Primitive Data Types

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CS 1323/1324

Announcements (Aug 21)

- zyBook and Turing's Craft Canvas grades
  - Websites automatically push grades to Canvas.
  - Canvas grade is not final until the deadline passes.
- Turing's Craft enrollment
  - Ignore instructions from the bookstore.
  - Activation code can be used as payment option on upgrade page.
- iClicker instructions correction
  - iClicker Reef subscription is not needed with a remote.
  - Contact me if you purchased both a subscription and a remote, and I will help you get a refund.
- iClicker account
  - Register remote and input student ID in profile.
  - Reef users: stay logged in and open course.

What Programs Do

- Programs solve problems by executing instructions
  - The instructions in the main program are run sequentially
  - Each instruction will do one or more of these things
    - Store data in the computer (today)
    - Perform operations on that data (soon)

Computer Memory

- Groups of 64 bits (0's and 1's)
- Each group has an address
- Interpretation of bits determined by type of data
  - Java keeps track of this for you

Address	Contents (8 bits shown)
273	0000 1111
274	0000 1111
275	1111 0000
276	1010 0101
277	1010 1010

Math and Computer Science

- Computer Science is part of mathematics
- Most Computer Scientists have lots of mathematical training
- Sometimes Math and CS agree
  - Real numbers and whole numbers are different things
- Sometimes Math and CS don't agree
  - CS does not have fractions
  - 2 and 2.0 are totally different in CS and identical in Math
- This is the source for lots of confusion, so pay attention to these subtle differences

iClicker Question

- If you multiply 10^a times 10^b, what do you get?

a) 10^{a+b}

b) 10^{ab}

c) 100^{ab}

d) Something else

Hint: Try some small numbers and see which works!

Integral Types

- int
  - Stores numbers between -2^{31} and 2^{31}
  - Encoded as 0's and 1's
- How big is that? (use exponents to find)
- Integral types are stored exactly, within their range
  - 2,000,000,000 + 1 = 2,000,000,001

What should be int?

- int is used for things that are countable
  - Number of clicks on a web site
  - Number of steps you took today
- int is **not** used for:
  - Things that are not numeric
    - Example: People's names
  - Things where fractions or decimals make sense
    - Number of gallons of gas in your tank
    - Number of miles you ran this morning

Find the int

- A program that calculates sales tax would store
  - Price of an item
  - Number purchased
  - Tax rate
  - Amount of sales tax
  - Name of item
  - Whether the item is taxable
  - Size of item (S, M or L)

Name	Address	Contents
price	100	1050
count	101	2
rate	102	0.06
sales tax	103	126
item	104	Dog food
isTaxable	105	true
size	106	L

Recall Scientific Notation

- Mantissa E Exponent
- 4.231E7 = ?
  - Move decimal 7 places to the right
- 4.231E-4 = ?
  - Move decimal 4 places to the left

Floating Point Types

- double
- Encoded as 0's and 1's in a complex scheme
- Numbers with a fractional part
  - double has about 15 numbers in mantissa
  - Stored approximately

iClicker Questions

- For each of the elements below, determine whether they should be an int or double
  - Answer a: int
  - Answer b: double

1. Number of vowels on a given page in Word
2. Number of **complete** paragraphs on a given page in Word
3. Number of inches of text on each page in Word

iClicker Question

What happens if we add 1.0 to 7325420000000000000.0 (stored as a double)?

a) 7325420000000000000.0

b) 7325420000000000001.0

c) Something else

Find the double

- A program that calculates sales tax would store
  - Price of an item
  - Number purchased
  - Tax rate
  - Amount of sales tax
  - Name of item
  - Whether the item is taxable
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Characters

- Single symbols in single quotes
  - Example: ‘Q’
- Characters are stored as numbers and encoded using an arbitrary scheme
  - ASCII table http://www.asciitable.com
    - Used when data saved to your hard drive if your computer is from the U.S.

Characters

- Case sensitive
  - ‘a’ and ‘A’ are not the same thing
- Numbers can be characters too
  - Example: ‘7’
- Space is a character too: ‘ ‘

Find the char

- A program that calculates sales tax would store
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Logical values

- boolean
  - true
  - false
- Examples:
  - Whether sales tax is charged or not
  - Whether an item is in stock or not
  - If the dog has been fed
- What descriptive words tend to indicate that something is a boolean value?

Find the boolean

- A program that calculates sales tax would store
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iClicker Questions

- For each of the elements below, determine the proper type
  - Answer a: int
  - Answer b: double
  - Answer c: char
  - Answer d: boolean
- Whether a word is or is not in the dictionary
- A person's first initial
- The number of characters in a person's name

String

- Strings are not primitive data types
  - They are a sequence of char
- Example: “Raven”
  - Example: “R”, “8”, and “ “
  - Example: “” (empty String)
- Use double quotes (remember: single quotes are for char)
- Strings are our first example of objects
  - Made up of primitive data type char in sequence

Find the String

- A program that calculates sales tax would store
  - Price of an item
  - Number purchased
  - Tax rate
  - Amount of sales tax
  - Name of item
  - Whether the item is taxable
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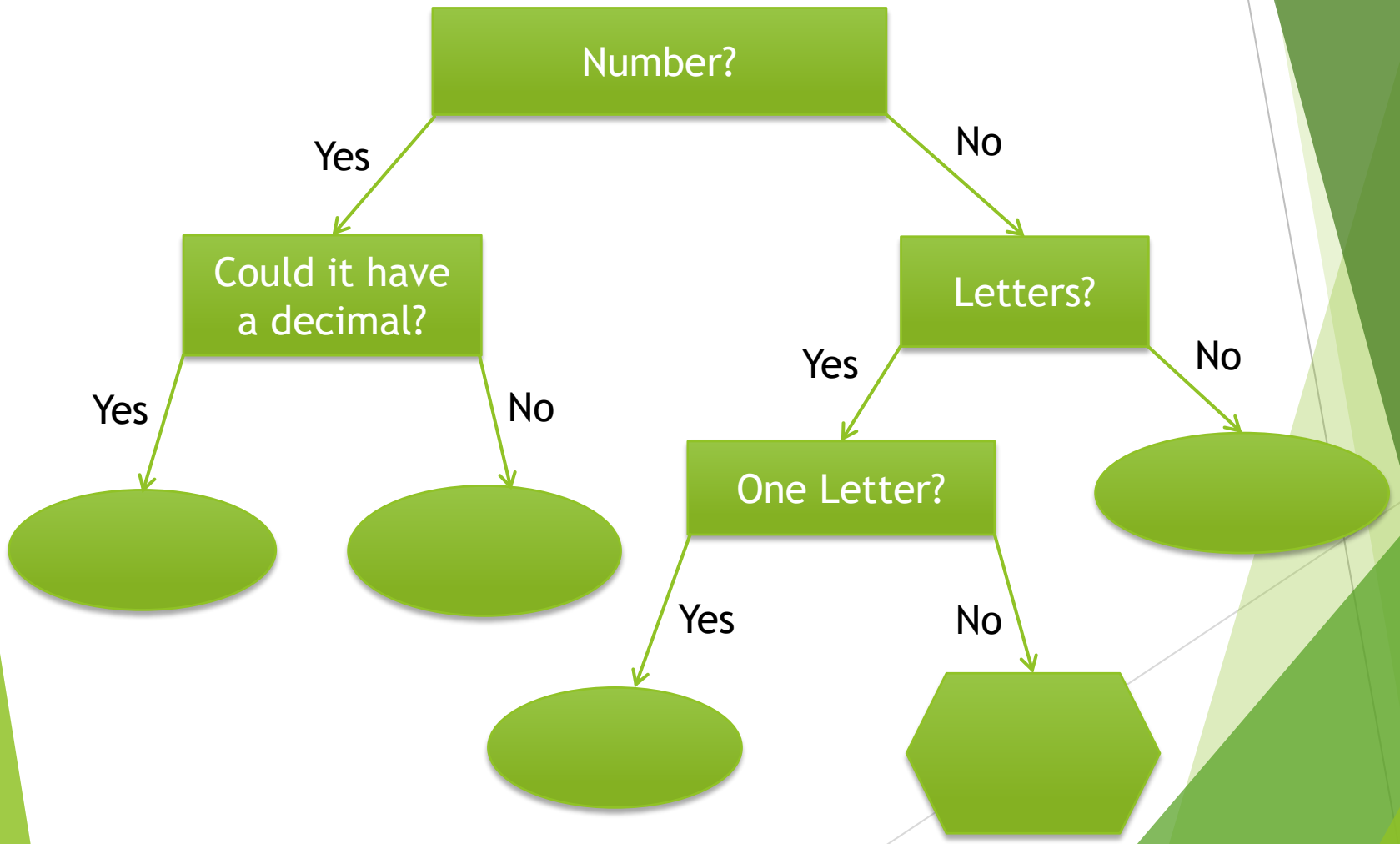
Fill in the Blanks

Alone, then with a neighbor, then we'll compare as a class



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- iClicker instructions correction (reminder)
  - iClicker Reef subscription is not needed with a remote.
  - Contact me if you purchased both a subscription and a remote, and I will help you get a refund.
- Turing's Craft enrollment difficulties
  - If you purchased access through the bookstore, your activation code can be found in your eLibrary.
  - Also, your email with the activation code may have been delayed. (Bookstore ran out of codes.)

iClicker Question Revisited

What happens if we add 1.0 to 7325420000000000000.0 (stored as a double)?

a) 7325420000000000000.0
b) 7325420000000000001.0
c) Something else

Let's use Eclipse to find out!

Variables

- Variables are locations in memory where we can store data
- Each variable has a type and a name
  - int
  - double
  - char
  - boolean
  - String
  - Must know type to know how to interpret 0's and 1's
- Variables can be changed at any time

Identifiers

- Identifiers are names we give variables
  - Easier than using addresses
- Rules
  - Alphanumeric (a to z and A to Z and 0 (zero) to 9)
    - Can't start with number
  - $, _ allowed, even at the start
    - But we won't use them
  - Java keywords not allowed
    - How do I know a keyword when I see it
      - Turns purple in eclipse
- Why can't identifiers start with a number?

Declare variables

- A variable declaration tells Java to set aside memory and give it a particular name.
- Example:

```
int size;
```

  Paraphrase: “I’m going to need to store an int in memory. Go get enough memory for me and name it size.”

- Each variable is declared only once
  - Why?

Conventions

- Everyday examples of social conventions
  - Driving on the right side of the road
  - Shaking hands with the right hand
- Java conventions for identifiers
  - Identifiers for primitive data start with small letters
  - Camel case
    - Subsequent words start with capital letters
- Longer variable names are generally better
  - Really bad habit: w, x, y, z, i, j, k

Example

- Declare variables to store
  - Number of cups of dog food Raven eats each day
  - Number of grams of dog food Raven eats each day
- Information
  - A gram weighs as much as a paper clip
  - Raven weighs 70 pounds and is hungry

Storing Data in Memory

```
int size;  // Declaration
size = 3; // Assignment statement
```

- Can combine

```
int size = 3;
```

- = stands for assignment
  - Not equality (that is ==)
- ***Take the value on the right and store it in the location on the left***
  - Asymmetric
  - Another example of a symbol that is totally different in CS than Math

Identifiers and Memory

- Computer memory
  - Identifier
  - Address
  - Location in memory
    - Stores 64 0's and 1's, but we won't show things this way
    - Interpreted by type
- Example

```
int age = 21 ;
int height = 68;
int weight = 120;
char finstInitial = 'F';
char middleInitial = 'S';
```

Identifier	Address	Contents
age	273	21
height	274	68
weight	275	120
firstInitial	276	'F'
middleInitial	277	'S'

Example

- int x = 3;
- x = 4;
- x = 5;
- Show memory diagram
- If you're thinking in Math, this is nonsense!
- Remember that = is storing in memory (assignment), not equality
  - Mentally pronounce = as "gets the value of " to help

iClicker Question

- Recall placement exam
  - int x = 10;
  - int y = 20;
  - y = x;
- What is stored in y?
  - Answer a: 10
  - Answer b: 20
  - Answer c: nothing

iClicker Question

int x = 4;

int y = 5;

Are the two statements below interchangeable (i.e. if you substituted one for the other would it be the same?)

```
x = y;

y = x;
```

- a: yes
- b: no

Write Java to store data

- A program that calculates sales tax would store
  - Price of an item
  - Number purchased
  - Tax rate
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