Ex 16: Hashing

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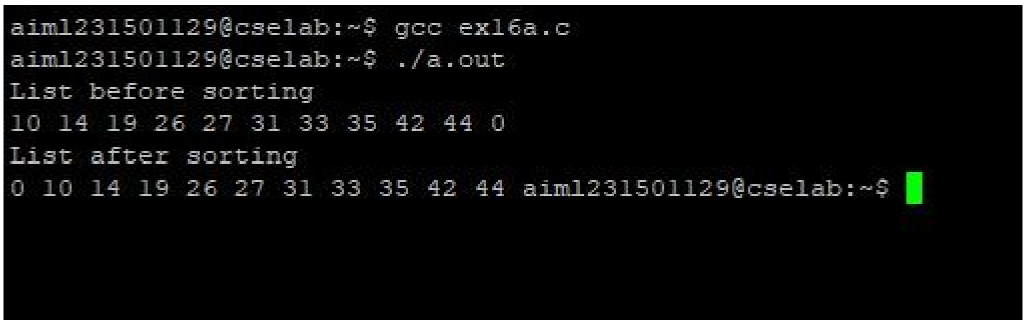
OPEN ADDRESING:

```
#include <stdio.h>

#define max 10

int a[11] = { 10, 14, 19, 26, 27, 31, 33, 35, 42, 44, 0 };
int b[10];

void merging(int low, int mid, int high) {
  int l1, l2, i;

  for(l1 = low, l2 = mid + 1, i = low; l1 <= mid && l2 <= high; i++) {
    if(a[l1] <= a[l2])
      b[i] = a[l1++];
    else
      b[i] = a[l2++];
  }

  while(l1 <= mid)
    b[i++] = a[l1++];

  while(l2 <= high)
```

```
      b[i++] = a[l2++];

   for(i = low; i <= high; i++)
      a[i] = b[i];
}

void sort(int low, int high) {
   int mid;

   if(low < high) {
      mid = (low + high) / 2;
      sort(low, mid);
      sort(mid+1, high);
      merging(low, mid, high);
   } else {
      return;
   }
}

int main() {
   int i;

   printf("List before sorting\n");

   for(i = 0; i <= max; i++)
      printf("%d ", a[i]);
```

```
  sort(0, max);


  printf("\nList after sorting\n");


  for(i = 0; i <= max; i++)
     printf("%d ", a[i]);
}
```

OUTPUT:



```
aiml231501129@cselab:~$ gcc ex16a.c
aiml231501129@cselab:~$ ./a.out
List before sorting
10 14 19 26 27 31 33 35 42 44 0
List after sorting
0 10 14 19 26 27 31 33 35 42 44 aiml231501129@cselab:~$
```

CLOSED ADDRESING:

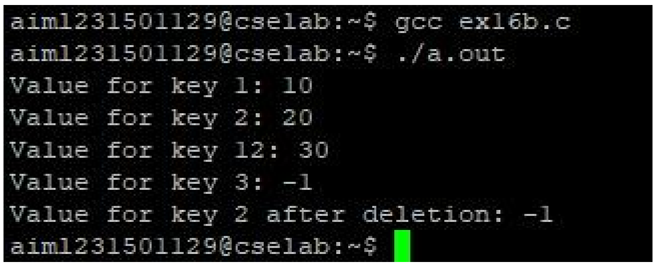
PROGRAM:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
typedef struct Node {
   int key;
   int value;
   struct Node* next;
} Node;
typedef struct HashTable {
   int size;
   Node** table;
```

```
} HashTable;
Node* createNode(int key, int value) {
    Node* newNode = (Node*)malloc(sizeof(Node));
    newNode->key = key;
    newNode->value = value;
    newNode->next = NULL;
    return newNode;
}
HashTable* createTable(int size) {
    HashTable* newTable = (HashTable*)malloc(sizeof(HashTable));
    newTable->size = size;
    newTable->table = (Node**)malloc(sizeof(Node*) * size);
    for (int i = 0; i < size; i++) {
        newTable->table[i] = NULL;
    }
    return newTable;
}
int hashFunction(int key, int size) {
    return key % size;
}
void insert(HashTable* hashTable, int key, int value) {
    int hashIndex = hashFunction(key, hashTable->size);
    Node* newNode = createNode(key, value);
    newNode->next = hashTable->table[hashIndex];
    hashTable->table[hashIndex] = newNode;
}
int search(HashTable* hashTable, int key) {
    int hashIndex = hashFunction(key, hashTable->size);
    Node* current = hashTable->table[hashIndex];
    while (current != NULL) {
        if (current->key == key) {
            return current->value;
        }
        current = current->next;
    }
    return -1;
}
void delete(HashTable* hashTable, int key) {
    int hashIndex = hashFunction(key, hashTable->size);
    Node* current = hashTable->table[hashIndex];
    Node* prev = NULL;
    while (current != NULL && current->key != key) {
        prev = current;
        current = current->next;
    }
    if (current == NULL) {
        return;
    }
    if (prev == NULL) {
        hashTable->table[hashIndex] = current->next;
    } else {
        prev->next = current->next;
    }
    free(current);
```

```
}
void freeTable(HashTable* hashTable) {
    for (int i = 0; i < hashTable->size; i++) {
        Node* current = hashTable->table[i];
        while (current != NULL) {
            Node* temp = current;
            current = current->next;
            free(temp);
        }
    }
    free(hashTable->table);
    free(hashTable);
}
int main() {
    HashTable* hashTable = createTable(10);

    insert(hashTable, 1, 10);
    insert(hashTable, 2, 20);
    insert(hashTable, 12, 30);

    printf("Value for key 1: %d\n", search(hashTable, 1));
    printf("Value for key 2: %d\n", search(hashTable, 2));
    printf("Value for key 12: %d\n", search(hashTable, 12));
    printf("Value for key 3: %d\n", search(hashTable, 3));

    delete(hashTable, 2);
    printf("Value for key 2 after deletion: %d\n", search(hashTable, 2));
    freeTable(hashTable);

    return 0;

}
```

OUTPUT:



```
aiml231501129@cselab:~$ gcc ex16b.c
aiml231501129@cselab:~$ ./a.out
Value for key 1: 10
Value for key 2: 20
Value for key 12: 30
Value for key 3: -1
Value for key 2 after deletion: -1
aiml231501129@cselab:~$
```

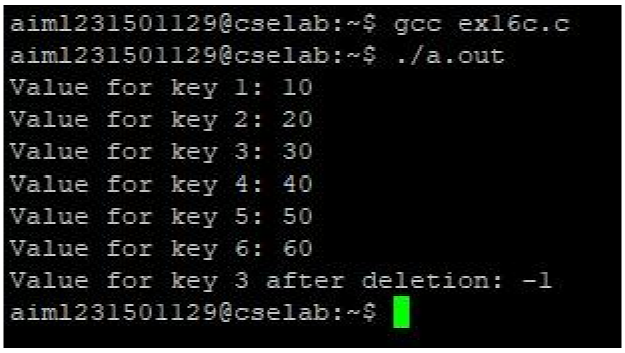
REHASHING:

PROGRAM:

```
#include <stdio.h>

#include <stdlib.h>


typedef struct Node {

    int key;

    int value;

    struct Node* next;

} Node;


typedef struct HashTable {

    int size;

    int count;

    Node** table;

} HashTable;
```

```
Node* createNode(int key, int value) {
    Node* newNode = (Node*)malloc(sizeof(Node));
    newNode->key = key;
    newNode->value = value;
    newNode->next = NULL;
    return newNode;
}

HashTable* createTable(int size) {
    HashTable* newTable = (HashTable*)malloc(sizeof(HashTable));
    newTable->size = size;
    newTable->count = 0;
    newTable->table = (Node**)malloc(sizeof(Node*) * size);
    for (int i = 0; i < size; i++) {
        newTable->table[i] = NULL;
    }
    return newTable;
}

int hashFunction(int key, int size) {
    return key % size;
}

void insert(HashTable* hashTable, int key, int value);

void rehash(HashTable* hashTable) {
    int oldSize = hashTable->size;

    Node** oldTable = hashTable->table;

    int newSize = oldSize * 2;

    hashTable->table = (Node**)malloc(sizeof(Node*) * newSize);

    hashTable->size = newSize;

    hashTable->count = 0;

    for (int i = 0; i < newSize; i++) {

        hashTable->table[i] = NULL;

    }


    for (int i = 0; i < oldSize; i++) {

        Node* current = oldTable[i];

        while (current != NULL) {

            insert(hashTable, current->key, current->value);

            Node* temp = current;

            current = current->next;

            free(temp);

        }

    }


    free(oldTable);

}


void insert(HashTable* hashTable, int key, int value) {

    if ((float)hashTable->count / hashTable->size >= 0.75) {

        rehash(hashTable);

    }
    int hashIndex = hashFunction(key, hashTable->size);
    Node* newNode = createNode(key, value);
    newNode->next = hashTable->table[hashIndex];
    hashTable->table[hashIndex] = newNode;
    hashTable->count++;
}

int search(HashTable* hashTable, int key) {
    int hashIndex = hashFunction(key, hashTable->size);
    Node* current = hashTable->table[hashIndex];
    while (current != NULL) {
        if (current->key == key) {
            return current->value;
        }
        current = current->next;
    }
    return -1;
}

void delete(HashTable* hashTable, int key) {
    int hashIndex = hashFunction(key, hashTable->size);
    Node* current = hashTable->table[hashIndex];
    Node* prev = NULL;
    while (current != NULL && current->key != key) {
        prev = current;
        current = current->next;
    }
    if (current == NULL) {
        return;
    }
    if (prev == NULL) {
        hashTable->table[hashIndex] = current->next;
    } else {
        prev->next = current->next;
    }
    free(current);
    hashTable->count--;
}

void freeTable(HashTable* hashTable) {
    for (int i = 0; i < hashTable->size; i++) {
        Node* current = hashTable->table[i];
        while (current != NULL) {
            Node* temp = current;
            current = current->next;
            free(temp);
        }
    }
    free(hashTable->table);
    free(hashTable);
}

int main() {
    HashTable* hashTable = createTable(5);


    insert(hashTable, 1, 10);

    insert(hashTable, 2, 20);

    insert(hashTable, 3, 30);

    insert(hashTable, 4, 40);

    insert(hashTable, 5, 50);

    insert(hashTable, 6, 60);


    printf("Value for key 1: %d\n", search(hashTable, 1));

    printf("Value for key 2: %d\n", search(hashTable, 2));

    printf("Value for key 3: %d\n", search(hashTable, 3));

    printf("Value for key 4: %d\n", search(hashTable, 4));

    printf("Value for key 5: %d\n", search(hashTable, 5));

    printf("Value for key 6: %d\n", search(hashTable, 6));


    delete(hashTable, 3);

    printf("Value for key 3 after deletion: %d\n", search(hashTable, 3));


    freeTable(hashTable);

    return 0;

}
```

OUTPUT:



```
aiml231501129@cselab:~$ gcc ex16c.c
aiml231501129@cselab:~$ ./a.out
Value for key 1: 10
Value for key 2: 20
Value for key 3: 30
Value for key 4: 40
Value for key 5: 50
Value for key 6: 60
Value for key 3 after deletion: -1
aiml231501129@cselab:~$
```