

## Review of the first 18 lectures

The exam is closed book, calculators and laptop computers are not allowed. Good examples of questions are quizzes and homework assigned at the end of each lecture. Also review the answers to the midterm exams.

This sheet contains some preliminary examples of questions about the first part of the course, on the material tested by the first midterm exam, up to chapter 6 in the textbook.

1. Write an ADT specification of time, represented by hours, minutes, and seconds. Time is kept in a 24-hour format, e.g.: 20:00:00 is 8PM.

Give a value definition of time. Define operations to see whether any two given times are equal and whether one time is later than another given time. Define the addition and subtraction of times. Subtraction of two times is only allowed if the first time is later than or equal to the second one. List all relevant conditions.

2. Show that  $O(\log_{10}(n))$  is  $O(\log_2(n))$ .
3. Consider the code below:

```
double x[n+1];
double v,y;
for(int i=0; i<n+1; i++)
    for(y=1.0, int j=0; j<n+1; j++)
        if(j != i)
            y = y*(v - x[j])/(x[i] - x[j]);
```

- (a) What are the preconditions on the numbers in the array  $x$ ? Use sufficient `assert` statements to enforce the preconditions.
  - (b) Give the loop invariant for the inner loop controlled by  $j$ . Describe using the proper mathematical terminology what the value for  $y$  represents.
  - (c) Count the number of arithmetical operations executed by the code for any value of  $n$ .
  - (d) Use the big  $O$  notation to bound the magnitude of the cost of the code in function of  $n$ .
4. A node in a single linked list with item type  $T$  as template is

```
struct Node
{
    T data; // T is template parameter
    Node *next; // pointer to next node

    Node(const T& item, Node* ptr = NULL) :
        data(item), next(ptr) {}
};
```

- (a) Describe an algorithm to convert a single linked list to a double linked list.
- (b) Write C++ code to define the conversion.

5. Given an STL vector of doubles, write the code to construct an STL list with the same content as the given vector.
6. Define a function that takes on input a nonempty STL list of integers and that returns the largest element of that list.
7. Consider the following postfix expression:  $7\ 3\ 4\ +\ *\ 8\ 2\ 5\ *\ -\ +$ .
  - (a) Draw the tree which represents this expression.
  - (b) Simulate the evaluation of the postfix expression using a stack. Draw all intermediate states of the stack.
8. Use a stack to convert  $7*(3 + 4) + 8 - 2*5$  to a postfix expression. Draw all intermediate states of the data structures.
9. Describe an implementation of a stack using an STL vector. Would you pop from the front or from the back? Justify your answer.
10. Assume we want to implement a priority queue with a single linked list. For every item in the queue we store a pair of doubles: the arrival time and the size of the job.
  - (a) Write a complete definition of the priority queue.
  - (b) Describe an algorithm to insert a job in any given queue. Items in the queue are sorted in increasing order on arrival time. Do not make assumptions on the arrival time of the item to insert. The priority queue may be empty. Illustrate your algorithm by drawing a general case inserting an item into a queue of at least five elements.
  - (c) Write C++ code to implement the algorithm described above.
11. Describe a solution to the previous exercise using the STL. Which data structure of the STL would you choose? Justify your choice.

**The final exam happens on Monday 11 December, from 8AM till 10AM, in 337 BSB.**

In case of a scheduling conflict with another final exam, please let me know as soon as possible so we can schedule a make up.

Observe the university rules concerning incompletes. An incomplete can only be granted if all of the following conditions are satisfied:

1. The student is in good standing and needs only a final exam to complete the course. In particular, this means that no midterms are skipped, attendance to the discussion sessions was documented by quiz scores, and all projects received a satisfactory grade.
2. Some event (for which adequate documentation can be provided) prevented the student from making a makeup final exam.

Note that these rules are from the university, the administration needs to approve incompletes.