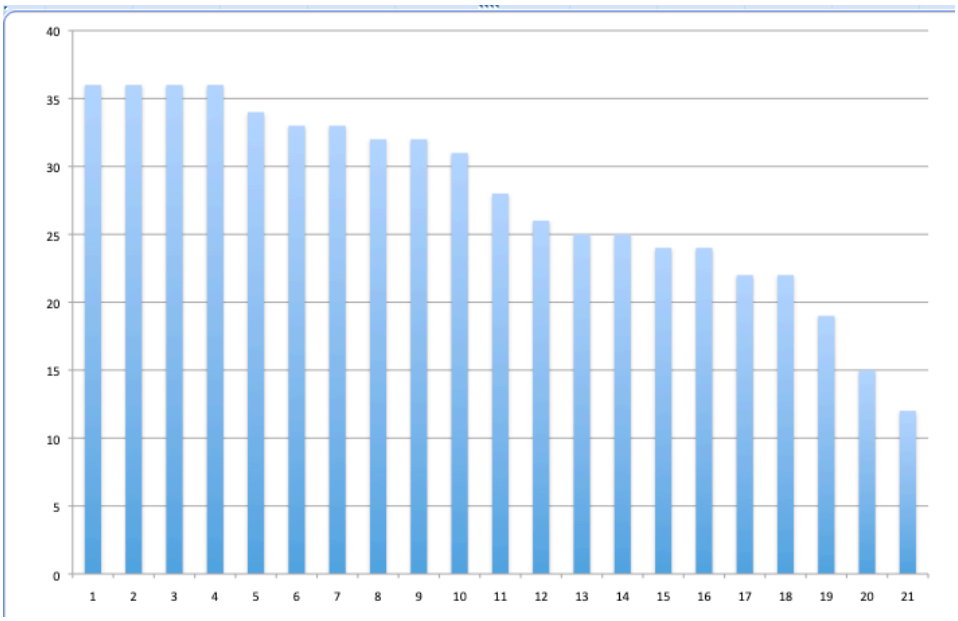
COS 109 Problem Set 7

Graded out of 36. As always, the further to the right you are on this graph, the more you should be paying attention to how well you understand the material.



Problem 1: Potpourri **8 x 2 = 16**

(a) 150 mi bookshelf == 1 TB ?

I think it's too low, but it depends on the assumptions.
My reasoning: 150 miles * 5280 feet * 12 inches = 9.5M inches.
If a 1-inch book has 500 pages and each page has 400 words, that's 200,000 words/book or about 1 MB/book, so about 10 TB.
But if the books were laid flat, maybe it's about right? Or if the text was compressed?

(b) (i) distance to Salt Lake?

1,900 miles (3,000km). 11 million sheets x 11 inches / 12 / 5280. Watch out for excessive precision.

(ii) height of Fine Hall

200 feet (65m)? One way to reason: a ream of paper (what you see at printers) is 500 sheets and is about 2 inches thick. Or a sheet is 0.1 mm.

A disturbing number of people did the arithmetic wrong, came up with buildings whose height would put Dubai skyscrapers to shame, and didn't think about the answer. The original *Prince* computation was quite reasonable.

(c) Human brain in GB?

175 * 10^21 / 1.75 * 10^9 bytes = 10^14 bytes = **10^5 GB**

(d) DVD in GB?

10^6 ^ 10^15 bytes / 250 * 10^9 dvds = 4 * 10^9 bytes == **4 GB in a dvd.** Pretty close to the right number.

(e) Why IV?

There are 256 possible column numbers. It must come from wanting to store the column number in a single byte (in earlier times when memory was tight).

(f) (i) How many bits for row number

20, based on "over 1 million".

(ii) Why XFD?

14 bits. In base 26 (and starting from 1, not 0), it's 2^14. It does seem odd to have 20+14 = 34 bits, which does not fit in 4 bytes and is way small for 5. I really wanted you to say something about the number of bits, not just that something had gone on long enough.

Problem 2: **2 + 2 + 4 = 8**

(a) Secret keys for Alice, Bob, Carol?

7

(b) Keys when David is added?

15

(c) Formula for #keys for N people?

2^n – 1. You should by now recognize the sequence 1, 3, 7, 15, [31, 63, ...], but if your answers were wrong for the first two parts, it's harder to see the pattern. You could also have checked with just Alice and Bob, or Alice all by herself.

Problem 3: **6 x 2 = 12**

(a) Fewest links to disconnect Princeton from Stanford?

AC and FG. A fair number of people thought that 3 were needed.

(b) Fewest routers to disconnect Princeton from Stanford?

AF or CF or AG or CG

(c) Routers exactly two hops from Princeton?

A D C F G

(d) Shortest path from Princeton to Stanford?

P C A S or P G F S

(e) Longest path from Princeton to Stanford?

P D G C A B F E S. It goes through all routers.

(f) Minimum links to connect R routers?

R - 1