THOMPSON RIVERS UNIVERSITY

COMP 3710 - 3
Applied Artificial Intelligence (3,1,0)
Fall 2017

Seminar/Lab 7.

Decision tree, and k-Nearest Neighbor (kNN) algorithm

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1. Decision tree

Here is the training data set.

Film	*Country*	*Big Star*	*Genre*	Success
Film 1	*USA*	*Yes*	*SF*	False
Film 2	*USA*	*No*	*Comedy*	False
Film 3	*USA*	*Yes*	*Comedy*	True
Film 4	*Europe*	*No*	*Comedy*	True
Film 5	*Europe*	*Yes*	*SF*	True
Film 6	*Europe*	*Yes*	*Romance*	False
Film 7	*Other*	*Yes*	*Comedy*	True
Film 8	*Other*	*No*	*SF*	False
Film 9	*Europe*	*Yes*	*Comedy*	False
Film 10	*USA*	*Yes*	*Comedy*	True

a) Construct a decision tree with the above table. You should show how in the tree is constructed, by computing information gains and entropies.

Gain(Country) = 1 – w-entropy(USA) – w-entropy(Europe) – w-entropy(Other)

= 1 – 4/10 * H(USA) – 4/10 * H(Europe) – 2/10 * H(Other)

= 1 – 4/10 * (-2/4 $\log_2(2/4)$ – 2/4 $\log_2(2/4)$) – 4/10 * H(Europe) – 2/10 * H(Other)

= 1 – 4/10 * (-2/4 $\log_2(2/4)$ – 2/4 $\log_2(2/4)$) – 4/10 * (-1/2 $\log_2(1/2)$ – 1/2 $\log_2(1/2)$)- 2/10 * (-1/2 $\log_2(1/2)$ – 1/2 $\log_2(1/2)$)

= 1 – (4/10 * 1) – (4/10 * 1) – (2/10 *1)

= 1 – 0.4 – 0.4 – 0.2

= 0

Gain(Big Star) = 1 – w-entropy(YES) – w-entropy(NO)

= 1 – 7/10 * H(YES) – 3/10 * H(NO)

= 1 – 7/10 * (-4/7 $\log_2(4/7)$ – 3/7 $\log_2(3/7)$) – 3/10 * (-2/3 $\log_2(2/3)$ – 1/3 $\log_2(1/3)$)

= 1 – (0.7 * 0.985) – (0.3 * 0.918)

= 0.0351

Gain(Genre) = 1 – w-entropy(SF) – w-entropy(Comedy) – w-entropy(Romance)

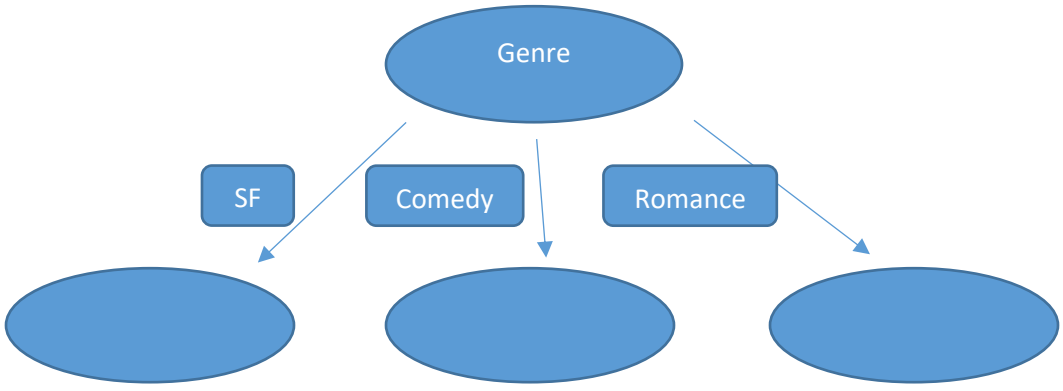
= 1 – 3/10 * H(SF) – 6/10 * H(Comedy) – 1/10 * H(Romance)

= 1 – 3/10 * (-1/3 $\log_2(1/3)$ – 2/3 $\log_2(2/3)$) – 6/10 * (-4/6 $\log_2(4/6)$ – 2/6 $\log_2(2/6)$) - 0

= 1 – (0.3 * 0.918) – (0.6 * 0.918) – 0

= 0.1738

- The information gain for *Country*= 0
- The information gain for *Big Star* = 0.0351
- The information gain for *Genre* = 0.1738
- Therefore, the attribute *Genre* provides the greatest information gain and so is placed at the top of the decision tree.



SF:

Film 1	*USA*	*Yes*	*SF*	False
Film 5	*Europe*	*Yes*	*SF*	True
Film 8	*Other*	*No*	*SF*	False

Gain(Country) = 1 – w-entropy(USA) – w-entropy(Europe) – w-entropy(Other)

= 1 – 1/3 * H(USA) – 1/3 * H(Europe) – 1/3 * H(Other)

= 1 – 1/3 * 0 – 1/3 * 0- 1/3 * 0

= 1

Gain(Big Star) = 1 – w-entropy(YES) – w-entropy(NO)

= 1 – 2/3 * H(YES) – 1/3 * H(NO)

= 1 – 2/3 * (-1/2 $\log_2(1/2)$ – 1/2 $\log_2(1/2)$) – 1/3 * 0

= 1 – (2/3 * 1)

= 1/3 = 0.33

- The information gain for *Country*= 1
- The information gain for *Big Star* = 0.33
- Therefore, the attribute *Country* provides the greatest information gain and so is placed under the SF.

Comedy:

Film 2	*USA*	*No*	*Comedy*	False
Film 3	*USA*	*Yes*	*Comedy*	True
Film 4	*Europe*	*No*	*Comedy*	True
Film 7	*Other*	*Yes*	*Comedy*	True
Film 9	*Europe*	*Yes*	*Comedy*	False
Film 10	*USA*	*Yes*	*Comedy*	True

Gain(Country) = 1 – w-entropy(USA) – w-entropy(Europe) – w-entropy(Other)

= 1 – 3/6 * H(USA) – 2/6 * H(Europe) – 1/6 * H(Other)

= 1 – 3/6 * (-2/3 $\log_2(2/3)$ – 1/3 $\log_2(1/3)$)– 2/6 * (-1/2 $\log_2(1/2)$ – 1/2 $\log_2(1/2)$)- 1/6* (-1 $\log_2(1)$ – 1 $\log_2(1)$)

= 1 – (3/6 *0.918) – (2/6 * 1) – (1/6 *0)

= 1 – 0.459 – 0.33

= 0.211

Gain(Big Star) = 1 – w-entropy(YES) – w-entropy(NO)

= 1 – 4/6 * H(YES) – 2/6 * H(NO)

= 1 – 4/6 * (-3/4 $\log_2(3/4)$ – 1/4 $\log_2(1/4)$) –2/6 * (-1/2 $\log_2(1/2)$ – 1/2 $\log_2(1/2)$)

= 1 – (4/6 *0.811) - (2/6 * 1)

= 0.126

- The information gain for *Country*= 0.211
- The information gain for *Big Star* = 0.126
- Therefore, the attribute *Country* provides the greatest information gain and so is placed under the comedy.

Romance:

Film 6	*Europe*	*Yes*	*Romance*	False

Gain(Country) = 1 – w-entropy(USA) – w-entropy(Europe) – w-entropy(Other)

= 1 –0– 1 * H(Europe) –0

= 1 – 1 * 0

= 1

Gain(Big Star) = 1 – w-entropy(YES) – w-entropy(NO)

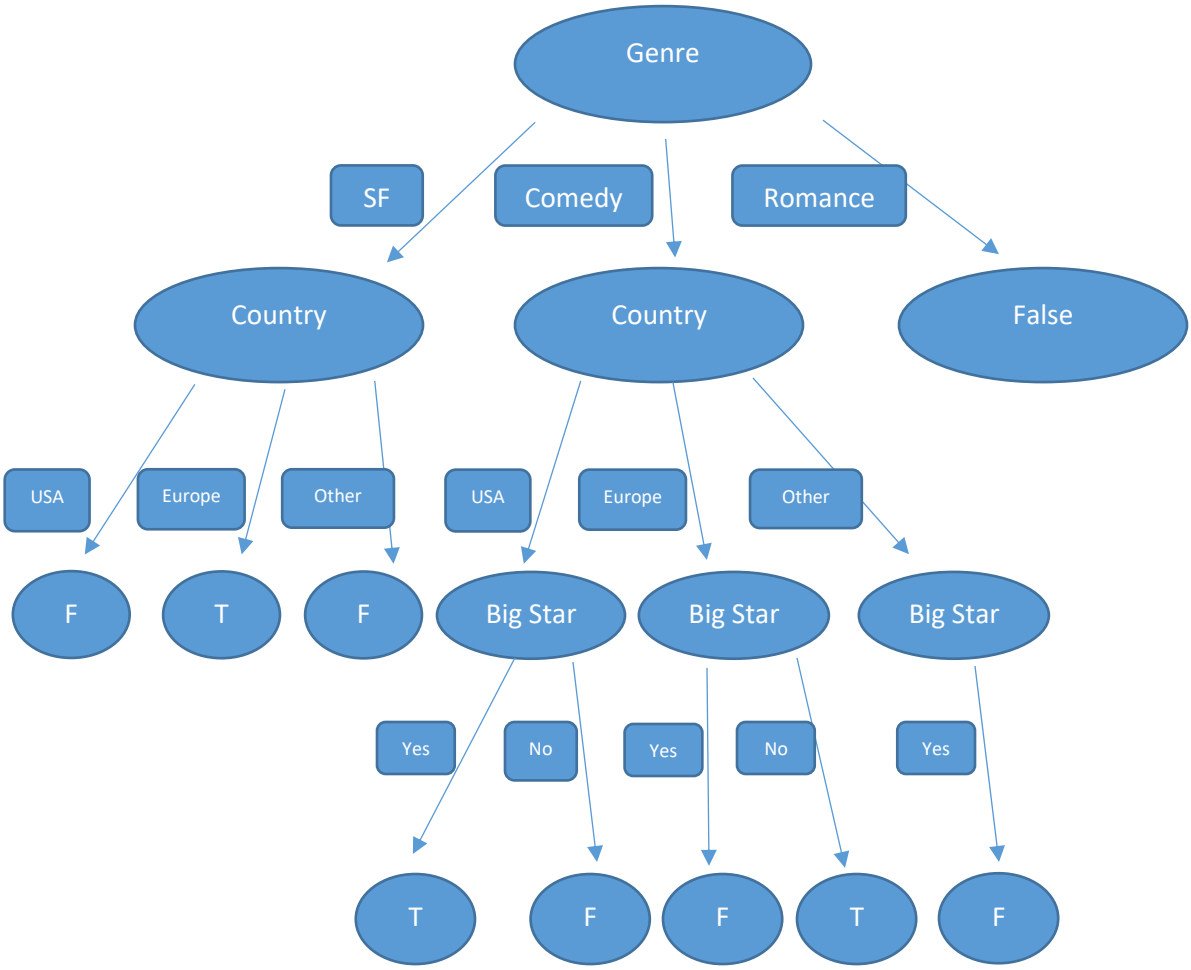
= 1 – 1 * H(YES) – 0 * H(NO)

= 1 –1* (-1 $\log_2(1)$ –0

= 1 – (1 * 0)

= 1

- The information gain for *Country*= 1
- The information gain for *Big Star* = 1
- And there is only one sample for Romance, the result only can be false.



b) Answer the next two queries using the above decision tree.

- (China, Yes, SF)

  From above decision tree, we can know other country in SF and has Big Star will be False

- (USA, No, Comedy)

  From above decision tree, we can see USA in Comedy and doesn't have Big Star will be False

2. k-Nearest Neighbor (kNN) algorithm

Here is the training data set for class grades.

MATH 1650	COMP 2230	COMP 3710	Grade level
4	3	4	Excellent
3	4	3	Good
3	4	4	Excellent
2	3	3	Okay
3	3	2	Good
2	3	2	Okay

a) Find the grade levels for the next two queries using the 3NN algorithm.

- (3, 2, 4)
- (3, 4, 3)

(3,2,4)	(4,3,4)		$\sqrt{2}$	Excellent
	(3,4,3)		$\sqrt{5}$	Good
	(3,4,4)	$\sqrt{(a_1-a_2)^2+(b_1-b_2)^2+(c_1-c_2)^2}$	2	
	(2,3,3)		$\sqrt{3}$	Okay
	(3,3,2)		$\sqrt{5}$	
	(2,3,2)		$\sqrt{6}$	

To decide the grade level for (3,2,4), we can see from above table, the minimum distance is $\sqrt{2}$, which means Excellent.

(3,4,3)	(4,3,4)		$\sqrt{3}$	
	(3,4,3)		0	Good
	(3,4,4)	$\sqrt{(a_1-a_2)^2+(b_1-b_2)^2+(c_1-c_2)^2}$	1	Excellent
	(2,3,3)		$\sqrt{2}$	Okay
	(3,3,2)		$\sqrt{2}$	
	(2,3,2)		$\sqrt{3}$	

To decide the grade level for (3,4,3), we can see from above table, the minimum distance is 0, which means Good.