Intercept = 0

Slope = 0.5

Bias and power

##

***Module 9. Sampling issues in random regression analyses***

**Step 1: The effect of the magnitude of Vs on power and bias in Vs**

**Sub-goal**: to develop understanding of how the magnitude of *Vs* (among-individual variance in slope) influence detectability of non-zero Vs when the other parameters like the numbers of individuals and repeats per individuals are fixed.

**Introduction**: In Module 6, we explored situations where individuals react to environmental changes in different manners, i.e., there exist non-zero among-individual variance in slope (VS) or individual by environment interactions (IxE).

It seems to make sence to be able to change Vs as well as VI to compare????

**Exercise:**

Here we depart from the random-intercept regression model presented in Step 4 of module 1 by introducing a parameter that allows defining individual deviations from the population mean response to environmental changes. The fundamental difference between the random-intercept regression and the random-slope model, is that while the former uses individual-level “random” effects to model individual-specific intercepts (i.e. that depict the between-individual variance of mean trait values), the latter introduces an additional “random” effect on the slopes (i.e. that describe how individuals respond to changing environments). For the random-intercept regression, we used the following model to recreate our simulated set of effects:

We will modify this model as:

in which is the effect of measured environment on the measure of phenotype in *i*th individual. Accordingly, we can apply the following parameterization regimes:

Number of individuals:

…….

All other things are fixed to certain values.

Set in background is the environmental variable and its sampling. Here we should use uniform sampling, where each individual is sampled at the same time so there are no biases. By definition, our environmental variable is also mean centered.

RUNNN

**Results**:

A mixed statistical model estimates these parameters:

|  |  |
| --- | --- |
| True | Estimated |
| Individual variance (VJ) = …… | Individual variance in sample (V’I) = ….. |
| Residual variance (VR) = ….. | Residual variance of sample (V’R) = ….. |
| Mean of the trait () = 0 | Sampled mean of the trait (’) = ….. |
| Population-specific slope of the environmental effect (β1) = ….. | |  | | --- | | Estimated population-specific slope of the environmental effect (β’1 ) = ….. | |
| Individual-specific response to an environmental effect (random slopes) variance (VSx) = ….. | Individual-specific response to an environmental effect (random slopes) variance (V’Sx) = ….. |

Individual-specific responses can be best visualised by plotting the individual-specific regression lines.

GRAPHS

Environment vs. Phenotype per individual (fitted reaction norms + individual’s dataset)

**Point:**

**XXXXX**

Again, we performed linear regression approach in a mixed model framework, but in this case we generated multiple regression lines (by defining different intercepts and slopes) for each individual in a single model to describe the individual-specific effect of an explanatory variable. Individual-specific responses to changes that occur along an environmental gradient form “reaction norms”. These reaction norms, if the environmental gradient is centered around zero, can be characterized by their intercept that describes individual mean expression values, and by their slope that expresses the plasticity of traits within individuals. Statistically, one can evaluate whether the random-intercept or the random-slope model fits the data at hand better. However, the consideration of differences in how individuals respond to environmental fluctuations may be straightforward on a biological basis. This model simultaneously accommodates tests for individual personality differences (i.e. the calculation of repeatability makes sense) as well as tests for individual by environment interaction.

**Statistical model:**

**Step 2: The effect of the number of individuals on bias in *Vsx* and power to detect *Vsx***

**Step 3: The effect of the number of repeats on bias in *Vsx* and power to detect *Vsx***

**Step 3: Sample size and precision**