Week 4 Quiz

TOTAL POINTS 9

1. Person 1 has hazard $h_1(t) = 1$, and Person 2 has hazard $h_2(t) = 2$. What is the probability of dying within the first year for each patient? **1 / 1 point**

   Hint:

   The survival function $S(t)$ in terms of the hazard function is:

   $$S(t) = e^{-\int_0^t h(s)ds}$$

   - (●) 0.63, 0.86
   - ( ) 0.37, 0.14
   - ( ) 0.6, 0.6

   ✓ **Correct**
   Note that since the hazards are constant.

2. Let $T > 0$. **1 / 1 point**

   For patient 1, let the survival function be $S_1(t)$ and the hazard function be $h_1(t)$.

   For patient 2, let the survival function be $S_2(t)$ and the hazard function be $h_2(t)$

   You see that $S_1(T) > S_2(T)$. The survival probability of patient 1 at time T is higher than the survival probability of patient 2 at time T.

   Which of the following is true about the hazard of patient 1 and 2 at time T?

   Hint:

   $$S(t) = e^{-\int_0^t h(s)ds}$$

   - ( ) h_1(T) > h_2(T)
   - ( ) h_1(T) < h_2(T)
   - ( ) h_1(T) = h_2(T)
   - (●) None of the above

   ✓ **Correct**

3. Now assume that the hazards for patient 1, h_1 and for patient 2, h_2 are proportional to each other. Also assume that $S_1(T) > S_2(T)$ for some T > 0. **1 / 1 point**

Then which of the following is true about the hazards?

- h_1(T) = h_2(T)
- h_1(T) > h_2(T)
- h_1(T) < h_2(T)

Correct

Since the hazards are proportional, we know that they cannot cross each other when we vary the time T.

Therefore if the survival function of Person 1 is above the survival function of Person 2 at any point, it must be above the person 2 survival function everywhere.

Since the survival function decays exponentially with the hazards (it is e raised to the power of negative 1 times the integral of the hazard) it means that the hazard of Person 1 is LESS than the hazard of Person 2.

Since the hazards are proportional, this must be true for any time T.

In particular $h_1(T) < h_2(T)$.

4. You've fit a Cox model on 2 features: age and smoking status. **1 / 1 point**

The coefficients of these features are:

$\beta_{age} = 0.9$ and $\beta_{smoker} = 10.0$.

What is the hazard ratio between Person 1, a 40 year old non-smoker, and Person 2, a 30 year old smoker?

Recall that Cox Proportional Hazards assumes a model of the form:

$$h(t) = \lambda_0(t)e^{(\beta_{age} \times Age + \beta_{smoker} \times Smoker)}$$

We're asking you to find the ratio:

$$\frac{h_1(t)}{h_2(t)}$$

- 2.64
- 2.7
- 0.36

5. You've fit a cox model and have the following coefficients: 1 / 1 point

$\beta_{female} = -1.0$

$\beta_{age} = 1.0,$

$\beta_{BP} = 0.6$

$$h(t) = \lambda_0(t)e^{((\beta_{female} \times female)+(\beta_{age} \times Age)+(\beta_{BP} \times BP))}$$

Which of the following interpretations is most correct?

- All other things held equal, having higher BP decreases your risk
- All other things held equal, being a female decreases your risk
- All other things held equal, having lower age increases your risk

✓ **Correct**

Note that the effect of increasing a feature x by 1 unit will be to multiply the hazard by $e^{(\beta_x)}$.

Since $e^{(0)} = 1$, a coefficient less than 0 (a negative coefficient) reduces the hazard. A coefficient greater than 0 (positive) increases the hazard.

6. Assume h_1(t) = t, and h_2(t) = 1.0. At which time T > 0 does S_1(T) = S_2(T)? 1 / 1 point

- 1
- None of the above
- 2
- 0.5

✓ **Correct**

Remember that the Cumulative hazard is the integral from 0 to t of the hazard function. Using calculus, one can see that the cumulative hazard for Person 1 is 0.5t^2 and for person 2, the cumulative hazard is t.

Since S(t) = exp(-H(t)), the survival functions are equal if and only if the cumulative hazard is equal.

Setting these equal to each other, we get t = 2. A common mistake is just to set the hazards equal, which would give you t = 1.

7. Using the Nelson-Aalen estimator estimate H(7), the value of the cumulative hazard at t=7 for this dataset. 1 / 1 point

ID	Outcome
1	3
2	4
3	8
4	6+

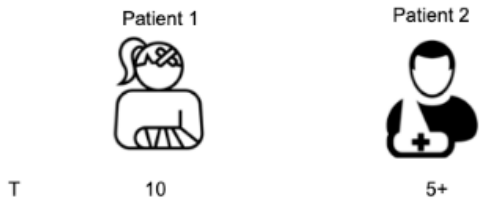
The Nelson-Aalen estimator is:

$$H(t) = \sum_{i=0}^{t} \frac{d_i}{n_i}$$

- 8/11
- 5/9
- 7/12

✓ Correct

8. Which risk assignments would make this pair **concordant**? 1 / 1 point



- 0.3, 0.8
- 0.5, 0.3
- 0.5, 0.5
- The pair is not permissible

✓ Correct
The pair is in fact not permissible. Since Patient 2 was censored before Patient 1 had the event, we cannot say who had a worse outcome.

9. Compute the Harrell C-index for the following dataset and risk scores:

1 / 1 point

ID	Outcome	Score
1	4	1.6
2	6+	1.2
3	5	0.8
4	7	0.1

Step 1: Find all the permissible pairs

Step 2: of the permissible pairs, determine which ones are concordant.

Step 3: of the permissible pairs, determine which ones are risk ties.

Harrell's c-index = $\frac{concordant + 0.5 \times riskties}{permissible}$

- ○ 1.0
- ◉ 0.8
- ○ 0.7

✓ Correct