Ensemble method (2)
Boosting

Ensemble method review

Problem: Trees are weak learner and trees overfit

Idea 1: Let's ensemble them

Idea 2: Let's decorrelate trees

Random Forest

Bagging and Random Forest

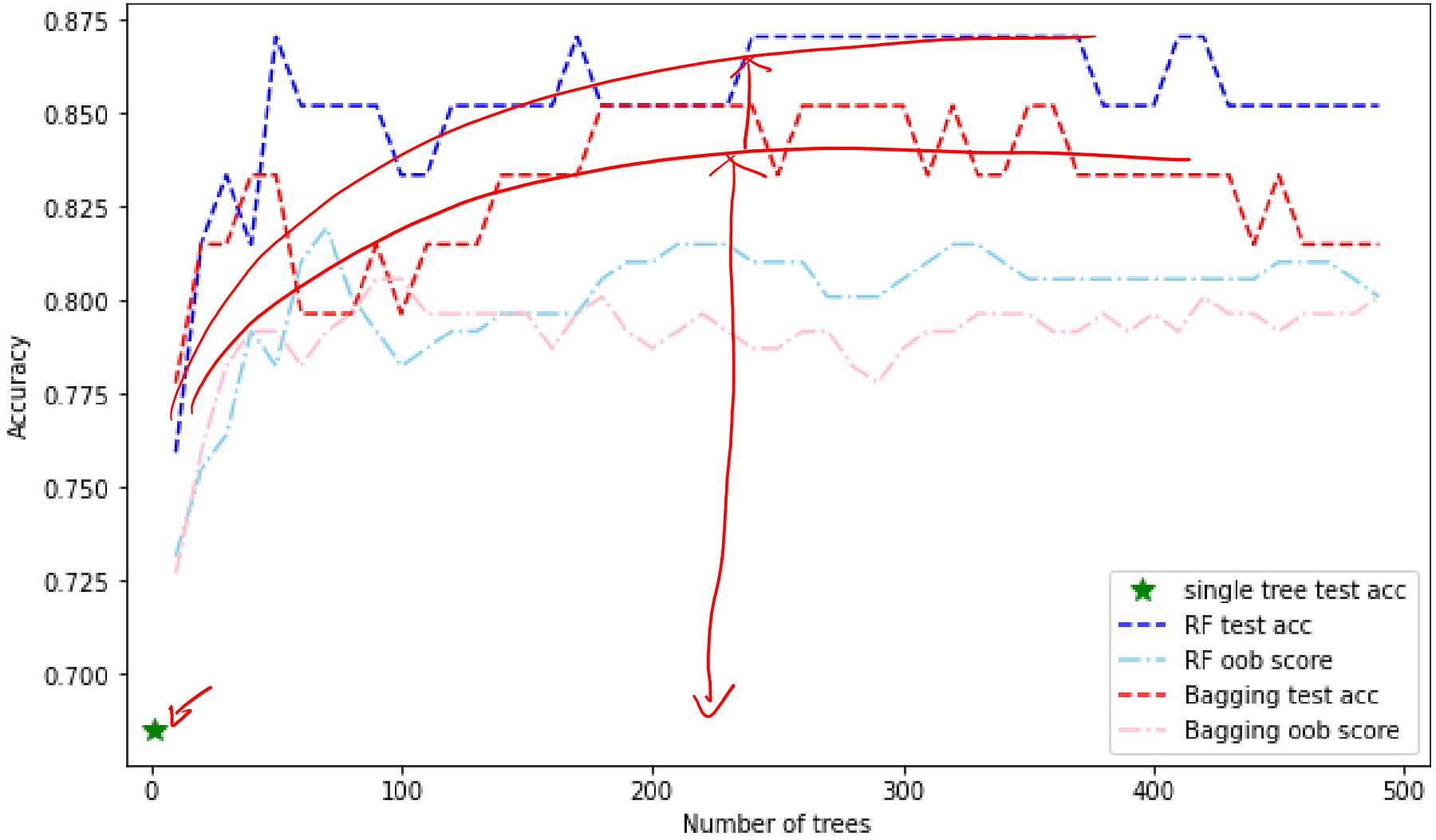
Bagging

- Random sample on data (row)
- Parallel ensembling

Random Forest

- Also on features (col)
- Further decorrelates the trees
- Parallel ensembling

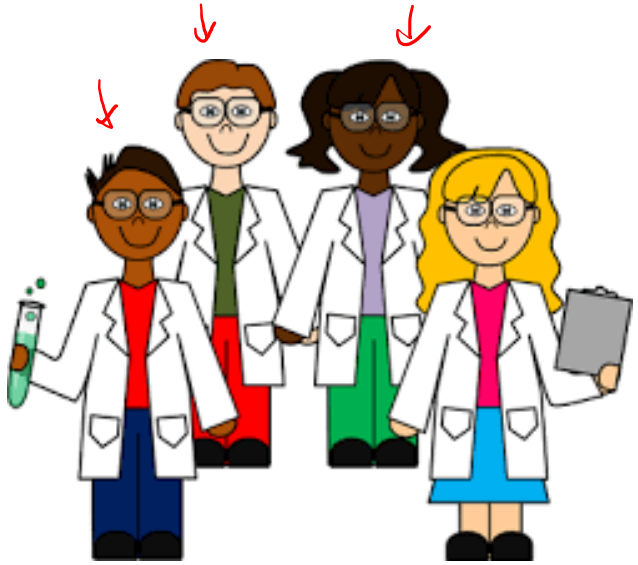
Power of an ensemble of trees

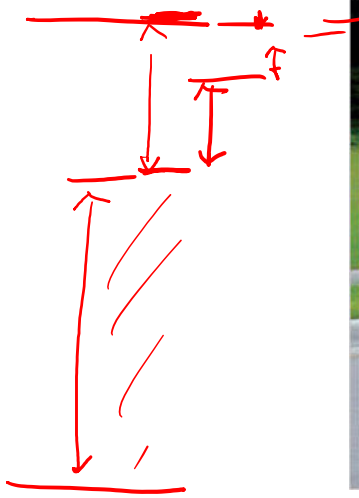


Boosting

Problem: Trees are weak learner and trees overfit

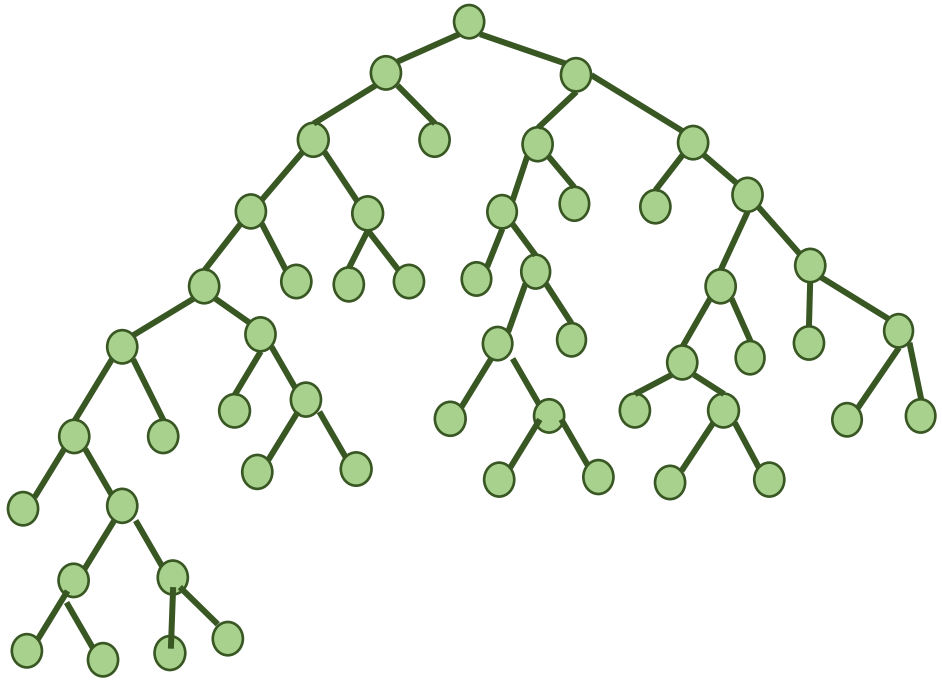
Idea 3: Let's make the trees a strong learner
How: Grow a small tree (stump) to fit residual



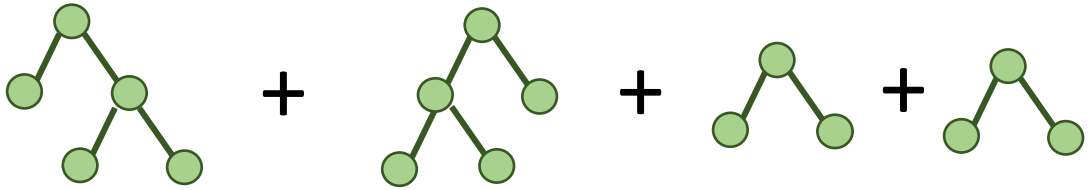


Boosting

Decision Tree



Boosting



Boosting algorithm

1. Initialize $f(x) = 0, r = y$
2. For $b = 1,2, \ldots, B$, repeat
   a) Fit a tree $f_b(x)$ to the training data (X, r)
   b) $f(x) \leftarrow f(x) + \lambda f_b(x)$
   c) $r \leftarrow r - \lambda f_b(x)$
3. output $\sum_{b=1}^{B} \lambda f_b(x)$

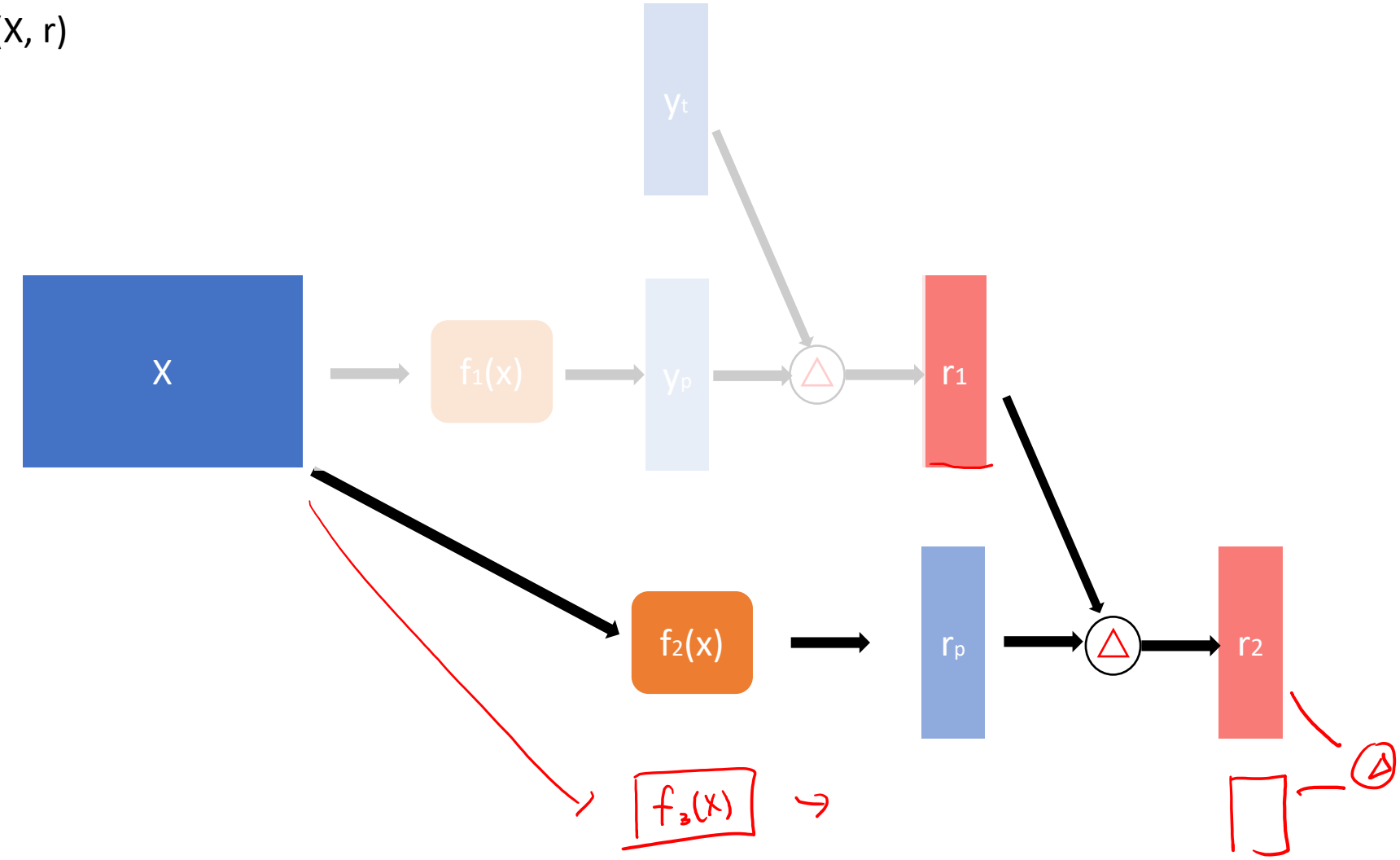
Boosting algorithm

For $b = 1,2, \ldots, B$, repeat

Fit a tree $f_b(x)$ to the training data (X, r)

$$f(x) \leftarrow f(x) + \lambda f_b(x)$$

$$r \leftarrow r - \lambda f_b(x)$$



Boosting Methods

- AdaBoost
- Gradient Boost