

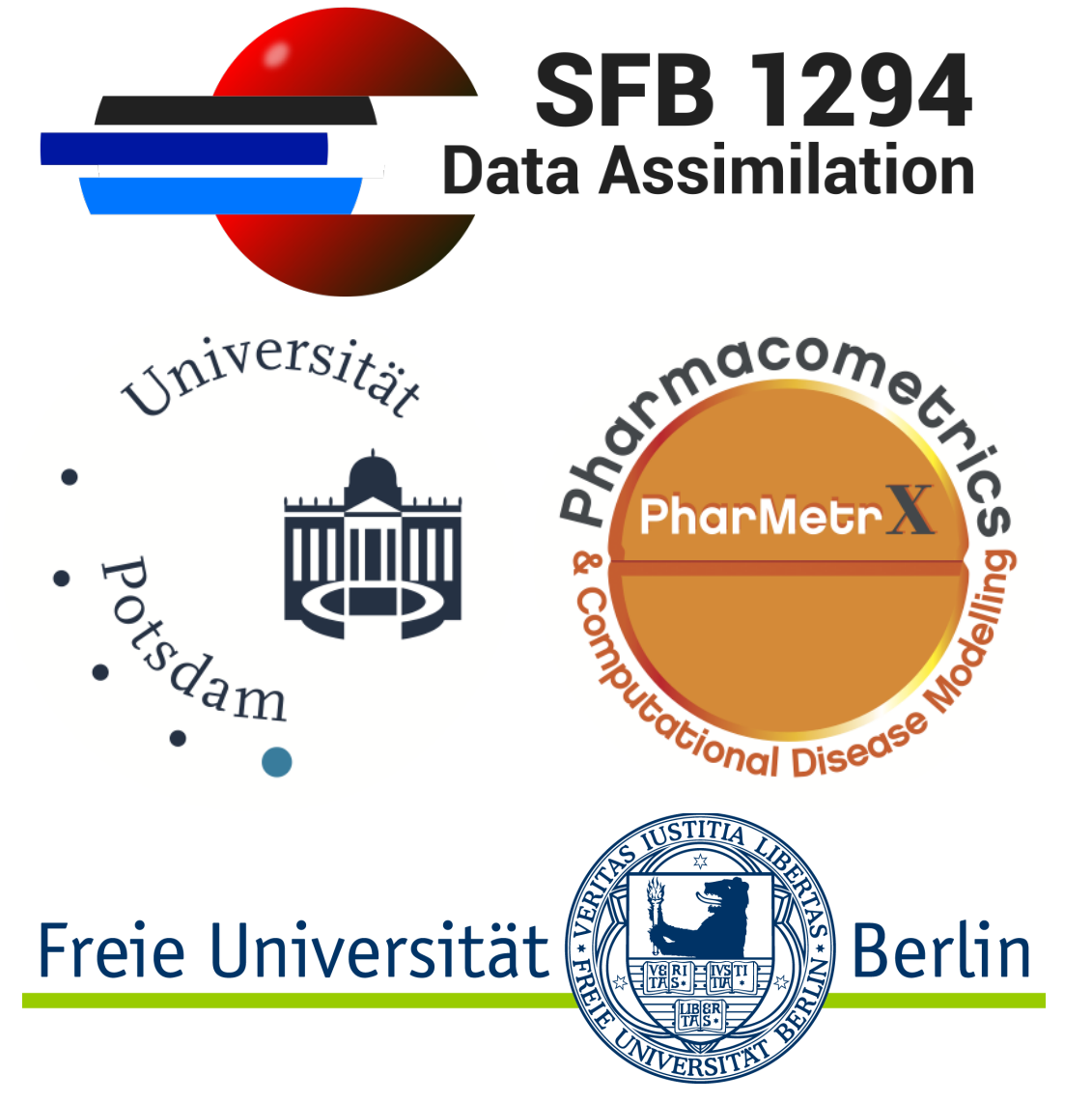
Simple and illustrative model to study Bayesian hierarchical modelling approaches for continued learning in model-informed precision dosing

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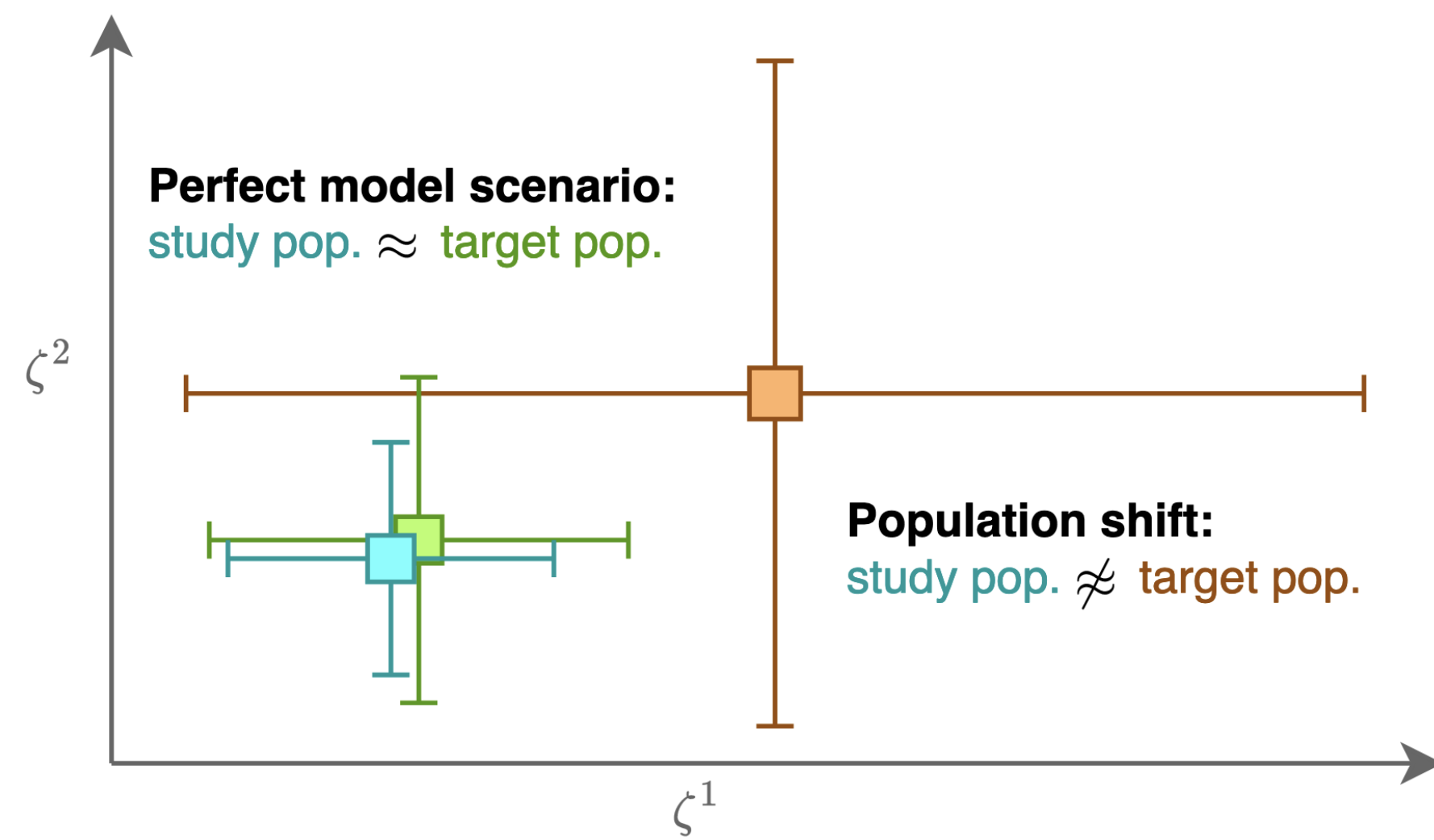
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Continued learning in model-informed precision dosing (MIPD)



Background:

MIPD relies on data from prior studies (model structure & parameter distributions)

Challenge:

How to detect and resolve if prior data does not accurately reflect target population?

Can we use continued learning to estimate the true population parameters regardless of the study design (sparse/dense sampling)?

Figure 1: Sequential Bayesian hierarchical modelling with parametric approximation under different study designs from [4]. **Performance lessens for sparse sampling.**

Bayesian hierarchical modelling and parametric approximation

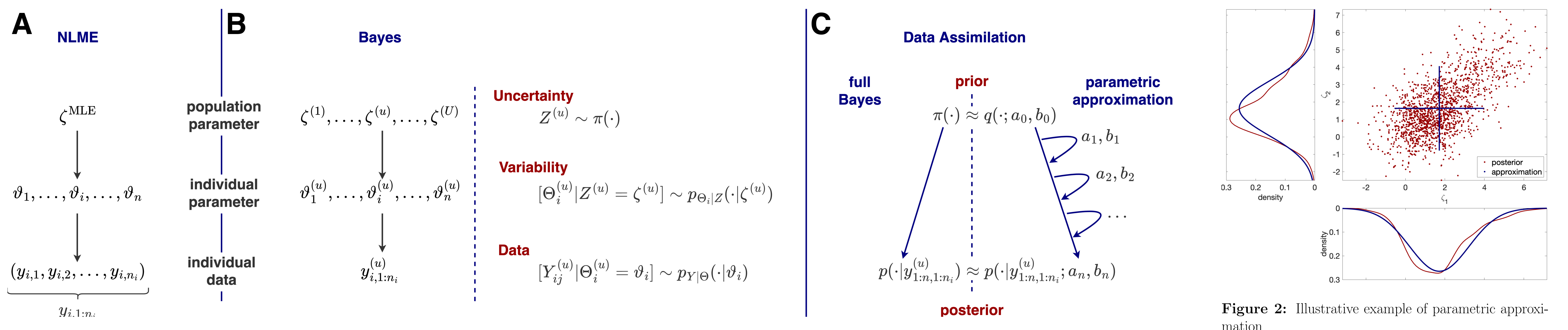
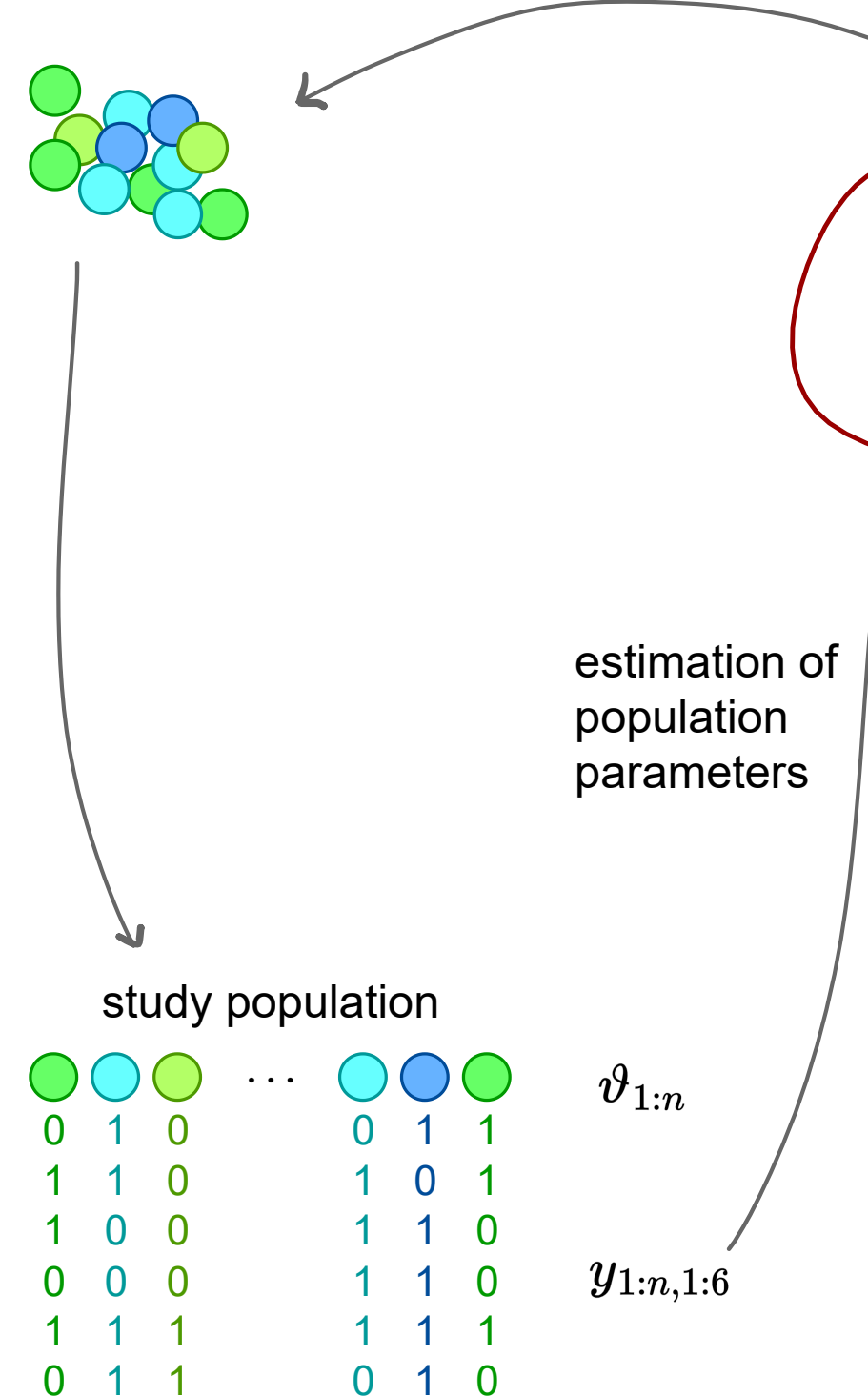


Figure 2: Illustrative example of parametric approximation

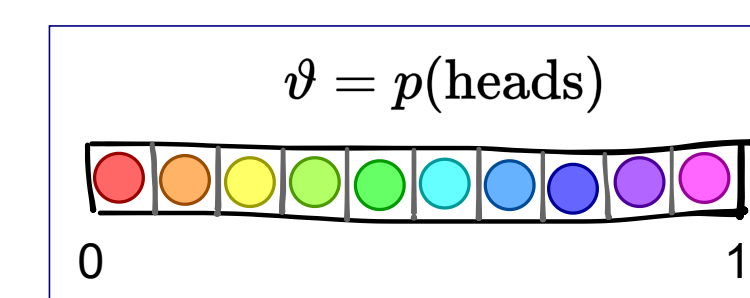
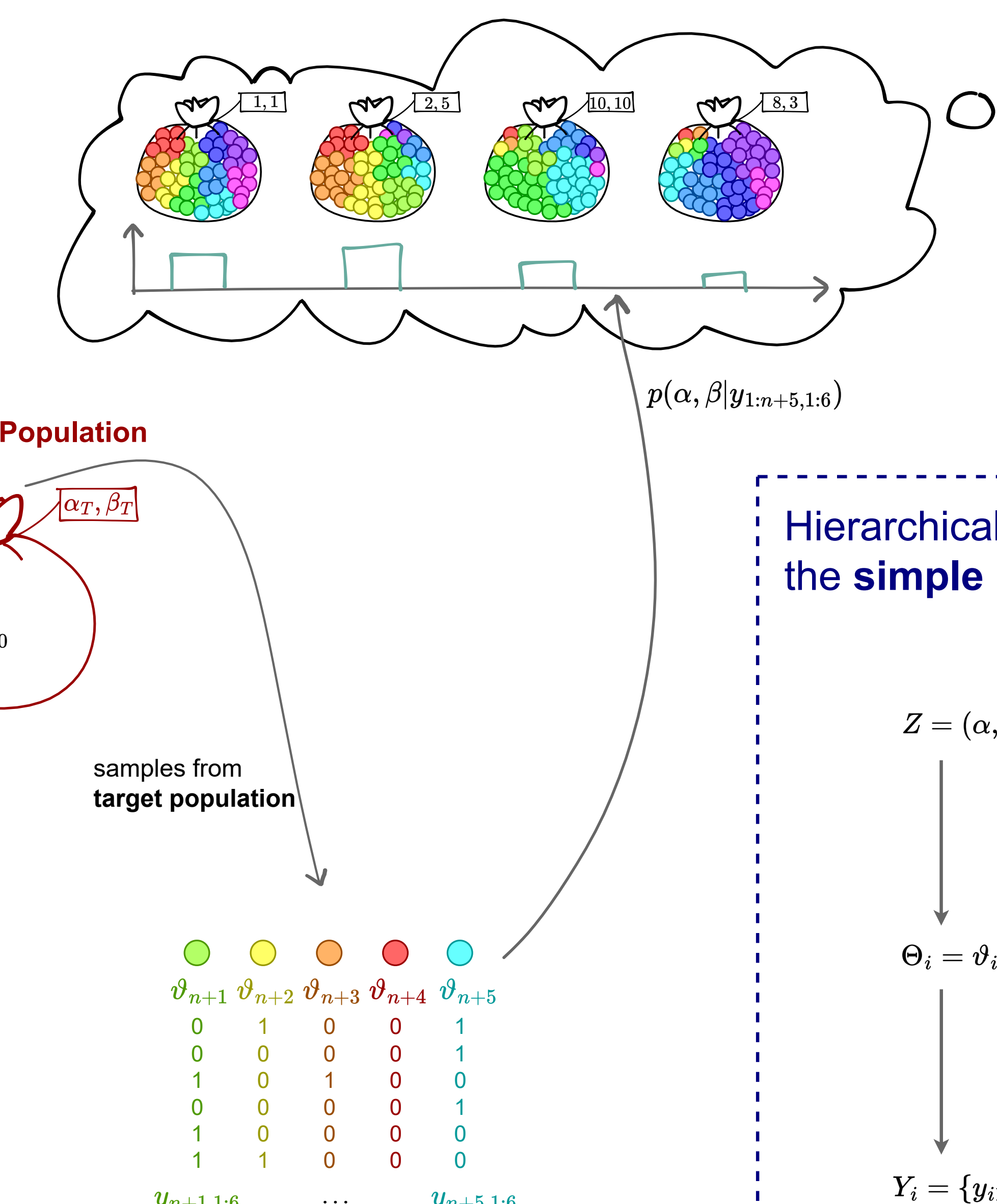
Simple model system: Coin model

Estimation of population parameters from the study population

study population: choose coins from the target population based on some inclusion criteria (e.g. weight, shape, ...)

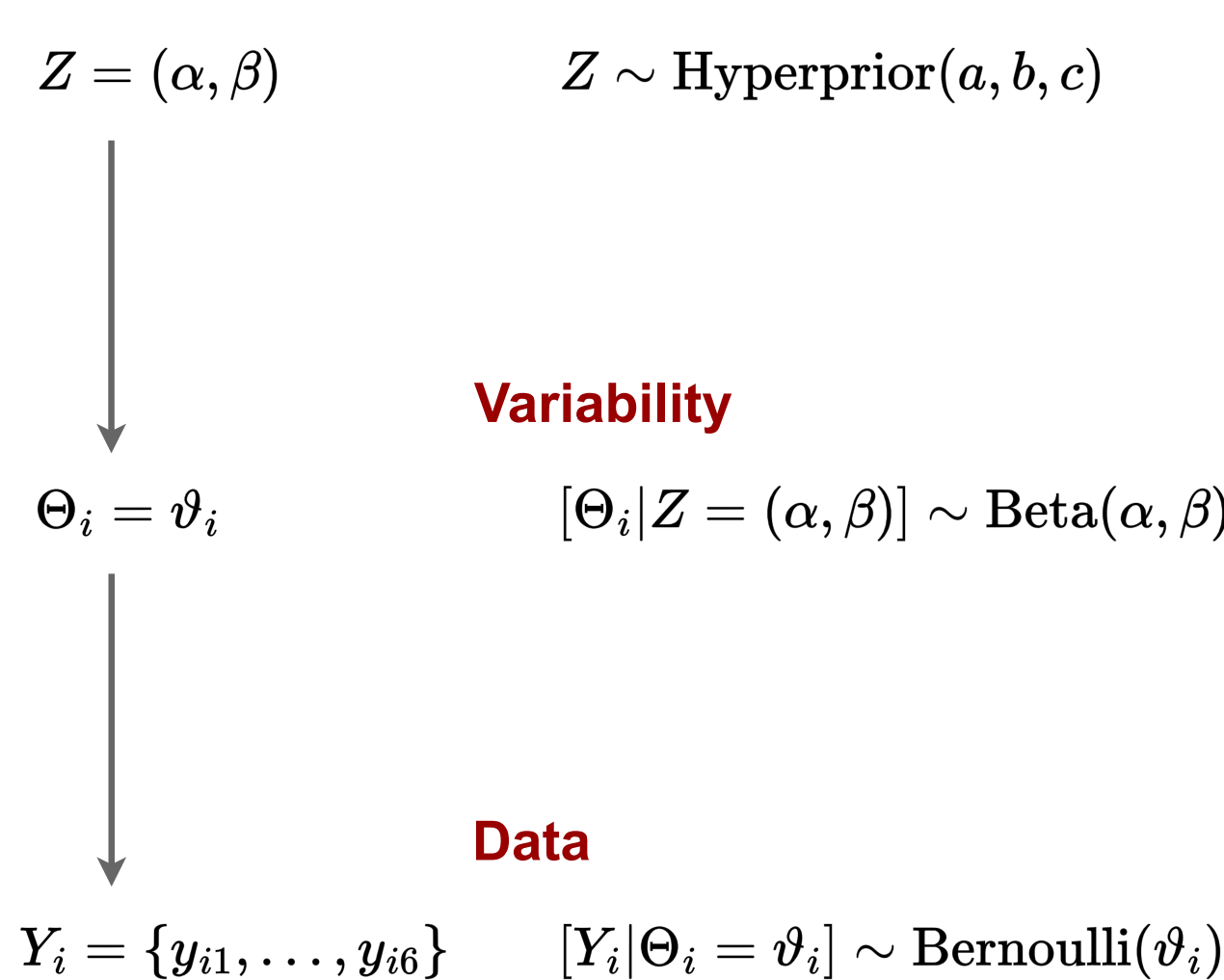


Decreasing uncertainty about target population by continued learning



the study population could have been chosen from any of these... so which one of these is the target population?

Hierarchical structure of the simple model system



Dependence on study design

Comparison of **sparse** (2 throws) and **dense** (10 throws) sampling.

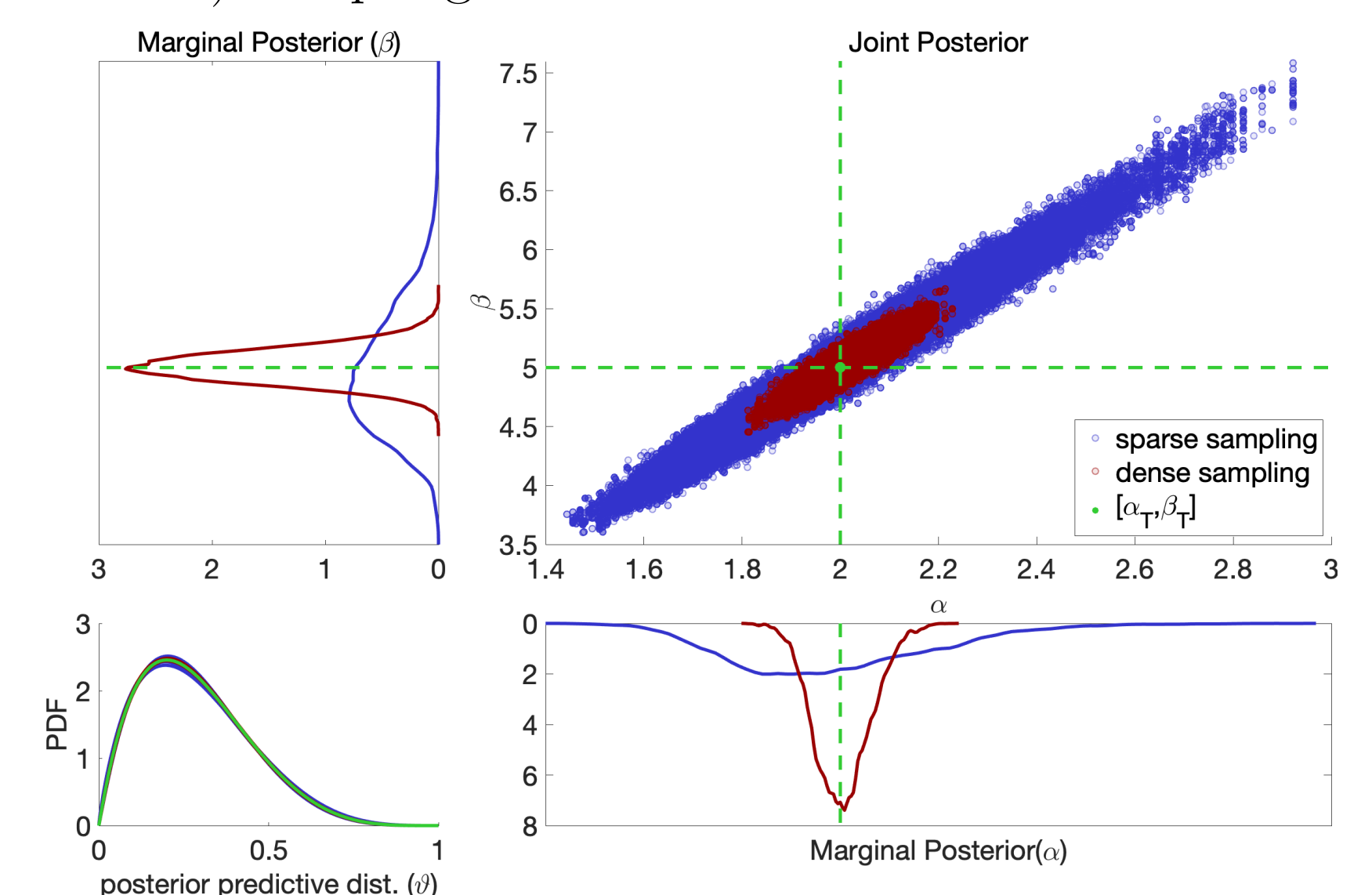


Figure 3: Joint posterior $p(\alpha, \beta | y_{1:n,1:n_i})$ using fully Bayesian hierarchical modelling with Metropolis Hastings.

- Dense sampling scenario results in much lower uncertainty about α_T, β_T .
- Characteristics of the data are captured and prediction of future data is possible in both scenarios.

Conclusion

- Simple & illustrative data model containing all statistical levels of hierarchical Bayes was developed.
- Estimation of population parameters and prediction of future data possible in model system for sparse and dense design.
- Important to distinguish between biases from estimation and approximation.

References

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