SZENT ISTVÁN UNIVERSITY

endure
diversifying crop protection

Weed model example using a lattice

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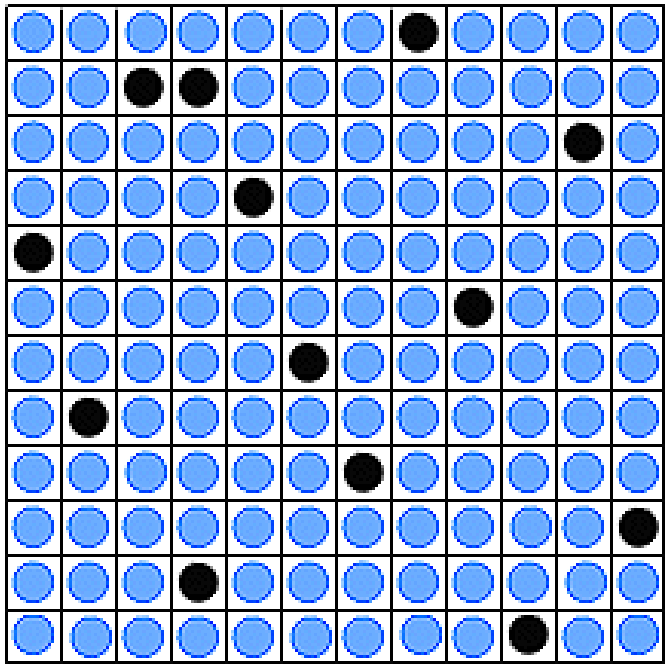
You should keep in mind

Weed models

- Weeds are plants
- Process based crop models
- Life cycle

- Competition of plant species can be modelled with lattice models

Lattice

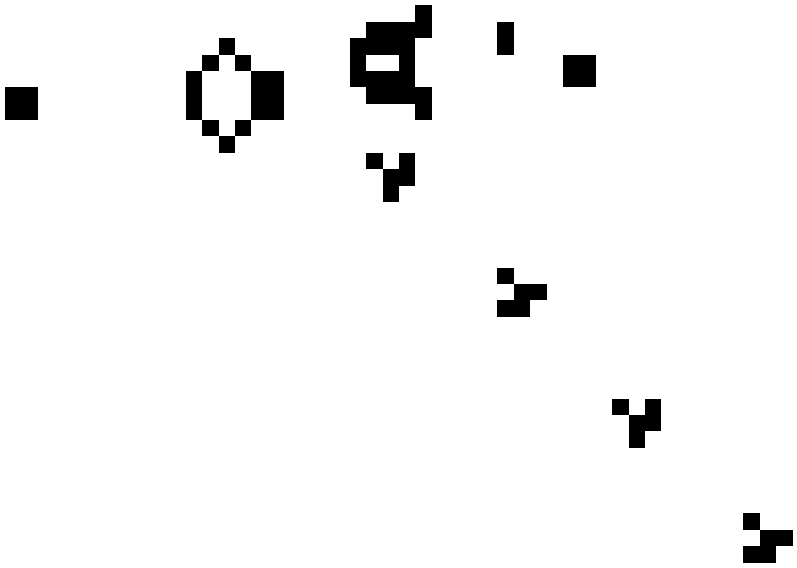


Cells

State of the cells, here 0 or 1 (TRUE/FALSE)

Lattice models

- Cells, state of the cells (0 or 1)
- Discrete in space and discrete in time
- State update depends on the neighbourhood



Conway's Game of Life

Lattice models

- Cells, state of the cells (0 or 1)
- State update depends on the neighbourhood
- Conway's Game of Life
- Cellular automata (automaton)

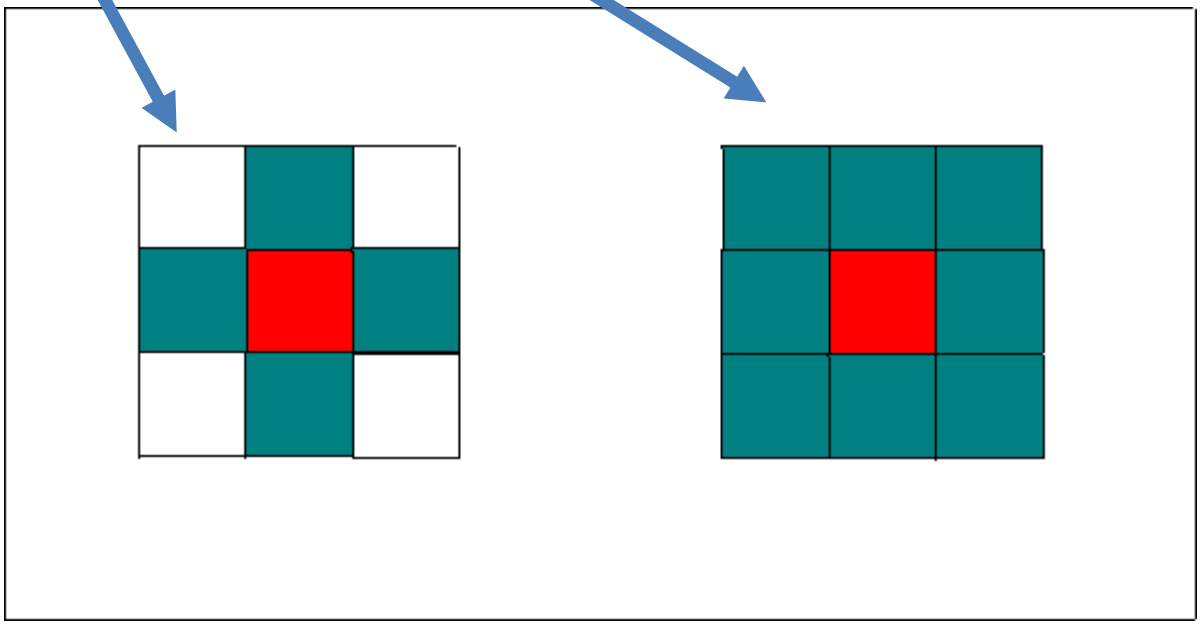
Cellular automata in biology

Cellular automata

- Simple lattice model
- Cells, state of the cells (0 or 1)
- State update depends on the neighbourhood

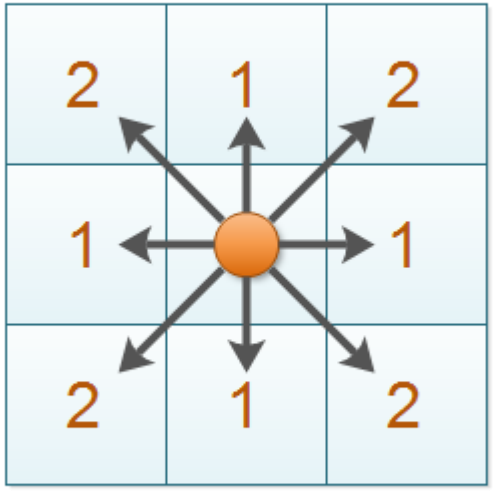
Neighbourhood in the lattice

- Moore (Chebyshev distance)
- von Neumann (Manhattan distance)



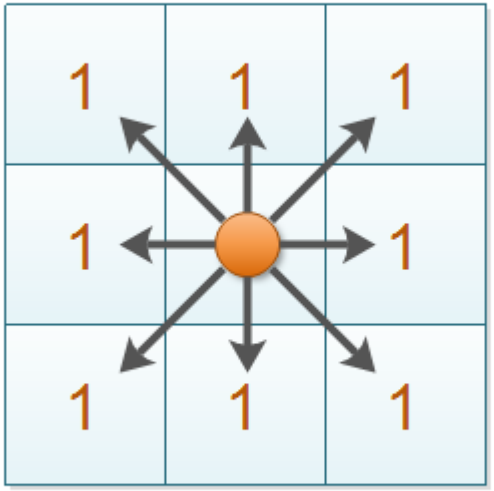
We can generalise

Manhattan Distance



$$|x_1 - x_2| + |y_1 - y_2|$$

Chebyshev Distance



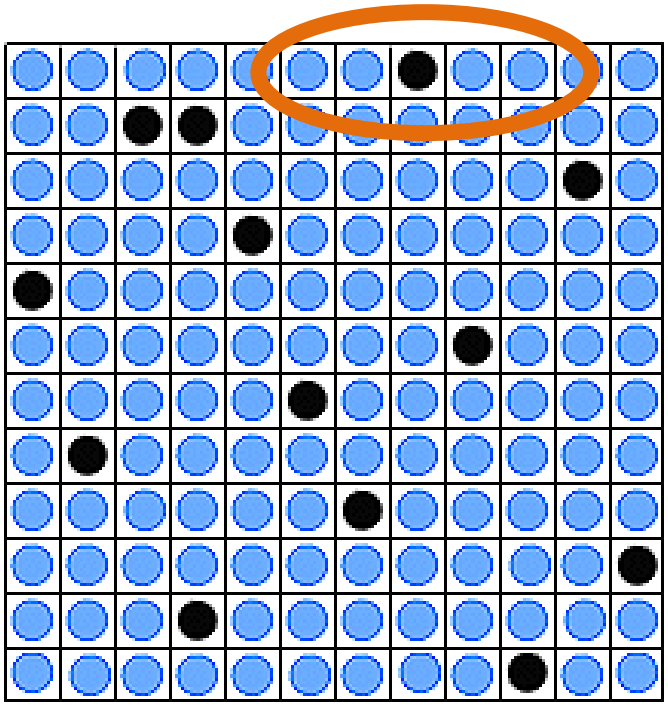
$$\max(|x_1 - x_2|, |y_1 - y_2|)$$

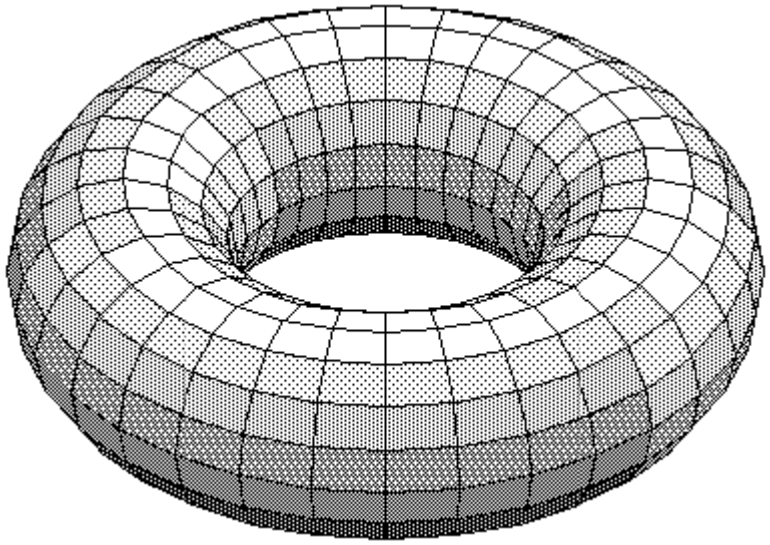
Stucture
squares vs hexagons

Civ1 vs Civ5

Prehaps the hexagons have clearer neighbourhood propeties,
but programming skills

Edge of the lattice





Create a torus – no edge effect

Lattice size

- Rule of thumb: bigger is better
- BUT CPU time

- Sensitivity analysis
  - to find a lattice size have no effect on the output

Moore nhood - R

```
field <- matrix(sample(0:1,64,replace=T),ncol=8)
# this is only 0s and 1s
field
field[5,4] # a particular cell
1:5 # easy way to do a sequence in R
field[4:6,3:5] # can be used in []

# How many 1s do we have in the Moore nhood of this cell?
sum(field[4:6,3:5])-field[5,4]
```

Moore nhood - R

```
# Lets assume we have crop cells (C), weed cells (W)
and cells without either of this two (else, E)
field2 <- matrix(sample(c("C","W","E"),64,
      replace=T),ncol=8)
field2
field2[6,3]# a particular crop cell
field2[5:7,2:4] # the nhood


# How many weed cells do we have in Moore nhood of
this cell?
sum(field2[5:7,2:4]=="W")
```

Toroidal arrangement - R

```
# Instead of adding and subtracting we define a new
vector of going South (down) in the lattice
#goingS should be (2,3,4,…,n,1)
goingS <- c(2:8,1)
# and going North (up)
#goingN should be c(n,1,2,3…,n-1)
goingN <- c(8,1:7)

#same for East and West
goingW <- goingS
goingE <- goingN
```

Toroidal arrangement - R

```
# Thus, the number of weed cells in Moore nhood of a cell [8,2]:
sum(field2[c(goingN[8],8,goingS[8]),c(goingE[2],2,goingW[2])]=="W")
```