Lecture 10

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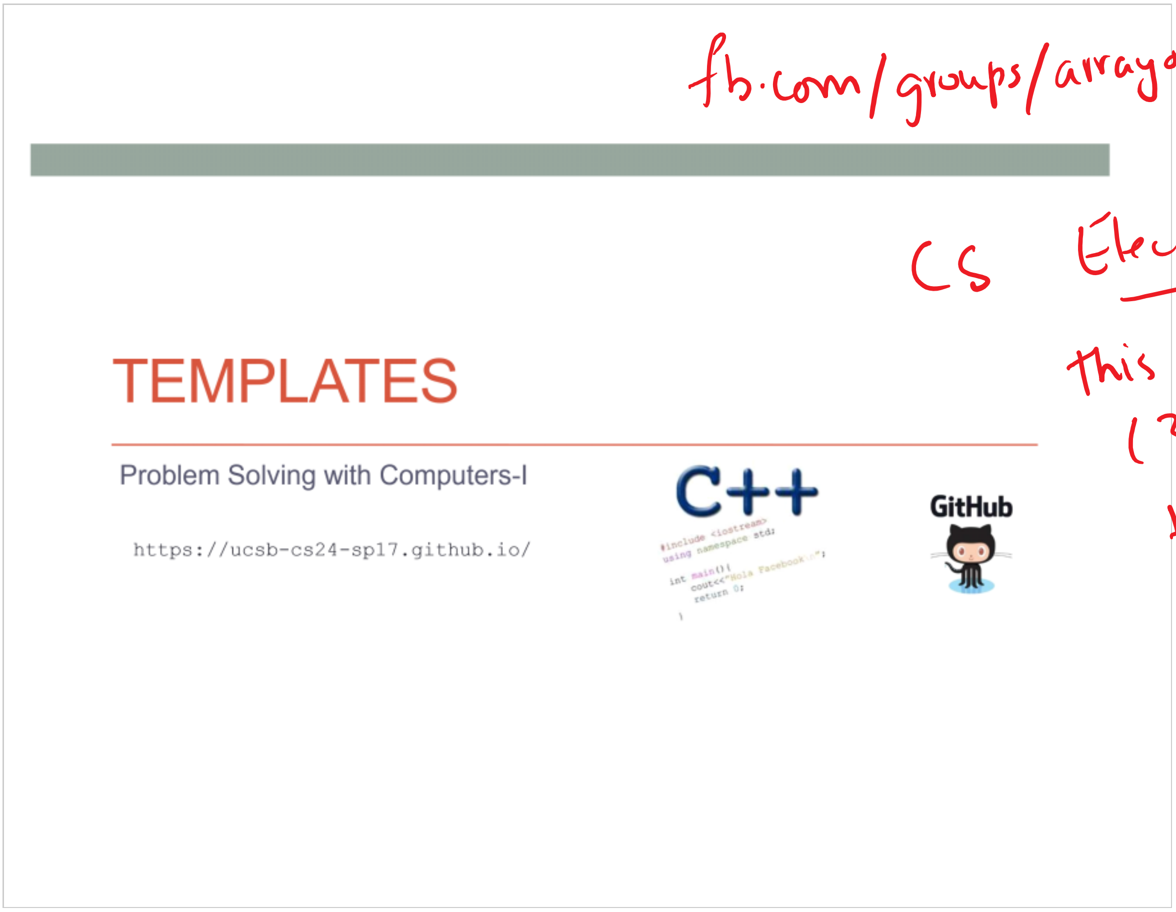

fb.com/groups/arrayoftalks.

CS Elective advising

this Wed (3:30pm-4:30pm)

HFH 1132

TEMPLATES

Problem Solving with Computers-I

https://ucsb-cs24-sp17.github.io/

C++

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

int main(){
    cout<<"Hola Facebook :)";
    return 0;
}
```

GitHub

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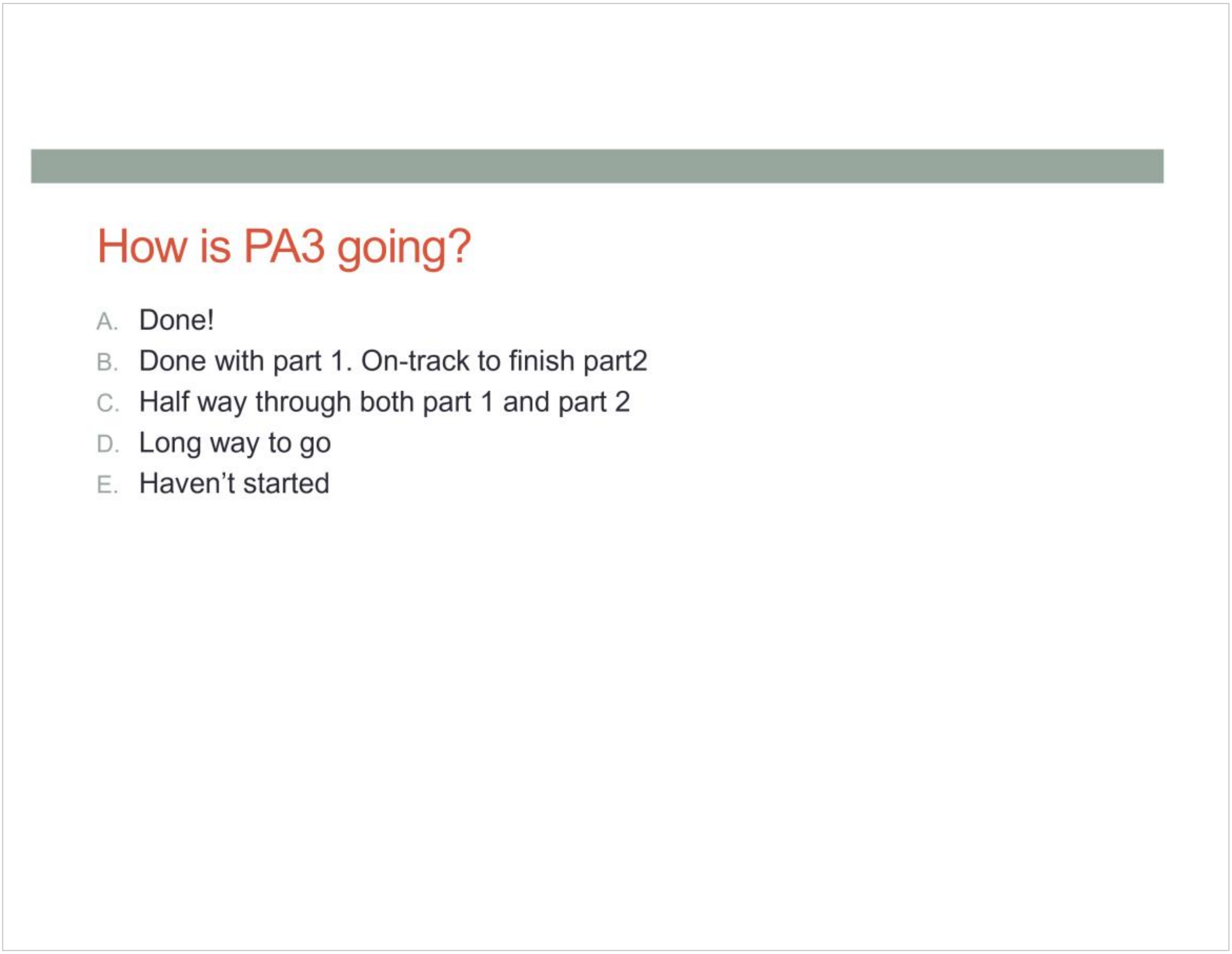

How is PA3 going?

A. Done!
B. Done with part 1. On-track to finish part2
C. Half way through both part 1 and part 2
D. Long way to go
E. Haven't started

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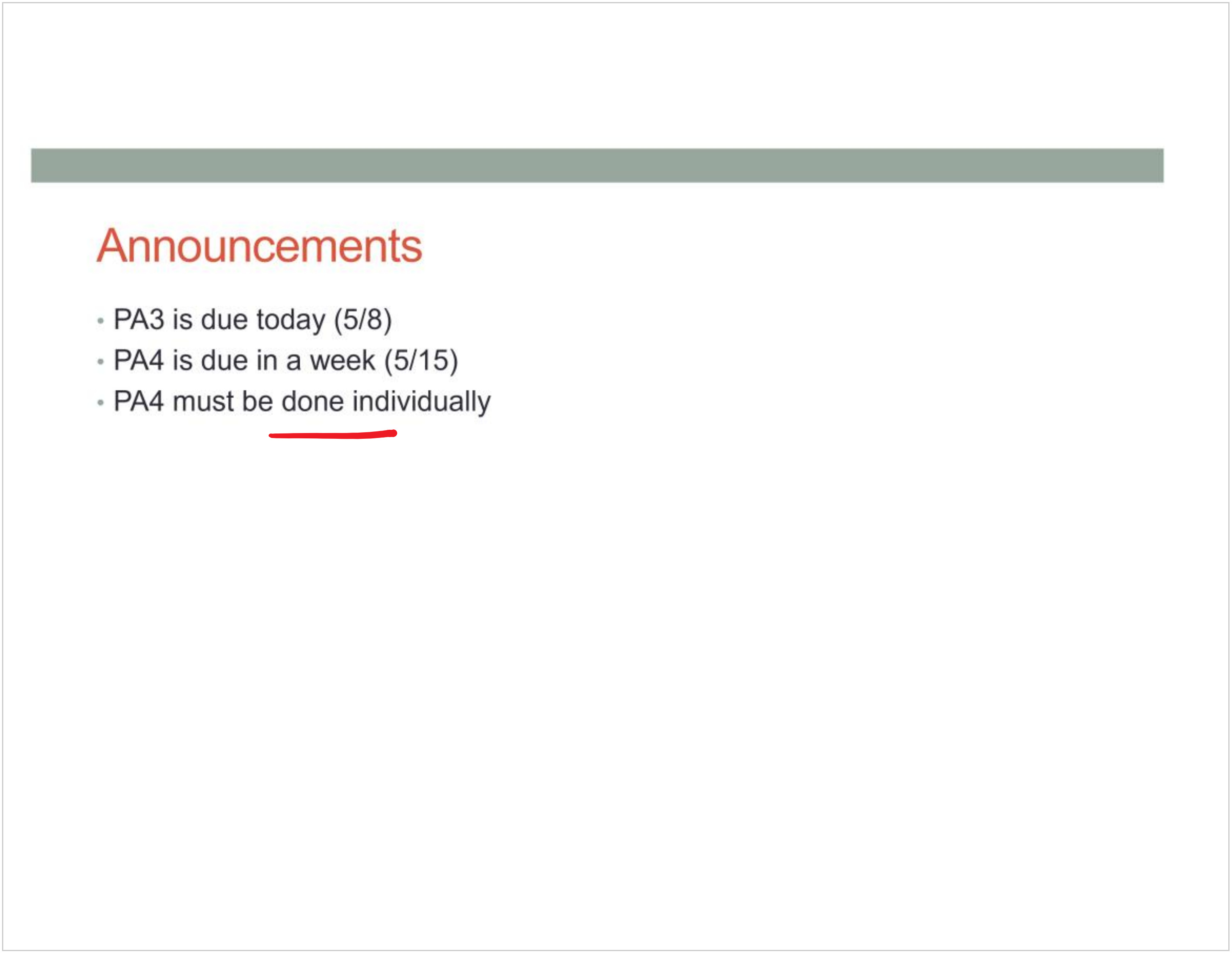

Announcements

- PA3 is due today (5/8)
- PA4 is due in a week (5/15)
- PA4 must be done individually

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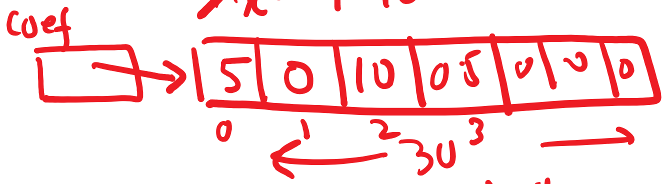
Polynomial class

- Differences between PA3 and PA4

$0.5x^3 + 10x^2 + 5$

$\rightarrow x^{35} + 10x$



class polynomial {

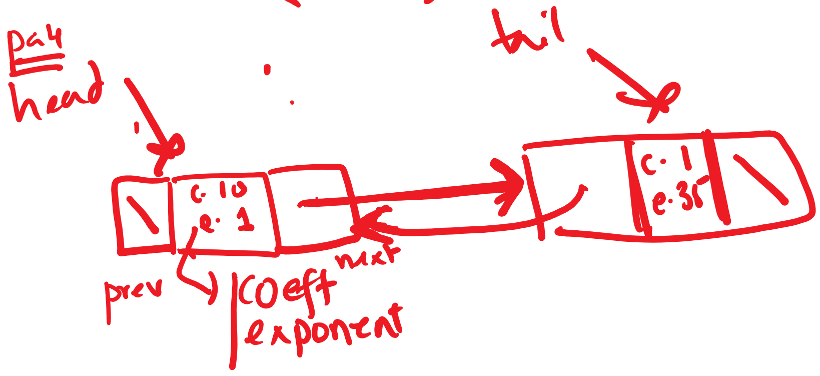
private:

double *coef;

uint size;

uint current_deg

}



polynomial {

Polynode *head;

Polynode *tail;

}

polynode *p1 = new polynode;

list → head = p1;

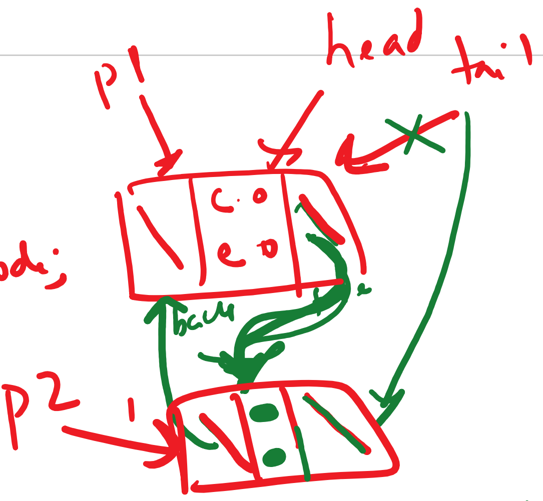
list → tail = p1;

Polynode * p2 = new polynode;

✓ list→tail = p2;

p1→set_fore(p2);

p2→set_back(p1);

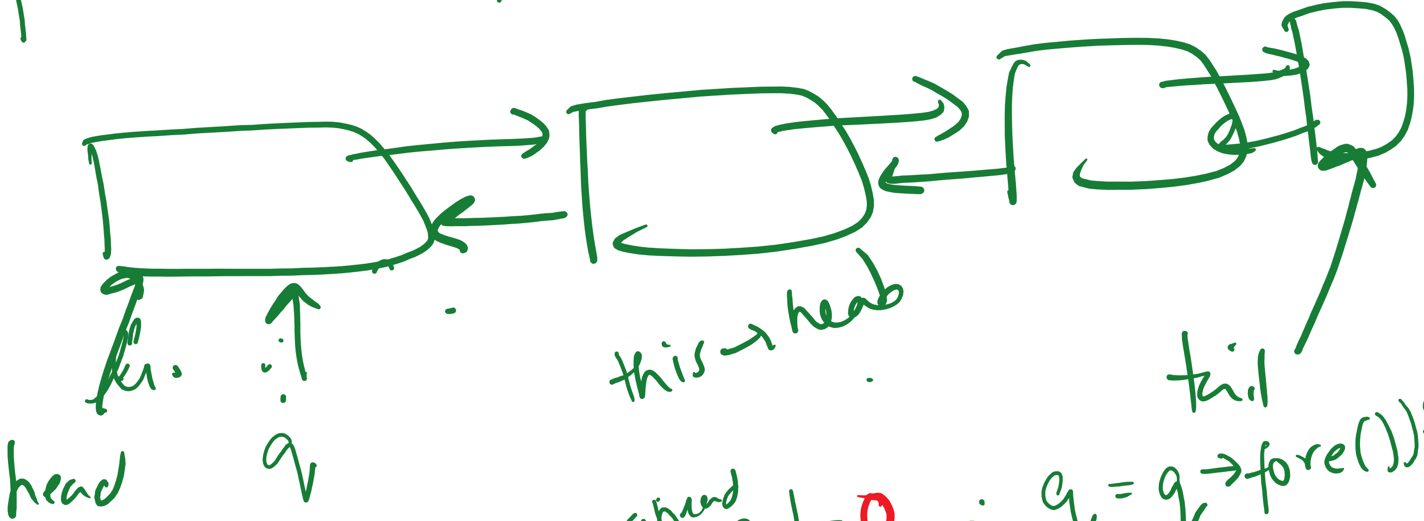


set_fore(polynode *)

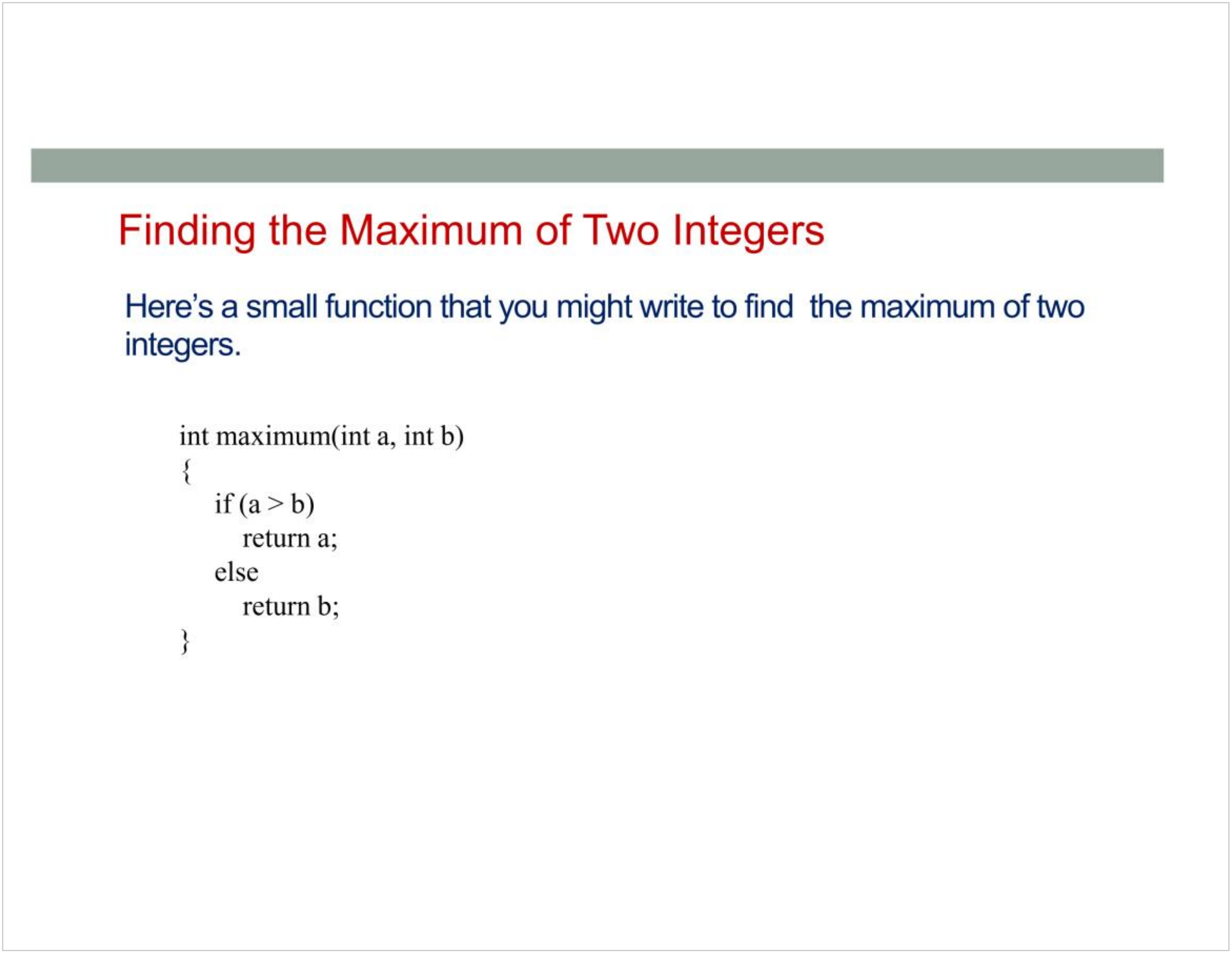
set_back(polynode *)

```
p1→set_fore( p2 );
p2→set_back( p1 );
```

set_fore (polynode *)
set_back (polynode *)



```
for( polynode *q=head ; q != 0 ; q = q→fore()){
        cout << q → coef () ;
        cout << q → exponen() ;
}
```



Finding the Maximum of Two Integers

Here's a small function that you might write to find the maximum of two integers.

```
int maximum(int a, int b)
{
    if (a > b)
        return a;
    else
        return b;
}
```

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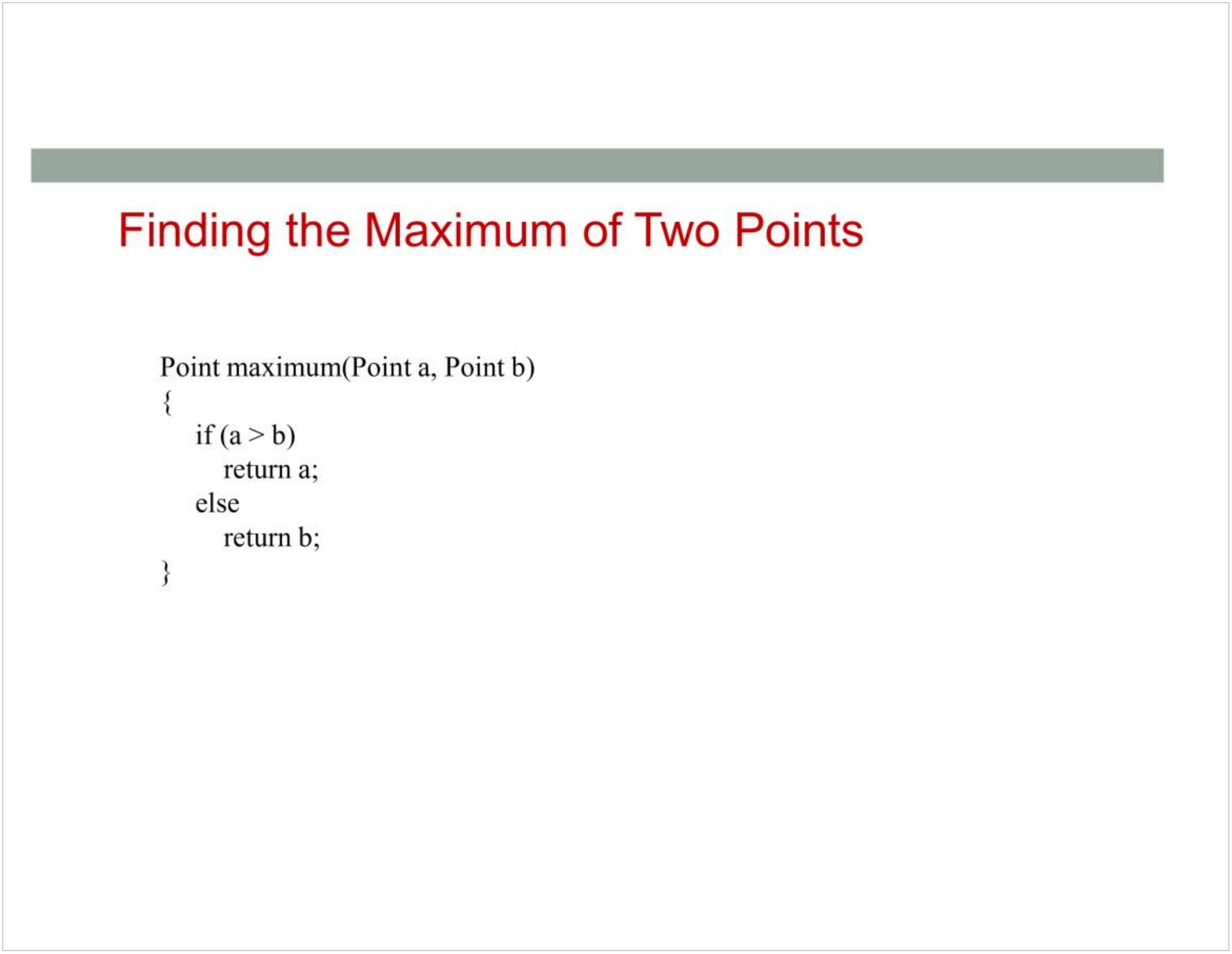
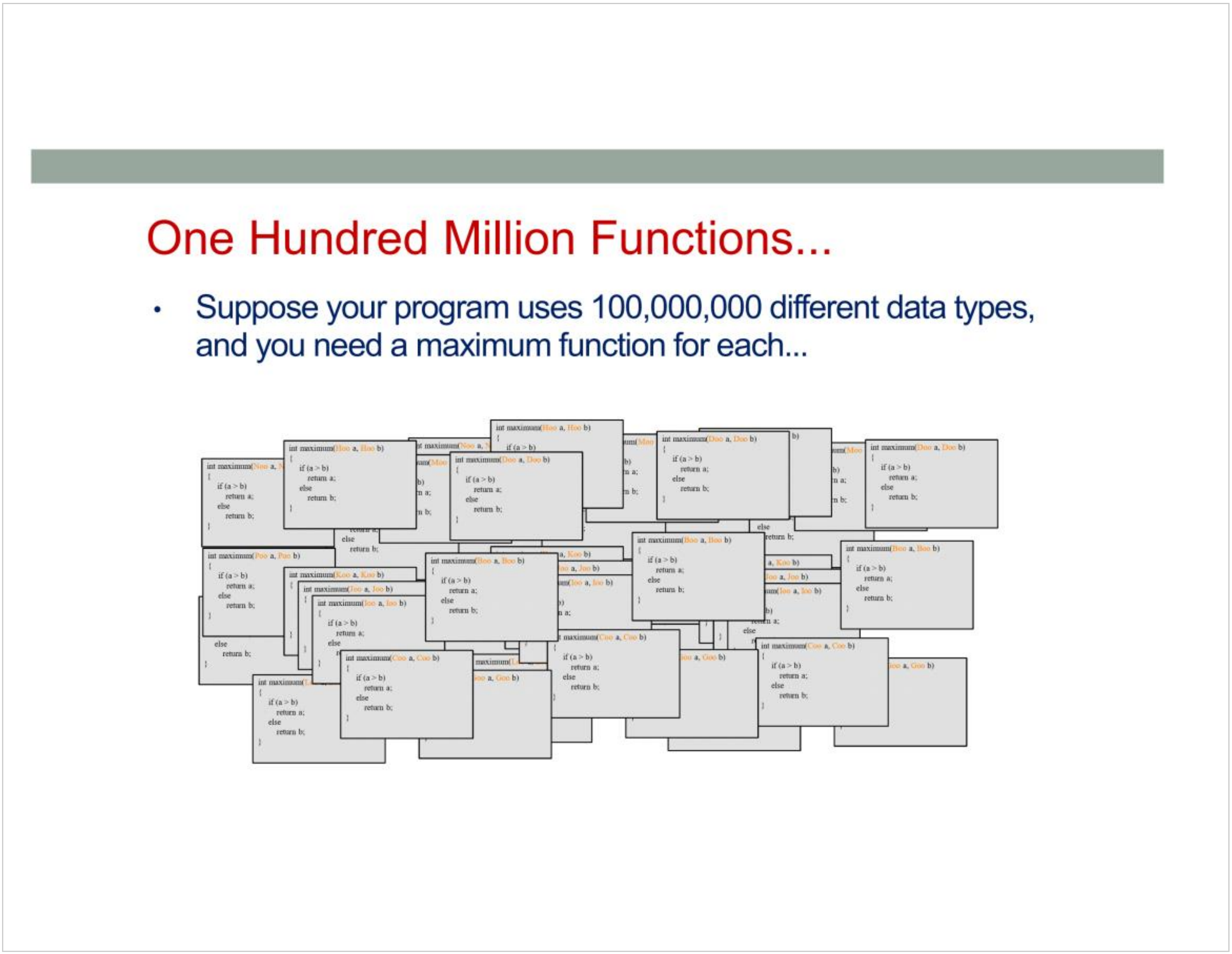


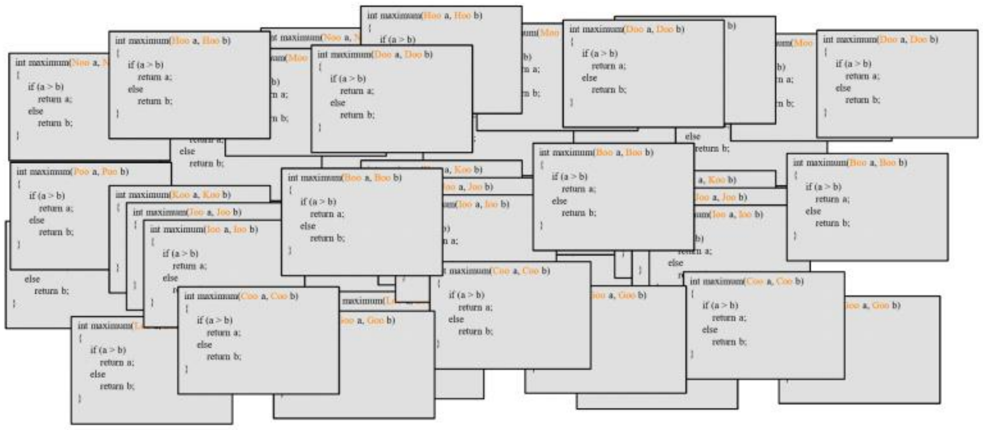
Finding the Maximum of Two Points

```
Point maximum(Point a, Point b)
{
    if (a > b)
        return a;
    else
        return b;
}
```



One Hundred Million Functions...

- Suppose your program uses 100,000,000 different data types, and you need a maximum function for each...



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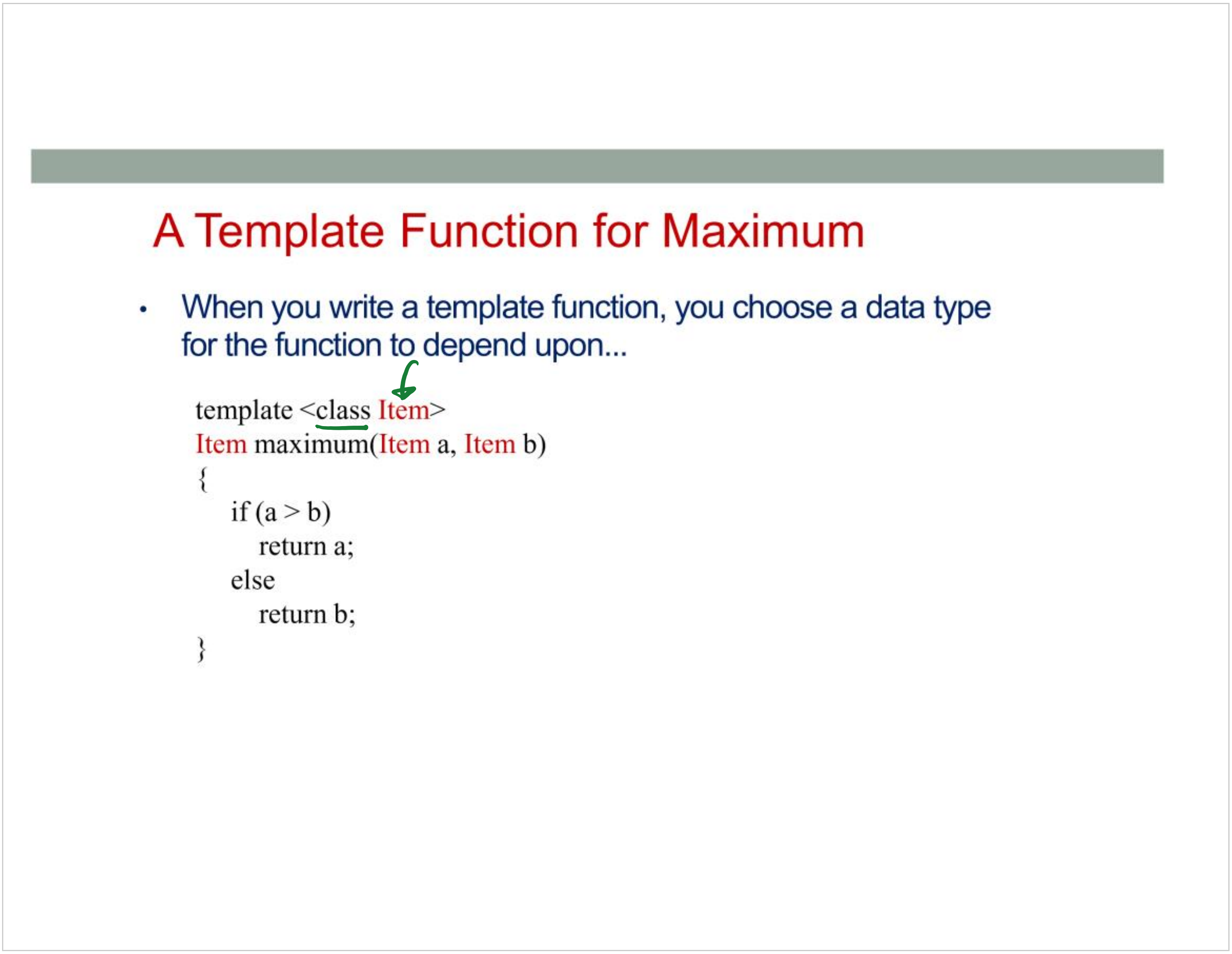
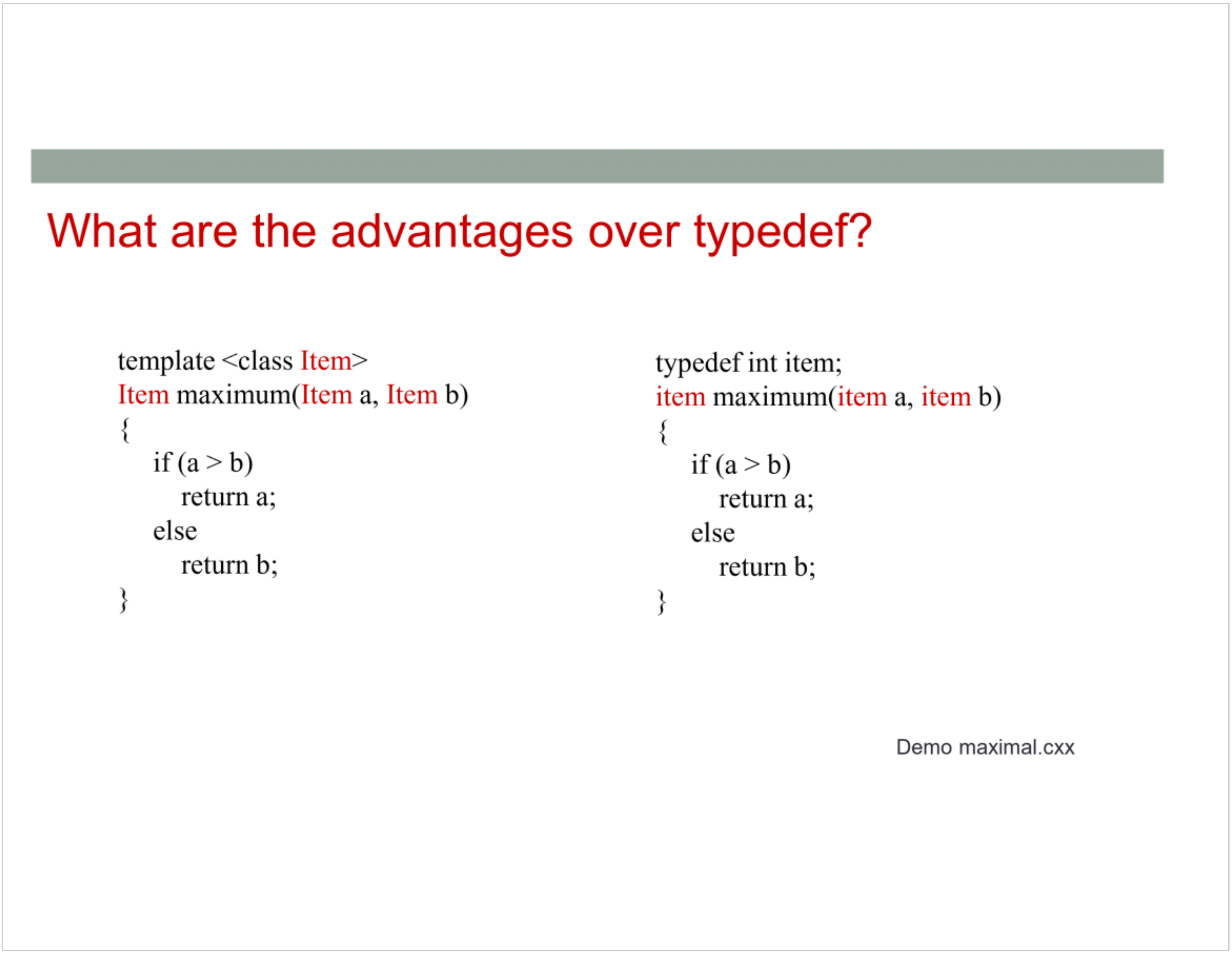


A Template Function for Maximum

- When you write a template function, you choose a data type for the function to depend upon...

```
template <class Item>
Item maximum(Item a, Item b)
{
    if (a > b)
        return a;
    else
        return b;
}
```

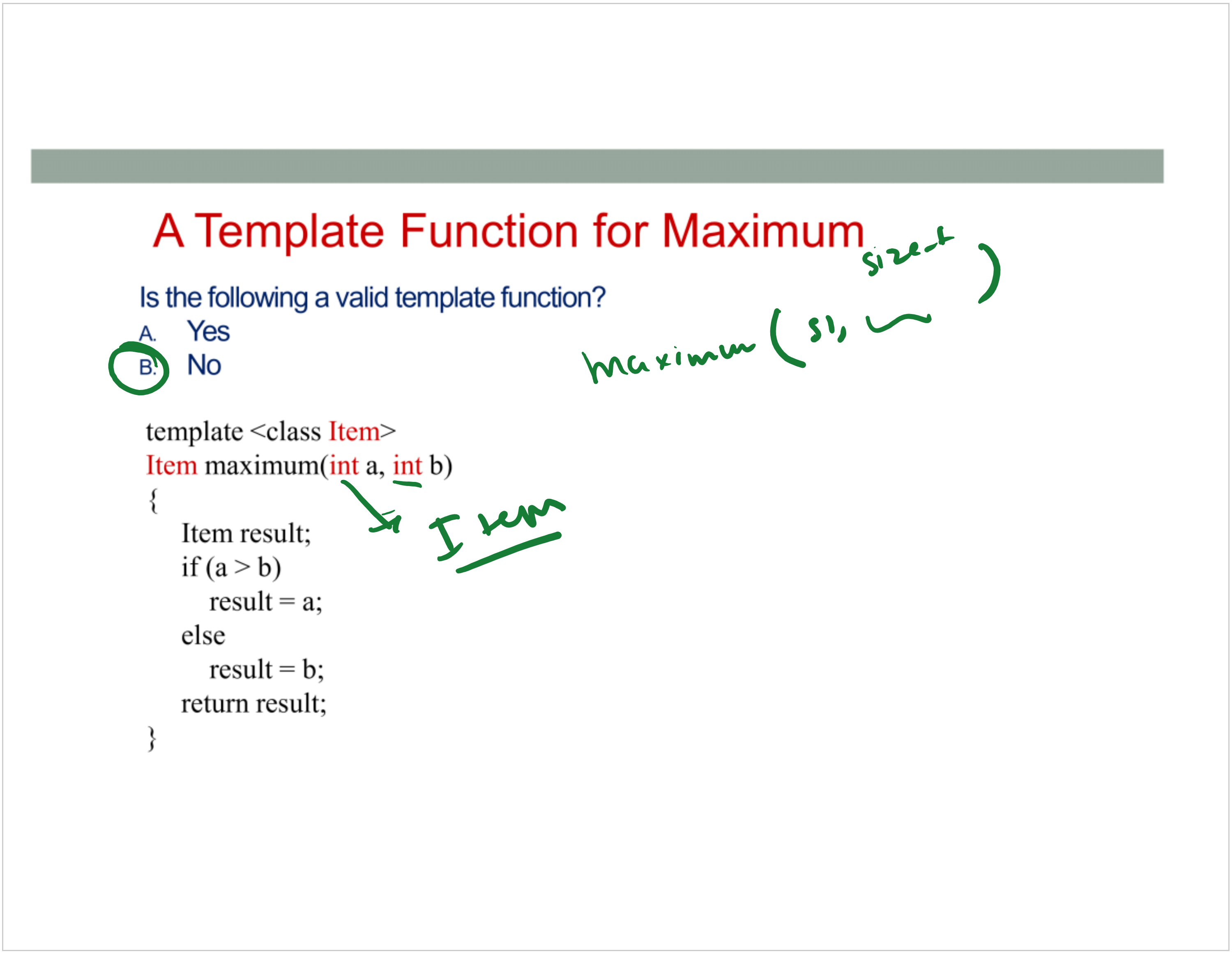


What are the advantages over typedef?

```
template <class Item>
Item maximum(Item a, Item b)
{
    if (a > b)
        return a;
    else
        return b;
}
```

```
typedef int item;
item maximum(item a, item b)
{
    if (a > b)
        return a;
    else
        return b;
}
```

Demo maximal.cxx



A Template Function for Maximum

Is the following a valid template function?

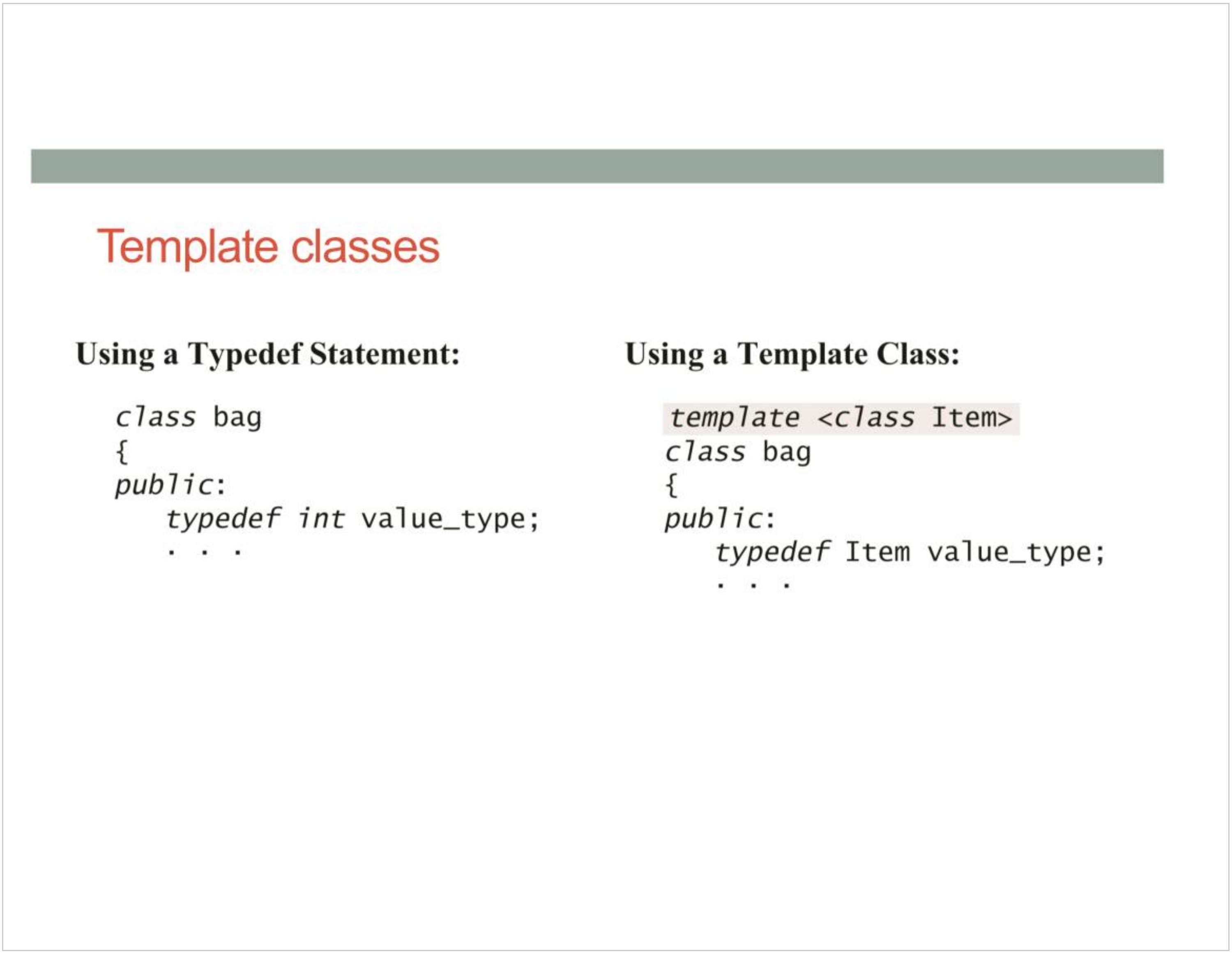
A. Yes
[✓ B. No]

size_t

maximum(s1, ~)

```
template <class Item>
Item maximum(int a, int b)
{
    Item result;
    if (a > b)
        result = a;
    else
        result = b;
    return result;
}
```

$\rightarrow$ Item



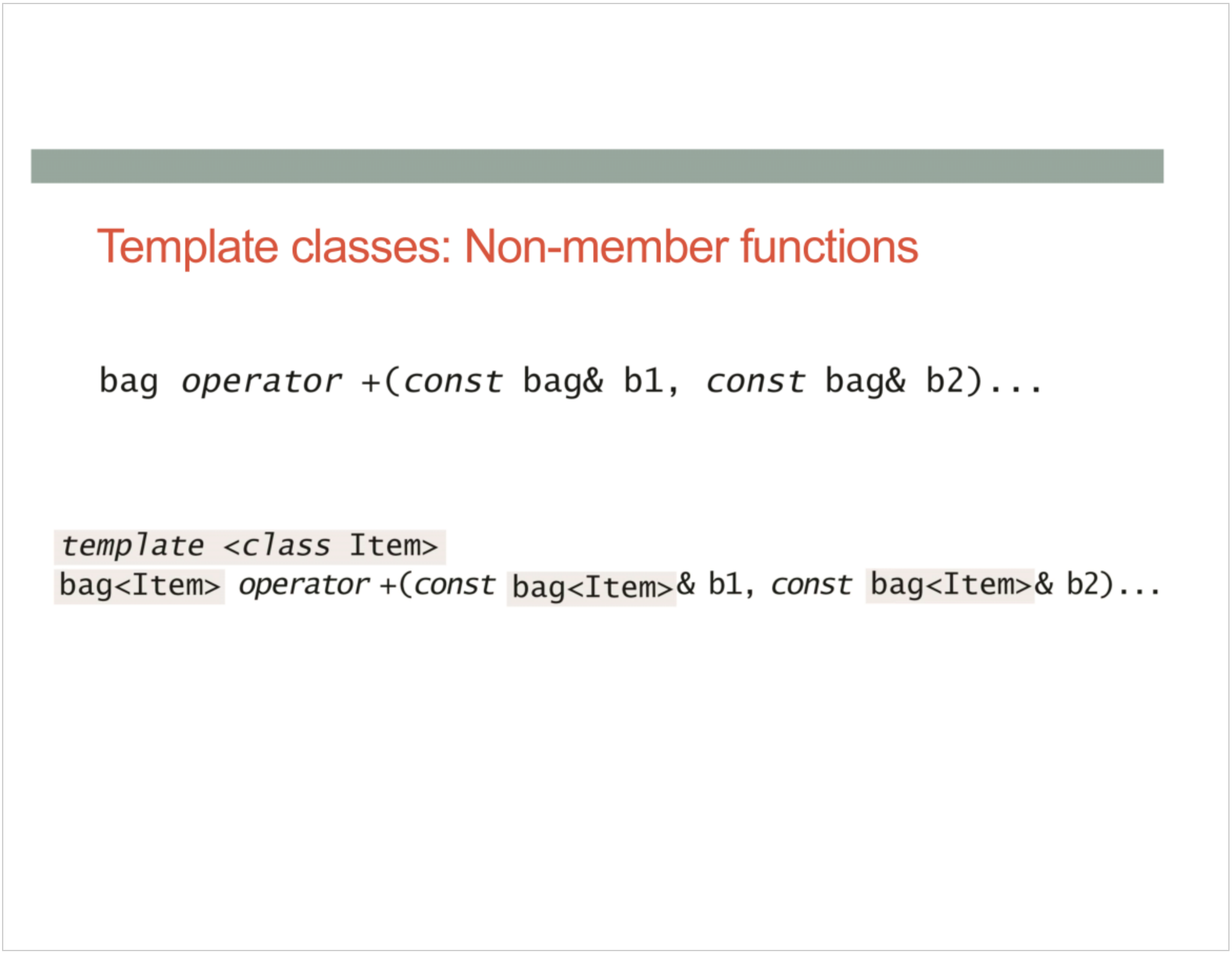
Template classes

Using a Typedef Statement:

```
class bag
{
public:
    typedef int value_type;
    . . .
```

Using a Template Class:

```
template <class Item>
class bag
{
public:
    typedef Item value_type;
    . . .
```



Template classes: Non-member functions

```
bag operator +(const bag& b1, const bag& b2)...
```

```
template <class Item>
bag<Item> operator +(const bag<Item>& b1, const bag<Item>& b2)...
```

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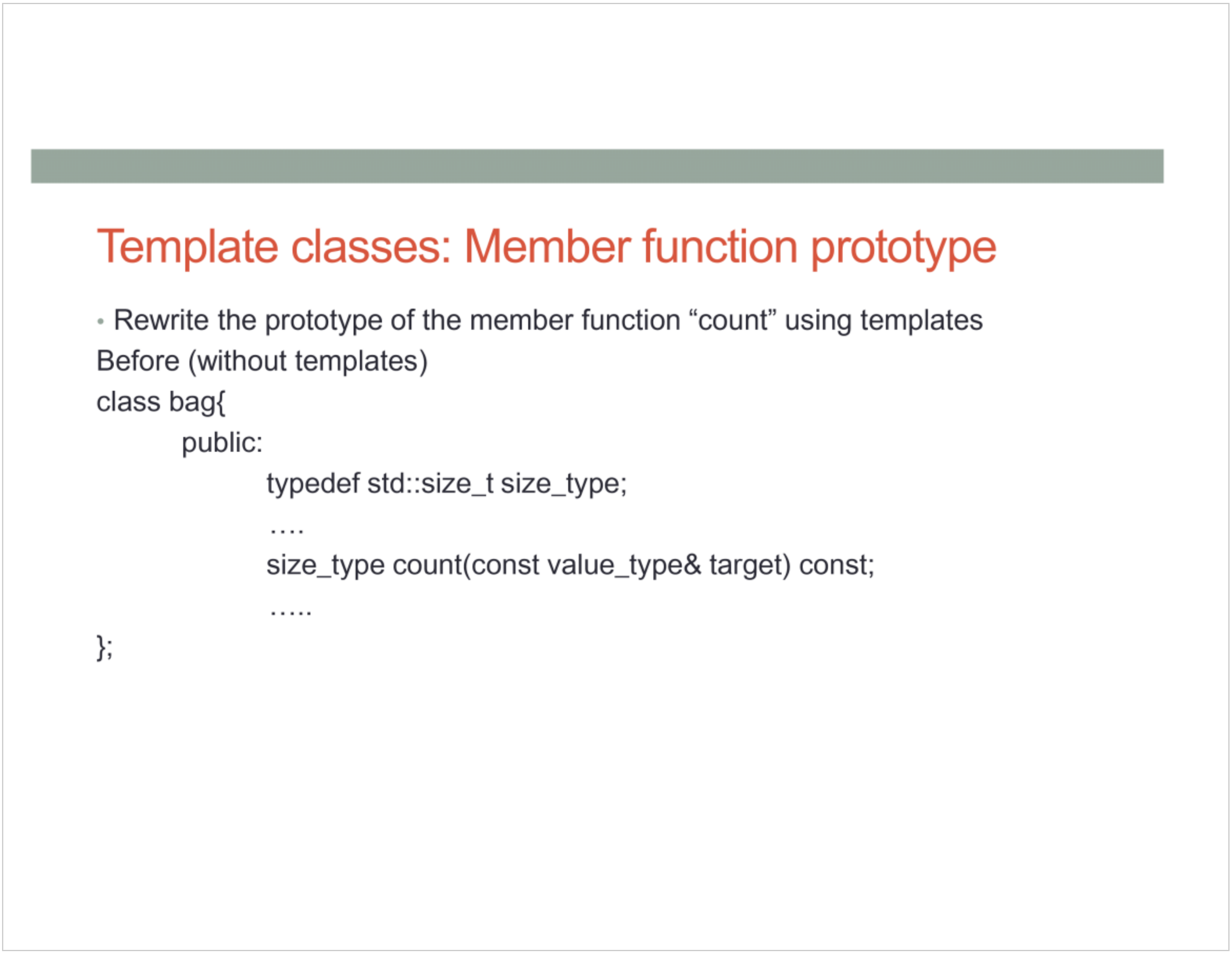

Template classes: Member function prototype

- Rewrite the prototype of the member function “count” using templates

Before (without templates)

```
class bag{
        public:
                typedef std::size_t size_type;
                ….
                size_type count(const value_type& target) const;
                …..
};
```

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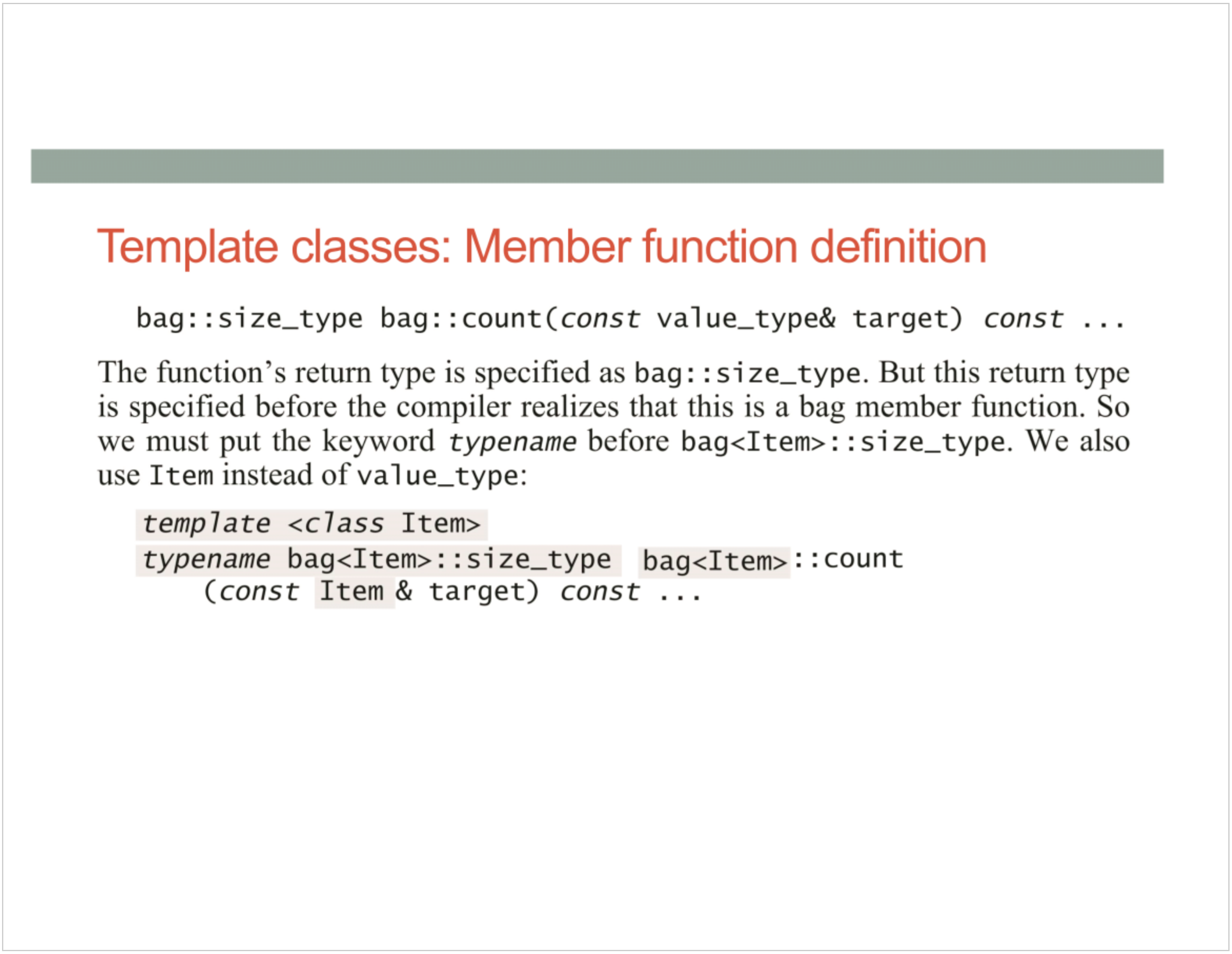
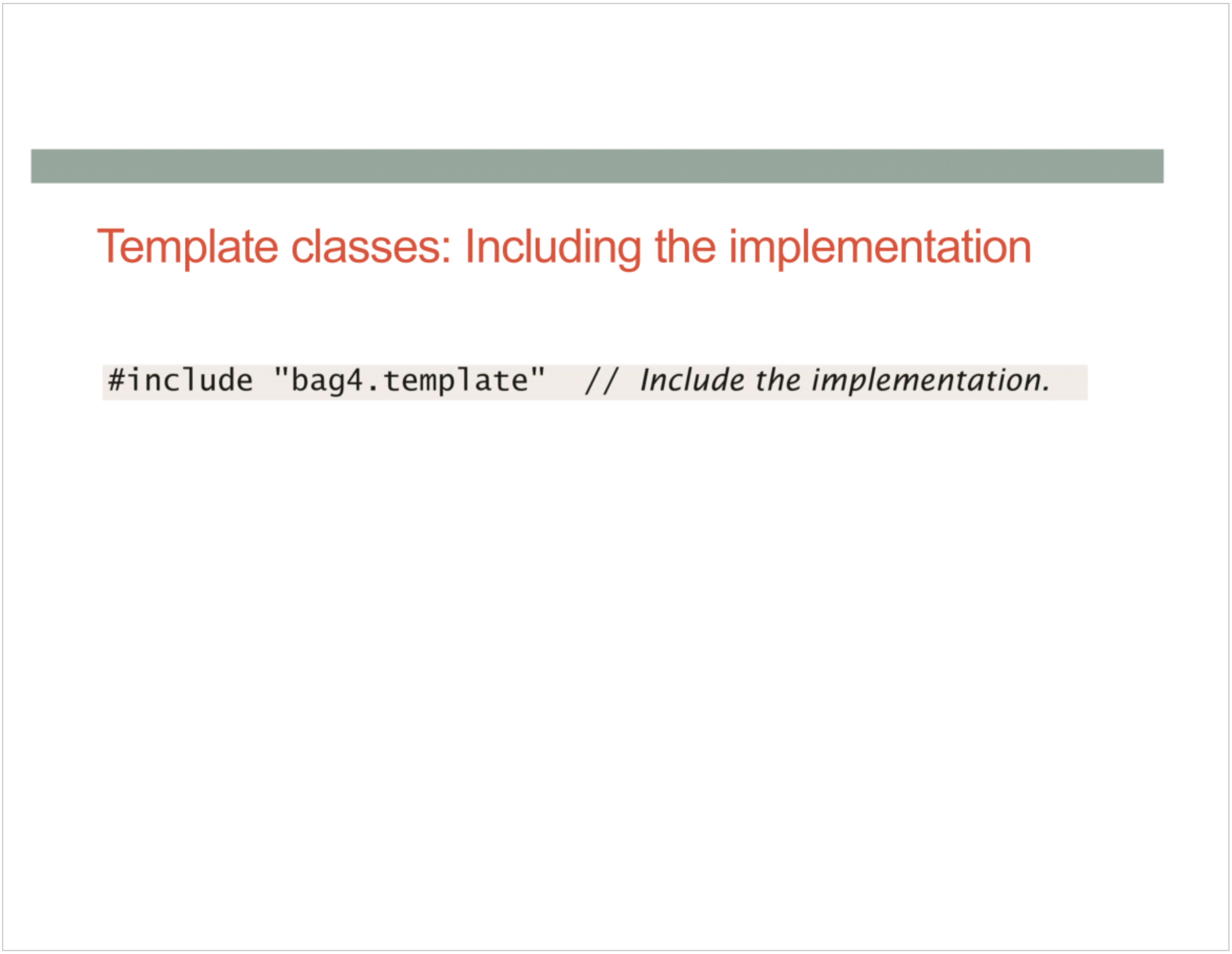


Template classes: Member function definition

```
bag::size_type bag::count(const value_type& target) const ...
```

The function's return type is specified as `bag::size_type`. But this return type is specified before the compiler realizes that this is a bag member function. So we must put the keyword *typename* before `bag<Item>::size_type`. We also use `Item` instead of `value_type`:

```
template <class Item>
typename bag<Item>::size_type  bag<Item>::count
    (const Item & target) const ...
```



Template classes: Including the implementation

```
#include "bag4.template"   // Include the implementation.
```

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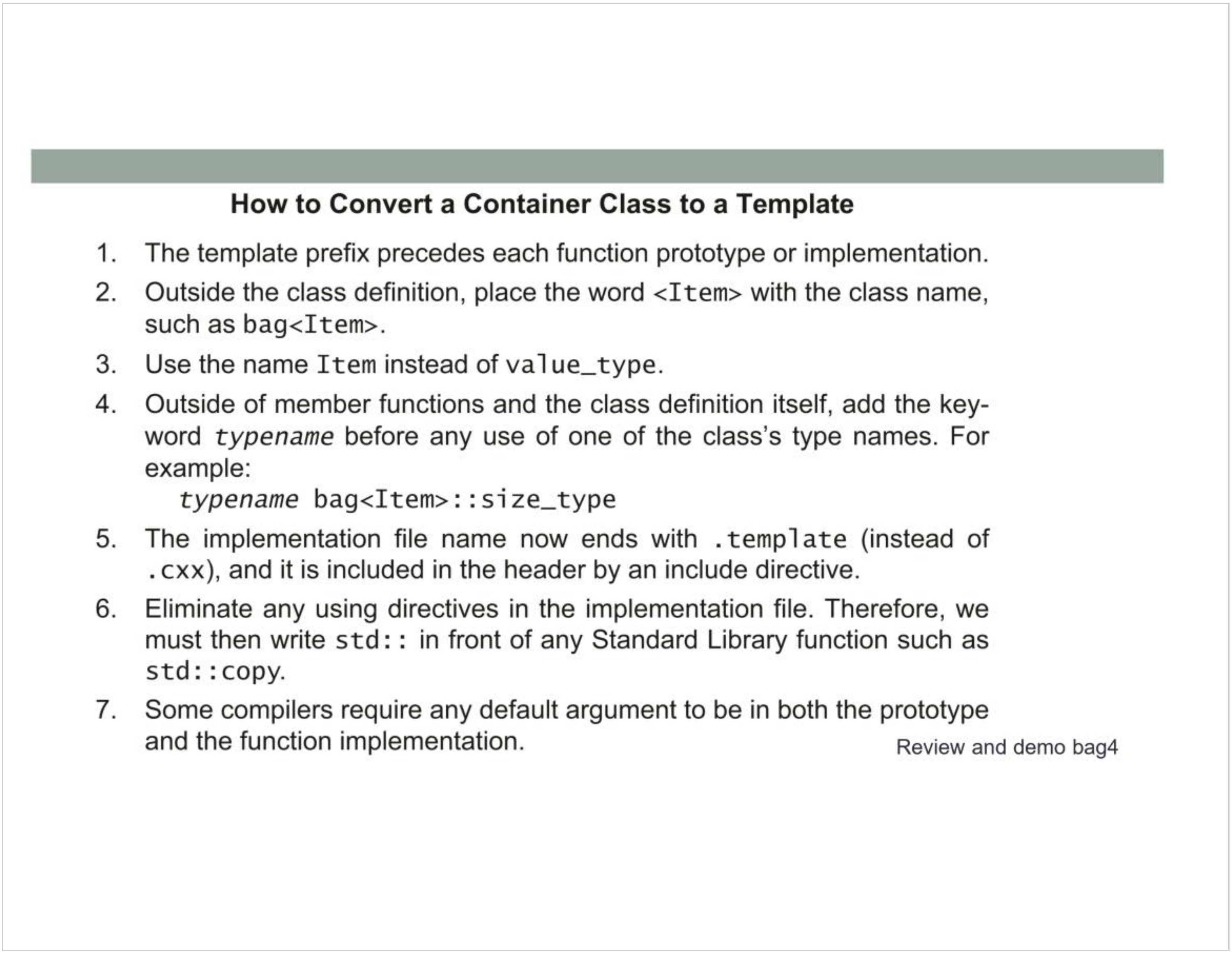

How to Convert a Container Class to a Template

1. The template prefix precedes each function prototype or implementation.
2. Outside the class definition, place the word `<Item>` with the class name, such as `bag<Item>`.
3. Use the name `Item` instead of `value_type`.
4. Outside of member functions and the class definition itself, add the keyword *typename* before any use of one of the class's type names. For example:
   `typename bag<Item>::size_type`
5. The implementation file name now ends with `.template` (instead of `.cxx`), and it is included in the header by an include directive.
6. Eliminate any using directives in the implementation file. Therefore, we must then write `std::` in front of any Standard Library function such as `std::copy`.
7. Some compilers require any default argument to be in both the prototype and the function implementation.

Review and demo bag4

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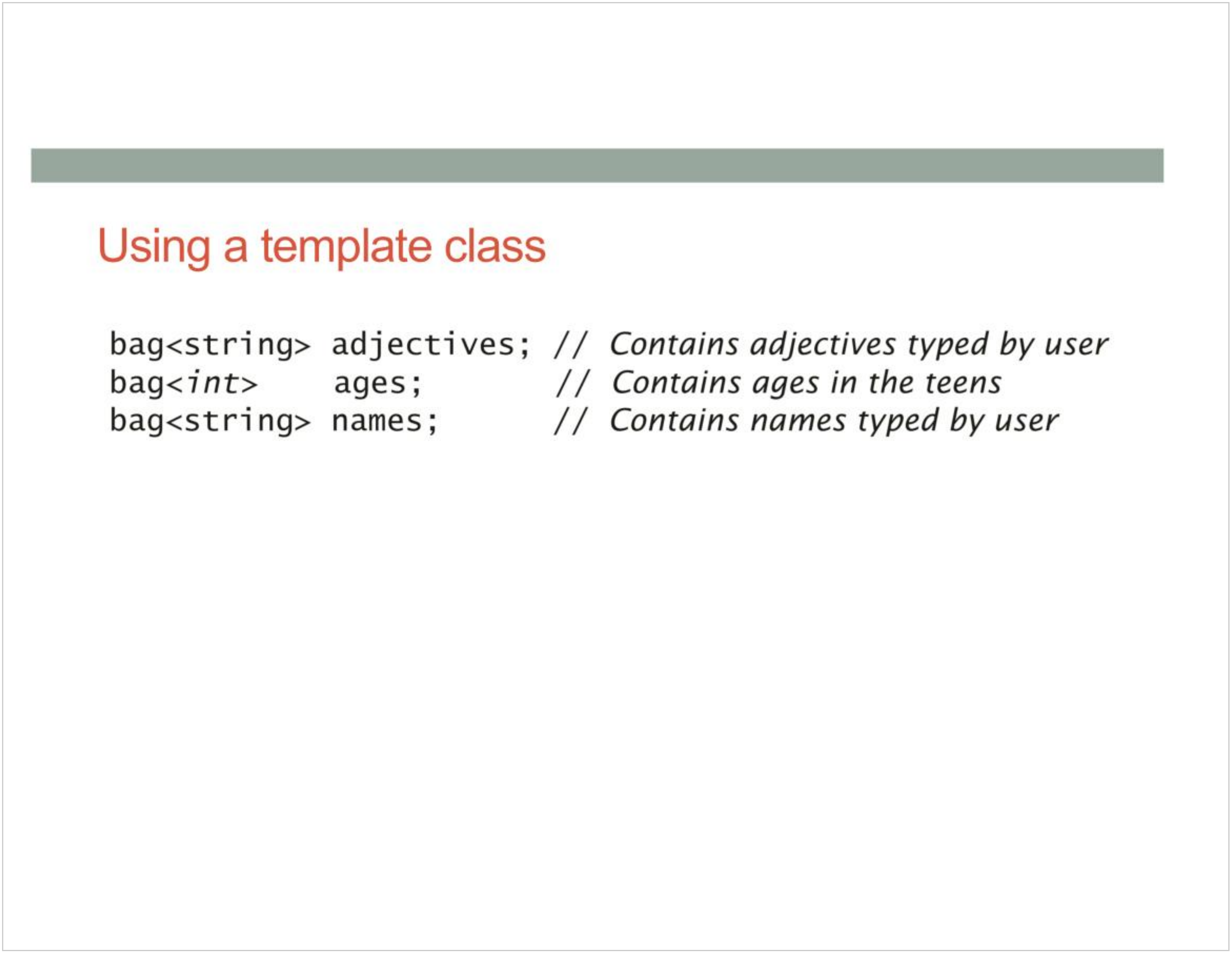

Using a template class

```
bag<string> adjectives; // Contains adjectives typed by user
bag<int>    ages;       // Contains ages in the teens
bag<string> names;      // Contains names typed by user
```