# **Review**

CS 350

Dr. Joseph Eremondi

Last updated: July 11, 2024

# **Overview**

• Functional Programming

- Functional Programming
  - o Immutable variables

- Functional Programming
  - o Immutable variables
  - Recursion

- Functional Programming
  - o Immutable variables
  - o Recursion
  - Data-types

- Functional Programming
  - o Immutable variables
  - o Recursion
  - Data-types
  - o Type-case

- Functional Programming
  - o Immutable variables
  - o Recursion
  - Data-types
  - o Type-case
- Interpreters

- Functional Programming
  - o Immutable variables
  - o Recursion
  - Data-types
  - o Type-case
- Interpreters
  - $\circ$  BNF

- Functional Programming
  - o Immutable variables
  - $\circ \ \ Recursion$
  - Data-types
  - Type-case
- Interpreters
  - o BNF
  - Abstract Syntax

- Functional Programming
  - o Immutable variables
  - o Recursion
  - Data-types
  - Type-case
- Interpreters
  - o BNF
  - Abstract Syntax
  - Parsing

- Functional Programming
  - o Immutable variables
  - o Recursion
  - Data-types
  - Type-case
- Interpreters
  - o BNF
  - Abstract Syntax
  - o Parsing
  - o Interpretation

- Functional Programming
  - o Immutable variables
  - o Recursion
  - Data-types
  - Type-case
- Interpreters
  - o BNF
  - Abstract Syntax
  - Parsing
  - Interpretation
  - Desugaring

- Functional Programming
  - o Immutable variables
  - Recursion
  - Data-types
  - Type-case
- Interpreters
  - o BNF
  - Abstract Syntax
  - Parsing
  - Interpretation
  - Desugaring
  - Substitution

**Functional Programming** 

• Repeat until we have a value:

- Repeat until we have a value:
  - o Take all the functions defined with define

- Repeat until we have a value:
  - Take all the functions defined with define
  - Replace them with their definitions, with arguments replacing parameters

- Repeat until we have a value:
  - Take all the functions defined with define
  - Replace them with their definitions, with arguments replacing parameters
  - o Simplify any if, cond, type-case etc.

# The Languages We've Built

• Many different languages

- Many different languages
  - $\circ \ \ \text{Gradually adding features}$

- Many different languages
  - o Gradually adding features
  - $\circ\;$  I'll give them names so we can tell them apart

- Many different languages
  - o Gradually adding features
  - o I'll give them names so we can tell them apart
- Each time we add a new feature, is a new language

- Many different languages
  - Gradually adding features
  - o I'll give them names so we can tell them apart
- Each time we add a new feature, is a new language
- Called "curly because" we write with Curly-brackets

- Many different languages
  - Gradually adding features
  - o I'll give them names so we can tell them apart
- Each time we add a new feature, is a new language
- Called "curly because" we write with Curly-brackets
- Write as S-expression strings

- Many different languages
  - Gradually adding features
  - o I'll give them names so we can tell them apart
- Each time we add a new feature, is a new language
- Called "curly because" we write with Curly-brackets
- Write as S-expression strings
  - Racket backtick ' turns strings into S-expressions

- Many different languages
  - Gradually adding features
  - o I'll give them names so we can tell them apart
- Each time we add a new feature, is a new language
- Called "curly because" we write with Curly-brackets
- Write as S-expression strings
  - Racket backtick ' turns strings into S-expressions
  - Separates different names/symbols and nests brackets

- Many different languages
  - Gradually adding features
  - o I'll give them names so we can tell them apart
- Each time we add a new feature, is a new language
- Called "curly because" we write with Curly-brackets
- Write as S-expression strings
  - Racket backtick ' turns strings into S-expressions
  - Separates different names/symbols and nests brackets
  - Parse turns S-expressions into AST

• Just has addition, multiplication, and numbers

- Just has addition, multiplication, and numbers
- AST type Expr

- Just has addition, multiplication, and numbers
- AST type Expr
- Value type Number

- Just has addition, multiplication, and numbers
- AST type Expr
- Value type Number
- Pipeline:

- Just has addition, multiplication, and numbers
- AST type Expr
- Value type Number
- Pipeline:
  - $\circ \; \; \mathsf{String} \to_{\mathsf{backtick}} \mathsf{S\text{-}Exp} \to_{\mathsf{parse}} \mathsf{Expr} \to_{\mathsf{interp}} \mathsf{Number}$

# **Curly-Cond**

• Adds ifo

### **Curly-Cond**

- Adds if o
  - $\circ\,$  Conditional expressions, branching depending on whether a value is 0

## **Curly-Cond**

- Adds if o
  - Conditional expressions, branching depending on whether a value is 0
  - o Adds a constructor to Expr

## **Curly-Cond**

#### • Adds if o

- Conditional expressions, branching depending on whether a value is 0
- Adds a constructor to Expr
- Adds case to parser and interp

• Adds {- x y}

- Adds {- x y}
- interp unchanged from Curly-Cond

- Adds {- x y}
- interp unchanged from Curly-Cond
- Introduces an intermediate AST type SurfExpr

- Adds {- x y}
- interp unchanged from Curly-Cond
- Introduces an intermediate AST type SurfExpr
  - $\circ \ \ \text{Expressions with syntactic sugar}$

- Adds {- x y}
- interp unchanged from Curly-Cond
- Introduces an intermediate AST type SurfExpr
  - Expressions with syntactic sugar
- Desugaring converts SurfExpr to Expr

- Adds {- x y}
- interp unchanged from Curly-Cond
- Introduces an intermediate AST type SurfExpr
  - o Expressions with syntactic sugar
- Desugaring converts SurfExpr to Expr
  - Translate away certain features

- Adds {- x y}
- interp unchanged from Curly-Cond
- Introduces an intermediate AST type SurfExpr
  - o Expressions with syntactic sugar
- Desugaring converts SurfExpr to Expr
  - Translate away certain features
  - o Also called elaboration

- Adds {- x y}
- interp unchanged from Curly-Cond
- Introduces an intermediate AST type SurfExpr
  - o Expressions with syntactic sugar
- Desugaring converts SurfExpr to Expr
  - Translate away certain features
  - Also called elaboration
- $\{-xy\}$  is the same as  $\{+x\{*-1y\}\}$

- Adds {- x y}
- interp unchanged from Curly-Cond
- Introduces an intermediate AST type SurfExpr
  - Expressions with syntactic sugar
- Desugaring converts SurfExpr to Expr
  - Translate away certain features
  - Also called elaboration
- {- x y} is the same as {+ x {\* -1 y}}
- $\begin{array}{c} \bullet \; \mathsf{String} \to_{\mathsf{backtick}} \mathsf{S-Exp} \to_{\mathsf{parse}} \mathsf{SurfaceExpr} \\ \to_{\mathit{elab}} \mathsf{Expr} \to_{\mathsf{interp}} \mathsf{Number} \end{array}$

• Adds function definitions and function calls

- Adds function definitions and function calls
  - $\circ\;$  Single parameter functions, number in, number out

- Adds function definitions and function calls
  - o Single parameter functions, number in, number out
- Functions have parameters

- Adds function definitions and function calls
  - o Single parameter functions, number in, number out
- Functions have parameters
  - So we add variables to Expr and SurfExpr

- Adds function definitions and function calls
  - o Single parameter functions, number in, number out
- Functions have parameters
  - So we add variables to Expr and SurfExpr
- Interpreter now parameterized by list of function definitions

- Adds function definitions and function calls
  - o Single parameter functions, number in, number out
- Functions have parameters
  - So we add variables to Expr and SurfExpr
- Interpreter now parameterized by list of function definitions
  - Parsed separately

- Adds function definitions and function calls
  - o Single parameter functions, number in, number out
- Functions have parameters
  - So we add variables to Expr and SurfExpr
- Interpreter now parameterized by list of function definitions
  - Parsed separately
- Function calls interpreted by substitution

- Adds function definitions and function calls
  - o Single parameter functions, number in, number out
- Functions have parameters
  - So we add variables to Expr and SurfExpr
- Interpreter now parameterized by list of function definitions
  - Parsed separately
- Function calls interpreted by substitution
  - Replace variable with value of concrete argument