



MONASH  
University

程序代写代做 CS编程辅导



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ation Period

Fac

Information Technology

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EXAM CODES:

TITLE OF PAPER:

EXAM DURATION:

FIT 008-FIT2085

Introduction to Computer Science

3 hours 10 mins

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#### Authorised Materials

OPEN BOOK

☐ YES

☒ NO

CALCULATORS

☐ YES

☒ NO

SPECIFICALLY PERMITTED ITEMS

☐ YES

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if yes, items permitted are:

#### Instructions

Please answer all questions online. Noting and calculations to be done in the scriptbook or working sheets provided.

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### Information

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# MIPS reference sheet

## Information

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System calls

Call code (\$v0)	Service	Arguments	Returns	Notes
1	Print integer	\$a0 = value to print	-	value is signed
4	Print string	\$a0 = address of string to print	-	string must be terminated with '\0'
5	Input integer	-	\$v0 = entered integer	value is signed
8	Input string	\$a0 = address at which the string will be stored \$a1 = maximum number of characters to read	-	returns if \$a1-1 characters or Enter typed, the string is terminated with '\0'
9	Allocate memory	\$a0 = number of bytes	\$v0 = address of first byte	
10	Exit	-	-	ends simulation

Table 2: General-purpose registers

Number	Name	Purpose
R0	\$zero	always contains zero
R01	\$at	reserved for assembler
R02, R03	\$v0, \$v1	system call code, return value
R04-R07	\$a0-\$a3	system call and function arguments
R08-R15	\$t0-\$t7	temporary storage (caller-saved)
R16-R23	\$s0-\$s7	temporary storage (callee-saved)
R24, R25	\$t8, \$t9	temporary storage (callee-saved)
R28	\$gp	pointer to global area
R29	\$sp	stack pointer
R30	\$fp	frame pointer
R31	\$ra	return address

Table 3: Assembler directives

.data	assemble into data segment
.text	assemble into text (code) segment
.word w1, w2, ...	allocate word(s) with initial value(s)
.space n	allocate n bytes of uninitialized, unaligned space
.ascii "string"	allocate ASCII string, do not terminate
.asciiz "string"	allocate ASCII string, terminate with '\0'

Table 4: Function calling convention

On function call:	<b>Caller:</b> saves temporary registers on stack passes arguments on stack calls function using <code>jal fn_label</code>	<b>Callee:</b> saves value of <code>\$ra</code> on stack saves value of <code>\$fp</code> on stack copies <code>\$sp</code> to <code>\$fp</code> allocates local variables on stack
	<b>Callee:</b> sets <code>\$v0</code> to return value clears local variables off stack restores saved <code>\$fp</code> off stack restores saved <code>\$ra</code> off stack returns to caller with <code>jra \$ra</code>	<b>Caller:</b> clears arguments off stack restores temporary registers off stack uses return value in <code>\$v0</code>

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Instruction (and pseudoinstruction) set

Instruction format	Operation	Immediate	Unsigned format
add Rdest, Rsrc1, Src2	$st = Rsrc1 + Src2$	addi	addu (no overflow trap)
sub Rdest, Rsrc1, Src2	$st = Rsrc1 - Src2$	-	subu (no overflow trap)
mult Rsrc1, Src2	$st = Rsrc1 * Src2$	-	mulu
div Rsrc1, Src2	$st = Rsrc1 / Src2$ $st = Rsrc1 \% Src2$	-	divu
and Rdest, Rsrc1, Src2	$st = Rsrc1 \& Src2$	andi	-
or Rdest, Rsrc1, Src2	$st = Rsrc1   Src2$	ori	-
xor Rdest, Rsrc1, Src2	$st = Rsrc1 \wedge Src2$	xori	-
nor Rdest, Rsrc1, Src2	$st = \sim(Rsrc1   Src2)$	-	-
sllv Rdest, Rsrc1, Src2	Shift Left Logical $Rdest = Rsrc1 \ll Src2$	sll	-
srlv Rdest, Rsrc1, Src2	Shift Right Logical $Rdest = Rsrc1 \gg Src2$ (MSB=0)	srl	-
sra Rdest, Rsrc1, Src2	Shift Right Arithmetic $Rdest = Rsrc1 \gg Src2$ (MSB preserved)	sra	-
mflhi Rdest	Move from Hi $Rdest = Hi$	-	-
mfllo Rdest	Move from Lo $Rdest = Lo$	-	-
lw Rdest, Addr	Load word $Rdest = mem32[Addr]$	-	-
sw Rsrc, Addr	Store word $mem32[Addr] = Rsrc$	-	-
la Rdest, Addr(or label)	Load Address (for instructions only) $Rdest = Addr$	-	-
beq Rsrc1, Rsrc2, label	Branch if equal if ( $Rsrc1 == Rsrc2$ ) PC = label	-	-
bne Rsrc1, Rsrc2, label	Branch if not equal if ( $Rsrc1 != Rsrc2$ ) PC = label	-	-
slt Rdest, Rsrc1, Src2	Set if less than if ( $Rsrc1 < Src2$ ) Rdest = 1 else Rdest = 0	slti	sltu
j label	Jump PC = label	-	-
jal label	Jump and link PC = PC + 4; PC = label	-	-
jr Rsrc	Jump register PC = Rsrc	-	-
jalr Rsrc	Jump and link register PC = PC + 4; PC = Rsrc	-	-

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# Python to MIPS translation

## Question 1

Translate the following Python code faithfully into MIPS assembly language. Make sure you follow the MIPS function calling and memory usage conventions.

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```
def func (n):  
    if n <= 0:  
        result = 0  
    else:  
        result = 4*n  
    return result
```



We ask that you translate the code into MIPS assembly language, using the sub-questions below. The concatenation of all 6 answers will form the entire translation of the Python code above.

Comments are not mandatory, but will help us understand your code and, in that way, can help you get extra points. Use '#' at the start of a line in your MIPS code to add a comment.

```
def func (n):
```

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```
if n <= 0:
```

```
result = 0
```

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```
else:
```

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```
result = 4*n+func(n-1)
```

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```
return result
```

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The Python function above can easily be implemented iteratively, rather than recursively. Assume the iterative version uses  $N$  bytes of Heap memory. What value is  $N$  and how many bytes will the recursive version use? Explain why (no explanation no marks).

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Assume now that the iterative version uses  $N$  bytes of Stack memory. What value is  $N$  and how many bytes will the recursive version use? Explain why (no explanation no marks).

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# Scoping with classes in Python

## Question 2

You are provided with the Python `myclass` module:

```
class myclass:
    def __init__(self, x):
        self.x = x

    def a(self):
        self.x = self.x + 1

    def b(self):
        self.x = x + 1

    def c(self):
        x = self.x + 1

    def __str__(self):
        return str(self.x)

def a(x):
    x = x - 1

def b():
    x = x + 2
```



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This module will be imported in each of the following questions. In each of the following questions, there will be exactly one print statement. We ask that you find the value being printed by each piece of code.

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For example, if the question is:

```
print(1)
```

Then your answer should be 1

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Pick one answer in this column for each of the boxes on the left

```
from myclass import *
myobject = myclass(1)
print(myobject)
```

· 7 · 4 · No output. The code produces an error.  
· 3 · 0 · 8 · 5 · 6 · None · 2 · 10 · 1 · 9

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```
from myclass import *
x = 2
myobject = myclass(x)
x = 1
print(myobject)
```

· 7 · 4 · No output. The code produces an error.  
· 3 · 0 · 8 · 5 · 6 · None · 2 · 10 · 1 · 9

```
from myclass import *
myclass.x = 3
myobject = myclass(2)
print(myobject)
```

· 7 · 4 · No output. The code produces an error.  
· 3 · 0 · 8 · 5 · 6 · None · 2 · 10 · 1 · 9

```
from myclass import *
myobject = myclass(3)
myclass.x = 4
print(myobject.x)
```

· 7 · 4 · No output. The code produces an error.  
· 3 · 0 · 8 · 5 · 6 · None · 2 · 10 · 1 · 9

```
from myclass import *
myclass.x = 6
myobject = myclass(myclass.x)
a(myclass.x)
print(myobject.x)
```

· 7 · 4 · No output. The code produces an error.  
· 3 · 0 · 8 · 5 · 6 · None · 2 · 10 · 1 · 9

```
from myclass import *
x = 5
myclass.x = 3
print(myclass(1).b())
```

· 7 · 4 · No output. The code produces an error.  
· 3 · 0 · 8 · 5 · 6 · None · 2 · 10 · 1 · 9

```
from myclass import *
x = 7
myobject = myclass(x)
myobject.c()
print(x)
```

· 7 · 4 · No output. The code produces an error.  
· 3 · 0 · 8 · 5 · 6 · None · 2 · 10 · 1 · 9

10  
Marks



```
from myclass import *
x = 6
b()
myobject = myclass(x)
myobject.a()
print(myobject)
```

```
from myclass import *
x = 2
print(myclass(a(x)))
```

```
from myclass import *
x = 0
myobject = myclass(x)
yourobject = myclass(myobject)
myobject.c()
a(yourobject.x)
print(yourobject)
```



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· 7 · 4 · No output. The code produces an error.

· 3 · 0 · 8 · 5 · 6 · None · 2 · 10 · 1 · 9

· 7 · 4 · No output. The code produces an error.

· 3 · 0 · 8 · 5 · 6 · None · 2 · 10 · 1 · 9

· 7 · 4 · No output. The code produces an error.

· 3 · 0 · 8 · 5 · 6 · None · 2 · 10 · 1 · 9

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# CS saves the world

## Question 3

Year 2069. A malevolent alien species who speaks in Python has sent the following message to Earth:

```
def mystery(x):  
    y = x % 2  
    x = x // 2  
    if x > 0:  
        y = y + mystery(x)  
    return y  
  
def enigma(x):  
    y = mystery(x)  
    if y > 1:  
        y = y + enigma(y)  
    return y  
  
#puny humans must print:  
print(enigma(4095))
```



20  
Marks

If we do not compute and send them the result of `enigma(4095)` within the next 3 hours (plus 10 minutes of reading), the aliens have promised that they would destroy the planet. As Earth's leading computer scientist, the task of saving humanity naturally lies with you. Your former esteemed FIT1008&2085 lecturers, recently retired, have advised you to first answer a series of questions before attempting to compute the final result.

Write the output of the function `mystery` for the input values:

- `x=1`
- `x=2`
- `x=3`
- `x=7`
- `x=8`
- `x=15`

What does the function `mystery` compute?

What is the time complexity of `mystery`, using the  $O()$  notation? Prove your answer.

Write the output of the function `enigma` for the input values:

- `x = 1`
- `x = 2`
- `x = 3`
- `x = 7`
- `x = 8`
- `x = 15`

What does the function `enigma` compute?

What is the best and worst time complexity of `enigma`, using the  $O()$  notation?

Prove your answer. What does `enigma(4095)` return? Justify your answer.

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# Natural merging

## Question 4

In this question we suppose that all sorting is done in a non-decreasing way.

We propose to write a new sorting algorithm that first detects when part of the data is already sorted.

For example, if the input list is [0, 4, 1, 2, 8, 5, 7, 9, 3, 6], then the algorithm will first detect the consecutive items that are already sorted: [0, 4], [1, 2, 8], [5, 7, 9] and [3, 6].

After this, the algorithm will merge these intervals two by two until the entire list is sorted.

Write a function `find_intervals` which takes a list as input, returns the list of indices between which the input list is already sorted. For the example above, the output would be [0, 2, 5, 8, 10], since the list is sorted between indices 0 and 2, 2 and 5, 5 and 8, and 8 and 9. Note that the last index in the output list (10) points outside of the input list.

We ask that you use this template:

```
def find_intervals(list):  
    separators = [0]  
    #TODO your code here  
    return separators
```

In the code above, the variable `separators` refers to the list of indices that you must return. You may use any Python built-in method for this function.

```
def find_intervals(l):  
    separators = [0]  
    #TODO your code here  
  
    return separators
```

What is the worst-case time complexity of the `find_intervals` function you have written? Explain your answer.

Write a function `natural_merge` which takes the list to sort as an input and sorts it. This function must call the previous function to determine intervals which are already sorted. You will not be penalised if you have not attempted or succeeded the previous questions. For this question you will be marked as if the previous questions had been answered correctly.

The function `natural_merge` must implement the following algorithm:

1. Find the intervals of the input list where the data is already sorted by calling the previous function.
2. Iterate through the list and merge the first and the second interval together. After the merge, these two intervals become a single interval, hence there is one fewer interval in the list. This continues until there is only a single interval left. For example, for our input list, we would obtain the following steps:  
[0, 4] [1, 2, 8] [5, 7, 9] [3, 6] and interval list [0, 2, 5, 8, 10]  
[0, 1, 2, 4, 8] [5, 7, 9] [3, 6] and interval list [0, 5, 8, 10]  
[0, 1, 2, 4, 5, 7, 8, 9] [3, 6] and interval list [0, 8, 10]  
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9] and interval list [0, 10]

To do the merging, you must call the function `merge` provided below:

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```
def merge(l, start, mid, end):
    """Merges the two sorted sublists of l
    between start and mid (excluded)
    and mid and end (excluded) """
    tmp = [None] * (end - start + 1)
    k1 = start
    k2 = mid
    use1 = False
    for k in range(start, end + 1):
        if k1 >= mid:
            use1 = False
            tmp[k] = l[k2]
            k2 += 1
        elif k2 >= end:
            use1 = True
            tmp[k] = l[k1]
            k1 += 1
        else:
            if l[k1] < l[k2]:
                use1 = True
            tmp[k] = l[k1]
            k1 += 1
        else:
            tmp[k] = l[k2]
            k2 += 1
    for k in range(start, end + 1):
        l[k] = tmp[k]
```

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Although we provide the code, you only need to call the function merge according to its documentation. Write the function natural\_merge below:

```
def natural_merge(l):
```

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What is the worst-case time complexity of the merge function we have provided? Explain your answer.

What is the best-case time complexity of the algorithm natural\_merge? Explain your answer. You may answer this question based on the description we provide of it, even if you have not implemented it.

What is the worst-case time complexity of the algorithm natural\_merge? Explain your answer. You may answer this question based on the description we provide of it, even if you have not implemented it.

How could a sorting algorithm with better time complexity be designed using the ideas presented in this question? Explain your answers.

## Resolving collisions

### Question 5

Suppose you are given the following set of keys to insert into a Hash table of size 11:

22, 23, 37, 29, 33, 39, 2, 27, 21, 17.

The hash function is given below.

```
def hash_function(key):  
    return key%11
```

Suppose that we use linear probing to resolve collisions. Select the correct state of the Hash Table after the keys are inserted.

Select one:

- ☐ 22, 23, 33, 2, 37, 27, 39, 29, None, 21, 17
- ☐ 22, 23, 37, 29, 33, 39, 2, 27, 21, 17
- ☐ 29, 37, 17, 33, 21, 2, 39, 23, 22, None, 27
- ☐ 39, 2, 22, 17, 23, 37, 29, None, 33, 21, 27
- ☐ 2, 37, None, 17, 23, 29, 39, 27, 33, 21, 22
- ☐ None, 2, 23, 21, 39, 33, 29, 22, 27, 37, 17
- ☐ 22, 23, 37, 29, 33, None, 27, 39, 17, 21, 2
- ☐ 17, 21, None, 2, 29, 23, 27, 22, 39, 33, 27
- ☐ 37, 2, 21, 29, 22, 33, None, 23, 17, 27, 39
- ☐ 21, 2, 22, 37, 39, 17, 23, 29, 27, None, 33
- ☐ 33, 29, 27, 37, 2, 22, 17, 21, None, 23, 39
- ☐ There is no correct state. Not all keys can be inserted.
- ☐ 22, 23, 2, None, 37, 27, 39, 29, 17, 33, 21
- ☐ 22, 23, 2, 17, 37, 27, 39, 29, None, 33, 21
- ☐ 22, 23, 2, 33, 37, 27, 39, 29, 17, None, 21
- ☐ 22, 23, None, 2, 37, 27, 39, 29, 17, 33, 21
- ☐ 22, 23, 2, None, 37, 27, 39, 29, 17, 33, 21

2

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