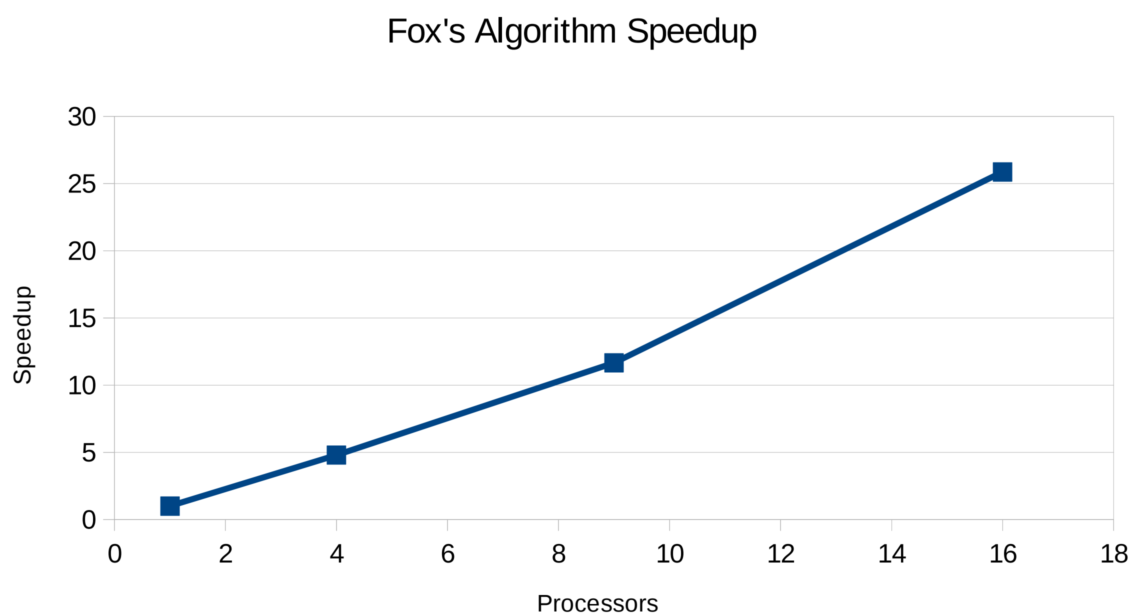
David Perry CS 525 4/9/2014

1.)

Number of Processors	**Time**	**Speedup**
1	39.945342063903809	N/A
4	8.323354959487915	4.7991876182535655
9	3.424404144287109	11.66490296729261
16	1.544705867767334	25.85951338531488



The speedup seen is super speedup. This means that the speedup increases by a factor larger than the number of processors being added. This occurs as diving the memory in blocks among processors results in less cache misses. Therefore, memory accesses need for computation are much more efficient as they receive data from the cache more often than from memory. Thus, not only is speedup observed because the work is split amongst processes but their memory accesses are also more efficient.

2.)

b.)

Operation	**P1**	**P2**	**P3**	**Read Source**	**Write Source**
R1	E	N/A	N/A	Memory	N/A
R2	S	F	I	Memory	N/A
W2	I	M	I	N/A	P2
R3	I	S	F	Memory	N/A
W3	I	I	M	N/A	P3
Replace(2)	I	N/A	M	N/A	N/A
R1	F	N/A	S	Memory	N/A
R2	S	F	S	P1	N/A

3.)

a.)

The first step in calculating the average path length is to calculate the total length of all paths from any given node in the binary hyper cube. To find this answer the following calculation must be performed:

$$L=\sum_{i=1}^{k} i*\binom{k}{i}$$

Now, this length can be divided amongst all other nodes. This will compute the average distance between a given node and all other nodes. Thus, the average length from any given node is:

$$L/(P-1)$$

Since the average distance of any given node to all other nodes is the same amongst every node in the hypercube every node will have the same average length to all other nodes. Therefore, the average length of a path in the entire hypercube is:

$$L/(P-1)$$

b.)

The first step in calculating the average path length is to calculate the total length of all paths from any given node in the binary hyper cube. To find this answer the following calculation must be performed:

$$\begin{aligned}
&step\,0: 2^0*\log(2^1)\\
&step\,1: 2^1*\log(2^2)\\
&\quad\vdots\\
&step\,\log(P): 2^k*\log(2^k+1)
\end{aligned}$$

Therefore, the total length of all paths from any given node is:

$$L=\sum_{k=0}^{\log(P)} 2^k*\log(2^{(k+1)})$$

Since the average distance of any given node to all other nodes is the same amongst every node in the binary tree every node will have the same average length to all other nodes. Therefore, the average length of a path in the entire binary tree is:

$$L/(P-1)$$

c.)

Each column and row in a torus can be thought of as a ring. Therefore, the first step in calculating the average path length is to consider the average path length of a ring. Since the longest path in a ring is always P/2 the average length will always be P/4.

Since, each column and row in the 3-d torus is a ring the P/4 many paths must be extended in 3 directions with P^(1/3) processors. Therefore, the total average length of a path in a 3-d torus is:

$$(3 * P^{(1/3)})/4$$

d.)

As a 3-d torus can be generalized to be a n-ary k-cube the average path length is:

(3 * k)/4