

## And Quiet Does Not Flow the Don: Statistical Analysis of a Quarrel between Nobel Laureates

The Nobel Prize in literature for 1965 was awarded to Mikhail Sholokhov (1905–1984), for the epic novel *Тихий Дон* about Cossack life and the birth of a new Soviet society (*And Quiet Flows the Don*, or *The Quiet Don*, in different translations). Sholokhov has been compared to Tolstoï and was at least a generation ago called ‘the greatest of our writers’ in the Soviet Union. In Russia alone, his books have been published in more than a thousand editions, selling in total more than 60 million copies. He was an elected member of the USSR Supreme Soviet, the USSR Academy of Sciences, and the CPSU Central Committee.



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But in the autumn of 1974 an article was published in Paris, *Стремля ‘Тихого Дона’ (Загадки романа)* (*The Rapids of Quiet Don: the Enigmas of the Novel*), by the author and critic D\*. He claimed that *Tikhii Don* was not at

all Sholokhov’s work, but that it rather was written by Fiodor Kriukov, a more obscure author who fought against bolshevism and died in 1920. The article was given credibility and prestige by none other than Aleksandr Solzhenitsyn (a Nobel prize winner five years after Sholokhov), who wrote a preface giving full support to D\*’s conclusion. Scandals followed, also touching the upper echelons of Soviet society, and Sholokhov’s reputation was faltering abroad (see e.g. Doris Lessing’s (1997) comments; “vibrations of dislike instantly flowed between us”). Are we in fact faced with one of the most flagrant cases of plagiarism in the history of literature?

### Approaching disputed authorship cases

The first reaction to accusations of plagiarism or to cases of disputed authorship is perhaps simply to listen to the points being made, checking the strength of argumentation by common sense or, if need be, with the careful scepticism of a court of law. In the present case, the claims made would perhaps be classified as unsubstantial. Various rumours were in circulation already from 1930, as detailed in Kjetsaa et al.’s account. Solzhenitsyn’s (1974) preface appears to rest on the opinion that (i) such a young and relatively uneducated person could not produce so much fine literature in such a short time-span; (ii) all his later work was produced at a much slower pace, and has a lower literary quality; (iii) Kriukov’s background and publications (summarised in Solzhenitsyn’s own Afterword to the 1974 publication) fit the storyteller’s perspectives better. To this



Mikhail Sholokhov (1905–1984),  
Nobel Laureate 1975.



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Aleksandr Solzhenitsyn (1918–),  
Nobel Laureate 1980.

was also added the unfortunate fact that Sholokhov’s personal author’s archives could not be found. Further elaborations, partly also through attempts at linguistic and stylistic analyses, can be seen in D\* (1974).

If the case still warrants further discussion, after initial scrutiny, one may enter the intriguing but difficult terrain of sorting out an author’s or artist’s ‘personal style’, whether in stylistic expression, or via smaller idiosyncrasies, or perhaps a bit more grandly in their themes and how these are developed. In a famous essay, Sir Isaiah Berlin (1953) made a bold attempt at sorting Russian authors into ‘hedgehogs’ and ‘foxes’, after the old Greek saying that Erasmus Rotterdamus records as *‘multa novit vulpes, verum echinus unum magnum’*: “the fox knows many tricks, but the hedgehog masters one big thing”. Thus Dostoyevskii and Ibsen were hedgehogs while Pushkin and Tolstoï were foxes – the latter trying however very hard to become a hedgehog, according to Berlin. In Hjort (2006), I follow such a literary classification challenge by arguing, in three languages, that Carl Barks is a fox while Don Rosa is a hedgehog. See in this connection also Gould (2003), who uses the hedgehog vs. fox dichotomy to address the misconceived gap between sciences and the humanities (in the best spirit of the Centre of Advanced Study).

But even experts on literature, art and music are prone to making occasional mistakes, as demonstrated often enough, and it is clear that independent arguments based on quantitative comparisons are of interest. If not taken as ‘direct proof’, then such comparisons may at least offer independent objective evidence and sometimes additional insights. In such a spirit, an inter-Nordic research team was formed in 1975, captained by Geir Kjetsaa, a professor of Russian literature at the Department of Literature, Regional Studies and European Languages at the University of Oslo, with the aim of disentangling the Don mystery. In addition to various linguistic analyses and several doses of detective work, quantitative data were gathered and organised, for example, relating to word lengths, frequencies of certain words and phrases, sentence lengths, grammatical characteristics, etc. These data were extracted from three corpora: (i) Ш, or Sh, from published work guaranteed to be by Sholokhov; (ii) Кр , or Kr,

that which with equal trustworthiness came from the hand of the alternative hypothesis Kriukov; and (iii) ТД, or TD, the Nobel winning apple of discord. Each of the corpora has about 50 000 words. My contribution here is to squeeze clearer author discrimination and some deeper statistical insights out of some of Kjetsaa et al.'s data.

### Sentence length distribution

Here I will focus on the statistical distribution of the number of words used in sentences, as a possible discriminant between writing styles. Table 1, where the first five columns have been compiled via other tables in Kjetsaa et al. (1984), summarises these data, giving the number of sentences in each corpus with lengths between 1 and 5 words, between 6 and 10 words, etc. The sentence length distributions are also portrayed in Figure 1, along with fitted curves described below. The statistical challenge is to explore whether there are any sufficiently noteworthy differences between the three empirical distributions, and, if so, whether it is the upper or lower distribution of Figure 1 that most resembles the one in the middle.

**Table 1:** Tikhii Don: number of sentences  $N_x$  in the three corpora Sh, Kr, TD of the given lengths, along with predicted numbers  $pred_x$  under the four-parameter model (1), and Pearson residuals  $res_x$ , for length groups  $x = 1, 2, 3, \dots, 13$ . The average sentence lengths are 12.30, 13.12, 12.67 for the three corpora, and the variance to mean dispersion ratios are 6.31, 6.32, 6.57.

		observed:			predicted:			residuals:		
from	to	Sh	Kr	TD	Sh	Kr	TD	Sh	Kr	TD
1	5	799	714	684	803.4	717.6	690.1	-0.15	-0.13	-0.23
6	10	1408	1046	1212	1397.0	1038.9	1188.5	0.30	0.22	0.68
11	15	875	787	826	884.8	793.3	854.4	-0.33	-0.22	-0.97
16	20	492	528	480	461.3	504.5	418.7	1.43	1.04	3.00
21	25	285	317	244	275.9	305.2	248.1	0.55	0.67	-0.26
26	30	144	165	121	161.5	174.8	151.1	-1.38	-0.74	-2.45
31	35	78	78	75	91.3	96.1	89.7	-1.40	-1.85	-1.55
36	40	37	44	48	50.3	51.3	52.1	-1.88	-1.02	-0.56
41	45	32	28	31	27.2	26.8	29.8	0.92	0.24	0.23
46	50	13	11	16	14.5	13.7	16.8	-0.39	-0.73	-0.19
51	55	8	8	12	7.6	6.9	9.4	0.14	0.41	0.85
56	60	8	5	3	4.0	3.5	5.2	2.03	0.83	-0.96
61	65	4	5	8	2.1	1.7	2.9	1.36	2.51	3.04
		4183	3736	3760						

A very simple model for sentence lengths is that of the Poisson, but one sees quickly that the variance is larger than the mean (in fact, by a factor of around six, see Table 1). Another possibility is that of a mixed Poisson, where the parameter is not constant but varies in the world of sentences. If  $X$  given  $\lambda$  is Poisson with this parameter, but  $\lambda$  has a Gamma ( $a, b$ ) distribution, then the marginal takes the form

$$f^*(y, a, b) = \frac{b^a}{\Gamma(a)} \frac{1}{y!} \frac{\Gamma(a + y)}{(b + 1)^{a+y}}$$

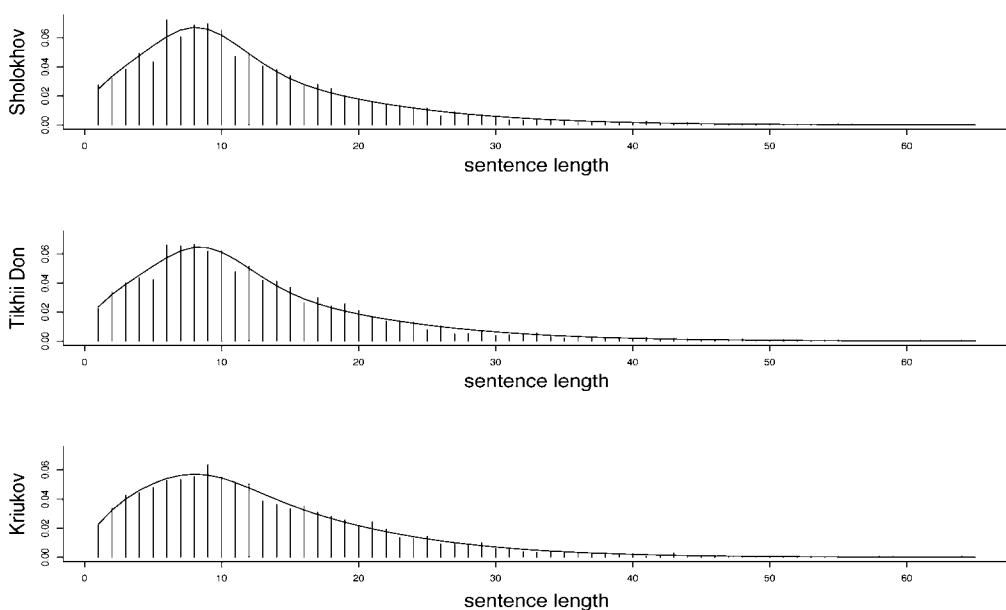
for  $y = 0, 1, 2, \dots$ ,

which is the negative binomial. Its mean is  $\mu = a/b$  and its variance  $a/b + a/b^2 = \mu(1 + 1/b)$ , indicating the level of over-dispersion. Fitting this two-parameter model to the data was also found to be too simplistic; clearly the muses had inspired the novelists to transform their passions

into patterns more variegated than those dictated by a mere negative binomial, their artistic outpourings also appeared to display the presence of two types of sentences, the rather long ones and the rather short ones, spurring in turn the present author on to the following mixture of one Poisson, that is to say, a degenerate negative binomial, and another negative binomial, with a modification stemming from the fact that sentences containing zero words do not really count among Nobel literature laureates (with the notable exception of a 1958 story by Heinrich Böll):

$$f(y, p, \xi, a, b) = p \frac{\exp(-\xi) \xi^y / y!}{1 - \exp(-\xi)} + (1 - p) \frac{f^*(y, a, b)}{1 - f^*(0, a, b)} \quad (1)$$

for  $y = 1, 2, 3, \dots$ . It is this four-parameter family that has been fitted to the data in Figure 1. The model fit is judged adequate, see Table 1, which in addition to the observed number  $N_x$  shows the expected or predicted number  $\text{pred}_x$  of sentences of the various lengths, for length groups  $x = 1, \dots, 13$ . Also included are Pearson residuals  $(N_x - \text{pred}_x) / \text{pred}_x^{1/2}$ . These residuals should essentially be on the standard normal scale provided the parametric model used to produce the predicted numbers is correct. Here there are no clear clashes with this hypothesis, particularly in view of the large sample sizes involved, with respectively 4183, 3736, 3760 sentences in the three corpora. The  $\text{pred}_x$  numbers in the table stem from minimum chi squared fitting for each of the three corpora, i.e. finding parameter estimates to minimise  $\sum_x \{N_x - \text{pred}_x(\theta)\}^2 / \text{pred}_x(\theta)$  with respect to the four parameters, where  $\text{pred}_x(\theta) = np_x(\theta)$  in terms of the sample size for the corpus and the inferred probability  $p_x(\theta)$  of writing a sentence with a length landing in group  $x$ .



**Figure 1.** Sentence length distributions, from 1 word to 65 words, for Sholokhov (top), Kriukov (bottom), and for ‘The Quiet Don’ (middle). Also shown, as continuous curves, are the distributions (1), fitted via maximum likelihood. The parameter estimates for  $(p, \xi, a, b)$  are  $(0.18, 0.10, 2.09, 0.16)$  for Sh,  $(0.06, 9.84, 2.24, 0.18)$  for Kr, and  $(0.17, 9.45, 2.11, 0.16)$  for TD.

### Statistical discrimination and recognition

Kjetsaa's group quite sensibly put up Sholokhov's authorship as the null hypothesis, and D\*'s speculations as the alternative hypothesis, in several of their analyses. Here I shall formulate the problem in terms of selecting one of three models inside the framework of three data sets from the four-parameter family (1):

$M_1$ : Sholokhov is the rightful author, so that text corpora Sh and TD come from the same statistical distribution, while Kr represents another;

$M_2$ : D\* and Solzhenitsyn were correct in denouncing Sholokhov, whose text corpus Sh is therefore not statistically compatible with Kr and TD, which are however coming from the same distribution; and

$M_0$ : Sh, Kr, TD represent three statistically disparate corpora.

Selecting one of these models via statistical methodology will provide an answer to the question of who is most probably the author.

Various model selection methods may now be applied to assist in ranking models  $M_1$ ,  $M_2$ ,  $M_0$  by plausibility; see Claeskens and Hjort (2007) for a broad overview. Here I choose to concentrate on an approach that hinges on the precise evaluation of *a posteriori* probabilities of the three models, given all available data, having started with any given *a priori* probabilities. This makes it possible for different experts, with differing degrees of prior opinions as to who is the most likely author, to revise their model probabilities in a coherent manner. This is quite similar to the so-called Bayesian Information Criterion (BIC), but certain aspects of the present situation call for refinements that make the analysis reported on here more precise than the traditional BIC. These refined scores are called BIC\* below; models with higher scores are more probable than those with lower scores.

In general, let  $p(M_1)$ ,  $p(M_2)$ ,  $p(M_0)$  be any engaged prior probabilities for the three possibilities; we should perhaps take  $p(M_0)$  close to zero, for example. Solzhenitsyn would take  $p(M_1)$  rather low and  $p(M_2)$  rather high, while more neutral observers would perhaps start with these two being equal to  $\frac{1}{2}$  and  $\frac{1}{2}$ . Writing next  $\theta_1$ ,  $\theta_2$ ,  $\theta_3$  for the three parameter vectors  $(p, \xi, a, b)$ , for respectively Sh, Kr, TD, model  $M_1$  holds that  $\theta_1 = \theta_3$  while  $\theta_2$  is different; model  $M_2$  claims that  $\theta_2 = \theta_3$  while  $\theta_1$  is different; and finally model  $M_0$  is open for the possibility that the three parameter vectors must be declared different. The posterior model probabilities may be computed as

$$p(M_j | \text{data}) = \frac{p(M_j) \exp(\frac{1}{2} \text{BIC}_j^*)}{p(M_0) \exp(\frac{1}{2} \text{BIC}_0^*) + p(M_1) \exp(\frac{1}{2} \text{BIC}_1^*) + p(M_2) \exp(\frac{1}{2} \text{BIC}_2^*)} \quad (2)$$

for  $j = 0, 1, 2$ . Space does not allow explaining in detail here how the three BIC\* scores are computed, but they involve finding maximum likelihood estimates of parameters under the three models and their precision matrices, along with accurate approximations of various integrals of dimensions 8 and 12; see Claeskens and Hjort (2007, Section 5.4) for a more detailed exposition of the somewhat elaborate mathematics involved.

## Conclusions

Using (2) to compute posterior model probabilities yields numbers close to zero for  $M_2$  and  $M_0$  and very close to one for  $M_1$ . With equal prior probabilities, we actually find 0.998 for Sholokhov with the remaining 0.002 shared between Kriukov and the neutral model that the three corpora are disparate, and even Solzhenitsyn, starting with perhaps  $p(M_1) = 0.05$  and  $p(M_2) = 0.95$ , will be forced to revise his  $M_1$ -probability to 0.99 and down-scale his  $M_2$ -probability to 0.01. We may conclude that the sentence length data speak very strongly in Sholokhov's favour, and dismiss D\*'s allegations as speculations: the Stalin Prize in Literature 1941 went to the right person. These figures might sound surprisingly clear-cut, in view of the relative similarity of the distributions portrayed in Figure 1. The reason lies with the large sample sizes, which increases detection power.

Of course the probabilities that come from applying (2) depend on the precise nature of (1), and must be interpreted with some caution. There would be other parametric families that also would fit the data, like a five-parametric mixture of two negative binomials, and these would lead to similar but not fully identical posterior model probabilities.

There have been various statistical studies related to disputed authorship cases in the literature, and one would expect this branch to expand with the increasing ease with which large texts may be inspected and analysed stylometrically via computers. Cox and Brandwood (1959) applied discriminant analysis in an attempt to order Plato's dialogues chronologically, using stress patterns of the last five syllables in each sentence. Mosteller and Wallace (1964, 1984) examined the federalist papers, where 12 essays were published anonymously, and used stylometry to demonstrate that James Madison is the likely author. Thisted and Efron (1987) used empirical Bayes methods to assess whether a poem discovered in the 1980s could be attributed to Shakespeare. It should be pointed out that some statistical techniques might be quite successful at finding differences between authors' or artists' styles, via qualitative measurements and analyses thereof, even if such discriminatory abilities might not offer real insights *per se* as to the 'real processes' that produce 'real art'. Thus Lyu, Rockmore and Farid (2004) provide digital techniques for distinguishing Pieter Brueghel the elder from various impostors, without pretensions of quantifying what makes Brueghel the elder 'better' than the others. I believe methods of the type discussed in the present article may be used in other studies involving 'authors' fingerprints', and that some such studies could shed light also on the intrinsically artistic aspects of the works under study. It is my ambition to demonstrate statistically that Bach cannot be the composer of Bach Cantata #189, for example, since *Meine Seele rühmt und preist*, although beautiful, is 'too plain' in parameters pertaining to musical variation to be the real thing. For the Don case, analysis based on model (1) shows that Kriukov has a significantly smaller  $p$  value than Sholokhov has (while other parameters match reasonably well, see Figure 1). Although based to some extent on conjecture, this is an indication that the latter varied the form of his sentences more than the former.

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