

LETTERS TO THE EDITOR

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STATISTICAL FORMULÆ

It is perhaps worth while for statistical computers to have some fresh formulæ in addition to the familiar ones found in the common text-books. These formulæ can at least serve to open up new methods of checking results obtained by older methods. Here is a variance formula for *k* varieties, x_1, x_2, \dots, x_k :

$$k^2 \sigma^2 = (k-1) \sum_{r=1}^{r=k} (x_r - m)^2 - \sum_{r=1}^{r=k} \sum_{s=1}^{s=k} (x_r - m)(x_s - m), (r \neq s) \quad (1)$$

m being any number whatsoever.

It leads to the coefficient of intra-class correlation (*R*) for *n* families with varying number of members in each family, in a new form not noticed before:

$$R = 1 - \frac{\sum k_i^2 \sigma_i^2}{\sigma^2 \sum k_i (k_i - 1)} \quad (2)$$

where k_i, σ_i^2 denote the number of members and the variance respectively in the *i*-th family and σ^2 is the general variance. The proof of this formula is immediate, if we set

$$P_i = \sum_{s=1}^{s=k_i} (x_{ir} - m)(x_{is} - m), (r \neq s);$$

and $S_i = (k_i - 1) \sum_{r=1}^{r=k_i} (x_{ir} - m)^2,$

where *m* is the general mean,

Then

$$R = \frac{\sum P_i}{\sum S_i} = 1 - \frac{\sum (S_i - P_i)}{\sum S_i} = 1 - \frac{\sum k_i^2 \sigma_i^2}{\sigma^2 \sum k_i (k_i - 1)}$$

It is readily seen that

$$R \geq - \sum k_i \sigma_i^2 / \sum k_i (k_i - 1) \sigma_i^2 \quad (3)$$

Lastly, if we consider three groups of variates (*x*), (*y*), (*z*) arranged as in the following table:

	x_1	x_2	.	.	.	.	x_m	
y_1	z_{11}	z_{21}	.	.	.	.	z_{m1}	v_1
y_2	z_{12}	z_{22}	.	.	.	.	z_{m2}	v_2
.
y_n	z_{1n}	z_{2n}	.	.	.	.	z_{mn}	v_n
	u_1	u_2	.	.	.	.	u_n	

where $mv_i = z_{i1} + z_{i2} + \dots + z_{mi}$, and $nu_j = z_{j1} + z_{j2} + \dots + z_{jn}$, we can write down the mean (*M*) and the variance (σ^2), of *mn* variates of the form $ax_j + by_i + cz_{ji}$ ($j=1, 2, \dots, m; i=1, 2, \dots, n$), *a, b, c* being any arbitrary constants, thus:

$$M = a\bar{x} + b\bar{y} + c\bar{z}; \quad (4)$$

$$\sigma^2 = a^2 \sigma_x^2 + b^2 \sigma_y^2 + c^2 \sigma_z^2 + 2r_{xu} ac \sigma_u \sigma_x + 2r_{yv} bc \sigma_v \sigma_y; \quad (5)$$

in the usual notation of Statistics.

The proof follows by ordinary methods of expansion and summation. The last formula is useful in some genetic investigations.

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