Homework 4

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Due date: Tuesday, December 3

1. **Survival of root canal filled teeth** Deep caries or restorations in teeth could lead to pulpal involvement, necessitating root canal therapy or extraction. In a retrospective dental study, the primary interest is to assess the impact of pulpal involvement on tooth survival. In this data analysis, a Cox model is fitted using the survival time of the teeth as the response variable. The covariates included in the model are

$$\text{MOLAR} = \begin{cases} 1 & \text{molar tooth} \\ 0 & \text{otherwise,} \end{cases} \quad \text{ROOT} = \begin{cases} 1 & \text{root canal treatment applied} \\ 0 & \text{otherwise,} \end{cases}$$

and three mutually exclusive categories of proximal contacts

$$\text{PC1} = \begin{cases} 1 & \text{nonbridge abutment with one proximal contacts} \\ 0 & \text{otherwise,} \end{cases}$$

$$\text{PC2} = \begin{cases} 1 & \text{nonbridge abutment with two proximal contacts} \\ 0 & \text{otherwise,} \end{cases}$$

$$\text{PCABUT} = \begin{cases} 1 & \text{bridge abutment} \\ 0 & \text{otherwise,} \end{cases}$$

and the number of pockets larger than 5 mm (POCKET). Use the attached the `coxph` output to answer the following questions:

```
> fm <- Surv(TIME, DELTA) ~ (MOLAR + ROOT)^2 + PC1 + PC2 + PCABUT + POCKET
> coxph(fm, data = dendata)
Call:
coxph(formula = fm, data = dendata)

              coef exp(coef) se(coef)     z       p
MOLAR      -0.8440    0.4300   0.5135 -1.64 0.10022
ROOT        1.5449    4.6876   0.3221  4.80 1.6e-06
PC1        -0.7587    0.4683   0.4202 -1.81 0.07100
PC2        -1.5423    0.2139   0.4242 -3.64 0.00028
PCABUT     -0.5207    0.5941   0.5114 -1.02 0.30860
POCKET      0.1463    1.1576   0.0814  1.80 0.07215
MOLAR:ROOT  0.6645    1.9435   0.5440  1.22 0.22192

Likelihood ratio test=97.66  on 7 df, p=<2e-16
n= 404, number of events= 109
```

a. **(2 points) Suppose the log-partial likelihood for the model is -581.4417, what is the log-partial likelihood for the reduced model with no covariates?**

The reduced log-partial likelihood can be obtained by solving $G = 2 \cdot \{\ell_p(\widehat{\beta}) - \ell_p(0)\}$, e.g., `-581.4417 - 97.66 / 2 =`-630.2717

b. **(2 points) What is the hazard ratio that compares teeth with bridge abutment with those without?**

The hazard ratio is 0.5941, indicating that patients with bridge abutment have lower (though not significant) risk of tooth loss.

c. **(2 points) What is the 95% confidence interval for the hazard ratio in #2?**

The 95% confidence interval is $(-0.5207 - 1.96 \times 0.5114, -0.5207 + 1.96 \times 0.5114) = (0.218, 1.619)$. The confidence interval includes 1 indicating the covariate effect is not significant at $\alpha = 0.05$.

d. **(2 points) What is the hazard ratio that compares teeth with nonbridge abutment and one proximal contacts with those with nonbridge abutment and two proximal contacts?**

The fitted hazard for patients with nonbridge abutment and one proximal contacts is $e^{-0.7587-0.5207}$ and the fitted hazard for patients with nonbridge abutment and two proximal contacts is $e^{-1.5423-0.5207}$. These implies that the hazard ratio is $e^{-0.7585+1.5423} \approx 2.1893$. The result indicates that patients with nonbridge abutment and one proximal contacts tend to have a higher risk of tooth loss than those with nonbridge abutment and two proximal contacts.

e. **(2 points) What is the hazard ratio that compares molar teeth with non-molar teeth** among those underwent root canal treatment**?**

Simple calculation gives the hazard ratio of $e^{-0.8440+0.6645} \approx 0.8357$, which indicates that patients non-molar teeth are more vulnerable when compare to the root canal counterpart.