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Certification of independent referee reports from a single contributor

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A journal with four departmental pen names requires two referee reports signed under names distinct from each other and from the byline. We consider continued operation during vacancies, including the quarter in which one contributor holds all four posts. Intake encodes the byline as a tetrahedral qubit state. A six-outcome joint measurement on two copies assigns a uniformly drawn eligible pair of signatures with zero probability of repeating the byline. We derive the person-level conflict rate for every partition of the four posts. With two posts per contributor, two thirds of panels contain the author. On the remaining panels the other contributor writes both reports. If all posts are held by one person, every issue passes the signature check and every report is self-review. The preparation ensembles for one and four contributors have trace distance zero even with arbitrarily many issues. A run of 1000 clean returns gives a 95 percent upper bound of 0.00299 on the signature conflict rate and leaves person-level self-review compatible with unity.

I. THE INDEPENDENCE RETURN

A quarterly review publishes papers, translations, correspondence and notices in four signed departments. A contribution appears under the pen name attached to its department. The journal requires two referee reports under signatures different from the byline and from each other. During a vacancy the same contributor may hold several departments. In the limiting case one person writes the article, prepares both reports and receives the decision. The independence return filed with the issue still has three signature fields.

We consider a return in which the byline is removed before dispatch. The four pen names each have a prescribed qubit state. For every article the compositor supplies two copies of the state for its byline. The handling desk measures them to obtain the signatures under which the reports must be prepared. The contributor can then write each report under the designated name. The object of the calculation is to determine how far a return prepared in this manner certifies independent review.

There are two possible errors to count. One is to commission a report under the byline on the article. The other is to commission it from the person who wrote the article. The first can be eliminated by quantum state exclusion [1]. The second depends on the allocation of departments. We allow that allocation to change without changing the imprint, as it would when a contributor takes over a vacant column. The record available to the auditor consists of the three signatures. Handwriting, payment records and the contents of the reports are outside the measurement.

II. DISPATCH UNDER TWO PEN NAMES

Index the departments by $a = 1, \dots, 4$. For a contribution to department a, prepare $\rho_a = |\psi_a\rangle\langle\psi_a|$ with Bloch vector $\mathbf{n}_a$ at vertex a of a regular tetrahedron [2]. Distinct state vectors have squared overlap $1/3$. We require every admissible pair of signatures to be equally likely conditional on the byline. This prevents the handling desk from assigning all the correspondence to the same department. Every department supplies the same number of articles in the model.

For one report the four measurement effects are $E_i = (I - \rho_i)/2$. They sum to I and give $\mathrm{tr}(E_i \rho_a) = (1 - \delta_{ia})/3$. This is the four-label qubit channel for uniform state exclusion [3]. Applying it separately to two copies would give duplicate signatures on one third of returns. Discarding the second signature until a different one appears consumes 2.5 copies per article on average. A joint measurement fills both fields from the two copies supplied.

Let u_i be a unit vector orthogonal to ψ_i, and S the projector on the symmetric subspace of two qubits. For an unordered pair ij define

$$v_{ij} = S(u_i \otimes u_j), \qquad G_{ij} = \tfrac{3}{4} |v_{ij}\rangle\langle v_{ij}|. \tag{1}$$

To check the normalization put $Q_i = |u_i\rangle\langle u_i|$. The tetrahedral first and second moments are $\sum_i Q_i = 2I$ and $\sum_i Q_i \otimes Q_i = 4S/3$. They follow by expanding $Q_i = (I - \mathbf{n}_i \cdot \boldsymbol{\sigma})/2$ along the three Pauli axes. Subtract the diagonal terms from $(\sum_i Q_i) \otimes (\sum_j Q_j)$, project with S on both sides and divide by two for unordered pairs. Multiplication by $3/4$ gives $\sum_{i<j} G_{ij} = S$. Identical pure preparations have support in S, so there is an outcome on every issue.

The probability of entering signatures ij is consequently

$$p(ij \mid a) = \tfrac{3}{4} |\langle u_i|\psi_a\rangle|^2 |\langle u_j|\psi_a\rangle|^2. \tag{2}$$

A factor vanishes when its index equals a. Otherwise it is $2/3$ after taking the squared modulus. An article signed A accordingly receives BC, BD or CD, each with probability $1/3$. These are the complete data used below. The compositor also has the classical option of

drawing a pair and printing the corresponding two letters. It gives the same audit statistics.

One copy does not suffice for the stipulated encoding. Each safe pair effect would have to annihilate two linearly independent vectors in dimension two. If dispatch is compulsory, its minimum probability of repeating the byline is $(1 - 1/\sqrt{3})/2$. To see this, let F_{ij} be any pair measurement. Its mean error is $\sum_{i<j} \operatorname{tr}[(\rho_i + \rho_j)F_{ij}]/4$. Each cost operator in parentheses has least eigenvalue $1 - 1/\sqrt{3}$. Summing the traces of the effects gives two. Equality follows by assigning one third of the projector on the lower eigenvector to each pair. Opposite tetrahedral edges give opposite Bloch vectors for these projectors. No knowledge of who holds a department enters this bound.

III. REDUCTION BY CONTRIBUTOR

Let $g(i)$ denote the person currently writing under signature i and let s_i count the departments held by that person, including i. For an article with byline a there are three admissible report signatures, $s_a - 1$ of which go back to the author. Under uniform dispatch without replacement the chance of at least one report from the author in a panel of r is

$$C_r(a) = 1 - \frac{\binom{4 - s_a}{r}}{\binom{3}{r}}, \qquad r = 1, 2. \tag{3}$$

A binomial coefficient is zero if the upper index is smaller than the lower. We average over bylines with weight $1/4$ each. Averaging equally over people would undercount the articles written by somebody holding more than one post.

A separate question is whether the reports are independent of each other. With the byline averaged out, all six pairs of report signatures occur equally often. If the department holdings are $s'_1, \dots, s'_K$ for K people, one person receives both reports with probability $\sum_{\ell} \binom{s'_\ell}{2}/6$. For the return to be independent in full, the byline and both referees must belong to three different people. Each unordered triple of signatures has probability $1/4$, giving

$$P_{\mathrm{ind}} = \tfrac{1}{4} \sum_{\ell<m<n} s'_\ell s'_m s'_n. \tag{4}$$

Table I exhausts the partitions of the four departments. It can be reproduced by forming the twelve equally likely returns (four bylines times three eligible pairs), replacing each letter by the name of its holder, and testing equality in the three fields.

TABLE I. Exact probabilities for a two-report return. The byline is distinct from both report signatures in every row. C_2 counts panels containing the article's author, B counts panels whose two reports have the same writer, and P_{ind} counts returns written by three people.

Posts per person	C_2	B	P_{ind}
1, 1, 1, 1	0	0	1
2, 1, 1	1/3	1/6	1/2
2, 2	2/3	1/3	0
3, 1	3/4	1/2	0
4	1	1	0

Consider the arrangement with two departments per contributor. In one third of returns the author receives neither invitation. In each such case both reports are written by the other person. In the remaining two thirds each person writes one report. Thus this staffing arrangement can provide outside review or reports from distinct writers on any given article. It cannot put both properties on the same return.

IV. VACANCIES AND REPEATED AUDITS

To calculate how the discrepancy develops over a period of understaffing, keep the papers department occupied and give the other three posts independent vacancy probability q. The papers contributor covers every vacancy. Each occupied post otherwise has its own writer. Holdings for v vacancies are $(1 + v, 1, \dots, 1)$ with $3 - v$ singleton posts. On inserting these four possibilities in Table I, the mean probability of self-review and the mean probability that the two referees are the same person become

$$\overline{C}_2 = q + \tfrac{1}{4} q^2 (1 - q), \qquad \overline{B} = \tfrac{1}{2}(q + q^2). \tag{5}$$

For example, when each of the three posts is vacant half the time, $17/32$ of articles return to their writer for review. The two reports come from one hand with probability $3/8$. The probability of repeating the printed byline is zero at every vacancy rate (Fig. 1).

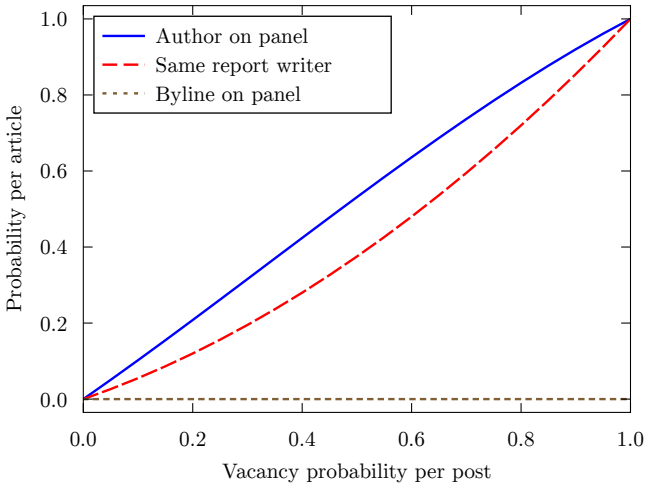


FIG. 1. Conflict probabilities per article under temporary cover. Curves average the twelve possible dispatches over the eight possible vacancy patterns. The horizontal series is the conflict count obtainable by comparing signatures.

Additional token measurements cannot estimate the number of contributors from these records. Fix any two assignments g and g' of people to the same four posts. Conditional on the byline, the density operators supplied at intake are identical under the two assignments. Any sequence of measurements with settings chosen from earlier outcomes therefore gives the same likelihood under g and g'. The same holds after averaging over bylines with the stated weights. In particular, the trace distance between the intake ensembles for one writer and four writers is zero. With equal prior probabilities for these two arrangements the best success probability in deciding which produced a run of issues is $1/2$, for any run length.

This distinction matters for a journal reporting an upper confidence limit. In 1000 independent returns with no repeated byline the exact one-sided 95 percent binomial upper bound on the signature conflict rate is $1 - 0.05^{1/1000} = 0.00299$. The observation has probability one under every row of Table I in the ideal protocol. Even a complete run of clean returns therefore leaves the upper bound on person-level self-review at one.

V. PREPARATION ERRORS AND THE PUBLISHED RETURN

A faulty preparation can introduce a visible conflict. For a single invitation suppose the compositor replaces the token by $I/2$ with probability p. The probability of dispatch under the byline becomes $c = p/4$. Every other signature has probability $(1 - c)/3$. For an author holding s assignments, the chance of receiving the invitation in person is then

$$C_1(s, p) = c + (s - 1)(1 - c)/3. \tag{6}$$

With $p = 0.01$ the desk would record about 2.5 byline matches per thousand single-report articles. For a contributor holding two posts the expected number of invitations to review one’s own work is 335 per thousand of that contributor’s articles. For a sole contributor it is 1000. Improving the polarization of the incoming tokens can eliminate the 2.5 recorded cases.

The calculation presumes that intake binds a token faithfully to the printed name and that articles are sampled by department. A department that publishes more frequently should receive its observed weight in Eq. (3). If contributors’ names are available independently, a separate check on those names can be made before the invitations leave the office. In a quarter with only one contributor such a check returns two unfilled vacancies.

Under the signature rule both vacancies can instead be filled on receipt. For an article in the papers department the contributor receives two commissions under other departmental names. On completion, the two reports and the author’s response can be filed under three distinct signatures, with no record in the return that any person corresponded with another.

[1] S. Bandyopadhyay, R. Jain, J. Oppenheim, and C. Perry, Phys. Rev. A **89**, 022336 (2014).
[2] J. M. Renes, R. Blume-Kohout, A. J. Scott, and C. M. Caves, J. Math. Phys. **45**, 2171 (2004).
[3] T. Heinosaari and O. Kerppo, J. Phys. A: Math. Theor. **52**, 395301 (2019).