UNIVERSITY of GUELPH

CIS2520 Data Structures
Sample Midterm Questions

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1)
What are the main advantages of Abstract Data Typing?

2)
What are the advantages of a sequential List implementation
over a linked List implementation? What are the disadvantages?

3)
Describe in pseudocode an algorithm for determining whether parentheses are balanced properly in algebraic expressions made of integers and of the symbols + – * / ( )

4)
Explain the concept of `#include` guards.

5)
To solve a given problem, you are wondering whether you should use an iterative approach or a recursive approach: what are the two questions that you should ask yourself?

6)
Consider the Towers of Hanoi puzzle with seven disks, 1 (smallest) to 7 (largest), and three pegs, A, B and C. At the beginning, all the disks are on A. At the end, they are on B. Write a C program that outputs a solution to the puzzle in the form:

```
Move 1 to B
Move 2 to C
......
```

7)
Consider the following concrete data structure definition for a list of integers:

```
typedef struct ListTag {
      int item;
      struct ListTag *next;
} List;
```

Write a recursive C function that outputs the items of a list in the backward direction (i.e., from the last to the first).

8)
Consider the List operations below:

```
Create: ∅ → List[T]
Insert: TxNxList[T] → List[T]
Remove: NxList[T] → List[T]
Full: List[T] → Boolean
Empty: List[T] → Boolean
Size: List[T] → N
Peek: NxList[T] → T
```

Write pre- and post- conditions for `Insert`, `Remove` and `Peek`.

9)
Given the Stack and Queue operations below,
describe in pseudocode an algorithm for reversing a stack using a queue.

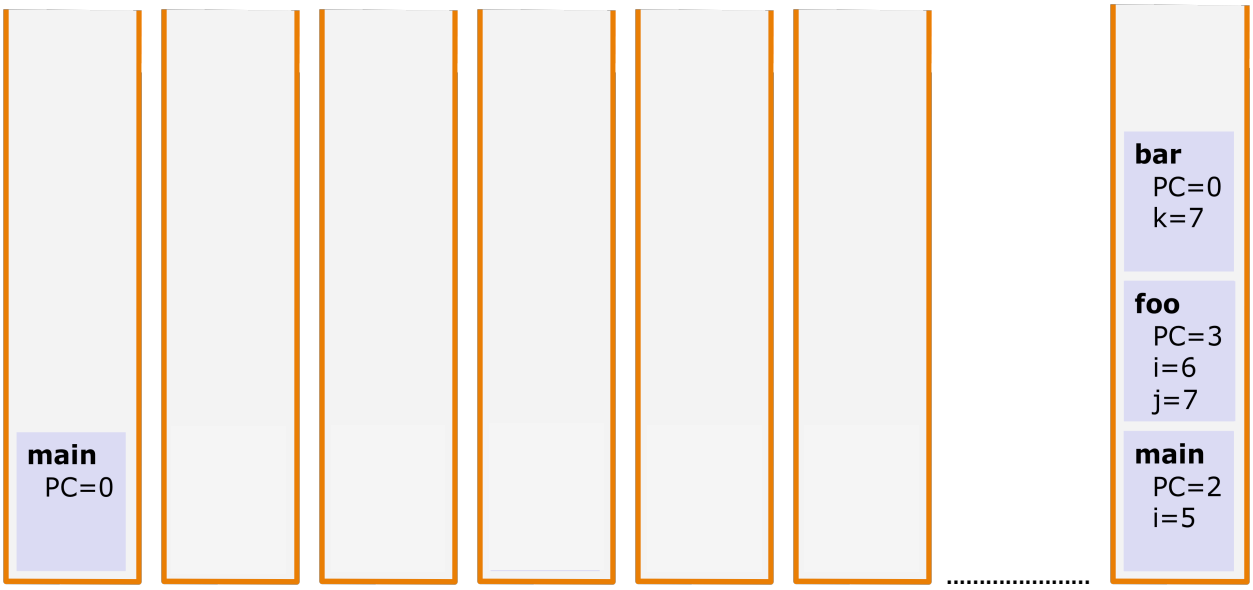
```
Create: ∅ → Stack[T]
Push: TxStack[T] → Stack[T]
Pop: Stack[T] → Stack[T]
Full: Stack[T] → Boolean
Empty: Stack[T] → Boolean
Size: Stack[T] → N
Top: Stack[T] → T
```

```
Create: ∅ → Queue[T]
Enqueue: TxQueue[T] → Queue[T]
Dequeue: Queue[T] → Queue[T]
Full: Queue[T] → Boolean
Empty: Queue[T] → Boolean
Size: Queue[T] → N
Head: Queue[T] → T
```

10)
Consider the functions below

```
int main (void) {int i=5; foo(i+1); ......}
void foo (int i) {int j; j=i+1; bar(j); ......}
void bar (int k) {......}
```

and the following states of the execution stack:



Complete the first five missing states.

11)
Consider the following concrete data structure definition for a list of integers:

```
#define MAXLISTSIZE 1000
typedef struct {
      int items[MAXLISTSIZE];
      int size;
} List;
```

Implement the function `Insert`.

12)
The speed of an algorithm can be measured through experimental analysis.
The principle of experimental analysis can be described in 4 steps: which ones?

13)
What are the issues and limitations of experimental analysis?

14)
What is a neighbourhood of infinity in the set $\mathbb{Z}_+$ of all positive integers?
Give a formal definition.

15)
Consider the function $f : \mathbb{Z}_+ \to \mathbb{R}_+$

$$n \mapsto 2\sqrt{n+7\sin(n)-1}$$

Show that it is defined on a neighbourhood of infinity.

16)
Consider two functions f and g from $\mathbb{Z}_+$ to $\mathbb{R}_+$. Assume each one is defined on a neighbourhood of infinity, and let S be a neighbourhood of infinity.
We say that $f \leq g$ on S if and only if: _____ (mathematical expression only)

17)
Consider the following functions:

$f : \mathbb{Z}_+ \to \mathbb{R}_+$ $\qquad$ $g : \mathbb{Z}_+ \to \mathbb{R}_+$

$n \mapsto 2\sqrt{n}+7\sin(n)-1$ $\qquad$ $n \mapsto 3\sqrt{n}$

Show that $f \leq g$ on a neighbourhood of infinity.

18)
Show that $2\sqrt{n}+7\sin(n)-1$ is $O(\sqrt{n})$.

19)
Consider three functions f, g and h from $\mathbb{Z}_+$ to $\mathbb{R}_+$. Assume each one is defined on a neighbourhood of infinity. Show that if f is O(g) and g is O(h) then f is O(h).

20)
Show that the algorithm below runs in O(n) time.

```
function ArrayMax (A)
     currentMax=A[0]
     for i=1 to A.length-1
          if A[i]>currentMax
          then currentMax=A[i]
     return currentMax
```