

# The Case of the Two-Faced Data

by

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## Introduction\*

Jane had always loved English. When she decided to apply to graduate school, she had an excellent undergraduate record and was an extremely strong candidate. Jane applied to the top Ph.D. programs in English. She was admitted to seven out of the eight schools to which she applied—every school except her first choice, Bronte University. Jane was not only heartbroken, she also truly didn't understand how this could have happened. She was a perfect candidate. Her advisor and other professors were also completely baffled. With the support of her friends, family and educators, Jane decided to do a little research into what went wrong.

## Question

1. How does this story relate to the article you read, “Study shows gender bias in science is real” (Yurkiewicz, 2012)?

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\*The data used throughout this case study is real and can be found in Bickel *et al.* (1975), but the identities and actions of those involved have been fictionalized.

## Part I – A Strongly Worded Letter

Bob Loblaw, Attorney at Law  
1 Lawyer Drive  
Mathematicstown, PI 31415

Bronte University Graduate Admissions Office  
100 Thrushcross Grange Dr.  
Wuthering Heights, WH 121847

To Whom It May Concern:

My office is representing Ms. Jane Eyre. The purpose of this letter is to inform you that Ms. Eyre will be moving forward with a discrimination lawsuit against Bronte University.

Ms. Eyre recently applied for admission to the Ph.D. program in English, and she possessed all the necessary qualifications. Unfortunately, she was not admitted due to unlawful discrimination.

As is well known, Title IX of the Education Amendments of 1972 “prohibits discrimination based on sex in education programs and activities that receive federal financial assistance.” Bronte University has a history of discrimination in the admissions process. For example, the table below breaks down the percent of women vs. men that were granted admission to your Ph.D. programs.

*Bronte University graduate admissions data.*

	<i>Applied</i>	<i>Accepted</i>	<i>Percent</i>
Women	449	113	25%
Men	1097	527	48%

The numbers speak for themselves. Bronte University admitted 48% of the males who applied and only admitted 25% of the female applicants. The evidence of discrimination is overwhelming, and Ms. Eyre is no exception. Thus, we will be seeking an overturned admissions decision, as well as a monetary settlement to cover emotional damages.

Sincerely,

*Bob Loblaw*

Bob Loblaw  
Attorney at Law

### Questions

2. Calculate the following.
  - a. How many women were not granted admission?
  - b. What percentage of women were not granted admission?
3. Calculate the following.
  - a. How many men were not granted admission?
  - b. What percentage of men were not granted admission?
4. Do you think gender discrimination played a role in Jane Eyre’s admission decision? Explain.

## Part II – A Reasonable Reply

Bronte University Graduate Admissions Office  
 100 Thrushcross Grange Dr.  
 Wuthering Heights, WH 121847

Bob Loblaw, Attorney at Law  
 1 Lawyer Drive  
 Mathematicstown, PI 31415

Dear Bob Loblaw:

Bronte University holds our applicants to the highest academic standards. Thus, we have a rigorous application process. We received an extremely high volume of applications this year, and many qualified candidates were not offered admission.

We are sympathetic to Ms. Eyre's situation, but we did not discriminate against her. The Bronte University Graduate program believes deeply in the importance of Title IX, and we do everything in our power to cultivate equality in all our programs.

I did some searching in our records, and I found the data that you're citing in your letter. You have combined two different departments and quoted total admission percentages. Below is a table that displays the same data broken down into two specific departments at Bronte.

*Bronte University graduate admissions data broken down by department.*

	<i>Applied</i>	<i>Accepted</i>	<i>Percent</i>
<i>Department A</i>			
Women	108	89	82%
Men	825	511	62%
<i>Department B</i>			
Women	341	24	7%
Men	272	16	6%

These data suggest that Bronte University actually favors female applicants, because in reality both departments admitted a higher percentage of women than men. In light of this information, we urge Ms. Eyre to drop her lawsuit against the university.

Sincerely,

*Catherine Earnshaw*

Catherine Earnshaw  
 Admissions Officer  
 Bronte University

### Questions

5. Use the data in Catherine Earnshaw's letter to answer the following questions.
  - a. How many total women applied?
  - b. How many total women were accepted?
  - c. What percentage of women who applied were accepted?
  - e. How many total men applied?
  - f. How many total men were accepted?
  - g. What percentage of men who applied were accepted?
  - h. Does this match the table in Bob Loblaw's letter?

*Definition:* A paradox is a statement that is seemingly contradictory or opposed to common sense and yet is perhaps true.\*

6. Consider the data presented in the two letters, and explain the paradox illustrated by the Bronte University graduate admissions data.

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\* Merriam-Webster Online Dictionary. <http://www.merriam-webster.com/dictionary/paradox>. Accessed September 2014.

### Part III – It Seems Impossible!

In an effort to come up with an explanation for this situation, let's take a closer look at the data in Catherine Earnshaw's letter.

#### *Questions*

7. Calculate the following.
  - a. How many people (both men and women) applied to Department A?
  - b. How many people (both men and women) were accepted by Department A?
  - c. What is the total percentage of applicants that were accepted by Department A?
  - d. How many people (both men and women) applied to Department B?
  - e. How many people (both men and women) were accepted by Department B?
  - f. What is the total percentage of applicants that were accepted by Department B?
  
8. In general, the following three trends are observed among graduate school applications and admissions:
  - More women apply to Ph.D. programs in the humanities than in engineering.
  - Ph.D. programs in engineering receive more applications from men than women.
  - Engineering programs have more grant money and are able to admit more students than programs in the humanities.Assume that of the two departments, A and B, one is a department in the humanities and the other is an engineering department. Based on the data in Catherine Earnshaw's letter, can you guess which is which? Explain.

## Part IV – A Simple Example

It turns out that the three bullets in Question 8 are precisely why the Bronte University data produce a paradox. Let's try to analyze this further with simple fictional data sets.

In 1961, President John F. Kennedy issued Executive Order 10925, which required government contractors to take “affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex or national origin.”\* Since then, numerous steps have been taken to encourage equal opportunity and diversity in higher education. Thus, for simplicity, we assume that as a result of these steps 100% of women who apply to an engineering program will be accepted.

Consider the following two data sets.

<i>Situation 1</i>				<i>Situation 2</i>			
	<i>Applied</i>	<i>Accepted</i>	<i>Percent</i>		<i>Applied</i>	<i>Accepted</i>	<i>Percent</i>
<i>Engineering</i>				<i>Engineering</i>			
Women	1	1	100%	Women	10	10	100%
Men	10	9	90%	Men	10	9	90%
<i>English</i>				<i>English</i>			
Women	10	5	50%	Women	10	5	50%
Men	5	1	20%	Men	5	1	20%
<i>Total</i>				<i>Total</i>			
Women	11	6	54%	Women	20	15	75%
Men	15	10	66%	Men	15	10	66%

Situation 1 depicts a scenario that follows the three trends from Question 8. That is, more women applied to the program in English than the engineering program, but the engineering program was able to admit a higher number of total applicants. Thus, Situation 1 resembles current graduate admissions data.

In Situation 2 we assume that the number of women who applied to the engineering program increased (leaving all other values fixed).

### Questions

9. Do the data in Situation 1 lead to a paradox? Explain.

10. Do the data in Situation 2 lead to a paradox? Explain.

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\* U.S. Equal Employment Opportunity Commission. “Executive Order 10925.” <https://www.eeoc.gov/eeoc/history/35th/thelaw/eo-10925.html>.  
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## Part V – What Does This Mean?

Let's summarize what the above calculations do and do not indicate.

### Questions

11. Was Jane Eyre discriminated against based on her gender?
  
12. Does gender discrimination exist in higher education?
  
13. What was the most surprising thing you learned from this exercise?
  
14. What aspects of this exercise were not surprising?

For the final questions, remove yourself from this specific story and think about the overall phenomena that we observed.

15. What is the biggest mathematical takeaway for you?
  
16. Can you think of other situations where this type of paradox could arise?

## References

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