FH-OÖ Hagenberg/HSD
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Übung 7

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Beispiel 1 (24 Punkte) Kaffeeautomat: Entwerfen Sie aus der nachfolgenden Spezifikation ein Klassendiagramm, instanzieren Sie dieses und implementieren Sie die Funktionalität entsprechend. Verwenden Sie dabei das Decorator-Pattern:

Ein Kaffeeautomat bietet verschiedene Kaffeesorten (Verlängerter, Espresso, Koffeinfrei) mit entsprechenden Zutaten (Zucker, Milch u. Schlagobers) an. Die Kaffeesorten und Zutaten haben jeweils unterschiedliche Preise und eine entsprechende Beschreibung. Eine Methode `GetCost()` liefert den Gesamtpreis des ausgewählten Kaffees und die Methode `GetDescription()` liefert dazu die entsprechende Beschreibung als `std::string` um z.B. folgende Ausgaben auf `std::cout` zu ermöglichen:

```
Espresso: Zucker, Schlagobers 2.89 Euro
Verlängerter: Zucker, Milch 2.93 Euro
Koffeinfrei: Milch, Milch, Schlagobers 3.15 Euro
```

Die Beschreibung und die Preise werden in einer separaten Preisliste (Konstanten in Header, Klasse, oder Namespace) festgelegt. Zutaten können mehrfach gewählt werden!

Achten Sie beim Design darauf, dass zusätzliche Kaffeesorten und Zutaten hinzugefügt werden können, ohne die bereits bestehenden Klassen verändern zu müssen. Beweisen Sie dies durch das Hinzufügen der Kaffeesorte "Mocca" und der Zutat "Sojamilch".

Implementieren Sie einen Testtreiber der verschiedene Kaffees mit unterschiedlichen Zutaten erzeugt, alle Methoden ausreichend testet und anschließend deren Beschreibung auf `std::cout` ausgibt.

Implementieren Sie weiters eine Klasse `CoffeePreparation` die nach dem FIFO-Prinzip arbeitet und folgende Schnittstelle aufweist:

```
1 void Prepare(/*Coffee*/);         //adds and prepares a coffee
2 void Display(std::ostream& os);   //outputs all coffees in preparation
3 /*Coffee*/ Finished();               //removes the prepared coffee
```

Testen Sie die Klasse ebenfalls ausführlich im Testtreiber!

Treffen Sie für alle unzureichenden Angaben sinnvolle Annahmen und begründen Sie diese. Verfassen Sie weiters eine Systemdokumentation (entsprechend den Vorgaben aus Übung1)!

Allgemeine Hinweise: Legen Sie bei der Erstellung Ihrer Übung großen Wert auf eine **saubere Strukturierung** und auf eine **sorgfältige Ausarbeitung!** Dokumentieren Sie alle Schnittstellen und versehen Sie Ihre Algorithmen an entscheidenden Stellen ausführlich mit Kommentaren! Testen Sie ihre Implementierungen ausführlich! Geben Sie den **Testoutput** mit ab!

Systemdokumentation
Projekt CoffeeMachine

Version 1.0

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Hagenberg, 29. Dezember 2025

Inhaltsverzeichnis

1 Organisatorisches

1.1 Team

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- Simon Vogelhuber, Matr.-Nr.: S2410306014, E-Mail: Simon.Vogelhuber@fh-hagenberg.at

1.2 Aufteilung der Verantwortlichkeitsbereiche

- Simon Offenberger
  - Design Klassendiagramm
  - Implementierung und Test der Klassen:
    - ICoffee,
    - Ingredient,
    - SojaMilk,
    - Milk,
    - Sugar,
    - Cream,
  - Implementierung des Testtreibers
  - Dokumentation
- Simon Vogelhuber
  - Design Klassendiagramm

  - Implementierung und Komponententest der Klassen:
    * CoffeePreparation,
    * ExtendedOne,
    * Espresso,
    * Decaff,
    * Mocha,
    * CoffeeInfo
  - Implementierung des Testtreibers
  - Dokumentation

1.3 Aufwand

- Simon Offenberger: geschätzt 4 Ph / tatsächlich 4 Ph
- Simon Vogelhuber: geschätzt 4 Ph / tatsächlich 3 Ph

2 Anforderungsdefinition (Systemspezifikation)

Das zu entwickelnde System dient der Simulation eines einfachen **Kaffeeautomaten** zur softwaretechnischen Abbildung von Kaffeevarianten und optionalen Zutaten. Ziel ist es, verschiedene Kaffeesorten dynamisch mit beliebig vielen (auch mehrfach wählbaren) Zutaten zu kombinieren und daraus **Gesamtpreis** sowie **Beschreibung** zu ermitteln. Die Implementierung hat das **Decorator-Pattern** zu verwenden und so gestaltet zu sein, dass neue Kaffeesorten und Zutaten ohne Anpassung bestehender Klassen ergänzt werden können.

2.1 Systemüberblick

Das System verwaltet zwei Elementgruppen:

- **Kaffeesorten** (Basisprodukte), z.B. *Verlängerter*, *Espresso*, *Koffeinfrei*
- **Zutaten** (Erweiterungen/Dekoratoren), z.B. *Zucker*, *Milch*, *Schlagobers*

Eine konkrete Bestellung besteht aus genau **einer Kaffeesorte** und **0..n Zutaten**. Zutaten dürfen **mehrfach** hinzugefügt werden. Für jede Bestellung müssen eine **textuelle Beschreibung** sowie der **Gesamtpreis** ausgegeben werden können.

2.2 Funktionale Anforderungen

2.2.1 Kaffeesorten (Basiskomponenten)

- Jede Kaffeesorte besitzt eine **Beschreibung** (z.B. Name der Sorte) sowie einen **Basispreis**.
- Eine Kaffeesorte stellt mindestens folgende Operationen bereit:

  - `GetCost()` liefert den Basispreis (ohne Zutaten).
  - `GetDescription()` liefert die Basisbeschreibung (ohne Zutatenliste).

2.2.2 Zutaten (Decorator)

- Jede Zutat referenziert **genau ein** bereits existierendes Kaffeeobjekt (Kaffeesorte oder bereits dekoriertes Objekt).
- Eine Zutat erweitert:
  - den Preis um ihren **Zutatenpreis**,
  - die Beschreibung um ihren **Zutatennamen** (als Bestandteil der Zutatenliste).
- Zutaten müssen **beliebig oft** hintereinander hinzugefügt werden können (z.B. *Milch, Milch*).

2.2.3 Preis- und Beschreibungsdaten (Preisliste)

- Preise und Beschreibungen von Kaffeesorten und Zutaten werden in einer separaten **Preisliste** (z.B. Konstanten in Header/Klasse/Namespace) definiert.
- Die fachliche Logik (Berechnung und Ausgabe) darf nicht durch „Hardcoding“ von Preisen in vielen Klassen unübersichtlich werden.

2.2.4 Preis- und Beschreibungsausgabe

- `GetCost()` liefert den **Gesamtpreis** des aktuell zusammengesetzten Kaffees (Basis + alle Zutaten).
- `GetDescription()` liefert eine **druckbare Beschreibung** zur Aus-

gabe auf `std::cout`, inkl. Zutaten in der Reihenfolge ihrer Hinzufügung.

- Die Ausgabe soll mindestens Ausgaben in folgender Form ermöglichen: *Espresso: Zucker, Schlagobers 2.89 Euro*

2.3 Erweiterbarkeit (Designanforderung)

- Das Design muss sicherstellen, dass **neue Kaffeesorten** und **neue Zutaten** hinzugefügt werden können, **ohne bestehende Klassen ändern zu müssen** (Open/Closed-Prinzip).
- Diese Erweiterbarkeit ist nachzuweisen durch das Hinzufügen mindestens von:
  - Kaffeesorte **„Mocca“**
  - Zutat **„Sojamilch“**

2.4 Zusatzkomponente: `coffeePreparation` (FIFO)

Zusätzlich ist eine Klasse `coffeePreparation` zu implementieren, die Bestellungen nach dem **FIFO-Prinzip** verwaltet. Sie stellt folgende Schnittstelle bereit:

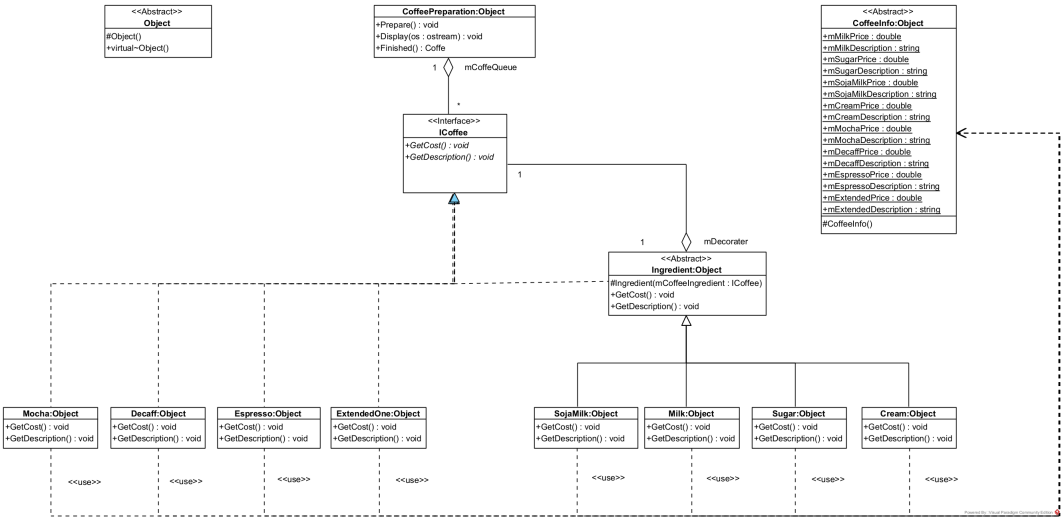
- `void Prepare(Coffee*);` // fügt einen Kaffee zur Vorbereitung hinzu
- `void Display(std ostream& os);` // gibt alle aktuell vorbereiteten Kaffees aus
- `Coffee* Finished();` // entfernt und liefert den zuerst vorbereiteten Kaffee

2.4.1 Verhaltensanforderungen `coffeePreparation`

- `Prepare` reiht Bestellungen in eine Warteschlange ein.
- `Finished` liefert das **älteste** Element der Warteschlange und entfernt es aus der Struktur.
- `Display` gibt den aktuellen Inhalt der Warteschlange in geeigneter Form aus (z.B. je Bestellung eine Zeile mit Beschreibung und Preis).

3 Systementwurf

3.1 Klassendiagramm



3.2 Designentscheidungen

Wie in der Aufgabenstellung gefordet wurde das Decorator-Pattern verwendet, um die Kaffeesorten und Zutaten zu implementieren.
Dies ermöglicht es, neue Zutaten und Kaffeesorten hinzuzufügen, ohne bestehende Klassen ändern zu müssen.
Dies wurde durch hinzufügen der Klassen `Mocha` und `SojaMilk` demonstriert.
Die Basiskomponente ist das Interface `ICoffee`, welche die Schnittstelle für alle Kaffeesorten und Zutaten definiert. Die konkreten Kaffeesorten (`Espresso`, `Decaff`, `Mocha`, `ExtendedOne`) erben direkt von `ICoffee` und implementieren die Methoden `GetCost()` und `GetDescription()`. Die Zutatenklassen (`Ingredient` und deren Unterklassen `Milk`, `SojaMilk`, `Sugar`, `Cream`) erben ebenfalls von `ICoffee` und enthalten eine Referenz auf ein `ICoffee`-Objekt, das sie dekorieren. Die Methoden `GetCost()` und `GetDescription()` der Zutatenklassen rufen die entsprechenden Methoden des dekorierten Objekts auf und erweitern deren Ergebnisse um den Preis und die Beschreibung der Zutat.

4 Dokumentation der Komponenten (Klassen)

Die HTML-Startdatei befindet sich im Verzeichnis ./../doxy/html/index.html

5 Testprotokollierung

```
1
2  ****************************************
3              TESTCASE START
4  ****************************************
5
6  Test Espresso
7
8  Test ICoffee Description
9  [Test OK] Result: (Expected: Espresso: == Result: Espresso:)
10
11 Test ICoffee Price
12 [Test OK] Result: (Expected: 3 == Result: 3)
13
14 Test for Exception in Testcase
15 [Test OK] Result: (Expected: true == Result: true)
16
17
18 ****************************************
19
20
21 ****************************************
22             TESTCASE START
23 ****************************************
24
25 Test Mocha
26
27 Test ICoffee Description
28 [Test OK] Result: (Expected: Mocha: == Result: Mocha:)
29
30 Test ICoffee Price
31 [Test OK] Result: (Expected: 2.7 == Result: 2.7)
32
33 Test for Exception in Testcase
34 [Test OK] Result: (Expected: true == Result: true)
35
36
37 ****************************************
38
39
40 ****************************************
41             TESTCASE START
42 ****************************************
```

```
43
44 Test Decaff
45
46 Test ICoffee Description
47 [Test OK] Result: (Expected: Decaff: == Result: Decaff:)
48
49 Test ICoffee Price
50 [Test OK] Result: (Expected: 2.8 == Result: 2.8)
51
52 Test for Exception in Testcase
53 [Test OK] Result: (Expected: true == Result: true)
54
55
56 ****************************************
57
58
59 ****************************************
60              TESTCASE START
61 ****************************************
62
63 Test Extended One
64
65 Test ICoffee Description
66 [Test OK] Result: (Expected: Extended One: == Result: Extended One:)
67
68 Test ICoffee Price
69 [Test OK] Result: (Expected: 5 == Result: 5)
70
71 Test for Exception in Testcase
72 [Test OK] Result: (Expected: true == Result: true)
73
74
75 ****************************************
76
77
78 ****************************************
79              TESTCASE START
80 ****************************************
81
82 Test Espresso with Milk
83
84 Test ICoffee Description
85 [Test OK] Result: (Expected: Espresso: Milk, == Result: Espresso: Milk,)
86
```

```
Test ICoffee Price
[Test OK] Result: (Expected: 5.5 == Result: 5.5)

Test for Exception in Testcase
[Test OK] Result: (Expected: true == Result: true)


*****************************************


*****************************************
              TESTCASE START
*****************************************

Test Extended One with SojaMilk

Test ICoffee Description
[Test OK] Result: (Expected: Extended One: SojaMilk, == Result: Extended
   ↪ One: SojaMilk,)

Test ICoffee Price
[Test OK] Result: (Expected: 20 == Result: 20)

Test for Exception in Testcase
[Test OK] Result: (Expected: true == Result: true)


*****************************************


*****************************************
              TESTCASE START
*****************************************

Test Mocha with Sugar

Test ICoffee Description
[Test OK] Result: (Expected: Mocha: Sugar, == Result: Mocha: Sugar,)

Test ICoffee Price
[Test OK] Result: (Expected: 4.2 == Result: 4.2)

Test for Exception in Testcase
[Test OK] Result: (Expected: true == Result: true)
```

```
130
131
132 ****************************************
133
134
135 ****************************************
136              TESTCASE START
137 ****************************************
138
139 Test Decaff with Cream
140
141 Test ICoffee Description
142 [Test OK] Result: (Expected: Decaff: Cream, == Result: Decaff: Cream,)
143
144 Test ICoffee Price
145 [Test OK] Result: (Expected: 4.8 == Result: 4.8)
146
147 Test for Exception in Testcase
148 [Test OK] Result: (Expected: true == Result: true)
149
150
151 ****************************************
152
153
154 ****************************************
155              TESTCASE START
156 ****************************************
157
158 Test Decaff with Cream and Cream
159
160 Test ICoffee Description
161 [Test OK] Result: (Expected: Decaff: Cream, Cream, == Result: Decaff: Cream
    ↪ , Cream,)
162
163 Test ICoffee Price
164 [Test OK] Result: (Expected: 6.8 == Result: 6.8)
165
166 Test for Exception in Testcase
167 [Test OK] Result: (Expected: true == Result: true)
168
169
170 ****************************************
171
172
```

```
173 ****************************************
174              TESTCASE START
175 ****************************************
176
177 Test Mocha alla Diabetes
178
179 Test ICoffee Description
180 [Test OK] Result: (Expected: Mocha: Sugar, Sugar, Sugar, Sugar, Sugar,
        ↪ Sugar, Sugar, Sugar, Sugar, == Result: Mocha: Sugar, Sugar, Sugar,
        ↪ Sugar, Sugar, Sugar, Sugar, Sugar, Sugar,)
181
182 Test ICoffee Price
183 [Test OK] Result: (Expected: 16.2 == Result: 16.2)
184
185 Test for Exception in Testcase
186 [Test OK] Result: (Expected: true == Result: true)
187
188
189 ****************************************
190
191 Test CoffeePreparation Display 1
192 [Test OK] Result: (Expected: Espresso: Milk 5.5 Euro
193 Extended One: SojaMilk 20 Euro
194  == Result: Espresso: Milk 5.5 Euro
195 Extended One: SojaMilk 20 Euro
196 )
197
198 Test CoffeePreparation Display 2
199 [Test OK] Result: (Expected: Extended One: SojaMilk 20 Euro
200  == Result: Extended One: SojaMilk 20 Euro
201 )
202
203 Test for Exception in Testcase
204 [Test OK] Result: (Expected: true == Result: true)
205
206 Test Exception Bad Ostream in CoffeePreparation
207 [Test OK] Result: (Expected: Error Bad Ostream == Result: Error Bad Ostream
        ↪ )
208
209 Test Exception Queue is Empty Display
210 [Test OK] Result: (Expected: Error No Coffe in the Machine! == Result:
        ↪ Error No Coffe in the Machine!)
211
212 Test Exception Queue is Empty Finished
```

```
213 [Test OK] Result: (Expected: Error No Coffe in the Machine! == Result:
    ↪ Error No Coffe in the Machine!)
214
215 Test for Exception in Ingedient CTOR
216 [Test OK] Result: (Expected: Error Nullptr! == Result: Error Nullptr!)
217
218 TEST OK!!
```

6 Quellcode

6.1 Object.hpp

```
1  /**
2   * @file Object.h
3   * @brief Defines a minimal base object with virtual destructor support.
4   */
5  #ifndef OBJECT_H
6  #define OBJECT_H
7
8  #include <string>
9
10 class Object{
11 public:
12
13 protected:
14
15    /**
16     * @brief Base constructor for derived objects.
17     */
18    Object() = default;
19 public:
20    /**
21     * @brief Virtual destructor to allow safe polymorphic deletion.
22     */
23     virtual ~Object() = default;
24 };
25
26 #endif // OBJECT_H
```

6.2 ICoffee.hpp

```cpp
/**
 * @file ICoffee.hpp
 * @brief Declares the abstract coffee interface for pricing and descriptions.
 */
#ifndef ICOFFEE_HPP
#define  ICOFFEE_HPP

#include <memory>
#include <string>

class ICoffee {
public:

   using Uptr = std::unique_ptr<ICoffee>;

   /**
    * @brief Compute the total cost of the coffee including decorations.
    * @return Final price in Euros.
    */
   virtual double GetCost() = 0;

   /**
    * @brief Provide a human-readable description of the coffee order.
    * @return Description string ending with a separator.
    */
   virtual std::string GetDescription() = 0;

   virtual ~ICoffee() = default;
};


#endif // !ICOFFEE_HPP
```

6.3 CoffeeInfo.hpp

```cpp
/**
 * @file CoffeeInfo.hpp
 * @brief Defines static price and label constants for all coffee drinks and add-ons.
 */
#ifndef COFFEE_INFO_HPP
#define  COFFEE_INFO_HPP

#include <string>
#include "Object.h"

class CoffeeInfo : Object {
public:

   inline static const double mEspressoPrice = 3;
   inline static const std::string mEspressoInfo = "Espresso";

   inline static const double mDecaffPrice = 2.8;
   inline static const std::string mDecaffInfo = "Decaff";

   inline static const double mMochaPrice = 2.7;
   inline static const std::string mMochaInfo = "Mocha";

   inline static const double mExtendedPrice = 5;
   inline static const std::string mExtendedInfo = "Extended␣One";

   inline static const double mMilkPrice = 2.5;
   inline static const std::string mMilkInfo = "Milk";

   inline static const double mSojaMilkPrice = 15;
   inline static const std::string mSojaMilkInfo = "SojaMilk";

   inline static const double mSugarPrice = 1.5;
   inline static const std::string mSugarInfo = "Sugar";

   inline static const double mCreamPrice = 2;
   inline static const std::string mCreamInfo = "Cream";

protected:
   CoffeeInfo() = default;
};


#endif // !COFFEE_INFO_HPP
```

6.4 Ingredient.hpp

```cpp
/**
 * @file Ingredient.hpp
 * @brief Declares the decorator base class that augments an ICoffee.
 */
#ifndef INGREDIENT_HPP
#define  INGREDIENT_HPP

#include "Object.h"
#include "ICoffee.hpp"

class Ingredient : public ICoffee , public Object {
public:
   inline static const std::string ERROR_NULLPTR = "Error␣Nullptr!";

   /**
    * @brief Forward cost request to the decorated coffee.
    * @return Accumulated coffee price.
    */
   virtual double GetCost() override;

   /**
    * @brief Forward description request to the decorated coffee.
    * @return Aggregated description string.
    */
   virtual std::string GetDescription() override;


   // explicitly delete Assign Op and Copy Ctor to prevent untestet behaviour
   void operator=(Ingredient& ind) = delete;
   Ingredient(Ingredient& ind) = delete;


protected:

   /**
    * @brief Construct a decorator around another coffee.
    * @param mCoffeeIngredient Coffee instance to wrap; must not be null.
    */
   Ingredient(ICoffee::Uptr mCoffeeIngredient);

   ICoffee::Uptr mDecorator;
};


#endif // !INGREDIENT_HPP
```

6.5 Ingredient.cpp

```cpp
/**
 * @file Ingredient.cpp
 * @brief Implements the decorator base class used by ingredient add-ons.
 */
#include "Ingredient.hpp"
#include <stdexcept>


Ingredient::Ingredient(ICoffee::Uptr mCoffeeIngredient)
{
    if (mCoffeeIngredient == nullptr) throw std::invalid_argument(ERROR_NULLPTR);

    mDecorator = move(mCoffeeIngredient);
}

double Ingredient::GetCost()
{
    return mDecorator->GetCost();
}

std::string Ingredient::GetDescription()
{
    return mDecorator->GetDescription();
}
```

6.6 CoffeePreparation.hpp

```cpp
/**
 * @file CoffeePreparation.hpp
 * @brief Declares a queue-based coffee preparation pipeline with output helpers.
 */
#ifndef COFFEE_PREPARATION_HPP
#define  COFFEE_PREPARATION_HPP

#include "ICoffee.hpp"
#include <deque>
#include <string>
#include <iostream>

class CoffeePreparation {
public:
   inline static const std::string ERROR_NULLPTR = "Error␣Nullptr!";
   inline static const std::string ERROR_BAD_OSTREAM = "Error␣Bad␣Ostream";
   inline static const std::string ERROR_NO_COFFE_IN_MACHINE = "Error␣No␣Coffe␣in␣the␣Machine!";

   CoffeePreparation() = default;

   /**
    * @brief Enqueue a coffee for preparation.
    * @param coffee Ownership of the coffee instance to queue.
    */
   void Prepare(ICoffee::Uptr coffee);

   /**
    * @brief Prints all coffees description and price to a stream.
    * @param ost Target output stream; must be valid.
    */
   void Display(std::ostream& ost);

   /**
    * @brief Remove and return the next finished coffee.
    * @return Unique pointer to the prepared coffee.
    */
   ICoffee::Uptr Finished();

   void operator=(CoffeePreparation & prep) = delete;
   CoffeePreparation(CoffeePreparation& prep) = delete;

private:
   std::deque<ICoffee::Uptr> mCoffeeQueue;
};


#endif // !COFFEE_PREPARATION_HPP
```

6.7 CoffeePreparation.cpp

```cpp
/**
 * @file CoffeePreparation.cpp
 * @brief Implements the coffee preparation queue with display and pickup helpers.
 */
#include "CoffeePreparation.hpp"

void CoffeePreparation::Prepare(ICoffee::Uptr coffee)
{
   if (coffee == nullptr) throw std::invalid_argument(ERROR_NULLPTR);

   mCoffeeQueue.push_back(move(coffee));
}

void CoffeePreparation::Display(std::ostream& ost)
{
   if (ost.bad()) throw std::invalid_argument(ERROR_BAD_OSTREAM);
   if (mCoffeeQueue.empty()) throw std::runtime_error(ERROR_NO_COFFE_IN_MACHINE);


   for(const auto & coffee : mCoffeeQueue) {
      std::string description = coffee->GetDescription();

      // discard the last "," to fullfill the requirement
      // in the excersise
      if (!description.empty()) {
         *description.rbegin() = ' ';
      }
      ost << description;
      ost << coffee->GetCost() << " Euro" << std::endl;
   }


}

ICoffee::Uptr CoffeePreparation::Finished()
{
   if (mCoffeeQueue.empty()) throw std::runtime_error(ERROR_NO_COFFE_IN_MACHINE);

   ICoffee::Uptr retCoffee = move(mCoffeeQueue.front());
   mCoffeeQueue.pop_front();

   return move(retCoffee);
}
```

6.8 SojaMilk.hpp

```cpp
/**
 * @file SojaMilk.hpp
 * @brief Declares the soja milk ingredient decorator for coffee orders.
 */
#ifndef SOJA_MILK_HPP
#define  SOJA_MILK_HPP

#include <string>

#include "Object.h"
#include "Ingredient.hpp"

class SojaMilk : public Ingredient {
public:

   /**
    * @brief Wrap a coffee with soja milk.
    * @param cof Coffee to decorate.
    */
   SojaMilk(ICoffee::Uptr cof) : Ingredient{ move(cof) } {}

   /**
    * @brief Return price including soja milk surcharge.
    */
   virtual double GetCost() override;

   /**
    * @brief Append soja milk label to description.
    */
   virtual std::string GetDescription() override;

   // explicitly delete Assign Op and Copy Ctor to prevent untestet behaviour
   void operator=(SojaMilk& ind) = delete;
   SojaMilk(SojaMilk& ind) = delete;
};

#endif // !SOJA_MILK_HPP
```

6.9 SojaMilk.cpp

```cpp
/**
 * @file SojaMilk.cpp
 * @brief Implements the soja milk ingredient decorator behavior.
 */
#include "SojaMilk.hpp"
#include "CoffeeInfo.hpp"

double SojaMilk::GetCost()
{
   return CoffeeInfo::mSojaMilkPrice + Ingredient::GetCost();
}

std::string SojaMilk::GetDescription()
{
   return Ingredient::GetDescription() + "␣" + CoffeeInfo::mSojaMilkInfo + ",";
}
```

6.10 Milk.hpp

```
/**
 * @file Milk.hpp
 * @brief Declares the milk ingredient decorator for coffee orders.
 */
#ifndef MILK_HPP
#define  MILK_HPP

#include <string>

#include "Object.h"
#include "Ingredient.hpp"

class Milk : public Ingredient {
public:

   /**
    * @brief Wrap a coffee with milk.
    * @param cof Coffee to decorate.
    */
   Milk(ICoffee::Uptr cof) : Ingredient{ move(cof) } {}

   /**
    * @brief Return price including milk surcharge.
    */
   virtual double GetCost() override;

   /**
    * @brief Append milk label to description.
    */
   virtual std::string GetDescription() override;

   // explicitly delete Assign Op and Copy Ctor to prevent untestet behaviour
   void operator=(Milk& ind) = delete;
   Milk(Milk& ind) = delete;
};

#endif // !MILK_HPP
```

6.11 Milk.cpp

```cpp
/**
 * @file Milk.cpp
 * @brief Implements the milk ingredient decorator behavior.
 */
#include "Milk.hpp"
#include "CoffeeInfo.hpp"

double Milk::GetCost()
{
   return CoffeeInfo::mMilkPrice + Ingredient::GetCost();
}

std::string Milk::GetDescription()
{
   return Ingredient::GetDescription() + "␣" + CoffeeInfo::mMilkInfo + ",";
}
```

6.12 Sugar.hpp

```
/**
 * @file Sugar.hpp
 * @brief Declares the sugar ingredient decorator for coffee orders.
 */
#ifndef SUGAR_HPP
#define  SUGAR_HPP

#include <string>

#include "Object.h"
#include "Ingredient.hpp"

class Sugar : public Ingredient {
public:

   /**
    * @brief Wrap a coffee with sugar.
    * @param cof Coffee to decorate.
    */
   Sugar(ICoffee::Uptr cof) : Ingredient{ move(cof) } {}

   /**
    * @brief Return price including sugar surcharge.
    */
   virtual double GetCost() override;

   /**
    * @brief Append sugar label to description.
    */
   virtual std::string GetDescription() override;

   // explicitly delete Assign Op and Copy Ctor to prevent untestet behaviour
   void operator=(Sugar& ind) = delete;
   Sugar(Sugar& ind) = delete;
};

#endif // !SUGAR_HPP
```

6.13 Sugar.cpp

```cpp
/**
 * @file Sugar.cpp
 * @brief Implements the sugar ingredient decorator behavior.
 */
#include "Sugar.hpp"
#include "CoffeeInfo.hpp"

double Sugar::GetCost()
{
   return CoffeeInfo::mSugarPrice + Ingredient::GetCost();
}

std::string Sugar::GetDescription()
{
   return Ingredient::GetDescription() + "␣" + CoffeeInfo::mSugarInfo + ",";
}
```

6.14 Cream.hpp

```
/**
 * @file Cream.hpp
 * @brief Declares the cream ingredient decorator for coffee orders.
 */
#ifndef CREAM_HPP
#define  CREAM_HPP

#include <string>

#include "Object.h"
#include "Ingredient.hpp"

class Cream : public Ingredient {
public:

   using Uptr = std::unique_ptr<Cream>;


   /**
    * @brief Wrap a coffee with cream.
    * @param cof Coffee to decorate.
    */
   Cream(ICoffee::Uptr cof) : Ingredient{ move(cof) } {}

   /**
    * @brief Return price including cream surcharge.
    */
   virtual double GetCost() override;

   /**
    * @brief Append cream label to description.
    */
   virtual std::string GetDescription() override;

   // explicitly delete Assign Op and Copy Ctor to prevent untestet behaviour
   void operator=(Cream& ind) = delete;
   Cream(Cream& ind) = delete;

};

#endif // !CREAM_HPP
```

6.15 Cream.cpp

```cpp
/**
 * @file Cream.cpp
 * @brief Implements the cream ingredient decorator behavior.
 */
#include "Cream.hpp"
#include "CoffeeInfo.hpp"

double Cream::GetCost()
{
   return CoffeeInfo::mCreamPrice + Ingredient::GetCost();
}

std::string Cream::GetDescription()
{
   return Ingredient::GetDescription() + "␣" + CoffeeInfo::mCreamInfo + ",";
}
```

6.16 ExtendedOne.hpp

```
1  /**
2   * @file ExtendedOne.hpp
3   * @brief Declares the extended coffee variant implementation of ICoffee.
4   */
5  #ifndef EXTENDED_ONE_HPP
6  #define  EXTENDED_ONE_HPP
7
8  #include "Object.h"
9  #include "ICoffee.hpp"
10
11
12 class ExtendedOne : public ICoffee, public Object {
13 public:
14
15    using Sptr = std::shared_ptr<ExtendedOne>;
16
17    ExtendedOne() = default;
18
19
20    /**
21     * @brief Return the price of the extended variant.
22     */
23    virtual double GetCost() override;
24
25    /**
26     * @brief Provide the extended variant description label.
27     */
28    virtual std::string GetDescription() override;
29
30    // explicitly delete Assign Op and Copy Ctor to prevent untestet behaviour
31    void operator=(ExtendedOne& ind) = delete;
32    ExtendedOne(ExtendedOne& ind) = delete;
33 };
34
35 #endif // !EXTENDED_ONE_HPP
```

6.17 ExtendedOne.cpp

```cpp
/**
 * @file ExtendedOne.cpp
 * @brief Implements the extended coffee variant pricing and description.
 */
#include "ExtendedOne.hpp"
#include "CoffeeInfo.hpp"


double ExtendedOne::GetCost()
{
   return CoffeeInfo::mExtendedPrice;
}

std::string ExtendedOne::GetDescription()
{
   return CoffeeInfo::mExtendedInfo + ":";
}
```

6.18 Espresso.hpp

```
/**
 * @file Espresso.hpp
 * @brief Declares the espresso coffee implementation of ICoffee.
 */
#ifndef ESPRESSO_HPP
#define  ESPRESSO_HPP

#include "Object.h"
#include "ICoffee.hpp"


class Espresso : public ICoffee , public Object {
public:

   using Sptr = std::shared_ptr<Espresso>;

   Espresso() = default;

   /**
    * @brief Return the price of an espresso.
    */
   virtual double GetCost() override;

   /**
    * @brief Provide the espresso description label.
    */
   virtual std::string GetDescription() override;


   // explicitly delete Assign Op and Copy Ctor to prevent untestet behaviour
   void operator=(Espresso& ind) = delete;
   Espresso(Espresso& ind) = delete;
};

#endif // !ESPRESSO_HPP
```

6.19 Espresso.cpp

```cpp
/**
 * @file Espresso.cpp
 * @brief Implements the espresso coffee pricing and description.
 */
#include "Espresso.hpp"
#include "CoffeeInfo.hpp"


double Espresso::GetCost()
{
   return CoffeeInfo::mEspressoPrice;
}

std::string Espresso::GetDescription()
{
   return CoffeeInfo::mEspressoInfo + ":";
}
```

6.20 Decaff.hpp

```
1  /**
2   * @file Decaff.hpp
3   * @brief Declares the decaffeinated coffee implementation of ICoffee.
4   */
5  #ifndef DECAFF_HPP
6  #define  DECAFF_HPP
7
8  #include "Object.h"
9  #include "ICoffee.hpp"
10
11 class Decaff : public ICoffee, public Object {
12 public:
13    using Sptr = std::shared_ptr<Decaff>;
14
15    Decaff() = default;
16
17
18    /**
19     * @brief Return the price of a decaffeinated coffee.
20     */
21    virtual double GetCost() override;
22
23    /**
24     * @brief Provide the decaff description label.
25     */
26    virtual std::string GetDescription() override;
27
28    // explicitly delete Assign Op and Copy Ctor to prevent untestet behaviour
29    void operator=(Decaff& ind) = delete;
30    Decaff(Decaff& ind) = delete;
31
32 };
33
34 #endif // !DECAFF_HPP
```

6.21 Decaff.cpp

```cpp
/**
 * @file Decaff.cpp
 * @brief Implements the decaffeinated coffee pricing and description.
 */
#include "Decaff.hpp"
#include "CoffeeInfo.hpp"

double Decaff::GetCost()
{
   return CoffeeInfo::mDecaffPrice;
}

std::string Decaff::GetDescription()
{
   return CoffeeInfo::mDecaffInfo + ":";
}
```

6.22 Mocha.hpp

```
1  /**
2   * @file Mocha.hpp
3   * @brief Declares the mocha coffee implementation of ICoffee.
4   */
5  #ifndef MOCHA_HPP
6  #define  MOCHA_HPP
7
8  #include "Object.h"
9  #include "ICoffee.hpp"
10
11
12 class Mocha : public ICoffee, public Object {
13 public:
14
15    Mocha() = default;
16
17
18    /**
19     * @brief Return the price of a mocha.
20     */
21    virtual double GetCost() override;
22
23    /**
24     * @brief Provide the mocha description label.
25     */
26    virtual std::string GetDescription() override;
27
28    // explicitly delete Assign Op and Copy Ctor to prevent untestet behaviour
29    void operator=(Mocha& ind) = delete;
30    Mocha(Mocha& ind) = delete;
31 };
32
33 #endif // !MOCHA_HPP
```

6.23 Mocha.cpp

```cpp
/**
 * @file Mocha.cpp
 * @brief Implements the mocha coffee pricing and description.
 */
#include "Mocha.hpp"
#include "CoffeeInfo.hpp"

double Mocha::GetCost()
{
   return CoffeeInfo::mMochaPrice;
}

std::string Mocha::GetDescription()
{
   return CoffeeInfo::mMochaInfo + ":";
}
```

6.24 main.cpp

```cpp
/**
 * @file main.cpp
 * @brief Runs sample preparations and tests for the coffee machine decorators.
 */
#include "vld.h"
#include "Mocha.hpp"
#include "ExtendedOne.hpp"
#include "Decaff.hpp"
#include "Espresso.hpp"
#include "Milk.hpp"
#include "Sugar.hpp"
#include "SojaMilk.hpp"
#include "Cream.hpp"
#include "CoffeePreparation.hpp"
#include "Test.hpp"
#include "CoffeeInfo.hpp"

#include <memory>
#include <iostream>
#include <cassert>
#include <sstream>
#include <fstream>

using namespace std;

static bool TestCoffeeIngridient(std::ostream& ost,ICoffee::Uptr cof, const std::string& description, const double price);
static bool TestCoffeeIngridientException(std::ostream& ost);
static bool TestCoffeePreparation(std::ostream& ost);


#define WriteOutputFile  true

int main()
{
   bool TestOK = true;
   ofstream output{ "Testoutput.txt" };

   if (!output.is_open()) {
      cerr << "Konnte Testoutput.txt nicht oeffnen" << TestCaseFail;
      return 1;
   }

   try {

      cout << TestStart;
      cout << "Test Espresso" << endl << endl;
      TestCoffeeIngridient(std::cout, make_unique<Espresso>(), CoffeeInfo::mEspressoInfo + ":", CoffeeInfo::mEspressoPrice);
      cout << TestEnd;

      cout << TestStart;
      cout << "Test Mocha" << endl << endl;
      TestCoffeeIngridient(std::cout, make_unique<Mocha>(), CoffeeInfo::mMochaInfo + ":", CoffeeInfo::mMochaPrice);
      cout << TestEnd;

      cout << TestStart;
      cout << "Test Decaff" << endl << endl;
      TestCoffeeIngridient(std::cout, make_unique<Decaff>(), CoffeeInfo::mDecaffInfo + ":", CoffeeInfo::mDecaffPrice);
      cout << TestEnd;

      cout << TestStart;
      cout << "Test Extended One" << endl << endl;
      TestCoffeeIngridient(std::cout, make_unique<ExtendedOne>(), CoffeeInfo::mExtendedInfo + ":", CoffeeInfo::mExtendedPrice);
      cout << TestEnd;

      cout << TestStart;
      cout << "Test Espresso with Milk" << endl << endl;
      TestCoffeeIngridient(std::cout, make_unique<Milk>(make_unique<Espresso>()),
         CoffeeInfo::mEspressoInfo + ": " + CoffeeInfo::mMilkInfo + ",",
         CoffeeInfo::mEspressoPrice + CoffeeInfo::mMilkPrice);
      cout << TestEnd;

      cout << TestStart;
```

```
73        cout << "Test␣Extended␣One␣with␣SojaMilk" << endl << endl;
74        TestCoffeeIngridient(std::cout, make_unique<SojaMilk>(make_unique<ExtendedOne>()),
75           CoffeeInfo::mExtendedInfo + ":␣" + CoffeeInfo::mSojaMilkInfo + ",",
76           CoffeeInfo::mExtendedPrice + CoffeeInfo::mSojaMilkPrice);
77        cout << TestEnd;
78
79        cout << TestStart;
80        cout << "Test␣Mocha␣with␣Sugar" << endl << endl;
81        TestCoffeeIngridient(std::cout, make_unique<Sugar>(make_unique<Mocha>()),
82           CoffeeInfo::mMochaInfo + ":␣" + CoffeeInfo::mSugarInfo + ",",
83           CoffeeInfo::mMochaPrice + CoffeeInfo::mSugarPrice);
84        cout << TestEnd;
85
86        cout << TestStart;
87        cout << "Test␣Decaff␣with␣Cream" << endl << endl;
88        TestCoffeeIngridient(std::cout, make_unique<Cream>(make_unique<Decaff>()),
89           CoffeeInfo::mDecaffInfo + ":␣" + CoffeeInfo::mCreamInfo + ",",
90           CoffeeInfo::mDecaffPrice + CoffeeInfo::mCreamPrice);
91        cout << TestEnd;
92
93        cout << TestStart;
94        cout << "Test␣Decaff␣with␣Cream␣and␣Cream" << endl << endl;
95        TestCoffeeIngridient(std::cout, make_unique<Cream>(make_unique<Cream>(make_unique<Decaff>())),
96           CoffeeInfo::mDecaffInfo + ":␣" + CoffeeInfo::mCreamInfo + ",␣" + CoffeeInfo::mCreamInfo + ",",
97           CoffeeInfo::mDecaffPrice + CoffeeInfo::mCreamPrice + CoffeeInfo::mCreamPrice);
98        cout << TestEnd;
99
100       cout << TestStart;
101       cout << "Test␣Mocha␣alla␣Diabetes" << endl << endl;
102       TestCoffeeIngridient(std::cout, make_unique<Sugar>(make_unique<Sugar>(make_unique<Sugar>(
103          make_unique<Sugar>(make_unique<Sugar>(make_unique<Sugar>(
104             make_unique<Sugar>(make_unique<Sugar>(make_unique<Sugar>(
105                make_unique<Mocha>()))))))))),
106          CoffeeInfo::mMochaInfo + ":␣" + CoffeeInfo::mSugarInfo + ",␣"
107          + CoffeeInfo::mSugarInfo + ",␣" + CoffeeInfo::mSugarInfo + ",␣"
108          + CoffeeInfo::mSugarInfo + ",␣" + CoffeeInfo::mSugarInfo + ",␣"
109          + CoffeeInfo::mSugarInfo + ",␣" + CoffeeInfo::mSugarInfo + ",␣"
110          + CoffeeInfo::mSugarInfo + ",␣" + CoffeeInfo::mSugarInfo + ",",
111          CoffeeInfo::mMochaPrice + CoffeeInfo::mSugarPrice * 9);
112       cout << TestEnd;
113
114
115       TestCoffeePreparation(std::cout);
116
117       TestCoffeeIngridientException(std::cout);
118
119
120       if (WriteOutputFile) {
121
122          output << TestStart;
123          output << "Test␣Espresso" << endl << endl;
124          TestCoffeeIngridient(output, make_unique<Espresso>(), CoffeeInfo::mEspressoInfo + ":", CoffeeInfo::mEspressoPrice);
125          output << TestEnd;
126
127          output << TestStart;
128          output << "Test␣Mocha" << endl << endl;
129          TestCoffeeIngridient(output, make_unique<Mocha>(), CoffeeInfo::mMochaInfo + ":", CoffeeInfo::mMochaPrice);
130          output << TestEnd;
131
132          output << TestStart;
133          output << "Test␣Decaff" << endl << endl;
134          TestCoffeeIngridient(output, make_unique<Decaff>(), CoffeeInfo::mDecaffInfo + ":", CoffeeInfo::mDecaffPrice);
135          output << TestEnd;
136
137          output << TestStart;
138          output << "Test␣Extended␣One" << endl << endl;
139          TestCoffeeIngridient(output, make_unique<ExtendedOne>(), CoffeeInfo::mExtendedInfo + ":", CoffeeInfo::mExtendedPrice);
140          output << TestEnd;
141
142          output << TestStart;
143          output << "Test␣Espresso␣with␣Milk" << endl << endl;
144          TestCoffeeIngridient(output, make_unique<Milk>(make_unique<Espresso>()),
145             CoffeeInfo::mEspressoInfo + ":␣" + CoffeeInfo::mMilkInfo + ",",
146             CoffeeInfo::mEspressoPrice + CoffeeInfo::mMilkPrice);
147          output << TestEnd;
```

```
148
149         output << TestStart;
150         output << "Test␣Extended␣One␣with␣SojaMilk" << endl << endl;
151         TestCoffeeIngridient(output, make_unique<SojaMilk>(make_unique<ExtendedOne>()),
152            CoffeeInfo::mExtendedInfo + ":␣" + CoffeeInfo::mSojaMilkInfo + ",",
153            CoffeeInfo::mExtendedPrice + CoffeeInfo::mSojaMilkPrice);
154         output << TestEnd;
155
156         output << TestStart;
157         output << "Test␣Mocha␣with␣Sugar" << endl << endl;
158         TestCoffeeIngridient(output, make_unique<Sugar>(make_unique<Mocha>()),
159            CoffeeInfo::mMochaInfo + ":␣" + CoffeeInfo::mSugarInfo + ",",
160            CoffeeInfo::mMochaPrice + CoffeeInfo::mSugarPrice);
161         output << TestEnd;
162
163         output << TestStart;
164         output << "Test␣Decaff␣with␣Cream" << endl << endl;
165         TestCoffeeIngridient(output, make_unique<Cream>(make_unique<Decaff>()),
166            CoffeeInfo::mDecaffInfo + ":␣" + CoffeeInfo::mCreamInfo + ",",
167            CoffeeInfo::mDecaffPrice + CoffeeInfo::mCreamPrice);
168         output << TestEnd;
169
170         output << TestStart;
171         output << "Test␣Decaff␣with␣Cream␣and␣Cream" << endl << endl;
172         TestCoffeeIngridient(output, make_unique<Cream>(make_unique<Cream>(make_unique<Decaff>())),
173            CoffeeInfo::mDecaffInfo + ":␣" + CoffeeInfo::mCreamInfo + ",␣" + CoffeeInfo::mCreamInfo + ",",
174            CoffeeInfo::mDecaffPrice + CoffeeInfo::mCreamPrice + CoffeeInfo::mCreamPrice);
175         output << TestEnd;
176
177         output << TestStart;
178         output << "Test␣Mocha␣alla␣Diabetes" << endl << endl;
179         TestCoffeeIngridient(output, make_unique<Sugar>(make_unique<Sugar>(make_unique<Sugar>(
180            make_unique<Sugar>(make_unique<Sugar>(make_unique<Sugar>(
181               make_unique<Sugar>(make_unique<Sugar>(make_unique<Sugar>(
182                  make_unique<Mocha>()))))))))),
183            CoffeeInfo::mMochaInfo + ":␣" + CoffeeInfo::mSugarInfo + ",␣"
184            + CoffeeInfo::mSugarInfo + ",␣" + CoffeeInfo::mSugarInfo + ",␣"
185            + CoffeeInfo::mSugarInfo + ",␣" + CoffeeInfo::mSugarInfo + ",␣"
186            + CoffeeInfo::mSugarInfo + ",␣" + CoffeeInfo::mSugarInfo + ",␣"
187            + CoffeeInfo::mSugarInfo + ",␣" + CoffeeInfo::mSugarInfo + ",",
188            CoffeeInfo::mMochaPrice + CoffeeInfo::mSugarPrice * 9);
189         output << TestEnd;
190
191
192         TestCoffeePreparation(output);
193
194         TestCoffeeIngridientException(output);
195
196
197         if (TestOK) {
198            output << TestCaseOK;
199         }
200         else {
201            output << TestCaseFail;
202         }
203
204         output.close();
205      }
206
207      if (TestOK) {
208         cout << TestCaseOK;
209      }
210      else {
211         cout << TestCaseFail;
212      }
213   }
214   catch (const string& err) {
215      cerr << err << TestCaseFail;
216   }
217   catch (bad_alloc const& error) {
218      cerr << error.what() << TestCaseFail;
219   }
220   catch (const exception& err) {
221      cerr << err.what() << TestCaseFail;
222   }
```

```
223     catch (...) {
224        cerr << "Unhandelt␣Exception" << TestCaseFail;
225     }
226
227     if (output.is_open()) output.close();
228
229     return 0;
230
231
232  }
233
234  bool TestCoffeeIngridient(std::ostream & ost,ICoffee::Uptr cof, const std::string & description, const double price)
235  {
236     assert(cof != nullptr);
237     assert(ost.good());
238
239     std::string error_msg;
240     bool TestOK = true;
241
242     try {
243        TestOK = TestOK && check_dump(ost, "Test␣ICoffee␣Description", cof->GetDescription(), description);
244        TestOK = TestOK && check_dump(ost, "Test␣ICoffee␣Price", cof->GetCost(), price);
245     }
246     catch (const string& err) {
247        error_msg = err;
248     }
249     catch (bad_alloc const& error) {
250        error_msg = error.what();
251     }
252     catch (const exception& err) {
253        error_msg = err.what();
254     }
255     catch (...) {
256        error_msg = "Unhandelt␣Exception";
257     }
258
259     TestOK = TestOK && check_dump(ost, "Test␣for␣Exception␣in␣Testcase", true, error_msg.empty());
260
261     return TestOK;
262  }
263
264  bool TestCoffeeIngridientException(std::ostream& ost)
265  {
266     assert(ost.good());
267
268     std::string error_msg;
269     bool TestOK = true;
270
271     try {
272        ICoffee::Uptr cof = make_unique<Milk>(nullptr);
273     }
274     catch (const string& err) {
275        error_msg = err;
276     }
277     catch (bad_alloc const& error) {
278        error_msg = error.what();
279     }
280     catch (const exception& err) {
281        error_msg = err.what();
282     }
283     catch (...) {
284        error_msg = "Unhandelt␣Exception";
285     }
286
287     TestOK = TestOK && check_dump(ost, "Test␣for␣Exception␣in␣Ingedient␣CTOR", Ingredient::ERROR_NULLPTR, error_msg);
288
289     return TestOK;
290  }
291
292  bool TestCoffeePreparation(std::ostream& ost) {
293
294     assert(ost.good());
295
296
297     std::string error_msg;
```

```
298     bool TestOK = true;
299
300     try {
301        CoffeePreparation CoffeeMachine;
302
303        CoffeeMachine.Prepare(make_unique<Milk>(make_unique<Espresso>()));
304        CoffeeMachine.Prepare(make_unique<SojaMilk>(make_unique<ExtendedOne>()));
305
306        stringstream expected_output;
307        stringstream actual_output;
308
309
310        CoffeeMachine.Display(actual_output);
311
312        expected_output << CoffeeInfo::mEspressoInfo + ":␣" + CoffeeInfo::mMilkInfo + "␣" << CoffeeInfo::mEspressoPrice + CoffeeInfo::mMi
313        expected_output << CoffeeInfo::mExtendedInfo + ":␣" + CoffeeInfo::mSojaMilkInfo + "␣" << CoffeeInfo::mExtendedPrice + CoffeeInfo:
314
315        TestOK = TestOK && check_dump(ost, "Test␣CoffeePreparation␣Display␣1", actual_output.str(), expected_output.str());
316
317        ICoffee::Uptr cof = CoffeeMachine.Finished();
318
319        actual_output.str("");
320        expected_output.str("");
321
322        CoffeeMachine.Display(actual_output);
323
324        expected_output << CoffeeInfo::mExtendedInfo + ":␣" + CoffeeInfo::mSojaMilkInfo + "␣" << CoffeeInfo::mExtendedPrice + CoffeeInfo:
325
326        TestOK = TestOK && check_dump(ost, "Test␣CoffeePreparation␣Display␣2", actual_output.str(), expected_output.str());
327
328        cof = CoffeeMachine.Finished();
329
330     }
331     catch (const string& err) {
332        error_msg = err;
333     }
334     catch (bad_alloc const& error) {
335        error_msg = error.what();
336     }
337     catch (const exception& err) {
338        error_msg = err.what();
339     }
340     catch (...) {
341        error_msg = "Unhandelt␣Exception";
342     }
343
344     TestOK = TestOK && check_dump(ost, "Test␣for␣Exception␣in␣Testcase", true, error_msg.empty());
345
346     try {
347
348        CoffeePreparation CoffeeMachine;
349
350        stringstream badstream;
351
352        badstream.setstate(ios::badbit);
353
354        CoffeeMachine.Display(badstream);
355     }
356     catch (const string& err) {
357        error_msg = err;
358     }
359     catch (bad_alloc const& error) {
360        error_msg = error.what();
361     }
362     catch (const exception& err) {
363        error_msg = err.what();
364     }
365     catch (...) {
366        error_msg = "Unhandelt␣Exception";
367     }
368
369     TestOK = TestOK && check_dump(ost, "Test␣Exception␣Bad␣Ostream␣in␣CoffeePreparation", CoffeePreparation::ERROR_BAD_OSTREAM, error_ms
370
371     try {
372
```

```
373         CoffeePreparation CoffeeMachine;
374
375         CoffeeMachine.Display(ost);
376      }
377      catch (const string& err) {
378         error_msg = err;
379      }
380      catch (bad_alloc const& error) {
381         error_msg = error.what();
382      }
383      catch (const exception& err) {
384         error_msg = err.what();
385      }
386      catch (...) {
387         error_msg = "Unhandelt␣Exception";
388      }
389
390      TestOK = TestOK && check_dump(ost, "Test␣Exception␣Queue␣is␣Empty␣Display", CoffeePreparation::ERROR_NO_COFFE_IN_MACHINE, error_msg)
391
392      try {
393
394         CoffeePreparation CoffeeMachine;
395
396         CoffeeMachine.Finished();
397      }
398      catch (const string& err) {
399         error_msg = err;
400      }
401      catch (bad_alloc const& error) {
402         error_msg = error.what();
403      }
404      catch (const exception& err) {
405         error_msg = err.what();
406      }
407      catch (...) {
408         error_msg = "Unhandelt␣Exception";
409      }
410
411      TestOK = TestOK && check_dump(ost, "Test␣Exception␣Queue␣is␣Empty␣Finished", CoffeePreparation::ERROR_NO_COFFE_IN_MACHINE, error_msg
412
413
414      return TestOK;
415   }
```

6.25 Test.hpp

```
/*****************************************************************//**
 * \file   Test.hpp
 * \brief  File that provides a Test Function with a formated output
 *
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 *********************************************************************/
#ifndef TEST_HPP
#define TEST_HPP

#include <string>
#include <iostream>
#include <vector>
#include <list>
#include <queue>
#include <forward_list>

#define ON 1
#define OFF 0
#define COLOR_OUTPUT OFF

// Definitions of colors in order to change the color of the output stream.
const std::string colorRed = "\x1B[31m";
const std::string colorGreen = "\x1B[32m";
const std::string colorWhite = "\x1B[37m";

inline std::ostream& RED(std::ostream& ost) {
   if (ost.good()) {
      ost << colorRed;
   }
   return ost;
}
inline std::ostream& GREEN(std::ostream& ost) {
   if (ost.good()) {
      ost << colorGreen;
   }
   return ost;
}
inline std::ostream& WHITE(std::ostream& ost) {
   if (ost.good()) {
      ost << colorWhite;
   }
   return ost;
}

inline std::ostream& TestStart(std::ostream& ost) {
   if (ost.good()) {
      ost << std::endl;
      ost << "****************************************" << std::endl;
      ost << "          TESTCASE START          " << std::endl;
      ost << "****************************************" << std::endl;
      ost << std::endl;
   }
   return ost;
}

inline std::ostream& TestEnd(std::ostream& ost) {
   if (ost.good()) {
      ost << std::endl;
      ost << "****************************************" << std::endl;
      ost << std::endl;
   }
   return ost;
}

inline std::ostream& TestCaseOK(std::ostream& ost) {

#if COLOR_OUTPUT
   if (ost.good()) {
      ost << colorGreen << "TEST OK!!" << colorWhite << std::endl;
   }
#else
```

```
73     if (ost.good()) {
74        ost <<  "TEST␣OK!!" <<  std::endl;
75     }
76  #endif // COLOR_OUTPUT
77
78     return ost;
79  }
80
81  inline std::ostream& TestCaseFail(std::ostream& ost) {
82
83  #if COLOR_OUTPUT
84     if (ost.good()) {
85        ost << colorRed << "TEST␣FAILED␣!!" << colorWhite << std::endl;
86
87     }
88  #else
89     if (ost.good()) {
90        ost << "TEST␣FAILED␣!!" << std::endl;
91
92     }
93  #endif // COLOR_OUTPUT
94
95     return ost;
96  }
97
98  /**
99     * \brief function that reports if the testcase was successful.
100    *
101    * \param testcase String that indicates the testcase
102    * \param succsessful true -> reports to cout test OK
103    * \param succsessful false -> reports test failed
104    */
105 template <typename T>
106 bool check_dump(std::ostream& ostr, const std::string& testcase, const T& expected, const T& result) {
107    if (ostr.good()) {
108 #if COLOR_OUTPUT
109       if (expected == result) {
110          ostr << testcase << std::endl <<  colorGreen << "[Test␣OK]␣" << colorWhite <<"Result:␣(Expected:␣" << std::boolalpha << expect
   << std::noboolalpha << std::endl << std::endl;
111       }
112       else {
113          ostr << testcase << std::endl << colorRed << "[Test␣FAILED]␣" << colorWhite << "Result:␣(Expected:␣" << std::boolalpha << expe
   << std::noboolalpha << std::endl << std::endl;
114       }
115 #else
116       if (expected == result) {
117          ostr << testcase << std::endl << "[Test␣OK]␣"  << "Result:␣(Expected:␣" << std::boolalpha << expected << "␣==" << "␣Result:␣"
118       }
119       else {
120          ostr << testcase << std::endl  << "[Test␣FAILED]␣"  << "Result:␣(Expected:␣" << std::boolalpha << expected << "␣!=" << "␣Resul
121       }
122 #endif
123       if (ostr.fail()) {
124          std::cerr << "Error:␣Write␣Ostream" << std::endl;
125       }
126    }
127    else {
128       std::cerr << "Error:␣Bad␣Ostream" << std::endl;
129    }
130    return expected == result;
131 }
132
133 template <typename T1, typename T2>
134 std::ostream& operator<< (std::ostream& ost,const std::pair<T1,T2> & p) {
135    if (!ost.good()) throw std::exception{ "Error␣bad␣Ostream!" };
136    ost << "(" << p.first << "," << p.second << ")";
137    return ost;
138 }
139
140 template <typename T>
141 std::ostream& operator<< (std::ostream& ost,const std::vector<T> & cont) {
142    if (!ost.good()) throw std::exception{ "Error␣bad␣Ostream!" };
143    std::copy(cont.cbegin(), cont.cend(), std::ostream_iterator<T>{ost, "␣"});
144    return ost;
145 }
```

```
146
147 template <typename T>
148 std::ostream& operator<< (std::ostream& ost,const std::list<T> & cont) {
149    if (!ost.good()) throw std::exception{ "Error␣bad␣Ostream!" };
150    std::copy(cont.cbegin(), cont.cend(), std::ostream_iterator<T>{ost, "␣"});
151    return ost;
152 }
153
154 template <typename T>
155 std::ostream& operator<< (std::ostream& ost,const std::deque<T> & cont) {
156    if (!ost.good()) throw std::exception{ "Error␣bad␣Ostream!" };
157    std::copy(cont.cbegin(), cont.cend(), std::ostream_iterator<T>{ost, "␣"});
158    return ost;
159 }
160
161 template <typename T>
162 std::ostream& operator<< (std::ostream& ost,const std::forward_list<T> & cont) {
163    if (!ost.good()) throw std::exception{ "Error␣bad␣Ostream!" };
164    std::copy(cont.cbegin(), cont.cend(), std::ostream_iterator<T>{ost, "␣"});
165    return ost;
166 }
167
168
169 #endif // !TEST_HPP
```