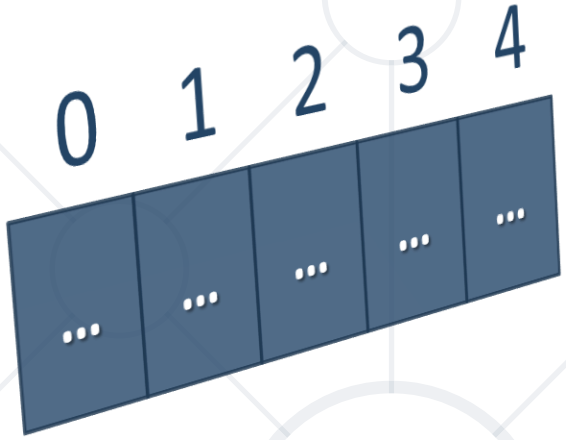
Stacks and Queues

Processing Sequences of Elements



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2. The "**Queue**" Data Structure (**FIFO** - first in, first out)
   - The Class **Queue<T>**
   - Enqueue(), Dequeue(), Peek(), ToArray(), Contains() and Count

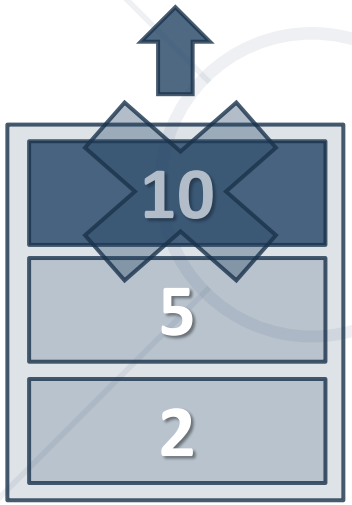
The "Stack" Data Structure

Using the **Stack<T>** Class

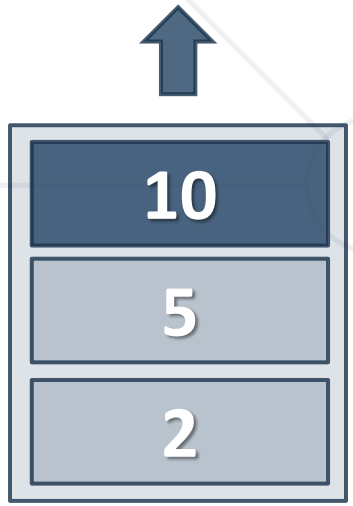
Stack – Abstract Data Type

- Stack implements a **LIFO** (last in, first out) collection
  - **Push**: insert an element at the top of the stack
  - **Pop**: take the element from the top of the stack
  - **Peek**: retrieve the topmost element without removing it

Push



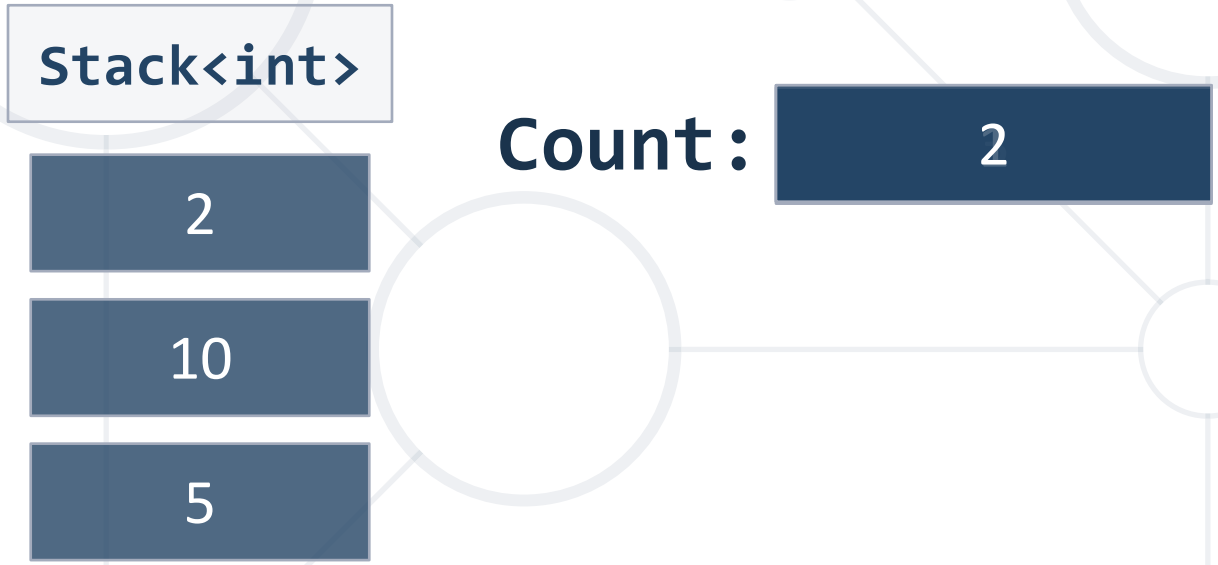
Pop



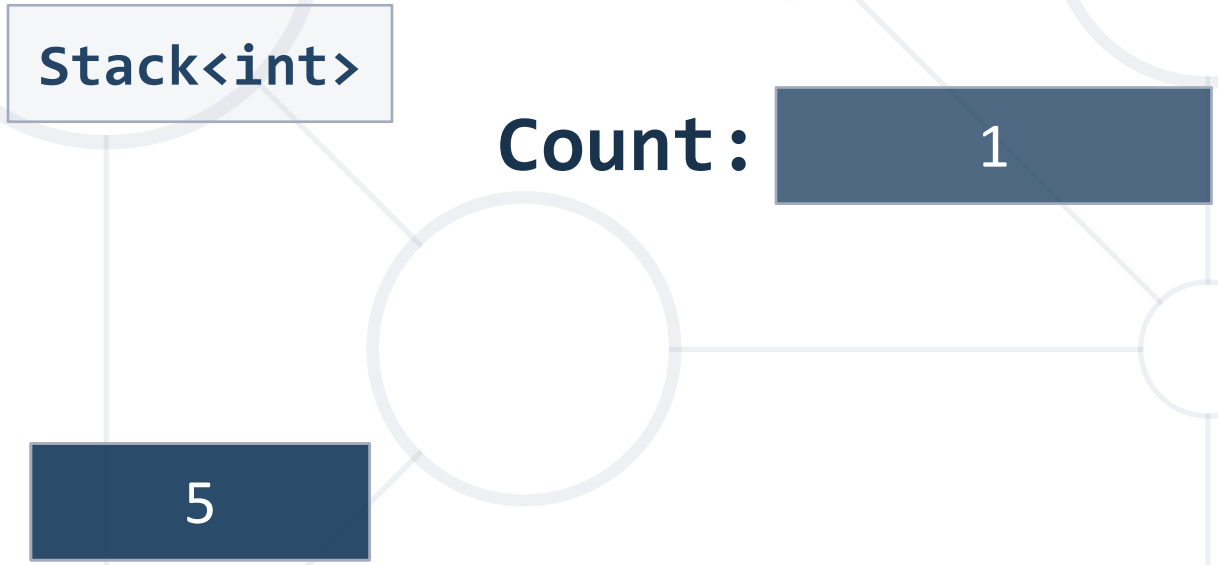
Peek

Push() – Adds an Element On Top of the Stack

Pop() – Returns and Removes the Last Element



Peek() - Returns the Last Element



Problem: Reverse a String

- Create a program that:
  - Reads an input string
  - **Reverses** its letters backwards using a **stack**

```
I Love C#  ➡  #C evoL I
```

```
Stacks and Queues  ➡  seueuQ dna skcatS
```

Check your solution here: https://judge.softuni.bg/Contests/1445/Stacks-and-Queues-Lab

Solution: Reverse Strings

```
var input = Console.ReadLine();
var stack = new Stack<char>();
foreach (var ch in input)
{
  stack.Push(ch);
}
while (stack.Count > 0)
{
  Console.Write(stack.Pop());
}
Console.WriteLine();
```

Stack – Utility Methods

```
Stack<int> stack = new Stack<int>();

int count = stack.Count;
bool exists = stack.Contains(2);
int[] array = stack.ToArray();
stack.Clear();
stack.TrimExcess();
```

Retains the order of elements

Remove all elements

Shrink the internal array

Problem: Stack Sum

- You are given a **list of numbers**. Push them into a stack and execute a sequence of **commands**:
  - **Add <n1> <n2>**: adds given two numbers to the stack
  - **Remove <count>**: if elements are enough, removes *count* elements
  - **End**: print the sum in the remaining elements from the stack and exit

```
1 2 3 4
ADD 5 6
REmove 3
eNd
```

```
Sum: 6
```

```
3 5 8 4 1 9
add 19 32
remove 10
add 89 22
end
```

```
Sum: 192
```

Check your solution here: https://judge.softuni.org/Contests/Practice/Index/1445#1

Solution: Stack Sum

```
var input =
     Console.ReadLine().Split().Select(int.Parse).ToArray();
Stack<int> stack = new Stack<int>(input);
var commandInfo = Console.ReadLine().ToLower();

while (commandInfo != "end")
{
  var tokens = commandInfo.Split();
  var command = tokens[0].ToLower();
  if (command == "add")
    // TODO: Parse the numbers and push them to the stack
```

Solution: Stack Sum

```
    else if (command == "remove") {
        var countOfRemovedNums = int.Parse(tokens[1]);
        if (countOfRemovedNums <= stack.Count)
        for (int i = 0; i < countOfRemovedNums; i++) {
            stack.Pop();
        }
    }
    commandInfo = Console.ReadLine().ToLower();
}
var sum = stack.Sum();
Console.WriteLine($"Sum: {sum}");
```

Problem: Matching Brackets

- We are **given an arithmetic expression** with brackets (**nesting is allowed**)
- **Extract all sub-expressions** in brackets

```
1 + (2 - (2 + 3) * 4 / (3 + 1)) * 5
```

```
(2 + 3)
(3 + 1)
(2 - (2 + 3) * 4 / (3 + 1))
```

Check your solution here: https://judge.softuni.org/Contests/Practice/Index/1445#3

Solution: Matching Brackets

```
var input = Console.ReadLine();
var stack = new Stack<int>();
for (int i = 0; i < input.Length; i++) {
  char ch = input[i];
  if (ch == '(') {
    stack.Push(i);
  } else if (ch == ')') {
    int startIndex = stack.Pop();
    string contents = input.Substring(
                      startIndex, i - startIndex + 1);
    Console.WriteLine(contents);
}
```

The "Queue" Data Structure

Using the **Queue<T>** Class

Queue – Abstract Data Type

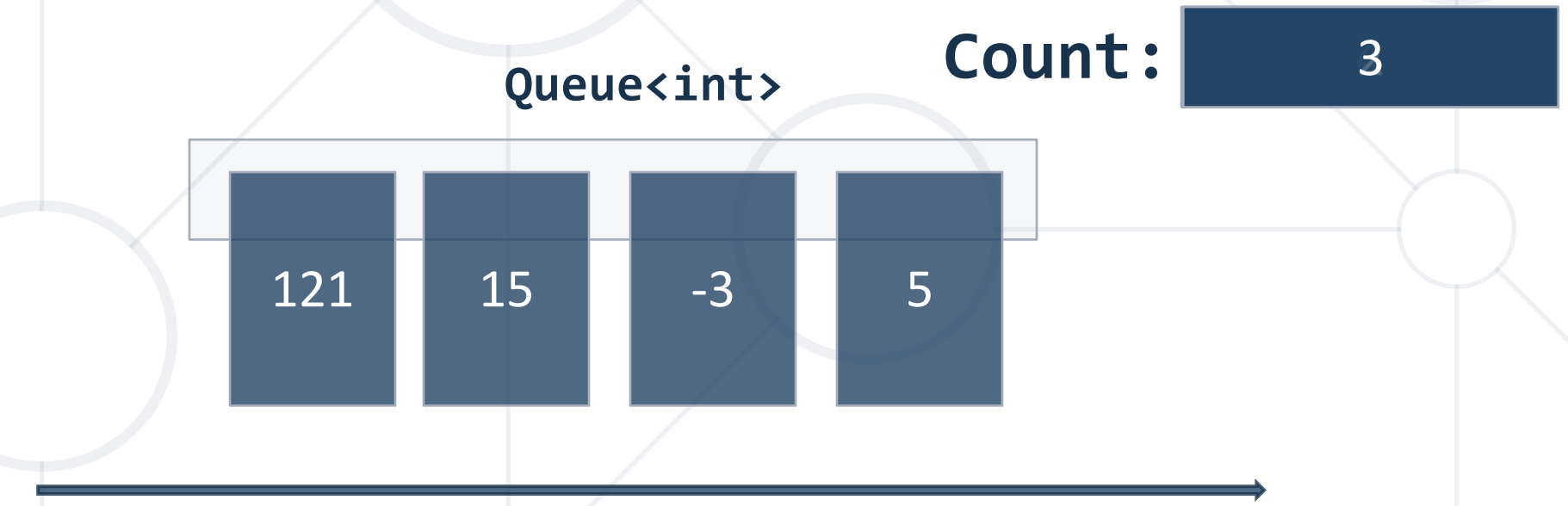
- Queue implements a **FIFO** (first in, first out) collection
  - **Enqueue**: append an element at the end of the queue

  - **Dequeue:** remove the first element from the queue

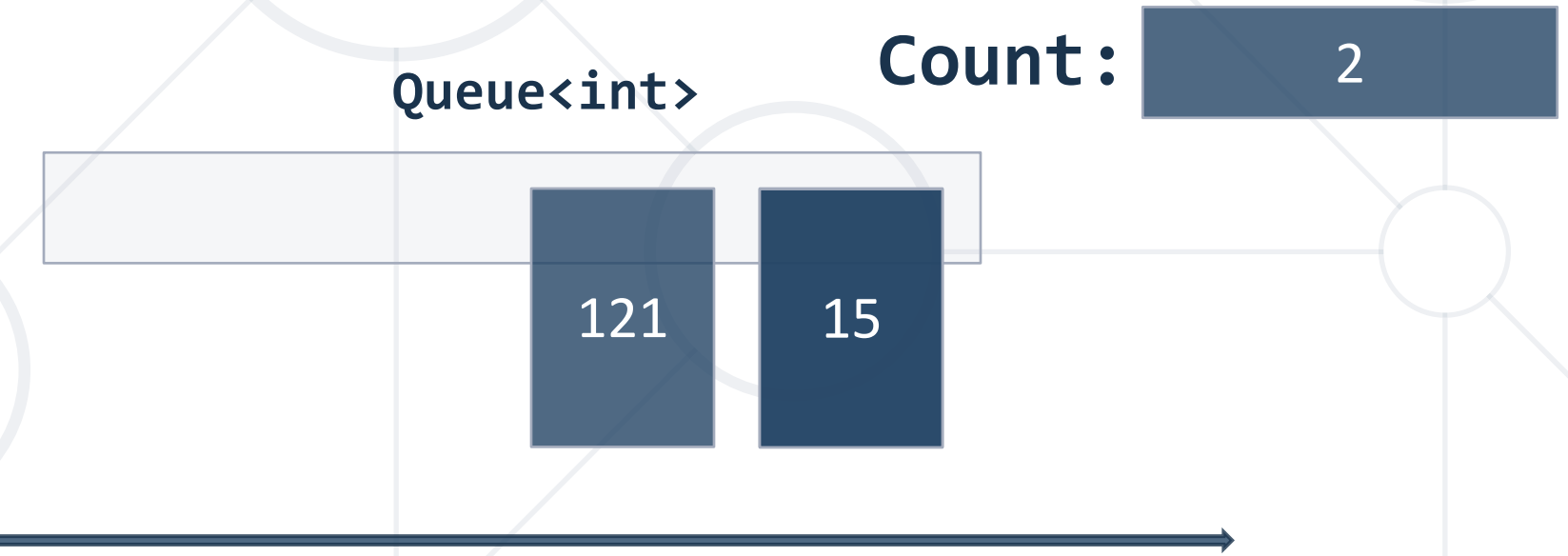
  - **Peek:** retrieve the first element of the queue without removing it

Enqueue() – Adds an Element to the Front

Dequeue() – Returns and Removes the First Element



Peek() – Returns the First Element



Queue – Utility Methods

```
Queue<int> queue = new
Queue<int>();
int count = queue.Count;
bool exists = queue.Contains(2);
int[] array = queue.ToArray();
queue.Clear();
queue.TrimExcess();
```

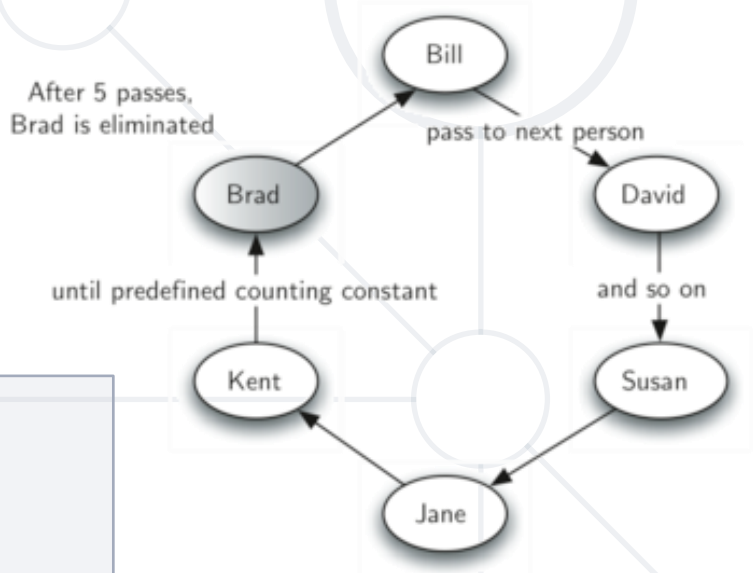
Retains the order of elements

Remove all elements

Resize the internal array

Problem: Hot Potato

- Children **form a circle** and pass a hot potato **clockwise**
- Every **n**th toss **a child is removed** until **only one remains**
  - **Upon removal** the potato is passed **along**
- Print the child that remains last

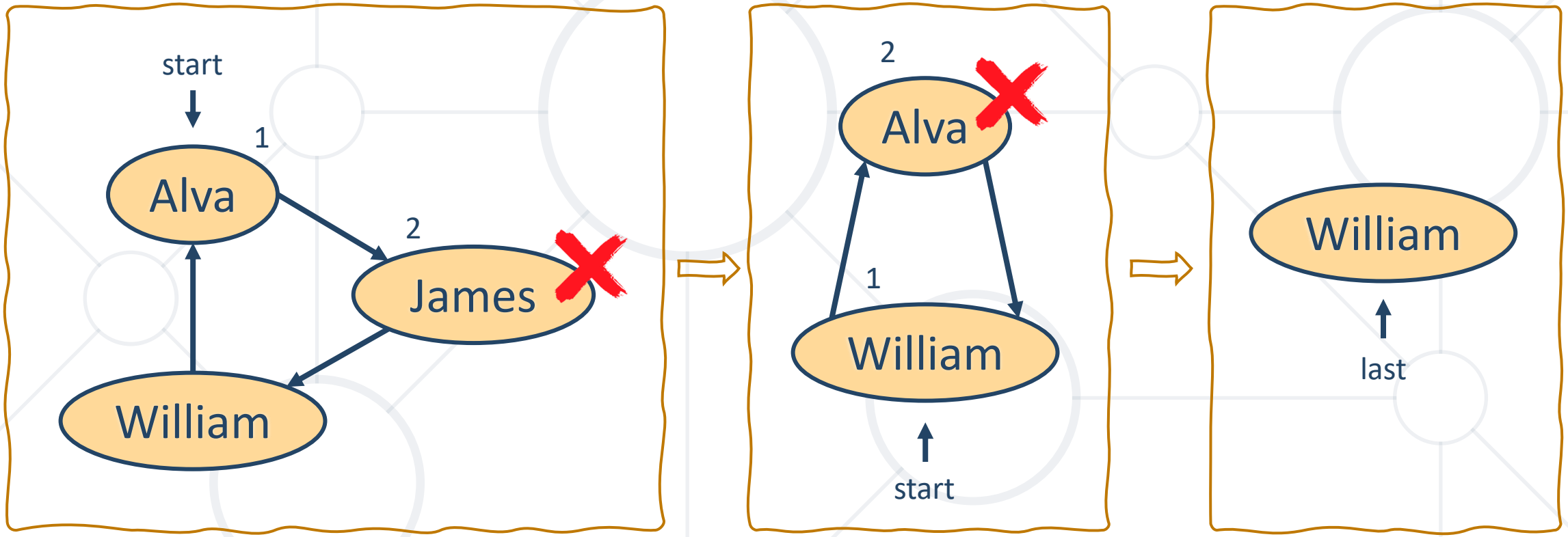



```
Alva James William
2
```

```
Removed James
Removed Alva
Last is William
```

Check your solution here: https://judge.softuni.org/Contests/Practice/Index/1445#6

Hot Potato: Illustration



Solution: Hot Potato

```
var children = Console.ReadLine().Split(' ');
var number = int.Parse(Console.ReadLine());
Queue<string> queue = new Queue<string>(children);
while (queue.Count > 1) {
  for (int i = 1; i < number; i++) {
    queue.Enqueue(queue.Dequeue());
  }
  Console.WriteLine($"Removed {queue.Dequeue()}");
}
Console.WriteLine($"Last in {queue.Dequeue()}");
```

Copies elements from the specified collection and keeps their order

Problem: Traffic Jam

- Cars are **queuing up** at a **traffic light**
- At every **green light**, **n** cars **pass** the crossroad
- After the **end command**, print **how many cars** have **passed**

```
3
Enzo's car
Jade's car
Mercedes CLS
Audi
green
BMW X5
green
end
```

```
Enzo's car passed!
Jade's car passed!
Mercedes CLS passed!
Audi passed!
BMW X5 passed!
5 cars passed the crossroads.
```

Check your solution here: https://judge.softuni.org/Contests/Practice/Index/1445#7

Solution: Traffic Jam

```
int n = int.Parse(Console.ReadLine());
var queue = new Queue<string>();
int count = 0;
string command;
while ((command = Console.ReadLine()) != "end")
{
  if (command == "green")
    // TODO: Add green light logic
  else
    queue.Enqueue(command);
}
Console.WriteLine($"{count} cars passed the crossroads.");
```

Summary

- `Stack<T>`
  - **LIFO** data structure (last-in, first-out)
  - `Push()`, `Pop()`, `Peek()`
- `Queue<T>`
  - **FIFO** data structure (first-in, first-out)
  - `Enqueue()`, `Dequeue()`, `Peek()`

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