Explaining GBMs globally

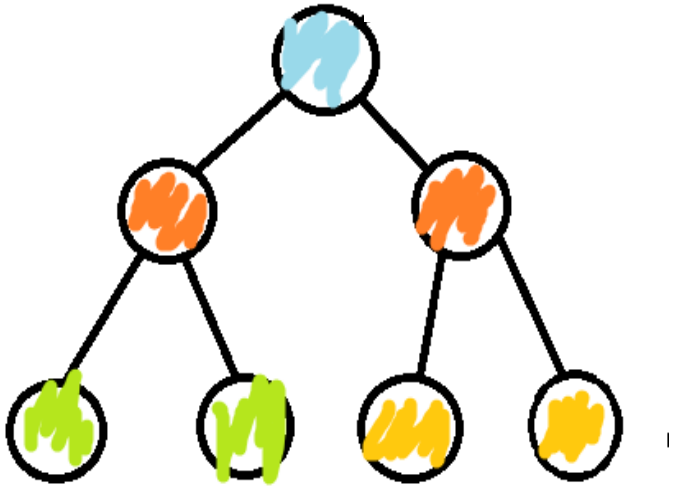
Global GBM explainability

Global explanation = Feature importance

To quantify feature importance:

- A metric to quantify the gain at each split.
- A way to calculate the feature gain across all trees in the ensemble.

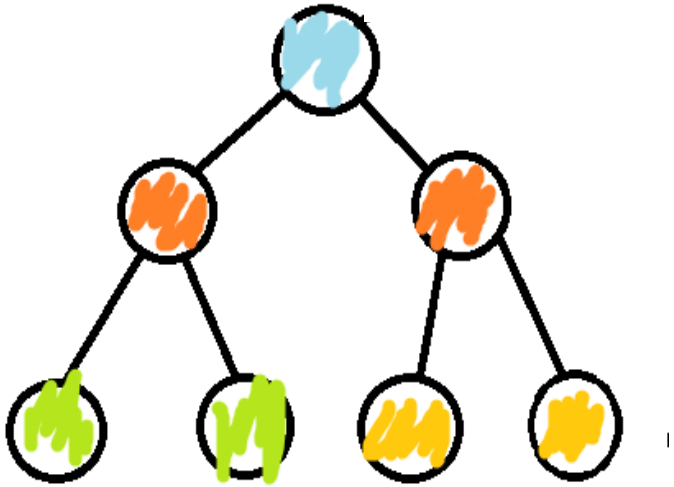
Gain metric



$$\text{Gain} = w \times H_{parent} - (w \times H_{left} + w \times H_{right})$$

H is a measure of impurity.

Gain metric: sklearn



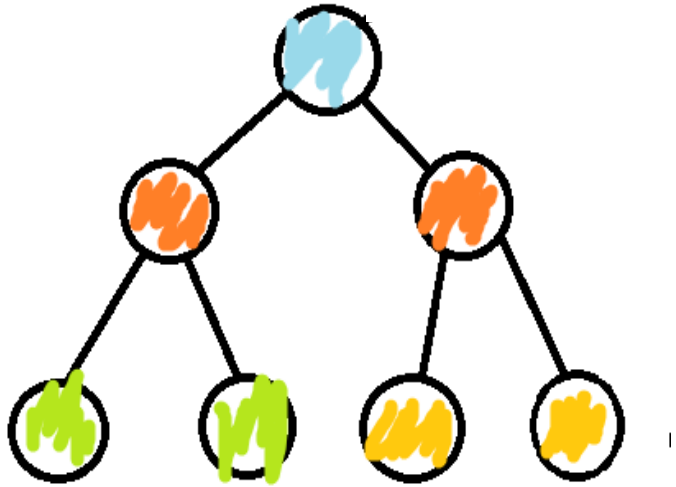
In GBMs, trees are regression trees.

- They fit to the residuals of former trees.

Sum of squares ➔ $$H(Q_m) = \frac{1}{n_m} \sum_{y \in Q_m} (y - \bar{y}_m)^2$$

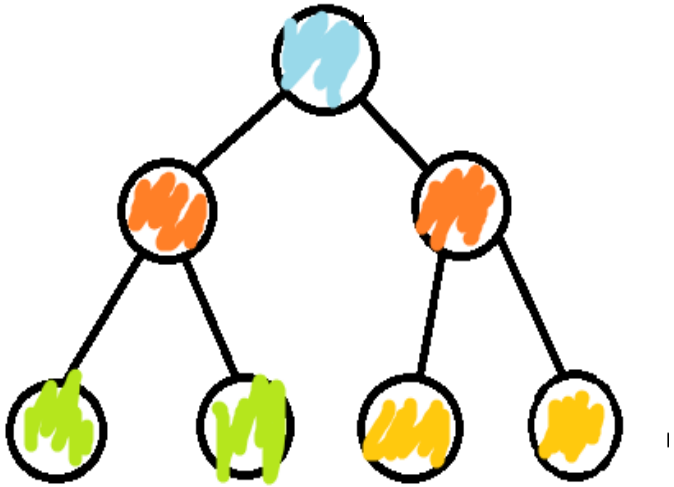
Friedman mse ➔ $$i^2(R_l, R_r) = \frac{w_l w_r}{w_l + w_r} (\bar{y}_l - \bar{y}_r)^2,$$

Gain metric: XGBoost



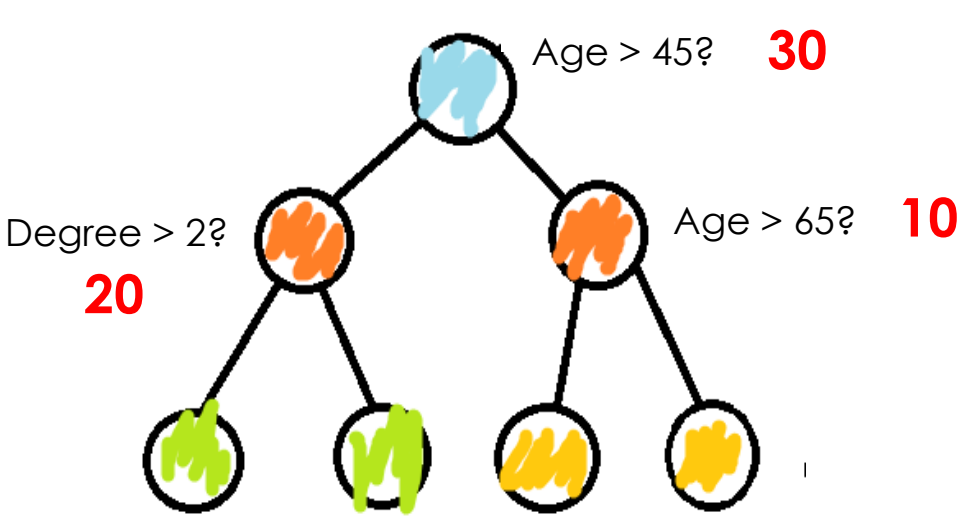
- **Gain – impurity decrease**: the mean gain (squared error) taking all splits that use the feature.
  - Can also be total gain.
- **Weight – split count** ➔ the number of times a feature is selected for a split in a tree.
- **Cover**: mean number of observations that a node splits, taken across all splits that use the feature.
  - Can also be total number of observations split across all nodes that use the feature.

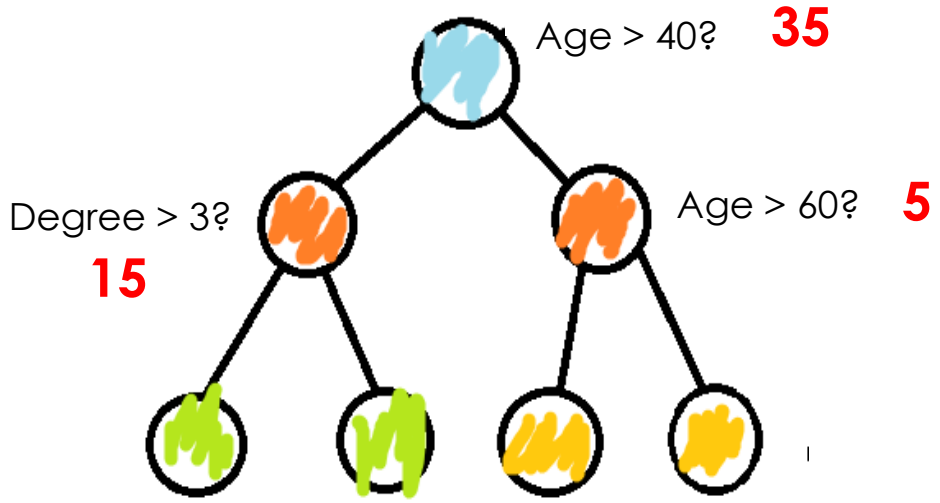
Gain metric: lightGBM



- **Gain – impurity decrease**: the total gain (squared error) taking all splits that use the feature.
- **Split ➔** the number of times a feature is selected for a split in a tree.

Feature importance: GBM





- Age = 30 + 10 + 35 + 5 = 80
- Degree = 20 + 15 = 35
- Total = 105

- Age = 80/105 = **0.76**
- Degree = 35/105 = **0.28**

We consider the ensemble as if it was one big tree.

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THANK YOU

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