



Multi-agent simulation with Gama and R Practical Training Manual

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Prerequisite: to have acquired basic notions in R (e.g. workspace, package, data.frame, list, for loop, function, etc.) and GIS (e.g. shapefile, attribute table, etc.) and corresponding skills.

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Chapter 1

Model presentation

1.1 Ecological bases

This model has been inspired by earlier works carried out by GDRI EHEDE researchers (Li et al., 2015; Clauzel et al., 2015; Li et al., 2017).

In brief, after Li et al. (2015), the black-and-white snub-nosed monkey *Rhinopithecus bieti* is endemic to Yunnan and Tibet, China, and categorized as "endangered" in the IUCN Red List. Surveys have shown that the monkeys live in 15 isolated groups, 12 of them in Yunnan, in a narrow range of the Three Parallel Rivers region, one of the most ecologically important areas of China, the rugged terrain of which makes it difficult to carry out surveys. The species is threatened by habitat alteration, poaching and economic activities such as farming and collection of timber. The areas between populations are damaged by logging, grazing, mining, agriculture and firewood collection. Because of this habitat fragmentation the monkeys may incur a high energy cost if they travel long distances between habitat patches. Fragmentation may subsequently prevent genetic exchange between populations, making the species more vulnerable to extinction. Where required, reserve managers need to establish habitat corridors to facilitate exchange between populations, identifying priority areas for restoration to increase landscape connectivity.

"Snubbies" is a nickname given to the species.

1.2 Geography and data

Tab. 1.1 describes the 5 habitat types defined by Li et al. (2017) and fig. 1.1 shows the study area and the location of the monkey groups with their ID number.

- The shapefile `source2P` corresponds to this map, and the predefined style file `source2P.qml` can be used in QGIS for a better display. The attribute `DN` gives the habitat types of Tab. 1.1.

- The shapefile `source2P_envconv` is the concave polygon of `source2P`
- The shapefile `groups` gives the geographical limit of each monkey group. The group ID number, the name of the area and a population size estimate are given as attributes.

Table 1.1: Habitat quality and composition after Li et al. (2017)

ID	habitat type	Land cover	Altitude	Cost value
1	Optimal	Armand pine and hemlock, fir-spruce forest, coniferous broad-leaved mixed forest	2250-4730	1
2	Suboptimal	Sclerophyllous evergreen broad-leaved forest, shrub-dominated land	1220-5240	10
3	Suitable	Cold coniferous forest, sub-alpine meadow, broad-leaved forest	1310-4950	70
4	Unfavourable	Warm coniferous forest (Yunnan pine forest), hot dry savanna, sparse shrub grass	1200-5490	90
5	Highly unfavourable	Cropland, settlements, water body, barren land	1215-5410	100

1.3 Model purpose

Here we want to build a multi-agent model to simulate and explore the effect of habitat and life-history trait parameters (real values known or unknown) on snubby dispersion.

1.4 Model parameters

1.4.1 Input parameters

step 1 hour (the iteration time resolution)

maximum speed the maximum speed (km/day) that can sustain a snubby in a favourable habitat

maximum survival [0,1] the maximum survival in a favourable habitat. The end user give it per year (s_y), but this should be converted to the scale of the step (here hour), using the following formula: $s_h = e^{\frac{\ln s_y}{365 \times 24}}$

disperser proportion the proportion of snubbies who evade their group and wander outside. The end user give it per year (p_y), but this should be converted to the scale of the step (hour): $p_h = e^{\frac{\ln p_y}{365 \times 24}}$

habitat viscosity [0,1] the resistance of a given habitat. Multiplies the maximum speed to give the speed really sustained in this habitat.

habitat security [0,1] the security of a given habitat. Multiplies the maximum survival to give the actual survival in this habitat.

long perception distance [default: 6 km] the radius within which a wandering snubby choose a long distance target.

short perception distance [default: long perception distance/3] the radius within which a wandering snubby chose a stepping stone habitat (short distance target) to the long distance target.

angle [default: 45°] the half-angle on each side of the bearing direction to the long distance target within which a wandering snubby chose a short distance target.

minimum habitat quality for a long distance target, MHQLD [default: 4] the minimum habitat quality to be chosen as a long distance target.

minimum habitat quality for a short distance target, MHQSD [default: 2] the minimum habitat quality to be chosen as a short distance target.

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1.4.2 During simulation

- When one snubby dies, one snubby is created in its aboriginal group.
- A wandering snubby chooses a long distance target randomly in habitats whose quality is equal or above MHQLD within the **long perception distance** radius. Then it chooses a short distance target (stepping stone) randomly in habitats whose quality is equal or above MHQSD within the **short perception distance** radius and within a sector defined by the **angle** on each side of the bearing direction to the long distance target. Then, it moves to the short distance target crossing habitats of various quality (speed and survival are applied according to **habitat viscosity** and **habitat security**) (see fig. 1.2). When it reaches the long distance target, it chooses another long distance target. The process is repeated iteratively until it dies or reaches another group on the way and integrate that group.

1.4.3 Output parameters

Bitmap Bitmap of snubby distribution (framerate: 6 months).

Shapefile Shapefile of snubby distribution with their individual attributes (framerate: 1 year).

group composition and wanderers Snubby number in each group and outside, split by group origin.

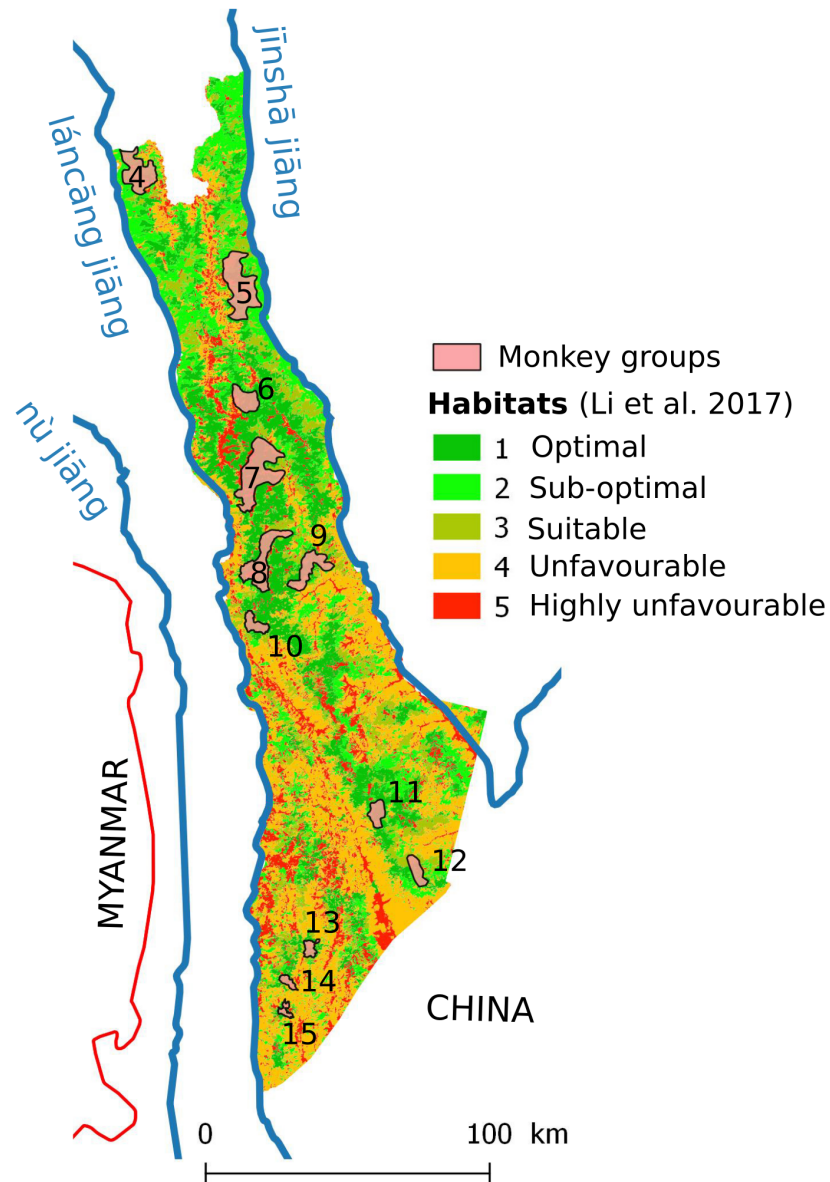


Figure 1.1: Study area. Numbers on the map are the group IDs.

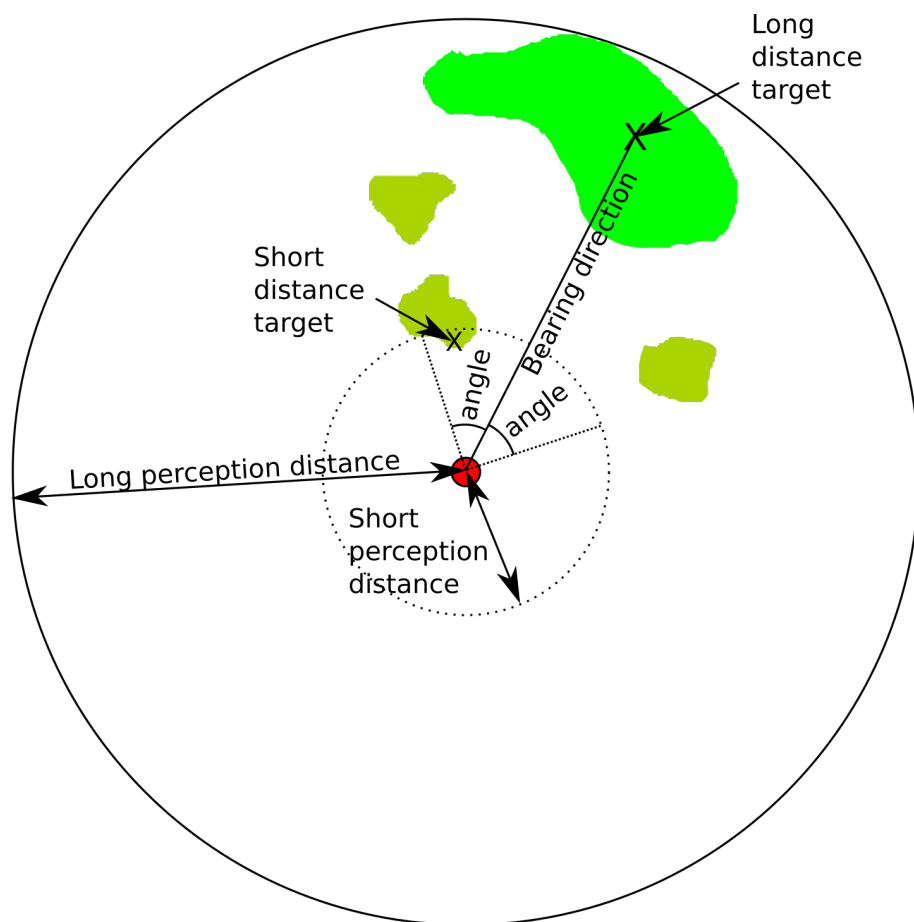


Figure 1.2: Movements parameters. Red circle is the snubby position, green areas are favourable habitats of various quality

Chapter 2

Gama model

2.1 Principle

See:

- Grignard et al. (2013)
- <https://gama-platform.github.io>
- <https://github.com/gama-platform/gama/wiki/Overview>
- <https://github.com/gama-platform/gama/wiki>
- <https://github.com/gama-platform/gama/wiki/Download>

2.2 Gama in practice

See practical training on November 6-7, 2018.



Bibliography

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