Expressions, Data Conversion, and Input

- Expressions
- Operators and Precedence
- Assignment Operators
- Data Conversion
- Input and the Scanner Class
- Reading for this class: L&L, 2.4-2.6, App D

Expressions

- An *expression* is a combination of one or more operators and operands
- *Arithmetic expressions* compute numeric results and make use of the arithmetic operators:

Addition	+
Subtraction	-
Multiplication	*
Division	/
Remainder	%

- If either or both operands used by an arithmetic operator are floating point, then the result is a floating point

Division and Remainder

- If both operands to the division operator (`/`) are integers, the result is an integer (the fractional part is discarded)

`14 / 3`	equals	`4`
`8 / 12`	equals	`0`

- The remainder operator (%) returns the remainder after dividing the second operand into the first

`14 % 3`	equals	`2`
`8 % 12`	equals	`8`

Operator Precedence

- Operators can be combined into complex expressions

```
result  =  total + count / max - offset;
```

- Operators have a well-defined precedence which determines the order in which they are evaluated
- Multiplication, division, and remainder are evaluated prior to addition, subtraction, and string concatenation
- Arithmetic operators with the same precedence are evaluated from left to right, but parentheses can be used to force the evaluation order
- See Appendix D for a more complete list of operators and their precedence.

Operator Precedence

- What is the order of evaluation in the following expressions?

```
a + b + c + d + e
  1   2   3   4
```

```
a + b * c - d / e
  3   1   4   2
```

```
a / (b + c) - d % e
  2    1    4   3
```

```
a / (b * (c + (d - e)))
  4    3    2    1
```

Assignment Revisited

- The assignment operator has a lower precedence than the arithmetic operators

First the expression on the right hand side of the = operator is evaluated

```
answer  =  sum / 4 + MAX * lowest;
        4      1   3     2
```

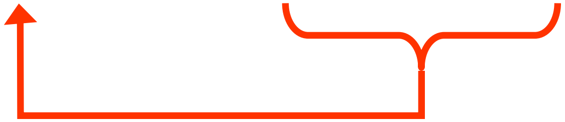
Then the result is stored in the variable on the left hand side

Assignment Revisited

- The right and left hand sides of an assignment statement can contain the same variable

First, one is added to the original value of count

```
count  =  count + 1;
```



Then the result is stored back into count (overwriting the original value)

Increment and Decrement

- The increment and decrement operators use only one operand
- The *increment operator* (`++`) adds one to its operand
- The *decrement operator* (`--`) subtracts one from its operand
- The statement

  ```
  count++;
  ```

  is functionally equivalent to

  ```
  count = count + 1;
  ```

Increment and Decrement

- The increment and decrement operators can be applied in:
  - *postfix form*:

    ```
    count++          count--
    ```

  - *prefix form*:

    ```
    ++count          --count
    ```

- These operators update the value in the memory location
- When used as part of a larger expression, the *prefix form* adds or subtracts one BEFORE the rest of the expression is evaluated and the *postfix form* does it AFTERWARDS
- Because of these subtleties, the increment and decrement operators should be used with care

Assignment Operators

- Often we perform an operation on a variable, and then store the result back into that variable
- Java provides *assignment operators* to simplify that process
- For example, the statement

```
num += count;
```

is equivalent to

```
num = num + count;
```

Assignment Operators

- There are many assignment operators in Java, including the following:

Operator	Example	Equivalent To
`+=`	`x += y`	`x = x + y`
`-=`	`x -= y`	`x = x - y`
`*=`	`x *= y`	`x = x * y`
`/=`	`x /= y`	`x = x / y`
`%=`	`x %= y`	`x = x % y`

Assignment Operators

- The right hand side of an assignment operator can be a complex expression
- The entire right-hand expression is evaluated first, then the result is combined with the original variable
- Therefore

```
result /= (total-MIN) % num;
```

is equivalent to

```
result = result / ((total-MIN) % num);
```

Assignment Operators

- The behavior of some assignment operators depends on the types of the operands
- If the operands to the += operator are strings, the assignment operator performs string concatenation
- The behavior of an assignment operator (+=) is always consistent with the behavior of the corresponding operator (+)

Data Conversion

- Sometimes it is convenient to convert data from one type to another
- For example, in a particular situation we may want to treat an integer as a floating point value
- These conversions do not change the type of a variable or the value that's stored in it – they only convert a value as part of a computation

Data Conversion

- Conversions must be handled carefully to avoid losing information
- *Widening conversions* are safest because they tend to go from a small data type to a larger one (such as a `short` to an `int`)
- *Narrowing conversions* can lose information because they tend to go from a large data type to a smaller one (such as an `int` to a `short`)
- In Java, data conversions can occur in three ways:
  - assignment conversion
  - promotion
  - casting

Assignment Conversion

- *Assignment conversion* occurs when a value of one type is assigned to a variable of another

- For example, the following assignment converts the value stored in the `dollars` variable to a `double` value

```
double money;
int dollars = 123;
money = dollars;     // money == 123.0
```

- Only widening conversions can happen via assignment

- The type and value of `dollars` will not be changed

Data Conversion

- *Promotion* happens automatically when operators in expressions convert their operands

- For example, if `sum` is a `double` and `count` is an `int`, the value of `count` is promoted to a floating point value to perform the following calculation：

```
double result = sum / count;
```

- The value and type of `count` will not be changed

Casting

- *Casting* is a powerful and dangerous conversion technique
- Both widening and narrowing conversions can be done by explicitly casting a value
- To cast, the desired type is put in parentheses in front of the value being converted
- For example, if `total` and `count` are integers, but we want a floating point result when dividing them, we cast `total` or `count` to a double for purposes of the calculation:

```
double result = (double) total / count;
```

- Then, the other variable will be promoted, but the value and type of `total` and `count` will not be changed

Some Special Cases

- The default type of a constant with a decimal point is double:

```
float f = 1.2;  // narrowing conversion
float f = (float) 1.2  // needs a cast
```

- Results of `int` divide by zero are different from `float` or `double` divide by zero
- If `int count == 0`, depends on type of sum:

```
ave = sum/count;// if int, exception
ave = sum/count;// if double, “NaN”
```

Reading Input

- Programs generally need input on which to operate
- The `Scanner` class provides convenient methods for reading input values of various types
- A `Scanner` object can be set up to read input from various sources, including from the user typing the values on the keyboard
- Keyboard input is represented by the `System.in` object

Reading Input

- The following line allows you to use the standard library Scanner class in statements in your class:

```
    import java.util.Scanner;
```

- The following line creates a Scanner object that reads from the keyboard:

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

- The `new` operator creates the `Scanner` object
- Once created, the `Scanner` object can be used to invoke various input methods, such as:

```
    String answer = scan.nextLine();
```

Reading Input

- The `Scanner` class is part of the `java.util` class library and must be imported into a program to be used
- See Echo.java (page 89)
- The `nextLine` method reads all of the input until the end of the line is found
- The details of object creation and class libraries are discussed later in the course

Input Tokens

- Unless specified otherwise, *white space* is used to separate the elements (called *tokens*) of the input
- White space includes space characters, tabs, new line characters
- The `next` method of the `Scanner` class reads the next input token and returns it as a String
- Methods such as `nextInt` and `nextDouble` read data of particular types
- See GasMileage.java (page 90)