Invisible Problems

On the job

Let’s imagine being a C++ programmer

We are ok with the language, but not super secure

We are tasked with upgrading a part of an older system

And in the section we are now, the best solution is a struct with two integers

Lets do this

```
struct VeryImportant
{
    int myOne;
    int myTwo;
};
```


“Please make sure everything is correctly initialized, we can’t have junk values here!”

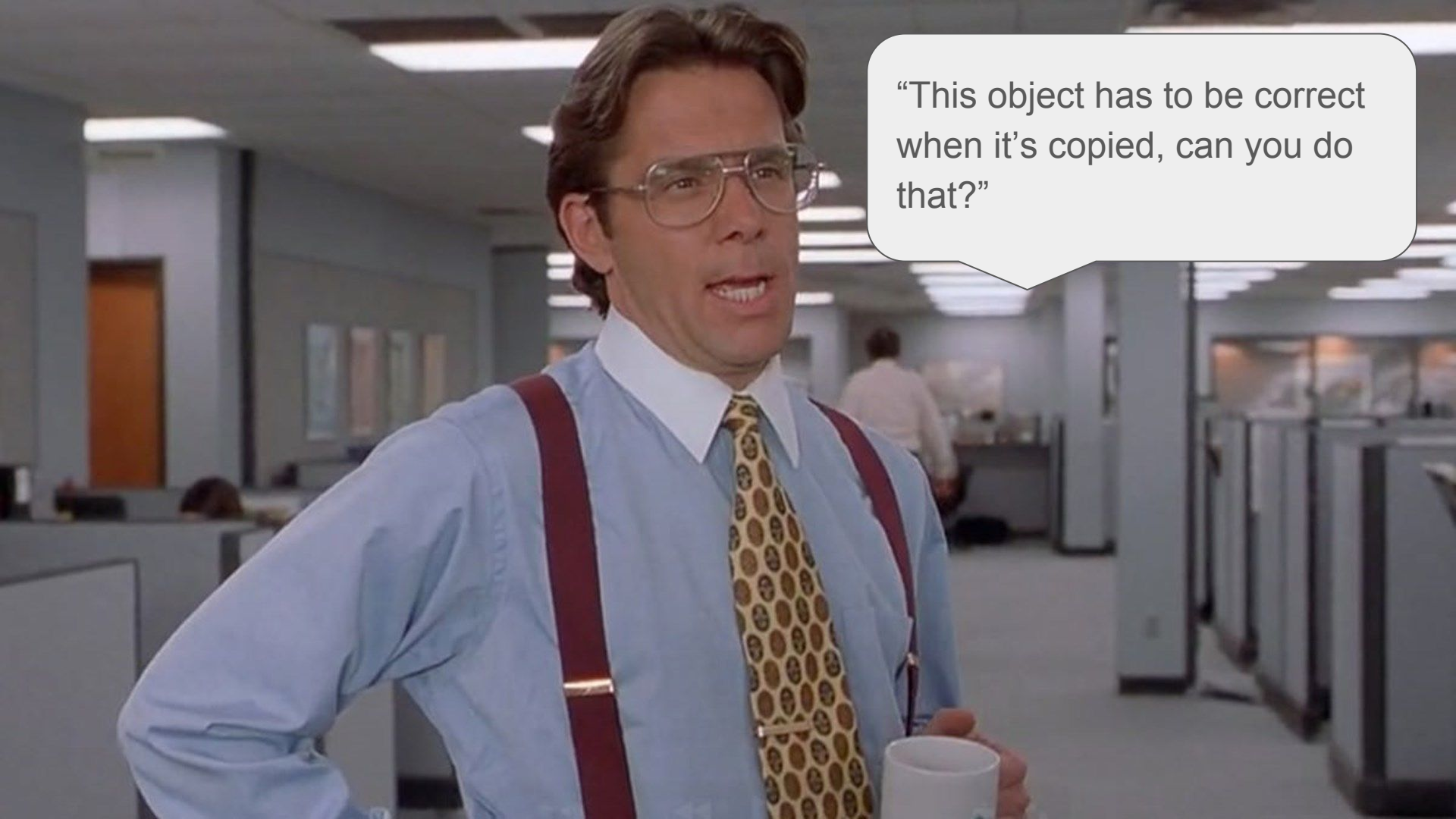
Zero is default? Right?

```
struct VeryImportant
{
    int myOne;
    int myTwo;
    VeryImportant(): myOne(0), myTwo(0) {}
};
```


“I want to be able to set the values when I create the object!”

We got this!

```
struct VeryImportant
{
    int myOne;
    int myTwo;
    VeryImportant(): myOne(0), myTwo(0) {}
    VeryImportant(int aOne, int aTwo)
        : myOne(aOne), myTwo(aTwo) {}
};
```


“This object has to be correct when it’s copied, can you do that?”

The rule of how many?

```
struct VeryImportant
{
     int myOne;
     int myTwo;
     VeryImportant(): myOne(0), myTwo(0) {}
     VeryImportant(int aOne, int aTwo): myOne(aOne), myTwo(aTwo) {}
     VeryImportant(const VeryImportant& aVery)
          : myOne(aVery.myOne), myTwo(aVery.myTwo) {}
     VeryImportant& operator=(const VeryImportant& aVery)
     {
          myOne = aVery.myOne;
          myTwo = aVery.myTwo;
          return *this;
     }
};
```


“We upgraded to the new compiler, it supports move semantics, can you make sure everything is movable?”

```
struct VeryImportant
{
     int myOne;
     int myTwo;
     VeryImportant(): myOne(0), myTwo(0) {}
     VeryImportant(int aOne, int aTwo): myOne(aOne), myTwo(aTwo) {}
     VeryImportant(const VeryImportant& aVery)
          : myOne(aVery.myOne), myTwo(aVery.myTwo) {}
     VeryImportant& operator=(const VeryImportant& aVery)
     {
          myOne = aVery.myOne;
          myTwo = aVery.myTwo;
          return *this;
     }
     VeryImportant(VeryImportant&& aVery)
          : myOne(aVery.myOne), myTwo(aVery.myTwo) {}
     VeryImportant& operator=(VeryImportant&& aVery)
     {
          myOne = aVery.myOne;
          myTwo = aVery.myTwo;
          return *this;
     }
};
```


“Why is our new VeryImportant struct slower than our old library?”

Searching starts

You look over your code, nothing

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You look over your code, nothing

You look at all the call sites, nothing

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You start doing git blame diffs, nothing

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You start doing git blame diffs, nothing

You go into assembly...

```
404dc4          callq  403720 <memcpy@plt>
```

“Why is my code slow?”

You start googling something like that

Sprinkle in memcpy and structs

A certain word keeps popping up

“Why is my code slow?”

You start googling something like that

Sprinkle in memcpy and structs

A certain word keeps popping up

Trivial

“Objects of trivially-copyable types are the only C++ objects that may be safely copied with std::memcpy”

C++ named requirements: *TriviallyCopyable*

Requirements

- Every copy constructor is trivial or deleted
- Every move constructor is trivial or deleted
- Every copy assignment operator is trivial or deleted
- Every move assignment operator is trivial or deleted
- at least one copy constructor, move constructor, copy assignment operator, or move assignment operator is non-deleted
- Trivial non-deleted destructor

This implies that the class has no virtual functions or virtual base classes.

```
struct VeryImportant
{
     int myOne;
     int myTwo;
     VeryImportant(): myOne(0), myTwo(0) {}
     VeryImportant(int aOne, int aTwo): myOne(aOne), myTwo(aTwo) {}
     VeryImportant(const VeryImportant& aVery)
          : myOne(aVery.myOne), myTwo(aVery.myTwo) {}
     VeryImportant& operator=(const VeryImportant& aVery)
     {
          myOne = aVery.myOne;
          myTwo = aVery.myTwo;
          return *this;
     }
     VeryImportant(VeryImportant&& aVery)
          : myOne(aVery.myOne), myTwo(aVery.myTwo) {}
     VeryImportant& operator=(VeryImportant&& aVery)
     {
          myOne = aVery.myOne;
          myTwo = aVery.myTwo;
          return *this;
     }
};
```

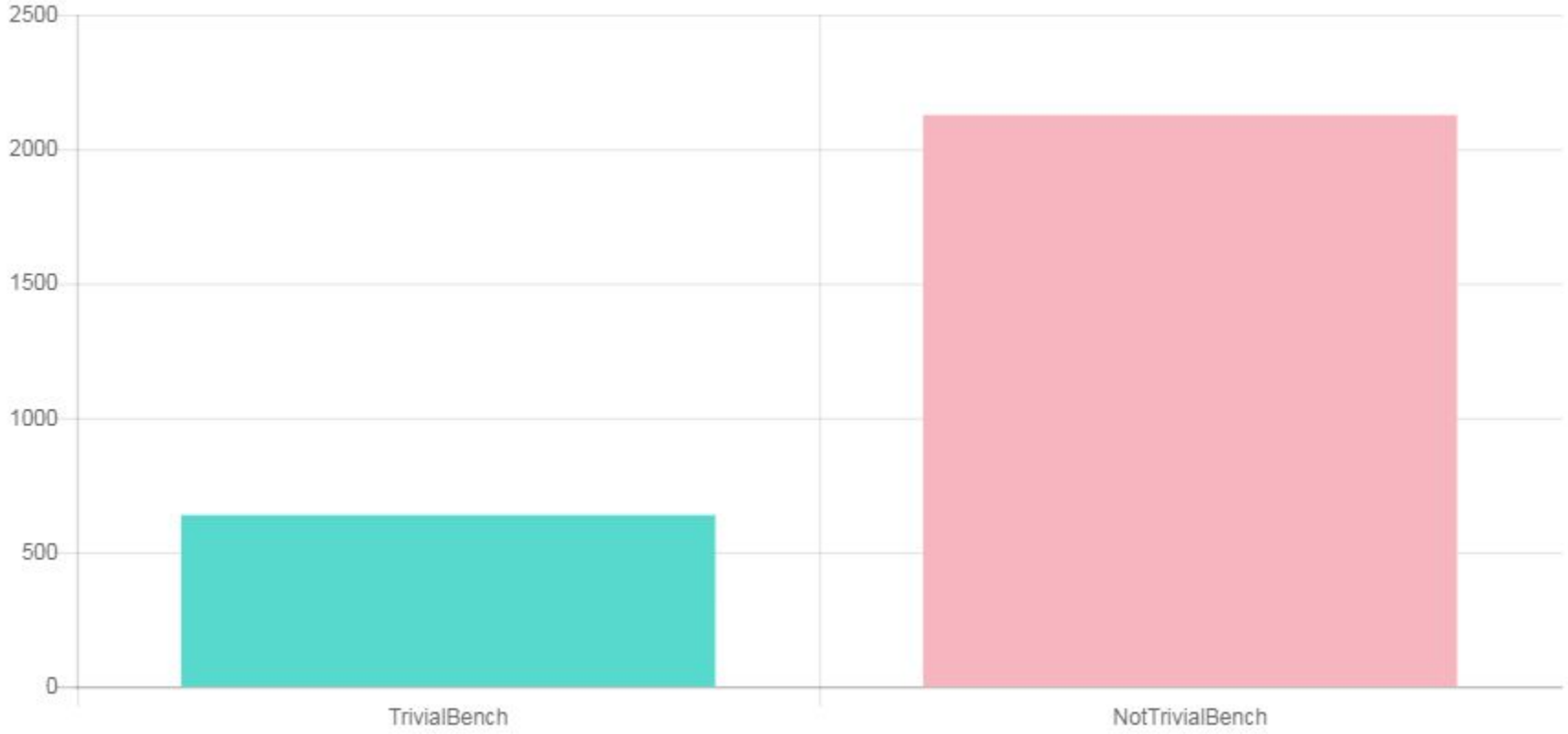
Trivial default constructor

The default constructor for class T is trivial (i.e. performs no action) if all of the following is true:

- The constructor is not user-provided (i.e., is implicitly-defined or defaulted on its first declaration)
- T has no virtual member functions
- T has no virtual base classes
- T has no non-static members with default initializers. (since C++11)
- Every direct base of T has a trivial default constructor
- Every non-static member of class type has a trivial default constructor

We’re back here

```
struct VeryImportant
{
    int myOne;
    int myTwo;
    VeryImportant(): myOne(0), myTwo(0) {}
    VeryImportant(int aOne, int aTwo): myOne(aOne), myTwo(aTwo) {}
};
```


2500
2000
1500
1000
500
0
TrivialBench
NotTrivialBench

The only healthy choice...

```
#define ENFORCE_TRIVIAL(t) \
static_assert(std::is_standard_layout_v<t>); \
static_assert(std::is_trivially_copyable_v<t>); \
static_assert(std::is_trivially_copy_assignable_v<t>); \
static_assert(std::is_trivially_copy_constructible_v<t>); \
static_assert(std::is_trivially_move_assignable_v<t>); \
static_assert(std::is_trivially_move_constructible_v<t>); \
static_assert(std::is_trivially_destructible_v<t>);

#define TRIVIAL_STRUCT(name, ...) \
struct name __VA_ARGS__; \
ENFORCE_TRIVIAL(name);
```

```
TRIVIAL_STRUCT(VeryImportant,
{
    int myOne;
    int myTwo;
    VeryImportant(): myOne(0), myTwo(0) {}
    VeryImportant(int aOne, int aTwo): myOne(aOne),
myTwo(aTwo) {}
});
```

My wish

```
struct [[bikeshed_trivially_copyable]] VeryImportant
{
    int myOne;
    int myTwo;
    VeryImportant(): myOne(0), myTwo(0) {}
    VeryImportant(int aOne, int aTwo)
        : myOne(aOne), myTwo(aTwo) {}
};
```

My wish

```
struct [[bikeshed_trivially_copyable]] VeryImportant
{
    int myOne;
    int myTwo;
    VeryImportant(): myOne(0), myTwo(0) {}
    VeryImportant(int aOne, int aTwo): myOne(aOne),
myTwo(aTwo) {}
    VeryImportant(const VeryImportant& aVery)
        : myOne(aVery.myOne), myTwo(aVery.myTwo) {}
    // Compile Error
};
```

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