03-60-440: Sample questions and answers

Questions are mostly from midterm and final exams in 2006. Some outdated questions are removed. Sample answers are in red font. They are provided by Wenyi Zhou.

1 Multiple choice questions

1. Which of the following language is a declarative language?

   (a) Algol
   (b) Java
   (c) C++
   (d) C#
   (e) Prolog

   Answer: e

2. Which one of the following is not a type of polymorphism

   (a) coercion
   (b) overloading
   (c) overriding
   (d) generics
   (e) All of them are types of polymorphism

   Answer: c

3. What formal system provides the semantic foundation for Prolog?

   (a) Predicate calculus;
   (b) Lambda calculus;
   (c) Hoare logic;
   (d) Propositional logic.

   Answer: a

4. Which of the following is the advantage of declarative languages over imperative languages?

   (a) Can use abstract data type;
   (b) Easy to verify the properties of the program;
   (c) Is more efficient;
   (d) Can be implemented by an interpreter or compiler;
   (e) Can be strong-typed.

   Answer: b

5. Given the expression $((\lambda x.x)\lambda x.x)a$ in lambda calculus. Derive the expression as far as possible using $\beta - reduction$. The final result will be:

   (a) $(\lambda x.x)a$
   (b) $\lambda x.x$
   (c) xa
   (d) a
   (e) none of the above

   Answer: d

6. Which of the following captures all the pointcuts of calling private methods that take int as its only argument?

(a) call(private int *())
(b) call(private * *(int))
(c) call (private *(int))
(d) call(* private *(*))
(e) None of above

Answer: b

7. Which one of the following is not a language construct in AspectJ?

(a) Pointcut
(b) Join point
(c) Aspect
(d) Advice

Answer: b

8. In Scheme language, which of the following is not a higher-order function?

(a) map
(b) member
(c) apply
(d) compose

Answer: b

9. What is the value of (map (lambda (x) (* 2 x)) '(1 2 3)) ?

(a) a run-time error
(b) ( ) (the empty list)
(c) 12
(d) (2 4 6)
(e) none of above

Answer: d

10. Given the following Java code: a = 2 * 3.14. It is using which of the following polymorphism?

(a) overloading;
(b) coercion;
(c) subtype polymorphism
(d) parametric polymorphism

Answer: b

11. Given the following class definition. Which of the following methods could be legally placed after the comment with the commented word "//Here"?

```
public class Rid{
       public void amethod(int i, String s){}
        //Here
}
```

(a) public void amethod(String s, int i)
(b) public int amethod(int i, String s)
(c) public void amethod(int i, String mystring)
(d) public void Amethod(int i, String s)

If there are more than one correct answers, select all of them.

Answer: a and d (overloaded methods need to have different method signature)

2 Select true or false for the following statements

1. In hybrid implementation, the source code is translated into intermediate code, then the intermediate code is interpreted. *Answer: True*.
2. In an abstract data type, the data representation of the type is the focus. *Answer: False. In ADT, a type is defined in terms of operations.*
3. One programming language can support multiple programming paradigms. *Answer: True.*
4. If we can prove the Hoare triple {P} S {Q}, we can say that program S is totally correct for the pre-condition P and pos-condition Q. *Answer: False*.
5. ~~Java supports higher order function. *Answer: False*~~

3 Provide short answers for the following questions, each in a few sentences

1. What is static binding? Give a short answer with one sentence. *Answer: The binding such as the association of a method name to the method definition is static, i.e., at compile time.*
2. Java 5 supports parametric polymorphism (generics). Write the name of another language that supports parametric polymorphism. *Answer: C++ (Template).*
3. Java language support automated garbage collection. Give the name of another language that supports automated garbage collection in its typical implementation. *Answer: C++ or C# for instance*
4. (Code scattering problem can be solved by which programming method? *Answer: Aspect-Oriented Programming*
5. Explain strong typing in one sentence. *Answer: The compiler tries to find as many potential errors as possible.*
6. Give an example in Java that violates strong typing. You need to write a fragment of the code and explain why it is not strong typing.
7. List the principal phases of compilation in the correct order. *Answer: Lexical analysis, Syntax analysis, Semantics analysis, Code generation.*
8. In Java, give an example of an attribute of a variable that has a static binding time. Give another example of an attribute that has a dynamic binding time.

```
a.  Static binding example:
  Dog d=new Dog();
  Interrogator.makeittalk(d);

b. Dynamic binding example:
  Animal animal=new Dog();
  Interrogator.makeittalk(animal);
```

9. Give one advantage of compilation over interpretation. *Answer: For instance, fast execution*
10. Give one advantage of interpretation over compilation. *Answer: For instance, source-level debugging, because run-time errors can refer to source-level units. It can take less time to interpret it than the total time required to compile and run it.*
11. Give one advantage of hybrid implementation. *Answer: Faster than pure interpretation since the source is translated only once.*
12. Give the following Java program. If there are compilation errors, point out the errors and change the program into a correct one. If it is correct, give the print out result.

```
1 public class Test {
2 static int count(Vector<Object> ns) {
3 int i=0;
4 for (Object n: ns) i++;
5 return i;
6 }
7 public static void main(String[] a) {
8 Vector<Integer> v = new Vector<Integer>();
9 v.add(214);
10 v.add(440);
11          System.out.println(count(v));
12 }
13 }
```

Notice that Vector $\langle Object \rangle$ is not a supertype of $Vector\langle Integer \rangle$. Modify line 2

```
static int count(Vector<Object> ns) {
```

as

```
static int count(Vector<? extend Object> ns) {
```

13. The following Java code wont compile:

```
1          public interface A { public int m2(int x);  }
2          public interface B { public String m2(int x);  }
3          public class C implements A, B {
4               public int m2(int x)   {      return x;   } }
5               public String m2(int x){   return new String(x+1);  }}
6            }
```

By modifying lines 4 and 5 only, make the program correct if possible. If you cannot make it correct, explain the reasons.

Answer: We cant make it correct by changing the part in italics only. Both interfaces A and B need to be implemented. m2 in two classes A and B has the same signature. Therefore they can not be implemented in the same class.

14. List four different language paradigms that are mentioned in this course and give one example language for each category.

    - Paradigm: AOP, representative language: AspectJ
    - Paradigm: OOP, representative language: Java
    - Paradigm: Functional Programming, representative language: Scheme
    - Paradigm: LogicProgramming, representative language: Prolog

15. Among the following list of programming languages and develop environment:

    Algol, C, C++, Java, C#, Fortran, LISP, Prolog, SIMULA, Scheme, Basic, COBOL, Eclipse, Perl, Ruby.

    - Which one is the earliest OO programming language? *Answer: SIMULA*
    - Which one is the first higher level programming language? *Answer: Fortran*
    - Which one is the first to use BNF to describe the grammar of the language? answerAlgol
    - Which one is an IDE? *Answer: Eclipse*

4 Other questions

1. Given the following definitions:

```
(define f (lambda (x) (lambda (y) (+ x y))))
(define (g x) ((f x) 3))
(define h (lambda (x) (lambda (y) (y x))))
(define (p f) ((h 2) f))
```

   a). What is the return value of (g 2)? *Answer: 5*

   b). What is the return value of (p +)? *Answer: 2*

2. Assuming that the following definitions are executed in this order:

   (define b (3 14 27))

   (define c (cons (car (cdr b)) (list a b c)))

   What is the result of typing the following into the Scheme interpreter:

   c *Answer: (14 a b c)*

   (car (cdr (cdr c))) *Answer: b*

3. Write the following two Prolog programs:

   (a) findnth that will find the Nth element in a list. For example, findnth([11, 12, 13, 14, 15], 4, X) returns X=14.

   (b) subset(A,S), which succeeds if the set A is a subset of the set S. For example, subset([2,5], [1,5,3,2]). returns Yes.

```
findnth([H|T], 1, H).
findnth([H|T], N, X):- N1 is N-1, findnth(T,N1,X).

subset([ ],Y).
subset([A|X],Y) :- member(A,Y), subset(X,Y).
```

4. Given the following Java classes and aspect, fill in the missing parts so that it can print out the following:

```
Wanna learn AspectJ?

Harry-ji, having fun?
```

```
public class MessageCommunicator {
public static void deliver(String message) {
  System.out.println(message);
}
public static void deliver(String person, String message) {
  System.out.print(person + "," + message);
}
}

public aspect HindiSalutationAspect {
pointcut sayToPerson(String person)
  : call(void MessageCommunicator.deliver(String,String)) &&arg(person,String);

void around(String person) : sayToPerson(person) {
   proceed (person + "-ji");
}
}
public class Test {
  public static void main(String[] args) {
    MessageCommunicator.deliver("Wanna learn AspectJ?");
    MessageCommunicator.deliver("Harry", "having fun?");
  }
}
```

5. Given the following XML document as an input for XSLT programs, answer the following questions:

```
<source>
  <employee>
        <firstName>Joe</firstName>
         <surName>Smith</surName>
  </employee>

  <employee>
     <firstName>Andrew</firstName>
     <surName>Wang</surName>
     <supervisor>
         <employee>
                <firstName>Steve</firstName>
                <surName>Miller</surName>
         </employee>
          <employee>
                <firstName>fn2</firstName>
                <surName>ln2</surName>
         </employee>

     </supervisor>
   </employee>
</source>
```

Quention 1: Write the output of the following XSLT program. You dont need to write the exact spaces and carriage returns.

```
<xsl:stylesheet xmlns:xsl="http://www.w3.org/1999/XSL/Transform" version="1.0">
<xsl:template match="source/employee">
</xsl:template>
<xsl:template match="employee/supervisor/employee">
first name is <xsl:value-of select="firstName"/>
</xsl:template>
</xsl:stylesheet>
```

Answer: Empty

Question 2: Write an XSLT program to extract a list of the first names of all the employees under supervisor elements, separated by coma. For this sample data, the output should be "Steve, fn2".

A sample solution is

```
<xsl:stylesheet   xmlns:xsl="http://www.w3.org/1999/XSL/Transform" version="1.0">
 <xsl:template match="source">
     <xsl:apply-templates select="employee"/>
  </xsl:template>

 <xsl:template match="source/employee">
     <xsl:apply-templates select="supervisor"/>
  </xsl:template>

<xsl:template match="supervisor">
 <xsl:apply-templates select="employee"/>
</xsl:template>

<xsl:template match="supervisor/employee[1]">
  <xsl:value-of select="firstName"/>
</xsl:template>
<xsl:template match="supervisor/employee[position()>1]">
  ,<xsl:value-of select="firstName"/>
</xsl:template>

</xsl:stylesheet>
```

6. Prove the following Hoare triple is true.

```
{true}
f := 1; n:=10;
while (n != 0) do ( f := n*f; n:=n-1; )
{f=10!}
```

Sample answer:

f	n
1	10
10*1	9
9*10*1	8

B is $n \neq 0$, $\neg B$ is $n = 0$, so P is $f = \frac{10!}{n!}$.

$$\left\{f = \frac{10!}{(n-1)!}\right\} n := n-1 \left\{f = \frac{10!}{n!}\right\} \quad \text{(1, by assignment axiom)}$$

$$\left\{n \times f = \frac{10!}{(n-1)!}\right\} f := n * f \left\{f = \frac{10!}{(n-1)!}\right\} \quad \text{(2, by assignment axiom)}$$

$$\left\{f = \frac{10!}{n!}\right\} f := n * f \left\{f = \frac{10!}{(n-1)!}\right\} \quad \text{(3, by arithmetic from 2)}$$

$$\left\{f = \frac{10!}{n!}\right\} f := n * f;\ n := n-1 \left\{f = \frac{10!}{n!}\right\} \quad \text{(4, by sequential composition on 3 and 1)}$$

$$n \neq 0 \wedge f = \frac{10!}{n!} \Rightarrow f = \frac{10!}{n!} \quad \text{(5, by arithmetic)}$$

$$\left\{n \neq 0 \wedge f = \frac{10!}{n!}\right\} f := n * f;\ n := n-1 \left\{f = \frac{10!}{n!}\right\} \quad \text{(6, by consequence rule on 5 and 4)}$$

$$\left\{f = \frac{10!}{n!}\right\} while(n \neq 0)do(f := n * f;\ n := n-1) \left\{n = 0 \wedge f = \frac{10!}{n!}\right\} \quad \text{(7, by while rule on 6)}$$

$$n = 0 \wedge f = \frac{10!}{n!} \Rightarrow 10! \quad \text{(8, by arithmetic)}$$

$$\left\{f = \frac{10!}{n!}\right\} while(n \neq 0)do(f := n * f;\ n := n-1) \left\{f = 10!\right\} \quad \text{(9, by consequence rule on 8 and 7)}$$

$$\left\{f = \frac{10!}{10!}\right\} n := 10; \left\{f = \frac{10!}{n!}\right\} \quad \text{(10, by assignment axiom)}$$

$$\{1 = 1\}\ f := 1;\ \{f = 1\} \quad \text{(11, by assignment axiom)}$$

$$\{true\}\ f := 1; n := 10; \left\{f = \frac{10!}{n!}\right\} \quad \text{(12, by sequential composition on 10 and 11)}$$

$$\{true\}\ f := 1; n := 10; WHILE \left\{f = \frac{10!}{n!}\right\} \quad \text{(13, by sequential composition on 12 and 9)}$$