Object-Oriented Software Engineering hw4

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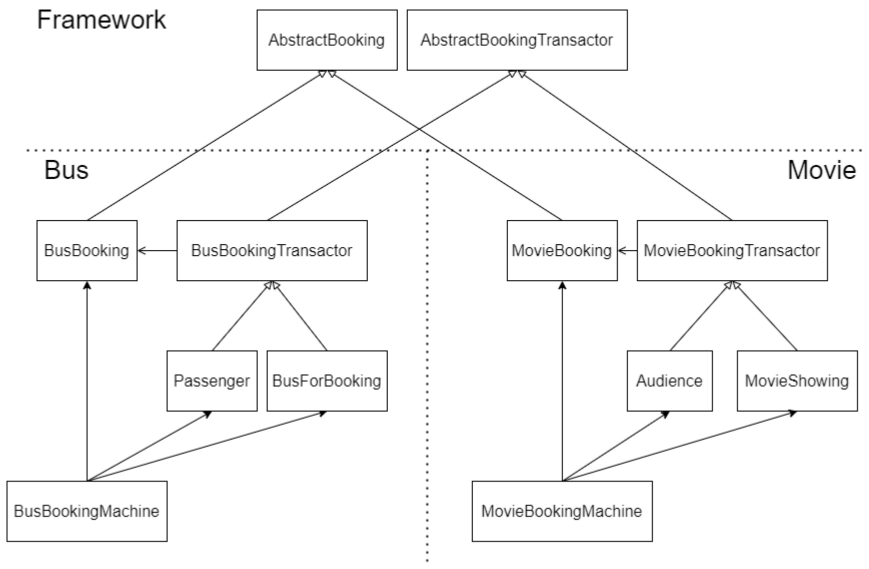
Environment

- OS: Ubuntu18.04.5 (WSL2)
- C++ compiler: g++ (Ubuntu 8.4.0-1ubuntu1~18.04) 8.4.0

Source code

Simple UML



File architecture

```
$ tree . -I 'bin|*.md'
.
├── Makefile
└── src/
    ├── booking_framework/
    │   ├── abstract_booking.h
    │   └── abstract_booking_transactor.h
    ├── bus_booking_system/
    │   ├── Makefile
    │   ├── bus_booking.cc
    │   ├── bus_booking.h
    │   ├── bus_booking_machine.cc
    │   ├── bus_booking_machine.h
    │   ├── bus_booking_transactor.cc
    │   ├── bus_booking_transactor.h
    │   ├── bus_for_booking.cc
    │   ├── bus_for_booking.h
    │   ├── date.cc
    │   ├── date.h
    │   ├── main.cc
    │   ├── passenger.cc
    │   └── passenger.h
    └── movie_booking_system/
        ├── Makefile
        ├── audience.cc
        ├── audience.h
        ├── date.cc
        ├── date.h
        ├── main.cc
        ├── movie_booking.cc
        ├── movie_booking.h
        ├── movie_booking_machine.cc
        ├── movie_booking_machine.h
        ├── movie_booking_transactor.cc
        ├── movie_booking_transactor.h
        ├── movie_showing.cc
        └── movie_showing.h

4 directories, 31 files
```

- File `src/booking_framework/abstract_booking.h`:

```cpp
#ifndef ABSTRACT_BOOKING
#define ABSTRACT_BOOKING

/**
 * @brief Abstract class for Booking.
 *
 * Any concrete booking should be derived from this class.
 */
class AbstractBooking {};

#endif /* ABSTRACT_BOOKING */
```

- File `src/booking_framework/abstract_booking_transactor.h`:

```cpp
#ifndef ABSTRACT_BOOKING_TRANSACTOR_H
#define ABSTRACT_BOOKING_TRANSACTOR_H

#include <memory>
#include <unordered_map>
#include "abstract_booking.h"

/**
 * @brief Abstract class of booking transactor.
 *
 * @tparam Booking the class name that used to be transacted.
 */
template <typename Booking>
class AbstractBookingTransactor {
 public:
  AbstractBookingTransactor() {
    static_assert(
        std::is_base_of<AbstractBooking, Booking>::value,
        "Your customed Booking should be derived from AbstractBooking.");
  }
  /**
   * @brief Add the booking into held booking list.
   *
   * @param booking_index the unique index.
   * @param booking the shared pointer to the booking object.
   */
  void AddBookingTransaction(int booking_index,
                             std::shared_ptr<Booking> booking) {
    held_bookings_.emplace(booking_index, booking);
    this->BookingAdded(booking);
  }

  /**
   * @brief Remove a booking from the booking list.
   *
   * @param booking_index the index of the booking to be removed.
   */
  void RemoveBookingTransaction(int booking_index) {
    auto erase_count = held_bookings_.erase(booking_index);

    if (erase_count == 0) {
      this->BookingEmptyWhenRemoved();
    }
    this->BookingRemoved();
  }

  std::unordered_map<int, std::shared_ptr<Booking>> get_held_bookings() const {
    return held_bookings_;
  }

  /* Hooks */
  /**
   * @brief The hook called when a Booking is added.
   *
   * Derived class can override this hook function.
   */
  virtual void BookingAdded(std::shared_ptr<Booking>) {}

  /**
   * @brief The hook called when a Booking is removed.
   *
   * Derived class can override this hook function.
   */
  virtual void BookingRemoved() {}

  /**
   * @brief The hook called when the held booking is empty during calling
   * RemoveBookingTransaction.
   *
   * Derived class can override this hook function.
   */
  virtual void BookingEmptyWhenRemoved() {}

 protected:
  std::unordered_map<int, std::shared_ptr<Booking>> held_bookings_;
};

#endif /* ABSTRACT_BOOKING_TRANSACTOR_H */
```

- File `src/bus_booking_system/bus_booking.h`:

```cpp
#ifndef BUS_BOOKING_H
#define BUS_BOOKING_H

#include <string>
#include "../booking_framework/abstract_booking.h"
#include "date.h"

class BusBooking : public AbstractBooking {
 public:
  BusBooking(std::string buyer_name, std::string bus_name, int num_of_people,
             Date bus_departure_date);
  std::string get_buyer_name() const;
  std::string get_bus_name() const;
  int get_num_of_people() const;
  Date get_bus_departure_date() const;

 private:
  std::string buyer_name_{""};
  std::string bus_name_{""};
  int num_of_people_{0};
  Date bus_departure_date_{1997, 1, 1};
};

std::ostream &operator<<(std::ostream &out, const BusBooking bus_booking);

#endif /* BUS_BOOKING_H */
```

- File `src/bus_booking_system/bus_booking.cc`:

```cpp
#include "bus_booking.h"

BusBooking::BusBooking(std::string buyer_name, std::string bus_name,
                       int num_of_people, Date bus_departure_date)
    : buyer_name_{buyer_name},
      bus_name_{bus_name},
      num_of_people_{num_of_people},
      bus_departure_date_{bus_departure_date} {}

```

```
std::string BusBooking::get_buyer_name() const { return buyer_name_; }
std::string BusBooking::get_bus_name() const { return bus_name_; }
int BusBooking::get_num_of_people() const { return num_of_people_; }
Date BusBooking::get_bus_departure_date() const { return bus_departure_date_; }

std::ostream &operator<<(std::ostream &out, const BusBooking bus_booking) {
  out << "Passenger: " << bus_booking.get_buyer_name()
      << ", Bus: " << bus_booking.get_bus_name()
      << ", Num of people: " << bus_booking.get_num_of_people()
      << ", Date: " << bus_booking.get_bus_departure_date();
  return out;
}
```

- File `src/bus_booking_system/bus_booking_machine.h`:

```
#ifndef BUS_BOOKING_MACHINE_H
#define BUS_BOOKING_MACHINE_H

#include "bus_booking.h"
#include "bus_for_booking.h"
#include "passenger.h"

class BusBookingMachine {
 public:
  /**
   * @brief Get the Booking Machine object.
   *
   * Because the constructor is private, the way to get booking machine is to
   * use this function.
   * @return BusBookingMachine&
   */
  static BusBookingMachine &GetBusBookingMachine() {
    static BusBookingMachine instance;
    return instance;
  }
  /**
   * @brief Copy constructor and copy assignment are deleted so that the object
   * cannot be copied.
   */
  BusBookingMachine(const BusBookingMachine &) = delete;
  void operator=(const BusBookingMachine &) = delete;
  /**
   * @brief Add one booking to connect two transactors.
   *
   * Every bookings increase the booking_index_ to make it unique.
   * Shared pointer (shared_ptr) is used to share the booking object to two
   * transactors, and the booking object will be freed automatically if the
   * pointer counter becomes 0.
   * @param passenger The pointer to the passenger.
   * @param bus The pointer to the bus.
   * @param num_of_people how many seats (number of people) are booked in this
   * action.
   */
  void MakeBooking(Passenger *const passenger, BusForBooking *const bus,
                   const int num_of_people);

 private:
  BusBookingMachine() {}
  inline static int booking_index_{0};
};

#endif /* BUS_BOOKING_MACHINE_H */
```

- File `src/bus_booking_system/bus_booking_machine.cc`:

```
#include "bus_booking_machine.h"

/**
 * @brief Adapter to make aggregate struct be shared.
 *
 * @tparam T The type of aggregate struct.
 * @tparam Args The variadic type of args.
 * @param args The in-order elements of aggregate struct.
 * @return std::shared_ptr<T>
 */
template <typename T, typename... Args>
static std::shared_ptr<T> make_aggregate_shared(Args &&... args) {
  return std::make_shared<T>(T{std::forward<Args>(args)...});
}

void BusBookingMachine::MakeBooking(Passenger *const passenger,
                                    BusForBooking *const bus,
                                    const int num_of_people) {
  auto booking = make_aggregate_shared<BusBooking>(
      passenger->get_name(), bus->get_name(), num_of_people,
      bus->get_departure_date());
  passenger->AddBooking(booking_index_, booking);
  bus->AddBooking(booking_index_, booking);
  booking_index_++;
}
```

- File `src/bus_booking_system/bus_booking_transactor.h`:

```
#ifndef BUS_BOOKING_TRANSACTOR_H
#define BUS_BOOKING_TRANSACTOR_H

#include <string>
#include "../booking_framework/abstract_booking_transactor.h"
#include "bus_booking.h"

class BusBookingTransactor : public AbstractBookingTransactor<BusBooking> {
 public:
  BusBookingTransactor(std::string name);
  std::string get_name();
  virtual void PrintBookings() const = 0;

 protected:
  std::string name_;
};

#endif /* BUS_BOOKING_TRANSACTOR_H */
```

- File `src/bus_booking_system/bus_booking_transactor.cc`:

```
#include "bus_booking_transactor.h"

BusBookingTransactor::BusBookingTransactor(std::string name) : name_{name} {}

std::string BusBookingTransactor::get_name() { return name_; }
```

- File `src/bus_booking_system/bus_for_booking.h`:

```
#ifndef BUS_FOR_BOOKING_H
#define BUS_FOR_BOOKING_H

#include <string>
#include "bus_booking.h"
#include "bus_booking_transactor.h"

class BusForBooking : public BusBookingTransactor {
 public:
  BusForBooking(std::string name, Date departure_date);
  void AddBooking(int, std::shared_ptr<BusBooking>);
  Date get_departure_date() const;

  /**
   * @brief Overridden function to print passenger info from movie's booking
   * list.
   */
  void PrintBookings() const final;

```

```cpp
 private:
  /* Custom Hooks */
  void BookingAdded(std::shared_ptr<BusBooking> b) final;
  Date departure_date_;
};

#endif /* BUS_FOR_BOOKING_H */
```

- File `src/bus_booking_system/bus_for_booking.cc`:

```cpp
#include "bus_for_booking.h"

BusForBooking::BusForBooking(std::string name, Date departure_date)
    : BusBookingTransactor{name}, departure_date_{departure_date} {}

void BusForBooking::AddBooking(int index, std::shared_ptr<BusBooking> booking) {
  this->AddBookingTransaction(index, std::move(booking));
}

Date BusForBooking::get_departure_date() const { return departure_date_; }

void BusForBooking::PrintBookings() const {
  const auto& bookings_ = this->get_held_bookings();
  if (bookings_.empty()) {
    std::cout << name_ << " does not have any passenger.\n";
    return;
  }
  std::cout << "The passengers of " << name_ << ":";
  for ([[maybe_unused]] const auto& [_, booking_ptr] : bookings_) {
    std::cout << " (" << booking_ptr->get_buyer_name() << ", "
              << booking_ptr->get_num_of_people() << ")";
  }
  std::cout << ".\n";
}

void BusForBooking::BookingAdded(std::shared_ptr<BusBooking> b) {
  std::cout << "[BusForBooking INFO] booking added!: (" << *(b.get()) << ")\n";
}
```

- File `src/bus_booking_system/date.h`:

```cpp
#ifndef DATE_H
#define DATE_H

#include <iostream>

struct Date {
  uint16_t year;
  uint8_t month;
  uint8_t day;
};
/**
 * @brief Define the output format for Date struct.
 *
 * @param out The output stream.
 * @param date The date that needs to be printed to output stream.
 * @return std::ostream&
 */
std::ostream &operator<<(std::ostream &out, const Date date);

#endif /* DATE_H */
```

- File `src/bus_booking_system/date.cc`:

```cpp
#include "date.h"

std::ostream &operator<<(std::ostream &out, const Date date) {
  out << date.year << "/" << static_cast<int>(date.month) << "/"
      << static_cast<int>(date.day);
  return out;
}
```

- File `src/bus_booking_system/main.cc`:

```cpp
#include <iostream>
#include <memory>
#include "bus_booking_machine.h"

int main([[maybe_unused]] int argc, [[maybe_unused]] char *argv[]) {
  /* New people */
  auto alice = std::make_unique<Passenger>("Alice");
  auto bob = std::make_unique<Passenger>("Bob");
  auto carol = std::make_unique<Passenger>("Carol");
  auto dave = std::make_unique<Passenger>("Dave");
  auto eve = std::make_unique<Passenger>("Eve");
  /* New buses */
  auto bus100 = std::make_unique<BusForBooking>("Bus100", Date{2021, 2, 25});
  auto bus101 = std::make_unique<BusForBooking>("Bus101", Date{2021, 2, 26});
  auto bus102 = std::make_unique<BusForBooking>("Bus102", Date{2021, 2, 27});
  auto bus103 = std::make_unique<BusForBooking>("Bus103", Date{2022, 2, 28});
  /* Book bus bookings */
  auto &bbmachine = BusBookingMachine::GetBusBookingMachine();
  bbmachine.MakeBooking(alice.get(), bus100.get(), 4);
  bbmachine.MakeBooking(alice.get(), bus102.get(), 2);
  bbmachine.MakeBooking(bob.get(), bus100.get(), 6);
  bbmachine.MakeBooking(carol.get(), bus101.get(), 3);
  bbmachine.MakeBooking(dave.get(), bus100.get(), 5);
  /* Validation */
  bus100->PrintBookings();
  alice->PrintBookings();
  bus101->PrintBookings();
  bob->PrintBookings();
  bus103->PrintBookings();
  eve->PrintBookings();
  return 0;
}
```

- File `src/bus_booking_system/passenger.h`:

```cpp
#ifndef PASSENGER_H
#define PASSENGER_H

#include <string>
#include "bus_booking.h"
#include "bus_booking_transactor.h"

class Passenger : public BusBookingTransactor {
 public:
  Passenger(std::string name);
  void AddBooking(int, std::shared_ptr<BusBooking>);

  /**
   * @brief Overridden function to print passenger info from movie's booking
   * list.
   */
  void PrintBookings() const final;

 private:
  /* Custom Hooks */
  void BookingAdded(std::shared_ptr<BusBooking> b) final;
};

#endif /* PASSENGER_H */
```

- File `src/bus_booking_system/passenger.cc`:

```cpp
#include "passenger.h"

Passenger::Passenger(std::string name) : BusBookingTransactor{name} {}

void Passenger::AddBooking(int index, std::shared_ptr<BusBooking> booking) {
  this->AddBookingTransaction(index, std::move(booking));
}

void Passenger::PrintBookings() const {
  const auto& bookings_ = this->get_held_bookings();
  if (bookings_.empty()) {
    std::cout << name_ << " does not book any booking for bus.\n";
    return;
  }
  std::cout << name_ << " has booked:";
  for ([[maybe_unused]] const auto& [_, booking_ptr] : bookings_) {
    std::cout << " (" << booking_ptr->get_bus_name() << ", "
              << booking_ptr->get_bus_departure_date() << ")";
  }
  std::cout << ".\n";
}

void Passenger::BookingAdded(std::shared_ptr<BusBooking> b) {
  std::cout << "[Passenger     INFO] booking added!: (" << *(b.get()) << ")\n";
}
```

- File `src/movie_booking_system/audience.h`:

```cpp
#ifndef AUDIENCE_H
#define AUDIENCE_H

#include <string>
#include "movie_booking.h"
#include "movie_booking_transactor.h"

class Audience : public MovieBookingTransactor {
 public:
  Audience(std::string name);
  void AddBooking(int, std::shared_ptr<MovieBooking>);

  /**
   * @brief Overridden function to print passenger info from movie's booking
   * list.
   */
  void PrintBookings() const final;

 private:
  /* Custom Hooks */
  void BookingAdded(std::shared_ptr<MovieBooking> b) final;
};

#endif /* AUDIENCE_H */
```

- File `src/movie_booking_system/audience.cc`:

```cpp
#include "audience.h"

Audience::Audience(std::string name) : MovieBookingTransactor{name} {}

void Audience::AddBooking(int index, std::shared_ptr<MovieBooking> booking) {
  this->AddBookingTransaction(index, std::move(booking));
}

void Audience::PrintBookings() const {
  const auto& bookings_ = this->get_held_bookings();
  if (bookings_.empty()) {
    std::cout << name_ << " does not book any booking for movie.\n";
    return;
  }
  std::cout << name_ << " has booked:";
  for ([[maybe_unused]] const auto& [_, booking_ptr] : bookings_) {
    std::cout << " (" << booking_ptr->get_movie_name() << ", "
              << booking_ptr->get_movie_showing_date() << ")";
  }
  std::cout << ".\n";
}

void Audience::BookingAdded(std::shared_ptr<MovieBooking> b) {
  std::cout << "[Audience     INFO] booking added!: (" << *(b.get()) << ")\n";
}
```

- File `src/movie_booking_system/date.h`:

```cpp
#ifndef DATE_H
#define DATE_H

#include <iostream>

struct Date {
  uint16_t year;
  uint8_t month;
  uint8_t day;
};
/**
 * @brief Define the output format for Date struct.
 *
 * @param out The output stream.
 * @param date The date that needs to be printed to output stream.
 * @return std::ostream&
 */
std::ostream &operator<<(std::ostream &out, const Date date);

#endif /* DATE_H */
```

- File `src/movie_booking_system/date.cc`:

```cpp
#include "date.h"

std::ostream &operator<<(std::ostream &out, const Date date) {
  out << date.year << "/" << static_cast<int>(date.month) << "/"
      << static_cast<int>(date.day);
  return out;
}
```

- File `src/movie_booking_system/main.cc`:

```cpp
#include <iostream>
#include <memory>
#include "movie_booking_machine.h"

int main([[maybe_unused]] int argc, [[maybe_unused]] char *argv[]) {
  /* New people */
  auto alice = std::make_unique<Audience>("Alice");
  auto bob = std::make_unique<Audience>("Bob");
  auto carol = std::make_unique<Audience>("Carol");
  auto dave = std::make_unique<Audience>("Dave");
  auto eve = std::make_unique<Audience>("Eve");
  /* New moviees */
  auto movie100 = std::make_unique<MovieShowing>("Movie100", Date{2021, 2, 25});
  auto movie101 = std::make_unique<MovieShowing>("Movie101", Date{2021, 2, 26});
  auto movie102 = std::make_unique<MovieShowing>("Movie102", Date{2021, 2, 27});
  auto movie103 = std::make_unique<MovieShowing>("Movie103", Date{2022, 2, 28});
  /* Book movie bookings */
  auto &mbmachine = MovieBookingMachine::GetMovieBookingMachine();
  mbmachine.MakeBooking(alice.get(), movie100.get(), /* num_of_pelple */ 4,
                        /* seat_number */ 0);
  mbmachine.MakeBooking(alice.get(), movie102.get(), /* num_of_pelple */ 2,
                        /* seat_number */ 1);
  mbmachine.MakeBooking(bob.get(), movie100.get(), /* num_of_pelple */ 6,
                        /* seat_number */ 2);
  mbmachine.MakeBooking(carol.get(), movie101.get(), /* num_of_pelple */ 3,
                        /* seat_number */ 3);
  mbmachine.MakeBooking(dave.get(), movie100.get(), /* num_of_pelple */ 5,
                        /* seat_number */ 4);
  /* Validation */
  movie100->PrintBookings();
  alice->PrintBookings();
  movie101->PrintBookings();
  bob->PrintBookings();
  movie103->PrintBookings();
  eve->PrintBookings();
  return 0;
}
```

- File `src/movie_booking_system/movie_booking.h`:

```
#ifndef MOVIE_BOOKING_H
#define MOVIE_BOOKING_H

#include <string>
#include "../booking_framework/abstract_booking.h"
#include "date.h"

class MovieBooking : public AbstractBooking {
 public:
  MovieBooking(std::string buyer_name, std::string movie_name,
               int num_of_people, int seat_number, Date movie_showing_date);
  std::string get_buyer_name() const;
  std::string get_movie_name() const;
  int get_num_of_people() const;
  int get_seat_number() const;
  Date get_movie_showing_date() const;

 private:
  std::string buyer_name_{""};
  std::string movie_name_{""};
  int num_of_people_{0};
  int seat_number_{0};
  Date movie_showing_date_{1997, 1, 1};
};

std::ostream &operator<<(std::ostream &out, const MovieBooking movie_booking);

#endif /* MOVIE_BOOKING_H */
```

- File `src/movie_booking_system/movie_booking.cc`:

```
#include "movie_booking.h"

MovieBooking::MovieBooking(std::string buyer_name, std::string movie_name,
                           int num_of_people, int seat_number,
                           Date movie_showing_date)
    : buyer_name_{buyer_name},
      movie_name_{movie_name},
      num_of_people_{num_of_people},
      seat_number_{seat_number},
      movie_showing_date_{movie_showing_date} {}

std::string MovieBooking::get_buyer_name() const { return buyer_name_; }
std::string MovieBooking::get_movie_name() const { return movie_name_; }
int MovieBooking::get_num_of_people() const { return num_of_people_; }
int MovieBooking::get_seat_number() const { return seat_number_; }
Date MovieBooking::get_movie_showing_date() const {
  return movie_showing_date_;
}

std::ostream &operator<<(std::ostream &out, const MovieBooking movie_booking) {
  out << "Passenger: " << movie_booking.get_buyer_name()
      << ", Movie: " << movie_booking.get_movie_name()
      << ", Num of people: " << movie_booking.get_num_of_people()
      << ", Seat number: " << movie_booking.get_seat_number()
      << ", Date: " << movie_booking.get_movie_showing_date();
  return out;
}
```

- File `src/movie_booking_system/movie_booking_machine.h`:

```
#ifndef MOVIE_BOOKING_MACHINE_H
#define MOVIE_BOOKING_MACHINE_H

#include "audience.h"
#include "movie_booking.h"
#include "movie_showing.h"

class MovieBookingMachine {
 public:
  /**
   * @brief Get the Booking Machine object.
   *
   * Because the constructor is private, the way to get booking machine is to
   * use this function.
   * @return MovieBookingMachine&
   */
  static MovieBookingMachine &GetMovieBookingMachine() {
    static MovieBookingMachine instance;
    return instance;
  }
  /**
   * @brief Copy constructor and copy assignment are deleted so that the object
   * cannot be copied.
   */
  MovieBookingMachine(const MovieBookingMachine &) = delete;
  void operator=(const MovieBookingMachine &) = delete;
  /**
   * @brief Add one booking to connect two transactors.
   *
   * Every bookings increase the booking_index_ to make it unique.
   * Shared pointer (shared_ptr) is used to share the booking object to two
   * transactors, and the booking object will be freed automatically if the
   * pointer counter becomes 0.
   * @param audience The pointer to the audience.
   * @param movie The pointer to the movie.
   * @param num_of_people how many seats (number of people) are booked in this
   * action.
   * @param seat_number the specified seat number.
   */
  void MakeBooking(Audience *const audience, MovieShowing *const movie,
                   const int num_of_people, const int seat_number);

 private:
  MovieBookingMachine() {}
  inline static int booking_index_{0};
};

#endif /* MOVIE_BOOKING_MACHINE_H */
```

- File `src/movie_booking_system/movie_booking_machine.cc`:

```
#include "movie_booking_machine.h"

/**
 * @brief Adapter to make aggregate struct be shared.
 *
 * @tparam T The type of aggregate struct.
 * @tparam Args The variadic type of args.
 * @param args The in-order elements of aggregate struct.
 * @return std::shared_ptr<T>
 */
template <typename T, typename... Args>
static std::shared_ptr<T> make_aggregate_shared(Args &&... args) {
```

```cpp
  return std::make_shared<T>(T{std::forward<Args>(args)...});
}

void MovieBookingMachine::MakeBooking(Audience *const audience,
                                      MovieShowing *const movie,
                                      const int num_of_people,
                                      const int seat_number) {
  auto booking = make_aggregate_shared<MovieBooking>(
      audience->get_name(), movie->get_name(), num_of_people, seat_number,
      movie->get_showing_date());
  audience->AddBooking(booking_index_, booking);
  movie->AddBooking(booking_index_, booking);
  booking_index_++;
}
```

- File `src/movie_booking_system/movie_booking_transactor.h`:

```cpp
#ifndef MOVIE_BOOKING_TRANSACTOR_H
#define MOVIE_BOOKING_TRANSACTOR_H

#include <string>
#include "../booking_framework/abstract_booking_transactor.h"
#include "movie_booking.h"

class MovieBookingTransactor : public AbstractBookingTransactor<MovieBooking> {
 public:
  MovieBookingTransactor(std::string name);
  std::string get_name();
  virtual void PrintBookings() const = 0;

 protected:
  std::string name_;
};

#endif /* MOVIE_BOOKING_TRANSACTOR_H */
```

- File `src/movie_booking_system/movie_booking_transactor.cc`:

```cpp
#include "movie_booking_transactor.h"

MovieBookingTransactor::MovieBookingTransactor(std::string name)
    : name_{name} {}

std::string MovieBookingTransactor::get_name() { return name_; }
```

- File `src/movie_booking_system/movie_showing.h`:

```cpp
#ifndef MOVIE_FOR_BOOKING_H
#define MOVIE_FOR_BOOKING_H

#include <string>
#include "movie_booking.h"
#include "movie_booking_transactor.h"

class MovieShowing : public MovieBookingTransactor {
 public:
  MovieShowing(std::string name, Date showing_date);
  void AddBooking(int, std::shared_ptr<MovieBooking>);
  Date get_showing_date() const;

  /**
   * @brief Overridden function to print passenger info from movie's booking
   * list.
   */
  void PrintBookings() const final;

 private:
  /* Custom Hooks */
  void BookingAdded(std::shared_ptr<MovieBooking> b) final;
  Date showing_date_;
};

#endif /* MOVIE_FOR_BOOKING_H */
```

- File `src/movie_booking_system/movie_showing.cc`:

```cpp
#include "movie_showing.h"

MovieShowing::MovieShowing(std::string name, Date showing_date)
    : MovieBookingTransactor{name}, showing_date_{showing_date} {}

void MovieShowing::AddBooking(int index,
                              std::shared_ptr<MovieBooking> booking) {
  this->AddBookingTransaction(index, std::move(booking));
}

Date MovieShowing::get_showing_date() const { return showing_date_; }

void MovieShowing::PrintBookings() const {
  const auto& bookings_ = this->get_held_bookings();
  if (bookings_.empty()) {
    std::cout << name_ << " does not have any passenger.\n";
    return;
  }
  std::cout << "The passengers of " << name_ << ":";
  for ([[maybe_unused]] const auto& [_, booking_ptr] : bookings_) {
    std::cout << " (" << booking_ptr->get_buyer_name() << ", "
              << booking_ptr->get_num_of_people() << ")";
  }
  std::cout << ".\n";
}

void MovieShowing::BookingAdded(std::shared_ptr<MovieBooking> b) {
  std::cout << "[MovieShowing INFO] booking added!: (" << *(b.get()) << ")\n";
}
```

Executive results

- booking_bus:

```
$ ./bin/booking_bus
[Passenger     INFO] booking added!:
(Passenger: Alice, Bus: Bus100, Num of people: 4, Date: 2021/2/25)
[BusForBooking INFO] booking added!:
(Passenger: Alice, Bus: Bus100, Num of people: 4, Date: 2021/2/25)
[Passenger     INFO] booking added!:
(Passenger: Alice, Bus: Bus102, Num of people: 2, Date: 2021/2/27)
[BusForBooking INFO] booking added!:
(Passenger: Alice, Bus: Bus102, Num of people: 2, Date: 2021/2/27)
[Passenger     INFO] booking added!:
(Passenger: Bob, Bus: Bus100, Num of people: 6, Date: 2021/2/25)
[BusForBooking INFO] booking added!:
(Passenger: Bob, Bus: Bus100, Num of people: 6, Date: 2021/2/25)
[Passenger     INFO] booking added!:
(Passenger: Carol, Bus: Bus101, Num of people: 3, Date: 2021/2/26)
[BusForBooking INFO] booking added!:
(Passenger: Carol, Bus: Bus101, Num of people: 3, Date: 2021/2/26)
[Passenger     INFO] booking added!:
(Passenger: Dave, Bus: Bus100, Num of people: 5, Date: 2021/2/25)
[BusForBooking INFO] booking added!:
(Passenger: Dave, Bus: Bus100, Num of people: 5, Date: 2021/2/25)
The passengers of Bus100: (Dave, 5) (Alice, 4) (Bob, 6).
Alice has booked: (Bus102, 2021/2/27) (Bus100, 2021/2/25).
The passengers of Bus101: (Carol, 3).
Bob has booked: (Bus100, 2021/2/25).
Bus103 does not have any passenger.
Eve does not book any booking for bus.
```

- booking_movie:

```
$ ./bin/booking_movie
[Audience     INFO] booking added!:
(Passenger: Alice, Movie: Movie100, Num of people: 4, Seat number: 0, Date: 2021/2/25)
[MovieShowing INFO] booking added!:
(Passenger: Alice, Movie: Movie100, Num of people: 4, Seat number: 0, Date: 2021/2/25)
[Audience     INFO] booking added!:
(Passenger: Alice, Movie: Movie102, Num of people: 2, Seat number: 1, Date: 2021/2/27)
[MovieShowing INFO] booking added!:
(Passenger: Alice, Movie: Movie102, Num of people: 2, Seat number: 1, Date: 2021/2/27)
[Audience     INFO] booking added!:
(Passenger: Bob, Movie: Movie100, Num of people: 6, Seat number: 2, Date: 2021/2/25)
[MovieShowing INFO] booking added!:
(Passenger: Bob, Movie: Movie100, Num of people: 6, Seat number: 2, Date: 2021/2/25)
[Audience     INFO] booking added!:
(Passenger: Carol, Movie: Movie101, Num of people: 3, Seat number: 3, Date: 2021/2/26)
[MovieShowing INFO] booking added!:
(Passenger: Carol, Movie: Movie101, Num of people: 3, Seat number: 3, Date: 2021/2/26)
[Audience     INFO] booking added!:
(Passenger: Dave, Movie: Movie100, Num of people: 5, Seat number: 4, Date: 2021/2/25)
[MovieShowing INFO] booking added!:
(Passenger: Dave, Movie: Movie100, Num of people: 5, Seat number: 4, Date: 2021/2/25)
The audiences of Movie100: (Dave, 5) (Alice, 4) (Bob, 6).
Alice has booked: (Movie102, 2021/2/27) (Movie100, 2021/2/25).
The audiences of Movie101: (Carol, 3).
Bob has booked: (Movie100, 2021/2/25).
Movie103 does not have any audience.
Eve does not book any booking for movie.
```