Discuss C++ Template Downcast

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

Original Discuss

http://bbs.sjtu.edu.cn/bbstcon,board,C,reid,1330078933,file,M.

1330078933.A.html

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  template <>
16  struct traits<A> { static int const value = true; };
17
18  template <typename T>
19  void f(T, typename enable_if<traits<T>::value>::type* = 0) { }
20
21  template <>
22  void f<A>(A, enable_if<traits<A>::value>::type*) { }
23
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 sentense, the compiler saw the instantiation of `DD<long>` , so it instantiate `DD#long` , and also `BB#long` .

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

This sentense 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 -> 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.