

# 项目报告（谢建福）

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## 小组成员

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- 谢建福;
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## 测试环境

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- Windows 10;
- JDK 8;
- Maven;
- IntelliJ IDEA;

## 测试工具

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### JUnit 4

JUnit是一个Java语言的单元测试框架。它由Kent Beck和Erich Gamma建立，逐渐成为源于Kent Beck的JUnit的JUnit家族中最为成功的一个。JUnit有它自己的JUnit扩展生态圈。多数Java的开发环境都已经集成了JUnit作为单元测试的工具。

### Jacoco

Jacoco是一个开源的代码覆盖率工具，可以嵌入到Ant、Maven中，并提供了EclEmma Eclipse插件,也可以使用JavaAgent技术监控Java程序。很多第三方的工具提供了对Jacoco的集成，如sonar、Jenkins等。

## 测试内容

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- 谢建福
  - com.google.common.base.CaseFormat;
  - com.google.common.hash.Crc32cHashFunctionTest;
  - com.google.common.primitives.BooleansTest;
  - com.google.common.primitives.BytesTest;
- 李宇恒
  - com.google.common.primitives.CharsTest;
  - com.google.common.primitives.DoublesTest;

## 测试标准

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- Line Coverage: above **90%**
- Condition/Clause Coverage: above **90%**

Jacoco中的Branch Coverage实际上是Condition Coverage

## 测试方式

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以函数/方法作为测试的基本对象，把被测函数/方法内部调用的函数/方法作为测试代码的一部分一起覆盖，对被测代码做 Line Coverage 和 Branch/Decision Coverage。

# 测试分析

## com.google.common.base.Format

### 覆盖情况

Element	Class, %	Method, %	Line, %	Branch, %
Ascii	100% (1/1)	45% (5/11)	33% (22/65)	44% (24/54)
CaseFormat	100% (7/7)	100% (27/27)	100% (68/68)	100% (28/28)

### 测试结果

CaseFormatTest	86 ms
normalizeWord	79 ms
converterTo	7 ms
to	0 ms

### 测试对象

#### to()

- 功能：实现格式转换，格式共有五种，包括LOWER\_CAMEL, UPPER\_CAMEL, LOWER\_HYPHEN, LOWER\_UNDERSCORE, UPPER\_UNDERSCORE。

- ```
public final String to(CaseFormat format, String str) {
    checkNotNull(format);
    checkNotNull(str);
    return (format == this) ? str : convert(format, str);
}

/** Enum values can override for performance reasons. */
String convert(CaseFormat format, String s) {
    // deal with camel conversion
    StringBuilder out = null;
    int i = 0;
    int j = -1;
    while ((j = wordBoundary.indexIn(s, ++j)) != -1) {
        if (i == 0) {
            // include some extra space for separators
            out = new StringBuilder(s.length() + 4 *
format.wordSeparator.length());
            out.append(format.normalizeFirstWord(s.substring(i, j)));
        } else {
            requireNonNull(out).append(format.normalizeWord(s.substring(i,
j)));
        }
        out.append(format.wordSeparator);
        i = j + wordSeparator.length();
    }
    return (i == 0)
        ? format.normalizeFirstWord(s)
        :
requireNonNull(out).append(format.normalizeWord(s.substring(i))).toString();
}
```

- 测试代码
  - 分析代码，提供所有特殊格式转换的测试样例；

```

o @Test
  public void to() {
      assertEquals("helloWorld",
          CaseFormat.LOWER_HYPHEN.to(CaseFormat.LOWER_CAMEL, "hello-world"));
      assertEquals("HelloWorld",
          CaseFormat.LOWER_HYPHEN.to(CaseFormat.UPPER_CAMEL, "hello-world"));
      assertEquals("hello-world",
          CaseFormat.LOWER_HYPHEN.to(CaseFormat.LOWER_HYPHEN, "hello-world"));
      assertEquals("hello_world",
          CaseFormat.LOWER_HYPHEN.to(CaseFormat.LOWER_UNDERSCORE, "hello-world"));
      assertEquals("HELLO_WORLD",
          CaseFormat.LOWER_HYPHEN.to(CaseFormat.UPPER_UNDERSCORE, "hello-world"));

      assertEquals("hello",
          CaseFormat.LOWER_UNDERSCORE.to(CaseFormat.LOWER_CAMEL, "hello"));
      assertEquals("helloWorld",
          CaseFormat.LOWER_UNDERSCORE.to(CaseFormat.LOWER_CAMEL, "hello_world"));
      assertEquals("helloWorldworld",
          CaseFormat.LOWER_UNDERSCORE.to(CaseFormat.LOWER_CAMEL,
              "hello_world_world"));
      assertEquals("HelloWorld",
          CaseFormat.LOWER_UNDERSCORE.to(CaseFormat.UPPER_CAMEL, "hello_world"));
      assertEquals("hello-world",
          CaseFormat.LOWER_UNDERSCORE.to(CaseFormat.LOWER_HYPHEN, "hello_world"));
      assertEquals("hello_world",
          CaseFormat.LOWER_UNDERSCORE.to(CaseFormat.LOWER_UNDERSCORE,
              "hello_world"));
      assertEquals("HELLO_WORLD",
          CaseFormat.LOWER_UNDERSCORE.to(CaseFormat.UPPER_UNDERSCORE,
              "hello_world"));

      assertEquals("helloWorld",
          CaseFormat.UPPER_UNDERSCORE.to(CaseFormat.LOWER_CAMEL, "HELLO_WORLD"));
      assertEquals("HelloWorld",
          CaseFormat.UPPER_UNDERSCORE.to(CaseFormat.UPPER_CAMEL, "HELLO_WORLD"));
      assertEquals("hello-world",
          CaseFormat.UPPER_UNDERSCORE.to(CaseFormat.LOWER_HYPHEN, "HELLO_WORLD"));
      assertEquals("hello_world",
          CaseFormat.UPPER_UNDERSCORE.to(CaseFormat.LOWER_UNDERSCORE,
              "HELLO_WORLD"));
      assertEquals("HELLO_WORLD",
          CaseFormat.UPPER_UNDERSCORE.to(CaseFormat.UPPER_UNDERSCORE,
              "HELLO_WORLD"));
  }

```

## converterTo()

- 功能：获取由当前格式转换到目标格式的转换器

```

• public Converter<String, String> converterTo(CaseFormat targetFormat) {
    return new StringConverter(this, targetFormat);
}

```

- 测试代码
  - 获取转换器，并验证转换器的功能是否匹配；

- ```

@Test
public void converterTo() {
    Converter<String, String> converter =
        CaseFormat.LOWER_CAMEL.converterTo(CaseFormat.UPPER_UNDERSCORE);
    assertEquals("HELLO_WORLD", converter.convert("helloWorld"));
    assertEquals("helloWorld",
        converter.correctedDoBackward("HELLO_WORLD"));
    assertEquals("LOWER_CAMEL.converterTo(UPPER_UNDERSCORE)",
        converter.toString());
    assertEquals(CaseFormat.LOWER_CAMEL.hashCode() ^
        CaseFormat.UPPER_UNDERSCORE.hashCode(), converter.hashCode());
    assertEquals(converter,
        CaseFormat.LOWER_CAMEL.converterTo(CaseFormat.UPPER_UNDERSCORE));
    assertEquals(converter,
        CaseFormat.LOWER_CAMEL.converterTo(CaseFormat.LOWER_UNDERSCORE));
    assertEquals(converter,
        CaseFormat.UPPER_CAMEL.converterTo(CaseFormat.UPPER_UNDERSCORE));
    assertEquals(converter, new Object());
}

```

### LOWER\_HYPHEN.normalizeWord()

- 功能：获得当前字符串的标准化字符串

- ```

String normalizeWord(String word) {
    return Ascii.toLowerCase(word);
}

```

- 测试代码

- ```

assertEquals("hello-world",
    CaseFormat.LOWER_HYPHEN.normalizeWord("Hello-world"));

```

### LOWER\_UNDERSCORE.normalizeWord()

- 功能：获得当前字符串的标准化字符串

- ```

String normalizeWord(String word) {
    return Ascii.toLowerCase(word);
}

```

- 测试代码

- ```

assertEquals("hello_world",
    CaseFormat.LOWER_UNDERSCORE.normalizeWord("Hello_world"));

```

### LOWER\_CAMEL.normalizeWord()

- 功能：获得当前字符串的标准化字符串

- ```

String normalizeWord(String word) {
    return firstCharOnlyToUpper(word);
}

```

- 测试代码

- 验证字符串为空和不为空时函数功能是否正常；

- ```
assertEquals("", CaseFormat.LOWER_CAMEL.normalizeWord(""));
assertEquals("HelloWorld",
CaseFormat.LOWER_CAMEL.normalizeWord("HElloworld"));
```

### UPPER\_CAMEL.normalizeWord()

- 功能：获得当前字符串的标准化字符串

- ```
String normalizeWord(String word) {
    return firstCharOnlyToUpper(word);
}
```

- 测试代码

- ```
assertEquals("HelloWorld",
CaseFormat.UPPER_CAMEL.normalizeWord("helloworld"));
```

### UPPER\_UNDERSCORE.normalizeWord()

- 功能：获得当前字符串的标准化字符串

- ```
String normalizeWord(String word) {
    return Ascii.toUpperCase(word);
}
```

- 测试代码

- ```
assertEquals("HELLO_WORLD",
CaseFormat.UPPER_UNDERSCORE.normalizeWord("Hello_world"));
```

## com.google.common.hash.Crc32cHashFunctionTest

### 覆盖情况

Element	Class, %	Method, %	Line, %	Branch, %
AbstractByteHasher	0% (0/1)	0% (0/12)	0% (0/32)	0% (0/6)
AbstractCompositeHashFunction	0% (0/2)	0% (0/20)	0% (0/61)	0% (0/36)
AbstractHasher	100% (1/1)	23% (3/13)	11% (4/35)	8% (1/12)
AbstractHashFunction	100% (1/1)	0% (0/9)	7% (1/13)	0% (0/2)
AbstractNonStreamingHashFunction	0% (0/3)	0% (0/16)	0% (0/32)	0% (0/6)
AbstractStreamingHasher	100% (1/1)	78% (11/14)	75% (47/62)	75% (12/16)
BloomFilter	0% (0/3)	0% (0/28)	0% (0/108)	0% (0/52)
BloomFilterStrategies	0% (0/4)	0% (0/20)	0% (0/105)	0% (0/44)
ChecksumHashFunction	0% (0/3)	0% (0/8)	0% (0/20)	0% (0/6)
Crc32cHashFunction	100% (2/2)	100% (10/10)	97% (44/45)	91% (11/12)

### 测试结果

✓ Crc32cHashFunctionTest	31 ms
✓ testToString	9 ms
✓ newHasher	22 ms
✓ bits	0 ms

## 测试对象

### bits()

- 功能：获取Crc32算法使用的位数

- ```
public int bits() {  
    return 32;  
}
```

- 测试代码

- ```
public void bits() {  
    assertEquals(32, new Crc32HashFunction().bits());  
}
```

### newHasher()

- 功能：返回Crc32cHasher对象，该对象可用于对输入内容生成CRC32C校验码。

- ```
public Hasher newHasher() {  
    return new Crc32cHasher();  
}  
  
static final class Crc32cHasher extends AbstractStreamingHasher {  
  
    Crc32cHasher() {  
        super(16);  
    }  
  
    private boolean finished = false;  
  
    private int crc0 = INVERSE_COMPUTE_FOR_WORD_OF_ALL_1S;  
    private int crc1 = 0;  
    private int crc2 = 0;  
    private int crc3 = 0;  
  
    @Override  
    protected void process(ByteBuffer bb) {  
        if (finished) {  
            throw new IllegalStateException(  
                "The behavior of calling any method after calling hash() is  
                undefined.");  
        }  
        while (bb.remaining() >= 16) {  
            crc0 = computeForWord(crc0);  
            crc1 = computeForWord(crc1);  
            crc2 = computeForWord(crc2);  
            crc3 = computeForWord(crc3);  
            crc0 ^= bb.getInt();  
            crc1 ^= bb.getInt();  
            crc2 ^= bb.getInt();  
            crc3 ^= bb.getInt();  
        }  
    }  
  
    @Override  
    protected void processRemaining(ByteBuffer bb) {
```

```

        if (finished) {
            return;
        }
        crc0 = combine(0, crc0);
        crc0 = combine(crc0, crc1);
        crc0 = combine(crc0, crc2);
        crc0 = combine(crc0, crc3);
        while (bb.hasRemaining()) {
            crc0 = (crc0 >>> 8) ^ BYTE_TABLE[(bb.get() ^ crc0) & 0xFF];
        }
        finished = true;
    }

    @Override
    protected HashCode makeHash() {
        if (!finished) {
            processRemaining(EMPTY);
        }
        return HashCode.fromInt(~crc0);
    }

    static final int[] BYTE_TABLE = {
        ...
    };

    static final int[][] STRIDE_TABLE = {
        ...
    };
    static final int INVERSE_COMPUTE_FOR_WORD_OF_ALL_1S = 0xee3ddcd;

    static int computeForWord(int word) {
        return STRIDE_TABLE[3][word & 0xFF]
            ^ STRIDE_TABLE[2][(word >>> 8) & 0xFF]
            ^ STRIDE_TABLE[1][(word >>> 16) & 0xFF]
            ^ STRIDE_TABLE[0][word >>> 24];
    }

    static int combine(int csum, int crc) {
        csum ^= crc;
        for (int i = 0; i < 4; i++) {
            csum = (csum >>> 8) ^ BYTE_TABLE[csum & 0xFF];
        }
        return csum;
    }

    private static final ByteBuffer EMPTY = ByteBuffer.allocate(0);
}

```

- 测试代码

- 验证hasher的每一个方法是否正常;

```

    public void newHasher() {
        Hasher hasher = new Crc32cHashFunction().newHasher();
        hasher.putBoolean(false);
        hasher.putByte((byte)123);
        hasher.putChar('a');
    }

```

```

        hasher.putFloat(123.123f);
        hasher.putBytes(new byte[]{1,2});
        assertEquals(109479762, hasher.hash().asInt());
        assertEquals(109479762, hasher.hash().asInt());
        hasher = new Crc32HashFunction().newHasher();

        hasher.putBytes(ByteBuffer.allocate(12).order(ByteOrder.LITTLE_ENDIAN).
putLong(123));

        hasher.putBytes(ByteBuffer.allocate(12).order(ByteOrder.LITTLE_ENDIAN).
putLong(123));

        hasher.putBytes(ByteBuffer.allocate(12).order(ByteOrder.LITTLE_ENDIAN).
putLong(123));

        hasher.putBytes(ByteBuffer.allocate(12).order(ByteOrder.LITTLE_ENDIAN).
putLong(123));

        hasher.putBytes(ByteBuffer.allocate(12).order(ByteOrder.LITTLE_ENDIAN).
putLong(123));

        hasher.putBytes(ByteBuffer.allocate(12).order(ByteOrder.LITTLE_ENDIAN).
putLong(123));

        hasher.putBytes(ByteBuffer.allocate(20).order(ByteOrder.LITTLE_ENDIAN).
putLong(123));
        assertEquals(1499445213, hasher.hash().asInt());
        hasher = new Crc32HashFunction().newHasher();
        assertEquals(0, hasher.hash().asInt());
    }

```

### toString()

- 功能：输出Hash生成的校验码类型

- ```
public String toString() {
    return "Hashing.crc32c()";
}
```

- 测试代码

- ```
public void testToString() {
    assertEquals("Hashing.crc32c()", new
Crc32HashFunction().toString());
}
```

## com.google.common.primitives.BooleansTest



## 覆盖情况

| Element  | Class, %   | Method, %    | Line, %        | Branch, %    |
|----------|------------|--------------|----------------|--------------|
| Booleans | 100% (4/4) | 100% (40/40) | 100% (149/149) | 100% (92/92) |

## 测试结果

|                                 |       |
|---------------------------------|-------|
| ✓ BooleansTest                  | 23 ms |
| ✓ testFalseFirst                | 14 ms |
| ✓ testToArray                   | 3 ms  |
| ✓ testJoin                      | 0 ms  |
| ✓ testLastIndexOf               | 0 ms  |
| ✓ testContains                  | 0 ms  |
| ✓ testEnsureCapacity            | 0 ms  |
| ✓ testCompare                   | 0 ms  |
| ✓ testLexicographicalComparator | 3 ms  |
| ✓ testReverse                   | 0 ms  |
| ✓ testHashCode                  | 1 ms  |
| ✓ testAsList                    | 0 ms  |
| ✓ testConcat                    | 0 ms  |
| ✓ testIndexOf                   | 0 ms  |
| ✓ testTrueFirst                 | 2 ms  |
| ✓ testCountTrue                 | 0 ms  |

## 测试对象

### trueFirst()

- 功能：返回boolean类型的比较器，true优先，表现在列表排序时为true在前；

```
public static Comparator<Boolean> trueFirst() {
    return BooleanComparator.TRUE_FIRST;
}
/** Comparators for {@code Boolean} values. */
private enum BooleanComparator implements Comparator<Boolean> {
    TRUE_FIRST(1, "Booleans.trueFirst()"),
    FALSE_FIRST(-1, "Booleans.falseFirst()");

    private final int trueValue;
    private final String toString;

    BooleanComparator(int trueValue, String toString) {
        this.trueValue = trueValue;
        this.toString = toString;
    }

    @Override
    public int compare(Boolean a, Boolean b) {
        int aVal = a ? trueValue : 0;
        int bVal = b ? trueValue : 0;
        return bVal - aVal;
    }

    @Override
    public String toString() {
        return toString;
    }
}
```

```
}
```

- 测试代码

```
o @Test
  public void testTrueFirst() {
    Comparator<Boolean> comparator = Booleans.trueFirst();
    List<Boolean> actual = new ArrayList<Boolean>(){
      add(false);
      add(true);
      add(false);
    };
    List<Boolean> expected = new ArrayList<Boolean>(){
      add(true);
      add(false);
      add(false);
    };
    actual.sort(comparator);
    assertEquals(expected, actual);
    assertEquals("Booleans.trueFirst()", comparator.toString());
  }
```

### falseFirst()

- 功能：返回boolean类型的比较器，false优先，表现在列表排序时为false在前；

```
• public static Comparator<Boolean> falseFirst() {
    return BooleanComparator.FALSE_FIRST;
  }
  /** Comparators for {@code Boolean} values. */
  private enum BooleanComparator implements Comparator<Boolean> {
    TRUE_FIRST(1, "Booleans.trueFirst()"),
    FALSE_FIRST(-1, "Booleans.falseFirst()");

    private final int trueValue;
    private final String toString;

    BooleanComparator(int trueValue, String toString) {
      this.trueValue = trueValue;
      this.toString = toString;
    }

    @Override
    public int compare(Boolean a, Boolean b) {
      int aVal = a ? trueValue : 0;
      int bVal = b ? trueValue : 0;
      return bVal - aVal;
    }

    @Override
    public String toString() {
      return toString;
    }
  }
}
```

- 测试代码

- ```

@Test
public void testFalseFirst() {
    Comparator<Boolean> comparator = Booleans.falseFirst();
    List<Boolean> actual = new ArrayList<Boolean>(){
        add(false);
        add(true);
        add(false);
    };
    List<Boolean> expected = new ArrayList<Boolean>(){
        add(false);
        add(false);
        add(true);
    };
    actual.sort(comparator);
    assertEquals(expected, actual);
    assertEquals("Booleans.falseFirst()", comparator.toString());
}

```

## hashCode()

- 功能: 返回hashCode值

- ```

public static int hashCode(boolean value) {
    return value ? 1231 : 1237;
}

```

- 测试代码

- ```

@Test
public void testHashCode() {
    assertEquals(1231, Booleans.hashCode(true));
    assertEquals(1237, Booleans.hashCode(false));
}

```

## compare()

- 功能: 比较两个boolean的大小

- ```

public static int compare(boolean a, boolean b) {
    return (a == b) ? 0 : (a ? 1 : -1);
}

```

- 测试代码

- 枚举全部四种输入情况进行测试

- ```

@Test
public void testCompare() {
    assertEquals(0, Booleans.compare(true, true));
    assertEquals(0, Booleans.compare(false, false));
    assertEquals(1, Booleans.compare(true, false));
    assertEquals(-1, Booleans.compare(false, true));
}

```

## contains()

- 功能：判断一个数组是否包含目标元素

```
public static boolean contains(boolean[] array, boolean target) {
    for (boolean value : array) {
        if (value == target) {
            return true;
        }
    }
    return false;
}
```

- 测试代码

- 分别测试 存在false和true / 仅存在false / 仅存在true 三种情况;

```
@Test
public void testContains() {
    boolean[] list = new boolean[] {
        false, true, false
    };
    assertTrue(Booleans.contains(list, true));
    assertTrue(Booleans.contains(list, false));
    boolean[] list2 = new boolean[] {
        false, false
    };
    assertFalse(Booleans.contains(list2, true));
    assertTrue(Booleans.contains(list2, false));
    boolean[] list3 = new boolean[] {
        true, true
    };
    assertTrue(Booleans.contains(list3, true));
    assertFalse(Booleans.contains(list3, false));
}
```

## indexOf()

- 功能：在数组中从左往右查找目标元素，如果存在返回下标，如果不存在返回-1

```
public static int indexOf(boolean[] array, boolean target) {
    return indexOf(array, target, 0, array.length);
}
private static int indexOf(boolean[] array, boolean target, int start, int
end) {
    for (int i = start; i < end; i++) {
        if (array[i] == target) {
            return i;
        }
    }
    return -1;
}
public static int indexOf(boolean[] array, boolean[] target) {
    checkNotNull(array, "array");
    checkNotNull(target, "target");
    if (target.length == 0) {
        return 0;
    }
}
```

```

outer:
for (int i = 0; i < array.length - target.length + 1; i++) {
    for (int j = 0; j < target.length; j++) {
        if (array[i + j] != target[j]) {
            continue outer;
        }
    }
    return i;
}
return -1;
}

```

- 测试代码

- 分别验证元素/序列存在数组和不存在数组两种情况;

```

@Test
public void testIndexOf() {
    boolean[] list = new boolean[] {
        false, true, false
    };
    assertEquals(1, Booleans.indexOf(list, true));
    assertEquals(0, Booleans.indexOf(list, false));
    boolean[] list2 = new boolean[] {
        false, false
    };
    assertEquals(-1, Booleans.indexOf(list2, true));
    assertEquals(0, Booleans.indexOf(list2, false));
    assertEquals(0, Booleans.indexOf(list, new boolean[]{}));
    assertEquals(1, Booleans.indexOf(list, new boolean[]{ true, false
    }));
    assertEquals(-1, Booleans.indexOf(list, new boolean[]{ false, false
    }));
}

```

## lastIndexOf()

- 功能: 在数组中从右往左查找目标元素, 如果存在返回下标, 如果不存在返回-1

```

public static int lastIndexOf(boolean[] array, boolean target) {
    return lastIndexOf(array, target, 0, array.length);
}

```

- 测试代码

- 分别验证元素存在和不存在序列两种情况;

- ```

@Test
public void testLastIndexOf() {
    boolean[] list = new boolean[] {
        false, true, false
    };
    assertEquals(1, Booleans.lastIndexOf(list, true));
    assertEquals(2, Booleans.lastIndexOf(list, false));
    boolean[] list2 = new boolean[] {
        false, false
    };
    assertEquals(-1, Booleans.lastIndexOf(list2, true));
    assertEquals(1, Booleans.lastIndexOf(list2, false));
}

```

## concat()

- 功能: 拼接多个数组

- ```

public static boolean[] concat(boolean[]... arrays) {
    int length = 0;
    for (boolean[] array : arrays) {
        length += array.length;
    }
    boolean[] result = new boolean[length];
    int pos = 0;
    for (boolean[] array : arrays) {
        System.arraycopy(array, 0, result, pos, array.length);
        pos += array.length;
    }
    return result;
}

```

- 测试代码

- ```

@Test
public void testConcat() {
    boolean[] list = new boolean[] {
        false, true, false
    };
    boolean[] list2 = new boolean[] {
        false, false
    };
    assertEquals(5, Booleans.concat(list, list2).length);
}

```

## ensureCapacity()

- 功能: 复制原数组, 并扩充到新的长度, 并在后面补上padding

- ```

public static boolean[] ensureCapacity(boolean[] array, int minLength, int padding) {
    checkArgument(minLength >= 0, "Invalid minLength: %s", minLength);
    checkArgument(padding >= 0, "Invalid padding: %s", padding);
    return (array.length < minLength) ? Arrays.copyOf(array, minLength + padding) : array;
}

```

- 测试代码

- 分别测试新长度小于原长和大于等于原长两种情况;

- ```
@Test
public void testEnsureCapacity() {
    boolean[] list = new boolean[] {
        false, true, false
    };
    boolean[] res = Booleans.ensureCapacity(list, 5, 3);
    assertEquals(8, res.length);
    res = Booleans.ensureCapacity(list, 2, 3);
    assertSame(list, res);
    try {
        res = Booleans.ensureCapacity(list, -1, 3);
        fail();
    } catch (IllegalArgumentException e) {
    }
    try {
        res = Booleans.ensureCapacity(list, 1, -3);
        fail();
    } catch (IllegalArgumentException e) {
    }
}
```

## join()

- 功能：将数组元素使用分隔符拼接成一个字符串

- ```
public static String join(String separator, boolean... array) {
    checkNotNull(separator);
    if (array.length == 0) {
        return "";
    }

    // For pre-sizing a builder, just get the right order of magnitude
    StringBuilder builder = new StringBuilder(array.length * 7);
    builder.append(array[0]);
    for (int i = 1; i < array.length; i++) {
        builder.append(separator).append(array[i]);
    }
    return builder.toString();
}
```

- 测试代码

- 分别测试空和非空两种情况;

- ```
@Test
public void testJoin() {
    assertEquals("false,true,false", Booleans.join(",", false, true,
false));
    assertEquals("", Booleans.join(", "));
}
```

## lexicographicalComparator()

- 功能：返回按字典序比较的比较器

```
public static Comparator<boolean[]> lexicographicalComparator() {
    return LexicographicalComparator.INSTANCE;
}

private enum LexicographicalComparator implements Comparator<boolean[]> {
    INSTANCE;

    @Override
    public int compare(boolean[] left, boolean[] right) {
        int minLength = Math.min(left.length, right.length);
        for (int i = 0; i < minLength; i++) {
            int result = Booleans.compare(left[i], right[i]);
            if (result != 0) {
                return result;
            }
        }
        return left.length - right.length;
    }

    @Override
    public String toString() {
        return "Booleans.lexicographicalComparator()";
    }
}
```

- 测试代码

- 验证comparator的功能;

```
@Test
public void testLexicographicalComparator() {
    Comparator<boolean[]> comparator =
        Booleans.lexicographicalComparator();
    assertTrue(comparator.compare(new boolean[] {}, new boolean[] {false})
        < 0);
    assertTrue(comparator.compare(new boolean[] {false}, new boolean[]
        {false, true}) < 0);
    assertTrue(comparator.compare(new boolean[] {false, true}, new
        boolean[] {true}) < 0);
    assertEquals("Booleans.lexicographicalComparator()",
        comparator.toString());
}
```

## toArray()

- 功能：将集合类容器转换成数组

```
public static boolean[] toArray(Collection<Boolean> collection) {
    if (collection instanceof BooleanArrayAsList) {
        return ((BooleanArrayAsList) collection).toBooleanArray();
    }

    Object[] boxedArray = collection.toArray();
    int len = boxedArray.length;
    boolean[] array = new boolean[len];
}
```



```

for (int i = 0; i < len; i++) {
    // checkNotNull for GWT (do not optimize)
    array[i] = (Boolean) checkNotNull(boxedArray[i]);
}
return array;
}

```

- 测试代码

- 通过验证array的长度来测试功能;

```

@Test
public void testToArray() {
    List<Boolean> list = new ArrayList<Boolean>(){
        add(false);
        add(true);
        add(false);
    };
    boolean[] res = Booleans.toArray(list);
    assertEquals(3, res.length);
    res = Booleans.toArray(Booleans.asList(false,true,false));
    assertEquals(3, res.length);
}

```

## asList()

- 功能: 将元素列表转换成List容器

```

public static List<Boolean> asList(boolean... backingArray) {
    if (backingArray.length == 0) {
        return Collections.emptyList();
    }
    return new BooleanArrayAsList(backingArray);
}

```

- 测试代码

- 转换成BooleanArrayAsList类型, 并测试BooleanArrayAsList类的方法

```

@Test
public void testAsList() {
    List<Boolean> res = Booleans.asList(false,true,false);
    assertEquals(3, res.size());
    assertFalse(res.isEmpty());
    assertTrue(res.contains(false));
    assertFalse(res.contains(0));
    assertFalse(Booleans.asList(true, true).contains(false));
    assertEquals(1, res.indexOf(true));
    assertEquals(2, res.lastIndexOf(false));
    res.set(1, false);
    assertEquals(-1, res.indexOf(true));
    assertEquals(-1, res.lastIndexOf(true));
    assertEquals(-1, res.indexOf(1));
    assertEquals(-1, res.lastIndexOf(1));
    assertEquals(Boolean.FALSE, res.get(1));
    assertEquals(0, res.subList(0,0).size());
    assertEquals(Boolean.FALSE, res.subList(0,1).get(0));
    assertEquals(1, res.subList(0,1).size());
}

```

```

        assertTrue(res.equals(res));
        assertTrue(res.equals(Booleans.asList(false, false, false)));
        assertFalse(res.equals(Booleans.asList(true, false, false)));
        assertFalse(res.equals(Booleans.asList(false, false)));
        assertFalse(res.equals(new boolean[]{false, false}));
        assertEquals(1258132, res.hashCode());
        assertEquals("[false, false, false]", res.toString());
        res = Booleans.asList();
        assertEquals(0, res.size());
        assertTrue(res.isEmpty());
        assertEquals("[true, true]", Booleans.asList(true,
true).toString());
    }

```

## countTrue()

- 功能：计算值为true的元素的数量

```

    public static int countTrue(boolean... values) {
        int count = 0;
        for (boolean value : values) {
            if (value) {
                count++;
            }
        }
        return count;
    }

```

- 测试代码

```

    @Test
    public void testCountTrue() {
        assertEquals(2, Booleans.countTrue(false, true, true, false));
    }

```

## reverse()

- 功能：数组翻转

```

    public static void reverse(boolean[] array) {
        checkNotNull(array);
        reverse(array, 0, array.length);
    }

    public static void reverse(boolean[] array, int fromIndex, int toIndex) {
        checkNotNull(array);
        checkPositionIndexes(fromIndex, toIndex, array.length);
        for (int i = fromIndex, j = toIndex - 1; i < j; i++, j--) {
            boolean tmp = array[i];
            array[i] = array[j];
            array[j] = tmp;
        }
    }

```

- 测试代码

- 测试翻转之后每个位置的元素值和长度是否正确;

```

○ @Test
  public void testReverse() {
      boolean[] tmp = new boolean[]{false, false, true};
      Booleans.reverse(tmp);
      assertTrue(tmp[0]);
      assertFalse(tmp[1]);
      assertFalse(tmp[2]);
      assertEquals(3, tmp.length);
  }

```

## com.google.common.primitives.BytesTest

### 覆盖情况

| Element ^ | Class, %   | Method, %    | Line, %        | Branch, %    |
|-----------|------------|--------------|----------------|--------------|
| Booleans  | 0% (0/4)   | 0% (0/40)    | 0% (0/149)     | 0% (0/92)    |
| Bytes     | 100% (2/2) | 100% (27/27) | 100% (111/111) | 100% (66/66) |

### 测试结果

|                  |       |
|------------------|-------|
| ✓ BytesTest      | 12 ms |
| ✓ asList         | 5 ms  |
| ✓ concat         | 0 ms  |
| ✓ toArray        | 1 ms  |
| ✓ contains       | 1 ms  |
| ✓ lastIndexOf    | 0 ms  |
| ✓ testHashCode   | 0 ms  |
| ✓ reverse        | 0 ms  |
| ✓ ensureCapacity | 4 ms  |
| ✓ indexOf        | 1 ms  |

### 测试对象

先初始化一些测试样例

```

private byte[] arr1 = new byte[]{ 1, 2, 3, 4, 5, 1, 2, 3, 4, 5};
private byte[] zeros = new byte[]{ 0, 0, 0 };
private byte[] empty = new byte[]{};

```

### hashCode()

- 功能：返回该元素的哈希值

```

• public static int hashCode(byte value) {
    return value;
}

```

- 测试代码

```

○ public void testHashCode() {
    assertEquals(1, Bytes.hashCode((byte) 1));
}

```

## contains()

- 功能：判断数组内是否存在目标元素

```
public static boolean contains(byte[] array, byte target) {
    for (byte value : array) {
        if (value == target) {
            return true;
        }
    }
    return false;
}
```

- 测试代码

```
@Test
public void contains() {
    assertTrue(Bytes.contains(arr1, (byte) 1));
    assertFalse(Bytes.contains(arr1, (byte) 0));
}
```

## indexOf()

- 功能：在数组中从左往右查找目标元素，如果存在返回下标，如果不存在返回-1

```
public static int indexOf(byte[] array, byte target) {
    return indexOf(array, target, 0, array.length);
}

private static int indexOf(byte[] array, byte target, int start, int end) {
    for (int i = start; i < end; i++) {
        if (array[i] == target) {
            return i;
        }
    }
    return -1;
}

public static int indexOf(byte[] array, byte[] target) {
    checkNotNull(array, "array");
    checkNotNull(target, "target");
    if (target.length == 0) {
        return 0;
    }

    outer:
    for (int i = 0; i < array.length - target.length + 1; i++) {
        for (int j = 0; j < target.length; j++) {
            if (array[i + j] != target[j]) {
                continue outer;
            }
        }
        return i;
    }
    return -1;
}
```

- 测试代码

- ```

@Test
public void indexOf() {
    assertEquals(2, Bytes.indexOf(arr1, (byte) 3));
    assertEquals(-1, Bytes.indexOf(arr1, (byte) 0));
    assertEquals(0, Bytes.indexOf(arr1, empty));
    assertEquals(1, Bytes.indexOf(arr1, new byte[]{2,3}));
    assertEquals(-1, Bytes.indexOf(arr1, new byte[]{2,1}));
}

```

## lastIndexOf()

- 功能：在数组中从右往左查找目标元素，如果存在返回下标，如果不存在返回-1

- ```

public static int lastIndexOf(byte[] array, byte target) {
    return lastIndexOf(array, target, 0, array.length);
}

private static int lastIndexOf(byte[] array, byte target, int start, int end) {
    for (int i = end - 1; i >= start; i--) {
        if (array[i] == target) {
            return i;
        }
    }
    return -1;
}

```

- 测试代码

- ```

@Test
public void lastIndexOf() {
    assertEquals(7, Bytes.lastIndexOf(arr1, (byte) 3));
    assertEquals(-1, Bytes.lastIndexOf(arr1, (byte) 0));
}

```

## concat()

- 功能：拼接多个数组

- ```

public static byte[] concat(byte[]... arrays) {
    int length = 0;
    for (byte[] array : arrays) {
        length += array.length;
    }
    byte[] result = new byte[length];
    int pos = 0;
    for (byte[] array : arrays) {
        System.arraycopy(array, 0, result, pos, array.length);
        pos += array.length;
    }
    return result;
}

```

- 测试代码

- ```

@Test
public void concat() {
    byte[] res = Bytes.concat(arr1, zeros, empty);
    assertEquals(13, res.length);
    assertEquals(3, res[2]);
    assertEquals(5, res[9]);
    assertEquals(0, res[10]);
}

```

## ensureCapacity()

- 功能：复制原数组，并扩充到新的长度，并在后面补上padding

- ```

public static byte[] ensureCapacity(byte[] array, int minLength, int padding) {
    checkArgument(minLength >= 0, "Invalid minLength: %s", minLength);
    checkArgument(padding >= 0, "Invalid padding: %s", padding);
    return (array.length < minLength) ? Arrays.copyOf(array, minLength + padding) : array;
}

```

- 测试代码

- ```

@Test
public void ensureCapacity() {
    byte[] res = Bytes.ensureCapacity(arr1, 5, 3);
    assertSame(res, res);
    res = Bytes.ensureCapacity(arr1, 11, 3);
    assertEquals(14, res.length);
    try {
        res = Bytes.ensureCapacity(arr1, -1, 3);
        fail();
    } catch (IllegalArgumentException e) {
    }
    try {
        res = Bytes.ensureCapacity(arr1, 1, -3);
        fail();
    } catch (IllegalArgumentException e) {
    }
}

```

## toArray()

- 功能：将集合类容器转换成数组

- ```

public static byte[] toArray(Collection<? extends Number> collection) {
    if (collection instanceof ByteArrayAsList) {
        return ((ByteArrayAsList) collection).toByteArray();
    }

    Object[] boxedArray = collection.toArray();
    int len = boxedArray.length;
    byte[] array = new byte[len];
    for (int i = 0; i < len; i++) {
        // checkNotNull for GWT (do not optimize)
        array[i] = ((Number) checkNotNull(boxedArray[i])).byteValue();
    }
}

```

```

    return array;
}

```

- 测试代码

```

    ○ @Test
      public void toArray() {
          List<Number> list = new ArrayList<Number>(){
              add(1);
              add(2);
              add(3);
          };
          byte[] res = Bytes.toArray(list);
          assertEquals(3, res.length);
          assertEquals(1, res[0]);
          assertEquals(2, res[1]);
          assertEquals(3, res[2]);
          res = Bytes.toArray(Bytes.asList((byte)1, (byte)2, (byte)3));
          assertEquals(3, res.length);
          assertEquals(1, res[0]);
          assertEquals(2, res[1]);
          assertEquals(3, res[2]);
      }

```

## asList()

- 功能: 转换成ByteArrayAsList类型, 并测试ByteArrayAsList类的方法

```

    • public static List<Byte> asList(byte... backingArray) {
        if (backingArray.length == 0) {
            return Collections.emptyList();
        }
        return new ByteArrayAsList(backingArray);
    }

    @GwtCompatible
    private static class ByteArrayAsList extends AbstractList<Byte>
        implements RandomAccess, Serializable {
        final byte[] array;
        final int start;
        final int end;

        ByteArrayAsList(byte[] array) {
            this(array, 0, array.length);
        }

        ByteArrayAsList(byte[] array, int start, int end) {
            this.array = array;
            this.start = start;
            this.end = end;
        }

        @Override
        public int size() {
            return end - start;
        }

        @Override

```

```

public boolean isEmpty() {
    return false;
}

@Override
public Byte get(int index) {
    checkElementIndex(index, size());
    return array[start + index];
}

@Override
public boolean contains(@CheckForNull Object target) {
    // Overridden to prevent a ton of boxing
    return (target instanceof Byte) && Bytes.indexOf(array, (Byte) target,
start, end) != -1;
}

@Override
public int indexOf(@CheckForNull Object target) {
    // Overridden to prevent a ton of boxing
    if (target instanceof Byte) {
        int i = Bytes.indexOf(array, (Byte) target, start, end);
        if (i >= 0) {
            return i - start;
        }
    }
    return -1;
}

@Override
public int lastIndexOf(@CheckForNull Object target) {
    // Overridden to prevent a ton of boxing
    if (target instanceof Byte) {
        int i = Bytes.lastIndexOf(array, (Byte) target, start, end);
        if (i >= 0) {
            return i - start;
        }
    }
    return -1;
}

@Override
public Byte set(int index, Byte element) {
    checkElementIndex(index, size());
    byte oldValue = array[start + index];
    // checkNotNull for GWT (do not optimize)
    array[start + index] = checkNotNull(element);
    return oldValue;
}

@Override
public List<Byte> subList(int fromIndex, int toIndex) {
    int size = size();
    checkPositionIndexes(fromIndex, toIndex, size);
    if (fromIndex == toIndex) {
        return Collections.emptyList();
    }
    return new ByteArrayAsList(array, start + fromIndex, start + toIndex);
}

```



```

}

@Override
public boolean equals(@CheckForNull Object object) {
    if (object == this) {
        return true;
    }
    if (object instanceof ByteArrayAsList) {
        ByteArrayAsList that = (ByteArrayAsList) object;
        int size = size();
        if (that.size() != size) {
            return false;
        }
        for (int i = 0; i < size; i++) {
            if (array[start + i] != that.array[that.start + i]) {
                return false;
            }
        }
        return true;
    }
    return super.equals(object);
}

@Override
public int hashCode() {
    int result = 1;
    for (int i = start; i < end; i++) {
        result = 31 * result + Bytes.hashCode(array[i]);
    }
    return result;
}

@Override
public String toString() {
    StringBuilder builder = new StringBuilder(size() * 5);
    builder.append('[').append(array[start]);
    for (int i = start + 1; i < end; i++) {
        builder.append(", ").append(array[i]);
    }
    return builder.append(']').toString();
}

byte[] toByteArray() {
    return Arrays.copyOfRange(array, start, end);
}

private static final long serialVersionUID = 0;
}

```

- 测试代码

```

○ @Test
public void asList() {
    List<Byte> res = Bytes.asList();
    assertEquals(0, res.size());
    assertTrue(res.isEmpty());
    res = Bytes.asList((byte)1, (byte)2, (byte)3);
}

```

```

assertEquals(3, res.size());
assertEquals(1, (byte)res.get(0));
assertEquals(2, (byte)res.get(1));
assertEquals(3, (byte)res.get(2));
assertFalse(res.isEmpty());
assertEquals(true, res.contains((byte) 1));
assertEquals(false, res.contains((byte) -1));
assertEquals(false, res.contains(new Object()));
assertEquals(-1, res.indexOf(new Object()));
assertEquals(0, res.indexOf((byte) 1));
assertEquals(-1, res.indexOf((byte) -1));
assertEquals(-1, res.lastIndexOf(new Object()));
assertEquals(-1, res.lastIndexOf((byte) -1));
res.set(2, (byte)1);
assertEquals(2, res.lastIndexOf((byte) 1));
assertEquals(0, res.subList(0, 0).size());
assertEquals(2, res.subList(0, 2).size());
assertEquals(2, (byte)res.subList(0, 2).get(1));
assertEquals(true, res.equals(res));
assertEquals(true, res.equals(Bytes.asList((byte)1, (byte)2,
(byte)1)));
assertEquals(false, res.equals(Bytes.asList((byte)1, (byte)2,
(byte)3)));
assertEquals(false, res.equals(Bytes.asList((byte)1, (byte)2)));
assertEquals(false, res.equals(Arrays.asList((byte)1, (byte)2)));
assertEquals("[1, 2, 1]", res.toString());
assertEquals(30815, res.hashCode());
}

```

## reverse()

- 功能: 数组翻转

- ```

public static void reverse(byte[] array, int fromIndex, int toIndex) {
    checkNotNull(array);
    checkPositionIndexes(fromIndex, toIndex, array.length);
    for (int i = fromIndex, j = toIndex - 1; i < j; i++, j--) {
        byte tmp = array[i];
        array[i] = array[j];
        array[j] = tmp;
    }
}

```

- 测试代码

- ```

@Test
public void reverse() {
    byte[] arr = new byte[]{1,2,3};
    Bytes.reverse(arr);
    assertEquals(3, arr.length);
    assertEquals(3, arr[0]);
    assertEquals(2, arr[1]);
    assertEquals(1, arr[2]);
}

```

# 为什么Crc32cHashFunctionTest没有达到 100% 的覆盖率

- 存在部分代码不对外开放，并且出现该问题的条件苛刻、情况罕见，很难通过编写输入参数覆盖相关代码；
- 例如，
  - 下面代码为Crc32cHashFunctionTest的protected方法process中部分代码，该部分代码未被覆盖

```
■ if (finished) {  
    throw new IllegalStateException(  
        "The behavior of calling any method after calling hash()  
is undefined.");  
}
```

- 其中finished为对象内部private修饰符修饰的变量

```
■ private boolean finished = false;
```

## 改进方法

- 使用反射的方式，修改类内部private变量的数值，进行测试；

## 无法提高测试覆盖率的原因

### Line Coverage

1. 存在死代码，该部分死代码永远不会被执行；

### Branch Coverage

1. 存在分支要求的条件矛盾，无法被满足；

- eg.

```
■ if(A == 1) {  
    if(A == 0) {  
        print('hello world!');  
    }  
}
```