University of
South Australia

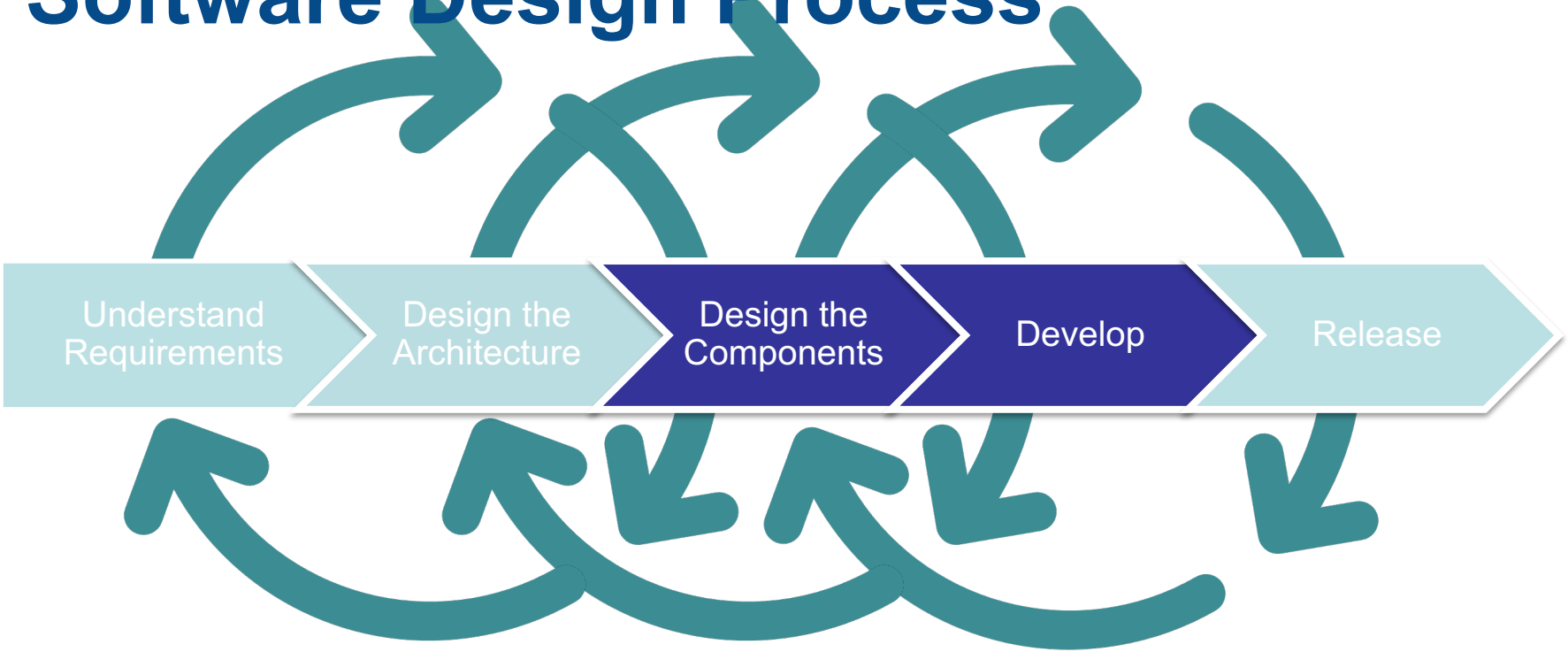
INFS 2044

Workshop 4b Answers

Preparation

- Read the required readings
- Watch the Week 4 Lecture
- Bring a copy of the workshop instructions (this document) to the workshop

Software Design Process



Where We Are At

- Designed system- and component- interfaces
- Drew Sequence, Communication, and Class Diagrams
- Assessed feasibility of an interaction design

Learning Objectives

- Develop use case realisations through interaction design and design principles
- Apply the Dependency Inversion principle to manage dependencies

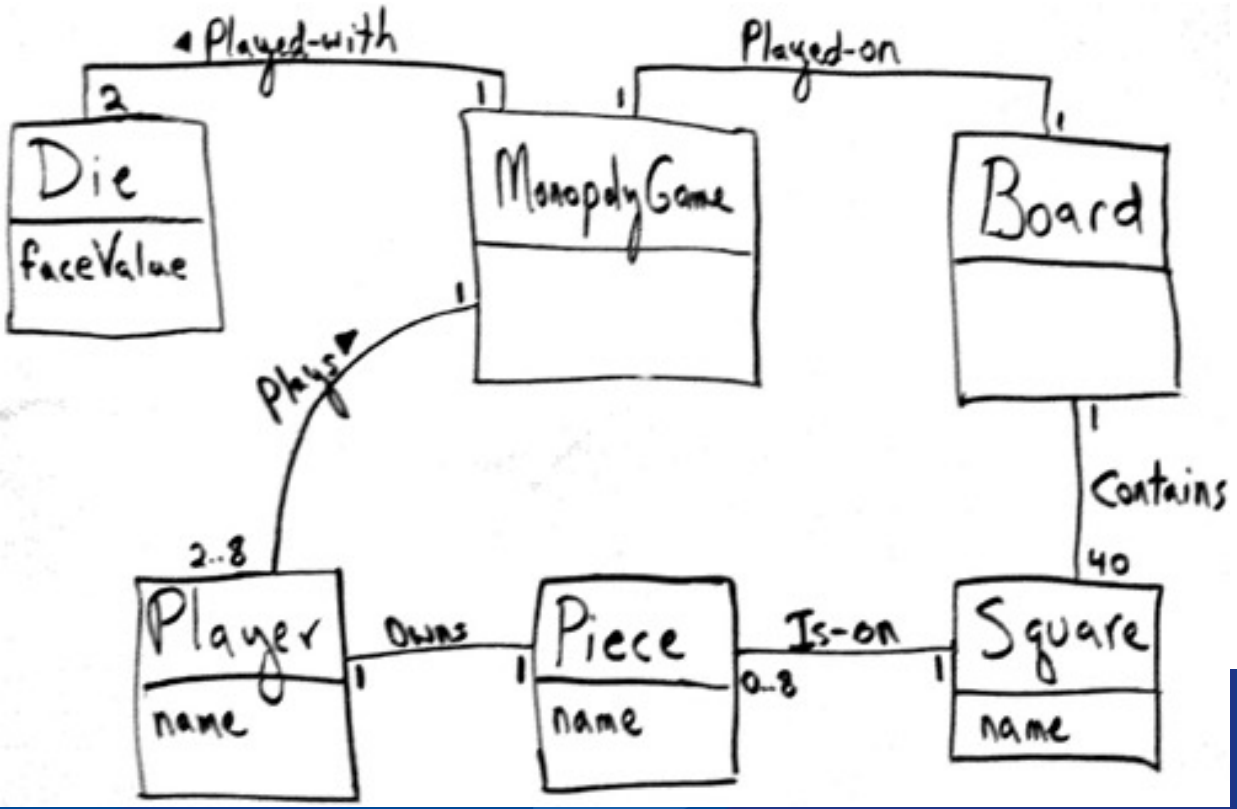
Task 1. Iterative Impl. Design

- Design an implementation for a simple Monopoly Game
- Your tutor will lead this activity.

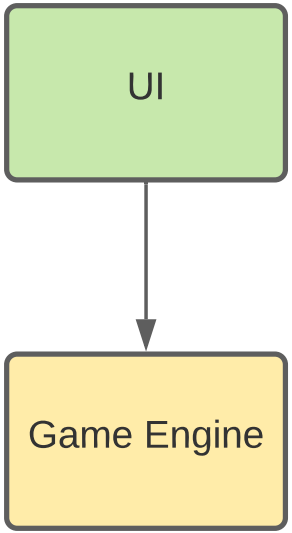
Monopoly

https://commons.wikimedia.org/wiki/File:Monopoly.jpg

Domain Model



Component Architecture



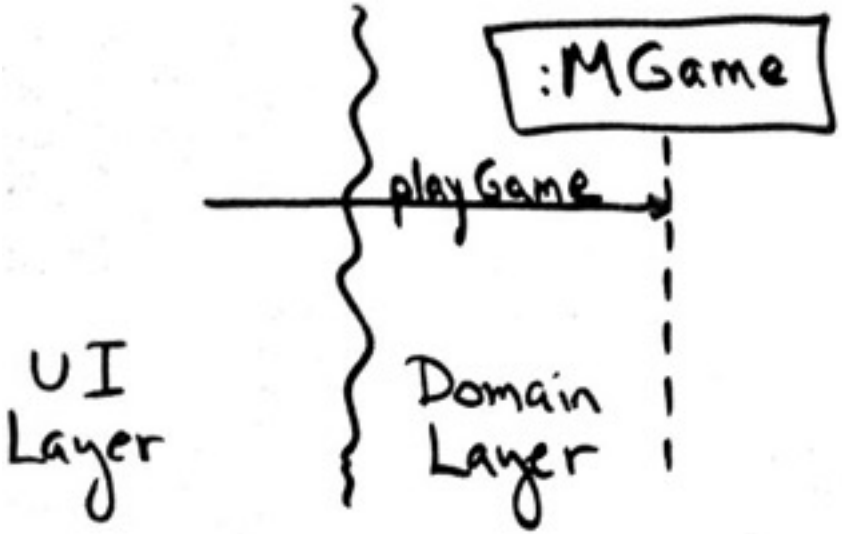
System Operations

- Initialize()
- **playGame()**

Heuristic #1: Choosing a Manager

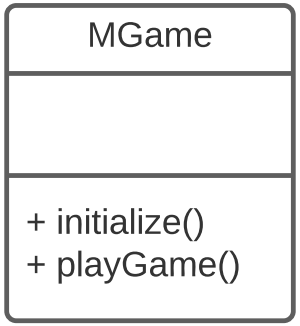
- Design Heuristic
  - System operations should be received by a dedicated object that orchestrates the implementation of these operations
  - Represents the overall “system,” “root object,” a specialized device, or a major subsystem.
  - Called *-Manager, *-Controller, *-Handler
- Related patterns
  - Controller
  - Façade

Introducing the Manager



Larman (2004) Applying UML and Patterns

Partial Class Diagram



The Game Loop

```
for N rounds:
     for each player p:
          p takes a turn
```

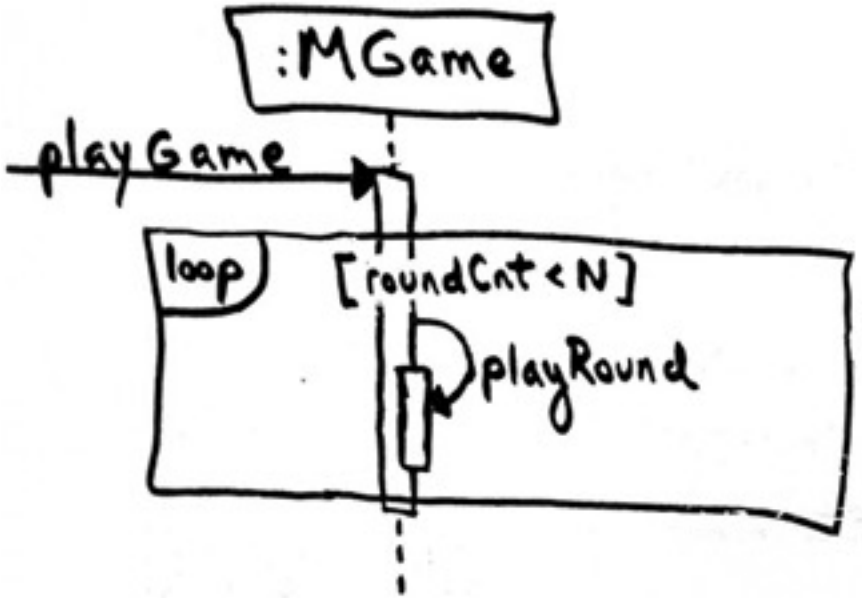
Who is responsible for controlling the game loop?

- The Manager?
- Another object?

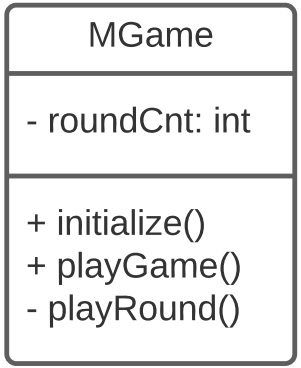
Heuristic #2: Information Need

Information Needed	Who Has the Information?
the current round count	No object has it yet, but the domain model suggests assigning this responsibility to the MonopolyGame object is justifiable.
all the players (so that each can be used in taking a turn)	Taking inspiration from the domain model, MonopolyGame is a good candidate.

Implementing the Game Loop

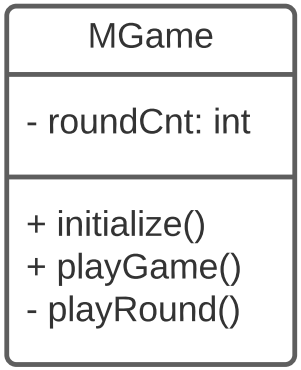


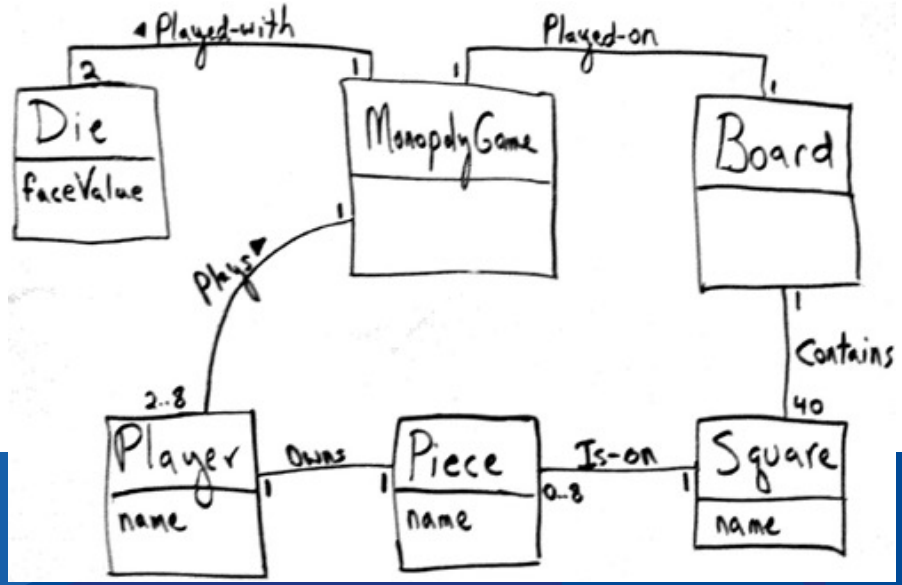
Partial Class Diagram



Taking a Turn

- Involves rolling the dice and moving a piece to the square indicated by the total dice face values





Larman (2004) Applying UML and Patterns

Who has the information?

Information Needed	Who Has the Information?
current location of the player (to know the starting point of a move)	Domain model suggests that a *Piece* knows its *Square* and a *Player* knows its *Piece*. Therefore, a *Player* software object could know its location.
the two *Die* objects (to roll them and calculate their total)	Taking inspiration from the domain model, *MonopolyGame* is a candidate since we think of the dice as being part of the game.
all the squares—the square organization (to be able to move to the correct new square)	the *Board* is a good candidate.

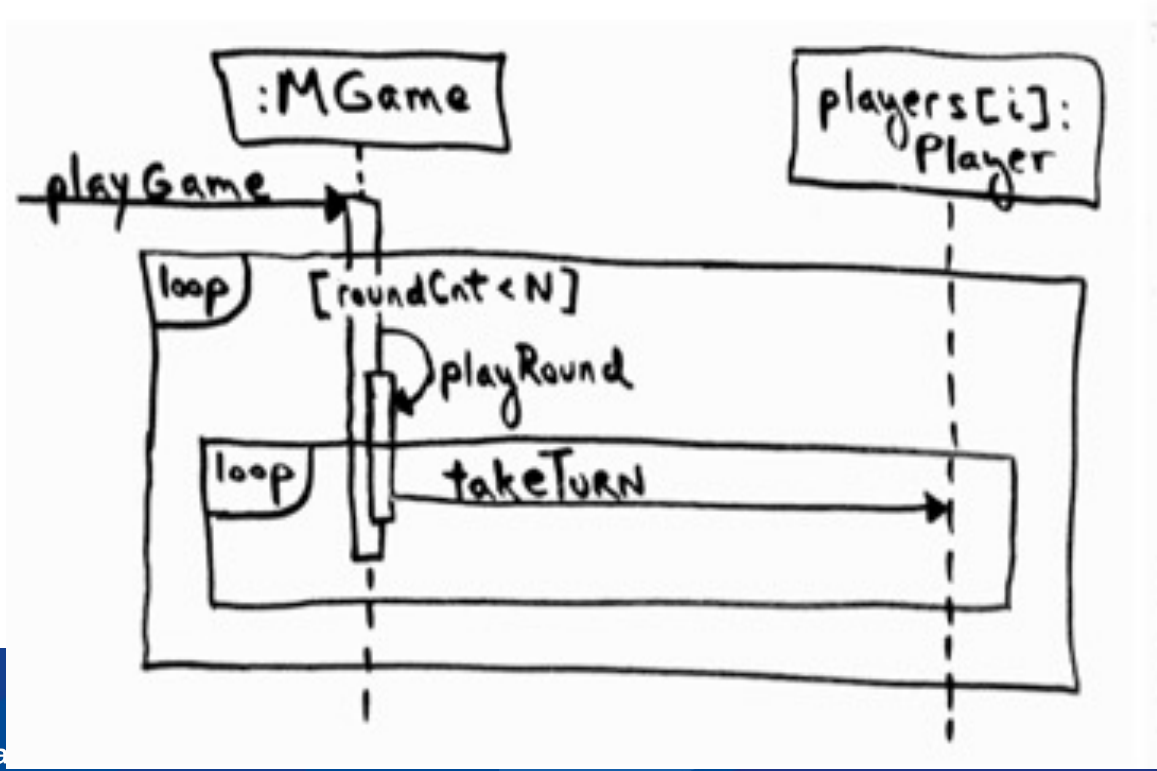
Heuristics to Apply #3

- **Who has the *majority* of information? (supports low coupling)**
  - Does not help here
- **When there are alternative design choices, consider the coupling and cohesion impact of each.**
  - Giving *MonopolyGame* more work impacts its cohesion. *Player* and *Board* are not doing anything yet, but no clear winner among them.

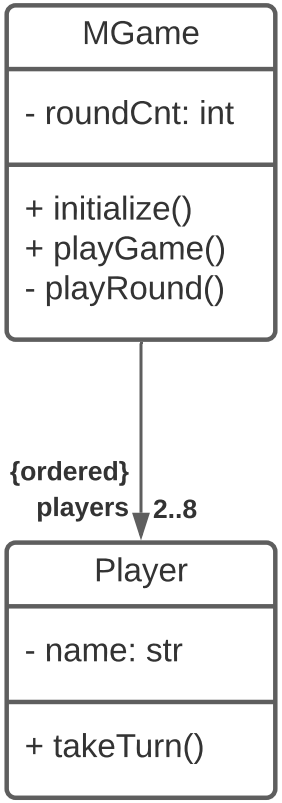
Heuristics to Apply #4

- **When there is no clear winner, consider future evolutions of the software (volatility)**
  - For the full game, taking a turn involves spending cash to buy property
  - The *Player* object knows a player's cash total
  - *Player* is a good candidate (but *not* because the human player takes the action)

Taking a Turn Interaction



Partial Class Diagram



Taking a Turn Actions

1. calculating a random number total between 2 and 12 (the range of two dice)

2. calculating the new square location

3. moving the player's piece from its old location to its new square location

Taking a Turn Implementation (1/2)

1. calculating a random number total between 2 and 12 (the range of two dice)
   - Domain Model suggests creating a Die object
2. calculating the new square location
   - The Board knows all the squares and hence can calculate the new square location given the old location and an offset
3. moving the player's piece from its old location to its new square location

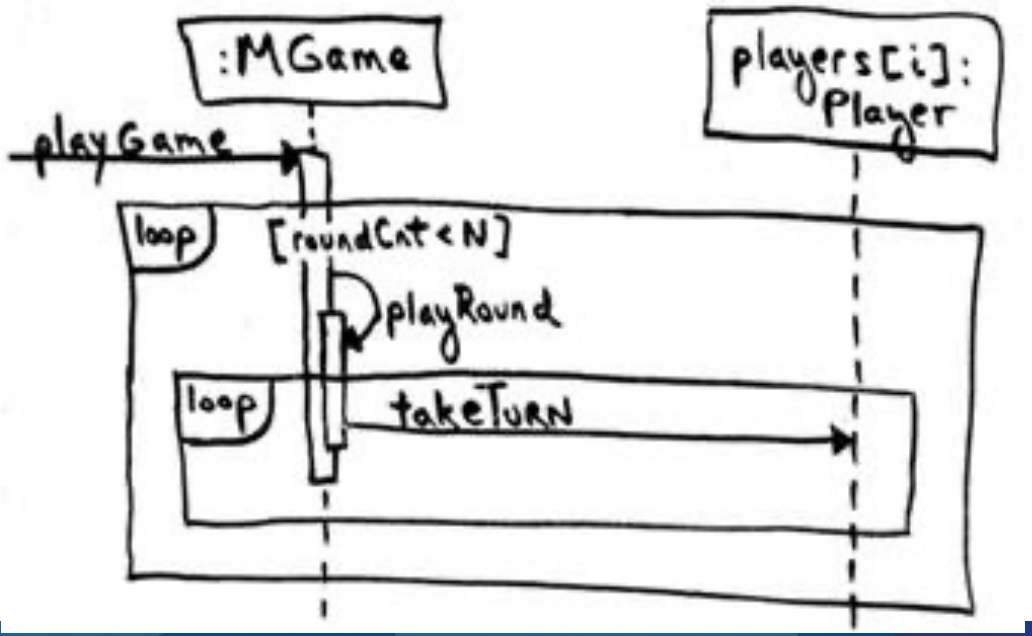
Taking a Turn Implementation (2/2)

3. moving the player's piece from its old location to its new square location
   - Player to know its Piece, and a Piece its Square location (or even for a Player to directly know its Square location).
   - Piece will set its new location, but it may receive that new location from its owner, the Player.
   - The Player coordinates all this as it is responsible for taking a turn

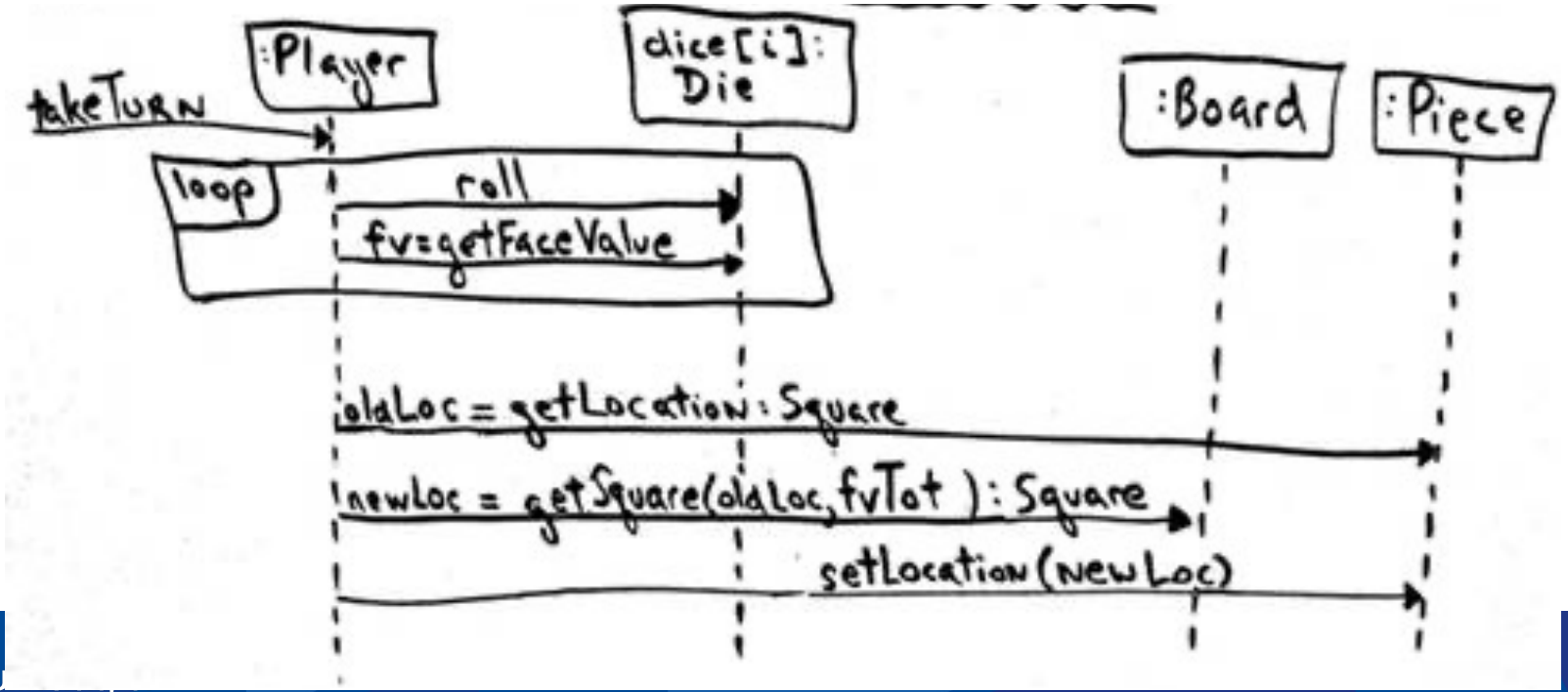
Taking a Turn Implementation (3/2)

3. moving the player's piece from its old location to its new square location
   - Player must collaborate with Die, Board, and Piece.
   - Player must have **visibility** (a reference) to these objects
   - Initialise Player with references to these objects at start-up

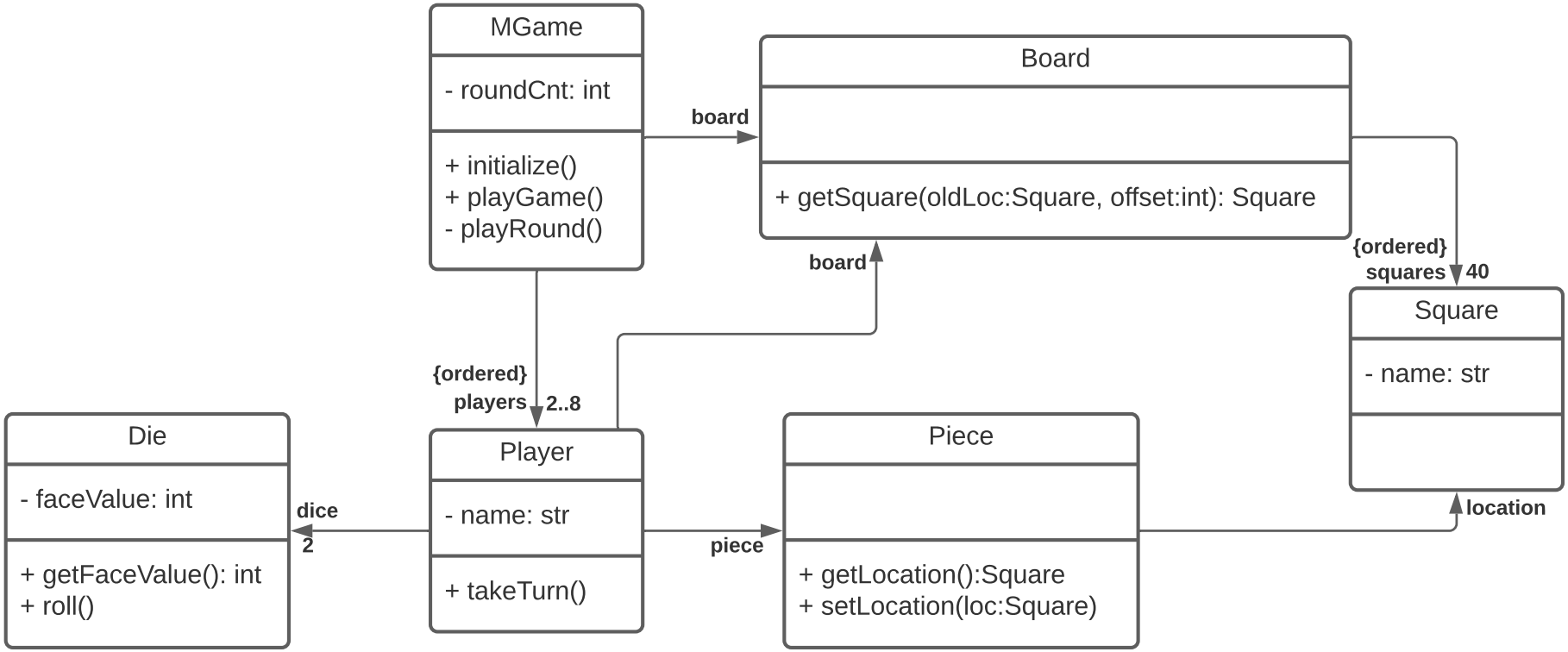
Final Design (1/3)



Final Design (2/3)



Final Design (3/3)



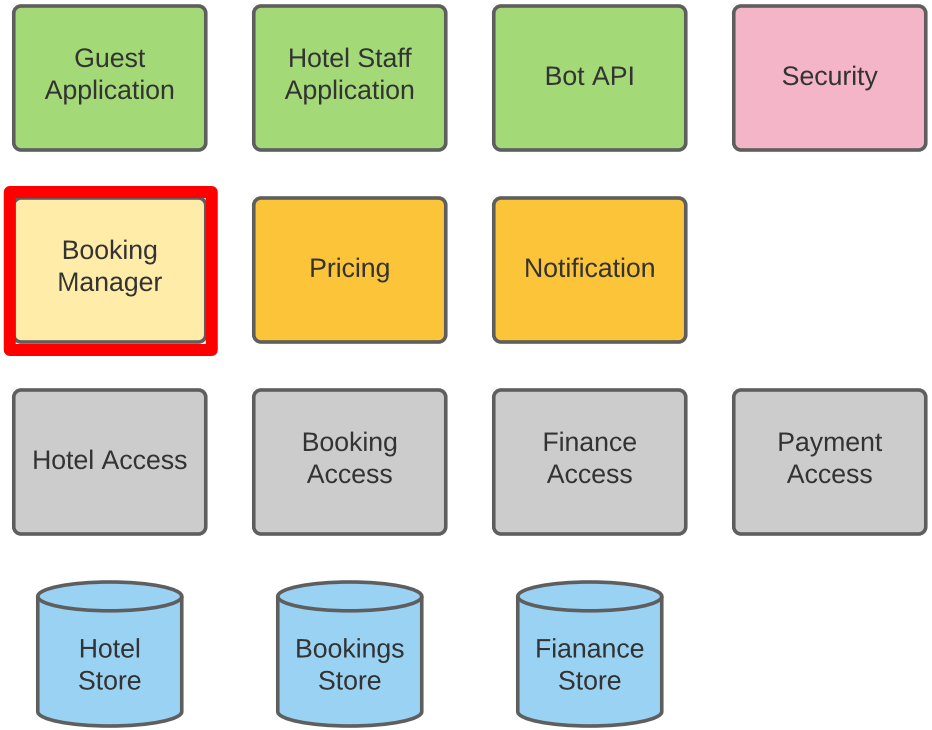
OO Design Process Summary

- Introduce Classes inspired by Domain Model
  - Lowers “Representational Gap”
- Allocate responsibilities according to Design Principles and heuristics as guides
- Incrementally build the interaction sequences and the class diagram

Task 2. FindRooms() Implementation

- Design an implementation for system operation findRooms(…) in the BookingManager component in the Booking System architecture.

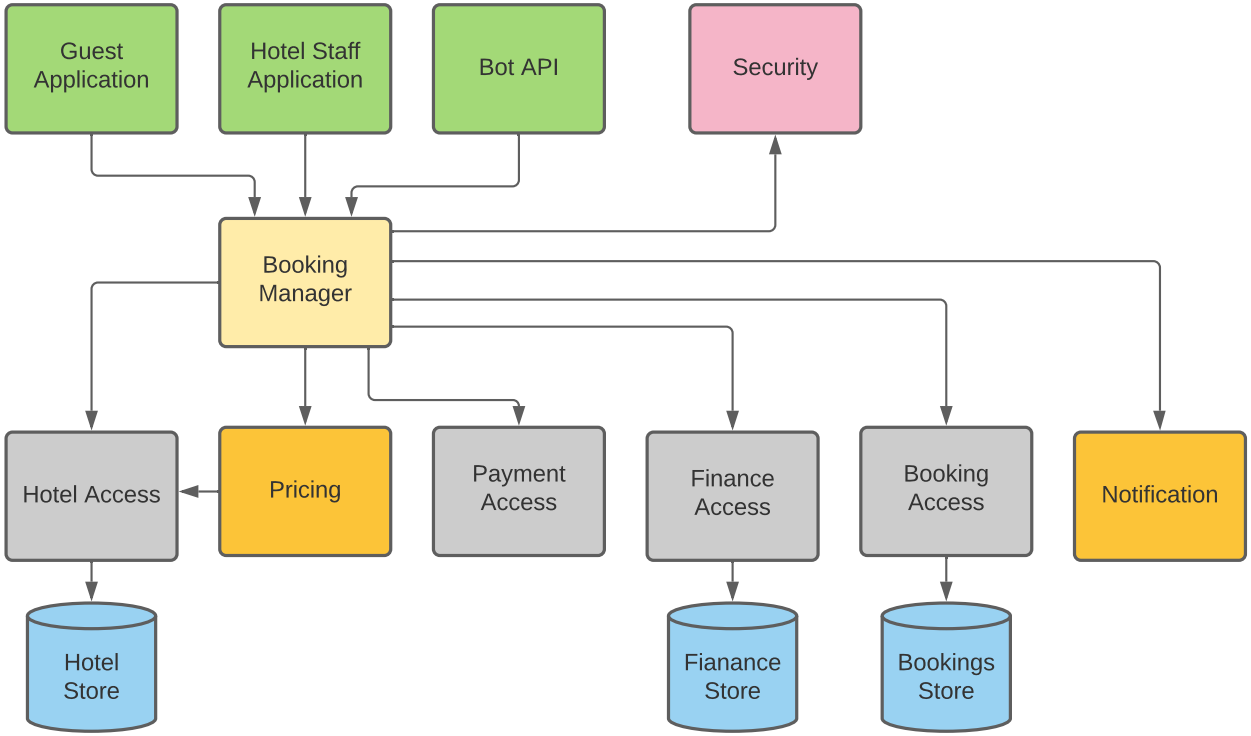
- Use the component decomposition on the next slide instead a domain model for populating the design.


Guest Application
Hotel Staff Application
Bot API
Security
Booking Manager
Pricing
Notification
Hotel Access
Booking Access
Finance Access
Payment Access
Hotel Store
Bookings Store
Fianance Store

UC01 Make Booking Main Scenario

1. ***User enters date range.***
2. ***System presents available rooms, their descriptions, and daily rates.***
3. *User selects room.*
4. *System presents total price.*
5. *User enters contact details and payment details.*
6. *System verifies that room is available for the period, creates booking for the room and associates booking with guest, verifies payment, records payment confirmation, and issues booking confirmation.*

Comm. Diagram for Make Booking



Booking Manager Operations

- findRooms(in:Date,out:Date): list(RoomDescriptor)
- getTotalPrice(roomID:str, in:Date, out:Date): int
- createBooking(roomID:str, in:Date, out:Date,
  pd:PaymentDetails, cd:ContactDetails): str

findRooms(…) Contract

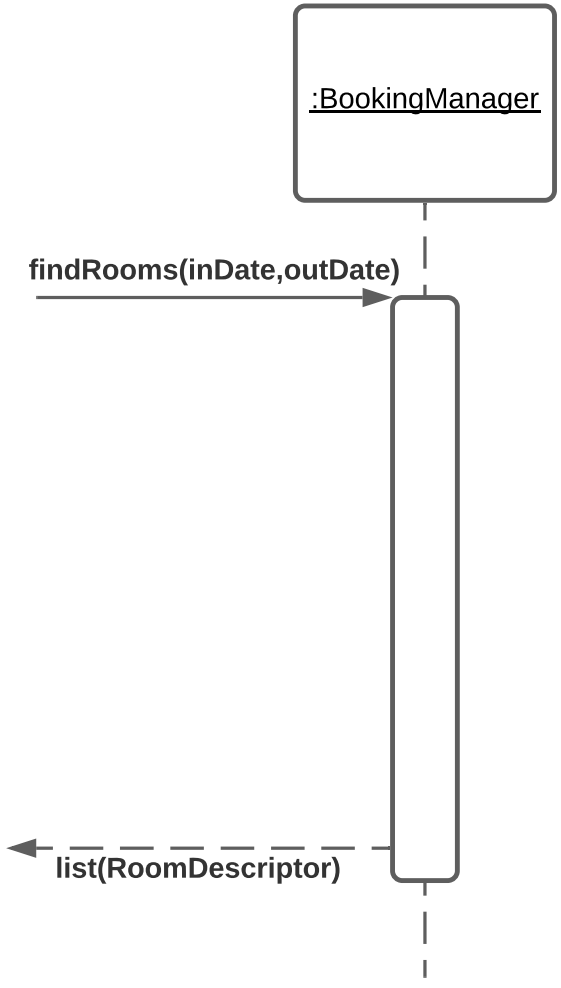
- **findRooms(checkin:Date,checkout:Date): list(RoomDescriptor)**
  - RoomDescriptor is a data structure that includes
    - » room ID
    - » room type
    - » description
    - » daily rate in AUD
- Preconditions: none
- Postconditions: none

BookingAccess Interface

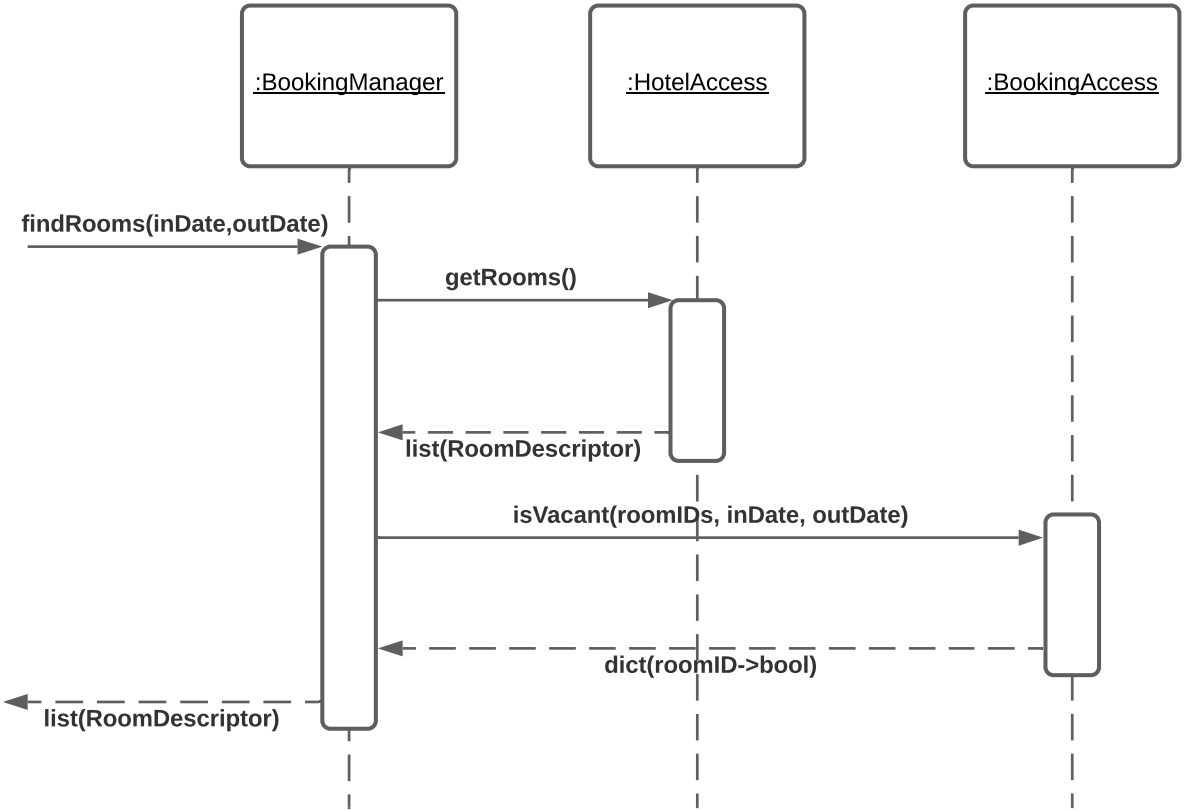
- **getBookings(roomIDs:list(str), from:Date, to:Date):**
  map(str-> list(BookingDescriptor))
  - Operation takes a list of roomIDs, returns bookings for each room
  - BookingDescriptor is a data structure containing the booking information
- **isVacant(list(roomIDs:list(str), from:Date, to:Date):**
  map(str-> boolean)
- **createBooking(roomID:str, in:Date, out:Date, guestID:str): str**
- **cancelBooking(bookingID:str): boolean**

Design Implementation Sequence

- Design the implementation sequence for findRooms(…) in the BookingManager
- Draw an interaction diagram showing the interaction sequence among operations in the components
- Stop at the boundaries of HotelAccess and BookingAccess
  - Don’t show how these operations are implemented


:BookingManager
findRooms(inDate,outDate)
list(RoomDescriptor)

FindRooms() Implementation



findRooms(…) in Python Code

```
class BookingManager:
    def __init__(self):
        self.__hotelAccess = HotelAccess("...")
        self.__bookingAccess = BookingAccess("...")

    def findRooms(self, inDate, outDate):
        rooms = self.__hotelAccess.getRooms()
        roomIDs = [r.id for r in rooms]
        available = self.__bookingAccess.isVacant(roomIDs, inDate, outDate)
        availableRooms = [r for r in rooms if available[r.id]]
        return availableRooms
```

Task 3. Dependency Inversion

- Consider the implementation of the Booking Manager on the following slide.
- Examine how the Booking Manager and the Resource Access components interact
- What implications are there in terms of coupling, cohesion, and information leakage?

findRooms(…) in Python Code

```
class BookingManager:
    def __init__(self):
        self.__hotelAccess = HotelAccess("...serverA:portA...")
        self.__bookingAccess = BookingAccess("...serverB:portB...")

    def findRooms(self, inDate, outDate):
        rooms = self.__hotelAccess.getRooms()
        roomIDs = [r.id for r in rooms]
        available = self.__bookingAccess.isVacant(roomIDs, inDate, outDate)
        availableRooms = [r for r in rooms if available[r.id]]
        return availableRooms
```

Implications

- Booking Manager needs to know details about the resource access components' implementation
  - How these components are constructed
  - How they are initialised
- Lowers Cohesion
- Resource Access components leak information
- Introduces coupling to an implementation
- Need to remove the dependency on implementation details

Dependency Inversion Principle (DIP)

- *“Code dependencies refer only to stable abstractions, not to (volatile) concrete elements”*
  - **Never mention the name of anything concrete and volatile.**
  - **Don’t refer to volatile concrete classes.**
    - » Refer to abstract interfaces instead.
  - **Don’t derive from volatile concrete classes.**
  - **Don’t override concrete functions.**

findRooms(…) in Python Code

```
class BookingManager:
    def __init__(self):
        self.__hotelAccess = MyHotelAccessImpl("...endpoint...")
        self.__bookingAccess = MyBookingAccessImpl("...endpoint...")

    def findRooms(self, inDate, outDate):
        rooms = self.__hotelAccess.getRooms()
        roomIDs = [r.id for r in rooms]
        available = self.__bookingAccess.isVacant(roomIDs, inDate, outDate)
        availableRooms = [r for r in rooms if available[r.id]]
        return availableRooms
```

Revised BookingManager

```
class BookingManager:
    def __init__(self, hotelAccess, bookingAccess):
        self.__hotelAccess = hotelAccess
        self.__bookingAccess = bookingAccess

    def findRooms(self, inDate, outDate):
        rooms = self.__hotelAccess.getRooms()
        roomIDs = [r.id for r in rooms]
        available = self.__bookingAccess.isVacant(roomIDs, inDate, outDate)
        availableRooms = [r for r in rooms if available[r.id]]
        return availableRooms
```

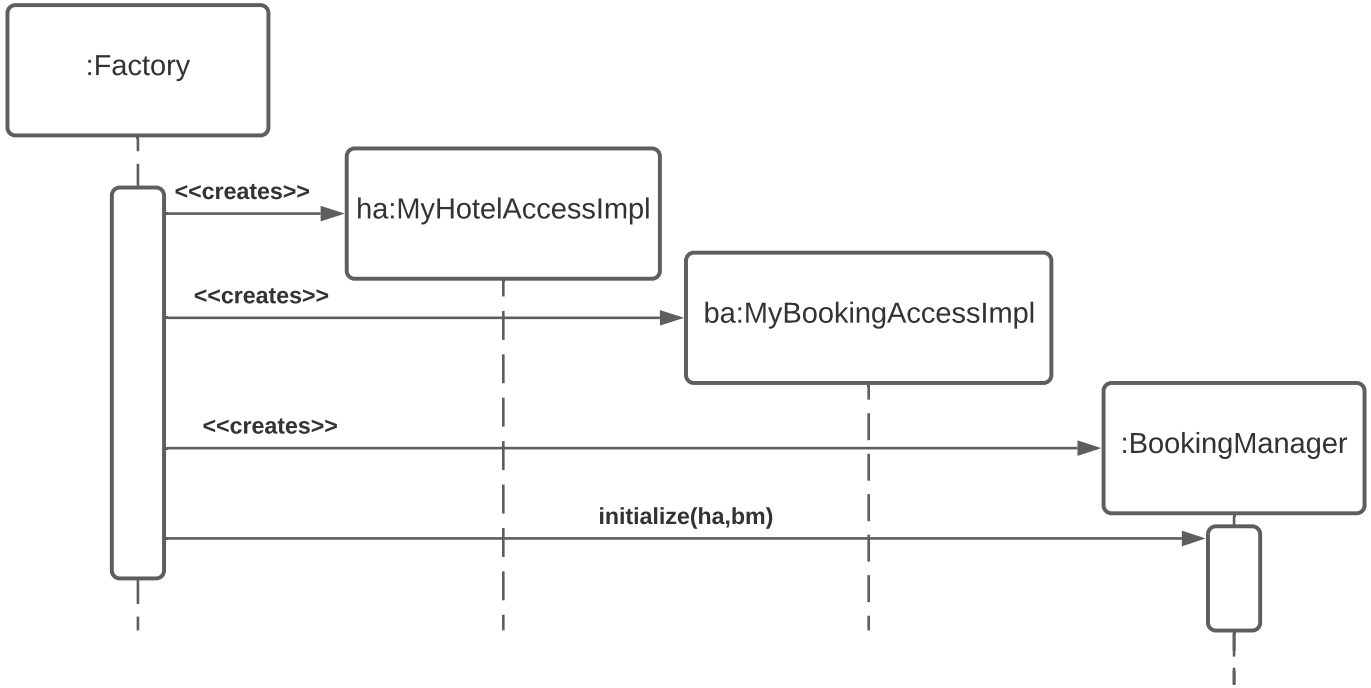
Revised Resource Access

```
class IHotelAccess:
    def getRooms(self): pass

class HotelAccess(IHotelAccess):
    def __init__(self, endpoint):
        pass

    def getRooms(self):
        "...fetch rooms and return..."
        return []   # not yet implemented
```

Creation of the Elements



You Should Know

- Apply heuristics and design principles to incrementally design an object-oriented implementation of component interfaces
- Apply the Dependency Inversion Principle to decouple concrete implementations

Activities this Week

- Complete Quiz 4
- Start on working on Assignment 1

University of
South Australia