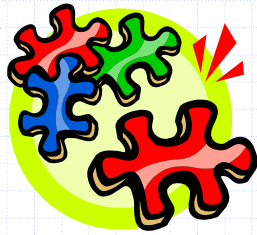
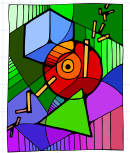


Sets



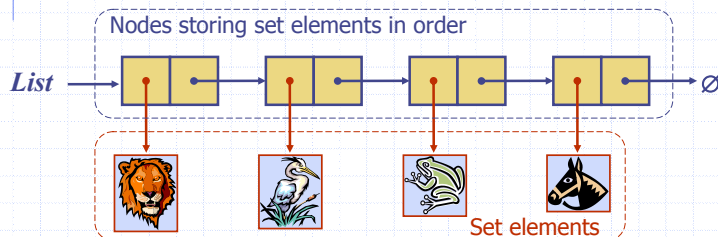
Set Operations (§ 10.6)



- ◆ We represent a set by the sorted sequence of its elements
- ◆ By specializing the auxiliary methods the generic merge algorithm can be used to perform basic set operations:
 - union
 - intersection
 - subtraction
- ◆ The running time of an operation on sets A and B should be at most $O(n_A + n_B)$
- ◆ Set union:
 - $aIsLess(a, S)$
 $S.insertFirst(a)$
 - $bIsLess(b, S)$
 $S.insertLast(b)$
 - $bothAreEqual(a, b, S)$
 $S.insertLast(a)$
- ◆ Set intersection:
 - $aIsLess(a, S)$
 { do nothing }
 - $bIsLess(b, S)$
 { do nothing }
 - $bothAreEqual(a, b, S)$
 $S.insertLast(a)$

Storing a Set in a List

- ◆ We can implement a set with a list
- ◆ Elements are stored sorted according to some canonical ordering
- ◆ The space used is $O(n)$



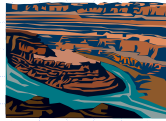
Generic Merging

- ◆ Generalized merge of two sorted lists A and B
- ◆ Template method **genericMerge**
- ◆ Auxiliary methods
 - $aIsLess$
 - $bIsLess$
 - $bothAreEqual$
- ◆ Runs in $O(n_A + n_B)$ time provided the auxiliary methods run in $O(1)$ time

```

Algorithm genericMerge(A, B)
    S ← empty sequence
    while ¬A.isEmpty() ∧ ¬B.isEmpty()
        a ← A.first().element(); b ← B.first().element()
        if a < b
            aIsLess(a, S); A.remove(A.first())
        else if b < a
            bIsLess(b, S); B.remove(B.first())
        else { b = a }
            bothAreEqual(a, b, S)
            A.remove(A.first()); B.remove(B.first())
    while ¬A.isEmpty()
        aIsLess(a, S); A.remove(A.first())
    while ¬B.isEmpty()
        bIsLess(b, S); B.remove(B.first())
    return S
    
```

Using Generic Merge for Set Operations



- ◆ Any of the set operations can be implemented using a generic merge
- ◆ For example:
 - For **intersection**: only copy elements that are duplicated in both list
 - For **union**: copy every element from both lists except for the duplicates
- ◆ All methods run in linear time.