Allocating Memory to Variables

Consider the following fragment of java code

```java
int a;
int b;
```

When this program is compiled memory is allocated to both variables. Since `a` and `b` are of type `int` and this is a primitive type in Java, the amount of memory allocated to `a` is large enough to store any value given to this variable; similarly for the memory allocated to `b`. 
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We can think of the memory of the computer as a group of cells where we can store values. Each cell has a unique address that can be used to access it. Each cell, for example, might consist of 1 byte (or 8 bits).
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For example, if \( a \) is allocated to address 100 and \( b \) is allocated to address 150, the computer’s memory will look like this:

\[
\begin{array}{c}
\text{100} \\
\text{4 bytes}
\end{array}
\quad \begin{array}{c}
\text{150} \\
\text{4 bytes}
\end{array}
\]

\( a \) and \( b \) are assigned each a block of 4 bytes because in Java an \texttt{int} has a size of 4 bytes. The first byte allocated to \( a \) is in address 100, the second one in address 101, and so on. Java keeps track of where the variables are stored in memory in a table called the \textit{symbol table}. 
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If now the following code is executed:

```java
a = 3;
b = 15;
```

The computer’s memory will look like this:

```
100
  3
150
  15
```
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Non-primitive variables are handled in a different manner. Consider the following Java class representing a rectangle:

```java
public class Rectangle {
    private int width, height;
    public Rectangle (int w, int h) {
        width = w;
        height = h;
    }
    public int getArea () {
        return width * height;
    }
}
```
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Consider the following Java code:

```java
Rectangle r;
r = new Rectangle (10,5);
```

When the declaration of `r` is processed (statement `Rectangle r;`), a block of memory is allocated to `r`, say starting at address 400 and large enough to store a reference to an object of class `Rectangle`:

```
null
```

```java
null
```
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By default Java stores the value null in each non-primitive variable when it is declared. When the object is created:

```
r = new Rectangle (10,5);
```

a block of free memory large enough to store the above object of the class Rectangle (large enough to store the int values for width and height and the methods of the class Rectangle) is allocated to this object and the values 10 and 5 are stored in it. Let this block of memory start at address 500. Note that the object is not stored in address 400, which was allocated to r. Instead in address 400 the computer stores the address 500 of the above object. The computer’s memory will now look like this:
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Object of class Rectangle

getArea()
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Variable \texttt{r} is called a \textit{reference variable}, as it does not store an object, but a reference or an address of an object. To access the content of the object referenced by \texttt{r} in Java we use the dereferencing operator \texttt{.}.

So, for example \texttt{r.width} has the value 10 and \texttt{r.height} has the value 5. Invoking the method \texttt{r.getArea()} will return the value 50.