fewer than 50,000 buffaloes have been killed for their tongues alone, and the most of these are undoubtedly chargeable against white men, who ought to have known better." Over three and a half million individuals are estimated to have been slaughtered in the southern herd between 1872 and 1874. In the latter year the hunters became alarmed at the great diminution in the number of the bison, and by the end of 1875 the great southern herd had ceased to exist as a body. The main body of the survivors, some 10,000 strong, fled into the wilder parts of Texas, where they have been gradually shot down, till a few years ago some two or three score remained as the sole survivors of the three or four millions of the great southern herd. Bison-hunting as a business definitely ceased in the south-west in 1880.

Almost equally brief, and equally decisive, is the history of the great northern herd. The estimated number in this herd in 1870 is roughly put at a million and a half, ranging over a much wider area than the southern herd. The portions of the herd in British North America appear to have been exterminated first. Previously to 1880, the Sioux Indians had made an enormous impression on the numbers of this herd in the States of Dakota and Wyoming; but the beginning of the final destruction of the herd may be said to date from that year, which was signalized by the opening of the Northern Pacific Railway, running right through their area. In that year the herd was hemmed in on three sides by Indians armed with breechloaders, who enormously reduced its numbers. A rising market for "buffalo-robes," in 1881, stimulated a rush on this herd, till "the hunting-season which began in October 1882 and ended in February 1883 finished the annihilation of the great northern herd, and left but a few small bands of stragglers, numbering only a very few thousand individuals all told." It was long thought that a large section of the herd was still surviving, and had escaped into British territory, but this proved to be a mistake.

"South of the Northern Pacific Railway, a band of about three hundred settled permanently in and around the Yellowstone National Park, but in a very short time every animal outside of the protected limits of the Park was killed; and whenever any of the Park buffaloes strayed beyond the boundary, they too were promptly killed for their heads and hides. At present the number remaining in the Park is believed by Captain Harris, the Superintendent, to be about two hundred, about one-third of which is due to the breeding in protected territory."

It is curious to notice that even the bison hunters themselves were unaware of the extinction of the northern herd in the spring of 1883; and costly expeditions were actually fitted out in the autumn of that year to arrive at the bison country and find that the "happy hunting-grounds" existed no longer.

Such very briefly is the mournful history of the extermination of the two great herds of American bison. Scattered individuals or small droves still exist here and there in the more secluded parts of the country, in addition to those preserved in the Yellowstone. The pursuit of them is, however, unremitting, and the author considers that the final disappearance of every unprotected individual is but a question of time. In 1889 some twenty bison were seen grazing in the Red Desert of Wyoming, which narrowly escaped destruction. We have already mentioned the survivors of the southern herd still lingering in Texas; but there is strong evidence of the existence in the British district of Athabasca of a herd of "wood-buffalo," estimated at upwards of 550 in number. Exclusive of those in the Yellowstone, the number of wild bison existing in the United States on January 1, 1889, is given as 85. Finally, the whole census of living examples of the American bison—both wild and tame—at the date mentioned, gives only 1091 individuals.

That the Government of the United States will do all they can to increase and preserve the herd in the Yellowstone Park goes without saying; but the warning of the author that without great care, and unless (if this be possible) crossed, they will gradually deteriorate in size, should not be overlooked.

The account of the Smithsonian Expedition into Montana, which forms the concluding portion of the volume, although well told, is not of sufficient general interest to need further notice here.

In conclusion, we have to congratulate the author on having brought together such a number of facts in relation to the extermination of the bison, which, if they had not been recorded while they were fresh in men's memories, would probably have been entirely lost.

R. L.

DICE FOR STATISTICAL EXPERIMENTS.

EVERY statistician wants now and then to test the practical value of some theoretical process, it may be of smoothing, or of interpolation, or of obtaining a measure of variability, or of making some particular deduction or inference. It happened not long ago, while both a friend and myself were trying to find appropriate series for one of the above purposes, that the same week brought me letters from two eminent statisticians asking if I knew of any such series suitable for their own respective and separate needs. The assurance of a real demand for such things induced me to work out a method for supplying it, which I have already used frequently, and finding it to be perfectly effective, take this opportunity of putting it on record.

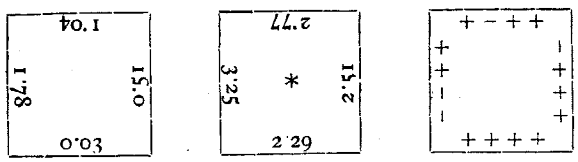
The desideratum is a set of values taken at random out of a series that is known to conform strictly to the law of frequency of error, the probable error of any single value in the series being also accurately known. We have (1) to procure such a series, and (2) to take random values out of it in an expeditious way.

Suppose the axis of the curve of distribution (whose ordinates at 100 equidistant divisions are given in my "Natural Inheritance," p. 205) to be divided into n equal parts, and that a column is erected on each of these, of a + or a − height as the case may be, equal to the height of the ordinate at the middle of each part. Then the values of these heights will form a series that is strictly conformable to the law of frequency when n is infinite, and closely conformable when n is fairly large. Moreover the probable error of any one of these values irrespectively of its sign, is 1.

As an instrument for selecting at random, I have found nothing superior to dice. It is most tedious to shuffle cards thoroughly between each successive draw, and the method of mixing and stirring up marked balls in a bag is more tedious still. A tee-totum or some form of roulette is preferable to these, but dice are better than all. When they are shaken and tossed in a basket, they hurtle so variously against one another and against the ribs of the basket-work that they tumble wildly about, and their positions at the outset afford no perceptible clue to what they will be after even a single good shake and toss. The chances afforded by a die are more various than are commonly supposed; there are 24 equal possibilities, and not only 6, because each face has four edges that may be utilized, as I shall show.

I use cubes of wood $1\frac{1}{4}$ inch in the side, for the dice. A carpenter first planed a bar of mahogany squarely and then sawed it into the cubes. Thin white paper is pasted over them to receive the writing. I use three sorts of dice, I., II., and III., whose faces are inscribed with the figures given in the corresponding tables. Each face contains the 4 entries in the same line of the table. The diagram shows the appearance of one face of each of the 3 sorts of dice; II. is distinguished from I. by an asterisk in the middle; III. is unmistakable. It must, however, be understood, that although the values are given to the second place of decimals both in the tables and in this diagram, I do not enter more than one decimal on the dice. The use of the second decimal is to make multiplication more accurate, when a series is wanted in which each term has a larger probable error than 1.

I. II. III.



In calculating Table I., n was taken as 48. This gives 24 positive and 24 negative values in pairs, but I do not enter the signs on the dice, only the 24 values, leaving the signs to be afterwards determined by a throw of die III. It will be observed that the difference between the adjacent values in Table I. is small at first, and does not exceed 0·2 until the last three entries are reached. These, which are included in brackets, differ so widely as to require exceptional treatment. I therefore calculated Table II. on the principle of dividing that portion of the curve of distribution to which those entries apply, into 24 equal parts and entering the value of the ordinate at the middle of each of those parts in that table. Moreover, instead of entering the three bracketed values on die I. I leave blanks. Then whenever die I. is tossed and a blank is turned up, I know that I have to toss die II., and to enter the value shown by it.

The precise process I follow is to put 2 or 3 of dice I. into a small waste-paper basket, to toss and shake them, to take them out and arrange them on a table side by side in a row, squarely in front of me, but by the sense of touch alone. Then for the first time looking at them, to write down the values that front the eye. If, however, one of the blank spaces fronts me, I leave a blank space in the entries. Having obtained as many values as I want from die I., I fill up the blank spaces by the help of die II.

Lastly, the signs have to be added. Now as $24 = 16 + 8 = 2^4 + 2^3$, it follows that 16 of the edges of die III. may be inscribed with sequences of 4 signs in every possible combination, and the remaining 8 with sequences of 3 signs. Then when die III. is thrown, the several entries along its front edge, which are 4 or 3 in number as the case may be, are inserted in an equal number of successive lines, so as to stand before the values already obtained from the other dice.

The most effective equipment seems to be 3 of die I., 2 of die II., 1 of die III., making 6 dice in all.

Values for Die I.

0·03	...	0·51	...	1·04	...	1·78
0·11	...	0·59	...	1·14	...	1·95
0·19	...	0·67	...	1·25	...	2·15
0·27	...	0·76	...	1·37	...	(2·40)
0·35	...	0·85	...	1·50	...	(2·75)
0·43	...	0·94	...	1·63	...	(3·60)

Values for Die II.

2·29	...	2·51	...	2·77	...	3·25
2·32	...	2·55	...	2·83	...	3·36
2·35	...	2·59	...	2·90	...	3·49
2·39	...	2·64	...	2·98	...	3·65
2·43	...	2·68	...	3·06	...	4·00
2·47	...	2·72	...	3·15	...	4·55

Values for Die III.

+ + + +	+ − − +	− − + +	+ − +
+ + + −	+ − − −	− − + −	+ − −
+ + − +	− + + +	− − − +	− + +
+ + − −	− + + −	− − − −	− + −
+ − + +	− + − +	+ + +	− − +
+ − + −	− + − −	+ + −	− − −

FRANCIS GALTON.

THE ROYAL SOCIETY SELECTED CANDIDATES.

THE following fifteen candidates were selected on Thursday last (April 24) by the Council of the Royal Society to be recommended for election into the Society. The ballot will take place on June 5, at 4 p.m. We print with the name of each candidate the statement of his qualifications.

SIR BENJAMIN BAKER, Mem. Inst. C.E.,

Hon. Mem. of the American Society of Mechanical Engineers, and of the Society of Engineers. Hon. Mem. of the Manchester Lit. and Phil. Soc. Has been engaged as an Engineer during the last twenty-five years, in the design and construction of many important works at home and abroad, including the Forth Bridge, and has carried out numerous investigations relating to the strength of materials and of engineering structures generally, and has contributed papers thereon to various Scientific Societies, viz., Proc. Inst. Civil Eng., Trans. Amer. Soc. Mech. Eng., Brit. Assoc. Reports, &c. Author of "A Theoretical Investigation into the Most Advantageous System of Constructing Bridges of Great Span," upon which plan the Forth Bridge and six of the largest bridges in the world have been built.

ROBERT HOLFORD MACDOWALL BOSANQUET, M.A.,

Fellow of St. John's College, Oxford. Barrister. Long and successful devotion to scientific inquiry, as shown by the following list of papers, and the printed copies sent herewith for the use of the Council:—"On an Experimental Determination of the Relation between the Energy and Apparent Intensity of Sounds of Different Pitch" (*Phil. Mag.*, xliv., 381–387); "On Just Intonation in Music; with a Description of a New Instrument for the Easy Control of all Systems of Tuning other than the Ordinary Equal Temperament" (Roy. Soc. Proc., xxi., 131–132); "Note on the Measure of Intensity on the Theories of Light and Sound" (*Phil. Mag.*, xlv., 215–218); "The Theory of the Division of the Octave, and the Practical Treatment of the Musical Systems thus obtained" (Roy. Soc. Proc., xxiii., 390–408); On the Polarization of the Light of the Sky" (*Phil. Mag.*, l., 497–520); "On a New Form of Polariscope and its Application to the Observation of the Sky" (*Phil. Mag.*, ii., 20–28); "On the Hindoo Division of the Octave, with some Additions to the Theory of Systems of the Higher Orders" (Roy. Soc. Proc., xxv., 540–541, xxvi., 372–384); "On the Relation between the Notes of Open and Stopped Pipes" (*Phil. Mag.*, vi., 63–66); "On the Present State of Experimental Acoustics" (*ibid.*, viii., 290–305); "Notes on Practical Electricity" (*ibid.*, xiv., 241–258); "On a Uniform Rotation Machine, and on the Theory of Electromagnetic Tuning Forks" (Roy. Soc. Proc., xxxiv., 445–447); "On Magneto-motive Force" (*Phil. Mag.*, xv., 205–217); "On Permanent Magnetism" (*ibid.*, 257–259, 309–316); "On Self-regulating Dynamo-electric Machines" (*ibid.*, 275–296); "On a Standard Tension Galvanometer" (*ibid.*, xvii., 27–30); "On a Determination of the Horizontal Component of the Earth's Magnetism at Oxford" (*ibid.*, 438–447); "On Electro-Magnets," No. I. (*ibid.*, 531–536); No. II., "On the Magnetic Permeability of Iron and Steel, with a new Theory of Magnetism" (*ibid.*, xix., 73–94); No. III., "Iron and Steel: a New Theory of Magnetism" (*ibid.*, 333–340); No. IV., "Cast Iron, Charcoal Iron, and Malleable Cast Iron" (*ibid.*, xx., 318–323); "Permanent Magnets," No. I. (*ibid.*, xviii., 142–153), No. II., "On Magnetic Decay" (*ibid.*, xix., 57–59); "On the Supposed Repulsion between Magnetic Lines of Force" (*ibid.*, 494–495). With a further list of twenty-seven papers.

SAMUEL HAWKESLEY BURBURY, M.A.,

Barrister-at-Law. Formerly Fellow of St. John's College, Cambridge. Second Classic, and Chancellor's Medallist, and fifteenth Wrangler in the year 1854. Has done much work in Mathematical Physics, espeially in the theories of Electricity and Magnetism and the Kinetic Theory of Gases. Joint author of Watson and Burbury's "Generalized Co-ordinates"; also of Watson and Burbury's "Electricity: Part I. Electrostatics." Author of sundry papers on physical science; for example, the following: Paper in *Phil. Mag.*, January 1876, "On the Second

Probable Error = InverseCDF[75%, N(0,sigma)] = 0.6745 sigma

TABLE 8.

ORDINATES TO NORMAL CURVE OF DISTRIBUTION on a scale whose unit = the Probable Error, and in which the 100 Grades run from 0° to 100°.

Grades	0	1	2	3	4	5	6	7	8	9
0	−∞	−3·45	−3·05	−2·79	−2·60	−2·44	−2·31	−2·19	−2·08	−1·99
10	−1·90	−1·82	−1·74	−1·67	−1·60	−1·54	−1·47	−1·42	−1·36	−1·30
20	−1·25	−1·20	−1·15	−1·10	−1·05	−1·00	−0·95	−0·91	−0·86	−0·82
30	−0·78	−0·74	−0.69	−0·65	−0·61	−0·57	−0·53	−0·49	−0·45	−0·41
40	−0·38	−0·34	−0·30	−0·26	−0·22	−0·19	−0·15	−0·11	−0·07	−0·04
50	0·00	+0·04	+0·07	+0·11	+0·15	+0·19	+0·22	+0·26	−0·30	+0·34
60	+0·38	+0·41	+0·45	+0·49	+0·53	+0·57	+0·61	+0·65	+0·69	+0·74
70	+0·78	+0·82	+0·86	+0·91	+0·95	+1·00	+1·05	+1·10	+1·15	+1·20
80	+1·25	+1·30	+1·36	+1·42	+1·47	+1·54	+1·60	+1·67	+1·74	+1·82
90	+1·90	+1·99	+2·08	+2·19	+2·31	+2·44	+2·60	+2·79	+3·05	+3·45

Examples of the way in which Table 8 is to be read :—

The ordinate at 0° is −infinity ; at 10° it is −1·90 ; at 11° it is −1·82 ; at 25° it is −1·00 ; at 75° it is +1·00. The Table does not go beyond Grade 99°, where the ordinate is + 3·45. At the Grade 100°, the ordinate would be + infinity.