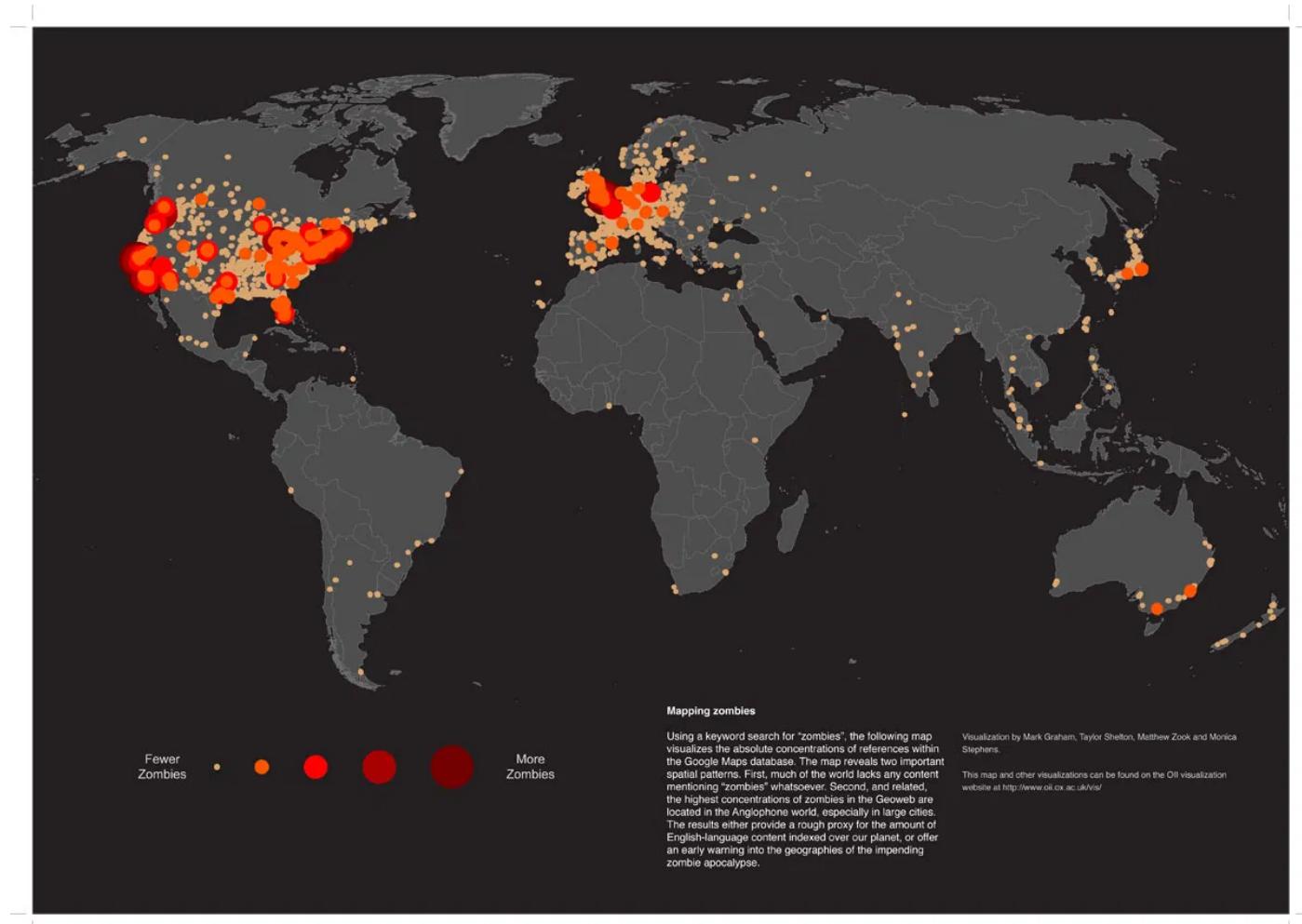


OpenMOLE an essential software to face Zombie outbreaks



22/11/2021
Romain Reuillon

Zombies infections



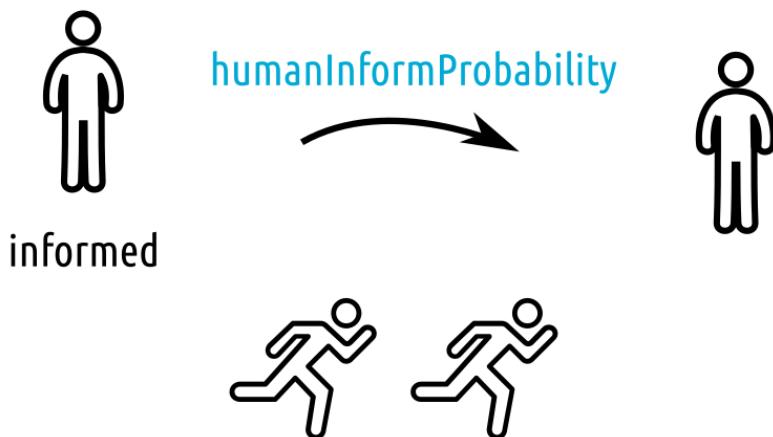
A Zombie model

<https://zombieland.openmole.org/>

Human communication is unknown

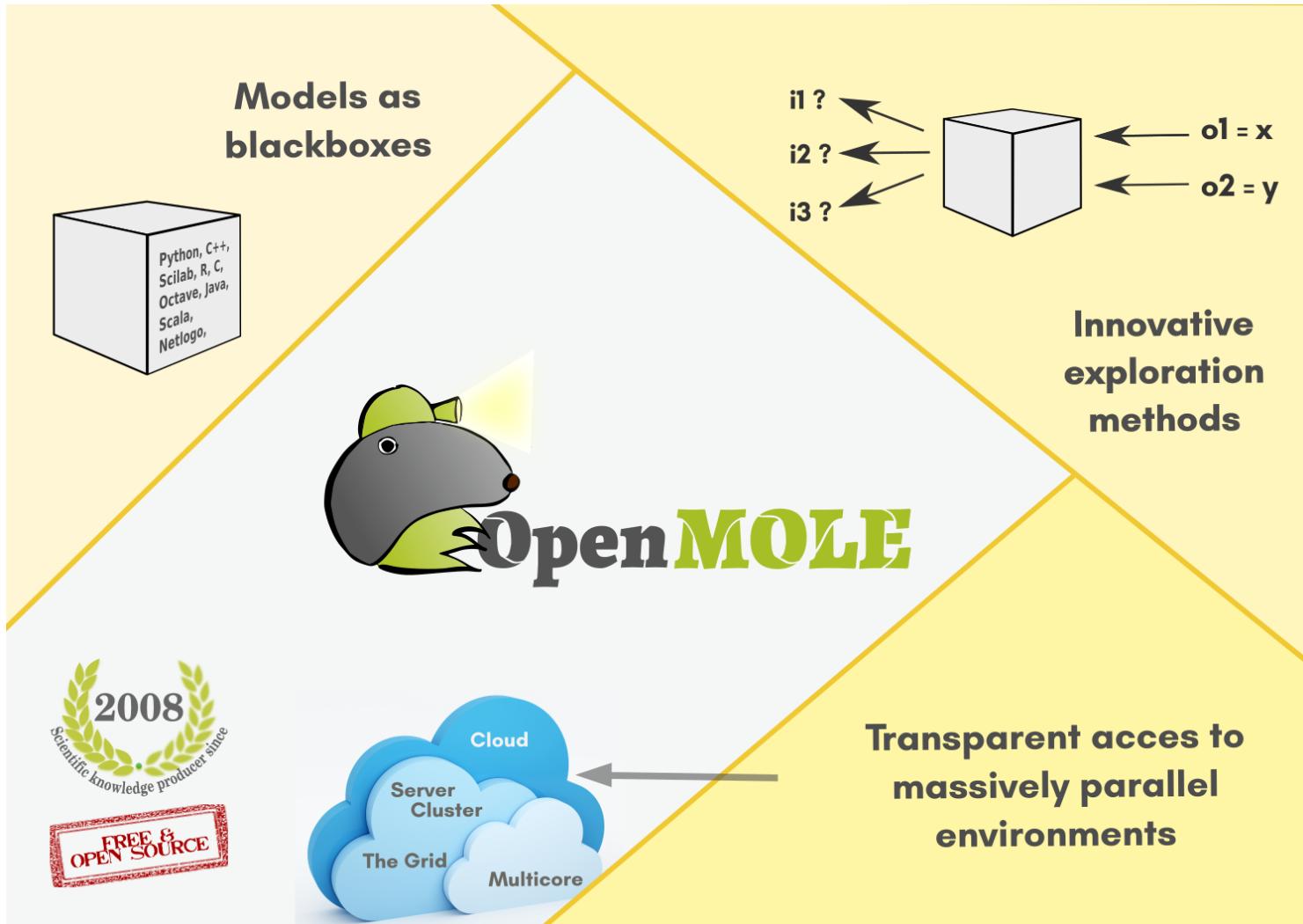
During a simulation, the humans can communicate about the *location of rescue zones*. Zombies do not communicate.

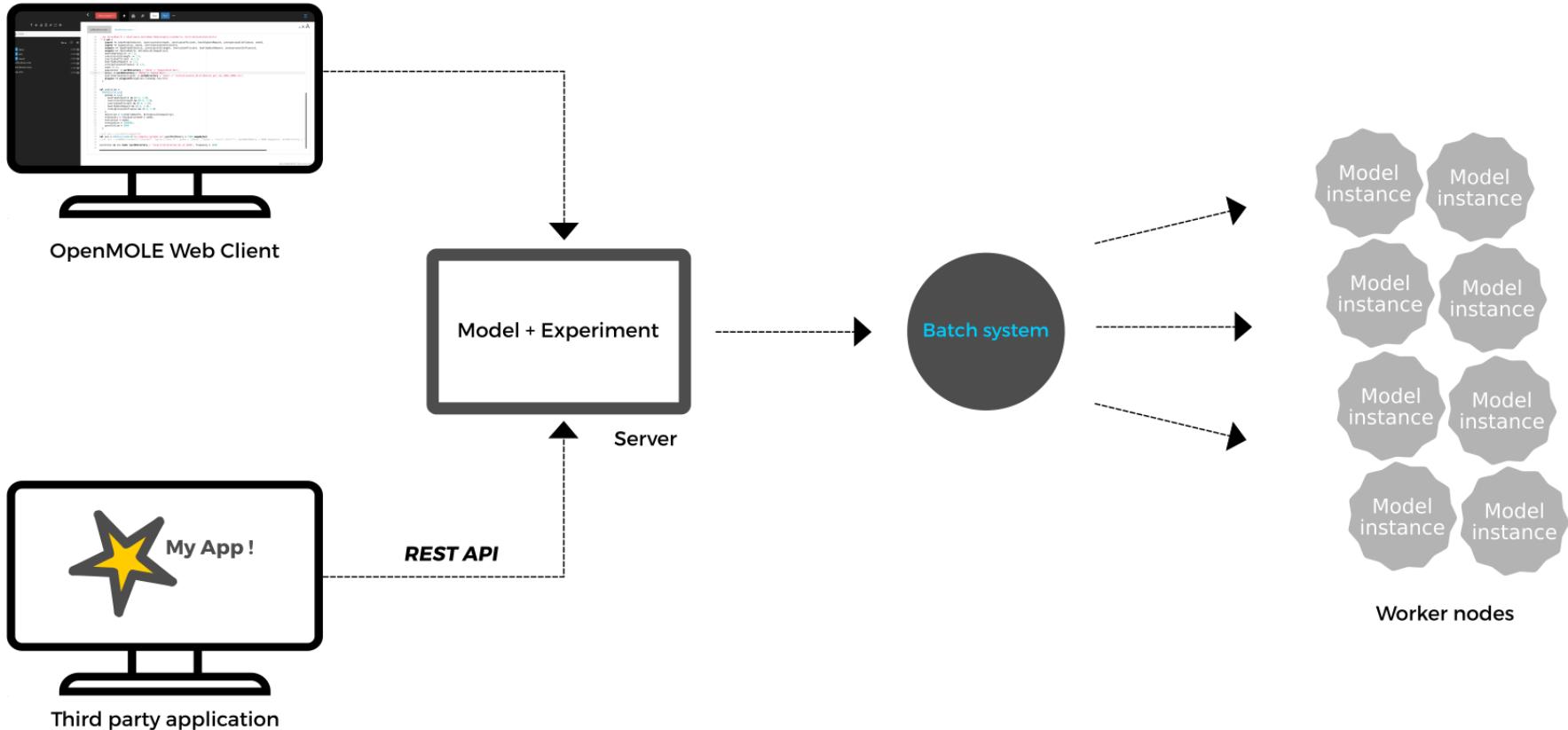
At the begining of the simulation, `informedRatio` of the human population is informed.



Humans can follow a running human with
a `humanFollowPobability`

OpenMOLE to the rescue





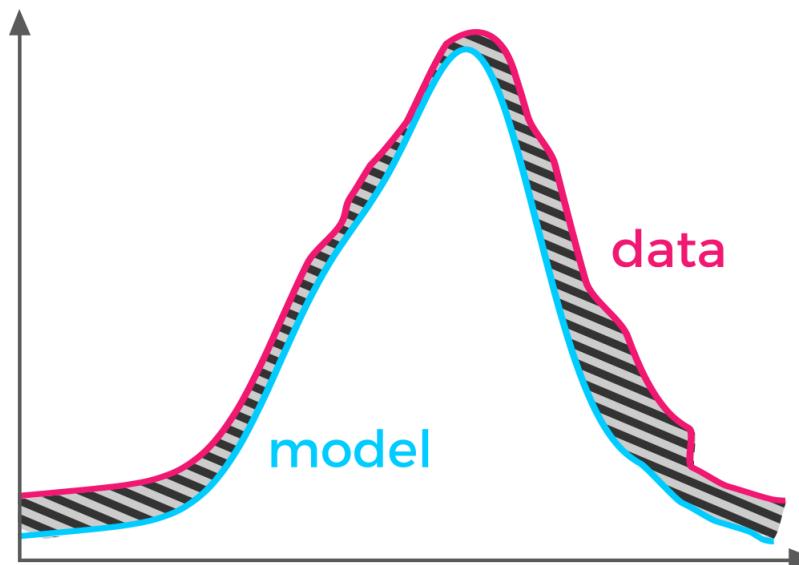
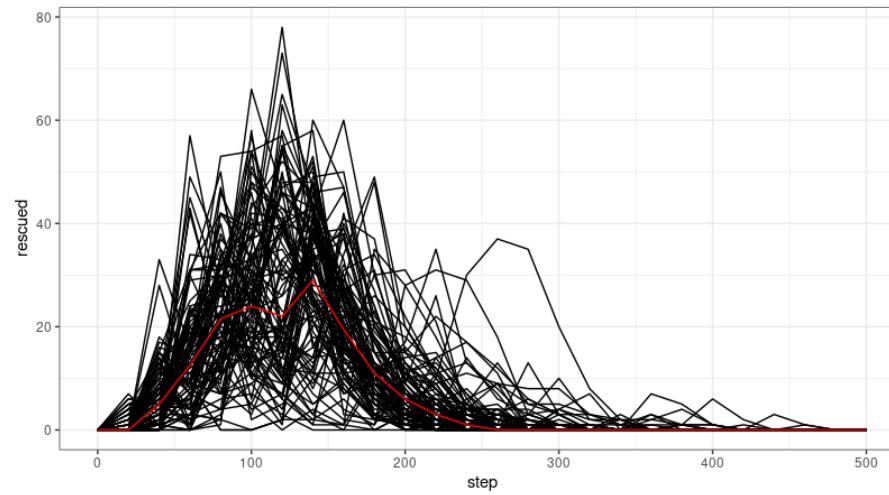
OpenMOLE for real

The screenshot shows the OpenMOLE web interface at localhost:46857/app. The interface has a dark theme with a top navigation bar containing various project links and a search bar. Below the navigation is a toolbar with buttons for 'New project', 'Test', and 'Run'. The main area is a code editor with tabs for several files: 'vigilence.oms' (active), 'model.oms', 'replication.oms', 'calibrate_median.oms', and 'population700.csv'. The code editor displays the following Scala code:

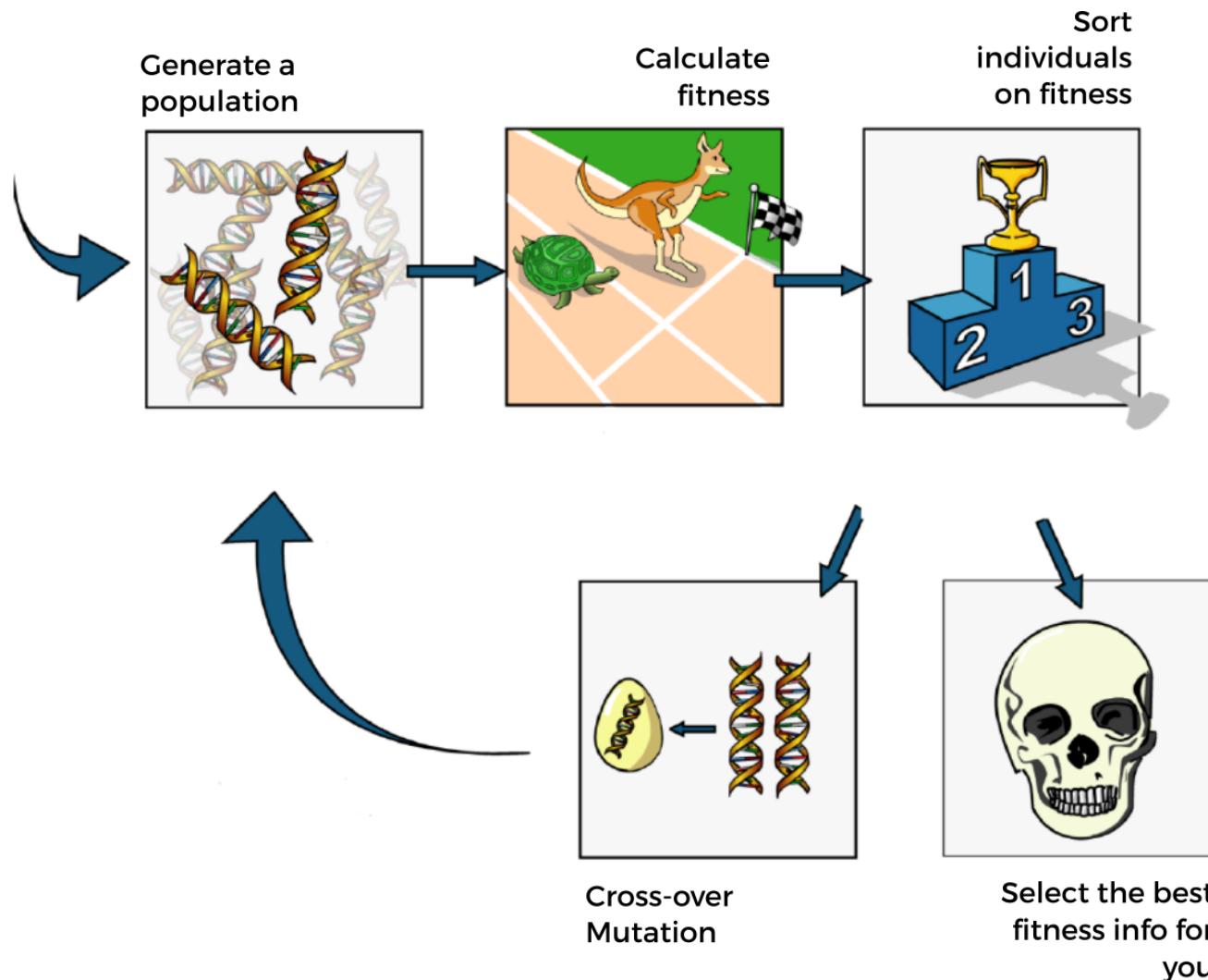
```
1 import zombies._  
2  
3 // Model inputs  
4 val humanFollowProbability = Val[Double]  
5 val humanInformedRatio = Val[Double]  
6 val humanInformProbability = Val[Double]  
7  
8 val seed = Val[Long]  
9  
10 // Model outputs  
11 val totalRescued = Val[Int]  
12 val halfRescued = Val[Int]  
13 val rescuedDynamic = Val[Array[Int]]  
14  
15 val model =  
16   ScalaTask("""|  
17     import zombies._  
18  
19     val rng = Random(seed)  
20  
21     val result = zombieInvasion(  
22       humanFollowProbability = humanFollowProbability,  
23       humanInformedRatio = humanInformedRatio,  
24       humanInformProbability = humanInformProbability,  
25       zombies = 4,  
26       humans = 250,  
27       steps = 500,  
28       random = rng)  
29  
30     val totalRescued = result.totalRescued  
31     val halfRescued = result.halfRescued  
32     val rescuedDynamic = result.rescuedDynamic()  
33     """") set (  
34       inputs += (seed, humanFollowProbability, humanInformedRatio, humanInformProbability),  
35       outputs += (rescuedDynamic, halfRescued, totalRescued),  
36     )
```

The sidebar on the left lists other projects: army, coop, helene, netlogo, redcross, results, results_test, trap, vigilence, calibrate.oms, explore.oms, model.oms, and replicate.oms. The bottom right corner shows the build information: 10.0-SNAPSHOT P... P... built the 11/10/2019 18:13:47.

Calibration



Seek for the fittest parameter sets



Some OpenMOLE code

```
NSGA2Evolution(
  evaluation = model,
  genome = Seq(
    humanInformedRatio in (0.0, 1.0),
    humanInformProbability in (0.0, 1.0),
    humanFollowProbability in (0.0, 1.0)
  ),
  objective = Seq(rescuedDynamic aggregate distanceMedian),
  stochastic = Stochastic(seed = mySeed, sample = 100),
  ...
)
```

Result

The screenshot shows the OpenMole web application interface. At the top, there is a navigation bar with various links and a search bar containing the text "add admin gitlab". Below the navigation bar, a header bar includes a "New project" button, a lightning bolt icon, a lock icon, and a speaker icon. On the left side, there is a sidebar with icons for calibration and distance, and a list of CSV files with their creation dates and edit icons. The main content area displays a table for "population13000.csv". The table has columns: "evolution\$generation", "humanInformedRatio", "humanInformProbability", "humanFollowProbability", "rescuedDynamic", and "evolution\$samples". A single row is shown with values: 13000, 0.08806635922765362, 0.09248903420070739, 0.17051186535157378, 4.5, and 100. There are also "First 100", "Last 100", and "All" buttons above the table. At the bottom right, there is some build information: "10.0-SNAPSHOT P... P...", "built the 11/10/2019 10:25:50", and a "gitlab" link.

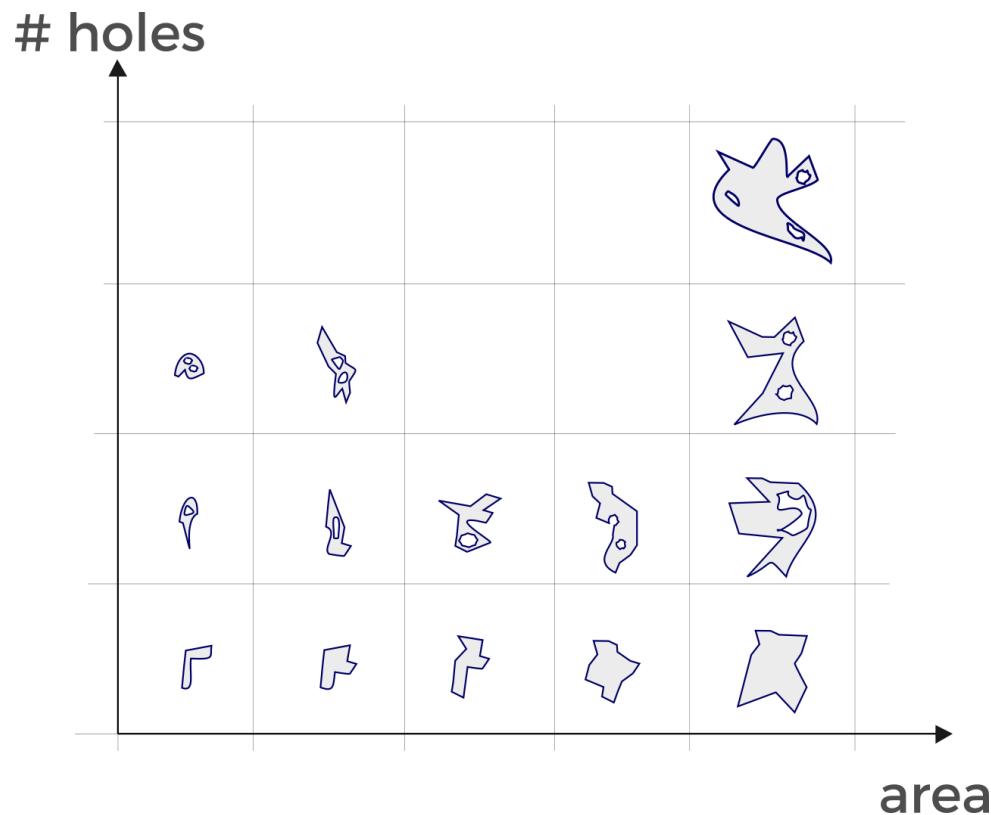
evolution\$generation	humanInformedRatio	humanInformProbability	humanFollowProbability	rescuedDynamic	evolution\$samples
13000	0.08806635922765362	0.09248903420070739	0.17051186535157378	4.5	100

10.0-SNAPSHOT P... P...
built the 11/10/2019 10:25:50
[gitlab](#)

PSE: seek for diversity

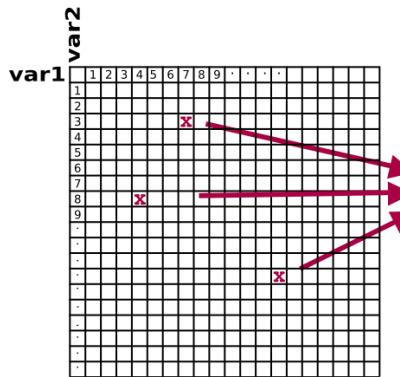


Deversity metrics

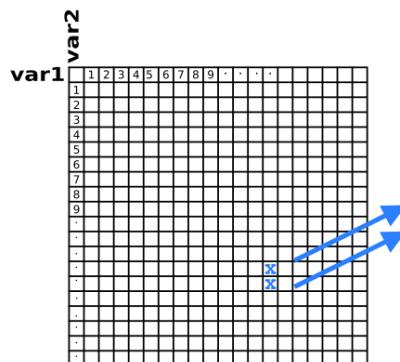


Sampling for diversity search

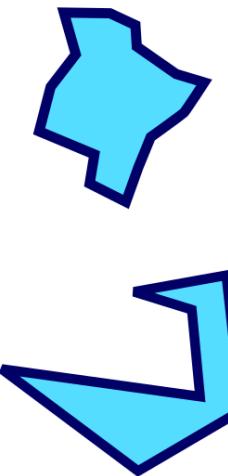
Very different inputs
can produce a similar
output pattern



Model

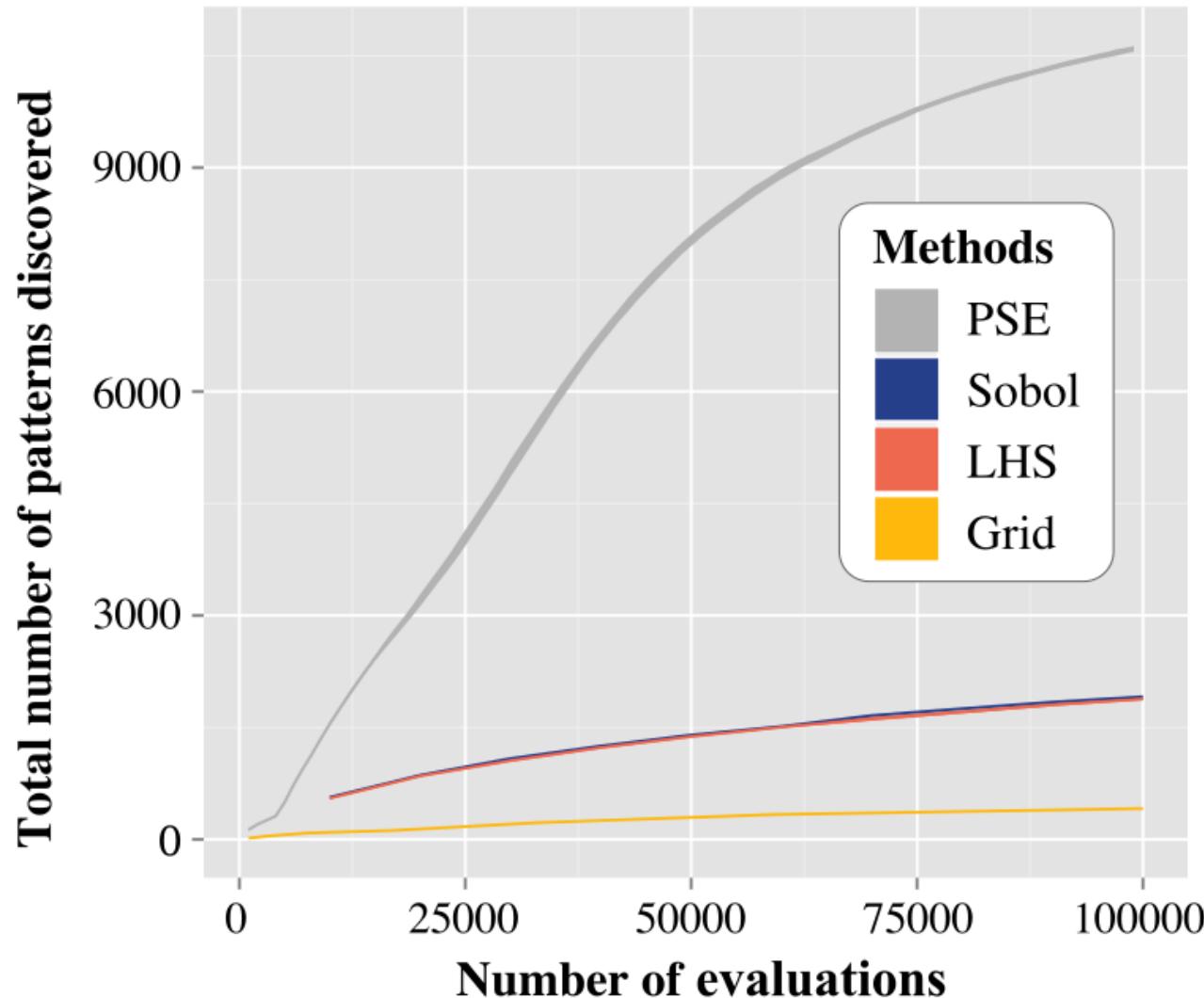


Model



Very close inputs can
produce very different
output patterns

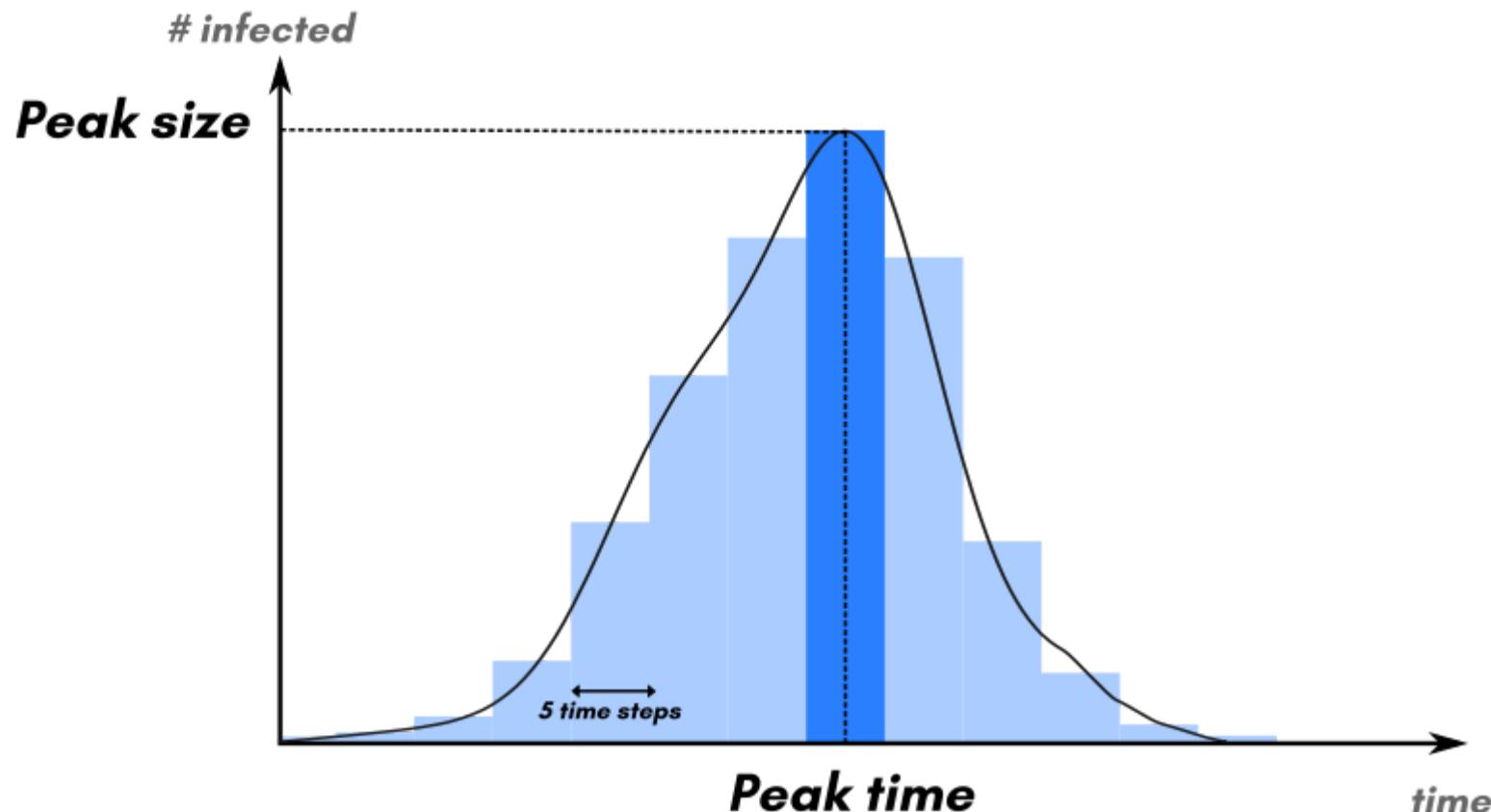
PSE performances



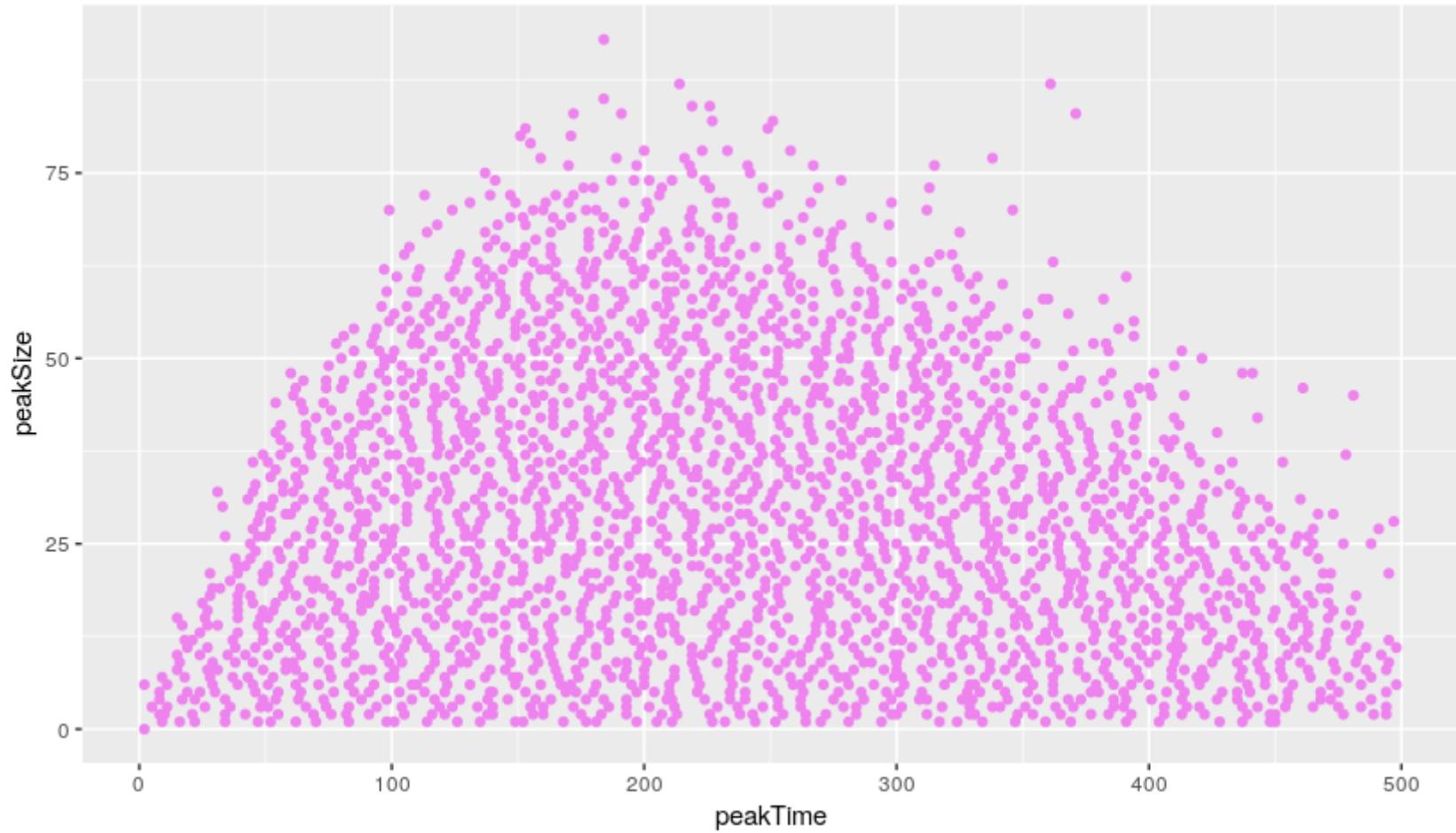
PSE for Zombies

Looking for possible:

- Peak size of infected humans over 5 time steps
- Peak time of infected humans over 5 time steps



Possible patterns

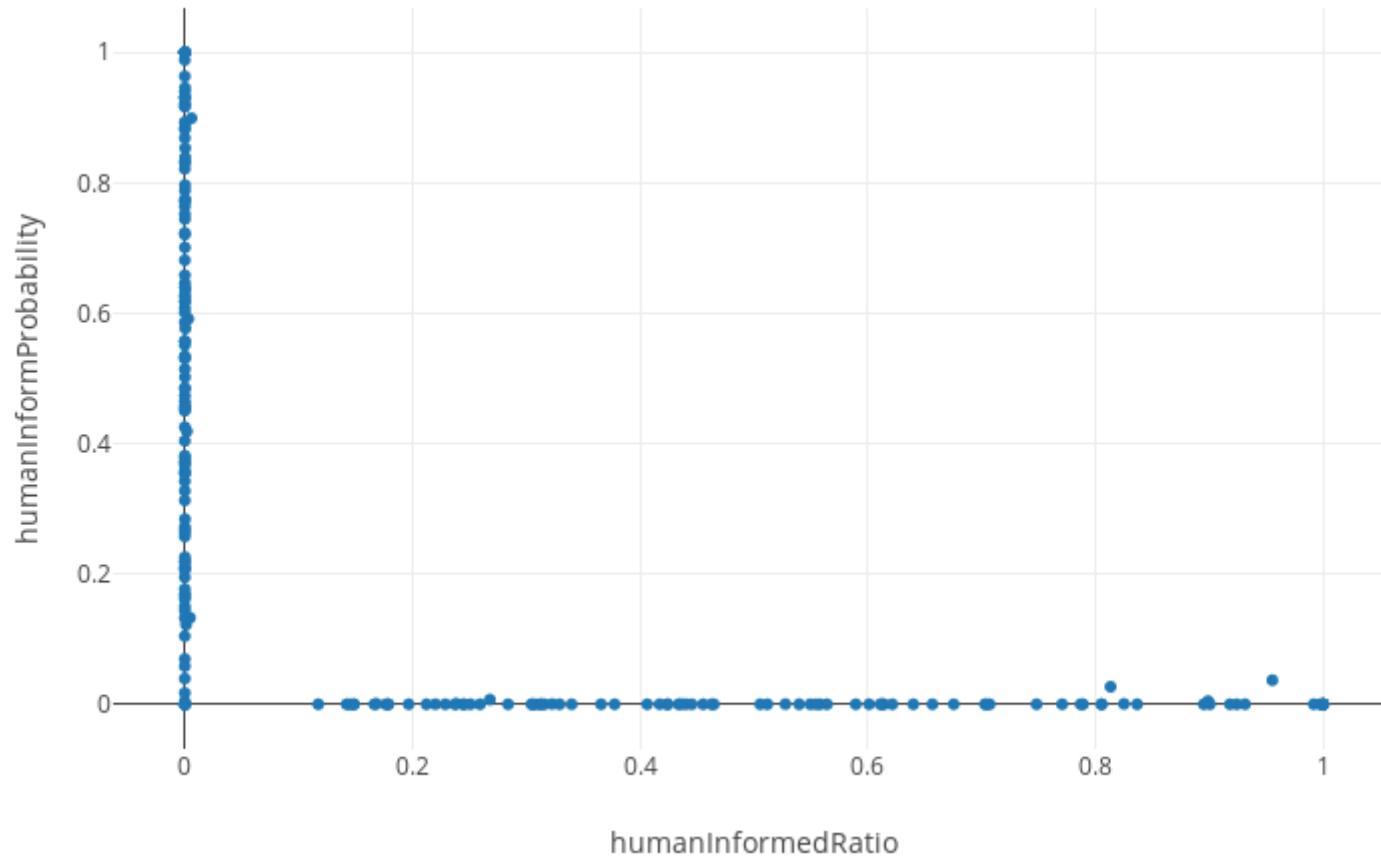


OSE (Ancestor search)



Which input values may lead to a rare but terrible Zombie attack ($\text{peakSize} > 50$) ?

OSE Results



At least 1 informed human or a very (non-zero) low informProbability permit to avoid a terrible attack.

Is it all?

- *Direct sampling*: Grid, Sobol, LHS, One Factor at A Time, Random, CSV, Spatial
- *Sensitivity*: Morris, Saltelli
- *Evolution*: NSGA2, Profiles, PSE, OSE, NichedNSGA2
- *Bayesian*: ABC
- And more to come: NSGA3, PPSE

Is OpenMOLE crafted for Zombies only?



Of course not !

DOCUMENTATION

Plug Your Model

1. [Scala](#)
2. [Java](#)
3. [Python](#)
4. [R](#)
5. [NetLogo](#)
6. [GAMA](#)
7. [Scilab](#)
8. [Julia](#)
9. [Any Other Executable](#)

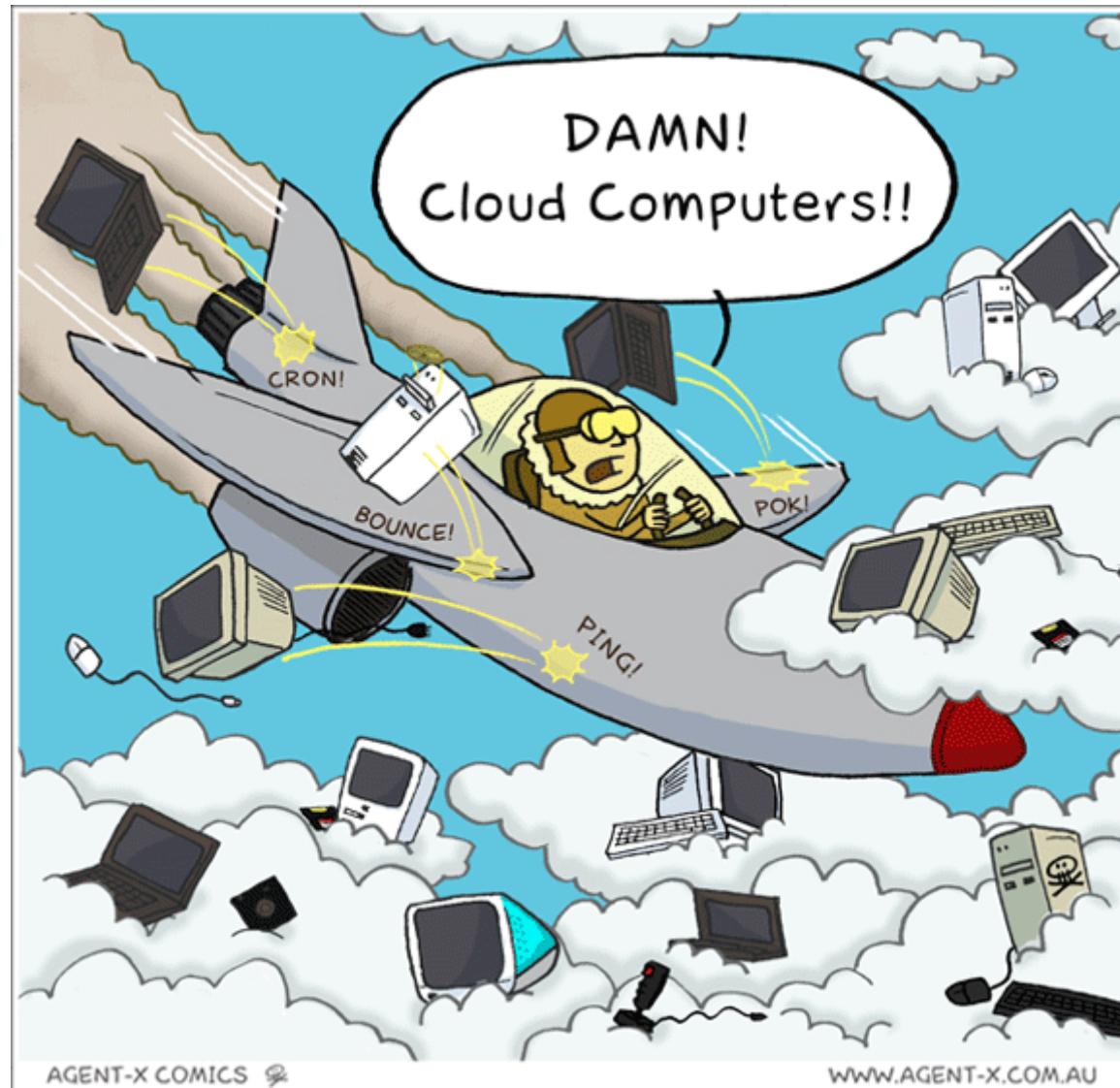
Explore Your Model

1. [Samplings](#)
 - a. [Elementary Samplings](#)
 - b. [Samplings for High Dimension Spaces](#)
 - c. [Uniform Sampling](#)
 - d. [Sampling Over Files](#)

Scaling



Execute anywhere



Zero deployment approach

- User code is automatically deployed at runtime
- No prior knowledge of remote environment needed
- No installation required on any machine

Distribute on your laptop or cluster:

- PBS, Torque, Condor, SLURM, SGE, OAR, DIRAC...

Useful links

- OpenMOLE site: openmole.org
- OpenMOLE chat: chat.openmole.org
- OpenMOLE next version: next.openmole.org
- OpenMOLE github: github.com/openmole/openmole
- OpenMOLE gitlab: gitlab.openmole.org/openmole/openmole



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HOME MODÈLES SAVOIR-FAIRE NOTRE APPROCHE PRODUITS ÉQUIPE ENTREPRISE

Exploration de modèles

Des modèles fiables pour des décisions éclairées

<https://trempoline.io>