

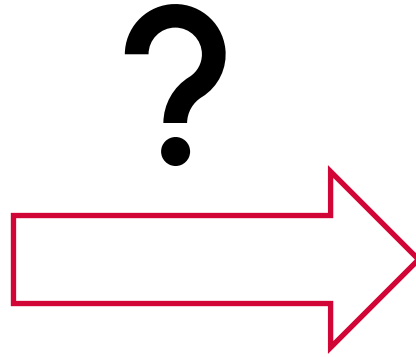
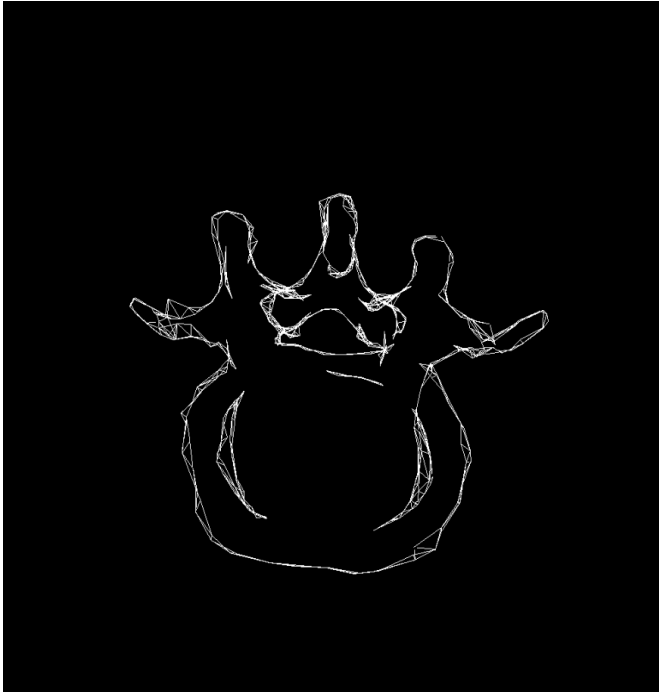


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of Basel

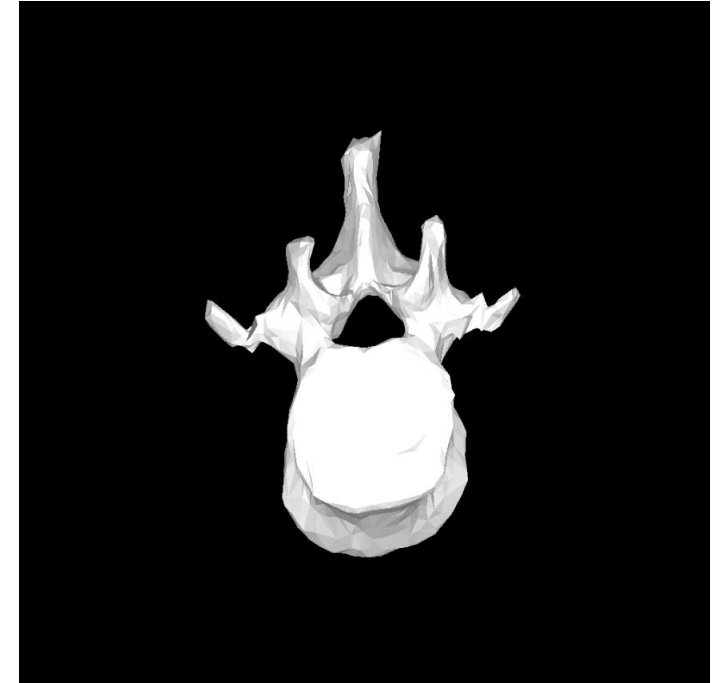
# Bayesian workflow

Marcel Lüthi, Departement of Mathematics and Computer Science, University of Basel

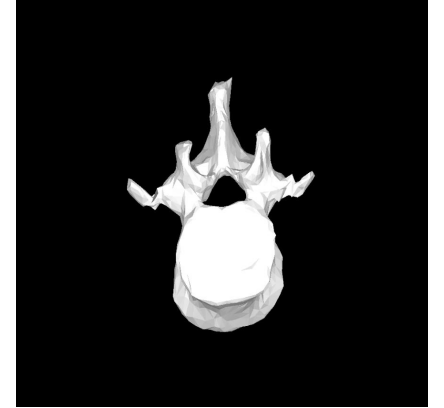
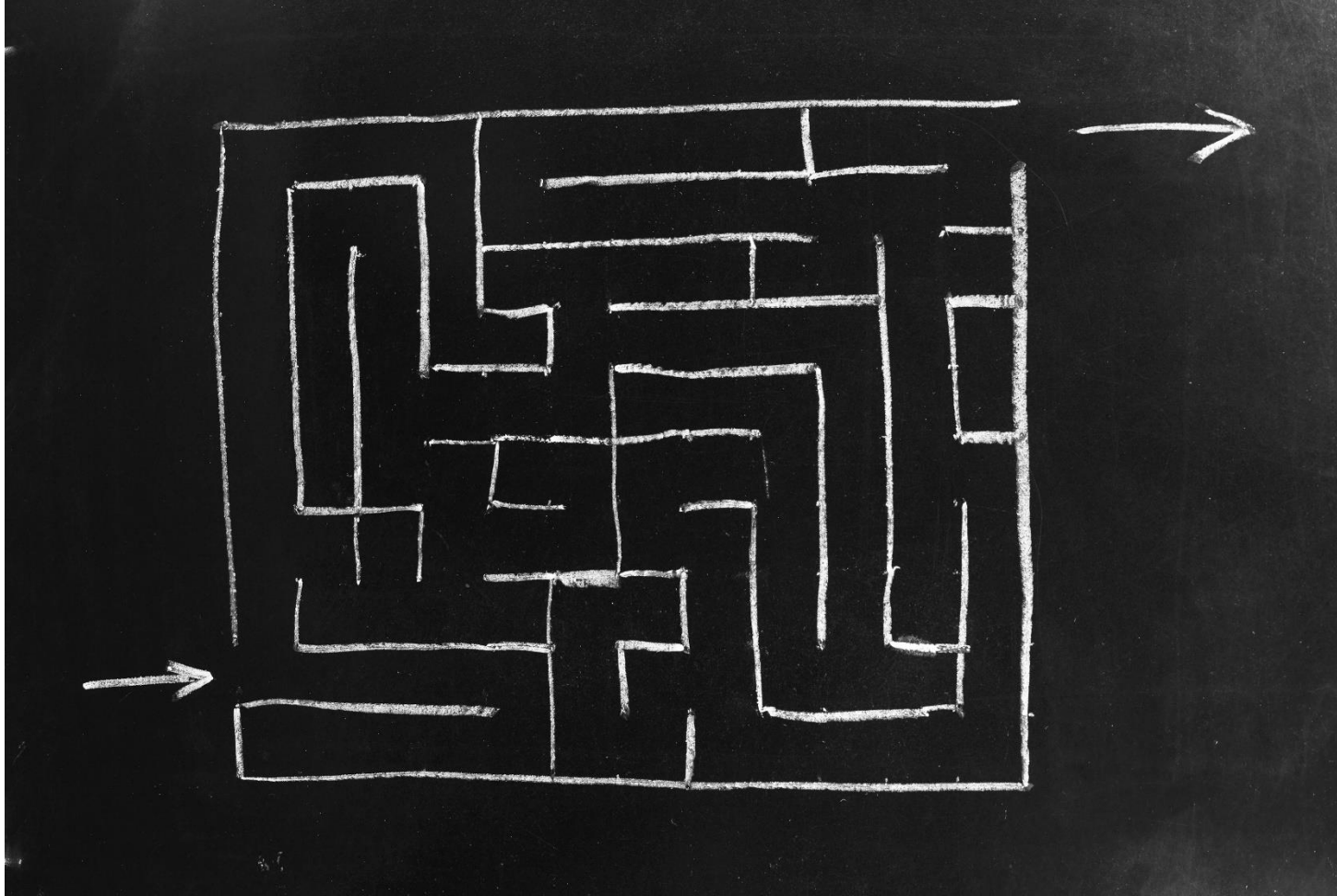
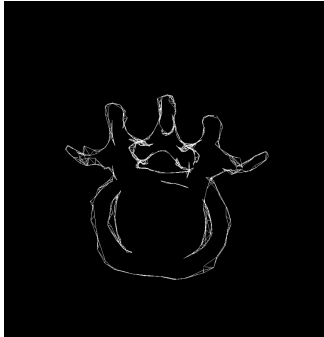
# Why a Bayesian workflow?



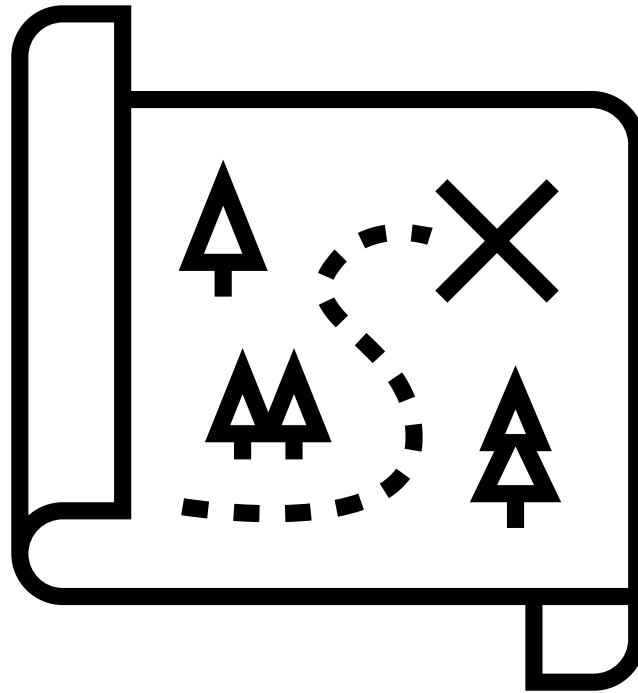
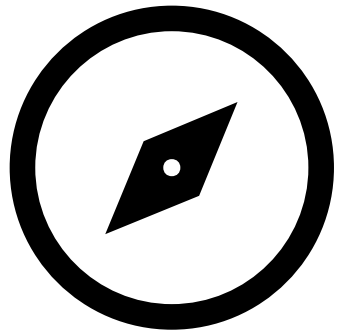
- What are the steps?
- How to start?



# Why a Bayesian workflow?



# What is it?



Tools to navigate all your adventures in data analysis!

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# The workflow

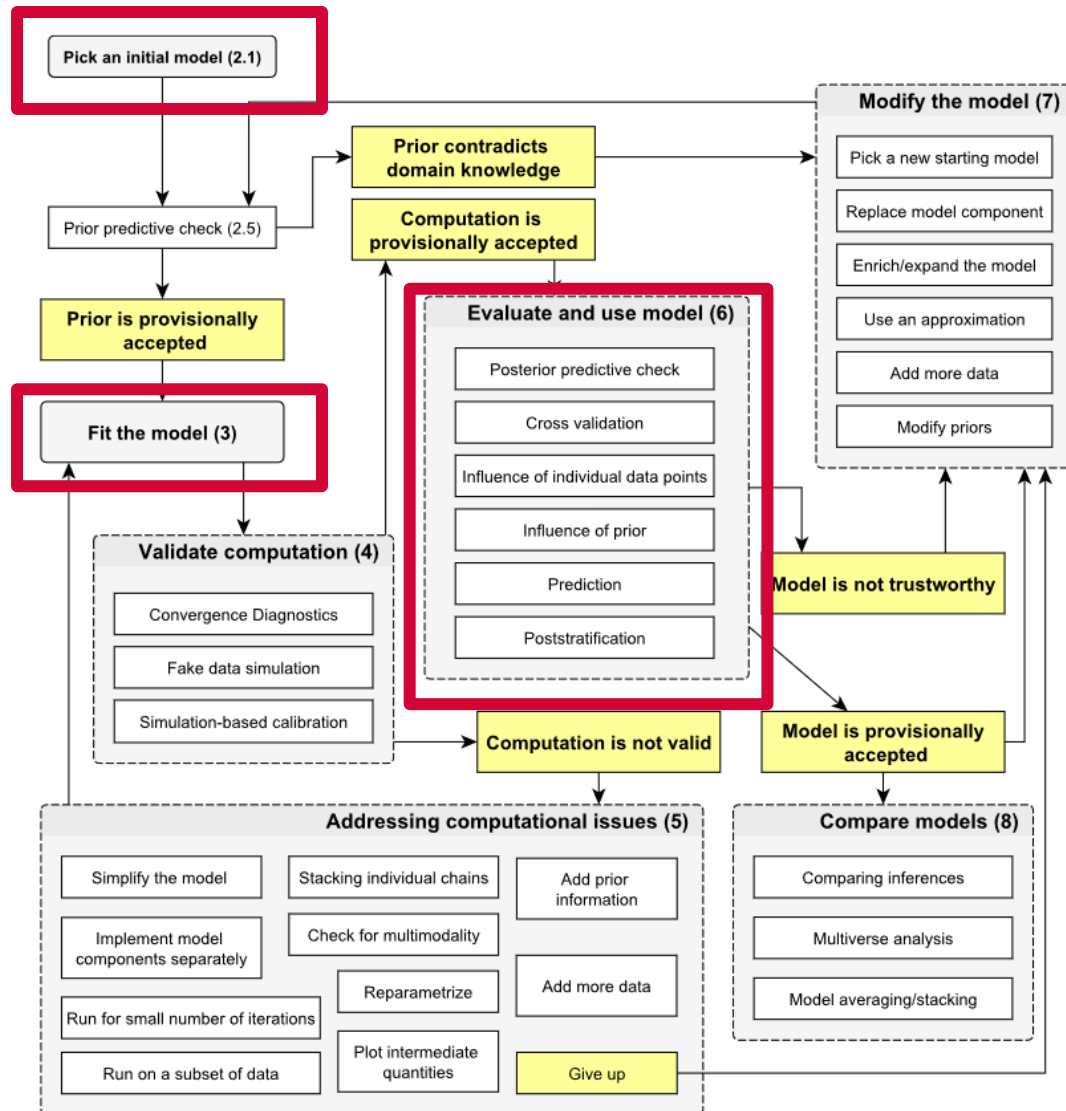


Illustration: Bayesian Workflow, Gelman et al.

## Pick a model

- Start with very simple but reasonable model

## Fit the model

- Perform probabilistic computations to update parameters of the model for given data

## Use the model

- Work with the model to do predictions

# The workflow

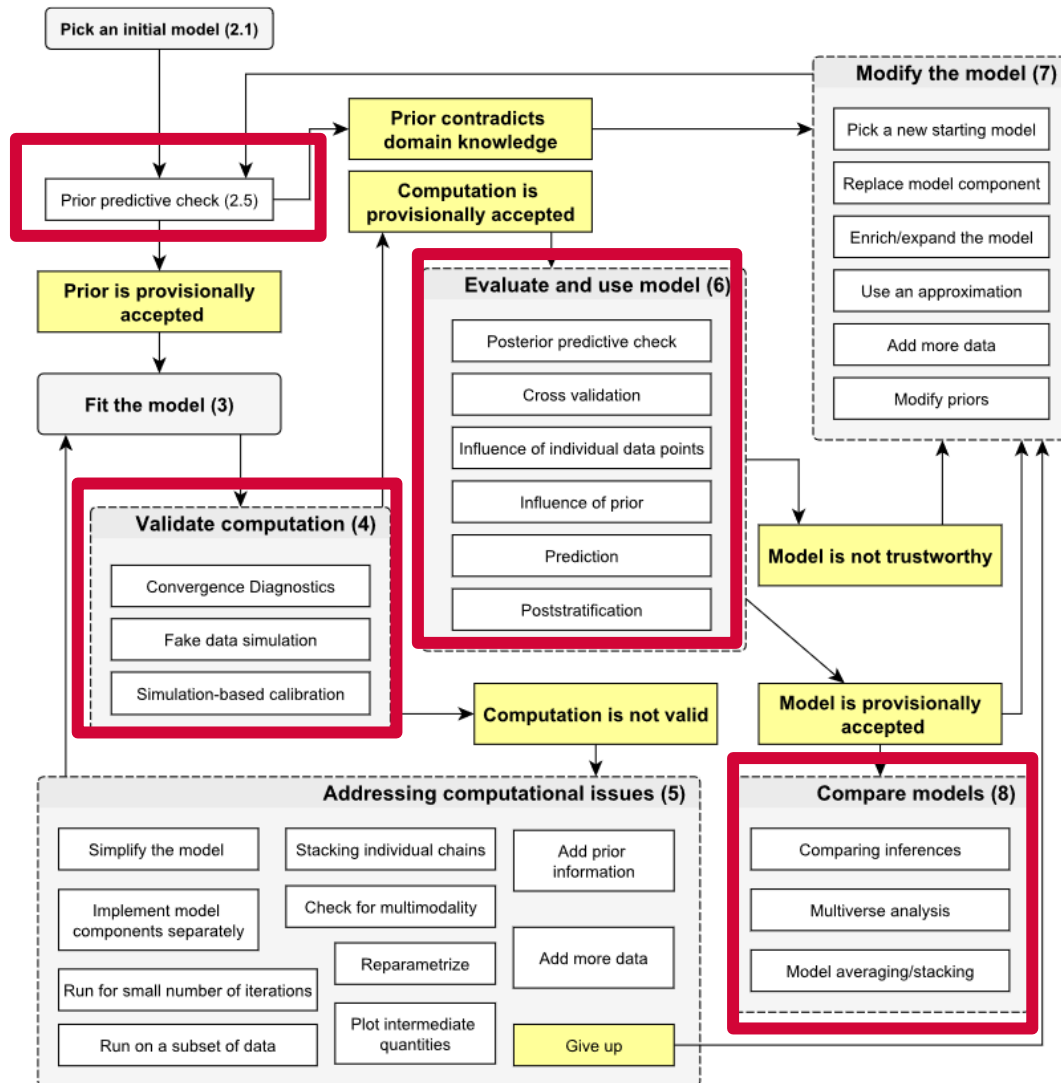


Illustration: Bayesian Workflow, Gelman et al.

## Prior checks

- Does a model correspond to known domain knowledge (previous experiments, measurements, experience, ...) ?

## Validate computation

Do the computations introduce bias or large approximation error?

## Evaluate model

- Does the fitted model represent the original data?
- Can left out data be predicted?
- How much does our prior knowledge influence the result?

## Compare models

- Do other models work equally well, better?

# Bayesian workflow in this course

## Prior modelling and checks

- Modeling distribution over vertebra shapes
- 3D Shape visualizations
- Generation of 2D contours images

## Computation

- Markov-Chain-Monte Carlo methods
- Fake-data simulations for checking computation

## Model evaluation

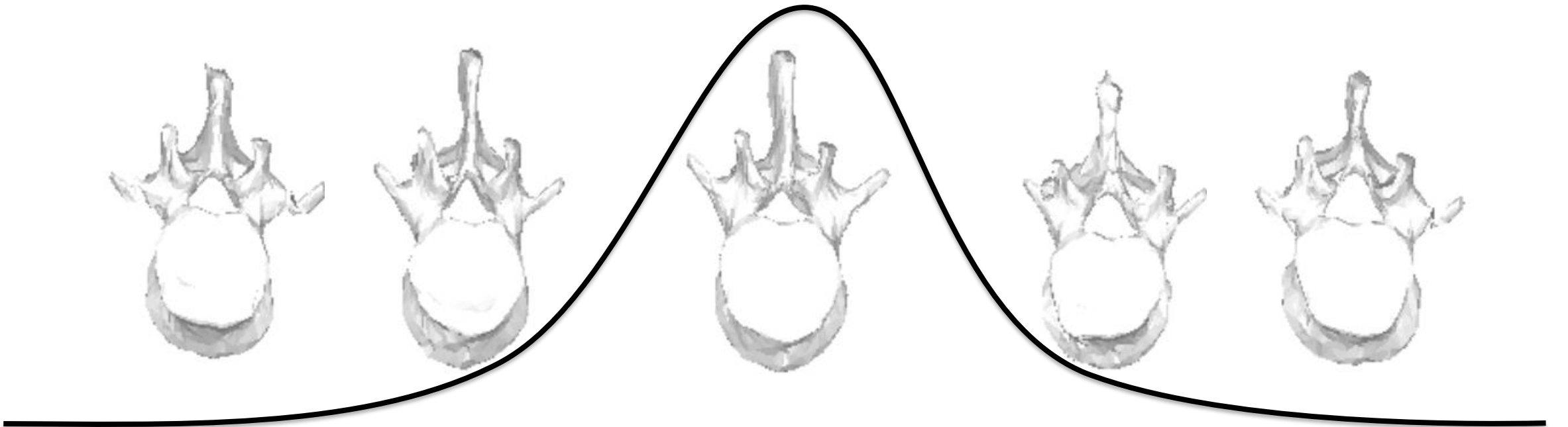
- Visual assessment of generated contours and 3D reconstruction
- Posterior-predictive checks

## Model comparison

- More realistic modelling real-world scenarios (unknown sensor-distance, pose, missing data)
-

# Walkthrough: Initial Model

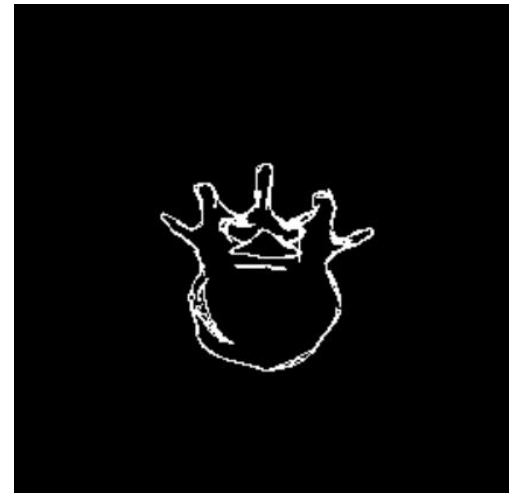
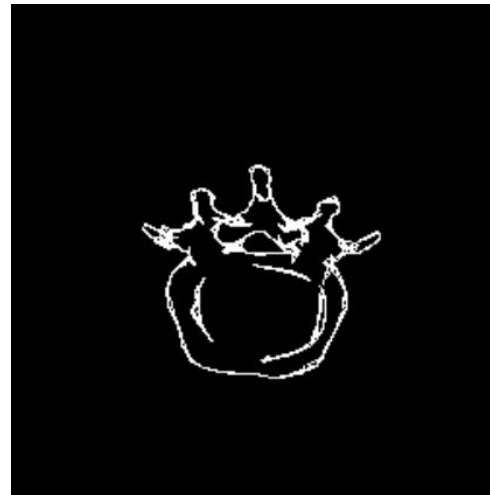
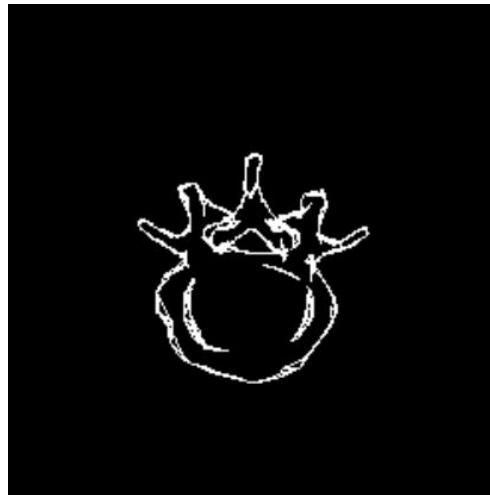
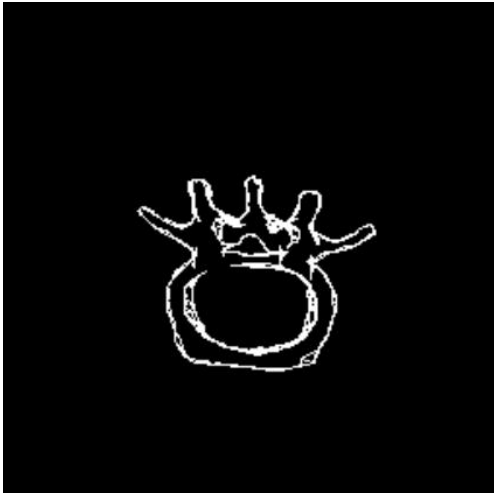
Modelling shapes as normal distributions





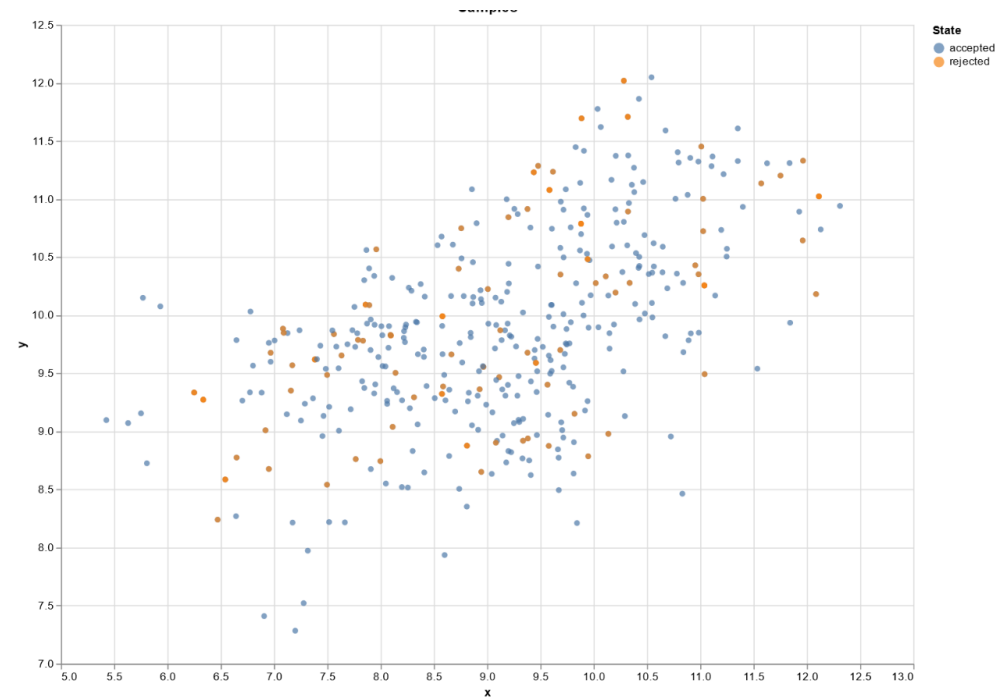
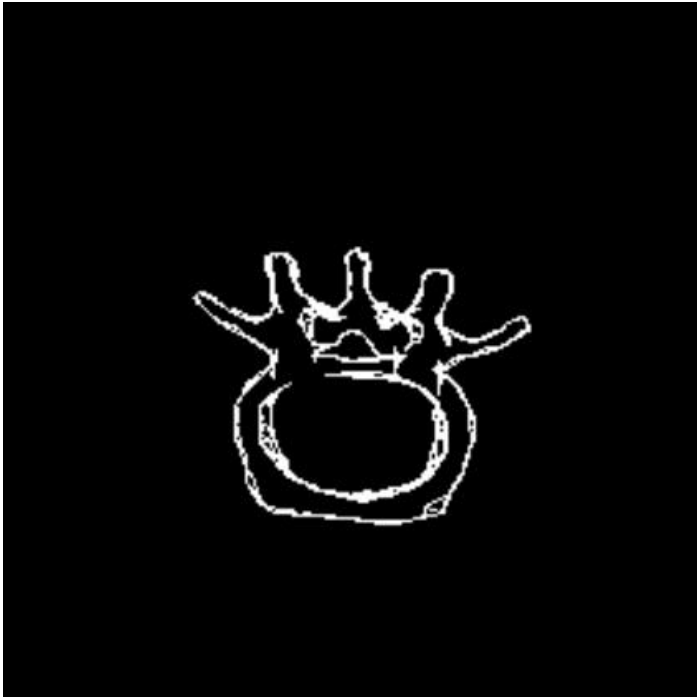
# Walkthrough: Prior-predictive checks

Sampled contours from the model



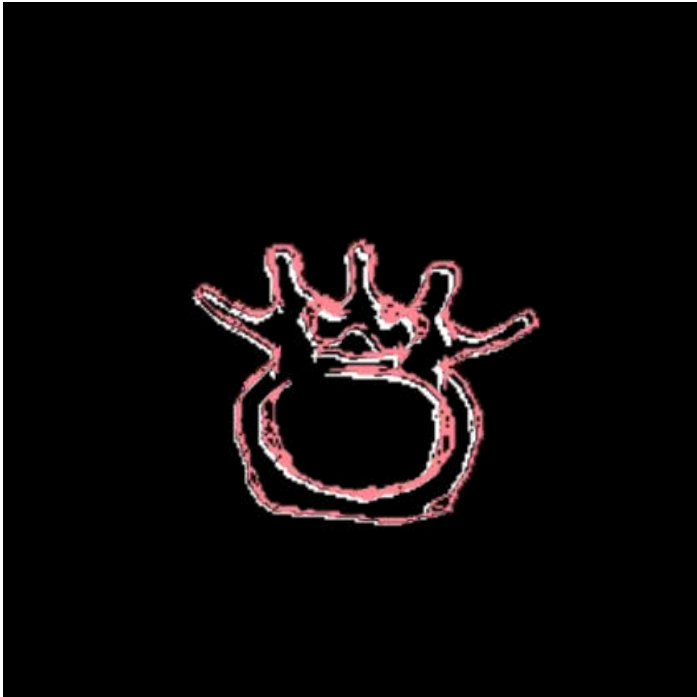
# Walkthrough: Computation

Running the Metropolis-Hastings algorithm on simulated data



# Walkthrough: Fake data simulation

Can we fit generated samples from the model?

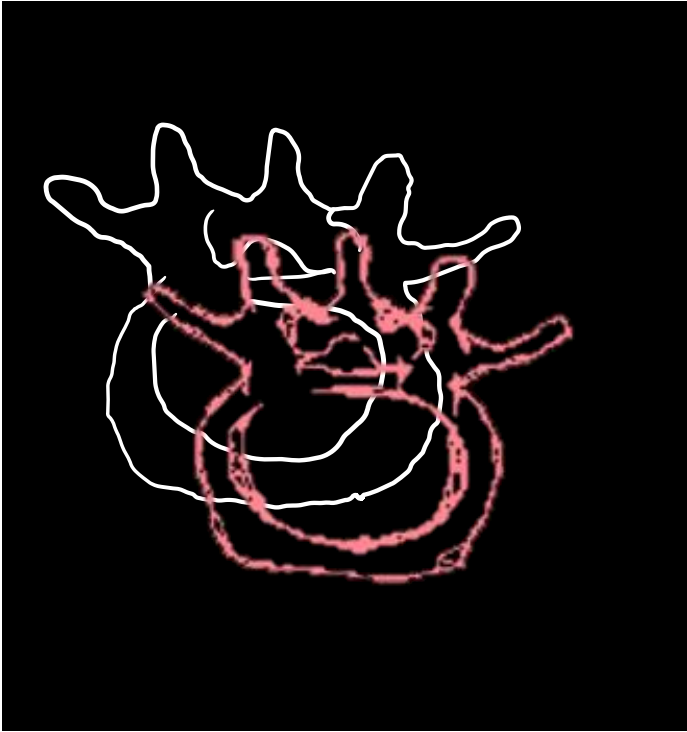


# Posterior predictive checks

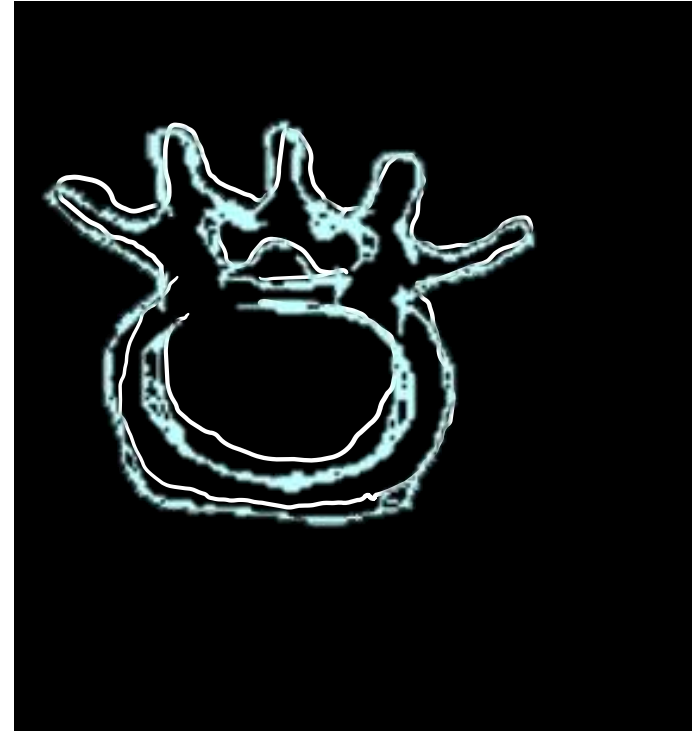
Is solution predictive of data we observed?



# Model comparison and improvement



Model of shape only



Model with pose and sensor-distance

# Goal of the Bayesian workflow

Distribution of 3D shapes explaining the contour

- Understanding of the uncertainty
- Understanding of the limitations and capabilities
- Understanding of the influencing factors

