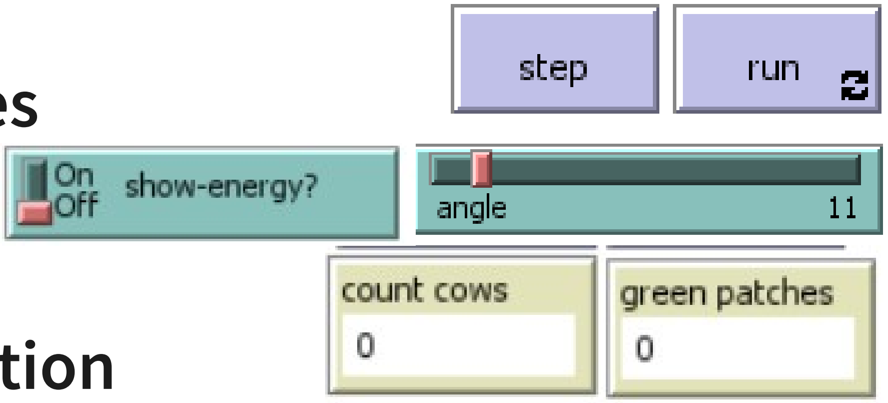
NetLogo

Andrea Sterbini – sterbini@di.uniroma1.it

NetLogo and NetLogoWeb
turtles + patches = movable agent simulations

Full Logo:
- procedures + reporters (functions)
- lists and filters
- anonymous functions (parametric code blocks)
- new agent types with added properties (OOP without inheritance?)

<u>Easy GUI construction</u>:
- Buttons to call functions/procedures
- Sliders to change global variables
- Labelled boxes to show values
- Plot graphs of values during simulation
- 2 versions: 2D and 3D canvas showing turtles, patches and edges



3 type of Agents (+ custom agents)

Turtles: movable entities

Patches: the canvas is covered by a grid of unmovable squares
- e.g. the grass of a field (2 or 3 dimensional MATRIX concept!!!)

Edges: links between two Turtles

Other “animal groups” can be easily defined:
- breed [singular plural]

Separate breeds can have separate sets of properties:
- cows-own [energy]

The Turtles’ set contains all other breeds (like “object” in Java)

An agent can change its breed type! (set breed ‘breedname’)

Programming style

Single-threaded	(the order of set elements is random)
Procedural	("to" procedures)
Functional !!!	("to-report" functions)
Data types:	
- lists	(immutable, untyped)
- arrays	(mutable, untyped)
- list-based operations	(map/filter/collect/ask/…)
- anonymous functions	(code blocks)

A LOT of built-in commands are functions/filters
THUS the language is very very readable

NetLogo and other Logos

Small syntactic differences

most Logos

```
to square :x
output :x * :x
end
```

NetLogo

```
to-report square [x]
report x * x
end
```

to-report	instead than	to
report	instead than	output
[args]	instead than	:arg

some precedence differences

Demo 1: Brownian motion

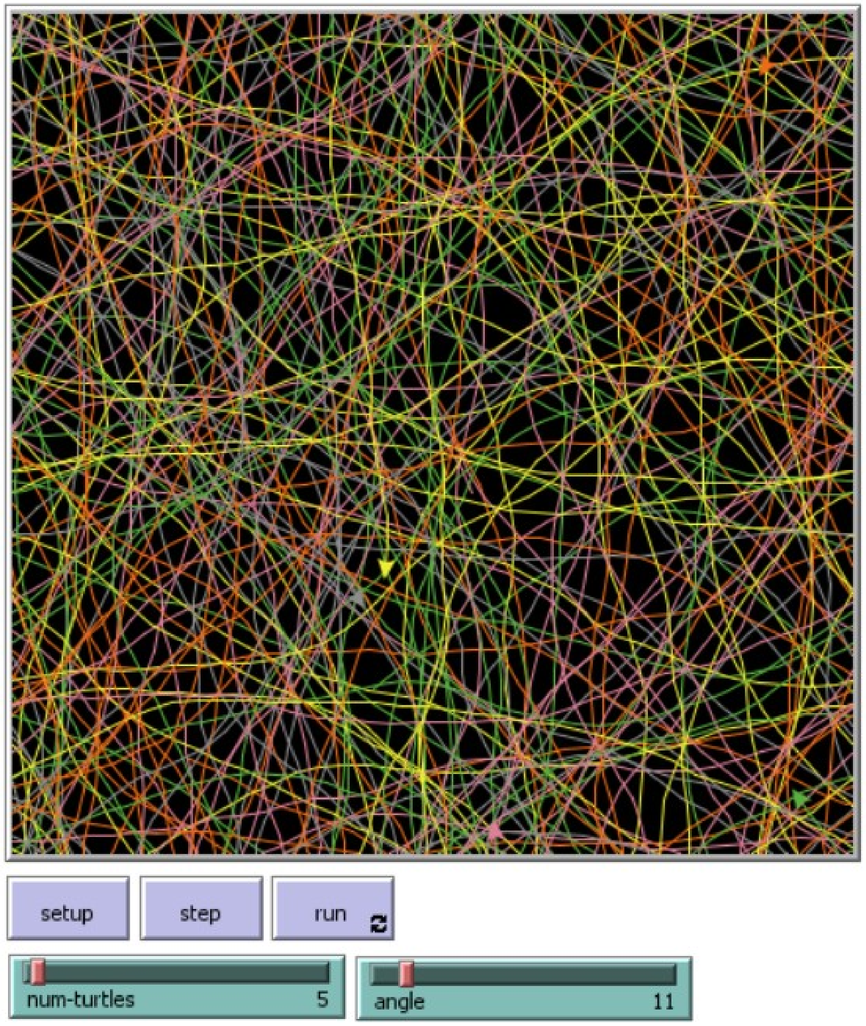
- start with N randomly placed turtles
- move each turtle
    - by 1 step
    - by changing slightly its heading

NO need for loops, just use repeating button

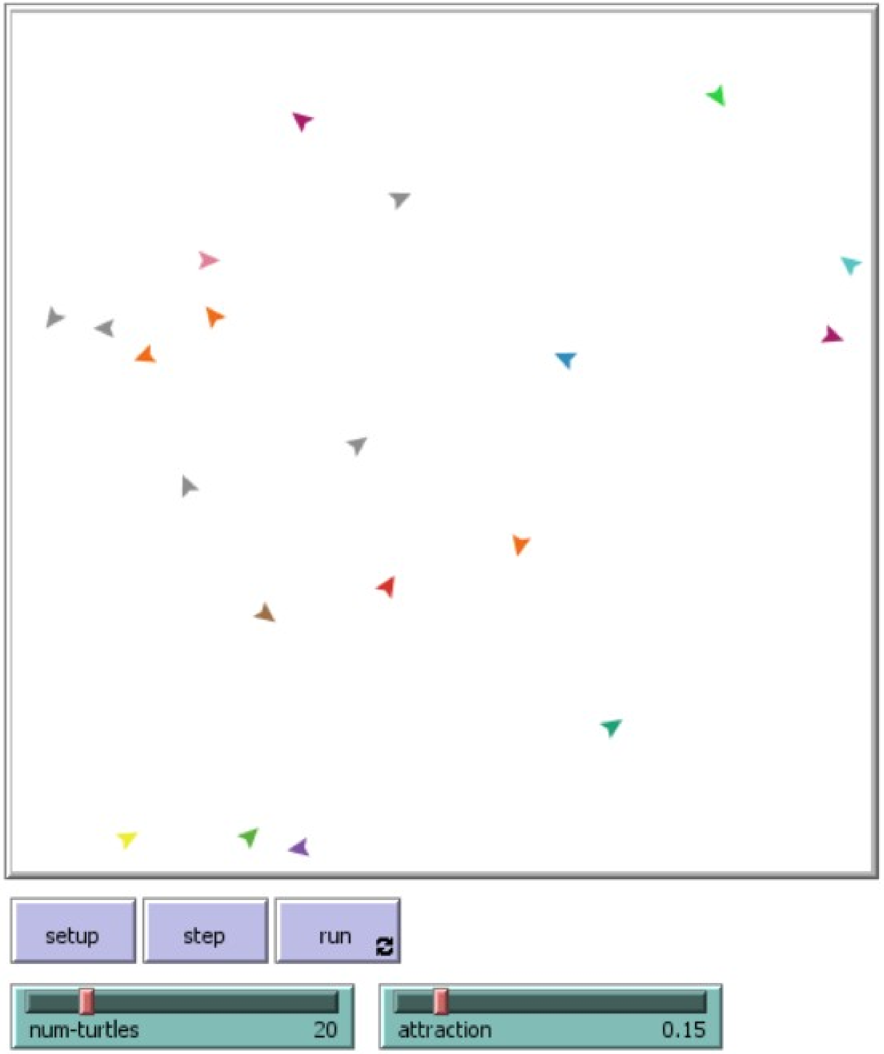
Globals: (interactive)

- max turn angle, # of turtles

```
to step
  ask turtles [
    set heading (heading + (random (2 * angle)) - angle)
    forward 1
  ]
  tick
end
```



Demo 2: a flock of birds



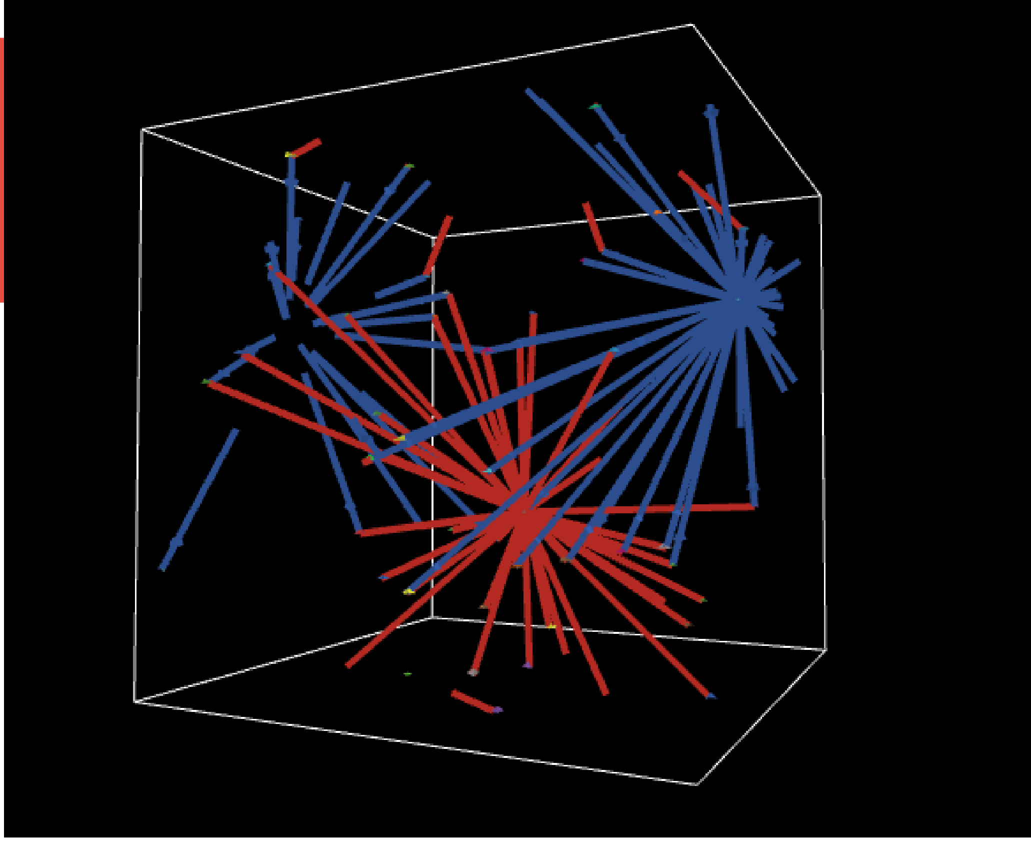
Here each turtle should:
- turn towards her nearest neighbour
- and move

Globals:
- # of turtles, attraction towards nearest

```
to-report closest-turtle
  report min-one-of (other turtles) [
      distance myself ]
end

to turn-towards [somebody]
    let difference subtract-headings heading (towards somebody)
    set heading (heading + (attraction * difference))
end
```

Demo 3: 3D links



- N turtles in random 3D position

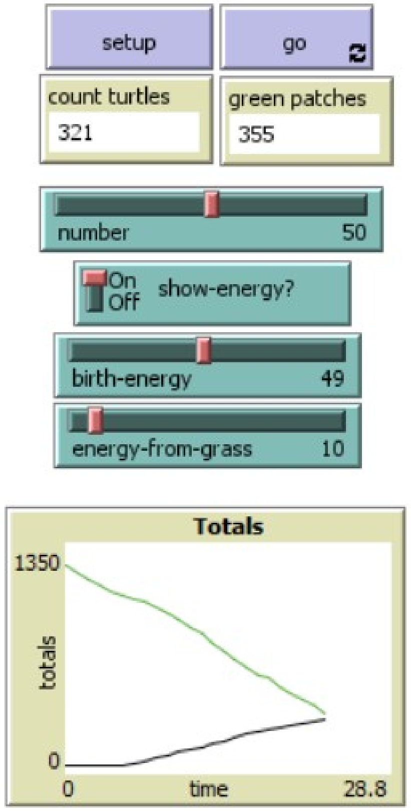
- 2 random turtles are connected to all other turtles with directed and undirected edges

- NOTICE: the world is a TORUS!

```
undirected-link-breed [ ulinks ulink ]
directed-link-breed   [ dlinks dlink ]
to setup
  clear-all
  create-turtles N [ setxyz random-xcor random-ycor random-zcor ]
  ask turtle random N
    [ create-ulinks-with other turtles [ set color red  ] ]
  ask turtle random N
    [ create-dlinks-to   other turtles [ set color blue ] ]
end
```

Demo 4: **cows on grass**

Cows:
- loose 1 energy per tick
- move at random
- eat grass gaining 10 e.
- if energy>50 spawn



count turtles 321

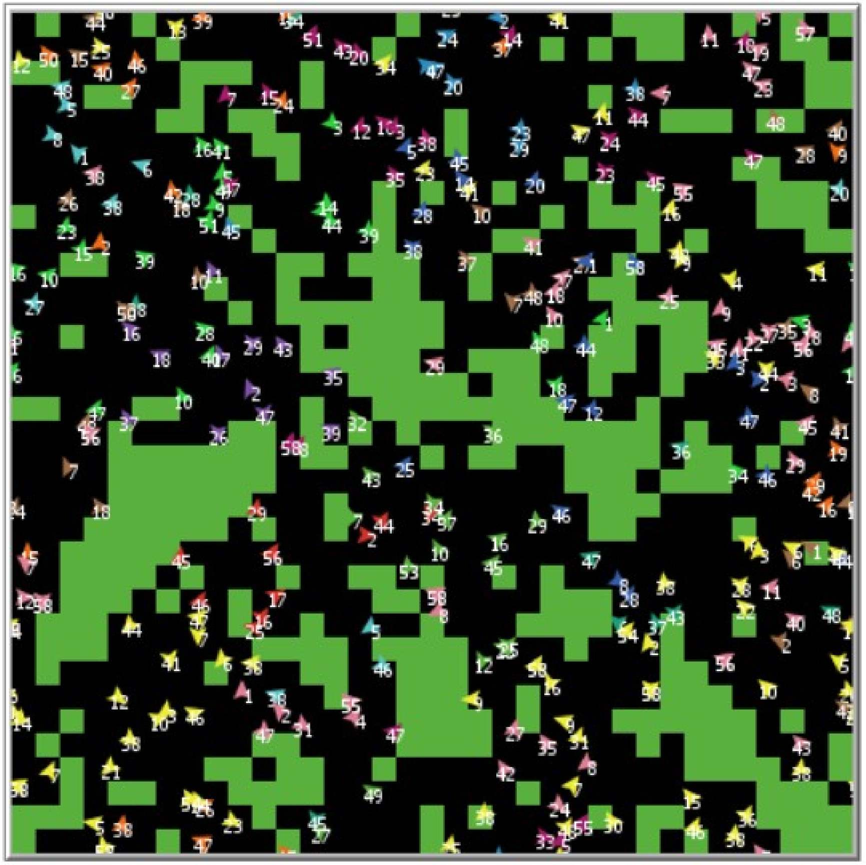
green patches 355

number 50

On Off show-energy?

birth-energy 49

energy-from-grass 10



Grass:
- new grass grows with 3% probability

Globals:
- show cow energy?, energy to give birth, energy from grass

Display:
- # of cows, # of grass patches

Demo 3: implementation …

```
breed [ cows cow ]

cows-own [energy]

… (setup removed)

to go
  if ticks >= 500 [ stop ]
  move-cows
  eat-grass
  check-death
  reproduce
  regrow-grass
  tick
end
```

```
to eat-grass
  ask cows [
    if pcolor = green [
      set pcolor black
      set energy (energy +
            energy-from-grass)
    ]
    ifelse show-energy?
      [ set label energy ]
      [ set label "" ]
  ]
end
```

… continue

```
to move-cows
  ask cows [
    right random 360
    forward 1
    set energy energy - 1
  ]
end

to reproduce
  ask cows [
    if energy > birth-energy [
      set energy energy - birth-energy
      hatch 1 [ set energy birth-energy ]
    ]
  ]
end
```

```
to check-death
  ask cows [
    if energy <= 0 [ die ]
  ]
end

to regrow-grass
  ask patches [
    if random 100 < 3 [
      set pcolor green
    ]
  ]
end
```

Extensions!!!

Arduino	GoGo boards	
CSV	Database	Profiler
Continuous f. optimiz.	Function roots	Matrix math
Modular models	Linear programming	Time series
Clustering	Freq. Distributions	Statistics
Cognitive Agents	Q-learning	Fuzzy logic
GIS	Epidemiology	Physics
Python	R	Scala
Webcam	Isometric visualization	Web

Other ideas

HubNet:	network of interacting models in the class
Modeling Commons:	cooperatively shared repository of models
Behavior Space:	hyper-parameters optimization
System Dynamics:	high-level models
Mathematica Link:	call Mathematica from Netlogo

Demo

DEMO