_{2m} & J_{2m} & \cdots & J_{2m} \end{bmatrix}$, where J_{2m} is the $2m \times 2m$ matrix with all entries equal to 1. This result is also proved using mathematical induction. As an application, we plan to apply these theorems to prepare aeroplane routing plans.

Keywords: Bipartite graph, Connectivity matrix, Matrix product, Matrix summation