

Structures

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Outline

- 1 Aggregate Data Types
- 2 Programming With Structures

The Problem

- We often need to store multiple related pieces of information.
- For instance, what does a stock holding look like?
 - Company Name
 - Stock Symbol
 - Purchase Price
 - Quantity
- How could we store this for each stock?

One Solution: Parallel Vectors

- We could make a vector for each field:

```
vector<string> company_name;  
vector<string> stock_symbol;  
vector<double> price;  
vector<int> quantity;
```

- This way, stock *i* has `company_name[i]`,
`stock_symbol[i]`, `price[i]`, **and** `quantity[i]`
- This is, of course, error prone and awkward!

A Better Approach

- Wouldn't it be nicer if we could do something like this?

```
Stock s;
```

- Or even better, make a vector of stocks?

```
vector<Stock> portfolio;
```

- It turns out, we can!

C++ struct

Stock Structure

```
struct Stock{  
    string company_name;  
    string stock_symbol;  
    double price;  
    int quantity;  
};
```

- A `struct` is a programmer defined **aggregate type**.
- A `struct` creates a custom type, which we can then use as any other variable type.
- The items within a `struct` are called fields.

Declaring and Using Struct Variables

- Structs operate like any other variable type, and fields are accessed using the '.' operator.

```
Stock s;  
s.company_name = "Microsoft";  
s.stock_symbol = "MSFT";
```

- The same is true of structs in vectors:

```
vector<Stock> list(10);  
list[0].company_name = "Microsoft";  
list[1].stock_symbol = "MSFT";
```

Defining Structures

- Typically, a `struct` will be defined in the global scope.
- `struct` definitions should go before function prototypes (either in `.h` or `.cpp` files).
- A typical layout of a `.h` file is:
 - 1 `struct` definitions.
 - 2 Function Prototypes
- A typical layout for a `.cpp` file is:
 - 1 Includes
 - 2 `struct` definitions
 - 3 Function Prototypes
 - 4 Main Function
 - 5 Function Definitions

Lab Activity: buysell.cpp

- 1 Create the directory `labs/week11`.
- 2 Copy `buysell.cpp` from `labs/week10` to `labs/week11`.
- 3 We will be modifying this file to use structures.
- 4 Make the following changes to `buysell.cpp`

buysell.cpp Includes and Structure

```
//Buy and sell stocks by symbol
#include <iostream>
#include <vector>
#include <string>
#include <algorithm>
#include <fstream>
#include <iomanip>

using namespace std;

//type definitions
struct Stock{
    string company_name;
    string stock_symbol;
    double price;
    int quantity;
};
```

buysell.cpp Function Prototypes

```
//function prototypes  
void buy(vector<Stock> &list);  
void sell(vector<Stock> &list);  
void display(vector<Stock> &list);  
void load(vector<Stock> &list);  
void save(vector<Stock> &list);
```

buysell.cpp Main Function

```
int main()
{
    int choice;
    enum menu_choices { BUY=1, SELL, DISPLAY, QUIT };
    vector<Stock> stocks;

    //load the stocks
    load(stocks);

    //display the menu
    do {
        //get the user's choice
        cout << "        MENU " << endl
             << "    1.) Buy a Stock" << endl
             << "    2.) Sell a Stock" << endl
             << "    3.) Display Stocks" << endl
             << "    4.) Quit" << endl
             << endl
             << "    Choice? ";
        cin >> choice;

        //do the menu choice
        if(choice == BUY) {
            buy(stocks);
        } else if(choice == SELL) {
            sell(stocks);
        } else if(choice == DISPLAY) {
            display(stocks);
        } else if(choice != QUIT) {
            cout << "Invalid selection. Please try again." << endl;
        }
    } while(choice != QUIT);

    //save the stocks
    save(stocks);
}
```

buysell.cpp Buy

```
//buy a stock
void buy(vector<Stock> &list)
{
    // Ask the user for a stock
    Stock stock;

    //get the stock Fields
    cout << "Company Name> ";
    cin >> stock.company_name;
    cout << "Symbol> ";
    cin >> stock.stock_symbol;
    cout << "Price> ";
    cin >> stock.price;
    cout << "Quantity> ";
    cin >> stock.quantity;

    // add the stock to the list
    list.push_back(stock);

    //sort the stocks
    //sort(list.begin(), list.end());
}
```

buysell.cpp Sell

```
//sell a stock
void sell(vector<Stock> &list)
{
    /*
        //ask the user for the stock
        string stock;
        cout << "Which stock do you want to sell? ";
        cin >> stock;

        //find the stock
        auto itr = find(list.begin(), list.end(), stock);

        //if the stock is in the list, remove
        //otherwise print an error message
        if(itr != list.end()) {
            list.erase(itr);
        } else {
            cout << "Could not find stock." << endl;
        }
    */
}
```

buysell.cpp Display

```
//display our stocks
void display(vector<Stock> &list)
{
    //print a header
    cout << left << setw(6) << "Symbol"
         << left << setw(15) << "Company Name"
         << right << setw(10) << "Quantity"
         << right << setw(10) << "Price" << endl
         << setfill('=') << setw(41) << '=' << endl
         << setfill(' ');
    //loop over all the stocks
    for(auto itr = list.begin(); itr != list.end(); itr++) {
        cout << left << setw(6) << itr->stock_symbol
             << left << setw(15) << itr->company_name
             << right << setw(10) << itr->quantity
             << right << fixed << setprecision(2) << setw(10)
             << itr->price
             << endl;
    }
}
```

buysell.cpp Load

```
//load the stocks from disk
void load(vector<Stock> &list)
{
    /*
        //open the file
        ifstream file;
        file.open("STOCK.LST");
        if(not file) {
            //return if the file does not exist
            return;
        }

        //read to the end of the file
        while(not file.eof()) {
            string stock;
            if(file >> stock) {
                //add all successfully read stocks
                list.push_back(stock);
            }
        }

        //close the file
        file.close();

    */
}
```


buysell.cpp Save

```
//save the file to disk
void save(vector<Stock> &list)
{
    /*
        //open the file
        ofstream file;
        file.open("STOCK.LST");
        if(not file) {
            //handle error
            cout << "Could not open file for writing." << endl;
            return;
        }

        //write the list to the file
        for(auto itr = list.begin(); itr != list.end(); itr++) {
            file << *itr << endl;
        }

        //close the file
        file.close();
    */
}
```