CMPS-112 · Programming Languages · Fall 2016 · Final Exam 1 of 1

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.PS

examboxes(5)

.PE

No books; No calculator; No computer; No email; No internet; No

notes; No phone. Do your scratch work elsewhere and enter only your

final answer into the spaces provided. Points will be deducted for

messy answers. Unreadable answers will be presumed incorrect.

.EQ

delim $$

.EN

1. For each language described here, fill in the name of the language.

Choose from among the following languages: Algol 60, AWK, Bash,

Basic, BCPL, C, C++, COBOL, Forth, FORTRAN, Haskell, Intercal,

Java, Lisp, ML, OCaml, Pascal, Perl, PL/I, Prolog, Simula 67,

Smalltalk. Grading: deduct ½ point for each wrong or missing

answer, but do not score less than 0. [3pt]

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| |Bjarne Stroustrup's most noted contribution to language design. |

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| |Business data processing language, designers included Grace Hopper. |

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| |Designed in Europe to express algorithms in a structured way. |

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| |First version of Unix was 9000 lines of this language (plus some assembly code). |

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| |List processing language typically used in artificial intelligence. |

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| |Numeric and scientific computation language developed at IBM. |

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| |Simulation language that influenced the design of C++. |

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| |Small language for structured programming designed by Niklaus Wirth. |

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| |Sun Microsystems claimed this language is ``write once, run anywhere''. |

+--------------+---------------------------------------------------------------------------------+

2. Prolog. Define some facts called arrow which describe this graph.

If a->b, then a is the first argument and b is the second argument.

[2pt]

.PS 1i

arrowht = circlerad

arrowwid = circlerad/2

A: circle "a"

B: circle "b" at A+(5\*circlerad,0)

C: circle "c" at A+(3\*circlerad,-5.196152\*circlerad)

D: circle "d" at C+(5\*circlerad,0)

E: circle "e" at B+(5\*circlerad,0)

arrow from A to B chop

arrow from A to C chop

arrow from B to C chop

arrow from C to D chop

arrow from D to E chop

arrow from B to E chop

.PE

3. Prolog. Write a relation ispath(X,Y) if there is a path from X to

Y in one or more steps. It fails if X=Y. Assume an acyclic graph.

[2pt]

4. Prolog. Write a relation findpath(X,Y,P) so that if there is a

path from X to Y in the previous question, it returns the path.

For example, in the first question, findpath(a,e,P) could return

P=[a,c,d,e] or P=[a,b,e], etc. Assume an acyclic graph. [3pt]

5. Ocaml. Define the function max which finds the largest element in

a list, given a comparison operator and a list. Use failwith if

the list is empty. The solution must be tail-recursive. Do not

use a higher-order function. [4pt]

# max;;

- : ('a -> 'a -> bool) -> 'a list -> 'a = <fun>

# max (>) [1;2;3;4];;

- : int = 4

# max (<) [1;2;3;4];;

- : int = 1

# max (>) [];;

Exception: Failure "max".

6. Ocaml: Define a function zip which takes two lists and returns a

list of tuples, pairing each corresponding element. If the lists

are of different lengths, ignore excess elements in the longer

list. [2pt]

# zip [1;2;3] ['a';'b';'c';'d'];;

- : (int \* char) list = [(1, 'a'); (2, 'b'); (3, 'c')]

7. Ocaml: Define a function unzip which takes a list of tuples and

returns a tuple of lists, the first list containing the first item

in each tuple, and the second list, the second item. [2pt]

# let l1, l2 = unzip [(1, 'a'); (2, 'b'); (3, 'c')];;

val l1 : int list = [1; 2; 3]

val l2 : char list = ['a'; 'b'; 'c']

8. Prolog. Write rules for determining the greatest common divisor of

two positive integers. Write code equivalent to the following C

function:

int gcd (int x, int y) {

while (x != y) if (x > y) x -= y; else y -= x;

return x;

}

An example of interaction is given here. [2pt]

| ?- gcd(111,259,Z).

Z = 37 ?

(1 ms) yes

9. Name the two general types of polymorphism, and for each of them,

name the specific kinds that represents each of them. [2pt]

+-------------------------------+-------------------------------+

| general | specific |

+-------------------------------+-------------------------------+

| | |

| +-------------------------------+

| | |

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| | |

| +-------------------------------+

| | |

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10. Scheme. Write a function that takes two lists as arguments and

which returns a single list where each element is a list of

corresponding pairs. If the lists are of different lengths,

trailing elements of the longer list are ignored. [2pt]

> (pairthem '(1 2 3 4) '(a b c d e))

((1 a) (2 b) (3 c) (4 d))

> (pairthem '(1 2 3 4 5) '(a b))

((1 a) (2 b))

11. Smalltalk: Define the class Stack. Internally it has an array of

fixed size and no attempt is made to verify pre- or post-

conditions. It simply crashes on overflow or underflow. Define

the following methods: [6pt]

(a) Class method new uses new: to create a stack of maximum

capacity 10.

(b) Class method new: creates a stack of the size given by its

argument.

(c) Instance method init: initializes the array representation and

sets the top to 0

(d) Instance method pop removes and returns the top item on the

stack.

(e) Instance method push: pushes a new item onto the top of the

stack.

(f) Instance method empty reports on whether the stack is empty or

not.

bash-3.2$ cat stack.test.st

FileStream fileIn: 'stack.st'.

s := Stack new.

s push: 1; push: 5; push: 10.

s inspect.

[s empty not] whileTrue: [

stdout << s pop << Character nl].

bash-3.2$ gst <stack.test.st

An instance of Stack

array: (1 5 10 nil nil nil nil nil nil nil )

top: 3

10

5

1

Multiple choice. To the left of each question, write the letter that

indicates your answer. Write Z if you don't want to risk a wrong

answer. Wrong answers are worth negative points. [12pt]

+--------------------------+------+------+------------+

|number of | |× 1 = | $= a$ |

|correct answers | | | |

+--------------------------+------+------+------------+

|number of | |× ½ = | $= b$ |

|wrong answers | | | |

+--------------------------+------+------+------------+

|number of | |× 0 = | 0 |

|missing answers | | | |

+--------------------------+------+------+------------+

|column total | 12 | | $= c$ |

|$ c = max ( a - b , 0 ) $ | | | |

+--------------------------+------+------+------------+

1. Language designed primarily to handle scalars, vectors, matrices,

and higher order arrays.

(A) APL

(B) COBOL

(C) FORTRAN

(D) PL/I

2. Scripting language covered during the last few lectures.

(A) Bash

(B) Perl

(C) Python

(D) Ruby

3. First two characters of a script source file.

(A) #!

(B) /\*

(C) //

(D) ;;

4. Earliest language which is an ancestor of Scheme.

(A) BCPL

(B) Cobol

(C) Fortran

(D) Lisp

5. Besides C, the object-oriented language which is an ancestor of

C++.

(A) Algol 60

(B) Fortran IV

(C) Pascal

(D) Simula 67

6. In Smalltalk: $ sqrt 2.0 $

(A) (sqrt 2.0)

(B) 2.0 sqrt

(C) 2.718281828459045

(D) sqrt (2.0)

7. In a ``lazy'' language, unevaluated arguments are passed into

functions by means of a:

(A) closure

(B) curry

(C) thunk

(D) tuple

8. Lisp was designed when, by whom, and where?

(A) 1953, John Backus.

(B) 1958, John McCarthy.

(C) 1959, Grace Hopper, et al.

(D) 1964, John Kemeny, Thomas Kurtz.

9. Unification is part of the static type checking algorithm used by

what language?

(A) C++

(B) Ocaml

(C) Prolog

(D) Smalltalk

10. Prolog:

| ?- X is sin(pi).

(A) X = -1.0

(B) X = 1.2246467991473532e-16

(C) X = 2.7182818284590451

(D) X = 3.1415926535897931

11. Smalltalk determines if an object can respond to a message by the

method of:

(A) same as in Java

(B) duck-typing

(C) generic parameters

(D) multiple inheritance

12. A C++ compiler does object-oriented dispatch via:

(A) duck typing

(B) heap allocated closure

(C) type inference

(D) virtual function table

The Antikythera mechanism, built ca. 150-100 BCE, is the oldest known

complex scientific calculator, and is sometimes called the first known

analog computer, with operational instructions written in Greek.

http://en.wikipedia.org/wiki/Antikythera\_mechanism

Multiple choice. To the left of each question, write the letter that

indicates your answer. Write Z if you don't want to risk a wrong

answer. Wrong answers are worth negative points. [12pt]

+--------------------------+------+------+------------+

|number of | |× 1 = | $= a$ |

|correct answers | | | |

+--------------------------+------+------+------------+

|number of | |× ½ = | $= b$ |

|wrong answers | | | |

+--------------------------+------+------+------------+

|number of | |× 0 = | 0 |

|missing answers | | | |

+--------------------------+------+------+------------+

|column total | 12 | | $= c$ |

|$ c = max ( a - b , 0 ) $ | | | |

+--------------------------+------+------+------------+

1. A closure is:

(A) A special field of a structure or class used to point at a

base class when implementing shared multiple inheritance.

(B) A special type declaration in Ocaml used to distinguish sum

types from product types.

(C) A structure on the heap, used to hold variables of an outer

function when referenced by an inner function.

(D) A table used to dynamically dispatch virtual functions in an

object-oriented environment.

2. The classic paper ``Go To Statement Considered Harmful'', CACM,

1968, was written by:

(A) John Backus

(B) Edsger Dijkstra

(C) Grace Hopper

(D) Donald Knuth

3. What Perl regex matches a sequence of letters, digits, and

underscores?

(A) \d+

(B) \n+

(C) \s+

(D) \w+

4. Which of the following C++ operators is ``lazy''?

(A) \*=

(B) ==

(C) >>

(D) ? :

5. What is 6?

(A) (apply + '(1 2 3))

(B) (cons + '(1 2 3))

(C) (list + '(1 2 3))

(D) (map + '(1 2 3))

6. Where is the variable a kept, given the following function

definition?

int f() { int a; return a; }

(A) function call stack

(B) heap

(C) initialized data segment

(D) uninitialized data segment

7. The PL/1 language allows a non-local goto directly from a function

to a label in a function deeper down in the function call stack,

thus returning past several levels of function calls. In Java,

something similar can be accomplished by what statement?

(A) goto

(B) implements

(C) synchronized

(D) throw

8. What kind of memory management fails to handle a cyclic data

structure?

(A) copying collector with semispaces

(B) malloc and free

(C) mark and sweep

(D) reference counting

9. If multiple threads sharing global variables are not synchronized

by means of a critical section, what program problem will appear?

(A) deadlock

(B) race condition

(C) segmentation fault

(D) semaphores

10. What is the type of

let f x y z = x + y + z;;

(A) val f : int \* int \* int -> int

(B) val f : int \* int -> int -> int

(C) val f : int -> int \* int -> int

(D) val f : int -> int -> int -> int

11. Which expression causes a list of length zero to be passed into

the function f?

(A) (f '())

(B) (f ())

(C) (f null?)

(D) (f nullptr)

12. What is the signature of Ocaml's List.map?

(A) ('a -> 'b) -> 'a list -> 'b list

(B) ('a -> bool) -> 'a list -> 'a list

(C) ('a -> 'b -> 'a) -> 'a -> 'b list -> 'a

(D) 'a list -> int