Text S1. Relationship between one-sided chi-square test and Bayesian log-likelihood score (LLS) method

Here we show that the one-sided chi-square test used for evaluating the significance of the overlap between the RH network and other existing datasets and the Bayesian log-likelihood score (LLS) approach used for integrating diverse datasets [1,2] are closely related. The Fisher’s exact test was used instead of the chi-square test when the expected value in a cell of the contingency table was \( \leq 50 \) (see Methods). However, the chi-square test approximates the Fisher’s exact test and useful insights into the overlap analysis are obtained through examining the chi-square test.

Suppose a reference and a test network, both of which are unweighted, and the following contingency table are given.

<table>
<thead>
<tr>
<th></th>
<th>Linked edges in test network</th>
<th>Non-linked edges in test network</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linked edges in reference network</td>
<td>a</td>
<td>b</td>
<td>a+b</td>
</tr>
<tr>
<td>Non-linked edges in reference network</td>
<td>c</td>
<td>d</td>
<td>c+d</td>
</tr>
<tr>
<td>Total</td>
<td>a+c</td>
<td>b+d</td>
<td>a+b+c+d</td>
</tr>
</tbody>
</table>

A chi-square statistic without any correction is given by

\[
\chi^2 = \frac{(ad - bc)^2}{(a+b)(c+d)(b+d)(a+c)}. \tag{1}
\]

We used this statistic for evaluating the significance of the overlap between the RH and other existing networks. A log-likelihood score (LLS) is defined as
and was used for measuring the data quality of the test network compared to the gold standard reference network in a modified Bayesian framework [1,2]. We impose a constraint that $LLS \geq 0$. Indeed, only the datasets with $LLS \geq \log 1.5$ were used in [1,2]. By combining (1) and (2), one can rewrite $\chi^2$ using $LLS$:

$$\chi^2 = (a+b+c+d) \frac{(a+c)(c+d)}{(a+b)(b+d)} \left(1 - \frac{a+b+c+d}{(a+b)\exp(LLS) + (c+d)}\right)^2.$$ 

The chi-square statistic $\chi^2$ is a bijective function of $LLS$ for $LLS \geq 0$. Therefore, the chi-square statistic has a monotonic relationship with the log-likelihood score ($LLS$).
