

Section 5:

HW6 and Interfaces

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How is Homework 6 going?

Agenda

- Reminders
 - HW 6 due next Wednesday night (5/9)
- Breadth-first search (BFS)
- Interfaces
- Parsing Marvel Data

Reminders:

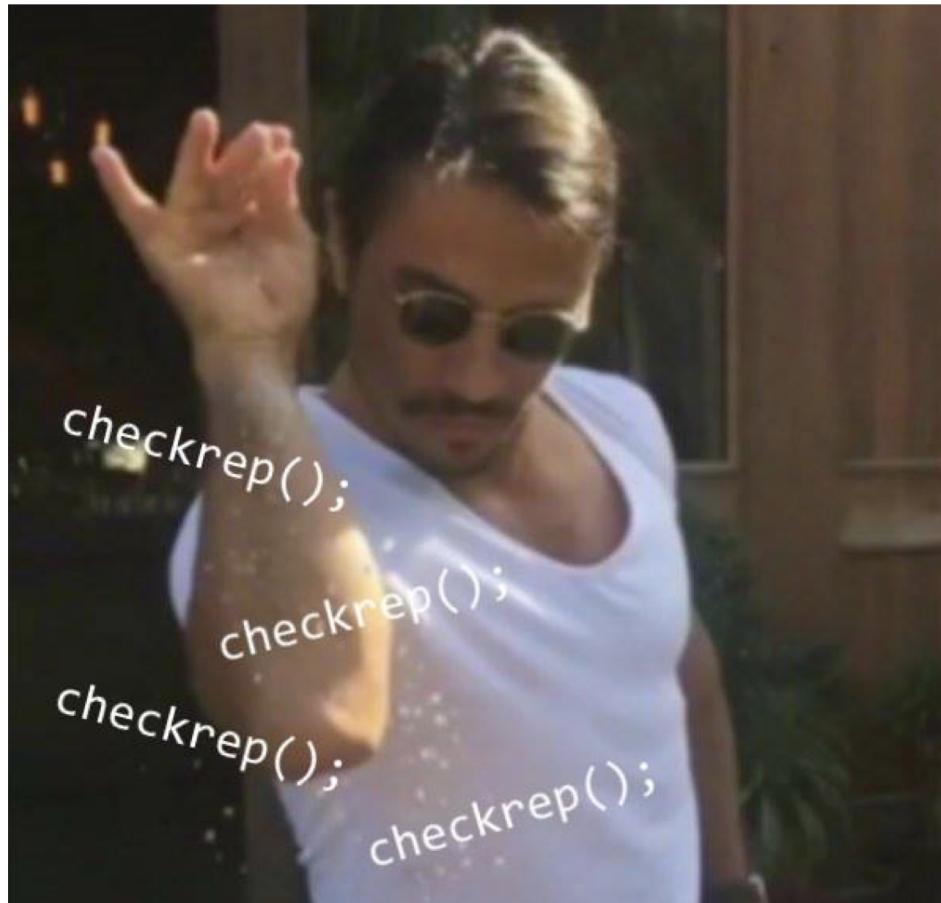
Expensive CheckReps are **BAD**

(at least when assignments are turned in, but can be useful for finding hard-to-discover problems – so need to be able to control expensive checks)

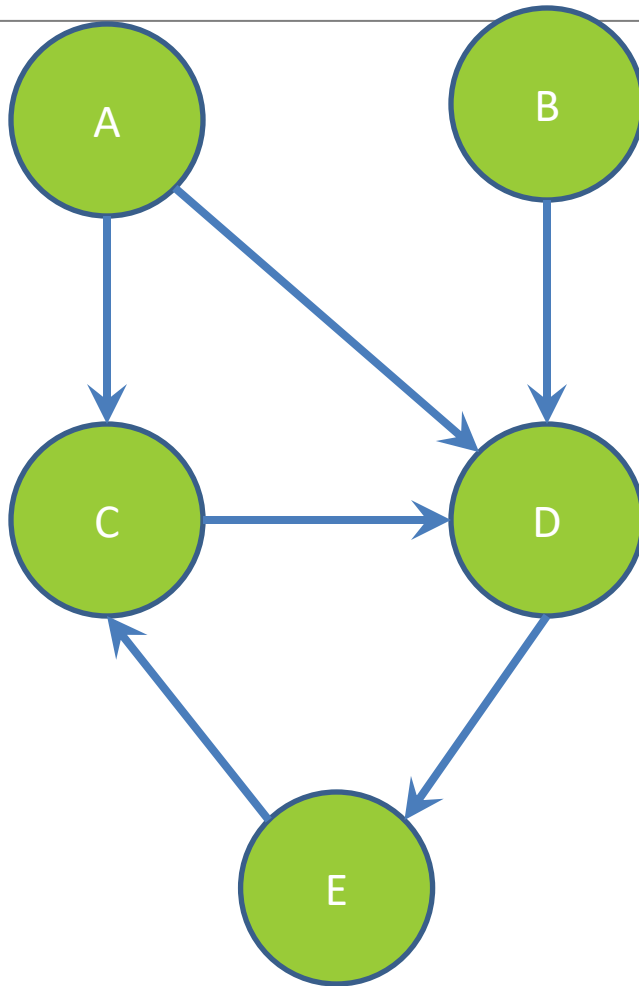
Debug flags are **GOOD**

(or enums to indicate depth of debug)

Don't forget your CheckReps!



Graphs



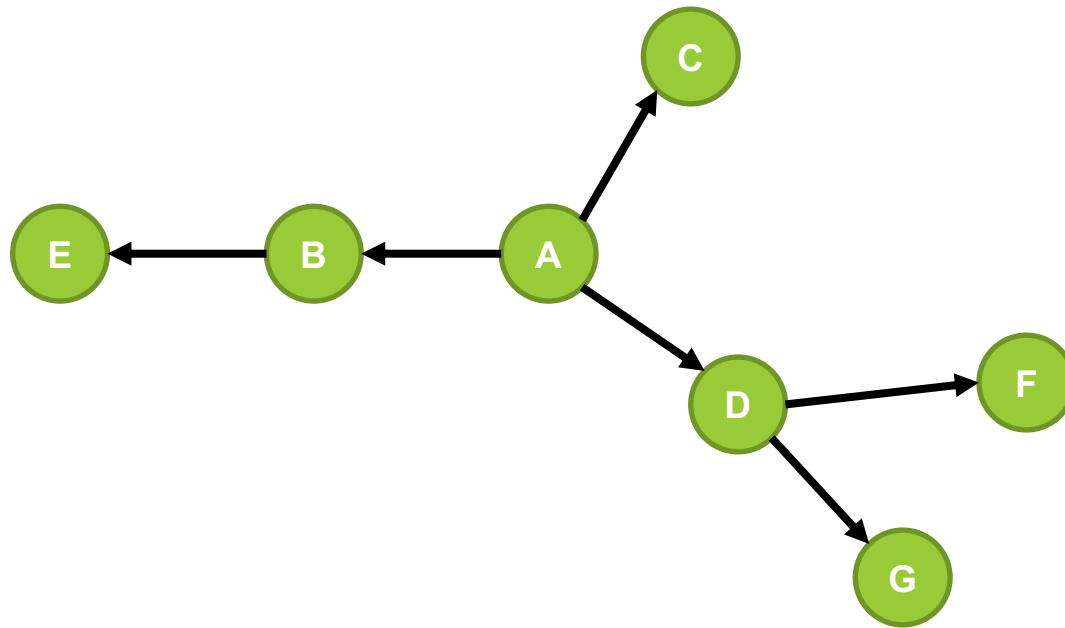
**Can I reach B
from A?**

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
 - BFS looks “wide”, DFS looks “deep”
 - DFS can also be used for discovery, but not the shortest path

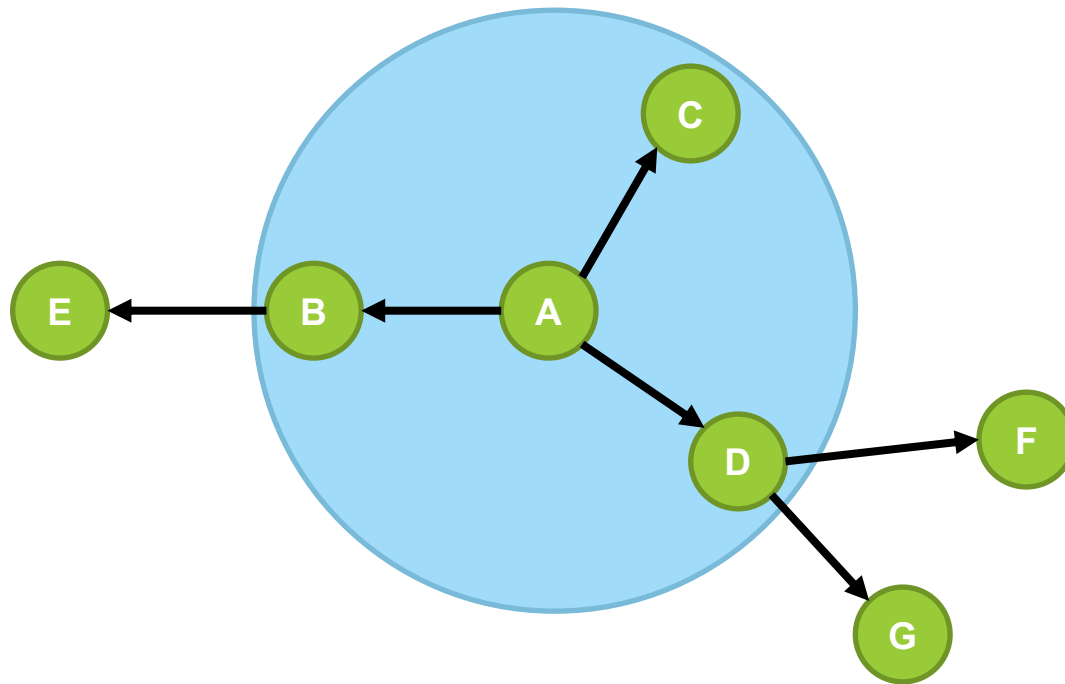
Breadth-First Search (BFS)

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



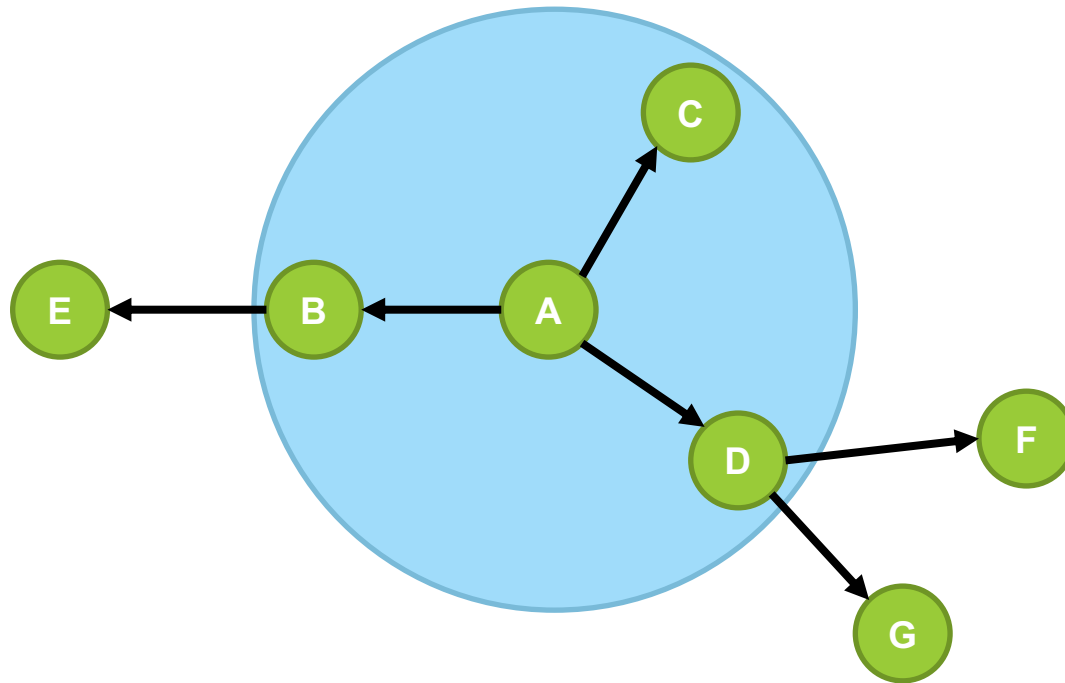
Breadth-First Search (BFS)

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



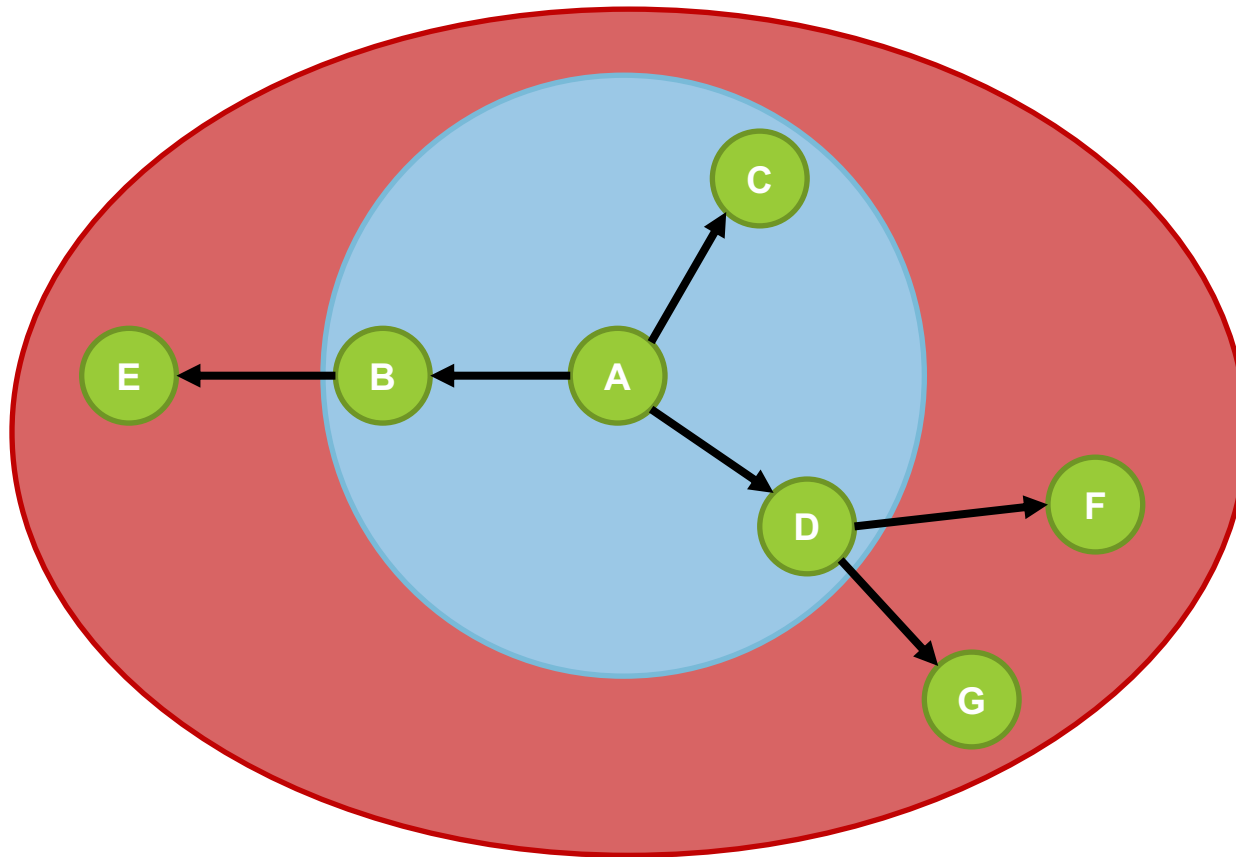
Breadth-First Search (BFS)

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

```
put start node in a queue
while (queue is not empty):
    pop node N off queue

    if (N is goal):
        return true
    else:
        for each node O that is child of N:
            push O onto queue
return false
```

Breadth-First Search

START:

Q: <A>

Pop: A, Q: <>

Q: <B, C>

Pop: B, Q: <C>

Q: <C>

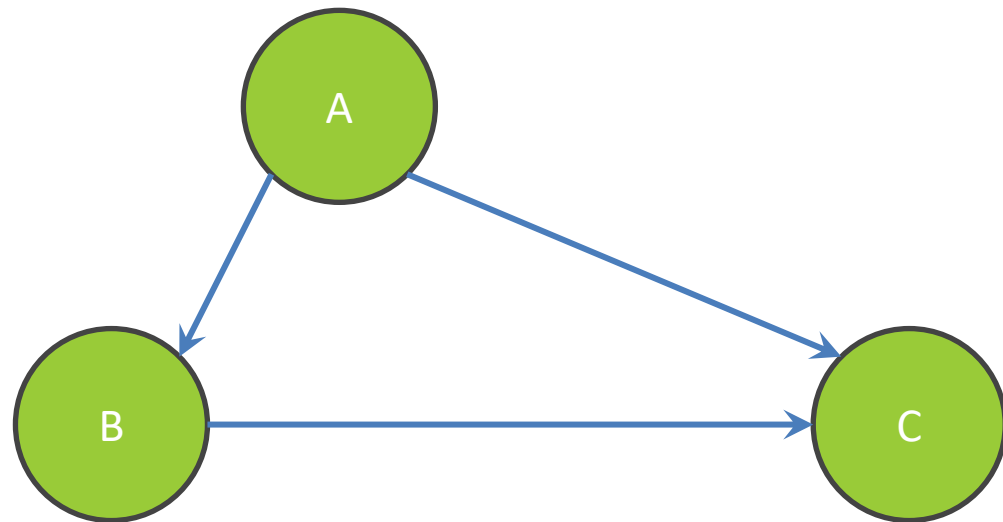
Pop: C, Q: <C>

Q: <>

DONE

Starting at A

Goal: Fully explore



Breadth-First Search with Cycle

START:

Q: <A>

Pop: A, Q: <>

Q:

Pop: B, Q: <>

Q: <C>

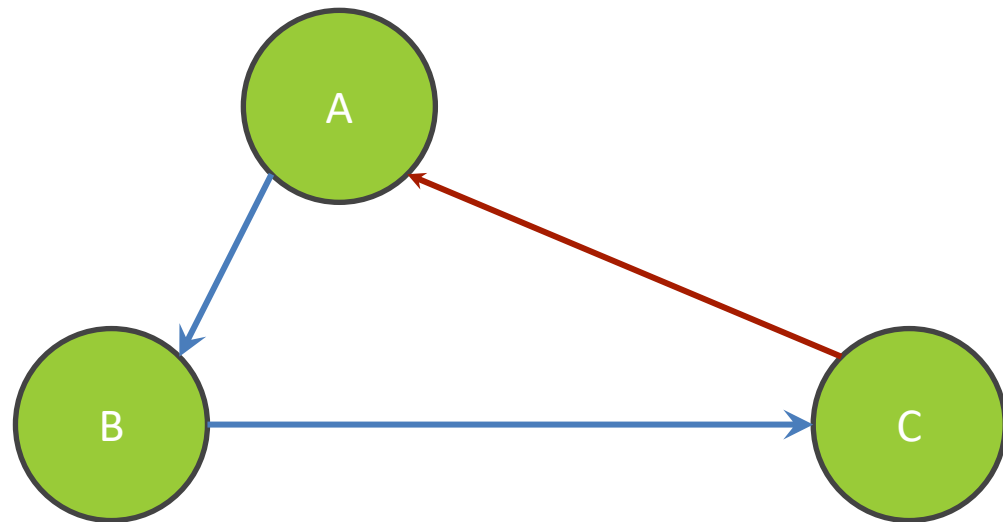
Pop: C, Q: <>

Q: <A>

NEVER DONE

Starting at A

Goal: Fully Explore



BFS Pseudocode

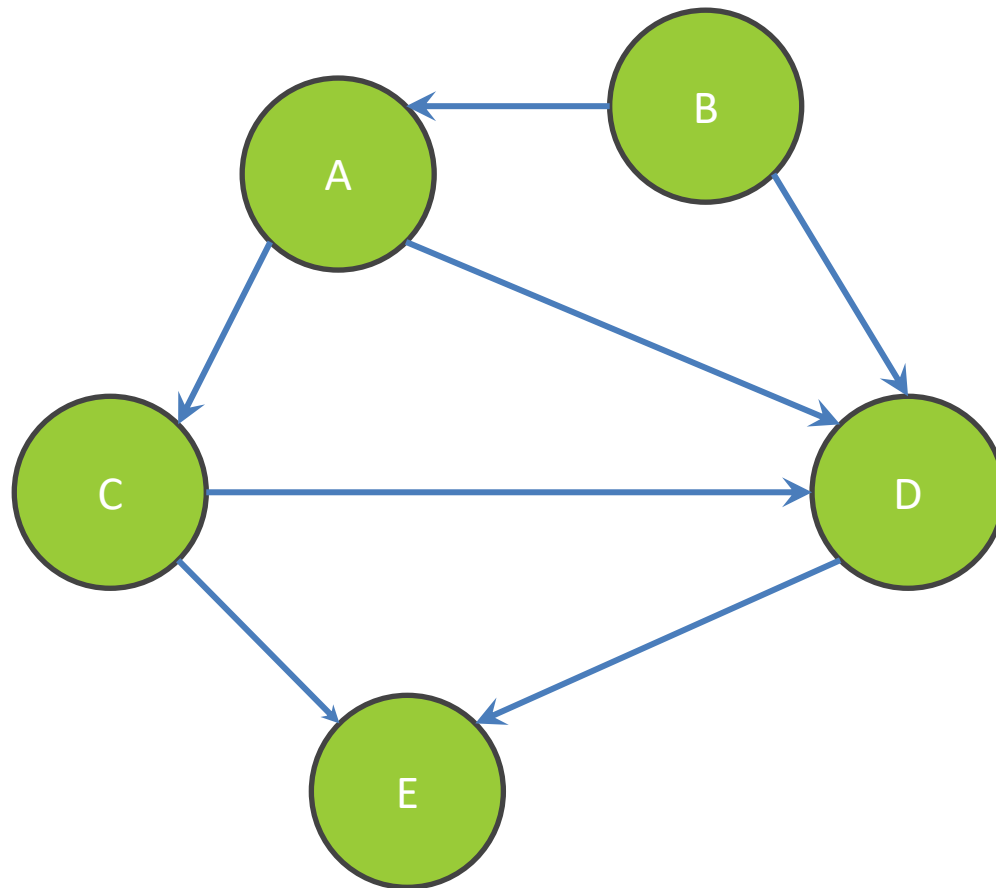
**Mark the node
as visited!**

```
put start node 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 O that is child of N:
            if O is not marked visited:
                push O onto queue
return false
```

Breadth-First Search

Problem: Find everything reachable from A

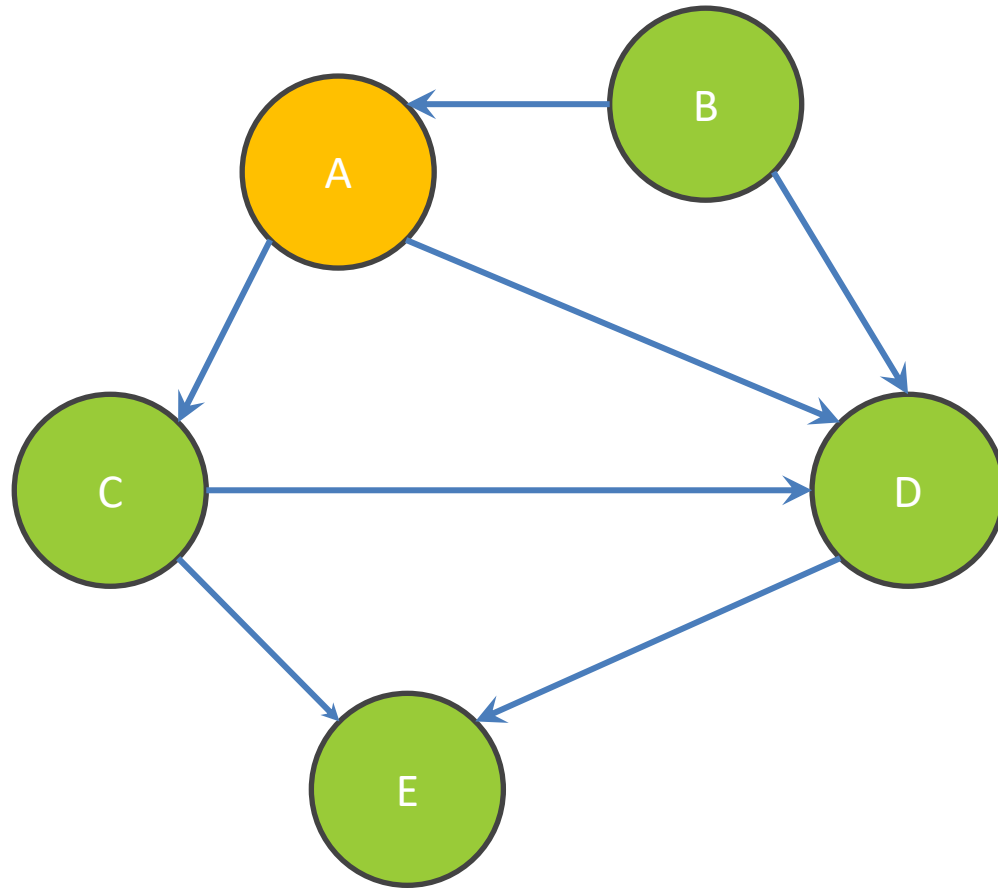
Q: <>



Breadth-First Search

Q: <>

Q: <A>

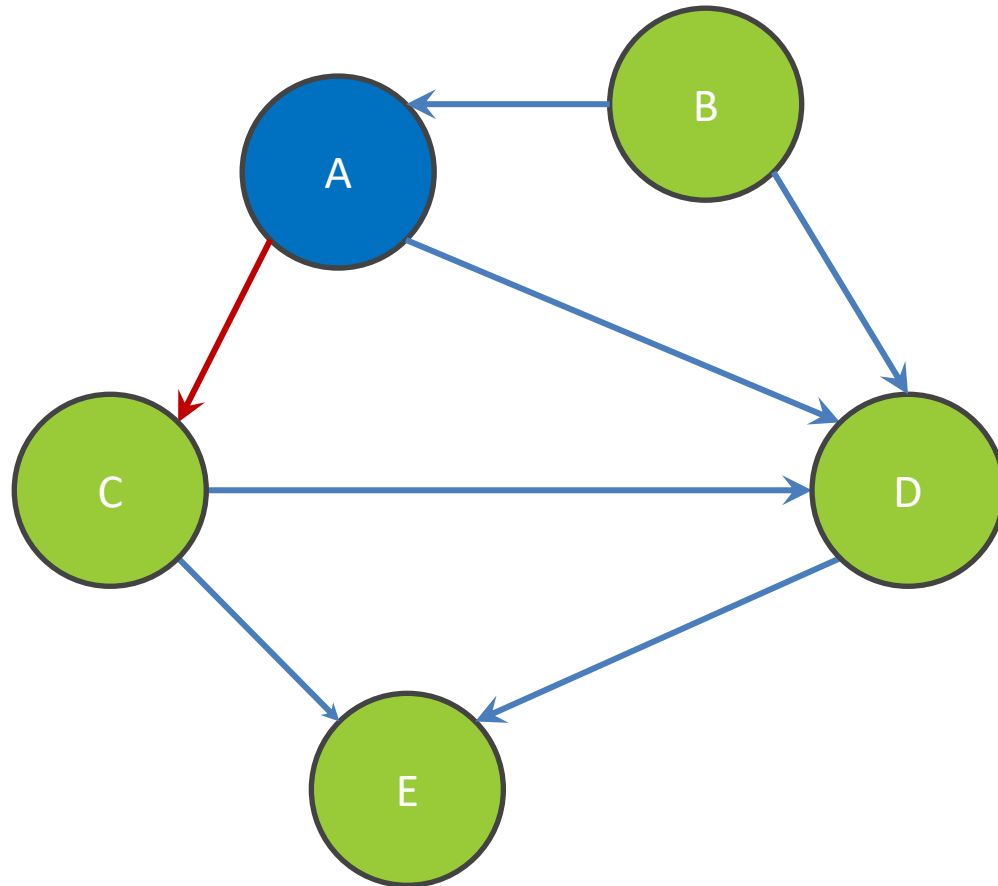


Breadth-First Search

Q: <>

Q: <A>

Q: <>



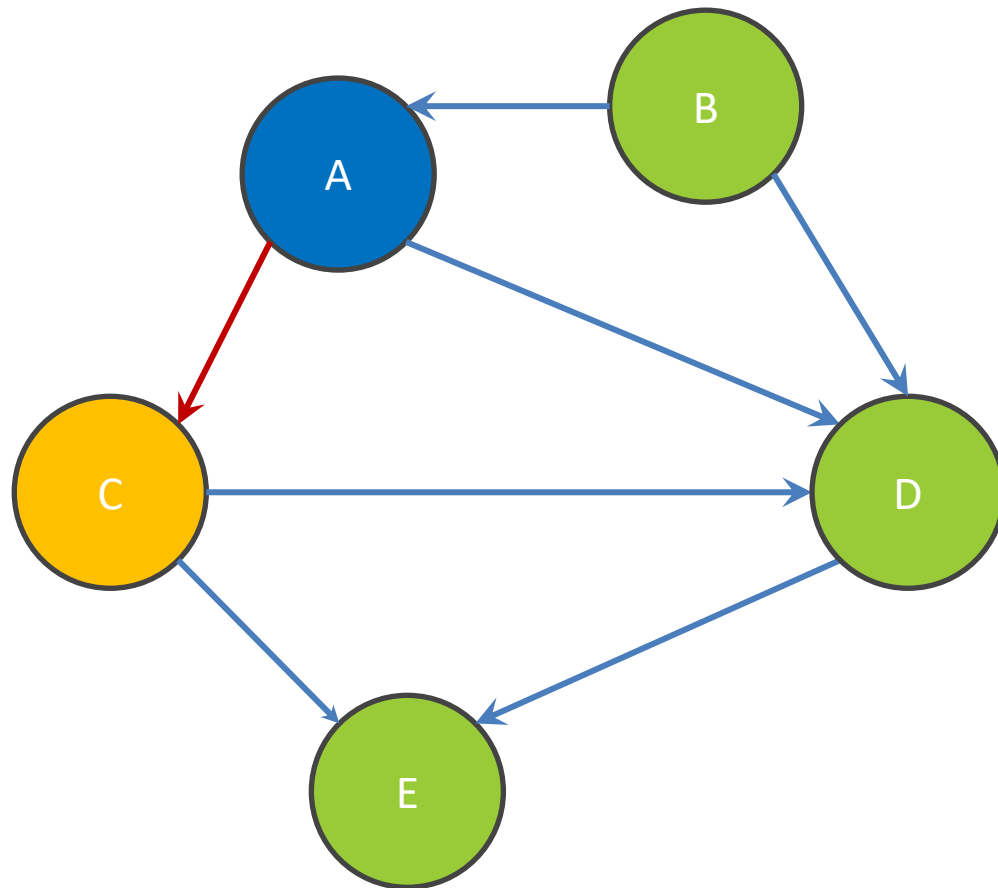
Breadth-First Search

Q: <>

Q: <A>

Q: <>

Q: <C>



Breadth-First Search

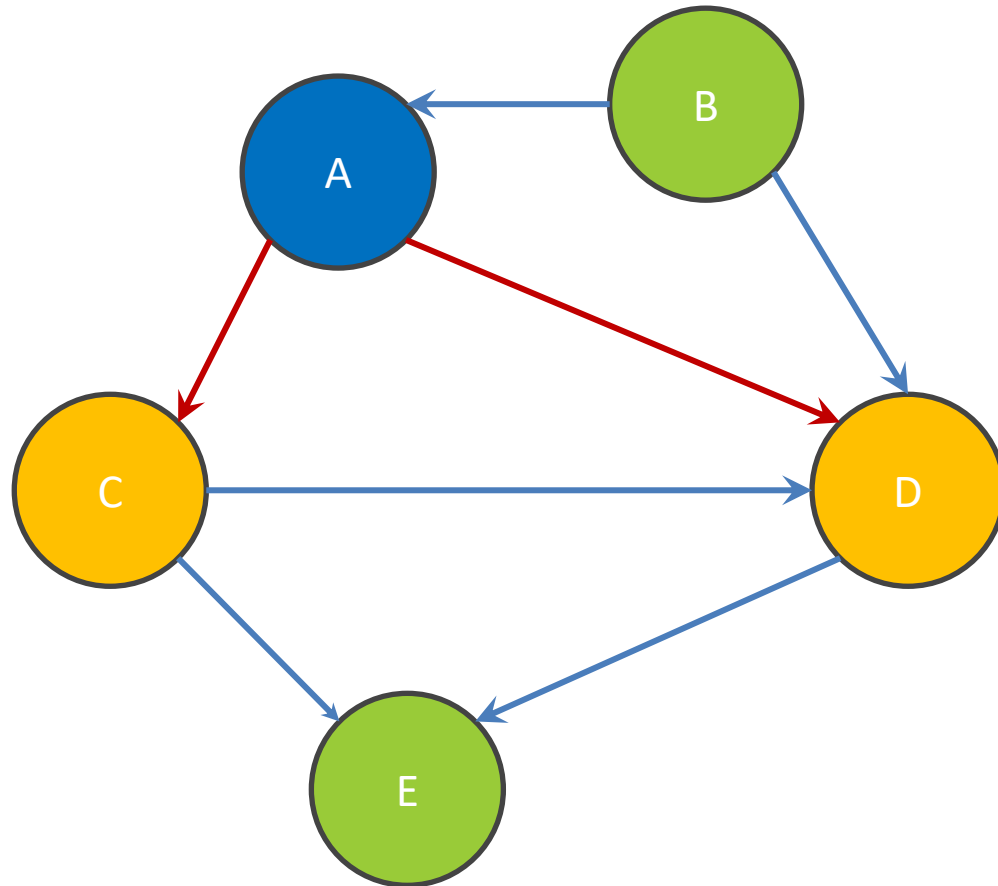
Q: <>

Q: <A>

Q: <>

Q: <C>

Q: <C ,D>



Breadth-First Search

Q: <>

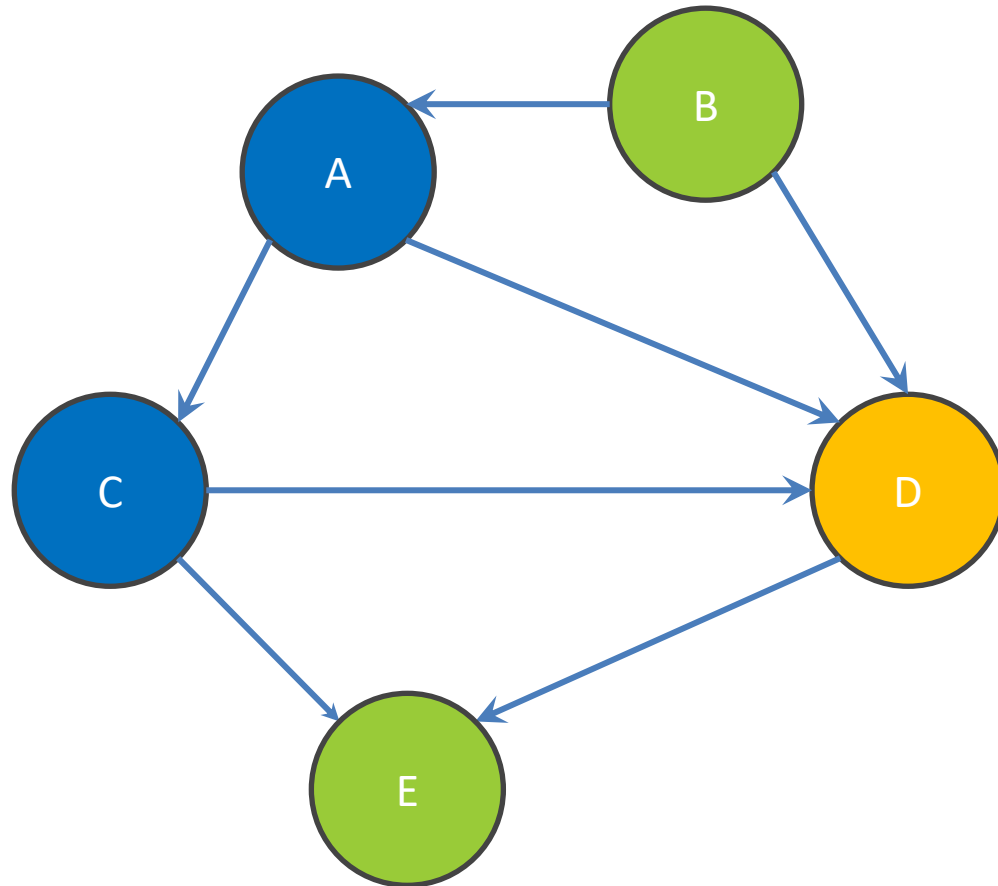
Q: <A>

Q: <>

Q: <C>

Q: <C ,D>

Q: <D>



Breadth-First Search

Q: <>

Q: <A>

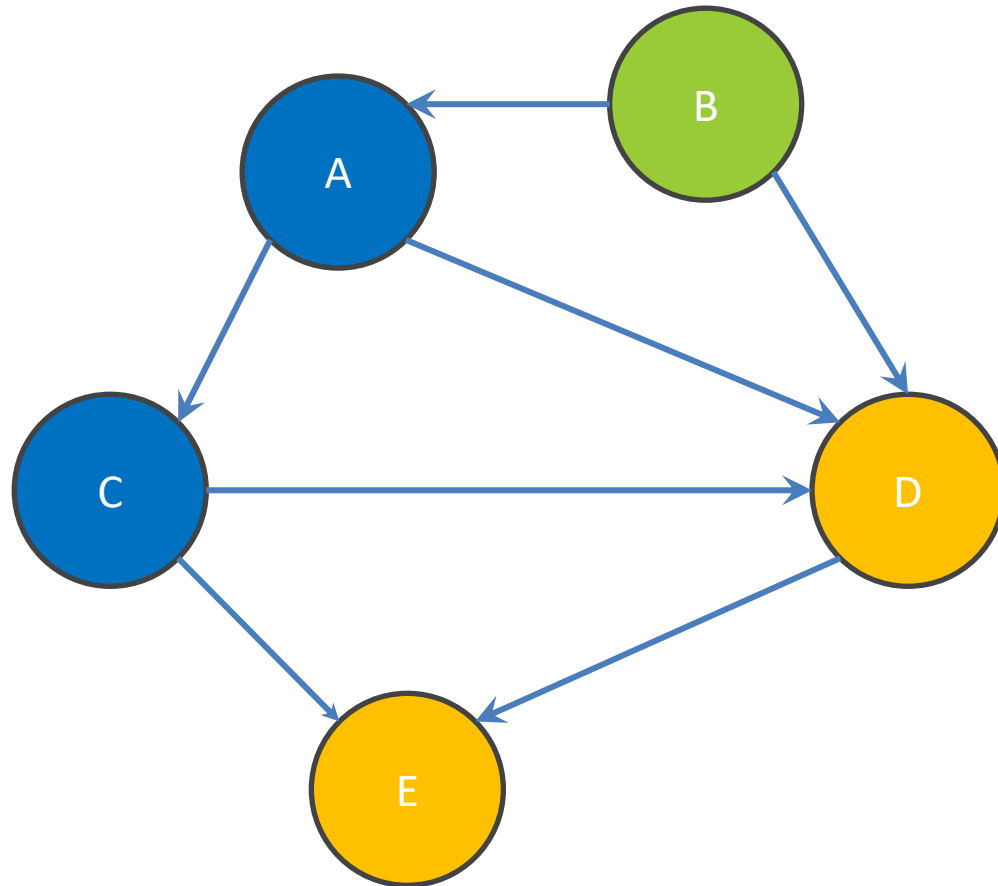
Q: <>

Q: <C>

Q: <C, D>

Q: <D>

Q: <D, E>



Breadth-First Search

Q: <>

Q: <A>

Q: <>

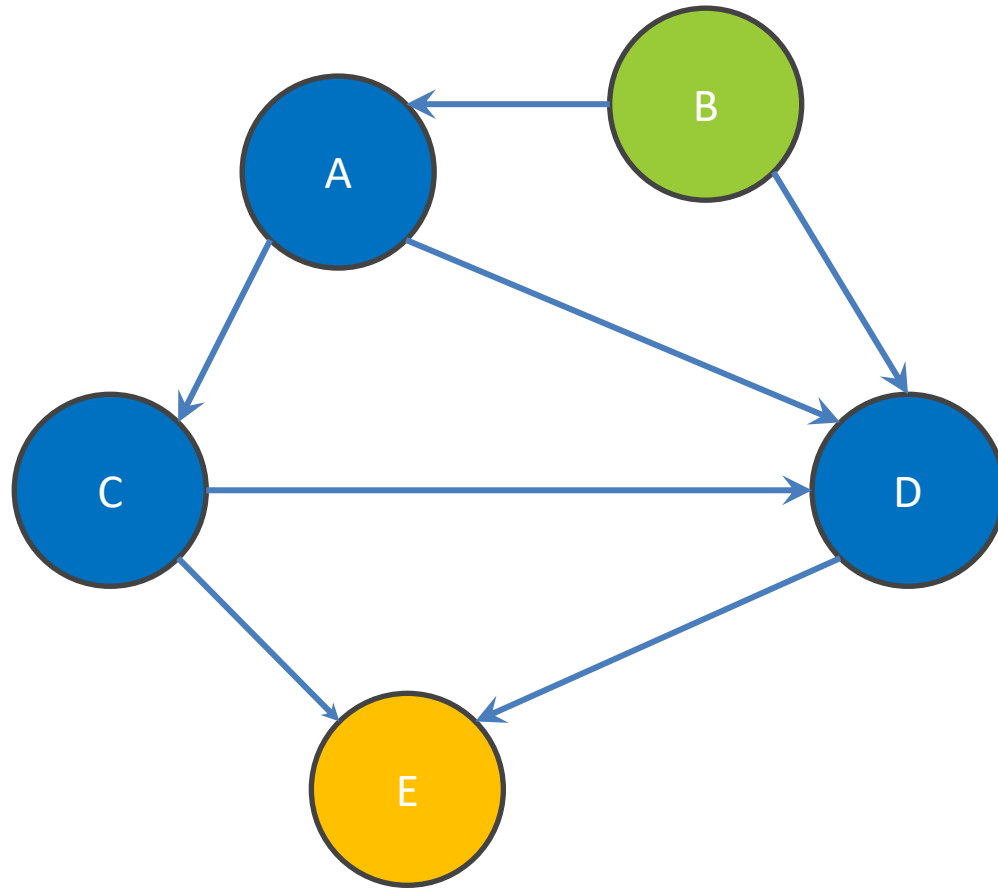
Q: <C>

Q: <C, D>

Q: <D>

Q: <D, E>

Q: <E>



Breadth-First Search

Q: <>

Q: <A>

Q: <>

Q: <C>

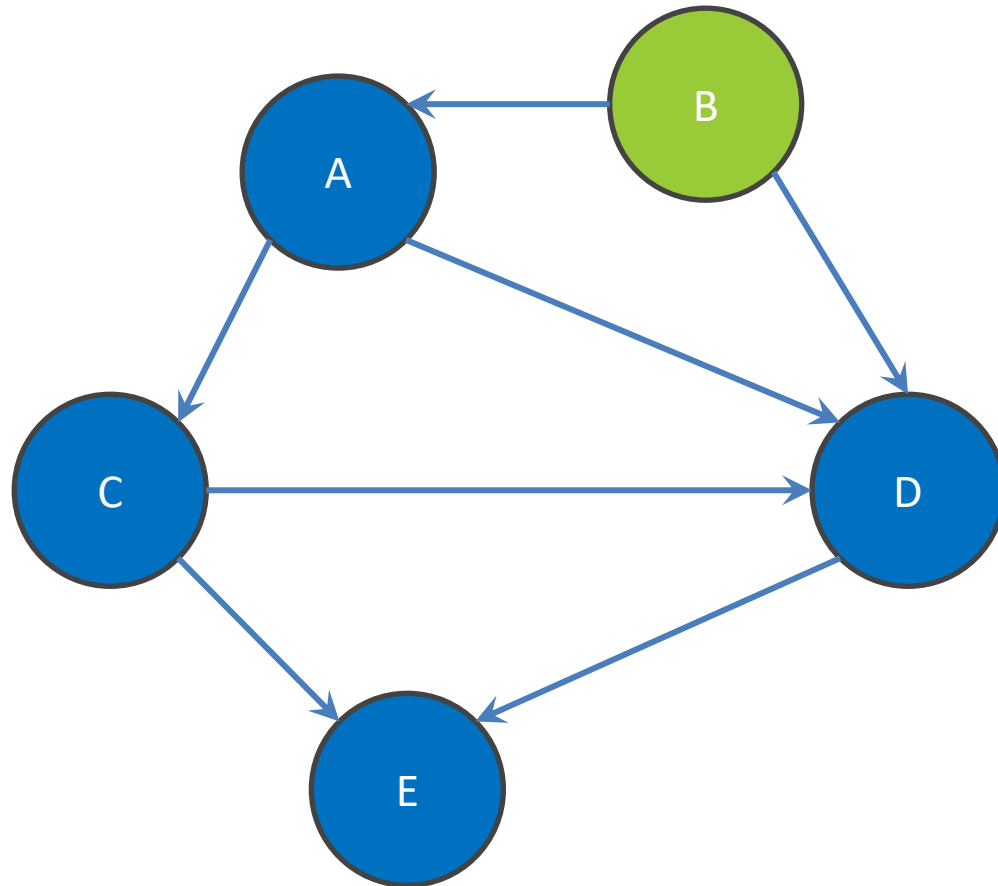
Q: <C ,D>

Q: <D>

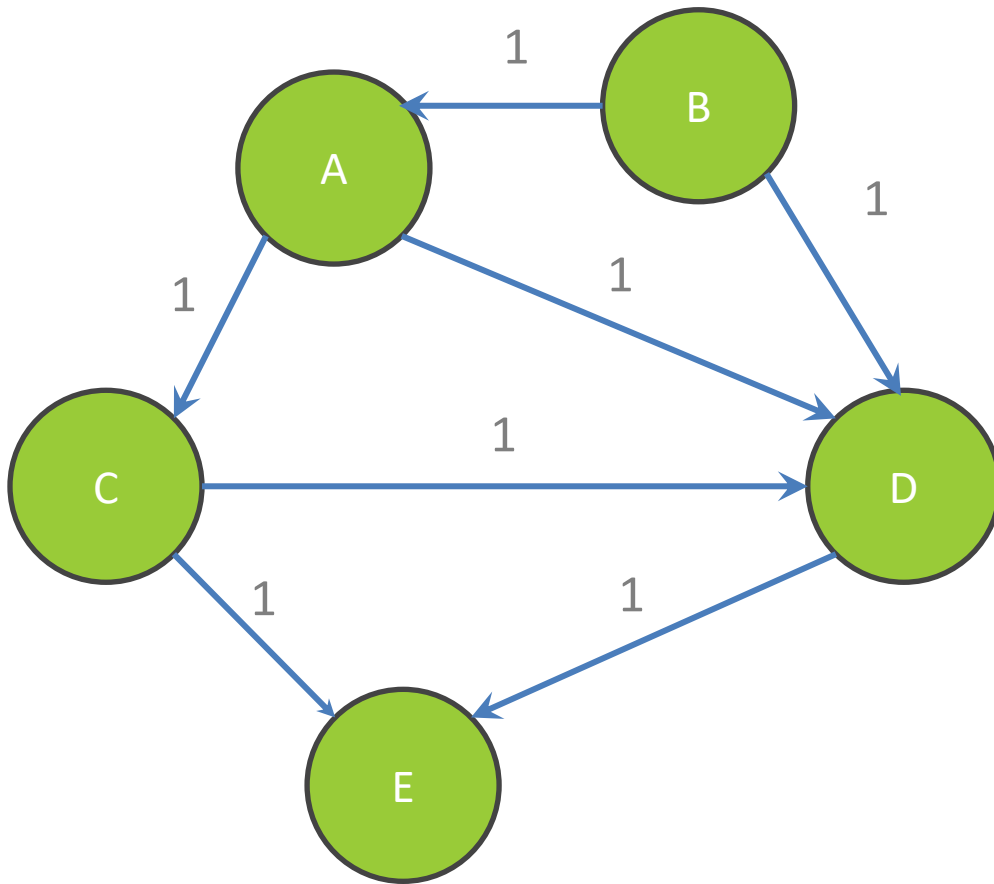
Q: <D, E>

Q: <E>

DONE



Shortest Paths with BFS

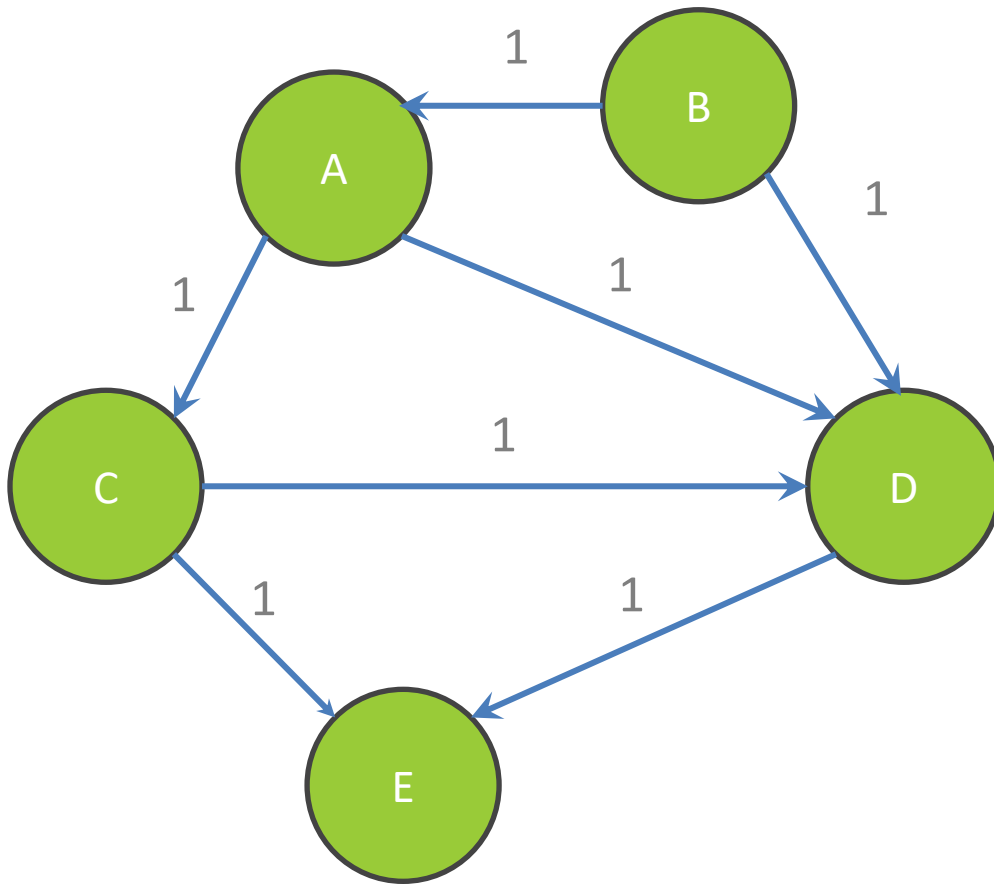


From Node B

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

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

Shortest Paths with BFS

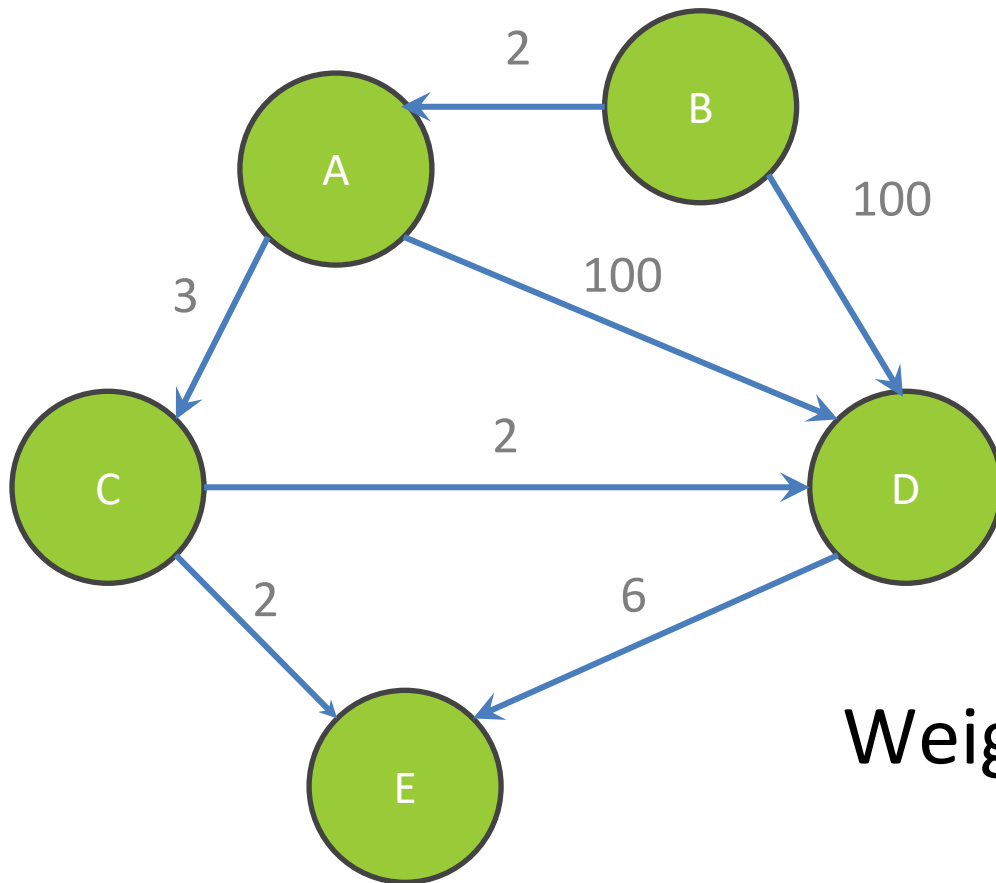


From Node B

Destination	Path	Cost
A	<B,A>	1
B		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

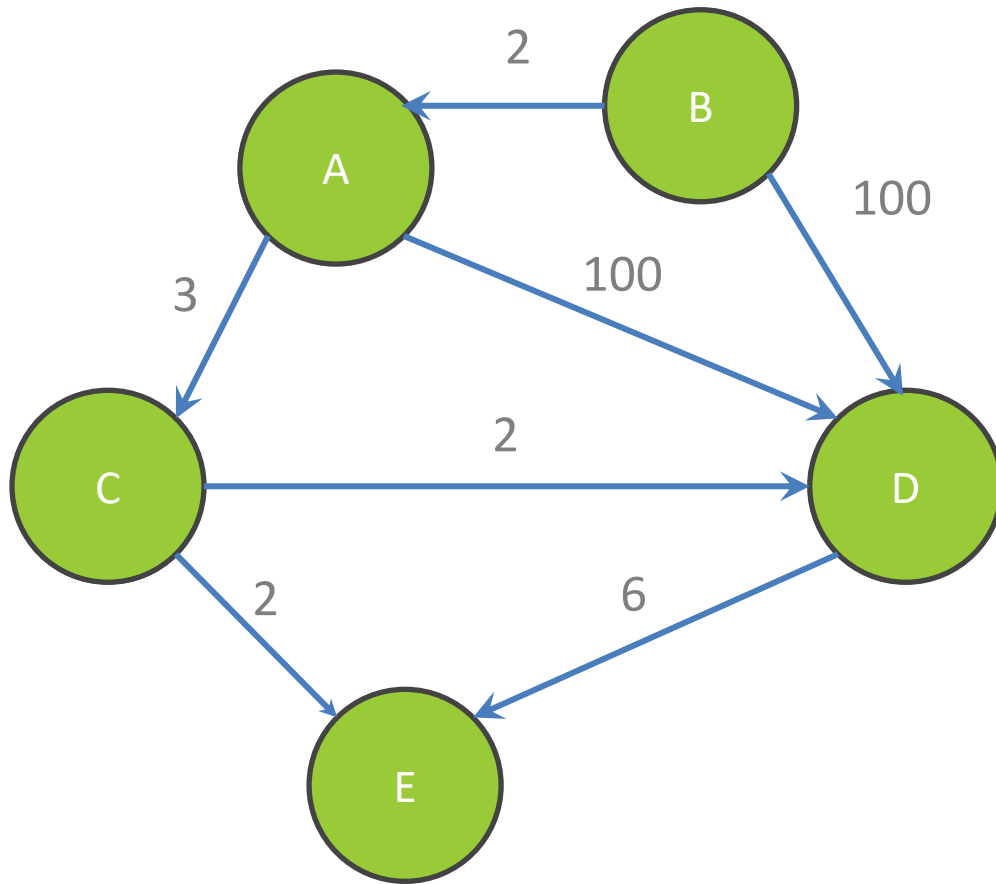


From Node B

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

Interfaces

Classes, Interfaces, and Types

- The fundamental unit of programming in Java is a class
- Classes can extend other classes and implement interfaces
- Interfaces can extend other interfaces

Classes, Objects, and Java

Everything is an instance of a class

- Defines data and methods

Every class extends exactly one other class

- Object if no explicit superclass
- Inherits superclass fields

Every class also defines a type

- Foo defines type Foo
- Foo inherits all inherited types

Interfaces

Pure type declaration

```
public interface Comparable {  
    int compareTo(Object other);  
}
```

Can contain:

- Method specifications (implicitly `public abstract`)
- Named constants (implicitly `public final static`)

Does not contain implementation!

Cannot create instances of interfaces



Implementing Interfaces

- A class can implement one or more interfaces
class Kitten implements Pettable, Huggable
- The implementing class and its instances have the interface type(s) as well as the class type(s)
- The class must provide or inherit an implementation of all methods defined by the interface(s)
 - Not true for abstract classes



Using Interface Types

- An interface defines a type, so we can declare variables and parameters of that type
- A variable with an interface type can refer to an object of any class implementing that type

```
List<String> x = new ArrayList<String>();  
void sort(List aList) {...}
```

Guidelines for Interfaces

- Provide interfaces for significant types and abstractions
- Write code using interface types like Map instead of HashMap and TreeMap wherever possible
 - Allows code to work with different implementations later on
- Both interfaces and classes are appropriate in various circumstances

Parsing Marvel Data

- Data is in marvel.tsv
 - Will be pushed with hw6
- Each line is in the form:
 - `"character" "book"`
 - Ex: `"CAPTAIN AMERICA" "N 57"`
- Parsing is already implemented for you!

Parsing Marvel Data

- `MarvelParser.parseData(String filename, Set<String> characters, Map<String, List<String>> books)`
- Call `parseData()` with an empty Set, Map
- `parseData()` will fill the Set with all comic book characters, Map with Characters → List of books they're in

HW 6 Demo
