

## Decision Trees Lab

1. Consider the following dataset, which contains examples describing several cases of sunburn:
  - a) What is the entropy of this dataset with respect to the target class label *Result*?

	Name	Hair	Height	Build	Lotion	Result
1	Sarah	blonde	average	light	no	sunburned
2	Dana	blonde	tall	average	yes	none
3	Alex	brown	short	average	yes	none
4	Annie	blonde	short	average	no	sunburned
5	Emily	red	average	heavy	no	sunburned
6	Pete	brown	tall	heavy	no	none
7	John	brown	average	heavy	no	none
8	Katie	brown	short	light	yes	none

- b) Construct the decision tree that would be built with Information Gain for this dataset. Show your work for selection of the root feature in your tree. You can infer the rest of the tree from the data.
  - c) Using your decision tree from (b), how would you classify the following example X?

	Hair	Height	Build	Lotion	Result
X	blonde	average	heavy	no	???

2. Consider the following dataset that aims to predict the risk of a loan application based on 3 features describing each applicant: credit history, debt, and income. Applications are assigned to 3 different risk classes: low, medium, high.

	Credit History	Debt	Income	Risk
1	bad	low	0to30	high
2	bad	high	30to60	high
3	bad	low	0to30	high
4	unknown	high	30to60	high
5	unknown	high	0to30	high
6	good	high	0to30	high
7	bad	low	over60	medium
8	unknown	low	30to60	medium
9	good	high	30to60	medium
10	unknown	low	over60	low
11	unknown	low	over60	low
12	good	low	over60	low
13	good	high	over60	low
14	good	high	over60	low

- What is the entropy of this dataset with respect to the target class label *Risk* based on the 14 examples above?
- Compute the entropy of each of the 3 descriptive features.
- Which one of the descriptive features would be selected by ID3 at the root of a decision tree? Explain your answer. Show all the steps of the calculations.

3. For the datasets analysed in the **03 DTrees** notebook, will the resulting trees be different if the feature selection criterion is **'gini'** instead of **'entropy'**.
4. If a decision tree is allowed to be too *bushy* it is likely to overfit the training data. Consequently decision trees are often pruned to prevent overfitting.  
In the example in the **'03 DTrees Lab** notebook we use the `min_samples_leaf` attribute to control the size of the tree.
  - a) What does the Iris Data tree look like when no pruning is enforced?
  - b) What other options does sklearn provide to manage the bushiness of the tree? <https://scikit-learn.org/stable/modules/generated/sklearn.tree.DecisionTreeClassifier.html>
  - c) Use two other pruning strategies to produce similar trees.
5. Download the zip file **'03-BYO DTree-Python focus'**. It contains a notebook that takes you through building your own Decision Tree classifier in Python with a significant focus on writing good Python code. Work through this notebook.