

Programming in C++ - Primer

Lesson 1 - Introduction

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Silicon Hill C++ Academy

2013/10/21

C++ Primer

Jakub Marek

Introduction

Motivation

Technical

Informative

First program

Digging
deeper

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- 6 Digging deeper

Welcome!

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■ Jakub 'Eremiell' Marek

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- Jakub 'Eremiell' Marek



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■ Jakub 'Eremiell' Marek



<http://fel.cvut.cz/>

<http://siliconhill.cz/>

■ Jakub 'Eremiell' Marek



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<http://siliconhill.cz/>

<http://brmlab.cz/>

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■ C++ hacker

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■ C++ hacker

■ email

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■ C++ hacker

■ email

■ IRC

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<marekj14@fel.cvut.cz>

Eremiell@chat.freenode.net

Who are you?

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6PM till 8PM

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6PM till 8PM
circa 60 min lecture

- Theory, problems, syntax, motivation, ...

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6PM till 8PM
circa 60 min lecture

- Theory, problems, syntax, motivation, ...

short break

Structure of lessons

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6PM till 8PM

circa 60 min lecture

- Theory, problems, syntax, motivation, ...

short break

circa 60 min labs

- Hands on experience

To get a diploma

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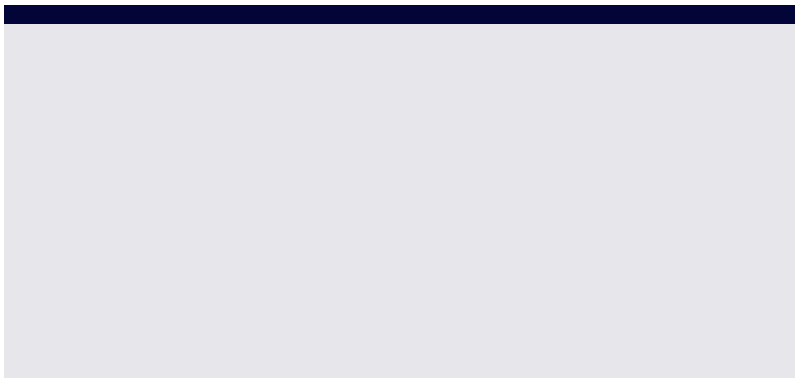
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You should come. . .

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- 90% red diploma
- 70% black diploma
- 50% green diploma
- 0% no diploma :(

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- 70% black diploma
- 50% green diploma
- 0% no diploma :(

Advanced class next semester

Class resources

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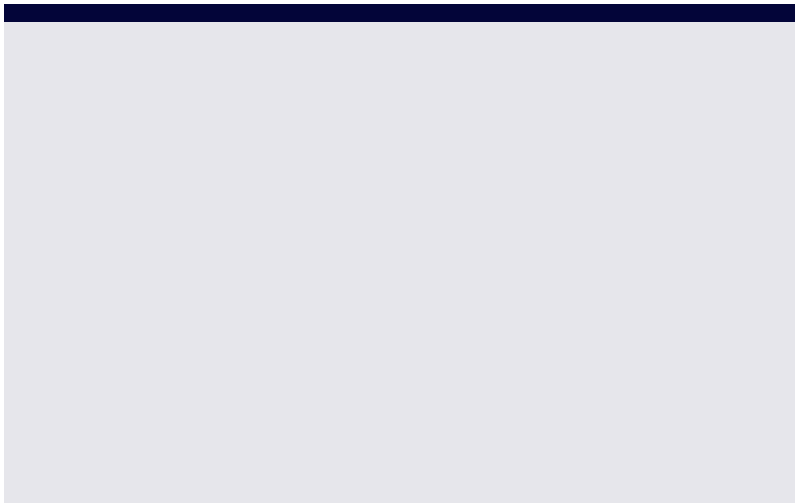
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C++ Akademie

<http://c.sh.cvut.cz/>

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C++ Akademie
IRC

<http://c.sh.cvut.cz/>
[#cppacadprimer@chat.freenode.net](https://chat.freenode.net/#cppacadprimer)

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<http://c.sh.cvut.cz/>

[#cppacadprimer@chat.freenode.net](http://chat.freenode.net/#cppacadprimer)

<http://git-scm.com/>

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- Decentralized Version Control System

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- Decentralized Version Control System
- Optimal for collaboration and for sharing things that change often

<http://c.sh.cvut.cz/>

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- Decentralized Version Control System
- Optimal for collaboration and for sharing things that change often

Bitbucket

- Registration <https://bitbucket.org/account/signup/>
- Academic Affiliate Program
<https://www.atlassian.com/software/views/bitbucket-academic-license.jsp>
- Class Presentations <https://bitbucket.org/Eremiell/c-academy-primer>

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GitHub

- Registration <https://github.com/>
- Academic Affiliate Program <https://github.com/edu>
- Class Presentations <https://github.com/Eremiell/C—Academy—Primer>

C++ Akademie

IRC



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GitHub

- Registration <https://github.com/>
- Academic Affiliate Program <https://github.com/edu>
- Class Presentations <https://github.com/Eremiell/C—Academy—Primer>

To learn more about git:



<https://www.codeschool.com/>

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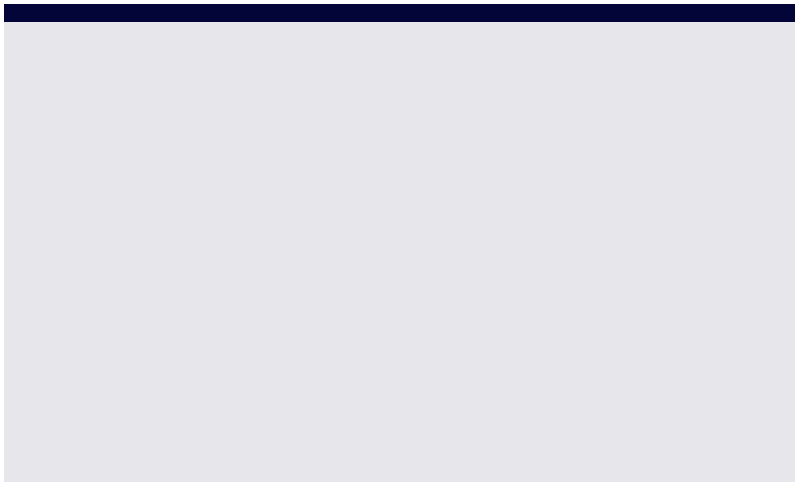
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1958 ALGOL58 (A)

- ALGOL60, ALGOL68

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1958 ALGOL58 (A)

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1966 BCLP (B)

- real B coming 1969

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- Dennis Ritchie
- linked closely to UNIX

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- C95, C99, C11

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1983 C++

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1989 ANSI C89

1990 ISO C90

- C95, C99, C11

1979 C with Classes

- Bjarne Stroustrup

1983 C++

1998 ISO C++98

- C++03 C++TR1(07)
C++11

Why C++?

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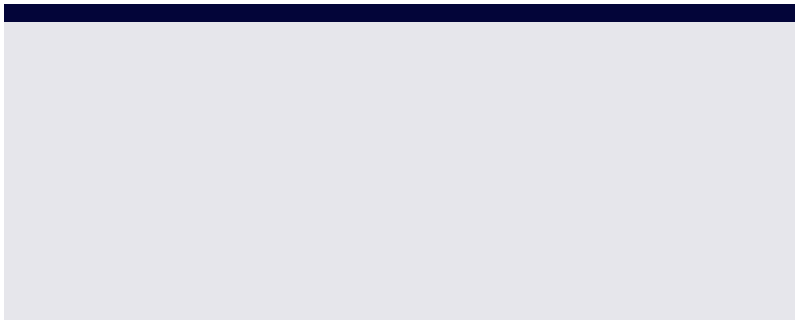
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- runs on anything

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- runs on anything
- is a general language

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- runs on anything
- is a general language
- runs from low to high

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- runs on anything
- is a general language
- runs from low to high
- contains everything

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- runs on anything
- is a general language
- runs from low to high
- contains everything
- is industrial standard

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- runs on anything
- is a general language
- runs from low to high
- contains everything
- is industrial standard
- based on C

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Why C?

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- C++ is based on it

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- C++ is based on it
- many valid C++ constructs are in fact plain C

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- C++ is based on it
- many valid C++ constructs are in fact plain C
- sometimes just to gain a different perspective

What are we going to learn?

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- Compilation
- Debugging
- Syntax
- Conditions
- Loops
- Functions
- Recursion
- Pointers
- Memory Allocation
- Arrays
- Strings
- Libraries
- Structures
- Classes
- Methods
- Objects

Questions?

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Bash commands

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`pwd` Prints full path to current
directory

`ls (-al) (<directory>)` Lists contents of directory

`cd (<directory>)` Switches to another directory

Bash commands

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`pwd` Prints full path to current directory

`ls (-al) (<directory>)` Lists contents of directory

`cd (<directory>)` Switches to another directory

`mkdir <name>` Makes new directory

`touch <name>` Makes new file

Bash commands

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<code>pwd</code>	Prints full path to current directory
<code>ls (-al) (<directory>)</code>	Lists contents of directory
<code>cd (<directory>)</code>	Switches to another directory
<code>mkdir <name></code>	Makes new directory
<code>touch <name></code>	Makes new file
<code>cp (-r) <from><to></code>	Copies from one file to another
<code>mv <from><to></code>	Moves (renames) file
<code>rm (-r) <name></code>	Removes file

Bash commands

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<code>pwd</code>	Prints full path to current directory
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<code>mkdir <name></code>	Makes new directory
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<code>cp (-r) <from><to></code>	Copies from one file to another
<code>mv <from><to></code>	Moves (renames) file
<code>rm (-r) <name></code>	Removes file
<code>cat <name></code>	Prints contents of file

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<code>pwd</code>	Prints full path to current directory
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<code>touch <name></code>	Makes new file
<code>cp (-r) <from><to></code>	Copies from one file to another
<code>mv <from><to></code>	Moves (renames) file
<code>rm (-r) <name></code>	Removes file
<code>cat <name></code>	Prints contents of file
<code>zip (-r) <where>.zip <what></code>	Makes zip archive
<code>unzip <what>.zip (-d<where>)</code>	Extracts zip archive

Bash commands

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<code>pwd</code>	Prints full path to current directory
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<code>rm (-r) <name></code>	Removes file
<code>cat <name></code>	Prints contents of file
<code>zip (-r) <where>.zip <what></code>	Makes zip archive
<code>unzip <what>.zip (-d<where>)</code>	Extracts zip archive
<code>tar -caf <where>.tar.gz <what></code>	Makes tar.gz archive
<code>tar -xzf <what>.tar.gz (-C<where>)</code>	Extracts tar.gz archive

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<code>pwd</code>	Prints full path to current directory
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<code>cat <name></code>	Prints contents of file
<code>zip (-r) <where>.zip <what></code>	Makes zip archive
<code>unzip <what>.zip (-d<where>)</code>	Extracts zip archive
<code>tar -caf <where>.tar.gz <what></code>	Makes tar.gz archive
<code>tar -xzf <what>.tar.gz (-C<where>)</code>	Extracts tar.gz archive
<code>man <command></code>	Prints manual page for given command

Compilation

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Compilation

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```
g++ -ansi -pedantic -Wall -Wextra (-ggdb) (-l<libraries...>) -o<target><files...>
```

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```
g++ -ansi -pedantic -Wall -Wextra (-ggdb) (-l<libraries...>) -o<target><files...>  
chmod +x <target>
```

Compilation

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```
g++ -ansi -pedantic -Wall -Wextra (-ggdb) (-l<libraries...>) -o<target><files...>  
chmod +x <target>  
./<target>
```

Compilation

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preprocessor (-E)

- includes header files
- runs macros
- replaces defines

Compilation

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preprocessor (-E)

- includes header files
- runs macros
- replaces defines

compiler (-S)

- compilation to assembly

preprocessor (-E)

- includes header files
- runs macros
- replaces defines

compiler (-S)

- compilation to assembly

assembler (-c)

- assemblies to object code

preprocessor (-E)

- includes header files
- runs macros
- replaces defines

compiler (-S)

- compilation to assembly

assembler (-c)

- assemblies to object code

linker

- links together your and library object codes

Debugging

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Debugging

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Compiler output

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Compiler output
Seek errors on listed lines

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Compiler output

Seek errors on listed lines

Check semicolons (;), brackets, typos, ...

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```
gdb <target>
```

```
gdb <target>
```

```
■ break <line#>
```

```
gdb <target>
```

- `break <line#>`
- `start`

```
gdb <target>
```

- `break <line#>`
- `start`
- `next`

```
gdb <target>
```

- `break <line#>`
- `start`
- `next`
- `continue`

```
gdb <target>
```

- `break <line#>`
- `start`
- `next`
- `continue`
- `<variable>`

```
gdb <target>
```

- `break <line#>`
- `start`
- `next`
- `continue`
- `<variable>`
- `<function>`

```
gdb <target>
```

- `break <line#>`
- `start`
- `next`
- `continue`
- `<variable>`
- `<function>`
- `quit`


```
gdb <target>
```

- `break <line#>`
- `start`
- `next`
- `continue`
- `<variable>`
- `<function>`
- `quit`
- `help`

valgrind

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valgrind

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```
valgrind ./<target>  
valgrind --leak-check=full ./<target>  
valgrind --help
```

Program path

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OS loads your program

Program path

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OS loads your program
OS calls `main()`

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OS loads your program
OS calls `main()`
`main()` calls and executes all of your program

Program path

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OS loads your program

OS calls `main()`

`main()` calls and executes all of your program

`main()` returns

Program path

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OS loads your program
OS calls `main()`
`main()` calls and executes all of your program
`main()` returns
program is terminated

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expression

`a + b`

statement

`a + b ;`

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expression

`a + b`

statement

`a + b ;`

right hand value

`a + b`

left hand value

`a`

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expression

`a + b`

statement

`a + b;`

right hand value

`a + b`

left hand value

`a`

parameter (formal parameter)

`int function(int p) {...}`

argument (actual parameter)

`function(a);`

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expression

`a + b`

statement

`a + b;`

right hand value

`a + b`

left hand value

`a`

parameter (formal parameter)

`int function(int p) {...}`

argument (actual parameter)

`function(a);`

declaration

`int a;`
`int function(int, double);`

definition

`int a = 5;`
`int function(int a, double d) {...}`

statement

`a = 5;`
`function(a, d);`

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expression

`a + b`

statement

`a + b;`

right hand value

`a + b`

left hand value

`a`

parameter (formal parameter)

`int function(int p) {...}`

argument (actual parameter)

`function(a);`

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`int a;`
`int function(int, double);`

definition

`int a = 5;`
`int function(int a, double d) {...}`

statement

`a = 5;`
`function(a, d);`

variable

`int main() {int a;}`

member

`class c {int a;};`

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expression

`a + b`

statement

`a + b;`

right hand value

`a + b`

left hand value

`a`

parameter (formal parameter)

`int function(int p) {...}`

argument (actual parameter)

`function(a);`

declaration

`int a;`
`int function(int, double);`

definition

`int a = 5;`
`int function(int a, double d) {...}`

statement

`a = 5;`
`function(a, d);`

variable

`int main() {int a;}`

member

`class c {int a;};`

procedure

`void procedure(...) {...}`

function

`int function(...) {...}`

method (member function)

`int c::method(...) {...}`

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expression

`a + b`

statement

`a + b;`

right hand value

`a + b`

left hand value

`a`

parameter (formal parameter)

`int function(int p) {...}`

argument (actual parameter)

`function(a);`

declaration

`int a;`
`int function(int, double);`

definition

`int a = 5;`
`int function(int a, double d) {...}`

statement

`a = 5;`
`function(a, d);`

variable

`int main() {int a;}`

member

`class c {int a;};`

procedure

`void procedure(...) {...}`

function

`int function(...) {...}`

method (member function)

`int c::method(...) {...}`

class

`class c {...};`

object (instance)

`c object(...);`

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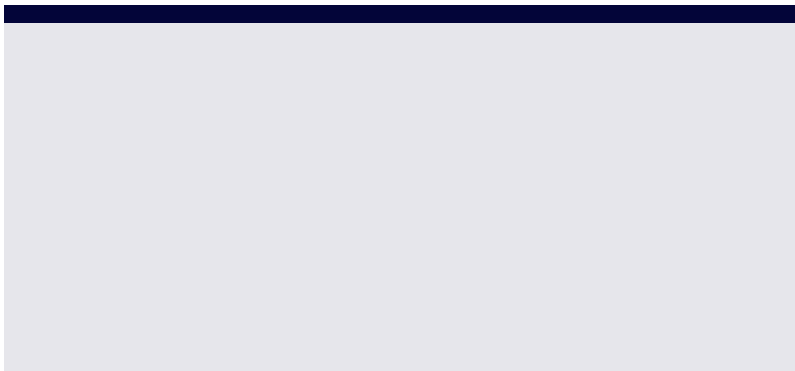
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C

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C

- source files: `.c`
- header files: `.h`

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C

- source files: `.c`
- header files: `.h`

C++

C

- source files: `.c`
- header files: `.h`

C++

- source files: `.c`, `.cc`, `.cp`, `.cpp`, `.cxx`, `.c++`
- header files: `.h`, `.hh`, `.hp`, `.hpp`, `.hxx`, `.h++`

C

- source files: `.c`
- header files: `.h`

C++

- source files: `.c`, `.cc`, `.cp`, `.cpp`, `.cxx`, `.c++`
- header files: `.h`, `.hh`, `.hp`, `.hpp`, `.hxx`, `.h++`

For clarity, we will use exclusively `.cpp` and `.hpp` .

Recommended IDEs

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Code::Blocks



- <http://codeblocks.org/>
- Linux, Win, MacOS

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- Linux, Win, MacOS

Geany



- <http://geany.org/>
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Monkey Studio



- <http://monkeystudio.org/>
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Monkey Studio



- <http://monkeystudio.org/>
- Linux, Win, MacOS

Notepad++



- <http://notepad-plus-plus.org/>
- Win

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cplusplus.com

<http://cplusplus.com/>

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-
- man 3 (C only)

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- man 3 (C only)
- C++ Programming Language (Stroustrup)
- C Programming Language (K&R)

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C++ FAQs

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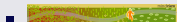
<http://cplusplus.com/>

- man 3 (C only)
- C++ Programming Language (Stroustrup)
- C Programming Language (K&R)



C++ FAQs

<http://parashift.com/c++-faq/>



Thinking in C++

<http://mindviewinc.com/Books/downloads.html>

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- C Programming Language (K&R)



C++ FAQs

<http://parashift.com/c++-faq/>

-  Thinking in C++

<http://mindviewinc.com/Books/downloads.html>

-  **stackoverflow**

<http://stackoverflow.com/>

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Let's start

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Let's start

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```
int main() {  
    return 0;  
}
```

Has to be done...

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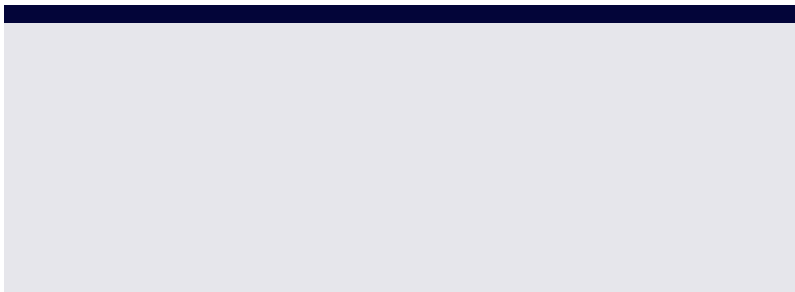
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Has to be done...

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```
#include <iostream>
```

```
int main() {  
    std::cout << "Hell 'o World!" << std::endl;  
    return 0;  
}
```

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```
#include <iostream>
```

```
using namespace std;
```

```
int main() {  
    cout << "Hell 'o World!" << endl;  
    return 0;  
}
```

Primitive data types

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type	size	min signed	max signed	max unsigned
Whole numbers				
char	1B	-128	127	255
wchar_t	4B	-2147483648	2147483647	-
short	2B	-32768	32767	65535
int	4B	-2147483648	2147483647	4294967295
long	8B	-9223372036854775808	9223372036854775807	18446744073709551615
long long	8B	-9223372036854775808	9223372036854775807	18446744073709551615
bool	1B	0	1	-
Real numbers				
float	4B	1.17549e-38	3.40282e+38	-
double	8B	2.22507e-308	1.79769e+308	-
long double	16B	3.3621e-4932	1.18973e+4932	-

Character representation

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Character representation

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1963 US-ASCII, revisions in 1967 and 1986 _____

USASCII code chart

<div><div>76543210</div><div>Bits</div></div>					<div><div>00000101101111</div></div>							
<div><div>Column</div><div>Row</div></div>					0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SP	0	@	P	\	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	\$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FS	.	<	L	\	l	|
1	1	0	1	13	CR	GS	-	=	M]	m	}
1	1	1	0	14	SO	RS	.	>	N	^	n	~
1	1	1	1	15	SI	US	/	?	O	_	o	DEL

Character representation

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1963 US-ASCII, revisions in 1967 and 1986 _____

USASCII code chart

<div><div>0 1 2 3 4 5</div><div>0 1 2 3 4 5</div></div>					0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1	
Bits	b ₄	b ₃	b ₂	b ₁	Column Row	0	1	2	3	4	5	6	7
0 0 0 0	0	0	0	0	0	NUL	DLE	SP	0	@	P	\	p
0 0 0 1	0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0 0 1 0	0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0 0 1 1	0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0 1 0 0	0	1	0	0	4	EOT	DC4	\$	4	D	T	d	t
0 1 0 1	0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0 1 1 0	0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0 1 1 1	0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1 0 0 0	1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1 0 0 1	1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1 0 1 0	1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1 0 1 1	1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1 1 0 0	1	1	0	0	12	FF	FS	.	<	L	\	l	|
1 1 0 1	1	1	0	1	13	CR	GS	-	=	M	]	m	}
1 1 1 0	1	1	1	0	14	SO	RS	.	>	N	^	n	~
1 1 1 1	1	1	1	1	15	SI	US	/	?	O	_	o	DEL

Since 1988 Unicode



<http://www.unicode.org/charts/>

Conditions: if

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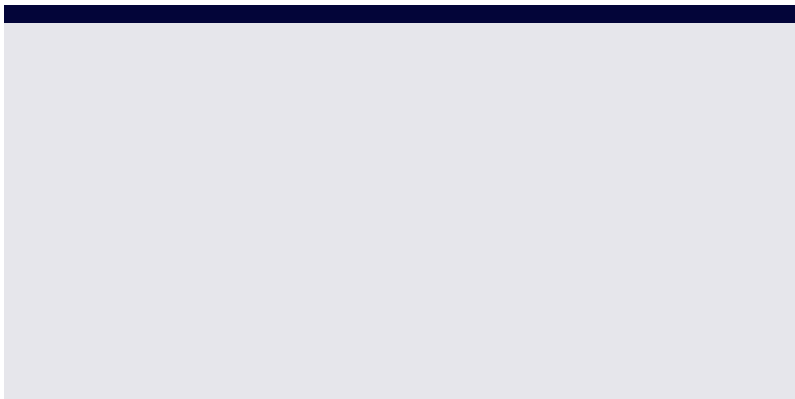
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Conditions: if

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```
if (<bool expression>) {  
    ...  
}  
else if (<bool expression>) {  
    ...  
}  
else {  
    ...  
}
```

Conditions: switch

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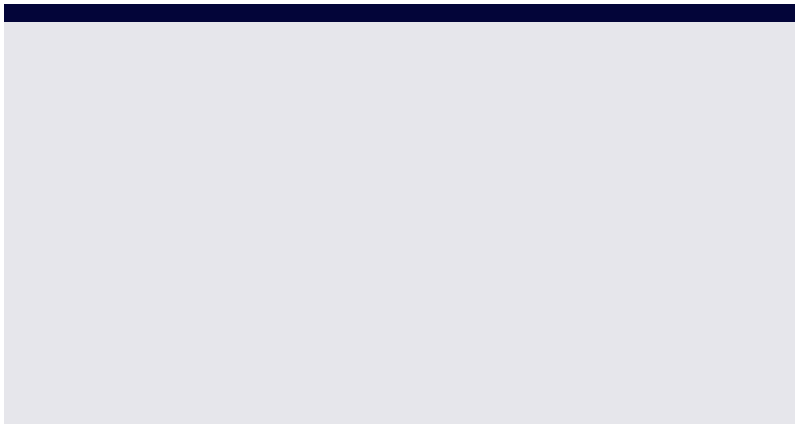
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Conditions: switch

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```
switch (<whole number expression>) {  
    case <whole number constant>:  
        ...  
        break ;  
    default :  
        ...  
        break ;  
}
```

Conditions: switch

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```
switch (<whole number expression>) {  
    case <whole number constant>:  
        ...  
        break ;  
    default :  
        ...  
        break ;  
}
```

Fall-through happens, when cases are not properly broken. Can be useful sometimes.

Conditions: ternary

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Conditions: ternary

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```
<bool expression>?<true statement>:<false statement>;
```

Conditions: ternary

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```
<bool expression>?<true statement>:<false statement>;
```

Is the most space efficient condition.

Conditions: ternary

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```
<bool expression>?<true statement>:<false statement>;
```

Is the most space efficient condition.

And is expression too!

Loops: while

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Loops: while

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```
while (<bool expression>) {  
    ...  
}
```

Loops: while

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```
while (<bool expression>) {
```

```
    ...
```

```
}
```

Or

```
do {
```

```
    ...
```

```
} while(<bool expression>);
```

Loops: while

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```
while (<bool expression>) {
```

```
    ...
```

```
}
```

Or

```
do {
```

```
    ...
```

```
} while(<bool expression>);
```

break command breaks out of the cycle. No more iterations will happen.

Loops: while

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```
while (<bool expression >) {  
    ...  
}
```

Or

```
do {  
    ...  
} while(<bool expression >);
```

break command breaks out of the cycle. No more iterations will happen.

continue command skips to the end of the loop and makes next condition check.

Loops: for

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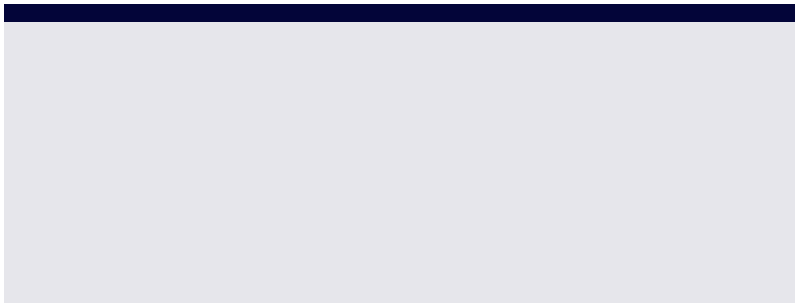
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Loops: for

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```
for (<initialization statement>; <bool expression>; <iteration statement>) {  
    ...  
}
```

Loops: for

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```
for (<initialization statement>; <bool expression>; <iteration statement>) {  
    ...  
}
```

Is equivalent to

```
<initialization statement>;  
while (<bool expression>) {  
    ...  
    <iteration statement>;  
}
```


Loops: for

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```
for (<initialization statement>; <bool expression>; <iteration statement>) {  
    ...  
}
```

Is equivalent to

```
<initialization statement>;  
while (<bool expression>) {  
    ...  
    <iteration statement>;  
}
```

There's for-each, but it's non-trivial.
We'll get to it later.

Functions

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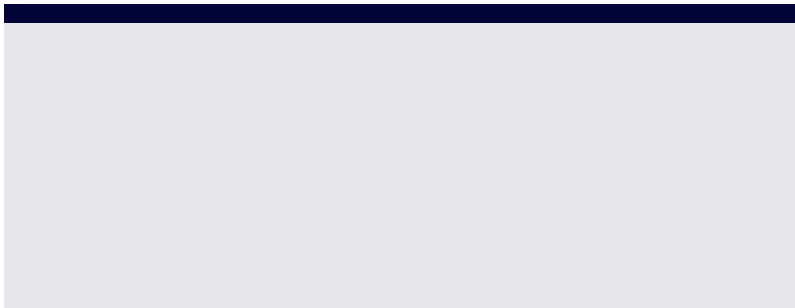
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Declaration: (Prototype)

```
<return type> <name> (<parameters... >);
```

Declaration: (Prototype)

```
<return type> <name> (<parameters... >);
```

Definition:

```
<return type> (<class >::)<name>(<parameters... >) {  
    ...  
    return <return type value>;  
}
```

Recursion

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C++ Primer

Jakub Marek

Introduction

Motivation

Technical

Informative

First program

Digging
deeper

A practice of calling function from it's own body.

Recursion

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A practice of calling function from it's own body.

```
int factorial(int i) {  
    if (i == 1) {  
        return i;  
    }  
    return i * factorial(i - 1);  
}
```

A practice of calling function from it's own body.

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int factorial(int i) {  
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Alternative to iteration.

A practice of calling function from it's own body.

```
int factorial(int i) {  
    if (i == 1) {  
        return i;  
    }  
    return i * factorial(i - 1);  
}
```

Alternative to iteration.

```
int factorial(int i) {  
    int r = 1;  
    for (int j = 1; j <= i; j++) {  
        r *= j;  
    }  
    return r;  
}
```

Operators

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Level	Operator	Description	Grouping
1	::	scope	Left-to-right
2	() [] . -> ++ - [d/s/r/c]_typeid	postfix	Left-to-right
	++ - - ~ ! sizeof new delete	unary (prefix)	
3	* &	indirection and reference (pointers)	Right-to-left
	+ -	unary sign operator	
4	(type)	type casting	Right-to-left
5	.* ->*	pointer-to-member	Left-to-right
6	* / %	multiplicative	Left-to-right
7	+ -	additive	Left-to-right
8	«»	shift	Left-to-right
9	<> <= >=	relational	Left-to-right
10	== !=	equality	Left-to-right
11	&	bitwise AND	Left-to-right
12	^	bitwise XOR	Left-to-right
13	|	bitwise OR	Left-to-right
14	&&	logical AND	Left-to-right
15	||	logical OR	Left-to-right
16	?:	conditional	Right-to-left
17	= *= /= %= += -= »= «= &= ^= =	assignment	Right-to-left
18	,	comma	Left-to-right

Questions?

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Break!

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