Decision trees and Random Forests

AI for ecologists

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20/05/25

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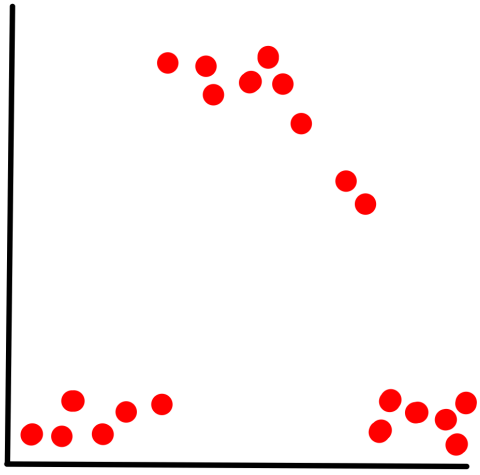
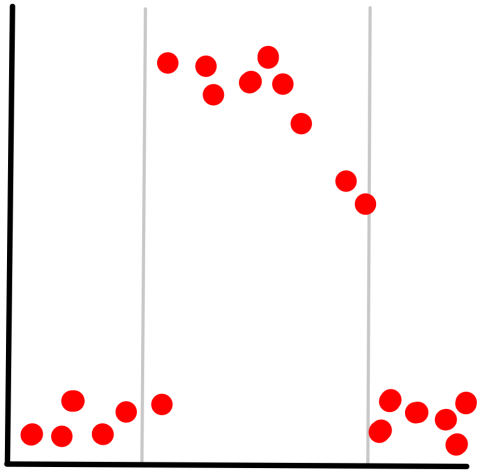
Introduction

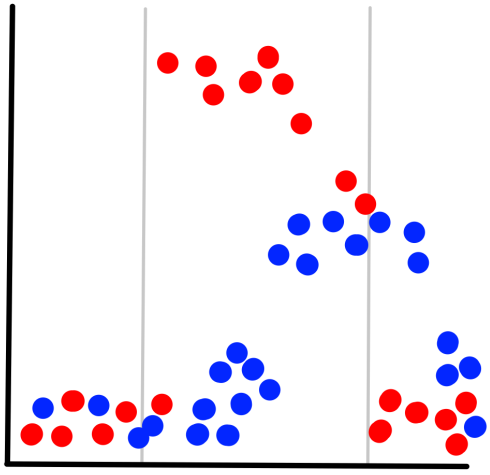
Motivation



Motivation



Motivation



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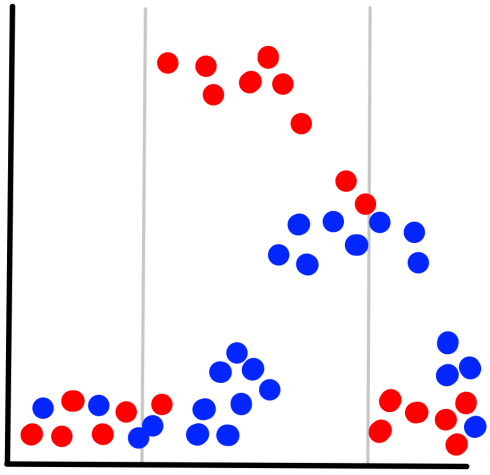

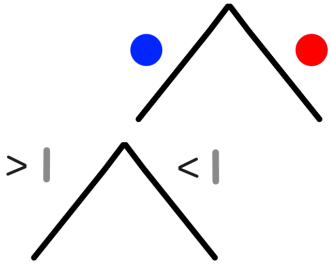

Decision Trees

Simple example

Disturbance	Habitat	Avg. temp.	Presence
Yes	Shrubs	10	0
Yes	Forests	12	0
No	Shrubs	18	1
No	Shrubs	25	1
Yes	Shrubs	28	1
Yes	Forests	30	0
No	Forests	33	0

Adapted from StatQuest

Simple example

Disturbance	Habitat	Avg. temp.	Presence
Yes	Shrubs	10	0
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No	Shrubs	18	1
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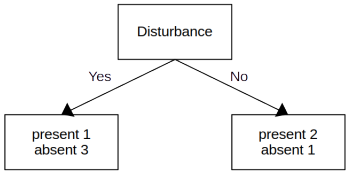
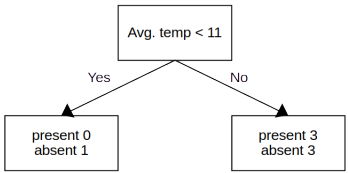
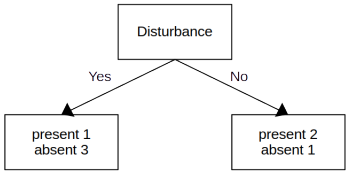
Yes	Shrubs	28	1
Yes	Forests	30	0
No	Forests	33	0

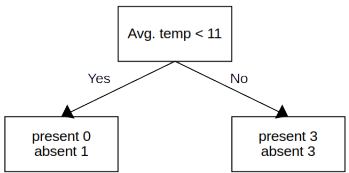




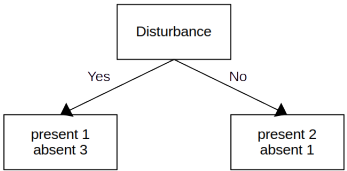
Gini impurity

$$\sum_{i=1}^{J}\left(p_i\sum_{k\neq i}p_k\right)=1-\sum_{i=1}^{J}p_i^2$$

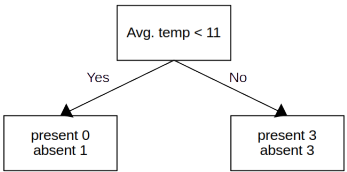




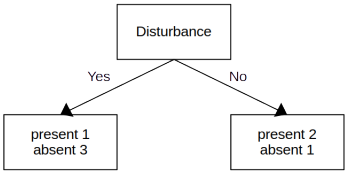
Gini impurity



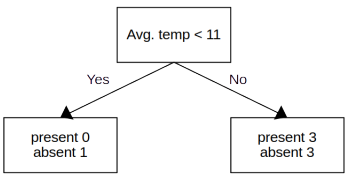
$$1 - (\frac{1}{1+3})^2 - (\frac{3}{1+3})^2 = 0.375$$



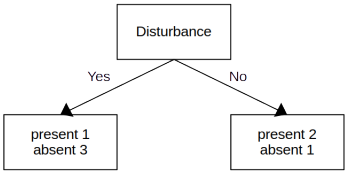
Gini impurity



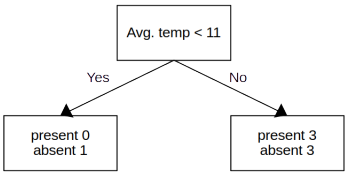
$$Leaf\ \ Gini = (\frac{4}{4+3})0.375$$



Gini impurity



$$1 - (\frac{0}{0+1})^2 - (\frac{1}{0+1})^2 = 0$$



Building the tree

Disturbance	Habitat	Avg. temp.	Presence
Yes	Shrubs	10	0
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No	Shrubs	25	1
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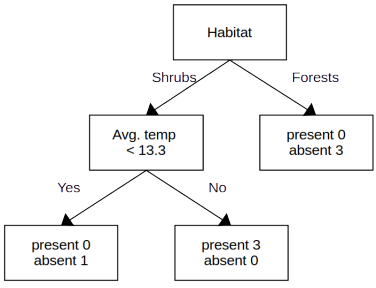
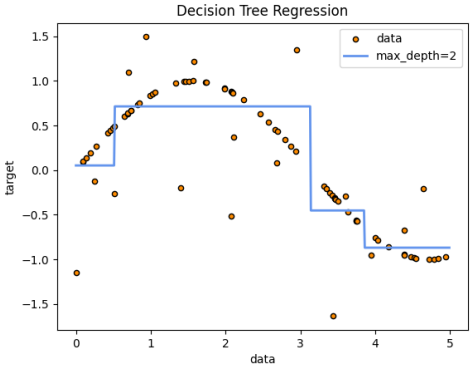
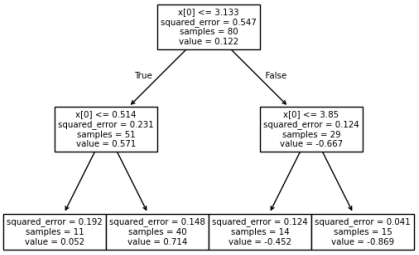
No	Forests	33	0



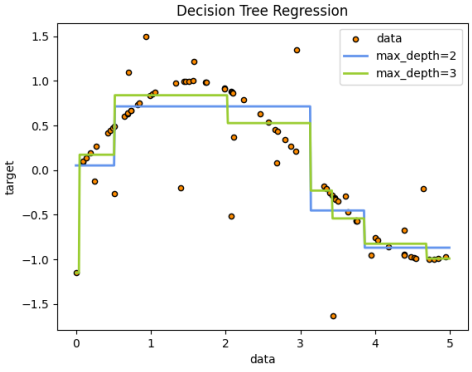
Regression trees

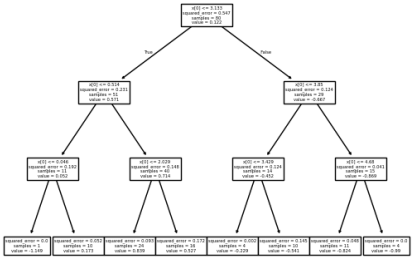




Adapted from sklearn documentation

Regression trees





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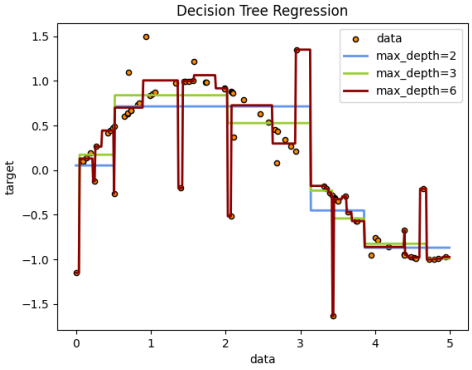
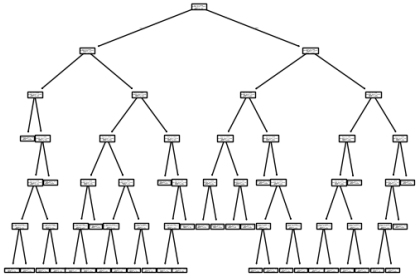
Regression trees





Adapted from sklearn documentation

Regression trees

Non-linear data, multiple outputs !

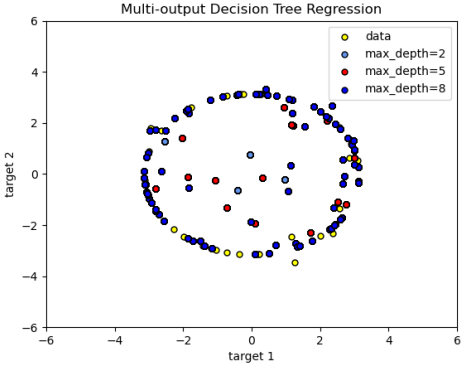


Figure from sklearn documentation

Random Forests

Main idea

Why not several trees ?

Boostraping

Disturbance	Habitat	Avg. temp.	Presence
Yes	Shrubs	10	0
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Yes	Shrubs	28	1
Yes	Shrubs	28	1

Subset variables

Disturbance	Habitat	Avg. temp.	Presence
Yes	Shrubs	10	0
Yes	Forests	12	0
Yes	Forests	12	0
No	Shrubs	18	1
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Subset variables

Disturbance	**Habitat**	**Avg. temp.**	Presence
Yes	**Shrubs**	**10**	0
Yes	**Forests**	**12**	0
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No	**Shrubs**	**25**	1
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No	**Shrubs**	**25**	1
Yes	**Shrubs**	**28**	1
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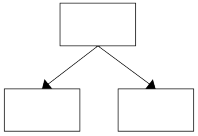

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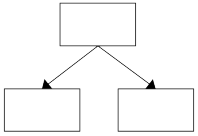

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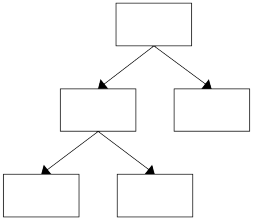

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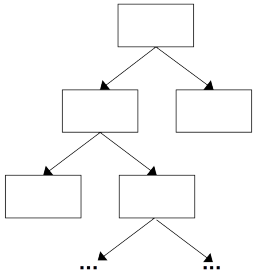
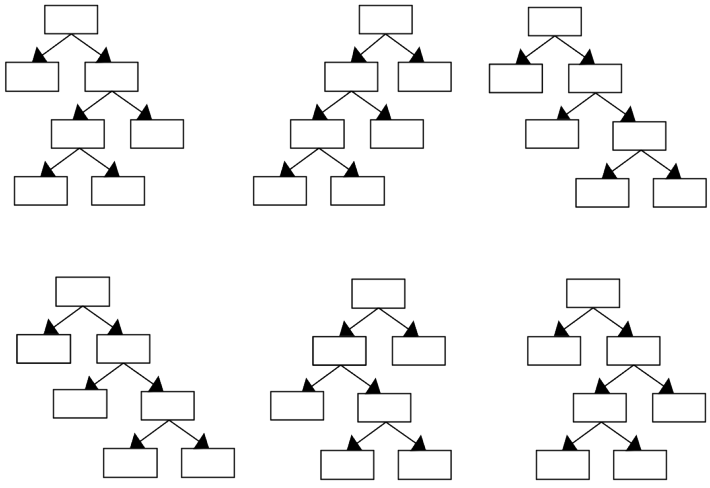
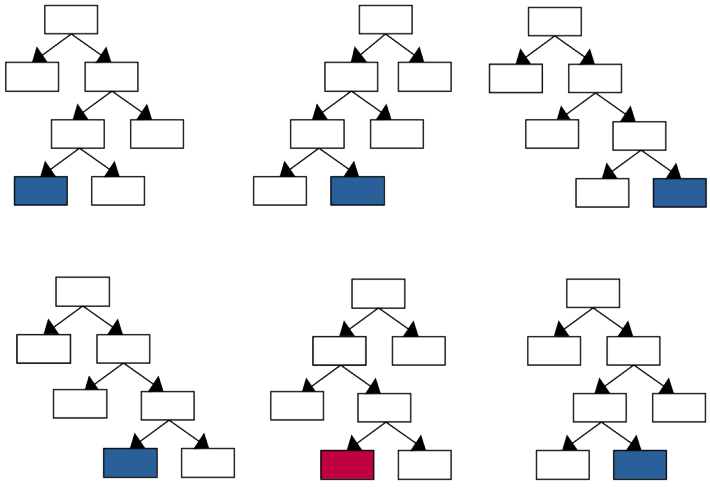
Yes	Shrubs	**28**	1
Yes	Shrubs	**28**	1



Building a Forest



Using the Forest



RF advantages

- different inputs

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- different outputs

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- $\approx$ explainable

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- pretty easy to fit

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$\rightarrow$ **seasoned and reliable**

RF drawbacks

- need to test hyper-parameters

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- **need to test hyper-parameters**

  How many trees ? how many subsets ? what depth ?

RF drawbacks

- **need to test hyper-parameters**

  How many trees ? how many subsets ? what depth ?
- **need for rich descriptors**

Decendants and variants

- Adaboost
- Gradient Boosting
- XGBoost
- ...

Useful ressources

- `scikit-learn` docs !
- StatQuest

Thanks for you attention !