Variables
Data Types

What is a reference?

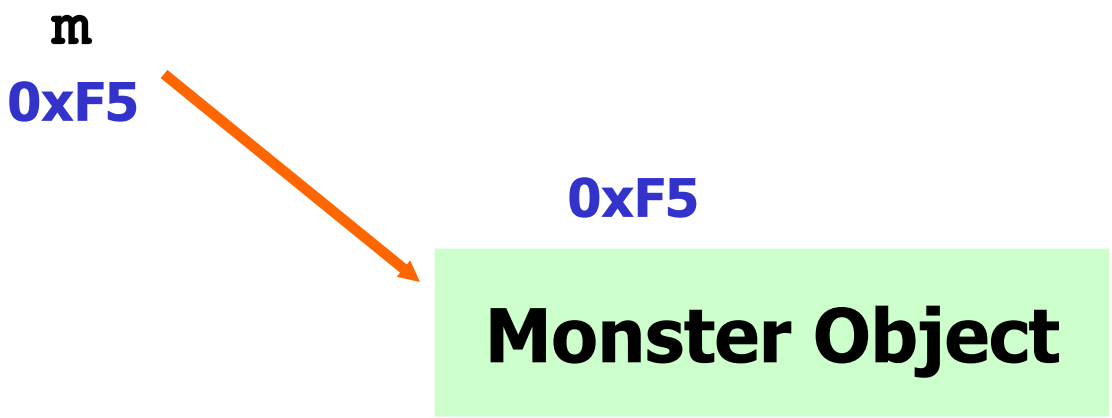
What is a reference?

A reference variable stores the memory address of an object.

```
Monster fred = new Monster();
Monster sally = new Monster();
```

What is a reference?

Monster m = new Monster();



m stores the address of a Monster

What is a variable?

What is a variable?

A variable is a storage location for a specified type of value.

```
int numDays = 365;
double hTownTax = 8.25;
char grade = 'A';
```

numDays	hTownTax
365	8.25

What is a variable?

```
int numDays = 365;
```

numDays

365

numDays stores an integer value

Identifier Names

What does identifier mean?

An identifier is used to identify something.

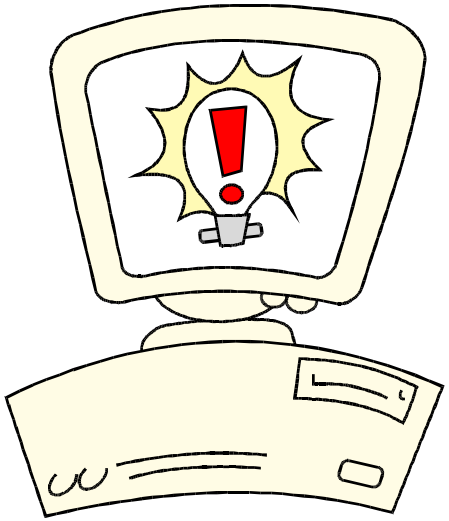
```
public class Triangle{    }

int width = 7;
```

Always start identifier names with letters.

Identifiers

Which of these would be legal identifiers?

1stYear
jump Up
feet2Inches
BigTriangle
SpaceInvaders



Identifier Names

Always use names that mean something.

```
double  totalPay;
class Triangle{ }
```

```
double a;          //very bad
class B{}          //very bad
```

What is a keyword?

Keywords are reserved words that the language uses for a specific purpose.

int double return void
static long break continue

Keywords cannot be used as identifiers.

Spelling Counts

SAM does not equal sam.
Sam does not equal sam.
Same does not equal sam.

Case is important as is spelling.

Open identifiers.java

```
//© A+ Computer Science  -  www.apluscompsci.com

//indentifier example

public class ?Indentifiers
{
        public static void main(String args[])
        {
                int big Num=99;

                double 1decimal = 8.25;

                double void = 657;

                char littleA = 'a';

                boolean isPrime = false;

                String s = "abc";
        }
}
```

Types of Variables

Data Types

byte	short	int
long	float	double

int whole
double fraction

The **type** states how much and what kind of data the variable can store.

All Data Types

data type	memory usage	min .. max
byte	8 bits	-128 to 127
short	16 bits	-32768 to 32767
int	32 bits	-2 billion to 2 billion
long	64 bits	-big to +big
float	32 bits	-big to +big
double	64 bits	-big to +big
char	16 bit unsigned	0 - 65535
reference	32 bits	n/a

It is important to know all data types and what each one can store.

Integers

Integers

```
int one = 120;
int two = 987123;
byte bite = 99;
long longInt = 99234423;

System.out.println(one);
System.out.println(two);
System.out.println(bite);
System.out.println(longInt);
```

OUTPUT

```
120
987123
99
99234423
```

Integers

```
int one = 120.0;

System.out.println(one);
```

OUTPUT
LOP error

Integer types can store integer values only. Integer types cannot store fractional / decimal values.

Attempting to assign fractional / decimal values to an integer type results in a loss of precision compile error.

Open integers.java integerslop.java

```
//integer example

public class Integers{

        public static void main(String args[])
        {
                int one = 120;  //legal assignment
                int two = 987123;
                int three = 999999999;
                byte bite = 99;
                long longInt = 99234423;


                System.out.println(one);
                System.out.println(two);
                System.out.println(bite);
                System.out.println(longInt);


                three = three * 3;   //creates an overflow error at runtime
                System.out.println(three);
        }
}
```

```
//integer example for loss of precision

public class IntegersLOP{

	public static void main(String args[])
	{
		int one = 120.0;
		System.out.println(one);
	}
}
```

Real Numbers
Fractional Values

Reals

```
double one = 99.57;
double two = 3217;
float three = 23.32f;

System.out.println(one);
System.out.println(two);
System.out.println(three);
```

OUTPUT

```
99.57
3217.0
23.32
```

Reals

```
double one = 120.7;
System.out.println(one);
one = 125;
System.out.println(one);
```

OUTPUT

120.7
125.0

Real types can store fractional/decimal values as well as integer values.

Open reals.java

```
//real/decimal number examples

public class Reals{

        public static void main(String args[])
        {
                double one = 99.57;
                double two = 3217;
                //float ten = 234.234;  //not legal
                float three = 23.32f;   //F states that 23.32 is a float
value

                System.out.println(one);
                System.out.println(two);
                System.out.println(three);

                //int or double values are just fine
                one=125;
                System.out.println(one);
        }
}
```

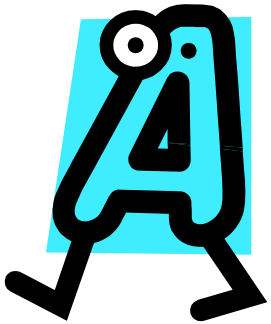
Characters

Characters

```
char let = 'A';
char fun = 65;

char test = 'a';
char go = 97;

char what = 48;
```

char variables are used to store a single letter.

char variables are actually integers.



Characters

char is a 16-bit unsigned int data type.

Here is a 16 bit pattern: 0000000000110011

char let = 65;

ASCII VALUES YOU MUST KNOW!

'A' – 65

'a' – 97

'0' - 48

ASCII Values

'A' - 65	'B' - 66	'C' - 67	...
'a' - 97	'b' - 98	'c' - 99	...
'0' - 48	'1' - 49	'2' - 50	...

Characters

```
char alpha = 'A';
char ascii = 65;
char sum = 'B' + 1;

System.out.println(alpha);
System.out.println(ascii);
System.out.println(sum);
System.out.println('B'+1);
```

OUTPUT

```
A
A
C
67
```

Open chars.java

```
//character example

public class Chars
{
        public static void main(String args[])
        {
                char alpha = 'A';
                char ascii = 65;
                char sum = 'B' + 1;

                System.out.println(alpha);
                System.out.println(ascii);
                System.out.println(sum);

                System.out.println('B'+1);   //char is an integer type

                System.out.println('A'+5);
                System.out.println((char)('A'+5));
        }
}
```

VOCABULARY WORDS

- variable
- primitive type
- reference type
- identifier
- keyword
- case sensitive
- integer
- real number
- floating point number
- character

Start work on the labs

Booleans

Booleans

```
boolean go = true;
System.out.println(go);
boolean stop = false;
System.out.println(stop);
```

OUTPUT

true
false

A boolean type can store true or false only.

Open booleans.java

```
//boolean example

public class Booleans
{
        public static void main(String args[])
        {
                boolean go = true;
                System.out.println(go);

                boolean stop = false;
                System.out.println(stop);

                //assign the value of variable stop to variable go
                stop = go;

                System.out.println(stop);
                System.out.println(go);
        }
}
```

Strings

Strings

```
String dude = "hello world";
String buddy = "whoot - \\\\\\\\\\\\";

System.out.println(dude);
System.out.println("buddy = " + buddy);
```

OUTPUT

```
hello world
buddy = whoot - \\\\\\
```

A String type stores groups of characters.

Open strings.java

```
//String example

public class Strings
{
        public static void main(String args[])
        {
                String dude = "hello world";
                String buddy = "whoot - \\\\\\\\\\\\";

                System.out.println(dude);
                System.out.println("buddy = " + buddy);
        }
}
```

Variable Assignment

The Assignment Statement

```
receiver = 57;
receiver = 239423;
```

In an assignment statement, the receiver is always on the left of the assignment operator (=).

Defining VS. Assigning

```
int num;
```

← definition only

```
int num = 99;
```

← definition and assignment

```
num = 56;
```

← assignment only

The Assignment Statement

```
int number = 75, bigNum=99;
double hTownTax = 8.25;
char bigA = 'A', littleA = 'a';
boolean isPrime = false;
String s = "abc";

System.out.println(number);
System.out.println(bigNum);
System.out.printf("%.2f\n",hTownTax);
System.out.println(bigA);
System.out.println(littleA);
System.out.println(isPrime);
System.out.println(s);
```

OUTPUT

```
75
99
8.25
A
a
false
abc
```

Open assignment.java

```
//variable assignment example

public class Assignment
{
        public static void main(String args[])
        {
                int number = 75, bigNum=99;
                double hTownTax = 8.25;
                char bigA = 'A', littleA = 'a';
                boolean isPrime = false;
                String s = "abc";

                System.out.println(number);
                System.out.println(bigNum);
                System.out.printf("%.2f",hTownTax);
                System.out.println(bigA);
                System.out.println(littleA);
                System.out.println(isPrime);
                System.out.println(s);
        }
}
```

Data Type Ranges

All Data Types

data type	memory usage	min .. max
byte	8 bits	-128 to 127
short	16 bits	-32768 to 32767
int	32 bits	-2 billion to 2 billion
long	64 bits	-big to +big
float	32 bits	-big to +big
double	64 bits	-big to +big
char	16 bit unsigned	0 - 65535
reference	32 bits	n/a

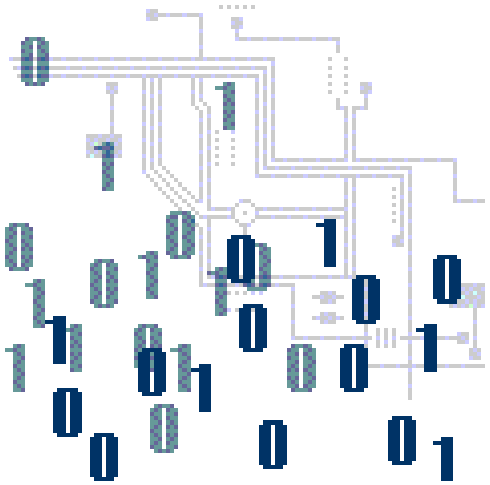
It is important to know all data types and what each one can store.

Memory

Memory consists of bits and bytes.

8 bits = 1001 0010 = 1 byte
16 bits = 0101 1001 0100 1001 = 2 bytes

The more bits you have the more you can store.



1 byte = 8 bits

Integer MIN and MAX

```
System.out.println(Byte.MIN_VALUE);
System.out.println(Byte.MAX_VALUE);

System.out.println(Short.MIN_VALUE);
System.out.println(Short.MAX_VALUE);
```

MIN_VALUE and MAX_VALUE are very useful for contest programming.

OUTPUT

```
-128
127
-32768
32767
```

Integer MIN and MAX

```
System.out.println(Integer.MIN_VALUE);
System.out.println(Integer.MAX_VALUE);

System.out.println(Long.MIN_VALUE);
System.out.println(Long.MAX_VALUE);
```

OUTPUT

```
-2147483648
2147483647
-9223372036854775808
9223372036854775807
```

Overflow Errors

```
int num = Integer.MAX_VALUE;
num=num+1;
System.out.println(num);
num=num-1;
System.out.println(num);
```

Why does adding 1 to MAX_VALUE give you the MIN_VALUE?

OUTPUT

-2147483648
2147483647

Open integersminmax.java

```
//integer min and max example

public class IntegersMinMax
{
        public static void main(String args[])
        {
                System.out.println(Byte.MIN_VALUE);
                System.out.println(Byte.MAX_VALUE);

                System.out.println(Short.MIN_VALUE);
                System.out.println(Short.MAX_VALUE);

                System.out.println(Integer.MIN_VALUE);
                System.out.println(Integer.MAX_VALUE);

                System.out.println(Long.MIN_VALUE);
                System.out.println(Long.MAX_VALUE);  //really big number

                int num = Integer.MAX_VALUE;
                num=num+1;
                System.out.println(num);
                num=num-1;
                System.out.println(num);
        }
}
```

Real MIN and MAX

```
System.out.println(Float.MIN_VALUE);
System.out.println(Float.MAX_VALUE);

System.out.println(Double.MIN_VALUE);
System.out.println(Double.MAX_VALUE);
```

MIN_VALUE and MAX_VALUE are very useful for contest programming.

OUTPUT

```
1.4E-45
3.4028235E38
4.9E-324
1.7976931348623157E308
```

Open realsminmax.java

```
//real number min and max example

public class RealsMinMax
{
	public static void main(String args[])
	{
		System.out.println(Float.MIN_VALUE);
		System.out.println(Float.MAX_VALUE);

		System.out.println(Double.MIN_VALUE);
		System.out.println(Double.MAX_VALUE);
			//really really big number
	}
}
```

Character MIN and MAX

```
out.println((int)Character.MIN_VALUE);
out.println((int)Character.MAX_VALUE);

out.println(Character.MIN_VALUE);
out.println(Character.MAX_VALUE);
```

MIN_VALUE and MAX_VALUE are very useful for contest programming.

OUTPUT

0
65535
?
?

Open charsminmax.java

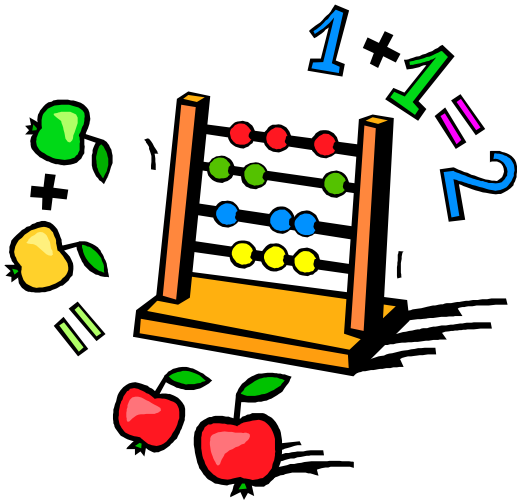
```
//characters min and max example

public class CharsMinMax
{
        public static void main(String args[])
        {
                System.out.println((int)Character.MIN_VALUE);
                //prints out 0
                System.out.println((int)Character.MAX_VALUE);
                //prints out 65535

                System.out.println(Character.MIN_VALUE);   //prints
                out a space
                System.out.println(Character.MAX_VALUE);
                //prints out a ?

                char let = Character.MAX_VALUE;
                System.out.println(let);
        }
}
```

Mixing data

Mixing Data

Java is a strong typed language.
You must pay attention to a variable's type when assigning a value.

```
int one=90;
char letter= 'A';
char let= 97;

one=letter;
letter=let;
one=let;
```



Mixing Data

```
int one = 90;
double dec = 234;
char letter = 'A';

System.out.println( one );
one = letter;          //char to int
System.out.println( one );

one = 'A';             //char to int
System.out.println( one );

System.out.println( dec );
dec = one;             //int to double
System.out.println( dec );
```

OUTPUT

90
65
65
234.0
65.0

Data type sizes often determine if assignment is legal.

32 bit == 32 bit

open mixingdata.java

```
//strong typed language example

public class MixingData
{
        public static void main(String args[])
        {
                int one = 90;
                double dec = 234;
                char letter = 'A';

                System.out.println( one );

                one = letter;  //char to int
                System.out.println( one );

                one = 'A';  //char to int
                System.out.println( one );

                System.out.println( dec );
                dec = one;  //int to double
                System.out.println( dec );

                System.out.println( letter );

                //letter = dec;  //double to int - not legal
                //System.out.println( letter );
        }
}
```

Continue work on the labs

AutoBoxing

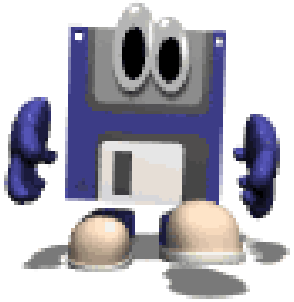
AutoUnboxing

References/Objects

In JAVA, you have 8 primitive data types.

All other variables in Java are reference variables. References refer to objects.

Monster m = new Monster();



References/Objects

primitive	object
byte	Byte
short	Short
int	Integer
long	Long
float	Float
double	Double
char	Character
boolean	Boolean

Box/Unbox

Before Java 5 added in autoboxing and autounboxing, you had to manually wrap primitives.

```
Integer x = new Integer(98);
int y = 56;
x= new Integer(y);
```

Box/Unbox

Java now wraps automatically.

```
Integer numOne = 99;
Integer numTwo = new Integer(99);
```

```
=99;
=new Integer(99);
```

These two lines are equivalent.

Box/Unbox

Java now wraps automatically.

Double numOne = 99.1;
Double numTwo = new Double(99.1);

=99.1;
=new Double(99.1);
These two lines are equivalent.

Box/Unbox

Before Java 5 added in autoboxing and autounboxing, you had to manually unwrap references.

```
Integer ref = new Integer(98);
int y = ref.intValue();
```

Box/Unbox

Java now unwraps automatically.

```
Integer num = new Integer(3);
int prim = num.intValue();
out.println(prim);
prim = num;
out.println(prim);
```

OUTPUT

```
3
3
```

```
prim=num.intValue();
prim=num;
```

These two lines are equivalent.

Box/Unbox

```
Double dub = 9.3;
double prim = dub;
out.println(prim);

int num = 12;
Integer big = num;
out.println(big.compareTo(12));
out.println(big.compareTo(17));
out.println(big.compareTo(10));
```

OUTPUT

```
9.3
0
-1
1
```

Open objects.java

```
//references example

public class Objects
{
        public static void main(String args[])
        {
                Integer intObj = 99;   //intObj refers to an Integer
object
                System.out.println(intObj);

                Double decObj = 9.84;
                System.out.println(decObj);

                double decPrim = decObj;
                decObj=decPrim;
                System.out.println(decPrim);
        }
}
```

GUI HELP

guihelp.java

```
//gui example

import javax.swing.JOptionPane;

public class GuiHelp
{
        public static void main(String args[])
        {
                int one, two, total;

                one = Integer.parseInt(JOptionPane.showInputDialog("Enter
                        an integer :: "));
                two = Integer.parseInt(JOptionPane.showInputDialog("Enter
                        an integer :: "));

                total = one + two;

                JOptionPane.showMessageDialog(null,"Total ::" + total);

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