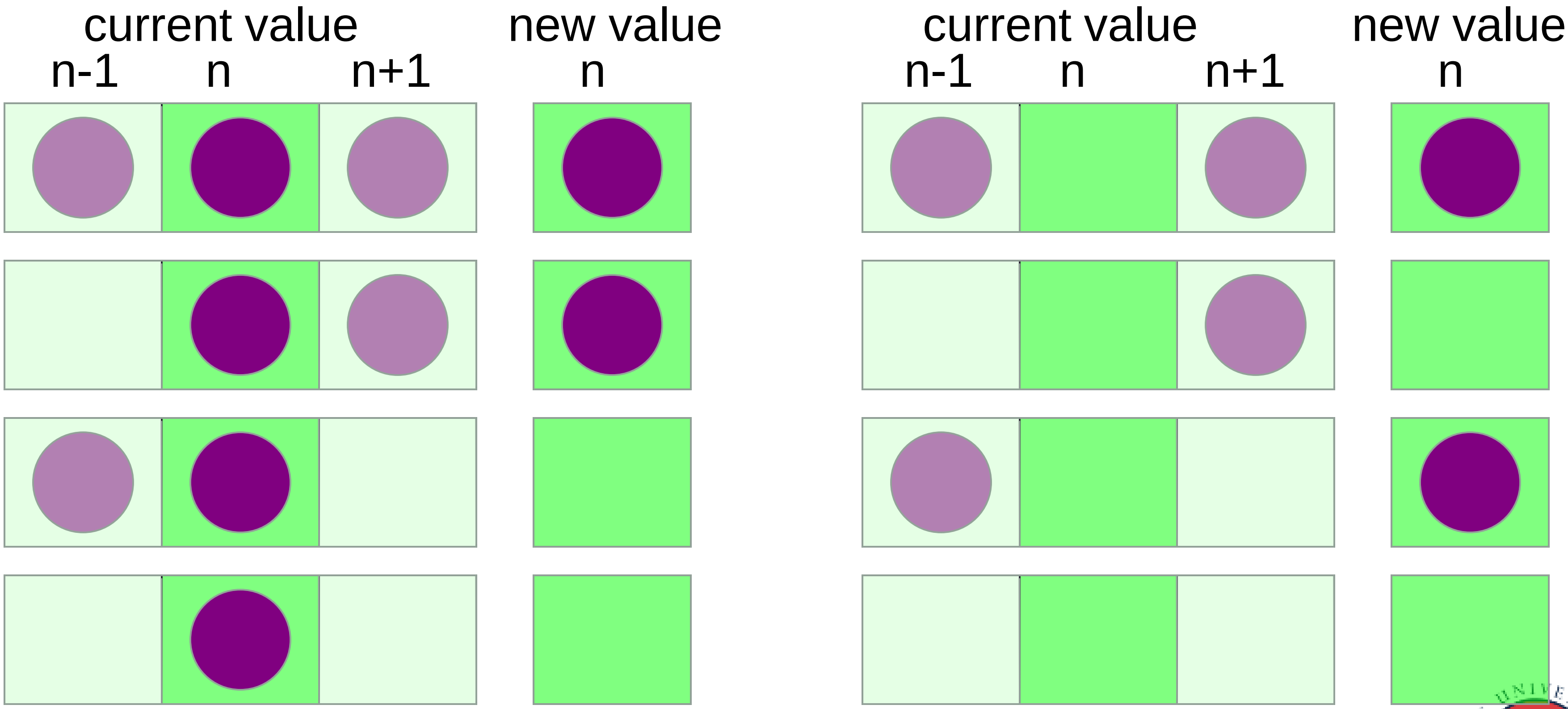
Message-Passing Programming

Cellular Automaton Exercise

Reusing this material

Traffic simulation

- Update rules depend on:
  - state of cell
  - state of nearest neighbours in both directions



State Table

- If $R^t(i) = 0$, then $R^{t+1}(i)$ is given by:

	$R^t(i\text{-}1) = 0$	$R^t(i\ \text{-}1) = 1$
$R^t(i+1) = 0$	0	1
$R^t(i+1) = 1$	0	1

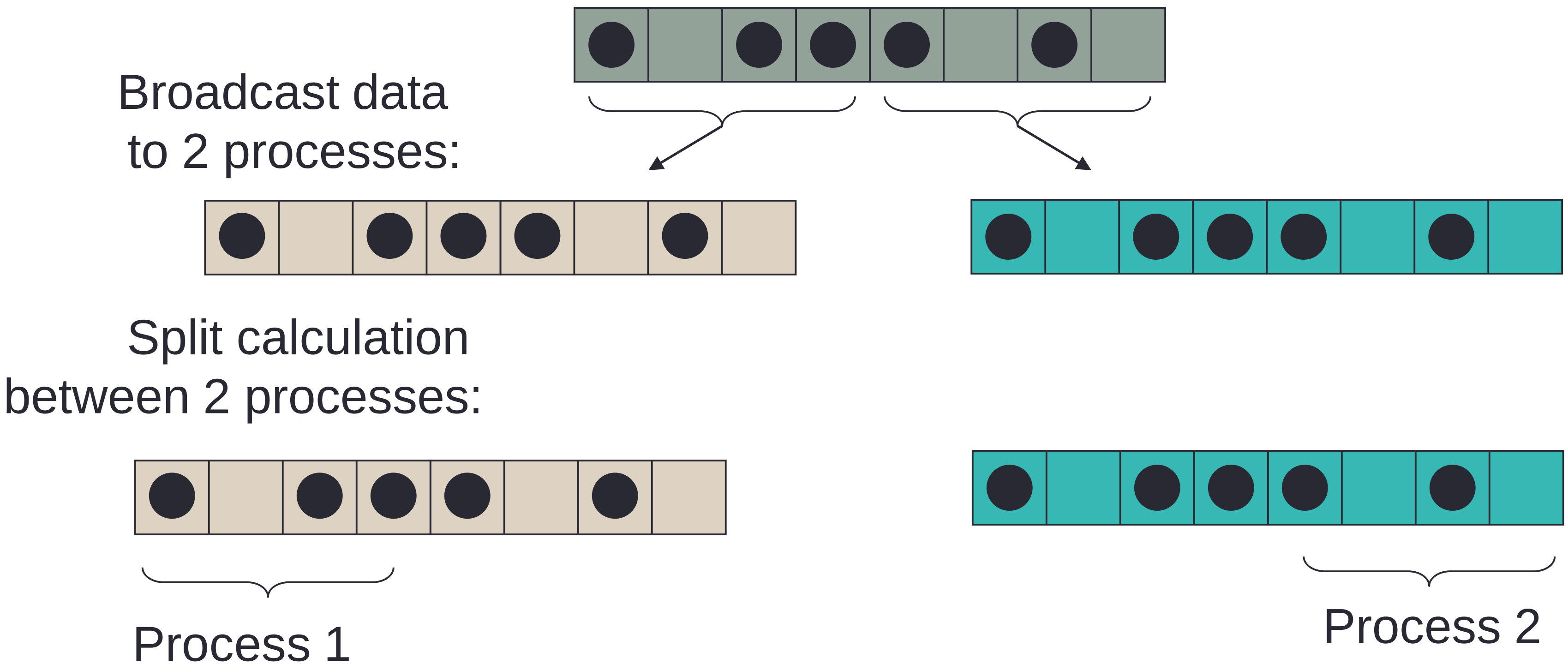
- If $R^t(i) = 1$, then $R^{t+1}(i)$ is given by:

	$R^t(i\text{-}1) = 0$	$R^t(i\ \text{-}1) = 1$
$R^t(i+1) = 0$	0	0
$R^t(i+1) = 1$	1	1

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
```

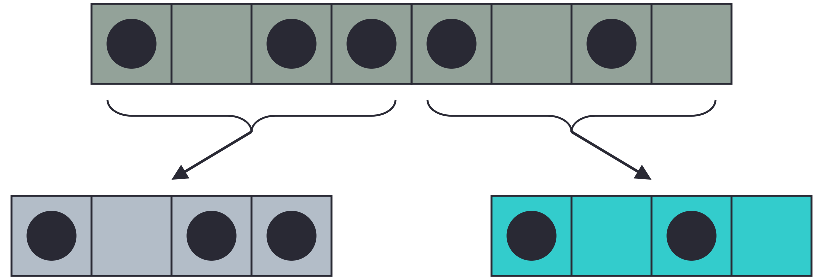
Parallelisation Strategy (1)



- 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

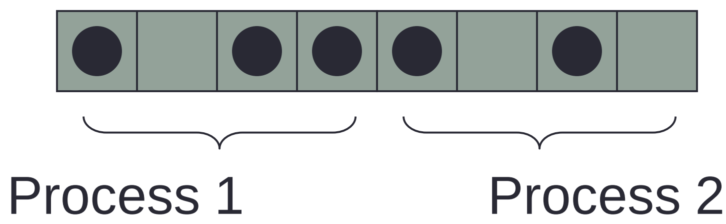
Parallelisation Strategy (2)

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:



- 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