

# Applying Polynomial Regression to Dyadic Data

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## Objectives

The purpose of this poster is to explore the application of polynomial regression on a dyadic family dataset.

## Introduction

Dyadic data:

- Used by family researchers who are interested in comparing the attitudes, behaviors, and opinions of family members, especially husbands and wives.
- Inter-individual reporting (e.g. comparison of husband's report of their support toward his wife to the wife's report of their support towards the husband)
- Intra-individual reporting (e.g. comparison of an observer's report of husband's hostility to an observer's report of the wife's hostility)

Difference scores are often used to analyze dyadic data, but we'll present an alternative to this called polynomial regression.

## Difference Scores

- Difference scores are used to see how well two variables or indices 'fit' together. Some examples of difference scores are:

$$\begin{aligned} Z &= \beta_0 + \beta_1(X - Y) + \epsilon \\ Z &= \beta_0 + \beta_1|X - Y| + \epsilon \\ Z &= \beta_0 + \beta_1(X - Y)^2 + \epsilon \end{aligned}$$

- There are some big issues with difference scores:
  - The most important reason to avoid using difference scores is that it makes it difficult to identify the underlying mechanism
  - Assumptions: the difference between two entities to the outcome variable are assumed to be symmetric and that the outcome is constant at all points where the two entities are equal

## What is polynomial regression?

Polynomial Regression (Edwards and Parry 1993) has been suggested as an alternative to difference scores.

- Take the Squared Difference and expand it

$$(X - Y)^2 = X^2 + Y^2 - 2XY$$

- This leads to using a quadratic regression model

$$Z = \beta_0 + \beta_1X + \beta_2Y + \beta_3X^2 + \beta_4Y^2 + \beta_5XY + \epsilon$$

When looking at the quadratic regression model, we are concerned with three key elements:

- Stationary Point: Points where the slope is zero no matter which direction you take the derivative
- Principal Axis: Measure the amount of "bend" in two directions at the stationary points
- Predicted Surface: a 3D-surface that allows us to view the predicted response

## Results

The fitted quadratic polynomial using perceived relationship instability as a predictor for relationship quality is:

$$\hat{z} = -0.52 + 0.25x + 0.23y + 0.02x^2 + 0.09xy + 0.37y^2$$

Stationary points are at  $(-10.19, 0.92)$

Likewise we can look at the principal axes:

$$\begin{aligned} y &= 82.92 + 8.05x \\ y &= -0.34 - 0.12x \end{aligned}$$

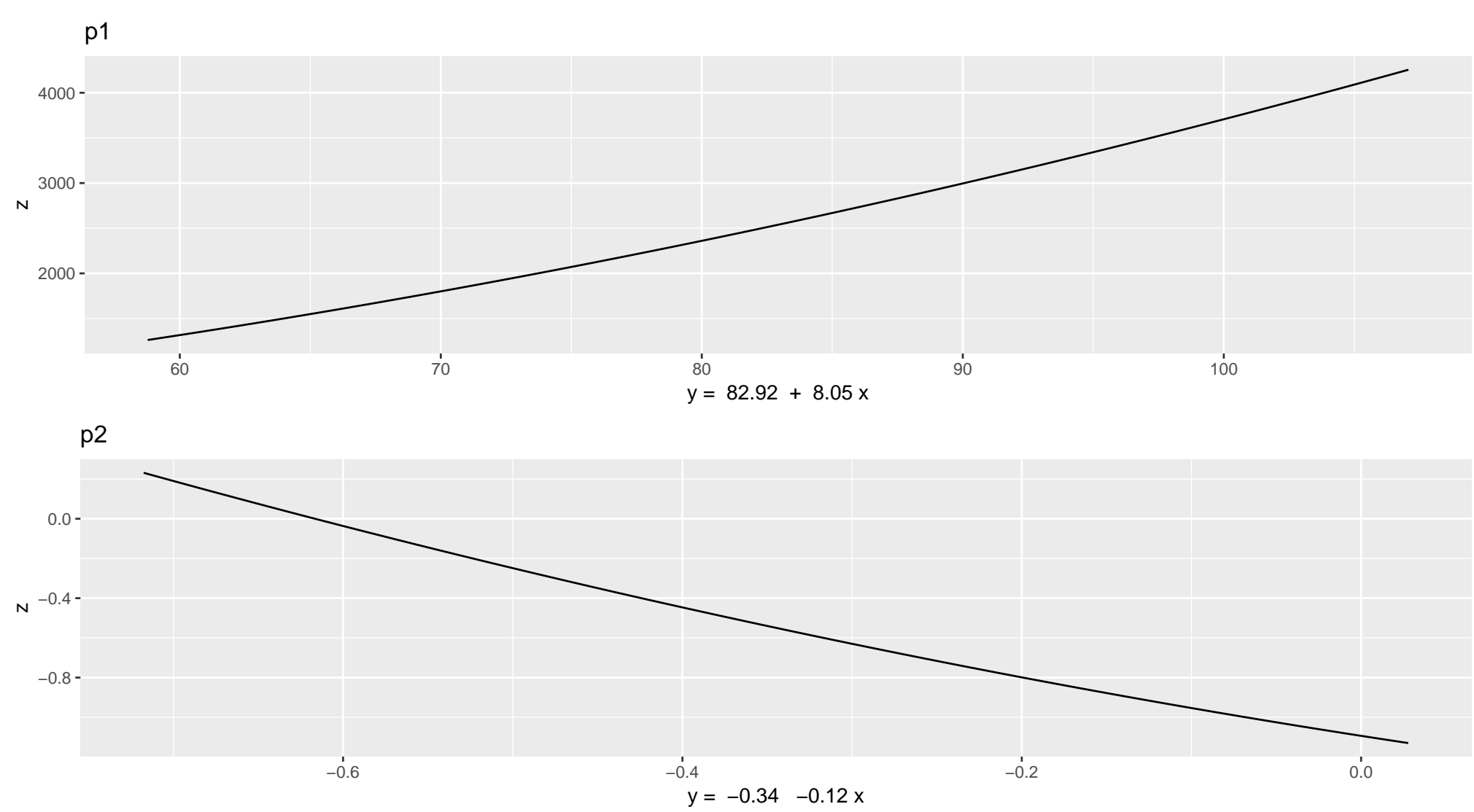


Figure: This Figure shows slices of the response surface taken at the two principal axes.

## Project Data

Here is some background on data used in this project:

- Data: from a multi-informant panel study (the Iowa Midlife Transition Project; 1991 – 2001)
- Concern: How do families cope during times of economic hardship (the "farm crisis" of 1984 – 1988)?
- Question: Is there congruence between questionnaire reports and observer ratings of specific behaviors (e.g., hostility; support)?

These are the variables of interest:

$Z$  : Obs RQ of couple  $i$ : 1 – 9

$Y_2$  : Wife( $i$ )'s Report of RI: 1 – 4

$X_2$  : Husband( $i$ )'s Report of RI: 1 – 4

Here are some screenshots of our predicted surface:

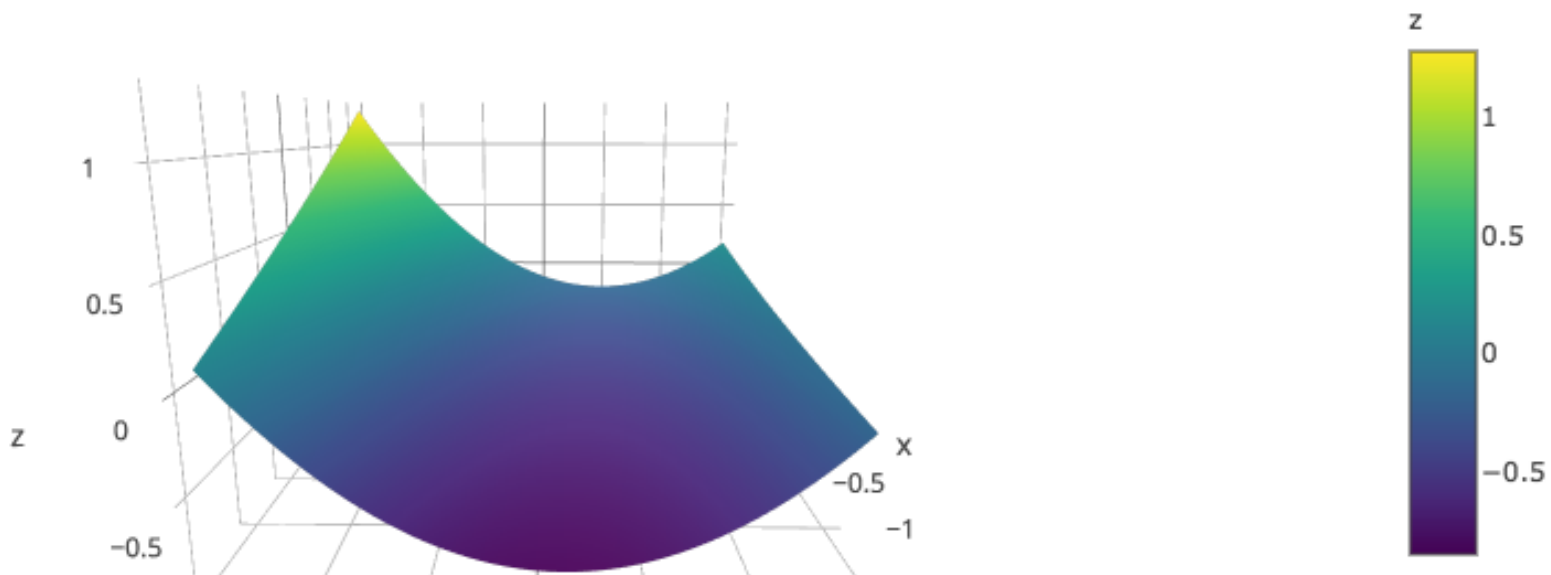


Figure: Predicted surface plot from the center perspective.

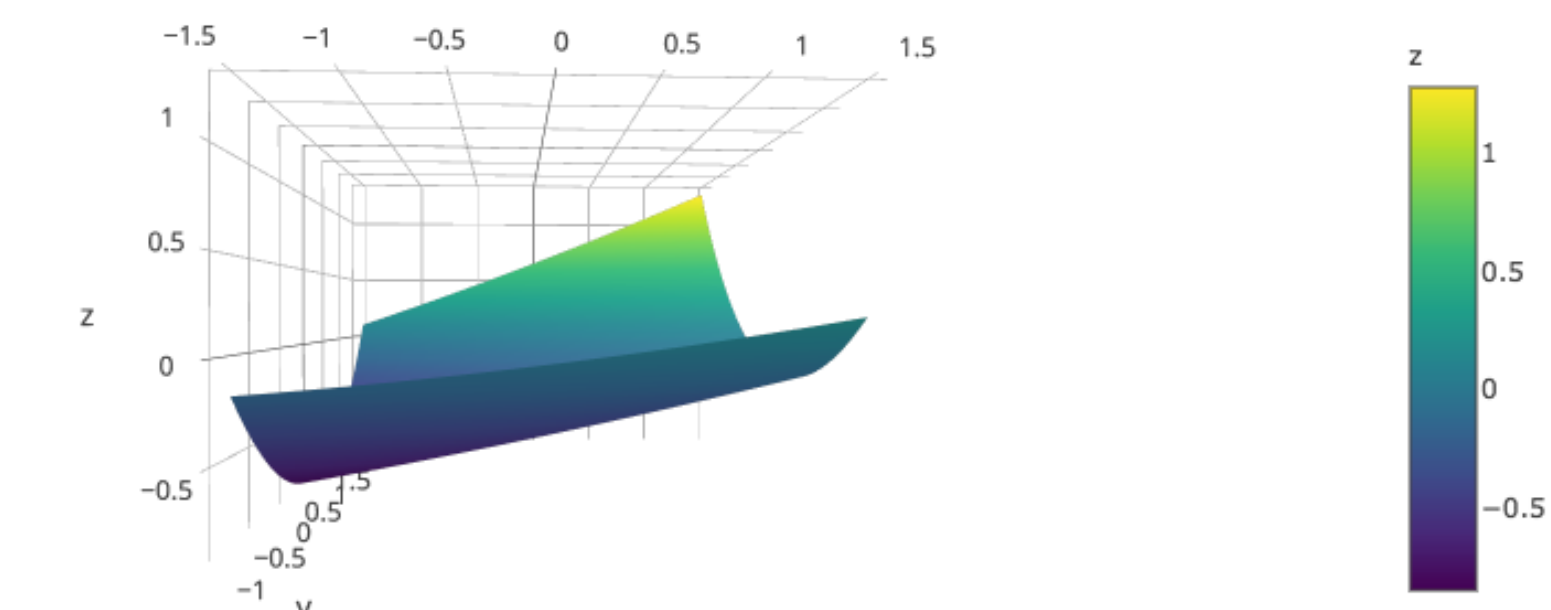


Figure: Predicted surface plot from the y axis perspective i.e. eliminating the x axis.

## Conclusion

Pros:

- Easily visualize the realm of possible combinations of the predictor variables and their effect on the predicted response
- Helps identify the underlying mechanism by seeing how different predictors affect the surface

Cons:

- Not super intuitive interpretations of model components
- Issues with data greatly affect inferences e.g. our variables were skewed heavily

## References

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- L. Alison Phillips. Congruence research in behavioral medicine: methodological review and demonstration of alternative methodology. *Journal of Behavioral Medicine*, 36(1):61–74, 2012.

## Contact Information

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