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UNIVERSITY

FACULTY OF BIOSCIENCE ENGINEERING

DEPARTMENT OF APPLIED ECOLOGY AND ENVIRONMENTAL BIOLOGY
AQUATIC ECOLOGY

GENETIC ALGORITHMS TO OPTIMISE SPECIES DISTRIBUTION MODELS

useful for freshwater management

Sacha Gobeyn & Peter L.M. Goethals (09/05/2017, ISESS2017)

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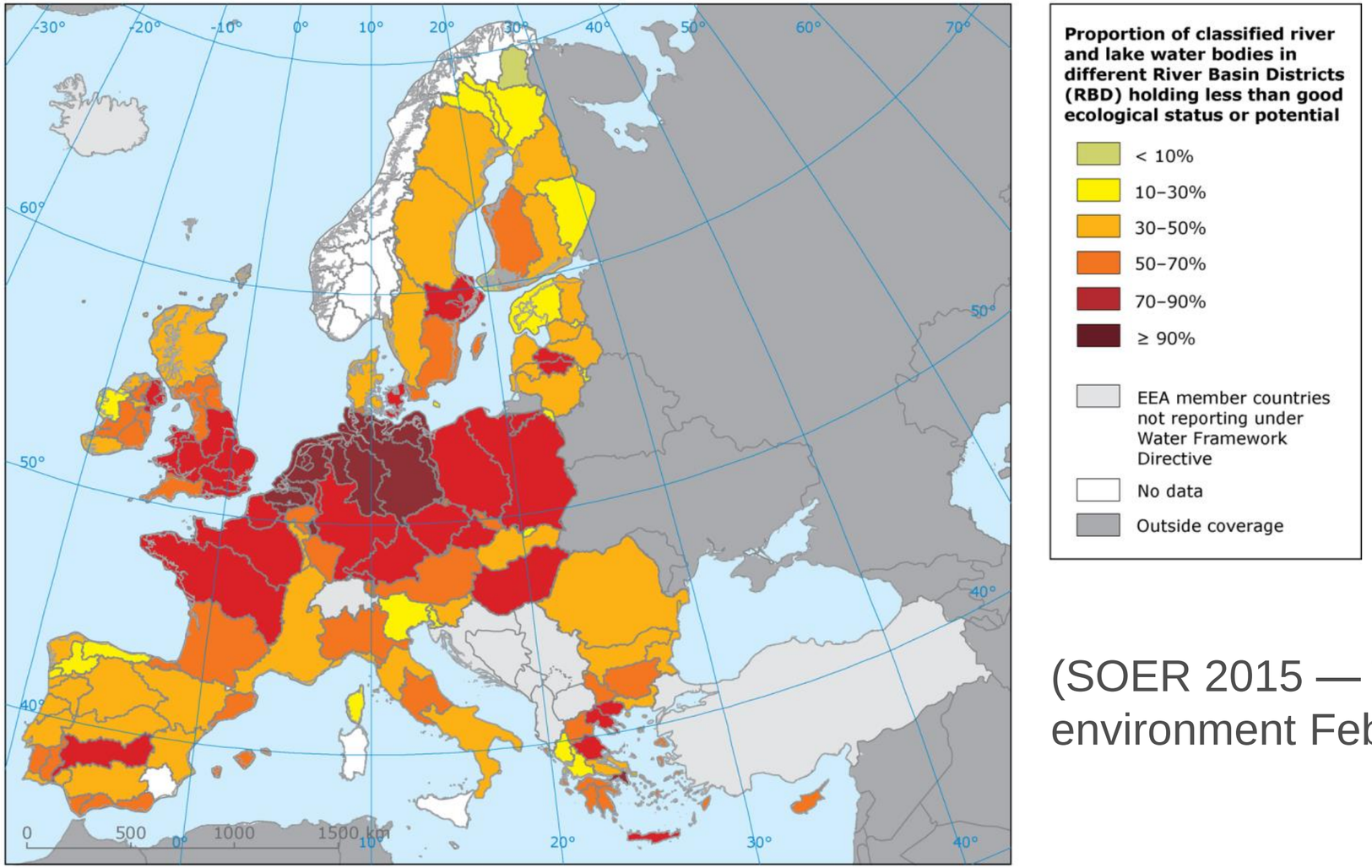
INTRODUCTION

– Freshwater management



Proportion of classified river and lake water bodies in different River Basin Districts (RBD) holding less than good ecological status or potential

- < 10%
- 10–30%
- 30–50%
- 50–70%
- 70–90%
- ≥ 90%
- EEA member countries not reporting under Water Framework Directive
- No data
- Outside coverage

(SOER 2015 — The European environment February 2015)

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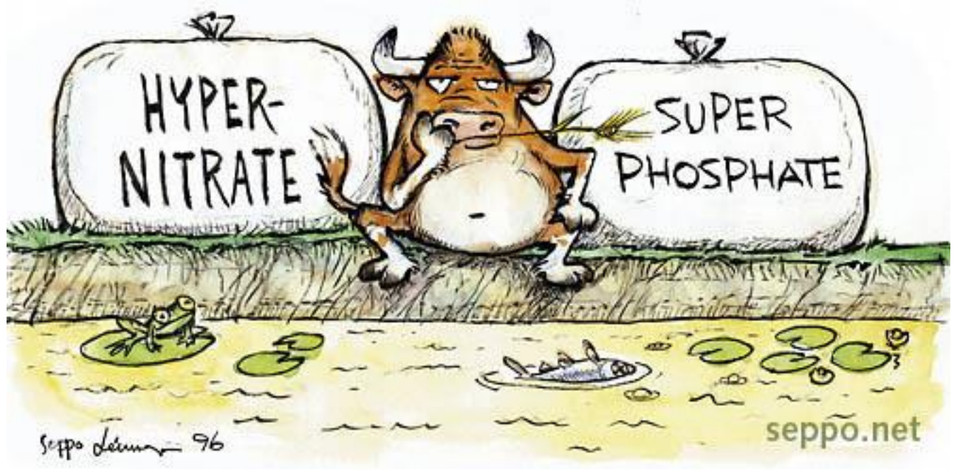
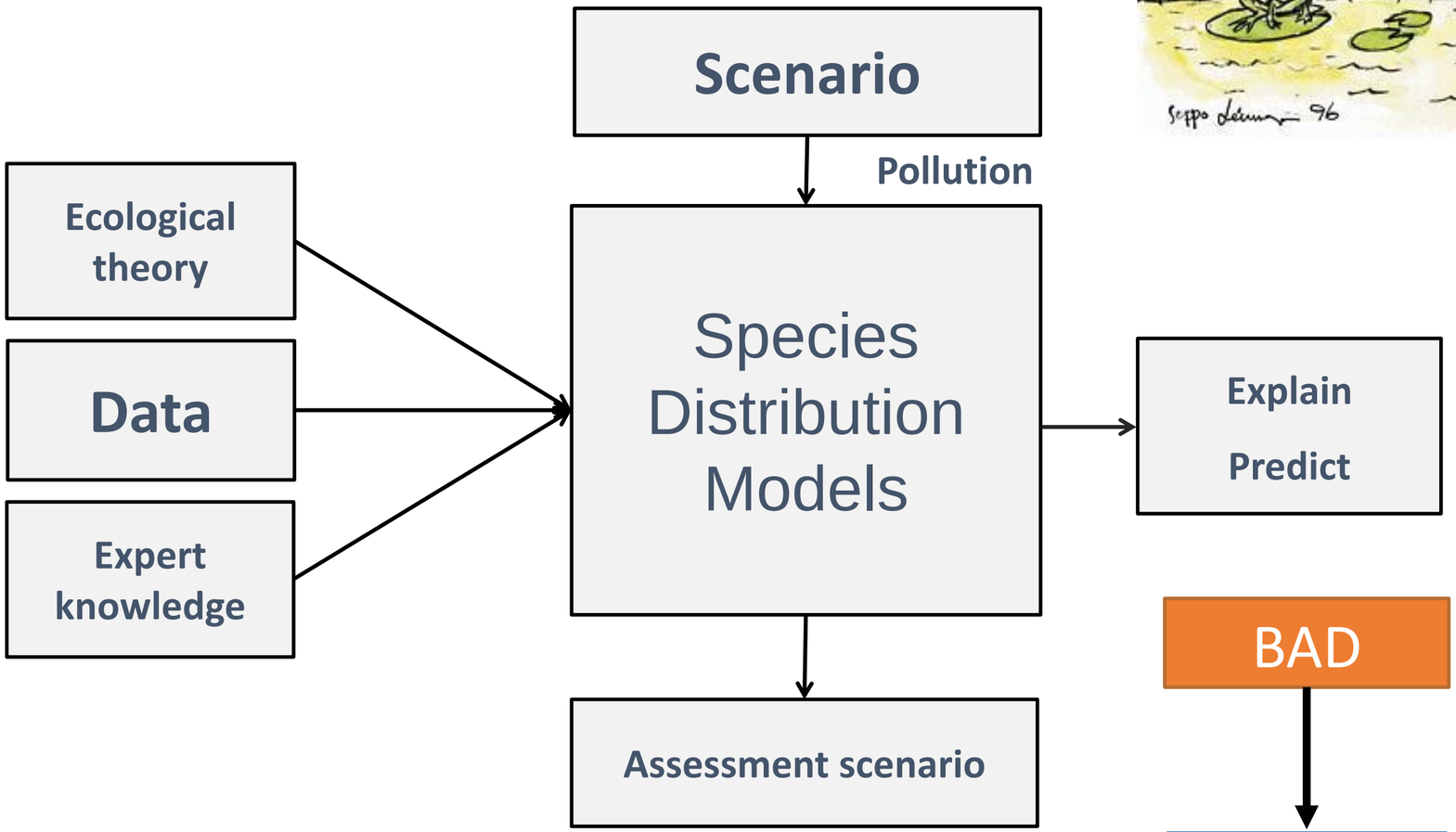
INTRODUCTION

- Freshwater management





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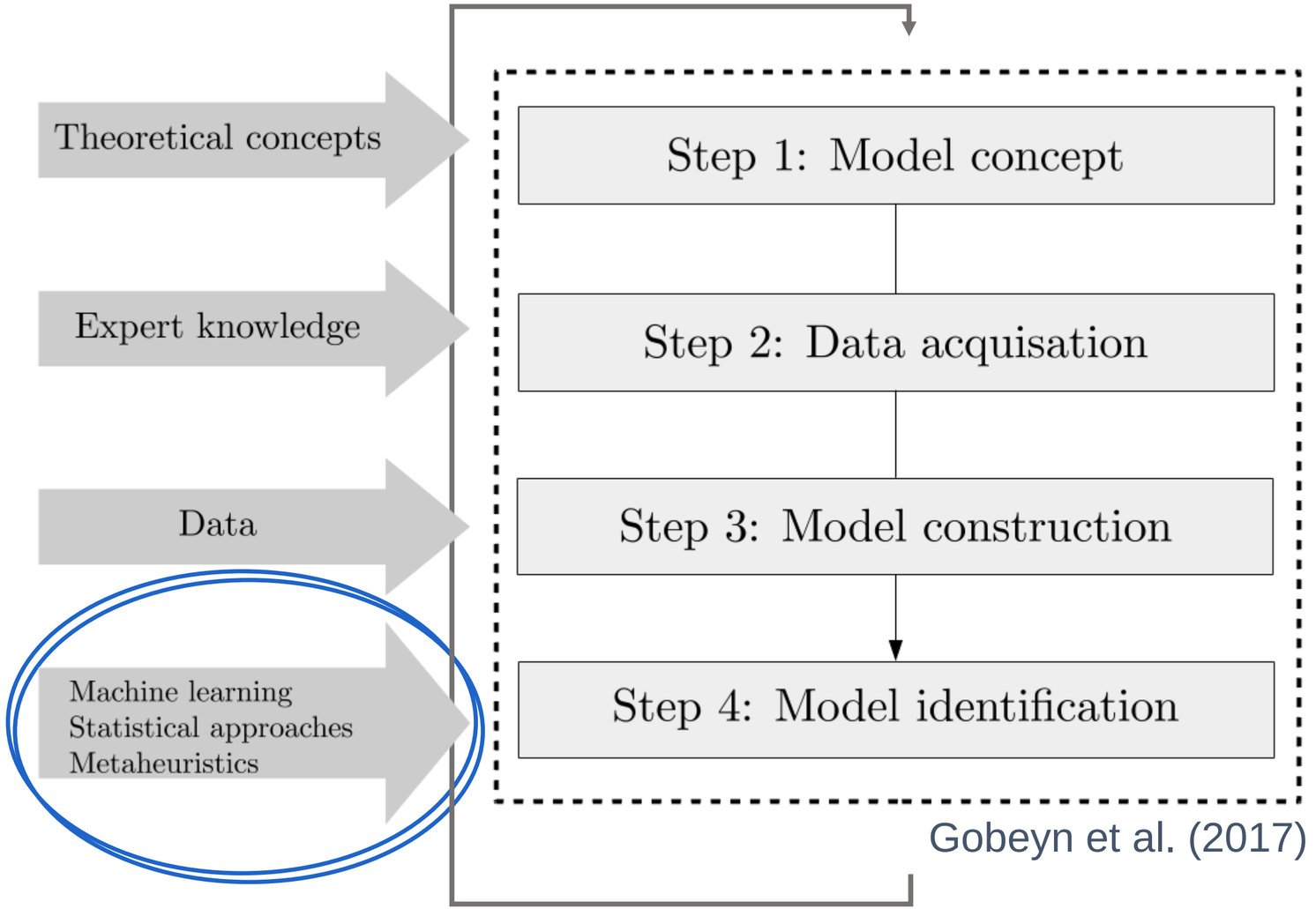
SPECIES DISTRIBUTION MODELS



Gobeyn et al. (2017)

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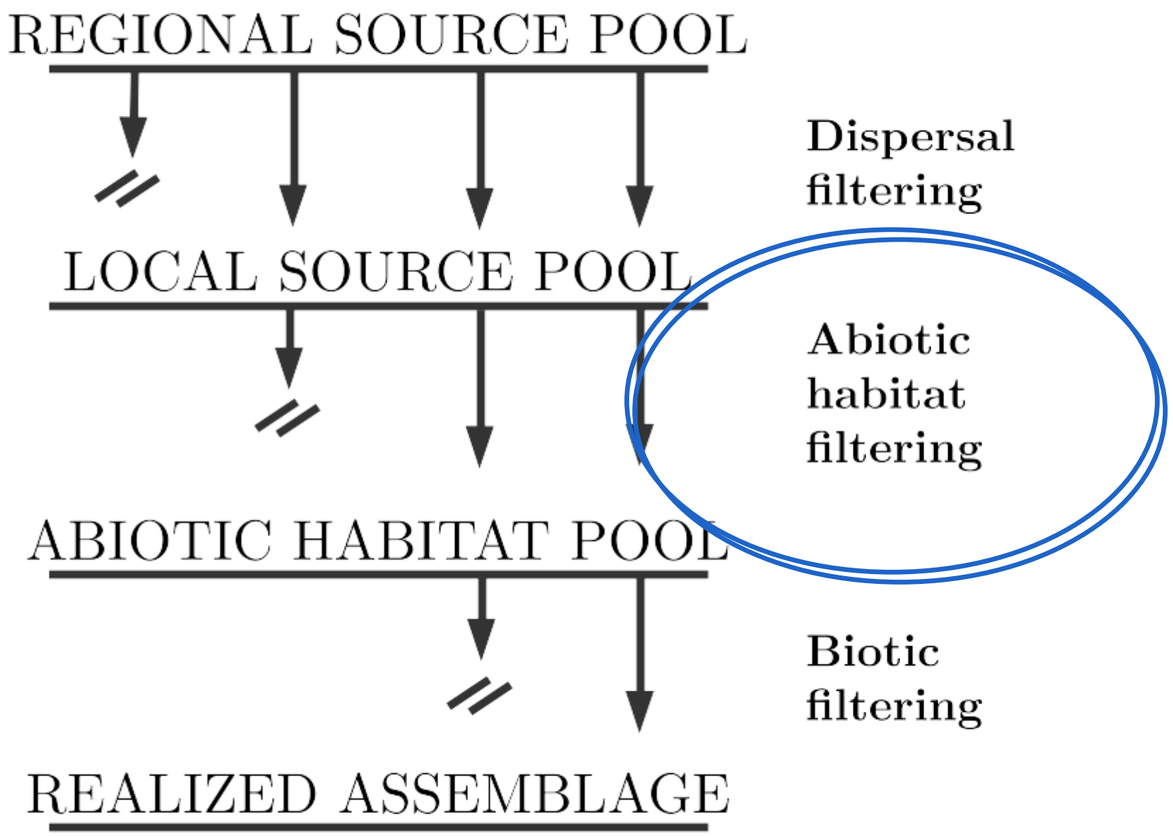
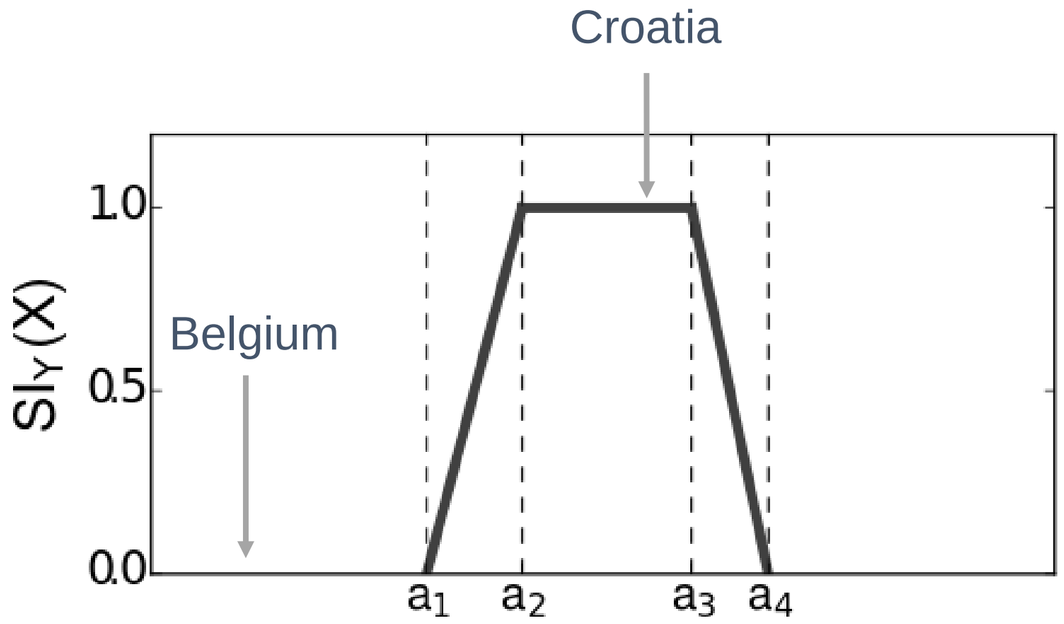
SPECIES DISTRIBUTION MODELS



Poff (1997)



e.g Temperature

$$HSI = f(SI_{X1}, SI_{X2}, .., SI_{Xn})$$

Y = species

X = input variable

$\boldsymbol{a}_Y$ = parameters of species response curve for input X

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MODEL OPTIMISATION

GIVEN data

FIND

- Input variables
- Species response curve parameters

WITH

- Optimisation algorithm

CONDITIONS

- Search a large unconstrained space
- Efficiently scan many possible distributions
- Preferably in an ensemble setting

EVEN MORE

- Automated
- Facilitate repeated analysis (on HPC)
- Open source

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MODEL OPTIMISATION

Machine learning (SVM, Decision Trees, ..)

Metaheuristic (GARP)

Statistical (GLM, GAM, ..)

Other (MAXENT, Fuzzy Logic, ..)

?

Implement metaheuristic Genetic Algorithm

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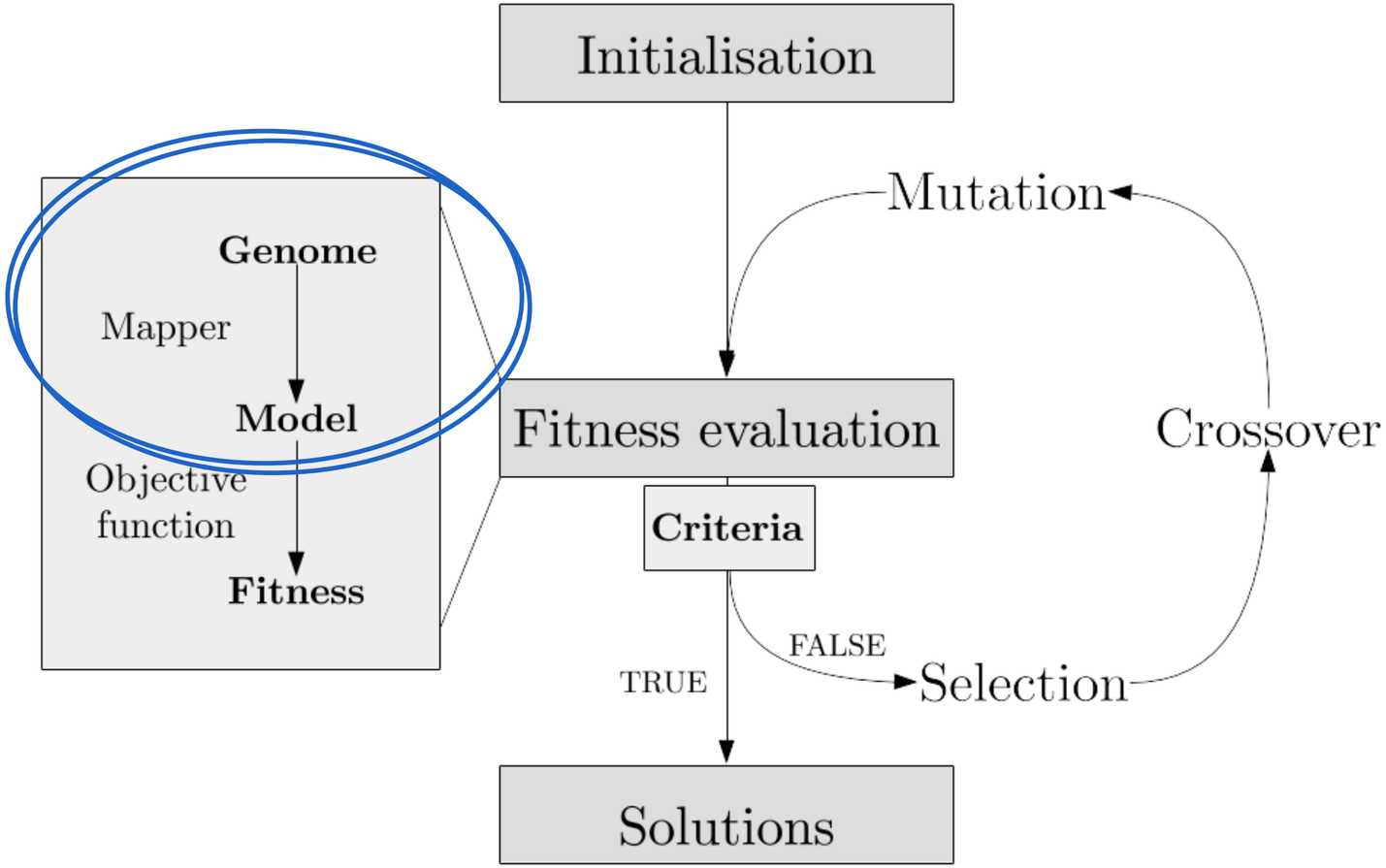
GENETIC ALGORITHM



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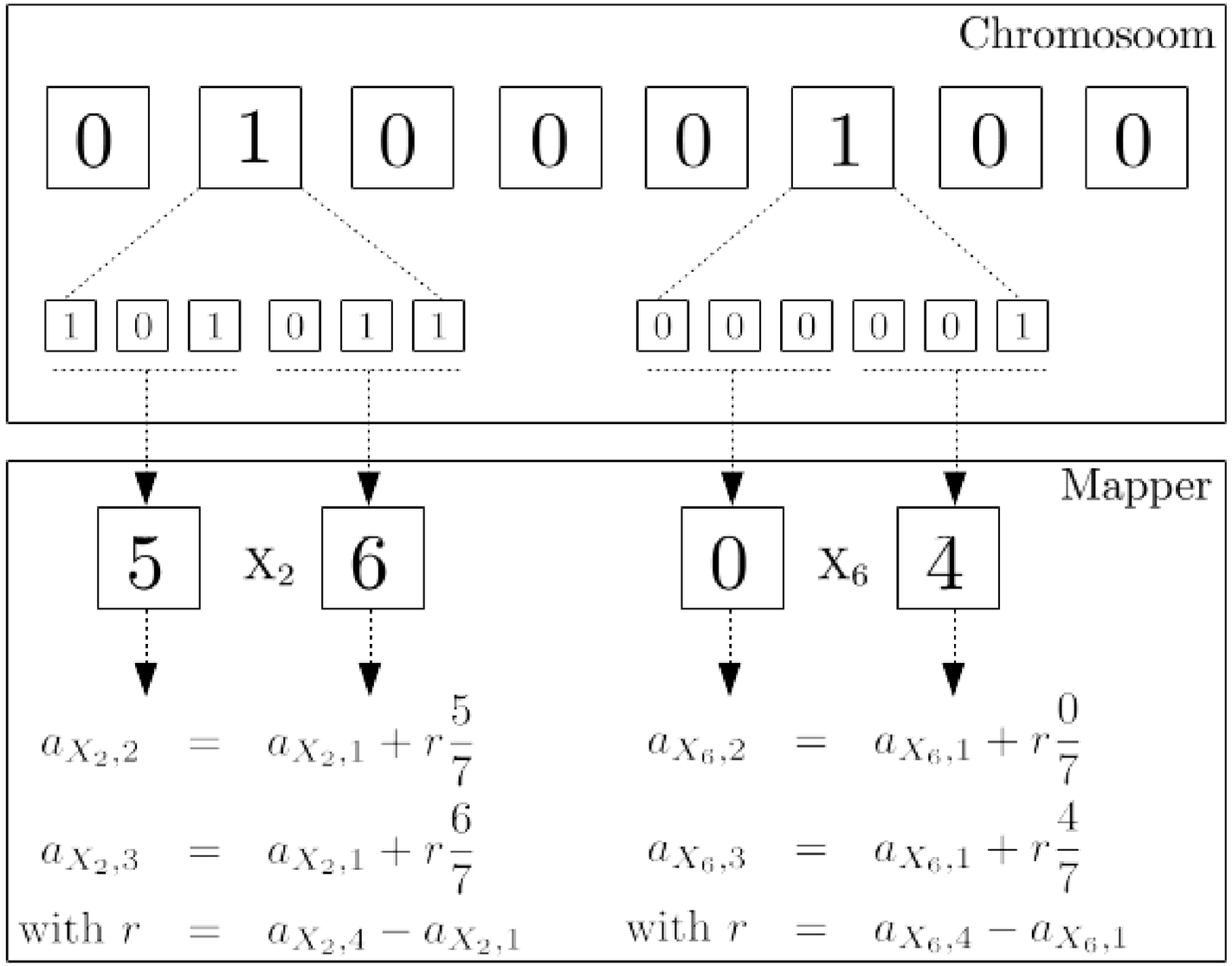
GENETIC ALGORITHM

input variables

parameters



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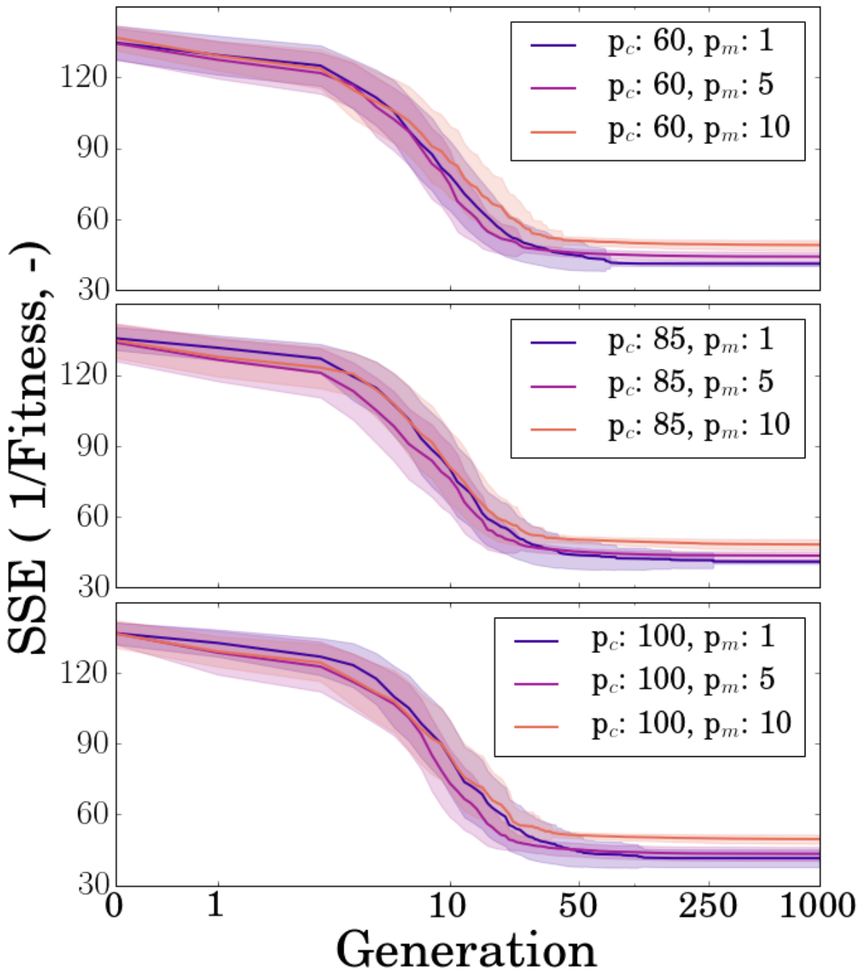
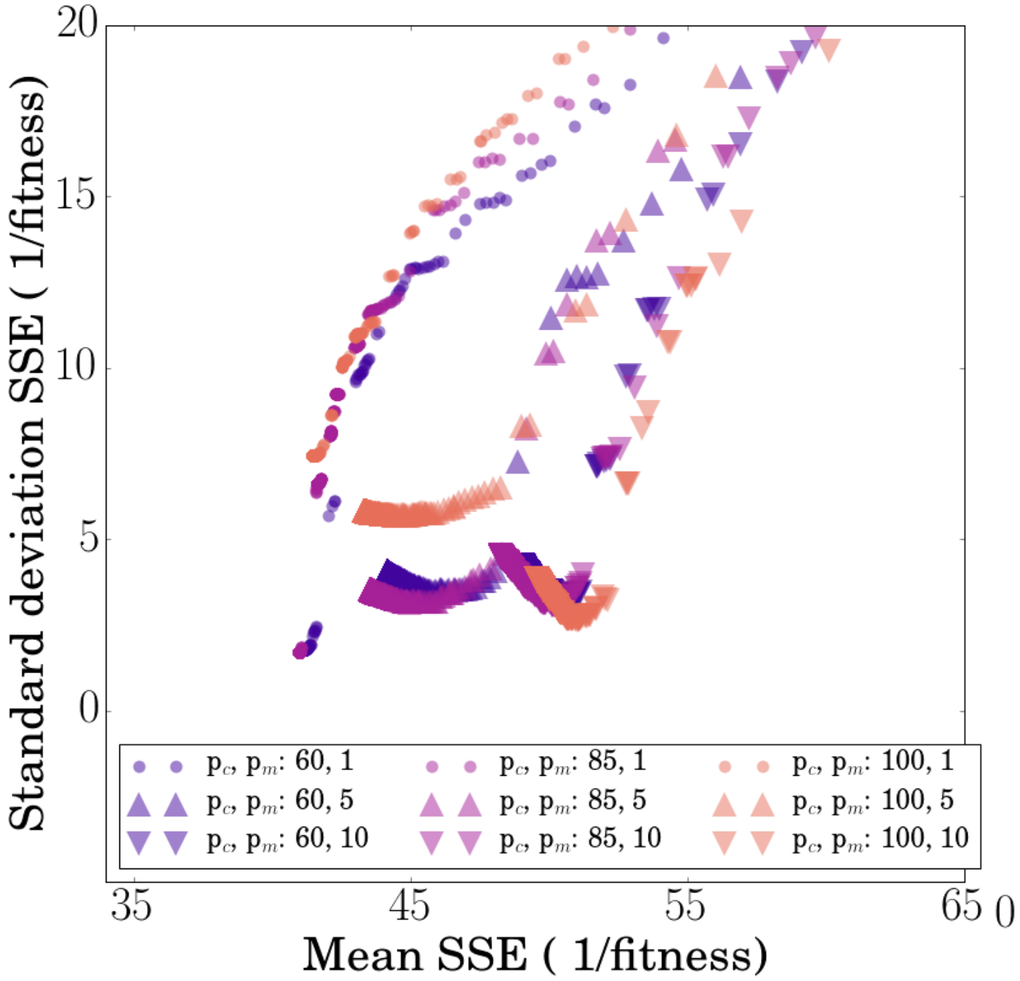
GENETIC ALGORITHM

- Hyper parameters? ⇨ Guidelines Gibbs et al. (2008, 2010)

  100 chromosomes, mutation rate = 5%, crossover rate = 100 %





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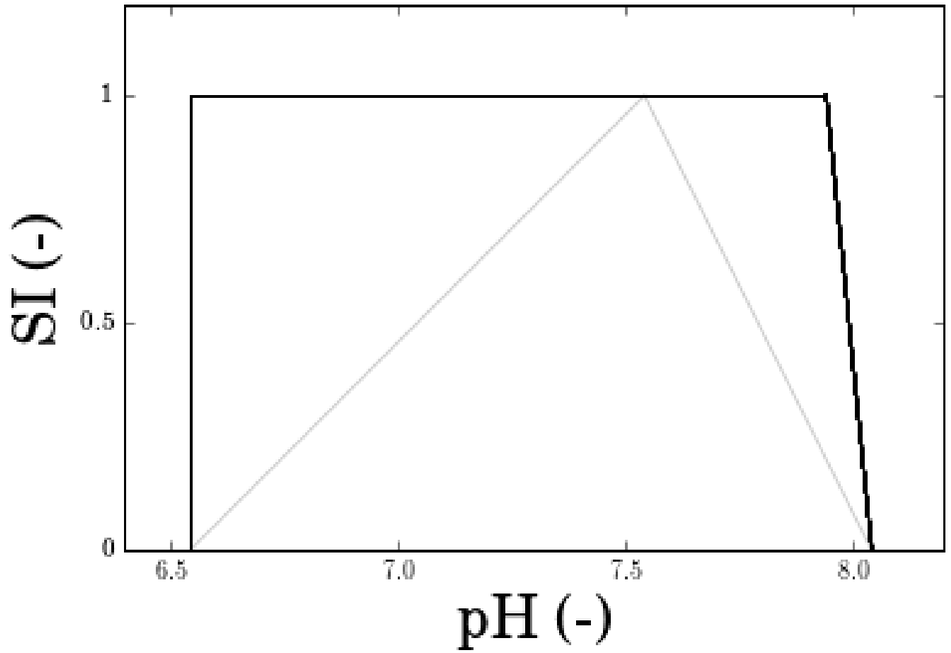
GENETIC ALGORITHM

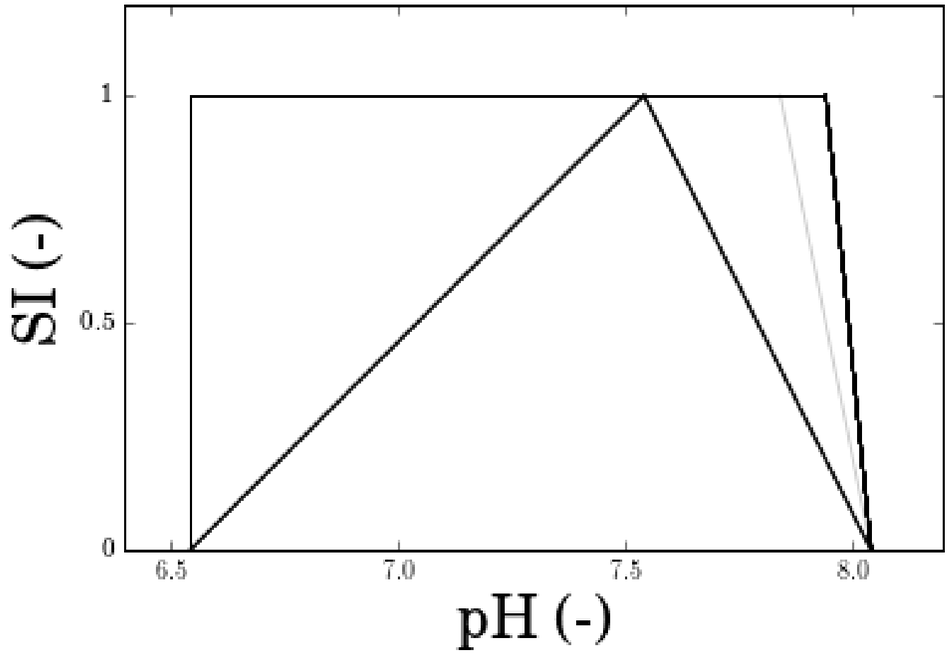
- Uncertainties!

  cloeon dipterum

1 % mutation rate



5 % mutation rate



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GENETIC ALGORITHM

- Hyper parameters
- Uncertainties!
- Encoding
  - ⇨ **Continuous** versus binary encoding
- Objective function
  - ⇨ Single or **multi-objective** optimisation
- How hard should a problem be for **algorithm to fail?**
  - ⇨ **Virtual approach**

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WHAT SOFTWARE IS AVAILABLE?

GitHub

https://sachagobeyn.github.io/SDMIT/

- Input variable selection
- Run on HPC
- Uncertainty analysis!

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