二叉树

Huffman编码树：算法实现

05-J3

树形建筑也出现了，看上去规模与地球上的差不多，
只是挂在树上的建筑叶子更为密集。

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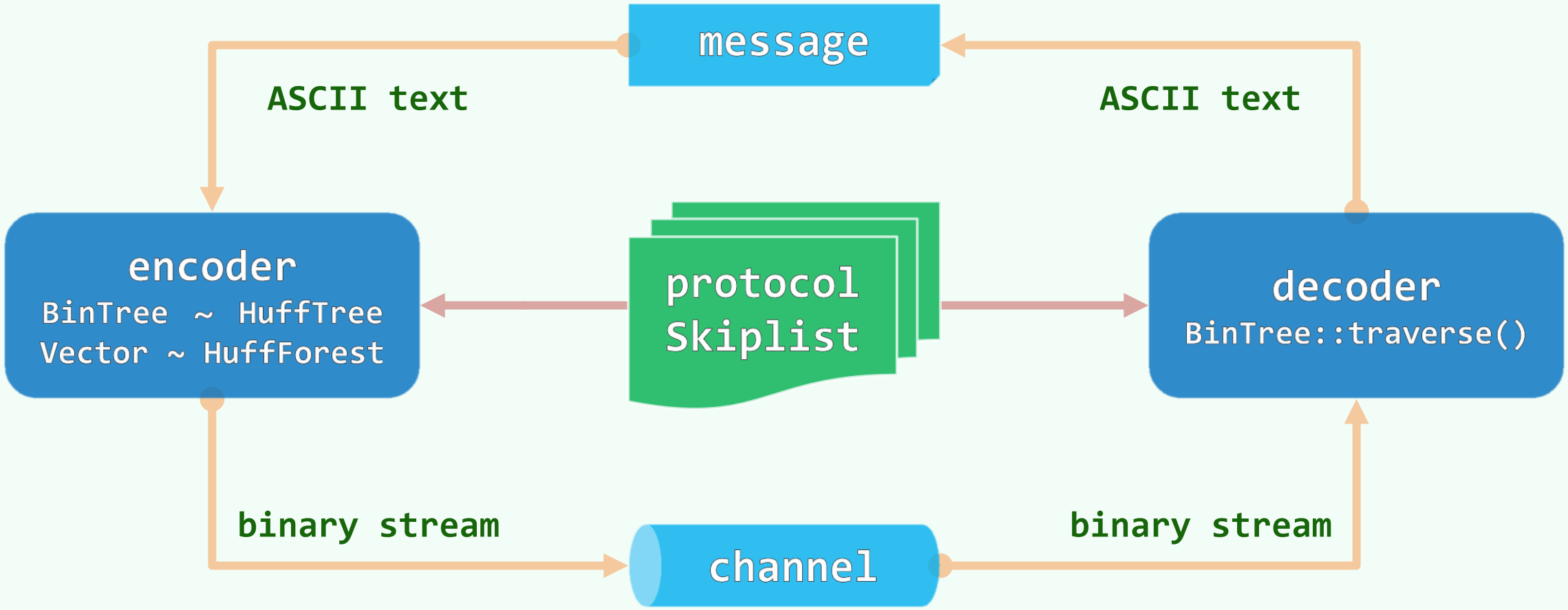
message
ASCII text
ASCII text
encoder
BinTree ~ HuffTree
Vector ~ HuffForest
protocol
Skiplist
decoder
BinTree::traverse()
binary stream
binary stream
channel

Huffman树与森林

```
❖ #define  N_CHAR  (0x80 - 0x20) //仅以可打印字符为例
❖ struct HuffChar { //Huffman（超）字符
     char ch; int weight; //字符、频率
     HuffChar ( char c = '^', int w = 0 ) : ch ( c ), weight ( w ) {};
     bool operator< ( HuffChar const& hc ) { return weight > hc.weight; } //比较器
     bool operator== ( HuffChar const& hc ) { return weight == hc.weight; } //判等器
  };
❖ #define HuffTree BinTree< HuffChar > //Huffman树，节点类型HuffChar
❖ typedef List< HuffTree * > HuffForest; //Huffman森林
```

构造编码树

```
❖HuffTree* generateTree( HuffForest * forest ) { //Huffman编码算法
    while ( 1 < forest->size() ) { //反复迭代，直至森林中仅含一棵树
       HuffTree *T1 = minHChar( forest ), *T2 = minHChar( forest );
       HuffTree *S = new HuffTree(); //创建新树，准备合并T1和T2
       S->insertAsRoot( HuffChar( '^', //根节点权重，取作T1与T2之和
          T1->root()->data.weight + T2->root()->data.weight ) );
       S->attachAsLC( S->root(), T1 ); S->attachAsRC( S->root(), T2 );
       forest->insertAsLast( S ); //T1与T2合并后，重新插回森林
    } //assert: 循环结束时，森林中唯一的那棵树即Huffman编码树
    return forest->first()->data; //故直接返回之
}
```

查找最小超字符

- Huffman编码的整体效率，直接决定于minHChar()的效率
- HuffTree* minHChar(HuffForest * forest) { //此版本仅达到$O(n)$，故整体为$O(n^2)$

```
    ListNodePosi( HuffTree* ) p = forest->first(); //从首节点出发
    ListNodePosi( HuffTree* ) minChar = p; //记录最小树的位置及其
    int minWeight = p->data->root()->data.weight; //对应的权重
    while (forest->valid(p = p->succ)) //遍历所有节点
       if( minWeight > p->data->root()->data.weight ) { //如必要
          minWeight = p->data->root()->data.weight; minChar = p; //则更新记录
       }
    return forest->remove( minChar ); //从森林中摘除该树，并返回
}
```

构造编码表

```
❖ #include "Hashtable.h" //用HashTable（第9章）实现
  typedef Hashtable< char, char* > HuffTable; //Huffman编码表
❖ static void generateCT //通过遍历获取各字符的编码
     ( Bitmap* code, int length, HuffTable* table, BinNodePosi(HuffChar) v) {
     if ( IsLeaf( * v ) ) //若是叶节点（还有多种方法可以判断）
        { table->put( v->data.ch, code->bits2string( length ) ); return; }
     if ( HasLChild( * v ) ) //Left = 0，深入遍历
        { code->clear(length); generateCT( code, length + 1, table, v->lc ); }
     if ( HasRChild( * v ) ) //Right = 1
        { code->set(length);   generateCT( code, length + 1, table, v->rc ); }
  } //总体O(n)
```