# A hybrid genetic algorithm for multi-depot and periodic vehicle routing problems

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Vehicle Routing Problem (VRP) formulations are used to model an extremely broad range of situations in many application fields, such as transportation, supply chain management, and production planning. As a result, since the first paper on the topic by Dantzig and Ramser in 1959, routing problems have made up an extensively studied field. However, some variants of the VRP have received considerably less attention in the literature. This is the case, in particular, of problems with multiple depots and multiple periods, which we address in this presentation.

We propose an algorithmic framework that successfully addresses three VRP variants: the multi-depot VRP, *MDVRP*, the periodic VRP, *PVRP*, and the multi-depot periodic VRP, *MDPVRP*, with capacitated vehicles and constrained route duration.

The metaheuristic that we present combines the exploration breadth of population-based evolutionary search, the aggressive-improvement capabilities of neighborhood-based metaheuristics, and advanced population-diversity management schemes. This method follows on the line of research initiated by Christian Prins and his colleagues in Troyes, which revolves around Genetic Algorithms for the classical VRP and several of its variants. A key characteristic of these GA's is the representation of solutions as *giant tours*. We retain this feature in our algorithmic framework, but we introduce several new ones, which play a central role in our method:

- An extended solution representation capable of dealing with multi-depot multi-period instances;
- A new crossover operator designed specifically to allow a wide variety in offspring;
- An efficient offspring education scheme that integrates key features from efficient neighborhood search procedures, e.g., memories and granular tabu search concepts;

- Population-diversity management mechanisms that allow a broader access to reproduction, while preserving the memory of what characterizes good solutions represented by the elite individuals of the population. In these mechanisms, the evaluation of individuals relies on both solution cost and diversity (distance-to-the-others) measures. As a result, premature population convergence is avoided and the overall performance of the method enhanced.

The resulting method, which we call *Hybrid Genetic Search with Adaptive Diversity Control* (*HGSADC*), performs impressively, in terms of both solution quality and computational efficiency. For all currently available benchmark instances for the three problem classes, HGSADC identifies either the best known solutions, including the optimal ones, or new best solutions. Moreover, with very limited adaptation, it also proves extremely competitive for the CVRP.