Astrostat lab4: model selection

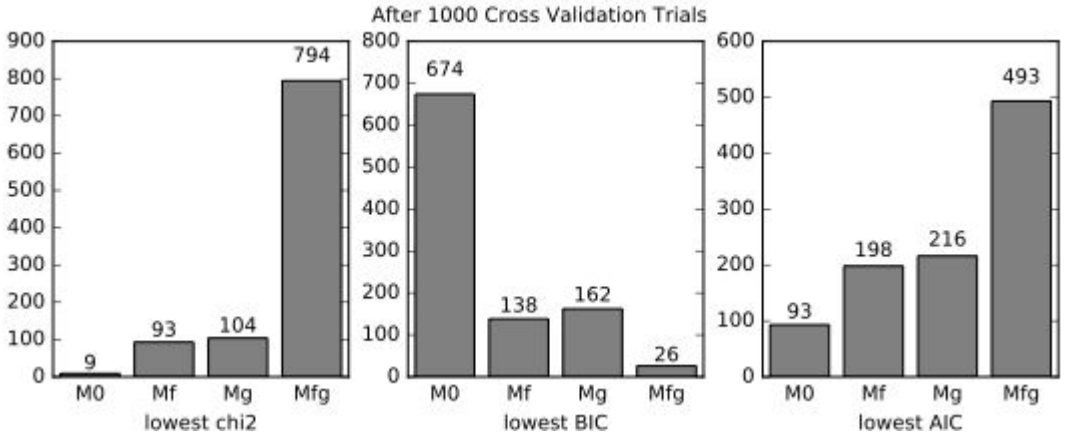
- When we try to fit existing data with our models, we often don't exactly know which model we should use
- Depending on which model we use to fit the data, we can arrive at wildly different conclusions
- Vogt, et al. (2010) claimed that they discovered two extra planets in a 4 planet system by fitting and consecutively subtracting sine waves to the star's light curve
- Findings later disproved by new data and more complex statistical techniques
- We'll try to do model selection on the original Glise581 data

- We defined four models:
  - M0: just confirmed planets b c d e
  - Mf: planets b c d e + planet f
  - Mg: planets b c d e + planet g
  - Mfg: planets b c d e + planet f and g
- As opposed to Vogt, et al.(2010), we're fitting for all the planets at the same time
- We first fit with fixed amplitude and frequency first to narrow down the phase and then do a full fit
- To evaluate our models, we looked at reduced Chi2, BIC and AIC
  - All three metrics penalizes more complex models, but BIC is the most harsh
  - The lower the value, the better the model

	Chi2	Reduced Chi2	BIC	AIC
M0	390.531	1.705	1201.513	1159.696
Mf	345.498	1.528	1172.935	1120.663
Mg	341.941	1.513	1169.378	1117.106
Mfg	297.536	1.334	1141.427	1078.701

- It is to be expected that more complex models will have a lower chi2
- But here it seems that Mfg does best in all categories with a Bayes factor of 8.96e-14 between M0 and Mfg
- Do we really prefer M0 to Mfg 8.96e-14 to 1??? (^this seems to support Vogt+(2010))
- Let's do some cross validation

- We did 1000 iterations of cross validation with leave p-out (p = 50, roughly 20% of our original dataset
- For each iteration we:
  - Fit all four models with the training set (first with fixed amplitude and frequency then a full fit)
  - Calculated chi2, AIC, and BIC for the validation set based on the best fit parameters on the training set
- Here we might be able to dispute Vogt's finding



- Out of 1000 iterations, the majority of them had Mfg being the best model based on Chi2 (this is, again, expected)
- However, ~68% of the time, M0 had the lowest BIC - this is because the BIC penalizes more complex models (average Bayes factor: we prefer M0 to Mfg, 762 to 1)
- The trend is not seen in AIC because it penalizes complex models less
- Looking at the BIC, we can't say that we prefer Mf, Mg or Mfg with 5 sigma (Vogt+, 2010)