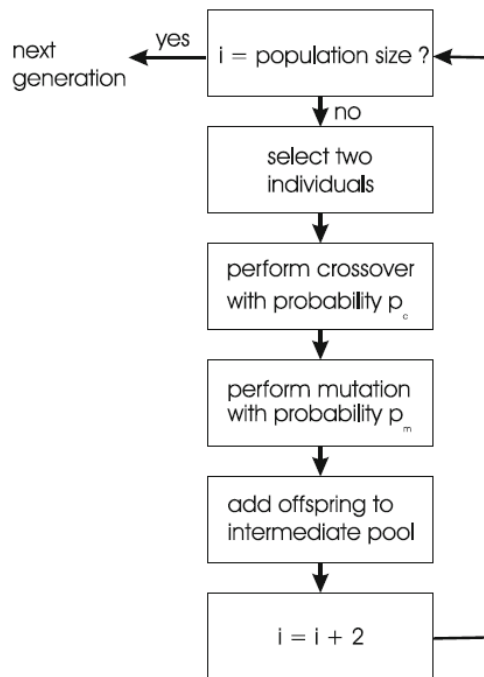
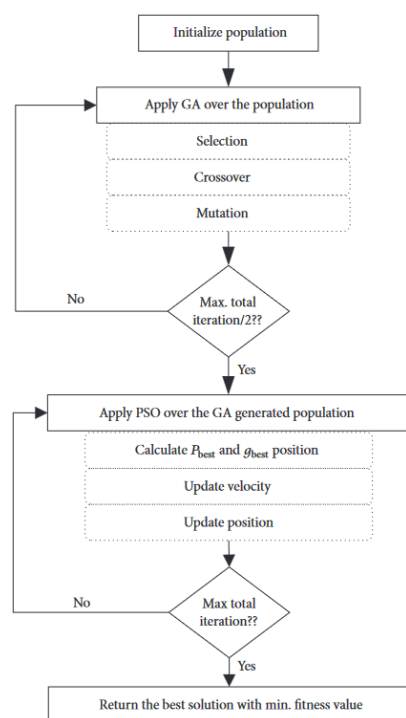
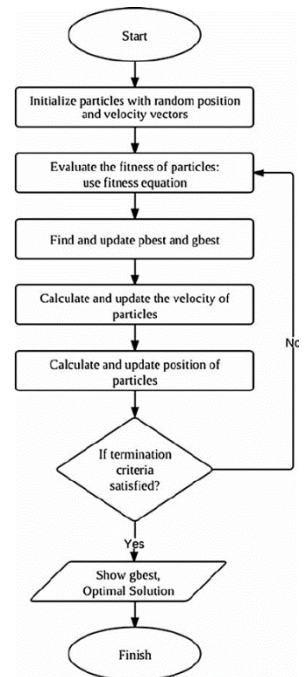


Both Particle Swarm Optimisation (PSO) and Genetic Algorithm (GA) fall under Evolutionary Algorithm (EA). One major factor for hybridisation is that many complex problems can be decomposed into a number of parts, for some of which exact methods, or very good heuristics, may already be available. In these cases, it makes sense to use a combination of the most appropriate methods for different subproblems.

Flowchart of GA:



Flowchart of PSO:



Hence, the flowchart of hybrid GA - PSO would look something like the flowchart on the left. Now let's look at the different operators involved in this hybrid model

i. Selection operator: In the GA algorithm, not all generated chromosomes are evolved through the GA operators in each iteration. Therefore, the chromosomes are passed through the tournament selection to select the best chromosome from a group of chromosomes. The function selects a random (id) after running several tournaments between few chromosomes. The selected ids represent the index of the selected chromosome from a set of chromosomes. The best chromosome in the group is

selected for crossover operator based on its fitness value.

- ii. Crossover operator: The crossover operator aims to generate new chromosomes through changing the position of the genes inside every two chromosomes. In the crossover, a random number is selected in the range of the number of the chromosome genes, to represent the division point of each chromosome into two parts. The crossover returns an offspring chromosome of two parts that contains both chromosomes' genes. The first group takes the first chromosome until the index, which is determined by the random number. The second chromosome has the second group starting from the index, which is determined by the random number, until the end of the chromosome.
- iii. Mutation operator: The mutation operator aims to make unusual modifications in the new chromosomes that are generated from the previous crossover operator with better fitness value than the existing chromosomes. The mutation operator operates over the returned chromosome from the selection method, and the occurrence of the mutation is based on the mutation rate variable. The mutation process starts with a number that is randomly generated to be less than or equal to the mutation rate. Two genes, are selected randomly from the same chromosome and checked to be different. If they are the same, their places are swapped to generate new chromosome, which represents a different distribution of the tasks over the available genes. The generated chromosome is then passed to the next stage of the algorithm.
- iv. Applying the PSO algorithm
  - a. Evolve  $g_{best}$  and  $p_{best}$  of the particles
  - b. Update the Velocity and Position matrix

Application of such hybrid algorithm has been in cloud computing, specifically in workflow scheduling. It has been found that this algorithm performs much better than either of those two evolutionary algorithms.