CSC110AB - Module 2

General Notes

Incremental development is the process of writing, compiling, and testing a small amount of code, then writing, compiling, and testing a small amount more (an incremental amount), and so on.

Zybooks

Variables and Assignments

A **variable**, such as `x` or `numPeople`, is used to hold a value.

An **assignment** assigns a variable a value, such as `x = 5`. That means that x is now assigned with 5 and will keep that value during future uses of the variable, until it is assigned again.

- The left side of an assignment must be a variable, and the right side an expression.
  - `x = 5`
  - `numPeople = 22`
  - `dayOfWeek = "Tuesday"`
- The `=` does **not** mean equality like it does in mathematics, it is an assignment of a left-side variable with a right-side value.

It's possible for variables to appear on the right side of an assignment as well:

- ```
  int x = 1;        // x = 1
  x = x + 1;    // x = 2 - This is one way to increment a variable by 1
  int y = 3;
  x = x + y;    // x = 5

  ========Incrementing===========
  int z = 10;
  z = z + 1;
  z += 1;
  z++;
  ++z;
  ```
- **Incrementing** a value is when you increase its value by 1 using one of the following formats:
  - `x = x + 1`
  - `x++`
    - Returns the value of the variable and increments it **after**.
  - `++x`
    - Increments the value of the variable **before** returning its value.
  ```

Variables (Int)

Variable Declarations

A **variable declaration** is a statement that declares a new variable, specifying the variable's name and *type*: `int myNum;`. The compiler ensures space in memory for the variable capable of storing the specified type *(int)*.

- Every variable corresponds to a location in memory where the value is stored. When the variable is called, it goes to the address in memory where the value is to retrieve that value.
- Modern compilers may optimize variables away, allocate variables on the stack, or use registers for variables.

Assignment Statements

An **assignment statement** assigns the variable on the left-side of the `=` with the current value of the right-side expression: `myAge = 12 + 12` assigns `myAge` with the value of `24`.

- If the variable has already been declared or initialized, then the type does not need to be stated again when assigning.

An **expression** may be a number ot a calculation.

- An integer appearing in an expression is called an **integer literal**.
  - It's good practice to minimize the use of literal numbers in code. It improves readability

Initializing Variables

An integer is initialized when it is **first** assigned a value, which is often done when it is declared:

```
int avgLifeSpan = 70;
```

- Initializing is not required.

Assignment Statement With Same Variable On Both Sides

Assignment statements are read left-to-right, meaning that you can have the same variable on both sides of the equation:

```
package mypackage;

public class Person {
    public static void main(String[] args) {
        int age;

        age = 10;
        System.out.println(age)   // Prints out: 10
```

```
        age = age + 2;
        System.out.println(age)   // Prints out: 12
    }
}
```

Common Errors

A common error is to read a variable that has not yet been assigned a value.

- Always assign a variable a value before reading it.
- **Do not write statements in reverse:**
  - `numPeople + numAdults = numPeople;`
  - `10 = jellyBeansCount`

Identifiers

Rules For Identifiers

A name created by a programmer for an item like a variable or method is called an **identifier**. An identifier must:

- be a sequence of letters (`a-z`, `A-Z`), underscore (`_`), dollar signs (`$`), and digits (`0-9`)
- start with a letter, underscore, or dollar sign

Note: `_` and `$` are both considered letters, but it's good practice to **not** use either in programmer-created identifiers.

- Identifiers are **case-sensitive**, so upper and lower case letters differ and can create entirely different variables.

A **reserved word** is a word that is part of the language, like `int`, `short`, or `double`. A reserved word is also known as a **keyword**.

- A programmer cannot use a reserved word as an identifier.
- Many language editors will automatically color a program's reserved words.

Style Guidelines For Identifiers

Naming conventions (style) are often defined by your company, team, teacher, etc. Two common conventions for naming variables:

- **Camel Case: Lower camel case** combines multiple words, removing spaces and capitalizing each word except the first:
  - `Spider-Man` -> `spiderMan`
  - `Number of People` -> `numberOfPeople`
  - `people_on_bus` -> `peopleOnBus`
- **Snake Case:** Words are lowercase and separated by an underscore:

- `Spider-Man` -> `spider_man`
- `Number of People` -> `number_of_people`
- `peopleOnBus` -> `people_on_bus`

Either convention can be chosen, just be consistent with the chosen one.

- Create meaningful identifier names that self-describe an item's purpose.
- Avoid abbreviations unless they're well-known like `num` in `numPassengers`.
- Do not use overly long identifier names like `averageAgeOfUclaGraduateStudent`.

Java Reserved Words / Keywords

abstract	final	public
assert	finally	return
boolean	float	short
break	for	static
byte	goto	strictfp
case	if	super
catch	implements	switch
char	import	synchronized
class	instanceof	this
const	int	throw
continue	interface	throws
default	long	transient
do	native	try
double	new	void
else	package	volatile
enum	private	while
extends	protected	

- `true`, `false`, and `nul` are also reserved and used for literals.

Arithmetic Expressions

Basics

- An **expression** is any individual item or combination of items, like variables, literals, operators, and parentheses, that evaluates to a value, often used on the right side of an assignment statement: `2 * (x + 1)`
- A **literal** is a specific value in code like `2`. An `operator` is a symbol
- An **operator** is a symbol that performs a built-in calculation, like `+`, which performs addition.

Other Arithmetic Operators:

Arithmetic Operator	Description
+	The **addition** operator is +, as in x + y.
-	The **subtraction** operator is **-**, as in x - y. Also, the - operator is for **negation**, as in -x + y, or x + -y.
___*___	The **multiplication** operator is ___*___, as in x * y.
/	The **division** operator is /, as in x / y.

Evaluation of Expressions

An expressions **evaluates** to a value, which replaces the expression. An expression is evaluated using the order of standard mathematics, known in programming as **precedence rules**:

Operator / Convention	Description	Explanation
( )	Items within parentheses are evaluated first	In **2 * (x + 1)**, the **x + 1** is evaluated first, with the result then multiplied by **2**.
unary -	**-** used for negation (*unary minus*) is next	In **2 * -x**, the **-x** is computed first, with the result then multiplied by **2**.
*** / %**	Next to be evaluated are ___*___, /, and %, having equal precedence.	(% is discussed elsewhere)
+ -	Finally come + and **-** with equal precedence.	In **y = 3 + 2 * x**, the **2 * x** is evaluated first, with the result then added to **3**, because * has higher precedence than +. Spacing doesn't matter: **y = 3+2 * x** would still evaluate **2 * x** first.
left-to-right	If more than one operator of equal precedence could be evaluated, evaluation occurs left to right.	In **y = x * 2 / 3**, the **x * 2** is first evaluated, with the result then divided by **3**.

- It helps to use parenthesis to explicitly make the order of evaluation, improving code readability and making the order clear.
- A common error is to omit parentheses and assume a different order of evaluation than actually occurs, leading to a bug.

Example: Calories burned by men and women: Source

> Men: Calories = [(Age * 0.2017) + (Weight * 0.09036) + (Heart Rate * 0.6309) - 55.0969] * Time / 4.184
> Women: Calories = [(Age * 0.074) - (Weight * 0.05741) + (Heart Rate * 0.4472) - 20.4022] * Time / 4.184

Converted To Programming Notation:

> caloriesMan = ((ageYears * 0.2017) + (weightPounds * 0.09036) + (heartBPM * 0.6309) - 55.0969) * timeMinutes / 4.184
> caloriesWoman = ((ageYears * 0.074) - (weightPounds * 0.05741) + (heartBPM * 0.4472) - 20.4022) * timeMinutes / 4.184

Arithmetic Expressions (int)

Style: Single Space Around Operators

It's good practice to include a single space around operators for readability, except when using the **unary minus (-)**, also known as the negative sign:

- `x = 1 + 2`
- `x = -1 - -y`

Compound Operators

Special operators called **compound operators** provide a shorthand way to update a variable, such as `userAge += 1` being shorthand for `userAge = userAge + 1`. Other compound operators include:

- `-=`
- `*=`
- `/=`
- `%=`

Floating-point numbers (double)

Floating-point (double) variables

- A **floating-point number** is a real number containing a decimal point that can appear anywhere (or "float") in the number.
  - *98.6*
  - *0.0000001*
  - *-20.1234*
- A **double** variable stores a floating-point number
  - `double milesTravel;` declares a double variable
- A **floating-point literal** is a number with a fractional part, even if the fraction is 0, as in *1.0*, *0.0*, or *99.573*.
  - It's good practice to always have a digit before the decimal point:
    - **.2** -> **0.2**

- Use **floating-point** numbers when performing division with fractions instead of **integers**.

Scanner's `nextDouble()` method reads a floating-point value from input.

- Very large and very small floating-point values may be printed using scientific notation.
  - Ex: If a floating variable holds the value `299792458.0` (the speed of light in m/s), the value will be printed as `2.99792458E8`.

Choosing a Variable Type (double vs int)

A variable's type should be based on the type of value held. Use integers for whole numbers that do not require a decimal, and floating-point variables when a decimal is required *(such as with fractions and averages)*.

Floating-point Division By Zero

Dividing a nonzero floating-point number by zero is undefined in regular arithmetic. Many programming languages produce an error when performing floating-point division by 0, but Java does not.

Java handles this operation by producing **infinity** or **-infinity**, depending on the signs of the operands. Printing a floating-point variable that holds infinity or -infinity outputs Infinity or -Infinity.

If the dividend and divisor in floating-point division are both 0, the division results in a "not a number". **Not a number (*NaN*)** indicates an unrepresentable or undefined value. Printing a floating-point variable that is *not a number* outputs `NaN`.

Manipulating Floating-point Output

By default, most programs output up to 5 decimal places. It's better to be specific with the amount of decimal points by changing how many are produced:

```
System.out.printf("%.2f", myFloat);
```

- The last digit will be rounded.
- The `%` is a substitution string that can be used with different letters after it to indicate the *type* of data to substitute. The value that will replace the `%` comes as the second parameter, `myFloat`.

```
System.out.printf("%s", "This is a string");
System.out.printf("%d", 52);
System.out.printf("%f", 52.0);  // Will print the maximum amount of decimals
```

Scientific Notation For Floating-point Literals

Scientific notation is useful for representing floating-point numbers that are much greater than or much less than **0**, such as **6.02 x 1023**

To write a floating-point literal using **scientific notation**, write an **e** preceding the power-of-10 exponent:

- **6.023 x 1023** -> **6.023e23**
- **1.23 x 10-4 -> 1.23e-4**
  - equals **0.000123**

Constant Variables

When a variable represents a literal, the variable's value should not be changed in the code (one way to do this is by preceding the variable declaration with `final`).

- An initialized variable whose value cannot change is called a **constant variable**, and is also known as a **final variable**.
- It's good practice to name constant variables in only upper-case letters with words separated by underscores, to make constant variables clearly visible in code.

Using Math Methods

Basics

A standard **Math class** has about 30 math operations in the form of methods.

- The `Math` class is part of Java's standard language package.

A **method** is a list of statements executed by invoking the method's name, such invoking is known as a **method call**.

- Any method input values or arguments appear within `( )`, separated by commas if more than one.

```
public class CalcSquareRoot {
    public static void main(String[] args) {
        double squareToFind = 36.0;

        squareRoot = Math.sqrt(squareToFind);

        System.out.println(squareRoot);
    }
}
```

- Java Math Class Documentation

Calls in Arguments

Commonly a method call's argument itself includes a method call:

- `Math.pow(2.0, Math.pow(x, y) + 1)`.

Integer Division and Modulo

Division: Integer Rounding

When the operands of `/` are integers, the operator performs integer division, which does not generate any fraction.

- Integers are rounded down, not up.
- If at least one operand is a floating-point value, then floating-point division occurs.

Division: Divide by 0

For integer division, the second operand of `/` or `%` must never be `0`, because division by `0` is mathematically undefined. A **divide-by-zero** error occurs at runtime if a divisor is `0`, causing a program to terminate.

- A *divide-by-zero* error is an example of a **runtime error**, a severe error that occurs at runtime and causes a program to terminate early.

Modulo (%)

The **modulo operator (%)** evaluates the remainder of the division of two integer operands

- `23 % 10` is `3`
- `11 % 5` is `1`

Modulo Use-Cases

- `randNum % 10`
  - **Yields 0 - 9:** Possible remainders are 0, 1, . . . , 8, 9. Remainder 10 is not possible:
    - Ex: `19 % 10` is `9`, but `20 % 10` is `0`.
- `randNum % 51`
  - **Yields 0 - 50:** Note that `% 50` would yield `0 - 49`.
- `(randNum % 9) + 1`
  - **Yields 1 - 9:** The `% 9` yields 9 possible values `0 - 8`, so the `+ 1` yields `1 - 9`.
- `(randNum % 11) + 20`
  - **Yields 20 - 30:** The `% 11` yields 11 possible values `0 - 10`, so the `+ 20` yields `20 - 30`.

Modulo can also be used to get the digit in a specific place of a number by using it with a power of 10 (10, 100, 1000, etc.).

- This can also be used with phone numbers to only get specific digits in it:

```
tmpVal = phoneNum / 10000; // / 10000 shifts right by 4, so 136555.
prefixNum = tmpVal % 1000; // % 1000 gets the right 3 digits, so 555.
```

- Dividing by a power of 10 shifts a value right. `321 / 10` is `32`. `321 / 100` is `3`.
- `%` by a power of 10 gets the rightmost digits. `321 % 10` is `1`. `321 % 100` is `21`.

Type Conversions

A type conversion is a conversion of one data type to another, such as an `int` to a `double`. The compiler automatically performs several common conversions between int and double types, such automatic conversions are known as **implicit conversion**.

- If a `double` is used in arithmetic, the other value is assigned as a `double` as well, and a floating-point operation is performed.
- For assignments, the right side type is converted to the left side type if the conversion is possible without loss of precision.
- *double-to-int* conversion may lose precision, so is not automatic.
- Because of implicit conversion, statements like `double someDoubleVar = 0;` or `someDoubleVar = 5;` are allowed, but discouraged. Using `0.0` or `5.0` is preferable.

Type Casting

A **type cast** explicitly converts a value of one type to another type. To type cast, precede an expression with `(type)` to convert the expression's value to the indicated type.

- `(double)myIntVar` converts `myIntVar` to a double if wasn't already one.

Common Errors

- A common error is to accidentally perform integer division when floating-point division was intended. The program below undesirably performs integer division rather than floating-point division.
- A common error is to cast the entire result of integer division, rather
- the operands, thus not obtaining the desired floating-point division.

Binary

a compiler must allocate some finite quantity of bits (e.g., **32 bits**) for a variable, and that quantity of bits limits the range of numbers that the variable can

represent.

Because each memory location is composed of bits (0s and 1s), a processor stores a number using **base 2**, known as a **binary number**.

For a number in the more familiar **base 10**, known as a decimal number, each digit must be **0-9** and each digit's place is weighed by increasing powers of **10**.

The compiler translates decimal numbers into binary numbers before storing the number into a memory location.

Base 10 Table

Decimal number with 3 digits	Representation
212	$= 2 \cdot 10^2 \quad + 1 \cdot 10^1 \quad + 2 \cdot 10^0$ $= 2 \cdot 100 \quad + 1 \cdot 10 \quad + 2 \cdot 1$ $= 200 \quad + 10 \quad + 2$ $= 212$

Base 2 Table

Binary number with 4 bits	Representation
1101	$= 1 \cdot 2^3 \quad + 1 \cdot 2^2 \quad + 0 \cdot 2^1 \quad + 1 \cdot 2^0$ $= 1 \cdot 8 \quad + 1 \cdot 4 \quad + 0 \cdot 2 \quad + 1 \cdot 1$ $= 8 \quad + 4 \quad + 0 \quad + 1$ $= 13$

Characters

Basics

A variable of **char** type can store a single character like the letter `m`.

- A **character literal** is surrounded with single quotes: `char myChar = 'm';`.

Getting a Character From Input

Java does not have a method for getting one character from input. Instead, the following sequence can be used:

```
myChar = scnr.next().charAt(0);
```

- `next()` gets the next sequence of non-whitespace characters (as a string), and `charAt(0)` gets the first character in that string.

A Character Is Internally Stored As a Number

Under the hood, a char variable stores a number.

- Ex: `a` is stored as `97`. In an output statement, the compiler outputs the number's corresponding character.

The numbers for each letter correspond to their **ASCII** values.

ASCII is an early standard for encoding characters as numbers. The following table shows the ASCII encoding as a decimal number (Dec) for common printable characters (for readers who have studied binary numbers, the table shows the binary encoding also). Other characters such as control characters (e.g., a "line feed" character) or extended characters (e.g., the letter "n" with a tilde above it as used in Spanish) are not shown. Source: http://www.asciitable.com/.

Many earlier programming languages like C or C++ use ASCII. Java uses a more recent standard called Unicode. ASCII can represent 255 items, whereas Unicode can represent over 64,000 items; Unicode can represent characters from many different human languages, many symbols, and more. (For those who have studied binary: ASCII uses 8 bits, while Unicode uses 16, hence the 255 versus 64,000). Unicode's first several hundred items are the same as ASCII. The Unicode encoding for these characters has 0's on the left to yield 16 bits.

Table 1

Binary	Dec	Char
010 0000	32	space
010 0001	33	!
010 0010	34	"
010 0011	35	#
010 0100	36	$
010 0101	37	%
010 0110	38	&
010 0111	39	'
010 1000	40	(
010 1001	41	)
010 1010	42	*
010 1011	43	+
010 1100	44	,
010 1101	45	-

Binary	Dec	Char
010 1110	46	.
010 1111	47	/
011 0000	48	0
011 0001	49	1
011 0010	50	2
011 0011	51	3
011 0100	52	4
011 0101	53	5
011 0110	54	6
011 0111	55	7
011 1000	56	8
011 1001	57	9
011 1010	58	:
011 1011	59	;
011 1100	60	<
011 1101	61	=
011 1110	62	>
011 1111	63	?

Table 2

Binary	Dec	Char
100 0000	64	@
100 0001	65	A
100 0010	66	B
100 0011	67	C
100 0100	68	D
100 0101	69	E
100 0110	70	F
100 0111	71	G
100 1000	72	H
100 1001	73	I
100 1010	74	J
100 1011	75	K
100 1100	76	L
100 1101	77	M
100 1110	78	N
100 1111	79	O
101 0000	80	P
101 0001	81	Q
101 0010	82	R
101 0011	83	S

Binary	Dec	Char
101 0100	84	T
101 0101	85	U
101 0110	86	V
101 0111	87	W
101 1000	88	X
101 1001	89	Y
101 1010	90	Z
101 1011	91	[
101 1100	92	\
101 1101	93	]
101 1110	94	^
101 1111	95	_

Table 3

Binary	Dec	Char
110 0000	96	‘
110 0001	97	a
110 0010	98	b
110 0011	99	c
110 0100	100	d
110 0101	101	e
110 0110	102	f
110 0111	103	g
110 1000	104	h
110 1001	105	i
110 1010	106	j
110 1011	107	k
110 1100	108	l
110 1101	109	m
110 1110	110	n
110 1111	111	o
111 0000	112	p
111 0001	113	q
111 0010	114	r
111 0011	115	s
111 0100	116	t
111 0101	117	u
111 0110	118	v
111 0111	119	w
111 1000	120	x
111 1001	121	y

Binary	Dec	Char
111 1010	122	z
111 1011	123	{
111 1100	124	{pipe char}
111 1101	125	}
111 1110	126	~

Escape sequences

In addition to regular characters like `Z`, `$`, or `5`, character encoding includes numbers for several special characters.

- A newline character is encoded as `10`. Because no visible character exists for a newline, the language uses an escape sequence: A two-character sequence starting with `\` that represents a special character.
- Ex: `\n` represents a newline character.

Escape sequences also enable representing characters like `'`, `"`, or `\`.

- `myChar = '\''` assigns `myChar` with a single-quote character.
- `myChar = '\\'` assigns `myChar` with `\`
  - just `'\'` would yield a compiler error, since `\'` is the escape sequence for `'`, and then a closing `'` is missing.

Common Escape Sequences

Escape Sequence	Char
\n	newline
\t	tab
\’	single quote
\”	double quote
\\	backslash

Outputting Multiple Character Variables With One Output Statement

```
System.out.print("" + c1 + c2);
```

- The initial `""` tells the compiler to output a string of characters, and the `+`'s concatenate the subsequent characters into such a string.

Common Errors

- A common error is to use double quotes rather than single quotes around a character literal, as in `myChar = "x"`, yielding a compiler error.

- Similarly, a common error is to forget the quotes around a character literal, as in `myChar = x`, usually yielding a compiler error (unless `x` is also a declared variable, then perhaps yielding a logic error).

Strings

A **string** is a sequence of characters. A **string literal** surrounds a character sequence with double quotes.

- `"Hello"`
- `"Goodbye"`
- `"42"`
- Various characters may be in a string.

String Variables and Assignments

A string variable is a reference type variable that refers to a String object. An **object** consists of some internal data items plus operations that can be performed on that data.

- Assigning one String variable to another String variable causes both variables to refer to the same String, and does not create a new String.

```
String myString = "This is a string!";
```

Getting a String Without Whitespaces From Input

A whitespace character is a character used to represent horizontal and vertical spaces in text, and includes spaces, tabs, and newline characters.

```
userString = scnr.next();
```

- Above shows the basic approach to get a string from input into variable userString. The approach automatically skips initial whitespace, then gets characters until the next whitespace is seen:

Getting a String With Whitespaces From Input

```
firstString = scnr.nextLine();
secondString = sncr.nextLine();
```

- Gets all remaining text on the input line, up to the next newline character *(which is removed from input but not put in stringVar)*.

Mixing `next()` and `nextLine()`

`next()` leaves the newline in the input, while `nextLine()` does not.

- Because of this, use two `nextLine()` method calls to skip the newline character.

- Using `nextline()` after `next()` will get any whitespace before the next character.

Integer Overflow

An integer variable cannot store a number larger than the maximum supported by the variable's data type. An **overflow** occurs when the value being assigned to a variable is greater than the maximum value the variable can store.

- *A common error is to try to store a value greater than about* 2 billion *into an int variable*
- Common source of overflow involves intermediate calculations.

Storing a 32-bit `int` as a 64-bit `long` would work for larger numbers.

Numeric Data Types

Integer Numeric Data Types

Declaration	Size	Supported Number Range
`byte myVar;`	**8 bits**	**-128 to 127**
`short myVar;`	**16 bits**	**32,768 to 32,767**
`int myVar;`	**32 bits**	**-2,147,483,648 to 2,147,483,647**
`long myVar;`	**64 bits**	**-9,223,372,036,854,775,808 to 9,223,372,036,854,775,807**

- **int** is the most commonly used integer type
- **long** is used for integers expected to exceed *~2 billion.*
- **short** is rarely used. One situation is to save memory when storing many smaller numbers.
  - *In an array for example*
- *A common error made by a program's user is to enter the wrong type, such as entering a string when the input statement was* `myInt = scnr.nextInt();` *where* `myInt` *is an* `int`*, which can cause strange program behavior.*

Floating-point Numeric Data Types

Declaration	Size	Supported Number Range
`float x;`	**32 bits**	**-3.4x1038 to 3.4x1038**
`double x;`	**64 bits**	**-1.7x10308 to 1.7x10308**

- The compiler uses one bit for sign, some bits for the mantissa, and some for the exponent.

  - The mantissa is the **6.02** in **6.02e23**
- **double** is the most commonly-used floating-point type
- **float** is typically only used in memory-saving situations, as discussed above.
- The mantissa is limited to ~**7** significant digits for float and ~**16** for double.

A variable cannot store a value larger than the maximum supported by the variable's data type. An **overflow** occurs when the value being assigned to a variable is greater than the maximum value the variable can store. Overflow with floating-point results in infinity.

On some processors, especially low-cost processors intended for "embedded" computing, like systems in an automobile or medical device, floating-point calculations may run slower than integer calculations, such as 100 times slower. Floating-point types are typically only used when really necessary. On more powerful processors like those in desktops, servers, smartphones, etc., special floating-point hardware nearly or entirely eliminates the speed difference.

Floating-point numbers are sometimes used when an integer exceeds the range of the largest integer type.

Random Numbers

Generating a Random Number

The **Random** class provides methods that return a random integer in the range from **-231** to **231 - 1** or a programmer-defined range.

```
import java.util.Random

public class ThreeRandomValues {
public static void main(String[] args) {
        Random randGen = new Random();            // New random number generator

        System.out.println(randGen.nextInt());
        System.out.println(randGen.nextInt());
        System.out.println(randGen.nextInt());
        System.out.println(randGen.nextInt());
        System.out.println(randGen.nextInt(20));  // Returns a number 0 to 19
    }
}
```

Specific ranges

A formula for determining the ranges:

randGen.nextInt((y - x) + 1) + x

- **x** is the lower boundary of the desired range
- **y** is the upper boundary of the desired range

1. Determine the desired range: **10 - 15**
2. Add one to the upper boundary: **10 - 16**
3. Subtract the upper boundary from the lower: **16 - 10 = 6**
4. Use the result in your random generator: `randGen.nextInt(6)`
5. Add the lower boundary to the random integer that gets produced:

```
myRandNum = randGen.nextInt(6) + 10;
```

Pseudo-random

The integers generated by a Random object are known as pseudo-random. "Pseudo" means "not actually, but having the appearance of". Internally, the `nextInt()` method has an equation to compute the next "random" integer from the previous one, (invisibly) keeping track of the previous one. For the first call to `nextInt()`, no previous random integer exists, so the method uses an integer known as the seed. `Random()` seeds the pseudo-random number generator with a number based on the current time. Since, the time is different for each program run, the program will get a unique sequence.

Reproducibility is important for testing some programs. (Players of classic arcade games like Pac-man may notice that the seemingly-random actions of objects actually follow the same pattern every time the game is played, allowing players to master the game by repeating the same winning actions).

A programmer can specify the seed when the Random object is created, as in `Random randGen = new Random(5);` or using the `setSeed()` method, as in `randGen.setSeed(5);` With a specific seed, each program run will yield the same sequence of pseudo-random numbers.

Reading API Documentation

Oracle's Java API Specification

The Oracle's Java API Specification provides detailed documents describing how to use the extensive set of classes Java provides for creating programs.

- The class documentation is known as an **Application Programming Interface (API)**.

The main page of the Java documentation lists all Java modules.

- A **module** is a group of related packages.
- A **package** is a group of related classes.

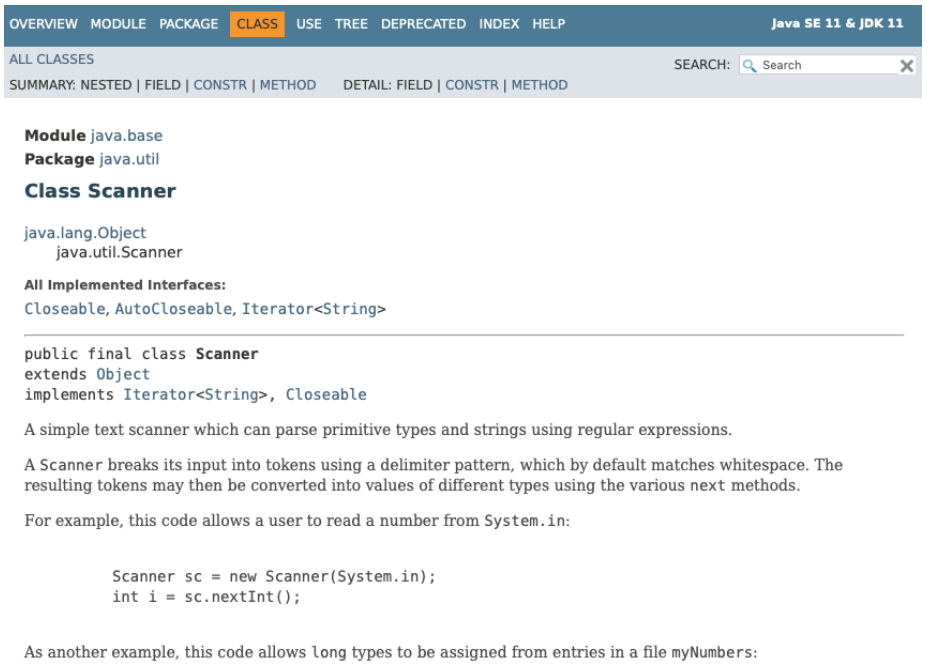
Organizing classes into modules and packages helps programmers find needed classes.

- *Ex: The java.base module defines Java's foundational packages and APIs.*
- java.base module documentation

Class Overview

The Scanner class is located in the package `java.util`. The Java documentation for a class consists of four main elements. The following uses the Scanner class to illustrate these documentation elements. The documentation for the Scanner is located at: Scanner class documentation.

Class overview: The first part of the documentation provides an overview of the class, describing the class' functionality and providing examples of how the class is commonly used in a program.

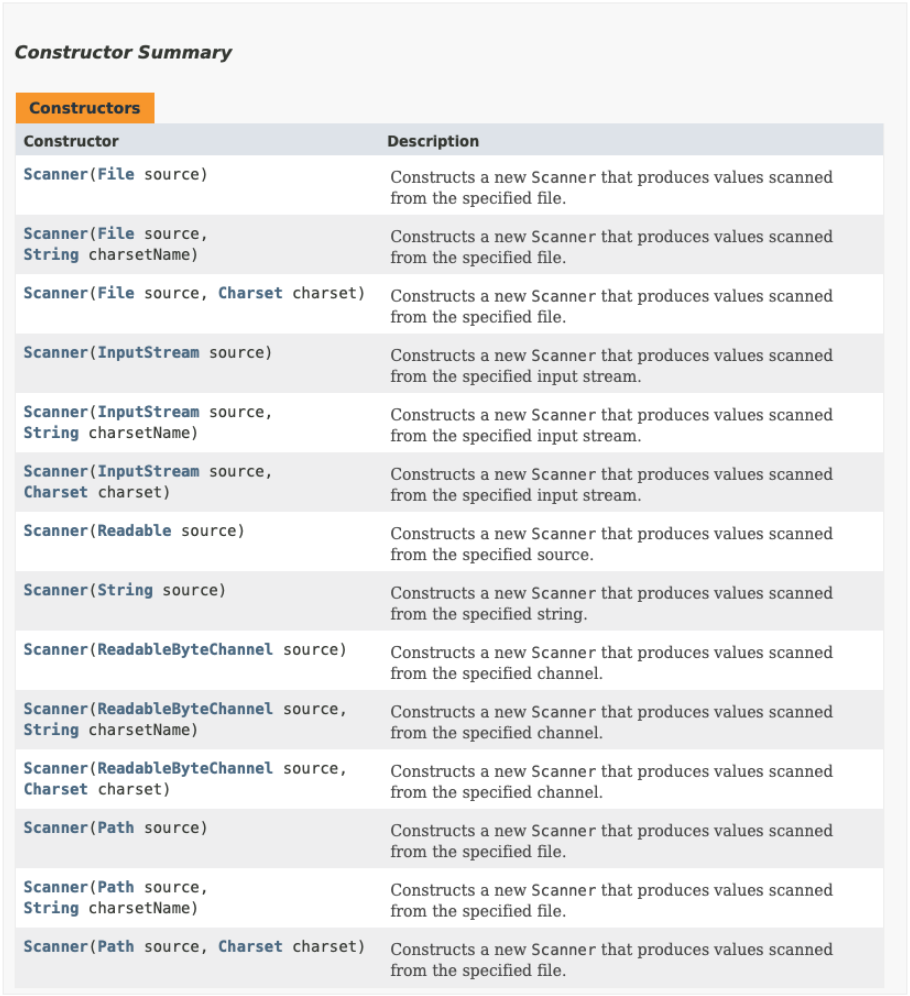


- The package in which a class is located appears immediately above the class name.
  - This package is located in `java.util`
- To use a class, a program must include an import statement that informs the compiler of the class' location.

```
import packageName.ClassName;
```

Constructor Summary

Constructor summary: Provides a list and brief description of the constructors that can be used to create objects of the class.



Constructor Summary

Constructors

Constructor	Description
`Scanner(File source)`	Constructs a new Scanner that produces values scanned from the specified file.
`Scanner(File source, String charsetName)`	Constructs a new Scanner that produces values scanned from the specified file.
`Scanner(File source, Charset charset)`	Constructs a new Scanner that produces values scanned from the specified file.
`Scanner(InputStream source)`	Constructs a new Scanner that produces values scanned from the specified input stream.
`Scanner(InputStream source, String charsetName)`	Constructs a new Scanner that produces values scanned from the specified input stream.
`Scanner(InputStream source, Charset charset)`	Constructs a new Scanner that produces values scanned from the specified input stream.
`Scanner(Readable source)`	Constructs a new Scanner that produces values scanned from the specified source.
`Scanner(String source)`	Constructs a new Scanner that produces values scanned from the specified string.
`Scanner(ReadableByteChannel source)`	Constructs a new Scanner that produces values scanned from the specified channel.
`Scanner(ReadableByteChannel source, String charsetName)`	Constructs a new Scanner that produces values scanned from the specified channel.
`Scanner(ReadableByteChannel source, Charset charset)`	Constructs a new Scanner that produces values scanned from the specified channel.
`Scanner(Path source)`	Constructs a new Scanner that produces values scanned from the specified file.
`Scanner(Path source, String charsetName)`	Constructs a new Scanner that produces values scanned from the specified file.
`Scanner(Path source, Charset charset)`	Constructs a new Scanner that produces values scanned from the specified file.

- When you use `scnr = new Scanner(System.in);`, you're constructing a `Scanner` object.
  - `System.in` is a `InputStream` object automatically created when a Java program executes.
  - The matching constructor is `Scanner(InputStream source`.

Method Summary

Method summary: Provides a list and brief description of all methods that can be called on objects of the class. The Java documentation only lists the

public methods that a program may use.

Method Summary

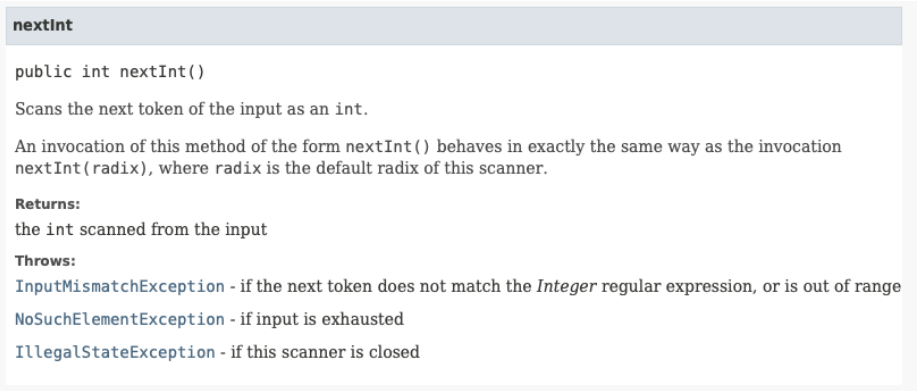
All Methods | **Instance Methods** | **Concrete Methods**

Modifier and Type	Method	Description
void	close()	Closes this scanner.
Pattern	delimiter()	Returns the Pattern this Scanner is currently using to match delimiters.
Stream<MatchResult>	findAll (String patString)	Returns a stream of match results that match the provided pattern string.
Stream<MatchResult>	findAll (Pattern pattern)	Returns a stream of match results from this scanner.
String	findInLine (String pattern)	Attempts to find the next occurrence of a pattern constructed from the specified string, ignoring delimiters.
String	findInLine (Pattern pattern)	Attempts to find the next occurrence of the specified pattern ignoring delimiters.
String	findWithinHorizon (String pattern, int horizon)	Attempts to find the next occurrence of a pattern constructed from the specified string, ignoring delimiters.
String	findWithinHorizon (Pattern pattern, int horizon)	Attempts to find the next occurrence of the specified pattern.
boolean	hasNext()	Returns true if this scanner has another token in its input.
boolean	hasNext (String pattern)	Returns true if the next token matches the pattern constructed from the specified string.

Constructor and Method Details

Constructor and Method Details: The documentation also provides a detailed description of all constructors and methods for the class.

For each method, the documentation provides the method declaration, a description of the method, a list of parameters (if any), a description of the method's return value, and a list of possible exceptions the method may throw.



nextInt

`public int nextInt()`

Scans the next token of the input as an `int`.

An invocation of this method of the form `nextInt()` behaves in exactly the same way as the invocation `nextInt(radix)`, where `radix` is the default radix of this scanner.

Returns:
the `int` scanned from the input

Throws:
`InputMismatchException` - if the next token does not match the *Integer* regular expression, or is out of range

`NoSuchElementException` - if input is exhausted

`IllegalStateException` - if this scanner is closed

Debugging

- **Debugging:** The process of determining and fixing the cause of a problem in a computer program.
- **Troubleshooting:** Another word for debugging.

Some good steps for methodically debugging:

1. Predict a *possible* cause of the problem
2. Conduct a test to validate that cause
    - *Note that a temporary statement commonly has a "FIXME" comment to remind* the programmer to delete this statement.
        - `// FIXME delete`
3. Repeat

A common error among new programmers is to try to debug without a methodical process, instead staring at the program, or making random changes to see if the output is improved.

Some methods for validating possible causes:

- Manually set a variable to a value.
- Insert print statements to observe variable values.
- Comment out unused code.
- Visually inspect the code (not every test requires modifying/running the code).

Statements inserted for debugging must be created and removed with care.

- A common error is to forget to remove a debug statement, such as a temporary statement that manually sets a variable to a value. Left-aligning such a statement and/or including a FIXME comment can help the programmer remember.
- Another common error is to use `/* */` to comment out code that itself contains `/* */` characters. The first `*/` ends the comment before intended, which usually yields a syntax error when the second `*/` is reached or sooner.

Style Guidelines

Each programming team, whether a company, open source project, or a classroom, may have **style guidelines** for writing code.

- **K&R style** for braces and indents is named after C language creators Kernighan and Ritchie.
- **Stroustrup style** for braces and indents is named after C++ language creator Bjarne Stroustrup.
- Google's Java Style Guidelines

Style Guide Examples

Sample guidelines used in this material	Yes	No (for our sample style)
Whitespace		

Each statement usually appears on its own line.	`x = 25;`
	`y = x + 1;`
		`x = 25;  y = x + 1;  // No`
		`if (x == 5) { y = 14; }  // No`

A blank line can separate conceptually distinct groups of statements, but related statements usually have no blank lines between them.	`x = 25;`
	`y = x + 1;`
		`x = 25;`
		`// No`
		`y = x + 1;`

Most items are separated by one space (and not less or more). No space precedes an ending semicolon.	`C = 25;`
	`F = ((9 * C) / 5) + 32;`
	`F = F / 2;`
		`C=25;`
		`// No`
		`F = ((9*C)/5) + 32; // No`
		`F = F / 2 ;`
		`// No`

Sub-statements are indented 3 spaces from parent statement. Tabs are not used as tabs may behave inconsistently if code is copied to different editors.
(Auto-tabbing may need to be disabled in some source code editors).
	`if (a < b) {`
	`  x = 25;`
	`  y = x + 1;`
	`}`
		`if (a < b) {`
		`  x = 25;`
		`// No`
		`  y = x + 1;`
		`// No`
		`}`
		`if (a < b) {`
		`x = 25;`
		`// No`
		`}`

Braces		

For branches, loops, methods, or classes, opening brace appears at end of the item's line. Closing brace appears under item's start.	`if (a < b) {`
	`  // Called K&R style`
	`}`
	`while (x < y) {`
	`  // K&R style`
	`}`
		`if (a < b)`
		`{`
		`  // Also popular, but we use K&R`
		`}`

For if-else, the else appears on its own line	`if (a < b) {`
	`  ...`
	`}`
	`else {`
	`  // Called Stroustrup style`
	`  // (modified K&R)`
	`}`
		`if (a < b) {`
		`  ...`
		`} else {`
		`  // Original K&R style`
		`}`

Braces always used even if only one sub-statement	`if (a < b) {`
	`  x = 25;`
	`}`
		`if (a < b)`
		`  x = 25;  // No, can lead to error later`

Naming		

Variable/parameter names are camelCase, starting with lowercase	`int numItems;`	`int NumItems;  // No`
		`int num_items;  // Common, but we don't use`

Variable/parameter names are descriptive, use at least two words (if possible, to reduce conflicts), and avoid abbreviations unless widely-known like "num". Single-letter variables are rare; exceptions for loop indices (i, j), or math items like point coordinates (x, y).	`int numBoxes;`
	`char userKey;`
		`int boxes;  // No`
		`int b;  // No`
		`char k;  // No`
		`char usrKey;  // No`

Constants use upper case and underscores (and at least two words)	`final int MAXIMUM_WEIGHT = 300;`	`final int MAXIMUMWEIGHT = 300;  // No`
		`final int maximumWeight = 300;  // No`
		`final int MAXIMUM = 300;  // No`

Variables usually declared early (not within code), and initialized where appropriate and practical.	`int i;`
	`char userKey = '-';`
		`int i;`
		`char userKey;`
		
		`userKey = 'c';`
		`int j;  // No`

Method names are camelCase with lowercase first.	`printHello()`	`PrintHello()  // No` `print_hello()  // No`
Miscellaneous		
Lines of code are typically less than 100 characters wide.	Code is more easily readable when lines are kept short. One long line can usually be broken up into several smaller ones.	