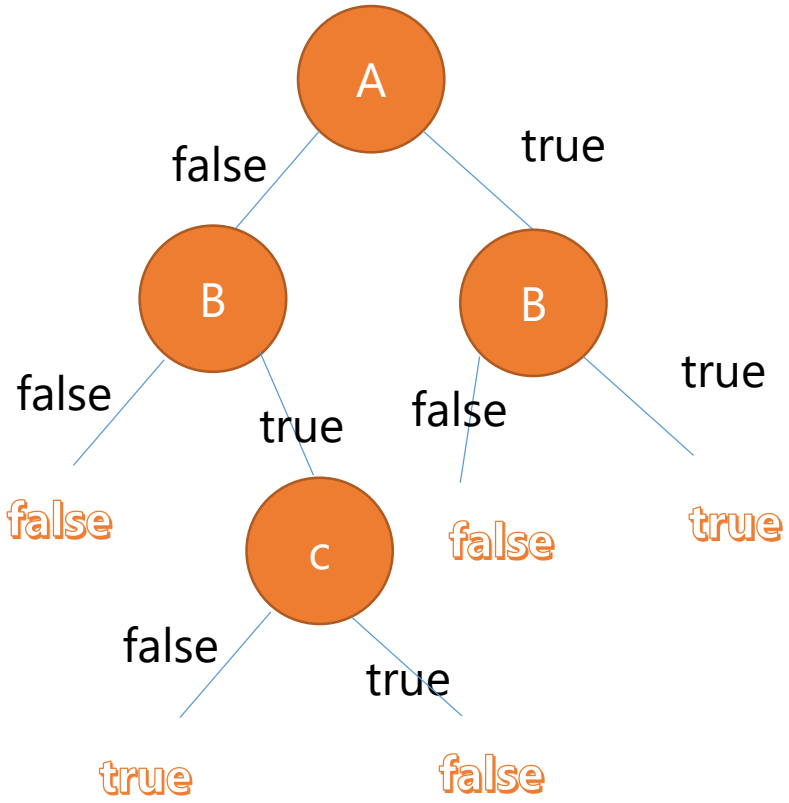
Machine Learning – ECERSICE 2

Amir Shokri

Exercise 2 – Decision Tree

(A AND B) OR (B AND C) XOR (A OR B)

A	B	C	RESULT
F	F	F	F
F	F	T	F
F	T	F	T
F	T	T	F
T	F	F	T
T	F	T	T
T	T	F	F
T	T	T	F



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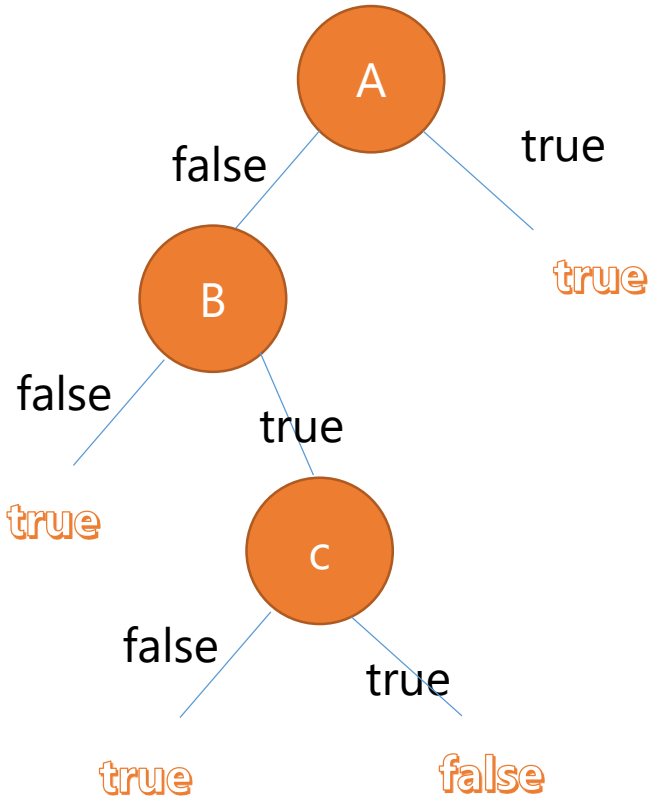
Exercise 2 – Decision Tree

(A AND B AND C) OR (C NAND B)

A	B	C	RESULT
F	F	F	T
F	F	T	T
F	T	F	T
F	T	T	F
T	F	F	T
T	F	T	T
T	T	F	T
T	T	T	T



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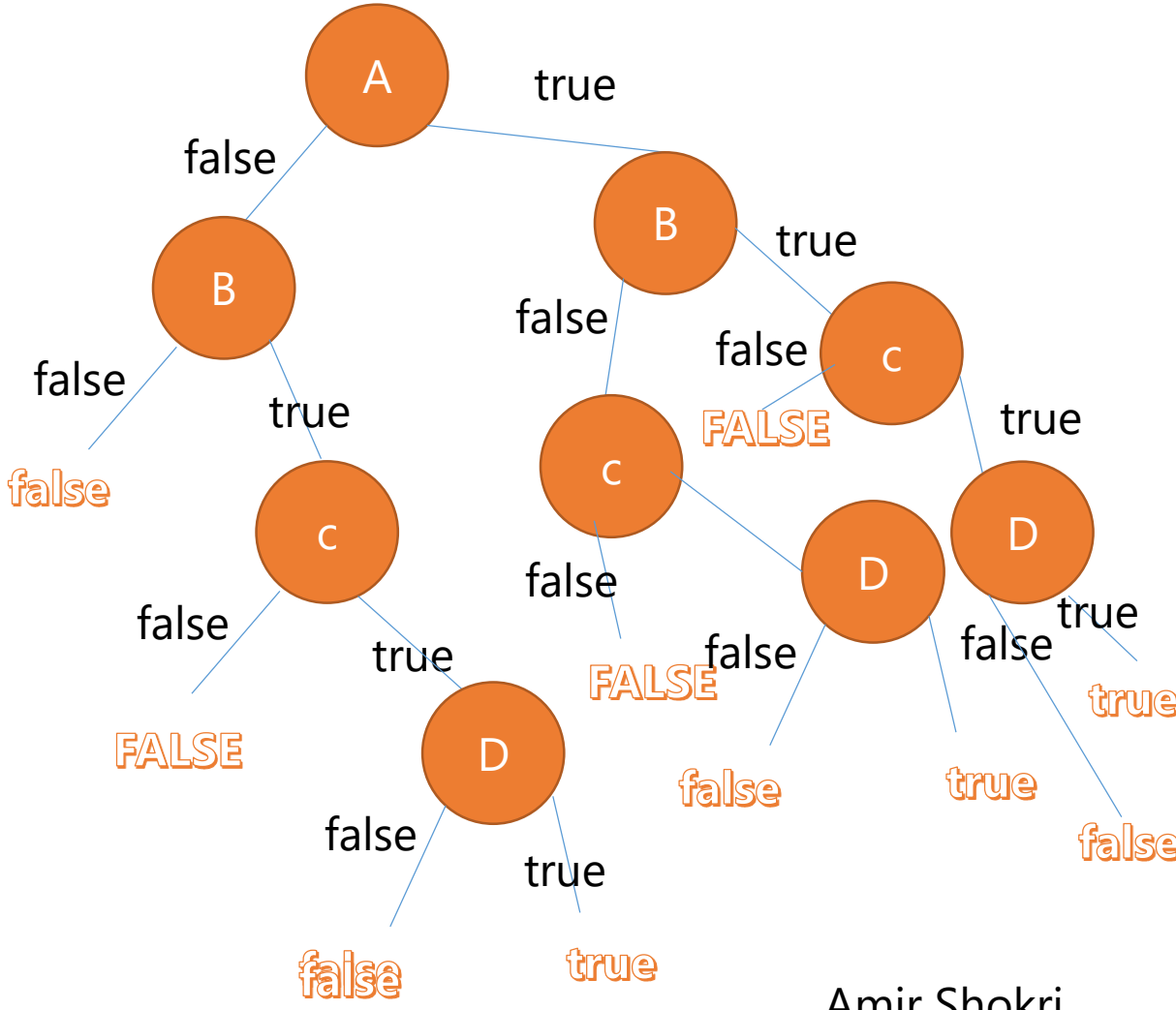
Exercise 2 – Decision Tree

(A OR B) AND (B OR C) AND (C AND D)

A	B	C	D	RESULT
F	F	F	F	F
F	F	F	T	F
F	F	T	F	F
F	F	T	T	F
F	T	F	F	F
F	T	F	T	F
F	T	T	F	F
F	T	T	T	T
T	F	F	F	F
T	F	F	T	F
T	F	T	F	F
T	F	T	T	T
T	T	F	F	F
T	T	F	T	F
T	T	T	F	F
T	T	T	T	T



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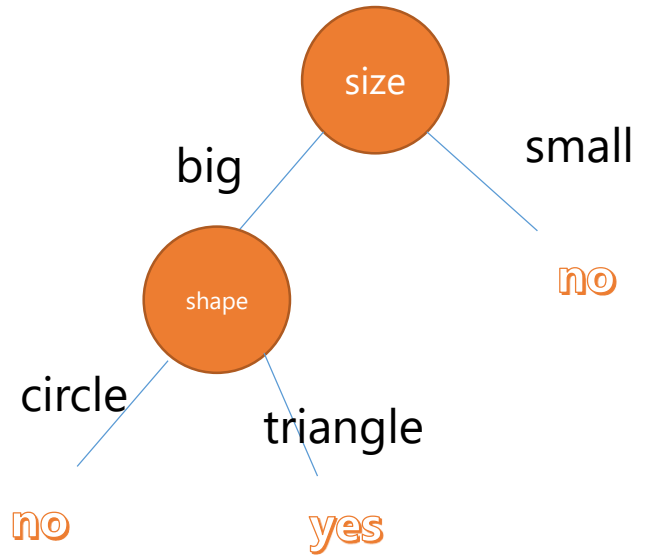
Exercise 2 – Decision Tree

Example	Size	Color	Shape	Class/Label
1	big	red	circle	No
2	big	red	triangle	Yes
3	small	red	circle	No
4	~~big~~	~~red~~	~~triangle~~	~~No~~
5	small	blue	circle	No



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Exercise 2 – FIND-S

Example	Size	Color	Shape	Class/Label
1	big	red	circle	No
2	big	red	triangle	Yes
3	small	red	circle	No
4	~~big~~	~~red~~	~~triangle~~	~~No~~
5	small	blue	circle	No

$h_0 = < \emptyset , \emptyset , \emptyset >$
$h_1 = < \emptyset , \emptyset , \emptyset >$
$h_2 = <$ big, red, triangle $>$
$h_3 = <$ big, red, triangle $>$
$h_4 = <$ big, red, triangle $>$

Exercise 2 – Candidate elimination

Example	Size	Color	Shape	Class/Label
1	big	red	circle	No
2	big	red	triangle	Yes
3	small	red	circle	No
4	~~big~~	~~red~~	~~triangle~~	~~No~~
5	small	blue	circle	No

$S_0 = < \emptyset , \emptyset , \emptyset >$

$G_0 = < ?, ?, ? >$

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Exercise 2 – Candidate elimination

Example	Size	Color	Shape	Class/Label
1	big	red	circle	No
2	big	red	triangle	Yes
3	small	red	circle	No
4	~~big~~	~~red~~	~~triangle~~	~~No~~
5	small	blue	circle	No

S_1 = < Ø , Ø , Ø >

G_1 = < small, ?, ?> < ?, blue, ? > < ?, ? ,triangle >

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Exercise 2 – Candidate elimination

Example	Size	Color	Shape	Class/Label
1	big	red	circle	No
2	big	red	triangle	Yes
3	small	red	circle	No
4	~~big~~	~~red~~	~~triangle~~	~~No~~
5	small	blue	circle	No

S_3 = < big, red, triangle >

G_3 = < ?, ? ,triangle >

Exercise 2 – Candidate elimination

Example	Size	Color	Shape	Class/Label
1	big	red	circle	No
2	big	red	triangle	Yes
3	small	red	circle	No
4	~~big~~	~~red~~	~~triangle~~	~~No~~
5	small	blue	circle	No

S_4 = < big, red, triangle >

G_4 = < ?, ? ,triangle >

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Exercise 2 – ID3

Example	Size	Color	Shape	Class/Label
1	big	red	circle	No
2	big	red	triangle	Yes
3	small	red	circle	No
4	~~big~~	~~red~~	~~triangle~~	~~No~~
5	small	blue	circle	No

Entropy : $\sum_{i=1} -p_i * \log_2(p_i)$

Entropy(S) : $(-p_+ \log_2 p_+) - (-p_- \log_2 p_-)$

Gain(S, A): $Entrophy(S) - \sum_{v=Values(A)} \frac{|S_v|}{|S|} Entrophy(S_v)$

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Exercise 2 – ID3

Example	Size	Color	Shape	Class/Label
1	big	red	circle	No
2	big	red	triangle	Yes
3	small	red	circle	No
4	~~big~~	~~red~~	~~triangle~~	~~No~~
5	small	blue	circle	No

Entropy

$$\sum_{i=1} -p_i * \log_2(p_i) = -\frac{3}{4}\log_2\frac{3}{4} - \frac{1}{4}\log_2\frac{1}{4} = 0.307 + 0.5 = 0.87$$

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Exercise 2 – ID3

Example	Size	Color	Shape	Class/Label
1	big	red	circle	No
2	big	red	triangle	Yes
3	small	red	circle	No
4	~~big~~	~~red~~	~~triangle~~	~~No~~
5	small	blue	circle	No

Gain size:

$$\begin{cases} entropy(small) => -\frac{2}{4}\left(\frac{0}{2}\log\frac{0}{2}+\frac{2}{2}\log\frac{2}{2}\right) \\ entropy(big) => -\frac{2}{4}\left(\frac{1}{2}\log\frac{1}{2}+\frac{1}{2}\log\frac{1}{2}\right) \end{cases}$$

$$Gain(S, \text{size}) = 0.87 - (0 + 0.5) = 0.37$$

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Exercise 2 – ID3

Example	Size	Color	Shape	Class/Label
1	big	red	circle	No
2	big	red	triangle	Yes
3	small	red	circle	No
4	~~big~~	~~red~~	~~triangle~~	~~No~~
5	small	blue	circle	No

Gain color:

$$\begin{cases} entropy(red) => -\frac{3}{4}\left(\frac{2}{3}\log\frac{2}{3}+\frac{1}{3}\log\frac{1}{3}\right) \\ entropy(blue) => -\frac{1}{4}\left(\frac{1}{1}\log\frac{1}{1}+\frac{0}{1}\log\frac{0}{1}\right) \end{cases}$$

$$Gain(S, \text{color}) = 0.87 - (0.29 + 0) = 0.58$$

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Exercise 2 – ID3

Example	Size	Color	Shape	Class/Label
1	big	red	circle	No
2	big	red	triangle	Yes
3	small	red	circle	No
4	~~big~~	~~red~~	~~triangle~~	~~No~~
5	small	blue	circle	No

Gain shape:

$$\begin{cases} entropy(circle) => -\frac{3}{4}\left(\frac{0}{3}\log\frac{0}{3}+\frac{3}{3}\log\frac{3}{3}\right) \\ entropy(triangle) => -\frac{1}{4}\left(\frac{1}{1}\log\frac{1}{1}+\frac{0}{1}\log\frac{0}{1}\right) \end{cases}$$

$$Gain(S, \text{shape}) = 0.87 - (0 + 0) = 0.87$$

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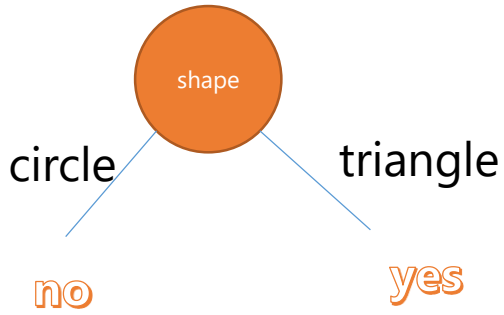
Exercise 2 – ID3

Example	Size	Color	Shape	Class/Label
1	big	red	circle	No
2	big	red	triangle	Yes
3	small	red	circle	No
4	~~big~~	~~red~~	~~triangle~~	~~No~~
5	small	blue	circle	No



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