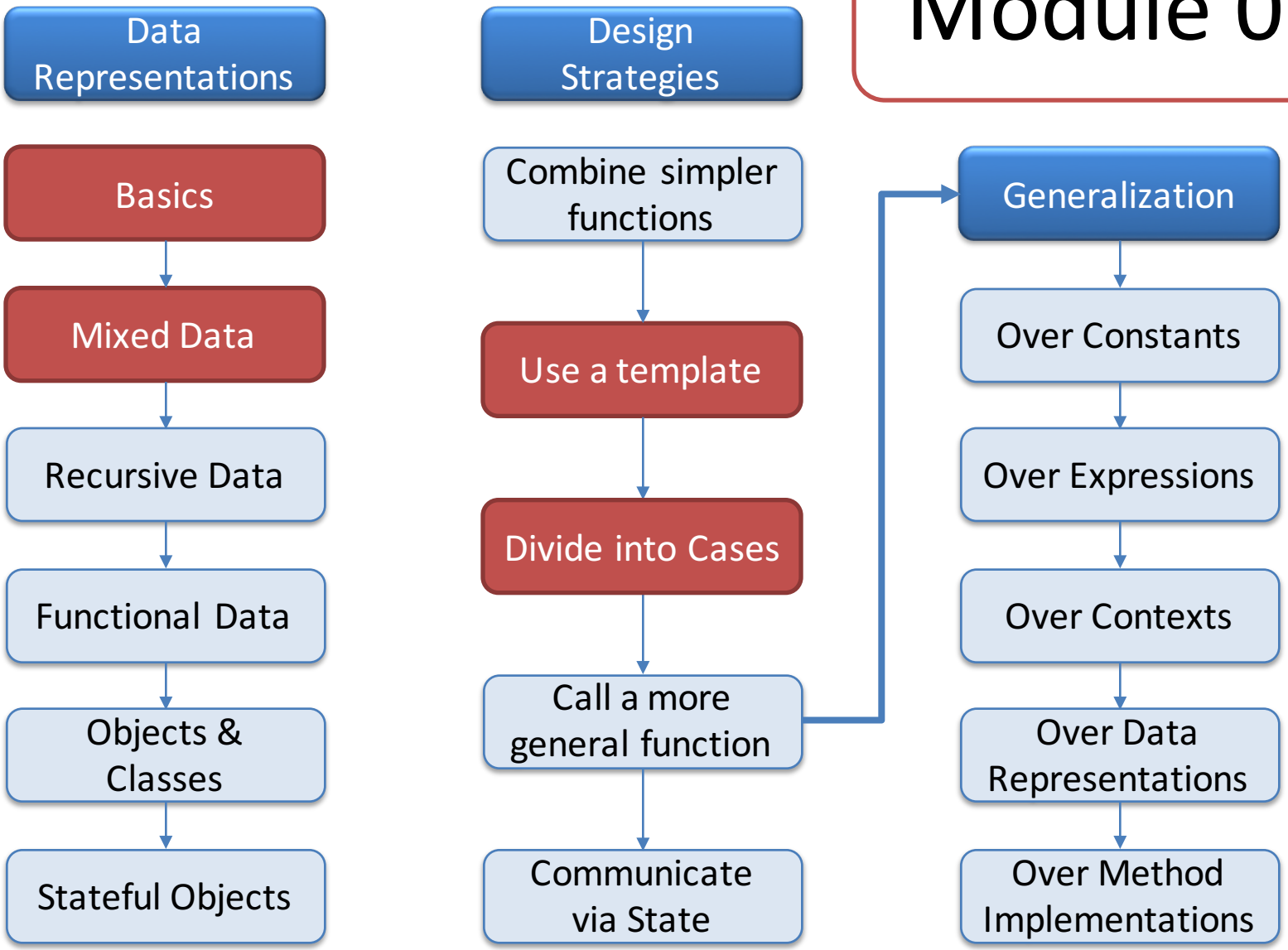
Design Strategies 2: Using a template

CS 5010 Program Design Paradigms "Bootcamp"

Lesson 2.1

Module 02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Basics
Mixed Data
Recursive Data
Functional Data
Objects & Classes
Stateful Objects
Design Strategies
Combine simpler functions
Use a template
Divide into Cases
Call a more general function
Communicate via State
Generalization
Over Constants
Over Expressions
Over Contexts
Over Data Representations
Over Method Implementations

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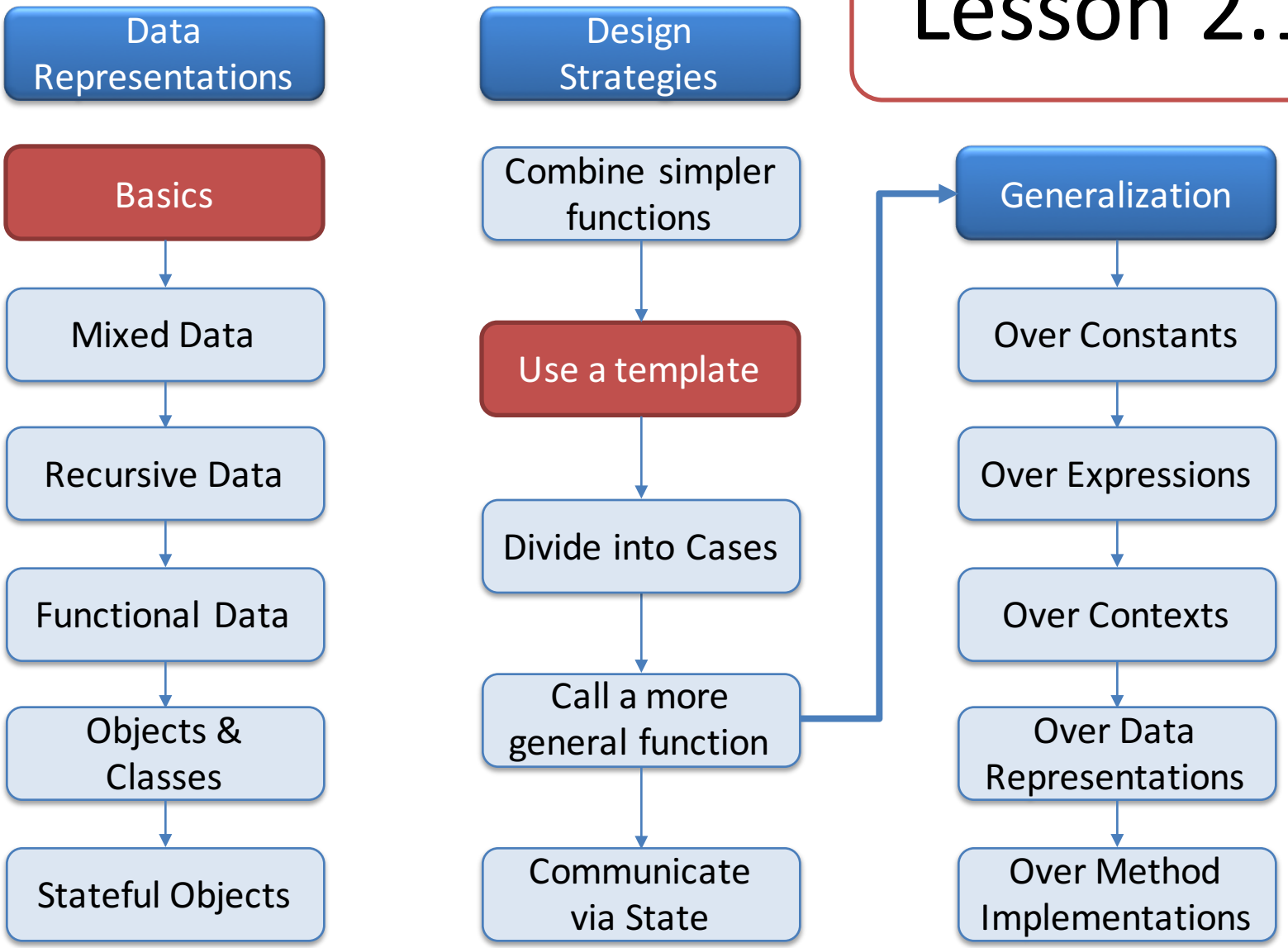
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Introduction

- In this lesson, we will show how to take apart non-scalar data using the destructor template for that type of data.
- This is the strategy you will use for the vast majority of your functions.

Let's see where we are

The Six Principles of this course

1. Programming is a People Discipline
2. Represent Information as Data; Interpret Data as Information
3. Programs should consist of functions and methods that consume and produce values
4. Design Functions Systematically
5. Design Systems Iteratively
6. Pass values when you can, share state only when you must.

The Function Design Recipe

1. Data Design
2. Contract and Purpose Statement
3. Examples and Tests
4. Design Strategy
5. Function Definition
6. Program Review

Design Strategies

1. Combine simpler functions
2. Use template for <data def> on <vble>
3. Divide into cases on <condition>
4. Use HOF <mapfn> on <vble>
5. Call a more general function

Use a destructor template

- Used when the problem can be solved by examining a piece of non-scalar data.
- Slogan:

The shape of the data determines the shape of the program.

What does it mean to “examine” a piece of data?

- If the data is compound data, this means extracting its fields.
- If the data is itemization data, this means determining which variant the data is.
- If the data is mixed data, this means determining which variant the data is, and then extracting its fields, if any.
- Every data definition includes a template that shows how this examination process is to be organized.
- Writing a function using a template is accomplished by filling in the blanks of the template.
  - Definition of "filling in the blank" to come in Slide 11.

From Template to Function Definition

Recipe for Using a Template
1. Make a copy of the template and uncomment it
2. Fill in the function name and add more arguments if needed
3. The strategy is “Use template for <data def> on <vble>,” where <data def> is the kind of data you are taking apart, and <vble> is the variable whose value you are looking at.
4. Fill in the blanks in the template by combining the arguments and the values of the fields using simpler functions.

Example: **book-receipts**

```
;; book-receipts : Book NonNegInt -> NonNegInt
;; GIVEN: a Book and the number of copies sold
;; RETURNS: the total receipts from the sales of the
;; given book. Ignores the number of copies on hand.
;; EXAMPLE:
;; (book-receipts
;;   (make-book "Felleisen" "HtdP2" 13 2795) 100)
;; = 279500
```

To do this, we'll need to look inside the Book to see its price, so we'll use the Book template

1. Make a copy of the template and uncomment it

```
(define (book-fn b)
  (...
    (book-author b)
    (book-title b)
    (book-on-hand b)
    (book-price b)))
```

2. Fill in the function name and add more arguments if needed

```
(define (book-receipts b sales)
  (...
    (book-author b)
    (book-title b)
    (book-on-hand b)
    (book-price b)))
```

3. Write down the strategy

```
;; STRATEGY: Use template for Book on b.
(define (book-receipts b sales)
  (...
    (book-author b)
    (book-title b)
    (book-on-hand b)
    (book-price b)))
```

4. Fill in the blanks in the template

```
;; STRATEGY: Use template for Book on b.
(define (book-receipts b sales)
  (* (book-price b) sales))
```

Things we didn't use:

```
(book-author b)
(book-title b)
(book-on-hand b)
```

That's OK!

We said:
"4. Fill in the blanks in the template by combining the arguments and the values of the fields using simpler functions."

Example: next state of traffic light

```
;; DATA DEFINITION:
;; a TrafficLightState (TLState) is one of
;; -- "red"
;; -- "yellow"
;; -- "green"
;; INTERPRETATION: self-evident
```

Contract and Purpose Statement

```
;; next-state : TLState -> TLState
;; GIVEN: a TLState
;; RETURNS: the TLState that follows the given TLState
;; EXAMPLES:
;; (next-state "red") = "green"
;; (next-state "yellow") = "red"
;; (next-state "green") = "yellow"
```

1. Make a copy of the template and uncomment it

```
(define (tls-fn state)
 (cond
   [(string=? state "red")    ...]
   [(string=? state "yellow") ...]
   [(string=? state "green")  ...]))
```

2. Fill in the function name and add more arguments if needed

```
(define (next-state state)
 (cond
   [(string=? state "red")    ...]
   [(string=? state "yellow") ...]
   [(string=? state "green")  ...]))
```

3. Fill in the strategy

```
;; STRATEGY: Use template for TLState on state

(define (next-state state)
 (cond
   [(string=? state "red")    ...]
   [(string=? state "yellow") ...]
   [(string=? state "green")  ...]))
```

4. Fill in the blanks

```
;; STRATEGY: Use template for TLState on state

(define (next-state state)
 (cond
   [(string=? state "red")    ...]
   [(string=? state "yellow") ...]
   [(string=? state "green")  ...]))
```

What is the answer for "red"?

4. Fill in the blanks

```
;; STRATEGY: Use template for TLState on state

(define (next-state state)
 (cond
   [(string=? state "red")    "green"]
   [(string=? state "yellow") ...]
   [(string=? state "green")  ...]))
```

What is the answer for "red"?

Answer (from examples): "green"

4. Fill in the blanks

```
;; STRATEGY: Use template for TLState on state

(define (next-state state)
 (cond
   [(string=? state "red")    "green"]
   [(string=? state "yellow") "red"]
   [(string=? state "green")  ...]))
```

What is the answer for "yellow"?

Answer (from examples): "red"

4. Fill in the blanks

```
;; STRATEGY: Use template for TLState on state

(define (next-state state)
 (cond
   [(string=? state "red")    "green"]
   [(string=? state "yellow") "red"]
   [(string=? state "green")  "yellow"]))
```

What is the answer for "green"?

Answer (from examples): "yellow"

Working with other kinds of data

- We've seen how to use templates for compound data and itemization data
- Mixed data works the same way.
- Copy the template, uncomment it, and fill in the missing pieces. That's it!
- If you've thought hard enough about your function, filling in the blanks is easy.

What can you put in the blanks?

- We said: Fill in the blanks in the template by combining the arguments and the values of the fields using simpler functions.
- This means :
  - You don't have to use all of the fields
  - You can use a field twice
  - You don't have to use the fields "in order"
- But it has to be simple, as in Lesson 1.7

Next Steps

- Study 02-1-book-receipts.rkt and 02-2-traffic-light.rkt in the Examples folder.
  - Be sure to finish the **previous-state** example in 02-2-traffic-light.rkt
- If you have questions or comments about this lesson, post them on the discussion board.
- Do the Guided Practices
- Go on to the next lesson.