Entering data using the keyboard is not always convenient…Since engineers deal with big amount of data, keyboard entry become unsatisfactory…

As an alternative, data can be entered once into a ***File*** and read as needed… And for many times…

Therefore, the results of a program can be stored into a ***File*** instead of sending them to the screen… Thus, result data can be analyzed by another program…

For permanent retention, the computer store files on ***secondary storage devices*** such as *magnetic disks* (Hard disk, Floppy), *optical discs* (CDROM, DVD) and *Tapes*…

The data Hierarchy

- The computer can construct a sophisticated way of representing data using only two states **0**s and **1**s…

  This two-states system is called ***Binary System***

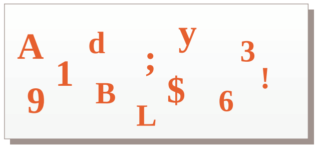
- Each **0** or **1** in a binary system is called a ***bit*** (binary digit) …

- But a single bit cannot store all the numbers, letters and special characters that the computer must process…

  The bits are put together in a group called a ***Byte***…

  There are usually ***8 bits in a byte***, which represents one ***Character*** of data…

- A ***Character*** is the smallest element of data… *letters digits special characters...*



- A ***Field*** is a set of related characters… *Student's ID, name, date of birth, major...*

990012

Computer Science

Joe Lee

12/January/1973

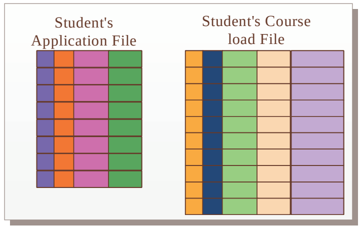
- A ***Record*** is a collection of related fields… *Student's record...*

990012	Joe Lee	Computer Science	12/January/1973
961234	Dany Eid	Translation	23/Mars/1972
997765	Tom Haj	Mathematics	30/Julia/1970

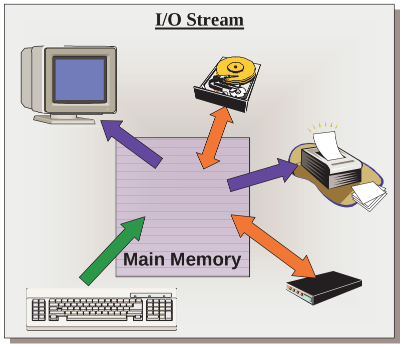
- A ***File*** is a collection of related records… *Student's application file...*

990012	Joe Lee	Computer Science	12/January/1973
961234	Dany Eid	Translation	23/Mars/1972
997765	Tom Haj	Mathematics	30/Julia/1970
997932	Dory Hajjar	Actuarial Science	30/Julia/1970
988295	GabbHoo	Mechanical Eng.	30/Julia/1970

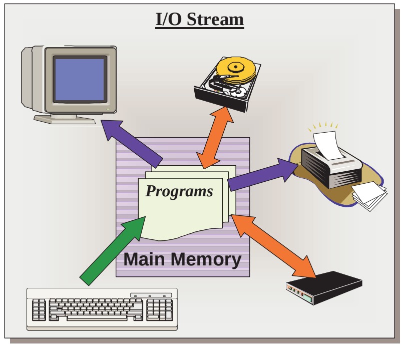
- A ***Database*** is a collection of interrelated files stored together with a minimum of redundancy… *Registrar's database...*



Input / Output Stream (Recall)



- C++ I/O occurs in a ***stream*** …where a stream is simply a sequence of data (bytes)…
- In input operations, the data flow from the device (keyboard, disk, etc.) to the main memory…
- In output operations, data flow from the main memory to the output device (screen, printer, disk)…



- To enable a program to communicate with any I/O device, an object (identification entity) must be created and a stream is associated with this object…

- The association of the stream and the object provides a communication channels between the program and a particular input / output device…

Standard Stream Objects (Recall)

- When a program is lunched by the operating system, four standard stream objects are automatically created and are made ready to be used by the program… Those objects are:
  - **`Standard Input`**… Usually connected to the keyboard.
  - **`Standard Output`**… Usually connected to the screen…
  - **`Standard Error`**…
  - **`Standard Log`**…

- In C++ those stream object can be referred to as follow:
  - **`Cin`** as the Standard Input…
  - **`Cout`** as Standard Output…
  - **`Cerr`** as Standard Error…
  - **`Clog`** as Standard Log…

Any other stream object, ***must first be created by the program*** before being used …

Stream Error States

The ***state of a stream*** may be tested trough a series of flags (***bits***) … They are:

- **eofbit**
- **failbit**
- **badbit**
- **goodbit**

➢ The **eofbit** is set for an input stream after ***end-of-file*** is encountered… An end-of-file is signaled after an attempt to read data beyond the end of the stream…

The `eof()` function can me used in the program to determine if end-of-file has been encountered on a stream…
It return's ***true*** if end-of-file has encountered and ***false*** otherwise…

```
...
for(;;) {
    cin >> val1;
    if (cin.eof())
       break;
    cout << val1 * 2 << endl;
}
...
```

➢ The **failbit** is set for a stream when a ***format error*** occurs on that stream … Such as entering non-digit characters into an integer variable…

The `fail()` function reports if a stream operation has failed…
It return's ***true*** if an operation has failed and ***false*** otherwise…

```
...
int val1;
 for(;;) {
    cin >> val1;
    if (cin.fail())
       break;
    cout << val1 * 2 << endl;
 }
...
```

➢ Note[JAN1] that rejected data is not lost, when the error occurs… It is up to the programmer to recover or to clear the buffer…

➢ The **badbit** is set for a stream when a severe error occurs that results in the loss of data… Such failures are normally non-recoverable…

The `bad()` function Reports if a stream operation has failed…
It return's ***true*** if an operation has failed and ***false*** otherwise…

➢ The **goodbit** is set for a stream when none of the bits (***eofbit, failbit, badbit***) is set for the stream…

The `good()` function Reports if a stream operation can be used…
It return's ***true*** when all of the three functions `eof()`, `fail()` and `bad()` return's false…

To restore a stream's state to "good", the `clear()` function can be used so that I/O may proceed on that stream…

The status of an I/O stream object can also be tested under the control of a selection structure or a repetition structure…

```
#include <iostream.h>
void main() {
   int val1;
   while (cin[JAN2] >> val1) {
      if (val1 == -1)
         break ;
      cout << val1 * 2 << endl;
   }
   if (!cin[JAN3]) {
      if (cin.bad())
         cout << "Bad Error...\n";
      if (cin.fail())
         cout << "Bad Input...\n";
      if (cin.eof())
         cout << "End of File...\n";
   }
}
```

➢ <u>`ios::operator void*`</u>[j4] is an operator that converts a ***stream*** to a ***pointer*** …
It provides a conversion, that when used in a condition tests it returns a Boolean value…
It returns 0 if either ***failbit*** or ***badbit*** is set in the stream's error state…

➢ <u>`ios::operator!`</u>[j5]
It returns a nonzero value if either ***failbit*** or ***badbit*** is set in the stream's error state…

<u>`operator void*`</u>

```
#include <iostream.h>
class A {
   friend istream & operator >> (istream &, A&);
   public:
      A (int a) {X = a;}
      int getX () {return X;};
      A& operator +=(int i) {
         X+=i;
         return *this;
      }
      operator void *() {
         cout <<"Ok\n";
         return 0;    }
   private:
      int X;
};
istream & operator >> (istream &in,A &o) {
   in >> o.X ;
   return in;
}

void main() {
   A a1(10), a2(20);
   if (a1){}          // Called.
   while(a1){}        // Called.
   a1 = a2;           // Not Called.
   a1;                // Not Called.
   if (a2 = a1);      // Called.
   if (a2==a1);       // Called for a2 then a1.
   if (a1 +=5);       // Called.
   if (cin >>a1);     // Not Called.
}
```

<u>Updating Sequential Access Files</u>

It is difficult to modify the data in a sequential file without the risk of destroying other data in the file…

➢ If the name ***Eddy*** needs to be changed to ***Edward***…

```
100 Tony 123.99
231 Bob 341.87
112 Eddy 0
143 Jimmy 8012.9
99 Joe 200
```

```
100 Tony 123.99
231 Bob 341.87
112 Edward
143 Jimmy 8012.9
99 Joe 200
```

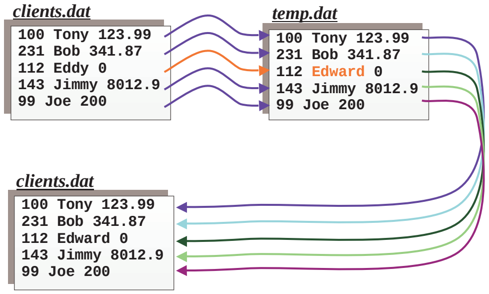
Solutions:

1. The whole file is read into the memory, modified in memory and then written back to the file…
2. The file is read and modified as it is written to a temporarily file. Finally the temporarily file is written back to the original.

Such solutions are awkward when updating single record at a time… They are acceptable when many records are update at a time…

```
// Updating data in a sequential file
#include <iostream.h>
#include <fstream.h>

int main() {
 int account, accNb;
 char name[ 30 ], newName[30];
 double balance;
 ifstream srcFile;
 ofstream dstFile;

 cout << "Enter the Account #";
 cin >>accNb;
 cout << "Enter new name: ";
 cin >> newName;

 srcFile.open("clients.dat", ios::in);
 dstFile.open("temp.dat", ios::out);
 if ( !srcFile || !dstFile) {
   cout << "Error in file open\n";
   return(1);
 }

 // Modify data in a temporary file…
 while (srcFile >> account >> name >> balance) {
   if (account == accNb)
     dstFile << account << " " << newName
          << " " << balance << endl;
   else
     dstFile << account << " " << name
          << " " << balance << endl;

 }
 srcFile.close();
 dstFile.close();
```

```
// Restore into original file…
srcFile.open("temp.dat", ios::in);
 dstFile.open("clients.dat", ios::out);
 if ( !srcFile || !dstFile) {
   cout << "Error in file open\n";
   return(1);
 }

 while (srcFile >> account >> name >> balance)
{
      dstFile << account << " " << name
              << " " << balance << endl;

 }
 srcFile.close();
 dstFile.close();

 return 0;
}
```



clients.dat

```
100 Tony 123.99
231 Bob 341.87
112 Eddy 0
143 Jimmy 8012.9
99 Joe 200
```

temp.dat

```
100 Tony 123.99
231 Bob 341.87
112 Edward 0
143 Jimmy 8012.9
99 Joe 200
```

clients.dat

```
100 Tony 123.99
231 Bob 341.87
112 Edward 0
143 Jimmy 8012.9
99 Joe 200
```