



CS110 Review
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Time and Place

Friday, December 20th, 2002; Davies Auditorium

Coverage

There will be 5-7 problems on the final exam. The exam will be cumulative, but will emphasize topics covered after the midterm.

TENTATIVE TOPICS (see the web page for a complete list):
Data storage and Manipulation (1.1-1.7, 2.1-2.5) • Bits and Computation • Digital Circuits • Memory, I/O, and storage • Computer arithmetic • Assembly language and RAM • Finite state machines
Operating Systems and Networks (3.1-3.7) • OS architecture • Processes • Network fundamentals • Internet; TCP/IP vs. UDP
Algorithms (4.1-4.6) • What is an algorithm? • Recursion • Asymptotic notation
Programming Languages (5.1-5.3, 5.5, 5.7) • Basics • Functions and objects • Logic programming and declarative programming
Artificial Intelligence(10.1, 10.3-10.5) • General concepts • Reasoning • Neural networks; genetic algorithms
Theory of Computation (11.1-11.6) • Turing Machines • Church's Thesis; P vs NP; NP-completeness • Cryptography
Database Structures (9.1-9.3) • Relational model • SQL query language

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Sample Problems

Midterm and homework questions are representative of the ones you might find on the final. The following sample problems should help you understand the material better. We'll try to go over most of them during the review session.

1. Factorial is defined as $n! = 1 \cdot 2 \cdot \dots \cdot n$. Design a recursive algorithm that computes the factorial of a given number. (ALGORITHMS)
2. Order the following functions by growth rate: $\sqrt{n}$, $n^{1.5}$, n^2 , $n \log n$, 2^n , 37 , $2^{n/2}$, n^3 , $n^2 \log n$, $\frac{2}{n}$. (ALGORITHMS)
3. Design a simple algorithm to detect if an array contains any duplicates. What is its time complexity? Can you do as good as $O(n)$? (ALGORITHMS)
4. Construct a finite automaton that accepts strings of the form 0^*1 . (ALGORITHMS)
5. Design a Turing machine that changes all the 1s it sees into 0s and all the 0s into 1s. (THEORY)
6. Give an example of a problem that is in both the class P and the class NP. (THEORY)
7. Suppose $N = p \cdot q = 437$, where $p = 19$ and $q = 23$ are two primes. Set $e = 13$ and $d = 61$ so that $de \bmod \phi(n) = 1$. What's the encryption of original data 180?. (CRYPTO)

Answer:

$$E_e(x) = x^e \bmod n \text{ and } D_d(y) = y^d \bmod n = x^{ed} \bmod n = x^{ed \bmod \phi(n)} \bmod n = x \bmod n.$$

$$\text{So, } E_{13}(180) = 180^{13} \bmod 437 = 208229648656711680000000000000 \bmod 437 = 329.$$

8. Is the problem of searching through a list for a particular value a polynomial problem? Justify your answer. (THEORY)
9. (OS)
 - What is the difference between virtual memory and main memory?
 - What is a multitasking operating system?
 - List four activities of a typical operating system.
10. List the four layers in the Internet software hierarchy and identify a task performed by each layer. (NETWORKS)
11. Suppose the procedure `modify` is defined by

```
procedure Modify(y)
y ← 7
print the value of y
```

If parameters are passed by value, what will be printed when the following segment is executed?
What if parameters are passed by reference?

```
x ← 5  
  
apply the procedure Modify to x  
  
print the value of X
```

(PROGRAMMING LANGUAGES)

12. Suppose you are going to write an object-oriented program for maintaining your financial records. What data should be stored inside the object representing your checking account? To what messages should that object be able to respond? What are other objects that might be used in the program? (PROGRAMMING LANGUAGES)

13. Draw a flowchart representing the structure expressed by the following C, C++, and Java statement.

```
for (x = 2; x < 8; x++) { ... } (PROGRAMMING LANGUAGES)
```

14. Below is a program written in the Random Access Language. Assume that the memory initially contains the value 1 in all locations. Show the contents of locations 0 through 10 when the program halts.

```
0: LDA 0  
1: ADD 0  
2: STA 0  
3: ADD 0  
4: STA 0  
5: STI 0  
6: SUB 10  
7: JMZ 9  
8: JMP 4  
9: HLT
```

(DATA STORAGE)

15. Represent these numbers in two's complement notation: -2, 0, 7, 10, 0.25. (DATA STORAGE)
16. Design a circuit for XOR using AND, NOT, OR gates. (DATA STORAGE)
17. How would you describe a production system for a 3x3 tic-tac-toe game? What heuristic would you use? (AI)
18. Translate the SQL statement `select JOB.JobTitle from ASSIGNMENT, JOB where ASSIGNMENT.JobId = JOB.JobId and ASSIGNMENT.EmplId = "34Y70"` into a sequence of SELECT, PROJECT, and JOIN operations. (DATABASE)
19. What is the role of a DBMS in the layered approach to a database implementation. (DATABASE)