"College Students' Conceptions of Probability"

Emma Morgan

Survey

- Students in intro stat class
- Views about probability
- Asked to assign probabilities and give explanations
- Results: Students confused about different views of probability

3 Views of Probability

- Classical – one can represent the sample space as a collection of equally like outcomes
- Frequency/empirical – one can repeat the random experiment many times under similar conditions, and the probability of an event is estimated by the relative frequency of the event in the collected results
- Subjective – probability is a numerical measure of a person's opinion of the likelihood of an event

Conclusion

- Students should be familiar with 3 viewpoints but they aren't
- Focus in an introductory statistics class should change from probability calculations to probability interpretations

Works Cited

Albert, J. H. (2003). College students' conceptions of probability. The American Statistician, 57(1), 37-45. Retrieved from http://search.proquest.com/docview/228435207?accountid=13158

Streakiness in Home Run Hitting

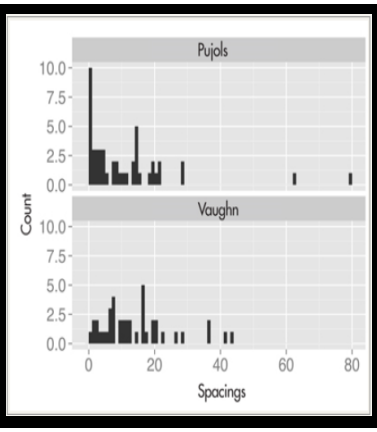
By: Michael Cherry

Streakiness in Home Run Hitting

- Spacings between home runs
- Statistical Test of Streakiness

Spacings Between Home Runs

- The journal compared Albert Pujol's 2009 MVP season to Mo Vaughn's 1998 MVP runner-up season
- It seems as if Vaughn hit home runs at a more consistent rate than Pujols
- 2 histograms were created to compare the 2 slugger's "streakiness"



Statistical Test of Streakiness

- To test for streakiness, Jim Albert used a Bayes factor
  - $BF_{SC} = P(data \mid M_S) / P(data \mid M_C)$
- If BF < 1, the player hits home runs at a more consistent rate
- If BF > 1, the player hits home runs at a more streaky rate

Statistical Test of Streakiness

- Albert Pujols' BF = 3.6
- Mo Vaughn's BF = 0.39
- These statistics made it easy to conclude that Pujols hit home runs at a more streaky pace than Vaughn

Works Cited

- Albert, Jim. "Streakiness in Home Run Hitting | CHANCE." Streakiness in Home Run Hitting | CHANCE. CHANCE, 24 Sept. 2014. Web. 06 Oct. 2014. <http://chance.amstat.org/2014/09/streakiness/>.

Multi-Tiered Playoffs and Their Impact on Professional Baseball

Nate Engleka

Background

- In 1995, the structure of MLB playoffs was changed from a best-of-seven divisional series to a two-tier playoff system before the world series. The first tier is a best-of-five divisional series with the addition of a wild-card, followed by a best-of-seven series and then the world series.

Findings in journal

- Longer playoff series favor the team with the better record. This decreases the likelihood of an upset.
- The wildcard series (best-of-five) added onto the divisional series decreases the chances of the better team winning, which increases the likelihood of an upset.

Is this fair?

- The previous two factors tend to cancel each other out. Is this fair for the best team?
  - No
- A structure where the best team plays another good team first (best-of-five series) and then a worse team second (best-of-seven series) would be the most "fair" in terms of probability.

Conclusion

- Statistically speaking, the current playoff structure discourages the best team making it to the world series. This, however, assumes independence between games, but in the real world factors such as injuries, home-field advantage, and players hitting hot streaks all affect each game. This makes the results less credible.

Citation

- Boronico, Jess S. "Multi-Tiered Playoffs and Their Impact on Professional Baseball." *The American Statistician* 53.1 (1999): 56-61. Web.

Are Histograms of Human Height Bimodal?

Kylie Krout
PSU 016
10/8/14

Appearance

- Usually appear bimodal due to the mixing of the histograms of men and women's height
- Individual histograms have normal distributions with similar variances
- Mixture of two normal distributions can only be bimodal if their means differ by more than the sum of the standard deviations

Test

- Government data from a National Health and Nutrition Examination Survey was used to construct an approximate theoretical density function for the mix of populations
- Ages ranged from 20 – 29
- Clearly not bimodal

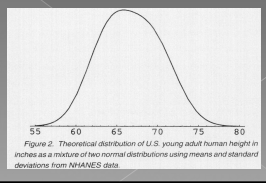


Figure 2. Theoretical distribution of U.S. young adult human height in inches as a mixture of two normal distributions using means and standard deviations from NHANES data.

Human Height is not Bimodal

- Many textbooks use human height as an example of bimodality
- Mixing groups can only create a bimodal histogram if ones support doesn't overlap the other's mode.
- Two standard deviations between the means is needed.

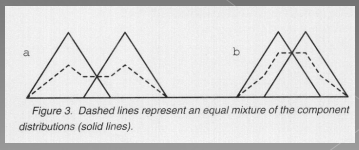
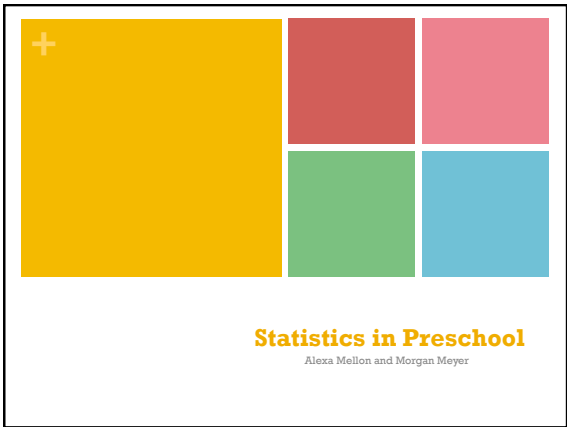


Figure 3. Dashed lines represent an equal mixture of the component distributions (solid lines).

Citations

- Schilling, M. F., Watkins, A. E., & Watkins, W. (2002). Is human height bimodal? *The American Statistician, 56*(3), 223-229. Retrieved from http://search.proquest.com/docview/228462538?accountid=13158



Statistics in Preschool

Alexa Mellon and Morgan Meyer

Intro

- The curriculum of grades K-12 often encompasses basic statistical concepts, starting as early as the kindergarten level.
- Kindergarteners are often taught how to collect data via simple tasks such as logging daily weather conditions or types of fruit utilizing frequency bar charts.
- According to Child and Family Studies Laboratory teachers at Brigham Young University, children possess a natural curiosity and by incorporating statistical projects in their pre-K curriculum, they will be more apt to pose and explore their questions.

Natural Curiosity

- The BYU preschool curriculum focuses around the central concept that children have a natural curiosity that should be directly incorporated into the curriculum.
- Instead of the traditional unit-based curriculum approach, teachers at BYU utilize a unique project-based approach allowing students to develop their curiosity to its full potential.
  - Ex. Survey work, a "Question of the Day" and experiments are used
- Children are taught how to pose questions to increase knowledge, define operational terms, summarize responses via tally or bar chart, observe variation in responses, develop interview skills, and test surveys.

What is the "Question of the Day"?

- The "Question of the Day" is a "one-question survey at the start of each class and is possibly the most popular activity in the BYU preschool."
- In the BYU preschool, there is a head teacher, a graduate student, and 5 undergraduate assistant teachers.
  - Every morning, the head teacher greets the class and poses the question of the day.
  - The question typically has a binary response.

"Question of the Day"

- By using large, children-friendly visuals and the students respond by writing their names on a poster board in the correct columns.
- Later in the day, as a class, the teachers and children organize and interpret the collected data from the day's question.
- Through the "Question of the Day", students learn skill such as how to pose a question, how to define operational terms, how to tabulate the responses, and how to observe variation in the responses.
- This allows students to better understand the concept of a question.

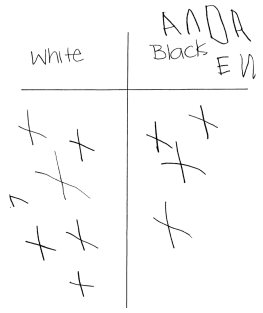
What is Learned

- Preschoolers begin to grasp a deeper understanding and reinforce the pattern of the structure of a question in their schema.
- Children also learn the importance of defining the terms in a question by learning that different words mean different things to different people.
  - Ex. The term "pet" may refer to a domestic animal such as a cat or dog to some but may refer to a farm animal such as a horse or cow to others.
- Children also learn to recognize that the numeral associated with the tally for each response summarizes the class opinion.

Survey Work

- Collecting data is something that children can comprehend very well.
- With BYU, kids are split up into small groups and given a question.
- They get various materials and the kids approach students and ask their question.
  - They tally the response of each individual.

Example Tally Sheet of One Child



What is Learned

- Children learn how to ask good questions
- Gain interview skills
- Learn how to represent responses using charts and tallies
  - They make bar charts and write the number that matches the number of tallies that they collected.
- In addition, the questions are based off of what the kids are learning in class.
  - For example, if they are learning about colors the question may be, "Do you like blue or pink?"

Citation

- Hilton, Sterling C., Scott D. Grimshaw, and Genan T. Anderson. "Statistics in Preschool." *The American Statistician* 55.4 (2001): 332-36. Web. 7 Oct. 2014.

Chance: A Curveball Index

Eric Kramer

Summary

- A means of comparing pitchers based on their fastball exists (speed), but no such basis for comparison exists for curveballs, breaking balls among them.
- Found basis for comparison by summing together 4 key components of a breaking ball pitch.
  - Breaking point (+)
  - Total break (+)
  - Rise (-)
  - Knee distance (-)
- Had a pitching coach rate each variable on a scale of 1-100 instead of having a batter simply try to hit the ball (experimental>observational).

Analysis

- By using a regression model, coefficients that determined the importance of each individual variable were calculated.
- Equation:
  - rating = 2.51rise + 1.88breakpoint – (0.47knee_dist + 0.51total break (1))
- R^2= 73%
  - Meaning that 73% of the rata could be accounted for by the variables present.
- Additional variables such as speed could be added to increase R squared value, but model not entirely final as of yet.
- Citation:
  - Greiner, Jarvis, and Jason Wilson. "A Curveball Index: Quantification of Breaking Balls for Pitchers | CHANCE." A Curveball Index: Quantification of Breaking Balls for Pitchers | CHANCE. 24 Sept. 2014. Web. 8 Oct. 2014.

Waiting Time and Expected Waiting Time

Paradoxical Situation

By V.C. HOMBAS

Waiting Time and Expected Waiting Time By V.C. HOMBAS

- Two players choose different triplets
- Penny flipped repeatedly until one wins

HHH V.S. THH

- The probability of HHH appears at the start?
- The probability of THH appears at the start?
- The probability of T precedes HH?

The possible outcomes of flipping a fair coin for 3 times.

HHH	HHT	HTH	HTT
TTT	TTH	THT	THH

Reference

- Hombas, V. (1997). *Waiting Time and Expected Waiting Time-Paradoxical Situations*. The American Statistician, 51(2), 130-133.

"The North Carolina Lottery Coincidence" -Leonard A. Stefanski

Ryan Williams

Stefanski, Leonard A. "The North Carolina Lottery Coincidence." The American Statistician 62.2 (2008): 130-34. Web. 7 Oct. 2014. <http://www.jstor.org/stable/27643990?seq=1>.

Coincidence?

- Reporter asked statistician the odds of the same numbers coming up twice in the lottery within 3 days, an event that had just occurred.
- Similar to the birthday problem, the chances are higher than expected, 1/191,919.
- Then explained how the real question would be the chances of the same numbers coming up in a short enough time for people to notice.

# Days (k)	Probability (p_k)	Approximately one in ...
2	1.737e-006	575,757
3	5.211e-006	191,919
7	3.647e-005	27,417
31	0.0008073	1,239
258	0.05596	18
365	0.1090	9

The Reporter's Viewpoint

- The reporter then asked the odds of herself winning the lottery twice with her set of lucky numbers. The chances were obviously much higher.
- The odds of this happening depend on perspective.
- If you look across a large time span and all lotteries, then it is not that rare to have repeat numbers winning.

"Statistics in the News"

By: Jean-Francoise Piante & Nancy Reid, 2011, Vol 65, Issue 2.

By: Vicky Hsu

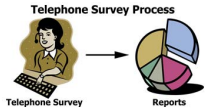
PSU016 Seminar

Classroom Activities

- **Some students good at math, some not. Different variety of students.**
- **Each week students receive handout w/ required reading/sections of articles & homework.**
- **Read background material on probability or graphical displays, asked to start finding headlines to relate to one of these topics**
- **"Question of the week" = Students ask questions**

Article Example I

- "Welfare recipient fun jobs, study says…"
- Article has: Specific surveying
- Students: Raised the alarm it's difficult to find homeless people using telephone surveys.

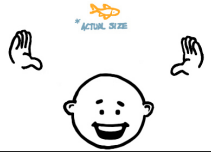


Article Example II

- "Can chocolate save your life?"
- Article:
  - » Sample of 20 study subjects.
  - » Study subjects run for three weeks.
- Students: Concluded after analysations, article unlikely to generalize very well with what's given.

In Conclusion

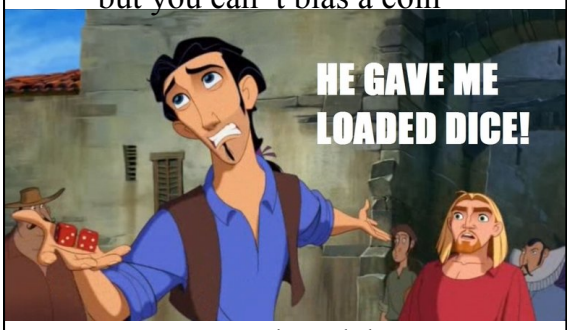
- Classroom activities help student engage. Stimulates brain.
- **"Many newspaper articles, and especially their headlines, are overstated, and after reviewing several dozen of these and pointing out the inevitable caveats, a rather gloomy picture tends to emerge."**



Citation

- Jean-François Plante & Nancy Reid (2011) Statistics in the News, The American Statistician, 65:2,
- 80-88, DOI: 10.1198/tast.2011.11018

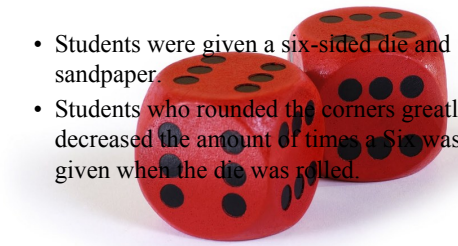
"You can load a die but you can't bias a coin"



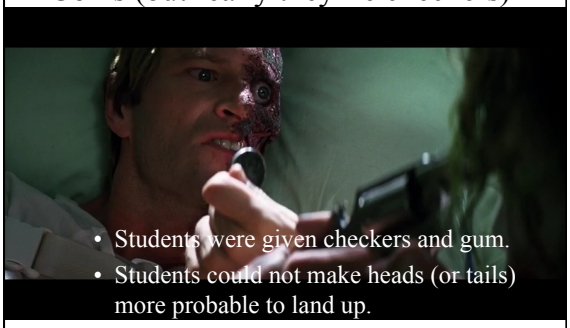
Noah Krechel

Dice

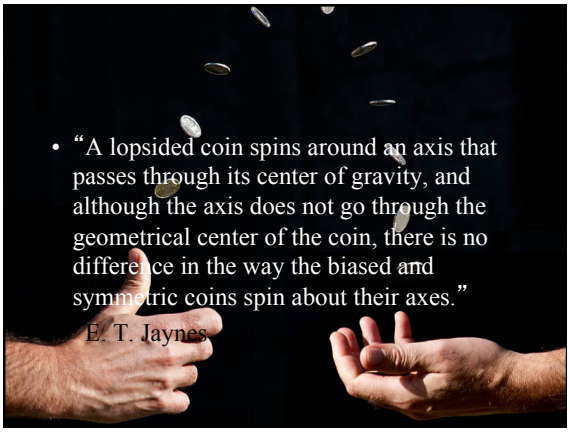
- Students were given a six-sided die and sandpaper.
- Students who rounded the corners greatly decreased the amount of times a Six was given when the die was rolled.



Coins (but really they're checkers)



- Students were given checkers and gum.
- Students could not make heads (or tails) more probable to land up.



- "A lopsided coin spins around an axis that passes through its center of gravity, and although the axis does not go through the geometrical center of the coin, there is no difference in the way the biased and symmetric coins spin about their axes."

  E. T. Jaynes

Bibliography

- Gelman, Andrew, and Deborah Nolan. "The American Statistician." *The American Statistician* 56.4 (2002): 299. Web. 7 Oct. 2014.
- "Harvery Dent" http://nitinvisualeffects.blogspot.com/p/binary-opposition_07.html
- "He gave me loaded dice" http://www.funnyjunk.com/funny_pictures/1150411/Loaded/
- "Coin flipping" http://sciencelens.co.nz/2012/06/01/flip-a-coin-day/
- "Rounded-edge dice" http://genius.com/KyoCross

Statistical Sleuthing by Leveraging Human Nature: A Study of Olympic Figure Skating

Emily Quick

Overall Idea

- Olympic Skating scoring system kept secret
- Trying to figure out scoring system
- Two ideas
  - Accidental randomization?
    - Separate panels of judges for each skater
  - Intentional permutation?
    - Common panel of judges

Actual Statistics

- H_0 **: accidental randomization theory** *(separate judging subpanels selected randomly for each skater)*
- H_A **: intentional permutation of scores** *(common randomly selected judging subpanel for every skater)*

Methodology

- Using Cramèr von-Mises and Kolmogorov tests
- A whole bunch of equations I don't recognize
  - Statistically significant results, reject the null

Conclusion

- Intentional permutation used for scoring skaters in 2010 Winter Olympics
- Results in unbiased scores, ISU (International Skating Union) rules still upheld

References

John W. Emerson & Taylor B. Arnold (2011) Statistical Sleuthing by Leveraging Human Nature: A Study of Olympic Figure Skating, The American Statistician, 65:3, 143-148

The Blindside Project: Measuring the Impact of Individual Offensive Linemen

BY BENJAMIN ALAMAR AND KEITH GOLDNER

By Zach Ricci

Purpose

- In 2010, Tom Brady won MVP.
- Guard Logan Mankins missed the first half of the year, and Brady's numbers were so much better with him on the field.
- How much do individual guards affect quarterback play?

Procedure

- They collected binary variables such as completion, sack, interception, designed screen play, designed roll out, and forced to scramble outside of the pocket.
- They also recorded distance and time of passes, as well as time in the pocket.

Conclusions

- The data analysis shows a very significant link between offensive linemen and a team's passing game.
- There is close enough of a relationship that you can actually put an exact number of improvement that you can expect if you switch certain linemen.
- Teams could evaluate their individual linemen easier.

Works Cited

- Alamar, B., & Goldner, K. (2011). The blindside project: Measuring the impact of individual offensive linemen. *Chance, 24*(4), 25-29. doi:http://dx.doi.org/10.1007/s00144-011-0036-3

America is Changing and So is the Census: The American Survey

By: Jonathan Liu

American Community Survey (ACS)

- The basis for the ACS, continuous measurement, originated with Leslie Kish in 1981.
- Continuous measurement emerged as the basis for a more cost-effective plan to provide more current data.
- The plan was to use Leslie's rolling-sample concept to replace the current decennial census.
- ACS came into action in 1995.

American Community Survey (ACS)

- Full implementation of the ACS began in 2005 for the population living in housing units (HUs). A HU is a house, apartment, mobile home, group of rooms, or a single room occupied as separate living quarters or intended for occupancy as separate living quarters.
- The ACS expanded to include people living in group quarters (GQ) facilities in 2006. GQ facilities are places where people live or stay that are normally owned or managed by an entity or organization providing housing and/or services.

Continuous measurement

- Continuous data collection every day of the year using mailout, telephone (CATI), and personal interviews (CAPI).
- 12 monthly samples with each sample taking 3 months to collect data.
- Data collection overlaps, with samples always being in one of the 3 data collection phases.
- Response rates have been at 95% each year.

Issues with ACS

- Although the ACS is a highly effective and accurate survey, there are external problems with it.
- Funding.
- Additional resources needed to store and update data
- Legitimacy- it has been mostly unknown.
- Period estimates- period of 1, 3, or 5 years for different population sizes.

ACS Data Products and Other Uses

- Two broad categories -aggregated data products and Public Use Microdata Sample (PUMS) data.
- Base tables - 1,200 different tables that contain basic distributions of demographic, social, economic, and housing characteristics.
- PUMS- information collected on each individual and household is released
- Other data uses include language, schools, disability.

Bibliography

America is Changing, and So is the Census: The American Community Survey

Nancy K. Torrieri

The American Statistician

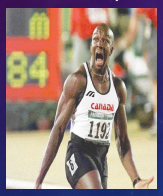
Vol. 61, No. 1 (Feb., 2007), pp. 16-21

Published by: Taylor and Francis, Ltd. on behalf of the American Statistical Association

Stable URL: http://www.jstor.org/stable/27643832

THE RACERS

Donovan Bailey



Michael Johnson

SPEED CURVES

Bailey

- Previous WR in 100m dash
  - 9.84 seconds
  - Reaction time: +.174 seconds

Johnson

- Previous WR in 200m dash
  - 19.32 seconds
  - Time at 100m: 10.12 seconds
  - Reaction time: +.161 seconds

KELLER MODEL

- 1973: Model for competitive running
  - Predicts velocity curve for a sprinter using resources in optimal way
    - F(t) is force per unit at time t
    - V(t) is velocity, r is daming coefficient
    - Newton's Second Law
- Bailey estimated for 13.97 s and Johnson estimated for 15.00 s
- DOES NOT TAKE INTO ACCOUNT THE CURVE IN THE 200M DASH

$$f(t) = \frac{dv(t)}{dt} + \frac{v(t)}{\tau} \quad (1)$$

$$v(t) = F\tau(1 - e^{-t/\tau}). \quad (2)$$

$$D(t) = F\tau^2(t/\tau + e^{-t/\tau} - 1). \quad (3)$$

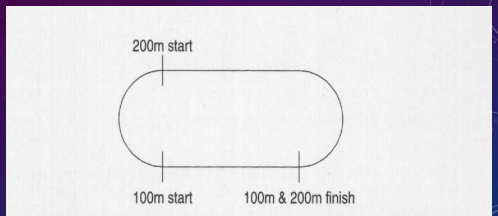


Figure 7. The Sprint Track, Showing Start and Finish Lines for the 100 and 200 meter Races.

Table 3. Official Times at Given Distances for Bailey; The "?" Indicates a Suspicious Time, Later Found to be in Error

Distance (m)	0	10	20	30	40	50	60	70	80	90	100
Original time (s)	.174	1.9	3.1	4.1	4.9	5.6	6.5	7.7?	8.2	9.0	9.84
Corrected time (s)	.174	1.9	3.1	4.1	4.9	5.6	6.5	7.2	8.1	9.0	9.84

Table 4. Estimated Times at Given Distances; Bailey Starts at the 100 m Mark; "+" Denotes Distance Past 100 m: For Example, "+12.9" Means 112.9 m

Distance (m)	0	50	100	+12.9	+40.3	+49.4	+67.7	+76.9	+86.0	+100
Bailey:	.174			2.8	5.0	5.7	7.0	7.8	8.5	9.84
Johnson:	.161	6.3	10.12	11.4	14.0	14.8	16.2	17.0	17.8	19.32

Table 5. Comparison of Official and Estimated Interval Times for Bailey

Distance (m)	0	10	20	30	40	50	60	70	80	90	100
Official	.174	1.9	3.1	4.1	4.9	5.6	6.5	7.2	8.1	9.0	9.84
Estimated	.174	2.1	3.4	4.3	5.1	5.7	6.4	7.2	8.0	8.9	9.84

Table 6. Estimated Times (seconds) for Johnson for Distances over 100 m

	100	110	120	130	140	150	160	170	180	190	200
Johnson	10.12	11.10	12.09	13.06	13.97	14.83	15.61	16.40	17.26	18.23	19.32

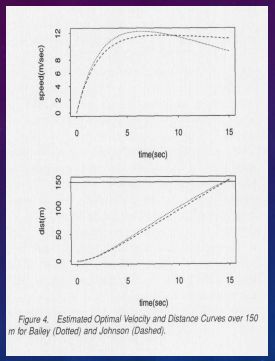


Figure 4. Estimated Optimal Velocity and Distance Curves over 150 m for Bailey (Dotted) and Johnson (Dashed).

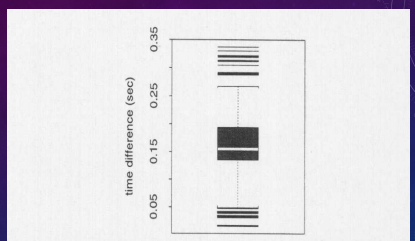


Figure 6. Boxplot of Johnson's Minus Bailey's Predicted 150 m Times from 1,000 Bootstrap Replications.

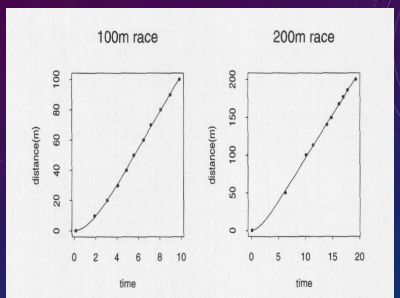


Figure 3. Estimated Distance Curves and Actual Distances (Points) from Least Squares Fit of Model (4).

CONCLUSION

- *It is not fair to compare the average speeds (higher for Johnson) because the start is the slowest part of the race, and Johnson had to start only once.
- *Bailey appeared to achieve a higher maximum speed, although the difference in maxima was not statistically significant
  - Johnson maintained a very high speed over a long time interval.
- Predictions from an extended version of Keller's optimal running model suggest that Bailey would win a (straight) 150 m race by .09 s.
  - However, they do not account for the fact that Johnson's times are based on a curved initial 100 m.
- Whose performance was more remarkable? Here, Johnson has the clear edge:
  - Johnson's winning margin over the second and third place finishers (the same runners in both races!) was much larger than Bailey's, and was the second largest in any Olympic 100 or 200 m final race.

MY CONCLUSION

Usain Bolt is fastest

- Article is as old as I am
- Times have gotten faster
- WR for 100m and 200m
- "If Queen Elizabeth knighthooded me and I would get the title Sir Usain Bolt. That sounds very nice." – Usain Bolt

CITATION

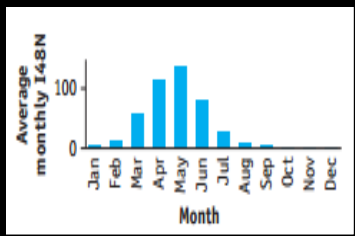
- Tibshirani, Robert. "Who Is the Fastest Man in the World?" The American Statistician 51.2 (1997): 106-11. RoQuest Social Sciences Premium Collection. Web. 7 Oct. 2014.

Overview

- Was the Titanic's sinking unlucky or exceptional?
- Typically blamed on human error
- Three main factors Titanic iceberg:
  - Time of year
  - Unusual spike in ice
  - Unusual weather co

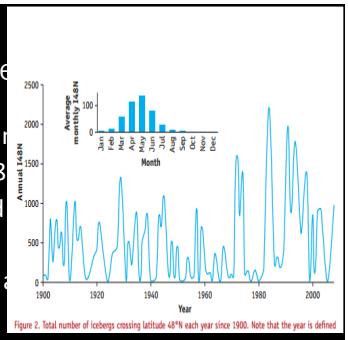
Time of year

- April 14th, 1912
- Increased risk from April to June.
- Crossing 48 N



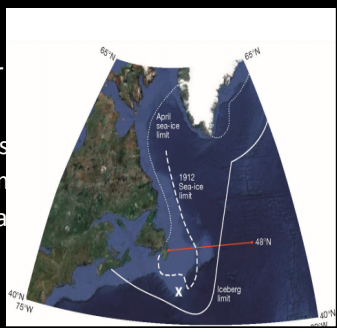
Unusual spike

- 1038 icebergs i 1912 crossing 48
- Only happened before
- Titanic iceberg a 41N



Unusual Weather

- Many weather Conditions factor Iceberg travel.
- Drove icebergs s
- Titanic iceberg n Further south tha usual



Conclusion

- Three unfavorable factors in titanic iceberg:
  - Time of year
  - Weather
  - Spike in icebergs
- It was unlikely for all of those factors to be present

Citation

- Bigg, Grant. ""The Iceberg Risk in the Titanic Year of 1912 Was It Exceptional?"" *Significance* July 2014: n. pag. Web. 7 Oct. 2014.

P-Value Precision and Reproducibility

Bobby Newman

P-Value

- Probability that getting a result that extreme if the null is true

Reproducibility

- P-Value .00001 .0001 .001 .005 .01 .05 .10
- RP .99 .97 .91 .8 .73 .5 .38

A tad confusing

- RP=power(Mua)=1-Ft,n-1,ncp(Ft-1,n-1(1-gamma))

Citation

Dennis D. Boos & Leonard A. Stefanski (2011) P-Value Precision and Reproducibility, The American Statistician, 65:4, 213-221, DOI: 10.1198/tas.2011.10129

Qualifying Times for the Boston Marathon

Zach Damiano

Problem

- Community of Boston Marathon runners continues to grow
- Set a competitive qualifying time for runners
- Different genders and ages need different times

Sampling

- Sampled 25 randomly selected competitive races, took a 95% confidence interval
- Found the average time to finish those races
- Split up gender and age to find new qualifying time for Boston Marathon

Solution

- Reduced qualifying time by 5 minutes 59 seconds for all categories
- Should have a 33% decrease in entrants
- 2014 Marathon had 32,458 starters and 31,926 finishers, the second largest Boston Marathon

Using Exam Scores to Estimate the Prevalence of Classroom Cheating

- Cheating is a problem in many classes
- Teachers need to minimize this as much as possible
- Other methods
  - Slight changes in test versions (i.e. changing one number in the problem)
  - Include correct answer, answers that could be obtained through errors in work, and completely wrong answers

$n_1(j)$ = number of students with the correct answer for question j,
$n_2(j)$ = number of students with a mistaken solution for question j,
$n_3(j)$ = number of students with the correct answer to the wrong test for question j,
$n_4(j)$ = number of students with a mistaken solution to the wrong test for question j.

$$\theta_1 = \alpha_1 + \alpha_3(\beta p + (1-\beta)q),$$

$$\theta_2 = \alpha_2 + \alpha_3\left(\beta\left[\frac{1}{2} - p\right] + (1-\beta)\left[\frac{1}{2} - q\right]\right),$$

$$\alpha_1 = \theta_1 - \theta_3,$$

$$\alpha_2 = \theta_1 + 2\theta_2 + \theta_3 - 1,$$

$$\beta = \frac{(\theta_1 + \theta_3)(1 - \theta_1 - \theta_2) - \theta_3}{(\theta_1 + \theta_3 - 2p)(1 - \theta_1 - \theta_2)}.$$

- Essentially, by using different versions of tests, teachers can determine the probability that a given student cheated on a test

Kvam, Paul H. "Using Exam Scores to Estimate the Prevalence of Classroom Cheating." *The American Statistician* 50.3 (1996): 238-42. *ProQuest.* Web. 7 Oct. 2014.