

## hashtable.cm

```
/*  
  
    Copyright (c) 2012–2016 Seppo Laakko  
    http://sourceforge.net/projects/cmajor/  
  
    Distributed under the GNU General Public License, version 3 (GPLv3).  
    (See accompanying LICENSE.txt or http://www.gnu.org/licenses/gpl.html  
    )  
  
*/  
  
// Copyright (c) 1994  
// Hewlett-Packard Company  
// Copyright (c) 1996  
// Silicon Graphics Computer Systems, Inc.  
// Copyright (c) 2009 Alexander Stepanov and Paul McJones  
  
using System;  
using System.Collections;  
  
namespace System.Collections  
{  
    public static class HashtablePrimes  
    {  
        static nothrow HashtablePrimes()  
        {  
            try  
            {  
                primes.Reserve(26);  
                primes.Add(53);  
                primes.Add(97);  
                primes.Add(193);  
                primes.Add(389);  
                primes.Add(769);  
                primes.Add(1543);  
                primes.Add(3079);  
                primes.Add(6151);  
                primes.Add(12289);  
                primes.Add(24593);  
                primes.Add(49157);  
                primes.Add(98317);  
                primes.Add(196613);  
                primes.Add(393241);  
                primes.Add(786433);  
                primes.Add(1572869);  
                primes.Add(3145739);  
                primes.Add(6291469);  
                primes.Add(12582917);  
                primes.Add(25165843);  
            }  
            catch { }  
        }  
    }  
}
```

```

        primes.Add(50331653);
        primes.Add(100663319);
        primes.Add(201326611);
        primes.Add(402653189);
        primes.Add(805306457);
        primes.Add(1610612741);
    }
    catch (const Exception& ex)
    {
        try
        {
            Console.Error() << "hashtable primes initialization
                                failed" << endl();
        }
        catch (const Exception&)
        {
        }
        exit(1);
    }
}

public static nothrow int GetNextPrime(int n)
{
    List<int>.ConstIterator p = LowerBound(primes.CBegin(),
        primes.CEnd(), n);
    if (p < primes.CEnd())
    {
        return *p;
    }
    return primes.Back();
}

private static List<int> primes;
}

public nothrow inline ulong GetHashCode(long x)
{
    return cast<ulong>(x);
}

public nothrow inline ulong GetHashCode(ulong x)
{
    return x;
}

public nothrow inline ulong GetHashCode(char x)
{
    return cast<ulong>(x);
}

public nothrow inline ulong GetHashCode(void* x)
{
    return cast<ulong>(x);
}

```

```

public nothrow inline ulong GetHashCode(const string& s)
{
    ulong hashCode = 14695981039346656037u;
    for (char c : s)
    {
        hashCode = hashCode ^ cast<ulong>(c);
        hashCode = hashCode * 1099511628211u;
    }
    return hashCode;
}

public class Hasher<T>: UnaryFun<T, ulong>
{
    public nothrow inline ulong operator()(const T& x)
    {
        return GetHashCode(x);
    }
}

public class Bucket<T> where T is Semiregular
{
    public typedef T ValueType;

    public Bucket(const ValueType& value_, Bucket<ValueType>* next_):
        value(value_), next(next_)
    {
    }
    public nothrow inline const ValueType& Value() const
    {
        return value;
    }
    public nothrow inline ValueType& Value()
    {
        return value;
    }
    public nothrow inline Bucket<ValueType>* Next() const
    {
        return next;
    }
    public nothrow void SetNext(Bucket<ValueType>* next_)
    {
        next = next_;
    }
    private ValueType value;
    private Bucket<ValueType>* next;
}

public abstract class HashtableBase<T> where T is Semiregular
{
    public typedef T ValueType;

    public default nothrow HashtableBase();
    public default nothrow HashtableBase(const HashtableBase<T>&);

```

```

    public default nothrow HashtableBase(HashtableBase<T>&&);
    public default nothrow void operator=(const HashtableBase<T>&);
    public default nothrow void operator=(HashtableBase<T>&&);
    public virtual nothrow ~HashtableBase()
    {
    }
    public abstract nothrow int GetBucketCount() const;
    public abstract nothrow int GetBucketIndex(const ValueType& value
        ) const;
    public abstract nothrow Bucket<ValueType>* GetBucket(int index)
        const;
}

public class HashtableIterator<T, R, P>
{
    public typedef T ValueType;
    public typedef R ReferenceType;
    public typedef P PointerType;
    public typedef HashtableIterator<ValueType, ReferenceType,
        PointerType> Self;

    public nothrow HashtableIterator(): table(null), bucket(null)
    {
    }
    public nothrow HashtableIterator(HashtableBase<ValueType>* table_,
        Bucket<ValueType>* bucket_): table(table_), bucket(bucket_)
    {
    }
    public nothrow ReferenceType operator*()
    {
        #assert(bucket != null);
        return bucket->Value();
    }
    public nothrow PointerType operator->() const
    {
        #assert(bucket != null);
        return &(bucket->Value());
    }
    public nothrow Self& operator++()
    {
        #assert(bucket != null && table != null);
        Bucket<ValueType>* old = bucket;
        bucket = bucket->Next();
        if (bucket == null)
        {
            int index = table->GetBucketIndex(old->Value());
            #assert(index != -1);
            ++index;
            int n = table->GetBucketCount();
            while (bucket == null && index < n)
            {
                bucket = table->GetBucket(index);
                ++index;
            }
        }
    }
}

```

```

    }
    }
    return *this;
}
public nothrow inline Bucket<ValueType>* GetBucket() const
{
    return bucket;
}
private HashtableBase<ValueType>* table;
private Bucket<ValueType>* bucket;
}

public nothrow bool operator==(T, R, P>)(const HashtableIterator<T, R,
P>& left, const HashtableIterator<T, R, P>& right)
{
    return left.GetBucket() == right.GetBucket();
}

public class Hashtable<KeyType, ValueType, KeyOfValue, HashFun =
Hasher<KeyType>, Compare = EqualTo<KeyType>> : HashtableBase<
ValueType>
where KeyType is Semiregular and ValueType is Semiregular and
KeySelectionFunction<KeyOfValue, KeyType, ValueType> and
HashFunction<HashFun, KeyType> and Compare is Relation and
Compare.Domain is KeyType
{
    public typedef Hashtable<KeyType, ValueType, KeyOfValue, HashFun,
Compare> Self;
    public typedef HashtableIterator<ValueType, ValueType&, ValueType
*> Iterator;
    public typedef HashtableIterator<ValueType, const ValueType&,
const ValueType*> ConstIterator;

    public nothrow Hashtable(): base(), buckets(), count(0),
loadFactor(0.0), maxLoadFactor(0.8), keyOf(), hash(), equal()
    {
    }
    public Hashtable(const Self& that)
    {
        CopyFrom(that);
    }
    public default nothrow Hashtable(Self&&);
    public void operator=(const Self& that)
    {
        Clear();
        CopyFrom(that);
    }
    public default nothrow void operator=(Self&&);
    public nothrow override ~Hashtable()
    {
        Clear();
    }
    public nothrow inline int Count() const

```

```

{
    return count;
}
public nothrow inline bool IsEmpty() const
{
    return count == 0;
}
public nothrow void Clear()
{
    int n = buckets.Count();
    for (int i = 0; i < n; ++i)
    {
        Bucket<ValueType>* bucket = buckets[i];
        while (bucket != null)
        {
            Bucket<ValueType>* next = bucket->Next();
            delete bucket;
            bucket = next;
        }
        buckets[i] = null;
    }
    count = 0;
}
public nothrow Iterator Begin()
{
    return Iterator(this, GetFirstBucket());
}
public nothrow ConstIterator Begin() const
{
    return ConstIterator(this, GetFirstBucket());
}
public nothrow ConstIterator CBegin() const
{
    return ConstIterator(this, GetFirstBucket());
}
public nothrow Iterator End()
{
    return Iterator(this, null);
}
public nothrow ConstIterator End() const
{
    return ConstIterator(this, null);
}
public nothrow ConstIterator CEnd() const
{
    return ConstIterator(this, null);
}
public nothrow void SetMaxLoadFactor(double maxLoadFactor_)
{
    maxLoadFactor = maxLoadFactor_;
}
public Pair<Iterator, bool> Insert(const ValueType& value)
{

```

```

    if (buckets.Count() == 0)
    {
        buckets.Resize(HashtablePrimes.GetNextPrime(0));
    }
    const KeyType& key = KeyOf(value);
    int index = Hash(key);
    #assert(index != -1);
    Bucket<ValueType>* bucket = buckets[index];
    while (bucket != null)
    {
        if (Equal(KeyOf(bucket->Value()), key))
        {
            return MakePair(Iterator(this, bucket), false);
        }
        bucket = bucket->Next();
    }
    bucket = new Bucket<ValueType>(value, buckets[index]);
    buckets[index] = bucket;
    ++count;
    SetLoadFactor();
    CheckForRehash();
    return MakePair(Iterator(this, bucket), true);
}

public nothrow void Remove(const KeyType& key)
{
    int index = Hash(key);
    if (index == -1) return;
    Bucket<ValueType>* bucket = buckets[index];
    Bucket<ValueType>* prev = null;
    while (bucket != null)
    {
        if (Equal(KeyOf(bucket->Value()), key))
        {
            if (prev != null)
            {
                prev->SetNext(bucket->Next());
            }
            else
            {
                buckets[index] = bucket->Next();
            }
            delete bucket;
            --count;
            SetLoadFactor();
            return;
        }
        prev = bucket;
        bucket = bucket->Next();
    }
}

public nothrow void Remove(Iterator pos)
{
    Bucket<ValueType>* bucket = pos.GetBucket();

```

```

    if (bucket != null)
    {
        int index = Hash(KeyOf(bucket->Value()));
        if (index == -1) return;
        Bucket<ValueType>* b = buckets[index];
        Bucket<ValueType>* prev = null;
        while (b != bucket && b != null)
        {
            prev = b;
            b = b->Next();
        }
        if (b == bucket)
        {
            if (prev != null)
            {
                prev->SetNext(b->Next());
            }
            else
            {
                buckets[index] = b->Next();
            }
            delete bucket;
            --count;
            SetLoadFactor();
        }
    }
}

public nothrow Iterator Find(const KeyType& key)
{
    int index = Hash(key);
    if (index >= 0)
    {
        Bucket<ValueType>* bucket = buckets[index];
        while (bucket != null)
        {
            if (Equal(KeyOf(bucket->Value()), key))
            {
                return Iterator(this, bucket);
            }
            bucket = bucket->Next();
        }
    }
    return Iterator(this, null);
}

public nothrow ConstIterator Find(const KeyType& key) const
{
    int index = Hash(key);
    if (index >= 0)
    {
        Bucket<ValueType>* bucket = buckets[index];
        while (bucket != null)
        {
            if (Equal(KeyOf(bucket->Value()), key))

```



```

        {
            return ConstIterator(this, bucket);
        }
        bucket = bucket->Next();
    }
}
return ConstIterator(this, null);
}
public nothrow ConstIterator CFind(const KeyType& key) const
{
    int index = Hash(key);
    if (index >= 0)
    {
        Bucket<ValueType>* bucket = buckets[index];
        while (bucket != null)
        {
            if (Equal(KeyOf(bucket->Value()), key))
            {
                return ConstIterator(this, bucket);
            }
            bucket = bucket->Next();
        }
    }
    return ConstIterator(this, null);
}
public override nothrow int GetBucketCount() const
{
    return buckets.Count();
}
public override nothrow int GetBucketIndex(const ValueType& value) const
{
    return Hash(KeyOf(value));
}
public override nothrow Bucket<ValueType>* GetBucket(int index) const
{
    return buckets[index];
}
private nothrow inline void SetLoadFactor()
{
    int bc = buckets.Count();
    if (bc == 0)
    {
        loadFactor = 1.0;
    }
    else
    {
        double c = count;
        loadFactor = c / bc;
    }
}
private void CheckForRehash()

```

```

{
    if (loadFactor > maxLoadFactor)
    {
        Rehash();
    }
}
private void Rehash()
{
    List<Bucket<ValueType>*> b;
    Swap(buckets, b);
    int n = b.Count();
    buckets.Resize(HashtablePrimes.GetNextPrime(n + 1));
    for (int i = 0; i < n; ++i)
    {
        Bucket<ValueType>* bucket = b[i];
        while (bucket != null)
        {
            const KeyType& key = KeyOf(bucket->Value());
            int index = Hash(key);
            #assert(index != -1);
            Bucket<ValueType>* next = bucket->Next();
            bucket->SetNext(buckets[index]);
            buckets[index] = bucket;
            bucket = next;
        }
    }
}
private nothrow Bucket<ValueType>* GetFirstBucket() const
{
    Bucket<ValueType>* bucket = null;
    int n = buckets.Count();
    for (int i = 0; i < n; ++i)
    {
        bucket = buckets[i];
        if (bucket != null)
        {
            break;
        }
    }
    return bucket;
}
private void CopyFrom(const Self& that)
{
    int n = that.buckets.Count();
    buckets.Resize(n);
    for (int i = 0; i < n; ++i)
    {
        Bucket<ValueType>* bucket = that.buckets[i];
        while (bucket != null)
        {
            buckets[i] = new Bucket<ValueType>(bucket->Value(),
                buckets[i]);
            bucket = bucket->Next();
        }
    }
}

```

```

        }
    }
    count = that.count;
    loadFactor = that.loadFactor;
    maxLoadFactor = that.maxLoadFactor;
}
private nothrow inline const KeyType& KeyOf(const ValueType&
    value) const
{
    return keyOf(value);
}
private nothrow inline int Hash(const KeyType& key) const
{
    if (buckets.IsEmpty()) return -1;
    return cast<int>(hash(key) % cast<ulong>(buckets.Count()));
}
private nothrow inline bool Equal(const KeyType& left , const
    KeyType& right) const
{
    return equal(left , right);
}
private List<Bucket<ValueType>*> buckets;
private int count;
private double loadFactor;
private double maxLoadFactor;
private KeyOfValue keyOf;
private HashFun hash;
private Compare equal;
}
}

```