

Restaurant Bills by Mr.G.

Is it possible to predict how much a party of twelve will spend in a restaurant? Not unless we know exactly what everyone is going to order. However, we can make an educated guess by using data collected in that restaurant. The bill at the end of a meal depends (in part) on how many people are eating, and so we can use a linear model to predict what the bill might be for a party of twelve.

A restaurant owner took a small ($n=10$) random sample of customers and recorded the number of people eating and how much they spent. We believe the bill will depend on the size of the party, so we'll consider the party size as the independent variable x and the bill as the dependent variable y , and look at a scatter plot of the two variables together. As expected, the plot shows a fairly strong positive correlation. Using Desmos, we generate a line of best fit, which turns out to be $y=11.16x+5.8$. A residual plot shows no obvious pattern, supporting our choice of a linear model, and a maximum residual (deviation from the model) of \$12.55. The slope indicates that, for every additional person eating, the bill goes up by about \$11.16. Using this linear model, we input 12 for x and get our prediction: the bill should be \$139.67.

Of course, this prediction is based on a linear representation of the data and is not exact. Notice how one party of three spent \$50.65, which is \$11.38 more than the model would predict. In other words, the model was off by 29%! If we extend this potential error to our party of twelve, we might expect that the bill could be as low as \$100 or as high as \$180. It could even be worse, if the party of twelve is an outlier - for example, if they just share a couple orders of nachos and only drink water. Usually, however, it would be reasonable to expect the bill for a party of twelve to be somewhat close to our prediction, if the sample data we have is representative. Despite the variability, a linear model makes the most sense to predict the restaurant bill.