Dynamic Vehicle Routing Problem

Reinforcement Learning vs Traditional Methods

The Problem

The DVRP aims to find the **least cost routes** to serve a set of **stochastic customers** with a given number of **capacitated vehicles**

Objective

Evaluate performance of RL algorithms against heursitic and metaheuristic algorithms - measured by **solution quality, computation time** and **dynamic adaption**

Methodology

- **Evaluated** on adapted CVRP **Solomon Instances** - with random, clustered and random-clustered instances ranging from **25-100 customers**
- **Benchmark** performance obtained from **PYVRPs Genetic Algorithm Solver**

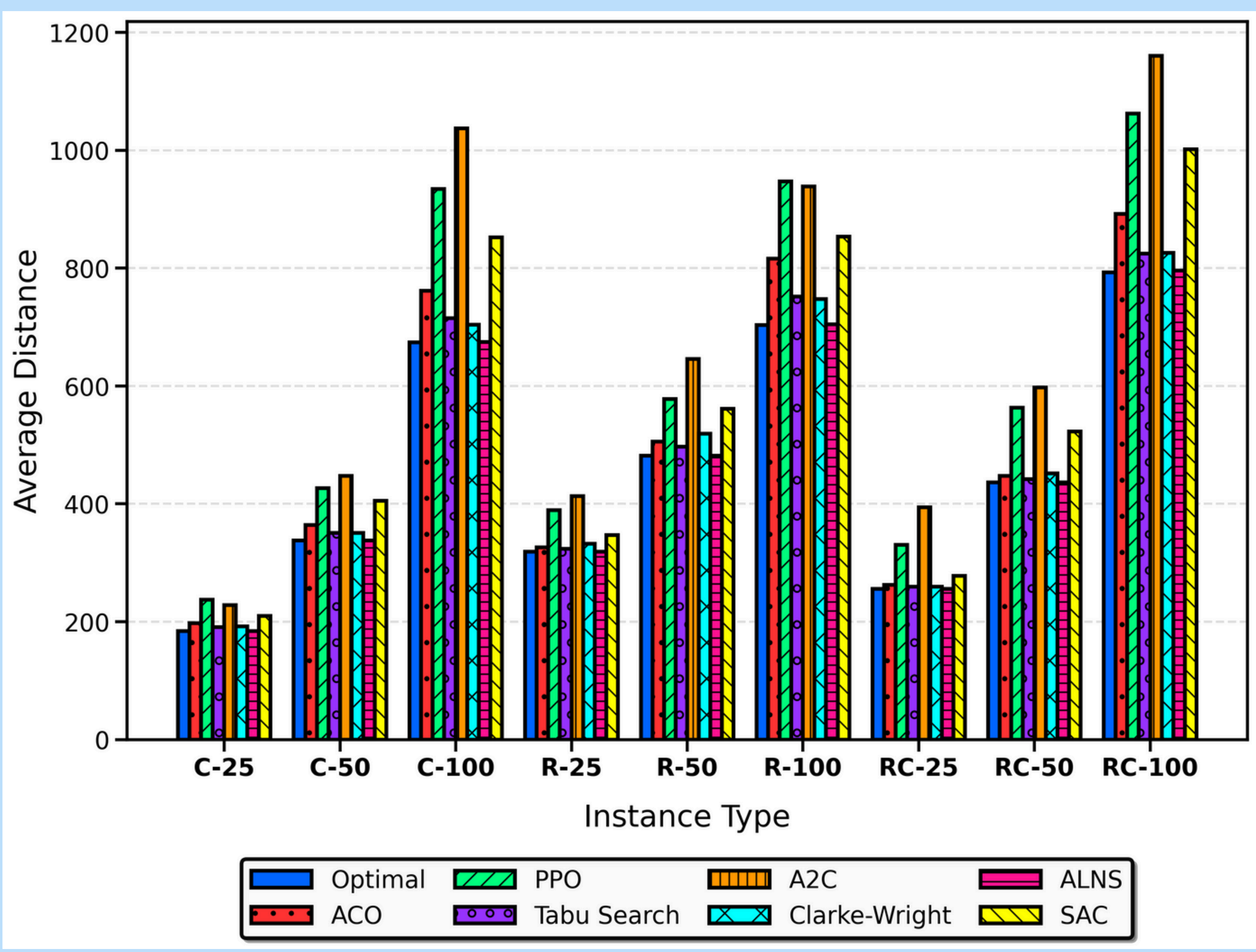
Algorithms

Traditional:
- Clarke-Wright Savings
- Tabu Search
- Ant Colony Optimisation (ACO)
- Adaptive Large Neighbourhood Search (ALNS)

RL:
- Soft Actor-Critic (SAC)
- Advantage Actor-Critic (A2C)
- Proximal Policy Optimisation (PPO)

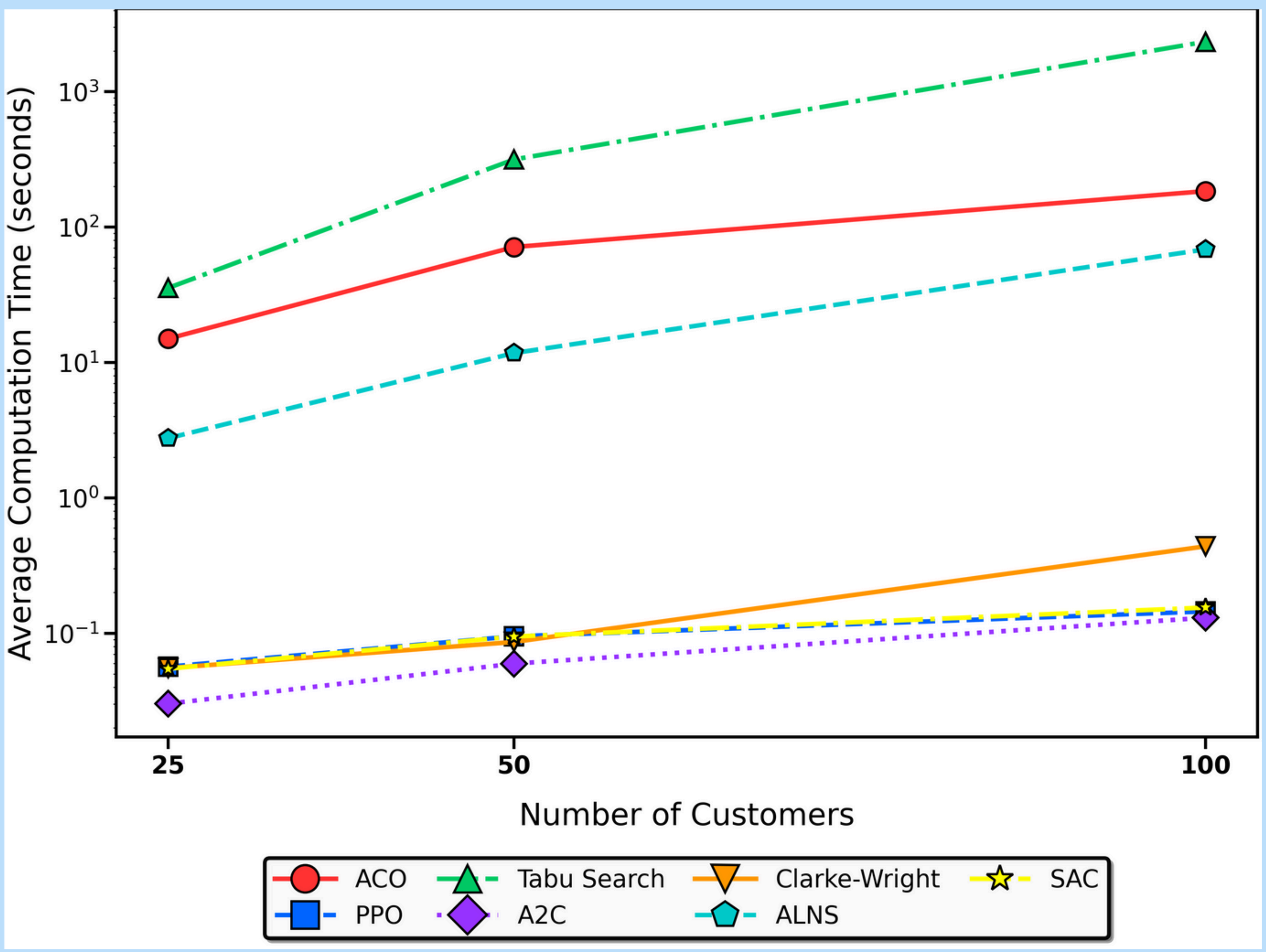
Results

Solution Quality



Traditional optimisation methods **consistently outperform** RL approaches. ALNS achieves near-optimal solutions (0.05% gap), followed by Clarke-Wright (4.26%) and ACO (4-20%). RL methods (PPO, A2C, SAC) show poor performance with 12-41% optimality gaps. All methods adapted to **dynamic customers**.

Computation Time



RL algorithms offer extremely **fast inference** (0.03-0.16s) but require **substantial upfront training**. Clarke-Wright provides quick solutions (0.05-0.47s). ALNS balances quality and speed (2.4-79.8s). ACO and Tabu Search deliver solutions at significantly longer runtimes (15-2400+s).

Conclusions

Current RL architectures are **fundamentally limited** for constrained vehicle routing problems, despite their ability to **adapt dynamically**. Traditional methods' superiority in this research demonstrates their continued effectiveness and highlights the need for **innovations** to render RL viable in this domain

University of Cape Town
Department of Computer Science
www.sit.uct.ac.za

Ryan Schapiro: schrya010@myuct.ac.za
Jayden Moore: mrxjay001@myuct.ac.za
Aidan Brand: brnaid002@myuct.ac.za
Supervised by **Krupa Prag:** krupa.prag@myuct.ac.za