

An Introduction to Processing

Variables, Data Types & Arithmetic Operators

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Topics list

1. Variables.
2. Assignment statement.
3. Data Types.
4. Java's Primitive Data Types
 1. Whole numbers.
 2. Decimal numbers.
 3. Others.
5. Arithmetic operators.

Variables

In Programming, variables:

- are created (defined) in your programs.
- are used to store data (whose value can change over time).
- have a data type.
- have a name.
- are a VERY important programming concept.

Variable names...

- Are case-sensitive.
- Begin with either:
 - a **letter (preferable)**,
 - the dollar sign "\$", or
 - the underscore character "_".
- Can contain letters, digits, dollar signs, or underscore characters.
- Can be any length you choose.
- Must not be a **keyword or reserved word** e.g. int, while, etc.
- Cannot contain white spaces.

Variable names should be carefully chosen

- Use full words instead of cryptic abbreviations e.g.
 - variables named **speed** and **gear** are much more intuitive than abbreviated versions, such as **s** and **g**.
- If the name consists of:
 - only one word,
 - spell that word in all lowercase letters e.g. **ratio**.
 - more than one word,
 - capitalise the first letter of each subsequent word e.g. **gearRatio** and **currentGear**.
 - This is called **camelCase**

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4. Java's Primitive Data Types

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Assignment Statement

- Values are stored in variables via assignment statements:

Syntax	<code>variable = expression;</code>
Example	<code>diameter = 100;</code>

- A variable stores a single value, so any previous value is lost.
- Assignment statements work by taking the value of what appears on the right-hand side of the operator and copying that value into a variable on the left-hand side.

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Data Types

- In Java, when we define a variable, we **have** to give it a data type.
- The data type defines the **kinds of values** (data) that can be stored in the variable e.g.
 - - 456
 - 2
 - 45.7897
 - I Love Programming
 - S
 - true
- The data type also determines the **operations** that may be performed on it.

Data Types

- Java uses two kinds of data types:
 - **Primitive** types
 - **Object** types
- We are only looking at **Primitive** types now; we will cover Object types later in the module.

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Java's Primitive Data Types

- Java programming language supports eight primitive data types.
- A primitive type is predefined by the language and is named by a reserved keyword.
- A primitive type is highlighted red when it is typed into the PDE e.g.

int numberOfItems;

boolean bounceUp;

float lengthOfRectangle;

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1. Variables.
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4. Java's Primitive Data Types

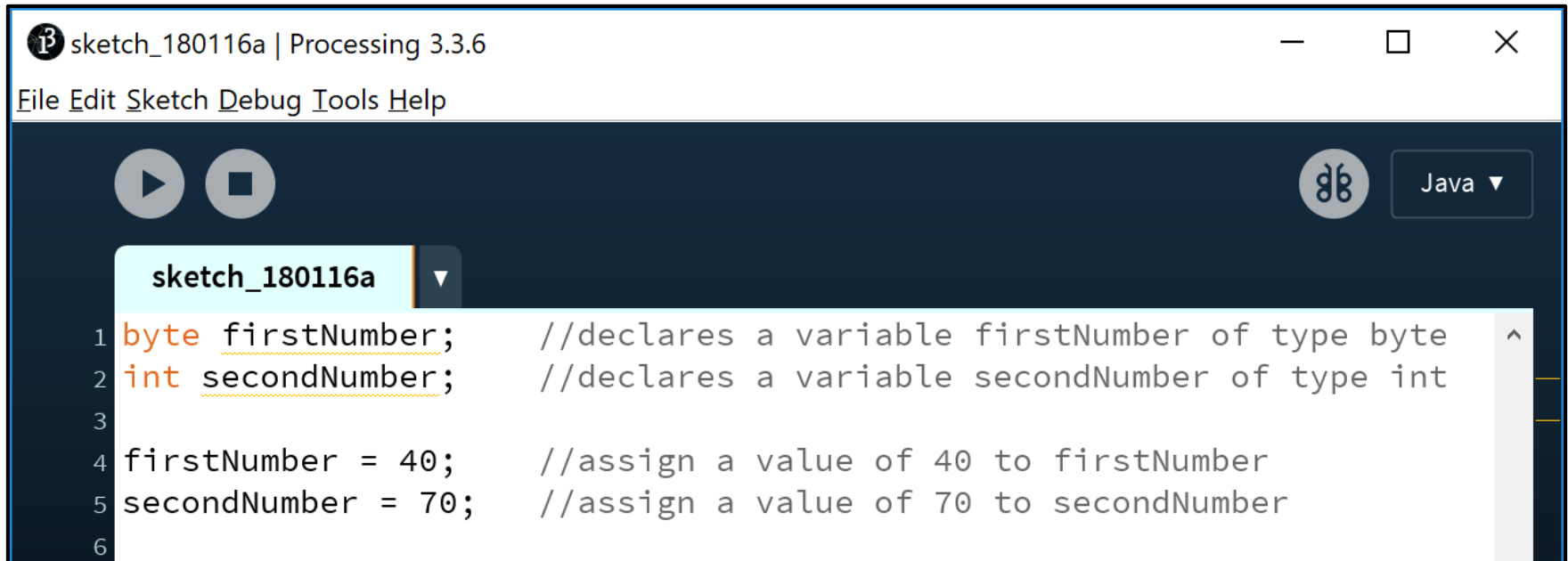
1. Whole numbers.
2. Decimal numbers.
3. Others.

5. Arithmetic operators.

Java's Primitive Data Types (whole numbers)

Type	Byte-size	Minimum value (inclusive)	Maximum value (inclusive)	Typical Use
byte	8-bit	-128	127	Useful in applications where memory savings apply.
short	16-bit	-32,768	32,767	
int	32-bit	-2,147,483,648	2,147,483,647	Default choice.
long	64-bit	-9,223,372,036,854,775,808	9,223,372,036,854,775,807	Used when you need a data type with a range of values larger than that provided by int.

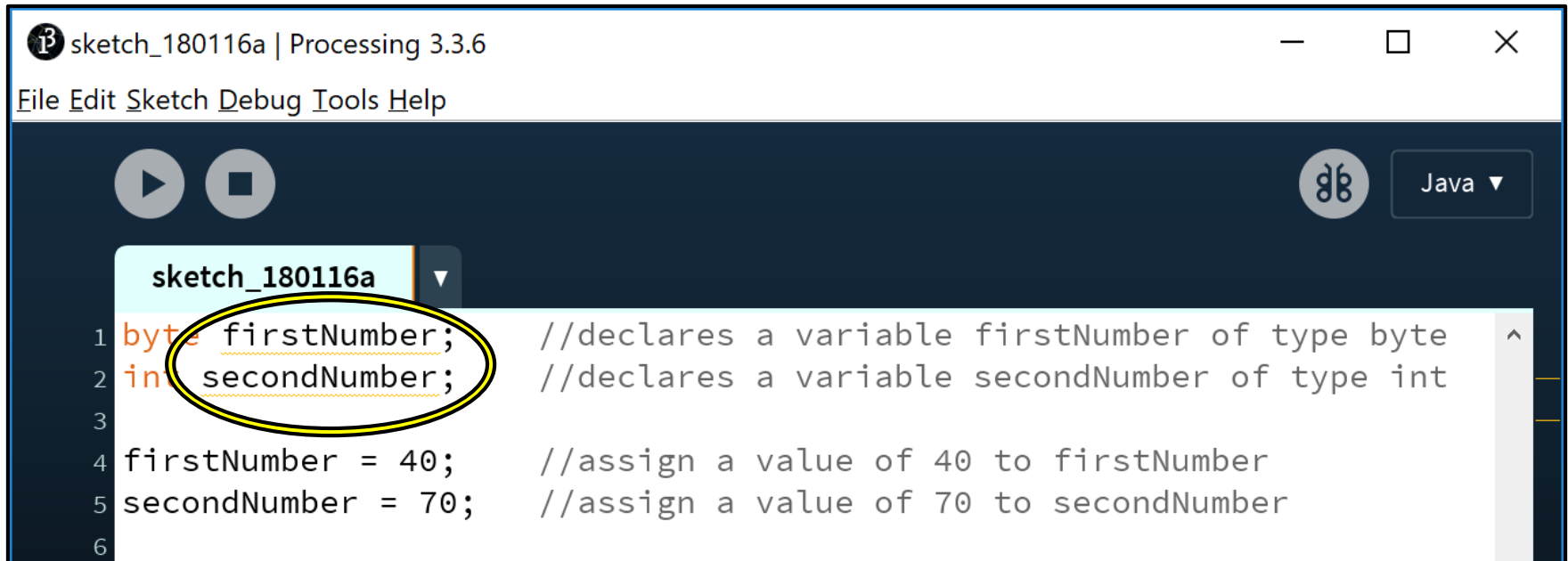
Declaring variables of a specific type



The screenshot shows the Processing IDE window titled "sketch_180116a | Processing 3.3.6". The menu bar includes "File", "Edit", "Sketch", "Debug", "Tools", and "Help". The toolbar contains a play button, a stop button, a debugger icon, and a language dropdown set to "Java". The code editor shows the following code:

```
1 byte firstNumber; //declares a variable firstNumber of type byte
2 int secondNumber; //declares a variable secondNumber of type int
3
4 firstNumber = 40; //assign a value of 40 to firstNumber
5 secondNumber = 70; //assign a value of 70 to secondNumber
6
```

Declaring variables of a specific type



sketch_180116a | Processing 3.3.6

File Edit Sketch Debug Tools Help

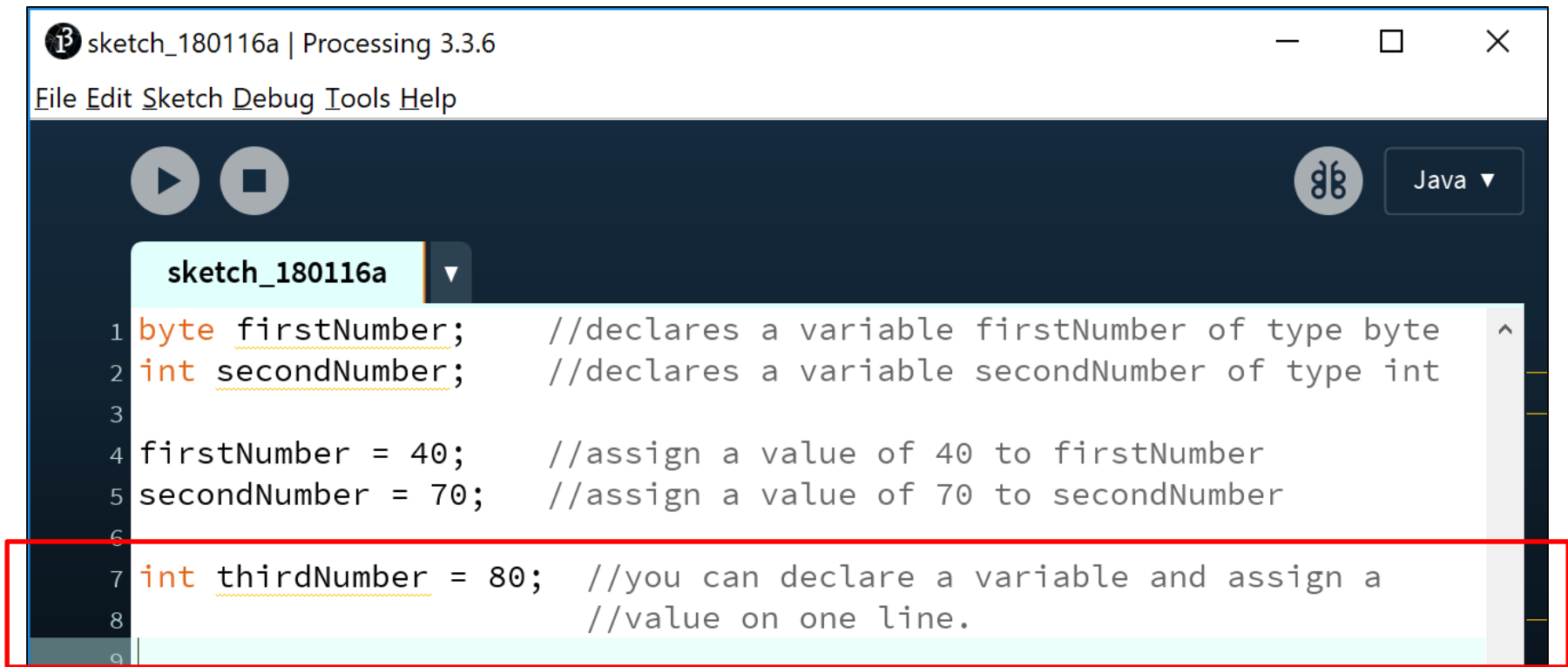
Java ▾

sketch_180116a ▾

```
1 byte firstNumber; //declares a variable firstNumber of type byte
2 int secondNumber; //declares a variable secondNumber of type int
3
4 firstNumber = 40; //assign a value of 40 to firstNumber
5 secondNumber = 70; //assign a value of 70 to secondNumber
6
```

YELLOW underline – a warning message that indicates that the variable hasn't been used meaningfully.

Declaring variables of a specific type

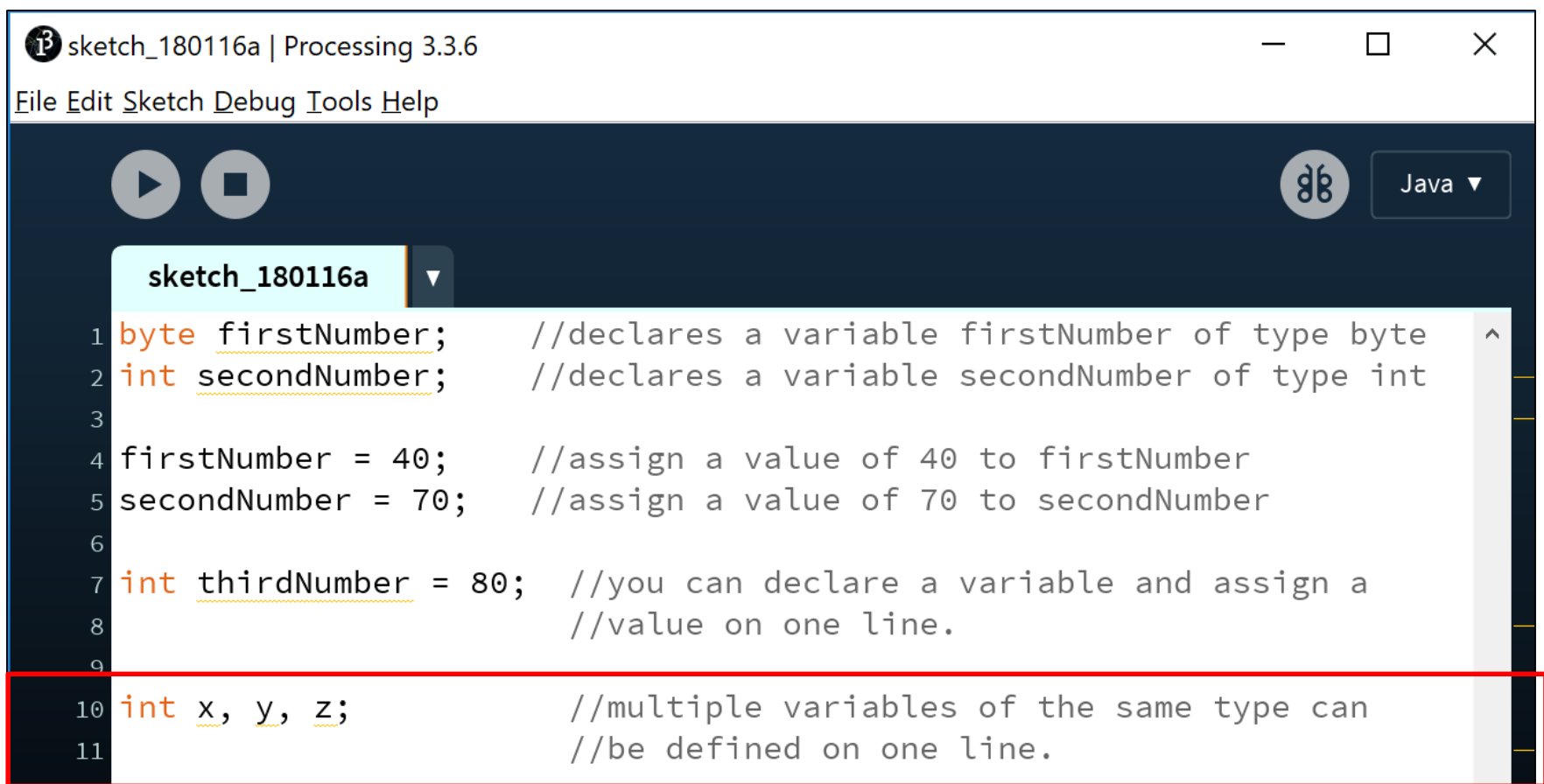


The screenshot shows the Processing IDE interface. The title bar reads "sketch_180116a | Processing 3.3.6". The menu bar includes "File", "Edit", "Sketch", "Debug", "Tools", and "Help". The toolbar contains a play button, a stop button, and a language selector set to "Java". The code editor displays the following Java code:

```
1 byte firstNumber; //declares a variable firstNumber of type byte
2 int secondNumber; //declares a variable secondNumber of type int
3
4 firstNumber = 40; //assign a value of 40 to firstNumber
5 secondNumber = 70; //assign a value of 70 to secondNumber
6
7 int thirdNumber = 80; //you can declare a variable and assign a
8 //value on one line.
```

The code is organized into a tab labeled "sketch_180116a". The line numbers 1 through 9 are visible on the left side of the editor. The code demonstrates declaring variables of type `byte` and `int`, and then assigning values to them. The final line shows how to declare and assign a variable in a single line.

Declaring variables of a specific type

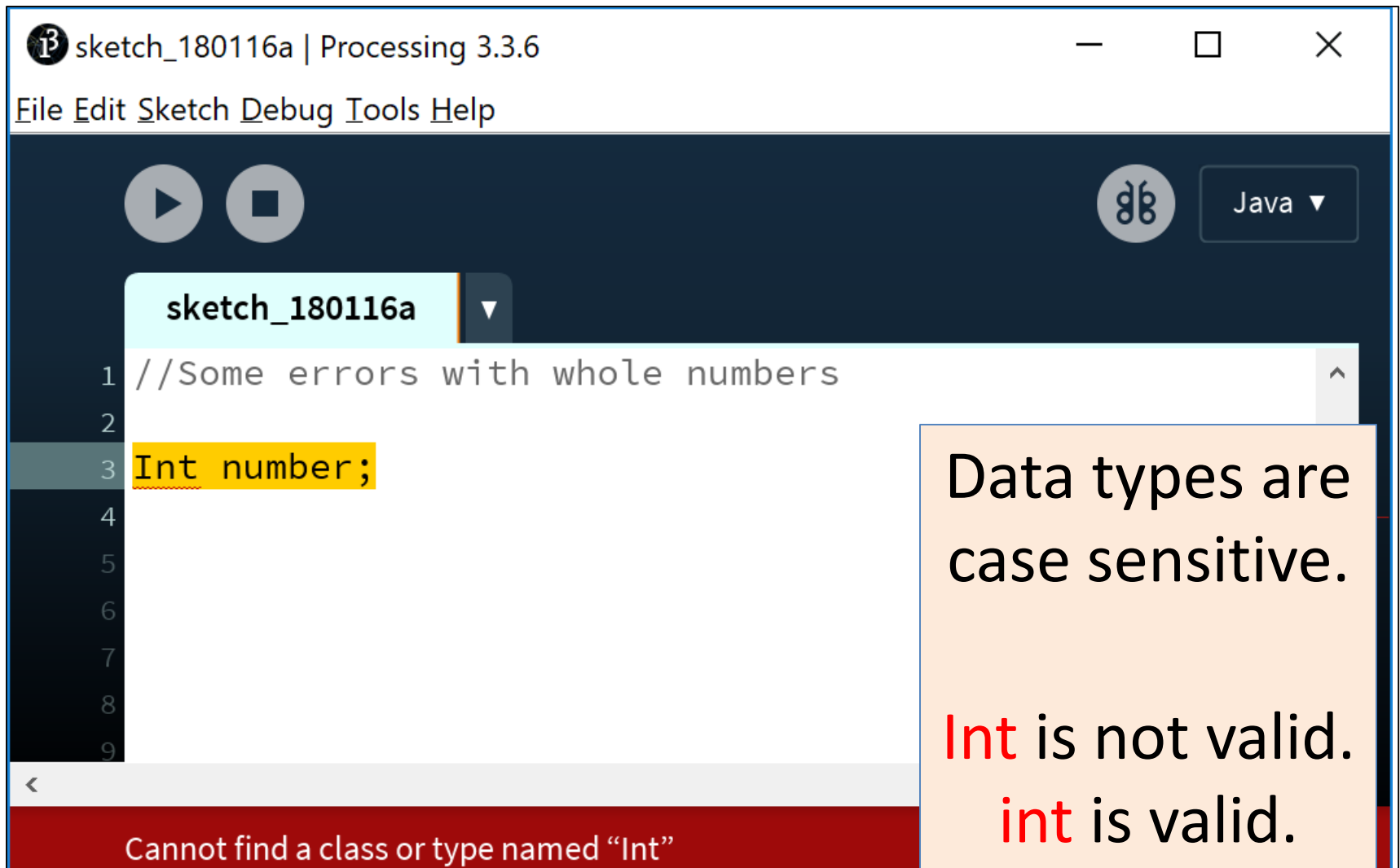


The screenshot shows the Processing IDE interface. The title bar reads "sketch_180116a | Processing 3.3.6". The menu bar includes "File", "Edit", "Sketch", "Debug", "Tools", and "Help". Below the menu bar are buttons for "Run" (a play icon) and "Stop" (a square icon). On the right side of the toolbar, there is a "Java" dropdown menu. The main code editor displays the following code:

```
1 byte firstNumber; //declares a variable firstNumber of type byte
2 int secondNumber; //declares a variable secondNumber of type int
3
4 firstNumber = 40; //assign a value of 40 to firstNumber
5 secondNumber = 70; //assign a value of 70 to secondNumber
6
7 int thirdNumber = 80; //you can declare a variable and assign a
8 //value on one line.
9
10 int x, y, z; //multiple variables of the same type can
11 //be defined on one line.
```

The code is color-coded: keywords like `byte`, `int`, and `firstNumber` are in orange, while comments are in grey. The last two lines of code, lines 10 and 11, are highlighted with a red rectangular border.

Declaring variables - some errors



The screenshot shows the Processing IDE interface. The title bar reads "sketch_180116a | Processing 3.3.6". The menu bar includes "File", "Edit", "Sketch", "Debug", "Tools", and "Help". The toolbar contains a play button, a stop button, a compiler icon, and a language dropdown set to "Java". The sketch name "sketch_180116a" is shown in a dropdown menu. The code editor displays the following code:

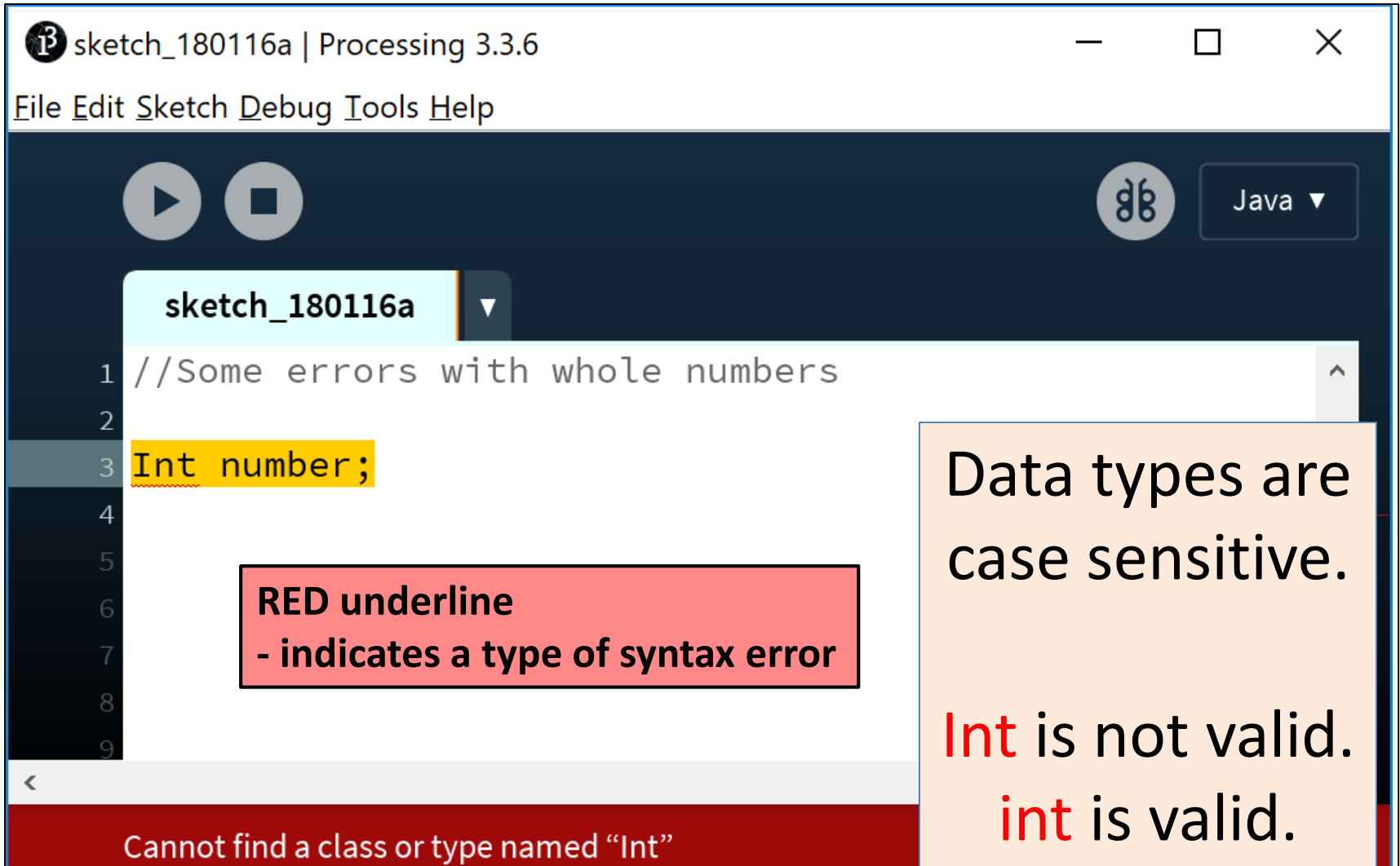
```
1 //Some errors with whole numbers
2
3 Int number;
4
5
6
7
8
9
```

A red error bar at the bottom of the IDE states: "Cannot find a class or type named 'Int'".

Data types are case sensitive.

Int is not valid.
int is valid.

Declaring variables - some errors



The screenshot shows the Processing IDE interface. The title bar reads "sketch_180116a | Processing 3.3.6". The menu bar includes "File", "Edit", "Sketch", "Debug", "Tools", and "Help". The toolbar contains a play button, a stop button, a palette icon, and a language dropdown set to "Java". The code editor shows the following code:

```
1 //Some errors with whole numbers
2
3 Int number;
4
5
6
7
8
9
```

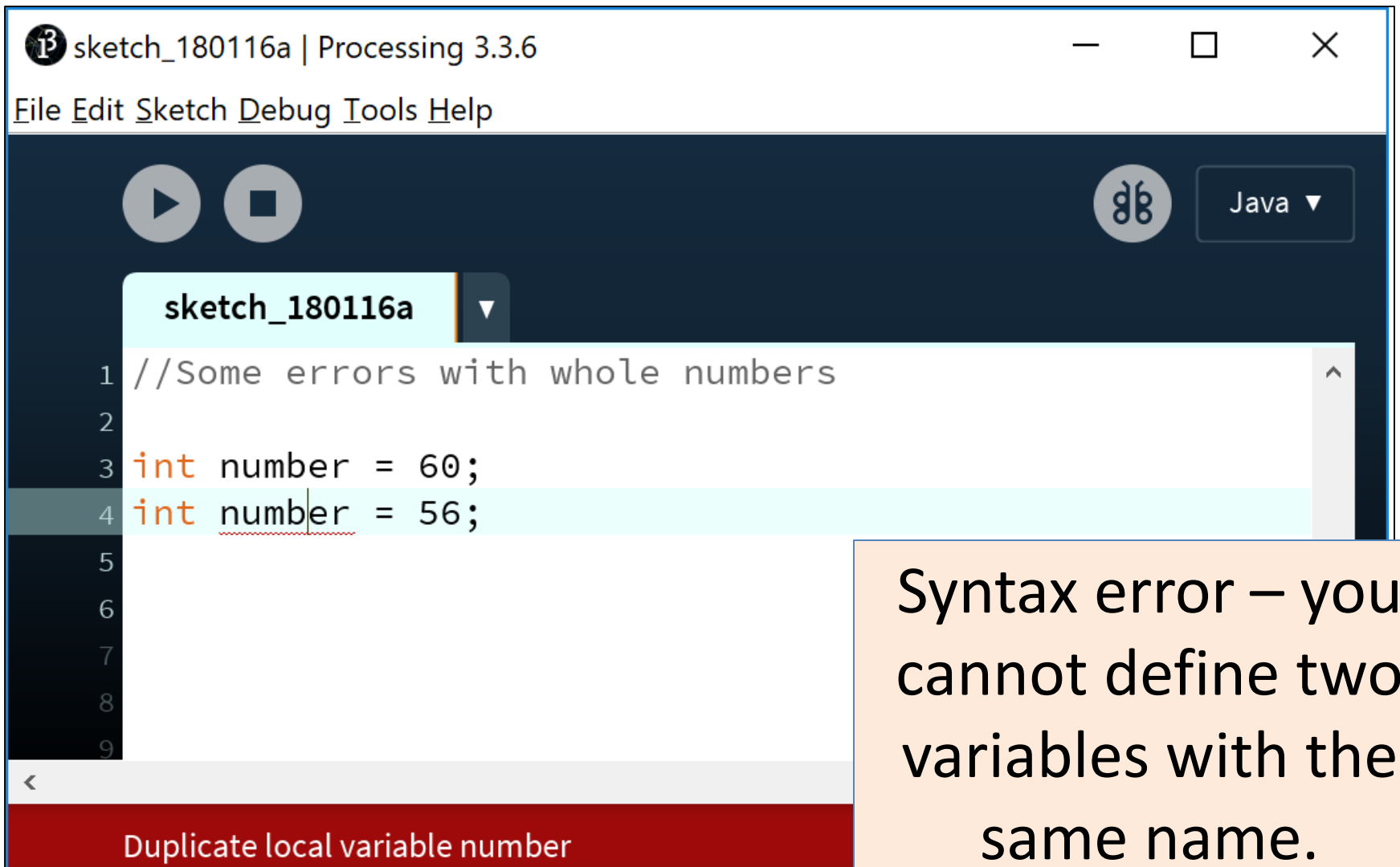
The word "Int" on line 3 is highlighted in yellow and has a red wavy underline underneath it. A red error message bar at the bottom of the editor reads: "Cannot find a class or type named 'Int'".

RED underline
- indicates a type of syntax error

Data types are case sensitive.

Int is not valid.
int is valid.

Declaring variables - some errors



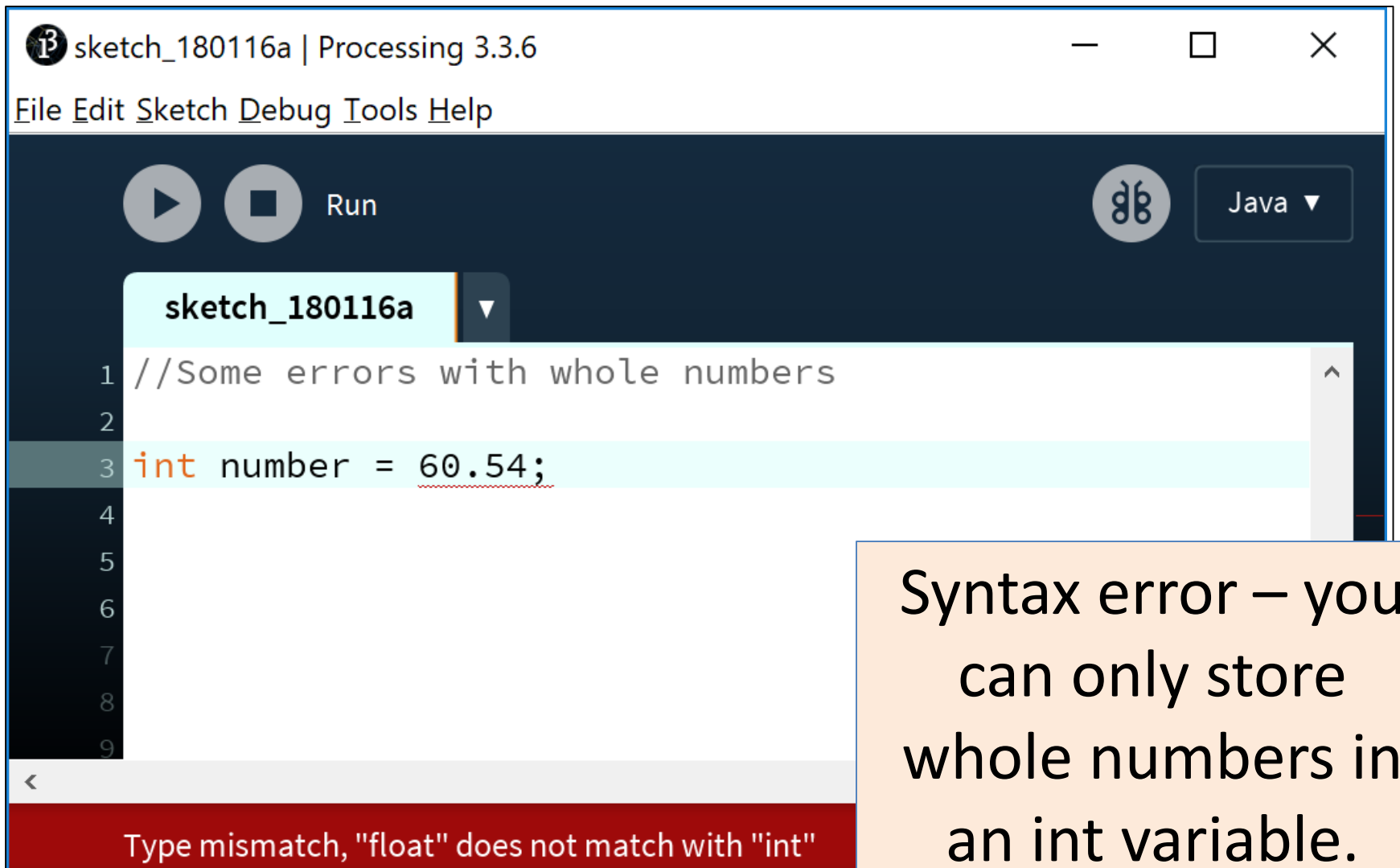
The screenshot shows the Processing IDE window titled "sketch_180116a | Processing 3.3.6". The menu bar includes "File", "Edit", "Sketch", "Debug", "Tools", and "Help". The toolbar contains a play button, a stop button, a Java logo, and a "Java" dropdown menu. The code editor shows the following code:

```
1 //Some errors with whole numbers
2
3 int number = 60;
4 int number = 56;
```

The fourth line, `int number = 56;`, is highlighted in light blue. A red squiggly line under the variable `number` indicates a syntax error. A red banner at the bottom of the IDE displays the message "Duplicate local variable number".

Syntax error – you cannot define two variables with the same name.

Declaring variables - some errors



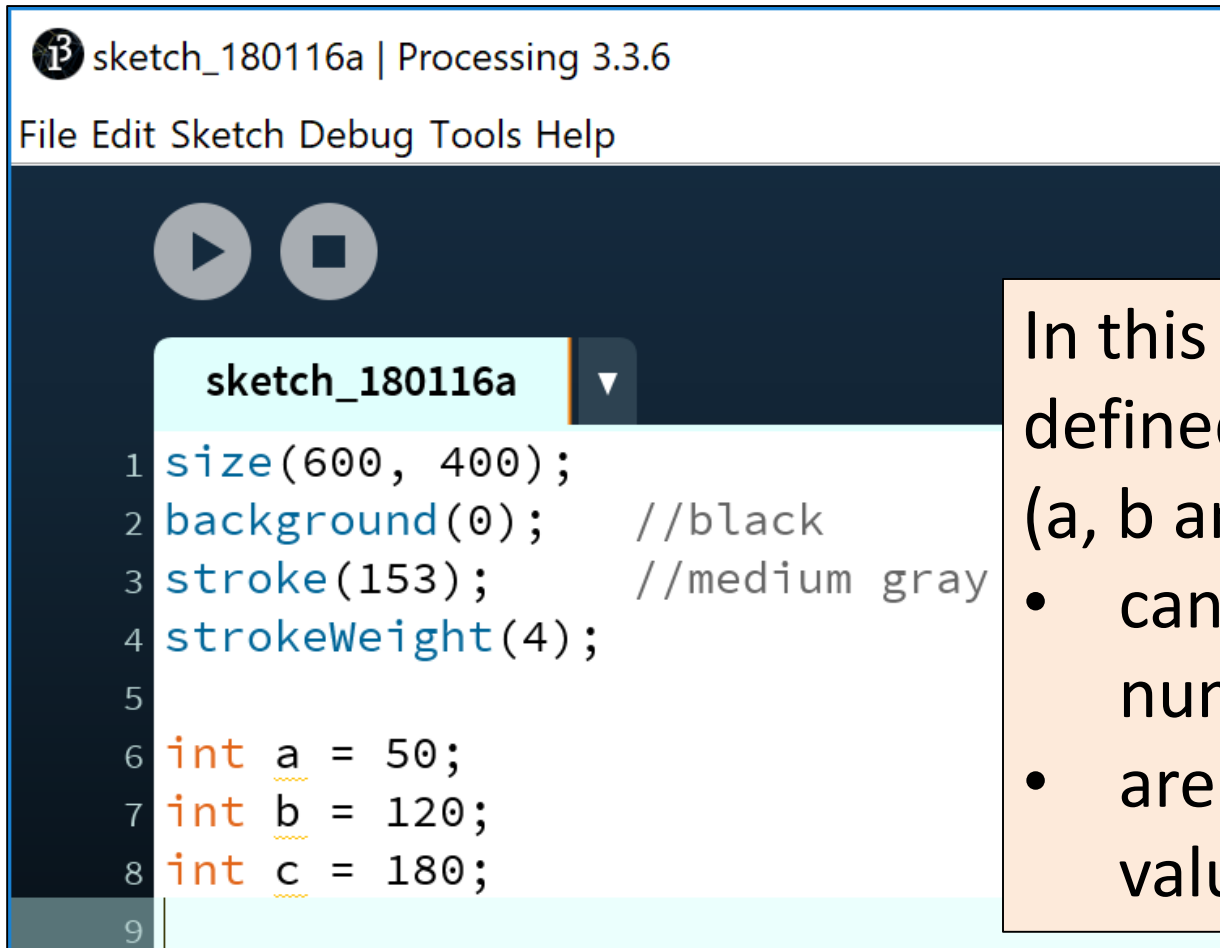
The screenshot shows the Processing IDE window titled "sketch_180116a | Processing 3.3.6". The menu bar includes "File", "Edit", "Sketch", "Debug", "Tools", and "Help". The toolbar contains a play button, a square button, and a "Run" label. On the right, there is a "Java" dropdown menu. The sketch name "sketch_180116a" is displayed in a dropdown. The code editor shows the following code:

```
1 //Some errors with whole numbers
2
3 int number = 60.54;
4
5
6
7
8
9
```

The line `int number = 60.54;` is highlighted in light blue. A red squiggly line is under the decimal part of the number. At the bottom of the IDE, a red error message reads: "Type mismatch, 'float' does not match with 'int'".

Syntax error – you can only store whole numbers in an int variable.

Java's Primitive Data Types: int example



sketch_180116a | Processing 3.3.6

File Edit Sketch Debug Tools Help

▶ ◻

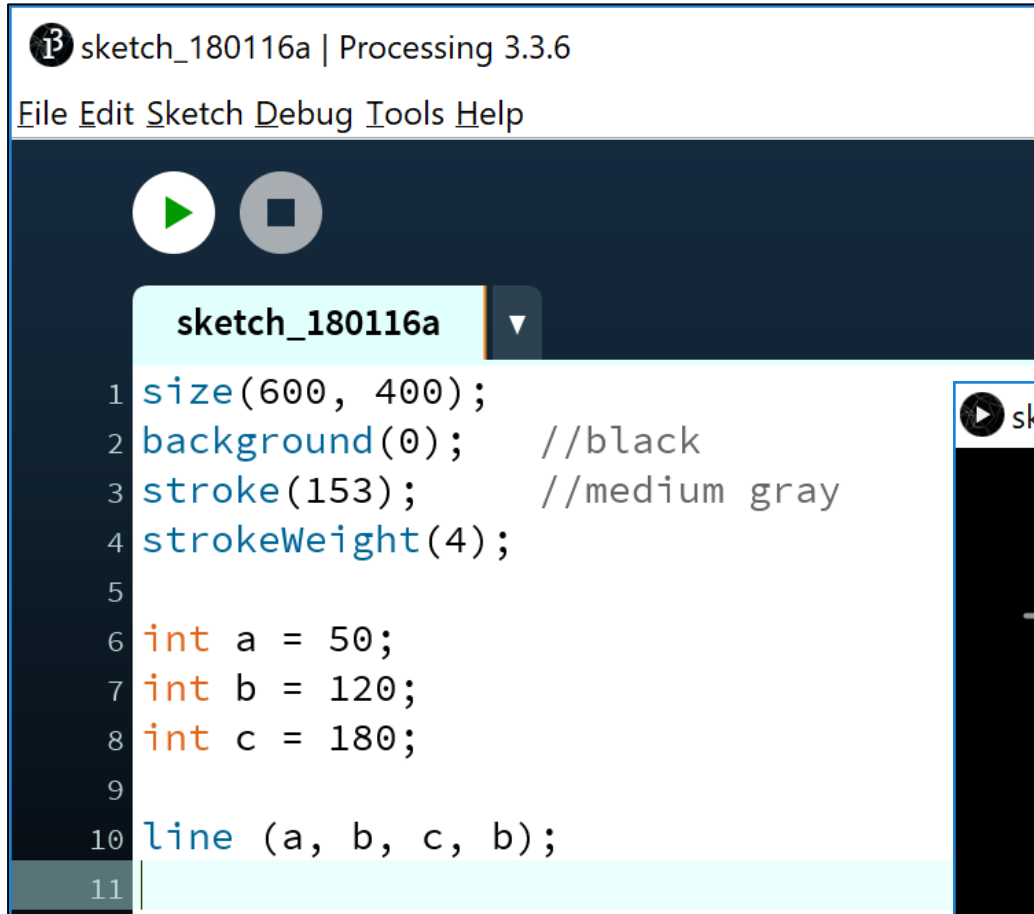
sketch_180116a ▼

```
1 size(600, 400);
2 background(0);    //black
3 stroke(153);      //medium gray
4 strokeWeight(4);
5
6 int a = 50;
7 int b = 120;
8 int c = 180;
9
```

In this example, we have defined three variables (a, b and c) that:

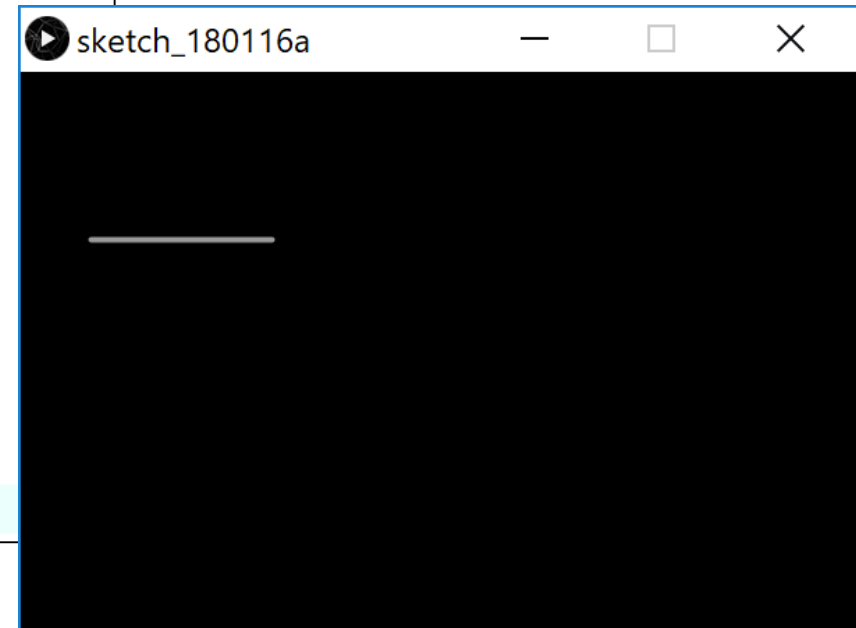
- can hold whole numbers (int).
- are set with a starting value.

Java's Primitive Data Types: int example

A screenshot of the Processing IDE interface. The title bar shows 'P sketch_180116a | Processing 3.3.6'. The menu bar includes 'File', 'Edit', 'Sketch', 'Debug', 'Tools', and 'Help'. Below the menu bar are two circular buttons: a green play button and a gray square button. A dropdown menu shows 'sketch_180116a'. The code editor displays the following code:

```
1 size(600, 400);
2 background(0);    //black
3 stroke(153);      //medium gray
4 strokeWeight(4);
5
6 int a = 50;
7 int b = 120;
8 int c = 180;
9
10 line (a, b, c, b);
11
```

We can pass the defined variables as values to functions.



Java's Primitive Data Types: int example

```
sketch_180116a ▼  
size(600, 400);  
background(0);    //black  
stroke(153);      //medium gray  
strokeWeight(4);  
  
int a = 50;  
int b = 120;  
int c = 180;  
  
line (a, b, c, b);
```

***Q:** Could we have used the **byte** data type instead of **int**?*

Type	Minimum value (inclusive)	Maximum value (inclusive)
byte	-128	127
short	-32,768	32,767
int	-2,147,483,648	2,147,483,647
long	-9,223,372,036,854,775,808	9,223,372,036,854,775,807

Java's Primitive Data Types: int example



The screenshot shows the Processing IDE interface. At the top, the title bar reads "sketch_180116a | Processing 3.3.6". Below it is a menu bar with "File", "Edit", "Sketch", "Debug", "Tools", and "Help". The main area contains a code editor for "sketch_180116a". The code is as follows:

```
1 size(600, 400);
2 background(0);    //black
3 stroke(153);      //medium gray
4 strokeWeight(4);
5
6 byte a = 50;
7 byte b = 120;
8 byte c = 180;
9
10 line (a, b, c, b);
11
```

A red error bar at the bottom of the code editor displays the message: "Type mismatch, 'int' does not match with 'byte'". This error is triggered by the assignment of the value 180 to the variable 'c' of type 'byte'.

Q: Could we have used the *byte* data type instead of *int*?

A: For *a* and *b* we could have; 50 and 120 fall below the max value of 127. But *c* produces a syntax error; 180 cannot fit into a 127 capacity variable.

Type	Min value	Max value
byte	-128	127
short	-32,768	32,767

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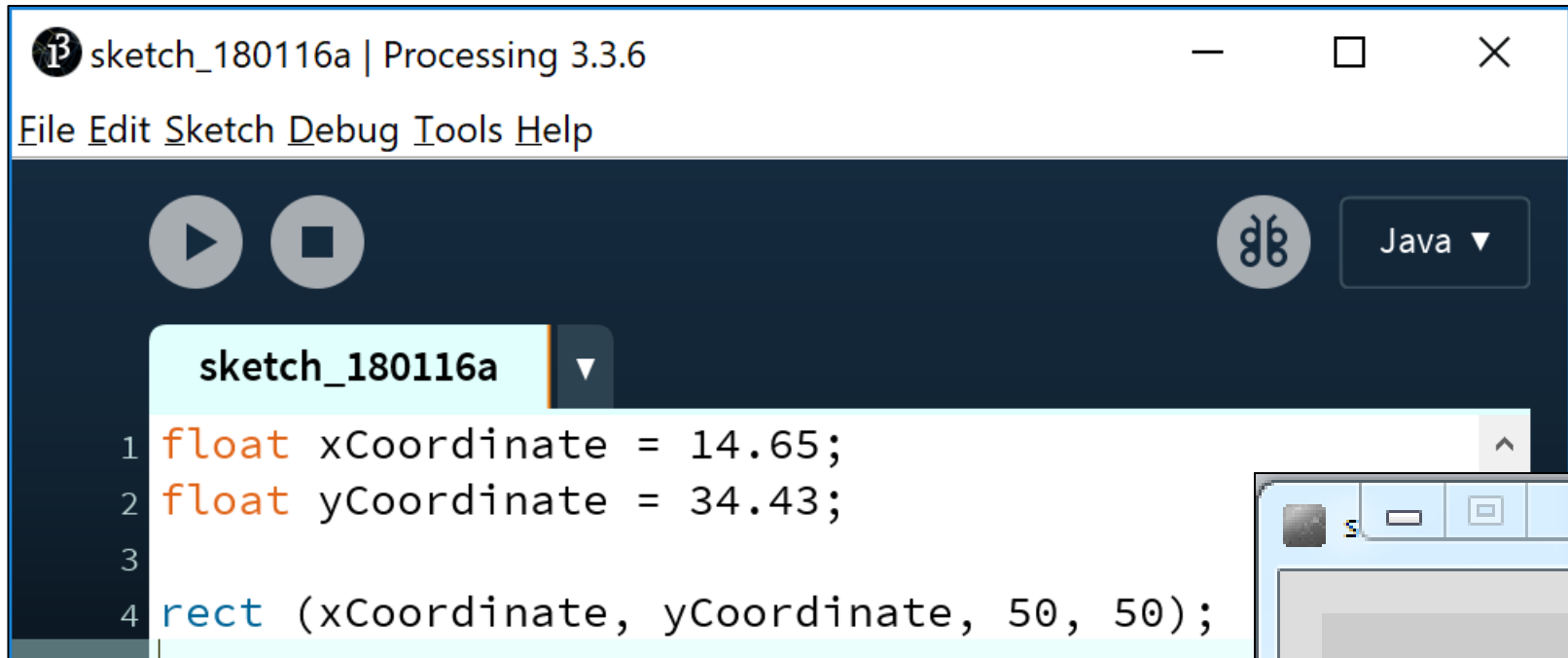


5. Arithmetic operators.

Java's Primitive Data Types (decimal numbers)

Type	Byte-size	Minimum value (inclusive)	Maximum value (inclusive)	Typical Use
float	32-bit	<i>Beyond the scope of this lecture .</i> <i>There is also a loss of precision in this data-type that we will cover in later lectures.</i>		Useful in applications where memory savings apply. Default choice when using Processing .
double	64-bit			Default choice when programming Java apps .

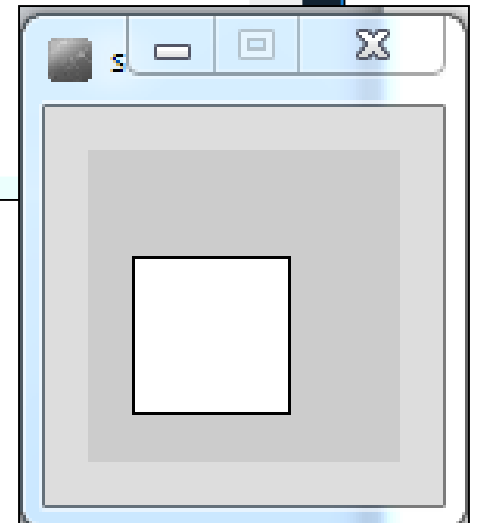
Java's Primitive Data Types: float example



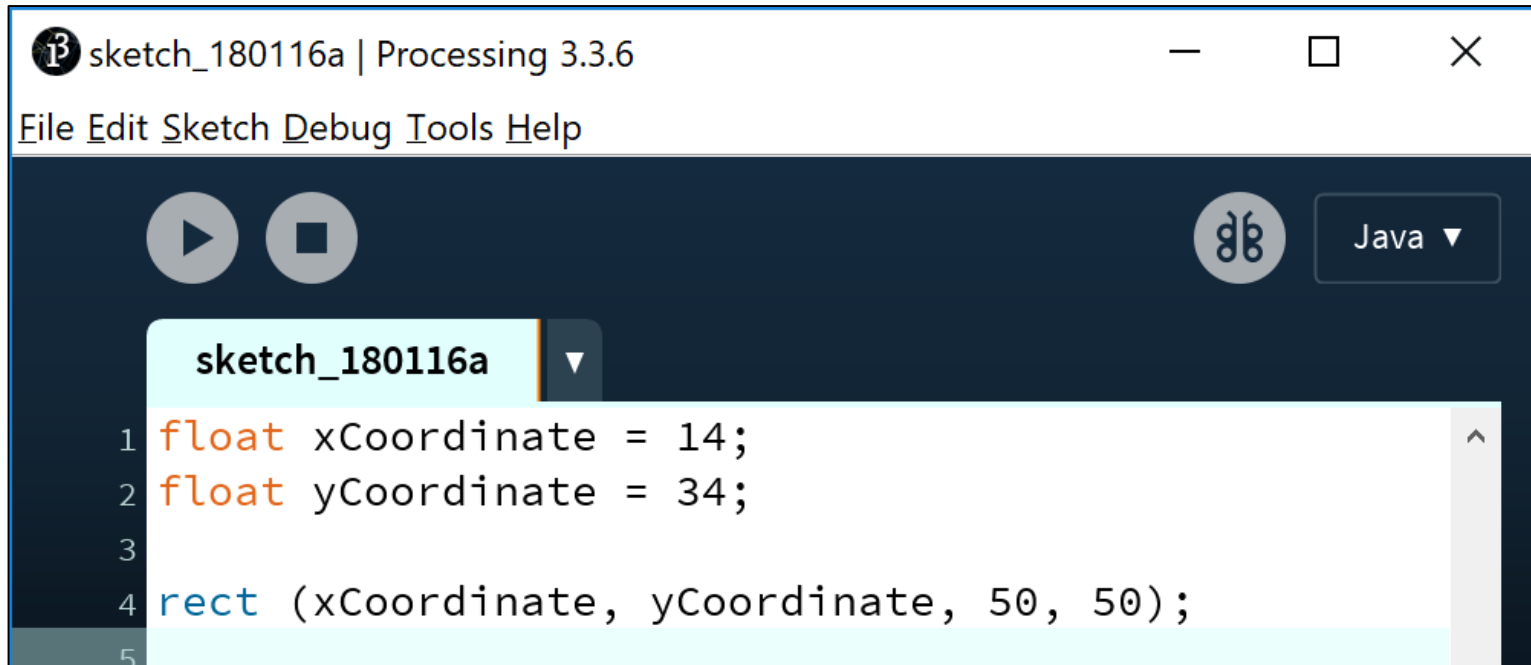
The screenshot shows the Processing IDE window titled "sketch_180116a | Processing 3.3.6". The menu bar includes "File", "Edit", "Sketch", "Debug", "Tools", and "Help". The toolbar contains a play button, a stop button, a Java logo, and a language dropdown set to "Java". The code editor shows the following code:

```
1 float xCoordinate = 14.65;  
2 float yCoordinate = 34.43;  
3  
4 rect (xCoordinate, yCoordinate, 50, 50);
```

We can pass the defined variables as values to functions.



Java's Primitive Data Types: float example



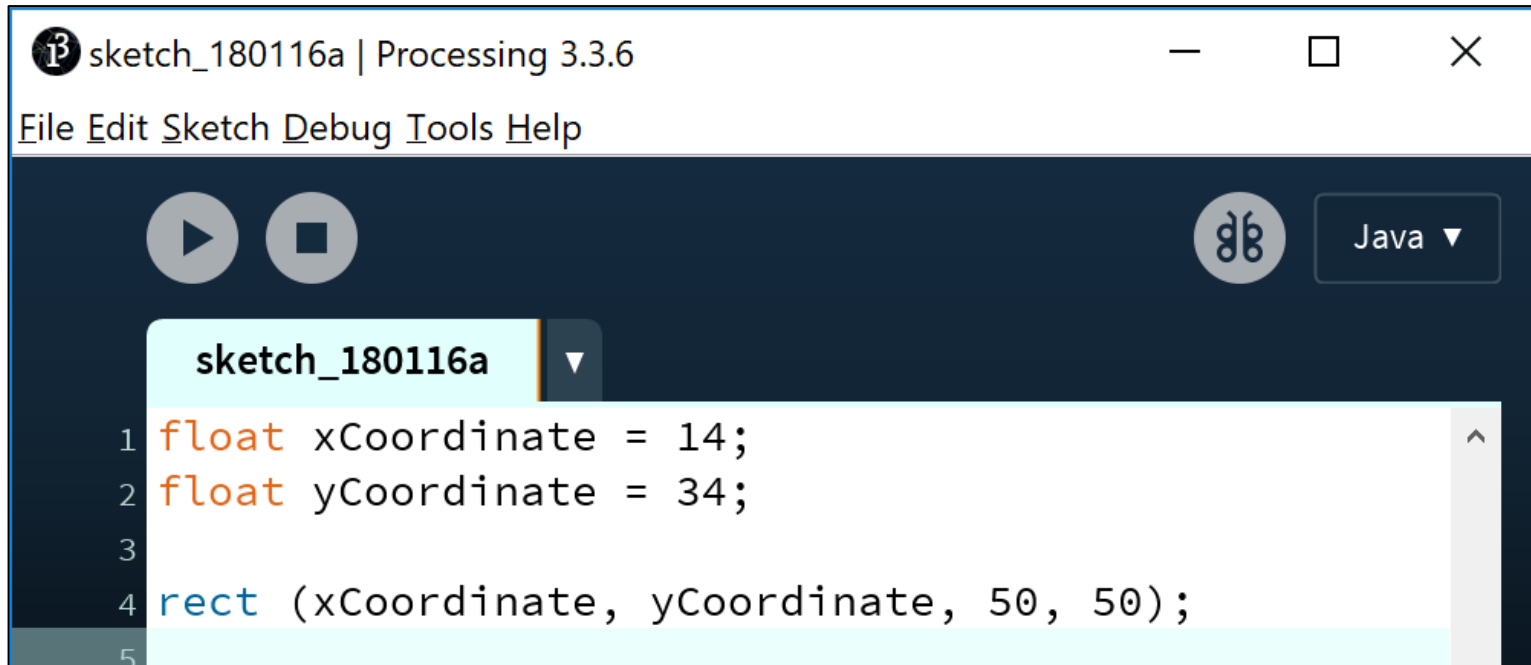
```
sketch_180116a | Processing 3.3.6
File Edit Sketch Debug Tools Help

1 float xCoordinate = 14;
2 float yCoordinate = 34;
3
4 rect (xCoordinate, yCoordinate, 50, 50);
5
```

Whole numbers can be placed into a **float** variable.

Q: Why?

Java's Primitive Data Types: float example



The screenshot shows the Processing IDE window titled "sketch_180116a | Processing 3.3.6". The menu bar includes "File", "Edit", "Sketch", "Debug", "Tools", and "Help". The toolbar contains a play button, a square button, a palette icon, and a language dropdown set to "Java". A file tab labeled "sketch_180116a" is active. The code editor displays the following Java code:

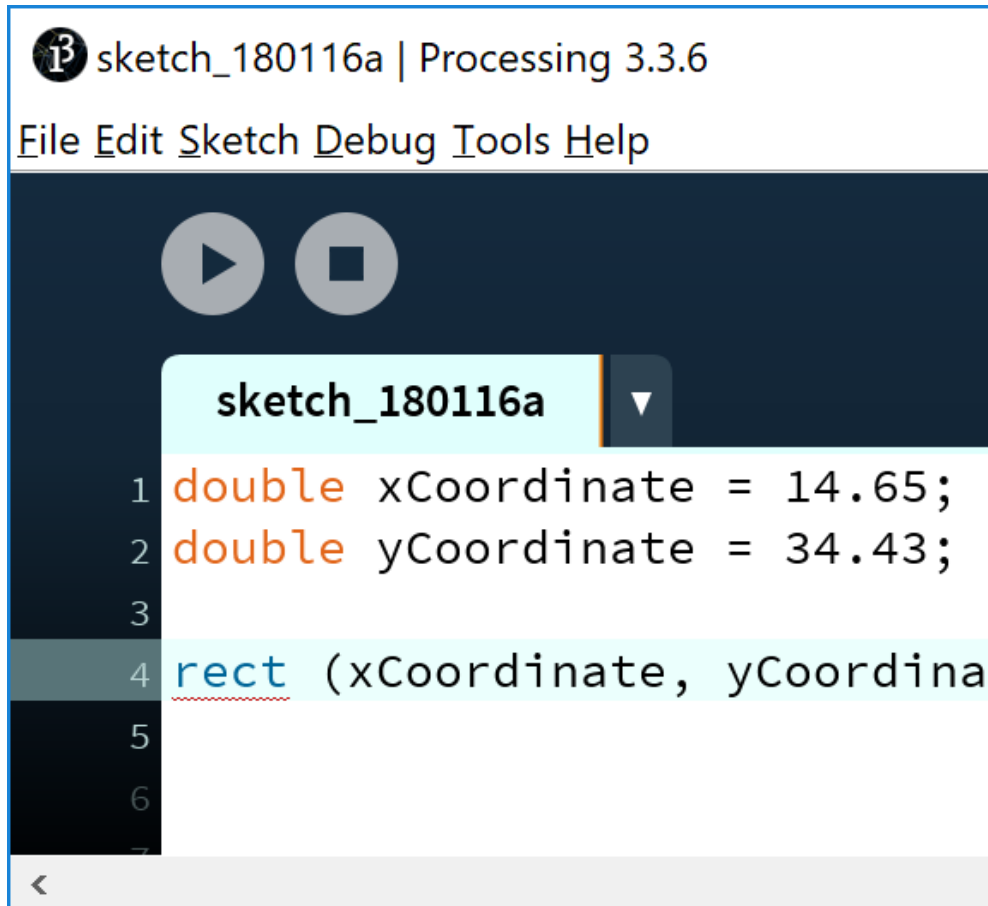
```
1 float xCoordinate = 14;  
2 float yCoordinate = 34;  
3  
4 rect (xCoordinate, yCoordinate, 50, 50);  
5
```

Whole numbers can be placed into a **float** variable.

Q: Why?

A: There is no loss of precision. We are not losing any data.

Passing variables as arguments: some errors



The screenshot shows the Processing IDE interface. At the top, the title bar reads "sketch_180116a | Processing 3.3.6". Below it is a menu bar with "File", "Edit", "Sketch", "Debug", "Tools", and "Help". The main workspace has a dark background with a toolbar containing a play button and a stop button. A tab labeled "sketch_180116a" is active. The code editor shows the following code:

```
1 double xCoordinate = 14.65;
2 double yCoordinate = 34.43;
3
4 rect (xCoordinate, yCoordinate, 50, 50);
5
6
7
```

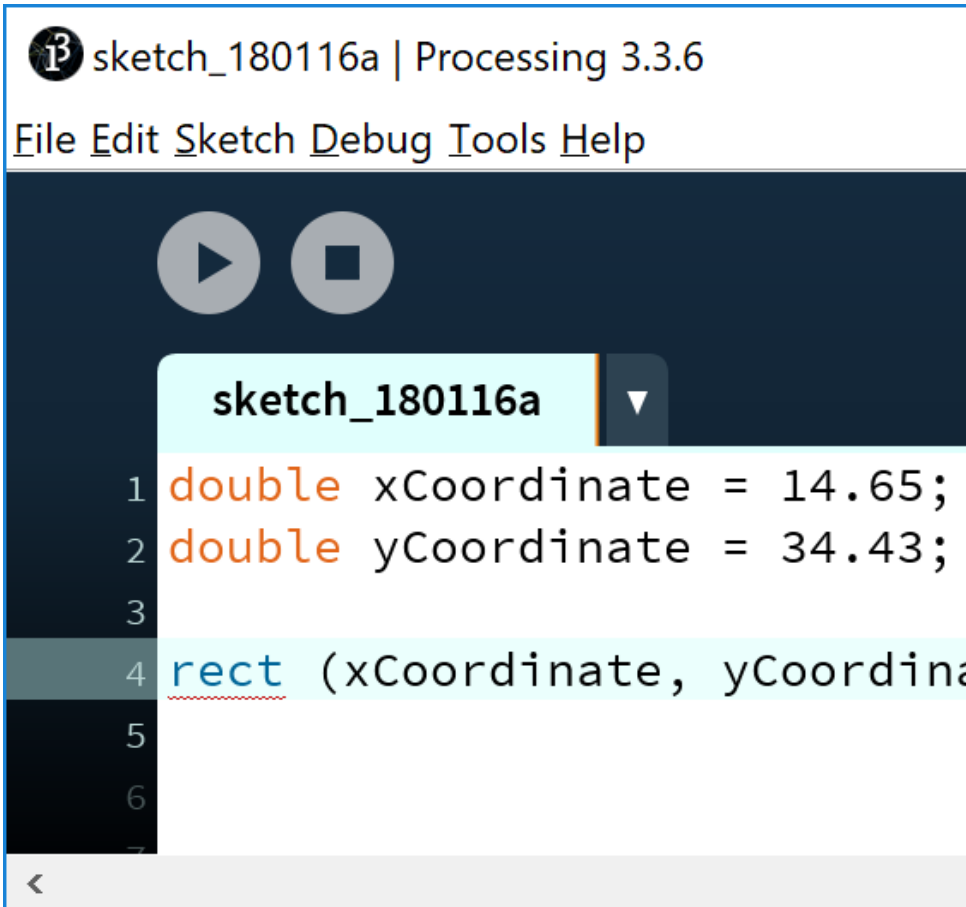
The word "rect" on line 4 is underlined with a red squiggly line, indicating a syntax error.

We changed the data type of our variables from **float** to **double**.

Q: Why are we getting this syntax error?

The function "rect()" expects parameters like: "rect(float, float, float, float)"

Passing variables as arguments: some errors



The screenshot shows the Processing IDE interface. At the top, the title bar reads "sketch_180116a | Processing 3.3.6". Below it is a menu bar with "File", "Edit", "Sketch", "Debug", "Tools", and "Help". The main editor area has a dark background. On the left, there are two circular buttons: a play button and a square button. Below these is a tab labeled "sketch_180116a". The code in the editor is as follows:

```
1 double xCoordinate = 14.65;
2 double yCoordinate = 34.43;
3
4 rect(xCoordinate, yCoordinate, 50, 50);
5
6
7
```

The word "rect" on line 4 is underlined with a red squiggly line, indicating a warning or error. To the right of the code editor, there is a light orange box with the following text:

A: a **double** variable has a larger capacity than a **float**. A **float** is required in the **rect()** method. The value stored in the double may not fit into the float.

At the bottom of the IDE window, there is a red banner with the text: "The function "rect()" expects parameters like: "rect(float, float, float, float)"

Passing variables as arguments: some errors

From: https://processing.org/reference/rect_.html

Syntax `rect(a, b, c, d)`

Parameters	a	float: x-coordinate of the rectangle by default
	b	float: y-coordinate of the rectangle by default
	c	float: width of the rectangle by default
	d	float: height of the rectangle by default


```
double xCoordinate = 14.65;  
double yCoordinate = 34.43;  
rect(xCoordinate, yCoordinate, 50, 50);
```

The function "rect()" expects parameters like: "rect(float, float, float, float)"

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Java's Primitive Data Types (others)

Type	Byte-size	Minimum value (inclusive)	Maximum value (inclusive)	Typical Use
char	16-bit	'\u0000' (or 0)	'\uffff' (or 65,535).	Represents a Unicode character.
boolean	1-bit	n/a		Holds either true or false and is typically used as a flag.

- We will go into more detail on these two data types in later lectures.

http://en.wikipedia.org/wiki/List_of_Unicode_characters

Java's Primitive Data Types (default values)

Data Type	Default Value
byte	0
short	0
int	0
long	0L
float	0.0f
double	0.0d
char	'\u0000'
boolean	false

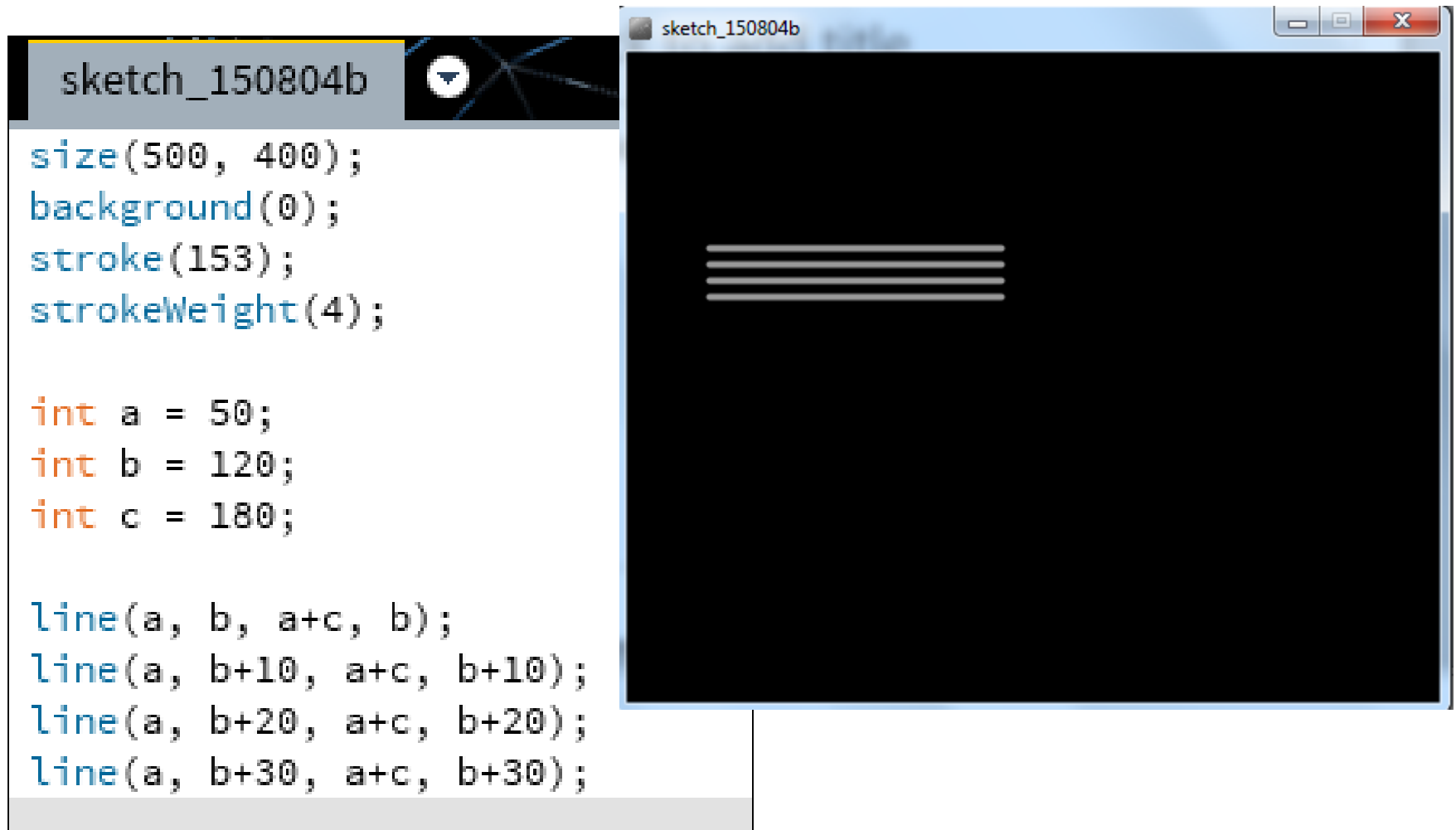
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Arithmetic Operators

Arithmetic Operator	Explanation	Example(s)
+	Addition	$6 + 2$ amountOwed + 10
-	Subtraction	$6 - 2$ amountOwed - 10
*	Multiplication	$6 * 2$ amountOwed * 10
/	Division	$6 / 2$ amountOwed / 10

Arithmetic operators: example 1



Arithmetic operators: example 2

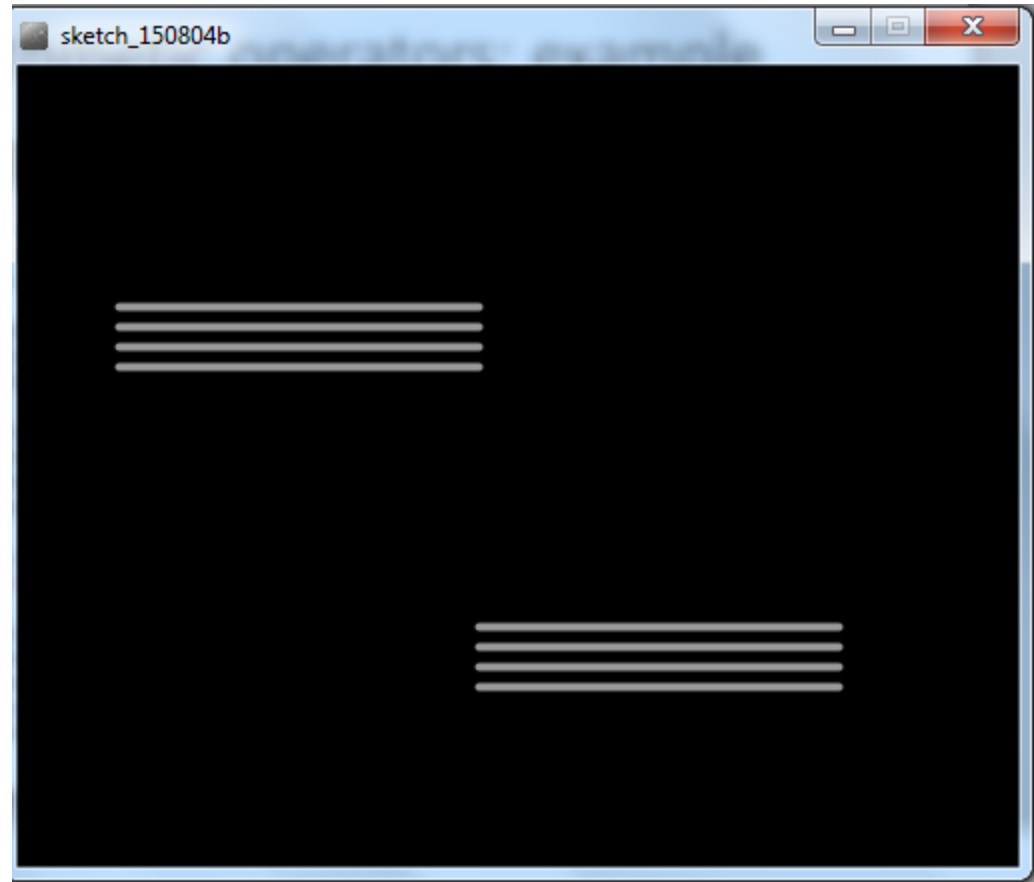
```
sketch_150804b
size(500, 400);
background(0);
stroke(153);
strokeWeight(4);

int a = 50;
int b = 120;
int c = 180;

line(a, b, a+c, b);
line(a, b+10, a+c, b+10);
line(a, b+20, a+c, b+20);
line(a, b+30, a+c, b+30);

a = a + c;
b = height-b;

line(a, b, a+c, b);
line(a, b+10, a+c, b+10);
line(a, b+20, a+c, b+20);
line(a, b+30, a+c, b+30);
```

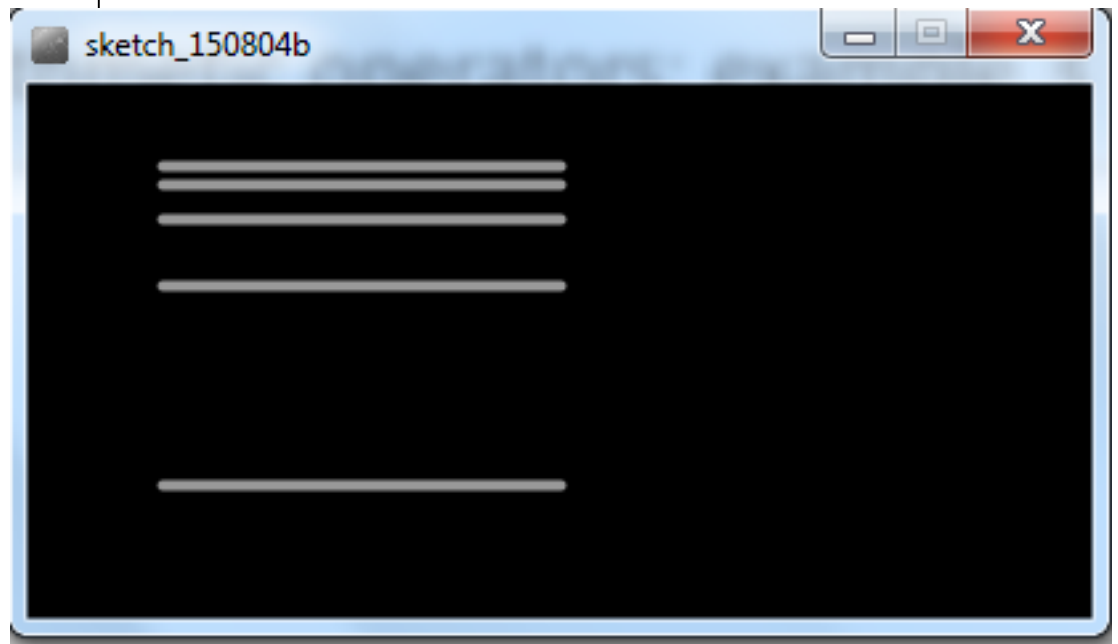


Arithmetic operators: example 3

```
sketch_150804b
size(400, 200);
background(0);
stroke(153);
strokeWeight(4);

int a = 50;
int b = 1500;
int c = 4;

line(a, b/10, a*c, b/10);
line(a, b/20, a*c, b/20);
line(a, b/30, a*c, b/30);
line(a, b/40, a*c, b/40);
line(a, b/50, a*c, b/50);
```



Questions?

