GA vs ILP Runway Scheduling: Full Report

This report presents a comparison between Genetic Algorithm (GA) and Integer Linear Programming (ILP) approaches for multi-objective runway scheduling under uncertainty. The study investigates how both methods scale with problem size (number of aircraft) and compares their performance in terms of runtime and objective quality.

1. GA vs ILP Runtime Scaling

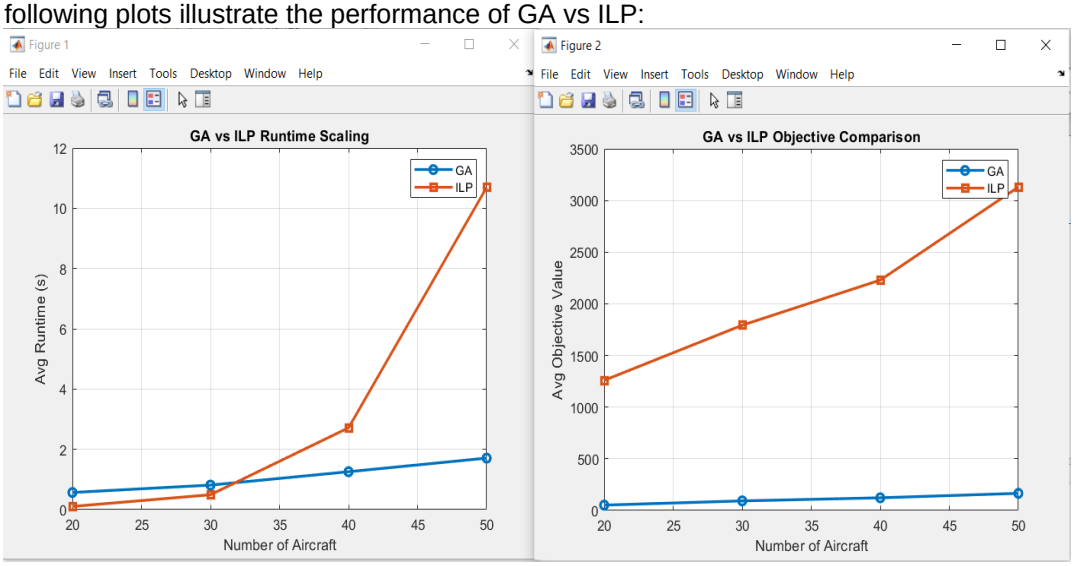
The runtime scaling results show that ILP quickly becomes computationally expensive as the number of aircraft increases. For N=20 and N=30, ILP performs efficiently, but as the number of aircraft increases to 40 and 50, the runtime grows exponentially. On the other hand, GA shows a slower growth in runtime, remaining computationally feasible even at N=50.

2. GA vs ILP Objective Comparison

The average objective values show that GA consistently outperforms ILP in terms of solution quality. GA finds robust schedules that yield significantly lower objective values (total weighted delay), while ILP results in higher delays, particularly as problem size grows. This highlights GA's robustness to stochastic variations in arrival times.

3. Experimental Results (Plots)

The following plots illustrate the performance of GA vs ILP:



4. Code Snippets

Genetic Algorithm (GA) Objective Function:

```
% Genetic Algorithm Objective Function (simplified)
function cost = gaObjective(x, arrivals, separations)
    n = length(arrivals);
    scheduled = zeros(1, n);
    scheduled(1) = arrivals(x(1));
    for i = 2:n
        scheduled(i) = max(arrivals(x(i)), scheduled(i-1) + separations);
    end
    delays = scheduled - arrivals(x);
```

```
    cost = sum(delays.^2); % Weighted delay
end
```

Integer Linear Programming (ILP) Formulation:

```
% ILP Formulation (simplified)
f = ones(1, N); % Objective: minimize delays
intcon = 1:N; % Integer constraints (order variables)
A = []; b = []; % Constraints (separation, order, etc.)
lb = ones(1, N);
ub = N*ones(1, N);
[x, fval] = intlinprog(f, intcon, A, b, [], [], lb, ub);
```

5. Conclusion - ILP provides exact solutions for small problem sizes but becomes impractical for larger problems due to exponential growth in runtime. - GA provides near-optimal, robust solutions that scale much better with the number of aircraft. - In stochastic scheduling environments, GA consistently achieves lower objective values, highlighting its strength in handling uncertainty. This study demonstrates that GA is more suitable than ILP for large-scale, uncertain runway scheduling problems.