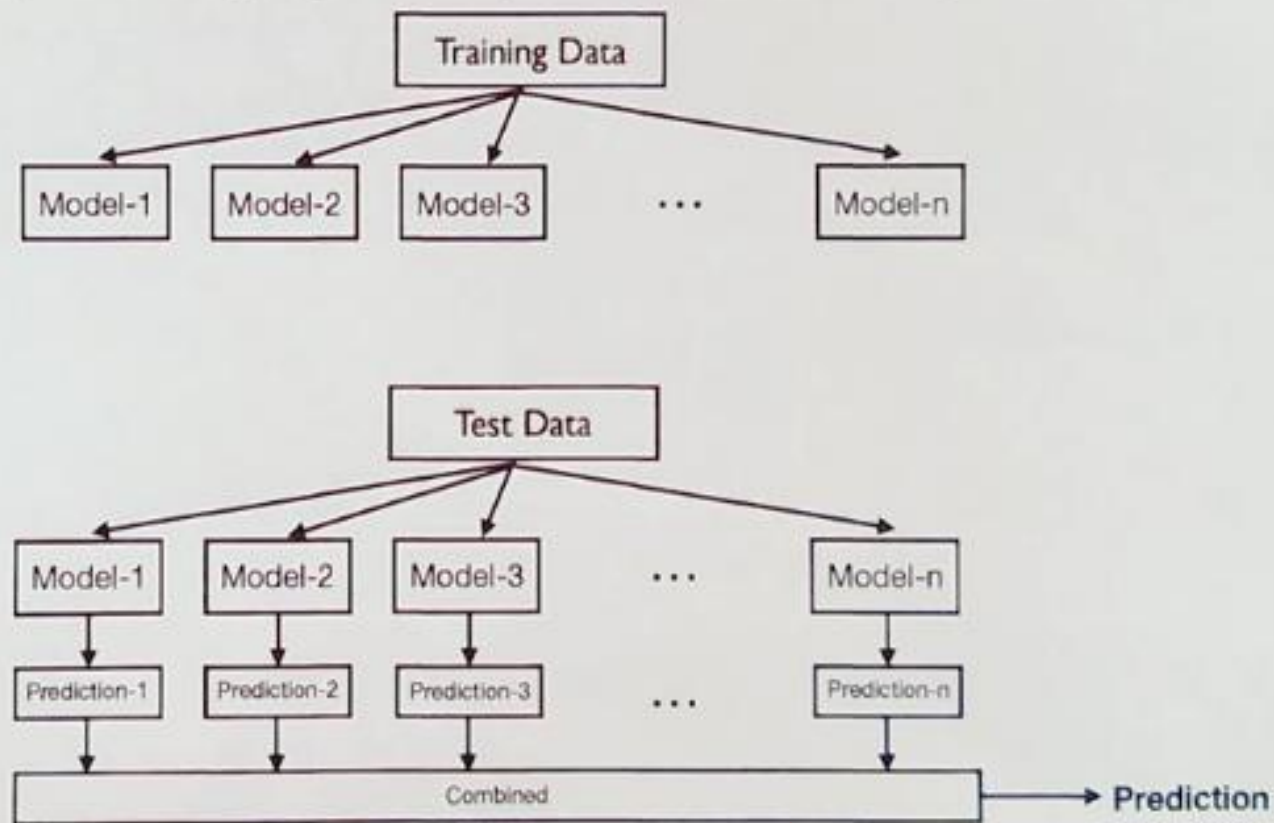


Ensemble Methods

- Ensembles are machine learning methods for combining predictions from multiple separate models.
- The central motivation is rooted under the belief that a committee of experts working together can perform better than a single expert.



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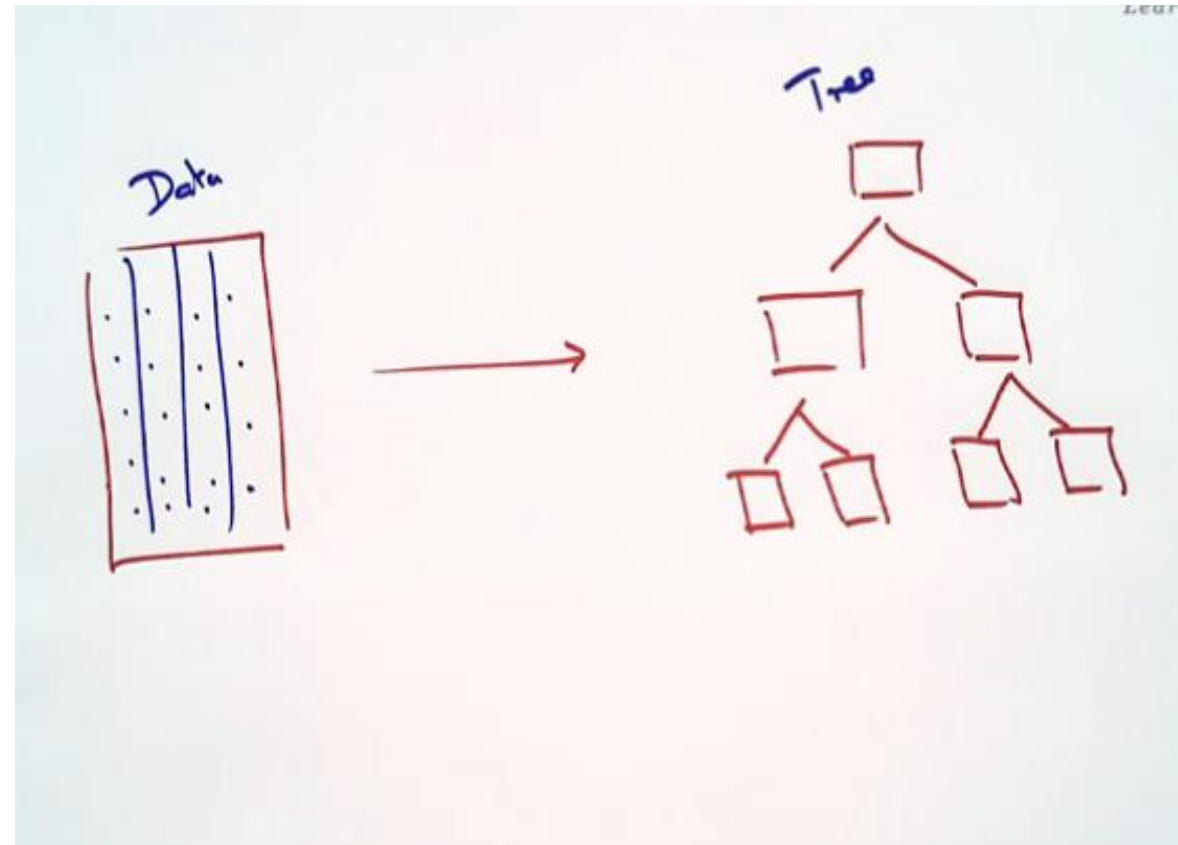
Example

	90% M1	90% M2	90% M3	...	90% M10	
Y	✓	✓	✓		✓	✓
Y	✓	X	X		✓	✓
Z	✓	✓	✓		X	✓
...	X	✓	✓		✓	...
...	✓	X	✓	...	✓	...
...	X	✓	✓		✓	...
...
...	✓	X	✓		✓	...

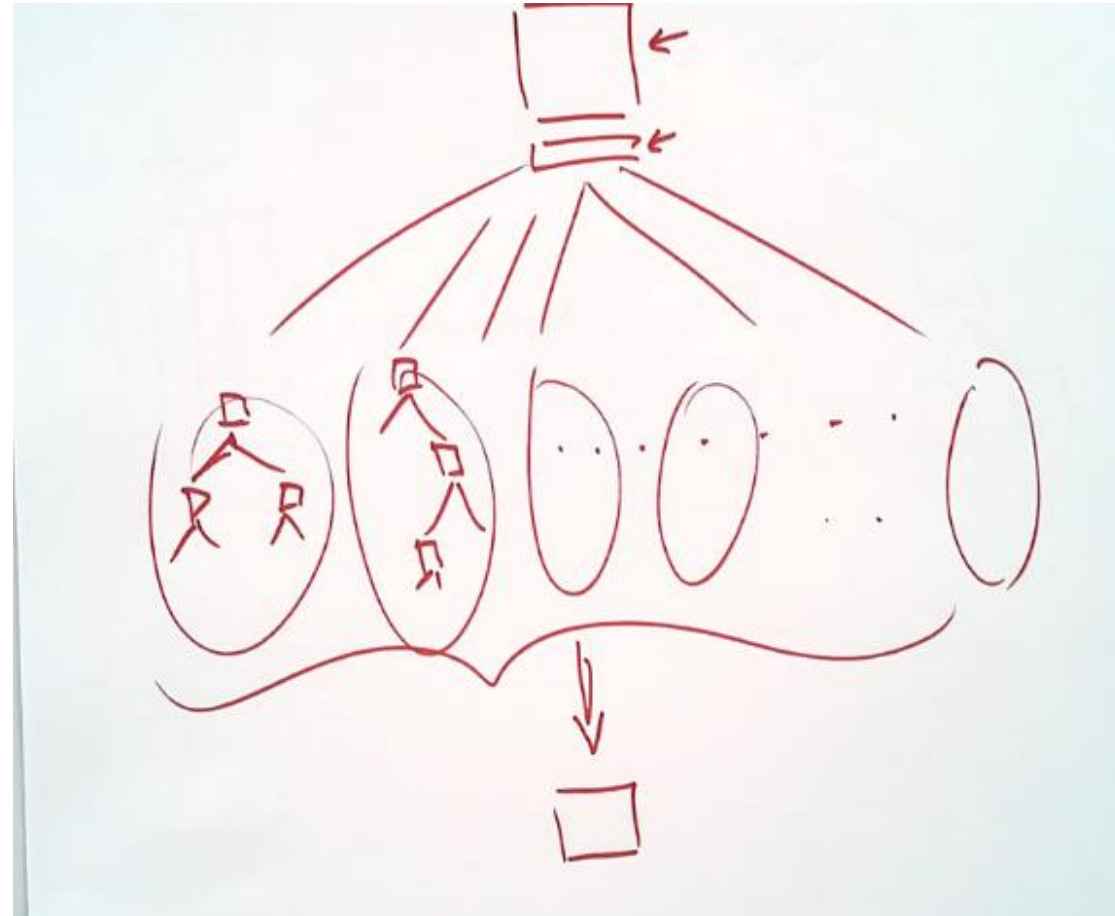
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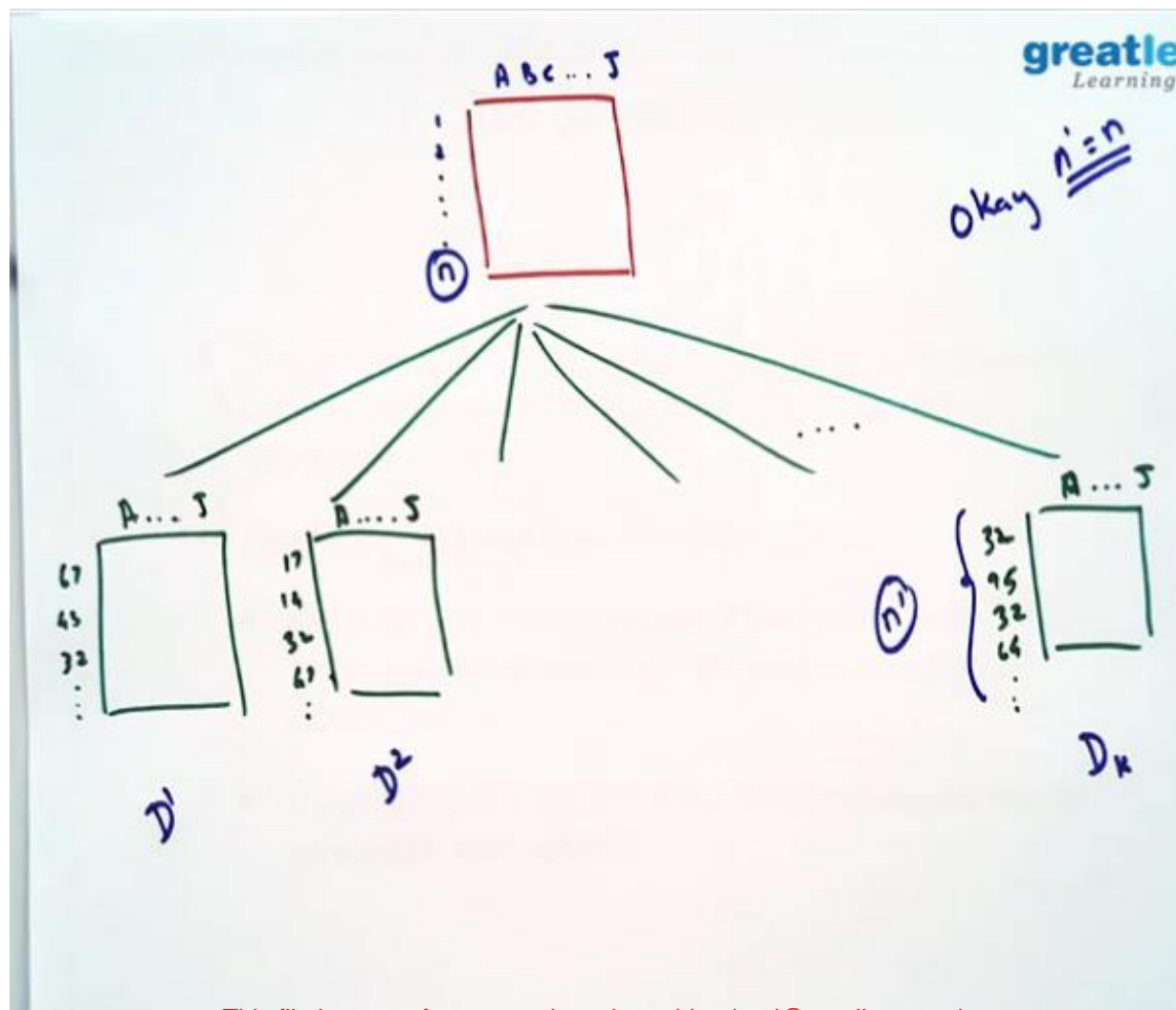
Random Forest



Random Forest



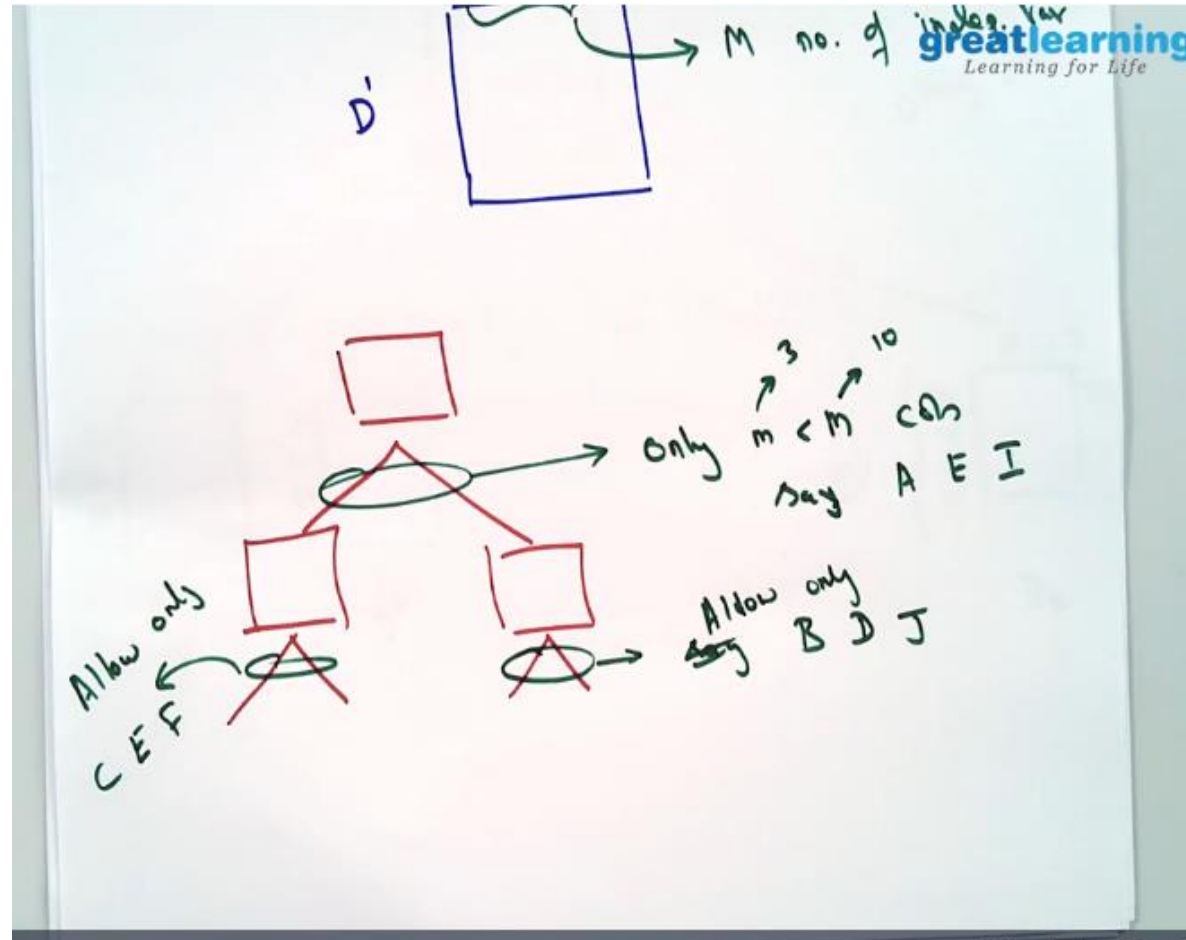
Random Forest



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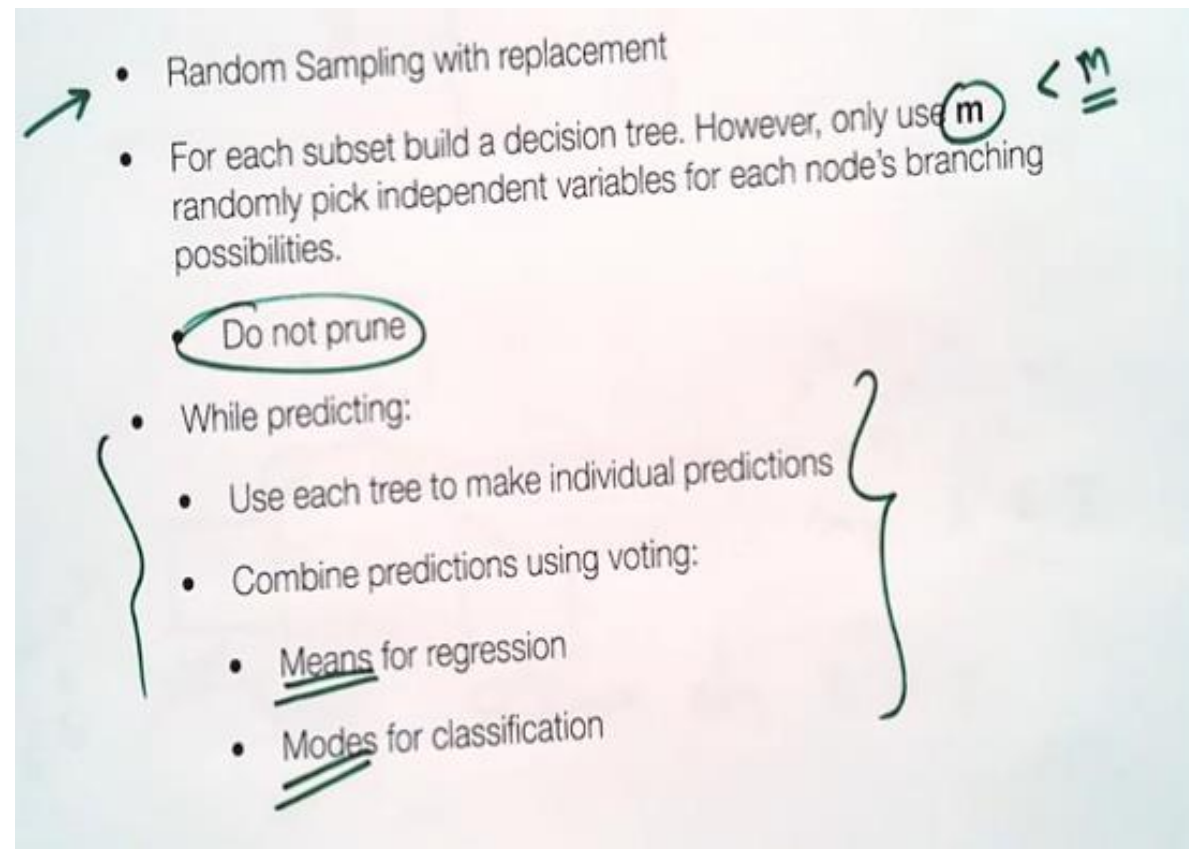
Random Forest



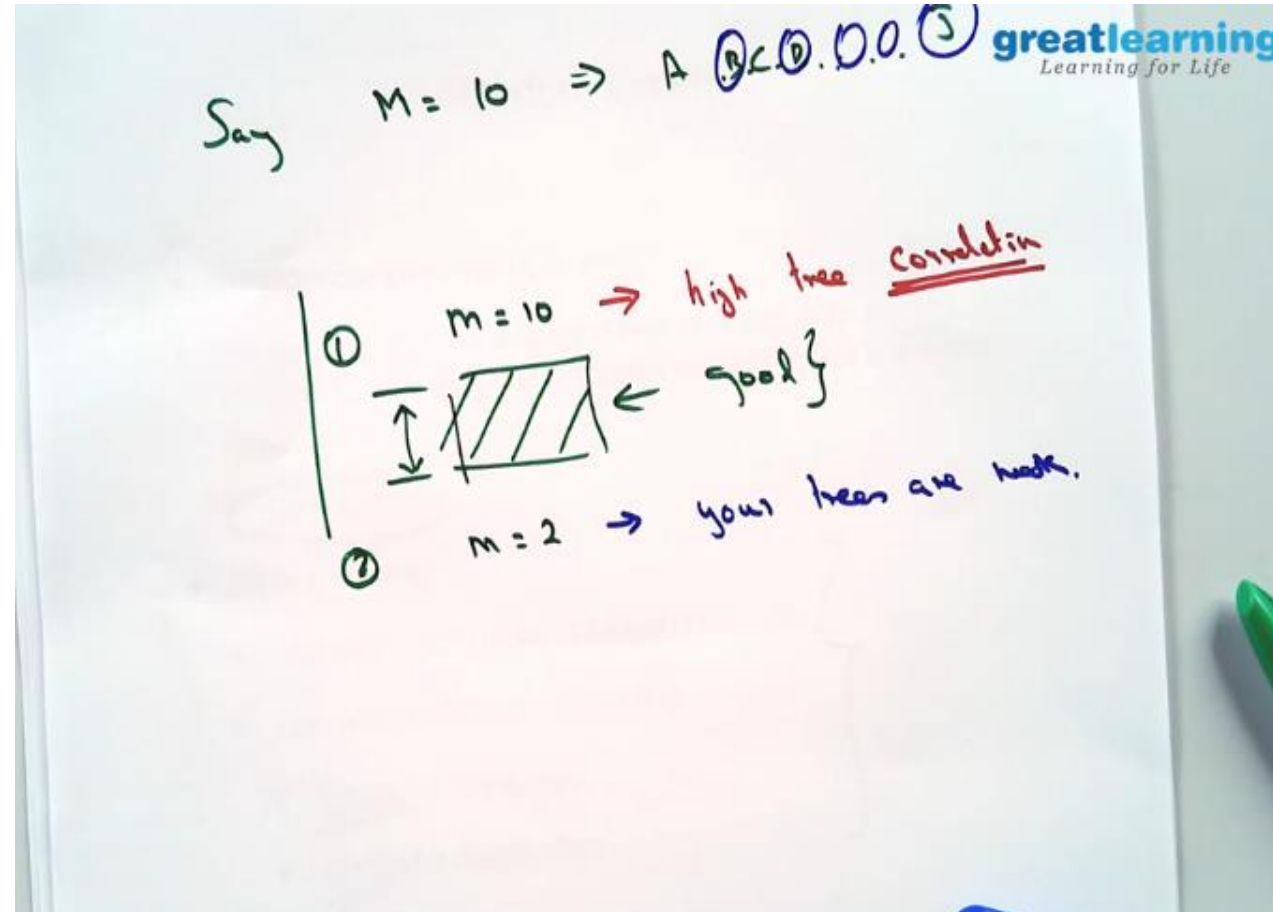
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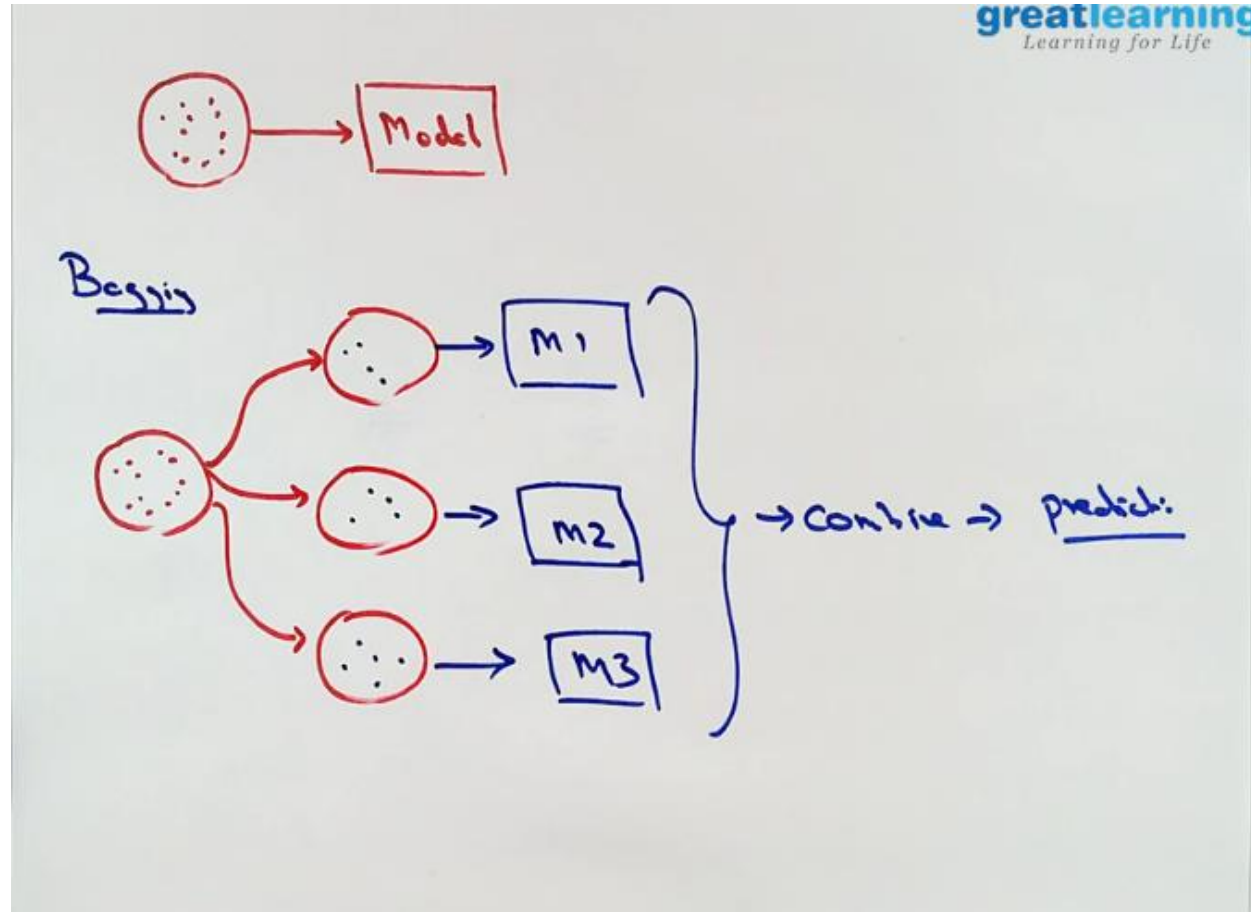
Random Forest

- 
- Random Sampling with replacement
 - For each subset build a decision tree. However, only use m $< M$ randomly pick independent variables for each node's branching possibilities.
 - Do not prune
 - While predicting:
 - Use each tree to make individual predictions
 - Combine predictions using voting:
 - Means for regression
 - Modes for classification

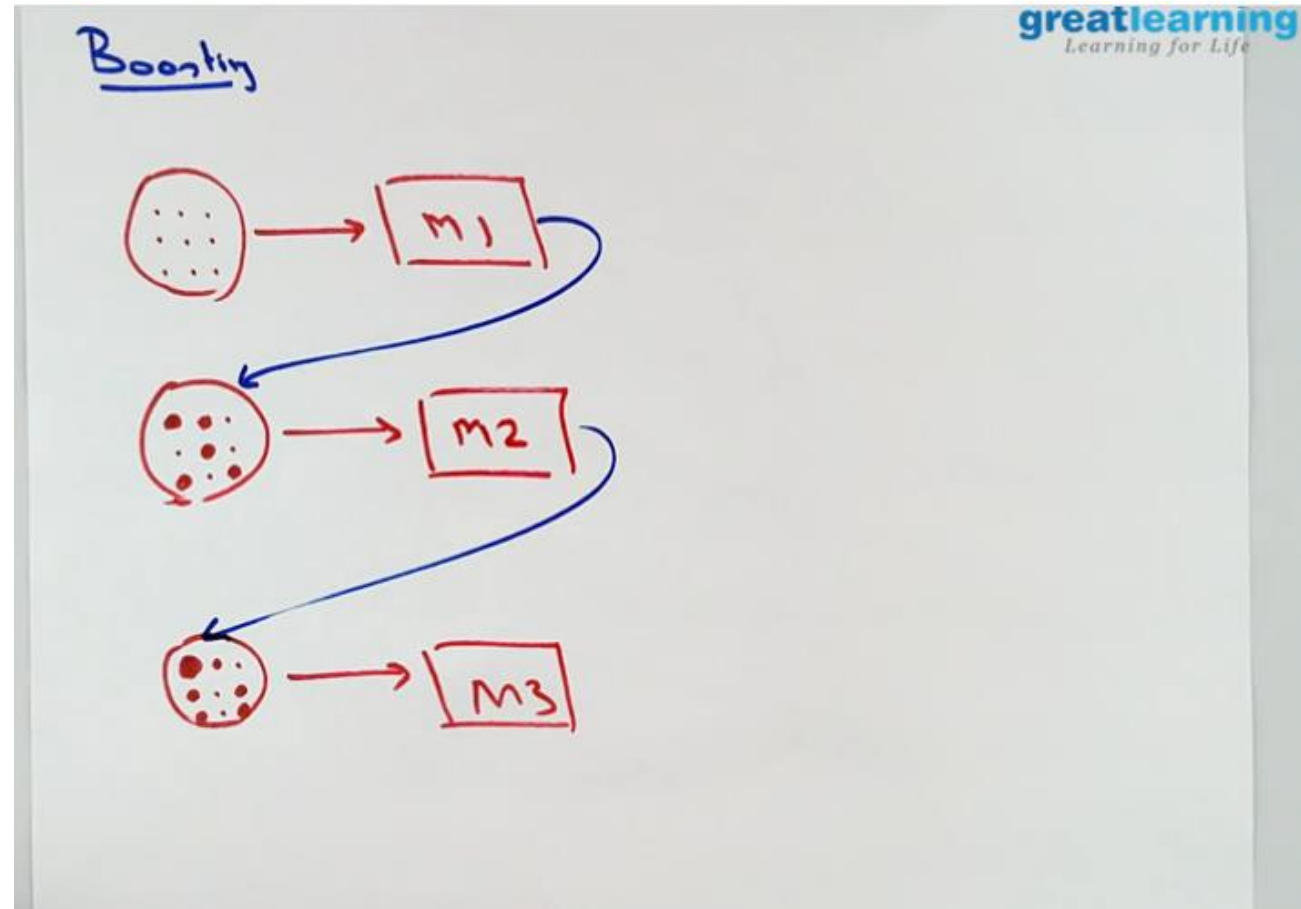
Random Forest



Bagging



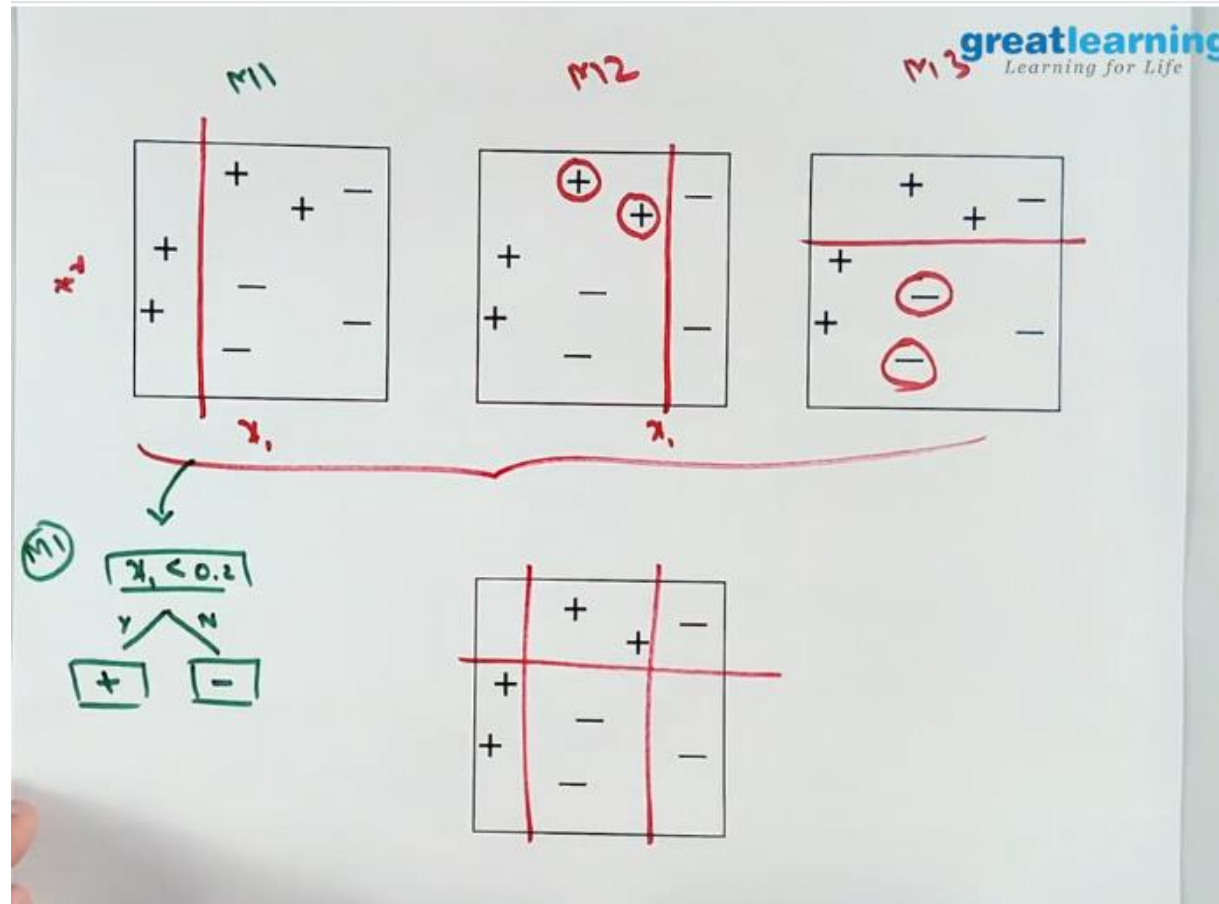
Boosting



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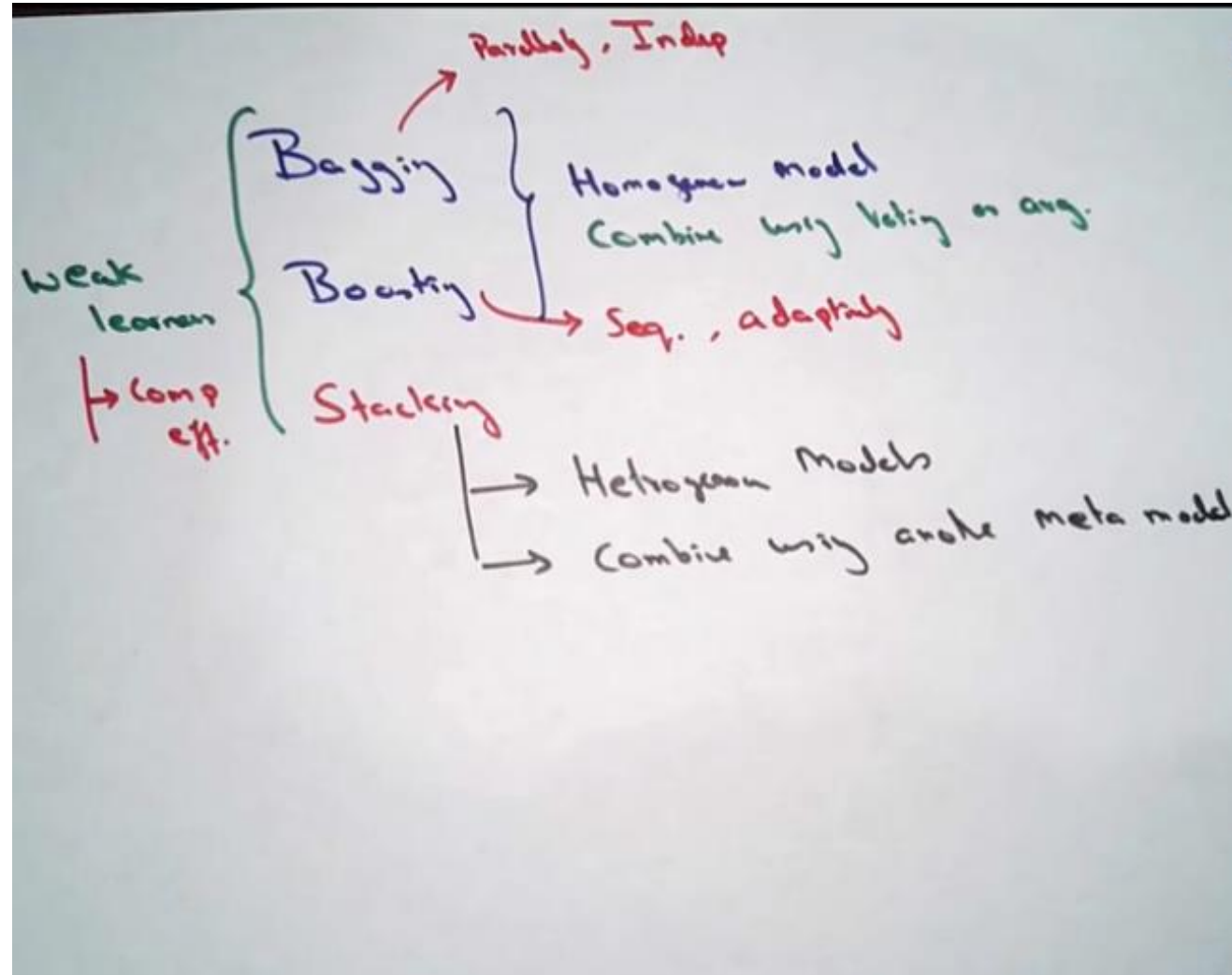
Boosting – Visual Example



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Stacking



Stacking

