Workshop 10.5a: Logistic regression

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August 23, 2016

Table of contents

1. Logistic regression

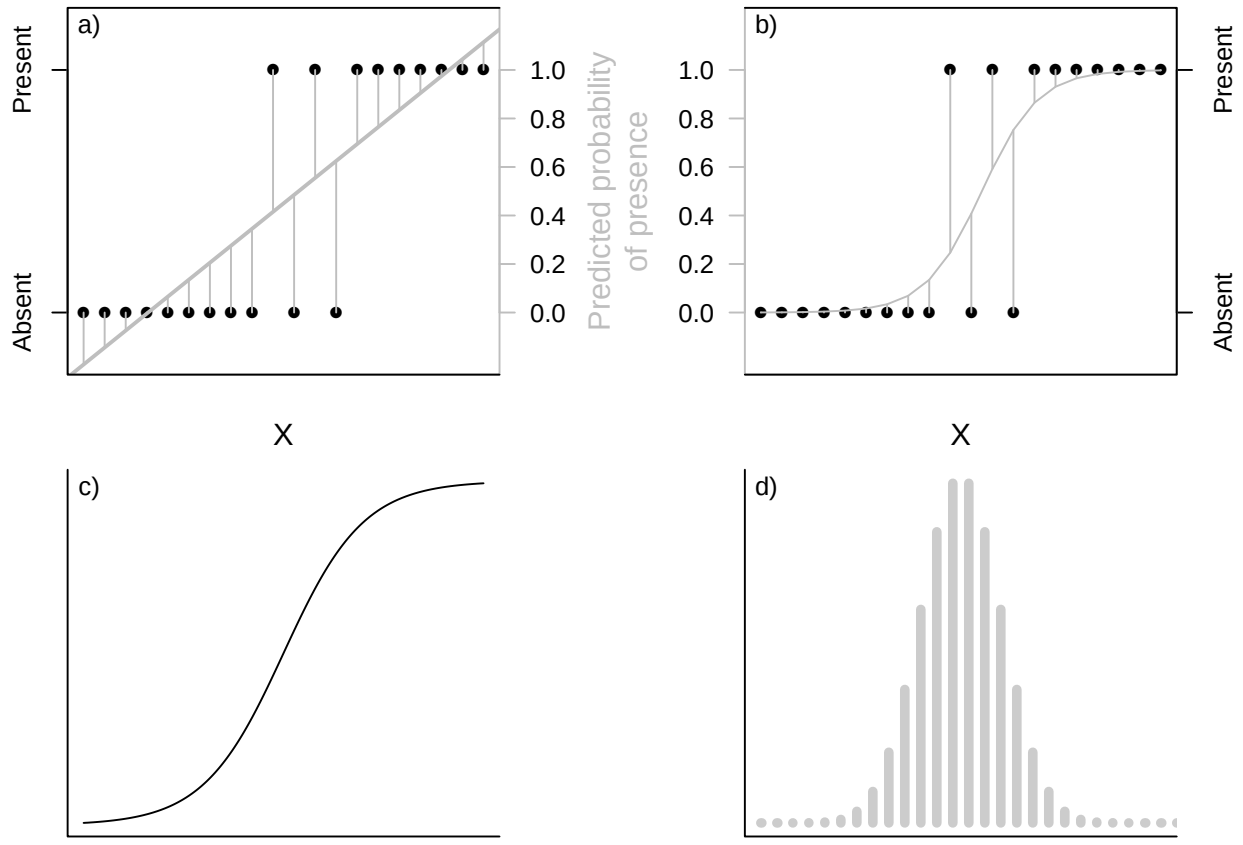
1.1. Logistic regression

1.1.1. Binary data

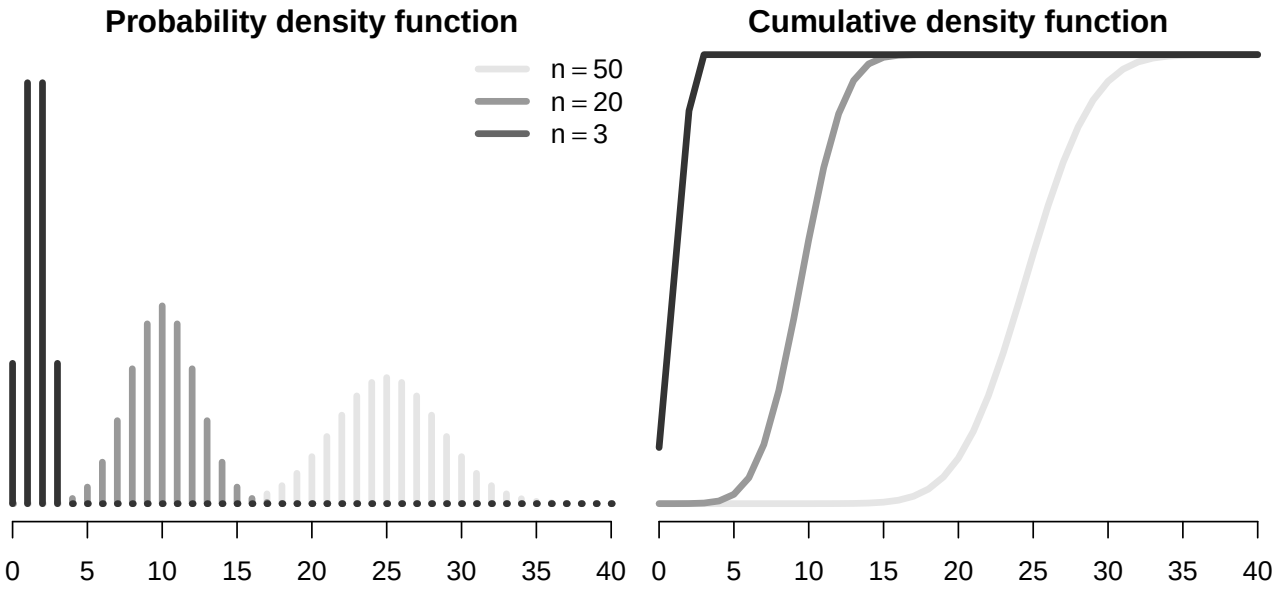
Link: $log\left(\frac{\pi}{1-\pi}\right)$

Transform scale of linear predictor $(-\infty, \infty)$ into that of the response (0,1)

1.2. Logistic regression



1.3. Logistic regression



$$E(Y) = \binom{n}{x} p^x (1-p)^{n-x}$$

Spread assumed to be equal to mean. ($\phi = 1$)

1.4. Dispersion

1.4.1. Over-dispersion

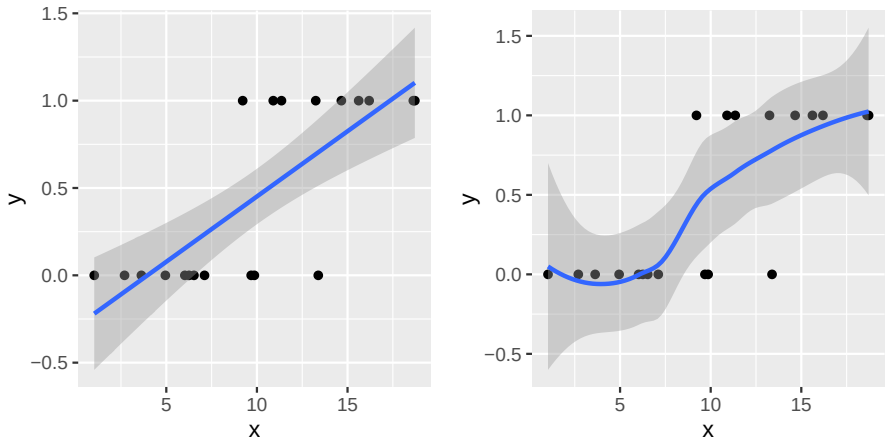
Sample more varied than expected from its mean

- variability due to other unmeasured influences
  - quasi- model
- due to more zeros than expected
  - zero-inflated model

1.5. Logistic regression

Example data

```
  y        x
1 0 1.024733
2 0 2.696719
3 0 3.626263
4 0 4.948643
5 0 6.024718
6 0 6.254113
```



1.6. Logistic regression

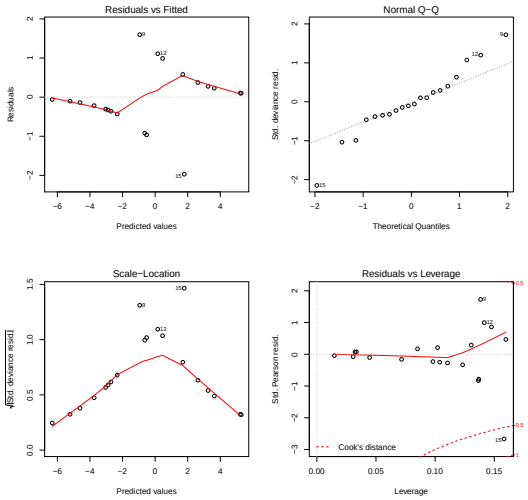
- Fit model

```
> dat.glmL <- glm(y ~ x, data = dat, family = "binomial")
```

1.7. Logistic regression

- Explore residuals

```
> par(mfrow=c(2,2))
> plot(dat.glmL)
```



1.8. Logistic regression

- Explore goodness of fit
- Pearson's χ^2 residuals

```
> dat.resid <- sum(resid(dat.glmL, type = "pearson")^2)
> 1 - pchisq(dat.resid, dat.glmL$df.resid)
```

```
[1] 0.8571451
```

- Deviance (G^2)

```
> 1-pchisq(dat.glmL$deviance, dat.glmL$df.resid)
```

```
[1] 0.8647024
```

1.9. Logistic regression

- Explore model parameters

Slope parameter is on log odds-ratio scale

```
> summary(dat.glmL)
```

```
Call:
glm(formula = y ~ x, family = "binomial", data = dat)

Deviance Residuals:
     Min        1Q    Median        3Q       Max
-1.97157  -0.33665  -0.08191   0.30035   1.59628

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -6.9899     3.1599  -2.212   0.0270 *
x             0.6559     0.2936   2.234   0.0255 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 27.526  on 19  degrees of freedom
Residual deviance: 11.651  on 18  degrees of freedom
AIC: 15.651

Number of Fisher Scoring iterations: 6
```

1.10. Logistic regression

- Quasi R^2

$$quasiR^2 = 1 - \left(\frac{deviance}{null\ \ deviance}\right)$$

```
> 1-(dat.glmL$deviance/dat.glmL$null)
```

```
[1] 0.5767057
```

1.11. Logistic regression

- LD50

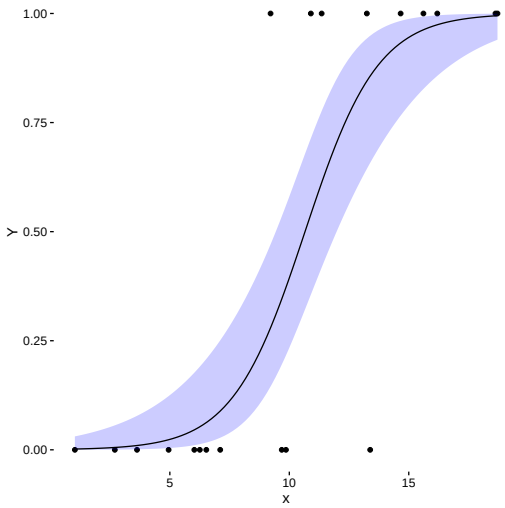
$$LD50 = -\frac{intercept}{slope}$$

```
> -dat.glmL$coef[1]/dat.glmL$coef[2]
```

```
(Intercept)
   10.65781
```

1.12. Logistic regression

- summary figure



2. Worked Examples

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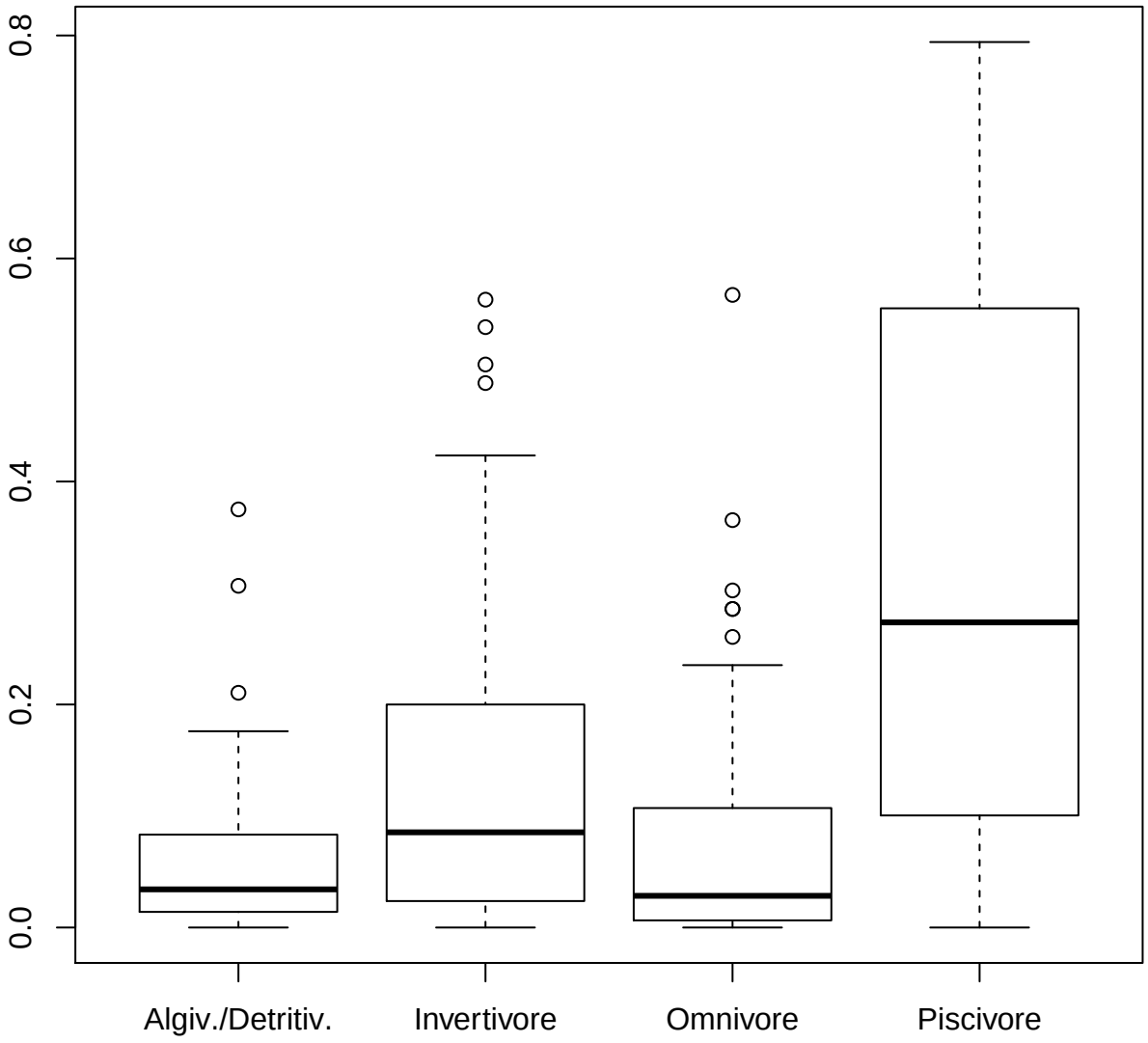
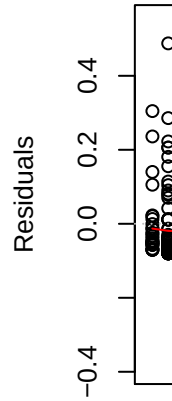
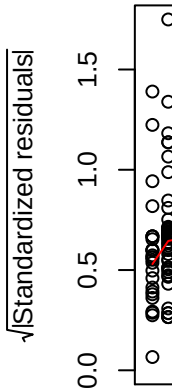
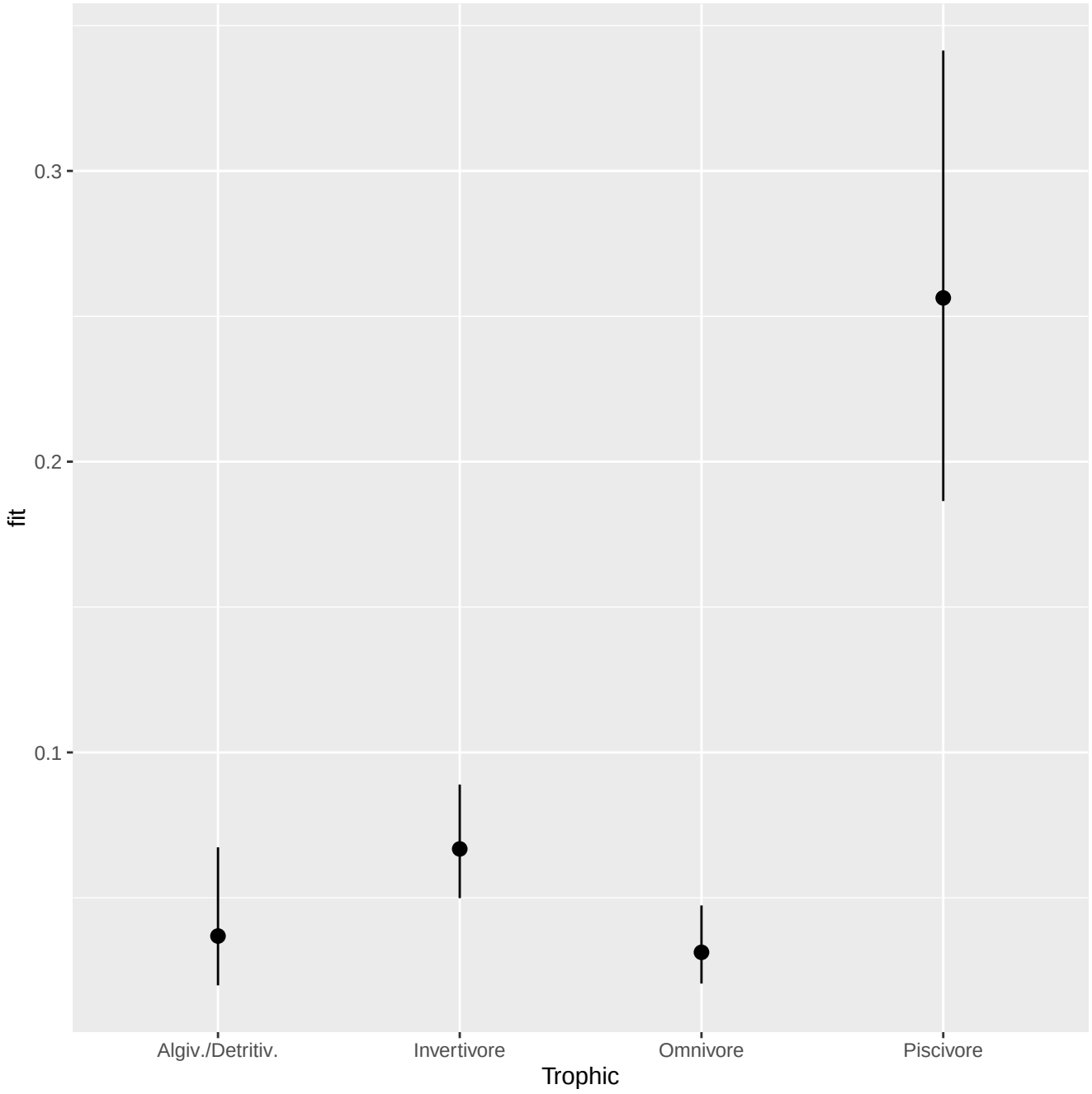
2.1. Worked Examples

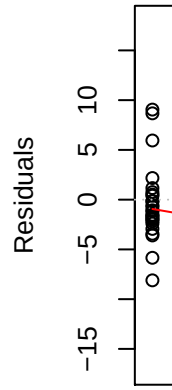


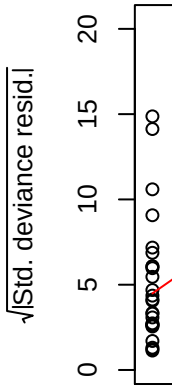





```
Error in qt(0.975, df = arrington.glm$df.resid): object 'arrington.glm' not found
```







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