Ensemble methods: boosting

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Examined ensemble methods

- Averaging (or blending)
- Weighted averaging
- Conditional averaging
- Bagging
- Boosting
- Stacking
- StackNet

What is Boosting

A form of weighted averaging of models where each model is built sequentially via taking into account the past model performance.

Main boosting types

- Weight based
- Residual based

Weight based boosting

Rownum	x0	x1	x2	x3	y
0	0.94	0.27	0.80	0.34	1
1	0.84	0.79	0.89	0.05	1
2	0.83	0.11	0.23	0.42	1
3	0.74	0.26	0.03	0.41	0
4	0.08	0.29	0.76	0.37	0
5	0.71	0.76	0.43	0.95	1
6	0.08	0.72	0.97	0.04	0

Weight based boosting

Rownum	x0	x1	x2	x3	y	pred
0	0.94	0.27	0.80	0.34	1	0.80
1	0.84	0.79	0.89	0.05	1	0.75
2	0.83	0.11	0.23	0.42	1	0.65
3	0.74	0.26	0.03	0.41	0	0.40
4	0.08	0.29	0.76	0.37	0	0.55
5	0.71	0.76	0.43	0.95	1	0.34
6	0.08	0.72	0.97	0.04	0	0.02

Weight based boosting

Rownum	x0	x1	x2	x3	y	pred	abs.error
0	0.94	0.27	0.80	0.34	1	0.80	0.20
1	0.84	0.79	0.89	0.05	1	0.75	0.25
2	0.83	0.11	0.23	0.42	1	0.65	0.35
3	0.74	0.26	0.03	0.41	0	0.40	0.40
4	0.08	0.29	0.76	0.37	0	0.55	0.55
5	0.71	0.76	0.43	0.95	1	0.34	0.66
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1	0.84	0.79	0.89	0.05	1	0.75	0.25	1.25
2	0.83	0.11	0.23	0.42	1	0.65	0.35	1.35
3	0.74	0.26	0.03	0.41	0	0.40	0.40	1.40
4	0.08	0.29	0.76	0.37	0	0.55	0.55	1.55
5	0.71	0.76	0.43	0.95	1	0.34	0.66	1.66
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Weight based boosting parameters

- Learning rate (or shrinkage or eta)
- Number of estimators
- Input model – can be anything that accepts weights
- Sub boosting type:
  - AdaBoost – Good implementation in sklearn (python)
  - LogitBoost - Good implementation in Weka (Java)

Residual based boosting

Rownum	x0	x1	x2	x3	y
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2	0.83	0.11	0.23	0.42	1	0.65	0.35
3	0.74	0.26	0.03	0.41	0	0.40	-0.40
4	0.08	0.29	0.76	0.37	0	0.55	-0.55
5	0.71	0.76	0.43	0.95	1	0.34	0.66
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Residual based boosting

Rownum	x0	x1	x2	x3	y	new pred
0	0.94	0.27	0.80	0.34	0.2	0.15
1	0.84	0.79	0.89	0.05	0.25	0.20
2	0.83	0.11	0.23	0.42	0.35	0.40
3	0.74	0.26	0.03	0.41	-0.4	-0.30
4	0.08	0.29	0.76	0.37	-0.55	-0.20
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To predict Rownum=1 we would say :

Final prediction = 0.75 + 0.20 = **0.95**

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Residual based boosting parameters

- Learning rate (or shrinkage or eta)
- Number of estimators
- Row (sub) sampling
- Column (sub) sampling
- Input model – better be trees.
- Sub boosting type:
  - Fully gradient based
  - Dart

Residual based favourite implementations

- Xgboost
- Lightgbm
- H2O's GBM
- Catboost
- Sklearn's GBM