

as a problem in statistical association, and admits of one, and only one, solution.

Consider the universe of N events, each consisting of D 's either lying or telling the truth, and of A 's either affirming or denying that D has lied. By the data, the frequency of D 's lying must be $2N/3$, and of his telling the truth, $N/3$. Also by the data, the frequency of D 's lying followed by A 's statement that D has lied must be $2N/3$ times $1/3$, and followed by A 's denial that D has lied it must be $2N/3$ times $2/3$. Likewise, the frequency of D 's telling the truth followed by A 's affirming that D lies must be $2N/9$, and followed by A 's denying that D has lied it must be $N/9$. The accompanying association table exhibits these frequencies; there are no inconsistencies. Out of the sub-universe $4N/9$ in which A says that D lies, D actually lies $2N/9$ times and tells the truth $2N/9$ times; and hence the desired probability is $1/2$. It can be nothing else.

	A says that D lies	A denies that D lies	Total
D lies	$2N/9$	$4N/9$	$2N/3$
D tells the truth	$2N/9$	$N/9$	$N/3$
Total	$4N/9$	$5N/9$	N

Whenever the prior probabilities, as here, are known, any straightforward problem in inverse probability can be recast into the form of an association or contingency table, and must lead to a unique solution. But when one tries to cast into the form of a table of association or contingency a problem in inverse probability for which the prior probabilities are unknown, then the ratios between the total frequencies of the 'cause' rows remain capable of arbitrary adjustment, and no unique probability can in general be found for a particular cause of the observed event. It is only when one or more of the class frequencies vanish in the table that any conclusions can be drawn without a knowledge of the prior probabilities, the argument then becoming a conditional syllogism, *modus tollens*. The method of association not only clarifies the solvable problems in inverse probability, but also demonstrates the logical fallacy involved in almost all applications of the method of inverse probability, when the prior probabilities are unknown.

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May 4.

¹ NATURE, 135, 451, March 23, 1935.

DR. STERNE'S statement concerning me, that: "He argues that . . . neither for his problem nor for Eddington's can there be any consistent, correct solution", is not quite accurate. I did not dispute that a combination of the data was possible which would allow of a unique result, but I claimed that such a combination did not yield 'probability' according to any significant meaning of the word. If the square of a man's height be divided by the natural logarithm of his age, and the result called his 'affability', this quality can be uniquely determined, but it gives no indication of the reception he is likely to give us. We can either (a) define probability in a purely mathematical way and so obtain a unique solution which may be both consistent and correct (although, in my opinion, Sir Arthur Eddington's solution was neither); or (b) refrain from calling meaningless mathematical functions 'probability', and then obtain two solutions to each problem.

I am willing to discuss the correctness of Sir Arthur Eddington's solution or the significance of his implied definition of probability, but to avoid taking up space unnecessarily, I will wait to hear in which, if either, question Dr. Sterne is now interested.

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The Breeding Age of the Yellow-bellied Toad, *Bombina variegata variegata*, Linn.

IN view of the scarcity of data on the age at which *Sabientia* begin to breed, and an apparently entire lack of information for the above species, it may be of interest to record that I have to-day seen eggs laid by a pair of these toads which were hatched in my terrarium in 1932. The animals are not yet full-grown, the male measuring 35 mm., the female 37 mm., whilst full-grown toads are about 45 mm.

The males had well-developed nuptial pads last summer, and vigorously attempted to mate with females of all ages, but were prevented from securing adult females permanently by the pugnacity of the older males¹. While I was watching last year, young females always released themselves.

The first sign of sexual behaviour was seen as early as 1933, when an animal only 20 mm. long seized another even smaller, which responded by the typical female release reaction. Behaviour which is sexual in character is not in this species invariably associated with reproduction, as noted for *Bufo bufo* by Hinsche², but it is interesting to find this complex behaviour already in existence in very small toads only one year old.

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N.W.7. June 10.

¹ Savage, R. M., "The Spawning, Voice and Sexual Behaviour of *Bombina variegata variegata*, Linn.", *P. Zool. Soc.*, 4, 889-898; 1932.
² Hinsche, G., "Über Brunst und Kopulationsreaktionen des *Bufo vulgaris*", *Z. vergl. Physiol.*, 4, 564-606; 1926.

Fossils as Indicators of Continental Drift

Most geologists will doubtless agree with Sir Arthur Smith Woodward as to the need for caution in the interpretation of some of the fossil evidence which has been regarded as supporting the hypothesis of continental drift¹. The possibility that fossils referred to the same genus or even the same species may have been developed in different areas (whether from a common or different ancestors) is familiar to those who have been concerned with Mollusca or Brachiopoda, but the implications as regards classification or the value of fossil lists are not so well understood, and Sir Arthur's warning is no doubt timely.

It may be remarked, however, that where, in any system, numbers of similar forms occur in a comparable sequence in widely separated areas, the evidence of a former connexion between the areas is immeasurably stronger; especially is this true where there is a succession of unrelated species belonging to different groups.

These conditions appear to be suitably illustrated in the Upper Carboniferous rocks of western Europe and the eastern States of America, where there is the additional advantage that both flora and non-marine fauna have required practically continuous continental areas for their migrations. As regards the floral succession, in particular, the similarity of the