# Common Bayesian Prior Distributions

Each prior is described by the belief it imposes on a model and its implications for scientific conclusions.

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| Prior Type | Belief Imposed on the Model | Implications for Scientific Conclusions |
| Uniform Prior | Assumes all values in a given range are equally likely; expresses complete ignorance within bounds. | Useful as a non-informative prior. Risky if bounds are wide or poorly chosen; may be improper for unbounded parameters. |
| Exponential Prior | Small values are more likely; assumes a rapid decay in probability with increasing parameter size. | Regularizes by discouraging large values. May bias results downward if decay rate is misaligned with reality. |
| Geometric Prior | Discrete prior assuming smaller counts are more likely; suitable for waiting times until the first success. | Encourages low counts. May bias inferences if the real distribution has higher variance. |
| Multimodal Prior | Reflects belief in multiple plausible regions for the parameter (e.g., multiple hypotheses). | Captures uncertainty in prior knowledge. Leads to complex posteriors, harder to summarize. |
| Poisson Prior | Models count data with an expected average rate (λ). | Useful for prior counts or event rates. Can mislead if data are overdispersed. |
| Gamma Prior | Positive-only prior, flexible for rates and precision parameters. | Widely used, especially for precision. May dominate inference if too informative. |
| Inverse Gamma Prior | Models positive continuous values, often variances. Assumes small variances more likely. | Common for variances in hierarchical models. Can be too strong a prior with small samples. |
| Beta Prior | Defined on [0,1]; expresses beliefs about probabilities (e.g., success rates). | Conjugate for binomial models. Can strongly influence results in small datasets. |
| Normal Prior | Assumes parameter is centered around a mean with symmetric uncertainty. | Regularizes parameters. Easily interpretable. Can constrain inference if too narrow. |
| Student’s t Prior | Like normal but with heavy tails. Allows for occasional large deviations. | Robust to outliers. Balances regularization with flexibility for large effects. |
| Laplace (Shrinkage) Prior | Belief in sparsity; many coefficients near zero, few large ones. | Performs shrinkage and implicit variable selection. Can underrepresent dense effects. |
| Binomial Prior | Belief about fixed number of successes in a fixed number of trials. | Encodes strong structural constraints. Useful when total trials are known and fixed. |