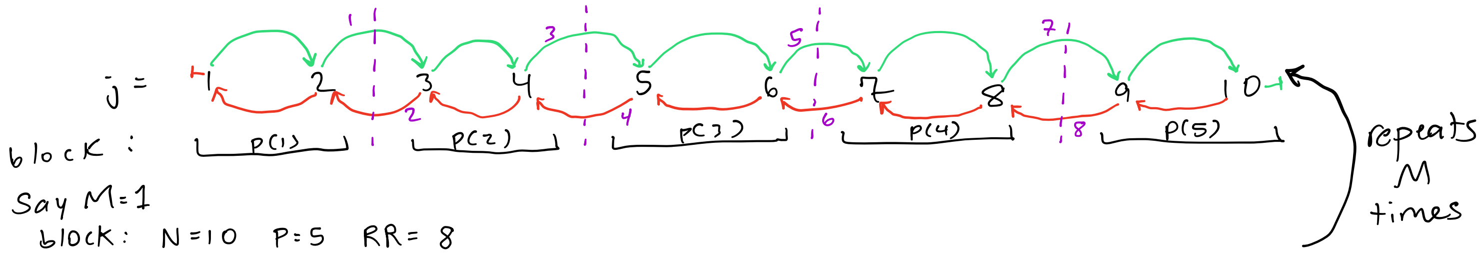
1)



Say M=1
block: N=10 P=5 RR= 8

Each block (place) has two remote reads per array iteration, but the first and last places only have one because either (j-1) or (j+1) doesn't exist.

$\therefore$ there are $\underbrace{2(P-2)}_{\text{middle}} + \underbrace{2}_{\text{first \& last}}$ remote reads for one iteration over the array.

However, we must also consider the total number of times we iterate over the array, M. Since we found $2(P-2)+2$ to be the exact formula for a single iteration over the array, we can conclude that the symbolic function for the total number of remote reads in this code is:

$$M(2(P-2) + 2)$$

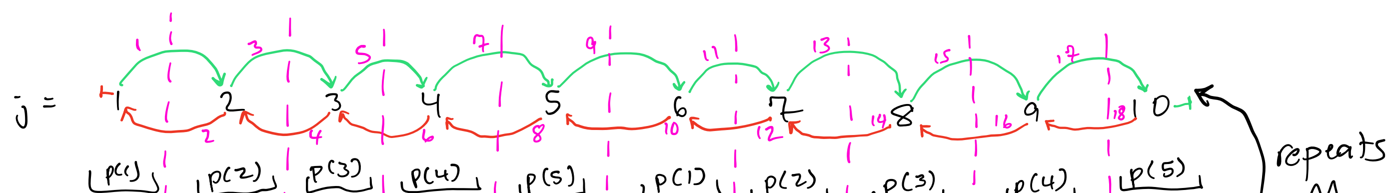
$$= M(2P-4+2)$$

$$= M(2P-2)$$

$$= \boxed{2M(P-1)}$$

□

2)



Say M=1
cyclic: N=10 P=5 RR= 18

10-1=9×2=18

In a cyclic distribution, the places are cycled through as the array is iterated over. This causes adjacent iterations to always have different places, unlike block distribution. Ignoring the boundary case (indexes 1 and N), there are two remote per ELEMENT (versus per place in block dist.ⁿ). This gives us:

$$2(N-1).$$

The first and last places (which are each one element) have one remote read each. Accounting for this, we can determine the exact formula for the number of remote reads for one iteration to be:

$$2(N-2)+2.$$

Now, to account for the number of iterations, M, we must multiply the above equation by M. Doing this, we can conclude that the exact formula for the total number of remote reads in this code written as a symbolic function is:

$$M(\overbrace{2(N-2)}^{\text{middle}} + \overbrace{2}^{\text{edges}})$$
$$= M(2N-4+2)$$
$$= M(2N-2)$$
$$= \boxed{2M(N-1)}$$

□

3) There must be at least one place and places cannot be empty, meaning there cannot be more places than indices. This means that

$$N \geq P.$$

The block distribution relies on the number of places, P, while the cyclic distribution relies on the array size parameter, N. Since we know that $N \geq P$, we can say that

$$2M(N-1) \geq 2M(P-1),$$

or that a cyclic distribution performs more remote reads than the block distribution in this code (and an equal number when $N = P$).

If we were to decrease the number of places, the block distribution's number of remote reads would decrease but the cyclic distribution's number of remote reads would stay the same. Similarly, if we increased the size of the array, N, the number of remote reads would be unchanged for the block distribution but would increase for the cyclic distribution.

These observations support the statement from the lecture slides that

> "Block distributions can improve the performance of parallel loops that exhibit spacial locality across contiguous iterations."

because this code exhibits spacial locality across contiguous iterations. $\square$