Communication Networks Spring 2021



Tobias Bühler https://comm-net.ethz.ch/

ETH Zürich

March 11 2021



Communication Networks Exercise 2



Some comments on last week's assignment

Overview current assignment

Solving a 2020 Dijkstra exam question

Time for you to solve the tasks

Solutions will be published next week



The Internet has a hierarchical structure

Tier-1 have no provider international

Tier–2	provide transit to Tier-3s
national	have at least one provider

Tier–3	do not provide any transit
local	have at least one provider











Task 1.6-g) Packet vs. Circuit Switching





Task 1.6-g) Packet vs. Circuit Switching





If A and B use packet switching

Communication Networks Exercise 2



Some comments on last week's assignment

Overview current assignment

Solving a 2020 Dijkstra exam question

Time for you to solve the tasks

Solutions will be published next week

Task 2.1: Dijkstra's algorithm



Let's compute the shortest-paths from *u* using Dijkstra's algorithm







Initialization

 $S = \{u\}$

for all nodes v: if (v is adjacent to u): D(v) = c(u, v)else:

$$D(v) = \infty$$

D is initialized based on u's weight, and S only contains u itself



A 3
B ∞
C ∞
D ∞
E 2

 ∞

 ∞

F

G

 $D(.) = S = \{u\}$



Loop

while not all nodes in S:

add w with the smallest D(w) to S update D(v) for all adjacent v not in S: $D(v) = min\{D(v), D(w) + c(w, v)\}$











D(.) = $S = \{u, E\}$ 3 Α В ∞ 3 $\mathsf{D}(v) = \min\{\infty, 2 + 1\}$ С D ∞ 2 Ε F ∞ 6 $\mathsf{D}(v) = \min\{\infty, 2 + 4\}$ G

Skipping a few steps...



D(.) = S = {u, E, A, C} A 3

В

С

D

Е

F

G









Here is the final state



D(.) :	=	S = {ι
А	3	В
В	5	F
С	3	
D	6	
E	2	
F	8	
G	6	

5 = {u, A, B, C, D, E, F,G} From the shortest-paths, *u* can directly compute its forwarding table



Forwarding table

destination	next-hop
А	А
В	А
С	Е
D	А
Е	Е
F	Е
G	Е

Task 2.2: Changing weights



Consider dynamic weights

Important: different weights for both link directions

Next-hop as tie-break value

Task 2.3: Link Weight Configuration



The Abilene network in the US

Task 2.4: Source-and-Destination-Based Routing

Is it possible to route packets based on the source address?

What are advantages/disadvantages?

Communication Networks Exercise 2



Some comments on last week's assignment

Overview current assignment

Solving a 2020 Dijkstra exam question

Time for you to solve the tasks

Solutions will be published next week

Task 2.5-a) Reverse Dijkstra (Exam question 2020)



#	U	А	В	С	D	Е	F	G	Н	Ι
1	0	2	3	1	-	-	-	10	-	11
2	0	2	2	1	8	-	-	10	-	11
3	0	2	2	1	8	-	-	10	-	11
4	0	2	2	1	8	100	-	10	-	11
5	0	2	2	1	8	9	15	10	-	11
6	0	2	2	1	8	9	15	10	-	11
7	0	2	2	1	8	9	13	10	14	11
8	0	2	2	1	8	9	12	10	14	11
9	0	2	2	1	8	9	12	10	13	11
10	0	2	2	1	8	9	12	10	13	11

Network with 10 nodes and unknown links and link weights

Full Dijkstra output for node U

Identify all the links and their weights visible in the Dijkstra output

There is at most one link between two nodes

All links have a positive weight

In case of nodes with equal shortest paths, the algorithm prefers the node coming first in the alphabet

Start with the first iteration of the Dijkstra output



#	U	А	В	С	D	Е	F	G	Н	Ι
1	0	2	3	1	_	_	-	10	-	11

Start with the first iteration of the Dijkstra output





Then continue with the node with the smallest distance



#	U	А	В	С	D	Е	F	G	Н	Ι
1	0	2	3	1	-	-	-	10	-	11
2	0	2	2	1	8	-	_	10	_	11

Add new links and update weights



#	U	А	В	С	D	Е	F	G	Н	Ι
1	0	2	3	1	-	-	-	10	-	11
 2	0	2	2	1	8	_	_	10	_	11

Add new links and update weights



	#	U	А	В	С	D	Ε	\mathbf{F}	G	Η	Ι
		1									
	2	0	2	2	1	8	-	-	10	-	11
-	3	0	2	2	1	8	_	_	10	-	11

Add new links and update weights



#	U	А	В	С	D	Е	F	G	Н	Ι
---	---	---	---	---	---	---	---	---	---	---

	3	0	2	2	1	8	-	-	10	-	11
-	4	0	2	2	1	8	100	_	10	-	11

Your turn



#	U	А	В	С	D	Е	F	G	Н	Ι
4	0	2	2	1	8	100	_	10	-	11

_

Next we look at node D



	#	U	А	В	С	D	Ε	\mathbf{F}	G	Η	Ι
	4	0	2	2	1	8	100	-	10	-	11
-	5	0	2	2	1	8	9	15	10	-	11

Your turn



#	U	А	В	С	D	Ε	F	G	Н	Ι
						-	1	-		
5	0	2	2	1	8	9	15	10	_	11
 6	0	2	2	1	8	9	15	10	-	11

Node E is next, nothing changes



#	U	А	В	С	D	Е	F	G	Н	Ι
	1						-			·
5	0	2	2	1	8	9	15	10	-	11
 6	0	2	2	1	8	9	15	10	-	11

Your turn



	#	U	А	В	С	D	Е	F	G	Н	Ι
											·
	6	0	2	2	1	8	9	15	10	-	11
-	7	0	2	2	1	8	9	13	10	14	11

Next we look at node G



#	U	А	В	С	D	Е	\mathbf{F}	G	Н	Ι
·	1									·
6	0	2	2	1	8	9	15	10	-	11
 7	0	2	2	1	8	9	13	10	14	11

Final network (a few steps skipped)



#	U	А	В	С	D	Ε	F	G	Н	Ι
9	0	2	2	1	8	9	12	10	13	11
 10	0	2	2	1	8	9	12	10	13	11

Task 2.5-b) Reverse Dijkstra (Exam question 2020)

Given Dijkstra's output, could we have missed a link starting at U? If yes, which one and with which weight? If no, why not?



#	U	А	В	С	D	Е	F	G	Н	Ι
1	0	2	3	1	-	-	-	10	-	11
2	0	2	2	1	8	-	-	10	-	11
3	0	2	2	1	8	-	-	10	-	11
4	0	2	2	1	8	100	-	10	-	11
5	0	2	2	1	8	9	15	10	-	11
6	0	2	2	1	8	9	15	10	-	11
7	0	2	2	1	8	9	13	10	14	11
8	0	2	2	1	8	9	12	10	14	11
9	0	2	2	1	8	9	12	10	13	11
10	0	2	2	1	8	9	12	10	13	11

Task 2.5-b) Reverse Dijkstra (Exam question 2020)

Given Dijkstra's output, could we have missed a link starting at U? If yes, which one and with which weight? If no, why not?

Not possible! During it initialization phase, Dijkstra considers all directly connected nodes. We will therefore see all links (with their cost) starting from node U.

Task 2.5-c) Reverse Dijkstra (Exam question 2020)

Given Dijkstra's output, could we have missed a link starting at C? If yes, which one and with which weight? If no, why not?



#	U	А	В	С	D	Е	F	G	Н	Ι
1	0	2	3	1	-	-	-	10	-	11
2	0	2	2	1	8	-	-	10	-	11
3	0	2	2	1	8	-	-	10	-	11
4	0	2	2	1	8	100	-	10	-	11
5	0	2	2	1	8	9	15	10	-	11
6	0	2	2	1	8	9	15	10	-	11
7	0	2	2	1	8	9	13	10	14	11
8	0	2	2	1	8	9	12	10	14	11
9	0	2	2	1	8	9	12	10	13	11
10	0	2	2	1	8	9	12	10	13	11

Task 2.5-c) Reverse Dijkstra (Exam question 2020)

Given Dijkstra's output, could we have missed a link starting at C? If yes, which one and with which weight? If no, why not? Possible! For example a link between C and G with weight > 8.



Communication Networks Exercise 2



Some comments on last week's assignment

Overview current assignment

Solving a 2020 Dijkstra exam question

Time for you to solve the tasks

Solutions will be published next week