CSCI 136
Data Structures & Advanced Programming

Memory, Objects, and Primitive Types

Goals

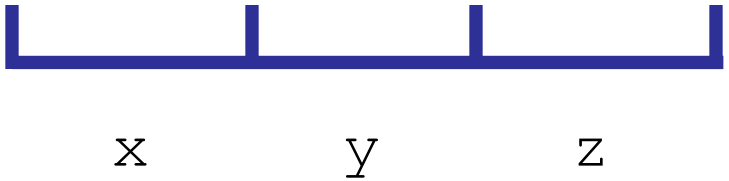
- Clear up some important points about Java:
  - Where are objects stored?
  - What distinguishes objects and primitive types?
  - When do values change?
  - How to move data around in Java

- Some stuff we've talked about
- Some stuff you've probably seen while coding
- Some new stuff

Basics of Variables

- Variables store information
- Behind the scenes: all of the local variables in each method are stored next to each other in memory

```
int x;
int y;
int z;
```



What is stored?

- For primitive types: exactly what you'd expect
- `int` stores a binary number equal to the integer
- `char` stores the Unicode value for the string in binary

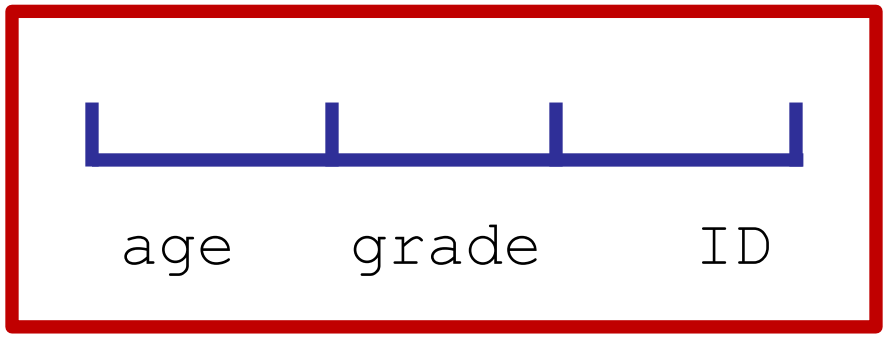
```
int x=10;
```

x

How to store objects

- When you use new, Java finds some unused memory (anywhere---not necessarily near any local variables) to store the object
- Needs to have room for all instance variables, etc.

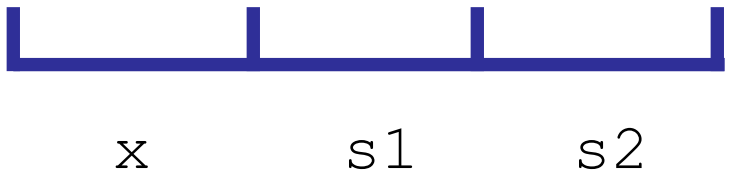
```
new Student()
```



What happens when you store an object

- You really just store the “address” of where the actual object is

```
int x;
Student s1;
Student s2;
```



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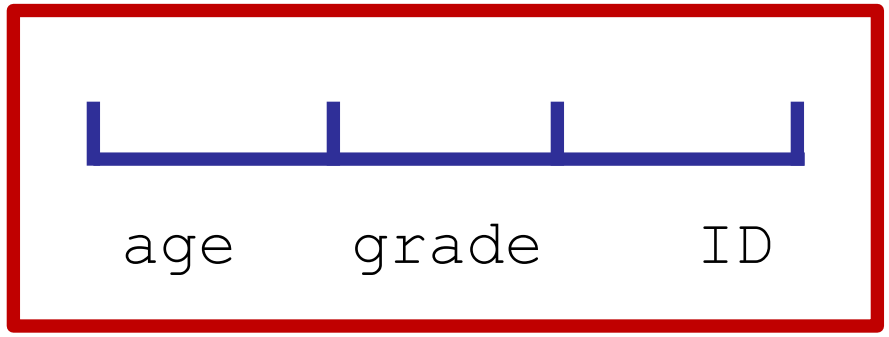
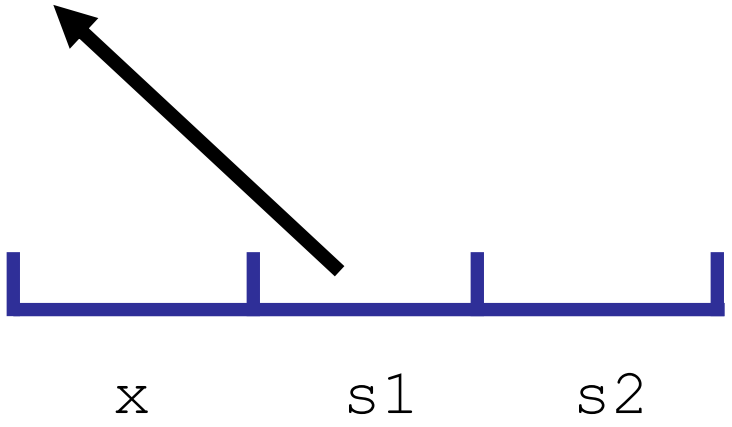



```
int x;
Student s1;
Student s2;
s1 = new Student();
```



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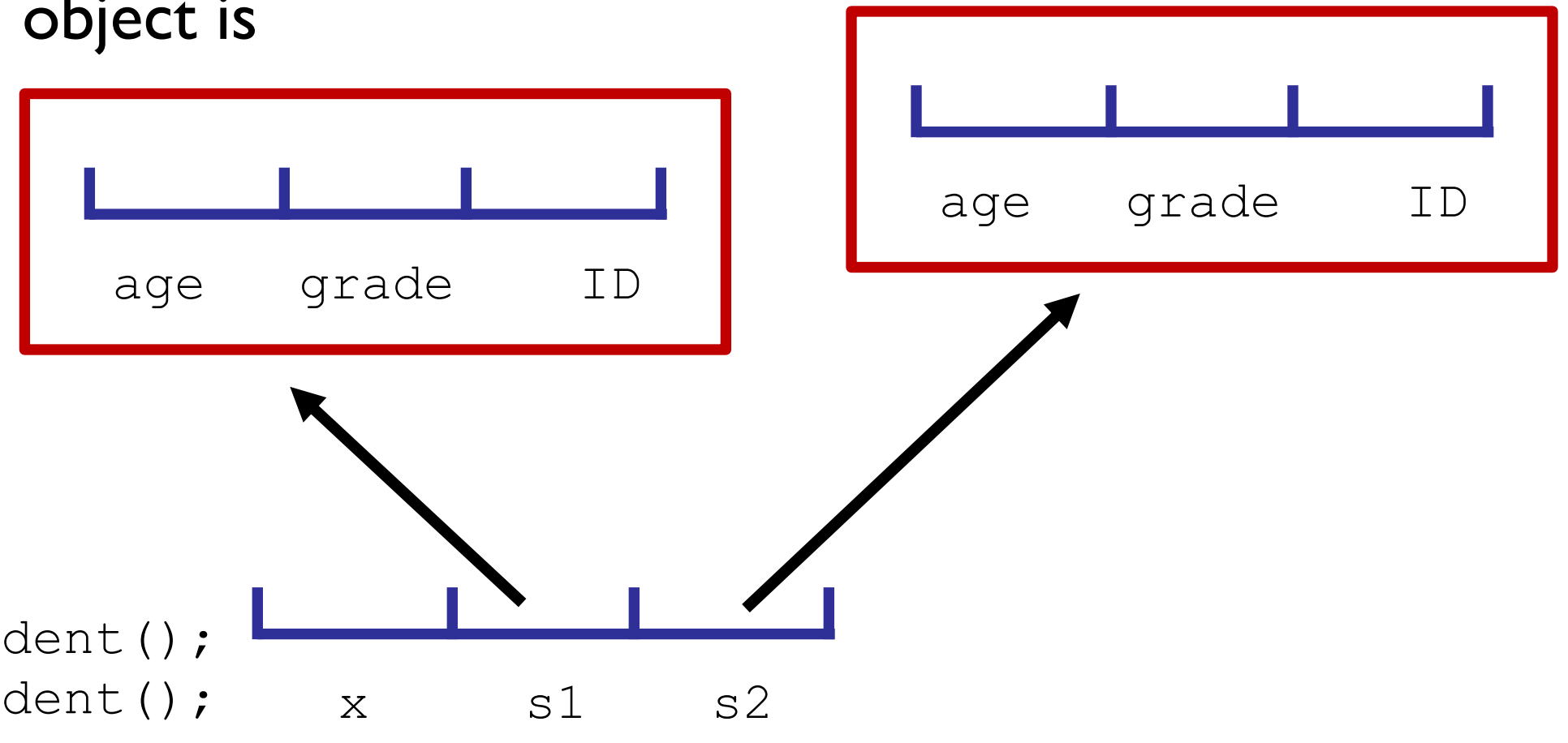
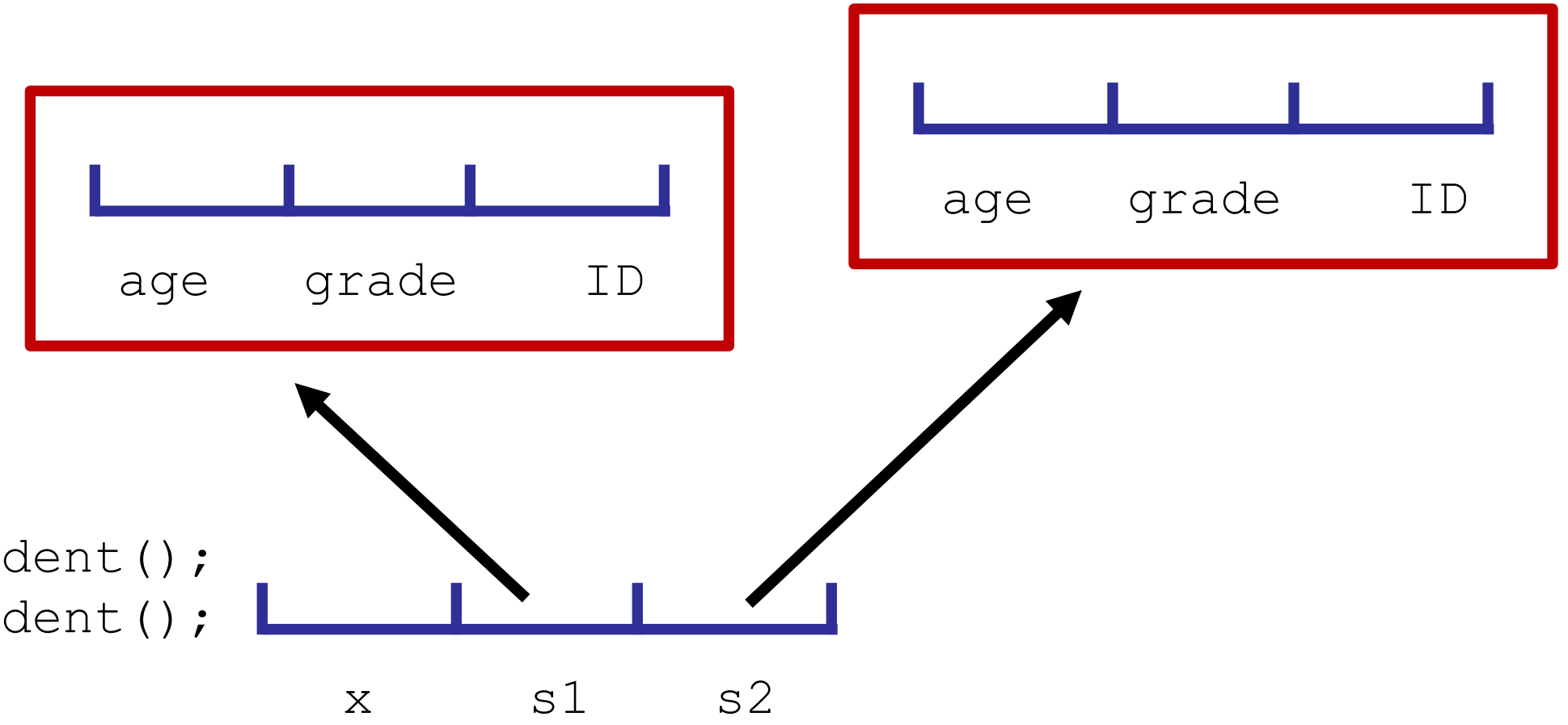



```
int x;
Student s1;
Student s2;
s1 = new Student();
s2 = new Student();
```

Why store the address?

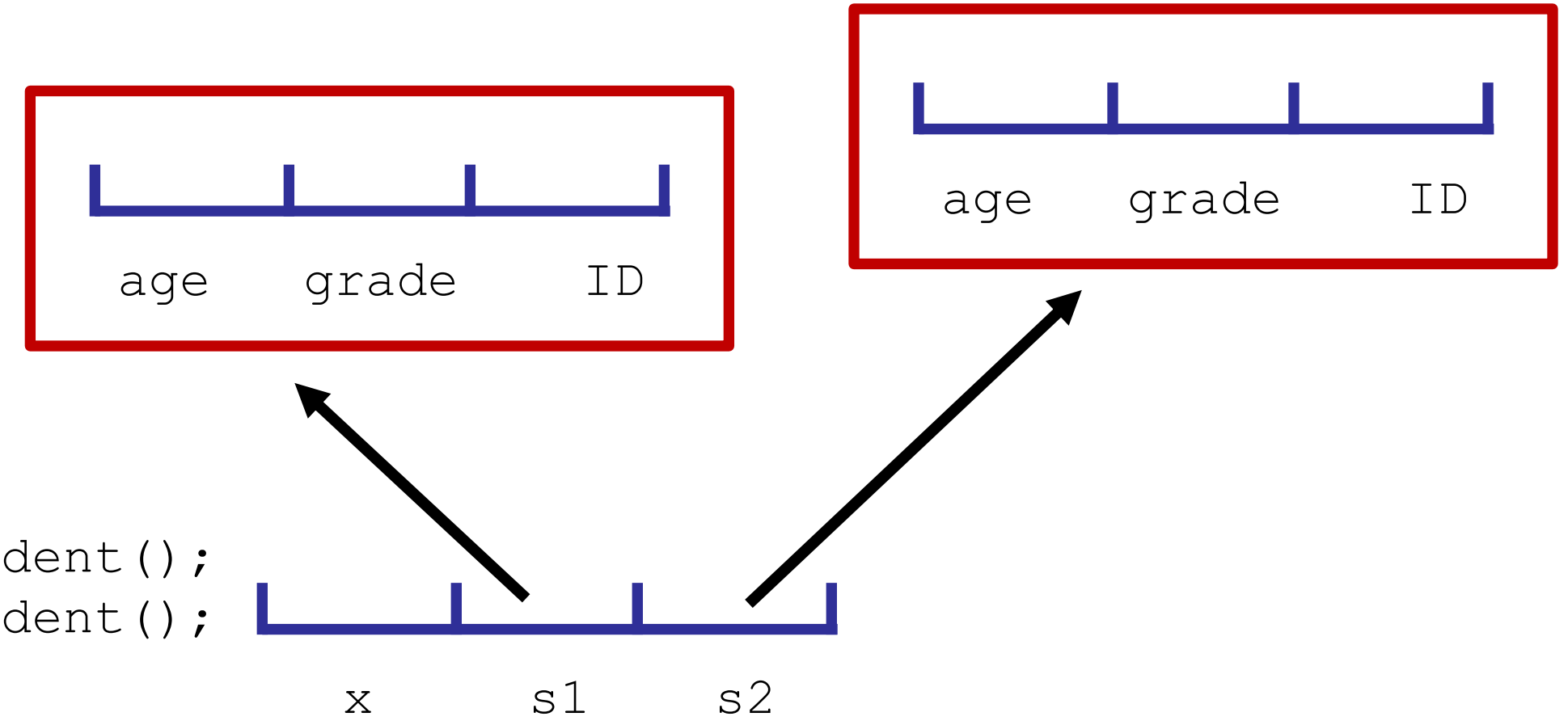
- Why can't we just make room inline like with an int?
- Answer: we may not know how large an object is
- Any examples of this?

Some implications



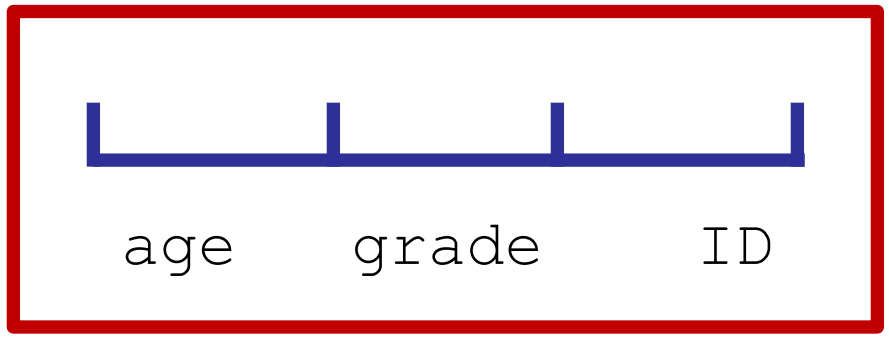

```
int x;
Student s1;
Student s2;
s1 = new Student();
s2 = new Student();
```

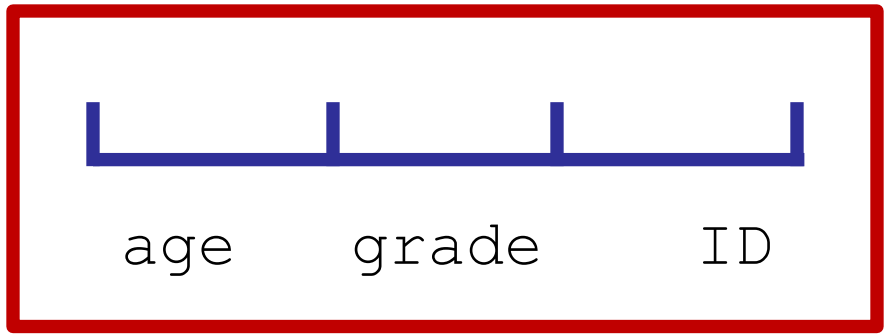
Some implications



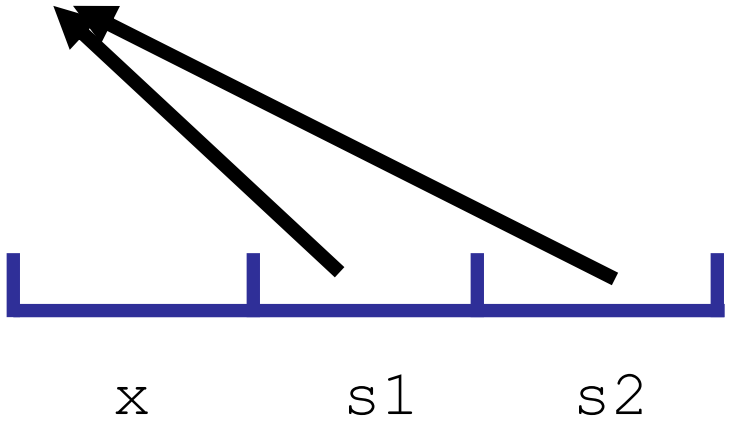

```
int x;
Student s1;
Student s2;
s1 = new Student();
s2 = new Student();
s2 = s1;
```

Some implications



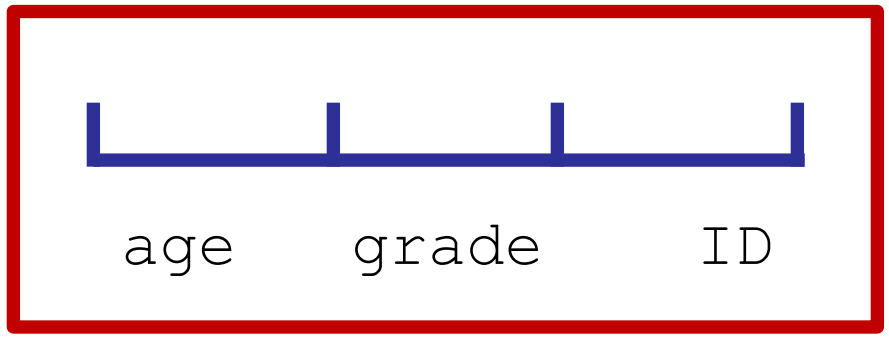


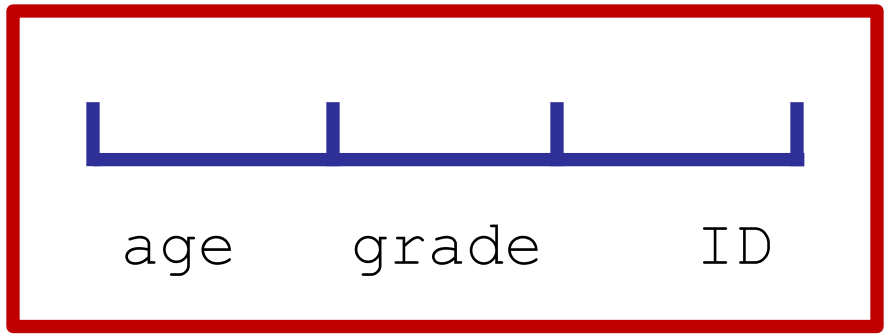

```
int x;
Student s1;
Student s2;
s1 = new Student();
s2 = new Student();
s2 = s1;
```



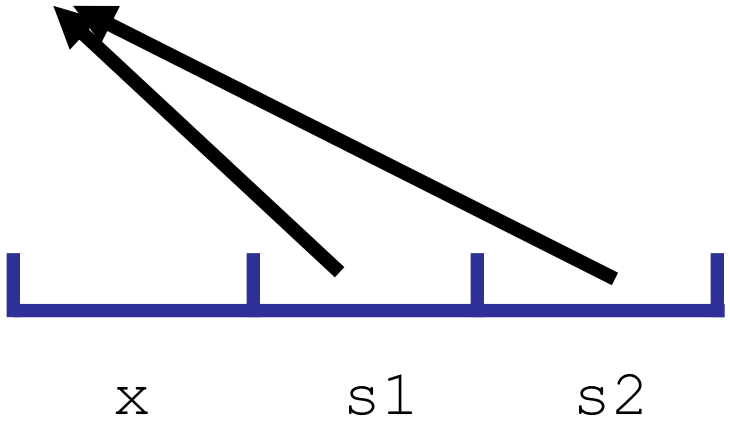
Some implications

- Any changes made to s2 will affect s1 and vice versa
- The former s2 will be (eventually) deleted






```
int x;
Student s1;
Student s2;
s1 = new Student();
s2 = new Student();
s2 = s1;
```



Copy

- Sometimes: want to actually make a new copy of an object
- Need to make a new one (using `new` and calling a constructor)
- Some classes have a "copy constructor," which take an object of the same type as argument and copy it over

```
Vector<Integer> vec1 = new Vector();
vec1.add(20);
Vector<Integer> vec2 = new Vector(vec1);
//the constructor for Vector copies vec1
```

Copy: primitive types

- Primitive types always just copy over the value

```
int x = 10;
int y = 20;
y = x;
y++;
```

After all this, `y` stores 11 and `x` stores 10

Method Parameters

- All parameters to methods are passed *by value*
- This means that any changes to parameters are not reflected in the original method

Parameters with objects

- Objects are passed the same way
- But, it's the *location* that must remain unchanged
- You can change the contents of objects in a method
- But you cannot change which object it is

- Let's see an example

null

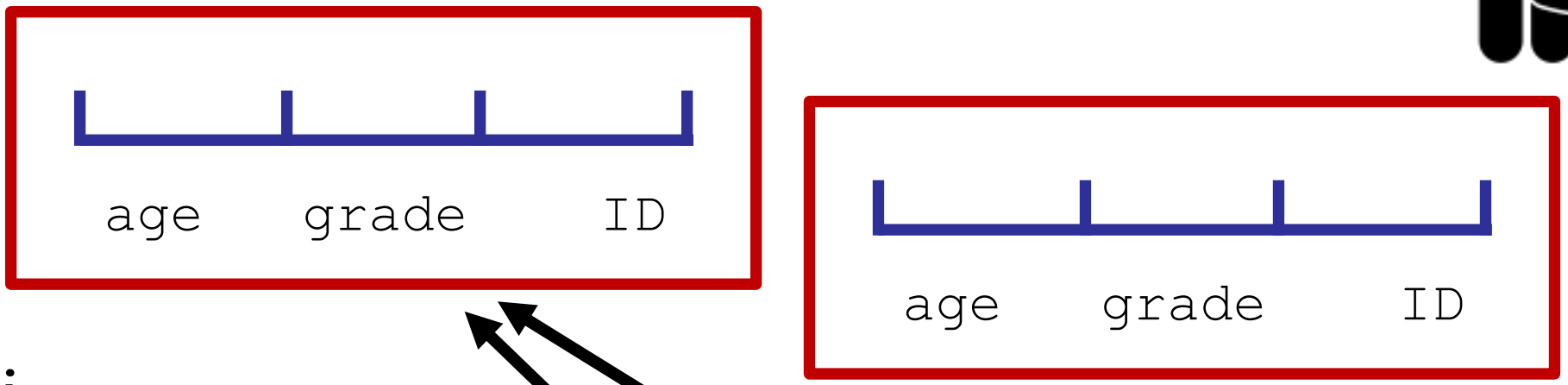
- Keyword in Java
- What happens when a variable doesn't store an address yet? Instead it stores null
- Idea: doesn't point to any object
- Any local object variables are null by default

Cleaning up old data

- When are objects deleted?
- Can't use scope
  - Could be "pointed to" from another method

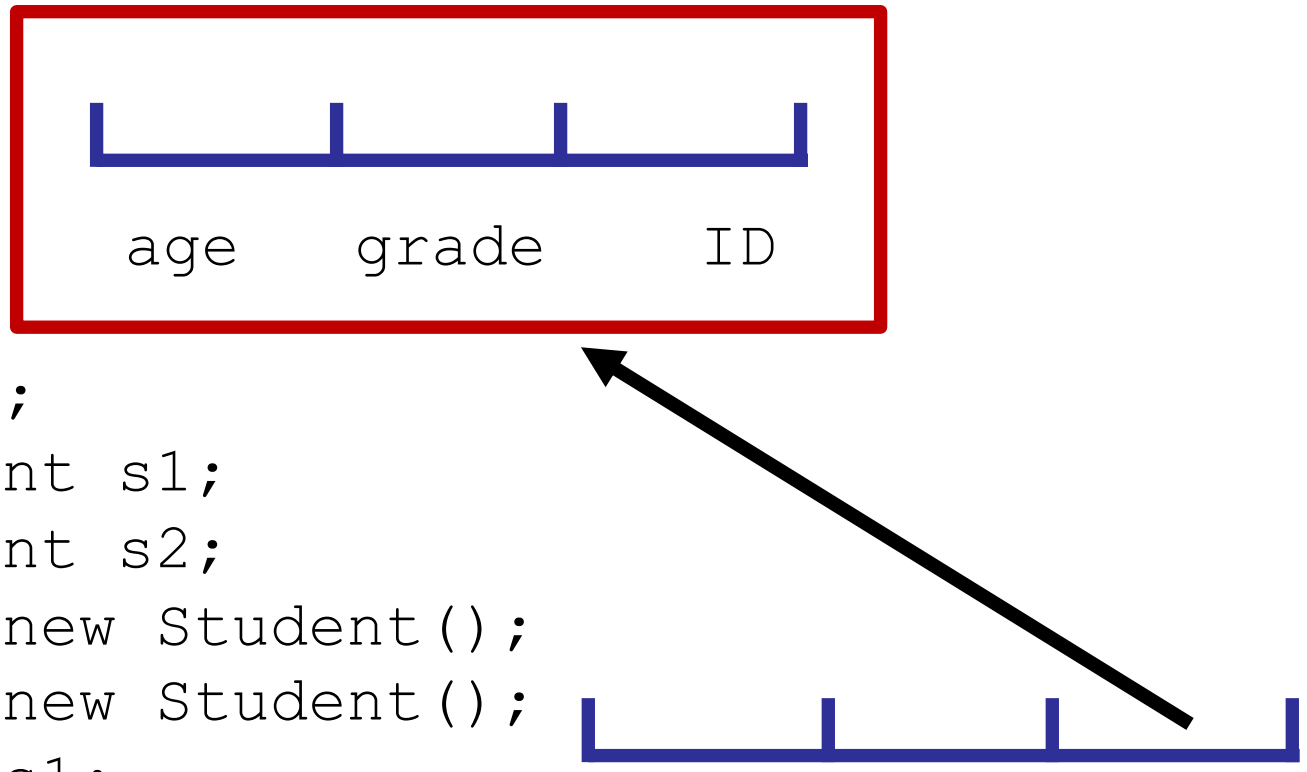
- Answer: Garbage collector
  - Every once in awhile, Java looks at everything you're storing in memory. If you're not pointing to an object anymore, it's deleted

Cleaning up old data




```
int x;
Student s1;
Student s2;
s1 = new Student();
s2 = new Student();
s2 = s1;
```

Cleaning up old data




```
int x;
Student s1;
Student s2;
s1 = new Student();
s2 = new Student();
s2 = s1;
s1 = null;
```

Cleaning up old data

- Garbage collection runs automatically
- You don't need to think about it!
  - If you aren't using it, it will be deleted
  - If you are using it, Java won't delete it

- Only comes up with space usage
  - Your program will only clear out space if you stop keeping track of it

Autoboxing

- Sometimes we really want primitive types to be treated as objects
- Otherwise we can't have a Vector of `int`s, or an Association of `int`s (annoying!)
- Java has a tool to help us out with this

Autoboxing

- Java converts int to Integer, char to Character, etc., automatically
- Your vector really does store objects of type Integer. But it's ok to do something like:

```
Vector<Integer> vec = new Vector<Integer>;
vec.add(10);
```

Unboxing

- Can do the opposite too!

```
Vector<Integer> vec = new Vector<Integer>;
vec.add(new Integer(10));
int x = vec.get(0);
```

SCOPE

Scope

- How long do local variables last in Java?
- When can they be accessed?

- Not talking about instance variables/objects---we already went over how long those last

Methods

- Any variable declared in a method only lasts until the end of the method

Loops/if statements/etc.

- Any variable declared in a loop (or an if statement, etc.) only lasts until the end of *that loop*

Slightly more technical outlook

- Local variables only last inside the curly braces in which they were created

- Even if you add in extra braces
  - Unclear why you'd want to?
  - But worth bearing in mind:
  - Variables cannot be accessed after the {} they are in is closed

Takeaways

- Objects are “pointed to” rather than being stored inline
- Take care when copying objects
- But, helpful when passing arguments to functions since changes to instance variables persist
- Autoboxing and garbage collection help us out in the background
- Keep an eye out for scope!