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Summer Term
2018

Exam in

Advanced Programming Techniques

July 24, 2018

Name: _____

Date of birth: _____

Student number: _____

Please do not fill out anything below this line!

Total number of points: _____ of 100

Grade: _____

Passed: ☐ Yes / ☐ No

Problem 1: Definitions and Terms (13 points)

(a) (4P) List the following:

Two standard library types: _____

_____

Two sequential containers: _____

_____

Two C++11 or 14 features: _____

_____

Two C++ keywords for access labels: _____

_____

(b) (3P) List two different kinds of smart pointers from the standard library and explain why they should be used instead of plain pointers.

_____

_____

_____

_____

_____

(c) (3P) Given is the function `fct` which takes a constant pointer to a `double` and a reference to a constant `std::list` as input and returns no value.
Using the `std::function` library type, define the variable `f` and initialize it with `fct`.

_____

_____

(d) (3P) List three different parts of the standard library by specifying the corresponding header file.

_____

_____

_____

_____

Problem 2: Errors and Function Matching (16 points)

Given is the following incorrect C++ program that should call the correct doit() function and output *2* as a string:

```
#include <iostream>

struct Foo {
    Foo(const Foo&) { n = 1; }
    virtual int doit() { return n; }
    virtual char doit() { return 1; }
  private:
    int n;
};

class Bar : Foo {
    Bar() { n=2;}
    void doit() { return n; }
};

void main() {

    Bar& f;
    Foo& fooref = &f;
    std::string s = fooref.doit();
    std::cout << s;

}
```

List all errors in the code and state how one can change the program such that the correct output is printed.

Problem 3: Programming with the Standard Library (7 points)

Please note: The questions assume that all necessary header files from the Standard Library are included and an implicit `using namespace std;`*. Likewise, you can safely assume the same for your code!*

Your task is to implement the function

```
template<typename T>
list<T> eraseDuplicates(const list<T> & input)
```

- this function should return a list consisting only of unique elements of the passed list `input`
- preserving the order of the `input` list is not important
- you can assume that instances of T can be compared for equality

Example usage:

```
list<string> l = {"a", "c", "b", "a",
                  "b", "b", "a",
                  "c", "c"};

auto res = eraseDuplicates(l);

res.sort();
for(const auto & e : res)
    cout << e << endl;
```

Expected output of above snippet:

```
a
b
c
```

Problem 4: Classes (12 points)

Write a class "Integer" such that following main function works and outputs "2343".

```
int main(){
  Integer i(1);
  Integer j(2);
  Integer k(3);

  std::cout << j;
  j = 3;
  std::cout << j;

  k = i + j;
  std::cout << k;

  std::cout << Integer::amount();
  return 0;
}
```

Problem 5: Questions on the Assignments and Project (12 points)

You are required to reference your project code in this task (*not* the assignment code) where indicated. Please provide line numbers as well as the file you are referring to.

(a) (4P) In the assignments, you implemented multiple variants of a `Matrix` class. One key differences was the specification of the matrix dimensions, either via constructor arguments or via template arguments:

```
template<typename T>
class Matrix {
  Matrix(size_t rows, size_t cols);
  /* ... */
};

template<typename T, size_t rows, size_t cols>
class Matrix {
  Matrix() {}
  /* ... */
};
```

Give two advantages and two disadvantages of the second approach (template arguments).

(b) (4P) Give two examples where you made use of C++11, C++14 or C++17 features in your project code. If you didn't use any such features give two examples where they *could* be used.

Discuss how this improved (would improve) code quality, e.g. by allowing a more concise formulation.

(c) (4P) When should be a “destructor” declared virtual and why?

What is the difference between variable declaration and variable definition?

Problem 6: Project (40 points)

Please make sure that you submit your project code with the exam paper such that we are able to check it! In case two groups submit the same code none of them will obtain any points for it.

(a) Which race did you implement in your group?

(b) What is your group's name?

(c) Did you pass the forward simulation task?

☐ Yes / ☐ No

(d) Did you pass the optimization task?

☐ Yes / ☐ No

(e) Did you pass the push challenge?

☐ Yes / ☐ No

(f) Did you pass the rush challenge?

☐ Yes / ☐ No