| COS 126 | General Computer Science | Spring 2011 |
|---|---|---|

# Written Exam 2 Solutions

1. **Data types.**

   (a) A data type is a set of *values* and *operations* on those *values*.

| *Java expression* | *type* | *value* |
|---|---|---|
| `r.length()` | `int` | `5` |
| `r.charAt(r.length())` | run-time exception | |
| `(t == u)` | `boolean` | `false` |
| `u.equals(t)` | `boolean` | `true` |
| `r.substring(0, r.length())` | `String` | `"Hello"` |

2. **Scientific computation.**

   (a) (ii)

   (b) 1/2, 3/4, 1, 123

3. **Linked structures.**

   I and III only

4. **Data type design.**

   (a) Y declaring instance variables to be `private`

   N declaring instance variables to be `immutable`
   *no such access modifier in Java*

   Y declaring instance variables to be `final`

   Y defensively copying instance variables

   N overloading instance methods
   *a feature of Java methods, but not related to immutability*

   (b) `double[]`     `Tour`     `Stack<String>`     `GuitarString`

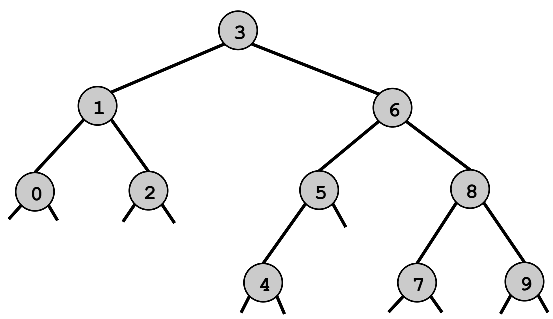
5. **Analysis of algorithms.**

(a) $N^2$

(b) $240 = 15 \times 4^2$

(c) $8N^2$

6. **Symbol tables.**




7. **Regular expressions.**

ii (i matches `aA`; iii matches `Aa`; iv doesn't match `a`)

8. **Theory of computation.**

(a)

B There exists a mathematical function that can be computed in Java, but *cannot* be computed on a Turing machine.

D There exists a mathematical function that can be computed in polynomial time on a quantum computer, but *cannot* be computed in polynomial time on a Turing machine. *Assume that quantum computers can be built.*

B There exists a mathematical function that can be computed in polynomial time in Java, but *cannot* be computed in polynomial time on a Turing machine.

A There exists a Universal Turing machine that can simulate the behavior of any other Turing machine.

A. known to be true

B. known to be false

C. if true would falsify the Church-Turing thesis

D. if true would falsify the *extended* Church-Turing thesis

E. if true would prove the Church-Turing thesis

(b) D Not all search problems can be solved in polynomial time.

A There exists a search problem that can be solved in polynomial time.

C Both FACTOR and 3-SAT can be solved in polynomial time.

B Exactly one of 3-SAT and TSP can be solved in polynomial time.

A. known to be true

B. known to be false

C. if true would imply $P = NP$

D. if true would imply $P \neq NP$

9. **Circuits.**

(a)

| $X$ | $Y$ | $Z$ | $f$ |
|---|---|---|---|
| 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 |

(b) $X'Y'Z' + X'YZ' + XY'Z + XYZ$

(c) $2^{(N+1)/2}$
There is one entry in the truth table (and an $N$-input AND gate) for each $N$-bit palindrome. For odd $N$, the first $(N+1)/2$ bits can be 0 or 1; the last $(N-1)/2$ bits equal the reverse of the first $(N-1)/2$ bits.