Ant System: Application to TSP

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Motivation:

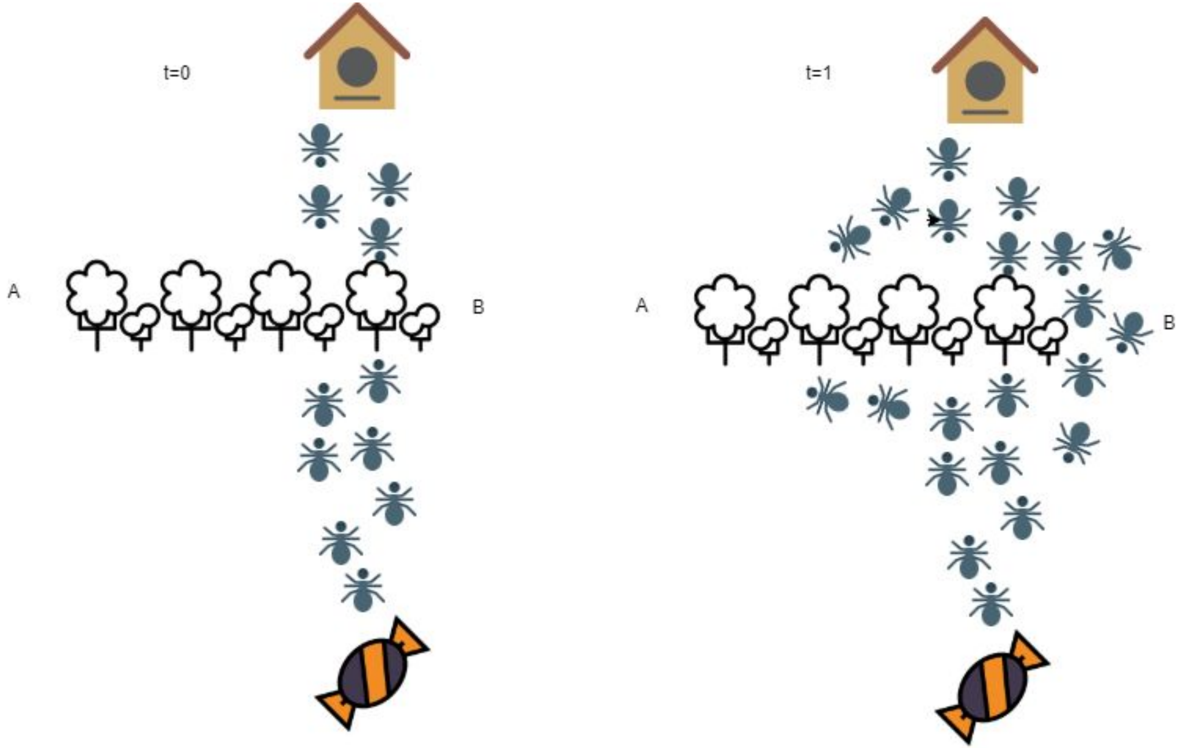
- Failed ant keeper
  - Virtual ants > Real Ants
- Inspired by real life biological ants
  - Ants = Mostly Blind
  - No method of visual communication
  - Pheromones!
  - Ants have been around since dinosaurs
  - Span every continent besides “Ant”arctica!
- Unique, and interesting approach

Origin:

- First presented by:
  - Marco Dorigo, Victor Maniezzo, Alberto Colorni
  - 1996
  - The Ant System: Optimization by a colony of cooperating agents
    - Implementation based on this.

Method Overview (Example):

- T=0
  - No pheromones.
  - Randomly traveling.
  - Both sides.
- T=1
  - 2x pheromone levels at B.
  - Influence movements towards B.
- How to represent?



Implementation/Representation

- N cities/locations
- N*N edges
- Graph data structure obvious choice
- K “ant” agents
- Each edge contains:
    - Pheromone at time t
    - Distance from node i to j

Implementation/Representation:

- Probabilistic Edge Choice:
  - τ : pheromone on edge i,j
  - α : parameter defining contribution of pheromone
  - β : parameter defining contribution of inverse distance.
  - η : 1/d inverse of distance of edge i,j
  - Only search edges we haven't used yet. (TSP)
  - Series of probabilities that sum to 1.
  - Use probability distribution to choose next edge.

$$p_{ij}^{k}(t) = \begin{cases} \dfrac{[\tau_{ij}(t)]^{\alpha} \cdot [\eta_{ij}]^{\beta}}{\sum\limits_{k \in allowed_k} [\tau_{ik}(t)]^{\alpha} \cdot [\eta_{ik}]^{\beta}} & \text{if } j \in allowed_k \\ 0 & \text{otherwise} \end{cases}$$

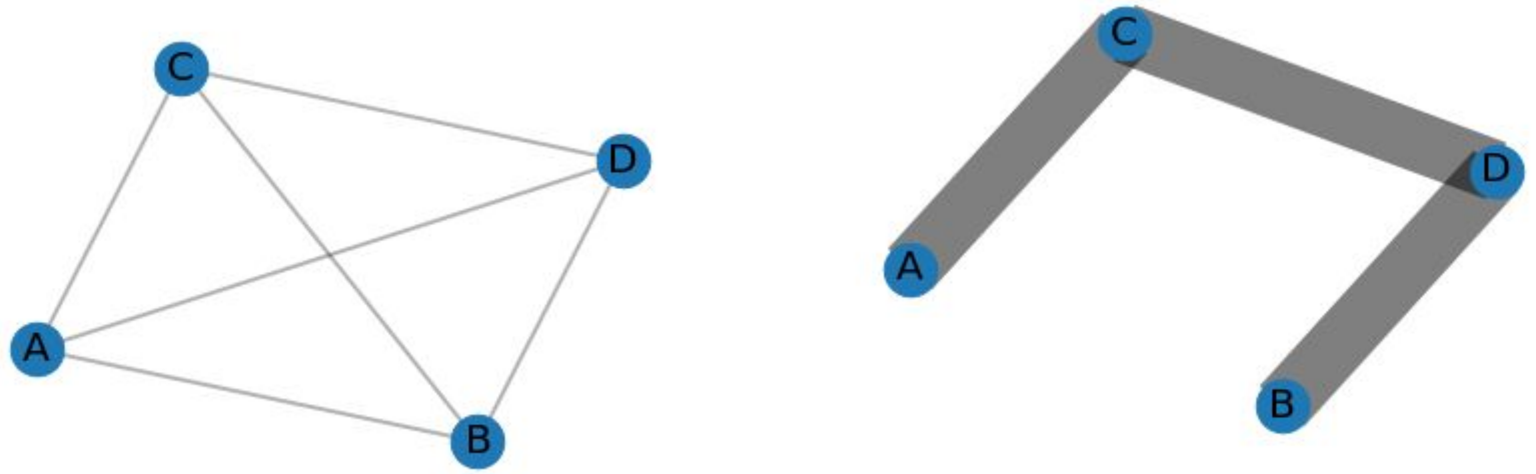
Implementation/Representation:

- Pheromone Update
  - Only update per cycle. (t+n)
  - p : parameter representing evaporation rate. (0-1)
  - Q : parameter controlling amount of pheromone deposited
  - L : represents the length of the tour that “ant” agent k took between time t to t+n.

$$\tau_{ij}(t+n)=\rho\cdot\tau_{ij}(t)+\Delta\tau_{ij}$$

$$\Delta\tau_{ij} = \sum_{k=1}^{m}\Delta\tau_{ij}^{k}$$

$$\Delta\tau_{ij}^{k} = \begin{cases} \dfrac{Q}{L_k} & \text{if k - th ant uses edge } (i, j) \text{ in its tour } (\text{between time t and t} + \text{n}) \\ 0 & \text{otherwise} \end{cases}$$



- Costly edges disappear

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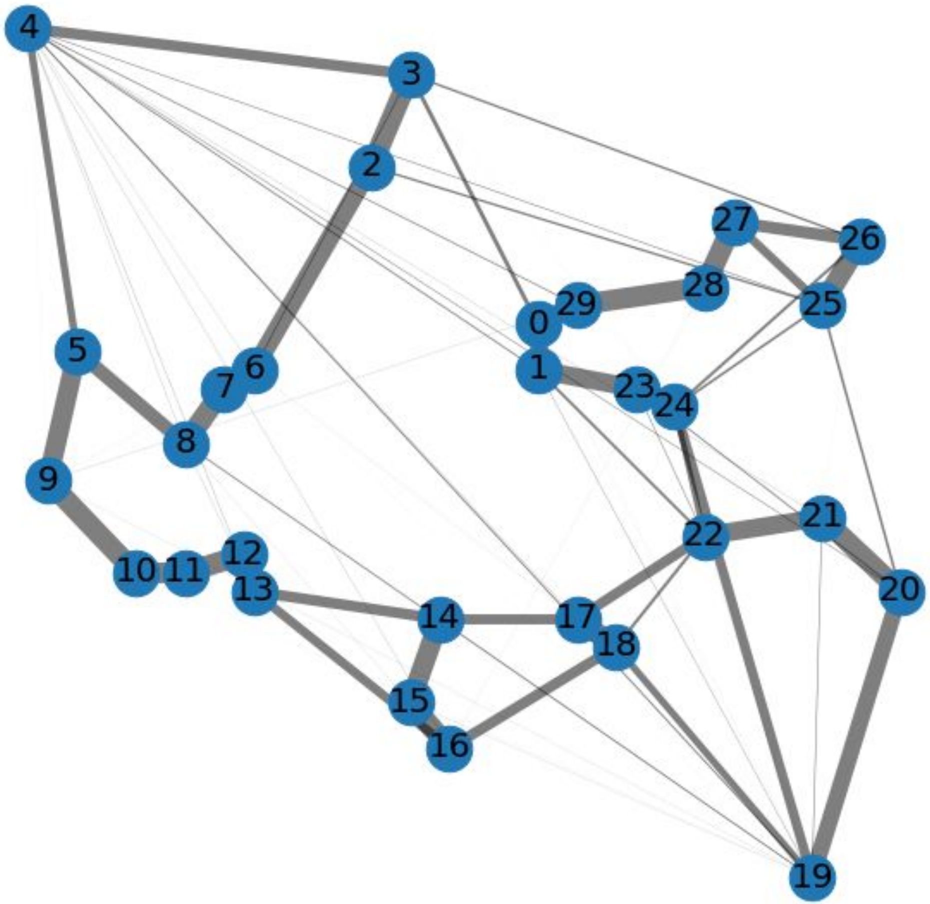

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Conclusion

- Very unique, and interesting algorithm
- Biological inspiration
- Shed light on different types of optimization algorithm
- Converges quickly
- Versatile
- A Lot of parameters to mess with!

Questions?