FREC 408

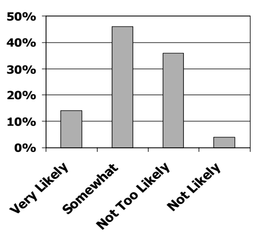
Group Exercise 3

How likely do you think Arnold Schwarzenegger will become the new governor of California?

How likely do you think Arnold Schwarzenegger will become the new governor of California?

Class response:

- **Very Likely** 14%
- **Somewhat Likely** **46%**
- **Not Too Likely** 36%
- **Not Likely at All** 4%



GROUP EXERCISE

- **Work together and share information**
- **Make sure everyone is involved and has a chance to**
  - **Contribute**
  - **Learn**
- **Seek me out if the group needs help**
- **Let me know if there are problems**

THE GROUPS

GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5
Adkins	Askin	Banks	Bather	Beitler
Dardis	Deaner	Delduco	Delle Donne	Dine
Fleming	Gauker	Gilreath	Harkins	Hershey
Nasatka	Netta	O'Neill	Parish	Polk
Smith	Smith	Smith	Snow	Strange

GROUP 6	GROUP 7	GROUP 8	GROUP 9	GROUP 10
Butkiewicz	Butkiewicz	Carbo	Clement	Connelly
Dripps	Dripps	Federer	Feierstein	Fillman
Maloney	Maloney	Marrin	McDonald	Mullin
Ryan	Ryan	Scafini	Sharp	Shiavi
Terczak	Terczak	Vormwald	Walker	Wisotzkey

Problem 1

- **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, of which you know**
  - **80% accurate for malignant lumps**
  - **90% accurate for benign lumps**

Source: Jessica Utts, "Seeing Through Statistics"

Problem

- 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
- Percentage it correctly

We ask that you solve for these probabilities

- Let A stand for the event that the lump is malignant
- Let B stand for the event that the lump is benign
- Let C stand for the event that the mammogram test says it is malignant
- **P(A) =**
- **P(B) =**
- **P(C|A) =**

Build a Table and fill in values

Reality	Test Show Malignant	Test Shows Benign	Total
Malignant			**1,000**
Benign			
Total			**100,000**

Build a Table and fill in values

Reality	Test Show Malignant	Test Shows Benign	Total
Malignant			**1,000**
Benign			99,000
Total			**100,000**

80% accurate for malignant lumps

Reality	Test Show Malignant	Test Shows Benign	Total
Malignant	800	200	**1,000**
Benign			99,000
Total			**100,000**

90% accurate for benign lumps

Reality	Test Show Malignant	Test Shows Benign	Total
Malignant	800	200	**1,000**
Benign	9,900	89,100	99,000
Total			**100,000**

Build a Table and fill in values

Reality	Test Show Malignant	Test Shows Benign	Total
Malignant	800	200	**1,000**
Benign	9,900	89,100	99,000
Total	10,700	89,300	**100,000**

We ask that you solve for these probabilities

- Let A stand for the event that the lump is malignant
- Let B stand for the event that the lump is benign
- Let C stand for the event that the mammogram test says it is malignant
- **P(A) = 1,000/100,000 = .01**
- **P(B) = 99,000/100,000 = .99**
- **P(C) = 10,700/100,000 = .107**
- **P(C|A) = 800/1,000 = .80**

Given the test result showed it was malignant, what is the probability that it is truly malignant?

Reality	Test Show Malignant	Test Shows Benign	Total
Malignant	800 7.5%	200 .2%	**1,000**
Benign	9,900 92.5%	89,100 99.8%	99,000
Total	10,700	89,300	**100,000**

Which way do you percentage the table???

Given the test result showed it was malignant, what is the probability that it is truly malignant?

Reality	Test Show Malignant	Test Shows Benign	Total
Malignant	800 7.5%	200 .2%	**1,000**
Benign	9,900 92.5%	89,100 99.8%	99,000
Total	10,700	89,300	**100,000**

The answer is 7.5%

Look at the Odds

- Odds of the test indicating a malignant tumor versus a benign tumor for those with a malignant tumor
  - 800/200 = 4.0
- **Odds of a malignant tumor for those with a negative test**
  - 9,900/89,100 = .1111
- **Odds Ratio = 4.0/.1111 = 36**
- **Those with a malignant tumor are 36 times more likely to have the mammogram test indicate a malignant tumor (than those with a benign tumor)**

Problem 2

- *I have two pairs of socks, and they look nearly identical - one navy blue and the other black. My wife matches the socks incorrectly much more than she does correctly. If all four socks are in front of her, it seems to me that her chances are 50% for a wrong match and 50% for a correct match. What do you think?*
- **Let**
  - NB stand for Navy Blue sock
  - B stand for Black sock
  - r and l stand for right sock and left sock
- The probability for the first pick at random = .25
- The probability of the second pick at random=.333

The probability of a right pick is 4(.0833) = .3333

First Pick	Second Pick	P
	NBr	**.0833**
NBl	Br	.0833
	Bl	.0833
	NBl	**.0833**
NBr	Br	.0833
	Bl	.0833
	NBr	.0833
Bl	NBl	.0833
	Br	**.0833**
	NBr	.0833
Br	NBl	.0833
	Bl	**.0833**

An Alternative Way: Let N stand for Navy Blue and B for Black

Once we select the first sock, the sample space for the second pick changes – it is conditioned on the first pick

First Pick	Second Pick	Correct	Prob
	N	**Yes**	**1/6**
N	B	No	1/6
	B	No	1/6
	N	No	1/6
B	N	No	1/6
	B	**Yes**	**1/6**

Only 2 of the 6 outcomes, or 1/3, would we have a correct match

Problem 3

- A fast food restaurant has determined that the chance a customer will order a soft drink is .90. The chance that a customer will order a hamburger is .6, and the chance for ordering french fries is .5.
- Let S = event of buying a soft drink
- Let H = event of buying a hamburger
- Let F = event of buying french fries

Problem 3

- If a customer places an order, what is the probability that the order will include a soft drink and no fries *if these two events are independent*?
  - If they are independent, $P(S \cap F)$ =
  - $P(S) \cdot P(F)$ =
  - .9 x .5 = .45

Problem 3

- The restaurant has also determined that if a customer orders a hamburger the chance the customer will also order fries is .8. Determine the probability that the order will include a hamburger and fries.
  - The problem states that the $P(F|H) = .8$
  - So, $P(H \cap F) = P(H) \cdot P(F|H)$ =
  - .6 x .8 = .48

Problem 4

- Consider another problem posed by Marilyn vos Savant in her weekly column, "Ask Marilyn."
- *A woman and a man (unrelated) each have two children. At least one of the woman's children is a boy, and the man's older child is a boy. Do the chances that the woman has two boys equal the chances that the man has two boys?*

Problem 4

- **Answer first based on your intuition**
  - Intuition would suggest that both are equally likely to have two boys.
- **Use a tree diagram or the rules of probability to solve the problem.**
  - Assume that the probability of a male is equal to the probability of a female, .5.

Probabilities for Problem 4

First Born (.5)	Second Born (.5)		
Boy	Boy	(.5) (.5) = .25	Two boys
	Girl	(.5)(.5) = .25	Boy and girl
Girl	Boy	(.5)(.5) = .25	Girl and Boy
	Girl	(.5)(.5) = .25	Two girls

Problem 4: Probability for the woman

- For the woman, all we know is that one of her children is a boy, so the conditional probability that she has two boys is now:
  - **1/3 = .333**
  - **The probability is conditioned on one of the children being a boy, and there are three outcomes where this could be the case.**
- Alternatively, use the conditional probability formula:
  - Let A = event of two boys
  - Let B = event of at least one child is a Boy
  - $P(A|B) = P(A \cap B)/P(B)$
  - **$P(A|B) = .25/.75 = .333$**

Problem 4: Probability for the Man

- For the man, now know is that the first child a boy, so the conditional probability that she has two boys is now:
  - **1/2 = .5**
  - **The probability is conditioned on the first children being a boy, and there are two outcomes where this could be the case.**
- Use the conditional probability formula:
  - Let A = event of two boys
  - Let B = event first child is a boy
  - $P(A|B) = P(A \cap B)/P(B)$
  - **$P(A|B) = .25/.5 = .5$**