Intelligent life on Earth

Christopher Lovell gave a fascinating statistical hitchhiker's guide to the Drake equation, Fermi's paradox, and the prospects for intelligent extraterrestrial civilisations ("Where is everybody?", page 24, December 2017). He concludes that a successful discovery would be one of humanity's greatest achievements, but failure might provide benefit too, as a reminder to protect our world from nuclear war and climate change. It was a timely point and a great article, but I wanted to add something: it is not only humanity that needs protection.

There is already evidence that non-human intelligent lifeforms exist. The behaviour of great apes, elephants, cetaceans, and some other wildlife suggests complex social interactions, learning and problem-solving ability, and signs of emotion and empathy. This makes it especially ironic that so many of these species are threatened or endangered due to poaching, habitat loss, and other threats. We might lose our only chance to really study and learn from these non-human intelligent beings in their own habitat.

I really admire Lovell's quest, which he shares with Drake, Fermi, Sagan and other greats. But it's even more important that we keep studying the non-human intelligences here on Earth, both to learn about them and to better protect them. Here, too, statistical modelling has a crucial role to play.[1,2]

John J. Dziak
State College, Pennsylvania

References

1. Alamgir, M., Mukul, S. A. and Turton, S. M. (2015) Modelling spatial distribution of critically endangered Asian elephant and Hoolock gibbon in Bangladesh forest ecosystems under a changing climate. *Applied Geography*, **60**, 10–19.

2. de Vos, A., Brownell, R. J. Jr., Tershy, B. and Croll, D. (2016) Anthropogenic threats and conservation needs of blue whales, *Balaenoptera musculus indica*, around Sri Lanka. *Journal of Marine Biology*, **2016**, 8420846.

Run or pass?

I read with interest your interview with Dennis Lock of the Miami Dolphins ("Winning the Super Bowl would be nice", page 38, October 2017), particularly the last two paragraphs of the "Cause and effect" box, discussing whether teams in the lead should pursue "run" or "pass" plays.

While it might be possible to construct an artificial example with a very unusual distribution, playing the less variable of two strategies with equal expected values is preferable for the team that is ahead. The reverse is true when behind. I give an artificial example from soccer.

Consider team A is ahead by five goals with 10 minutes to go. Suppose team B has the opportunity to go for a goal every minute until the end of play. Suppose team B has a constant probability of 0.4 of scoring a goal on each independent attempt. The probability that team A wins is 0.6331 and the probability of a draw is 0.2508.

Consider the less variable possibility in which team B plays four attempts at goal where the probability of a goal is 1, and six attempts where the score probability is 0. Under this less variable scenario, team A must win by 1 goal.

The less variable approach is the preferable one for the team that is ahead (team A) and the more variable one preferable for the team that is behind. This can be considered an example of binomial versus Poisson binomial. Other examples are of course possible, but the result is quite a general one.

Graham Pollard
University of Canberra

The airport fallacy, continued

We appreciate the comments of John Lewis (page 46, December 2017) on our article "What are the odds!? The 'airport fallacy' and statistical inference" (page 38, August 2017). We agree with all he says, except: "It is hard to see why [the pre-specification paradigm of clinical trials that validates hypothesis testing] is not possible in most areas of scientific work covered by standard texts on the design and analysis of experiments."

This is a legitimate question, but one that cannot easily be addressed here. The clinical trial paradigm of experimentation as rigidly controlled confirmation of completely predefined hypotheses simply does not fit the iterative, exploratory nature of the way most science is done. Rather, most science – including experimentation – is part of an inductive learning strategy in which theory, empiricism, expertise and some form of reproducibility are more important than one-shot results.

Further, as mentioned in our article, the hard reality is that rigorous, controlled reproduction efforts have met with resistance, despite efforts at change.

A few specific reasons that can make the clinical trial paradigm more difficult and expensive to apply than Lewis believes are as follows:

- Unlike clinical trials, which have pre-specified inclusion/exclusion criteria, there is often no defined and meaningful population represented by the sample – the purpose is to elaborate a mechanism/principle.[1] For instance, experimentation in transgenic mice is intended to build evidence for a candidate drug's eventual utility in humans, not in transgenic mice.
- Randomisation and blinding are often difficult, too inefficient given limited availability of scarce experimental resources, or physically impossible.
- Relatively few scientists or engineers know about or use textbook experimental design.[2]
- Quality control/assurance as practised in clinical trials is almost non-existent in research labs (go.nature.com/2kG5FM8).

There is a great deal more that could/should be said, but we hope

We welcome comments from readers – please email **significance@rss.org.uk**. Contributions should be no more than 300 words in length and clearly marked "for publication". Published responses may be edited to fit.

that this at least provides a glimpse of the difficulties to which we alluded.
Bert Gunter, Pleasant Hill, CA
and Christopher Tong, Sparks, NV

References

1. Deming, W. E. (1975) On probability as a basis for action. *American Statistician*, **29**(4), 146–152.

2. Festing, M. F. W. (2014) Randomized block experimental designs can increase the power and reproducibility of laboratory animal experiments. *ILAR Journal*, **55**(3), 472–476.

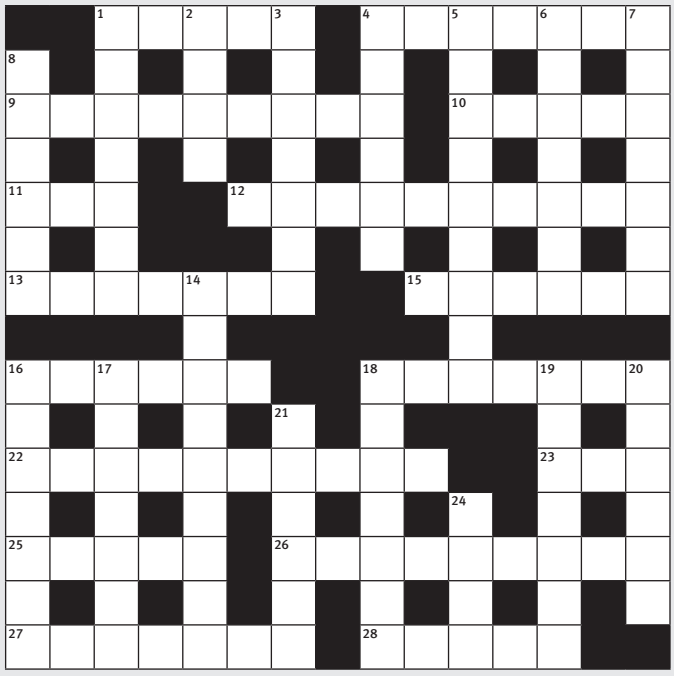
Professor Moriarty on the binomial theorem

Building on the details of the life of "ex-Professor Moriarty of mathematical celebrity" in "The Final Problem" from *The Memoirs of Sherlock Holmes* (1894) by Sir Arthur Conan Doyle, Anthony Horowitz, in his *Moriarty* (2014, pp. 329–330), records:

> I was the Napoleon of crime. ... I was indeed one of two boys – twins – born to a respectable family, born in Ballinasloe, County Galway. ... I found myself at Hall's Academy in Waddington where I excelled at astronomy and mathematics. From there I went to Queen's College, Cork, where I studied under the great George Boole and it was with his guidance that, at the age of twenty-one, I published a treatise on Binomial Theorem which, I am proud to say, caused quite a stir across Europe. As a result I was offered the Mathematical Chair of a university ...

This statement immediately suggests a "Final Problem" of our own, which readers of *Significance* might wish to consider. Assuming that Professor Moriarty was born about 1841, so that he studied in Cork, Ireland, with George Boole (1815–1864) towards the end of his career, and was about 50 years old when, in May 1891, he struggled with Sherlock Holmes above the Reichenbach Falls in Switzerland, outline the contributions that Moriarty might have made to the binomial theorem.
Richard Farebrother
Shrewsbury, England

Wiley Prize Crossword: *Two Ways* by Sam Buttrey



Send your solution to: *Significance* Crossword Competition, Royal Statistical Society, 12 Errol Street, London, EC1Y 8LX or scan it and email to significance@rss.org.uk. The competition is sponsored by Wiley (wiley.com/statistics), who will give the winner £100 or $150 to spend on Wiley books. Closing date: 11 March 2018. The winner will be chosen randomly from the correct entries, and the correct solution published in a future issue. Photocopies are acceptable.

Something special is happening at the seven crossings of unenumerated clues in this puzzle. Those seven Down answers are unchanged, but they will need to be entered carefully. In some cases, they will be shortened in a particular way. Those seven Across answers will need to be changed to match.

Across

1 Break from deranged, i.e. fake, TV (two words)
4 Washes handfuls of diamonds, perhaps (7)
9 Send to India, maybe, for courteous make-over (9)
10 Like an elegant restaurant in France, ours has starters of trout almondine (hyphenated)
11 Vehicle in the front (3)
12 Company bigwig I sack is San Jose resident, perhaps (10)
13 Temporary housing, in a place I have not yet decided
15 Compartment at top has irregularly set blades
16 Sees crews out east pick up southerly heading (6)
18 Pet eels, splashing at top of tower (7)
22 Fictitious coral, happy at sea (10)
23 People or horse drug administration is lax
25 Iron mine has someone in power on the inside, like a ship, traditionally
26 Outlaw ropes dead bandit (9)
27 Mocks deceased queen on May 15, among others (7)
28 On big boat in river, a couple is seen painting

Down

1 Shakespearean creation is caught turning again at itself (7)
2 Be aware of nothing, it sounds like (4)
3 Observe unhelpfully, with too many words (7)
4 Party's fate is uncertain (6)
5 Invite aura to dance around, moving by itself (9)
6 Japanese organisation blasted one half of Chicago, almost (7)
7 Psychiatrists finish evaluations, watch for signs (7)
8 100 ÷ 5 equals, at first, 10 – bent one particular way (6)
14 Group from Milan, Michigan removed and recombined (9)
16 Mark ate, and ate quickly (7)
17 Caretaker's finally ejecting tenant (7)
18 Breaking news, as a Welsh city comes into view (7)
19 Vote for a hundred thousand codfish (7)
20 Mostly jealousy at club's surround (6)
21 Bit of shoulder pad at top of expensive silk suit (6)
24 Einstein and Da Vinci – perhaps magic spirits? (4)

Solution to December issue's crossword:
***TASS* by Goujeers**

The theme was trumps in the Tarot pack of cards (using the Rider Waite deck). In the title, ASS = RUMP.

Across: 1, 12 homophone ruff = trump (Bridge), stories US spelling of storeys; **4** GI CIA in MAN; **10** anag in 'UNTERS; **11** pun on whirled; **13** ELP OMEN replacing "us" in MUSE; **14** PRIG in UHT; **16** (l)EDGE(r); **19** 2 defs; **21** anag; **24** anag; **25** LIVED, rev; **26** PRO in EM; **27** PO rev + ARE rev + TORS; **28** 2 defs; **29** HUSK(ie)S.

Down: 1 T(o)RUS + T(o)FU + L; **2** anag; **3** 2 defs (Bridge term); **5** AB SOLVE; **6** anag (W = with); **7** I's RA EL; **8** anag; **9** HER MIT; **15** hidden; **17** CHEVR(e) + alternate letters; **18** ANAL + Y (chromosome) + SIS; **20** SOU in LETT; **21** pun on colonel; **22** anag; **23** STAR + ER; **25** def + hidden.

Winner: Michael Collop, Devon, UK