Object Oriented Programming

File Handling

File Handling

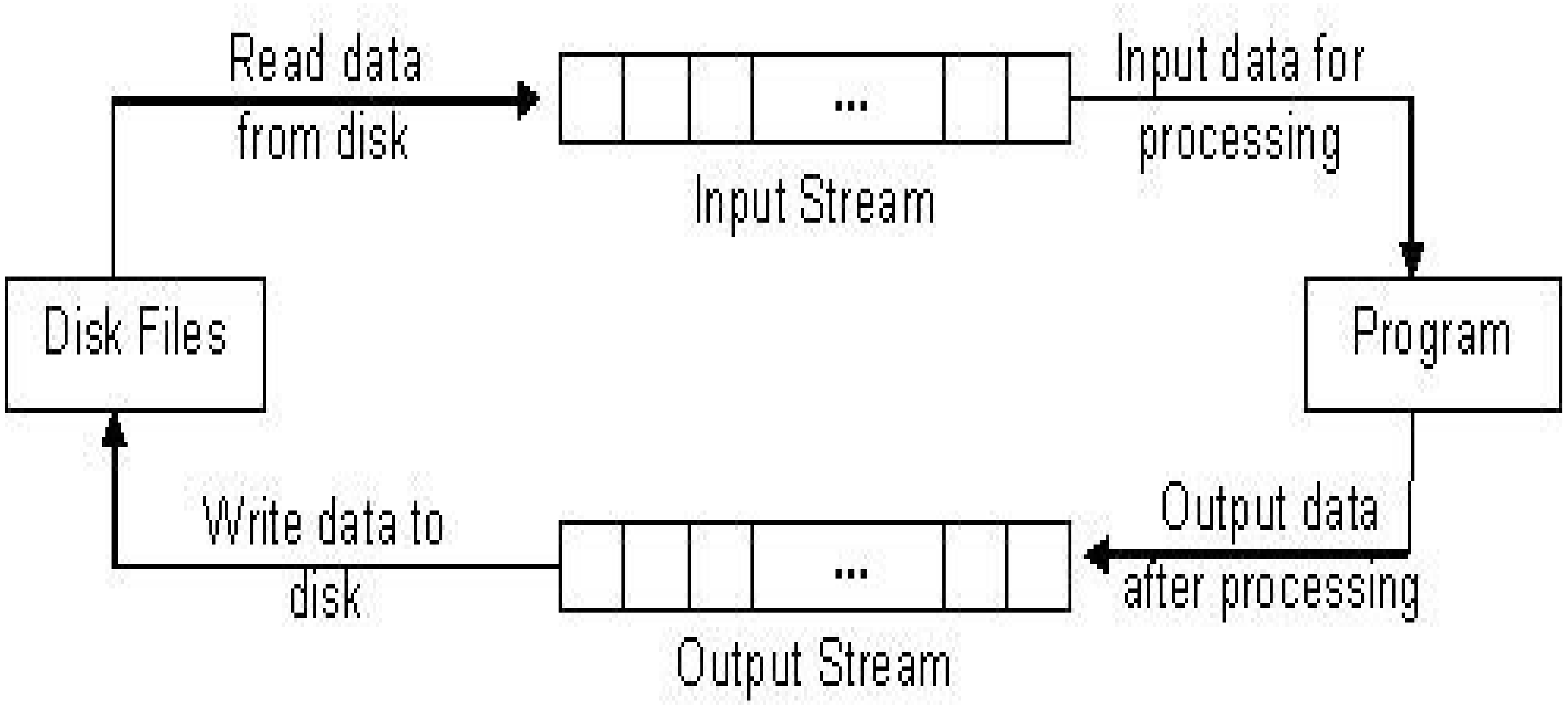
Introduction

- All programs we looked earlier:
  - input data from the keyboard.
  - output data to the screen.
- Output would be lost as soon as we exit from the program.
- How do we store data permanently?
  - We can use secondary storage device.
  - Data is packaged up on the storage device as data structures called files.

Streams Usage

- We've used streams already
  - cin
    - Input from stream object connected to keyboard
  - cout
    - Output to stream object connected to screen
- Can define other streams
  - To or from files
  - Used similarly as cin, cout

File input and output streams



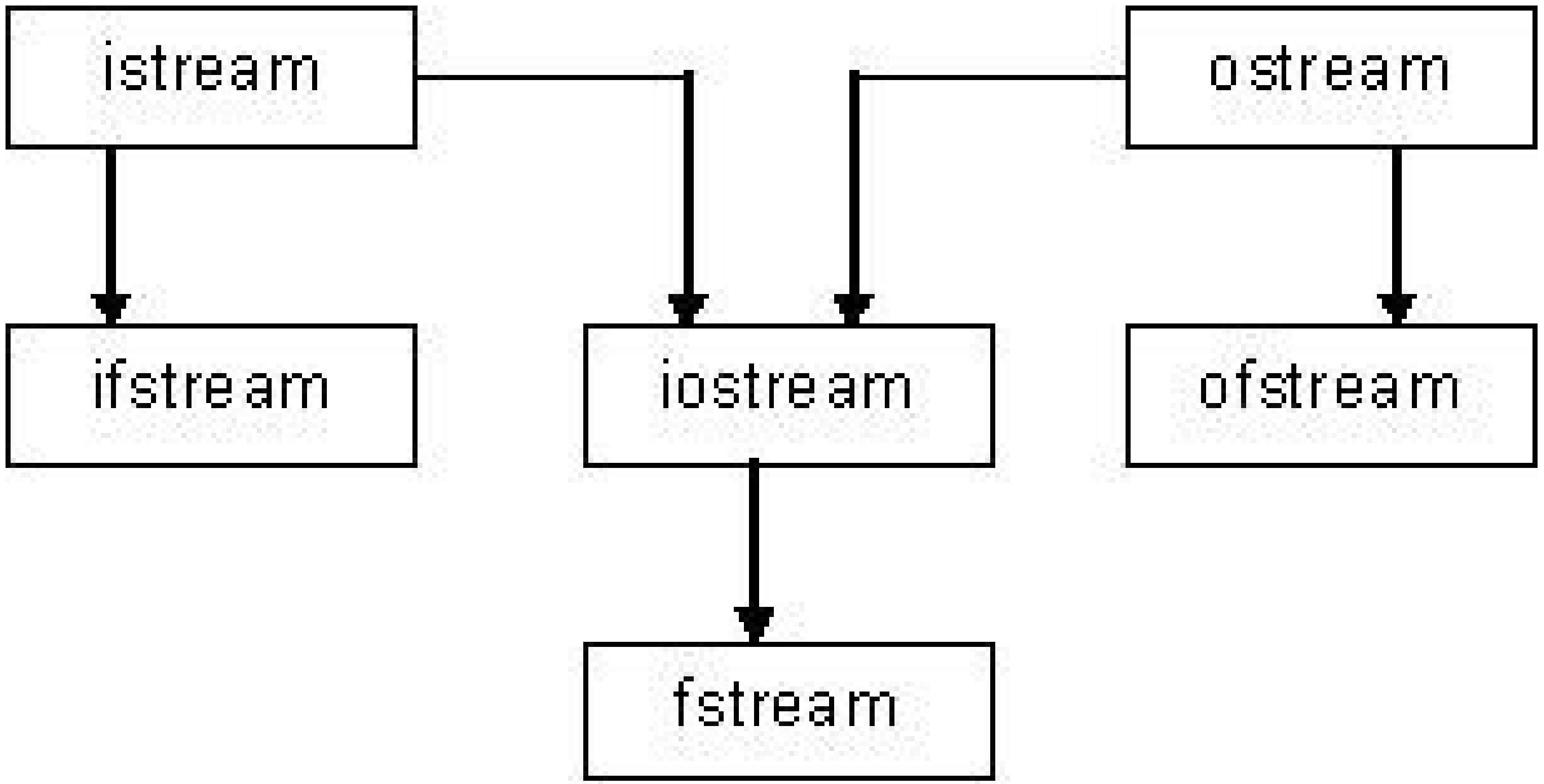
Streams

- File Input Stream – reads data from disk file to the program.

- File output Stream – writes data to the disk file from the program.

- The I/O system of C++ contains:
  - ifstream – provides input operations on files
  - ofstream – provides output operations on files
  - fstream – supports for simultaneous input and output operations on files

Stream Classes



The Data Hierarchy

- From smallest to largest
  - Bit (binary digit)
    - 1 or 0
    - Everything in computer ultimately represented as bits
  - Character set
    - Digits, letters, symbols used to represent data
    - Every character represented by 1's and 0's
  - Byte: 8 bits
    - Can store a character (**`char`**)

The Data Hierarchy (contd.)

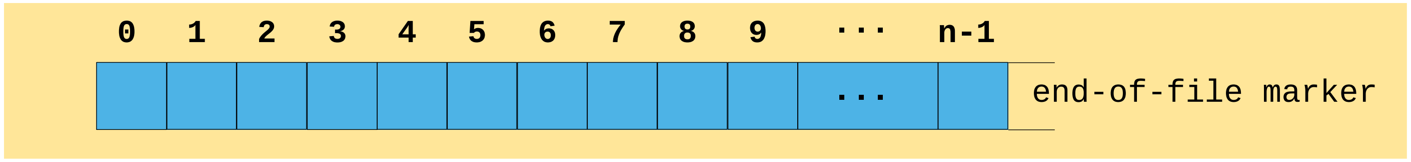
- From smallest to largest (continued)
  - Field: group of characters with some meaning
    - e.g., Your name
  - Record: group of related fields
    - **`struct`** or **`class`** in C++
    - In payroll system, could be name, S#, address, wage
    - Each field associated with same employee
    - Record key: field used to uniquely identify record
  - File: group of related records
    - Payroll for entire company
  - Database: group of related files
    - Payroll, accounts-receivable, inventory…

General File I/O Steps

- Declare a file name variable
- Associate the file name variable with the disk file name
- Open the file
- Use the file
- Close the file

Files and Streams

- C++ views file as sequence of bytes
  - Ends with *end-of-file* marker



Creating a Sequential-Access File

- C++ imposes no structure on file
  - Concept of "record" must be implemented by programmer
- To open file, create objects
  - Creates "line of communication" from object to file
  - Classes
    - **`ifstream`** (input only)
    - **`ofstream`** (output only)
    - **`fstream`** (I/O)
  - Constructors take *file name* and *file-open mode*

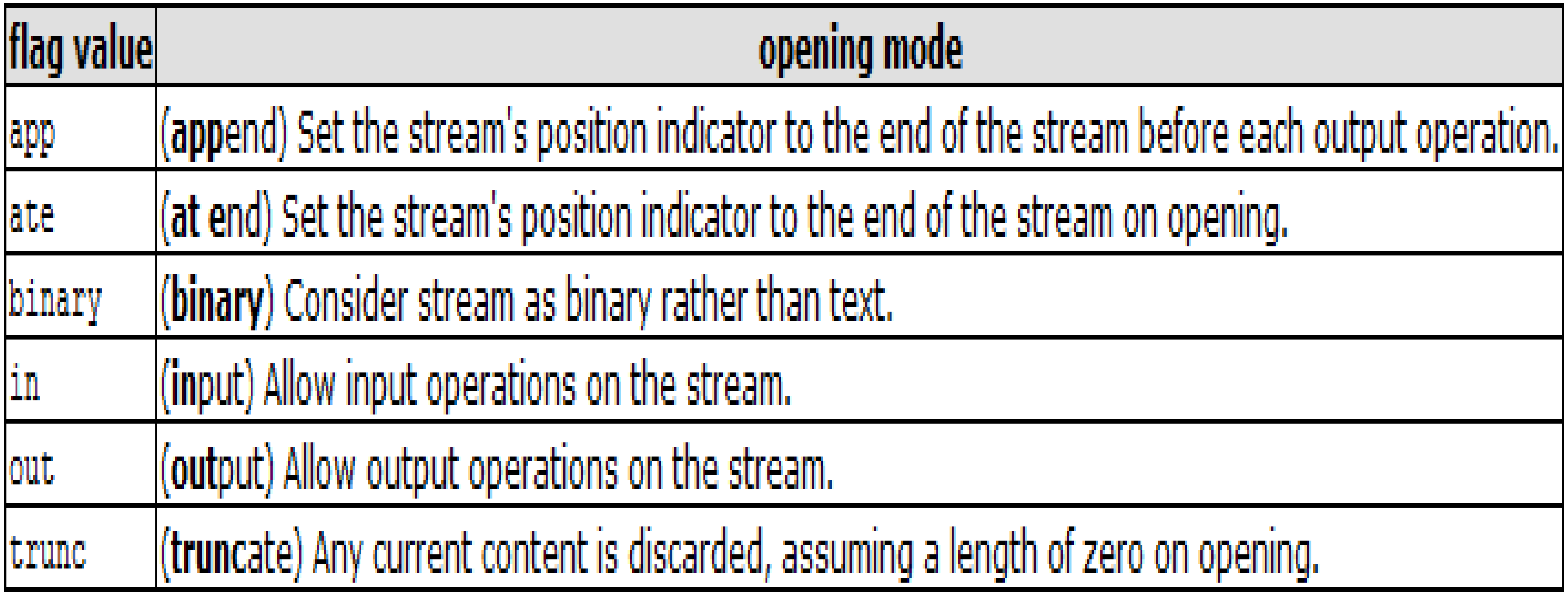
```
ofstream outClientFile( "filename", fileOpenMode );
```

  - To attach a file later

```
ofstream outClientFile;
outClientFile.open( "filename", fileOpenMode);
```

Creating a Sequential-Access File

- File-open modes



flag value	opening mode
`app`	(**append**) Set the stream's position indicator to the end of the stream before each output operation.
`ate`	(**at end**) Set the stream's position indicator to the end of the stream on opening.
`binary`	(**binary**) Consider stream as binary rather than text.
`in`	(**input**) Allow input operations on the stream.
`out`	(**output**) Allow output operations on the stream.
`trunc`	(**truncate**) Any current content is discarded, assuming a length of zero on opening.

Creating a Sequential-Access File

- Operations
  - Overloaded **`operator!`**
    - **`!outClientFile`**
    - Returns nonzero (true) if some error
      - Opening non-existent file for reading, no permissions, disk full etc.
  - Writing to file (just like **`cout`**)
    - **`outClientFile << myVariable`**
  - Closing file
    - **`outClientFile.close()`**
    - Automatically closed when destructor called

```
// Create a sequential file.
#include <iostream>
#include <fstream>
using namespace std;

int main()    {
     // ofstream constructor opens file
     ofstream outClientFile( "clients.txt",
ios::out );
     // exit program if unable to create file
     if ( !outClientFile ) {  // overloaded ! operator
     cout << "File could not be opened" << endl;
     exit( 1 );
} // end if
```

```
   cout << "Enter the account, name, and balance." << endl
      << "Enter \’N\’ to end input.\n? ";

   int account;
   char name[ 30 ], ch=‘y’;
   double balance;
   // read account, name and balance from cin, then place in file
   while (ch == ‘y’) {
          cin >> account >> name >> balance;
       outClientFile << account << ' ' << name << ' ' << balance
                     << endl;
       cout << "? ";
              cin>>ch;

   } // end while
  return 0;  // ofstream destructor closes file
} // end main
```

```
Enter the account, name, and balance.
Enter ‘N’ to end input.
100 Jones 24.98
? Y
200 Doe 345.67
? Y
300 White 0.00
? Y
400 Stone -42.16
? Y
500 Rich 224.62
? N
```

Reading Data from a Sequential-Access File

- Reading files
  - `ifstream inClientFile( "filename", ios::in );`
  - Overloaded `!`
    - **`!inClientFile`** tests if file was opened properly
- Upcoming example
  - Credit manager program
  - List accounts with zero balance, credit, and debit

```
const int  ZERO = 0, CREDIT = 1, DEBIT = 2, END = 3;

int main()
{
   // ifstream constructor opens the file
   ifstream inClientFile( "clients.txt", ios::in );

   // exit program if ifstream could not open file
   if ( !inClientFile )
   {
      cout << "File could not be opened" << endl;
      exit( 1 );
   } // end if

   int request;
   int account;
   char name[ 30 ];
   double balance;

   // get user's request (e.g., zero, credit or debit balance)
   request = getRequest();
```

```
// process user's request
while ( request != END ) {

   switch ( request ) {

      case ZERO:
         cout << "\nAccounts with zero balances:\n";
         break;

      case CREDIT:
         cout << "\nAccounts with credit balances:\n";
         break;

      case DEBIT:
         cout << "\nAccounts with debit balances:\n";
         break;

   } // end switch
   // read account, name and balance from file
   inClientFile >> account >> name >> balance;

   // display file contents (until eof)
   while ( !inClientFile.eof() ) {

      // display record
      if ( shouldDisplay( request, balance ) )
         cout << account << ' '<<name <<  ' '<< balance << endl;

      // read account, name and balance from file
      inClientFile >> account >> name >> balance;
   } // end inner while

   inClientFile.clear();    // reset eof for next input
   inClientFile.seekg( 0 ); // move to beginning of file
   request = getRequest();  // get additional request from user
} // end outer while
```

```
// getRequest function definition
  int getRequest()
        {
             int choice;

             cout<<"Enter 0 to see zero balance accounts"<<endl;
             cout<<"Enter 1 to see credit balance accounts"<<endl;
             cout<<"Enter 2 to see debit balance accounts"<<endl;
             cout<<"Enter 3 to end the program"<<endl;

             cin>>choice;
             return choice;
       }
// shouldDisplay function definition
       bool  shouldDisplay(int req, double bal)
       {

          if( (req == ZERO && bal == 0) || (req == CREDIT && bal < 0) ||
        (req == DEBIT && bal > 0) )
               return true;
          else return false;
       }
```

Reading Data from a Sequential-Access File

- File position pointers
  - Files have "get" and "put" pointers
    - Index of next byte to read/write
  - Functions to reposition pointer
    - **`seekg`** (seek get for **`istream`** class)
    - **`seekp`** (seek put for **`ostream`** class)
  - **`seekg`** and **`seekp`** take *offset* and *direction*
    - Direction (**`ios::beg`** default)
      - **`ios::beg`** - relative to beginning of stream
      - **`ios::cur`** - relative to current position
      - **`ios::end`** - relative to end
    - Offset: number of bytes relative to direction

Reading Data from a Sequential-Access File

- Examples
  - **`fileObject.seekg(0)`**
    - Goes to start of file (location **`0`**) because **`ios::beg`** is default
  - **`fileObject.seekg(n)`**
    - Goes to nth byte from beginning
  - **`fileObject.seekg(n, ios::cur)`**
    - Goes n bytes forward from current position
  - **`fileObject.seekg(y, ios::end)`**
    - Goes y bytes back from end
  - **`fileObject.seekg(0, ios::cur)`**
    - Goes to last byte
  - **`seekp`** similar

Reading Data from a Sequential-Access File

- To find pointer location
  - `tellg` and `tellp`
  - `int location = fileObject.tellg()`

Storage in Sequential-Access File

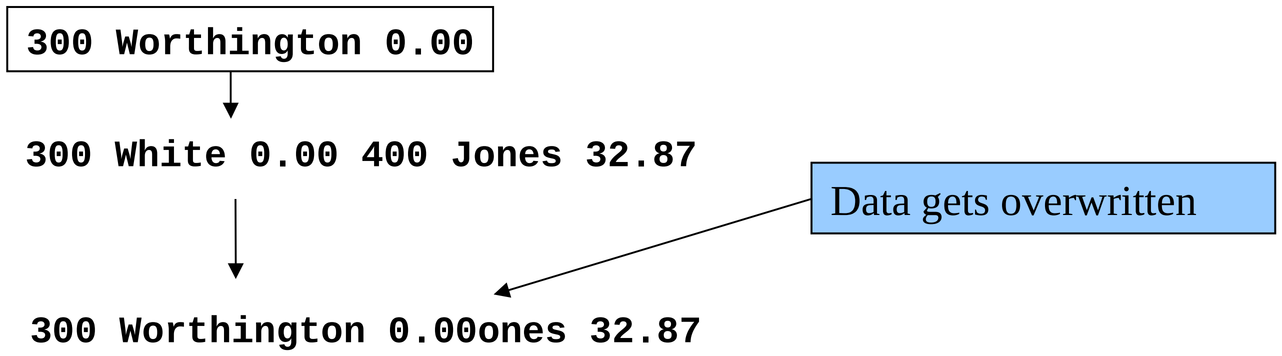
- `"1234567"` (`char *`) vs `1234567` (`int`)
  - `char *` takes 7 bytes (1 for each character)
  - `int` takes fixed number of bytes
    - 123 same size in bytes as 1234567
- `<<` operator
  - `outFile << number`
    - Outputs `number` (`int`) as a `char *`
    - Variable number of bytes

Updating Sequential-Access Files

- Updating sequential files
  - Risk overwriting other data
  - Example: change name "White" to "Worthington"
    - Old data

```
300 White 0.00 400 Jones 32.87
```

    - Insert new data



```
300 Worthington 0.00
```

```
300 White 0.00 400 Jones 32.87
```

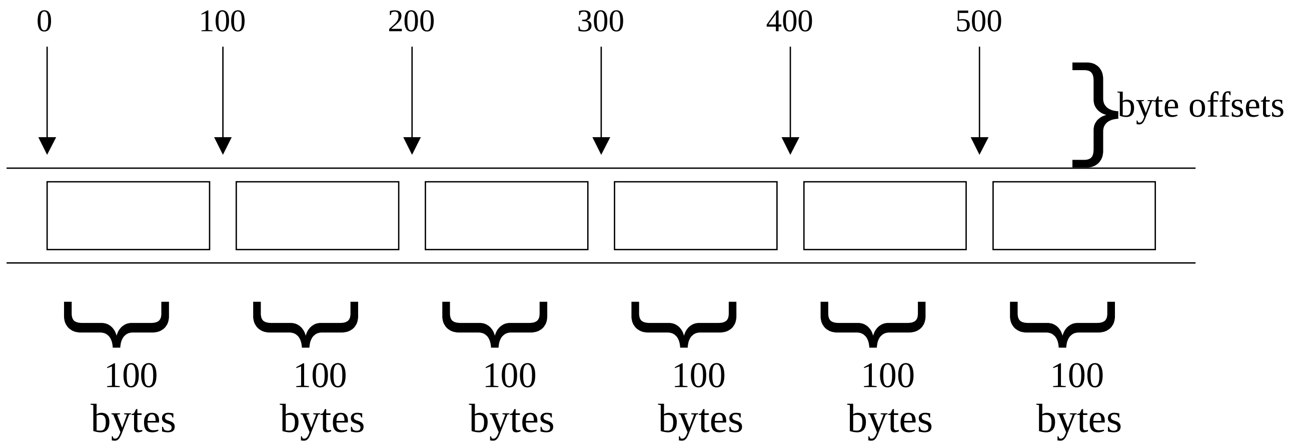
```
300 Worthington 0.00ones 32.87
```

Random-Access Files

- Instant access
  - Want to locate record quickly
    - Airline reservations, Banking system, ATMs
  - Sequential files must search through each one
- Random-access files are solution
  - Instant access
  - Update/delete items without changing other data

Random-Access Files

- C++ imposes no structure on files
  - Programmer must create random-access files
  - Fixed-length records
    - Calculate position in file from record size and key



`<<` operator vs. **`write()`**

- **`outFile << number`**
  - Outputs **`number`** (**`int`**) as a **`char *`**
  - Variable number of bytes
- **`outFile.write(` *`const char *, size`* `);`**
  - Outputs raw bytes
  - Takes pointer to memory location, number of bytes to write
    - Copies data directly from memory into file
    - Does not convert to **`char *`**

Creating a Random-Access File

- Example

```
outFile.write( reinterpret_cast<const char *>(&number),
   sizeof( number ) );
```

  - **`&number`** is an **`int *`**
    - Convert to **`const char *`** with **`reinterpret_cast`**
  - **`sizeof(number)`**
    - Size of **`number`** (an **`int`**) in bytes
  - **`read`** function similar (more later)
  - Must use **`write`**/**`read`** when using raw, unformatted data
    - Use **`ios::binary`** for raw writes/reads

Creating a Random-Access File

- Problem statement
  - Credit processing program
  - Record
    - Account number (key)
    - First and last name
    - Balance
  - Account operations
    - Update, create new, delete, list all accounts in a file

Next: program to create blank 100-record file