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
```

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6 * (3 + 5)

1 + 'hello'.len()
```

DSSL2 statements

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

DSSL2 functions

```
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# Finds the length of the hypotenuse.
def hypotenuse(a, b):
    (a * a + b * b).sqrt()
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    if n == 0:
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    else:
        n * fact(n - 1)
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DSSL2 assertions and test cases

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

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assert_eq fact(5), 120
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```

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:

```
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:

```
#lang dssl2

let CM_PER_INCH = 2.54

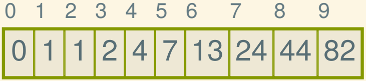
# Converts centimeters to inches.
def cm_to_inch(cm):
    cm / CM_PER_INCH

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

test 'round trip':
    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:



0	1	2	3	4	5	6	7	8	9
0	1	1	2	4	7	13	24	44	82

- 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 ]
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# you can give names to test cases
# and get nicer error messages than bare assumptions
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    assert_eq v[3], 2
    assert_eq v[6], 13
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Vector operations

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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 `0`s
  - Much nicer than typing the whole thing!
- Supports more complicated descriptions too, see the docs

Example: average

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

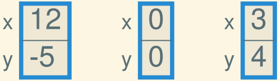
# sum: Vector<Number> -> Number
# Sums the elements of a non-empty vector.
def sum(vec):
    let result = 0
    # for-each loop, like in C++
    # `v` becomes each element of the vector, in turn
    for v in vec:
        result = result + v
    return result
```

Discuss with your Neighbor

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

Structs

- Another key building block



x 12
y -5

x 0
y 0

x 3
y 4

```
struct posn:
    let x
    let y

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

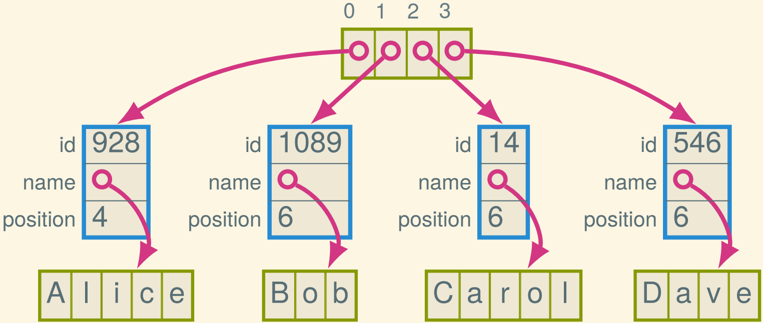
Working with structs

```
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
```

Structs and vectors



```
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

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

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```
employees[2].position
```

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

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

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```

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

```
employees[2].position = 5
```

Generalizing

```
# 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 machanism to group data and operations together

Our first class example

```
class Posn:
    let x                      # fields: initialized by
    let y                      # the constructor

    def __init__(self, x, y):  # constructor: method
        self.x = x             # with a special name
        self.y = y

    def get_x(self): self.x    # fields are private
                               # `return` is optional
    def get_y(self): self.y    # `self` = receiver

    def distance(self, other): # some other method
        # need to use getter for `other`
        let dx = self.x - other.get_x()
        let dy = self.y - other.get_y()
        (dx * dx + dy * dy).sqrt()
```

Using the `Posn` class

```
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

Codewalk

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