Welcome to Week 16, Lecture 01!

Linear Regression - Revisited

Agenda

- Assignments
- Announcements

- Today:
  - Why Use Linear Regression?
  - How does Linear Regression work?
  - What are coefficients?
  - The 4 Assumptions of Linear Regression
  - Demo: How to fit a linear regression with statsmodels.

- Next Class:
  - Diagnosing a Regression model
  - Iterating on our model
  - Advanced approaches

Assignments

Only 1 required assignment:

- **Project 3 - Part 4(Core)**

Highly Recommended:

- Do Project 3 - Part 5 for your portfolio!!!

Week 3 assignment feedback will be added by E.O.D. tomorrow.

Final Assignment Deadline = Friday at 9 AM PST!

- All resubmissions from week 1 and 2 .
- All week 3 and 4 assignments turned in.
    - If you are asked for resubmissions for week 3 assignments, I will extend deadline to Monday.

📣 Announcements

- **Alumni Onboarding Info Session:**
  - Next Class 05/12/22 @ 4:30 PM PST (During pre-lecture office hours)
    - Sarah Lee Catli, our Alumni Community Development Manager will be joining us to discuss all of the great benefits our alumni receive post-graduation.

- 🎓 **Online DS Graduation!**
  - **Friday, May 27th @ 5 PM PST**
    - Our cohort + students from 12 week program.
    - In the same Zoom Room as lecture

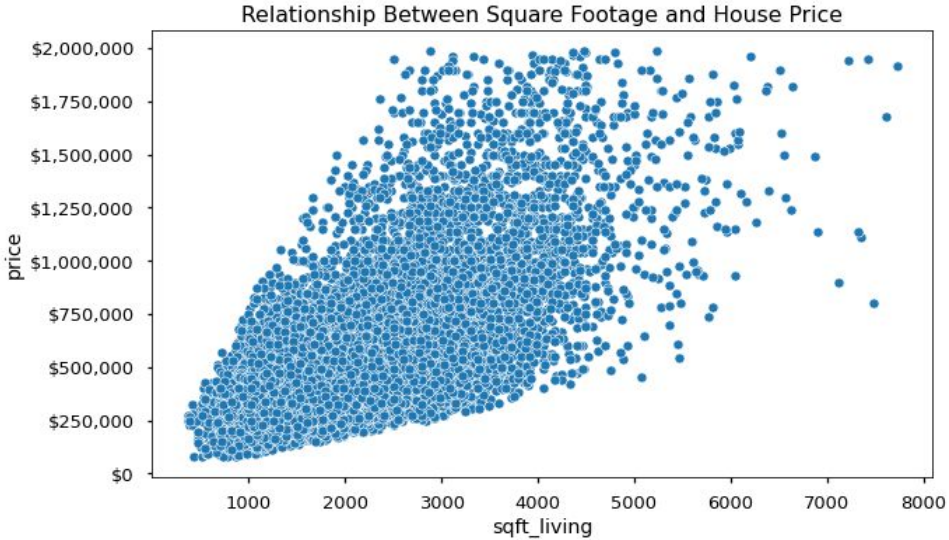
- **Bonus Lecture Friday:**
  - **Topic: Creating Your Own Python Package/Module**
  - Date: Friday 05/13/22 @ 5 PM PST
    - We will start with a review of writing functions
    - Then discuss moving our functions to an external .py file (making a module)
    - Then we will discuss how to make an actual PyPi Package (pip-installable)

Why Linear Regression?

You have been hired by a homeowner's association to analyze the prices of homes sold in their region and to give them advice on how to increase the resale value of their homes.

We want a **simple way to summarize the effect of a feature** on the home's price. For example, Square Footage.

What data science/machine learning tools do we have that would accomplish this?



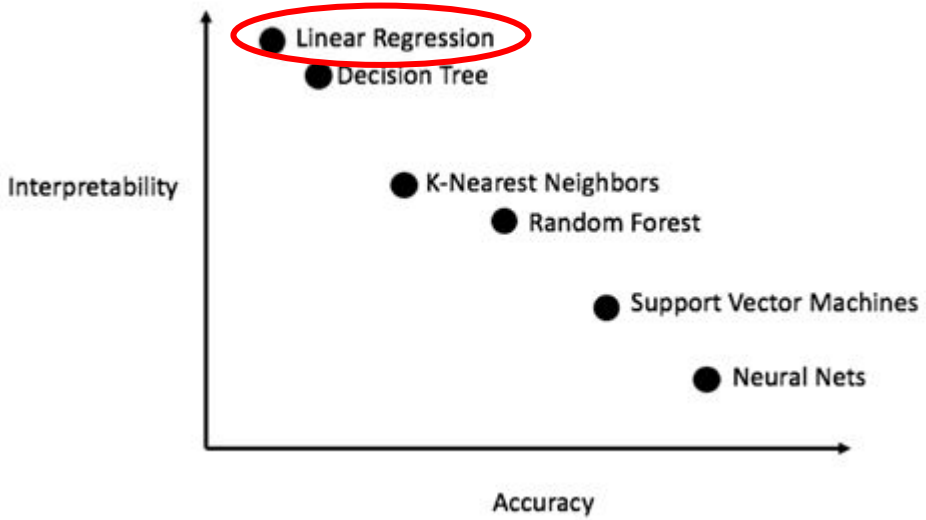
Why Linear Regression?

PROS:

- Its quick!
- Its simple.
- It's easy to interpret.

CONS:

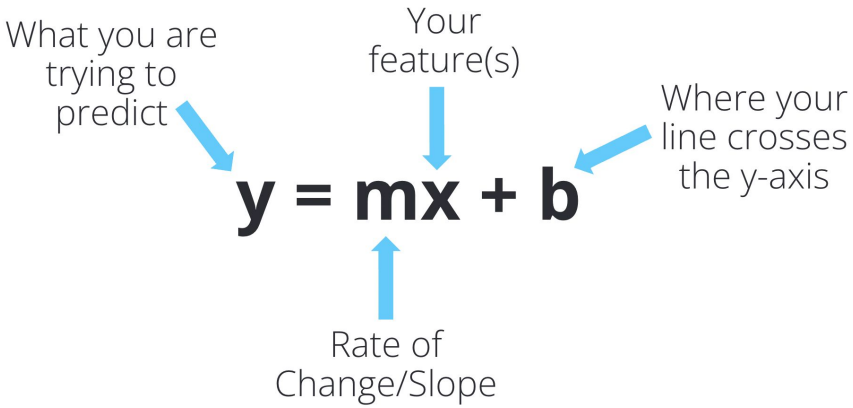
- It's the "dumbest" regression model.
- Least accurate.
- It's *picky*! (There are several assumptions built into it, like hypothesis testing.)

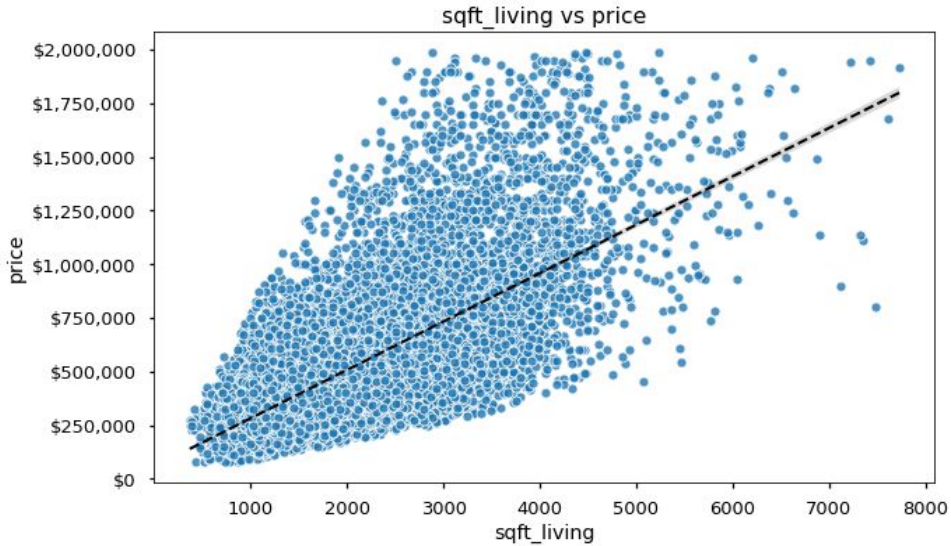


How does it work?

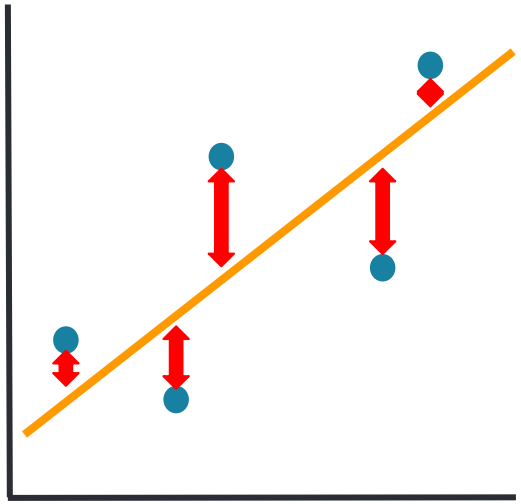
Linear Regression!

- It calculates a best-fit line that has:
  - *m:* a slope/rate of change.
  - b: the y-intercept/constant.





How does it work?



- Try many different values for slope
- Try many different values for the intercept
- Choose the best slope and intercept **that minimized the sum of the squared errors (e.g. Mean Squared Error).**

What are coefficients?

In data science...

We use “betas” (β) to represent our **coefficients**.

- The slope (m) for X-column becomes β_1
- The intercept (b) becomes β_0

$$y = mx + b$$

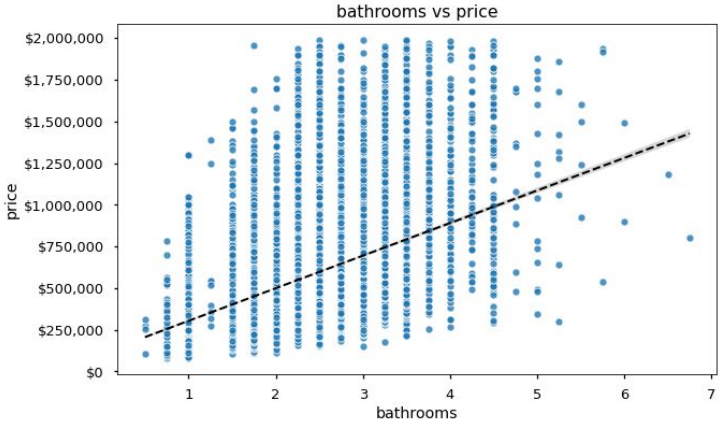
$$\downarrow \qquad \downarrow$$

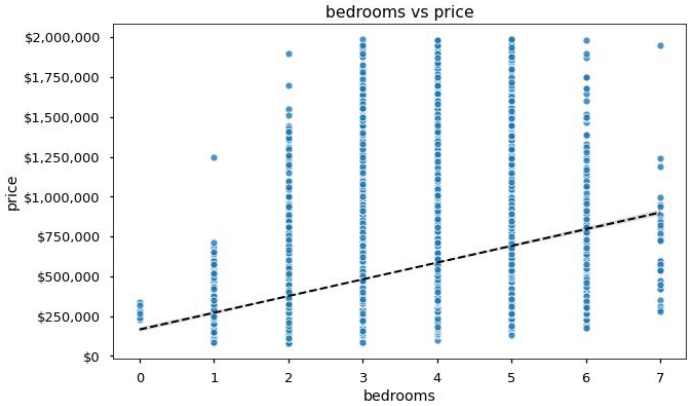
$$y = \beta_1 x + \beta_0$$

Multiple Regression

With multiple X-columns, we calculate a coefficient for each column (x_1, x_2 , etc).

$$y = \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_0$$





Colab Notebook

- Here is the colab notebook that generated the visualizations on the prior slides.
  - It has a small example of a Linear Regression with scikit-learn.
  - *Depending on time, we may/may not walk through it in class.*

- Because today…we are abandoning scikit-learn! 😱

Linear Regression Assumptions

The 4 Assumptions of Linear Regression

The first 2 assumptions are about the **features:**

- **Linearity**
- **Independence of features** (AKA Little-to-No Multicollinearity)

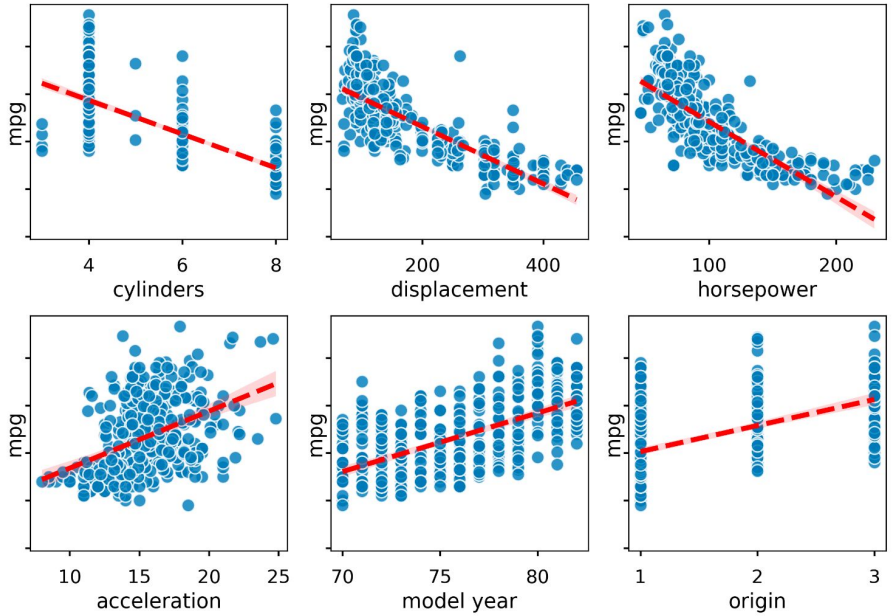
The last 2 assumptions are about the **residuals (errors):**

- **Normality**
- **Homoscedasticity**

Assumption of Linearity

That the input features have a linear relationship with the target.

- To check:
  - Use visualizations!

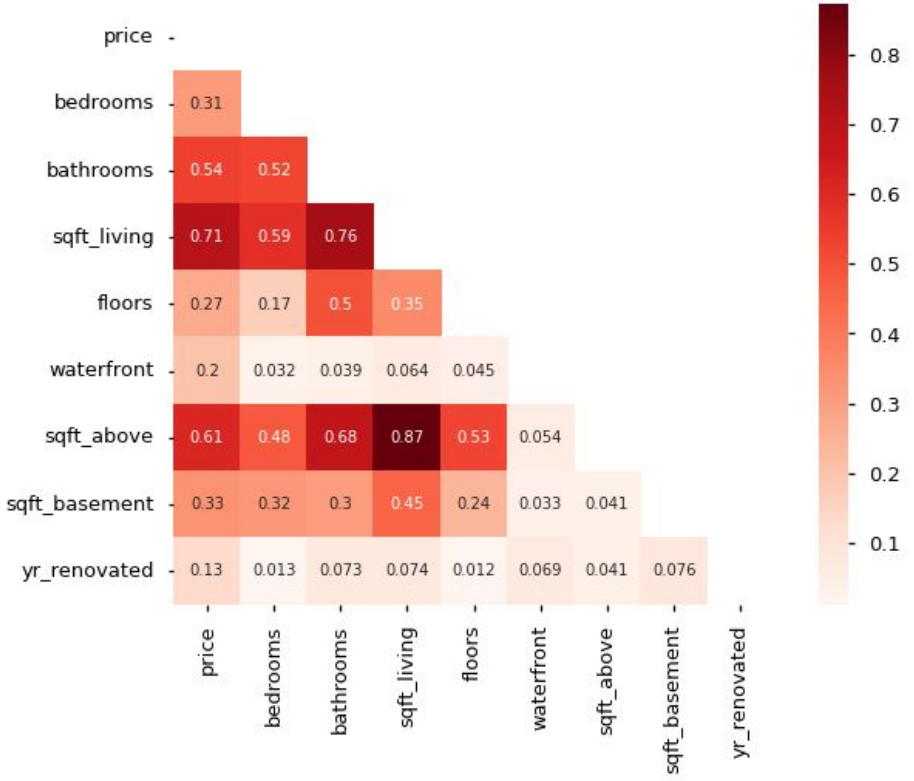


Independence of features

(AKA Little-to-No Multicollinearity)

That the features are not strongly related to other features.

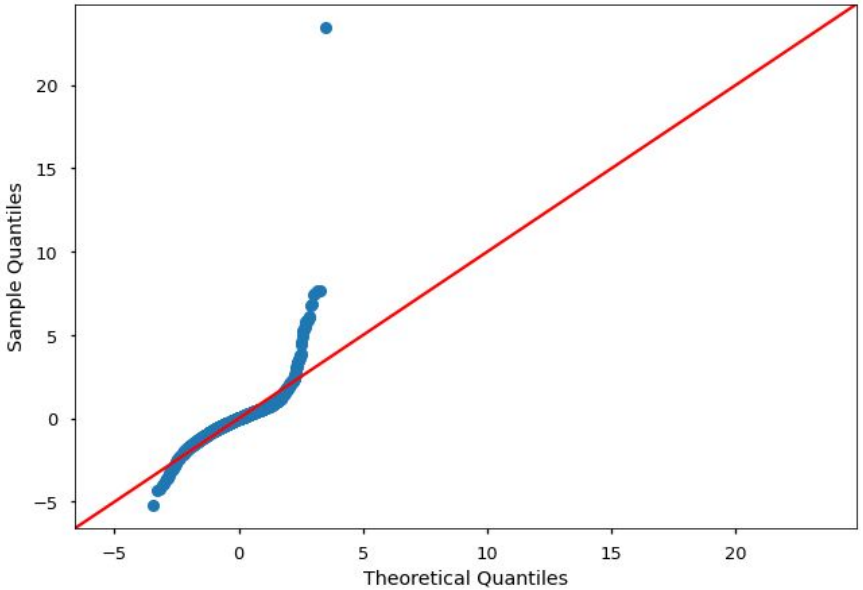
- To Check:
  - Use correlation heatmaps!
  - Use Variance Inflation Factor!



Normality (of residuals)

The model's residuals are approximately normally distributed.

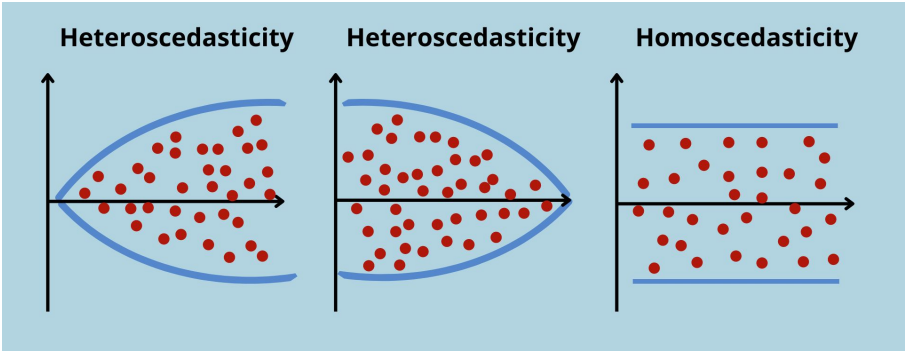
- To Check:
  - Use a Quantile-Quantile (Q-Q) Plot!

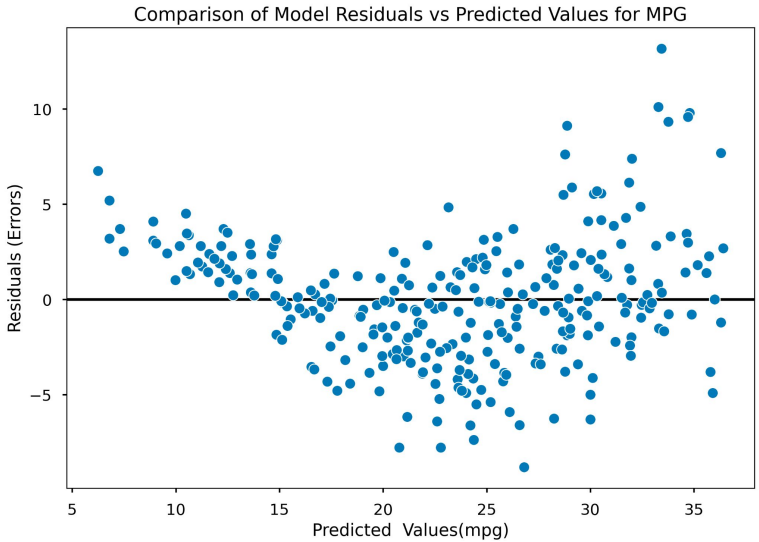


Homoscedasticity (Equal Variance)

The model residuals have equal variance across all predictions.

- To Check:
  - Plot a residual scatter plot!
    - X-axis: Predicted Y-Values
    - Y-axis: Residuals (y-y_pred)





Fitting a Linear Regression with Statsmodels

Walkthrough: Linear Regression with statsmodels

Fitting a linear regression to predict movie revenue.

- Basically, the optional assignment: Project 3 - Part 5.
- Repo: https://github.com/coding-dojo-data-science/data-enrichment-linear-regression-with-movies

- Today:
  - Preparing the data for a statsmodels OLS.
  - Fitting and evaluating an OLS model.
  - Interpreting the Model Summary and its coefficients.

- Next Class:
  - Diagnosing the model
  - Better meeting the assumptions
  - Advanced approaches to dealing with multicollinearity