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Optimisation of Truck Freight Preventive Maintenance Schedules using Simulations and Genetic Algorithms

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1 Context

Truck freight is used for the bulk haulage of resources. The failure of a mobile asset carrying critical materials can have a significant flow-on cost for the fleet owner and client. Preventive maintenance can reduce the likelihood of these failures, but it also has a cost and reduces the availability of the fleet. How often should it be conducted to maximise the fleet's productivity?
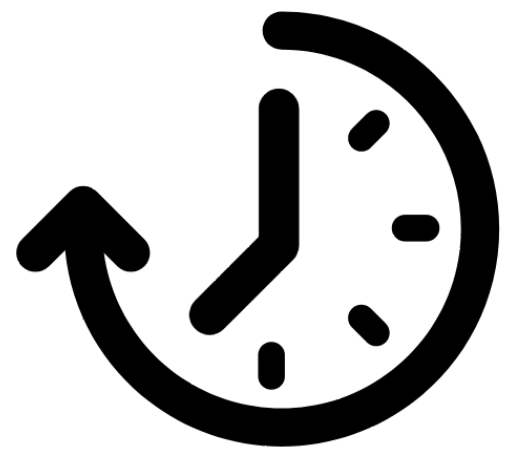
2 Problem Statement

The aim of the project is to optimise the preventive maintenance schedules for a fleet of remote operating vehicles using simulations and genetic algorithms.

3 Reliability Analysis

Maintenance records are analysed to create a dataset of historical failures and suspended measurements. Maximum likelihood estimation is conducted on the dataset to estimate reliability distributions for the components in the trucks. Components are grouped into subsystems in the model.
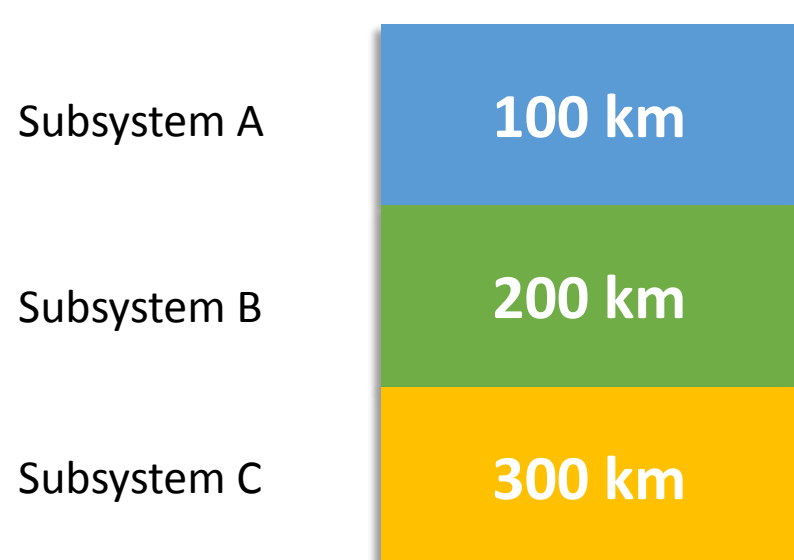
Subsystem A

Subsystem B

Subsystem C
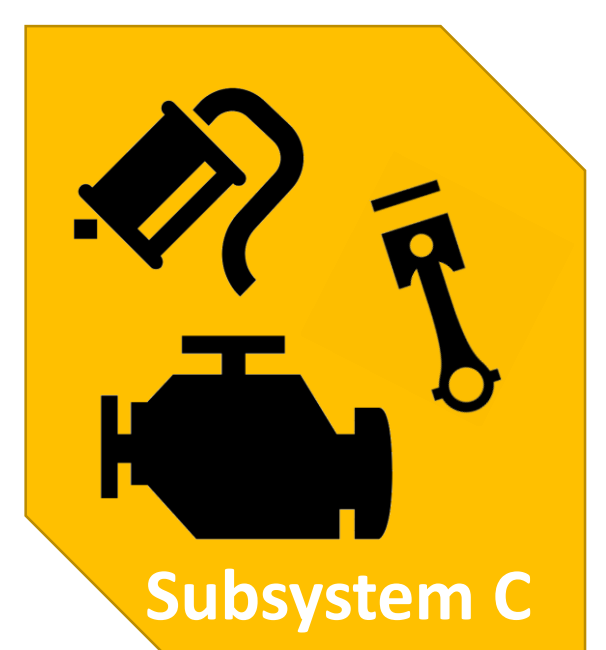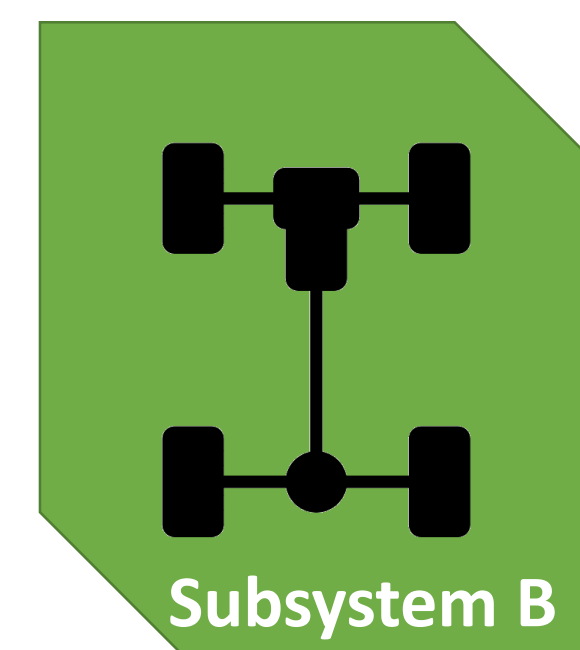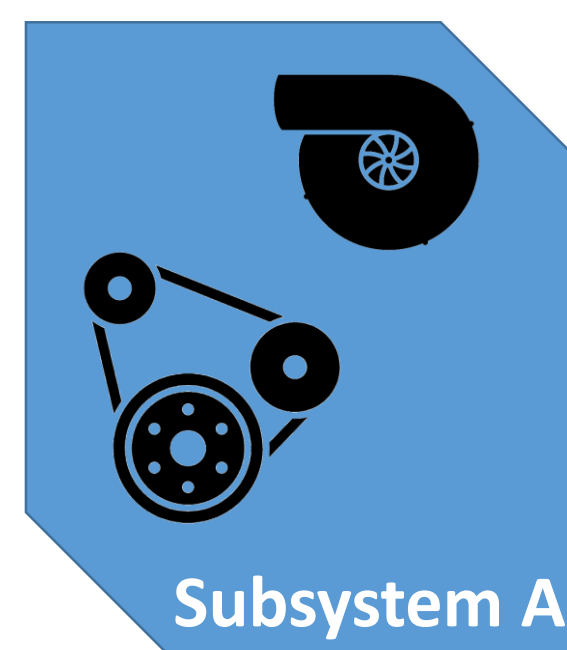
Trial Schedule → Simulation → Trial Results

Conduct maintenance every:

Subsystem A	100 km
Subsystem B	200 km
Subsystem C	300 km

Trial schedules are generated by the genetic algorithm and fed to the simulation model. Simulation results are assigned a score by the fitness function. The genetic algorithm creates a new population to test in the simulation based on the top scoring schedules.
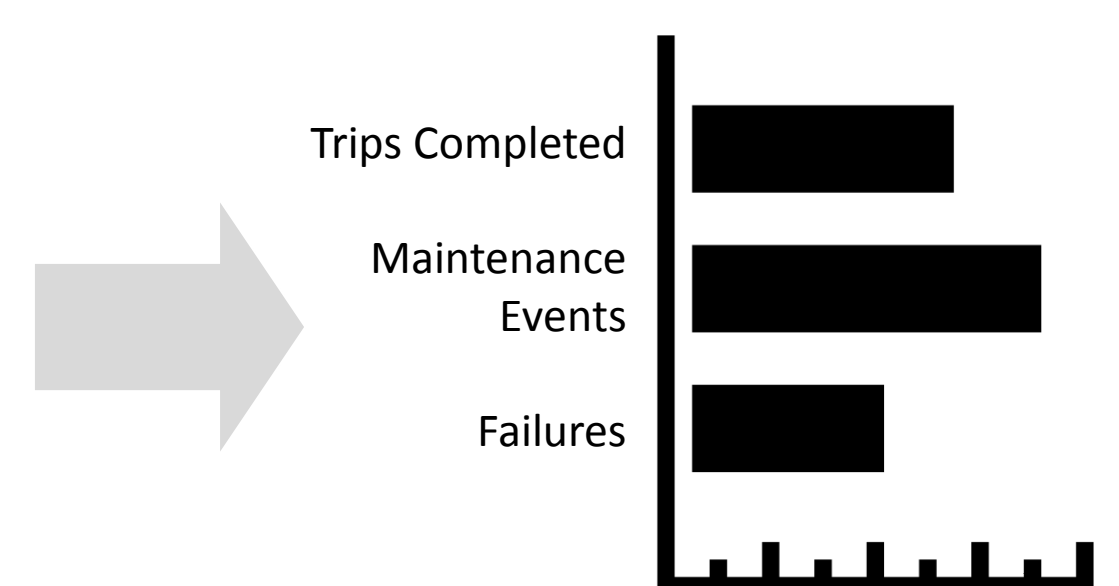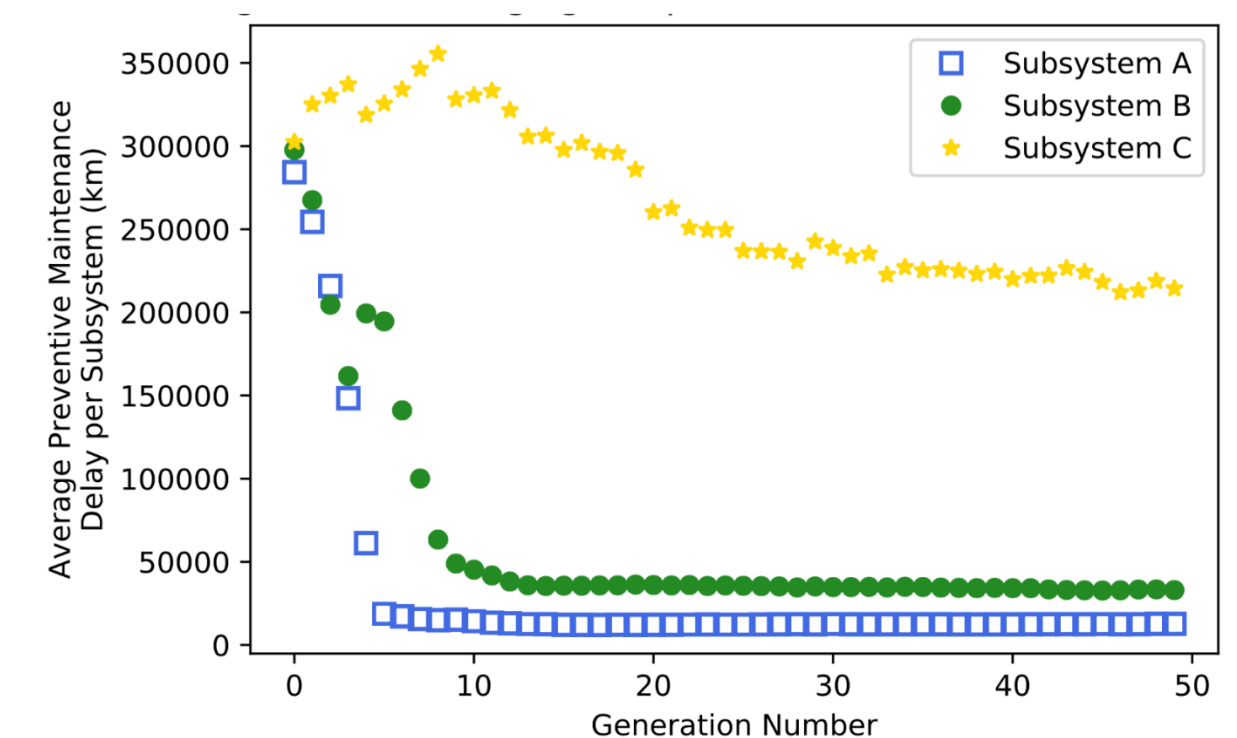
4 Simulation Model

The fleet of trucks is simulated completing journeys. Every time a journey is completed by a vehicle, the simulation checks whether it is due for maintenance based on the input trial maintenance schedule. Subsystems experience stochastic failures based on the reliability analysis.

- Subsystem Reliabilities
- Maintenance Effectiveness
- Operation Logistics
- Maintenance Constraints
- Fleet Size
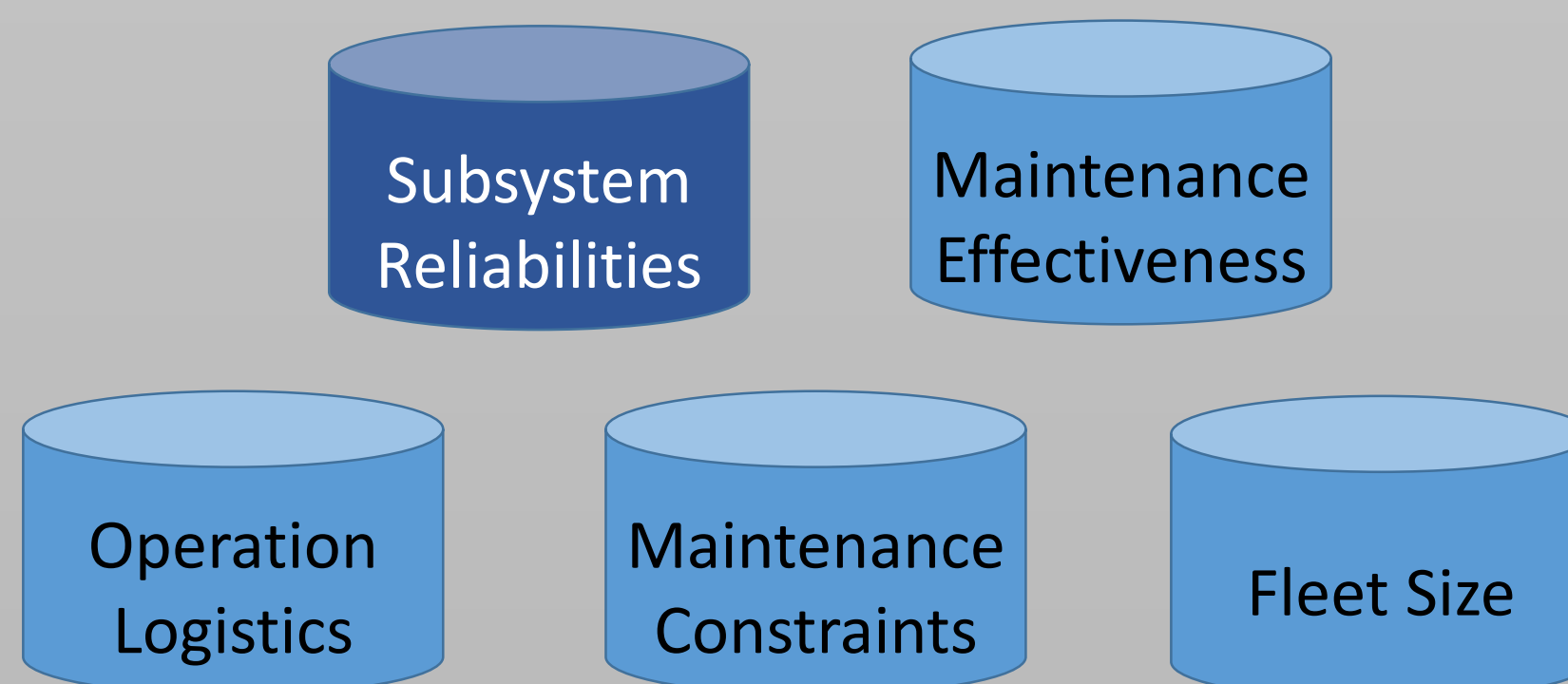
Number of simulated events:

- Trips Completed
- Maintenance Events
- Failures

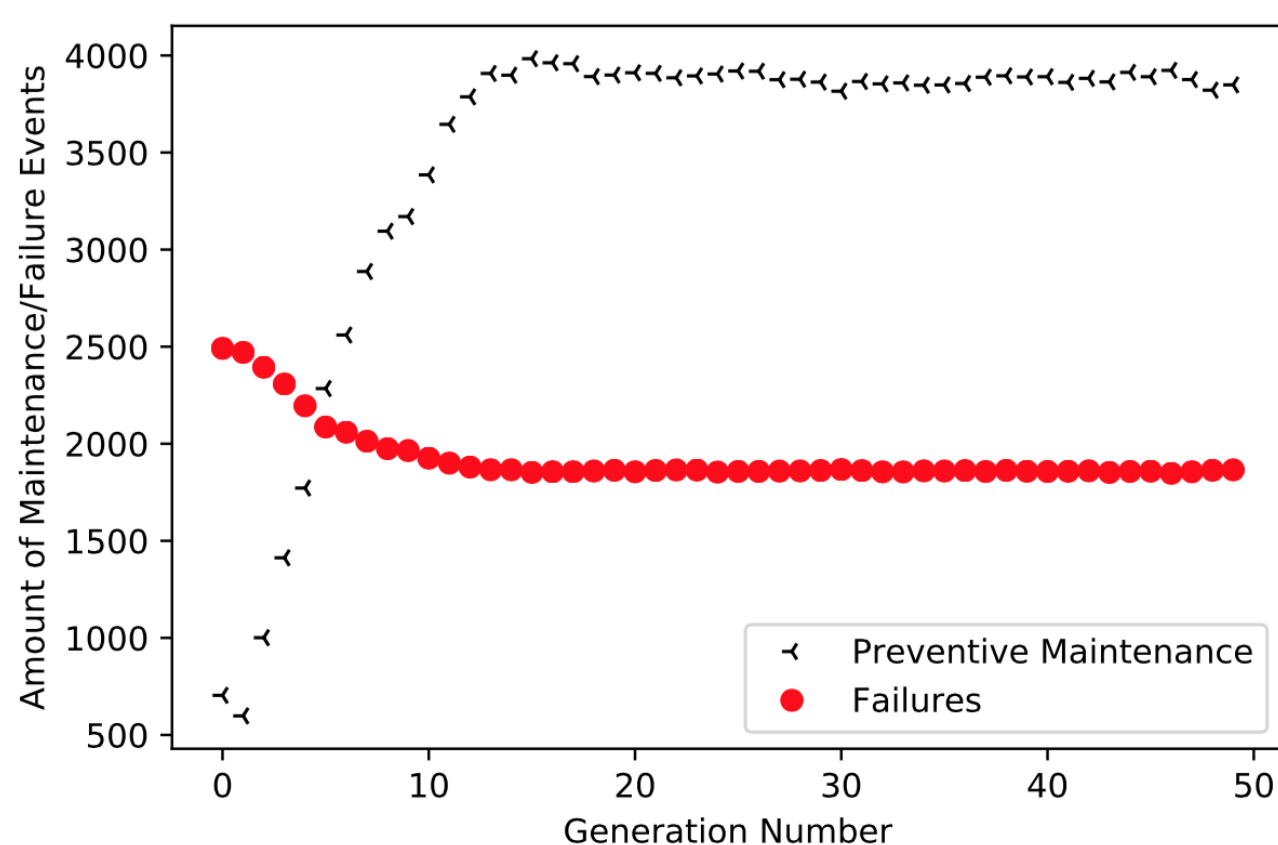**Figure 1** Genetic Algorithm Converging to Optimal Maintenance Schedule

Figure 2 Trend in Preventive Maintenance and Failures Throughout Simulation

5 Results

Genetic algorithm successfully optimised the maintenance schedule for the fleet of prime movers as modelled using their real maintenance data. Simulation was validated and verified. Fleet owners will be able to optimise maintenance planning for other mobile load haul assets using this process.
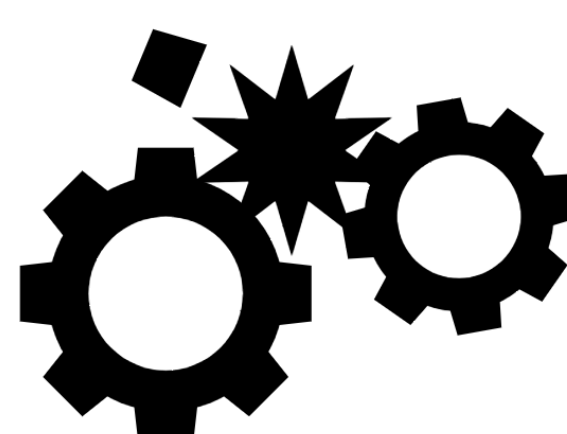
Reduced Field Failures

Maximised Availability

Minimised Maintenance Cost

UWA System Health Lab