GENESIS: GENETIC EVOLUTION OF DEEP NEURAL NETWORKS FOR OPTIMAL SERVICE FUNCTION CHAIN EMBEDDING

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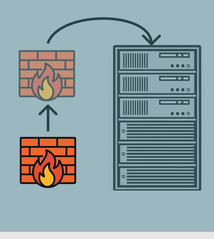
Service Function Chaining (SFC)

SFC combines NFV and SDN to create a service overlay over the physical network to make computer networks programmable. This takes us a step closer to autonomous networks.

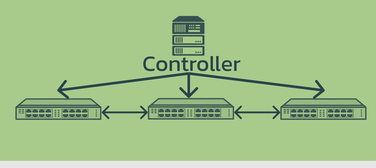
Network Function Virtualisation (NFV)

NFV virtualises network functions such as firewalls and embeds them on servers (hosts).



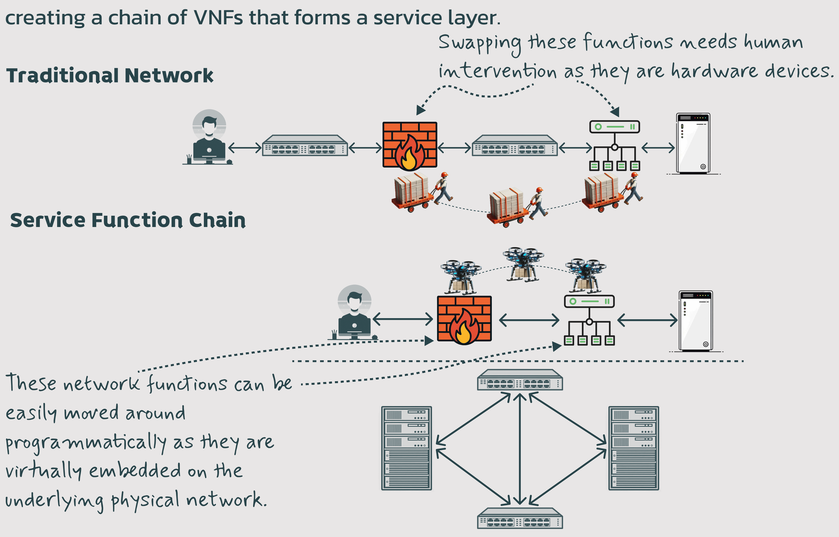
Software Defined Networking (SDN)

SDN separates the control plane of network switches from the data plane allowing network paths to be programmed by a controller.



Service Layer

The Virtualised Network Functions (VNFs) produced by NFV are linked together using SDN, creating a chain of VNFs that forms a service layer.

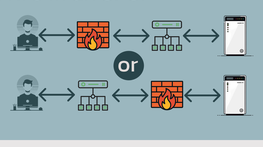


SFC Embedding Challenges

Optimally embedding SFCs on the physical network is NP-hard. It consists of three sub-problems. Studies show that to produce an optimal solution, all three sub-problems have to be optimised simultaneously, rather than sequentially.

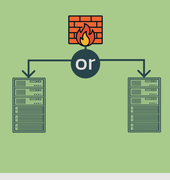
VNF Chain Composition

How to optimally order the VNFs in an SFC?



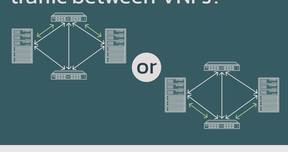
VNF Embedding

How to optimally embed VNFs on hosts?



Virtual Link Embedding

How to optimally route traffic between VNFs?



Optimisation Goals

Maximise Acceptance Ratio

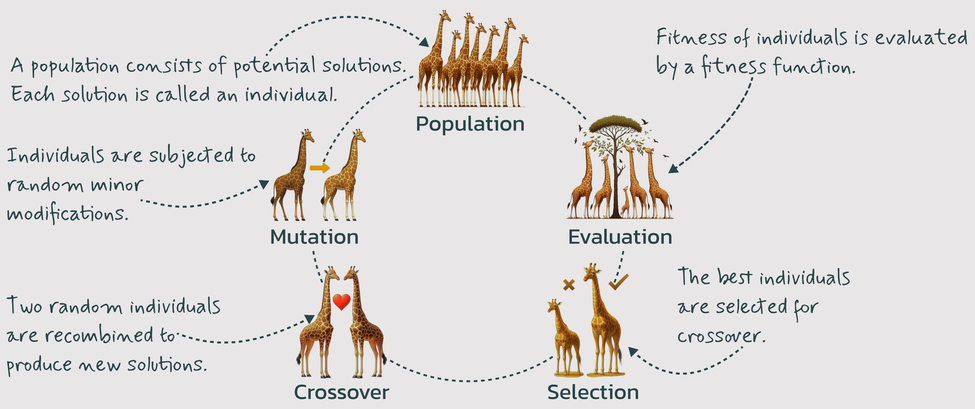
Acceptance Ratio is the number of SFCs that can be embedded over the number of requests received to embed SFCs.

Minimise Traffic Latency

Traffic latency is the round-trip time traffic takes to traverse SFCs.

Genetic Algorithms (GAs)

GAs are metaheuristic algorithms that can optimise NP-hard problems. They apply the idea of evolution to optimise complex problems by evolving potential solutions iteratively.

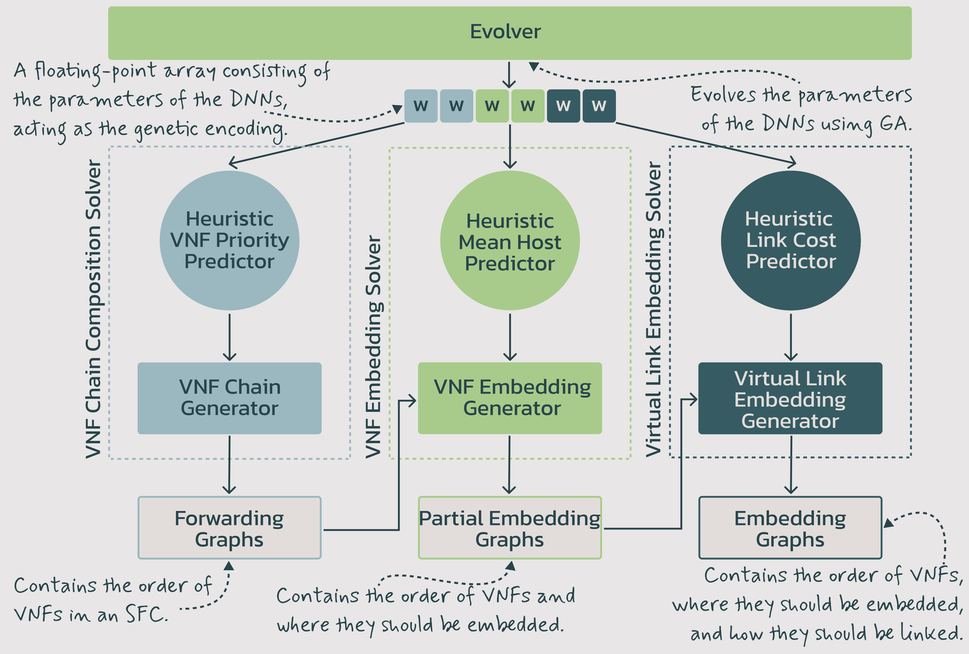


Why GAs?

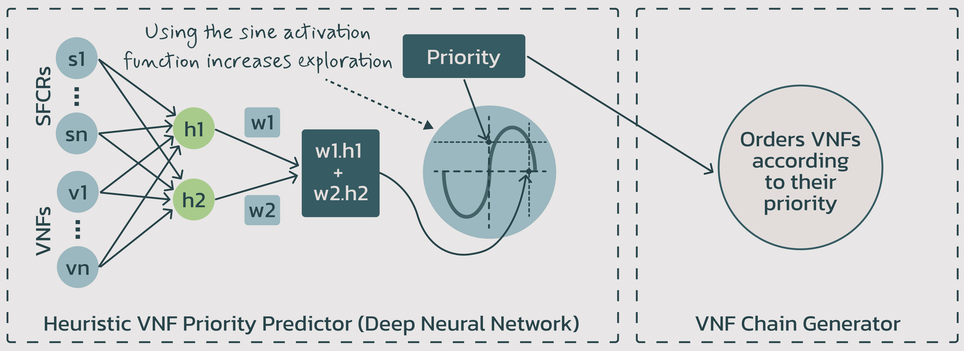
Only 19 of the 209 studies used GAs.	GAs adapt to dynamic network environments.	GAs don't need a fitness function gradient.	GAs can search concurrently.

GENESIS

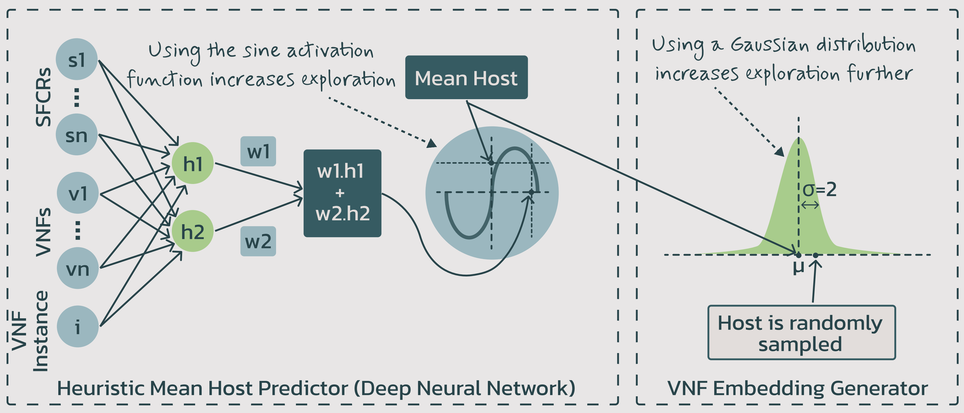
We can't use the usual encodings as we have to optimise the VNF Chain Composition, VNF Embedding and Virtual Link Embedding sub-problems simultaneously. So, we evolve the parameters of three DNNs (predictors) using a floating-point array as the encoding.



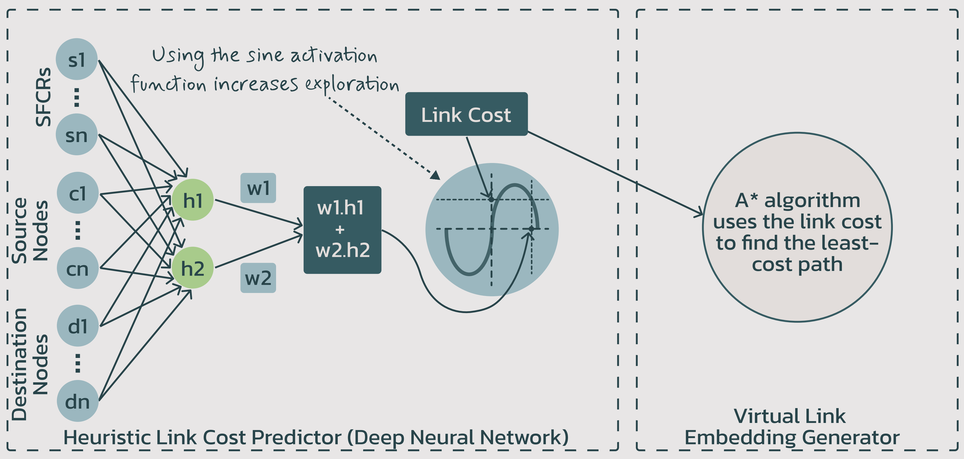
VNF Chain Composition Solver



VNF Embedding Solver



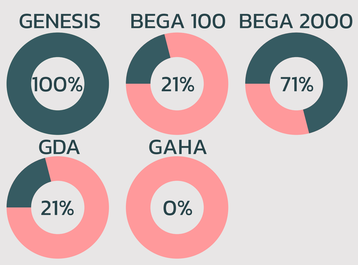
Virtual Link Embedding Solver



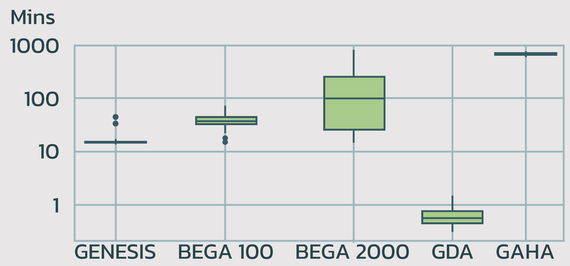
Evaluation & Conclusion

We compared GENESIS with two GAs, viz. BEGA and GAHA, and a greedy algorithm called GDA. We created two instances of BEGA, setting its population size to 100 (BEGA 100) and 2000 (BEGA 2000). We set the population size of GAHA and GENESIS to 100. We ran 48 experiments with different network configurations.

Convergence Percentage



Execution Time



Conclusion

The experimental results show that GENESIS can optimally embed SFCs across diverse static network scenarios, taking significantly less time than other GA-based approaches.