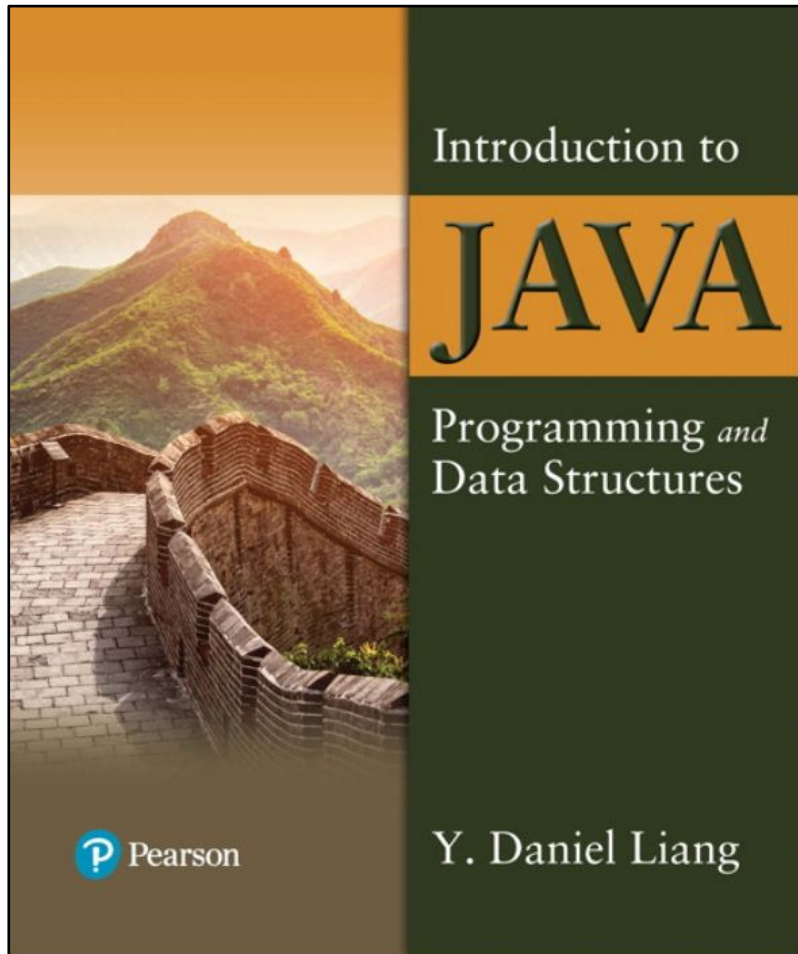


# Introduction to Java Programming and Data Structures

Twelfth Edition



## Chapter 4

Mathematical Functions,  
Characters, and Strings

# Character Data Type

```
char letter = 'A'; (ASCII)
```

```
char numChar = '4'; (ASCII)
```

```
char letter = '\u0041'; (Unicode)
```

```
char numChar = '\u0034'; (Unicode)
```

Four hexadecimal digits.

NOTE: The increment and decrement operators can also be used on char variables to get the next or preceding Unicode character. For example, the following statements display character b.

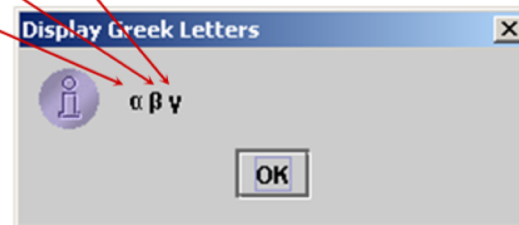
```
char ch = 'a';
```

```
System.out.println(++ch);
```

# Unicode Format

Java characters use **Unicode**, a 16-bit encoding scheme established by the Unicode Consortium to support the interchange, processing, and display of written texts in the world's diverse languages. Unicode takes two bytes, preceded by `\u`, expressed in four hexadecimal numbers that run from `'\u0000'` to `'\uFFFF'`. So, Unicode can represent `65535 + 1` characters.

Unicode `\u03b1` `\u03b2` `\u03b3` for three Greek letters



# ASCII Code for Commonly Used Characters

<b>Characters</b>	<b>Code Value in Decimal</b>	<b>Unicode Value</b>
'0' to '9'	48 to 57	\u0030 to \u0039
'A' to 'Z'	65 to 90	\u0041 to \u005A
'a' to 'z'	97 to 122	\u0061 to \u007A

# Escape Sequences for Special Characters

Escape Sequence	Name	Unicode Code	Decimal Value
<code>\b</code>	Backspace	<code>\u0008</code>	8
<code>\t</code>	Tab	<code>\u0009</code>	9
<code>\n</code>	Linefeed	<code>\u000A</code>	10
<code>\f</code>	Formfeed	<code>\u000C</code>	12
<code>\r</code>	Carriage Return	<code>\u000D</code>	13
<code>\\</code>	Backslash	<code>\u005C</code>	92
<code>\"</code>	Double Quote	<code>\u0022</code>	34

# Appendix B: ASCII Character Set (1 of 2)

ASCII Character Set is a subset of the Unicode from \u0000 to \u007f

**TABLE B.1** ASCII Character Set in the Decimal Index

-	0	1	2	3	4	5	6	7	8	9
0	nul	soh	stx	etx	eot	enq	ack	bel	bs	ht
1	nl	vt	ff	cr	so	si	dle	dcl	dc2	dc3
2	dc4	nak	syn	etb	can	em	sub	esc	fs	gs
3	rs	us	sp	!	"	#	\$	%	&	'
4	(	)	*	+	,	-	.	/	0	1
5	2	3	4	5	6	7	8	9	:	;
6	<	=	>	?	@	A	B	C	D	E
7	F	G	H	I	J	K	L	M	N	O
8	P	Q	R	S	T	U	V	W	X	Y
9	Z	[	\	]	^	_	`	a	b	c
10	d	e	f	g	h	i	j	k	l	m
11	n	o	p	q	r	s	t	u	v	w
12	x	y	z	{		}	~	del	-	-

# Appendix B: ASCII Character Set (2 of 2)

ASCII Character Set is a subset of the Unicode from \u0000 to \u007f

**TABLE B.2** ASCII Character Set in the Hexadecimal Index

-	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	nul	soh	stx	etx	eot	enq	ack	bel	bs	ht	nl	vt	ff	cr	so	si
1	dle	dcl	dc2	dc3	dc4	nak	syn	etb	can	em	sub	esc	fs	gs	rs	us
2	sp	!	“	#	\$	%	&	‘	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6	‘	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	p	q	r	s	t	u	v	w	x	y	z	{		}	~	del

# Casting between char and Numeric Types

```
int i = 'a'; // Same as int i = (int) 'a';
```

```
char c = 97; // Same as char c = (char) 97;
```

# Comparing and Testing Characters

```
if (ch >= 'A' && ch <= 'Z')
```

```
    System.out.println(ch + " is an uppercase letter");
```

```
else if (ch >= 'a' && ch <= 'z')
```

```
    System.out.println(ch + " is a lowercase letter");
```

```
else if (ch >= '0' && ch <= '9')
```

```
    System.out.println(ch + " is a numeric character");
```

```
        ch - '0';
```

# Methods in the Character Class

char

Character.isDigit(ch);

**Method**

**Description**

`isDigit(ch)`

Returns true if the specified character is a digit.

`isLetter(ch)`

Returns true if the specified character is a letter.

`isLetterOfDigit(ch)`

Returns true if the specified character is a letter or digit.

`isLowerCase(ch)`

Returns true if the specified character is a lowercase letter.

`isUpperCase(ch)`

Returns true if the specified character is an uppercase letter.

`toLowerCase(ch)`

Returns the lowercase of the specified character.

`toUpperCase(ch)`

Returns the uppercase of the specified character.

`ch = Character.toLowerCase();`

# The String Type

The char type only represents one character. To represent a string of characters, use the data type called String. For example,

```
String message = "Welcome to Java";
```

String is actually a predefined class in the Java library just like the System class and Scanner class. The String type is not a primitive type. It is known as a **reference type**. Any Java class can be used as a reference type for a variable. Reference data types will be thoroughly discussed in Chapter 9, “Objects and Classes.” For the time being, you just need to know how to declare a String variable, how to assign a string to the variable, how to concatenate strings, and to perform simple operations for strings.

# Simple Methods for String Objects (1 of 2)

`message.length();`

## Method

## Description

---

<code>length()</code>	Returns the number of characters in this string.
<code>charAt(index)</code>	Returns the character at the specified index from this string.
<code>concat(s1)</code>	Returns a <u>new</u> string that concatenates this string with string <code>s1</code> .
<code>toUpperCase()</code>	Returns a <u>new</u> string with all letters in uppercase.
<code>toLowerCase()</code>	Returns a <u>new</u> string with all letters in lowercase.
<code>trim()</code>	Returns a <u>new</u> string with whitespace characters trimmed on both sides.

`msg = msg.toUpperCase();`

## Simple Methods for String Objects (2 of 2)

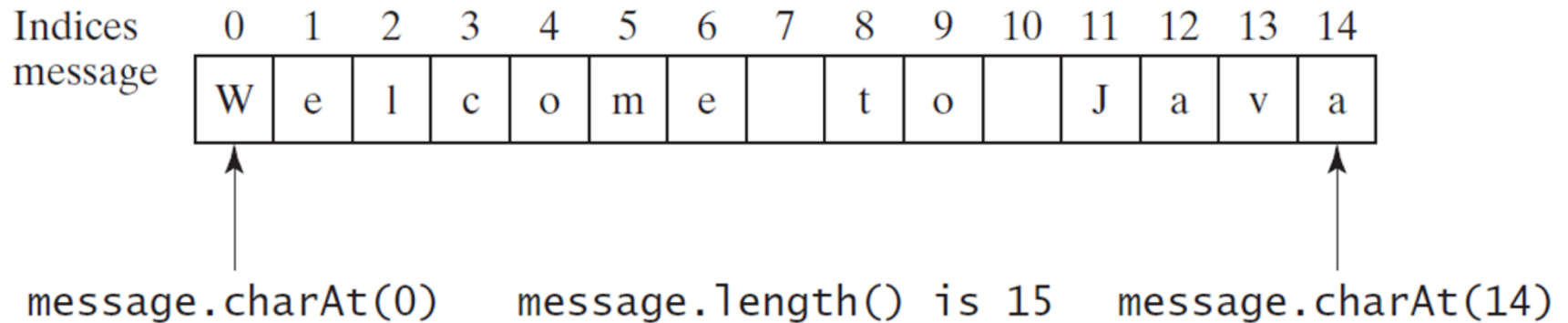
Strings are objects in Java. The methods in the preceding table can only be invoked from a specific string instance. For this reason, these methods are called **instance methods**. A non-instance method is called a **static method**. A static method can be invoked without using an object. All the methods defined in the **Math** class are static methods. They are not tied to a specific object instance. The syntax to invoke an instance method is **referenceVariable.methodName(arguments)**.

# Getting String Length

```
String message = "Welcome to Java";
```

```
System.out.println("The length of " + message + " is "  
+ message.length());
```

# Getting Characters from a String



String message = **"Welcome to Java"**;

System.out.println(**"The first character in message is "**  
**+ message.charAt(0)**);

# Converting Strings

"Welcome".toLowerCase() returns a new string, welcome.

"Welcome".toUpperCase() returns a new string,  
WELCOME.

" Welcome ".trim() returns a new string, Welcome.

# String Concatenation

String s3 = s1.concat(s2); or String s3 = s1 + s2;

// Three strings are concatenated

String message = "Welcome " + "to " + "Java";

// String Chapter is concatenated with number 2

String s = "Chapter" + 2; // s becomes Chapter2

// String Supplement is concatenated with character B

String s1 = "Supplement" + 'B'; // s1 becomes SupplementB

# Reading a String From the Console

```
Scanner input = new Scanner(System.in);
```

```
System.out.print("Enter three words separated by  
spaces: ");
```

```
String s1 = input.next();
```

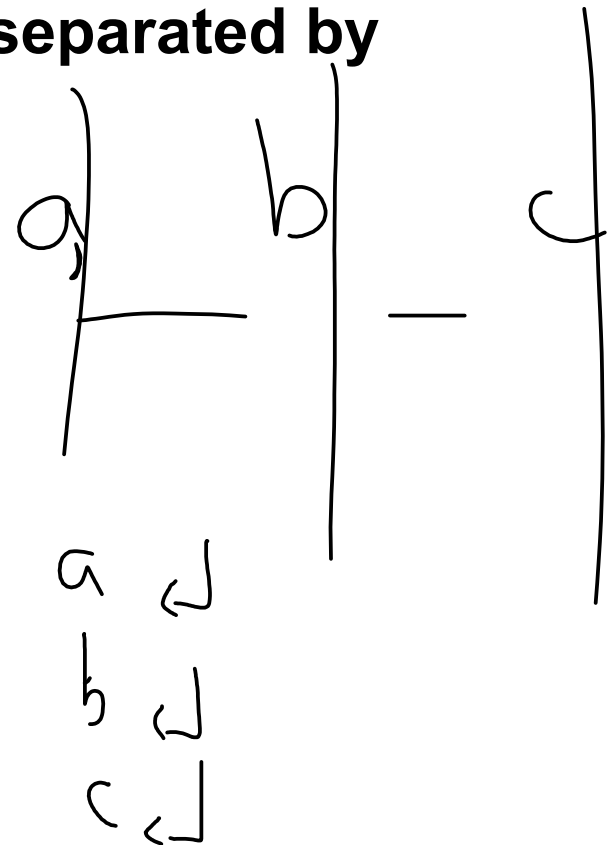
```
String s2 = input.next();
```

```
String s3 = input.next();
```

```
System.out.println("s1 is " + s1);
```

```
System.out.println("s2 is " + s2);
```

```
System.out.println("s3 is " + s3);
```



# Reading a Character From the Console

```
Scanner input = new Scanner(System.in);
```

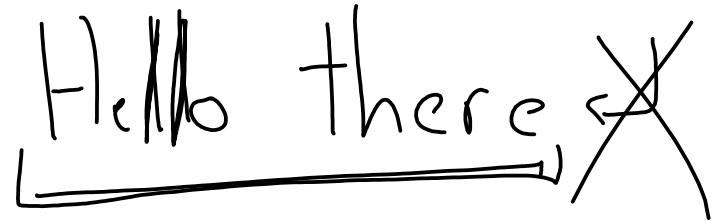
```
System.out.print("Enter a character: ");
```

```
String s = input.nextLine();
```

```
char ch = s.charAt(0);
```

```
System.out.println("The character entered is " + ch);
```

Hello there ↩



# Comparing Strings

Method	Description
<code>equals(s1)</code>	Returns true if this string is equal to string <code>s1</code> .
<code>equalsIgnoreCase(s1)</code>	Returns true if this string is equal to string <code>s1</code> ; it is case insensitive.
<code>compareTo(s1)</code>	Returns an integer greater than 0, equal to 0, or less than 0 to indicate whether this string is greater than, equal to, or less than <code>s1</code> .
<code>compareToIgnoreCase(s1)</code>	Same as <code>compareTo</code> except that the comparison is case insensitive.
<code>startsWith(prefix)</code>	Returns true if this string starts with the specified prefix.
<code>endsWith(suffix)</code>	Returns true if this string ends with the specified suffix.

[OrderTwoCities](#)

# Obtaining Substrings

## Method

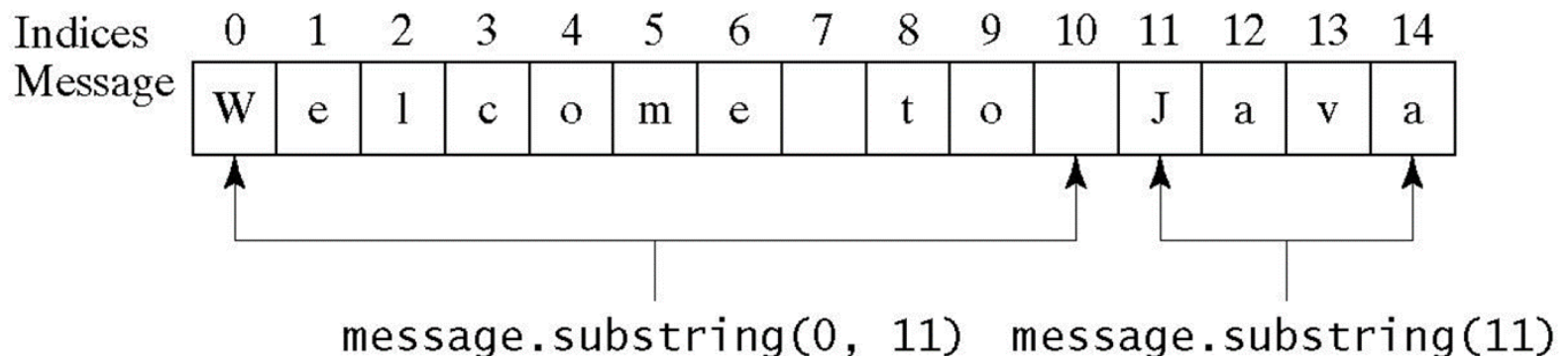
## Description

`substring(beginIndex)`

Returns this string's substring that begins with the character at the specified `beginIndex` and extends to the end of the string, as shown in Figure 4.2.

`substring(beginIndex, endIndex)`

Returns this string's substring that begins at the specified `beginIndex` and extends to the character at index `endIndex - 1`, as shown in Figure 9.6. Note that the character at `endIndex` is not part of the substring.



# Finding a Character or a Substring in a String (1 of 2)

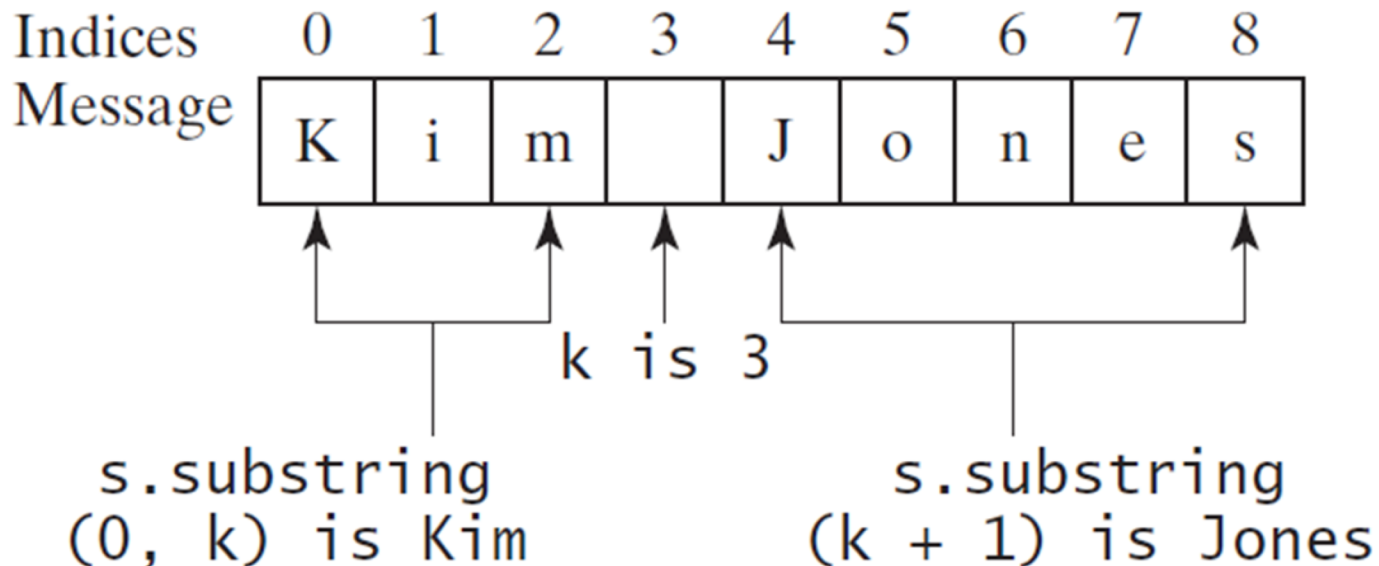
Method	Description
<code>indexOf(ch)</code>	Returns the index of the first occurrence of <code>ch</code> in the string. Returns <code>-1</code> if not matched.
<code>indexOf(ch, fromIndex)</code>	Returns the index of the first occurrence of <code>ch</code> after <code>fromIndex</code> in the string. Returns <code>-1</code> if not matched.
<code>indexOf(s)</code>	Returns the index of the first occurrence of string <code>s</code> in this string. Returns <code>-1</code> if not matched.
<code>indexOf(s, fromIndex)</code>	Returns the index of the first occurrence of string <code>s</code> in this string after <code>fromIndex</code> . Returns <code>-1</code> if not matched.
<code>lastIndexOf(ch)</code>	Returns the index of the last occurrence of <code>ch</code> in the string. Returns <code>-1</code> if not matched.
<code>lastIndexOf(ch, fromIndex)</code>	Returns the index of the last occurrence of <code>ch</code> before <code>fromIndex</code> in this string. Returns <code>-1</code> if not matched.
<code>lastIndexOf(s)</code>	Returns the index of the last occurrence of string <code>s</code> . Returns <code>-1</code> if not matched.
<code>lastIndexOf(s, fromIndex)</code>	Returns the index of the last occurrence of string <code>s</code> before <code>fromIndex</code> . Returns <code>-1</code> if not matched.

# Finding a Character or a Substring in a String (2 of 2)

```
int k = s.indexOf(' ');
```

```
String firstName = s.substring(0, k);
```

```
String lastName = s.substring(k + 1);
```



# Conversion between Strings and Numbers

```
int intValue = Integer.parseInt(intString);
```

```
double doubleValue = Double.parseDouble(doubleString);
```

```
String s = number + "";
```

# Formatting Output

Use the printf statement.

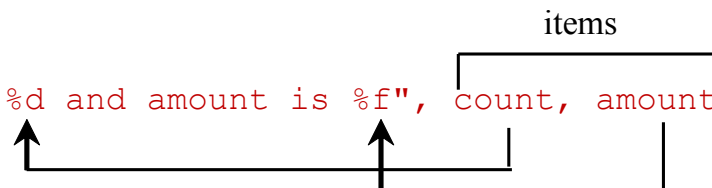
```
System.out.printf(format, items);
```

Where format is a string that may consist of substrings and format specifiers. A format specifier specifies how an item should be displayed. An item may be a numeric value, character, boolean value, or a string. Each specifier begins with a percent sign.

# Frequently-Used Specifiers

Specifier	Output	Example
<code>%b</code>	a boolean value	true or false
<code>%c</code>	a character	'a'
<code>%d</code>	a decimal integer	200
<code>%f</code>	a floating-point number	45.460000
<code>%e</code>	a number in standard scientific notation	4.556000e+01
<code>%s</code>	a string	"Java is cool"

```
int count = 5;  
double amount = 45.56;  
System.out.printf("count is %d and amount is %f", count, amount);
```



```
display          count is 5 and amount is 45.560000
```

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