Classes/Instances (Java)

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What We Have Done

- constructor, finalizer, GC, object lifecycle
- static variables: "global" variables shared within the scope of the class

belong to
the class

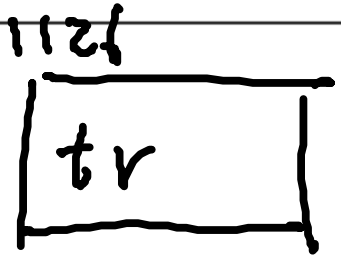
Static Variables Revisited (1/1)

```
1  public class Record{
2    private static int total_rec = 0;
3    private int id;
4    public Record(){ id = total_rec++;}
5  }
6  public class RecordDemo{
7    public static void main(String[] arg){
8      Record r1 = new Record();
9      Record r2 = null;
10     Record r3 = new Record();
11     System.out.println(r1.total_rec);
12     System.out.println(r2.total_rec);
13     System.out.println(Record.total_rec);
14     System.out.println(r1.id);
15     System.out.println(r2.id);
16     System.out.println(Record.id);
17   }
18 }
```

- `r2.total_rec` ⇒ `Record.total_rec` in **compile time**

Static Variables Revisited (1/1)

```
1  public class Record{
2    private static int total_rec = 0;
3    private int id;
4    public Record(){ id = total_rec++;}
5  }
6  public class RecordDemo{
7    public static void main(String[] arg){
8      Record r1 = new Record();
9      Record r2 = null;
10     Record r3 = new Record();
11     System.out.println(r1.total_rec);
12     System.out.println(r2.total_rec);
13     System.out.println(Record.total_rec);
14     System.out.println(r1.id);
15     System.out.println(r2.id);
16     System.out.println(Record.id);
17   }
18 }
```



- `r2.total_rec` ⇒ `Record.total_rec` in **compile time**

Static Variables Revisited: Key Point

`static` variable:
of the **class** (shared), not of an instance; compile-time binding (i.e. static binding)

Static Methods (1/2)

```
1  public class myMath{
2    public double mean(double a, double b){
3      return (a + b) * 0.5;
4    }
5  }
6  public class MathDemo{
7    public static void main(String[] arg){
8      double i = 3.5;
9      double j = 2.4;
10     myMath m = new MyMath();
11     System.out.println(m.mean(i, j));
12   }
13 }
```

- new a `myMath` instance just for computing `mean` –unnecessary

Static Methods (2/2)

```
1   class myMath{
2     static double mean(double a, double b){
3       return (a + b) * 0.5;
4     }
5   }
6   public class MathDemo{
7     public static void main(String[] arg){
8       double i = 3.5;
9       double j = 2.4;
10      System.out.println(myMath.mean(i, j));
11      System.out.println(( new myMath() ).mean(i, j));
12    }
13  }
```

- make the method a `static` (class) one
  —no need to new an instance
- similar to static variable usage

Static Methods: Key Point

`static` method:
associated with the **class**,
no need to create an instance

Use of Static Methods (1/2)

```
1  public class UtilDemo{
2    public static void main(String[] arg){
3      System.out.println(Math.PI);
4      System.out.println(Math.sqrt(2.0));
5      System.out.println(Math.max(3.0, 5.0));
6      System.out.println(Integer.toBinaryString(15));
7    }
8  }
```

- commonly used as utility functions
  (so don't need to create instance)
- main is static (called by classname during '`java className`')
- tools for other static methods

Use of Static Methods (2/2)

```
1   class Record{
2     private static int total_rec = 0;
3     public Record(){ total_rec++; }
4     public static void show_total_rec(){
5       System.out.println(total_rec);
6     }
7   }
8   public class RecordDemo{
9     public static void main(String[] arg){
10      Record r1 = new Record();
11      Record.show_total_rec();
12    }
13  }
```

- class related actions rather than instance related actions

Use of Static Methods: Key Point

`static` method:

- compile time determined (bound)
- per class
- sometimes useful

Fun Time (1)

What happens in memory?

```
1 int i;
2 short j;
3 double k;
4 char c = 'a';
5 i = 3; j = 2;
6 k = i * j;
```

Life Cycle of a Primitive Variable (C/Java)

- declared and created

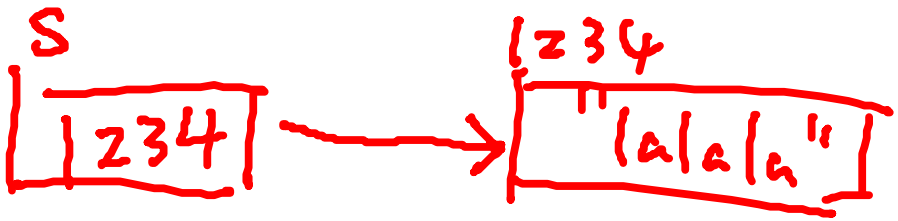
```
1   int count;
```

- used and modified

```
1   count += 1;
```

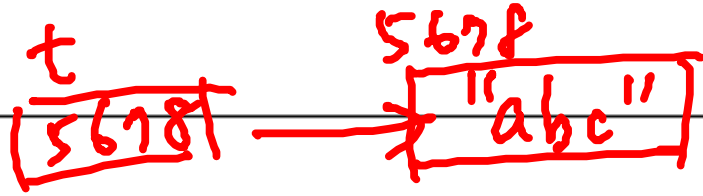
- destroyed
  –automatically (when out of scope)

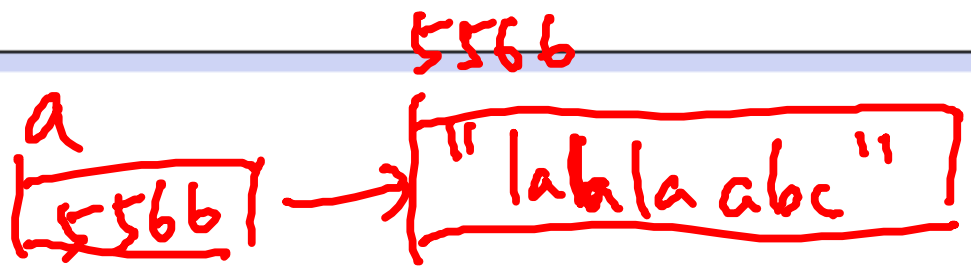
Fun Time (2)



What happens in memory?

```
1 String s = "lalala";
2 String t = "abc";
3 String a = s + t;
```





(new StringBuffer()).append(s).append(t).toString()

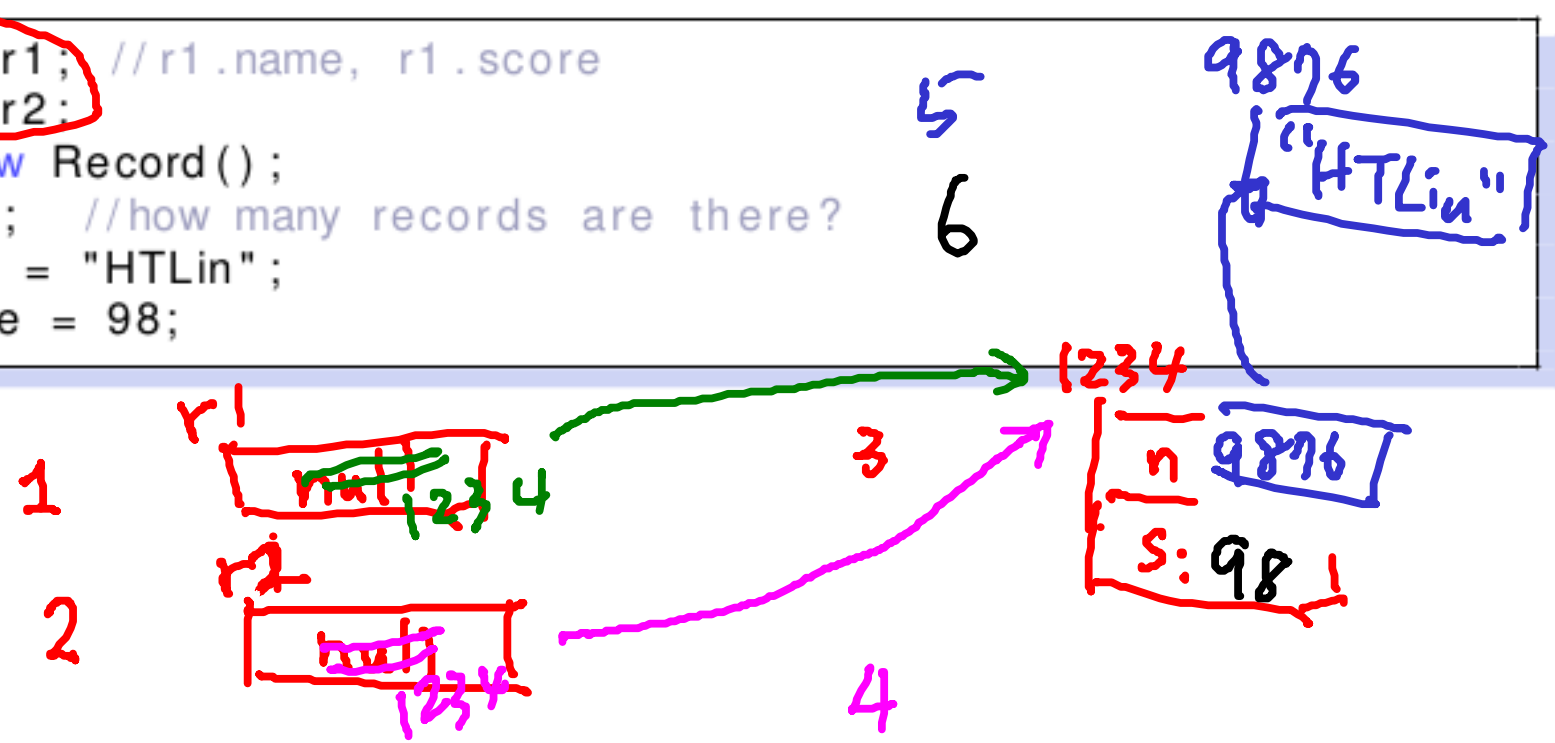
Fun Time (3)

instance var
static var
"null"

local var

What happens in memory?

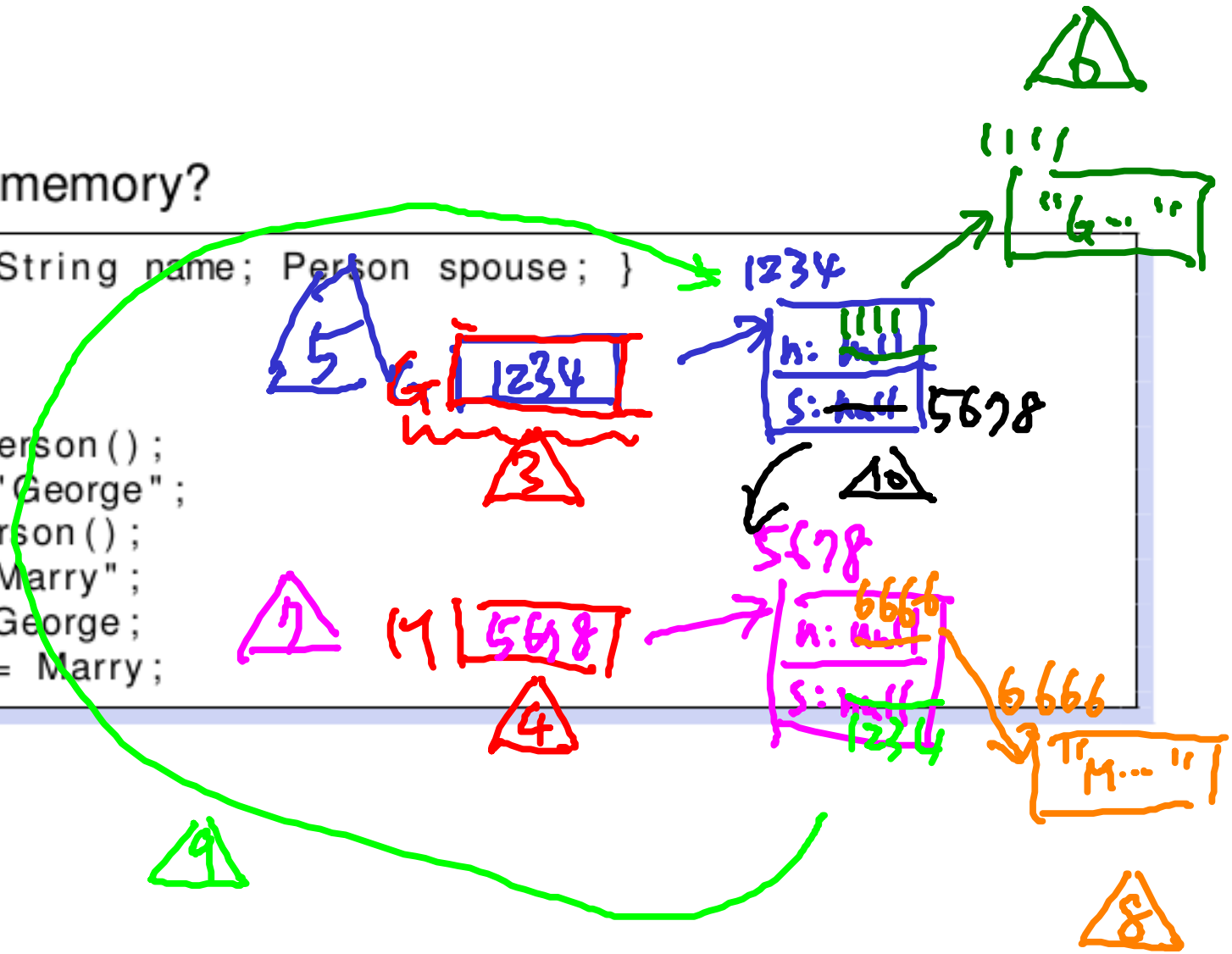
```
1 Record r1; //r1.name, r1.score
2 Record r2;
3 r1 = new Record();
4 r2 = r1;  //how many records are there?
5 r1.name = "HTLin";
6 r2.score = 98;
```



Fun Time (4)

What happens in memory?

```
1  class Person{ String name; Person spouse; }
2
3  Person George;
4  Person Marry;
5  George = new Person();
6  George.name = "George";
7  Marry = new Person();
8  Marry.name = "Marry";
9  Mary.spouse = George;
10 George.spouse = Marry;
```



Fun Time (5)

What happens in memory?

```
1 class Person{ String name; Person spouse; }
2
3 Person George;
4 George = new Person();
5 George.name = "George";
6 George.spouse = new Person();
7 George.spouse.name = "Marry";
8 George.spouse = new Person();
9 George.spouse.name = "Lisa";
```

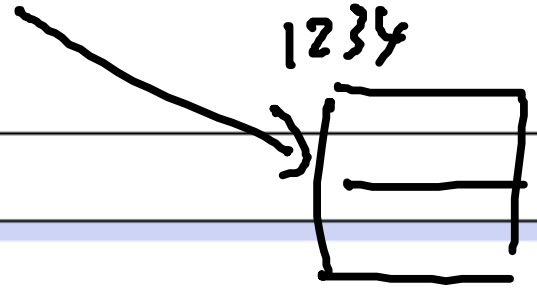
Life Cycle of an Object Instance (Java)

- reference declared

```
1  Record r;
```

- instance created

```
1  r = new Record();
```



- used and modified

```
1  System.out.println(r.name);
```

- destroyed
  –automatically (when out of **use**)

Reference: Key Point

int

Integer

- a instance occupies a space in the memory;
  老太太住在屏東一個房子裡面
- reference (a.k.a. safe pointer): the "address" to the instance;
  用"海角七號"就可以找到老太太
- class-type variable: holds the reference;
  一個"信封"，上面寫著海角七號
- any operation on the instance goes thru the reference;
  要請老太太"回憶"時，拿個信封上寫"海角七號"，接著寫"回憶"，阿Ja就會使命必達了

```
老人 信封= new 老人(老太太的身家資料);
信封.回憶();
```

null Revisited (1/2)

```
1  class Record{
2    String name;
3    String ID;
4    int score;
5  }
6
7  public class RecordDemo{
8    public static void main(String[] arg){
9      Record r1 = new Record();
10     System.out.println(r1.score);
11     System.out.println(r1.name);
12   }
13 }
```

- null: Java's reserved word of saying "no reference"
- default initial value for extended types (if initialized automatically)
- 0, NULL, anything equivalent to integer 0: C's way of saying "no reference"

null Revisited (2/2)

```
1   class Record{
2     String name;
3     String ID;
4     int score;
5   }
6
7   public class RecordDemo{
8     public static void main(String[] arg){
9       Record r1 = null;
10      System.out.println(r1.score);
11      System.out.println(r1.name);
12    }
13  }
```

ohohoh

- null pointer exception (run time error): accessing the component of "no reference"

`null` Revisited: Key Point

`null`: Java's special way of saying "no reference"

Reference Equal (1/2)

```
1  class Record{
2    String name;
3    int score;
4  }
5
6  public class RecordDemo{
7    public static void main(String[] arg){
8      Record r1, r2;
9      r1 = new Record(); r2 = new Record();
10     r1.name = "HTLin"; r1.score = 95;
11     r2.name = "HTLin"; r2.score = 95;
12     System.out.println(r1 == r2);
13     r2 = r1;
14     System.out.println(r1 == r2);
15   }
16 }
```

- reference equal: comparison by “reference value”

Reference Equal (2/2)

```
1  class Record{
2    String name;
3    int score;
4  }
5
6  public class RecordDemo{
7    public static void main(String[] arg){
8      Record r1, r2;
9      r1 = null; r2 = new Record();
10     System.out.println(r1 == r2);
11     r2 = r1;
12     System.out.println(r1 == r2);
13   }
14 }
```

- `null` does not equal non-null ..... o_O
- `null` equals `null` ..... O_o

Reference Equal: Key Point

==: reference equal rather than content equal for extended types

String Equal (1/1)

```
1  public class StringDemo{
2    static String s1;
3    static String s2;
4    public static void main(String[] arg){
5      s1 = "HTLin";
6      s2 = "HTLin";
7      System.out.println(s1 == s2);
8      s1 = s1 + "lalala";
9      s2 = s2 + "lalala";
10     System.out.println(s1 == s2);
11     System.out.println(s1.equals(s2));
12   }
13 }
```

- first `true`: compiler allocates one constant string only
- second `false`: two different string references
- third `true`: an action (method) for content comparison

String Equal: Key Point

String `==`: still reference equal, use `.equals` if want content equal

Reference Argument/Parameter (1/3)

```
1  class Tool{
2    bool tricky(String s1, String s2){
3      s2 = s2 + "";
4      return (s1 == s2);
5    }
6  }
7  public class Demo{
8    public static void main(String[] arg){
9      Tool t = new Tool();
10     String sa = "HTLin";
11     String sb = sa;
12     System.out.println(t.tricky(sa, sb));
13     System.out.println(sa == sb);
14     System.out.println(t.tricky(sa + "", sb));
15   }
16 }
```

1234 1234

5678

false

1234

1234

true

- reference parameter passing: again, value copying
- sa, sb copied to s1, s2
- s2 (reference) changed, sb didn't

Reference Argument/Parameter (2/3)

```
1  class myInt{int val; myInt(int v){val = v;}}
2  class Tool{
3    void swap(myInt first, myInt second){
4      int tmp = first.val;
5      first.val = second.val;
6      second.val = tmp;
7      System.out.println(first.val);
8      System.out.println(second.val);
9    }
10 }
11 public class Demo{
12   public static void main(String[] arg){
13     Tool t = new Tool();
14     myInt i = new myInt(3);
15     myInt j = new myInt(5);
16     t.swap(i, j);
17     System.out.println(i.val);
18     System.out.println(j.val);
19   }
20 }
```

- swapped as requested

Reference Argument/Parameter (3/3)

```
1  class myInt{int val; myInt(int v){val = v;}}
2  class Tool{
3    void swap(myInt first, myInt second){
4      myInt tmp = first;
5      first = second;
6      second = tmp;
7      System.out.println(first.val);
8      System.out.println(second.val);
9    }
10 }
11 public class Demo{
12   public static void main(String[] arg){
13     Tool t = new Tool();
14     myInt i = new myInt(3);
15     myInt j = new myInt(5);
16     t.swap(i, j);
17     System.out.println(i.val);
18     System.out.println(j.val);
19   }
20 }
```

Integer

- what happens?

Reference Argument/Parameter: Key Point

argument $\Rightarrow$ parameter: by reference copying
same for return value

this (1/1)

```
1  class Record{
2    int score;
3    void set_to(int score){ this.score = score; }
4    void adjust_score{ this.set_to(score+10); }
5  }
```

- which score? which set_to?
- `this`: my (the object's)

this: Key Point

`this`: the reference variable pointing to the object itself