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How to optimize a probabilistic binary forecast in view of forecast reliability

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We investigate how to adjust or train a probabilistic binary forecast to be reliable. We mathematically prove that a necessary, but not sufficient, condition for achieving a reliable probabilistic forecast is maximizing the Peirce skill score (PSS) at the threshold probability of the climatological base rate. The condition is confirmed by using artificially synthesized forecast-outcome pair data and previously published probabilistic solar flare forecast models. The condition gives a partial answer as to why some probabilistic forecast system lack reliability, because the system, which does not satisfy the proved condition, can never be reliable. The result implies that those who want to develop a reliable probabilistic forecast system must adjust or train the system so as to maximize PSS near the threshold probability of the climatological base rate.