CS61B Lecture #2

- Please make sure you have obtained an account and used our "Account Administration" page to register by the end of the first lab, no matter what TeleBEARS thinks about your status.
- The only text is *Head First Java*.
- I will deal with concurrent enrollment students soon. Please go to lab/discussion in the meantime.
- If you don't have the prerequisites for this course, you can take the course at your own risk (we do use some material from CS61A).
- If you decide not to take this course after all, please tell TeleBEARS ASAP, so that I have a reasonably accurate count of class membership.

Prime Numbers

Problem: want `java primes` U to print prime numbers through U.

You type: `java primes 101`

It types:
```
2 3 5 7 11 13 17 19 23 29
31 37 41 43 47 53 59 61 67 71
73 79 83 89 97 101
```

Definition: *A prime* number is an integer greater than 1 that has no divisors smaller than itself other than 1.

Useful Facts:

- $k \leq \sqrt{N}$ iff $N/k \geq \sqrt{N}$, for $N, k > 0$.
- If k divides N then N/k divides N.

So: Try all potential divisors up to and including the square root.

Plan

```
class primes {
  /** Print all primes up to ARGS[0] (interpreted as an
   *  integer), 10 to a line. */
  public static void main(String[] args) {
    printPrimes(Integer.parseInt(args[0]));
  }

  /** Print all primes up to and including LIMIT, 10 to
   *  a line. */
  private static void printPrimes(int limit) {
    /*{ For every integer, x,  between 2 and LIMIT, print it if
        isPrime(x), 10 to a line. }*/
  }

  /** True iff X is prime */
  private static boolean isPrime(int x) {
    return /*( X is prime )*/;
  }
}
```

Testing for Primes

```
private static boolean isPrime(int x) {
  if (x <= 1)
    return false;
  else
    return ! isDivisible(x, 2);  // "!" means "not"
}

/** True iff X is divisible by any positive number >=K and < X,
 *  given K > 1. */
private static boolean isDivisible(int x, int k) {
  if (k >= x)            // a "guard"
    return false;
  else if (x % k == 0)  // "%" means "remainder"
    return true;
  else // if (k < x && x % k != 0)
    return isDivisible(x, k+1);
}
```

Thinking Recursively

Understand and check `isDivisible(13,2)` by *tracing one level.*

```
/** True iff X is divisible by
 *  some number >=K and < X,
 *  given K > 1. */
boolean isDivisible(int x, int k) {
  if (k >= x)
    return false;
  else if (x % k == 0)
    return true;
  else
    return isDivisible(x, k+1);
}
```

- Call assigns `x=13, k=2`
- Body has form '`if (k >= x)` S_1 `else` S_2'.
- Since $2 < 13$, we evaluate the first `else`.
- Check if $13 \bmod 2 = 0$; it's not.
- Left with `isDivisible(13,3)`.
- Rather than tracing it, instead use the *comment:*
- Since 13 is *not* divisible by any integer in the range 3..12 (and $3 > 1$), `isDivisible(13,3)` must be *false,* and we're done!
- Sounds like that last step begs the question. Why doesn't it?

Lesson: Comments aid understanding. Make them *count*!

Iteration

- `isDivisible` is *tail recursive*, and so creates an *iterative process*.
- Traditional "Algol family" production languages have special syntax for iteration. Four equivalent versions of `isDivisible`:

```
if (k >= x)
  return false;
else if (x % k == 0)
  return true;
else
  return isDivisible(x, k+1);
```

```
while (k < x) { // !  (k >= x)
  if (x % k == 0)
    return true;
  k = k+1;
  // or k += 1, or k++ (yuch).
}
return false;
```

```
int k1 = k;
while (k1 < x) {
  if (x % k1 == 0)
    return true;
  k1 += 1;
}
return false;
```

```
for (int k1 = k; k1 < x; k1 += 1) {
  if (x % k1 == 0)
    return true;
}
return false;
```

Using Facts about Primes

- We haven't used the Useful Facts from an earlier slide.
- Only have to check for divisors up to the square root.
- So, reimplement `isPrime`:

```
private static boolean isPrime(int x) {
  if (x <= 1)
    return false;
  else
    return ! isDivisible(x, 2, (int) (Math.round(Math.sqrt(x) + 1.0))
    // "(int) E" means "convert to int".  Math.round returns a ‘long
}

/** True iff X is divisible by any positive number >=K and < LIM,
 *  given K > 1. */
private static boolean isDivisible(int x, int k, int lim) {
  if (k >= lim)       // a "guard"
    return false;
  else if (x % k == 0)  // "%" means "remainder"
    return true;
```

```
  else // if (k < x && x % k != 0)
    return isDivisible(x, k+1);
}
```

Final Task: printPrimes

```
/** Print all primes up to and including LIMIT, 10 to
 *  a line. */
private static void printPrimes(int limit) {









}
```

printPrimes: One solution

```
/** Print all primes up to and including LIMIT, 10 to
 *  a line. */
private static void printPrimes(int limit) {
    int np;
    np = 0;
    for (int p = 2; p <= limit; p += 1) {
        if (isPrime(p)) {
            System.out.print(p + " ");
            np += 1;
            if (np % 10 == 0)
                System.out.println();
        }
    }
    if (np % 10 != 0)
        System.out.println();
}
```