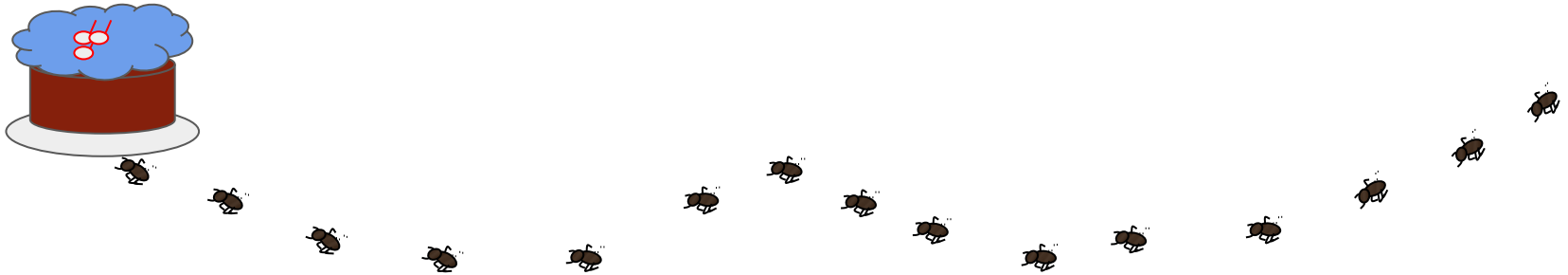

Ant Colony Algorithm - Discussion

Dr. Kiran Manjappa
Dept. of IT, NITK

Previous Session

- SI
  - Can not speak, still they communicate, coordinate and achieve the goal
  - Stigmergy - Pheromone - Indirect way of communication.
  - Ants, Termites, Bees
  - Foraging behavior, Nest Building, Finding Nectar Place.
- Ants, Termites, Bees and Bats

Ant Colony Algorithm

- The route discovery phase - Two Stages
  - Reverse Route Setup - Destination to Source - Forward Ants
  - Forward Route Setup - Source to Destination - Backward Ants
- Source will release *n* ants to find the optimal path
- Along the path, ants will deposit pheromone (*p*) in each visited node.
- Pheromone Table - Analogous to Routing Table

d - destination
n - next hop
p - pheromone concentration

d	*n*	*p*
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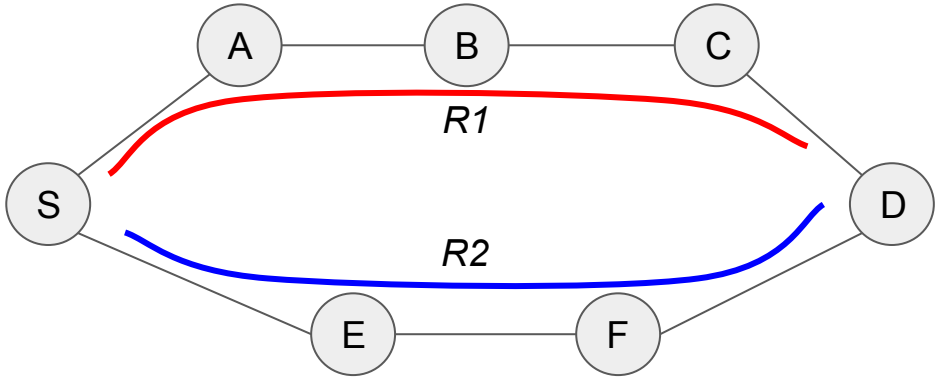
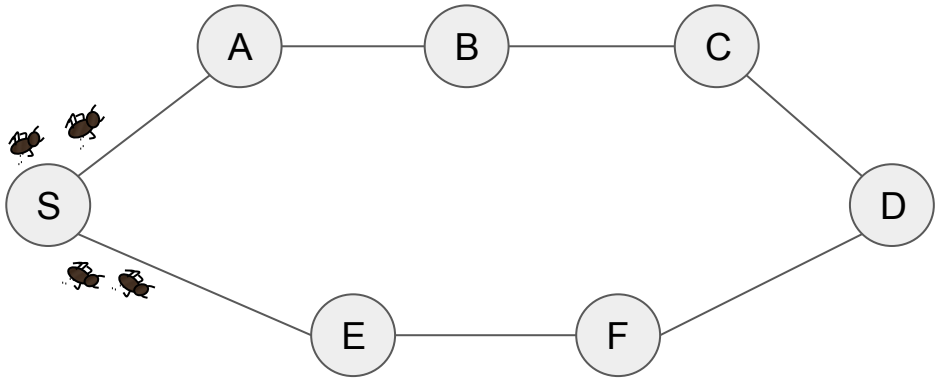


Source S releases *n* ants to find the the optimal path to D

Each ant deposit an pheromone amount equal to 1

For simplicity, the decay concept is not used for route setup phase in this example.

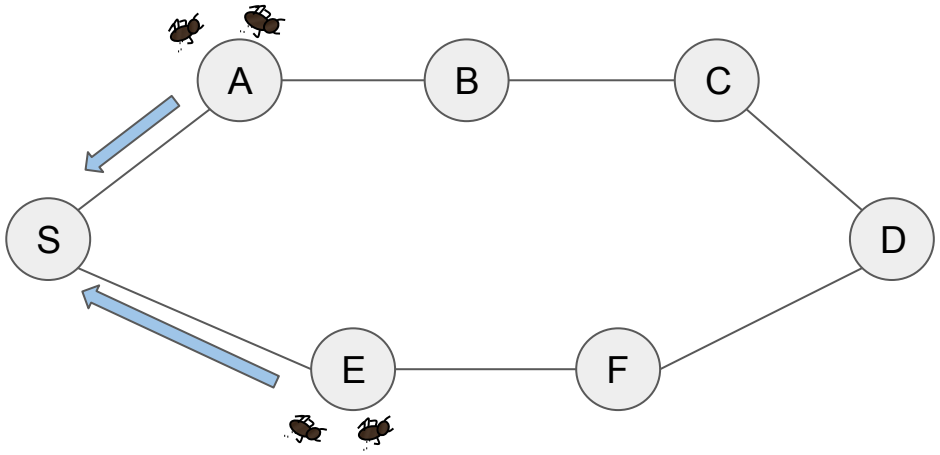
Reverse Path Setup - Forward Ants



@ node S

d	*n*	*p*

Reverse Path Setup - Forward Ants



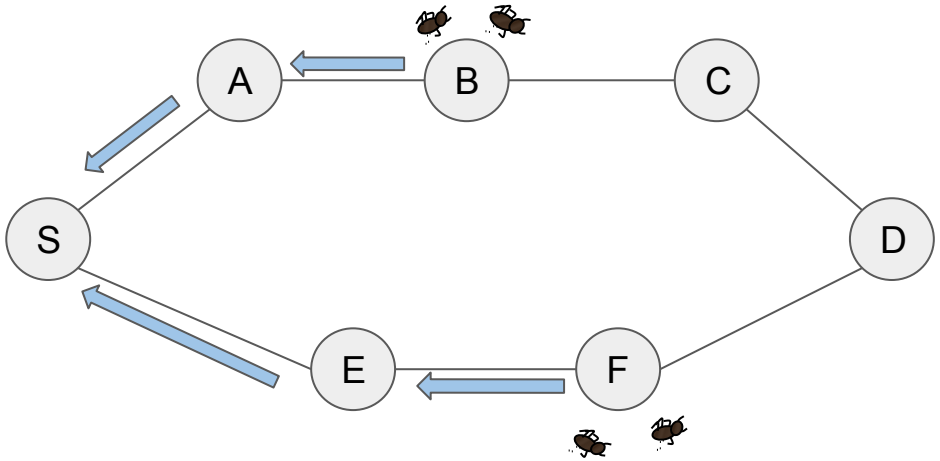
@ node A

d	*n*	*p*
S	*S*	*2*

@ node E

d	*n*	*p*
S	*S*	*2*

Reverse Path Setup - Forward Ants



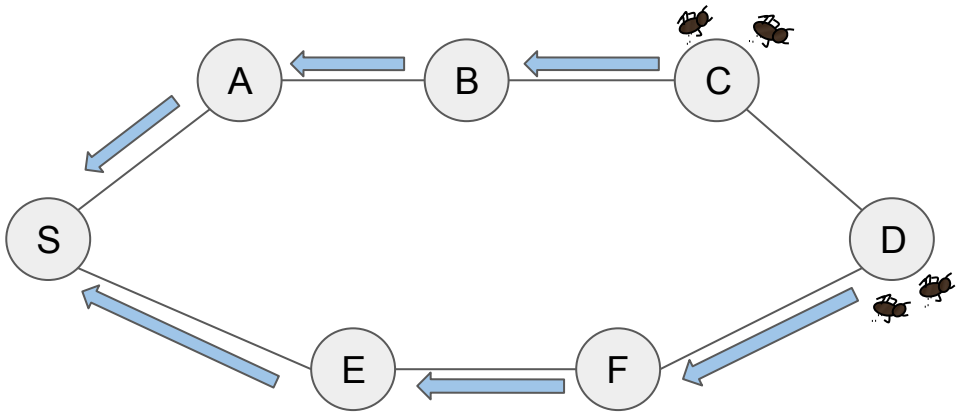
@ node B

d	*n*	*p*
S	*A*	*2*

@ node F

d	*n*	*p*
S	*E*	*2*

Reverse Path Setup - Forward Ants



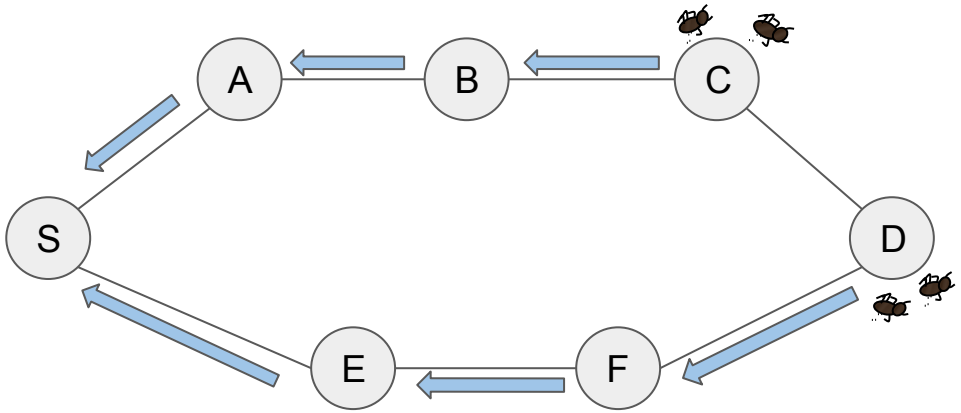
@ node C

d	*n*	*p*
S	*B*	*2*

@ node D

d	*n*	*p*
S	*F*	*2*

Reverse Path Setup - Forward Ants



@ node D

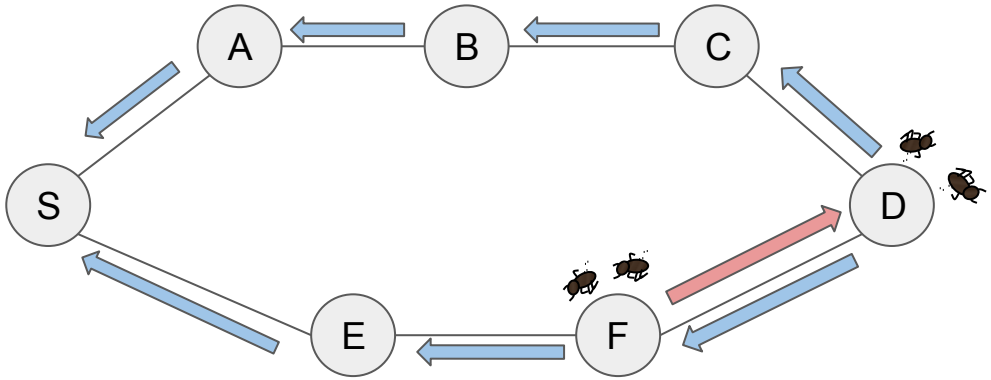
d	*n*	*p*
S	*F*	*2*

Now from D, ants will traverse back to source

Forward Path Setup - Reverse Ants.

Ants checks the pheromone table entry in D

Forward Path Setup - Reverse Ants



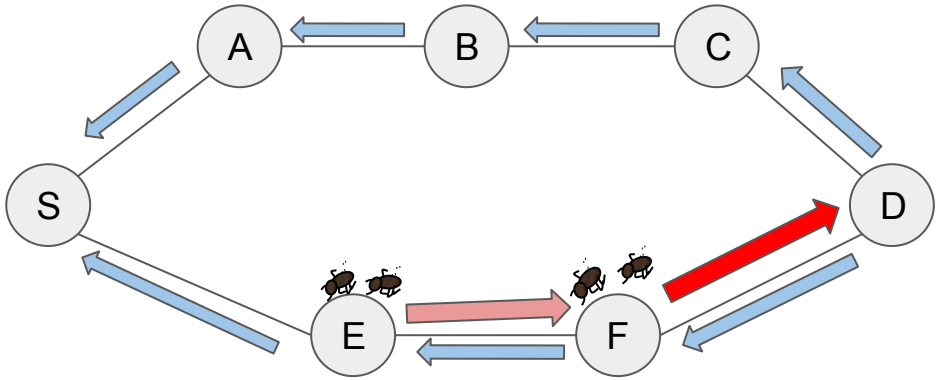
@ node D

d	*n*	*p*
S	*F*	*2*
S	*C*	*2*

@ node F

d	*n*	*p*
S	*E*	*2*
D	*D*	*2*

Forward Path Setup - Reverse Ants



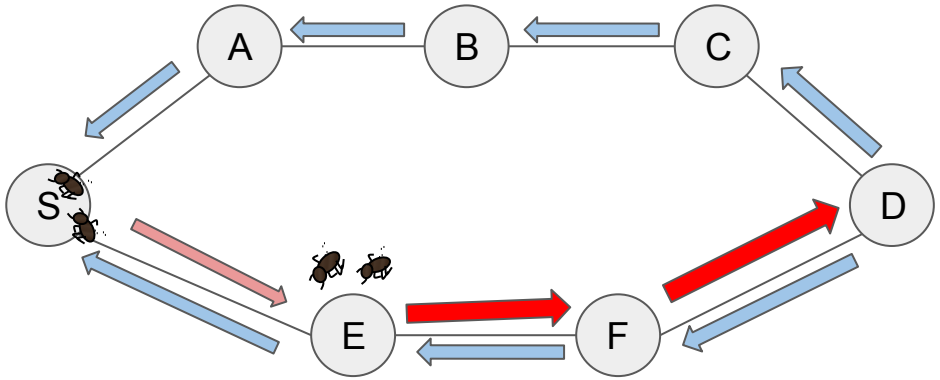
@ node F

d	*n*	*p*
S	*E*	*2*
D	*D*	~~*2*~~ *4*

@ node E

d	*n*	*p*
S	*S*	*2*
D	*F*	*2*

Forward Path Setup - Reverse Ants



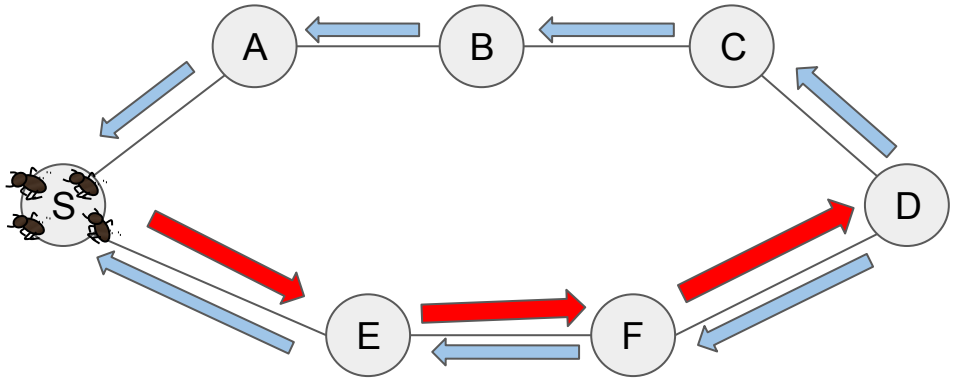
@ node E

d	*n*	*p*
S	*S*	*2*
D	*F*	~~*2*~~ *4*

@ node S

d	*n*	*p*
D	*E*	*2*

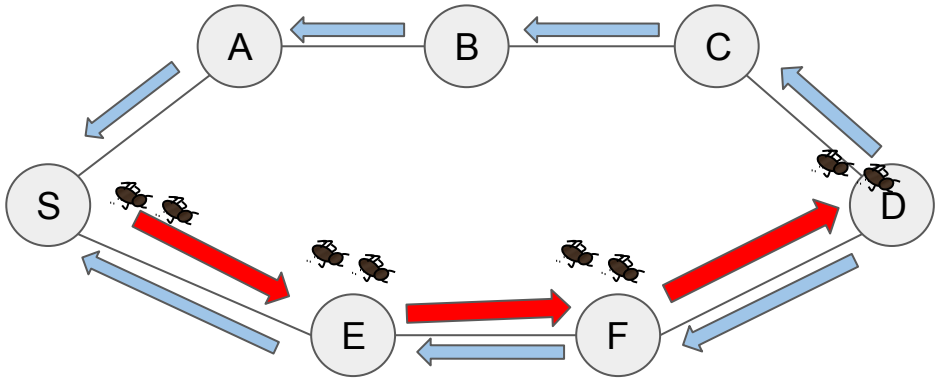
Forward Path Setup - Reverse Ants



@ node S

d	*n*	*p*
D	*E*	~~*2*~~ *4*

Next Iteration



@ node S

d	*n*	*p*
D	*E*	*4*

@ node E

d	*n*	*p*
S	*S*	~~*2*~~ *4*
D	*F*	*4*

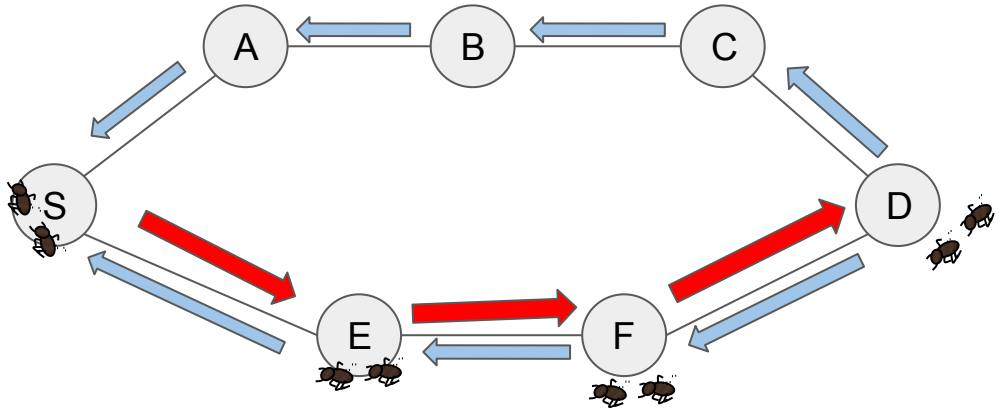
@ node F

d	*n*	*p*
S	*E*	~~*2*~~ *4*
D	*D*	*4*

@ node D

d	*n*	*p*
S	*F*	~~*2*~~ *4*
S	*C*	*2*

Forward Path Setup - Reverse Ants



@ node S

d	*n*	*p*
D	*E*	~~*4*~~ *6*

@ node E

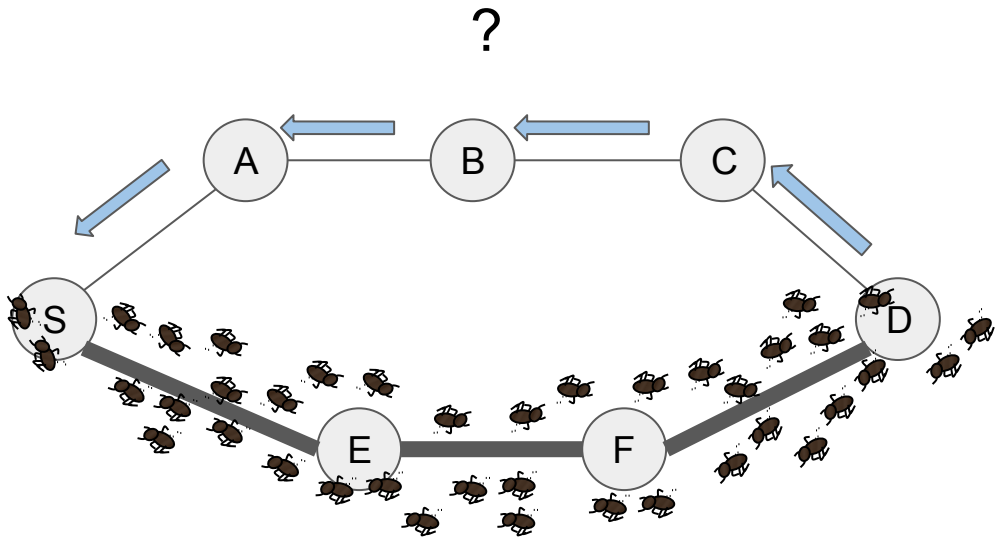
d	*n*	*p*
S	*S*	*4*
D	*F*	~~*4*~~ *6*

@ node F

d	*n*	*p*
S	*E*	*4*
D	*D*	~~*4*~~ *6*

@ node D

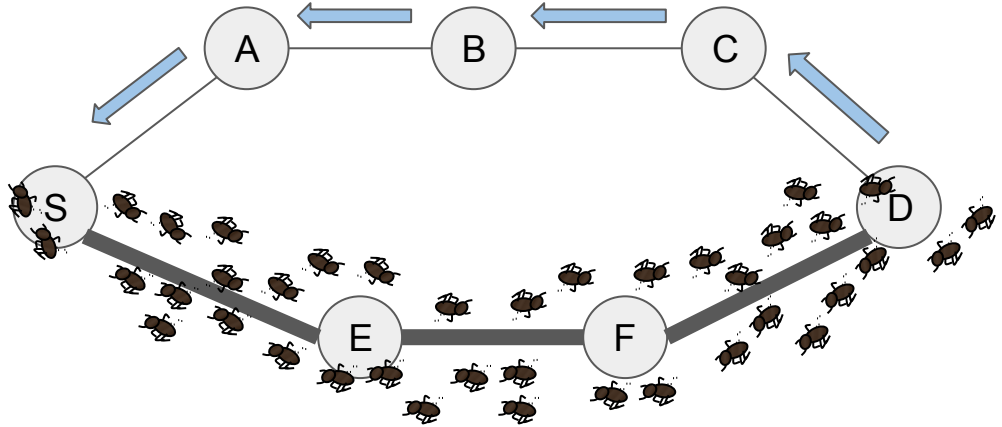
d	*n*	*p*
S	*F*	*4*
S	*C*	*2*



Pheromone Decays over time.

The routing table entries are removed once the pheromone becomes zero.

?



@ node A

d	*n*	*p*
S	*S*	*0*

@ node B

d	*n*	*p*
S	*A*	*0*

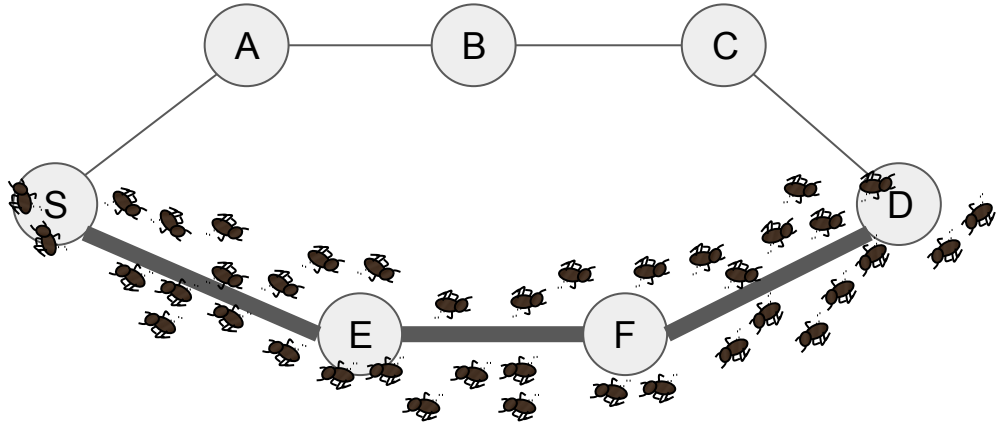
@ node C

d	*n*	*p*
S	*B*	*0*

@ node D

d	*n*	*p*
S	*F*	*2*
S	*C*	*0*

?



@ node A

d	*n*	*p*

@ node B

d	*n*	*p*

@ node C

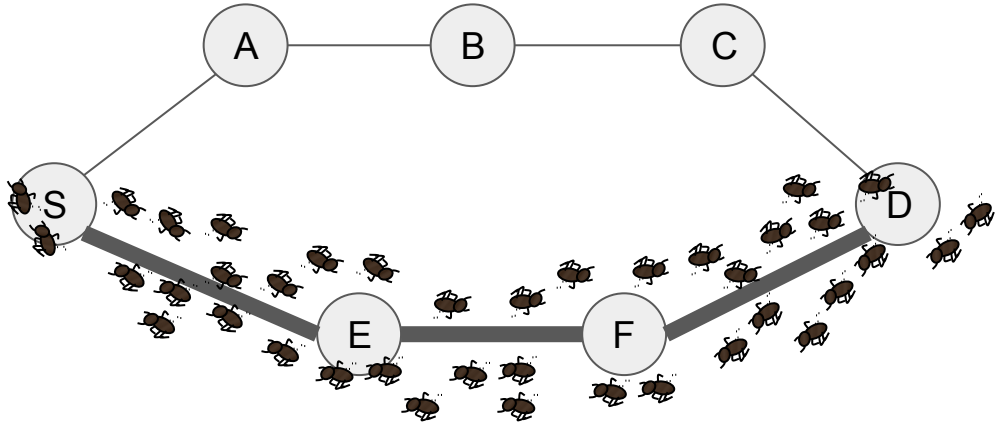
d	*n*	*p*

@ node D

d	*n*	*p*
S	*F*	*2*

When Pheromone (p) becomes zero, the corresponding entry will be removed from the table

Route Maintenance- Part



Congestion ?

ACA Optimization

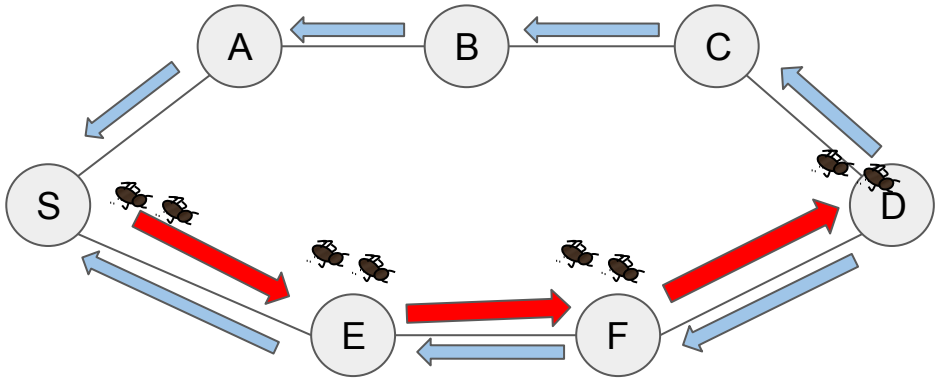
- Two Types of Pheromone
  - Trail Pheromone - Attracts
  - Danger Pheromone - Attack / Escapes
- Every ants also adds a very small amount of danger pheromone in the pheromone table (0.1).
- tp = 1 , dp = 0.1

- Once the dp reaches a threshold, the path is congested.
- Before anywhere near the threshold, the ants will divert the path sensing the danger.
- Change the table structure for the Congestion Avoidance
    - Avoidance - Preventing congestion to happen.

d - destination
n - next hop
tp - pheromone concentration
dp - danger pheromone

d	*n*	*tp*	*dp*
--	--	--	--
--	--	--	--

ACA Optimization



@ node S

d	n	tp	dp
D	E	4	

@ node E

d	n	tp	dp
S	S	~~2~~ 4	0.2
D	F	4	

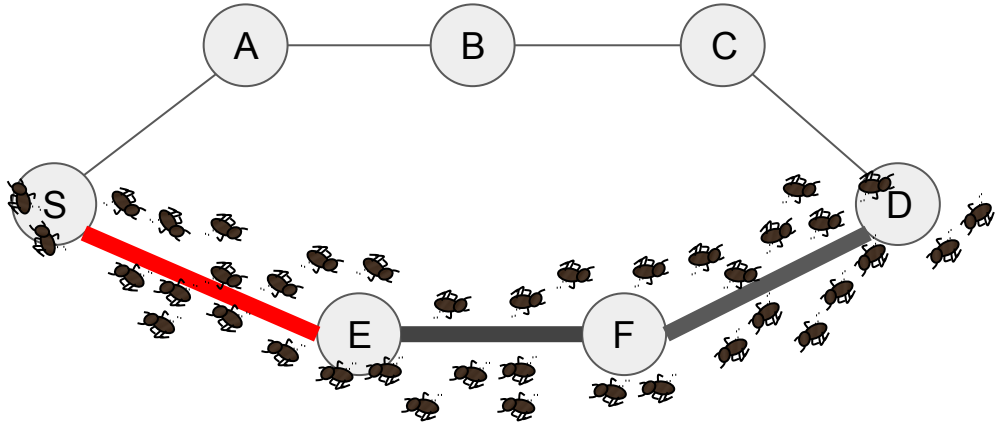
@ node F

d	n	tp	dp
S	E	~~2~~ 4	0.2
D	D	4	

@ node D

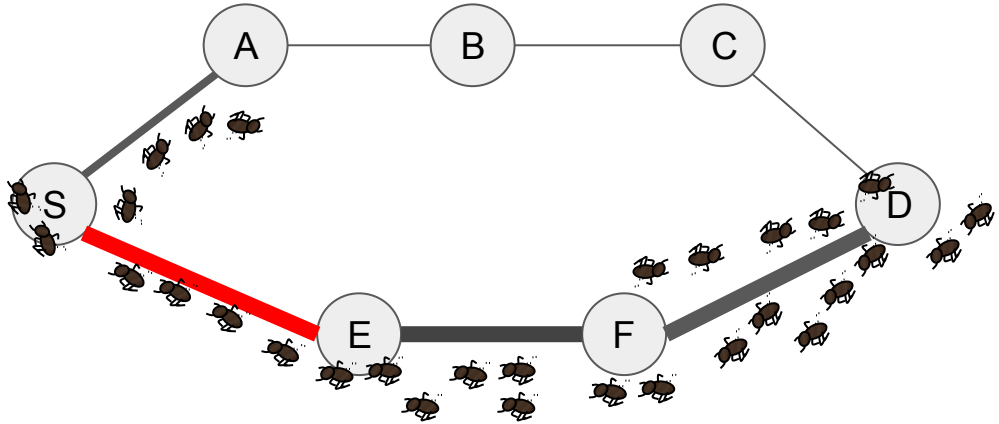
d	n	tp	dp
S	F	~~2~~ 4	0.2
S	C	2	

Route Maintenance- Part



Congestion ?

Route Maintenance- Part



Congestion ?

Assignment 3 (10 Marks)

Detailed problem statement is given in the moodle.

Deadline is 13-11-2020, Friday 8 pm.