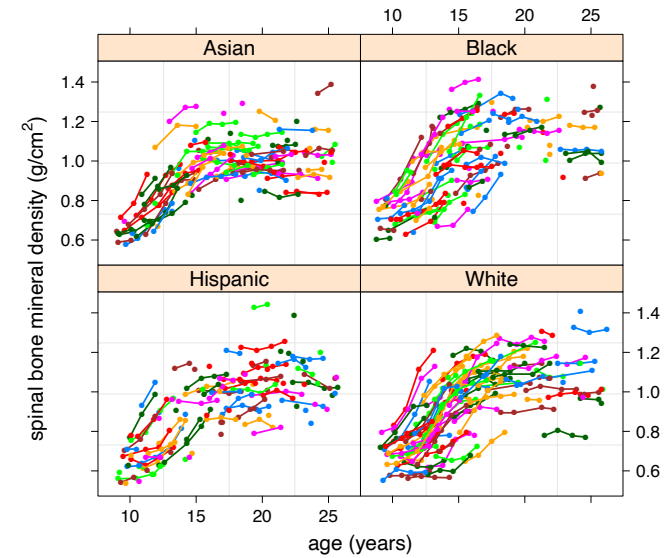


37457

Advanced Bayesian Methods

Some Generalized Additive Models Extensions



Generalized Additive Mixed Model Extension

SBMD = spinal bone mineral density

Ordinary generalized additive model:

$$SBMD_i = f(\text{age}_i) + \beta_2 \text{Black}_i + \beta_3 \text{Hispanic}_i + \beta_4 \text{White}_i + \varepsilon_i$$

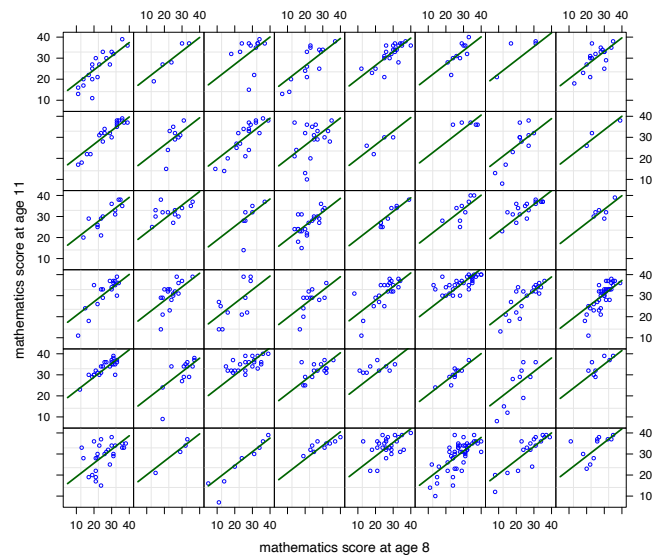
But this ignores the longitudinal (repeated measures) aspect of the data.

↓

Generalized additive mixed model:

$$SBMD_{ij} = u_{\text{grp},i} + f(\text{age}_{ij}) + \beta_2 \text{Black}_i + \beta_3 \text{Hispanic}_i + \beta_4 \text{White}_i + \varepsilon_{ij},$$

$$u_{\text{grp},i} \overset{\text{ind.}}{\sim} N(0, \sigma_{\text{grp}}^2).$$



Treating Grouped and Penalized Splines Together

$$Z = \left[\begin{array}{c|c} \text{random} & \text{spline} \\ \text{intercept} & \text{basis} \\ \text{indicators} & \text{functions} \end{array} \right]$$

$$\text{covariance matrix of random effects vector} = \begin{bmatrix} \sigma_{\text{grp}}^2 \mathbf{I} & \mathbf{0} \\ \mathbf{0} & \sigma_{\text{spl}}^2 \mathbf{I} \end{bmatrix}$$

σ_{grp}^2 = controls between-group variability

σ_{spl}^2 = controls amount of spline penalization

See [Assignment 7](#) for further details and Stan implementation.

Bivariate Function Extensions

Generalized additive model with three predictors:

$$y_i = \beta_0 + f_1(x_{1i}) + f_2(x_{2i}) + f_3(x_{3i}) + \varepsilon_i$$

A **bivariate function extension**:

$$y_i = \beta_0 + f_{12}(x_{1i}, x_{2i}) + f_3(x_{3i}) + \varepsilon_i$$

Often (but not necessarily) the (x_{1i}, x_{2i}) data correspond to geographical position (e.g. (longitude, latitude)).

This extension also known as a **geoadditive model**.

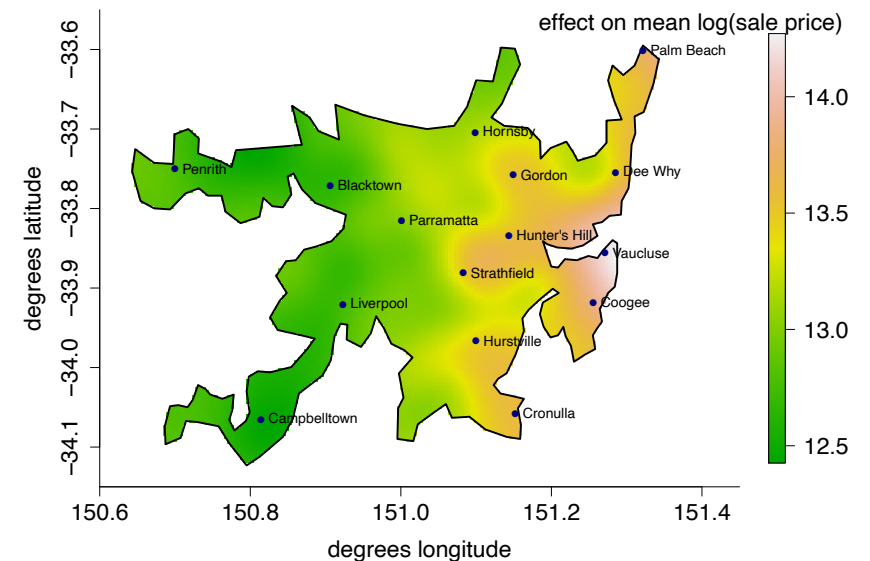
Sydney Real Estate Example

The HRW package in R has a demonstration named

`SydneyDisplaySophis`

that fits such a geoadditive model to data from

37,676 houses in **OUR CITY**.

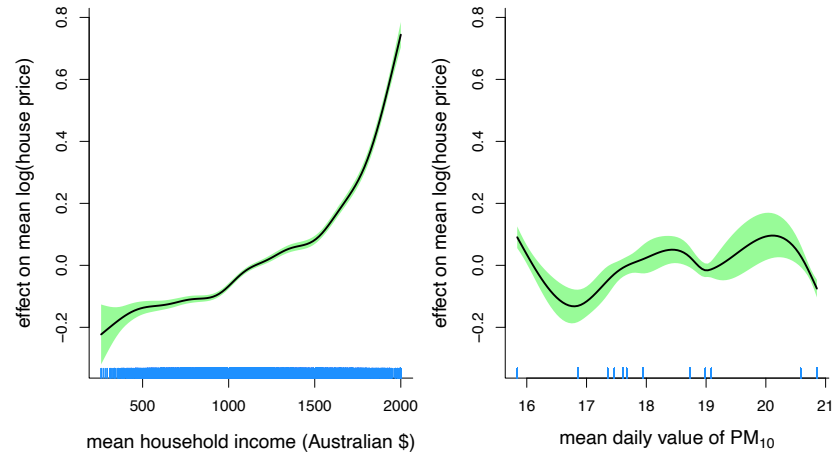


Bivariate Penalized Splines in Assignment 7

See [Assignment 7](#) for further details and Stan implementation of:

bivariate penalized splines

(including [very cool 3D spin graphics](#)).



Penalized Splines for Bivariate Functions

Note to presenter: Run scallopFull.Rs (in sprSC)