Section 6:
Breadth-first Search

SLIDES ADAPTED FROM ALEX MARIAKAKIS,

WITH MATERIAL FROM KRYSTA YOUSOUFIAN, MIKE ERNST, KELLEN DONOHUE

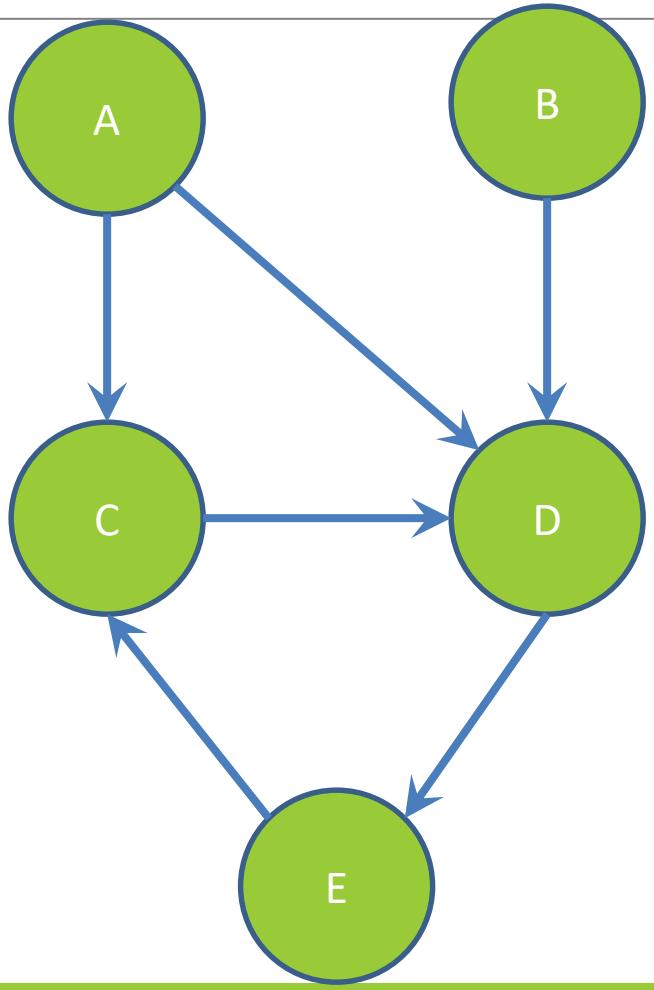
How is Homework 5 going?

Any questions?

Agenda

* Breadth-first search (BFS)

Graphs



Can I reach B from A?

Breadth-First Search (BFS)

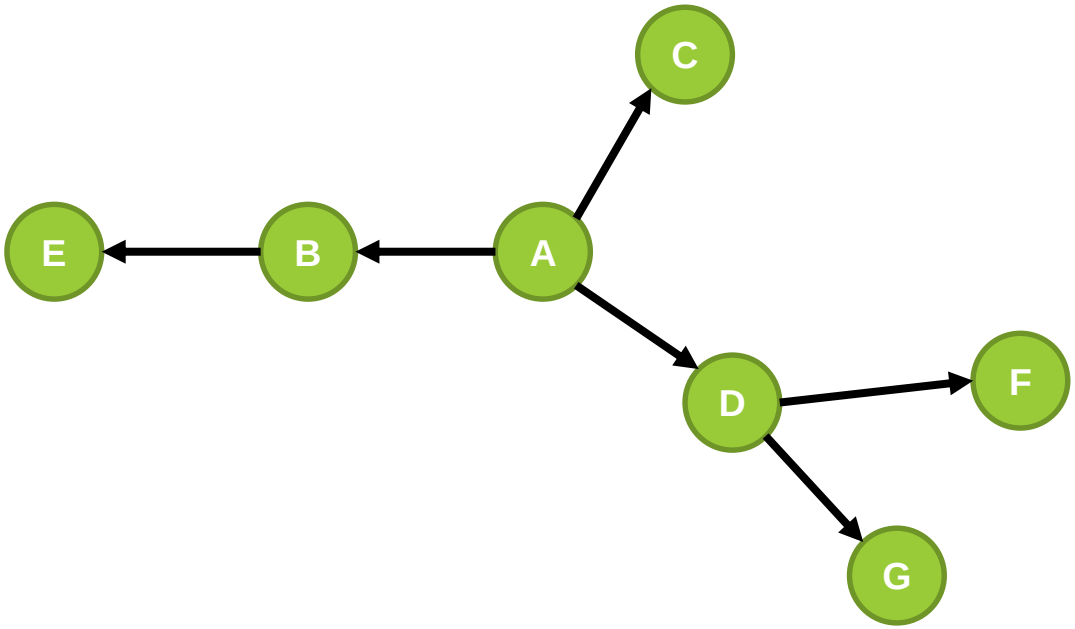
- Often used for discovering connectivity
- Calculates the **shortest path**

  if and only if all edges have same **positive** or **no weight**

- Depth-first search (DFS) is commonly mentioned with BFS

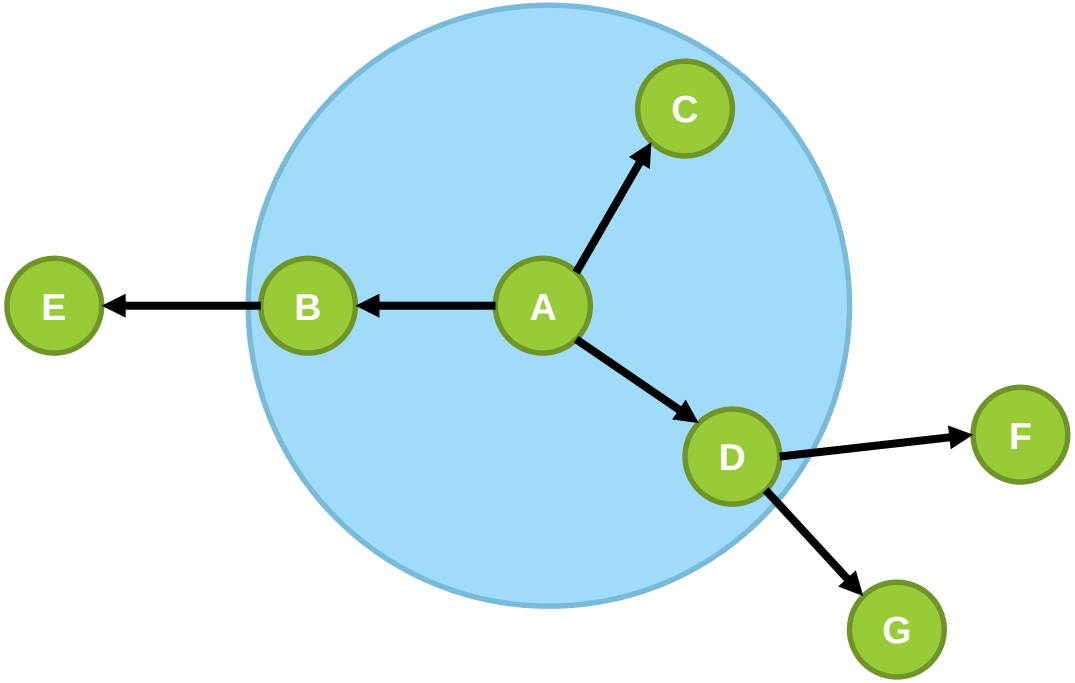
Breadth-First Search (BFS)

Starting at **A**, which nodes will be visited first in a BFS?



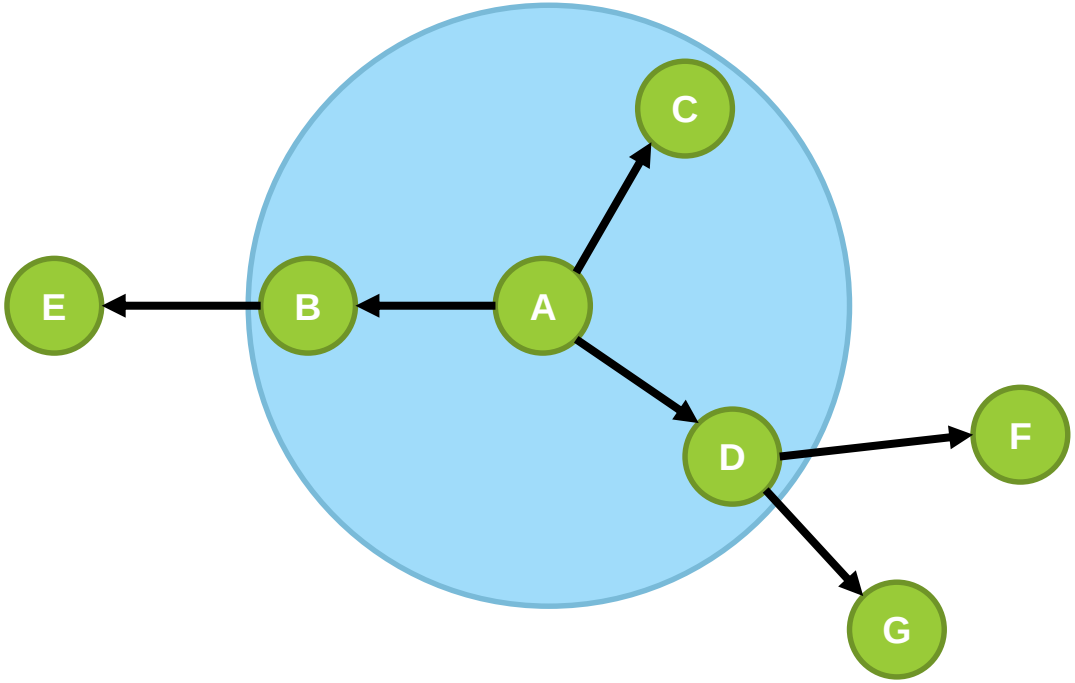
Breadth-First Search (BFS)

Starting at **A**, which nodes will be visited first in a BFS? **B, C, D**



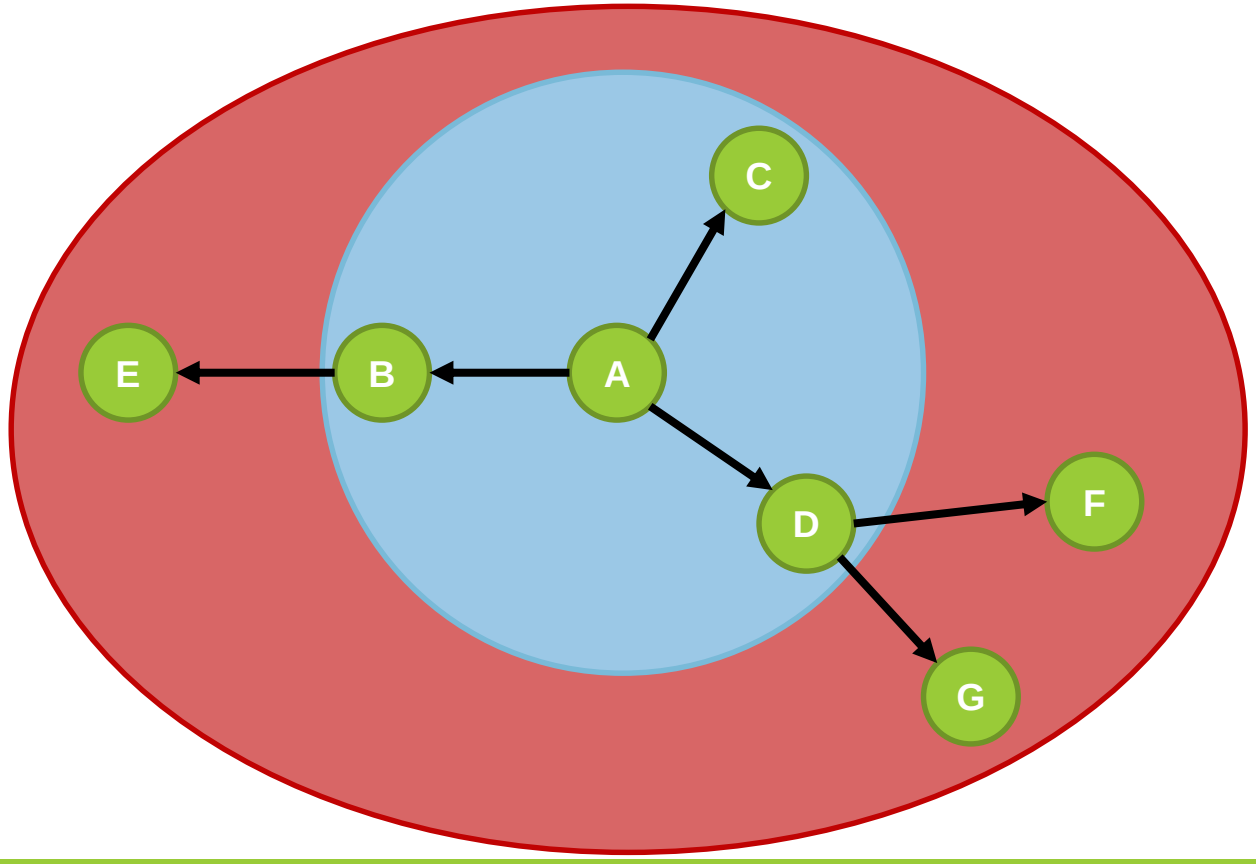
Breadth-First Search (BFS)

Starting at **A**, which nodes will be visited second in a BFS?



Breadth-First Search (BFS)

Starting at **A**, which nodes will be visited second in a BFS? **E, F, G**



BFS Pseudocode

```
boolean bfs(Node start, Node goal):
    put start in a queue
        while (queue is not empty):
                pop node N off queue

                if (N is goal):
                        return true
                else:
                        for each node C that is child of
N:


                                push C onto queue
        return false
```

Breadth-First Search

START:

Q: <A>

Pop: A, Q: <>

Q: <B, C>

Pop: B, Q: <C>

Q: <C>

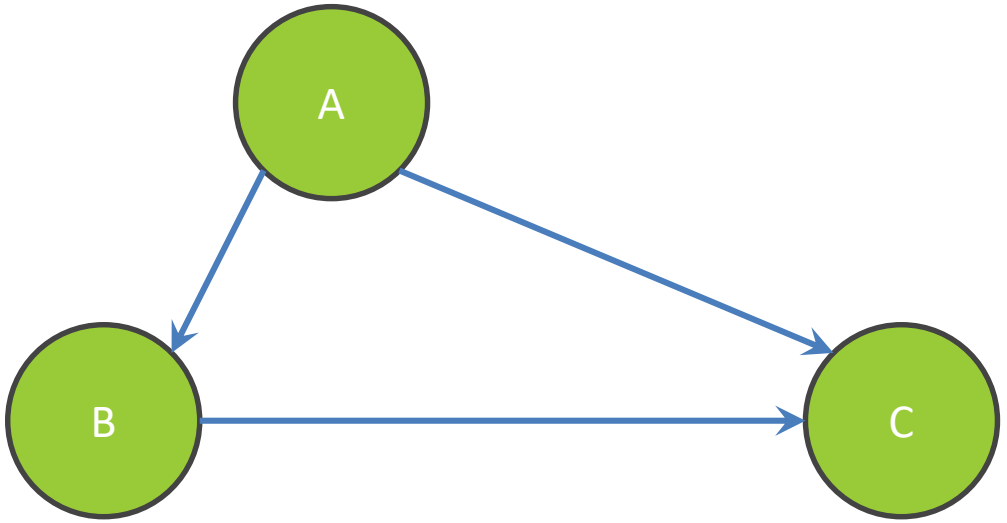
Pop: C, Q: <C>

Q: <>

DONE

Starting at A

Goal: C



Breadth-First Search with Cycle

START:

Q: <A>

Pop: A, Q: <>

Q: <B>

Pop: B, Q: <>

Q: <C>

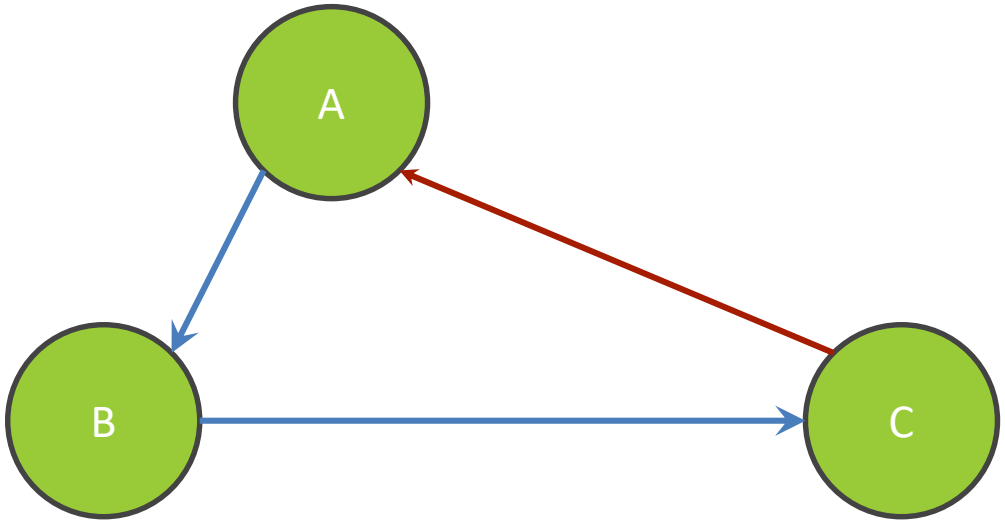
Pop: C, Q: <>

Q: <A>

NEVER DONE

Starting at A

Goal: **D**



BFS Pseudocode

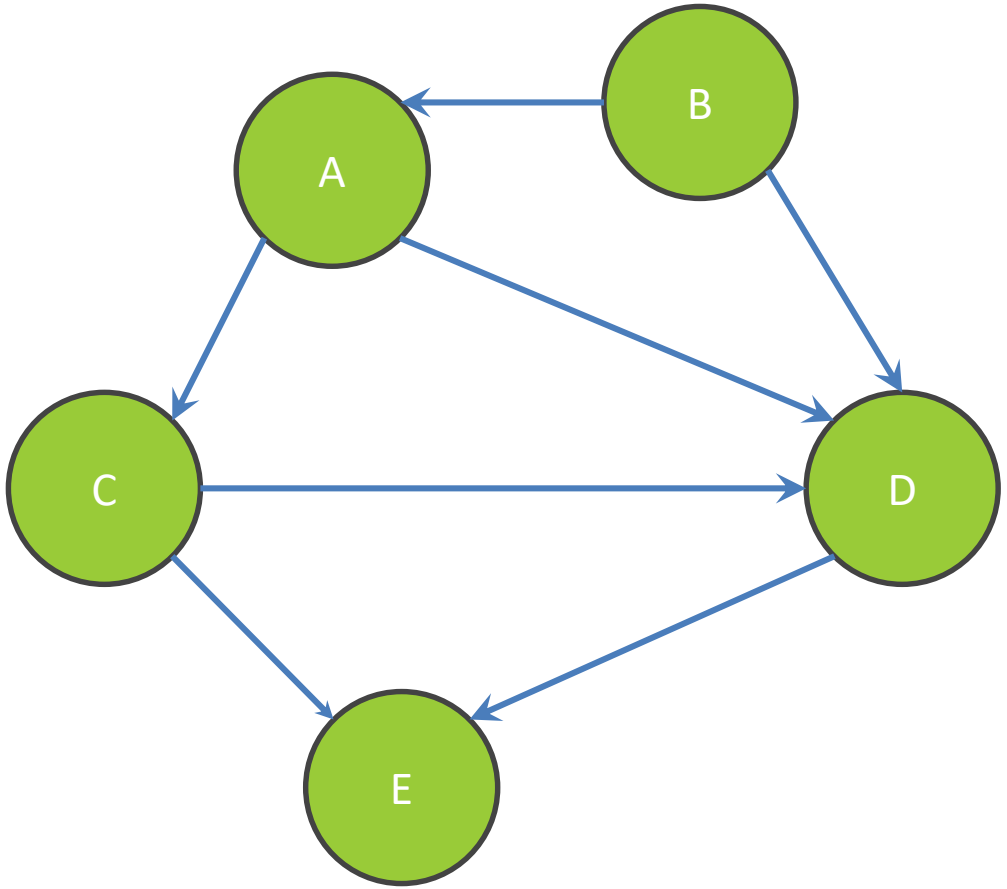
```
boolean bfs(Node start, Node goal):
    put start in a queue
    while (queue is not empty):
        pop node N off queue
        mark node N as visited
        if (N is goal):
            return true
        else:
            for each node C that is child of N:
                if C is not marked visited:
                    push C onto queue
    return false
```

Mark the node as visited!

Breadth-First Search

Problem: Find everything reachable from A

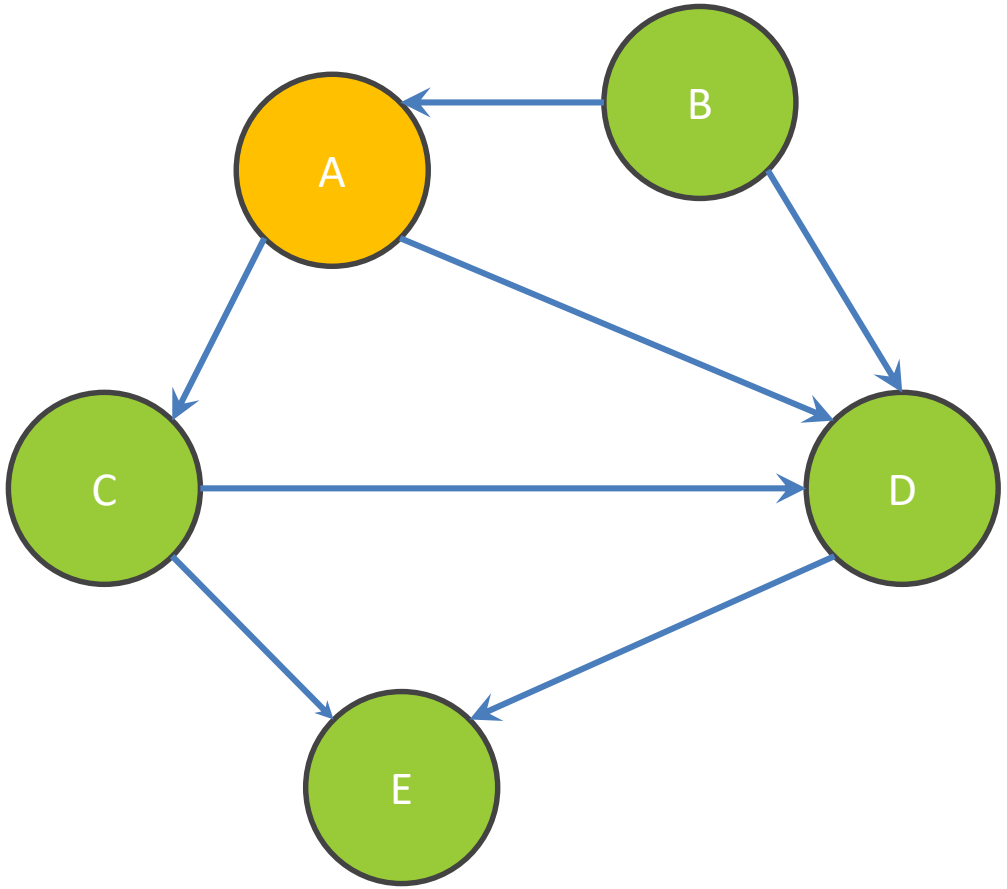
Q: <>



Breadth-First Search

Q: <>

Q: <A>

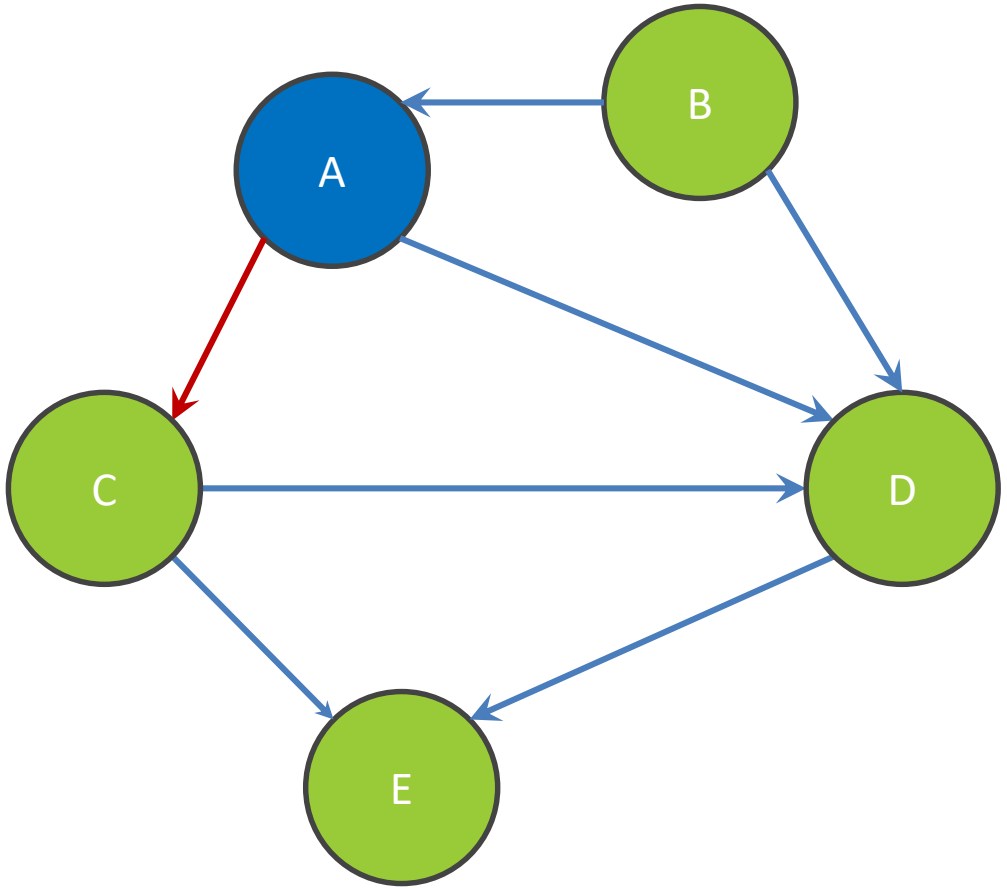


Breadth-First Search

Q: <>

Q: <A>

Q: <>



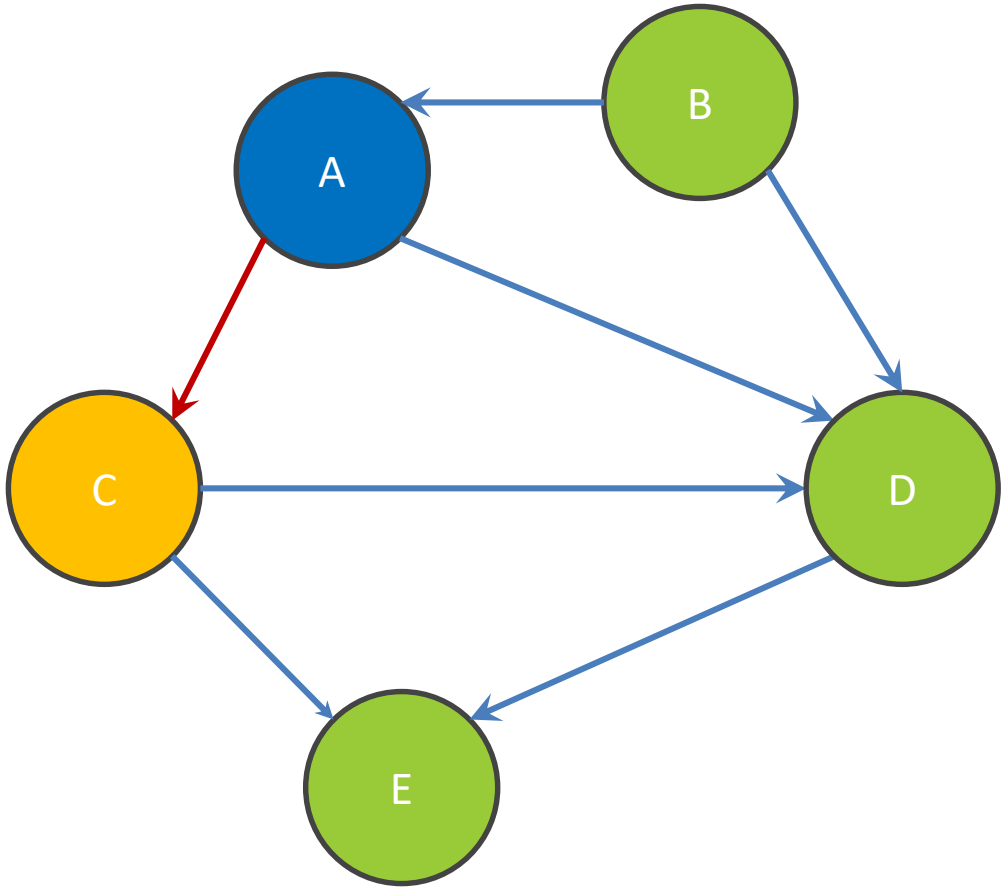
Breadth-First Search

Q: <>

Q: <A>

Q: <>

Q: <C>



Breadth-First Search

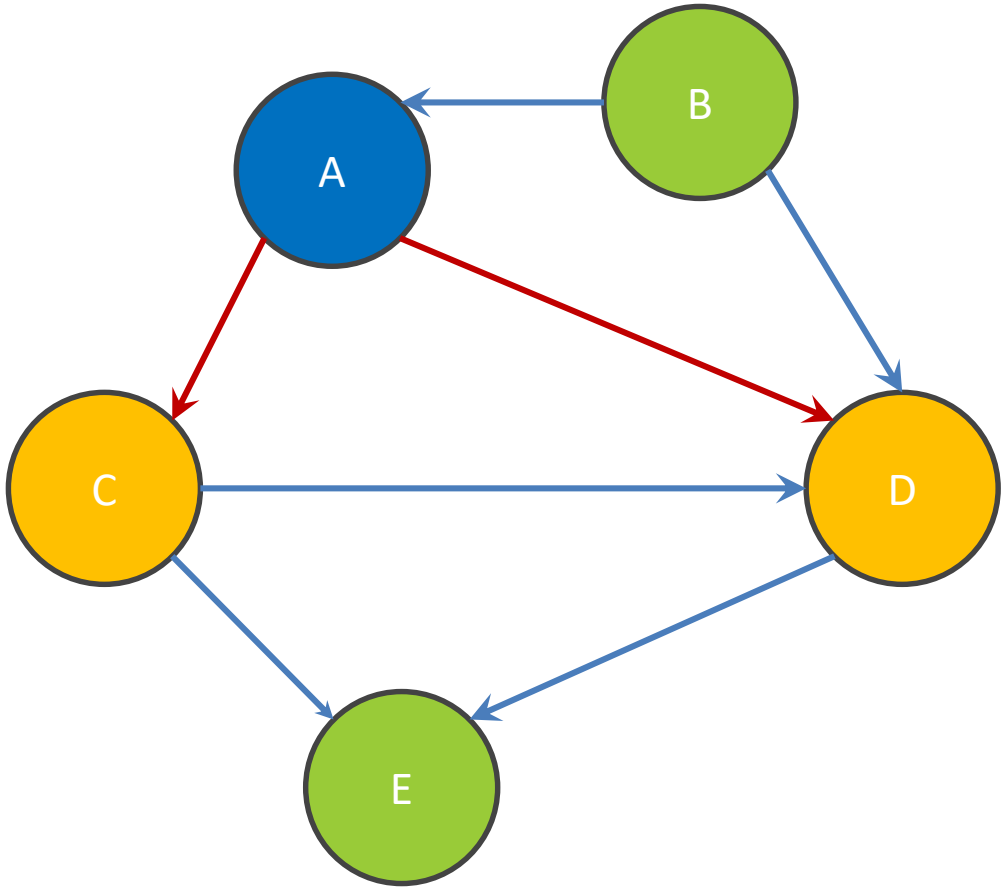
Q: <>

Q: <A>

Q: <>

Q: <C>

Q: <C ,D>



Breadth-First Search

Q: <>

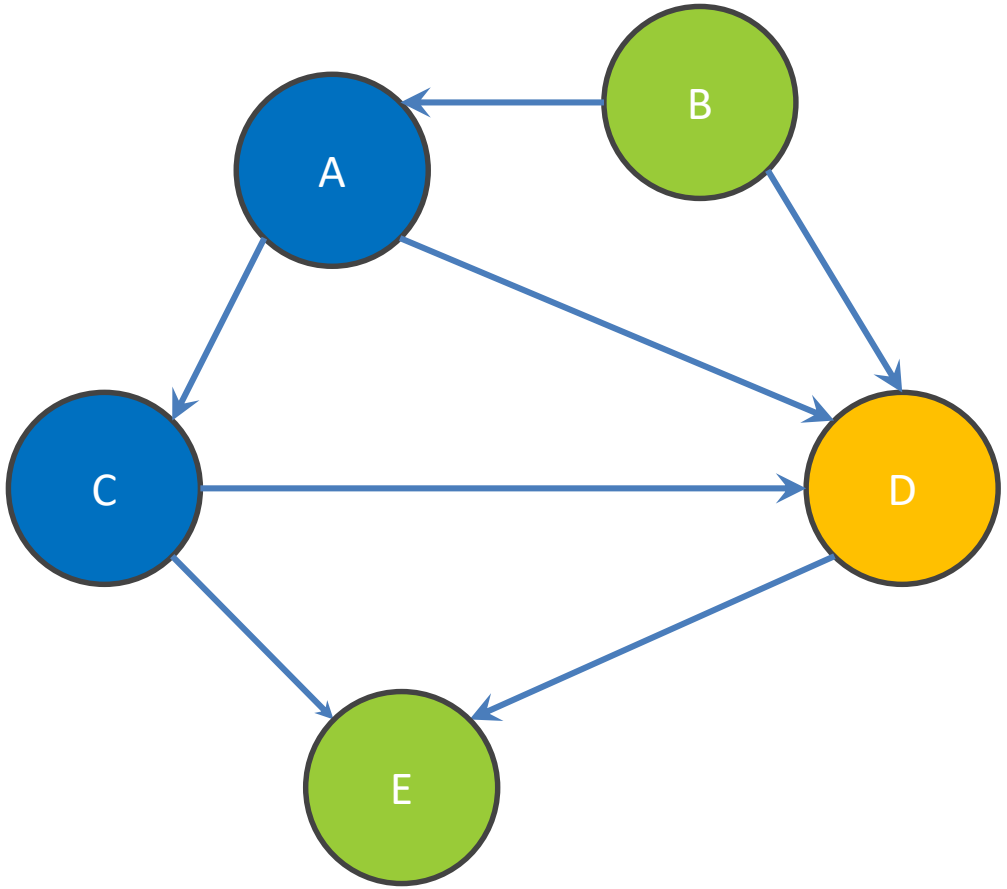
Q: <A>

Q: <>

Q: <C>

Q: <C ,D>

Q: <D>



Breadth-First Search

Q: <>

Q: <A>

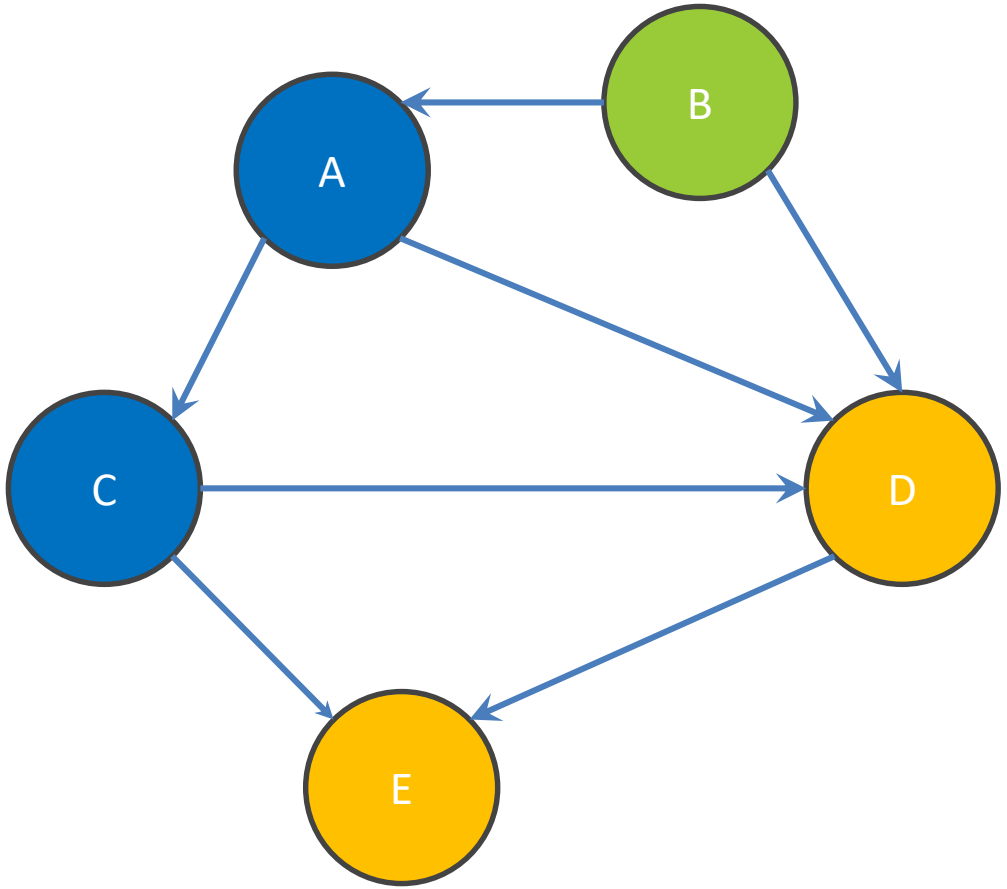
Q: <>

Q: <C>

Q: <C ,D>

Q: <D>

Q: <D, E>



Breadth-First Search

Q: <>

Q: <A>

Q: <>

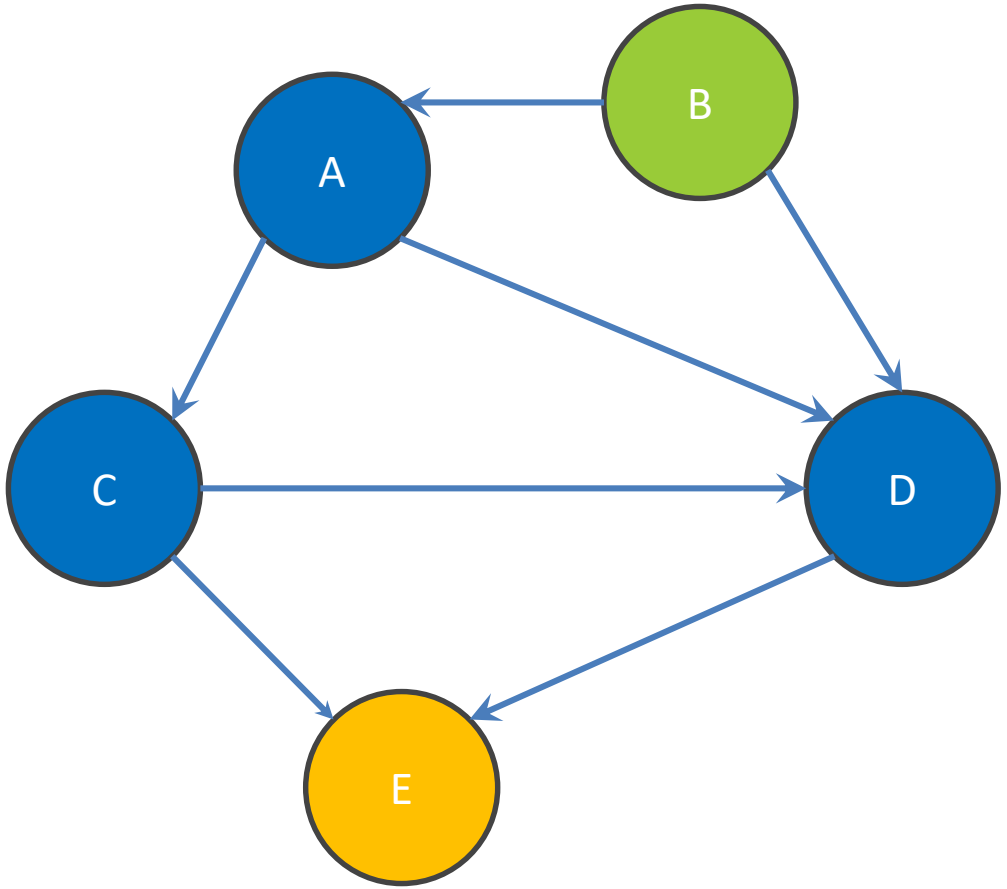
Q: <C>

Q: <C ,D>

Q: <D>

Q: <D, E>

Q: <E>



Breadth-First Search

Q: <>

Q: <A>

Q: <>

Q: <C>

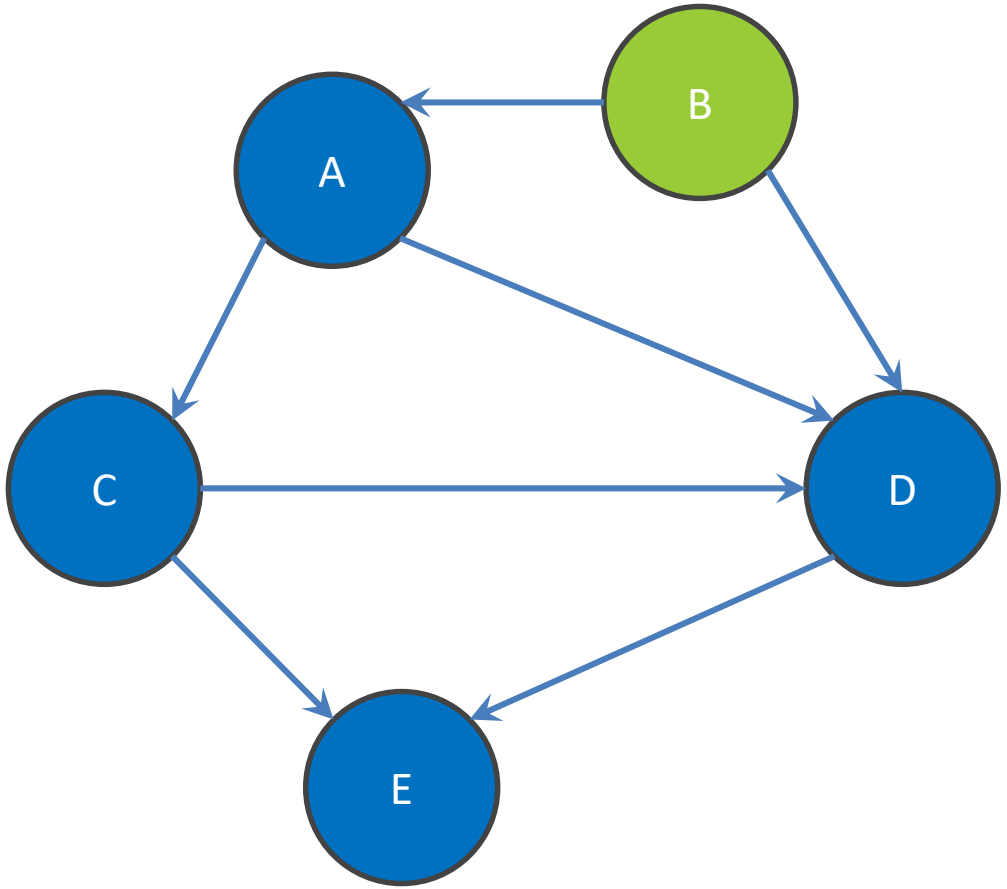
Q: <C ,D>

Q: <D>

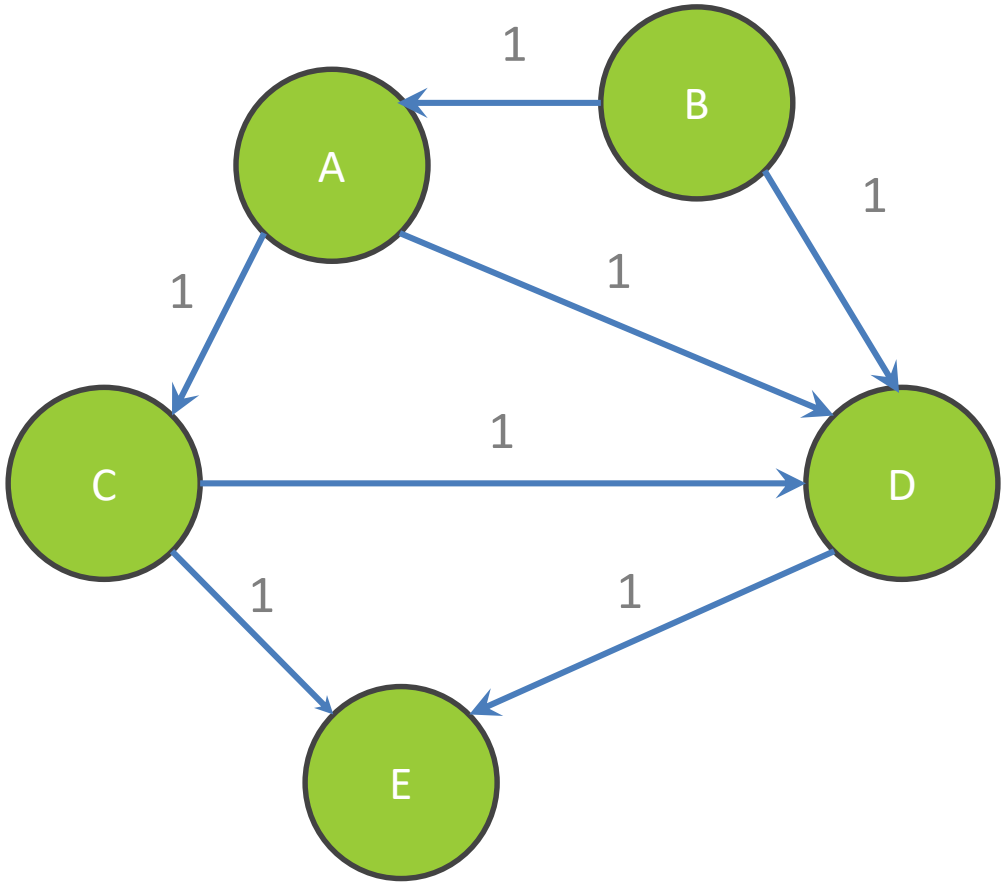
Q: <D, E>

Q: <E>

DONE



Shortest Paths with BFS

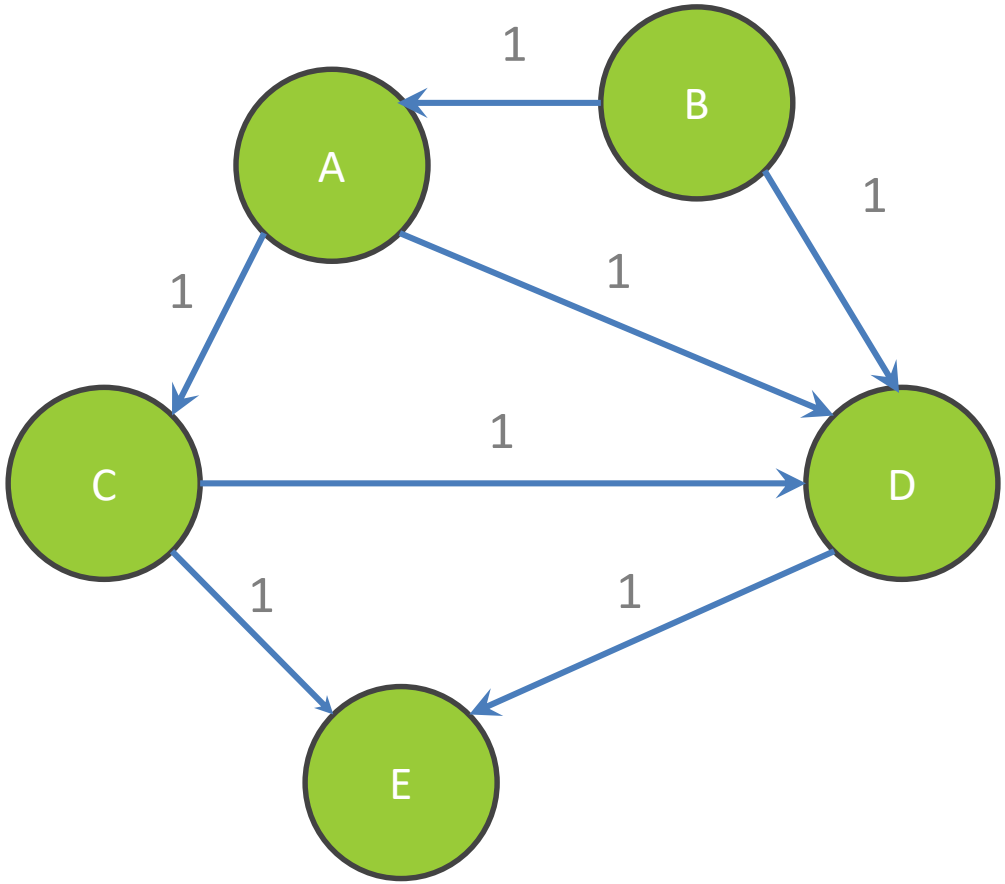


From Node B

Destination	Path	Cost
A		
B	<B>	0
C		
D		
E		

Shortest path to D? to E?
What are the costs?

Shortest Paths with BFS

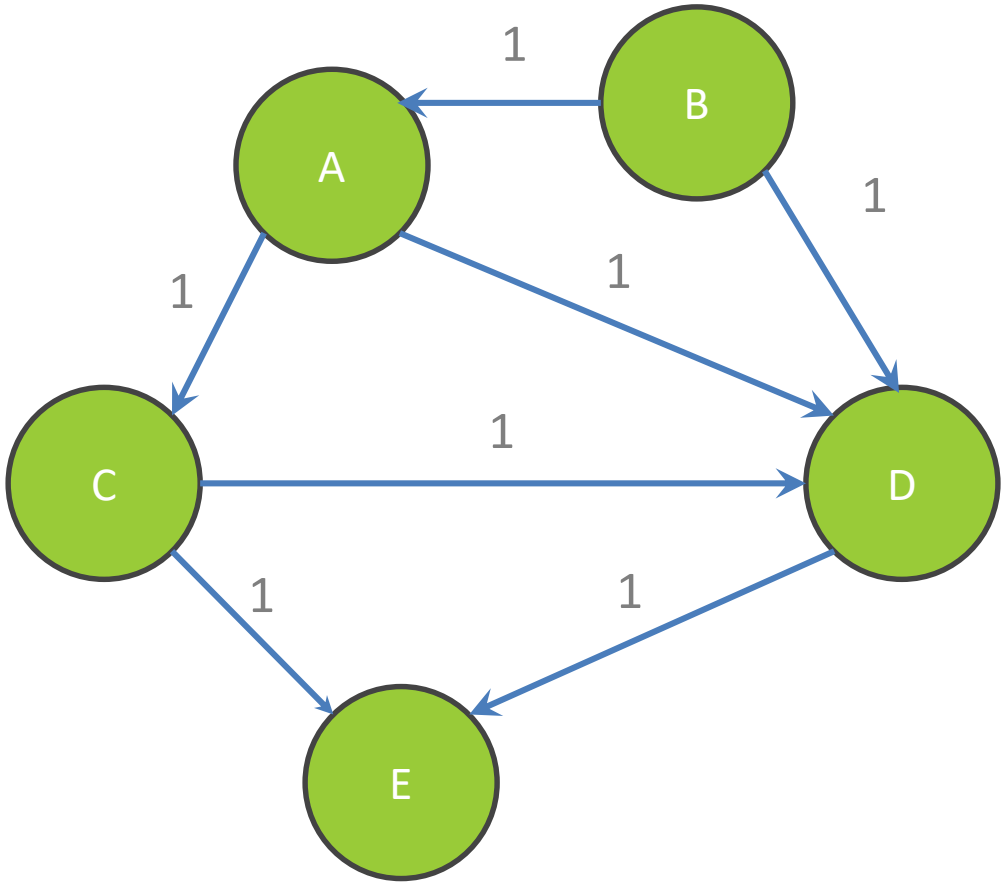


From Node B

Destination	Path	Cost
A	<B,A>	1
B	<B>	0
C		
D	<B,D>	1
E		

Shortest path to D? to E?
What are the costs?

Shortest Paths with BFS

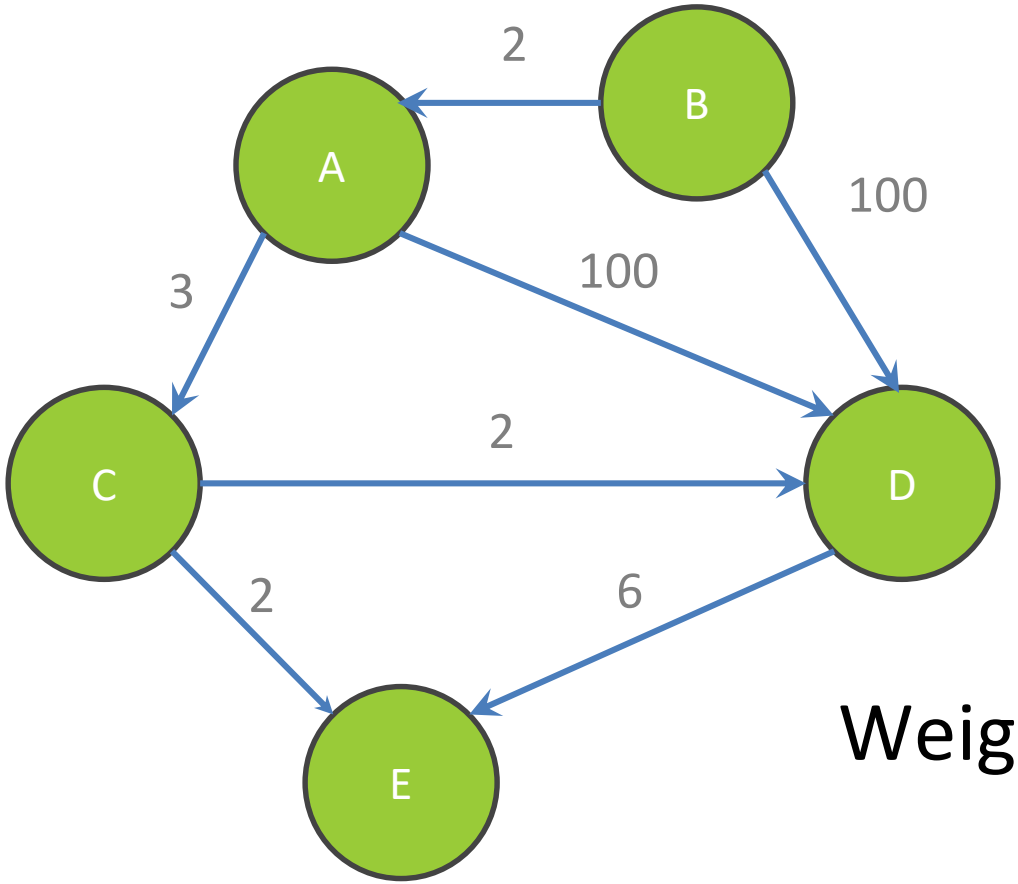


From Node B

Destination	Path	Cost
A	<B,A>	1
B	<B>	0
C	<B,A,C>	2
D	<B,D>	1
E	<B,D,E>	2

Shortest path to D? to E?
What are the costs?

Shortest Paths with Weights

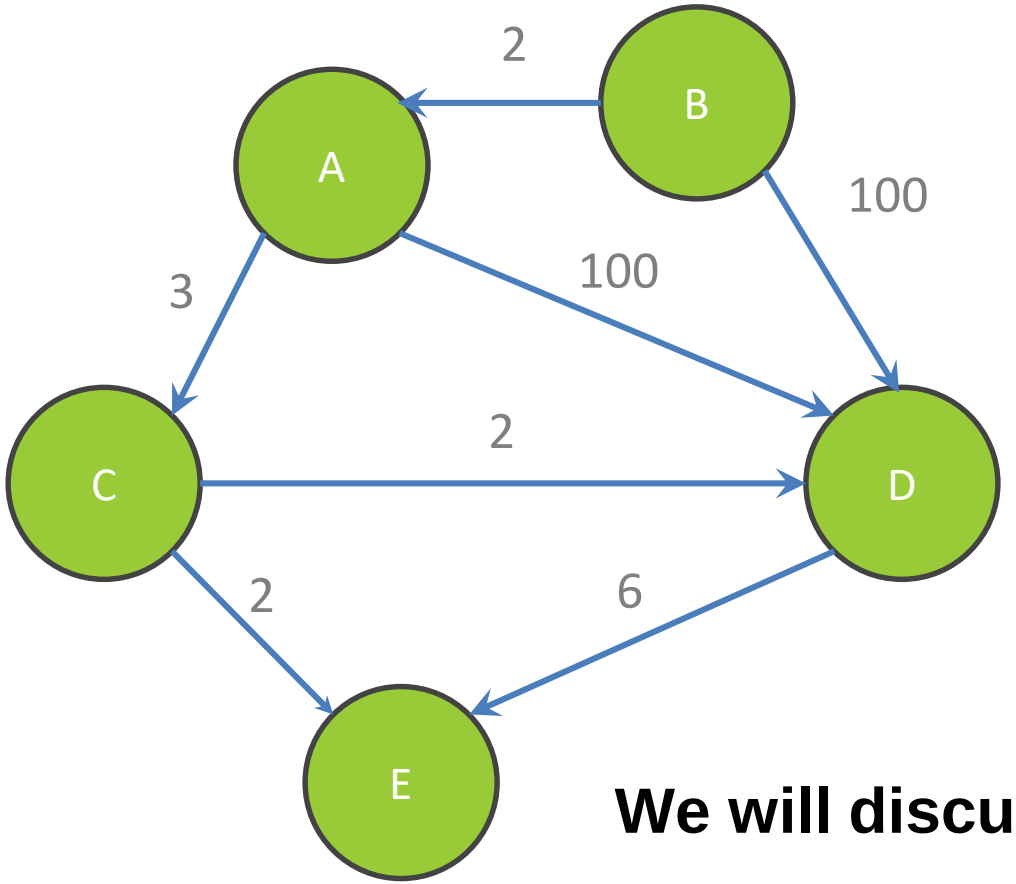


From Node B

Destination	Path	Cost
A		
B		
C		
D		
E		

Weights are not the same!
Are the paths?

Shortest Paths with Weights



From Node B

Destination	Path	Cost
A	<B,A>	2
B	<B>	0
C	<B,A,C>	5
D	<B,A,C,D>	7
E	<B,A,C,E>	7

We will discuss Dijkstra next section!