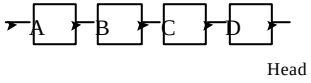
Queue

Queue

- New nodes can be added only to the rear
- Existing nodes can be removed only at the front
- First-in, first-out (FIFO)
- End of queue indicated by a link member to NULL
- Constrained version of a linked list

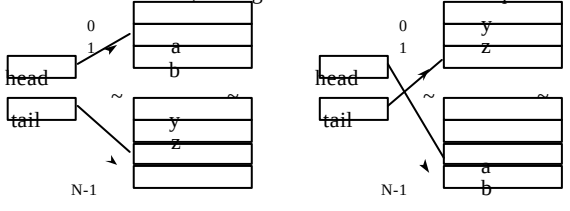


Enqueue & Dequeue

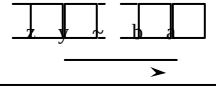
- **enqueue**
  - Adds a new node to the rear of the queue
- **dequeue**
  - Removes a node from the front of the queue
  - Stores and returns the dequeued value

Queues Using Arrays

- The circular list, or ring buffer is often used for a queue



tail is the index of the first free cell



Queues Using Arrays

- Insert at tail, if not full:

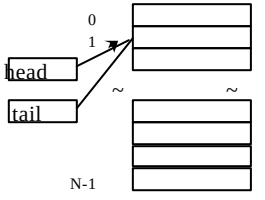
```
put data in cell tail;
tail = (tail+1) % N;
```

- Delete from head, if not empty:

```
remove data from cell head;
head = (head+1) % N;
```


Queues Using Arrays

- When the queue is either full or empty, the 2 indices have the same value, so we cannot distinguish these two cases.
- A better way is to use an index for the head, and a count of the number of cells occupied.



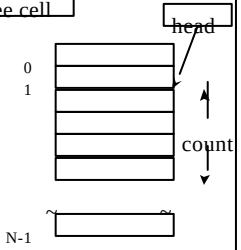
Queues Using Arrays

- ~~Code when we use an index for head and a~~ count: ~~(head+count)%N gives the first free cell~~
- ~~Insert at tail, if not full:~~

```
put data in cell (head+count)%N;
count++;
```

- ~~Delete from head, if not empty:~~

```
remove data from cell head;
head = (head+1) % N;
count--;
```

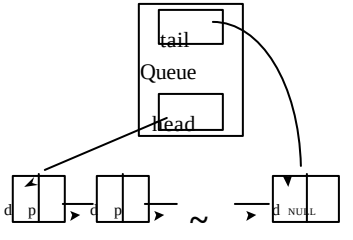


Queues Using Linked Lists

- In a queue, data is added at one end (the tail) and removed from the other end (the head). A linked list is adequate for ~~this purpose with the~~ addition of a pointer to the tail:

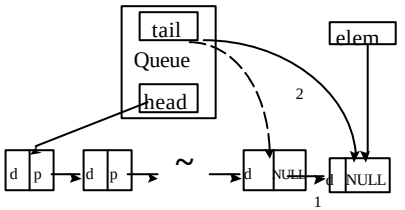
```
class Queue_node {
char * name;
int age;
  ~
Queue_node * next;
};
```

```
class Queue {
Queue_node * head;
Queue_node * tail;
};
```



Inserting at the Queue Tail

```
void add_to_tail(Queue_node * elem) {
    if(q.tail = = NULL)      /* queue is empty */
      q.head = q.tail = elem;
    else {
      q.tail -> next = elem;
      q.tail = elem;
}
```



Example 11A

```
/* 11 A
Operating and maintaining a queue */
#include<stdio.h>
#include<stdlib.h>
#include<conio.h>
struct queueNode{   /* self-referential structure */
   char data;
   struct queueNode *nextPtr;
};
typedef struct queueNode QueueNode;
typedef QueueNode *QueueNodePtr;
/* function prototypes */
void printQueue( QueueNodePtr );
int isEmpty( QueueNodePtr );
char dequeue( QueueNodePtr *, QueueNodePtr * );
void enqueue( QueueNodePtr *, QueueNodePtr *, char );
void instructions( void );
```


Example 11A (cont')

```
int main()
{
   QueueNodePtr headPtr = NULL, tailPtr = NULL;
   int choice;
   char item;

   instructions();
   printf( "? " );
   scanf( "%d", &choice );

   while ( choice != 3 ) {

     switch( choice ) {

        case 1:
           printf( "Enter a character: " );
           scanf( "\n%c", &item );
           enqueue( &headPtr, &tailPtr, item );
           printQueue( headPtr );
           break;
```


Example 11A (cont')

```
    case 2:
           if ( !isEmpty( headPtr ) ) {
             item = dequeue ( &headPtr, &tailPtr );
             printf( "%c has been dequeued.\n", item );
           }
           printQueue( headPtr );
           break;
        default:
           printf( "Invalid choice. \n\n" );
           instructions();
           break;
     }
     printf( "? " );
     scanf( "%d", &choice );
   }

   printf( "End of run. \n" );
   getch();
   return 0;
}
```

Example 11A (cont')

```
void instructions( void )
{   printf ( "Enter your choice:\n"
            "   1 to add an item to the queue\n"
            "   2 to remove an item from the queue \n"
            "   3 to end\n" );
}
void enqueue ( QueueNodePtr *headPtr, QueueNodePtr *tailPtr, char value )
{   QueueNodePtr newPtr;
  (void *) newPtr = malloc ( sizeof( QueueNode ) );
  if ( newPtr != NULL ) {
    newPtr->data = value;
    newPtr->nextPtr = NULL;
    if ( isEmpty( *headPtr) )
      *headPtr = newPtr;
    else
      ( *tailPtr )->nextPtr = newPtr;
    *tailPtr = newPtr;
  }
  else
    printf( "%c not inserted. No memory available\n", value );
}
```


Example 11A (cont')

```
char dequeue ( QueueNodePtr *headPtr, QueueNodePtr *tailPtr )
{
  char value;
  QueueNodePtr tempPtr;

  value = ( *headPtr )->data;
  tempPtr = *headPtr;
  *headPtr = ( *headPtr )->nextPtr;

  if ( *headPtr == NULL )
    *tailPtr = NULL;

  free( tempPtr );
  return value;
}

int isEmpty ( QueueNodePtr headPtr )
{
  return headPtr == NULL;
}
```


Example 11A (cont')

```
void printQueue( QueueNodePtr currentPtr )
{
  if (currentPtr == NULL )
    printf( "Queue is empty. \n\n" );
  else {
    printf( "The queue is:\n" );

    while ( currentPtr != NULL ) {
      printf( "%c --> ", currentPtr->data );
      currentPtr = currentPtr->nextPtr;
    }

    printf( "NULL\n\n" );
  }
}
```


Output Result