In [1]:

```
%load_ext autoreload
%autoreload 2

%matplotlib inline
```

Imports

In [2]:

```
import sys
sys.executable
```

Out[2]:

```
'/Users/parrt/opt/anaconda3/bin/python'
```

In [3]:

```
import sys
import os
# add library module to PYTHONPATH
sys.path.append(f"{os.getcwd()}/../")

import sklearn
from sklearn.tree import DecisionTreeClassifier, DecisionTreeRegressor
import xgboost as xgb
from xgboost import plot_importance, plot_tree, plotting

from dtreeviz import trees

import graphviz
import matplotlib.pyplot as plt
from matplotlib.pylab import rcParams

import pandas as pd
import numpy as np
from dtreeviz.models.shadow_decision_tree import ShadowDecTree
from dtreeviz.models.xgb_decision_tree import ShadowXGBDTree
```

In [4]:

```
pd.options.display.max_rows = 999
```

Train

In [5]:

```
random_state = 1234
dataset = pd.read_csv("../data/titanic/titanic.csv")
# Fill missing values for Age
dataset.fillna({"Age":dataset.Age.mean()}, inplace=True)
# Encode categorical variables
dataset["Sex_label"] = dataset.Sex.astype("category").cat.codes
dataset["Cabin_label"] = dataset.Cabin.astype("category").cat.codes
dataset["Embarked_label"] = dataset.Embarked.astype("category").cat.codes
features = ["Pclass", "Age", "Fare", "Sex_label", "Cabin_label", "Embarked_label"]
target = "Survived"
```

In [6]:

```
dtrain = xgb.DMatrix(dataset[features], dataset[target])
```

In [7]:

```
params = {"max_depth":3, "eta":0.05, "objective":"binary:logistic", "subsample":1}
xgb_model = xgb.train(params=params, dtrain=dtrain, num_boost_round=8)
```

In [8]:

```
xgb_model.trees_to_dataframe().query("Tree == 0")
```

Out[8]:

	Tree	Node	ID	Feature	Split	Yes	No	Missing	Gain	Cover
0	0	0	0-0	Sex_label	1.00	0-1	0-2	0-1	246.604279	222.75
1	0	1	0-1	Pclass	3.00	0-3	0-4	0-3	60.127525	78.50

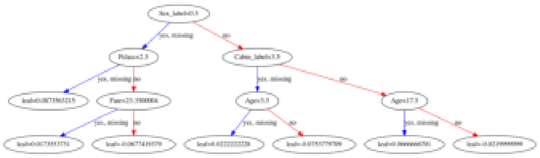
	Tree	Node	ID	Feature	Split	Yes	No	Missing	Gain	Cover
2	0	2	0-2	Cabin_label	4.00	0-5	0-6	0-5	29.516968	144.25
3	0	3	0-3	Leaf	NaN	NaN	NaN	NaN	0.087356	42.50
4	0	4	0-4	Fare	23.35	0-7	0-8	0-7	17.870434	36.00
5	0	5	0-5	Age	3.50	0-9	0-10	0-9	14.429703	118.25
6	0	6	0-6	Age	17.50	0-11	0-12	0-11	8.358520	26.00
7	0	7	0-7	Leaf	NaN	NaN	NaN	NaN	0.017355	29.25
8	0	8	0-8	Leaf	NaN	NaN	NaN	NaN	-0.067742	6.75
9	0	9	0-9	Leaf	NaN	NaN	NaN	NaN	0.022222	3.50
10	0	10	0-10	Leaf	NaN	NaN	NaN	NaN	-0.075378	114.75
11	0	11	0-11	Leaf	NaN	NaN	NaN	NaN	0.066667	2.00
12	0	12	0-12	Leaf	NaN	NaN	NaN	NaN	-0.022000	24.00

In [9]:

```
# rcParams['figure.figsize'] = 50,30
plot_tree(xgb_model)
```

Out[9]:

```
<AxesSubplot:>
```



save the model

In [10]:

```
import joblib
# joblib.dump(xgb_model, "xgb_model")
```

Init shadow tree

In [11]:

```
d = dataset[features + [target]]
d_matrix = xgb.DMatrix(d)
```

In [12]:

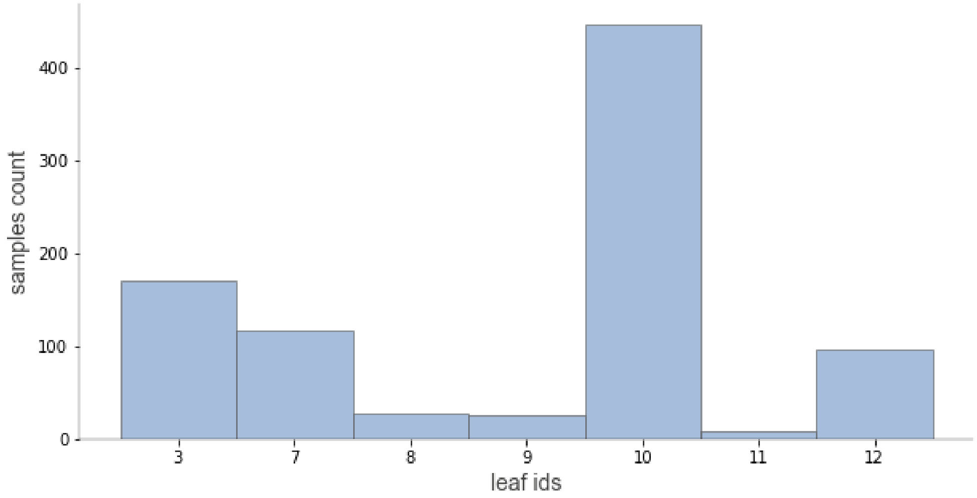
```
xgb_shadow = ShadowXGBDTree(xgb_model, 1, d[features], d[target], features, target, class_names=[0, 1])
```

Visualisations classifier

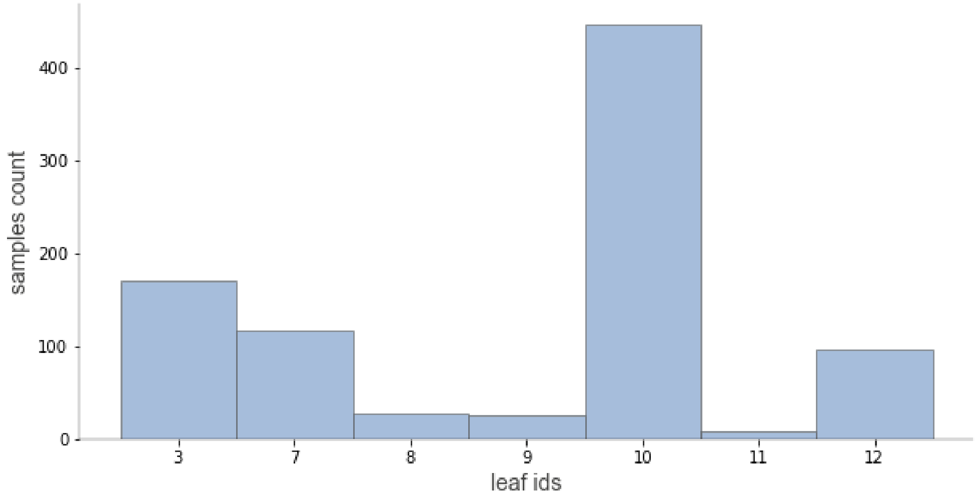
viz_leaf_samples

In [13]:

```
trees.viz_leaf_samples(xgb_model, d[features], features, tree_index=1)
```

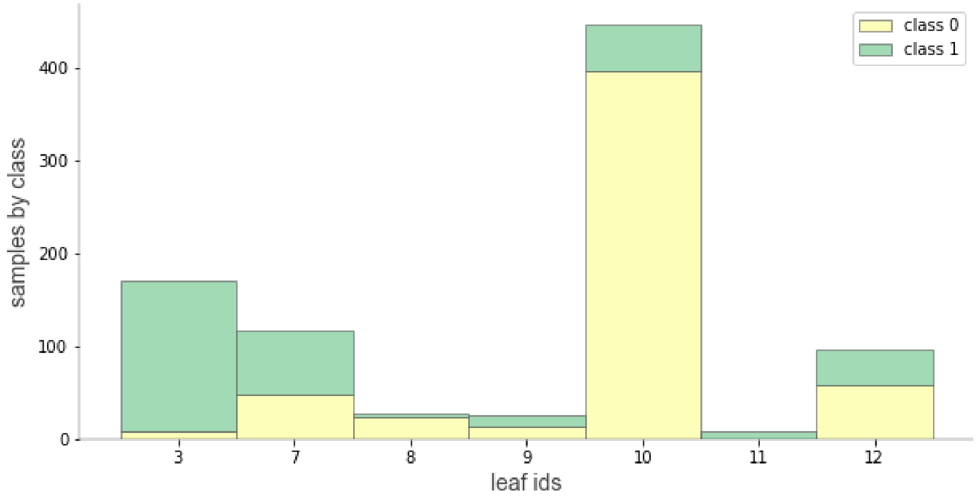


In [14]:
```
trees.viz_leaf_samples(xgb_shadow)
```

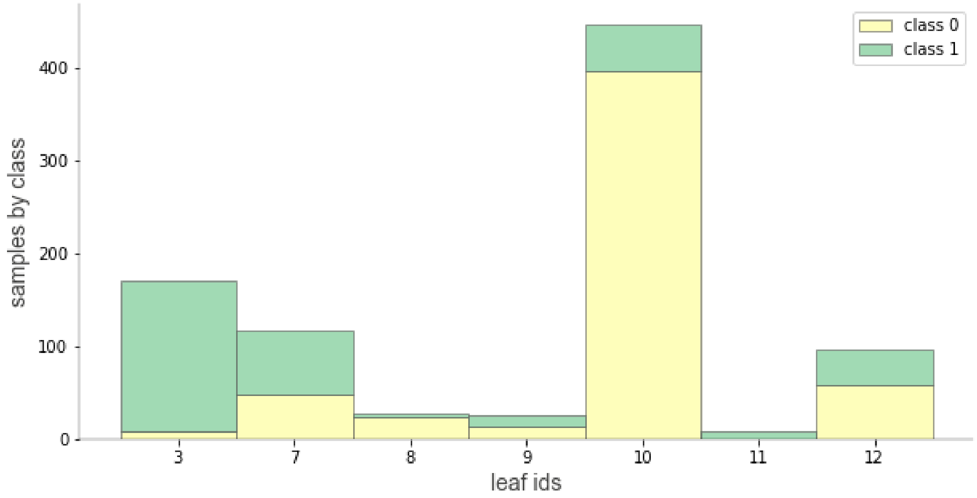


ctreeviz_leaf_samples

In [15]:
```
trees.ctreeviz_leaf_samples(xgb_model, d[features], d[target], features, tree_index=1  )
```



In [16]:
```
trees.ctreeviz_leaf_samples(xgb_shadow)
```

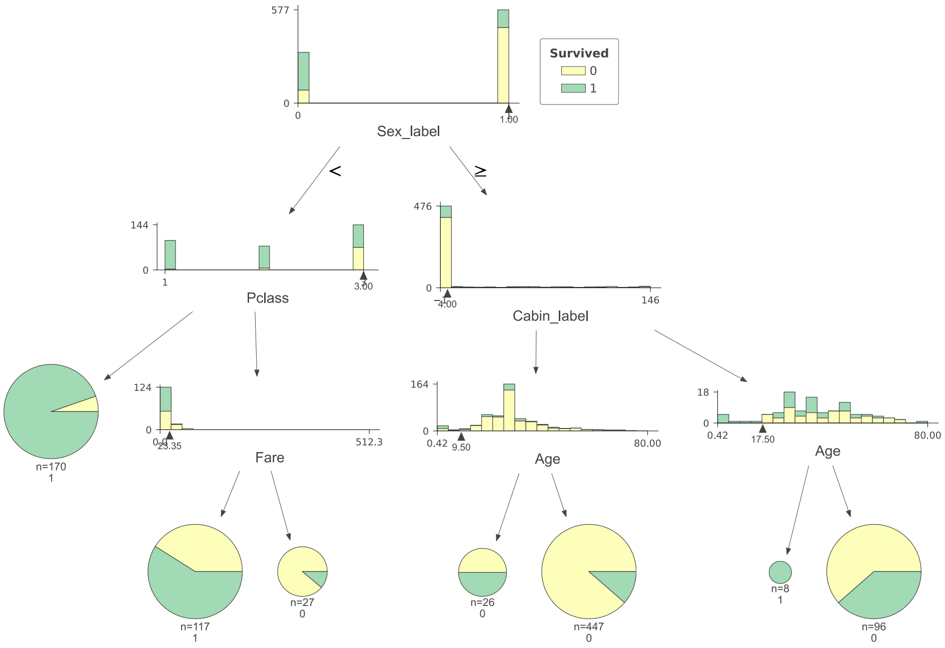


dtreeviz

In [17]:

```
trees.dtreeviz(xgb_model, d[features], d[target], features, target, class_names=[0, 1], tree_index=1)
```

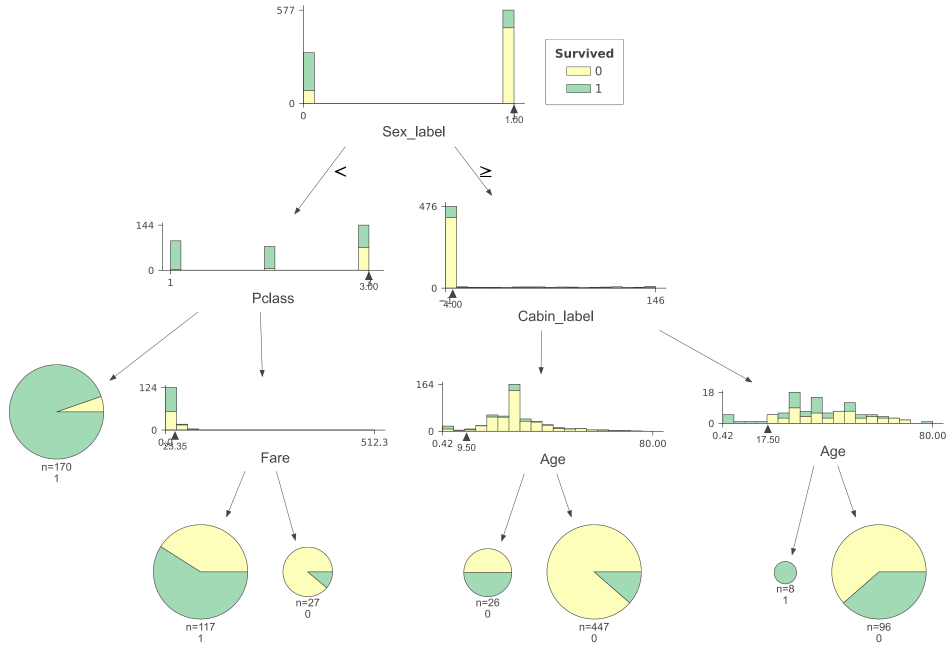
Out[17]:



In [18]:

```
trees.dtreeviz(xgb_shadow)
```

Out[18]:



describe_node_sample

In [19]:

```
trees.describe_node_sample(xgb_model, 1, d[features], feature_names=features, tree_index=1)
```

Out[19]:

	Pclass	Age	Fare	Sex_label	Cabin_label	Embarked_label
count	314.000000	314.000000	314.000000	314.0	314.000000	314.000000
mean	2.159236	28.216730	44.479818	0.0	23.745223	1.401274
std	0.857290	12.877543	57.997698	0.0	43.225526	0.863605
min	1.000000	0.750000	6.750000	0.0	-1.000000	-1.000000
25%	1.000000	21.000000	12.071875	0.0	-1.000000	1.000000
50%	2.000000	29.699118	23.000000	0.0	-1.000000	2.000000
75%	3.000000	35.000000	55.000000	0.0	35.750000	2.000000
max	3.000000	63.000000	512.329200	0.0	145.000000	2.000000

In [20]:

```
trees.describe_node_sample(xgb_shadow, 1)
```

Out[20]:

	Pclass	Age	Fare	Sex_label	Cabin_label	Embarked_label
count	314.000000	314.000000	314.000000	314.0	314.000000	314.000000
mean	2.159236	28.216730	44.479818	0.0	23.745223	1.401274
std	0.857290	12.877543	57.997698	0.0	43.225526	0.863605
min	1.000000	0.750000	6.750000	0.0	-1.000000	-1.000000
25%	1.000000	21.000000	12.071875	0.0	-1.000000	1.000000
50%	2.000000	29.699118	23.000000	0.0	-1.000000	2.000000
75%	3.000000	35.000000	55.000000	0.0	35.750000	2.000000
max	3.000000	63.000000	512.329200	0.0	145.000000	2.000000

explain_prediction_path

In [21]:

```
X = dataset[features].iloc[10]
```

In [22]:
```
X
```

Out[22]:
```
Pclass              3.0
Age                 4.0
Fare               16.7
Sex_label           0.0
Cabin_label       145.0
Embarked_label      2.0
Name: 10, dtype: float64
```

In [23]:
```
print(trees.explain_prediction_path(xgb_model, X, dataset[features], dataset[target], explanation_type="
```

```
3.0 <= Pclass
Fare < 23.35
Sex_label < 1.0
```

In [24]:
```
print(trees.explain_prediction_path(xgb_shadow, X, explanation_type="plain_english"))
```

```
3.0 <= Pclass
Fare < 23.35
Sex_label < 1.0
```

Regressor

Visualisations regressor

In [25]:
```
features_reg = ["Pclass", "Survived", "Fare", "Sex_label", "Cabin_label", "Embarked_label"]
target_reg = "Age"
```

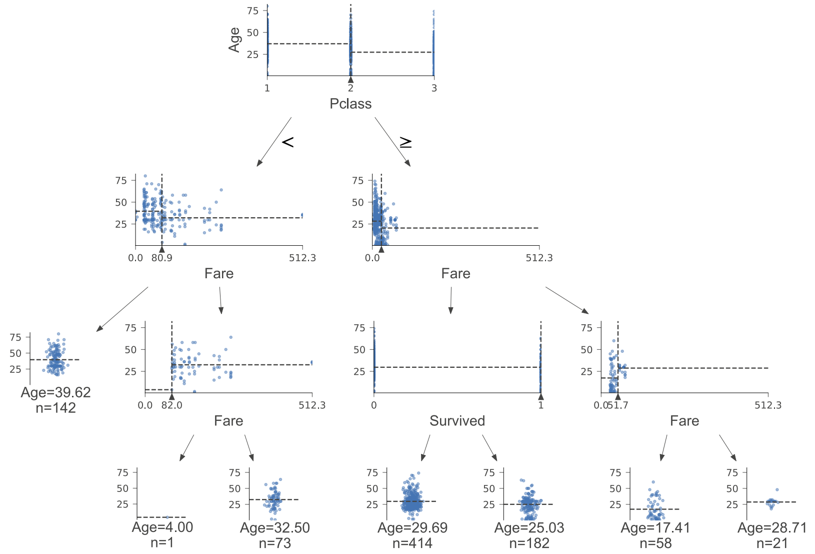
In [26]:
```
dtrain_reg = xgb.DMatrix(dataset[features_reg], dataset[target_reg])
params_reg = {"max_depth":3, "eta":0.05, "objective":"reg:squarederror", "subsample":1}
xgb_model_reg = xgb.train(params=params_reg, dtrain=dtrain_reg, num_boost_round=8)
```

In [27]:
```
xgb_shadow_reg = ShadowXGBDTree(xgb_model_reg, 1, dataset[features_reg], dataset[target_reg], features_r
```

dtreeviz

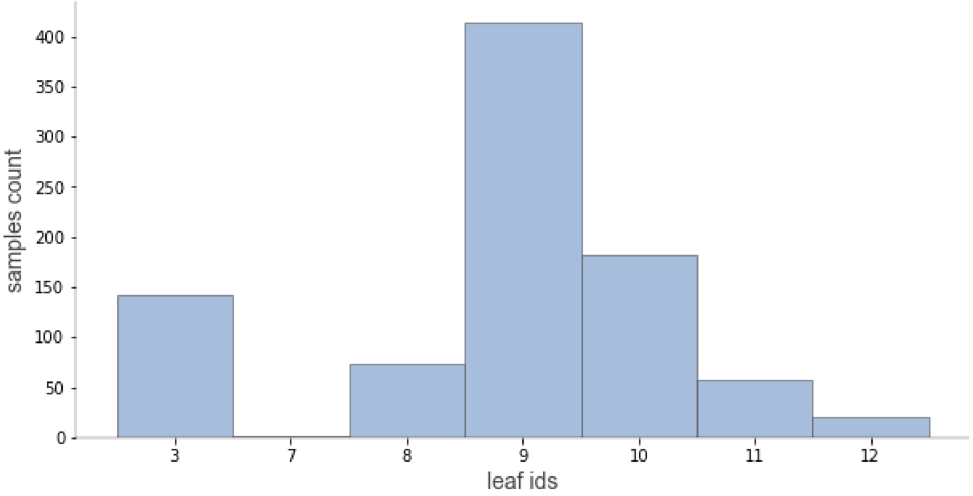
In [28]:
```
trees.dtreeviz(xgb_shadow_reg)
```

Out[28]:

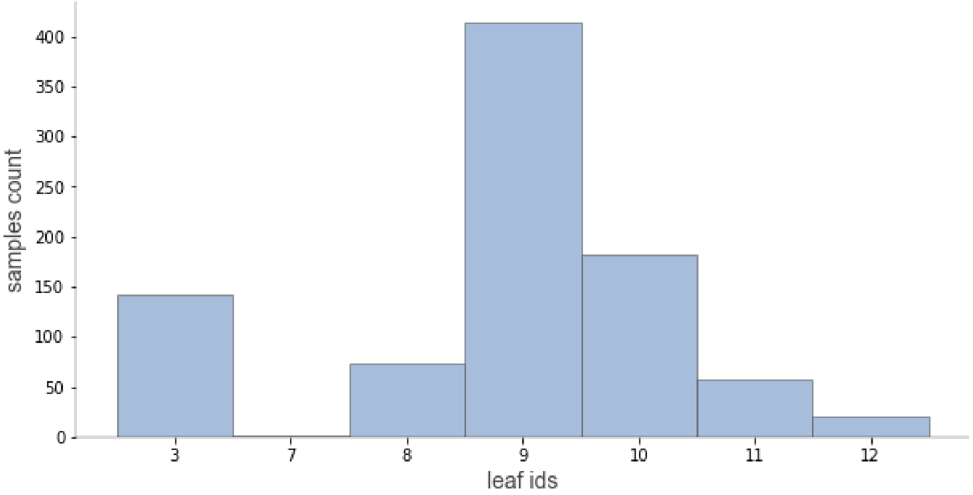


viz_leaf_samples

```
In [29]: trees.viz_leaf_samples(xgb_model_reg, dataset[features_reg], features_reg, tree_index=1)
```



```
In [30]: trees.viz_leaf_samples(xgb_shadow_reg)
```



describe_node_sample

```
In [31]: trees.describe_node_sample(xgb_model_reg, node_id=9, x_data=dataset[features_reg], feature_names=feature
```

Out[31]:

	Pclass	Survived	Fare	Sex_label	Cabin_label	Embarked_label
count	414.000000	414.0	414.000000	414.000000	414.000000	414.000000
mean	2.792271	0.0	11.021476	0.855072	1.966184	1.678744
std	0.406173	0.0	5.698663	0.352454	20.066568	0.664333
min	2.000000	0.0	0.000000	0.000000	-1.000000	0.000000
25%	3.000000	0.0	7.750000	1.000000	-1.000000	2.000000
50%	3.000000	0.0	8.050000	1.000000	-1.000000	2.000000
75%	3.000000	0.0	13.000000	1.000000	-1.000000	2.000000
max	3.000000	0.0	27.750000	1.000000	145.000000	2.000000

```
In [32]: trees.describe_node_sample(xgb_shadow_reg, node_id=9)
```

Out[32]:

	Pclass	Survived	Fare	Sex_label	Cabin_label	Embarked_label
count	414.000000	414.0	414.000000	414.000000	414.000000	414.000000

	Pclass	Survived	Fare	Sex_label	Cabin_label	Embarked_label
mean	2.792271	0.0	11.021476	0.855072	1.966184	1.678744
std	0.406173	0.0	5.698663	0.352454	20.066568	0.664333
min	2.000000	0.0	0.000000	0.000000	-1.000000	0.000000
25%	3.000000	0.0	7.750000	1.000000	-1.000000	2.000000
50%	3.000000	0.0	8.050000	1.000000	-1.000000	2.000000
75%	3.000000	0.0	13.000000	1.000000	-1.000000	2.000000
max	3.000000	0.0	27.750000	1.000000	145.000000	2.000000

explain_prediction_path

In [33]:

```
X_reg = dataset[features_reg].iloc[10]
X_reg
```

Out[33]:

```
Pclass              3.0
Survived            1.0
Fare               16.7
Sex_label           0.0
Cabin_label       145.0
Embarked_label      2.0
Name: 10, dtype: float64
```

In [34]:

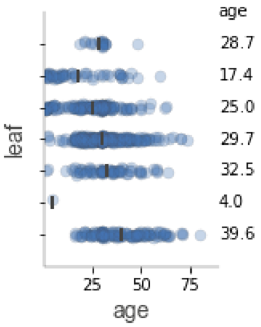
```
print(trees.explain_prediction_path(xgb_shadow_reg, X_reg, explanation_type="plain_english"))
```

```
2.0 <= Pclass
1.0 <= Survived
Fare < 27.83
```

viz_leaf_target

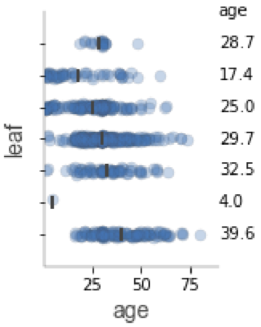
In [35]:

```
trees.viz_leaf_target(xgb_model_reg, dataset[features_reg], dataset[target_reg], feature_names=features_
```



In [36]:

```
trees.viz_leaf_target(xgb_shadow_reg)
```



rtreeviz_univar

In progress...

In [37]:

```
# features_reg_univar = ["Pclass"]
# target_reg_univar = "Age"

# dtrain_reg_univar = xgb.DMatrix(dataset[features_reg_univar], dataset[target_reg_univar])
# params_reg_univar = {"max_depth":3, "eta":0.05, "objective":"reg:squarederror", "subsample":1}
# xgb_model_reg_univar = xgb.train(params=params_reg_univar, dtrain=dtrain_reg_univar, num_boost_round=

# xgb_shadow_reg_univar = ShadowXGBDTree(xgb_model_reg_univar, 1, dataset[features_reg_univar], dataset[
# trees.rtreeviz_univar(xgb_shadow_reg_univar, dataset[features_reg_univar], dataset[target_reg_univar],
```

Unit test

The following code will help us during unit testing process

In [38]:

```
features_reg_test = ["Pclass", "Survived", "Fare", "Sex_label", "Cabin_label", "Embarked_label"]
target_reg_test = "Age"
```

In [39]:

```
dataset_reg_test = pd.read_csv("../testing/testlib/models/fixtures/dataset.csv")
```

In [40]:

```
dtrain_reg_test = xgb.DMatrix(dataset_reg_test[features_reg_test], dataset_reg_test[target_reg_test])
params_reg_test = {"max_depth":3, "eta":0.05, "objective":"reg:squarederror", "subsample":1}
xgb_model_reg_test = xgb.train(params=params_reg, dtrain=dtrain_reg_test, num_boost_round=8)
```

Save the model

In [41]:

```
import joblib
```

In [42]:

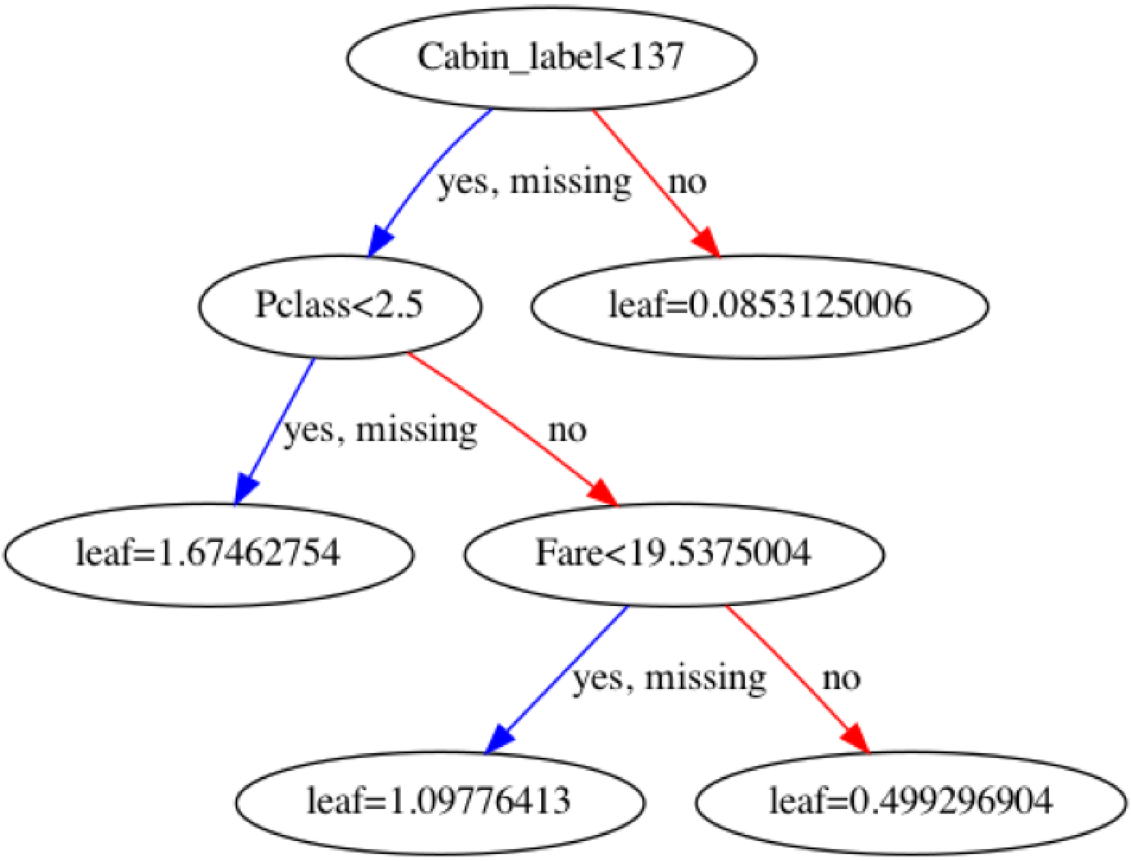
```
#joblib.dump(xgb_model_reg_test, "/Users/tudorl/Documents/workspace/personal/dtreeviz/testing/dtreeviz/
```

In [43]:

```
rcParams['figure.figsize'] = 15,10
plot_tree(xgb_model_reg_test, num_trees=1)
```

Out[43]:

```
<AxesSubplot:>
```



In [44]:

```
node_data = dataset_reg_test.query("Cabin_label < 137 and Pclass >= 2.5 and Fare >= 19.5375004")
node_data
```

Out[44]:

	Pclass	Age	Fare	Sex_label	Cabin_label	Embarked_label	Survived
7	3	2.0	21.075	1	-1	2	0
13	3	39.0	31.275	1	-1	2	0
16	3	2.0	29.125	1	-1	1	0

In [45]:

```
np.mean(node_data["Age"])
```

Out[45]:

```
14.333333333333334
```