Basic Probability

The HBO cable network took a survey of 500 subscribers to determine people's favourite show.

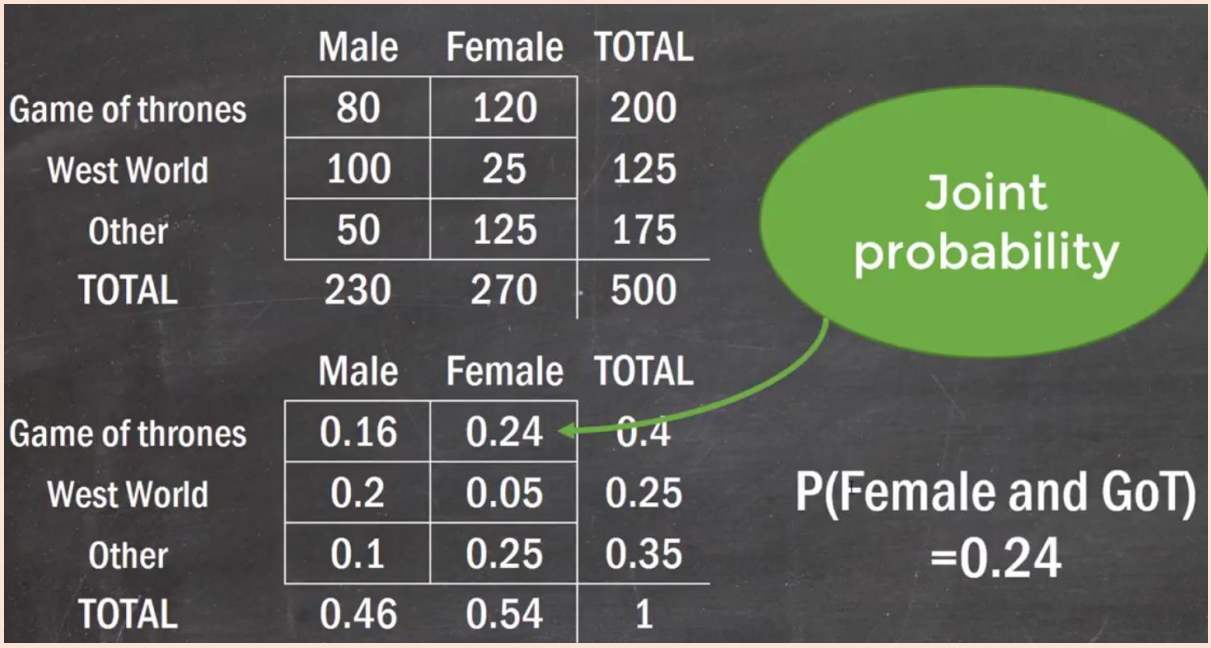
	Male	Female	TOTAL
Game of thrones			
West World			
Other			
TOTAL			500

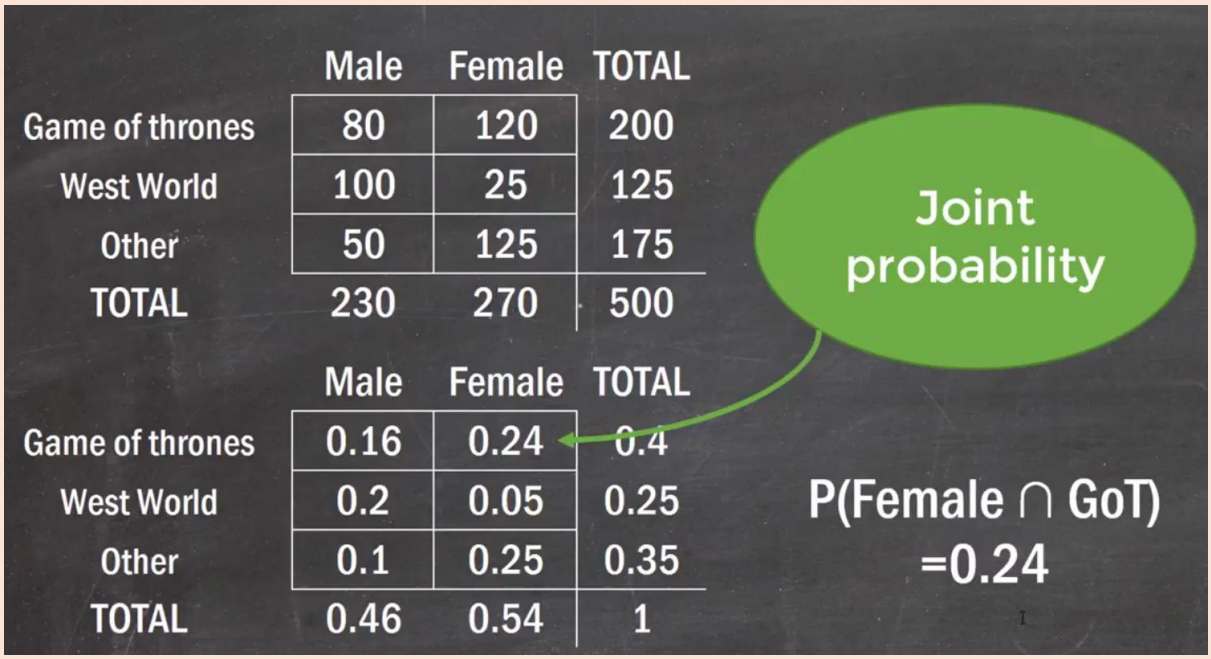
	Male	Female	TOTAL
Game of thrones	80	120	
West World	100	25	
Other	50	125	
TOTAL			500

	Male	Female	TOTAL
Game of thrones	80	120	200
West World	100	25	125
Other	50	125	175
TOTAL	230	270	500

	Male	Female	TOTAL
Game of thrones	80	120	200
West World	100	25	125
Other	50	125	175
TOTAL	230	270	500

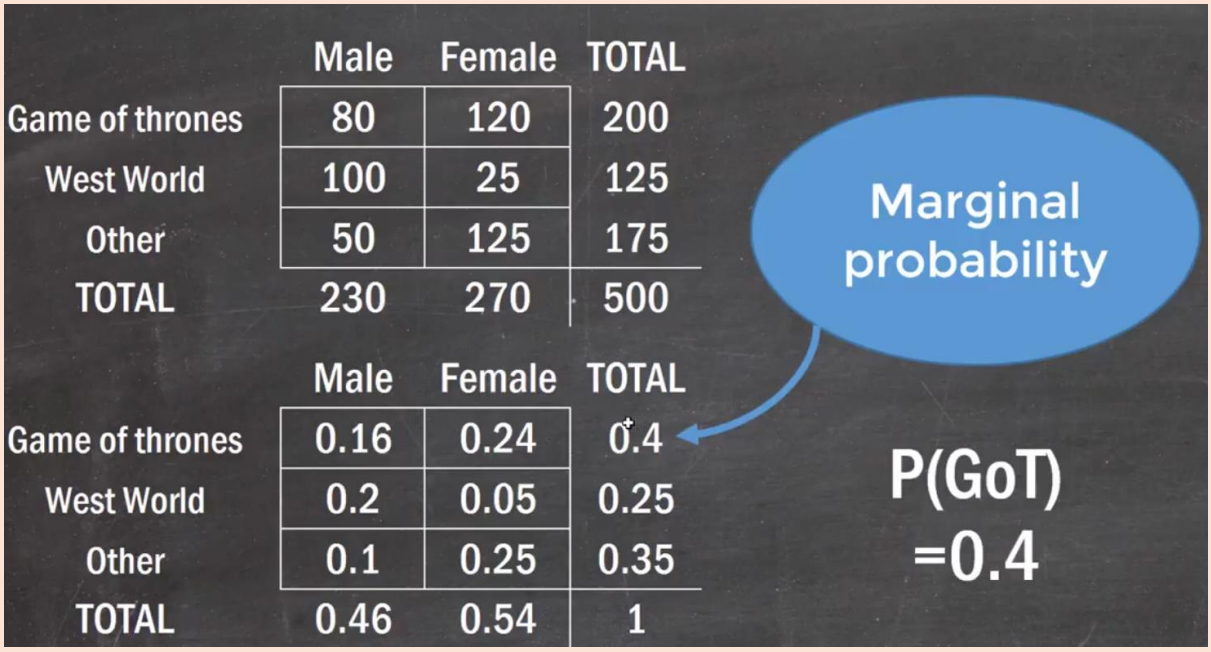
	Male	Female	TOTAL
Game of thrones	0.16	0.24	0.4
West World	0.2	0.05	0.25
Other	0.1	0.25	0.35
TOTAL	0.46	0.54	1



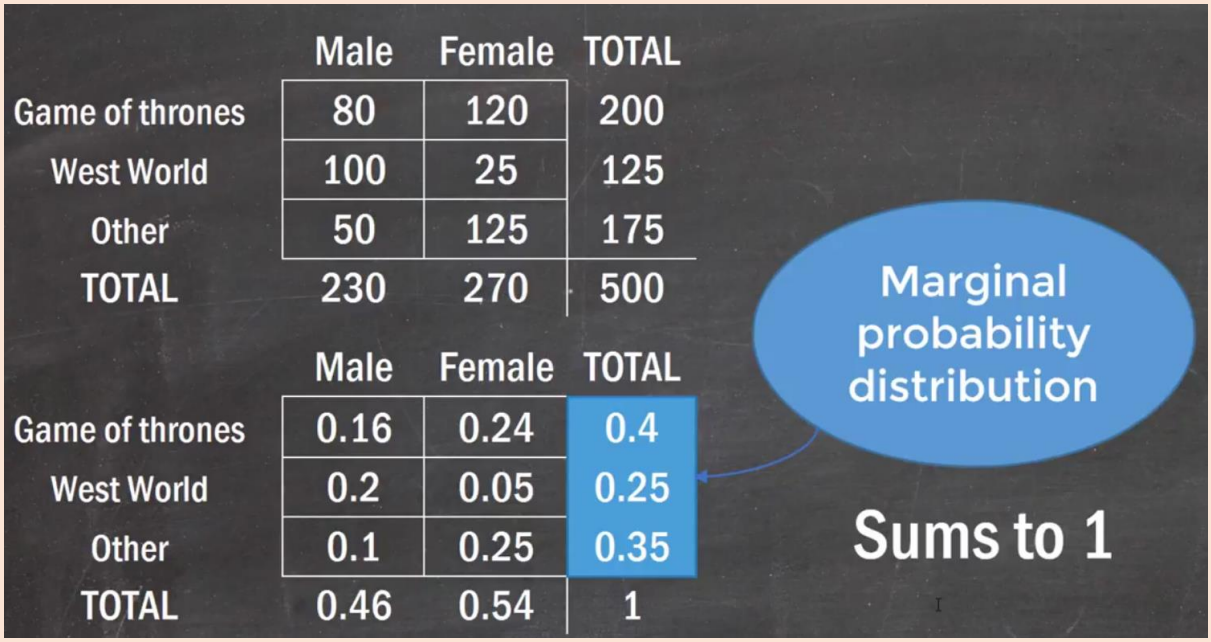


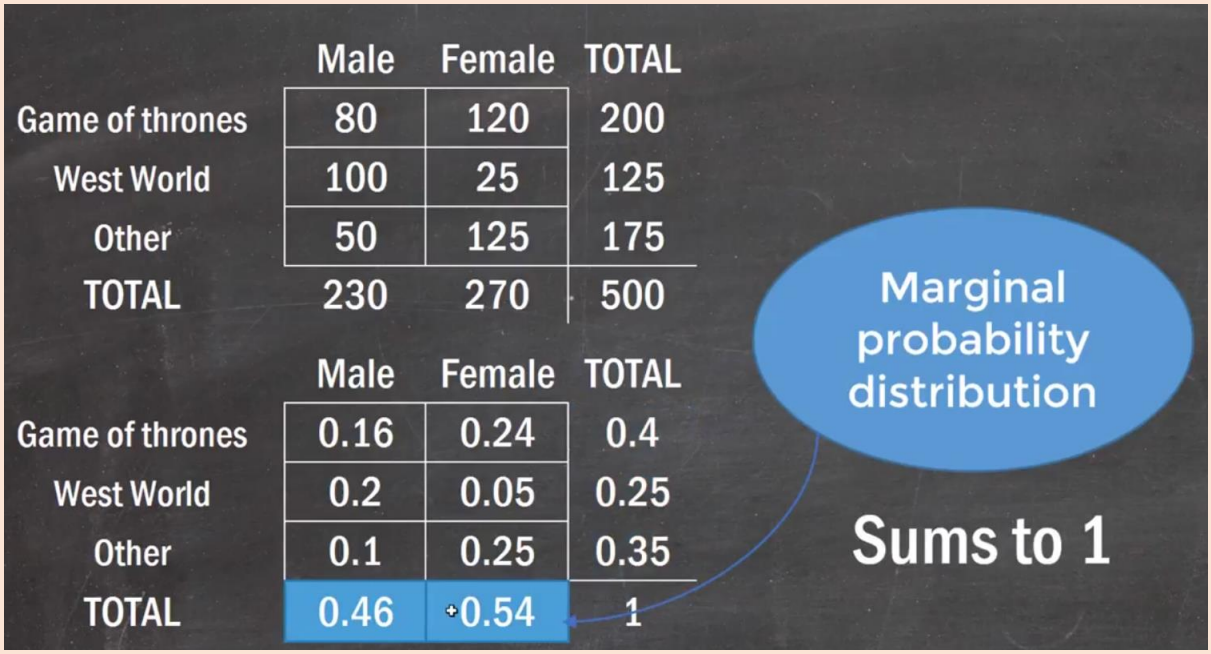
Note: Sum of all joint probability values should be equal to one.

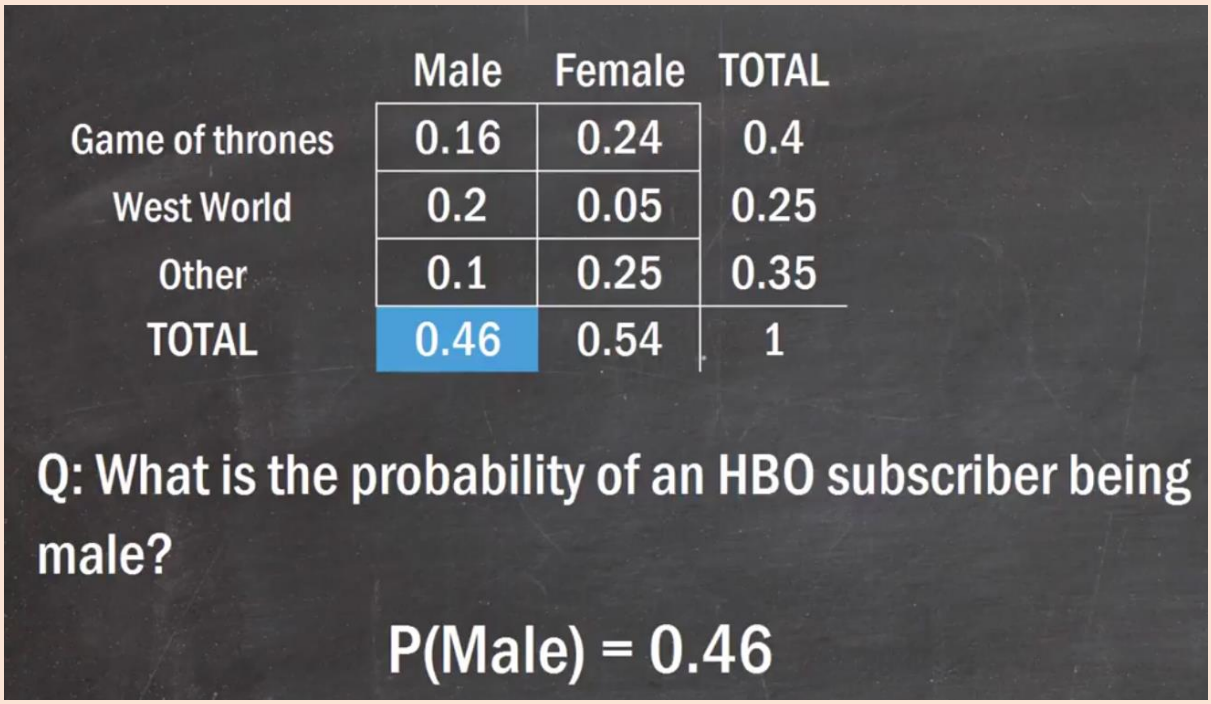
0.16 + 0.24 + 0.2 + .05 + .1 + .25 = 1

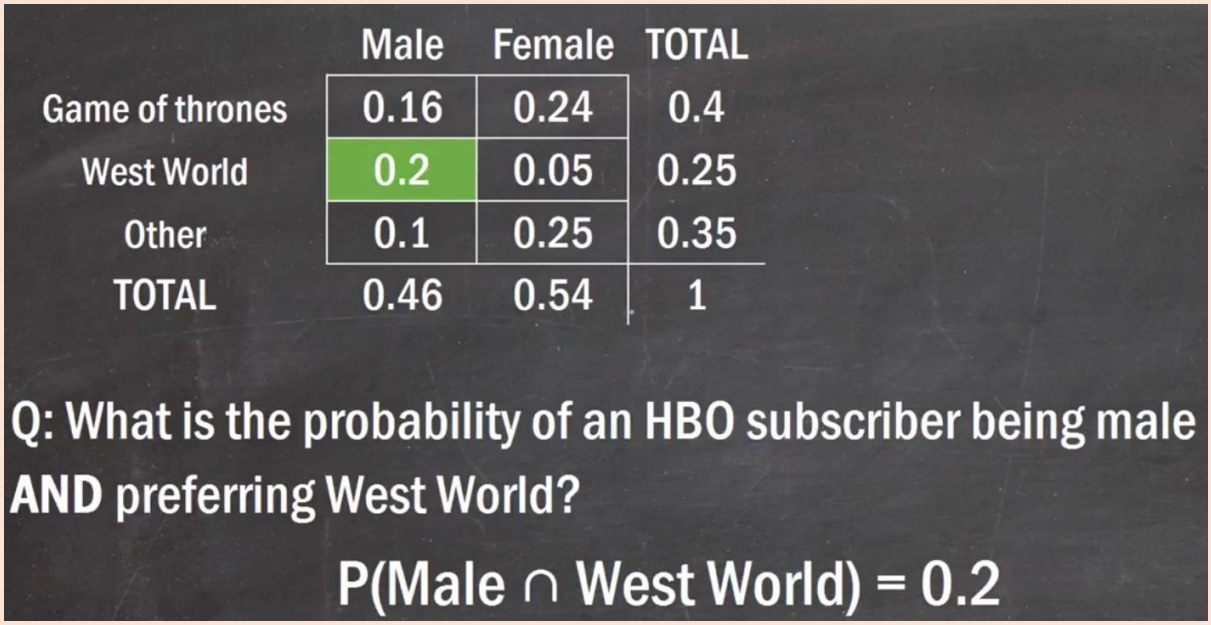


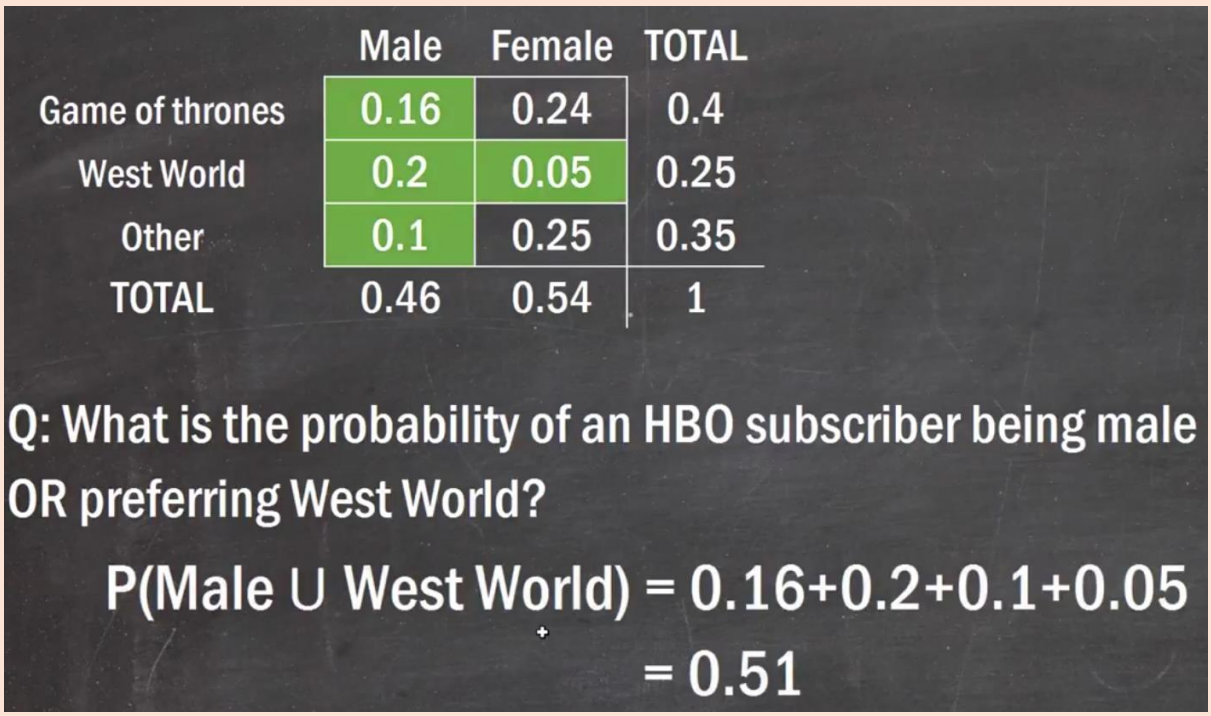
Marginal Probability is also called as Simple Probability.




Male Female TOTAL
Game of thrones 80 120 200
West World 100 25 125
Other 50 125 175
TOTAL 230 270 500
Male Female TOTAL
Game of thrones 0.16 0.24 0.4
West World 0.2 0.05 0.25
Other 0.1 0.25 0.35
TOTAL 0.46 0.54 1
Marginal probability distribution
Sums to 1


Male Female TOTAL
Game of thrones 0.16 0.24 0.4
West World 0.2 0.05 0.25
Other 0.1 0.25 0.35
TOTAL 0.46 0.54 1
Q: What is the probability of an HBO subscriber being male?
P(Male) = 0.46


Male Female TOTAL
Game of thrones 0.16 0.24 0.4
West World 0.2 0.05 0.25
Other 0.1 0.25 0.35
TOTAL 0.46 0.54 1
Q: What is the probability of an HBO subscriber being male AND preferring West World?
P(Male ∩ West World) = 0.2


Male Female TOTAL
Game of thrones 0.16 0.24 0.4
West World 0.2 0.05 0.25
Other 0.1 0.25 0.35
TOTAL 0.46 0.54 1
Q: What is the probability of an HBO subscriber being male OR preferring West World?
P(Male ∪ West World) = 0.16+0.2+0.1+0.05
= 0.51

	Male	Female	TOTAL
Game of thrones	0.16	0.24	0.4
West World	0.2	0.05	0.25
Other	0.1	0.25	0.35
TOTAL	0.46	0.54	1

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

Q: What is the probability of an HBO subscriber being male OR preferring West World?

P(Male ∪ West World) =

	Male	Female	TOTAL
Game of thrones	0.16	0.24	0.4
West World	0.2	0.05	0.25
Other	0.1	0.25	0.35
TOTAL	0.46	0.54	1

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

Q: What is the probability of an HBO subscriber being male OR preferring West World?

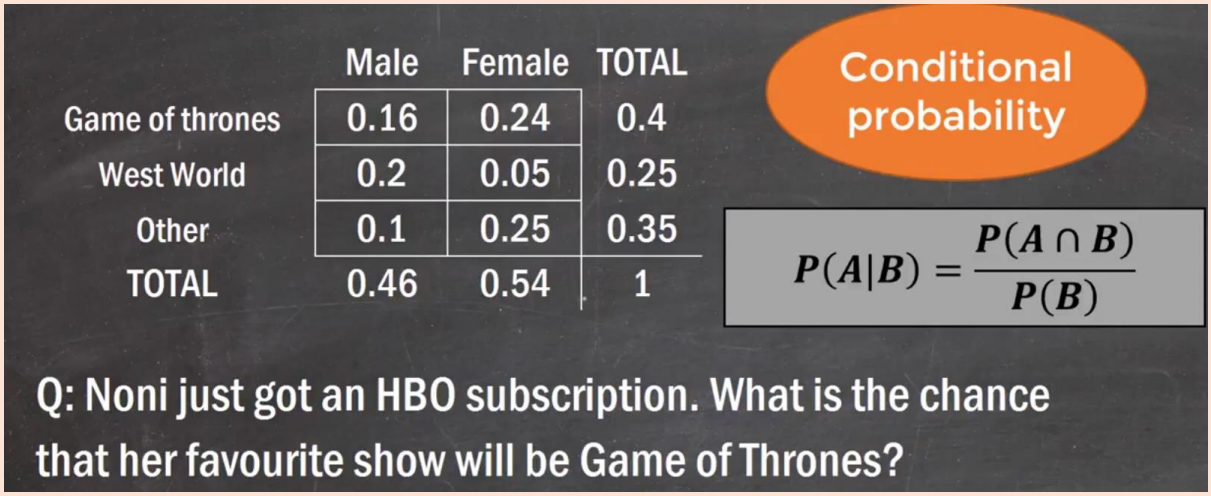
P(Male ∪ West World) = 0.25 + 0.46 – 0.2

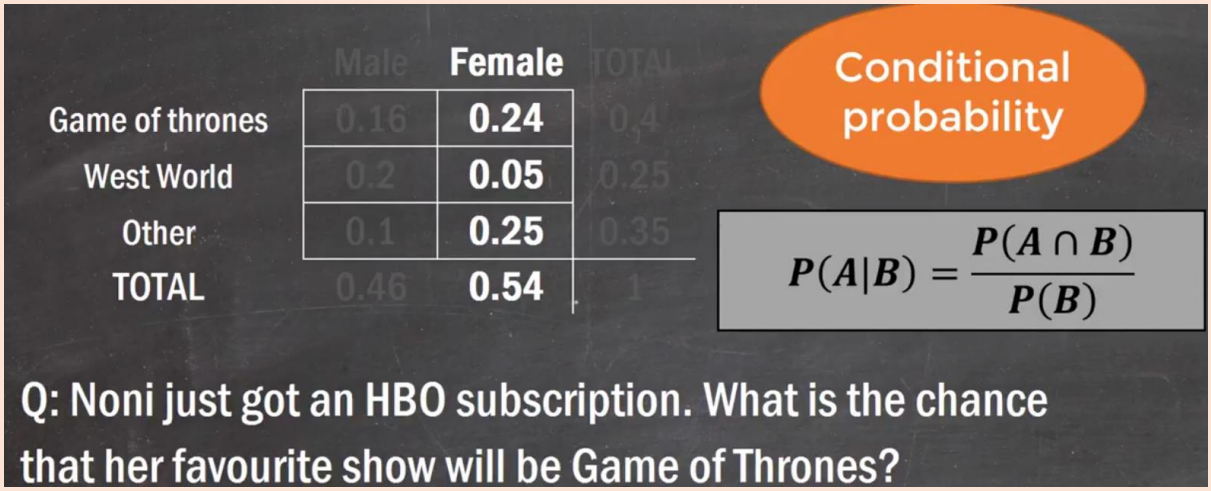
= 0.51

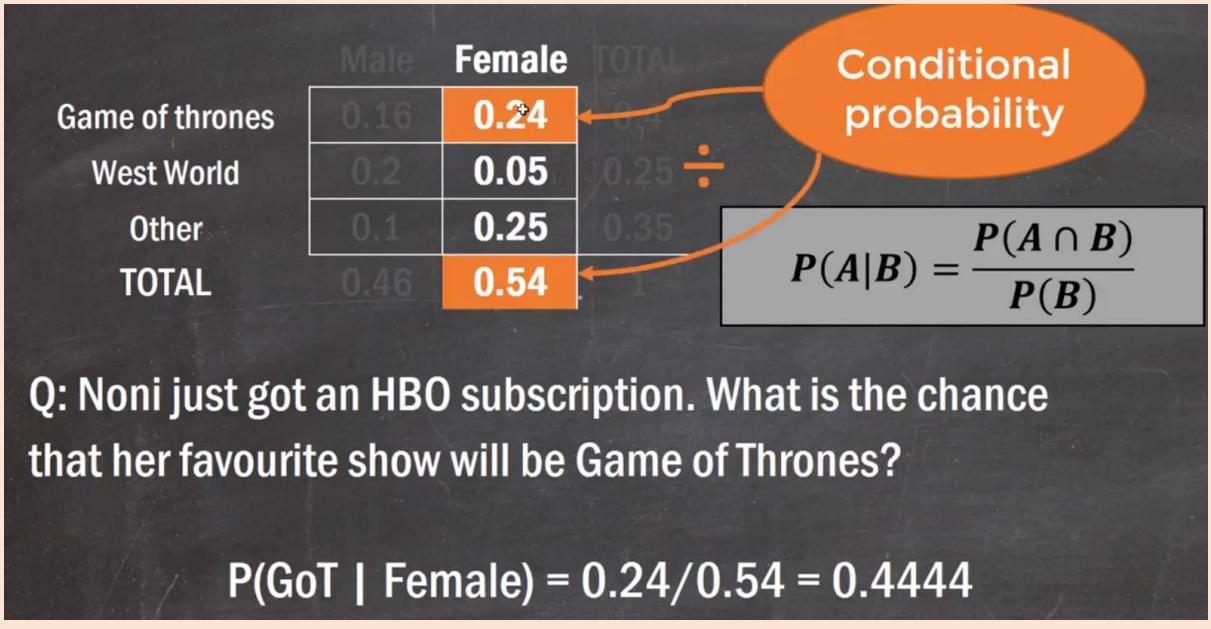
	Male	Female	TOTAL
Game of thrones	0.16	0.24	0.4
West World	0.2	0.05	0.25
Other	0.1	0.25	0.35
TOTAL	0.46	0.54	1

Conditional probability

Q: Noni just got an HBO subscription. What is the chance that her favourite show will be Game of Thrones?


Male Female TOTAL
Game of thrones 0.16 0.24 0.4
West World 0.2 0.05 0.25
Other 0.1 0.25 0.35
TOTAL 0.46 0.54 1
Conditional probability
$P(A|B) = \frac{P(A \cap B)}{P(B)}$
Q: Noni just got an HBO subscription. What is the chance that her favourite show will be Game of Thrones?


Female
Game of thrones 0.24
West World 0.05
Other 0.25
TOTAL 0.54
Conditional probability
$P(A|B) = \frac{P(A \cap B)}{P(B)}$
Q: Noni just got an HBO subscription. What is the chance that her favourite show will be Game of Thrones?


Female
Game of thrones 0.24
West World 0.05
Other 0.25
TOTAL 0.54
÷
Conditional probability
$P(A|B) = \frac{P(A \cap B)}{P(B)}$
Q: Noni just got an HBO subscription. What is the chance that her favourite show will be Game of Thrones?
P(GoT | Female) = 0.24/0.54 = 0.4444

	Female	P(Show | Female)
Game of thrones	0.24	0.444
West World	0.05	0.093
Other	0.25	0.463
TOTAL	0.54	1

Conditional probability

$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

Q: Noni just got an HBO subscription. What is the chance that her favourite show will be Game of Thrones?

	Female	P(Show | Female)
Game of thrones	0.24	0.444
West World	0.05	0.093
Other	0.25	0.463
TOTAL	0.54	1

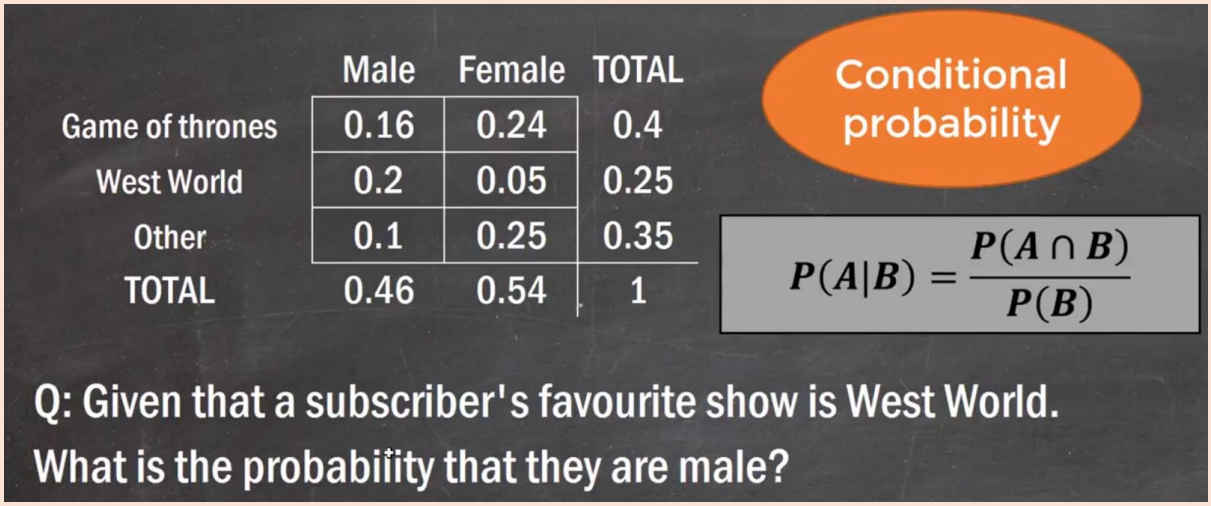
Conditional probability distribution

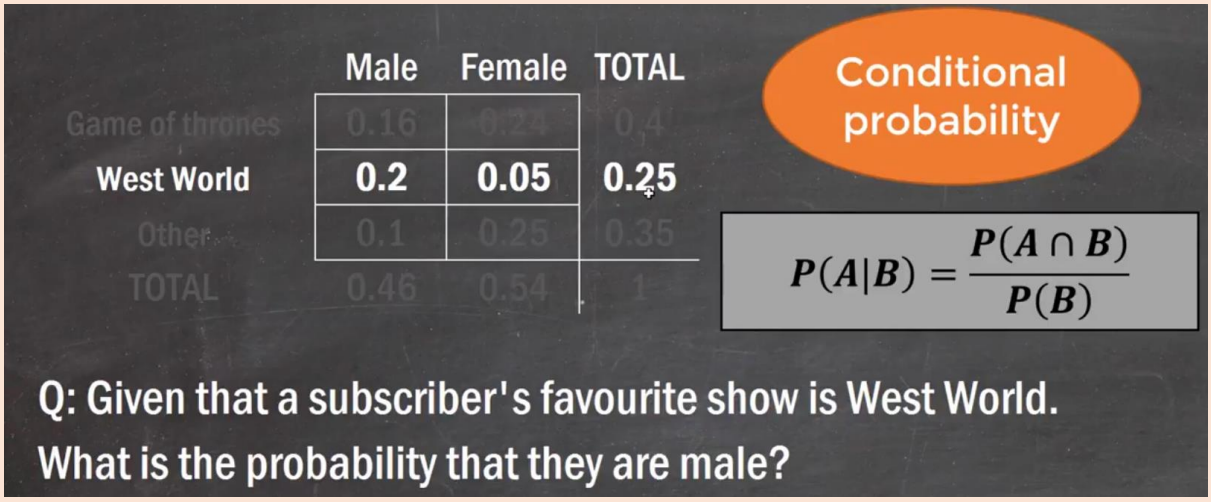
Q: Noni just got an HBO subscription. What is the chance that her favourite show will be Game of Thrones?

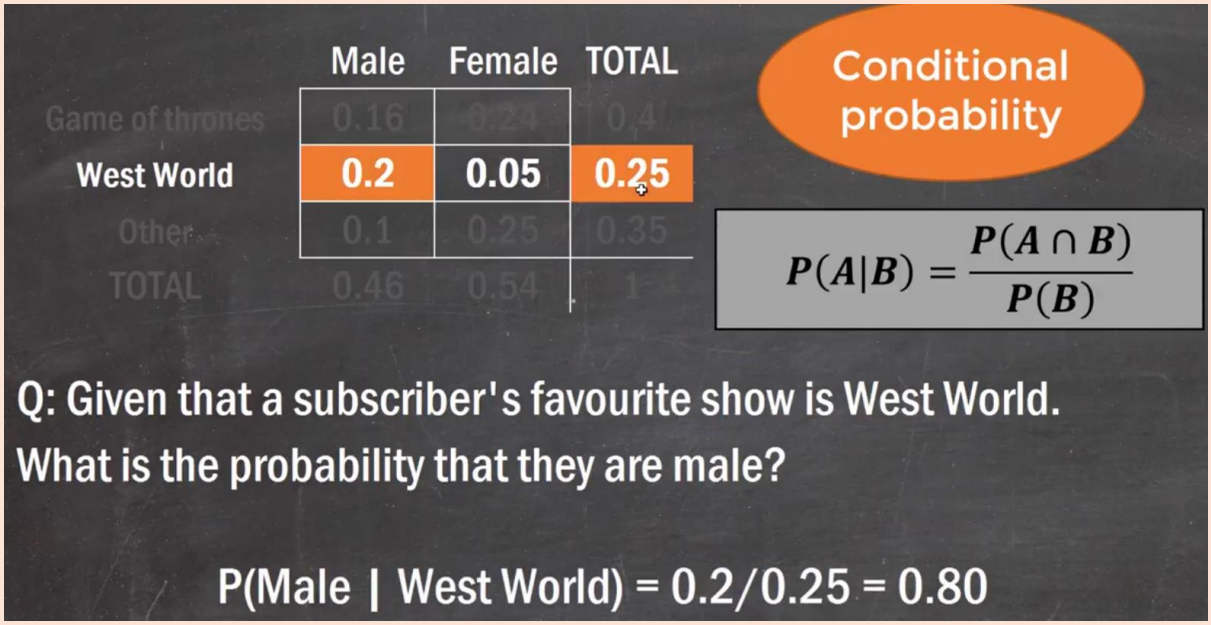
	Female	P(Show | Female)	TOTAL
Game of thrones	0.24	0.444	0.4
West World	0.05	0.093	0.25
Other	0.25	0.463	0.35
TOTAL	0.54	1	1

Conditional probability distribution

Q: Noni just got an HBO subscription. What is the chance that her favourite show will be Game of Thrones?


Male Female TOTAL
Game of thrones 0.16 0.24 0.4
West World 0.2 0.05 0.25
Other 0.1 0.25 0.35
TOTAL 0.46 0.54 1
Conditional probability
$P(A|B) = \frac{P(A \cap B)}{P(B)}$
Q: Given that a subscriber's favourite show is West World.
What is the probability that they are male?


Male Female TOTAL
West World 0.2 0.05 0.25
Conditional probability
$P(A|B) = \frac{P(A \cap B)}{P(B)}$
Q: Given that a subscriber's favourite show is West World.
What is the probability that they are male?


Male Female TOTAL
West World 0.2 0.05 0.25
Conditional probability
$P(A|B) = \frac{P(A \cap B)}{P(B)}$
Q: Given that a subscriber's favourite show is West World.
What is the probability that they are male?
P(Male | West World) = 0.2/0.25 = 0.80

	Male	Female	TOTAL
Game of thrones	0.16	0.24	0.4
West World	0.2	0.05	0.25
Other	0.1	0.25	0.35
TOTAL	0.46	0.54	1

	Male	Female	TOTAL
Game of thrones	0.16	0.24	0.4
West World	0.2	0.05	0.25
Other	0.1	0.25	0.35
TOTAL	0.46	0.54	1

If independent then:

$$P(A|B) = P(A)$$

	Male	Female	TOTAL
Game of thrones	0.16	0.24	0.4
West World	0.2	0.05	0.25
Other	0.1	0.25	0.35
TOTAL	0.46	0.54	1

If independent then:

$$P(A|B) = P(A)$$

P(West World | Female) = 0.05/0.54 = 0.093

P(West World) = 0.25

Therefore NOT INDEPENDENT as $0.093 \neq 0.25$

i.e. The variable gender influences the West World show.

	Male	Female	TOTAL
Game of thrones	0.16	0.24	0.4
West World	0.2	0.05	0.25
Other	0.1	0.25	0.35
TOTAL	0.46	0.54	1

If independent then:

$$P(A \cap B) = P(A) \times P(B)$$

	Male	Female	TOTAL
Game of thrones	0.16	0.24	0.4
West World	0.2	0.05	0.25
Other	0.1	0.25	0.35
TOTAL	0.46	0.54	1

If independent then:

$$P(A \cap B) = P(A) \times P(B)$$

P(West World ∩ Female) = 0.05

P(West World) X P(Female) = 0.54 X 0.25 = 0.14

Therefore NOT INDEPENDENT as 0.05 ≠ 0.14