

C++ Templates

Function Swap Two Items

- Swapping two **integers**

```
void swap(int& a, int& b) {  
    int temp = a;  
    a = b; b = temp;  
}
```

- Swapping two **strings**

```
void swap(string& s1, string& s2)  
    string temp = a;  
    a = b; b = temp;  
}
```

- Swapping two instances of a class

```
void swap(TypeT& s1, TypeT& s2)
```



Same Same but Different

- Same for a lot of algorithms like sorting
- Do we have to write the same function for EVERY type?
 - Time Consuming
 - Difficult to modify ALL together
 - E.g. new features, found a bug
- In C++, we can use templates to save our time

C++ Function Templates

```
template<class TypeT>
```

```
void bubble(TypeT a[], int n) {
```

```
    int i, j;
```

```
    for (i = 0; i < n - 1; i++)
```

```
        for (j = i + 1; j < n; j++)
```

```
            if (a[i] > a[j])
```

```
                swap(a[i], a[j]);
```

```
}
```

The Same for Class

```
class ListNode
{
private:
    int _item;
    ListNode *_next;

public:
    ListNode(int);
    int content() { return _item; };
    friend class List;
};

class List
{
private:
    int _size;
    ListNode *_head;

public:
    List()
```

- So far, we have constructed a Linked List for integers
- To construct a LL for strings, or other type, we just need to change these

C++ Template with Type : T

Add "template < class T>"

```
class ListNode
{
private:
    int _item;
    ListNode *_next;

public:
    ListNode(int);
    int content() { return _item; };
    friend class List;
};
```

```
class List
{
private:
    int _size;
    ListNode *_head;

public:
    List()
    {
```

int becomes T

ListNode becomes
ListNode<T>

```
template <class T>
class ListNode
{
private:
    T _item;
    ListNode<T> *_next;

public:
    ListNode(T);
    T content() { return _item; };
    friend class List<T>;
};
```

```
template <class T>
class List
{
private:
    int _size;
    ListNode<T> *_head;

public:
```

Same for the Function Bodies

```
void List::insertHead(int n)
{
    ListNode *aNewNode = new ListNode(n);
    aNewNode->_next = _head;
    _head = aNewNode;
    _size++;
};
```

Linked List for
Integers

```
template <class T>
void List<T>::insertHead(T n)
{
    ListNode<T> *aNewNode = new ListNode<T>(n);
    aNewNode->_next = _head;
    _head = aNewNode;
    _size++;
};
```

Linked List Template
for any type/class

Template File Organization

- However, compiling template files is a big headache
- There are a few methods programmers are using but we will just introduce one that is
 - Easiest to use
 - Reduce errors
 - More compatible with all the platforms

Naming the File

- Let's say you want to implement a template for Linked List
- You can still do the same thing for the header file
- However, there are two changes:
 - Rename the Linked List .cpp template to .hpp (optional)
 - Include the .hpp file in your .h file

MS Visual Studio

- For MSVC users
 - When you add the files to your project, include the .hpp under Headers instead of Sources

