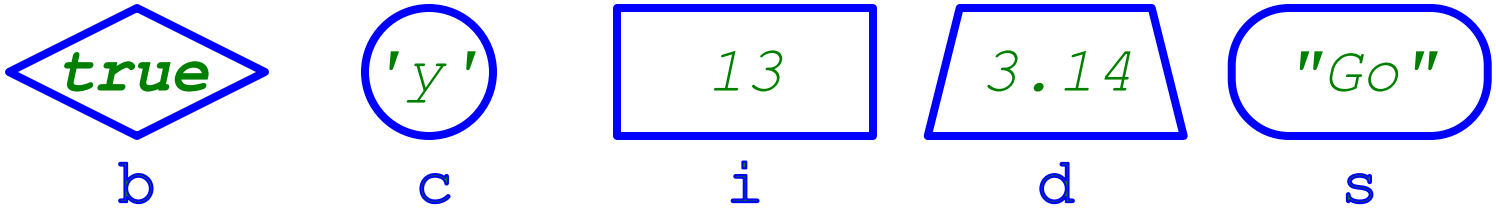
Variables, Types, Values



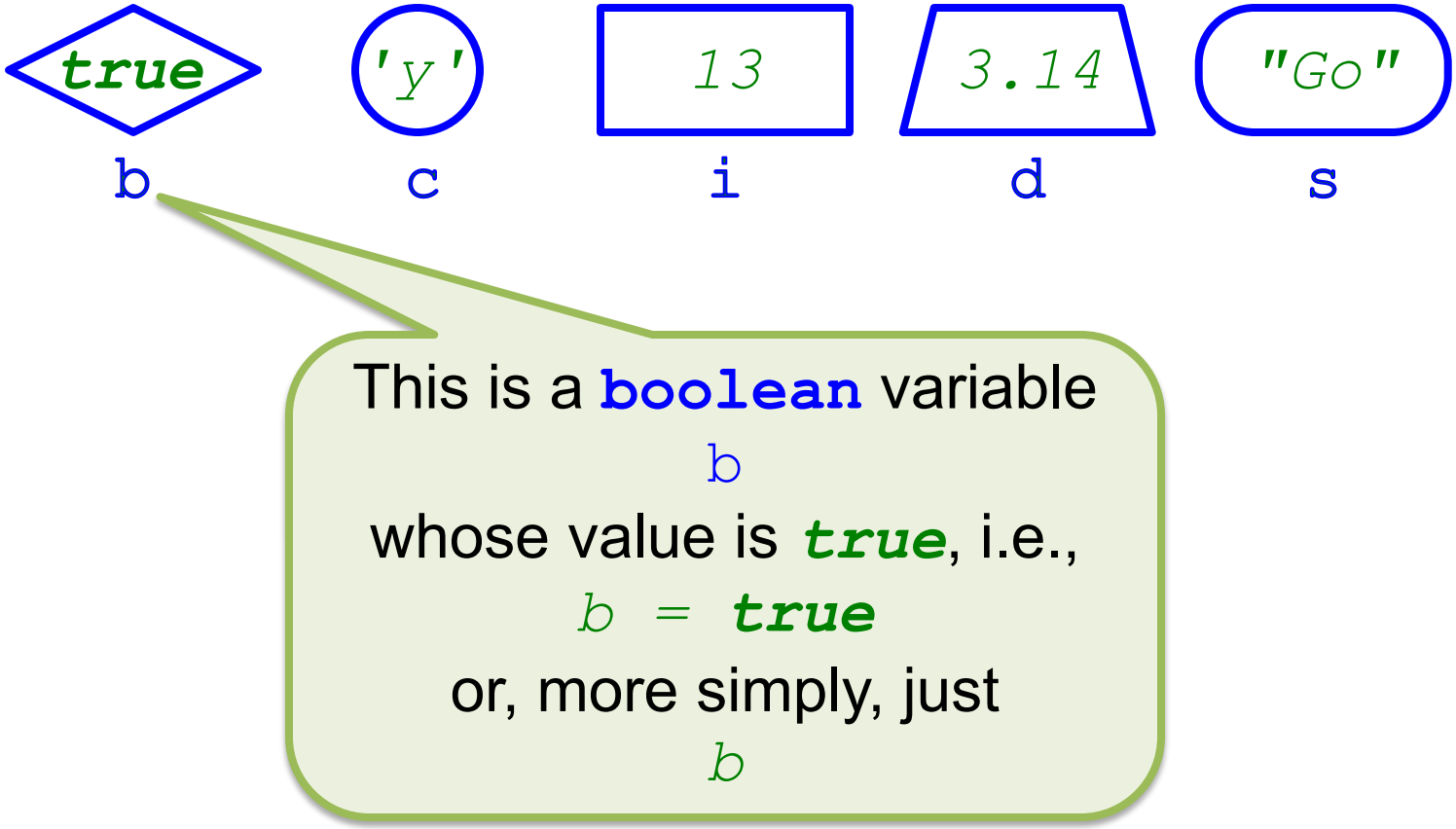

Variables

- A ***variable*** is the name of a “location” that “stores” a ***value*** of a particular ***type***
  - We might say the variable “has” that value
  - We might say the variable “has” that type or “is of” that type

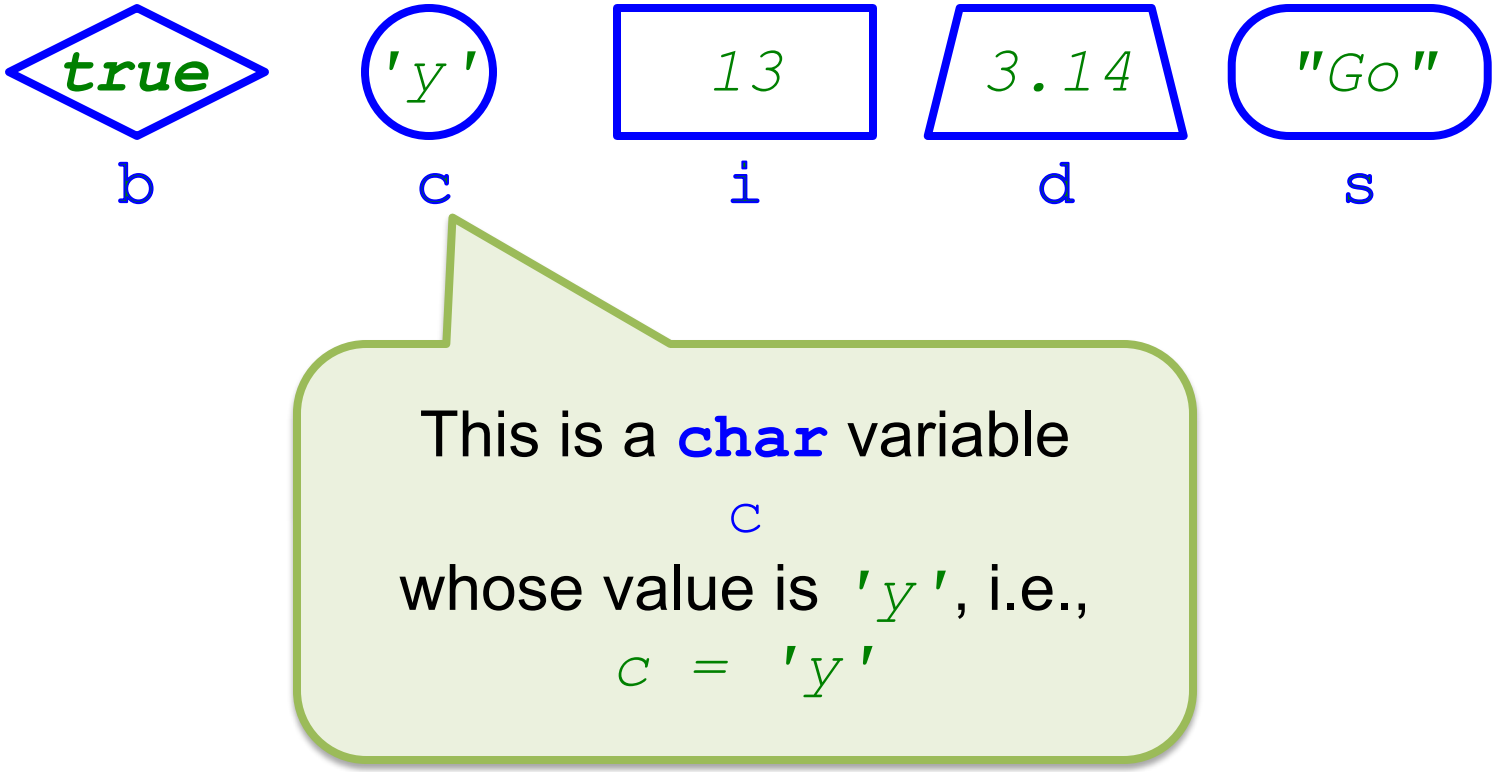
Examples



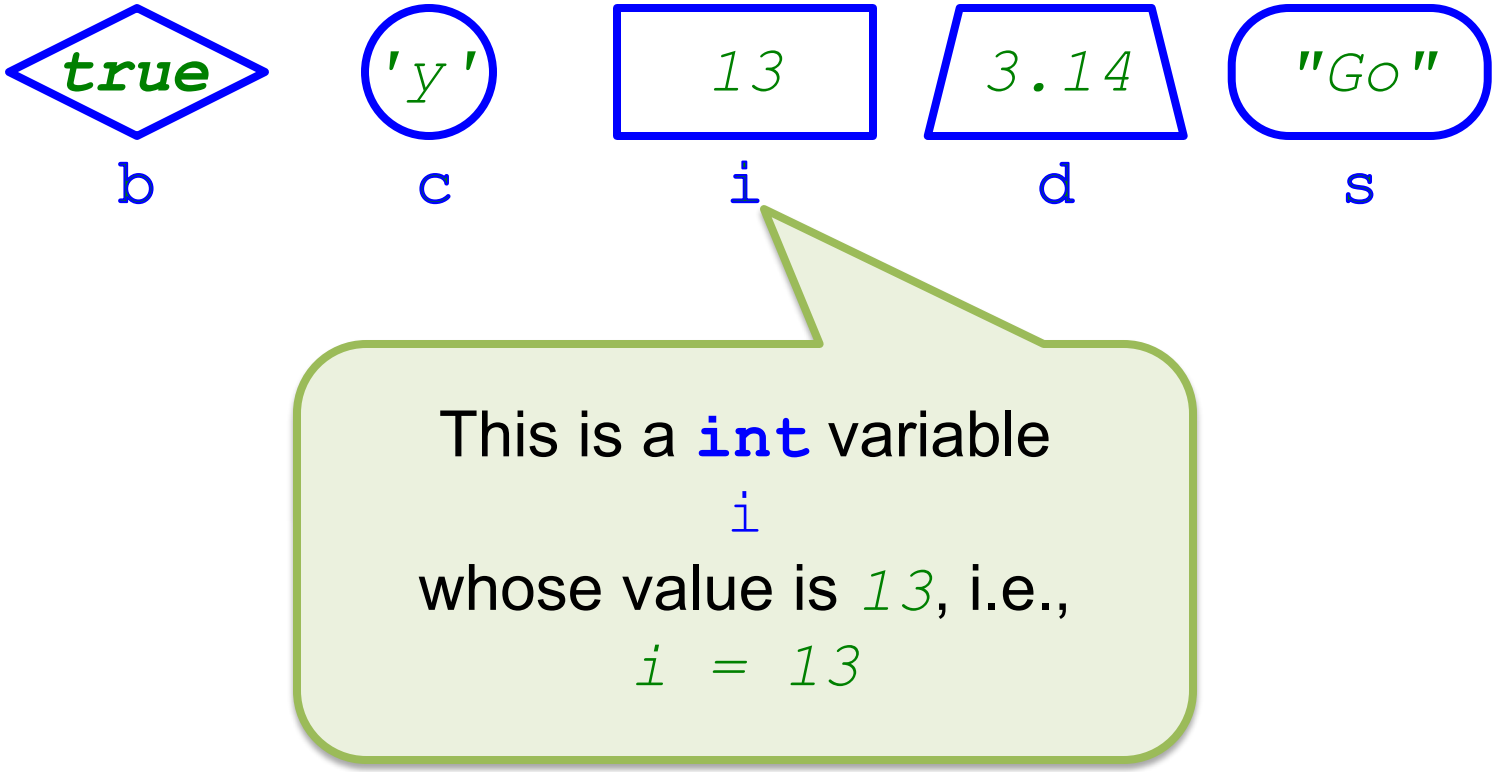
Examples


true
'y'
13
3.14
"Go"
b
c
i
d
s
This is a boolean variable
b
whose value is true, i.e.,
b = true
or, more simply, just
b

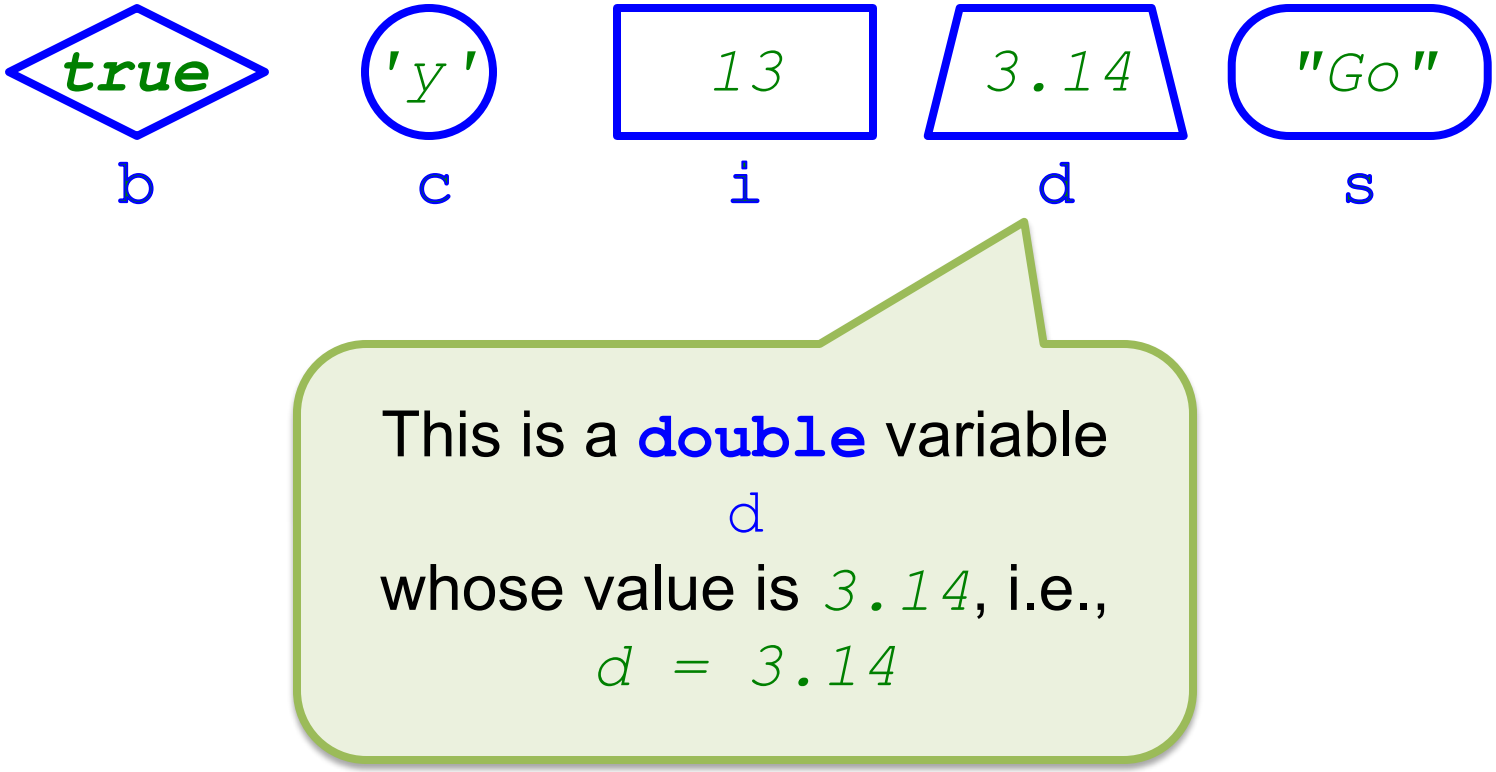
Examples


true
'y'
13
3.14
"Go"
b
c
i
d
s
This is a char variable
c
whose value is 'y', i.e.,
c = 'y'

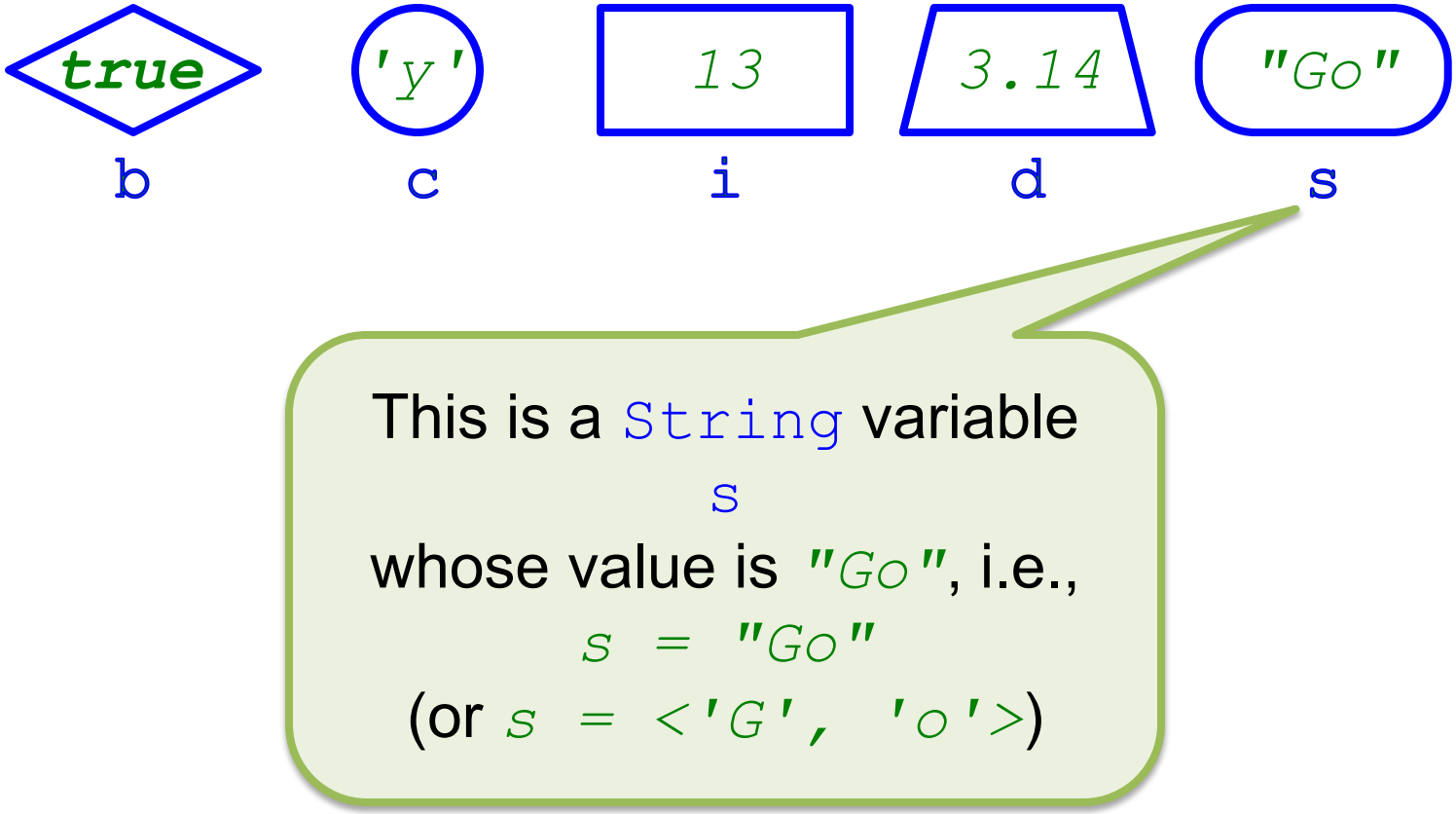
Examples


true
'y'
13
3.14
"Go"
b
c
i
d
s
This is a int variable
i
whose value is 13, i.e.,
i = 13

Examples


true
'y'
13
3.14
"Go"
b
c
i
d
s
This is a double variable
d
whose value is 3.14, i.e.,
d = 3.14

Examples


true
'y'
13
3.14
"Go"
b
c
i
d
s
This is a String variable
s
whose value is "Go", i.e.,
s = "Go"
(or s = <'G', 'o'>)

Types

- A ***type*** is the name of the set of all possible values that a variable might have
- Examples:
  - A variable of type `String` might have values like `"foo"`, `"Hello World"`, etc.
  - A variable of type **`int`** might have values like `-1`, `18`, etc.
  - A variable of type **`double`** might have values like `3.1416`, `10.0`, etc.

Program vs. Mathematical Variables

- A ***program variable*** has a particular value at any one time during program execution, and that value (generally) may change at other times
- A ***mathematical variable*** stands for an arbitrary but fixed value

Program vs. Mathematical Types

- A ***program type*** has a corresponding ***mathematical type*** that ***models*** it

Program vs. Mathematical Types

- A ***program type*** has a corresponding ***mathematical type*** that ***models*** it

When reasoning about a *program variable* of a given *program type*, treat its value at any given time as if it were a *mathematical variable* of the corresponding *mathematical type*.

Mathematical Models

Program type	***Mathematical type***
`String`	***string of character***
`boolean`	***boolean***
`char`	***character***
`int`	***integer*** (*-2147483648* through *2147483647*)
`double`	***real*** (about $\pm 10^{\pm 308}$, 15 significant digits)

Mathematical Models

Program type	***Mathematical type***
`String`	***`string of character`***
`boolean`	
`char`	
`int`	ugh
`double`	(about $\pm 10^{\pm 308}$, 15 significant digits)

`String` is ***built-in*** to Java; **`boolean`**, **`char`**, **`int`**, and **`double`** are among the 8 ***primitive*** (and also built-in) types of Java; differences later.

Mathematical Models

Program type	***Mathematical type***
`String`	***string of character***
	boolean
	character
	integer (*-2147483648* through *2147483647*)
`double`	***real*** (about $\pm 10^{\pm 308}$, 15 significant digits)

All these mathematical types are "built-in" to mathematics!

Mathematical Models

Program code is shown in a `blue fixed-width` font, with keywords in **`bold`**.

Program type	
`String`	
`boolean`	***`boolean`***
`char`	***`character`***
`int`	***`integer`*** (*`-2147483648`* `through` *`2147483647`*)
`double`	***`real`*** (`about` $\pm 10^{\pm 308}$, `15 significant digits`)

Mathematical Models

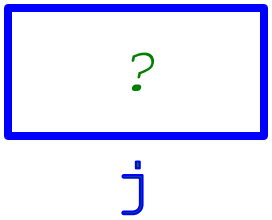
Mathematics is shown in a *green fixed-width italic* font, with keywords in ***bold***.

	Mathematical type
`string`	***string of character***
`boolean`	***boolean***
`char`	***character***
`int`	***integer*** (*-2147483648* through *2147483647*)
`double`	***real*** (about $\pm 10^{\pm 308}$, 15 significant digits)

Declaring a Variable

- When you ***declare*** a program variable, you both provide a name for a location to store its value, and indicate its program type
  - Recall: the program type determines the mathematical type, which in turn determines the possible values the variable can have

```
int j;
```



Declaring a Variable

- When you ***declare*** a program variable, you both provide a name for a location to store its value, and in[illegible]icate its program type
  - Recall: the pro[illegible] mathematical [illegible] the possible v[illegible]

```
int j;
```

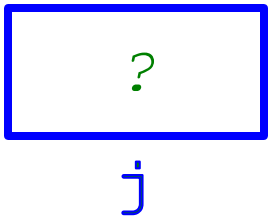
The standard Java convention for naming variables is to use ***camel case***: start with a lower case letter and only capitalize the first letter of each following word, e.g., `myLuckyNumber`

Declaring a Variable

- When you ***declare*** a program variable, you both provide a name for a location to store its value, and indicate its program type
  - Recall: the [illegible] rmines the mathematic[illegible] rn determines the possible[illegible] e can have

```
int j;
```

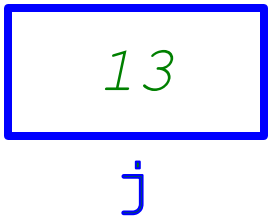
This is an `int` variable `j` whose value is ***undefined***.



Initializing a Variable

- To ***initialize*** a variable, you ***assign*** it a ***value***
  - Recall: the program type determines the mathematical type, which in turn determines the possible values the variable can have

```
int j = 13;
```

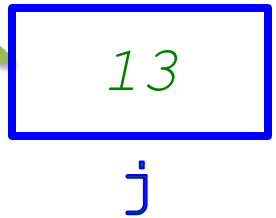


Initializing a Variable

- To ***initialize*** a variable, you ***assign*** it a ***value***
  - Recall: the program type determines the mathematical type, which in turn determines the possible values the variable can have

```
int j = 13;
```

This is an `int` variable `j` whose value is *13*, i.e., *j = 13*



Reasoning: Tracing Tables

Code	***State***
	`x = 1.414`
`int j = 13;`	
	`x = 1.414` `j = 13`

Reasoning: Tracing Tables

Code	***State***
`int j = 13`	
	`x = 1.414` `j = 13`

Every other row in the left column contains some ***program*** statement(s).

Reasoning: Tracing Tables

Code	***State***
`int j = 13`	
	`x = 1.414` `j = 13`

Every other row in the right column contains some ***mathematical*** sentences ("facts").

Reasoning: Tracing Tables

Coc	***tate***
`int j = 13;`	
	`x = 1.414` `j = 13`

This equal sign, in code, means ***assignment*** of a value to a program variable.

Reasoning: Tracing Tables

Coc	***tate***
`int j = 13;`	
	`x = 1.414` `j = 13`

This equal sign, in mathematics, means ***equality*** of two values.

Reasoning: Tracing Tables

There is no value for mathematical variable *j* in this state because program variable `j` hasn't been declared yet.

	State
	x = 1.414
`int j = 13;`	
	x = 1.414 *j = 13*

Reasoning: Tracing Tables

There is a value for `j` in this state because `j` has been declared before this state.

	State
	`x = 1.414`
`int j = 13;`	
	`x = 1.414` `j = 13`

Literals

- A data value appearing, literally, in a program is called a ***literal***

```
String fileName = "foo.txt";
boolean found = false;
char win = 'W';
int j = 13;
double ht = 9.27;
```

Literals

- A data value appearing, literally, in a program is called a ***literal***

```
String fileName = "foo.txt";
boolean found = false;
char win = 'W';
int j = 13;
double ht = 9.27;
```

This is a `String` literal; written as characters between double-quote marks: `"…"`

Literals

- A data value appearing, literally, in a program is called a ***literal***

```
String fileName = "foo.txt";
boolean found = false;
char win = 'W';
int j = 13;
double ht = 9.27;
```

This is a **`boolean`** literal; must be either **`true`** or **`false`**.

Literals

- A data value appearing, literally, in a program is called a ***literal***

```
String fileName = "foo.txt";
boolean found = false;
char win = 'W';
int j = 13;
double ht = 9.27;
```

This is a **`char`** literal; normally written as a single character between single-quote marks: `'…'`

Literals

- A data value appearing, literally, in a program is called a ***literal***

```
String fileName = "f
boolean found = fals
char win = 'W';
int j = 13;
double ht = 9.27;
```

This is an **`int`** literal; normally written (as in mathematics) as a decimal constant.

Literals

- A data value appearing, literally, in a program is called a ***literal***

```
String fileName = "foo.txt";
boolean found = fals
char win = 'W';
int j = 13;
double ht = 9.27;
```

This is a **`double`** literal; normally written (as in mathematics) as a decimal constant *with* a decimal point.

Forms of Literals

Program type	***Literal examples***
`String`	`"I\'m"  "at OSU"`
`boolean`	**`true  false`**
`char`	`'A'  '\t'  '\"'` `'\u03c0'`
`int`	`29  -13` `035  0x1a`
`double`	`18.  18.0` `8E-4  6.022E23`

Forms of Literals

Program type	***Literal examples***
`String`	`"I\'m"` `"at OSU"`
`boolean`	**`true`** **`false`**
`c`	`A'` `'\t'` `'\"'` `'\u03c0'`
`int`	`29` `-13` `035` `0x1a`
`double`	`18.` `18.0` `8E-4` `6.022E23`

escaped special character: single-quote

Forms of Literals

Program type	***Literal examples***
St	"I\'m" "at OSU"
bo	**true** **false**
char	'A' '\t' '\"' '\u03c0'
int	29 -13 035 0x1a
double	18. 18.0 8E-4 6.022E23

non-printing character: tab

Forms of Literals

Program type	***Literal examples***
St	I\'m" "at OSU"
bo	**true** **false**
char	'\t' '\"' '\u03c0'
int	29 -13 035 0x1a
double	18. 18.0 8E-4 6.022E23

Unicode character: small Greek π

Forms of Literals

Program type	***Literal examples***
`St`	`I\'m"  "at OSU"`
`bo`	**`true  false`**
`char`	`'A'  '\t'  '\"'` `'\u03c0'`
`int`	`29  -13` `035  0x1a`
`double`	`18.  18.0` `8E-4  6.022E23`

octal integer (base-8): 29 in decimal

Forms of Literals

Program type	***Literal examples***
St	I\'m" "at OSU"
bo	**true** **false**
char	'A' '\t' '\"' '\u03c0'
int	29 -13 035 0x1a
double	18. 18.0 8E-4 6.022E23

hexadecimal integer (base-16): 26 in decimal

Forms of Literals

Program type	***Literal examples***
`String`	`"I\'m"  "at OSU"`
`bo`	**`true  false`**
	`'A'  '\t'  '\"'` `'\u03c0'`
`int`	`29  -13` `035  0x1a`
`double`	`18.  18.0` `8E-4  6.022E23`

scientific notation:

8×10^{-4}

Constants

- A variable whose value is initialized and never changed is called a ***constant***

```
int myLuckyNumber = 13;
double avogadro = 6.022E23;
```

Constants

- A variable whose value is initialized and never changed is called a ***constant***

```
final int myLuckyNumber = 13;
final double avogadro = 6.022E23;
```

The keyword **`final`** indicates to the compiler your intent that a variable is actually a constant.

Constants

- A variable whose value is initialized and never changed is called a ***constant***

```
final int myLuckyNumber = 13;
final double avogadro = 6.022E23;
```

When constants are declared inside a method, the standard Java convention is to use camel case just like for variables.

Constants

- A variable whose value is initialized and never changed is called a ***constant***

```
final int MY_LUCKY_NUMBER = 13;
final double AVOGADRO = 6.022E23;
```

When constants are declared at the class level, the standard Java convention is to use all upper case letters and to separate the words with '_'.

Resources

- *Java for Everyone*, Chapter 2
  - https://library.ohio-state.edu/record=b8347056~S7