He Shoots, He Scores!:
Simpson's Paradox in KSU basketball field goal statistics

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Reactivation and Induction Ceremony
Pi Mu Epsilon Kansas Beta Chapter
Kansas State University
April 17, 2015

Who was the best shooter?

	Trevor Huffman			Bryan Bedford		
	Made	Att	Avg	Made	Att	Avg
2-pointers	57	127	**0.449**	13	30	0.433
3-pointers						
all field goals						

So far, looks like Huffman.

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3-pointers	35	100	**0.350**	0	1	0.000
all field goals						

Yeah, it's Huffman.

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all field goals	92	227	0.405			

But, wait, be careful...

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Not so fast...

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Hmmm.... Is it Huffman or Bedford?

Simpson's Paradox

- ▶ Trend in data reverses when two or more categories are combined

- ▶ Described by
    - ▶ Karl Pearson, et al. (1899)
    - ▶ Udny Yule (1903)
    - ▶ Edward H. Simpson (1951)

- ▶ Famous examples (see Wikipedia)
    - ▶ UC Berkeley gender bias case (grad school admission) (1973)
    - ▶ Kidney stone treatment study (1986)
    - ▶ Batting averages

Why is it paradoxical?

- ▶ Our intuition tells us the average for the combined data should be the midpoint of the averages of the two categories.

- ▶ This is true if the categories are weighted equally (ratios have the same denominators).

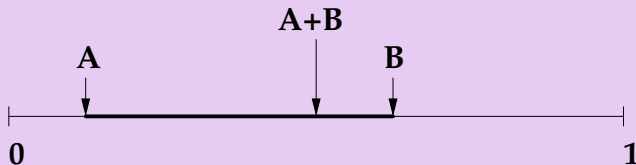50% data in Category A — 50% data in Category B
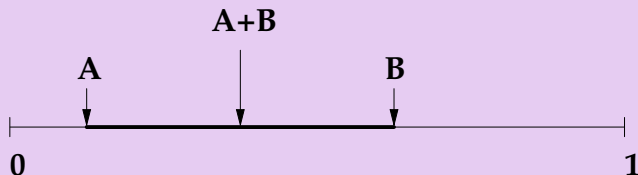
Simpson's Paradox

- In fact, the overall average can be anywhere between the two category averages.
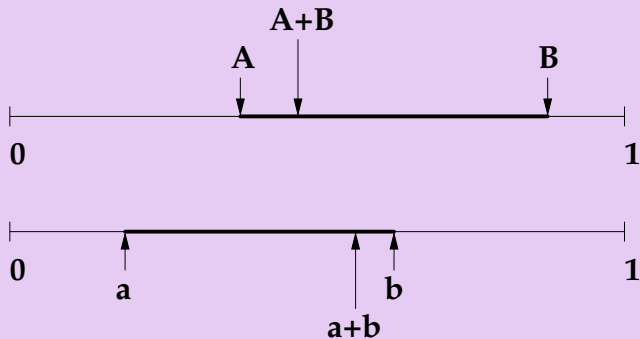
75% data in Category A — 25% data in Category B
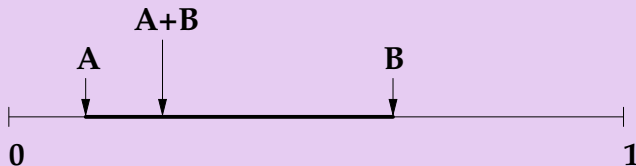
25% data in Category A — 75% data in Category B

Simpson's Paradox

$a < A$ and $b < B$,

but $a + b > A + B$ (where $a + b$ denotes overall average)

Back to basketball: Lurking variables

	Trevor Huffman			Bryan Bedford		
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3-pointers	35	100	**0.350**	0	1	0.000
all field goals	92	227	0.405	13	31	**0.419**

- $\frac{100}{227} = 44\%$ of Huffman's shots were 3-pointers
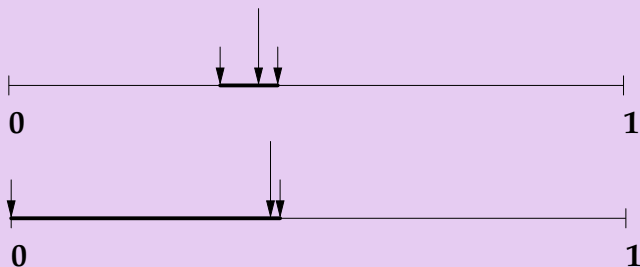- Only $\frac{1}{31} = 3\%$ of Bedford's shots were 3-pointers
- 3-pointers are harder

Lurking variable: 3-pointers are hard

Huffman:

44% 3-pointers — 56% 2-pointers

$0.350 < 0.0405 < 0.449$

0   1

0   1

Bedford:

3% 3-pointers — 97% 2-pointers

$0.000 < 0.0419 < 0.433$

Another example: 2002-03 season

	Anthony Wilkins			Antonio Gates		
	Made	Att	Avg	Made	Att	Avg
2-pointers	31	56	**0.554**	216	440	0.491
3-pointers	67	171	**0.392**	15	43	0.349
all field goals	98	227	0.432	231	483	**0.478**

- ▶ 75% of Wilkins's shots were 3-pointers
- ▶ Only 9% of Gates's shots were 3-pointers
- ▶ Gates now plays tight end for the Chargers

Women can be paradoxical, too

	Jamie Rubis			Lindsay Shearer		
	Made	Att	Avg	Made	Att	Avg
2-pointers	119	234	**0.509**	86	170	0.506
3-pointers	36	97	**0.371**	5	21	0.238
all field goals	155	331	0.468	91	191	**0.476**

- ▶ 29% of Rubis's shots were 3-pointers
- ▶ Only 11% of Shearer's shots were 3-pointers

Simpson's Paradox Challenge

These and other examples from *my* KSU's stats can be found at

www.math.kent.edu/~darci/simpson

Can you find examples in *your* KSU's stats?
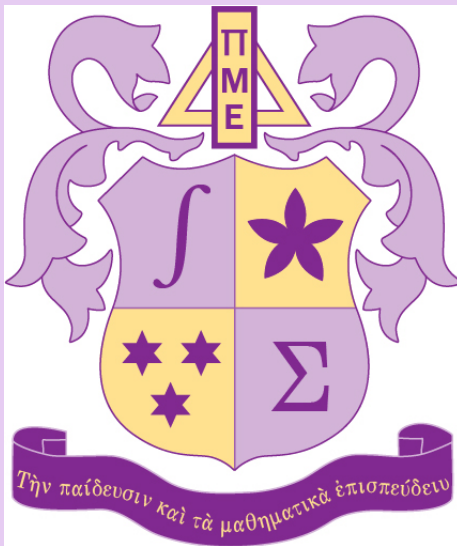
- ▶ To elect members on an honorary basis according to their proficiency in mathematics

- ▶ To promote activities that enhance the mathematical and scholarly development of its members

The History of Pi Mu Epsilon

- Founded at Syracuse University on December 8th, 1913
- Named using Greek letters stemming from the Greek words for scholarship (Pi), mathematics (Mu), and promotion (Epsilon)
- Incorporated on May 25th, 1914. Re-incorporated in 1988.
- A national society comprised of local chapters at colleges and universities.
- Currently there are 384 chapters in 48 states and the District of Columbia.
- Each chapter is designated by its own Greek Letter and a chapter number.
- The Kansas Beta Chapter (chapter 31) was chartered at Kansas State University in 1935

The Society Council

- ▶ Angela Spalsbury, Ohio Xi at Youngstown State University (President)
- ▶ Paul Fishback, Michigan Iota at Grand Valley State University (President-Elect)
- ▶ Eve Torrence, Virginia Iota at Randolph-Macon College (Past-President)
- ▶ Stephanie Edwards, Michigan Delta at Hope College (Secretary-Treasurer)
- ▶ Brigitte Servatius, Massachusetts Alpha at Worcester Polytechnic Institute (Journal Editor)
- ▶ Councilors
  - ▶ Chad Awtrey, North Carolina Nu at Elon University
  - ▶ Jennifer Beineke, Massachusetts Kappa at Western New England University
  - ▶ Darci Kracht, Ohio Epsilon at Kent State University
  - ▶ Ben Ntatin, Tennessee Epsilon at Austin Peay University

Financial support for various organizations:

- American Mathematics Competitions

- American Regional Mathematics League

- Mathematical Association of America (MAA) National Meeting Poster Session

Chapter Grants:

- Matching Prize Grants ($100)

- Matching Conference Grants ($300)

- Richard A. Good Lectureship Grants ($500)

The *Pi Mu Epsilon Journal*

- ▶ Published in the fall and spring of each year
- ▶ Cash prizes for student-authored articles

"This award had a MAJOR impact on my vision for a research career." Robert Devaney, Boston University, MAA Past-President

in conjunction with MAA MathFest 2015
August 5th-8th
Washington, DC

Fifteen-minute talks may be expository on material most undergraduates have not seen in their classrooms or on new research accomplished while an undergraduate.

Activities Sponsored by the Mathematical Association of America

- ▶ Cirque de Mathematiques: A Combination of Drama, Magic, Mime and Dance

- ▶ The Man Who Knew Infinity: Sneak Peek and Expert Panel

- ▶ Mathematicians by Day, Musicians by Night

- ▶ Student Poster Sessions and Other Undergraduate Activities

Awards for Student Talks at the National PME Meeting

Talks are judged, and cash prizes ($150) are awarded by several professional organizations:

- ▶ The American Mathematics Society
- ▶ The MAA Special Interest Groups on Mathematical Biology and Environmental Mathematics
- ▶ The American Statistical Association
- ▶ The Society for Industrial and Applied Mathematics
- ▶ Budapest Semesters in Mathematics

Professor Noam Elkies, Harvard University

- ▶ PME provides transportation support for up to 5 student speakers from each Chapter: up to $600 per student with a $1200 per Chapter maximum.

- ▶ An NSA grant provides a stipend to help defray lodging and food expenses. (in 2014: $380 each)

- ▶ **Almost all PME student speakers receive travel and sustenance grants.**

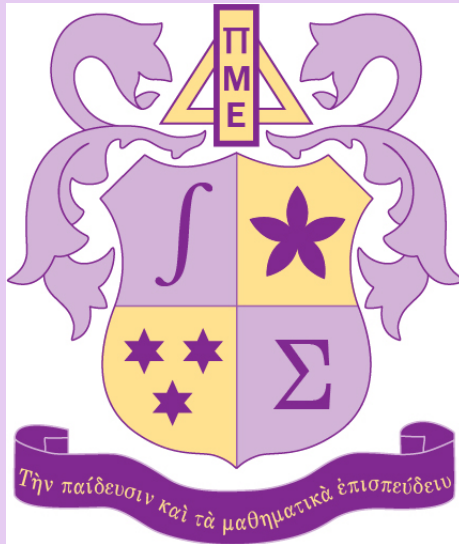- ▶ For further details, see www.pme-math.org/apply-for-funding.

Student Survey Comments

- "MathFest is an excellent opportunity to expand your mathematical knowledge, meet distinguished mathematicians, and learn about careers in your field. It was a wonderful and fun experience and you should definitely participate."

- "I would tell students that they should participate and give a talk. It has been a memorable and great experience that will help me in several ways in the future."

I solemnly promise
that I will exert my best efforts
to promote true scholarship,
particularly in mathematics,
and that I will support the objectives
of the Pi Mu Epsilon Honor Society.