Coursework #3: Stochastic Optimisation

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I optimized the TSP problems using ACO(Ant Colony Optimization) algorithm.

ACO is probabilistic and meta-heuristic optimization to find an optimal path on the graph by employing ant pheromone mechanism. Ants select next node with weighted probabilities of the nodes to visit and leave pheromone on their visited path. Then, it evaporates and adds pheromones to their paths. Finally, optimal pheromones are survived and they can find the optimal path.

The pseudo-code is below.

```
def explore(start_node):
  # visit iteratively until all nodes are visited
  while visitables is not empty:
      next_edge = select_next_edge(current_node) # ant selects next node
      next_node = next_edge.dst
      path.append(next_node) # ant adds visited node to path
      visitables.remove(next_node)
      current_node = next_node

  # add the last node to the result path
  last_node = path[-1] # pick the last node of path
  edges.append(graph.edges[last_node][start_node])
  path.append(start_node)

for i = 0 to num_iter:
    for ant in ants:
        start_node = random.choice(graph.nodes) # pick randomly initial node
        ant.explore(start_node) # send ant and store path into each ant.path
        fitness = ant.evaluate() # get distance of visited nodes as fitness
        if fitness < best_fitness: # update best fitness
            best_path = ant.path
            best_fitness = fitness

        add_pheromone(ant.edges, fitness) # add pheromone to edges ant visited
    evaporate(graph.edges) # evaporate pheromones
    add_pheromone(best_edges, best_fitness) # add pheromone to edges best ant visited
    update_probabilities(graph.edges) # update probabilities
```

Each ant selects node weighted-randomly as the below probability of each node to visit.

$$p_{i,j} = \frac{{\tau_{i,j}}^{\alpha}{\eta_{i,j}}^{\beta}}{\sum_{l \notin S}{\tau_{i,l}}^{\alpha}{\eta_{i,l}}^{\beta}}$$

The probability is based on pheromone and cost. I added each ant's pheromones after the ant's tour ends and the best ant pheromones to the best path after each iteration.

Evaluation

I chose the default parameters as follows through parameter optimization tests

$$ants = 50, iteration = 100\ \alpha = 10,\ \beta = 10,\ probability = 0.1$$

the $probability$ means about exploitation. otherwise ants explore path with biased probabilities of each edges to visit.

the below results are TSP best costs optimized by ACO.

$$dj38 : 6660,\ bays29 : 2067,\ rl11849 : 1175070$$

bay29's best cost of known solution is 2020. But, In rl11849, the result was pretty good.

References

- M. Dorigo and L. M. Gambardella, "Ant colony system: a cooperative learning approach to the traveling salesman problem," in *IEEE Transactions on Evolutionary Computation*, vol. 1, no. 1, pp. 53-66, April 1997
- Ant colony optimization algorithms, https://en.wikipedia.org/wiki/Ant_colony_optimization_algorithms