Week 7 meeting notes

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| Proposal marks should be released soon  No clear problems with citations  Anything you can find in a year 1 or 2 undergrad textbook you can take as assumed knowledge  For a year 3 undergrad textbook you could probably state it without needing to cite it: e.g. del nu scales with numax.  However if you were to say del nu scales with numax which you can approximate with the relation numax0.88, that would require a citation as that is a specific scaling relation that someone must have derived using some data.  But L proportional to Teff4 is known. |
| Next assessed work is Guy’s marking of the “textbooks”  Textbooks should show we are good scientists: record progress, how we approach the project. Progress, independence, methodology, persistency. |
| Discussion of Github:  Commit with titles, to describe what has been done  Work in a way that works for me, but constantly commit to github with changes  “git pull🡪do some work🡪git add, git commit, git push” |
| Where do we want to be by the end of term:  Start by working on neural net  Then work with 1 star and model it and work up from there  Input variations:  Parameters we don’t want to constrain (I think?) = free parameter, and marginalize over all possible values, weighted by how likely they are to match the data.  If we ignore a variable like helium, we pick a value for helium and fix that parameter, thus you don’t see the variation in the observables due to helium changing, which means we underestimate in all the other parameters  We might include: mass, age, metallicity, helium, alpha (mixing length)  Each parameter will have a prior associated with it. As we are looking at open clusters the priors for age, metallicity and helium will be quite narrow and the mass prior will be quite wide    You can give an upper and lower limit for the parameters and say they’re uniform in the middle but we will probably put a Gaussian over them because neural nets prefer distributions.  For the mixing length which we are somewhat ignoring: 1.7-2.3 are the values which we typically measure between, so you could take that as a uniform distribution.  We can also take the grid of models and fit the sun quickly which would give back a distribution for alpha, and then we state that the alpha for the sun is representative of the true alpha.  We use that distribution form the sun as a prior on alpha but it has hard boundaries at 1.7 and 2.3.  We can test different versions of this and see what happens |
| The tasks:  1. grid of stellar models: mass, age, metallicity, helium, mixing length  2. Neural net: takes the inputs for the model and converts to L, Teff, delnu  3. Modelling tool: star by star basis (everything inside the box)  We need to run tests so that we know the neural net is precise enough (given our definition of precise).  We will want to take some points out of the grid (leave them out of the training) and see if we can model back to those points with reasonable uncertainties (simulation test).  Modelling tool is designed to tell us: what mass and age a star is given an observed luminosity and temperature. It’s a sanity check: check observables map correctly back to points from the grid and that it can map between points in the grid.  4. HBM  Take say 100 stars from the grid with similar ages and then do we get back the correct age and distribution etc.  Observe an apparent magnitude with distance+parallax which you then turn into absolute magnitude and then into luminosity.  Using extinction: the green catalogue in python allows you to enter coordinates and an estimate of the distance and it returns the extinction which you then subtract from the luminosity. |
| MESA model Guy is giving us:  Terminates when there is 5% left of central hydrogen i.e. no subgiant or redgiant branch  Get rid of the pre-main sequence  We know M67 has an age of about 4Gyrs, so there is no point to train a neural net outside of the ages of 2-6 Gyrs.  We write code to train neural net but we choose some different architecture, but we guess some number of epochs and send it to Guy to train it.  We want to have a working neural net that works to a precision of 0.005 dex (0.5% precision), though we should make a determination of how accurate we want it to be.  Most logical loss function is MAE (mean absolute error), although the Median Absolute Error is smaller. We probably want to train using the Mean Absolute Error and then evaluate using the Median Absolute Error.  To determine an adequate guess than the number of epochs to train for we can take a small portion of the grid (e.g. say only where the metallicity is solar and take a few masses) train the neural net till it reaches the desired precission, suggested architecture (3,8,8,2) = (inputs,nodes, hidden layers, outputs).  Sensible number of epochs = 50,000    You can regularize which Guy successfully did with L2 regularization (which adds the sum of the weights squared to the loss function. Which is the same as putting a Gaussian prior on the values of the weights).  We want to try an architecture which is the smallest we can get away with such that its faster (start with small architecture and work up).  Google collab allows us free computation using a GPU  Tangent about training a GAN (art salesman and art counterfeiter) |
| Discussion about how the neural net weights determine the possible trainable functions based on regularization and architecture  Low regularization and large architecture makes the functions very “wiggly”.  We could do this ourselves to give some arguments about why we chose a certain architecture based on how well the functions match that of stellar evolution.  Can be done in numpy (some additional thing about setting the x and y to 0 was mentioned but I don’t remember exactly).  Wouldn’t be insane to put in the report |
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Students To Do:  
Harry should improve commits to github  
Make a regularization+architecture graph (at least I want to try it)

Guy to do:  
send the Sun Model notebook

Next week:  
guy is in barcelona so we can organise a skype if we feel like it (later on in the week) but we still can send our neural nets to Guy to get trained.