C++ and Game Development: the Good, the Bad, and the Ugly

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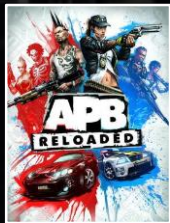Italian C++ Conference 2023
June 10, Rome

About Me

Previously C.T.O. at **IOI Interactive**

In AAA game development since 2008:
　　　Realtime Worlds, IO Interactive, Ubisoft Montreal

Released Titles: APB (2010), Hitman Absolution (2012),
Rainbow 6 Siege (2015), Hitman Trilogy (2016, 2018, 2021)

Speaker at International Gaming Conferences:
GDC 2013, CEDEC 2013, GDC 2016, 4C 2017, 4C 2018

Ph.D. in Computer Engineering, Robotics
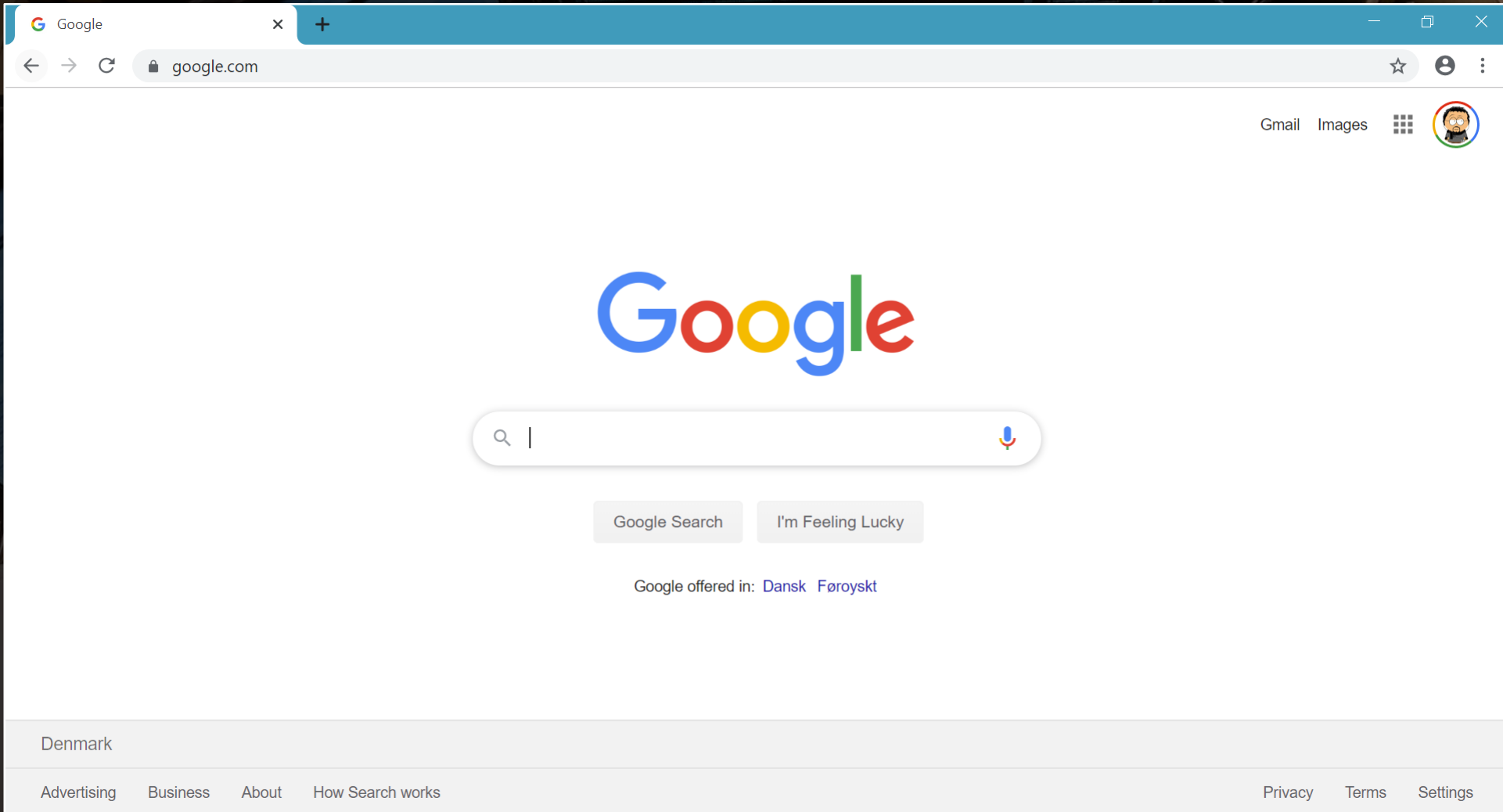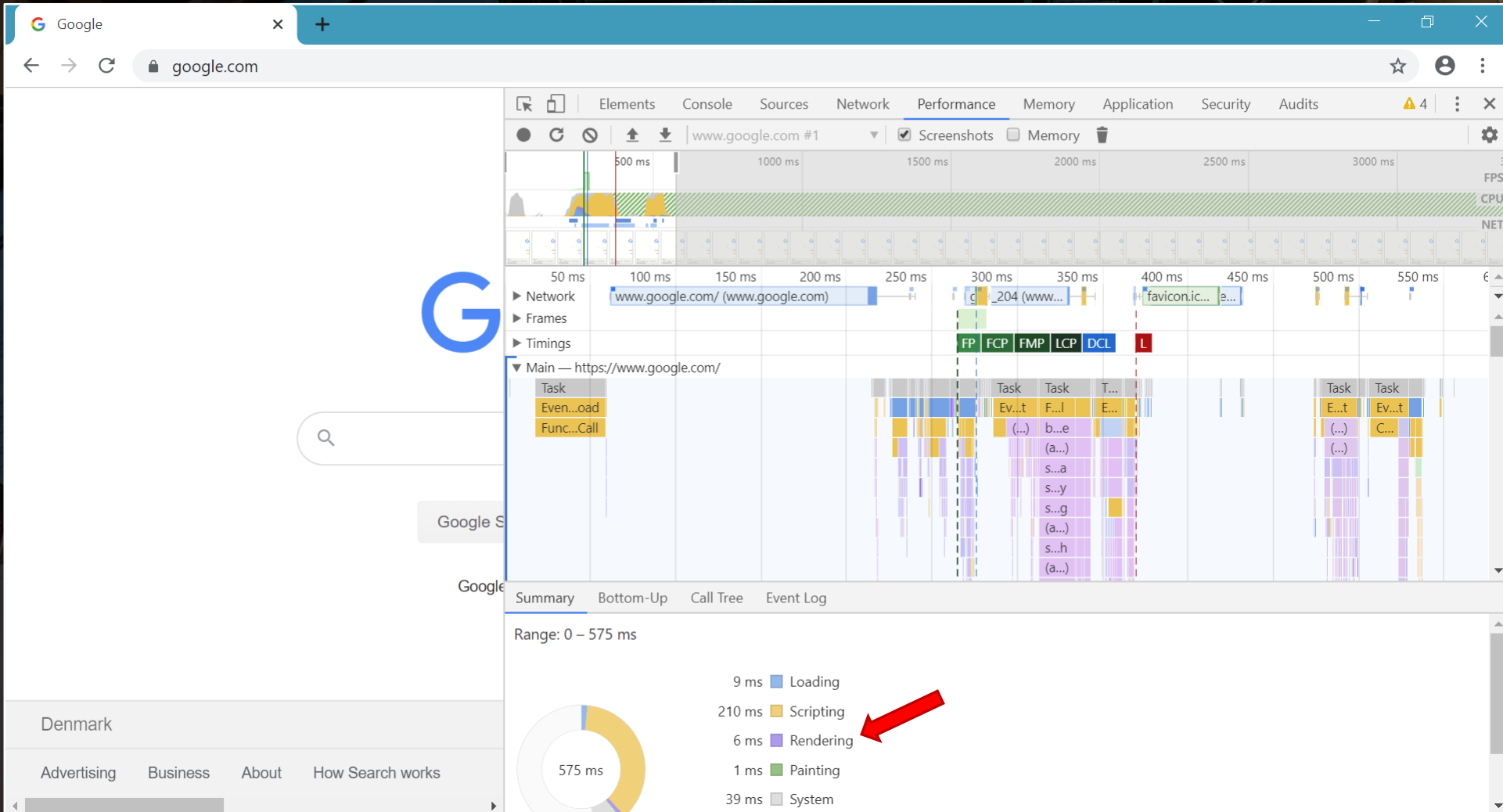Coding in C++ since 1997, in C# since 2008

Game Development

Game Development
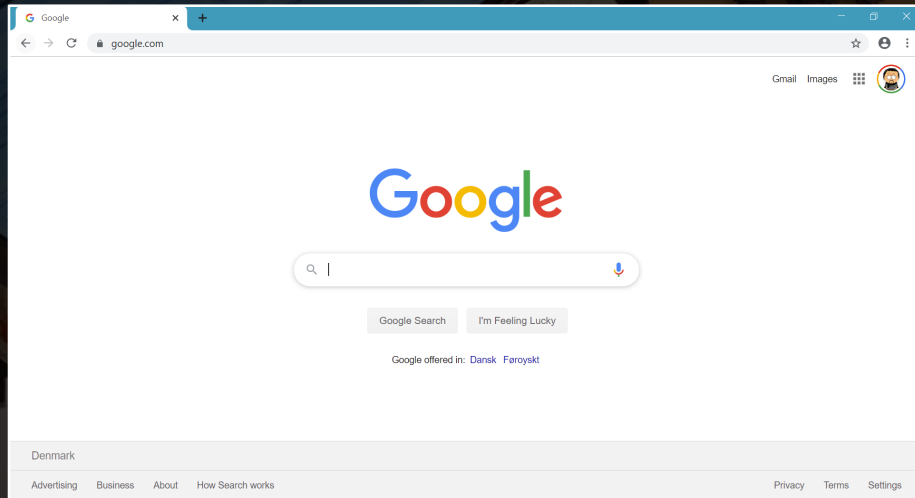
Game Development
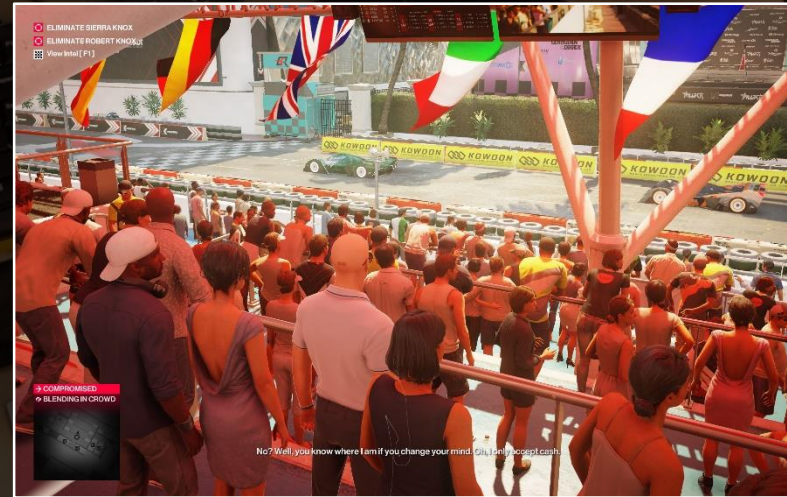
Game Development

Game Development

Game Development

7ms

16ms

Game Development

21ms
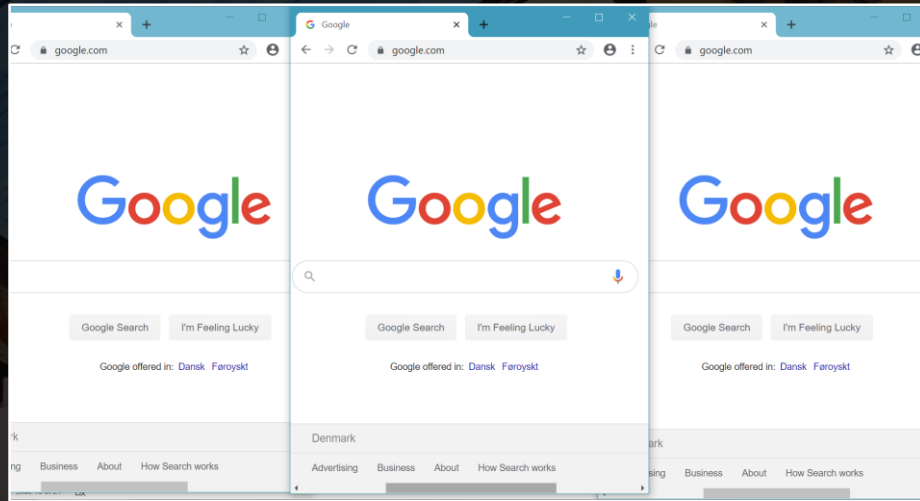
16ms
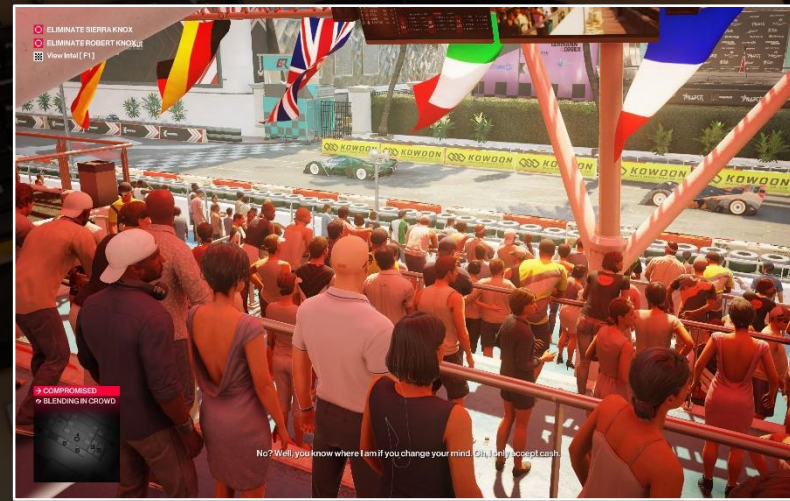
Games vs Web/App Development

Games

◦ Perf is king

◦ ns - ms

◦ 30-120 FPS

◦ Native, Strongly Typed Languages

Web / Apps

◦ Perf what?!?

◦ ms – secs

◦ 50ms responsive

◦ Wrongly Typed Languages

Games Programming

Hardware and Dev Environment

Soft Realtime Embedded

x64 CPUs since 2013

Both Major consoles have converged to a PC

Memory savvy

Windows dominated

Visual Studio

Dev Methodologies and Adoption

Used to be one-shot development

Now largely transitioned to serviced

Late adopters of new programming trends
- using Assembly while world was on C
- using C while world was on C++
- still using C++ while world is trying out new things...

Games Programming

Extreme Performance Requirements

Efficient Memory Usage

Extremely Iterative Development

Constant need to innovate

Large Expensive Productions

Milestones and Deadlines driven

Software to make software

Game Engine

- Actual runtime running a game
- Set of tools to create the game
  - World Editor
  - Build System
  - Data Processing Pipeline
  - Scripting Language

Commercial Game Engines

- Unreal (AAA)
- Unity (Mobile / Indie)

Engine Adoption by Studio Size

Small (1 - 50)
◦ Unity

Medium (50 - 200)
◦ Unreal
◦ Custom Engines

Large (200 – std::numeric_limits<int64_t>::max())
◦ Unreal
◦ Company-Wide Engines

Programmers in the games industry

Game Programmers, C++

Engine & Tools Programmers, C++ / C#

Render Programmers, C/C++

Online Programmers, C#

…

Languages

Engine
◦ C++, C, Assembly, C#

Scripting
◦ Lua
◦ Custom Script Languages
◦ Visual Scripting

Tools
◦ C++, C#, Web stuff

C++ in games development

C++ YES

Templates

Lambda

Move semantics

Auto

Algorithms

Variadic Templates

C++ NO

STL

Exceptions

RTTI

Boost

libraries

C++ DYI

Reflection

Codegen

SoA

Hot Reloading

Garbage Collection

Task Library / Graph Library
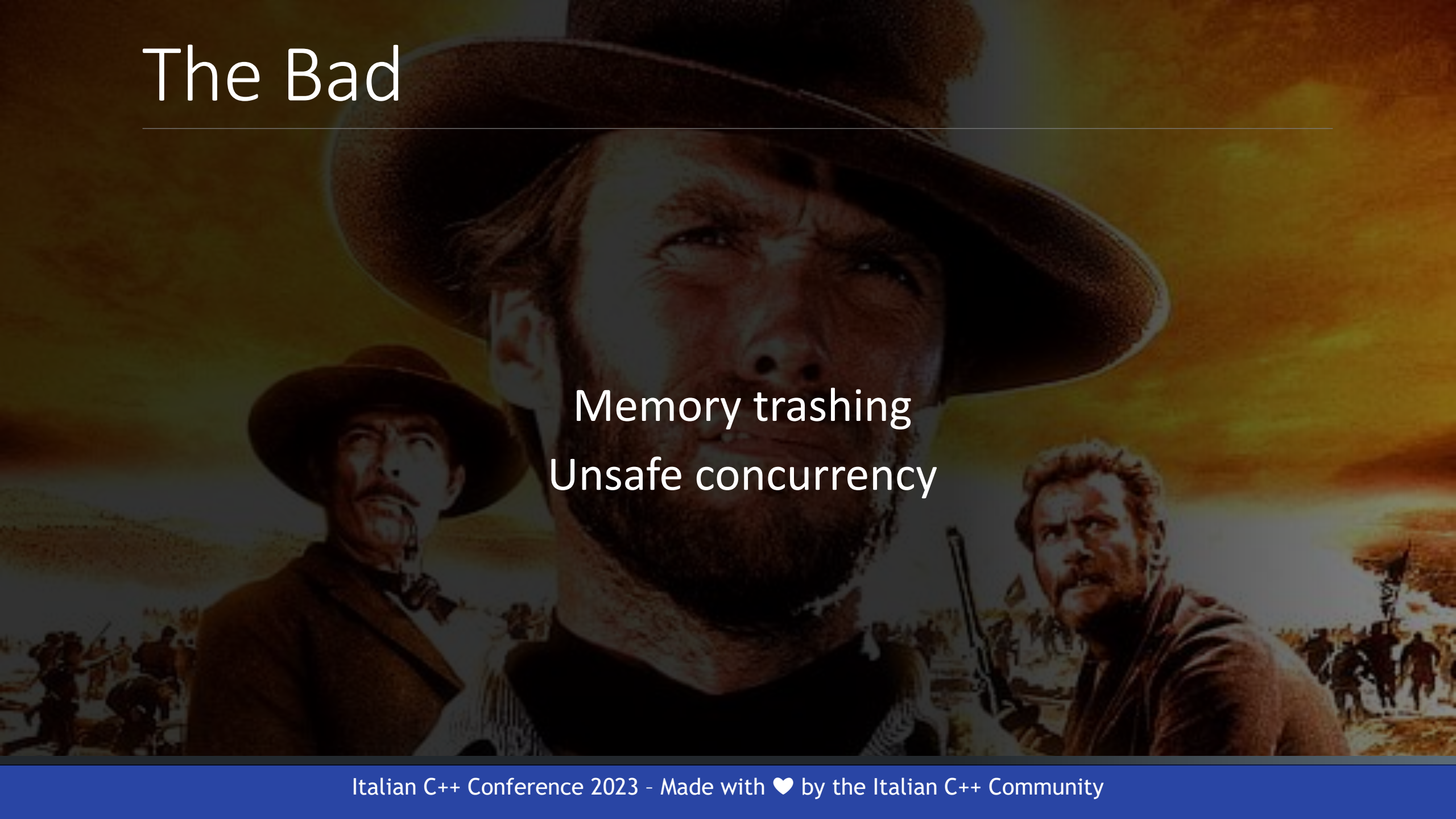
The Good, The Bad, The Ugly

The Good

C++ is still the dominant language for game development

It's improving at a decent pace

The Bad

Memory trashing

Unsafe concurrency

The Ugly

Compile Times ☹
Compile Times ☹
Compile Times ☹

G2 Codebase

```
k:\Small Apps>cloc-1.64.exe d:\W\3\PRJ_PRO\main\code
    44571 text files.
    35334 unique files.
    24152 files ignored.

2 errors:
Unable to read:  d:\W\3\PRJ_PRO\main\code\_build/engine.VC.VC.opendb
Unable to read:  d:\W\3\PRJ_PRO\main\code\_build/engine.VC.VC.opendb

http://cloc.sourceforge.net v 1.64  T=254.64 s (109.6 files/s, 28540.6 lines/s)
-------------------------------------------------------------------------------
Language                          files        blank       comment          code
-------------------------------------------------------------------------------
C++                                5703       337620        257175       2229704
C#                                 7699       206868        110538       1070434
C/C++ Header                       7923       186410        146058        670863
XML                                 222         1915           468        529389
Javascript                         1246        84555        168651        456384
JSON                                449           88             0        115554
CSS                                 293        12478          3732        107143
HTML                                969        25796           277        100643
XSD                                  62          294           452         92116
MSBuild script                      594            7          3765         90789
C                                    92         5302          3842         46095
Lua                                 780        10597          8328         42058
XAML                                186         2286           559         23233
ASP.Net                             505          784            21         20136
Java                                224         2918           762         13810
PowerShell                          121         2630          1234         11032
Razor                               177          778            92          9039
OpenCL                               14         2438          1958          8773
Assembly                             27          804          1326          5239
Python                               67         1145          1069          4801
SQL                                 152          238           168          3746
LESS                                 31          147           105          3376
SASS                                 29           67            56          3228
Pig Latin                            17          368            40          1734
DOS Batch                           161          350            80          1515
Perl                                  2          206           213          1337
```

CLOC claims:
   ~5700 source files
   ~7700 header files

Total: ~3M lines of C++

0.7M lines in headers
2.2M lines in sources

~32% of code in headers
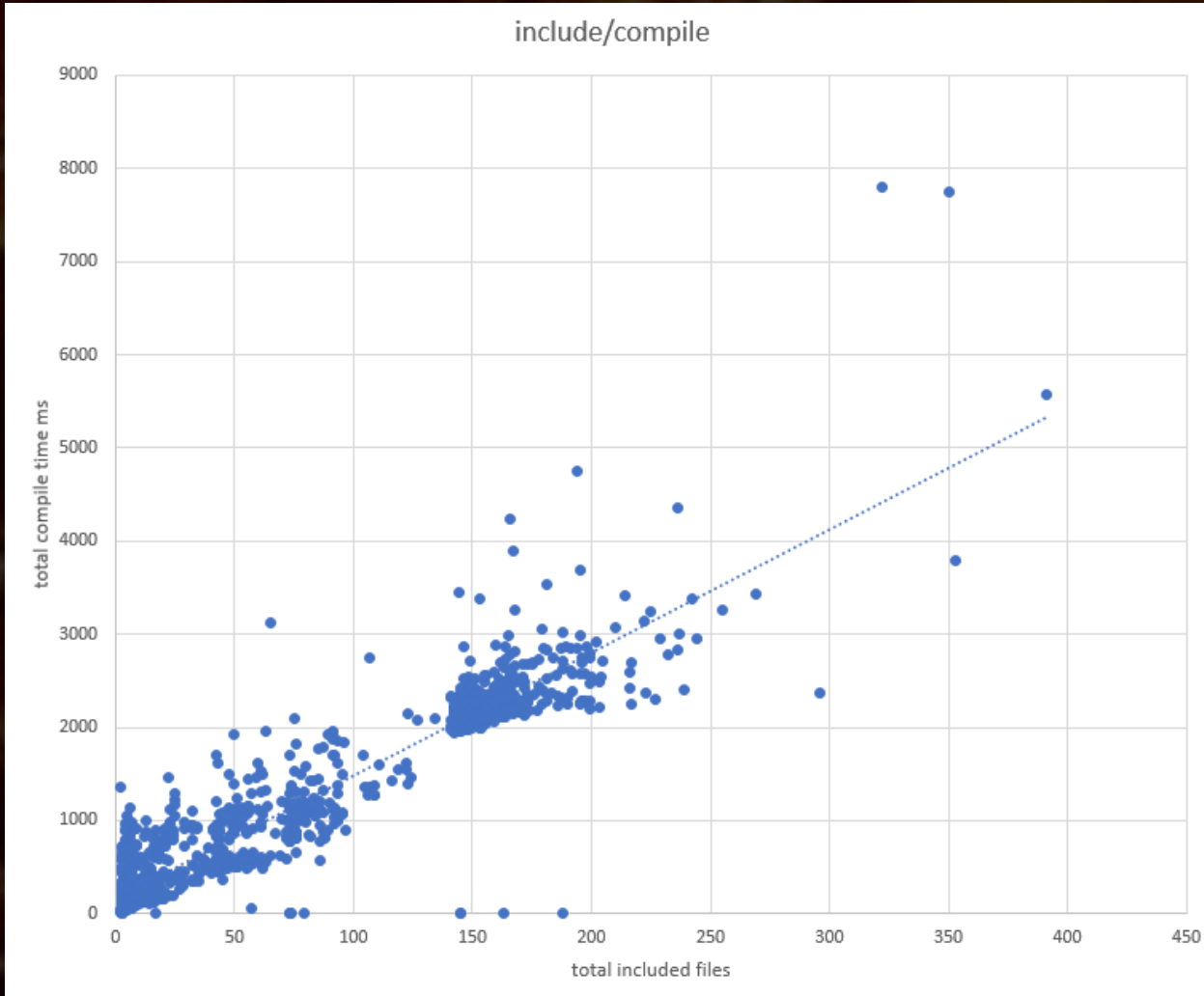
Case Study: HM2 Gameplay Code

HITMAN.DLL

Sources:1481 lines:510796

(avg: 350 lines)

Headers:2411 lines:249341

(avg: 100 lines)

1 line in header every 3 lines of code
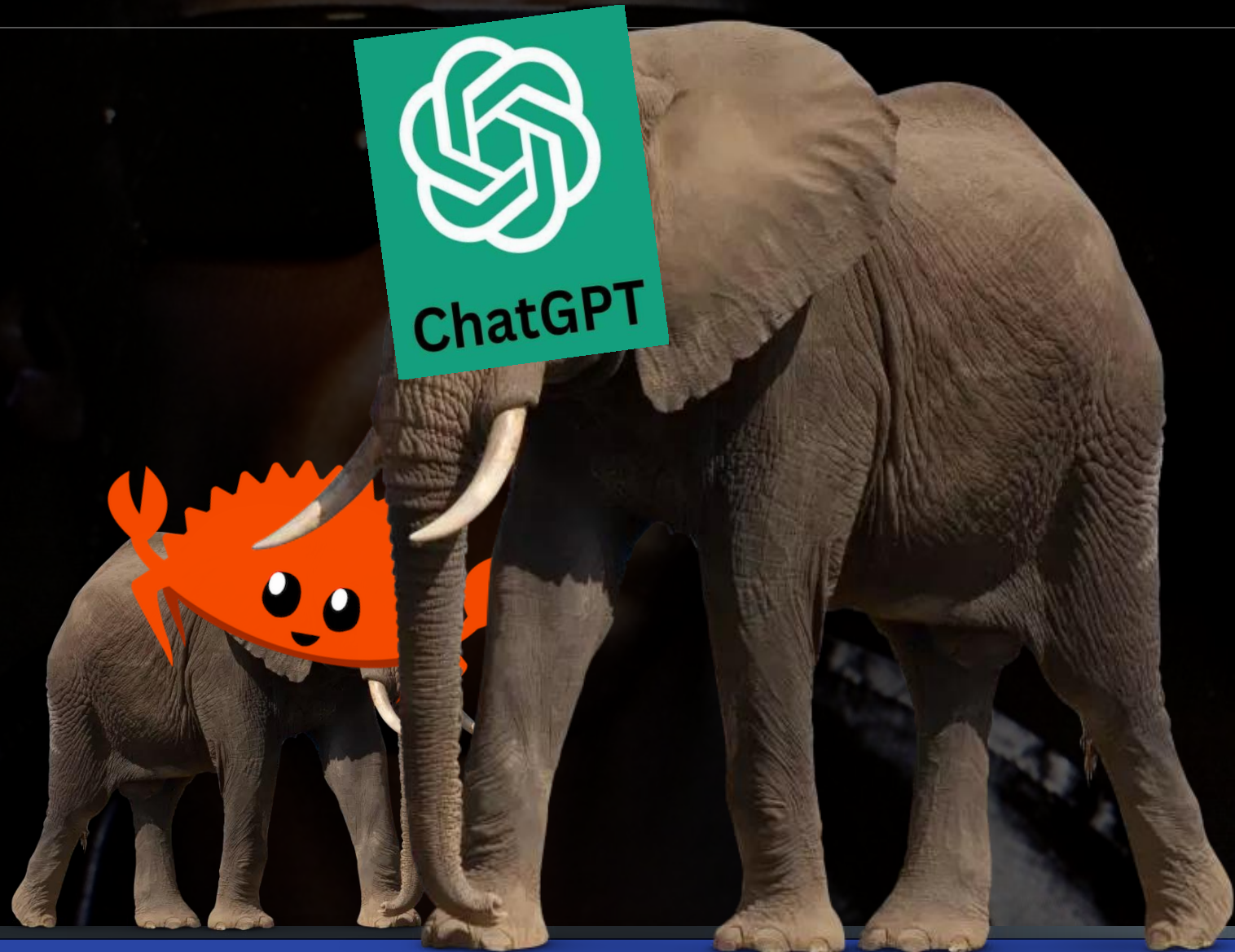
On Headers and Compile Time

Linear correlation between total compile times and number of headers included (both directly, and indirectly through other includes)

Future of C++
in Game Development

The Elephant in the room

Will C++ be replaced in games?

Yes, but not any time soon

The competitor's ecosystem is not ready

e.g. Embark Studios is work on a game/engine in Rust...

...yet their next games will ship on Unreal in C++

Italian C++ Community
www.italiancpp.org

Q&A

linkedin.com/in/mauriziodepascale

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