1 Agent-based modeling of science

Goals: Demonstrate the consequences of the choice of diagnostics of cosmological parameter tensions within the context of large current missions. Explicitly show when "garden of forking paths" considerations, or data-dependent modeling choices, matter, and what the consequences are. Show how and when strategies like blinding experimental results can help, and when they cannot.

Methods: We build an agent-based model for generating and interpreting data from cosmological experiments. Our data-generating process contains systematic errors, which the agents attempt to model, while also aiming to determine the nature of the model generating the data. We explore the consequences of a few decision rules that resemble those implemented by human cosmologists for the convergence of the process as a whole.

2 Architecture

This section describes the architecture of the simulation.

2.1 Cosmology

We adopt two fiducial models: a wCDM model and a LCDM model, both of which are consistent with Planck20XX.

2.2 Data Generator

This section describes the data vectors we generate.

2.2.1 Idealized Data

CMB We generate a CMB power spectrum (C_ℓ) measurement.

Matter Power Spectrum We generate a matter power spectrum, as inferred from lensing or galaxy clustering or some other clever thing..

Supernova This could be any standard candle or standard ruler measurement.

2.2.2 Noise

Each of these measurements has irreducible noise, arising from cosmic variance and other (unbiased) sources of measurement error.

2.2.3 Systematic Errors

There's a true systematic error in each of these data sets, and an ascending hierarchy of complexity that the experiments can use (if forced to) in order to try to model it.

2.3 Interpretation

2.3.1 Model fitting

Each data set is fit to a model.

2.3.2 Tension Assessment

One of the tension metrics is used to assess concordance.

2.3.3 Decision Rules

We write down a decision rule that gets followed in the absence of concordance.

2.3.4 Systematic Error Modeling Update

As a result of the decision rules, the consensus may conclude that one or more contributing experiments need to update their systematic errors. The Consensus issues instructions to this effect.

2.4 Procedure

1. Each experiment *collects data*.
2. Each experiment *fits a model*, including both cosmological and nuisance parameters.
3. Each experiment *reports its posterior* to the Consensus module.
4. The consensus *estimates the degree of tension.*
5. Given the combination of tensions between experiments, and its internal *decision rule*, the Consensus *issues nuisance model update instructions to zero or more experiments*, or *updates the consensus cosmological model.*
6. Any experiments ordered to update their nuisance models do so, and then the process repeats.

We monitor the collective posterior of the Consensus, and see whether and how quickly it shrinks around the true model.