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## Prediction Intervals

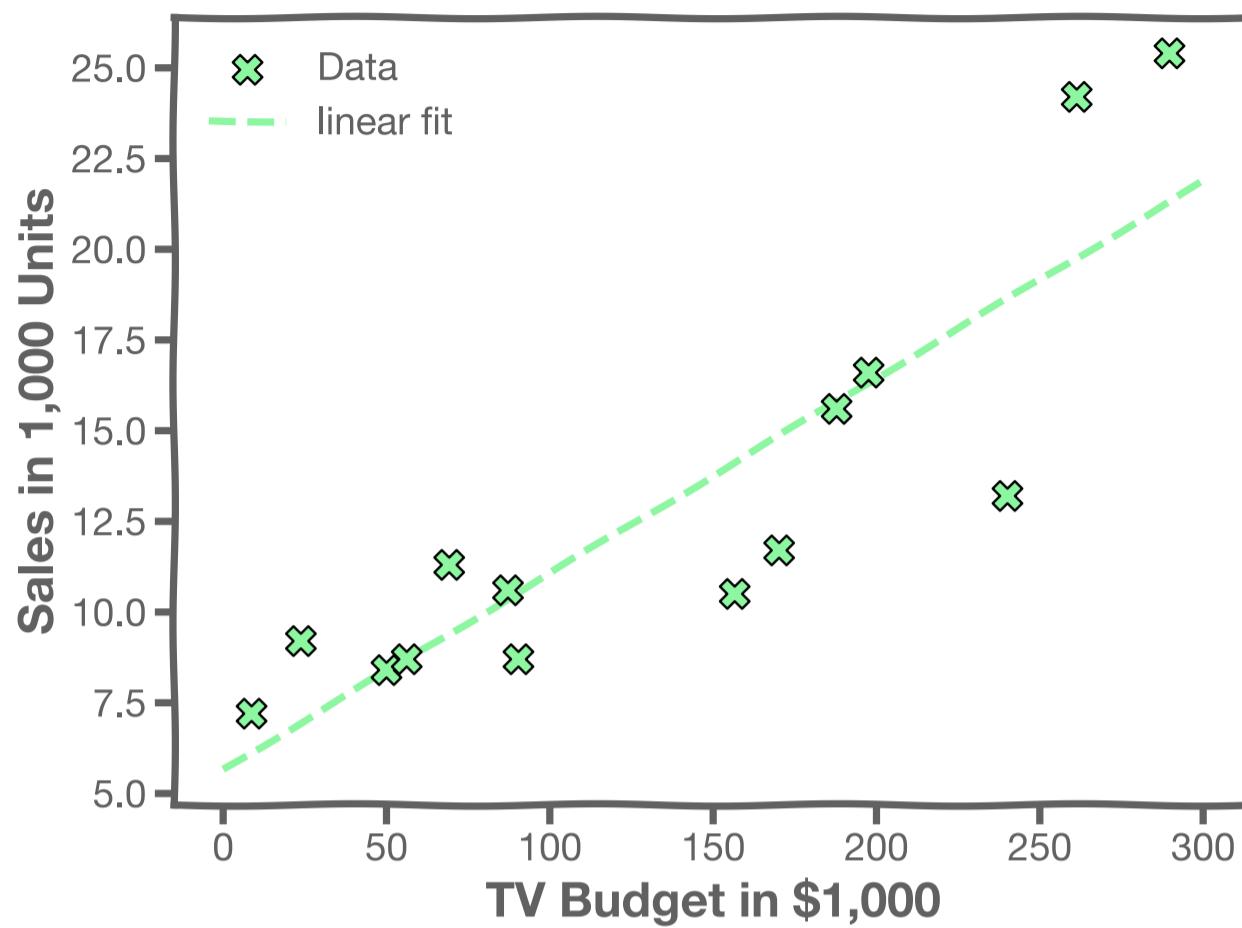
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XPERT

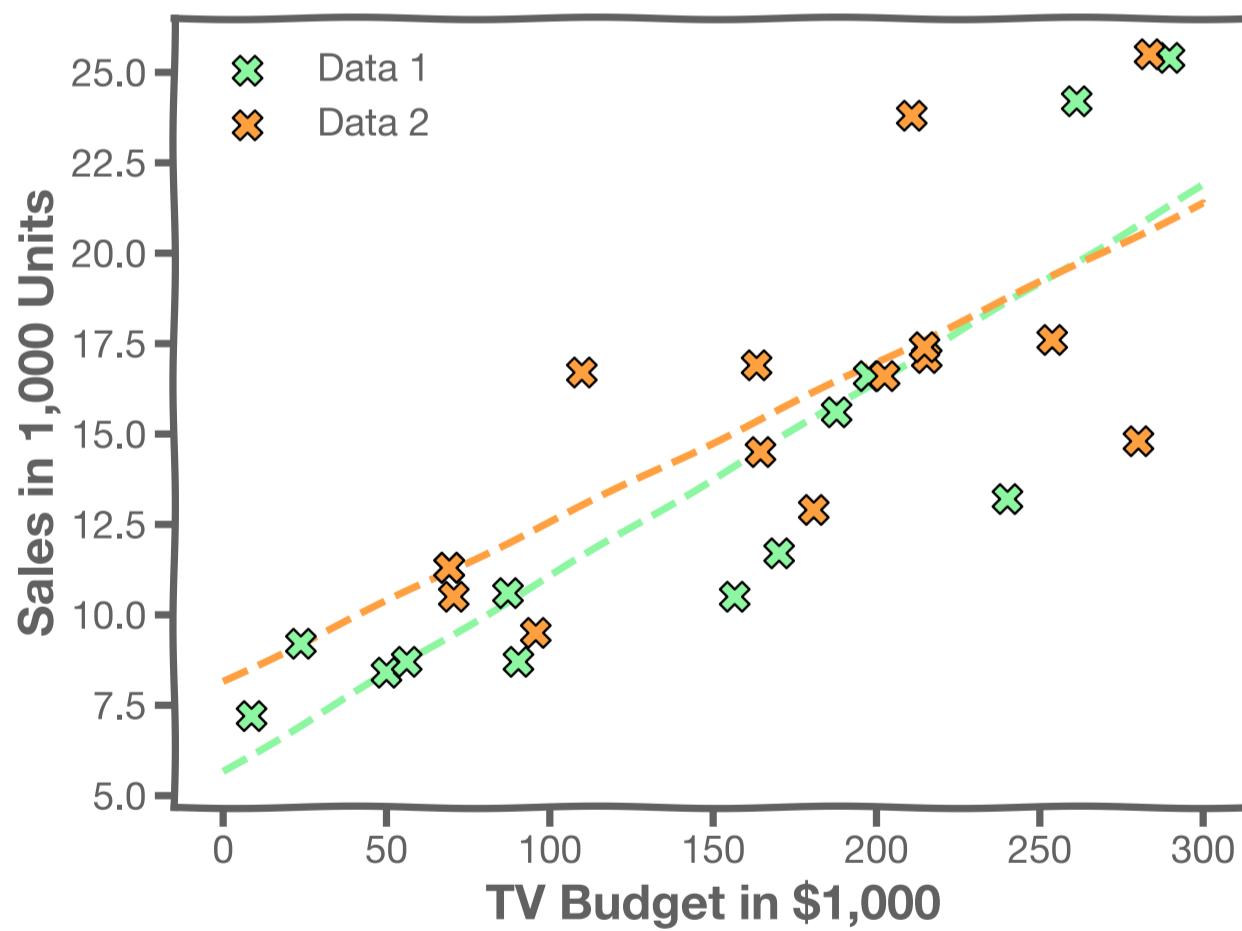
## How well do we know $\hat{f}$ ?

Our confidence in  $f$  is directly related to the confidence in  $\beta$ , which we can use to determine the model  $f(x) = X\beta$

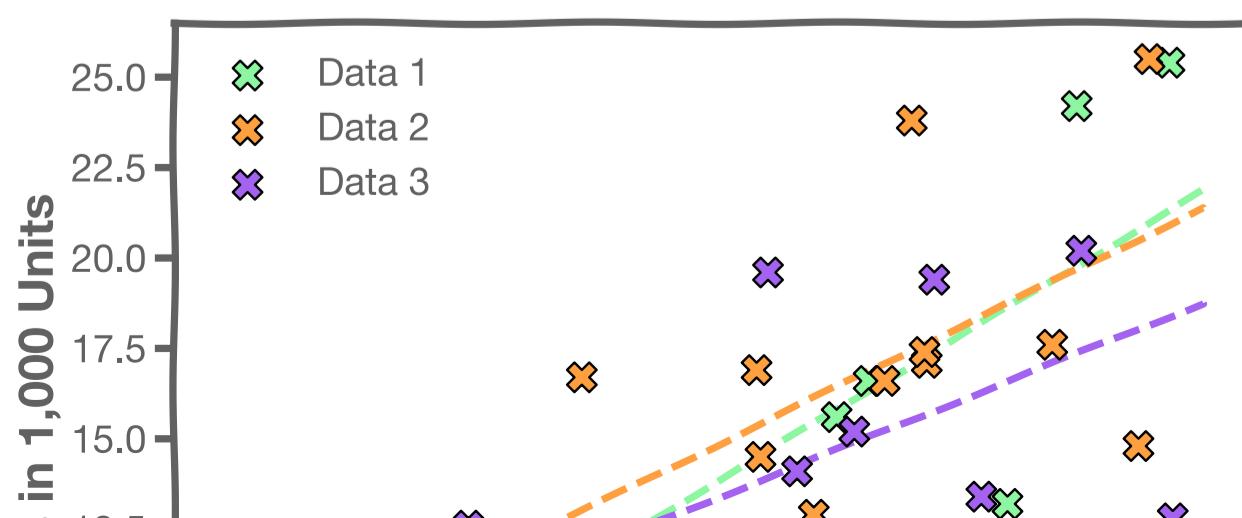
Here we show one models' predictions given the fitted coefficients.



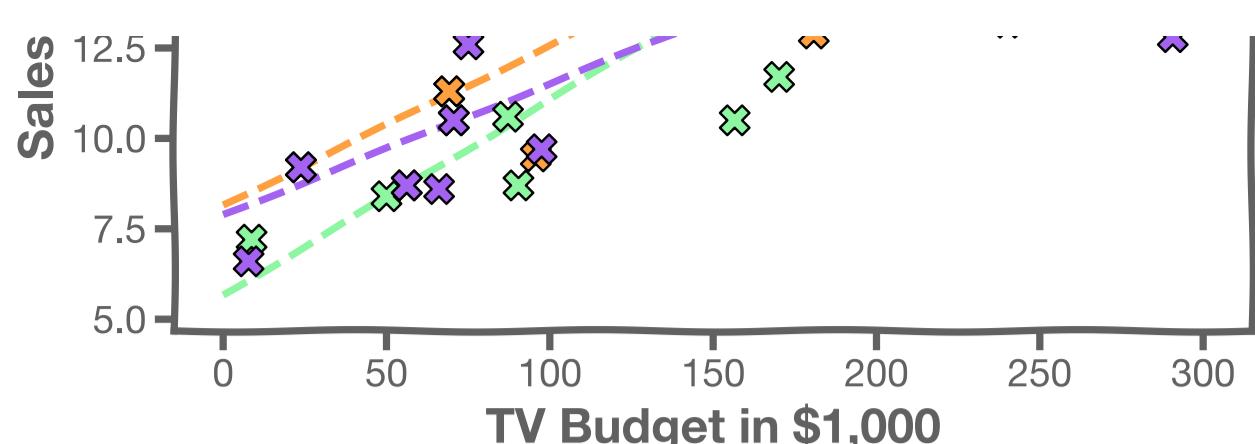
Here is another one.



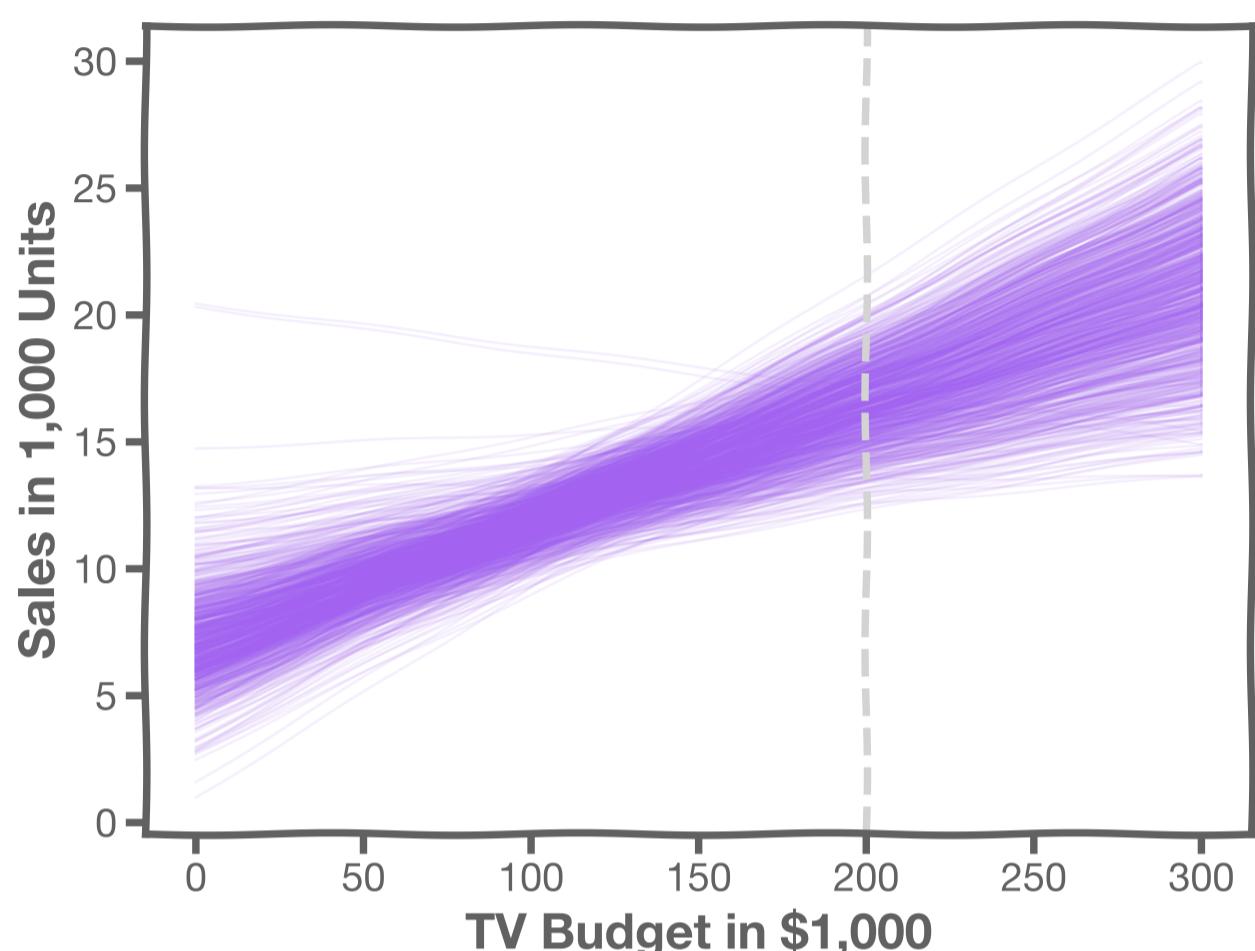
There is one such regression line for every bootstrapped sample.



Calculator

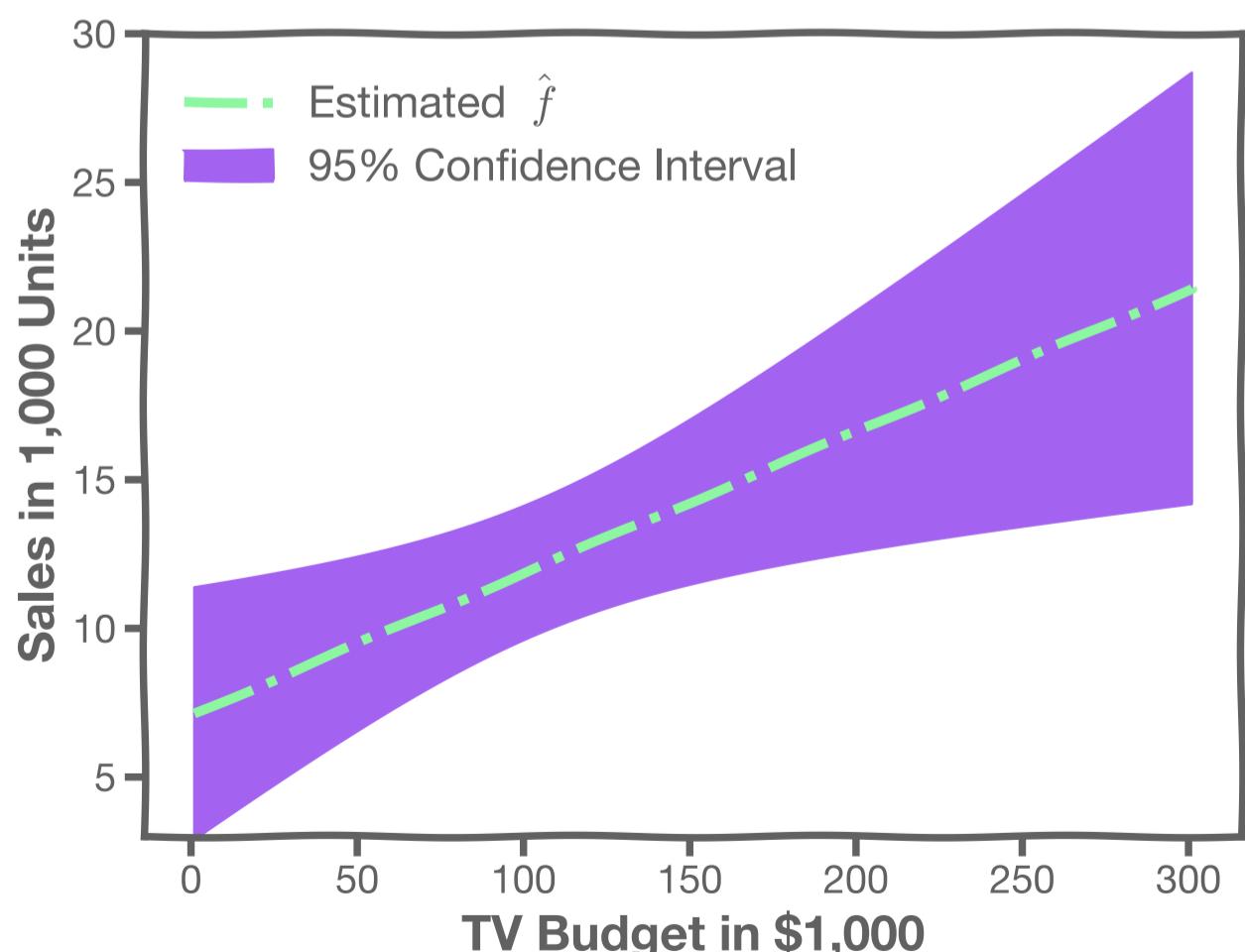


The following plot shows all regression lines for 1,000 such bootstrapped samples.



For a given  $\mathbf{x}$ , we examine the distribution of  $\hat{f}$  and determine the mean and standard deviation.

For every  $\mathbf{x}$ , we calculate the mean and standard deviation of the models,  $\hat{\mu}_f$  (shown with dotted line) and the 95% CI of those models (shaded area)



### Confidence in predicting $\hat{y}$

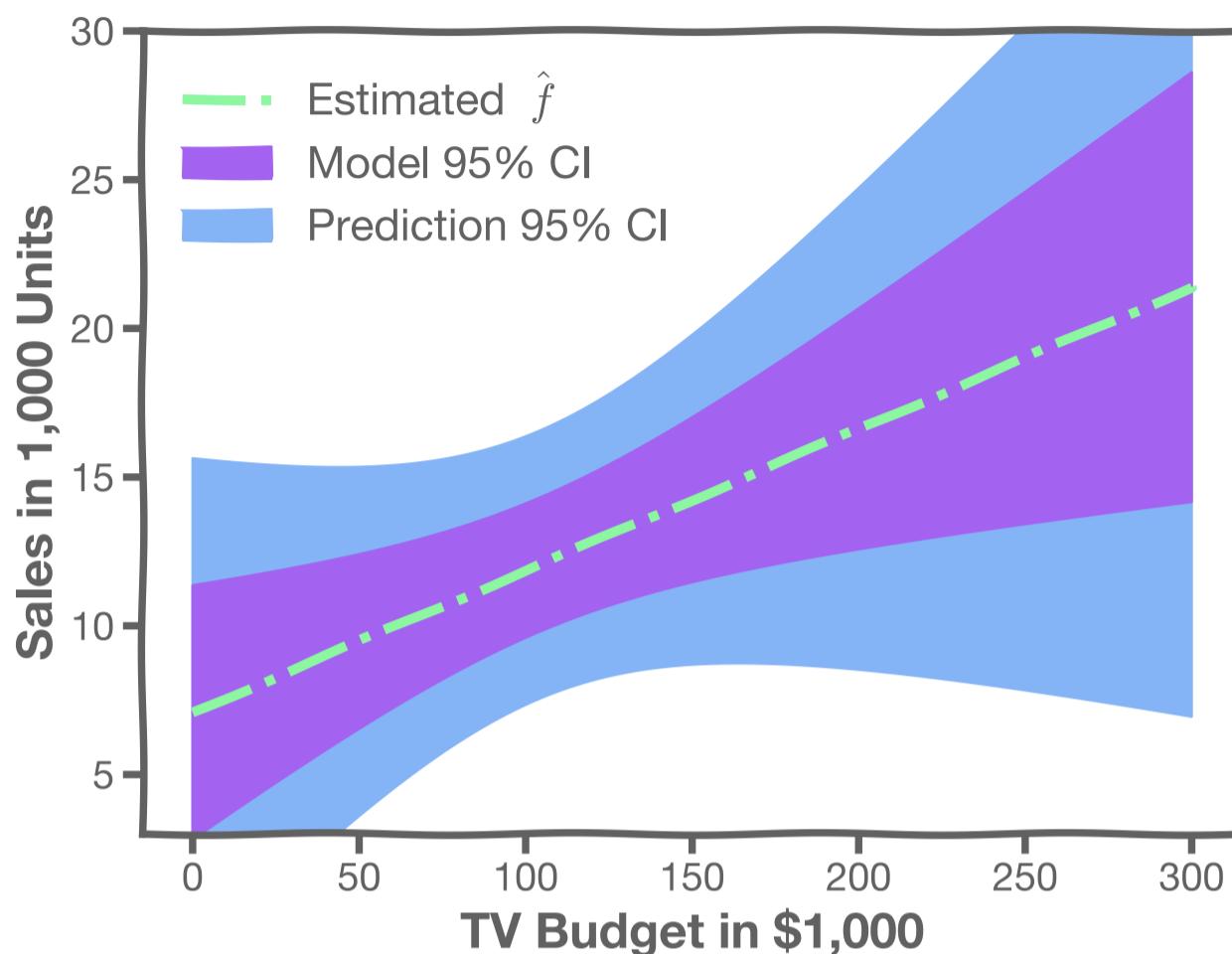
Even if we know  $f(\mathbf{x})$  - the response value cannot be perfectly predicted because of the random error in the model (irreducible error).

Calculator

To find out how much  $Y$  will vary from  $\hat{y}$ , we use **prediction intervals**.

The prediction interval is obtained using the following method:

- For a given  $x$ , we have a distribution of models  $f(x)$
- For each of these  $f(x)$ , the prediction for  $y \approx \mathcal{N}(f(x), \sigma_\epsilon)$
- The prediction confidence intervals are then the 95% region as depicted in the plot



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