EvoLP.jl: Modular Optimisation in Julia using Evolutionary Computation

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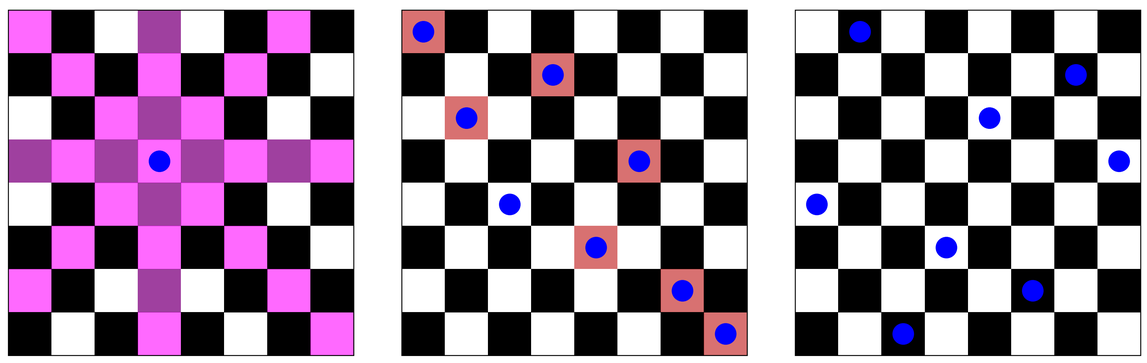
Abstract

We present an **open-source software framework**, **EvoLP.jl** [2], to support the research in **optimisation** using **Evolutionary Computation** (EC) in the Norwegian scientific community. EC is highly relevant in many problems in **artificial intelligence**, **engineering** and **statistics** when non-convex or non-differentiable functions appear. The software is a **package** in the **Julia programming language** that provides **reusable** computing *blocks* for experimenting and analysing several components for single-objective EC algorithms. By stacking these blocks, the user can quickly create **modular solvers** where each of the components can be easily swapped for testing. In addition, it provides a few built-in algorithms ready to use out of the box. A bunch of utilities for analysis are available as well: **test** functions, **result** reporting, and statistics **logging** and **overview**. **EvoLP.jl** is an effort of the **Norwegian Open Artificial Intelligence Lab**.

A visual example: The 8-queens problem

This example deals with a classical combinatorial problem in AI where the goal is to place 8 queens in a chess board such that no queen checks each other [1]. **Fig. 1** shows three configurations where the constraints and possible clashes are highlighted.



(a) Queen constraints **(b)** Generated conflicts **(c)** Possible solution

Figure 1: The 8-queens problem. 1a shows the constraints (in pink) imposed by the placement of a single queen piece (in blue). 1b highlights the conflicts arising from a possible configuration of the board. 1c illustrates one possible solution with no conflicts.

Let's design a solution

Using the **provided blocks** we can set up a solver quickly. We would need:

- A permutations **generator**
- A tournament **selector**
- A permutation **recombinator**
- A permutation **mutator**
- An **objective**: **minimise** conflicts

Let's code the solution

What is Julia?

Julia is high-level, **high-performance** programming language very suitable for **scientific computing**. It is part of the PetaFLOPS Club (10^{15} floating point operations per second) along with C, C++ and Fortran, and its syntax is similar to Python or MATLAB. This is the Julia code for solving the 8-queen problem using **EvoLP.jl**:

```
using EvoLP
X = permutation_vector_pop(100, 8, 1:8)
S = TournamentSelectionSteady(5)
C = OrderOneCrossover()
M = SwapMutation()
f = diag_constraints(x)
result  = mySteadyGA(statsbook, diag_constraints, X, 500,
↪  S, C, M, 0.8)
@show optimum(result)
@show optimizer(result)
```

And here is one **possible output** of the solution above:

```
optimum(result) = 0
optimizer(result) = Any[5, 1, 8, 6, 3, 7, 2, 4]
```

Check the full **step-by-step** example in the **documentation**.

What else can EvoLP do?

Components

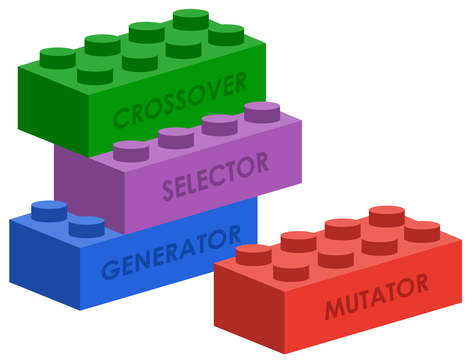


Figure 2: Stack the components together to make your own solver.

- Random **population generators** for vectors and particles
- Parent **selectors**
- Several **recombinators** and **mutators**
- **Test functions** for benchmarking your algorithms
- Convenient **result reporting** and a logbook for **statistics**
- Built-in **algorithms**
- Support for **custom operators**

And what can I use it for?

Combinatorial challenges:

- Assignment and packing
- Scheduling and search
- Constraint satisfaction and optimisation

Numerical optimisation and **tuning** for machine learning:

- Hyperparameter tuning
- Neuroevolution
- Feature selection

Jump right into it

EvoLP.jl is well-tested, provides extensive documentation and is free—available for everyone to use under an open-source license at **GitHub**. After **installing Julia**, you can **install EvoLP.jl** by using the Julia **REPL**:

```
julia> import Pkg
julia> Pkg.add("EvoLP")
```

This should install **EvoLP** in your system.

Figure 3: Visit the GitHub repository by scanning this QR code.

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References

[1] S. Russell and P. Norvig. *Artificial Intelligence: A Modern Approach*. Pearson Series in Artificial Intelligence. Pearson, 2020.

[2] X. F. C. Sánchez-Díaz and O. J. Mengshoel. EvoLP.jl: a playground for evolutionary computation in Julia. In *NAIS'23: Symposium of the Norwegian AI Society*, Bergen, Norway, June 2023.