

C++ now

C++ Painkillers

Anastasia Kazakova

2024

About me

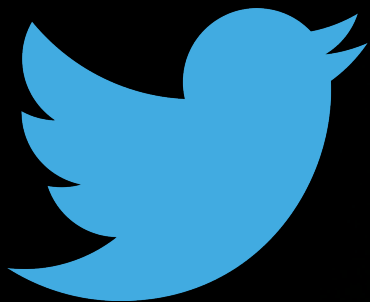
—



C++: Embedded,
Telecom, 4G/LTE



Head of Marketing
& BizDev



@anastasiak2512



The Dutch C++ Group



cppunderthesea.nl

C++ Painkillers

—

1. Stories about the tools
2. Why this talk
3. Vitamin, Painkiller, or Cure?
4. Where and when do tools help
5. C++ toolability
6. Tools for C++ painpoints
7. Start thinking about tools earlier
8. Era of AI

C++ Painkillers stories

—

Story #0 “Popov 📻”

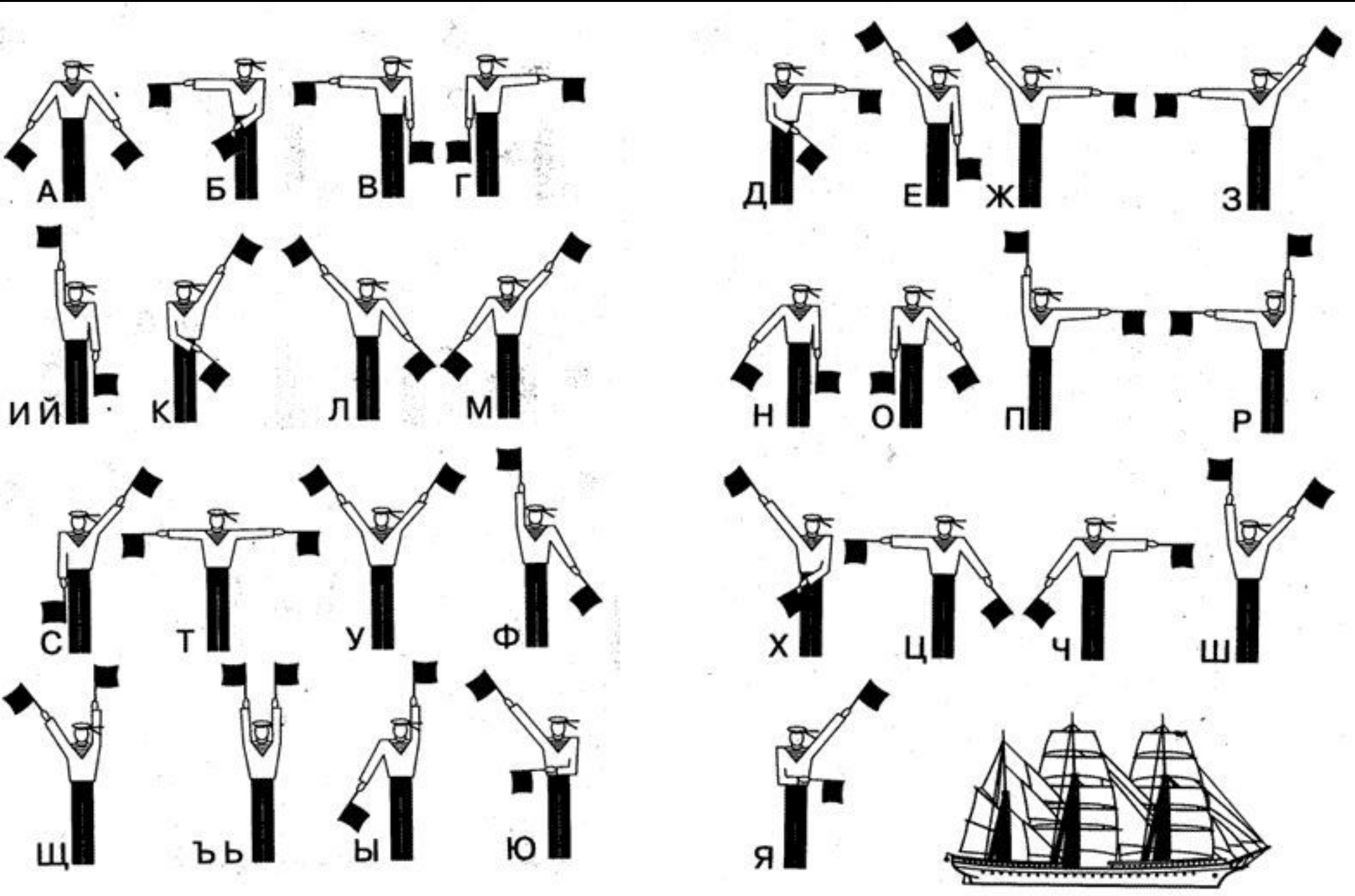
Popov 📻

—



[en.wikipedia.org/wiki/Aleksandr_Popov_\(physicist\)](https://en.wikipedia.org/wiki/Aleksandr_Popov_(physicist))

Popov 📻



Popov



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Do we have a problem?

—

Language

Tooling

Other

Tools are on top for years!

<i>Which of these do you find frustrating about C++ dev?</i>	<i>Major %</i>
Managing libraries my application depends on	45 %
Build times	43 %
Setting up a CI pipeline from scratch	30 %
Managing CMake projects	30 %
Concurrency safety: Races, deadlocks, performance bottlenecks	27 %
Setting up a dev env from scratch	26 %
Parallelism support	23 %
Managing Makefiles	20 %
Memory safety: Bounds safety issues	20 %
Memory safety: Use-after-delete/free	20 %
Debugging issues in my code	18 %
Managing MSBuild projects	16 %
Unicode, internationalization, and localization	16 %
Security issues: disclosure, vulnerabilities, exploits	12 %
Type safety: Using an object as the wrong type	12 %
Memory safety: Memory leaks	12 %
Moving existing code to the latest language standard	9 %

Do we have a problem?

—

[“How To Address 7 Major C++ Pain Points with CLion”](#) © CLion blog

[“C++ MythBusters”](#) and [“C++ MythBusters Strike 2”](#) © Victor Ciura

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Vitamin, Painkiller, or Cure?

—

“We throw away the candy.

We look at vitamins.

We really like painkillers.”

© Kevin Fong, venture capitalist

Vitamin, Painkiller, or Cure?

—

Painkiller = a quick-fix, a tool

Vitamin = guidelines, code styles, best practices

Cure = a language feature

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Tools help: with macros #1

```
#define MAGIC 100
#define CALL_DEF(val, class_name) int call_##class_name() \
                                   { return val; }

#define CLASS_DEF(class_name) class class_##class_name { \
                               public: \
                                   int count_##class_name; \
                                   CALL_DEF(MAGIC, class_name) \
                               };
```

```
CLASS_DEF(A)
CLASS_DEF(B)
CLASS_DEF(C)
```

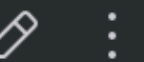
Declared in: MacroDebug.cpp

Definition:

```
#define CLASS_DEF(class_name) class class_##class_name { \
                               public: \
                                   int count_##class_name; \
                                   CALL_DEF(MAGIC, class_name) \
                               };
```

Replacement:

```
class class_A {
public:
    int count_A;
    int call_A() { return 100; }
};
```



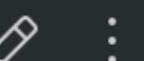
Declared in: MacroDebug.cpp

Definition:

```
#define CLASS_DEF(class_name) class class_##class_name { \
                               public: \
                                   int count_##class_name; \
                                   CALL_DEF(MAGIC, class_name) \
                               };
```

Replacement:

```
class class_C {
public:
    int count_C;
    int call_C() { return 100; }
};
```



Tools help: with macros #2

```
static int v;
```

```
#define __NEW_VAR(name, num) static void *__v_##num = (void *)&name;
```

```
#define _NEW_VAR(name, num) __NEW_VAR(name, num)
```

```
#define NEW_VAR(name) _NEW_VAR(name, __COUNTER__)
```

```
void counter_macro_sample() {
```

```
    NEW_VAR(v)
```

```
    NEW_VAR(v)
```

```
    NEW_VAR(v)
```

```
}
```

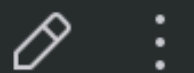
Declared in: MacroDebug.cpp

Definition:

```
#define NEW_VAR(name) _NEW_VAR(name, __COUNTER__)
```

Replacement:

```
static void *__v_0 = (void *) &v;
```



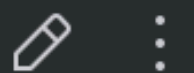
Declared in: MacroDebug.cpp

Definition:

```
#define NEW_VAR(name) _NEW_VAR(name, __COUNTER__)
```

Replacement:

```
static void *__v_2 = (void *) &v;
```



Tools help: with macros #3

```
BOOST_AUTO_TEST_SUITE(demo_suite)

BOOST_AUTO_TEST_CASE(test_equal_1)
{
    BOOST_CHECK_EQUAL(MY_ONE, 1);
}

BOOST_AUTO_TEST_CASE(test_equal_word)
{
    char *name = new char[4];
    name[1] = 't';
    name[2] = 'e';
    name[3] = 's';
    name[4] = 't';

    BOOST_CHECK_EQUAL(name, "test")
}

BOOST_AUTO_TEST_SUITE_END()
```

Declared in: unit_test_suite.hpp

Definition:

```
#define BOOST_AUTO_TEST_CASE(...) \
    BOOST_TEST_INVOKE_IF_N_ARGS( 1, \
    BOOST_AUTO_TEST_CASE_NO_DECOR, \
    BOOST_AUTO_TEST_CASE_WITH_DECOR, \
    __VA_ARGS__)
```

Replacement:

```
struct test_equal_word : public BOOST_AUTO_TEST_CASE_FIXTURE {
    void test_method();
};

static void test_equal_word_invoker() {
    ::boost::unit_test::unit_test_log.set_checkpoint(
        ::boost::unit_test::const_string("_file_name_", sizeof("_file_name_") - 1), static_cast<std::size_t>(16),
        (::boost::wrap_stringstream().ref() << "" << "test_equal_word" << "\" fixture ctor").str());
    test_equal_word t;
    ::boost::unit_test::unit_test_log.set_checkpoint(
        ::boost::unit_test::const_string("_file_name_", sizeof("_file_name_") - 1), static_cast<std::size_t>(16),
        (::boost::wrap_stringstream().ref() << "" << "test_equal_word" << "\" fixture setup").str());
    boost::unit_test::setup_conditional(t);
    ::boost::unit_test::unit_test_log.set_checkpoint(
        ::boost::unit_test::const_string("_file_name_", sizeof("_file_name_") - 1), static_cast<std::size_t>(16),
        (::boost::wrap_stringstream().ref() << "" << "test_equal_word" << "\" test entry").str());
    t.test_method();
    ::boost::unit_test::unit_test_log.set_checkpoint(
        ::boost::unit_test::const_string("_file_name_", sizeof("_file_name_") - 1), static_cast<std::size_t>(16),
        (::boost::wrap_stringstream().ref() << "" << "test_equal_word" << "\" fixture teardown").str());
    boost::unit_test::teardown_conditional(t);
    ::boost::unit_test::unit_test_log.set_checkpoint(
        ::boost::unit_test::const_string("_file_name_", sizeof("_file_name_") - 1), static_cast<std::size_t>(16),
        (::boost::wrap_stringstream().ref() << "" << "test_equal_word" << "\" fixture dtor").str());
}

struct test_equal_word_id {
};

static boost::unit_test::ut_detail::auto_test_unit_registrar test_equal_word_registrar162 __attribute__((__unused__))(
    boost::unit_test::make_test_case(&test_equal_word_invoker, "test_equal_word", "_file_name_", 16),
    boost::unit_test::decorator::collector_t::instance());

void test_equal_word::test_method()
```

Tools help: with macros #4

```
#define DECL(z, n, text) text ## n = n;  
BOOST_PP_REPEAT(5, DECL, int x)
```

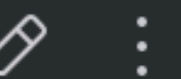
Declared in: repeat.hpp

Definition:

```
# define BOOST_PP_REPEAT BOOST_PP_CAT(BOOST_PP_REPEAT_,  
BOOST_PP_AUTO_REC(BOOST_PP_REPEAT_P, 4))
```

Replacement:

```
int x0 = 0;  
int x1 = 1;  
int x2 = 2;  
int x3 = 3;  
int x4 = 4;
```



Tools help: with overloads

```
class Fraction {...};

bool operator==(const Fraction& lhs, const Fraction& rhs) {...};

bool operator!=(const Fraction& lhs, const Fraction& rhs) {...};

Fraction operator*(Fraction lhs, const Fraction& rhs) {...};

std::ostream& operator<<(std::ostream& out, const Fraction& f)
{
    return out << f.num() << '/' << f.den();
}

void fraction_sample() {
    Fraction f1(3, 8), f2(1, 2);

    std::cout << f1 << " * " << f2 << " = " << f1 * f2 << '\n';
}
```


Tools help: with overloads

```
std::cout << f1 << " * " << f2 << " = " << f1 * f2 << '\n';
```

Declared in: operator_usages_highlight.cpp

```
std::basic_ostream<char> &operator<<(std::basic_ostream<char> &out, const Fraction  
```

```
std::cout << f1 << " * " << f2 << " = " << f1 * f2 << '\n';
```

Declared in: ostream

namespace std

template<_Traits>

```
basic_ostream<char, _Traits> &operator<<(basic_ostream<char, _Traits> &__os, const char *__str)
```

["operator<<" on cppreference.com](#) 



```
std::cout << f1 << " * " << f2 << " = " << f1 * f2 << '\n';
```

Declared in: ostream

namespace std

public:

```
basic_ostream &basic_ostream::operator<<(int __n)
```

Tools help: named parameters

—

Named arguments

by Ehsan Akhgari and Botond Ballo, [N4172](#)

Self-explanatory Function Arguments

by Axel Naumann, [P0671](#)

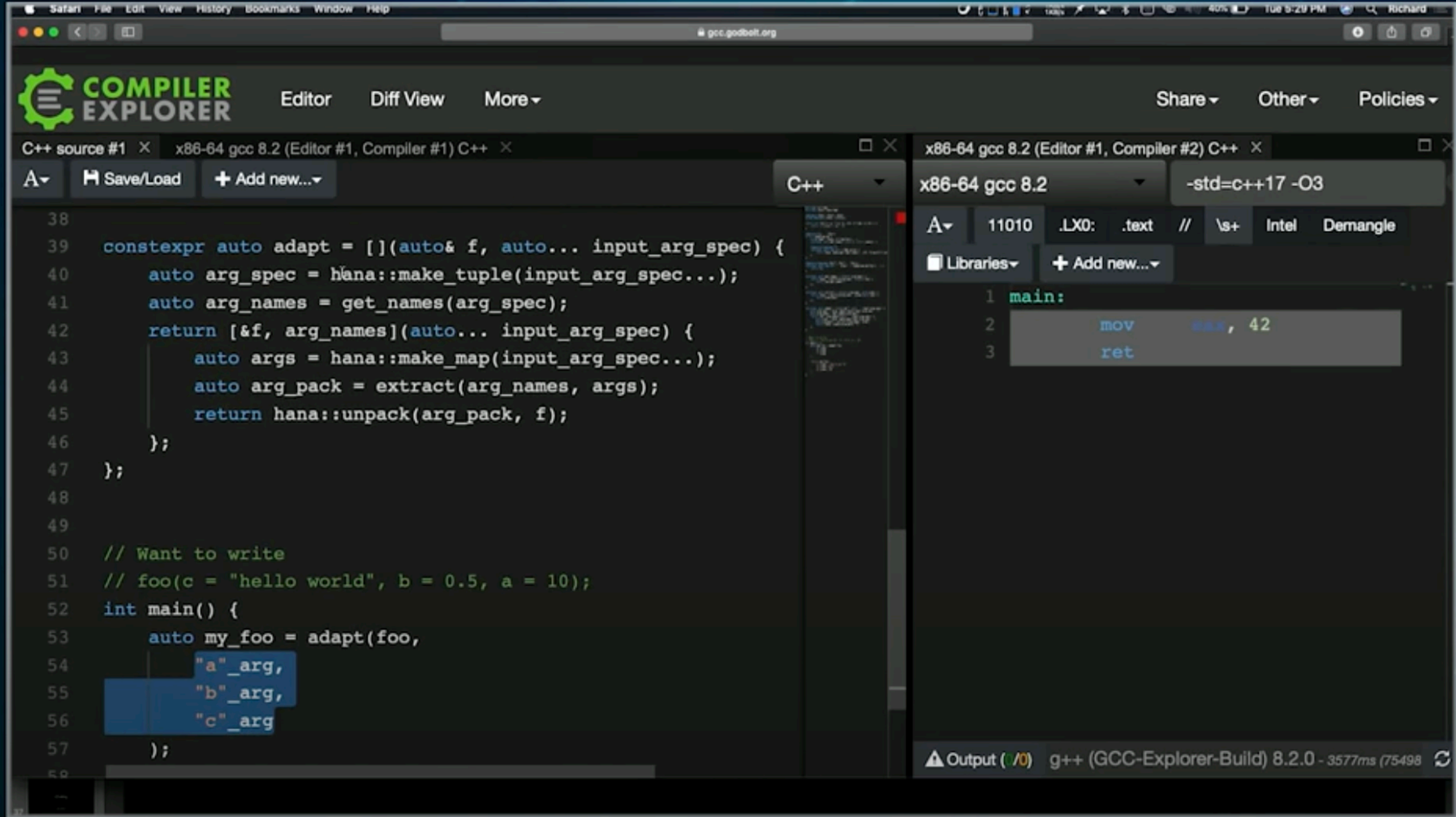
Boost.Parameter

by David Abrahams and Daniel Wallin, [docs](#)

Tools help: named parameters

—

cppcon | 2018
THE C++ CONFERENCE • BELLEVUE, WASHINGTON



The screenshot shows the Compiler Explorer web interface. The left pane displays C++ source code with line numbers 38 to 59. The code defines a lambda function `adapt` and uses it in `main` with named arguments `"a"_arg`, `"b"_arg`, and `"c"_arg`. The right pane shows the assembly output for `main`, which is a simple `mov` instruction followed by `ret`. The interface includes tabs for source code, assembly, and output, as well as buttons for saving and adding new projects.



Richard Powell is standing at a podium, presenting. He is wearing a black t-shirt with the word "const" on it. A laptop is open on the podium in front of him.

RICHARD POWELL

Named Arguments
from Scratch

Tools help: named parameters

#1 Parameters of the same type, like weight, height, positions, etc.

```
4
5 → GameState::GameState(int fieldWidth,
6                          int fieldHeight)
7     : field_(aleft: 0, atop: 0, awidth: fieldWidth, aheight: fieldHeight),
8       ball_(pos: QPointF(xpos: field_.width() / 2, ypos: field_.height() - 30),
9             speed: QPointF(xpos: 200, ypos: -200)),
10      paddle_(pos: QPointF(xpos: field_.width() / 2, ypos: field_.height() - 10),
11              width: 60, height: 20),
12      score_(0) {
13
```

Tools help: named parameters

#2 Pass-by-value and pass-by-reference

```
→ void GameState::processCollisions() {  
    if (applyCollision(& ball_, type: getCollisionWithWalls( b: ball_, bounding: getField()))  
  
    for (auto iter : iterator<Brick *> = bricks_.begin(); iter != bricks_.end(); ++iter) {  
        if (applyCollision(& ball_, type: getCollisionWithBrick( b: ball_, brick: iter->aabb  
            bricks_.erase( position: iter);  
            score_ += 1;  
            return;  
        }  
    }  
  
    if (applyCollision(& ball_, type: getCollisionWithBrick( b: ball_, brick: paddle_.aabb()))  
}
```

Tools help: type hints

—

Types:

- variables
- lambda
- deduced return types
- structured bindings

```
template<typename T, typename U>
auto doOperation(T t, U u) -> decltype(t + u) {
    return t + u;
}

void fun_type() {
    auto op :int  = doOperation(t: 3, u: 0);
    auto op1 :long = doOperation(t: 3L, u: 0);
    auto op2 :double = doOperation(t: 3.0, u: 0);

    std::cout << op << " " << op1 << " " << op2;
}

void type_hints_bind() {
    int a = 1, b = 2;
    const auto&[x :int & , y :int & ] = std::tie(&a, &b);
    const auto tuple :const tuple<int, char, double> = std::tuple(1, 'a', 2.3);
    const auto& [i :const int , c :const char , d :const double ] = tuple;
}
```


Tools help: with DSLs

Unreal Engine
reflection
macros-based dialect

405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424

```
// Current health of the Pawn
UPROPERTY(EditAnywhere, BlueprintReadWrite, Replicated, Category = Health)
float
/** Ta
virtua
/** Pa
virtua
/** Ki
virtua
/** Re
virtua
/**
* Kill
* @par
```

Unreal Engine reflection macro
UPROPERTY

Properties are declared using standard C++ variable syntax, preceded by the UPROPERTY macro which defines property metadata and variable specifiers.

Remarks: The UPROPERTY macro enables a member variable of a UCLASS or a USTRUCT to be used as a UPROPERTY.
A UPROPERTY has many uses. It can allow the variable to be replicated, serialized, and accessed from Blueprints. They are also used by the garbage collector to keep track of how many references there are to a UObject.
Learn more: [Properties](#), [Property Specifiers](#).

Example:

UPROPERTY([specifier, specifier, ...], [meta(key=value, key=value, ...)])
Type VariableName;

285
286
287
288
289
290
291
292
293

```
/** default inventory list */
UPROPERTY(EditOnly, Category = Inventory)
TArray<class AShooterWeapon*> Inventory;
```

EditDefaultsOnly
EditInstanceOnly

Press ↵ to insert, → to replace

EditDefaultsOnly
(Unreal Engine reflection specifier)

Indicates that this property can be edited by property windows, but only on archetypes. This Specifier is incompatible with any of the "Visible" Specifiers.

Tools help: with guidelines

—

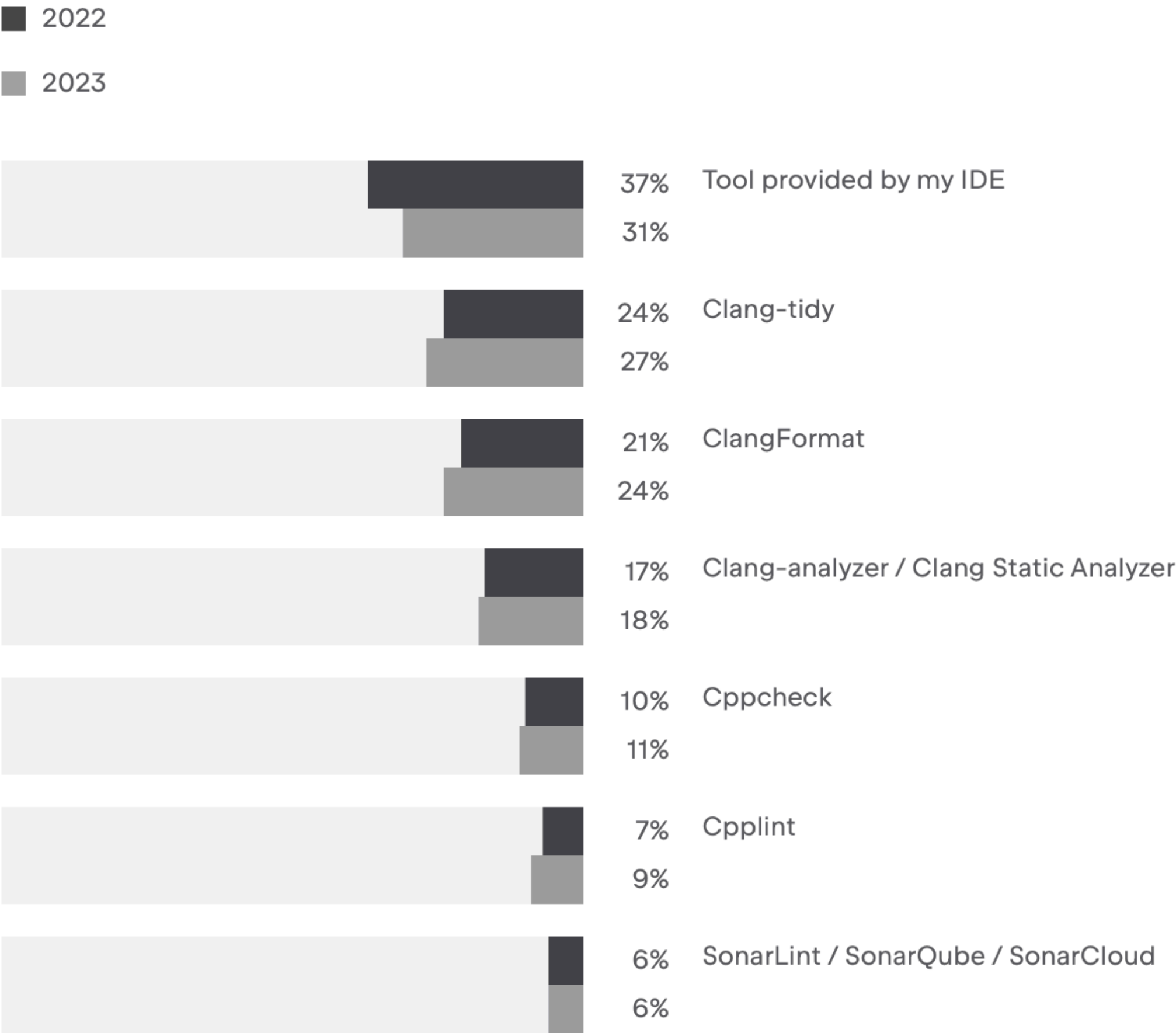
Checks and fixes in ClangTidy

cppcoreguidelines-avoid-capturing-lambda-coroutines	
cppcoreguidelines-avoid-const-or-ref-data-members	
cppcoreguidelines-avoid-do-while	
cppcoreguidelines-avoid-goto	
cppcoreguidelines-avoid-non-const-global-variables	
cppcoreguidelines-avoid-reference-coroutine-parameters	
cppcoreguidelines-init-variables	Yes
cppcoreguidelines-interfaces-global-init	
cppcoreguidelines-macro-usage	
cppcoreguidelines-misleading-capture-default-by-value	Yes
cppcoreguidelines-missing-std-forward	
cppcoreguidelines-narrowing-conversions	
cppcoreguidelines-no-malloc	
cppcoreguidelines-no-suspend-with-lock	
cppcoreguidelines-owning-memory	
cppcoreguidelines-prefer-member-initializer	Yes
cppcoreguidelines-pro-bounds-array-to-pointer-decay	
cppcoreguidelines-pro-bounds-constant-array-index	Yes
cppcoreguidelines-pro-bounds-pointer-arithmetic	
cppcoreguidelines-pro-type-const-cast	
cppcoreguidelines-pro-type-cstyle-cast	Yes
cppcoreguidelines-pro-type-member-init	Yes
cppcoreguidelines-pro-type-reinterpret-cast	
cppcoreguidelines-pro-type-static-cast-downcast	Yes
cppcoreguidelines-pro-type-union-access	
cppcoreguidelines-pro-type-vararg	
cppcoreguidelines-rvalue-reference-param-not-moved	
cppcoreguidelines-slicing	
cppcoreguidelines-special-member-functions	
cppcoreguidelines-virtual-class-destructor	Yes

modernize-avoid-bind	Yes
modernize-avoid-c-arrays	
modernize-concat-nested-namespaces	Yes
modernize-deprecated-headers	Yes
modernize-deprecated-ios-base-aliases	Yes
modernize-loop-convert	Yes
modernize-macro-to-enum	Yes
modernize-make-shared	Yes
modernize-make-unique	Yes
modernize-min-max-use-initializer-list	Yes
modernize-pass-by-value	Yes
modernize-raw-string-literal	Yes
modernize-redundant-void-arg	Yes
modernize-replace-auto-ptr	Yes
modernize-replace-disallow-copy-and-assign-macro	Yes
modernize-replace-random-shuffle	Yes
modernize-return-braced-init-list	Yes
modernize-shrink-to-fit	Yes
modernize-type-traits	Yes
modernize-unary-static-assert	Yes
modernize-use-auto	Yes
modernize-use-bool-literals	Yes
modernize-use-constraints	Yes
modernize-use-default-member-init	Yes
modernize-use-designated-initializers	Yes
modernize-use-emplace	Yes
modernize-use-equals-default	Yes
modernize-use-equals-delete	Yes
modernize-use-nodiscard	Yes
modernize-use-noexcept	Yes
modernize-use-nullptr	Yes
modernize-use-override	Yes
modernize-use-starts-ends-with	Yes
modernize-use-std-numbers	Yes
modernize-use-std-print	Yes
modernize-use-trailing-return-type	Yes
modernize-use-transparent-functors	Yes
modernize-use-uncaught-exceptions	Yes
modernize-use-using	Yes

Tools help: with guidelines

Which of the following tools do you or your team use for guideline enforcement or other code quality/analysis?



Bryce Adelstein Lelbach
Principal Architect at NVIDIA

I think the decrease in IDE-provided analysis tools here is indicative of people incorporating static analysis into their CI, like running the Clang-tidy/ClangFormat/Clang static analyzer in GitHub Actions.

[X \(formerly Twitter\)](#)

C++ Painkillers stories

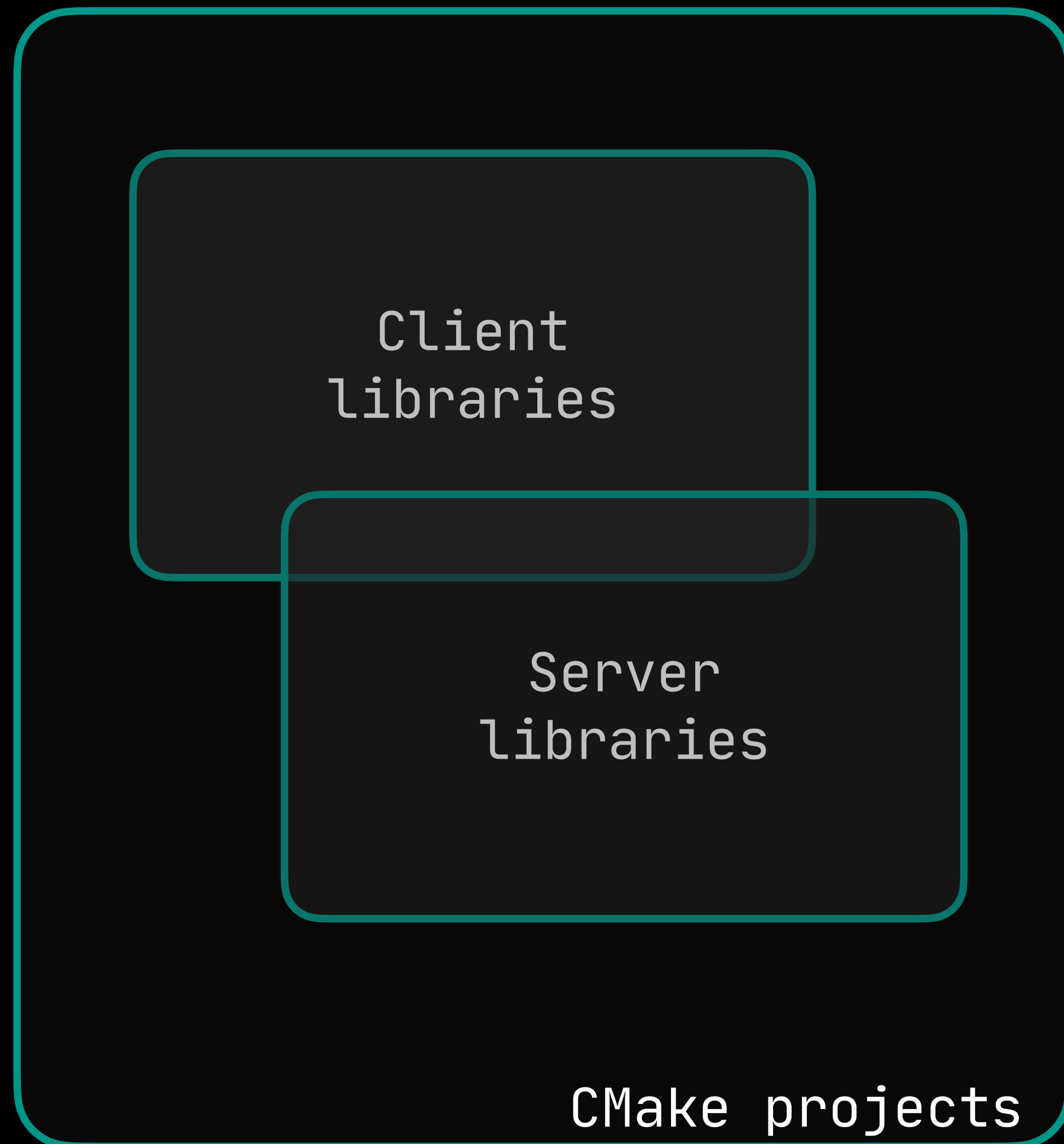
–

Story #1

“Dependency validation with NetBeans”

Dependency validation with NetBeans

—



```
$ cmake ..
```

CMake configures the
project

NetBeans

```
$ cmake --build
```

CMake builds an already-
generated project binary
tree

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Role of the C++ tooling

–

C++Now 2017

[A look at C++ through the glasses of a language tool](#)

CppCon 2017

[New standards to the rescue: the view through an IDE's glasses](#)

CppCon 2017

[Tools from the C++ eco-system to save a leg](#)

CppCon 2018

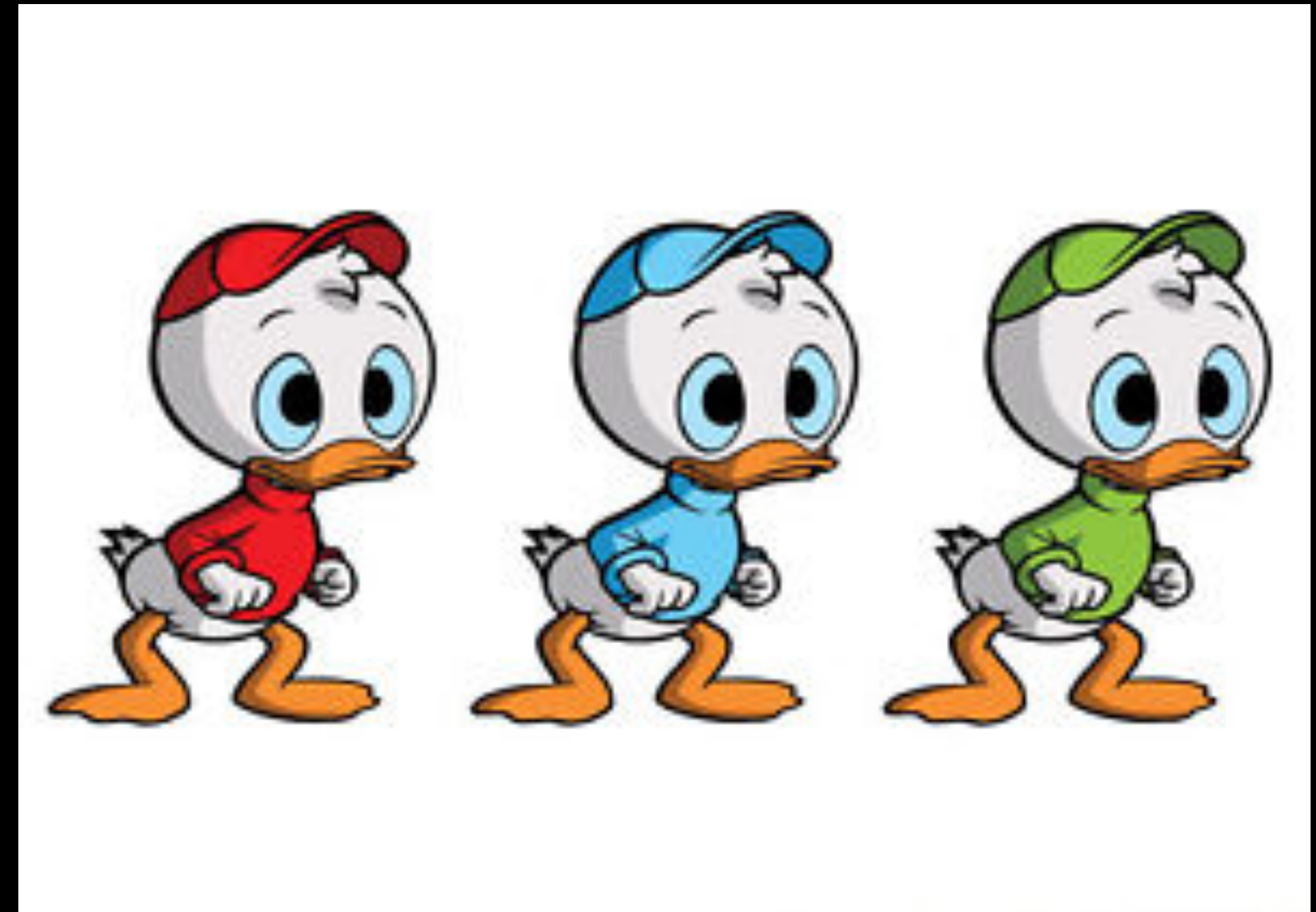
[Debug C++ Without Running](#)

C++ toolability: sameness

–

```
template<class T, int ... X>  
T pi(T(X...));
```

```
int main() {  
    return pi<int, 42>;  
}
```



```
constexpr auto rexpr = ^int;  
typename[:rexpr:] a = 42;
```

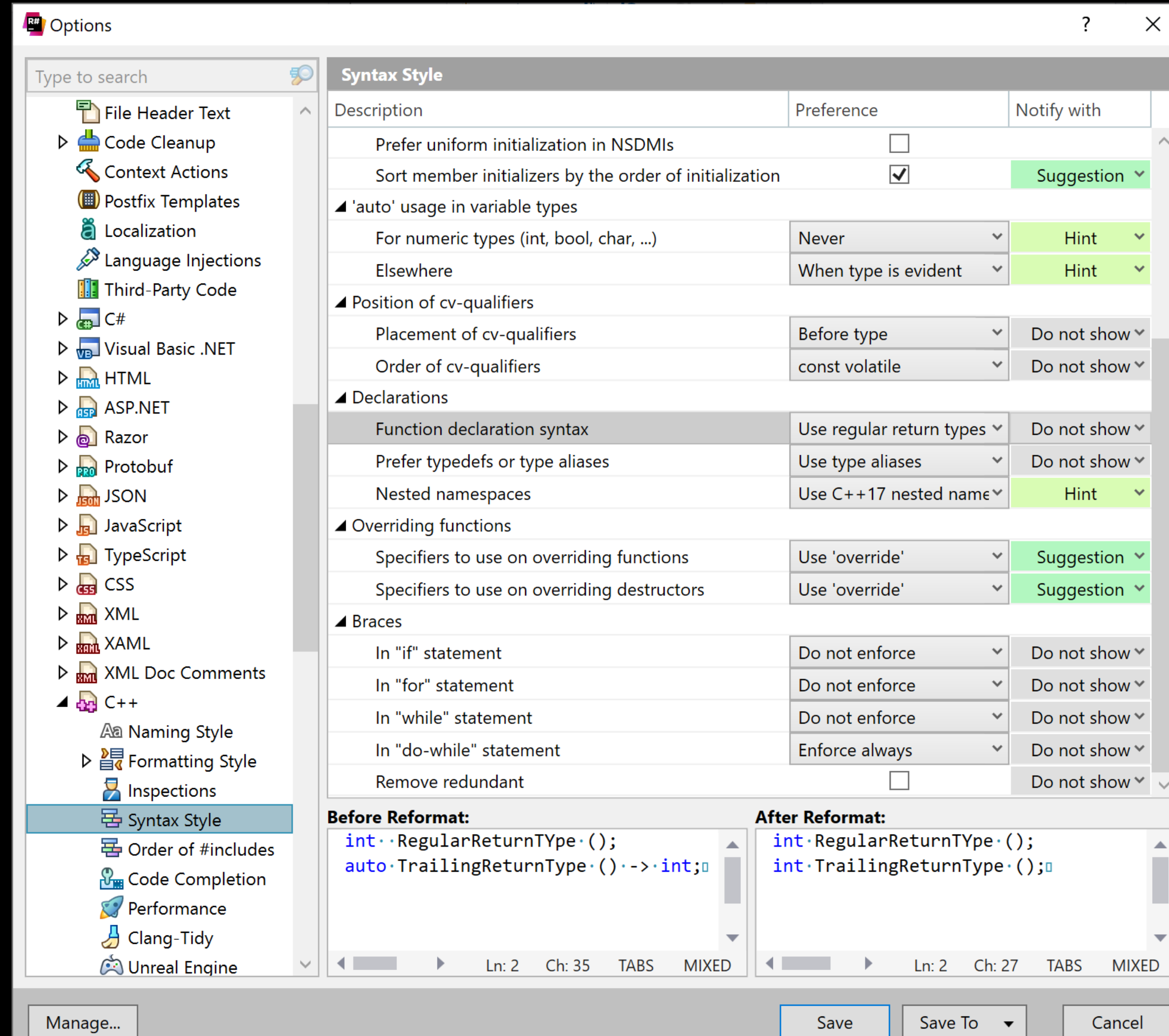
C++ toolability: sameness

Almost Always Auto or when type is evident or never for numeric types.

Const before or after the type it applies to.

Trailing return type for lambdas or always.

Virtual explicitly (UE) or override/final and no virtual (C++ Core Guidelines).



C++ toolability

—

```
template<int>
struct x {
    int z;
    bool p;
    x(int i) { }
};
```

```
void test(int y) {
```

```
    const int a = 100;
```

```
    auto k = x<a>(0);
    auto l = y<a>(0);
```

```
}
```

```
x<100> k = x<a>(0)
```

Size = 8 bytes



```
bool l = y<a>(0)
```

Size = 1 byte



C++ toolability

Declared in: main.cpp

y::y(x)



```
void test() {  
    struct x {  
    };
```

```
    struct y {  
        y(x) {};  
        x(z);  
    };  
}
```

Declared in: main.cpp

x y::z

Size = 1 byte



C++ toolability

—

```
void test() {  
    struct x {  
        x(int) { };  
    };  
}
```

```
int y = 100;
```

```
auto a = (x)-5;  
auto b = (y)-5;
```

```
}
```

```
x a = (x)-5
```

Size = 1 byte



```
int b = (y)-5
```

Size = 4 bytes



C++ toolability

-

```
int(x), y, a, b, c, d, e, f, *z;
```

```
int(x), y, a, b, c, d, e, f, new int;
```



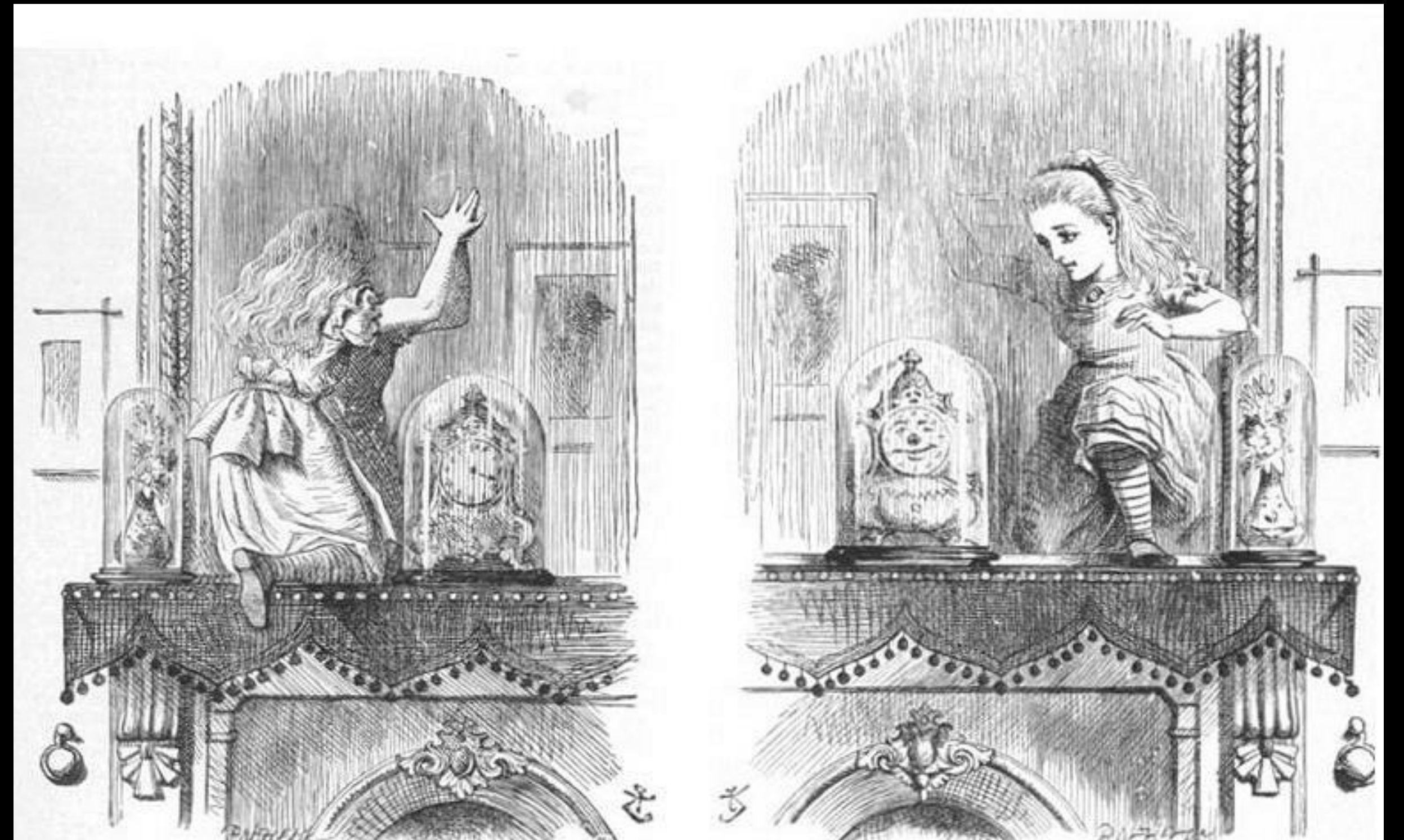
C++ toolability

—

To parse C++

we need to distinguish

types from non-types



C++ toolability

—

Fuzzy parsing is
kinda possible but...

ClangFormat

```
46  template<int N>
47  struct A {
48      A(int p) {}
49      operator int() { return N; }
50  };
51
52  ▶ int main() {
53      // Formatting setting for templates and
54      // integer expressions are different
55      int A = 10;
56  if (A < 3 + 6 > (2 + 8) + 1 > 5) {
57      std::cout << "print A" << std::endl;
58  }
59
60      int B = 10;
61      if (B < 20 > 5 + 5 > 5 + 10) {
62          std::cout << "print B" << std::endl;
63      }
64      return 0;
65  }
```

f main



56:39 (39 chars, 1 line break)

LF

UTF-8

.clang-tidy

ClangFormat

C++: cf_parser | Debug

C++ toolability

—

Resolve depends on:

- order of the definitions
- default arguments
- overload resolution
- project model context

```
//foo.h
#ifdef MAGIC
template<int>
struct x {
    x(int i) { }
};
```

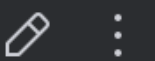
```
#else
int x = 100;
#endif
```

```
//foo.cpp
#include "foo.h"
void test(int y) {
    const int a = 100;

    auto k = x<a>(0);
}
```

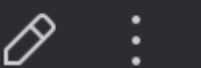
```
x<100> k = x<a>(0)
```

Size = 1 byte



```
bool k = x<a>(0)
```

Size = 1 byte



C++ toolability

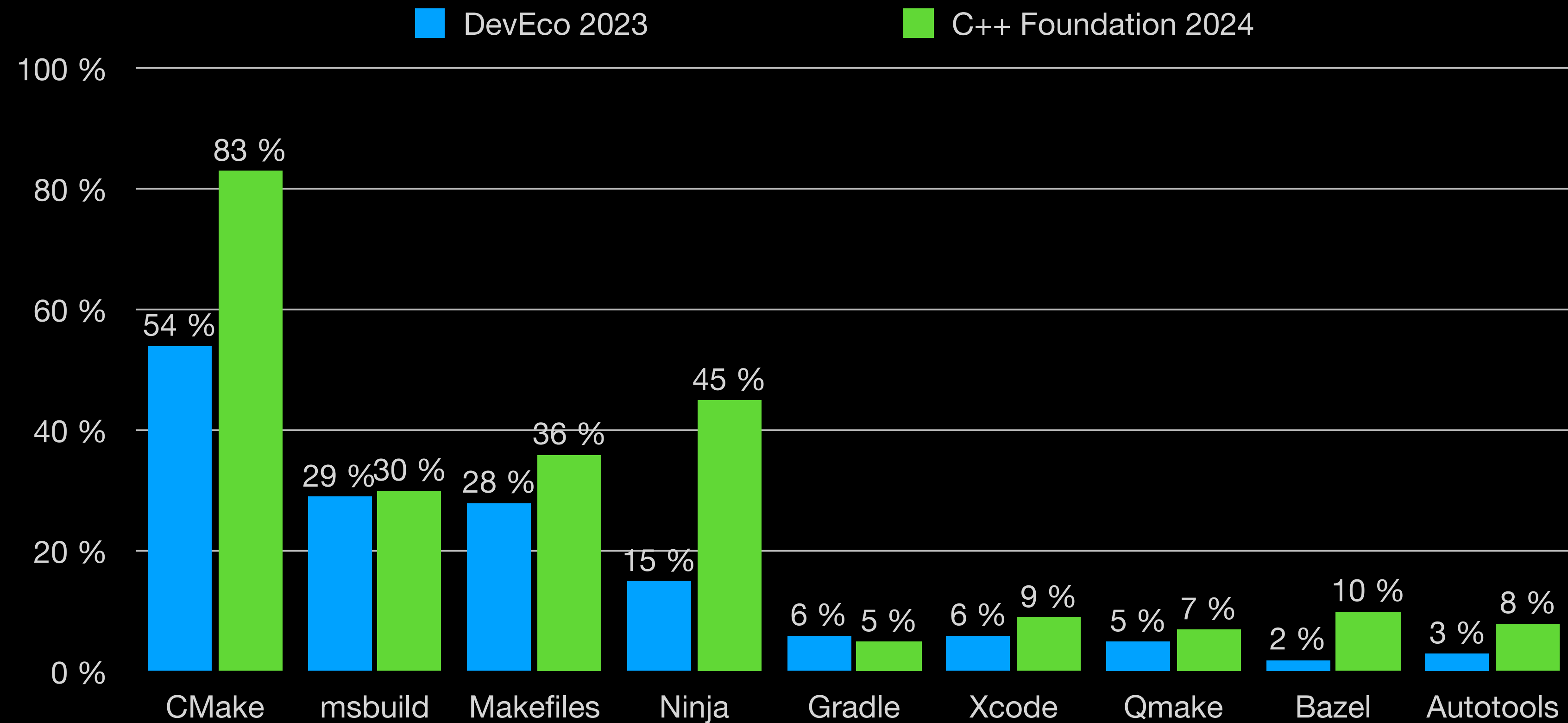
You wanna **standard C++
Build System?**

You got One!

It's called **CMake!**

© Bryce Adelstein

Leibach, CppNow 2021



C++ Painkillers

—

1. Stories about the tools
2. Why this talk
3. Vitamin, Painkiller, or Cure?
4. Where and when do tools help
5. C++ toolability
6. Tools for C++ painpoints
7. Start thinking about tools earlier
8. Era of AI

Tools for C++ painpoints

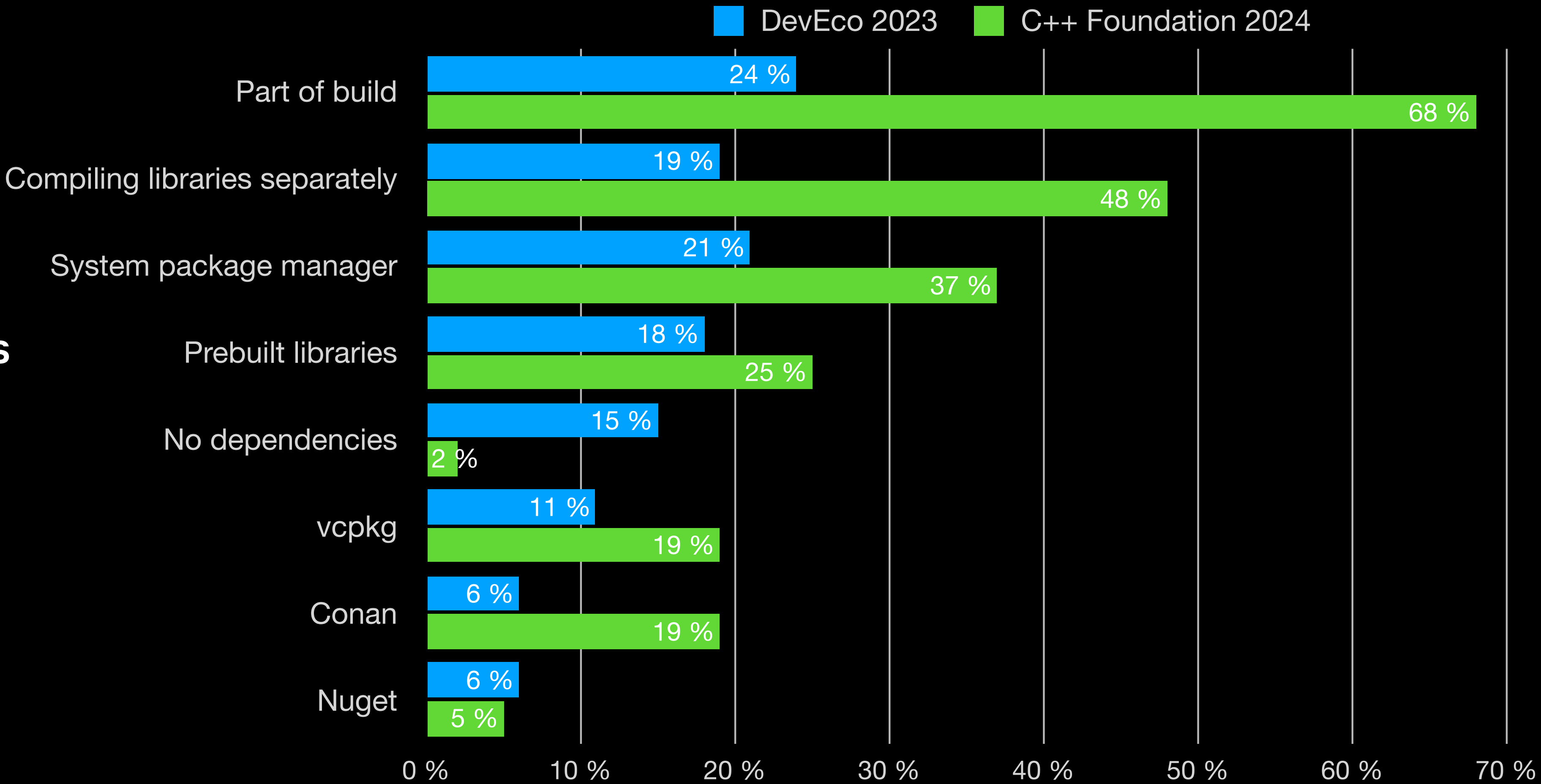
—

Which tools to use?

<i>Which of these do you find frustrating about C++ dev?</i>	<i>Major %</i>
Managing libraries my application depends on	45 %
Build times	43 %
Setting up a CI pipeline from scratch	30 %
Managing CMake projects	30 %
Concurrency safety: Races, deadlocks, performance bottlenecks	27 %
Setting up a dev env from scratch	26 %
Parallelism support	23 %
Managing Makefiles	20 %
Memory safety: Bounds safety issues	20 %
Memory safety: Use-after-delete/free	20 %
Debugging issues in my code	18 %
Managing MSBuild projects	16 %
Unicode, internationalization, and localization	16 %
Security issues: disclosure, vulnerabilities, exploits	12 %
Type safety: Using an object as the wrong type	12 %
Memory safety: Memory leaks	12 %
Moving existing code to the latest language standard	9 %

Tools for C++ painpoints

#1 Managing libraries



Tools for C++ painpoints

#1 Managing libraries

40% repos with

CMakeLists.txt inside

Query summary

Query type: **Count**

✓ Forks dropped

✓ Archived dropped

Primary language of repositories: C C++

Licenses: Any

Updated after: 01/01/2020, 00:00:00

Stars: [10 .. Any]

File's language: Text CMake

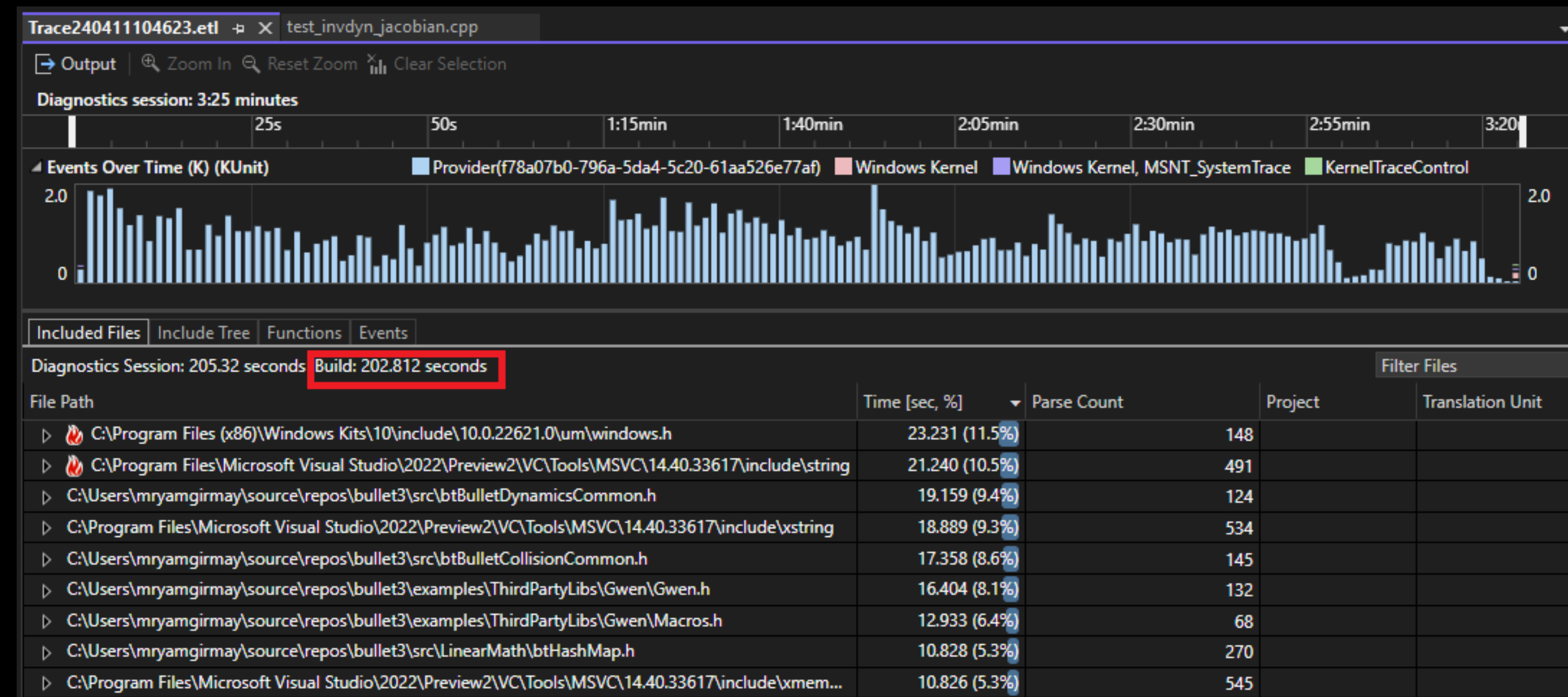
File's path REGEX: CMakeLists.txt

Percentage of repositories to analyze, %: 100

Tools for C++ painpoints

#2 Build times

- Build insights
- Include cleanup
- Include Diagnostics



```
// Test of kinematic consistency: check if finite differences of ve  
// match positions
```

```
#include <gtest/gtest.h>
```

```
#include "Bullet3Common/b3Random.h"
```

```
#include "CloneTreeCreator.hpp"
```

```
#include "CoilCreator.hpp"
```

```
#include "DillCreator.hpp"
```

```
#include "RandomTreeCreator.hpp"
```

```
#include "BulletInverseDynamics/MultiBodyTree.hpp"
```

```
#include <MultiBodyTreeCreator.hpp>
```

```
#include <Bullet3Common/b3Scalar.h>
```

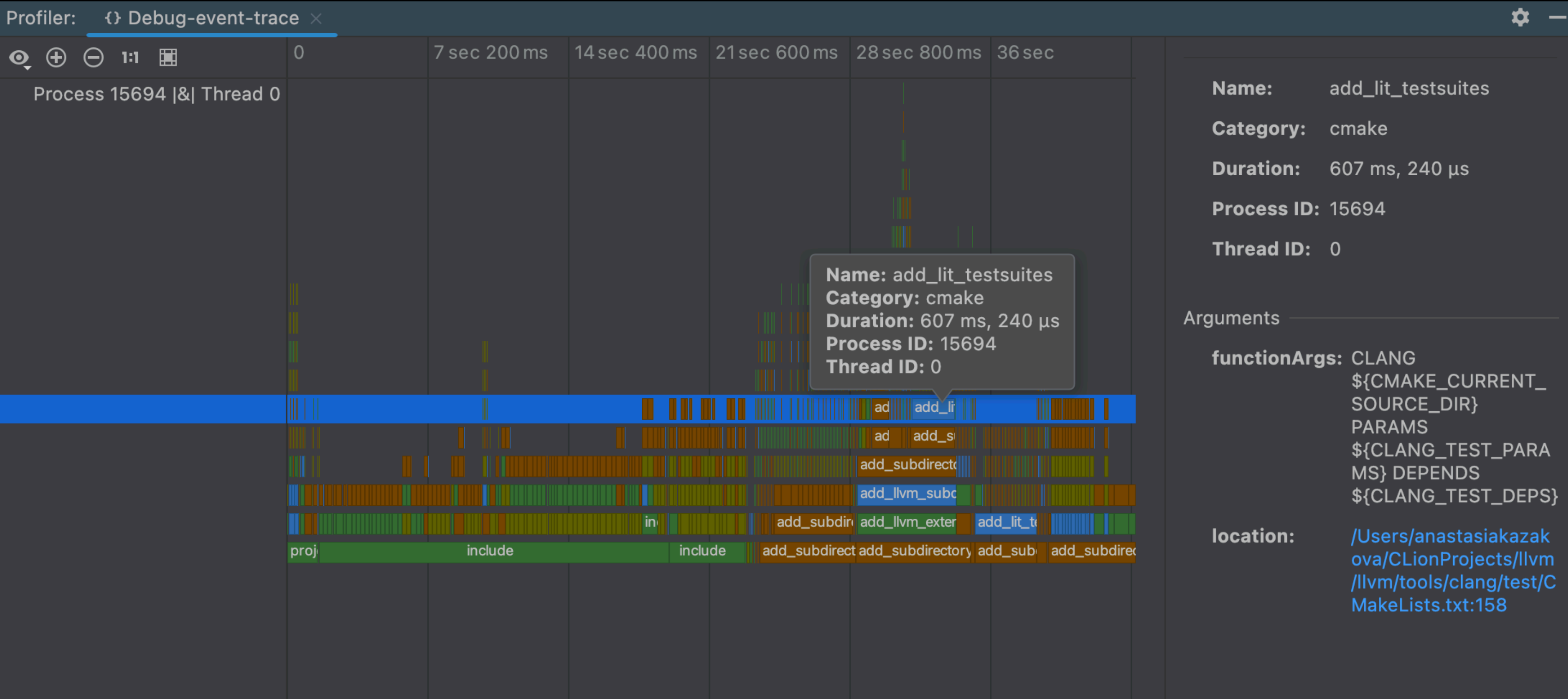
```
#include <BulletInverseDynamics/details/IDLinearMathInterface.hpp>
```

Tools for C++ painpoints

—

#2 Build times

← CMake configuration
profiling



Tools for C++ painpoints

#3 CI pipelines

- test frameworks
- CI integrations
- variety of toolchains
- visual tools
- IDEs integrations

The screenshot displays the TeamCity Pipelines web interface. At the top, the 'Run #15' status is shown as 'Running'. Below this, a progress bar indicates the pipeline's progress, with a '20%' completion mark. The pipeline consists of several steps: 'Frontend - Build_1' (1m 3s, Tests passed: 12), 'Publish artifacts' (Success), 'Deployment' (Step 1/2), 'Backend - Build' (2m, Success), 'Backend - Deploy' (2m 27s, Success), 'Tests' (1m 45s, Tests passed: 3), and 'Frontend - Build_2' (1m 45s, Success). The 'Backend - Deploy' step is currently selected, and its details are shown on the right. The details include the step's status ('Success'), its running time (2m 04s), and the agent used ('Linux-Medium-i-09b8a648a...'). Below the step details, a log viewer shows the execution of the 'Step 1/1: simpleRunner (Command Line)', including commands like 'Finalize build settings', 'Collecting changes in 1 VCS root', 'Parallel tests: freeze', and 'Will use agent side checkout'.

TeamCity Pipelines

Home / Open Source Project / Run #15

Run #15 Edit pipeline Run

Status: Running In queue: 1m 23s Running time: 20m Optimized: On -20% Branch: something-new Triggered by: Noah Schneider at 8 Aug 16:45 Repository: github.com/Noah/Open-Source-project +2

Backend - Deploy

Status: Success In queue: 1m 23s Running time: 2m 04s Agent: Linux-Medium-i-09b8a648a... Open Terminal

Search in log Filter View Download

10:19:05 Finalize build settings

... 10:19:05 > Collecting changes in 1 VCS root 1s

... 10:19:05 > Parallel tests: freeze 1s

10:19:05 The build is removed from the queue to be prepared for the start

... 10:19:05 Step 1/1: simpleRunner (Command Line) 10s

10:19:05 Will use agent side checkout

10:19:05 + Clearing temporary directory: /mnt/agent/temp/buildTmp

10:19:05 - Container wrapper: prepare reusable container

10:19:05 Process exited with code 1

10:19:05 - Container wrapper: prepare reusable container

10:19:05 Process exited with code 1

10:19:05 Process exited with code 1

10:19:05 Process exited with code 1

10:19:05 The build is removed from the queue to be prepared for the start

Tools for C++ painpoints

#4 Managing CMake

C++ now

CMake + Conan: 3 Years Later

A Motivating Example (Poll #2)

What will be printed during the configuration phase?

```
set(foo ON)

message(foo)
message("foo")
message(${foo})

if(foo)
    message("#1")
endif()
if("foo")
    message("#2")
endif()
if(${foo})
    message("#3")
endif()
```

epam C++Now 2021 - CMake + Conan: 3 years later 8

JET BRAINS Bloomberg Engineering

CppNow.org

CMake + Conan: 3 Years Later - Mateusz Pusz - [CppNow 2021]

Tools for C++ painpoints

#4 Managing CMake

- CMake as a language
- Debugging CMake
- Profiling CMake
- CMake Presets
- CMake File API
- Help from AI

```
add_executable(arkanoid ${SOURCE_FILES})
target_link_libraries(ark arkanoidLib)
```

arkanoid (in Debug_demo/CMakeLists.txt)
arkanoidLib (in Debug_demo/CMakeLists.txt)
arkanoidTest (in Debug_demo/CMakeLists.txt)

Press ^ to choose the selected (or first) suggestion and Next Tip

```
$<TARGET_FILE:Qt${QT_VERSION}::${comp}>
$<TARGET_FILE_DIR:${target}>
```

```
13 add_ex
14 add_executable()
15 cuda_add_executable()
16 qt_add_executable()
17
18 Press ^ to choose the selected (or first) suggestion and Next Tip
19 $<TARGET_FILE:Qt${QT_VERSION}::${comp}>
20 $<TARGET_FILE_DIR:${target}>
21 )
22 endmacro()
23
24 if (WIN32)
25     copy_dll(arkanoid Core)
26     copy_dll(arkanoid Gui)
27     copy_dll(arkanoid Widgets)
```

add_executable

Contents

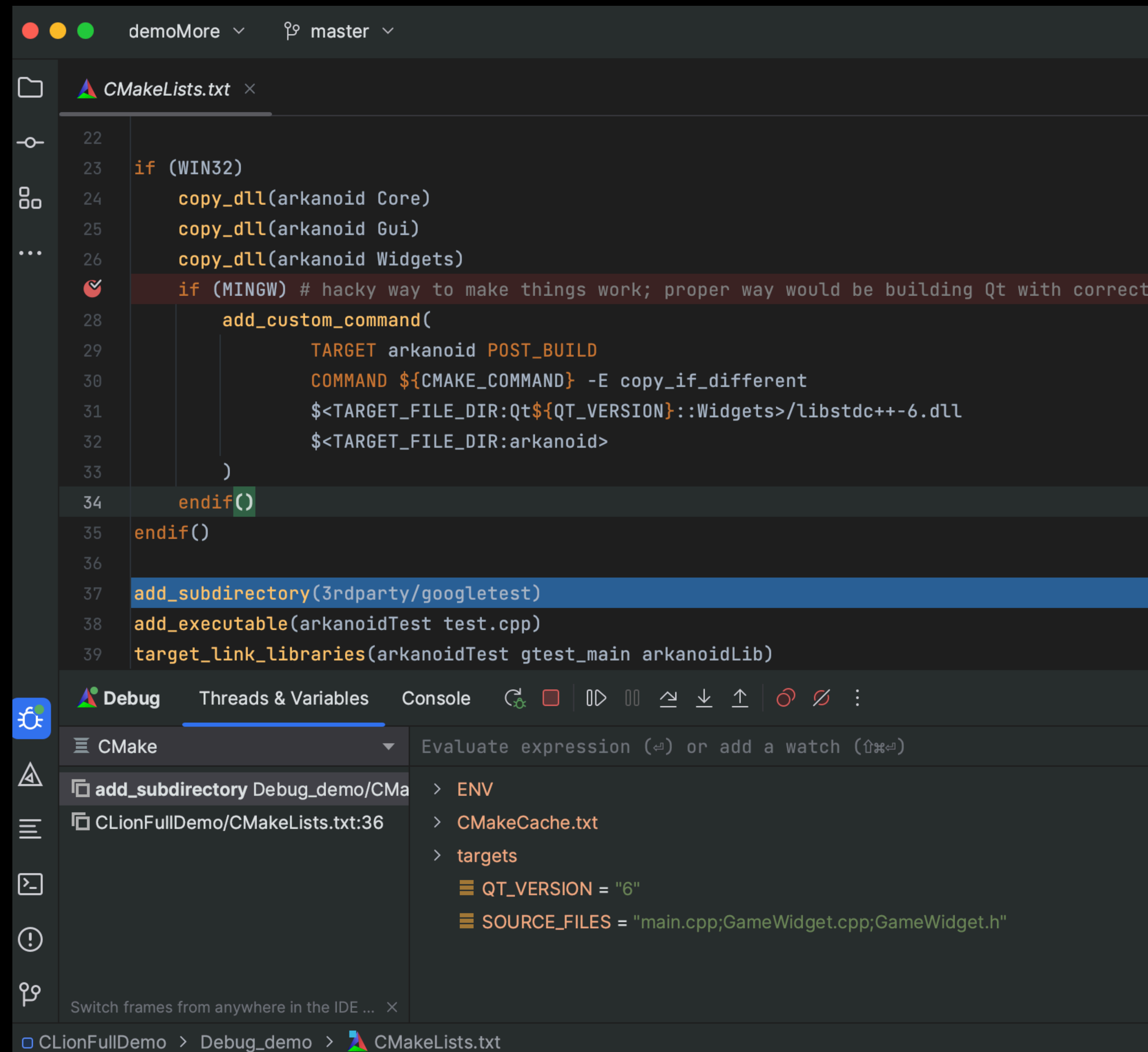
- add_executable
 - Normal Executables
 - Imported Executables
 - Alias Executables
 - See Also

Add an executable to the project using the specified source files.

Tools for C++ painpoints

#4 Managing CMake

- CMake as a language
- Debugging CMake
- Profiling CMake
- CMake Presets
- CMake File API
- Help from AI



Tools for C++ painpoints

#4 Managing CMake

- CMake as a language
- Debugging CMake
- Profiling CMake
- CMake Presets
- CMake File API
- Help from AI

AI Assistant

All ChatsNew Chat

Me

How to link openmp to CMake

AI Assistant

You can add OpenMP to your CMake configuration fairly easily. Here's a quick example of how to do it:

CMake

See Diff and Apply

```
find_package(OpenMP)

if(OpenMP_CXX_FOUND)
    add_executable(your_executable your_source_files.cpp)
    target_link_libraries(your_executable PUBLIC
        ${OpenMP_CXX_LIBRARIES})

```

7 more line(s)

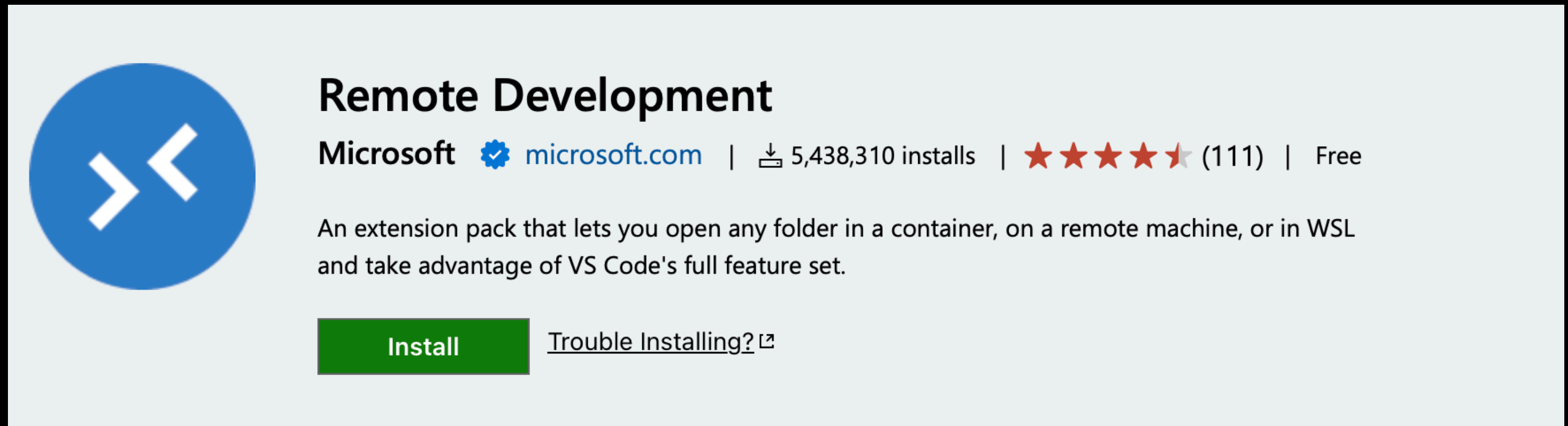
In the above example:

- `find_package(OpenMP)` will look for the OpenMP in your system. If CMake is able to find OpenMP, the boolean variable `OpenMP_CXX_FOUND` is set to true, else false.

Tools for C++ painpoints

#6 Setting up dev env

- start instantly
- onboard easily
- zero configuration time
- local & remote
- reproducible dev artefacts

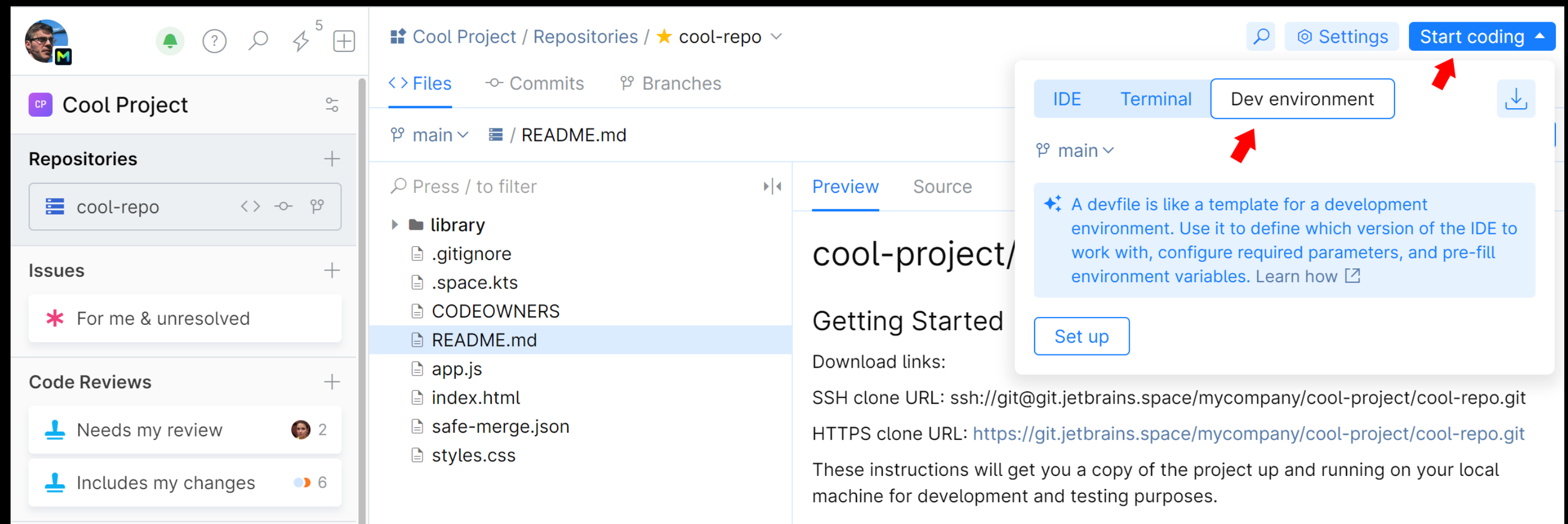


Remote Development

Microsoft  microsoft.com |  5,438,310 installs |  (111) | Free

An extension pack that lets you open any folder in a container, on a remote machine, or in WSL and take advantage of VS Code's full feature set.

[Install](#) [Trouble Installing?](#)



The image shows the Visual Studio Code interface with the Remote Development extension installed. The left sidebar shows the 'Cool Project' workspace with a 'cool-repo' repository. The main editor area shows the 'README.md' file. A 'Dev environment' panel is open on the right, displaying a 'Getting Started' guide with download links for SSH and HTTPS. Red arrows point to the 'Start coding' button in the top right and the 'Dev environment' tab in the panel.

Getting Started

Download links:

SSH clone URL: `ssh://git@git.jetbrains.space/mycompany/cool-project/cool-repo.git`

HTTPS clone URL: `https://git.jetbrains.space/mycompany/cool-project/cool-repo.git`

These instructions will get you a copy of the project up and running on your local machine for development and testing purposes.

Tools for C++ painpoints

–

#8 Thread, memory, and type safety

Painkillers

- Data Flow Static Analysis
- Sanitizers
- Valgrind

Tools for C++ painpoints

DFA: lifetime safety

```
void sample() {  
    int *p = nullptr;  
    {  
        int x = 0;  
        p = &x;  
        std::cout << *p;  
    }  
    std::cout << *p;  
}
```

Local variable 'p' may point to memory which is out of scope

int *p = nullptr

Tools for C++ painpoints

DFA: lifetime safety

```
const char *sample() {  
    auto string = std::string("text");  
    auto view = std::string_view(string);  
    auto ptr = view.begin();  
    return ptr;  
}
```

The address of the local variable 'view' may escape the function

```
const char *ptr = view.begin()
```

Tools for C++ painpoints

DFA: bounds safety

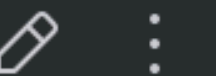
```
class Test {  
    static const int width = 200;  
    static const int height = 100;  
  
    int matrix[height][width];  
  
public:  
    void test() {  
        for (int i = 0; i < width; i ++)  
            for (int j = 0; j < height; j ++)  
                matrix[i][j] = 0;  
    }  
};
```

Index may have a value of '100' which is out of bounds

Declared in: arrayIndexOutOfBounds.cpp

private:

int[height][width] Test::matrix



Tools for C++ painpoints

DFA: Use-after-delete/free

```
static void delete_ptr(int *ptr) {  
    delete ptr;  
}
```

```
int handle_pointer() {  
    int* int_ptr = new int;  
  
    delete_ptr(int_ptr);  
    *int_ptr = 1;  
  
    return 0;  
}
```

Local variable 'int_ptr' may point to deallocated memory

`int *int_ptr = new int`

Tools for C++ painpoints

DFA: NULL dereferencing

```
class Deref {  
    int* foo() {  
        return nullptr;  
    }  
  
public:  
    void bar() {  
        int* buffer = foo();  
        buffer[0] = 0;  
    }  
};
```

Pointer may be null

`int *Deref::buffer = foo()`



Tools for C++ painpoints

-

+

Makefiles

MSBuild

Debug

C++ modernisation

<i>Which of these do you find frustrating about C++ dev?</i>	<i>Major %</i>
Managing libraries my application depends on	45 %
Build times	43 %
Setting up a CI pipeline from scratch	30 %
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Security issues: disclosure, vulnerabilities, exploits	12 %
Type safety: Using an object as the wrong type	12 %
Memory safety: Memory leaks	12 %
Moving existing code to the latest language standard	9 %

Tools for C++ painpoints

–

Tools build a **safe environment** for C++ developers where they can simply focus on **ideas** and **code** them.

C++ Painkillers stories

–

Story #2

“Your data w/o your tools”

Your data w/o your tools

—

```
    ide1: BM-DMA at 0xc008-0xc00f, BIOS settings: hdc:pio, hdd:pio
ne2k-pci.c:v1.03 9/22/2003 D. Becker/P. Gortmaker
    http://www.scyld.com/network/ne2k-pci.html
hda: QEMU HARDDISK, ATA DISK drive
ide0 at 0x1f0-0x1f7,0x3f6 on irq 14
hdc: QEMU CD-ROM, ATAPI CD/DVD-ROM drive
ide1 at 0x170-0x177,0x376 on irq 15
ACPI: PCI Interrupt Link [LNKC] enabled at IRQ 10
ACPI: PCI Interrupt 0000:00:03.0[A] -> Link [LNKC] -> GSI 10 (level, low) -> IRQ
    10
eth0: RealTek RTL-8029 found at 0xc100, IRQ 10, 52:54:00:12:34:56.
hda: max request size: 512KiB
hda: 180224 sectors (92 MB) w/256KiB Cache, CHS=178/255/63, (U)DMA
hda: set_multmode: status=0x41 { DriveReady Error }
hda: set_multmode: error=0x04 { DriveStatusError }
ide: failed opcode was: 0xef
hda: cache flushes supported
    hda: hda1
hdc: ATAPI 4X CD-ROM drive, 512kB Cache, (U)DMA
Uniform CD-ROM driver Revision: 3.20
Done.
Begin: Mounting root file system... .
/init: /init: 151: Syntax error: 0xforce=panic
Kernel panic - not syncing: Attempted to kill init!
```

—

C++ Painkillers

—

1. Stories about the tools
2. Why this talk
3. Vitamin, Painkiller, or Cure?
4. Where and when do tools help
5. C++ toolability
6. Tools for C++ painpoints
7. Start thinking about tools earlier
8. Era of AI

Tools and language evolution

–

SG15, Tooling

Topics related to creation of developer tools for standard C++, including but not limited to modules and package management.

Tools and language evolution

–

Many new C++ language features now
start with **Clang-based** implementation

Tools and language evolution

—

C++20

Modules

Modules (since C++20)

Most C++ projects use multiple translation units, and so they need to share [declarations](#) and [definitions](#) across those units. The usage of [headers](#) is prominent for this purpose, an example being the [standard library](#) whose declarations can be provided by [including the corresponding header](#).

Modules are a language feature to share declarations and definitions across translation units. They are an alternative to some use cases of headers.

Modules are orthogonal to [namespaces](#).

```
// helloworld.cpp
export module helloworld; // module declaration

import <iostream>;        // import declaration

export void hello()      // export declaration
{
    std::cout << "Hello world!\n";
}
```

```
// main.cpp
import helloworld; // import declaration

int main()
{
    hello();
}
```

Tools and language evolution: Modules

–

CMake + VS generator

```
add_executable(ModuleSample a.ixx main.cpp)
```

Tools and language evolution: Modules

CMake +

GCC/Clang compiler flags

```
function(add_module name)
    file(MAKE_DIRECTORY ${PREBUILT_MODULE_PATH})
    add_custom_target(${name}.pcm
        COMMAND
        ${CMAKE_CXX_COMPILER}
        -std=gnu++20
        -x c++
        -fmodules
        -c
        ${CMAKE_CURRENT_SOURCE_DIR}/${ARGN}
        -Xclang -emit-module-interface
        -o ${PREBUILT_MODULE_PATH}/${name}.pcm
    )
endfunction()
```


Tools and language evolution: Modules

—

Natively in CMake 3.25

([CMake examples](#))

```
add_executable(simple)
target_sources(simple
    PRIVATE
        main.cxx
    PRIVATE
        FILE_SET CXX_MODULES
        BASE_DIRS
            "${CMAKE_CURRENT_SOURCE_DIR}"
        FILES
            importable.cxx)
target_compile_features(simple PUBLIC cxx_std_20)

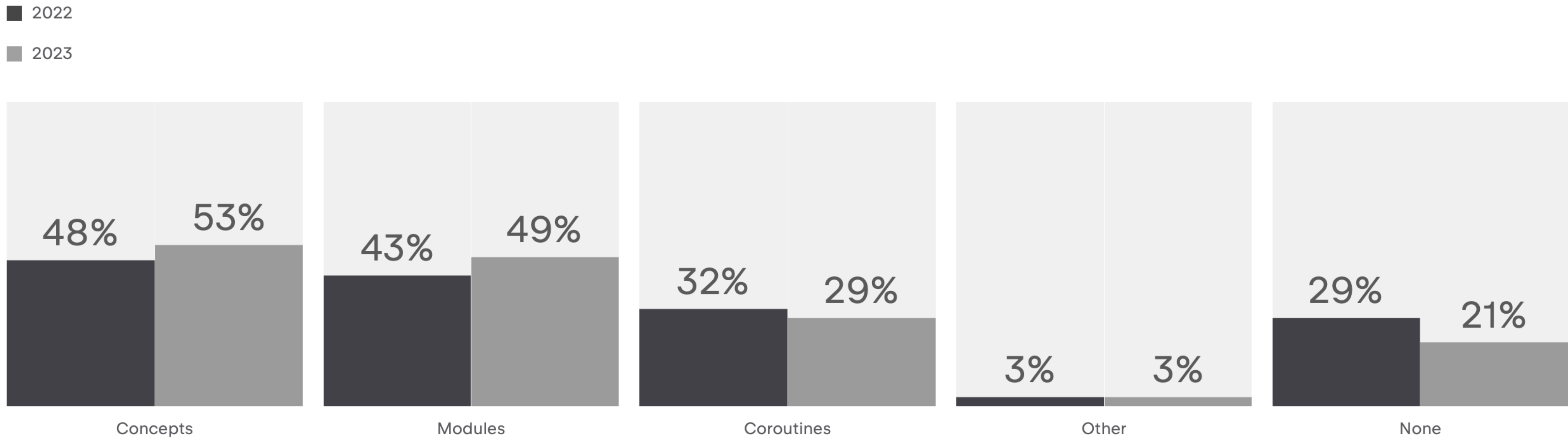
add_test(NAME simple COMMAND simple)
```


Tools and language evolution: Modules

CMake 3.26: support for modules was added
into file-api

Tools and language evolution: Modules

Is your current project planning to use any of the following C++20 features in the next 12 months?



Tools and language evolution: Contracts

C++26 ?
Contracts

```
#include <cassert>
```

```
void f(int p) {  
    assert(p > 7);
```

```
    if (p == 6) {
```

```
        //d
```

```
    } else
```

```
        //d
```

```
    }
```

```
}
```

Condition is always false

Simplify 'if' statement

More actions...

Tools and language evolution: Reflection

C++26 ?
Reflection



P2996: Reflection for C++26

1. Reflection Operator (^)
2. Splicers ([: ... :])
3. std::meta::info
4. Metafunctions
 1. Name & Location:
 1. name_of
 2. qualified_name_of
 3. display_name_of
 4. source_location_of
 2. Type Queries:
 1. type_of
 2. parent_of
 3. dealias
 - (+ Other Type Predicates)
 4. Access modifiers: is_public, is_protected, is_private
 5. Inheritance: is_virtual, is_pure_virtual, is_override, ...
 6. Encapsulation: is_class_member, is_namespace_member, is_deleted, ...
 7. Advanced Type Queries: is_incomplete_type, is_template, is_special_member, ...
3. Template Queries:
 1. template_of
 2. template_arguments_of
4. Member Queries:
 1. member_of
 2. bases_of
 3. (non) static_data_member_of
 4. subobject_of
 5. enumerators_of
5. substitute (template)
6. reflect Invoke
7. value_of<T> (meta object)
8. test_type(s) ("is_same")
9. reflect_value (operand)
10. define_class (injection)
11. Data Layout:
 1. offset_of
 2. size_of
 3. bit_offset_of
 4. bit_size_of
 5. alignment_of
12. (+) Type Traits...?

Tools and language evolution: Reflection

C++26 ?

Reflection

```
struct TU_Ticket {  
    static constexpr int next() {  
        // ...  
    }  
};
```

```
void a() {  
    TU_Ticket::next();  
}
```

```
std::integral_constant<int, TU_Ticket::next()> b();
```

<https://lists.isocpp.org/sg7/2024/02/0480.php>

Tools and language evolution

—

P2656

C++ Ecosystem International Standard

Users should be able to **mix and match their preferred** build systems, compilers, linkers, package managers, static analyzers, runtime analyzers, debuggers, profilers, etc. without needing the tools to have vendor specific knowledge of each other. Vendors should be able to **focus on direct tool improvements**, rather than figuring out how to interact with yet another proprietary interface.

1. Definitions.
2. Build System $\Leftrightarrow$ Package Manager Interoperation.
3. Minimum set of recognized file extensions.
4. Tool introspection.
5. Portable diagnostics format via SARIF.
6. Command line portability.

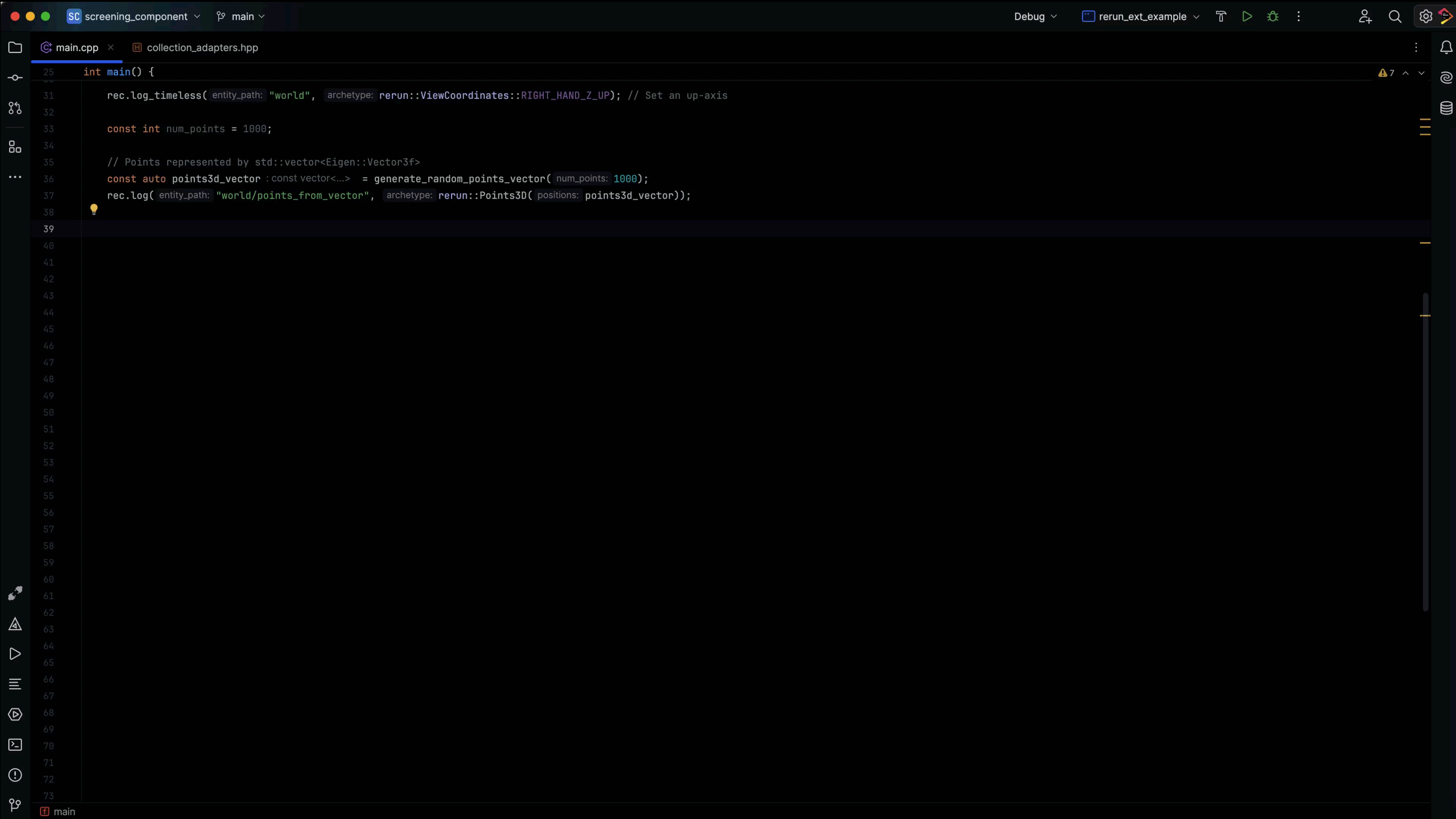
C++ Painkillers

—

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8. Era of AI

Era of AI

Writing
context-aware
code



Era of AI

—

Improving the code

```
main.cpp x
1  #include <array>
2  #include <iostream>
3
4  int main() {
5      constexpr std::array Numbers{1, 3, 5, 6, 7, 9, 10, 11, 13};
6
7      size_t oddNumberCount = 0;
8      for (auto &number : const int & : Numbers) {
9          if (number % 2) {
10             oddNumberCount++;
11         }
12     }
13
14     std::cout << oddNumberCount;
15
16     return 0;
17 }
18
```

Era of AI

—

Summarizing for
VCS or documentation

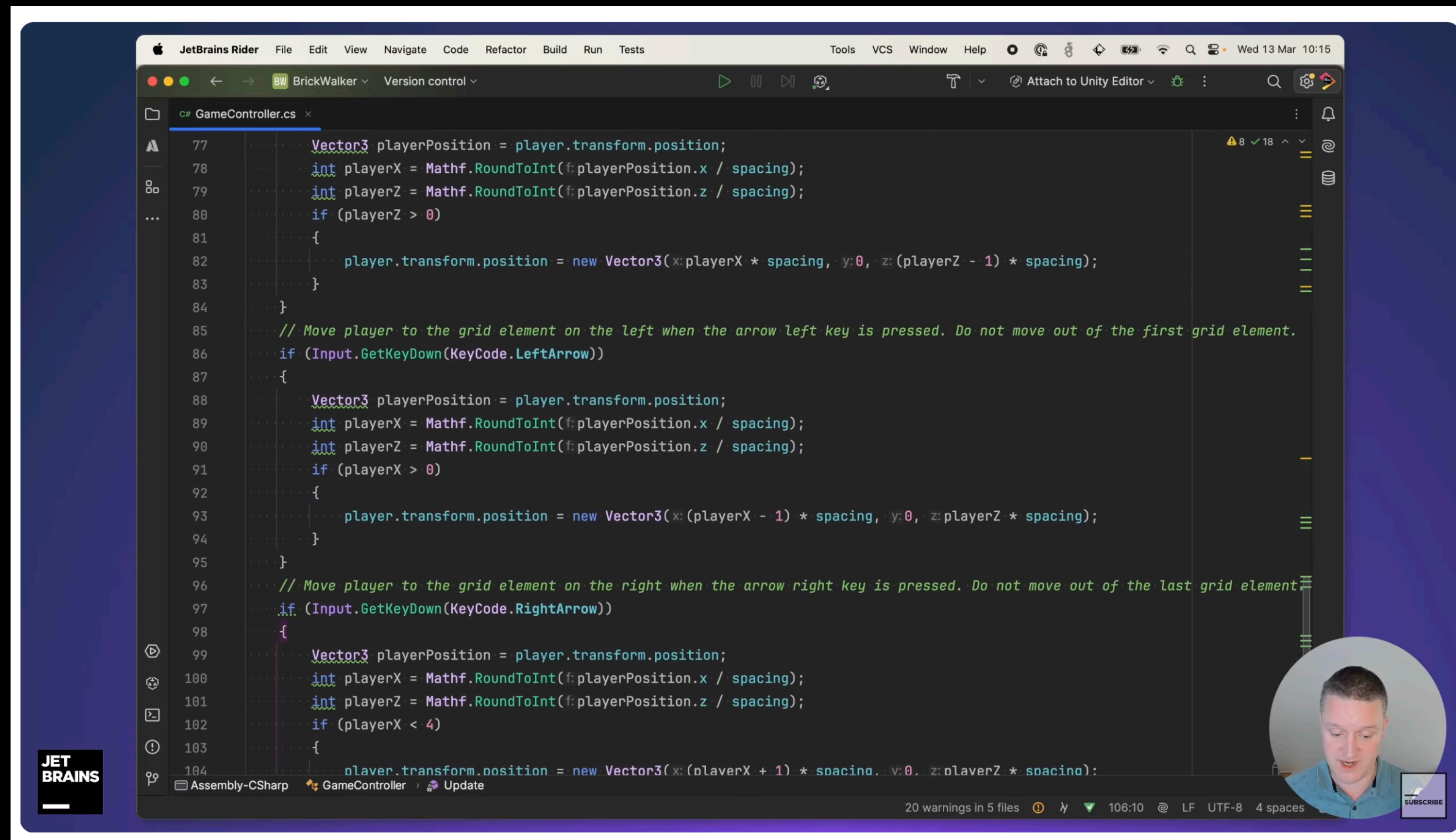
```
Collisions.cpp ×
7      if (ballBB.top() < bounding.top()) return Top;
8      return None;
9  }
10
11  → ← CollisionType getCollisionWithBrick(const Ball& b, const QRectF& brick)
12      auto ballBB:QRectF = b.aabb();
13      auto inters:QRectF = ballBB.intersected(brick);
14      if (inters.isEmpty()) {
15          return None;
16      }
17      else {
18          if (inters.width() > inters.height()){
19              if(inters.center().y()<ballBB.center().y()) {
20                  return Top;
21              }
22              else
23              {
24                  return Bottom;
25              }
```

Era of AI: real-world examples

How Copilot is being used by the Time Travel Debugging team for repetitive C++ coding © Microsoft

Can I script a Unity Game with AI Assistant in under 15 minutes? ©

Maarten Balliauw, JetBrains



Era of AI: real-world examples

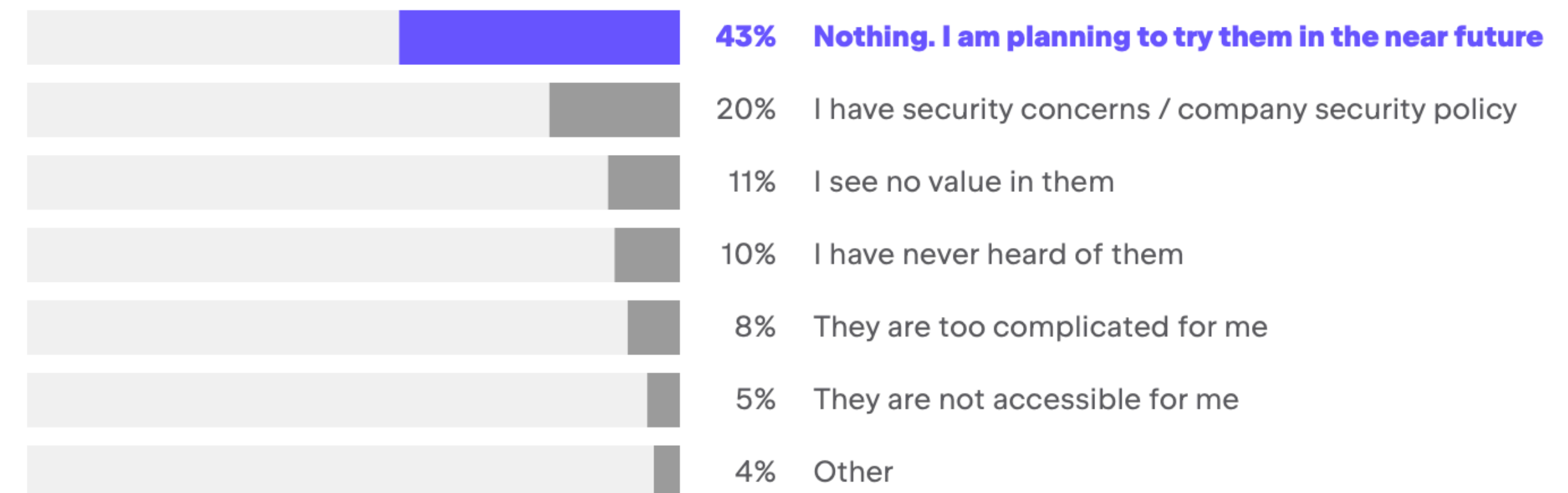
GDC: Are generative AI tools being used at your company or department?

49% Generative AI tools are currently being used in their company

31% personally use Generative AI tools

21% of AAA developers said their companies have banned the use of such tools. Compared to **9%** indie.

What stops you from learning about generative AI tools?



*This question was shown only to the developers who chose "None" in the previous question.

C++ Painkillers

—

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8. Era of AI
9. Questions