Problem Set 1

Zach Neveu

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1 Question 1

`A` is the correct choice. To perform leave-one-out validation, it is necessary to train the model on all data except one point, then repeat this process for every point. This requires training the model as many times as there are data points which is quite expensive computationally.

2 Question 2

- 5 fold cross-validation * 4 regularization strengths
- Hold-out method to estimate generalization error with only 1 strength
- Time taken: $5 * 4(D_{train} + D_{test}) + D_{train} + D_{test}$
- Time taken: $21 * N_{train}^2 + \frac{21}{2} N_{test}^2$
- Time taken ($N = 5000$): $21 * (.9 * 5000)^2 + \frac{21}{2}(.1 * 5000)^2$
- Time = $4.3575e8 = 435,750,000$

3 Question 3

- Q1 -> Q8,Q5,Q3 -> blue,blue,red -> blue -> wrong
- Q2 -> Q5,Q6,Q4 -> blue,blue,red -> blue -> wrong
- Q3 -> Q6,Q5,Q8 -> blue,blue,blue -> blue -> wrong
- Q4 -> Q7,Q2,Q6 -> blue,red,blue -> blue -> wrong
- Q5 -> Q3,Q6,Q8 -> red,blue,blue -> blue -> right
- Q6 -> Q3,Q5,Q7 -> red,blue,blue -> blue -> right
- Q7 -> Q6,Q3,Q4 -> blue,red,red -> red -> wrong
- Q8 -> Q1,Q5,Q3 -> red,blue,red -> red -> wrong
- 2/8 total correct

4 Question 4

- $Z = x + y$
- $E[Z] = E[x + y] = E[x] + E[y]$

5 Question 5

- nslots = 38
- nred = 18
- nblack = 18
- p(red) = p(black) = p(win) = 18/38
- E(win) = p(win)*2 = 36/38*$1 ≈ $0.95

6 Question 6

- p(cancer) = 0.007
- p(positive | cancer) = 0.9
- p(positive| no cancer) = 0.08
- p(cancer | positive) = p(positive | cancer) * p(cancer) / p(positive)
- p(cancer | positive) = 0.9*0.007 / (p(positive | cancer)*p(cancer) + p(positive | no cancer)*p(no cancer))
- p(cancer | positive) = 0.9*0.007 / (0.9*0.007 + 0.08*(1-0.007))
- p(cancer | positive) = .0734
- So there is a 7.34% chance she has cancer if the mammogram comes back positive.

7 Question 7

- $Var(y) = E[y^2] - E[y]^2$
- Since $1^2 = 1$, $Var(y) = E[y] - E[y]^2$
- $Var(y) = p - p^2 = p(1 - p)$

8 Question 8

$$conv(x(n), y(n)) = \begin{cases} \frac{1}{6}(x+2)^2 & -2 \le x < 2 \\ \frac{4}{3}x & 2 \le x < 4 \\ 6 - \frac{1}{6}(x-2)^2 & 4 \le x < 8 \\ 0 & o.w. \end{cases}$$

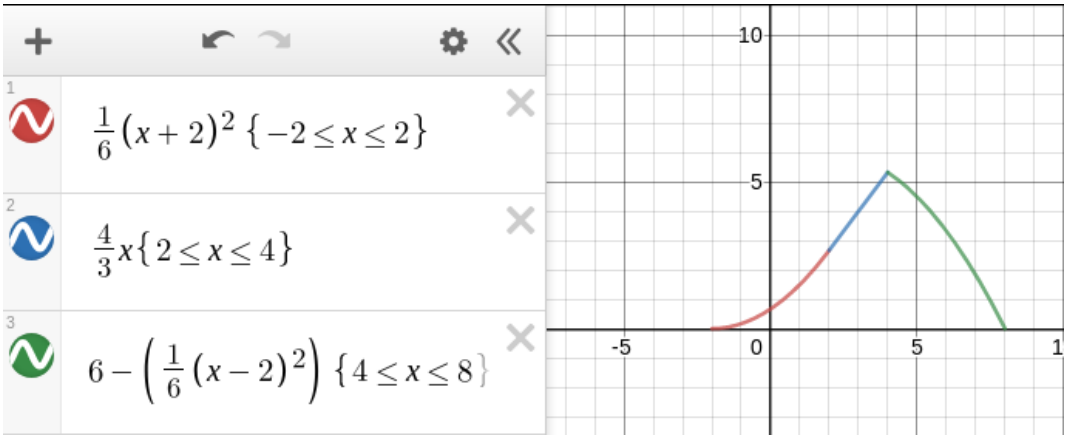

Figure 1: conv

9 Question 9

Part A

$$x(t) = A\cos(2\pi F_0 t + \theta) = Re(Ae^{j2\pi F_0 t + \theta}) = \frac{A}{2}\left(e^{-(j2\pi F_0 t + \theta)} + e^{j2\pi F_0 + \theta}\right)$$

Part B

Fourier Coefficients: $a_0 = 0, a_1 = \frac{A}{2}, a_n = 0 \; for \; n > 1$

Part C

Power (RMS): $\sqrt{\frac{1}{2}}A$
Energy: ∞ since signal is not time limited and has constant amplitude