# Wombat Example 9A

Problem statement

- Monthly weight records from birth to weaning of beef calves

- Analysis using random regression with an additional random effect

- Fit quadratic B-splines as basis functions

Description of dataset

- 'animal' and 'subject' = animal ID
- btype = birth type class
- dagroup = ?
- cgroup = contemporary group
- pdam = permanent environmental effect of dam
- gdam = genetic effect of dam
- weight = response
- age = age of calves (in months)
- sex

Random Intercept and Slope
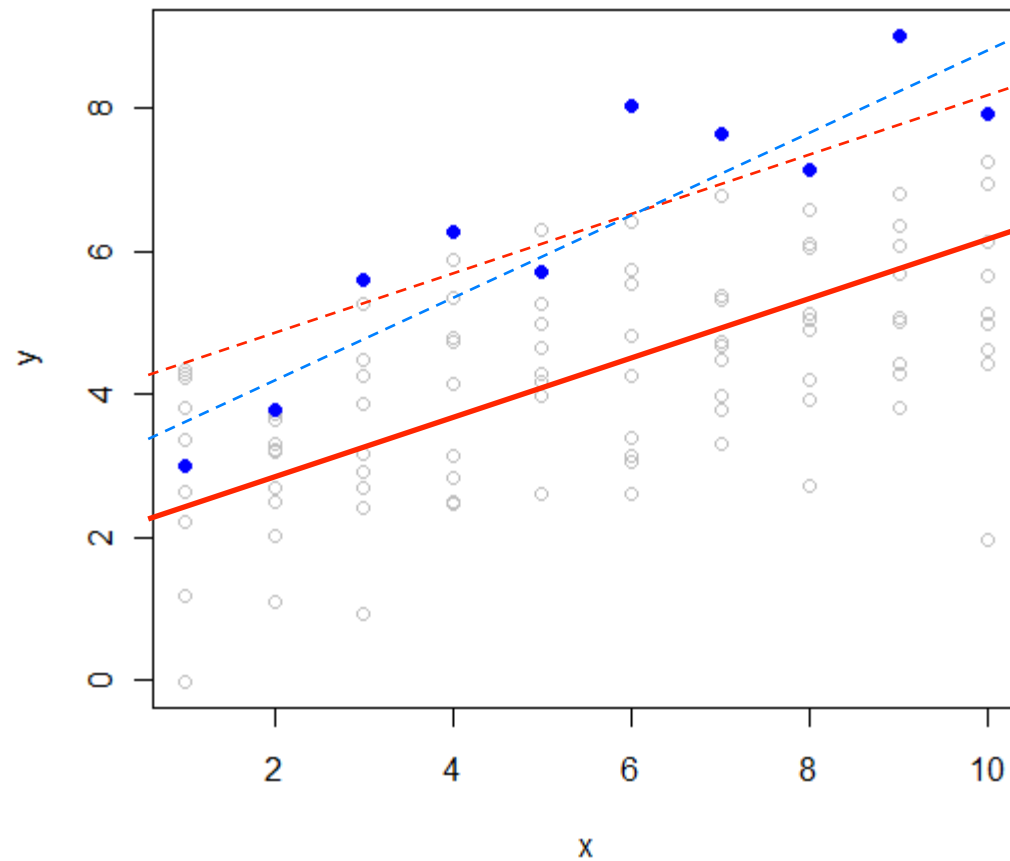
Random regressions model

Fixed effect for i^{th} contemporary group

No. of regression coefficients

Response

r^{th} random regression coefficient for permanent environmental effect of dam k

r^{th} B-spline function evaluated at age t_{ijk}

$$y_{ijk} = c_i + \sum_{r=0}^{n_\alpha} \alpha_{rj} B_r(t_{ijk}) + \sum_{r=0}^{n_\beta} \beta_{rj} B_r(t_{ijk}) + \sum_{r=0}^{n_\gamma} \gamma_{rk} B_r(t_{ijk}) + e_{ijk}$$

r^{th} random regression coefficient for direct additive genetic effect of animal j

r^{th} random regression coefficient for permanent environmental effect of animal j

$$e \sim N\left[\boldsymbol{0}, \mathbf{I}\sigma_e^2\right] \qquad \alpha \sim N\left[0, \mathbf{I}\sigma_\alpha^2\right] \qquad \beta \sim N\left[0, \mathbf{I}\sigma_\beta^2\right] \qquad \gamma \sim N\left[0, \mathbf{I}\sigma_\gamma^2\right]$$

Splines and B-Splines

Splines:
- Curves consisting of individual segments joined smoothly
- Segments given by polynomials
- Points at which they join are called knots

B-Splines:
- Set of overlapping, smooth and non-negative functions
- Are unimodal
- Sum to unity for all values of t.
- Are defined recursively

Age (here)

Knot in k^{th} interval

Total no. of knots = $n - p + 1$

$$B_{k,p}(t) = \frac{t - T_k}{T_{k+p} - T_k} B_{k,p-1}(t) + \frac{T_{k+p+1} - t}{T_{k+p+1} - T_{k+1}} B_{k+1,p-1}(t)$$

interval

Degree of spline function

Meyer, Genet. Sel. Evol. 37 (2005) 473–500

Description of parameters

- **ANAL RR** - random regression analysis
- **FIX cgroup** - fixed effects
- **COV age(6, bspq)** - fixed covariable. n =6 is the degree of fit with basis function = quadratic b-spline. Could also use (POL or LEG)
- **RRC age** - random regression control variable
- **RAN animal(6, bspq) nrm** - additive genetic effect for animal is random. Each animal has its unique intercept and slope across levels of age
- **RAN (subject, bspq)** - permanent environmental effect for animal is random. Each animal has its unique intercept and slope across levels of age
- **trait** - response

Description of parameters

- VAR animal 6 - assume covariance matrix among RR coefficients for animal is unstructured. Elements of upper triangle supplied

- VAR residual 1 HET 10 :
  - residual 1: dimension of each residual covariance matrix =1, usually equal to no. of traits
  - HET 10: heterogeneous error covariances. Here separate residual variances are being fit for each pair of levels of age

Additional parameters

- **RUNOP** - For specifying run time options on the first line of the parameter file
- **logdia** - Diagonal elements of covariance matrices are log transformed
- **aireml** - Average Information algorithm used
- **metis14,0,3,2** - Selects an ordering using a multilvel nested dissection procedure so as to optimize computational time.
  - 14 graph separators
  - 0 rows in matrices to be treated as dense
  - standard edge matching strategy
  - 1-sided node refinement