Constraint Optimisation for Social Impact

Supervision team

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Research project

Constraint Programming is a paradigm for problem solving using Artificial Intelligence which has shown exemplary performance in solving combinatorial problems. These problems involve identifying feasible or optimal solutions from a very large set of candidate solutions. These problems range from allocating hospital beds, optimising the use of equipment in factories, and vehicle routing. I am particularly motivated by applications of constraint optimisation for social impact, with applications across climate, energy, environmental sustainability, public health, urban planning and policy development.

One ongoing project (in collaboration with Princeton and Yale University) considers CP approaches to optimise the captive breeding programme for the Galápagos giant tortoise. Captive breeding programs play a critical role in combating the ongoing biodiversity crisis by preserving the most endangered species and supporting reintroduction efforts. Maintaining the genetic health of captive populations requires careful management to prevent inbreeding and maximise the effective population size. Decisions about which males and females should be bred together are guided by the principle of minimizing relatedness between pairs. Methods to select breeding pairs are well developed, however, some species' ecology requires them to live in groups, and evaluating optimal groupings of multiple males and females that would be suitable to breed together is a more complex problem. Current computational tools to support the design of group-living captive breeding programs suffer from challenges of scalability and flexibility. We demonstrate the applicability of constraint programming (CP) approaches to optimize breeding groups to minimize relatedness. Exploration of the needs of Galapagos giant tortoise captive breeding program has informed the development of our flexible approach to capture the constraints on viable captive breeding program design. Our findings have directly informed the implementation of new group configurations at the captive breeding centre.

Applicant skills/background

This project requires a strong background in computer science, operations research, or applied mathematics, with expertise in optimisation, algorithms, or artificial intelligence. A strong interest in using computational techniques for societal benefit is essential.

References

Forshaw, M., Gray, R., Ochoa, A., Miller, J. M., Brzeski, K. E., Caccone, A., & Jensen, E. L. (2025, April). Constraint Optimisation Approaches for Designing Group-Living Captive Breeding Programmes. In Proceedings of the AAAI Conference on Artificial Intelligence (Vol. 39, No. 27, pp. 27989-27997).