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Asymptotics Drill HW

1. Ordering Run Times

1) n^2
   a) Doubling: $(2n)^2/n^2 = 4$: algorithm increases by a factor of 4
   b) Adding 1: $(n+1)^2/n^2 = (n^2+2n+1)/n^2 = 1$ (as n gets arbitrarily big and n^2 in the denominator grows, the terms 2n and 1 in numerator become negligible) : algorithm basically remains the same

2) n^3
   a) Doubling: $(2n)^3/n^3 = 8$: algorithm increases by a factor of 8
   b) Adding 1: $(n+1)^3/n^3 = (n^3+3n^2+3n+1)/n^3 = 1$ (as n gets arbitrarily big, the terms $3n^2$, 3n, and 1 in numerator become negligible) : algorithm basically remains the same

3) $100n^2$
   a) Doubling: $100(2n^2)/100n^2 = 4$: algorithm increases by a factor of 4
   b) Adding 1: $100(n+1)^2/100n^2 = (100n^2+200n+200)/100n^2 = 1$ (as n gets arbitrarily big, the terms 200n and 200 in numerator become negligible) : algorithm basically remains the same

4) nlogn
   a) Doubling: 2n(log2n)/nlogn = 2 (as n becomes arbitrarily big, log2n/logn approaches 1) : algorithm increases by a factor of 2
   b) Adding 1: (n + 1)(log(n+1))/nlogn = 1 (as n becomes arbitrarily big, the equation approaches 1)

5) 2^n
   a) Doubling: $2^{2n}/2^n = 2^n$: algorithm increases by a factor of 2^n
   b) Adding 1: $2^{n+1}/2^n = 2$: algorithm increases by a factor of 2

2. Really Understanding Order of Growth

10^{10} operations per second * 60 seconds * 60 minutes = 3.6 * 10^{13} operations per hour

Solve for n value which will produce less than $3.6 * 10^{13}$ steps:

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1) $n^2 = 3.6 * 10^{13}$: $n < 6000000$
2) $n^3 = 3.6 * 10^{13}$: $n < 33019.27249$
3) $100n^2 = 3.6 * 10^{13}$: $n < 600000$
4) $nlogn = 3.6 * 10^{13}$: $n < 2.8893 * 10^{12}$
5) $2^n = 3.6 * 10^{13}$: $n = log(3.6 * 10^{13})$: $n < 13.5563$
6) $2^{2n} = 3.6 * 10^{13}$: $n < 6.77815$