Communication Networks

Spring 2025

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comm-net.ethz.ch

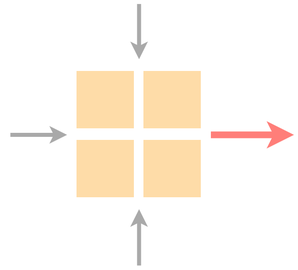
ETH Zürich

06 Mar 2025

Slides partly adapted from Lukas Röllin

Communication Networks

Spring 2025



Last week’s exercise

Important lecture topics

Time to solve the exercise

Communication Networks

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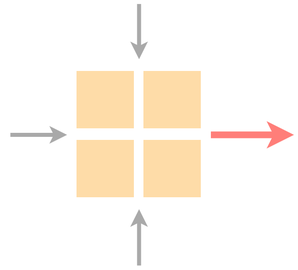

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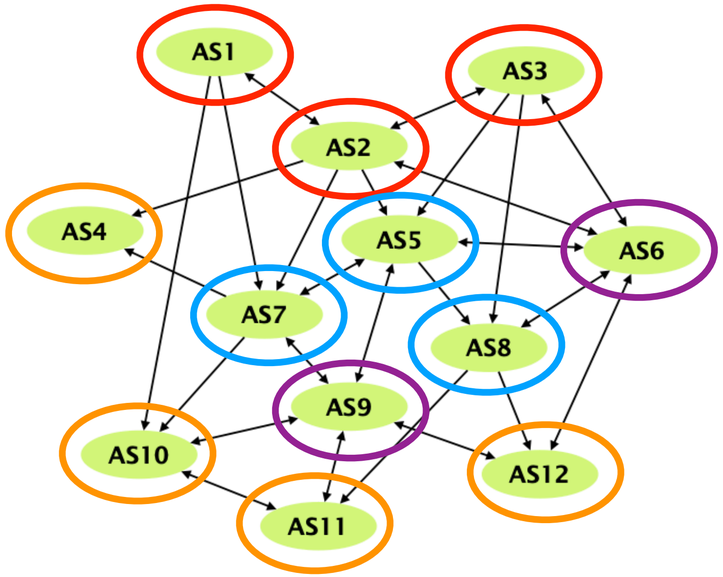
Task 1.2: AS classification

Definitions

Tier 1	Provider of at least one AS and never a customer
Tier 2	Provider of at least one AS and customer of at least one AS
Tier 3	Never a provider and customer of at least one AS
IXP	Only peering connections

Task 1.2: AS classification

Hint

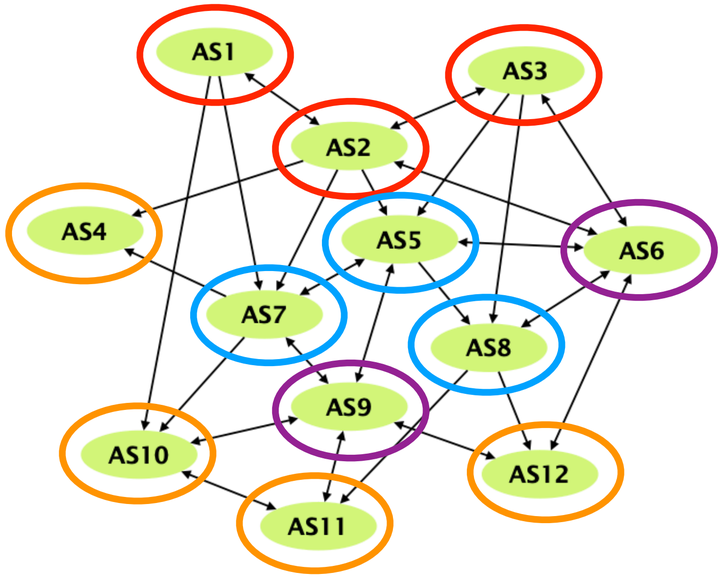


Start with identifying Tier 1/2/3s ignoring peering connections

Identify IXPs as ASes with only peering connections

Task 1.2: AS classification

Can a Tier 1 be a direct provider of a Tier 3?



In theory — yes

AS2 (Tier 1) provider of AS4 (Tier 3)

In practice — rare

due to cost/business reasons

Traceroute from within the ETH network gives surprising output

Possible reasons?

```
georgiafragkouli@philipps-screen-gfragkouli ~ % traceroute sydney.edu.au
traceroute to sydney.edu.au (20.248.131.216), 64 hops max, 40 byte packets
 1  rou-etx-1-staff-net-etx-dock-1-a.ethz.ch (10.6.48.1)  7.011 ms  6.793 ms  6.108 ms
 2  rou-bgw-hci-staff-net (10.1.2.54)  10.909 ms  5.725 ms  11.691 ms
 3  20.248.131.216 (20.248.131.216)  12.545 ms  10.328 ms  6.290 ms
 4  20.248.131.216 (20.248.131.216)  15.174 ms  3.330 ms  13.042 ms
 5  20.248.131.216 (20.248.131.216)  5.499 ms  3.506 ms  4.478 ms
 6  20.248.131.216 (20.248.131.216)  32.029 ms  14.086 ms  10.376 ms
 7  20.248.131.216 (20.248.131.216)  29.156 ms  5.424 ms  10.090 ms
 8  20.248.131.216 (20.248.131.216)  4.977 ms  14.864 ms  32.947 ms
 9  20.248.131.216 (20.248.131.216)  22.862 ms  84.157 ms  5.846 ms
10  20.248.131.216 (20.248.131.216)  343.513 ms  305.945 ms  312.293 ms
11  20.248.131.216 (20.248.131.216)  305.814 ms  302.234 ms  305.432 ms
```

Looping on same hop

End network modifies replies

ETH network modifies replies

Traceroute from within the ETH network gives surprising output

Most likely reason: ETH network modifies replies

Why is it most likely reason?	It happens only in the ETH network and for different, independent destinations
What is happening?	External routers reply with their src IP ETH rewrites src IP to IP of traceroute dst
Why is it happening?	traceroute does not tell us ETH net admins: it saves resources on firewall https://networkdirection.net/articles/firewalls/icmpinspection/

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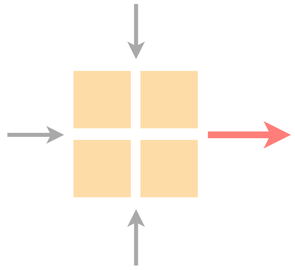


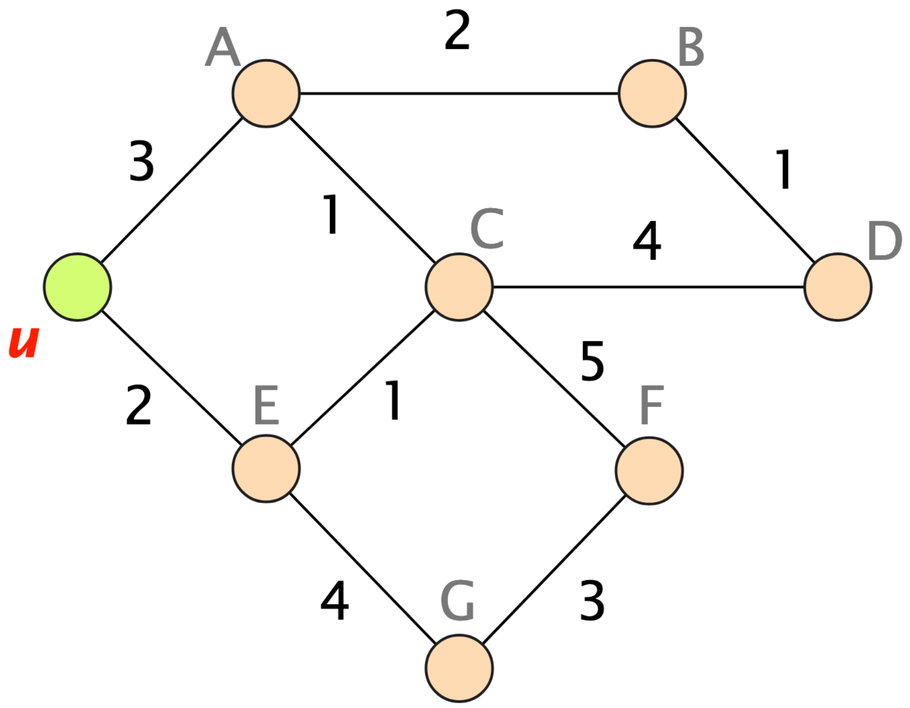
Last week's exercise

Important lecture topics

Time to solve the exercise

Dijkstra's algorithm computes

shortest cost from a node to every other node



Inputs

source u

cost c(n1,n2) for all n1,n2

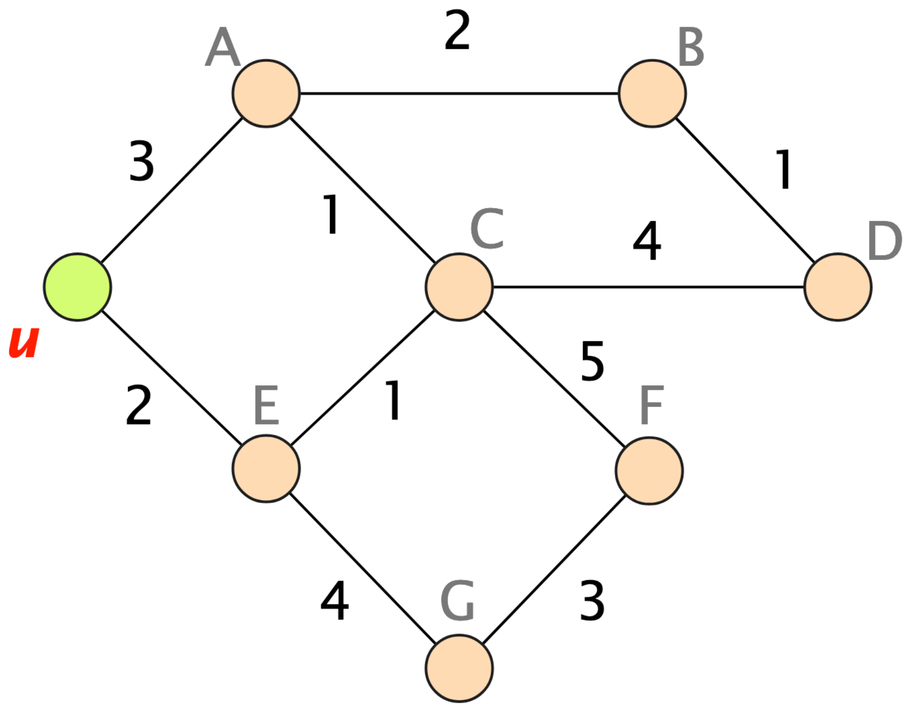
Data structures

S: nodes with known shortest cost

D(n): shortest cost to n

Dijkstra's algorithm computes

shortest cost from a node to every other node

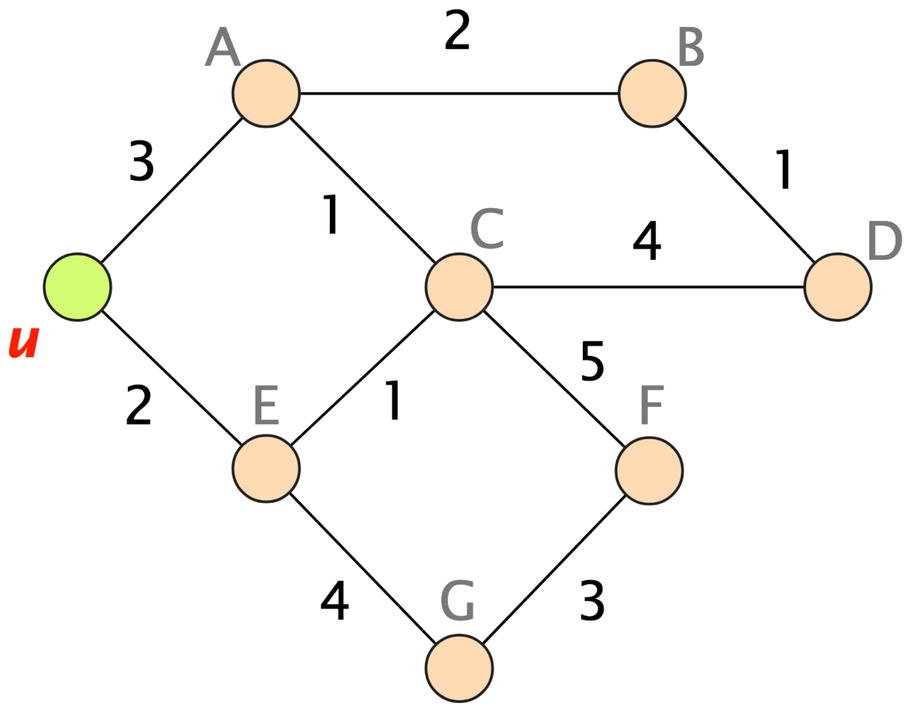


D(.) = S = {u}

A	3
B	∞
C	∞
D	∞
E	2
F	∞
G	∞

Dijkstra's algorithm computes

shortest cost from a node to every other node

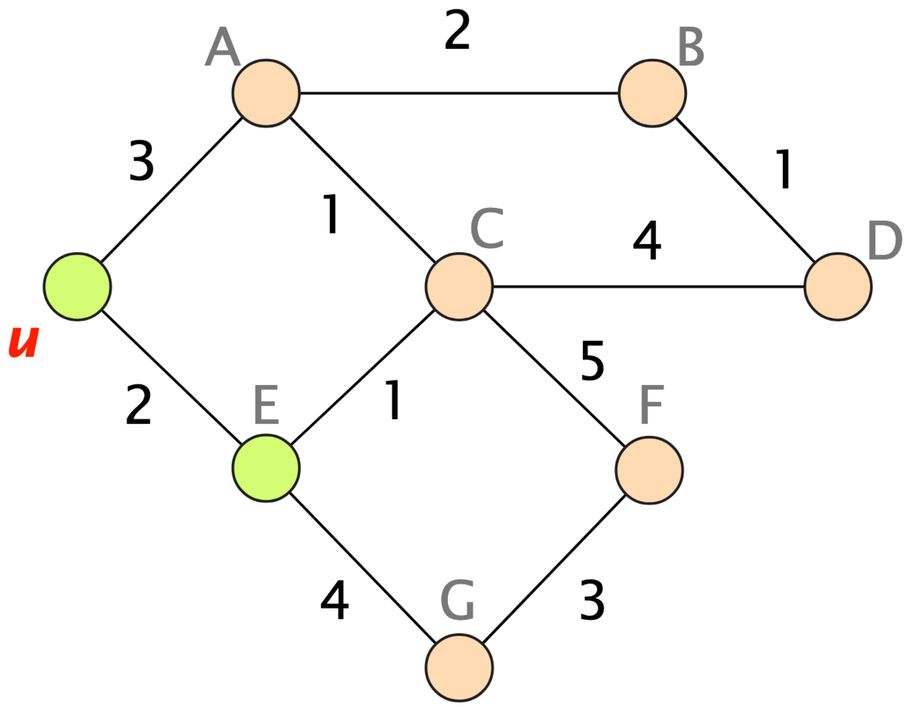


D(.) = S = {u}

A	3
B	∞
C	∞
D	∞
E	2 — smallest D(*w*)
F	∞
G	∞

Dijkstra's algorithm computes

shortest cost from a node to every other node



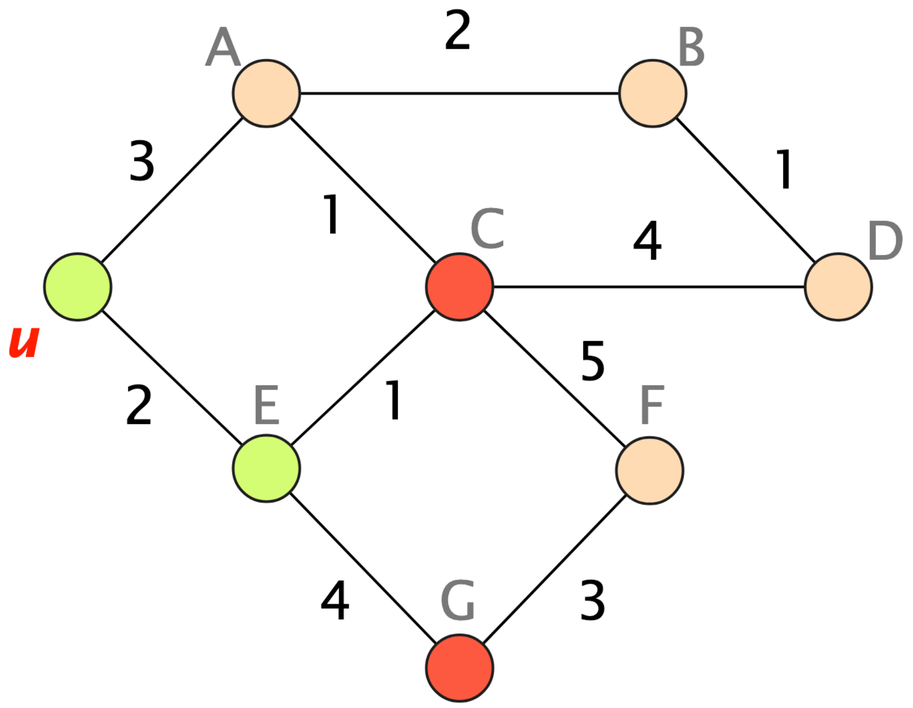
add E to S

S = {u, E}

D(.) =	
A	3
B	∞
C	∞
D	∞
E	2
F	∞
G	∞

Dijkstra's algorithm computes

shortest cost from a node to every other node

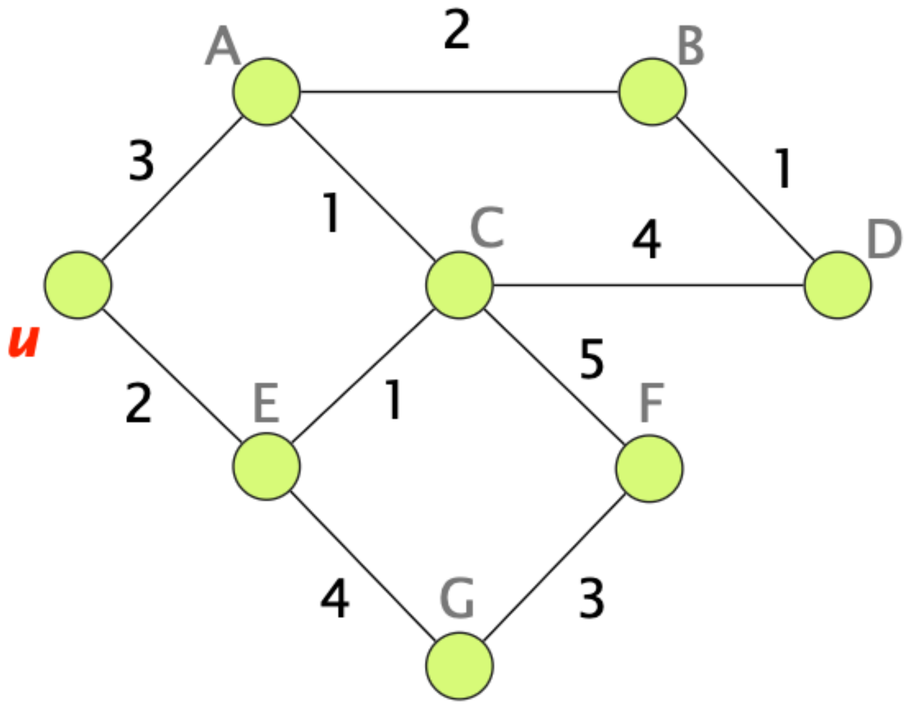


D(.) = S = {u, E}

A	3	
B	∞	
C	3	D(*v*) = min{∞, 2 + 1}
D	∞	
E	2	
F	∞	
G	6	D(*v*) = min{∞, 2 + 4}

Dijkstra's algorithm computes

shortest cost from a node to every other node



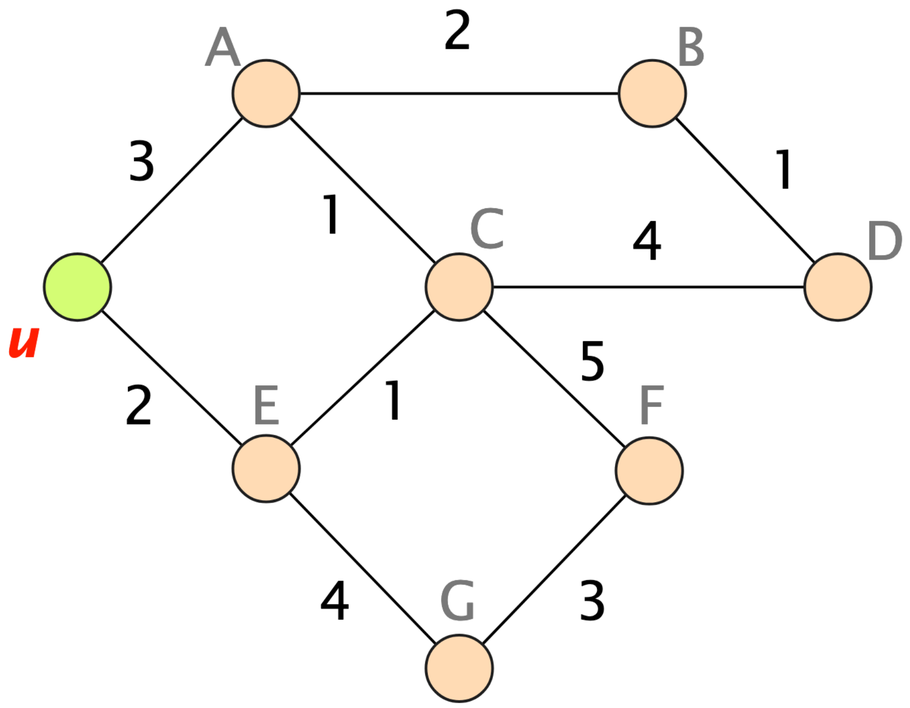
D(.) =

A	3
B	5
C	3
D	6
E	2
F	8
G	6

S = {u, A, B, C, D, E, F,G}

Find u's forwarding table?

For each destination, what is the next hop to use?

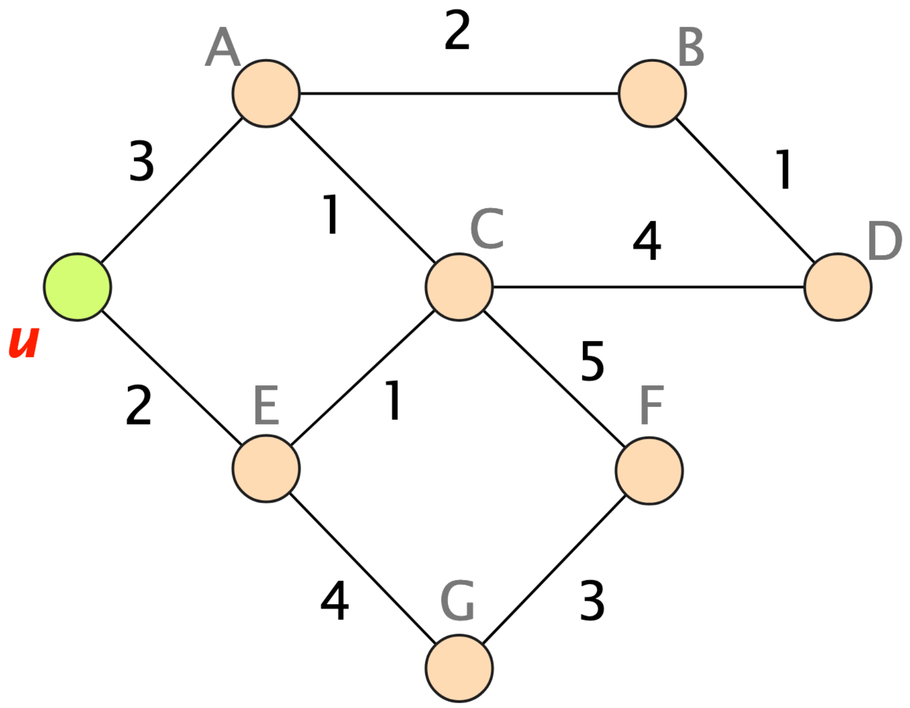


Can be computed from shortest path: first hop on shortest path

Eg if u->A->B->D shortest path to D, u uses A as next hop to D

Find shortest paths?

Maintain one more data structure



Inputs

source u

cost c(n1,n2) for all n1,n2

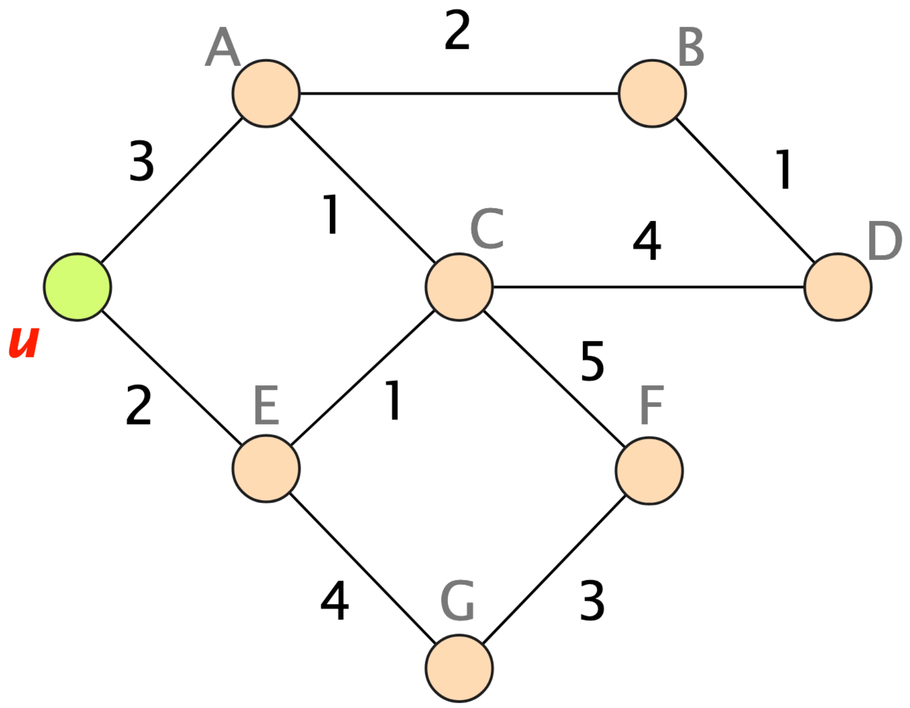
Data structures

S: nodes with known shortest cost

D(n): shortest cost to n

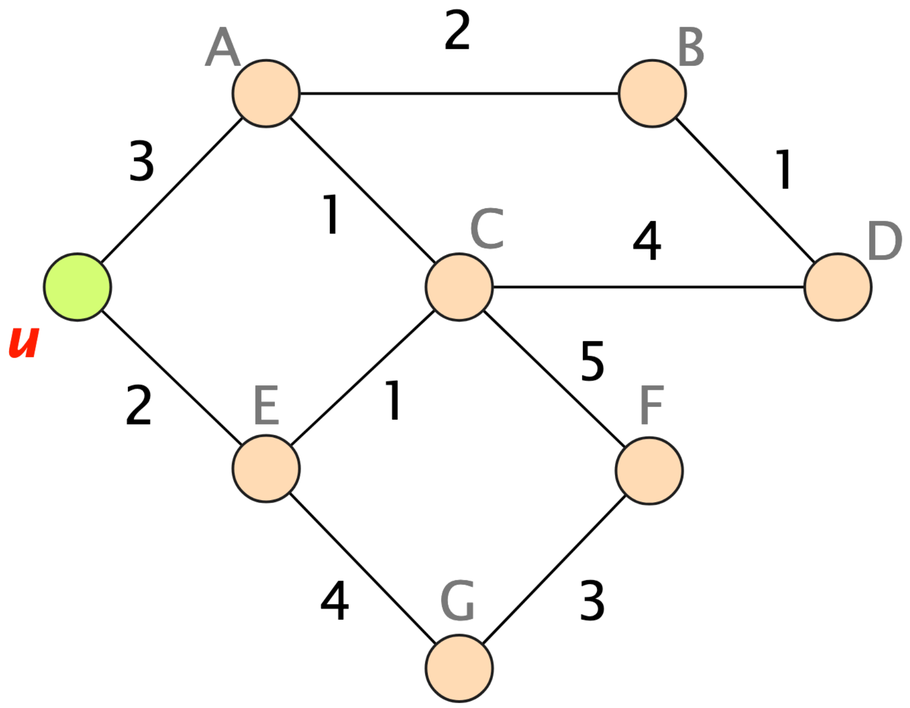
p(n): prev node on shortest path to n

Dijkstra's algorithm also computes u's forwarding table



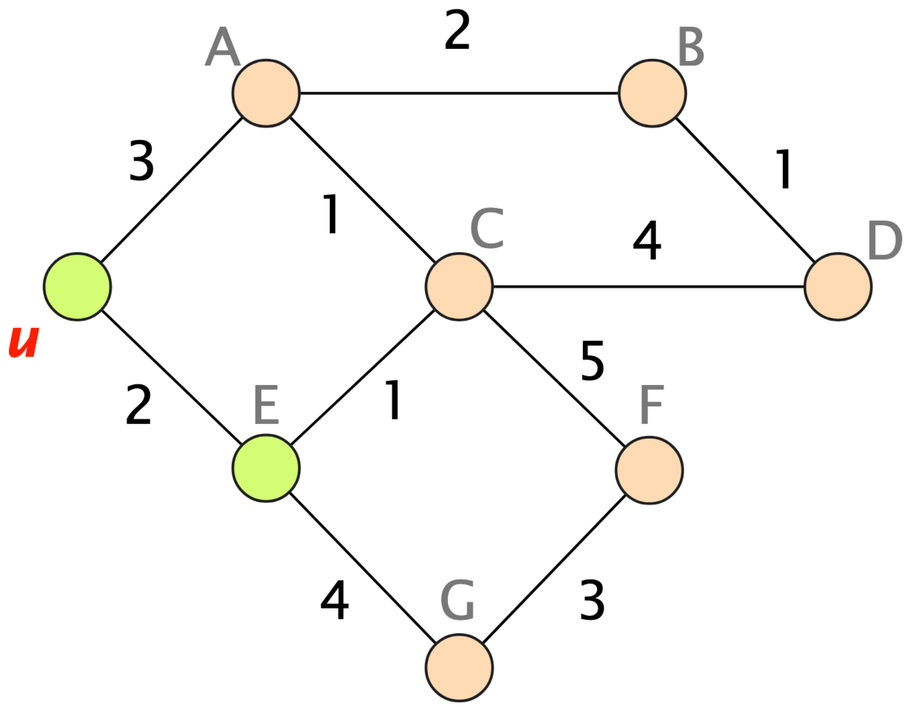
p(.) =		D(.) =		S = {u}
A	u	A	3	
B	null	B	∞	
C	null	C	∞	
D	null	D	∞	
E	u	E	2	
F	null	F	∞	
G	null	G	∞	

Dijkstra's algorithm also computes u's forwarding table



p(.) =		D(.) =		S = {u}
A	u	A	3	
B	null	B	∞	
C	null	C	∞	
D	null	D	∞	
E	u	E	2	smallest D(*w*)
F	null	F	∞	
G	null	G	∞	

Dijkstra's algorithm also computes u's forwarding table

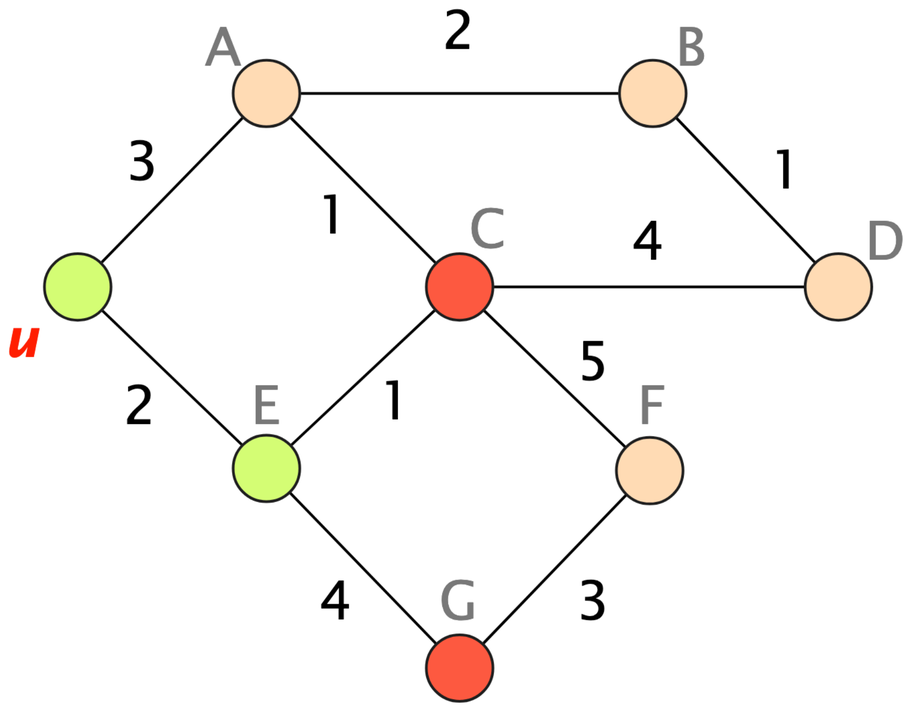


add E to S

S = {u, E}

p(.) =		D(.) =	
A	u	A	3
B	null	B	∞
C	null	C	∞
D	null	D	∞
E	u	E	2
F	null	F	∞
G	null	G	∞

Dijkstra's algorithm also computes u's forwarding table



p(.) =		D(.) =		S = {u, E}
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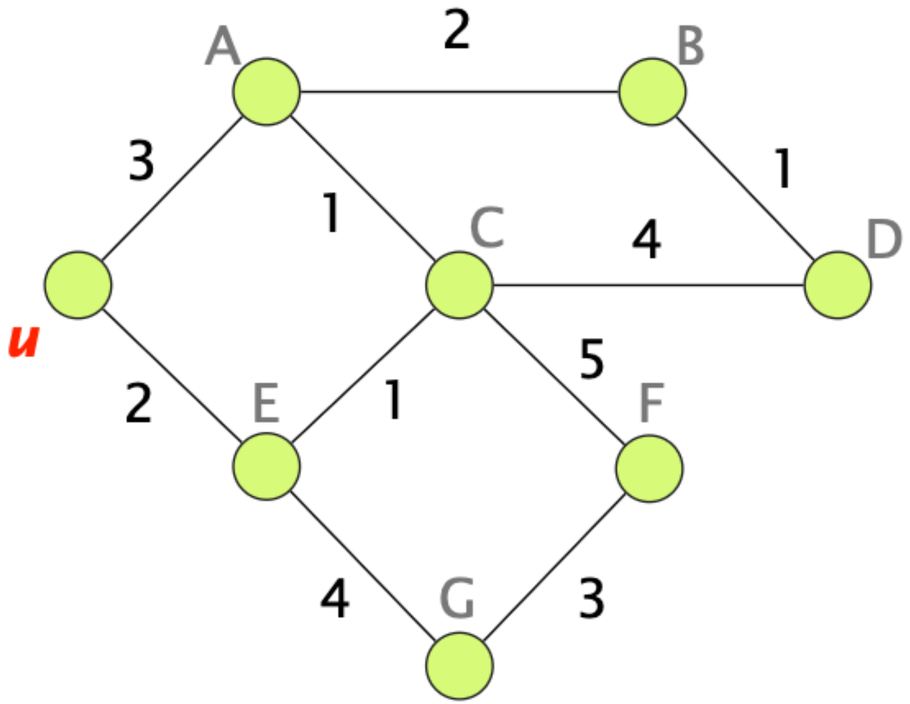
B	null	B	∞	
C	E	C	3	D(*v*) = min{∞, 2 + 1}
D	null	D	∞	
E	u	E	2	
F	null	F	∞	
G	E	G	6	D(*v*) = min{∞, 2 + 4}

Dijkstra's algorithm also computes u's forwarding table

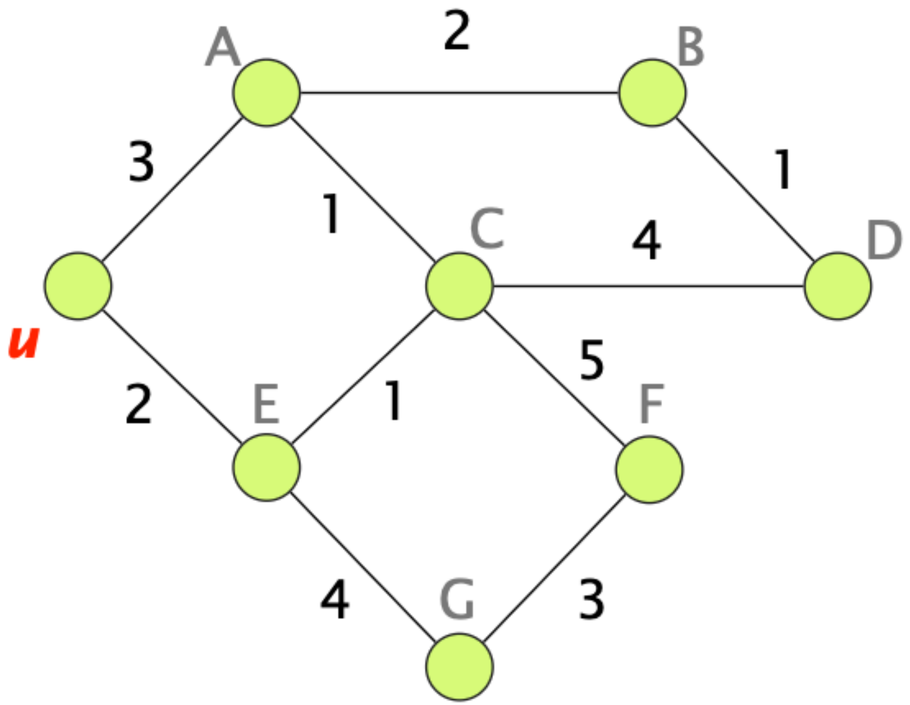


p(.) =		D(.) =	
A	u	A	3
B	A	B	5
C	E	C	3
D	B	D	6
E	u	E	2
F	C	F	8
G	E	G	6

S = {u, A, B, C, D, E, F,G}

Dijkstra's algorithm also computes u's forwarding table

Eg u's next hop to D?



p(.) =

A	u
B	A
C	E
D	B
E	u
F	C
G	E

p(D) = B

p(B) = A

p(A) = u

path: u->A->B->D
next hop: A

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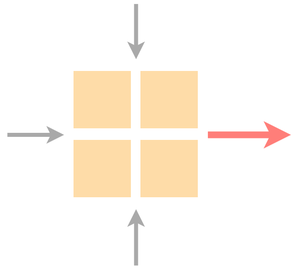

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