Homework 3

Overview

The code simulates a motion-adaptation task for a set of observers under different conditions and compares various models of motion adaptation and attention effects. Four distinct models are considered to understand the influence of adaptation direction, attention, and their interaction on perceptual decision-making in a motion discrimination task.

Initialization and Data Generation

- **Coherence Levels**: Defined a range of motion coherence levels from -1.0 to 1.0 (20 levels).
- **Trial and Subject Setup**: Set the number of trials (`ntrials`) and the number of subjects (`nsubs`).
- **Psychometric Function Generator**: Defined a cumulative normal psychometric function to simulate observer responses.
- **Model Parameters**: Specified parameters for four different models (M1, M2, M3, M4), considering Point of Subjective Equality (PSE) and slope variations.

Model Descriptions

- **M1**: No adaptation effect (identical slopes and PSEs across conditions).
- **M2**: Adaptation effect on PSE, no attentional effect (two distinct PSEs per subject).
- **M3**: Effects of attention enhancing the motion after-effect (four distinct PSEs per subject).
- **M4**: Attention effect on slope in addition to the effects in M3.

Simulating Observer Responses

- Generated simulated observer data for each model by varying PSE and slope values according to the model specifications.
- Random variations were introduced to the PSE and slope parameters to simulate individual differences.

Parameter Estimation and Model Fitting

- Used `fmincon` to optimize model parameters by minimizing the negative log-likelihood (NLL).
- Estimated optimal parameters for each model and subject.
- Calculated model fits for different coherence levels.

Model Evidence Calculation

- Implemented Bayesian model-fitting to calculate model evidence.
- Used Jeffreys priors, modified by the constraints of each model, for the slope and PSE parameters.
- Calculated and normalized the model evidence for each subject and model.

Statistical Analysis

- Calculated Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and Bayes Factor (BF) for model comparisons.
- Presented mean values for NLL, AIC, BIC, BF estimation and model evidence across subjects for each model.

The Bayesian model evidence seems okay but appears to be go haywire, maybe because of some kind of very low exponential values? Not sure!

However, for different ground truths, we can observe, that NLL, AIC, BIC and Bayes Factor all suggest the corresponding model to be the best one. However, it fails when the ground truth model is Model 4. This might be happening because the difference between Model 3 and Model 4 lies only in the slope estimation which might not be a good enough excuse to consider a complex model to fit the data.

I loved this assignment overall and I am curious to know where my Bayesian model-fitting has failed.

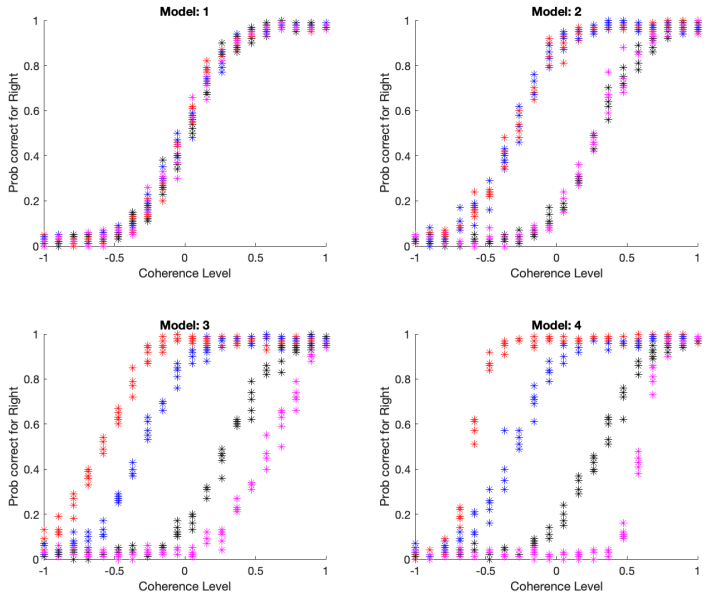

Fig 1: Data simulated using the four different models

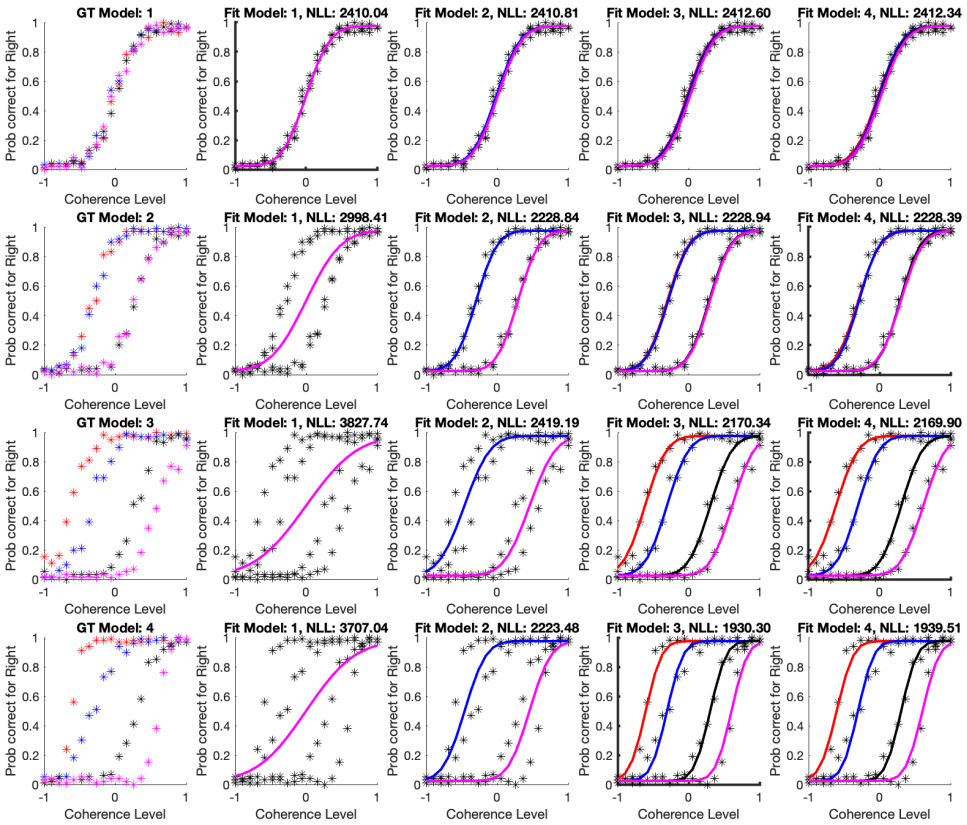

Fig 2: Data simulated using the four different models in each row and the model fits applied in each column. The best model fit based on NLL is highlighted with a black border.

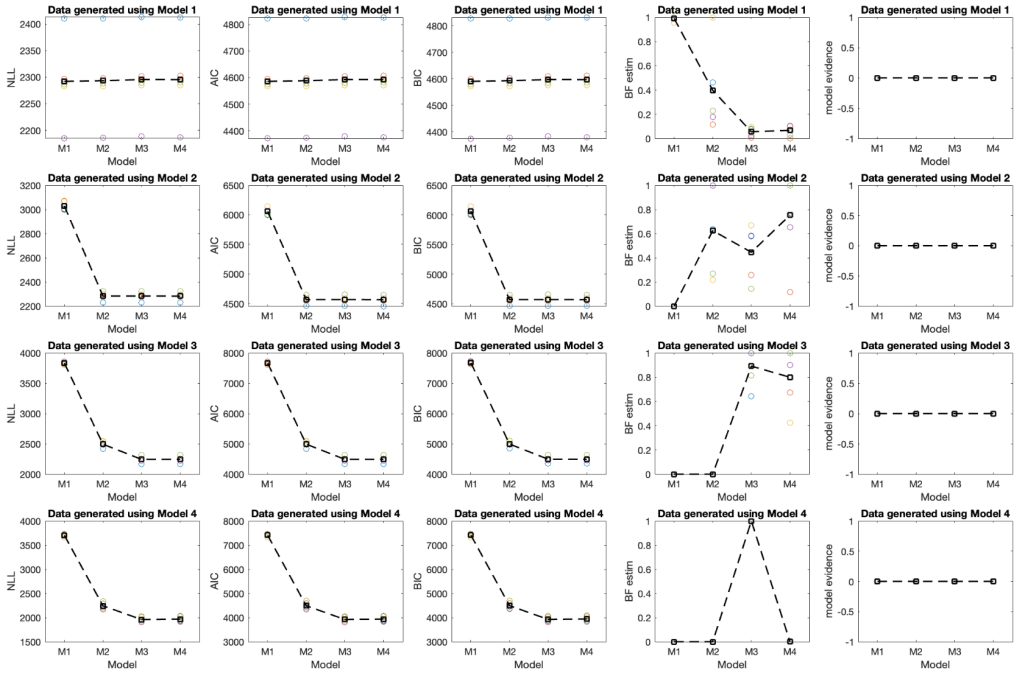

Fig 3: For each ground truth model (in each row), NLL, AIC, BIC BF estimation and Bayesian Model Evidence (which I am bummed about :/)