NetLogo

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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?)

Easy GUI construction:

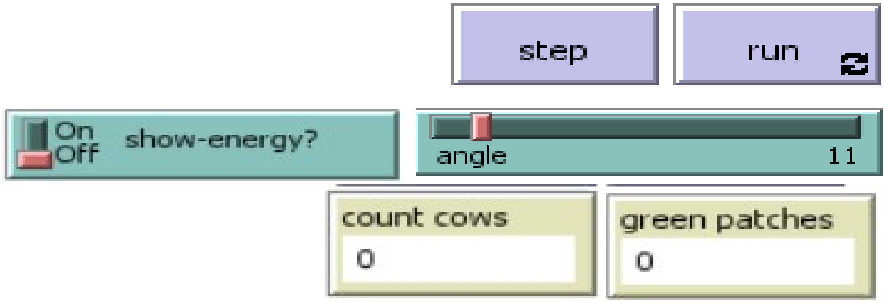
- Buttons to call functions/procedures

- Sliders to change global variables

- Labelled boxes to show values

- Plot graphs of values during simulation

- 2 NetLogo versions: 2D and 3D canvas showing turtles, patches and edges



3 type of Agents (+ custom agents)

Turtles: movable entities (with respect to the 2D or 3D canvas)

Patches: the canvas is covered by a <u>grid of unmovable squares</u> (cubes)
- e.g. the grass of a field or a pixellated volume (2 or 3 dim. MATRIX concept)

Edges: directed/undirected links between two Turtles in 3D space

Other "custom animal groups" can be easily defined:
- breed [singular plural]

<u>Separate breeds</u> can have <u>separate sets of properties</u>:
- cows-own [energy]

The Turtles' set contains all other breeds (like "object" in Java)

<u>An agent can change its breed type!</u> (set breed 'breedname')

Programming style

Single-threaded	**(BUT the order of set elements is random)**
Procedural	**(“to” for procedures)**
Functional	**(“to-report” for functions)**
Data types:	
- lists	**(immutable, untyped)**
- arrays	**(mutable, untyped)**
- list-based operations	**(map / filter / collect / ask / ...)**
- anonymous functions	**(code blocks passed as arguments)**

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**

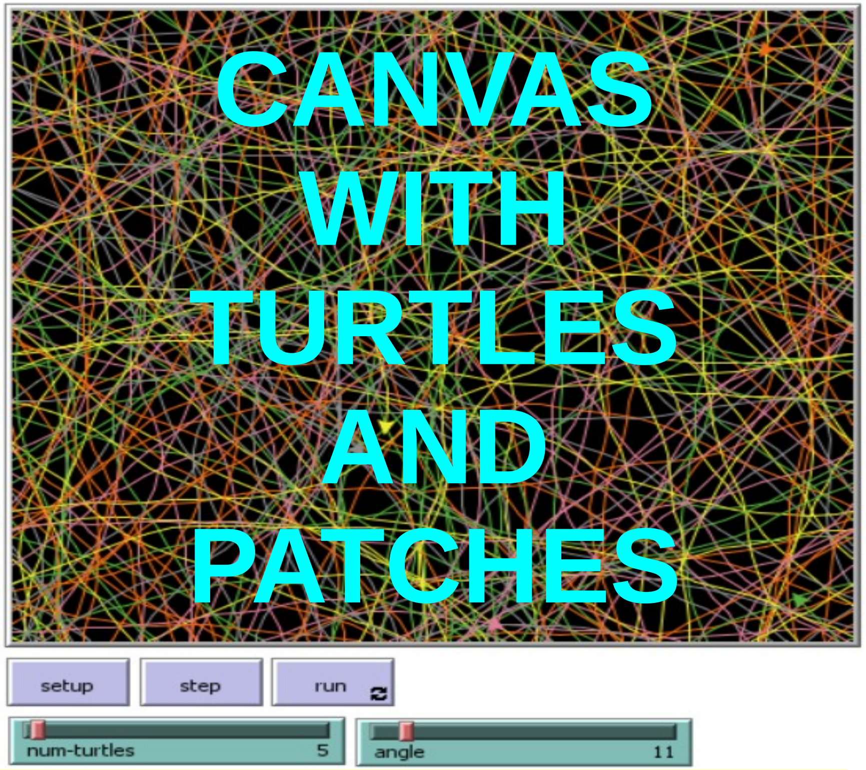
some precedence differences

Demo 1: Random walk

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

NO main loop, just use a repeating button with a single simulation "step" procedure

Globals: (interactive slider) max turn angle, # of turtles



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

This is an anonymous block executed **IN EACH TURTLE's CONTEXT!**

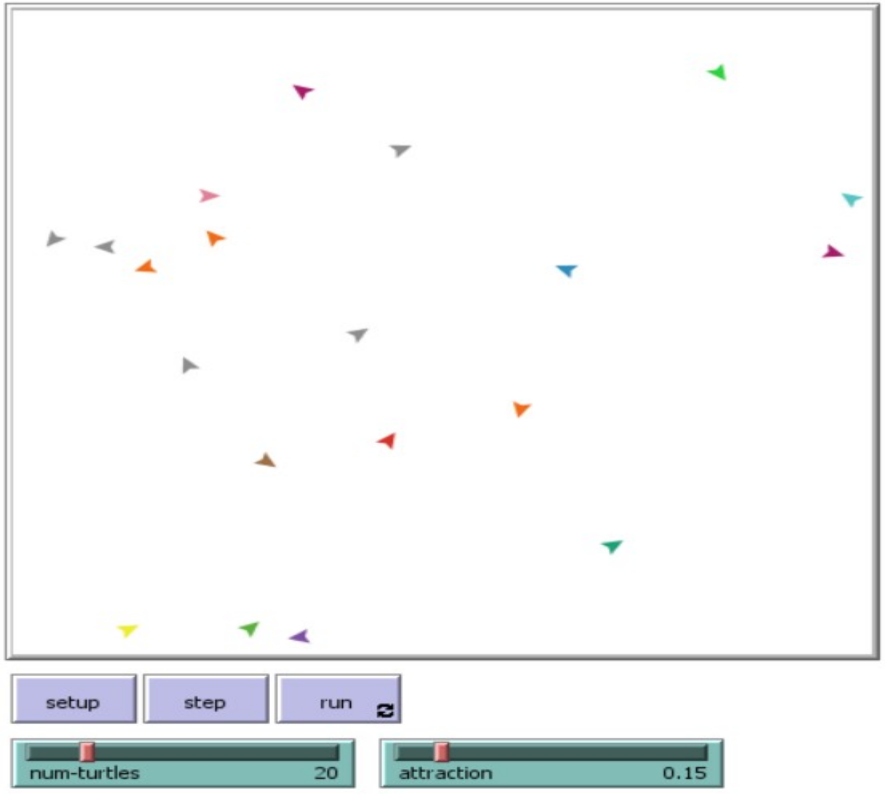
Demo 2: a flock of birds

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

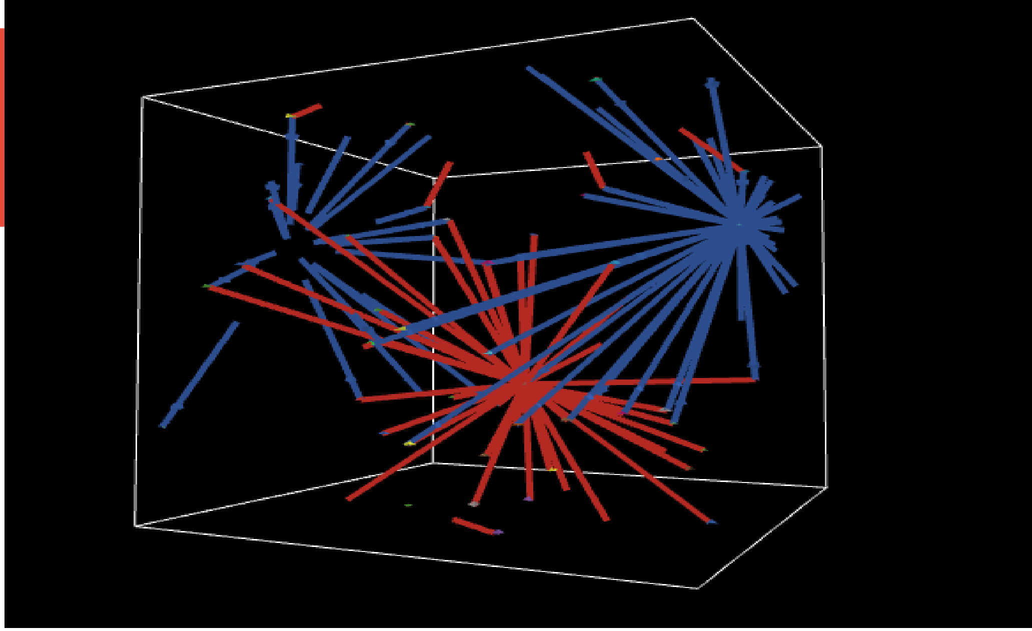
Globals:
- # of turtles, attraction force towards nearest one

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

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



Demo 3: 3D links



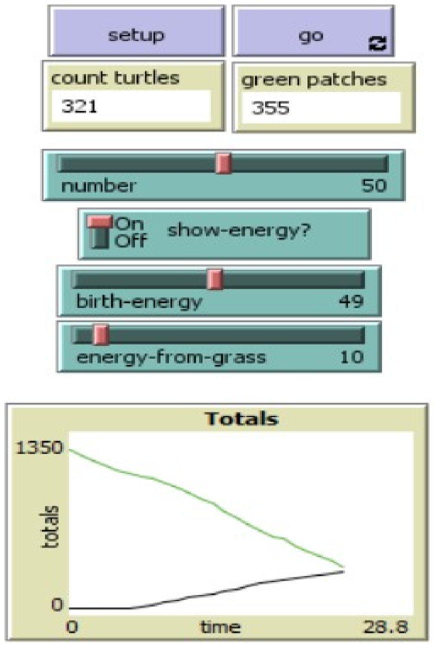
- N turtles in random 3D position

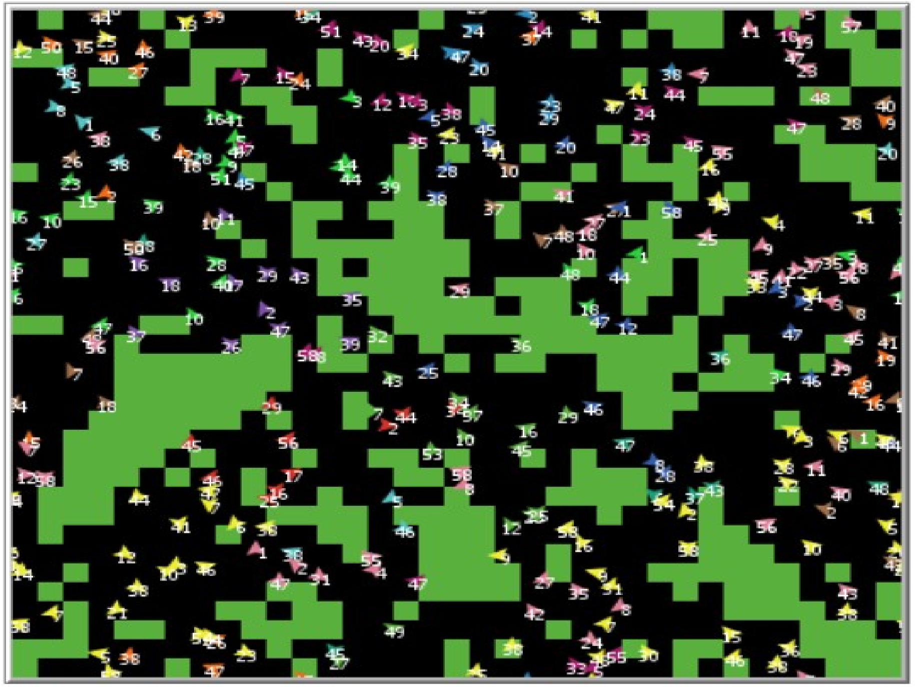
- 2 random turtles are connected to all other turtles with directed and undirected edges

- 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 energy

- if energy>50 spawn

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 4: implementation ...

```
breed [ cows cow ]          ; define cows
cows-own [energy]           ; add attribute
… (setup removed)

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

```
to eat-grass    ; eating increases energy
   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                  ; move all cows
  ask cows [
    right random 360     ; change
direction
    forward 1                  ; move
    set energy energy – 1 ; lose energy
  ]
end

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

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

to regrow-grass  ; 3% of grass regrows
    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

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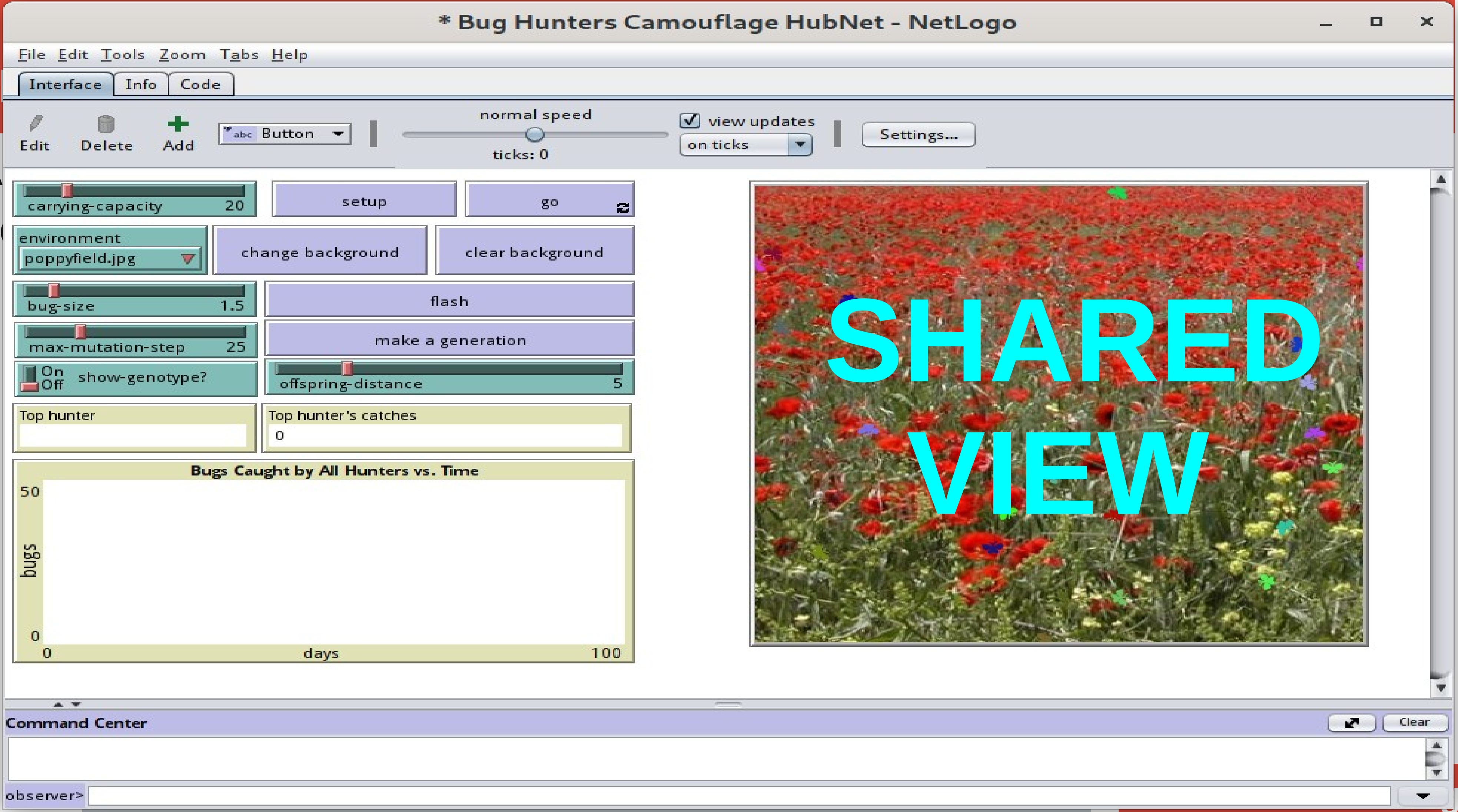


* Bug Hunters Camouflage HubNet - NetLogo

File Edit Tools Zoom Tabs Help

Interface | Info | Code

Edit | Delete | Add | Button | normal speed | ticks: 0 | ✓ view updates | on ticks | Settings...

carrying-capacity 20

setup

go

environment: poppyfield.jpg

change background

clear background

bug-size 1.5

flash

max-mutation-step 25

make a generation

On/Off show-genotype?

offspring-distance 5

Top hunter

Top hunter's catches: 0

Bugs Caught by All Hunters vs. Time (bugs 0–50; days 0–100)

Command Center | Clear

observer>

go

Client GUI

Simplified GUI edited in the main app. The main code must handle the standard messages.

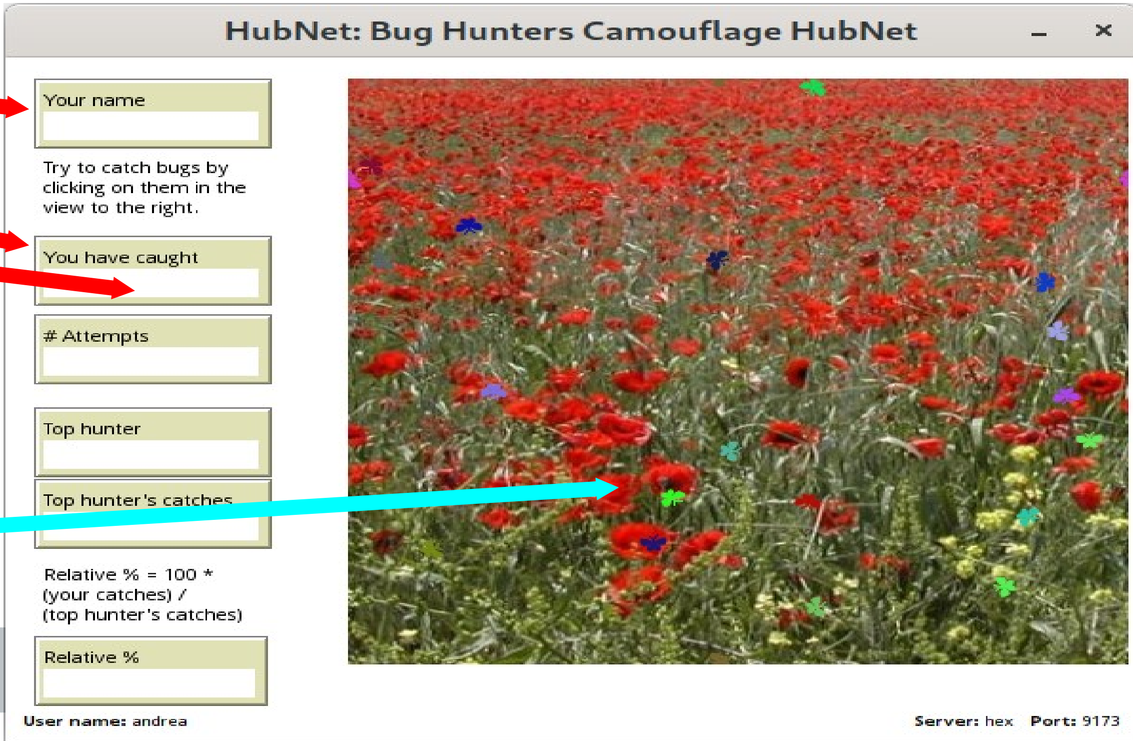
All widgets send/receive standardized messages

- **client ID**
- **widget tag**
- **widget content**

The View shows the canvas+turtles

Clicks of clients on views -> 2 messages

- **mouse down / up**
- **mouse position**


HubNet: Bug Hunters Camouflage HubNet

Your name

Try to catch bugs by clicking on them in the view to the right.

You have caught

Attempts

Top hunter

Top hunter's catches

Relative % = 100 * (your catches) / (top hunter's catches)

Relative %

User name: andrea

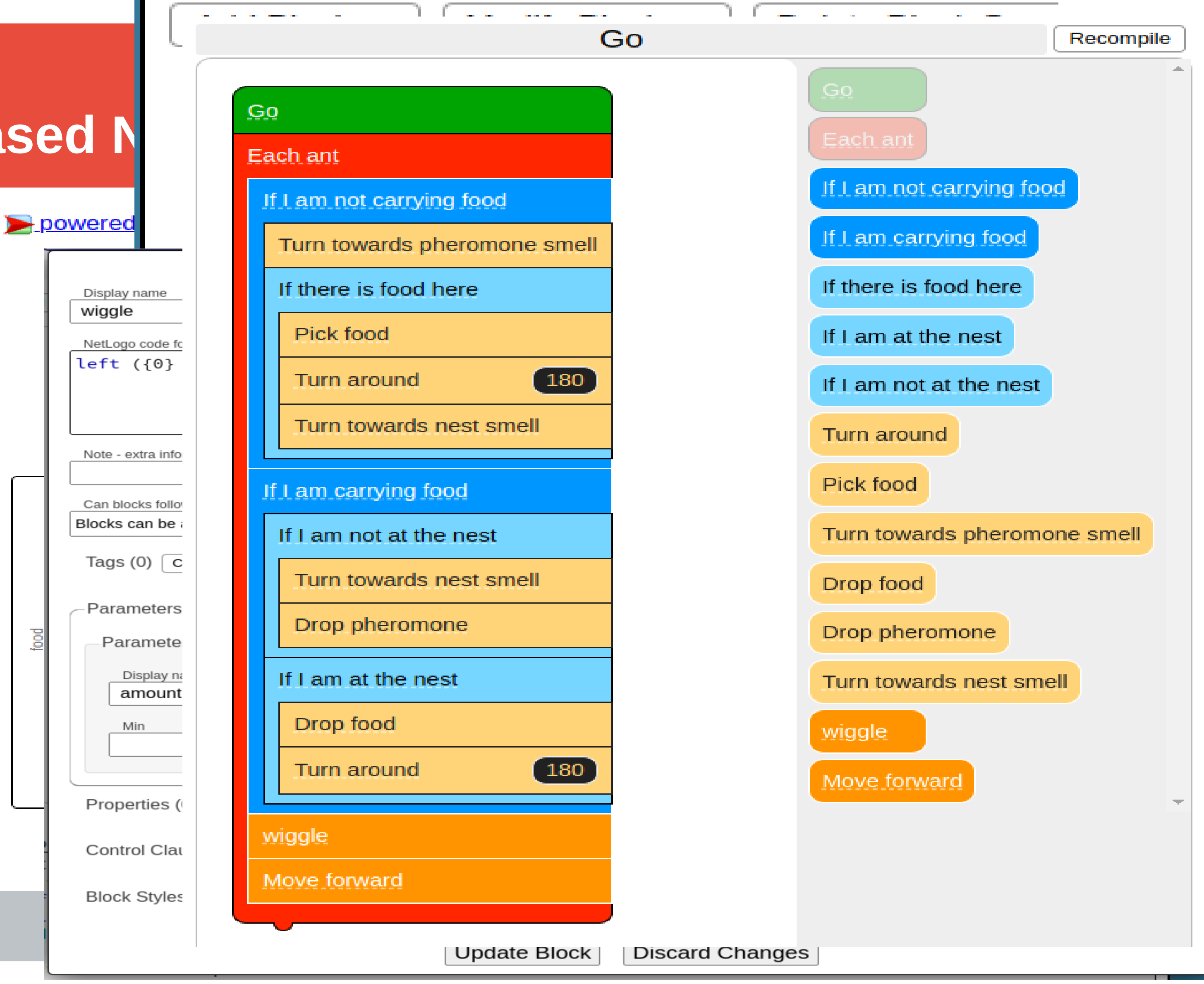
Server: hex Port: 9173

NetTango: block-based N

Web-based NetLogo editor / simulator

Define blocks containing snippets of code (macro operations)

Kid program by using your defined blocks


powered

Display name
wiggle

NetLogo code fo
```
left ({0}
```

Note - extra info

Can blocks follo
Blocks can be

Tags (0)

Parameters
Paramete
Display na
amount
Min

Properties (

Control Clau

Block Styles

Update Block
Discard Changes

Go
Recompile

```
Go
  Each ant
    If I am not carrying food
      Turn towards pheromone smell
      If there is food here
        Pick food
        Turn around 180
        Turn towards nest smell
    If I am carrying food
      If I am not at the nest
        Turn towards nest smell
        Drop pheromone
      If I am at the nest
        Drop food
        Turn around 180
    wiggle
    Move forward
```

Go
Each ant
If I am not carrying food
If I am carrying food
If there is food here
If I am at the nest
If I am not at the nest
Turn around
Pick food
Turn towards pheromone smell
Drop food
Drop pheromone
Turn towards nest smell
wiggle
Move forward

Other ideas

Modeling Commons:	cooperatively shared repository of models
Behavior Space:	hyper-parameters optimization over many model runs
System Dynamics:	high-level modeling (instead than agent-based) with evolution of global measures (e.g. #of sheeps vs # of wolves)
Mathematica Link:	call Mathematica from Netlogo

Demo

DEMO