CS 3520/6520
Programming Languages

Fall 2024

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Ashton Hunt

CS 3520/6520 Programming Languages

CS 3520/6520 Programming Languages

a survey course:

[1]

an object-oriented language

a functional language

a logic language

CS 3520/6520 Programming Languages

Not a survey course:

an object-oriented language

a functional language

a logic language

CS 3520/6520 Programming Languages

This course is about programming language **concepts**

lexical scope	closures	recursion
λ-calculus	objects	classes
continuations	eager and lazy evaluation	
state	type checking	polymorphism
soundness	type inference	subtyping
compilation	garbage collection	

... especially **functional programming** concepts

use one language, implement many languages

CS 3520/6520 Programming Languages

This course is about programming language **concepts**

- To help you understand new programming languages
- To make you a better programmer in any language

Course Details

See syllabus in Canvas

In person, livestreamed and recorded via Zoom

Formal prerequisite: CS 3500

Informal prerequisite: more programming experience than that

Grading:

- Weekly homework (55%)
- Two mid-term exams (30%)
- Extended final homework (10%)
- Online quizzes (5%)

Late policy for homework: up to 48 hours, two automatic "free lates"

Lectures are Online

All slide presentations are online

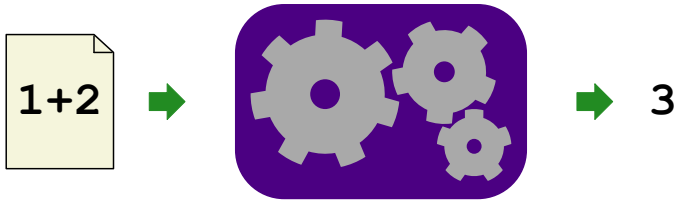
- **Watch the videos before class**

- **Take the quiz before class**
  - ≥ 60% over semester ⇒ 100%
  - no late quizzes

- **Meet as a class for more examples and homework solutions**
  - a.k.a. "recitation"
  - guideline: no new material introduced in class
  - will need in-class volunteers

Interpreters

- **Learn concepts by implementing interpreters**



new concept ⇒ new interpreter

We'll always call the language that we implement **Moe**, even though the language keeps changing

Moe = successor to Curly

Racket and Shplait

- **Implement interpreters using Shplait, a variant of Racket**

Historically: **Lisp** ⇒ **Scheme** ⇒ **Racket** ⇒ **Rhombus** ⇒ **Shplait**

Racket and Shplait

- **Implement interpreters using Shplait, a variant of Racket**

Historically: **Lisp** ⇒ **Scheme** ⇒ **Racket** ⇒ **Rhombus** ⇒ **Shplait** ⇐ **OCaml**

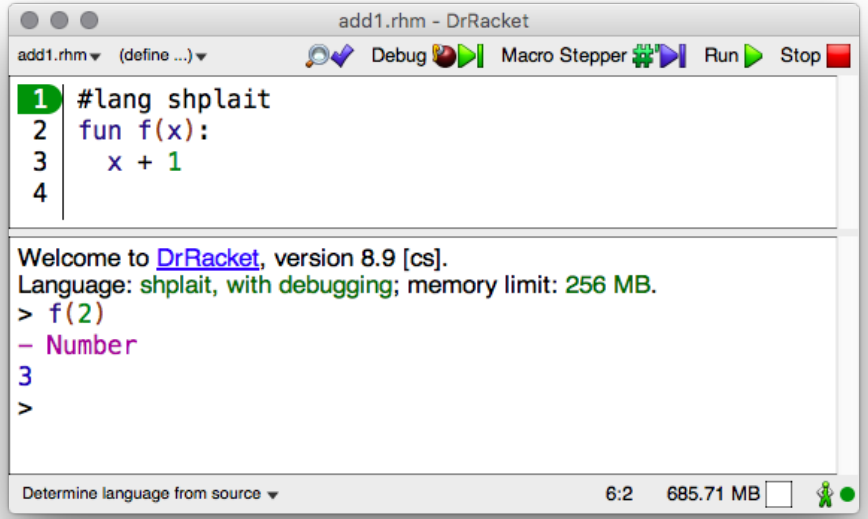
Racket is

- a programming language
- a language for creating programming languages

... including **Shplait**

Sh = *Shrubbery*, a notation
PLAI = *Programming Languages: Application and Interpretation*, a textbook
t = *types*, a la ML

DrRacket

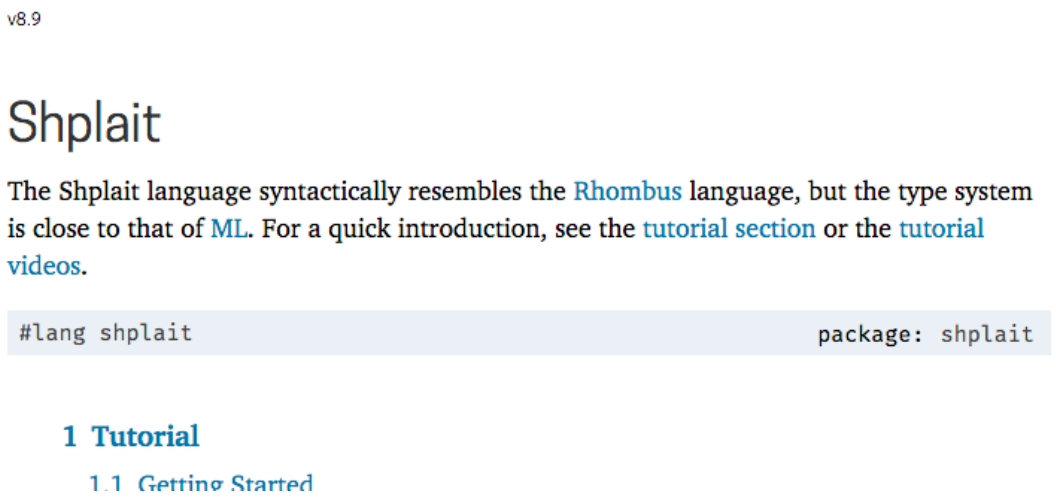

add1.rhm - DrRacket
add1.rhm
(define ...)
Debug
Macro Stepper
Run
Stop
1 #lang shplait
2 fun f(x):
3 x + 1
4
Welcome to DrRacket, version 8.9 [cs].
Language: shplait, with debugging; memory limit: 256 MB.
> f(2)
- Number
3
>
Determine language from source
6:2
685.71 MB

Preview: Shplait Tutorial

`https://docs.racket-lang.org/shplait@shplait`

or locally after install via DrRacket:

Help → **Racket Documentation** → search **`shplait`**



v8.9

Shplait

The Shplait language syntactically resembles the Rhombus language, but the type system is close to that of ML. For a quick introduction, see the tutorial section or the tutorial videos.

```
#lang shplait                                    package: shplait
```

1 Tutorial

1.1 Getting Started

Preview: Shplait Notation

```
f(x)
```

```
f(x)
```

```
1+2
```

```
1 + 2
```

```
1+2*3
```

```
1 + 2 * 3
```

```
s=6
```

```
def s = 6
```

```
f(x)=x+1
```

```
fun f(x):
  x + 1
```

$$\begin{cases} x<0 & -1 \\ x=0 & 0 \\ x>0 & 1 \end{cases}$$

```
cond
| x < 0: -1
| x == 0: 0
| x > 0: 1
```

Preview: Shplait Data

- Numbers and strings — obvious

```
1   -42   "Hello, World!"
```

- Booleans — straightforward

```
#true   #false
```

- Symbols — unusual

```
#'apple   #'def
```

Preview: Shplait Quoted Code

- Single quote `'` instead of string `"` convenient

```
'x'
```

```
'x + 1'
```

```
'fun f(x):
   x + 1'
```

Preview: Shplait Datatypes

```
type Shape
| circle(radius :: Int)
| rectangle(width :: Int,
             height :: Int)

fun area(s):
  match s
  | circle(r): 3 * r * r
  | rectangle(w, h): w * h

check: area(circle(2))
       ~is 12
check: area(rectangle(4, 5))
       ~is 20
```

Preview: Interpreters

See **`lambda.rhm`**

Example **Shplait** program:

```
type Value
| intV(n :: Int)
| closV(arg :: Symbol,
       body :: Exp,
       env :: Env)
```

Example **Moe** program:

```
3 * 4 + 8
```

Example **Moe** program as a **Shplait** value:

```
'3 * 4 + 8'
```

Datatype and Function Shapes Match

```
type Shape
| circle(radius :: Int)
| rectangle(width :: Int,
             height :: Int)
| adjacent(left :: Shape,
            right :: Shape)

fun area(s):
  match s
  | circle(r): 3 * r * r
  | rectangle(w, h): w * h
  | adjacent(l, r): area(l)
                      + area(r)

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       ~is 20
check: area(adjacent(circle(2), rectangle(4, 5)))
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```

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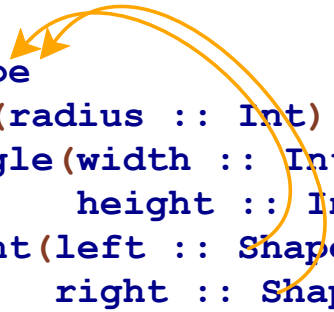

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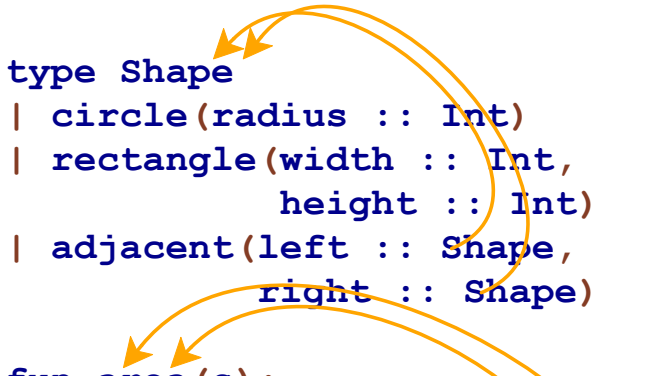

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Course Outline

- Functional programming
- Interpreters
- State
- Control
- Compilation and GC
- Objects and classes
- Types
- Macros and more

Rest of Today

- Take "Syllabus" quiz
- Watch "Shplait Tutorial" videos (~30 minutes)
- Take "Shplait Tutorial" quiz

Quizzes due by the end of the day

Homework 0

- Create handin account
- Shplait warm-up exercises

Due Friday, August 23