# Fundamentals of ActionScript 3.0

## DEVELOP AND DESIGN

Doug Winnie

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Peachpit Press

**Fundamentals of ActionScript 3.0: Develop and Design**
Doug Winnie

**Peachpit Press**
1249 Eighth Street
Berkeley, CA 94710
510/524-2178
510/524-2221 (fax)

Find us on the Web at: www.peachpit.com
To report errors, please send a note to errata@peachpit.com
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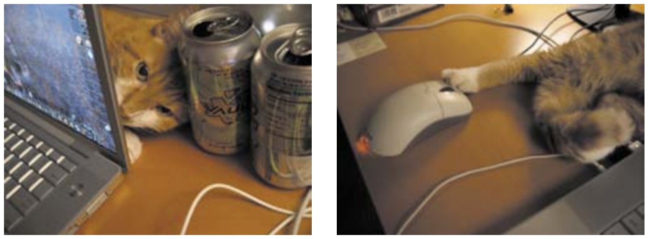
ISBN 13: 978-0-321-77702-7
ISBN 10: 0-321-77702-6

9 8 7 6 5 4 3 2 1

Printed and bound in the United States of America

*This book is dedicated to Hoover. Hoover was a big part of my life,*
*and was always by my side while doing "tech-no" things. I miss you Hoover!*



*This book is also dedicated to my husband, Mike.*
*While not always into my "tech-no" things, he is my inspiration for doing*
*great things—"tech-no" or not. Thanks, Groovy Dude!*

## ACKNOWLEDGEMENTS

With too many people to mention individually, I'm going to do a group acknowledgement of all of the members of the Adobe Flash Professional, Flash Player, AIR, and Flex teams that have inspired me to create great things, and to a platform that overcomes amazing obstacles to give creative and web professionals the ability to express themselves wherever they go.

I also want to acknowledge Chris Coudron, my tech reviewer and friend, for his effort to make me look good in code and for reminding me that there is not a NOR operator in ActionScript. D'oh!

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# INTRODUCTION

Welcome to ActionScript. Over the next several chapters, you'll be introduced to one of the most versatile programming languages to create web applications for the browser, desktop applications, and mobile apps for multiple platforms. For years the Flash Platform has provided people with the most powerful set of technologies to creatively express themselves across multiple screens and platforms with its combination of the Flash Player and AIR runtimes, tools like Flash Professional CS5.5 and Flash Builder 4.5, and languages and frameworks like ActionScript 3.0 and Flex 4.5.

Over the last several years, I have taught people how to make their projects interactive and how to captivate and engage users. During that time at San Francisco State University, my series on Adobe TV, and conference appearances, I have appreciated the difficulty of learning scripting and coding. Learning programming is a steep task, and there are many ways to teach it. What I have found is that combining programming basics, simple examples, problem solving, and real-world projects has been very effective, and it is what you have in your hands (or on your screen) now.

## WHO THIS BOOK IS FOR

This book is crafted for people who are familiar with Flash Professional, the animation and interactive design tool from Adobe Systems that is part of Creative Suite. The lessons and projects here assume that you have a basic understanding of the Flash Professional product. This book is designed for people who are new to coding or are struggling with the migration from ActionScript 2.0 to 3.0. Here are some examples of what you should know and be able to do before attempting to start with this book:

- Import graphical assets from Creative Suite design tools
- Create timeline animations using tweens using keyframes
- Create symbols using the Library panel
- Organize and rename timelines in the Timeline panel and symbols in the Library panel
- Publish and build animations for the web browser

With these basic skills, you can create very interesting web animations; however, without ActionScript, the animations lacked any interaction with the user, and there is no way to bring them to other platforms including mobile devices. That is exactly what this book will teach you—how to make these projects interactive and take them further.

The latest edition, Flash Professional CS5.5, has added a significant number of new features to support mobile app creation that are covered at the end of the book.

## WHO THIS BOOK IS NOT FOR

If you are already an intermediate or advanced coder, this book may be too basic for your needs. There are a significant number of books that focus on advanced ActionScript 3.0 concepts, including the adoption of best practices and code design patterns that will make you a better and more proficient coder.

In addition, if you have never worked with Flash Professional, I recommend you learn how to use the basic product before tackling the contents here. There are excellent books available to help you learn how to get started with Flash Professional to create animations and how to master design workflows when working with Creative Suite design applications like Photoshop, Illustrator, and Fireworks.

## HOW YOU WILL LEARN

This book has a specific methodology for how the concepts are introduced. First are the fundamentals of how to interact and work with objects that are on the Stage. The examples that are in the book are simple—and this is intentional, to help you understand how ActionScript works without getting into the weeds of your project's design or assets. You can adapt and expand these simple examples for your own projects.

After you gather a sizable amount of new ActionScript know-how, it is time to put it to work. There are three major projects in the book that pose real-world situations for you to solve using the skills you have learned. The projects present you with a programming challenge and ask you to solve it. You can compare your finished projects with the examples in the book to discover how your approach matches or differs.

## WHAT YOU WILL LEARN

This book is divided into five major parts.

### PART 1: GETTING THE FUNDAMENTALS

You'll learn general ActionScript concepts that you can use to make ActionScript interact with objects on the Stage and in the Library of your project. You'll build on this, understanding how to flow your code through reusable modules called functions, and then how to respond to user interaction with event handlers.

### PART 2: EXPLORING THE BASICS OF CLASSES

You'll jump into the basics of what is called object-oriented programming (OOP), which is what separates the coders from the scripters. Through OOP you can unlock a lot of flexibility in how you create projects, learning how to make reusable objects and containers that can extend the sophistication of your projects.

### PART 3: RESPONDING TO CONDITIONALS AND WORKING WITH LOGIC

Adapting your project based on certain conditions then is the focus of the next section, where through the use of conditionals, your project can adapt to different interactions from the user or even to random events to begin introducing gaming concepts to your project.

### PART 4: GETTING CREATIVE WITH ACTIONSCRIPT

Although ActionScript is a programming language, it has its creative side. This is covered in the fourth section, where you will learn how to draw, animate, and work with external assets in your projects.

### PART 5: CREATING MULTI-SCREEN PROJECTS

After you have mastered all the previous topics, it is time to take your projects out of the browser and take advantage of the Flash Platform to create desktop applications for Windows and Mac OS X operating systems and mobile apps for the popular Android and iOS platforms.

You'll cover a lot, but at the end, you'll have a solid foundation on how ActionScript works and the power that you have at your fingertips to express yourself across screens and platforms.

**So let's get started!**

# WELCOME TO ACTIONSCRIPT 3.0

ActionScript 3.0 is the programming language of the Adobe Flash Platform, a multi-screen and mutli-device development platform for creating interactive and expressive content. With the latest generation of the Adobe runtimes, Flash Player and AIR, you can take your ideas and creative vision to the browser, desktop, mobile phones, tablets, and Internet-enabled televisions. Let's review some of the tools that you'll be working with.

## THE TOOLS AND RUNTIMES

In the course of this book, there are three main tools and runtimes that you'll be working with:

### FLASH PROFESSIONAL CS5.5

The latest generation of the Flash authoring tool combines powerful animation capabilities, library management, and an integrated coding environment designed for ActionScript 3.0 coding. Part of Creative Suite 5.5, Flash Professional CS5.5 adds new support to work with the latest generation of Adobe AIR and Flash Player 10.2 to create content and applications for the popular Android and iOS mobile platforms.

### FLASH PLAYER 10.2

Flash Player is what brings the web to life. It is the Internet plug-in for your desktop or mobile phone that allows you to play interactive content, video, and games. The latest version includes enhanced support for hardware acceleration, better video playback, and memory and processor performance optimization.

### ADOBE AIR 2.6

The Adobe AIR runtime is what allows interactive designers and developers to take their applications outside the browser and bring them to the Windows and Mac OS X operating systems as desktop applications, or to the Android and iOS platforms as installable mobile applications.

## OTHER HELPFUL TOOLS

Although not part of this book, there are other tools that are helpful for working with the Flash Platform, including:

### ADOBE FLASH BUILDER 4.5

Flash Builder is the professional coding IDE for the Flash Platform. It includes advanced programming functionality to optimize projects, and it makes working with larger projects and coordinating projects with teams easier. Flash Builder also supports working with Flash Professional projects and using the Adobe Flex framework.

### ADOBE FLEX 4.5

The Flex framework is used specifically to create data-driven applications for the browser, desktop, and mobile devices. Incorporating skinnable components, declarative layout, ActionScript logic, and support for a growing set of platforms, it is the fastest way to create a robust application for multiple screens and devices.

### ADOBE FLASH CATALYST CS5.5

Flash Catalyst is designed to work in a team environment when a designer and a developer are building an Internet application using the Flex framework. Interaction designers can create skins for Flex components and craft the overall user interface of a Flex application as a wireframe, prototype, or a finished application. Flash Catalyst CS5.5 introduces round-trip functionality with Flash Builder 4.5 to allow designers and developers to work collaboratively.

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# 4

# ACTIONSCRIPT AND MATH

ActionScript has tons of mathematical operators built in to the language to help you evaluate mathematical equations. Now, I wouldn't throw away your handheld calculator just yet. ActionScript has a lot of power, but it's designed to help with your applications, not for general use. In addition to these mathematical operators, there are some functions that can help with common mathematical tasks like rounding numbers.

In this section, you'll learn all the basic arithmetic operators that you'll use in ActionScript. Also, there are some convenient shortcuts to make working with math easier that you'll cover as well.

## MATHEMATICAL **OPERATORS**

In ActionScript, you can use simple math operators to perform arithmetic functions with your numbers or variables. The math functions that are part of ActionScript are nearly identical to basic math functions that you already know. Some of the symbols and names are different, but the principles are the same.

### ADDITION AND SUBTRACTION

Let's get started with adding and subtracting numbers.

1. Create a new ActionScript 3.0 project in Flash Professional CS5.5 and enter the following code into the timeline:

```
// Math operators: addition and subtraction
trace ( 2 + 3 );
trace ( 3 - 2 );
```

2. Run the project and look at the Output panel; you'll see the following:

```
5
1
```

This shouldn't be surprising, since you are adding and subtracting the numbers. You use the + and – operators to indicate that you are adding or subtracting. One thing to note is the white-space characters used in the example. Notice the spaces between the operators and the numbers. This is for readability and doesn't affect the execution of the code. You can remove the spaces if you want, for example:

```
trace ( 2 + 3 );
trace (2+3);
```

These two lines perform exactly the same function and will generate the same result.

## ADDITION OR CONCATENATION?

In the previous chapter, you used the + sign, but it wasn't a mathematical operator. You can use the + operator to do two things. When working with strings, the + operator is called the concatenation operator and takes two strings and combines them together, in essence gluing the end of one string to the beginning of the next. When working with numbers, the + operator is the addition mathematical operator, adding two numeric values together and generating a new numeric result.

Look at the following example.

1. Remove the existing code and enter the following code:

```
// Addition vs. Concatenation
trace ( 2 + 2 ); // addition
trace ( "two" + "two" ); // concatenation
trace ( "2" + "2" ); // concatenation
```

2. Run this code; you'll see the following displayed in the Output panel:

```
4
twotwo
22
```

The first line of code in the example is pretty simple; you are adding the numbers 2 and 2 using the addition operator, resulting in a value of 4.

The second line of code has two strings, denoted by quotation marks, that are being "glued" together, creating a single string using the string concatenation operator. The result is "twotwo."

The last line uses the number 2 on both sides of the operator. Notice that the numbers are surrounded by quotation marks, which means that it is no longer a number value, but instead the character 2. When you force the number 2 to be a string using quotation marks, the + operator concatenates the strings, "gluing" them together forming the string, 22.

What makes this confusing is that the Output panel doesn't distinguish between strings and numbers. So, when you see 22 in the Output panel, is it a number or a string? There is a way to find out the type of a value and display it: by using the typeof statement.

3. To see how typeof works, update the previous example as follows:

```
// Addition vs. Concatenation
trace ( typeof(2 + 2) ); // addition
trace ( typeof("two" + "two") ); // concatenation
trace ( typeof("2" + "2") ); // concatenation
```

4. Run this updated example; you'll see the following in the Output panel:

```
number
string
string
```

What is happening is that the operation (either addition or concatenation) is taking place, and the typeof statement is determining the type of the result and then sending that to the Output panel via the trace statement.

Now for one final twist. If you mix up the number and string types, what happens?

5. Replace the existing code with the following:

```
trace ( 2 + "2" );
```

Wow. Now you have a number on the left side, and a string on the right side. Who wins?

6. Run the project.

The answer is that the string wins. The result is the string, "22". In this case the operator converts the number 2 to the string "2" and then "glues" it to the right "2" creating the string "22". It seems confusing at first, but after you work with it a while, it will become second nature to you—promise!

## MULTIPLICATION AND DIVISION

Now, look at the * and / operators for multiplication and division.

1. Replace the code in the timeline with the following:

   ```
   // Math operators: Multiplication and Division
   trace ( 2 * 3 );
   trace ( 5 / 2 );
   ```

   The first statement uses the multiplication operator, which is an asterisk, `*`. The division operator is a forward slash, `/`, and the order of the division is that it divides the value on the left by the value on the right.

2. Run the project; you'll see the following in the Output panel:

   ```
   6
   2.5
   ```

Again, pretty simple stuff—but the next one will probably be new to you.

## MODULO, THE OPERATOR FORMERLY KNOWN AS LONG DIVISION WITH REMAINDERS

The *modulo* operator finds the remainder after a division operation. The modulo is quite helpful in many situations, including determining if a number is odd or even. Take a look at how it works.

1. Replace the code you have with the following, and take a look at the output:

   ```
   // Math operators: Modulo
   trace ( 5 % 2 );
   ```

2. Run the project; you'll see the following displayed in the Output panel:

   ```
   1
   ```

   The `%` symbol invokes the modulo operator, finding the remainder after attempting a division of the value on the left with the value on the right. In this example, it divides 5 by 2, resulting in 2 and a remainder of 1. To see this written out in long division format, check out **Figure 4.1**.

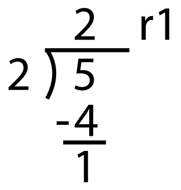


**FIGURE 4.1** 5 divided by 2 written in long division format, showing the remainder, or modulo.

### WHAT ON EARTH IS MODULO USED FOR?

That is a great question, and one that has a great answer as well. One of the most common uses is to determine if a value is a multiple of another. For example, to find out if a value is an even multiple of 3, you can use something like this:

```
myValue % 3;
```

If the result is 0, that means there are no remainders, and the number is an even multiple of 3.

Another common use is to determine if a number is even or odd. Even numbers are evenly divisible by 2, so by that definition you could use this:

```
myValue % 2;
```

If the result is 0, the number is evenly divisible by 2, making it even. If it isn't, then the number is odd.

## VARIABLES AND COMBINED ASSIGNMENT OPERATORS

You'll commonly want to complete a math function and assign the resulting value back to some named object, called a *variable*. ActionScript makes this easier by letting you combine arithmetic and assignment operators together. Take a look at an assignment operator example:

1. Create a new ActionScript 3.0 project and enter in the following code for the project:

```
// Assignment Operators
var myValue:Number = 2;
myValue = myValue + 2;
trace(myValue);
var myOtherValue:Number = 2;
myOtherValue += 2;
trace(myOtherValue);
```

2. Run the project. You'll get the following in the Output panel:

```
4
4
```

Let's walk through the code and explain how you get this result and what role variables and combined assignment operators play.

## VARIABLES

You haven't really seen much about the `var` statement yet, so let's reveal a little bit more about it. You have used it in the past to create named object containers that you have then assigned MovieClip symbols to using the `new` statement. You can also use `var` to create variables; in fact, variables is what `var` stands for. Variables are named objects that can contain variable values.

Take a look at the second line of the assignment operators example:

```
var myValue:Number = 2;
```

The `var` statement is creating a variable called `myValue`. See that `:Number` after the variable name? You have to tell ActionScript what type of data your variable can hold, similar to how you did when using the `function` statement. In this case, you are saying that `myValue` will contain a number. When you create the variable, it is empty, but when you assign the numeric value 2 to it, you can refer to that value using the name `myValue`.

```
myValue = myValue + 2;
trace(myValue);
```

On the second line above, you are accessing the `myValue` object and are assigning a new value to it. Notice that you are not using the `var` statement here, because `var` is only used to create a new variable. You don't need to use it again if you are referring to a variable that has already been created. Before you assign the value, you need to complete the evaluation on the right side of the assignment operator. In this case, you are taking the existing value of `myValue`, 2, and adding the value 2 to it. This value is then assigned back to `myValue`, overwriting the existing value. In the last line of the first block, you send that value to the Output panel using the `trace` statement, which displays 4.

This completes the analysis of the first part of the code.

## COMBINED ASSIGNMENT OPERATORS

Take a look at the second block of code. This section of code works identically to the first block, with two exceptions. In this section, you are creating a new variable called `myOtherValue`:

```
var myOtherValue:Number = 2;
myOtherValue += 2;
trace(myOtherValue);
```

In the first line, you need to use the `var` statement since you have not created that variable before. You then assign the numeric value 2 to it.

On the next line, you come across the first combined assignment operator, `+=`. This operator is combining addition with assignment. In this case it is taking the existing value of `myOtherValue` and is adding 2 to it and automatically assigning it back to the `myOtherValue` variable. Always put the arithmetic operator before the assignment operator. You can use this shortcut with any of the basic arithmetic operators:

```
// All combined assignment operators
var myValue:Number = 100;
myValue += 50; // 100+50 = 150
myValue -= 125 // 150-125 = 25
myValue *= 3   // 25*3 = 75
myValue /= 5   // 75/5 = 15
myValue %= 4   // 15%4 = 3
trace (myValue);
```

Programmers often use these combined assignment operators as shortcuts since they are nice time savers. Hopefully, you'll find they are too!

## **INCREMENT** AND **DECREMENT** OPERATORS

When you work with ActionScript a lot, you'll commonly be adding or removing 1 from variables and properties.

To make this process easier, there is a shortcut called the *increment* and *decrement* operators. Take a look at the following code.

1. Create a new ActionScript 3.0 project and enter in the following code for the project:

```
// Increment and Decrement
var myValue:Number = 5;
trace(myValue);
myValue++;
trace(myValue);
myValue--;
trace(myValue);
```

2. Run this project. You'll see the following in the Output panel:

```
5
6
5
```

In the increment and decrement example, the value of `myValue` is initially set at 5 and is sent to the Output panel. The number is then increased by 1 and sent again, resulting in 6.

When you add a double minus, `--`, to the end, it decrements the value by 1. The value of `myValue` is already 6 based on the previous function, and is then decremented to be 5 again.

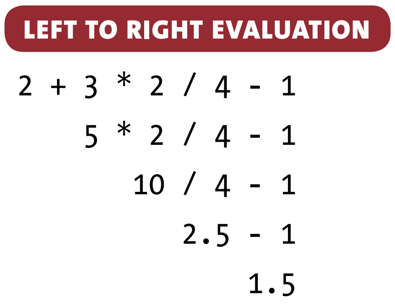
## IT IS ALL A MATTER OF STYLE

When you add a double plus, ++, to the end of a variable name, you increment it by 1. As a result, the following three lines of code do the exact same thing:

```
myValue = myValue + 1;

myValue += 1;

myValue++;
```

The following three lines of code do the same thing, similarly to the example earlier for the increment operator:

```
myValue = myValue - 1;

myValue -= 1;

myValue--;
```



LEFT TO RIGHT EVALUATION

```
2 + 3 * 2 / 4 - 1
    5 * 2 / 4 - 1
       10 / 4 - 1
          2.5 - 1
              1.5
```

**FIGURE 4.2** Incorrect left-to-right order of operations

By default, mathematical functions do not run from left to right, but follow a specific *order of operations*. You may recall from math classes that certain mathematical functions are calculated before others, regardless of their left-to-right order.

1. Create a new ActionScript 3.0 project and enter in the following code for the project:

   ```
   // Order of Operations
   var answer:Number = 2 + 3 * 2 / 4 - 1;
   trace(answer);
   ```

   In this example, you have a number of math functions that are running from left to right. If you don't follow the order of operations and evaluate it from left to right, you get 1.5, as shown in **Figure 4.2**.

2. Run the code. You'll see what might seem unexpected: 2.5. Why? Because certain math functions are executed before others. In fact, this is the order:

   1. Multiplication, Division, and Modulo
   2. Addition and Subtraction

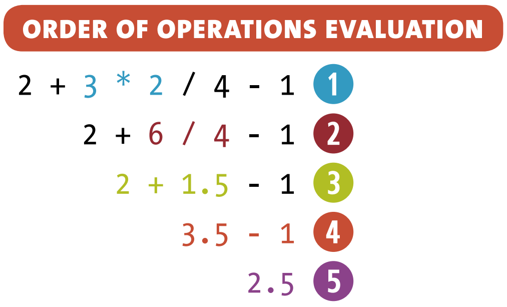


**FIGURE 4.3** Correct order of operations for the evaluation

All the multiplication, division,and modulo operations are processed from left to right to the end. Then calculation starts again from the left and processes addition and subtraction. Look at **Figure 4.3** to see how this works.

When the Flash runtime looks at the ActionScript, it starts from the left, evaluating the expression:

- It ignores the 2 + 3, since the rules dictate processing only multiplication, division, and modulo at this point.
- 3 × 2 = 6 ❶
- 6 / 4 = 1.5 ❷

Since there are no more multiplication, division, or modulo operations, it returns to the beginning and processes addition and subtraction.

- 2 + 1.5 = 3.5 ❸
- 3.5 - 1 = 2.5 ❹

You have the final result, 2.5 ❺, which is then sent to the Output panel.

You can alter the order of operation by using parentheses. This will force Flash to adopt a specific path of calculating the results. You'll learn about overriding the order of operation rules in the next section.

## USING PARENTHESES TO FORCE ORDER

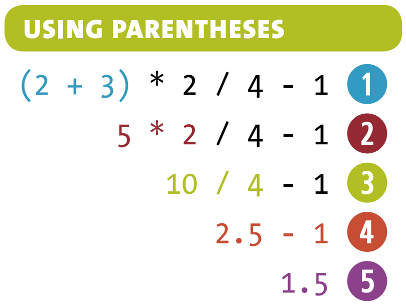


**FIGURE 4.4** Forcing the order with parentheses using order of operations

You can force the earlier example to follow the order of operation that results in the value of 1.5. You can use parentheses to group calculations together. In the order of operations, math operations that are grouped within a pair of parentheses are always calculated first.

You can adjust the example to get the 1.5 that you originally calculated by performing the calculations from left to right:

```
// Order of Operations
var answer:Number = (2 + 3) * 2 / 4 - 1;
trace(answer);
```

Now instead of skipping the first addition action, the Flash runtime calculates what is inside the parentheses first and then continues across, as shown in **Figure 4.4**.

When the Flash runtime looks at the ActionScript, it starts with the first set of parentheses it finds:

- 2 + 3 = 5, which is the only set of parentheses ❶

It then starts back at the beginning with multiplication, division, and modulo:

- 5 × 2 = 10 ❷
- 10 / 4 = 2.5 ❸

Now that it is finished with multiplication, division, and modulo, it starts back on the left and evaluates addition and subtraction:

- 2.5 - 1 = 1.5 ❹

You end up with 1.5 ❺, which is then sent to the Output panel.

You can nest parentheses within each other, but just make sure that every opening parenthesis has a matching closing parenthesis. This is one of the most common bugs you'll find in your programs, unmatched parentheses and braces.

## SUMMING UP MATH OPERATIONS

You have covered a lot of math in this chapter, but more importantly, you were able to expand your knowledge of working with numbers and variables and start doing some calculations with them. **Table 4.1** will serve as a handy reference for the operations that were covered in this chapter:

**TABLE 4.1** Mathematical Operators

| OPERATOR | DEFINITION | EXAMPLE |
|---|---|---|
| + | Addition | 4 + 5 results in 9 |
| – | Subtraction | 5 – 4 results in 1 |
| * | Multiplication | 2 * 3 results in 6 |
| / | Division | 5 / 2 results in 2.5 |
| % | Modulo | 5 / 2 results in 1 |
| += | Addition assignment | if x is 5, x += 3 changes x to 8 |
| -= | Subtraction assignment | if x is 5, x -= 2 changes x to 3 |
| *= | Multiplication assignment | if x is 5, x *= 3 changes x to 15 |
| /= | Division assignment | if x is 5, x /= 2 changes x to 2.5 |
| %= | Modulo assignment | if x is 5, x %= 2 changes x to 1 |
| ++ | Increment | if x is 5, x++ changes x to 6 |
| -- | Decrement | if x is 5, x-- changes x to 4 |

## WRAPPING **UP**

In this chapter, you learned the basics of working with variables and how to change numeric values using arithmetic operators in ActionScript. You also learned some of the common shortcuts advanced programmers use to save time when working with math operators, including working with combined assignment operators and the increment and decrement operators.

When working with operators in ActionScript, keep the following in mind to avoid common pitfalls and errors:

- When creating a variable and referring to it the first time, you need to use the `var` statement to create it. You can then refer to it without the `var` statement afterwards.
- When using the + operator, be sure to not inadvertently mix up strings and numbers, as strings will concatenate and ignore the numeric values.
- The modulo operator calculates the remainder after attempting to complete an even division.
- If you are working with a combination of multiplicative (multiplication, division, or modulo) functions and summation (addition or subtraction) functions, remember that ActionScript will evaluate your equation using mathematical order of operations.
- To quickly modify an existing value based on a function, you can use combined assignment operators to save time.
- If you are adding or subtracting 1 to or from a value, you can use increment or decrement operators, using `++` or `--` as a quick shortcut.
- To force the order of operations to do something specific, you can use parentheses to group evaluations you want to process first.

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