

Bootstrap aggregating

Problem:

Overfitting to training set

Solution:

Bootstrap training set into multiple sets

Fit a model to each random set

Each model has one vote, choose max vote

	Date	Title	Budget	DomesticTotalGross	Director	Rating	Runtime
0	2013-11-22	The Hunger Games: Catching Fire	130000000	424668047	Francis Lawrence	PG-13	146
1	2013-05-03	Iron Man 3	200000000	409013994	Shane Black	PG-13	128
2	2013-11-22	Frozen	150000000	400738009	Chris BuckJennifer Lee	PG	108
3	2013-07-03	Despicable Me 2	760000000	368061265	Pierre CoffinChris Renaud	PG	98
4	2013-06-14	Man of Steel	225000000	291045518	Zack Snyder	PG-13	143
5	2013-10-04	Gravity	100000000	274092705	Alfonso Cuaron	PG-13	91
6	2013-06-21	Monsters University	NaN	268492764	Dan Scanlon	G	107
7	2013-12-13	The Hobbit: The Desolation of Smaug	NaN	258366855	Peter Jackson	PG-13	161
8	2013-05-24	Fast & Furious 6	160000000	238679850	Justin Lin	PG-13	130
9	2013-03-08	OZ The Great and Powerful	215000000	234911825	Sam Raimi	PG	127
10	2013-05-16	Star Trek Into Darkness	190000000	228778661	J.J. Abrams	PG-13	123
11	2013-11-08	Thor: The Drak World	170000000	206362140	Alan Taylor	PG-13	120
12	2013-06-21	World War Z	190000000	202359711	Marc Forster	PG-13	116
13	2013-03-22	The Croods	135000000	187168425	Kirk De MiccoChris Sanders	PG	98
14	2013-06-28	The Heat	43000000	159582188	Paul Feig	R	117
15	2013-08-07	We're the Millers	37000000	150394119	Rawson Marshall Thurber	R	110
16	2013-12-13	American Hustle	40000000	150117807	David O. Russell	R	138
17	2013-05-10	The Great Gatsby	105000000	144840419	Baz Luhrmann	PG-13	143

Training
set

Test set

Bootstrap: Sample with replacement

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Bootstrap: Sample with replacement

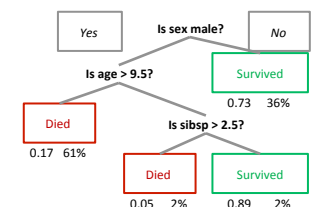
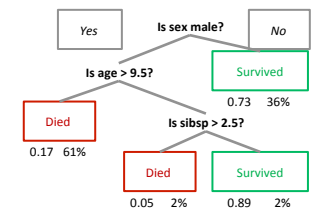
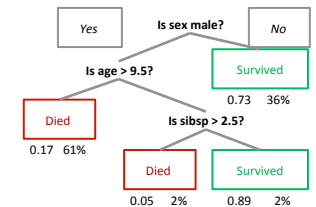
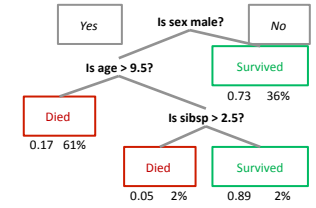
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Classification: Major vote

Regression: Average outcome

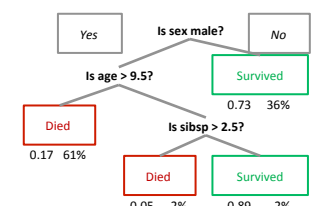
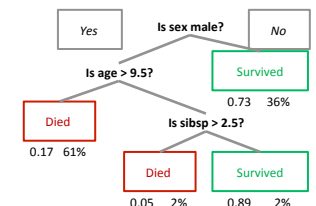
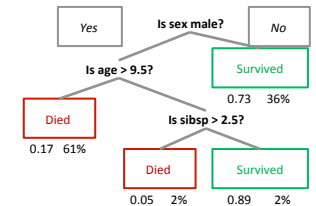
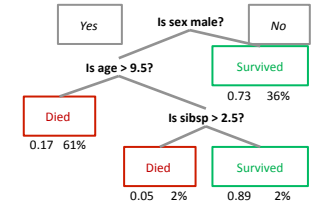
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2013-12-13	American Hustle	40000000	150117807	David O. Russell	R	138
2013-05-10	The Great Gatsby	105000000	144840419	Baz Luhrmann	PG-13	143

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2013-06-14	Man of Steel	225000000	291045518	Zack Snyder	PG-13	143
2013-10-04	Gravity	100000000	274092705	Alfonso Cuaron	PG-13	91
2013-06-21	Monsters University	NaN	268492764	Dan Scanlon	G	107
2013-12-13	The Hobbit: The Desolation of Smaug	NaN	258366855	Peter Jackson	PG-13	161
2013-05-24	Fast & Furious 6	160000000	238679850	Justin Lin	PG-13	130
2013-03-08	OZ The Great and Powerful	215000000	234911825	Sam Raimi	PG	127
2013-05-16	Star Trek Into Darkness	190000000	228778661	J.J. Abrams	PG-13	123
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from sklearn.ensemble import BaggingClassifier
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Ensemble Methods: Random Forests

Tree Bagging with a twist

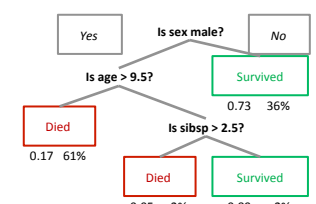
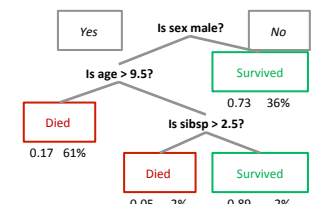
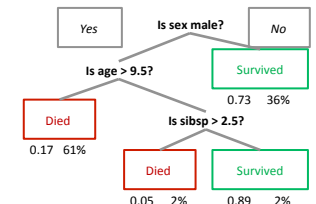
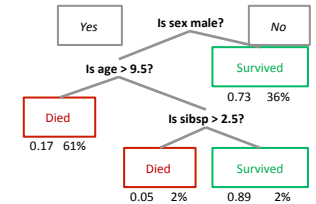
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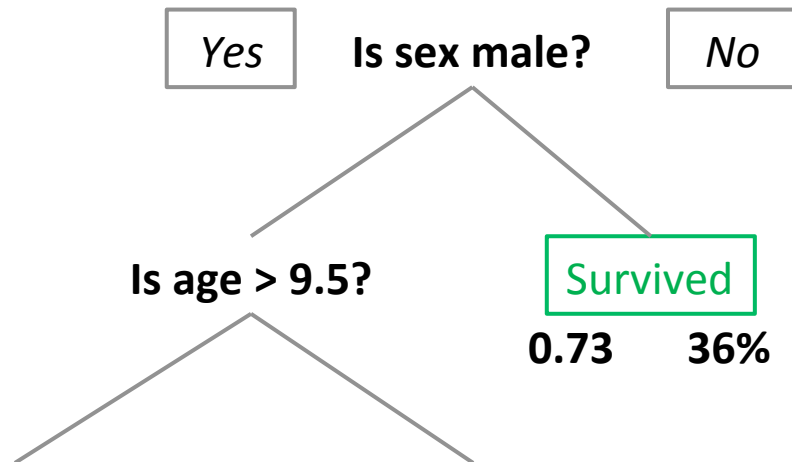
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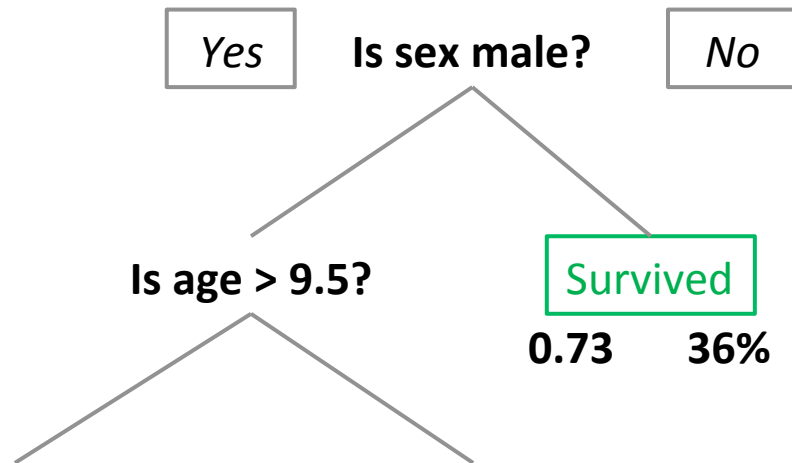
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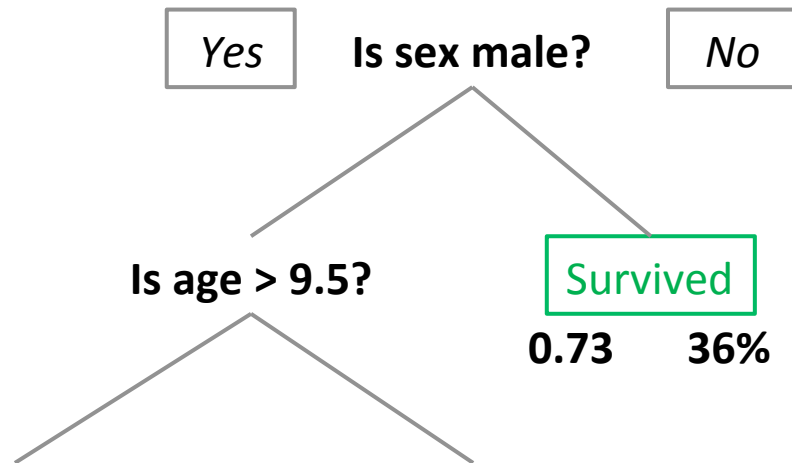
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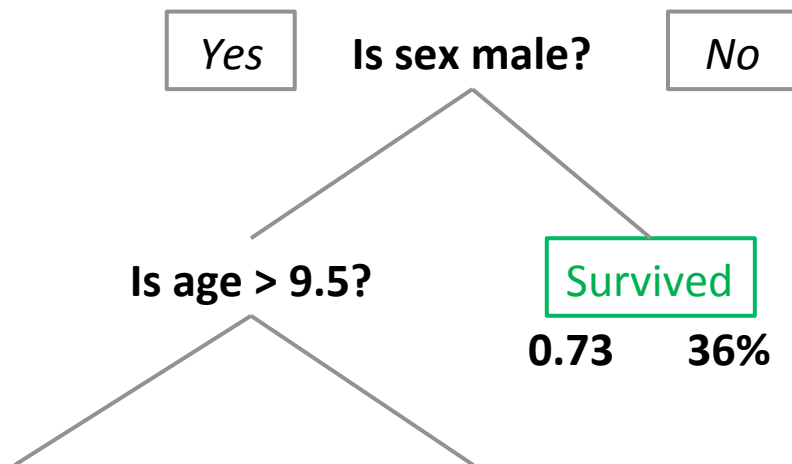
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For a split, do not take the “best” feature split.



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First, randomly choose $\sqrt{n_feat}$ features.



Introduce randomness when building each tree.
For a split, do not take the “best” feature split.
First, randomly choose $\sqrt{n_feat}$ features.
Only choose the best split among these.



```
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```

```
from sklearn.ensemble import RandomForestRegressor
```

```
from sklearn.ensemble import RandomForestClassifier
```

```
from sklearn.ensemble import RandomForestRegressor
```

```
from sklearn.ensemble import ExtraTreesClassifier?
```

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```
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Even more randomized:

For each feature, split rule is random, not optimal