What is null?

```
/*
 * s is given the value null (similar to nil in Scheme).
 */
AShape s;
```

- When a variable of some class is declared without any initial instantiation, it is *automatically* assigned the value `null`.
- `null` represents “non-existence”. Assign `null` to a variable of some class only if you want to express “non-existence”.

Instance Fields and Instance Methods

```
AShape s = new Rectangle(6, 7);

AShape t = new Rectangle(3, 4);

s.dArea();
```

- The code for `dArea` is executed and can only access the `_dWidth` and `_dHeight` of `s`. It does not know anything about the `_dWidth` and `_dHeight` of `t`.
- `_dWidth` and `_dHeight` are said to be *instance* fields (or variables) of `Rectangle`.

Instance Fields and Instance Methods (cont.)

- `double dArea()` is said to be an *instance* method of `s` of `Rectangle`.
  - It can only be called on an existing instance of a class.

Static Fields and Static Methods

- Suppose we want to keep track of how many Rectangles are being created during the course of our program. What do we need?

- Answer: a field that is unique and global to all instances of Rectangle and that can be accessed by all methods in Rectangle. In Java, we use the keyword `static`.

Static Fields and Static Methods (cont.)

```
class Rectangle extends AShape
{
  private static int _iCOUNT; // Initial value is 0.

  // ... other code ...

  public Rectangle(double width, double height)
  {
    // Each time this constructor is called,
    // _iCOUNT is incremented by 1.
    _iCOUNT++;
    // ... other code ...
  }
```

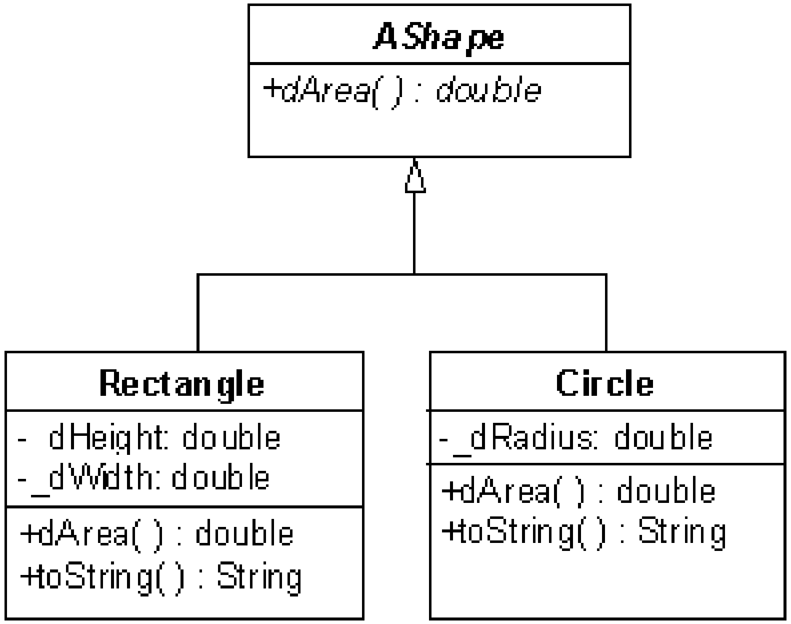
Static Fields and Static Methods (cont.)

- `static` methods cannot access instance fields. They can only access `static` fields.
- `static` methods can be called before any instantiation of the class. (Recall `main`.)

Example: `System` is a `class`. `out` is a `static` variable.

```
System.out.println(cirPizza);
```

Taxonomy Tree



- A class and all of its subclasses form a taxonomy tree. The above UML diagram shows the taxonomy tree of `AShape` and its variants (or subclasses), namely `Rectangle` and `Circle`.

Polymorphism

```
AShape s = new Circle(2.7); // OK.

AShape t = new Rectangle(3, 4); // OK.

t = s; // OK, the old Rectangle is gone.

Circle u = new Rectangle(5, 6); // NO!
```

- A variable of class `AShape` can be assigned any instance of subclasses of `AShape` at any time in a program. `AShape` is said to be *polymorphic*.

Polymorphism (cont.)

- In general, a variable of a superclass can be assigned an instance of any of its subclasses, but not the other way around. Polymorphism means a class can be represent any of its subclasses.

- *We can think of* `polymorphism` *as viewing the taxonomy tree from the top down.*

Inheritance

- The "is-a" relationship between two classes is called *inheritance*.
  - Class B *inherits* class A means that B can automatically access all the non-private fields of A and perform all the non-private methods of A.
    - In Java, B can override a non-private method of A, and provide new behavior by redefining it with new code.
    - B may also have additional fields and methods that A has absolutely no knowledge of. As such, B is said to be a specialization of A.
- *We can think of* `inheritance` *as viewing the taxonomy tree from the bottom up.*