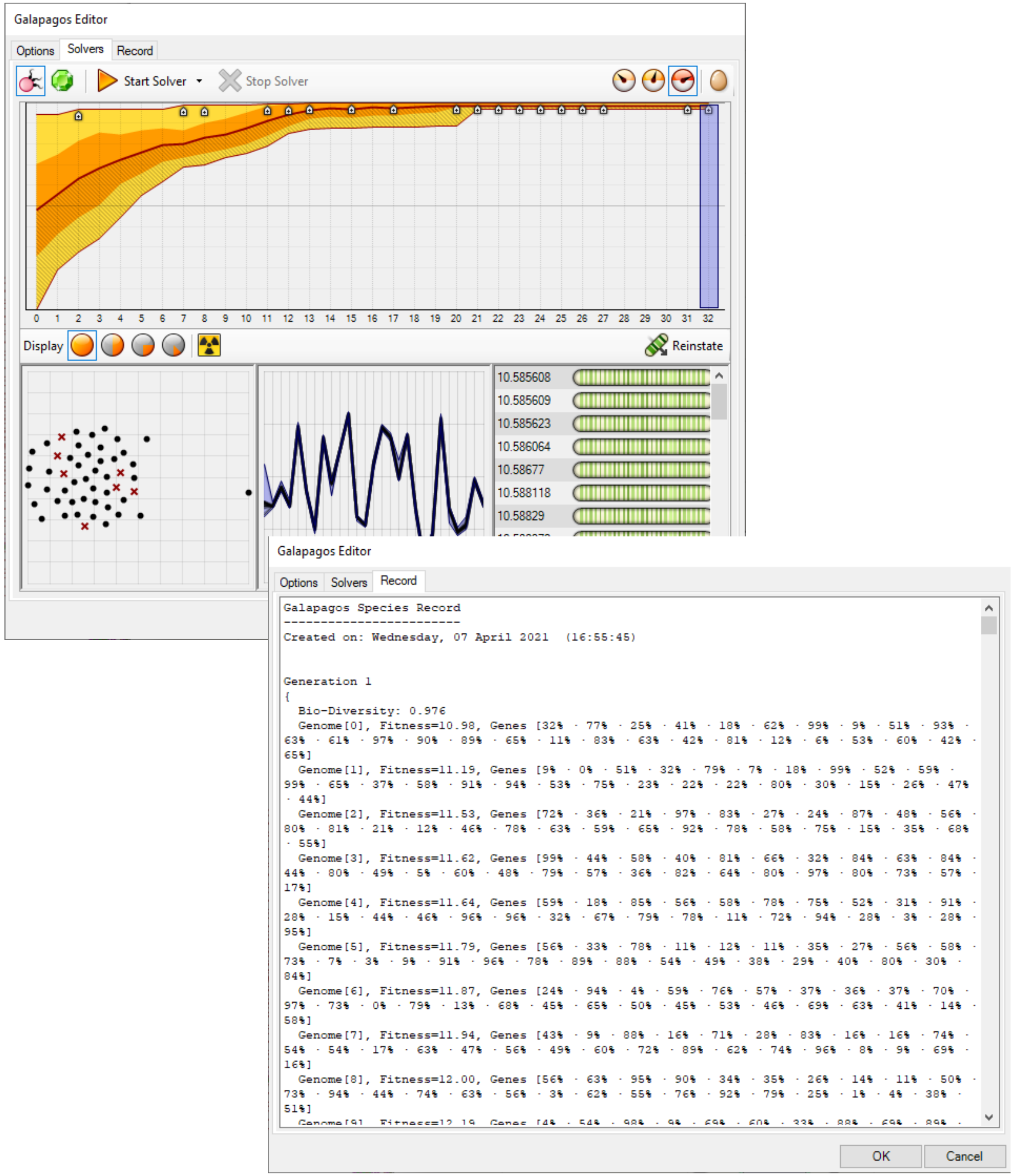
How to visualize an optimisation process

Optimisation parameters, convergence graph, best solutions

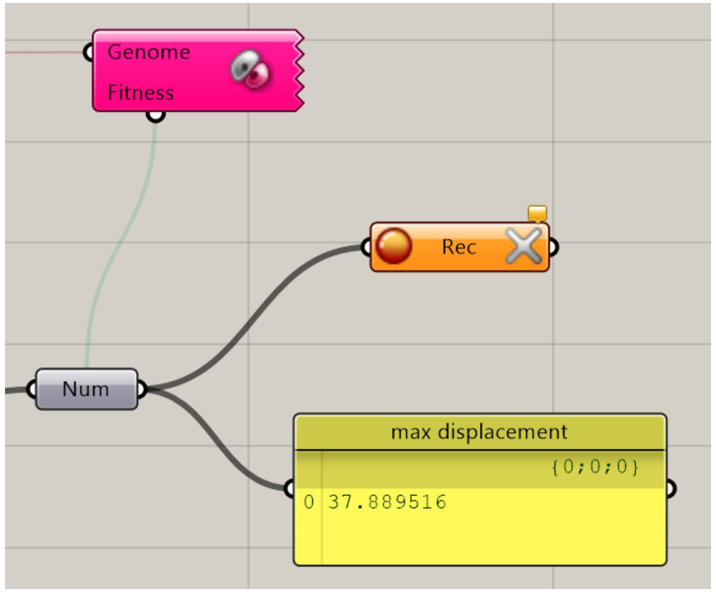
The Galapagos GA solver



Unlike other optimization solvers, Galapagos does not store information about the optimization process (convergence graph, solutions, etc.) within the GH file. Once we close the Galapagos interface, such information is lost.

However, Galapagos does generate a text log file. This file contains information about the optimisation process, but extracting data is not straightforward and requires good coding skills.

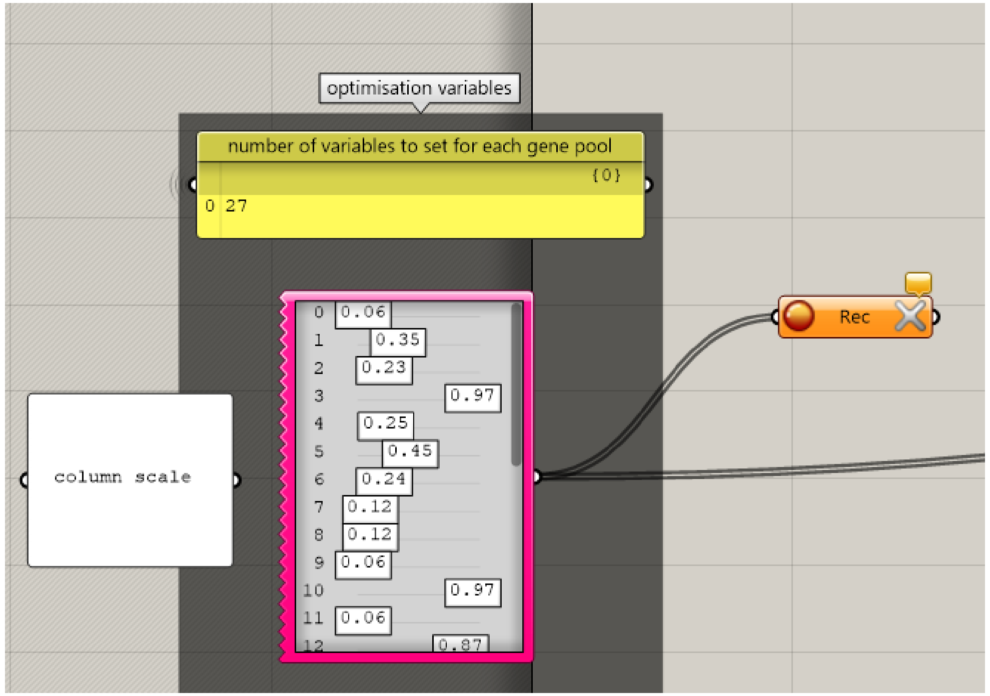
The Galapagos GA solver



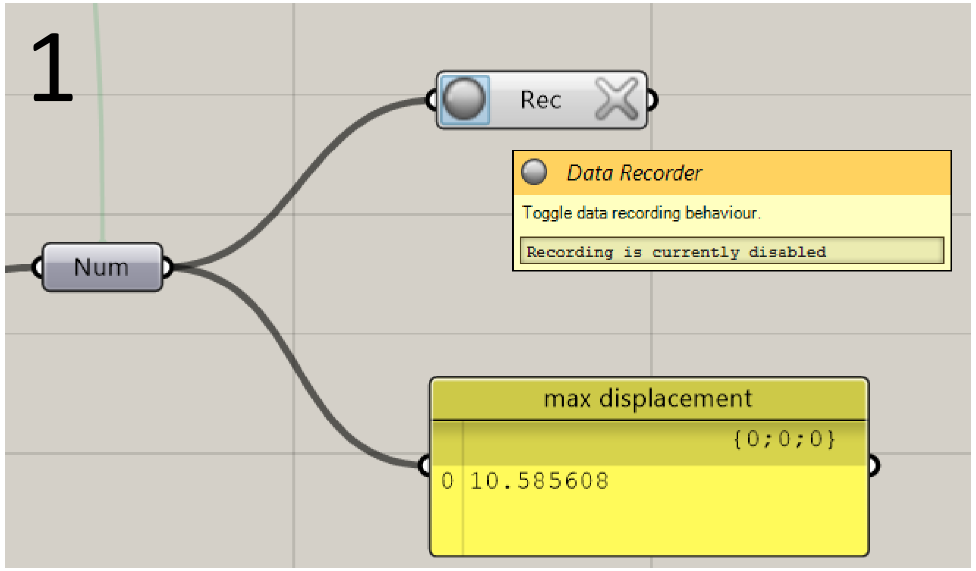
If you want to save information about the optimisation process, we recommend using a 'record' component (to be enabled before running the optimisation process).

You have to record both:

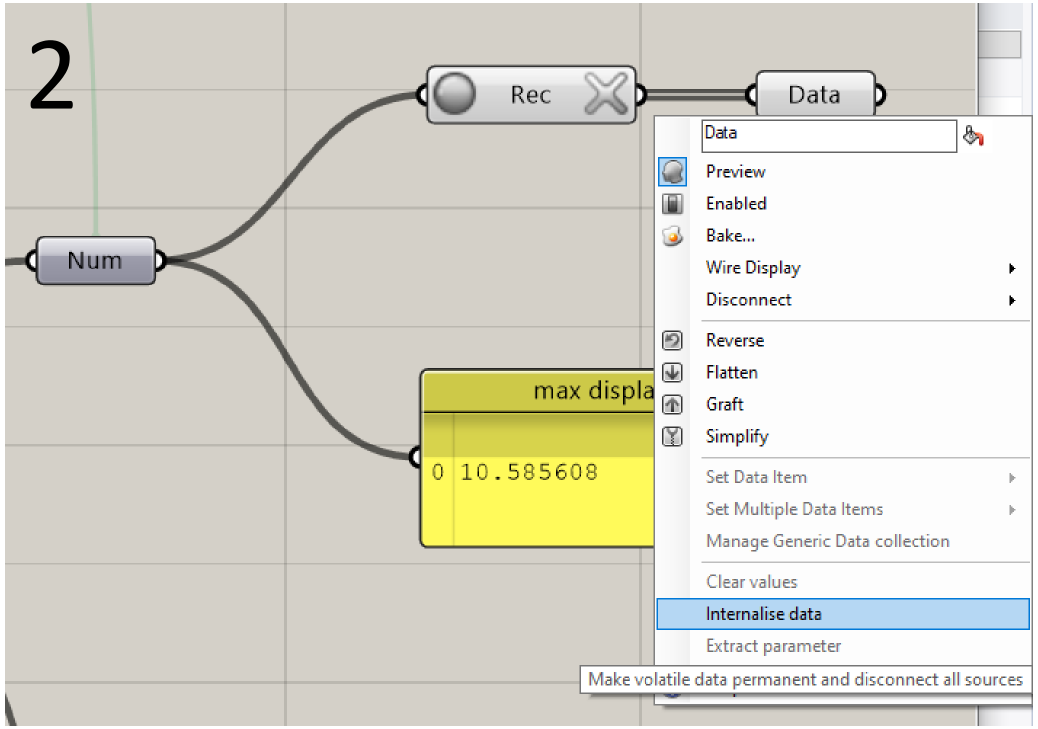
- 'fitness' (objective function/performance) and
- 'genome' (the design parameters)



Internalise the optimisation data in your GH file



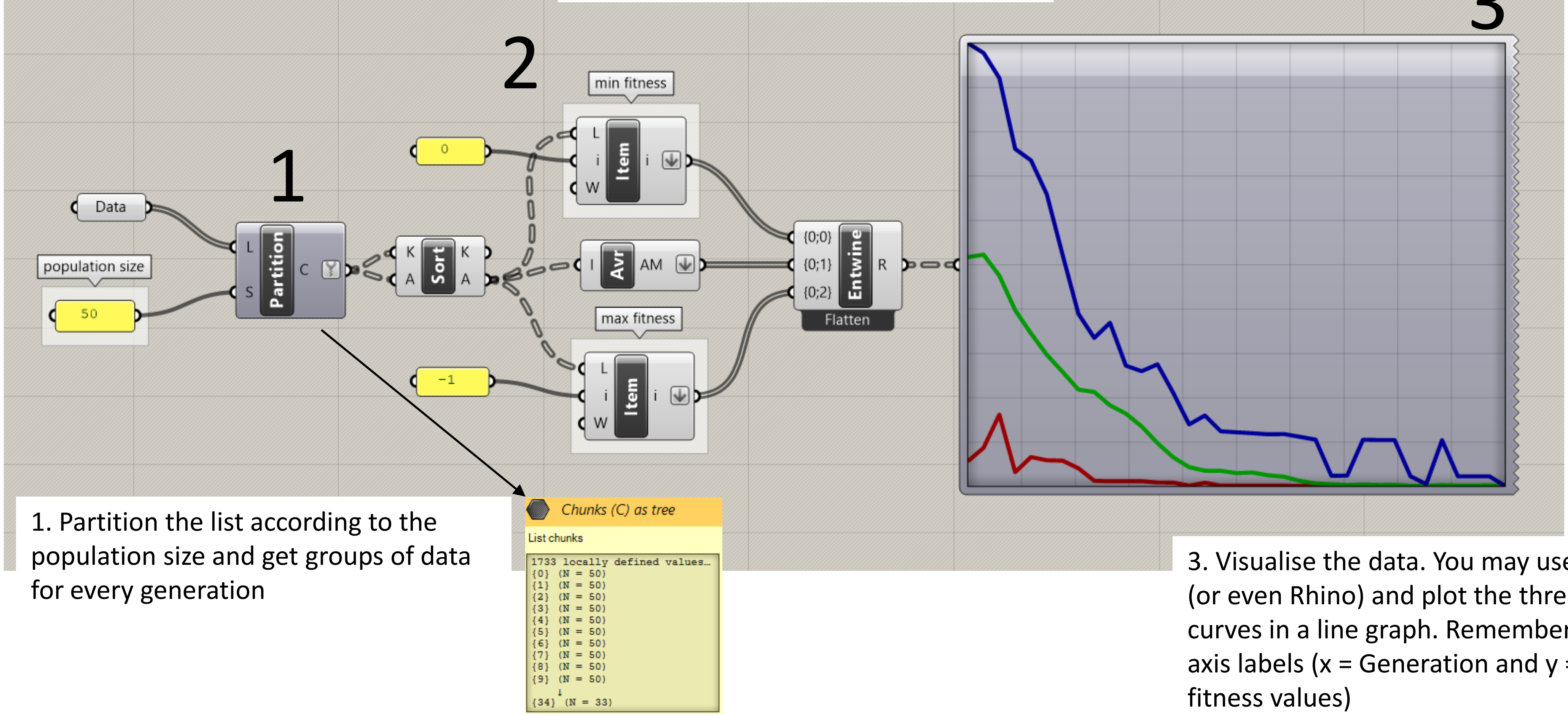
After closing the Galapagos canvas, disable the Rec buttons (from fitness and genome).



Plug the Rec output into a Data collector and internalise the data (repeat for Genome). After saving the Grasshopper file, this information will be accessible at any time.

Reconstruction of convergence graph from fitness values

2. Sort values and retrieve: min, max, and average fitness for every generation



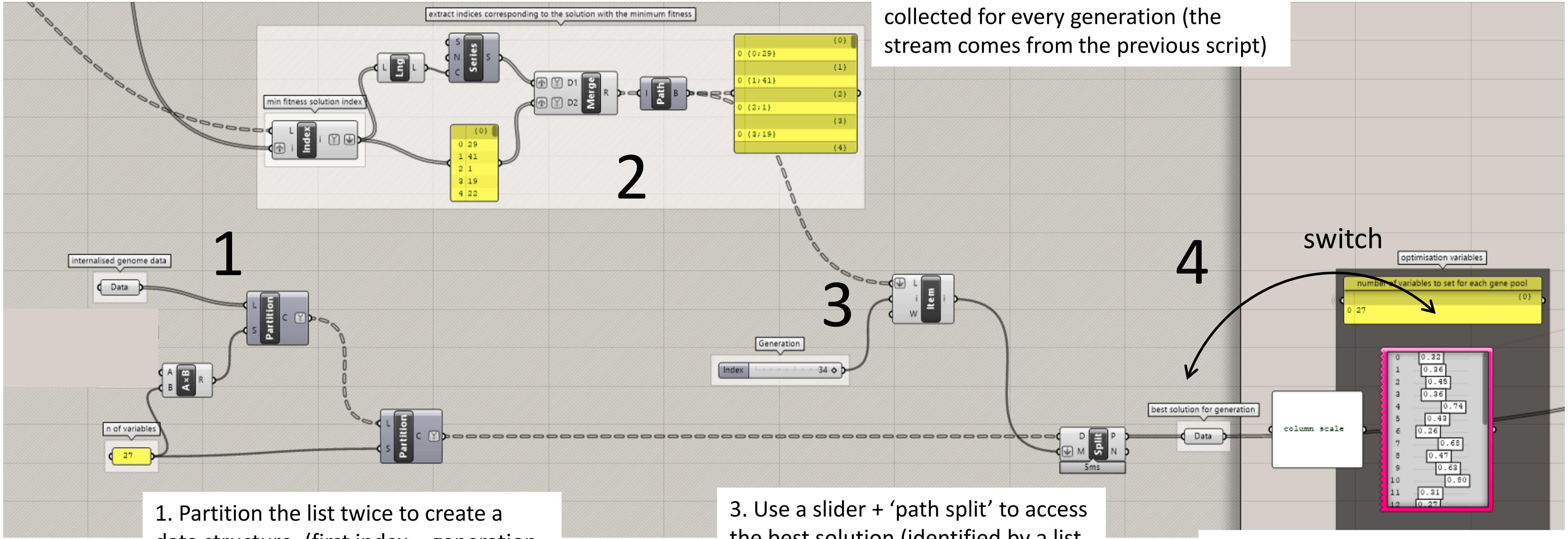
1. Partition the list according to the population size and get groups of data for every generation

3. Visualise the data. You may use Excel (or even Rhino) and plot the three curves in a line graph. Remember to put axis labels (x = Generation and y = fitness values)

n of branches = n of generations = 35

Get the best solution for each generation

2. Extract the index of the minimum value from the list of fitness values collected for every generation (the stream comes from the previous script)

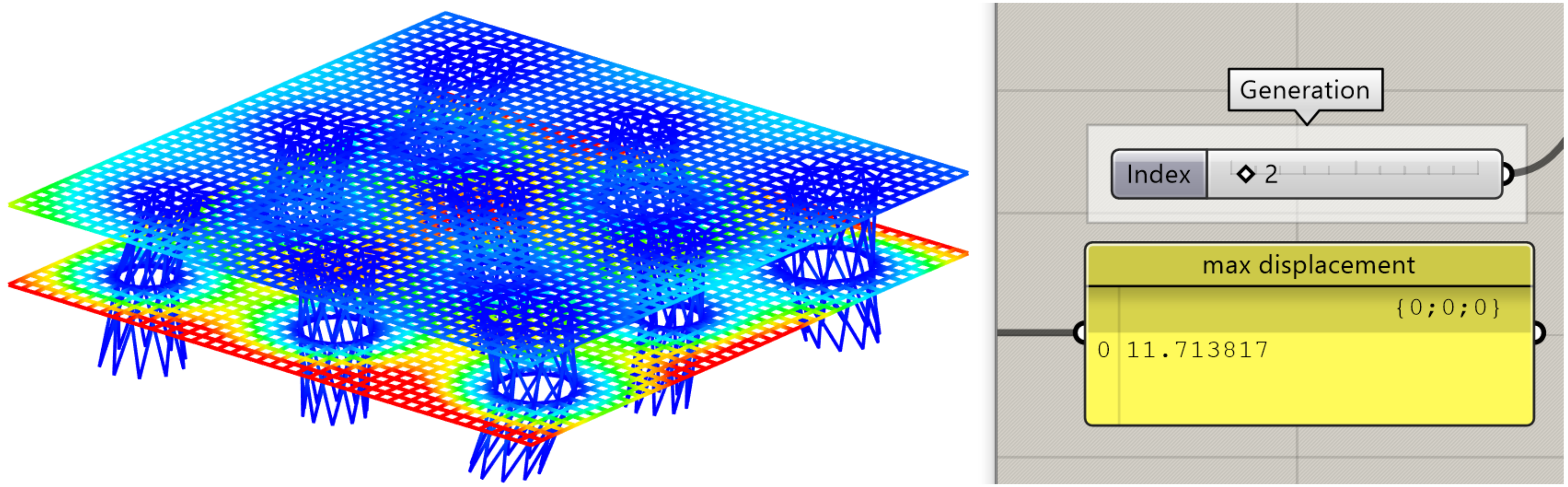


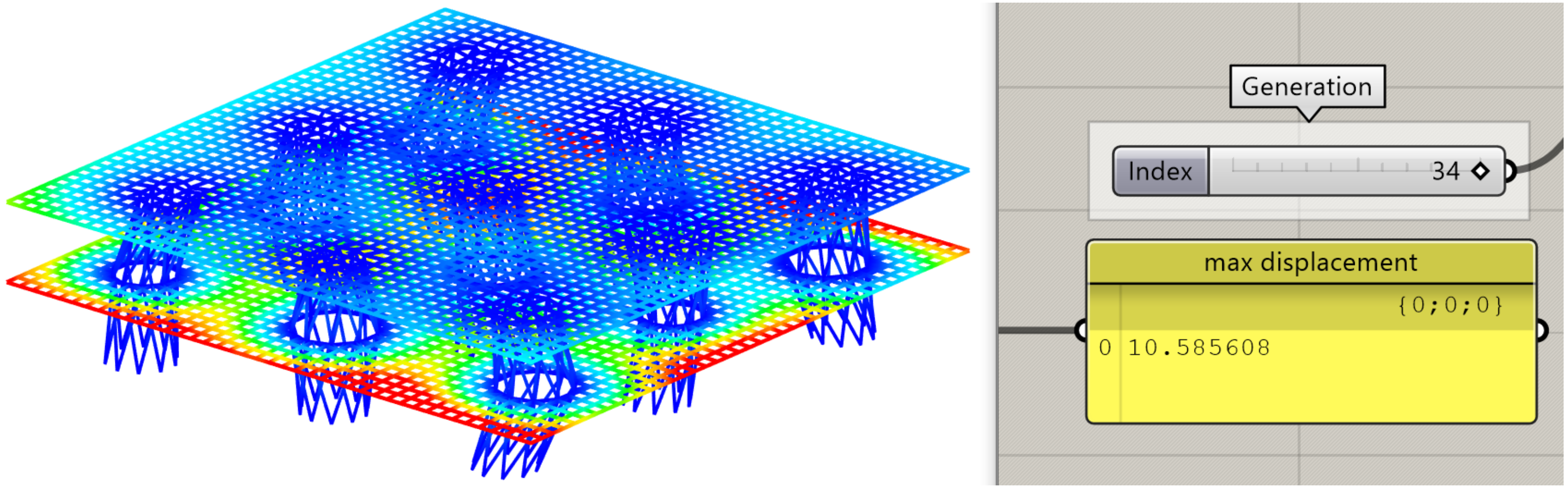
1. Partition the list twice to create a data structure. (first index = generation, second index = list of variables identifying a solution)

3. Use a slider + ‘path split’ to access the best solution (identified by a list of variables) for every generation

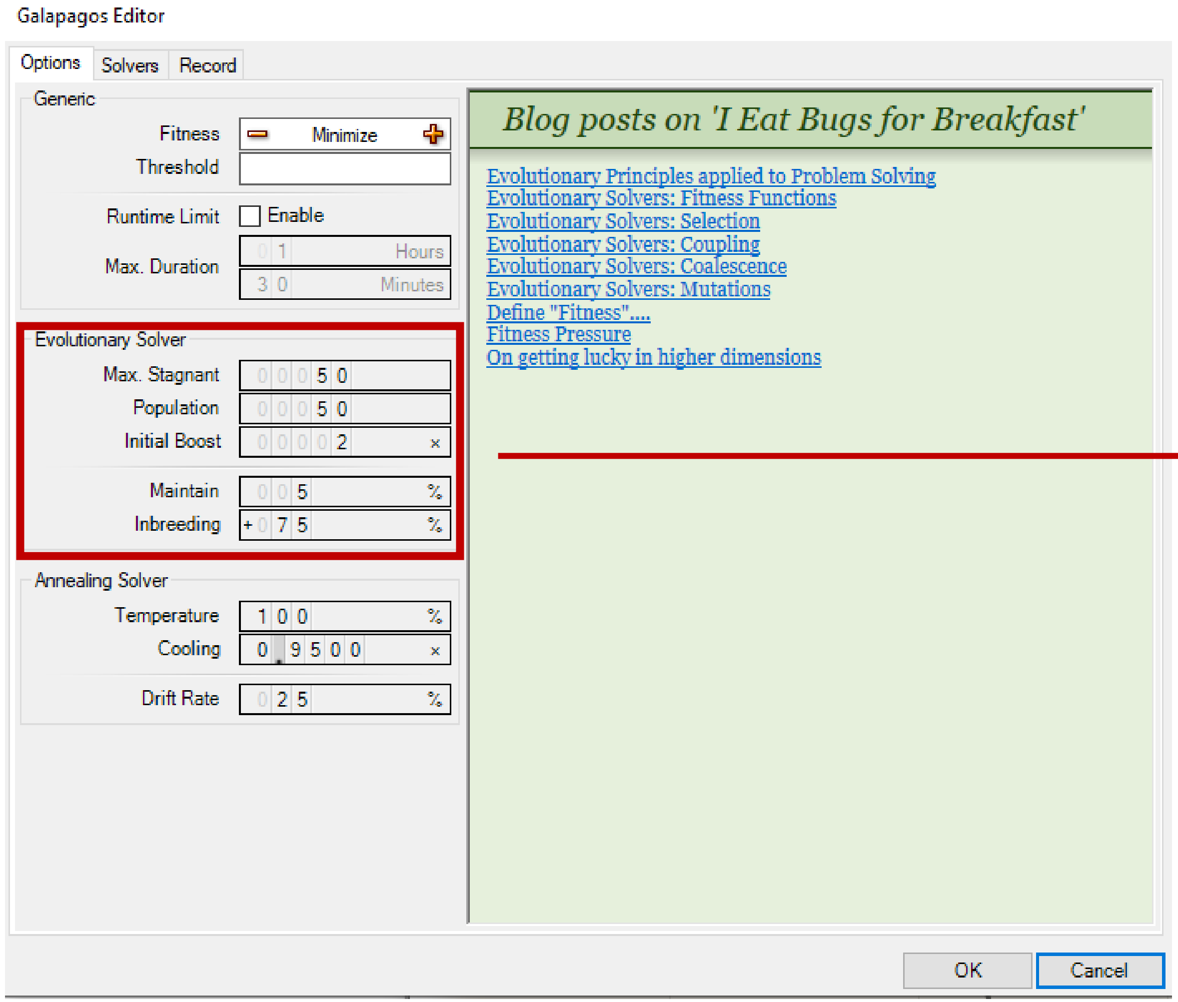
4. Replace the sliders or gene pool with the retrieved data

How to get the best solution (or design option) for each GA generation





Explain the optimisation process and its parameters



<u>Copy these values in a table and place the table next to your diagrams.</u>

Max stagnant is also known as the termination criterion (after 50 generations the process will stop if a better solution is not found).

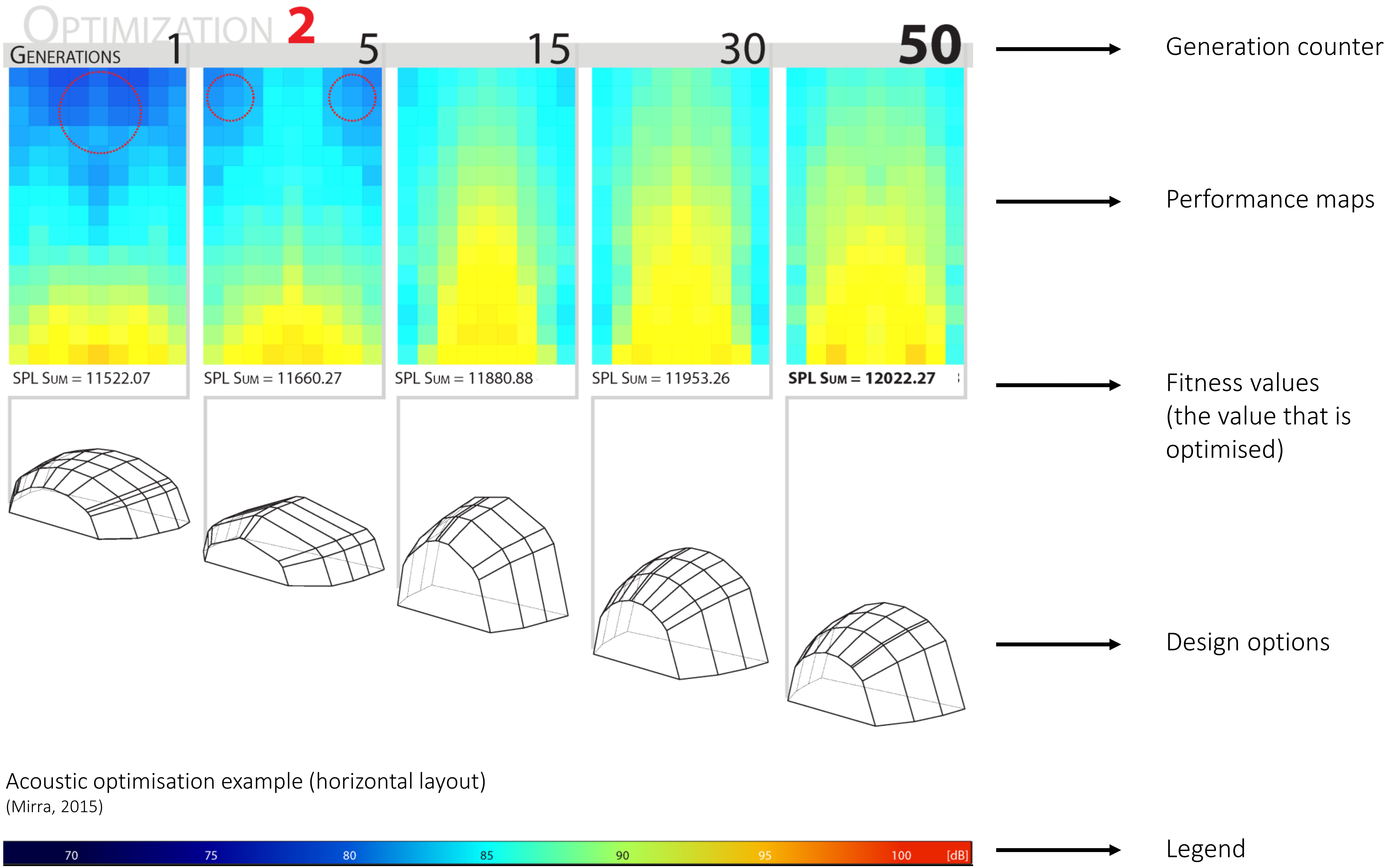
Population indicates the population size (the number of design options that are generated at each iteration, and are then recombined).

Initial boost is a multiplier of the population size for the first iteration only.

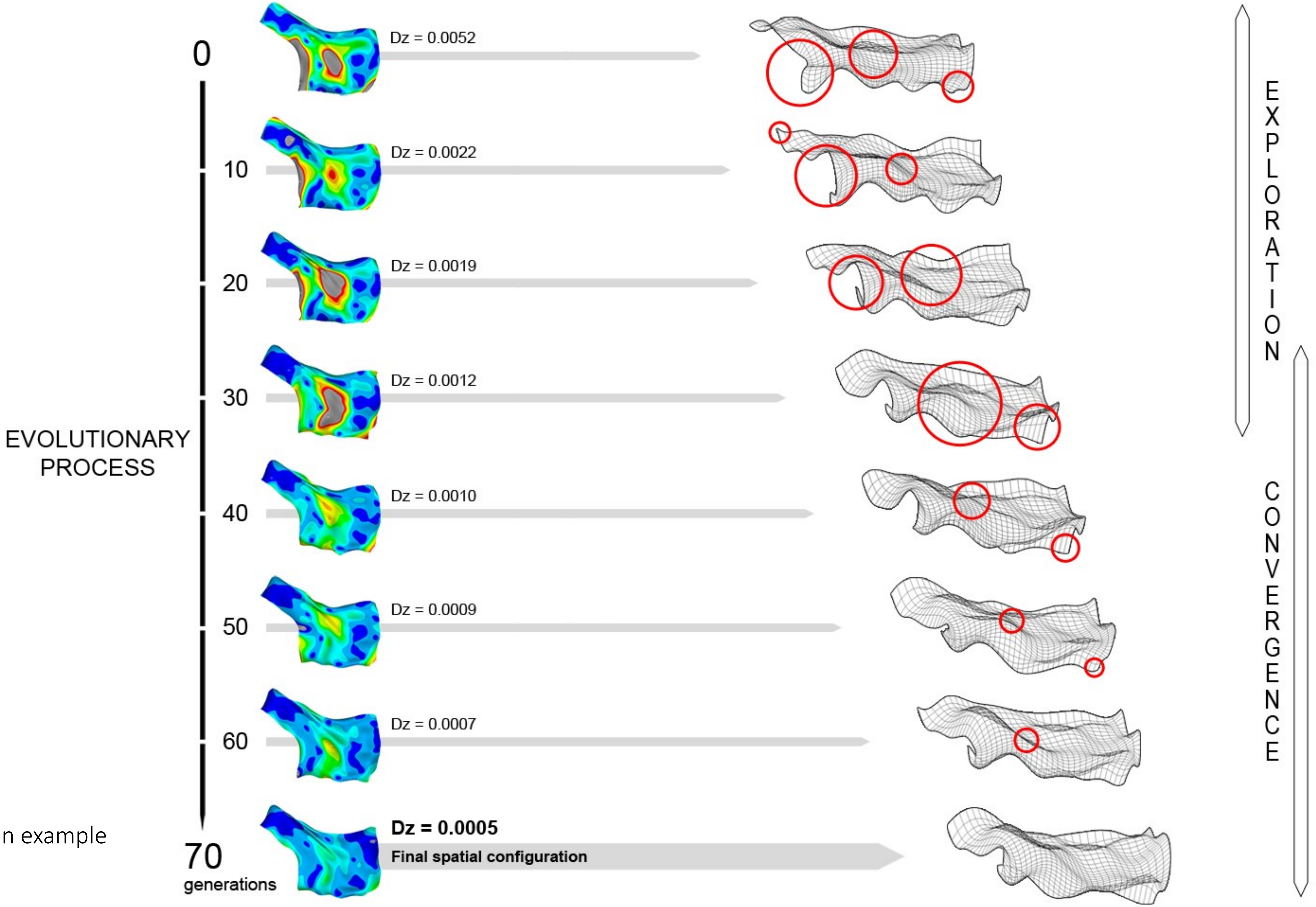
Maintain, also known as "Elitism" determines the number of design options that are preserved as they are from one generation to another (to avoid a decrease in performance through recombination)

Inbreeding, also known as crossover, indicates the percentage of design options that are recombined at each generation. Having a low number will allow the GA to explore more design options but the process will be slower (will run for more generations to get meaningful outcomes). High numbers will allow the GA to converge quickly, in most cases too quickly.

Finding the best values depend on the problem to solve and is a trial-and-error process.

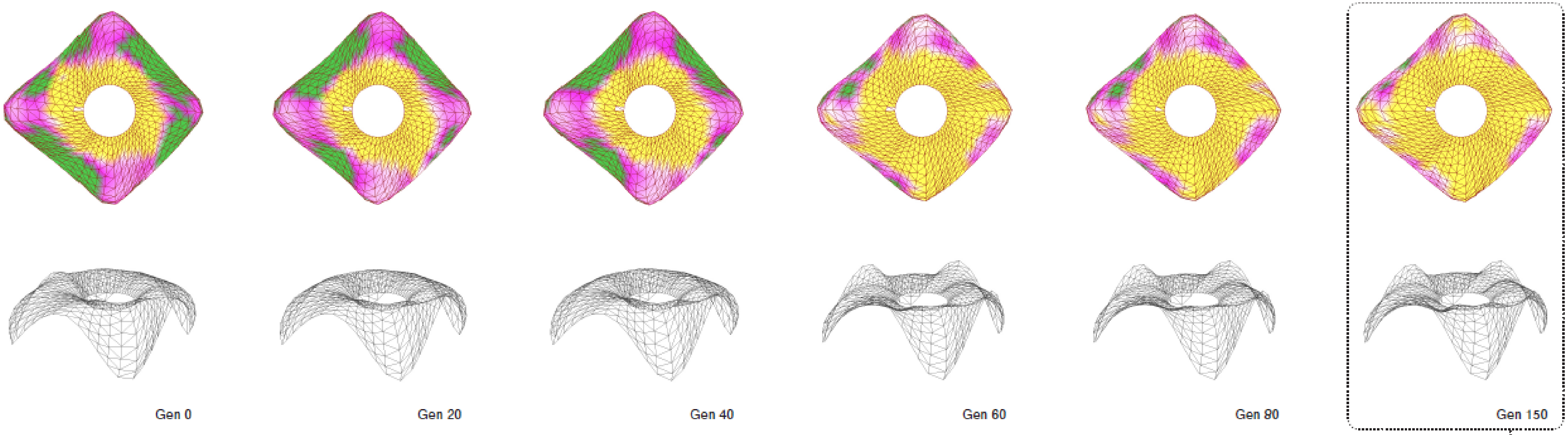


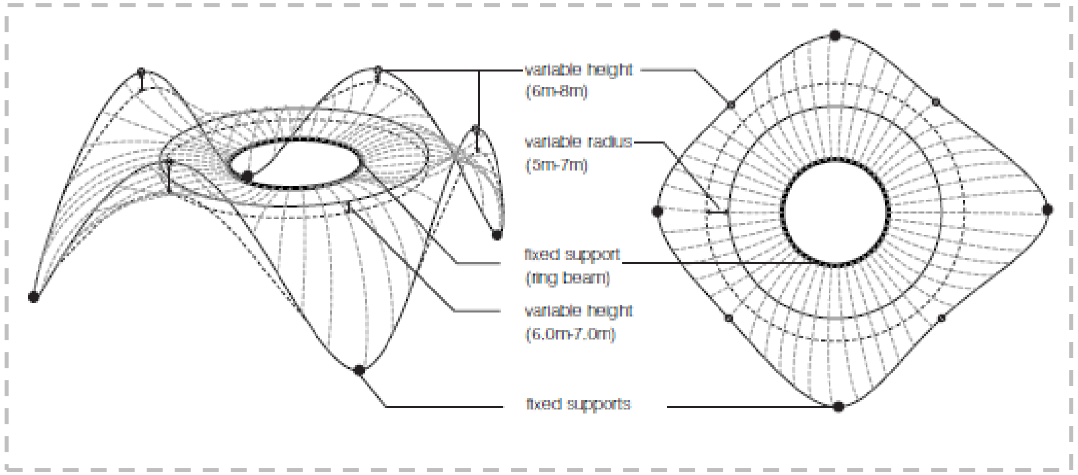
Acoustic optimisation example (horizontal layout)
(Mirra, 2015)



Structural optimisation example (vertical layout)
(Pugnale, 2007)

Synthesis including design variables, performance, and optimisation





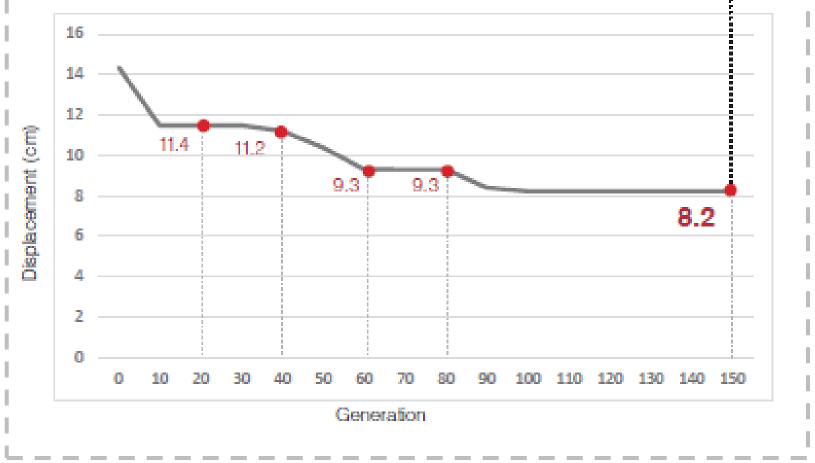
Design variables + constraints

Displacement Legend (cm)

- <1
- 1 - 2
- 2 - 3
- >3

Fitness: Displacement (cm)
Types of Loads: Mesh Load & Gravity load
Amount of Load: 1kN/m²
Number of Supports: 4 ground supports(fixed translation and rotational vectors) and ring beam support (fixed translation vectors and rotation vectors (free to rotate on the Z axis)

Structural analysis data



Optimisation convergence graph

Image credits: Kevin George (Studio CDE 20, 2013)