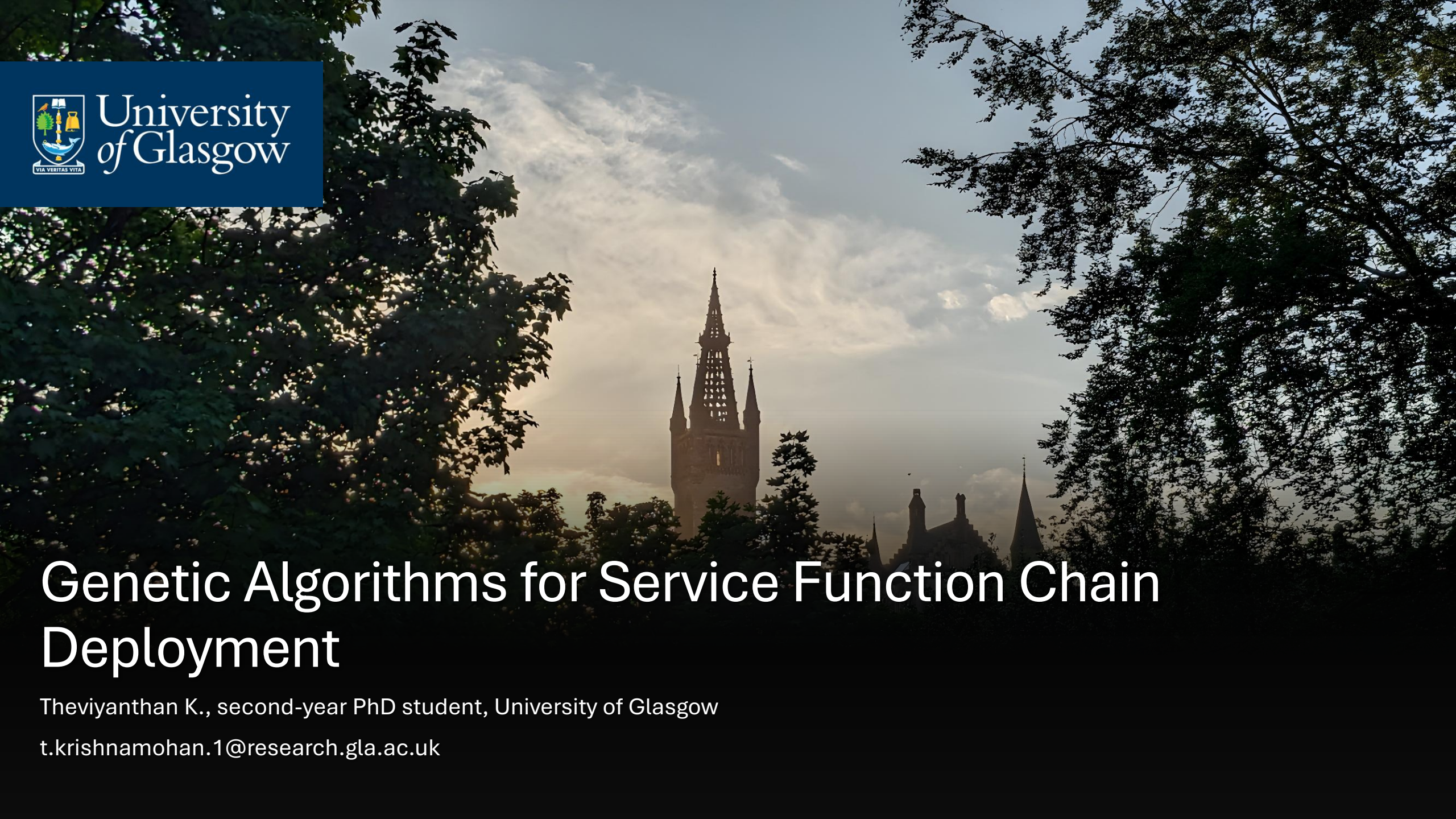

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Genetic Algorithms for Service Function Chain Deployment

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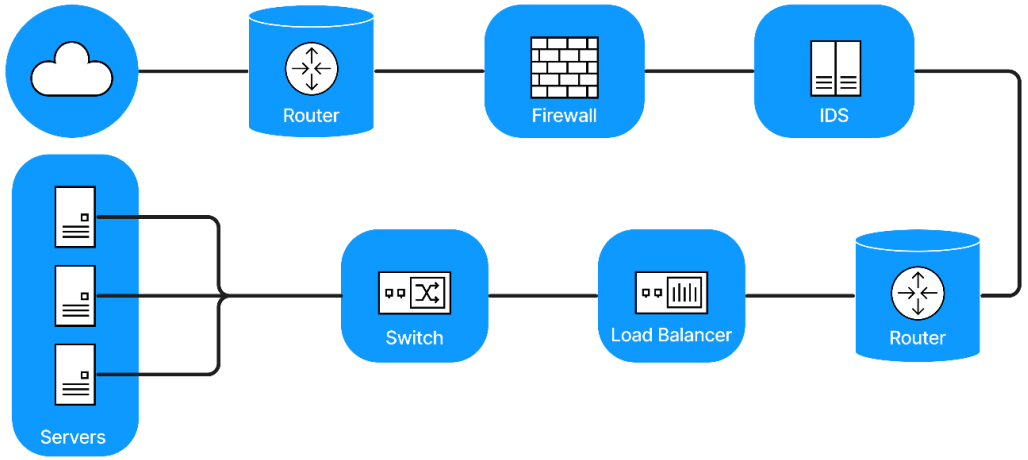
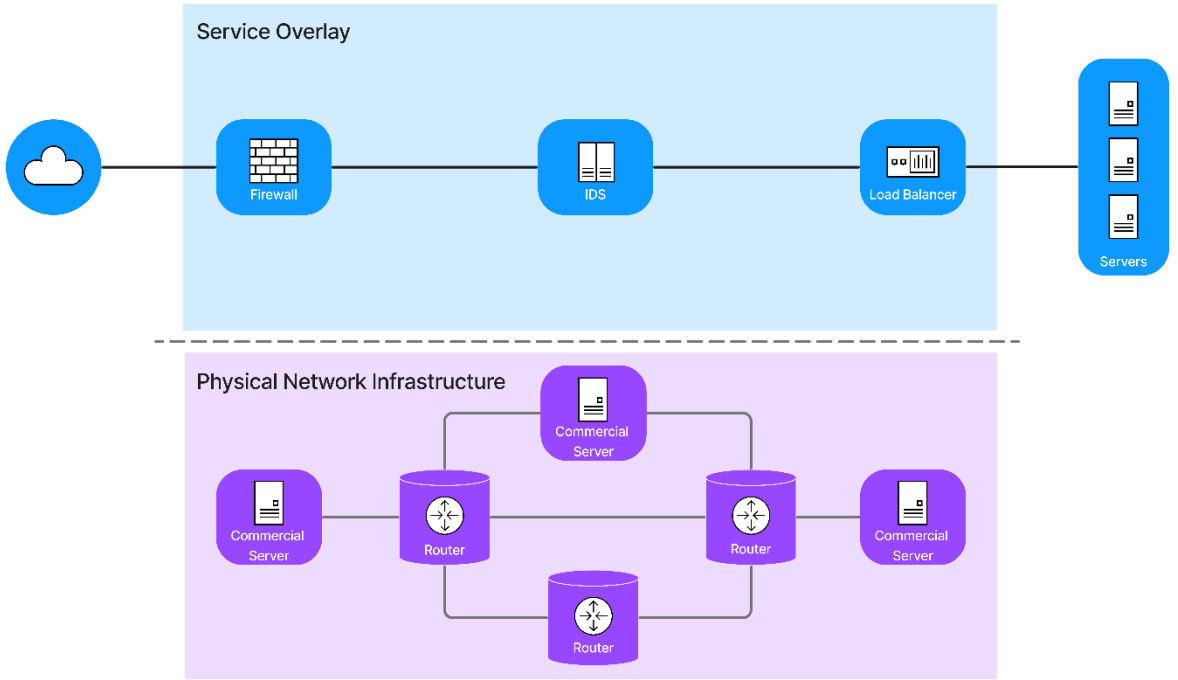
What are Service Function Chains (SFCs)?

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

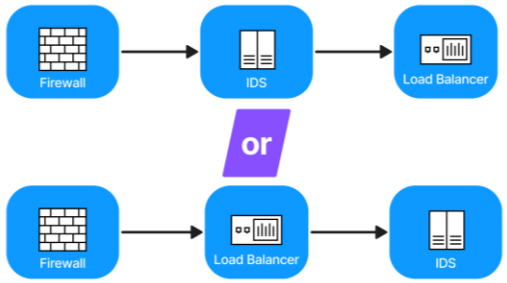
A traditional network:



A Service Function Chain:



Optimisation Challenges

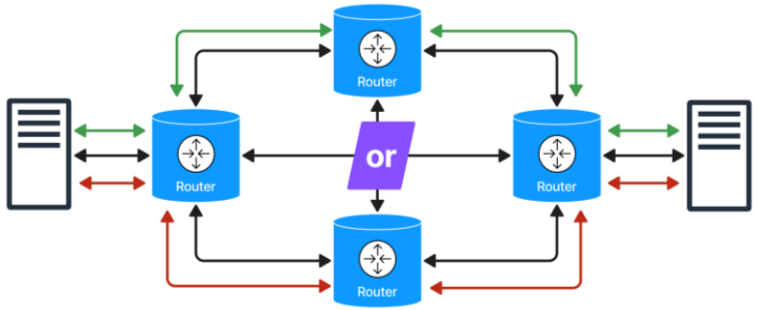


1. Chain composition

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.

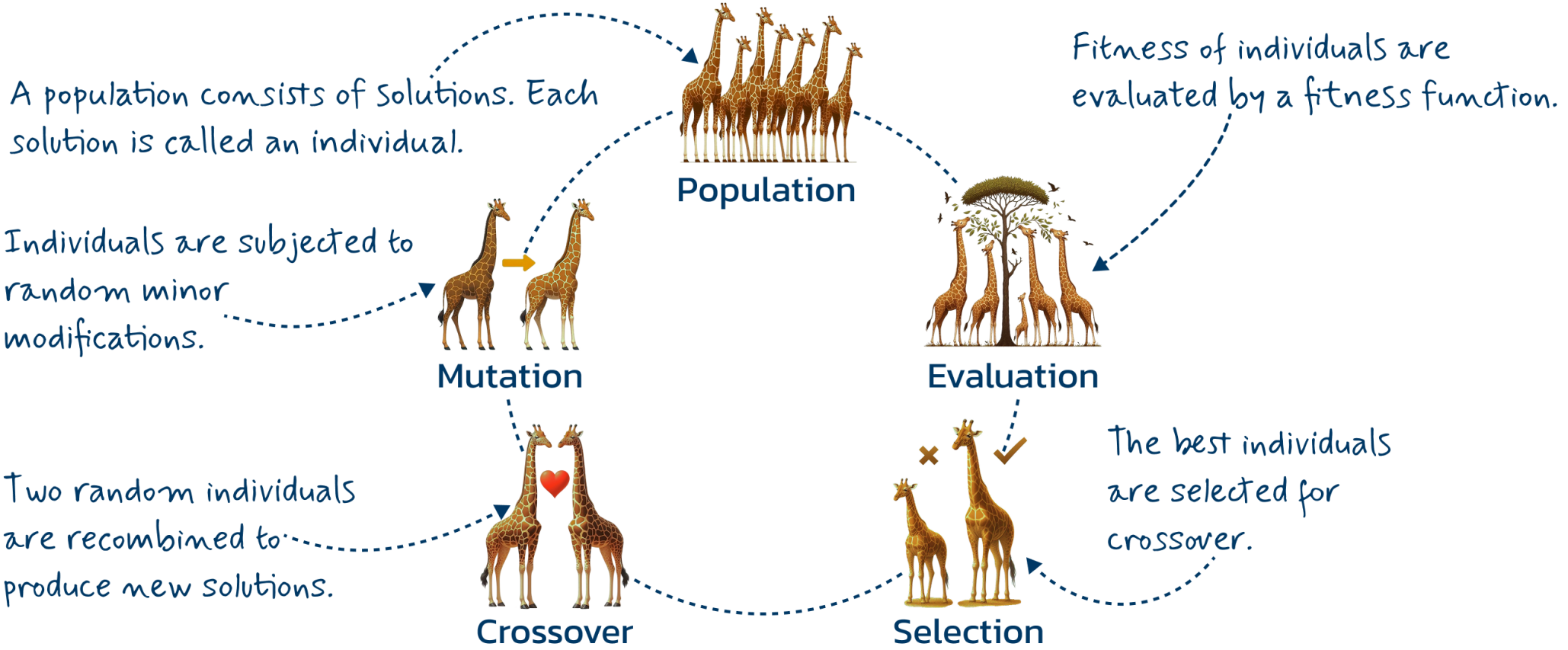
The problem with existing solutions

- 77% of the solutions performed only numerical analysis ==> No experimentation

- Only 3/163 solutions solve all three problems.
  - 2 of these have experimentation, but only for static environments

- Only 12/163 studies used GAs.
  - 1/163 solved all three problems with a GA ==> analytics only for a static environment, no experimentation

Genetic Algorithms

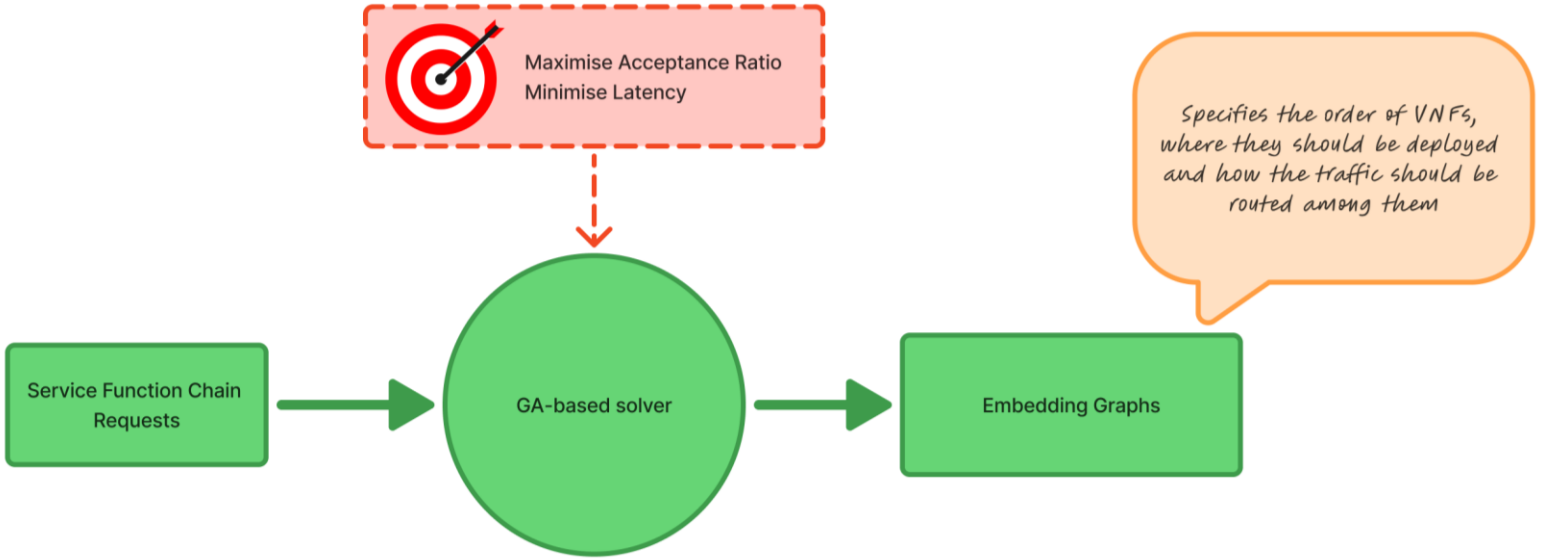


GAs can adapt well to a dynamic environment [1].

[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.

Proposed GA-based solution

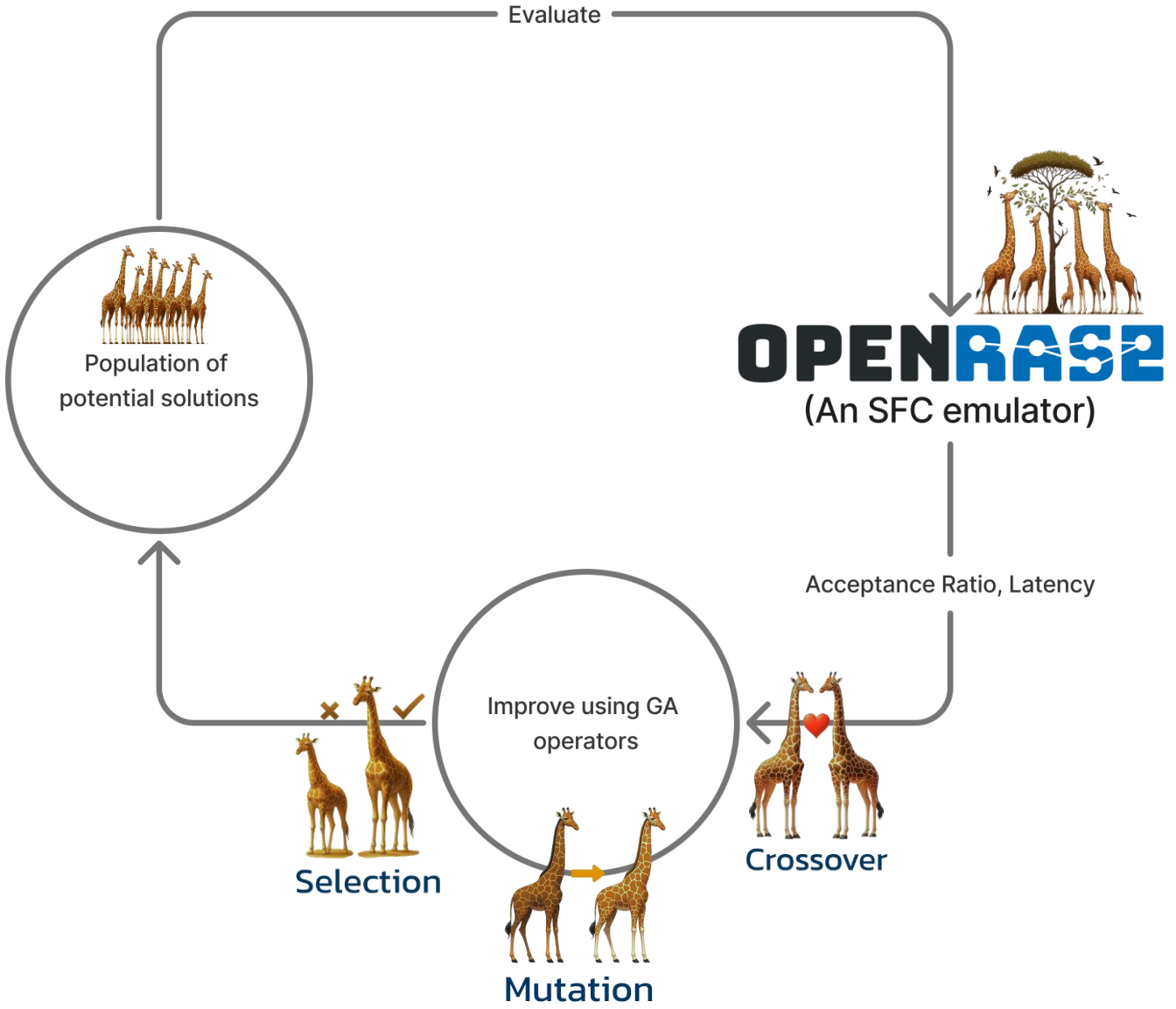
My goal is to solve all three problems in a dynamic environment by experimentation using GAs.



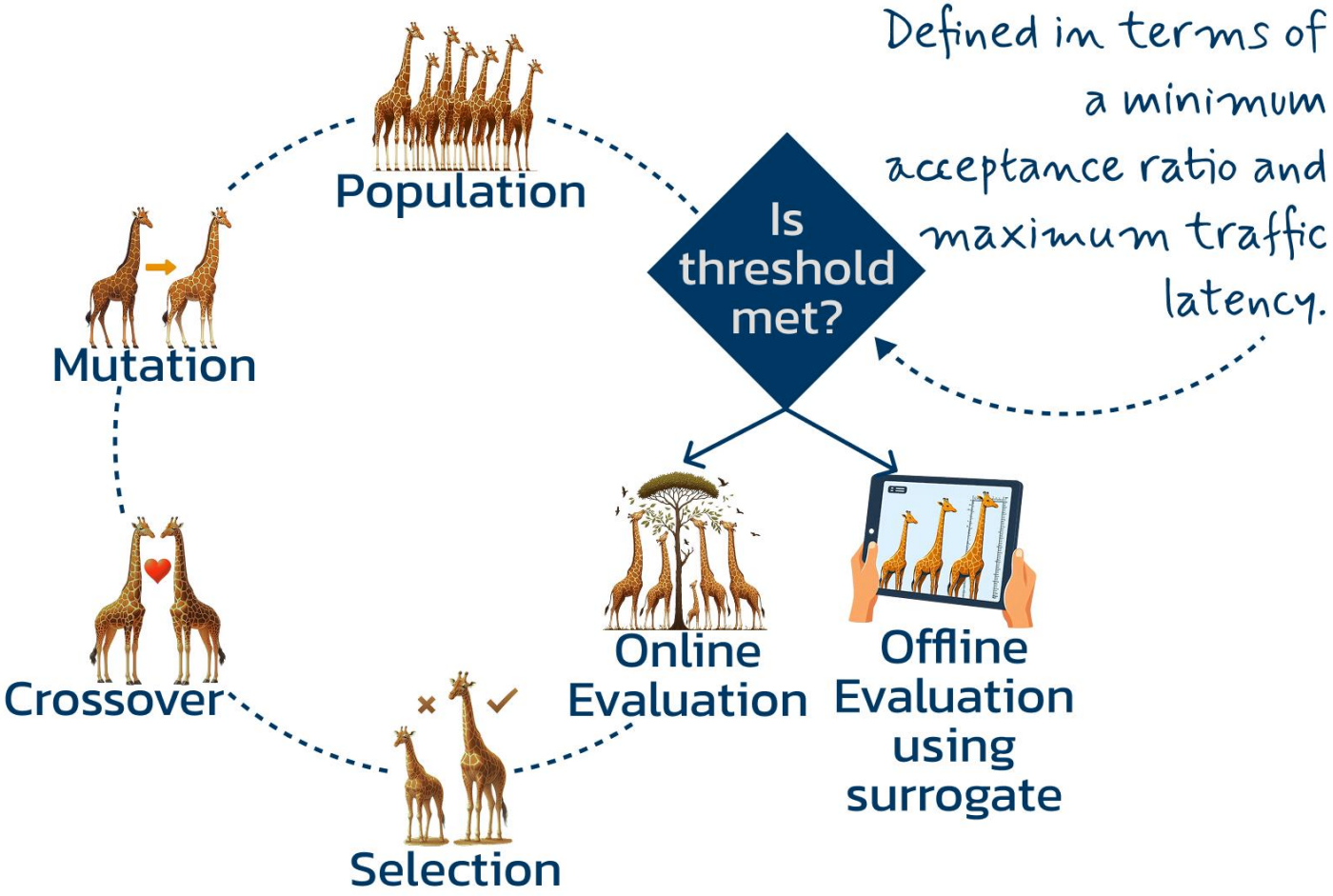
- Acceptance Ratio— accepted SFC Requests / SFC Requests received.
- Latency— time taken for traffic to traverse the SFC

Online Evolution

- It involves evaluating potential solutions on a network and evolving them using Genetic Algorithms.
- Simulators and numerical analysis may not capture the complexity of real networks.
- Makes the solution self-adaptive.
- But it is time-consuming.

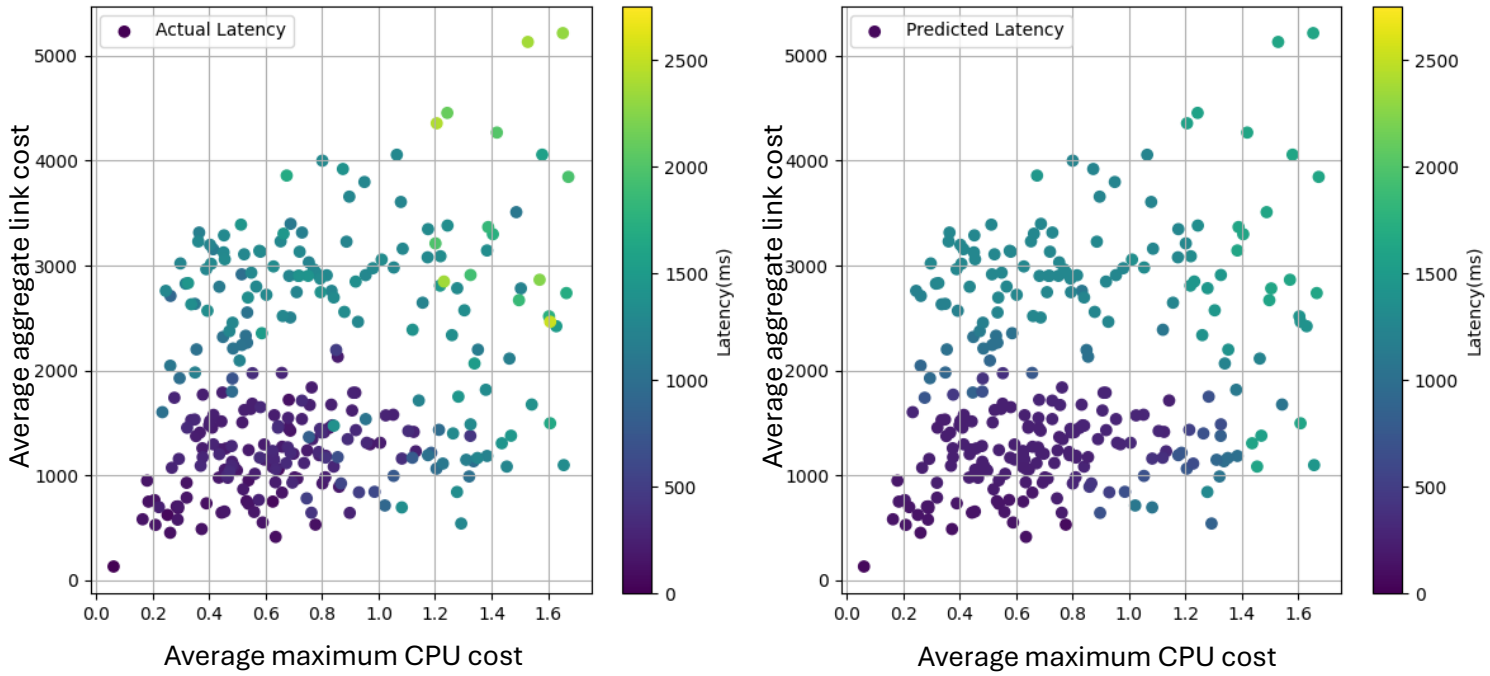


Hybrid Online-Offline Learning



Surrogate

The surrogate is an Artificial Neural Network trained on data from OpenRASE. It predicts the latency of a set of embedding graphs, allowing us to perform online evolution quickly.



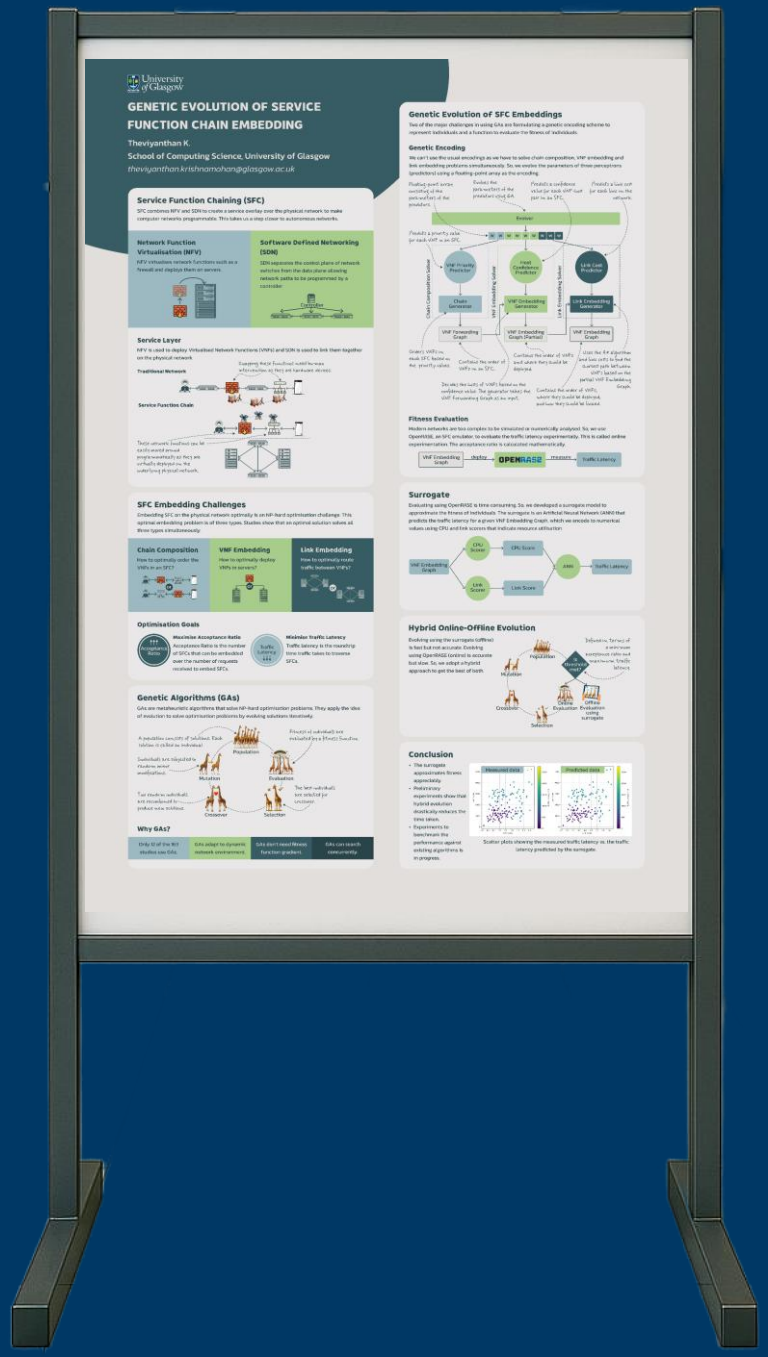
$$CPU\ Cost\ of\ a\ host = \frac{CPUs\ demanded\ by\ the\ deployed\ VNFs\ in\ a\ host}{CPUs\ available\ in\ a\ host}$$

$$Link\ Cost\ of\ a\ link\ = \frac{total\ requests\ traversing\ the\ link\ at\ a\ given\ time}{the\ bandwidth\ of\ the\ link\ in\ MB}$$

Next

- Preliminary experiments show hybrid online-offline evolution produces optimal solutions within a short time.
  - Avoids getting stuck at local maxima unlike online evolution.
  - The solution is more accurate unlike in offline evolution.
- Finding a way to genetically represent the three problems for GAs.
- Evaluating the performance on a dynamic environment.

You can find me at the poster session!



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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.