Analysing phonological systems: on Bayesian typological research

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Workshop “Language Sampling: Issues and challenges”, Institute for Linguistic Studies

Presentation is available here:
https://github.com/agricolamz/2019.12.20_SPb_samples

In this talk I will cover the following:

- Goals of linguistic typology
- Different strategies of sampling
- The Bayesian way of thinking about linguistic typology
- Case study: vowels

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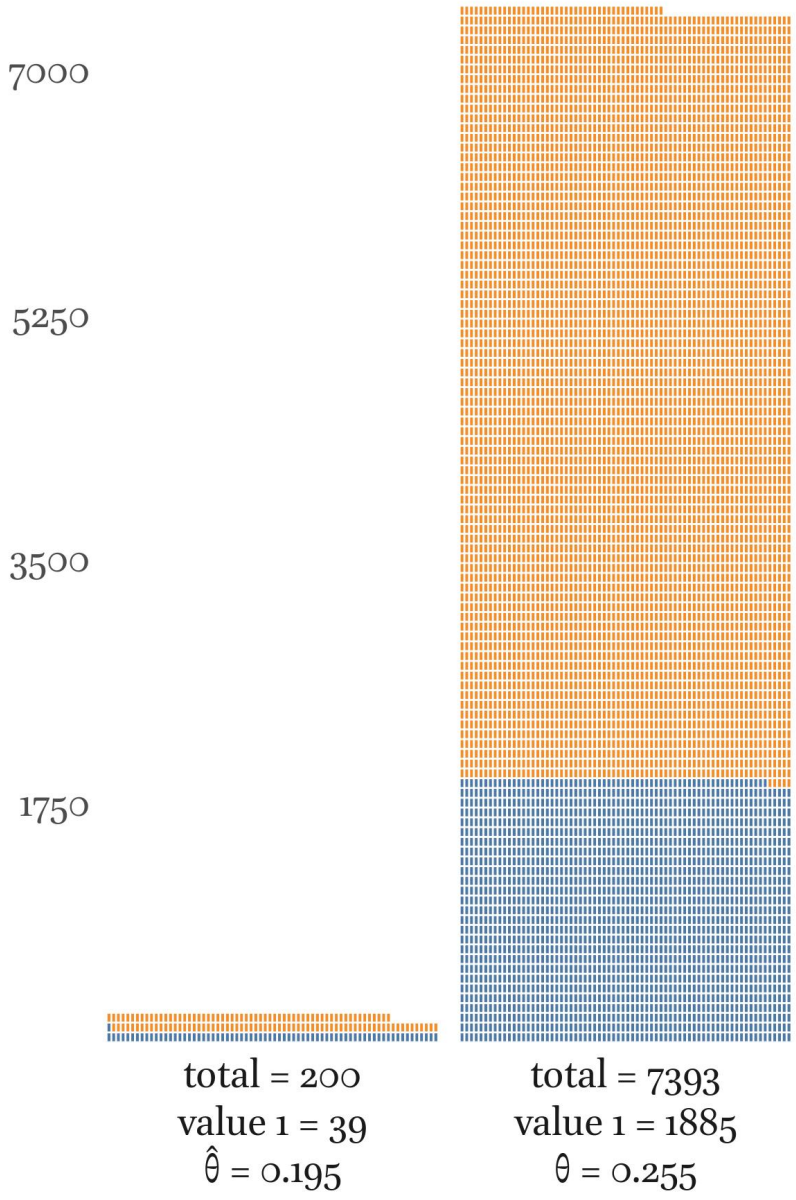
- Pick a sample of languages, calculate the desired statistics, e. g. $\hat{\theta}$
- From now on $\hat{\theta}$ is the best estimation of θ that you know, add some **confidence intervals** of you need to convince an editor who is mad about statistics
- After you have published your paper, your project is finished

There are different types of sampling



Random sampling

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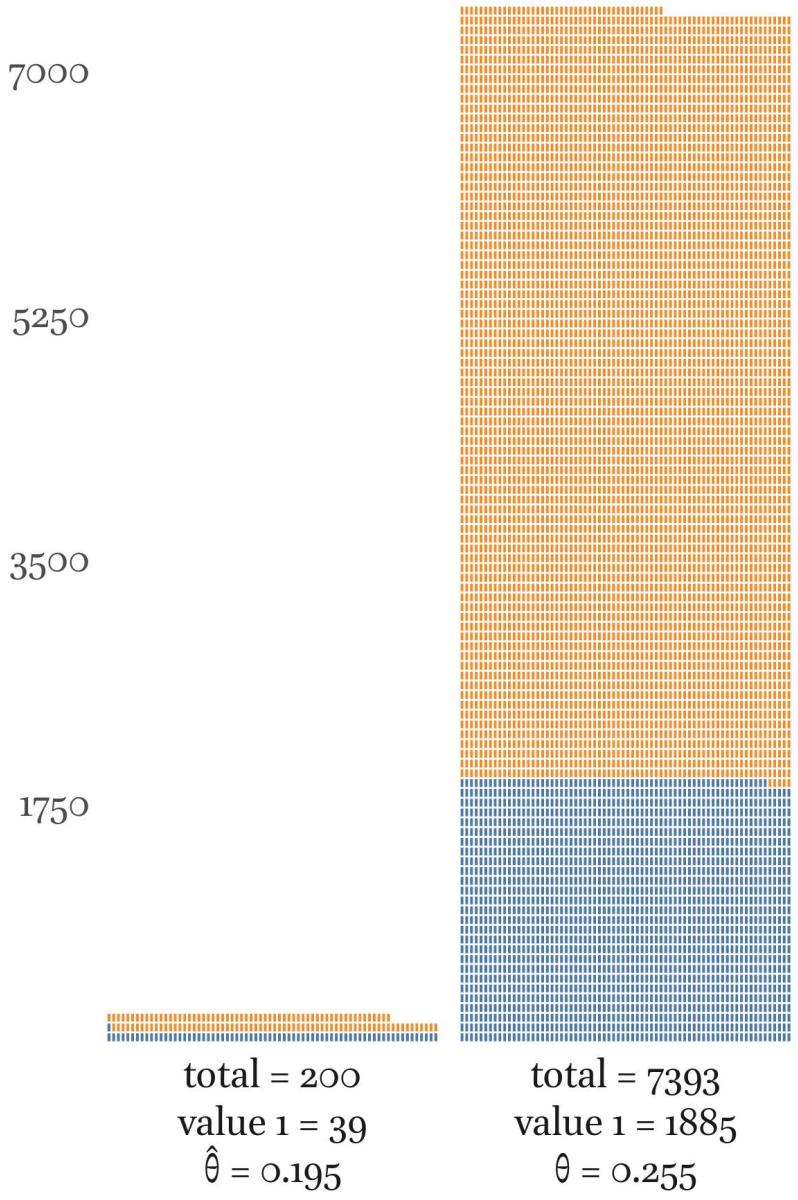
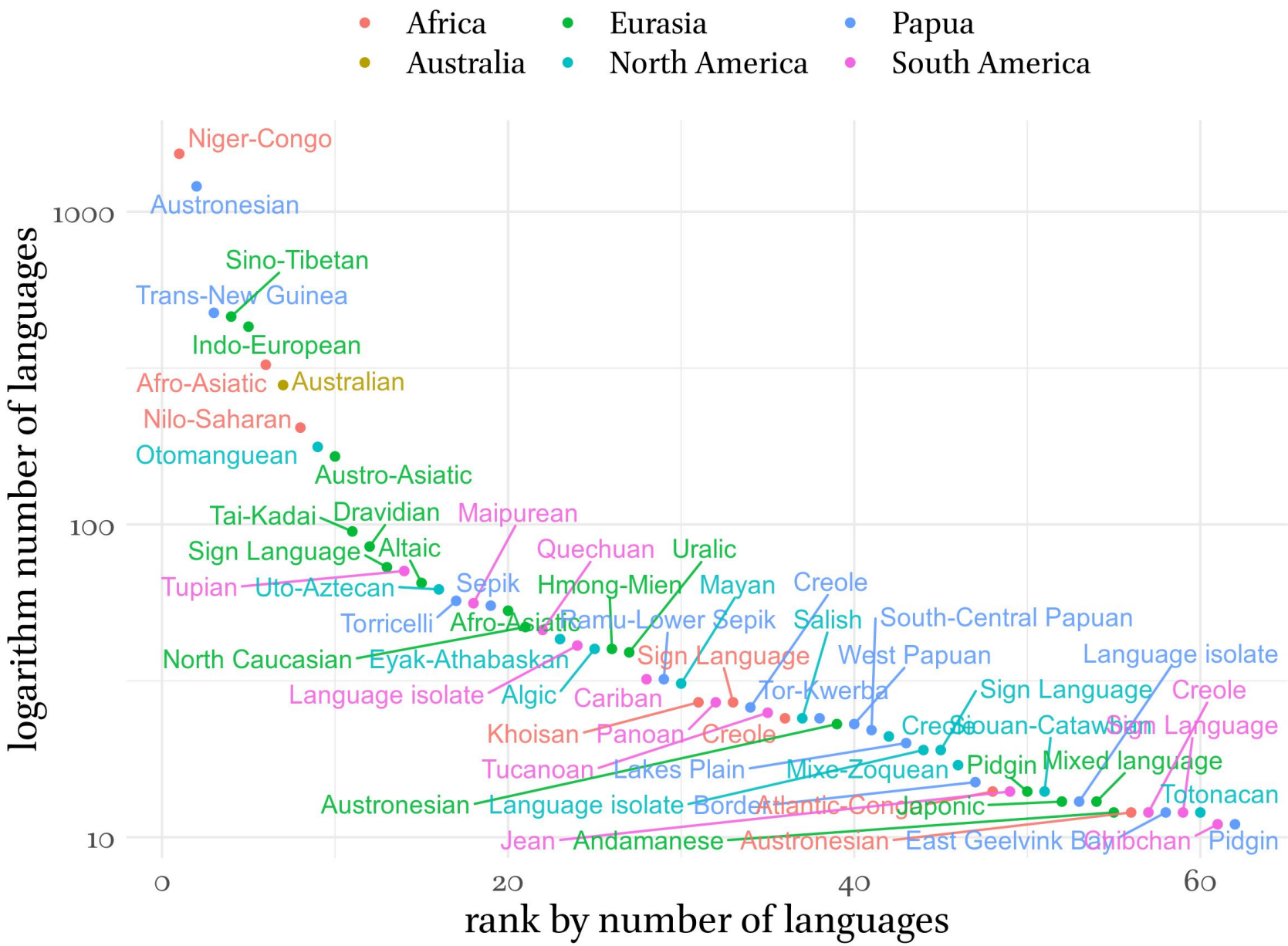


Random sampling

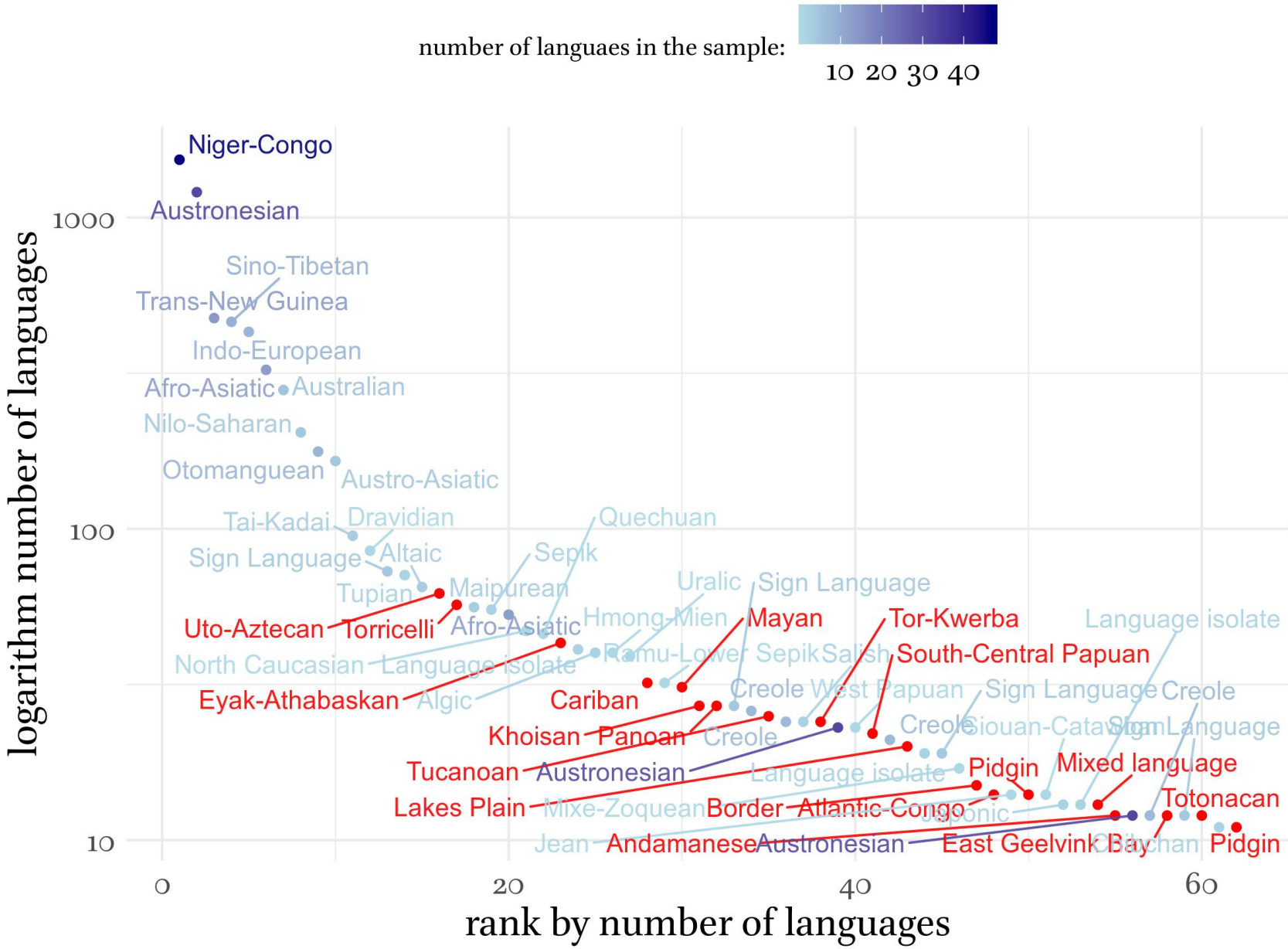
each member of the population has an equal probability of selection

!!! but each language is grouped in **a language family** and **an area**, so observations are not independent…

Language families (number of languages > 10)



Language families presented in our 200 sample



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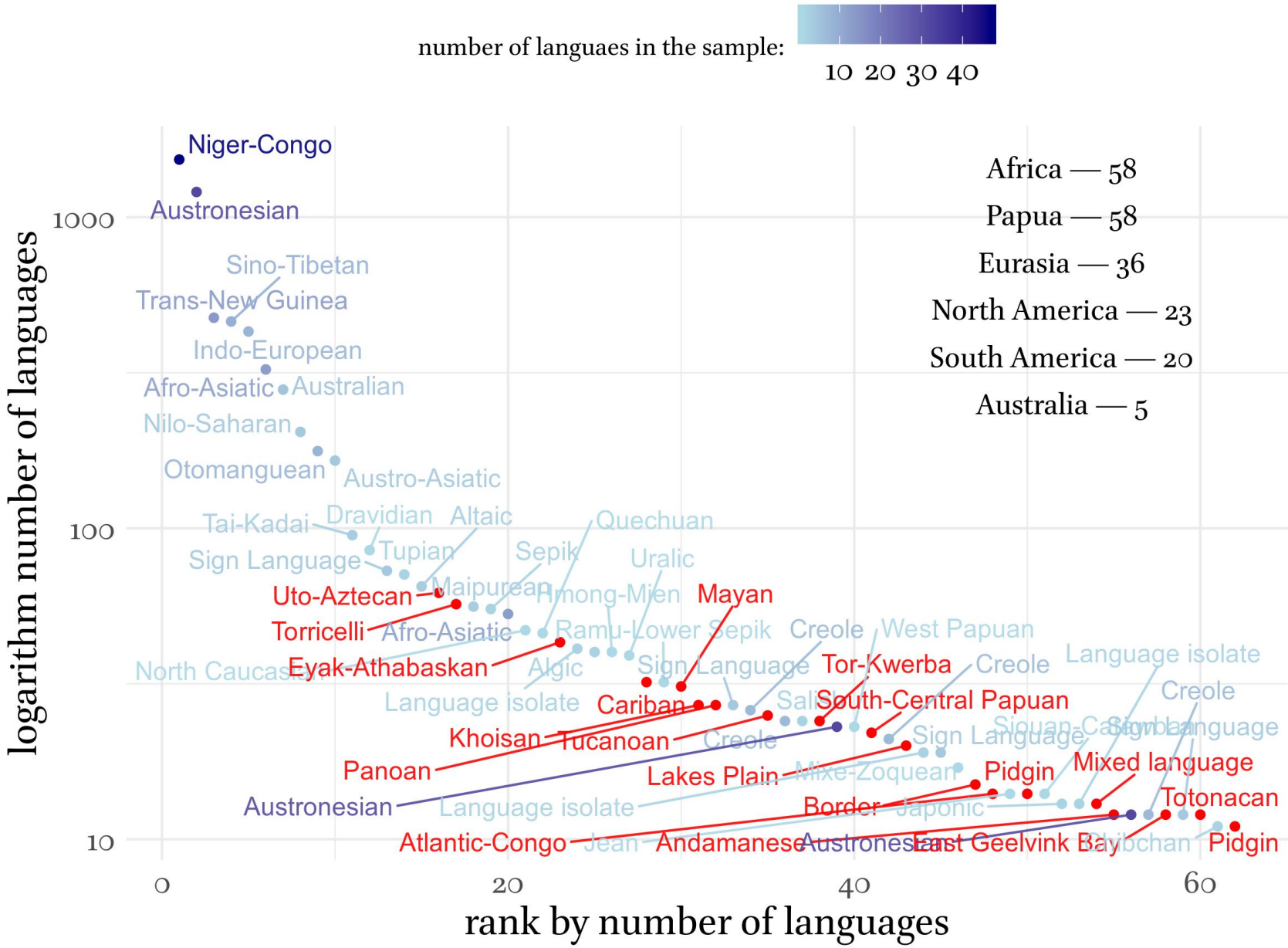

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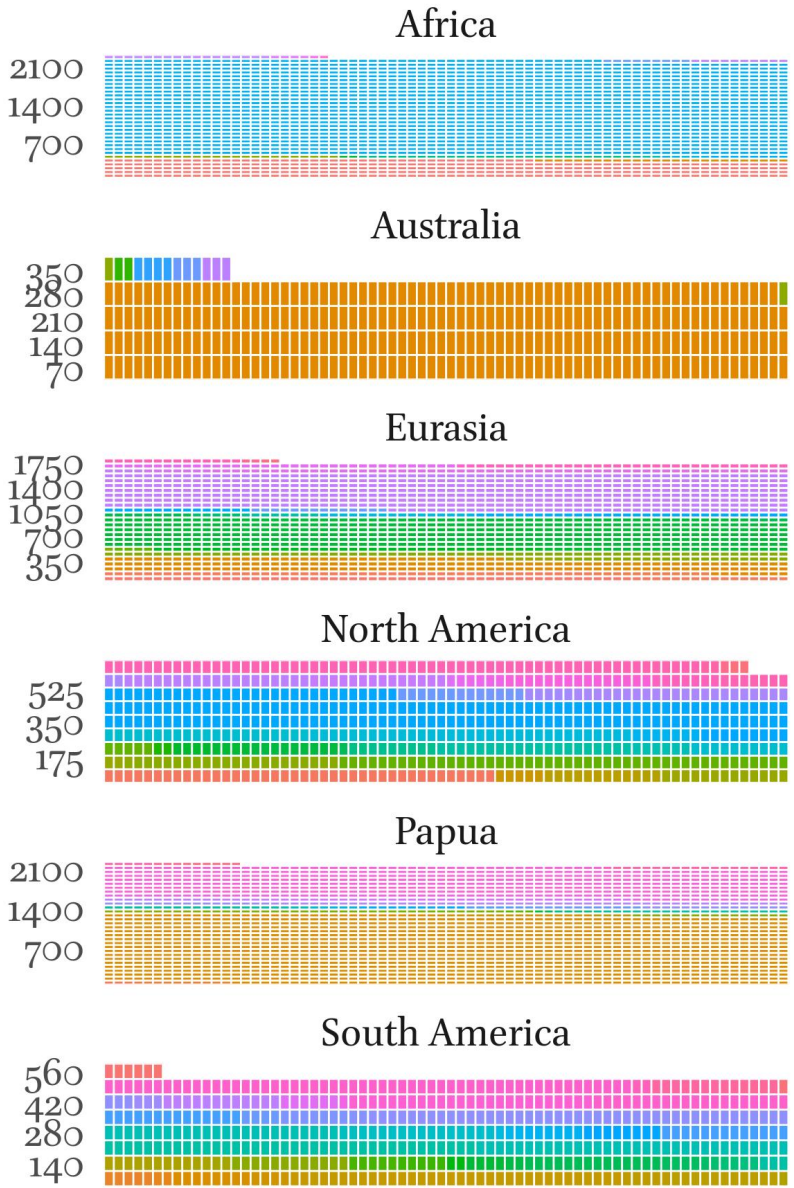

Stratified random sampling divide the population into groups that differ in important ways, and then perform random sampling for each group

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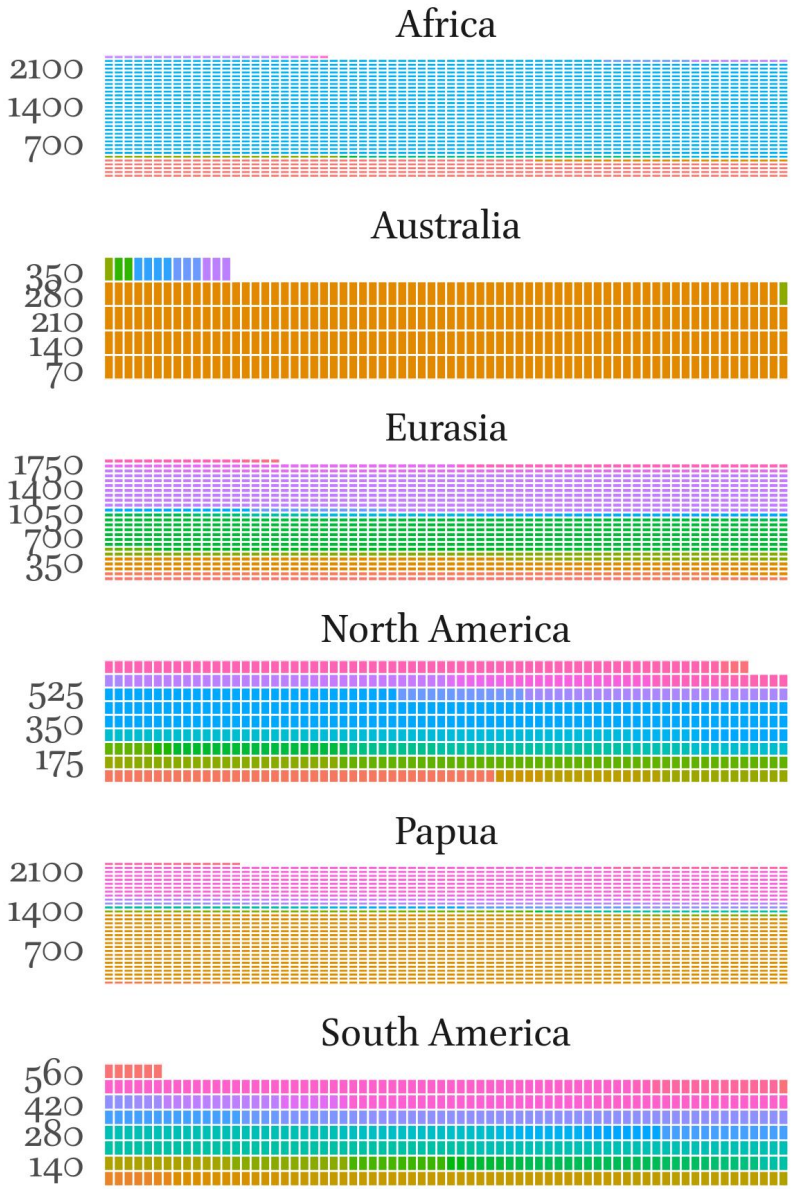

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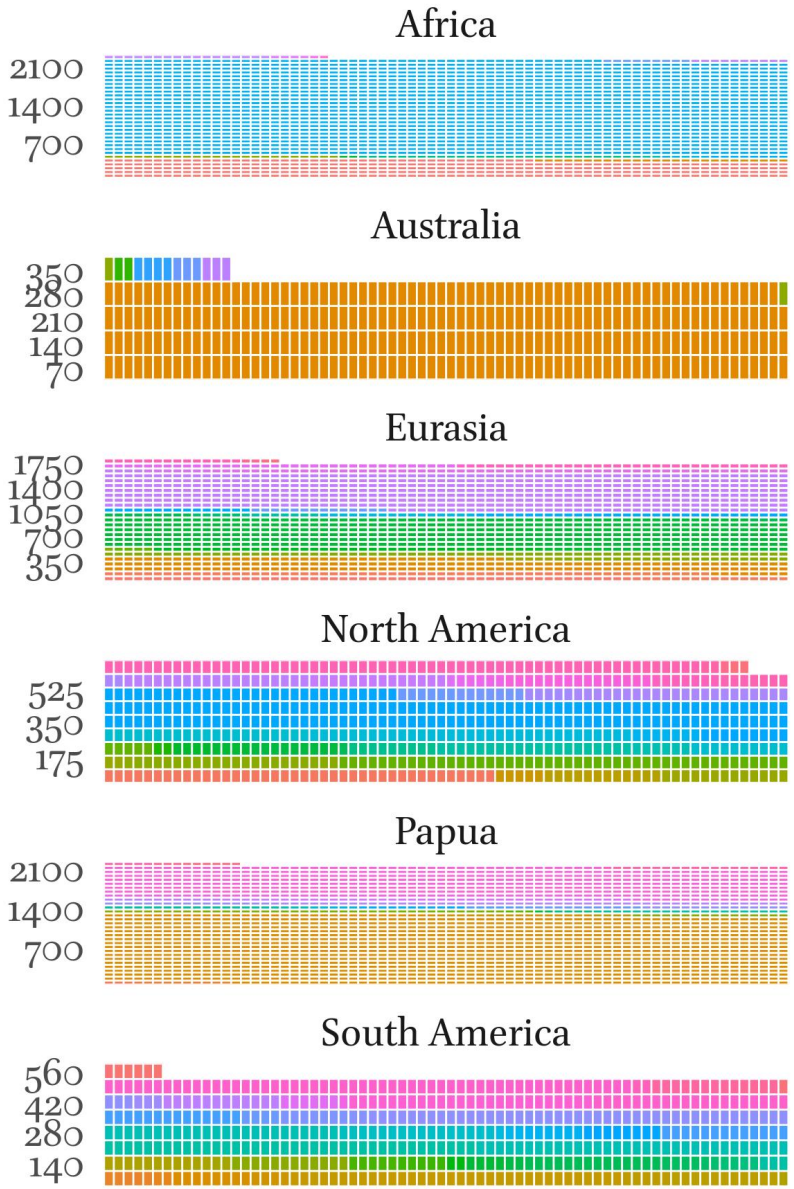

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!!! The Glottolog version in the `lingtypology` package suggests that there are 214 unique combinations (142 sign languages and 82 isolates counted as one family)

⇒ So to create a statistically reasonable sample one needs to get around 300 languages

I am not the first to discuss this problem

- [Bell 1978] “Language Samples”
- [Dryer 1989] “Large Linguistic Areas and Language Sampling”
- [Perkins 1989] “Statistical Techniques for Determining Language Sample Size”
- [Nichols 1992] “Linguistic Diversity in Space and Time”
- [Rietveld and Van Hout 1993] “Statistical Techniques for the Study of Language and Language Behaviour”
- [Rijkhoff and Bakker 1998] “Language sampling”
- [Maslova 2000] “A dynamic approach to the verification of distributional universals”
- [Widmann 2001] “Language Sampling for Typological Studies”
- [Janssen et al. 2006] “Randomization Tests in Language Typology”
- [Baker 2010] “Language Sampling”

Sampling bias

- Geneological
- Caused by contact
- Cultural
- Typological
- Populational

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Sampling bias

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- Bibliographical
- Typologistical — only typologists think that one typological value corresponds to one so called language

Theoretical linguists

- Complain about how hard it is to solve a problem
- Don't publish any results until it will be ideal

Computational linguists

- Solve the wrong problem
- Publish messy data and messy results

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My suggestion:

- Don't do any sampling
- Use a linguistic family (or analogous units) as a minimal unit of typological research
- Analyse all languages in a family
- Publish your data
- Make a call for contributions
- Update your results

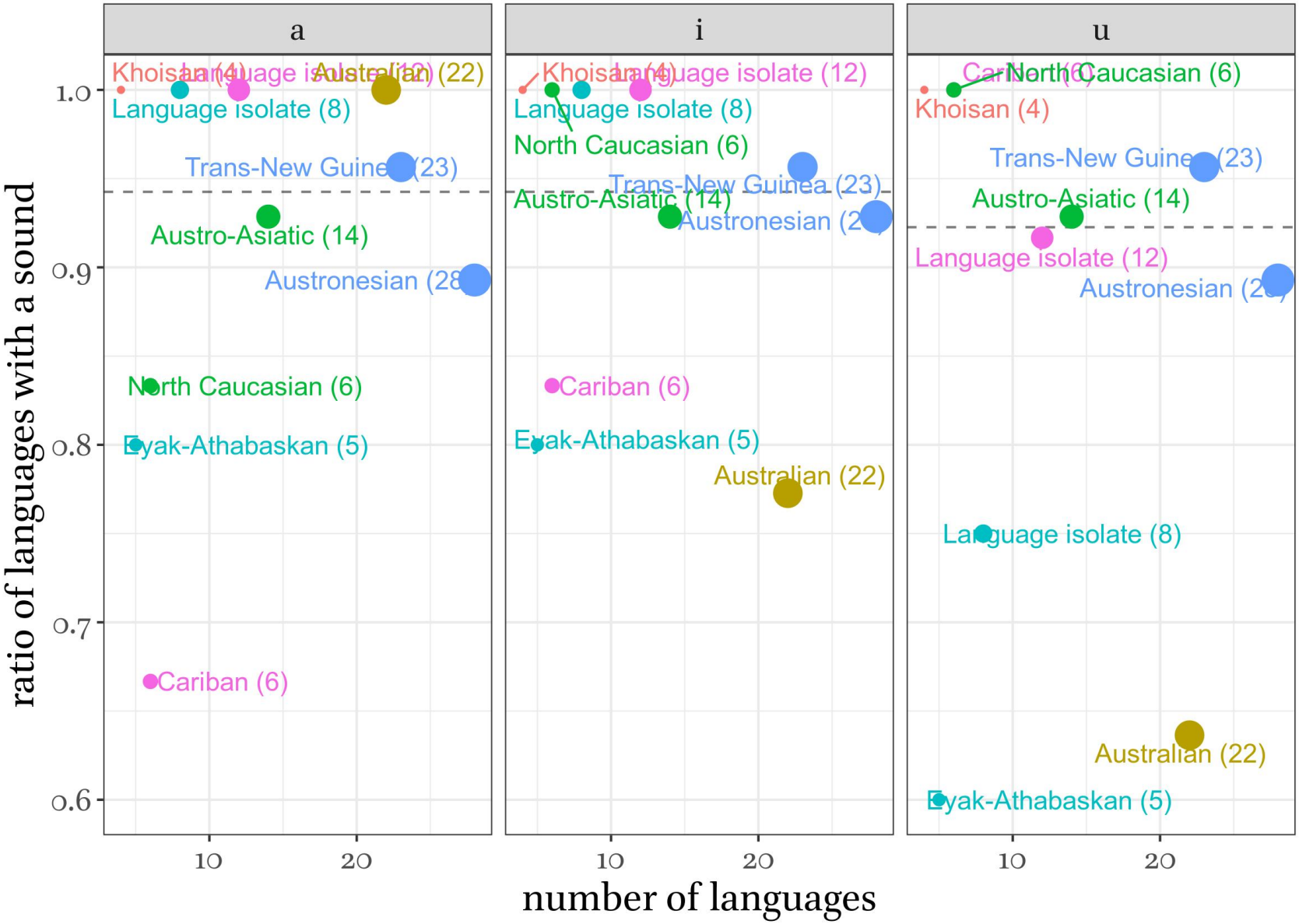
frequentist view

- There is a population with one fixed value θ
- Sample from the population and estimate the value $\hat{\theta}$
- If you want to replicate the previous study, resample the data and reestimate the value $\hat{\theta}$

Bayesian view

- There is a value θ that could be described as a distribution of probabilities
- Take into account previous works and formulate **prior** knowledge about θ
- Sample from the population and estimate the value θ
- Use Bayes' formula to get **posterior** distribution of θ
- Use an obtained result as a future prior and update your previous data

Case study: how frequent are *a*, *i* and *u*? (10 families)



sample of 128 languages

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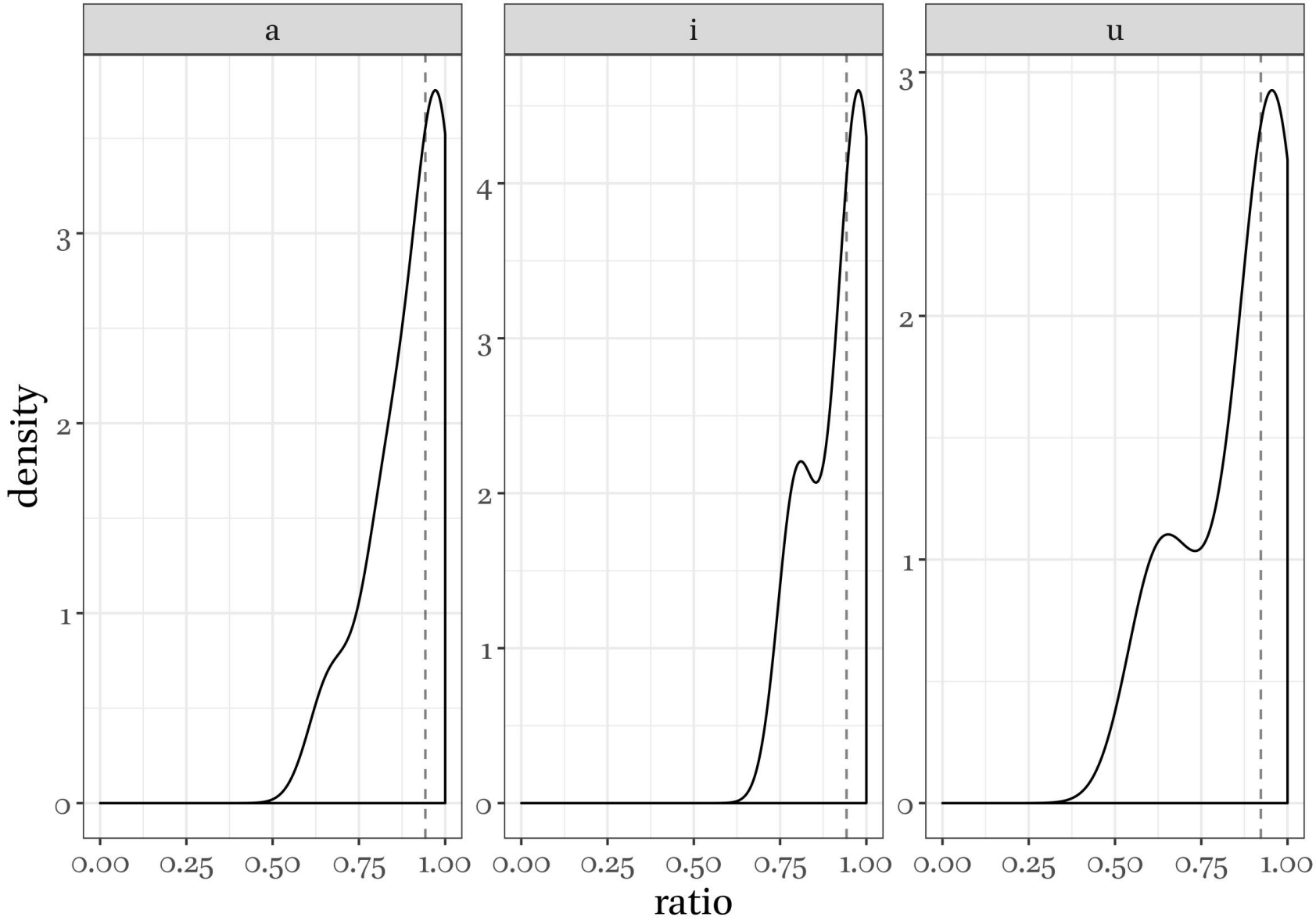
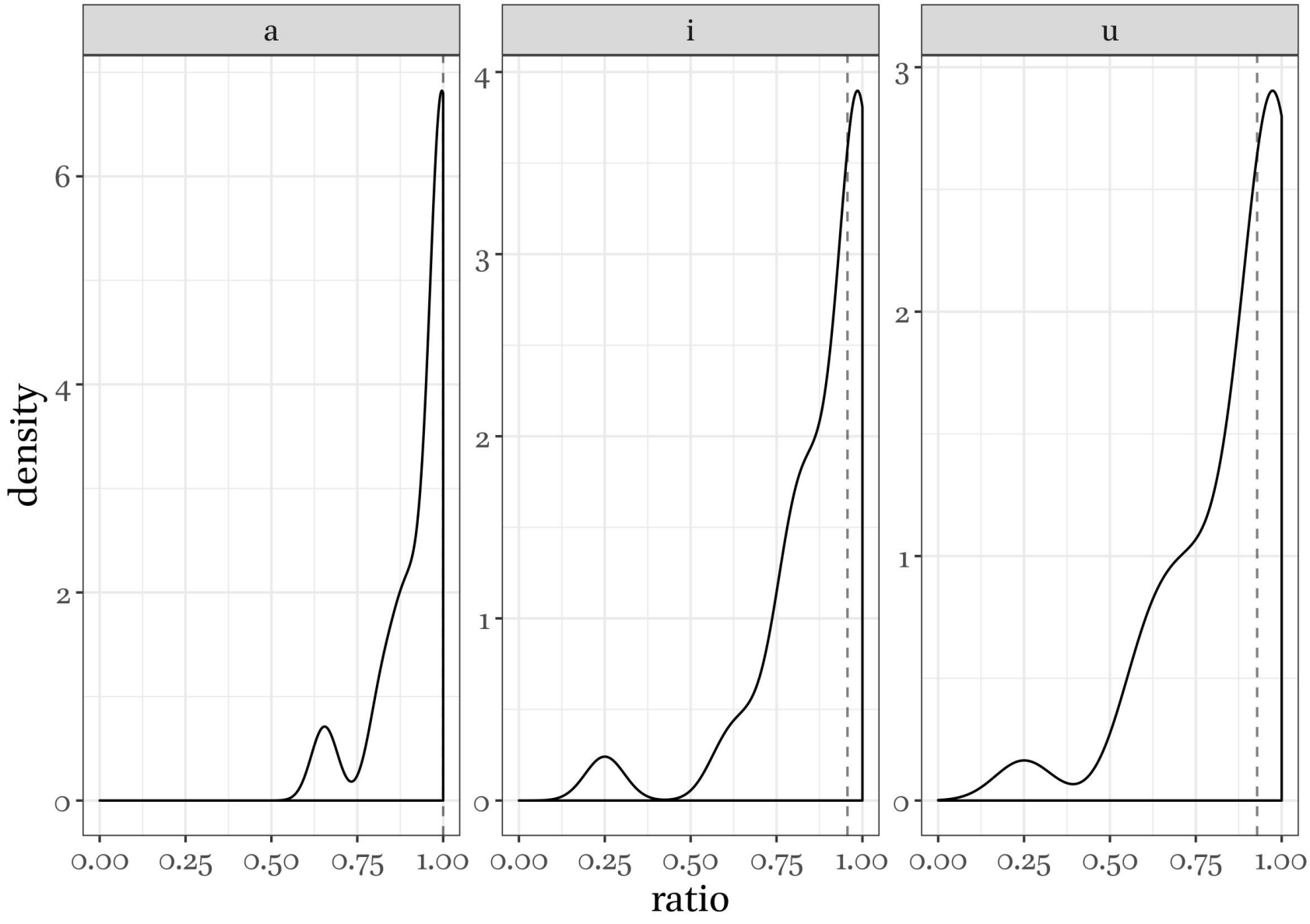


sample of 128 languages

Case study: how frequent are *a*, *i* and *u*? (29 families)



sample of 354 languages

What about phonology?

It is possible to use phonological units or relations from any phonological theory you like:

- Features, feet, syllables, etc.
- Feature constituents, OT constraints, exemplars, phonological are diachronic alternations
- Phonological distinctions (e. g. /i/ vs. /ɨ/)
- …

Send me a letter!
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Presentation is available here:
tinyurl.com/y3wtkcbq

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