Structs, Vectors, and Classes in DSSL2

CS 214, Fall 2019
Welcome to DSSL2

- A close relative of Python
- But with data structures taken out!
  - (Otherwise, where’s the fun?)
- And with data structure building blocks added in
- Built on top of Racket
  - But quite different from Racket/BSL/ISL/…
Welcome to DSSL2

- Code organized in statements, functions, and classes
  - Similar to C++
- Variables and data are mutable (= assignment)
  - Similar to C++
- No explicit pointers (arrows) or memory management
  - Similar to the 111 teaching languages
- No explicit types
  - Similar to the 111 teaching languages
- (These also apply to Python)
DSSL2 expressions

3 + 5  # comments start with `#` and continue
       # to the end of the line

6 * (3 + 5)

1 + 'hello'.len()
DSSL2 expressions

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DSSL2 statements

let x = 5

# variable definitions use ‘let’ –
# this minor difference from Python
# helps avoid ambiguity and thus bugs
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println(8 * x)  # an expression can also be a statement
DSSL2 statements

```python
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    # this minor difference from Python
    # helps avoid ambiguity and thus bugs

println(8 * x)  # an expression can also be a statement

if condition:  # indentation matters! just like Python
do_some_stuff()
else:
do_other_stuff(x, y, z)
```
DSSL2 functions

# hypotenuse: Number Number -> Number
# Finds the length of the hypotenuse.
def hypotenuse(a, b):
    \((a \ast a + b \ast b).\sqrt()\)
DSSL2 functions

# hypotenuse: Number Number -> Number
# Finds the length of the hypotenuse.
def hypotenuse(a, b):
    (a * a + b * b).sqrt()

# fact: Natural -> Natural
# Computes the factorial of `n`.
def fact(n):
    if n == 0:
        1
    else:
        n * fact(n - 1)
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DSSL2 assertions and test cases

An assertion errors (and stops your program) if it fails:

# fails if fact(5) != 120:
assert_eq fact(5), 120
DSSL2 assertions and test cases

An assertion errors (and stops your program) if it fails:

```python
# fails if fact(5) != 120:
assert_eq fact(5), 120
```

To run multiple tests, put your assertions in test blocks. When an error happens in a test block, it counts it as a failed test and continues running the program after the test block:

```python
test 'fact works':
    assert_eq fact(3), 6
    assert_eq fact(5), 120
```
DSSL2 programs

Every DSSL2 program starts with a #lang line, followed by any number of statements:

```dssl2
#lang dssl2

let CM_PER_INCH = 2.54

# Converts centimeters to inches.
def cm_to_inch(cm):
    cm / CM_PER_INCH

# Converts inches to centimeters.
def inch_to_cm(inches):
    inches * CM_PER_INCH

# Round trip test:
assert_eq inch_to_cm(cm_to_inch(17)), 17
assert_eq cm_to_inch(inch_to_cm(17)), 17
```
Vectors

- One of the key building blocks of data structures:

  $\begin{array}{cccccccccc}
  0 & 1 & 1 & 2 & 4 & 7 & 13 & 24 & 44 & 82 \\
  \end{array}$

- Literal vector notation:

  $[0, 1, 1, 2, 4, 7, 13, 24, 44, 82]$
Vector operations

let \( v = [ \ 0, 1, 1, 2, 4, 7, 13, 24, 44, 82 \ ] \)
Vector operations

let v = [ 0, 1, 1, 2, 4, 7, 13, 24, 44, 82 ]

# you can give names to test cases
# and get nicer error messages than bare assumptions

test 'vector basics':
    assert_eq v[3], 2
    assert_eq v[6], 13
Vector operations

let v = [ 0, 1, 1, 2, 4, 7, 13, 24, 44, 82 ]

# you can give names to test cases
# and get nicer error messages than bare assumptions

test 'vector basics':
  assert_eq v[3], 2
  assert_eq v[6], 13

test 'vector set':
  v[6] = 23
  assert_eq v[6], 23
What if I want a really big vector?

- Vector comprehensions allow you to create a vector using a “description” rather than literal elements

```
[ 0; 1000000 ]
```

- Creates a vector with 1000000 elements, all 0s
  - Much nicer than typing the whole thing!
- Supports more complicated descriptions too, see the docs
Example: average

```python
# average: Vector<Number> -> Number
# Averages the elements of a non-empty vector.
def average(vec):
    sum(vec) / vec.len()

# sum: Vector<Number> -> Number
# Sums the elements of a non-empty vector.
def sum(vec):
    let result = 0
    # for-each loop, like in C++
    # `v` becomes each element of the vector, in turn
    for v in vec:
        result = result + v
    return result
```
Discuss with your Neighbor

- Discuss what you already know about DSSL2
- And what is still mysterious
- In 2 minutes, let’s hear your questions
struct posn:
  let x
  let y

# different ways to construct
posn { x: 12, y: -5 }
posn { x: 0, y: 0 }
posn(3, 4)
Working with structs

```plaintext
struct posn:
    let x
    let y

let p = posn(3, 4)
assert posn?(p) # asserts that the result is true
assert_eq p.x, 3
assert_eq p.y, 4 # uses `.=` notation, like C++

p.x = 6
assert_eq p.x, 6
assert_eq p.y, 4
```
struct employee:
    let id; let name; let position

let employees = [
    employee(928, "Alice", 4),
    employee(1089, "Bob", 6),
    employee(14, "Carol", 6),
    employee(546, "Dave", 6)
]
Working with structs and vectors

```swift
struct employee {
    let id; let name; let position
}

let employees = [
    employee(928, "Alice", 4),
    employee(1089, "Bob", 6),
    employee(14, "Carol", 6),
    employee(546, "Dave", 6),
]

QUIZ. Suppose we want to find out Carol’s position:
```
struct employee:
    let id; let name; let position

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QUIZ. Suppose we want to find out Carol’s position:

employees[2].position

QUIZ: How can we give her a promotion (from 6 to 5)?
Working with structs and vectors

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    let id; let name; let position
}

let employees = [
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    employee(546, "Dave", 6),
]

QUIZ. Suppose we want to find out Carol’s position:

employees[2].position

QUIZ: How can we give her a promotion (from 6 to 5)?

employees[2].position = 5
```
# promote_employee : Vector<Employee> Natural →
# Decrements the position of the `index`th employee.
def promote_employee(employees, index):
    let emp = employees[index]
    # `emp` is not a copy! so we modify the original
    emp.position = emp.position - 1
Classes

- Structs and vectors are enough to represent any data
- But data structures = representation + operations
  - Classes allow us to combine the two
- Classes ≈ structs with methods
  - A code organization mechanism to group data and operations together
Our first class example

class Posn:
    let x
    let y

    def __init__(self, x, y):
        self.x = x
        self.y = y

    def get_x(self):
        return self.x

    def get_y(self):
        return self.y

    def distance(self, other):
        dx = self.x - other.get_x()
        dy = self.y - other.get_y()
        return (dx * dx + dy * dy).sqrt()
Using the `Posn` class

```rust
let p = Posn(3, 4)
assert_eq! p.get_x(), 3
assert_eq! p.get_y(), 4
assert_error! p.x          // # fields are private

let q = Posn(0, 0);
assert_eq! p.distance(q), 5
```
Discuss with your Neighbor

- Now that we’ve seen more of DSSL2, let’s repeat the exercise
- In 2 minutes, let’s hear your questions
Let’s look at a rational number class
For more DSSL2 information

See the DSSL2 reference (or help desk)
Next time: The humble linked list