ETH zürich

Exercise Session W11

Computer Science (CSE & CBB & Statistics) – AS 23

Overview

`n.ethz.ch/~agavranovic`

Today's Agenda

Follow-up
Feedback on **code** expert
Objectives
`&` vs `*`
References vs Pointers
`this->`
Dynamic Data Structures & Iterators
Outro

1. Follow-up

Follow-up from previous exercise sessions

Regarding PVK

Follow-up from previous exercise sessions

Regarding PVK

- By now you should all have received an e-mail from VMP informing you about the PVKs

2. Feedback on **code** expert

Specific things regarding **code** expert tasks

E8:T1: "Vector and Matrix Operations"

- Pay attention to the "constness" of the function arguments
- The vectors and matrices should not be changed → should be passed as `const` references

E8:T4: "Trapezoid Printing"

- Read the tasks carefully :)
- Careful with `print_diamond` and `print_hourglass`: Special cases are required if the widths are 0, otherwise there is infinite output

Questions?

3. Objectives

Objectives

- ☐ be able to understand the differences between pointers and references
- ☐ be able to trace and write programs with pointers
- ☐ be able to write programs that use dynamic memory
- ☐ be able to implement simple containers

4. & vs *

The meanings of &

The symbol & has many meanings in C++ which is confusing
It has *3 different meanings* depending on its position in code:

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```
bool z = x && y;
```

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   bool z = x && y;
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2. to *declare* a variable as an alias
   ```
   int& y = x;
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The meaning of &

1. as AND-operator
   ```
   bool z = x && y;
   ```
2. to *declare* a variable as an alias
   ```
   int& y = x;
   ```
3. to get the *address* of a variable (address-operator)
   ```
   int *ptr_a = &a;
   ```

The meanings of $*$

Ditto with the symbol $*$.

The meaning of $*$

The meanings of ∗

Ditto with the symbol ∗.

The meaning of ∗

1. as (arithmetic) multiplication-operator

```
z = x * y;
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1. as (arithmetic) multiplication-operator
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   ```
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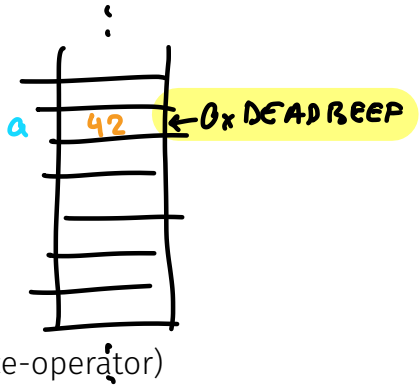
Ditto with the symbol ∗.

The meaning of ∗

1. as (arithmetic) multiplication-operator
   ```
   z = x * y;
   ```
2. to declare a pointer variable
   ```
   int* ptr_a = &a;
   ```
   fmt()
3. to access a variable via its pointer (dereference-operator)
   ```
   int a = *ptr_a;
   ```
   *(0x0...F)
   42



Questions?

5. References vs Pointers

References

```
void references(){
  int  a = 1;
  int  b = 2;
  int& x = a;
  int& y = x;
  y = b;

  std::cout
  << a << " "
  << b << " "
  << x << " "
  << y << std::endl;
}
```

Trace program and write expected output, if the function is called

References

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2 2 2 2
```

Pointers

```
void pointers(){
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Trace program and write expected output, if the function is called

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1 2 0x7ffe4d1fb904 0x7ffe4d1fb904
```

(The addresses could be different each time when called!)

Pointers und Adressen

```
void ptrs_and_addresses(){
  int  a = 5;
  int  b = 7;

  int* x = nullptr;
  x = &a;

  std::cout << a << "\n";
  std::cout << *x << "\n";

  std::cout << x << "\n";
  std::cout << &a << "\n";
}
```

Trace program and write expected output, if the function is called

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  std::cout << x << "\n";
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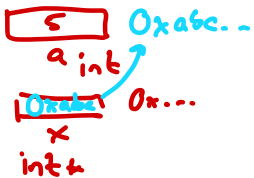
}
```

Trace program and write expected output, if the function is called

```
5
5
0x7ffe4d1fb914
0x7ffe4d1fb914
```



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Questions?

6. this->

What the f*&k is `this->`?

The meaning of `this->`

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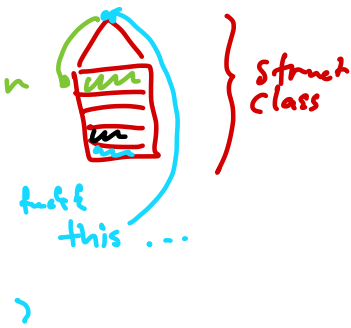

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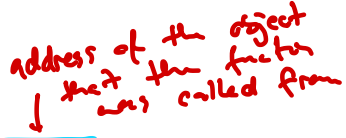
`this->` has two parts

- **`this`**
  - is a pointer to the current object (class or struct)
  - so it is of type **`T*`**
- **`->`**
  - is a cool looking operator
  - **`this->member_element`** is equivalent to **`*(this).member_element`**
  - the arrow operator dereferences a pointer to an object in order to access one of its members (functions or variables)



7. Dynamic Data Structures & Iterators

"Our-List" Primer I

We will implement (parts of) our own linked-list

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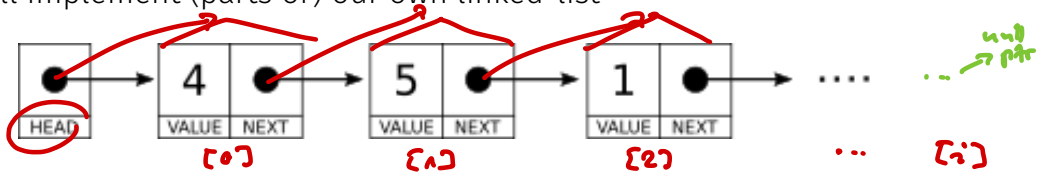

- A list is comprised of "blocks" of **`lnodes`** with one **`lnode`** always pointing to the next

"Our-List" Primer I

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"Our-List" Primer I

We will implement (parts of) our own linked-list

- A list is comprised of "blocks" of **`lnodes`** with one **`lnode`** always pointing to the next
- But what even is an **`lnode`**?
- Answer: A struct made up of an **`int value`** and an **`lnode`**-pointer

"Our-List" Primer I

First task: Implement a constructor that initializes a new list with iterators

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- Idea: Use the iterators to add new **`lnodes`** to the list
- How can we access the different elements?
  - Access to Value of the **`lnode`** that the iterator is pointing to:

`*it` ← return int value

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    `*it`
  - Next **`lnode`** in line:

    `node->next`

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- How can we access the different elements?
  - Access to Value of the **`lnode`** that the iterator is pointing to:

    `*it`
  - Next **`lnode`** in line:

    `node->next`
  - Create a pointer to a new **`lnode`**:

    `new lnode{value, pointer}`

    Remember: `new T` returns a `T*`

Exercise "our_list::init"

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- Open "`our_list::init`" on **code** expert

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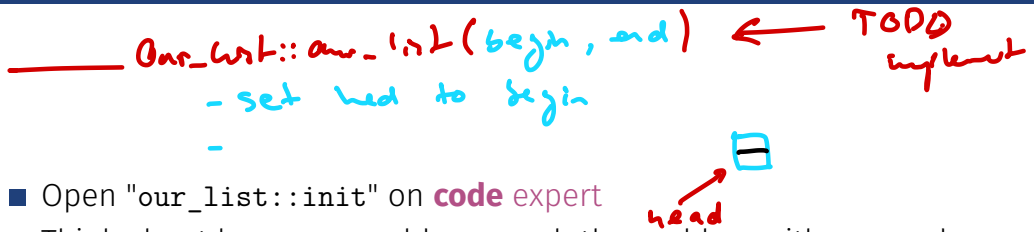
Exercise "our_list::init"



- Open "our_list::init" on **code** expert
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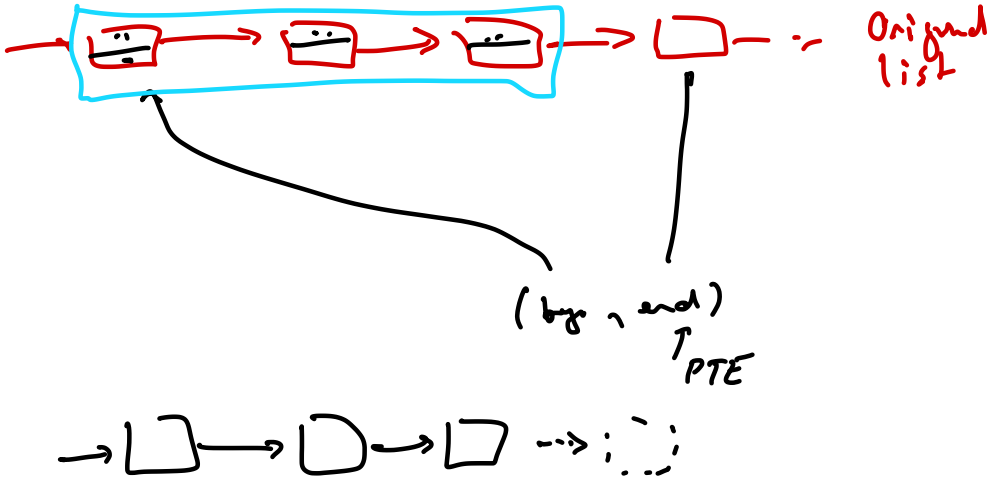
- Implement a solution (optionally in groups)

Exercise "`our_list::init`" (Solution)



Exercise "our_list::init" (Solution)

constructor

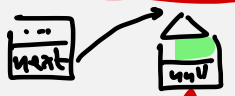
```
our_list::our_list(our_list::const_iterator begin,
                   our_list::const_iterator end) {
  this->head = nullptr;                          // Init head (safely)

  if (begin == end) {return;}                    // Case: empty list

  our_list::const_iterator it = begin;           // Adding first element
  this->head = new lnode { *it, nullptr };
  ++it;
  lnode *node = this->head;

  for (; it != end; ++it) {                      // Adding remainig elements
    node->next = new lnode { *it, nullptr };
    node = node->next;
  }
}
```

lnode*



Questions?

"Our-List" Primer II

Second task: Implement a method of the class "`our_list`" that swaps a node with the next one

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"Our-List" Primer II

Second task: Implement a method of the class "`our_list`" that swaps a node with the next one

- You can use a similar approach to other swap functions (i.e. with a temporary variable `tmp`)
- However:
  - Use Pointers
  - What happens in the case of 0 (when the head pointer should be swapped)?
  - How can you avoid suddenly accessing memory that is not yours?

Exercise "`our_list::swap`"

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Exercise "`our_list::swap`" (Solution)

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```
void our_list::swap(unsigned int index) {

  if (index == 0) {

    assert(this->head != nullptr);
    assert(this->head->next != nullptr);

    lnode* tmp = this->head->next;
    this->head->next = this->head->next->next;
    tmp->next = this->head;
    this->head = tmp;

  }
```

Exercise "our_list::swap" (Solution)

```
else {  lnode* prev = nullptr;
        lnode* curr = this->head;

        while (index > 0) {                  // Find the element
          prev = curr;
          curr = curr->next;
          --index;
        }

        assert(curr != nullptr);
        assert(curr->next != nullptr);

        lnode* tmp = curr->next;             // Swap with the next one
        curr->next = curr->next->next;
        tmp->next = curr;
        prev->next = tmp;                   }}// two '}' to close function
```

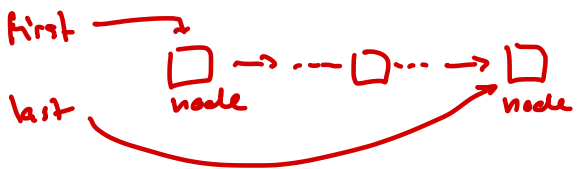
Questions?

8. Outro

General Questions?

Re: TASK 3 "Dynamic Queue"

→ In the "invariant"-part of the task, the "first" and "last" refer to the pointers first and last, NOT the first and last nodes!



General Questions?

Re: TASK 3 "Dynamic Queue"

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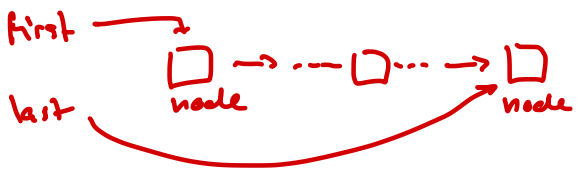


Hey, let's get together and party!
On Thursday, 7th of December from 19:00 to 23:00 at CAB D 21
yours truly, rwko
PS: We'll bring the glühwein and beer!
[rw::ko]
voeth

Till next time!

Cheers!