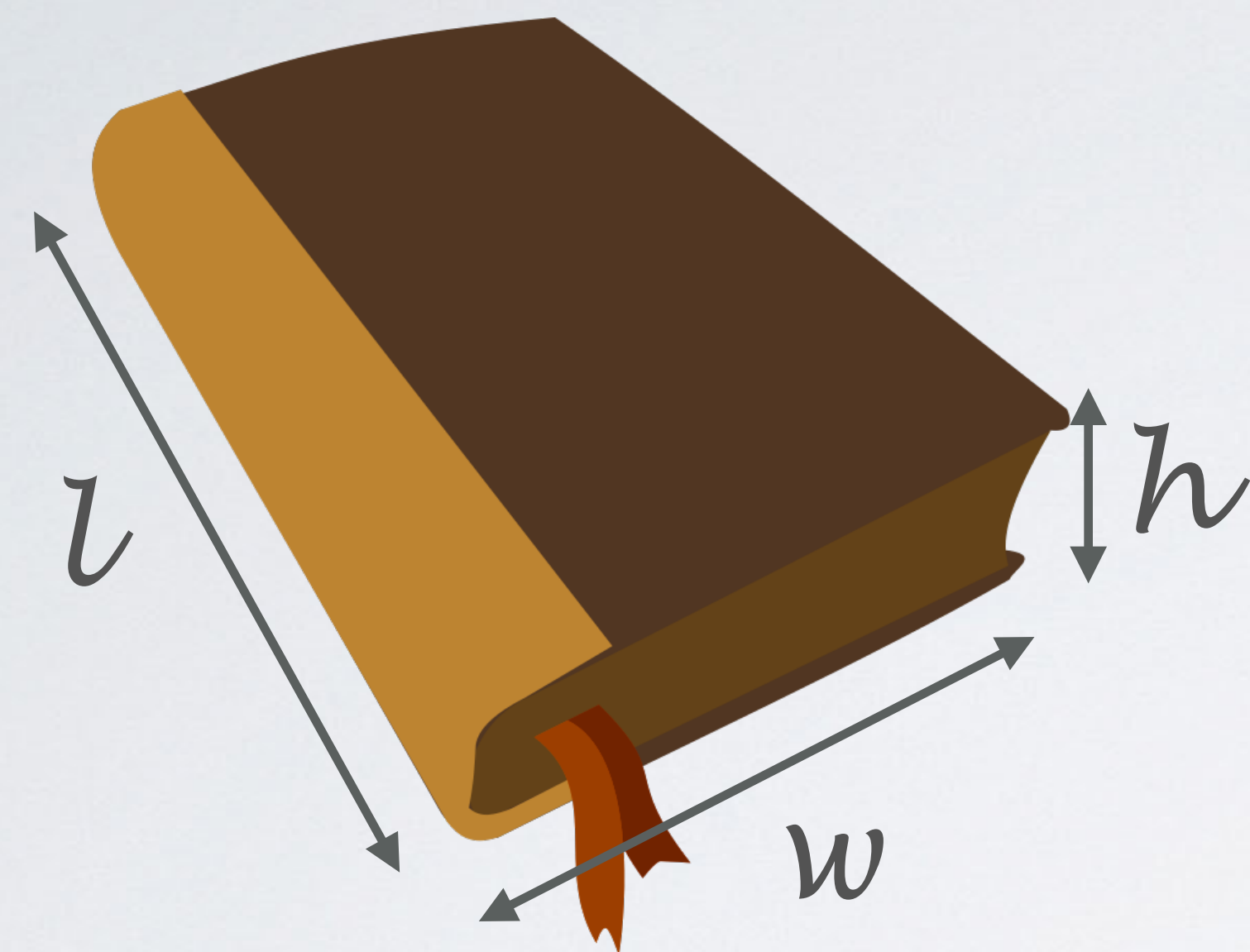


multiple predictors

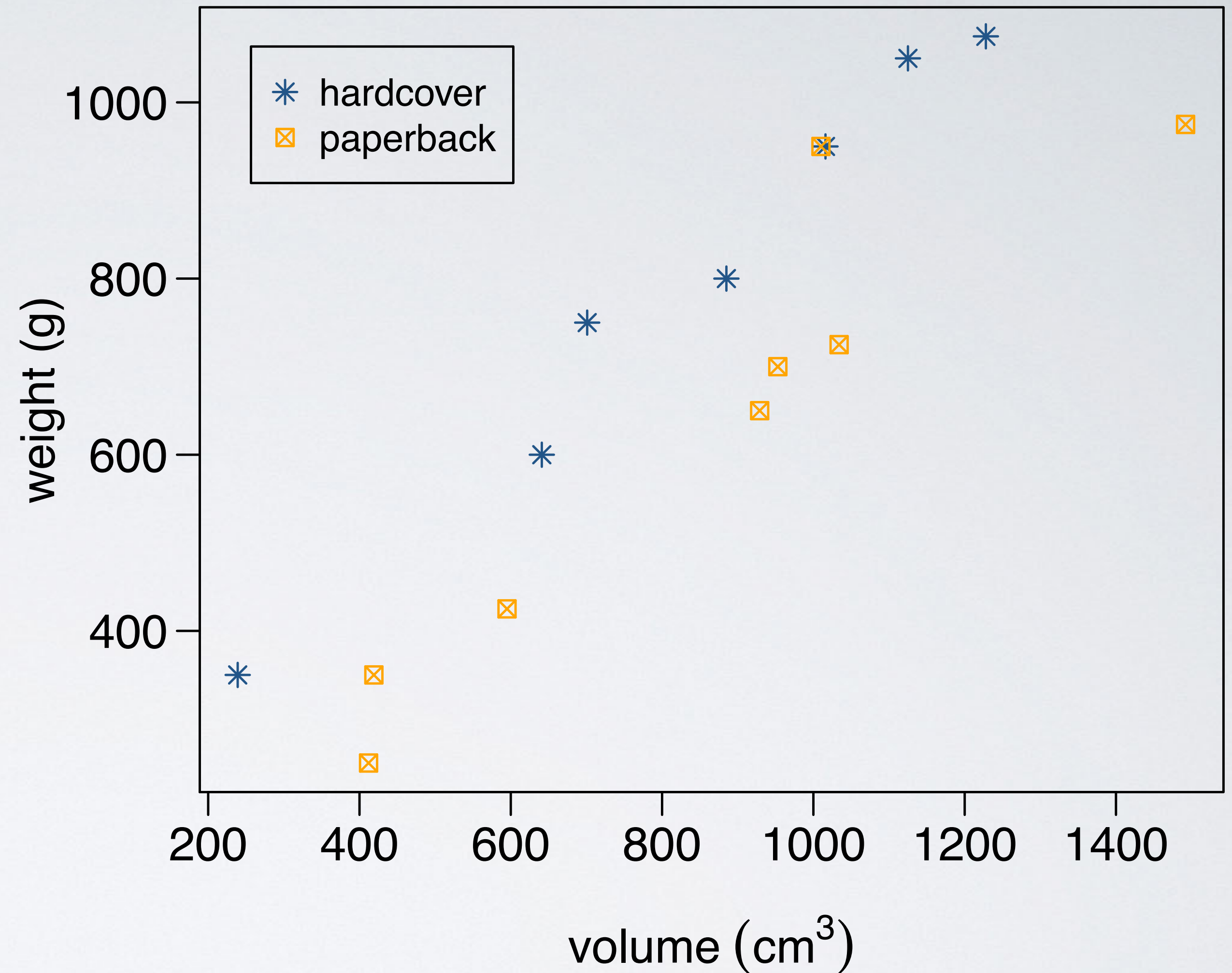
weights of books



	weight (g)	volume (cm	cover
1	800	885	hb
2	950	1016	hb
3	1050	1125	hb
4	350	239	hb
5	750	701	hb
6	600	641	hb
7	1075	1228	hb
8	250	412	pb
9	700	953	pb
10	650	929	pb
11	975	1492	pb
12	350	419	pb
13	950	1010	pb
14	425	595	pb
15	725	1034	pb

Can you identify a trend in the relationship between volume and weight of hardcover and paperback books?

Paperbacks generally weigh less than hardcover books.



R

```
# load data
> library(DAAG)
> data(allbacks)

# fit model
> book_mlr = lm(weight ~ volume + cover, data = allbacks)
> summary(book_mlr)
```

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)	
(Intercept)	197.96284	59.19274	3.344	0.005841	**
volume	0.71795	0.06153	11.669	6.6e-08	***
cover:pb	-184.04727	40.49420	-4.545	0.000672	***

Residual standard error: 78.2 on 12 degrees of freedom
Multiple R-squared: 0.9275, Adjusted R-squared: 0.9154
F-statistic: 76.73 on 2 and 12 DF, p-value: 1.455e-07

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	197.96	59.19	3.34	0.01
volume	0.72	0.06	11.67	0.00
cover:pb	-184.05	40.49	-4.55	0.00

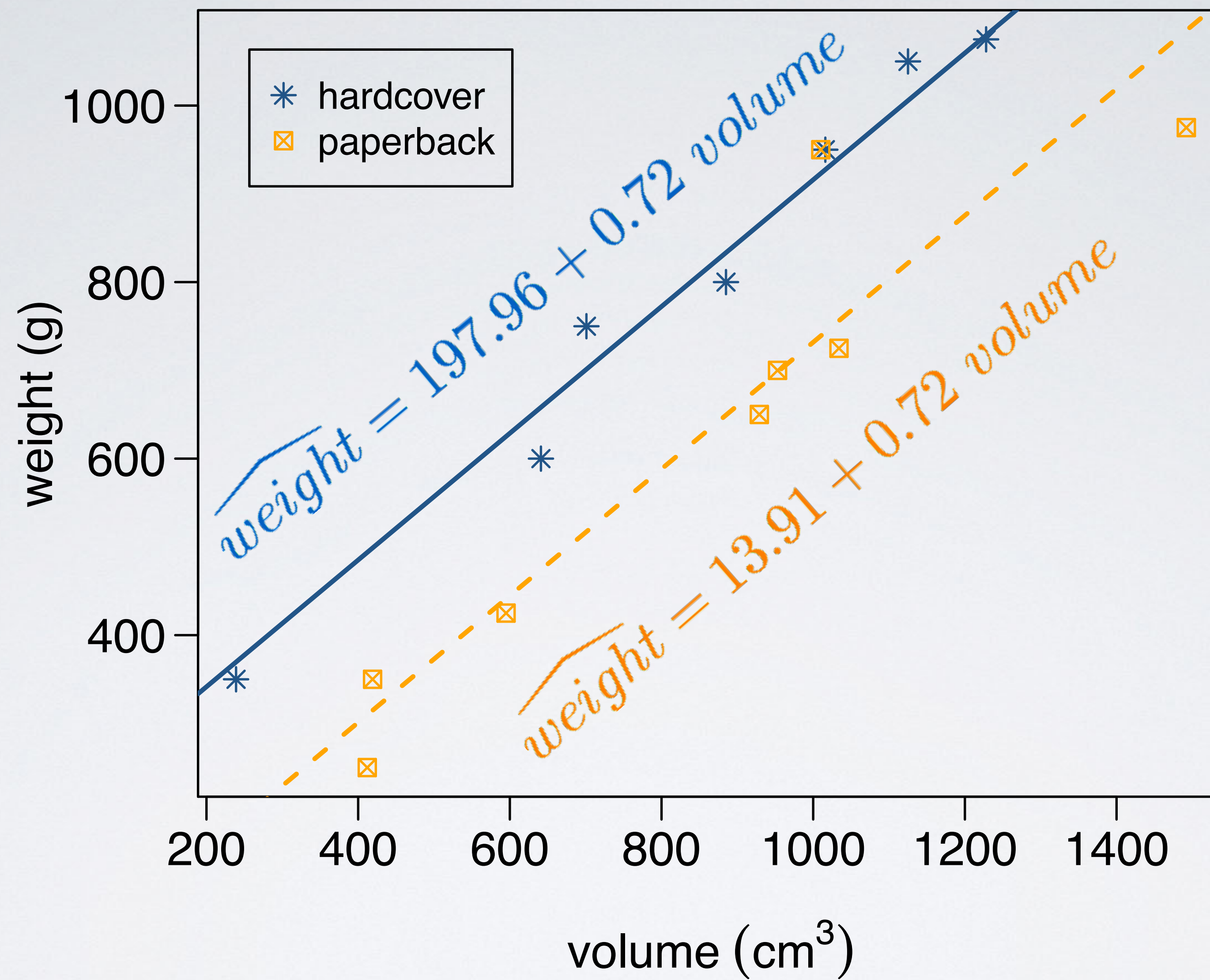
$$\widehat{weight} = 197.96 + 0.72 \text{ volume} - 184.05 \text{ cover} : \text{pb}$$

- For hardcover books: plug in **0** for cover:

$$\begin{aligned}\widehat{weight} &= 197.96 + 0.72 \text{ volume} - 184.05 \times 0 \\ &= 197.96 + 0.72 \text{ volume}\end{aligned}$$

- For paperback books: plug in **1** for cover:

$$\begin{aligned}\widehat{weight} &= 197.96 + 0.72 \text{ volume} - 184.05 \times 1 \\ &= 13.91 + 0.72 \text{ volume}\end{aligned}$$



interpreting the regression parameters: slope

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	197.96	59.19	3.34	0.01
volume	0.72	0.06	11.67	0.00
cover:pb	-184.05	40.49	-4.55	0.00

$$\widehat{weight} = 197.96 + 0.72 \text{ volume} - 184.05 \text{ cover : pb}$$

Slope of **volume**: All else held constant, for each 1 cm³ increase in volume the model predicts the books to be heavier on average by 0.72 grams.

Slope of **cover**: All else held constant, the model predicts that paperback books weigh 184.05 grams lower than hardcover books, on average.

interpreting the regression parameters: intercept

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	197.96	59.19	3.34	0.01
volume	0.72	0.06	11.67	0.00
cover:pb	-184.05	40.49	-4.55	0.00

$$\widehat{weight} = 197.96 + 0.72 \text{ volume} - 184.05 \text{ cover : pb}$$

Intercept: Hardcover books with no volume are expected on average to weigh 198 grams.

- Meaningless in context, serves to adjust the height of the line.

prediction

Predict the weight of a paperback book that is 600 cm³ in volume.

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	197.96	59.19	3.34	0.01
volume	0.72	0.06	11.67	0.00
cover:pb	-184.05	40.49	-4.55	0.00

$$\widehat{weight} = 197.96 + 0.72 \text{ volume} - 184.05 \text{ cover : pb}$$

$$197.96 + 0.72 \times 600 - 184.05 \times 1 = 445.91 \text{ grams}$$

interaction variables

- ▶ Model assumes hardcover and paperback books have the same slope for the relationship between their volume and weight.
- ▶ If this isn't reasonable, then we would include an **interaction** variable in the model (beyond the scope of this course).

