

# OpenGL<sup>®</sup>

## Programming Guide

*Ninth Edition*

*The Official Guide to Learning  
OpenGL<sup>®</sup>, Version 4.5 with SPIR-V*



John Kessenich • Graham Sellers • Dave Shreiner

The Khronos OpenGL ARB Working Group

# OpenGL Programming Guide 8th Edition

**Ken Arroyo Ohori**



## **OpenGL Programming Guide 8th Edition:**

*OpenGL Programming Guide : the Official Guide to Learning OpenGL, Version 4.3*, 2013      **OpenGL SuperBible**  
Graham Sellers, Richard S Wright Jr., Nicholas Haemel, 2013-07-19 OpenGL SuperBible Sixth Edition is the definitive programmer's guide, tutorial, and reference for the world's leading 3D API for real-time computer graphics. OpenGL 4.3: The best all-around introduction to OpenGL for developers at all levels of experience; it clearly explains both the newest API and indispensable related concepts. You'll find up-to-date, hands-on guidance for all facets of modern OpenGL development on both desktop and mobile platforms, including transformations, texture mapping, shaders, buffers, geometry management, and much more. Extensively revised, this edition presents many new OpenGL 4.3 features, including compute shaders, texture views, indirect draws, and enhanced API debugging. It has been reorganized to focus more tightly on the API to cover the entire pipeline earlier and to help you thoroughly understand the interactions between OpenGL and graphics hardware. Coverage includes: A practical introduction to the essentials of real-time 3D graphics. Core OpenGL 4.3 techniques for rendering transformations and texturing. Foundational math for creating interesting 3D graphics with OpenGL. Writing your own shaders with examples to get you started. Cross-platform OpenGL, including essential platform-specific API initialization. Material for Linux, OS X, and Windows. Vertex processing, drawing commands, primitive processing, fragments, and framebuffers. Using compute shaders to harness today's graphics cards for more than graphics. Monitoring and controlling the OpenGL graphics pipeline. Advanced rendering: light simulation, artistic and non-photo-realistic rendering, and deferred shading. Modern OpenGL debugging and performance optimization. Bonus material and sample code are available from the companion Web site: [openglsuperbible.com](http://openglsuperbible.com).      OpenGL Programming Guide Dave Shreiner, Graham Sellers, John Kessenich, Bill Licea-Kane, 2013-03-19 Includes Complete Coverage of the OpenGL Shading Language. Today's OpenGL software interface enables programmers to produce extraordinarily high-quality computer-generated images and interactive applications using 2D and 3D objects, color images, and programmable shaders. OpenGL Programming Guide: The Official Guide to Learning OpenGL, Version 4.3 Eighth Edition has been almost completely rewritten and provides definitive comprehensive information on OpenGL and the OpenGL Shading Language. This edition of the best-selling Red Book describes the features through OpenGL version 4.3. It also includes updated information and techniques formerly covered in OpenGL Shading Language, the Orange Book. For the first time, this guide completely integrates shader techniques alongside classic function-centric techniques. Extensive new text and code are presented demonstrating the latest in OpenGL programming techniques. OpenGL Programming Guide Eighth Edition provides clear explanations of OpenGL functionality and techniques, including processing geometric objects with vertex tessellation and geometry shaders, using geometric transformations and viewing matrices, working with pixels and texture maps through fragment shaders, and advanced data techniques using framebuffer objects and compute shaders. New OpenGL features covered in this edition include: Best

practices and sample code for taking full advantage of shaders and the entire shading pipeline including geometry and tessellation shaders Integration of general computation into the rendering pipeline via compute shaders Techniques for binding multiple shader programs at once during application execution Latest GLSL features for doing advanced shading techniques Additional new techniques for optimizing graphics program performance [Lecture Slides for Programming in C++ \(Version 2018-02-15\)](#) Michael D. Adams,2018-02-15 This document which consists of over 2000 lecture slides offers a wealth of information on many topics relevant to programming in C including coverage of the C language itself the C standard library and a variety of other libraries numerous software tools and an assortment of other programming related topics The coverage of the C language and standard library is current with the C 17 standard C PROGRAMMING LANGUAGE Many aspects of the C language are covered from introductory to more advanced This material includes the preprocessor language basics objects types values operators expressions control flow constructs functions and namespaces classes templates function class variable and alias templates variadic templates template specialization and SFINAE lambda expressions inheritance run time polymorphism and CRTP exceptions exception safety and RAII smart pointers memory management new and delete operators and expressions placement new and allocators rvalue references move semantics and perfect forwarding concurrency memory models and happens before and synchronizes with relationships C STANDARD LIBRARY AND VARIOUS OTHER LIBRARIES Various aspects of the C standard library are covered including containers iterators algorithms I O streams time measurement and concurrency support threads mutexes condition variables promises and futures atomics and fences A number of Boost libraries are discussed including the Intrusive Iterator and Container libraries The OpenGL library and GLSL are discussed at length along with several related libraries including GLFW GLUT and GLM The CGAL library is also discussed in some detail SOFTWARE TOOLS A variety of software tools are discussed including static analysis tools e g Clang Tidy code sanitizers e g ASan UBSan and TSan debugging and testing tools e g Catch2 performance analysis tools e g Perf PAPI Gprof and Valgrind Callgrind build tools e g CMake and Make and version control systems e g Git OTHER TOPICS An assortment of other programming related topics are also covered including data structures algorithms computer arithmetic e g floating point arithmetic and interval arithmetic cache efficient algorithms vectorization good programming practices and software documentation [Lecture Slides for Programming in C++ \(Version 2021-04-01\)](#) Michael D. Adams,2021-04-01 This document which consists of approximately 2900 lecture slides offers a wealth of information on many topics relevant to programming in C including coverage of the C language itself the C standard library and a variety of other libraries numerous software tools and an assortment of other programming related topics The coverage of the C language and standard library is current with the C 20 standard C PROGRAMMING LANGUAGE Many aspects of the C language are covered from introductory to more advanced This material includes the preprocessor language basics objects types values operators expressions control flow constructs functions namespaces and comparison classes

templates function class variable and alias templates variadic templates template specialization and SFINAE concepts  
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 Container libraries The OpenGL library and GLSL are discussed at length along with several related libraries including  
 GLFW GLUT and GLM The CGAL library is also discussed in some detail SOFTWARE TOOLS A variety of software tools are  
 discussed including static analysis tools e.g. Clang Tidy and Clang Static Analyzer code sanitizers e.g. ASan LSan MSan TSan  
 and UBSan debugging and testing tools e.g. Valgrind LLVM XRay and Catch2 performance analysis tools e.g. Perf PAPI Gprof  
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 and LSP clients servers OTHER TOPICS An assortment of other programming related topics are also covered including data  
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 vectorization good programming practices software documentation software testing e.g. static and dynamic testing and  
 structural coverage analysis and compilers and linkers e.g. Itanium C ABI

**Lecture Slides for Programming in C++**  
**(Version 2019-02-04)** Michael D. Adams, 2019-02-04 This document which consists of approximately 2500 lecture slides  
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**OpenGL Programming Guide** John Kessenich,Graham Sellers,Dave Shreiner,2016-07-25 Complete Coverage of OpenGL 4 5 the Latest Version Includes 4 5 4 4 SPIR V and Extensions The latest version of today s leading worldwide standard for computer graphics OpenGL 4 5 delivers significant improvements in application efficiency flexibility and performance OpenGL 4 5 is an exceptionally mature and robust platform for programming high quality computer generated images and interactive applications using 2D and 3D objects color images and shaders OpenGL Programming Guide Ninth Edition presents definitive comprehensive information on OpenGL 4 5 4 4 SPIR V OpenGL extensions and the OpenGL Shading Language It will serve you for as long as you write or maintain OpenGL code This edition of the best selling Red Book fully integrates shader techniques alongside classic function centric approaches and contains extensive code examples that demonstrate modern techniques Starting with the fundamentals its wide ranging coverage includes drawing color pixels fragments transformations textures framebuffers light and shadow and memory techniques for advanced rendering and nongraphical applications It also offers discussions of all shader stages including thorough explorations of tessellation geometric and compute shaders New coverage in this edition includes Thorough coverage of OpenGL 4 5 Direct State Access DSA which overhauls the OpenGL programming model and how applications access objects Deeper discussions and more examples of shader functionality and GPU processing reflecting industry trends to move functionality onto graphics processors Demonstrations and examples of key features based on community feedback and suggestions Updated appendixes covering the latest OpenGL libraries related APIs functions variables formats and debugging and profiling techniques

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Janke,2014-09-18 A comprehensive exploration of the mathematics behind the modeling and rendering of computer graphics scenes Mathematical Structures for Computer Graphics presents an accessible and intuitive approach to the mathematical ideas and techniques necessary for two and three dimensional computer graphics Focusing on the significant mathematical results the book establishes key algorithms used to build complex graphics scenes Written for readers with various levels of mathematical background the book develops a solid foundation for graphics techniques and fills in relevant graphics details often overlooked in the literature Rather than use a rigid theorem proof approach the book provides a flexible discussion that moves from vector geometry through transformations curve modeling visibility and lighting models Mathematical Structures for Computer Graphics also includes Numerous examples of two and three dimensional techniques along with numerical calculations Plenty of mathematical and programming exercises in each chapter which are designed particularly for graphics tasks Additional details at the end of each chapter covering historical notes further calculations and connected concepts for readers who wish to delve deeper Unique coverage of topics such as calculations with homogeneous coordinates computational geometry for polygons use of barycentric coordinates various descriptions for curves and L system techniques for recursive images Mathematical Structures for Computer Graphics is an excellent textbook for undergraduate courses in computer science mathematics and engineering as well as an ideal reference for practicing engineers researchers and professionals in computer graphics fields The book is also useful for those readers who wish to understand algorithms for producing their own interesting computer images     **OpenGL Programming Guide** ,2007     *Bridging the Gap between Rendering and Simulation Frameworks* Nico Hempe,2016-06-06 Taking into account aspects of semantic world models and graph databases Nico Hempe presents concepts for a new class of modern Multi Domain VR Simulation Systems based on the principles of the research field of eRobotics Nico Hempe not only shows how to overcome structural differences between rendering and simulation frameworks to allow attractive and intuitive representations of the generated results he also demonstrates ways to enable rendering supported simulations The outcome is an intuitive multi purpose development tool for multiple applications ranging from industrial domains over environmental scenarios up to space robotics     8th Annual Conference of the International Association for Mathematical Geology ,2002     CompTIA A+ Certification All-in-One Exam Guide, 8th Edition (Exams 220-801 & 220-802) Michael Meyers,2012-08-01 The bestselling CompTIA A reference and test preparation guide fully revised for the new 2012 exam topics Written by the leading authority on CompTIA A certification and training the new edition of this trusted resource offers complete up to date coverage of CompTIA A exams 220 801 and 220 802 You ll find learning objectives at the beginning of each chapter exam tips practice exam questions and in depth explanations Prepare for the exams with confidence McGraw Hill is a Gold Level CompTIA Authorized Partner offering Authorized CompTIA Approved Quality Content to give you the competitive edge on exam day This comprehensive guide also serves as an essential on the job reference after certification Covers all exam objectives including how to Work with CPUs

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Woo,OpenGL Architecture Review Board,1993 This book explains how to create graphics programs using OpenGL Release 1 It presents the overall architecture of OpenGL and discusses in detail every function included in the specification Numerous programming examples in C show how to use OpenGL functions

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