

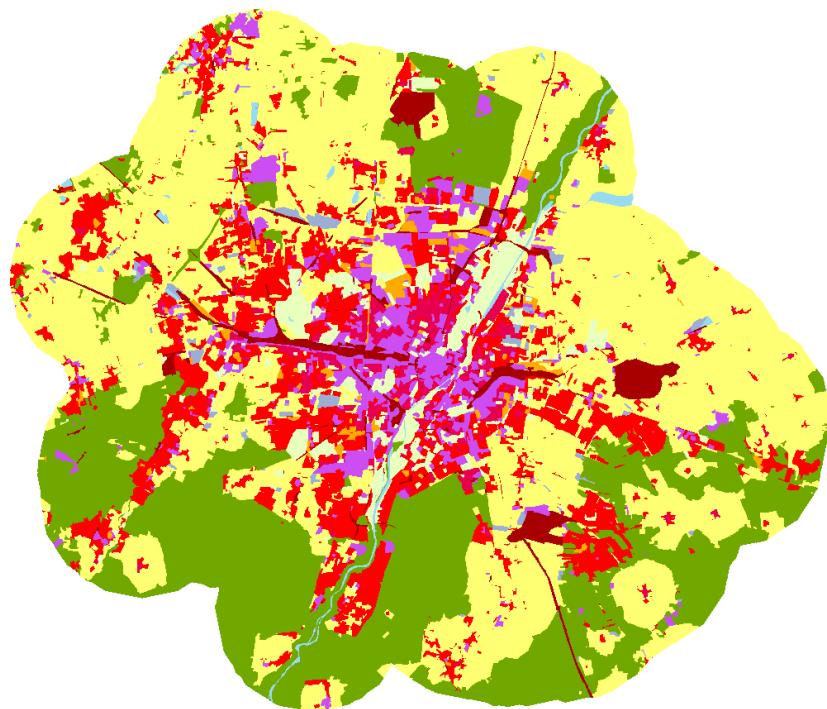
SE-12

# Etude de phénomènes spatiaux: AC et MBA

## Séance préliminaire

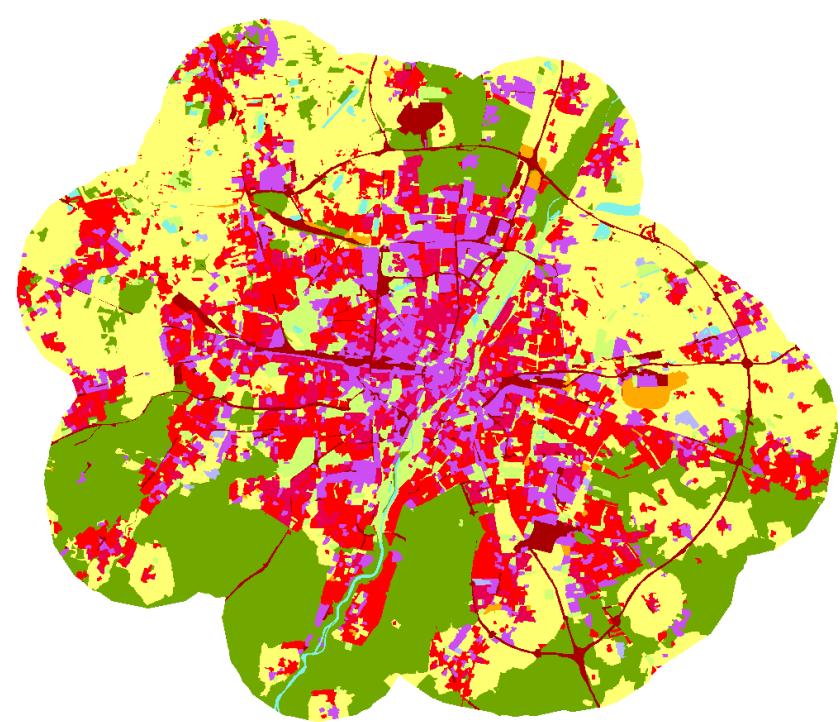
Thomas Favre-Bulle (ALICE)

André Ourednik (Chôros)



1955

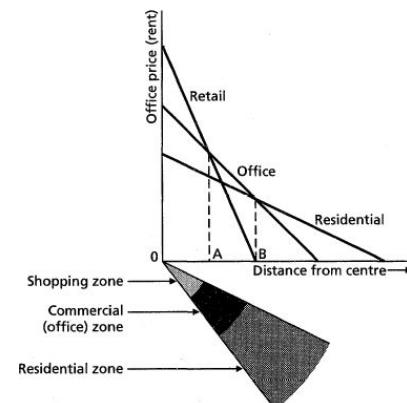
- Continuous Urban Fabric
- Discontinuous Dense Urban Fabric
- Discontinuous Medium Density Urban Fabric
- Discontinuous Low Density Urban Fabric
- Discontinuous Very Low Density Urban Fabric
- Isolated Structures
- Industrial, commercial, public, military and private units
- Fast transit roads and associated land
- Other roads and associated land
- Railways and associated land
- Port areas
- Airports
- Mineral extraction and dump sites
- Construction sites



1990

- Land without current use
- Green urban areas
- Sports and leisure facilities
- Arable land (annual crops)
- Permanent crops
- Pastures
- Complex and mixed cultivation patterns
- Orchards
- Forests
- Herbaceous vegetation associations
- Open spaces with little or no vegetation
- Wetlands
- Water bodies

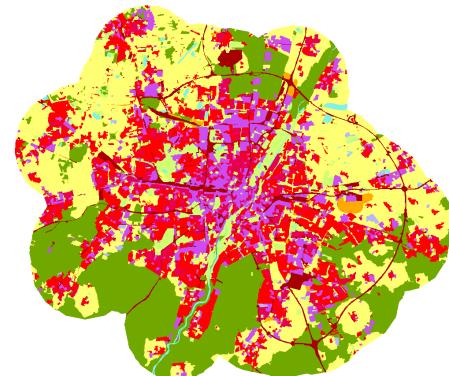
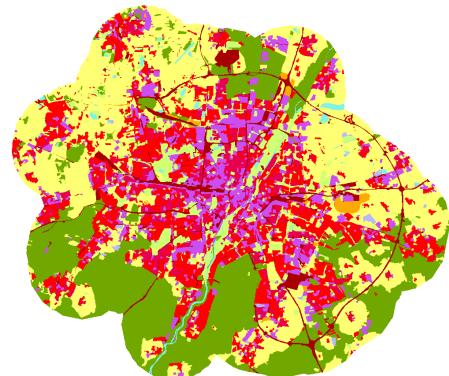
top-down

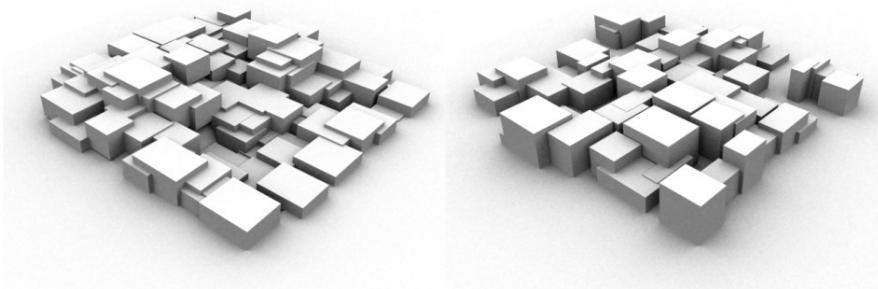
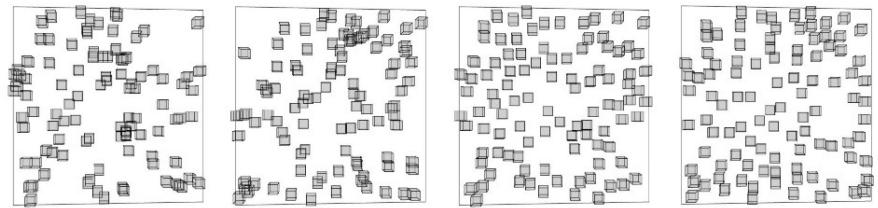


bottom-up

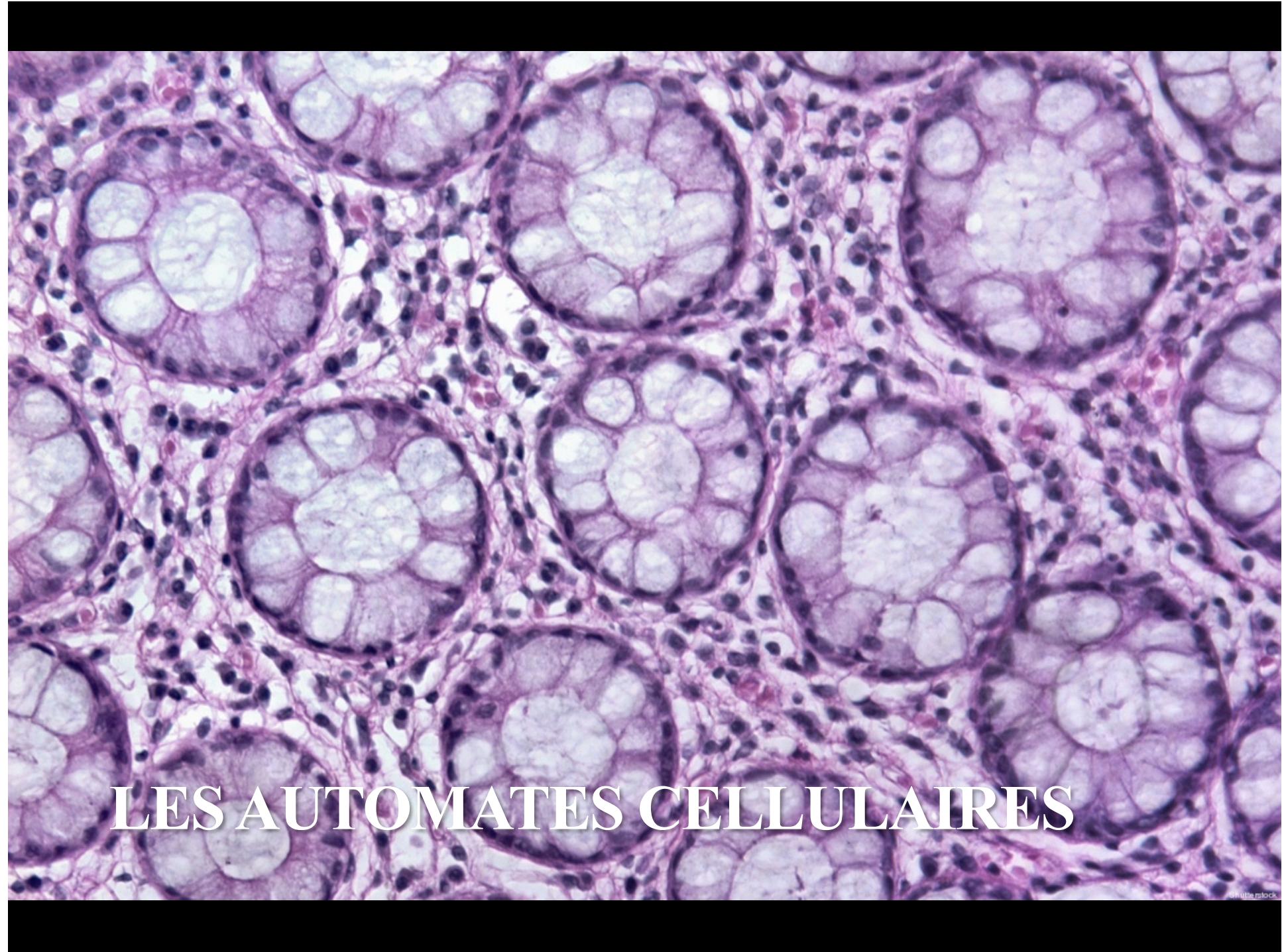


émergence





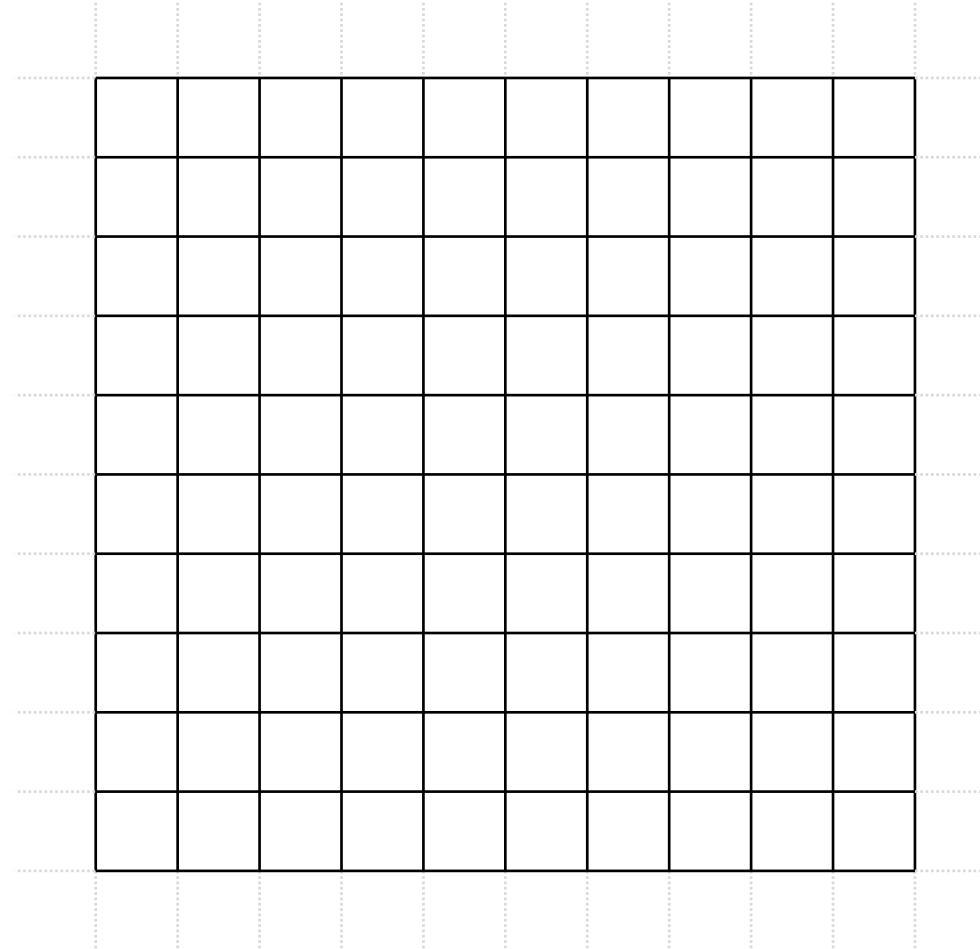
m o d è l e



LES AUTOMATES CELLULAIRES

# Automate cellulaires: définition générale

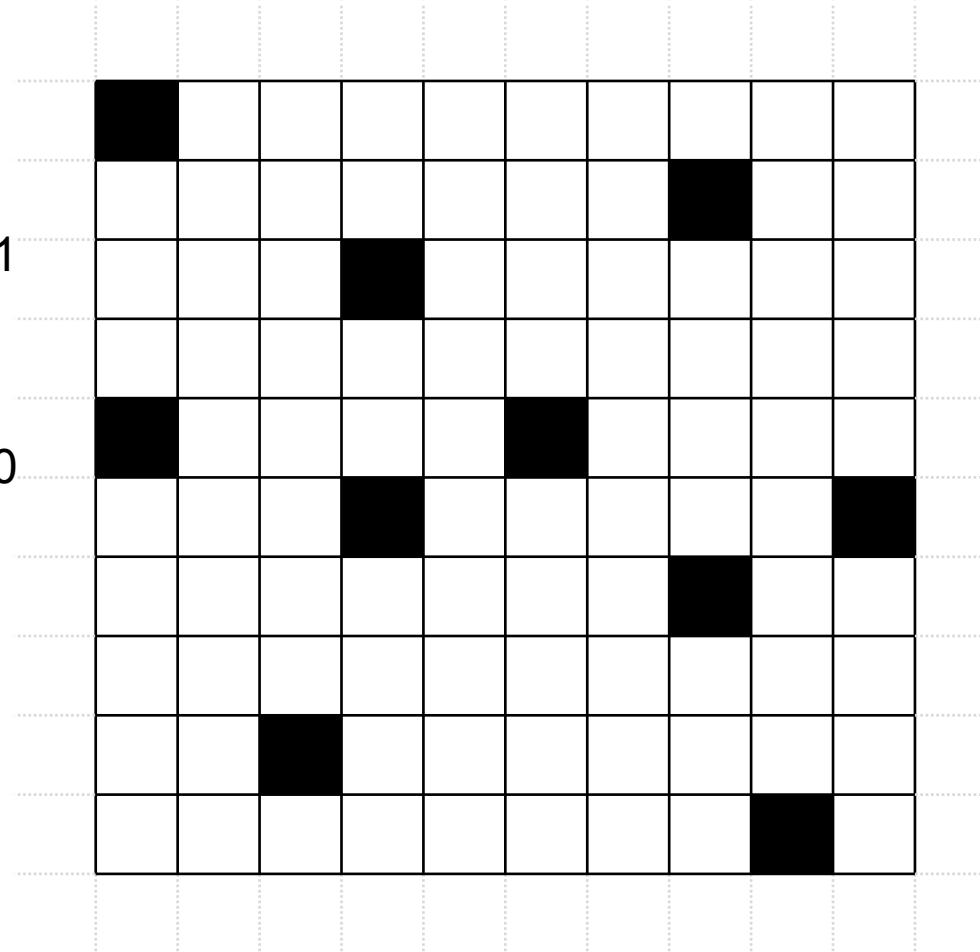
- Espace discret (discontinu)  
cellules
- Etats où peuvent se trouver les cellules
- Temps discret (discontinu)  
itérations
- Règles de transition  
état de la cellule à l'itération suivante

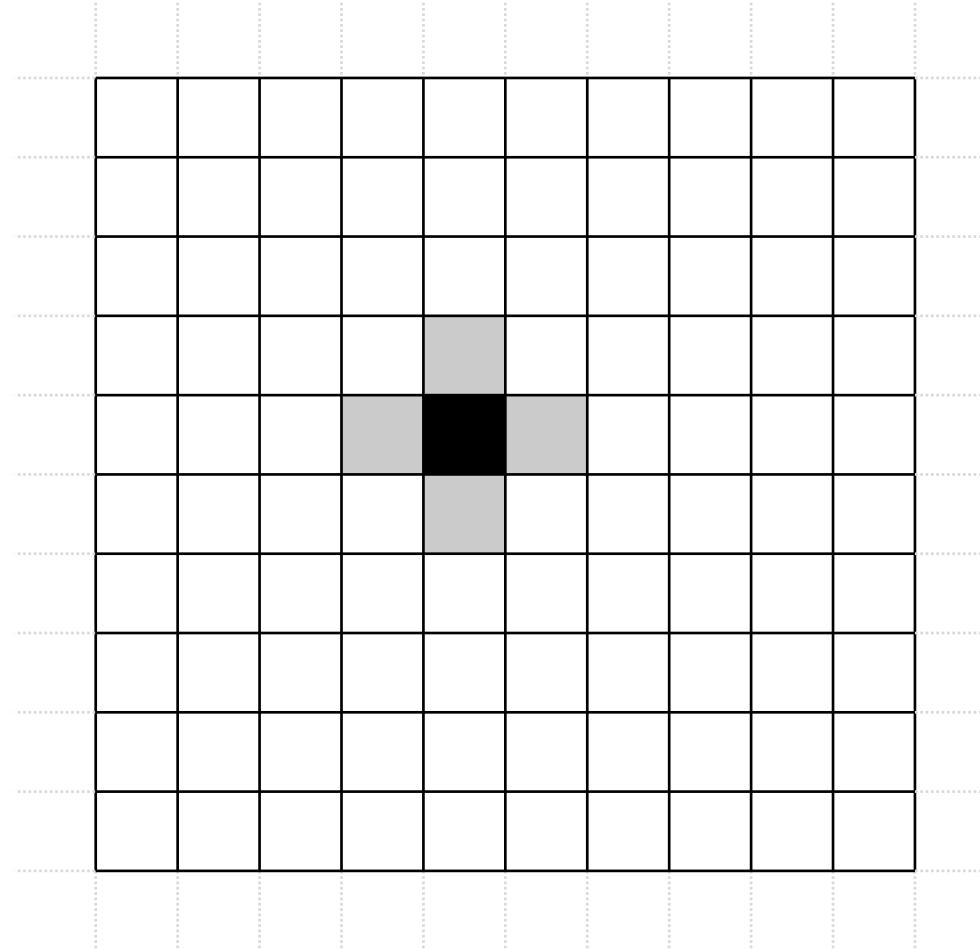


cellule dans l'état 1

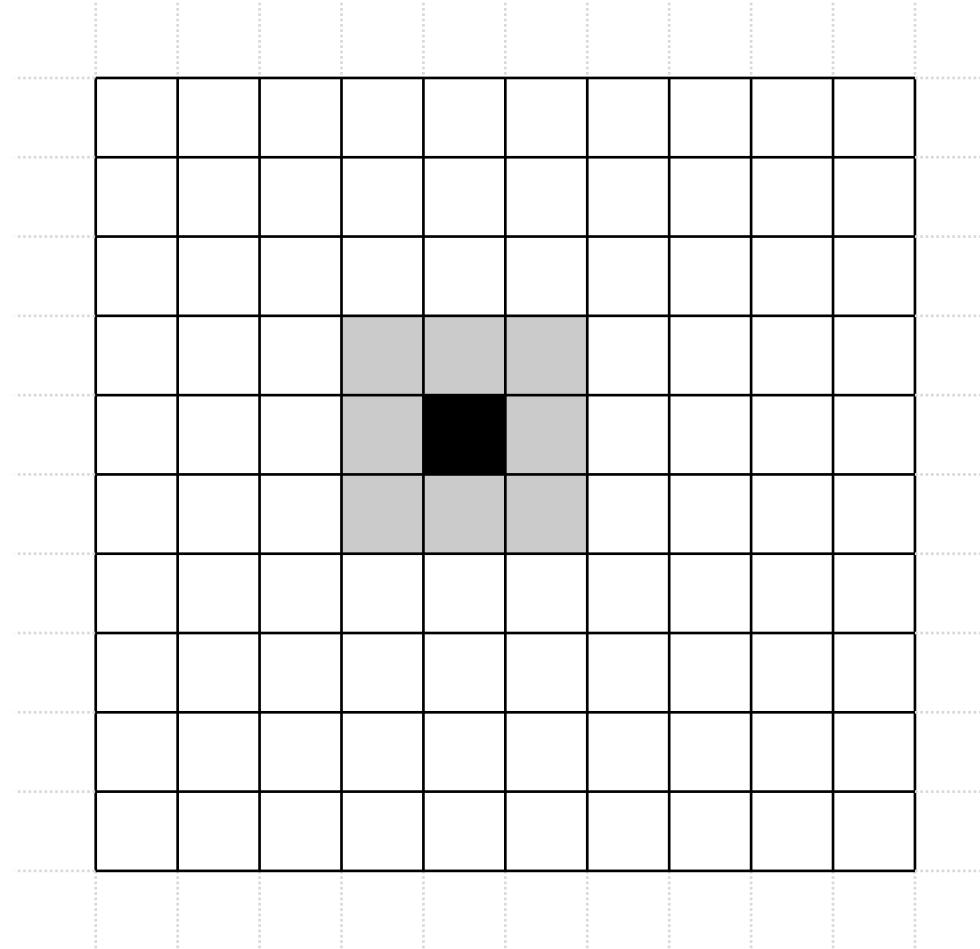


cellule dans l'état 0





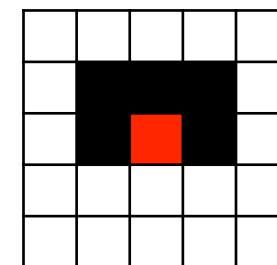
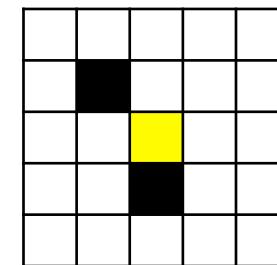
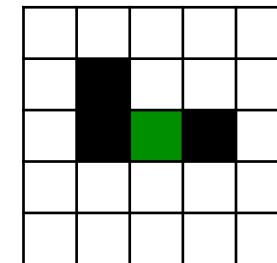
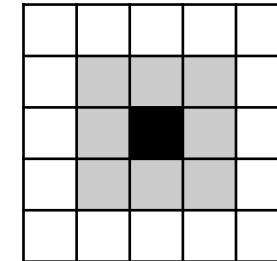
Voisinage de von Neumann

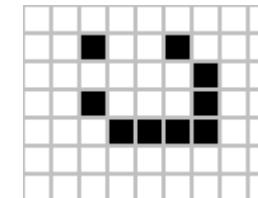
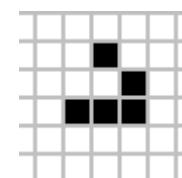
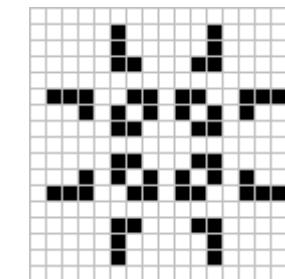
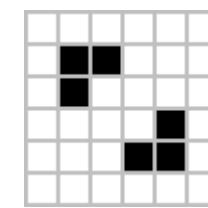
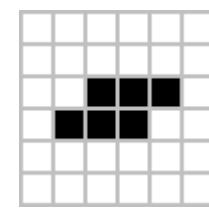
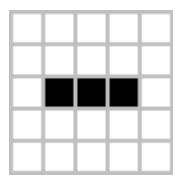
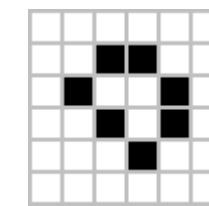
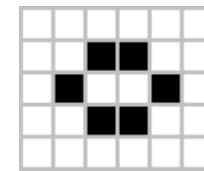
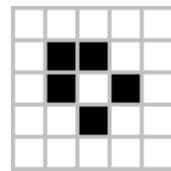
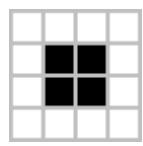


Voisinage de Moore

# Règles de transition

- L'état d'une cellule au temps  $t+1$  est défini par son propre état et par l'état de ses voisines au temps  $t$ .
- Exemple (*game of life*)
  - Si une cellule a exactement 3 voisines vivantes, elle est **vivante à l'étape suivante**.
  - Si une cellule a exactement 2 voisines vivantes, elle **reste dans son état actuel** à l'étape suivante.
  - Si une cellule a <2 ou >3 voisines vivantes, elle est **morte** à l'étape suivante.



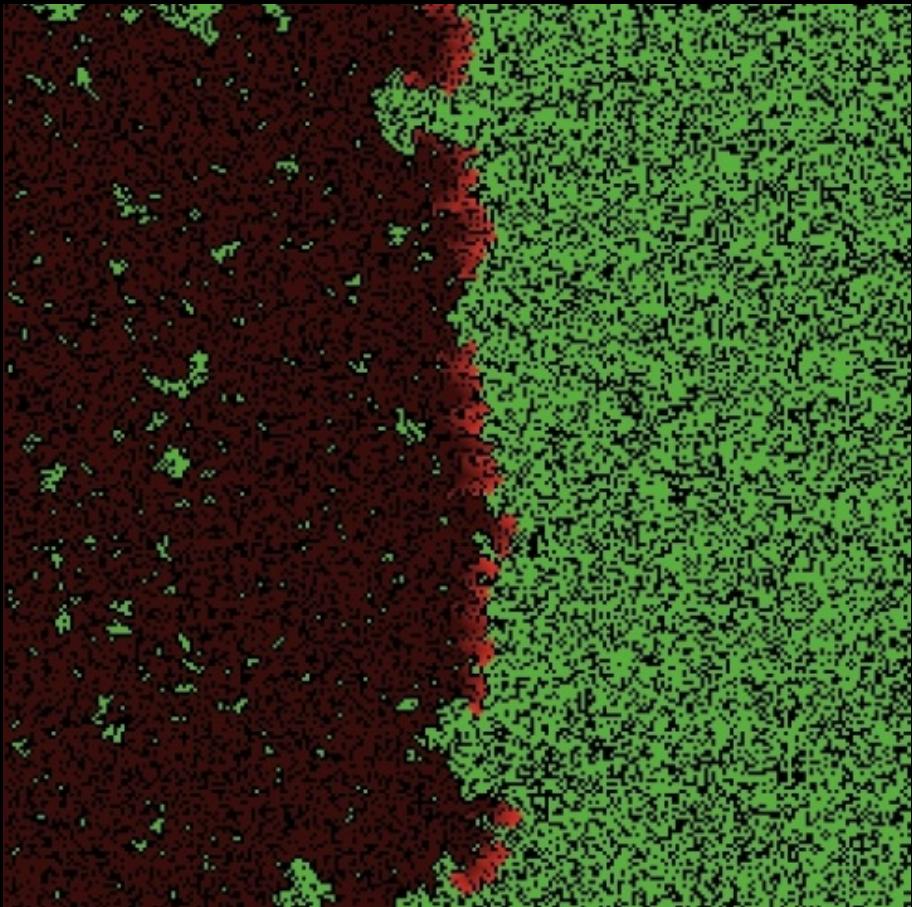


*Conway's game of life, 1970*

*cf. <http://lslwww.epfl.ch/biowall/Camera/CameraF/CameraF.html>*



*Conway's game of life, 1970*



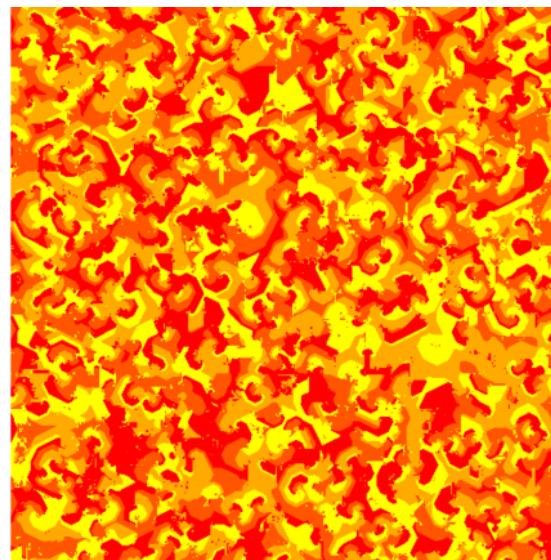
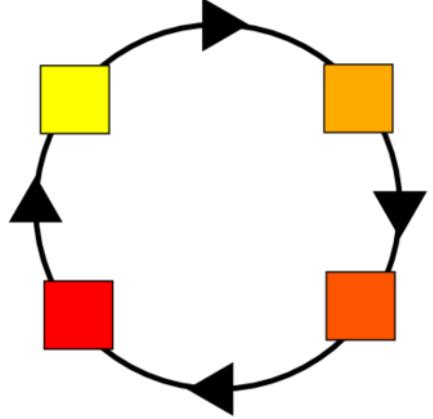
Feu de forêt

<http://ccl.northwestern.edu/netlogo/models/Fire>

Automate à 3 états:

- Arbre
- Feu
- Arbre brûlé

à chaque itération  
toutes les cellules voisines  
(von Neumann, degré 1)  
d'un feu possédant de la  
végétation prennent feu

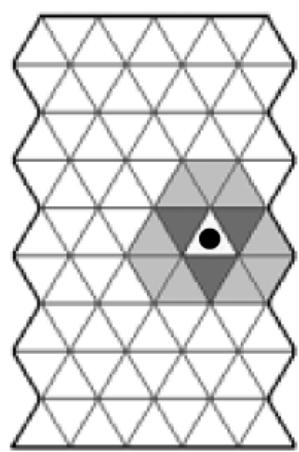


Griffeath

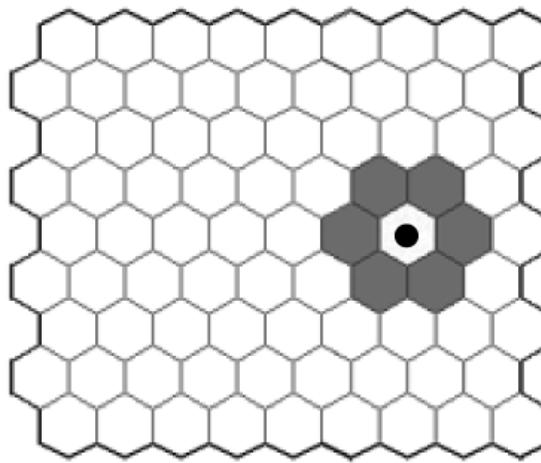
# Variations sur l'espace

- Forme des cellules
- Étendue du voisinage
- Espaces limités / espaces illimités mais finis  
(tores et sphères)
- Espaces multi-échelles
- Automates cellulaires 3D
- ...

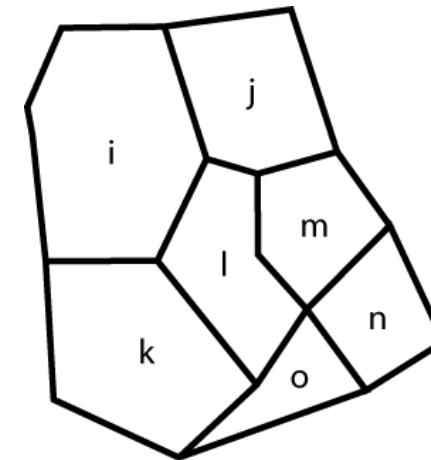
# Les formes de cellules



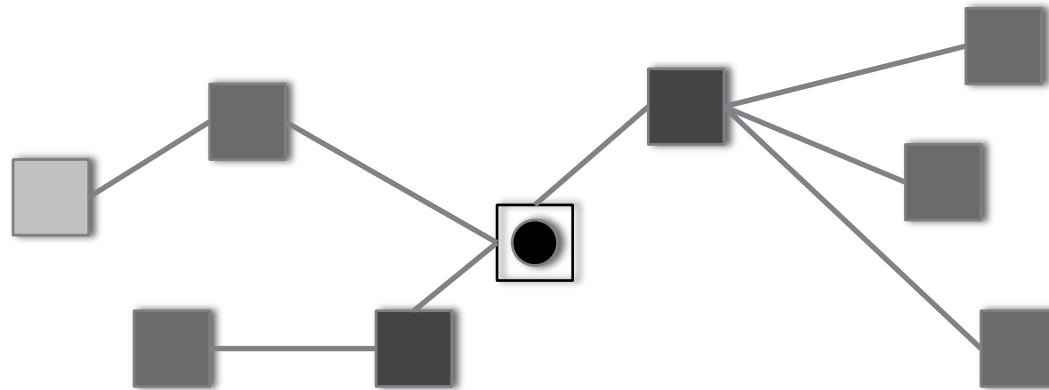
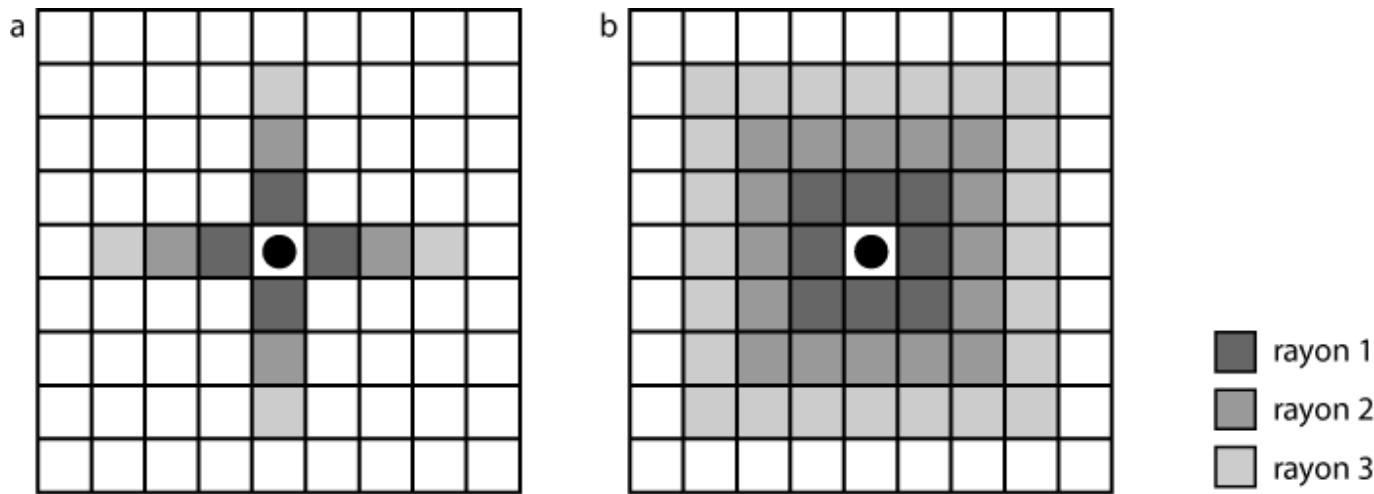
■ Voisinage de von Neumann et de Moore



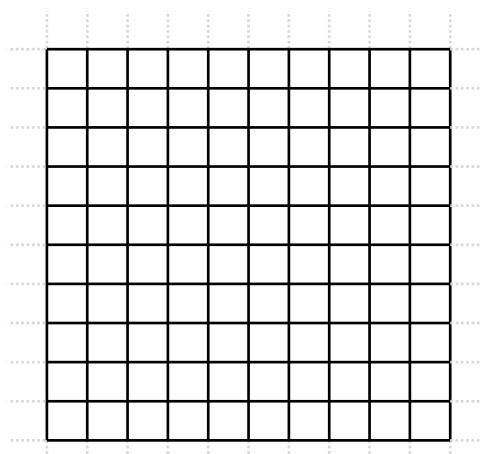
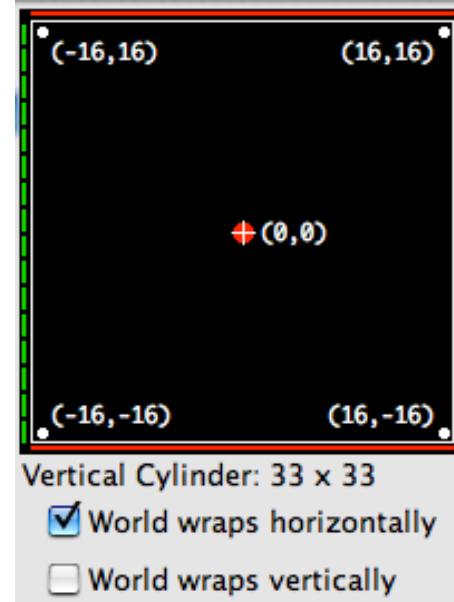
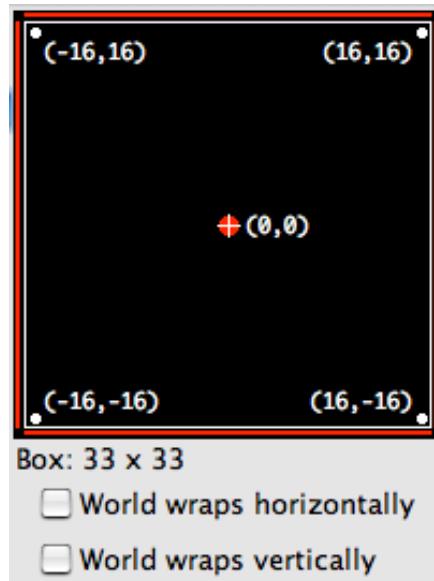
■ Voisinage de Moore seulement



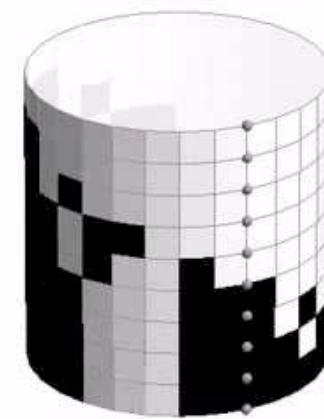
# Le voisinage



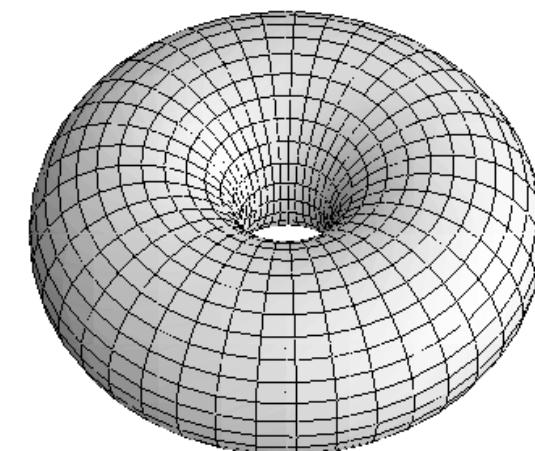
# Topologie



surface

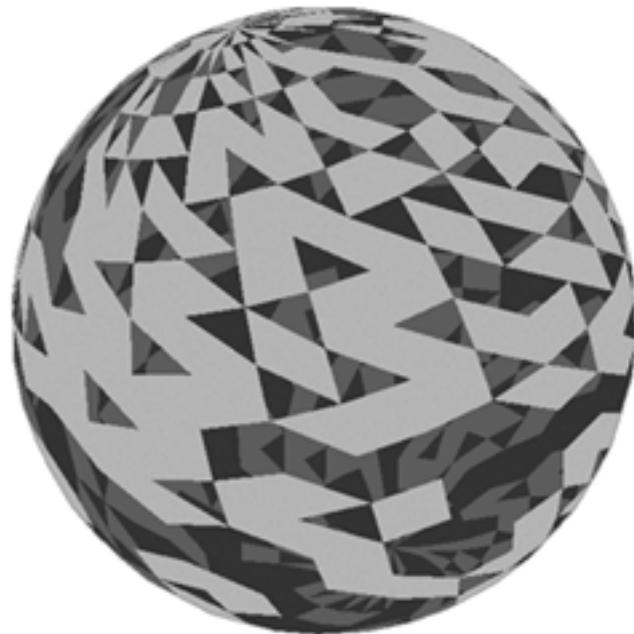


cylindre

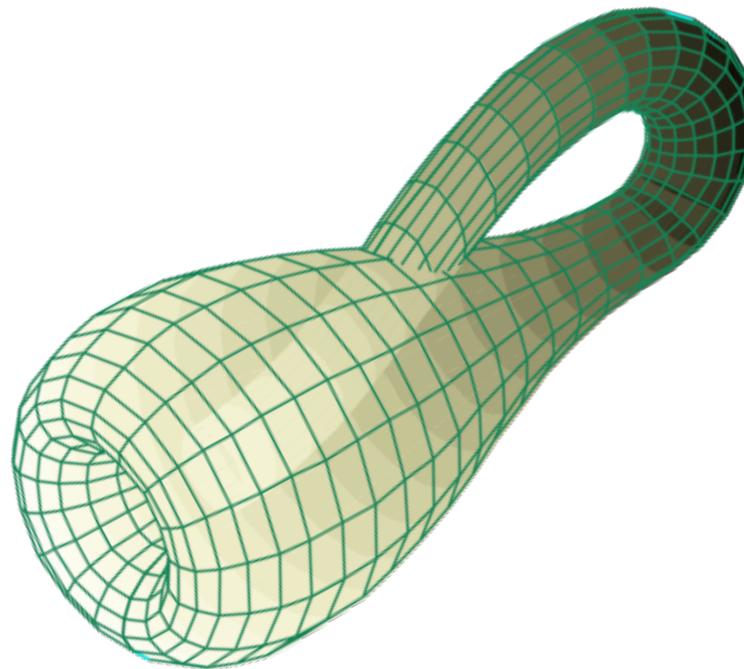


tore

# Topologie



sphère



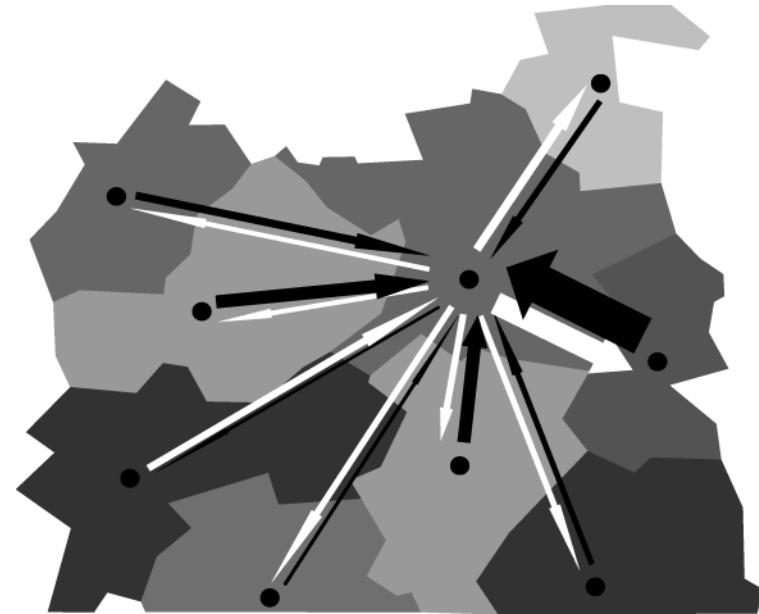
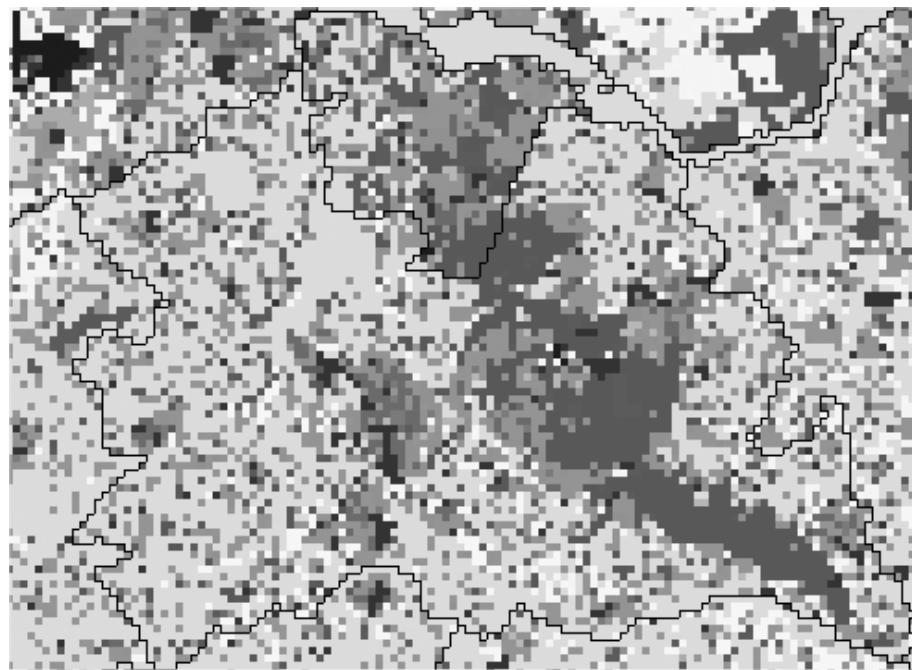
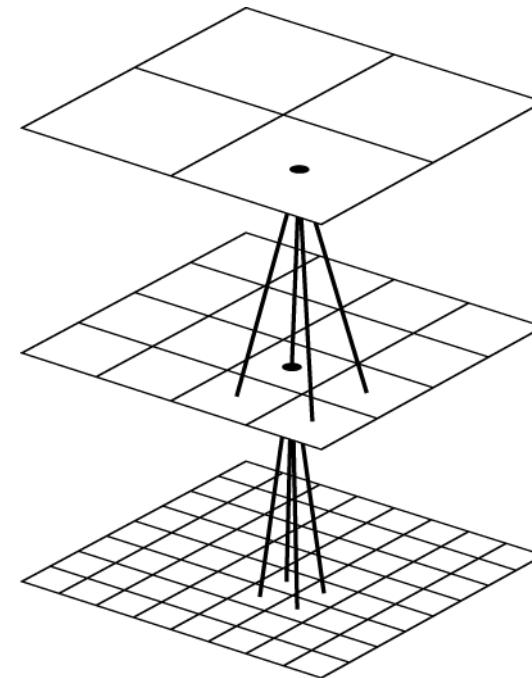
bouteille de Klein



# Règles de transition

- Règles déterministes
  - `ifelse P [Q] [R]`
- Règles stochastiques
  - `ifelse (P and random 100 > 50) [Q] [R]`

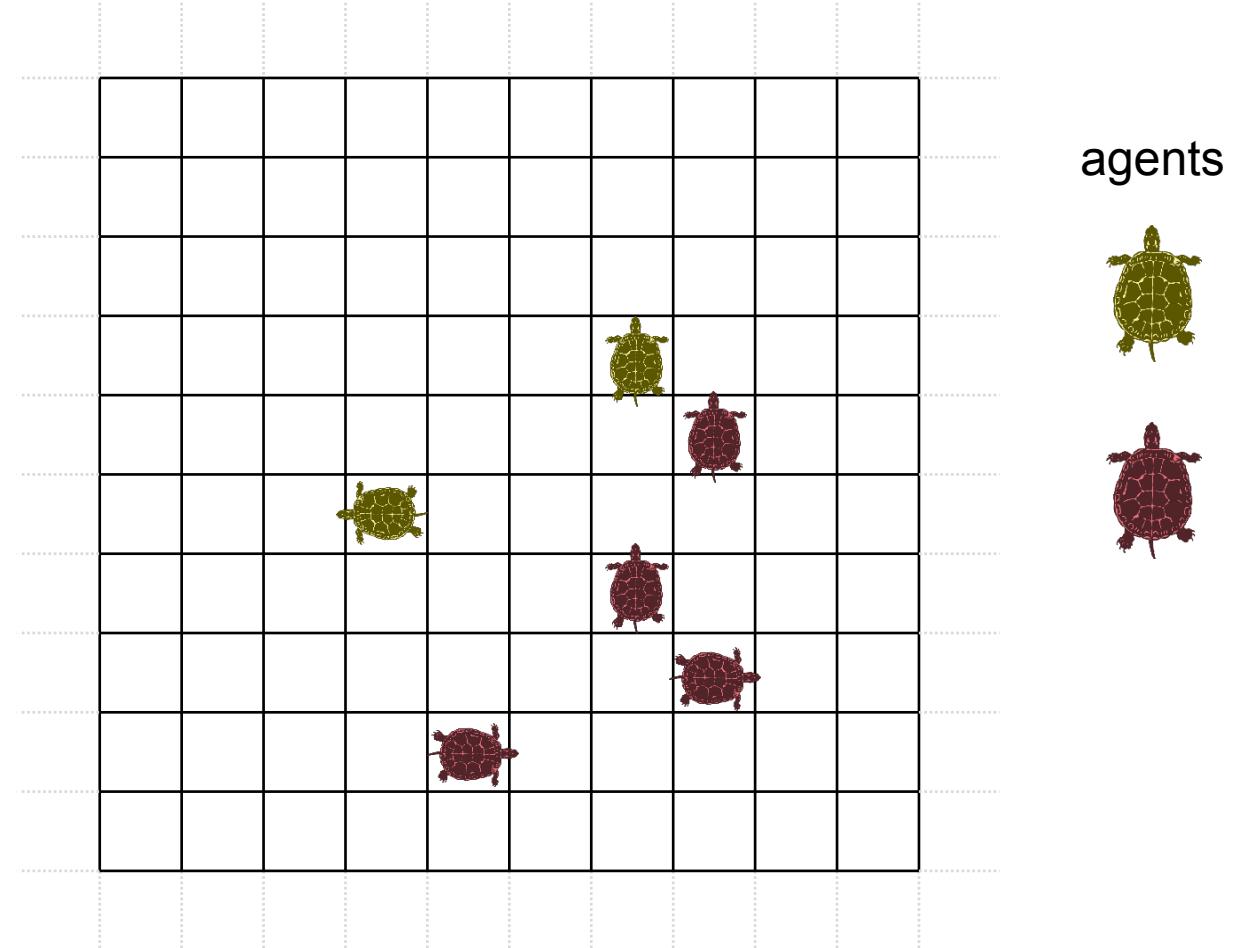
## Échelles imbriquées



# LES MODÈLES BASÉS AGENTS

# Modèles basés agents: définition générale

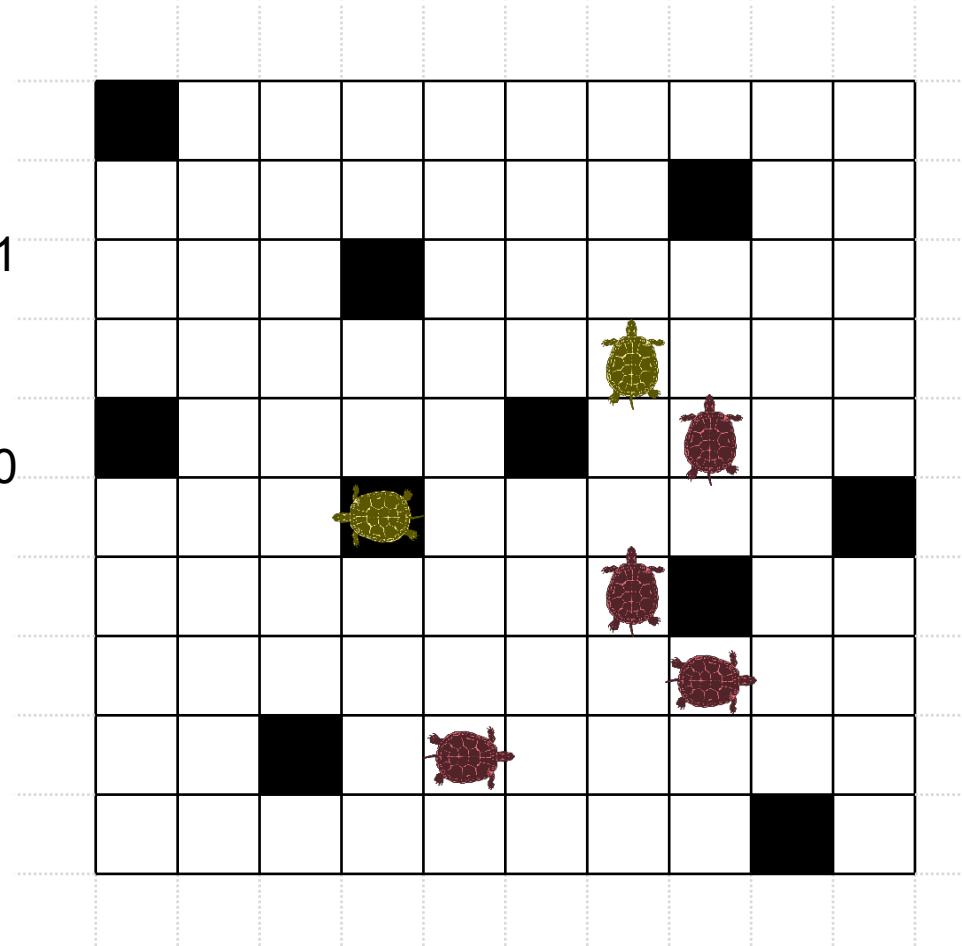
- Espace discret  
cellules
- Etats où peuvent se trouver les cellules
- Agents
  - Lieu (cellule) où se trouve l'agent
  - Direction / vision de l'agent
  - États où se trouve l'agent / type d'agent
  - Relations avec d'autres agents
- Temps discret  
itérations
- Règles de transition  
état de la cellule/agent à l'itération suivante
- **Règles de mouvement**  
changement de lieux et de relations



cellule dans l'état 1



cellule dans l'état 0



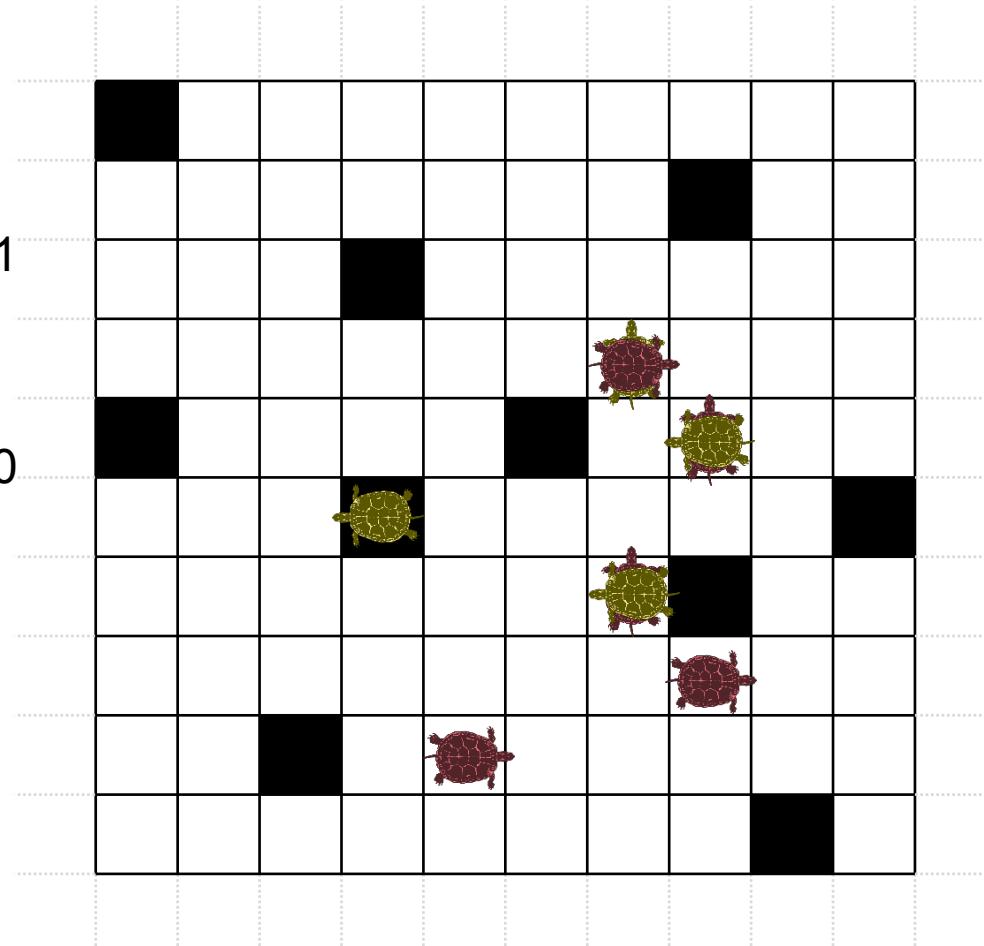
agents



cellule dans l'état 1



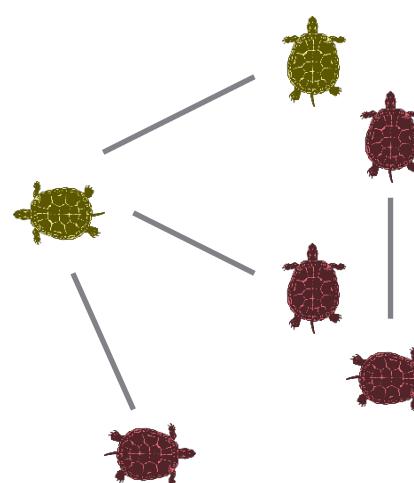
cellule dans l'état 0

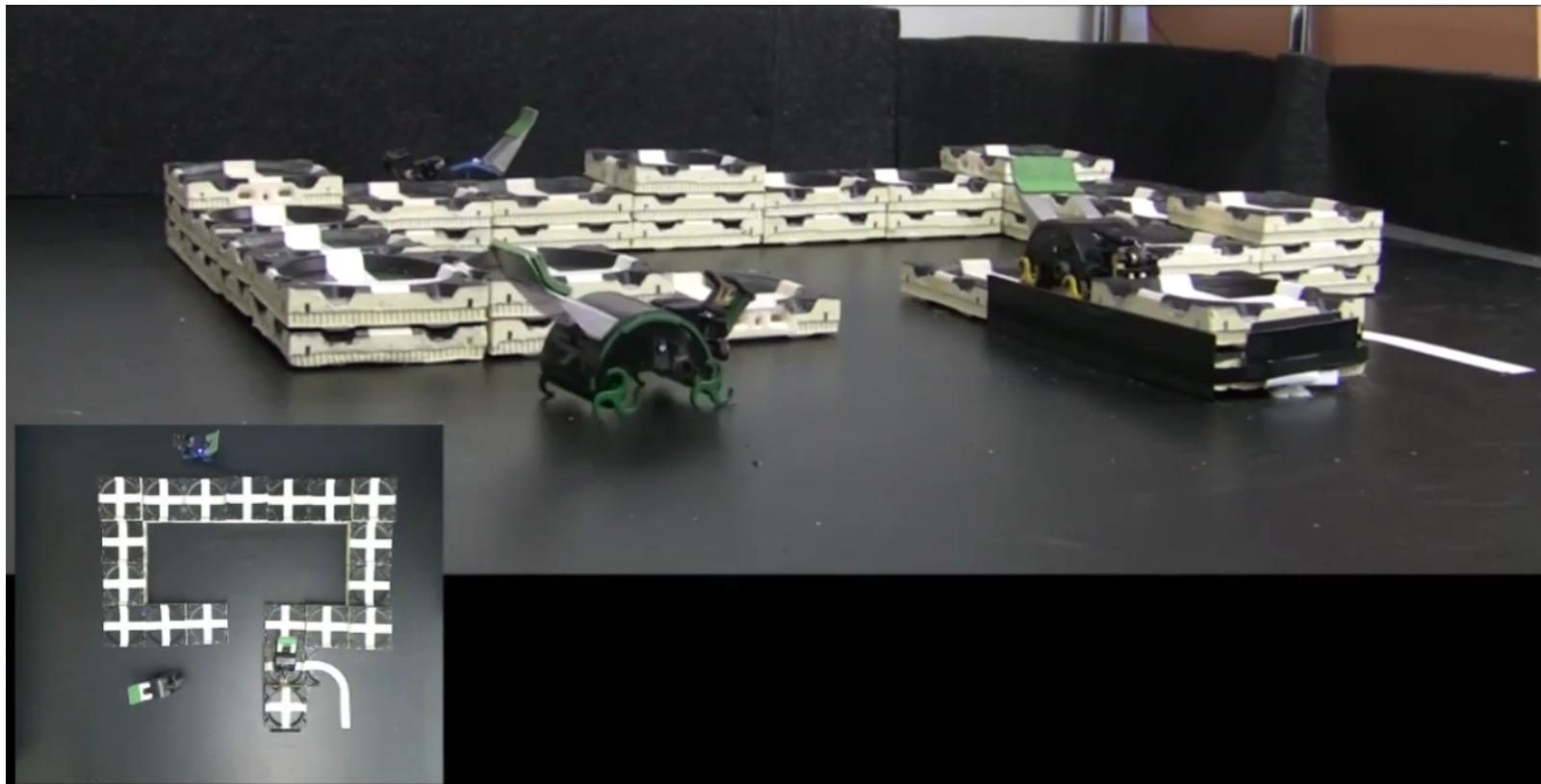


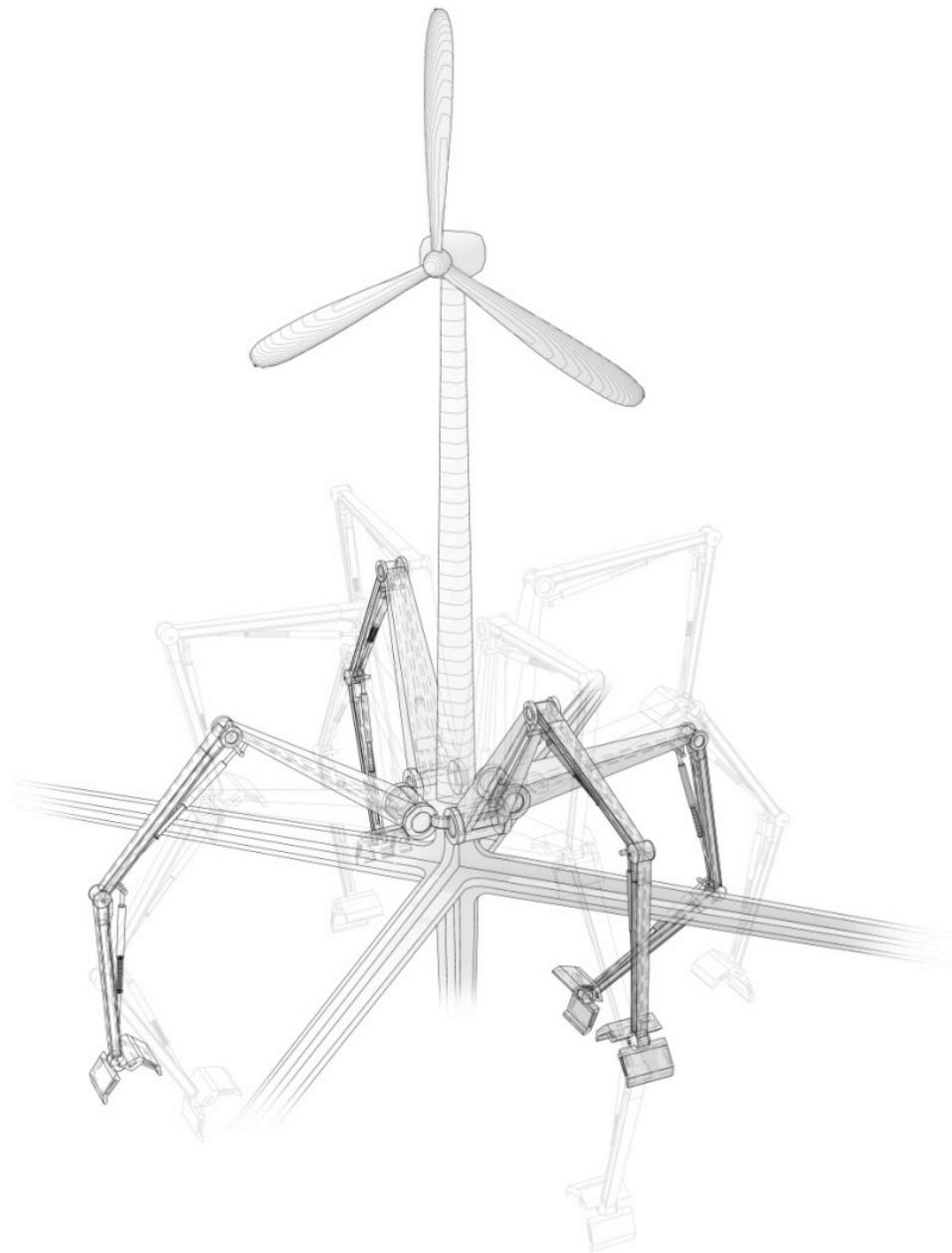
agents

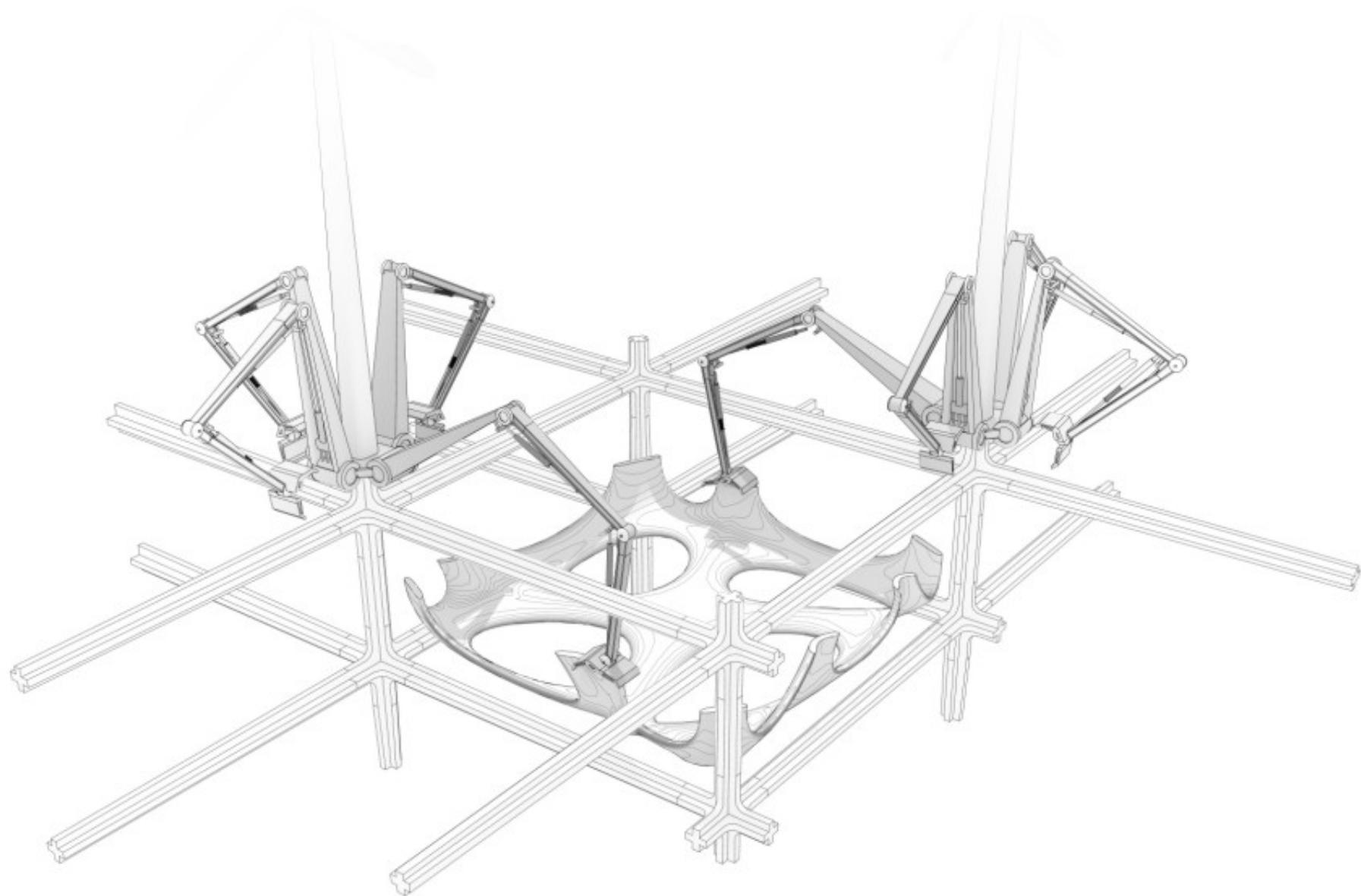


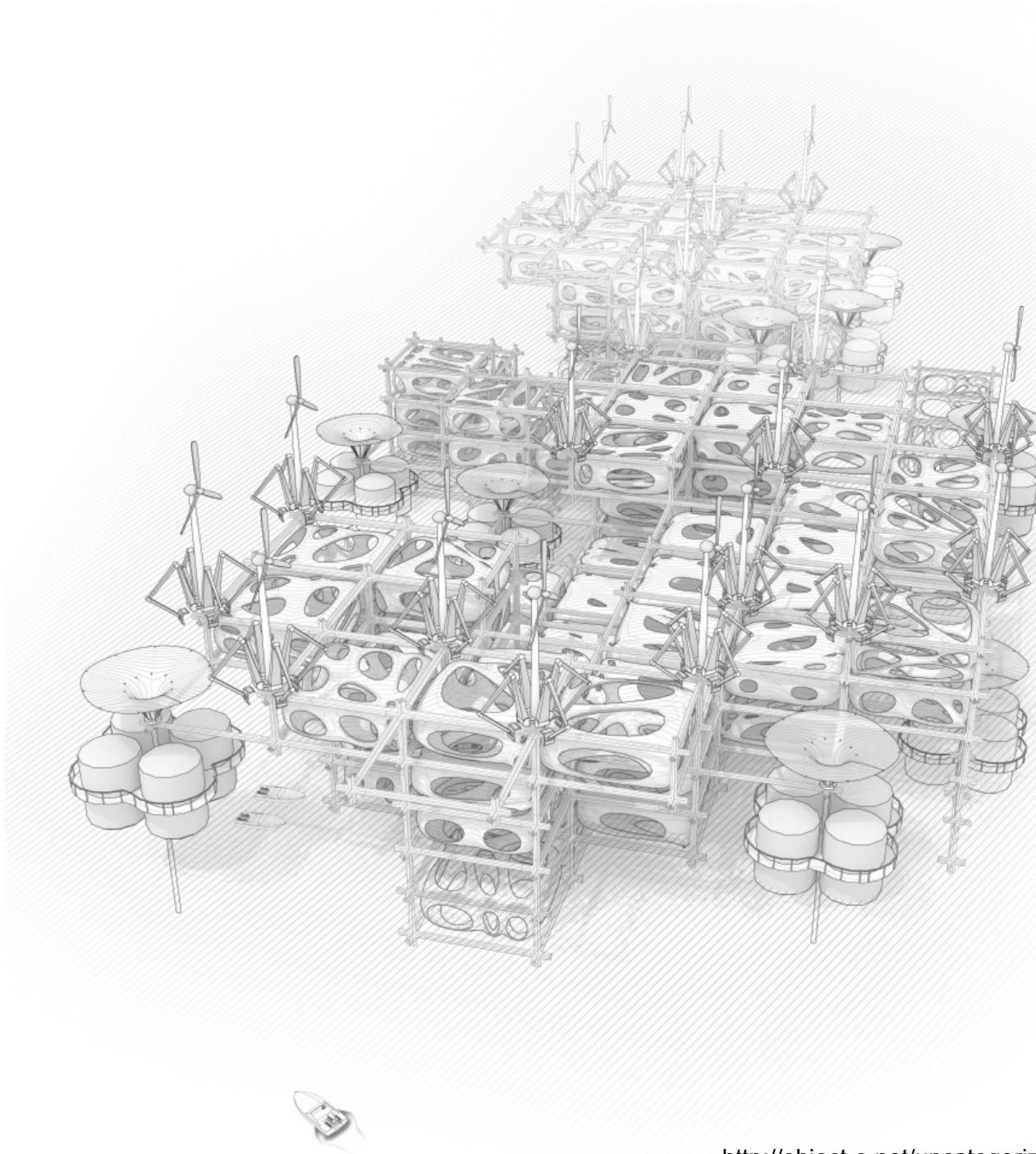
agents





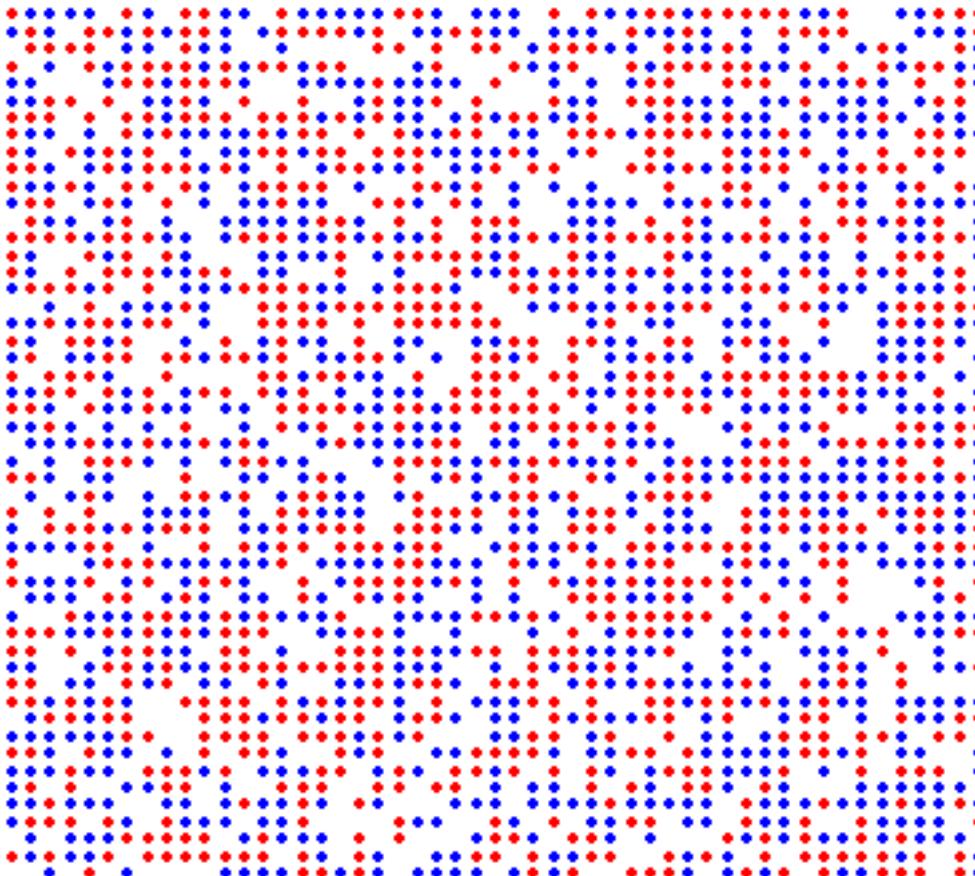






<http://object-e.net/uncategorized/protocolinfrastructure>

## Step 1



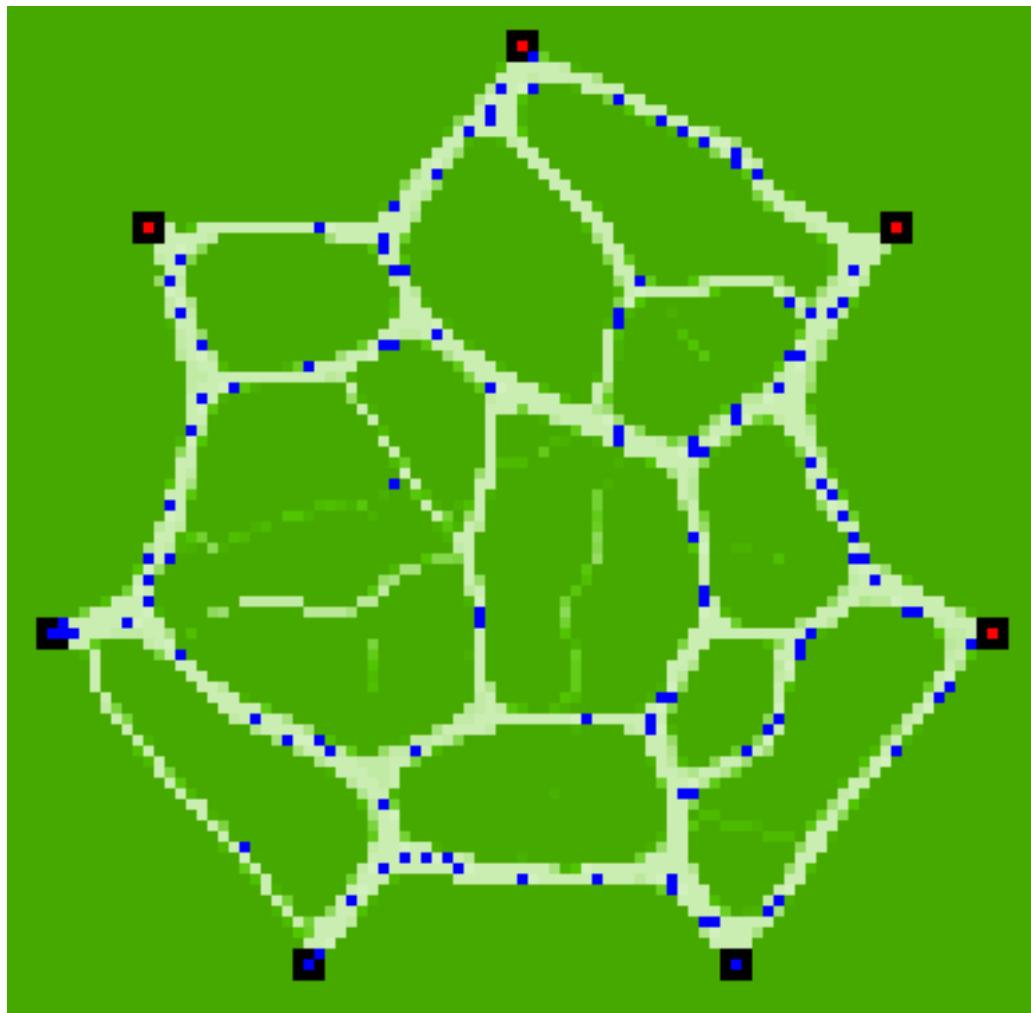
● individu population A

● individu population B

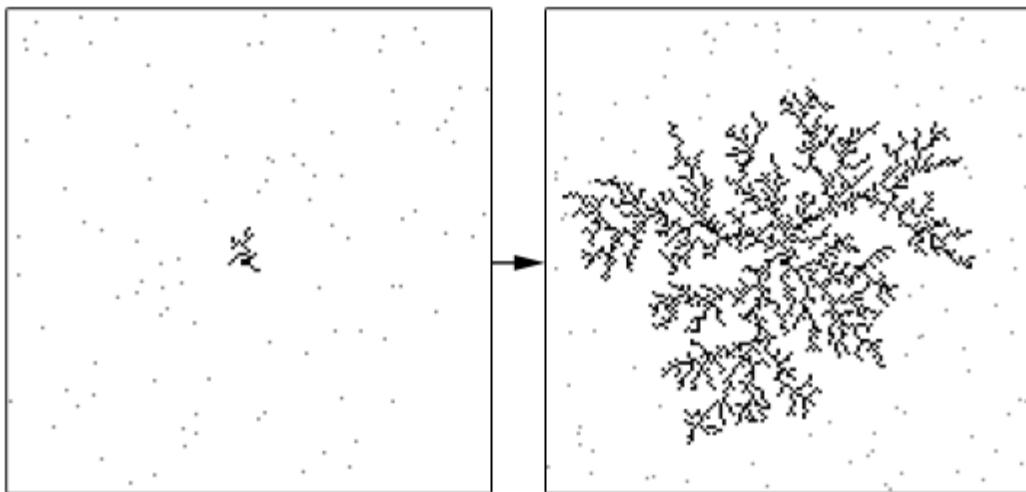
● : quand j'ai trop de voisins rouges, je déménage

● : quand j'ai trop de voisins bleus, je déménage

Thomas C. Schelling 1978



Kitsopoulos 2003 – *Paths in the green*



« Arbre brownien » produit par un MBA sur la base de l'agrégation par diffusion. Permet de modéliser les dépôts de minéraux



exemple matériel: arbre formé par électrodéposition dans une solution de sulfate de cuivre

# MBA 1D: embouteillages



Traffic

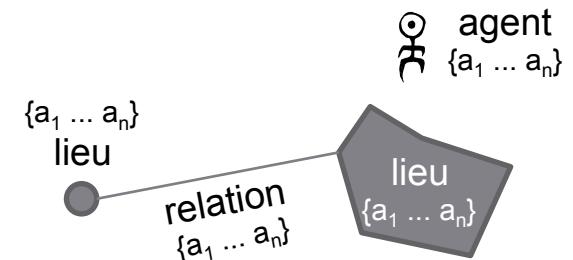
<http://ccl.northwestern.edu/netlogo/models/TrafficBasic>

<http://ccl.northwestern.edu/netlogo/models/TrafficGrid>

<http://ccl.northwestern.edu/netlogo/models/Traffic2Lanes>

# AC et MBA comme modèles dynamiques de l'espace habité

- Éléments statiques
  - *lieux* (points, surfaces, volumes)
  - *relations* entre ces lieux (topologiques, métriques)
  - *attributs* (rattachés aux lieux et à aux relations)
- Agents
  - position
  - attributs
  - relations avec les éléments statiques et les autres agents
- Dynamique
  - *règles de transition* d'état (changeant les valeurs des attributs)
  - *paramètres*, faisant varier les règles de transition



NETLOGO 5.0.5

# NetLogo 5.0.5

- Types de NetLogo existants
- Interface
- Model library
- etc.

