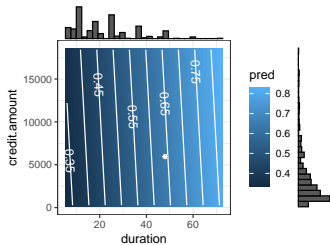


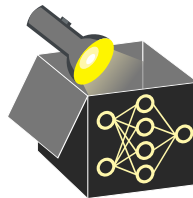
Interpretable Machine Learning

LIME Examples



Learning goals

- See real-world data examples
- See application to image and text data



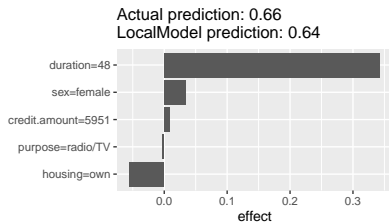
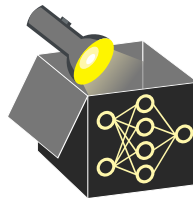
EXAMPLE ON CREDIT DATASET (TABULAR)



- Model: SVM with RBF kernel
- \mathbf{x} : first data point of the dataset with $\hat{f}_{bad}(\mathbf{x}) = 0.658$
- \mathbf{z} : training data \rightsquigarrow weighted by the Gower proximity
- Surrogate model \hat{g} : L_1 -regularized linear model with 5 features

age	sex	job	housing	saving	checking	credit.amount	duration	purpose
22	female	2	own	little	moderate	5951	48	radio/TV

EXAMPLE ON CREDIT DATASET (CONT'D)

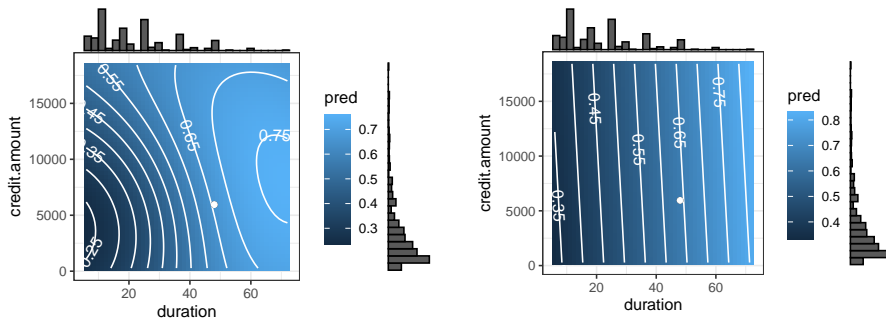


Effects of surrogate model, i.e. $\hat{\theta}^T \mathbf{x}$

- The local model prediction for \mathbf{x} is $\hat{g}(\mathbf{x}) = 0.64$ vs. $\hat{f}(\mathbf{x}) = 0.658$
- \hat{g} has a local fidelity of $L(\hat{f}, \hat{g}, \phi_{\mathbf{x}}) = 4.82$ with $\phi_{\mathbf{x}}(\mathbf{z})$ as the Gower proximity and $L(\hat{f}_{bad}(\mathbf{z}), g(\mathbf{z}))$ as the euclidean distance

EXAMPLE ON CREDIT DATASET (CONT'D)

- 2-dim ICE plots (aka. prediction surface plot) of credit amount and duration show how the surrogate model g linearly approximates the previously nonlinear prediction surface of \hat{f}_{bad}



2-dim ICE plot of \hat{f}_{bad} (**left**) and surrogate g (**right**) for features duration and credit amount.

The white dot is \mathbf{x} . The histograms display the marginal distribution of the training data \mathbf{X} .

LIME FOR TEXT DATA

► Shen, Ian, (2019)



LIME can also be applied to text data:

- Raw text representations:
 - Binary vector indicating the presence or absence of a word
 - A vector of word counts
- Examples for *"This text is the first text."* and *"Finally, this is the last one."*:

this	text	is	the	first	finally	last	one
1	2	1	1	1	0	0	0
1	0	1	1	0	1	1	1

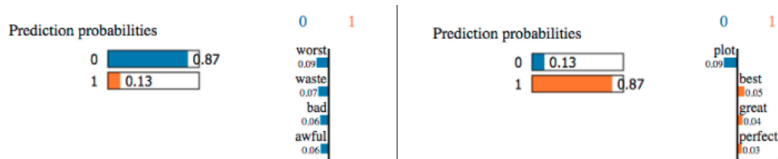
- **Sampling:** Randomly set the entry of individual words to 0; equal to removing all occurrences of this word in the text.
- **Proximity:** Exponential kernel with cosine distance.
 - Neglects words that do not occur in both texts
 - Measures the distance irrespective of the text size

LIME FOR TEXT DATA (CONT'D)

► Shen, Ian, (2019)



- Random forest classifier labeling movie reviews from IMDB
 - 0: negative
 - 1: positive
- Surrogate model is a sparse linear model



Words like “worst” or “waste” indicate negative review while words like “best” or “great” indicate positive review

LIME FOR IMAGE DATA

LIME also works for image data:

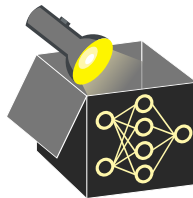
- **Idea:** Each obs. is represented by a binary vector indicating the presence or absence of superpixels

► Achanta et al. 2012

- Superpixels are interconnected pixels with similar colors (absence of a single pixel might not have a (strong) effect on the prediction)
- **Warning:** Size of superpixels needs to be determined before the segmentation takes place
- **Sampling:** Randomly switching some of the superpixels “off”, i.e., by coloring some superpixels uniformly



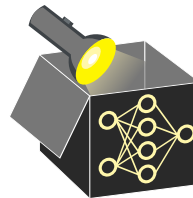
Example for
superpixels of
different sizes



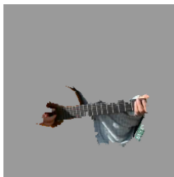
LIME FOR IMAGE DATA (CONT'D)

► Ribeiro. 2016

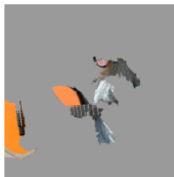
- Explaining prediction of pre-trained inception neural network classifier
- **Sampling**: Graying out all superpixels besides 10 superpixels
- **Surrogate**: Locally weighted sparse linear models
- **Proximity**: Exponential kernel with euclidean distance



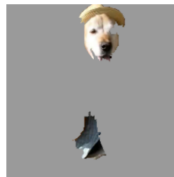
(a) Original Image



(b) Explaining *Electric guitar*



(c) Explaining *Acoustic guitar*



(d) Explaining *Labrador*

Top 3 classes predicted