Y4 Project meeting 9 record

Date and time: 04/12/19, 15:00-14:45

Attended by: Guy, Harry, Hin and Alex

Doctor student Alex was invited to join the meeting as he (and other people working with Guy) were doing similar work to the project. Alex also acted as a person with no prior knowledge of our project that we were to explain the project to.

Discussed:

1. Described the outlines, aims, plans and current state of project to Alex, also explained the process of incorporating NN into a HBM framework in the context of an open cluster.
2. Tenda has created a huge grid (10k tracks) with larger mass range 0.8 to 3 Msun that has pre MS to RC, Fe/H -1 to -0.5 dex, alpha_MLT 1.7 to 2.3, Y 2.4 to 3.2, no overshooting. Tenda has also calculated a grid specifically for M67 stellar properties. These two grids can be combined to allow NN to learn precisely in the fine M67 region, and the broad features of the larger, but coarse grid. There are possibilities to include an even larger but coarser scaled grid at the background.
3. Division of labour: Proposed for Harry to specialize on NNs and Hin to specialize on HBMs, and share the code/data/structure in between. But still should keep in mind either of us should be familiar with both things for writing final report.
4. About hyper-priors in HBM:
    a. Mass: since there is no clear distribution to mass in open clusters (unlike age, Y and FeH), we would want to model mass differently. Options are to either not constraint mass with hyper-priors entirely and treat it as “inside the pgm box” variable, or to apply initial mass function + age (lifetime) effect + observational (luminosity) bias on the mass – Entirely different topic, and very hard to model.
    b. Alpha_MLT: may or may not want to use a single parameter to describe MLT, or describe it with a distribution (like age).
5. Solving github issues:
    a. #23: since feh and MLT do not vary in small grid, NN has no grasp on how to model those parameters in accordance to the observables, creating bad sampling on the HBM. Solution: treat feh and MLT as fixed parameters and only vary mass and age.
    b. #24 (not being able to do dot products using pymc3.math.dot to emulate NN weights multiplication):
        i. 1. Could look into an example on pymc3’s site that integrates NN with HBM modelling.
        ii. 2. Could replace pymc3.math.dot with Theano.tensor.dot
        iii. 3. Think about artificially adding a dimension to the weights matrix to allow it to be multiplied by the 3D input matrix, also check all the dimensions are at the right locations (order in rows-columns-layers).
        iv. Guy, Alex and Tanda will be tackling relevant problems themselves on Friday (06/12)
6. Might want to consider setting/documenting seeds used for reproductivity

7. Possible publications:
    a. Discussed the possibilities of incorporating students into Guy's paper planned to be published about demonstrating the possibility of NN+HBM modelling as co-authors.
8. Biases from systemics: inherent biases of our inference caused by errors on stellar models we use. We might want to investigate how to model the biases across a population of stars, through Gaussian process.
9. Potentials of project:
    a. Apply method on not just M67 but multiple open clusters
    b. Take Guy and his team's machinery and apply on a number of other types of star with available asteroseismic data eg. eclipsing binaries, thick disc stars (Mg/Fe), gyrochronology, Gaia stars, chemically identical stars tagged by spectroscopy
10. Project work 1 is due at end of term, a reminder is given to keep the github up to date and reflective of the amount of work we have done. Keep opening github issues.
11. Work during holiday? Work is not required over the holiday, but if we feel like we want to make progress, Guy will be able to reply emails/issues during the break except for obvious dates (eg. Christmas day). Consider the possibility of taking timeouts from the project.

To do:

Students:

1. Add bounded parameters and weakly informative hyper-priors to HBM (mass, age, MLT) and do some tests on the boundaries to be set.
2. Create a pseudo-cluster from datapoints directly taken off the grids (so they have similar age, feh and MLT), and have HBM model the observables of that cluster to find the stellar fundamentals of the stars.
3. Decide on better NN configuration after results on the current mid grid's fit is out

Supervisor:

1. Run Harry's mid grid NN function now that the GPU is fixed

Next meeting: 09/12/2019

Recorded by: Hin