

Are Your Randoms **Truly** Random?

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Presented by

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Are your randoms truly random?

Very Important
Points

*We're going
to have three
of them
during the
presentation,
so keep
watching!*



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Talking Points

- Definitions
- Policy Requirements
- Evaluating Randomness
- Looking Beyond The Numbers
- Protecting Your Integrity
- Misconceptions about Randomness
- What you CAN Control: Maximizing Customer Satisfaction



Random (/ˈræŋ dəm/) adj.

- Unpredictable
- Without any discernable system or pattern
- Lacking apparent purpose or cause
- Independent from prior events
- Governed by a formal chance process
- Stochastic (reveals trends)



Our First
Very Important Point

*Reject the common,
everyday usage and
meaning of the word
"random."*

*Adopt a new concept
of "random" that
embraces the
mathematical
definition.*



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Let Policy Be Your Guide

- Workplace / Unregulated
- US Dept. of Transportation

**§ 40.365 (b) ...appropriate grounds for starting a
PIE proceeding.**

**(14) ...(e.g., failure to properly conduct the
selection process for random testing).**



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DOT Regulations

§ 40.347 What functions may C/TPAs perform ...?

- ✓ Operate random testing programs for employers
 - ✓ Combine employees from more than one employer (if permitted by all agencies involved)
 - ✓ Select at the highest rate required
- DO NOT**
- Randomly select from a “Follow-up Pool”
 - Include non-covered employees
 - Use Alternates for FAA randoms



DOT Administrations

“ The selection of employees for random drug testing shall be made by a *scientifically valid method*, such as a *random-number table* or a *computer-based random number generator* that is matched with employees' Social Security numbers, payroll identification numbers, or other comparable identifying numbers. Under the selection process used, *each covered employee shall have an equal chance of being tested each time selections are made.* ”

- FAA: 14 CFR Part 121, Appendix I
- FMCSA: § 382.305 (i)(1,2)
- FTA: § 655.45(e)
- PHMSA: § 199.105 (c)(5)
- USCG: 46 CFR § 16.230 (c)



Federal Railroad Random Drug Testing

- § 219.601(b)(1) Selection of covered employees for testing must be made by a method employing objective, neutral criteria which ensure that every covered employee has a substantially equal statistical chance of being selected within a specified time frame. The method may not permit subjective factors to play a role in selection, i.e., no employee may be selected as the result of the exercise of discretion by the railroad. The selection method must be capable of verification with respect to the randomness of the selection process, and any records necessary to document random selection must be retained for not less than 24 months from the date upon which the particular specimens were collected.



More Tidbits From the Register...

§ 382.305 (4) The program must ensure to the maximum extent practicable that each covered employee perceives the possibility that a random alcohol test may be required at any time the employee reports for work and at any time during the duty tour (except any period when the employee is expressly relieved of any responsibility for performance of covered service).

§ 655.45 (g) Each employer shall ensure that random drug and alcohol tests conducted under this part are unannounced and unpredictable, and that the dates for administering random tests are spread reasonably throughout the calendar year. Random testing must be conducted at all times of day when safety-sensitive functions are performed.



An Experiment

- **Were the winners selected by using a random method?**
- **Was the selection unannounced and unpredictable?**
- **Can everything we did be verified?**
- **Did everyone in the pool have an equal chance of being selected?**

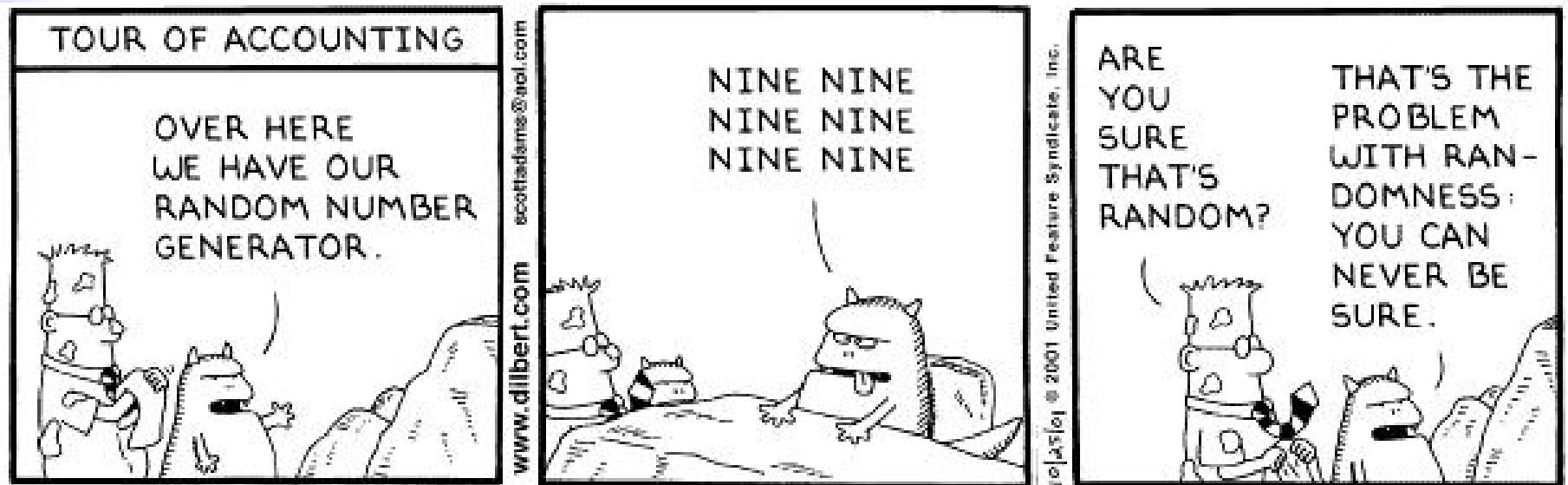


Methods of Random Selection

- **“True Random Numbers” come from a chaotic natural source**
 - Nuclear Decay (“HotBits”)
 - Atmospheric Noise (“random.org”)
 - Brownian Motion (“LavaRand”)
- **“Pseudorandom Number Generators” effectively simulate random numbers**
 - Linear Congruential Algorithms
 - Mersenne Twister
 - MS CAPI



Attitudes and Expectations



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Expressing Probability and Odds

- Describe the likelihood that a national holiday will fall on a Monday or Friday.

Mathematical Probability

- Always lies between 0 and 1
- Impossible=0
- Guaranteed=1

“Two in Seven”

$$\frac{2}{7}$$

$$\frac{28.6\%}{0.285714}$$

Odds

- Ratio of probabilities
- Used in Bookmaking
- Expression varies by location

“Five to Two *against*”

$$5:2$$

“Two to Five”

$$\frac{2}{5}$$

$$0.\overline{40}$$



Probability of a Simple “Streak”

1/16 0.0625 6.25%



All of these sequences have the same probability!



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“Flipping Out” over Basic Probability

Any sequence

$$1/16 = 6.25\%$$

At least 3 heads

$$5/16 = 31.25\%$$

2 Heads (or Tails)

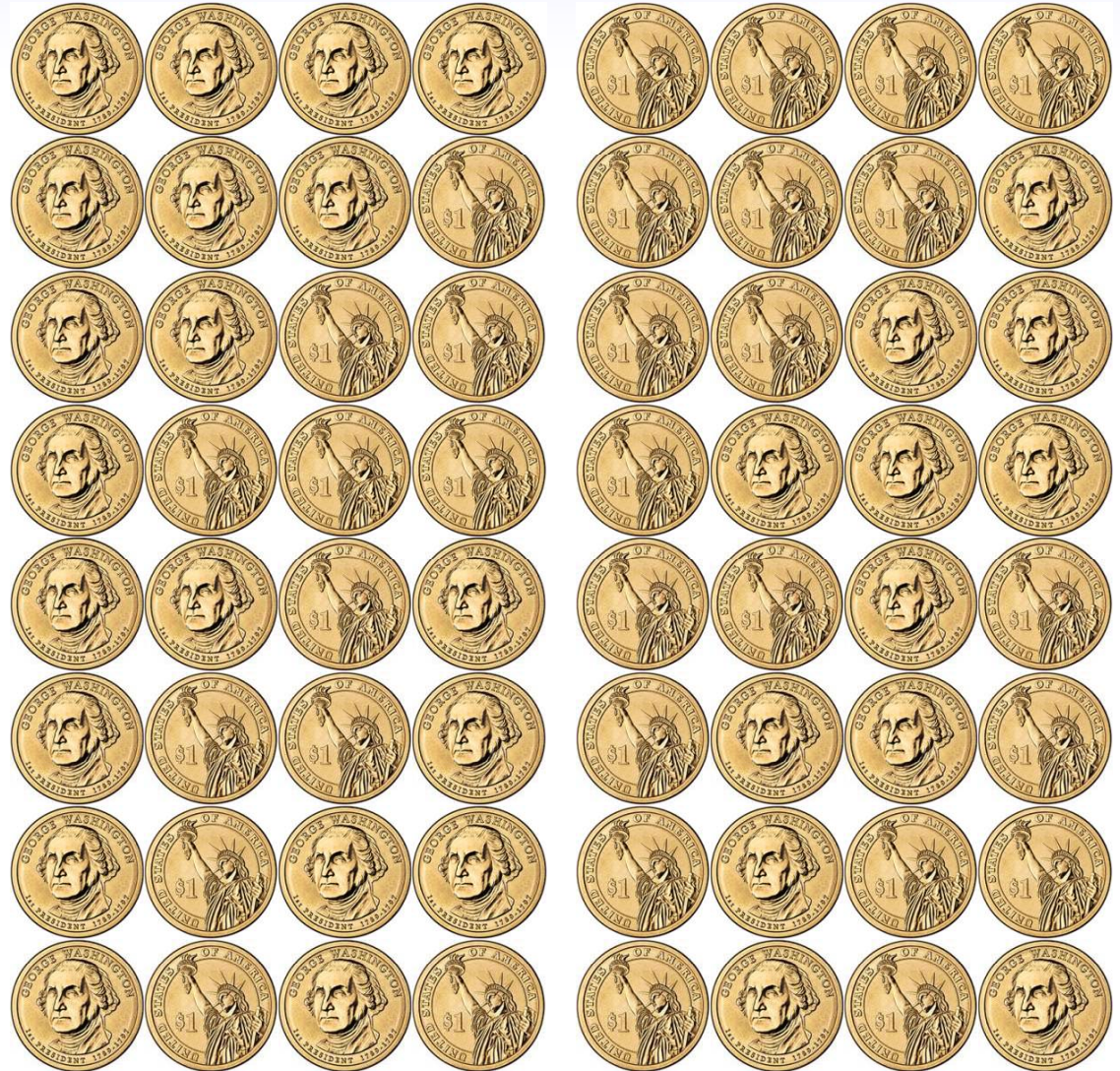
$$6/16 = 37.5\%$$

Run of 3 or more

$$6/16 = 37.5\%$$

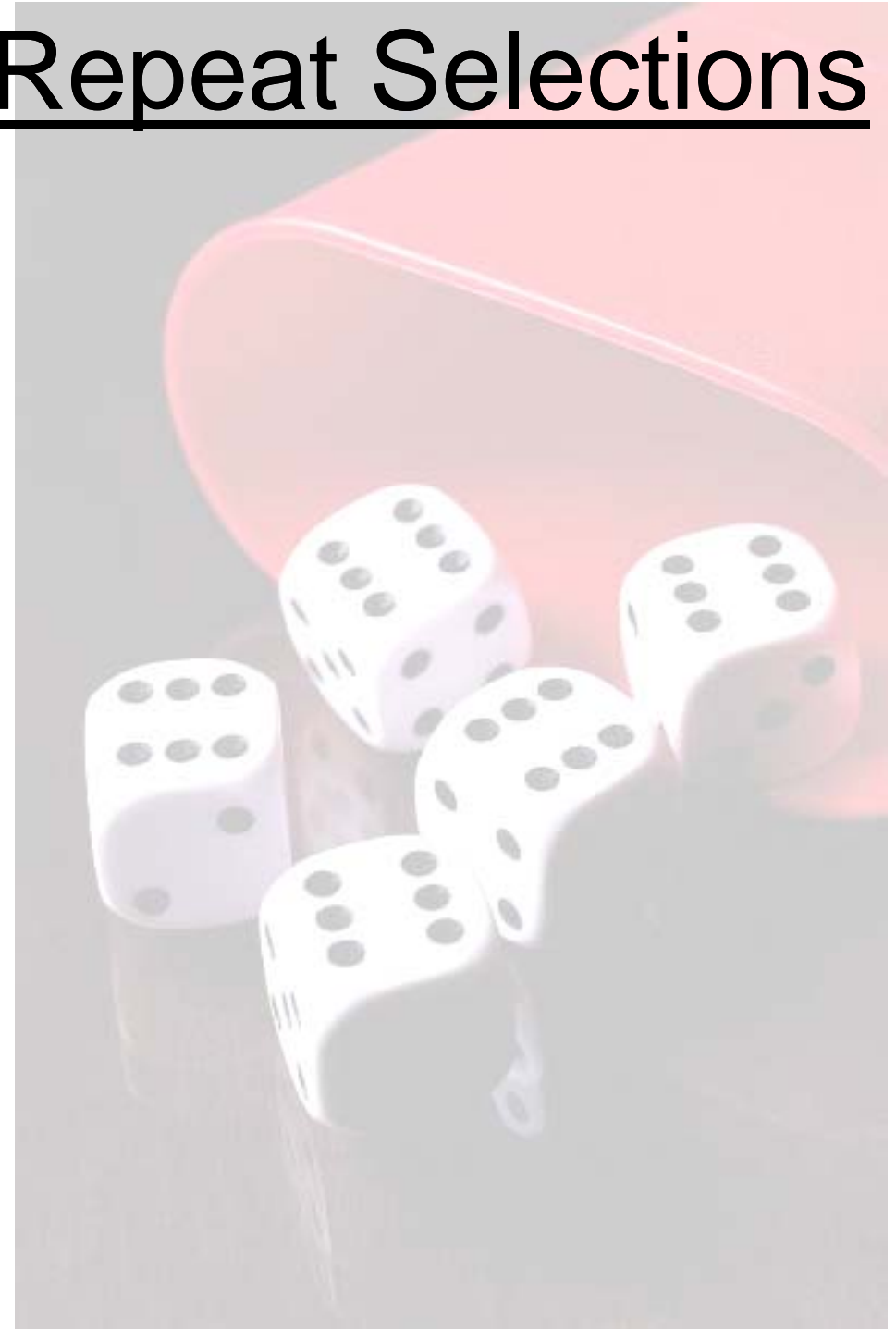
3 or more of same

$$10/16 = 62.5\%$$



Expect Repeat Selections

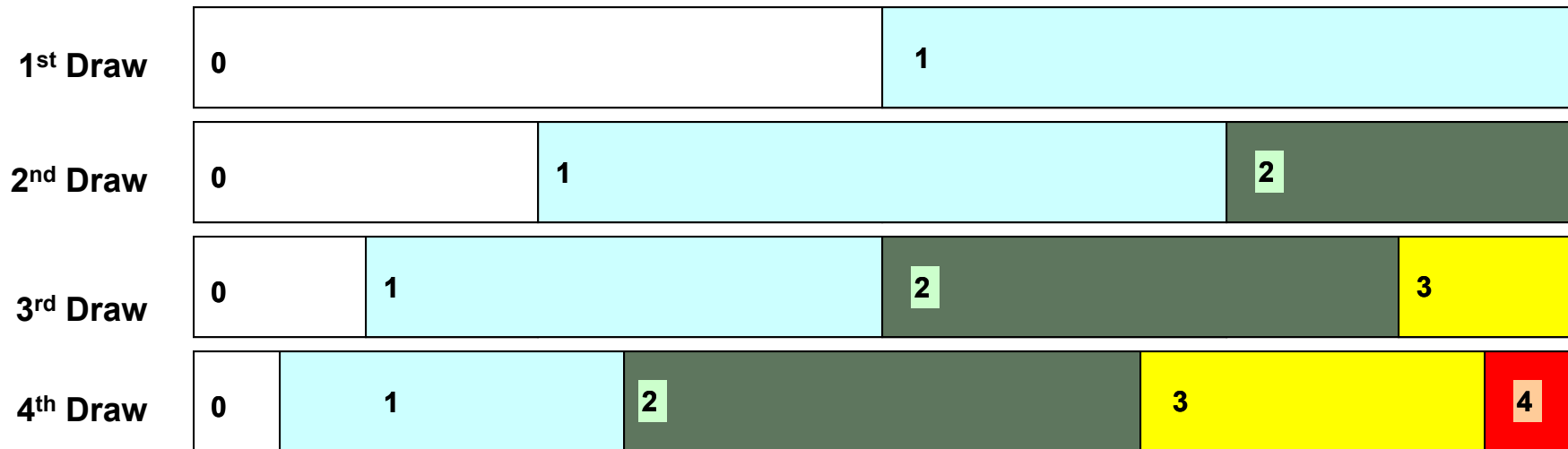
- Remember: Each random selection should be independent of prior selections.
- Repeat selections are desirable!
 - The *perceived* risk of repeat selection deters potential offenders.
 - Repeated selection catches offenders.
- The occurrence of repeat selection is governed by laws of statistical probability.



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Example: Repeat Selections

These bars demonstrate the likelihood of repeat selections in a series of four random draws. A 50% selection rate has been used to emphasize the principles at work.

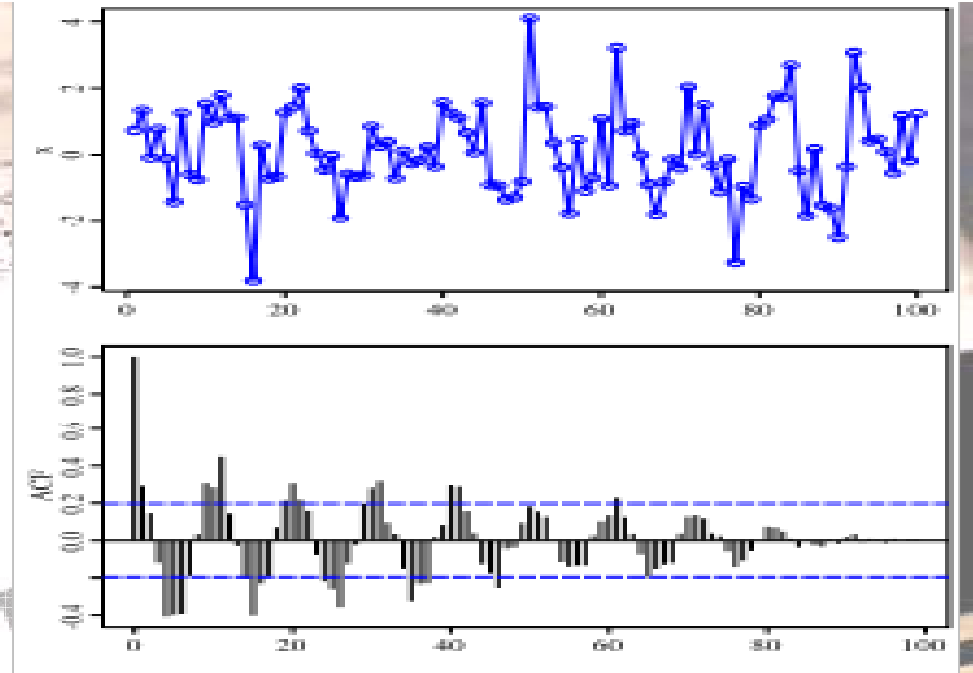


- Lower selection rates will reduce the probability of selection at any given time. However...
- The maximum *possible* number of selections will increase with repeated selections.



How Random Is “*Random Enough?*”

- **Chi-Square Test**
- **Arithmetic Mean**
- **Student’s T-test**
- **Monte Carlo Value for π (pi)**
- **Entropy (Information Density)**
- **Autocorrelation Test**



Calculating the Chi-Square Distribution

$$\sum_{i=1}^k \left(\frac{X_i - \mu_i}{\sigma_i} \right)^2$$

Sharpen your pencils! Dust off your slide rule!



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A man in a brown blazer is pointing at a whiteboard in a lecture hall. The whiteboard contains text about randomness. The background shows a wooden wall with a framed picture and a chandelier.

Our Second Very Important Point

*One cannot
determine
randomness by
looking at a sequence
of numbers or
selections.*

*Randomness can only
be evaluated through
a series of controlled
experiments
conducted by an
expert.*




Looking Beyond the Numbers

- Is the application of randomness theoretically sound?
- Does your random selection system (RSS) allow you to adjust the likelihood of repeat selections?
- Does your RSS track data modifications affecting eligibility and identifiers?
- Can you “fake” it?



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A close-up photograph of a hand with the index finger pointing towards the right, set against a black background. The hand is positioned on the left side of the slide, pointing towards the text on the right.

What is the
greatest danger to
your random
selection program?

It's Been Said...
About Meeting Quotas

“ One of our companies needed an extra dozen alcohol tests to reach the 10% testing rate. [We] pulled 25 to be safe, and we only completed what we needed. So, I have a bunch of tests that will never be performed. What do you recommend? [Classify them as] not-performed, cancelled, or just leave them alone? ”



What Would You Do?

Running Two Selections

- You accidentally perform two "identical" selections for the same quarter.



What Would You Do?

Testing the Doppelgänger

- A random test result comes in from the lab, and you discover that the participant was in your pool twice.



What Would You Do?

Uncooperative Employer

- An employer in a consortium pool consistently fails to send its employees in for testing.



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What Would You Do?

Responses to Repeat Selections

- How do you cope with pressure from an employer who complains about repeat selections?



It's Been Said...

About Achieving the Desired Results

“

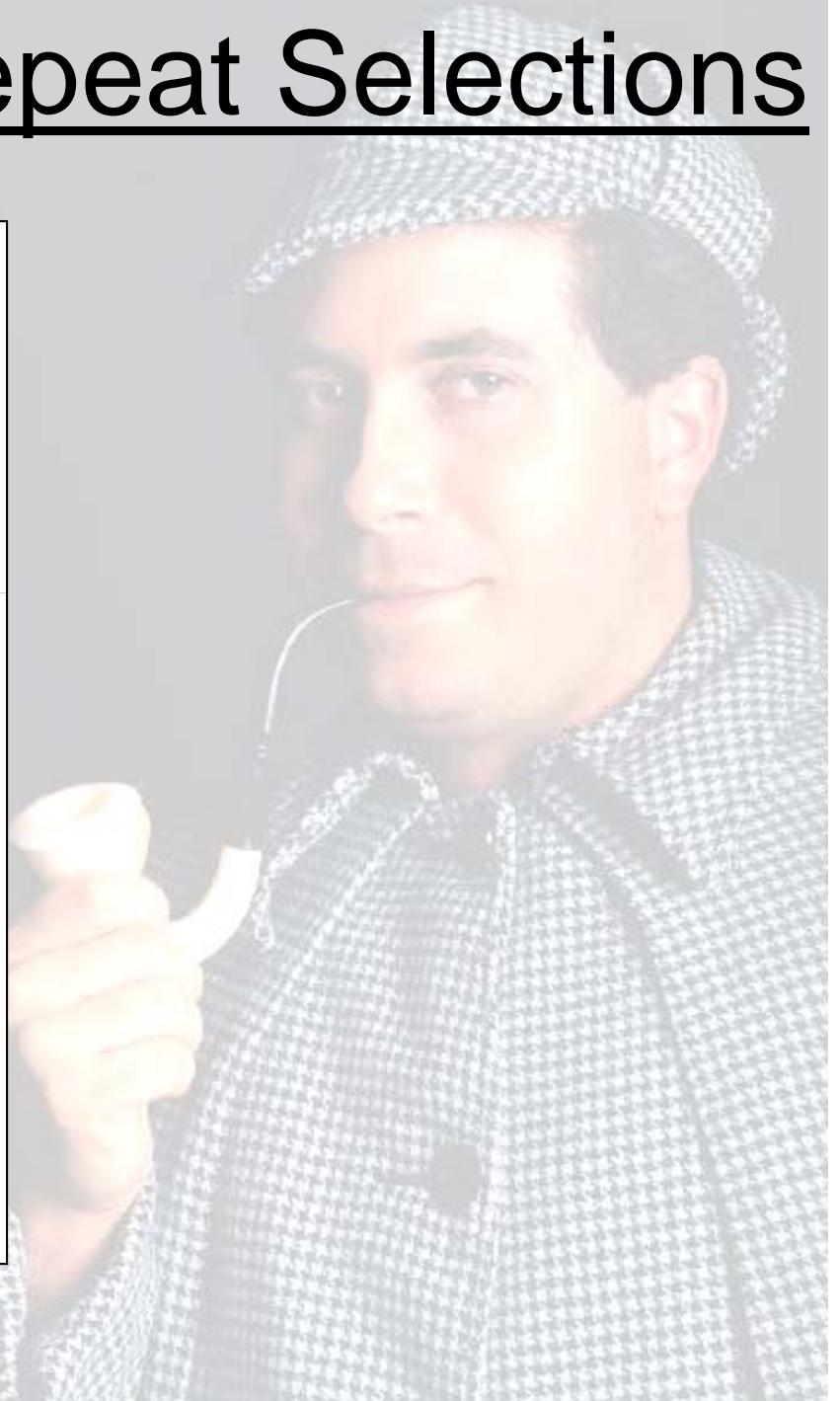
I'll just keep running
and canceling
[random] batches 'til I
get what I want.

”



Investigating Repeat Selections

- Check your system.
 - Duplicates:
 - Similar names
 - Transposed ID's
 - Selection Rates
- Investigate thoroughly.
- Get all the relevant history and facts.
- Discard the irrelevant facts.
- Consider what didn't happen as well as what did.



Misconceptions about Randomness

The Gambler's Fallacy

- The belief that a “streak” affects the likelihood of subsequent events.
 - The streak can be perceived in the occurrence *or non-occurrence* of an event.
- The fallacy arises in believing that probability of a **series of events** *prior to the first event* impacts the likelihood of a **single event** *following a series*.



The Gambler's Fallacy

Probability of predicting 5 heads before the first flip:

$$1/32 = 3.125\%$$



Now pretend we have already flipped four heads:



A gambler operating under this Fallacy might bet heavily
for or against a fifth HEAD.

Actual probability of a 5th HEAD: $\frac{1}{2} = 50\%$



Misconceptions about Randomness

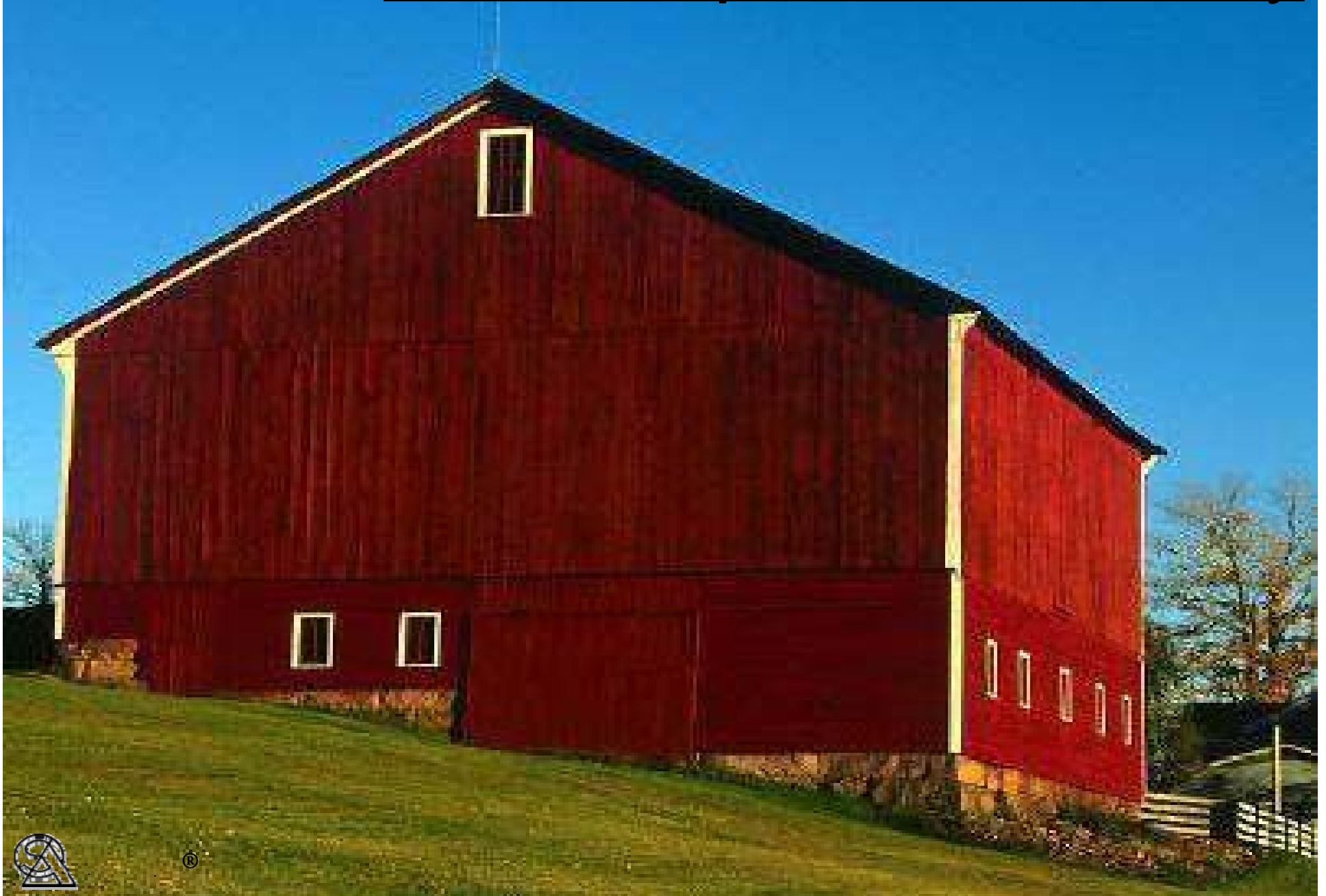
The Clustering Illusion

- The tendency to view all clusters of events as “significant”
- Gained prominence in epidemiology
- A.K.A. “The Texas Sharpshooter Fallacy”



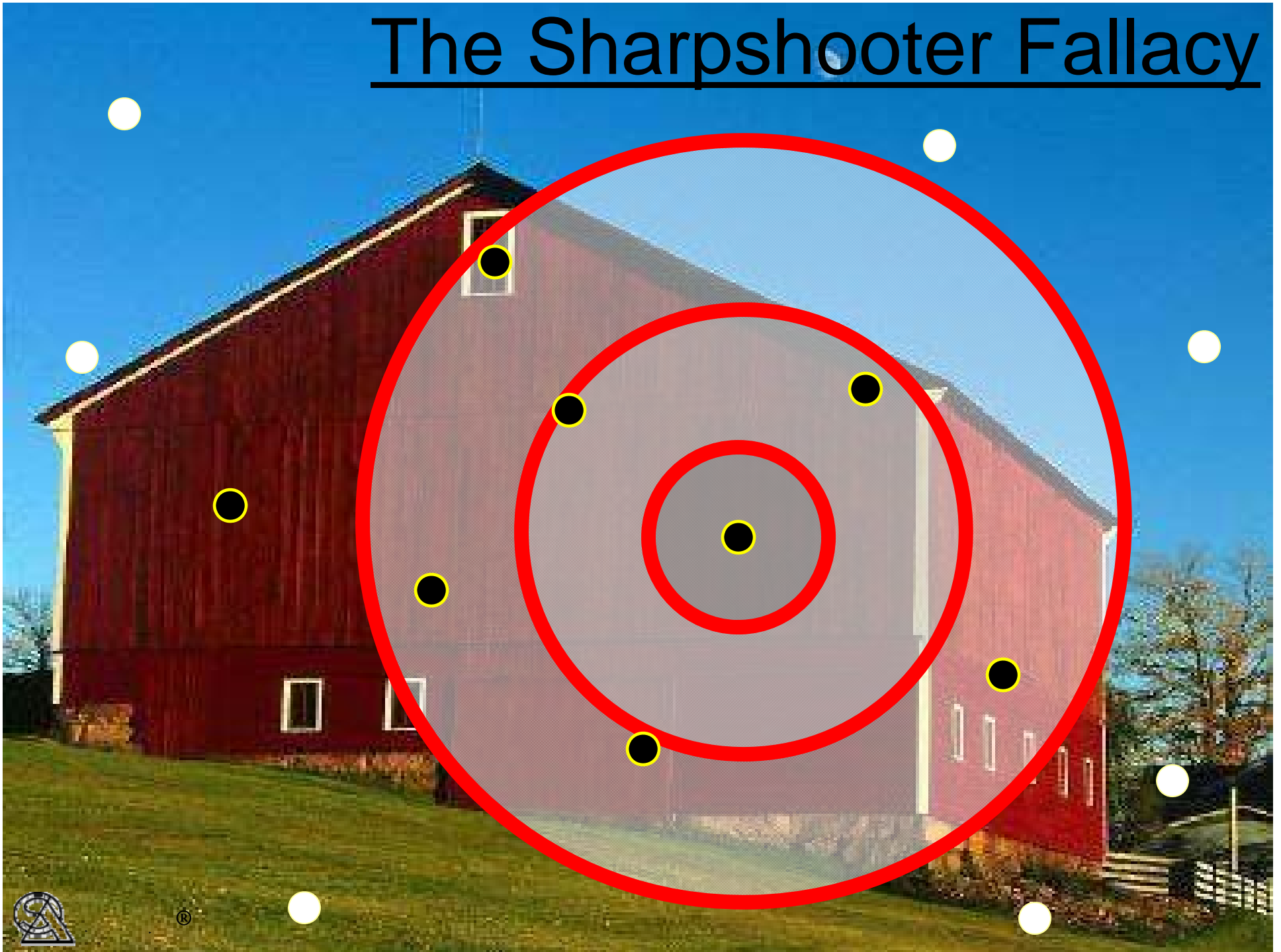
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The Sharpshooter Fallacy



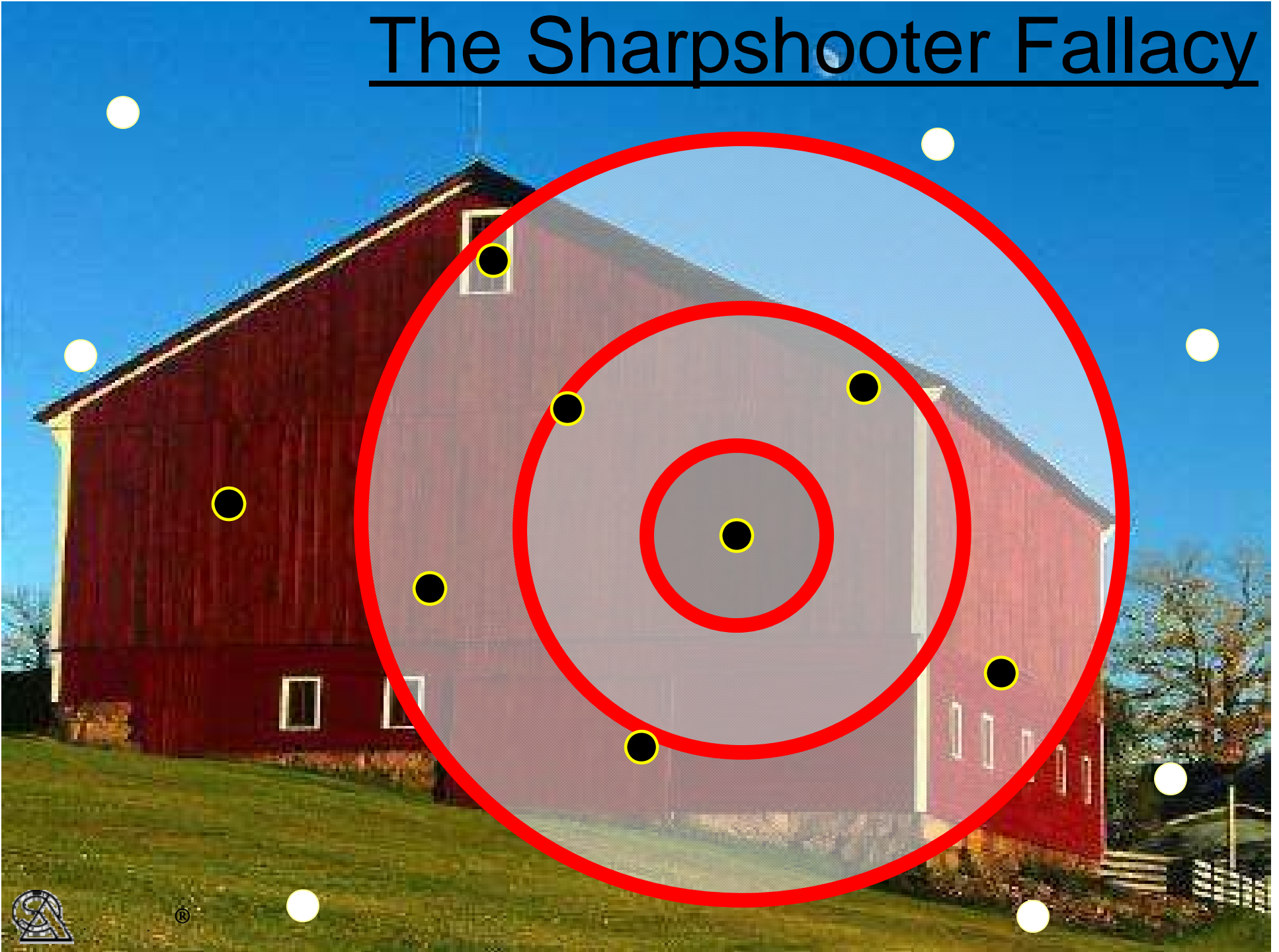
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The Sharpshooter Fallacy



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The Sharpshooter Fallacy



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Misconceptions about Randomness

Belief in “The Law of Small Numbers”

- The fallacy of assuming that the pattern of a large population will be replicated in all of its subsets



“Flipping Out” over Basic Probability

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Other Pertinent Logical Fallacies

- Affirming the Consequent
- Correlation Implies Causation
- Confirmation Bias
- Availability Heuristic
- Regression Fallacy



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What You *Can* Control

- ✓ **Reduce Selection Rate (Don't over-test)**
- ✓ **Reduce Selection Frequency**
- ✓ **Get the rosters accurate *before* the draw**
- ✓ **Minimize your use of alternates**
- ✓ **Isolate Poor Performers**
- ✓ **Counsel your customers and manage their expectations**



Programmatic Integrity



- Do not impose anyone's personal sense of "fairness" [read: "bias"].
- Maintain bulletproof documentation.
- Maintain accurate and timely data.
- Establish clear roles and responsibilities for employer-clients.
- Stay involved!



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*Randomness can only
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a series of controlled
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**Our Third
Very Important Point**

*Stay Involved!
Recognize when someone
is trying to interfere with
the random
process.*

*Their success could
jeopardize your
random programs
and your business.*



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Your Random Selection Program Has Many Moving Parts

- Source of *sufficiently random* numbers
- Valid/Compliant selection *methodology*
- Observation of “best practices”
- Thorough record keeping
- Sound data
- Cooperative clients



Things to Remember

- Random numbers themselves are only a small part of an effective and compliant Random Drug & Alcohol Testing program.
- Let the *Governing Policy* be your guide.
- Minimize repeat selections by reducing selection frequency and selection rates.
- A qualified statistician can evaluate your random selection system, through *controlled experiments*.



Things to Remember

- Manage customer expectations.
- Perform *thorough and systematic* investigation of complaints; look at the big picture.
- Be impeccable! *Resist the temptation to manipulate outcomes.*



On Randomness, Statistics, and Probability

“There are three kinds of lies: lies, damn lies, and statistics.”

Benjamin Disraeli

“There is no direct relation between the truth of a proposition and its probability.”

John Maynard Keynes

“With randomness it is very unlikely to be embarrassed, but even if you get embarrassed, you can't replicate it.”

Carl Pomerance

“Fate laughs at probabilities.”

Lytton Bulwer

“When you have eliminated the impossible, what ever remains, however improbable, must be the truth.”

Sir Arthur Conan Doyle



Learning More

- **Intro to Random Number Generators**

- http://en.wikipedia.org/wiki/Random_number_generator
- <http://random.org/essay.html>

- **Statistical Tests for Randomness**

- http://en.wikipedia.org/wiki/Randomness_tests
- <http://www.fourmilab.ch/random/>
- <http://stat.fsu.edu/pub/diehard/>
- <http://csrc.nist.gov/rng/>

- **Logical Fallacies**

- <http://www.nizkor.org/features/fallacies/>
- http://en.wikipedia.org/wiki/Logical_fallacy
- <http://www.fallacyfiles.org/>



Learning More

- **DOT Drug & Alcohol Testing Policy *per* Randoms**
 - <http://www.datia.org/forums>
 - <http://www.dot.gov/ost/dapc>
 - <http://www.fmcsa.dot.gov/rules-regulations/administration/fmcsr/interp382.305.htm>
 - http://www.faa.gov/about/office_org/headquarters_offices/avs/offices/aam/drug_alcohol/policy/media/200607_Part_40_QnA.pdf
 - <http://www.fra.dot.gov/us/content/523>
 - <http://www.dot.gov/ost/dapc/qanda.html>
 - <http://transit-safety.volpe.dot.gov/Safety/DATesting/Regulations/html/faqs.htm>
 - <http://www.uscg.mil/hq/gm/moa/ctpareview.htm>

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