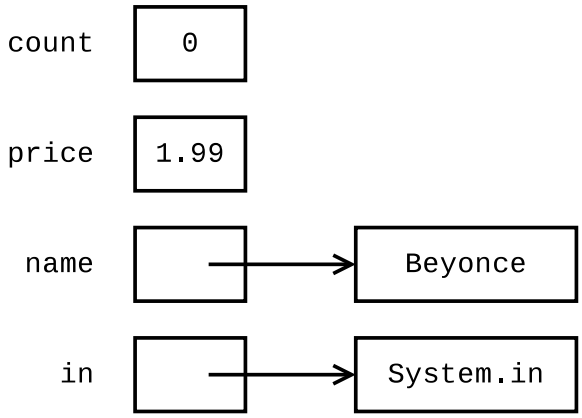
Model 1 Reference Types

```
int count;
double price;
String name;
Scanner in;

count = 0;
price = 1.99;
name = "Beyonce";
in = new Scanner(System.in);
```



Java has eight primitive types (see **??**). All other types of data are called ***reference*** types, because **their value is a memory address**. When drawing memory diagrams, use an arrow to reference other memory locations (rather than make up integer values for the actual addresses).

Questions (20 min) Start time:

1. What are the names of the reference types in the example above?

String and Scanner

2. Notice the pattern Java uses for type names like `int` and `String`:

a) Are reference type names all lowercase or capitalized? Capitalized

b) Are primitive type names all lowercase or capitalized? All lowercase

3. Variables in Java can use at most eight bytes of memory. Explain why the values `"Beyonce"` and `System.in` cannot be stored directly in the memory locations for `name` and `in`.

Both values are much larger than eight bytes, so they need to be stored somewhere else.

4. What is the value of the variable `count`? What is the value of the variable `price`?

The values are 0 and 1.99. They are stored directly in the variable's memory.

5. What is the value of the variable `name`? What is the value of the variable `in`?

The values are memory addresses. They reference the location where the actual data is stored.

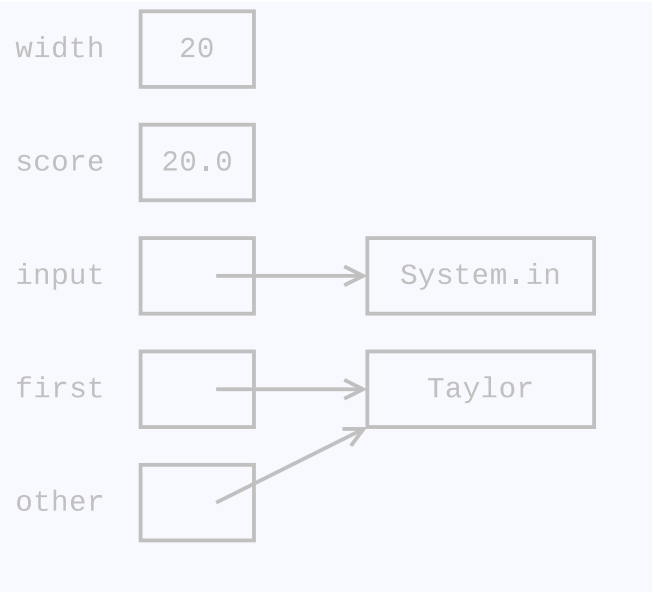
6. Carefully explain what it means to assign one variable to another. For example, what does the statement `price = count;` do in terms of memory?

Assignment simply copies the value of one variable to another. In the case of reference types, it only copies the memory location.

7. Draw a memory diagram for the following code. Make sure your answer is consistent with what you wrote for #6.

```
int width;
double score;
Scanner input;
String first;
String other;

width = 20;
score = 0.94;
input = new Scanner(System.in);
first = "Taylor";
score = width;
other = first;
```



8. What is the output of the following statements after running the code above? Explain your answer using the diagram.

```
first = "Swift";
System.out.println(other);
```

The output is `Taylor`, because changing the value (i.e., reference) of `first` does not affect the value of `other`.

9. (Optional) Paste the contents of *TaylorSwift.java* into Java Visualizer. What differences do you notice between the diagram in Java Visualizer and yours from #7?

Answers might include:

- The variables are drawn in (method) frames.
- There are no boxes drawn around the objects.