Lecture 7.1

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Meta-heuristic Algorithms

Course Learning Outcomes

- 2. Assess the suitability of different algorithms for solving a given problem
- 3. Solve computationally difficult real world problems using appropriate algorithmic techniques.

Algorithm Design Paradigms

So far we have seen various kinds of algorithm design approaches. No design is perfect and they come with their pros and cons.

- Brute force
- Divide and Conquer
- Dynamic Programming
- Greedy Approach (not yet studied)

Solve complex problems like TSP

- No one has ever found an algorithm for the Traveling Salesperson problem whose worst-case time complexity is better than exponential. Yet, no one has ever proved that the algorithm is not possible.
- Worst case Time complexity with various approaches:
  - Brute Force – factorial
  - Dynamic Programming – exponential
  - Divide & Conquer?

Do we have a satisfactory solution?

- There are no 'deterministic method' that can solve TSP better than exponential.
- That means we cannot have solutions for large problems in a reasonable time frame.
- But we have seen solutions can be obtained very quickly. Such as GPS tracking, shortest route etc.

Artificial Intelligence Methods

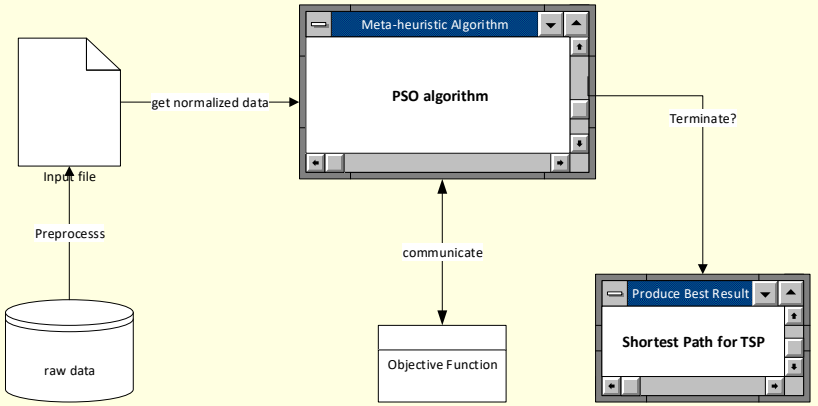
- These complex optimization problems can be solved by meta-heuristic algorithms.
- Like:
  - Genetic Algorithm
  - Particle Swarm Optimization
  - Ant Colony Optimization
  - Etc.

Particle Swarm Optimization (PSO)

PSO Algorithm

```
//PSO Algorithm:
//Input: problem in matrix form;
//output: optimum solution
read(); // read the matrix from the file;
parameter_setting();
for(int i=0; i<max_iter; i++)
      for(int j=0; j<swarm_size; j++)
            best_neighbor = get_best_neighbor(particle[j]);
      if(best_neighbor<global_best)
            global_best = best_neighbor;
      End if;
      extra_best = move_towards(particle[j], best_neighbor);
      If(global_best<extra_best)
            solution = global_best;
      End if;
      else
            solution = extra_best;
      End for_loop;
End for_loop;
```

Framework



Evolutionary Algorithm