

## Tutorial 10: Bayesian inference for proportions (beta-binomial model)

Required files: `Tutorial10.R`, `Tutorial10Function.R`, `isatest.rdata`. You will also need the R objects created during Tutorial 9a.

In this tutorial we will return to the fish infection data analysed in Tutorial 9a. This time we will use Bayesian inference to estimate the prevalence of infection under different priors and sample sizes.

Use the script `Tutorial10.R` to run the code required to answer the questions of this session.

### Prior distributions

We can use a beta distribution to elicit prior distributions for the proportion infected fish we want to estimate. The beta distribution is defined for random variables on the interval  $[0, 1]$  (like the proportion parameter) and has parameters  $a$  and  $b$ . This distribution can have a variety of shapes depending on its parameter values. We will use two prior distributions to make inferences about the proportion of infected fish.

**Question 1.1:** What do these prior distributions tell about the possible values for the prevalence of infection? (*Use step 1 of the R script*)

## Posterior distributions

As shown in the lecture, given a binomial model for the data and a beta prior with parameters  $a$  and  $b$ , the posterior has also a beta distribution with parameters  $a + x$  and  $b + n - x$ , where  $n$  is the sample size and  $x$  is the number of infected fish in the sample. So we can use **R** to make inferences about the proportion parameter based on the priors and our samples.

## Bayesian interval and point estimation

**Question 1.2:** Evaluate the effect of the prior distribution on the Bayesian estimates. Compare also the Bayesian estimates with the previously calculated frequentist estimates for the proportion of infected fish (In Tutorial 9a). (*Use steps 2 and 3 of the R script*)