How to Run the Rhino EMT's Political-Ecological Simulation Model

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Needed software and files

It is necessary to download two free software packages: the Java SE Development Kit 8, and gnuplot. See
`www.oracle.com/technetwork/java/javase/downloads/jdk8-download-2133151.html`, and
`https://sourceforge.net/projects/gnuplot/`. In addition, a text editor such as Wordpad will be needed.

You will also need to download the jini v2.1 starter kit from `https://mvnrepository.com/artifact/com.sun.jini/jini-starterkit` or similar. Verify that this package installs into the folder `c:/jini2_1`.

The **id** system consists of a set of Java class files. These may be found on the web at `www4.uwm.edu/people/haas/downloads`. The needed .zip files are `idsrce.7z`, and `batfiles.7z`.

To run the article's analyses, one needs to download `wrkshpinputs.7z`, `wrkshppars.7z`, `wrkshpdats.7z`, `wrkshpblns.7z`, `wrkshpgps.7z`, `wrkshpnts.7z`, `wrkshplsts.7z`, and `emat.dfn`.

If you need a PostScript to PDF translator, a free one, `ps2pdf` is part of the Ghostscript package available at
`www.ghostscript.com/download/gsdnld.html`. After installing, the path environment variable needs to be edited to include the string:
`C:\Program Files\gs\gs9.19\lib;C:\Program Files\gs\gs9.19\bin`. Then, at a command prompt, an Encapsulated PostScript file may be converted to a PDF file with the command
`ps2pdf yourfile.eps yourfile.pdf` where "yourfile" is the name of the file being converted.

General setup of an IBM

1. An IBM operates as follows. First, individuals are initialized along with their environment. Then, time is incremented by some amount and each individual's status is *updated* based on the model's equations describing how the individual is affected by this passage of time (which may include the individual's activities such as eating). This is incremented as each individual is updated again. These two activities are repeated until the simulation's stop time is reached.

2. The key idea of an IBM is that aggregate behavior patterns of a group of animals will *emerge* through the collective behavior of individuals. This is how nature works and hence an IBM is, in this way, a more faithful representation of an ecological process than an aggregate model such as a predator-prey differential equation system is.

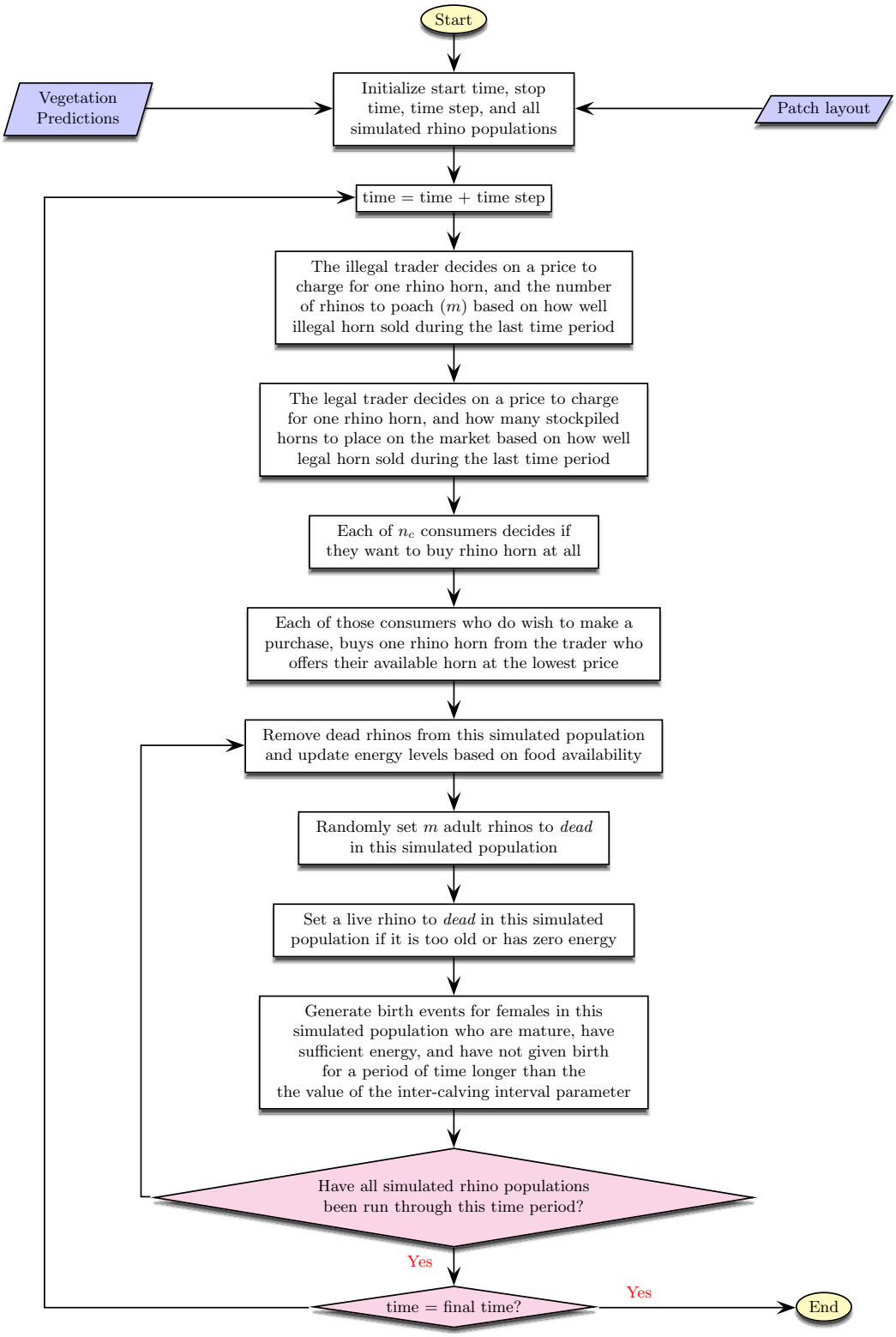
Integrating a poaching operation model with an IBM

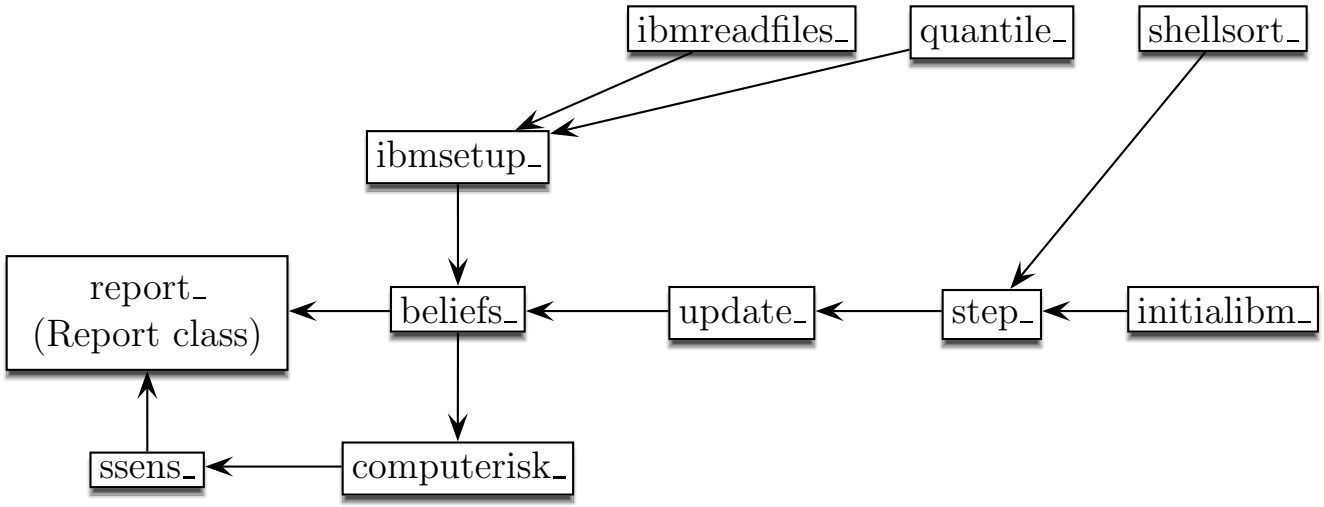
One way to do this is to build an *agent-based* submodel of wildlife trafficking and have it interact with a submodel composed of a population dynamics IBM of the species being traded. We call the result an *economic-ecological* model.

Overview of the rhino IBM

Spatial effects are coarsely modeled by defining a patch partition of the region and keeping track of each animal's patch membership.

Step-by-step details of the rhino IBM


Start
Vegetation Predictions
Initialize start time, stop time, time step, and all simulated rhino populations
Patch layout
time = time + time step
The illegal trader decides on a price to charge for one rhino horn, and the number of rhinos to poach (m) based on how well illegal horn sold during the last time period
The legal trader decides on a price to charge for one rhino horn, and how many stockpiled horns to place on the market based on how well legal horn sold during the last time period
Each of n_c consumers decides if they want to buy rhino horn at all
Each of those consumers who do wish to make a purchase, buys one rhino horn from the trader who offers their available horn at the lowest price
Remove dead rhinos from this simulated population and update energy levels based on food availability
Randomly set m adult rhinos to *dead* in this simulated population
Set a live rhino to *dead* in this simulated population if it is too old or has zero energy
Generate birth events for females in this simulated population who are mature, have sufficient energy, and have not given birth for a period of time longer than the the value of the inter-calving interval parameter
Have all simulated rhino populations been run through this time period?
Yes
time = final time?
Yes
End


ibmreadfiles_
quantile_
shellsort_
ibmsetup_
report_
(Report class)
beliefs_
update_
step_
initialibm_
ssens_
computerisk_

Example: An economic-ecological model of South African rhinos

Input files

1. **id** command files: `krhino.id`, `trdrs.id`, `middle.id`, `poachers.id`, `anti-poach.id`, and `rhinoeco.id`
2. Parameter files: `trdrs-hyp.par`, `middle-hyp.par`, `poachers-hyp.par`, `anti-poach-shoot.par`, and `rhinoeco-hyp.par`
3. Data files: `knprhinos.dat`, `allknpveg.dat`, `patches.dat`, and `knpremoved.dat`

Commands to run the example

1. Open a command prompt window by clicking `All Programs` > `Accessories` > `Command Prompt`. Change folder with `cd ../../workshop` (or similar).
2. Set `TNMNDS` to 40, and `NMNETS` to 5. Delete all `*.class` files with the command `del *.class`, and then recompile the entire **id** package with `compile Run_id.java`.
3. Run the example with `idalone krhino.id`.
4. To see a list of files sorted by most recently created, enter the command `dir /o-d`.

Output files

1. `prices.plt`
2. `krhinoest.html`
3. `finalpop.dat`
4. average abundance: `sq.plt`, all abundance realizations: `sqabund.plt` (names are set in `trdrs.id`)

Plotting support

Use **gnuplot** to create complex graphics of the IBM output. In this example, running the batch file `abunds.gp` creates a **gnuplot** plot of rhino abundance over time across all management strategies.

This is accomplished in two steps. First, enter the command `gnuplot` at the command prompt. Second, at the `gnuplot` command prompt, enter the command `load "abunds.gp"`.