

Sample Solution to Quiz 4

1. A recursive procedure for powering

In class, we covered a fast, iterative procedure for raising a number x to the power n , that takes time proportional to $\log n$. Write a simple *recursive* procedure to do the same. (You may use “pseudocode” or any programming language. The precise syntax is not important.)

Hint: For recursion, separate the cases: n is even or odd. Also remember the base case.

Answer: We assume here that n is a nonnegative integer.

Power(x, n)

1. if $n = 0$ return 1
2. else
3. if n is even return Power($x * x, n/2$)
4. else return $x * \text{Power}(x, n - 1)$

2. The following questions concern the article on the Java Virtual Machine that was handed out last week:

(a) The article claims that the concept of JVM makes Java more portable. Explain how.

Answer: Since Java compilers compile Java code to JVM bytecode, which is standardized across all platforms, a Java program can run on any machine architecture as long as a JVM is implemented on the machine. Writing a JVM for a given machine architecture is much easier than writing a compiler that translates Java code into machine code since the JVM instruction set is simple and consists of a small number of primitive instructions. Note that the concept of Virtual machine is not tied to the Java programming language in any way. It is applicable to any programming language.

(b) Give one-sentence definitions for each of the following components of the Java Virtual Machine: the *stack*, the *program counter*, and the *heap*.

Answer: The stack is where the local variables, operands for the instruction set, results of the execution of an instruction, and the state of a method invocation, are stored. The program counter points to the next instruction in the program that is to be executed, during a given run of the program. The heap is where Java objects of the given program are stored.