Name: Solutions

Exam II - CSCI3155 - Summer 2019

Answer the questions in the box provided.

1. (5 points) The following lettuce program is written in the form of:

```
let x = 5
  in x + x
```

Answer: A

A. Concrete Syntax
B. Inference Rules
C. Abstract Syntax
D. Proof Tree

2. (5 points) What does the following Lettuce expression evaluate to?

```
let f = function(x) 3
        function(y) 7
          (x + y) * y
  in f(3)(7)
```

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Answer:

A. NumVal(10)
B. NumVal(30)
C. Closure(y, (x + y) * y), σ)
D. Closure(x, function(y) (x + y) * y), σ)

3. (5 points) What is the data structure that was used to implement evaluation environments(σ)?

Answer: D

A. Binary Trees
B. Abstract Syntax Trees
C. Lists
D. Dictionaries

4. (5 points) What is the name of the property we defined which describes programs which only use identifiers that have already been declared?

Answer: A

A. Well-Formedness
B. Well-Typedness
C. Declaration-Safe
D. Totality

5. (5 points) What should replace the question marks in the following inference rule?

$$\frac{\sigma \vdash e_1 \Downarrow \text{NumVal}(v_1) \qquad \sigma \vdash e_2 \Downarrow \text{NumVal}(v_2)}{\sigma \vdash Plus(e_1, e_2) \Downarrow v_1 + v_2} \;\Downarrow\text{-ARITH-BINOP-OK}$$

Answer:

A. Num(n)
B. Const(n)
C. $\mathbb{Z}$
D. $\mathbb{N}$

Different this Semester

6. (5 points) Which constructor/lettuce expression is this inference rule written for? What should **C** be replaced with?

$$\frac{\sigma \vdash e_1 \Downarrow v_1 \qquad v_1 \neq error \qquad \sigma[x \mapsto v_1] \vdash e_2 \Downarrow v_2 \qquad v_2 \neq error}{\sigma \vdash \mathbf{C}(x, e_1, e_2) \Downarrow v_2}$$

Answer: B

A. FunCall
B. Let
C. IfThenElse
D. Ident

7. (5 points) What are operational semantics?

Answer: D

A. A process for reducing an expression to some normal form
B. Interpreting syntax as a process to be performed on a stack machine
C. A procedure for turning a program in a language into machine code
D. Rules for evaluating some program(an expression) to a value

8. (5 points) What is the name of the strategy of nesting single-argument functions in order to simulate a multi-argument function?

Answer: C

A. β-Reduction
B. Higher-Ordered Functions
C. Currying
D. λ-nesting

9. (5 points) What are the three parts of a closure?

Answer:

A. Argument, Function Body, and Environment
B. Parameter, Evaluation, and Environment
C. Argument, Bindings, and Dictionary
D. Parameter, Function Body, and Types

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10. (5 points) Which is *not* an expression in Lettuce?

Answer:

A. Num(5)
B. Bin(Add)
C. Plus(Ident(x), Bin(Add))
D. Pow(Ident(x), Ident(y))

Old Material

11. (5 points) What is the closure generated by evaluating the function definition g on the fourth line below?

```
let x = 7
  in let y = 2
    in let f = function(x) x + 5
      in let g = function(y) y + x
        in g(f(y))
```

Answer

A. Closure$(y, y + x, [x \mapsto 7,\ y \mapsto 2,$
$f \mapsto \text{Closure}(x, x + 5, [x \mapsto 7, y \mapsto 2]))$

B. Closure$(x, x + 5, [x \mapsto 7, y \mapsto 2]))$

C. Closure$(y, y + x, \sigma)$

D. Closure$(y, y + x, [x \mapsto 7,$
$f \mapsto \text{Closure}(x, x + 5, [x \mapsto 7, y \mapsto 2]))$

Next Exam

12. (5 points) The inference rules we have written in class describe what property of our language?

Answer: D

A. Concrete Syntax
B. Abstract Syntax
C. Parsing
D. Semantics

13. (5 points) What is Well-Formedness?

Answer: A

A. The property of a program which only uses identifiers that are already declared and in scope
B. The property that whenever a program is run it will produce a valid output
C. The property that a program is only constructed of valid syntactic constructors
D. The property that a program is well defined for all possible inputs

14. (5 points) Which is the proper form of an inference rule?

Answer: C

A. $\frac{\text{Input}}{\text{Output}}$ B. $\frac{\text{Recursion}}{\text{Evaluation}}$ C. $\frac{\text{Premise}}{\text{Conclusion}}$ D. $\frac{\text{Numerator}}{\text{Denominator}}$

15. (5 points) Semantics are...

Answer: B

A. the evaluations of programs
B. the meaning of a program
C. the symbols of a program
D. the parsing of a program

16. (5 points) Which is *not* a value in Lettuce?

Answer

A. Numbers
B. Functions
C. Closure
D. Booleans

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17. (5 points) What is the type of the following function?

$$\begin{aligned} &\text{bar } f\ x\ y\ = y \text{ match} \\ &\quad \text{True} \to f\ x \\ &\quad \text{False} \to (\text{Succ } (\text{Succ x})) \end{aligned}$$

Answer: C

A. Higher-Order
B. Polymorphic
C. $(\mathbb{N} \to \mathbb{N}) \to \mathbb{N} \to \mathbb{B} \to \mathbb{N}$
D. Binary Operation

18. (5 points) What does the following lettuce program evaluate to?

```
if 5 == True
  then 7
  else 10
```

Answer: B

A. NumVal(7)
B. NumVal(10)
C. BmVal(False)
D. Error

19. (5 points) What does the following lettuce program evaluate to?

```
let f = 100
 in let f = function(x) if x >= 10
                        then f(x - 9)
                        else x
   in f(17)
```

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Answer:

A. NumVal(100)
B. NumVal(1700)
C. NumVal(8)
D. Error

20. (5 points) What data structure describes Syntax of programming languages?

Answer: C

A. Lists
B. Networks
C. Trees
D. Graphs