Optimal and robust exoplanet detection

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Exoplanet detection can be based on several statistical significance metrics: signal to noise ratio, false alarm probability, Bayes factor. It is not clear which one of these metrics is the best, and what is the meaning of their significance scale. We exhibit a new exoplanet detection criterion which is demonstrably optimal in the sense that it maximises true detections for a certain tolerance to false ones. It leads to up to 30% more true detections than existing criteria, and is calibrated: 9 out of 10 detections made with probability 90% are correct. The optimality of this criterion and its calibration rely on a choice of noise model and priors, which might be faulty. The fact that the alternative models considered might all be unrealistic is usually overlooked in exoplanet detection. To address this issue, we introduce a new class of statistical tests based on the predictive ability of the model.