ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Distributed Computing

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Distributed Systems Part II

Exercise Sheet 10

Quiz

1 Pop Quiz

a) Is the following statement true: If 3/4 of the edges in a network each have a slack of at least 75% both in the old and new flows, it is always possible to perform a sequence of capacity-consistent updates from the old to the new flows?

b) How can the central controller in SDNs decide in polynomial time if updating the single-destination forwarding rules of all nodes at once would create a loop somewhere?

c) When the SDN controller wants to update prefix-based forwarding rules, how can you guarantee loop-free updates – if you are allowed to split up the forwarding rules?

Basic

2 Network Updates

Assume you have a network with n nodes and an extra node d as a destination. You want to migrate the network from an old set of forwarding rules to a new set of forwarding rules – without introducing loops in the process!

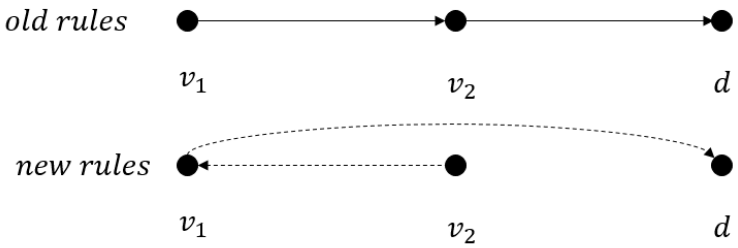

Figure 1: Simple example: In the old rules, v_1 forwards to d via v_2, and v_2 is directly connected to d. In the new rules, v_2 forwards to d via v_1, and v_1 is directly connected to d. The node v_2 may not migrate in a first update step, because that would induce a potential loop between v_1 and v_2!

a) Construct an example graph with old and new rules that needs at least three update steps.

b) You know from the lecture that you can always migrate at least one rule per step. What property does this rule have?

c) Give a class of graphs with n nodes and a single destination with old and new rules that needs exactly n update steps to migrate without loops.

d) Give all different ways to migrate the network in Figure 2 without introducing loops.

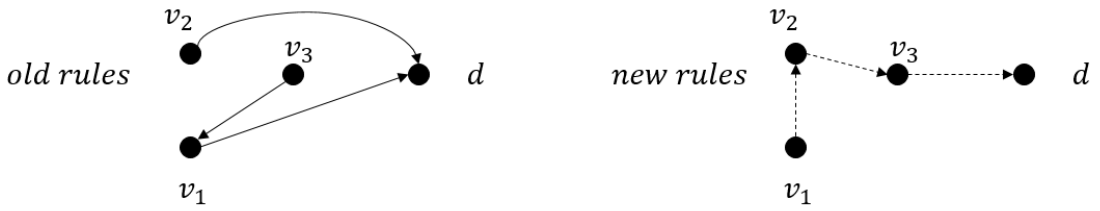

Figure 2: Another example for a set of old and new rules.

Advanced

3 Capacity-Consistent Updates

Consider the network in Figure 3 with four flows. These four flows shall be migrated to the placement in Figure 4, but with capacity-consistent updates.

a) Why is it not possible to achieve this in one capacity-consistent update?

b) If you would like to update only one flow to its final placement, for which flows could you do this in one capacity-consistent update?

c) How many capacity-consistent updates do you need to move all flows to their desired placement?

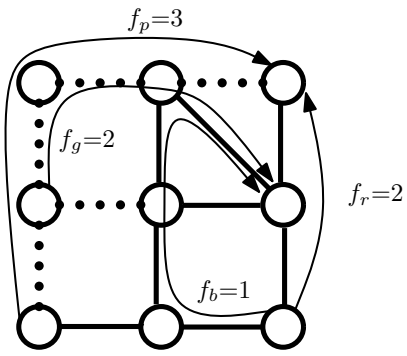

Figure 3: Initial old configuration.

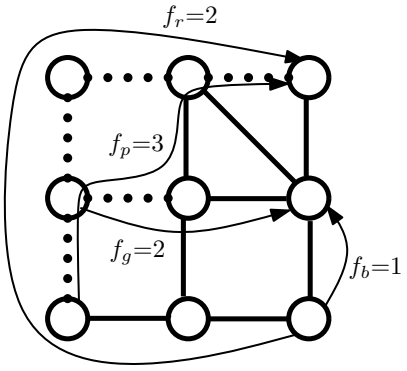

Figure 4: Desired new configuration.

The solid edges have a capacity of 3 in each direction, the dotted edges have a capacity of 5 in each direction. It holds that $f_r = 2$, $f_b = 1$, $f_g = 2$ and $f_p = 3$.