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.

https://docs.oracle.com/javase/tutorial/java/nutsandbolts/variables.html

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**

https://docs.oracle.com/javase/tutorial/java/nutsandbolts/variables.html

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Assignment Statement

- Values are stored in variables via assignment statements:

Syntax	`variable = expression;`
Example	`diameter = 100;`

- 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 **<u>have</u>** to give it a data type.

- The data type defines the **<u>kinds of values</u>** (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 **<u>operations</u>** 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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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.

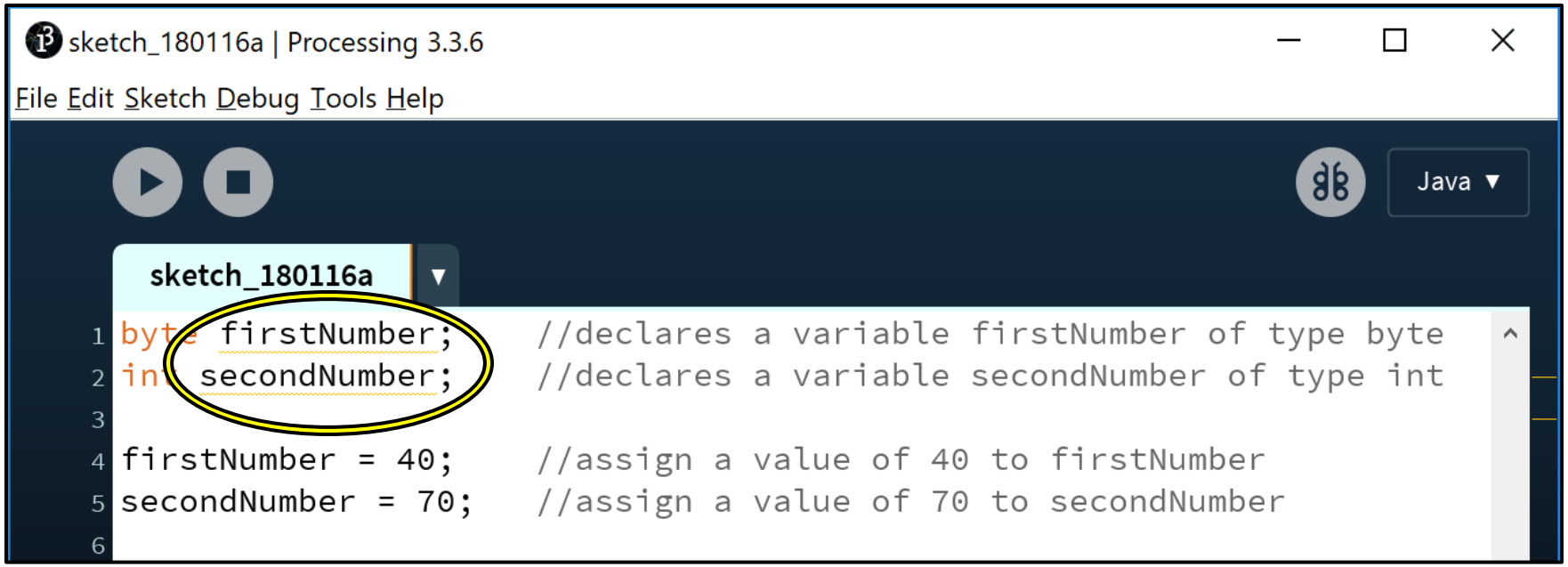
$2^{NumberOfBits}$	Range of values
2^0	1
2^1	2
2^2	4
2^3	8
2^4	16
2^5	32
2^6	64
2^7	128
2^8	256

If the eight bit is used for the sign, we get a range from -128 to +127

i.e. 256/2 = +-128 values,

but a value is required to store 0, so range is **-128 to +127**

Declaring variables of a specific type



YELLOW underline - indicates that the variable hasn't been used meaningfully

Declaring variables of a specific type

sketch_180116a | Processing 3.3.6

File Edit Sketch Debug Tools Help

Java

sketch_180116a

```
byte firstNumber;     //declares a variable firstNumber of type byte
int secondNumber;     //declares a variable secondNumber of type int

firstNumber = 40;     //assign a value of 40 to firstNumber
secondNumber = 70;    //assign a value of 70 to secondNumber

int thirdNumber = 80;  //you can declare a variable and assign a
                       //value on one line.
```

Declaring variables of a specific type

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Java

sketch_180116a

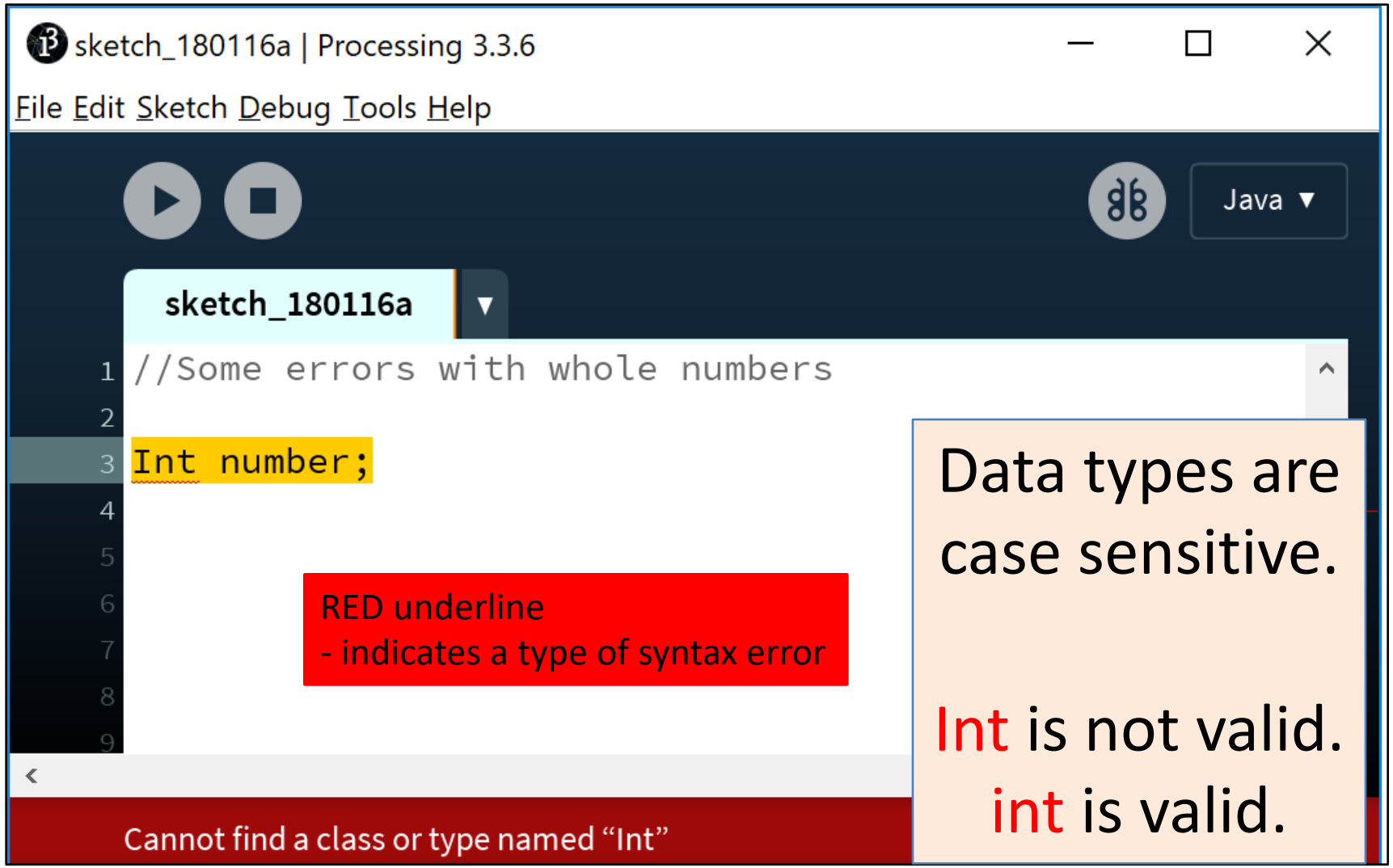
```
byte firstNumber;     //declares a variable firstNumber of type byte
int secondNumber;     //declares a variable secondNumber of type int

firstNumber = 40;     //assign a value of 40 to firstNumber
secondNumber = 70;    //assign a value of 70 to secondNumber

int thirdNumber = 80;  //you can declare a variable and assign a
                       //value on one line.

int x, y, z;           //multiple variables of the same type can
                       //be defined on one line.
```

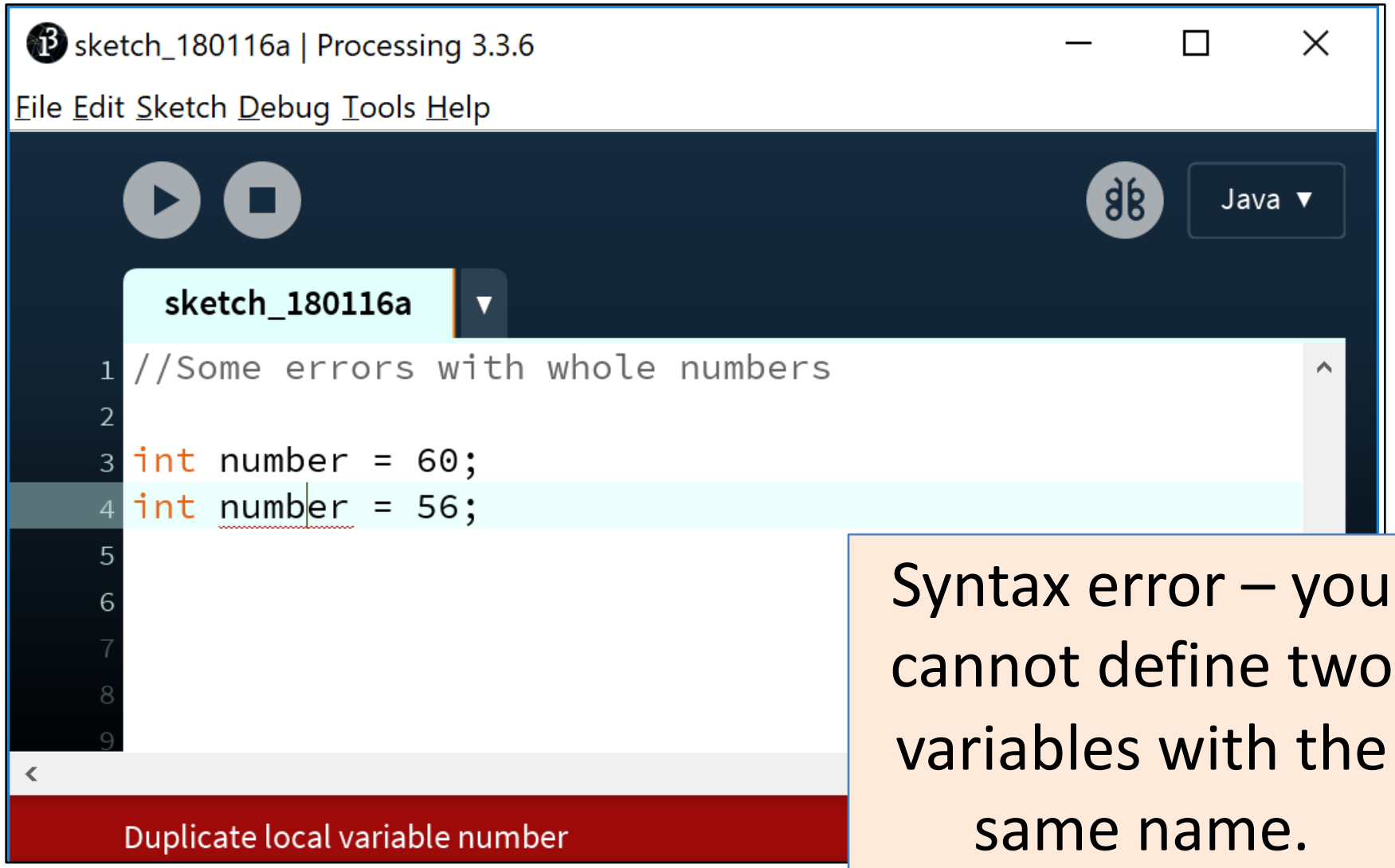
Declaring variables - some errors



Data types are case sensitive.

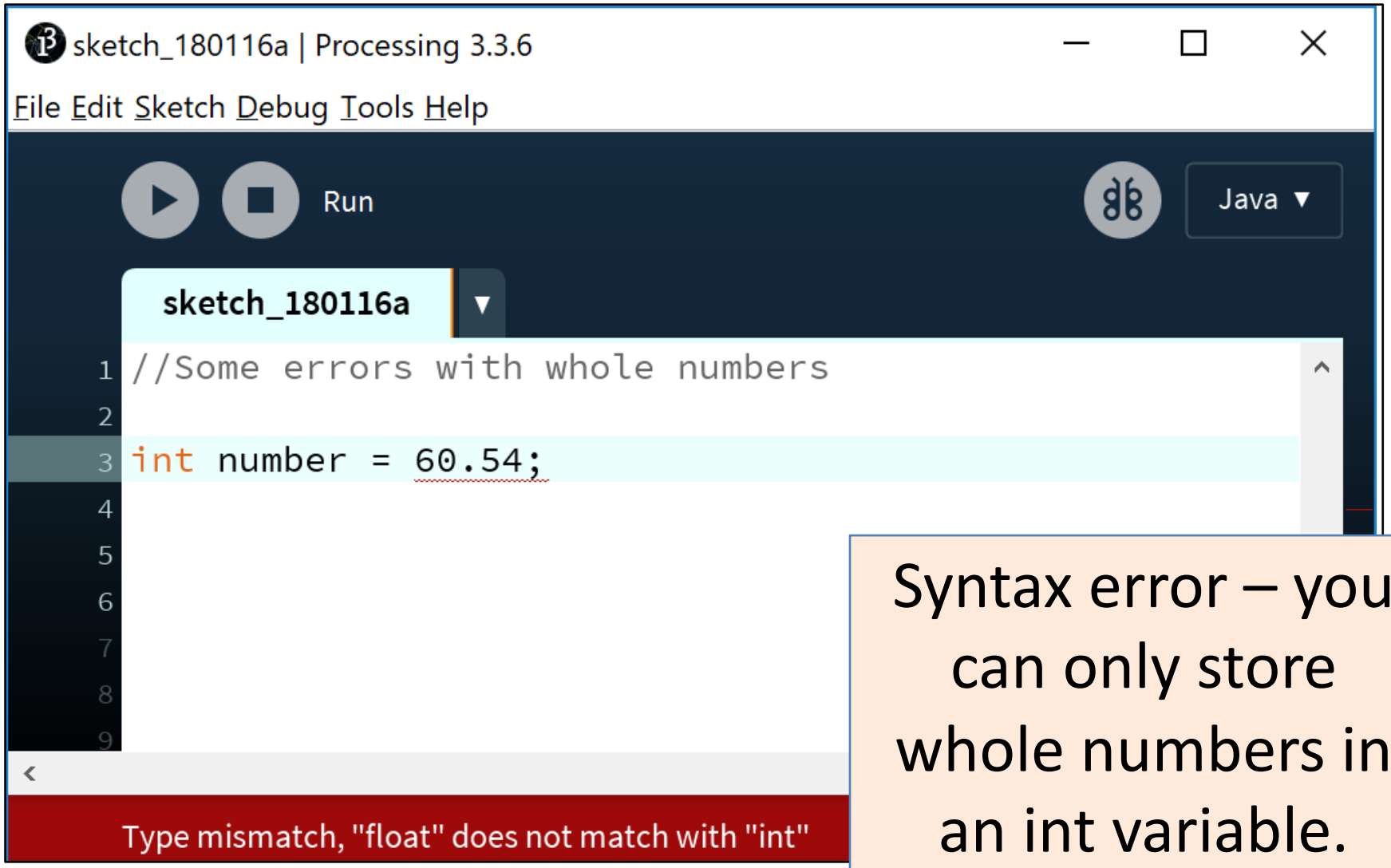
Int is not valid.
int is valid.

Declaring variables - some errors



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

Declaring variables - some errors



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

Java's Primitive Data Types: int example

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sketch_180116a

```
size(600, 400);
background(0);    //black
stroke(153);      //medium gray
strokeWeight(4);

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

In this example, we have:

- defined three variables (a, b and c)
- that can hold whole numbers (int).
- and are set with a starting value.

Based on the Processing Example: Basics → Data → Variables

Java's Primitive Data Types: int example

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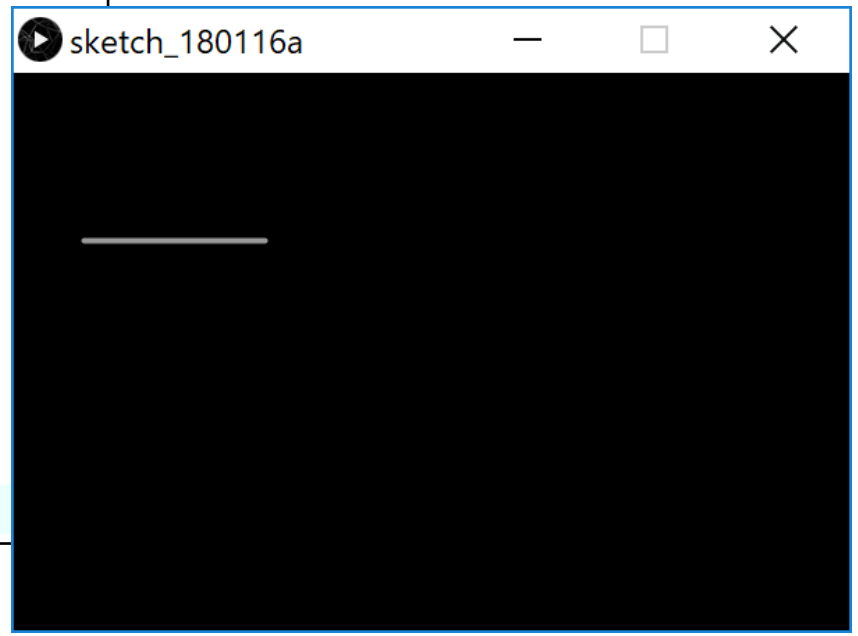
sketch_180116a

```
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);
```

We can pass the defined variables as values to functions.



Based on the Processing Example: Basics → Data → Variables

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

Based on the Processing Example: Basics → Data → Variables

Java's Primitive Data Types: int example

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sketch_180116a

```
size(600, 400);
background(0);    //black
stroke(153);      //medium gray
strokeWeight(4);

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

line (a, b, c, b);
```

Type mismatch, "int" does not match with "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

Based on the Processing Example: Basics → Data → Variables

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Java's Primitive Data Types (decimal numbers)

Type	Byte-size	Minimum value (inclusive)	Maximum value (inclusive)	Typical Use
float	32-bit	*Beyond the scope of this lecture .* *There is also a loss of precision in this data-type that we will cover in later lectures.*		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

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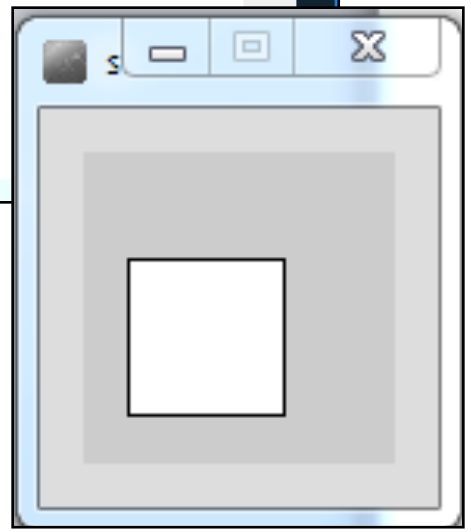
Java

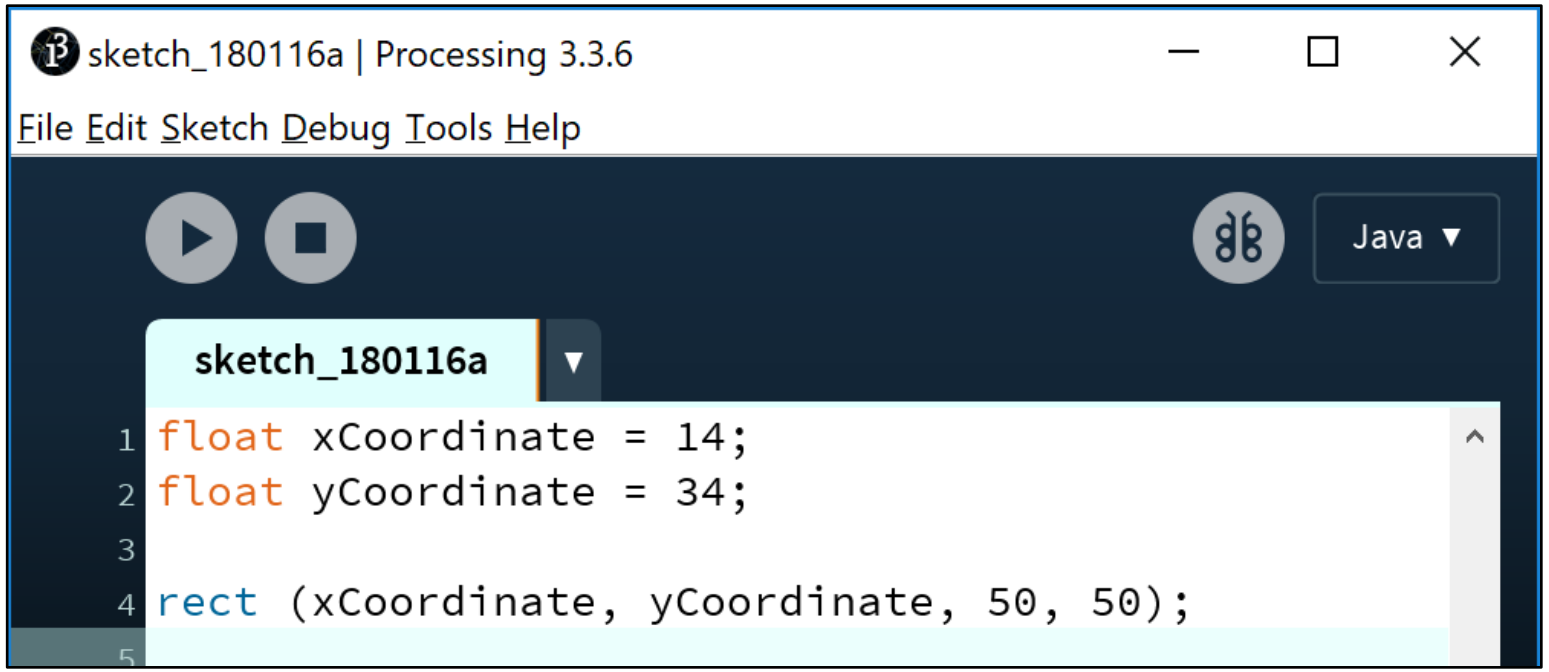
sketch_180116a

```
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.

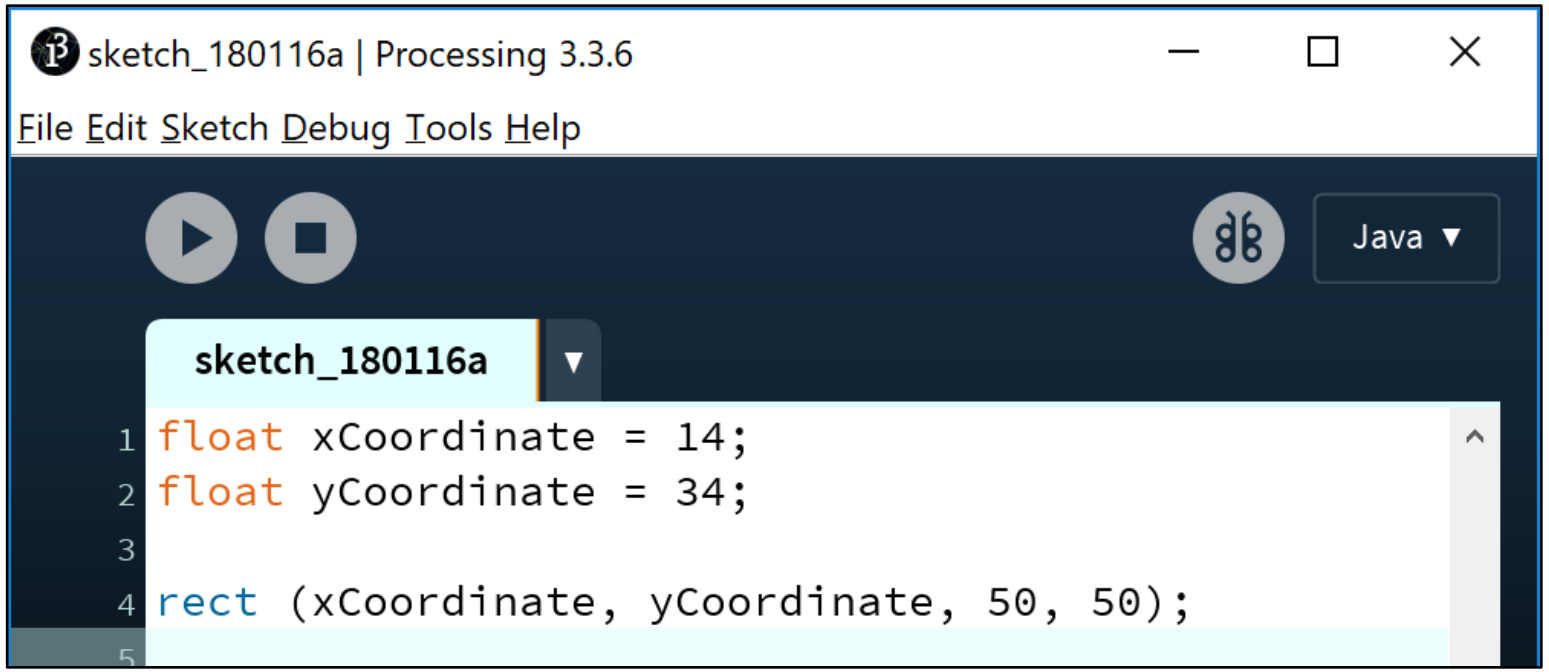
Java's Primitive Data Types: float example



Whole numbers can be placed into a float variable.

Q: Why?

Java's Primitive Data Types: float example



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

sketch_180116a | Processing 3.3.6

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sketch_180116a

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

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

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

Q: Why are we getting this syntax error?

Passing variables as arguments: some errors

sketch_180116a | Processing 3.3.6

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sketch_180116a

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

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

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.

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

http://docs.oracle.com/javase/tutorial/java/nutsandbolts/datatypes.html

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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

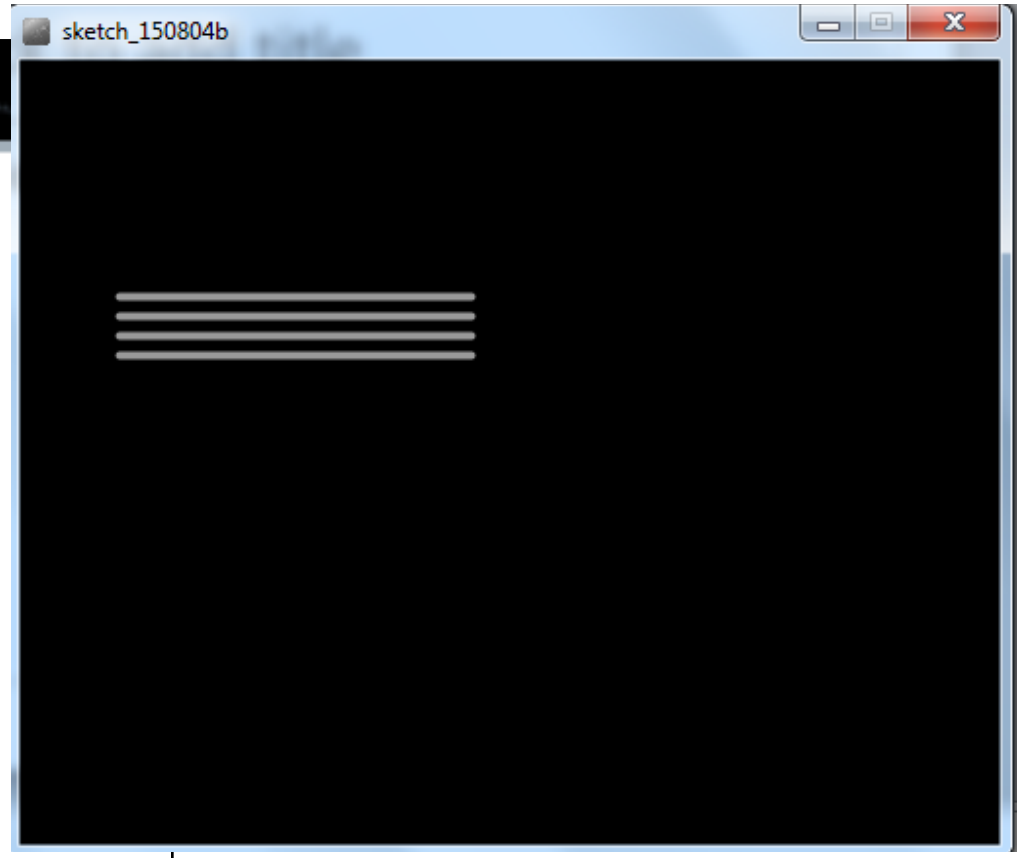
Arithmetic operators: example 1

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);
```



Based on the Processing Example: Basics → Data → Variables

Arithmetic operators: example 2

sketch_150804b

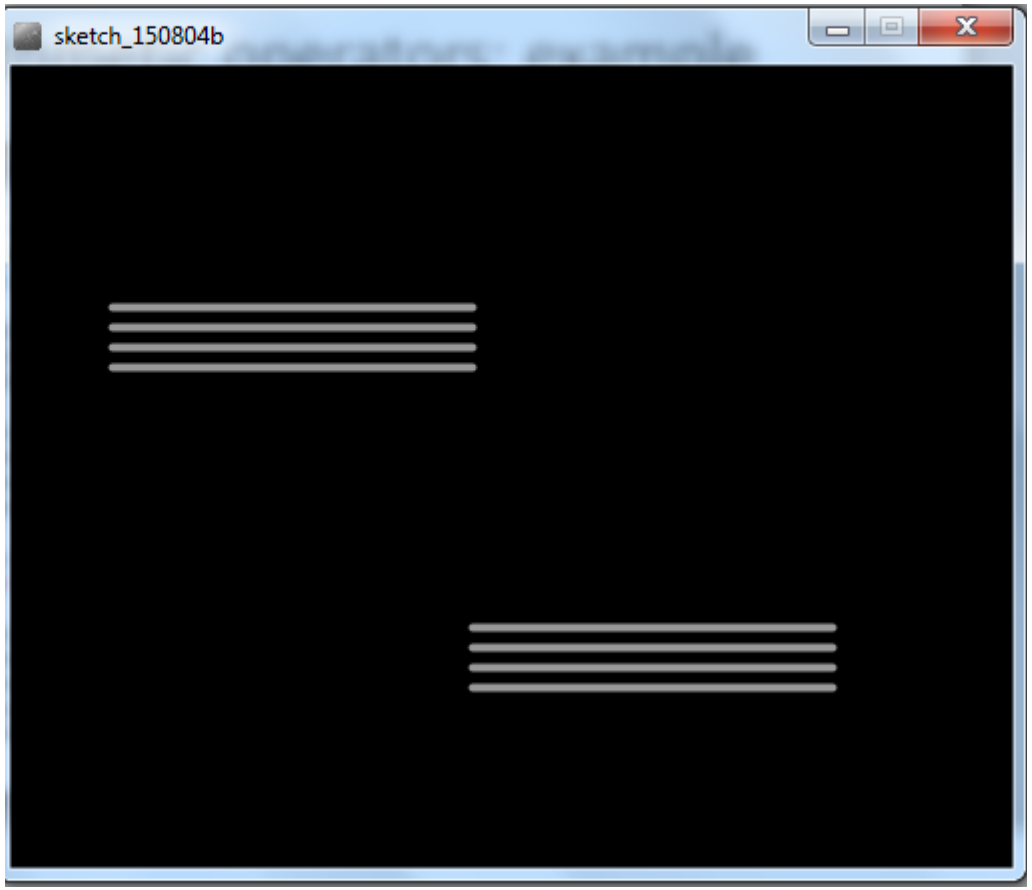
```
size(500, 400);
background(0);
stroke(153);
strokeWeight(4);

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);
```



Based on the Processing Example: Basics → Data → Variables

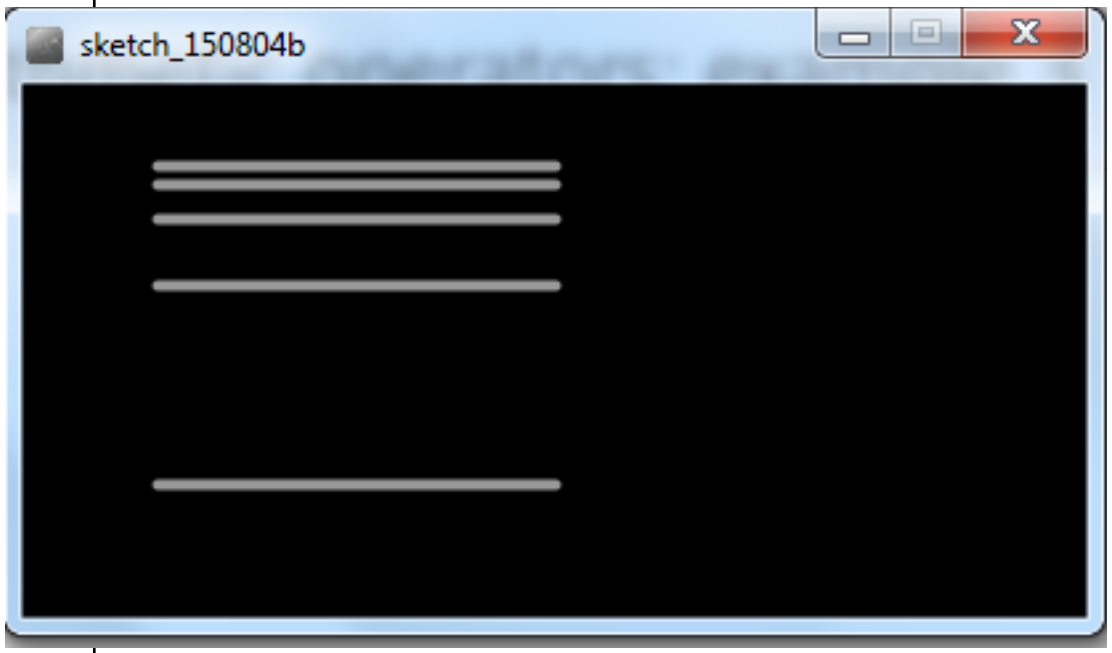
Arithmetic operators: example 3

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);
```



Based on the Processing Example: Basics → Data → Variables

Questions?