# Some features of modern C++ Writing readable code

Programming Concepts in Scientific Programming

EPFL, Master class

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# C++ versions

- C++98

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- C++98
- C++11
- C++14
- C++17

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- C++98
- C++11
- C++14
- C++17
- C++20 (not yet out)

# Writing **readable** code: **auto**

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std::vector<double> vec(10);
std::vector<double>::iterator it = vec.begin();
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It is not convenient:

# Writing **readable** code: **auto**

```
std::vector<double> vec(10);
std::vector<double>::iterator it = vec.begin();
```

It is not convenient:

```
std::vector<double> vec(10);
auto it = vec.begin();
```

# Writing **readable** code: range loops

```
std::vector<double> vec(10);
auto it = vec.begin();
auto end = vec.end();

for (; it != end; ++it) {
  std::cout << *it;
}
```

# Writing **readable** code: range loops

So common that it is possible to write

```
std::vector<double> vec(10);

for (double p : vec) {
  std::cout << p;
}
```

# Writing **readable** code: range loops

So common that it is possible to write

```
std::vector<double> vec(10);

for (double p : vec) {
  std::cout << p;
}
```

Combined with the auto

```
std::vector<double> vec(10);

for (auto p : vec) {
  std::cout << p;
}
```

# Smart Pointers

```
double *get_vector(int n) {

  double *v = new double[n];
  return v;
}
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# Smart Pointers

```
double *get_vector(int n) {

  double *v = new double[n];
  return v;
}
```

To use it beware to free/delete it:

```
  double *vector = get_vector(10);
  // ... do what I need
  delete[] vector;
```

# Smart Pointers

- Memory allocated on the heap needs to be freed
- Forgetting is prone to memory leaks
- Accessing freed memory: unknown result (*Segmentation Fault* usually)

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- Memory allocated on the heap needs to be freed
- Forgetting is prone to memory leaks
- Accessing freed memory: unknown result (*Segmentation Fault* usually)
- std::shared_ptr are pointers meant to be shared
- std::unique_ptr are pointers guarantied to be unique

# Smart Pointers

```cpp
#include <iostream>
#include <memory>

std::unique_ptr<double> get_scalar() {
  // create a unique pointer
  return std::make_unique<double>(3);
}

int main() {

  std::unique_ptr<double> ptr = get_scalar();
  // ... do what I need like...
  std::cout << *ptr;
  // no need to delete scalar (will be automatically)

  // cannot be copied => compilation error
  // std::unique_ptr<double> ptr_copy = ptr;
}
```

# Smart Pointers

```
#include <iostream>
#include <memory>

std::shared_ptr<double> get_vector(int n) {
  return std::shared_ptr<double>(new double[n]);
}

int main() {

  std::shared_ptr<double> ptr1 = get_vector(10);
  std::shared_ptr<double> ptr2 = ptr1;

  // memory of pointer freed when
  // ptr1 and ptr2 are out of scope
}
```

# Writing **readable** code: Functors

```
struct MyFunctor {
  int operator()() { return 2; }
};
```

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```
struct MyFunctor {
  int operator()() { return 2; }
};
```

```
int main() {
  auto f = MyFunctor();
  std::cout << f() << std::endl;
}
```

# Writing **readable** code: Functors

```
struct MyFunctor {
  int operator()(double v) { return v * 2; }
};
```

# Writing **readable** code: Functors

```
struct MyFunctor {
  int operator()(double v) { return v * 2; }
};
```

```
auto f = MyFunctor();

std::vector<double> vec;
for (auto d : vec) {
  auto res = f(d);
}
```

# Writing **readable** code: Functors

```
struct MyFunctor {
  int operator()(double v) { return v * 2; }
};

template <typename V, typename T> void for_each(V &vec, T f
  for (auto d : vec) {
    auto res = f(d);
  }
}

int main() {
  auto f = MyFunctor();
  std::vector<double> vec(10);
  for_each(vec, f);
}
```

# Writing **readable** code: Lambda functors

http://en.cppreference.com/w/cpp/language/lambda

```
struct MyFunctor {
  MyFunctor(double a) : a(a) {}

  int operator()(double v) { return v * 2; }
  double a;
};
```

# Writing **readable** code: Lambda functors

http://en.cppreference.com/w/cpp/language/lambda

```
struct MyFunctor {
  MyFunctor(double a) : a(a) {}

  int operator()(double v) { return v * 2; }
  double a;
};
```

Calling:

```
  double a = 2.;
  MyFunctor f(a);
```

# Writing **readable** code: Lambda functors

http://en.cppreference.com/w/cpp/language/lambda

```
struct MyFunctor {
  MyFunctor(double a) : a(a) {}

  int operator()(double v) { return v * 2; }
  double a;
};
```

Calling:

```
  double a = 2.;
  MyFunctor f(a);
```

**Replaced with**:

```
  auto f_lambda = [a](double d) { return a * d; };
```

# Writing **readable** code: Lambda functors

```
template <typename V, typename T> void for_each(V &vec, T f
  for (auto d : vec) {
    auto res = f(d);
  }
}

int main() {
  std::vector<double> vec(10);
  for_each(vec, [](double d) { return 2 * d; });
}
```

# Writing **readable** code: Lambda functors

```
template <typename V, typename T> void for_each(V &vec, T f
  for (auto d : vec) {
    auto res = f(d);
  }
}

int main() {
  int a = 2;
  std::vector<double> vec(10);
  for_each(vec, [a](double d) { return d * a; });
}
```

# Writing **readable** code: For each

```cpp
#include <algorithm>
#include <iostream>
#include <numeric>
#include <vector>

int main() {
  std::vector<double> v(10);
  std::iota(v.begin(), v.end(), 0);
  std::for_each(v.begin(), v.end(), [](double &x) { x = x * x; });
  std::for_each(v.begin(), v.end(),
                [](double x) { std::cout << x << std::endl; });
}
```

What is this code doing ? (homework)

help @ http://en.cppreference.com/

# Modern C++

## Take away message

- **auto**: automatic declaration of type on a function return
- **range loop**: Efficient syntax to loop over generic containers (vector, list, set)
- **functors**: object with () operator, to store functions
- **lambda**: compact declaration of functors
- **std::for_each**: apply a functor to every item of a container