Local minima and capture-recapture models

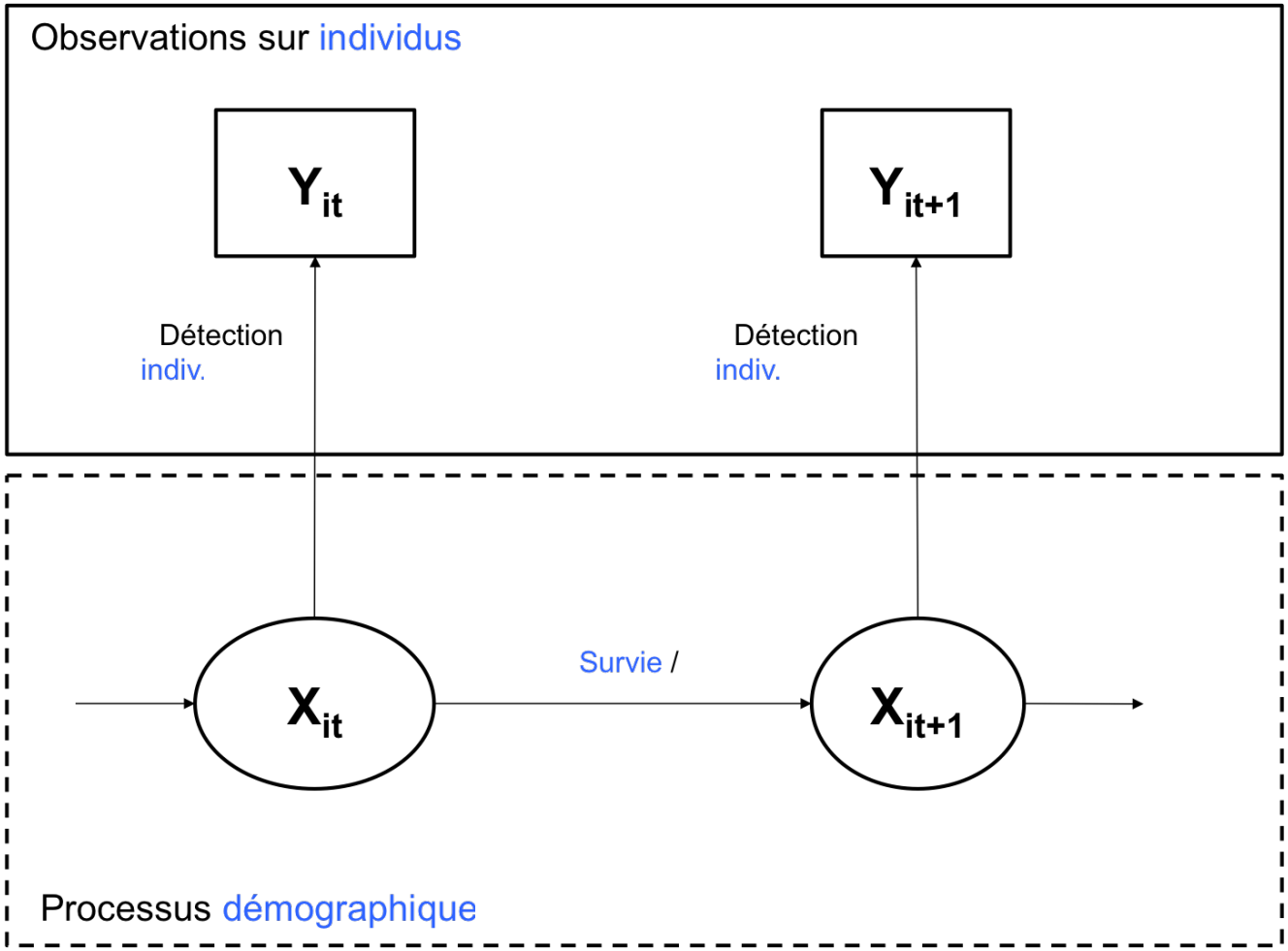
Olivier Gimenez

Multistate capture-recapture models

- Individual data on marked animals/plants
- Repeated sampling in time
- Survival, movement between states
- States = sites, breeding, disease, behavior
- Individual detectability < 1, heterogeneous

- Lebreton, J.-D., Nichols, J.D., Barker, R.J., Pradel, R. & Spendelow, J.A. (2009) Modeling Individual Animal Histories with Multistate Capture-Recapture Models. Advances In Ecological Research, 41, 87–173.

CR models are hierarchical



- Gimenez, O., Lebreton, J.-D., Gaillard, J.-M., Choquet, R. & Pradel, R. (2012) Estimating demographic parameters using hidden process dynamic models. TPB, 82, 307–316.
- Gimenez, O., Rossi, V., Choquet, R., Dehais, C., Doris, B., Varella, H., Vila, J.-P. & Pradel, R. (2007) State-space modelling of data on marked individuals. Ecol Mod, 206, 431–438.

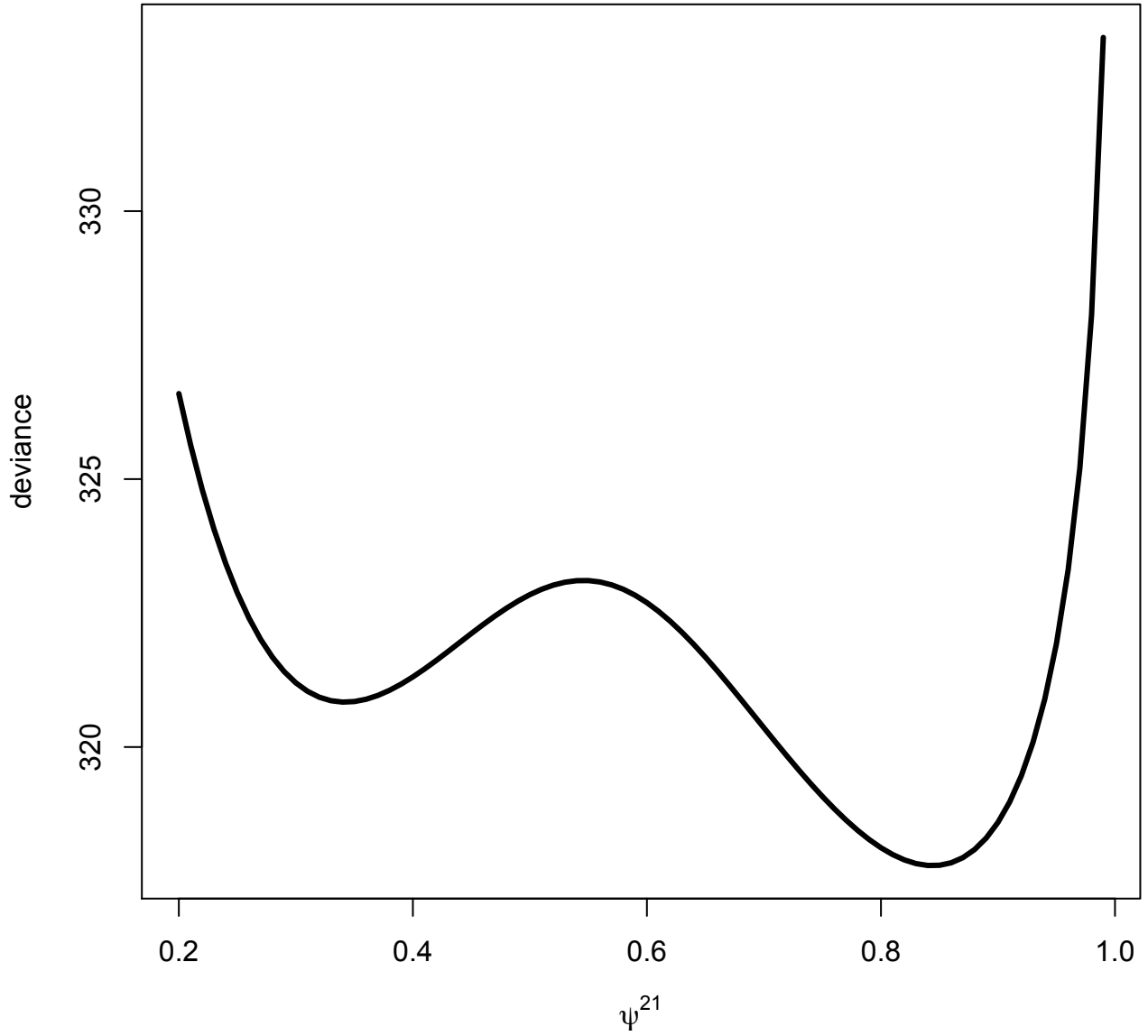
Simulated data

- 2 states, 7 occasions
- Survival = 1, detection = 0.6
- Transition 1 -> 2 = 0.6
- Transition 2 -> 1 = 0.85

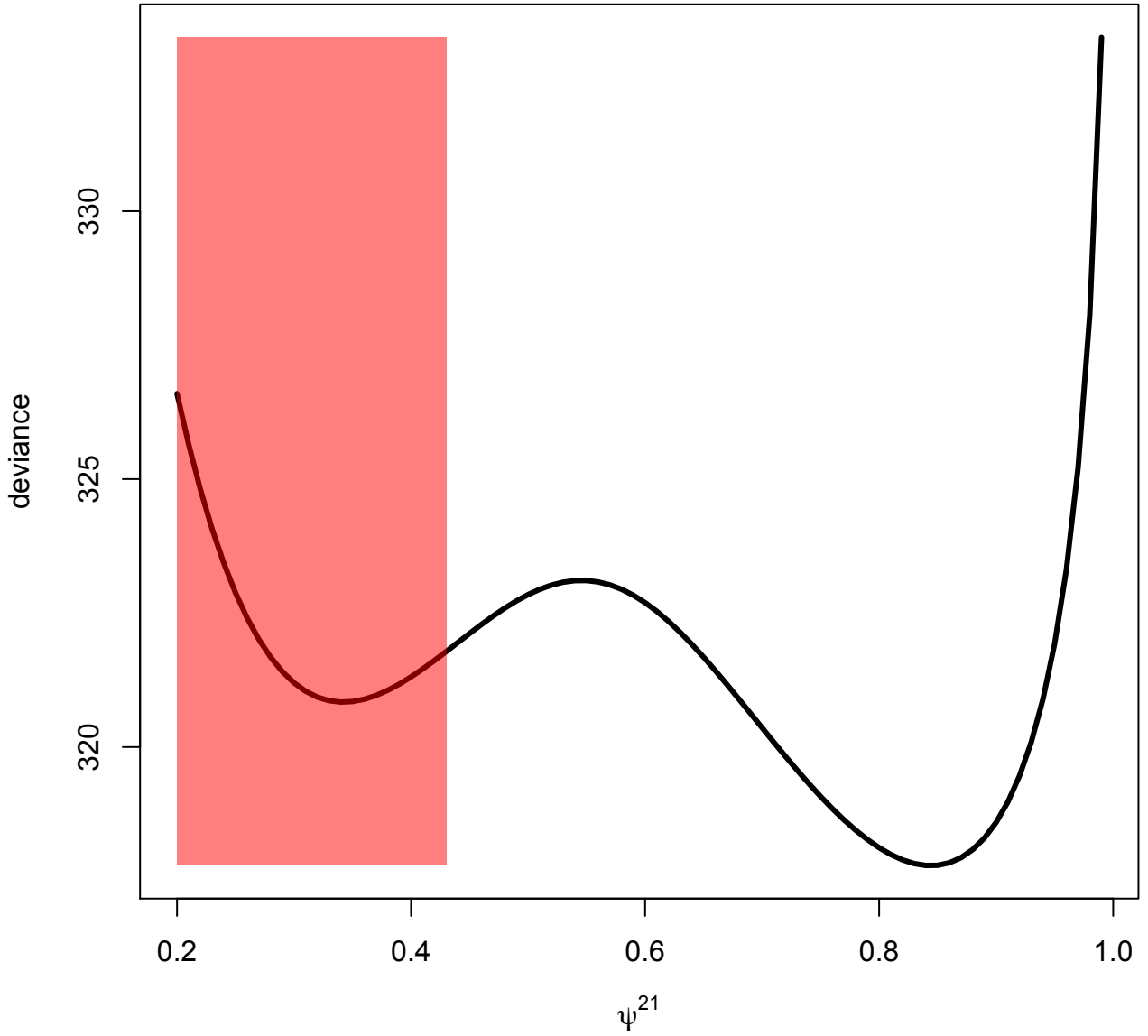
```
2021202 4;          1110101 4;
2020201 4;          1010101 4;
2020202 4;          1010102 4;
2201021 4;          2102011 4;
```

- Courtesy of J. Dupuis; cf. Gimenez, O., Choquet, R., Lamor, L., Scofield, P., Fletcher, D., Lebreton, J.-D. & Pradel, R. (2005) Efficient profile-likelihood confidence intervals for capture-recapture models. Journal of Agricultural, Biological, and Environmental Statistics, 10, 184–196.

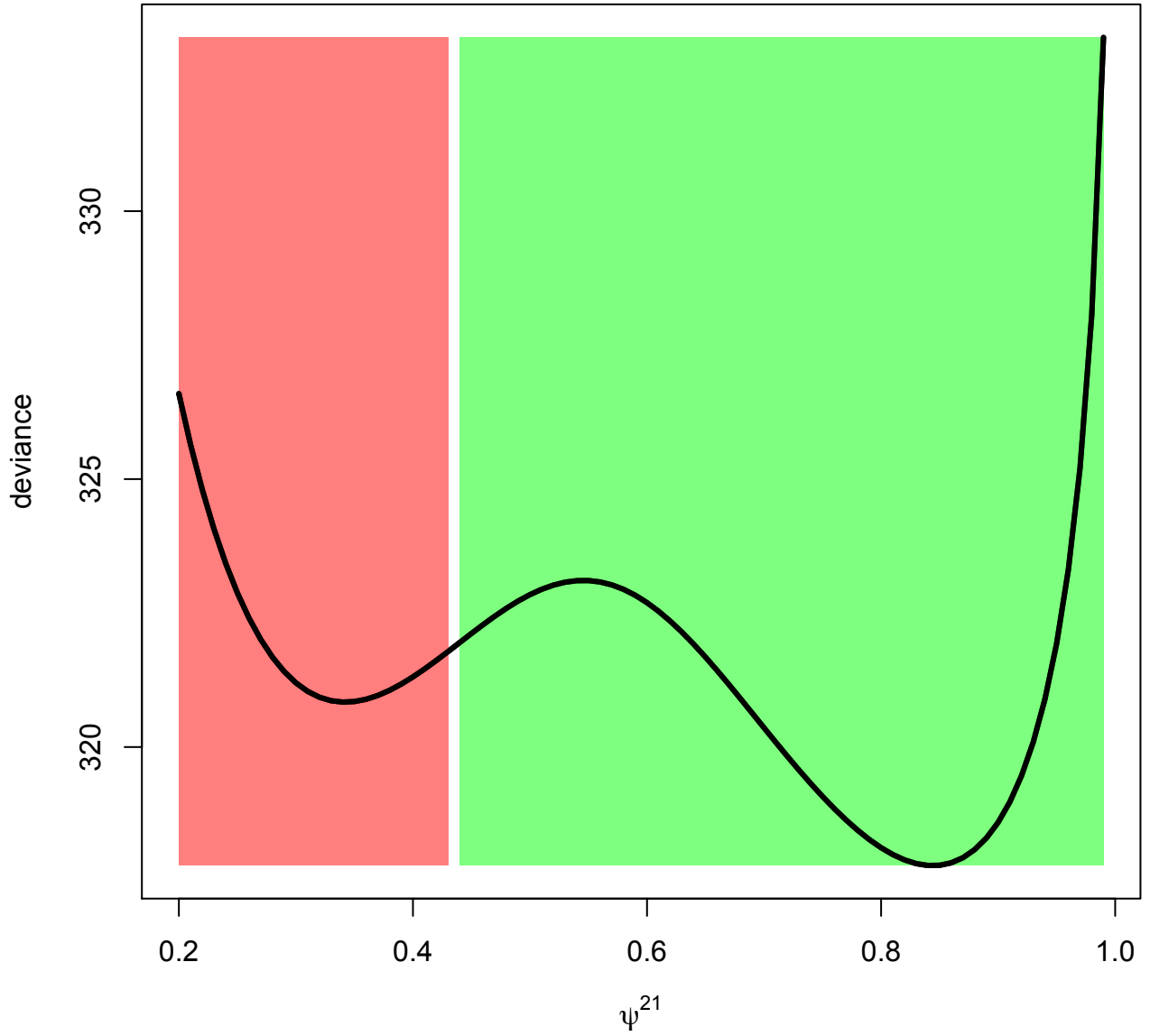
Deviance as a function of transition 2->1



Initial values lead to *local* minimum



Initial values lead to *global* minimum



Influence of link function?

- By link function, I mean:

  $f(\psi) = \beta$ and β is estimated on $]-\infty,+\infty[$
- Alternative: constrained optimisation

Influence of link function?

- Sin link function: $\Psi^{12} = 0.25$; $\Psi^{21} = 0.34$!

- E. Cooch, G. White 2012, Gentle introduction to MARK, ch 9

$\Psi^{12} = 0.6$; $\Psi^{21} = 0.85$

Influence of link function?

- Sin link function: $\Psi^{12} = 0.25$; $\Psi^{21} = 0.34$!
- Logit link function: $\Psi^{12} = 0.60$; $\Psi^{21} = 0.84$

- E. Cooch, G. White 2012, Gentle introduction to MARK, ch 9

$\Psi^{12} = 0.6$; $\Psi^{21} = 0.85$

Quasi-Newton (BFGS) vs. simulated annealing

- Sin link function BFGS: $\Psi^{12} = 0.25$; $\Psi^{21} = 0.34$

- E. Cooch, G. White 2012, Gentle introduction to MARK, ch 9

$\Psi^{12} = 0.6$; $\Psi^{21} = 0.85$

Quasi-Newton (BFGS) vs. simulated annealing

- Sin link function BFGS: $\Psi^{12} = 0.25$; $\Psi^{21} = 0.34$
- Sin link function SA: $\Psi^{12} = 0.60$; $\Psi^{21} = 0.84$

- E. Cooch, G. White 2012, Gentle introduction to MARK, ch 9

$\Psi^{12} = 0.6$; $\Psi^{21} = 0.85$

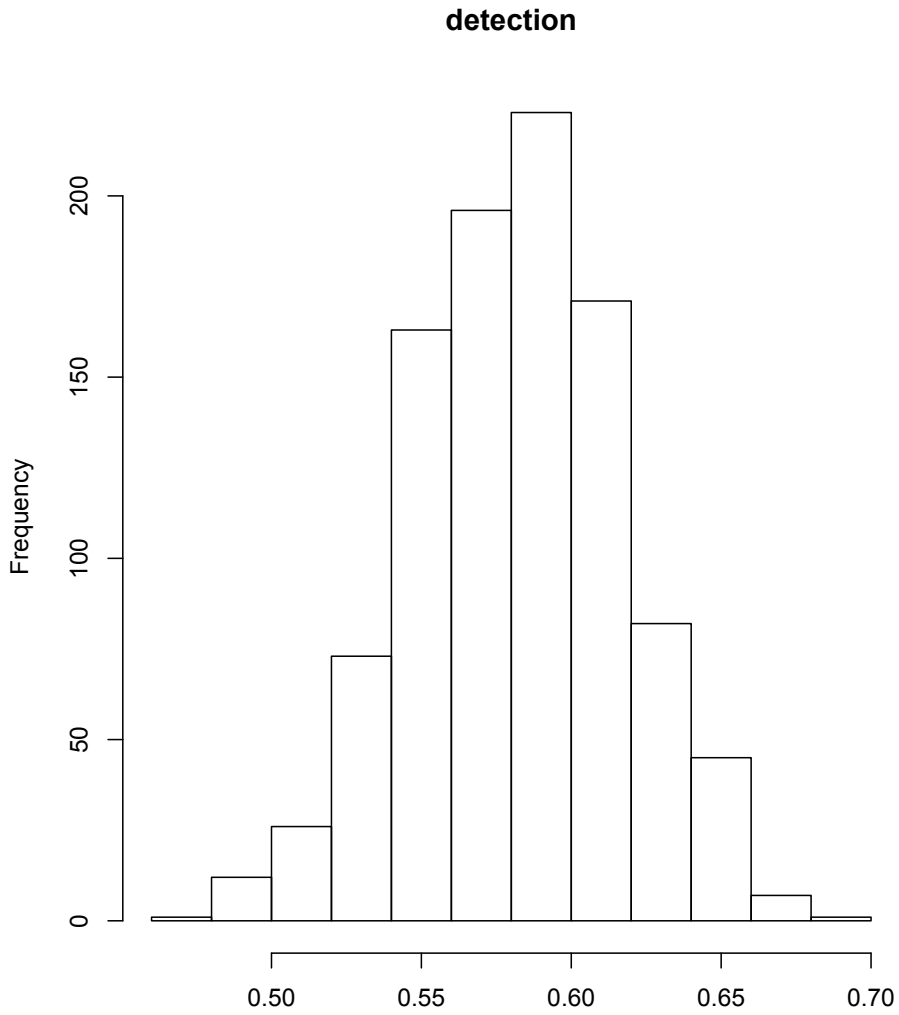
Quasi-Newton (BFGS) vs. simulated annealing

- Sin link function BFGS: $\Psi^{12} = 0.25$; $\Psi^{21} = 0.34$
- Sin link function SA: $\Psi^{12} = 0.60$; $\Psi^{21} = 0.84$
- But: SA is much (much) slower than BFGS

- E. Cooch, G. White 2012, Gentle introduction to MARK, ch 9

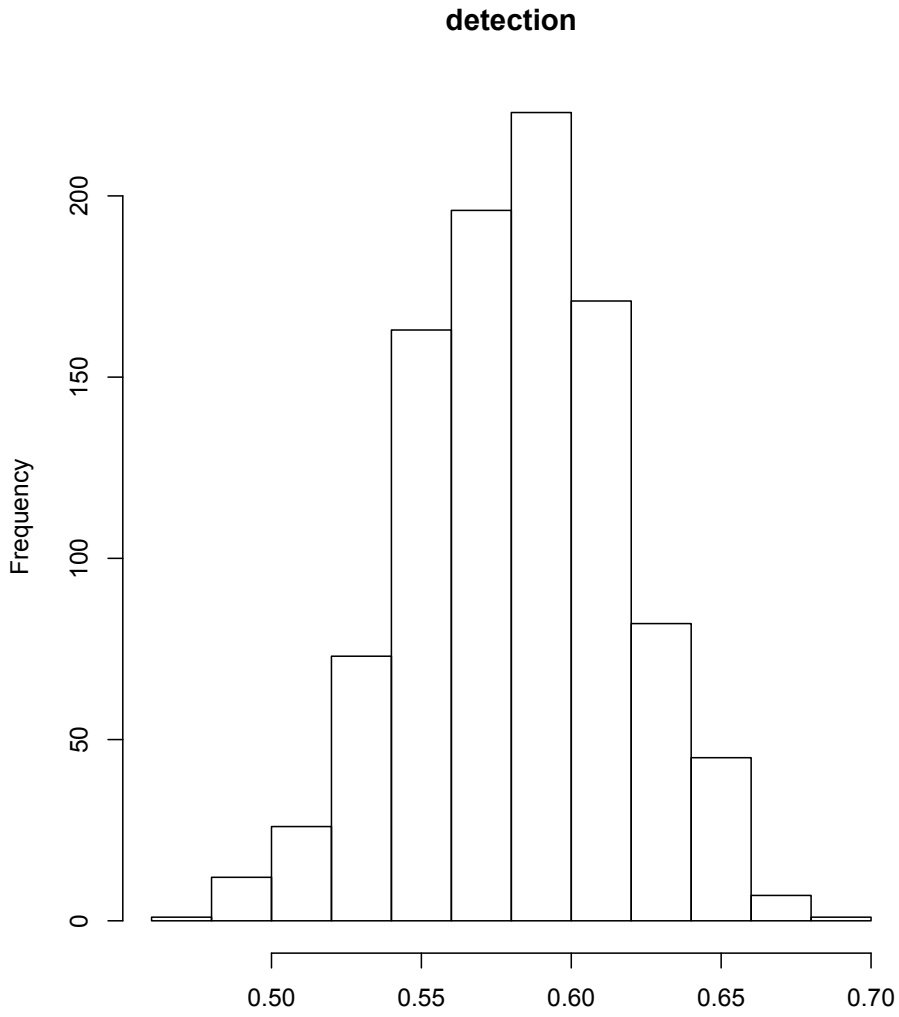
$\Psi^{12} = 0.6$; $\Psi^{21} = 0.85$

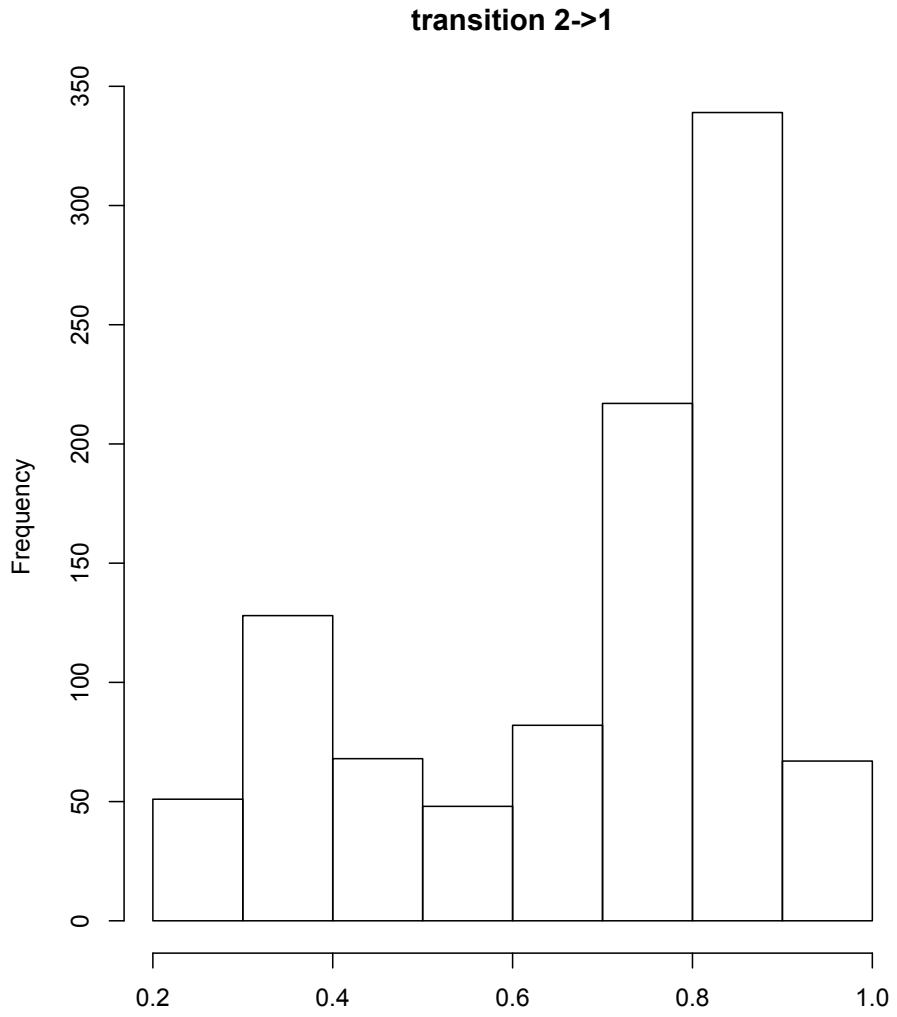
MCMC



detection = 0.6

MCMC





$\Psi^{21} = 0.85$ (sin link)

Implementation

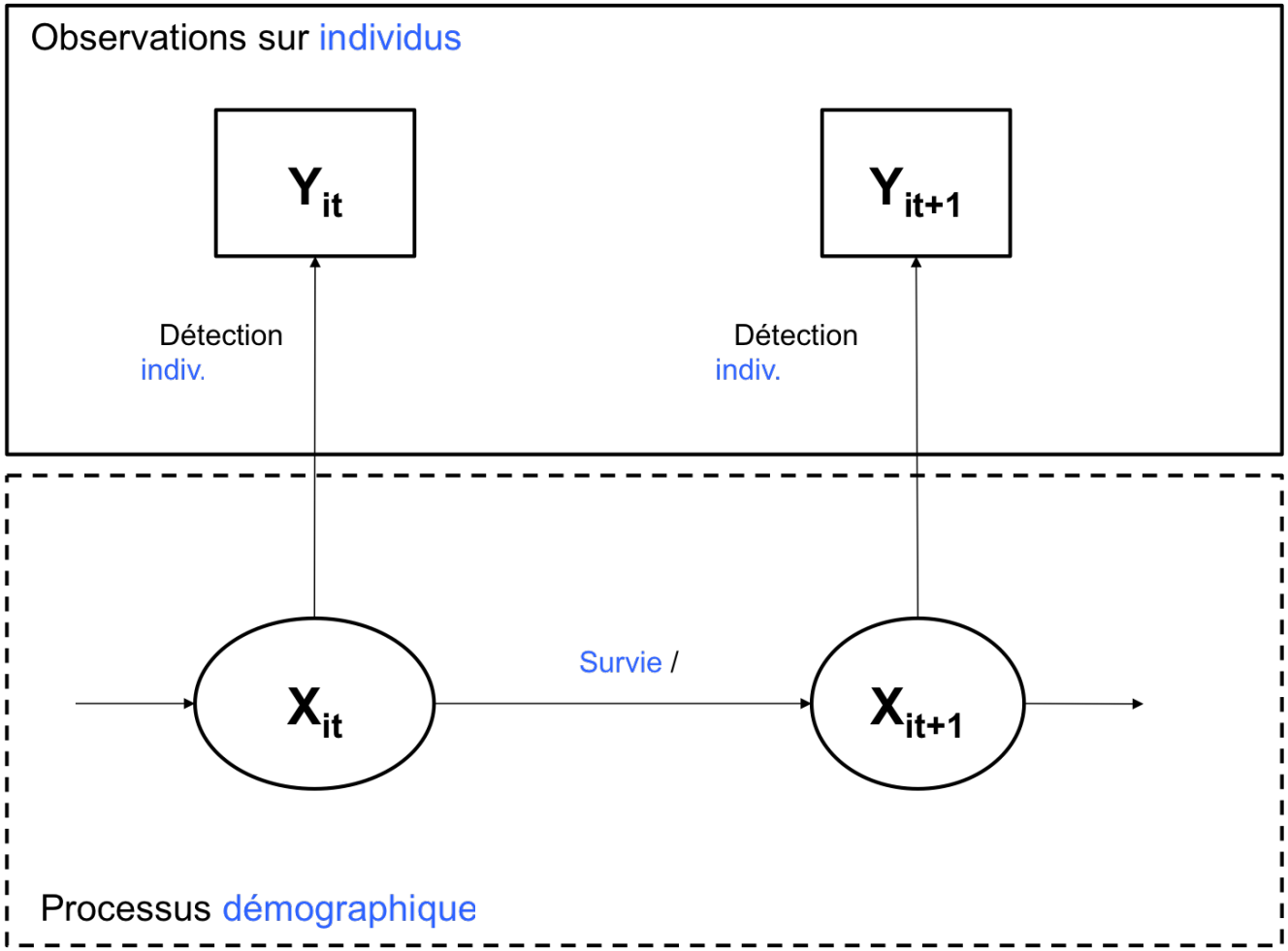
- Mark called from R using package Rmark
- Jags called from R using package R2jags
- Code and slides available on GitHub:

  https://github.com/oliviergimenez/multistate_local_minima

Ongoing work

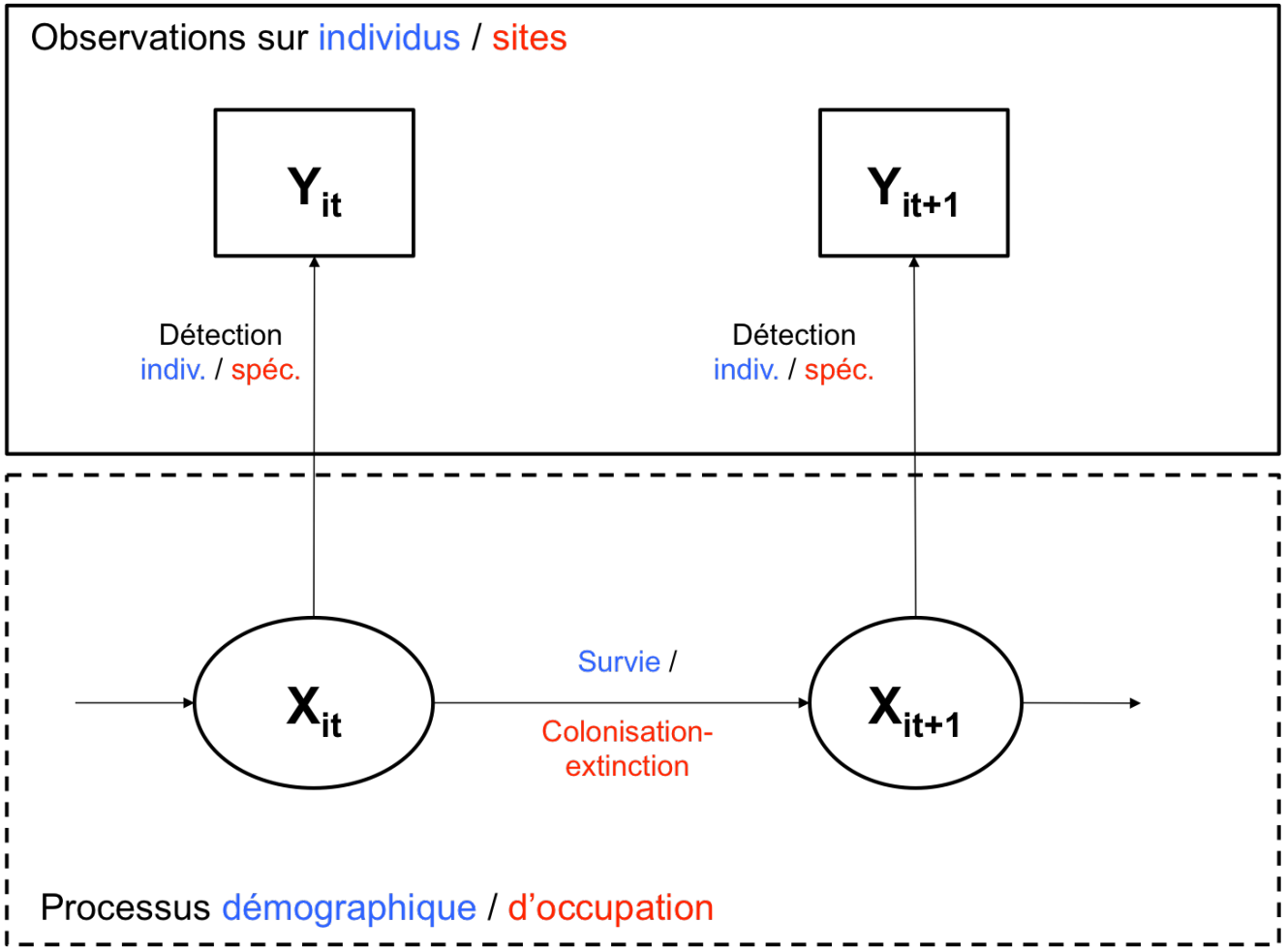
- Local minima in dynamic occupancy models?

CR models are hierarchical



- Gimenez, O., Lebreton, J.-D., Gaillard, J.-M., Choquet, R. & Pradel, R. (2012) Estimating demographic parameters using hidden process dynamic models. TPB, 82, 307–316.
- Gimenez, O., Rossi, V., Choquet, R., Dehais, C., Doris, B., Varella, H., Vila, J.-P. & Pradel, R. (2007) State-space modelling of data on marked individuals. Ecol Mod, 206, 431–438.

Occupancy models are hierarchical



- Gimenez, O., Blanc, L., Besnard, A., Pradel, R., Doherty, P.F., Marboutin, E. & Choquet, R. (2014) Fitting occupancy models with E-SURGE: Hidden Markov modelling of presence-absence data. Methods in Ecology and Evolution, 5, 592–597.

Explore other avenues…

BIOMETRICS 57, 240-244

Minimising model fitting objectives that contain spurious local minima by bootstrap restarting

S. N. Wood
The Mathematical Institute, University of St Andrews
North Haugh, St Andrews KY16 9SS, U.K.
email: snw@st-and.ac.uk

Journal of Statistical Software
May 2011, Volume 42, Issue 11. *http://www.jstatsoft.org/*

Genetic Optimization Using Derivatives: The rgenoud Package for R

Walter R. Mebane, Jr.
University of Michigan

Jasjeet S. Sekhon
UC Berkeley

An escape-from-local minima technique in unconstrained optimization using a grid-like approach and interval equations

Ioannis A. Nikas, and Theodoula N. Grapsa
Division of Computational Mathematics and Informatics,
Department of Mathematics, University of Patras,
GR 265 04 Rio, Greece,
nikas@math.upatras.gr,grapsa@math.upatras.gr

Key words: Global Optimization, grid-like technique, interval equations, escape from local minima.

Regrouping Particle Swarm Optimization: A New Global Optimization Algorithm with Improved Performance Consistency Across Benchmarks

George I. Evers and Mounir Ben Ghalia
The Electrical Engineering Department
The University of Texas-Pan American
Edinburg, Texas USA
george@georgeevers.org, benghalia@utpa.edu

3rd International Conference on Experiments/Process/System Modeling/Sim

MULTISTART OPTIMIZATION WITH A TRAINABLE DECISION MAKER FOR AVOIDING HIGH-VALUED LOCAL MINIMA

N. Kyrgios[1], C. Voglis[1] and I.E. Lagaris[1]
[1]University of Ioannina, Dept. of Computer Science,
P.O. BOX 1186, 45110 Ioannina, Greece