

Optimizing the Surge Arresters Location for Improving Lightning Induced Voltage Performance of Distribution Network

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Presentation Outline

- 1. Introduction*
- 2. Modelling Lightning Induced Voltage*
- 3. Improving Lightning performance*
- 4. Optimizing Tool*
- 5. Conclusions and Future Work*

Introduction - Motivation

- *Power quality has become one of the main area of interest around the world for mains, utilities, industries and consumers.*
- *Lightning causes around 50% of the network electromagnetic disturbances (short interruptions and voltage sags)*



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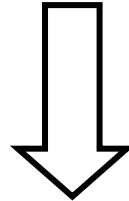


Introduction - Motivation

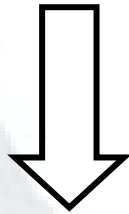
- *Millions of USD for losses caused by lightning in distribution network*
- *Is important to look forward techniques for reducing lightning impact on distribution networks.*
- *Shielding wire groundings, surge arresters and enhancement of Line BIL are a very useful technique*

Lightning Induced Voltage Modelling

*By means of accurate calculation of lightning-induced overvoltages on
real distribution networks*

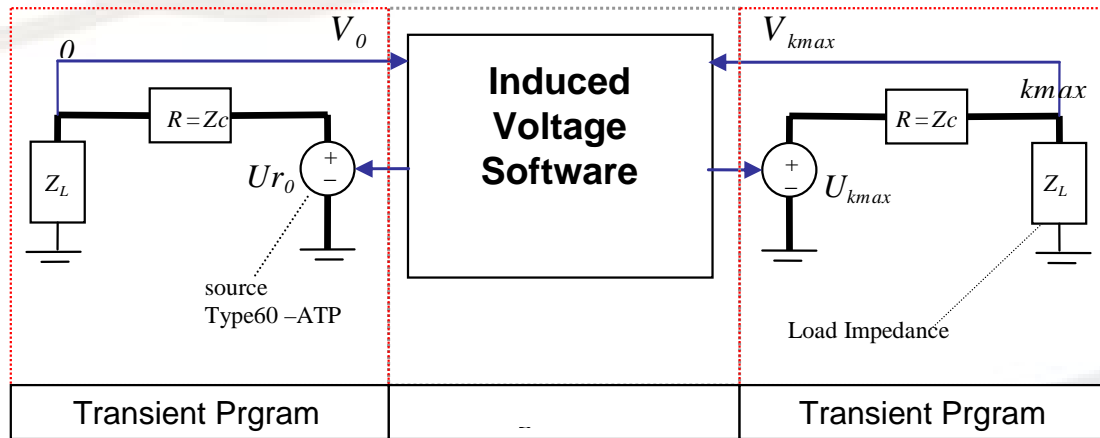


*Optimized design of distribution networks against
external overvoltages*



*Correct definition of number and location of protective devices (**shielding wire groundings and surge arresters**)*

Link with Transient Analysis Software



- LIOV-EMTP/MATLAB (Methodology A)

EMTP96 – using **TACS** on a **DLL** and **MATLAB** – using **S-function**

- YALUK-ATP (Methodology A)

ATP – Using **Foreign Models** on a **DLL**

- LIV-ATP (Methodology B)

ATP programmed in **MODELS**

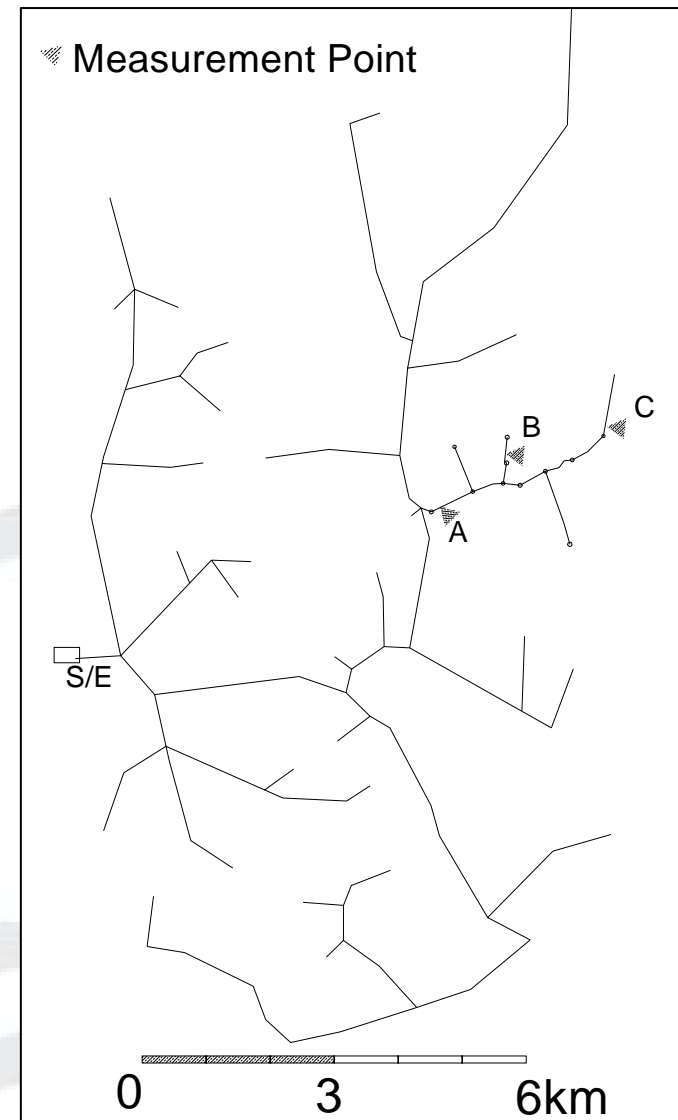
Diminishing Number of Failures

- *Surge Arrester (SA) helps to Diminish the fault rate due to induced Voltages*
- *The best solution for a straight line is locate a SA **Every Pole***



Diminishing Number of Failures

- *Which is the best SA location?*
 - *If the number of SA is fixed and limited?*
 - *If it is used a Complex distribution Network with non-homogeneous pole distribution?*



Software Tool – Structure

- *It was developed a Optimizig Software Tool for SA location.*
- *Object function is diminish number of failures for a fixed number of SA*
- *Based on Genetic Algorithm (GA) Technique*
- *Each ‘individual’ (possible solution) is characterized with an unique SA location*
- *For each individual it should be calculated the lightning-induced voltage performance of the line.*
- *It is used a certain number of strokes for this task*

What is Genetic Algorithm?

Initial individual
generation

C_1

C_2

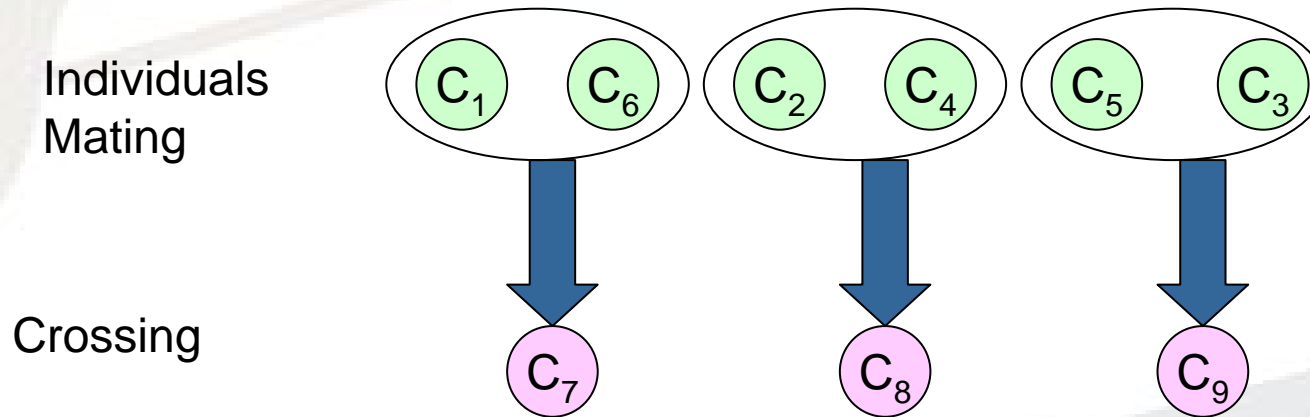
C_3

C_4

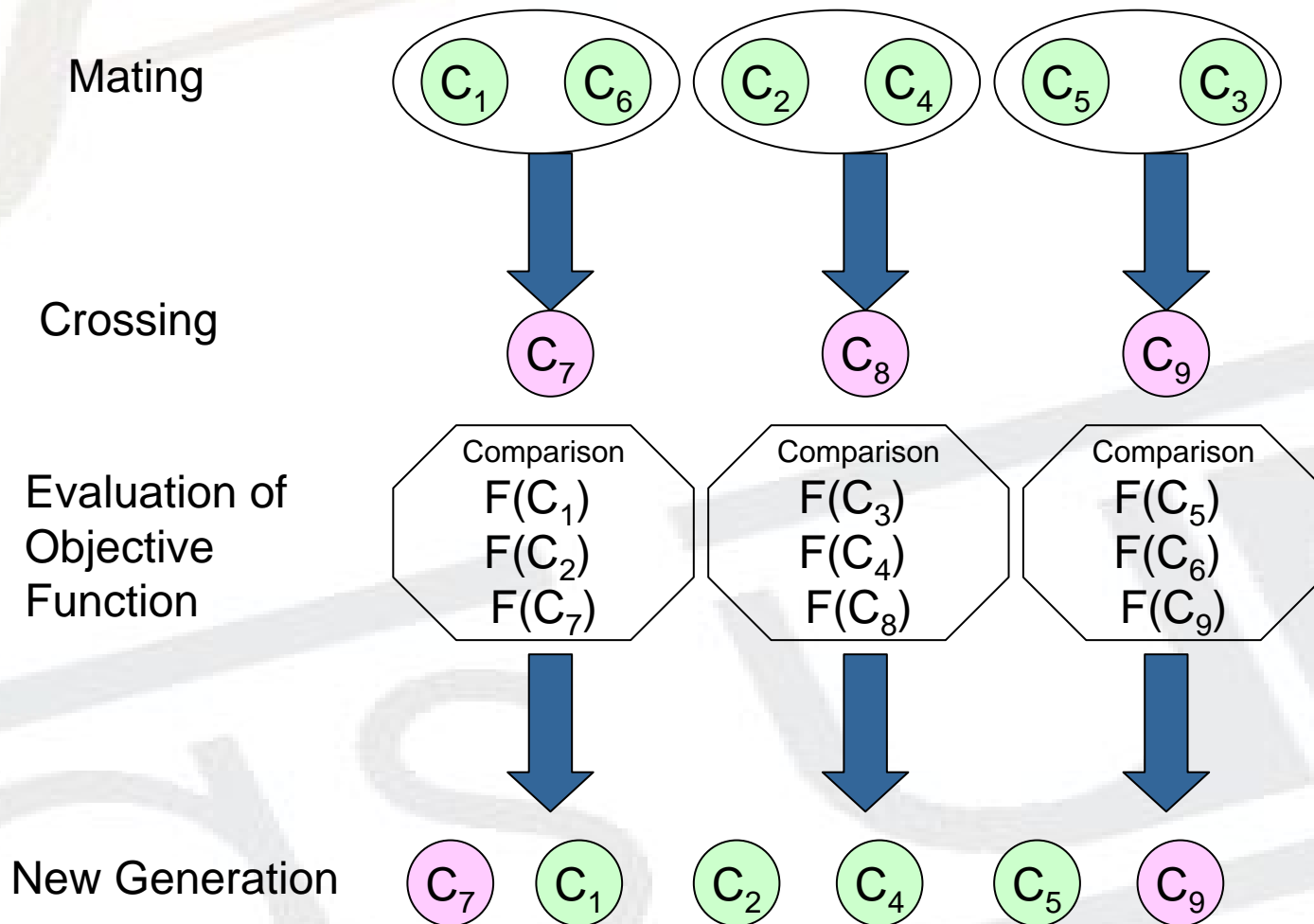
C_5

C_6

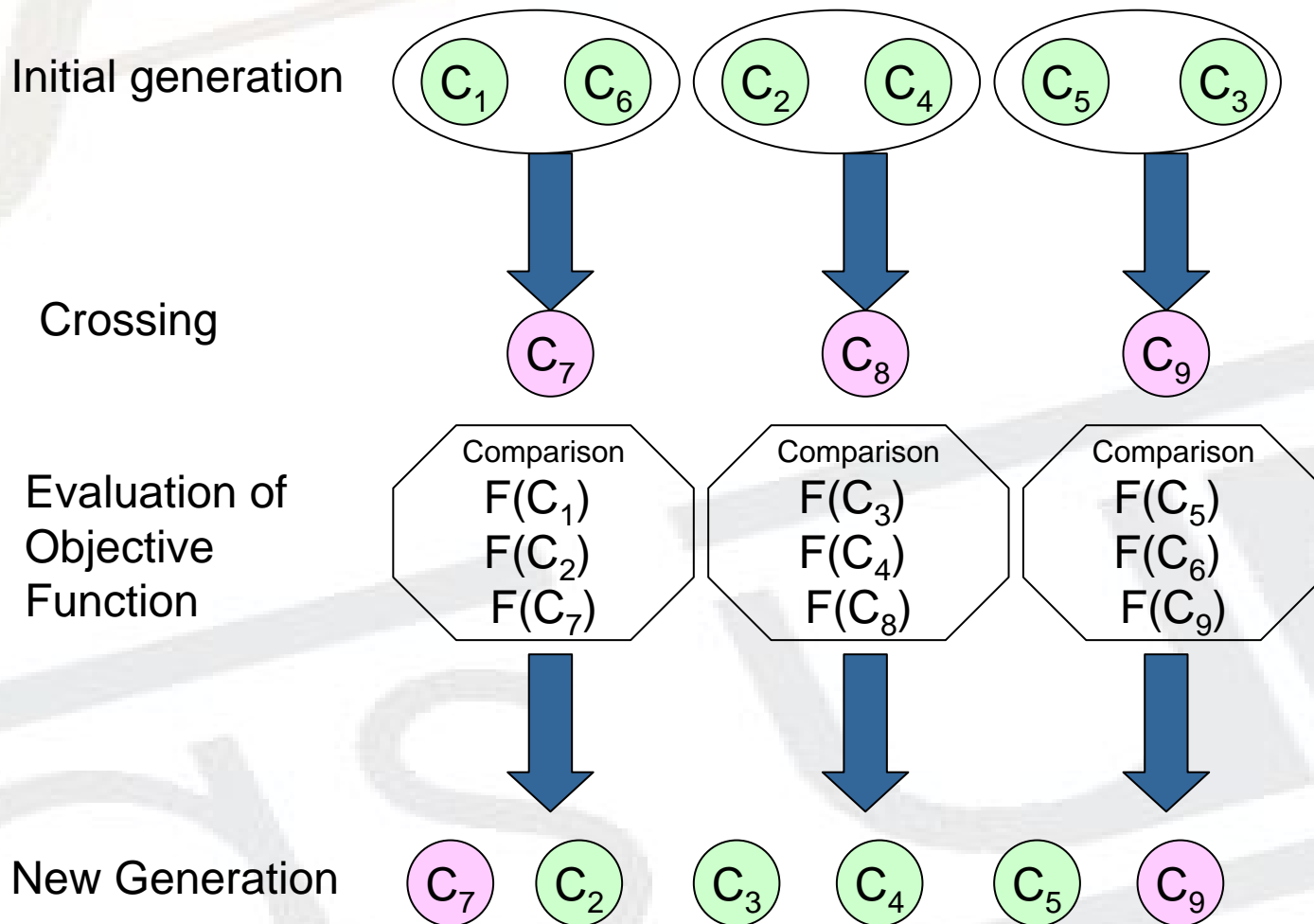
What is Genetic Algorithm?



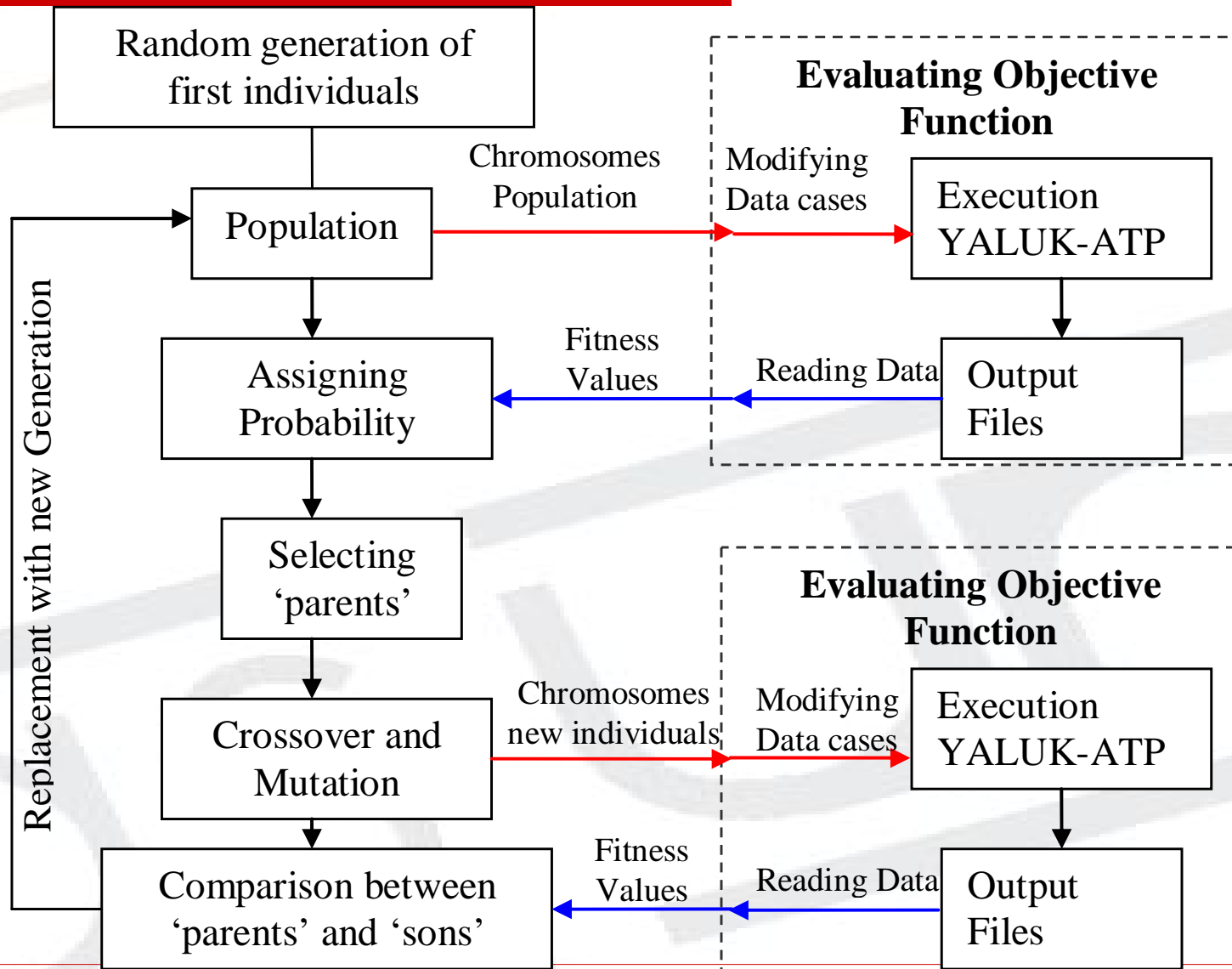
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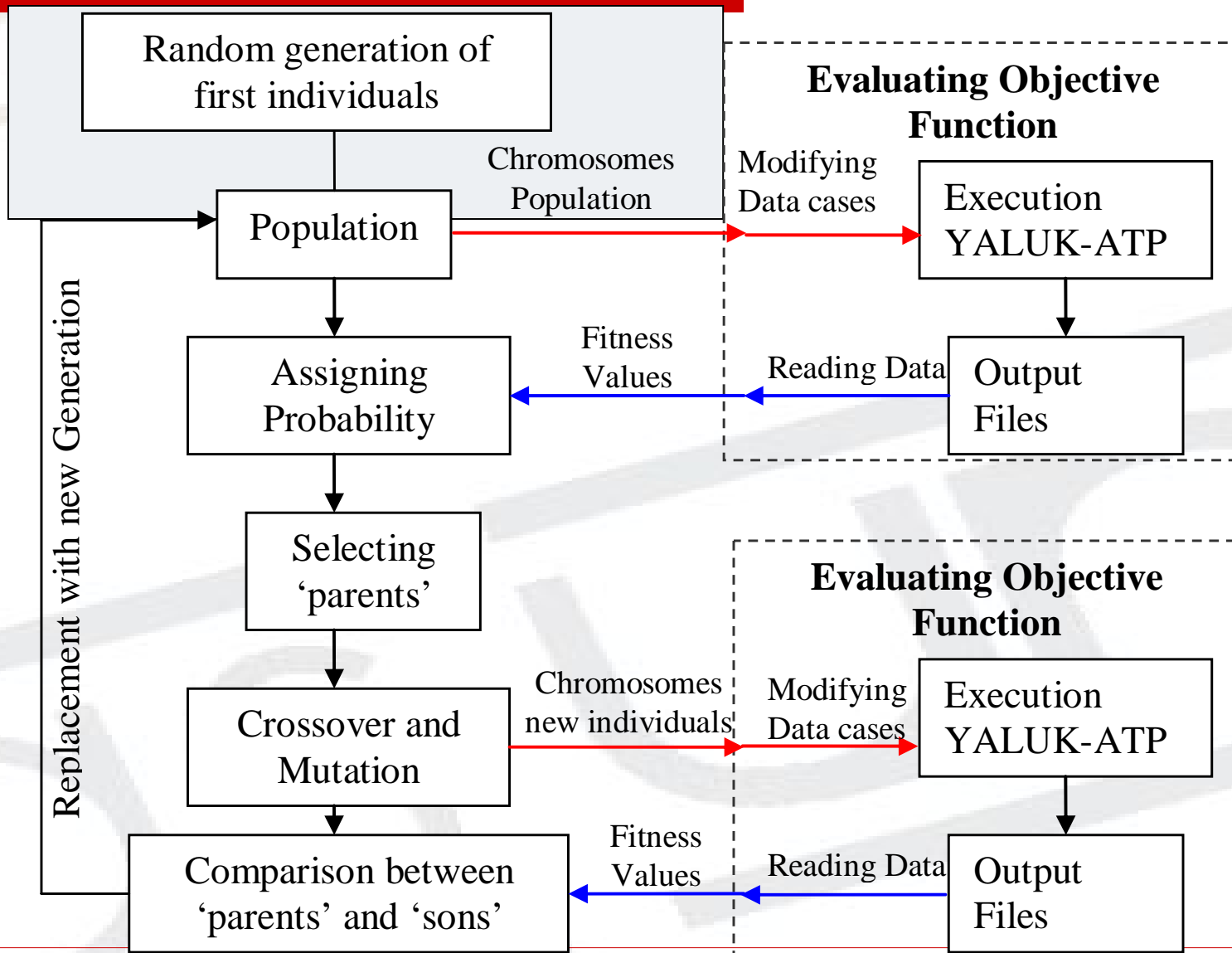
What is Genetic Algorithm?



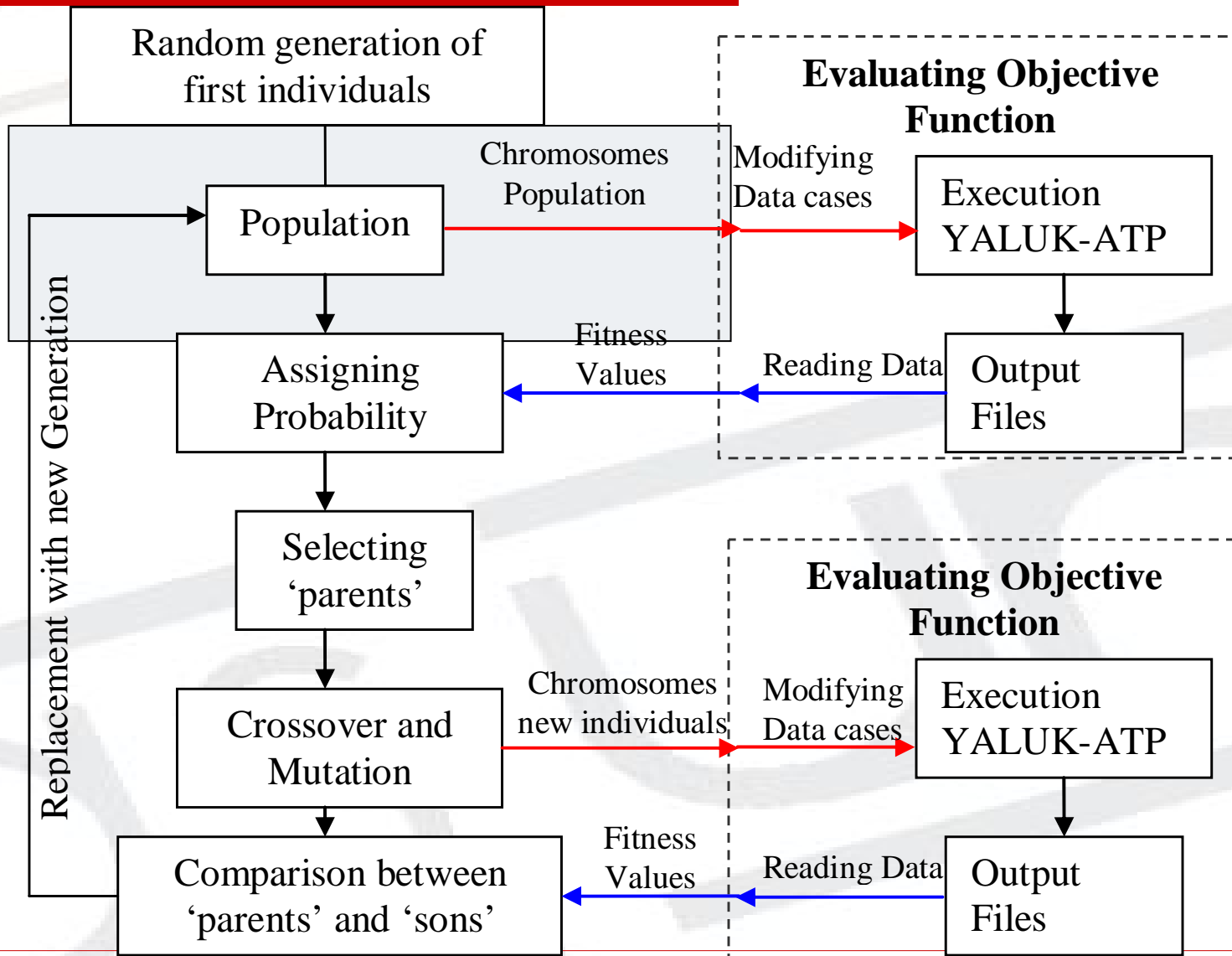
Genetic Algorithm Scheme



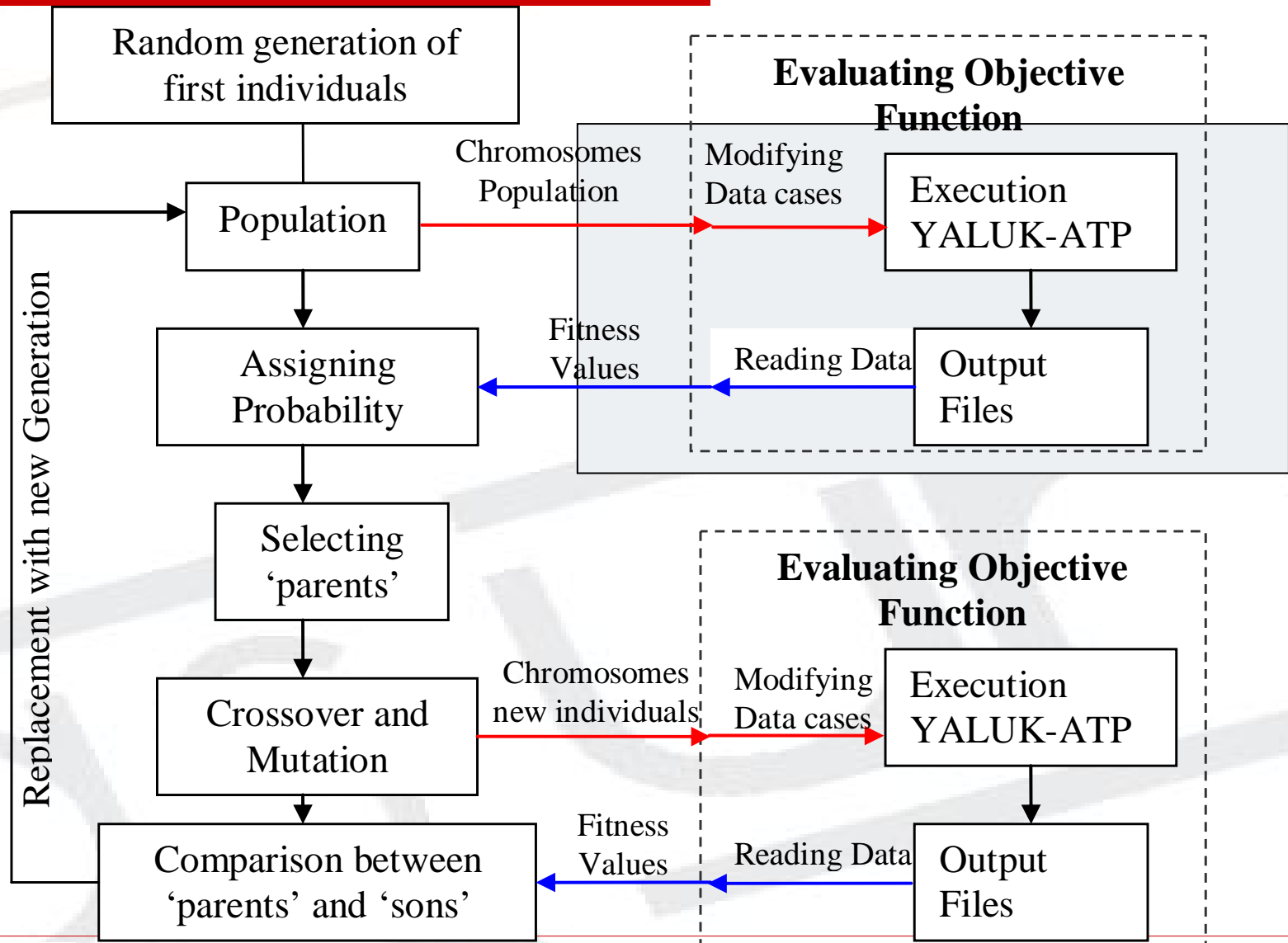
Genetic Algorithm Scheme



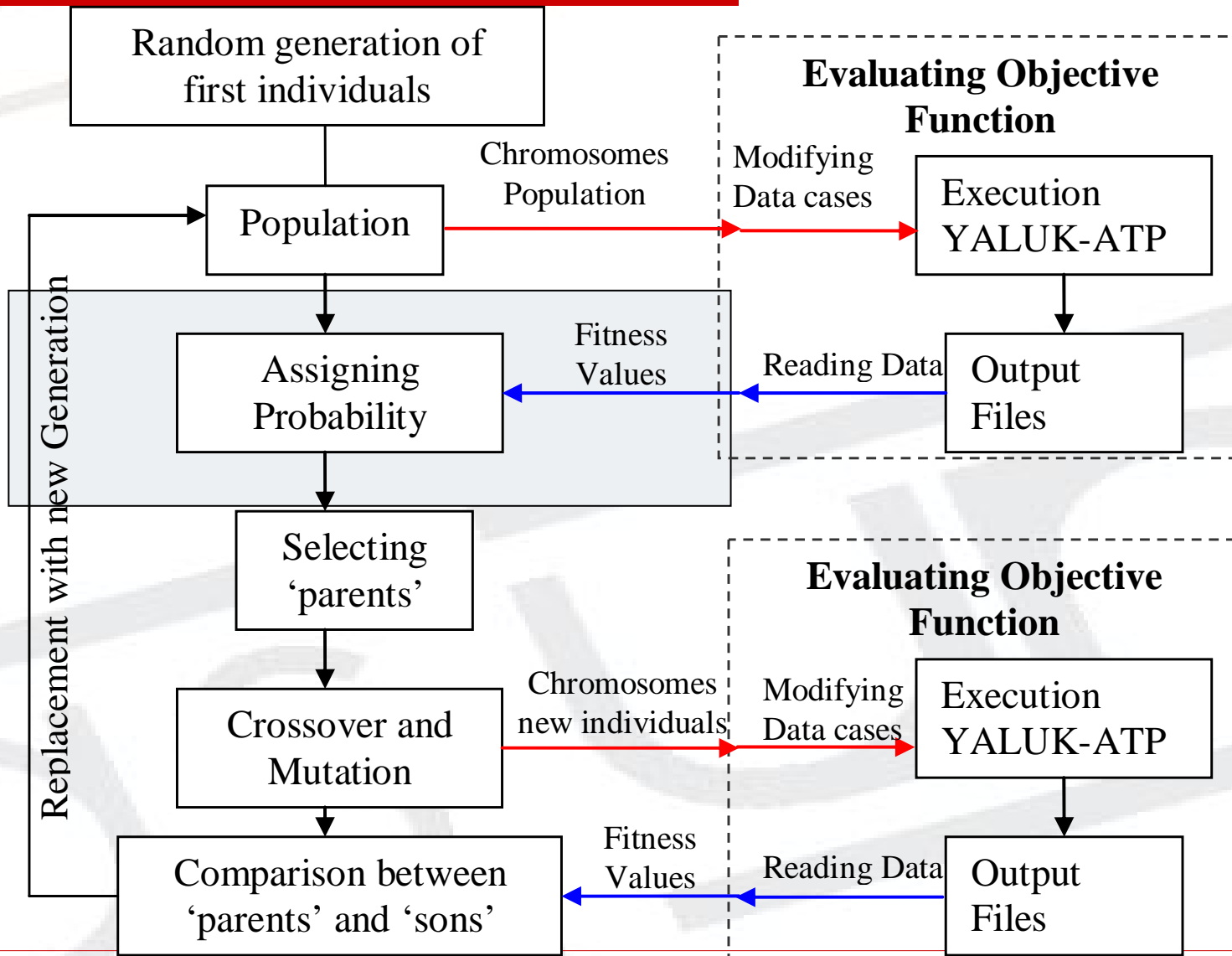
Genetic Algorithm Scheme



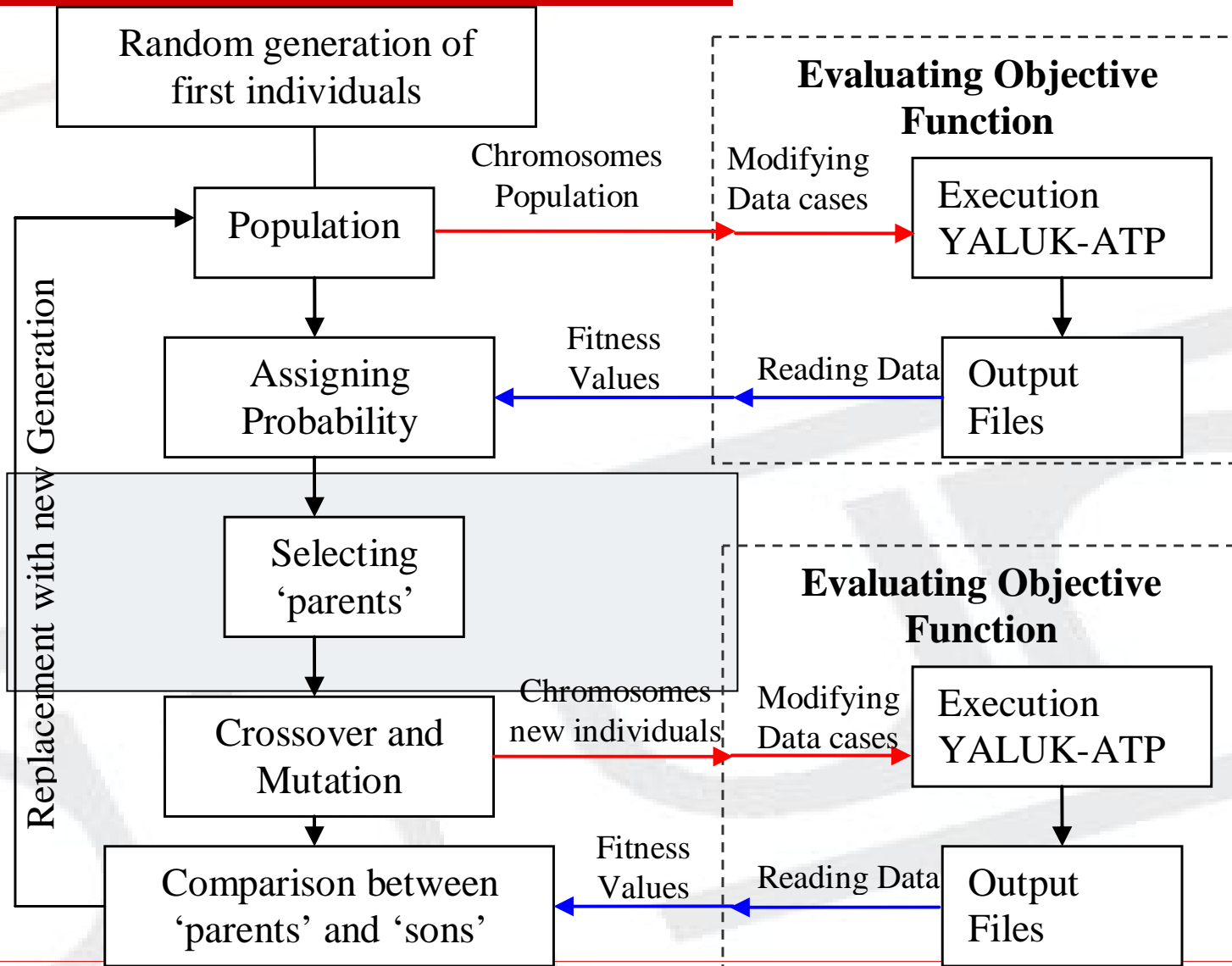
Genetic Algorithm Scheme



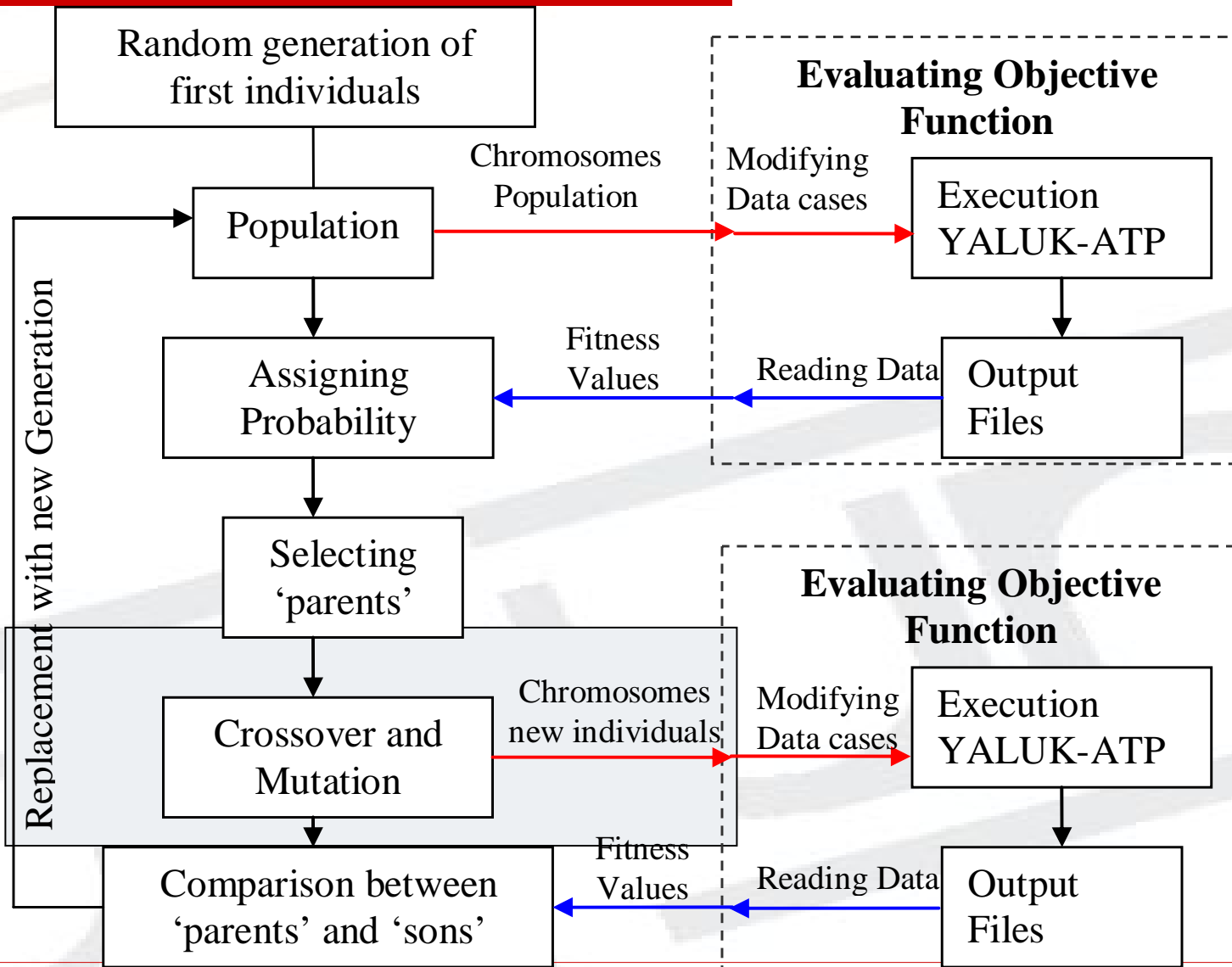
Genetic Algorithm Scheme



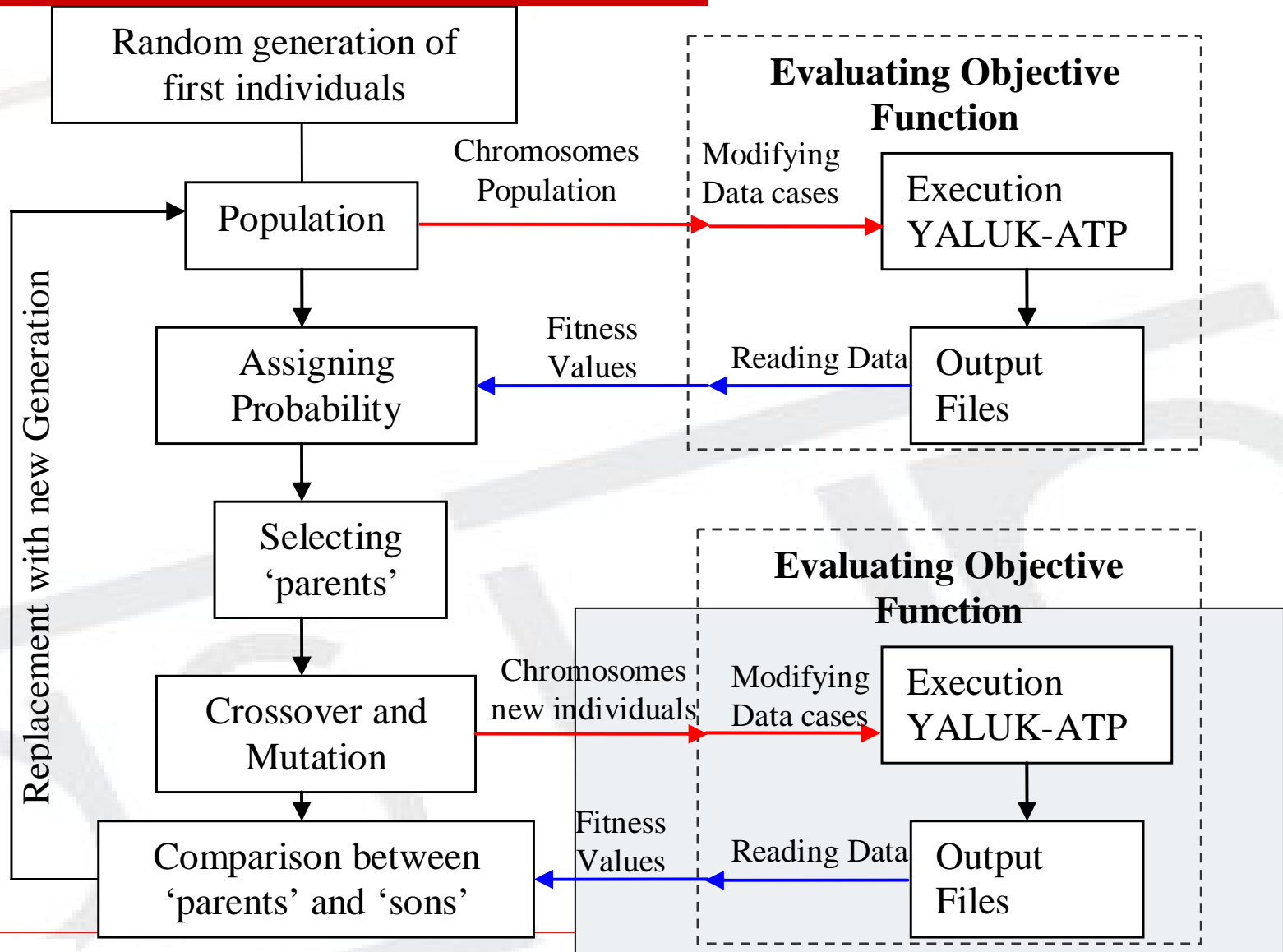
Genetic Algorithm Scheme



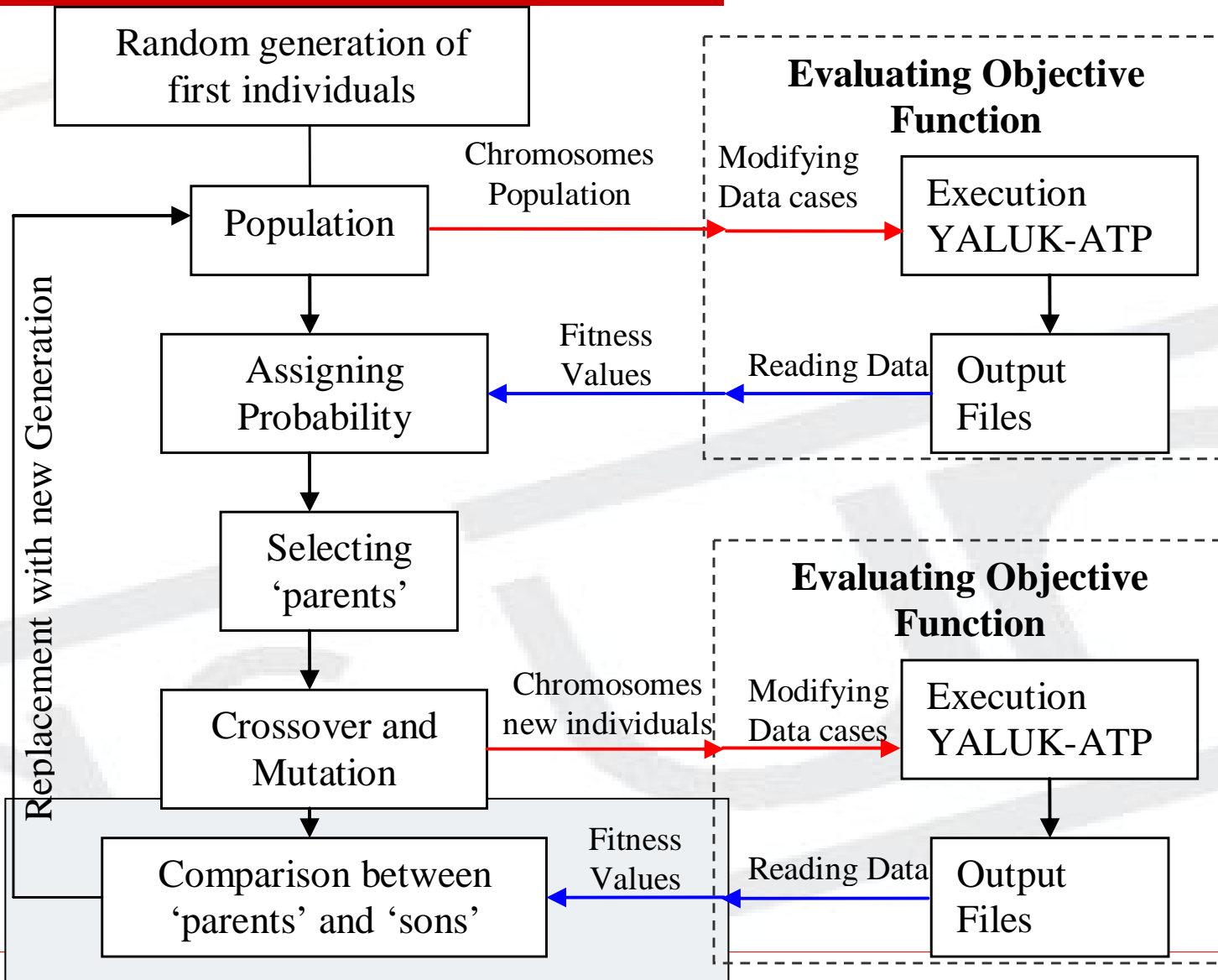
Genetic Algorithm Scheme



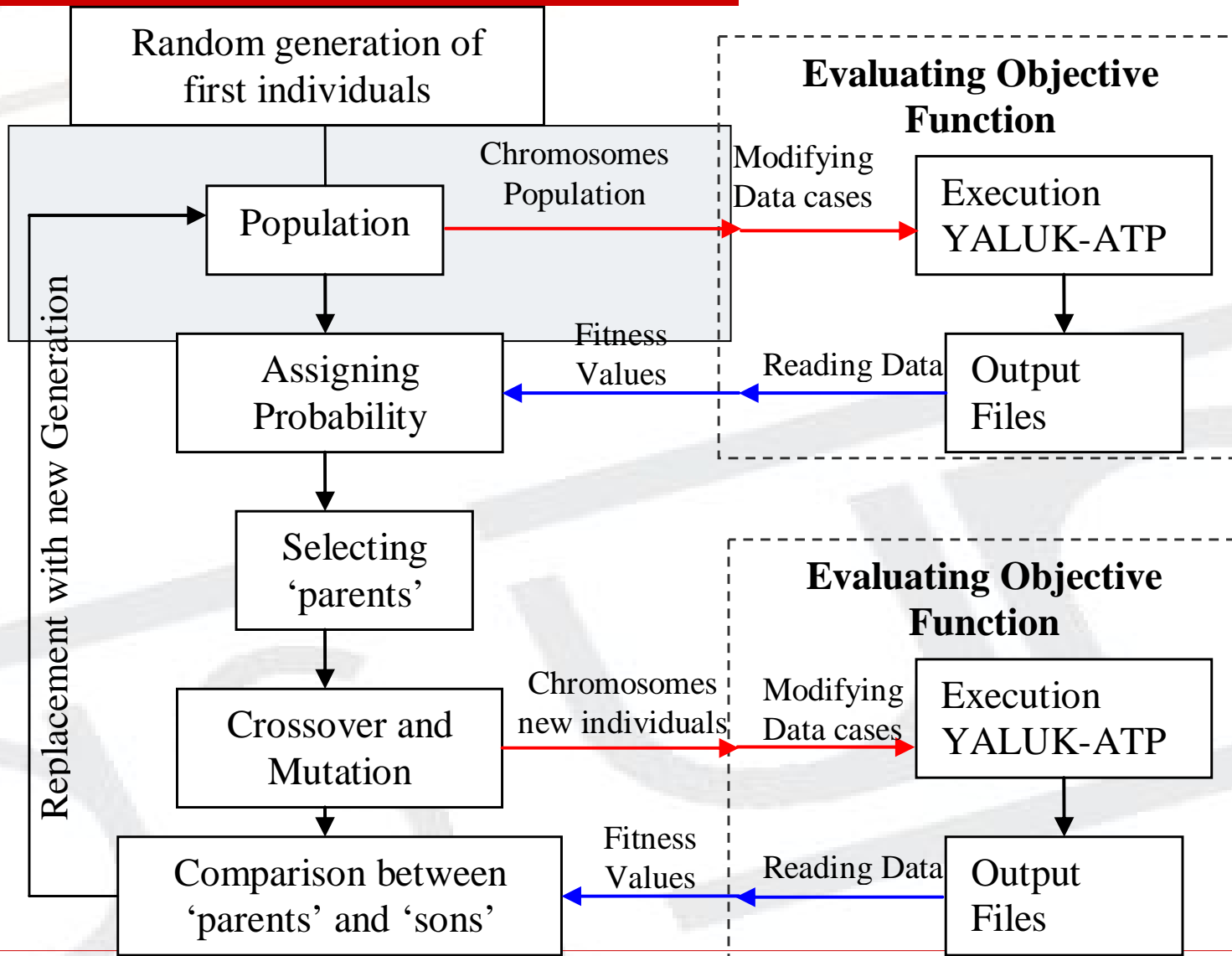
Genetic Algorithm Scheme



Genetic Algorithm Scheme



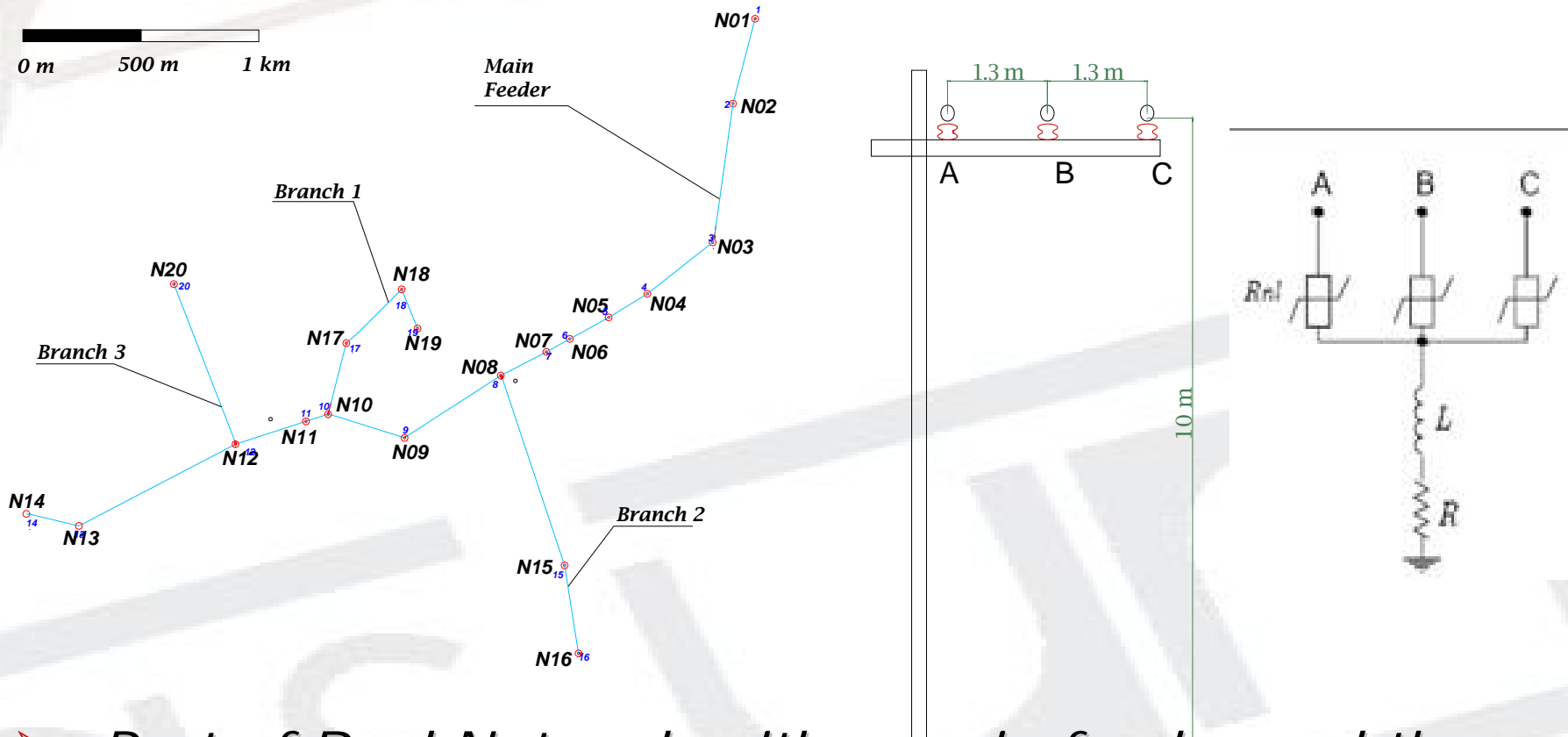
Genetic Algorithm Scheme



Example of Genetic Algorithm Tool

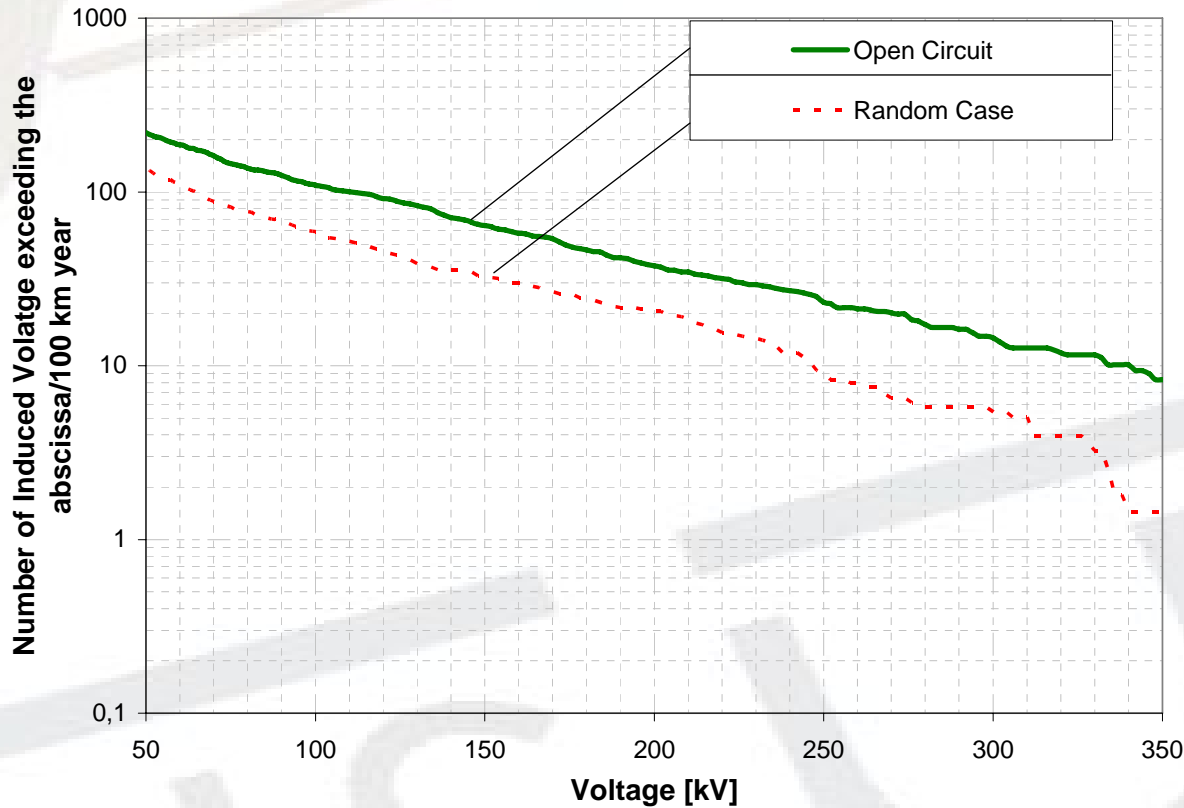
- *20 Nodes Network (three phase)*
- *Location of 4 three phase Surge Arresters*
- *4845 possible SA locations*
- *Lightning performance calculated with*
 - *40 Strokes*
 - *100 Strokes*
- *It is chosen a base case with a SA located randomly*

Effect of Power System Components

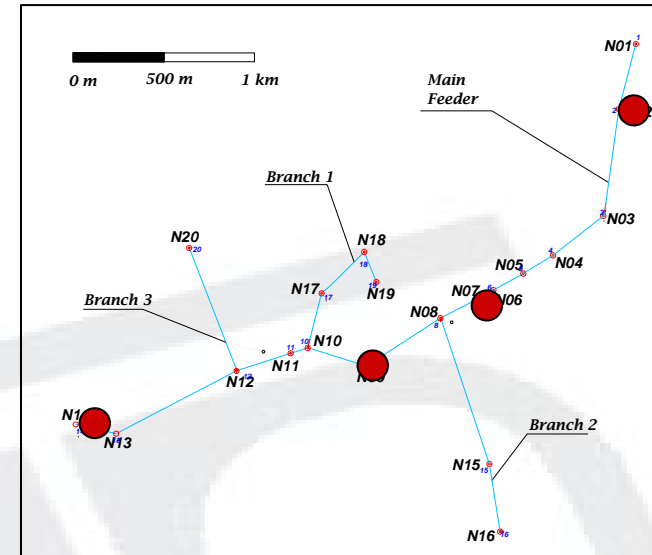


- Part of Real Network with a main feeder and three branches with different length.
- Total length 7km aprox.

Engineering Application

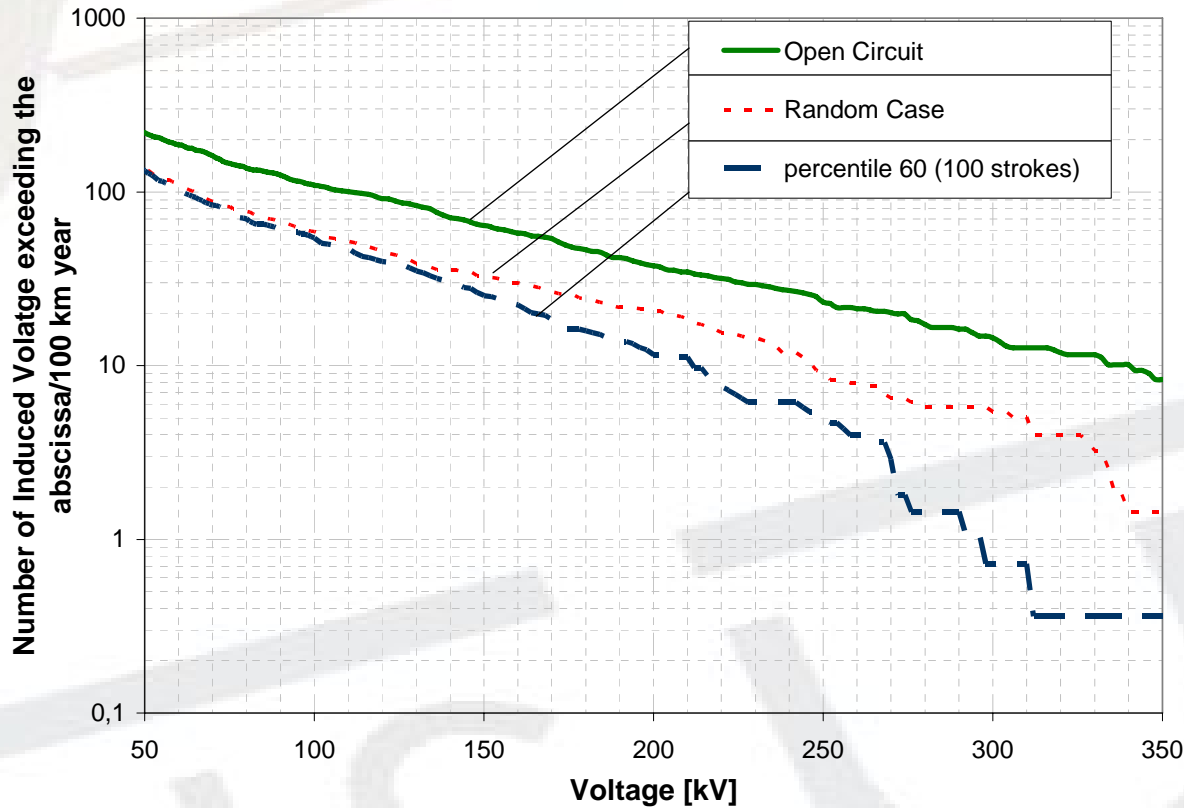


SA – Location - Random

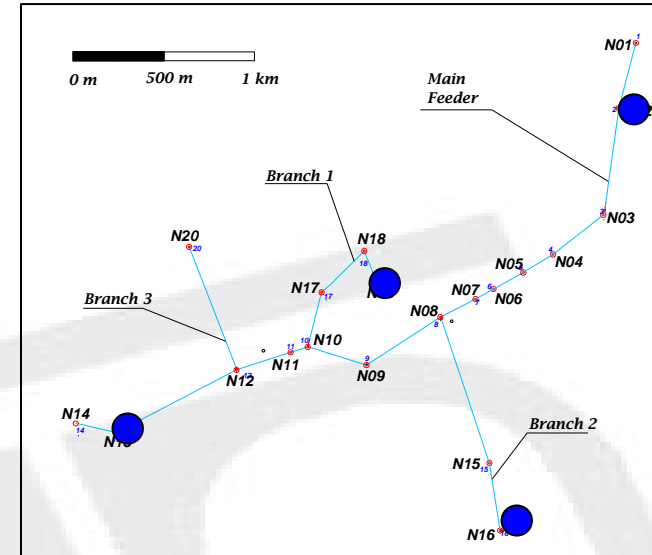


- Random case diminish the number of outages for 200kV from 35 to 20

Engineering Application



SA – Location – Genetic Alg



- Random case diminish the number of outages for 200kV from 35 to 20
- Running Genetic Algorithm Tool the number of failures for 200kV is 10

Conclusions

- *Here is described a new methodology based on genetic algorithms intended to find an optimal solution for the location of a set of surge arresters.*
- *This methodology could bring better results when a reasonably probability curve is possible to be obtained for each individual.*
- *Greater number of strokes should be used for each solution, implying that big efforts should be done in order to reduce induced voltage computation time.*

Conclusions

- *This tool allows to find a “good” solution but not always this is the best one.*
- *This proposed methodology contributes on the researching focused on the using of artificial intelligence techniques, such as, genetic algorithms for designing and planning the distribution network systems optimally.*
- *Further work should be done in increasing the number of parameters to simulate meanwhile it is improve the computation time.*

THANK YOU

FOR YOUR ATTENTION