- **Helper Functions and Reuse**
- **Conditionals**
- **Evaluation Rules for cond**
- **Design Recipe with cond**
- **Compound Data**

Designing Programs

Design recipe

- As outlined last lecture

Helper functions and reuse

- Writing writing a function, consider whether existing functions help
  - Example: **`wearing-glasses?`** uses **`add-glasses`**
- Look for functions that you wish you had written
  - Example: **`same-person-maybe-disguised?`** needs **`wearing-beard?`**

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(bigger-image? ■ ■) "should be" false
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Another Example

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```
; bigger-image? : image image -> bool
; Returns true if a has more pixels than b
(define (bigger-image? a b)
  (> (* (image-width a) (image-height a))
     (* (image-width b) (image-height b))))

(bigger-image? ■ ■) "should be" true
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Another Example

Write the function **`bigger-image?`** which checks whether one image has more pixels than a second image

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; bigger-image? : image image -> bool
; Returns true if a has more pixels than b
(define (bigger-image? a b)
  (> (image-size a) (image-size b)))


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Wish list: **`image-size`**

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Wish list: **`image-size`**

Fullfill wishes by applying the recipe again

(exercise for the reader)

Reuse

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; otherwise returns b
(define (max-image a b) ...)
```

Reuse

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Instead of returning a **`bool`**, we need to do one of two things, so we need **cond**

- Helper Functions and Reuse
- **Conditionals**
- Evaluation Rules for cond
- Design Recipe with cond
- Compound Data

Conditionals in Algebra

General format of conditionals in algebra:

$$\begin{cases} \textit{answer} & \textit{question} \\ \quad\ldots & \\ \textit{answer} & \textit{question} \end{cases}$$

Example:

$$\text{abs}(x) = \begin{cases} x & \text{if } x > 0 \\ -x & \text{otherwise} \end{cases}$$

$$\text{abs}(10) = 10$$

$$\text{abs}(-7) = 7$$

Conditionals

General syntax of **cond** in our language:

```
(cond
  [question answer]
  ...
  [question answer])
```

- Any number of **cond** lines
- Each line has one *question* expression and one *answer* expression

```
(define (abs x)
  (cond
    [(> x 0) x]
    [else (- x)]))
(abs 10) "should be" 10
(abs -7) "should be" 7
```

Completing max-image

- Use **cond** to complete **max-image**

```
(define (max-image a b)
  (cond
    [(bigger-image? a b) a]
    [else b]))
```

- Helper Functions and Reuse
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Evaluation Rules for cond

First question is literally `true` or **`else`**

```
(cond
  [true answer]
  ...
  [question answer])
```
→ *answer*

- Keep only the first answer

Example:

```
(* 1 (cond          → (* 1 0) → 0
     [true 0]))
```

Evaluation Rules for cond

First question is literally `false`

```
(cond
  [false answer]
  [question answer]   →   (cond
  ...                       [question answer]
  [question answer])        ...
                            [question answer])
```

- Throw away the first line

Example:

```
(+ 1 (cond                → (+ 1 (cond
       [false 1]                  [true 17]))
       [true 17]))

                          → (+ 1 17) → 18
```

Evaluation Rules for cond

First question isn't a value, yet

```
(cond                          (cond
  [question answer]      →       [nextques answer]
  ...                            ...
  [question answer])             [question answer])
```

where ***question*** → ***nextques***

- Evaluate first question as sub-expression

Example:

```
(+ 1 (cond              → (+ 1 (cond
       [(< 1 2) 5]                [true 5]
       [else 8]))                 [else 8]))

                        → (+ 1 5) → 6
```

Evaluation Rules for cond

Only queston is false answers

```
(cond
 [false 10])
```

→ *error: all questions false*

- Helper Functions and Reuse
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- **Design Recipe with cond**
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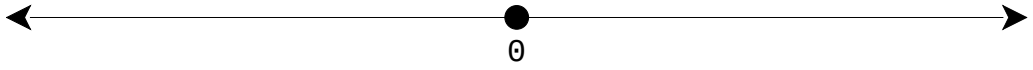
Examples

When the problem statement divides the input into several categories, test each one

Example:

Write the function **`line-part`** that determines whether a number is on zero, to the left, or to the right on a number line




```
(line-part 0) "should be" 'zero
(line-part -3) "should be" 'left
(line-part 3) "should be" 'right
```

Body

When the problem statement divides the input into *N* categories:

- Start the body with a **`cond`** expression and *N* lines
- Formulate a question to recognize each category

Example:

Write the function **`line-part`** that determines whether a number is on zero, to the left, or to the right on a number line

Three cases, so three lines:

```
(define (line-part n)
  (cond
    [(= n 0) ...]
    [(< n 0) ...]
    [(> n 0) ...]))
```

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Finding Images

(image-inside?  ) → true

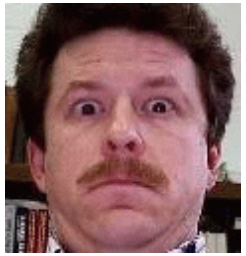
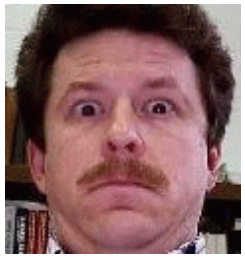
(image-inside?  ) → false

Image Tests in Conditionals

Now we can combine such operators with **cond**:

```
; detect-person : image image image -> image
; Returns a or b, depending on which is in i
(define (detect-person i a b)
  (cond
    [(image-inside? i a) a]
    [(image-inside? i b) b]))
```

```
(detect-person
```



```
)
```

"should be"

Finding and Adjusting Images

Suppose we want to write **`frame-person`**:

`(frame-person`   **`)`**

`"should be"` 

Need an operator that reports *where* an image exists

Finding an Image Position

~~`find-image : image image -> num num`~~

Must return a single value

Correct contract:

```
find-image : image image -> posn
```

- A **`posn`** is a ***compound value***

Positions

- A **posn** is

  ```
  (make-posn X Y)
  ```

  where **X** is a **num** and **Y** is a **num**

Examples:

```
(make-posn 1 2)
```

```
(make-posn 17 0)
```

A **posn** is a value, just like a number, symbol, or image

posn-x and posn-y

The **posn-x** and **posn-y** operators extract numbers from a **posn**:

```
(posn-x (make-posn 1 2)) → 1

(posn-y (make-posn 1 2)) → 2
```

- General evaluation rules for any **X** and **Y**:

```
(posn-x (make-posn X Y)) → X

(posn-y (make-posn X Y)) → Y
```

Positions and Values

Is `(make-posn 100 200)` a value?

Yes.

A **posn** is

`(make-posn X Y)`

where **X** is a **num** and **Y** is a **num**

Positions and Values

Is `(make-posn (+ 1 2) 200)` a value?

No. `(+ 1 2)` is not a **num**, yet.

- Two more evaluation rules:

`(make-posn X Y)` → `(make-posn Z Y)`
when `X` → `Z`

`(make-posn X Y)` → `(make-posn X Z)`
when `Y` → `Z`

Example:

`(make-posn (+ 1 2) 200)` → `(make-posn 3 200)`

More Examples

Try these in DrScheme's stepper:

```
(make-posn (+ 1 2) (+ 3 4))

(posn-x (make-posn (+ 1 2) (+ 3 4)))

; pixels-from-corner : posn -> num
(define (pixels-from-corner p)
  (+ (posn-x p) (posn-y p)))
(pixels-from-corner (make-posn 1 2))

; flip : posn -> posn
(define (flip p)
  (make-posn (posn-y p) (posn-x p)))
(flip (make-posn 1 2))
```