

RULES OF PROBABILITY WITH EXAMPLES FROM A TABLES

3. What is the union between events A and B? That is being both a Highly Likely Voter and Voting for Busch? $(A \cup B) =$

We have a cross-tabulation of Who Vote for by whether you are a Likely Voter

| | Vote Bush | Vote Gore | Row Total |
|---------------|-----------|-----------|-----------|
| Highly Likely | 14 | 7 | 21 |
| Not Highly | 10 | 11 | 21 |
| Column Total | 24 | 18 | 42 |

_____ Everyone who says they would vote for Bush
 _____ + Everyone who says they are a likely voter
 _____ - Everyone who both says they will vote for Bush and is a likely Voter
 _____ $(A \cup B)$

And the Probability of Events A and B $P(A \cup B) =$ _____

4. What about the Intersection of being a Likely Voter and voting for Bush?
 $(A \cap B)$

_____ Everyone who both says they will vote for Bush and is a likely Voter

What is the $P(A \cap B)$? _____

5. Let Event C be Female. What is Event C and show its probability?

We have a cross-tabulation of Who Vote for by whether you are a Female

| | Vote Bush | Vote Gore | Row Total |
|--------------|-----------|-----------|-----------|
| Males | 10 | 2 | 12 |
| Females | 14 | 16 | 30 |
| Column Total | 24 | 18 | 42 |

Females _____

$P(C) =$ _____

$(A \cap C) =$ _____

$P(A \cap C) =$ _____

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6. **Conditional Probability** is stated as *“The Probability of Voting for Bush given you are a Female”*, and it is defined as:

$$P(A|C) = P(A \cap C)/P(C)$$

$$P(A|C) = \underline{\hspace{15em}}$$

7. **The Complement of A**, expressed as A^c would be Vote for Gore.

What is the $P(A^c) = \underline{\hspace{15em}}$

What is $P(A^c \cap C) = \underline{\hspace{15em}}$

8. **So what is the Probability of Voting for Gore given you are a Female?**

$$P(A^c|C) = P(A^c \cap C)/P(C)$$

$$P(A^c|C) = \underline{\hspace{15em}}$$

9. **Look at the Table from the SAS program:**

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TABLE OF GENDER BY VOTE2000
GENDER(GENDER)      VOTE2000(WHO WILL YOU VOTE FOR)
Frequency,
Percent  ,
Row Pct  ,
Col Pct  , BUSH  , GORE  , Total
#####$#####$#####$
MALE    ,    10 ,    2 ,    12
        , 23.81 ,    4.76 , 28.57
        , 83.33 , 16.67 ,
        , 41.67 , 11.11 ,
#####$#####$#####$
FEMALE  ,    14 ,    16 ,    30
        , 33.33 , 38.10 , 71.43
        , 46.67 , 53.33 ,
        , 58.33 , 88.89 ,
#####$#####$#####$
Total   ,    24 ,    18 ,    42
        , 57.14 , 42.86 , 100.00
    
```

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You have three different percentages for the first cell (Male and Bush):

| | | |
|---------|---|-----------------------|
| Percent | The cell value over the total | $23.81 = 10/42 * 100$ |
| Row Pct | The cell value over the row margin on the right | $83.33 = 10/12 * 100$ |
| Col Pct | The cell value over the column margin on the bottom | $41.67 = 10/24 * 100$ |

Note that:

$P(A \cap C) = .3333$ is the percent for the first cell for females

$P(A|C) = P(A \cap C)/P(C) = .4667$ is the row proportion for females who vote for Bush

$P(A^c|C) = P(A^c \cap C)/P(C) = .5333$ is the row proportion for females who vote for Gore

10. So what do you think the $P(C|A) = P(A \cap C)/P(A) =$ _____

This is the Probability of being a female given you vote for Bush. Does this make any sense?

11. Be careful how you look at data, and how you percentage it!

- The leading cause of death of children 1 to 4 years of age is accidents!
- 36% of all deaths for this age group comes from accidents
- One might conclude there is an accident waiting to happen for our you children

- But the death rate for children 1 to 4 is 38.3 per 100,000 children
- This means the probability of a child aged 1 to 4 dying is only .000383
- And the overall probability of dying from an accident is .000138
- Anyone with toddlers knows that they are amazingly indestructible!
- But we also know how tragic it is when one dies from an accident

| Cause of Death | Deaths | Nondeaths | Total |
|----------------|--------|------------|------------|
| Accidents | 2,147 | ? | ? |
| All Others | 3,801 | ? | ? |
| Total | 5,948 | 15,535,974 | 15,530,026 |

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12. Next we will look at the odds and odds ratios.

The odds of a Female voting for Bush is: $(\# \text{ Females for Bush})/(\# \text{ Females not for Bush})$

$$14/16 = \underline{\hspace{2cm}}$$

An odds ratio less than 1 means that females are less likely to vote for Bush as not vote for Bush. A value of one is the pivot point.

The odds of a Female voting for Gore is: $(\# \text{ Females for Gore})/(\# \text{ Females not for Gore})$

$$16/14 = \underline{\hspace{2cm}}$$

Note that the later odds is the reciprocal of the first.

An odds Ratio is the ratio of two odds and compares the two odds, most often for two groups. We might want to compare the Odds Ratio of the Odds of Men Voting for Bush versus the Odds of Women voting for Bush.

Odds of Men voting for Bush = $\underline{\hspace{2cm}}$

Odds of Women voting for Bush = $\underline{\hspace{2cm}}$

Odds Ratio = $\underline{\hspace{2cm}}$

What does this mean?

13. Extra Problem

- You are a doctor and a patient comes with a lump in her breast
- You know that there is only a 1% chance that it is malignant
 - Only 1,000 of 100,000 such lumps would be malignant
- But you urge a mamogram, or which you know they are:
 - 80% accurate for malignant lumps
 - 90% accurate for benign lumps

- The test comes back indicating that the lump is malignant
- **What is the probability that the lump is truly malignant, given the test indicates it is malignant?**
- **Hint:** build a mock table based on 100,000 people

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| Reality | Test Shows Malignant | Test Shows Benign | Total |
|----------------|---------------------------------|------------------------------|--------------|
| Malignant | | | 1,000 |
| Benign | | | |
| Total | | | 100,000 |