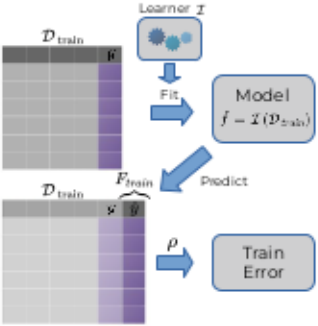
TRAINING ERROR

Simply plugin predictions for data that model has been trained on:

$$\rho(\mathbf{y}_{\text{train}}, \boldsymbol{F}_{\text{train}}) \text{ where } \boldsymbol{F}_{\text{train}} = \begin{bmatrix} \hat{f}_{\mathcal{D}_{\text{train}}}(\mathbf{x}^{(1)}_{\text{train}}) \\ \dots \\ \hat{f}_{\mathcal{D}_{\text{train}}}(\mathbf{x}^{(m)}_{\text{train}}) \end{bmatrix}$$

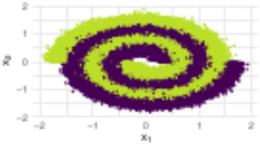


A.k.a. apparent error or resubstitution error.

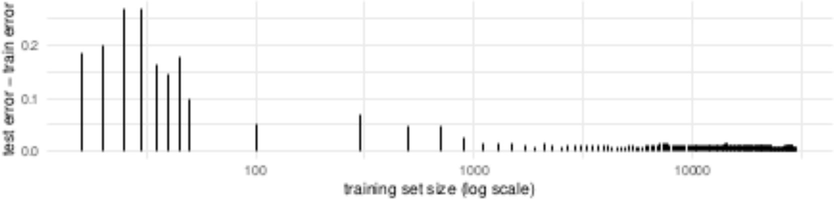
EXAMPLE 1: KNN

For large data, and some models, train error **can maybe** yield a good approximation of the GE:

- Use k-NN ($k = 15$).
- Up to 30K points from `spirals` to train.
- Use very large extra set for testing (to measure "true GE").

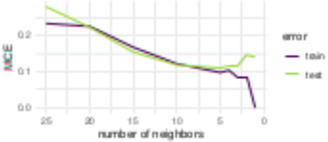


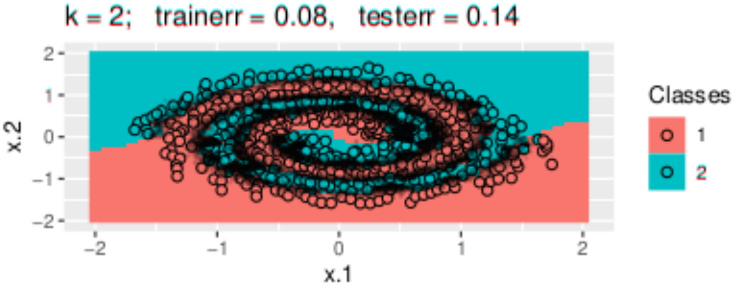
We increase train size, and see how gap between train error and GE closes.



EXAMPLE 1: KNN / 2

- Fix train size to 500 and vary k.
- Low train error for small k is deceptive. Model is very local and overfits.



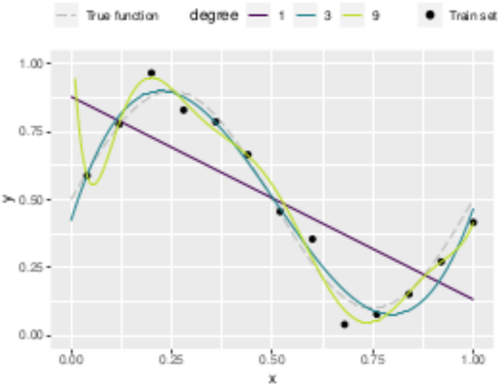


Black region are misclassifications from large test test.

EXAMPLE 2: POLYNOMIAL REGRESSION / 2

Simple model selection problem: Which d?

Visual inspection vs quantitative MSE on training set:



- $d = 1$: MSE = 0.036: clearly underfitting
- $d = 3$: MSE = 0.003: pretty OK
- $d = 9$: MSE = 0.001: clearly overfitting

Using the train error chooses overfitting model of maximal complexity.