# Endosymbiotic Particle System in NetLogo

#### Antonio Di Mauro

Department of Computer Science University of Pisa

Project discussion of Computational Models for Complex Systems

Course



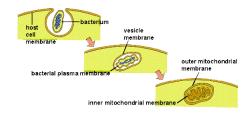
# Endosymbiotic Theory (Symbiogenesis)

Endocytosis = (cyto = cell) a process of "cell eating", cells are engulfed and digested as food

Endosymbiosis = cells are engulfed but not digested, cells live together in a mutually benefitting relationship, or symbiosis

# Endosymbiotic Theory (cont.)

- Evolutionary theory of the origin of eukaryotic cells from prokaryotic organisms
- Proposed by Konstantin Mereschkowski in 1905 and advanced with microbiological evidence by Lynn Margulis in 1967
- Original hypothesis proposed that aerobic bacteria (that require oxygen) were ingested by anaerobic bacteria, and each have a survival advantage



## The Particle System

The approach to the endosymbiotic system is a particle system with attractions and repulsions among entities (without phagocytosis). Below the steps in a single unit of time made by a particle:

- Find <u>affine</u>: the particle find the neighbour with the maximum quantity of molecule of interest
- Find not affine: the particle find the neighbour with the minimum quantity of molecule of interest
- Move away: the particle rejects the not affine and moves away from it
- Move towards: the particle is attracted by the affine and moves towards it
- Onsume: the particle consumes the quantity of the molecule of interest of the affine
- Produce: the particle increases the quantities of its molecules



## NetLogo Functions

### Find affine and not affine

```
to find-affine
  let idx species
  set affine max-one-of neighbours [ item idx species-molecules ]
  set not-affine min-one-of neighbours [ item idx species-molecules ]
  if affine = not-affine
    [ set not-affine no-turtles ]
end
```

### Move away

```
to move-away-not-affine
  if not-affine != no-turtles [
  face not-affine
  rt 180
  fd 1 ]
end
```

#### Move towards

```
to move-to-affine
  if affine != no-turtles [ move-to affine ]
end
```

## NetLogo Functions (cont.)

#### Consume

### Produce

```
to produce
  let indexer ( range 0 length species-molecules )
  foreach indexer [ idx ->
    if (item idx species-molecules) < 1
    [ set species-molecules replace-item idx species-molecules
        (item idx species-molecules + (production-rate * item idx species-molecules)) ]
    end</pre>
```



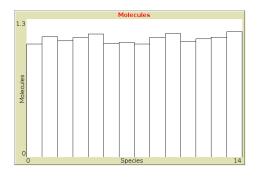
### NetLogo Parameters



- population: the number of particles
- ② vision: number of patches visible by a particle, used to find neighbours
- consumption-rate: the rate (between 0 and 1) of comsumption of molecules
- production-rate: the rate (between 0 and 1) of production of molecules



# NetLogo Plot



• Monitoring the quantities of molecules of each species in the system



# Empirical facts

- Increasing/decreasing the vision leads to decreasing/increasing of clusters
- increasing or decreasing the reproduction and consumption rates causes a temporary instability of the quantities of molecules, but its stabilizes quickly

Lets see the code...

