

Discuss C++ Template Downcast

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This is a discuss in C board in bbs.sjtu.edu.cn, about type downcast in C++ template.

Original Discuss

The problem

Today I read a book about we can do cast-down in template, so I write this to test:

```
1  template <bool _Test, class _Type = void>
2  struct enable_if { };
3
4  template<class _Type>
5  struct enable_if<true, _Type> {
6      typedef _Type type;
7  };
8
9  class A { };
10 class B : A { };
11
12 template <typename T>
13 struct traits { static int const value = false;
14 };
15
16 template <>
17 struct traits<A> { static int const value = true; };
18
19 template <typename T>
20 void f(T, typename enable_if<traits<T>::value>::type* = 0) { }
21
22 template <>
23 void f<A>(A, enable_if<traits<A>::value>::type*
24 ) { }
25
```

```

26 template <typename T>
27 class BB {};
28
29 template <typename T>
30 class DD : public BB<T> {};
31
32 template <typename T> void ff(BB<T>) {};
33
34 int main(int argc, char * argv[])
35 {
36     A a; B b;
37     DD<long> dd;
38     //f(b);
39     ff(dd);
40 }

```

It is strange when `f` it don't allow my specified `f<A>` .

But in `ff` it allowed `ff<BB<long>>` .

Tested under VC10 and GCC3.4

My answer to the problem

Let's think ourself as compiler to see what happened there.

Define mark `#` : `A#B` is the instantiated result when we put `B` into the parameter `T` of `A<T>` .

First we discuss ff

```

1 DD<long> dd;

```

After this sentence, the compiler saw the instantiation of `DD<long>` , so it instantiate `DD#long` , and also `BB#long` .

```
1 ff(dd);
```

This sentence required the compiler to calculate set of overloading functions.

Step 1 we need to infer `T` of `ff<T>` from argument `DD#long` – `> BB<T>` . Based on the inference rule:

```
Argument with type :code:`class_template_name<T>`  
>` can be use to infer :code:`T``.
```

So compiler inferred `T` as `long` . Here if it is not `BB` but `CC` which is complete un-related, we can also infer, as long as `CC` is a template like `CC<T>` .

Step 2 Template Specialization Resolution. There is only one template here so we matched `ff<T>` .

Step 3 Template Instantiation

After inferred `long` \rightarrow `T` , compiler instantiated `ff#long` .

Set of available overloading functions : `{ff#long}`

Then overloading resolution found the only match `ff#long`` , checked its real parameter `DD#long` can be down-cast to formal parameter `BB#long` .

Then we discuss f

```
1 f(b);
```

Calculate set of overloading functions.

Step 1 infer all template parameters for template `f` . According to inference rule:

Parameter with type `T` can be used to infer `T` .

So `B -> T` is inferred.

Step 2 Template Specialization Resolution.

Here `B` is not `A` so we can not apply specialization of `f<A>` , remaining `f<T>` as the only alternative.

Step 3 Template Instantiation.

When we put `B` into `f<T>` to instantiate as `f#B` , we need to instantiate `traits#B`` .

There is no specialization for `B` so we use template `traits<T>` , `traits#B::value=false` , so `enable_if#false` didn't contains a type , an error occurred.

The only template is mismatch, available overloading functions is empty set. So we got an error.