CS 135 Winter 2018

Tutorial 2
Goals of this tutorial

You should be able to...

• understand and perform Boolean algebra.
• understand and use conditional expressions.
• write sufficient test cases for functions containing conditional expressions.
Review: Boolean-valued functions

Boolean-valued functions produce Boolean values: true and false. These functions are also called predicates.

Standard Racket uses #t and #f, or #true and #false; these will sometimes show up in basic tests and correctness tests.

Racket provides many built-in Boolean functions (for example, to do numerical comparisons: (>= x y), (= x y)).
Review: Boolean-valued functions

Note that comparison functions are often specific to certain data types (for example, \((= \ a \ b)\) vs. \((\text{symbol}=? \ x \ y)\), where \(a\) and \(b\) are numbers, but \(x\) and \(y\) are symbols).

The naming convention for most predicates and Boolean parameters is to append a question mark to the name (for example, \(\text{even}\)?, \(\text{symbol}\)?, \(\text{expired}\)?).
Review: Boolean Operators

and and or are special forms in Racket.

and and or may have two or more arguments.

Their arguments are evaluated from left to right.

and:

• If an argument evaluates to false, the entire expression evaluates to false.

• Otherwise, the next argument is evaluated.

• If there are no arguments remaining, the expression evaluates to true.
Review: Boolean Operators

or:

- If an argument evaluates to true, the entire expression evaluates to true.
- Otherwise, the next argument is evaluated.
- If there are no arguments remaining, the expression evaluates to false.

not:

- not must have exactly one argument.
- If the argument evaluates to true, the entire expression evaluates to false.
- If the argument evaluates to false, the entire expression evaluates to true.
Clicker Question - Boolean Expressions

Which of the following expressions evaluates to true?

A \((= \text{green \ green})\)

B \((\text{not (not false)})\)

C \((\text{check-expect (min } (+ 3 4) 8) 7)\)

D \((\text{or } (= 81 (\text{expt 3 4})) (< (\text{sqr 5}) 28))\)

E \((\text{and true (not true)})\)
Group Problem - valid-pin?

The Bank of Amestris has the following rules for setting a Bank PIN:

- A Bank PIN must be a 4-digit positive integer.
- For security reasons, a PIN cannot consist of the same digit appearing 4 times.

For example, 8242 is considered a valid Bank PIN, but 3333 is not. **Using only boolean expressions**, write a function `valid-pin?` that consumes a number, and produces `true` if the number is considered a valid PIN according to the rules above, and `false` otherwise. Include a purpose, contract, and examples.
Review: Conditional Expressions

The general form of a conditional expression is

```lisp
(cond
  [question1 answer1]
  [question2 answer2]
  ...
  [questionk answerk])
```

where `questionk` could be `else`. 
Each of the questions must evaluate to a **boolean** value.

The questions are evaluated from **top to bottom**.

If a question evaluates to **true**, no more questions are evaluated and the cond expression is reduced to just the answer for that question.

If none of the questions evaluate to **true**, then the result is the answer in the **else** clause.

If there are no questions that evaluate to **true** and there is no **else** clause, then Racket will report an error.
Clicker Question - Cond Expression

What does the following cond expression evaluate to?

(cond
  [(< 18 18) 'blue]
  [(and (not false) (= (max 4 -6) (sqr 2))) 'red]
  [(= (/ 3 (sqrt 9)) 2) 'yellow]
  [else 'green])

A 'blue
B 'red
C 'yellow
D 'green
E Nothing. There is an error.
Note: Tests for conditional expressions

- Test for each clause in the cond expression.
- If the function specifications allow for this:
  - Test all boundary points.
  - Write at least one test for each interval (not including the boundary).
- DrRacket highlights unused code.
  - Having no code highlighted does not mean that your code is fully tested.
  - However, highlighted code means your testing is incomplete.
Clicker Question - Testing

(define (foo x)
  (cond
    [(< x 0) (exp x)]
    [(<= x 50) (sub1 x)]
    [(< x 500) (sqr x)]
    [(<= x 5000) (/ x 2)]
    [else (add1 x)]))

Minimally, how many tests would be required for this function?

A  5
B  6
C  7
D  8
E  9
Group Problem - receives-discount/cond?

A warehouse store discounts its merchandise according to the following rules:

- All items in the clearance section are discounted.
- If an item has been in the store for at least 6 weeks, it is only discounted if the item is an 'appliance or 'clothing.
- If an item has been in the store for at least 3 weeks, but less than 6 weeks, it is only discounted if the item is a 'food.
- All other items are not discounted.

Using cond and no Boolean operations (so no and, or, or not), write a function receives-discount/cond? that consumes the number of weeks an item has been in the store, a symbol representing the type of the item, and a Boolean value representing whether the item is in the clearance section. The function produces true if the item receives a discount, and false otherwise. Include the full design recipe.
Group Problem - receives-discount/bool?

Now write a function `receives-discount/bool?`, which consumes the same parameters as `receives-discount/cond?` but uses only Boolean operations, and no instances of `cond`. You only need to write the function definition. Here are the discount rules as a reminder:

- All items in the clearance section are discounted.
- If an item has been in the store for at least 6 weeks, it is only discounted if the item is an `appliance` or `clothing`.
- If an item has been in the store for at least 3 weeks, but less than 6 weeks, it is only discounted if the item is a `food`.
- All other items are not discounted.
**Group Problem - loan-interest**

The Bank of Amestris also issues loans to its customers, which have either a 'standard or 'premium account. Their loan policies are as follows:

- If a customer has a bad credit history, the Bank refuses to give them a loan.

- Otherwise, if the duration of a loan is no more than 3 months, or the amount of money loaned is less than $500, no interest is paid on the loan.

- Otherwise, if a customer has a 'premium account, and the loan amount is no more than $25,000, interest is calculated based on the 'premium rate of 10%.

- Otherwise, interest is calculated on the 'standard rate of 15%.

Interest is calculated by multiplying the amount of the loan, the duration, and the interest rate together. You may assume that the amount and duration of a loan are both positive.
Group Problem - loan-interest

Write a function loan-interest, which consumes the amount and duration of the loan in months, a Boolean which is true if the customer has a bad credit history, and a symbol representing the account-type. The function will produce the amount of interest that the customer must pay on the loan, or $-1$ if the Bank refuses to give a loan. You do not need to include a full set of tests. Here are the policies as a reminder:

- If a customer has a bad credit history, the Bank refuses to give them a loan.
- Otherwise, if the duration of a loan is no more than 3 months, or the amount of money loaned is less than $500, no interest is paid on the loan.
- Otherwise, if a customer has a 'premium account, and the loan amount is no more than $25,000, interest is calculated based on the 'premium rate of 10%.
- Otherwise, interest is calculated on the 'standard rate of 15%.