Methods for providing decision makers with optimal solutions for multiple objectives that change over time

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INTRODUCTION

Decision making - with the goal of finding the optimal solution - is an important part of modern life. For example: In the control room of an airport, the goals or objectives are to minimise the risk of airplanes colliding, minimise the time that a plane has to wait for take-off or landing and maximise the utilisation of all landing strokes. In order to make the best decision, you need the optimal solution(s) for the problem that you are trying to solve.

DYNAMIC MOOP

The control room example has more than one goal, and therefore is a multi-objective optimisation problem (MOOP). By minimising the possibility of a collision, you increase the time that a plane has to wait to take-off or land. These goals are in conflict with each another. Therefore, there isn't a single solution, but a set of optimal solutions, called the Pareto optimal front (POF).

When the objectives change over time, the problem is called a dynamic MOOP (DMOOP). This research focuses on finding the POF for DMOOPs, in order to provide the decision maker with the set of optimal solutions.

VECTOR EVALUATED PSO

Kennedy and Eberhart [1] introduced particle swarm optimisation (PSO) that is based on the social behaviour of bird flocks. Each swarm has a number of particles, with each particle position representing a possible solution. The position of the particle is updated by taking into account its current position, its best position found so far and the best position found so far by other particles in its vicinity.

Vector evaluated PSO (VEPSO) is a multi-swarm variation of PSO [2]. Each swarm optimises only one objective and then shares its knowledge with another swarm. This is illustrated in **Figure 1**.

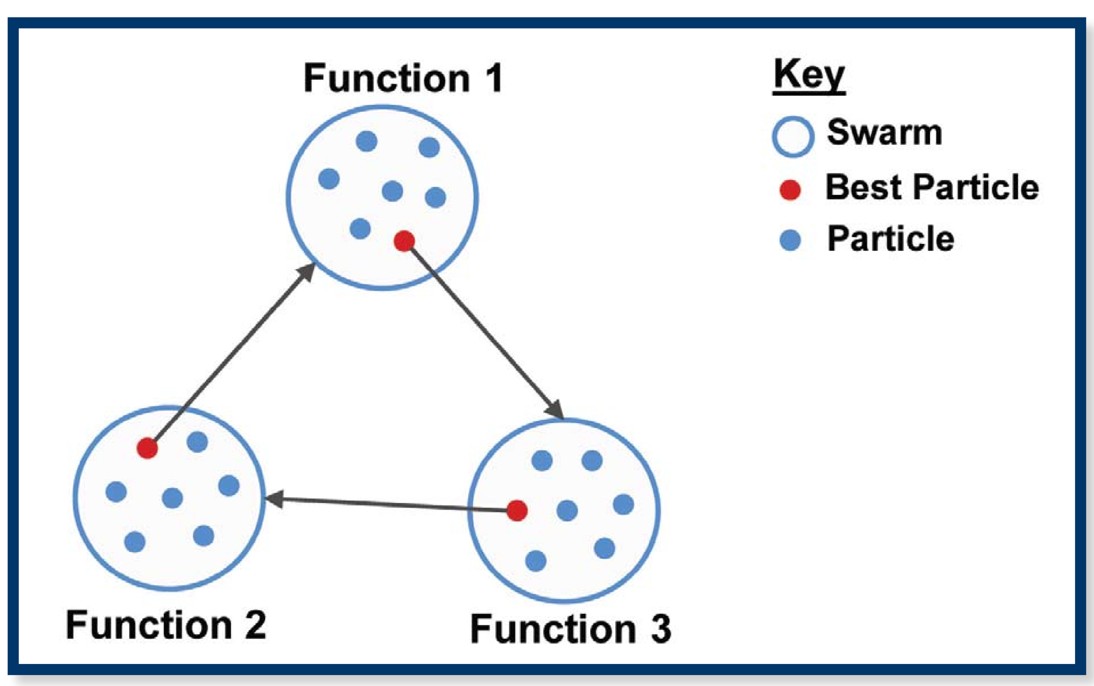

Figure 1: VEPSO swarm-sharing knowledge

RESULTS

The set of solutions found for two DMOOPs are presented in **Figures 2 and 3**.

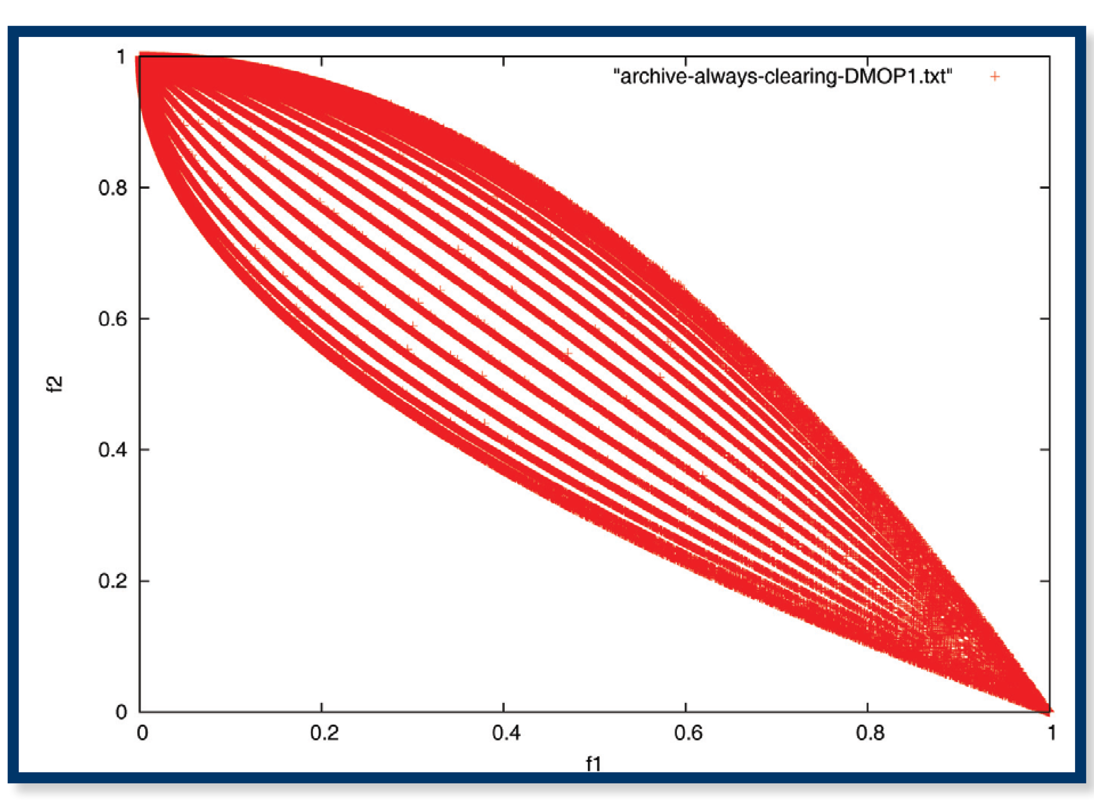

Figure 2: Tracking solutions of the DMOP2 [3] problem

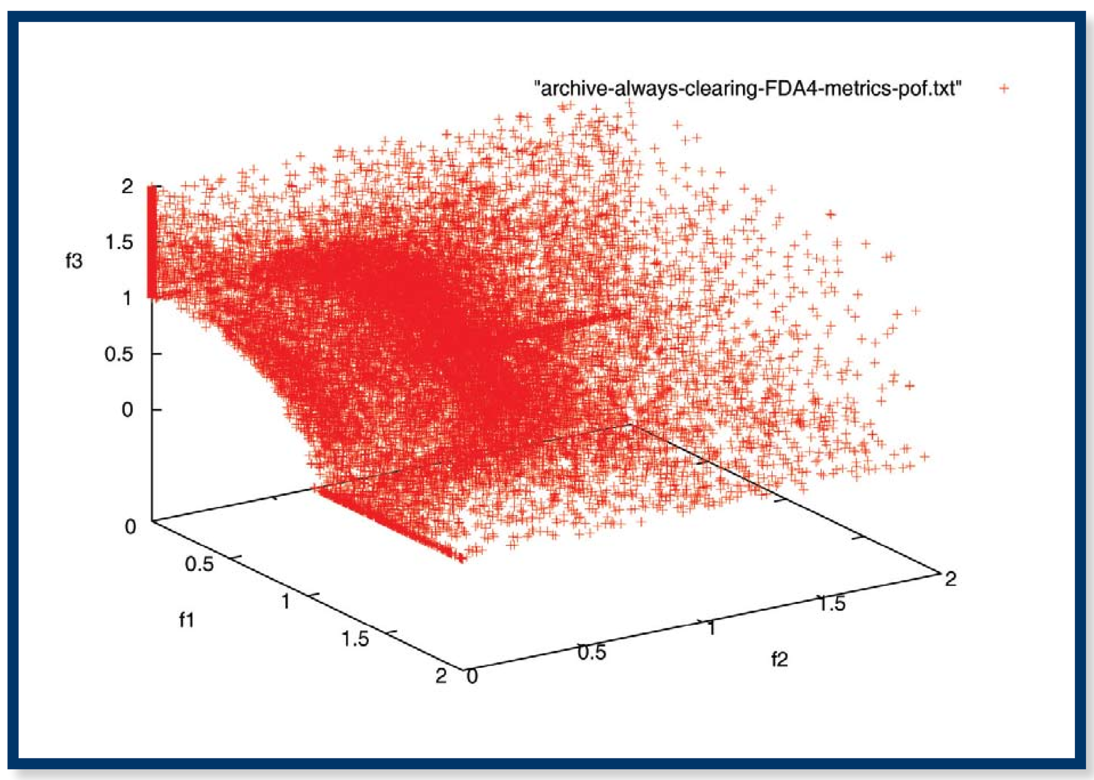

Figure 3: Tracking solutions of the FDA4 [4] problem

APPLICATION AREAS

This research can be applied to a vast range of applications, such as:

- Scheduling problems such as timetables or production plants
- Target tracking in military operations
- Routing in telecommunication networks
- Pricing of mobile networks
- Stock market prediction
- Air traffic control
- Traffic flow.

REFERENCES

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[3] C-K. Goh and K.C. Tan. Competitive-Cooperative Coevolutionary Paradigm for Dynamic Multiobjective Optimization, IEEE Transactions on Evolutionary Computation, 13(1): 103-127, 2009.
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Everyday scheduling and tracking tasks can be improved through methods to identify sets of optimal solutions.