

Exercise Session

Week 03

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Today's topics

▶ polybox for session material

▶ Mail to TA

Intro

Expressions

for-loops

Debugging

Follow-up

- Are **all of you** able to use [code]expert now?
- Use the "Playground" on [code]expert to test out ideas and play around with stuff you've learned. You can find it under "Code Examples" at the very bottom of the page
- The moodle-page for the Self-Assessments is now open and much better visible from the course page, give them a try!

Questions re: Homework?

Expressions

- Repetition: what was a `bool` again?
- Precedences
- (Parenthesis) are your best friends
- Order matters
- Be aware of *short circuits*

← reasons
for lots of bugs

Booleans

- usually just called bools
- either true or false

Booleans


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- either true or false
- `false == 0`
- `true != 0`

Booleans

- usually just called `bools`
- either `true` or `false`
- `false == 0`
- `true != 0`
- whenever `true` turns into a number (`int`), it'll be the number `1`
- whenever a number that is `!= 0` turns into a `bool`, it'll turn into `true`

Precedences Ranking

$(++(a++))$ (doesn't compile)

1. $a++$, $a--$ 
2. $++a$, $--a$, $-a$, $!a$, $*a$, $\&a$
3. $*$, $/$, $\%$
4. $+$, $-$
5. $<$, $<=$, $>$, $>=$
6. $==$ $!=$
7. $\&\&$ } *And*
8. $||$ } *Or*
9. $=$, $+=$, $-=$, $*=$, $/=$, $\%=$

(use) (parenthesis) (!)

$5 + (7 \cdot 2)$ ~~*~~ $(5 + 7) \cdot 2$

- (parenthesis) work much like in real math
- used to make the correct evaluation obvious
- or to change the way the expression is evaluated

(use) (parenthesis) (!)

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Task

Make the evaluation of the following expression obvious:

$(3 < (4 + 1)) \&\& (2 < 3)$

Hint: use the previous slide

(use) (parenthesis) (!)

- (parenthesis) work much like in real math
- used to make the correct evaluation obvious
- or to change the way the expression is evaluated

Task

Make the evaluation of the following expression obvious:

$3 < 4 + 1 \ \&\& \ 2 < 3$

Hint: use the previous slide

Solution

$(3 < (4 + 1)) \ \&\& \ (2 < 3)$

Multiple operators with same precedence

Quick Task

How would you parenthesize the expression below to make it obvious?

`((false && false) && true)`

Multiple operators with same precedence

Quick Task

How would you parenthesize the expression below to make it obvious?

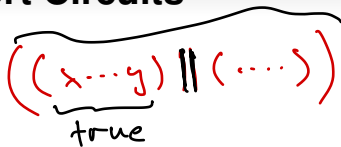
```
false && false && true
```

Quick Solution

Just "read" from left to right:

```
(false && false) && true
```

Short Circuits



if it knows
what it'll eval' to,
the machine

Short Circuit

"&&" and "||" evaluate the left expression first and ~~if it's false~~ they *won't check the right side.*

What are the implications of that? See next slide.

Short Circuit in Code

```
if (3 > 2 && 10 > 11){
    std::cout << "Of course not!\n";
} // not a short circuit evaluation

int a = 3;

if (false && ++a < 2){
    std::cout << "Of course not!\n";
} // a short circuit evaluation

std::cout << a << "\n"; // what will be the output?

if (++a < 2 && false){
    std::cout << "Of course not!\n";
} // another short circuit evaluation

std::cout << a << "\n"; // what will be the output?
```


Let's check comprehension

Task

Evaluate the following expression by hand and write down each intermediate step. Assume `int x = 1`:

$(x == 1) \ || \ (1 / (x - 1) < 1)$

Remember: Parenthesis are your friends.

Let's check comprehension

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Evaluate the following expression by hand and write down each intermediate step. Assume `int x = 1`:

`x == 1 || 1 / (x - 1) < 1`

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Solution

First: parenthesize!

`(x == 1) || ((1 / (x - 1)) < 1)`, start on left side

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```

Remember: Parenthesis are your friends.

Solution

First: parenthesize!

```
(x == 1) || ((1 / (x - 1)) < 1), start on left side
```

```
(1 == 1) || ((1 / (x - 1)) < 1)
```

```
true || ((1 / (x - 1)) < 1)*
```

Let's check comprehension

Task

Evaluate the following expression by hand and write down each intermediate step. Assume `int x = 1`:

```
x == 1 || 1 / (x - 1) < 1
```

Remember: Parenthesis are your friends.

Solution

First: parenthesize!

```
(x == 1) || ((1 / (x - 1)) < 1), start on left side
```

```
(1 == 1) || ((1 / (x - 1)) < 1)
```

```
true || ((1 / (x - 1)) < 1)*
```

```
true
```

*(true || whatever) always eval's to (true)

And another one

Task

Evaluate the following expression by hand and write down each intermediate step. Assume `int x = 1;`

`!((1 < 2) && (x == 1)) + 1`

`(true && true) + 1`

`!(true) + 1`

`false + 1`

`0 + 1 = 1 (= true)`

And another one

Task

Evaluate the following expression by hand and write down each intermediate step. Assume `int x = 1`:

```
!(1 < 2 && x == 1) + 1
```

Solution

```
!(1 < 2 && x == 1) + 1
```

And another one

Task

Evaluate the following expression by hand and write down each intermediate step. Assume `int x = 1`:

```
!(1 < 2 && x == 1) + 1
```

Solution

```
!(1 < 2 && x == 1) + 1
```

```
(!( (1 < 2) && (x == 1) )) + 1
```


And another one

Task

Evaluate the following expression by hand and write down each intermediate step. Assume `int x = 1`:

```
!(1 < 2 && x == 1) + 1
```

Solution

```
!(1 < 2 && x == 1) + 1
```

```
(!((1 < 2) && (x == 1))) + 1
```

```
(!((true) && (true))) + 1
```

And another one

Task

Evaluate the following expression by hand and write down each intermediate step. Assume `int x = 1`:

```
!(1 < 2 && x == 1) + 1
```

Solution

```
!(1 < 2 && x == 1) + 1  
(!((1 < 2) && (x == 1))) + 1  
(!((true) && (true))) + 1  
(!(true)) + 1
```

And another one

Task

Evaluate the following expression by hand and write down each intermediate step. Assume `int x = 1`:

```
!(1 < 2 && x == 1) + 1
```

Solution

```
!(1 < 2 && x == 1) + 1  
(!((1 < 2) && (x == 1))) + 1  
(!((true) && (true))) + 1  
!(true) + 1  
false + 1
```

And another one

Task

Evaluate the following expression by hand and write down each intermediate step. Assume `int x = 1`:

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!(1 < 2 && x == 1) + 1
```

Solution

```
!(1 < 2 && x == 1) + 1  
(!((1 < 2) && (x == 1))) + 1  
(!((true) && (true))) + 1  
!(true) + 1  
false + 1  
0 + 1
```

And another one

Task

Evaluate the following expression by hand and write down each intermediate step. Assume `int x = 1`:

```
!(1 < 2 && x == 1) + 1
```

Solution

```
!(1 < 2 && x == 1) + 1
(!((1 < 2) && (x == 1))) + 1
(!((true) && (true))) + 1
(!(true)) + 1
false + 1
0 + 1
1
```

Questions?

$(2 < a) < 4$

$\underbrace{\text{true or false}}_{1 \text{ or } 0} < 4$
 $\underbrace{\hspace{10em}}_{\text{true}}$

for-loops

- what is a *loop*
- we'll get to know *scopes* a bit better
- an intro to *Program Tracing*

Scope

- Any time you use the {squiggly brackets} you create a *scope*

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Scope

- Any time you use the {squiggly brackets} you create a *scope*
- You can think of a scope as a closed world in itself
- Information can't flow out of the scope, but outside information (variables etc.) is available inside the scope
- When the scope closes (program hits the right "}") the information inside of that scope dies
- ([code]expert example)

General structure of a for-loop

`int n = ...;`

1: `int i = 1;`
2: `i < n;`
3: `i++;` } example

① ② ③

```
for(init; condition; expression){  
    statement 1;  
    statement 2;  
    ...  
}
```

④ (the actual code)

(1, 2, 4, 3)

Important note

the `expression-part` will get executed **after** the statements. !

3

4

Program Tracing

”*Program Tracing* is the process of executing program code by hand, with concrete inputs.”

It’s quite an important skill in the beginning. At some point, you’ll be able to do it in your head. You’ll see an example with a simple for-loop in the next few slides.

Concrete example of a for-loop

:: open "example of a for-loop"-slides ::

Questions?

Exercise: Strange Sum

Task

Open "Strange Sum" in your [code]expert and give it a try it yourself. Solve it individually (with pen and paper.)

Description:

Write a program that reads a number $n > 0$ from standard input and outputs the sum of all positive numbers up to n that are odd but not divisible by 5. (10min)

Space for student solution (attempts)

stsum

```
for ( int i = 1 ;           ; i += 2 )
```

```
    if ( i % 5 ) ..
```

Solution to "Strange Sum"

```
// input
unsigned int strangesum = 0;
unsigned int n;
std::cin >> n;

// computation
for(unsigned int i = 1; i <= n; i++){
    if((i % 2) == 1){
        if(i % 5){
            strangesum += i;
        }
    }
}

// output
std::cout << strangesum << "\n";
```

Sweeter solution to "Strange Sum"

```
// input
unsigned int strangesum = 0;
unsigned int n;
std::cin >> n;

// computation
for(unsigned int i = 1; i <= n; i++){
    if( ((i % 2) == 1) && (i % 5) ){
        strangesum += i;
    }
}

// output
std::cout << strangesum << "\n";
```

Even sweeter solution to "Strange Sum"

```
// input
unsigned int strangesum = 0;
unsigned int n;
std::cin >> n;

// computation
for(unsigned int i = 1; i <= n; i+=2){
    if(i % 5){
        strangesum += i;
    }
}

// output
std::cout << strangesum << "\n";
```

Questions?

Exercise: Largest Power

Task

Open "Largest Power" in your [code]expert and give it a try it yourself. Solve it individually with pen and paper.

Description:

Write a program that inputs a positive natural number n and outputs the largest number p that is a power of 2 and smaller or equal to n . (15min)

Exercise: Largest Power

Task

Open "Largest Power" in your [code]expert and give it a try it yourself. Solve it individually with pen and paper.

Description:

Write a program that inputs a positive natural number n and outputs the largest number p that is a power of 2 and smaller or equal to n . (15min)

Task

Now, discuss with your neighbor. Did they have a similar approach? What can you learn from each other? (7min)

Space for student solution (attempts)

Solution to "Largest Power"

```
#include <iostream>
#include <cassert>

int main () {
    unsigned int n;
    std::cin >> n;
    assert(n >= 1);

    unsigned int power = 1;
    → for (; power <= n / 2; power *= 2);

    std::cout << power << std::endl;

    return 0;
}
```

Debugging

”*Debugging* is the process of finding and resolving bugs (defects or problems that prevent correct operation) within programs, software, or systems.”

You’ll spend a lot of time doing this, so try to do it effectively.

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Task

Propose a way of finding the bug in the following code.

Debugging non_terminating.cpp

```
int main () {
    const int n = 6;

    // Compute n^12
    int prod = 1;
    for (int i = 1; 1 <= i < 13; ++i) {
        prod *= n;
    }

    // Output stars
    for (int i = 1; i < prod; ++i) {
        std::cout << "*";
    }
    std::cout << "\n";
    return 0;
}
```

Live demo

Disclaimer: This might go horribly wrong

Debugging non_terminating.cpp

Question

How can we know at which line the program gets stuck?

Debugging non_terminating.cpp

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Answer

Try to print something to the console at various lines and see what gets printed.

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Why doesn't the first loop terminate?

Debugging non_terminating.cpp

Question

How can we know at which line the program gets stuck?

Answer

Try to print something to the console at various lines and see what gets printed.

Question

Why doesn't the first loop terminate?

Answer

The condition is wrong. It should be: `1 <= i && i < 13`.

Debugging non_terminating.cpp

Question

How can we investigate further why the program does not print anything?

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Question

How can we investigate further why the program does not print anything?

Answer

Print the value of `prod` after the first loop

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How we can get to know why `prod` became negative?

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Question

How can we investigate further why the program does not print anything?

Answer

Print the value of `prod` after the first loop

Question

How we can get to know why `prod` became negative?

Answer

Print the value of `prod` in *each* iteration of the first loop

Final Questions?