# A Hands-on IODA Tutorial

## Interaction-Oriented Simulation within NetLogo

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# Outline of the tutorial

1. The Interaction-Oriented Approach (IODA)
2. The IODA extension for NetLogo
3. Let's code !

— I —

# The Interaction-Oriented approach (IODA)

# Limitation of classical MABS approaches

- excessive focus on individuals
  - strong dependencies agents/behaviors
  - make model revisions difficult
- alternative: separation declarative/procedural :
  - simplifies expertise acquisition
  - enhanced model intelligibility
  - increased reutilisability
  - homogeneity of the concepts

# The notion of interaction

**behavior = abstract description + modalities**

**abstract description** :

conditions/actions rules = interactions

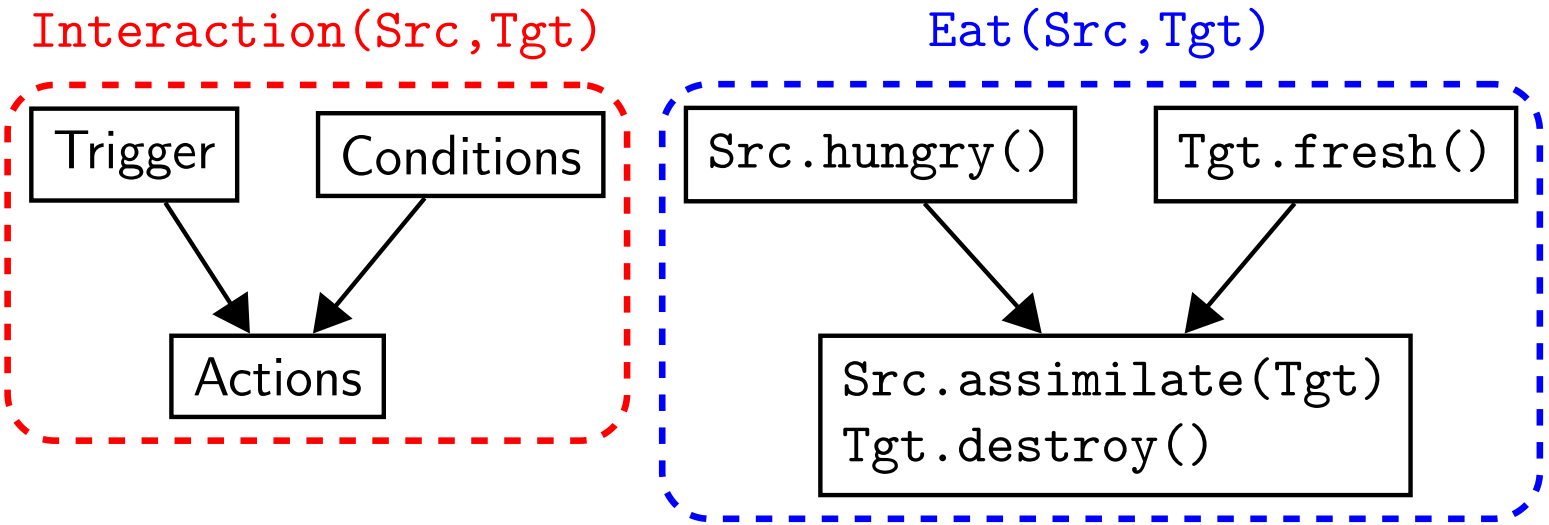
rely upon generic perception/action capabilities (**primitives**)

\+ **execution modalities** :

variability in the primitives,

depending on agent families

# Structure of an interaction




**Trigger:** motivations/goals for doing the actions

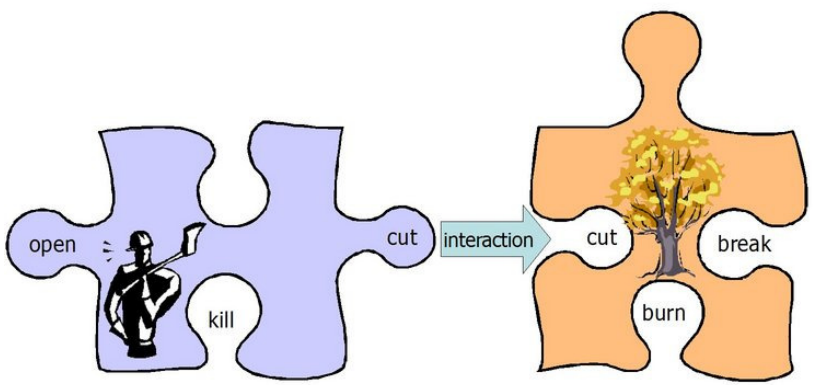
**Conditions:** prerequisite that allow the realization of the actions

**Actions:** list of the actions to perform

# The interaction-oriented approach

## 3 key ideas

- each relevant entity is an agent
  = entity with **perception** and **action** capabilities
- each behavior is an interaction
  = **conditions/actions rule** involving several agents
- a generic engine determines what interactions may occur



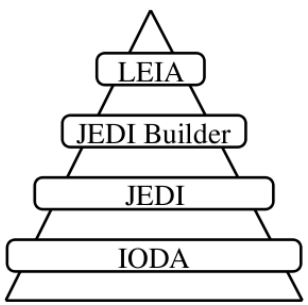

agents characterized by their capability to **perform** (source) or **undergo** (target) an interaction

[Mathieu & *al.* 2001]

# The IODA approach

separation between declarative/procedural parts:

- automatization of model implementation and of simulations analysis
- elicitation of simulation biases [Kubera & *al.* 2008]




**IODA** Interaction-Oriented Design of Agent simulations
**methodology and modelling frame**

**JEDI** Java Environment for the Design of agent Interactions
**highly tunable platform**
[Kubera & *al.* 2011]

**JEDI-Builder** Code generator
**IODA model → JEDI simulation**

**LEIA** LEIA lets you Explore Interactions for your Agents
**Explorer for the simulation space**
[Gaillard & *al.* 2010]

# Interaction and update matrices

| Sources \ Targets | ∅ | Trees | Grass | Sheep | Goats | Wolves |
|---|---|---|---|---|---|---|
| Trees | | | | | | |
| Grass | Grow (0)<br>Spread (1) | | | | | |
| Sheep | Die (3)<br>Wander (0) | | Eat (2; 0) | Mate (1; 0) | | |
| Goats | Die (4)<br>Wander (0) | Climb (3; 1) | Eat (2; 0) | | Mate (1; 0) | |
| Wolves | Die (4)<br>Wander (0) | | | Eat (3; 1) | Eat (2; 1) | Mate (1; 0) |

| | UPDATE |
|---|---|
| Trees | |
| Grass | |
| Sheep | Age (2)<br>BecomeSick (1) |
| Goats | Age (2)<br>BecomeSick (1) |
| Wolves | Age (1) |

- synthetic view of all behaviors
- actions resulting from decisions vs. spontaneous state changes

# An homogeneous handling of entities

- each relevant entity is an agent
- the actitivy of agents is characterized dynamically:

  **active agent:** acts upon the others
  = no-empty line in the interaction matrix

  **passive agent:** undergoes actions from other entities
  = non-empty column in the interaction matrix

  **labile agent:** spontaneous state change
  = non-empty line in the update matrix

- optimization of the simulation engine

[Kubera *& al.* 2010]

# "Reactive" IODA engine

during a time step:

1. **Update:** each **labile** agent performs the realizable interactions from the update matrix

2. **Interaction selection:** each **active** agent
   1. perceives neighbors (among the passive agents)
   2. filters targets of interactions that it can perform
      i.e. agents which *can undergo* those interactions
   3. evaluates the triggers and conditions of those interactions
   4. selects one realizable interaction with the highest priority level
   5. performs the corresponding actions

— II —

# The IODA extension for NetLogo

# Overview

The principles and algorithms of IODA can be implemented on any platform

within NetLogo:

- Java extension $\longrightarrow$ required data structures
  + file reading functions
  + consistency checking / primitives to write
- NetLogo include file $\longrightarrow$ reactive simulation engine

# Features

- agent families = `turtles`, *`breeds`* or `patches`
- target selection policies
- consistency checking
- easy tuning of perception
- physical/social environnements (`links`)

`http://www.lifl.fr/SMAC/projects/ioda/ioda_for_netlogo/`

# Principles

a **IODA NetLogo** simulation =

- classical NetLogo program using the extension
  + definition of the concrete primitives
  for each agents family
- definition of the interactions in a text file
- definition of the interaction and update matrices in a text file
- delegation of the scheduling to a dedicated procedure `ioda:go`

# Example (1) – behaviors

- inspired by the classical `Termites` model in the NetLogo library
- everything is an agent: termites + wood chips

| Source \ Target | ∅ | chips | termites |
|---|---|---|---|
| chips | | | |
| termites | (MoveRandomly, 0) | (MoveRandomly, 10, 1)<br>(PutDown, 20, 0.3)<br>(PickUp, 30, 1) | |

# Example (2) – NetLogo template

```
__includes ["../../IODA_2_2.nls"]
extensions [ioda]

breed [ termites termite ]
breed [ chips chip ]
termites-own [ carrying? ]

to setup
  clear-all
  create-termites nb-termites [ init-termite ]
  create-chips nb-chips [ init-chip ]
  ioda:load-interactions "interactions.txt"
  ioda:load-matrices "matrix.txt" " \t"
  ioda:setup
  reset-ticks
end

to go
  ioda:go
  tick
end
```

# Example (3) - matrices

- defined in a CSV file (arbitrary separators)
- here: a file "matrix.txt"

```
;source      interaction     priority   target   distance
termites     MoveRandomly    0
termites     MoveRandomly    10      chips  1
termites     PutDown         20      chips  0.3
termites     PickUp          30      chips  1
```

# Example (4) – interactions

defined in a text file (here: `"interactions.txt"`)

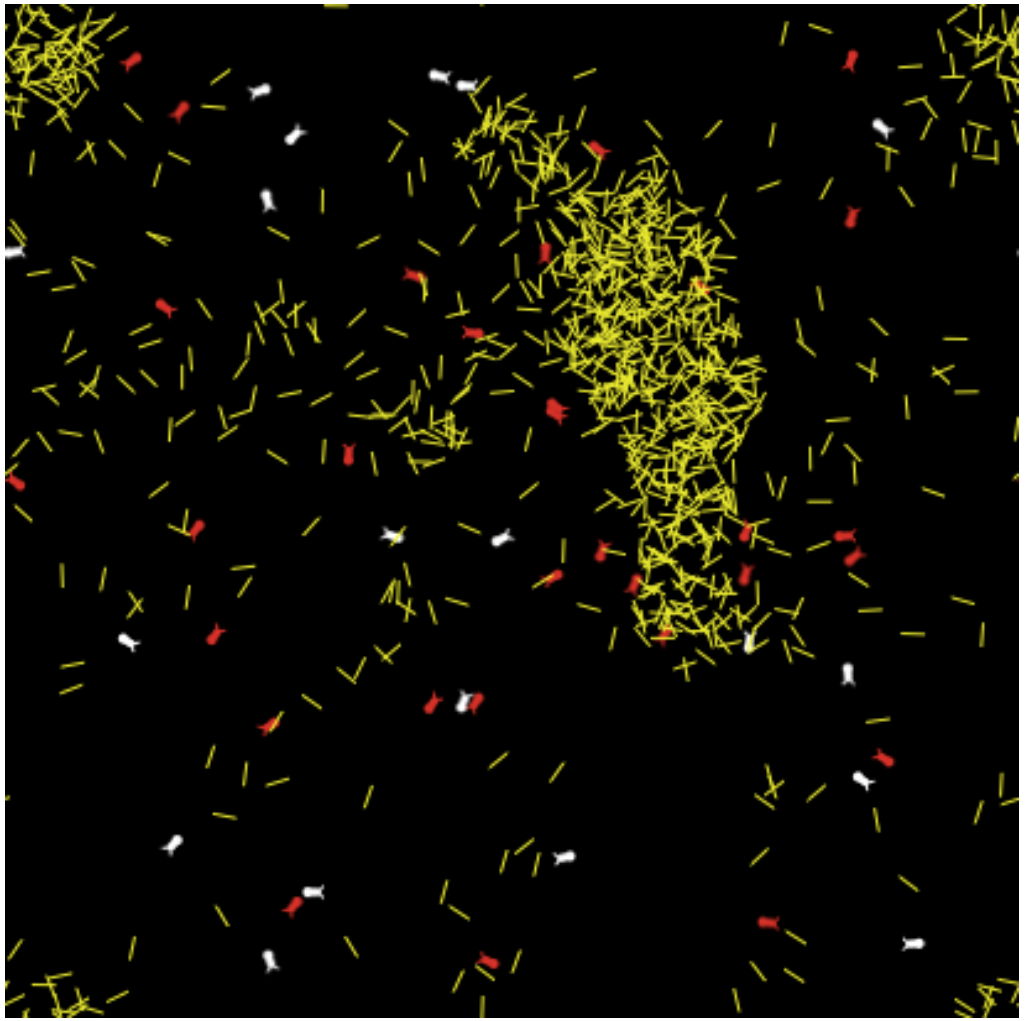
```
interaction MoveRandomly
  actions    wiggle
end

interaction PickUp
  condition           not-carrying?
  actions             take-load get-away
end

interaction PutDown
  condition           carrying?
  actions             drop-load random-turn get-away
end
```

# Example (5) – primitives

```
to-report termites::not-carrying?
  report not carrying?
end
to-report termites::carrying?
  report carrying?
end
to termites::filter-neighbors
  ioda:filter-neighbors-in-radius 1
end
to termites::take-load
  set carrying? true
  ask ioda:my-target [ioda:die]
end
to termites::wiggle
  left random 50 right random 50 fd 1
end
to termites::drop-load
  set carrying? false
  hatch-chips 1 [init-chip]
end
to termites::get-away
  fd 20
end
to termites::random-turn
  right random 360
end
```

- each abstract primitive must be concretely defined for the agents family that are likely to use it
- `filter-neighbors` primitive for handling the perception of neighbors
- predefined primitives e.g. `ioda:die`

# Example (6) – outcome



— III —

# Let's code!

# Using the extension

http://www.lifl.fr/SMAC/projects/ioda/SSC2014