OOP with Java

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OOP with Java

- 通知
  - Project 6: 6 月 8 日晚 9 点

- 复习
  - 继承
    - 代码复用
    - 向上转换，多态 (父类与子类的类型转换)
  - 接口
    - ~~代码复用~~
    - 向上转换，多态 (多个父接口)
  - 内部类
    - 代码复用
    - 向上转换，多态 (灵活实现多继承)

- 复习
  - 内部类
    - 定义在一个类的内部

```
class Outer{
    …
    class Inner{
        ...
    }
    ...
}
```

```
public class Parcel{
    class Contents{
        private int i = 11;
        public int value() {return i;}
    }
    class Destination{
        private String label;
        Destination(String r) {label = r;}
        String readLabel() { return label;}
    }
    public Destination to(String s){
        return new Destination(s);
    }
    public Contents contents(){
        return new Contents();
    }
    public void ship(String dest){
        Contents c = new Contents();
        Destination d = new Destination(dest);
        System.out.println(d.readLabel());
    }

    public static void main(String []args){
        Parcel p = new Parcel();
        Parcel.Destination d = p.to(“Tasmania”);
        Parcel.Contents c = p.contents();
    }
```

- 复习
  - 内部类
    - 每个内部类对象包含的有一个外部类对象的引用
      - OuterClassName.this
    - 创建内部类
      - OuterClassObject.new
      - 在外部类的非静态方法中可以直接创建（默认外部类对象是 this)

```
public class Parcel{
    class Contents{
        private int i = 11;
        public int value() {return i;}
    }
    class Destination{
        private String label;
        Destination(String r) {label = r;}
        String readLabel() { return label;}
    }

    public Destination to(String s){
        return new Destination(s);
    }
    public Contents contents(){
        return new Contents();
    }

    public static void main(String []args){
        Parcel p = new Parcel();
        Parcel.Destination d = p.new Destination("T");
        Parcel.Contents c = p.new Contents();
    }
}
```

- 复习
  - 匿名内部类
    - 没有名字的内部类
    - 必须继承某个类，或实现某个接口

```
public class Parcel{

    public Contents contents(){
        return new Contents() {
            // anonymous inner class definition
            private int i = 11;
            public int value() {return i;}
        };
    }

    public static void main(String []args){
        Parcel p = new Parcel();
        Contents c = p.contents();
    }
}
```

```
public class Parcel{
     class PContents implements Contents{
        private int i = 11;
        public int value() {return i;}
    }

    public Contents contents(){
        return new PContents() ;
    }

    public static void main(String []args){
        Parcel p = new Parcel();
        Contents c = p.contents();
    }
}
```

- 复习
  - 通过内部类灵活实现多继承

```
interface A { }
interface B { }
class X implements A, B {}


class Y implements A{
    B makeB() {
        return new B(){};
    }
}

public class Test{
    static void takeA(A a) {}
    static void takeB(B b) {}
    public static void main(String []args){
        X x = new X();
        Y y = new Y();
        takeA(x); takeB(x);
        takeA(y); takeB(b.makeB());
    }
}
```

```
class A { }
abstract class B { }
// class X implements A, B {}
// won't compile

class Y extends A{
    B makeB() {
        return new B(){};
    }
}

public class Test{
    static void takeA(A a) {}
    static void takeB(B b) {}
    public static void main(String []args){
        Y y = new Y();
        takeA(y); takeB(b.makeB());
    }
}
```

OOP with Java

- 容器简介
- Collection
  - List, Set, Queue
- Map
- Collection and Iterator

容器简介

- 如何将对象组织起来？

```
int a = 0;
int b = 0;
...
int z = 0;

MyType m_a = new MyType();
MyType m_b = new MyType();
...
MyType m_c = new MyType();
```

容器简介

- 数组

```
int [ ] a = new int[]{1,2,3};

MyType [ ] b = new MyType[3];

MyType [ ] c = new MyType[3] {
    new MyType(),
    new MyType(),
    new MyType() };
```

长度不可变

1. 无法添加和删除数组元素
2. 数组元素之间的关系？(Set)

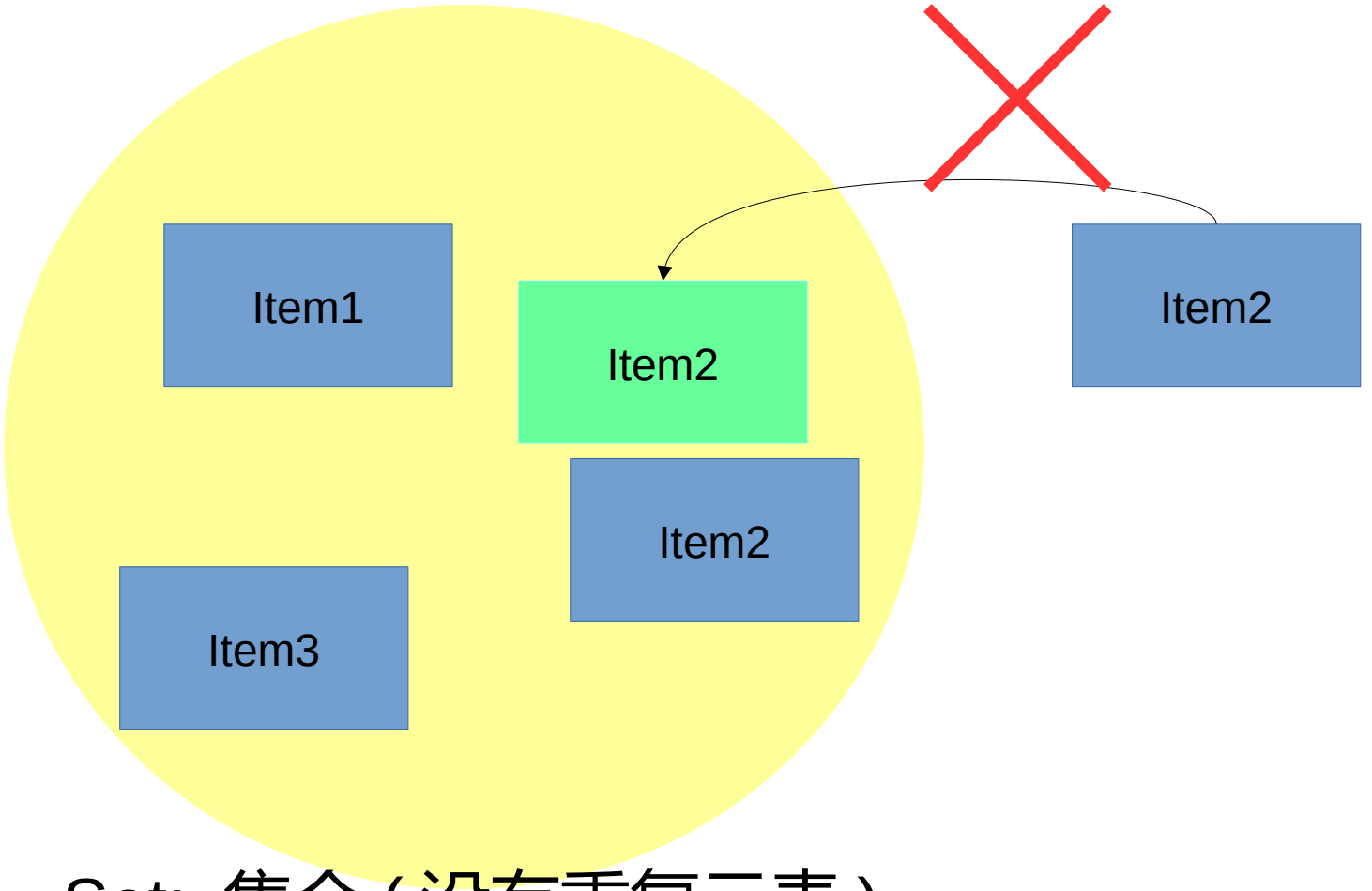
容器简介

- 容器
  - 提供更灵活的组织对象的方式
    - 动态添加，删除
  - 例如
    - List, Set, Queue
    - Map
  - 位于包 java.util 中

List: 一列有序的对象
(数组 , 链表)

```
import java.util.*;


ArrayList a = new ArrayList();
LinkedList b = new LinkedList();

//Implement List interface
List c = a;
List d = b;
```

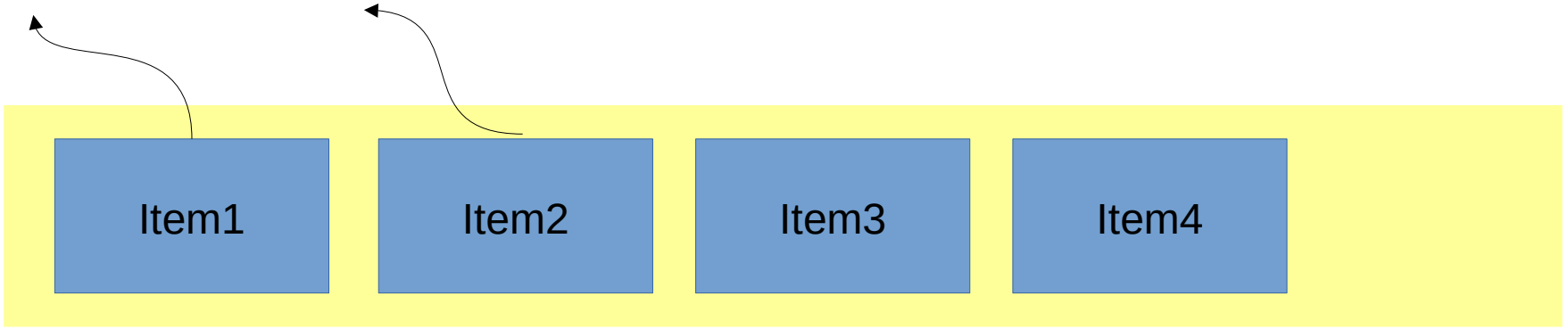
List 接口



Set: 集合 (没有重复元素)

```
import java.util.*;

HashSet a = new HashSet();
TreeSet b = new TreeSet();

//implement Set interface
Set c = a;
Set d = b;
```

Set 接口

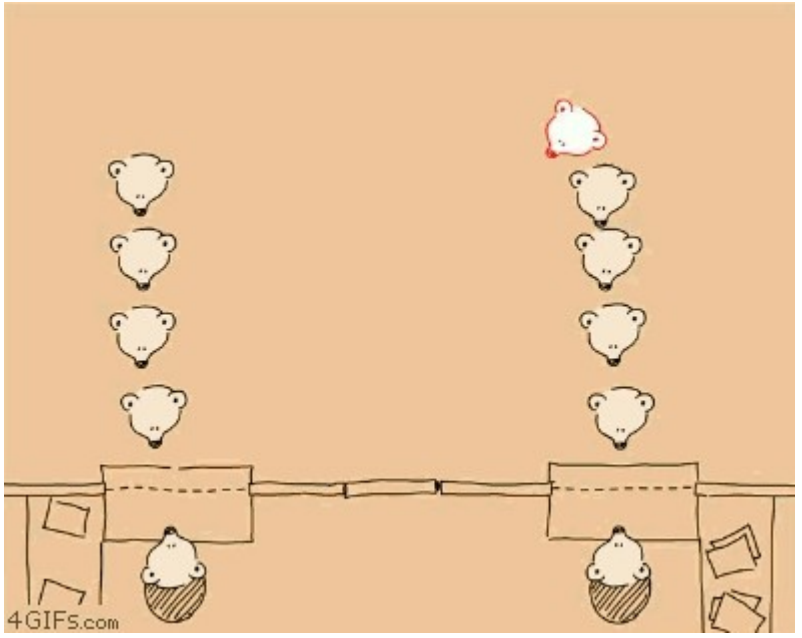


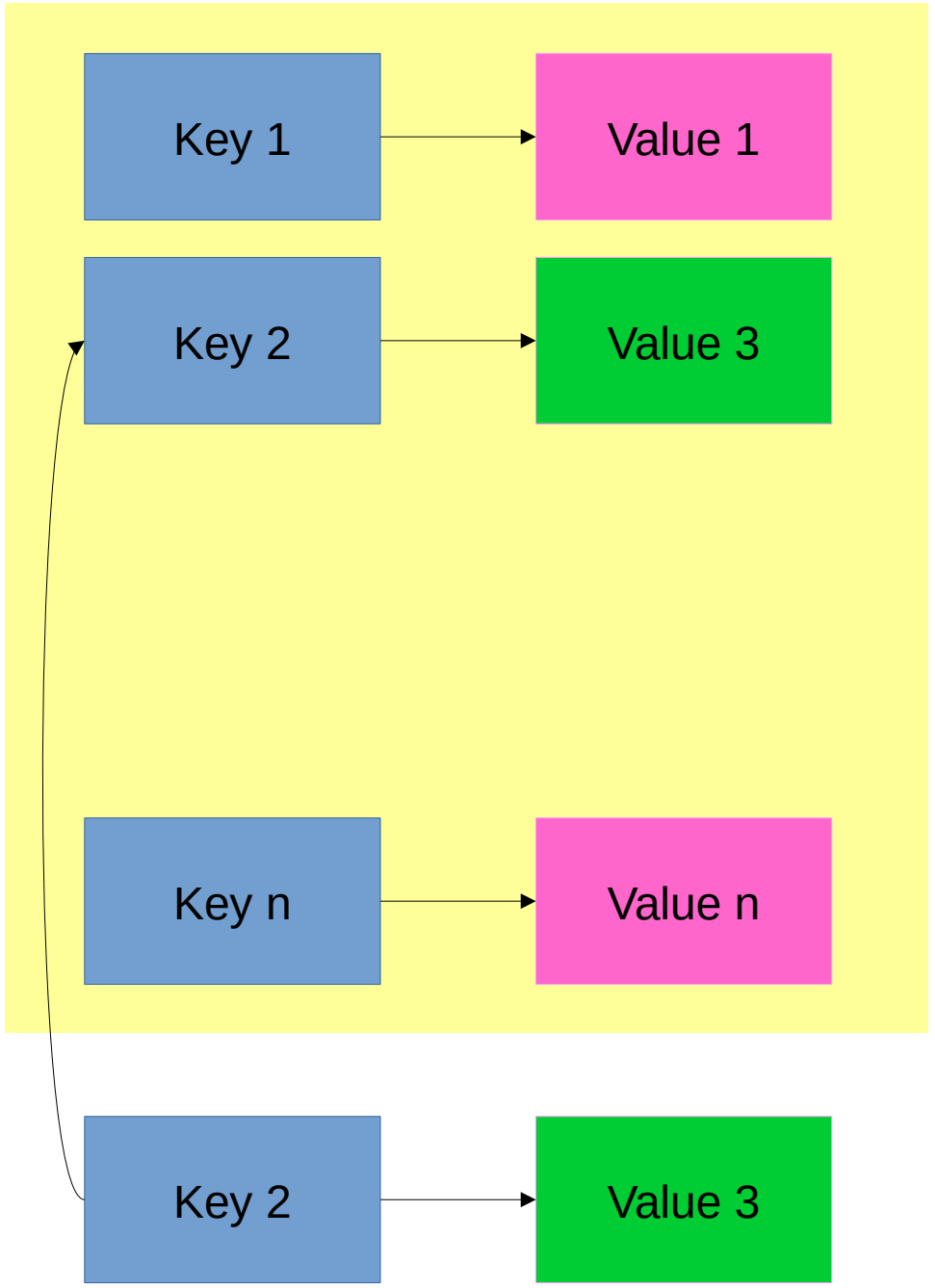
Queue: 队列
- enqueue (进队)
- dequeue (出队)
- 先进先出
- 应用 : 任务调度

```
import java.util.*;

LinkedList a = new LinkedList();
PriorityQueue b = new PriorityQueue();

//Implement Queue interface
Queue c = a;
Queue d = b;
```

Queue 接口

- 队列
  - 先进先出 (First in, first out)
  - 先来先服务 (First come, first serve)





Map:

- Key-value 对
- Key 不重复
- value 可以重复
- 应用： 单词出现次数

```
import java.util.*;

//Implement Map interface
HashMap a = new HashMap();
```

Map 接口

容器简介

- 泛型 (generic) 与类型安全的容器
  - 容器可以存放的类型为 Object
  - 任何类型的对象都能放入容器
  - 容器的类型只能在运行时确定

```
class Apple {
    private static long counter;
    private final long id = counter++;
    public long id() { return id; }
}
class Orange { }
```

```
public class ApplesAndOrangesWithoutGenerics {
public static void main(String[] args) {
    ArrayList apples = new ArrayList();
    for(int i = 0; i < 3; i++)
        apples.add(new Apple());

    // Not prevented from adding an Orange to apples:
    apples.add(new Orange());
    for(int i = 0; i < apples.size(); i++)
        ((Apple)apples.get(i)).id();
        // Orange is detected only at run time
    }
}
```

容器简介

- 类型安全的容器
  - 定义容器为只能存放某种类型的对象
  - 编译时确定类型
- 泛型编程 (generic)

```
class Apple {
    private static long counter;
    private final long id = counter++;
    public long id() { return id; }
}
class Orange { }
```

```
public class ApplesAndOrangesWithGenerics {
public static void main(String[] args) {
    ArrayList<Apple> apples = new ArrayList<Apple>();
    for(int i = 0; i < 3; i++)
        apples.add(new Apple());

    // Compile error!
    // apples.add(new Orange());
    for(int i = 0; i < apples.size(); i++)
        apples.get(i).id();
    for(Apple c: apples)
        System.out.println(c.id());
    }
}
```

容器简介

- 类型安全的容器
  - Upcasting 适用

```
class GrannySmith extends Apple {}
class Gala extends Apple {}
class Fuji extends Apple {}
class Braeburn extends Apple {}
```

```
public class GenericsAndUpcasting {
    public static void main(String[] args) {
        ArrayList<Apple> apples = new ArrayList<Apple>();

        apples.add(new GrannySmith());
        apples.add(new Gala());
        apples.add(new Fuji());
        apples.add(new Braeburn());
        for(Apple c : apples)
            System.out.println(c);
    }
}
```

容器简介

- 类型安全的容器
  - 不能指定基本类型
  - 使用基本类型的 wrapper
  - Autoboxing and unboxing

```
import java.util.*;

// compile error
// ArrayList<int> a = new ArrayList<int>();
ArrayList<Integer> a = new ArrayList<Integer>();
For (int i  = 0; i < 10; ++i)
    a.add(i); //autoboxing
```

容器简介

- 容器接口
  - Collection 接口： 用于存放一组对象
    - List 接口： 对象按照插入顺序排列容器中的对象
    - Set 接口： 容器中不能有重复的对象
    - Queue 接口： 按 " 队列 " 规则插入 / 删除对象
  - Map 接口
    - 用于存放一组 “键 - 值对” (key-value pair)
      - key 的类型 , value 的类型
      - 按照 key 查找对应的 value
    - 也称为 dictionary, associative array

容器简介

```
import java.util.*;

//List is an interface
List<Apple> a = new ArrayList<Apple>();
List<Apple> b = new LinkedList<Apple>();

//Collection is an interface
Collection<Apple>  c = new ArrayList<Apple>();
```

容器简介

- 容器重写了 toString() 方法，可以帮助可视化容器的内容

```
import java.util.*;

ArrayList<String> a = new ArrayList<String>();
a.add(“rat”);
a.add(“cat”);
a.add(“dog”);
a.add(“dog”);
System.out.println(a);
```

```
public class PrintContainers{
    static Collection fill(Collection<String> c){
        c.add(“rat”);
        c.add(“cat”);
        c.add(“dog”);
        c.add(“dog”);
    }
    static Map fill(Map<String, String> m){
        m.put(“rat”, “Fuzzy”);
        m.put(“cat”, “Rags”);
        m.put(“dog”, “Bosco”);
        m.put(“dog”, “Spot”);
    }
    public static void main(String [] args){
        System.out.println(fill(new ArrayList<String>()));
        System.out.println(fill(new LinkedList<String>()));

        System.out.println(fill(new HashSet<String>()));
        System.out.println(fill(new TreeSet<String>()));
        System.out.println(fill(new LinkedHashSet<String>()));

        System.out.println(fill(new HashMap<String, String>()));
        System.out.println(fill(new TreeMap<String, String>()));
        System.out.println(fill(new LinkedHashMap<String, String>()));
    }
```

```
[rat, cat, dog, dog] //ArrayList
[rat, cat, dog, dog] //LinkedList
[cat, dog, rat] // HashSet
[cat, dog, rat] // TreeSet
[rat, cat, dog] // LinkedHashSet
{cat=Fuzzy, dog=Spot, rat=Fuzzy} //HashMap
{cat=Fuzzy, dog=Spot, rat=Fuzzy} //TreeMap
{rat=Fuzzy, cat=Fuzzy, dog=Spot}
//LinkedHashMap
```

List:
- ArrayList 实现为数组
- LinkedList 实现为链表

Set/Map
- Hash: 实现为 hash 表，查询较块
- Tree: 实现为查询树，按顺序排列
- LinkedHash: 按照插入顺序排列

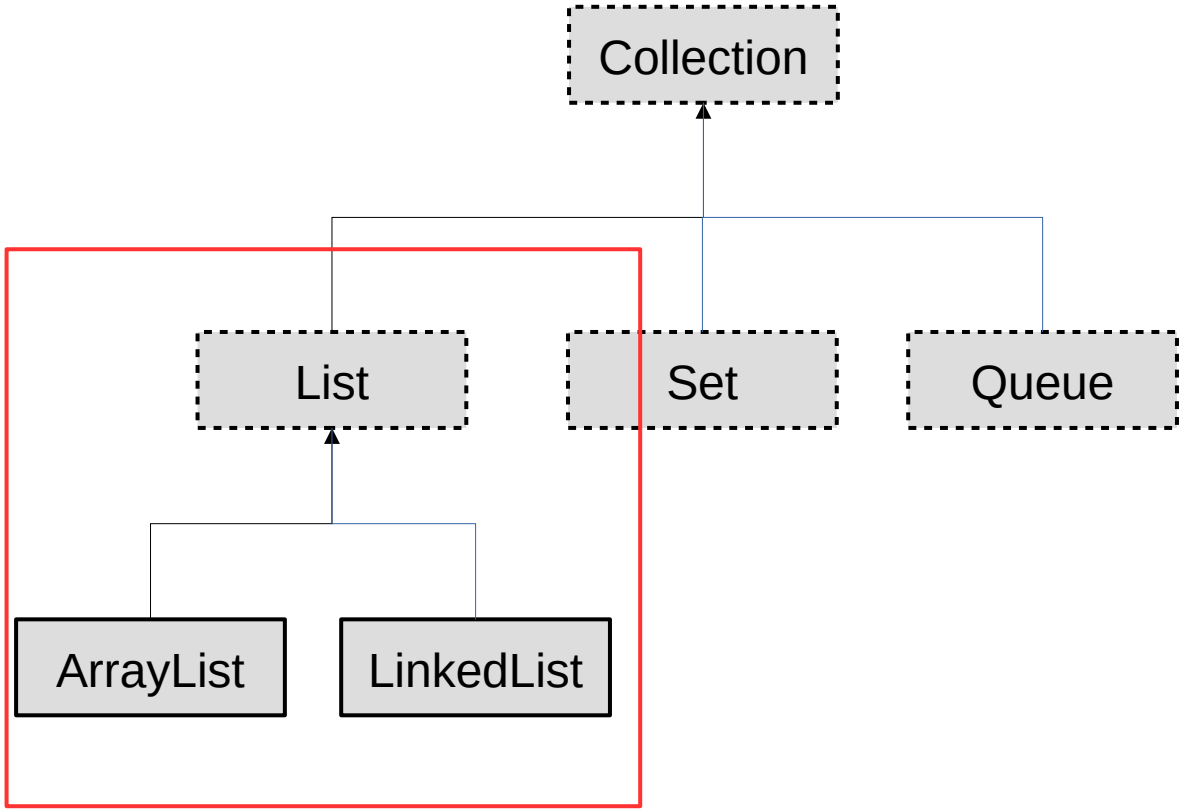
容器简介

- 总结
  - 容器类型
    - Collection: List, Set, Queue
    - Map
  - 类型安全的容器
    - ArrayList<T> a = new ArrayList<T>();
  - Upcasting and Autoboxing

List

- 两种类型的 List
  - ArrayList
    - “ 可扩展数组”
    - 适用于随机访问， 插入删除较慢
  - LinkedList
    - 双向链表
    - 适用于顺序访问， 插入删除较快
    - 实现了 Queue 接口

List



List

- List 接口
  - add(): 添加元素
  - remove(): 删除元素
  - get(): 返回第 i 个位置的元素
  - size(): 返回元素数量
  - ...

List

- 构造函数
  - ArrayList

```
ArrayList<E>();
ArrayList<E>(int initialCapacity);
ArrayList<E>(Collection<E> c);
```

  - LinkedList

```
LinkedList<E>();
LinkedList<E>(Collection<E> c);
```

```
import java.util.*;

ArrayList<String> a = new ArrayList<String>();
//  插入 add(Object o)
a.add(“rat”); a.add(“cat”); a.add(“dog”); a.add(“dog”);

//  查询 contains (Object o)
System.out.println(a.contains(“cat”));

//  删除 remove(Object o) ( 若不在 List 中 ，返回 false，否则返回 true)
a.remove(“dog”); a.remove(“dag”);

//  访问第 i 个元素 : get(int)
a.get(0);

//  对象的数量 : size()
a.size();

//  序号   indexOf
a.indexOf(“cat”);
```

```
import java.util.*;

ArrayList<String> a = new ArrayList<String>();
//  插入 add(Object o)
a.add(“rat”); a.add(“cat”); a.add(“dog”); a.add(“dog”);

//  子表   subList(int fromIndex, int toIndex)
List<String> sub = a.subList(2, 3);

//  是否为空   isEmpty()
System.out.println(a.isEmpty());

//  返回迭代器   iterator()
Iterator it = a.iterator();

//  返回 List 迭代器   listIterator()
ListIterator lit = a.listIterator();

//  转为数组
Object [] aarray = a.toArray();
```

List

- Iterator (迭代器)
  - 通常需要访问 / 遍历 Collection 中的元素

```
ArrayList<String> a = new ArrayList<String>();
…...
a.get(i);

LinkedList<String> b = new LinkedList<String>();
……
b.get(i);

Static void visit(List<String> ls) {
    ls.get(i);
   ….
}
```

- 缺点
  - 依赖于 Collection 接口
  - 其他没有实现 Collection 接口的类无法使用函数 visit
- 解决方法 iterator，包含方法
  - next()
  - hasNext()
  - remove()
- Collection 接口
  - iterator()
  - 返回该 List 的迭代器

List

- iterator()

```
ArrayList<String> a = new ArrayList<String>();
a.add(“rat”);a.add(“cat”);a.add(“dog”);a.add(“dog”);
Iterator<String> it = a.iterator();
while(it.hasNext()){
    String s = it.next();
    System.out.println(s);
}

// identical to
for(String i: a)
    System.out.println(i);
```

List

- iterator

```
Import java.util.*
public class Iteration {
    public static void display(Iterator<String> it){
        while(it.hasNext()){
            String s = it.next();
            System.out.println(s);
        }
    }
    public static void main(String[]args){
        ArrayList<String> a = new ArrayList<String>();
        a.add(“rat”);a.add(“cat”);a.add(“dog”);a.add(“dog”);

        LinkedList<String> b = new LinkedList<String>(a);
        HashSet<String> c = new HashSet<String>(a);
        TreeSet<String> d = new TreeSet<String>(a);

        display(a.iterator());
        display(b.iterator());
        display(c.iterator());
```

List

- ListIterator
  - List 接口提供
  - 扩展了 Iterator
  - 双向遍历
    - hasNext(), hasPrevious()
    - next(), previous()

List

- LinkedList
  - 实现 List 接口
  - 实现 Queue 接口
    - add(), remove(), element()
    - offer(), poll(), peek()
  - 提供更多的方法

List

- LinkedList 方法

```
import java.util.*;

LinkedList<String> a = new LinkedList<String>();
a.add(“rat”); a.add(“cat”); a.add(“dog”); a.add(“dog”);

// 返回链表首元素 getFirst(), element(), 若链表为空则抛出异常
a.getFirst(); a.element();

// 返回链表首元素 peek(), 若链表为空则返回 null
a.peek();

// 删除并返回链表首元素 removeFirst(), remove(), 若链表为空则抛出异常
String s = a.remove();

// 删除并返回链表首元素 poll, 若链表为空则返回 null
String s = a.poll();
```

List

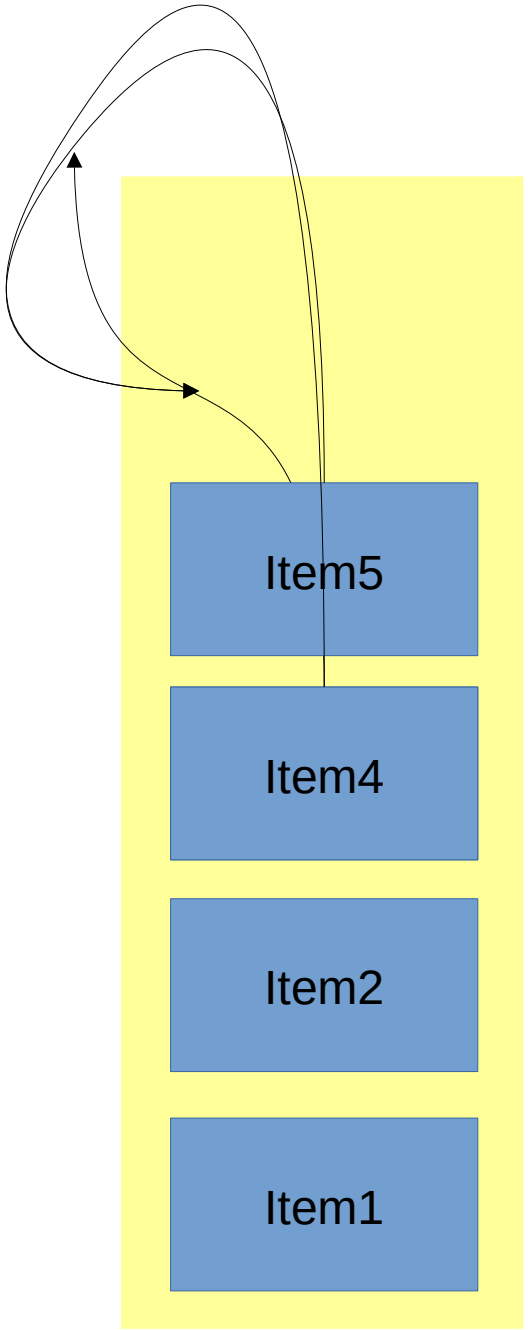
- LinkedList 方法

```
import java.util.*;

LinkedList<String> a = new LinkedList<String>();
a.add(“rat”); a.add(“cat”); a.add(“dog”); a.add(“dog”);

// 在链表头添加对象  addFirst()
a.addFirst(“tiger”);

// 在链表尾添加对象  add(), addLast(), offer()
a.add(“cow”); a.addLast(“cow”);
```

List

- LinkedList 应用 : Stack
  - 后进先出 (Last In First Out, LIFO)
  - push: 将一个对象入栈
  - pop: 从栈中取出一个元素 : 按照 LIFO 原则

List




```
LinkedList<Item> s = new LinkedList<Item>();
        s.push(item1);
        s.push(item2);
        s.push(item3);
        s.pop();
        s.push(item4);
        s.push(item5);
        s.pop();
        s.pop();
```

List

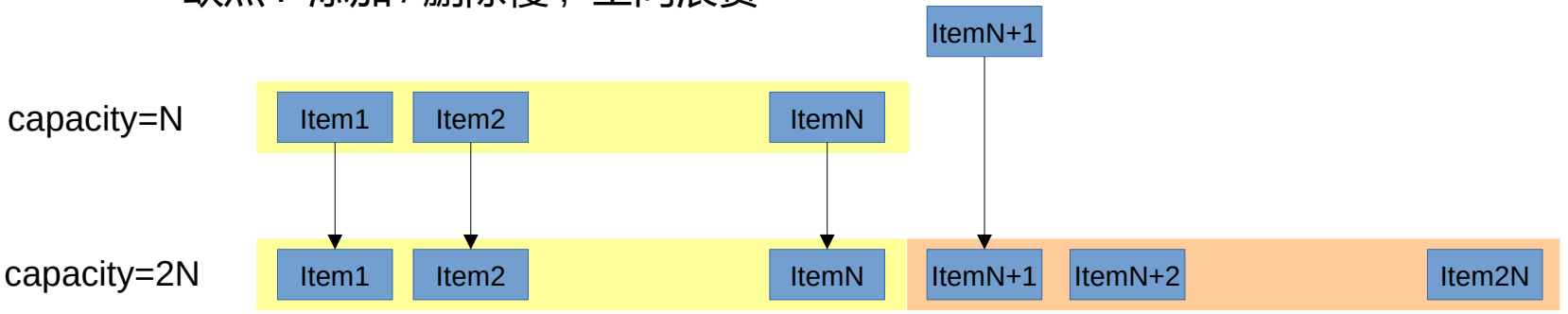
```
import java.util.LinkedList;
public class Stack<T> {
    private LinkedList<T> storage = new LinkedList<T>();
    public void push(T v) { storage.addFirst(v); }
    public T peek() { return storage.getFirst(); }
    public T pop() { return storage.removeFirst(); }
    public boolean empty() { return storage.isEmpty(); }
    public String toString() { return storage.toString(); }
}
```

```
public class StackTest {
    public static void main(String[] args) {
    Stack<String> stack = new Stack<String>();
    for(String s : "My dog has fleas".split(" "))
        stack.push(s);
    while(!stack.empty())
        System.out.print(stack.pop() + " ");
    }
}
```

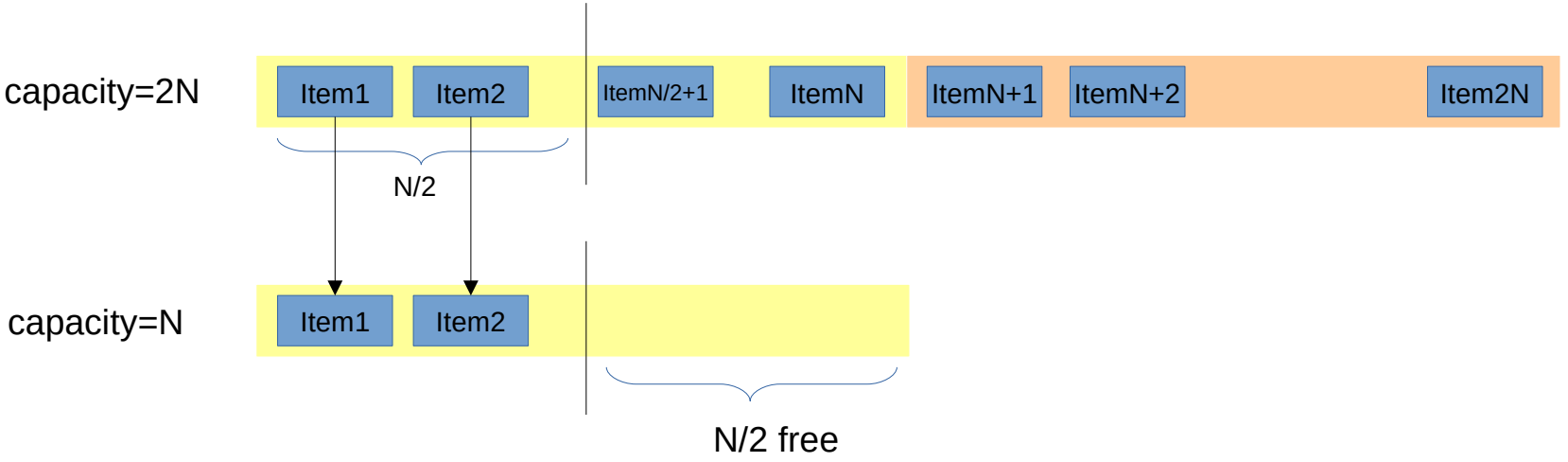
List

- Stack 的应用
  - 上下文无关文法

- ArrayList
  - 对象存储在数组中 (可变长数组)
  - 优点 : 随机访问快
  - 缺点 : 添加 / 删除慢 , 空间浪费



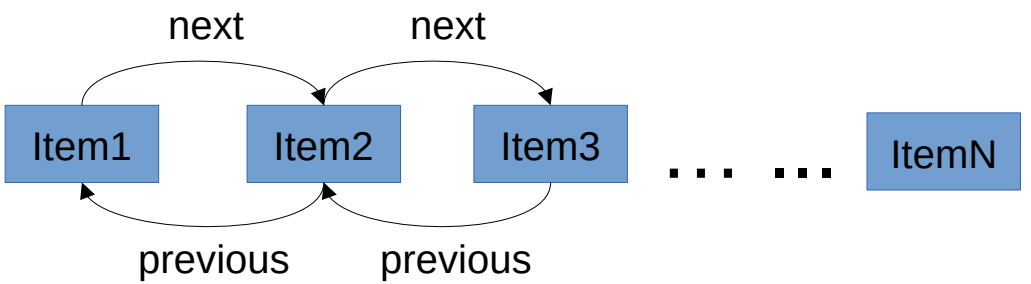
扩张

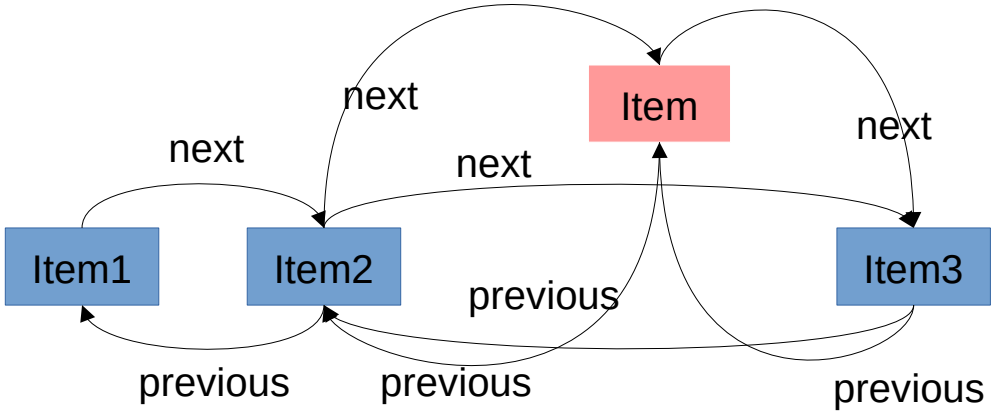


缩减

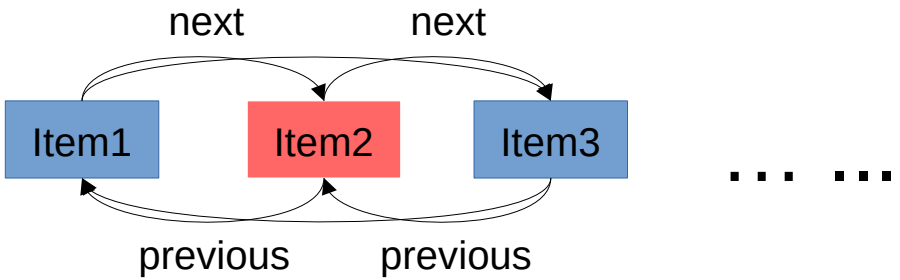
每次扩张或缩减数组长度时，保证新的数组有一半的可用空间

- LinkedList
  - 双向链表
  - 优点：添加 / 删除较快，无空间浪费
  - 缺点：随机访问慢





插入

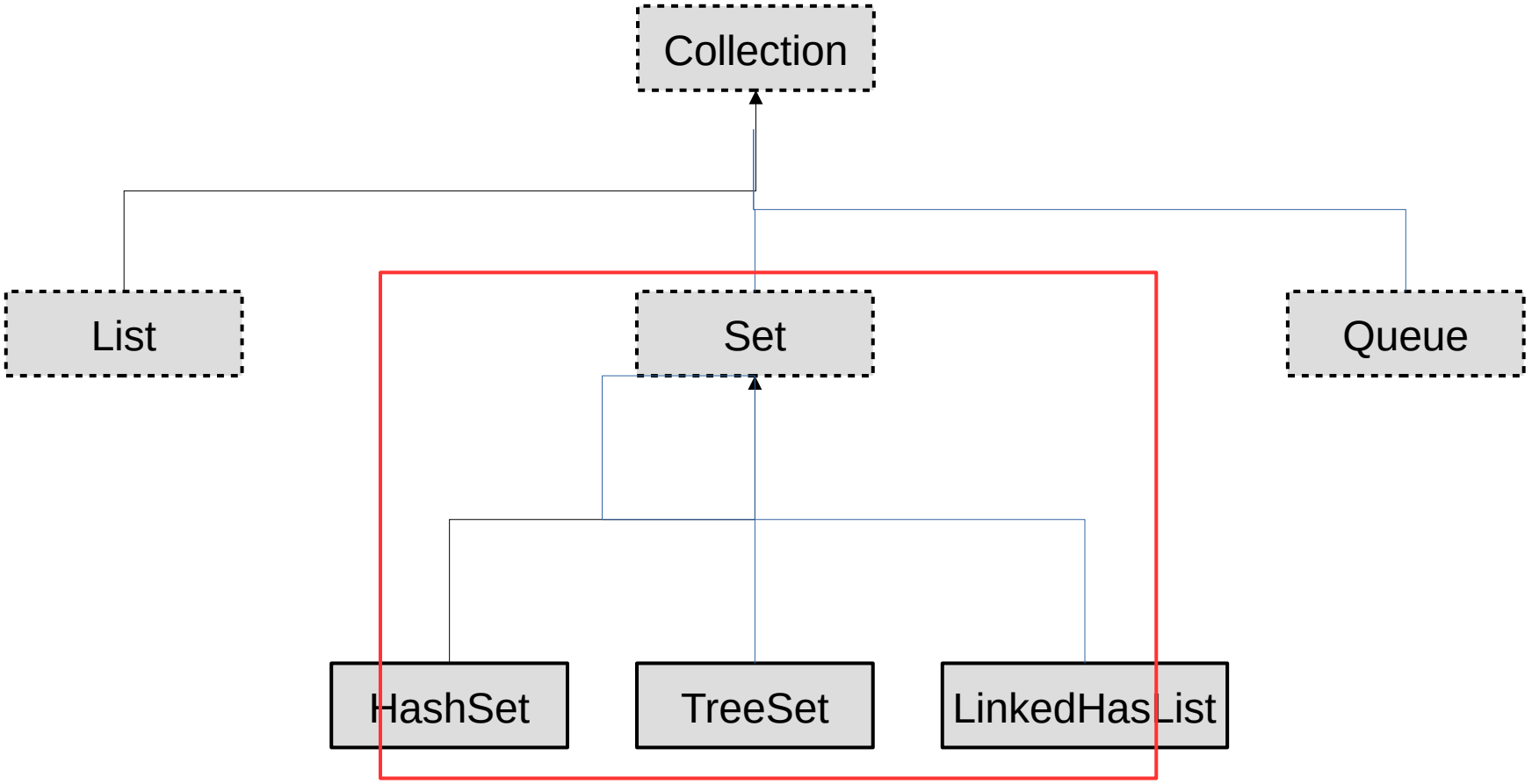


删除

List

- 总结
  - List 接口
    - add(), remove(), get(), size(), indexOf()
  - ArrayList
    - 可变长度数组
  - LinkedList
    - 链表
    - 实现 Queue 接口
  - 迭代器 Iterator

Set



Set

- Set 接口
  - 容器中不能出现重复的元素
  - 没有对 Collection 接口扩展
  - 三种主要实现
    - HashSet
    - TreeSet
    - LinkedHashSet

Set

- Set 接口
  - add(Object o), addAll(Collection<E> c)
  - remove(Object o), removeAll(Collection<E> c)
  - contains(Object o)
  - iterator()
  - size()
  - toArray()
  - ...

Set

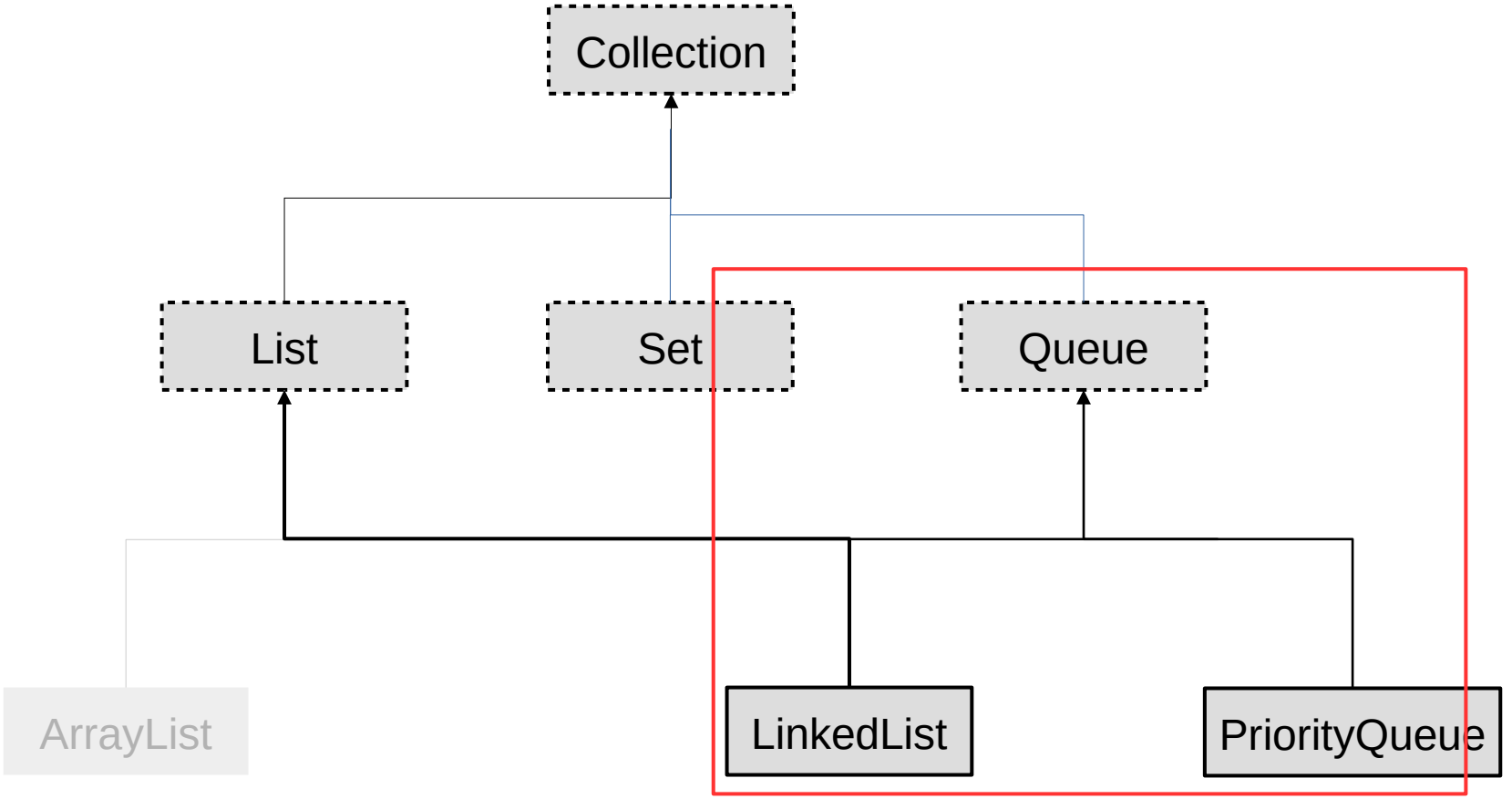
- HashSet
  - 特点：快速（插入，删除，查找），无序

```
import java.util.*

public class SetOfInteger {
    public static void main(String[] args) {
        Random rand = new Random(47);
        Set<Integer> intset = new HashSet<Integer>();
        for (int i = 0; i < 10000; i++)
            intset.add(rand.nextInt(30));
        System.out.println(intset);
}
```

Set

- TreeSet
  - 特点：速度较慢 (插入，删除，查找)，有序
- LinkedHashSet
  - 特点：速度快，按插入顺序排列

Queue


Collection
List
Set
Queue
ArrayList
LinkedList
PriorityQueue

Queue

- Queue 接口
  - 队列规则：先进先出 (First in, First out)
  - 接口
    - offer(Object o), add(Object o): 将对象加入队列尾部
    - poll(), remove(): 弹出位于队首的对象
    - peek(), element(): 返回位于队首的对象，并不删除
  - LinkedList
  - PriorityQueue

```
import java.util.*

public class QueueTest {
    public static void printQ(Queue queue) {
        while(queue.peek() != null)
            System.out.print(queue.remove() + " ");
        System.out.println();
    }
    public static void main(String[] args) {
        Queue<Integer> queue = new LinkedList<Integer>();
        Random rand = new Random(47);
        for(int i = 0; i < 10; i++)
            queue.offer(rand.nextInt(i + 10));
        printQ(queue);

        Queue<Character> qc = new LinkedList<Character>();
        for(char c : "Brontosaurus".toCharArray())
            qc.offer(c);
        printQ(qc);
    }
```

Queue

- PriorityQueue
  - 优先级队列
    - 每次出队时，选择优先级最高的对象
    - 队列中的对象可以比较优先级
    - 普通队列也可看成优先级队列：优先级为加入队列的时间

```
import java.util.*;
public class PriorityQueueTest {
    public static void main(String[] args) {
        PriorityQueue<Integer> qi = new PriorityQueue<Integer>();
        int [ ] iarray = {25, 22, 20, 18, 14, 9, 3, 1, 1, 2, 3, 9, 14, 18, 21, 23, 25};
        for (int i: iarray)
            qi.offer(i);
        printQ(qi);

        PriorityQueue<Character> qc = new PriorityQueue<Character>();
        for(char c : "Brontosaurus”.toCharArray())
            qc.offer(c);
        printQ(qc);
    }
}
```

Queue

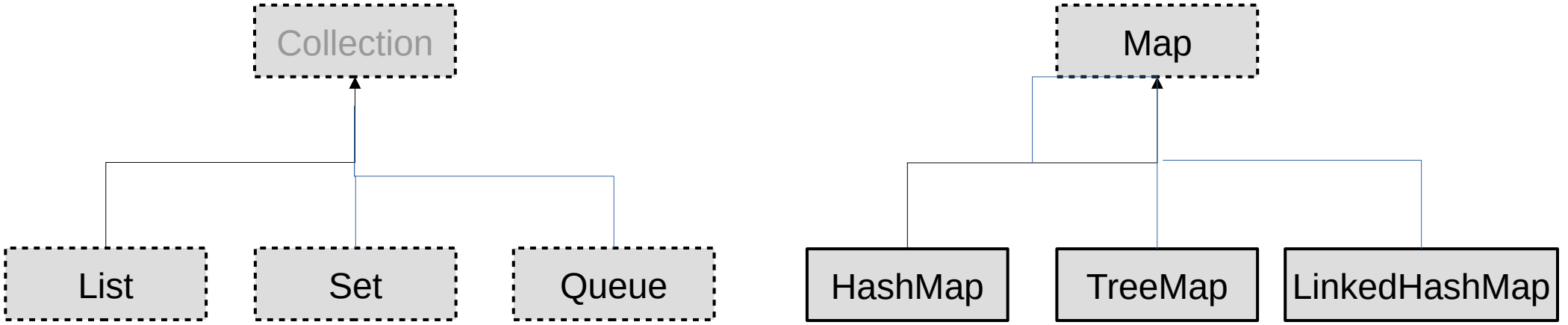
- 自定义优先级
  - 构造函数

```
PriorityQueue<E>(int initialCapacity, Comparator<E> comparator)
```

  - Comparator 接口
    - 定义两个元素的优先级关系
    - 包含方法 compare(E e1, E e2)
      - Compare 返回负数当 e1 优先级低于 e2
      - Compare 返回正数当 e1 优先级高于 e2
      - Compare 返回 0 当 e1 优先级等于 e2

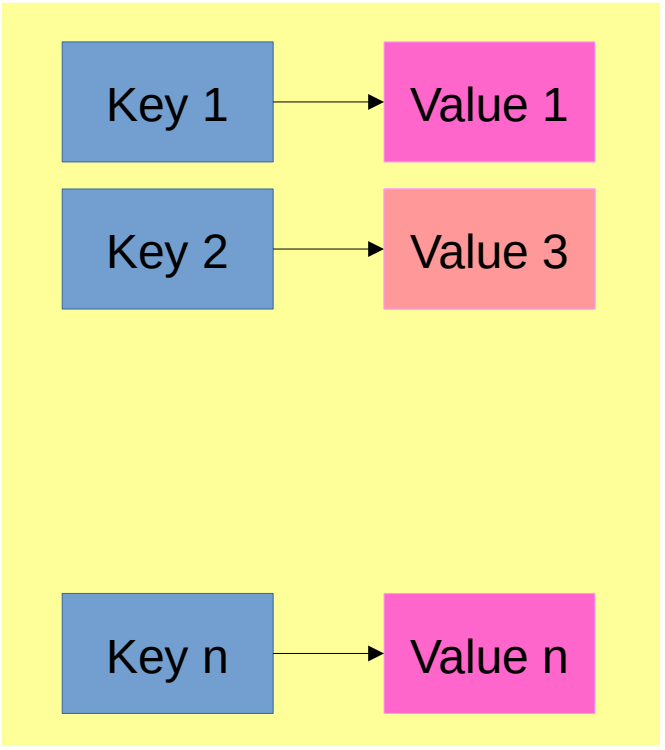
```
public class PriorityQueueTest {
    public static void main(String[] args) {
        PriorityQueue<Character> qc = new PriorityQueue<Character>();
        for(char c : "Brontosaurus”.toCharArray())
            qc.offer(c);
        printQ(qc);

        PriorityQueue<Character> rqc = new PriorityQueue<Character>(10,
                new Comparator<Character>(){
                    public int compare(Character c1, Character c2){
                        if (c1 > c2)
                            return -1;
                        else if (c1 < c2)
                            return 1;
                        else
                            return 0;
                    }
                });
        for(char c : "Brontosaurus".toCharArray())
            rqc.offer(c);
        printQ(rqc);
    }
```

Map


Collection
List
Set
Queue
Map
HashMap
TreeMap
LinkedHashMap

Map

- Map
  - Key-value pair



Map

- Map 接口
  - 存入键值对 : put(K key, V value)
  - 返回键对应的值 : get(K key)
  - 是否包含键 key: containsKey(Object key)
  - 是否包含值 value: containsValue(Object value)
  - 返回键组成的 Set: keySet()
  - 返回值组成的 Collection: values()

```
import java.util.*

public class MapTest {
    public static void main(String[] args) {
        HashMap<String, String>m = new HashMap<String, String>()
        m.put(“rat”, “Fuzzy”);
        m.put(“cat”, “Rags”);
        m.put(“dog”, “Bosco”);
        m.put(“dog”, “Spot”);
        System.out.println(m.get(“dog”));
        System.out.println(m.containKey(“dog”));
        System.out.println(m.containValue(“dog”));
        System.out.println(m.keySet());
        System.out.println(m.values());
}
```

```
import java.util.*

public class MapTest {
    public static void main(String[] args) {
        HashMap<String, ArrayList<Integer>>m = new HashMap<>()
        m.put("rat", new ArrayList<Integer>(Array.asList(1,2,3)));
        m.put("cat", new ArrayList<Integer>(Array.asList(4,5,6)));
        m.put("dog", new ArrayList<Integer>(Array.asList(7,8,9)));
        m.put("dog", new ArrayList<Integer>(Array.asList(10,11,12)));
        System.out.println(m.get("dog"));
        System.out.println(m.containKey("dog"));
        System.out.println(m.keySet());
        System.out.println(m.values());

        HashMap<String, HashMap<String, Integer>>n = new HashMap<>();
        ...
}
```

Array.asList:

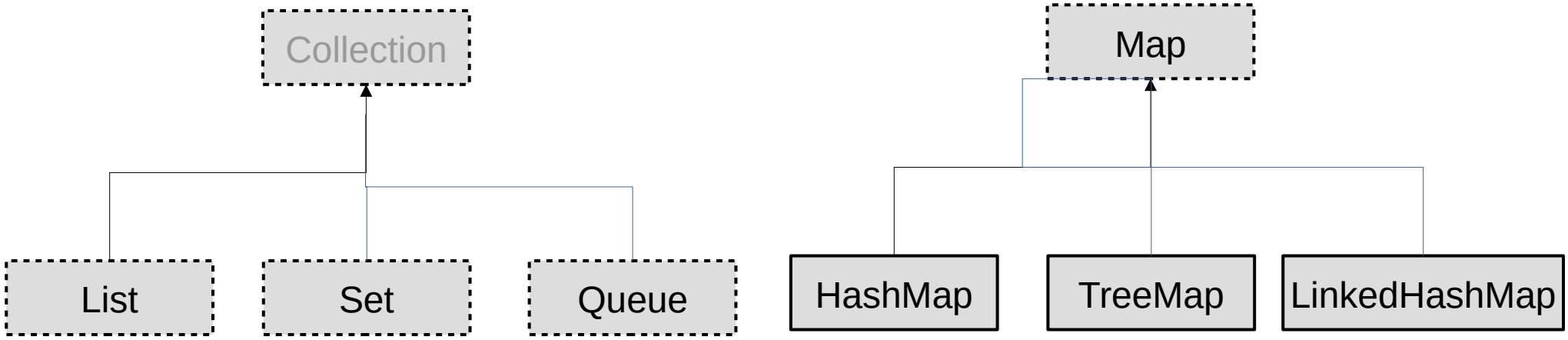
- 将数组转化成 List （文档）
- 包： java.util.Array
- 可变参数数量

Map

- Map
  - 建议 : Immutable key

迭代器与 foreach

- Iterable 接口
  - 提供 iterator(): 返回迭代器
- Collection 扩展了 Iterable 接口
- foreach 语句
  - 对所有实现 Iterable 接口的类
  - 数组


Collection
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