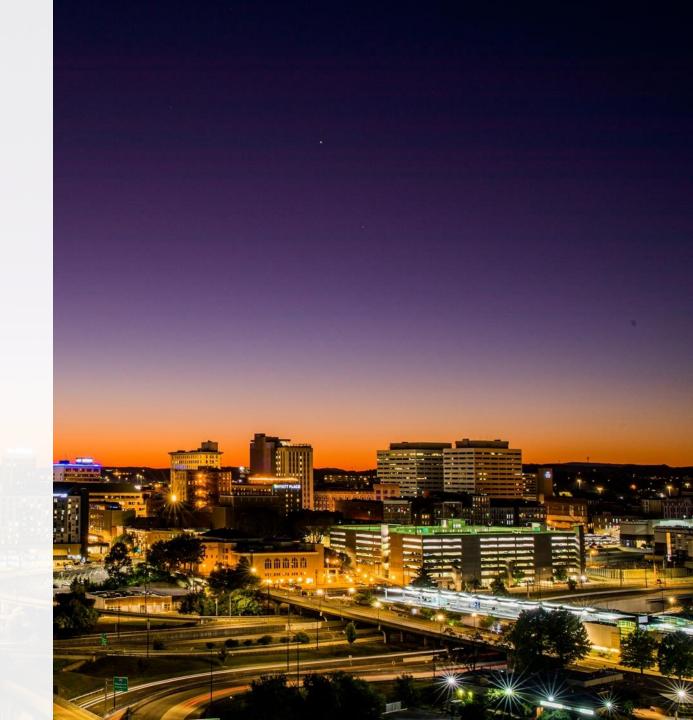
NE697: Introduction to Geant4

C++ Basics

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THE UNIVERSITY OF TENNESSEE KNOXVILLE



Today's Agenda

Administrative items?

Will grade assignment 2 this weekend

Pointers and Memory

- There are many different ways to do things, + it's hard!
- Often times, it's a design choice for a specific app/library
- You're stuck with what you're given
 - If the library uses raw pointers, it's hard to use smart pointers, and vice versa
- In addition, Geant4 uses the "singleton" pattern frequently
 - One and only one instance of an object (think "manager" types)
 - Effectively a global variable, which is discouraged
- My personal strategy: avoid pointers where possible
- The std:: collections (array, vector, etc) have pointers underneath, so passing those objects around is cheap



Pointers and Memory

- Remember: it's all about bytes
 - "Types" are just a filter for interpreting bytes
 - When you declare a variable
 - Request N bytes of contiguous memory (int: 4 or 8)
 - Receive the address of the bytes and map it to the variable
 - Using that variable just says "interpret these bytes as an int"
 - The same is true whether it's on the stack or the heap
 - Heap: instead of just mapping variable → memory (value), we have a variable that holds the memory address
 - [DEMO CONT'D]
 - [Quick DEMO on function arguments]



- The heart of object-oriented programming
- Think in terms of objects that have interfaces
 - Objects are just collections of data (and/or functions)
 - Turn the knob, pull the lever, access the data
- Make things compact and self-contained, with default values
 - Always a trade-off in complexity/maintainability/performance
 - Watch out for over-engineering



- Classes and structs are (almost) the same under the hood! These differences are just how people use them
- "members": variables/functions belonging to an object
- struct: data structure
 - Typically contains only data members that are publicly accessible
 - An easy way to capture multiple values to pass around
- class: complex object
 - Typically contains data members and functions
 - Usually split into public and private/protected access levels



- Fundamentally the same, except one thing:
 - structs default to public members
 - classes default to private members
- Access levels
 - public: anyone with access to an instance can see/modify
 - protected: can only access within the object (inherited)
 - private: can only access within the object (not inherited)
- Protect your data by making them private
 - Manipulate with "accessors," a well-defined interface
 - Will lead to more boilerplate. That's C++ for ya!



- Anatomy of a class
 - Constructor: same as __init__() in python. Initializes your object
 - There is a "default constructor" that is special and takes no args
 - The compiler will make a trivial one for you, if and only if you don't make one
 - Member variables: used to store data in the object
 - Exist for the lifetime of the instance of the object
 - Member functions: do things with the object
 - Access to all the member variables via "this->" pointer (self. in python)
 - Don't need to pass "this" in, it's always there in your class scope
 - Destructor: clean up so the object's memory can be safely returned to the pool



- [DEMO]
 - "Point" struct
 - Nested struct (Event)
 - Allocating/de-allocating for a little pointer practice
 - Upgrade Point to a class
 - Constructors and destructors
 - Basic member functions
 - Moving Point to its own source files
 - Organizing project code files: src/ and include/
 - Updating CMakeLists.txt for the new structure

