

# Multiple Regression: Nonlinear Models

PSY 5102: Advanced Statistics for  
Psychological and Behavioral Research 2

---

---

---

---

---

---

---

---

## Goals

- Introduce the idea of curvilinear regression
- Polynomials
  - Quadratic
  - Cubic

---

---

---

---

---

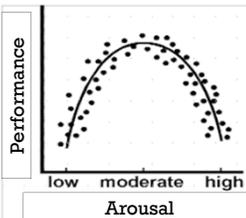
---

---

---

## When Must Curves Be Fitted?

- We can use linear regression to fit curves
- This can be extremely useful if you think the relationship between X and Y may be nonlinear
  - Example: Yerkes-Dodson Law deals with the relationship between arousal and performance being curvilinear (i.e., inverted U shape)
- This is important because there are no straight lines that will adequately fit these sorts of curvilinear relationships
  - It is not always easy to see nonlinear relationships in scatterplots



---

---

---

---

---

---

---

---

## Polynomial Regression

- ◉ To account for curvature, we can perform something called “polynomial regression” which consists of fitting a polynomial instead of a line
- ◉ Linear model
  - $Y = A + \beta_1 X + e$
- ◉ Quadratic model (1 bend in the data)
  - $Y = A + \beta_1 X + \beta_2 X^2 + e$
- ◉ Cubic model (2 bends in the data)
  - $Y = A + \beta_1 X + \beta_2 X^2 + \beta_3 X^3 + e$
- ◉ Quartic model (3 bends in the data)
  - $Y = A + \beta_1 X + \beta_2 X^2 + \beta_3 X^3 + \beta_4 X^4 + e$
- ◉ The higher the order of the polynomial, the more curvature for which it can account

---

---

---

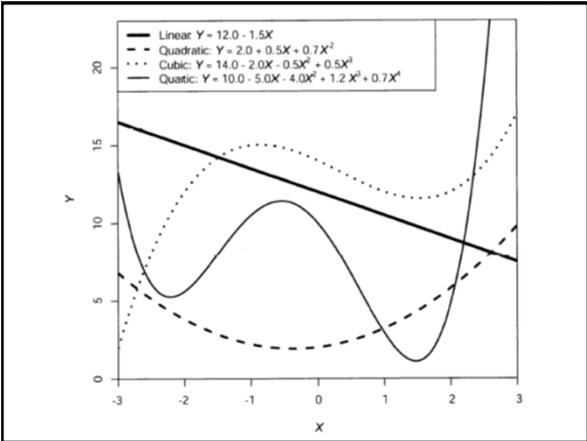
---

---

---

---

---




---

---

---

---

---

---

---

---

## Which to Choose: Quadratic or Cubic?

- ◉ In general, choose the LOWEST order polynomial possible (e.g., prefer linear to quadratic...quadratic to cubic)
- ◉ This is aimed at (1) “Occam’s razor” meaning that simpler models are preferred and (2) the higher the order of the polynomial term, the more parameters to estimate (it is easier to estimate a few parameters than it is to estimate many)

---

---

---

---

---

---

---

---

### Exploratory Approach for Selecting the Polynomials

- The regression output provides a formal method for selecting the appropriate polynomial
  - This method typically agrees with looking at the residual plot
- The regression output provides p-values for each term in the regression
- These p-values can be used to guide decisions about which polynomial terms to include in the model

---

---

---

---

---

---

---

---

### Exploratory Approach for Selecting the Polynomials

- Begin by fitting the quartic model
  - If the quartic term is significant, use the quartic model
- If the quartic term is NOT significant, remove it, and rerun the model
  - Look to see whether the cubic term is significant
- If the cubic term is NOT significant, remove it, and rerun the model
  - Look to see whether the quadratic term is significant
- If the quadratic term is NOT significant, remove it, and rerun the model (i.e., simple linear regression)

---

---

---

---

---

---

---

---