BIT

4. Data Abstract

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Content

- **Dynamic Storage Allocation**
- **C libraries**
- **Class**
- **The preprocessor**
- **Nested structures**

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4.1 Dynamic Storage Allocation

- **Fixed(Static) and Dynamic Allocation**
  - **Allocating memory for objects at compile time– Fixed (Static) Allocation**
  - **Allocating memory for objects at run time-- Dynamic storage Allocation**

4.1.1 Dynamic Allocation

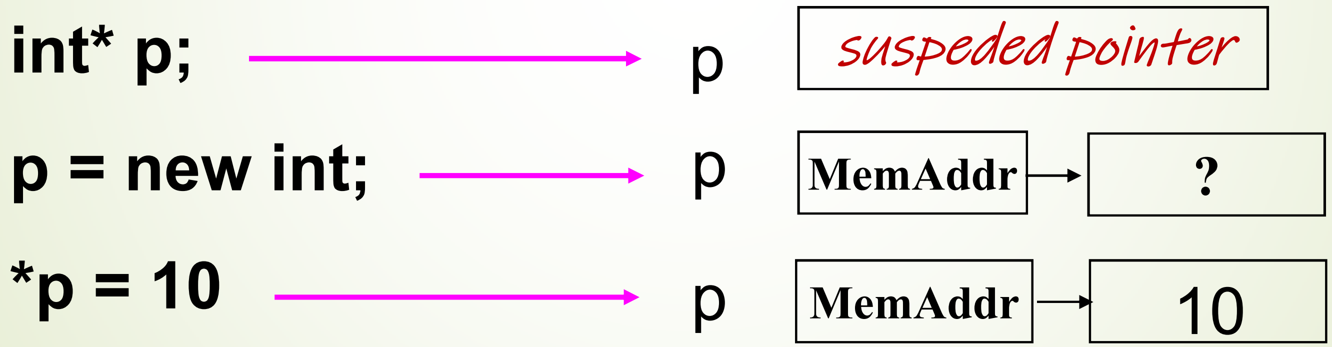
- Before program is run, we don't know how much memory we'll use. Thus we need dynamically allocate memory to program.
- In C it provides two functions: malloc() and free().
- In C++ it provides two new keywords: *new* and *delete*.

"*new*" is used to dynamically allocate memory.

"*delete*" is used to dynamically release memory.

4.1.1 Dynamic Allocation

- The ***new*** operator is used to allocate memory dynamically.



int* p;

p suspeded pointer

p = new int;

p MemAddr ?

*p = 10

p MemAddr 10

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4.1.1 Dynamic Allocation

```
#include <iostream.h>
int main()
{
        int *p;
        p = new int;
        *p = 10;
        cout << "Dynamically allocate memory.";
        delete p;
        return 0;
}
```

int* p = new int(10);

What's the meaning?
int* p = new int[10];

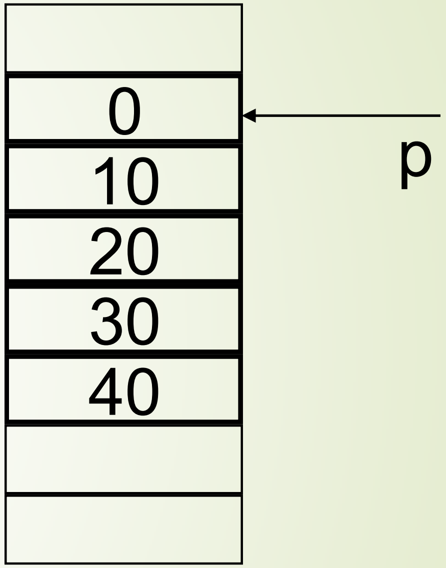
The *delete operator* is used to deallocate memory space.

4.1.1 Dynamic Allocation

- The ***delete*** operator is used to deallocate memory space (released dynamically)
  - ➢ delete p;
  - ➢ delete[ ] arrayName;

4.1.1 Dynamic Allocation

```
#include <iostream>
using namespace std;
int main() {
   int* p = new  int [5] ;
   for (int j=0; j < 5; ++j)
        *(p + j) = 10 * j;
   for ( j=0 ; j < 5; j++ )
        cout  <<  "p[" << j << "] = " << p[j] << endl;
    delete[ ] p;
    return 0;
}
```



What's the difference with *delete p* ?

4.1.2 Dealing with memory exhaustion

- *Memory exhaustion* occurs when there is not enough available memory to satisfy a request made for dynamic memory by the *new* operator.
- It can be tested by the return value from new.

```
#include <iostream>
using namespace std;
int main()
{
  int * p = new int[50];
  if (p == nullptr)    { cout << "Exhaustion!";  return 0;  }
 // other codes
 delete[ ]  p;
 return 0;
}
```

4.2 C libraries

- In C when you start to deal with a set of characteristics, it is very convenient to clump them together into a struct.

See also: STASH

Deficiencies:

- C codes are difficult to understand;
- Redundant information is in the interface definition;
- Data structure of the Stash is separated from its implementation.

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The basic object

```
// Header file of C++ library
struct  Stash
{   // Member variable or data member
    int size;               // Size of each space
    int quantity;           // Number of storage spaces
    int next;               // Next empty space
    unsigned char* storage; // Dynamically allocated storage
    void initialize(int size);  // Member functions!
    void cleanup( );
    int add(const void* element);
    void* fetch(int index);
    int count( );
    void inflate(int increase);
};
```

4.3 class

- The class is a fundamental OOP(Oriented-Object Programming) concept in C++.
- **The** class **is identical to the** struct **keyword in every way except one:** class **defaults to** private, **whereas** struct **defaults to** public**.**

4.3.1 Stash

```
// Header file of C++ library
class  Stash   {
private:
    int size;               // Size of each space
    int quantity;           // Number of storage spaces
    int next;               // Next empty space
    unsigned char* storage;
    // Dynamically allocated storage
public:
    void initialize(int size);
    void cleanup( );
    int add(const void* element);
    void* fetch(int index);
    int count( );
    void inflate(int increase);
};
```

4.3.1 Stash

```
// Implementation file of C++ library
#include "CppLib.h"
#include <iostream>
#include <cassert>
using namespace std;
const int increment = 100;

void Stash::initialize(int sz) {……}
int Stash:: add(const void* element) {……}
void* Stash:: fetch(int index) {……}
int Stash:: count() {……}
void Stash:: inflate(int increase) {……}
void Stash:: cleanup() {……}
```

```
int main()
{
  Stash intStash;
  intStash.initialize(sizeof(int));
  …………
   return 0;
}
```

4.3.2 Abstract data typing

- **The ability to package data with functions allows you to create a new data type, such as Stach. This is often called *encapsulation.***

- **Stach is an *abstract data type (user-defined type), and can be used as int.***

- ***object.memberFunction(arglist)* is "calling a member function for an object." In object-oriented parlance, this is also referred to as "*sending a message to an object*."**

4.4 Nested structures

```
// Nested struct in linked list
#ifndef STACK_H
#define STACK_H
class Stack {
        class Link  {
              void* data;
              Link* next;
              void initialize(void* dat, Link* nxt);
         }* head;
         void initialize();
         void push(void* dat);
         void cleanup();
};
#endif // STACK_H ///:~
```

```
void Stack::Link::initialize(void* dat, Link* nxt)
{  // To assign the arguments  to the members.
              data = dat;        next = nxt;
}

void Stack::initialize() { head = 0; }
  ..........
```

4.5 Global scope resolution

```
// Global scope
// resolution

int a;
void f( ) { }

class S
{
    int a;
    void f( );
};
```

```
void S::f( )
{
    ::f();          // global f();
    ::a++;          // global a
    a--;            // struct's a
}

int main( )
{
    S s;
    f();            // global f();
    return 0;
}
```

Summary

- ***abstract data type.***
- **Variables you create using this *type* are called** *objects***, or** *instances***, of that type.**
- **Calling a member function for an object is called** *sending a message* **to that object.**
- **A lot more you can do to make programming safer in C++.**