Boolean Matrix Transpose Algorithm follows Parallel Computing Strategy

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Abstract: *In 2016, Sanil put forward an algorithm to transpose Zero- One matrix. This paper explains the algorithm's parallel nature with the support of an example.*

Keywords: *Boolean Matrix, Parallel computing.*

I. Introduction

A matrix with entities that are either zero or one is called a Boolean matrix [1]. The transpose of a matrix A of order m x n is achieved by exchanging the rows and columns. In Parallel computing, there exists combination of operations to solve a single task [2]. This paper illustrates the parallel computing strategy of the proposed Boolean Matrix Transpose algorithm [3].

II. The Method

Let **A** be a Boolean Matrix of order n **x** m. Then the transpose of **A** can be computed as:

1. Initialize the matrix A of order n **x** m .
2. Create the reference matrix .
3. Compute $\mathbf{A}^{\mathbf{T}}$ by combining the characteristics of logical AND with logical OR operations in parallel way with the reference matrix.

III. PARALLEL STRATEGY

Consider the following example, Let **A** be a Boolean Matrix of order 4 **x** 5.

That is, **A** =>

0	1	1	0	1
0	0	0	0	0
1	0	0	1	0
0	0	0	0	0

A operates logical AND (□) with reference matrix **D** as follows:

Reference Matrix D

□

•	**1**	**0**	**0**	**0**
•	**0**	**1**	**0**	**0**
•	**0**	**0**	**1**	**0**
•	**0**	**0**	**0**	**1**
	↓	↓	↓	↓
	z	**y**	**x**	**w**

Here, the values filled in **z**, **y**, **x** and **w** are according to the formulation,

$$\sum_{i=1}^{p} W_{i,j}, \text{ where } j = 1,2, \ldots\ldots q.$$

That is the first input binary vector operates logical AND with reference matrix **D** in parallel way as follows:

Reference Matrix D

1 (i=1)	•	**1** (i=1,j=1)	**0** (i=1,j=2)	**0** (i=1,j=3)	**0** (i=1,j=4)
0 (i=2)	•	**0** (i=2,j=1)	**1** (i=2,j=2)	**0** (i=2,j=3)	**0** (i=2,j=4)
0 (i=3)	•	**0** (i=3,j=1)	**0** (i=3,j=2)	**1** (i=3,j=3)	**0** (i=3,j=4)
0 (i=4)	•	**0** (i=4,j=1)	**0** (i=4,j=2)	**0** (i=4,j=3)	**1** (i=4,j=4)
		↓ **z**	↓ **y**	↓ **x**	↓ **w**

(i) The value of **z**:

$$\sum_{i=1}^{4} W_{i,j=1} = W_{1,1} + W_{2,1} + W_{3,1} + W_{4,1} = 1 + 0 + 0 + 0 = 1$$

Where,

$$W_{1,1} = I_{Text(i=1)} \cdot D_{i=1,\ j=1} = 1\ .1 = 1$$
$$W_{2,1} = I_{Text(i=2)} \cdot D_{i=2,\ j=1} = 0\ .0 = 0$$
$$W_{3,1} = I_{Text(i=3)} \cdot D_{i=3,\ j=1} = 0\ .0 = 0$$
$$W_{4,1} = I_{Text(i=4)} \cdot D_{i=4,\ j=1} = 0\ .0 = 0$$

(ii) The value of **y**:

$$\sum_{i=1}^{4} W_{i,j=2} = W_{1,2} + W_{2,2} + W_{3,2} + W_{4,2} = 0 + 0 + 0 + 0 = 0$$

Where,

$$W_{1,2} = I_{Text(i=1)} \cdot D_{i=1,\ j=2} = 1\ .0 = 0$$
$$W_{2,2} = I_{Text(i=2)} \cdot D_{i=2,\ j=2} = 0\ .1 = 0$$
$$W_{3,2} = I_{Text(i=3)} \cdot D_{i=3,\ j=2} = 0\ .0 = 0$$
$$W_{4,2} = I_{Text(i=4)} \cdot D_{i=4,\ j=2} = 0\ .0 = 0$$

(iii) The value of **x**:

$$\sum_{i=1}^{4} W_{i,j=3} = W_{1,3} + W_{2,3} + W_{3,3} + W_{4,3} = 0 + 0 + 0 + 0 = 0$$

Where,

$$W_{1,3} = I_{Text(i=1)} \cdot D_{i=1,j=3} = 1\ .0 = 0$$
$$W_{2,3} = I_{Text(i=2)} \cdot D_{i=2,\ j=3} = 0\ .0 = 0$$
$$W_{3,3} = I_{Text(i=3)} \cdot D_{i=3,\ j=3} = 0\ .1 = 0$$
$$W_{4,3} = I_{Text(i=4)} \cdot D_{i=4,\ j=3} = 0\ .0 = 0$$

(iv) The value of **w**:

$$\sum_{i=1}^{4} W_{i,j=4} = W_{1,4} + W_{2,4} + W_{3,4} + W_{4,4} = 0 + 0 + 0 + 0 = 0$$

Where,

$$W_{1,4} = I_{Text(i=1)} \cdot D_{i=1,\ j=4} = 1\ .0 = 0$$
$$W_{2,4} = I_{Text(i=2)} \cdot D_{i=2,\ j=4} = 0\ .0 = 0$$
$$W_{3,4} = I_{Text(i=3)} \cdot D_{i=3,\ j=4} = 0\ .0 = 0$$
$$W_{4,4} = I_{Text(i=4)} \cdot D_{i=4,\ j=4} = 0\ .1 = 0$$

This gives the transpose of the binary vector as the output,

z	y	x	w
1	0	0	0

In the same way, output binary vectors of the input given is as follows:

That is $\mathbf{A}^{\mathbf{I}}$ =>

0	0	1	0
1	0	0	0
1	0	0	0
0	0	1	0
1	0	0	0

That is the transpose of inputted Boolean Matrix **A** of order 4 **x** 5 is $\mathbf{A}^{\mathbf{I}}$ of order 5 **x** 4.

IV. SUMMARY

This paper presents an illustration oriented study on the algorithm for Boolean Matrix transpose. Here, we observe the algorithm follows parallel computing strategy.

REFERENCES

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