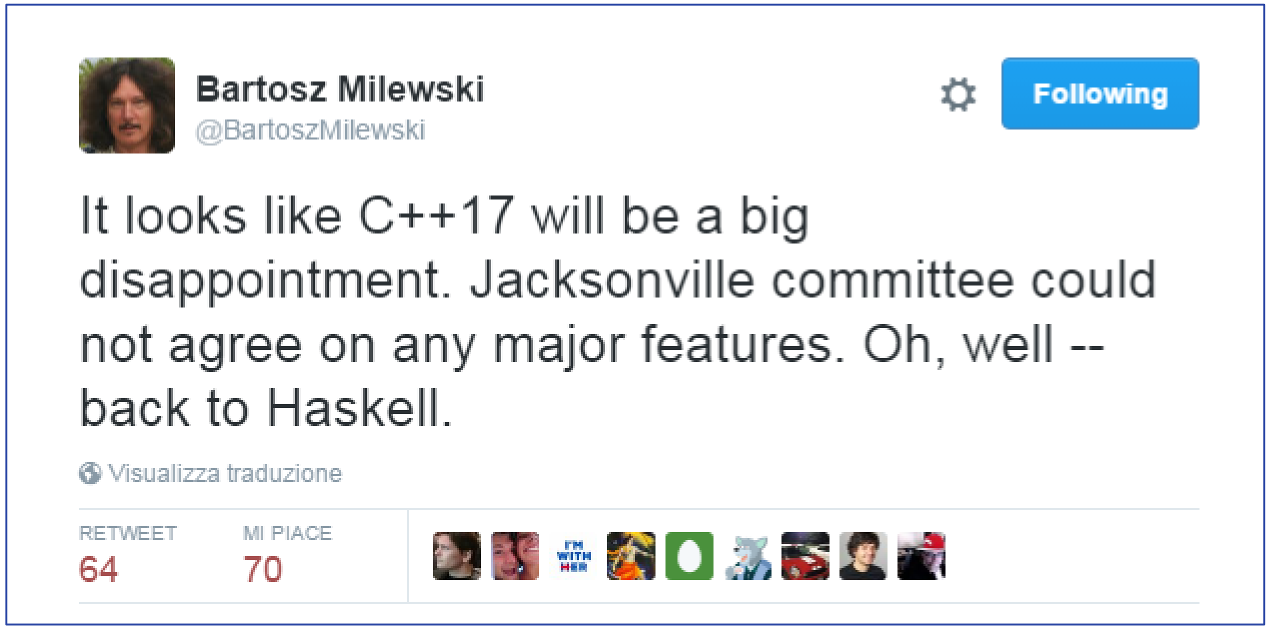
C++ Day 2016
29 Ottobre / Firenze

# C++17 for the daily job

Marco Arena – Italian C++ Community

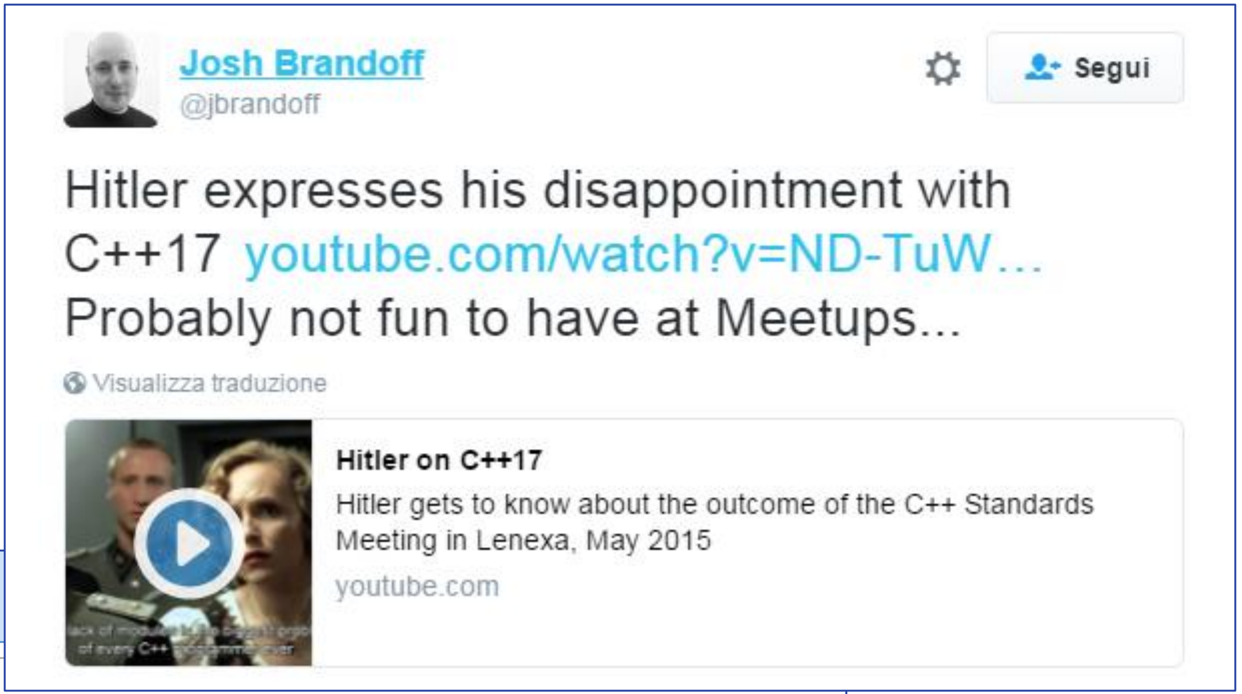
www.italiancpp.org


Bartosz Milewski
@BartoszMilewski

It looks like C++17 will be a big disappointment. Jacksonville committee could not agree on any major features. Oh, well -- back to Haskell.

Visualizza traduzione

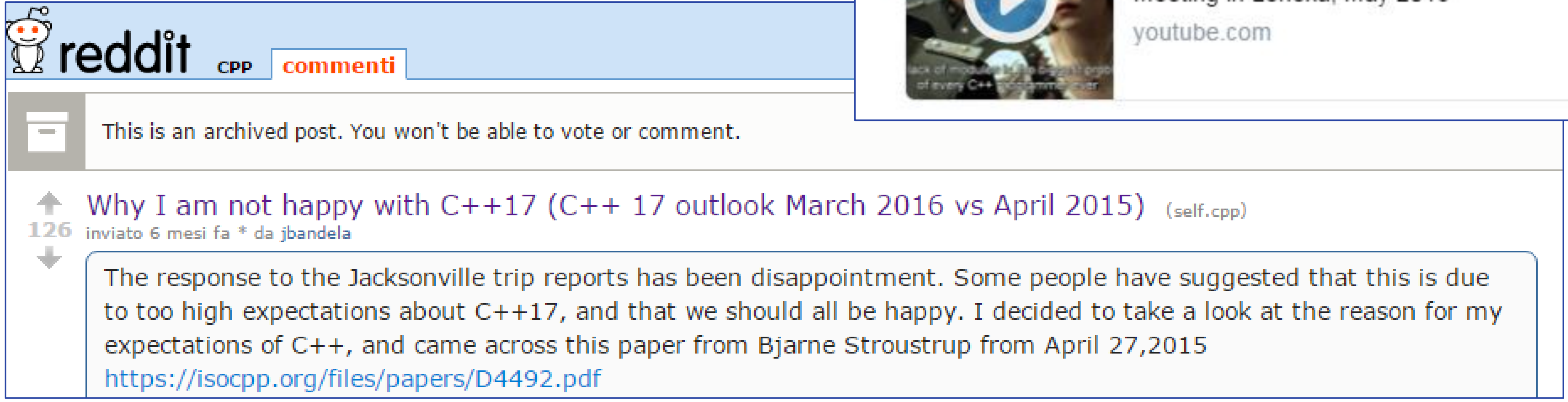
RETWEET 64 MI PIACE 70


Josh Brandoff
@jbrandoff

Hitler expresses his disappointment with C++17 youtube.com/watch?v=ND-TuW... Probably not fun to have at Meetups...

Visualizza traduzione

Hitler on C++17
Hitler gets to know about the outcome of the C++ Standards Meeting in Lenexa, May 2015
youtube.com



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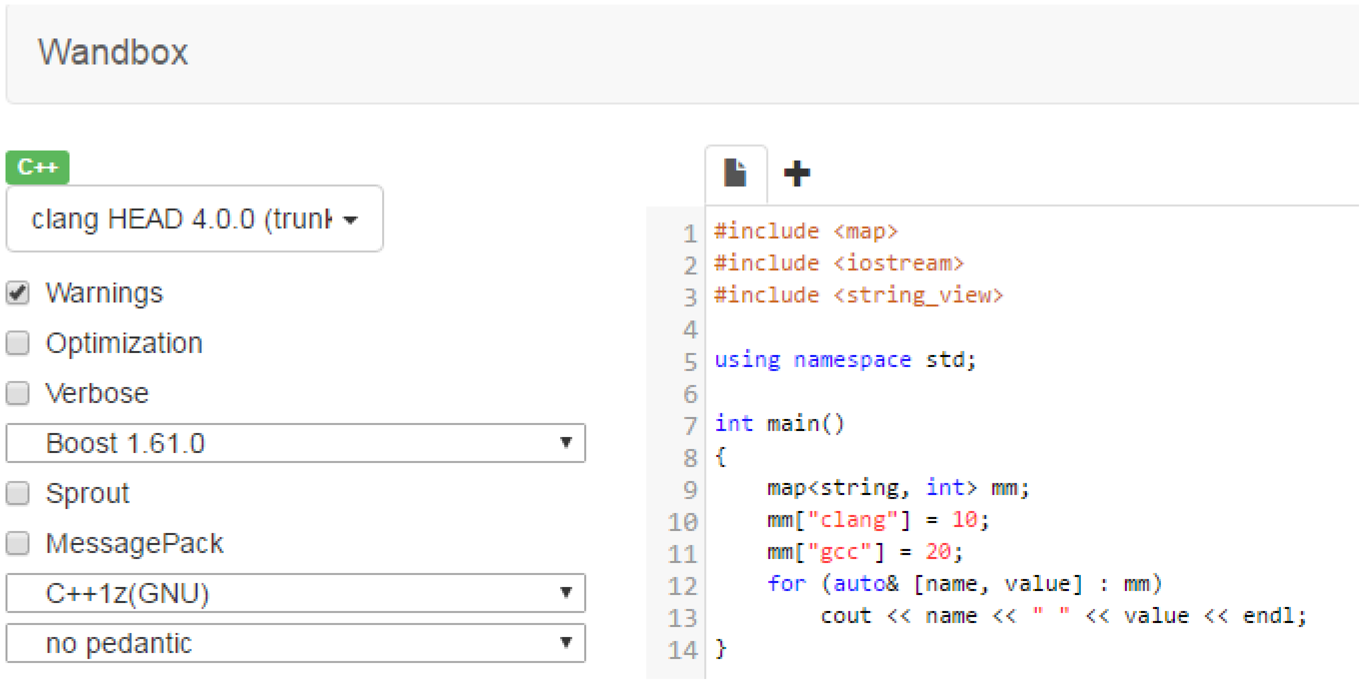
126 Why I am not happy with C++17 (C++ 17 outlook March 2016 vs April 2015) (self.cpp)
inviato 6 mesi fa * da jbandela

The response to the Jacksonville trip reports has been disappointment. Some people have suggested that this is due to too high expectations about C++17, and that we should all be happy. I decided to take a look at the reason for my expectations of C++, and came across this paper from Bjarne Stroustrup from April 27,2015 https://isocpp.org/files/papers/D4492.pdf

# C++17

Compared to C++11, C++17 provides many more «tiny» features, suitable for all and for the daily job.

## How to try (some features of) C++17?



Wandbox

C++

clang HEAD 4.0.0 (trunk

- [✓] Warnings
- [ ] Optimization
- [ ] Verbose

Boost 1.61.0

- [ ] Sprout
- [ ] MessagePack

C++1z(GNU)

no pedantic

```cpp
#include <map>
#include <iostream>
#include <string_view>

using namespace std;

int main()
{
    map<string, int> mm;
    mm["clang"] = 10;
    mm["gcc"] = 20;
    for (auto& [name, value] : mm)
        cout << name << " " << value << endl;
}
```

http://melpon.org/wandbox

## string*

## Can we do better?

```
vector<string> split(const string& str, const char* delims)
{
        vector<string> ret;
        string::size_type start = 0;
        auto pos = str.find_first_of(delims, start);
        while (pos != string::npos) {
                if (pos != start)
                        ret.push_back(str.substr(start, pos - start));
                start = pos + 1;
                pos = str.find_first_of(delims, start);
        }
        if (start < str.length())
                ret.push_back(str.substr(start, str.length() - start));

        return ret;
}
```

# string_view

```
vector<string_view> split(string_view str, string_view delims)
{
        vector<string_view> ret;
        string::size_type start = 0;
        auto pos = str.find_first_of(delims, start);
        while (pos != string::npos) {
                if (pos != start)
                        ret.push_back(str.substr(start, pos - start));
                start = pos + 1;
                pos = str.find_first_of(delims, start);
        }
        if (start < str.length())
                ret.push_back(str.substr(start, str.length() - start));

        return ret;
}
```

# string_view

```
StringContainer form_name = form.GetField("name"); // some UI control
string_view nameView = form_name.cptr(); // .cptr() returns a const char*

auto trimmed  = nameView.substr(nameView.find_first_not_of(‘ ’)); // trim

// we have map<string, Profile, less<>> nameToProfile, somewhere
auto profileIt = nameToProfile.find(trimmed); // no new string…
```

http://en.cppreference.com/w/cpp/string/basic_string_view

## to_chars/from_chars

```
char arr[5] {};
auto value1 = 10, value2 = 20;
auto ptrStart = arr; auto ptrEnd = arr + 5;
auto res = to_chars(ptrStart, ptrEnd, value1);
if (!res.overflow) // fitted the buffer
    res = to_chars(res.ptr, ptrEnd, value2);
// [‘1’, ‘0’, ‘2’, ‘0’, \0]

string_view sv {arr, arr+2}; // 10
int value1;
auto out = from_chars(sv.begin(), sv.end(), value1);
if (out.ec) {} // if parse error
```

http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2016/p0067r4.html

## Reading strings from C-arrays…

```
void ExternalAPI(char* out, int size);

char tmp[1024] {}; // all \0
ExternalAPI(tmp, 1024);
string s(tmp); // uff
```

## non-const `string::data()`

```
void ExternalAPI(char* out, int size);

string s(1024, ‘\0’); // don’t forget the initial char
ExternalAPI(s.data(), s.size());
```

http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2016/p0272r1.html

## Filesystem

## Filesystem (aka: Boost.Filesystem)

```
path p = current_path();
directory_iterator it{p};
while (it != directory_iterator{})
       std::cout << *it++ << '\n';
```

```
path p{"C:\\"};
p /= "Windows\\System";
std::cout << p.string() << '\n';
```

```
path p{"cppday16.txt"};
std::cout << p.stem() << '\n';
std::cout << p.extension() << '\n';
```

http://en.cppreference.com/w/cpp/filesystem

## Associative Containers Additions

## Efficient update or insert?

```
string& update_or_insert(int key, string&& s)
{
    return mm[key] = move(s);
}
```

(apart from possible performance penalties)
What if key/value are not default constructible?

## More efficient update or insert

```
string& update_or_insert(int key, string&& s)
{
    auto p = cache.equal_range(key);
    if (p.first != p.second)
        return it.first->second = move(s);
    return cache.emplace_hint(p.first, key, move(s))->second;
}
```

Works, but it's not so good with unordered_map…

## insert_or_assign

```
string& update_or_insert(int key, string&& s)
{
    return mm.insert_or_assign(key, move(s)).first->second;
}
```

Efficient and consistent on unordered_map

http://en.cppreference.com/w/cpp/container/map/insert_or_assign

## emplace

```
std::map<std::string, std::unique_ptr<Foo>> m;



m["foo"] = nullptr;

auto ptr = std::make_unique_ptr<Foo>;

auto res = m.emplace("foo", std::move(ptr));

assert(ptr); // ?
```

## try_emplace

```
std::map<std::string, std::unique_ptr<Foo>> m;



m["foo"] = nullptr;

auto ptr = std::make_unique<Foo>();

auto res = m.try_emplace("foo", std::move(ptr));

assert(ptr); // never fires
```

# try_emplace

```
template< class... Args >
std::pair<iterator,bool> emplace(Args&&... args);
template <class... Args>
pair<iterator, bool> try_emplace(const key_type& k, Args&&... args);

map<string, string> mm;

mm.emplace(piecewise_construct, forward_as_tuple("pippo"), forward_as_tuple(10, ‘c’));

mm.try_emplace("pippo", 10, ‘c’);
```

http://en.cppreference.com/w/cpp/container/map/try_emplace
http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2014/n4279.html

## map update key «rustic»

```
map<string, string> languageToExample;

...

auto toRemove = languageToExample.find("objective-c");

languageToExample.emplace("swift", move(toRemove->second));

languageToExample.erase(toRemove);
```

## extract

```
map<string, string> languageToExample;

...

auto toUpdate = languageToExample.extract("objective-c");

toUpdate.key() = "swift";

languageToExample.insert(move(toUpdate)); // move back
```

http://en.cppreference.com/w/cpp/container/map/extract

## merge

```
map<string, string> contactsPhoneMarcoOld;
map<string, string> contactsPhoneMarcoNew;

// conflicts are not extracted from contactsPhoneMarcoOld
contactsPhoneMarcoNew.merge(move(contactsPhoneMarcoOld));

// possible as well (IMHO: less explicit)
contactsPhoneMarcoNew.merge(contactsPhoneMarcoOld);
```

http://en.cppreference.com/w/cpp/container/map/merge

## Syntactic sugar (can cause diabetes!)

## Guaranteed Copy elision *

```
vector<int> CreateVector()
{
     vector<int> v;
     // complex logic
     return v; // won't be copied/moved
}
```

(*) Under certain conditions: http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2016/p0135r1.html

## Structured bindings

```
tuple<double, double, int> CreateParams() { ... }

// x, y, dim are independent variables
auto [x, y, dim] = CreateParams();

~~auto [x, y, std::ignore] = CreateParams();~~ // not proposed
```

Tuple Protocol: `tuple_size`, `tuple_element`, `get`

## Structured bindings

```
array<int, 3> arr{{1,2,3}};
auto [x, y, z] = arr;
~~auto [x, y] = arr;~~
```

```
Foo f;
auto& [a, b] = f;
```

```
struct Foo {
    int i=10;
    string hello = "hello";
};
```

## Structured bindings - Beautiful iteration

```
map<string, int> mm;

for (auto& p : mm)
   cout << p.first << ", " << pp.second << "\n";

for (auto& [name, value]: mm)
   cout << name << ", " << value << "\n";
```

http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2016/p0217r2.html

## `if/switch` statements with initializer

```
map<string, int> mm;
...

if (auto [iter, succeeded] = mm.insert({"hi", 30}); succeeded)
    cout << iter->second;
```

http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2016/p0305r0.html

## Template deduction: functions vs classes

```
template<typename Func>
class LambdaVisitor : SomeVisitor {
     Func visitFn;
public:
     LambdaVisitor(Func f) : visitFn{f} {}
     void Visit(const Node& node) { visitFn(node); }
     // ...
};

template<typename Func> LambdaVisitor<Func> MakeLambdaVisitor(Func f) {
     return {f};
}

auto visitor = MakeLambdaVisitor([](const Node& n) {...});
```

# Template deduction: functions vs classes

```
template<typename Func>
class LambdaVisitor : SomeVisitor {
     Func visitFn;  lock_guard<mutex> sg;
public:
     LambdaVisitor(Func f) : visitFn{f} {}
     void Visit(const Node& node) { visitFn(node); }
     // ...
};
// oops
template<typename Func> LambdaVisitor<Func> MakeLambdaVisitor(Func f) {
     return {f};
}

auto visitor = MakeLambdaVisitor([](const Node& n) {...});
```

## Template parameters deduction for ctors

```
template<typename Func>
class LambdaVisitor : SomeVisitor {
     Func visitFn; lock_guard<mutex> sg;
public:
     LambdaVisitor(Func f) : visitFn{f} {}
     void Visit(const Node& node) { visitFn(node); }
     // ...
};
```

```
LambdaVisitor visitor { [](const Node& n) {...} };
```

http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2016/p0091r2.html

## How to create tuples in C++14

```
using Config = tuple<string, int, int>;

~~vector<Config> configs =~~
~~      { {"marco", 29, 250 }, {"matteo", 28, 200 }, {"luca", 33, 100} };~~

vector<Config> configs = {
      make_tuple("marco", 29, 250),
      make_tuple("matteo", 28, 200),
      make_tuple("luca", 33, 100)
};
```

## pair & tuple constructor explicitness

Only if any of the types has an explicit constructor.

```
using Config = tuple<string, int, int>;

vector<Config> configs = {
    {"marco", 29, 250 }, {"matteo", 28, 200 },
    {"luca", 33, 100}
};
```

http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2015/n4387

## Parallel STL

## Parallel STL

```
vector<int> nums = …



auto evens = count(begin(nums), end(nums), 23);

auto evens = count(std::par, begin(nums), end(nums), 23);
```

# Parallel STL

|  |  |
|---|---|
| `std::seq` | Sequential execution, on the calling thread |
| `std::par` | Execution on 1 or more threads (sequential on each thread) |
| `std::par_unseq` | Execution on 1 or more threads, potentially vectorized |

# Parallel STL

```
auto norm =
       sqrt(
              transform_reduce(par_unseq,
                     begin(x), end(x),     // range
                     multiplies<>{},       // transformation (map)
                     0.0,                  // init value
                     plus<>(),             // reduction
              )
);
```

## Don’t have parallel overload

```
make_heap   push_heap   pop_heap   sort_heap

is_permutation   next_permutation   prev_permutation

lower_bound    upper_bound    equal_range    binary_search

accumulate     partial_sum    iota

copy_backward
```

http://en.cppreference.com/w/cpp/algorithm

http://www.open-std.org/jtc1/sc22/wg21/docs/papers/2015/n4507.pdf

## Library Fundamentals

# optional<T>

```
class Message {
   optional<int> size;
   optional<Data> payload;
   // ...
};

Message mex = Receive(...);
if (mex.size.has_value() && mex.payload.has_value())
{
   // use *mex.size & *mex.payload
}
```

http://en.cppreference.com/w/cpp/utility/optional

# any / safe void*

```
vector<any> fruits;
fruits.emplace_back(in_place<Apple>, "melinda");
fruits.emplace_back(in_place<Banana>, "Del Monte", 5);

auto& apple = any_cast<Apple&>(fruits[0]); // good or throws std::bad_any_cast
auto banana = any_cast<Banana*>(fruits[1]); // good or nullptr
```

http://en.cppreference.com/w/cpp/utility/any

# variant<Args…> / safe union

```
using ConfigEntry = variant<string, int, double, vector<double>>;

map<string, ConfigEntry> programConfig;
programConfig["Company"] = "Sole";
programConfig["Version"] = 15;
programConfig["Coeffs"] = {1.0, 2.0};

cout << paramConfig["Version"].index(); // 1 (in boost is called which())
cout << paramConfig["Company"].get<string>();
```

http://en.cppreference.com/w/cpp/utility/variant

## Generic Programming

## Nested namespace declarations

```
namespace std::experimental
{
    // ...
}
```

## apply & invoke

```
void print(const string& arg, int i) { ... }

auto args = tuple{"Welcome to C++ Day"s, 2016};
apply(print, args);

array<int, 4> coefficients { {1, 2, 3, 4} }; // satisfies "tuple protocol"
cout << apply(func, coefficients);

cout << invoke(func, 1, 2, 3, 4);

// do not work on overloads
```

## make_from_tuple

```
static const tuple<int> tinyConfig = ...;
static const tuple<int, double> mediumConfig = ...;
static const tuple<int, string, double, bool> completeConfig = ...;

Game CreateGame(int config) {
   switch(config)
      case 1:
        return make_from_tuple<Game>(tinyConfig);
      case 2:
        return make_from_tuple<Game>(mediumConfig);
      case 3:
        return make_from_tuple<Game>(completeConfig);
}
```

## if

```
template<size_t Dim>
struct Vector {
        float v[Dim];
        float operator[](size_t idx) { return v[idx]; }

        auto CrossProduct(const Vector& other) {
                if (Dim==2) {
                        return v[0]*other[1] - v[1]*other[0];
                }
                if (Dim==3) {
                        return Vector<3>{v[1]*other[2]-v[2]*other[1], ...}
                }
        }
};
```

# if constexpr

```
template<size_t Dim>
struct Vector {
        float v[Dim];
        float operator[](size_t idx) { return v[idx]; }

        auto CrossProduct(const Vector& other) {
                if constexpr(Dim==2) {
                        return v[0]*other[1] - v[1]*other[0];
                }
                if constexpr(Dim==3) {
                        return Vector<3>{v[1]*other[2]-v[2]*other[1], ...}
                }
        }
};
```

## My C++17 for the daily job

# My C++17 for the daily job

- `string_view` & co.
- Filesystem
- Associative containers additions
- Syntactic sugar & corrections
- Parallel STL
- Library fundamentals (`optional`, `any`, `variant`)
- Generic Programming (`apply`, `make_from_tuple`, `constexpr if`)

## What’s missing?

Detailed list of (currently) approved C++17 features:

http://stackoverflow.com/questions/38060436/what-are-the-new-features-in-c17

C++17 in VS "15" Preview:

https://blogs.msdn.microsoft.com/vcblog/2016/10/11/c1417-features-and-stl-fixes-in-vs-15-preview-5/

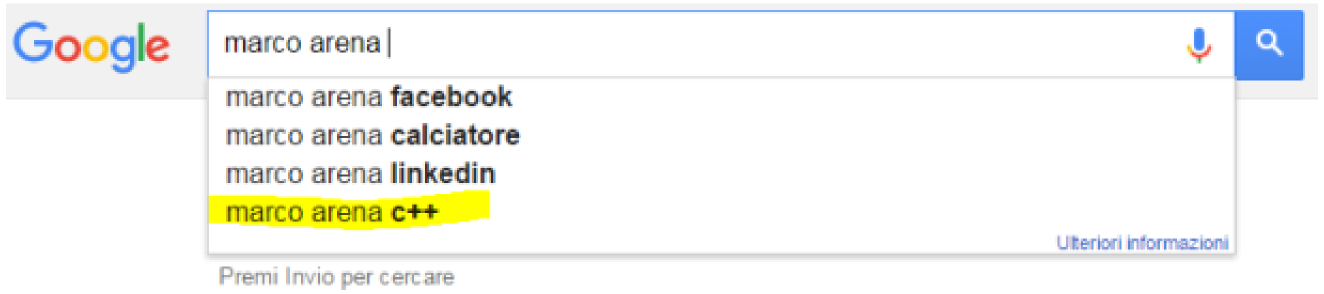
Clang Status :

http://clang.llvm.org/cxx_status.html

GCC Status :

https://gcc.gnu.org/projects/cxx-status.html#cxx11

# Who I am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marco@italiancpp.org

marcoarena.wordpress.com

# Grazie!