

Programming Language Concepts, CS2104 (October 3, 2010)

Tutorial 11 (Please prepare in advance)

Exercise 1. (Executing Threads) Execute the following example with help of the abstract machine.

```
local A B C in
  thread if A then B=true else B=false end end
  thread if B then C=false else C=true end end
  A=false
end
```

Just sketch the execution, the important point here is to understand how threads are created and executed.

Exercise 2. (Threads) Give the values for the variables after execution has terminated:

```
thread if X==1 then Y=2 else Z=2 end end
thread if Y==1 then X=1 else Z=2 end end
X=1
```

and also for:

```
thread if X==1 then Y=2 else Z=2 end end
thread if Y==1 then X=1 else Z=2 end end
X=2
```

Exercise 3. (Stream) Write a producer which would produce a list of squares (starting from N) and a consumer which would compute the min/max values. Write this as a concurrent program with two threads. Implement also:

- (i) consumer-driven concurrent computation
- (ii) use a bounded buffer of size 3

Exercise 4. (Higher-Order) The “eight-queens puzzle” asks how to place eight queens on a chessboard so that no queen is in attacked by any other (i.e., no two queens are in the same row, column, or diagonal). One possible solution is shown in the figure below. One way to solve the puzzle is to work across the board, placing a queen in each column. Every time a queen is placed in a column, it must be in a position such that the current queen is not in check from the previously placed queens. The position of the current queen is not necessarily unique (or a position may not exist at all). To find all solutions, we could start a separate thread to for every viable position of the current queen, and do that recursively when we attempt to place a new queen in the next column.

Some of the threads may end up at a point where no new queen can be added to the board. We would like such threads to terminate silently. Some other threads may succeed

in placing a queen in every column, and thus find a solution to the puzzle. We would like such threads to print out their solution, and then terminate. Write an Oz program that implements this idea.

