

## 12.3: The Continuity Correction

Okay, time for a little bit of a digression. I've been lying to you a little bit so far. There's a tiny change that you need to make to your calculations whenever you only have 1 degree of freedom. It's called the "continuity correction", or sometimes the **Yates correction**. Remember what I pointed out earlier: the  $\chi^2$  test is based on an approximation, specifically on the assumption that binomial distribution starts to look like a normal distribution for large N. One problem with this is that it often doesn't quite work, especially when you've only got 1 degree of freedom (e.g., when you're doing a test of independence on a 2×2 contingency table). The main reason for this is that the true sampling distribution for the  $X^2$  statistic is actually discrete (because you're dealing with categorical data!) but the  $\chi^2$  distribution is continuous. This can introduce systematic problems. Specifically, when N is small and when  $df=1$ , the goodness of fit statistic tends to be "too big", meaning that you actually have a bigger  $\alpha$  value than you think (or, equivalently, the p values are a bit too small). Yates (1934) suggested a simple fix, in which you redefine the goodness of fit statistic as:

$$X^2 = \sum_i \frac{(|E_i - O_i| - 0.5)^2}{E_i}$$

Basically, he just subtracts off 0.5 everywhere. As far as I can tell from reading Yates' paper, the correction is basically a hack. It's not derived from any principled theory: rather, it's based on an examination of the behaviour of the test, and observing that the corrected version seems to work better. I feel obliged to explain this because you will sometimes see R (or any other software for that matter) introduce this correction, so it's kind of useful to know what they're about. You'll know when it happens, because the R output will explicitly say that it has used a "continuity correction" or "Yates' correction".

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