

# C++11/14 Rocks

Clang Edition

Alex Korban

---

# Contents

---

<b>Introduction</b>	<b>9</b>
C++11 guiding principles . . . . .	9
<b>Type Inference</b>	<b>11</b>
auto . . . . .	11
Some things are still manual . . . . .	12
More than syntactic sugar . . . . .	12
Why else do we need it? . . . . .	13
Objection, Your Honor! . . . . .	14
Diving in . . . . .	14
A little bit of auto history . . . . .	16
decltype . . . . .	17
Side effects . . . . .	18
decltype . . . . .	19
auto, decltype - how about both at once? . . . . .	20
<b>Lambda Expressions</b>	<b>22</b>
Why do we need this thing? . . . . .	22
Return type . . . . .	23
Lambda parameters . . . . .	24
Lambda body . . . . .	24
Storing lambdas . . . . .	25
std::function to the rescue . . . . .	25
References to outside context . . . . .	26

Closures . . . . .	27
Capturing in C++11 . . . . .	27
Capturing by reference . . . . .	28
Default capture modes . . . . .	29
Capturing class members . . . . .	30
Limitations of capturing . . . . .	32
Mutable lambdas . . . . .	32
Conversion to function pointers, nested lambdas, recursion . . . . .	34
How not to shoot yourself in the foot . . . . .	35
Rules of thumb for lambdas . . . . .	37
Lambda syntax in all its glory . . . . .	38
<b>Template Features</b>	<b>39</b>
Variadic templates . . . . .	39
What else are variadic templates good for? . . . . .	40
Back to the example . . . . .	40
Working with parameter packs . . . . .	41
Traversing template parameter packs . . . . .	44
Constraining parameter packs to one type . . . . .	44
More places to expand a parameter pack . . . . .	45
Nested variadic templates . . . . .	45
Multiple parameter packs in function templates, non-type parameter packs	46
Template aliases . . . . .	47
Using <code>using</code> instead of <code>typedef</code> . . . . .	49
Closing angle brackets are officially allowed to tail-gate . . . . .	49
Local and unnamed types as template arguments . . . . .	50
extern templates . . . . .	51
Default values for function template parameters . . . . .	52
Arbitrary expressions in template deduction contexts . . . . .	53

<b>Class Features</b>	<b>55</b>
In-class initializers for non-static data members . . . . .	55
Inheriting constructors . . . . .	58
Delegating constructors . . . . .	61
Default methods . . . . .	63
Deleted methods . . . . .	65
override and final . . . . .	67
Extended friend declarations . . . . .	68
Nested class access rights . . . . .	70
<b>The Dream of Uniform Initialization</b>	<b>72</b>
Embrace the braces . . . . .	73
initializer_list . . . . .	75
Narrowing conversions . . . . .	77
Distortions of the uniformity continuum . . . . .	77
Want a move-only type in your vector? . . . . .	78
auto + {} . . . . .	78
<> + {} = ? . . . . .	79
Surprising consequences of narrowing . . . . .	80
What's the verdict? . . . . .	80
<b>Move Semantics</b>	<b>82</b>
What are the benefits? . . . . .	82
How does this stuff work? . . . . .	83
Revision part 1: lvalue vs. rvalue . . . . .	83
Revision part 2: const attribute + lvalue/rvalue . . . . .	85
Revision part 3: reference initialization . . . . .	86
Rvalue references . . . . .	87

Overload resolution . . . . .	88
Implementing move semantics . . . . .	90
Compiler generated move operations . . . . .	92
Implementing your own move operations . . . . .	92
<code>std::move</code> . . . . .	95
Moving it right . . . . .	95
Rvalue references to <code>const</code> values . . . . .	95
Derived class construction . . . . .	96
Move construction in terms of assignment . . . . .	96
Check for self-assignment . . . . .	97
Don't make move constructors <code>explicit</code> . . . . .	98
Reference qualifiers for member functions . . . . .	98
Move-only types . . . . .	101
<b>Perfect Forwarding Problem and Solution</b>	<b>103</b>
Reference collapsing and rvalues in templates . . . . .	105
How the forward template works . . . . .	106
Bonus: implementation of <code>std::move</code> . . . . .	109
<b><code>constexpr</code> Mechanism</b>	<b>111</b>
What else is it good for? . . . . .	111
What's in a constant expression? . . . . .	111
<code>constexpr</code> variables . . . . .	111
<code>const</code> and <code>constexpr</code> . . . . .	112
<code>constexpr</code> functions . . . . .	112
Literal types . . . . .	114
A couple more notes on <code>constexpr</code> functions . . . . .	115
<b>Range-based for Loop</b>	<b>117</b>

<b>nullptr</b>	<b>120</b>
What's the advantage over NULL? . . . . .	121
<b>enum Changes</b>	<b>122</b>
Scoped enums . . . . .	122
Specifying the underlying type . . . . .	123
Forward declaration . . . . .	123
<b>Compile Time Assertions</b>	<b>127</b>
<b>Literals</b>	<b>129</b>
Unicode support and literals . . . . .	129
Unicode character literals . . . . .	130
Raw literals . . . . .	130
User defined literals . . . . .	132
Types of literals . . . . .	133
Literal operators for integers . . . . .	134
Character and string literal operators . . . . .	138
<b>noexcept</b>	<b>140</b>
noexcept for your own functions . . . . .	140
noexcept operator . . . . .	141
When to use noexcept . . . . .	142
A couple more notes on noexcept . . . . .	143
<b>Explicit Conversion Operators</b>	<b>144</b>
<b>Inline Namespaces</b>	<b>145</b>
Why not just add a using statement? . . . . .	146

<b>Alignment</b>	<b>148</b>
alignof . . . . .	148
alignas . . . . .	148
<b>sizeof Applied to Non-static Data Members</b>	<b>150</b>
<b>Memory Model</b>	<b>151</b>
Multi-threading related semantics . . . . .	151
<b>Thread local storage</b>	<b>152</b>
Thread local initialization . . . . .	153
Thread local destruction . . . . .	153
<b>Attributes</b>	<b>155</b>
Standard attributes . . . . .	156
<b>POD Types, Trivial Types, and Standard Layout Types</b>	<b>157</b>
Trivial classes . . . . .	157
Trivially copyable classes . . . . .	157
Trivial operations . . . . .	158
Standard layout types and classes . . . . .	158
Changed restrictions on unions . . . . .	159
Discriminated unions . . . . .	161
<b>C99 Compatibility Features</b>	<b>165</b>
<b>Deprecated and Removed Features</b>	<b>166</b>
<b>C++14</b>	<b>167</b>
Return type deduction for functions . . . . .	167
Redeclaration . . . . .	168

Generic lambdas . . . . .	170
Extended capturing in lambdas . . . . .	170
Revised restrictions on constexpr functions . . . . .	171
constexpr variable templates . . . . .	172
decltype(auto) . . . . .	172
Literals . . . . .	173
[[deprecated]] attribute . . . . .	174
Aggregate initialization . . . . .	174
Beyond C++14 . . . . .	175
<b>Writing Cross-Platform Code</b>	<b>176</b>
<b>Conclusion</b>	<b>178</b>
<b>Contact Information and License Agreement</b>	<b>179</b>
License agreement . . . . .	179