Lab 2
Stack and Queue

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Note

In this tutorial, we will approach two new data structures: Stack and Queue which you can implement by using Linked list.
After completing this tutorial, you can:

- Implement a Stack ADT.
- Implement a Queue ADT.
- Apply the Stack and the Queue to solve the problems.

Part I
Classwork

In this part, lecturer will:

- Summarize the theory related to this lab.
- Instruct the lesson in this lab to the students.
- Explain the sample implementations.

Responsibility of the students in this part:

- Students practice sample exercises with solutions.
- During these part, students may ask any question that they don't understand or make mistakes. Lecturers can guide students, or do general guidance for the whole class if the errors are common.

1. Introduction

We have several ways to approach Stack ADT and Queue ADT implementation. By using Linked List, there are two ways: composition and inheritance. These ways were instructed in the theory class. In this Lab, we will introduce a different way, from scratch.

1.1. Stack

First, we demonstrate Stack, which is one of the most popular ADT. The order in which elements come off a Stack gives rise to its alternative name, **LIFO** (last in, first out). In Stack, we have two important methods:

- Push, which adds new element to the top of Stack;
- Pop, which removes the top element of Stack.

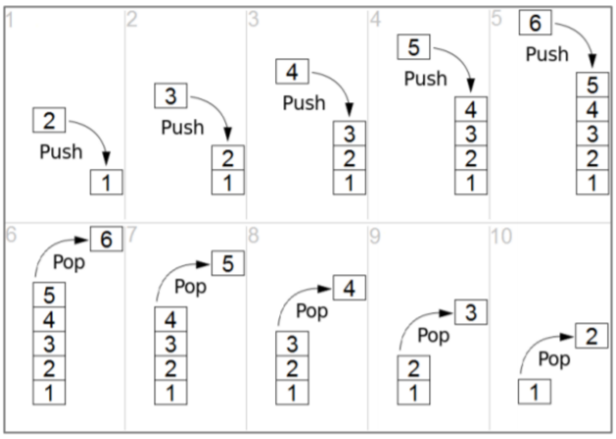


Figure 1: Push and Pop methods in Stack

Figure 1 illustrates the two methods, Push and Pop

1.2. Queue

Next, we consider Queue, which is one of the most popular ADT like Stack. The order in which elements come off a Queue gives rise to its alternative name, **FIFO** (first in, first out). In Queue, we have two important methods:

- enQueue, which adds new element to the Queue;
- deQueue, which removes the first element of Queue.

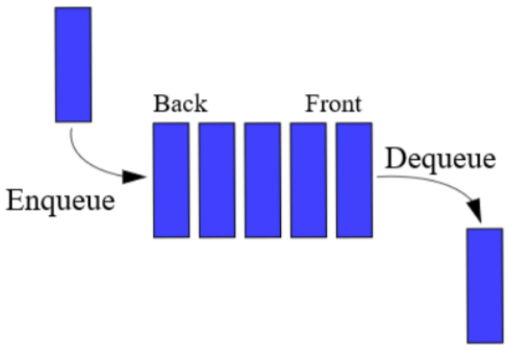


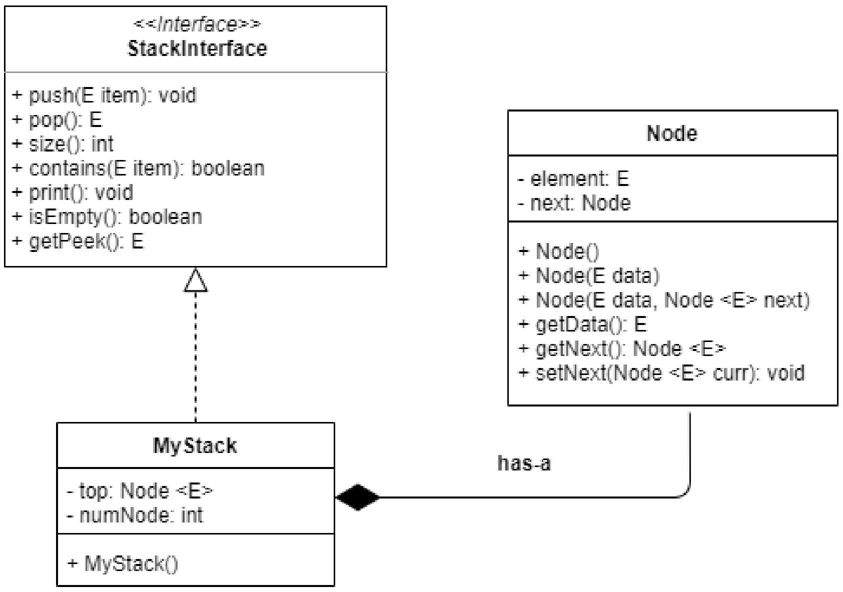
Figure 2: enQueue and deQueue methods in Queue

Figure 2 illustrates the two methods, enQueue and deQueue. We must notice that queue maintains and tracks two positions, *front* and *rear*.

In the next section, we will consider the UML model of Stack and Queue.

2. UML Model

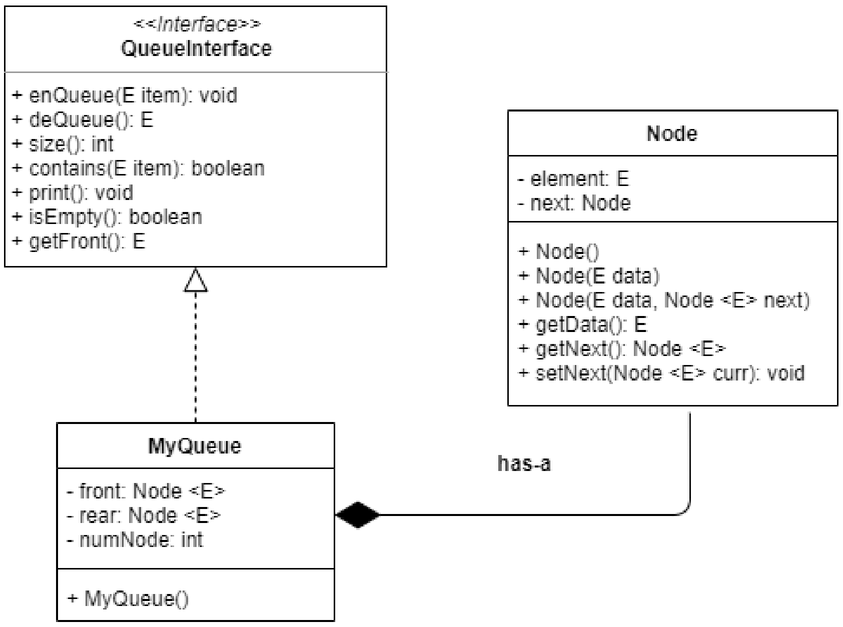
2.1. Class Diagram of Stack



The following figure presents an UML model of Stack:

- *StackInterface* represents public functions of Stack, e.g., push a new item, pop an item.
- *Node* class represents an item (node) in Stack.
- *MyStack* class implements *StackInterface* and includes items that have *Node* type.

2.2. Class Diagram of Queue



The following figure presents an UML model of Queue:

- *QueueInterface* represents public functions of Queue, e.g., enqueue new item, dequeue an item.
- *Node* class represents an item (node) in Queue.
- *MyQueue* class implements *QueueInterface* and includes items have *Node* type.

Part II
Excercise

Responsibility of the students in this part:

- Complete all the exercises with the knowledge from **Part I**.
- Ask your lecturer if you have any question.
- Submit your solutions according to your lecturer requirement.

Exercise 1

We can implement Stack and Queue with Array, Linked List (via composition or inheritance), or from scratch with the ListNode (as the class diagrams in the previous session). In this Lab, you can choose one way you prefer to define the Stack ADT and Queue ADT. The **Stack** ADT and the **Queue** ADT need contain general data type **<E>**. Then, implement **Fraction** class and test your Stack and Queue.

After defining your Stack and Queue, apply them to solve the below Exercises.

Exercise 2

Compute the result of the following expression by using recursive approach and eliminate recursive by using **Stack**.

$$P(n) = \begin{cases} 2^n + n^2 + P(n-1), & \text{n} > 1 \\ 3, & \text{n} = 1 \end{cases}$$

Exercise 3

Write a program that reads in a sequence of characters and prints them in reverse order, using **Stack**.

Exercise 4

Write a program that reads in a sequence of characters, and determines whether its parentheses, braces, and curly braces are ”balanced”.

Hint: for left delimiters, *push* onto **Stack**; for right delimiters, *pop* from **Stack** and check whether popped element matches right delimiter.

Exercise 5

Show how to implement a **Queue** using two **Stack**.

Exercise 6

A palindrome is a word or a phrase that is spelled the same forward and backward. For example, ”dad” is a palindrome; ”A man, a plan, a canal: Panama” is a palindrome if you take out the spaces and ignore the punctuation.

Implement a program to determine whether an input is palindrome using one **<Character> Stack** and one **<Character> Queue**.