Victoria University of Wellington, New Zealand
Te Whare Wananga o te Upoko o te Ika a Maui
Aotearoa

# SWEN221: Software Development

## 24: Review

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# Admin

- **Marks released:**
  - Lab 1 – 9, **but not Lab 10**
  - Assignments 1 – 4, **but not 5 or 6**

- **Check you have:**
  - All marks listed as you expect
  - Completed enough Self Assessment questions

# **EXAM:** Wed 15th June @14:30

- Exam Rooms
  - HULT323, KKLT303, MCLT103
- The questions
  - Exam is **TWO HOURS** long
  - 4 compulsory questions worth 30 **marks** each
  - Should spend at most **30 minutes** on each question
  - Generally, each has **easy** bits, **medium hard** bits and **hard** bits
    - If you cannot do a part, do not waste time stressing about it
    - Go and find something easier!
- As usual, you should make sure you can do **past papers!**
  - Look under "Past Exams" on course homepage + library
  - **Note:** exams after 2012 were **Three HOURS** long

**CALCULATORS ARE NOT ALLOWED!!!**

- Simple stuff you need to know:
  - What **variables** and **parameters** are and do
  - What **static** means
  - What an **iterator** is
  - What **for(**Collection l : ls**)** { … } does, and for other looping constructs
  - What **`++i`** and **`i++`** mean and how they differ
  - What **new** does
  - The difference between **references** and **objects** and **primitives**
  - How to write **recursive** methods
  - How to write a **class**, **interface**, **abstract class**
  - How to use **extends** and **implements**
  - How to generate **control flow graph** from method
  - …

- Interesting stuff you need to know:
  - How **Polymorphism** really works in Java
  - How **inheritance** and **subtyping** work together
  - How to use **Java Generics,** including type bounds
  - What **public/private/protected** do and don't do
  - How to write **JUnit tests**, and what **test coverage** is
  - How to use **Exceptions**
  - How to write **equals**, **hashCode** and **compareTo** methods
  - How to calculate **test coverage** (for given criteria)
  - What **inner** and **anonymous** classes are
  - What **reflection, serialisation + cloning** are
  - What **Lambdas, Streams** and **Optional** are
  - What **Garbage Collection** is
  - …

# #2 - The JUnit 4 API

A range of assertion methods:

- assertTrue(boolean)
- assertTrue(String message, boolean)

And a whole lot more:

- assertEquals(Object expect, Object actual)
- assertEquals(float expected, float actual, float delta)
- assertNull, assertNotNull
- assertTrue, assertFalse
- assertSame, assertNotSame
- fail(), fail(String message)

# #3 - Debugging

- **Defect**: Error in code created by programmer
- **Infection:** Error in program state
- **Propagation:** – Bad program state leads to more bad states
- **Failure:** Program finally does something wrong

# #4 – Code Style

```
class Date {
 int day;   // day field
 int month; // month field
 int year;  // year field

 int nextDay() {   // next day method
  int r = day + 1; // r is day + 1
  return r;        // return r
}}
```

- What's wrong with this?

# #5 - Inheritance and Subtyping

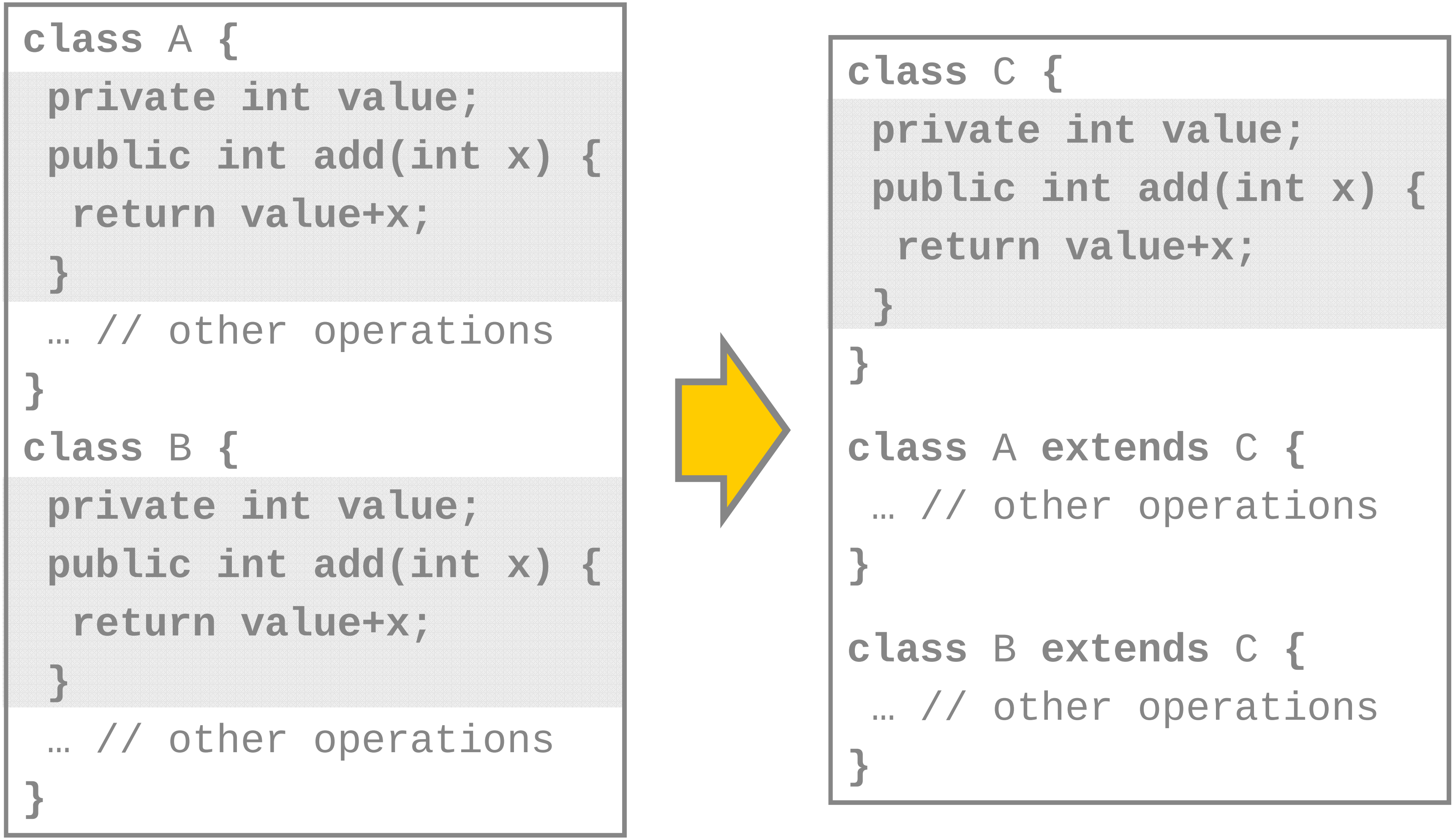
- For two classes/interfaces A and B:
  - if A **extends** B, or A **implements** B, then A <: B

```
class Point { int xpos; int ypos; … }
class ColouredPoint extends Point { int colour; }

void move(Point p, int dx, int dy) {
 p.xpos += dx;
 p.ypos += dy;
}
ColouredPoint cp = new ColouredPoint(…);
move(cp,1,1);
System.out.println(“cp.xpos = “ + cp.xpos);
```

Through p we cannot see “colour” but it is there!

  - Therefore, in this case, ColouredPoint <: Point
  - Meaning we can use a ColouredPoint instead of a Point!

# #6 - Inheritance II



```
class A {
 private int value;
 public int add(int x) {
  return value+x;
 }
 … // other operations
}
class B {
 private int value;
 public int add(int x) {
  return value+x;
 }
 … // other operations
}
```

```
class C {
 private int value;
 public int add(int x) {
  return value+x;
 }
}

class A extends C {
 … // other operations
}

class B extends C {
 … // other operations
}
```

# #7 - Polymorphism

```
class Cat {
 String whatAmI() {
  return “I’m a Cat!”;
}}

class Kitten extends Cat {
 String whatAmI() {
  return “I’m a Kitten!”;
}}

class NinjaKitten extends Kitten {
 String isKickedBy(Kitten k) { return “Ouch!”; }
}

Cat bob = new NinjaKitten();
System.out.println(“Bob: ” + bob.whatAmI());
```

A) `Bob: “I’m a Kitten!”`

B) `Bob: “Ouch!”`

C) **error**

# #8 – Polymorphism II

- Allows to create a hierarchy of classes/interfaces, and to model our problem domain.

- Dynamic dispatch (overriding) ensures subclass can change behaviour as needed

- For example, method toString()
  - allows any possible object,
  - of any possible class,
  - included the one that still does not exist, to **decide** how to convert into a String

# #9 - Exceptions

- Unchecked Exceptions
  - Subclasses of `RuntimeException`
  - E.g. `NullPointerException` and `IndexOutOfBoundsException`
- Checked Exceptions
  - Subclasses of `Exception`, but not `RuntimeException`
  - e.g. IOException
  - Must be declared in a method's *throws clause*:
    - If it throws one, or doesn't catch one thrown by called method
    - Otherwise compile-time error

# #10 - Assertions

```
assert x!=null;
```

if x is null and assertions are enabled, then the semantic of the assertion is equivalent to simply

```
throw new AssertionError();//Unchecked
Exception
assert x!=null : "msg";
```

if x is null and assertions are enabled, then the semantic of the assertion is equivalent to simply

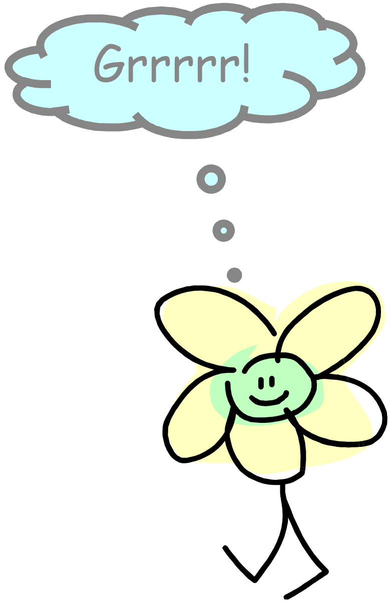
```
throw new AssertionError("msg");//Unchecked
Exception
```

# #11 - Encapsulation

```
class Money {
 ~~public int dollars;~~
 public int cents; ~~// cents < 100 must always hold~~
 …
}
```

```
class Account {
 int balance; // in cents
 …
 void deposit(Money m) {
  balance += (m.dollars*100) + m.cents;
 }
 Money getBalance() {
  Money r = new Money();
  r.dollars = 0;
  r.cents = balance;
  return r;
}}
```

Doesn't work now



# #12 – Object Contracts

- Need to override `Object.equals`
- Trickier than it sounds:
  - "It is ***reflexive***: for any non-null reference value x, x.equals(x) should return true."
  - "It is ***symmetric***: for any non-null reference values x and y, x.equals(y) should return true if and only if y.equals(x) returns true."
  - "It is ***transitive***: for any non-null reference values x, y, and z, if x.equals(y) returns true and y.equals(z) returns true, then x.equals(z) should return true."
  - "It is ***consistent***: for any non-null reference values x and y, multiple invocations of x.equals(y) consistently return true or consistently return false, provided no information used in equals comparisons on the objects is modified."
  - "For any non-null reference value x, x.equals(null) should return false."

# #13 - Puzzlers

- How to check an integer is odd?

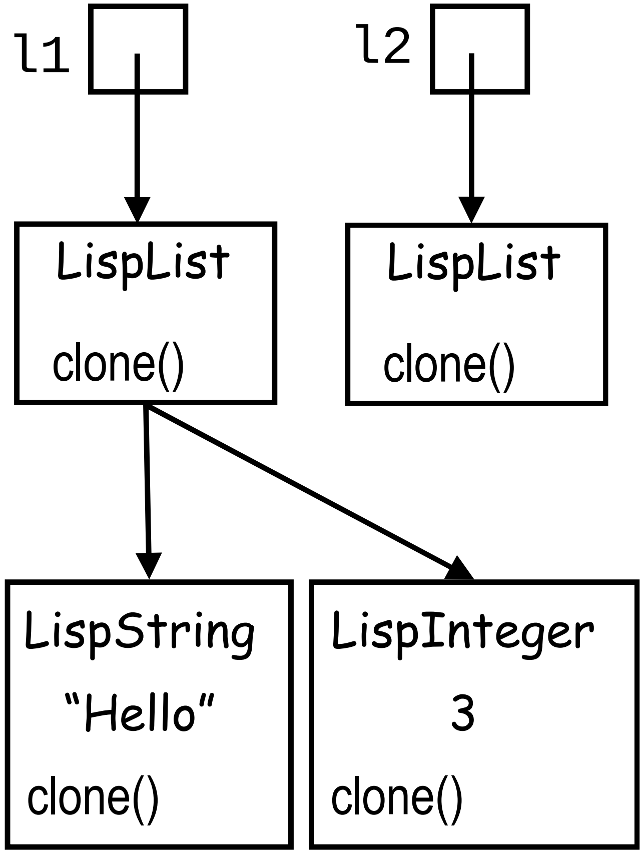
```
boolean isOdd(int x) {
 return (x%2) == 1;
}
```

  - Does this method work?

A) Yes B) No C) Don't know

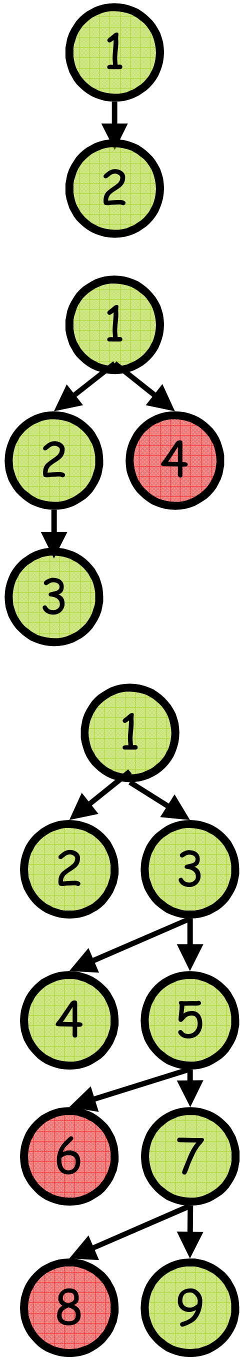
# #14 – Serialisation + Cloning

```
class LispList implements cloneable {
 private List<ListExpr> elements =
              new ArrayList<ListExpr>();
 …
 public Object clone() {
  try { return super.clone(); }
  catch(CloneNotSupportedException e) {
  // cannot get here
}}}
LispInteger i = new LispInteger(3);
LispString s = new LispString(“Hello”);
LispList l1 = new LispList();
l1.add(i);
l1.add(s);
LispExpr l2 = (LispExpr) l1.clone();
```



- What does this actually do?

```
class Card {
 private int number, suit;

 public Card(int n, int s) { number = n; suit = s; }

 public boolean equals(Object o) {
  if(o instanceof Card) {
   Card c = (Card) o;
   return c.number == number && c.suit == suit;
  }
  return false;
 }

 public int compareTo(Card c) {
  if(suit > c.suit) { return -1; }
  else if(suit < c.suit) { return 1; }
  else if(number < c.number) { return -1; }
  else if(number > c.number) { return 1; }
  else { return 0; }
}}
```



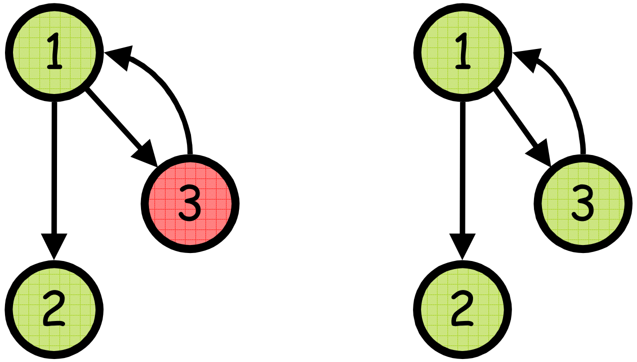
Method Coverage = 3 / 3 = **100%**

Statement Coverage = 12 / 15 = **80%**

Branch Coverage = 2 / 5 = **40%**

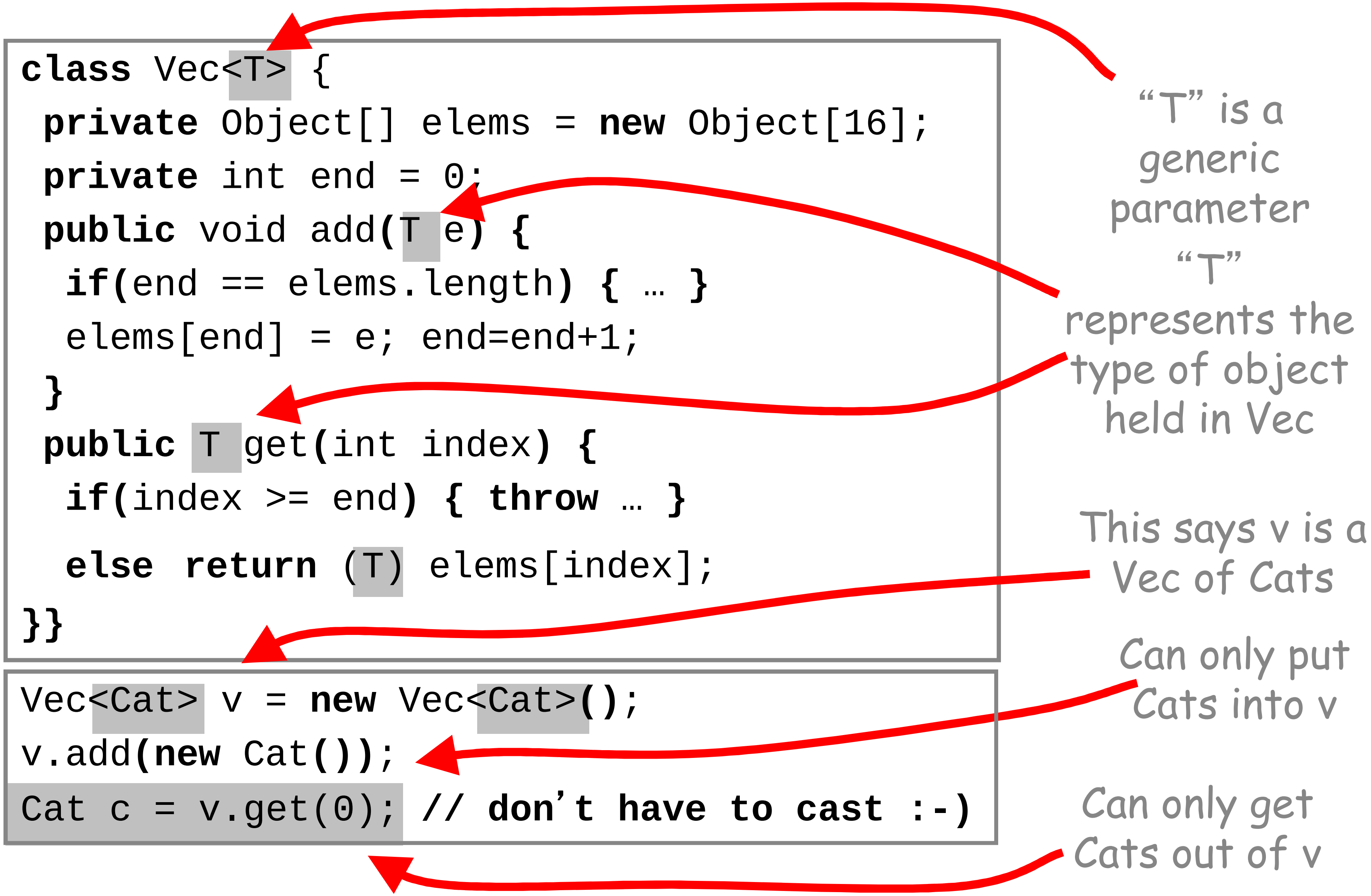
# #16 – Testing III

**Definition**: A **simple execution path** is a path through the method which iterates each loop at most once.



- Simple Path Coverage Criteria:
  - Aim to test all simple paths through a method
  - Helps keep the number of tests manageable
  - Two paths in above loop example

# #17 – Generics I



```
class Vec<T> {
 private Object[] elems = new Object[16];
 private int end = 0;
 public void add(T e) {
  if(end == elems.length) { … }
  elems[end] = e; end=end+1;
 }
 public T get(int index) {
  if(index >= end) { throw … }

  else  return (T) elems[index];
}}
```

```
Vec<Cat> v = new Vec<Cat>();
v.add(new Cat());
Cat c = v.get(0); // don’t have to cast :-)
```

“T” is a generic parameter

“T” represents the type of object held in Vec

This says v is a Vec of Cats

Can only put Cats into v

Can only get Cats out of v

# #18 - Generics II

```
class Cup<T> {
  T f;
  Cup(T f) {
    this.f = f;
  }
}
```

**Cup<Tea>**

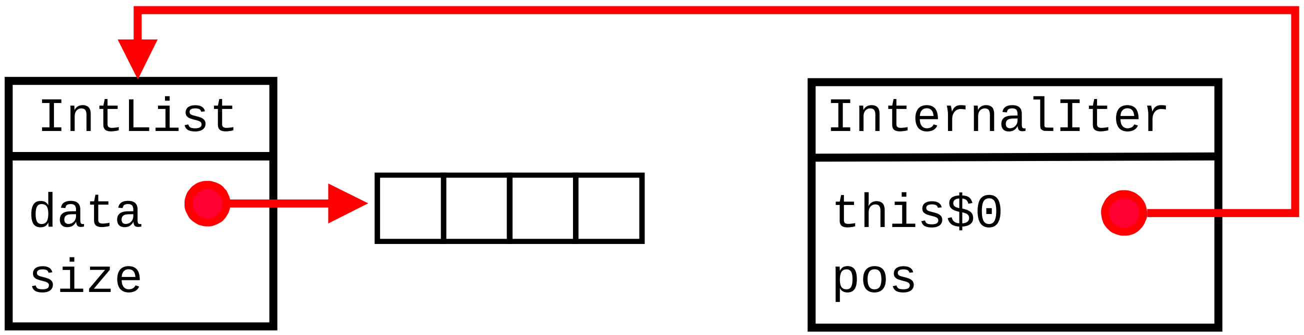
```
Cup<Tea> myCup = new Cup<Tea>(new Tea());
```

# #19 - Reflection

- Reflection gives access to *metadata*
  - That is, data about data
  - In this case, the data describes our classes
  - We can find out:
    - What an object's class is
    - What methods that class has (inc. private + protected)
    - What their parameter / return types are
    - What fields that class has (inc. private + protected)
    - What their types are
    - What interfaces the class implements
    - What class it extends from

# #20 - Inner Classes

- Inner classes have *parent pointer*
  - For accessing fields/methods of enclosing class (parent)
  - Parent pointer automatically supplied for new inner class



```
public class IntList implements Iterable<Integer> {
 private int[] data;
 private int size;

 private class InternalIter implements Iterator<Integer> {
  private int pos;
}}
```

# #21 – Lambdas

## Comparators using long syntax for anonimus classes

```
Collections.sort(ls,new Comparator<String>(){
      public int compare(String s1, String s2) {
            return s1.compareToIgnoreCase(s2);
      }});
```

## Comparators using short syntax for anonimus classes

```
Collections.sort(ls,(s1,s2)->s1.compareToIgnoreCase(s2));
```

- Convenient syntax for anonymous nested classes

# #22 – Optional & Streams

You can easily do that using streams:

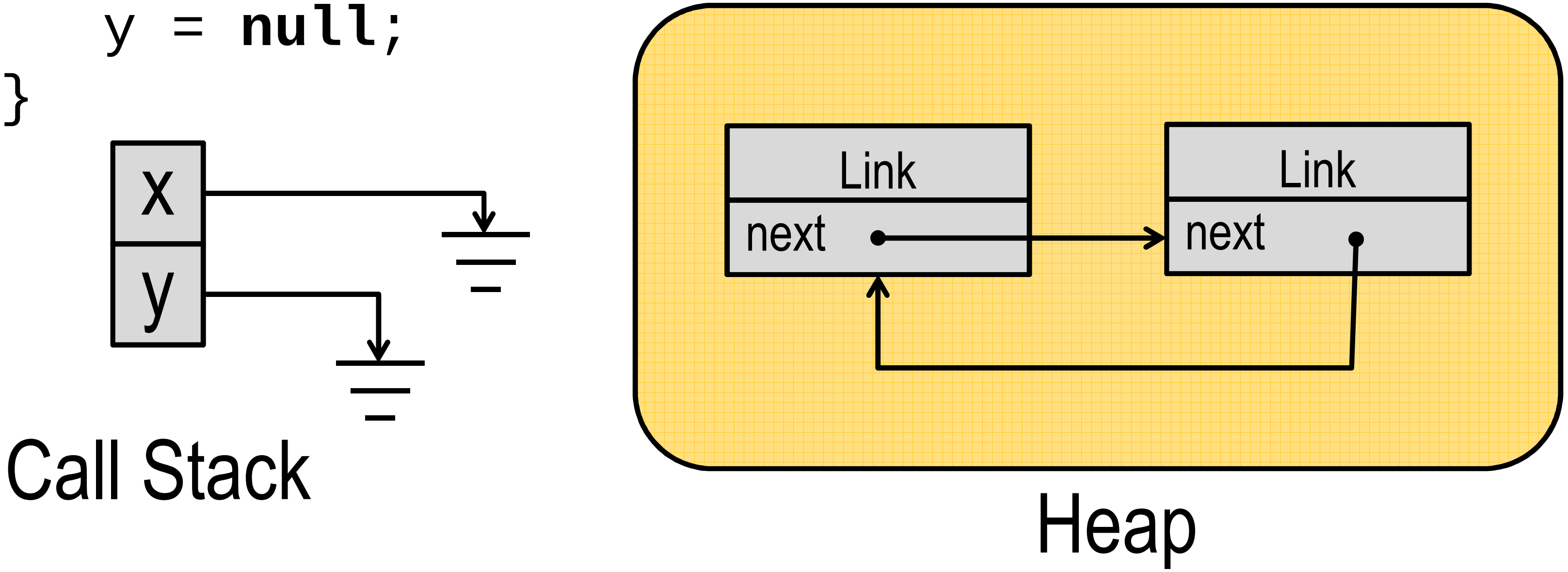
```
List<Aeroplane> attempts=...

attempts.stream()//first, cache the fitness
  .forEach(a->a.computeAverageFlightTime());

List<Aeroplane> best20 = attempts.stream()
  .sorted((a1,a2)->a1.getFlightTime()-a2.getFlightTime())
  .limit(20)//take the first 20
  .collect(Collectors.toList());
```

`computeAverageFlightTime` can be slow, you could need to do it for all your attempts!

- **Modern** hardware have multiple processors.

# #23 Garbage Collection

```
class Link {
  private Link next;
  public Link(Link next) { this.next = next; }
  public static void main(String[] args) {
    Link x = new Link(null);
    Link y = new Link(x);
    x.next = y;
    x = null;
    y = null;
}}
```



That’s all folks … Good Luck!!