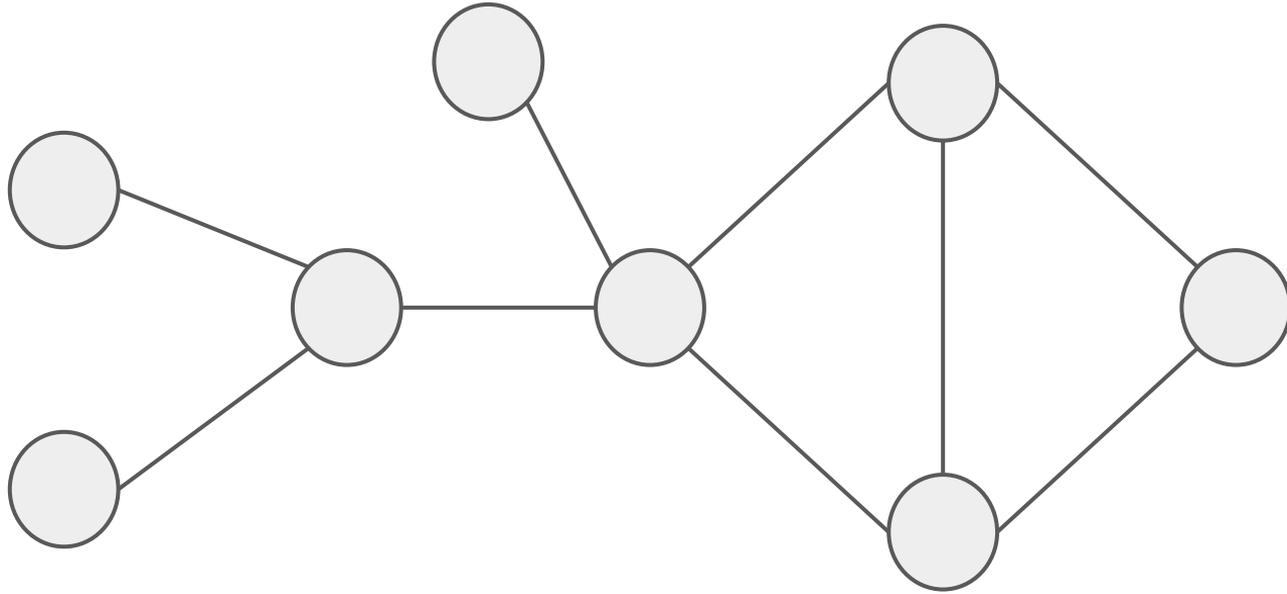


# Learning Algorithms with Self-Play: A New Approach to the Distributed Directory Problem

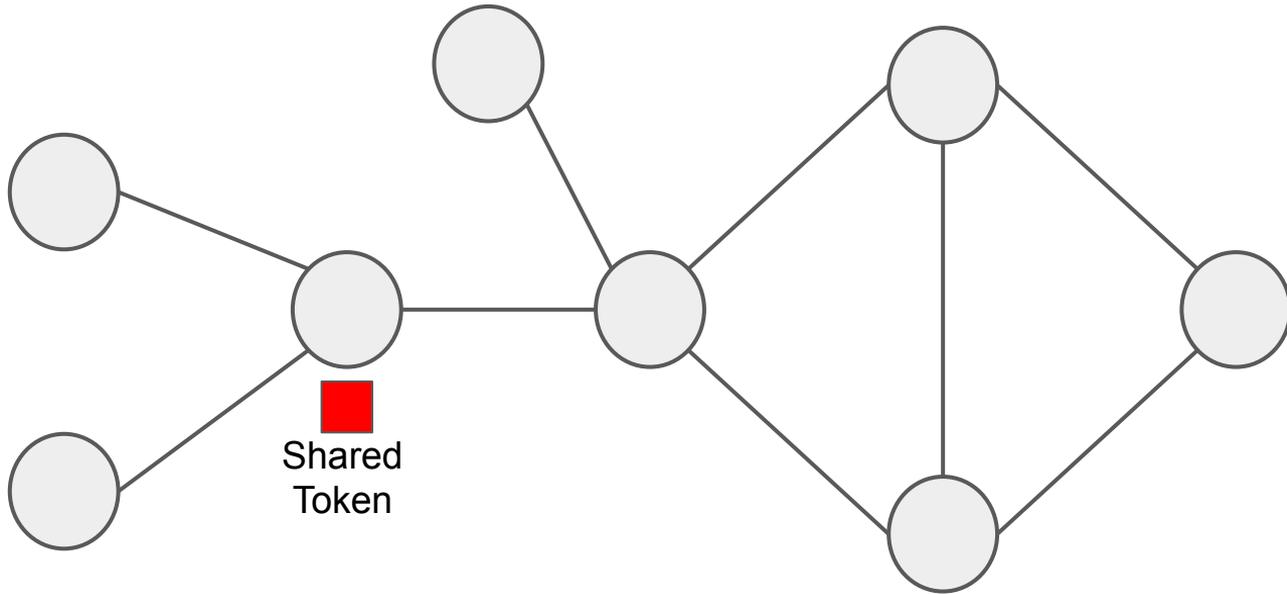
ICTAI '21

Oliver Richter, Lukas Rusch, Roger Wattenhofer (ETH Zurich, Switzerland)  
Pankaj Khanchandani (Adobe Systems, India)

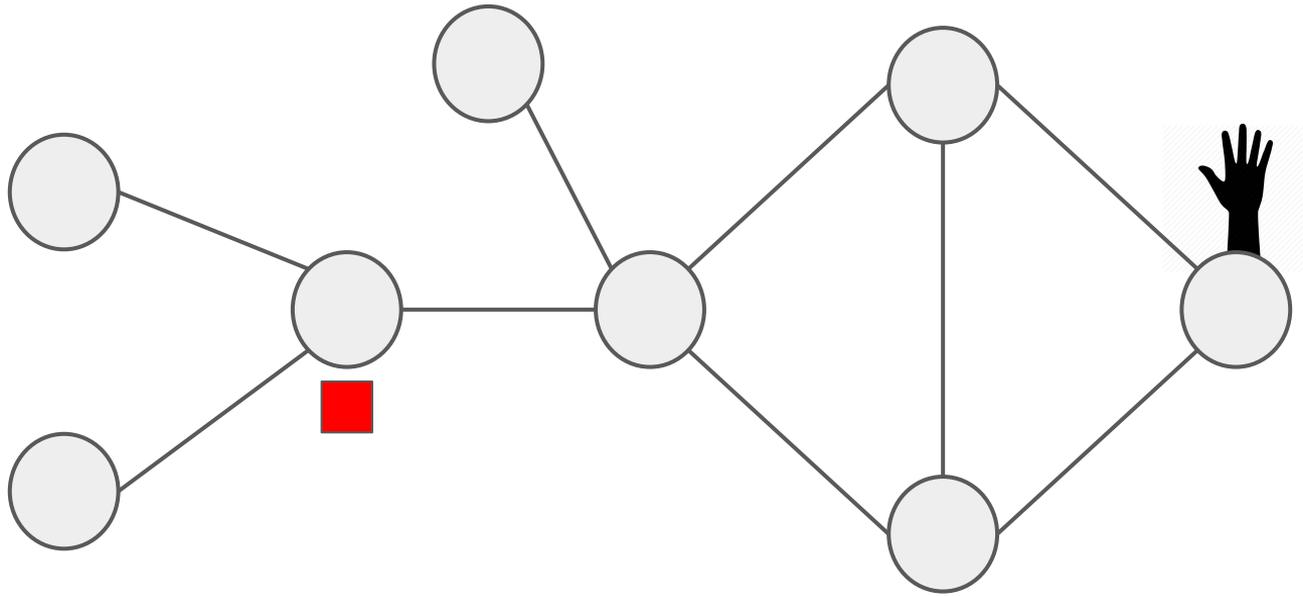
# Distributed Directory



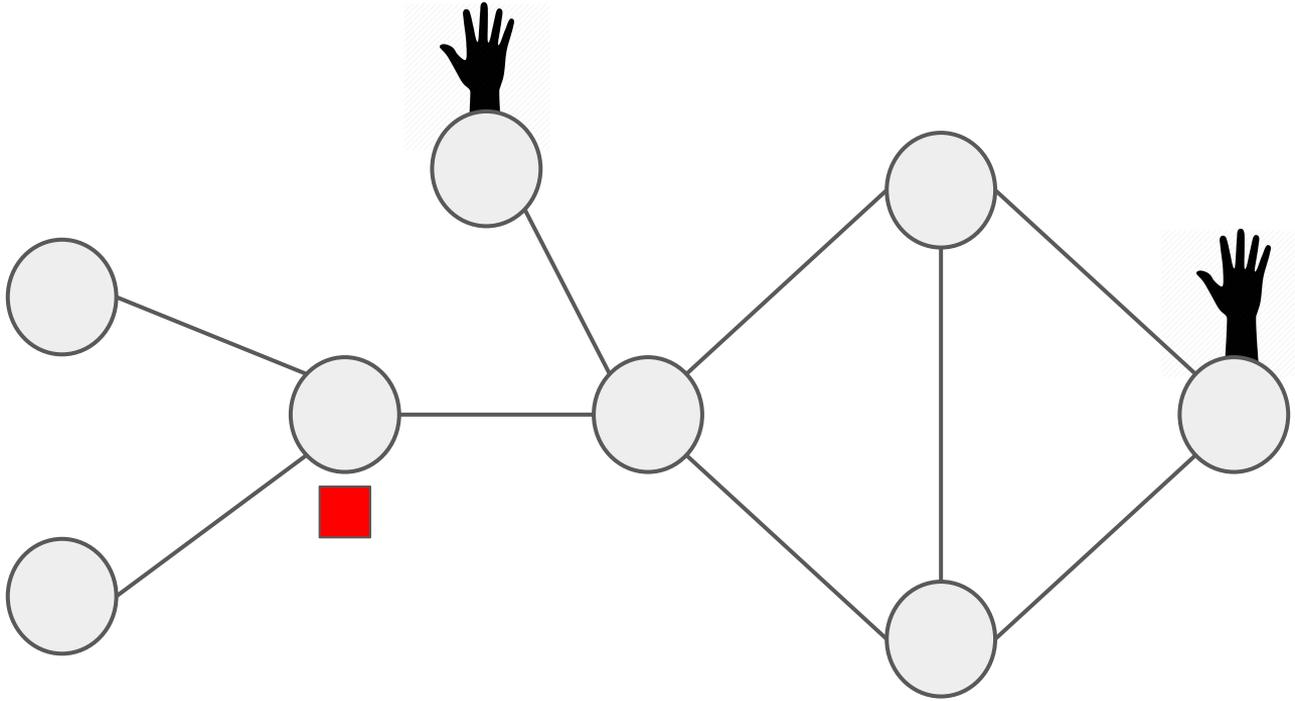
# Distributed Directory



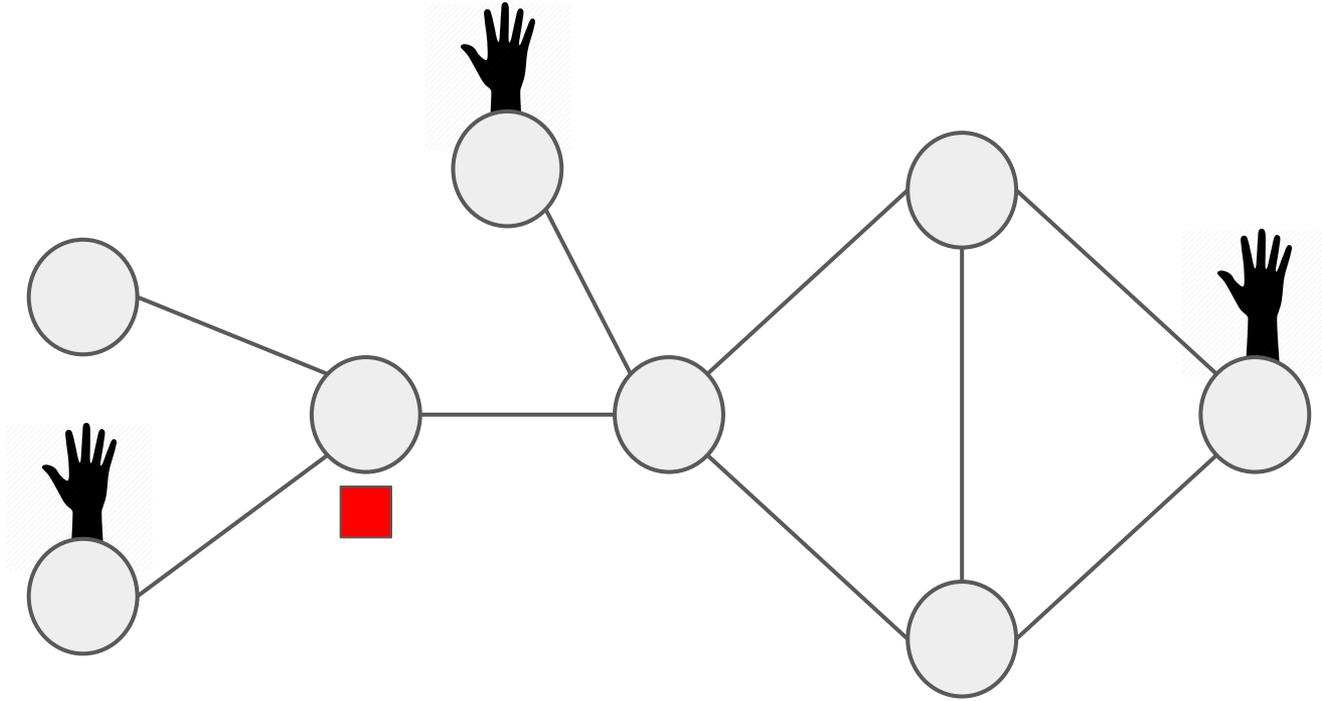
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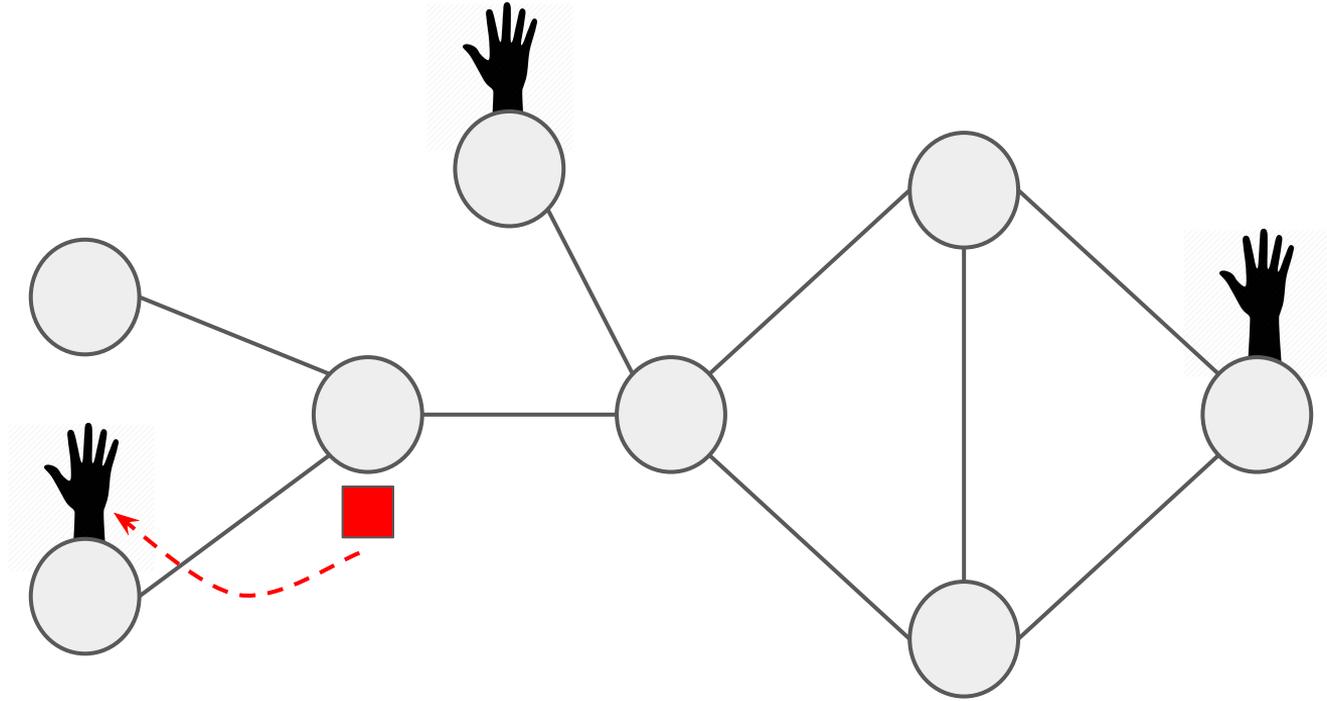
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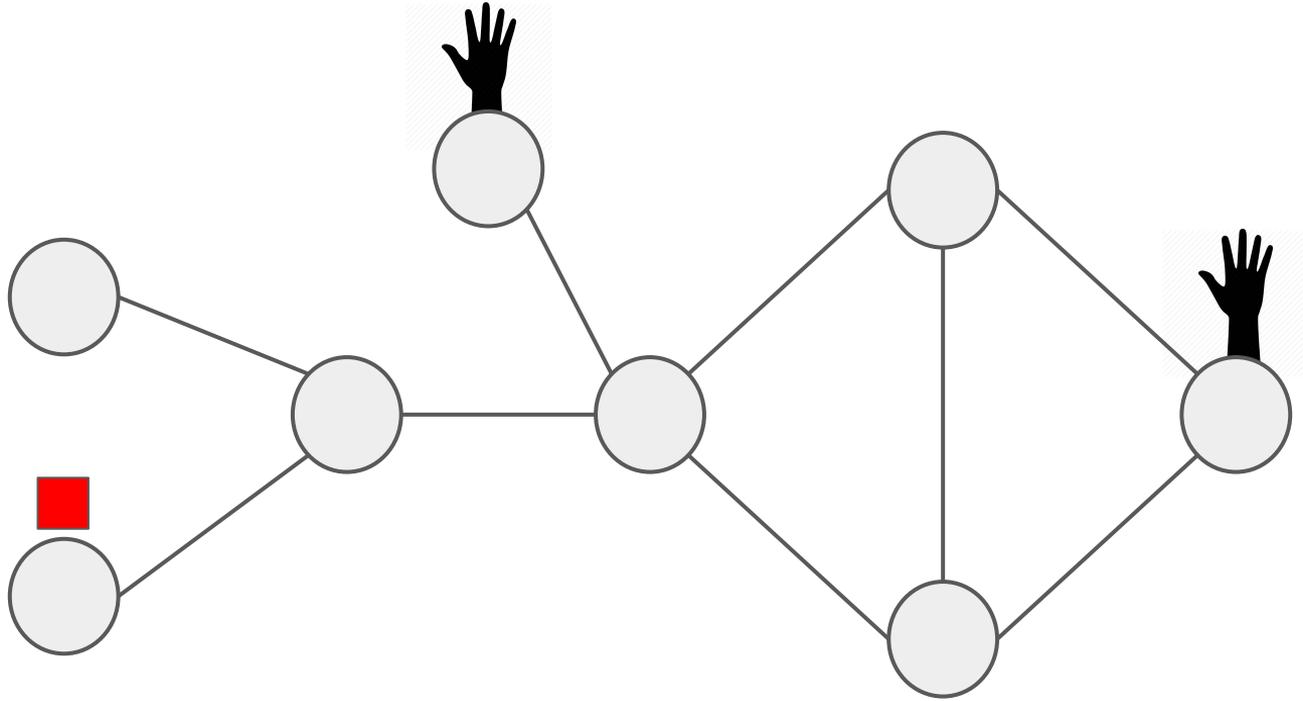
# Distributed Directory



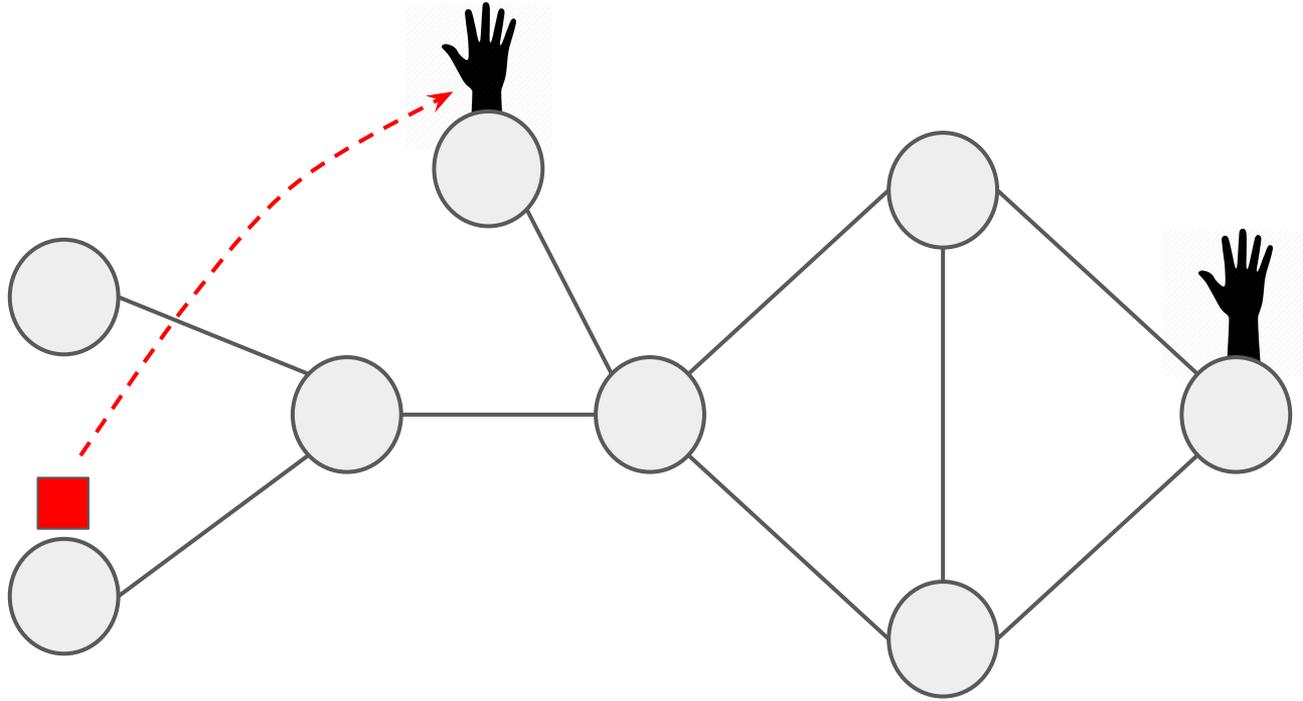
# Distributed Directory



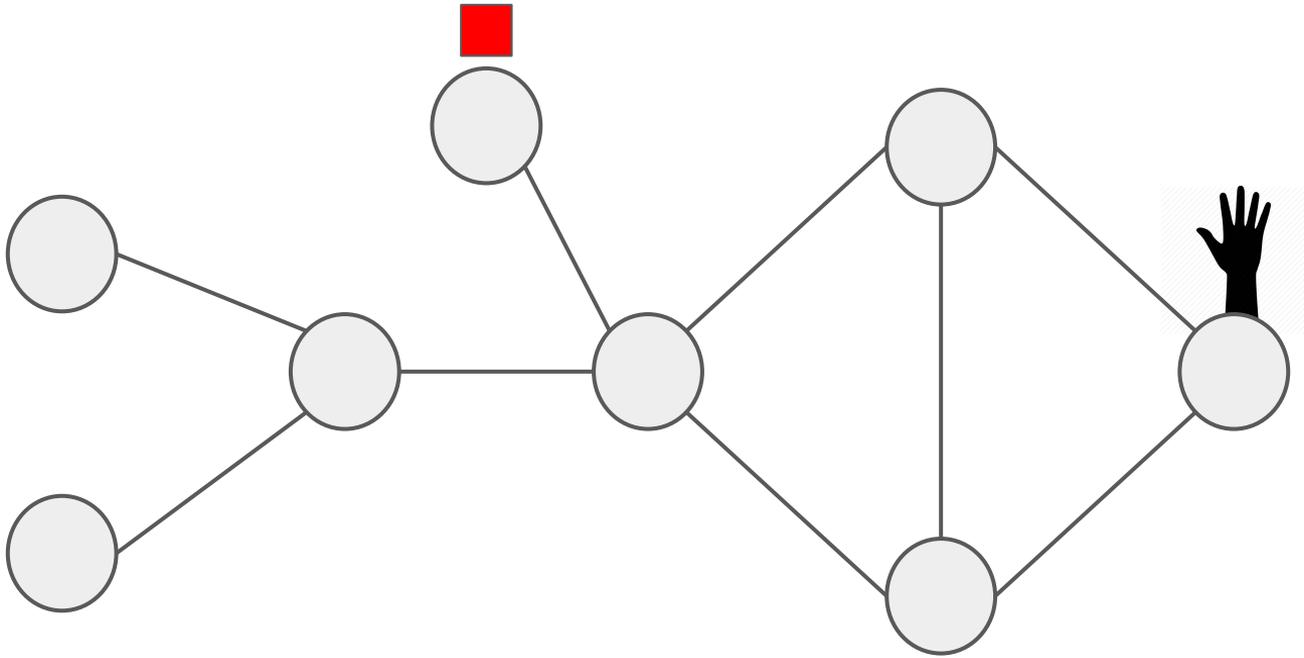
# Distributed Directory



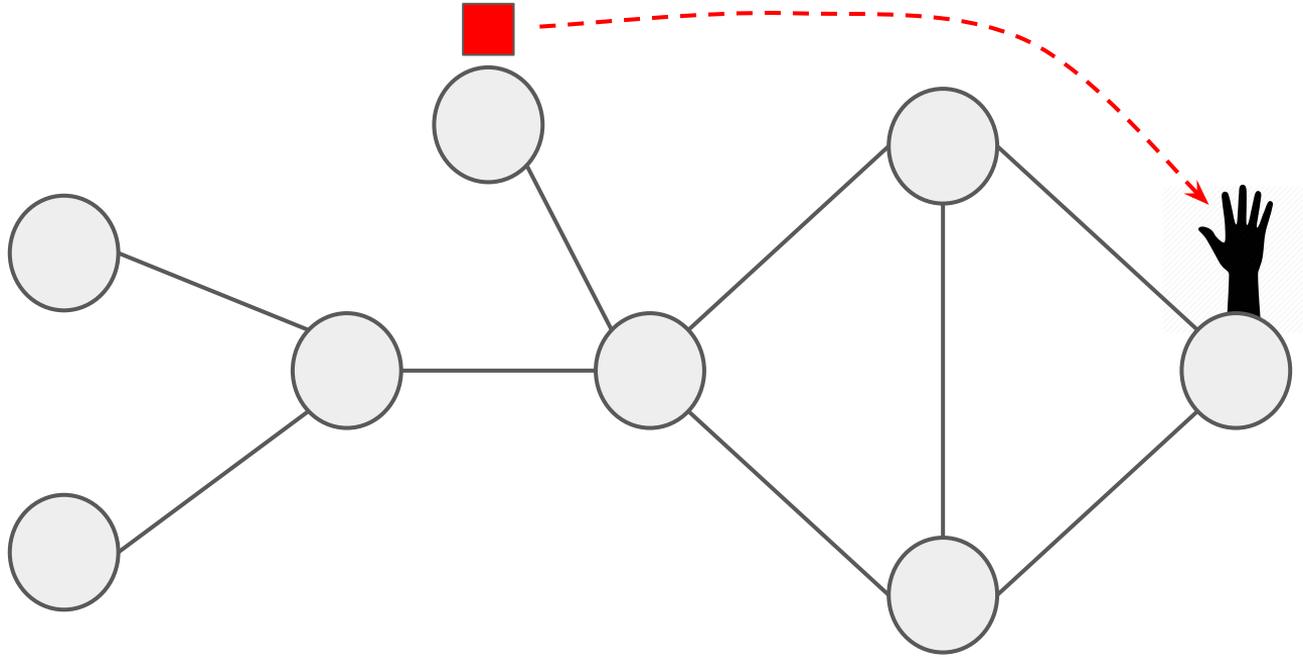
# Distributed Directory



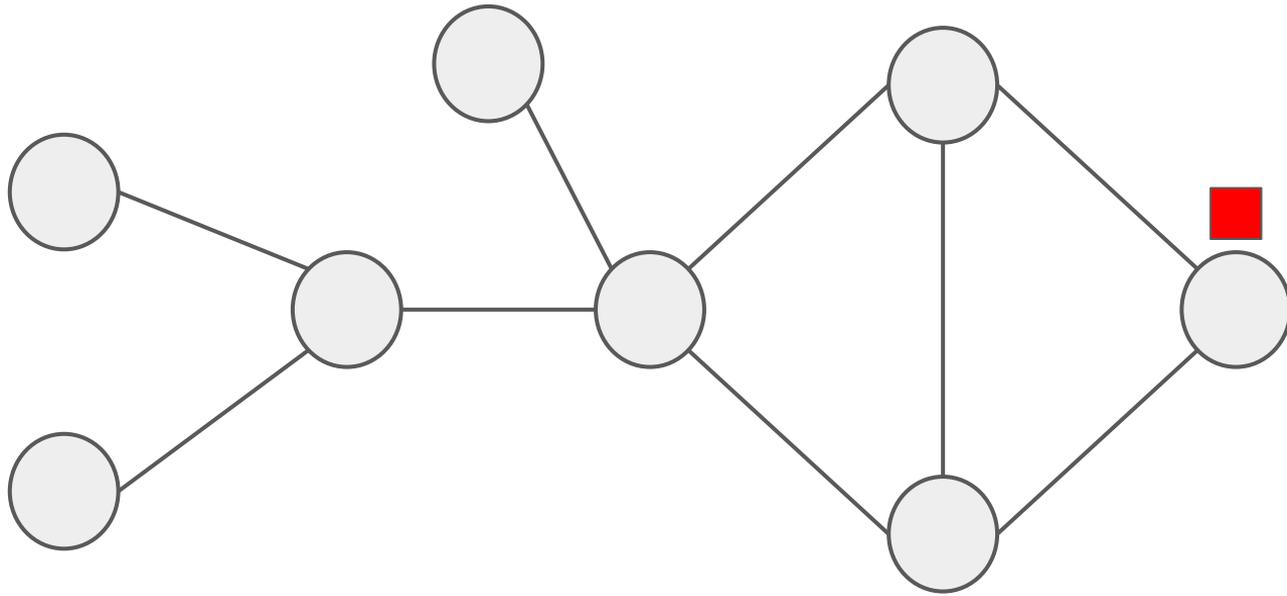
# Distributed Directory



# Distributed Directory

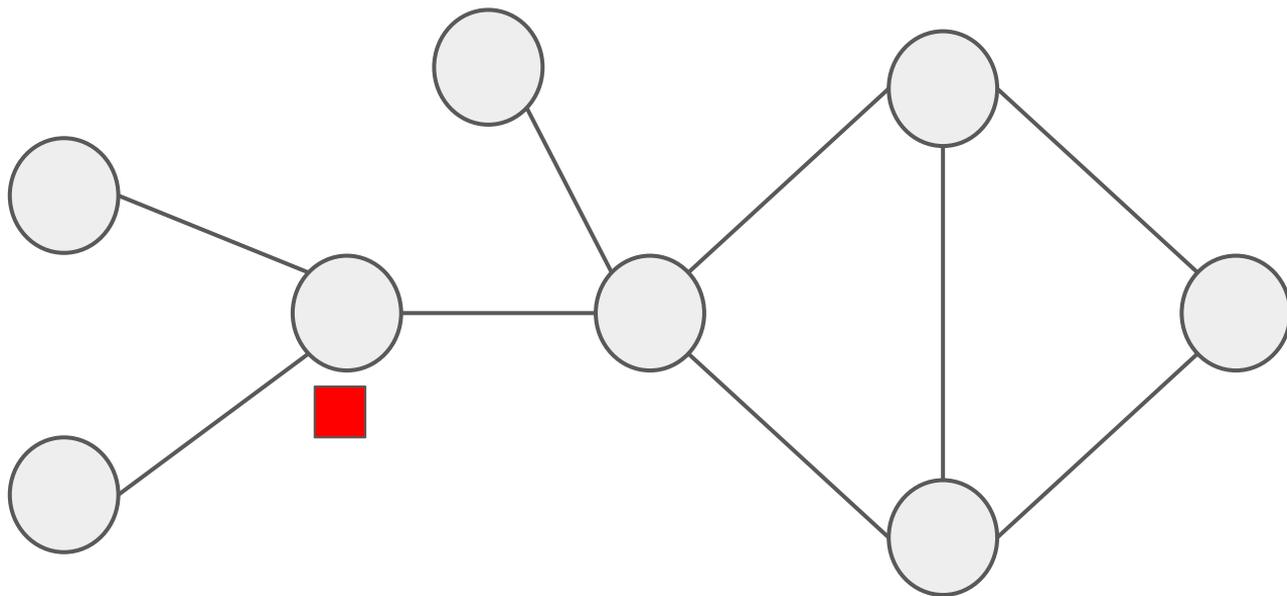


# Distributed Directory



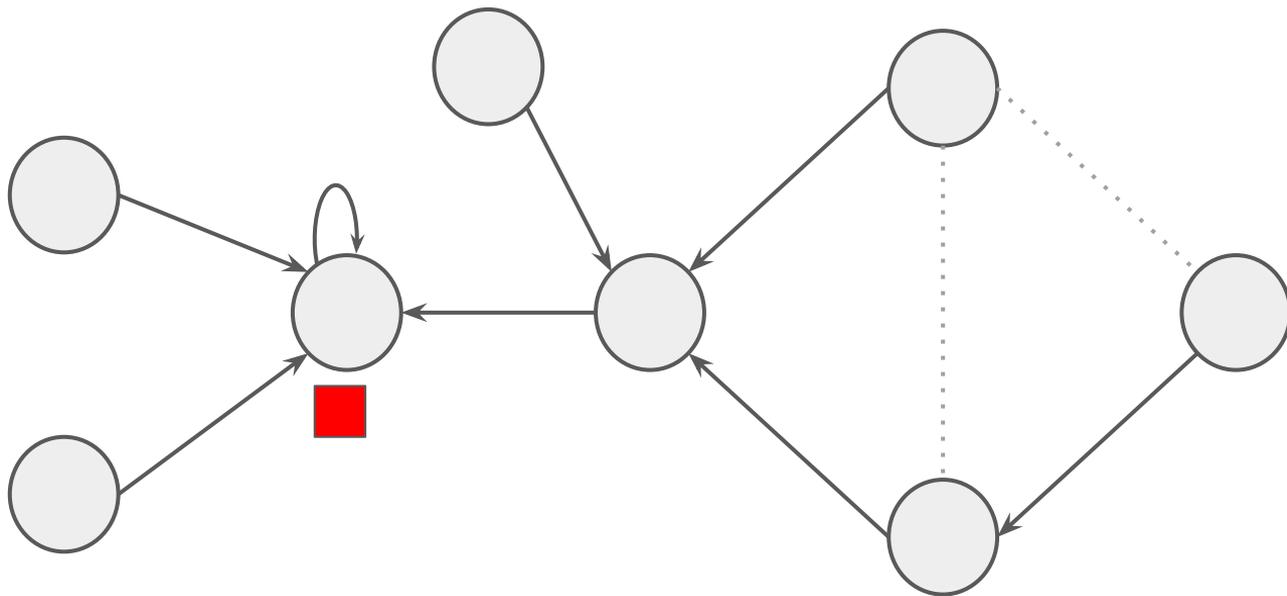
# Arrow

[Demmer & Herlihy 1998]



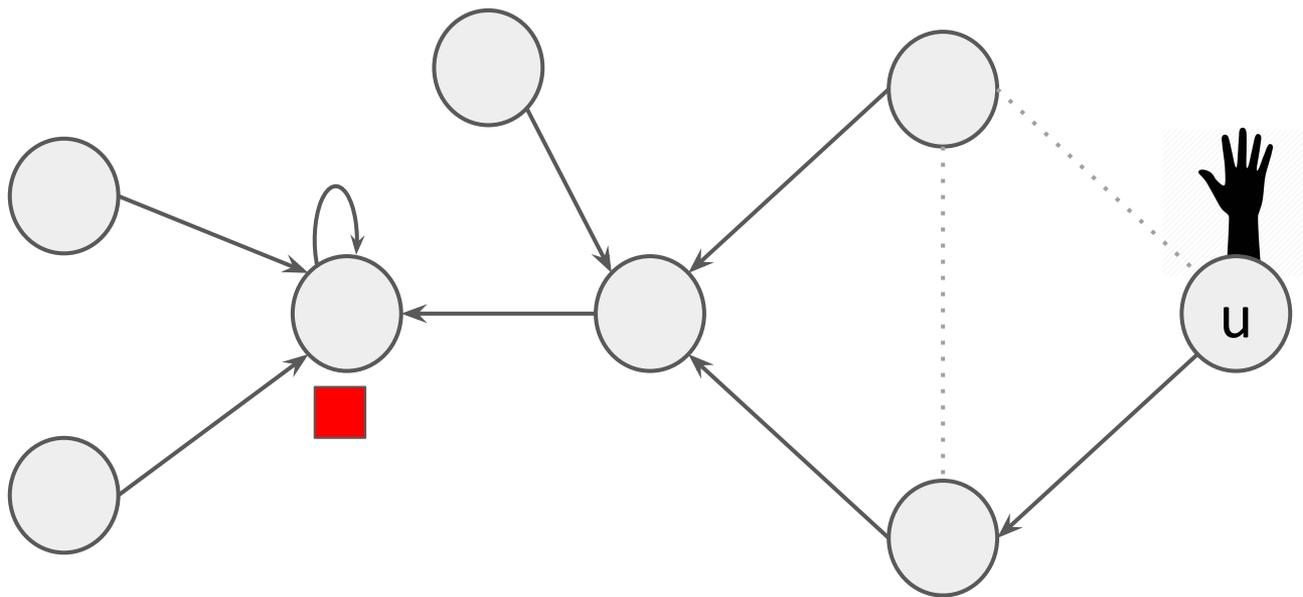
# Arrow

[Demmer & Herlihy 1998]



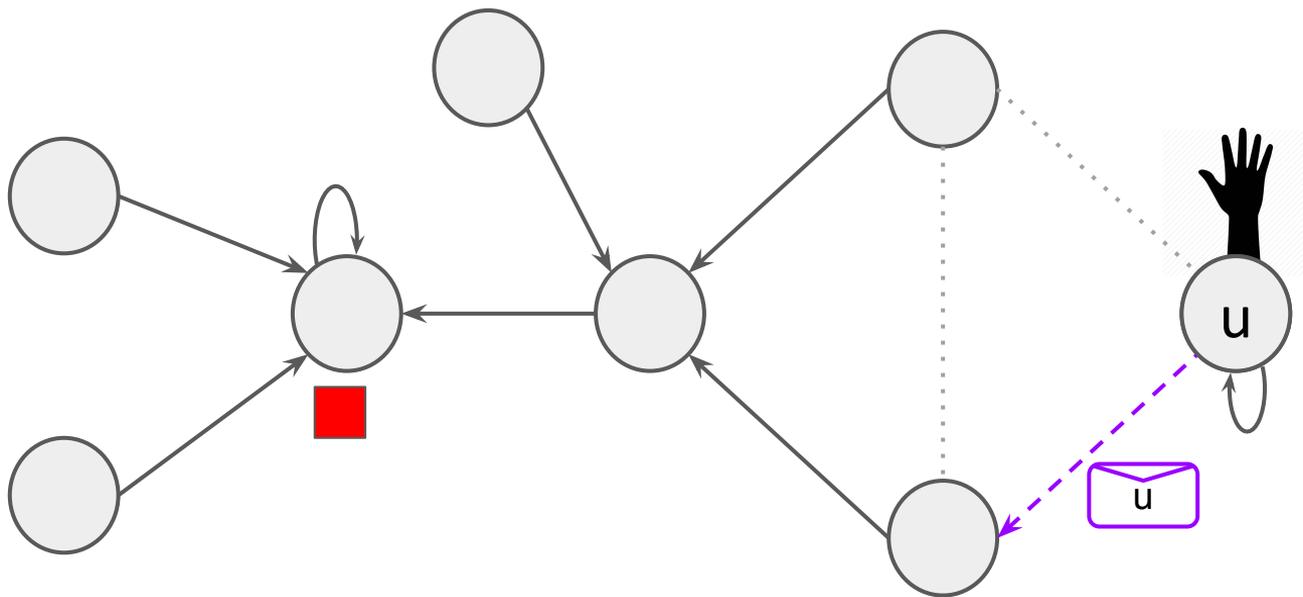
# Arrow

[Demmer & Herlihy 1998]



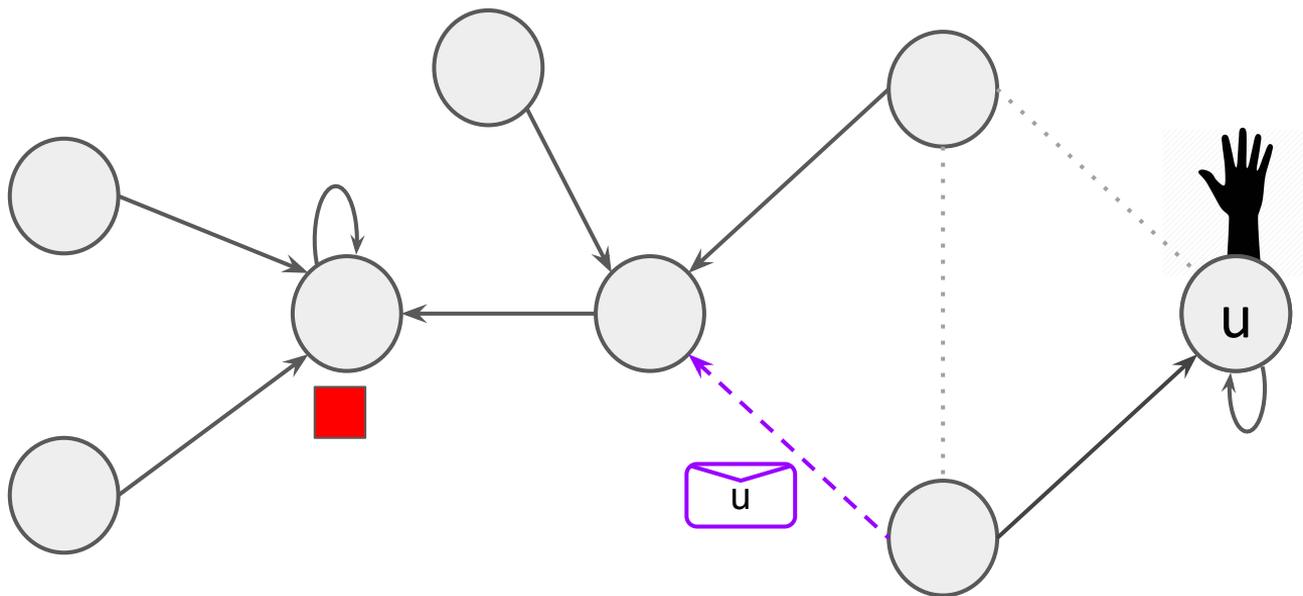
# Arrow

[Demmer & Herlihy 1998]



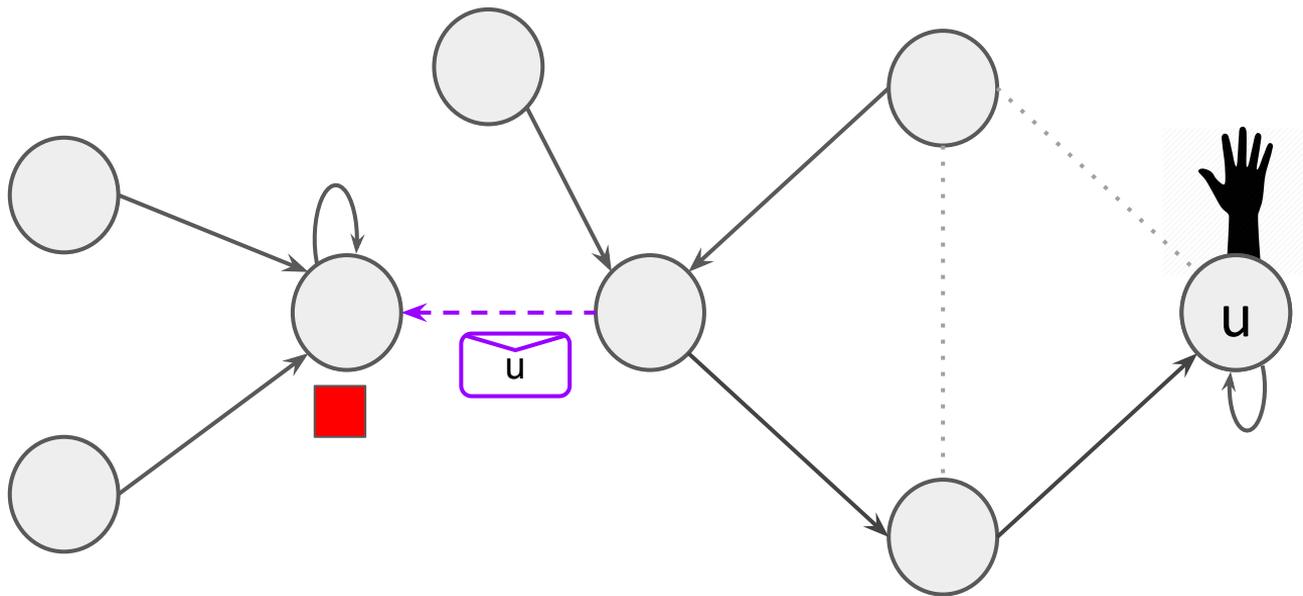
# Arrow

[Demmer & Herlihy 1998]



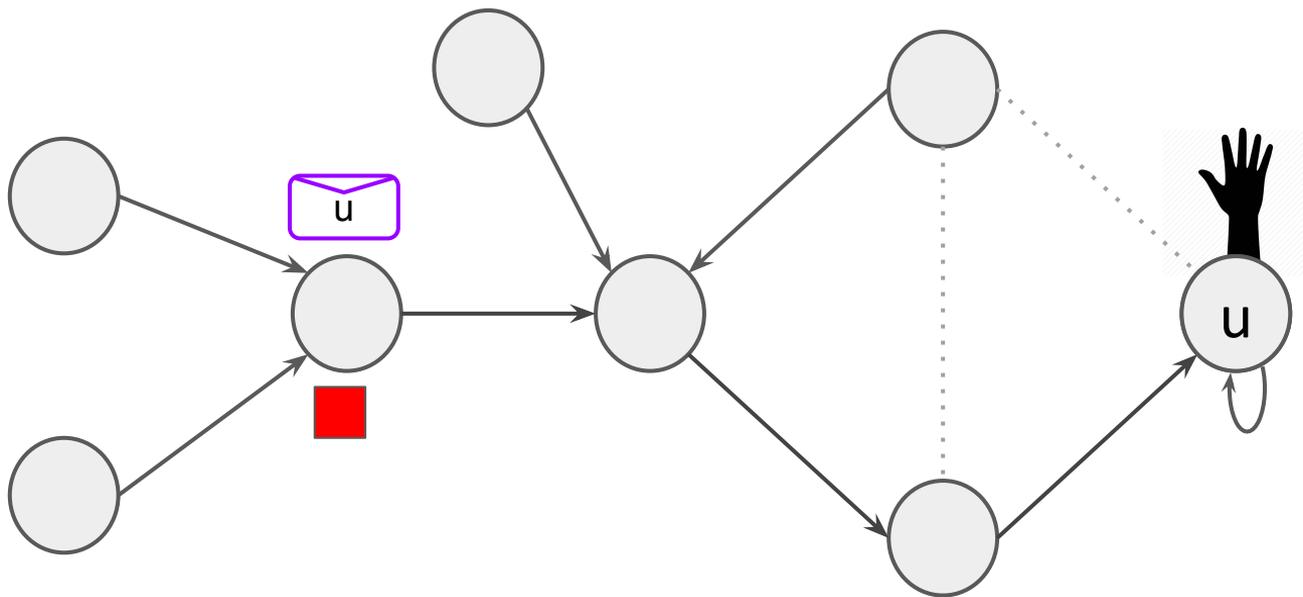
# Arrow

[Demmer & Herlihy 1998]



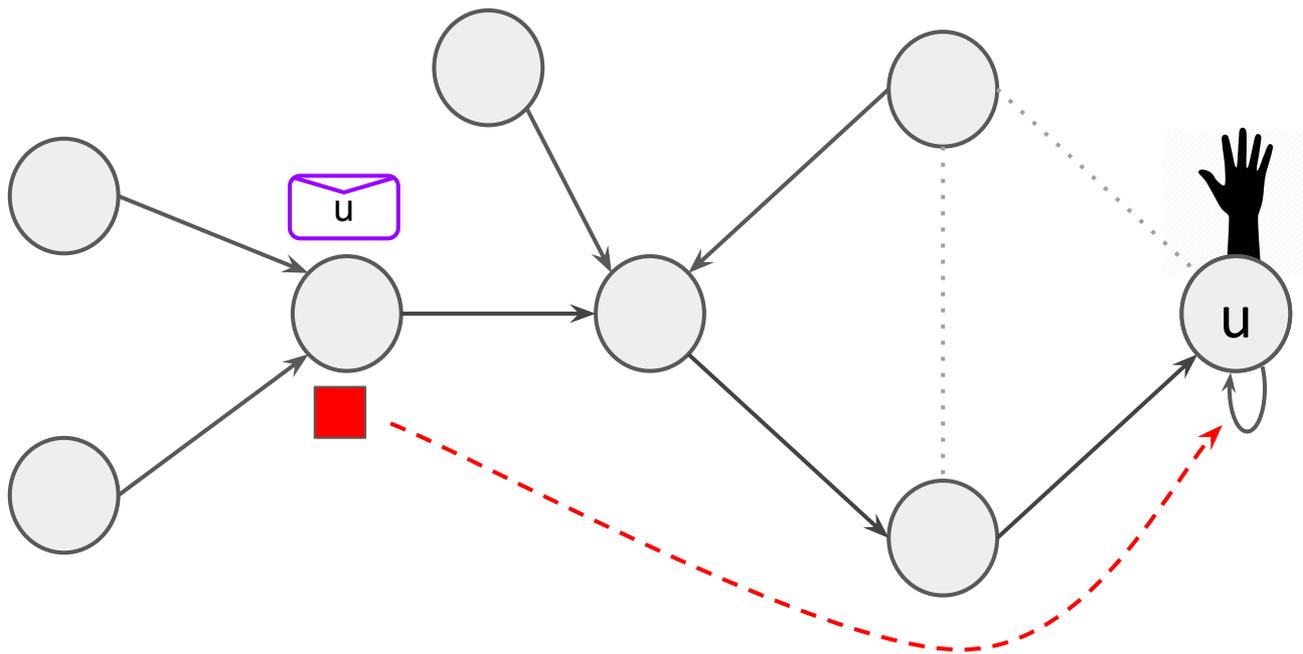
# Arrow

[Demmer & Herlihy 1998]



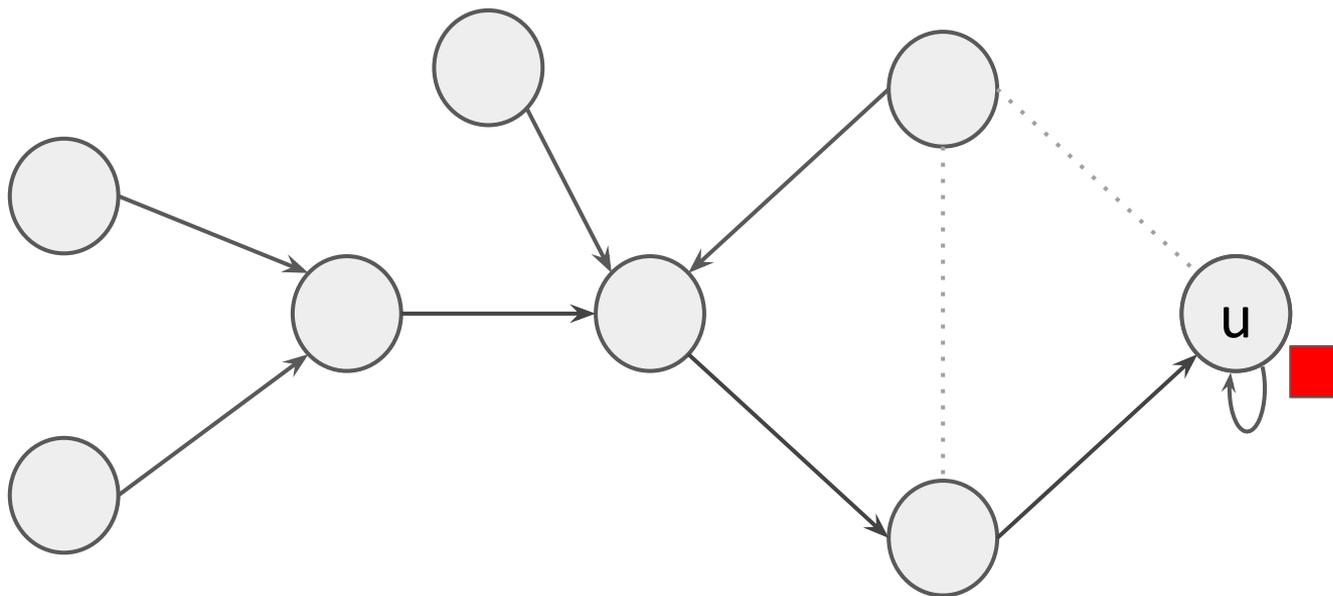
# Arrow

[Demmer & Herlihy 1998]

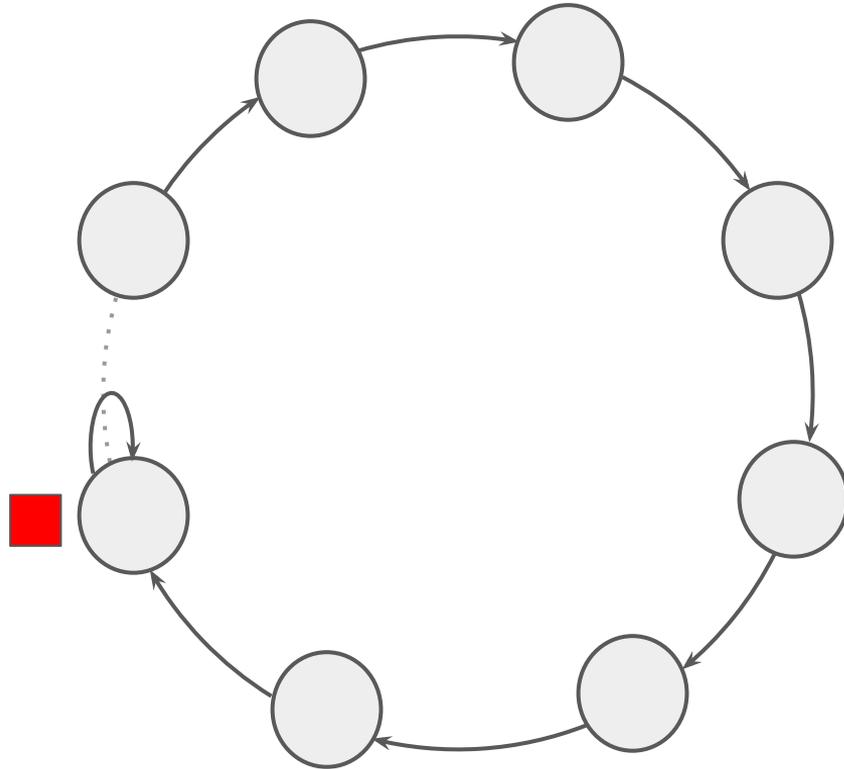


# Arrow

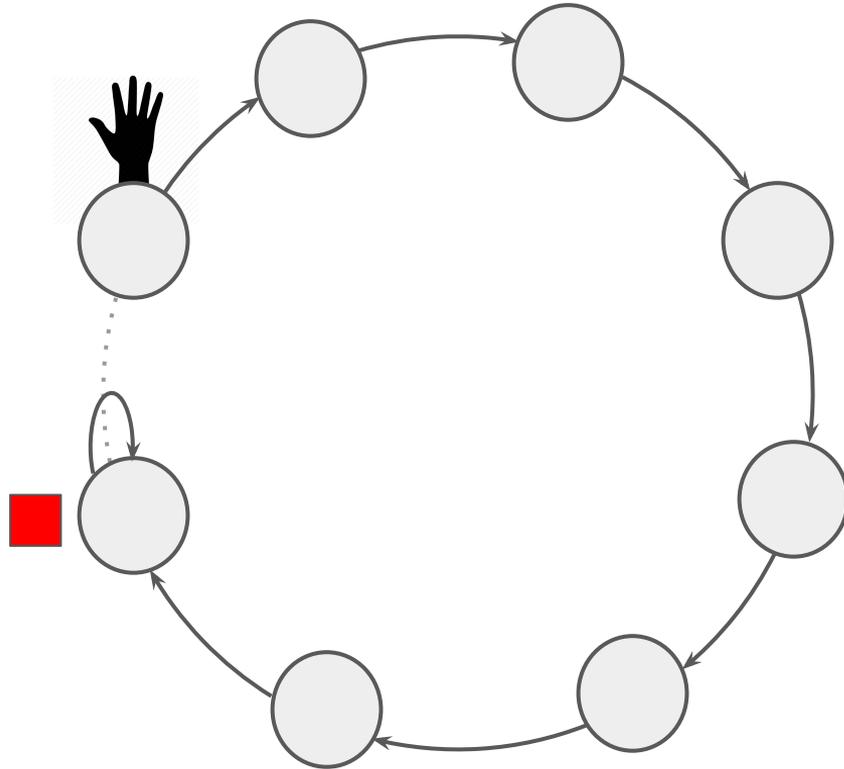
[Demmer & Herlihy 1998]



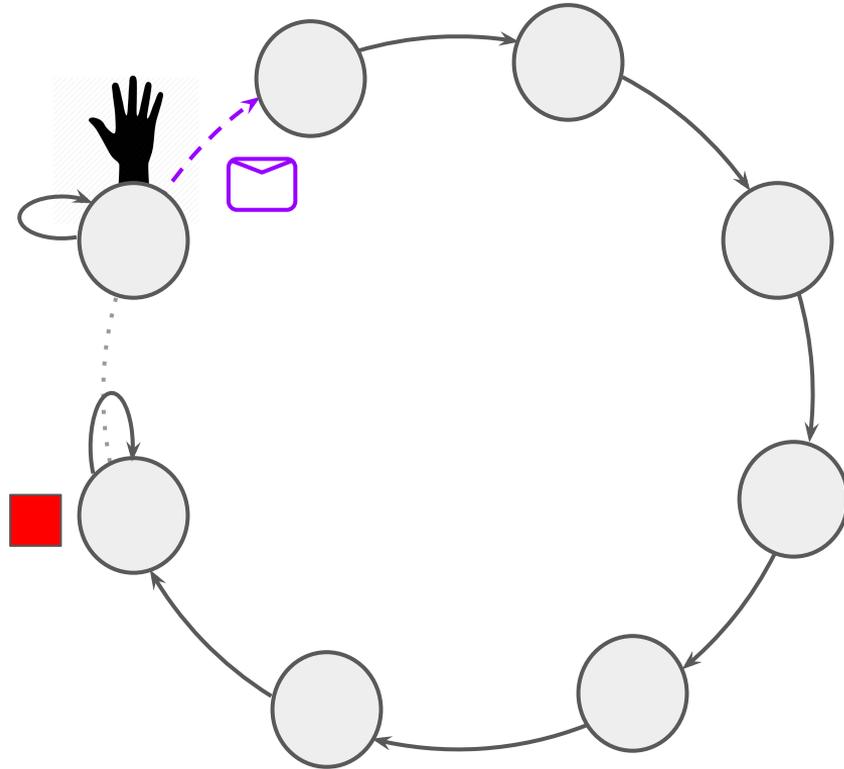
# Arrow on Rings



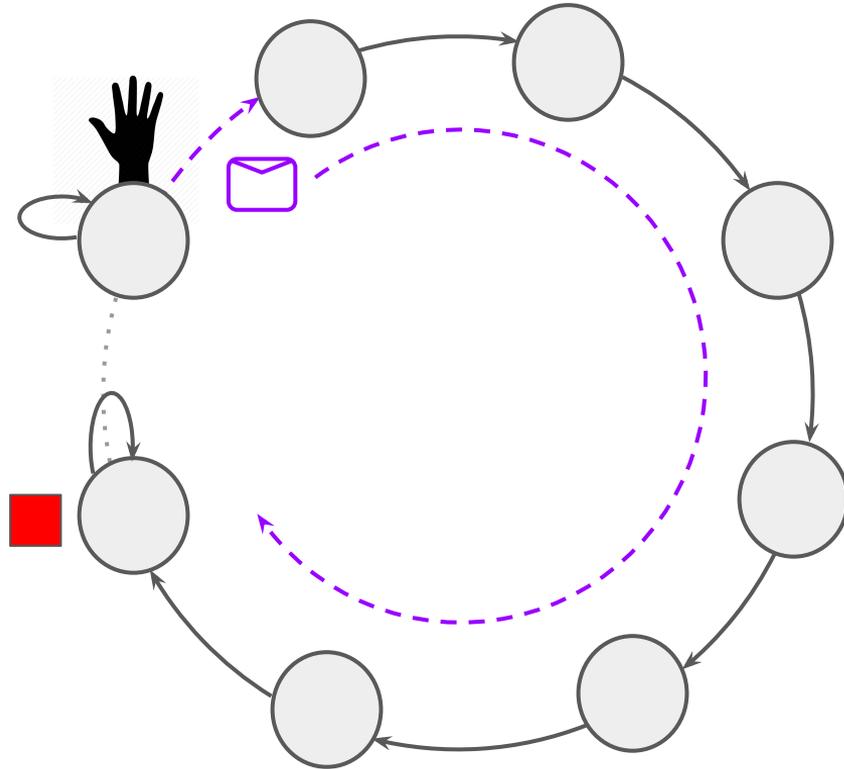
# Arrow on Rings



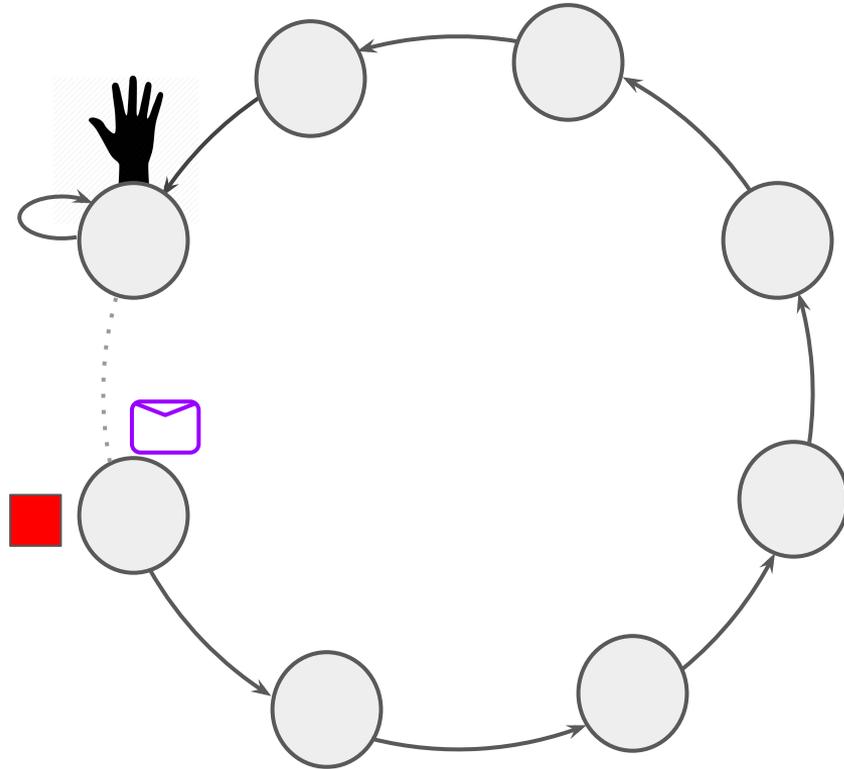
# Arrow on Rings



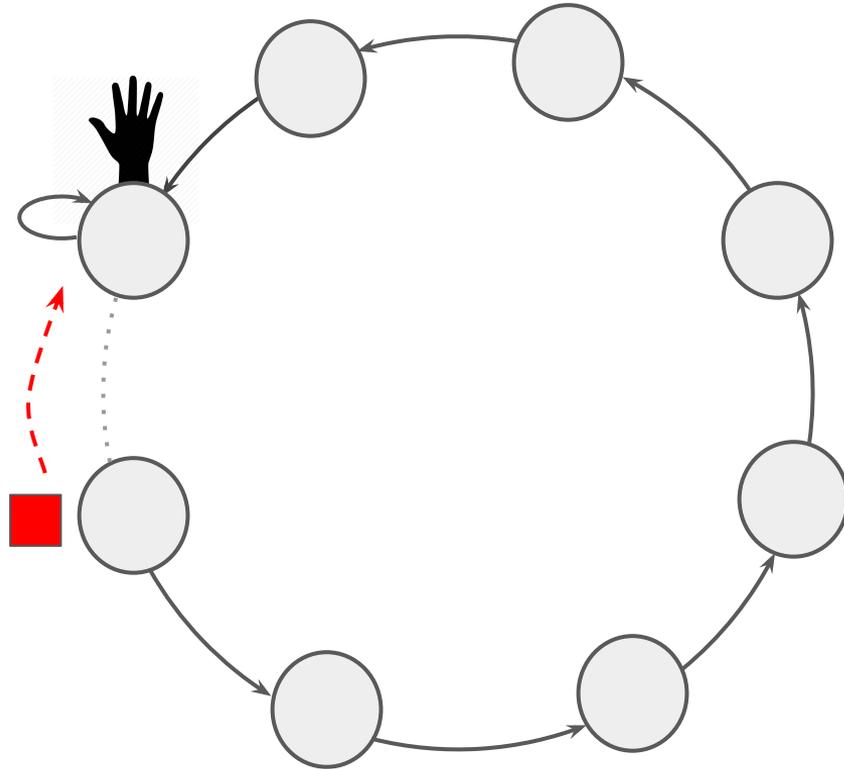
# Arrow on Rings



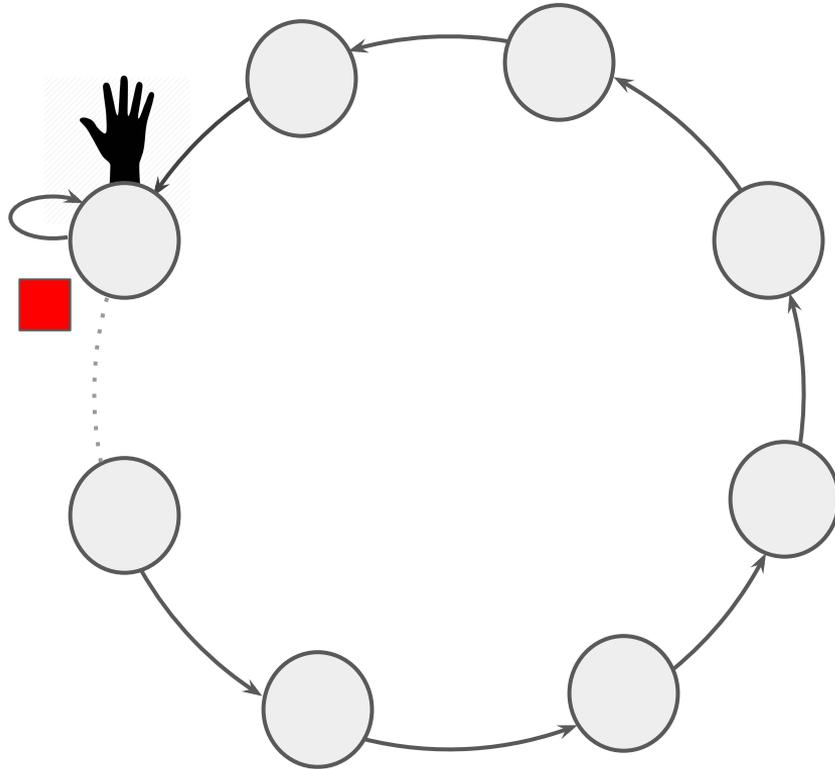
# Arrow on Rings



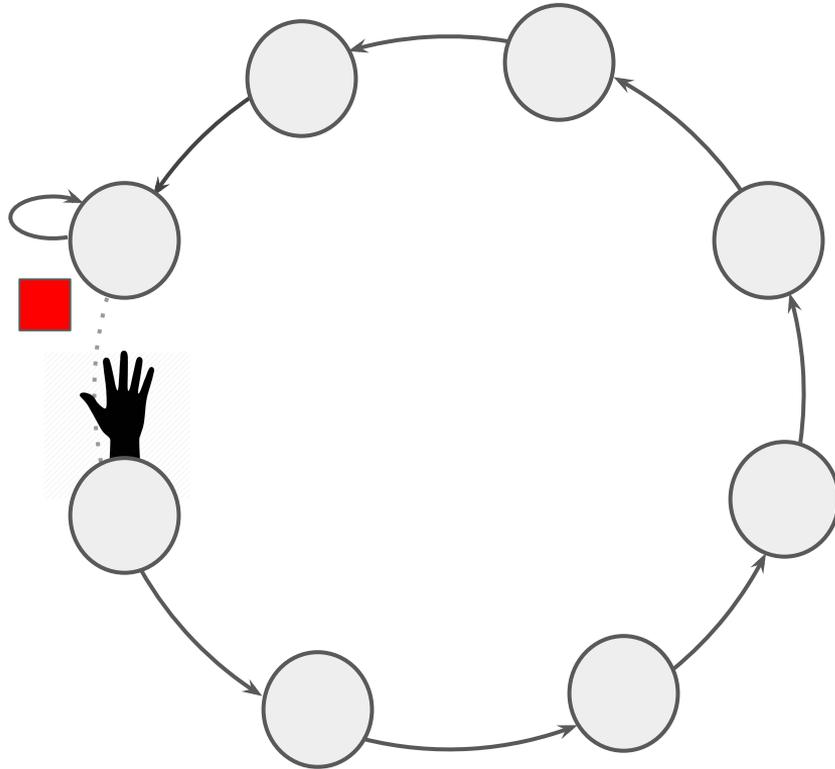
# Arrow on Rings



# Arrow on Rings

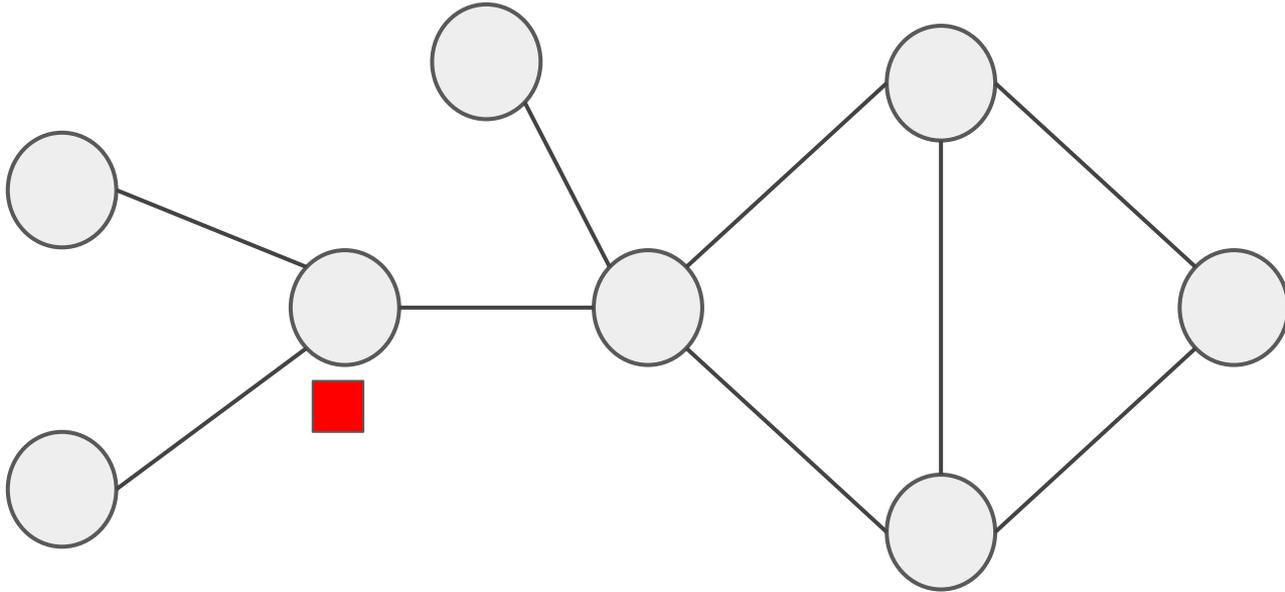


# Arrow on Rings



# Arvy

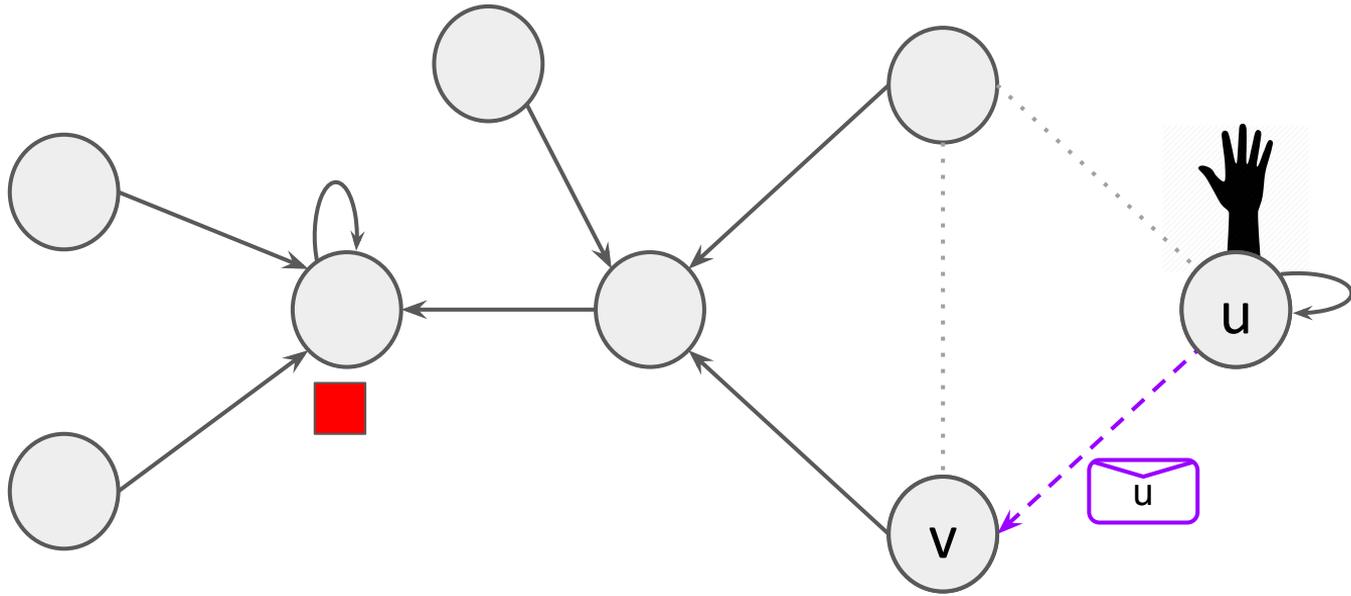
[ACM SPAA '19]



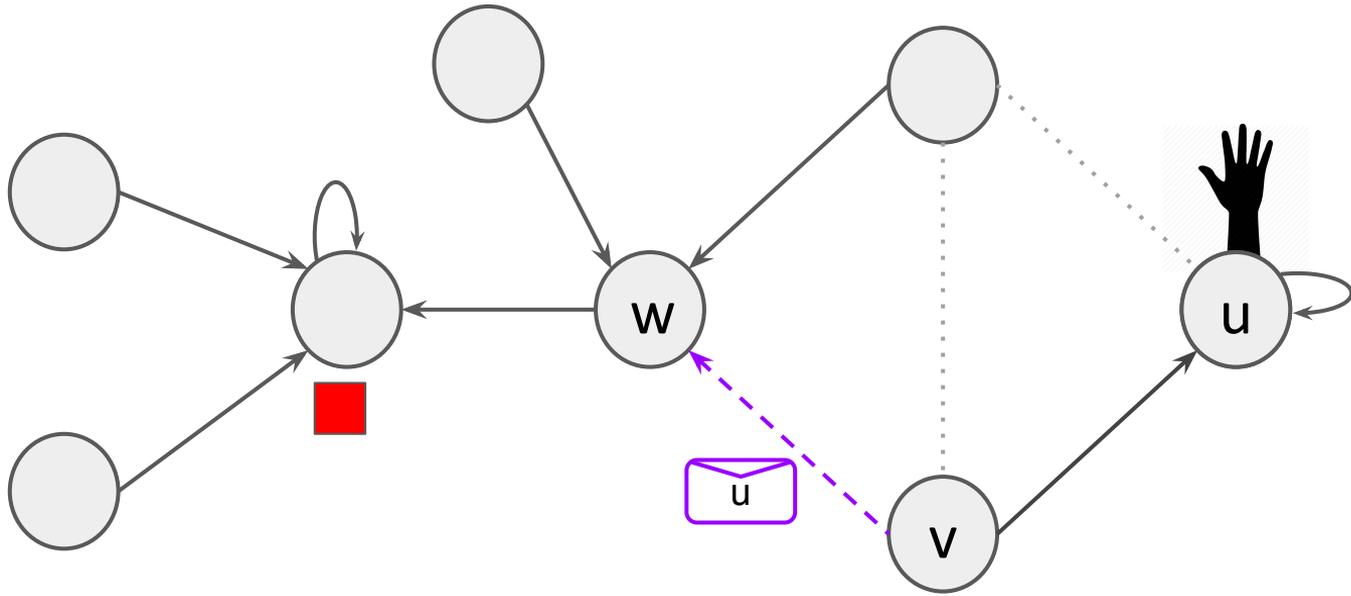




# Arvy

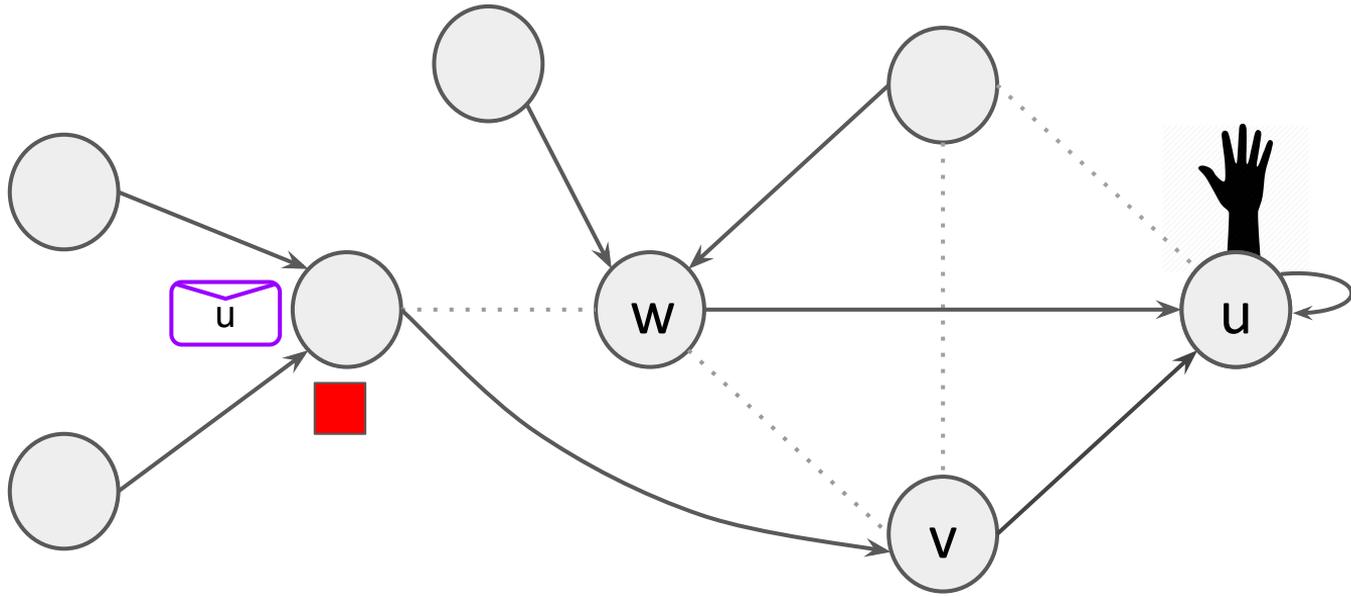


# Arvy

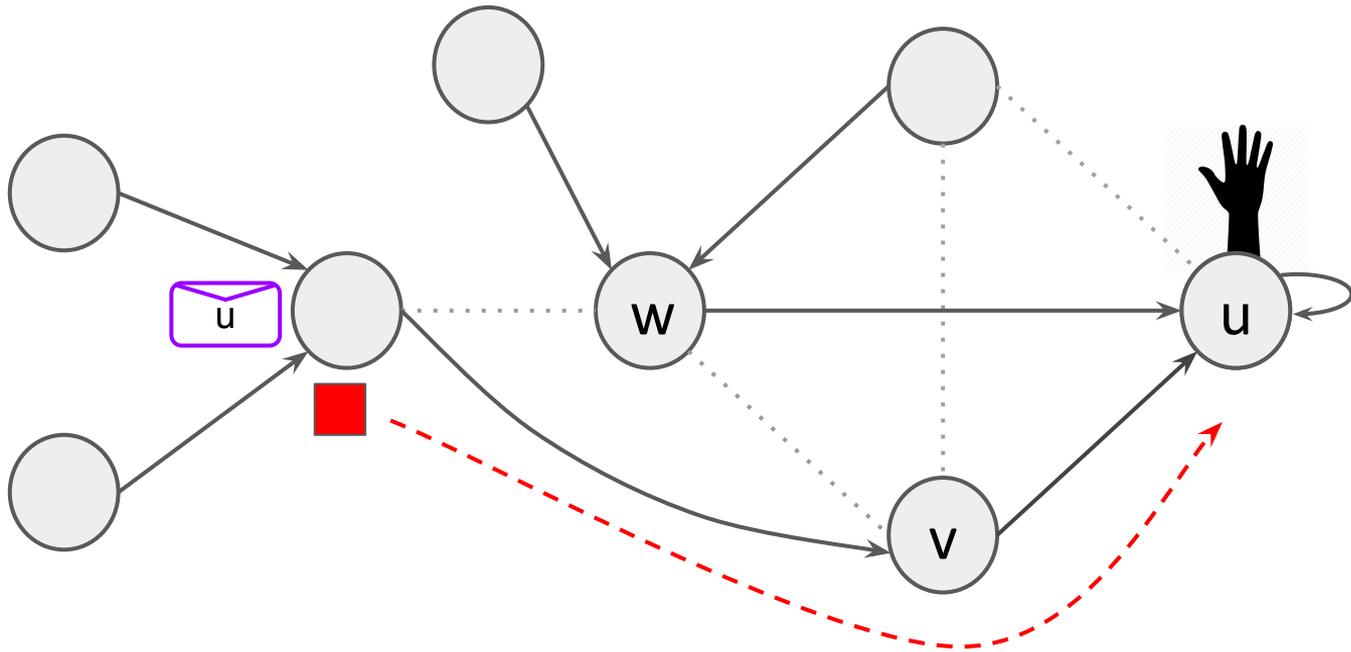




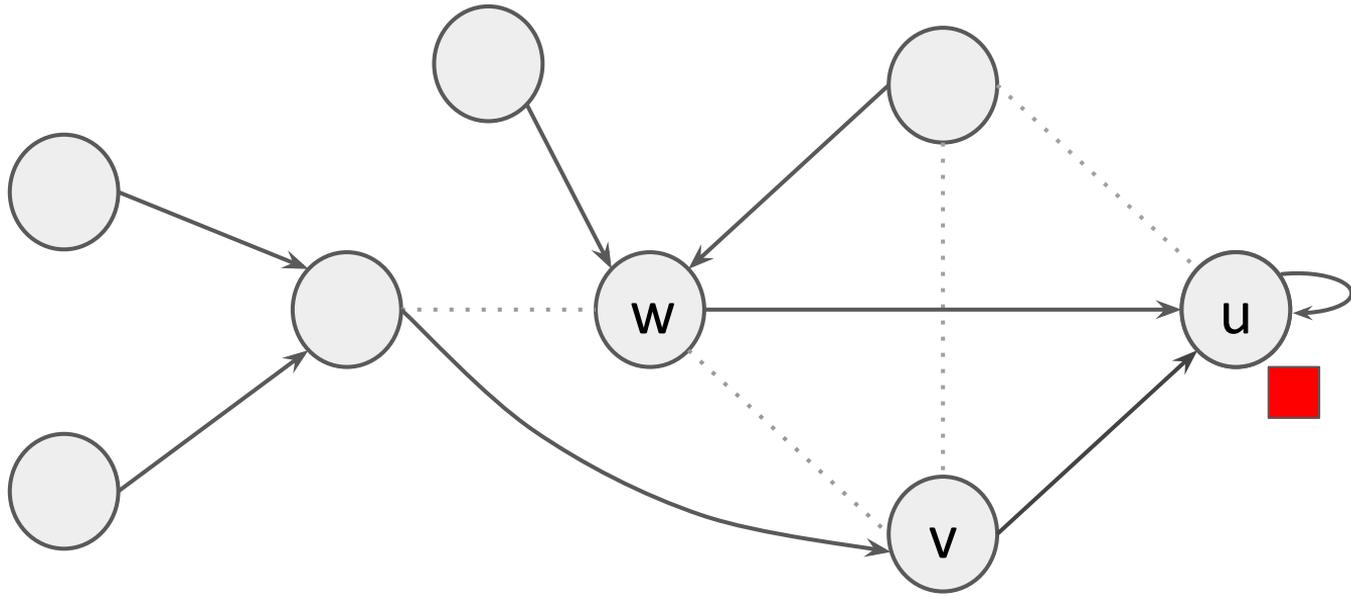
# Arvy



# Arvy



Arvy



# Arvy Performance

$\sigma$  = input request sequence

$$\text{Cost}(\sigma) = \text{Cost of Algorithm}(\sigma) / \text{Cost of Oracle}(\sigma)$$

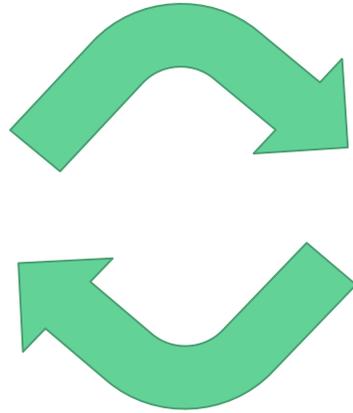
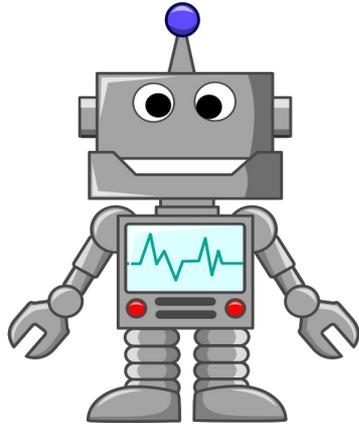
$$\text{Competitive Ratio} = \text{Max}_{\sigma} \text{Cost}(\sigma)$$

# Arvy Performance

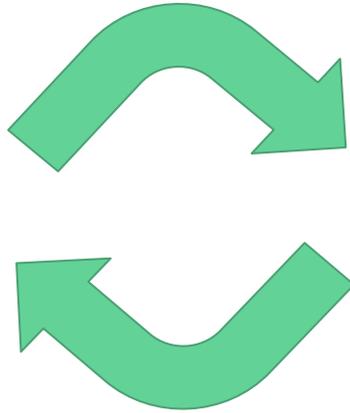
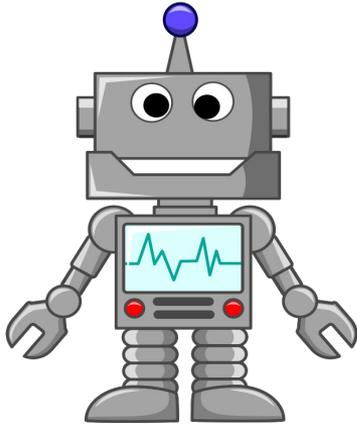
<u>Graph</u>	<u>Arvy Protocol</u>	<u>Upper Bound</u>
Tree	Arrow	$O(1)$
Cycles	Bridge	$O(1)$
Grids	Arrow	$O(\sqrt{n})$

# Arvy Performance

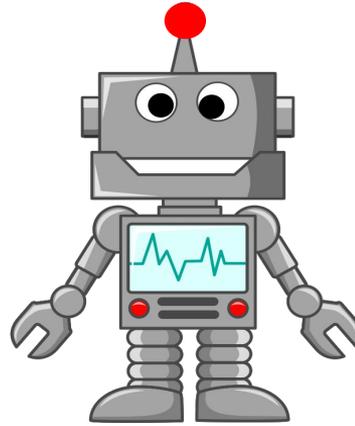
<u>Graph</u>	<u>Arvy Protocol</u>	<u>Upper Bound</u>
Tree	Arrow	$O(1)$
Cycles	Bridge	$O(1)$
Grids	Arrow	$O(\sqrt{n})$
Treewidth = ?	Arvy = ?	?



Route Agent  $\pi_A$

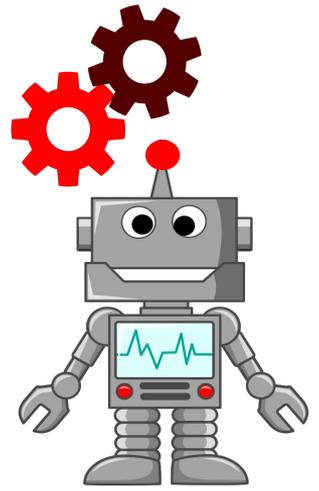
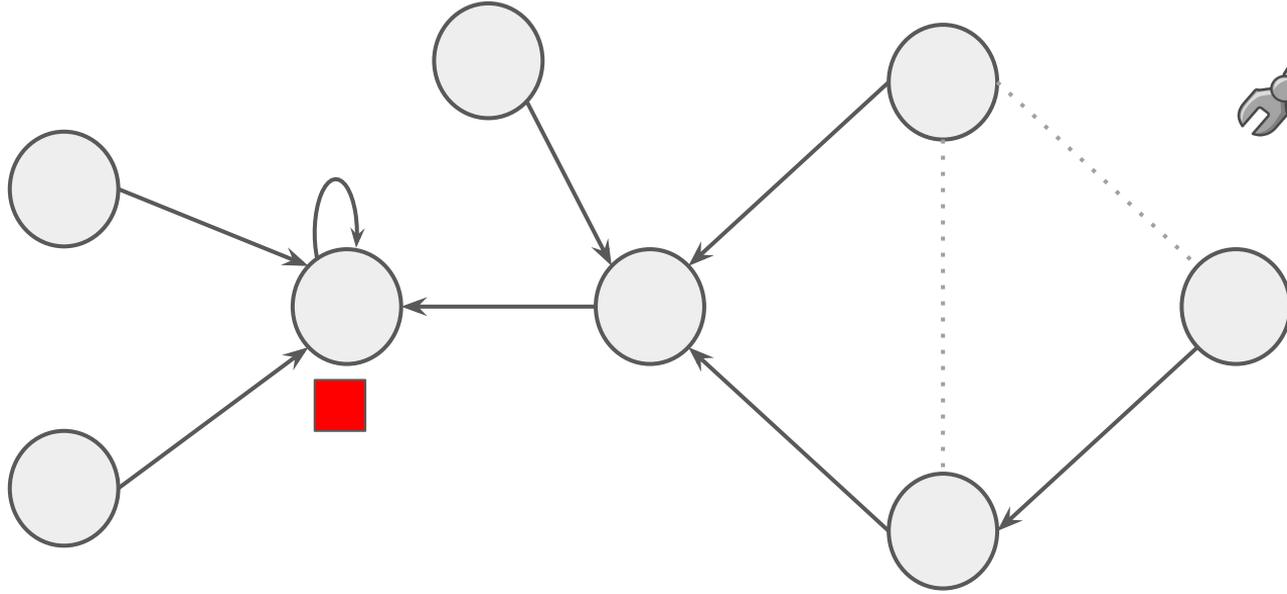


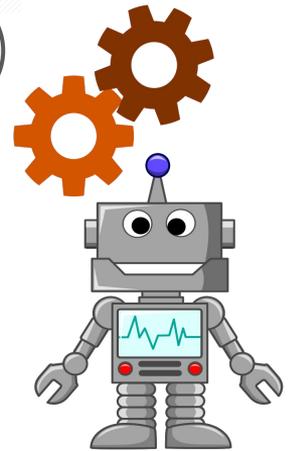
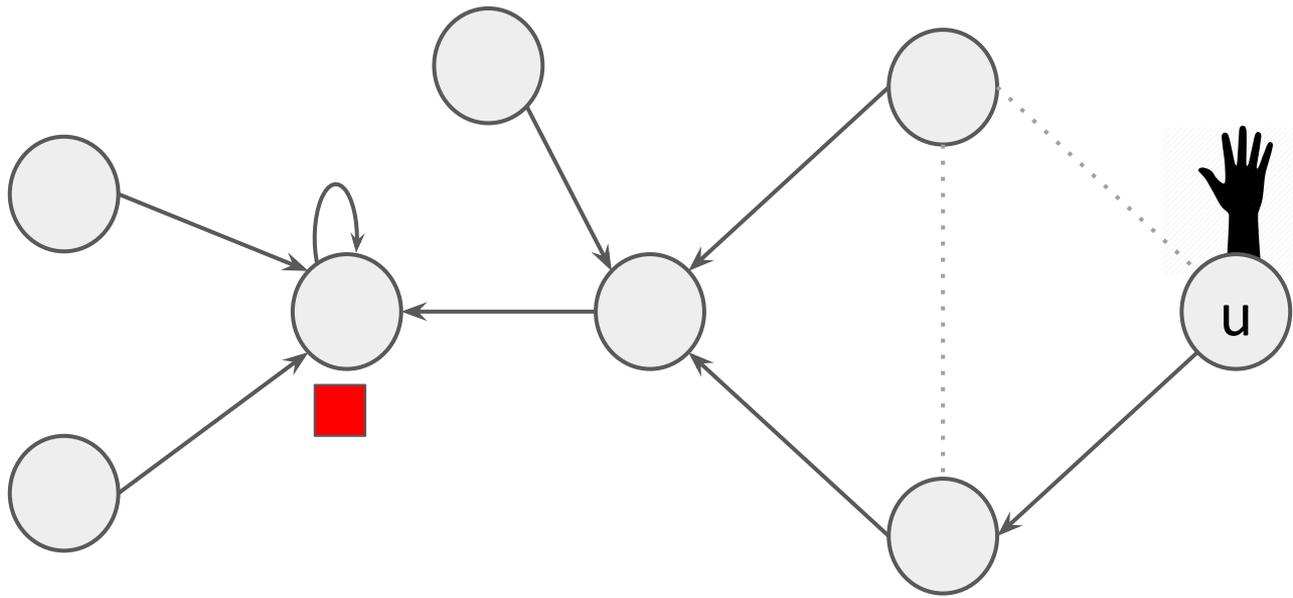
Request Agent  $\pi_\sigma$

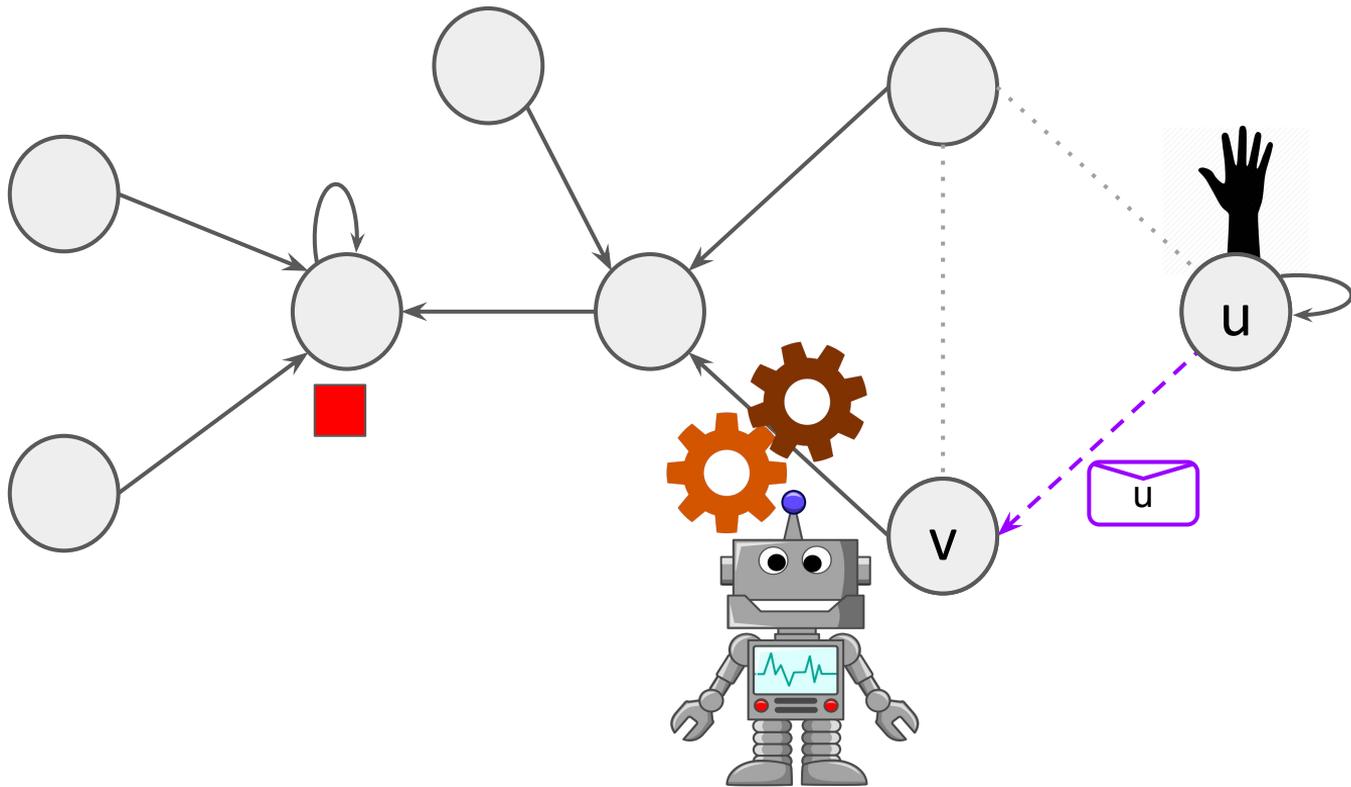


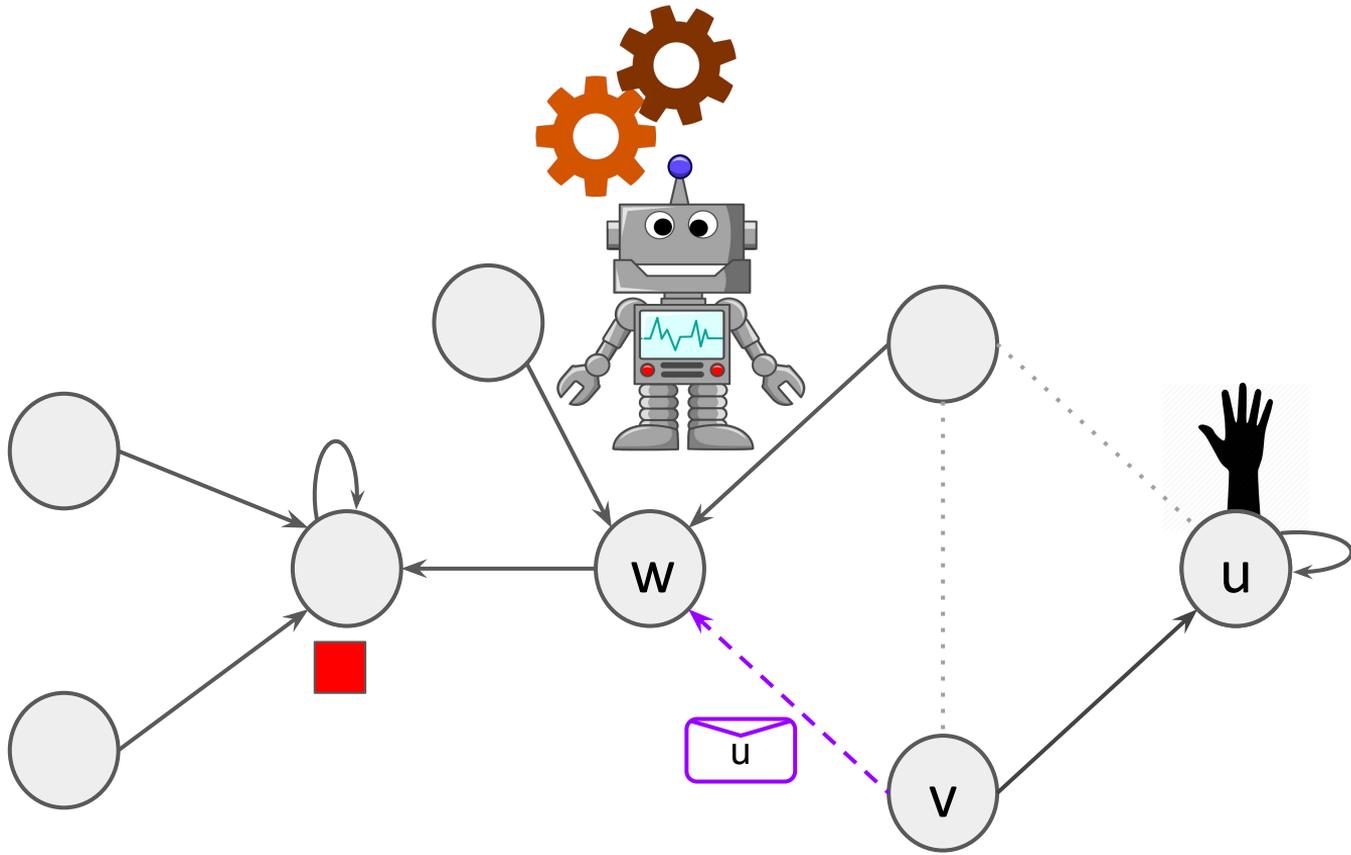
... trained to minimize competitive ratio

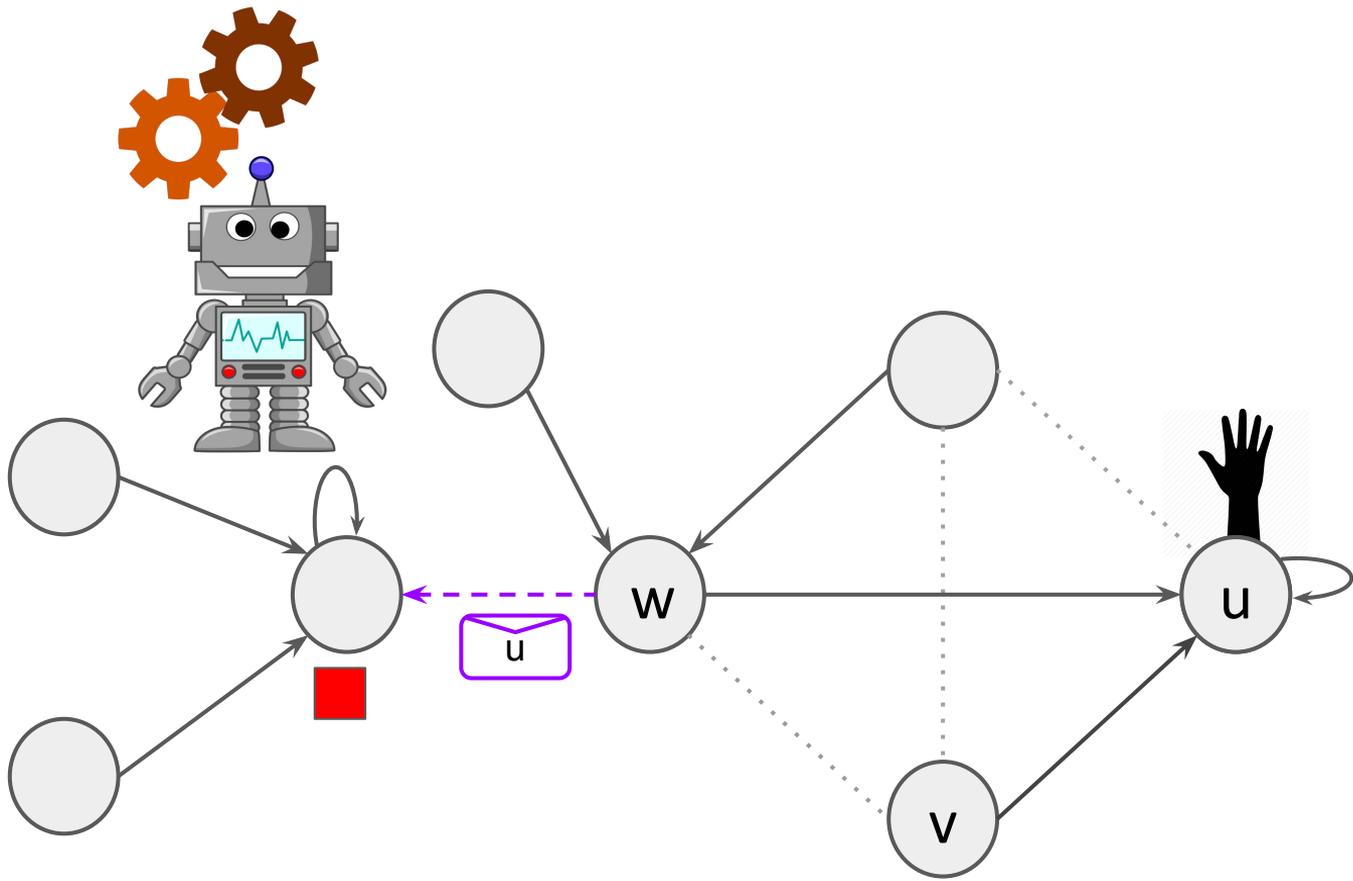
... trained to maximize competitive ratio

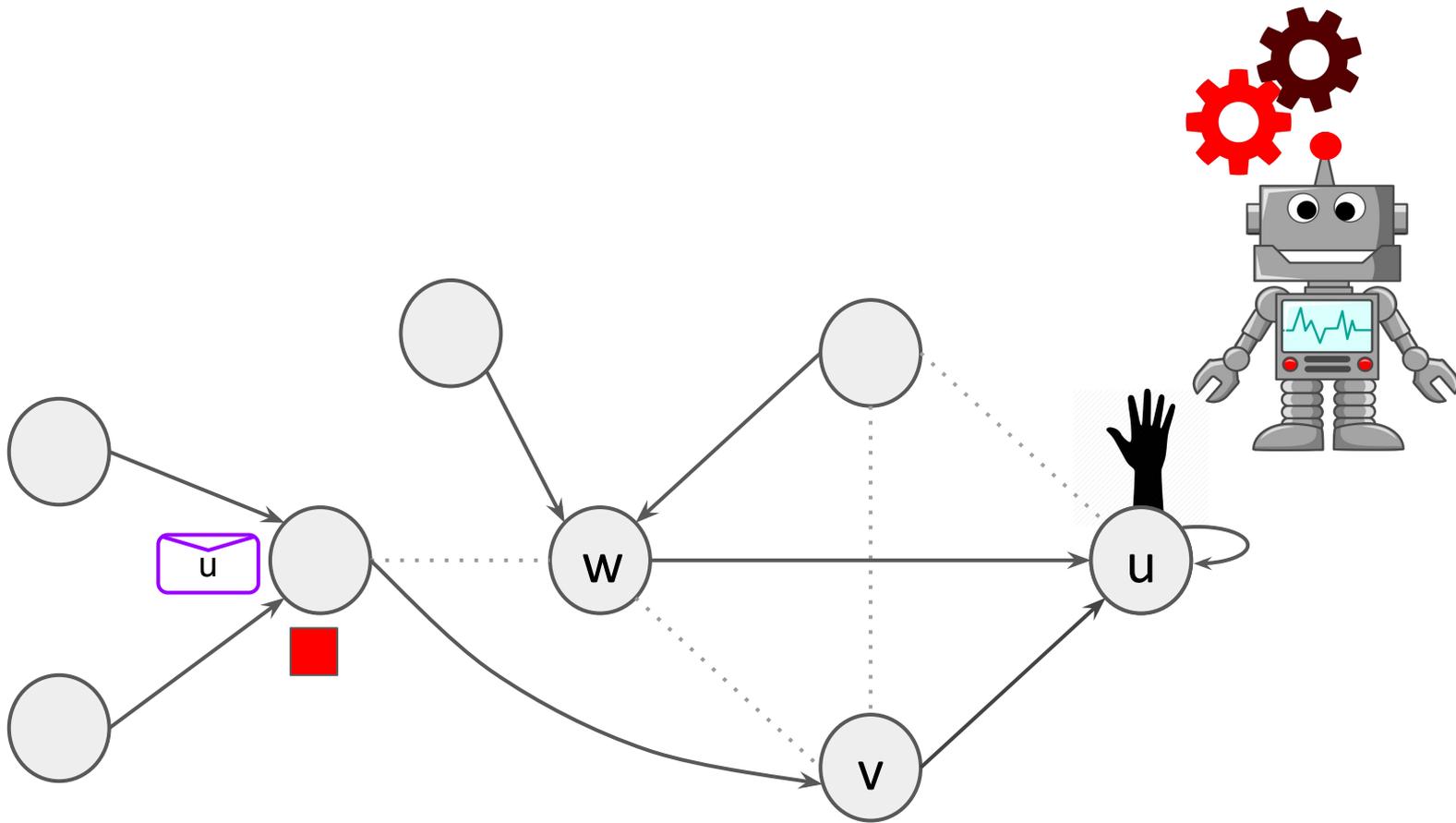




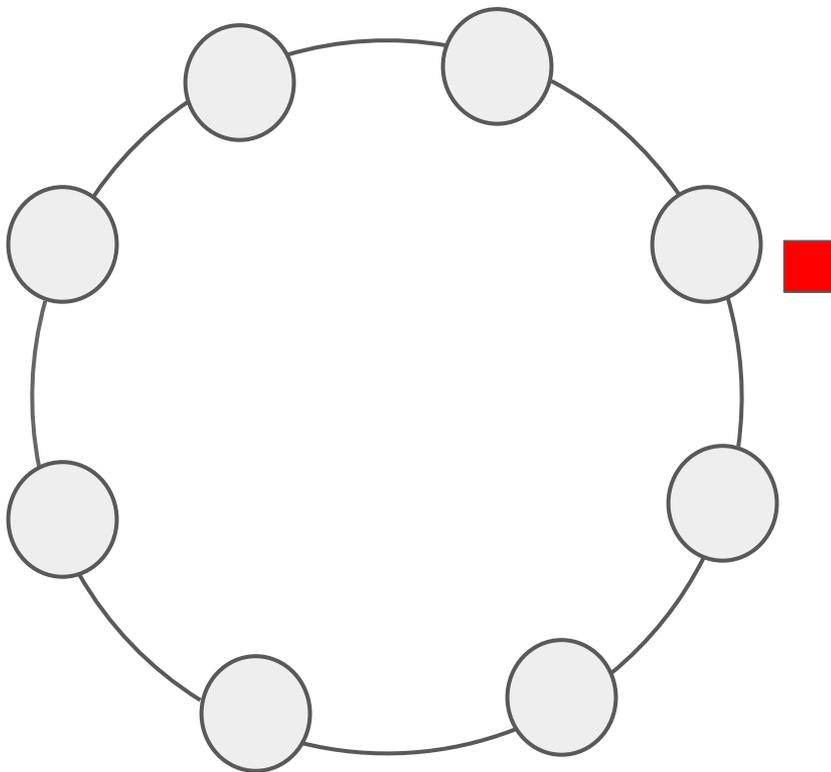


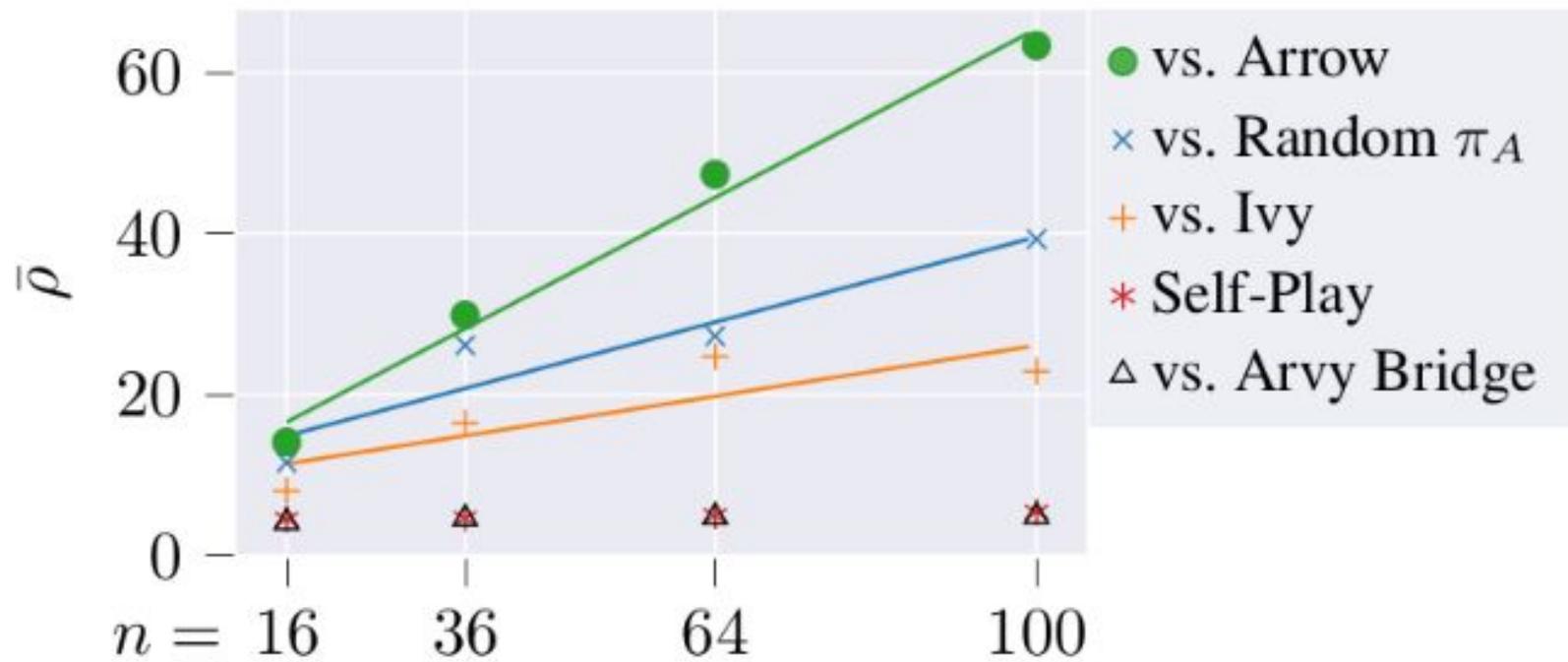


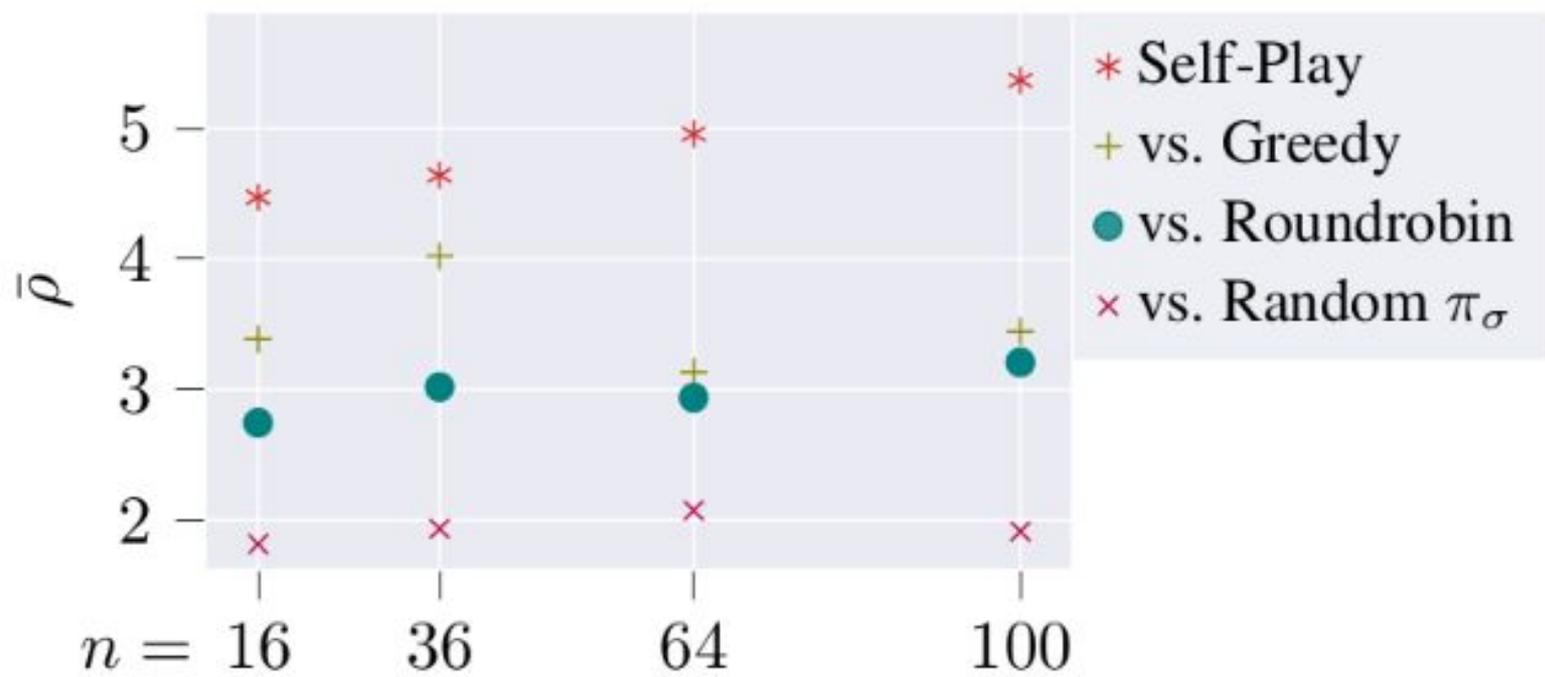




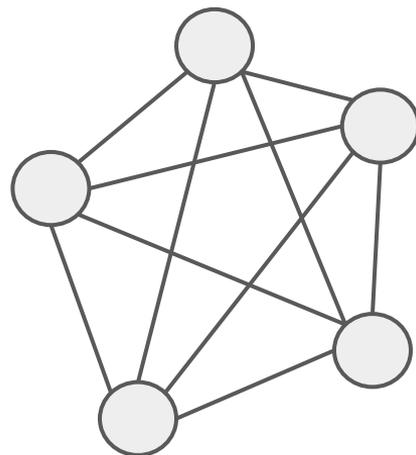
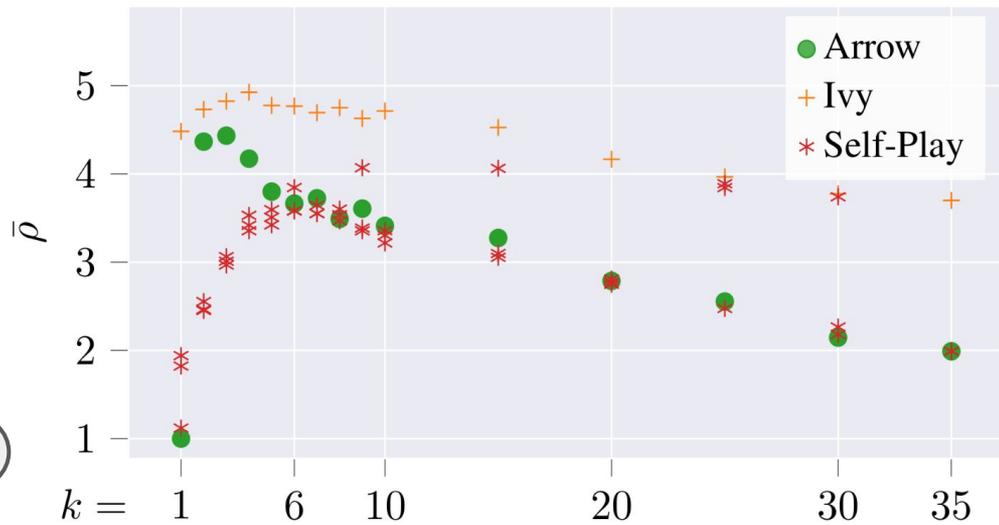
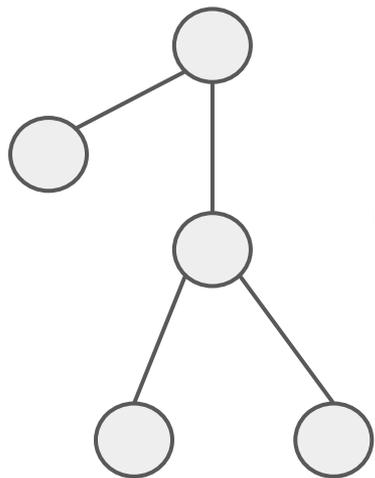
# Cycles







# Treewidth



???

