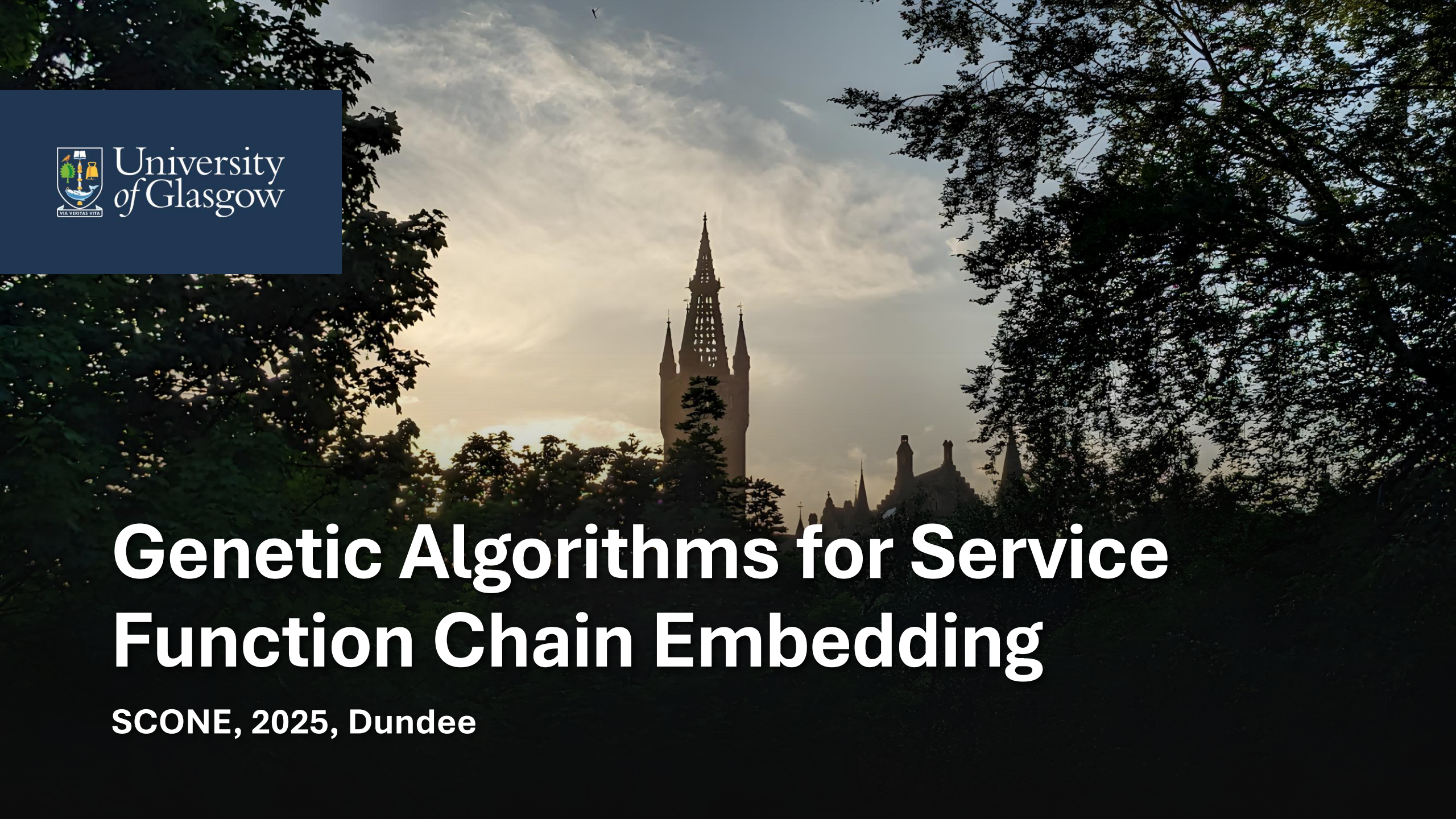

Genetic Algorithms for Service Function Chain Embedding

SCONE, 2025, Dundee

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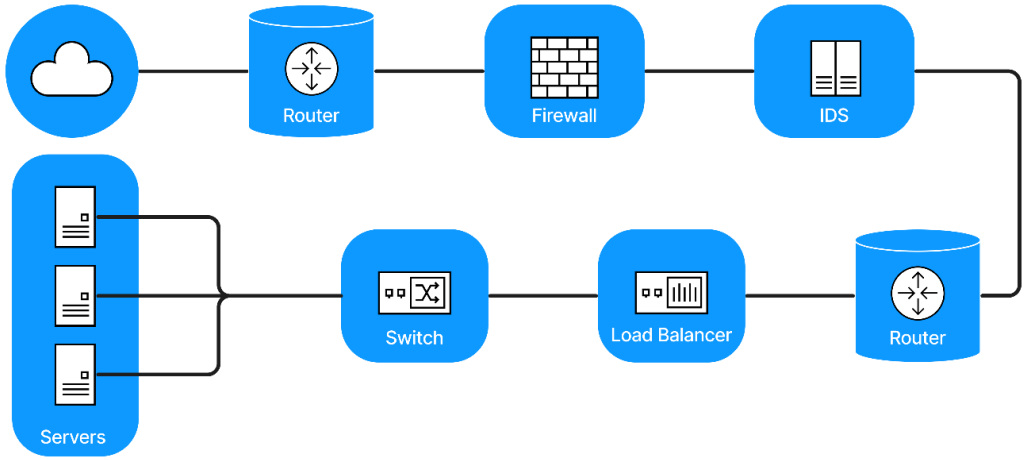
Background

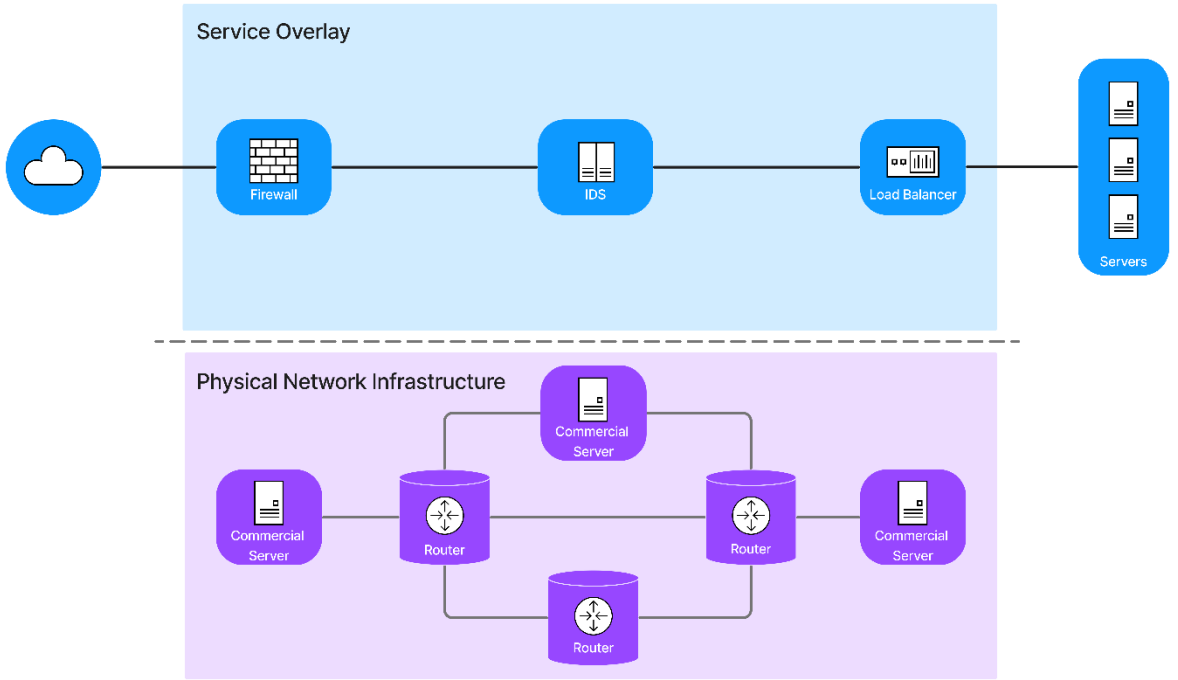
What are Service Function Chains (SFCs)?

- SFCs combine Network Function Virtualisation and Software-Defined Networking and create a service overlay over the physical network.

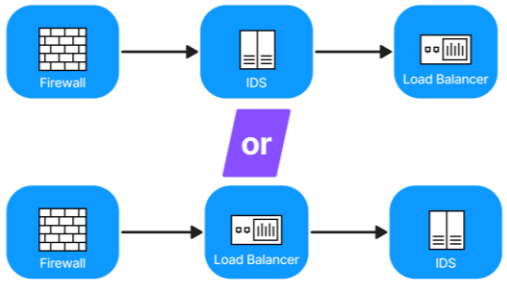
A traditional network:



A Service Function Chain:



Optimisation Challenges

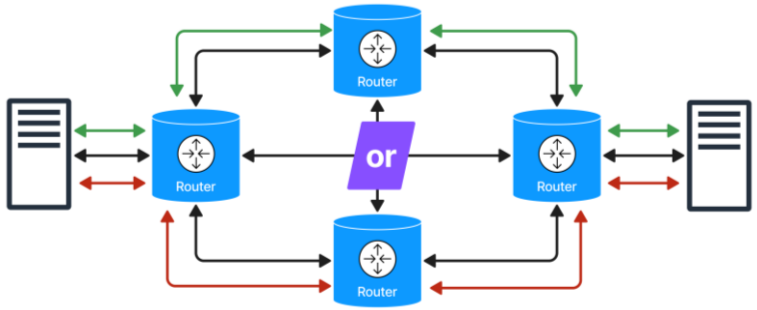


1. Chain composition

How should the Virtual Network Functions (VNFs) be ordered for optimal performance?

2. VNF embedding

Where should the VNFs be deployed for optimal performance?



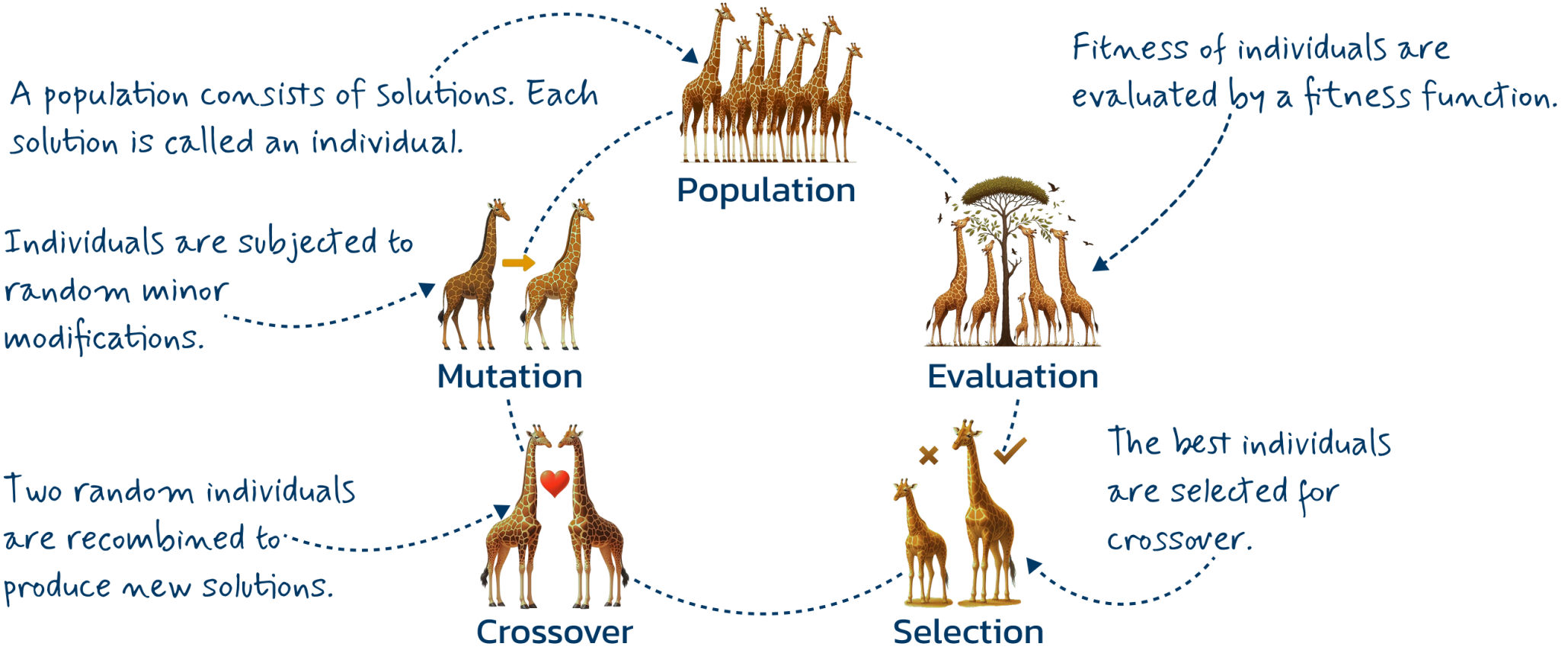
3. Link embedding

How should the VNFs be linked for optimal performance?

- This is an NP-hard optimisation problem [1].

[1] J. Gil Herrera and J. F. Botero, "Resource Allocation in NFV: A Comprehensive Survey," in *IEEE Transactions on Network and Service Management*, vol. 13, no. 3, pp. 518-532, Sept. 2016, doi: 10.1109/TNSM.2016.2598420.

Genetic Algorithms

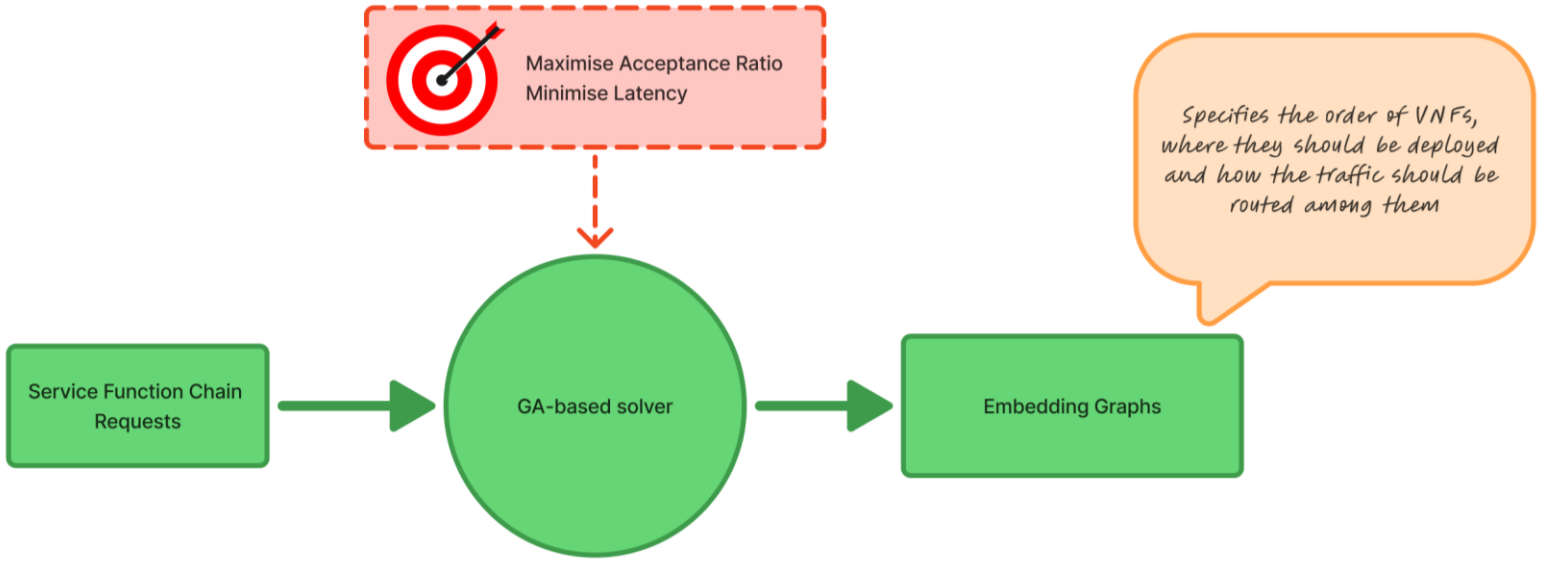


GAs can adapt well to a dynamic environment [1].

[1] N. Mori and H. Kita, "Genetic algorithms for adaptation to dynamic environments - a survey," 2000 26th Annual Conference of the IEEE Industrial Electronics Society. IECON 2000. 2000 IEEE International Conference on Industrial Electronics, Control and Instrumentation. 21st Century Technologies, Nagoya, Japan, 2000, pp. 2947-2952 vol.4, doi: 10.1109/IECON.2000.972466.

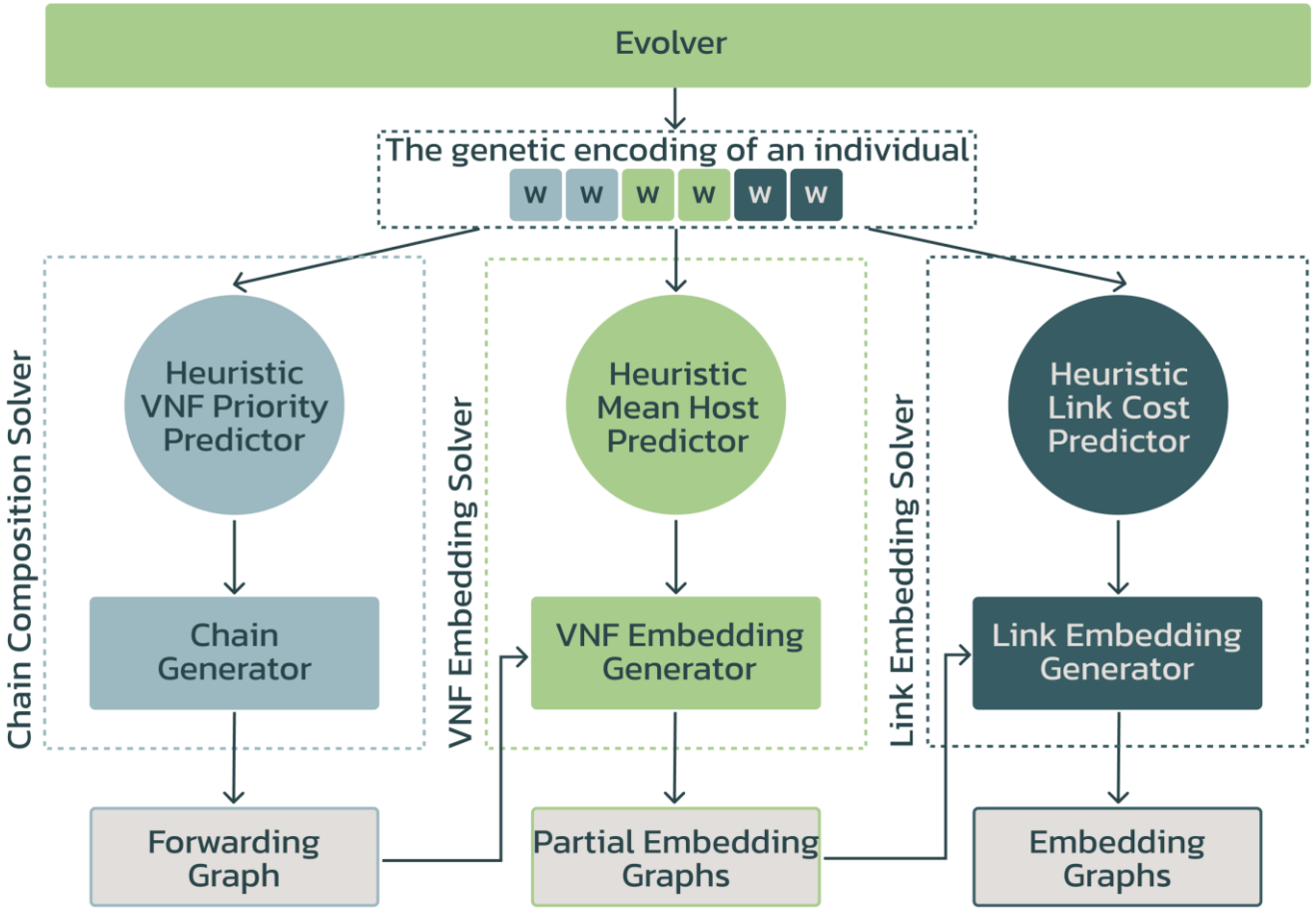
My Approach

Bird Eye View



- Acceptance Ratio—the number of SFC Requests that can be accepted over the total number of SFC Requests received.
- Latency—the amount of time taken for traffic to traverse the SFC

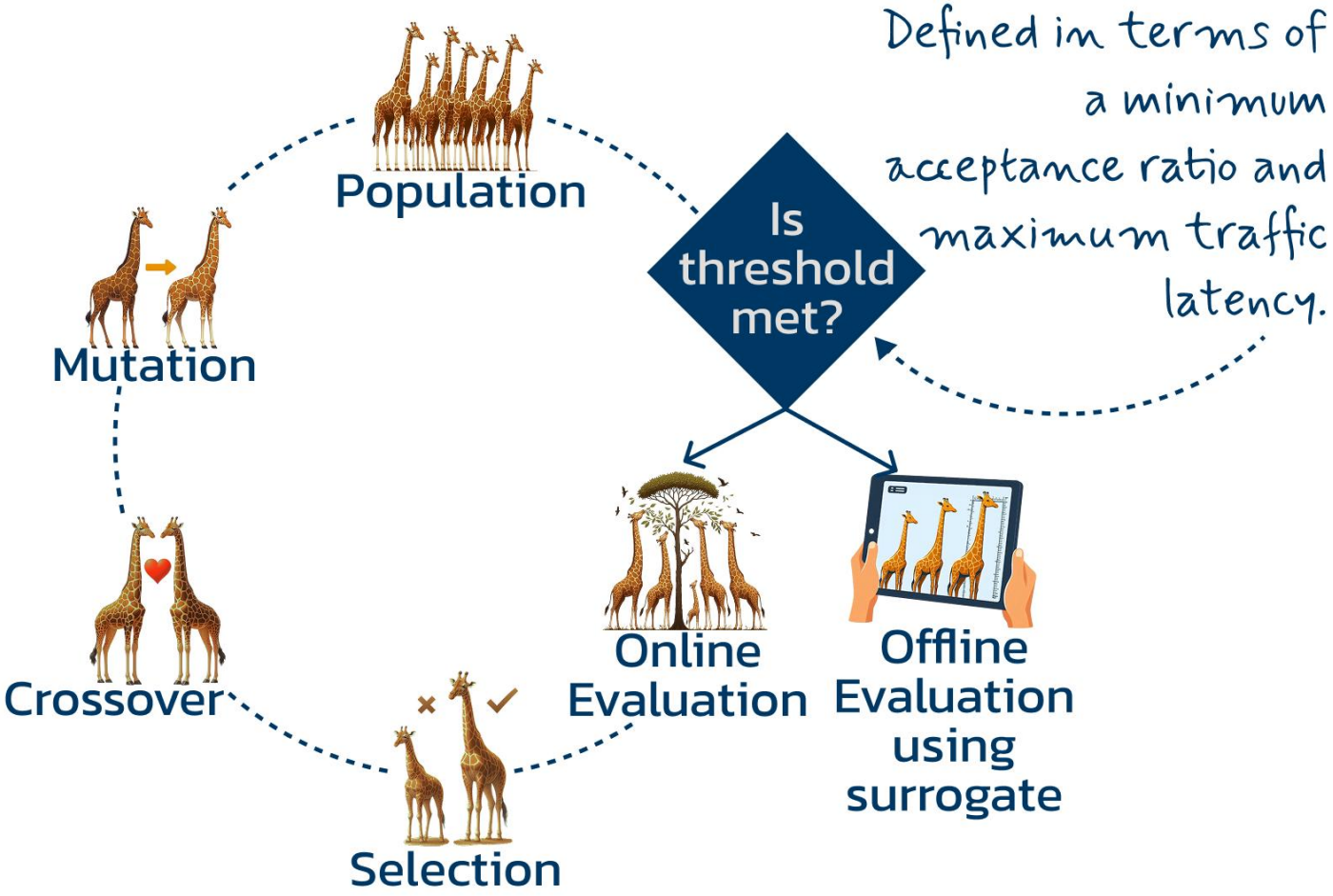
GENESIS Architecture



Fitness Evaluation

Online Evaluation	Offline Evaluation
Live experiments on a testbed/emulator.	Uses mathematical models/simulators.
Captures the complexity of modern networks.	Abstracts complexity and is less accurate.
Enables GA to adapt to changes in the network environment.	Static and the model/simulator has to be updated to reflect network changes.
Very slow.	Very fast.

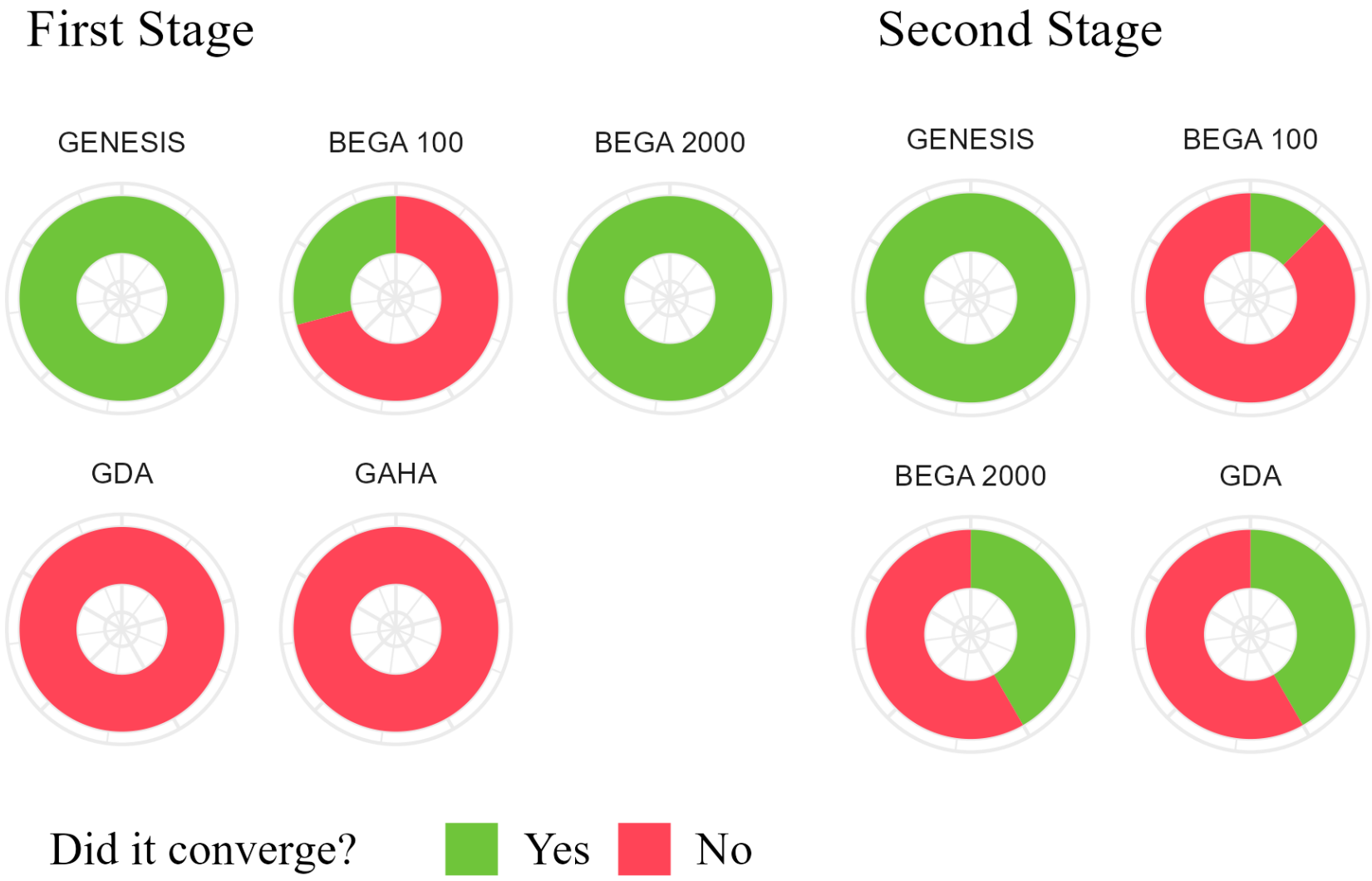
Hybrid Online-Offline Evolution



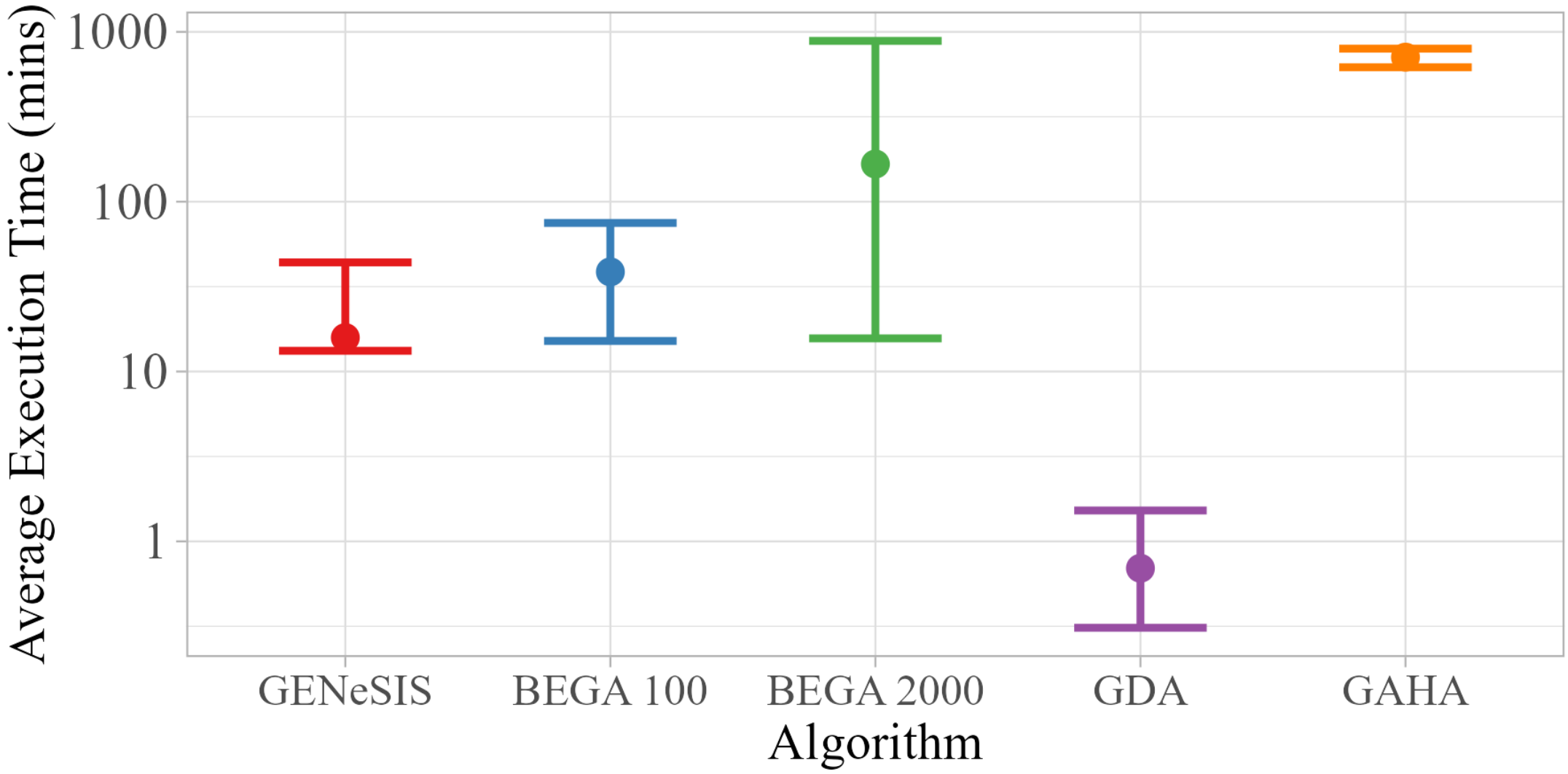
Experimental Evaluation

- We evaluated our GA-based approach in a data centre environment across 48 scenarios with varying traffic, CPU, bandwidth and SFC configurations.
- We run these experiments in two stages, with 24 experiments in each.
- We compared our approach with two state-of-the-art GAs and a greedy algorithm.
- The evolution converges when a threshold is reached or the no. of generations exceeds 500.

Results


First Stage
GENESIS
BEGA 100
BEGA 2000
GDA
GAHA
Second Stage
GENESIS
BEGA 100
BEGA 2000
GDA
Did it converge?
Yes
No

Results


Average Execution Time (mins)
1000
100
10
1
GENeSIS
BEGA 100
BEGA 2000
GDA
GAHA
Algorithm

Questions

Thank You

Appendix

Why Genetic Algorithms?

- It is a heuristic algorithm that can solve NP-hard problems.
- It can adapt to an uncertain/unknown environment.
- It is an underutilised algorithm in the SFC realm. Only 12/163 surveyed studies use GAs.