CSED 2014

Hashing
Equivalent Classes

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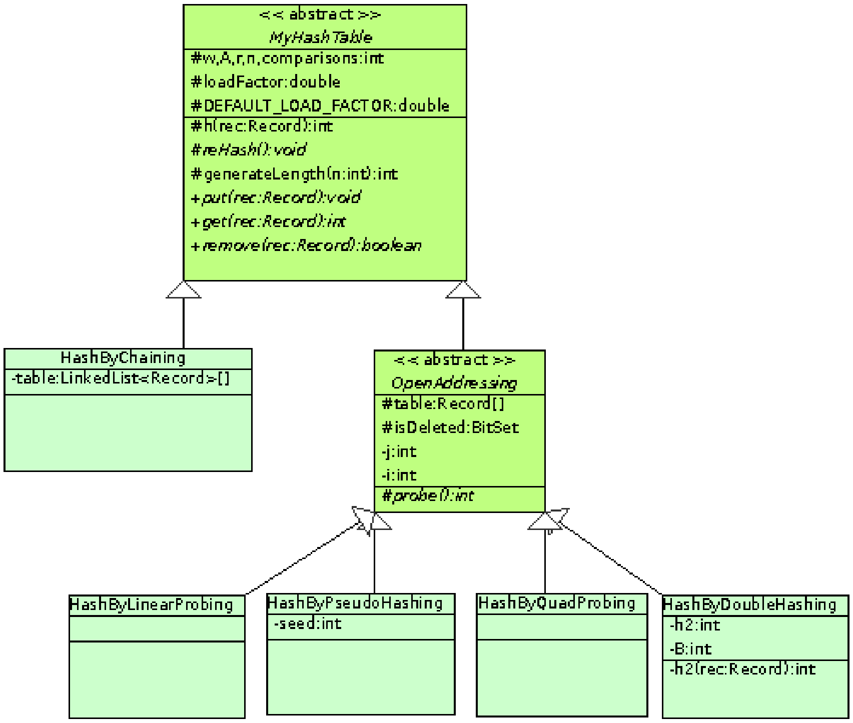
12

UML :



Algotithms :

Hashing algorithms:

```
h1(Record rec) //primary hashing function based on name field
        k <- rec.getName().hashCode();
        //A*k mod 2^w >> (w-r)
        //taking the mod to  2^w = taking the w bits from the number
        return A*k >> (w-r);

h2(Record rec) //secondary hashing used in DoubleHashing
         k <- rec.getName().hashCode();
        h2 = (A*k + B)% (1<<r);
        //where A and B are Primes
        return h2;
```

Algorithm : ReHash()

```
    make a new table with double size
    re-put all entries in the old table
```

Hash By Chaning

```
Algorithm : put (Record rec)
    index <- h(rec);
    add record to table at index ;
    comparisons <- 0;
    loadFactor <- ++n / (1<<r) ;
    if (loadFactor > DEFAULT_LOAD_FACTOR)
        reHash() ;

Algorithm : get(Record rec)
    comparisons <- 0;
    index <- h(rec);
        for (all entries at index in table){
            comparisons++;
            if (rec == entry)return index;
        }
    //if didn't return at the for loop it means that rec is not found in the table;
    return comparisons =-1 ;

Algorithm : Remove(Record rec)
    index = h(rec);
    comparisons = 0;

        for (all entries at index in table){
            if (rec== entry)
                comparisons++;
                remove rec from table;
                return true;
        }
        //if didn't return in the for loop then rec was not found in the table
        comparisons = -1;
        return false ;
```

Open Addressing Class

```
Algorithm : put(Record rec)
    h <- h(rec);
    index <- h;
    j = comparisons <- 0 ; // j is the number of collisions
    while(table[index]!=null  &&  record at index is not marked for deletion){
        index <- probe(h,j++);
        comparisons++;
    }
    table[index] <- rec ;

    loadFactor <- ++n / (1<<r) ;
    if (loadFactor > DEFAULT_LOAD_FACTOR)
        reHash() ;

Algorithms : get(Record rec)
    // To improve, when an element is searched and found in the table,
    // the element is relocated to the first location marked for deletion
    // that was probed during the search.

    h = h(rec);
    int i <- h;
    j == comparisons <- 0 ;
    int firstDeleted <- -1;
    boolean found = false ;

    //don't have to check that # of probes < length  as i rehash when the load factor > 0.7
    // for sure i'll find an empty slot

        while(table[i] != null){
                comparisons++;
                if (record was marked for deletion)
                    if (firstDeleted == -1)
                        firstDeleted = i;
                    i <- probe(h,j++);

                else
                    found = rec.equals(table[i]);
                    // update the table
                    if (found && firstDeleted != -1)
                        table[firstDeleted] = rec ;
                    break;

        }

        if (found)
            return i;
        else
```

```
            return comparisons = -1;
```

```
Algorithm : remove(Record rec)
    index <- get(rec);
    if (found)
        return false;

    mark entry as deleted
    n--;
    return true;
```

Linear Probing Class

```
Algorithm : probe(int i, int j)
    return (i+j)%(1<<r);
```

Quad Probing Class

```
Algorithm : probe(int i, int j)
    return (i+j*j)%(1<<r);
```

Double Hashig Class

```
Algorithm : probe(int i, int j)
    return h+j*h2;
```

pseudo Random Probing Class

```
Algorithm : probe(int i, int j)
    return (seed*(h+j) + j*7549 )%(1<<r);
```

DataStrucures :

BitSet : to mark entries in the table as deleted (in open addressing classes)

Order comparison

hashing by external Chaining
memory : n records + n links (int size links)
order : \theta (1 + \alpha) == O(m)
where m is the table size

hashing by open Addressing
memory : n records
order : \theta (1/(1-\alpha))