

Generics

EECS 211

Winter 2017

(Monomorphic) max functions

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double max(double x, double y)
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double max(double x, double y)
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    if (x < y) return y; else return x;
}
```

```
const string& max(const string& x, const string& y)
{
    if (x < y) return y; else return x;
}
```

A generic max function

```
template <typename T>  
const T& max(const T& x, const T& y)  
{  
    if (x < y) return y; else return x;  
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const T& max(const T& x, const T& y)  
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```

This is actually `std::max`.

A (monomorphic) pair class

In `Int_double_pair.h`:

```
class Int_double_pair
{
public:
    Int_double_pair(int, double);

    int first() const;
    double second() const;

private:
    int first_;
    double second_;
};

bool operator==(const Int_double_pair&,
                const Int_double_pair&);
```

Int-double-pair implementation

In Int_double_pair.cpp

```
Int_double_pair::Int_double_pair(int first, double second)
    : first_(first), second_(second)
{ }
```

```
int Int_double_pair::first() const
{ return first_; }
```

```
double Int_double_pair::second() const
{ return second_; }
```

```
bool operator==(const Int_double_pair& a,
                const Int_double_pair& b)
{
    return a.first() == b.first() && a.second() == b.second();
}
```


What if we want a pair of a string and a char?

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```
class String_char_pair
{
public:
    String_char_pair(std::string, char);

    const std::string& first() const;
    char second() const;

private:
    std::string first_;
    char second_;
};

bool operator==(const String_char_pair&,
                const String_char_pair&);
```

Introducing generics

A generic class is a class that works with multiple other types

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If we make a generic `Pair` class, then we can use it as:

- `Pair<int, double>`
- `Pair<std::string, char>`
- and many more!

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A generic class is a class that works with multiple other types

If we make a generic `Pair` class, then we can use it as:

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- `Pair<std::string, char>`
- and many more!

We do this using a *template*

Interface for generic pair

In Pair.h:

```
template <typename T1, typename T2>
class Pair
{
public:
    Pair(const T1&, const T2&);
    const T1& first() const;
    const T2& second() const;

private:
    T1 first_;
    T2 second_;
};

template <typename T1, typename T2>
bool operator==(const Pair<T1, T2>&, const Pair<T1, T2>&);
```

Implementing templates

When we implement a class template:

- Every member function must be templated as well.
- Templated definitions must be visible where they are used.
- This means that templated definitions usually *must* go in a header.

Implementation of generic pair

Also in Pair.h:

```
template <typename T1, typename T2>  
Pair<T1, T2>::Pair(const T1& first, const T2& second)  
    : first_(first), second_(second)  
{ }
```

```
template <typename T1, typename T2>  
const T1& Pair<T1, T2>::first() const  
{ return first_; }
```

```
template <typename T1, typename T2>  
const T2& Pair<T1, T2>::second() const  
{ return second_; }
```

```
template <typename T1, typename T2>  
bool operator==(const Pair<T1, T2>& a, const Pair<T1, T2>& b)  
{ return a.first() == b.first() && a.second() == b.second(); }
```


Templates impose requirements on type parameters

For this to compile, `operator==` must be defined for `T1` and `T2`, whatever they are:

```
template <typename T1, typename T2>  
bool operator==(const Pair<T1, T2>& a, const Pair<T1, T2>& b)  
{ return a.first() == b.first() && a.second() == b.second(); }
```

– To CLion! –