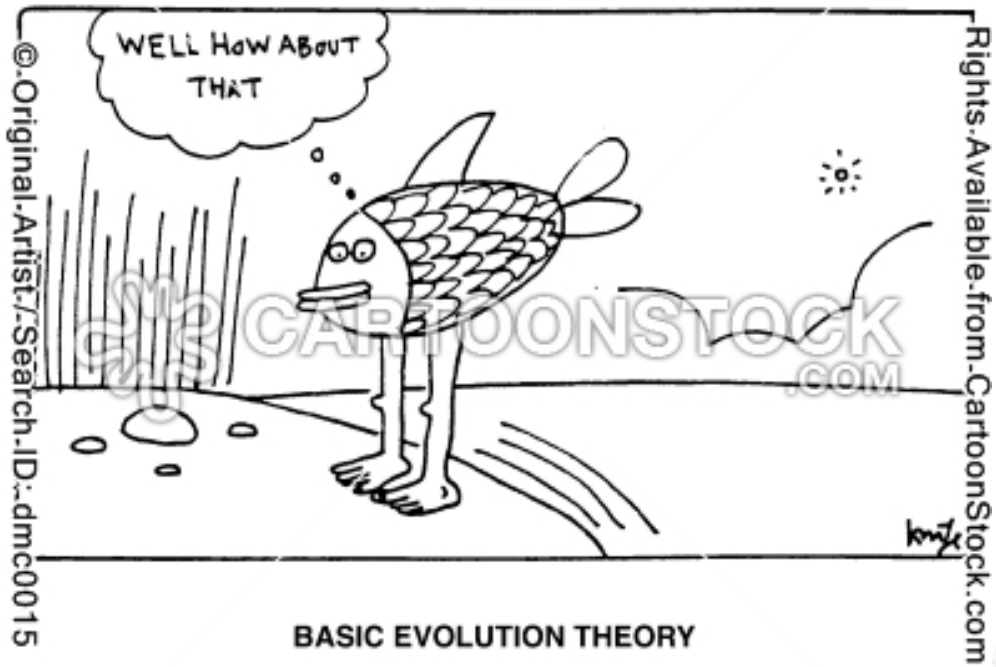
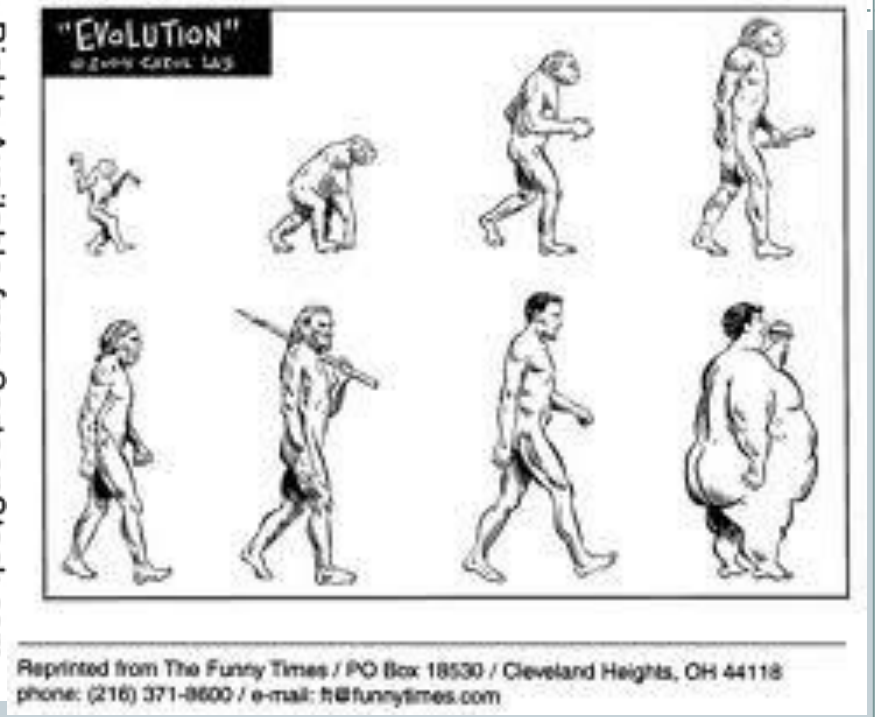
ACO





Lecture slides are prepared using several teaching resources and no authorship is claimed for any slides.

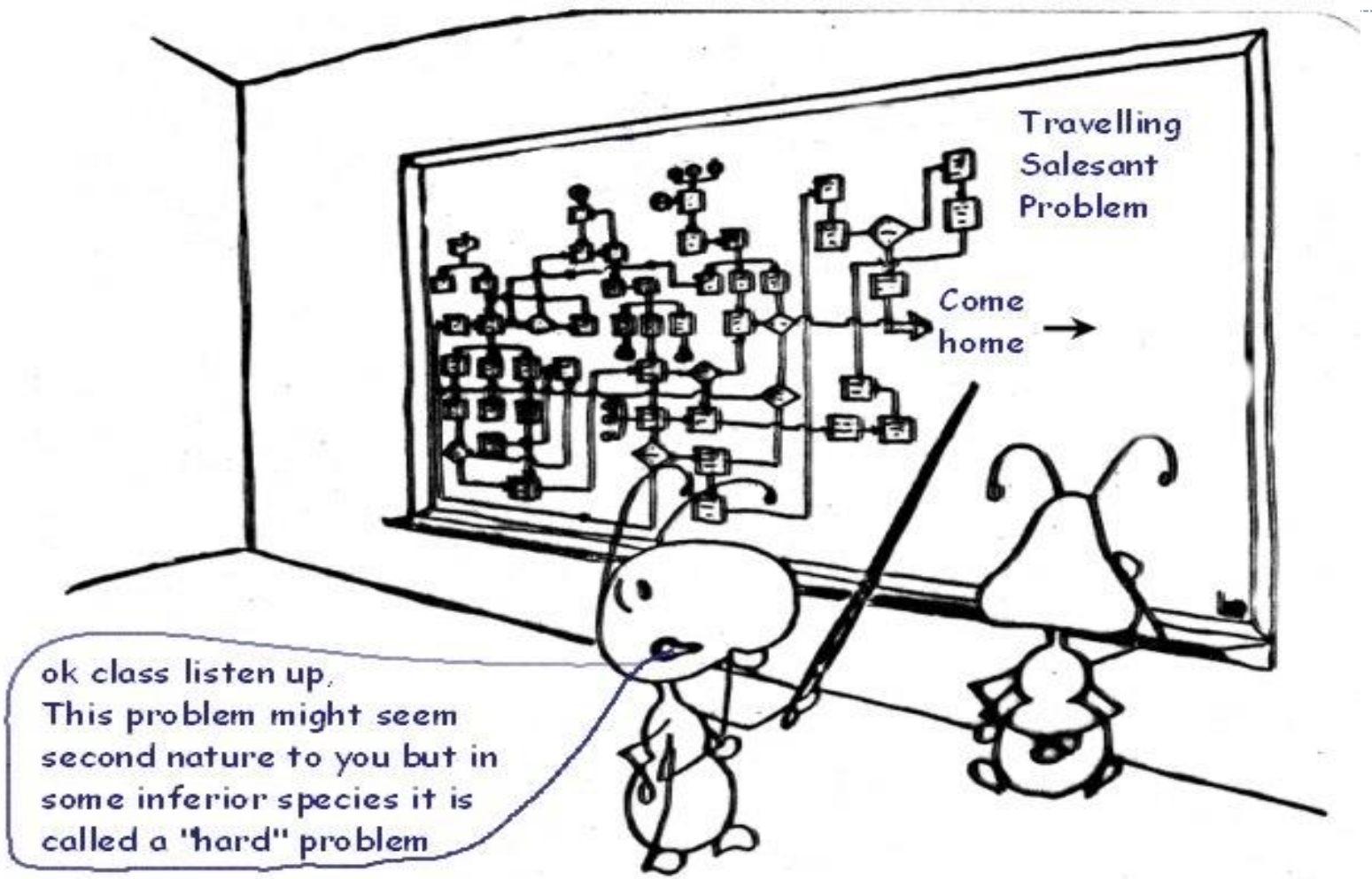
Benefits of GA/MA

- Concept is easy to understand
- Modular, separate from application
- Supports multi-objective optimization
- Always an answer; answer gets better with time
- Inherently parallel; easily distributed
- Many ways to speed up and improve a GA/MA-based application as knowledge about problem domain is gained
- Easy to exploit previous or alternate solutions
- Flexible building blocks for hybrid applications

When to Use a GA/MA

- Alternate solutions are too slow or overly complicated
- Problem is similar to one that has already been successfully solved by using a GA/MA
- Want to hybridize with an existing solution
- Benefits of the GA/MA technology meet key problem requirements

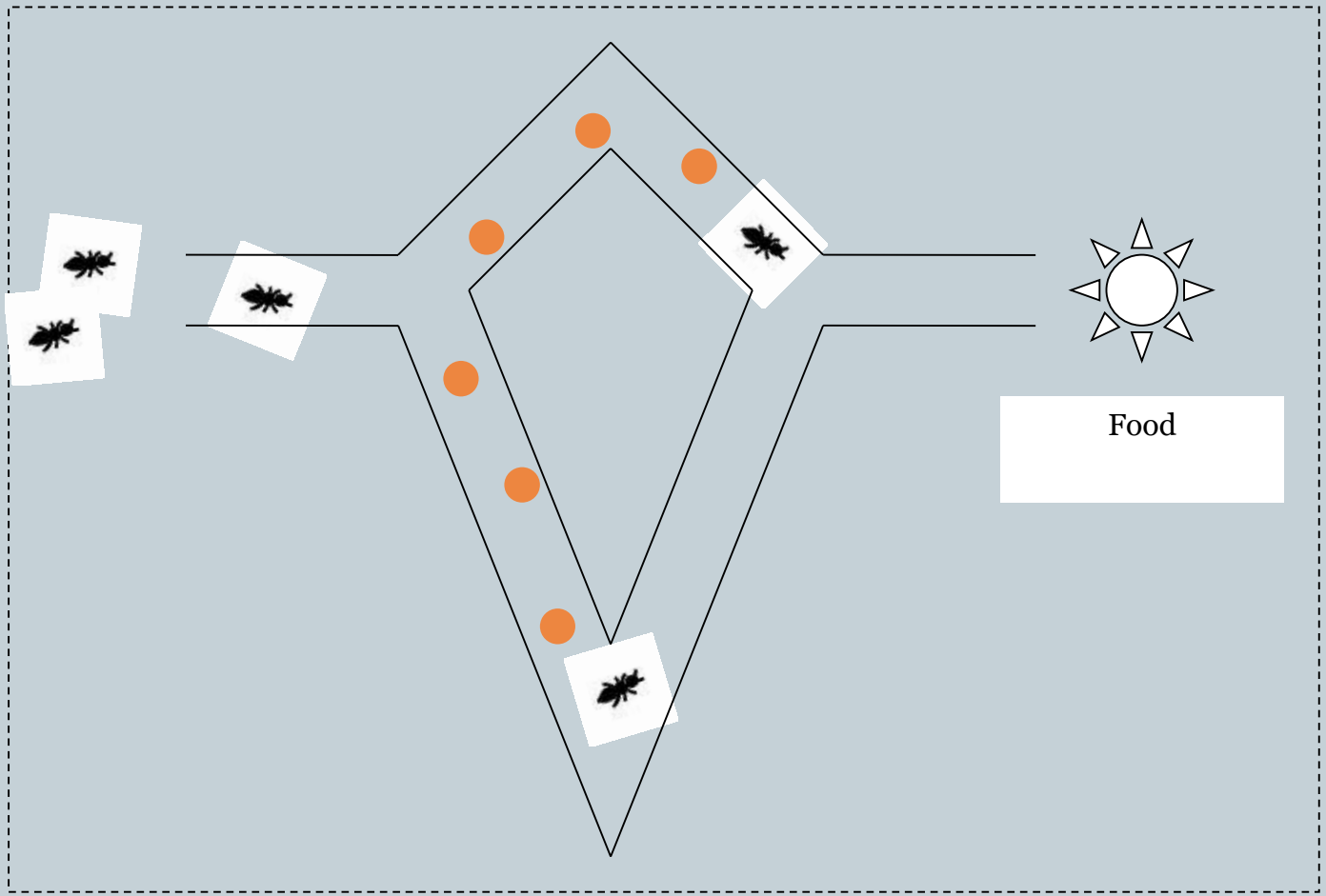
Ant Colony Optimization



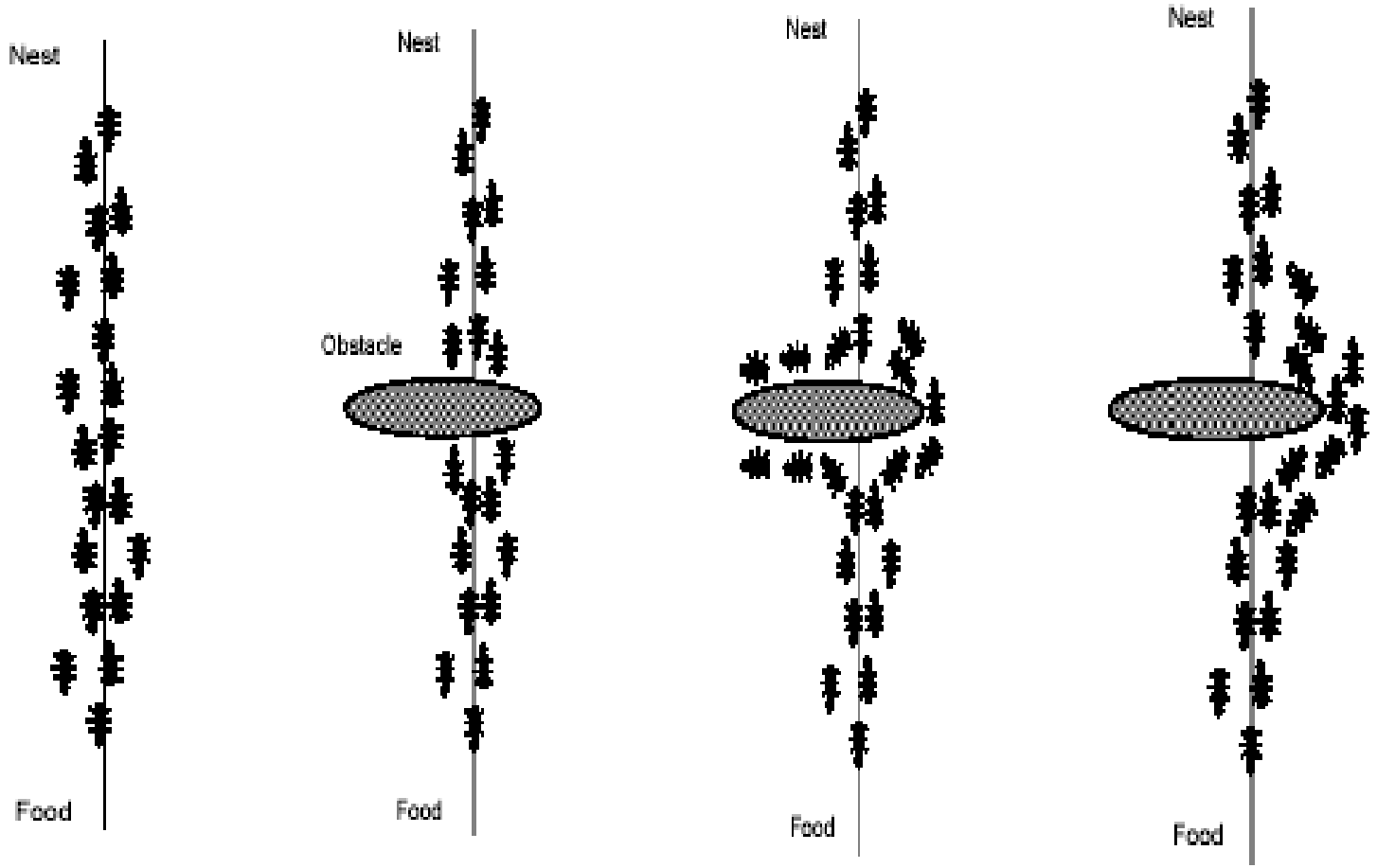
Swarm intelligence

- Collective system capable of accomplishing difficult tasks in dynamic and varied environments without any external guidance or control and with no central coordination
- Achieving a collective performance which could not normally be achieved by an individual acting alone
- Constituting a natural model particularly suited to distributed problem solving

Double Bridge experiment



Natural behavior of ant



How to implement in a program

- Ants: Simple computer agents
- Move ant: Pick next component
- Pheromone: $\tau_{i,j}^{k}$
- Distance: η
- Next move: Use distance/probablity to move ant

A simple TSP example

A

B

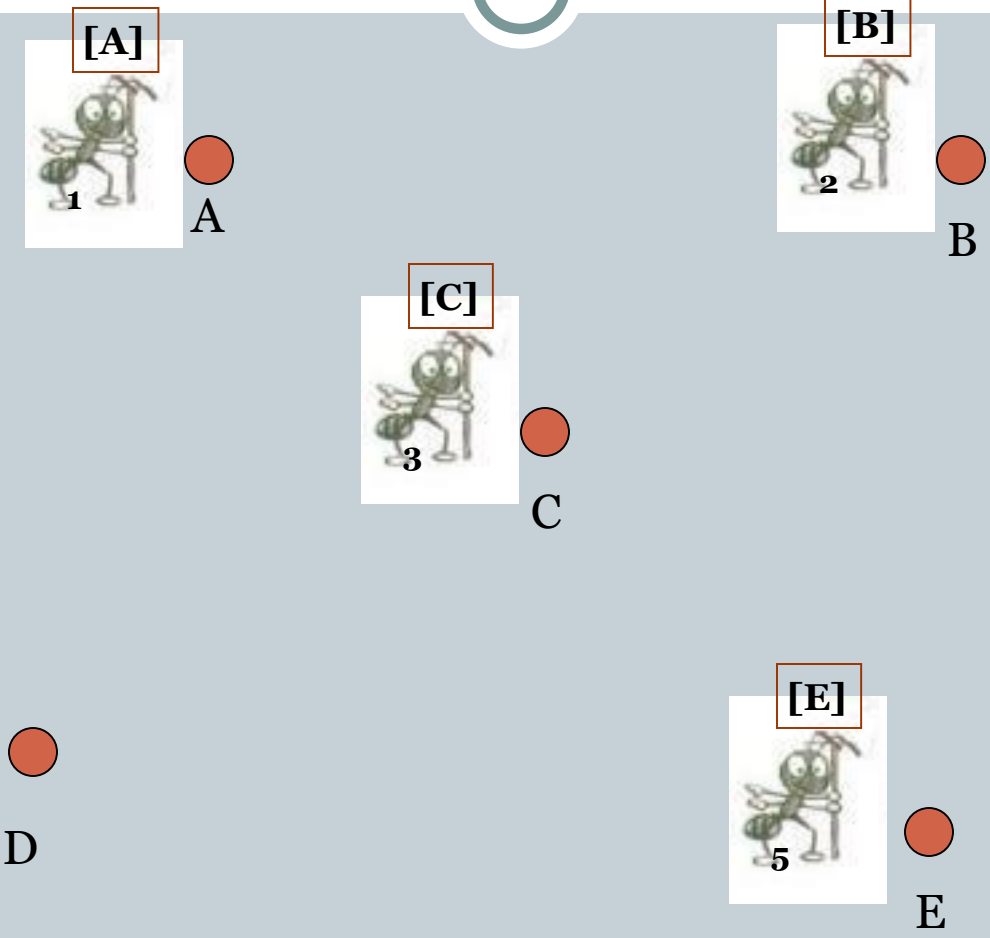
C

D

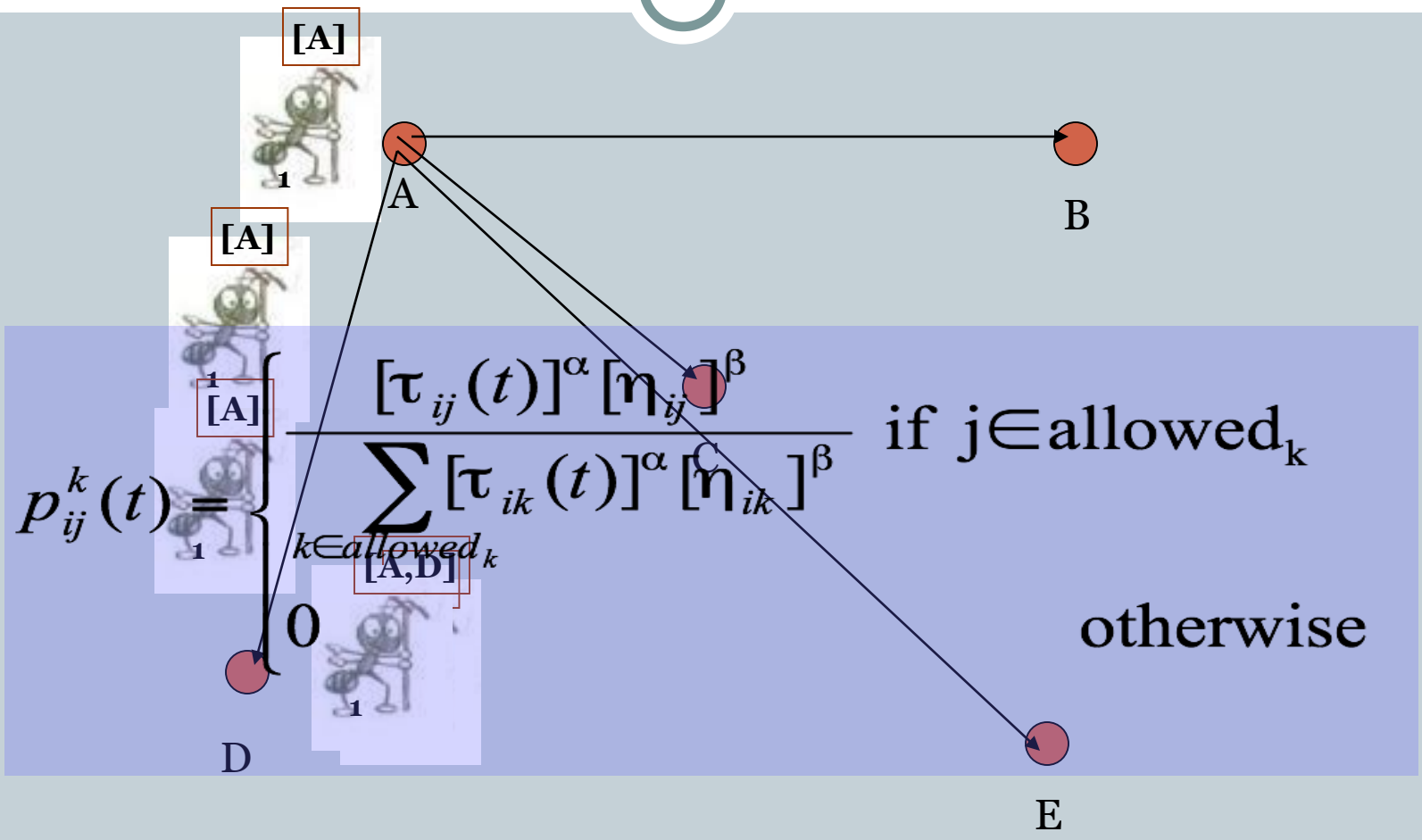
E

d_{AB} =100;d_{BC} = 60…;d_{DE} =150

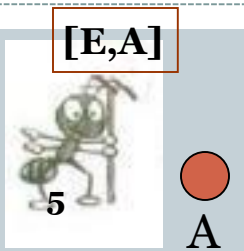
Iteration 1



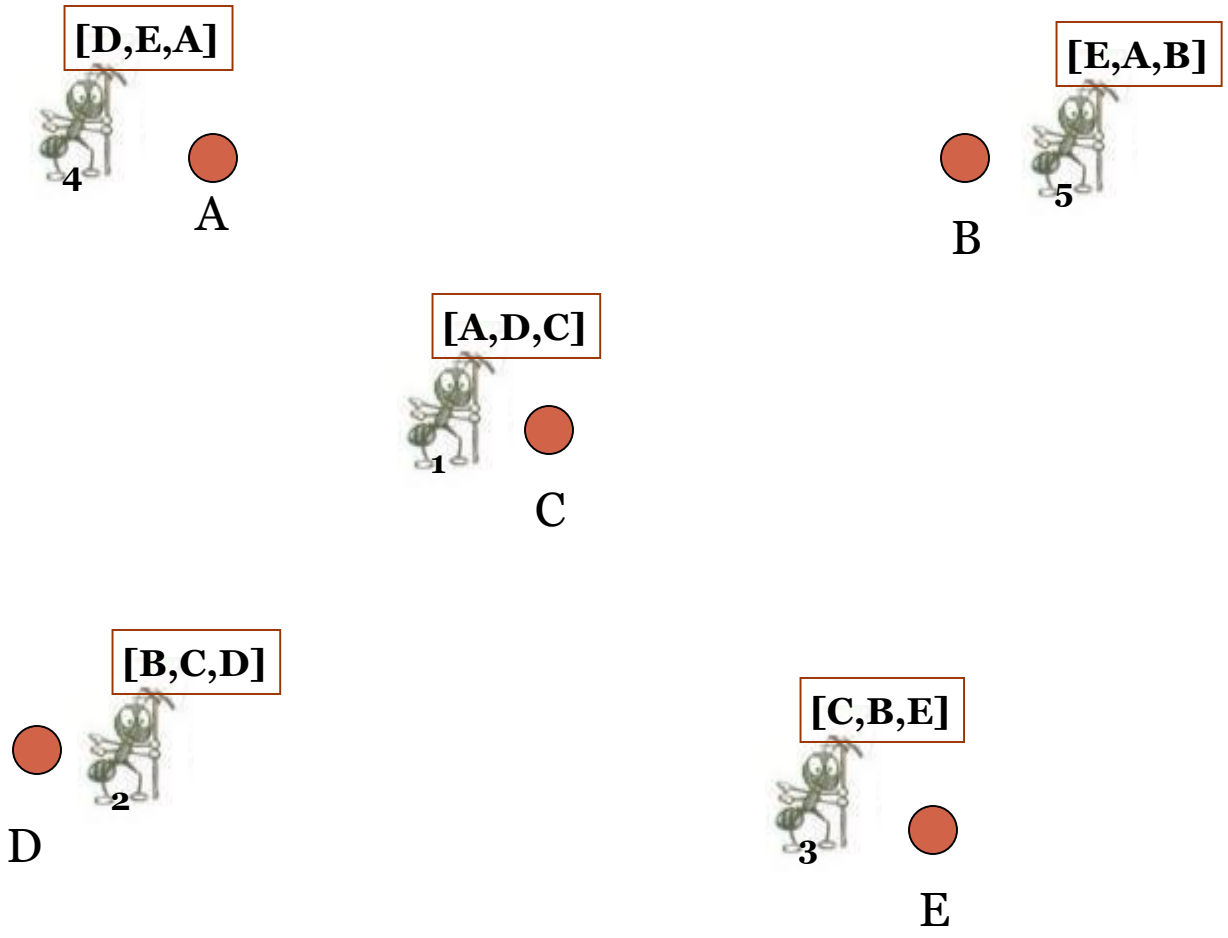
How to build next sub-solution?



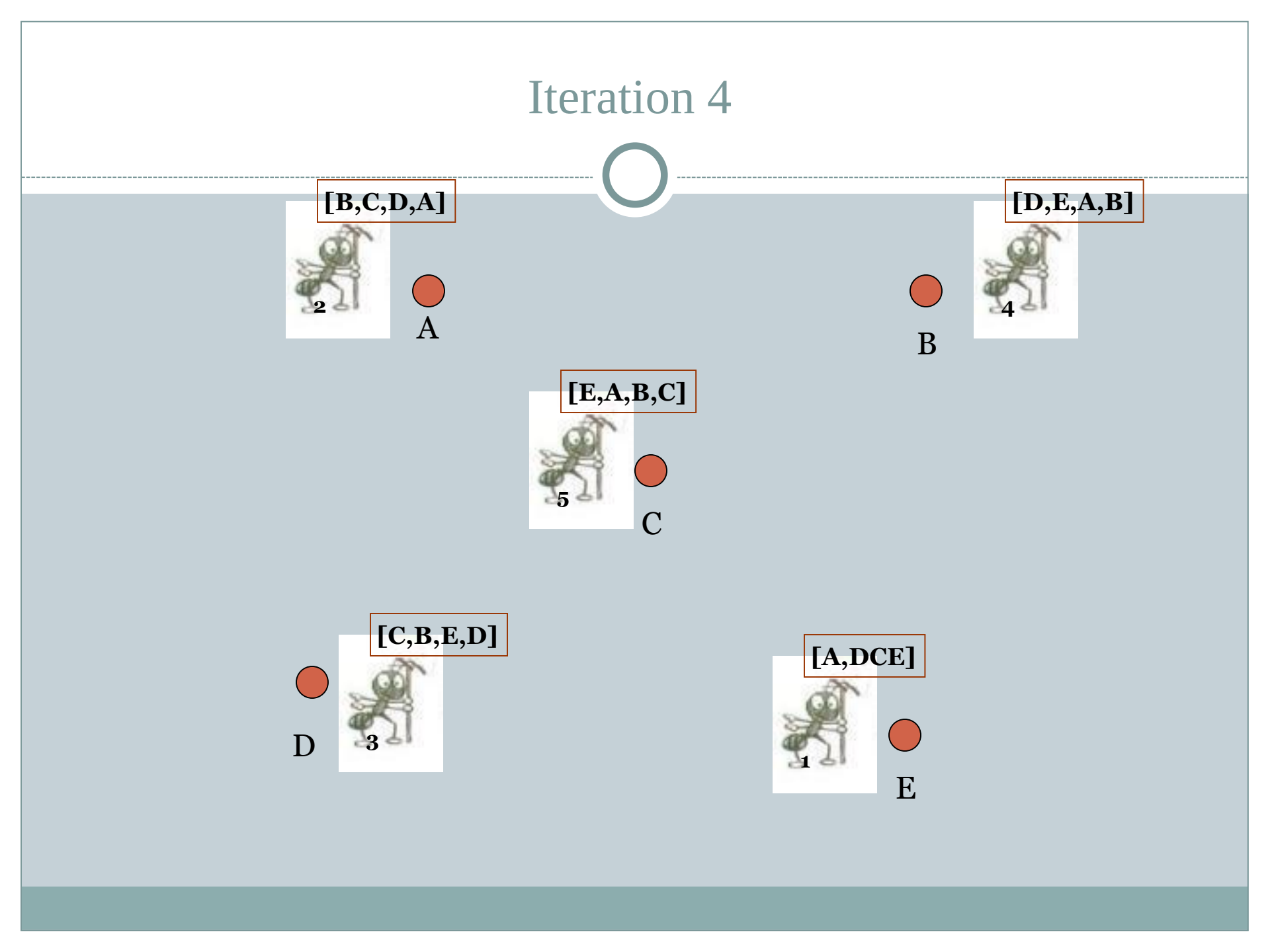
Iteration 2



Iteration 3



Iteration 4



Iteration 5

A

B

C

D

E

[A,D,C,E,B]

$L_1 = 300$

[B,C,D,A,E]

$L_2 = 450$

[C,B,E,D,A]

$L_3 = 260$

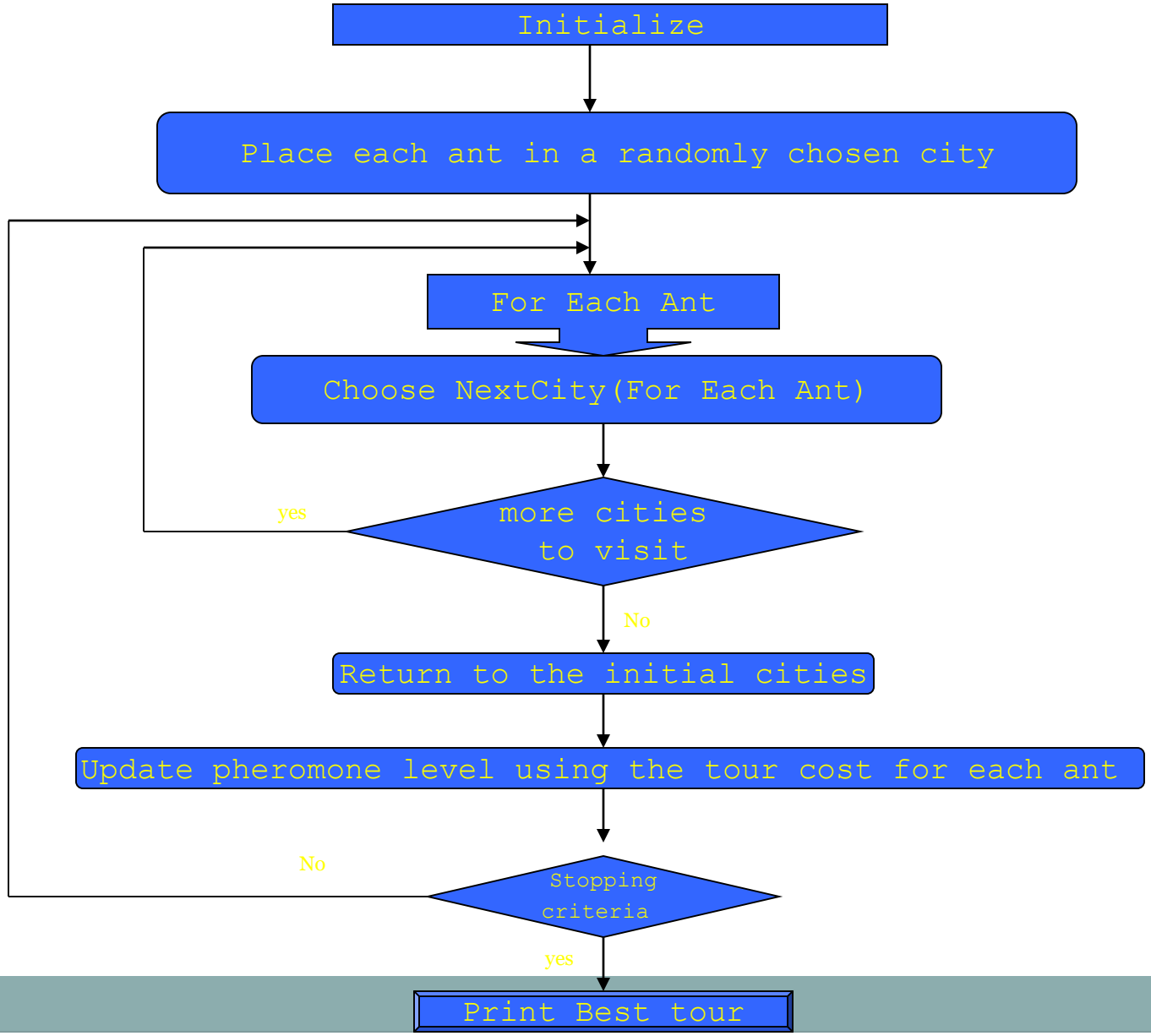
[D,E,A,B,C]

$L_4 = 280$

[E,A,B,C,D]

$L_5 = 420$

Ant Systems Algorithm for TSP

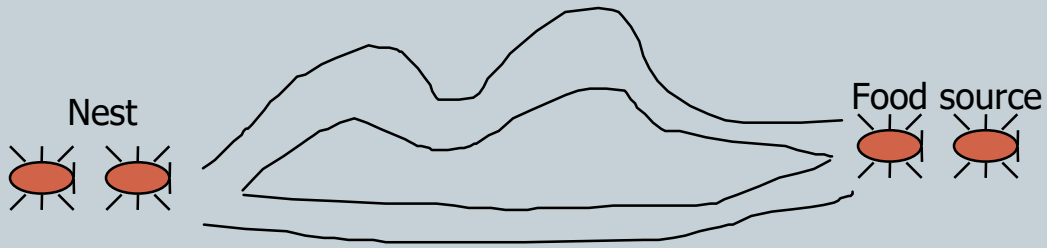


Ant Colony Algorithms

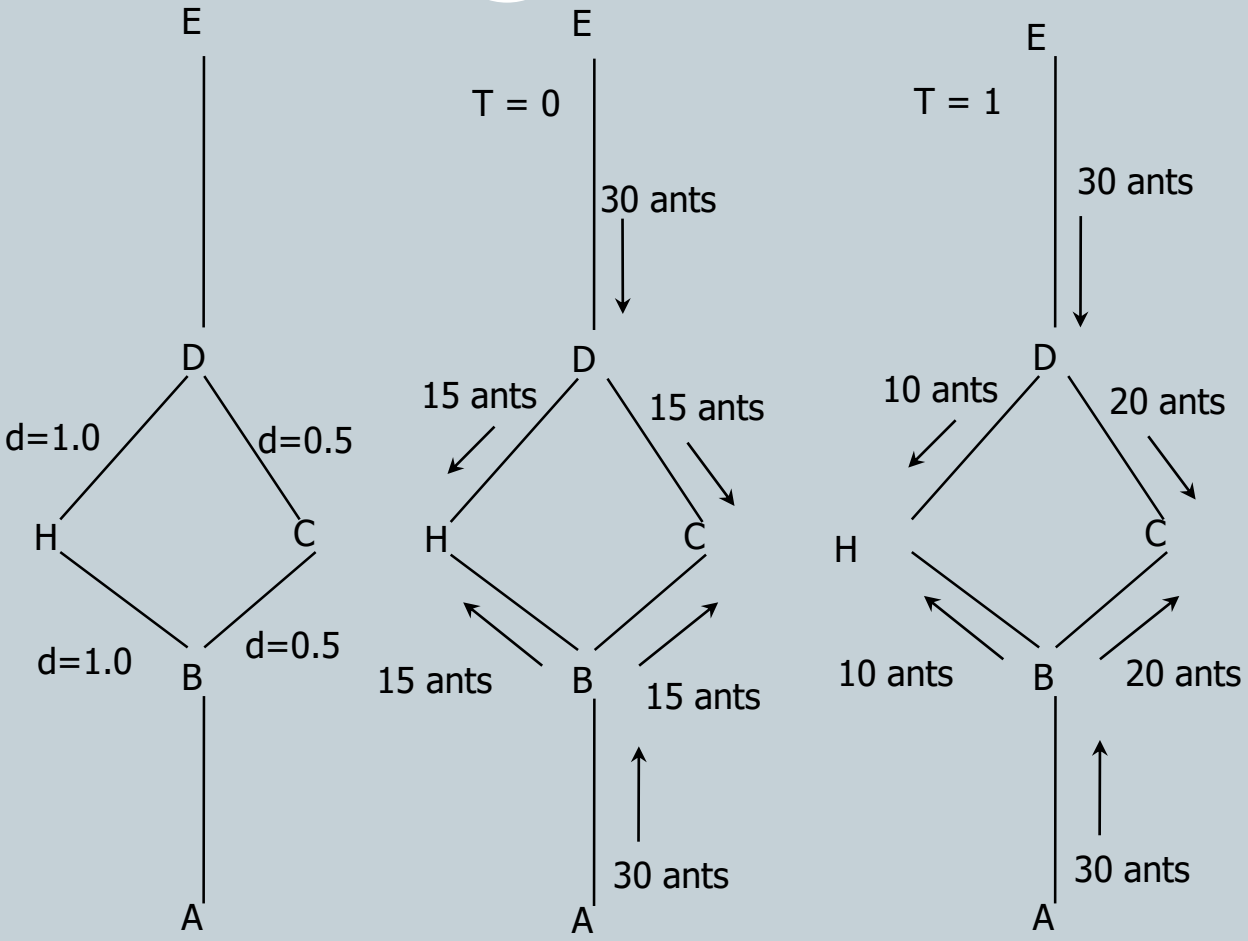
- Although one ant is capable of building a solution, it is the behavior of an ensemble of ants that exhibits the shortest path behavior.
- The behavior is induced by indirect communication (pheromone paths) without central control.

Pheromone Trails

- Species lay pheromone trails traveling from nest, to nest or possibly in both directions.
- Pheromones evaporate.
- Pheromones accumulate with multiple ants using path.



Pheromone Trails Example



Pheromone Update Rule

- In class … on board

Ant Colony Algorithms

- Pheromone mediated “following” behavior induces the emergence of shortest paths.
- Probability of choosing a branch of a path at a certain time depends on the total amount of pheromone on the branch.
- The choice is proportional to the number of ants that have used the branches.

Next Class

- Games