Informatique et systèmes
de communication ISC
Haute Ecole d'Ingénierie
Hochschule für Ingenieurwissenschaften

205.1 Functional programming & CompPhy crossover

# Final project

## Modelling collective physical phenomena with actor-based simulations

Rev 1.00

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# Your mission:

You have been commissioned to help the government understand and simulate complex societal challenges:

**Case 1** 🦠 : The Federal Office for Health requires an analysis of how epidemic control measures are adopted by the population. They are particularly interested in understanding whether clusters of non-compliant behavior can form and persist.

**Case 2** 🌲 : The Federal Office for the Environment wants to assess how climate change may influence the frequency and severity of forest fires.

You will help your client gain an understanding of these complex phenomena through agent-based computer simulations.

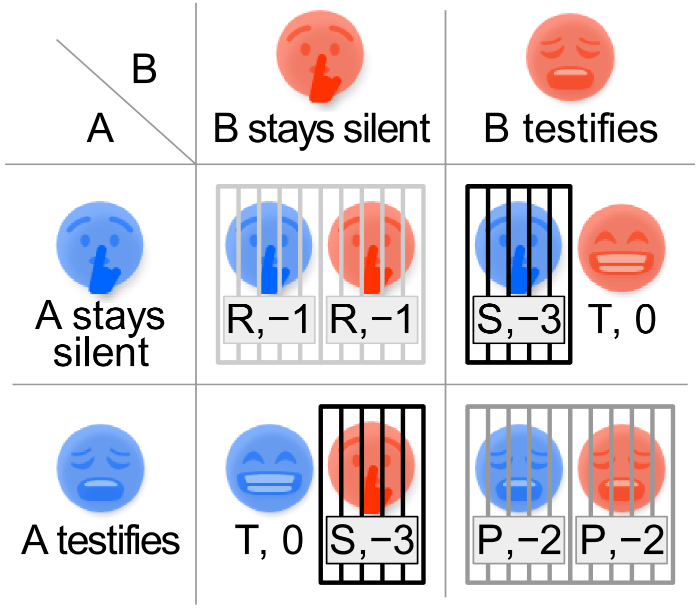
# Project 1 🦠 : Adoption of Rules in Societies

**Understand how collective behaviors spread in societies**

- finite-size actors in a continuous world
- include prisoner-dilemma interactions (in a neighborhood)
- model strategies and conversions
- add actor mobility (random walks, diffusion, ….)
- study influence of world and actor's geometry

# Project 1 🦠 : Resources

**Social behaviour can be modelled by (iterated) prisoner's dilemma**




- Article on diffusive prisoner's dilemma

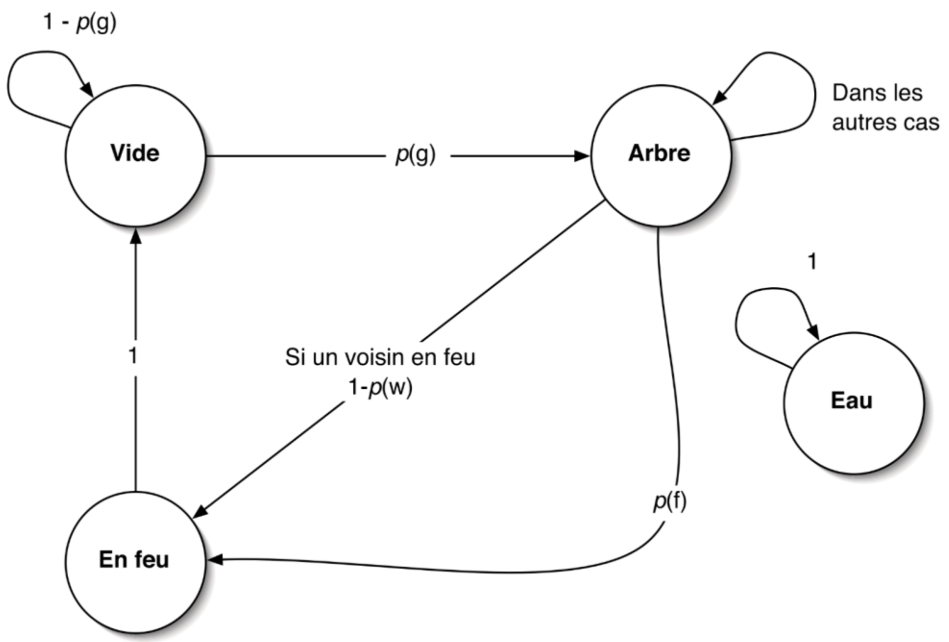
# Project 2 🌲 : Dynamics of Forest Fires

**Understand how fires spread / how they can be contained**

- grid-world
- include different types of cells
- add transition dynamics (and ignition factors)
- add external drivers

# Project 2 🌲 : Resources

## Forest fires can be modelled by cellular automata




Avec :
g = probabilité de générer un arbre
f = probabilité de prendre feu spontanément
w = probabilité de *watering*

A possible cellular automata for forest fire simulation

# Objectives

Model
Simulate
Visualize
Interpret

- simulate complex processes driven by simple actor-based dynamics
- identify macroscopic variables of interest
- model phases transitions
- study driving factors and interpret them

Focus on presentation of key results and conclusions.

# In practice, you must… For CompPhy2

- be able to **explain your modeling approach**, including:
  - assumptions you made
  - parametrizations you used
  - processes and equations governing the problem
- propose and **implement an extension** of the problem (new process, …)
- **interpret** the numerical results
- identify a **phase-transition**-like behaviour
- choose salient indicators to **visualize the states** of the system and its transitions (phase diagrams)

# In practice, you must... For `FuncProg`

- Explain your **implementation design** and how it relates to your modelling assumptions
- Model of time, local and global state, concurrency
- Demonstrate (2 examples) how you used specific **functional programming constructs**

# 2. CONSTRAINTS

# Code constraints

- use `sbt` as a complete build tool
- use Scala (with `vars` if really needed)
  - visualizations can (should) be done outside Scala
- be hosted on `github`
  - with access rights for `pmudry` and `cedrictravelletti`
  - with a `readme.me` with instructions
  - screenshots and 15 seconds video 1080p60

# 3. GRADING

# Grading

- Individual assessment , June 18th
  - Oral exam, 20'
    - 10' presentation
      - Final project demo (2 min)
      - Physical model (6 min)
      - Implementation model (2 min)
    - 10' questions
- Gives a mark for *Computational Physics 2*
- Influcences the mark of *Functional programming* +/- 0.5
  - Hand-in, June 16th 19h.