Bayesian First Aid:

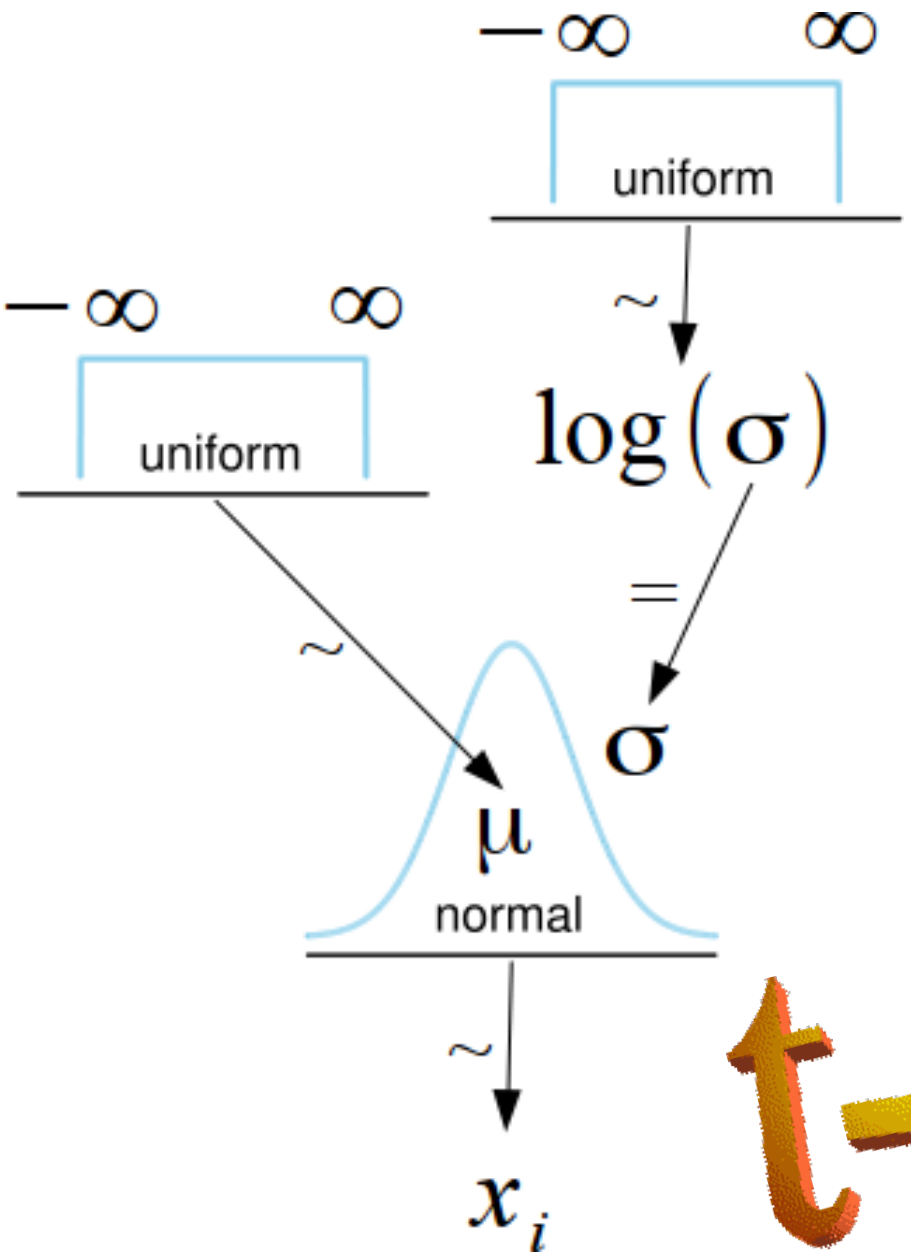
Replacing Null Hypothesis tests
by Bayesian Estimation

Rasmus Bååth
Lund University Cognitive Science

Which is the most popular Bayesian model?

- More than a 100 years old.
- 170,000 hits on Google Scholar in 2013 alone.
- Despite its name, the model was first used as a quality control method when brewing beer.


t-test



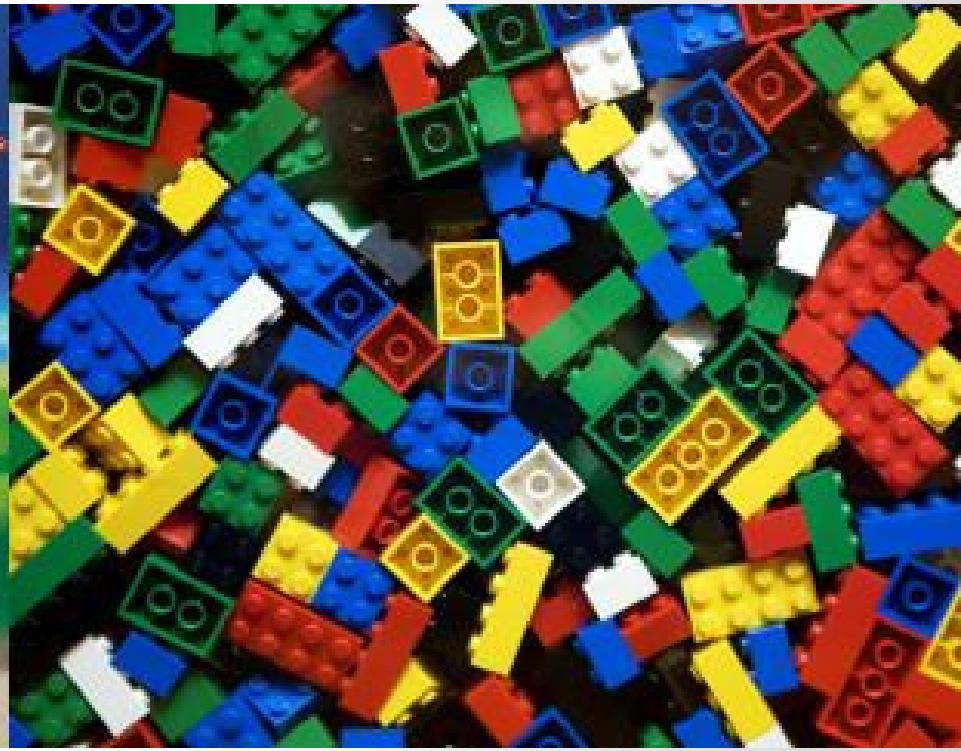
t-test

Inside every classical test there is a Bayesian model trying to get out.

The next 15 minutes

1. (Shortly), why go Bayesian?
2. Bayesian First Aid, an R package and a gateway drug.
3. Live demo with butterflies and hands.

Classical tests vs Bayesian models



Bayes is more flexible

Easy handling of:

Unbalanced groups

Missing values

Optional Stopping

Multiple Comparisons

Non-normal distributions

Strange designs

Prior knowledge

If you can model it, you can estimate it!

The cost of a Bayesian Analysis

- You have to specify your model.
- You have to specify it completely, including priors.
- You can’t use Excel, SPSS, Stata, nor Statistica ...

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NLA
PLA
CES
DE
MO


JAGS


STAN

https://github.com/rasmusab/bayesian_first_aid

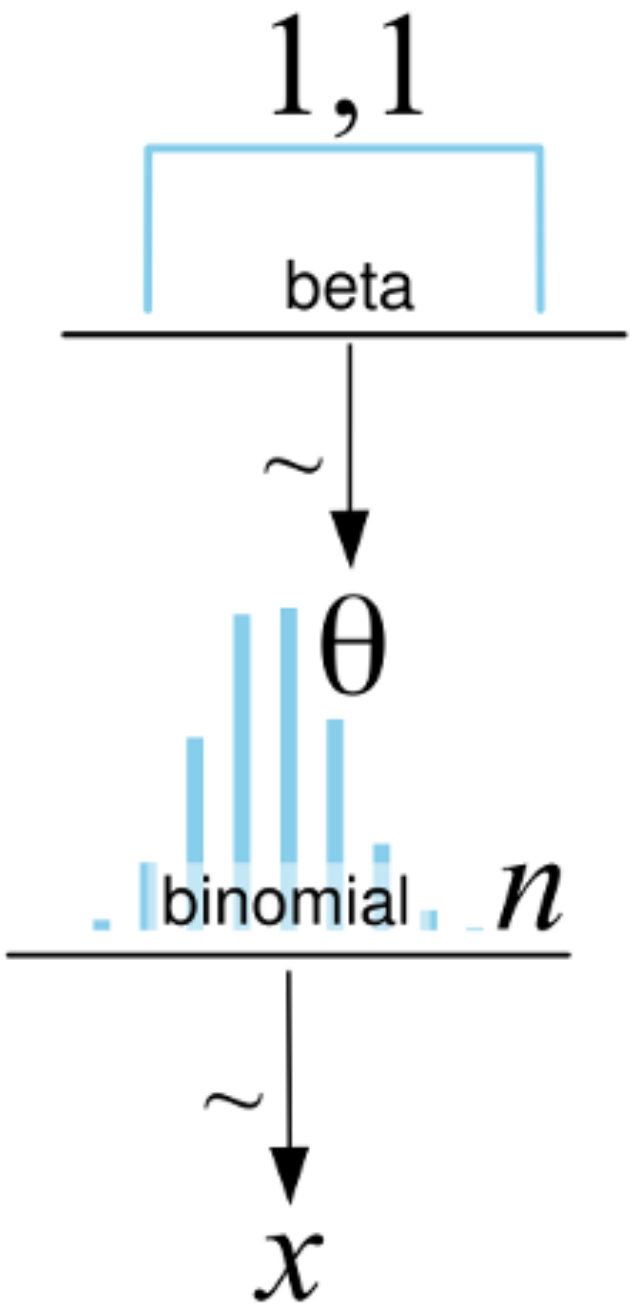
Bayesian First Aid

- An ongoing project to replace the classical tests in R with reasonable Bayesian alternatives
- Easy syntax
  - `t.test(x, y)` → `bayes.t.test(x, y)`
  - `binom.test(x, n)` → `bayes.binom.test(x, n)`
  - `cor.test(x1, x2)` → `bayes.cor.test(x, n)`
- Informative output with `plot`, `summary` and `diagnostics`
- Escape the defaults with `model.code`

Time for demo!

1. Binomial test with butterflies
2. (*Intermission*)
3. Correlation test with hands


Binomia



$$x \sim \text{Binom}(\theta, n)$$

$$\theta \sim \text{Beta}(1, 1)$$

Parmesan, C. et al. (1999).
Poleward shifts in geographical ranges of butterfly species associated with regional warming. *Nature*, *399*(6736), 579-583.

The southern boundary analysis used data for 40 species, of which the southern boundaries have retracted northwards in the past 30–100 years for 22%, remained stable for 72%, and extended southwards for 5% (Table 2, binomial test, 9 retracting north, 2 extending south, $P < 0.04$).

Here a live demonstration took place, basically a short version of the following blog post:

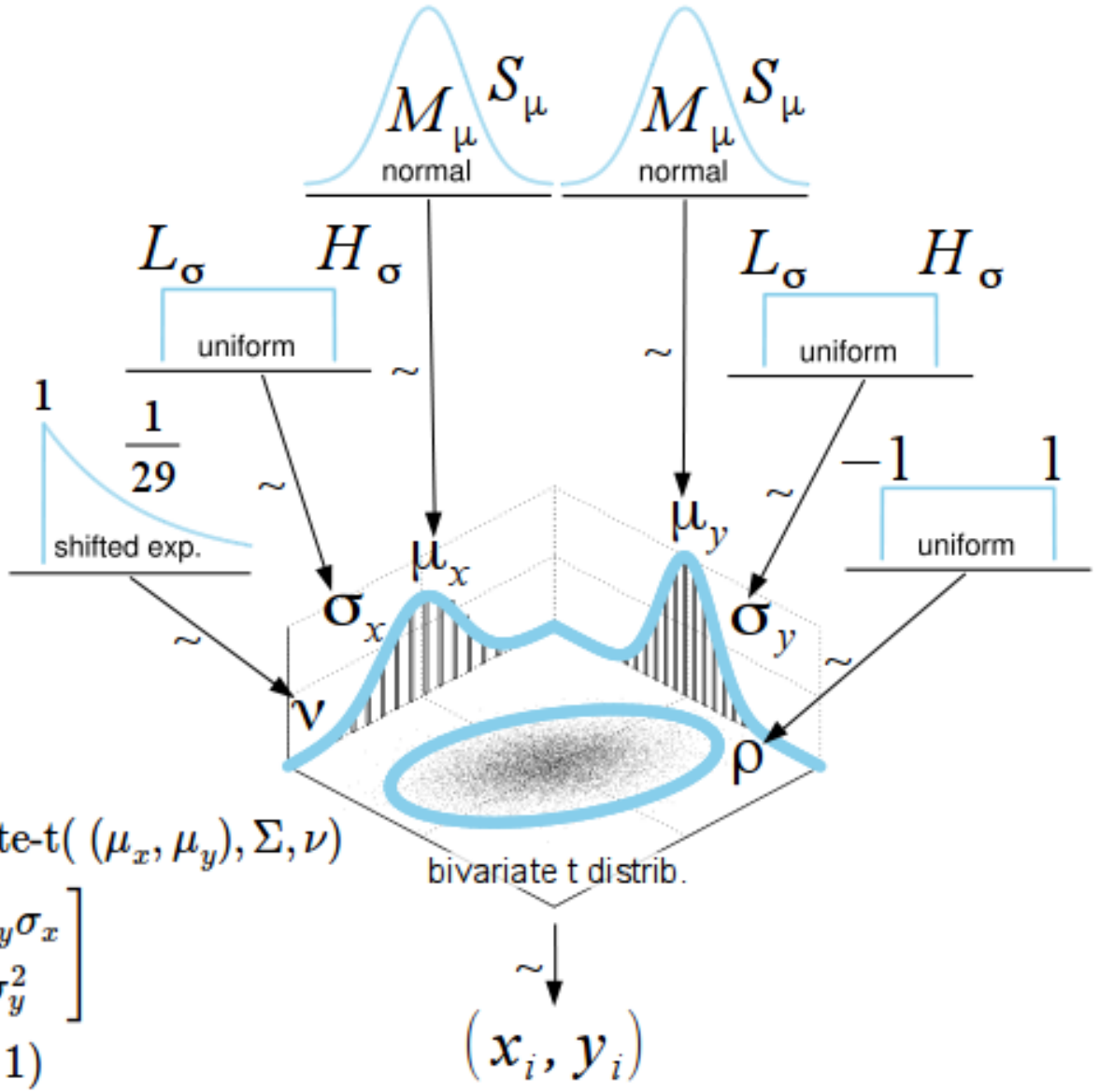
http://sumsar.net/blog/2014/01/bayesian-first-aid-binomial-test/


It's
INTERMISSION
Time, Folks!

beepr

```
install.packages("beepr")
```

Conclusiones



$$(x_i, y_i) \sim \text{Bivariate-t}(\ (\mu_x, \mu_y), \Sigma, \nu)$$

$$\Sigma = \begin{bmatrix} \sigma_x^2 & \rho\sigma_y\sigma_x \\ \rho\sigma_y\sigma_x & \sigma_y^2 \end{bmatrix}$$

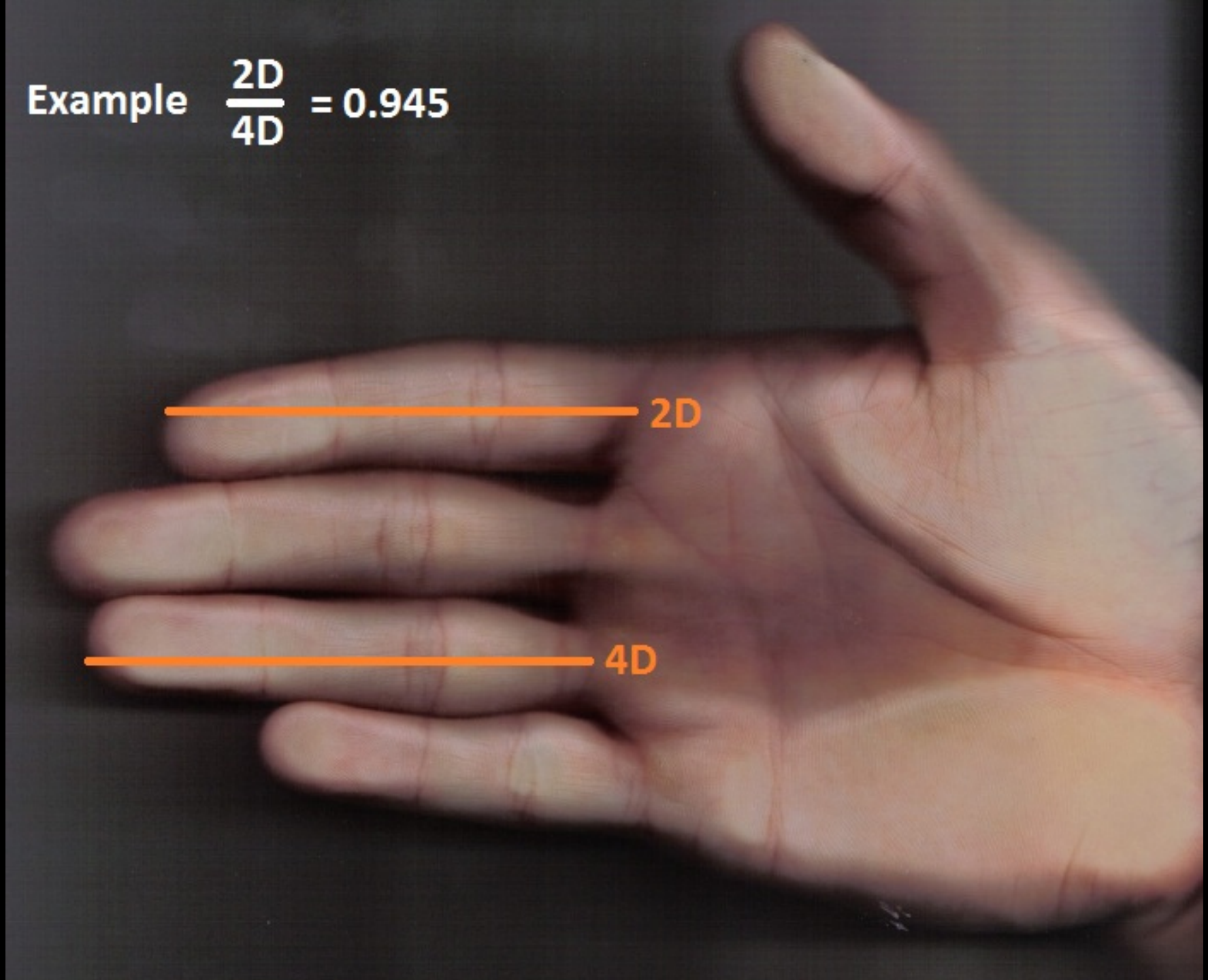
$$\rho \sim \text{Uniform}(-1, 1)$$

$$\mu_x, \mu_y \sim \text{Normal}(M_\mu, S_\mu)$$

$$\sigma_x, \sigma_y \sim \text{Uniform}(L_\sigma, H_\sigma)$$

$$\nu \sim \text{ShiftedExp}(\tfrac{1}{29}\ , \text{shift} = 1)$$

Hone, L. S., & McCullough, M. E. (2012).
2D: 4D ratios predict hand grip strength (but not hand grip endurance) in men (but not in women).
Evolution and Human Behavior, *33*(6), 780-789.


Example 2D/4D = 0.945
2D
4D

Here a live demonstration took place again, basically a short version of the following blog post:

http://sumsar.net/blog/2014/03/bayesian-first-aid-pearson-correlation-test/

In summary

- Bayesian methods are really useful and flexible.
- It has never been more easy to get started thanks to R and JAGS.
- Bayesian First Aid makes it even easier!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