

Decision Tree using Gini Index – Solved Example

Weekend	Weather	Parents	Money	Decision
W1	Sunny	Yes	Rich	Cinema
W2	Sunny	No	Rich	Tennis
W3	Windy	Yes	Rich	Cinema
W4	Rainy	Yes	Poor	Cinema
W5	Rainy	No	Rich	Stay In
W6	Rainy	Yes	Poor	Cinema
W7	Windy	No	Poor	Cinema
W8	Windy	No	Rich	Shopping
W9	Windy	Yes	Rich	Cinema
W10	Sunny	No	Rich	Tennis

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W6	Rainy	Yes	Poor	Cinema
W7	Windy	No	Poor	Cinema
W8	Windy	No	Rich	Shopping
W9	Windy	Yes	Rich	Cinema
W10	Sunny	No	Rich	Tennis

- Compute the **Gini Index** for the overall collection of training examples.
- There are **four possible output variables** **Cinema**, **Tennis**, **Stay In** and **Shopping**.
- The data has **6 instances of Cinema**, **2 instances of Tennis**, **1 instance of Stay In** and **1 of shopping**.

$$\begin{aligned} Gini(S) = 1 - [& \left(\frac{6}{10}\right)^2 + \left(\frac{2}{10}\right)^2 + \\ & \left(\frac{1}{10}\right)^2 + \left(\frac{1}{10}\right)^2] = 0.58 \end{aligned}$$

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W5	Rainy	No	Rich	Stay In
W6	Rainy	Yes	Poor	Cinema
W7	Windy	No	Poor	Cinema
W8	Windy	No	Rich	Shopping
W9	Windy	Yes	Rich	Cinema
W10	Sunny	No	Rich	Tennis

- Computation of **Gini Index for Money** Attribute
- It has **two possible values of Rich (7 examples)** and **Poor (3 examples)**.
- For **Money = Poor**, there are **3 examples with "Cinema"**.
- $Gini(S) = 1 - \left[\left(\frac{3}{3}\right)^2\right] = 0$ ✓ 7
- For **Money = Rich**, there are **2 examples with "Tennis"**, **3 examples with "Cinema"** and **1 example with "Stay in", "Shopping" each**
- $Gini(S) = 1 - \left[\left(\frac{2}{7}\right)^2 + \left(\frac{3}{7}\right)^2 + \left(\frac{1}{7}\right)^2 + \left(\frac{1}{7}\right)^2\right] = 0.694$

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W3	Windy	Yes	Rich	Cinema
W4	Rainy	Yes	Poor	Cinema
W5	Rainy	No	Rich	Stay In
W6	Rainy	Yes	Poor	Cinema
W7	Windy	No	Poor	Cinema
W8	Windy	No	Rich	Shopping
W9	Windy	Yes	Rich	Cinema
W10	Sunny	No	Rich	Tennis

- Computation of **Gini Index for Money** Attribute
- It has **two possible values of Rich (7 examples)** and **Poor (3 examples)**.
- For **Money = Poor**, there are **3 examples with "Cinema"**.
- $Gini(S) = 1 - \left[\left(\frac{3}{3}\right)^2\right] = 0$ ✓ 7
- For **Money = Rich**, there are **2 examples with "Tennis"**, **3 examples with "Cinema"** and **1 example with "Stay in", "Shopping" each**
- $Gini(S) = 1 - \left[\left(\frac{2}{7}\right)^2 + \left(\frac{3}{7}\right)^2 + \left(\frac{1}{7}\right)^2 + \left(\frac{1}{7}\right)^2\right] = 0.694$
- Weighted Average(Money)**

$$= 0 * \left(\frac{3}{10}\right) + 0.694 * \left(\frac{7}{10}\right) = 0.486$$

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W4	Rainy	Yes	Poor	Cinema
W5	Rainy	No	Rich	Stay In
W6	Rainy	Yes	Poor	Cinema
W7	Windy	No	Poor	Cinema
W8	Windy	No	Rich	Shopping
W9	Windy	Yes	Rich	Cinema
W10	Sunny	No	Rich	Tennis

- Computation of **Gini Index for Parents** Attribute
- It has two possible values of **Yes (5 examples)** and **No (5 examples)**.
- For **Parents = Yes**, there are **5 examples**, all with "Cinema".
- $Gini(S) = 1 - \left[\left(\frac{5}{5}\right)^2\right] = 0$
- For **Parents = No**, there are **2 examples with "Tennis"**, **1 example with "Stay in"**, **"Shopping"** and **"Cinema"** each
- $Gini(S) = 1 - \left[\left(\frac{2}{5}\right)^2 + \left(\frac{1}{5}\right)^2 + \left(\frac{1}{5}\right)^2 + \left(\frac{1}{5}\right)^2\right] = 0.72$
- Weighted Average(Parents)**

$$= 0 * \left(\frac{5}{10}\right) + [0.72 * \left(\frac{5}{10}\right)] = 0.36$$

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W1	Sunny	Yes	Rich	Cinema
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W3	Windy	Yes	Rich	Cinema
W4	Rainy	Yes	Poor	Cinema
W5	Rainy	No	Rich	Stay In
W6	Rainy	Yes	Poor	Cinema
W7	Windy	No	Poor	Cinema
W8	Windy	No	Rich	Shopping
W9	Windy	Yes	Rich	Cinema
W10	Sunny	No	Rich	Tennis

- Computation of **Gini Index for Weather** Attribute
- It has three possible values of **Sunny (3 examples)**, **Rainy (3 examples)** and **Windy (4 examples)**.
- For **Weather = Sunny**, there are **2 examples** with "Cinema" and **1** with "Tennis".
$$Gini(Sunny) = 1 - \left[\left(\frac{2}{3}\right)^2 + \left(\frac{1}{3}\right)^2 \right] = 0.444$$
- For **Weather = Rainy**, there are **2 examples** with "Cinema" and **1 example** with "Stay in".
$$Gini(Rainy) = 1 - \left[\left(\frac{2}{3}\right)^2 + \left(\frac{1}{3}\right)^2 \right] = 0.444$$
- For **Weather = Windy**, there are **3 examples** with "Cinema" and **1 example** with "Shopping".
$$Gini(Windy) = 1 - \left[\left(\frac{3}{4}\right)^2 + \left(\frac{1}{4}\right)^2 \right] = 0.375$$

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W1	Sunny	Yes	Rich	Cinema
W2	Sunny	No	Rich	Tennis
W3	Windy	Yes	Rich	Cinema
W4	Rainy	Yes	Poor	Cinema
W5	Rainy	No	Rich	Stay In
W6	Rainy	Yes	Poor	Cinema
W7	Windy	No	Poor	Cinema
W8	Windy	No	Rich	Shopping
W9	Windy	Yes	Rich	Cinema
W10	Sunny	No	Rich	Tennis

Weighted Average(Weather)

$$= 0.444 * \left(\frac{3}{10}\right) + 0.444 * \left(\frac{3}{10}\right) + 0.375 * \left(\frac{4}{10}\right)$$

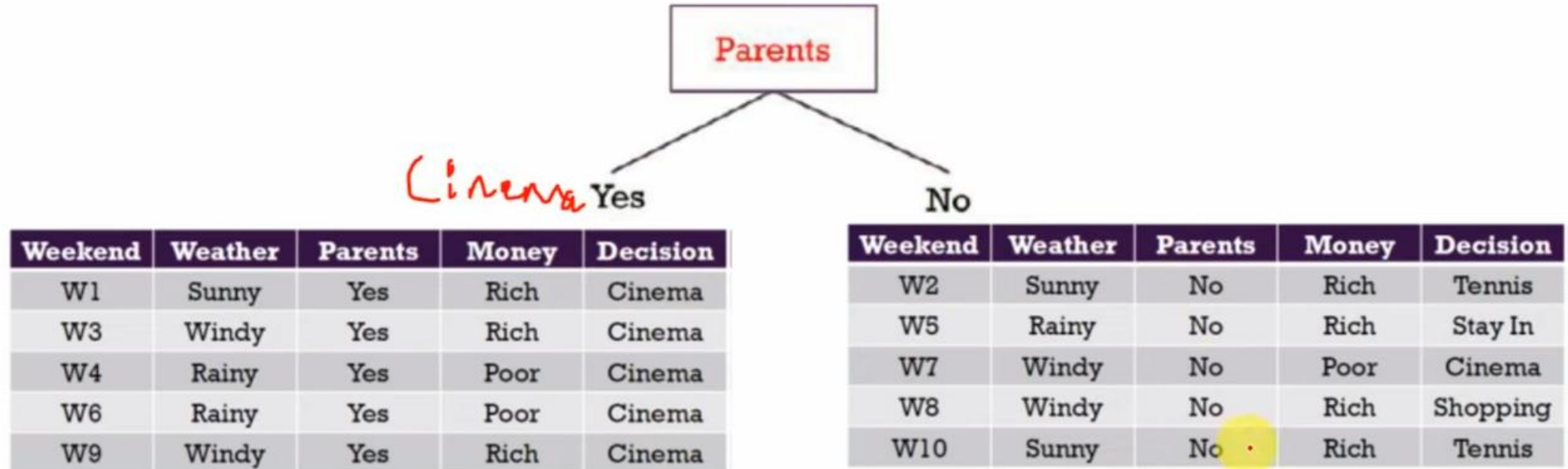
= 0.416

For Weather - Gini Index: 0.416

For Parents - Gini Index: 0.36

For Money - Gini Index: 0.486

Decision Tree using Gini Index – Solved Example



Decision Tree using Gini Index – Solved Example

Weekend	Weather	Parents	Money	Decision
W2	Sunny	No	Rich	Tennis
W5	Rainy	No	Rich	Stay In
W7	Windy	No	Poor	Cinema
W8	Windy	No	Rich	Shopping
W10	Sunny	No	Rich	Tennis

Computation of Gini Index for Parents = No | Weather Attribute

- **Sunny (2 examples)**
- For Parent= No | Weather = Sunny, there are 2 example with "Tennis.
- $Gini(S) = 1 - \left[\left(\frac{2}{2}\right)^2\right] = 0$

Decision Tree using Gini Index – Solved Example

Weekend	Weather	Parents	Money	Decision
W2	Sunny	No	Rich	Tennis
W5	Rainy	No	Rich	Stay In
W7	Windy	No	Poor	Cinema
W8	Windy	No	Rich	Shopping
W10	Sunny	No	Rich	Tennis

Computation of Gini Index for Parents = No | Weather Attribute

- **Windy (2 example)**
- For Parents = No | Weather = Windy, there is 1 example with “Cinema” and 1 example with “Shopping”.
- $Gini(S) = 1 - \left[\left(\frac{1}{2}\right)^2 + \left(\frac{1}{2}\right)^2 \right] = \underline{0.5}$

$$Weighted\ Average(Parents = No | Weather) = 0 * \left(\frac{2}{5}\right) + 0 * \left(\frac{1}{5}\right) + 0.5 * \left(\frac{2}{5}\right) = \underline{0.2}$$

Decision Tree using Gini Index – Solved Example

Weekend	Weather	Parents	Money	Decision
W2	Sunny	No	Rich	Tennis
W5	Rainy	No	Rich	Stay In
W7	Windy	No	Poor	Cinema
W8	Windy	No	Rich	Shopping
W10	Sunny	No	Rich	Tennis

Computation of Gini Index for Parents = No | Money Attribute

- Rich (4 examples)
- For Parents = No | Money = Rich, there is 1 example with “stay in” and “Shopping” each and 2 examples of “Tennis”.
- $Gini(S) = 1 - \left[\left(\frac{1}{4}\right)^2 + \left(\frac{1}{4}\right)^2 + \left(\frac{2}{4}\right)^2\right] = 0.625$

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Weekend	Weather	Parents	Money	Decision
W2	Sunny	No	Rich	Tennis
W5	Rainy	No	Rich	Stay In
W7	Windy	No	Poor	Cinema
W8	Windy	No	Rich	Shopping
W10	Sunny	No	Rich	Tennis

Computation of Gini Index for Parents = No | Money Attribute

- Poor (1 example)
- For Parents = No | Money = Poor, there is 1 example with “Cinema”.
- $Gini(S) = 1 - \left[\left(\frac{1}{1}\right)^2\right] = 0$

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Weekend	Weather	Parents	Money	Decision
W2	Sunny	No	Rich	Tennis
W5	Rainy	No	Rich	Stay In
W7	Windy	No	Poor	Cinema
W8	Windy	No	Rich	Shopping
W10	Sunny	No	Rich	Tennis

Computation of Gini Index for Parents = No | Money Attribute

- Poor (1 example)
- For Parents = No | Money = Poor, there is 1 example with “Cinema”.
- $Gini(S) = 1 - \left[\left(\frac{1}{1}\right)^2\right] = 0$
- $Weighted\ Average\ (Parents = No | Money) = 0.625 * (4/5) + 0 * (1/5) = 0.5$

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Weekend	Weather	Parents	Money	Decision
W2	Sunny	No	Rich	Tennis
W5	Rainy	No	Rich	Stay In
W7	Windy	No	Poor	Cinema
W8	Windy	No	Rich	Shopping
W10	Sunny	No	Rich	Tennis

For Parents = No | Weather - Gini Index: 0.2

For Parents = No | Money - Gini Index: 0.5

Weather is selected as it has smallest Gini index.

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Weekend	Weather	Parents	Money	Decision
W2	Sunny	No	Rich	Tennis
W5	Rainy	No	Rich	Stay In
W7	Windy	No	Poor	Cinema
W8	Windy	No	Rich	Shopping
W10	Sunny	No	Rich	Tennis

Now, for Parent=No & Weather=Sunny, we have all instances as Tennis.

Weekend	Weather	Parents	Money	Decision
W2	Sunny	No	Rich	Tennis ✓
W10	Sunny	No	Rich	Tennis ✓

Now, for Parent=No & Weather=Windy, we need to split.

Weekend	Weather	Parents	Money	Decision
W7	Windy	No	Poor	Cinema
W8	Windy	No	Rich	Shopping

Now, for Parents=No & Weather=Rainy, we have all instances as Stay In.

Weekend	Weather	Parents	Money	Decision
W5	Rainy	No	Rich	Stay In ✓