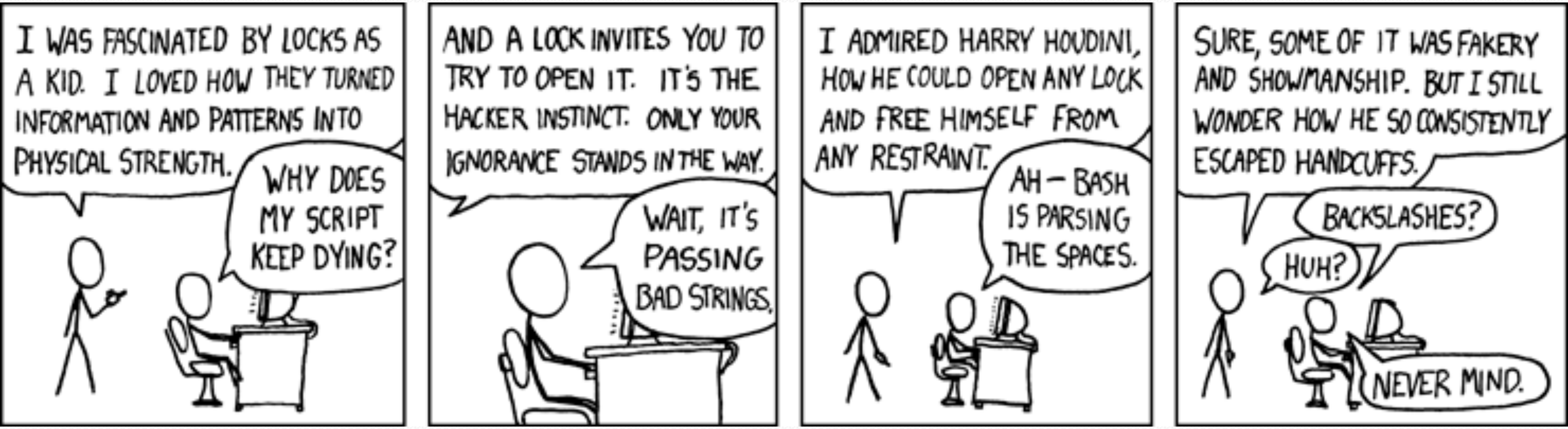

I WAS FASCINATED BY LOCKS AS A KID. I LOVED HOW THEY TURNED INFORMATION AND PATTERNS INTO PHYSICAL STRENGTH.
WHY DOES MY SCRIPT KEEP DYING?
AND A LOCK INVITES YOU TO TRY TO OPEN IT. IT'S THE HACKER INSTINCT. ONLY YOUR IGNORANCE STANDS IN THE WAY.
WAIT, IT'S PASSING BAD STRINGS.
I ADMIRED HARRY HOUDINI, HOW HE COULD OPEN ANY LOCK AND FREE HIMSELF FROM ANY RESTRAINT.
AH — BASH IS PARSING THE SPACES.
SURE, SOME OF IT WAS FAKERY AND SHOWMANSHIP. BUT I STILL WONDER HOW HE SO CONSISTENTLY ESCAPED HANDCUFFS.
BACKSLASHES?
HUH?
NEVER MIND.

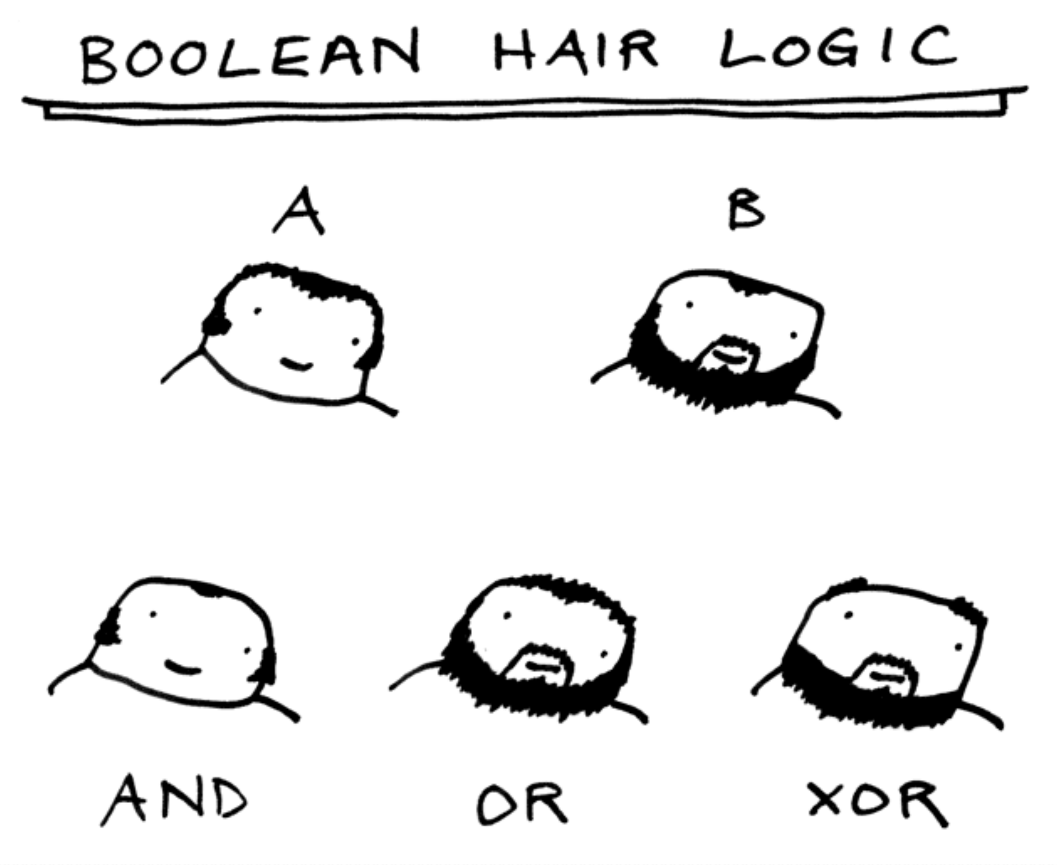
Building Java Programs

Chapter 4

Lecture 4-2: Advanced `if/else`; Cumulative sum;

String/char

reading: 4.2, 4.4 - 4.5

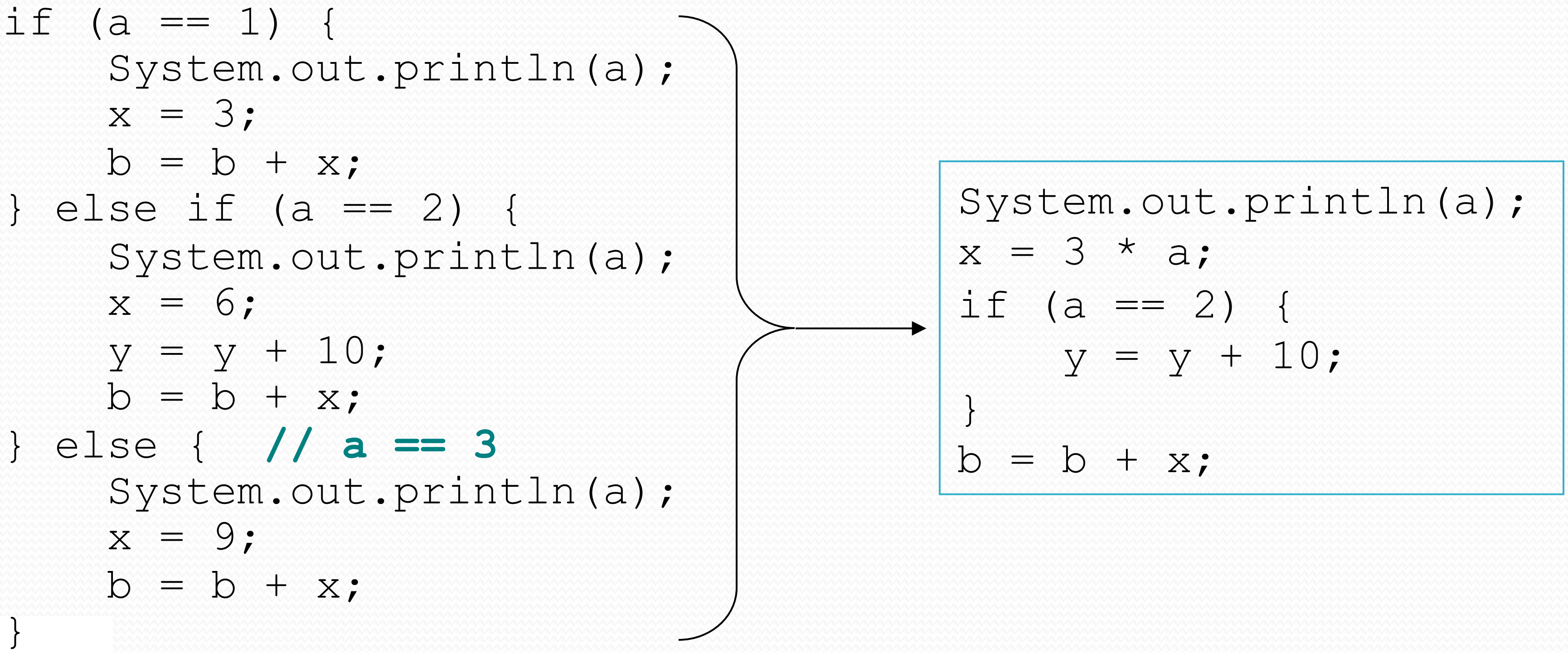

BOOLEAN HAIR LOGIC
A
B
AND
OR
XOR

Advanced `if/else`

reading: 4.4 - 4.5

Factoring `if/else` code

- **factoring**: Extracting common/redundant code.
  - Can reduce or eliminate redundancy from `if/else` code.
- Example:



```
if (a == 1) {
    System.out.println(a);
    x = 3;
    b = b + x;
} else if (a == 2) {
    System.out.println(a);
    x = 6;
    y = y + 10;
    b = b + x;
} else {  // a == 3
    System.out.println(a);
    x = 9;
    b = b + x;
}
```

```
System.out.println(a);
x = 3 * a;
if (a == 2) {
    y = y + 10;
}
b = b + x;
```

The "dangling if" problem

- What can be improved about the following code?

```
if (x < 0) {
    System.out.println("x is negative");
} else if (x >= 0) {
    System.out.println("x is non-negative");
}
```

- The second if test is unnecessary and can be removed:

```
if (x < 0) {
    System.out.println("x is negative");
} else {
    System.out.println("x is non-negative");
}
```

  - This is also relevant in methods that use `if` with `return`...

if/else with return

```
// Returns the larger of the two given integers.
public static int max(int a, int b) {
    if (a > b) {
        return a;
    } else {
        return b;
    }
}
```

- Methods can return different values using `if/else`
  - Whichever path the code enters, it will return that value.
  - Returning a value causes a method to immediately exit.
  - All paths through the code must reach a `return` statement.

All paths must return

```
public static int max(int a, int b) {
    if (a > b) {
        return a;
    }
    // Error: not all paths return a value
}
```

- The following also does not compile:

```
public static int max(int a, int b) {
    if (a > b) {
        return a;
    } else if (b >= a) {
        return b;
    }
}
```

  - The compiler thinks `if/else/if` code might skip all paths, even though mathematically it must choose one or the other.

Logical operators

- Tests can be combined using *logical operators*:

Operator	Description	Example	Result
`&&`	and	`(2 == 3) && (-1 < 5)`	`false`
`||`	or	`(2 == 3) || (-1 < 5)`	`true`
`!`	not	`!(2 == 3)`	`true`

- "Truth tables" for each, used with logical values *p* and *q*:

p	q	p && q	p || q
true	true	true	true
true	false	false	true
false	true	false	true
false	false	false	false

p	!p
true	false
false	true

Evaluating logical expressions

- Relational operators have lower precedence than math; logical operators have lower precedence than relational operators

```
5 * 7 >= 3 + 5 * (7 - 1) && 7 <= 11
5 * 7 >= 3 + 5 * 6 && 7 <= 11
35    >= 3 + 30 && 7 <= 11
35    >= 33 && 7 <= 11
true && true
true
```

- Relational operators cannot be "chained" as in algebra

```
2 <= x <= 10
true   <= 10
Error!
```

(assume that `x` is `15`)

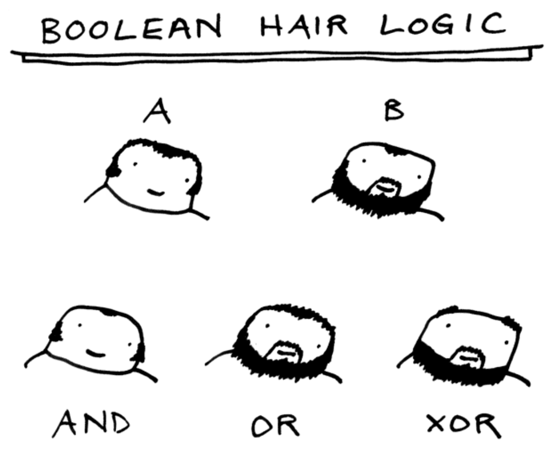
  - Instead, combine multiple tests with `&&` or `||`

```
2 <= x && x <= 10
true   && false
false
```

Logical questions

- What is the result of each of the following expressions?

```
int x = 42;
int y = 17;
int z = 25;
```



- `y < x && y <= z`
- `x % 2 == y % 2 || x % 2 == z % 2`
- `x <= y + z && x >= y + z`
- `!(x < y && x < z)`
- `(x + y) % 2 == 0 || !((z - y) % 2 == 0)`

  - Answers: `true`, `false`, `true`, `true`, `false`

Cumulative algorithms

reading: 4.2

Adding many numbers

- How would you find the sum of all integers from 1-1000?

```
// This may require a lot of typing
int sum = 1 + 2 + 3 + 4 + ... ;
System.out.println("The sum is " + sum);
```

- What if we want the sum from 1 - 1,000,000?
  Or the sum up to any maximum?
  - How can we generalize the above code?

Cumulative sum loop

```
int sum = 0;
for (int i = 1; i <= 1000; i++) {
    sum = sum + i;
}
System.out.println("The sum is " + sum);
```

- **cumulative sum**: A variable that keeps a sum in progress and is updated repeatedly until summing is finished.
  - The `sum` in the above code is an attempt at a cumulative sum.
  - Cumulative sum variables must be declared *outside* the loops that update them, so that they will still exist after the loop.

Cumulative product

- This cumulative idea can be used with other operators:

```
int product = 1;
for (int i = 1; i <= 20; i++) {
    product = product * 2;
}
System.out.println("2 ^ 20 = " + product);
```

  - How would we make the base and exponent adjustable?

`Scanner` and cumulative sum

- We can do a cumulative sum of user input:

```
Scanner console = new Scanner(System.in);
int sum = 0;
for (int i = 1; i <= 100; i++) {
    System.out.print("Type a number: ");
    sum = sum + console.nextInt();
}
System.out.println("The sum is " + sum);
```

Cumulative sum question

- Modify the `Receipt` program from Ch. 2.
    - Prompt for how many people, and each person's dinner cost.
    - Use static methods to structure the solution.

- Example log of execution:

```
How many people ate? 4
Person #1: How much did your dinner cost? 20.00
Person #2: How much did your dinner cost? 15
Person #3: How much did your dinner cost? 30.0
Person #4: How much did your dinner cost? 10.00

Subtotal: $75.0
Tax: $6.0
Tip: $11.25
Total: $92.25
```

Cumulative sum answer

```
// This program enhances our Receipt program using a cumulative sum.
import java.util.*;

public class Receipt2 {
    public static void main(String[] args) {
        Scanner console = new Scanner(System.in);
        double subtotal = meals(console);
        results(subtotal);
    }

    // Prompts for number of people and returns total meal subtotal.
    public static double meals(Scanner console) {
        System.out.print("How many people ate? ");
        int people = console.nextInt();
        double subtotal = 0.0;            // cumulative sum

        for (int i = 1; i <= people; i++) {
            System.out.print("Person #" + i +
                             ": How much did your dinner cost? ");
            double personCost = console.nextDouble();
            subtotal = subtotal + personCost;  // add to sum
        }
        return subtotal;
    }
    ...
```

Cumulative answer, cont'd.

```
    ...

    // Calculates total owed, assuming 8% tax and 15% tip
    public static void results(double subtotal) {
        double tax = subtotal * .08;
        double tip = subtotal * .15;
        double total = subtotal + tax + tip;

        System.out.println("Subtotal: $" + subtotal);
        System.out.println("Tax: $" + tax);
        System.out.println("Tip: $" + tip);
        System.out.println("Total: $" + total);
    }
}
```

if/else, return question

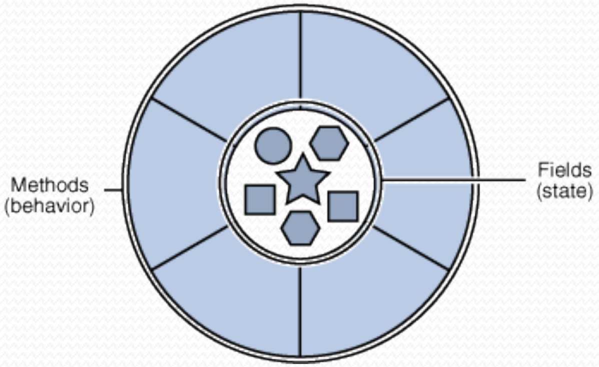
- Write a method countFactors that returns the number of factors of an integer.
  - countFactors(24) returns 8 because 1, 2, 3, 4, 6, 8, 12, and 24 are factors of 24.

- Solution:

```
// Returns how many factors the given number has.
public static int countFactors(int number) {
    int count = 0;
    for (int i = 1; i <= number; i++) {
        if (number % i == 0) {
            count++;  // i is a factor of number
        }
    }
    return count;
}
```

Objects (usage)

- **object:** An entity that contains data and behavior.
  - *data*: variables inside the object
  - *behavior*: methods inside the object
    - You interact with the methods; the data is hidden in the object.
    - A **class** is a type of objects.



- Constructing (creating) an object:

  Type objectName = new **Type**(**parameters**);

- Calling an object's method:

  objectName.**methodName**(**parameters**);

Strings

- **string**: An object storing a sequence of text characters.
  - Unlike most other objects, a `String` is not created with `new`.

```
String name = "text";
String name = expression;
```

  - Examples:

```
String name = "Marla Singer";
int x = 3;
int y = 5;
String point = "(" + x + ", " + y + ")";
```

Indexes

- Characters of a string are numbered with 0-based *indexes*:

```
String name = "Ultimate";
```

index	0	1	2	3	4	5	6	7
character	U	l	t	i	m	a	t	e

  - First character's index : 0
  - Last character's index : 1 less than the string's length

  - The individual characters are values of type `char` (seen later)

`String` methods

Method name	Description
`indexOf(`**`str`**`)`	index where the start of the given string appears in this string (-1 if not found)
`length()`	number of characters in this string

`substring(`**`index1`**`, `**`index2`**`)`
or
`substring(`**`index1`**`)`
	the characters in this string from *index1* (inclusive) to *index2* (exclusive);
	if *index2* is omitted, grabs till end of string

`toLowerCase()`	a new string with all lowercase letters
`toUpperCase()`	a new string with all uppercase letters

- These methods are called using the dot notation:

```
String starz = "Yeezy & Hova";
System.out.println(starz.length());   // 12
```

String method examples

```
// index     012345678901
String s1 = "Stuart Reges";
String s2 = "Marty Stepp";

System.out.println(s1.length());         // 12
System.out.println(s1.indexOf("e"));     // 8
System.out.println(s1.substring(7, 10)); // "Reg"

String s3 = s2.substring(1, 7);
System.out.println(s3.toLowerCase());    // "arty s"
```

- Given the following string:

```
// index       0123456789012345678901
String book = "Building Java Programs";
```

  - How would you extract the word "Java" ?

Modifying strings

- Methods like `substring` and `toLowerCase` build and return a new string, rather than modifying the current string.

```
String s = "Aceyalone";
s.toUpperCase();
System.out.println(s);    // Aceyalone
```

- To modify a variable's value, you must reassign it:

```
String s = "Aceyalone";
s = s.toUpperCase();
System.out.println(s);    // ACEYALONE
```

Strings as user input

- `Scanner`'s `next` method reads a word of input as a `String`.

```
Scanner console = new Scanner(System.in);
System.out.print("What is your name? ");
String name = console.next();
name = name.toUpperCase();
System.out.println(name + " has " + name.length() +
    " letters and starts with " + name.substring(0, 1));
```

Output:

```
What is your name? Nas
NAS has 3 letters and starts with N
```

- The `nextLine` method reads a line of input as a `String`.

```
System.out.print("What is your address? ");
String address = console.nextLine();
```

Name border

```
HELENE
HELEN
HELE
HEL
HE
H
HE
HEL
HELE
HELEN
HELENE
MARTIN
MARTI
MART
MAR
MA
M
MA
MAR
MART
MARTI
MARTIN
```

- Prompt the user for full name
- Draw out the pattern to the left
- This should be resizable. Size 1 is shown and size 2 would have the first name twice followed by last name twice

Strings question

- Write a program that reads two people's first names and suggests a name for their child

Example Output:

```
Parent 1 first name? Danielle
Parent 2 first name? John
Child Gender? f
Suggested baby name: JODANI

Parent 1 first name? Danielle
Parent 2 first name? John
Child Gender? Male
Suggested baby name: DANIJO
```

The equals method

- Objects are compared using a method named `equals`.

```
Scanner console = new Scanner(System.in);
System.out.print("What is your name? ");
String name = console.next();
if (name.equals("Lance")) {
    System.out.println("Pain is temporary.");
    System.out.println("Quitting lasts forever.");
}
```

  - Technically this is a method that returns a value of type `boolean`, the type used in logical tests.

String test methods

Method	Description
equals(**str**)	whether two strings contain the same characters
equalsIgnoreCase(**str**)	whether two strings contain the same characters, ignoring upper vs. lower case
startsWith(**str**)	whether one contains other's characters at start
endsWith(**str**)	whether one contains other's characters at end
contains(**str**)	whether the given string is found within this one

```
String name = console.next();
if(name.endsWith("Kweli")) {
   System.out.println("Pay attention, you gotta listen to hear.");
} else if(name.equalsIgnoreCase("NaS")) {
   System.out.println("I never sleep 'cause sleep is the cousin of
                     death.");
}
```

Type `char`

- `char` : A primitive type representing single characters.
  - Each character inside a `String` is stored as a `char` value.
  - Literal `char` values are surrounded with apostrophe (single-quote) marks, such as `'a'` or `'4'` or `'\n'` or `'\''`
  - It is legal to have variables, parameters, returns of type `char`

```
char letter = 'S';
System.out.println(letter);               // S
```

- `char` values can be concatenated with strings.

```
char initial = 'P';
System.out.println(initial + " Diddy");  // P Diddy
```

The `charAt` method

- The `char`s in a `String` can be accessed using the `charAt` method.

```
String food = "cookie";
char firstLetter = food.charAt(0);    // 'c'

System.out.println(firstLetter + " is for " + food);
System.out.println("That's good enough for me!");
```

- You can use a `for` loop to print or examine each character.

```
String major = "CSE";
for (int i = 0; i < major.length(); i++) {
    char c = major.charAt(i);
    System.out.println(c);
}
```

Output:

```
C
S
E
```

char vs. String

- "h" is a String
  'h' is a char   (the two behave differently)

- String is an object; it contains methods

```
String s = "h";
s = s.toUpperCase();        // 'H'
int len = s.length();       //  1
char first = s.charAt(0);   // 'H'
```

- char is primitive; you can't call methods on it

```
char c = 'h';
c = c.toUpperCase();   // ERROR: "cannot be dereferenced"
```

- What is s + 1 ? What is c + 1 ?
- What is s + s ? What is c + c ?

`char` vs. `int`

- All `char` values are assigned numbers internally by the computer, called *ASCII* values.
  - Examples:

    `'A'` is 65, `'B'` is 66, `' '` is 32

    `'a'` is 97, `'b'` is 98, `'*'` is 42
  - Mixing `char` and `int` causes automatic conversion to `int`.

    `'a' + 10` is 107, `'A' + 'A'` is 130
  - To convert an `int` into the equivalent `char`, type-cast it.

    `(char) ('a' + 2)` is `'c'`

Comparing `char` values

- You can compare `char` values with relational operators:

  `'a' < 'b'` and `'X' == 'X'` and `'Q' != 'q'`

  - An example that prints the alphabet:

```
for (char c = 'a'; c <= 'z'; c++) {
    System.out.print(c);
}
```

- You can test the value of a string's character:

```
String word = console.next();
if (word.charAt(word.length() - 1) == 's') {
    System.out.println(word + " is plural.");
}
```

String/char question

- A *Caesar cipher* is a simple encryption where a message is encoded by shifting each letter by a given amount.
  - e.g. with a shift of 3, A → D, H → K, X → A, and Z → C

- Write a program that reads a message from the user and performs a Caesar cipher on its letters:

```
Your secret message: Brad thinks Angelina is cute
Your secret key: 3
The encoded message: eudg wklqnv dqjholqd lv fxwh
```

Strings answer 1

```
// This program reads a message and a secret key from the user and
// encrypts the message using a Caesar cipher, shifting each letter.

import java.util.*;

public class SecretMessage {
    public static void main(String[] args) {
        Scanner console = new Scanner(System.in);

        System.out.print("Your secret message: ");
        String message = console.nextLine();
        message = message.toLowerCase();

        System.out.print("Your secret key: ");
        int key = console.nextInt();

        encode(message, key);
    }

    ...
```

Strings answer 2

```
    // This method encodes the given text string using a Caesar
    // cipher, shifting each letter by the given number of places.
    public static void encode(String text, int shift) {
        System.out.print("The encoded message: ");
        for (int i = 0; i < text.length(); i++) {
            char letter = text.charAt(i);

            // shift only letters (leave other characters alone)
            if (letter >= 'a' && letter <= 'z') {
                letter = (char) (letter + shift);

                // may need to wrap around
                if (letter > 'z') {
                    letter = (char) (letter - 26);
                } else if (letter < 'a') {
                    letter = (char) (letter + 26);
                }
            }
            System.out.print(letter);
        }
        System.out.println();
    }
}
```