CM1602 : Data Structures and Algorithms for AI

5. Queue

Lecture 5 | R. Sivaraman

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MODULE CONTENT

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Learning Outcomes

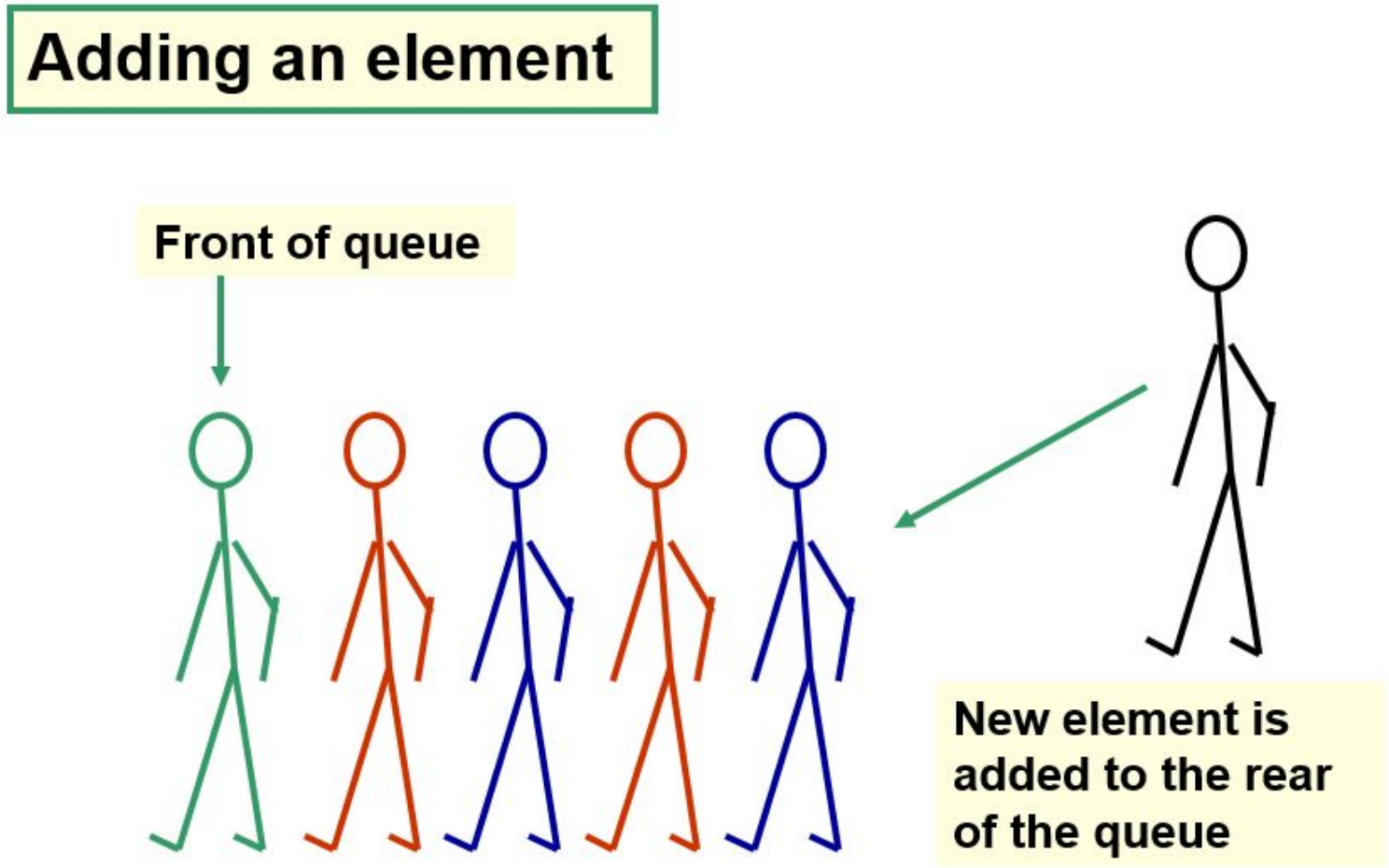
- LO1 : Describe the fundamental concepts of algorithms and data structures.
- LO3 : Apply appropriate data structures given a real-world problem to meet requirements of programming language APIs.
- On completion of this lecture, students are expected to be able to:
  - Describe Queues, types of queues and when queue is used
  - Implement Queue for a real life scenario

Introduction

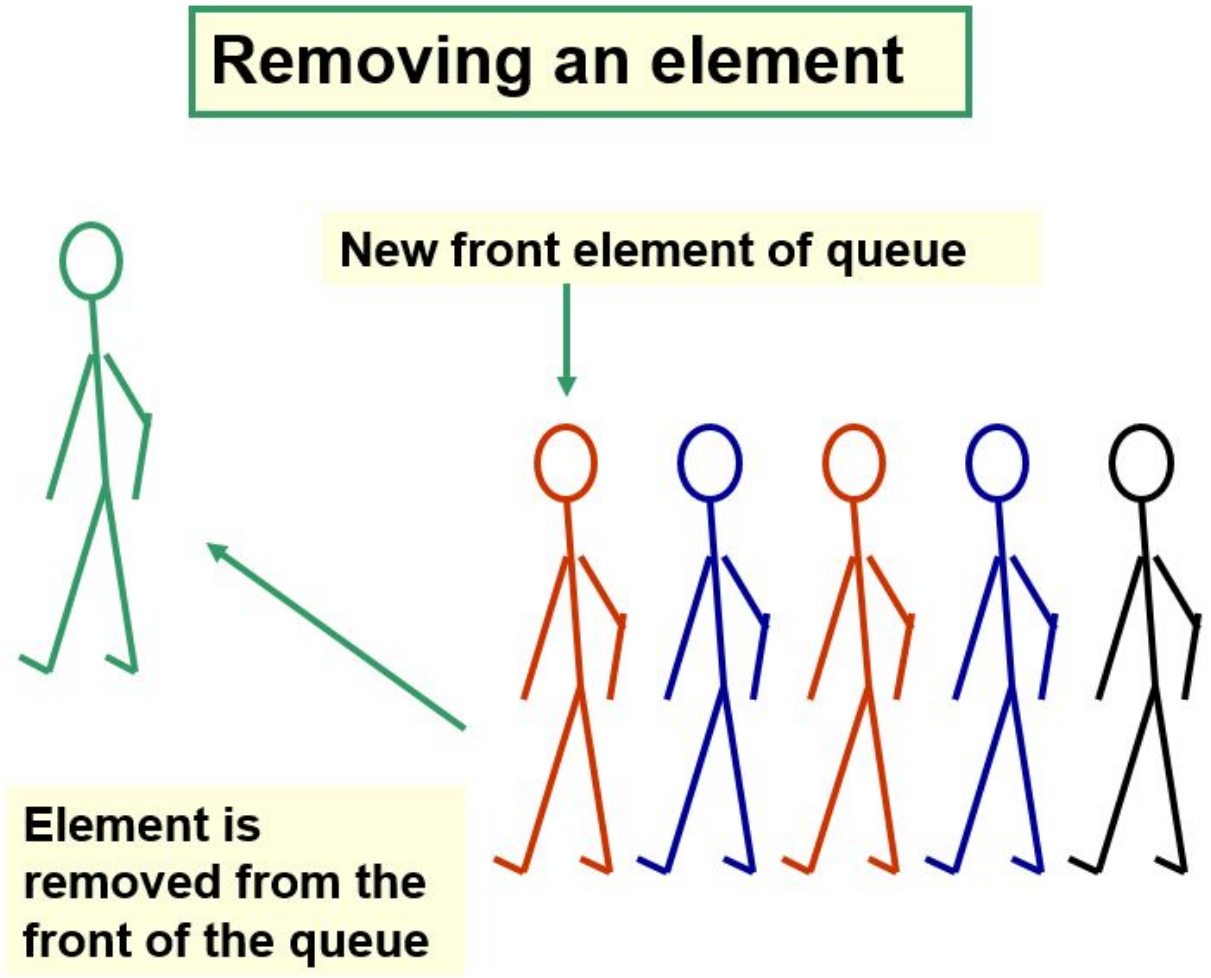
Introduction

- Queue: a collection whose elements are added to the rear of the queue and removed from the front of the queue
- A queue is a FIFO (first in, first out) data structure
- Any waiting line is a queue:
  - The check-out line at a grocery store
  - The cars at a stop light
  - An assembly line

Introduction



Introduction



Uses of Queues in Computing

- For any kind of problem involving FIFO data
- Printer queue (e.g. printer in MC 235)
- Keyboard input buffer
- GUI event queue (click on buttons, menu items)
- To encode messages (more on this later)

Queue Class

- Definitions:
  - Front
  - Rear
  - noOfItems
  - maxSize
  - queueArray

Queue Class

- Methods:
  - Enqueue
  - Dequeue
  - isFull
  - isEmpty

Queue Class

```
1  class Queue {
2      private int front;
3      private int rear;
4      private int noOfItems;
5      private int maxSize;
6      private int queueArray[];
7
8      public Queue(int size)
9      {
10         maxSize = size;
11         front = 0
12         rear = -1;
13         noOfItems = 0;
14         queueArray = new int[maxSize];
15     }
```

IsFull and IsEmpty methods

```
18      public boolean isFull()
19      {
20          return (rear == maxSize-1);
21      }
22
23
24      public boolean isEmpty()
25      {
26          return (noOfItems == 0);
27      }
28
```

Enqueue

- Method to add an element to the queue
- The element is added to the rear of the queue
- Steps:
  - Check if the queue is not full
  - Increment the rear
  - Add the element to the rear
  - Increment the noOfItems

Enqueue

```
30      public void enqueue(int item)
31      {
32          if (isFull())
33          {
34              System.out.println("The Queue is full");
35          }
36          else
37          {
38              queueArray[++rear] = item;
39              noOfItems++;
40          }
41      }
```

Dequeue

- Method to delete an element to the queue
- The element is deleted from the front of the queue
- Steps:
  - Check if the queue is not empty
  - Decrease the noOfItems
  - Return the value on the front
  - Increment the front

Dequeue

```
44      public int dequeue()
45      {
46          if (isEmpty())
47          {
48              System.out.println("The Queue is Empty");
49          }
50          else
51          {
52              noOfItems--;
53              return queueArray[front++];
54          }
55      }
```

Types of Queue

Simple Queue

- It defines the simple operation of queue in which insertion occurs at the rear of the list and deletion occurs at the front of the list

Types of Queue

Circular Queue

- Insertion and deletion is similar to simple queue but the Last node is connected back to the first node.
- It is an abstract data type and It is also known as Ring buffer

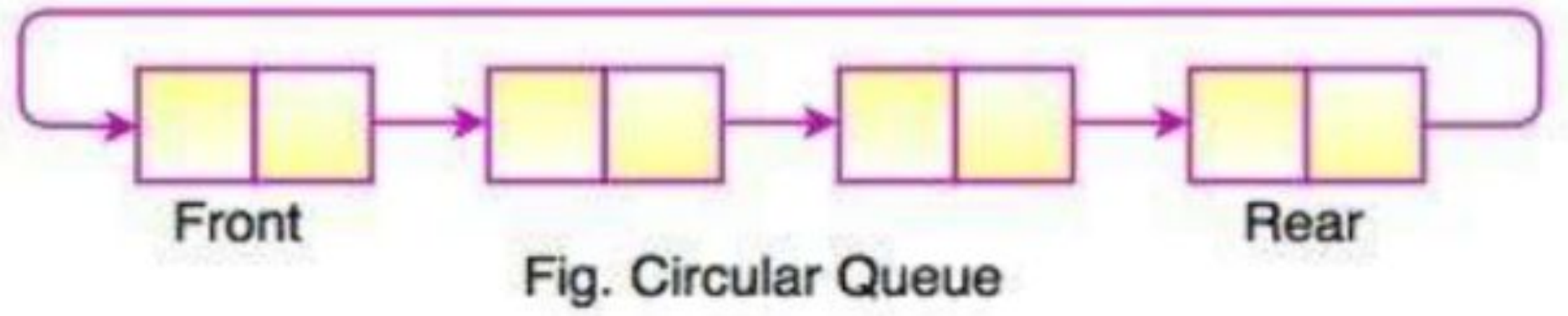


Fig. Circular Queue

Types of Queue

Circular Queue

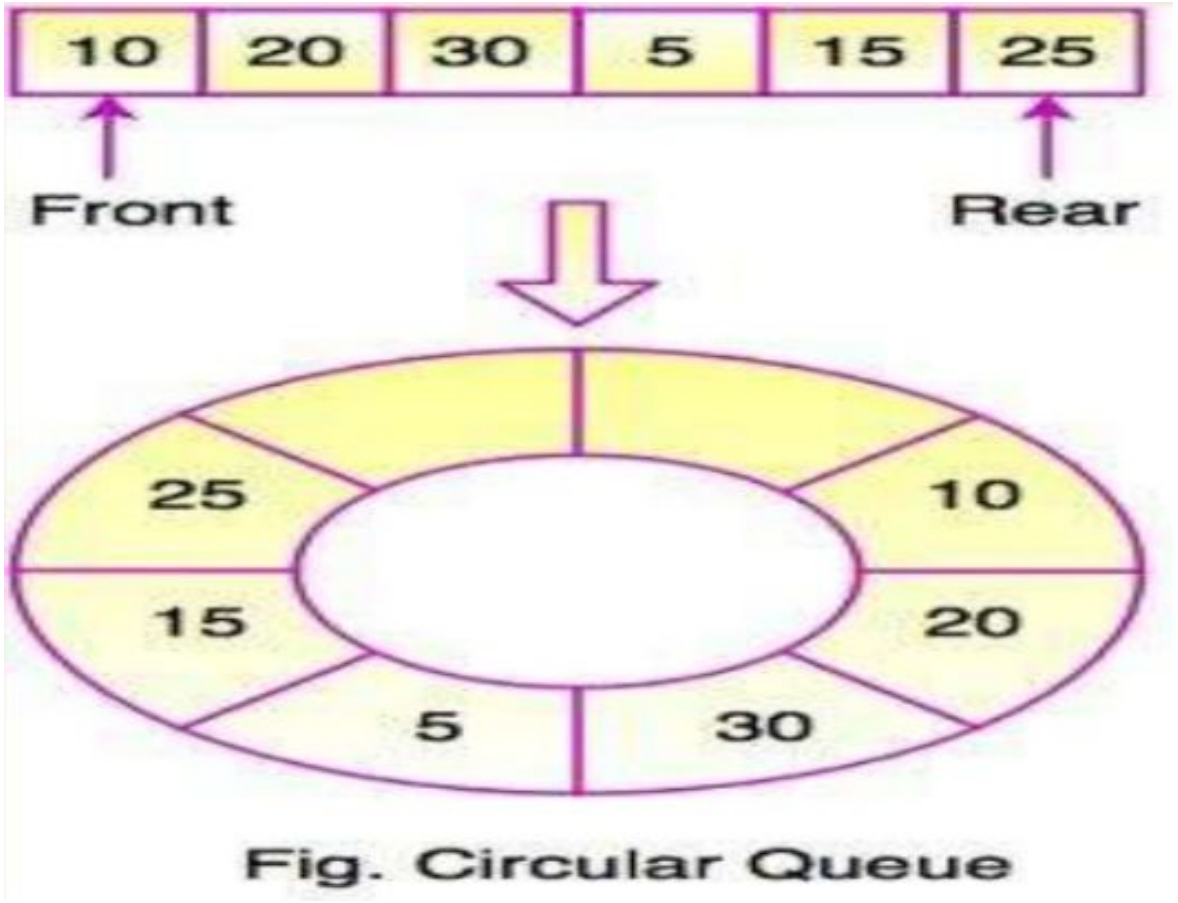


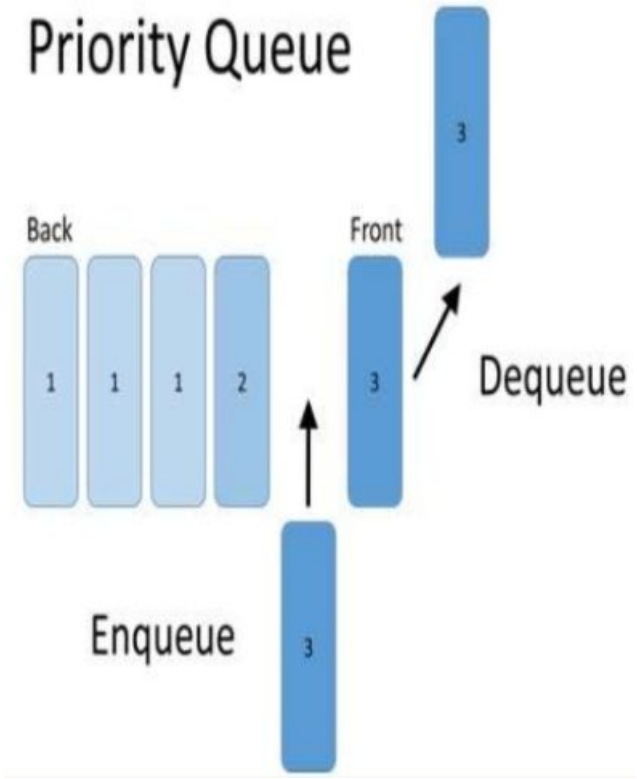
Fig. Circular Queue

Types of Queue

Priority Queue

- Priority Queue contains data items which have some preset priority
- While removing, data item with highest priority is removed first
- Insertion is performed in the order of arrival.

Types of Queue



Queue Implementation using Linked List

```
1  class QNode {
2      int key;
3      QNode next;
4
5      // constructor to create a new linked list node
6      public QNode(int key)
7      {
8          this.key = key;
9          this.next = null;
10     }
11 }
```

Queue Implementation using Linked List

```
14  class Queue {
15      QNode front, rear;
16
17      public Queue()
18      {
19          this.front = this.rear = null;
20      }
21
```

Queue Implementation using Linked List

```
22      // Method to add an key to the queue.
23      void enqueue(int key)
24      {
25
26          // Create a new LL node
27          QNode temp = new QNode(key);
28
29          // If queue is empty, then new node is front and rear both
30          if (this.rear == null) {
31              this.front = this.rear = temp;
32              return;
33          }
34
35          // Add the new node at the end of queue and change rear
36          this.rear.next = temp;
37          this.rear = temp;
38      }
```

Queue Implementation using Linked List

```
40      // Method to remove an key from queue.
41      void dequeue()
42      {
43          // If queue is empty, return NULL.
44          if (this.front == null)
45              return;
46
47          // Store previous front and move front one node ahead
48          QNode temp = this.front;
49          this.front = this.front.next;
50
51          // If front becomes NULL, then change rear also as NULL
52          if (this.front == null)
53              this.rear = null;
54      }
```