

2014 Coincidence NNN1 1

## Statistical Literacy: Coincidence

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[www.StatLit.org/pdf/2014-Schild-NNN1-Slides.pdf](http://www.StatLit.org/pdf/2014-Schild-NNN1-Slides.pdf)

Oct 2011 2


## Law of Very-Large Numbers

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Not the same as Law of Large Numbers!!!

Unlikely is almost certain given enough tries.


Given an event: one chance in N.  
In N tries, one event is 'expected';  
\* More likely than not. Schield (2012)




2014 Coincidence NNN1 3


## Coincidence?

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$3.14 \rightarrow \pi$   
 $\pi \rightarrow 3.14$





MOM


WOW

coincidence? I think not!

2014 Coincidence NNN1 4

## The "Birthday" Problem: Chance of a matching birthday

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Richard von Mises (1938)

In a group of 28 people, a birthday match is *expected*.

The trick is to show it, – not just to prove

Try this Excel den

[www.StatLit.org/Excel/2012Schild-Bday.xls](http://www.StatLit.org/Excel/2012Schild-Bday.xls)



2014 Coincidence NNN1 5

## The "Birthday" Problem Math Answer

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If the chance of a rare event is  $p$  and  $p = 1/k$ , then this event is "expected" in  $k$  trials.

In a group of size  $N$ , there are  $(N-1)(N/2)$  pairs.

Solve for  $N(k)$ .  $k = (N-1)(N/2) = (N^2 - N)/2$

Quadratic:  $N^2 - N - 2k = 0$

Estimate:  $N^2 \sim 2/p$ .

Trial and error:  $27^2 \sim 2 \cdot 364$

Q. Are students convinced? No!!!

2014 Coincidence NNN1 6

## 49 Connections: Quadrant 1

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Schield (2011)		RICHARD VON MISES' BIRTHDAY PROBLEM							28 People	
Month	Day	10	11	11	9	4	7	6	Month	Day
		16	18	8	9	13	25	24		
8	20						1		7	25
10	29								8	16
4	11								11	6
3	3								11	29
1	3								8	3
3	30								3	24
10	28								1	15
Month	Day	5	2	6	2	1	7	5		
		28	8	6	12	14	1	25		



2014 Coincidence NNN1 13

### Connections and Chance

Pairs	GROUP	Details
196	Quadrants 1-4	49 pairs each
49	Side-to-Side	
49	Top-to-Bottom	
84	Within each side	21 pairs each
378	TOTAL	


A "birthday" match has one chance in 365.  
 In a group of 28, we have 378 pairs:  $(N-1)(N/2)$ .  
 A match is expected: Match is more likely than not.

2014 Coincidence NNN1 14

### Runs: Flipping Coins

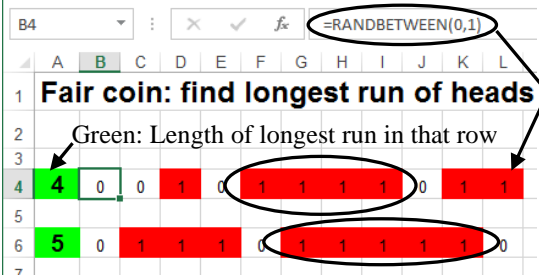
Law of Very-Large Numbers (Qualitative):  
 The very unlikely is almost certain given enough tries

Law of Expected Values:  
 Events with 1 chance in k are "expected" in k tries.



Oct 2011 17

### Flip coins in rows. 1=Heads (Red fill) Adjacent Red cells is a Run of heads.




Fair coin: find longest run of heads  
 Green: Length of longest run in that row

Source: [www.statlit.org/Excel/2012Schield-Runs.xls](http://www.statlit.org/Excel/2012Schield-Runs.xls)

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### Chance of a run of 19 heads: One chance in $2^{19} = 1$ in 524,288



Oct 2011 17

### Consider a run of 10 heads? What is the chance of that?

Question is ambiguous! Doesn't state context!

- Chance of 10 heads on **the next 10 flips**?  
 $p = 1/2$ ;  $k = 10$ .  
 $P = p^k = (1/2)^{10} =$  one chance in 1,024
- What is the chance of *at least* one set of 10 heads [somewhere] when flipping 1,024 sets of 10 coins each? At least 50%.\*

\* Schield (2012)

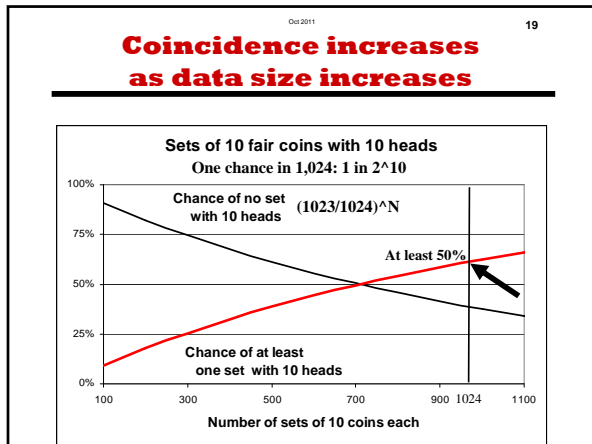
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### Runs in Flipping a Fair Coin

- Unlikely is expected given enough tries.
- Unlikely (1 chance in k) is *expected* in k tries

Run of 6 is expected in 64 tries:  $2^6 = 64$ .  
 Run of 7 is expected in 128 tries:  $2^7 = 128$   
 Run of 8 is expected in 256 tries:  $2^8 = 256$

**k tries = k flips of a coin**



**Michael Blastland's  
*The Tiger that Isn't***

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With rice scattered in two dimensions, people can often see memorable shapes.

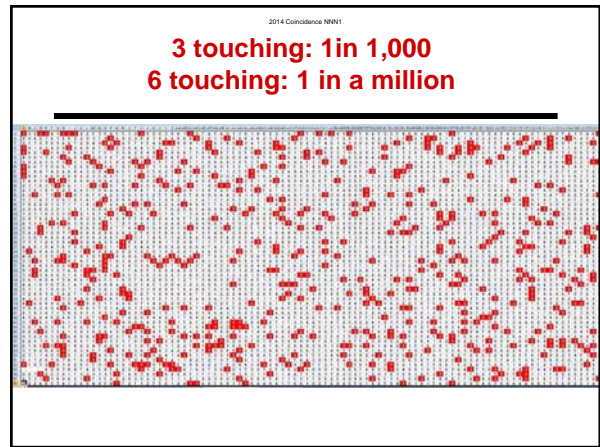
After this webinar, check out this Excel scattered-rice demo with 1 chance in 100 per cell:

[www.StatLit.org/Excel/2012Schield-Rice.xls](http://www.StatLit.org/Excel/2012Schield-Rice.xls)

**Patterns in Rice: # Touching**  
2:1/100; 4:1/10,000; 6: 1/1,000,000

2014 Coincidence NNN1

A3		=RANDBETWEEN(0,9)																
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
3	9	3	2	9	9	4	1	9	9	9	2	2	5	3	5	0	5	5
4	8	0	6	4	1	6	7	4	0	2	2	0	3	7	0	9	8	0
5	3	1	7	3	5	2	5	6	8	7	2	0	4	8	9	2	9	6
6	9	0	1	4	3	4	2	8	9	2	6	6	4	7	7	9	2	3
7	9	6	2	1	9	0	4	3	8	6	2	7	5	7	5	1	3	3
8	4	3	6	1	5	8	1	9	4	8	4	9	2	6	1	8	7	2
9	0	0	2	4	3	0	5	5	9	3	1	6	9	5	3	5	8	4
10	9	6	6	7	5	0	6	6	1	2	6	6	0	9	3	6	7	8
11	9	1	0	4	7	4	2	4	4	0	4	3	8	8	4	9	8	5
12	9	8	0	1	4	6	0	8	2	0	4	2	3	5	6	4	5	7



**Coincidence Outcomes**

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Students must “see” that coincidence

- may be more common than expected
- depends on the context
- may be totally spurious
- may be a sign of causation

**References**

Oct 2011 24

**Papers:**

Schield (2012). Coincidence in Runs and Clusters  
[www.statlit.org/pdf/2012Schield-MAA.pdf](http://www.statlit.org/pdf/2012Schield-MAA.pdf)

Schield (2014). Two Big Ideas for Teaching Big Data  
[www.statlit.org/pdf/2014-Schield-ECOTS.pdf](http://www.statlit.org/pdf/2014-Schield-ECOTS.pdf)

**Downloadable spreadsheets:**

- Birthdays: [www.statlit.org/Excel/2012Schield-Bday.xls](http://www.statlit.org/Excel/2012Schield-Bday.xls)
- Runs of Coins: [www.statlit.org/Excel/2012Schield-Runs.xls](http://www.statlit.org/Excel/2012Schield-Runs.xls)