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Object Oriented Design

Week 9-2

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Template and STL

- In Week 4 tutorial
- AutoFreePtr class:

```
class AutoFreePtr {
    char *ptr;   // a pointer to an allocated char array
public:
    // you need implement here
}
```

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Template and STL

```
    class AutoFreePtr {
    char *ptr;
public:
    AutoFreePtr():ptr(0) {}
    ~AutoFreePtr() {
        delete[] ptr;
    }

    AutoFreePtr(char *ptr):ptr(0){
        operator=(ptr);
    }

    char *operator=(char *ptr) {
        if(this->ptr) delete[] this->ptr;
        this->ptr = ptr;
        return this->ptr;
    }

    operator char* () {
        return ptr;
    }

    char &operator[](int index) {
        return ptr[index];
    }
};
```

```
void removeSpace(char *str) {
    int n = strlen(str);
    AutoFreePtr tmp = new char[n+1];
    strcpy(tmp, str);
    int i, j;
    for (i = j = 0; i < n; i++)
        if (str[i] != ' ')
            tmp[j++] = str[i];
    tmp[j] = '\0';
    strcpy(str, tmp);
}
```

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Template and STL

- In C++'s standard library (std::)
- auto_ptr : provides similar auto release mech.
- Template?

Invitation

Dear

Date

Place

auto_ptr<   >

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auto_ptr

- include <memory>
- auto_ptr : provides similar auto release mech.
- Template?

Invitation

Dear

Date

Place

auto_ptr< >

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```
#include <memory>
using namespace std;

void foo() {
   auto_ptr<int> p(new int);
   *p = 10;
}

int main(void) {
   foo();
   return 0;
}
```

- <int>
- auto_ptr has int*
- p : variable
- call constructor
- needs int *

- auto_ptr p;
  - compiler error...not arg for the template

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- declare with a template
  - a customised class is instantly created.

- operator*, operator-> ..predefined

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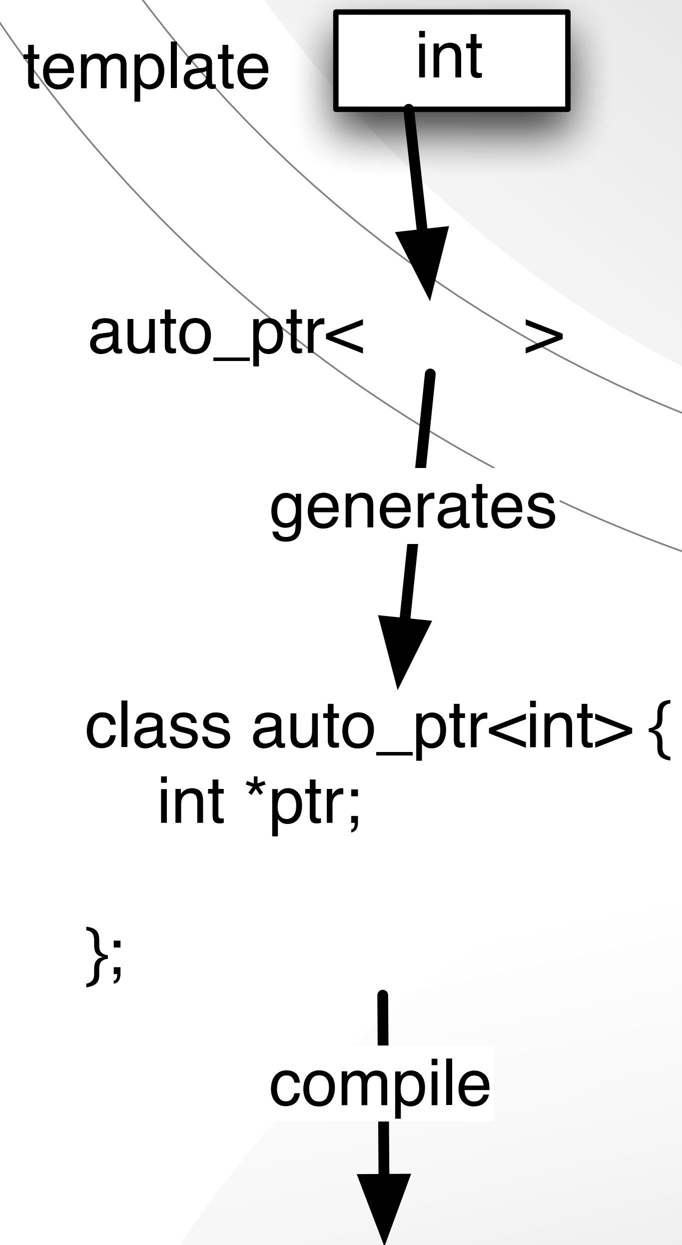
```
   #include <memory>
using namespace std;

void foo() {
   auto_ptr<int> p(new int);
   *p = 10;
}

int main(void) {
   foo();
   return 0;
}
```



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type of templates

- function template
- class template

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how to make it

- “template” keyword

```
#include <iostream>
using namespace std;

template <class type> void display(type arg) {
   cout << arg << endl;
}
```

- `template <class type>` specify template
- `void display(type arg)` function def.
- `type` : an arbitrary type.

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how to make it

- "template" keyword

```
#include <iostream>
using namespace std;

template <class type> void display(type arg) {
  cout << arg << endl;
}
```

- `void display(int arg)`
- `void display(double arg)`
- etc.

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Template Parameter (T/type)

```
template <typename type> void display(type arg) {
   cout << arg << endl;
}
```

or

```
template <typename T> void display(T arg) {
   cout << arg << endl;
}
```

or

```
template <class T> void display(T arg) {
   cout << arg << endl;
}
```

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```
   #include <iostream>
#include <string>
using namespace std;

template <typename T> void display(T arg) {
   cout << arg << endl;
}

int main() {
   display(30.0);
   string str = "hello";
   display(str);
   return 0;
}
```

- `void display(int arg)`
- `void display(string arg)`

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explicit use

```
#include <iostream>
#include <string>
using namespace std;

template <typename T> void display(T arg) {
   cout << arg << endl;
}

int main() {
   display<double>(30.0);
   string str = "hello";
   display<string>(str);
   return 0;
}
```

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arbitrary type...

- statements in the template function
  - might not support certain types,
  - might give you compilation errors,
- `template <typename T> void display(T arg)`
  - `operator << (ostream)` must support `T`

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```
template <typename T> T abs(T arg) {
    T temp;
    temp = (arg < 0) ? -arg : arg;
    return temp;
}
```

- imagine T as “int”, “double”, etc.
- T can be use anywhere in the function:
  - return type
  - arg type
  - local variable..

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```
    template <typename T> T abs(T arg) {
    T temp;
    temp = (arg < 0) ? -arg : arg;
    return temp;
}

int main() {
    int i = -30;
    double d = -4343.88;
    i = abs(i);
    d = abs(d);

    return 0;
}
```

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```
template <typename T> T abs(T arg) {
   T temp;
   temp = (arg < 0) ? -arg : arg;
   return temp;
}

int main() {
   char *p = “hello”;
   p = abs(p);

   return 0;
}
```

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explicit specialisation

- create a special function for char *
- don’t specify <typename T>..just <>

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```
   template <typename T> T abs(T arg) {
   T temp;
   temp = (arg < 0) ? -arg : arg;
   return temp;
}

template <> char *abs(char *arg) {
    // some implemenation to abs a string
    ...
}

int main() {
   char *p = "hello";
   p = abs(p);

   return 0;
}
```

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explicit specialisation

- abs(“hello”)
  - not instantiation from a template
  - just call the specialised function.

- if there is a pre-defined function (like abs(int)),
- predefined function will becalled
  - abs(int) ..... std-lib’s abs function
  - abs(double) ..... function template’s abs()

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how can I call abs(int)?

- want to call function template abs(int)

```
abs<int>(i);
```

- When you use a function template
  - make sure to check the desired f.t. is actually called.

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how about macro?

- `#define abs(a) (((a)<0)?-(a):(a))`

- char literal replacement.
- side effects.
- explicit specialisation?

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many parameters?

```
template<class T, class U, class V> void bar(T x, U y, V
z) {
  ...
}

string str = "hello";
int i = 20;
double d = 30.5;
bar(str, i, d);

bar<string, int, double>(str, i, d);
```

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class template

- function template :
  - you specify data types the function can use.

- if you specify data type a class can use
  - class template

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```
   class MultiString {
   string s1, s2;
public:
   MultiString(const string& a, const string& b) : s1(a), s2(b) {}
   string getS1() const {return s1;}
   string getS2() const {return s2;}
};
```

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```
template <class T> class MultiData {
   T s1, s2;
public:
   MultiData(const T& a, const T& b) : s1(a), s2(b) {}
   T getS1() const {return s1;}
   T getS2() const {return s2;}
};
```

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```
   template <class T> class MultiData {
   T s1, s2;
public:
   MultiData(const T& a, const T& b);
   T getS1() const {return s1;}
   T getS2() const {return s2;}
};

template <class T> MultiData<T>::MultiData(const T& a, const
T& b) : s1(a), s2(b) {}
```

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```
template <class T, class U> class MultiData {
   T s1;
   U s2;
public:
   MultiData(const T& a, const U& b);
   T getS1() const {return s1;}
   U getS2() const {return s2;}
};

template <class T, class U> MultiData<T, U>::MultiData(const
T& a, const U& b) : s1(a), s2(b) {}
```

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```
int main() {
string str1 = "hello";
string str2 = "world";
int i = 20, j = 40;
double d = 88.3, e = 2.0;

MultiData<string, string> ssd(str1, str2);
MultiData<string, double> sdd(str1, e);
MultiData<int, int> sdd(i, j);
}
```

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```
int main() {
    string str1 = "hello";
    string str2 = "world";
    int i = 20, j = 40;
    double d = 88.3, e = 2.0;

    MultiData<string, string> *ssd;
    ssd = new MultiData<string, string>(str1, str2);

    MultiData<string, double> *sdd;
    sdd = MultiData<string, double>(str1, e);
}
```

•

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```
int main() {
MultiData<MultiData<int, string>, MultiData<double, string> >
   isds(MultiData<int, string>(12, "hello"),
        MultiData<double, string>(3.4, "world"));
}
```

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