CS383 Programming Languages

Quiz 3

1. Which one of the following is not a possible lambda expression?

a. Variable: x

b. Condition: if e1 then e2 else e3

c. Abstraction: λ x . e

d. Application: e1 e2

2. Which one of the following statements is correct?

a. a name and the object it denote are the same thing.

b. an object can have only one name.

c. a name can denote different objects at different times.

d. λ -calculus uses dynamic binding

3. What are the free variables in the following lambda expression?

x (λy · y z x) (λm · λn · l m n)

a. x, z, l

b. x, y, z, l, m, n

c. x, z, n

d. y, l, m

*4. For the following substitutions, which is incorrect?

a. $x[y/x] = y$

b. $\lambda\, x \cdot z\ w[y/x] = \lambda y \cdot z\ w$

c. $(\lambda x \cdot (x\ z))[v/x] = (\lambda y \cdot (v\ y))[z/y]$

d. $x\ z\ w[y/x] = y\ z\ w$

Substitution:

a. x [[e/x]] = ?

b. y [[e/x]] = ? (if y ≠ x)

c. (\x.e1) [[e/x]] = ?

d. (\y.e1) [[e/x]] = ? (if y ≠ x)

6. What's the result of the following lambda expression, under full beta-reduction?

$$(\lambda x \cdot x)((\lambda x \cdot x)(\lambda z \cdot (\lambda x \cdot x)z))$$

Full beta-reduction: any redex

a. $\lambda z \cdot z$

b. x

c. z

d. $\lambda z \cdot \lambda z \cdot z\ z$

5. Which one of the following is different from the other three after call by name evaluation?

Call-by-name: leftmost, outermost redex first, NO reduction inside lambda abstractions

a. λx. x x

b. (λx. x x) (λy. y y)

c. (λy. λx. y x) (λx. x x) (λy. y y)

d. (λx. (λx. x x) x) (λx. x x)

7. What is the first step of

(λy. (λx. x) y) ((λu. u) (λv. v))

under call-by-name evaluation?

Call-by-name: leftmost, outermost redex first,
NO reduction inside lambda abstractions

a. (λy. y) ((λu. u) (λv. v))

b. (λx. x) ((λu. u) (λv. v))

c. (λy. (λx. x) y) (λv. v)

d. (λy. (λx. x) y) (λu. u)

*8. What is the first step of
(λy. (λx. x) y) ((λu. u) (λv. v))
under call-by-value evaluation?

call-by-value: only outermost redex, whose RHS must be a value(λ abstraction), no reduction inside abstraction

a. (λy. y) ((λu. u) (λv. v))

b. (λx. x) ((λu. u) (λv. v))

c. (λy. (λx. x) y) (λv. v)

d. (λy. (λx. x) y) (λu. u)

9. Application associate to the _____?

e.g. M N L = (M N) L – associate to the left
or M(N L) – associate to the right

a. Left
b. Right

*10. What's equivalent to **λy.y z λx.x y z**?

a. λy.(y z) λx.((x y) z) -extends as far as possible to the right?

b. λy.(y (z λx.(x (y z)))) -association to the left?

c. (λy.(y z)) λx.((x y) z) -extends as far as possible to the right?

d. λy.((y z) λx.((x y) z))