Common probability distributions

Measurements

Normal



μ mean
σ standard deviation

All real numbers. Much distribution, very symmetry, wow. Pick me, c'mon just do it. Ah, linear regression.

Student-t

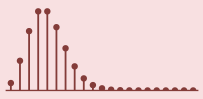


ν degrees of freedom, smaller $\nu \to$ heavier tails
μ mean, if $\nu > 1$
σ scale; variance is $\sigma^2\nu/(\nu-2)$ if $\nu > 2$

All real numbers. Robust alternative to Normal. Good choice if many outliers. At $\nu > 30$ turns into Normal.

Counts

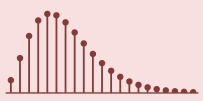
Poisson



λ rate: both the mean and the variance

Non-negative integers. Counts of events occuring at a fixed rate. Poisson regression, heh. $\lambda \to$ Gamma prior.

Negative binomial



μ mean
φ dispersion: variance is $\mu + \mu^2/\varphi$
smaller $\varphi \to$ more overdispersion

Non-negative integers. Robust alternative to Poisson when mean and variance need to be decoupled.

Probabilities

Beta



α number of prior successes
β number of prior failures

Between 0 and 1. Typically a probability, very useful as a prior for Bernoulli and Binomial.

Dirichlet

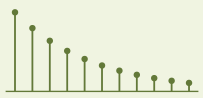


α vector of K concentrations;
mean of component k is $\alpha_k / \sum_j \alpha_j$

Simplex of length K. K probabilities summing to 1; a prior for Categorical and Multinomial.

Waiting times

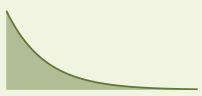
Geometric



p probability of success in each trial; mean is $(1-p)/p$

Non-negative integers. The number of failures before the first success. Survival models. $p \to$ Beta prior.

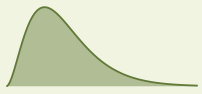
Exponential



λ rate: events per unit of time; mean is $1/\lambda$

Positive reals. Waiting time until the next event at a constant rate. Survival models. $\lambda \to$ Gamma prior.

Gamma



α shape
β rate; mean is α/β, variance is α/β^2

Positive reals. Waiting time for α events, e.g. three Covid infections; good choice as prior for rates.

Outcomes & choices

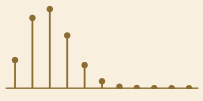
Bernoulli



p probability of a 1 ("success")

0 or 1. A single binary outcome, e.g. coin lands heads. Logistic regression. $p \to$ Beta prior.

Binomial



n number of trials
p probability of success per trial

Integers 0 to n. Successes in n with the same p, e.g. coin throws. Logistic regression. $p \to$ Beta prior.

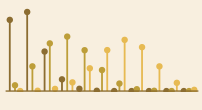
Categorical



θ simplex of length K; θ_k is the probability of category k

Integers 1 to K. Choose one of K, e.g. your favourite color. Multinomial regression. $\theta \to$ Dirichlet prior.

Multinomial



n number of draws
θ simplex of length K; see Categorical

K counts summing to n. Choose n times out of 1 to K . Multinomial regression, durrr. $\theta \to$ Dirichlet prior.