CS 561, HW1

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Due: Sept 4

Exercise number are all from the second edition of Cormen, Leiserson, Rivest and Stein. Reminder: All the homeworks are closed Internet!

1. Exercise 3.1-2: Show that for any real constants a and b, where $b > 0$, that $(n+a)^b = \theta(n^b)$
2. Exercise 3.1-5: Prove Theorem 3.1
3. Exercise 3.1-7: Prove that $o(g(n)) \cap \omega(g(n))$ is the empty set
4. Problem 3-3 (ordering by asymptotic growth rates)
5. Prove that $\log n! = \theta(n \log n)$ and that $n! = \omega(2^n)$ and $n! = o(n^n)$
6. Problem 7-2 (Alternative quicksort analysis)
7. Exercise 8.1-3: Show that there is no comparison sort whose running time is linear for at least half of the $n!$ inputs of length n. What about a fraction of $1/n$ of the inputs of length n? What about a fraction of $1/2^n$?
8. Exercise 8.4-3: Let X be a random variable that is equal to the number of heads in two flips of a fair coin. What is $E(X^2)$? What is $E^2(X)$?
9. Problem 8-4 (Water Jugs)
10. Bad Santa. You are a clever child presented with n boxes, exactly half of which contain a present (assume n is even). An adversarial Santa lines up the boxes on a table and allows you to consider each box only once in order; you must decide if you want to open that box or pass on it, never to see it again. Design an algorithm that ensures that you find at least one present and minimizes the expected number of boxes that you open to do so. *Note: As silly as this problem sounds, it actually*

has applications in designing power-aware sensor networks: boxes are time steps, presents are messages, opening a box means being awake in a time step. Hint: You may find the following inequality useful $(1-x) \leq e^{-x}$