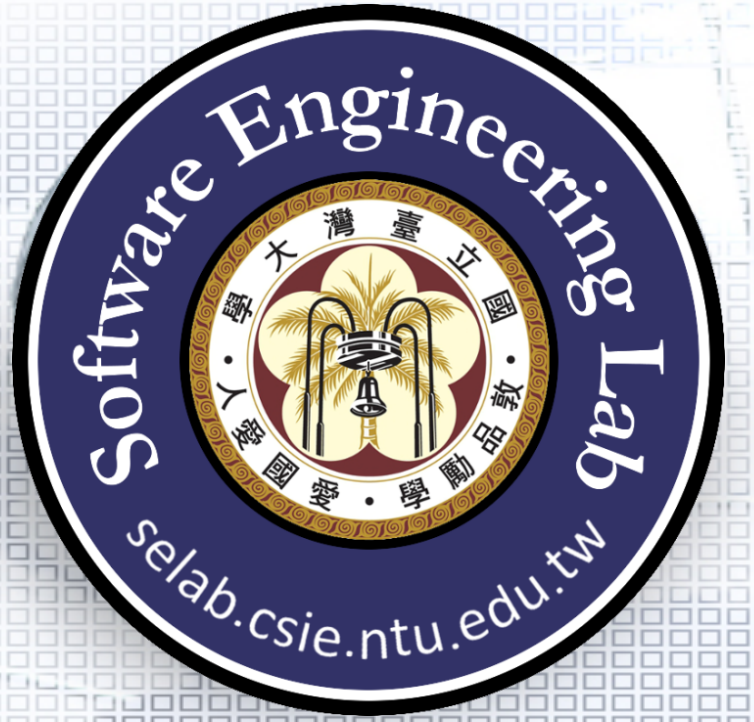


Builder Pattern

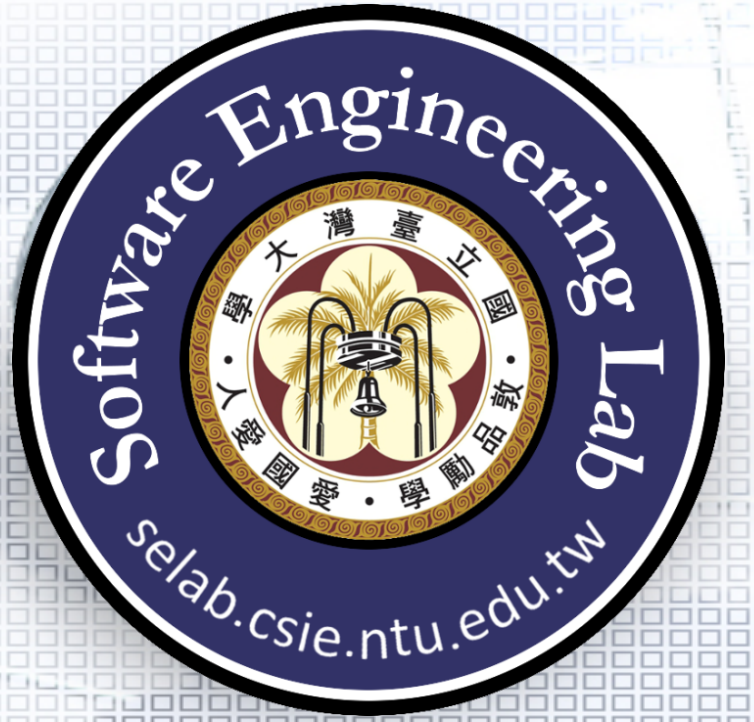
Prof. Jonathan Lee（李允中）
Department of CSIE
National Taiwan University

Design Aspect of Builder

how a composite object gets created

Outline

- An RTF (Rich Text Format) Converter Requirements Statements
- Initial Design and Its Problems
- Design Process
- Refactored Design after Design Process
- Recurrent Problems
- Intent
- Builder Pattern Structure
- Abstract Factory vs. Builder
- A Vacation Planner: Another Example
- Homework



A Rich Text Format Converter (Builder)

Prof. Jonathan Lee (李允中)

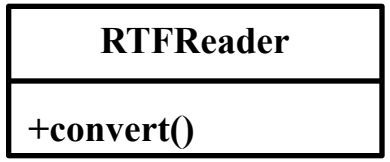
Department of Computer Science and Information Engineering
National Taiwan University

Homework: Requirements Statement

- A reader for the RTF (Rich Text Format) document exchange format should be able to convert RTF to many text formats.
- The reader converts RTF documents into TeX text or into a text widget by recognizing different RTF tokens (Character, Font Change and Paragraph).

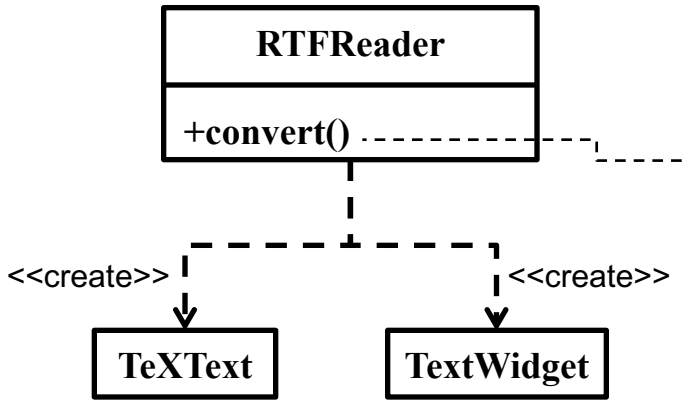
Requirements Statements$_1$

- A reader for the RTF (Rich Text Format) document exchange format should be able to convert RTF to many text formats.



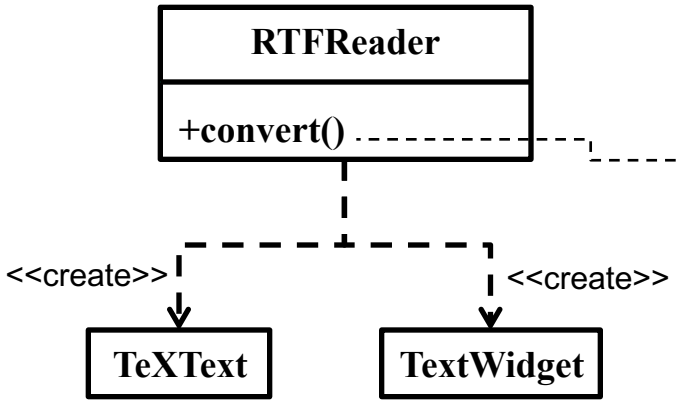
Requirements Statements$_2$

- The reader converts RTF documents into TeX text or into a text widget by recognizing different RTF tokens (Character, Font Change and Paragraph).




```
if(converterType==“TeX"){
for(Character token : content.toCharArray()){
        switch(token){
            case CHAR:
            //Convert Character Step
            case FONT:
            //Convert Font Change Step
            case PARA:
            //Convert Paragraph Step
        }
    }
    // return the TeX document
}else{
for(Character token : content.toCharArray()){
        switch(token){
            case CHAR:
            //Convert Character Step
            case FONT:
            //Convert Font Change Step
            case PARA:
            //Convert Paragraph Step
        }
    }
    // return the TextWidget document
}
```

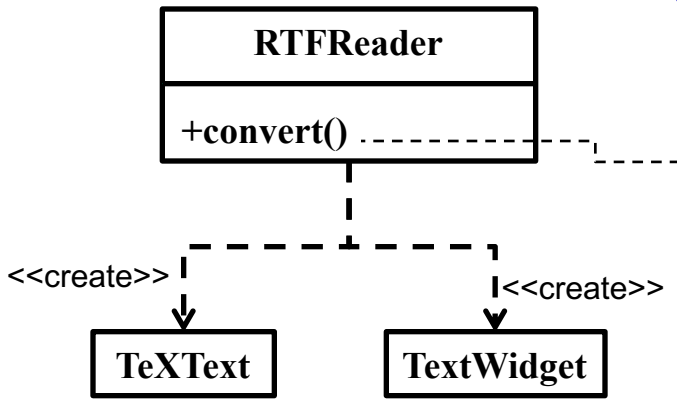
Initial Design - Class Diagram




```
if(converterType==“TeX"){
for(Character token : content.toCharArray()){
        switch(token){
            case CHAR:
            //Convert Character Step
            case FONT:
            //Convert Font Change Step
            case PARA:
            //Convert Paragraph Step
        }
    }
    // return the TeX document
}else{
for(Character token : content.toCharArray()){
        switch(token){
            case CHAR:
            //Convert Character Step
            case FONT:
            //Convert Font Change Step
            case PARA:
            //Convert Paragraph Step
        }
    }
    // return the TextWidget document
}
```

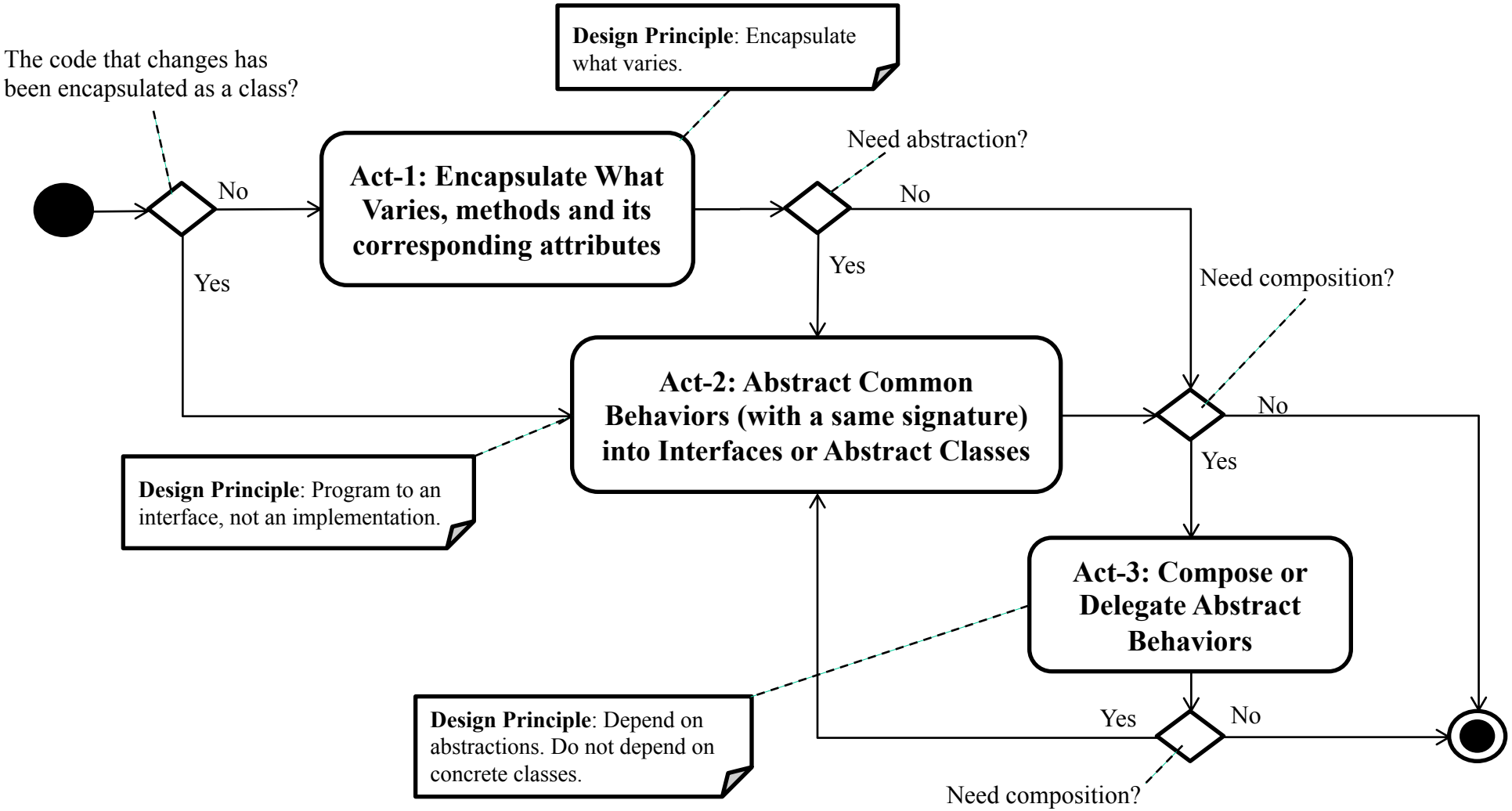
Problems with Initial Design

Problem: When adding a new conversion, we need to modify the reader.



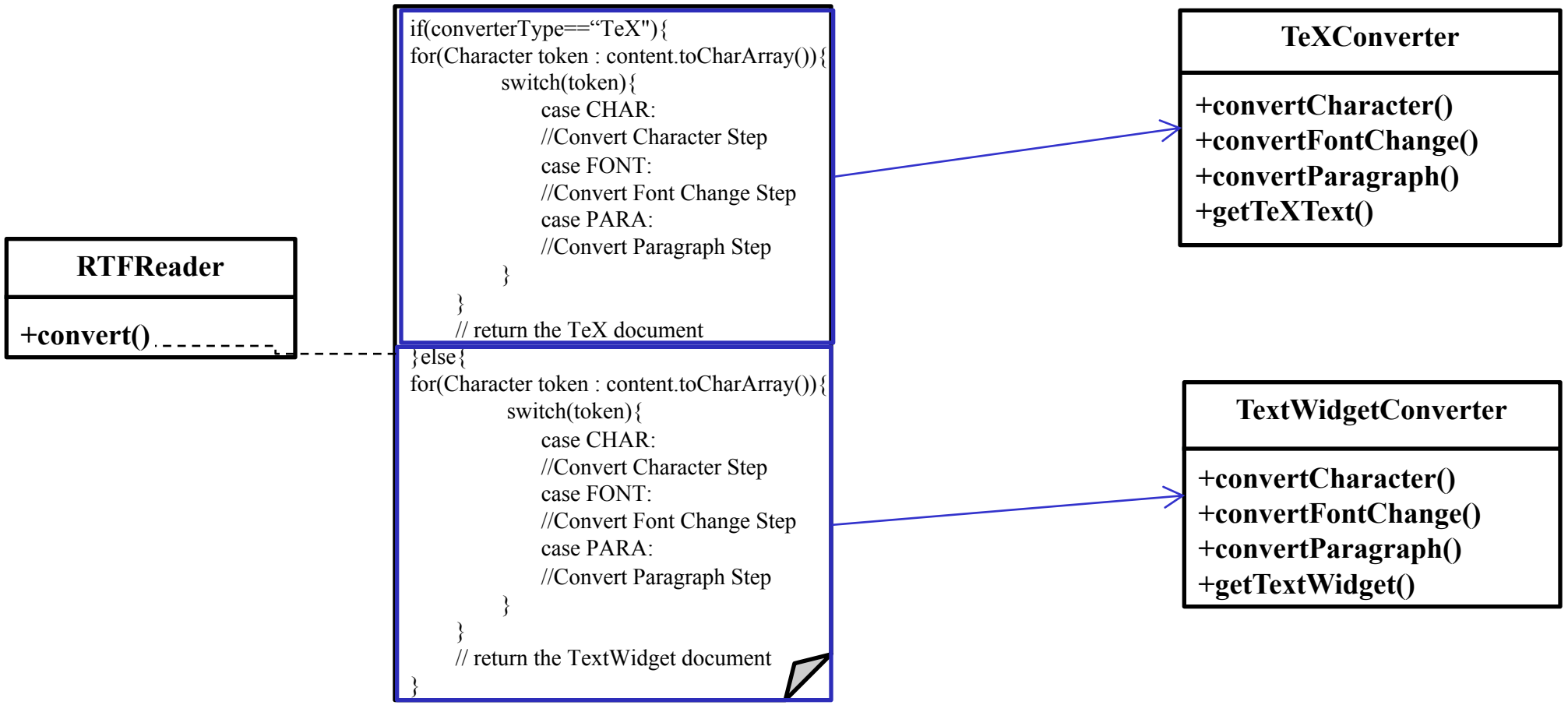

```
if(converterType==“TeX"){
for(Character token : content.toCharArray()){
        switch(token){
            case CHAR:
            //Convert Character Step
            case FONT:
            //Convert Font Change Step
            case PARA:
            //Convert Paragraph Step
        }
    }
    // return the TeX document
}else{
for(Character token : content.toCharArray()){
        switch(token){
            case CHAR:
            //Convert Character Step
            case FONT:
            //Convert Font Change Step
            case PARA:
            //Convert Paragraph Step
        }
    }
    // return the TextWidget document
}
```

Design Process for Change



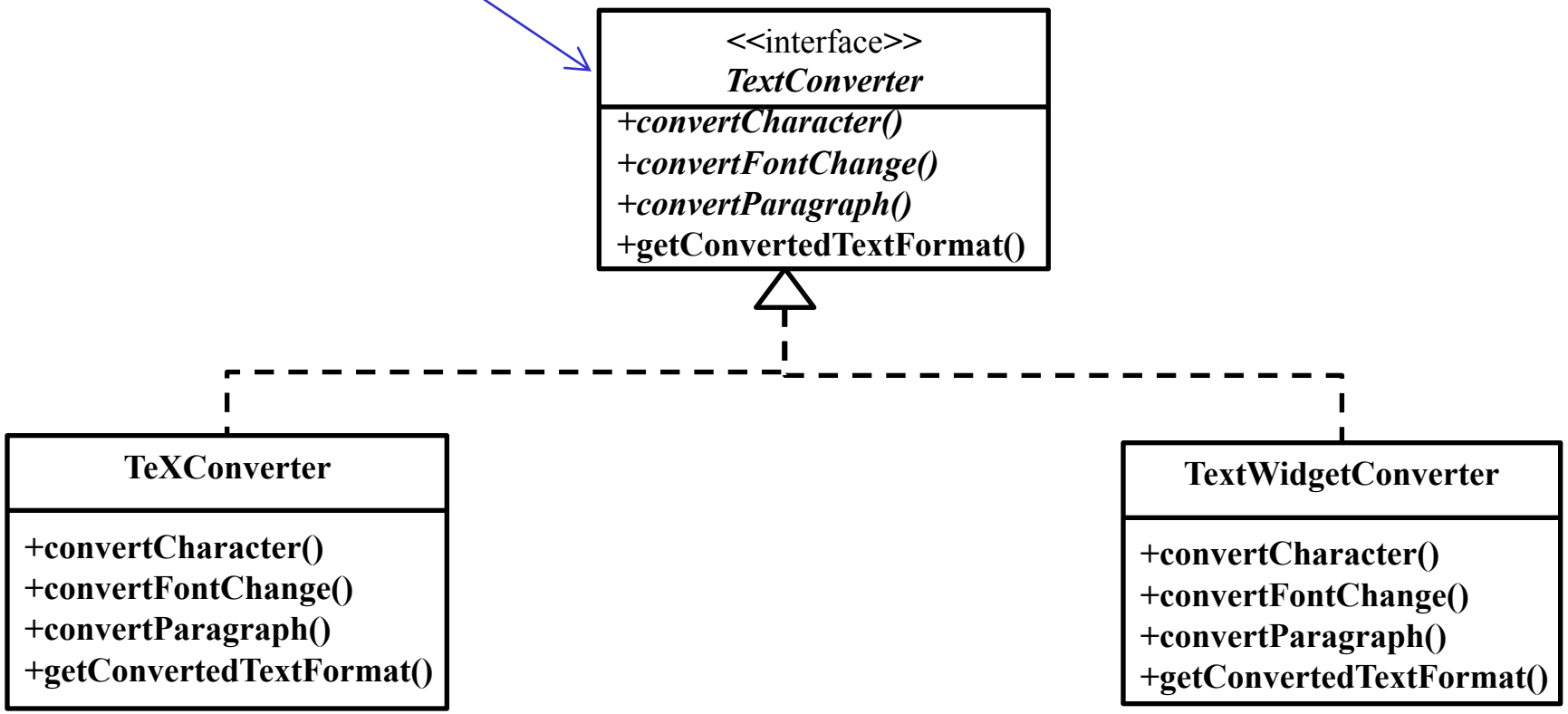
Act-1: Encapsulate What Varies

Act-1.3: Encapsulate a part of a method body into a concrete class



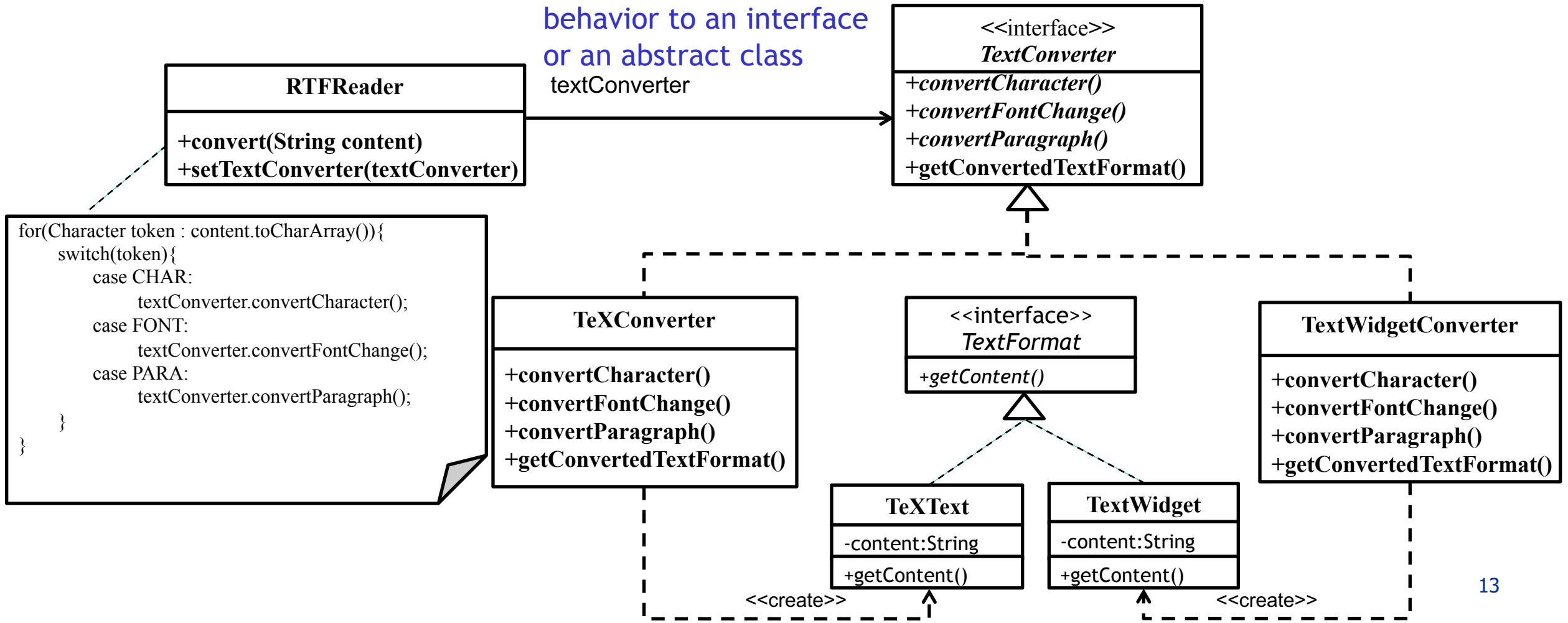
Act-2: Abstract Common Behaviors

Act-2.1: Abstract common behaviors with a same signature into interface through polymorphism

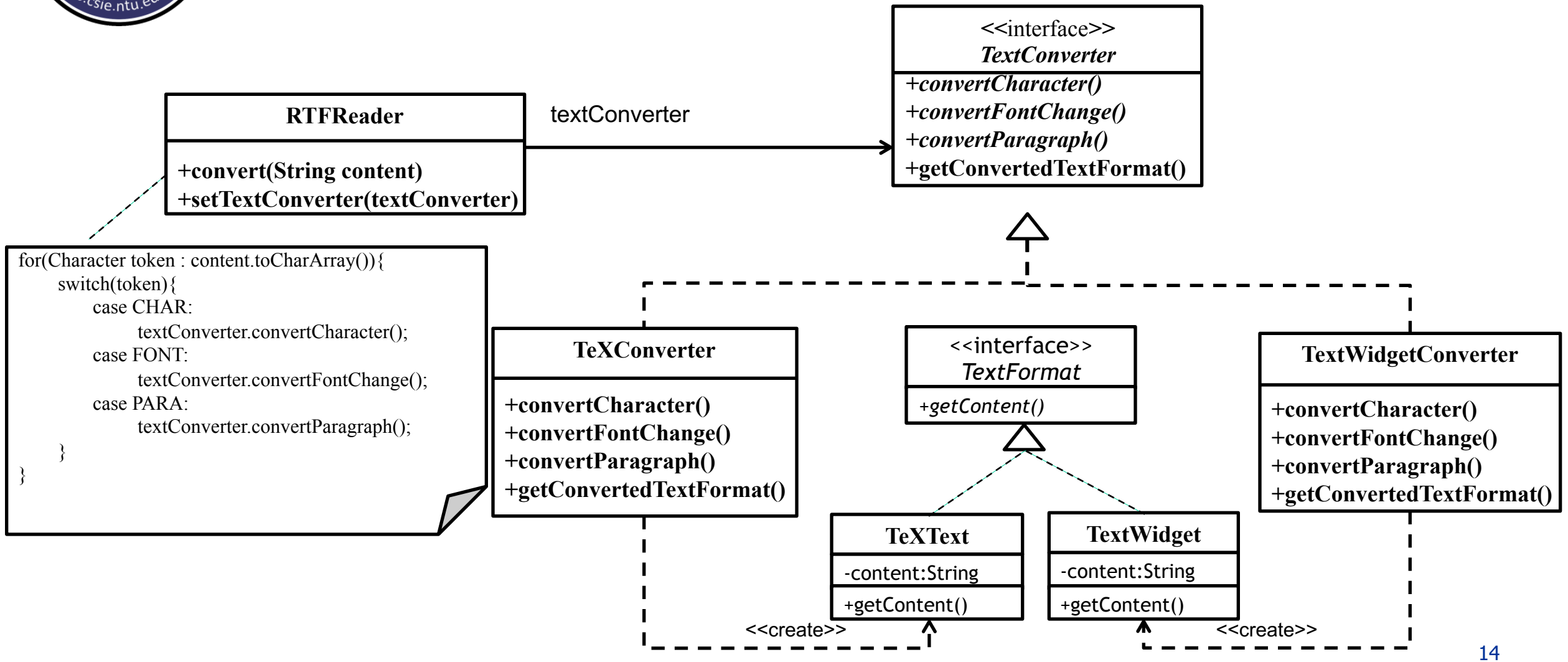


Act-3: Compose Abstract Behaviors

Act-3.3: Delegate behavior to an interface or an abstract class



Refactored Design after Design Process



Source code

RTFReader

```
public class RTFReader {
    private TextConverter textConverter;

    public TextFormat convert(String content){
        for(Character token : content.toCharArray()){
            switch (token) {
            case 'C':
                textConverter.convertCharacter();
                break;
            case 'F':
                textConverter.convertFontChange();
                break;
            case 'P':
                textConverter.convertParagraph();
                break;
            default:
                break;
            }
        }
        return textConverter.getConvertedTextFormat();
    }

    public void setTextConverter(TextConverter textConverter){
        this.textConverter = textConverter;
    }
}
```

Source code

TextConverter

```
public interface TextConverter {

    public void convertCharacter();

    public void convertFontChange();

    public void convertParagraph();

    public TextFormat getConvertedTextFormat();
}
```

Source code

TeXConverter

```
public class TeXConverter implements TextConverter{
    private String content = "";

    @Override
    public void convertCharacter() {
        content = content + 'c';
    }

    @Override
    public void convertFontChange() { content = content + '_'; }

    @Override
    public void convertParagraph() { content = content + '|'; }

    @Override
    public TeXText getConvertedTextFormat(){
        TeXText teXText = new TeXText(content);
        content = "";
        return teXText;
    }

}
```

Source code

TextWidgetConverter

```
public class TextWidgetConverter implements TextConverter{
private String content = "";

    @Override
    public void convertCharacter() { content = content + "<Char>"; }

    @Override
    public void convertFontChange() { content = content + "<Font>"; }

    @Override
    public void convertParagraph() { content = content + "<Paragraph>"; }

    @Override
    public TextWidget getConvertedTextFormat(){
        TextWidget textWidget = new TextWidget(content);
        content = "";
        return textWidget;
    }

}
```

Source code

TextFormat

```
public interface TextFormat {
    public String getContent();
}
```

TextWidget

```
public class TextWidget implements TextFormat{
    private String content;
    public TextWidget(String content) { this.content = content; }

    public String getContent() { return content; }
}
```

TeXText

```
public class TeXText implements TextFormat{
    private String content;
    public TeXText(String content){
        this.content = content;
    }

    public String getContent() { return content; }
}
```

Input:

```
[Text_format]

[TRF_token]

…
```

Output:

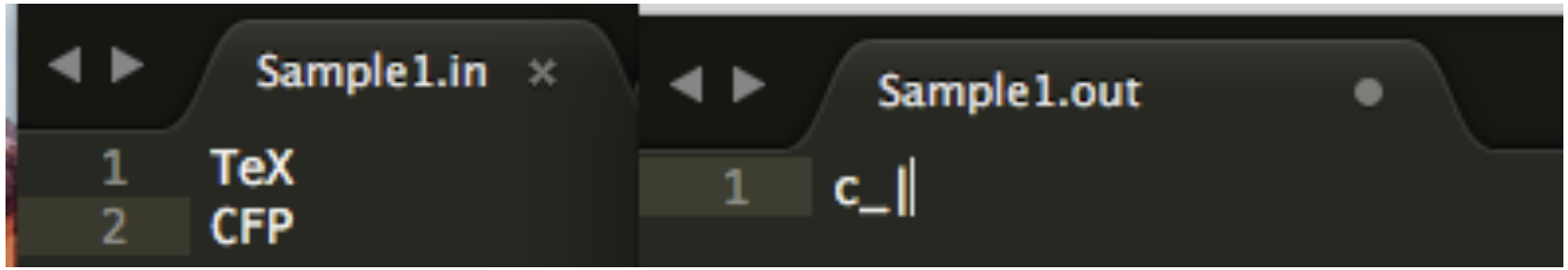
```
[converted_token]…

…
```

Test cases

- TestCase 1: Three convert type for TeX
- TestCase 2: Three convert type for TextWidget
- TestCase 3: Complex

Test case1



Test case2

Sample2.in

```
1 TextWidget
2 CFP
```

Sample2.out

```
1 <Char><Font><Paragraph>
```

Test case3

Sample3.in

```
TeX
FPCPPCFFCPCPFFPPCCPFCPPCFFFCPCFFPCCFPPFPCFCFCFFFPPPPFPFFPCFFFPPCCFFFPFFPPCFPPPFPCPCF
CFCCPPPPCPPCCPFF
TextWidget
PFPPCPFPCFCCCFPFFCPFPFPFFFFCPFFPFCPCFFPCCPFFPFPPCFFCCPFFFPFPPCPCPPCFFCFCPFPPCCCCPCFC
FCFFCPPFPCFFPFCC
TeX
PFFCCCFCCCFPFPFFPPPFFFFCCFFCFCCPFCCPPCCFFPFFFFFPCPCPCFFCPPCFFFFCPCCPPFCCFCFFPPPCCCPPF
PCCCCPFCCFFFFFCC
TextWidget
CFCPFFCCCPFCFCCPFFPFPCFCPCCCPCFFCCCPCPPCPFPFCPPCCFFPPFCFCCFPFPPCCCFCCCCCPPFFCPCFPFFC
CPCPCPFPPFPFCFFP
TeX
CCCPPPPPFPCCPPPCPFCFCFPCPFPFPPPFCFFCFCPFFPFCFPFFFPCCFPCCFPFPFPPCCPFPCFCFPFPPPFFFPCCP
FPFPCCPFFCFPPCCC
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```

8 lines, 433 characters selected — Tab Size: 4

Sample3.out

```
_|c||c__c|c|__||cc|_c||c___c|c__|cc_||_|c_c_c___||||_|__|c___||cc___|__||c_|||_|c|c_c_cc||||c||c
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```

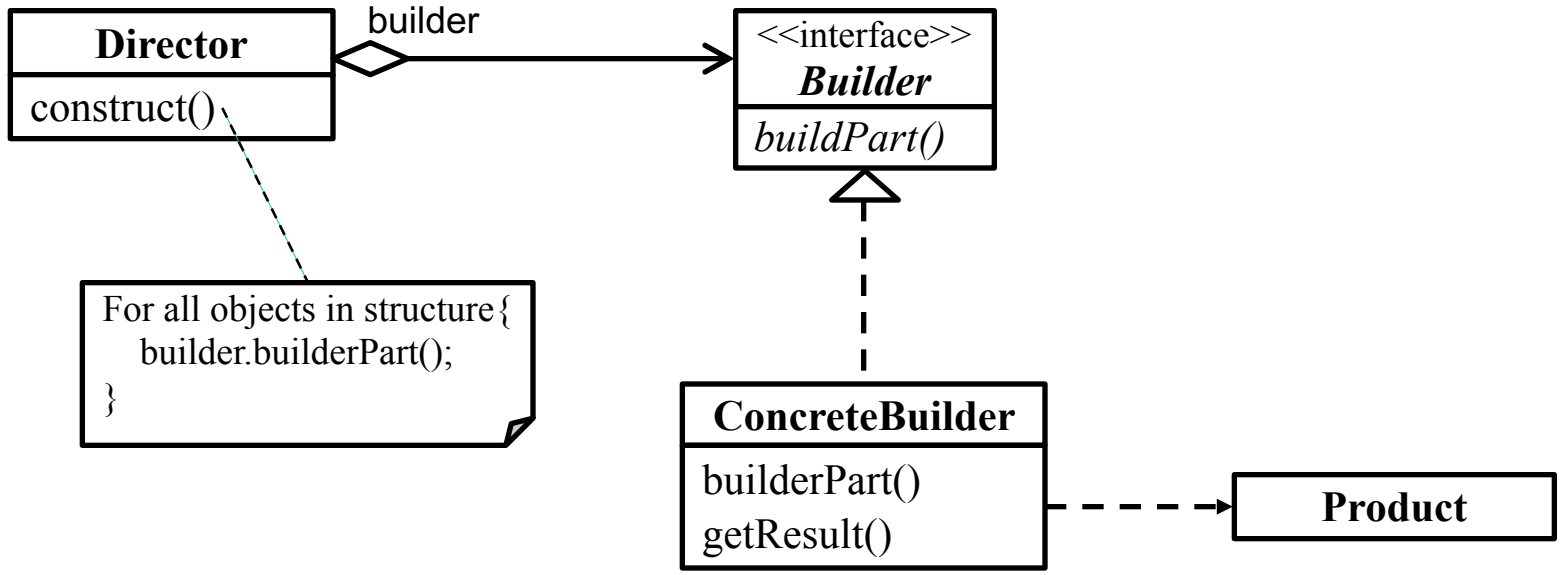
Recurrent Problem

- Construct complex objects step-by-step, and return the product as a final step.

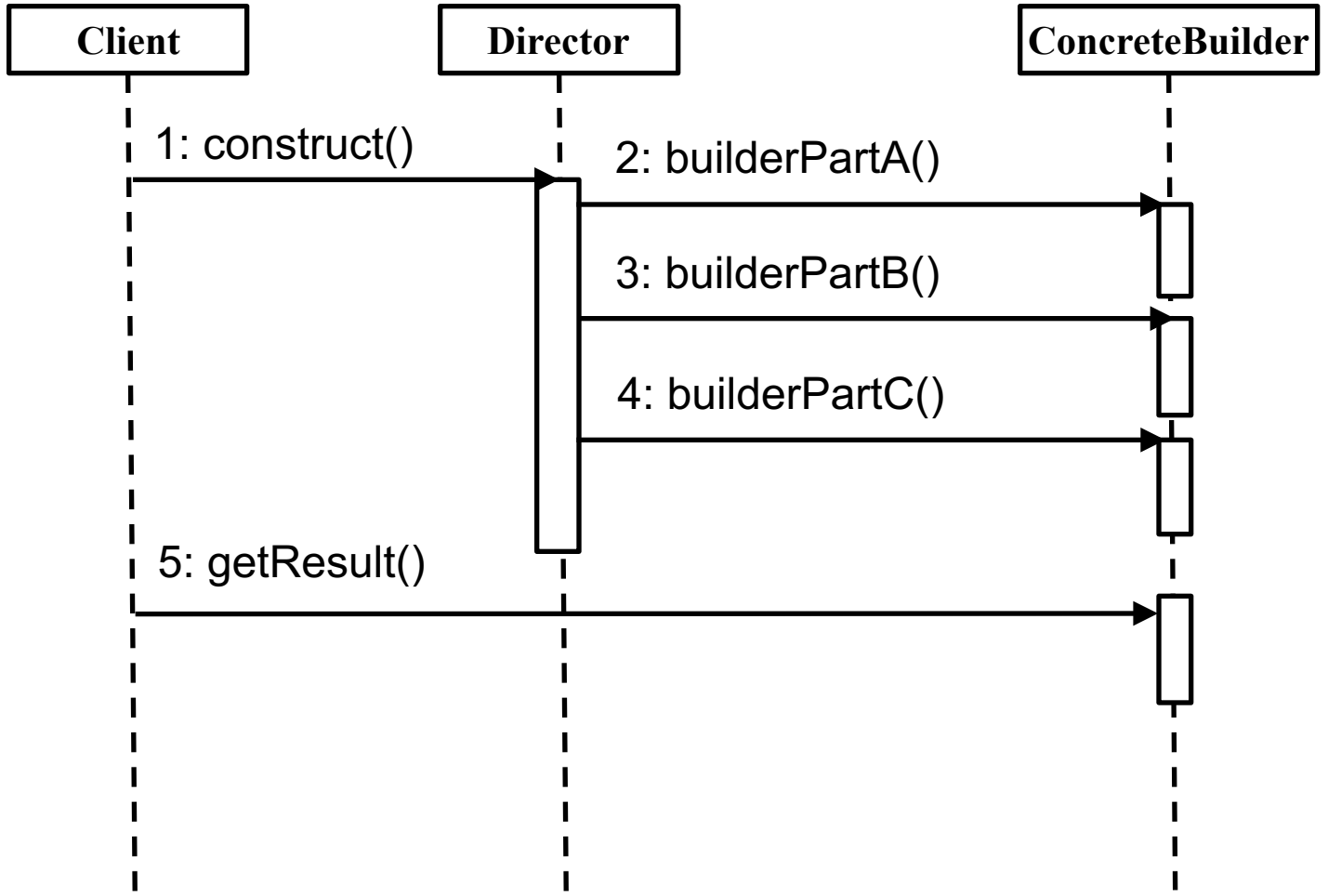
Builder Pattern

- Intent
  - Separate the construction of a complex object from its representation so that the same construction process can create different representations.

Builder Pattern Structure$_1$



Builder Pattern Structure$_2$



Builder Pattern Structure$_3$

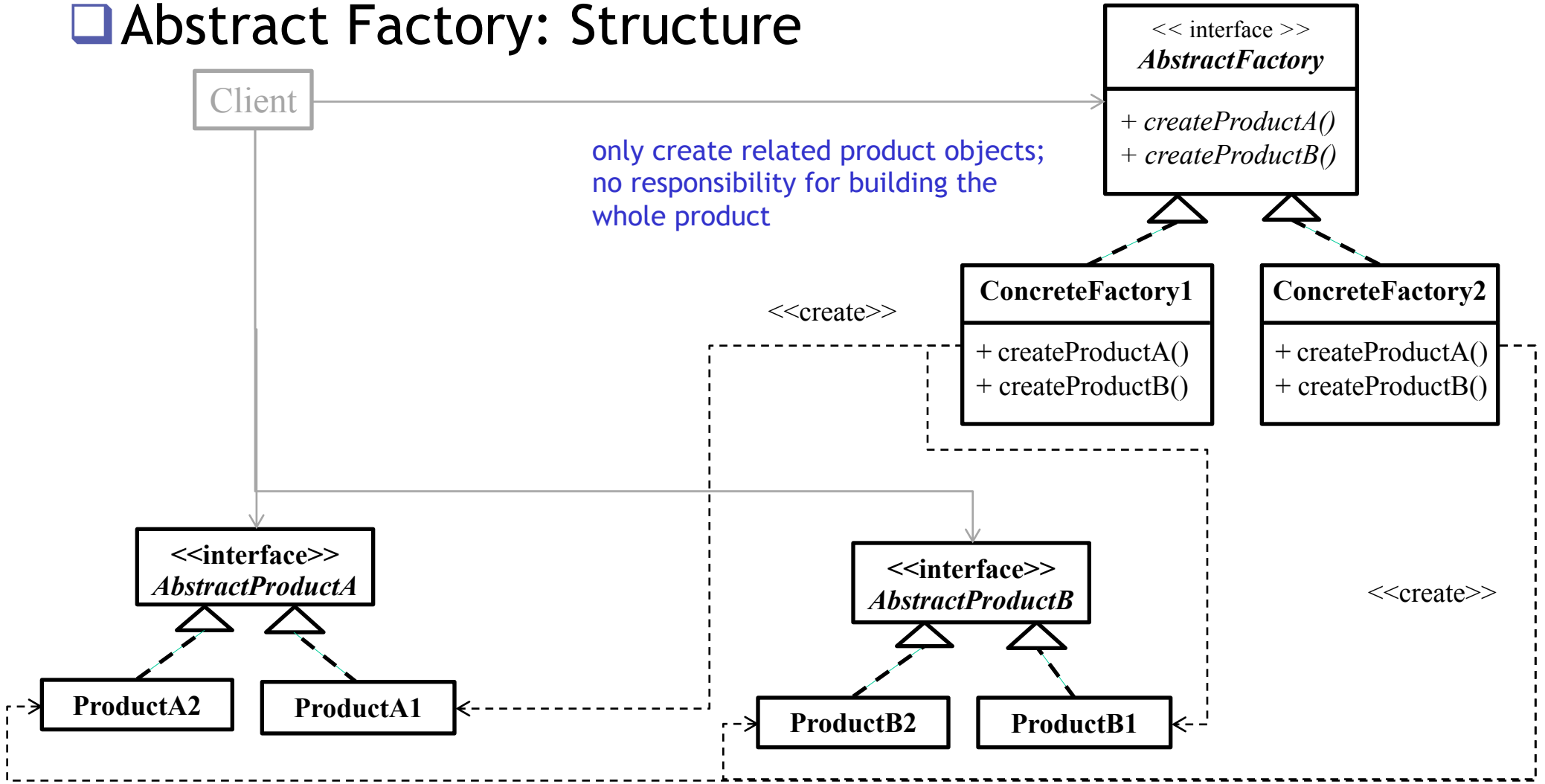
	Instantiation	Use	Termination
Director	Don't Care	Don't Care	Don't Care
Builder	X	Director uses Builder to invoke ConcreteBuilders' method to build product through polymorphism.	X
ConcreteBuilder	Don't Care	Director invokes ConcreteBuilder's method to build product through polymorphism.	Don't Care
Product	ConcreteBuilder	Don't Care	Don't Care

Abstract Factory vs. Builder$_1$

- Abstract Factory
  - families of product objects
  - Create a set of related or dependent objects, and return each object once it is created
- Builder
  - how a composite object gets created
  - Create a set of related or dependent objects, and provide an interface to return the final product

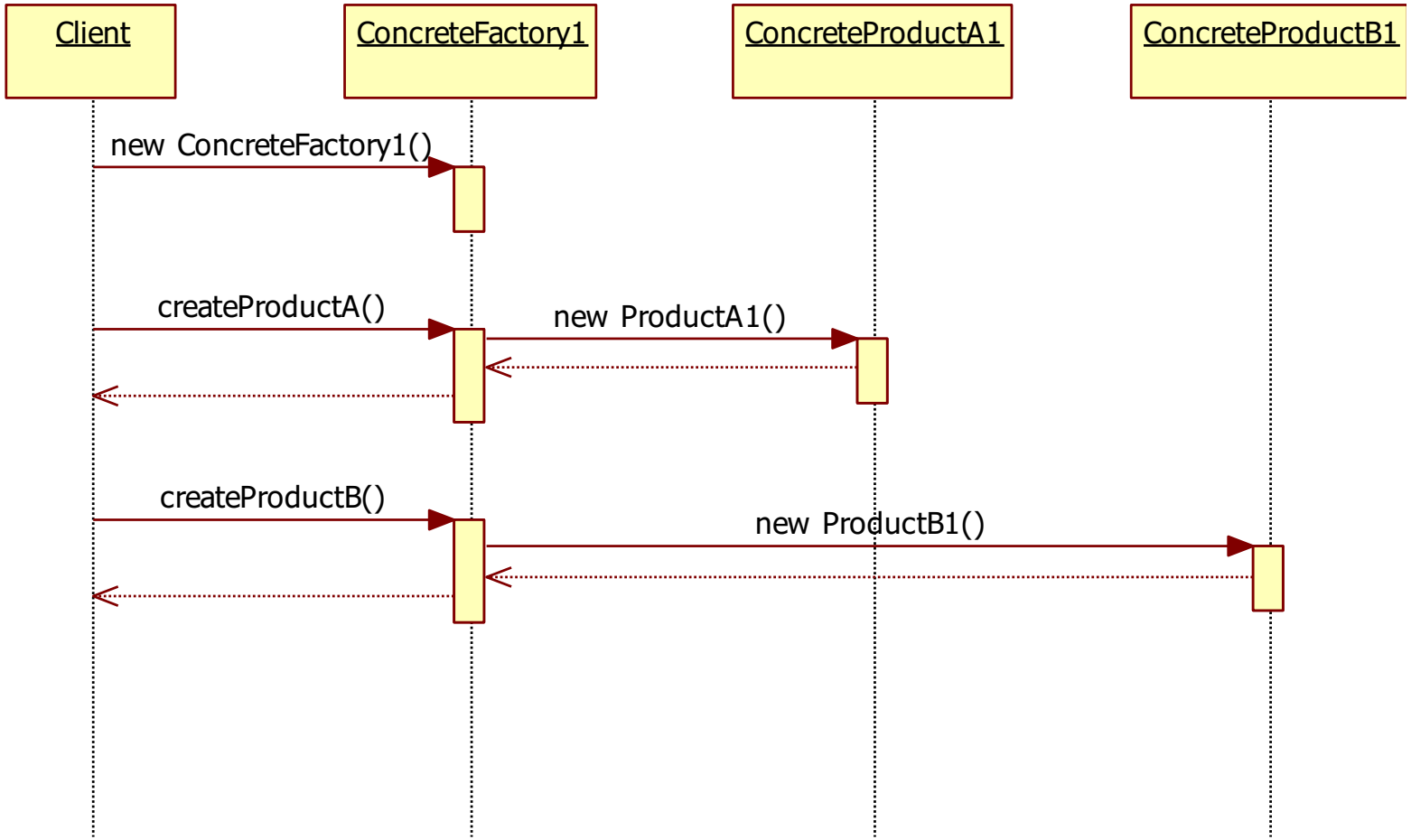
Abstract Factory vs. Builder$_2$

- Abstract Factory: Structure



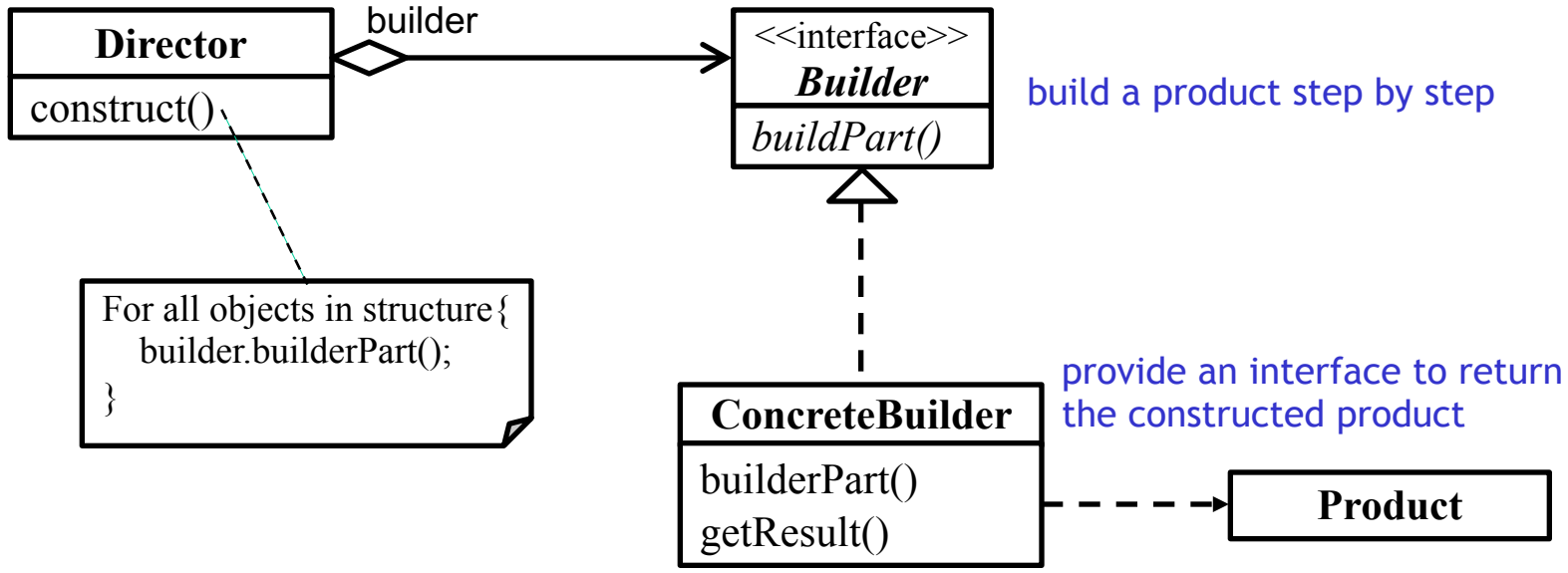
Abstract Factory vs. Builder$_3$

- Abstract Factory: Sequence Diagram



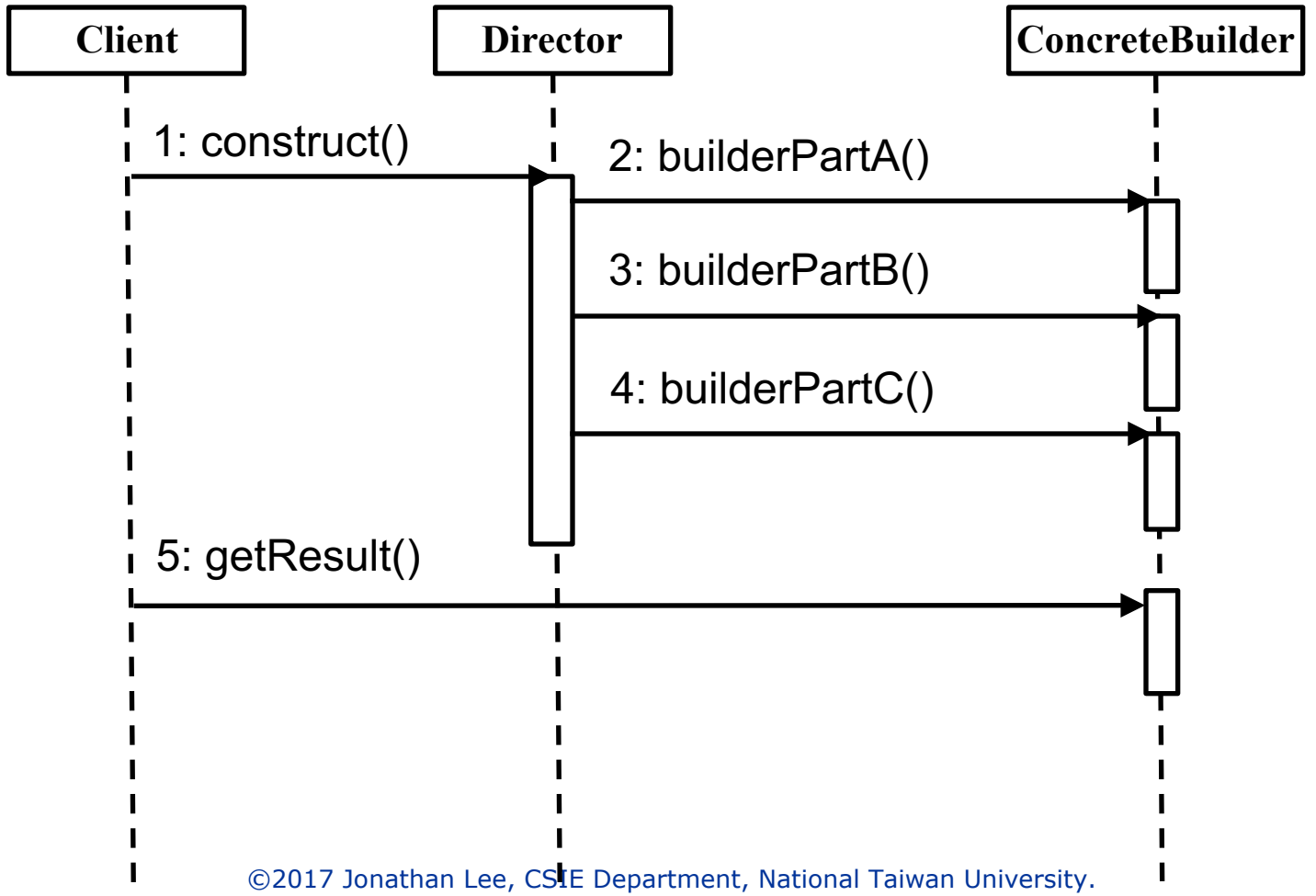
Abstract Factory vs. Builder 4

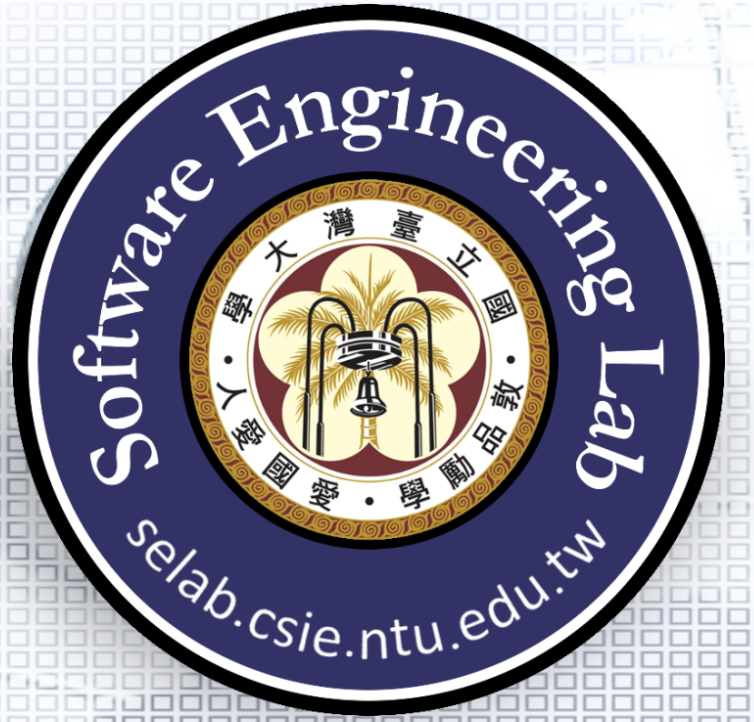
- Builder: Structure



Abstract Factory vs. Builder 5

- Builder: Sequence Diagram





A Vacation Planner (Builder)

Prof. Jonathan Lee (李允中)

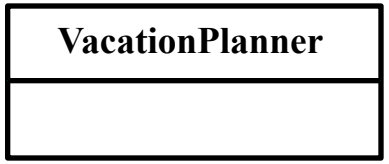
Department of Computer Science and Information Engineering
National Taiwan University

Requirements Statement

- Patternsland wants to build a vacation planner.
- A vacation planner can choose a hotel and various types of admission tickets, make restaurant reservations, even book special events and day. The different types of vacations, such as normal and backpacking, can have different options.

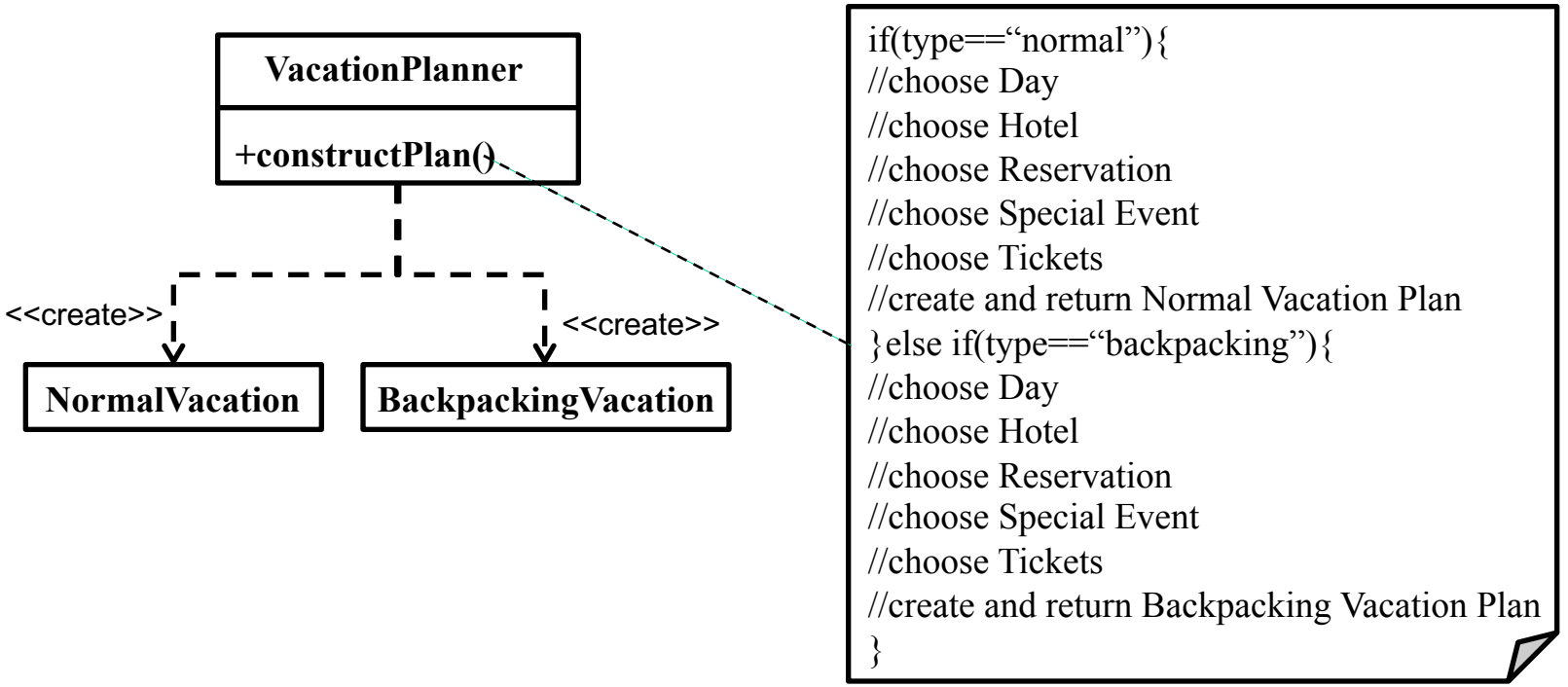
Requirements Statements$_1$

- Patternsland wants to build a vacation planner.

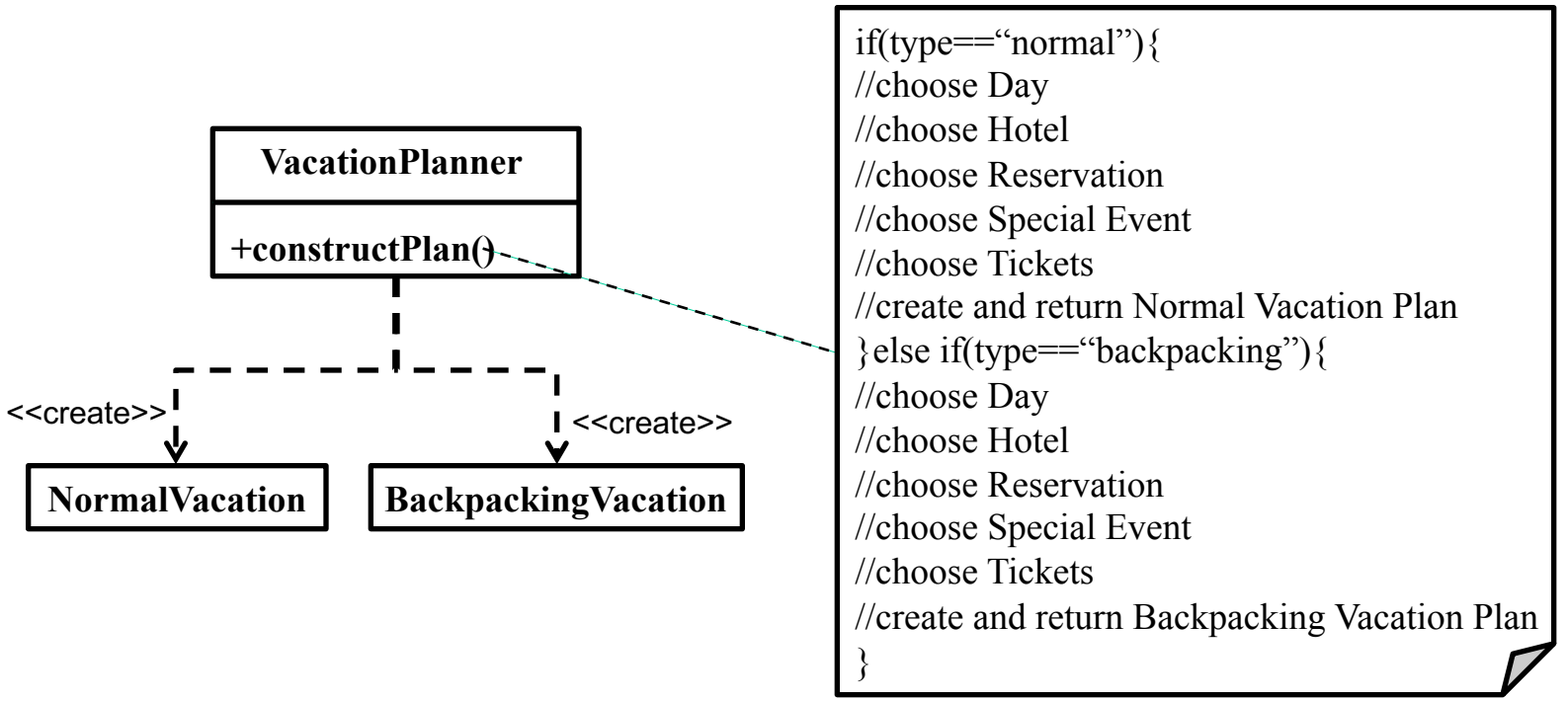


Requirements Statements$_2$

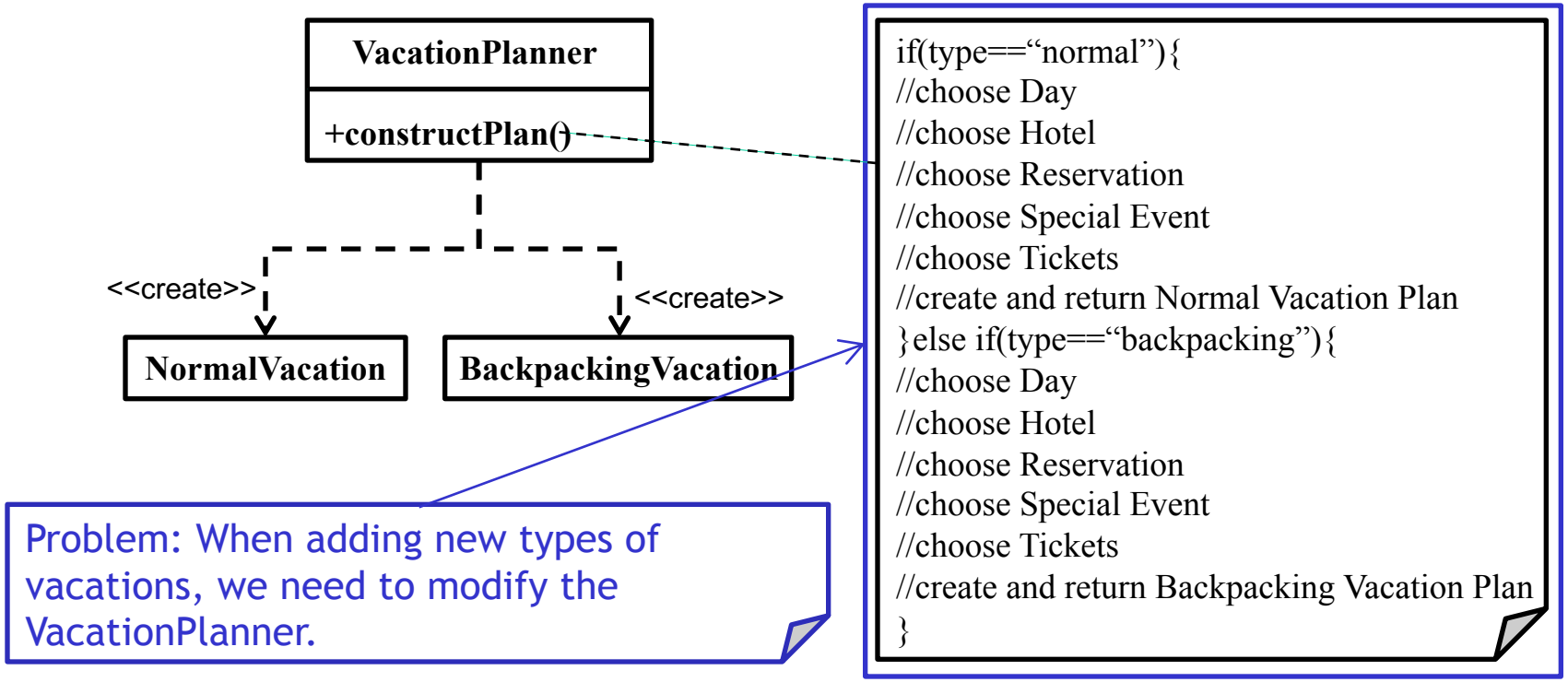
- A vacation planner can choose a hotel and various types of admission tickets, make restaurant reservations, even book special events and day. The difference types vacation (normal, backpacking) will have different options.



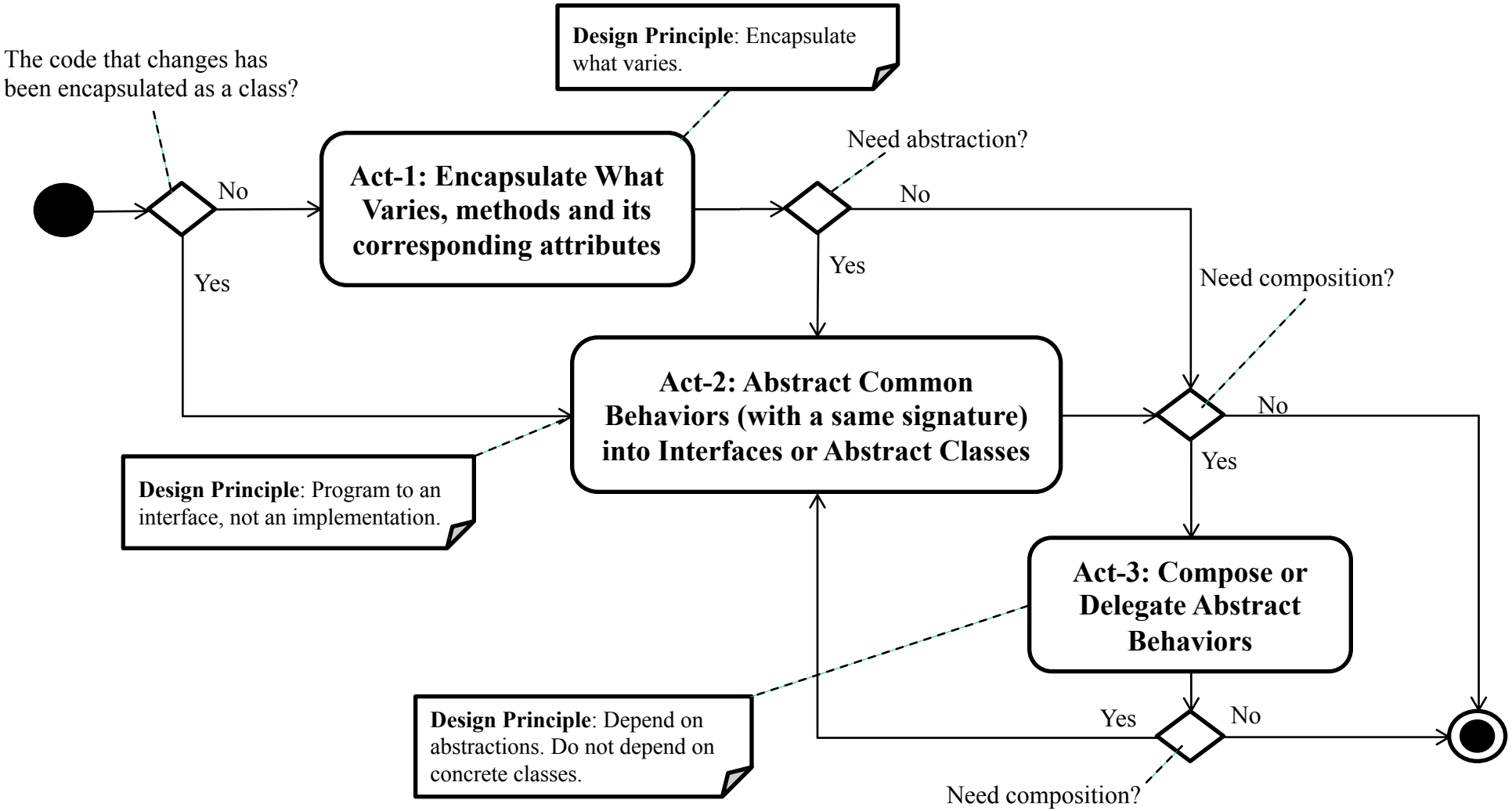
Initial Design - Class Diagram



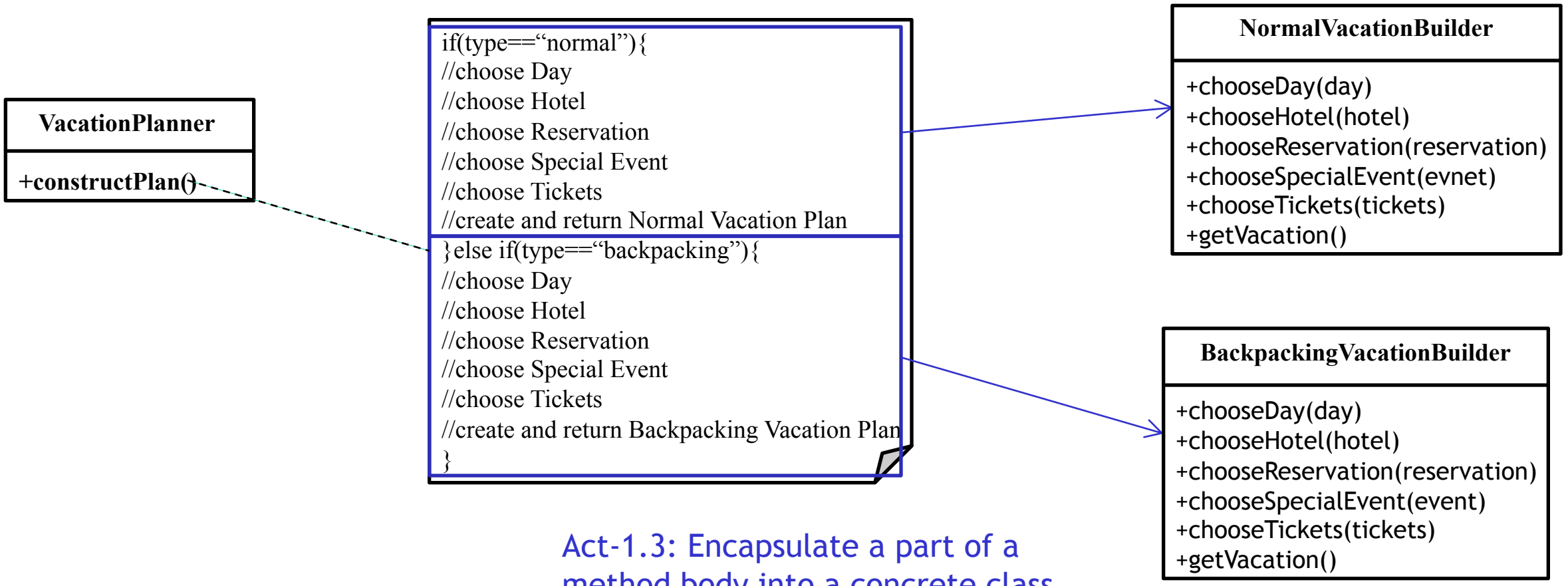
Problems with Initial Design



Design Process for Change



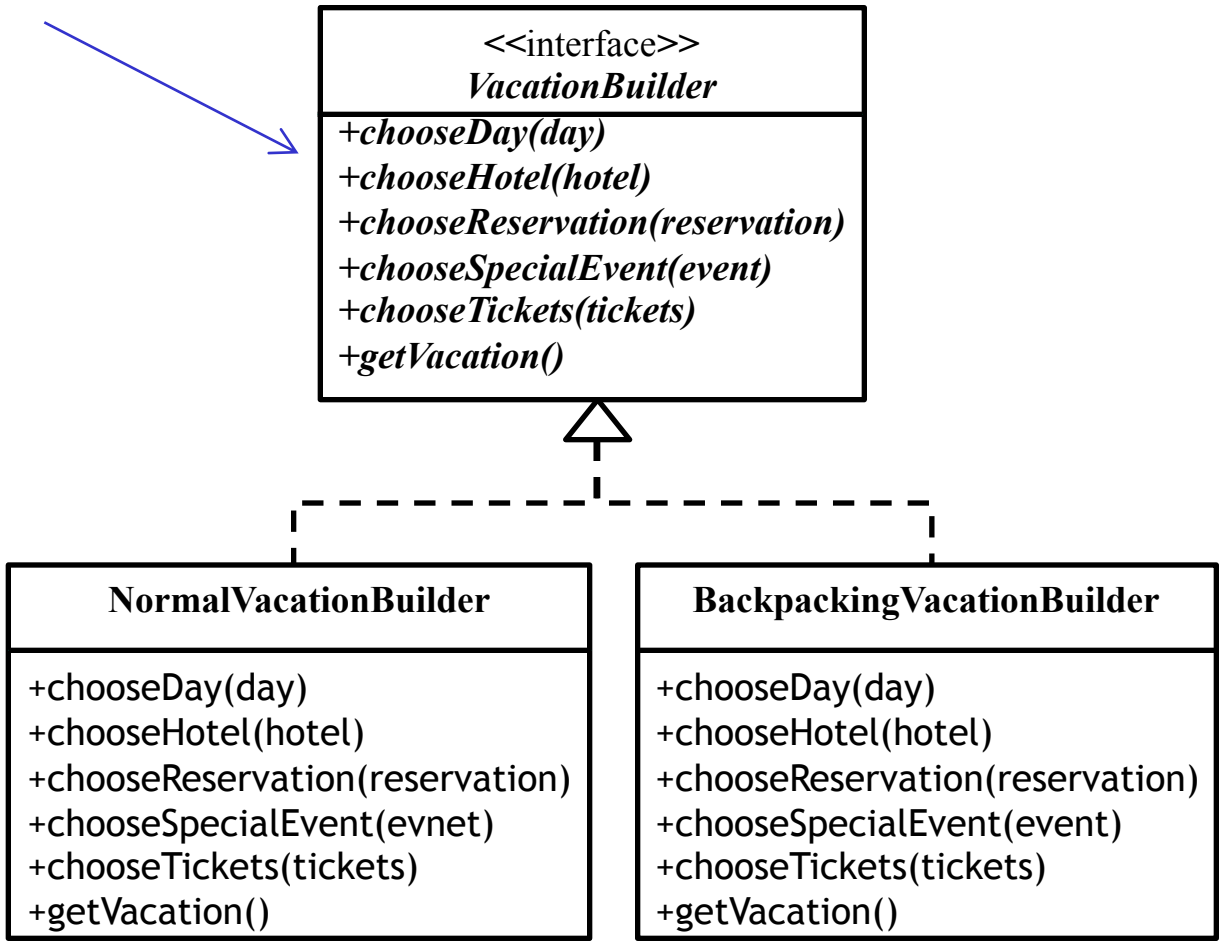
Act-1: Encapsulate What Varies



Act-1.3: Encapsulate a part of a method body into a concrete class

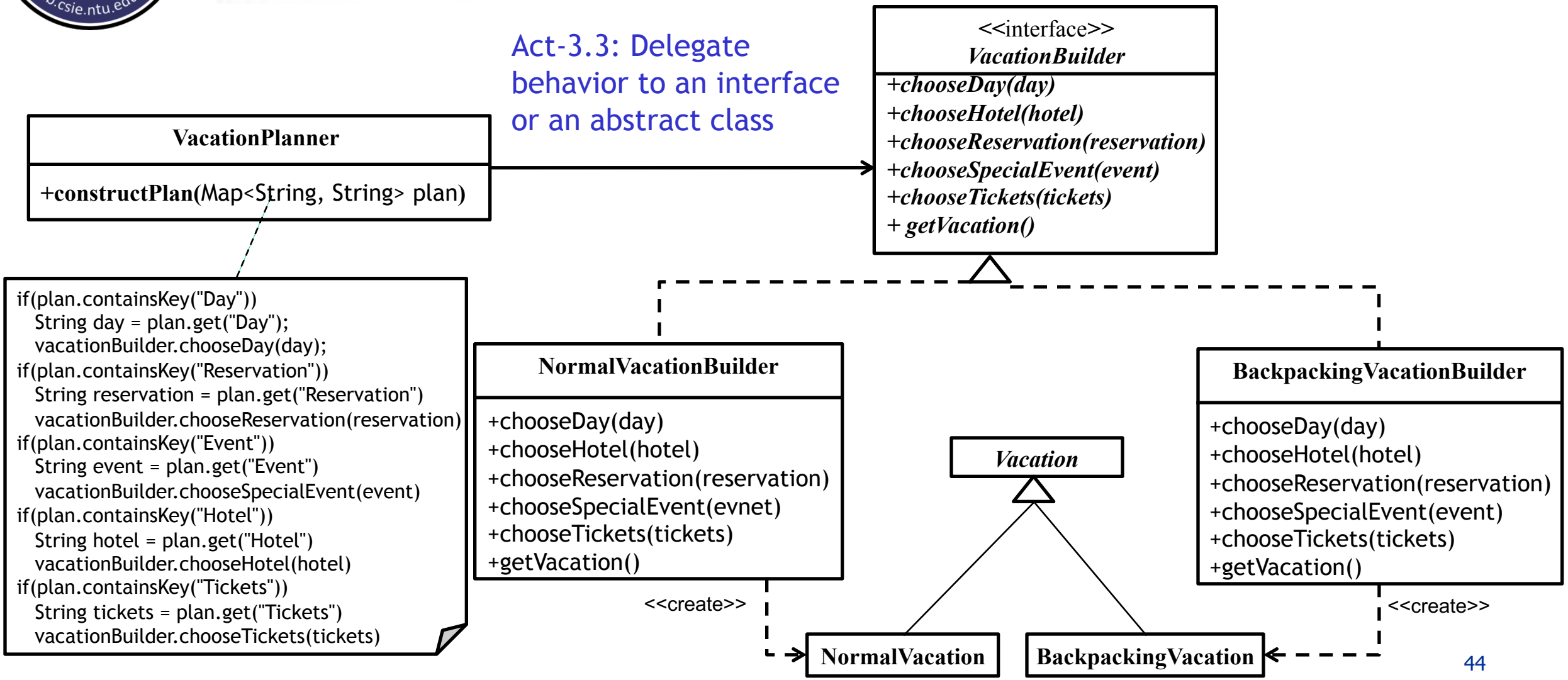
Act-2: Abstract Common Behaviors

Act-2.1: Abstract common behaviors with a same signature into interface through polymorphism

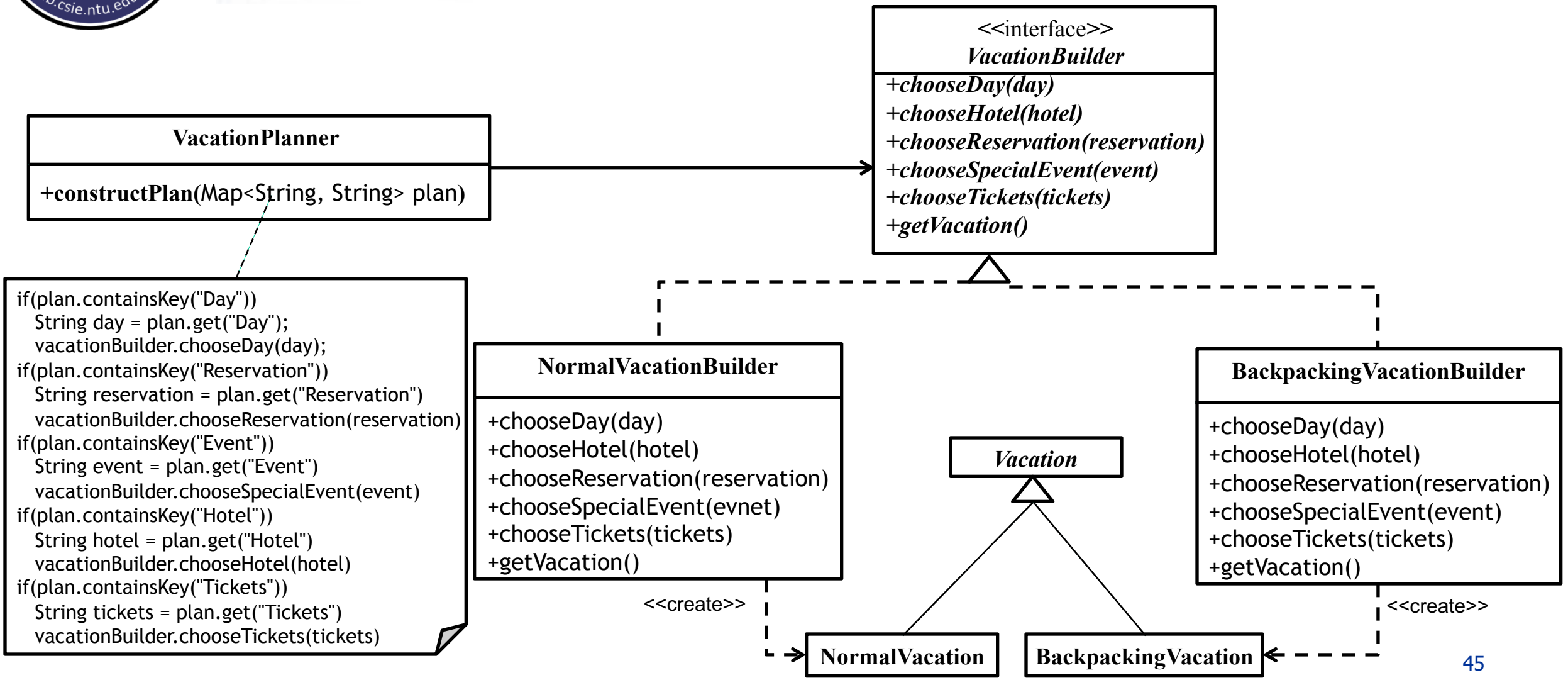


Act-3: Compose Abstract Behaviors

Act-3.3: Delegate behavior to an interface or an abstract class



Refactored Design after Design Process



VacationPlanner

```
public class VacationPlanner {
    private VacationBuilder vacationBuilder = null;

    public void setVacationBuilder(VacationBuilder vacationBuilder) { this.vacationBuilder = vacationBuilder; }

    public Vacation constructPlan(Map<String, String> plan){
        if(plan.containsKey( key: "Day")){
            String day = plan.get("Day");
            vacationBuilder.chooseDay(day);
        }
        if(plan.containsKey( key: "Reservation")){
            String reservation = plan.get("Reservation");
            vacationBuilder.chooseReservation(reservation);
        }
        if(plan.containsKey( key: "Event")){
            String event = plan.get("Event");
            vacationBuilder.chooseSpecialEvent(event);
        }
        if(plan.containsKey( key: "Hotel")){
            String hotel = plan.get("Hotel");
            vacationBuilder.chooseHotel(hotel);
        }
        if(plan.containsKey( key: "Tickets")){
            String tickets = plan.get("Tickets");
            vacationBuilder.chooseTickets(tickets);
        }
        return vacationBuilder.getVocation();
    }
}
```

VacationBuilder

```
public interface VacationBuilder {
    public void chooseDay(String day);
    public void chooseHotel(String hotel);
    public void chooseReservation(String reservation);
    public void chooseSpecialEvent(String event);
    public void chooseTickets(String tickets);
    public Vacation getVocation();
}
```

NormalVacationBuilder

```java
public class NormalVacationBuilder implements VacationBuilder{
    private String day = "";
    private String hotel = "";
    private String reservation = "";
    private String event = "";
    private String tickets = "";


    @Override
    public Vacation getVocation() { return new NormalVacation(day, hotel, reservation, event, tickets); }


    @Override
    public void chooseDay(String day) { this.day = day; }


    @Override
    public void chooseHotel(String hotel) { this.hotel = hotel; }


    @Override
    public void chooseReservation(String reservation) { this.reservation = reservation; }


    @Override
    public void chooseSpecialEvent(String event) { this.event = event; }


    @Override
    public void chooseTickets(String tickets) { this.tickets = tickets; }

}
```

BackpackingVacationBuilder

```
public class BackpackingVacationBuilder implements VacationBuilder{
    private String day = "";
    private String hotel = "";
    private String reservation = "";
    private String event = "";
    private String tickets = "";


    @Override
    public Vacation getVocation() { return new BackpackingVacation(day, hotel, reservation, event, tickets); }


    @Override
    public void chooseDay(String day) { this.day = day; }


    @Override
    public void chooseHotel(String hotel) { this.hotel = hotel; }


    @Override
    public void chooseReservation(String reservation) { this.reservation = reservation; }


    @Override
    public void chooseSpecialEvent(String event) { this.event = event; }


    @Override
    public void chooseTickets(String tickets) { this.tickets = tickets; }

}
```

Vacation

```java
public abstract class Vacation {
    private String day = "";
    private String hotel= "";
    private String reservation = "";
    private String specialEvent = "";
    private String tickets = "";

    public Vacation(String day, String hotel, String reservation, String specialEvent, String tickets) {
        this.day = day;
        this.hotel = hotel;
        this.reservation = reservation;
        this.specialEvent = specialEvent;
        this.tickets = tickets;
    }

    @Override
    public String toString(){
        String string = getClass().getName() + "\n" +
                        "Day:" + day + "\n" +
                        "Hotel:" + hotel + "\n" +
                        "Reservation:" + reservation + "\n" +
                        "SpecialEvent:" + specialEvent + "\n" +
                        "Tickets:" + tickets + "\n";

        return string;
    }
}
```

Source code

BackpackingVacation

```
public class BackpackingVacation extends Vacation{

    public BackpackingVacation(String day, String hotel, String reservation, String specialEvent, String tickets)
        super(day, hotel, reservation, specialEvent, tickets);
    }

}
```

NormalVacation

```
public class NormalVacation extends Vacation{

    public NormalVacation(String day, String hotel, String reservation, String specialEvent, String tickets) {
        super(day, hotel, reservation, specialEvent, tickets);
    }

}
```

Input / Output

Input:

```
[Vacation_type]

Day [day]

SpecialEvent [event]

Hotel [hotel]

Reservation [reservation]

Tickets [tickets]

// input information order could be different from above.


...
```

Output:

```
[Vacation_type]Vacation

Day:[day]

Hotel:[hotel]

Reservation:[reservation]

SpecialEvent:[event]

Tickets:[tickets]

//output order must be the same as above.
```

Test cases

- TestCase 1: only Normal
- TestCase 2: only Backpacking
- TestCase 3: Both Normal and Backpacking
- TestCase 4: Complex

Test case1

Sample1.in

```
1  Normal
2  Day Monday
3  SpecialEvent eventA
4  Hotel hotelA
5  Reservation reservationA
6  Tickets TicketsA
```

Sample1.out

```
1  NormalVacation
2  Day:Monday
3  Hotel:hotelA
4  Reservation:reservationA
5  SpecialEvent:eventA
6  Tickets:TicketsA
```

Test case2

Sample2.in

```
1 Backpacking
2 Day Monday
3 SpecialEvent eventA
4 Hotel hotelA
5 Reservation reservationA
6 Tickets TicketsA
```

Sample2.out

```
1 BackpackingVacation
2 Day:Monday
3 Hotel:hotelA
4 Reservation:reservationA
5 SpecialEvent:eventA
6 Tickets:TicketsA
```

Test case3

Sample3.in

```
1  Normal
2  Day Monday
3  SpecialEvent eventA
4  Hotel hotelA
5  Reservation reservationA
6  Tickets TicketsA
7  Backpacking
8  Day TuesDay
9  SpecialEvent eventB
10 Hotel hotelB
11 Reservation reservationB
12 Tickets TicketsB
13 Normal
14 Day Sunday
15 SpecialEvent eventC
16 Hotel hotelC
17 Reservation reservationC
18 Tickets TicketsC
```

Sample3.out

```
1  NormalVacation
2  Day:Monday
3  Hotel:hotelA
4  Reservation:reservationA
5  SpecialEvent:eventA
6  Tickets:TicketsA
7  BackpackingVacation
8  Day:TuesDay
9  Hotel:hotelB
10 Reservation:reservationB
11 SpecialEvent:eventB
12 Tickets:TicketsB
13 NormalVacation
14 Day:Sunday
15 Hotel:hotelC
16 Reservation:reservationC
17 SpecialEvent:eventC
18 Tickets:TicketsC
```

Test case4

Sample4.in

```
1  Normal
2  Day Monday
3  SpecialEvent eventA
4  Hotel hotelA
5  Reservation reservationA
6  Tickets TicketsA
7  Backpacking
8  SpecialEvent eventB
9  Hotel hotelB
10 Tickets TicketsB
11 Reservation reservationB
12 Normal
13 Day Sunday
14 Hotel hotelC
15 Tickets TicketsC
16 SpecialEvent eventC
```

Sample4.out

```
1  NormalVacation
2  Day:Monday
3  Hotel:hotelA
4  Reservation:reservationA
5  SpecialEvent:eventA
6  Tickets:TicketsA
7  BackpackingVacation
8  Day:
9  Hotel:hotelB
10 Reservation:reservationB
11 SpecialEvent:eventB
12 Tickets:TicketsB
13 NormalVacation
14 Day:Sunday
15 Hotel:hotelC
16 Reservation:
17 SpecialEvent:eventC
18 Tickets:TicketsC
```