An Introduction to XGBoost

王社英

April 17, 2020

Outline

XGBoost Introduction

Decision Tree Algorithm

Gradient Boosting

Tree Boosting

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Decision Tree Algorithm

- ID3
- C4.5
- CART

Gradient Boosting

- Gradient Boosting
- Gradient Boosting Boosting

Tree Boosting

- Additive Training
- Model Complexity
- The Structure Score
- Learn the tree structure

XGBoost Introduction

XGBoost[CG16] is a scalable end to end tree boosting system.

- a novel sparsity aware algorithm for sparse data
- weighted quantile sketch for approximate tree learning
- insights on cache access patterns, data compression and sharding

By combining these insights, XGBoost scales beyond billions of examples using far fewer resources than existing systems.

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Decision Tree Algorithm

ID3

Apache Spark is a unified analytics engine for large-scale data processing.

Decision Tree Algorithm

C4.5

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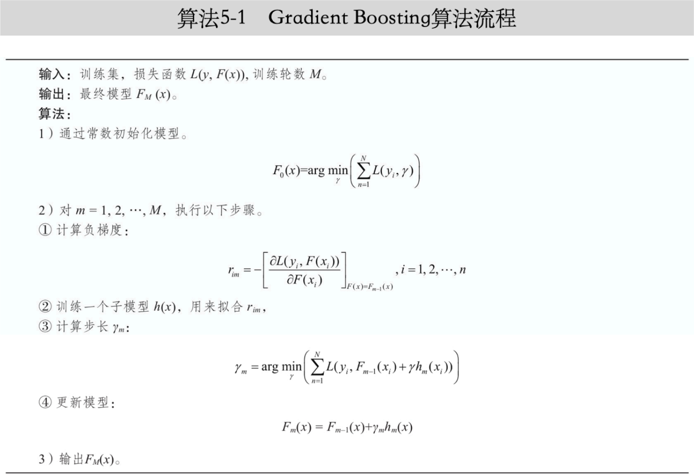


算法5-1　Gradient Boosting算法流程

输入： 训练集，损失函数 $L(y, F(x))$，训练轮数 M。

输出： 最终模型 $F_M(x)$。

算法：

1）通过常数初始化模型。

$$F_0(x)=\arg\min_{\gamma}\left(\sum_{n=1}^{N} L(y_i, \gamma)\right)$$

2）对 $m = 1, 2, \cdots, M$，执行以下步骤。

① 计算负梯度：

$$r_{im} = -\left[\frac{\partial L(y_i, F(x_i))}{\partial F(x_i)}\right]_{F(x)=F_{m-1}(x)}, i = 1, 2, \cdots, n$$

② 训练一个子模型 $h(x)$，用来拟合 r_{im}，

③ 计算步长 γ_m：

$$\gamma_m = \arg\min_{\gamma}\left(\sum_{n=1}^{N} L(y_i, F_{m-1}(x_i) + \gamma h_m(x_i))\right)$$

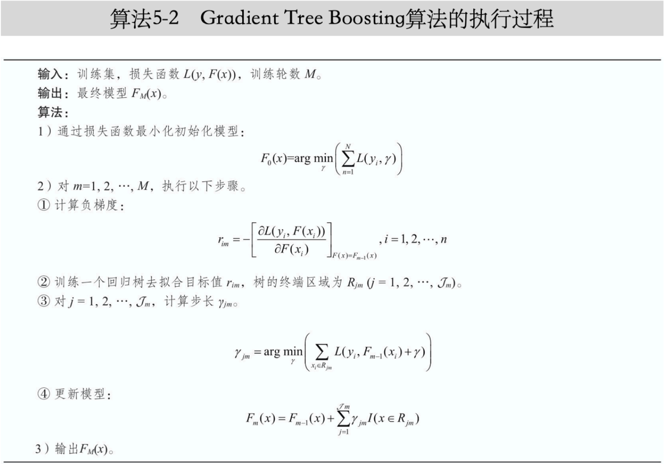
④ 更新模型：

$$F_m(x) = F_{m-1}(x) + \gamma_m h_m(x)$$

3）输出$F_M(x)$。

Gradient Tree Boosting

Gradient Tree Boosting[xgb01]



算法5-2 Gradient Tree Boosting算法的执行过程

输入： 训练集，损失函数 $L(y, F(x))$，训练轮数 M。

输出： 最终模型 $F_M(x)$。

算法：

1）通过损失函数最小化初始化模型：

$$F_0(x)=\arg\min_{\gamma}\left(\sum_{n=1}^{N}L(y_i,\gamma)\right)$$

2）对 $m=1, 2, \cdots, M$，执行以下步骤。

① 计算负梯度：

$$r_{im}=-\left[\frac{\partial L(y_i,F(x_i))}{\partial F(x_i)}\right]_{F(x)=F_{m-1}(x)}, i=1,2,\cdots,n$$

② 训练一个回归树去拟合目标值 r_{im}，树的终端区域为 R_{jm} $(j=1, 2, \cdots, \mathcal{J}_m)$。

③ 对 $j=1, 2, \cdots, \mathcal{J}_m$，计算步长 γ_{jm}。

$$\gamma_{jm}=\arg\min_{\gamma}\left(\sum_{x_i\in R_{jm}}L(y_i,F_{m-1}(x_i)+\gamma)\right)$$

④ 更新模型：

$$F_m(x)=F_{m-1}(x)+\sum_{j=1}^{\mathcal{J}m}\gamma_{jm}I(x\in R_{jm})$$

3）输出$F_M(x)$。

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Questions and Answers?

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Thank You!

References I

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深入理解 XGBoost：高效机器学习算法与进阶.
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