**Prof. Luiz Paulo Lopes Fávero**
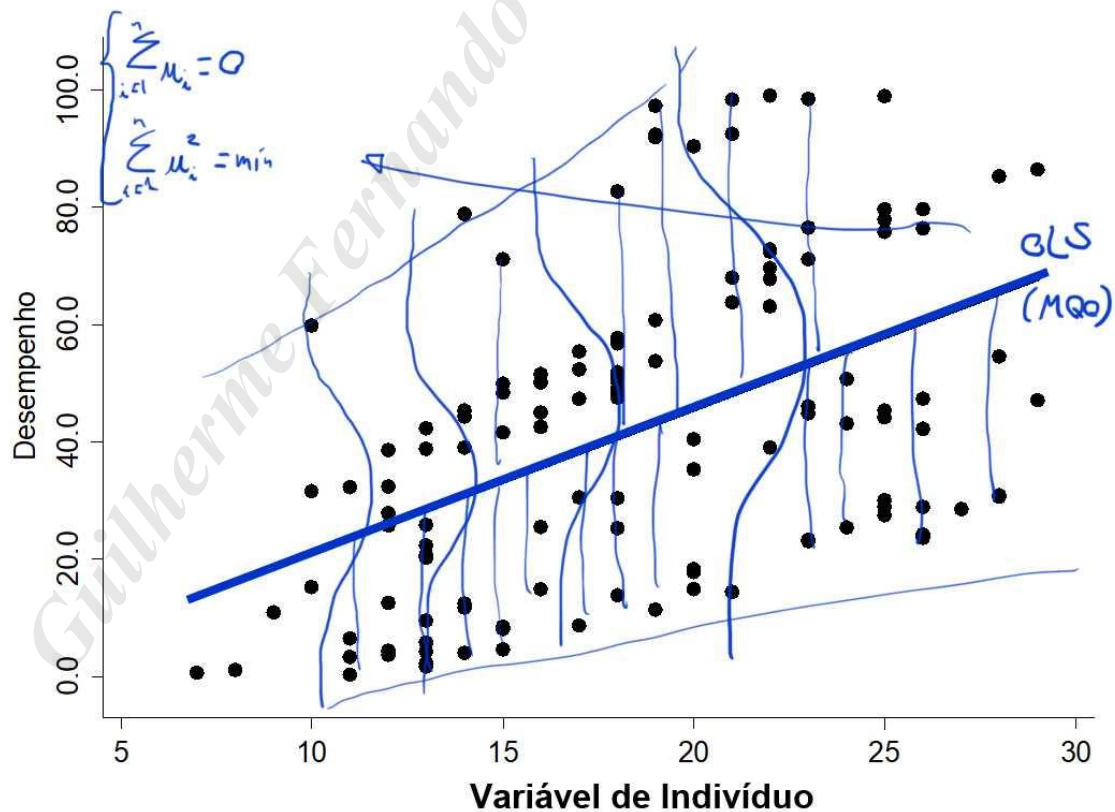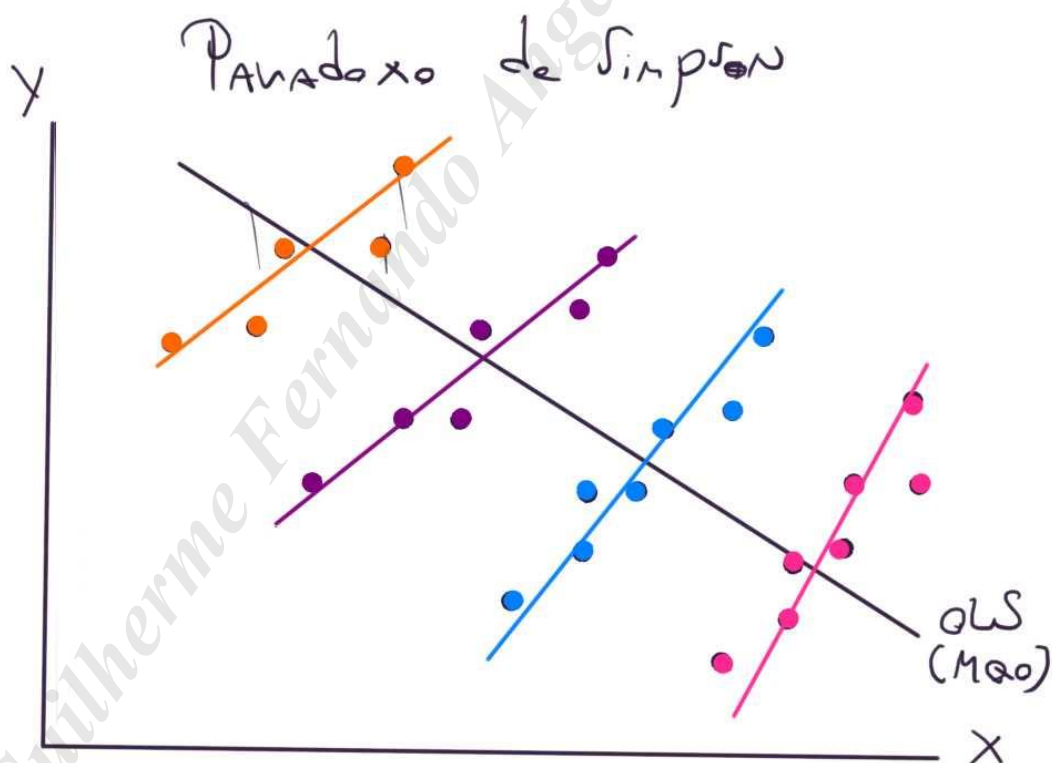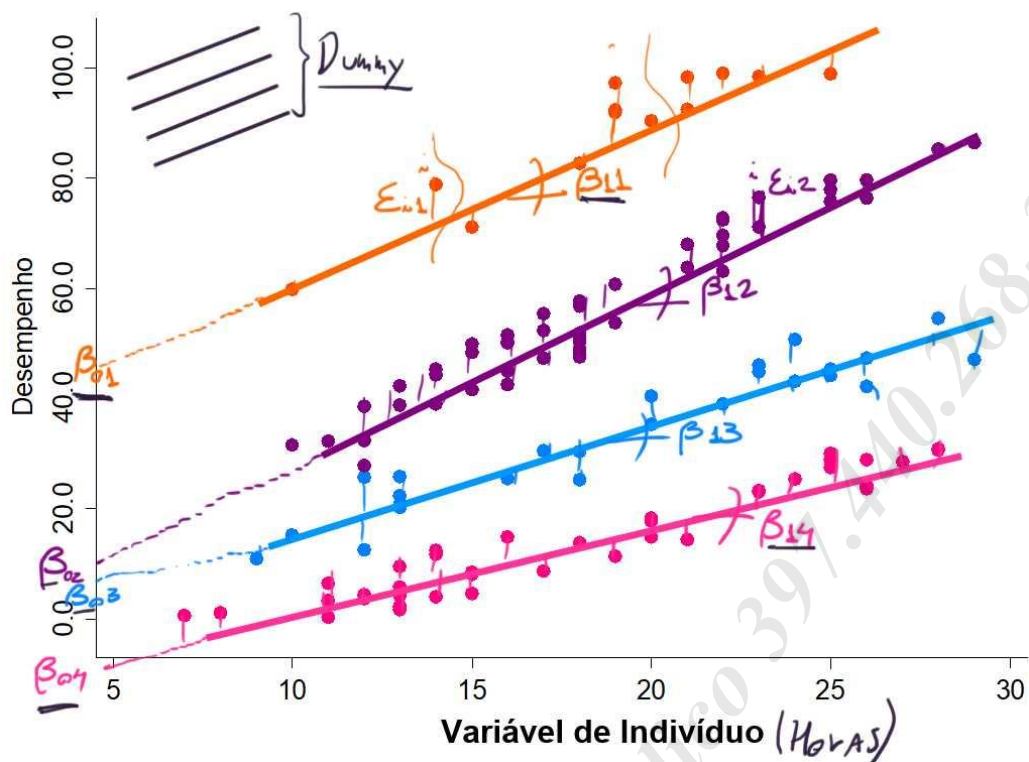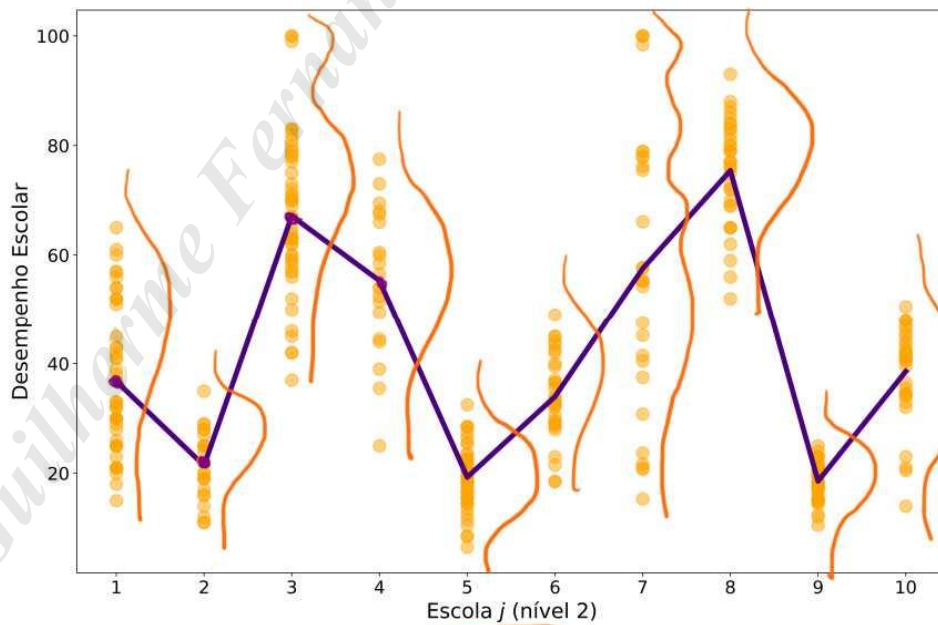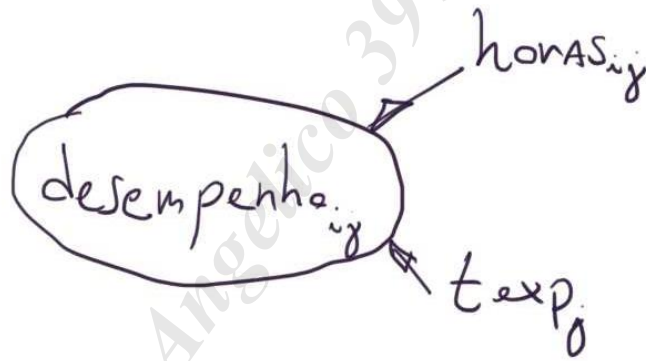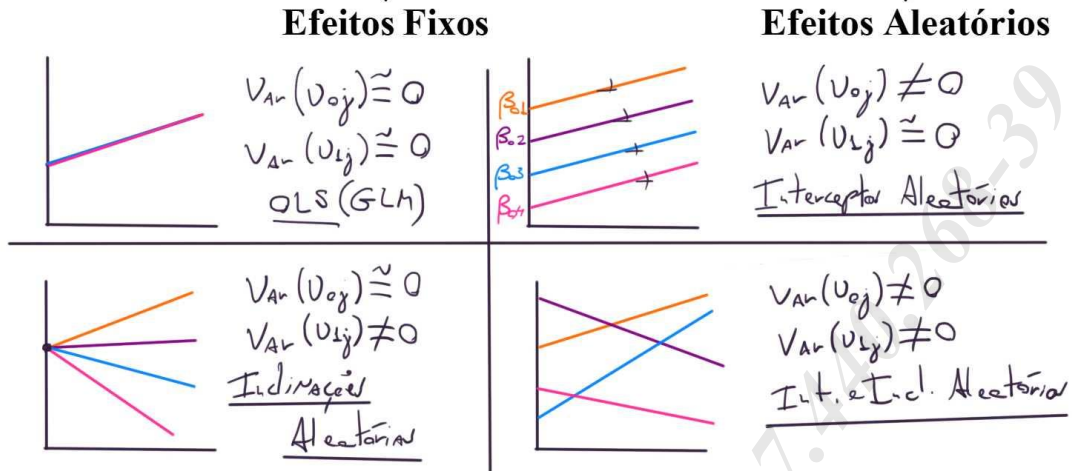
PRINTS FEITOS DURANTE A AULA DE 17/09/2024:



**Modelos Lineares Generalizados Multinível (GLMM)**

- Modelos Multinível.
- Modelos Hierárquicos.
- HLM (Hierarchical Linear Models)
- Mixed Models.
- GLLAMM (Generalized Linear and Latent Multilevel Models).
- Nested Models (Aninhados)
- Modelos Contextuais.
- RCM (Random Coefficient Models)

Paradoxo de Simpson

$$Y_{ij} = \underbrace{\gamma_{00} + \gamma_{10}.X_{ij} + \gamma_{01}.W_j + \gamma_{11}.W_j.X_{ij}}_{\textbf{Efeitos Fixos}} + \underbrace{\nu_{0j} + \nu_{1j}.X_{ij} + \varepsilon_{ij}}_{\textbf{Efeitos Aleatórios}}$$



$Var(\nu_{0j}) \cong 0$
$Var(\nu_{1j}) \cong 0$
$\underline{OLS\,(GLM)}$

$Var(\nu_{0j}) \neq 0$
$Var(\nu_{1j}) \cong 0$
$\underline{Interceptos\ Aleatórios}$

$Var(\nu_{0j}) \cong 0$
$Var(\nu_{1j}) \neq 0$
$\underline{Inclinações}$
$\underline{Aleatórias}$

$Var(\nu_{0j}) \neq 0$
$Var(\nu_{1j}) \neq 0$
$\underline{Int.\ e\ Incl.\ Aleatórias}$

$horas_{ij}$

desempenho$_{ij}$

$t\,exp._j$



Desempenho Escolar

Escola $j$ (nível 2)

## Box Plot
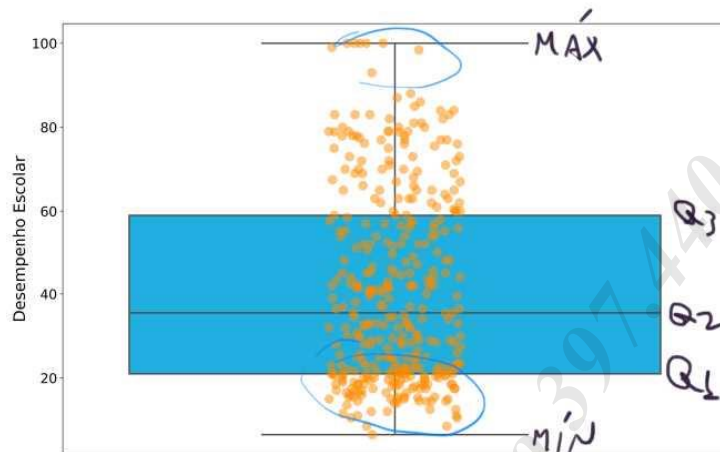


## Step-up Strategy:

- Modelo Nulo ($v_{oj}$)
- Modelo Int. e Incl. Aleatórias ($v_{1j}$)
- Modelo Completo ($X, W$).
  $\underbrace{\phantom{X, W}}_{\text{Efeitos Fixos.}}$

```
           Mixed Linear Model Regression Results
===============================================================
Model:            MixedLM  Dependent Variable: desempenho
No. Observations: 358      Method:             REML
No. Groups:       10       Scale:              142.9242
Min. group size:  20       Log-Likelihood:     -1416.0074
Max. group size:  48       Converged:          Yes
Mean group size:  35.8
---------------------------------------------------------------
                  Coef.   Std.Err.   z    P>|z|  [0.025 0.975]
---------------------------------------------------------------
Intercept         42.387   6.468   6.553  0.000  29.709 55.065
escola Var        414.067  16.695
===============================================================
```

Handwritten annotations: $Var(\varepsilon_{ij})$ next to Scale; $EF.\ \gamma_{00}$ next to Intercept; $Var(v_{0j})$ next to escola Var.

$$desempenho_{ij} = 42{,}387 + v_{0j} + \varepsilon_{ij}$$

(with $\gamma_{00}$ labeled above 42,387)

$$ICC_{(escola)} = \frac{414{,}067}{414{,}067 + 142{,}9242} = 74{,}34\%$$

(intraclass correlation) — efeito escola



Desempenho escolar - Escola 1

(Scatter plot: x-axis "Quantidade Semanal de Horas de Estudo do Aluno" from 0 to 35; y-axis "Desempenho Escolar" from 0 to 100; legend "escola" with values 1–10)