STAT 557 Homework 4

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1. (a) The fitted result is shown in the table below. From the table we can see only sex and age are significant in this model and thus appear to be associated with the incidence of bile duct hyperplasia.

	Estimate	Std.Error	z value	$\Pr(>\|z\|)$
Intercept	2.641695	2.170701	1.217	0.22361
tier2	0.223906	0.445897	0.502	0.61556
tier3	0.442747	0.434731	1.018	0.30847
tier4	0.313559	0.435332	0.720	0.47136
tier5	0.561481	0.450625	1.246	0.21276
sex	-1.220903	0.496367	-2.460	**0.01391**
weight	-0.007937	0.015552	-0.510	0.60981
age	-0.029098	0.009029	-3.223	**0.00127**
pbb	0.029886	0.040542	0.737	0.46104

(b) The sex is code as 1 for female and 0 for male. So $\beta_5 = -1.22$ means with all other conditions the same, the log odd for female to get a bile duct hyperplasia is 1.22 lower than that of male. The 95% interval for β_5 is

$$(-2.1937823, -0.2480237)$$

so the 95% for $\exp(\beta_5)$ is

$$(0.1114942, 0.7803415)$$

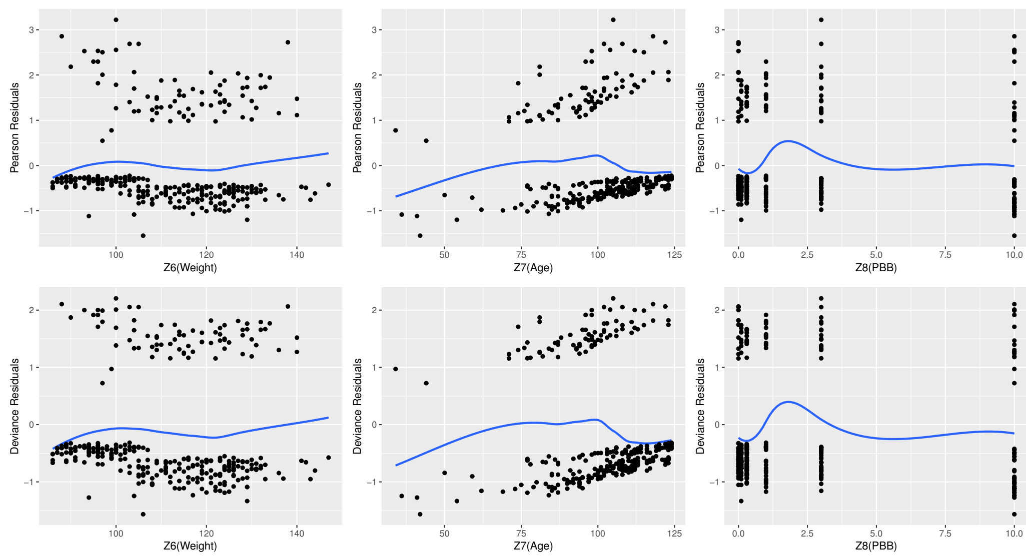
(c) β_8 has an estimated value 0.029886, which means with all other conditions the same, by increasing 1 unit of pbb, the log odd of getting bile duct hyperplasia would increase by 0.029886. The 95% interval for β_5 is

$$(-0.04957632, 0.10934832)$$

so the 95% for $\exp(\beta_5)$ is

$$(0.9516325, 1.1155509)$$

(d) The Pearson and Deviance residual plots with smooth curves are shown below.

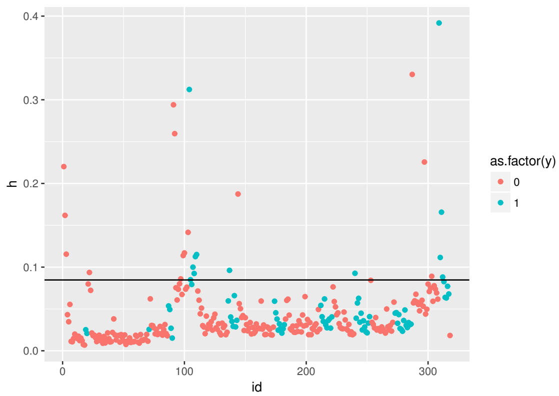


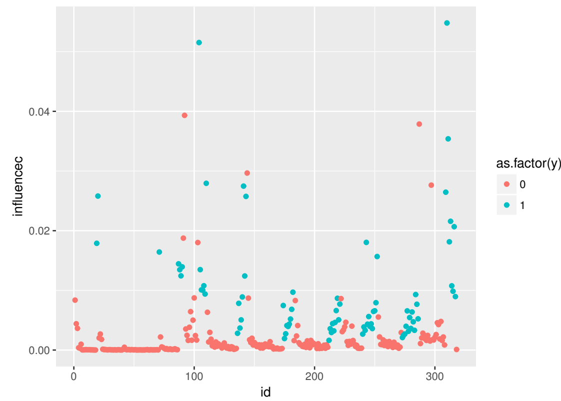
The smooth curves are not flat and suggest the model does not fit the data well.

(e) Using stepwise selection and start with the model with $Z_5Z_6, Z_5Z_7, Z_5Z_8, Z_6Z_7, Z_6Z_8, Z_7Z_8$. The `step` function in are end up with the model with $Z_5Z_7, Z_5Z_8, Z_6Z_7, Z_6Z_8, Z_7Z_8$ added to the model in (a). PBB in this model is significant and has positive estimate, thus it suggests increased PBB increases the risk of bile duct hyperplasia.

	Estimate	Std.Error	z value	$\Pr(>\|z\|)$
Intercept	38.238171	15.385454	2.485	0.01294
tier2	0.339782	0.458687	0.741	0.45883
tier3	0.454982	0.449678	1.012	0.31164
tier4	0.595394	0.449606	1.324	0.18542
tier5	0.753045	0.465302	1.618	0.10558
sex	-7.668968	3.237539	-2.369	0.01785
weight	-0.287320	0.126967	-2.263	0.02364
age	-0.363190	0.146640	-2.477	0.01326
pbb	-1.524012	0.672345	-2.267	**0.02341**
sex:age	0.051360	0.030589	1.679	0.09315
sex:pbb	0.434339	0.154426	2.813	0.00491
weight:age	0.002619	0.001210	2.165	0.03040
weight:pbb	0.007860	0.005022	1.565	0.11758
age:pbb	0.005695	0.002365	2.409	0.01601

(f) From the plot of leverage against id and influence (c) against id, we can there are several potential extreme covariate value and outliers, roughly for id around 0, 100 and 300.





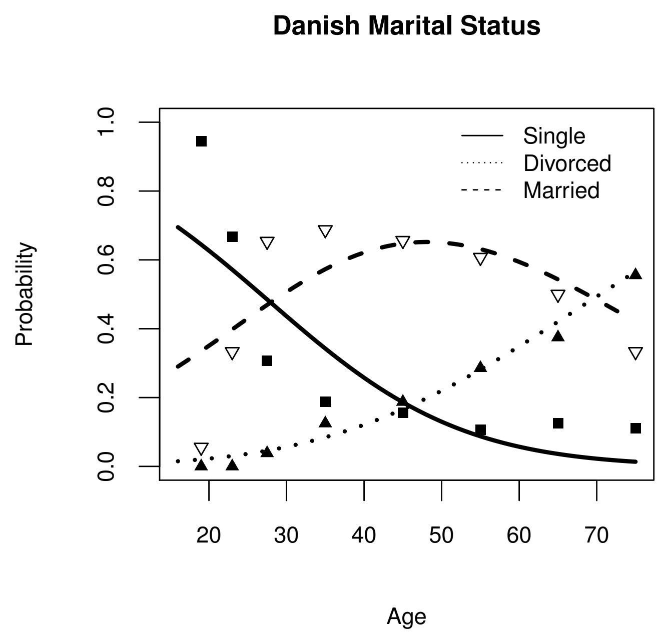
(g)

(h)

2. (a) i. The value of log-likelihood ratio $G^2 = 24.3237$. The degrees of freedom is 12 and p-value is 0.0183736. With small p-value, we conclude that the model does not fit the data well.

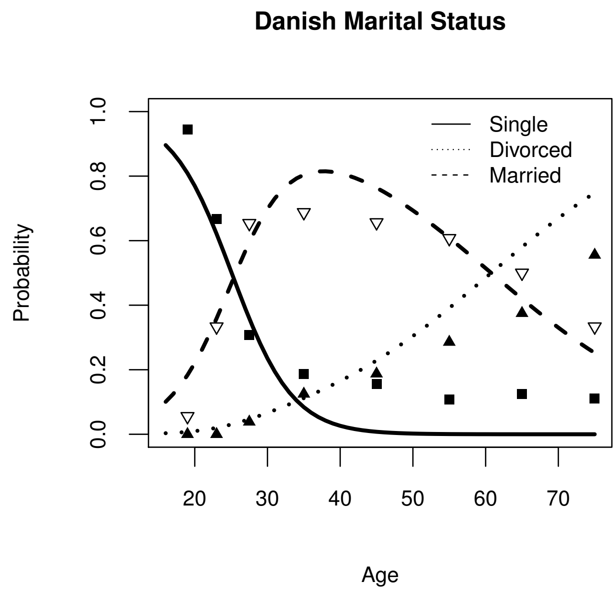
ii. The estimated $\hat{\alpha}_0 = -2.96174, \hat{\alpha}_1 = 0.05521$.
For α_0, it means for people in Denmark at age 16, the log ratio of divorced probability vs married probability is α_0 and estimated to be -2.96174.
For α_1, it means with 1 year increasing in age, for people in Denmark the log ratio of divorced probability vs married probability would increase by α_1 and estimated to be 0.05521.

iii. From the plot we can see the single probability and deviate from the data a lot. And for married probability the model does not fit the data well for small age under 40. The fit of divorced probability is pretty good.



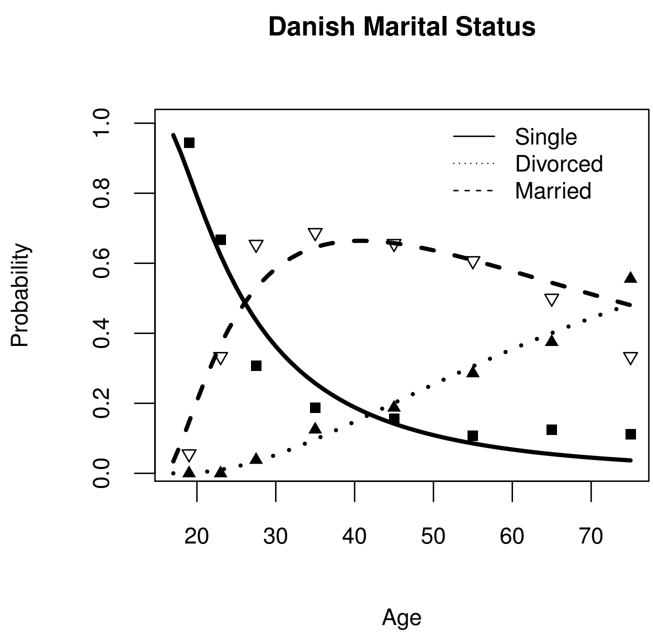
(b) i. The value of log-likelihood ratio $G^2 = 8.6595$. The degrees of freedom is 10 and p-value is 0.564694. With large but not close to 1 p-value, we conclude that the model fit the data somehow well.

ii. From the plot we can see the married probability is fitted a lot better than the previous model. The single probability is fitted well for small age, which is a lot better than the previous model. The divorced probability is also fitted well for small age, but not very well for large age.



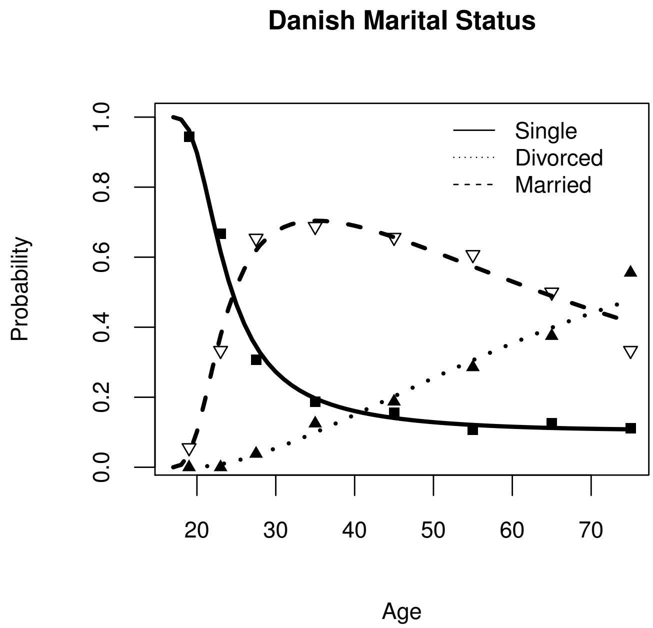
(c) i. The value of log-likelihood ratio $G^2 = 7.8249$. The degrees of freedom is 12 and p-value is 0.7986598. With large but not close to 1 p-value, we conclude that the model fit the data somehow well.

ii. From the plot we can see the three probability lines are all fitted pretty well. And for large age the divorced probability and single probability are fitted better than model B. Also for age around 30 to 40, the married probability is fitted better then that of model B.



(d) i. The value of log-likelihood ratio $G^2 = 1.7077$. The degrees of freedom is 10 and p-value is 0.9981293. With large and close to 1 p-value, we conclude that the model fit the data pretty well.

ii. From the plot we can see the three probability lines are all fitted really well and a lot better than the previous 3 models.



(e) The table is shown below. From the table we can see model D has the smallest deviance, AIC and SC. But model C also has small AIC and BIC, which are close to those of model D, and the number of parameters for model C is smaller than that of model D. However the deviance of model D is a lot smaller than that of model C, so I think it is worth to add more parameters. And from the plot we can see model D gives the best fitting of data. What's more, 6 is not to many for number of parameters, hence I think model D is the best.

Model	No. Parameters	Deviance	AIC	SC (BIC)
A	4	24.32368	73.03223	73.34999
B	6	8.659453	61.367997	61.844646
C	4	7.824851	56.533395	56.851161
D	6	1.707711	54.416255	54.892904