Generalized Linear Models

Week 3 - AYU - Individual

Type 1: Logistic Regression

Problem 1

A statistician uses logistic regression to model a probability of success of a random variable. You are given

- There is one predictors and an intercept in the model
- The estimates of success at $x = 1$ and $x = 2$ are 0.2 and 0.3, respectively.

Calculate $\hat{\beta}_1$ the estimated slope of the model.

Problem 2

You are given the following information for a GLM of customer retention

Response variable	Retention	
Response distribution	Binomial	
Link	Logit	
Parameter	df	$\hat{\beta}$
Intercept	1	1.530
Number of Drivers	1	
1	0	0.000
>1	1	0.735
Last Rate Change	2	
< 0%	0	0.000
0%-10%	1	−0.031
> 10%	1	−0.372

Calculate the probability of retention for a policy with 3 drivers and a prior rate changes of 5%.

(A) Less than 0.85
(B) At least 0.85, but less than 0.87
(C) At least 0.87, but less than 0.89
(D) At least 0.89, but less than 0.91
(E) At least 0.91

Problem 3

You are given the following information for a GLM to estimate the probability of claim. Distribution selected is Binomial (Bernoulli) and the link function is logit.

Parameter	β
Intercept	-1.485
Vehicle Body	
Coupe	-0.881
Roadster	-1.047
Sedan	-1.175
Station wagon	-1.083
Truck	-1.118
Utility	-1.330
Driver's Gender	
Male	-0.025
Area	
B	0.094
C	0.037
D	-0.101

Calculate the estimated probability of claim for

- Driver Gender: Female
- Vehicle Body: Sedan
- Area: D

(A) Less than 0.045
(B) At least 0.045, but less than 0.050
(C) At least 0.050, but less than 0.055
(D) At least 0.055, but less than 0.060
(E) At least 0.060

Problem 4

You are given the following output from a logistic regression to estimate the probability of death cancer patients.

Parameter	$\hat{\beta}$
Intercept	0.05
Daily dosage of drug (mg)	-0.04
Size of the tumor (cm)	1.00
Weekly expenditure ($000s)	-1.20

Calculate the estimated probability of death for a patient who has a tumor of 2cm, spends $780 on medical treatment and 10mg of drug is injected everyday.

(A) Less than 0.5
(B) At least 0.5, but less than 0.6
(C) At least 0.6, but less than 0.7
(D) At least 0.7, but less than 0.8
(E) At least 0.8

Type 2: Poisson Regression

Problem 5

You are given the following for a model of vehicle claim counts by policy

- The response distribution is Poisson and the link function is a log link function
- The parameters are given as follows.

Parameter	**Degrees of Freedom**	$\hat{\beta}$
Intercept	1	-2.663
Number of Youthful Drivers		
0		
1	1	0.132
Number of Adult Drivers		
1		
2	1	-0.031

Calculate the predicted claim count for a policy with one adult driver and one youthful driver.

(A) Less than 0.072
(B) At least 0.072, but less than 0.074
(C) At least 0.074, but less than 0.076
(D) At least 0.076, but less than 0.078
(E) At least 0.078

Problem 6

You are given the follow.

Response variable	Number of Diabetes Deaths		
Response distribution	Poisson		
Link	Log		
Parameter	df	$\hat{\beta}$	p-value
Intercept	1	-15.000	< 0.0001
Gender: Female	1	-1.200	< 0.0001
Gender: Male	0	0.000	
Age	1	0.150	< 0.0001
Age^2	1	0.004	< 0.0001
Age $\times$ Gender: Female	1	0.012	< 0.0001
Age $\times$ Gender: Male	0	0.000	

Calculate the predicted number deaths for a population of 100,000 females age 25

(A) Less than 3
(B) At least 3, but less than 5
(C) At least 5, but less than 7
(D) At least 7, but less than 9
(E) At least 9

Problem 7

You are given the follow result of a Poisson Regression where the response is the total number of claims for a risk group. Calculate the estimated total number of claims for a risk group consisting of 2,000 female aged 25.

Parameter	**Degrees of Freedom**	$\hat{\beta}$
Intercept	1	-2.63
Age	1	0.15
Gender		
Female	1	-1.42
Male	0	0.00

(A) Less than 1,500
(B) At least 1,500, but less than 1,600
(C) At least 1,600, but less than 1,700
(D) At least 1,700, but less than 1,800
(E) At least 1,800

Problem 8 (SRM - Sample Question 11)

Determine which of the following pairs of distribution and link function is the most appropriate to model if a person is hospitalized or not.

(A) Normal distribution, identity link function
(B) Normal distribution, logit link function
(C) Binomial distribution, linear link function
(D) Binomial distribution, logit link function
(E) It cannot be determined from the information given.

Problem 9 (SRM - Sample Question 45)

The actuarial student committee of a large firm has collected data on exam scores. A generalized linear model where the target is the exam score on a 0-10 scale is constructed using a log link, resulting in the following estimated coefficients

Predictor Variables	Coefficient
Intercept	– 0.1
Study Time (in units of 100 hours)	0.5
Attempt (1 for first attempt, else 0)	0.5
Master's degree (1 for Yes, 0 for No)	– 0.1
Interaction of Attempt and Master's degree	0.2

The company is about to offer a job to an applicant who has a Master's degree and for whom the exam would be a first attempt. It would like to offer half of the study time that will result in an expected exam score of 6.0.

Calculate the amount of study time that the company should offer.

(A) 123 hours
(B) 126 hours
(C) 129 hours
(D) 132 hours
(E) 135 hours

Problem 10

You are given the following output of an GLM.

Response variable	Claim size	
Response distribution	Gamma	
Link	Log	
Scale parameter	1	
Parameter	df	$\hat{\beta}$
Intercept	1	2.100
Zone	4	
1	1	7.678
2	1	4.227
3	1	1.336
4	0	0.000
5	1	1.734
Vehicle Class	6	
Convertible	1	1.200
Coupe	1	1.300
Sedan	0	0.000
Truck	1	1.406
Minivan	1	1.875
Stationwagon	1	2.000
Utility	1	2.500
Driver Age	2	
Youth	1	2.000
Middle age	0	0.000
Old	1	1.800

Calculate the predicted claim size for an observation from Zone 3 with driver Class Truck and Driver Age Old.

(A) Less than 650
(B) At least 650, but less than 700
(C) At least 700, but less than 750
(D) At least 750, but less than 800
(E) At least 800

Problem 11

You are given the following output of an GLM.

Response variable		retention
Response distribution		binomial
Link		square root
Pseudo R^2		0.6521
Parameter	df	$\hat{\beta}$
Intercept	1	0.6102
Tenure		
< 5 years	0	0.0000
≥ 5 years	1	0.1320
Prior Rate Change		
$< 0\%$	1	0.0160
[0%,10%]	0	0.0000
$> 10\%$	1	-0.0920
Amount of Insurance (000's)	1	0.0015

Calculate the probability of a policy with 4 years of tenure that experienced at a 12% prior rate increase and has 225,000 in amount of insurance will retain into the next policy term.

(A) Less than 0.6
(B) At least 0.6, but less than 0.7
(C) At least 0.7, but less than 0.8
(D) At least 0.8, but less than 0.9
(E) At least 0.9