# Evolutionary Techniques in Coalition Formation in Multi-agent Systems

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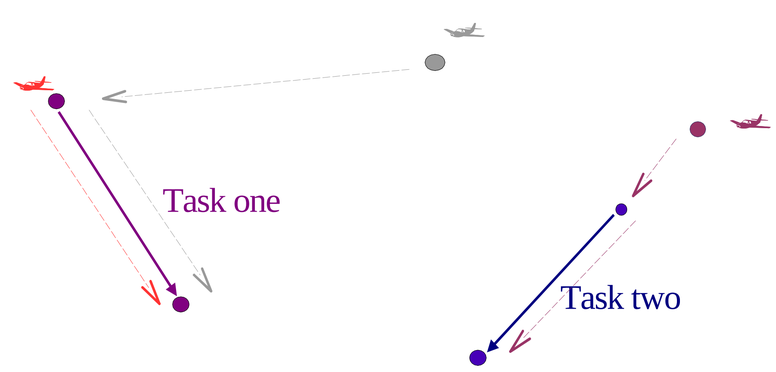
## COALITION FORMATION

- arises in situations, when there is no agent, which can fulfil task, that was given to MAS.
- can be used for obtain better performance from the multi-agent system.
- was solved by many means of AI, but usually not with stochastic methods.

## SOLVED PROBLEM

- Simulation of transportation company.
- Aeroplanes on different airports. Each aeroplane has given range.
- Task is given by:
  - Starting airport
  - Final airport
  - Weight of cargo to be transported
- The goal is for to find coalition of agents (aeroplanes) for each task such that:
  - Each aeroplane is able to fly directly from its home airport to the starting airport of the task.
  - Each aeroplane is able to fly directly from the starting airport of the task to the final airport of the task.
  - Sum of weight of the cargo, that can be transported by aeroplanes assigned to the task is equal or greater than weight of cargo that should be transported.
  - The sum of travelled kilometers is the least possible.




## GA IMPLEMENTATION

- One dimensional genes. Each allele includes the number of aeroplane and the number of the task to which is the aeroplane assigned (0 not assigned).
- Fitness: Sum of travelled kilometers.
- Decoding:
  - The gene is sequentially scanned and if the aeroplane, that is assigned to the unsatisfied task is found, then if it can participate on the task, it is added to the coalition (that solves given task).
  - If any task(s) is/are unsatisfied, then unassigned aeroplanes are added into coalition(s)
  - If neither unassigned aeroplanes satisfies tasks, then penalty function is used as follows:

$$v = 5 \cdot \left( \frac{w_r}{w_t} \right) \cdot l$$

  - $w_r$ unsatisfied weight of cargo, $w_t$ weight of cargo for given task, $l$ distance between starting and final airport.
- The OX crossover and two type of mutation were used.

## RESULTS

- The GA was compared with CLP in $E^cL^iPS^e$.
- Both algorithms found best solutions.

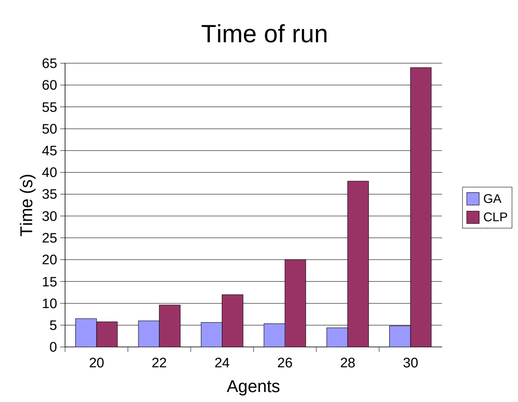



***Chart 1**: Comparison of times of run between GA (one run of GA) and CLP.*

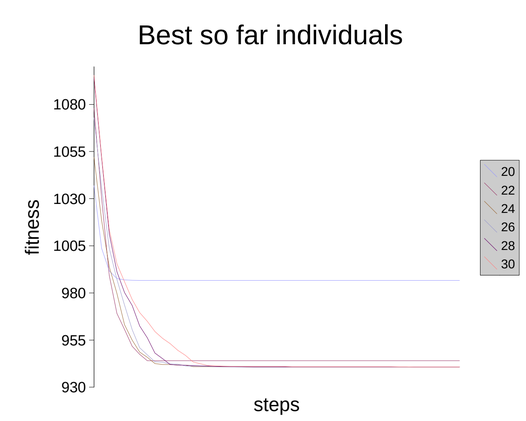



***Chart 2**: Best so far individuals in GA runs*

- GA was, in more complex environments, clearly faster than CLP.
- In the future we will implement parallel GA on more complex problem.