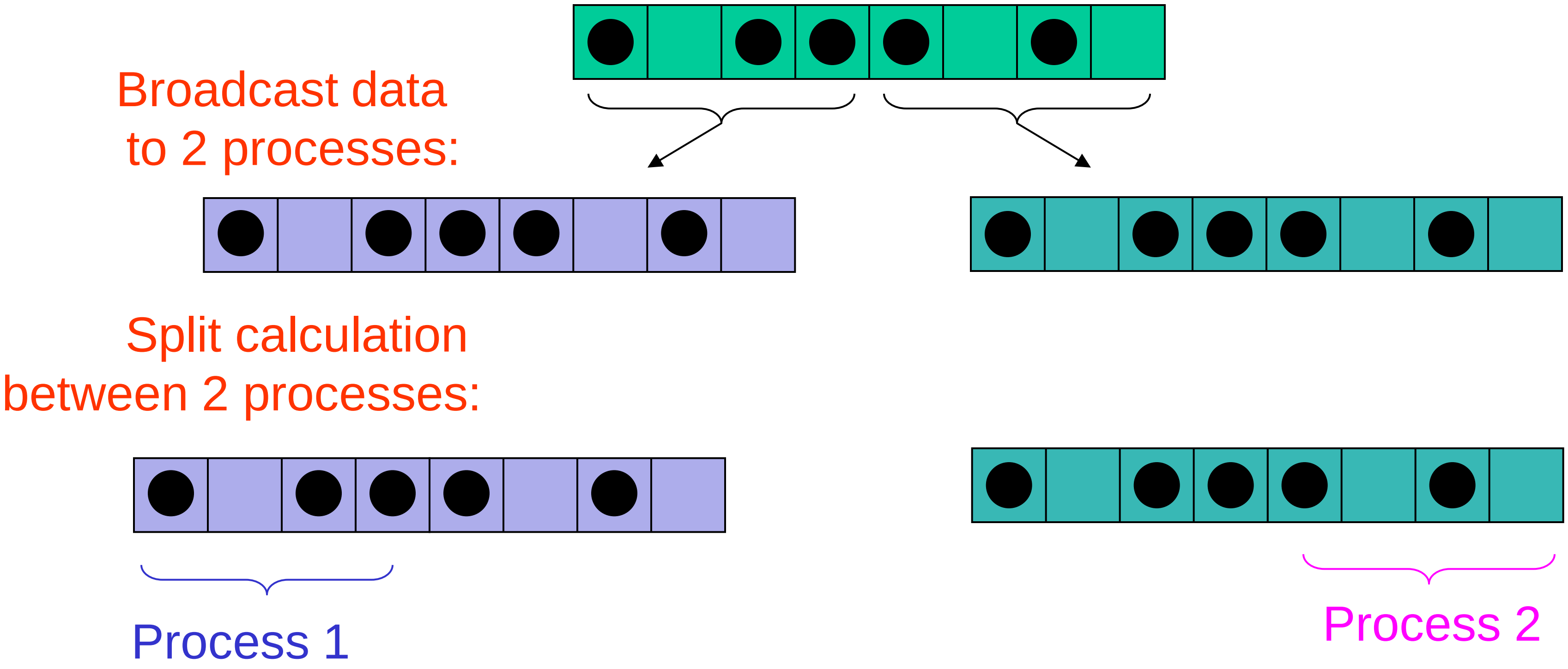
Message-Passing Programming

Cellular Automaton Exercise

Pseudo Code

```
declare arrays old(i) and new(i), i = 0,1,...,N,N+1
initialise old(i) for i = 1,2,...,N-1,N (eg randomly)
loop over iterations
 set old(0) = old(N) and set old(N+1) = old(1)
 loop over i = 1,...,N
  if old(i) = 1
   if old(i+1) = 1 then new(i) = 1 else new(i) = 0
  if old(i) = 0
   if old(i-1) = 1 then new(i) = 1 else new(i) = 0
 end loop over i
 set old(i) = new(i) for i = 1,2,...,N-1,N
end loop over iterations
```

Parallelisation Strategy (1)



Broadcast data to 2 processes:

Split calculation between 2 processes:

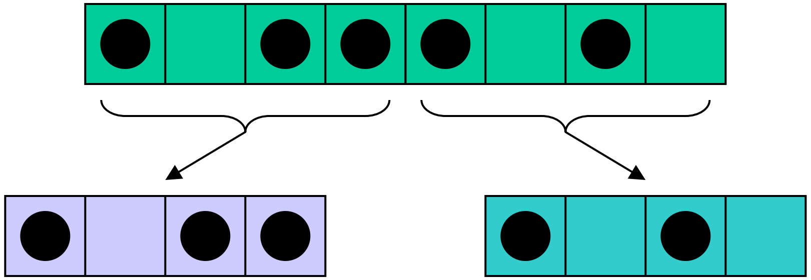
Process 1

Process 2

- Globally resynchronise all data after each move
    - a **replicated data** strategy
- Every process stores the entire state of the calculation
    - e.g. any process can compute total number of moves

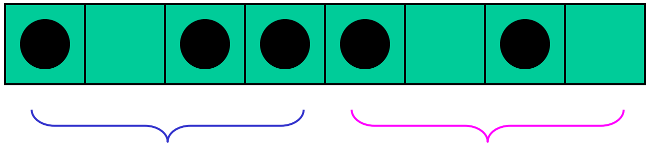
Parallelisation Strategy (2)

Scatter data between 2 processes: **distributed data** strategy



- •Internal cells can be updated independently.
- •Must communicate with neighbouring processes to update edge cells.
- •Sum local number of moves on each process to obtain total number of moves at each iteration.

Split calculation between 2 processes:



Process 1

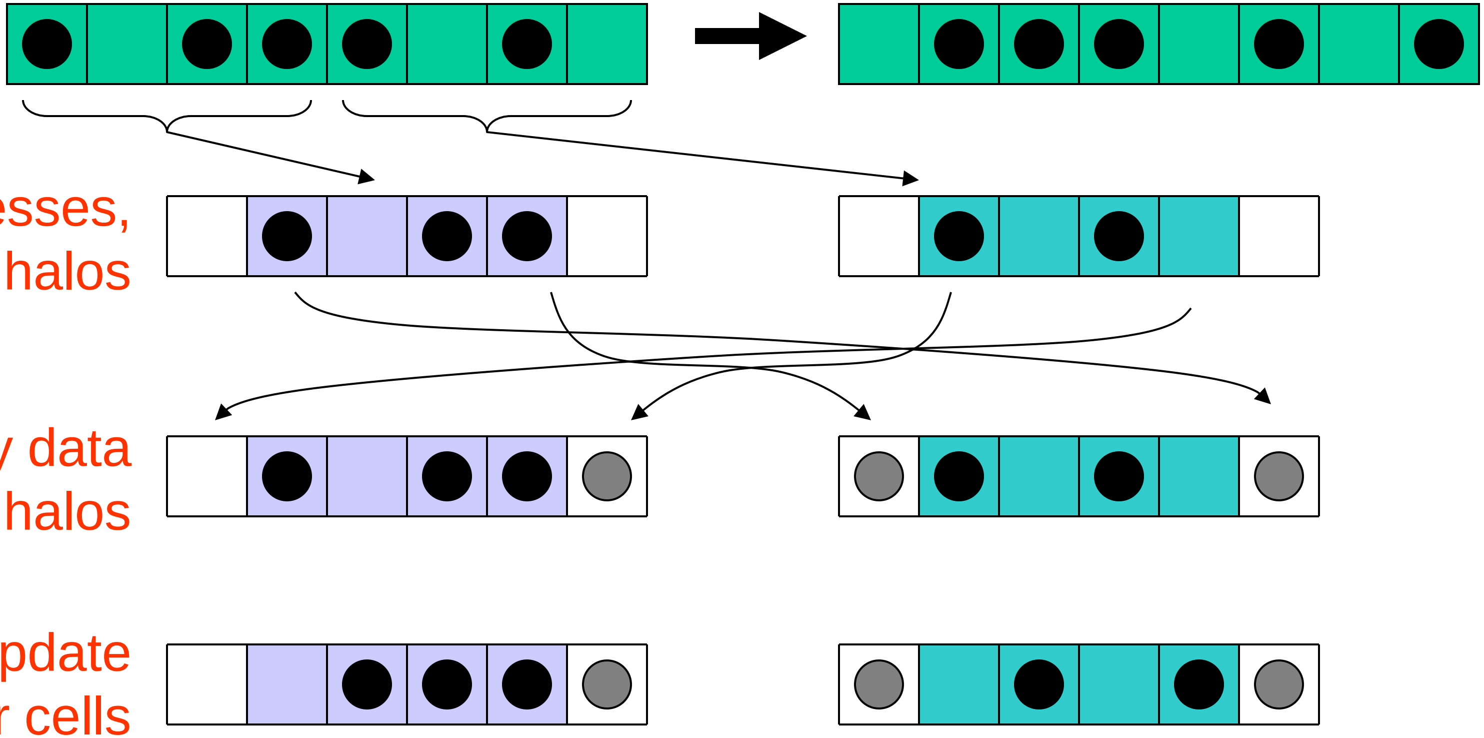
Process 2

- •Each process must know which part of roadway it is updating.
- •Synchronise at completion of each iteration and obtain total number of moves.

Parallelisation

- Load balance not an issue
  - updates take equal computation regardless of state of road
  - split the road into equal pieces of size *N*/*P*
- For each piece
  - rule for cell *i* depends on cells *i*-1 and *i*+1
  - the *N*/*P* - 2 interior cells can be updated independently in parallel
  - however, the edge cells are updated by other processors
    - similar to having separate rules for boundary conditions
- Communications required
  - to get value of edge cells from other processors
  - to produce a global sum of the number of cars that move

Message Passing Parallelisation



2 processes, add halos

copy data to halos

update interior cells

local moves = 1

local moves = 2

global moves = 3