Uncertainty in Recurrent Decision Tree Classifiers

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Explainable Machine Learning

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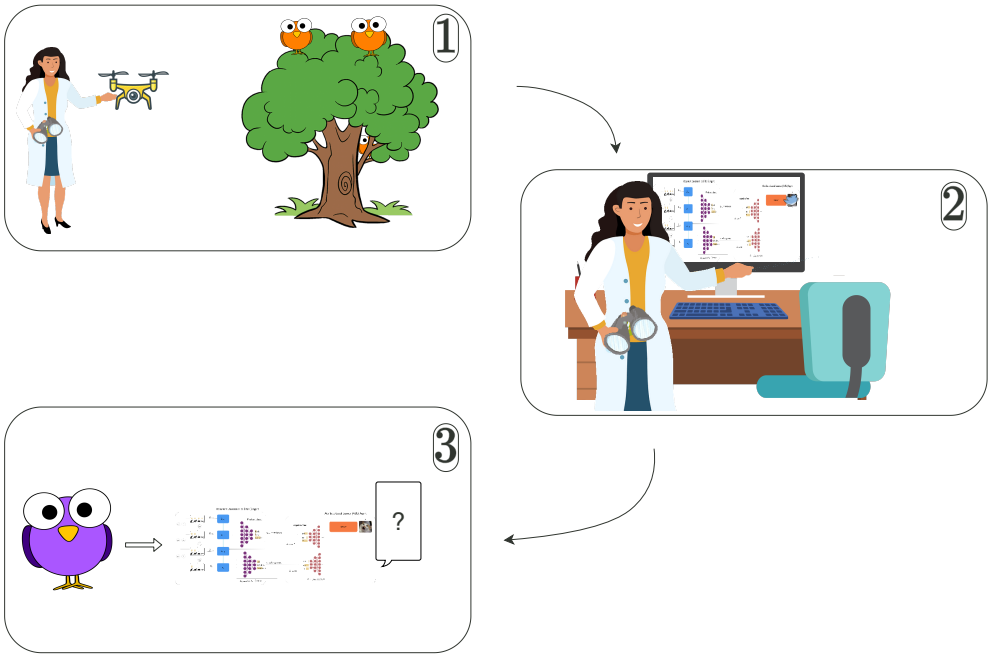
- There are a lot of architectures that perform great on image classification tasks
- Maybe, most prominently: ResNet
- However, they only yield a classification
- In many settings a classification is not worth much without the reasoning behind it

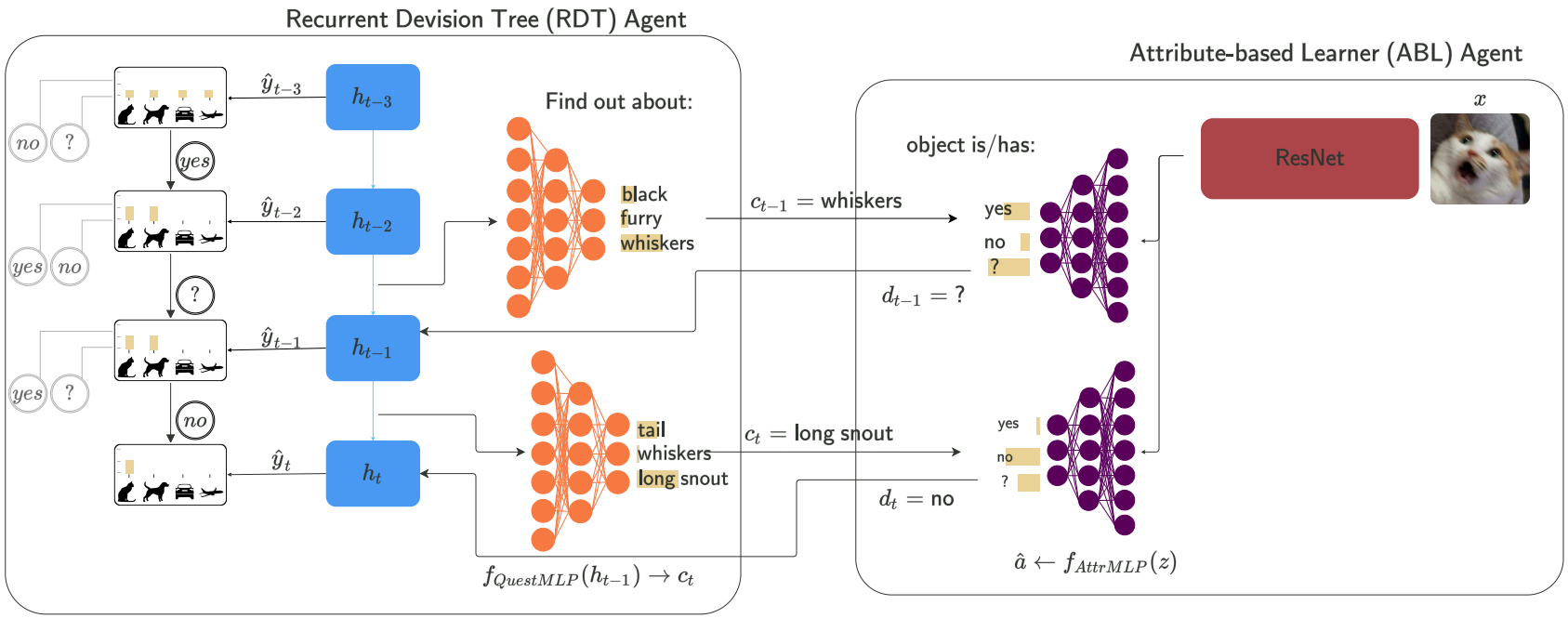
Why do we need uncertainty?

A Practical Example...



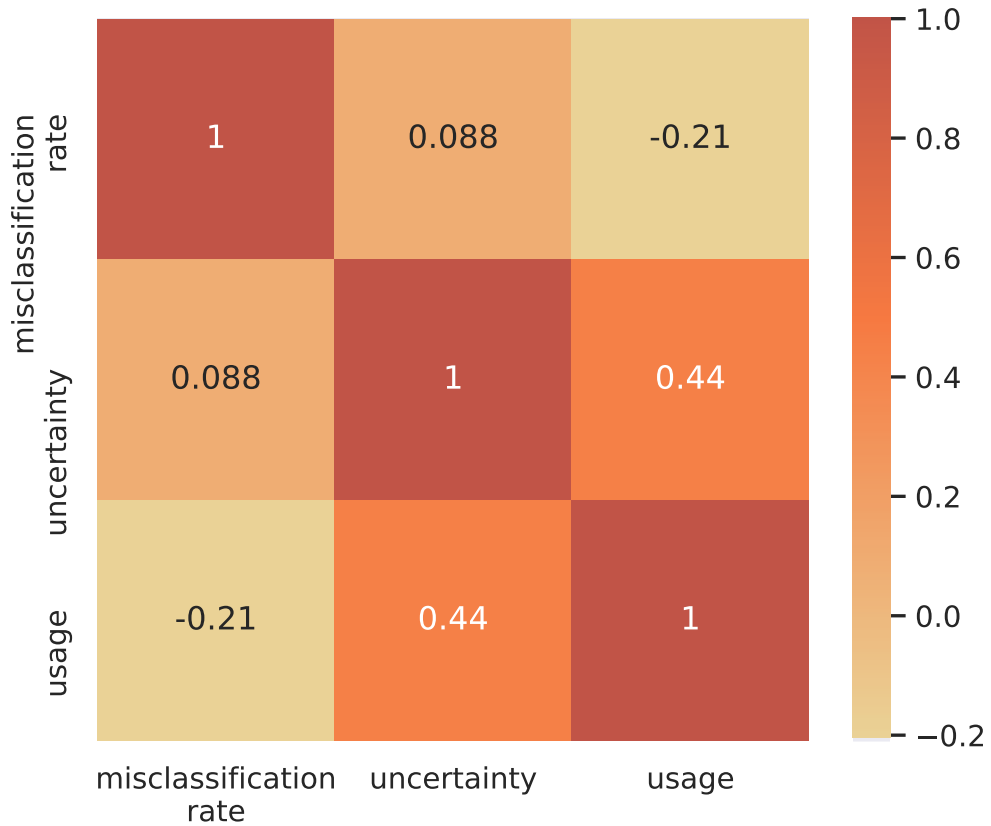
- The ornithologist is tasked to survey bird species, which she automates using a drone and computer vision software
- She uses our model to go through the vast amount of collected data
- Some bird species unknown to the model appear in the data. The model yields high uncertainty and the ornithologist can classify them manually

test


Recurrent Devision Tree (RDT) Agent
Attribute-based Learner (ABL) Agent
Find out about:
black
furry
whiskers
tail
whiskers
long snout
object is/has:
yes
no
?
ResNet
x
$\hat{y}_{t-3}$
$\hat{y}_{t-2}$
$\hat{y}_{t-1}$
$\hat{y}_t$
h_{t-3}
h_{t-2}
h_{t-1}
h_t
$c_{t-1} = \text{whiskers}$
$d_{t-1} = ?$
$c_t = \text{long snout}$
$d_t = \text{no}$
$f_{QuestMLP}(h_{t-1}) \rightarrow c_t$
$\hat{a} \leftarrow f_{AttrMLP}(z)$

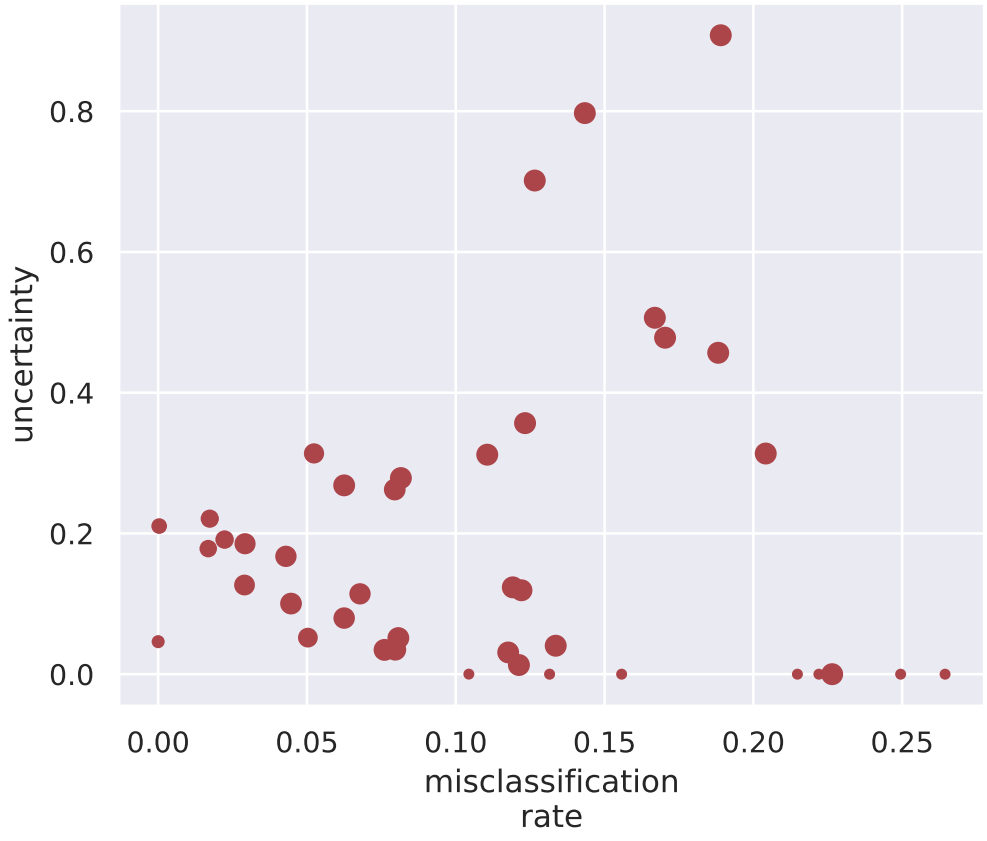
Experiments

Investigating Uncertainties

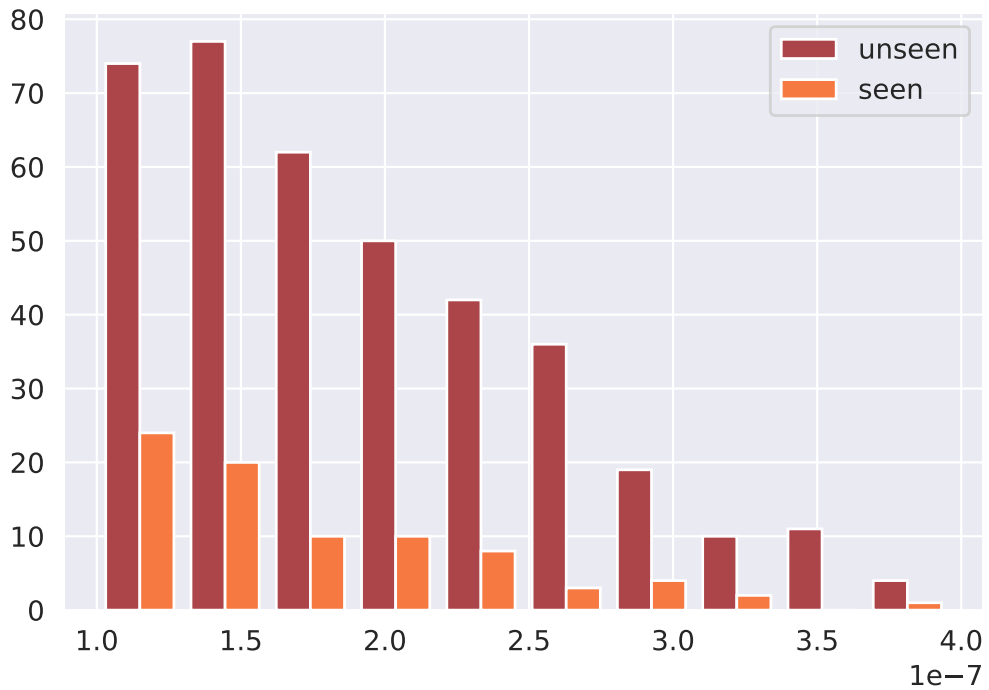


Experiments

Investigating Uncertainties



Experiments
OOD Detection



Experiments

Results on Benchmark Datasets

	AWA2	aPY	CUB
ResNet [HZRS16]	98.2 ± 0.0	85.1 ± 0.6	79.0 ± 0.2
DT	78.0 ± 0.4	64.3 ± 0.6	19.3 ± 0.3
dNDF[KFCRB15]	97.6 ± 0.2	85.0 ± 0.6	73.8 ± 0.3
RDTC[AA19]	98.0 ± 0.1	85.7 ± 0.7	78.1 ± 0.2
XDT	73.9 ± 0.9	59.9 ± 1.5	4.9 ± 1.3
aRDTC[AA19]	98.6	86.1	77.9 ± 0.6
remRDTC(ours)	98.7	86.4	77.7
extRDTC(ours)	98.7	85.4	77.8

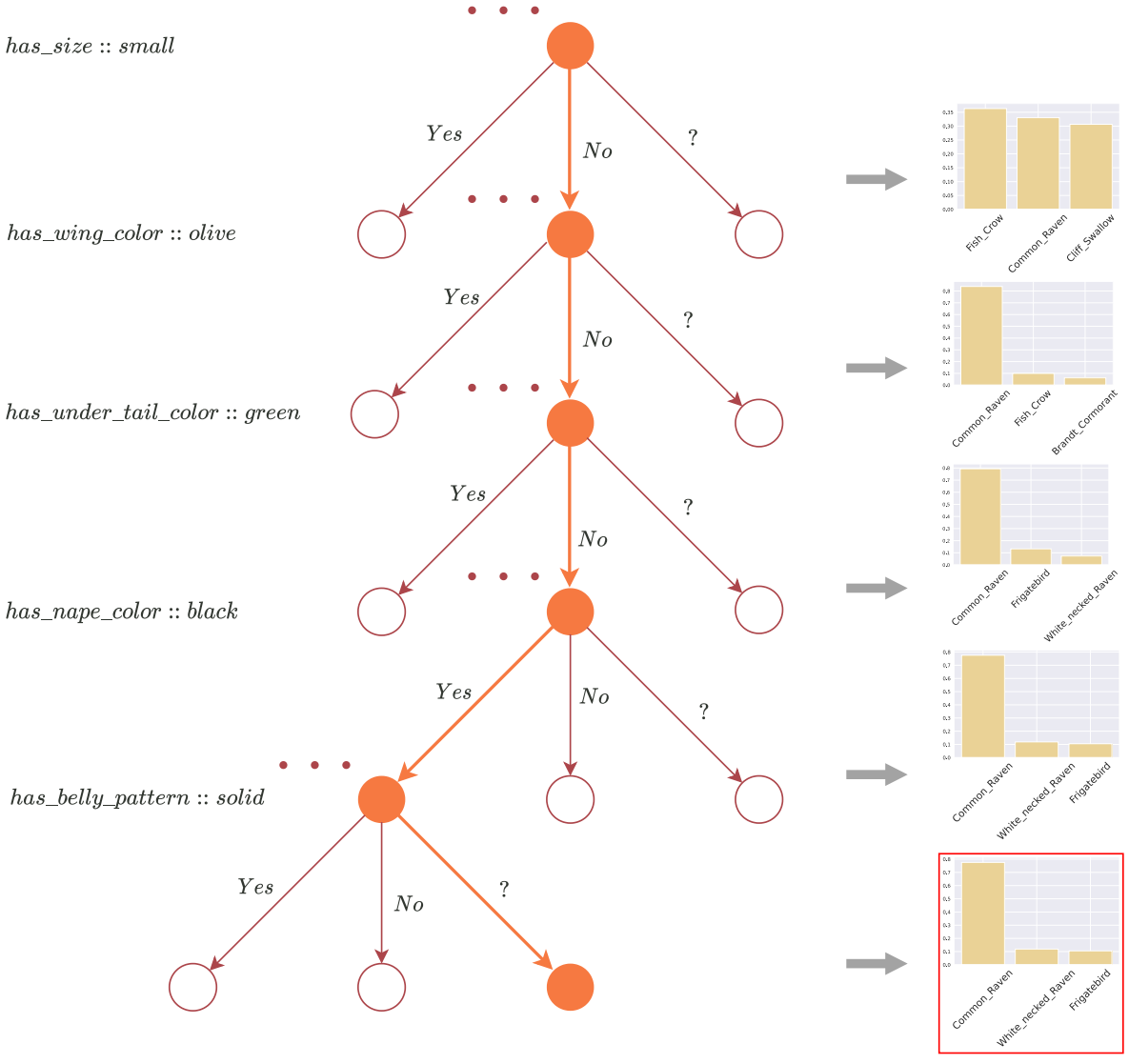
Experiments

Results on Benchmark Datasets

	aRDTC [AA19]	Random Baseline	remRDTC	extRDTC
AWA2				
Class	98.6	98.5	98.7	98.7
Attribute	80.4	84.6	87.5	82.31
aPY				
Class	86.1	86.5	86.4	85.4
Attribute	86.4	86.2	87.6	87.12
CUB				
Class	77.9	76.8	77.7	77.8
Attribute	68.6	70.0	77.4	82.6

Conclusions

A qualitative Example



[AA19] Stephan Alaniz and Zeynep Akata. Explainable observer-classifier for explainable binary decisions. arXiv preprint arXiv:1902.01780, 2019.

[HZRS16] Kaiming He, Xiangyu Zhang, Shaoqing Ren, and Jian Sun. Deep residual learning for image recognition. In Proceedings of the IEEE conference on computer vision and pattern recognition, pages 770–778, 2016.

[KFCRB15] Peter Kontschieder, Madalina Fiterau, Antonio Criminisi, and Samuel Rota Bulo. Deep neural decision forests. In Proceedings of the IEEE international conference on computer vision, pages 1467–1475, 2015.