Report for Offline-4 Decision Tree

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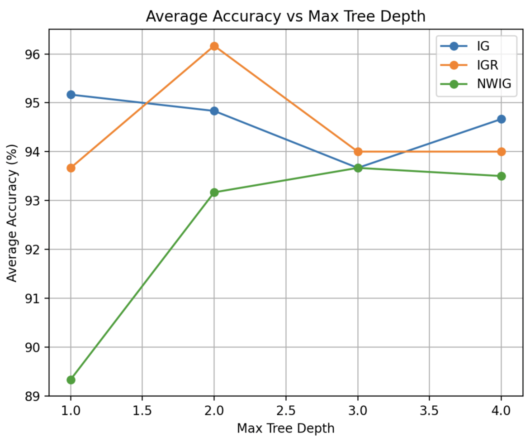
Average Accuracy of Different Criteria Across Max Depths

Table 1: Average Accuracy (%) and Node number for IG, IGR, and NWIG Criteria at Various Max Depths of iris.csv

Max Depth	IG		IGR		NWIG	
	Accuracy (%)	Avg Nodes	Accuracy (%)	Avg Nodes	Accuracy (%)	Avg Nodes
1	95.17	10.70	93.67	10.55	89.33	10.30
2	94.83	23.55	96.17	20.75	93.17	20.25
3	93.67	29.35	94.00	26.80	93.67	28.20
4	94.67	30.70	94.00	27.00	93.50	27.40



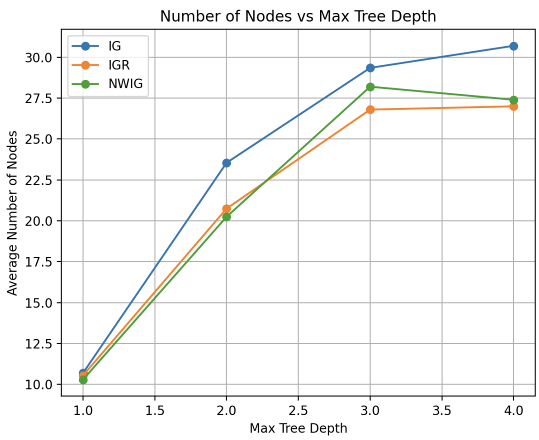
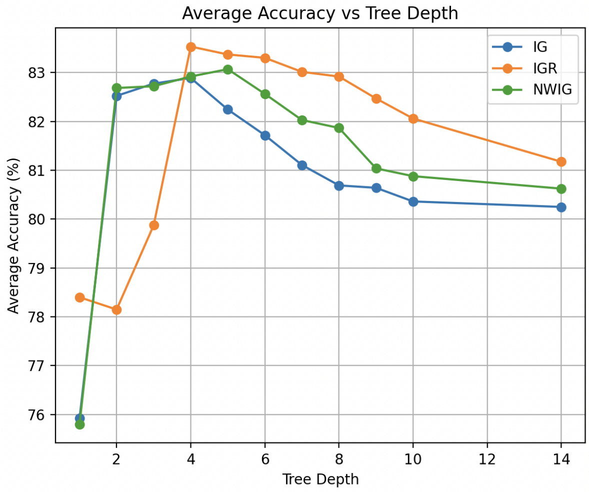
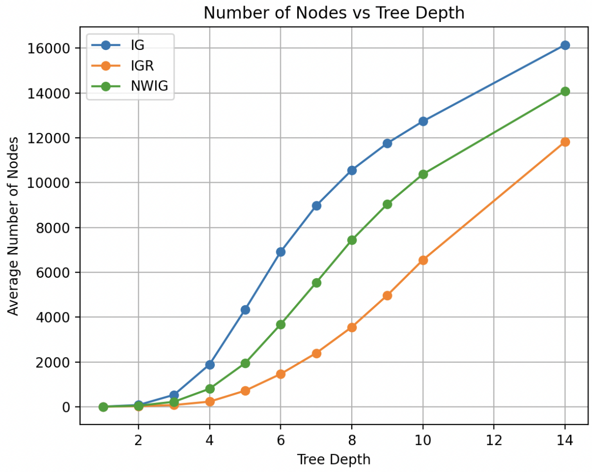


Table 2: Average Accuracy (%) and Node number for IG, IGR, and NWIG Criteria at Various Max Depths of adult.data

Depth	IG		IGR		NWIG	
	Accuracy (%)	Avg Nodes	Accuracy (%)	Avg Nodes	Accuracy (%)	Avg Nodes
1	75.92	7.00	78.40	7.00	75.80	7.00
2	82.53	79.40	78.15	25.30	82.69	48.30
3	82.78	533.85	79.87	79.45	82.72	224.65
4	82.89	1890.40	83.53	229.90	82.92	804.45
5	82.24	4341.10	83.37	717.75	83.07	1946.35
6	81.72	6918.50	83.30	1464.25	82.56	3680.80
7	81.11	8975.15	83.02	2396.35	82.03	5543.30
8	80.69	10563.5	82.92	3556.55	81.87	7438.15
9	80.64	11761.4	82.47	4977.25	81.04	9044.50
10	80.36	12737.8	82.06	6550.70	80.88	10377.9
14	80.25	16150.8	81.18	11824.8	80.62	14088.3





Discussion

From the experimental results, several observations can be made regarding the performance of the three attribute selection criteria—Information Gain (IG), Information Gain Ratio (IGR), and Normalized Weighted Information Gain (NWIG)—across different tree depths.

For the dataset Of Iris.csv , At a shallow depth of 1, **IG performs best with the highest accuracy of 95.17%**, indicating its effectiveness when aggressive pruning is applied.Though it changes over iterations as every time the test and train sets are split in random

At depth 2, IGR outperforms the others with an accuracy of 96.17% while also maintaining a relatively small number of nodes, suggesting better generalization. Interestingly, at depth 3, both IG and IGR reach the same accuracy (94.00%), but IGR builds a more compact tree, making it more efficient. At depth 4, IG again leads in accuracy (94.67%) but with slightly increased tree complexity with higher depth.

Pruning clearly plays a key role in controlling overfitting. Shallower trees (depths 1–2) not only reduce the number of nodes significantly but often maintain or even improve accuracy but it laso varries with iteration for different split of dataset.

In contrast, deeper trees (depths 3–4) tend to overfit, especially in the case of NWIG, where accuracy does not improve much despite of an increase in tree size. Among all criteria, IGR shows the most consistent and stable performance across depths, making it a good choice for the Iris.csv dataset. NWIG, on the other hand, shows signs of overfitting and bad performance, particularly at shallow depths, and offers little gain with deeper trees.

Overall, IG is best suited for simpler models**(But one thing to mention in this case, when i first implemented the decision tree without quantization/discritization, too much splitting for IG caused much much performance degradation, having accuracy less than 50% but didnt affect IGR and NWIG)**, IGR performed optimal in terms of both accuracy and depth, and NWIG was not that effective in many cases here.

For dataset adult.data I have shown plot varrying tree depths 1 to 14 which has shown some interesting and different insights from the previous small dataset.

At very shallow depth (1), all criterion performed poorly (75-78% accuracy) **where IGR hold modest result among them**, but as depth increases to 2-4, there is a notable improvement. IG peaks in accuracy (82.89%) at depth 4, while IGR achieves the highest accuracy overall (83.53%) at the same depth. NWIG closely follows, reaching 83.07% at depth 5. However, after depth 4-5, each of the criterion has shown degrardation of accuracy with the increasing of depth but not much drastic change.

Considering the number of nodes grows much significantly with depth at IG, it showing

the lowest accuracy throughout the plot. Similar but with more accuracy trends are seen for IGR and NWIG, although IGR consistently uses fewer nodes for good accuracy, reflecting better efficiency in tree growth. This highlights a key trade-off: IG and NWIG achieve early gains at depth 2**(still less than IGR that acquires greater in the next depth)** but with much higher complexity later, while IGR maintains strong accuracy with more compact trees.

Ultimately, IGR emerges again as the most balanced and scalable criterion here also in adult.data maintaining less nodecounts and better accuracy with increasing depth. In contrast, IG and NWIG should be used cautiously at higher depths unless computational resources are not a concern.