Slide 1

Regression with Dummy Variables
Two-Way ANOVA

Slide 2

The Hormone Data

Human growth hormone was administered at a clinical research center to growth hormone deficient, short children who had not yet reached puberty. The investigator was interested in the effects of gender (factor A) and bone development (factor B) on the rate of growth induced by the hormone administration, which is measured as the growth rate difference in centimeters per month.

	Bone Development		
Gender	Severely Depressed	Moderately Depressed	Mildly Depressed
Male	1.4	2.1	.7
	2.4	1.7	1.1
	2.2		
Female	2.4	2.5	.5
	1.8	.9	
	2.0	1.3	

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The Table of Cell Means

	Bone Development			Row
Gender	Severely Depressed	Moderately Depressed	Mildly Depressed	Averages
Male	2.0	1.9	.9	1.657
Female	2.4	2.1	.9	1.628
Column Averages	2.1	2.02	.9	**1.643**

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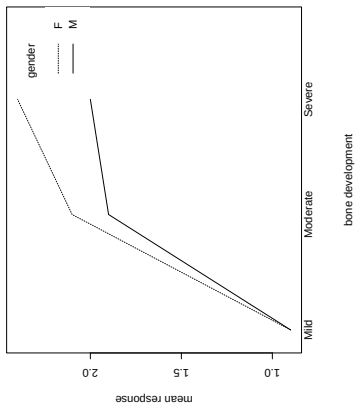

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Regression Approach with Dummy Variables

First, we define one Dummy variable (z^G) to account for **gender** and two dummy variables (z_1^B and z_2^B) to account for **bone development**.

$$Z_i^G = \begin{cases} 1 & \text{if the } i\text{th child is Male.} \\ 0 & \text{if the } i\text{th child is Female.} \end{cases}$$

$$Z_{i1}^B = \begin{cases} 1 & \text{if } i\text{th child's bone development was "Moderately" depressed.} \\ 0 & \text{if } i\text{th child's bone development was not "Moderate" depressed.} \end{cases}$$

$$Z_{i2}^B = \begin{cases} 1 & \text{if } i\text{th child's bone development was "Severely" depressed.} \\ 0 & \text{if } i\text{th child's bone development was not "Severely" depressed.} \end{cases}$$

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New Data Layout

Model $y_i = \beta_0 + \beta_1\, z_i^G + \beta_2\, z_{i1}^B + \beta_3\, z_{i2}^B + \beta_4\, z_i^G \cdot z_{i1}^B + \beta_5\, z_i^G \cdot z_{i2}^B + \varepsilon_i$

id	**response**	**gender**	**bone**	z^G	z_1^B	z_2^B	$z^G \cdot z_1^B$	$z^G \cdot z_2^B$
1	1.4	M	Severe	1	0	1	0	1
2	2.4	M	Severe	1	0	1	0	1
3	2.2	M	Severe	1	0	1	0	1
4	2.1	M	Moderate	1	1	0	1	0
5	1.7	M	Moderate	1	1	0	1	0
6	0.7	M	Mild	1	0	0	0	0
7	1.1	M	Mild	1	0	0	0	0
8	2.4	F	Severe	0	0	1	0	0
9	2.5	F	Moderate	0	1	0	0	0
10	1.8	F	Moderate	0	1	0	0	0
11	2.0	F	Moderate	0	1	0	0	0
12	0.5	F	Mild	0	0	0	0	0
13	0.9	F	Mild	0	0	0	0	0
14	1.3	F	Mild	0	0	0	0	0

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SSE for Several Model Fits

Model	SSE
$y_i = \beta_0 + \beta_1\, z_i^G + \beta_2\, z_{i1}^B + \beta_3\, z_{i2}^B + \beta_4\, z_i^G \cdot z_{i1}^B + \beta_5\, z_i^G \cdot z_{i2}^B + \varepsilon_i$	1.3000
$y_i = \beta_0 + \beta_1\, z_i^G + \beta_2\, z_{i1}^B + \beta_3\, z_{i2}^B + \varepsilon_i$	1.3754
$y_i = \beta_0 + \beta_1\, z_i^G + \varepsilon_i$	5.7714
$y_i = \beta_0 + \beta_1\, z_{i1}^B + \beta_2\, z_{i2}^B + \varepsilon_i$	1.4680

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Questions

1. Can the Two-Way ANOVA technique be applied?
2. Test whether **gender** and **bone** interact?
   ($F = .232$ and $F(.95, 2, 8) = 4.40$)
3. Test the main effect of **gender**?
   ($F = .673$ and $F(.95, 1, 10) = 4.96$)
4. Test the main effect of **bone**?
   ($F = 15.98$ and $F(.95, 2, 10) = 4.10$)