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Deviance plays the role of residual sum of squares in linear regression. To assess the significance of a factor(s), we compare the Deviance for models with and without the factor in question. You'll see how to calculate the deviance for this model type on the next page.

Likelihood Ratio Tests: Deviance_Reduced Model - Deviance_General Model ~chi-squared

European Dippers - males only						
Reduced Model	General Model	Chi-sq. df	Prob.			
{Phi(.) p(.) PIM}	{Phi(t) p(.) PIM}	3.000 5	0.7000			
{Phi(.) p(.) PIM}	{Phi(.) p(t) PIM}	2.378 5	0.7947			
{Phi(.) p(.) PIM}	{Phi(t) p(t) PIM}	5.414 9	0.7968			
{Phi(t) p(.) PIM}	{Phi(.) p(t) PIM}	-0.622 0	*****			
{Phi(t) p(.) PIM}	{Phi(t) p(t) PIM}	2.414 4	0.6601			
{Phi(.) p(t) PIM}	{Phi(t) p(t) PIM}	3.036 4	0.5518			

NOTE: the LRT works only for nested models, i.e., comparison #4 is not conceptually valid even if the test were possible mathematically.

Another role of Deviance is in testing for GOF – this will be the next major topic that we tackle. Here's a table that we'll use to gain understanding of how the saturated model's deviance and deviance *df* are calculated. A saturated model fits perfectly and is sometimes a model in the model set (e.g., S(week) in lab 1) and sometimes not (like in Lab 3 where we can't run such a model but can calculate the deviance as below).

		_		Contribution to DEV	Re-releases	Pieces of Information
EH	ni	Ri		(ni*ln(ni/Ri))	•	i` í l
1111110		1:		1	 6	4
1111000			12		 4	
1100000			12		 8	
1010000			12	1	2	
100000	5		12	-4.3773437	5	
0111100	1	20	20	-2.9957323	4	3
0111000	1		20	-2.9957323	3	
0110000	7		20	-7.3487549	14	
0100000	11		20	-6.576207	11	
0011110	1	2	5 25	-3.2188758	4	4
0011100	4		25	-7.3303259	12	
0011000	8		25	-9.1154743	16	
0010110	1		25	-3.2188758	3	
0010000	11		25	-9.0307861	11	
0001111	6	2	2 22	-7.7956979	18	4
0001110	3		22	-5.9772905	9	
0001100	6		22	-7.7956979	12	
0001001	1		22	-3.0910425	1	
0001000	6		22	-7.7956979	6	
0000111	10	2	2 22	-7.8845736	20	2
0000110	3		22	-5.9772905	6	
0000100	9		22	-8.0443609	9	
0000011	12	2	3 23	-7.8070508	12	1
0000010	11		23	-8.1135884	11	
0000001	17	1	7 17	0		
/* SUM	141	14	l <mark>InL</mark>	-138.33957	207	18
			-2InL	276.679136		

The -2lnL value of 276.679, effective sample size of 207, and d.f. of 18 can now be used in comparisons and tests for fitted models. E.g., model Phi(.), p(.), has 2 parameters and -2lnL = 318.494, the deviance is 318.494 - 276.679 = 41.815, and deviance d.f. = 16 (18 – 2).

Discussion of Questions that some students have struggled with in past years.

- 1. $5 \hat{\phi}' s, 5 \hat{p}' s, \& 1 \text{ combo.} = \hat{\phi}_1, \hat{\phi}_2, ..., \hat{\phi}_5, \hat{p}_2, \hat{p}_3, ..., \hat{p}_6, \text{ and } \hat{\phi}_6 \cdot \hat{p}_7$
- 2. Sine link gets it right: k=11. Logit link gets it wrong: k=10.
- 3. Students typically do pretty well with this one but ... some forget to check the # of parameters in all of the models. For part *b*, you could do model averaging as

long as you were paying attention to the problem with phi_6 in the phi(t),p(t) model. For example, if you just do model averaging, for this parameter, you'll see the following:

Apparent Survval Parameter (Phi) Group 1 Parameter 6						
Model	Weight E	stmate St	andard Error			
{Phi(.) p(.) PIM}	0.96003	0.5658226	0.0355404			
$\{Phi(t) p(.) PIM\}$	0.02253	0.6319703	0.0796463			
$\{Phi(.) p(t) PIM\}$	0.01650	0.5560768	0.0342813			
{Phi(t) p(t) PIM}	0.00093	0.7637583	514.1293800			
Weighted Average	().5673361	0.5140185			
Unconditional SE 15.6690091						
95% CI for Wgt. Ave. Est. (logit trans.) is 0.0000000 to 1.0000000						
Percent of Variation Attributable to Model Variation is 99.89%						

You don't have much model-selection uncertainty here and so you could just use the best model to make inferences if you wanted to.

Parameter	Estimate	Standard Erro	r Lower	Upper
1:Phi	0.5658226	0.0355404	0.4953193	0.6337593
2:p	0.9231757	0.0363182	0.8149669	0.9704014

4. Here's how to calculate the probability of getting a 1000000 encounter history (see text on this topic on page 420 of Williams et al.). Be sure you understand.

$$\chi_{7} = 1$$

$$\chi_{6} = (1 - \phi_{6}) + \phi_{6} \cdot (1 - p_{7}) \cdot \chi_{7}$$

$$\chi_{5} = (1 - \phi_{5}) + \phi_{5} \cdot (1 - p_{6}) \cdot \chi_{6}$$

$$\chi_{4} = (1 - \phi_{4}) + \phi_{4} \cdot (1 - p_{5}) \cdot \chi_{5}$$

$$\chi_{3} = (1 - \phi_{3}) + \phi_{3} \cdot (1 - p_{4}) \cdot \chi_{4}$$

$$\chi_{2} = (1 - \phi_{2}) + \phi_{2} \cdot (1 - p_{3}) \cdot \chi_{3}$$

$$\chi_{1} = (1 - \phi_{1}) + \phi_{1} \cdot (1 - p_{2}) \cdot \chi_{2}$$

So, for model phi(.), p(.) with MLE's of phi=0.5658226 & p=0.9231757, the probability of an individual having a 1000000 for its encounter history is 0.4539083.

In **R**, you'd simply type:

```
phi=.5658226

p=.9231757

x7=1

x6=(1-phi)+phi*(1-p)*x7

x5=(1-phi)+phi*(1-p)*x6

x4=(1-phi)+phi*(1-p)*x5

x3=(1-phi)+phi*(1-p)*x4

x2=(1-phi)+phi*(1-p)*x3

x1=(1-phi)+phi*(1-p)*x2

x1 # = 0.4539083
```