# Functional Regression
# Using the `fda` Package in R

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Ramsay, Hooker and Graves (2009) *Functional Data Analysis with R and Matlab* (Springer)

# This Presentation

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# What Is Functional Regression?

Functional Data Analysis extends spline smoothing to:

- an arbitrary finite basis approximation to a function space
- smoothing with an arbitrary linear differential operator

Functional regression = fitting a model where

- the response or
- an explanatory variable

is a function.

# Different types of Functional Regression

Functional regression = fitting a model where

- the response or
- an explanatory variable

is a function.

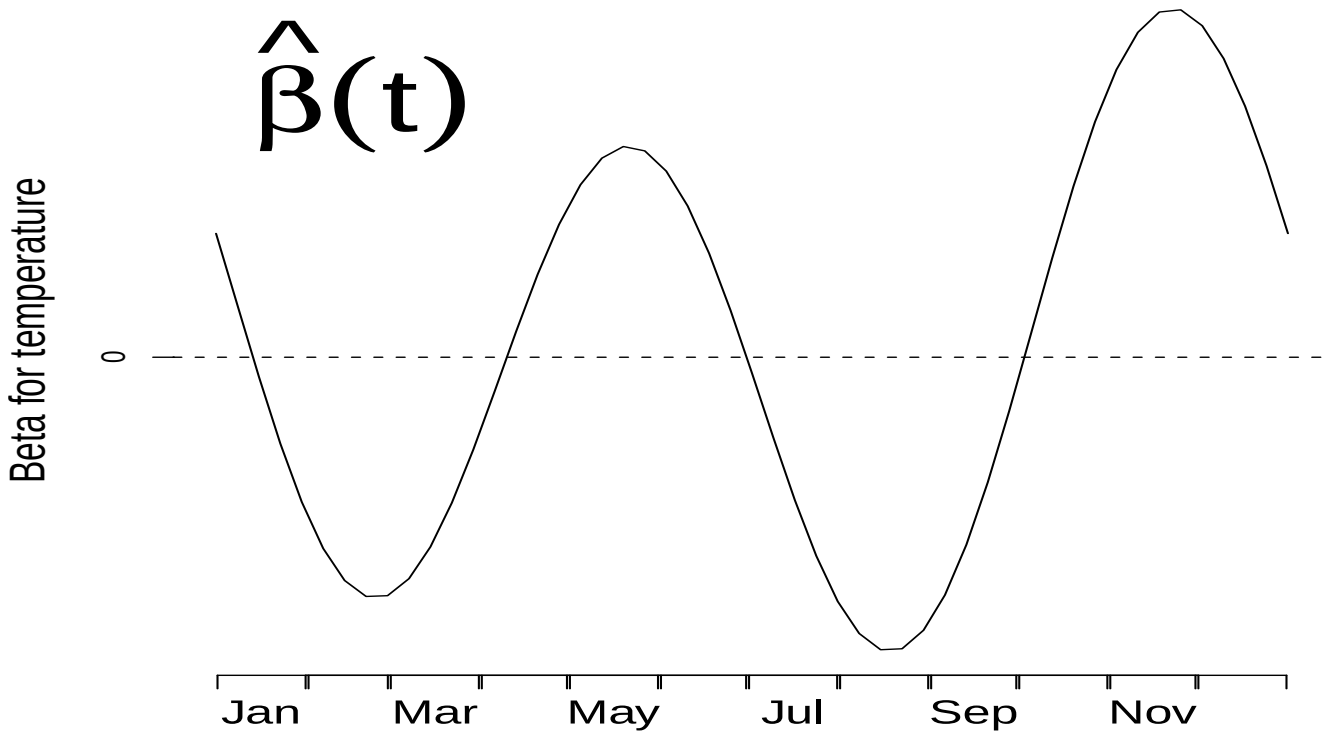
| | Explanatory Variable | |
|---|---|---|
| response | *scalar* | *function* |
| *scalar* | lm | fRegress.numeric |
| *function* | fRegress.fdPar | fRegress.fdPar / linmod / pda.df |

R code for all of these appears in script files in the `fda` package

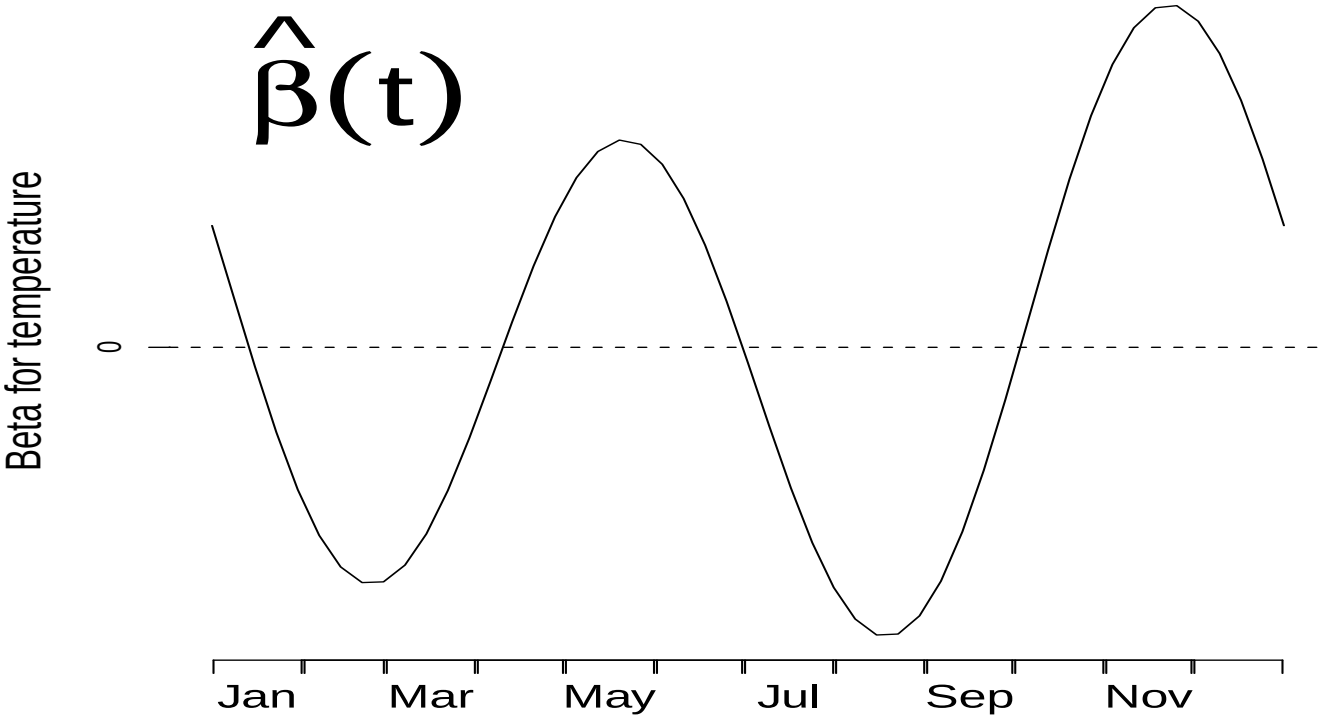
# fRegress.numeric: Scalar Response

$$y_i = \alpha_0 + \int x_i(t)\beta(t)dt + \epsilon_i.$$

`log(annual precipitation) ~ (temperature profile)`



# log(annual precipitation) ~ temperature(t)




Conclusion: Wetter locations tend to be

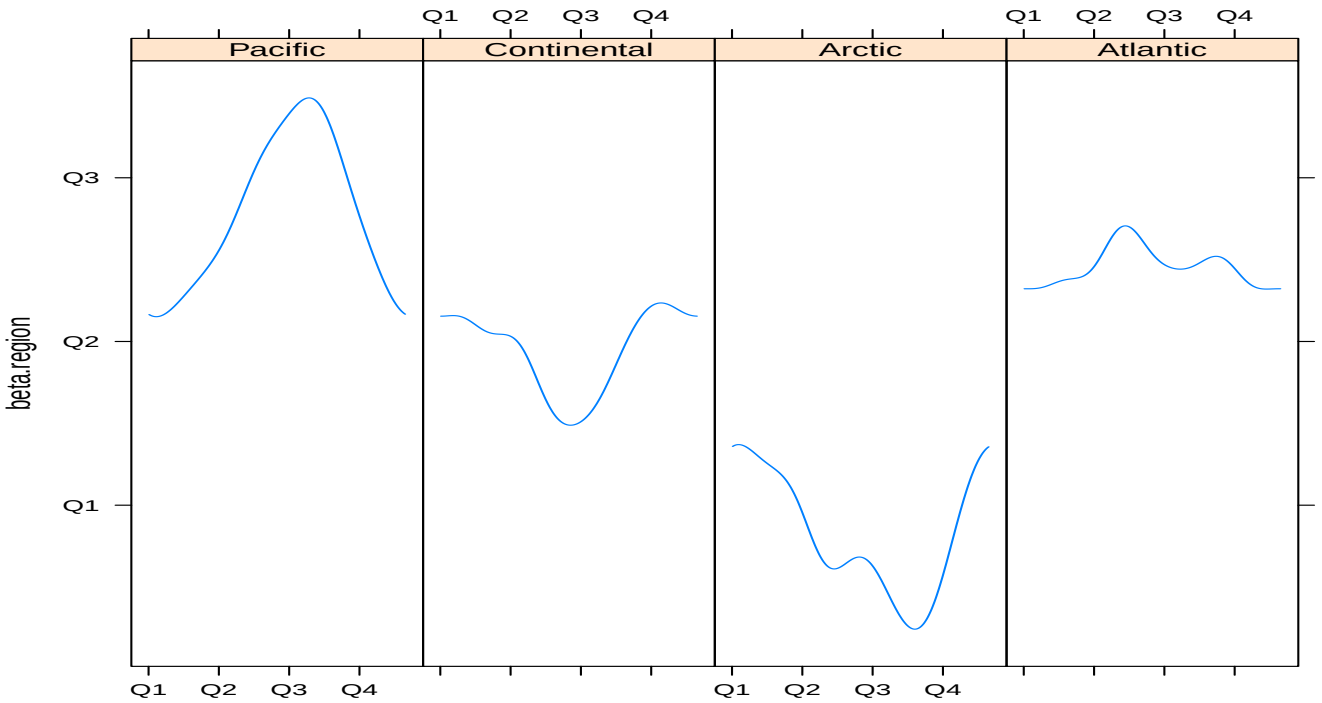
- cooler in February and August and
- warmer in May and November

Ramsay, Hooker, Graves (2009, Fig. 9.1)

# fRegress.numeric: functional response, x = scalar

$$y_i(t) = \beta_0(t) + \sum x_{ij}\beta_j(t) + \epsilon_i(t)$$

`temperature ~ region`; Region Deviation:

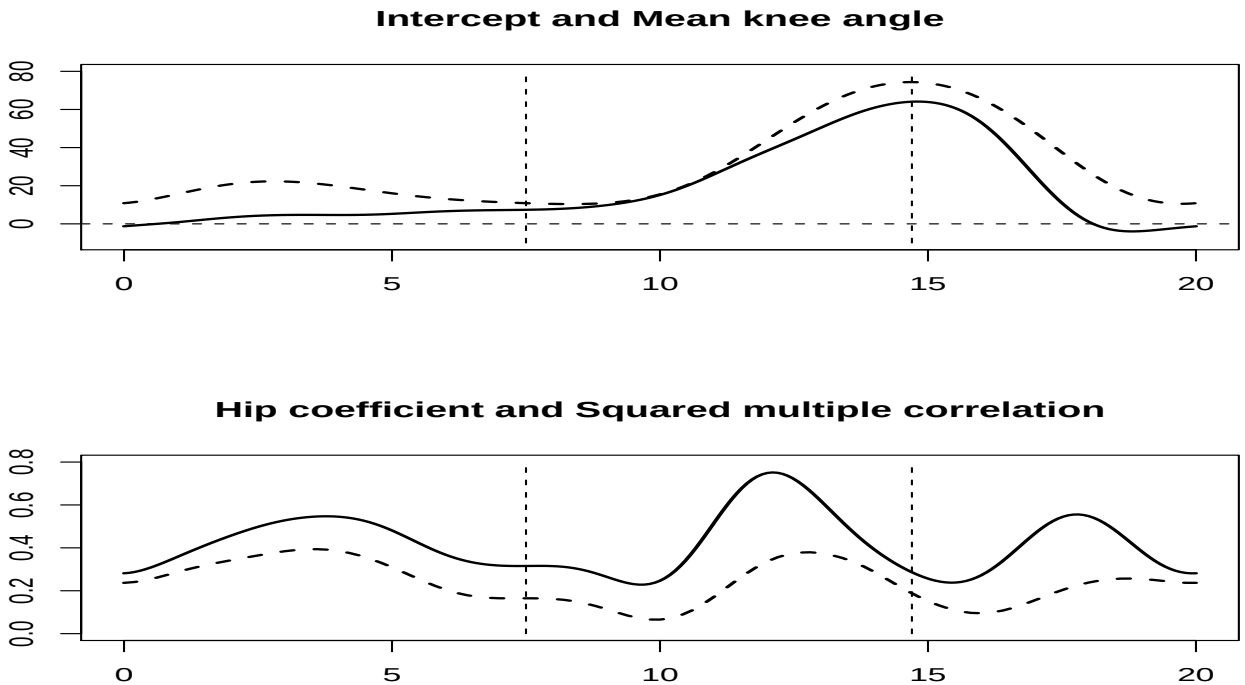



Ramsay, Hooker, Graves (2009, Fig. 10.1)

# fRegress.fdPar: Concurrent Functional Model

$$y_i(t) = \beta_0(t) + \sum x_{ij}(t)\beta_j(t) + \epsilon_i(t)$$

`(knee angle) ~ (hip angle)`




Ramsay, Hooker and Graves (2009, Fig. 10.7)

# fRegress.formula: Simple fRegress Setup

# linmod: Full Integration Regression

Ramsay, Hooker and Graves (2009) *Functional Data Analysis with R and Matlab* (Springer, ch. 10)

# pda.fd: Estimating a Differential Equation

Ramsay, Hooker and Graves (2009) *Functional Data Analysis with R and Matlab* (Springer, ch. 11)

# Closing Remarks

# References