What is a program? What is code?

- Instructions in a language a computer executes
  - Languages have different characteristics, strengths, weaknesses
  - Scheme, BASIC, C++, Fortran, Java, Perl, PHP, ...

- Computer executes one instruction at a time
  - Memory and state of machine change
  - Execute the next instruction
  - Repeat
  - Stop, run out of memory, pull plug, ...

Creating a Program

- Specify the problem
  - remove ambiguities
  - identify constraints
- Develop algorithms, design classes, design software architecture
- Implement program
  - revisit design
  - test, code, debug
  - revisit design
- Documentation, testing, maintenance of program
- From ideas to electrons

Writing and Understanding Java

- Language independent skills in programming
  - What is a loop, how do you design a program?
  - What is an array, how do you access files?

- However, writing programs in any language requires understanding the syntax and semantics of the programming language
  - Syntax is similar to rules of spelling and grammar:
    - i before e except after c
    - Two spaces after a period, then use a capital letter

Syntax and Semantics

- Semantics is what a program (or English sentence) means
  - You ain’t nothing but a hound dog.
  - La chienne de ma tante est sur votre tete.

- At first it seems like the syntax is hard to master, but the semantics are much harder
  - Natural languages are more forgiving than programming languages.
Toward an Understanding of Java

- Traditional first program, doesn’t convey power of computing but it illustrates basic components of a simple program

```java
public class SayHello {
    // traditional first program
    public static void main(String[] args) {
        System.out.println("Hello World!");
    }
}
```

- This program must be edited/typed, compiled and executed

Methods/Functions can return values

- What does the square root function do?
  - When called with parameters of 4, 6.2, -1
- What does the method getGcount() return?

```java
public class DNAstuff {
    public int getGcount(String dna) {
        int total = 0;
        for(int k=0; k < dna.length(); k++){
            if (dna.charAt(k) == 'g'){
                total = total + 1;
            }
        }
        return total;
    }
}
```

Control in Java and Programming

- The computer executes your program one statement at a time, from top to bottom within the method/function that’s called.

```java
public int daysIn(int month) {
    if (month == 1) return 31;
    if (month == 2) return 28;
    if (month == 3) return 31;
    ...
}
```

- What is the anatomy of a function? Of an if-statement? How do we specify these?

Lydia Kavraki

- Awards
  - Grace Murray Hopper
  - Brilliant 10

“I like to work on problems that will generally improve the quality of our life,”

What’s the thing you love most about science?

“Working with students and interacting with people from diverse intellectual backgrounds. Discovery and the challenge of solving a tough problem, especially when it can really affect the quality of our lives. I find the whole process energizing.”
**Anatomy of a method**

```java
public Type Name(parameter-list) {
    statement-list
}
```

```java
parameter-list:: empty-list || non-empty-list
non-empty-list:: Type Name
non-empty-list:: Type Name, non-empty-list
if ( boolean-expression ) {
    statement-list
}
```

**zero-one, true-false, boolean**

```java
if ( a == b ) {
    statement-list
}
```

```java
if ( a relational-operator b ) {
    statement-list
}
```

```java
if ( bool-expr conditional bool-expr ) {...}
if ( boolean-function ) {...}
```

**John Kemeny (1926-1982)**

Invented BASIC, assistant to Einstein, Professor and President of Dartmouth

"If you have a large number of unrelated ideas, you have to get quite a distance away from them to get a view of all of them, and this is the role of abstraction."

"...it is the greatest achievement of a teacher to enable his students to surpass him."

**Anatomy of for-loop**

```java
String s = new String("AGTCCG");
String rs = new String(""");
for(int k=0; k < 3; k++){
    rs = rs + s.charAt(k);
}
```

- Initialization happens once
- Loop test evaluated
- If true body executes
- If false skip after loop
- After loop body, increment executed and test re-evaluated
- What should be true about test?
- What about body?
- What about together?
Program Style

- People who use your program don’t read your code
  - You’ll write programs to match user needs

- People who maintain or modify your program do read code
  - Must be readable, understandable without you next door
  - Use a consistent programming style, adhere to conventions

- Identifiers are names of functions, parameters, (variables, classes, …)
  - Sequence of letters, numbers, underscore _ characters
  - Cannot begin with a number (we won’t begin with _)
  - big_head vs. BigHead, we’ll use AlTeRnAtInG format
  - Make identifiers meaningful, not droll and witty

Equality of values and objects

```java
int x = 3*12;
if (x == 36) {is-executed}
String s = new String("genetic");
String t = s.substring(0,4);
if (t == "gene") {not executed}
if (t.equals("gene")) {is-executed}
```

- Primitive types are boxes
  - Object types are labels on boxes
    - If we don’t call new there’s no box for the label
    - No box is called null, it means no object referred to or referenced by variable/pointer/reference

Objects and values

- Primitive variables are boxes
  - think memory location with value
- Object variables are labels that are put on boxes
  ```java
  String s = new String("genome");
  String t = new String("genome");
  if (s == t) {they label the same box}
  if (s.equals(t)) {contents of boxes the same}
  ```
  - What’s in the boxes? "genome" is in the boxes

Objects, values, classes

- For primitive types: int, char, double, boolean
  - Variables have names and are themselves boxes (metaphorically)
  - Two int variables assigned 17 are equal with ==
- For object types: String, Sequence, others
  - Variables have names and are labels for boxes
  - If no box assigned, created, then label applied to null
  - Can assign label to existing box (via another label)
  - Can create new box using new
- Object types are references or pointers or labels to storage
Don Knuth (Art of Programming)

"My feeling is that when we prepare a program, it can be like composing poetry or music; as Andrei Ershov has said, programming can give us both intellectual and emotional satisfaction, because it is a real achievement to master complexity and to establish a system of consistent rules."

“We have seen that computer programming is an art, because it applies accumulated knowledge to the world, because it requires skill and ingenuity, and especially because it produces objects of beauty.”

Ada Lovelace, 1816-1853

- Daughter of Byron, advocate of work of Charles Babbage, designer of early “computer” (the Analytical Engine)
  - Made Babbage’s work accessible
  - “It would weave algebraic patterns the way the Jacquard loom wove patterns in textiles”
- Tutored in mathematics by Augustus de Morgan
- Marched around the billiard table playing the violin
- Ada is a notable programming language