Using Statistics to Analyze your Results

Warm Up

1. What is a hypothesis?
2. What is a prediction?
3. How are they different?

Hypotheses and Predictions

- **Hypothesis:** is a possible explanation of a phenomenon that is testable
- **Prediction:** A forecasted outcome of an event based on evidence or a hypothesis.
- **Hypotheses lead to predictions**: if I do this, and the hypothesis is correct, _____ will happen.
- Methods are devised to test these predictions.

Null Hypothesis (H_0)

A **null hypothesis** is that the outcome is explained by chance.

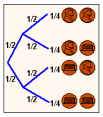
Why are statistics important?

- Once you have your result, you need to be able to explain what it means
- We use a statistical test to investigate whether our result can be explained by the null hypothesis (chance).

Statistics is just an extension of probability theory, so rather than starting with bees, let's talk about coins…

Flipping coins

- What's the odds that you flip a coin and get tails?
- What's the odds that you flip a coin twice and get 2 tails?
- What's the odds that you flip a coin two times and get one tail and one head?



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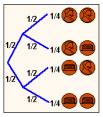


These examples are simple enough that we can calculate by hand using some mathematical rules.

$$P(A \text{ and } B) = P(A \cap B) = P(A)P(B)$$

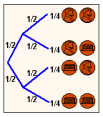
$$P(A \text{ or } B) = P(A \cup B) = P(A) + P(B)$$

Flipping coins

- Probability of getting heads twice in a row
  = P (getting heads 1st time AND getting heads 2nd time)
  = P (heads 1st time) * P (heads 2nd time) =
  = .5 * .5 = .25
- Probability of getting 1 head and 1 tail in two throws
  = P (getting heads 1st time AND getting tails 2nd time)
  OR P (getting tails 1st time AND getting heads 2nd time)
  = P (.5 * .5) + P (.5 * .5) = .50

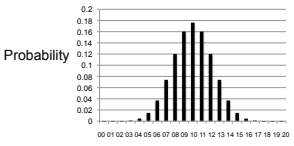
Flipping coins

- What's the odds that you flip a coin 20 times and get 14 heads or more?
- Hard to calculate by hand! Need to use statistics.



Probability distribution

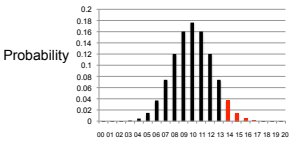
- What's the odds that you flip a coin 20 times and get 14 heads or more?
- Look at a "probability distribution" graph
- If we added up all the heights of all the columns, we would get 1 (100% of the time we get one of these outcomes)



This is a binomial distribution, similar to the normal distribution, or the familiar 'bell curve'

Probability distribution

- In our case, we need to add up the bars above 14, 15, 16, 17, 18, 19 and 20.
- We get about .06 or 6%.



Binomial test

It would be a bummer if we had to add up columns on graphs each time we did this (and not very accurate!).

Instead, we make the computer do the work for us, by doing a statistical test, specifically, a binomial test: A statistical test that allows us to calculate the probability that an outcome occurred by chance, used when there only two kinds of outcomes.

Binomial test in Excel

Result : You flip your coin 20 times, and 14 times it's heads. Question: What is the probability of getting 14 or more heads?

Calculate in Excel: We get 0.057

=BINOMDIST(6, 20, 0.5, TRUE).

6 = the number of times it is tails, 20-14= 6.

20 = the number of times you flipped the coin.

0.5 = the expected probability of getting heads

TRUE = calculating the sum of the probabilities of the observed number and all more extreme values (14 +15 + 16 + 17 +18 +19 +20)

Testing hypotheses

- Now when you get a result like 14/20 heads, what do you think?

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- Now when you get a result like 14/20 heads, what do you think?
- May be I'm really lucky (or unlucky!) and this occurred by chance This is the null hypothesis
- May be my coin is not fair.

Testing hypotheses

- When we do a statistical test, the computer returns a number called P, which is the percent chance that our result could have occurred by random.
- Generally, when P is < 0.05, we reject the null hypothesis.
- So for our example, P = 0.057. What do we conclude?

How does this relate to our bees?

Coin activity

- Using scotch tape and anything you can find, alter the tail side of a coin.
- Flip 20 times (make sure they're big, high flips).
- Which side came up more?
- What is P, the percent chance that randomly that side would come up that amount or more.
- Do you reject the null hypothesis?

Evaluate the Bee Data Given

- Here's some hypothetical bee data:

Dish	Number of Bees Landed
Control	21
Experiment	8
Total	**29**

Was the result significant? Do we accept the null hypothesis?

Bee Activity Share out

- P =BINOMDIST(8,29,0.5, TRUE)
- P = 0.012
- We rejected the null hypothesis because 0.012< 0.05 (This means that our data was statistically significant and the bee's did avoid the predators!)
- Why would scientists design experiments, so that they are binomial in nature?

Conclusion

- A **binomial test** is a statistical test that allows us to calculate the deviations observes from what was expected
- You calculate a binomial test in Excel by: =BINOMDIST(6, 20, 0.5, TRUE)
- **P** is the percent chance that what happened occurred randomly. Generally, **when P < .05 we reject the null hypothesis**
- A **null hypothesis** is that the outcome is explained by chance.

Now work on your own data

Open a new Word Document and Excel Document and title them your "group name bee results".

- Add up all of your bees on control and on your experimental dishes and create a table. You can analyze bees and wasps separately and/or together.
- Calculate your p value
- Gather data from other groups that tested the same thing and copy tables into your results, adding these data to yours.
- Again calculate a p value. Have your interpretations changed?

Now work on your own data

- Be sure to save your results in Excel and Word
- Email your work to the group.