The `File` Class

An abstract representation of file and directory pathnames.

Construction: `File(String pathname)`

Some useful methods:

```
boolean exists()
boolean createNewFile()
boolean delete()
long    length()
```

The `RandomAccessFile` Class

Supports reading/writing to a random access file.

Construction:

```
RandomAccessFile(File file, String mode)
RandomAccessFile(String name, String mode)
mode:  “r”   “rw”   (“rws”   “rwd”)
```

Logical view is that underlying file is a sequence (i.e., array) of bytes.

Maintains an internal *file pointer* to the current location within the file.

Reads/writes advance the file pointer.

Writes at the end of the file cause it to be extended.

RandomAccessFile Example

```
public class rafExample {

   public static void main(String[] args) {
      try {
         long offset = 0;
         RandomAccessFile raf = new RandomAccessFile(args[0], "r");

         //Get the position of the first record (should be 0):
         offset = raf.getFilePointer();

         //Grab first line (first complete record):
         String record = raf.readLine();
         //Tell the world:
         System.out.println("The record offset is: " + offset);
         System.out.println("The record is: " + record);

      } catch (FileNotFoundException e) {
         System.err.println(“Could not file file: " + args[0]);
      } catch (IOException e) {
         System.err.println("Writing error: " + e);
      }
    }
}
```

The Scanner Class

A simple text scanner which can parse primitive types and strings using regular expressions.

A Scanner breaks its input into tokens using a delimiter pattern, which by default matches whitespace. The resulting tokens may then be converted into values of different types using the various next methods.

Construction: `Scanner(InputStream source)`

`Scanner(String source)`

Configuration: `useDelimiter(String pattern)`

The `Scanner` Class

Some useful methods:

```
String next()
byte   nextByte()
int    nextInt()
. . .
boolean hasNext()              boolean hasNextByte()
boolean hasNextInt()           boolean hasNextLine()
. . .
void close()
```

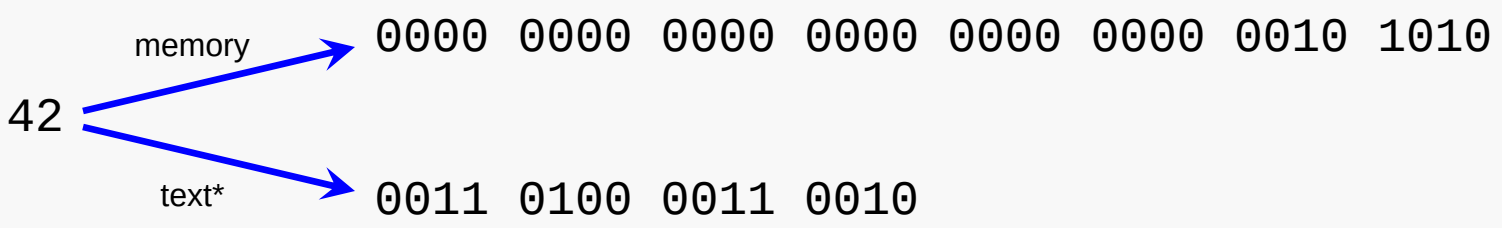
Scanner Example

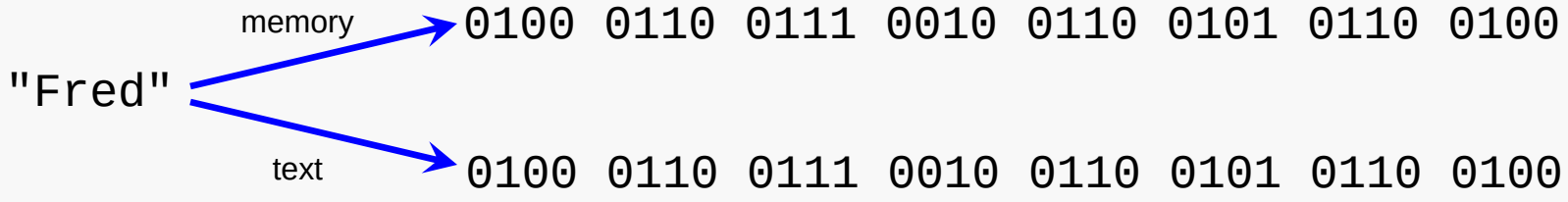

```
public class scannerExample {

   public static void main(String[] args) {

      String line = "foo\tbar\twidget";

      Scanner s = new Scanner(line);
      s.useDelimiter("\t");
      String  token1  = s.next();
      String  token2  = s.next();
      String  token3  = s.next();

      System.out.println(token1 + "  " + token2 + "  " + token3);
   }
}
```

Text versus Binary Files

In a text file, data is represented using some sort of text-relevant encoding scheme, such as ASCII or Unicode.

In a binary file, data is represented in precisely the same way it would be represented in memory.





*ASCII

Hexdump View

Viewing data in pure binary form is often not very illuminating; here's a view of part of a binary file in hex form:

```
        00  01  02  03  04  05  06  07      08  09  0A  0B  0C  0D  0E  0F
        ------------------------------------------------------------------
00000   2C  01  29  00  62  00  F9  00      A2  01  32  00  AA  00  6E  00
00001   DA  01  16  00  CD  00  97  00      B5  01  09  00  E5  00  C7  00
00002   9F  00  C4  00  FD  01  3A  01      22  00  D3  01  0E  01  10  00
00003   F3  00  88  00  82  01  3D  00      5B  00  71  00  5F  01  02  00
00004   A7  00  8D  01  37  00  9A  00      BD  00  DA  00  78  00  AF  01
00005   07  00  EB  01  1A  00  B2  00      68  00  00  03  68  69  6D  02
00006   61  73  05  74  68  65  72  65      05  42  75  72  6E  73  02  73
00007   6F  06  62  75  72  6E  65  64      09  77  61  6E  64  65  72  69
00008   6E  67  05  6E  65  27  65  72      04  68  61  74  68  09  66  6F
. . .
```

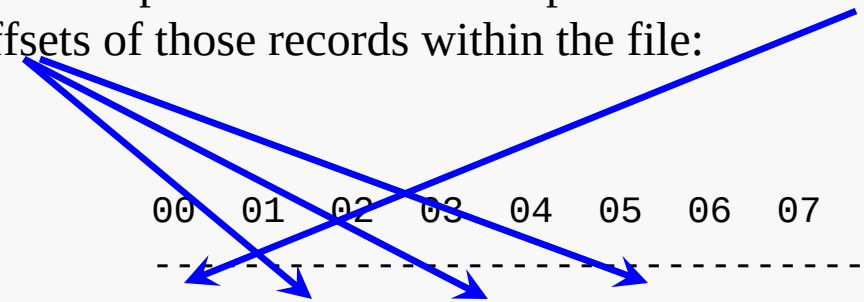
1 byte == 2 nybbles: 0010 1100

2 bytes == short int in big-endian order

Example of Binary File Layout

The binary file shown before is logically divided into two parts.

The first part is a header that specifies the number of records in the file and then the offsets of those records within the file:



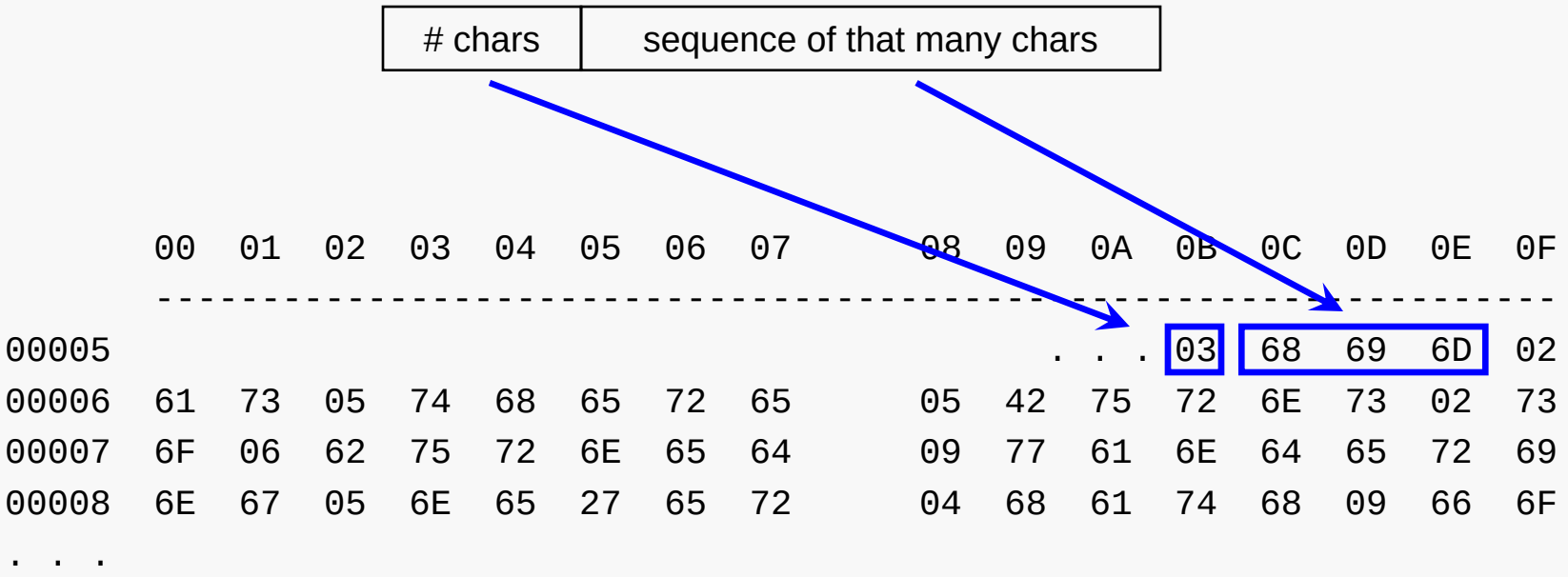
```
        00  01  02  03  04  05  06  07      08  09  0A  0B  0C  0D  0E  0F
        ------------------------------------------------------------------
00000   2C  01  29  00  62  00  F9  00      A2  01  32  00  AA  00  6E  00
00001   DF  01  16  00  CD  00  97  00      B5  01  09  00  E5  00  C7  00
00002   9F  00  C4  00  FD  01  3A  01      22  00  D3  01  0E  01  10  00
00003   F3  00  88  00  82  01  3D  00      5B  00  71  00  5F  01  02  00
00004   A7  00  8D  01  37  00  9A  00      BD  00  DA  00  78  00  AF  01
00005   07  00  EB  01  1A  00  B2  00      68  00  00  . . .
```

The number of records is specified using a 1-byte integer value.

The offsets of those records are specified as 2-byte integer values.

Example of Binary File Layout

The remainder of the file consists of a sequence of two-part records:



The number of characters is specified using a 1-byte integer value.

The characters are specified using ASCII codes.

Example: File Navigation and Binary Input

The file actually contains a quotation. Each record specifies a "word" that makes up part of the quotation, and we must create the proper quotation from the file.

Logically, we need to:

- get the # of records in the file
- get the offset of the first record
- get the record from that offset and print it
- go back and get the offset of the second record
- get the second record and print it
- . . . until we've processed the specified number of records

Java Solution

```
public class FileReader {

    public static void main(String[] args) {
       try {
          byte  numWords    = 0;
          short wordOffset  = 0;
          byte  wordLength  = 0;

          RandomAccessFile raf = new RandomAccessFile("1.Data.bin", "r");

          // Get the number of words in the quotation:
          numWords = raf.readByte();

          System.out.println("The number of words is: " + numWords);
. . .
```

Java Solution

```
. . .
          for (int pos = 0; pos < numWords; pos++) {
             // Get the offset of the first word:
             wordOffset = raf.readShort();

             // Save offset to return for next offset:
             long offsetOfNextOffset = raf.getFilePointer();

             // Go to that position.
             raf.seek(wordOffset);

             // Get the length of the word:
             wordLength = raf.readByte();

             // Get the word (in ASCII):
             byte Word[] = new byte[wordLength];
             raf.read(Word);

             // Make Java happy:
             String sWord = new String(Word);
. . .
```

Java Solution

```
. . .
            // Report results:
            System.out.println("The next word is at offset:     " +
                wordOffset);
            System.out.println("The length of the next word is: " +
                wordLength);
            System.out.println("The next word is:               " + sWord);

            // Seek back to position of next offset:
            raf.seek(offsetOfNextOffset);
         }
         raf.close();

      } catch (FileNotFoundException e) {
          System.err.println("This shouldn't happen: " + e);
      } catch (IOException e) {
          System.err.println("Writing error: " + e);
      }
   }
}
```

Results

```
The number of words is: 44
The next word is at offset:     297
The length of the next word is: 8
The next word is:               Breathes
The next word is at offset:     98
The length of the next word is: 5
The next word is:               there
The next word is at offset:     249
The length of the next word is: 3
The next word is:               the
The next word is at offset:     162
The length of the next word is: 4
The next word is:               man,
. . .
The next word is at offset:     178
The length of the next word is: 2
The next word is:               --
The next word is at offset:     104
The length of the next word is: 5
The next word is:               Burns
```

Bit Manipulation in Java

Java provides a number of operators for manipulating operands at the bit level:

```
&       bit-wise AND
|       bit-wise OR
^       bit-wise XOR
<<      shift bits to left 1
>>      shift bits to right 1, preserving sign
>>>     shift bits to right 1, shifting in 0
. . .
```

Example: Printing the Bits


```
public class PrintBits
{
   public static void main( String args[] )
   {
      // get input integer
      Scanner scanner = new Scanner( System.in );
      System.out.println( "Please enter an integer:" );
      int input = scanner.nextInt();

      // display bit representation of an integer
      System.out.println( "\nThe integer in bits is:" );

      // create int value with 1 in leftmost bit and 0s elsewhere
      int displayMask = 1 << 31;
. . .
```

1000 0000 0000 0000 0000 0000 0000 0000

Example: Printing the Bits

```
. . .
      // for each bit display 0 or 1
      for ( int bit = 1; bit <= 32; bit++ )
      {
         // use displayMask to isolate bit
         System.out.print( ( input & displayMask ) == 0 ? '0' : '1' );

         input <<= 1; // shift value one position to left

         if ( bit % 8 == 0 )
            System.out.print( ' ' ); // display space every 8 bits
      } // end for
   } // end main
} // end class PrintBits
```

mask off all but the high bit of `input`

move next bit into high position for next masking

Example adapted from Deitel JHTP7