Machine learning: prediction, classification and clustering

UBB Faculty of Sociology

Course Agenda

#1 Intro, Simple Linear Regression

#2 Python recap, Git, Handling data, EDA

#3 Regression, Decision Trees

#4 Bias, Variance, Overfitting, Classification, Metrics

#5 Random Forest Classifier, Clustering

#6 Neural Newtorks

#7 Help Final Project

#8 Help Final Project

3. Linear Regression, Decision Trees

#3.1 Catch up
#3.2 Linear Regression recap
#3.3 Decision Trees Regression
#3.4 Regression implementation
#3.5 Final Project Task 2 - Census Data EDA
#3.6 Questions & Further reading

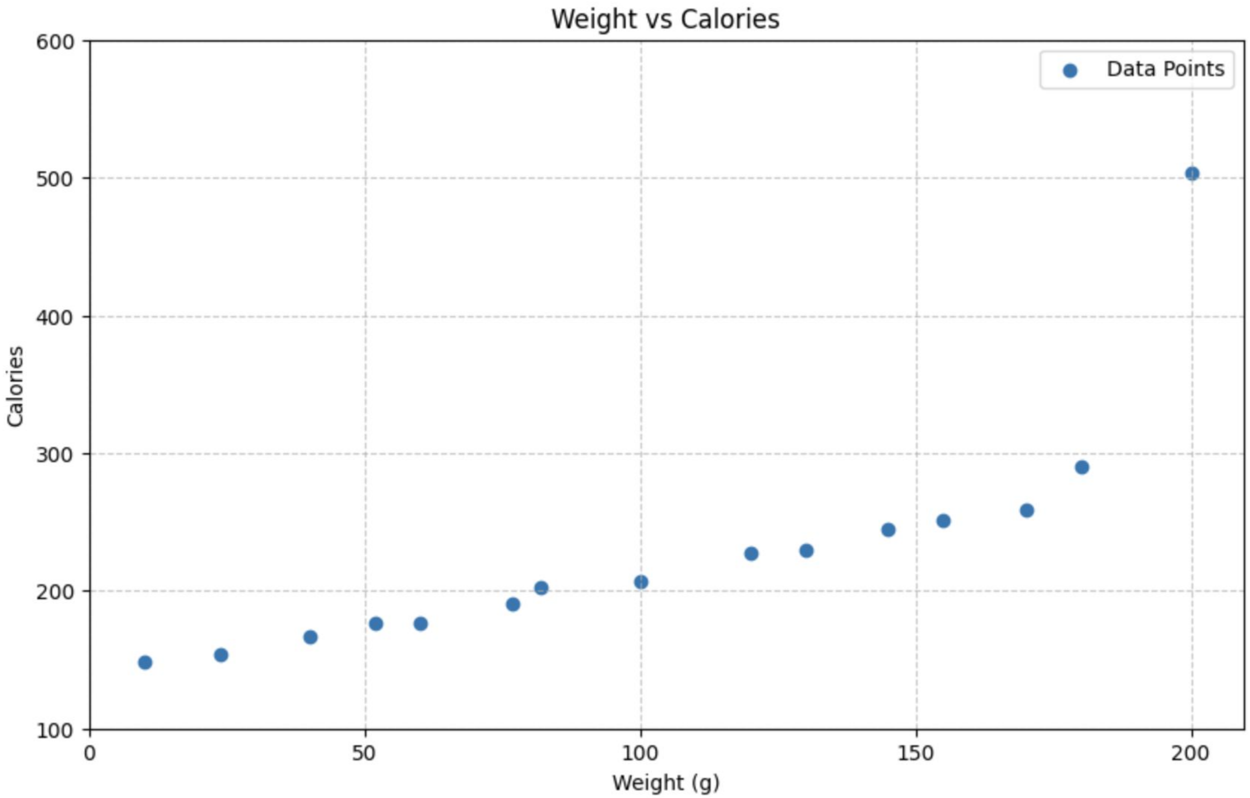
3.1 Catch up

Share one thing that stood out to you:

one thing you found surprising / interesting / useful etc.

3.2 Linear Regression recap

Predict calories



Eq of the line:
y = ax + b

Where:
a: slope
b: intercept
x: data

How lines work:
Calories =
Slope * Weight +
Intercept

Predict the calories

Calories for 15 apple pie slices:

148, 154, 167, 176, 176,

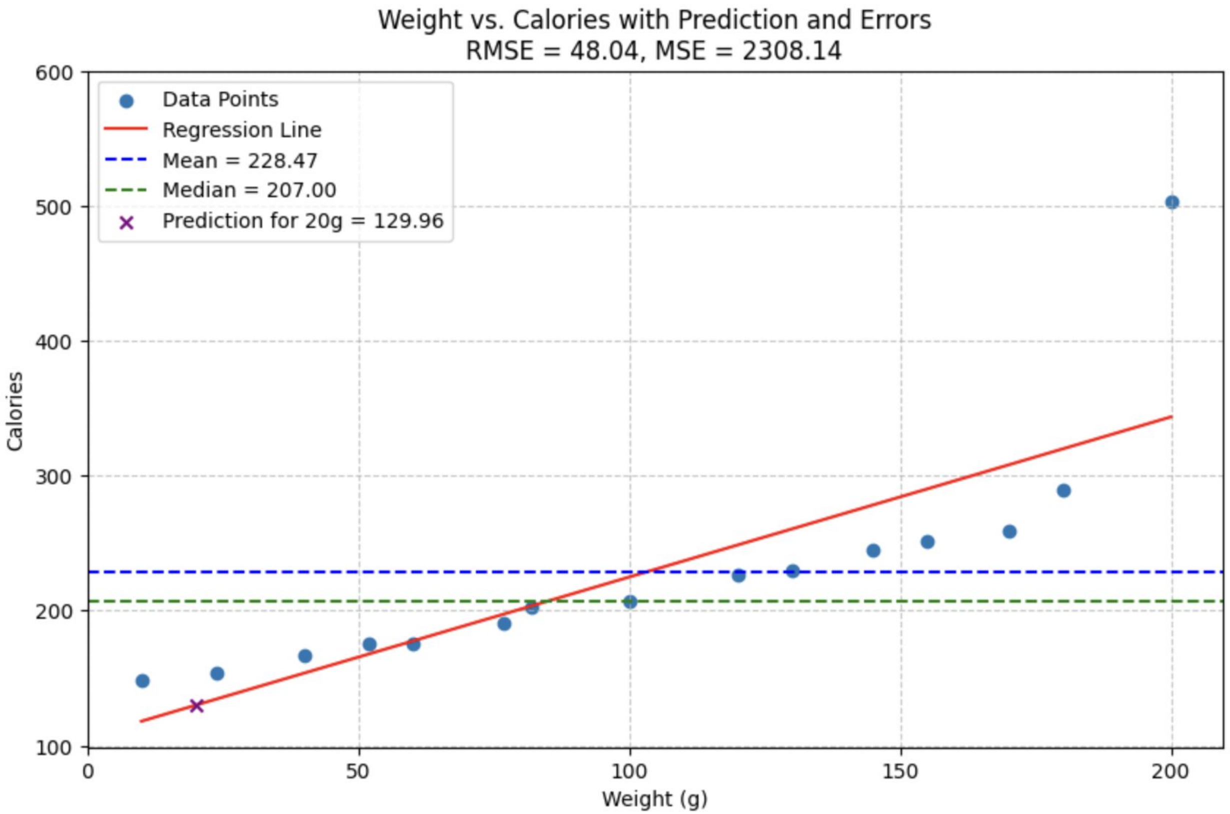
191, 203, **207**, 227, 230,

245, 251, 259, 290, 503

Mean: 228,47

Median: 207

Predict calories



Eq of the line:
y = ax + b

Where:
a: slope
b: intercept
x: data

How lines work:
Calories =
1.19*20 + 106.2=131

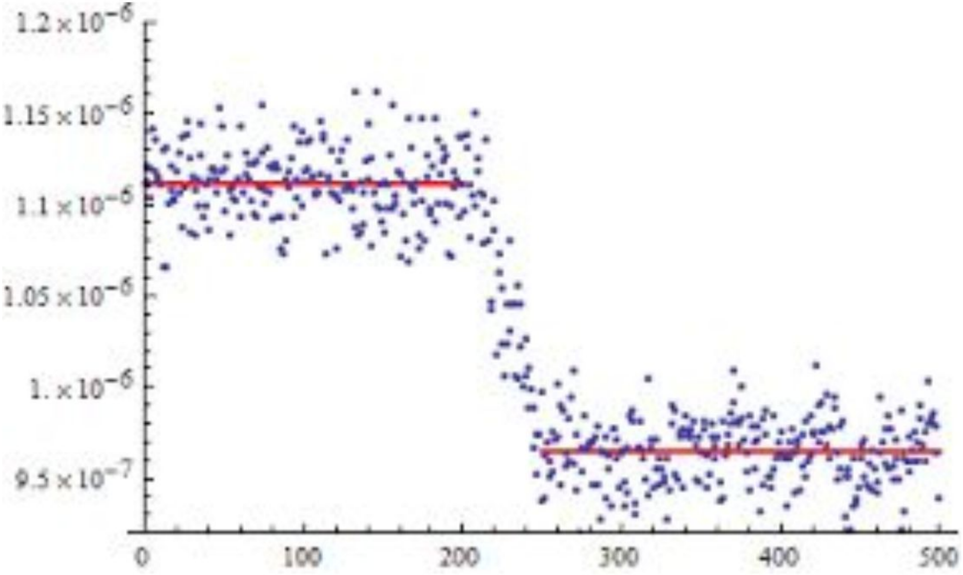
Code on Colab

Data is not always linear

No problem!

There are non-linear regression models:

- Decision Tree Regression
- SVM with non-linear kernels
- Neural networks
- KNN
- Ensemble methods



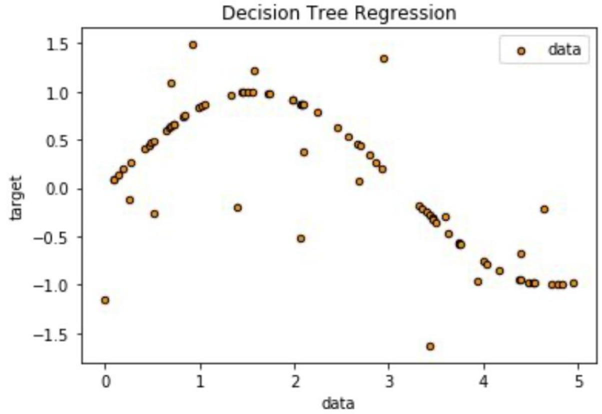
3.3 Decision Trees Regression

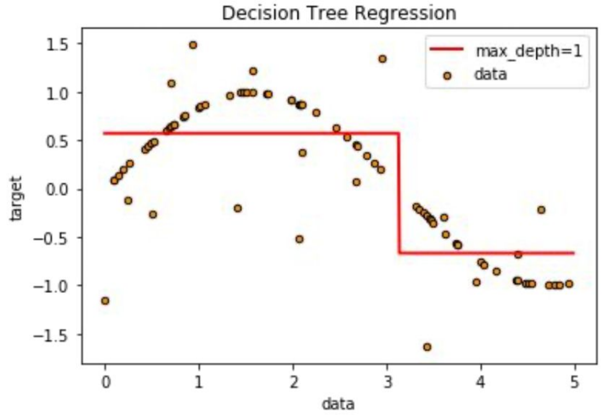
Decision Tree Regression

Decision Trees Regression is a very fast algorithm How it works: A two step repeating process

1. Take some random samples in the subtree split the dataset in two
2. Save the random split which separates the data by value the best

Then, repeat for the newly created subtrees



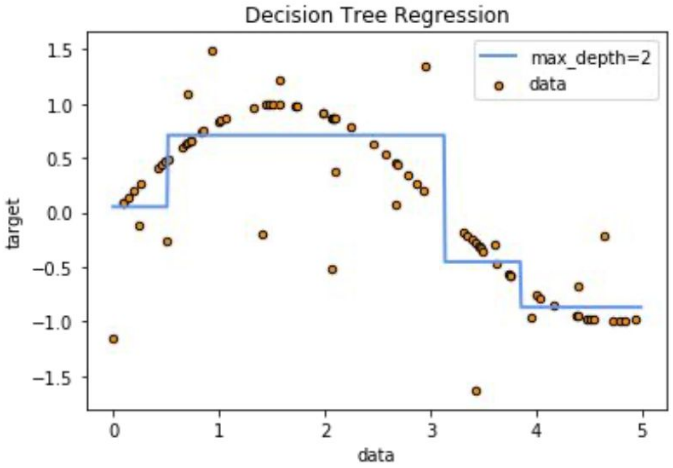


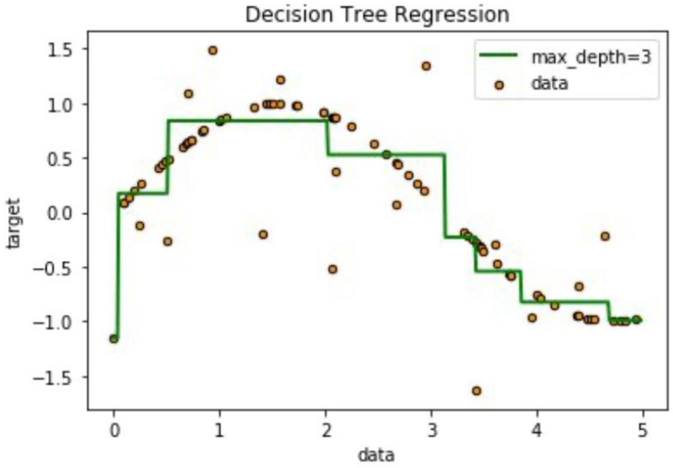
Decision Tree Regression

Decision Trees Regression is a very fast algorithm How it works: A two step repeating process

1. Step 1
    1. Take some random samples in the subtree split the dataset in two
    2. Save the random split which separates the data by value the best

2. Step 2
    1. Take some random samples in the subtree split the dataset in two
    2. Save the random split which separates the data by value the best





Decision Tree Regression

Decision Trees Regression is a very fast algorithm How it works: A two step repeating process

3. Step 3
    1. Take some random samples in the subtree split the dataset in two
    2. Save the random split which separates the data by value the best

……..

n. Step n

n.1 Take some random samples in the subtree split the dataset in two

n.2 Save the random split which separates the data by value the best

Decision Tree Regression

Stop Criteria:

- **Maximum Depth:** Stops growing the tree when the maximum depth is reached.
- **Minimum Samples per Leaf:** Requires a minimum number of samples in each leaf node.
- **Minimum Samples per Split:** Requires a minimum number of samples to attempt a split.
- **Maximum Number of Nodes:** Limits the total number of nodes in the tree.
- **No Further Split Improves Performance:** Stops when no split improves the target metric.
- **Early Stopping with Cross-Validation:** Stops if validation performance does not improve.
- **Insufficient Data:** Stops if a node has too few samples for further splitting.

Decision Tree Regression

Advantages:

- We get a nice, explainable model, easy to understand by humans
- Very fast prediction for new samples

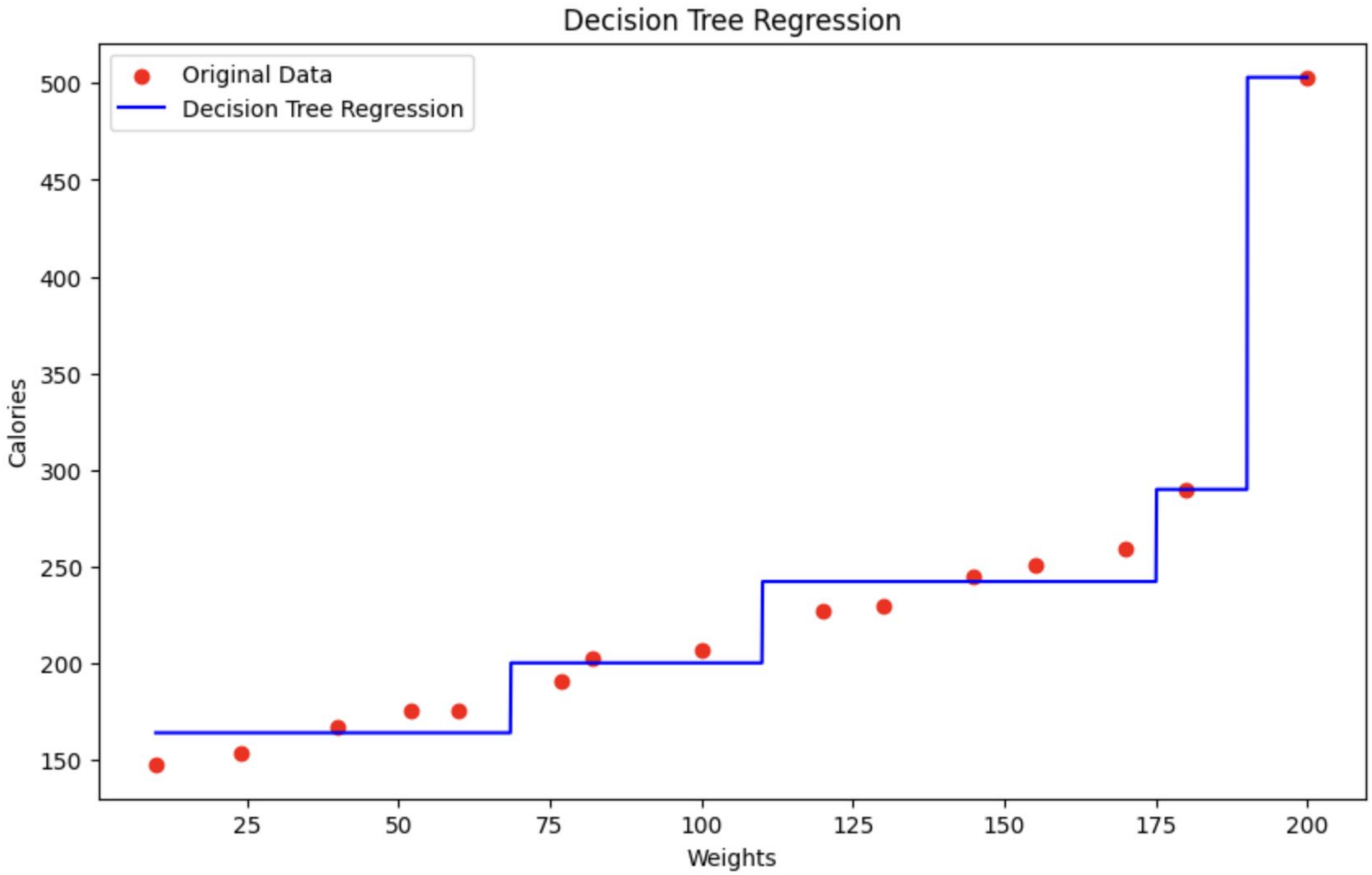
Decision Tree Regression

Disadvantages:

- Leaves grow exponentially by depth
- Very prone to overfitting

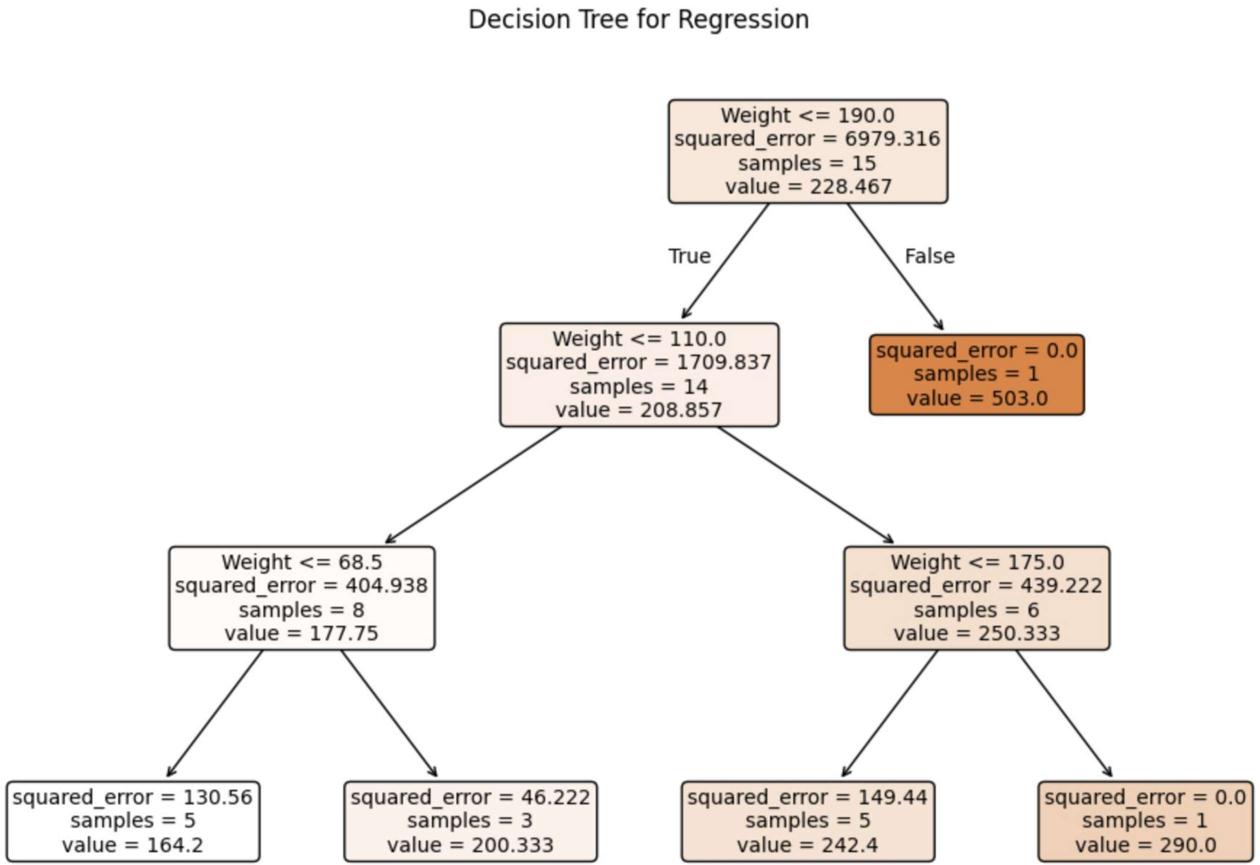
Decision Tree Regression Calories

Code on Colab



Decision Tree Regression Calories

Code on Colab



3.4 Regression implementation

- Penguins size
- California Housing

3.5 Final Project Task 2 - Census Data EDA

https://github.com/zahariesergiu/ubb-sociology-ml/blob/main/final_project/Final_Project_Task_2_Census_EDA.ipynb

3.6 Further Reading & Questions

#1 Regression Trees explained: https://www.youtube.com/watch?v=g9c66TUylZ4

#2 Decision Trees Split Criteria: https://scientistcafe.com/ids/splitting-criteria

#3 Self-supervised learning: https://ai.meta.com/blog/self-supervised-learning-the-dark-matter-of-intelligence/

#4 Feature scaling @ Kaggle: https://www.kaggle.com/code/mysarahmadbhat/all-about-feature-scaling/notebook

#5 Nature article: statistics and machine learning:

https://www.nature.com/articles/nmeth.4642?source=post_page-----64b49f07ea3--------------------------------

#6 If correlation doesn’t imply causation, then what does?:

https://michaelnielsen.org/ddi/if-correlation-doesnt-imply-causation-then-what-does/

#7 Requirements for talking about cause and effect:

https://towardsdatascience.com/are-you-guilty-of-using-the-word-experiment-incorrectly-9068baeab7a4

Thank you !!

Machine Learning Engineer / Data Scientist
zahariesergiu@gmail.com
https://www.linkedin.com/in/zahariesergiu/
https://github.com/zahariesergiu/ubb-sociology-ml