Stack: Linked List

```c
Stack initStack() {
  Stack s = (Stack) malloc(sizeof(StackType));
  s->top = NULL; return s; }
int empty(Stack S) {
  return (S->top == NULL); }
void push(Stack S, StackData d) {
  Node * n = (Node *)malloc(sizeof(Node));
  n->data = d; n->next = S->top; S->top = n; }
StackData pop(Stack S) {
  if(empty(S)) exit(1); // check empty
  StackData toReturn = S->top->data;
  Node * tmp = S->top;
  S->top = S->top->next;
  free(tmp);
  return toReturn; }
StackData peek(Stack S) {
  if(empty(S)) return BAD;
  return S->top->data; }
void freeStack(Stack S) {
  while(!empty(S)) pop(S);
  free(S); }
```

Queue: Array - head points 1 before head value

```c
Queue initQueue() {
  Queue q = malloc(sizeof(QueueType));
  q->head = 0; q->tail = 0; return q; }
int empty(Queue Q) { return (Q->head == Q->tail); }
void enqueue(Queue Q, QueueData d) {
  if (full(Q)) {
    printf("Queue full can’t add\n"); return;
  }
  Q->tail++;
  Q->tail = Q->tail % MAX_Q; // wrap
  Q->data[Q->tail] = d;
}
QueueData dequeue(Queue Q) {
  if (empty(Q)) {
    printf("queue empty\n"); exit(1);
  }
  Q->head++;
  Q->head = Q->head % MAX_Q; // wrap
  return Q->data[Q->head]; }
int full(Queue Q) {return (Q->tail % MAX_Q==Q->head-1);}
void freeQueue(Queue Q) { free(Q); }
int length(Queue Q) {
  if (Q->head <= Q->tail)
    return Q->tail - Q->head;
  else
    return MAX_Q - (Q->head - Q->tail); }
```

Print bases

```c
void printNumInBase(int base, int n) {
  char digits[] = "0123456789ABCDEFGHIJKLMOPQRSTUVWXYZ";
  if (n < 0) { printf("-"); printNumInBase(base, -1 * n);
  } else if (n < base) { printf("%c", digits[n]);
  } else {
    printNumInBase(base, n /base);
    printNumInBase(base, n %base);
}}
```

Sieve of Eratosthenes: O(n log(log n))

```c
int i, j; // make sure numbers are positive!!!
int max = atoi(argv[1]); int len = max + 1;
int prime_count = 0;
bool *hits = malloc(len * sizeof(bool));
  for (i = 0; i < len; i++)
   hits[i] = false;   // clear hits array
// it. In arr till sqrt(len), mark off multiples of primes
for (i = 2; i * i <= len; i++) {
  if (!hits[i]) { // mark off its multiples in hits
    for (j = i; j < len; j++) { hits[j * i] = true; }
for (i = 2; i < len; i++) if (!hits[i]) printf("%d\n", i);
free(hits); // /\ prints primes
```

Russian Peasant Algorithm

```c
int peasant(int a, int b) {
  if (b == 1) return a;
  if(b % 2 == 0) return peasant(a*2, b/2);
  return peasant(a*2, b/2) + a; }
```

GCD

```c
int gcd(int a, int b) {
  if (b == 0) return a;
  return gcd(b, a % b); }
```

Sum Digits

```c
int sumDigits(int n) {
  if (n == 0) return 0;
  return sumDigits(n - 1) + n; }
```

Palindrome ----------------

```c
int is_palindrome(char *str, int s, int e) {
  if (s >= e) { return 1;
  } else if (str[s] != str[e]) { return 0;
  } else {
    return is_palindrome(str, s + 1, e - 1);
    return result;
  }
}
```

Merge sorted linked lists

```c
Node *merge(Node *list1, Node *list2) {
  if (list1 == NULL) { return copyList(list2);
  } else if (list2 == NULL) { return copyList(list1);
  } else if (list1->num < list2->num) {
    return makeNode(list1->num, merge(list1->next, list2));
  } else {
    return makeNode(list2->num, merge(list1, list2->next));
  }}
```

Postfix calculator

```c
for (i = 0; exp[i]; ++i) {
        if (isdigit(exp[i])) push(stack, exp[i] - '0');
        Else {
            int val1 = pop(stack);
            int val2 = pop(stack);
            switch (exp[i]) {
            case '+': push(stack, val2 + val1); break;
            case '-': push(stack, val2 - val1); break;
            case '*': push(stack, val2 * val1); break;
            case '/': push(stack, val2/val1); break;
            }
        }
    }
    return pop(stack); }
```

Linked List insert in order

```c
void insertInOrder(int n, Node ** list_ptr) {
  Node * list = *list_ptr;
  while (list != NULL) {
    if (n < list->num) { list = list->next;}
    else { list->next = makeNode(n, list->next); return; }
}  }
```

Reverse

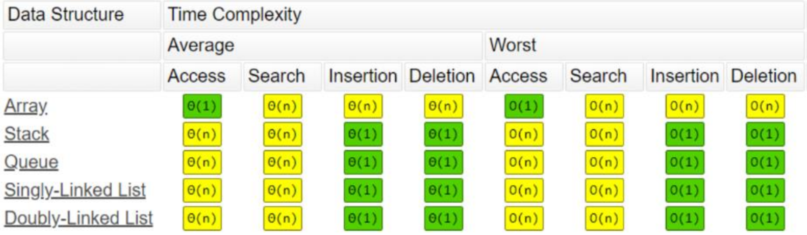
```c
void RecursiveReverse(struct node** headRef) {
  struct node* first; struct node* rest;
  if (*headRef == NULL) return; // empty list base case
  first = *headRef; rest = first->next;
  if (rest == NULL) return;
  RecursiveReverse(&rest);
  first->next->next = first;
  first->next = NULL;
  *headRef = rest; }
```

Pair Matching

```c
int i;
Stack s = initStack();
  for (i = 0; i < numread; i++) {
    if ('[' == input[i] || '(' == input[i]) {
    push(s, input[i]);
  } else if (']' == input[i]) {
    if (pop(s) != '[') { printf("no\n"); return; }
  } else if (')' == input[i]) {
    if (pop(s) != '(') { printf("no\n"); return; }
  }
}
if (empty(s)) { printf("yes\n");
} else { printf("no\n"); }
```

Count occurrences in Linked List ------------------------

```c
int countR(Node * top, int n) {
  if (top == NULL) return 0;
  if (top->num == n)  return count(top->next, n) + 1;
  else return count(top->next, n);}
```



Data Structure	Time Complexity							
	Average				Worst			
	Access	Search	Insertion	Deletion	Access	Search	Insertion	Deletion
Array	Θ(1)	Θ(n)	Θ(n)	Θ(n)	O(1)	O(n)	O(n)	O(n)
Stack	Θ(n)	Θ(n)	Θ(1)	Θ(1)	O(n)	O(n)	O(1)	O(1)
Queue	Θ(n)	Θ(n)	Θ(1)	Θ(1)	O(n)	O(n)	O(1)	O(1)
Singly-Linked List	Θ(n)	Θ(n)	Θ(1)	Θ(1)	O(n)	O(n)	O(1)	O(1)
Doubly-Linked List	Θ(n)	Θ(n)	Θ(1)	Θ(1)	O(n)	O(n)	O(1)	O(1)

```
Node *makeNode(int n, Node *nextItem) {
  Node *ret = (Node *)malloc(sizeof(Node));
  ret->num = n; ret->next = nextItem;
  return ret; }
```

Insert head:

```
*listPtr = makeNode(n, *listPtr); // top points at new node
```

Insert Tail

```
void insertTail(int n, Node **listPtr) {
  Node *list = *listPtr;
  if (list == NULL) {*listPtr = makeNode(n, NULL); return; }
  while (list != NULL) {
    if (list->next == NULL)
        list->next = makeNode(n, NULL);
        return;
    }
    list = list->next;}}
```

Delete --------

```
int delete (Node *toDelete, Node **listPtr) {
  Node *list = *listPtr;
  if (toDelete == NULL || list == NULL) {return 0;}
  if (toDelete == list) {
    *listPtr = list->next; free(toDelete); return 1;
  }
  Node *before = list; list = list->next;
  while (list != NULL) {
    if (toDelete == list) {
      before->next = list->next; free(list); return 1;
    }
    before = list; list = list->next;
  }
  return 0; // toDelete not found
}
```

False is 0; True is != 0

```
O(log n) - binary search
for(i=0; i*i < n; i++) { //something in constant time...}
O(n log n)
for (i = 0; i < n; i++) {      // linear loop  O(n) * ...
  for (j = 1; j*j < n; j++) {  // ...log (n)
    // do something in constant time... }}
```

3	6	14	15	18	20	22	35	37	39	40	41	45	57	60	62

```
bin(int firstIndex, int lastIndex); // for 41
bin(0, 15); bin(8, 15);
bin(8, 11); bin(10, 11);bin(11, 11);
```

```
O(1)
O(log n) - for (i=0; i<n; i*=2)
  binary search
O(n^(0.5)) - for(i = 0; i * i < n; i++)
O(n)
  single iteration
O(n log n)
  heapsort
  merge sort
  Quick sort
O(n^2)
  insertion sort
  selectin sort
O(2^n)
  recursion: towers of Hanoi
  scheduling
O(n!)
O(n^3):
for(i = 0; i < n; i++)
  for(j = 0; j < n; j++)
    for(k = 0; k < j; k++)
O(n log n):
for(i = 0; i < n; i++)
  for(j = 1; j < n; j = j*2)
```

Circular Linked List

```
Node * top = NULL;
Node * tail = makeNode(3, top);
makeNode(2, top);
makeNode(1, tail);
void printList(struct Node *first) {
 struct Node *temp = first;
   if (first != NULL)
     do { temp = temp->next; } while (temp != first); }
```

gdb:

```
info break
backtrace
cont
print
step
break [line]
info frame
```

Hanoi:

```
void t(int n, char from_rod, char to_rod, char aux_rod) {
    if (n == 1) return;
    t(n-1, from_rod, aux_rod, to_rod);
    t(n-1, aux_rod, to_rod, from_rod); }
```

QUEUES arrays:

ARR[SIZE] means the queue can hold 9 values but the data array which the queue values are stored in can be full (with 10 values). When full, the value currently pointed to by head is not actually in the queue. Queue is empty when head == tail, full when tail % SIZE == head - 1.

Repeated Div:

```
for (i = 2; i <= max; i++) {
  int found_prime = 1;
    for (j = 2; j * j <= i; j++) {
      if (i % j == 0){ found_prime = 0;  break; }
    }
    if (found_prime) printf("%d\n", i); // print prime
  }
```