We have:

We approximate:

So we have:

And we want:

With

# Problem 1

We look to solve for

we have

Solving with mathematica:

Which is closest to which is D

# Problem 2

We take

See attached code and plots.

For we have the following bounds:

A:

B:

C:

D:

So the answer is D

# Problem 3

so the first breakpoint is . So we know that for we have

See attached code.

For we have the following bounds:

A:

B:

C:

D:

So the answer is C

# Problem 4

For any to point data set We know the mean squared error is:

We differentiate w.r.t. looking to minimize the error:

We substitute in and simulate 1,000,000 randomly sampled data sets (see code): Result is which makes the answer E

# Problem 5

In order to approximate the bias relative to we integrate over

This is valid due to the odd symetry of

Which is closest to 0.3 out of the options thus the answer is B.

# Problem 6

We are looking for:

We approximate this in a simulation as shown in the code

The simulation returned a variance of which is closest to 0.2 so the answer is A

# Problem 7

(a)

we know from the book (p65) that hypotheses of this form have and , for a total expected

(b)

We know from the previous questions that hypotheses of this form have and for a total expected

(c)

We know from the book (p65) that hypotheses of this form have and for a total expected

(d)

The model we are working with is

we have the error for a given 2 point dataset:

differentiating:

we look to estimate via simulation substituting

The simulation (run a couple times) is approximately which means that . So we know that we have approximately the same as from p65 of the book which is

Simulation returns so the expected is unreasonably high.

(e)

Knowing the performance for the model , we can see that the model will also be high variance because the model that will minimize expected mean squared error would be similar as that of (d) which means that it would have the same as (d) but strictly greater so it is expected to be the highest expect out of sample error.

The model has the least expected out of sample error thus the answer is B

# Problem 8

If and , so since , as long as , since the recursive definition is multiplying the previous by 2 and then subtracting. We know that is 0 when , thus the growth function will stop being once which occurs when which occurs when calculating . So the breakpoint, k, is and so the answer is C.

# Problem 9

We can dismiss options D and E immediately by considering the case in which are all disjoint from one another. In this case, the intersection would be the empty set which have despite the fact that the of any need not be 0 which would mean that the minimum would be greater than 0 which would be in violation of the bound.

1. is clearly a valid bound, albeit a loose bound, since we are taking the sums of the despite knowing that the intersection hypothesis set is no more complex than the least complex set in .
2. Is also a valid bound because the intersection hypothesis is no more complex the the least complex set in . Thus, the is properly bounded
3. Since (b) is a valid bound than (c) must also be a valid, but looser bound because the max cannot be less than the min .

We also know that (b) is tighter than (a) because is necessarily an element in the summation: .

So the tightest bound is B

# Problem 10

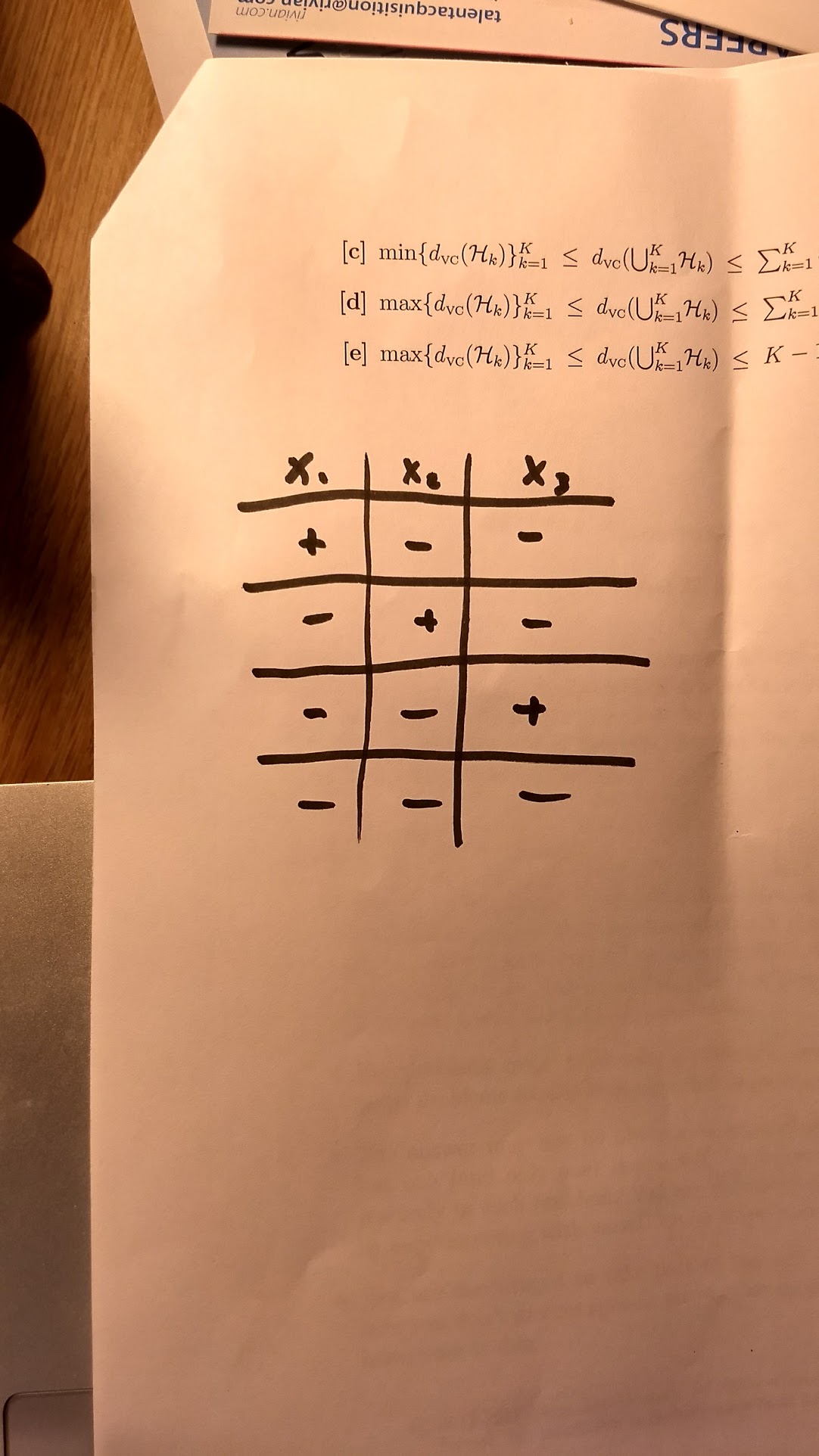
We know that is a valid lower bound since the set with the greatest is, by definition of union, a subset of the union of and we know that a hypothesis set that is a subset of another can’t have a greater than the other.

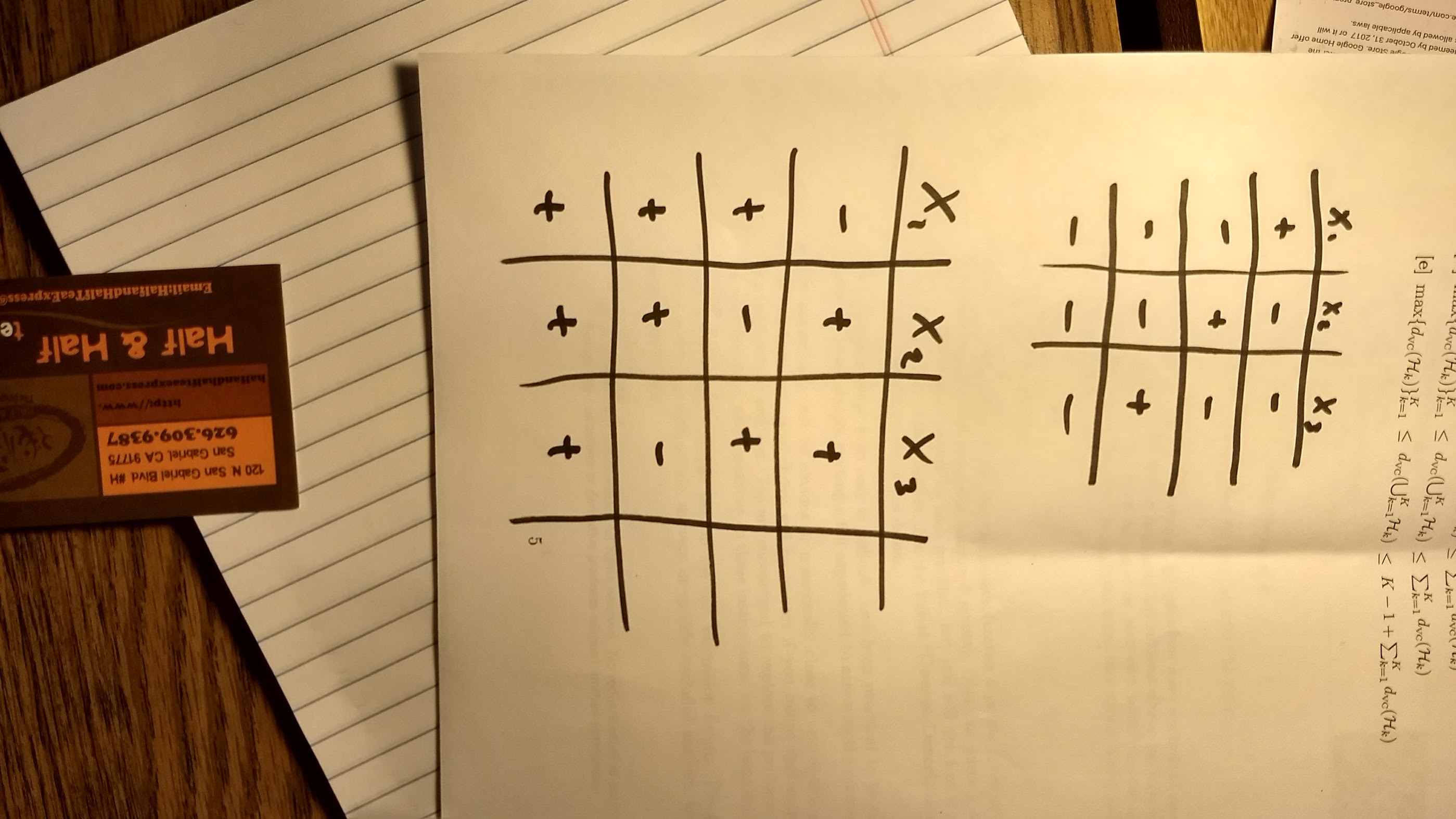
So we can eliminate a,b, and c because their lower bounds are not the tightest even if they are valid bounds.

So we compare the following upper bounds:

and

Consider with breakpoint and defined as follows:



and with breakpoint and defined distinctly from as such:

We can see that has and

Furthermore we know that we have

Thus the proper upper bound is given by and the answer is E