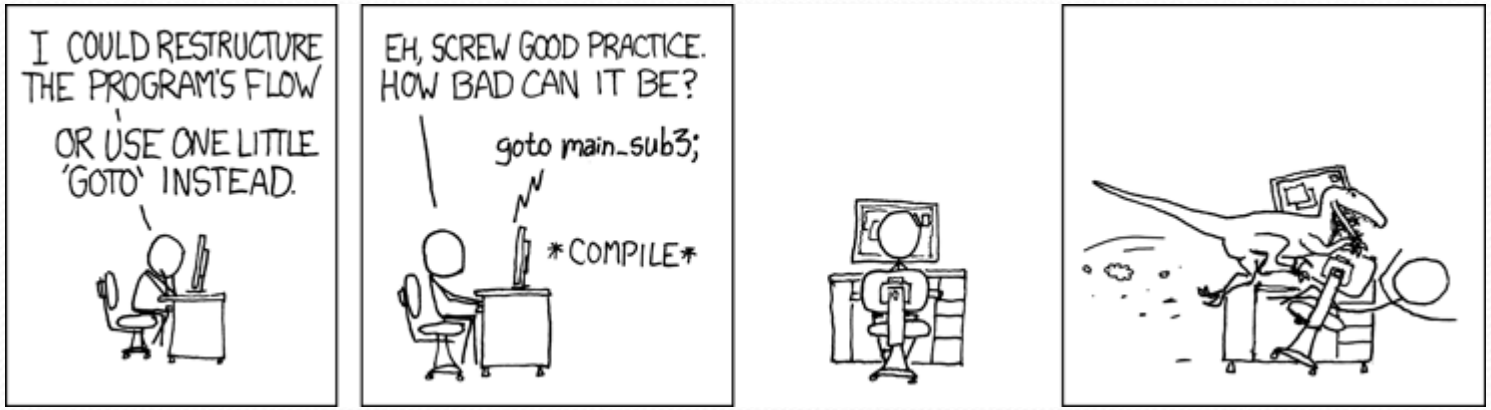
# CSE 143

Lecture 3: `ArrayIntList;`

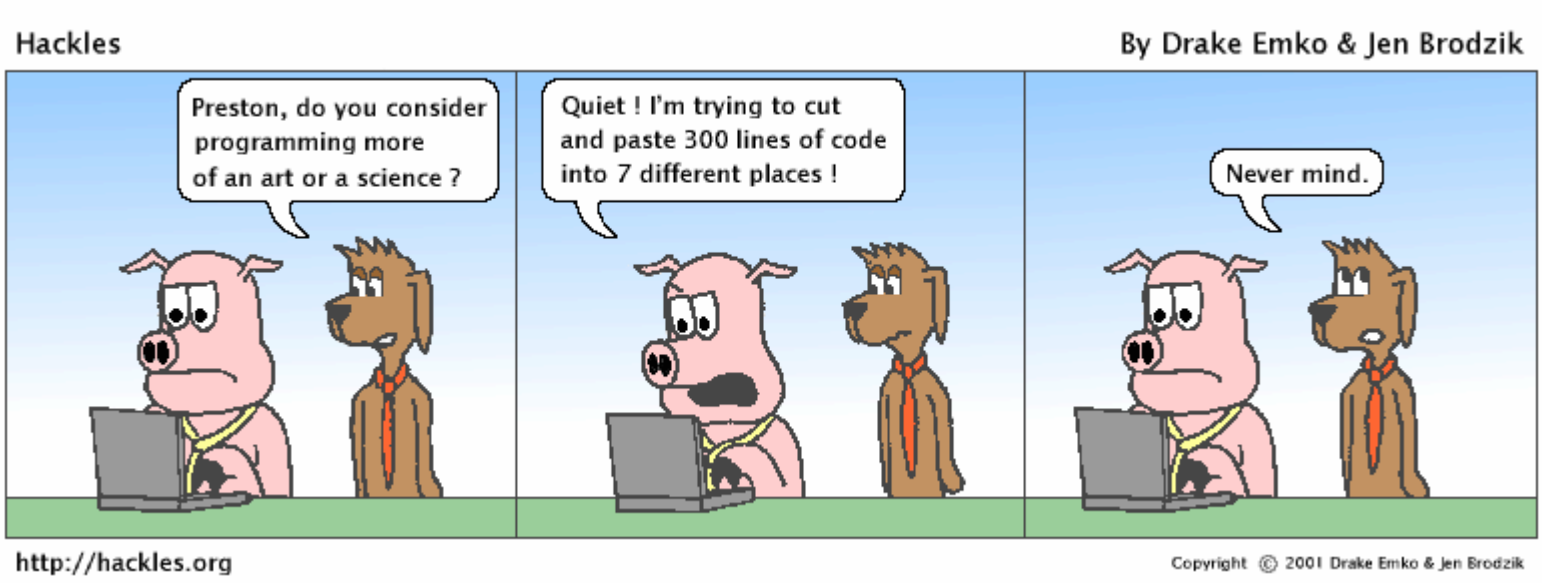
pre/post conditions and exceptions

**reading: 4.4 15.1 - 15.3**



# Why does style matter?

- Maintenance
  - `// magic number`
    `int magicNumber = 9;`
- Getting a job
  - Every company has a different style guide



# Implementing `remove`

- Again, we need to shift elements in the array
  - this time, it's a left-shift
  - in what order should we process the elements?
  - what indexes should we process?

| *index* | *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* |
|---|---|---|---|---|---|---|---|---|---|---|
| *value* | 3 | 8 | 9 | 7 | 5 | 12 | 0 | 0 | 0 | 0 |
| *size* | 6 | | | | | | | | | |

- `list.remove(2);` `// delete 9 from index 2`

| *index* | *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* |
|---|---|---|---|---|---|---|---|---|---|---|
| *value* | 3 | 8 | **7** | **5** | **12** | 0 | 0 | 0 | 0 | 0 |
| *size* | **5** | | | ← | | | | | | |

# Implementing `remove` code

```
public void remove(int index) {
    for (int i = index; i < size; i++) {
        list[i] = list[i + 1];
    }
    size--;
    list[size] = 0;        // optional (why?)
}
```

| index | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| value | 3 | 8 | 9 | 7 | 5 | 12 | 0 | 0 | 0 | 0 |
| size | 6 | | | | | | | | | |

- `list.remove(2);` `// delete 9 from index 2`

| index | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| value | 3 | 8 | **7** | **5** | **12** | 0 | 0 | 0 | 0 | 0 |
| size | **5** | | | ← | | | | | | |

# Preconditions

- **precondition**: Something your method *assumes is true* at the start of its execution.
  - Often documented as a comment on the method's header:

```
// Returns the element at the given index.
// Precondition: 0 <= index < size
public int get(int index) {
    return elementData[index];
}
```

  - Stating a precondition doesn't really "solve" the problem, but it at least documents our decision and warns the client what not to do.
  - What if we want to actually enforce the precondition?

# Throwing exceptions (4.4)

```
throw new ExceptionType();
throw new ExceptionType("message");
```

- Generates an exception that will crash the program, unless it has code to handle ("catch") the exception.

- Common exception types:
  - `ArithmeticException, ArrayIndexOutOfBoundsException, FileNotFoundException, IllegalArgumentException, IllegalStateException, IOException, NoSuchElementException, NullPointerException, RuntimeException, UnsupportedOperationException`

- Why would anyone ever *want* a program to crash?

# `this` keyword

- **`this`** : A reference to the *implicit parameter*
  (the object on which a method/constructor is called)

- Syntax:
  - To refer to a field: `this.field`
  - To call a method: `this.method(parameters);`
  - To call a constructor from another constructor: `this(parameters);`

# Class constants

```
public static final type name = value;
```

- **class constant**: a global, unchangeable value in a class
  - used to store and give names to important values used in code
  - documents an important value; easier to find and change later

- classes will often store constants related to that type
  - `Math.PI`
  - `Integer.MAX_VALUE`, `Integer.MIN_VALUE`
  - `Color.GREEN`

```
// default array length for new ArrayIntLists
public static final int DEFAULT_CAPACITY = 10;
```

# Running out of space

- What should we do if the client starts out with a small capacity, but then adds more than that many elements?

| index | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| value | 3 | 8 | 9 | 7 | 5 | 12 | 4 | 8 | 1 | 6 |
| size | 10 | | | | | | | | | |

- `list.add(15);` `// add an 11th element`

| index | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| value | 3 | 8 | 9 | 7 | 5 | 12 | 4 | 8 | 1 | 6 | **15** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| size | **11** | | | | | | | | | | | | | | | | | | | |

- Answer: **Resize the array** to one twice as large.

# The `Arrays` class

- The `Arrays` class in `java.util` has many useful methods:

| Method name | Description |
|---|---|
| `binarySearch(`**array**`, `**value**`)` | returns the index of the given value in a *sorted* array (or < 0 if not found) |
| `binarySearch(`**array**`, `**minIndex**`, `**maxIndex**`, `**value**`)` | returns index of given value in a *sorted* array between indexes *min* / *max* - 1 (< 0 if not found) |
| `copyOf(`**array**`, `**length**`)` | returns a new resized copy of an array |
| `equals(`**array1**`, `**array2**`)` | returns `true` if the two arrays contain same elements in the same order |
| `fill(`**array**`, `**value**`)` | sets every element to the given value |
| `sort(`**array**`)` | arranges the elements into sorted order |
| `toString(`**array**`)` | returns a string representing the array, such as `"[10, 30, -25, 17]"` |

- Syntax: `Arrays.`**methodName**`(`**parameters**`)`

# Problem: size vs. capacity

- What happens if the client tries to access an element that is past the size but within the capacity (bounds) of the array?
  - Example: `list.get(7);` on a list of size 5 (capacity 10)

| *index* | *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* |
|---|---|---|---|---|---|---|---|---|---|---|
| *value* | 3 | 8 | 9 | 7 | 5 | 0 | 0 | 0 | 0 | 0 |
| *size* | 5 | | | | | | | | | |

  - Currently the list allows this and returns 0.
    - Is this good or bad? What (if anything) should we do about it?

# Private helper methods

```
private type name(type name, ..., type name) {
    statement(s);
}
```

- a **private method** can be seen/called only by its own class
  - your object can call the method on itself, but clients cannot call it
  - useful for "helper" methods that clients shouldn't directly touch

```
private void checkIndex(int index, int min, int max) {
    if (index < min || index > max) {
        throw new IndexOutOfBoundsException(index);
    }
}
```

# Postconditions

- **postcondition**: Something your method *promises will be true* at the *end* of its execution.
  - Often documented as a comment on the method's header:

```
// Makes sure that this list's internal array is large
// enough to store the given number of elements.
// Postcondition: elementData.length >= capacity
public void ensureCapacity(int capacity) {
    // double in size until large enough
    while (capacity > elementData.length) {
        elementData = Arrays.copyOf(elementData,
                                    2 * elementData.length);
    }
}
```

  - If your method states a postcondition, clients should be able to rely on that statement being true after they call the method.