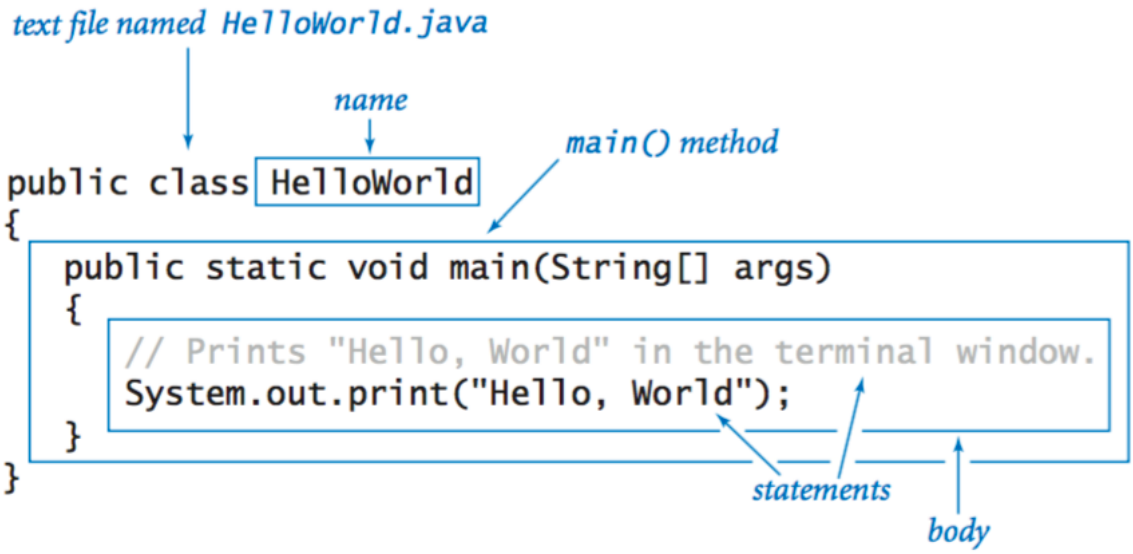
Search

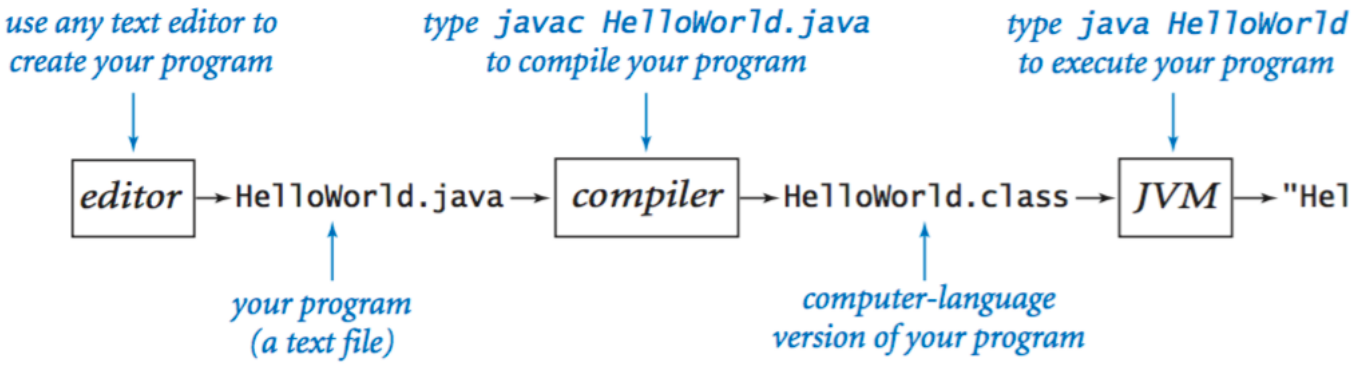
Appendix D: Java Programming Cheatsheet

This appendix summarizes the most commonly-used Java language features in the textbook. Here are the APIs of the most common libraries.

Hello, World.



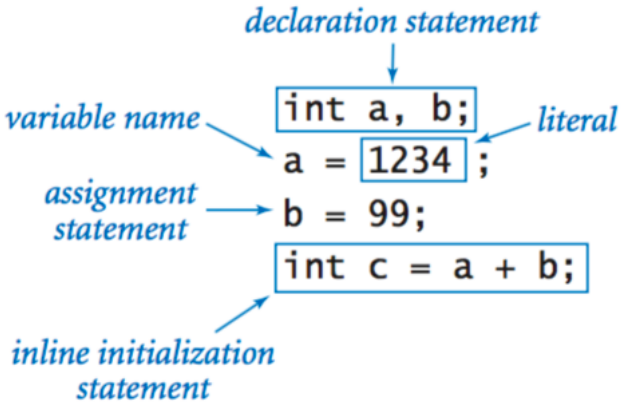
Editing, compiling, and executing.



Built-in data types.

type	*set of values*	*common operators*	*sample literal v*
`int`	integers	`+ - * / %`	`99 12 214748`
`double`	floating-point numbers	`+ - * /`	`3.14 2.5 6.0`
`boolean`	boolean values	`&& || !`	`true fals`
`char`	characters		`'A' '1' '%'`
`String`	sequences of characters	`+`	`"AB" "Hello"`

Declaration and assignment statements.



Integers.

values	integers between -2^{31} and $+2^{31}-1$					
typical literals	`1234 99 0 1000000`					
operations	*sign*	*add*	*subtract*	*multiply*	*divide*	*re*
operators	`+ -`	`+`	`-`	`*`	`/`	

expression	*value*	*comment*
`99`	`99`	*integer literal*
`+99`	`99`	*positive sign*
`-99`	`-99`	*negative sign*
`5 + 3`	`8`	*addition*
`5 - 3`	`2`	*subtraction*
`5 * 3`	`15`	*multiplication*
`5 / 3`	`1`	*no fractional part*
`5 % 3`	`2`	*remainder*
`1 / 0`		*run-time error*
`3 * 5 - 2`	`13`	** has precedence*
`3 + 5 / 2`	`5`	*/ has precedence*
`3 - 5 - 2`	`-4`	*left associative*
`( 3 - 5 ) - 2`	`-4`	*better style*
`3 - ( 5 - 2 )`	`0`	*unambiguous*

Floating-point numbers.

values	real numbers (specified by IEEE 754 standard)			
typical literals	`3.14159`	`6.022e23`	`2.0`	`1.4142135623730951`
operations	*add*	*subtract*	*multiply*	*divide*
operators	`+`	`-`	`*`	`/`

expression	*value*
`3.141 + 2.0`	`5.141`
`3.141 - 2.0`	`1.111`
`3.141 / 2.0`	`1.5705`
`5.0 / 3.0`	`1.6666666666666667`
`10.0 % 3.141`	`0.577`
`1.0 / 0.0`	`Infinity`
`Math.sqrt(2.0)`	`1.4142135623730951`
`Math.sqrt(-1.0)`	`NaN`

Booleans.

values	*true or false*		
literals	`true`	`false`	
operations	and	or	not
operators	&&	||	!

a	*!a*
`true`	`false`
`false`	`true`

a	*b*	*a && b*	*a || b*
`false`	`false`	`false`	`false`
`false`	`true`	`false`	`true`
`true`	`false`	`false`	`true`
`true`	`true`	`true`	`true`

Comparison operators.

op	*meaning*	*true*	*false*
`==`	*equal*	`2 == 2`	`2 == 3`
`!=`	*not equal*	`3 != 2`	`2 != 2`
`<`	*less than*	`2 < 13`	`2 < 2`
`<=`	*less than or equal*	`2 <= 2`	`3 <= 2`
`>`	*greater than*	`13 > 2`	`2 > 13`
`>=`	*greater than or equal*	`3 >= 2`	`2 >= 3`

non-negative discriminant?	`(b*b - 4.0*a*c) >= 0.0`
beginning of a century?	`(year % 100) == 0`
legal month?	`(month >= 1) && (month <= 12)`

Printing.

`void System.out.print(String s)`	*print s*
`void System.out.println(String s)`	*print s, followed by a newline*
`void System.out.println()`	*print a newline*

Parsing command-line arguments.

`int Integer.parseInt(String s)`	*convert s to an int value*
`double Double.parseDouble(String s)`	*convert s to a double value*
`long Long.parseLong(String s)`	*convert s to a long value*

Math library.

`public class Math`

`double abs(double a)`	*absolute value of a*
`double max(double a, double b)`	*maximum of a and b*
`double min(double a, double b)`	*minimum of a and b*
`double sin(double theta)`	*sine of theta*
`double cos(double theta)`	*cosine of theta*
`double tan(double theta)`	*tangent of theta*
`double toRadians(double degrees)`	*convert angle from degrees to*
`double toDegrees(double radians)`	*convert angle from radians to*
`double exp(double a)`	*exponential* (e^a)
`double log(double a)`	*natural log* ($\log_e a$, *or* $\ln a$)
`double pow(double a, double b)`	*raise a to the bth power* (a^b)
`long round(double a)`	*round a to the nearest intege*
`double random()`	*random number in* [0, 1)
`double sqrt(double a)`	*square root of a*
`double E`	*value of e (constant)*
`double PI`	*value of π (constant)*

The full java.lang.Math API.

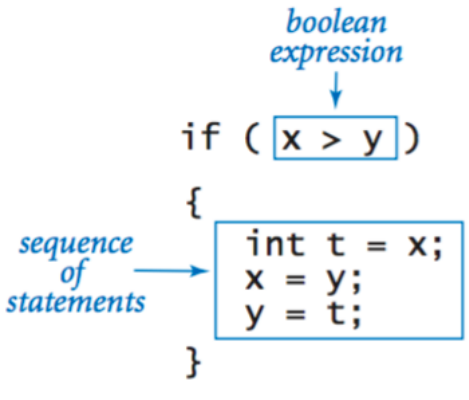
Java library calls.

method call	*library*	*return type*	*value*
`Integer.parseInt("123")`	`Integer`	`int`	`123`
`Double.parseDouble("1.5")`	`Double`	`double`	`1.5`
`Math.sqrt(5.0*5.0 - 4.0*4.0)`	`Math`	`double`	`3.0`
`Math.log(Math.E)`	`Math`	`double`	`1.0`
`Math.random()`	`Math`	`double`	*random in* [0, 1)
`Math.round(3.14159)`	`Math`	`long`	`3`
`Math.max(1.0, 9.0)`	`Math`	`double`	`9.0`

Type conversion.

expression	*expression type*	*expression value*
`(1 + 2 + 3 + 4) / 4.0`	`double`	`2.5`
`Math.sqrt(4)`	`double`	`2.0`
`"1234" + 99`	`String`	`"123499"`
`11 * 0.25`	`double`	`2.75`
`(int) 11 * 0.25`	`double`	`2.75`
`11 * (int) 0.25`	`int`	`0`
`(int) (11 * 0.25)`	`int`	`2`
`(int) 2.71828`	`int`	`2`
`Math.round(2.71828)`	`long`	`3`
`(int) Math.round(2.71828)`	`int`	`3`
`Integer.parseInt("1234")`	`int`	`1234`

Anatomy of an if statement.



If and if-else statements.

absolute value	`if (x < 0) x = -x;`

put the smaller value in x and the larger value in y	`if (x > y)`
	`{`
	`  int t = x;`
	`  x = y;`
	`  y = t;`
	`}`

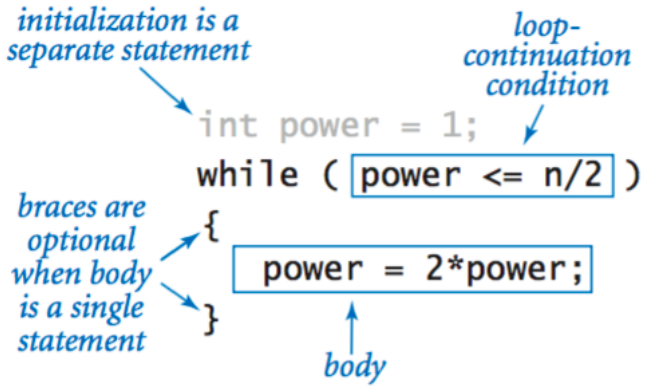
maximum of x and y	`if (x > y) max = x;` `else  max = y;`
error check for division operation	`if (den == 0) System.out.println("Division by zero");` `else  System.out.println("Quotient = " + num/`

error check for quadratic formula	`double discriminant = b*b - 4.0*c;`
	`if (discriminant < 0.0)`
	`{`
	`  System.out.println("No real roots");`
	`}`
	`else`
	`{`
	`  System.out.println((-b + Math.sqrt(discriminant))/`
	`  System.out.println((-b - Math.sqrt(discriminant))/`
	`}`

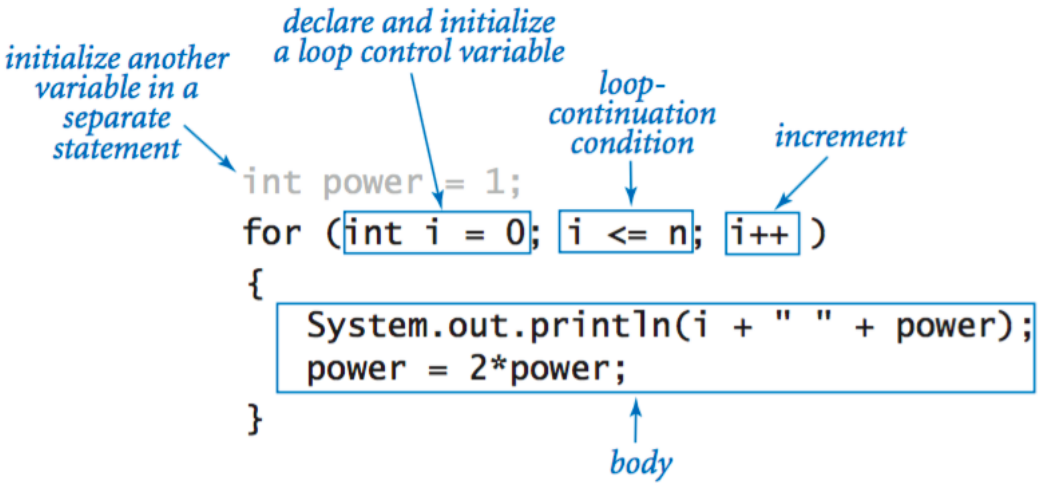
Nested if-else statement.

```
if      (income <      0) rate = 0.00;
else if (income <   8925) rate = 0.10;
else if (income <  36250) rate = 0.15;
else if (income <  87850) rate = 0.23;
else if (income < 183250) rate = 0.28;
else if (income < 398350) rate = 0.33;
else if (income < 400000) rate = 0.35;
else                      rate = 0.396;
```

Anatomy of a while loop.



Anatomy of a for loop.



Loops.

compute the largest power of 2 less than or equal to n	`int power = 1;`
	`while (power <= n/2)`
	`  power = 2*power;`
	`System.out.println(power);`

compute a finite sum $(1 + 2 + \ldots + n)$	`int sum = 0;`
	`for (int i = 1; i <= n; i++)`
	`  sum += i;`
	`System.out.println(sum);`

compute a finite product $(n! = 1 \times 2 \times \ldots \times n)$	`int product = 1;`
	`for (int i = 1; i <= n; i++)`
	`  product *= i;`
	`System.out.println(product);`

print a table of function values	`for (int i = 0; i <= n; i++)` `  System.out.println(i + " " + 2*Math.PI*i/`

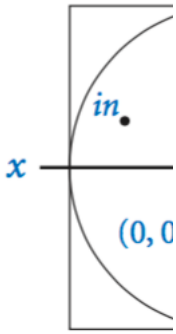
compute the ruler function (see PROGRAM 1.2.1)	`String ruler = "1";`
	`for (int i = 2; i <= n; i++)`
	`  ruler = ruler + " " + i + " " + ruler;`
	`System.out.println(ruler);`

Break statement.

```
int factor;
for (factor = 2; factor <= n/factor; factor++)
   if (n % factor == 0) break;

if (factor > n/factor)
   System.out.println(n + " is prime");
```

Do-while loop.

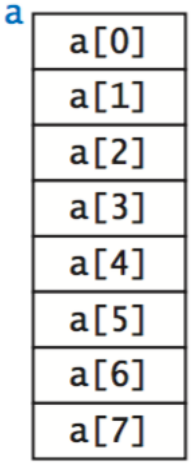
```
do
{  // Scale x and y to be random in (-1, 1).
   x = 2.0*Math.random() - 1.0;
   y = 2.0*Math.random() - 1.0;
} while (Math.sqrt(x*x + y*y) > 1.0);
```



Switch statement.

```
switch (day) {
   case 0: System.out.println("Sun"); break;
   case 1: System.out.println("Mon"); break;
   case 2: System.out.println("Tue"); break;
   case 3: System.out.println("Wed"); break;
   case 4: System.out.println("Thu"); break;
   case 5: System.out.println("Fri"); break;
   case 6: System.out.println("Sat"); break;
}
```

Arrays.



Inline array initialization.

```
String[] SUITS = { "Clubs", "Diamonds", "Hearts", "Spades"

String[] RANKS = {
   "2", "3", "4", "5", "6", "7", "8", "9", "10",
   "Jack", "Queen", "King", "Ace"
};
```

Typical array-processing code.

create an array with random values	`double[] a = new double[n];`
	`for (int i = 0; i < n; i++)`
	`  a[i] = Math.random();`

print the array values, one per line	`for (int i = 0; i < n; i++)` `  System.out.println(a[i]);`

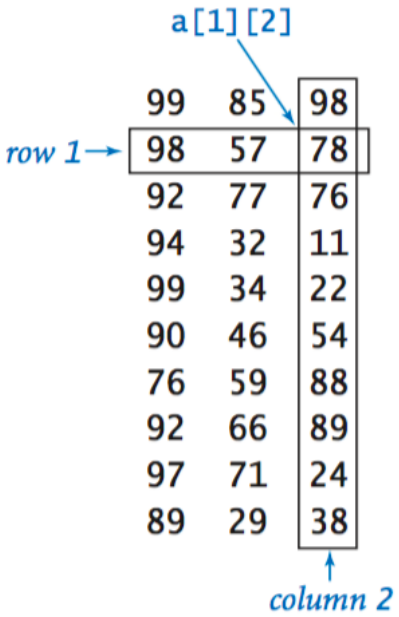
find the maximum of the array values	`double max = Double.NEGATIVE_INFINITY;`
	`for (int i = 0; i < n; i++)`
	`  if (a[i] > max) max = a[i];`

compute the average of the array values	`double sum = 0.0;`
	`for (int i = 0; i < n; i++)`
	`  sum += a[i];`
	`double average = sum / n;`

reverse the values within an array	`for (int i = 0; i < n/2; i++)`
	`{`
	`  double temp = a[i];`
	`  a[i] = a[n-1-i];`
	`  a[n-i-1] = temp;`
	`}`

copy sequence of values to another array	`double[] b = new double[n];`
	`for (int i = 0; i < n; i++)`
	`  b[i] = a[i];`

Two-dimensional arrays.



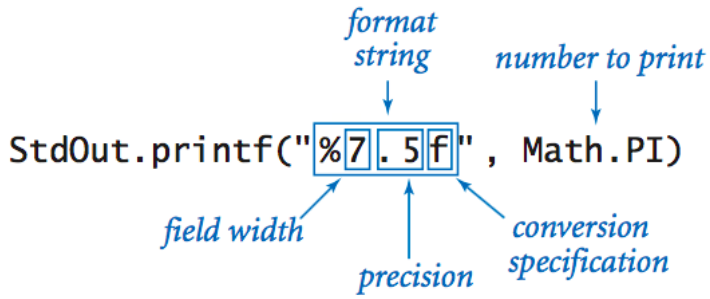
Inline initialization.

```
double [][] a =
{
   { 99.0, 85.0, 98.0,  0.0 },
   { 98.0, 57.0, 79.0,  0.0 },
   { 92.0, 77.0, 74.0,  0.0 },
   { 94.0, 62.0, 81.0,  0.0 },
   { 99.0, 94.0, 92.0,  0.0 },
   { 80.0, 76.5, 67.0,  0.0 },
   { 76.0, 58.5, 90.5,  0.0 },
   { 92.0, 66.0, 91.0,  0.0 },
   { 97.0, 70.5, 66.5,  0.0 },
   { 89.0, 89.5, 81.0,  0.0 },
   {  0.0,  0.0,  0.0,  0.0 }
};
```

Our standard output library.

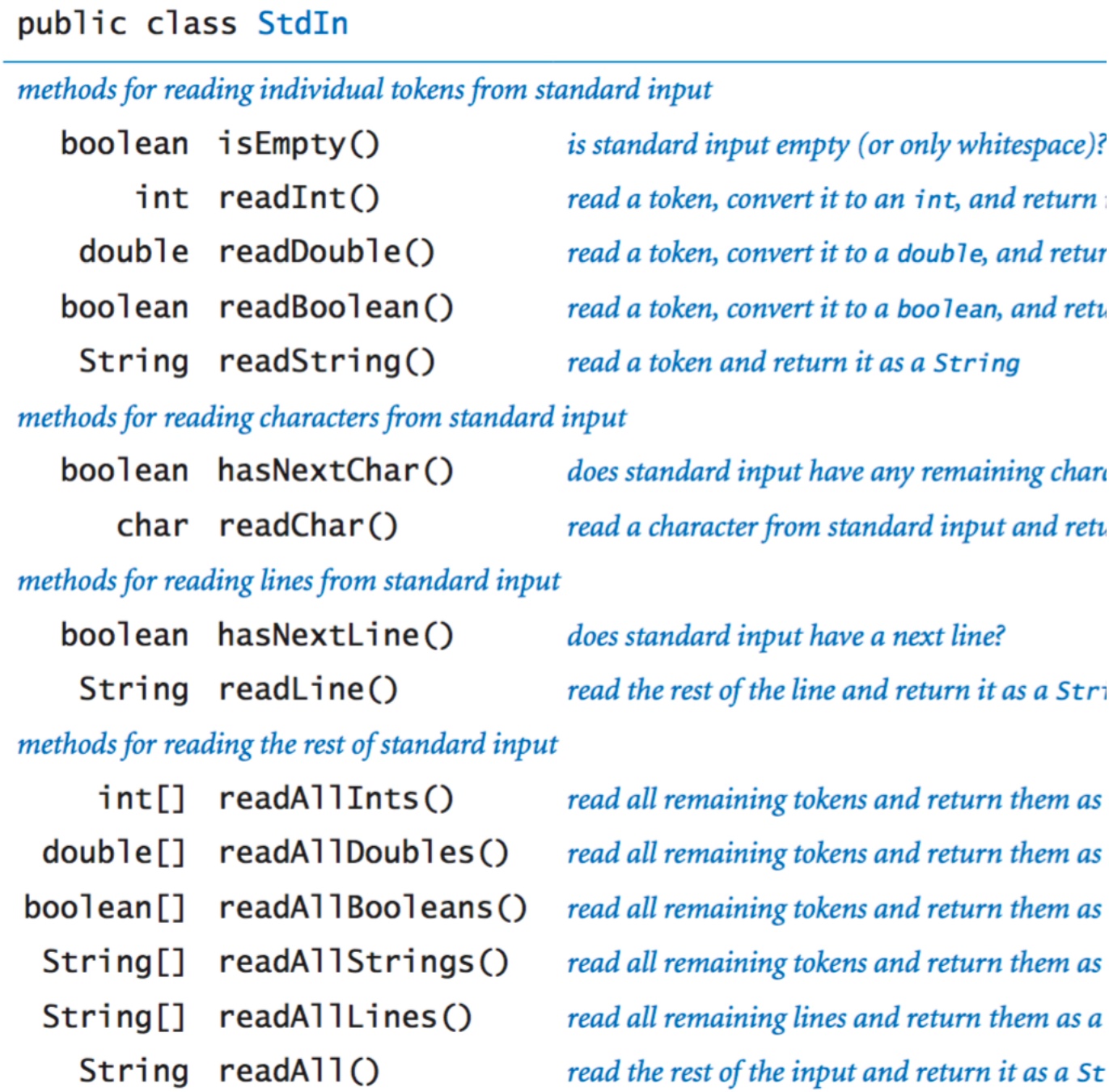
```
public class StdOut

   void  print(String s)                  print s to standard output
   void  println(String s)                print s and a newline to standard o
   void  println()                        print a newline to standard output
   void  printf(String format, ... )      print the arguments to standard ou
                                          as specified by the format string fo
```

The full StdOut API.



type	code	typical literal	sample format strings	converted string values for output
int	d	512	"%14d" "%-14d"	" 512" "512 "
double	f e	1595.1680010754388	"%14.2f" "%.7f" "%14.4e"	" 1595.17" "1595.1680011" " 1.5952e+03"
String	s	"Hello, World"	"%14s" "%-14s" "%-14.5s"	" Hello, World" "Hello, World " "Hello "
boolean	b	true	"%b"	"true"

Our standard input library.



public class StdIn

methods for reading individual tokens from standard input

boolean	isEmpty()	*is standard input empty (or only whitespace)?*
int	readInt()	*read a token, convert it to an int, and return*
double	readDouble()	*read a token, convert it to a double, and retur*
boolean	readBoolean()	*read a token, convert it to a boolean, and retu*
String	readString()	*read a token and return it as a String*

methods for reading characters from standard input

boolean	hasNextChar()	*does standard input have any remaining chara*
char	readChar()	*read a character from standard input and retu*

methods for reading lines from standard input

boolean	hasNextLine()	*does standard input have a next line?*
String	readLine()	*read the rest of the line and return it as a Stri*

methods for reading the rest of standard input

int[]	readAllInts()	*read all remaining tokens and return them as*
double[]	readAllDoubles()	*read all remaining tokens and return them as*
boolean[]	readAllBooleans()	*read all remaining tokens and return them as*
String[]	readAllStrings()	*read all remaining tokens and return them as*
String[]	readAllLines()	*read all remaining lines and return them as a*
String	readAll()	*read the rest of the input and return it as a St*

The full StdIn API.

Our standard drawing library.

public class StdDraw

drawing commands

```
void line(double x0, double y0, double x1, double y1)
void point(double x, double y)
void circle(double x, double y, double radius)
void filledCircle(double x, double y, double radius)
void square(double x, double y, double radius)
void filledSquare(double x, double y, double radius)
void rectangle(double x, double y, double r1, double r2)
void filledRectangle(double x, double y, double r1, doubl
void polygon(double[] x, double[] y)
void filledPolygon(double[] x, double[] y)
void text(double x, double y, String s)
void picture(double x, double y, String filename)
```

control commands

`void setXscale(double x0, double x1)`	*reset x-scale to (x0, x1)*
`void setYscale(double y0, double y1)`	*reset y-scale to (y0, y1)*
`void setPenRadius(double radius)`	*set pen radius to `radius`*
`void setPenColor(Color color)`	*set pen color to `color`*
`void setFont(Font font)`	*set text font to `font`*
`void setCanvasSize(int w, int h)`	*set canvas size to w-by-h*
`void clear(Color color)`	*clear the canvas to color c*
`void show(int dt)`	*show and pause dt millise*
`void save(String filename)`	*save to a `.jpg` or `.png` fi*

The full StdDraw API.

Our standard audio library.

```
public class StdAudio

     void  play(String filename)                    play the given .wav file
     void  play(double[] a)                         play the given sound w
     void  play(double x)                           play sample for 1/4410
     void  save(String filename, double[] a)        save to a .wav file
 double[]  read(String filename)                    read from a .wav file
```

The full StdAudio API.

Command line.

```
public class AddInts
{
   public static void main(String[] args)
   {
      int n = Integer.parseInt(args[0]);
      int sum = 0;
      for (int i = 0; i < n; i++)
      {
         int value = StdIn.readInt();
         sum += value;
      }
      StdOut.println("Sum is " + sum);
   }
}
```

parse command-line argument

read from standard input stream

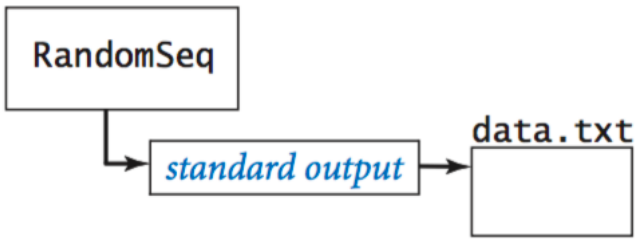
print to standard output stream

command line

```
% java AddInt
144
233
377
1024
Sum is 1778
```

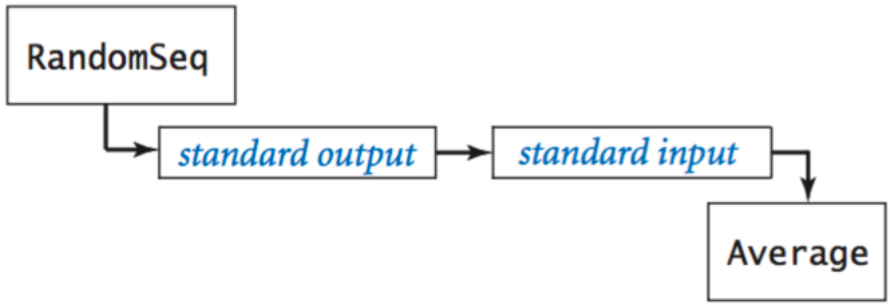
Redirection and piping.

```
% java RandomSeq 1000 > data.txt
```

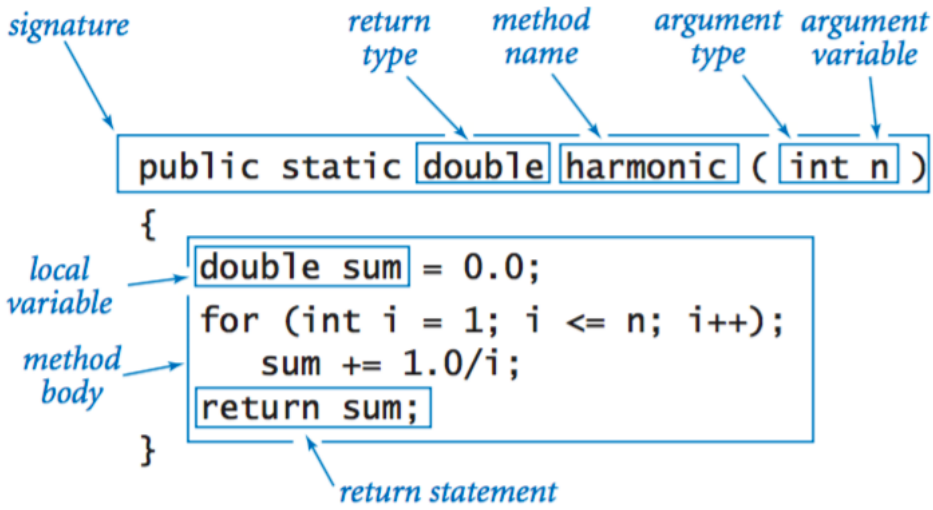



```
% java Average < data.txt
```

```
% java RandomSeq 1000 | java Average
```



Functions.



absolute value of an `int` value

```
public static int abs(int x)
{
   if (x < 0) return -x;
   else       return  x;
}
```

absolute value of a `double` value

```
public static double abs(double x)
{
   if (x < 0.0) return -x;
   else         return  x;
}
```

primality test

```
public static boolean isPrime(int n)
{
   if (n < 2) return false;
   for (int i = 2; i <= n/i; i++)
      if (n % i == 0) return false;
   return true;
}
```

hypotenuse of a right triangle

```
public static double hypotenuse(double a, double
{  return Math.sqrt(a*a + b*b);  }
```

harmonic number

```
public static double harmonic(int n)
{
   double sum = 0.0;
   for (int i = 1; i <= n; i++)
      sum += 1.0 / i;
   return sum;
}
```

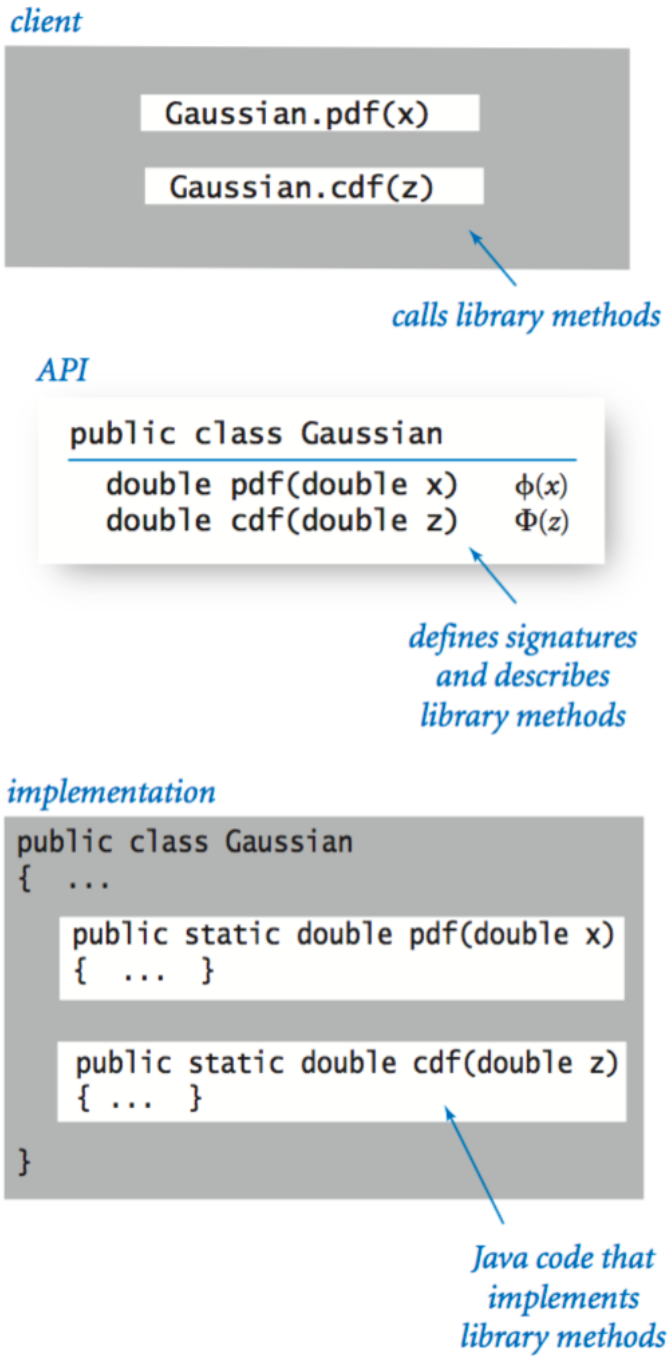
uniform random integer in [0, n)

```
public static int uniform(int n)
{  return (int) (Math.random() * n);  }
```

draw a triangle

```
public static void drawTriangle(double x0, double
                                double x1, double
                                double x2, double
{
   StdDraw.line(x0, y0, x1, y1);
   StdDraw.line(x1, y1, x2, y2);
   StdDraw.line(x2, y2, x0, y0);
}
```

Libraries of functions.



Our standard random library.

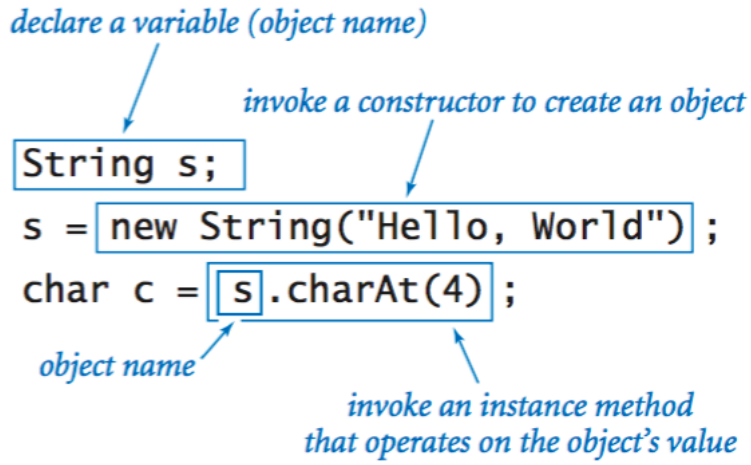
```
public class StdRandom

      void  setSeed(long seed)                          set the seed for re
       int  uniform(int n)                              integer between (
    double  uniform(double lo, double hi)               real between lo
   boolean  bernoulli(double p)                         true with probab
    double  gaussian()                                  normal, mean 0,
    double  gaussian(double mu, double sigma)           normal, mean mu
       int  discrete(double[] probabilities)            i with probabilit
      void  shuffle(double[] a)                         randomly shuffle
```

Our standard statistics library.

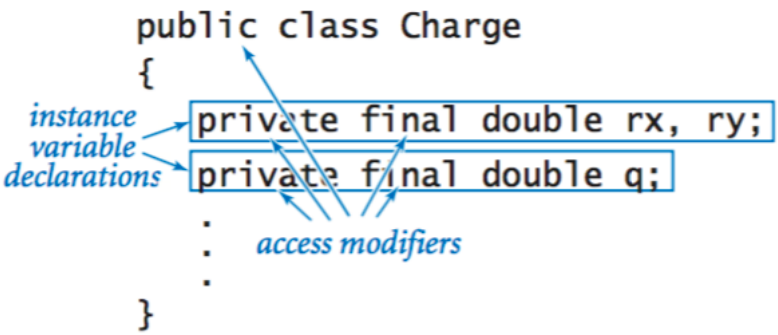
```
public class StdStats
```

`double max(double[] a)`	*largest value*
`double min(double[] a)`	*smallest value*
`double mean(double[] a)`	*average*
`double var(double[] a)`	*sample variance*
`double stddev(double[] a)`	*sample standard deviat*
`double median(double[] a)`	*median*
`void plotPoints(double[] a)`	*plot points at (i, a[i])*
`void plotLines(double[] a)`	*plot lines connecting (i*
`void plotBars(double[] a)`	*plot bars to points at (i*

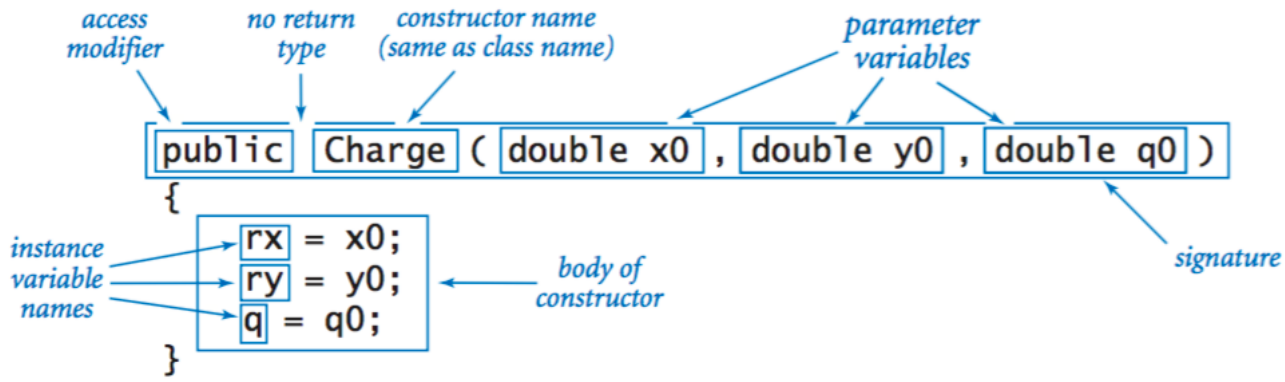
Using an object.



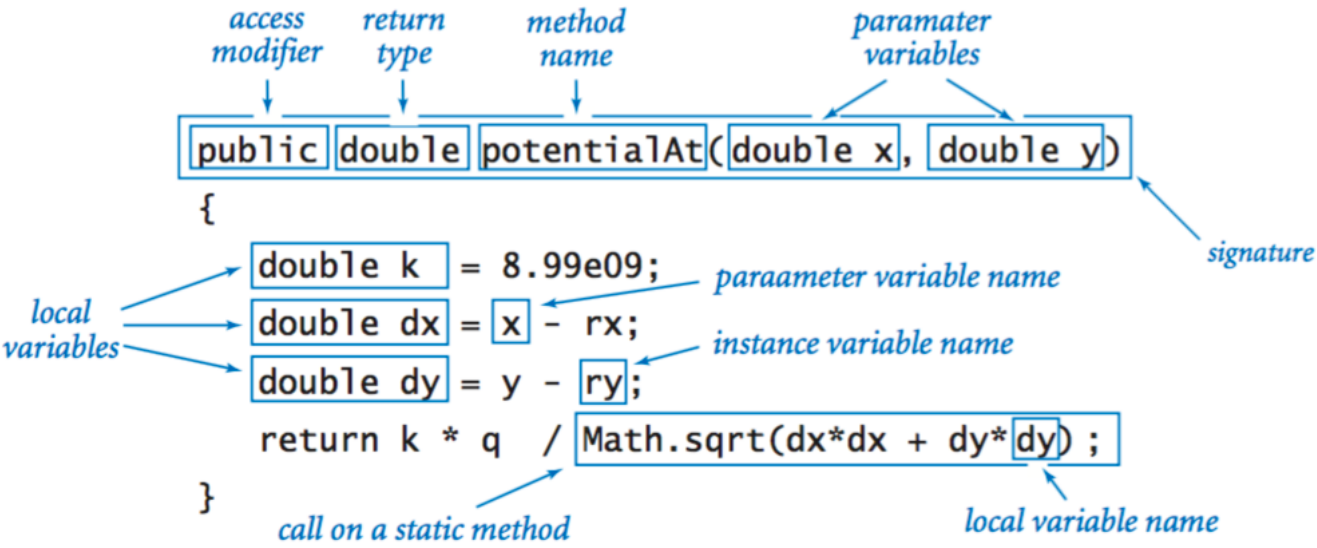
Instance variables.



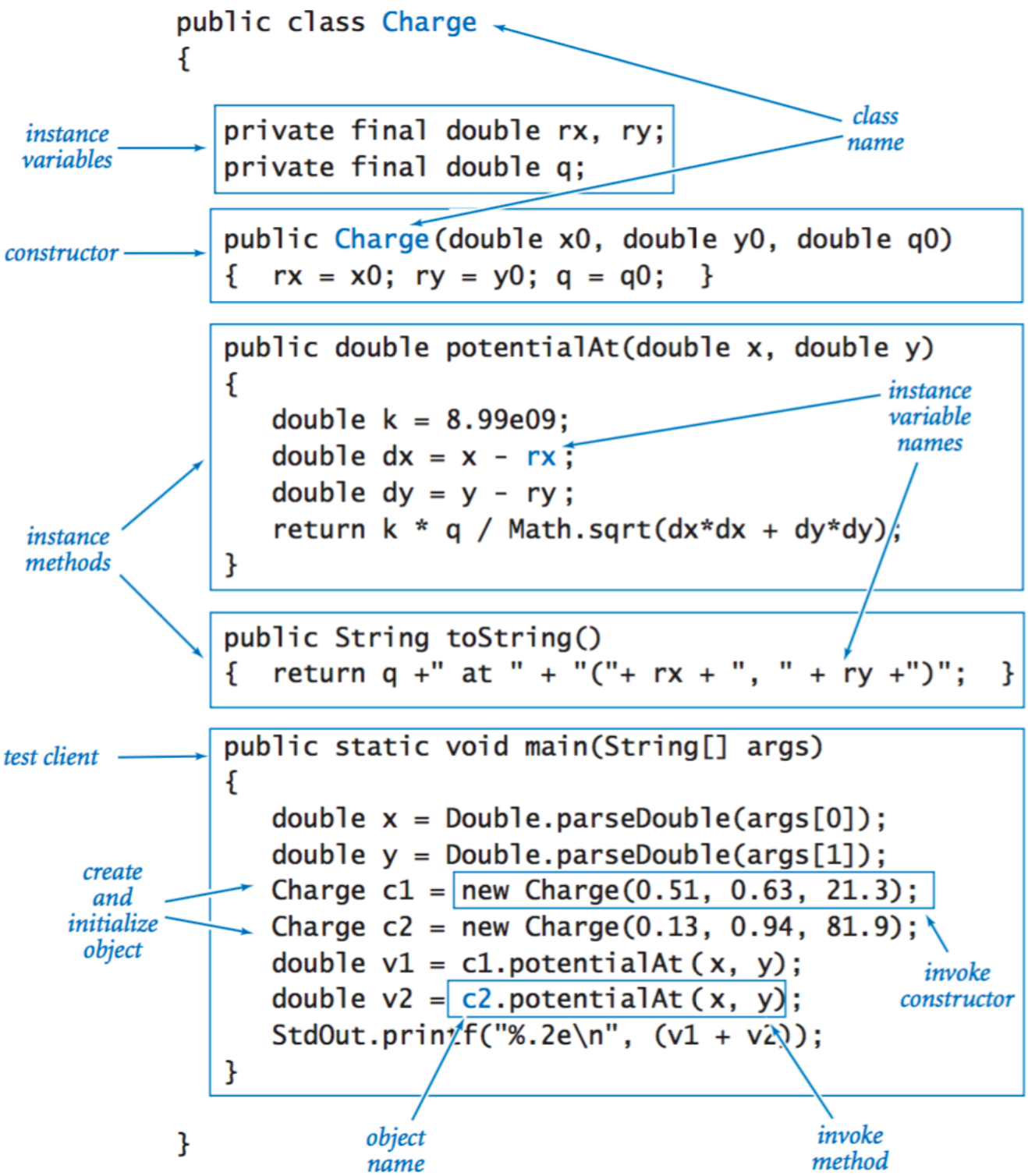
Constructors.



Instance methods.



Classes.



Object-oriented libraries.

client

```
Charge c1 = new Charge(0.51, 0.63, 21.3);

c1.potentialAt(x, y)
```

creates objects and invokes methods

API

```
public class Charge
-------------------------------------------------------------
        Charge(double x0, double y0, double q0)

double potentialAt(double x, double y)   potential at (x, y) due to charge

String toString()                        string representation
```

defines signatures and describes methods

implementation

```
public class Charge
{
   private final double rx, ry;
   private final double q;

   public Charge(double x0, double y0, double q0)
   {  ...  }

   public double potentialAt(double x, double y)
   {  ...  }

   public String toString()
   {  ...  }
}
```

defines instance variables and implements methods

Java's String data type.

public class String

	String(String s)	*create a string with the sa*
int	length()	*number of characters*
char	charAt(int i)	*the character at index i*
String	substring(int i, int j)	*characters at indices i thr*
boolean	contains(String substring)	*does this string contain s*
boolean	startsWith(String pre)	*does this string start with*
boolean	endsWith(String post)	*does this string end with*
int	indexOf(String pattern)	*index of first occurrence o*
int	indexOf(String pattern, int i)	*index of first occurrence o*
String	concat(String t)	*this string with t append*
int	compareTo(String t)	*string comparison*
String	toLowerCase()	*this string, with lowercase*
String	toUpperCase()	*this string, with uppercas*
String	replaceAll(String a, String b)	*this string, with as replac*
String[]	split(String delimiter)	*strings between occurrenc*
boolean	equals(Object t)	*is this string's value the sa*
int	hashCode()	*an integer hash code*

The full java.lang.String API.

```
String a = new String("now is");
String b = new String("the time");
String c = new String(" the");
```

instance method call	*return type*	*return value*
a.length()	int	6
a.charAt(4)	char	'i'
a.substring(2, 5)	String	"w i"
b.startsWith("the")	boolean	true
a.indexOf("is")	int	4
a.concat(c)	String	"now is the"
b.replace("t","T")	String	"The Tim"
a.split(" ")	String[]	{ "now", "is" }
b.equals(c)	boolean	false

Java's Color data type.

public class java.awt.Color

	Color(int r, int g, int b)	
int	getRed()	*red intensity*
int	getGreen()	*green intensity*
int	getBlue()	*blue intensity*
Color	brighter()	*brighter version of this color*
Color	darker()	*darker version of this color*
String	toString()	*string representation of this color*
String	equals(Object c)	*is this color's value the same as c ?*

The full java.awt.Color API.

Our input library.

public class In

	In()	*create an input stream from standard input*
	In(String name)	*create an input stream from a file or website*
instance methods that read individual tokens from the input stream		
boolean	isEmpty()	*is standard input empty (or only whitespace)*
int	readInt()	*read a token, convert it to an int, and return*
double	readDouble()	*read a token, convert it to a double, and retu*
	...	
instance methods that read characters from the input stream		
boolean	hasNextChar()	*does standard input have any remaining cha*
char	readChar()	*read a character from standard input and ret*
instance methods that read lines from the input stream		
boolean	hasNextLine()	*does standard input have a next line?*
String	readLine()	*read the rest of the line and return it as a Str*
instance methods that read the rest of the input stream		
int[]	readAllInts()	*read all remaining tokens; return as array of*
double[]	readAllDoubles()	*read all remaining tokens; return as array of*
	...	

The full In API.

Our output library.

public class Out	
Out()	*create an output stream to standard*
Out(String name)	*create an output stream to a file*
void print(String s)	*print* `s` *to the output stream*
void println(String s)	*print* `s` *and a newline to the output s*
void println()	*print a newline to the output stream*
void printf(String format, ...)	*print the arguments to the output str as specified by the format string* `for`

The full Out API.

Our picture library.

public class Picture	
Picture(String filename)	*create a picture from*
Picture(int w, int h)	*create a blank w-by-*
int width()	*return the width of*
int height()	*return the height of*
Color get(int col, int row)	*return the color of p*
void set(int col, int row, Color color)	*set the color of pixel*
void show()	*display the picture i*
void save(String filename)	*save the picture to a*

The full Picture API.

Our stack data type.

public class Stack<Item> implements Iterable<Item>	
Stack()	*create an empty stack*
boolean isEmpty()	*is the stack empty?*
void push(Item item)	*push an item onto the stack*
Item pop()	*return and remove the item that was inserted most recently*
int size()	*number of items on stack*

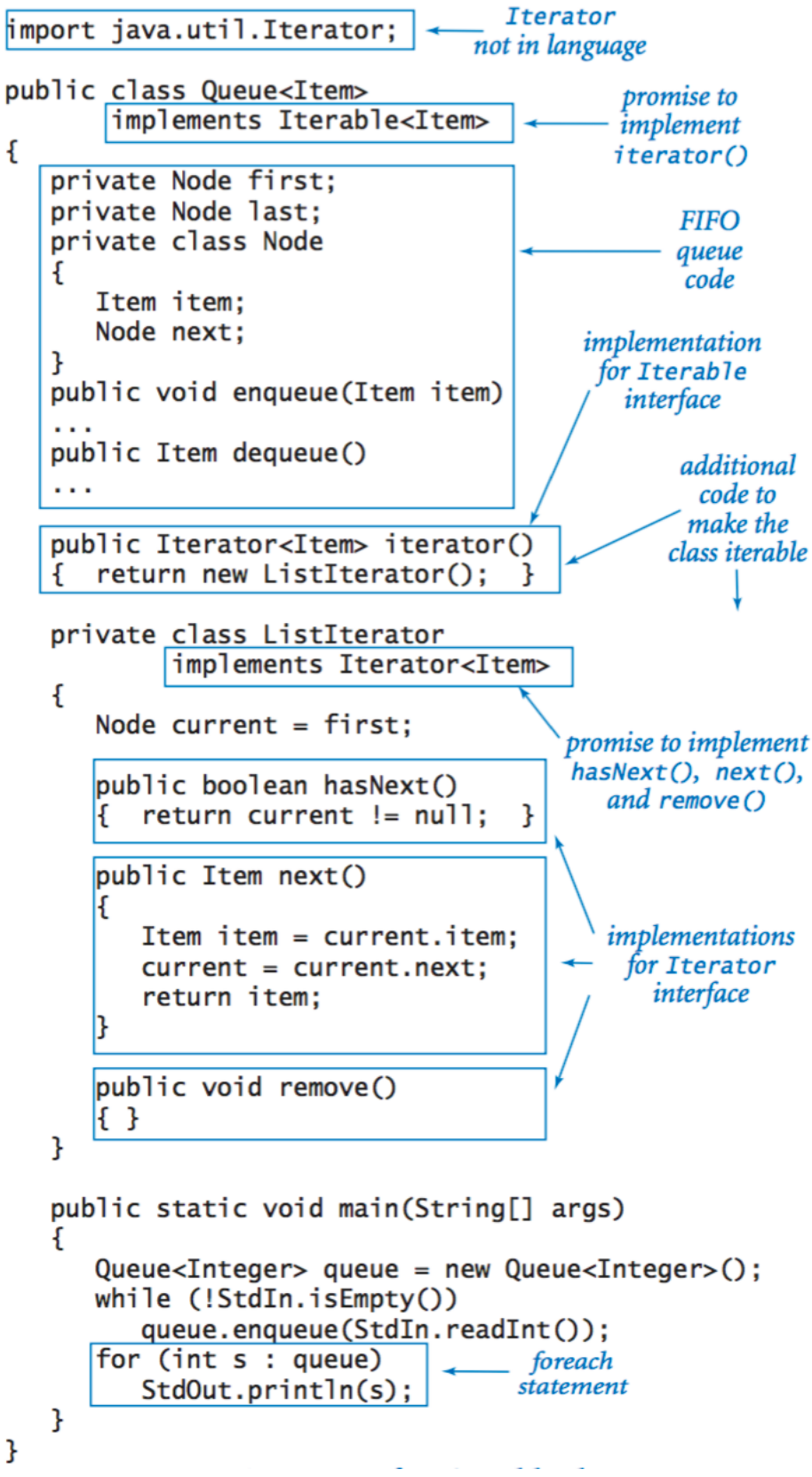
The full Stack API.

Our queue data type.

public class Queue<Item> implements Iterable<Item>	
Queue()	*create an empty queue*
boolean isEmpty()	*is the queue empty?*
void enqueue(Item item)	*insert an item onto queue*
Item dequeue()	*return and remove the item that was inserted least recently*
int size()	*number of items on queue*

The full Queue API.

Iterable.



Our symbol table data type.

public class ST<Key extends Comparable<Key>, Value>		
	ST()	*create an empty symbol tabl*
void	put(Key key, Value val)	*associate* `val` *with* `key`
Value	get(Key key)	*value associated with* `key`
void	remove(Key key)	*remove* `key` *(and its associa*
boolean	contains(Key key)	*is there a value associated w*
int	size()	*number of key–value pairs*
Iterable<Key>	keys()	*all keys in the symbol table*

The full ST API.

Our set data type.

public class SET<Key extends Comparable<Key>> implements It		
	SET()	*create an empty set*
boolean	isEmpty()	*is the set empty?*
void	add(Key key)	*add* `key` *to the set*
void	remove(Key key)	*remove* `key` *from set*
boolean	contains(Key key)	*is* `key` *in the set?*
int	size()	*number of elements in set*

The full SET API.

Our graph data type.

```
public class Graph

                  Graph()
                  Graph(String filename, String delimiter)
            void  addEdge(String v, String w)
             int  V()
             int  E()
Iterable<String>  vertices()
Iterable<String>  adjacentTo(String v)
             int  degree(String v)
         boolean  hasVertex(String v)
         boolean  hasEdge(String v, String w)
```

The full Graph API.

Compile-time and run-time errors.

Here's a list of errors compiled by Mordechai Ben-Ari. It includes a list of common error message and typical mistakes that give rise to them.

Last modified on February 28, 2017.