Prestatistics: Acceleration and New Hope for Non-STEM Majors

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Learning Is

Learning is embedding new knowledge
in the rich soil
of what you already know.

Marlieke van Kesteren at VU University Amsterdam

Outline

Show Me the Data!

West Virgina:

% of entering freshmen who enroll in remedial courses in their first year:

- 2-year: 69.8%
- 4-year non flagship: 15.6%

% of remedial students completing gateway courses within two academic years

- 2-year: 16.9%
- 4-year non flagship: 26.9%

Source: Complete College America

Show Me the Data!

College of San Mateo (in California)

Students who pass algebra sequence and statistics:

- Within 2 years: 13%
- Within 5 years: 21%

Algebra Preparation for Most Non-STEM Majors

Traditional algebra sequence is

- an inefficient preparation for statistics.
- not in line with most non-STEM majors' careers.

A Very Rough Estimation

$$(0.5)(0.9)(0.5)(0.9)(0.65) \approx 0.13$$

A Very Rough Estimation

$$(0.5)(0.9)(0.5)(0.9)(0.65) \approx 0.13$$

$$(0.5)(0.9)(0.65) \approx 0.29$$

My Department's Use of Prestatistics

- Prestatistics replaces elementary algebra and intermediate algebra.
- Statistics course is unchanged.

Prestatistics Course Content

Chapters:

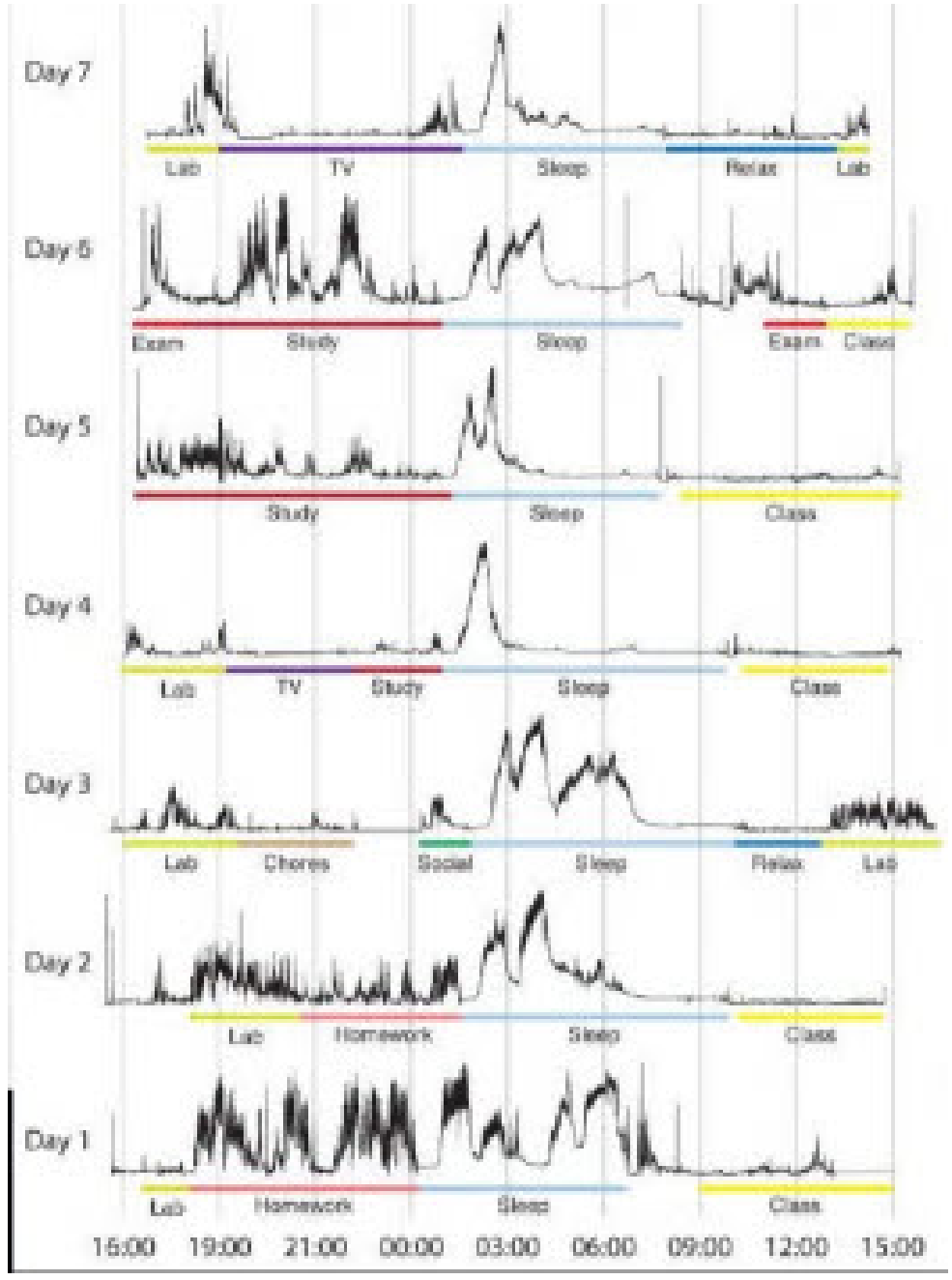
- 1: Arithmetic review
- 2: Observational studies and experiments
- 3: Statistical diagrams
- 4: Measures of center and spread
- 5: Probability laws and normal distribution
- 6: Linear regression
- 7. Graphing and interpreting linear functions
- 8. Solving linear equations and inequalities.
- 9: More linear regression
- 10: Exponential regression

Course Structure

- 6-unit course
- 2 hours on Tuesdays, 1 hour other weekdays
- Supplemental Instruction
- StatCrunch
- Online homework
- 3 projects
- 7 tests, 10 quizzes, 1 final exam
- Cumulative tests

A Typical Day

Brain Activity



Importance of Empathy

"High personal warmth with
high active demandingness"

Judith Kleinfeld (1972)

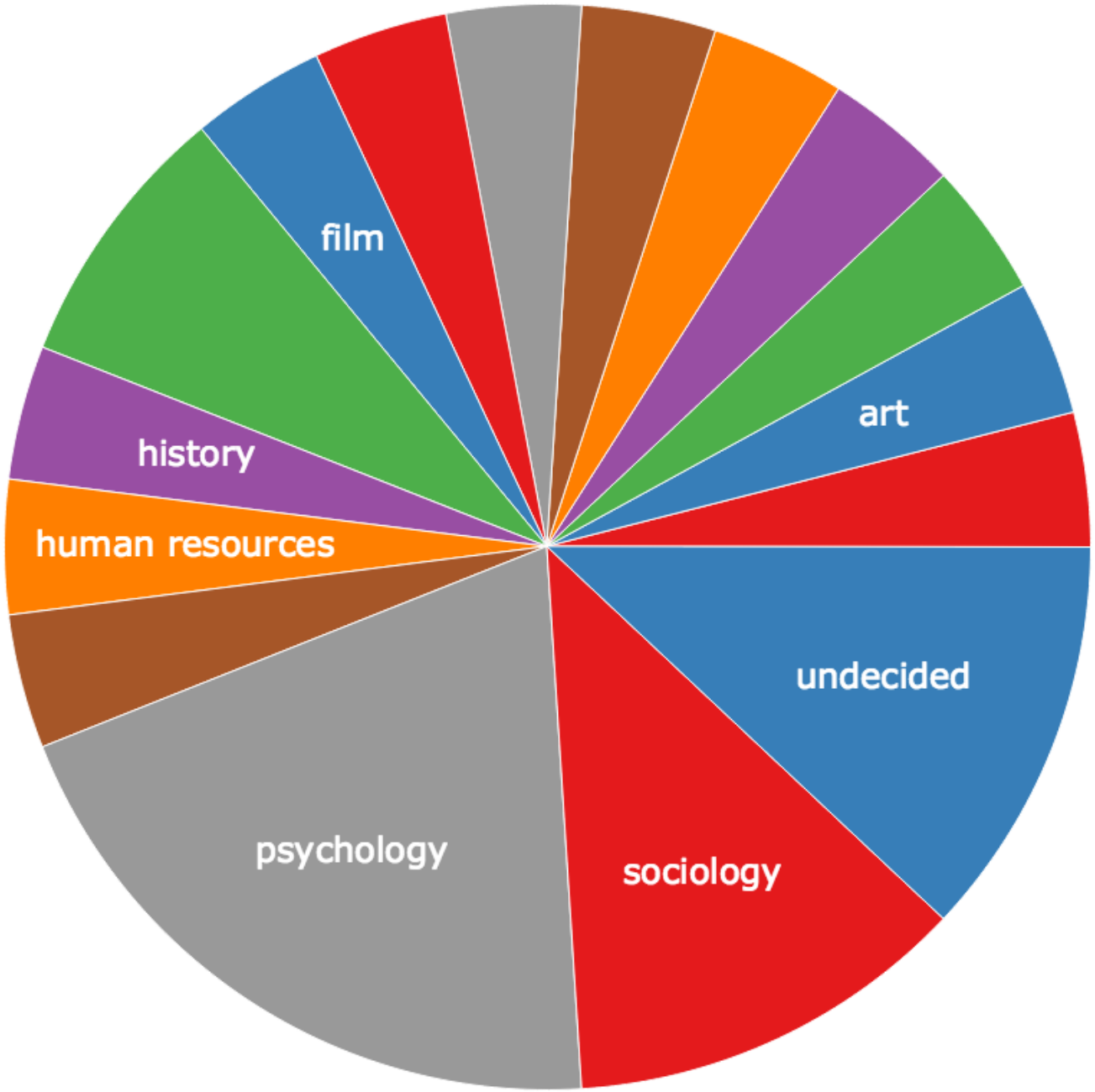
Improve Students' Beliefs and Behaviors

- Belonging
  (Walton and Cohen)
- "Grow your brain"
  (Yeager and Walton)

Who Can Take the Course?

- Prerequisite: Arithmetic
- Students who will take statistics and no other math courses.

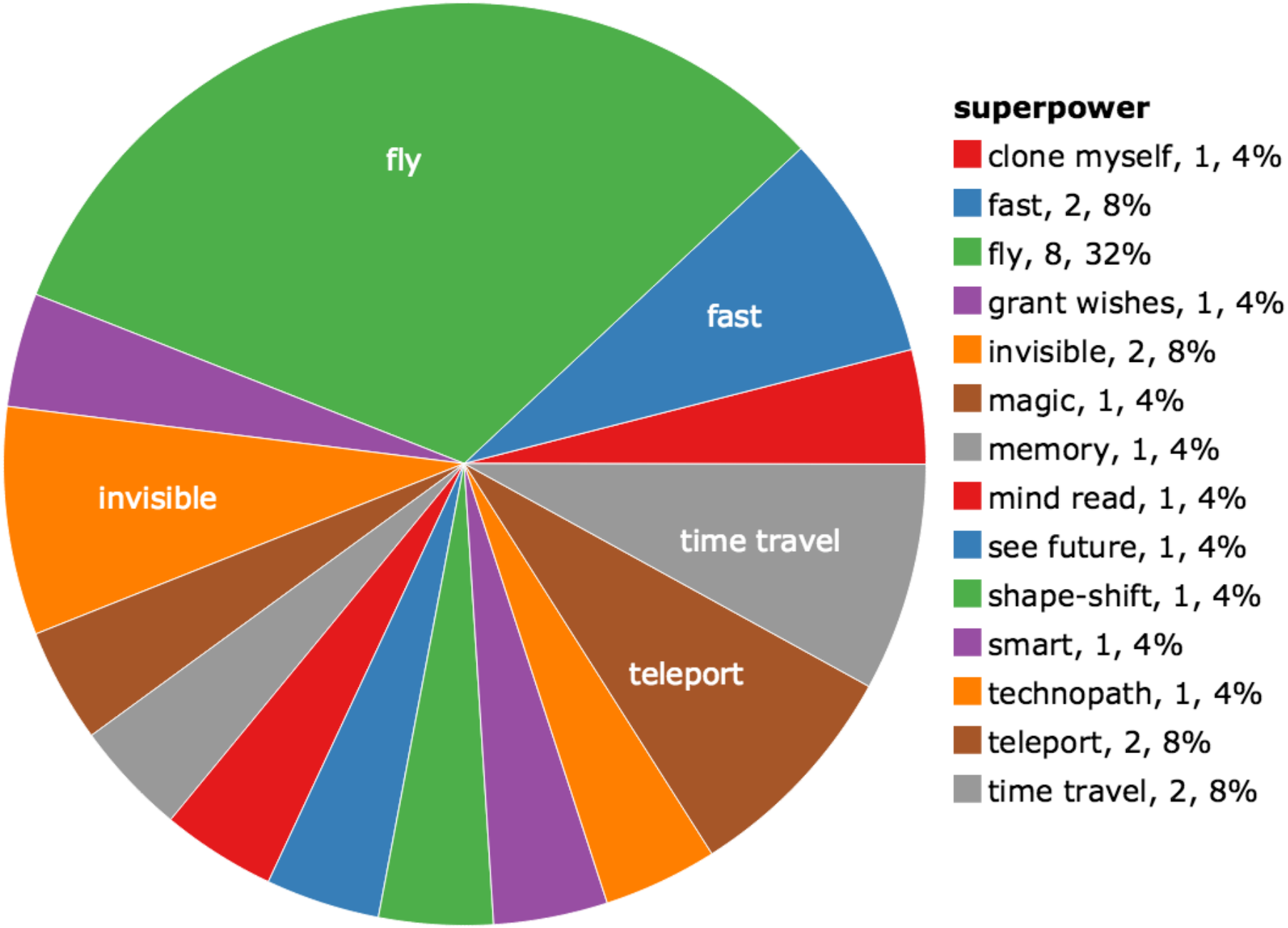
Fall 2016 Students' Majors



Major

- adminstration of justice, 1, 4%
- art, 1, 4%
- art therapy, 1, 4%
- broadcasting, 1, 4%
- communications, 1, 4%
- criminal justice, 1, 4%
- english, 1, 4%
- ethnics, 1, 4%
- film, 1, 4%
- graphic design, 2, 8%
- history, 1, 4%
- human resources, 1, 4%
- political science, 1, 4%
- psychology, 5, 20%
- sociology, 3, 12%
- undecided, 3, 12%

If You Could Have One Superhero Power . . .



Fall 2016 Students' Majors

Fall 2016 Students' Majors

Emily

What the Course Should Not Be

Acceleration should not mean . . .

- Deleting challenging topics.
- Dumbing-down remaining topics.
- Duplicating the first half of statistics.

Avoid the 3 Ds!

Goal of Course

Have students embed new statistical knowledge in the rich soil of what they already know.

Big Question

But How?

Goal of Course

By productive struggle

Big Question

Come again?

Goal of Course

- Students work collaboratively
- Unfamiliar problems

Big Question

But which problems?

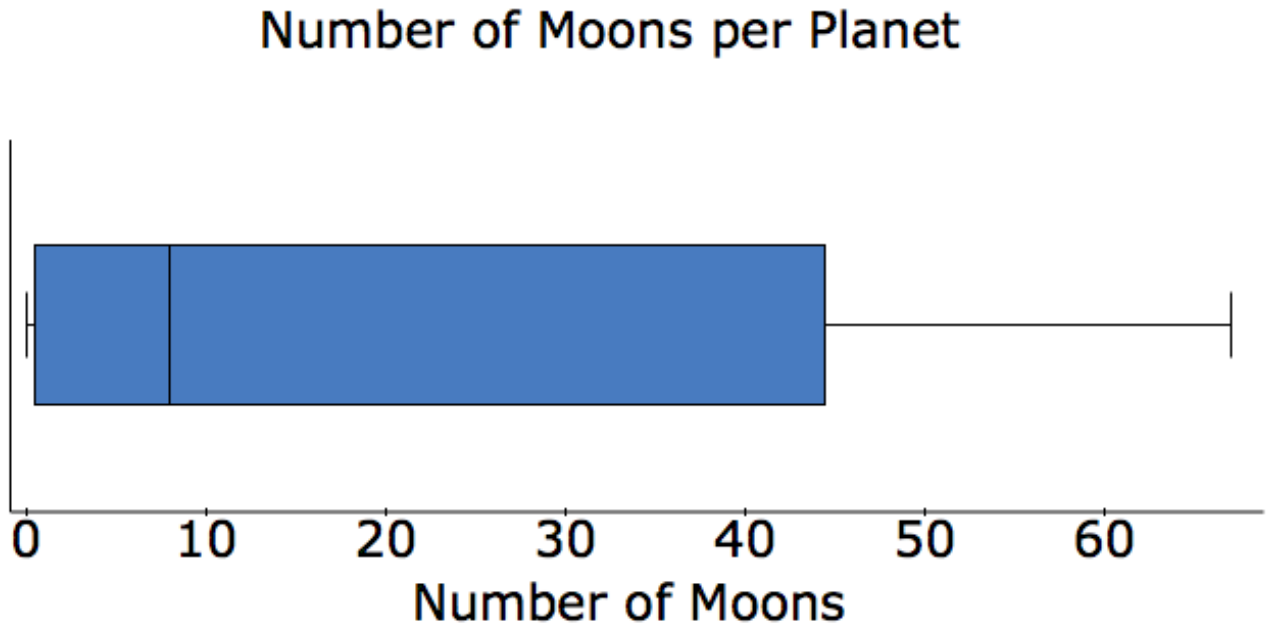
Goal of Course

- Problems that address fundamental concepts
- Problems that drive to the heart of students' misconceptions

Big Question

This better be good.

Interpreting Boxplots

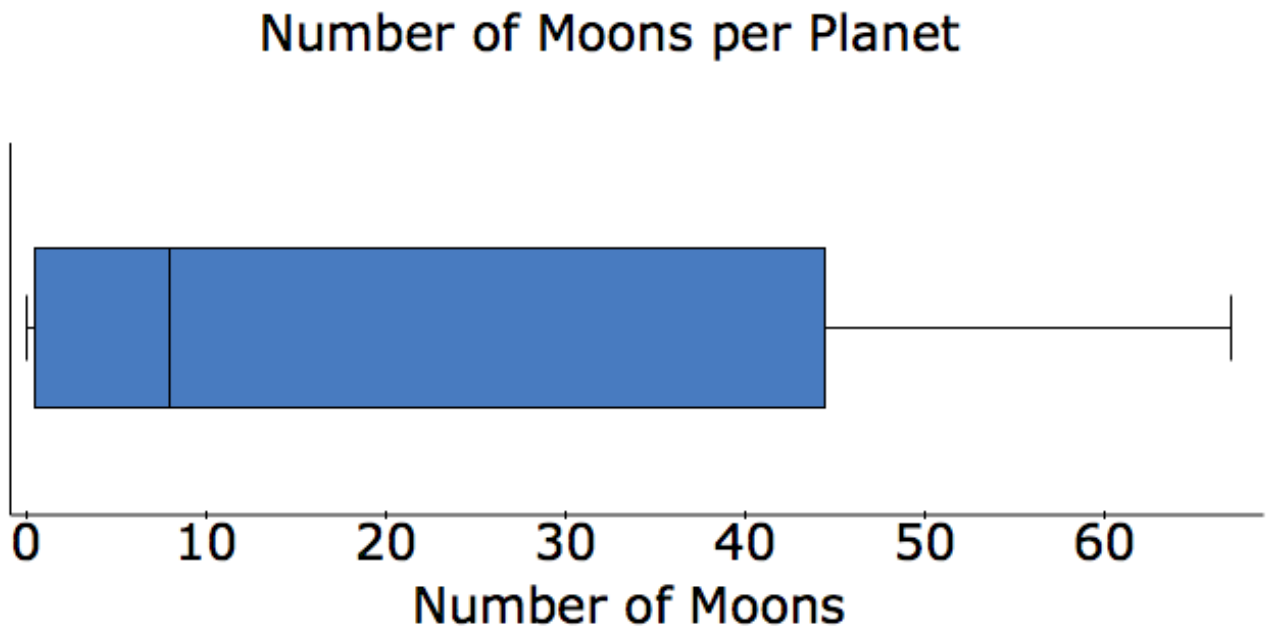


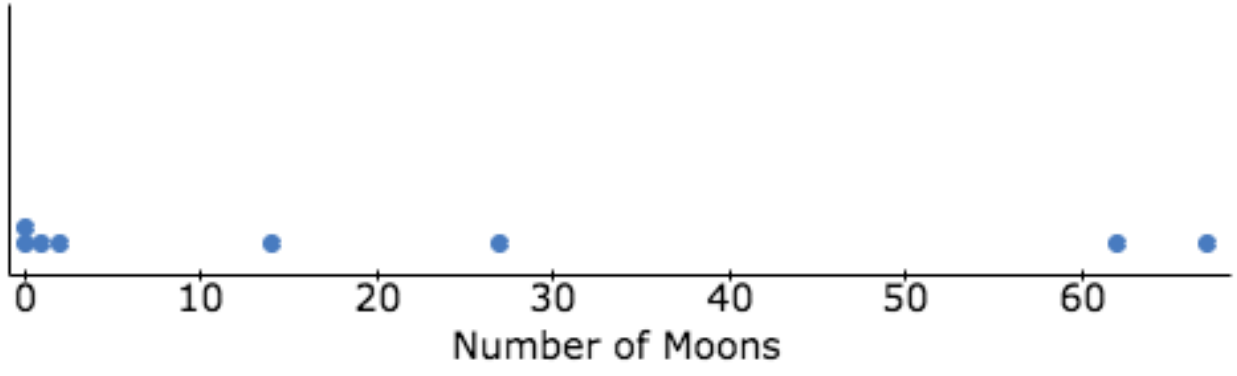
A student says there are more planets that have between 8 and 45 moons than there are planets that have less than 8 moons, because the right part of the box is longer than the combined length of the left whisker and left part of the box. What woud you tell the student?

Big Question

Straight up.

Interpreting Boxplots



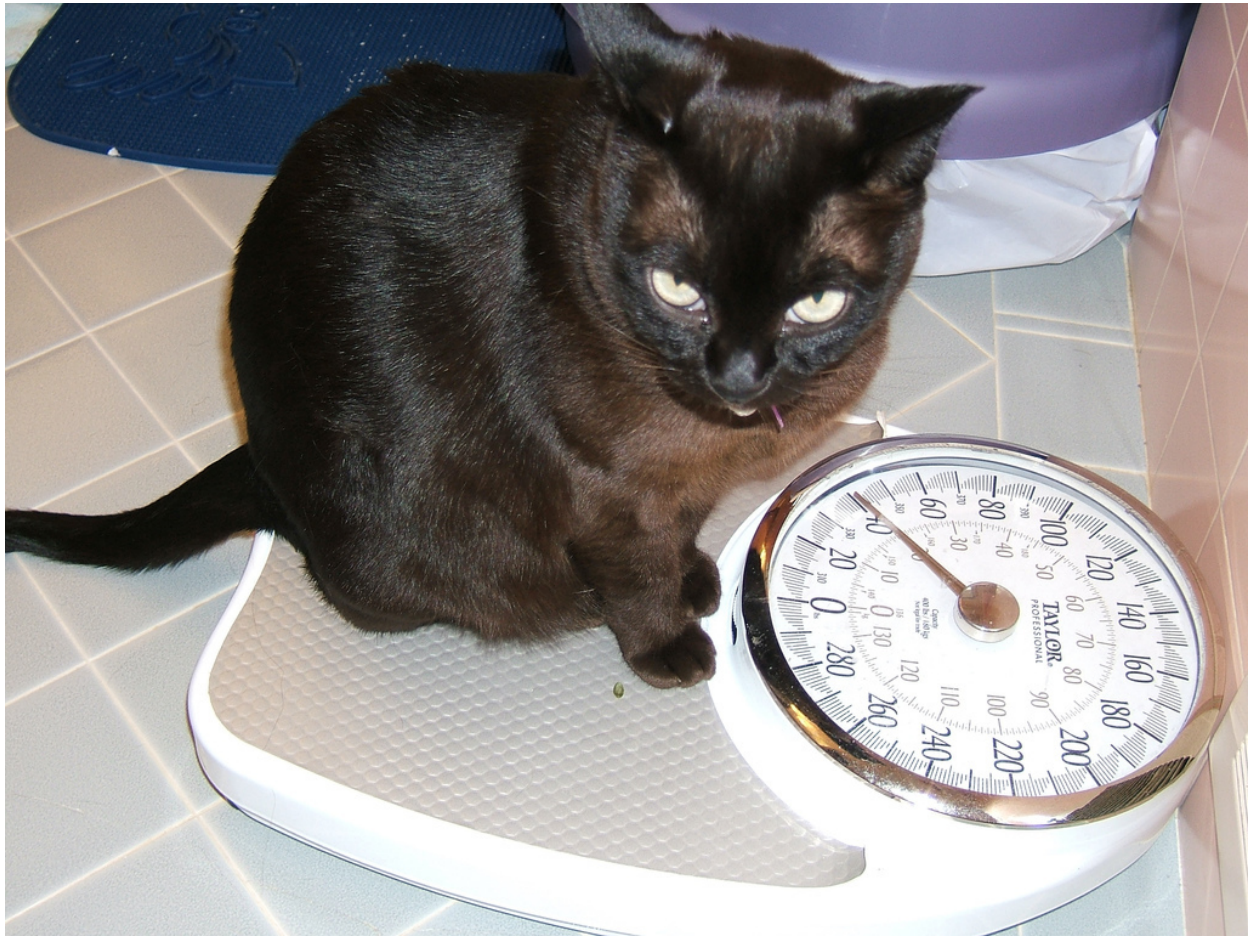


Number of Planets

8 or 9?

Sample Size versus Center

Which would tend to be larger, the mean weight of 20,000 randomly selected cats or the mean weight of 5 randomly selected human adults? Explain.



Big Question

Dude, seriously? 20,000 cats?

Sample Size versus Center

What's the mean weight of three 10-pound cats?

$$\frac{10+10+10}{3} = \frac{3(10)}{3} = 10$$

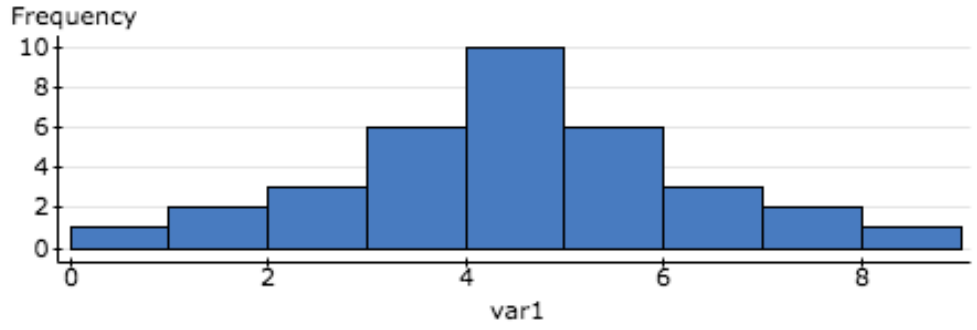
Okay, what's the mean weight of four 10-pound cats?

$$\frac{10+10+10+10}{4} = \frac{4(10)}{4} = 10$$

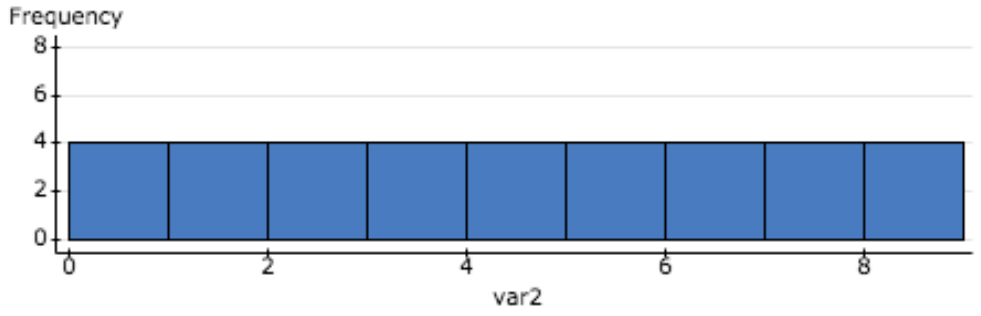
Standard Deviation

Which distribution has the smallest standard deviation? The largest? Explain.

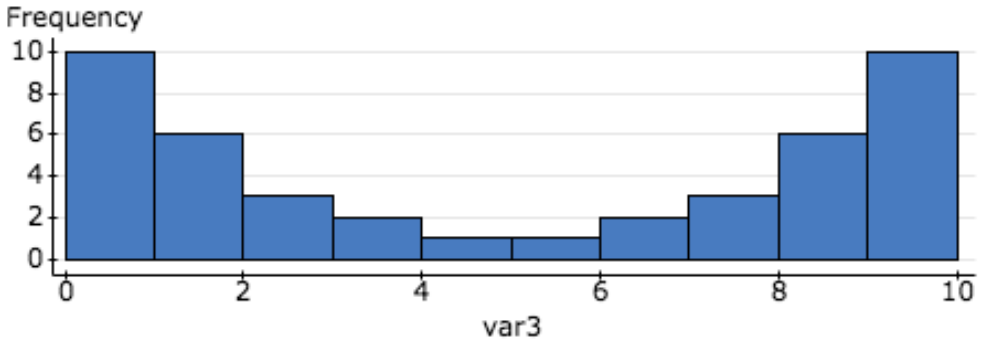
Dist 1:



Dist 2:



Dist 3:

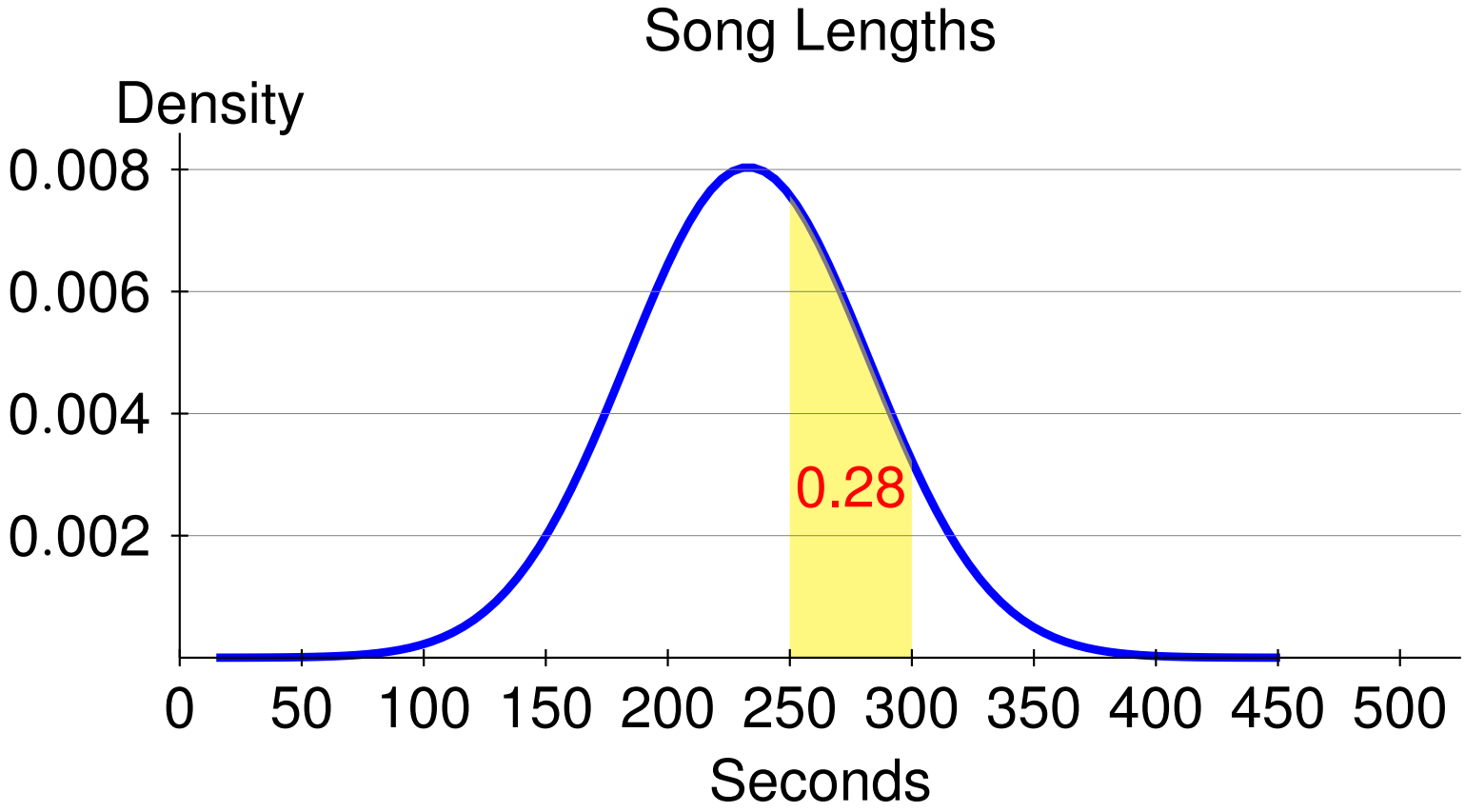


Song Lengths Played by Live 105

Procrastinistas

Song Lengths Played by Live 105

Area of a Bar versus Area Under Normal Curve

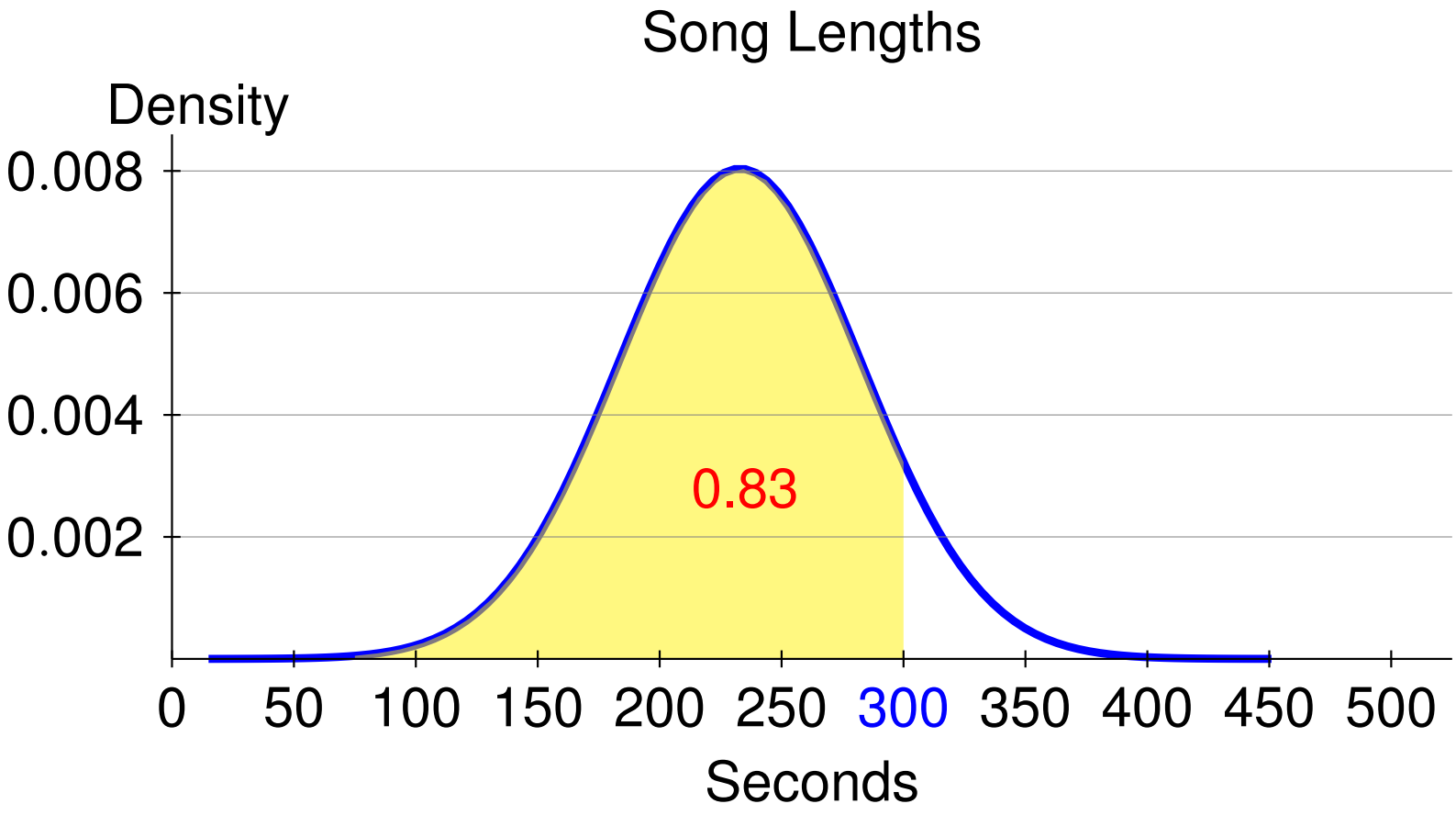


On the basis of the above graph, a student determines that the percentage of songs between 250 and 350 seconds (twice the length in songs) is $2(28) = 56\%$. What would you tell the student?

Big Question

I'm hip to you, dude. The student's flat-out wrong. The student's always wrong. Honestly, what do you think you're doing in front of the classroom?

Area of a Bar versus Area Under Normal Curve



- Find the percentile for a 300-second long song.
- Find the song length at the 83rd percentile.

What's the Connection?

Relative Frequency Histogram

?

?

?

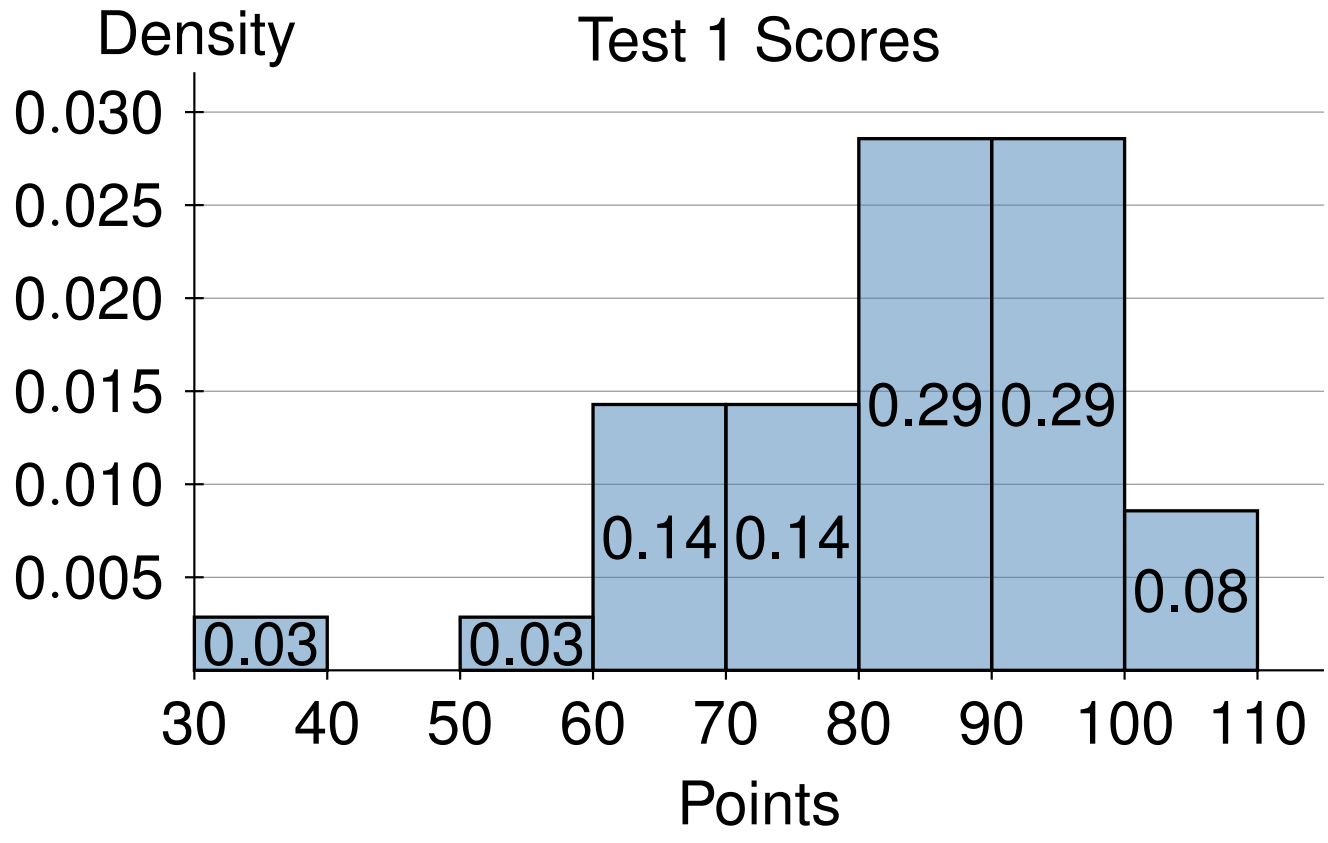
Normal Curve

The Missing Ingredient

Density histograms

Definition of Density Histogram

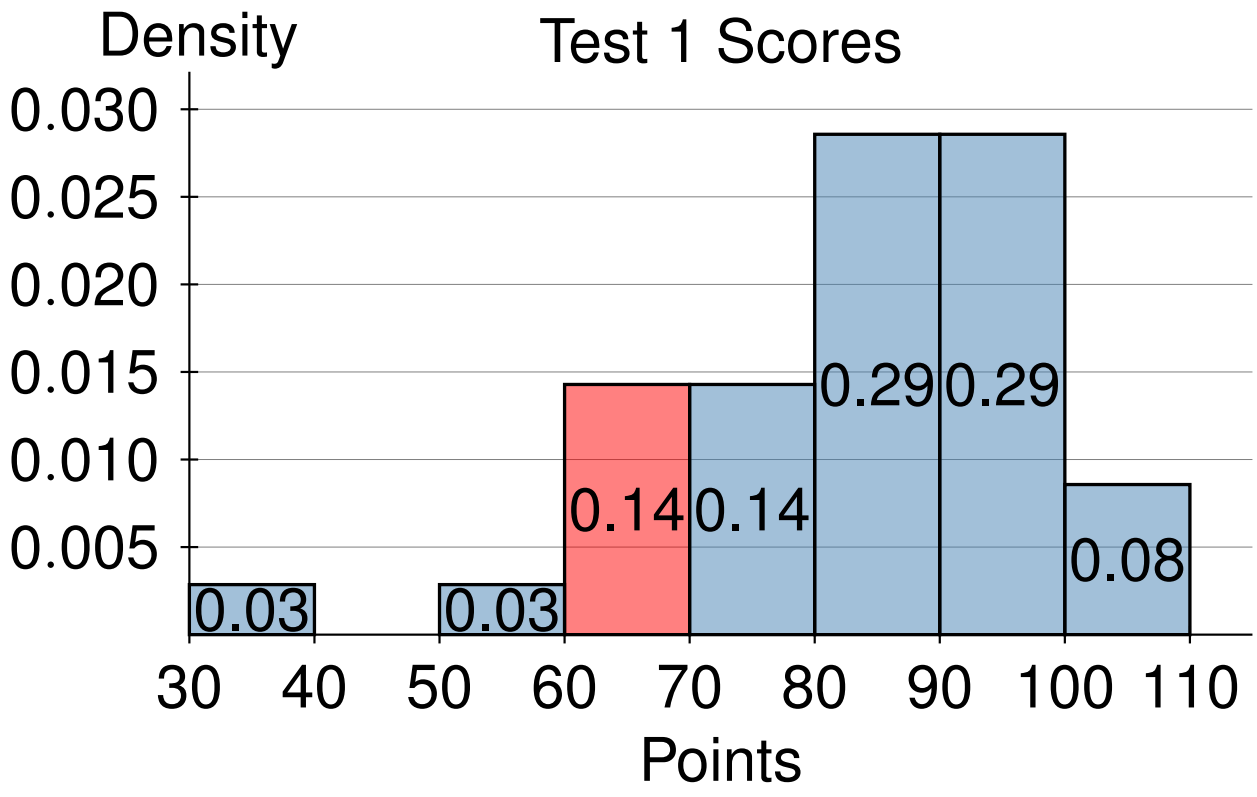
$$\text{density} = \frac{\text{relative frequency}}{\text{class width}}$$



$$\text{density} = \frac{\text{relative frequency}}{\text{class width}}$$

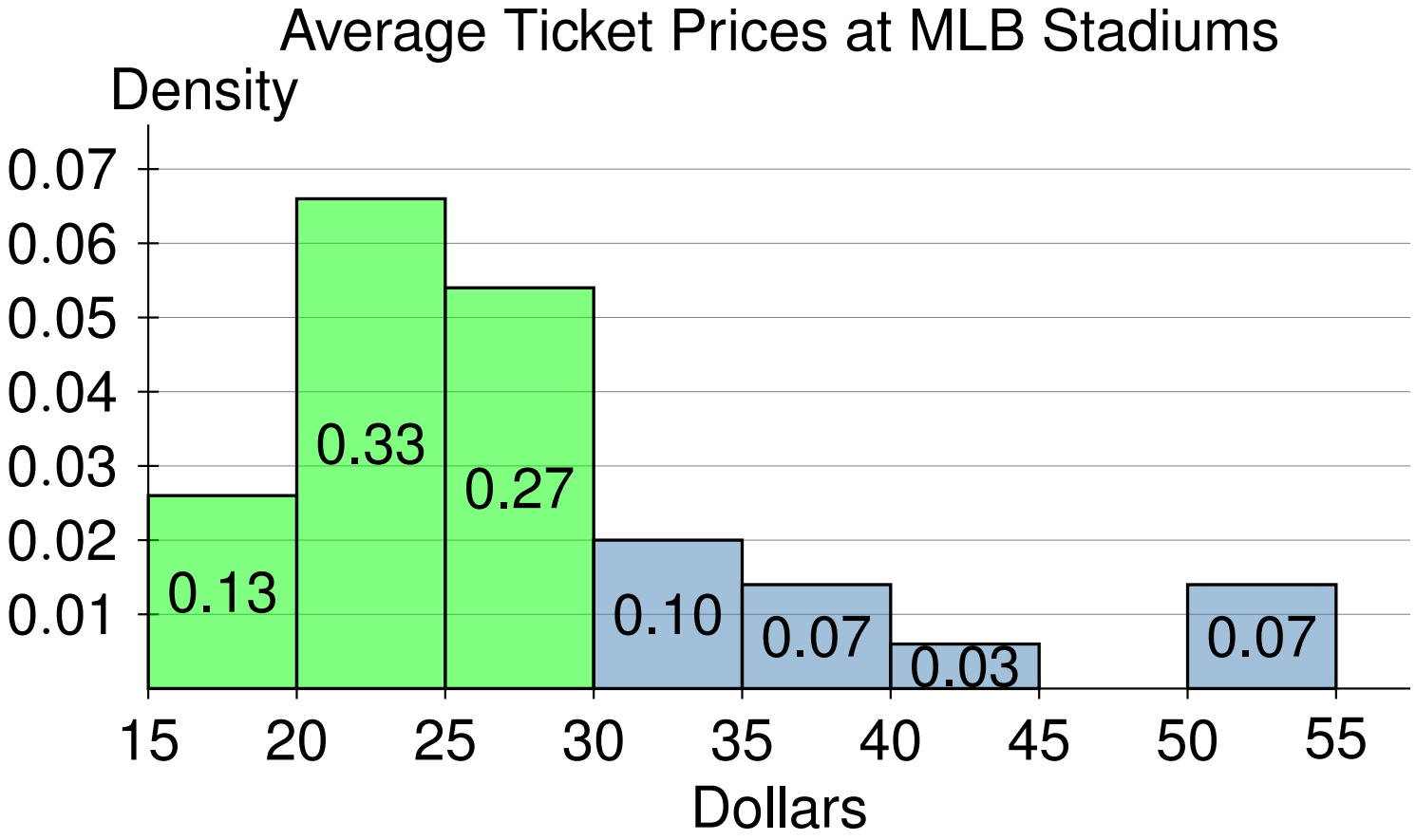
$$\text{area of bar} = \frac{\text{relative frequency}}{\text{class width}} \cdot \text{class width}$$

$$\text{area of bar} = \text{relative frequency}$$



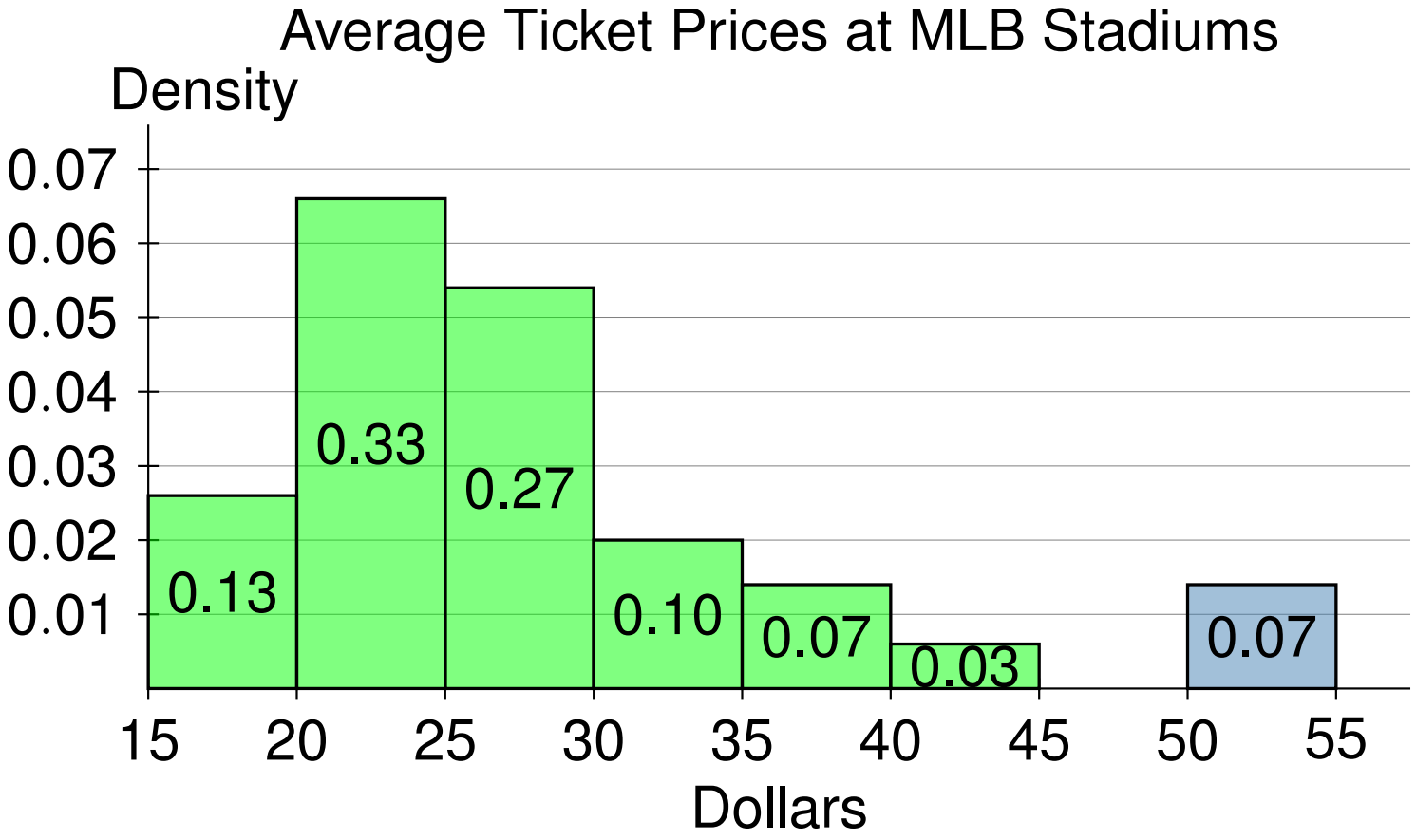
Average Ticket Prices at MLB Stadiums

Density Histogram and Adding Areas



Find the percentile for a $30 ticket.

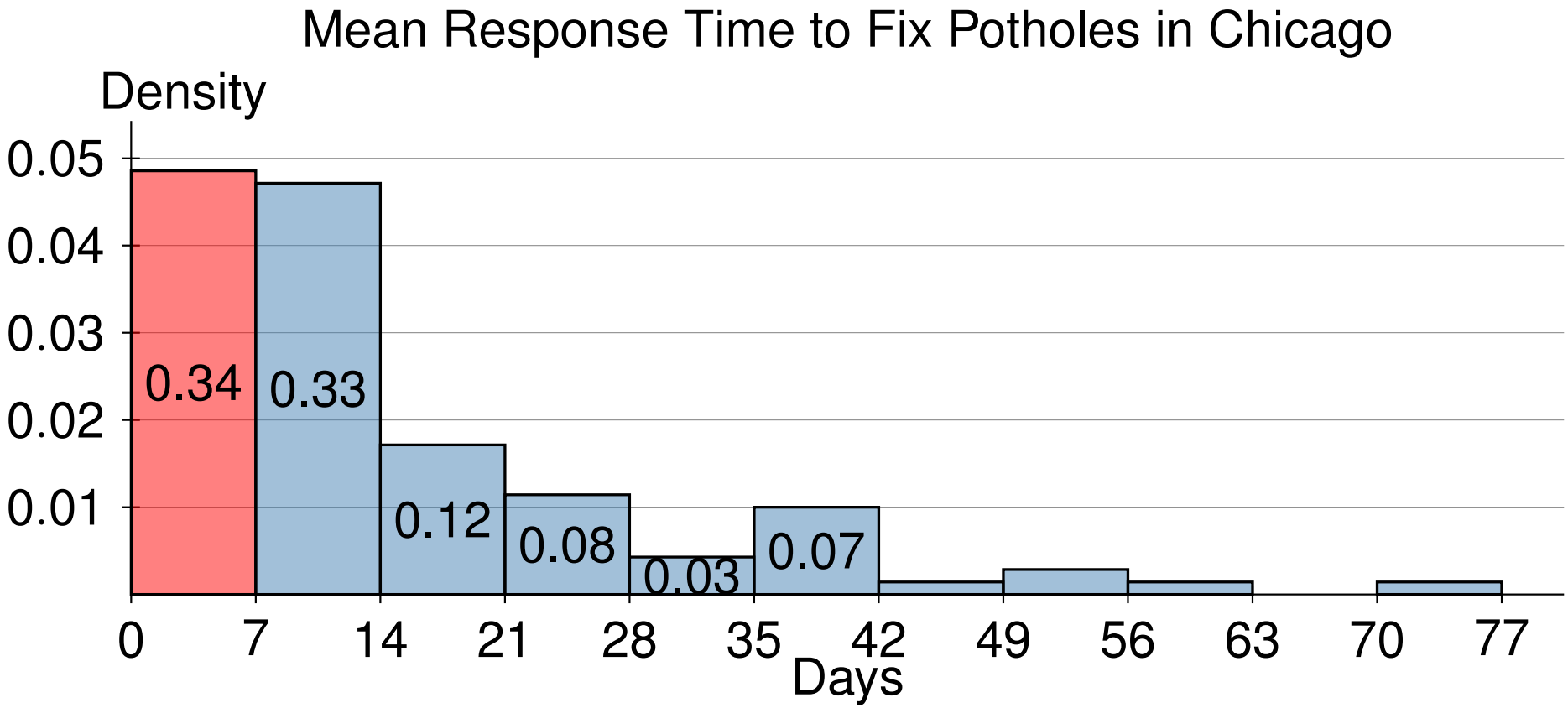
Density Histogram and Adding Areas



Find the ticket price at the 93rd percentile.

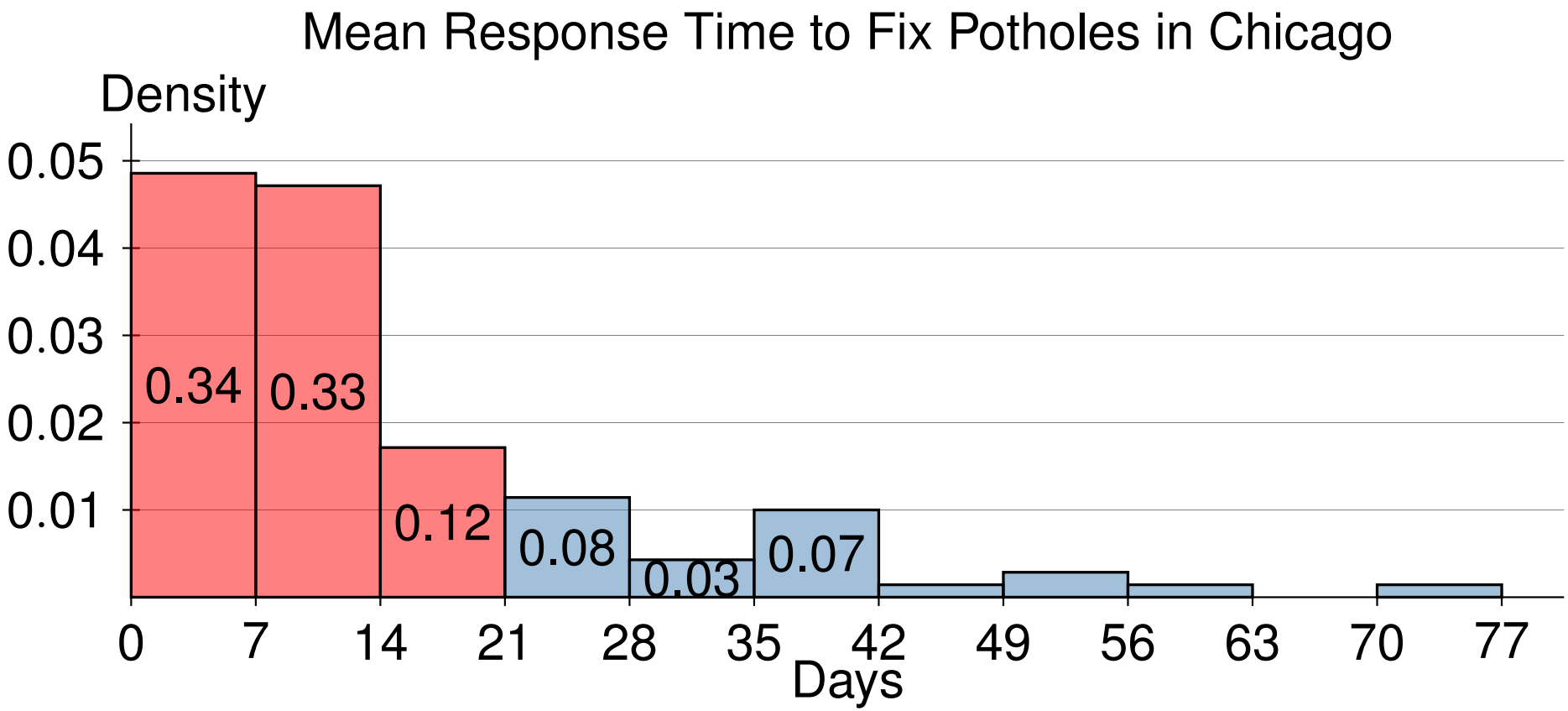
Mean Response Time to Fix Potholes in Chicago

Ask Authentic Questions



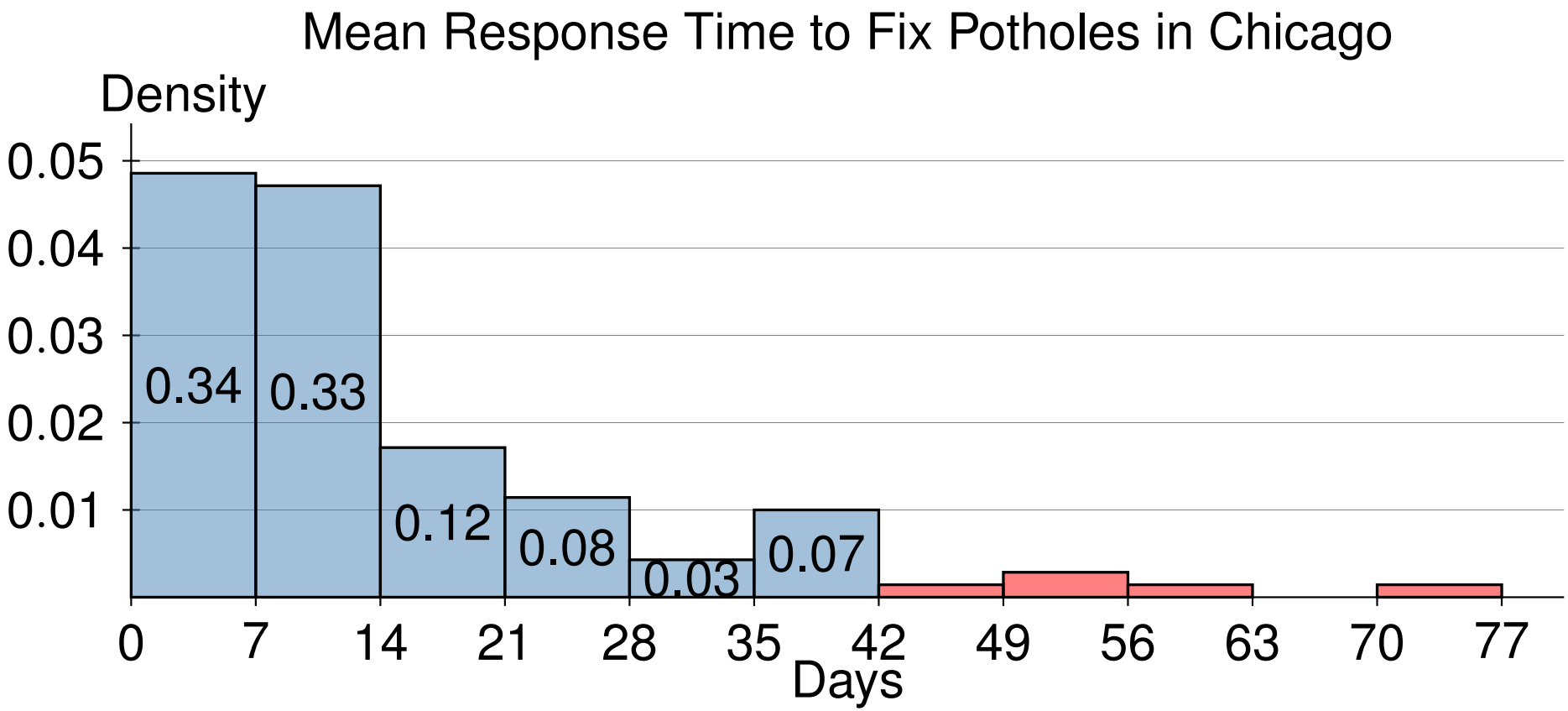
Has Chicago met its goal of 7 days?

Address Difficult Terminology



Find the proportion of mean response times that are at most 20 days.

Address Difficult Terminology

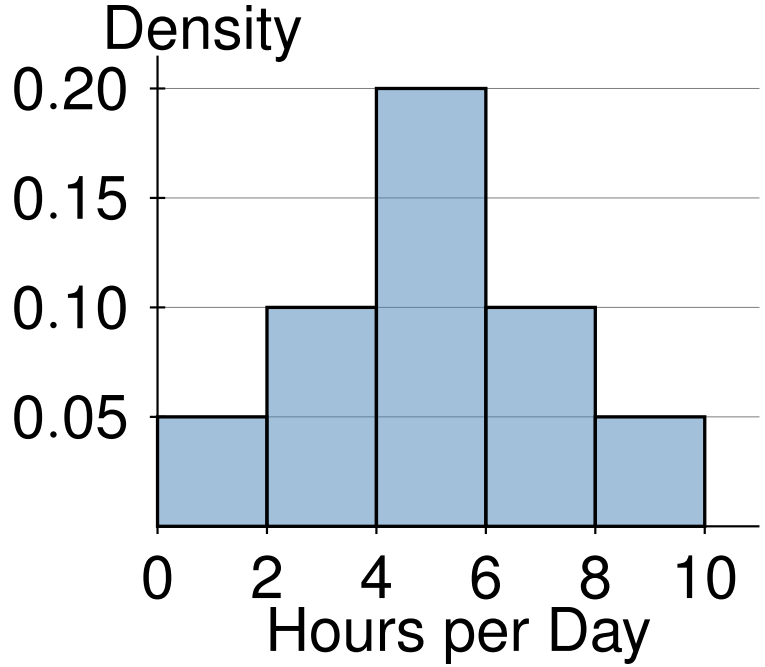


Find the proportion of mean response times that are at least 42 days.

Television Viewing Durations

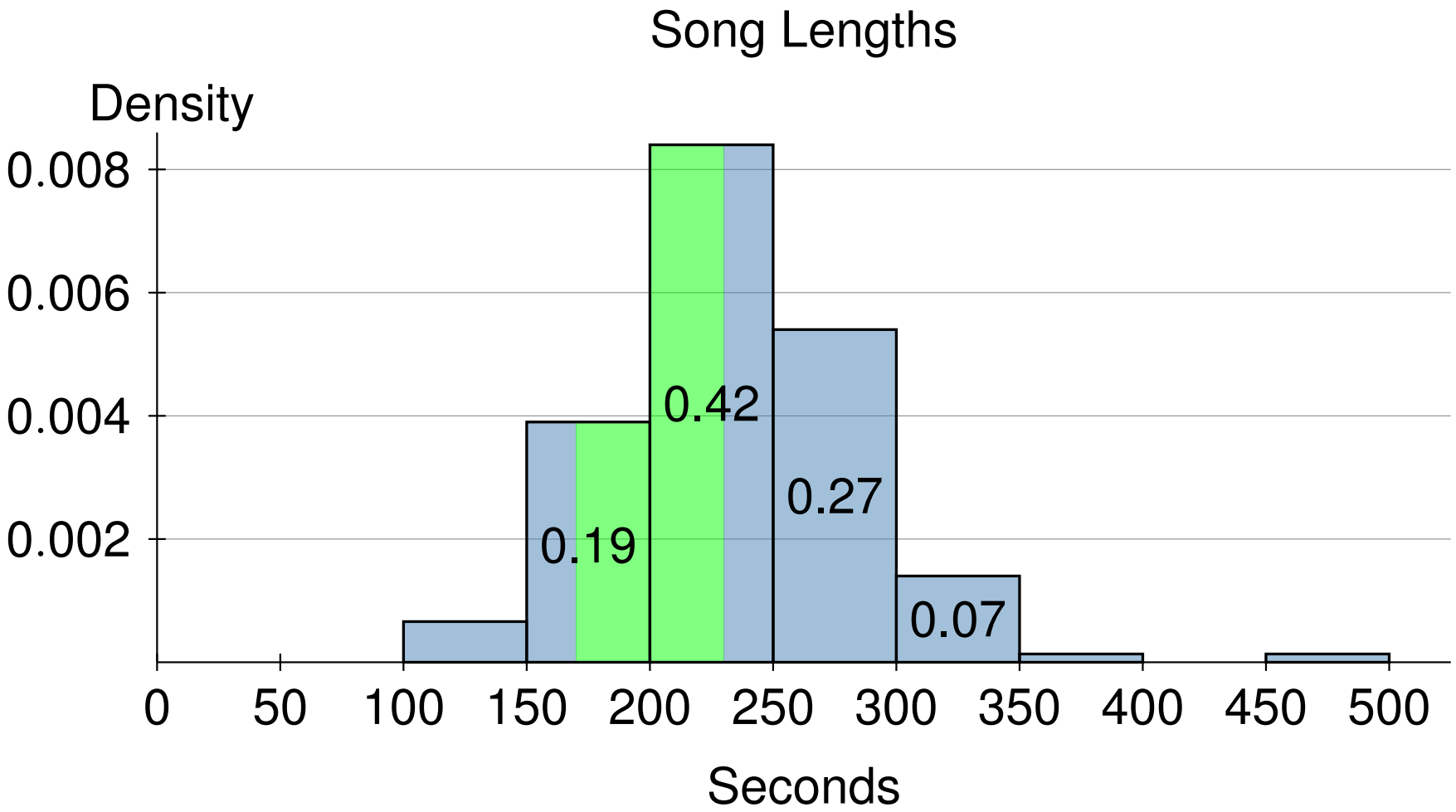
Collaborative Activity: Areas of Density Histograms

Television Viewing Durations in the Summer by College Students



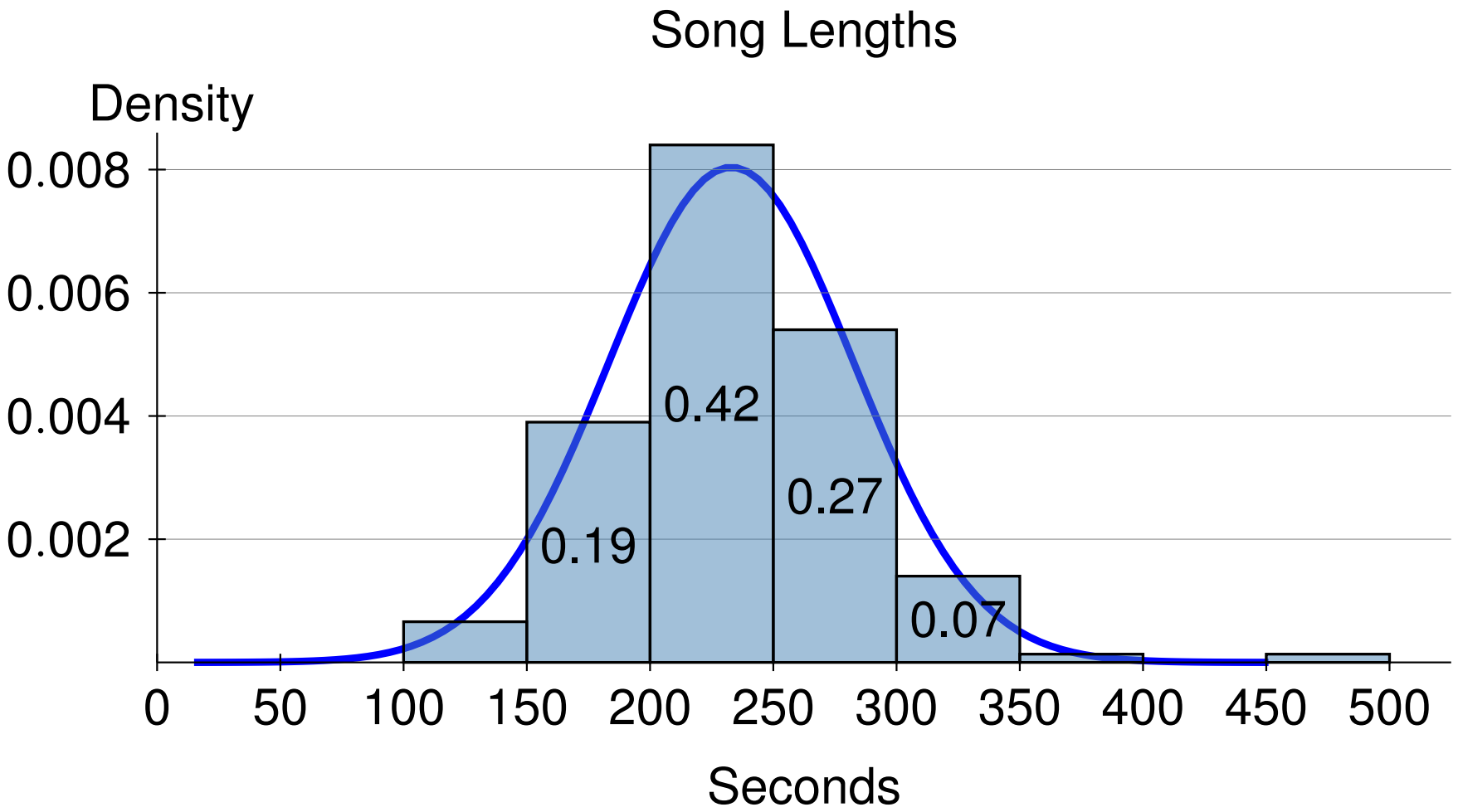
1. Compute the area of each of the five bars.
2. Find the total area.
3. What is the total area of *any* density histogram? Explain.

Motivating the Normal Curve

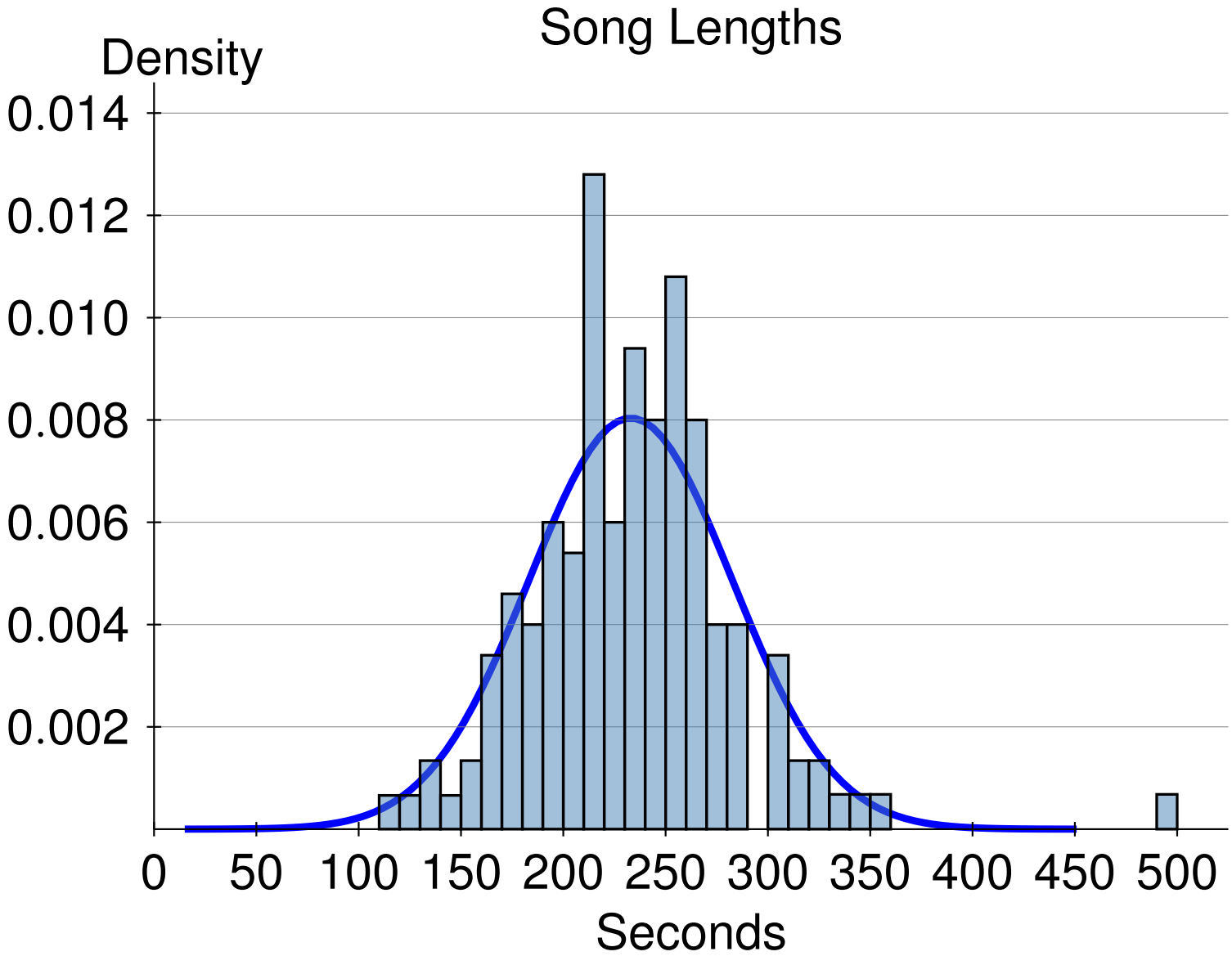


What is the probability of randomly selecting a song length between 170 and 230 seconds?

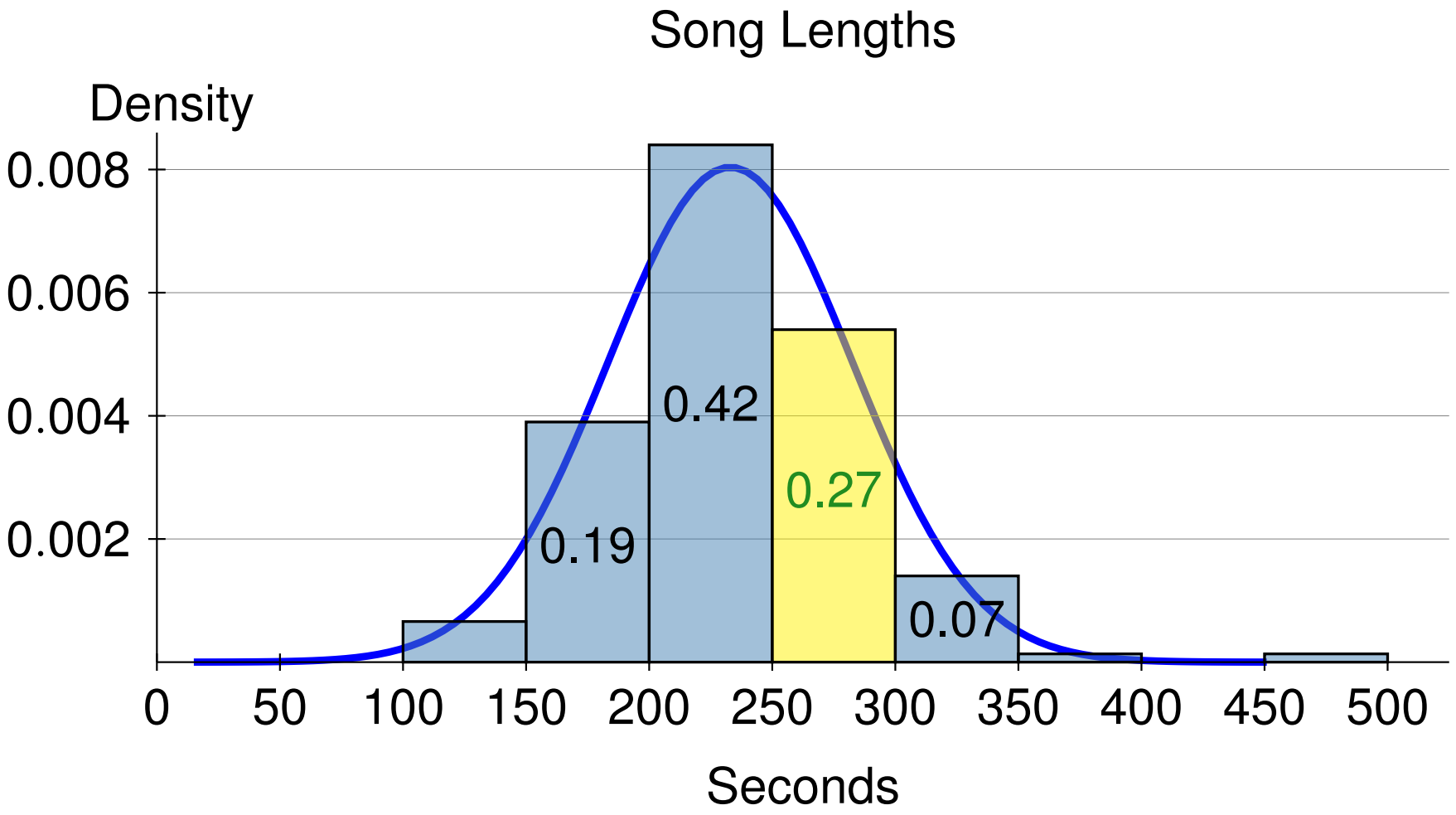
Introducing the Normal Curve



Using Smaller Class Sizes



Area of a Bar versus Area Under Normal Curve



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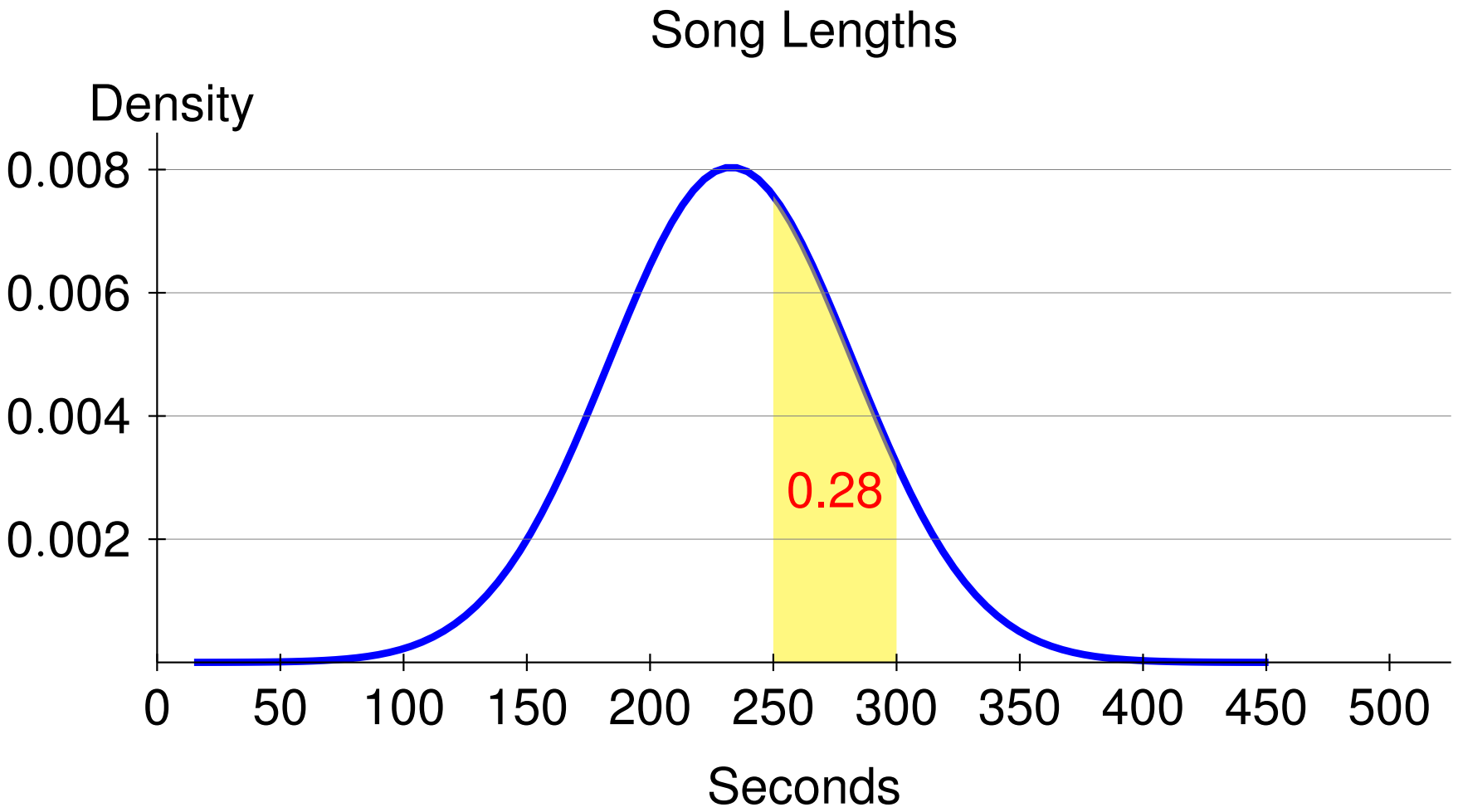
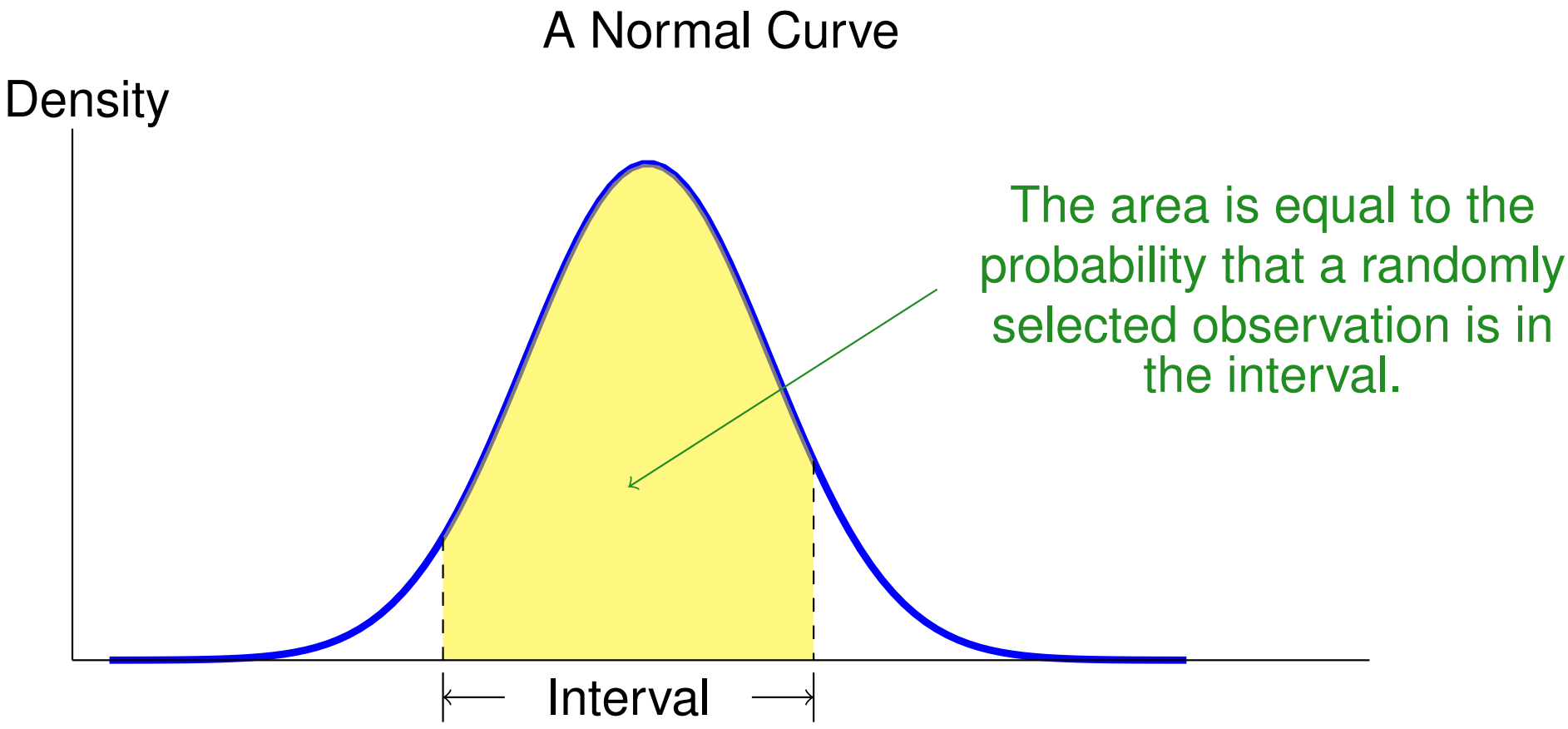
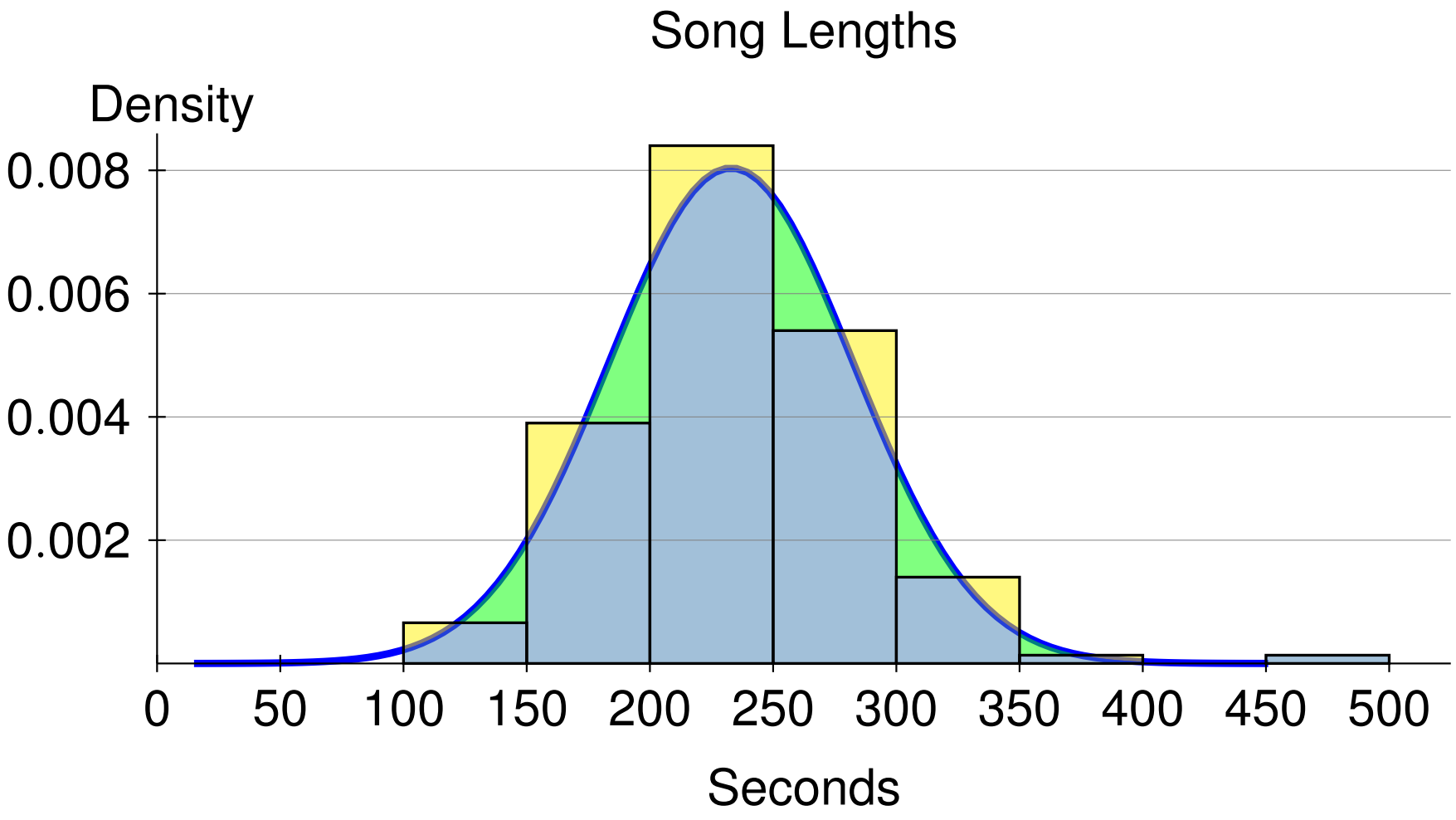


Area is Equal to Probability



Total Area Under Normal Curve



The total area under a normal curve is equal to 1.

Mini Essays Encourage Students to Dig Deeper

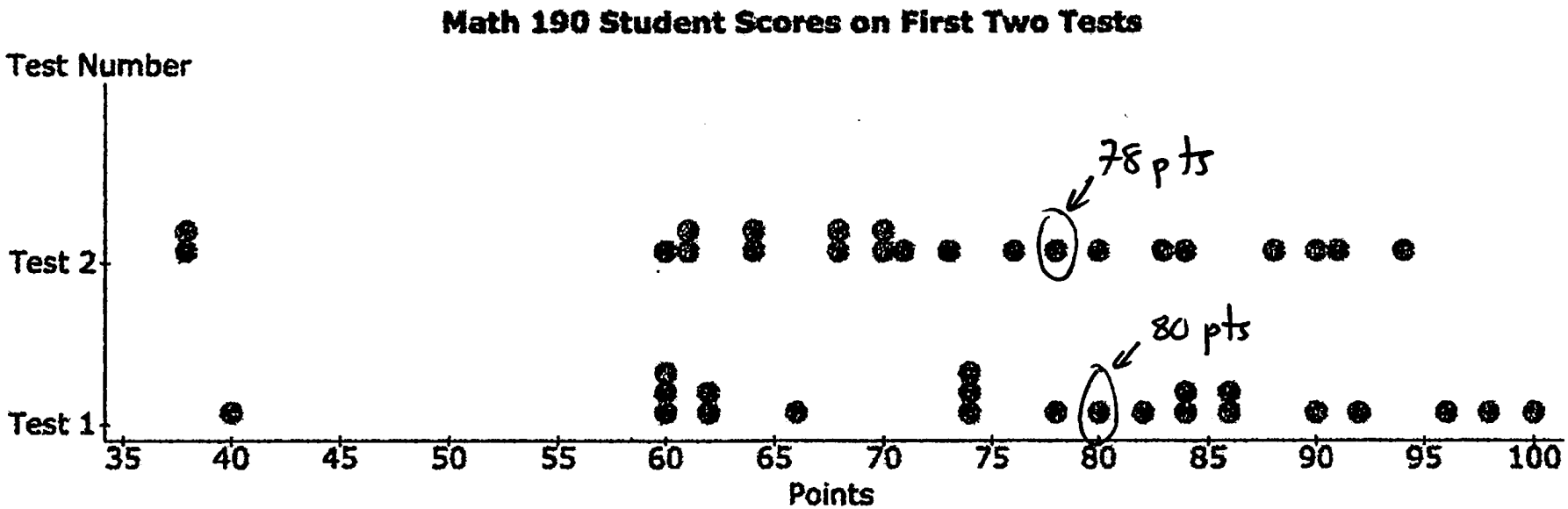
If one of these two guys passed your intro stats course, which one would he be?

Mini Essays Encourage Students to Dig Deeper

- Ask about key concepts.
- Misconception or gap in understanding
- Group activities, homework, group quizzes, tests

A Mini Essay Question

The scores from Test 1 and Test 2 for our class are described by the following two dotplots. A student in our class earned 80 points on Test 1 and 78 points on Test 2. The student thinks that he or she did worse on Test 2. What would you tell the student?



A Mini Essay Question

The scores from Test 1 and Test 2 for our class are described by the following two dotplots. A student in our class earned 80 points on Test 1 and 78 points on Test 2. The student thinks that he or she did worse on Test 2. What would you tell the student? Use concepts we have discussed to support your argument. Perform some calculations, but also write a through response to explain why your calculations are relevant. Use vocabulary we have been using in class.

A Mini Essay Question

$$\text{Test 1} = \frac{12}{22} = 0.545 \quad \text{55th percentile}$$

$$\text{Test 2} = \frac{15}{22} = 0.681 \quad \text{68th percentile}$$

If you are looking at her standing in the overall concept of score she would see that she actually did better on Test 2 due to her only beng #7 in running for 100%. Compared to test one she was #10.

$$\frac{27}{44} = 0.613$$

After both her tests she still sits at the 61st percentile in her class.

Project Assignments Provide Big Picture

- Data set with lots of individuals and variables
- Groups of students pose a question without viewing the data
- Groups analyze data
- Students write reports individually

Project Assignments Provide Big Picture

Roller Coaster Data

Name of Ride	Park	City
State	Country	Type
Construction	Height (ft)	speed (mph)
Length (ft)	Inversions	Number of Inversions
Duration	GForce	Opened

Challenges of Transition to Statistics

- Workload
- Culture clash of teaching styles

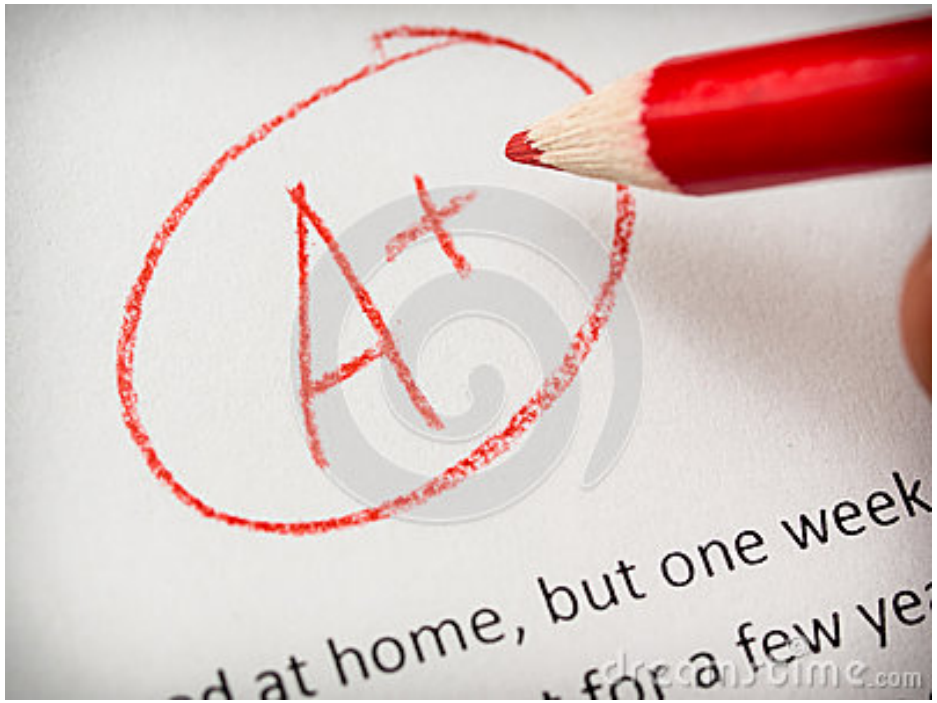
Show Me the Data!

Students who pass algebra sequence and statistics:

- Within 2 years: 13%
- Within 5 years: 21%

Students who pass prestatistics and statistics:

- Within 1.5 years: 23%
- Within 5 years: ????



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