Even More C++

Outline

- Dynamic Memory
- Data Structures
- Other Data Types

Data Structures

- A data structure is a group of data elements grouped together under one name
  - Not quite the same thing as a data type
  - Use struct to define a structure in C++

```
struct type_name {
member_type1 member_name1;
member_type2 member_name2;
member_type3 member_name3;
.
.
} object_names;
```

```
struct product {
  int weight;
  double price;
} ;

product apple;
product banana, melon;
```

```
struct product {
  int weight;
  double price;
} apple, banana, melon;
```

- Accessing data elements in a structure

```
apple.weight
apple.price
banana.weight
banana.price
melon.weight
melon.price
```

An Example of struct

```
// example about structures
#include <iostream>
#include <string>
#include <sstream>
using namespace std;

struct movies_t {
  string title;
  int year;
} mine, yours;

void printmovie (movies_t movie);

int main ()
{
  string mystr;

  mine.title = "2001 A Space Odyssey";
  mine.year = 1968;

  cout << "Enter title: ";
  getline (cin,yours.title);
  cout << "Enter year: ";
  getline (cin,mystr);
  stringstream(mystr) >> yours.year;

  cout << "My favorite movie is:\n ";
  printmovie (mine);
  cout << "And yours is:\n ";
  printmovie (yours);
  return 0;
}

void printmovie (movies_t movie)
{
  cout << movie.title;
  cout << " (" << movie.year << ")\n";
}
```

```
Enter title: Alien
Enter year: 1979

My favorite movie is:
 2001 A Space Odyssey (1968)
And yours is:
 Alien (1979)
```

An Example of an Array of structs

```
// array of structures
#include <iostream>
#include <string>
#include <sstream>
using namespace std;

struct movies_t {
  string title;
  int year;
} films [3];

void printmovie (movies_t movie);

int main ()
{
  string mystr;
  int n;

  for (n=0; n<3; n++)
  {
    cout << "Enter title: ";
    getline (cin,films[n].title);
    cout << "Enter year: ";
    getline (cin,mystr);
    stringstream(mystr) >> films[n].year;
  }

  cout << "\nYou have entered these movies:\n";
  for (n=0; n<3; n++)
    printmovie (films[n]);
  return 0;
}

void printmovie (movies_t movie)
{
  cout << movie.title;
  cout << " (" << movie.year << ")\n";
}
```

```
Enter title: Blade Runner
Enter year: 1982
Enter title: The Matrix
Enter year: 1999
Enter title: Taxi Driver
Enter year: 1976

You have entered these movies:
Blade Runner (1982)
The Matrix (1999)
Taxi Driver (1976)
```

Pointers to Structures

- The arrow operator -> is used to access structures that have member elements

```
struct movies_t {
  string title;
  int year;
};

movies_t amovie;
movies_t * pmovie;
```

```
pmovie = &amovie;
```

`pmovie->title` is equivalent to: `(*pmovie).title`

`*pmovie.title` is equivalent to: `*(pmovie.title)`

Expression	What is evaluated	Equivalent
`a.b`	Member `b` of object `a`	
`a->b`	Member `b` of object pointed to by `a`	`(*a).b`
`*a.b`	Value pointed to by member `b` of object `a`	`*(a.b)`

Nesting Structures

- Structures can be nested within other structures

```
struct movies_t {
  string title;
  int year;
};

struct friends_t {
  string name;
  string email;
  movies_t favorite_movie;
} charlie, maria;

friends_t * pfriends = &charlie;
```

```
charlie.name
maria.favorite_movie.title
charlie.favorite_movie.year
pfriends->favorite_movie.year
```

Other Data Types: Aliases

- Two ways to create a type alias:
  - `typedef existing_type new_type_name;`
  - `using new_type_name = existing_type;`

```
typedef char C;
typedef unsigned int WORD;
typedef char * pChar;
typedef char field [50];
```

```
using C = char;
using WORD = unsigned int;
using pChar = char *;
using field = char [50];
```

```
C mychar, anotherchar, *ptc1;
WORD myword;
pChar ptc2;
field name;
```

- "using" is more generic, but "typedef" is likely found more often in existing code

Other Data Types: Unions

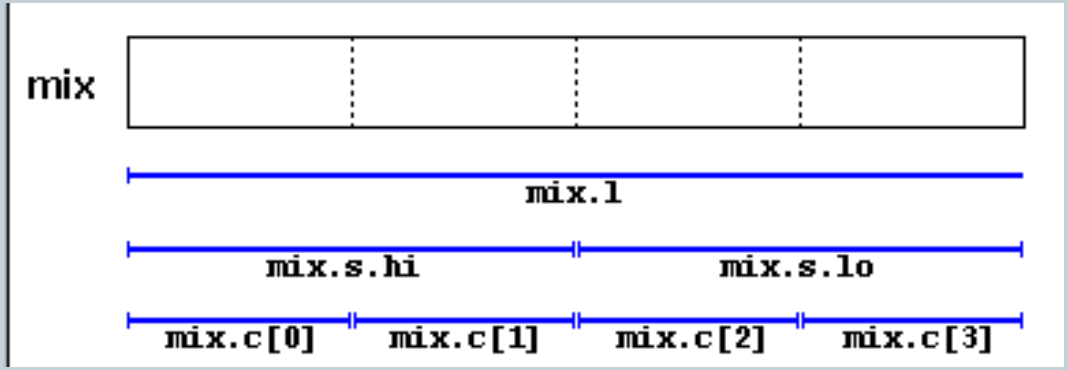
- Declaration similar to struct, but meaning is very different

```
union mytypes_t {
  char c;
  int i;
  float f;
} mytypes;
```

- All three member elements use the same memory space
  - Memory allocated is the size of the largest
    - In the example above, probably the size of a float
- Use this when you want to access an element in its entirety or as an array of smaller elements

Union Example

```
union mix_t {
  int l;
  struct {
    short hi;
    short lo;
    } s;
  char c[4];
} mix;
```



Anonymous Unions

structure with regular union	structure with anonymous union

struct book1_t {
  char title[50];
  char author[50];
  union {
  float dollars;
  int yen;
  } price;
} book1;
	struct book2_t {
	  char title[50];
	  char author[50];
	  union {
	  float dollars;
	  int yen;
	  };
	} book2;

```
book1.price.dollars
book1.price.yen
```

```
book2.dollars
book2.yen
```

Enumerated Types (enum)

```
enum type_name {
  value1,
  value2,
  value3,
  .
  .
} object_names;
```

```
enum colors_t {black, blue, green, cyan, red, purple, yellow, white};
```

```
colors_t mycolor;

mycolor = blue;
if (mycolor == green) mycolor = red;
```

- You can use these names or their integer equivalents

Enumerated Types (enum class)

```
enum class Colors {black, blue, green, cyan, red, purple, yellow, white};
```

```
Colors mycolor;

mycolor = Colors::blue;
if (mycolor == Colors::green) mycolor = Colors::red;
```

Summary

- Dynamic Memory
- Data Structures
- Other Data Types