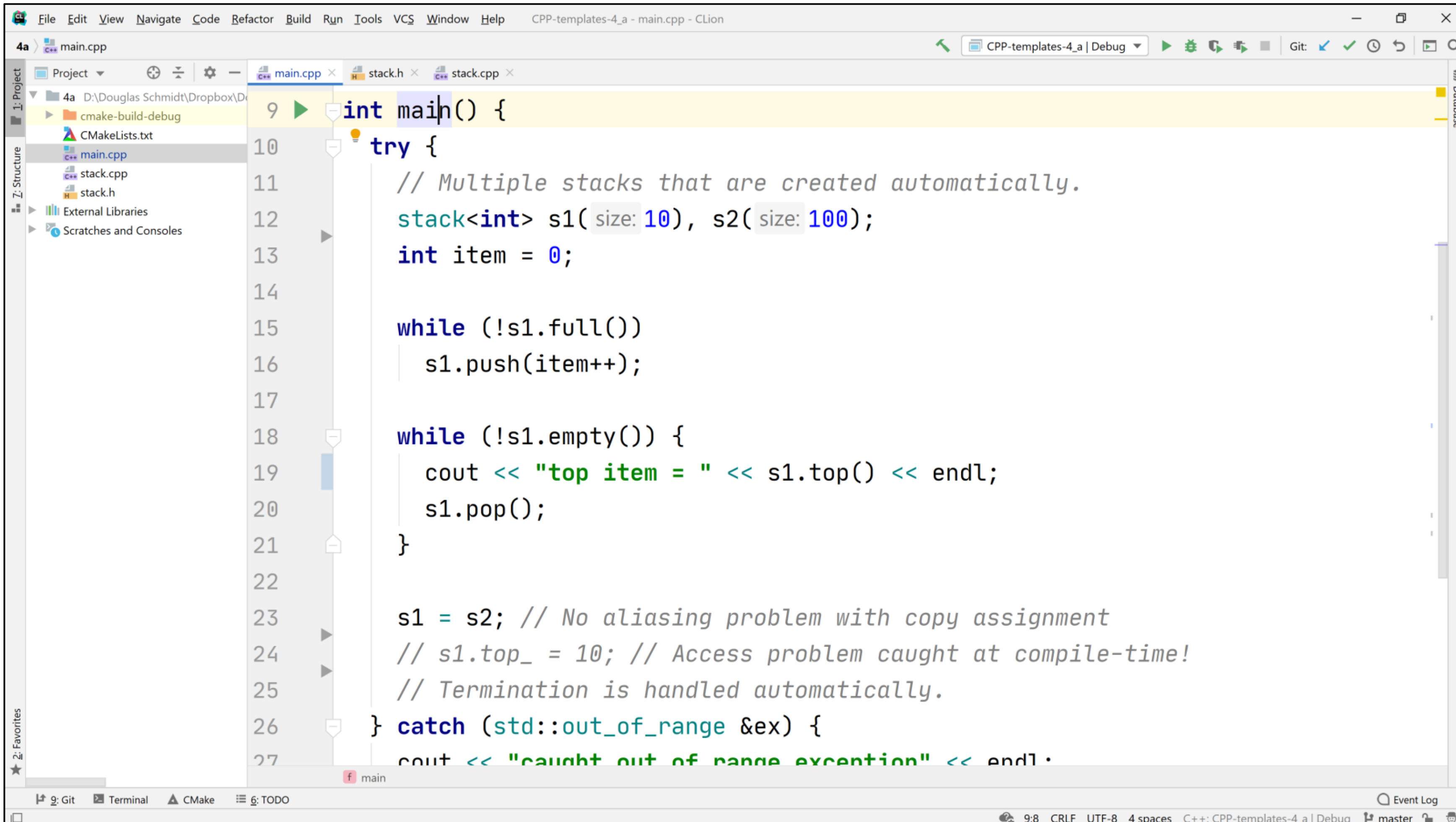
Template Implementation in C++

- A parameterized type Stack class interface using C++



See CPlusPlus/tree/master/overview/capabilities/4-C++-templates

Pros of Template Implementation in C++

- All the benefits of C++ data abstraction, plus it is simple to generalize by the type
- We also showcased core patterns/idioms for writing exception-safe C++ code

Cons of Template Implementation in C++

- Requires programmers to call full() & empty() explicitly, which means errors can silently creep in..
  - We'll fix this with C++ exceptions features
- Can't customize the implementation at runtime
  - We'll fix this with C++ object-oriented programming features

End of C++ Generic Programming Stack Implementation

Evolution of Programming Abstraction Mechanisms: C++ Exception Handling

Douglas C. Schmidt

d.schmidt@vanderbilt.edu

www.dre.vanderbilt.edu/~schmidt

Professor of Computer Science

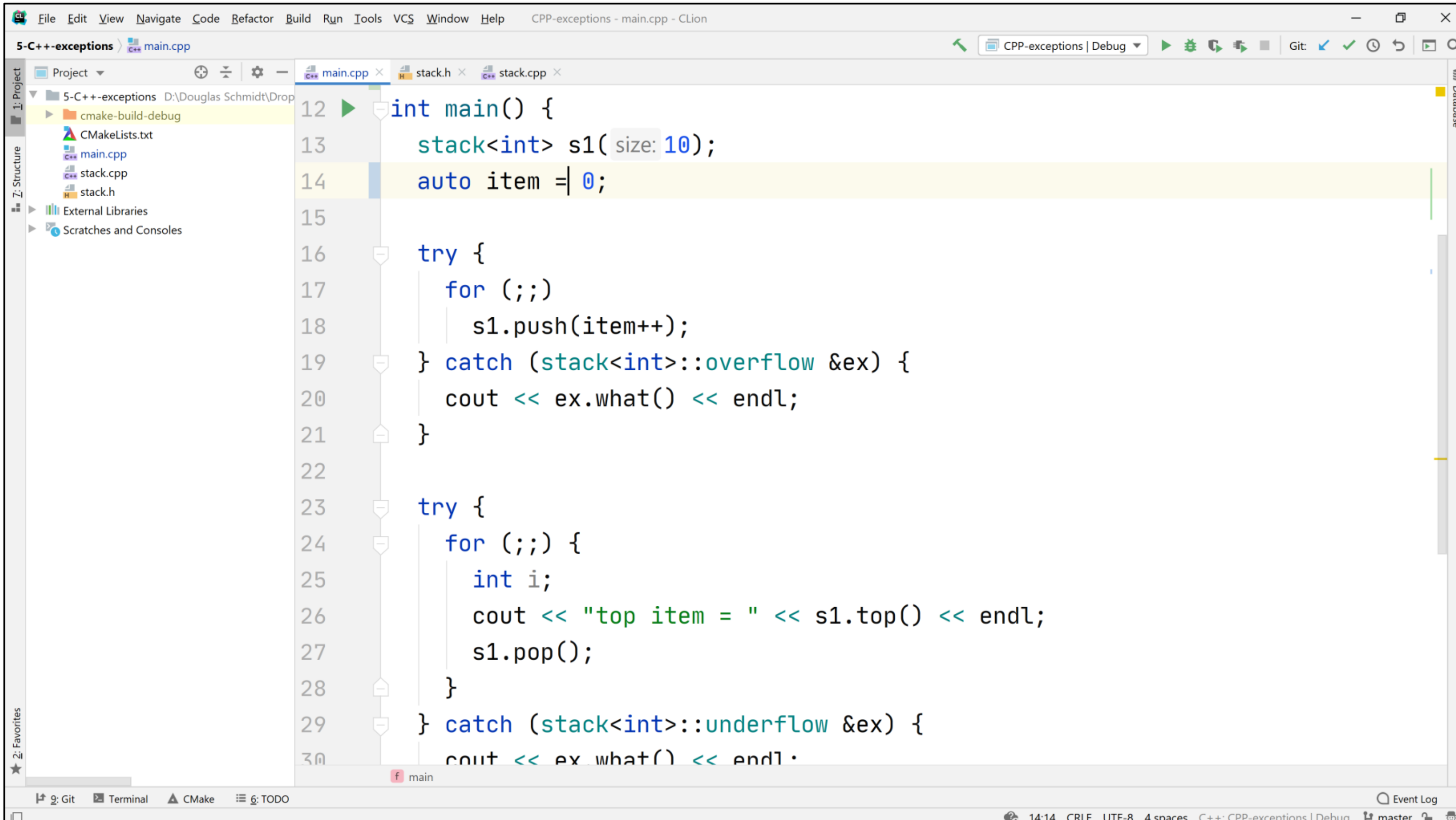
Institute for Software Integrated Systems

Vanderbilt University
Nashville, Tennessee, USA

C++ Exception Handling Stack Implementation

Exception Handling Implementation in C++

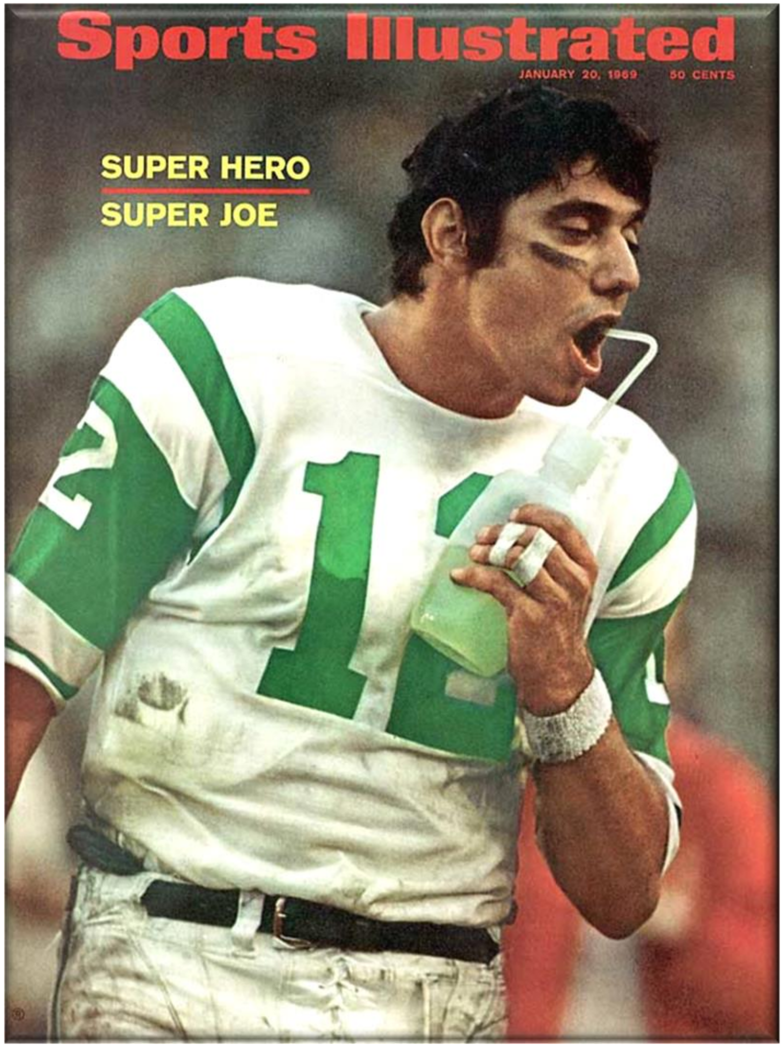
- C++ exceptions separate error handling from normal processing



See CPlusPlus/tree/master/overview/capabilities/5-C++-exceptions

Exception Handling Implementation in C++

- There are several types of exception handling "guarantees"



See www.boost.org/community/exception_safety.html for more info

Exception Handling Implementation in C++

- There are several types of exception handling "guarantees"
  - *No* guarantee – memory can be leaked, invariants of a component are not preserved, etc.

```
template<typename T>
stack<T> &
stack<T>::operator=(const
stack<T> &s) {
  if (this != &s) {
    T *t = new T[s.size_];
    for (size_t i = 0; i <
           s.size_; ++i)
      t[i] = s.stack_[i];

    delete [] stack_;
    stack_ = t;
    top_ = s.top_;
    size_ = s.size_;
  }
  return *this;
}
```

See CPlusPlus/tree/master/overview/capabilities/3-C++-data-abstraction

Exception Handling Implementation in C++

- There are several types of exception handling "guarantees"
  - *No* guarantee – memory can be leaked, invariants of a component are not preserved, etc.
  - The *basic* guarantee – the invariants of a component are preserved & no resources are leaked

```
template<typename T>
stack<T> &
stack<T>::operator=(const
stack<T> &s) {
  if (this != &s) {
    try {
      T *t = new T[s.size_];
      for (size_t i = 0; i <
            s.size_; ++i)
        t[i] = s.stack_[i];

      delete [] stack_;
      stack_ = t;
      top_ = s.top_;
      size_ = s.size_;
    } catch (exception &ex) {
      delete [] t;
   } ...
```

See CPlusPlus/tree/master/overview/capabilities/4-C++-templates

Exception Handling Implementation in C++

- There are several types of exception handling "guarantees"
  - *No* guarantee – memory can be leaked, invariants of a component are not preserved, etc.
  - The *basic* guarantee – the invariants of a component are preserved & no resources are leaked
  - The *strong* guarantee – the operation either completes successfully or throws an exception, leaving the program state exactly as it was before the operation started

```
template<typename T>
stack<T> &
stack<T>::operator=(const
                    stack<T> &rhs) {
  if (this != &rhs)
    stack<T>(rhs).swap(*this);
  return *this;
}
```

See CPlusPlus/tree/master/overview/capabilities/4-C++-templates

Exception Handling Implementation in C++

- There are several types of exception handling "guarantees"
  - *No* guarantee – memory can be leaked, invariants of a component are not preserved, etc.
  - The *basic* guarantee – the invariants of a component are preserved & no resources are leaked
  - The *strong* guarantee – the operation either completes successfully or throws an exception, leaving the program state exactly as it was before the operation started
  - The *no-throw* guarantee – that the operation will not throw an exception

```
template<typename T>
class stack {
public:
  class overflow {};
  class underflow {}
  ...
  stack(stack &&rhs)
    noexcept;

  stack &operator=(stack &&rhs)
    noexcept;

  void swap(stack &rhs)
    noexcept;
} ...
```

See CPlusPlus/tree/master/overview/capabilities/4-C++-templates

Pros of Exception Handling Implementation

- **Pros**
  - Exception handling provides a disciplined way of dealing with erroneous run-time problems by separating error handling from normal code
  - Exception handling makes it possible to deal with constructor failures in C++

Cons of Exception Handling Implementation

- **Cons**
  - Exceptions are hard to program correctly if you don't apply the patterns/idioms we've discussed
    - e.g., due to the chances for resource leaks and/or corruption
  - Exceptions can yield increased time/space overhead in programs

End of C++ Exception Handling Stack Implementation