

What is  $n$ ?

David Fletcher

Department of Mathematics and Statistics

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- ▶ Hirotake Akaike 1927–2009 (AIC in 1971)

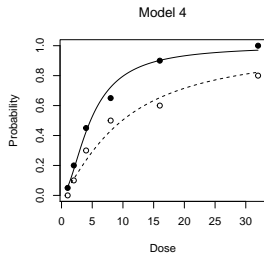
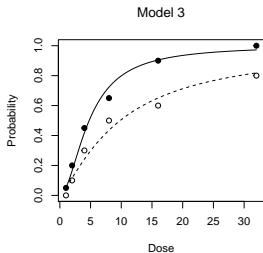
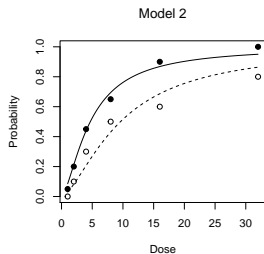
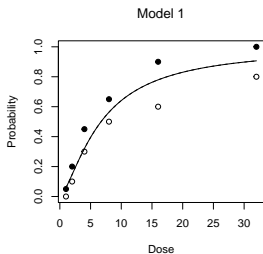


- ▶ Gideon Schwarz 1933–2007 (SIC in 1978)



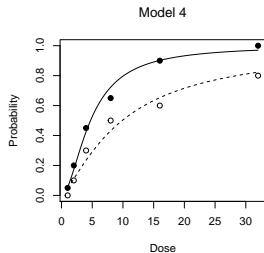
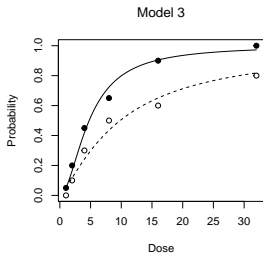
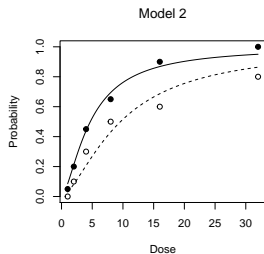
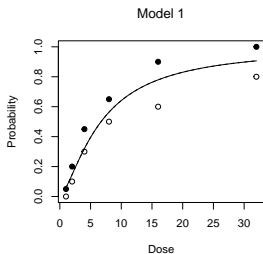
# What is $n$ ?

- ▶ Tobacco budworm: resistance to pesticide
- ▶ Sex and dose: 20 individuals per group



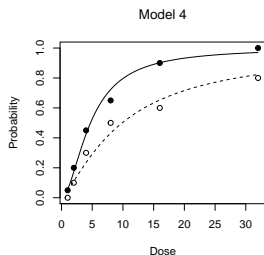
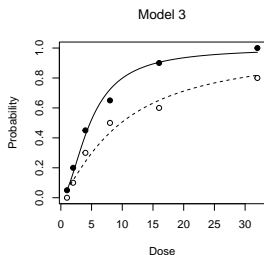
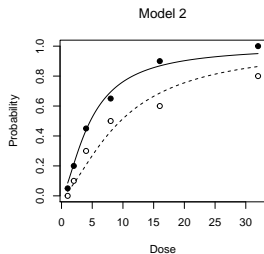
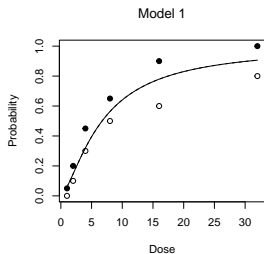
# What is n?

- ▶ Binomial model:  $\text{logit}(\pi) = \beta_0 + \beta_1 \log_2(\text{dose})$
- ▶ Four options:  $\beta_0$  and  $\beta_1$  vary by group or not



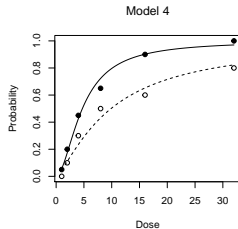
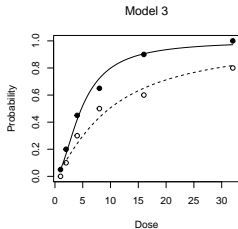
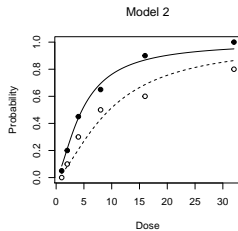
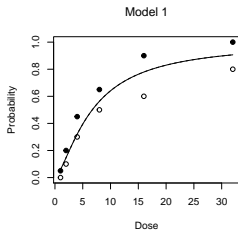
# What is n?

- Overdispersion?  $\hat{\phi} = \frac{X^2}{n-p} = 0.44$   $n = 12$



# What is $n$ ?

- ▶  $AIC = -2 \log \hat{L} + 2p$
- ▶  $BIC = -2 \log \hat{L} + p \log(n)$





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Weight	n	Model			
		1	2	3	4
AIC		0.00	0.24	0.55	0.21
BIC	12	0.01	0.25	0.58	0.17
BIC	240	0.03	0.28	0.65	0.04



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- ▶ `glm` in R:  $n = 12$  if data in binomial format  
 $n = 240$  if data in binary format



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- ▶ `glm` in R:  $n = 12$  if data in binomial format  
 $n = 240$  if data in binary format
- ▶ AICc?



# What is $n$ ?

- ▶  $\text{BIC} = -2 \log \hat{L} + p \log(n)$
- ▶ Kass and Raftery 1995

Normal model

$n =$  number of observations

Binomial model

$n =$  total number of trials

Poisson model (contingency table)

$n =$  total count



# What is $n$ ?

Mark-recapture data (BBC 1996)

- ▶ Multinomial model

$$n = 1?$$

- ▶ Overdispersion  $\hat{\phi} = \frac{\chi^2}{n-p}$

$n =$  number of observable capture-histories

- ▶  $\text{AIC} = -2 \log \hat{L} + 2p$

$$\text{BIC} = -2 \log \hat{L} + p \log(n)$$

$n =$  number of individuals in the study



# What is n?

BACI study in Sydney (Roberts 1993)

- ▶ Control vs Comparison site
- ▶  $n = ?$

Mathematics education (Holton et al. 1999)

- ▶ One classroom
- ▶  $n = ?$

Pseudo-replication

Hierarchical design (and model)

Repeated measures



# What is $n$ ?

## Effective $n$

- ▶ Factorial experiments (Mead 1990)
- ▶ Model averaging (Fletcher & Dillingham 2011)
- ▶ Overdispersion (Diaconis & Efron 1985)
- ▶ Serial correlation (Diggle 1990)
- ▶ Surveys (Lumley & Scott 2015)





# What is n?

Google n



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## Images for n



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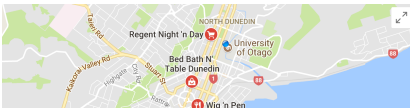
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