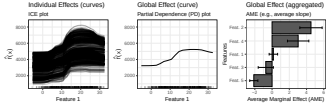
Interpretable Machine Learning

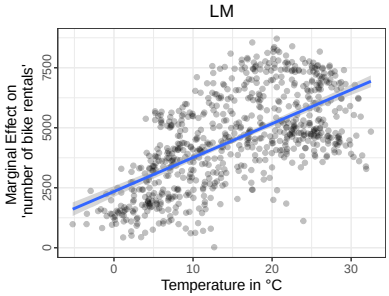
Introduction to Feature Effects

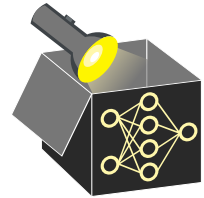


Learning goals

- Global Feature Effects
- Local Feature Effects

FEATURE EFFECTS - GLOBAL VIEW

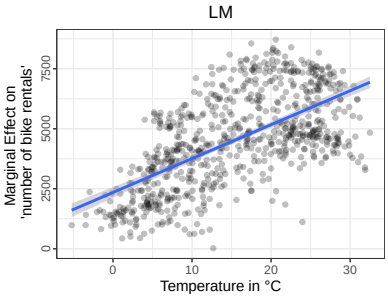


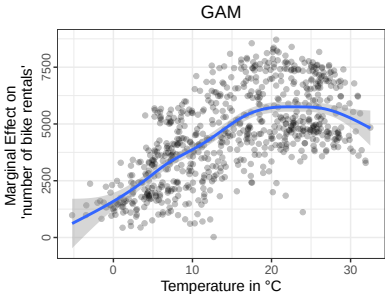


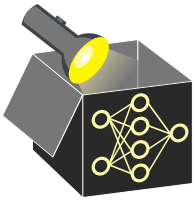
LM without interaction: $\hat{\theta}_j$ is linear effect of feature x_j (applies globally to all observations):

- Model equation: $\hat{f}(\mathbf{x}) = \hat{\theta}_0 + x_1\hat{\theta}_1$
- Single value $\hat{\theta}_1$ describes global effect

FEATURE EFFECTS - GLOBAL VIEW







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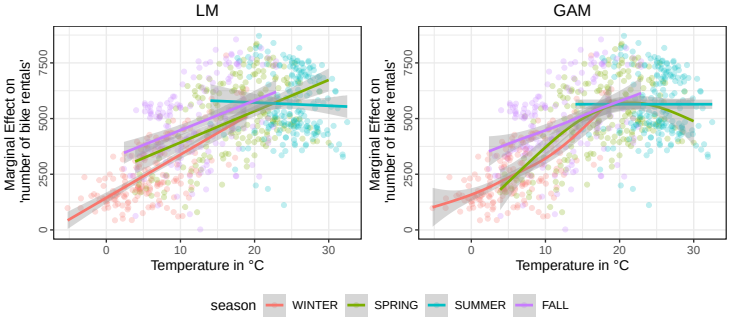
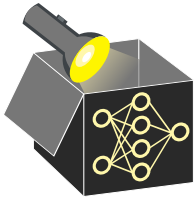
GAM without interaction: $\hat{f}_j(x_j)$ is non-linear effect of feature x_j (applies globally):

- Model equation: $\hat{f}(\mathbf{x}) = \hat{\theta}_0 + \hat{f}_j(x_1)$
- Curve $\hat{f}_1$ describes global effect

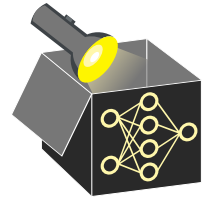
FEATURE EFFECTS - LOCAL VIEW





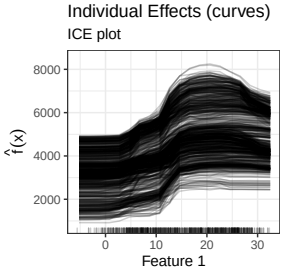
- Interactions: Feature effect is modified by other features and varies across observations
  $\Rightarrow$ Effect of temperature varies across seasons
  $\Rightarrow$ Multiple values / curves needed to describe effect
- ML models often model non-linear effects and complex interactions
  $\Rightarrow$ Need for local feature effect methods, e.g., analyze effect for individual observations
  $\Rightarrow$ Analyzing global effects by aggregating local effects

FEATURE EFFECTS



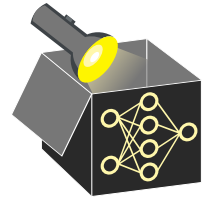
Feature effects visualize or quantify marginal contribution of a feature of interest w.r.t. predictions

- Similar to regression coefficients (LMs) or Splines (GAMs)
- Different aggregation levels for feature effects exist (simplification but information loss)
- Methods: ICE curves (local curves)



Individual (curves)

FEATURE EFFECTS



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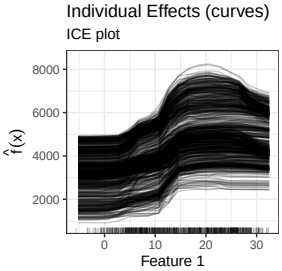
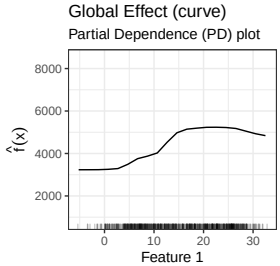
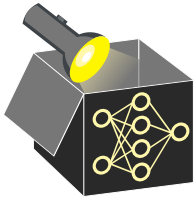
- Methods: ICE curves (local curves), PD and ALE plots (global curves)





Individual (curves) $\xrightarrow[\text{curves}]{\text{aggregate}}$ Global (single curve)

FEATURE EFFECTS



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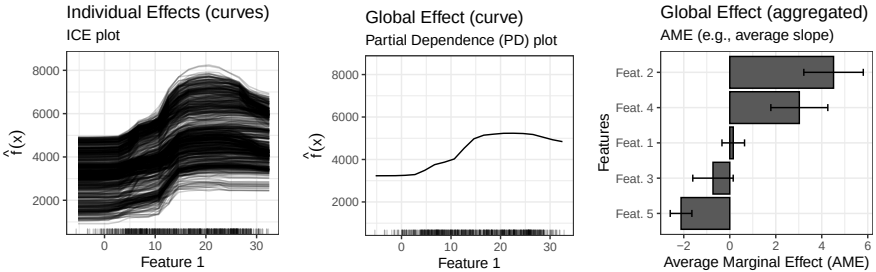
- Different aggregation levels for feature effects exist (simplification but information loss)
- Methods: ICE curves (local curves), PD and ALE plots (global curves), AME (global value)



Individual (curves) $\xrightarrow[\text{curves}]{\text{aggregate}}$ Global (single curve) $\xrightarrow[\text{slopes}]{\text{aggregate}}$ Global (single value)