**Week 1:**

Meeting 17/01

* Met Ben and Arkistis.
* Described by background in programming and theory.
* Power spectrum: (dark) matter distribution of the universe
* BNN bit more detail.
* Testing/Developing on Colab… final training on colab
* Play around (install at least) with BaCoN for next week, read paper and cosmology notes.

Work during the week:

* Wrapped my head around file management with github, colab and vscode.
* Read the power spectra chapter of cosmology notes. Very beyond my level but I think I have some sort of grasp. Will try explaining what I’ve understood in meeting with Ben and Alkistis.
* Read the readme in the BaCoN Repo.

**Week 2 (Understanding what’s going on)**

For meeting on 26/1

* Will try explaining what I’ve understood about power spectra:
  + Dark matter needed to explain observations like galactic rotation curves, dark energy needed to explain additional energy density that results in the flat universe we have observed.
  + The data are the fourier wavenumbers of the density contrast, explain redshift bins 🡪 redshift bins quantify the distance (thus age) at which we are measuring / calculating the power spectrum. How does this tie into the maths?
  + Density contrast describes the (fractional?) oscillation of energyy density within a comoving volume.
  + Why does density contrast reveal about both dark energy and dark matter?
  + Power spectrum w.r.t k is thus the average of the squared modulus components across all directions for a magnitude k.
  + New physics 🡪 not lambda cdm
  + Input to BNN = spectrum normalised by planck spectrum and centred around 1
* From readme:
  + Datagenerator reads data in format (by cols): k, redshift bins 1,2,3.
* Questions:
  + What does the datagenerator file do exactly (besides add noise and scramble example indices)? Is that it?
  + Why are there various power spectra for each theory if they are all computed by the same package with the same parameters? Different model parameters per iteration?
  + Why do unknown models necessarily produce signals correlated in space and time 🡪 don’t expect discontinuities in physical quantities.
  + What is MCMC / explain the bottom of the tree in paper. 🡪 statisitical analysis probing parameter space using a Markov chain, we end up sampling the more probable parameters 🡪 we can create pdfs in parameter space 🡪give most likely parameters and errors in estimated values
  + Covariance formula page 4 of paper.
  + Is there a reason why BNN’s estimated classification probabilities are not representative of real probabilities (page 4)?
* How much theory do I need to understand for the two approaches suggested by ben? How would you suggest quickly absorbing the theory (suggest a review paper perhaps?)

Project Ideas:

* Ben’s suggestions: Why is the ML approach worth an entire project? Surely optimising the models and then evaluating generalisation is a reasonable project?
* Page 3, inclusion alternate theories
* Using other software packages

Theory to learn:

* Convolutional BNN in detail

**Week 3:**

Meeting:

* Dark matter is entirely based on gravitational evidence.
* Slightly different definition of power spectrum (potentially equivalent) between Ben’s definition and Cosmology notes definition. Cosmology definition looks at correlations between points.
* To measure density contrast, we measure redshift of all galaxies, and match pairs of galaxies at similar redshift, find the redshift, regress and ft.
* Ben to send paper
* Power spectrum 🡪 two point correlation of a field.
* CMB temperature power spectrum is the density contrast power spectrum of the early universe.
* Density contrast is of the (total) matter energy density (radiation has a really low contribution)
* We treat total matter abundance as approximately equal to dark matter 🡪 density contrast tells us mainly about dark matter.
* Applying energy and momentum conservation to the density contrast in the context of the expanding universe causes dark energy to enter in the Hubble factor (dark energy affects the rate of the universe’s expansion).--> looking at different redshifts helps with out prediction of dark energy.
* Modified bacon from Ben’s student more readable + new dataset
* Might be more manageable using smaller dataset.

Todo:

* Use updated bacon
* Read entire bacon paper
* Fully understand the code and do the example classification
* Skim through other papers

**Week 4:**

Work done during week:

* Read some more of bacon paper.

Project ideas:

* Inclusion of alternate theories 🡪 data from ben on untested theories
* Eliminating the need for a two-label by inclusion of enough theories in five-label? See IV F.
* ~~Alternative software packages~~
* ~~Randomly generated (unknown data) 🡪 improve methodology, relies on ReACT sets anyways.~~
* ~~Rework / improve noise model~~

Questions for meeting/things to learn:

* ~~Variational inference for learning weight posterior distribution? Same distribution for each weight?~~
* ~~Explanation of covariance~~
* ~~Thresholding explanation page 4~~
* ~~Probability distribution explanation~~
* ~~Gaussian noise model~~
* ~~How were mean model parameters and stdevs found.~~ 🡪 means from planck satellite, stdevs are forecasted constraints from Euclid.
* ~~Learn about CNNs and read IIIB.~~
* Explain IV, B, C and ~~fig 7,8 (x-axis? F values?)~~

Meeting 7/2 todo:

* Run classification example for next week (priority). (Bacon II)
* Train a model with the new data.