LING2136 / 4136

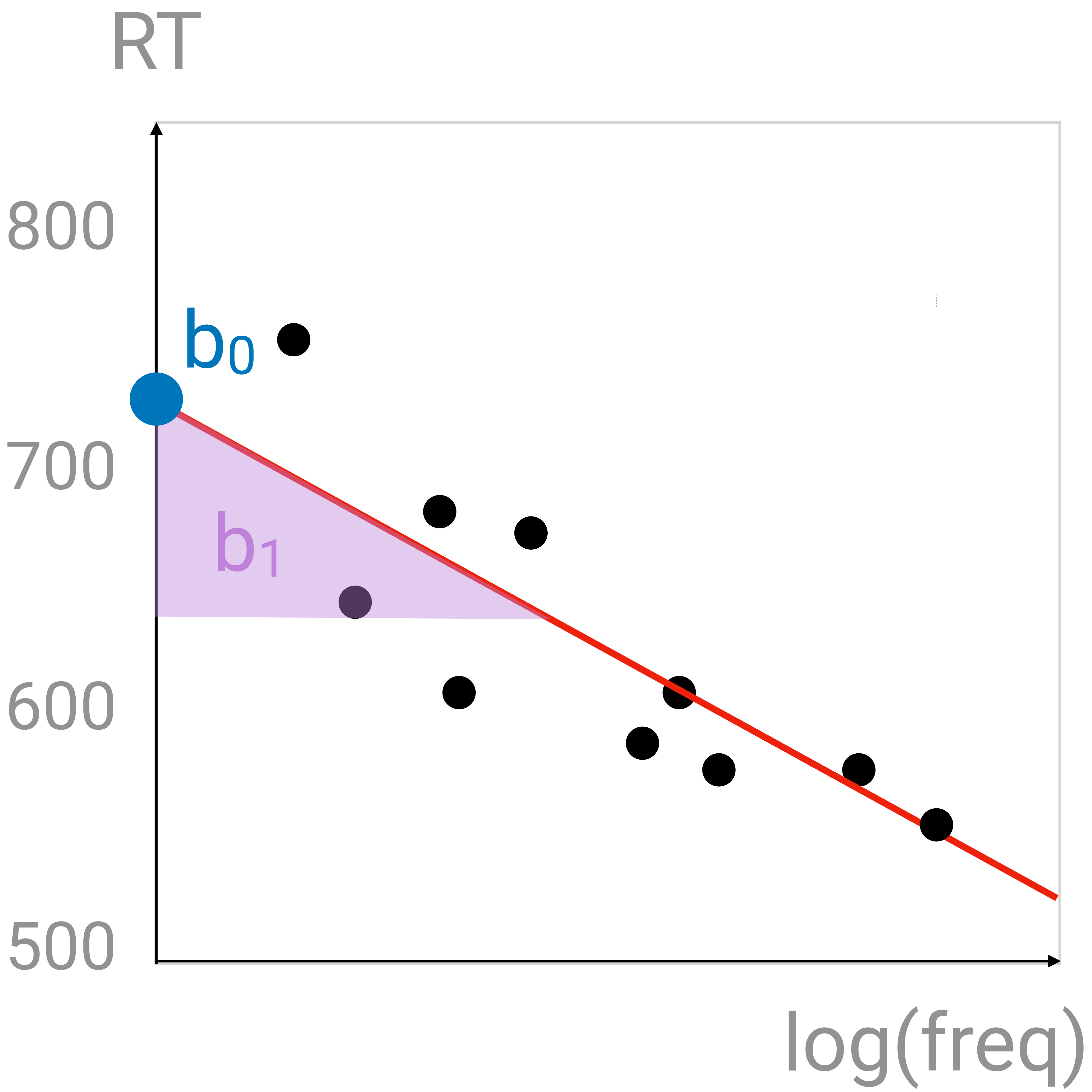
Advanced Statistical Methods for Language Students

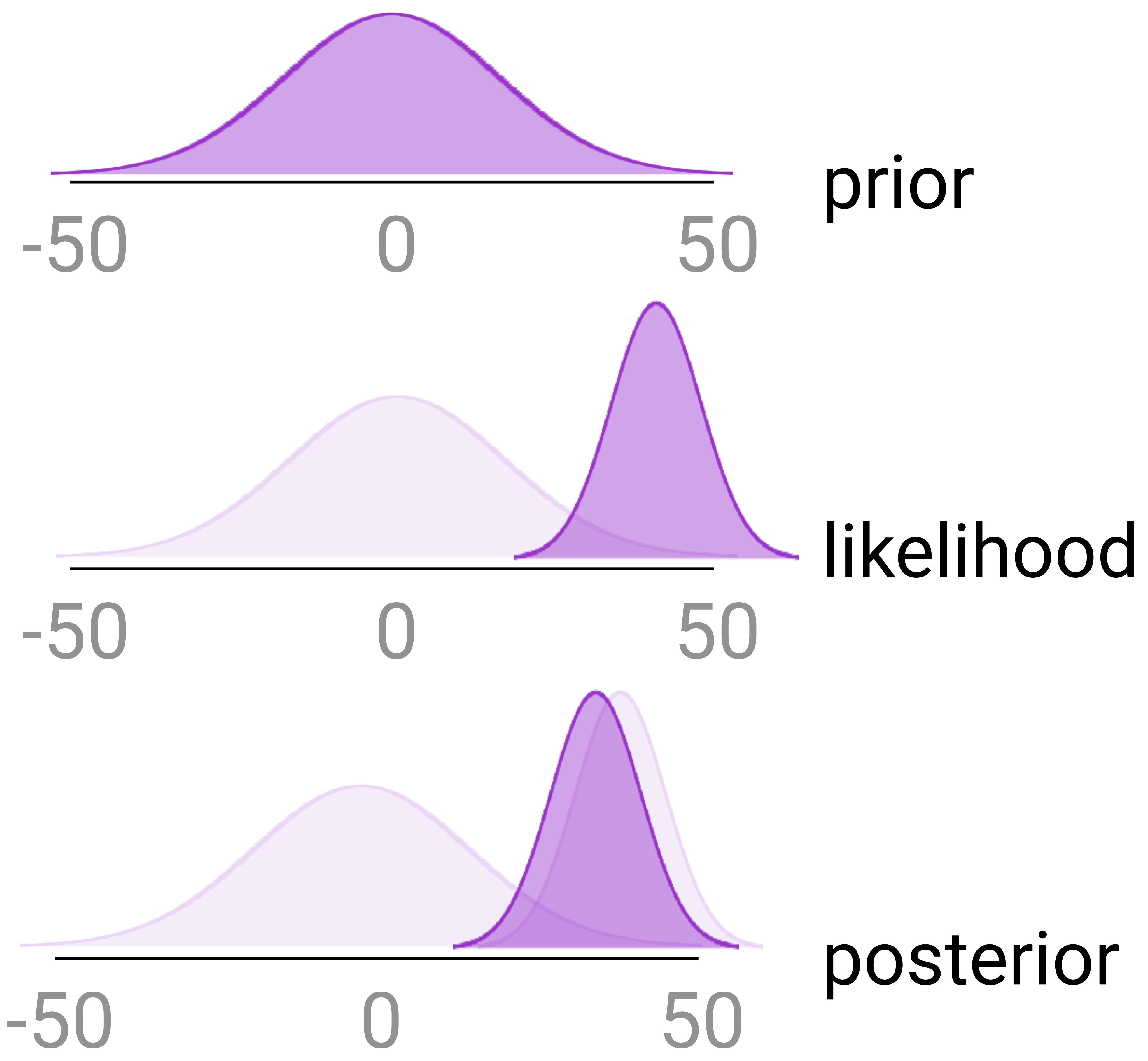
Session-06: Distributions & Priors

Lecturer: Timo Roettger

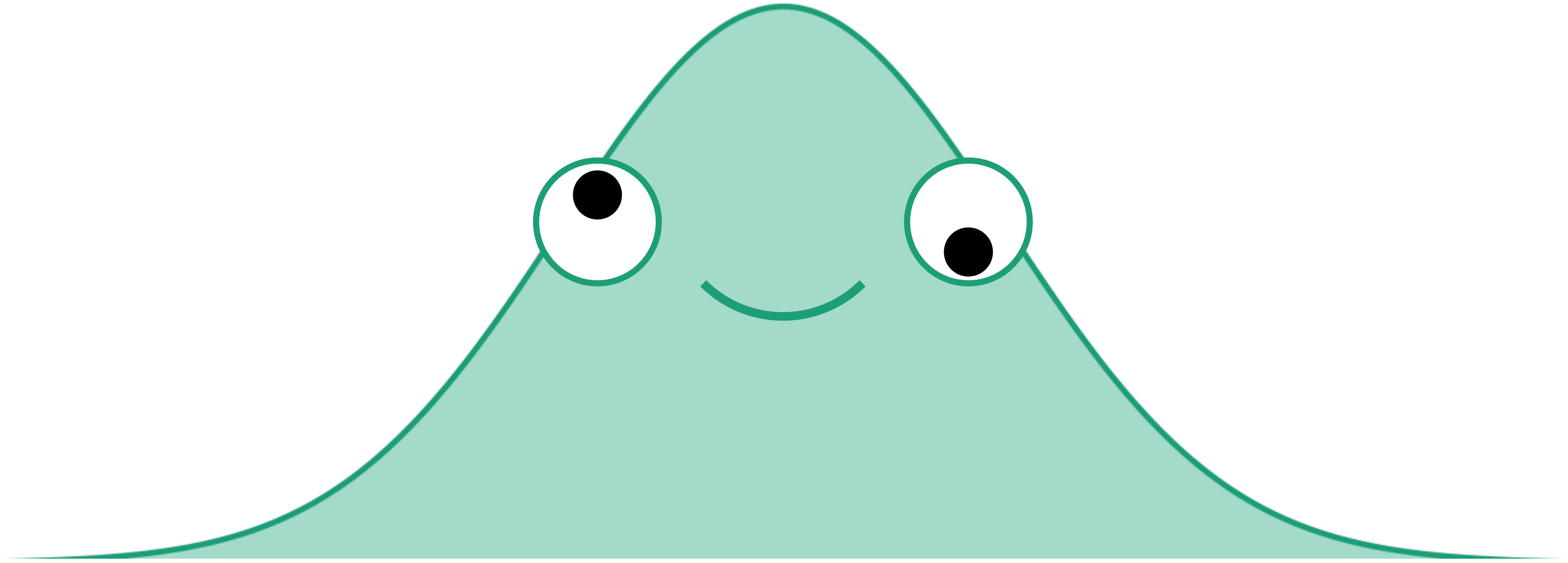
BELIEF

RT = b0 - b1 * log(frequency)



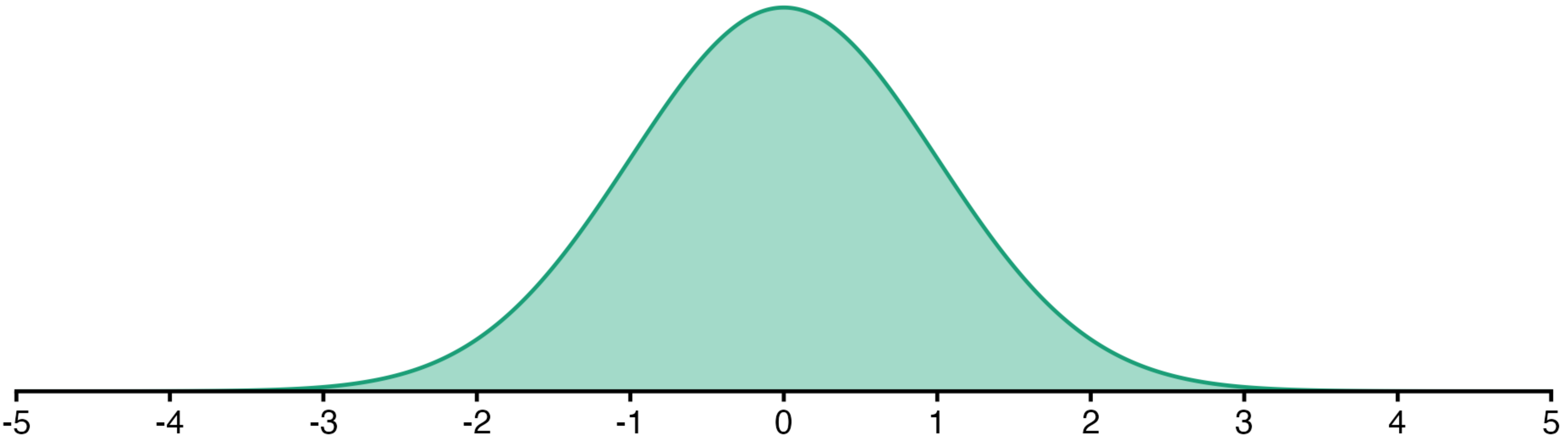


The Normal



The Gaussian (normal) distribution

has parameters: mean (μ) & standard deviation (σ)



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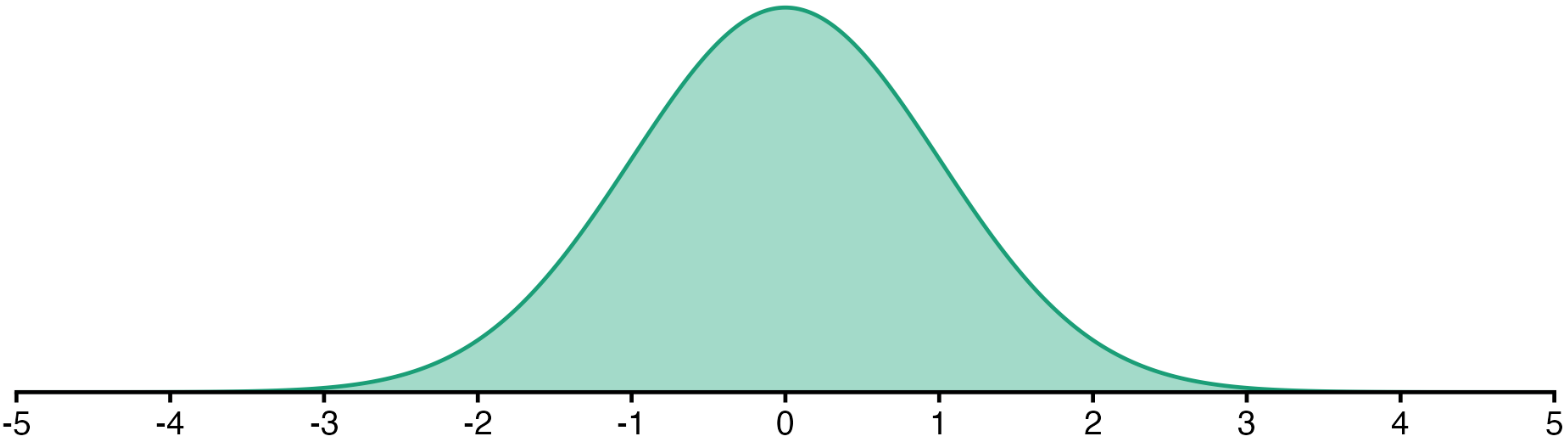
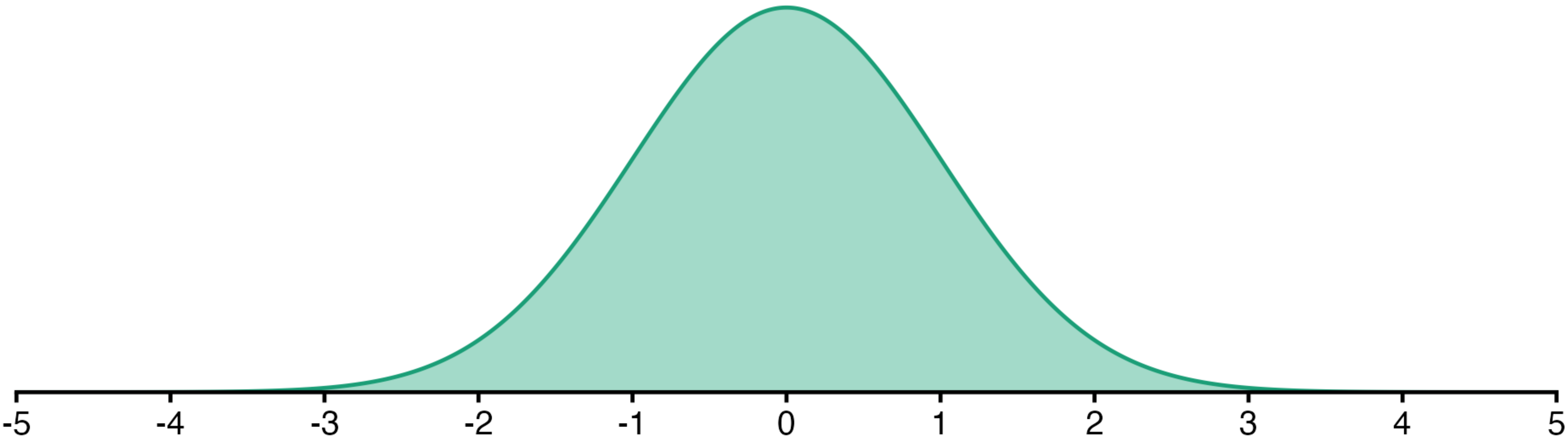


The Gaussian (normal) distribution

has parameters: mean (μ) & standard deviation (σ)

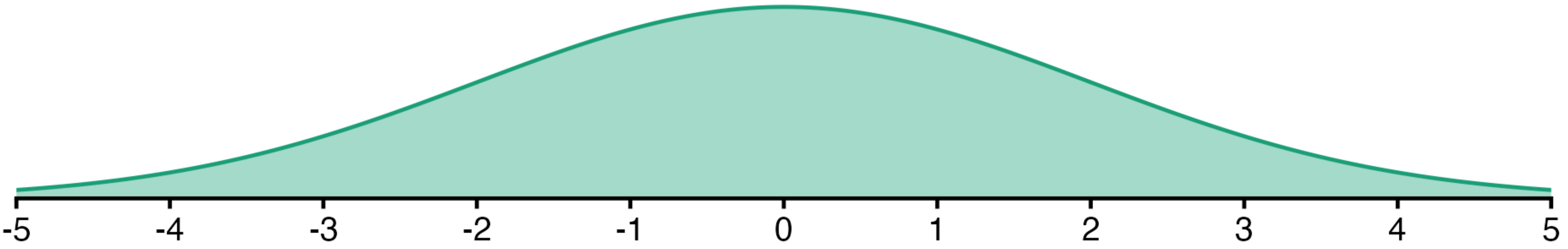
Normal (0,1)



The Gaussian (normal) distribution

has parameters: mean (μ) & standard deviation (σ)

Normal (0,2)



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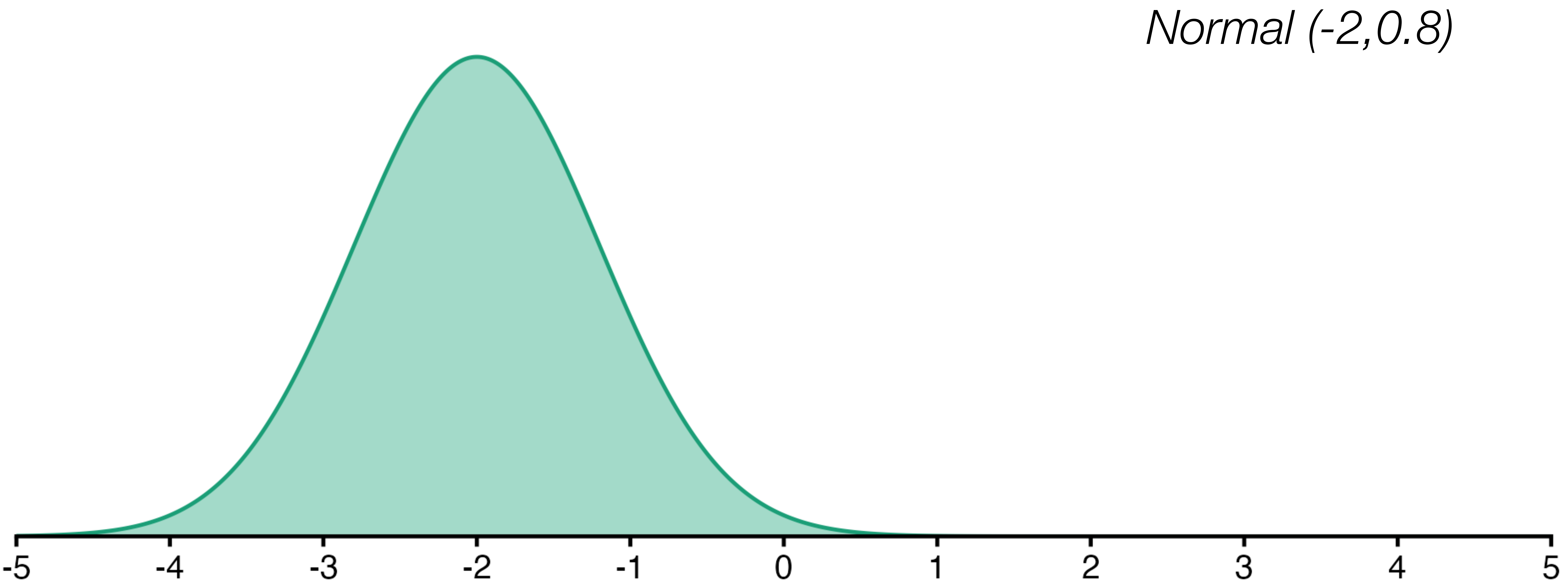

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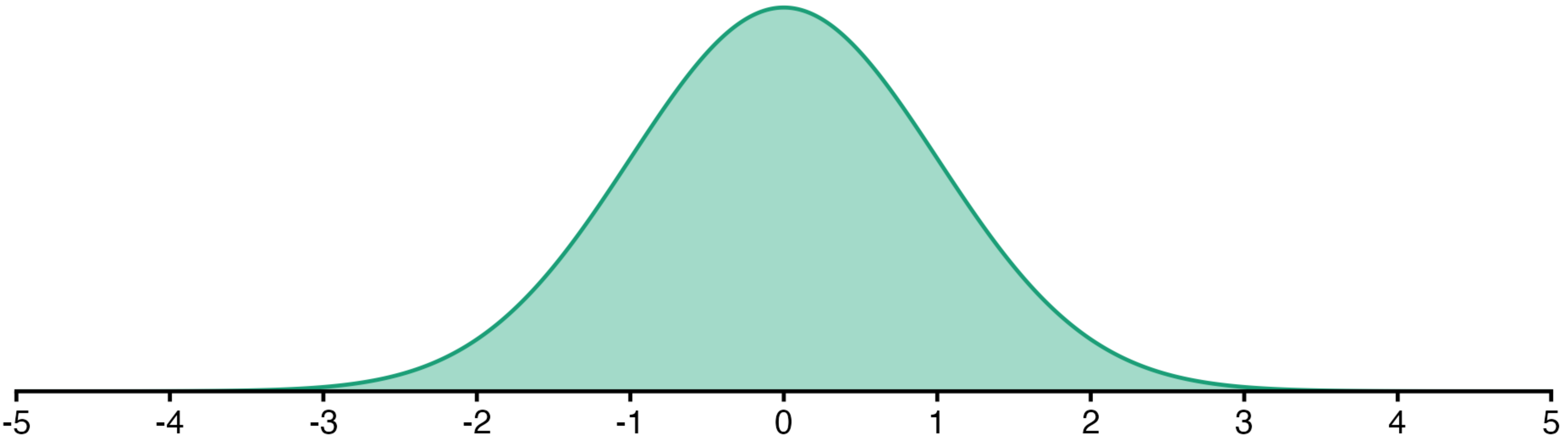
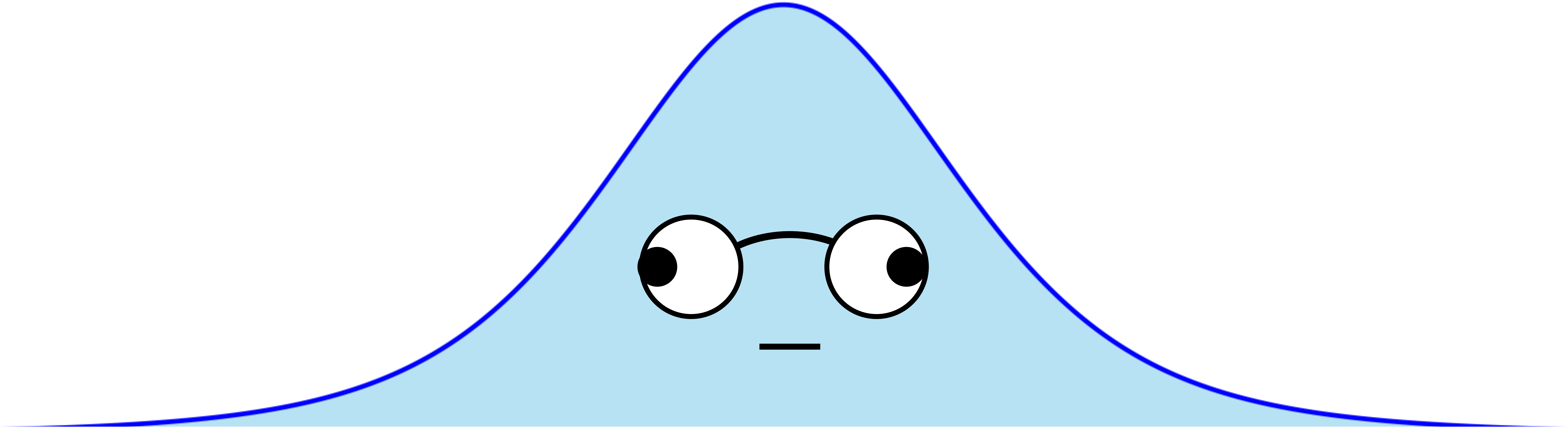
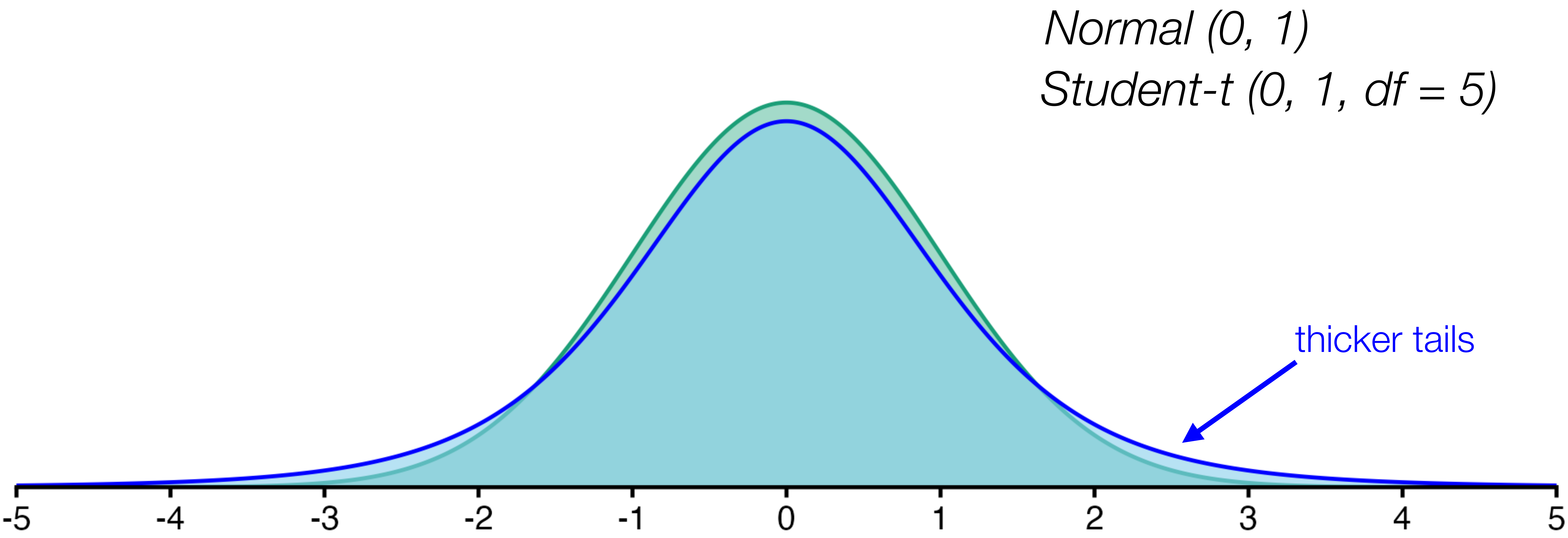


The Student-t



The student-t distribution

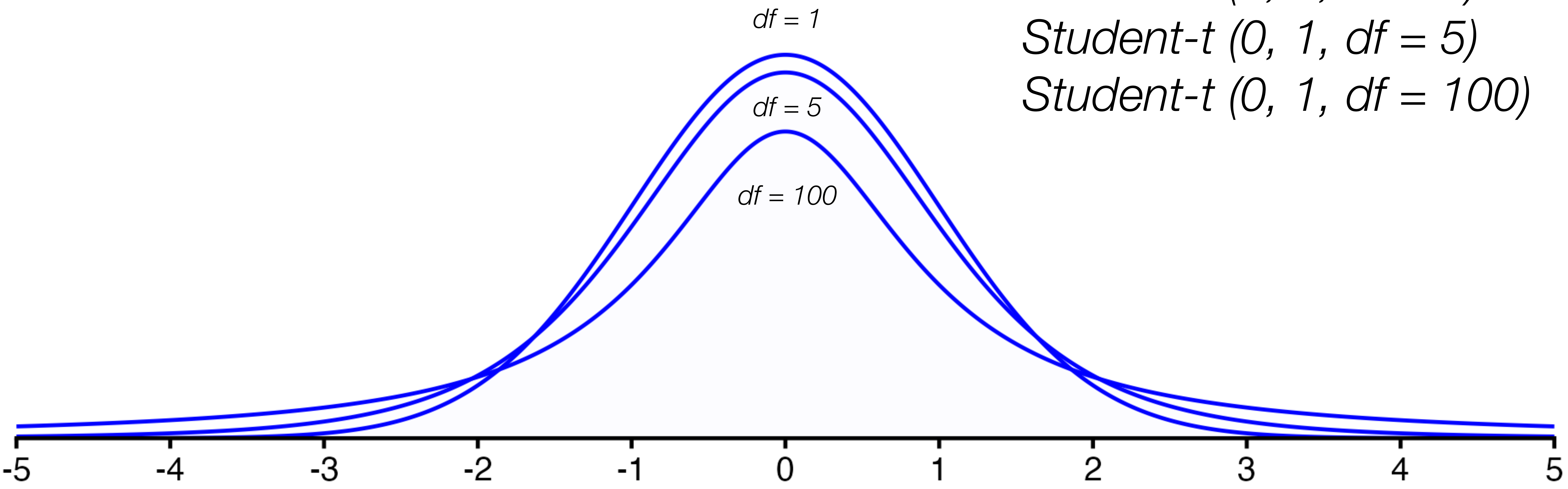
has parameters: mean (μ), scale (σ) and degrees of freedom (df)



The student-t distribution

has parameters: mean (μ), scale (σ) and degrees of freedom (df)

Student-t (0, 1, df = 1)
Student-t (0, 1, df = 5)
Student-t (0, 1, df = 100)



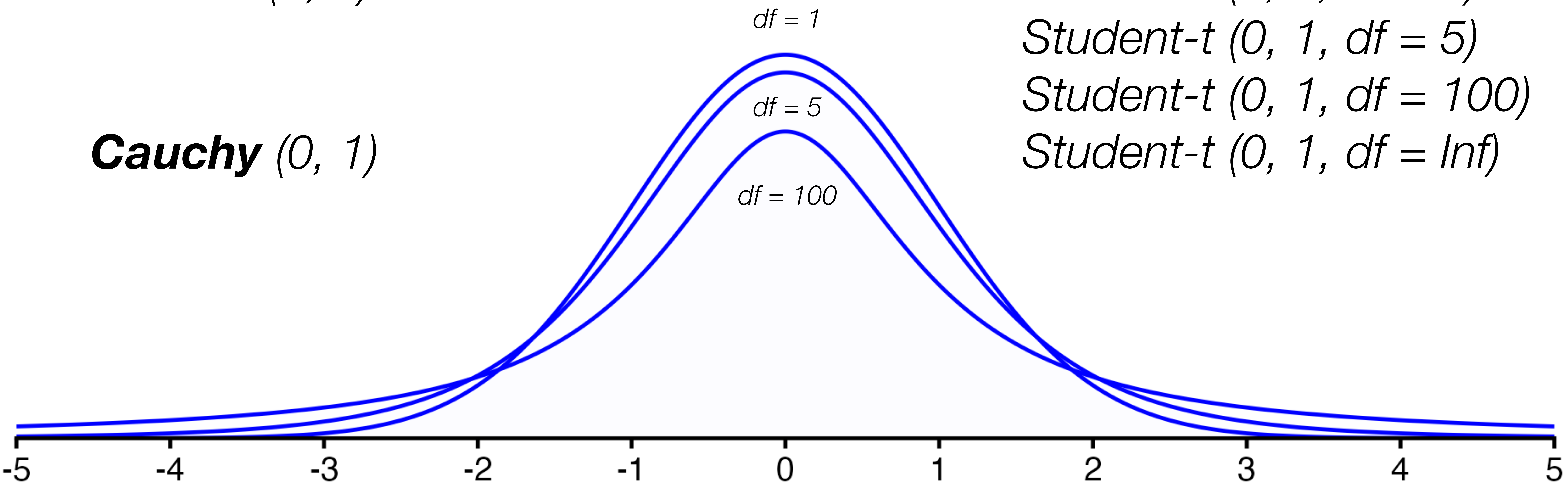
The student-t distribution

has parameters: mean (μ), scale (σ) and degrees of freedom (df)

Normal *(0, 1)*

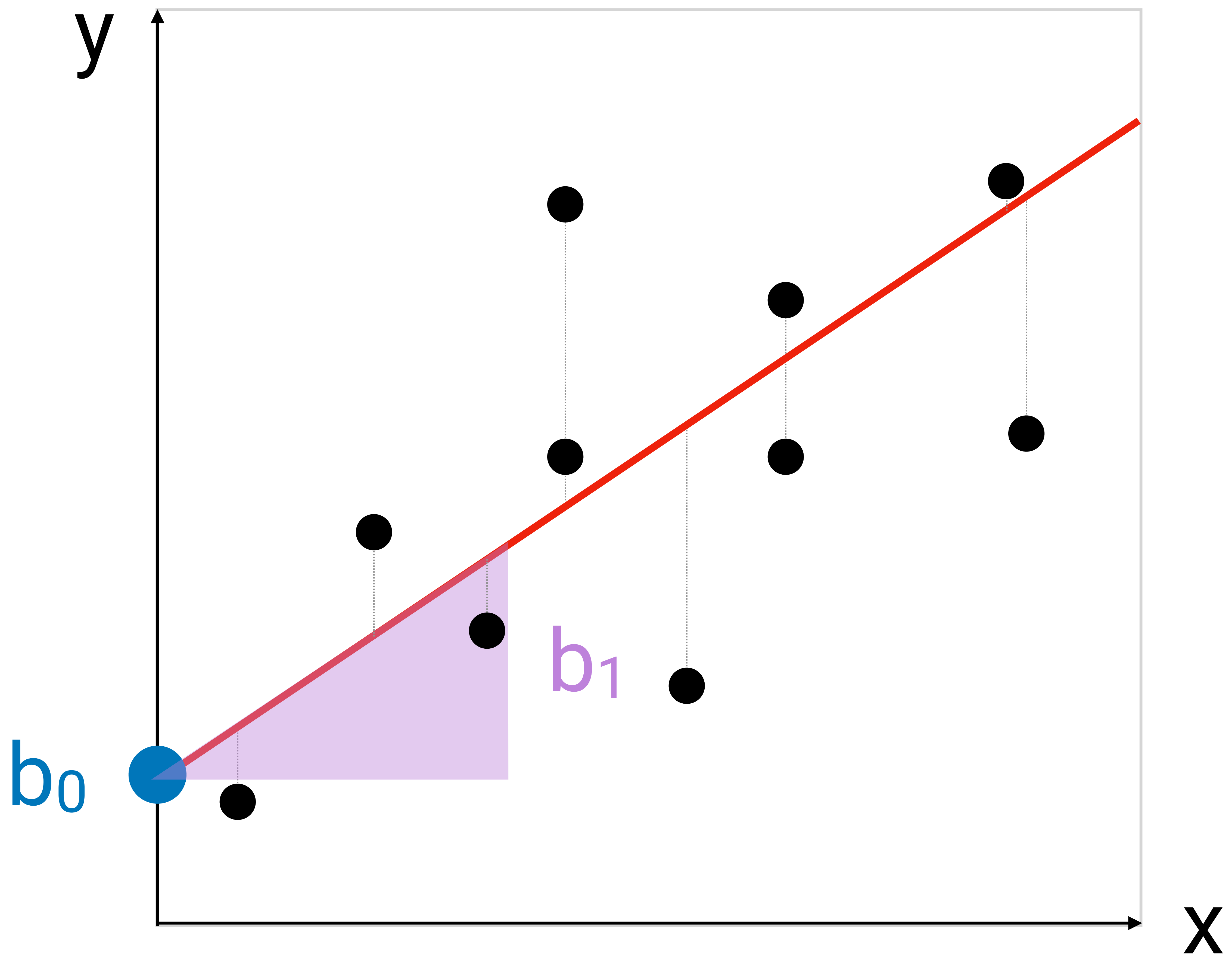
Cauchy *(0, 1)*

Student-t (0, 1, df = 1)
Student-t (0, 1, df = 5)
Student-t (0, 1, df = 100)
Student-t (0, 1, df = Inf)



Priors in linear models

$y = b_0 + b_1 * x + \sigma$



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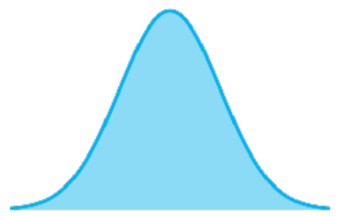

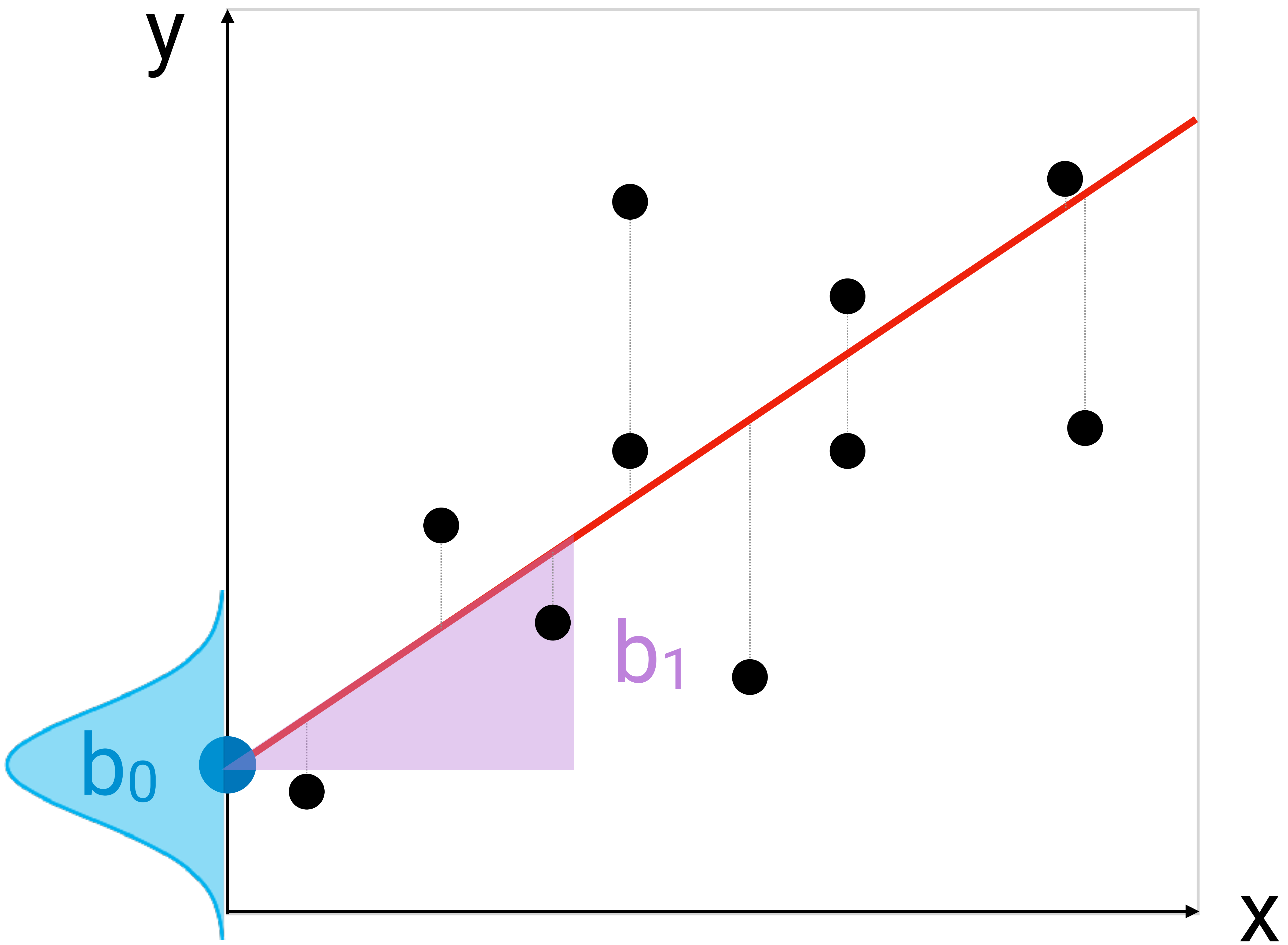

Priors in linear models

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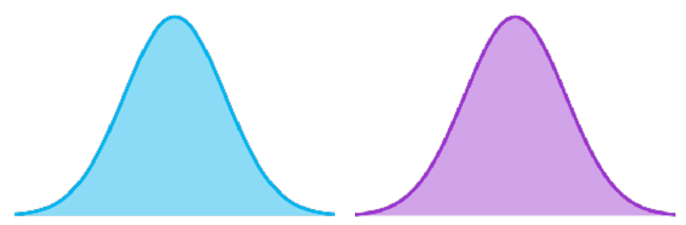
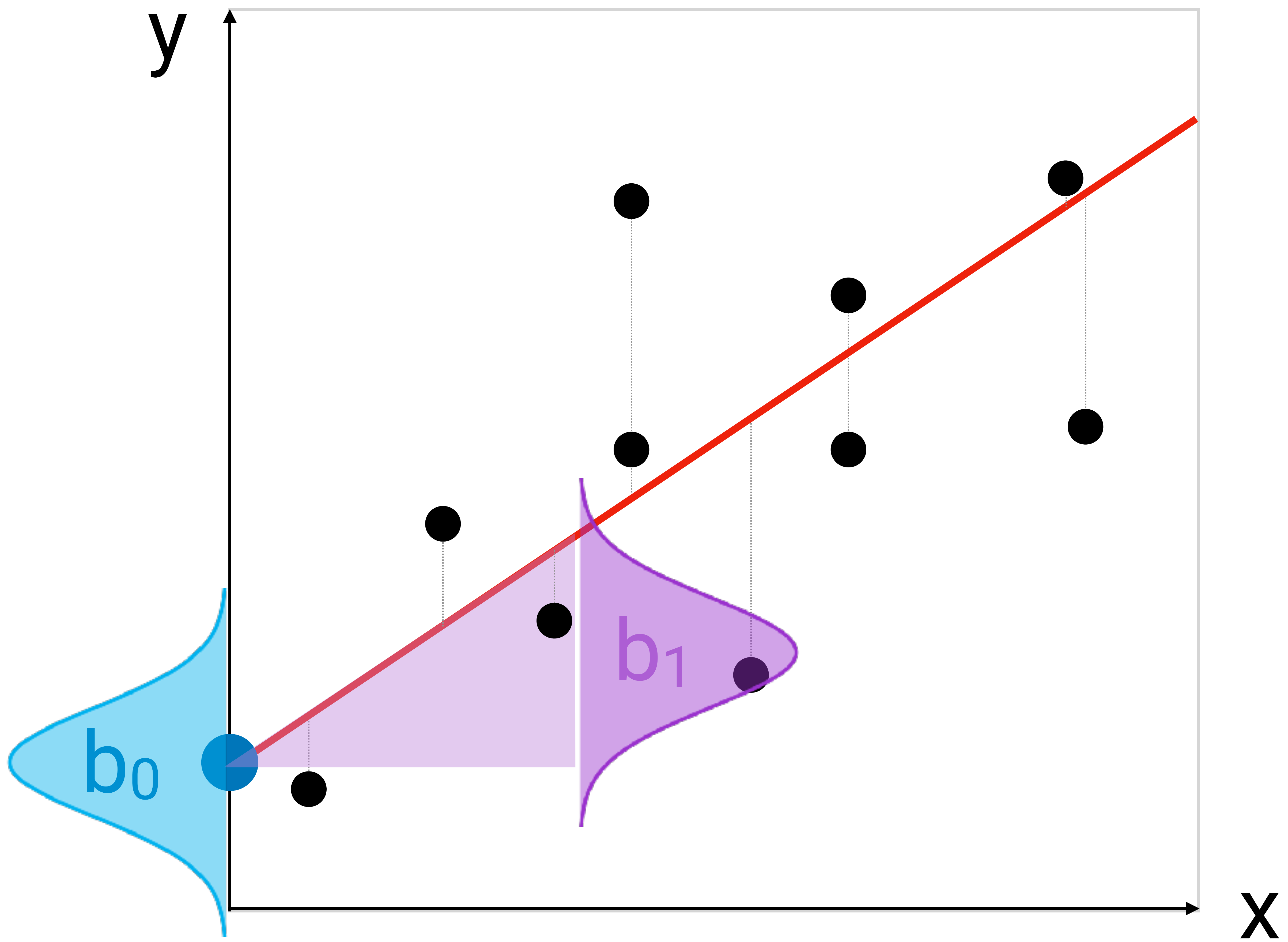
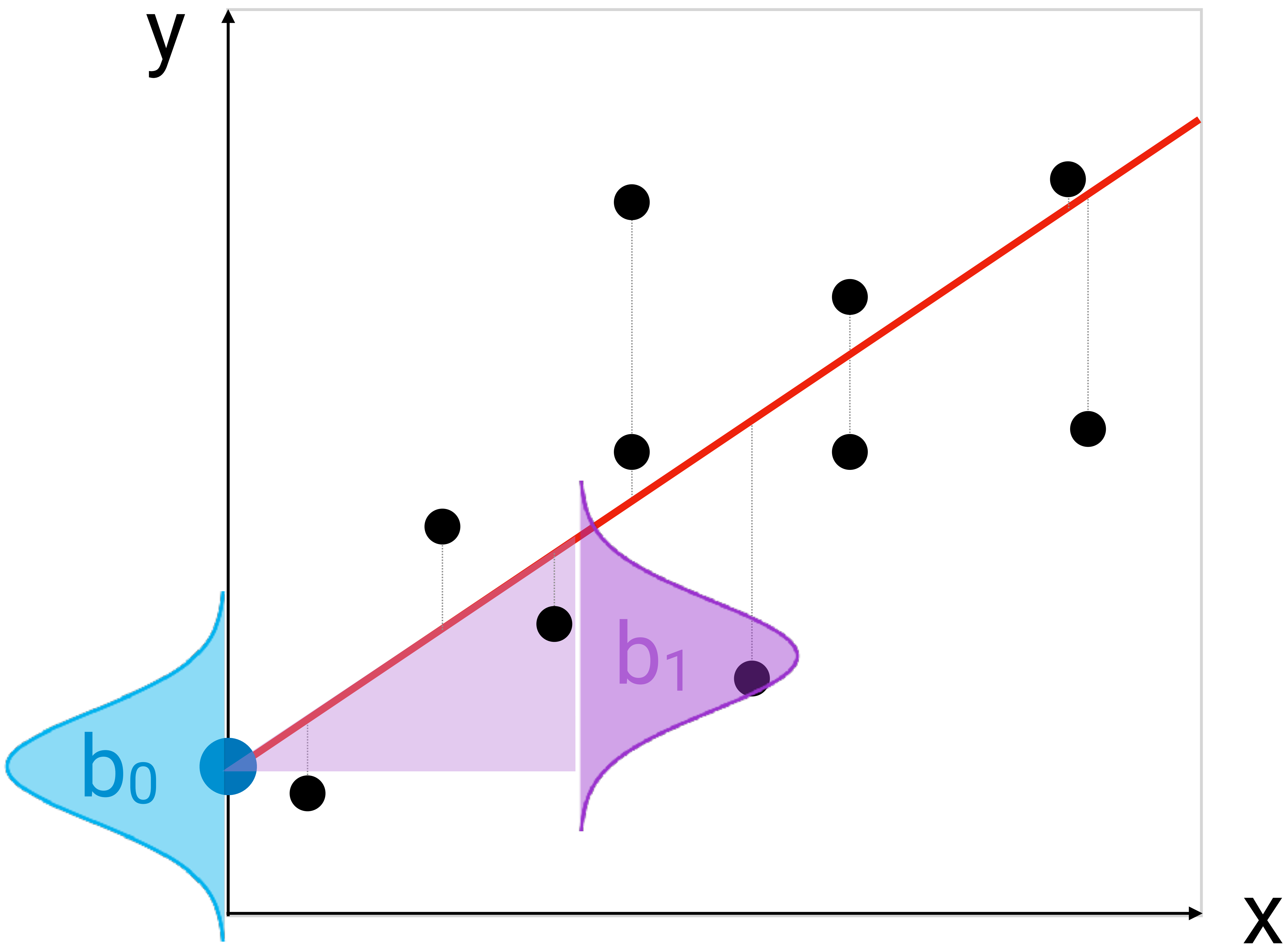




Priors in linear models

$y = b_0 + b_1 * x + \sigma$

every parameter is modelled
as a probability distribution
and received a prior

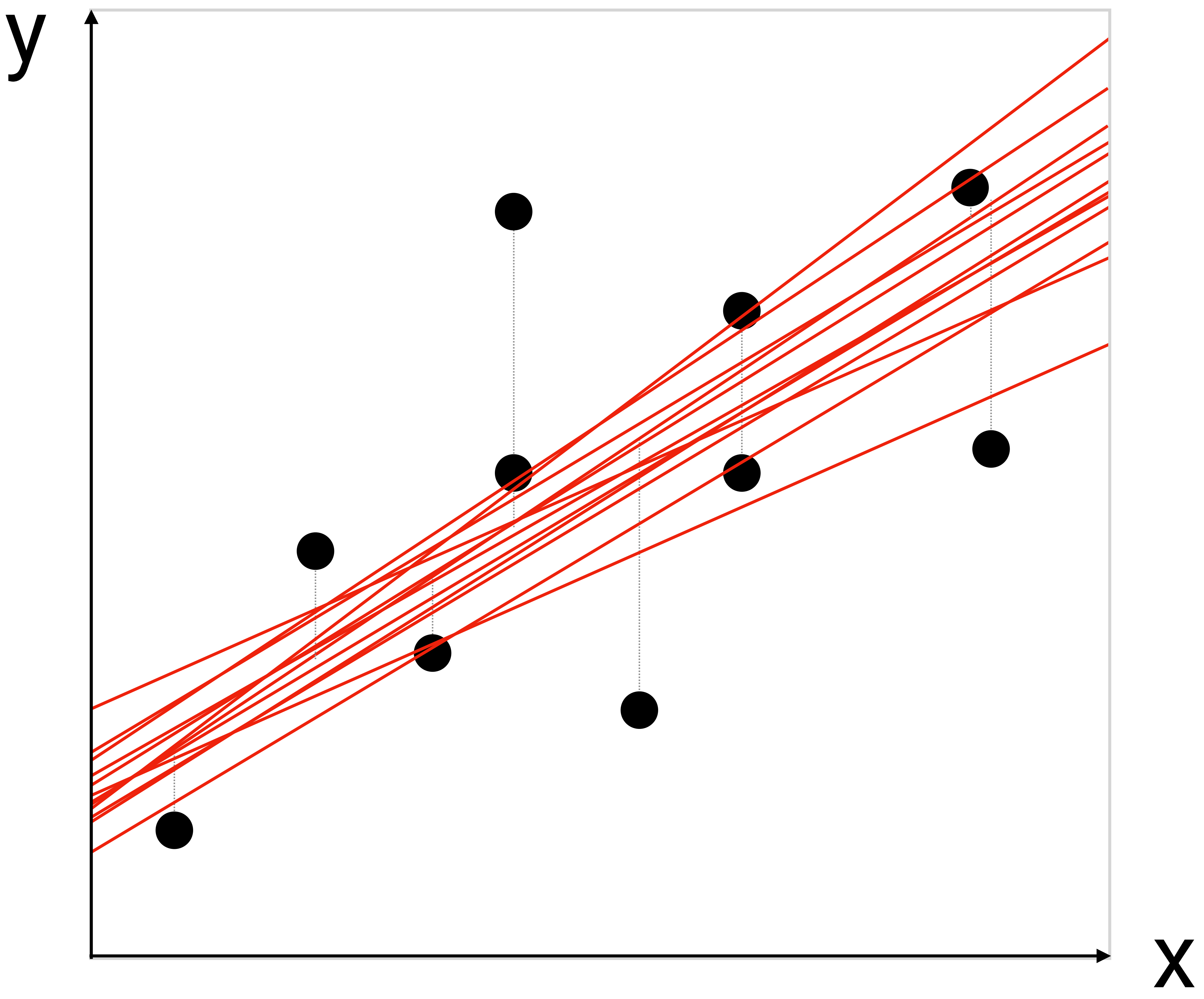


Priors in linear models

$$y = b_0 + b_1 * x + \sigma$$

every parameter is modelled
as a probability distribution
and received a prior

the model predicts a range
of plausible intercepts and
slopes, i.e. a range of
plausible linear models



How to specify priors?

Think, think, think

a. does the parameter have natural bounds?

b. what distribution does the parameter have?

c. what are plausible value ranges?

How to specify priors?

Practically

1. what priors do I need to specify?
    1a. specify model formula
    1b. get prior

```
formula <- bf(response ~ predictor, data)
```

```
get_prior(formula, data)
```

2. define priors

```
mypriors <- c(prior(normal(107, 50),
                     class = 'Intercept'),
               prior(normal(0, 50),
                     class = ‘b’))
```

3. run prior predictive check

```
xmld <- brm(formula,
             prior = my_priors,
             sample_prior = "only")
```

4. plot, evaluate and adjust if needed

But don’t we bias our results with priors?

Weakly informative priors

RT = 500 - 26 * frequency

```
prior(normal(0, 50), class = 'b',
coef = frequency)
```

This prior assumes that the effect of frequency on RT is on average **zero**, but could also be negative or positive, assuming a lot of plausible values between -50 and 50 (± 1 SDs), and most of it between -100 and 100 (± 2 SDs)

So we are **agnostic** as to the frequency effect, actually assigning the highest probability to an **effect of zero**.