

# Topic 5: ANOVA and general linear models

# Example: Analysis of Covariance

`lm(mass ~ pop + svl)`

$$\text{mass}_i = \alpha + \beta_{j(i)} * \text{pop}_i + \delta * \text{svl}_i + \varepsilon_i$$

$\alpha$  = constant

$\beta$  = one constant per population  $j$

$\delta$  = constant to be multiplied with snout–vent length

$\varepsilon_i$  = residual for snake  $i$

$\varepsilon_i \sim \text{Normal}(0, \sigma^2)$

# Example: Analysis of Covariance

$$\text{mass}_i = \alpha + \beta_{j(i)} * \text{pop}_i + \delta * \text{svl}_i + \varepsilon_i$$

```
> model.matrix(lm(mass ~ pop + svl))  
  (Intercept) pop2 pop3 svl  
1           1    0    0  40  
2           1    0    0  45  
3           1    1    0  39  
4           1    1    0  50  
5           1    0    1  52  
6           1    0    1  57
```



# Example: Analysis of Covariance

$$\begin{pmatrix} 6 \\ 8 \\ 5 \\ 7 \\ 9 \\ 11 \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 40 \\ 1 & 0 & 0 & 45 \\ 1 & 1 & 0 & 39 \\ 1 & 1 & 0 & 50 \\ 1 & 0 & 1 & 52 \\ 1 & 0 & 1 & 57 \end{pmatrix} * \begin{pmatrix} \alpha \\ \beta_1 \\ \beta_2 \\ \delta \end{pmatrix} + \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \varepsilon_4 \\ \varepsilon_5 \\ \varepsilon_6 \end{pmatrix}$$

```
> lm(mass ~ pop + svl) # Additive model
```

```
call:
```

```
lm(formula = mass ~ pop + svl)
```

```
Coefficients:
```

(Intercept)	pop2	pop3	svl
-3.43860	-1.49123	0.05263	0.24561

# Exercise: General Linear Models

- 30 aspen trees
- **crownclass**: 1=dominant; 2=codominant; 3=intermediate; 4=suppressed
- **age** (years)
- stem **dbh** (diameter outside bark measured at 1.3 m above ground, cm)
- **height** (m) from ground to tree tip
- stem **volume** per tree ( $\text{m}^3$ ).