HOW TIME-BOUND IS YOUR GRAMMAR? PUSHING THE LIMITS OF COMPARATIVE METHODS THROUGH SYNTAX

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LONG-STANDING PROBLEM OF HISTORICAL LINGUISTICS

- **How much similarity is required to demonstrate true language relatedness** when regular sound correspondences are not retrievable?

THE PARAMETRIC COMPARISON METHOD

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Evidence for syntax as a signal of historical relatedness

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A MODEL OF UG AND VARIATION

- Conceptual simplification on the basis of a **Principles and Schemata Model**

  (Longobardi 2005, 2017)

  - ‘Initial stage of UG (S_0) only contains parameter schemata, and not an extensional list of parameters’

PARAMETER SCHEMATA (LONGOBARDI 2017)

- Is F, F a feature, **grammaticalized**?
- Does F, F a grammaticalized feature, **Agree** with a category X (i.e. does F probe X)?
- Is F, F a grammaticalized feature, "strong" (i.e. does F **overtly attract** X, probe X with an EPP feature)?
- Is F, F a grammaticalized feature, **spread** on a category X?
- Does a functional category (a set of lexically co-occurring grammaticalized features) X have a **phonological matrix** Φ?
- Does F, F a grammaticalized feature, **probe** the minimal accessible category of type X (or is **pied-piping** possible)?
- Are f1 and f2, the respective values of two grammaticalized features, associated on a category X?
- Are f1 and f2, two feature values associated on X, optionally associated?
- Does a functional feature (set) exist in the vocabulary as a bound/free morpheme?

Nothing else is a parameter

91 PARAMETERS DEFINING THE SYNTAX OF THE NOMINAL DOMAIN

- The status of **features associated with D**, e.g. person, number, gender and definiteness
- Syntactic properties of **adjectives**, **relative clauses**, **genitival arguments** and **possessives**, **demonstratives**
- Type and scope of **N-movement**

PARAMETER IMPLICATIONS

- Parameter values: **[+]** or **[-]**
- But parameter values **imply each other** as well: **0** is the state of a parameter which is completely irrelevant owing to the settings of other parameters
- Large number of **parametric interdependencies** (implicational universal principles)
  - Out of 50x91=4550 cells (parameter states), 2045 are null (contain 0), i.e. **44.9%** of the information is redundant

THE EFFECT OF PARAMETRIC IMPLICATIONS

- To appreciate the typological restrictiveness of a realistic parameter system, we must calculate the **number of possible languages generated**.
- The **first 30 parameters** from TableA (less implicationally constrained than the successive ones) **generate less than 2^{19} admissible grammars** (Bortolussi et al. 2011, Ceolin et al. submitted), at least **eleven orders of magnitude less** than the 2^{30} expected under total independence (i.e. less than 500k as opposed to more than 1 billion)

TWO FURTHER STEPS TOWARDS PARSIMONY

i) implied parameters **do not play a role in acquisition** (are never present in the child's mind)

ii) only **[+] valued** parameters are present in the child's mind

iii) to take into account (i) and (ii), we calculated syntactic pairwise distances according to the **Jaccard** formula:

$$\Delta \text{Jaccard}(A,B) = \frac{[\,N_{-+} + N_{+-}\,]}{[\,N_{-+} + N_{+-} + N_{++}\,]}$$

AN EMPIRICAL IMPLEMENTATION OF THE PCM

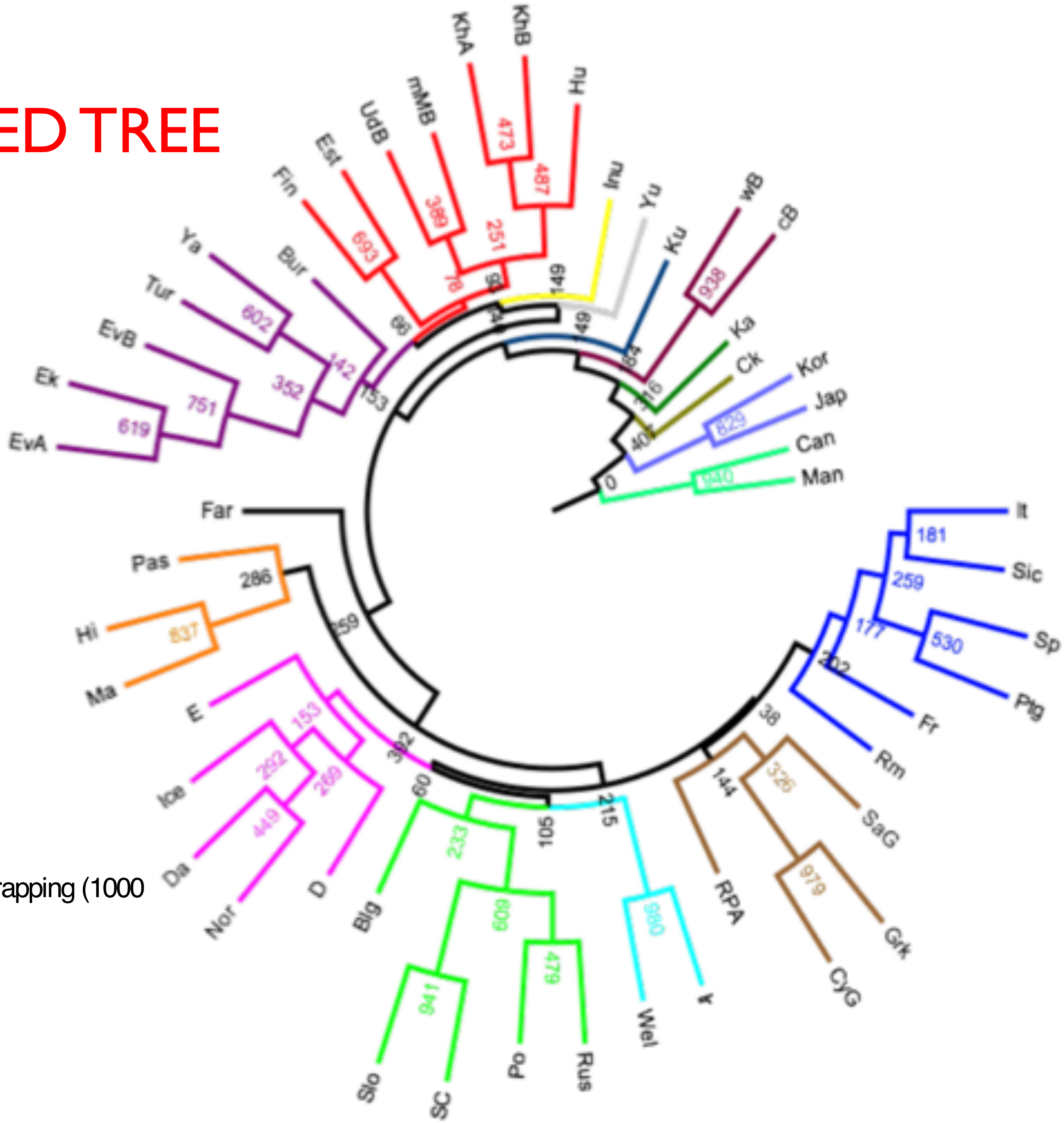
- **50** languages
- **14** traditionally recognized and irreducible families (scattered across Europe, Asia and the Americas)

- **Sino-Tibetan**: Mandarin (Man) and Cantonese (Can).
- **Korean**: Korean (Kor).
- **Japonic**: Japanese (Jap).
- **Muskogean**: Chickasaw (Ck).
- **Guaicuruan**: Kadiweu (Ka).
- **Basque**: Western and Central Basque (wB and cB).
- **Carib**: Kuikuro (Ku).

- **Indo-European**:
  - Indo-Iranian: Farsi (Far), Pashto (Pas), Marathi (Ma), Hindi (Hi);
  - Greek: Romeyka Pontic (RPA), Salento Greek (SaG), Standard Modern Greek (Grk), Cypriot Greek (CyG);
  - Romance: Romanian (Rm), French (Fr), Italian (It), Sicilian (Sic), Spanish (Sp), Portuguese (Ptg);
  - Germanic: English (E), German (D), Icelandic (Ice), Danish (Da), Norwegian (Nor);
  - Celtic: Irish (Ir), Welsh (Wel);
  - Slavic: Bulgarian (Blg), Russian (Rus), Polish (Po), Serbo-Croat (SC), Slovenian (Slo).

- **Yukaghir**: Yukaghir (Yu).
- **Inuit**: Inuktitut (Inu).
- **Mongolian**: Buryat (Bur).
- **Turkic**: Turkish (Tur), Yakut (Ya).
- **Tungusic**: two varieties of Even (EvA, EvB), Evenki (Ek).
- **Uralic**: Balto-Finnic: Finnish (Fin), Estonian (Est); Mari: Meadow Mari (mM); Permic: Udmurt (Ud); Ugric: Hungarian (Hu), two varieties of Khanty (KhA, KhB).

DISTANCE-BASED TREE



KITSCH Tree from the 50 languages.

Consensus tree calculated after a bootstrapping (1000 samples).

MACRO-FAMILIES

- Tree topologies cannot prove genetic relationship. One needs to rely on **statistical testing** (Kessler and Lehtonen 2006)

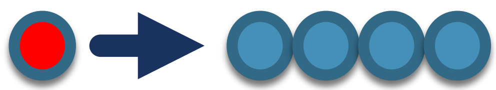
- First step: determining a **null distribution**

NULL DISTRIBUTION

- With only **14 families** it's **difficult to determine a null distribution by internal sampling**. Also, with **most** of the languages being from **Eurasia**, it's **difficult to control for historical relations**
- Solutions: we generate artificial languages by recombining the parametric values of the sample. Values are chosen probabilistically, using evidence weighted for families **Implicational constraints are also applied**
- We generate a sample of **7000 languages**

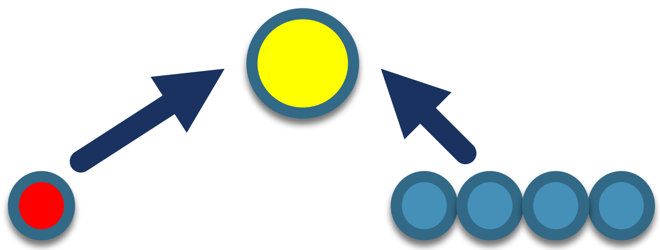
MEDIAN TESTS

- We **compare distributions** of real and artificial distances by means of Mann-Whitney U tests.
- **First test**:
  - Compare median of distances calculated from a **group of real languages** (e.g. Indo-European) versus median of distances calculated from a **group of artificial languages of the same size**.
  - Repeat 1000 times.
  - Check p-values range.



MEDIAN TESTS

- **Second test**:
  - Compare median of distances calculated from a **group of real languages of size N** versus median of distances calculated from a **bigger sample** (2000 languages).
  - Repeat the same using each of the 1000 artificial samples of the same size N instead.
  - Check p-values range.

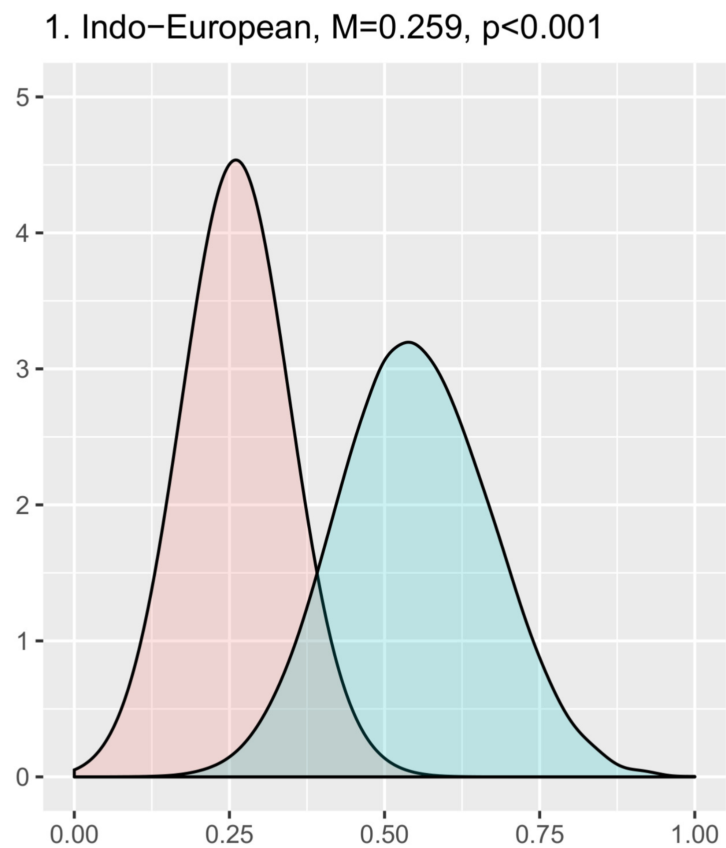


WHICH MACRO-FAMILIES?

- Potentially, many ($2^N-(N+1)$).
  - We start from **two well-established families**, IE and Uralic.
  - We move to **previously hypothesized macrofamilies**, Altaic and Indo-Uralic.
  - We test two groups suggested by the tree, Uralo-Altaic and Uralo-Altaic-Inuktitut.
- **Important**: when testing across families, **remove family-internal pairs** (and adjust artificial sample accordingly through sampling)

A. Well-established families

1. Indo-European
2. Uralic



n_pairs = 277

median = 0.259, sd = 0.058

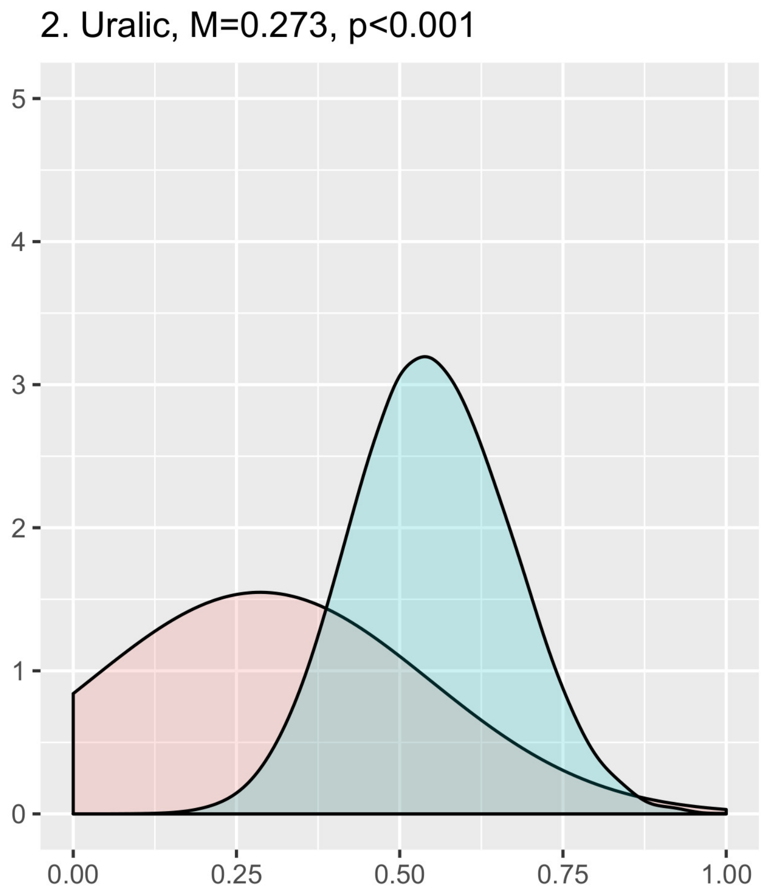
range_mannwhitney = $[1.47*10^{-6}, 0.0002]$

Test1 = <0.001

mannwhitney_bigsample = $1.34*10^{-172}$

min_artificial = $2.61*10^{-16}$

Test2 = <0.001



n_pairs = 17

median = 0.273, sd = 0.113

range_mannwhitney = $[9.98*10^{-7}, 0.029]$

Test1 = <0.001

mannwhitney_bigsample = $1.57*10^{-10}$

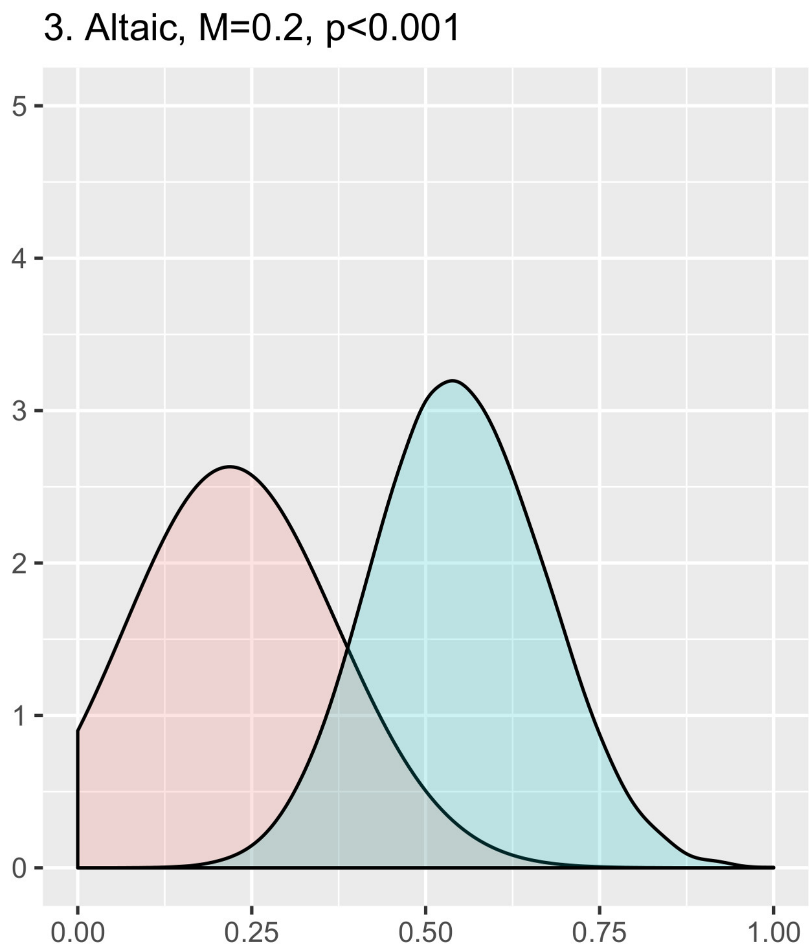
min_artificial = $3.15*10^{-9}$

Test2 = <0.001

B. **Hypothesized macro-families**

3. Altaic

4. Indo-Uralic



n_pairs = 11

median = 0.2, sd = 0.068

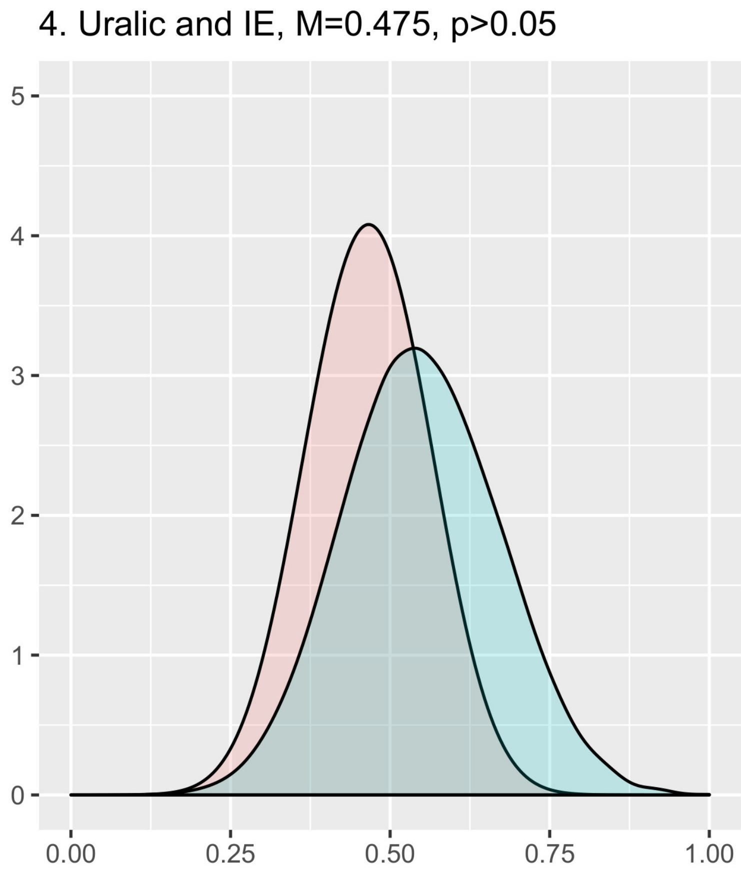
range_mannwhitney = [0.001, 0.007]

Test1 = <0.001

mannwhitney_bigsample = $1.58*10^{-8}$

min_artificial = $3.35*10^{-6}$

Test2 = <0.001



n_pairs =184

median = 0.475, sd = 0.059

range_mannwhitney = $[5.4*10^{-60}, 0.98]$

Test1 = 0.116

mannwhitney_bigsample = $3.53*10^{-26}$

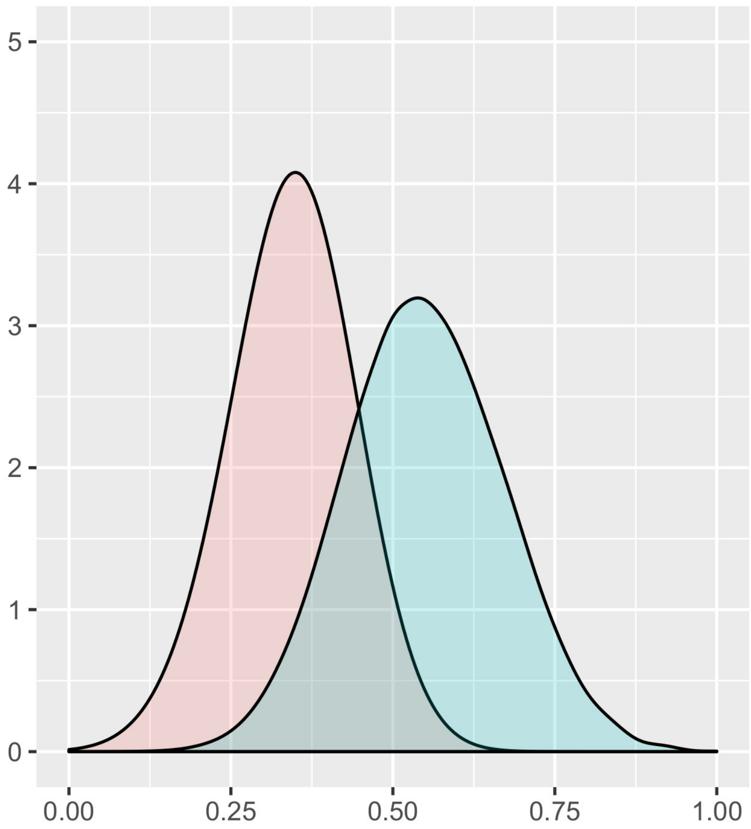
min_artificial = $1.74*10^{-80}$

Test2 = 0.073

C. Further groups suggested by the tree

5. Uralo-Altaic
6. Uralo-Altaic-Inuktitut

5. Uralic and Altaic, M=0.35, p<0.001



n_pairs = 42

median= 0.35, sd = 0.057

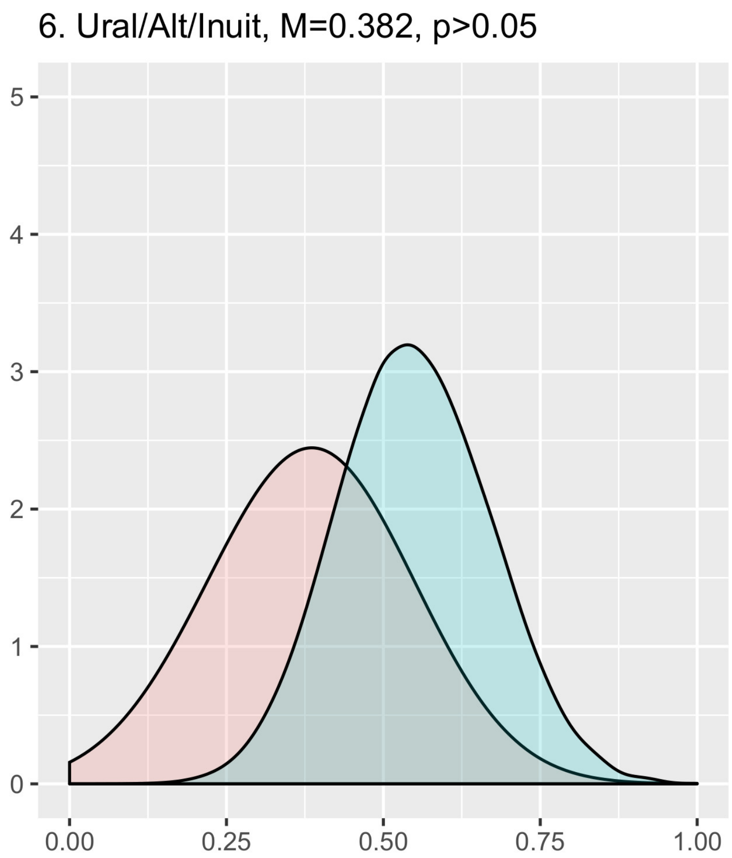
range_mannwhitney = $[4.12*10^{-15}, 0.007]$

Test1 = <0.001

mannwhitney_bigsample = $3.94*10^{-23}$

min_artificial = $4.12*10^{-22}$

Test1 = <0.001



n_pairs = 13

median= 0.382, sd = 0.069

range_mannwhitney = [$1.05*10^{-5}$, 0.797]

Test1 = 0.090

mannwhitney_bigsample = $1.48*10^{-6}$

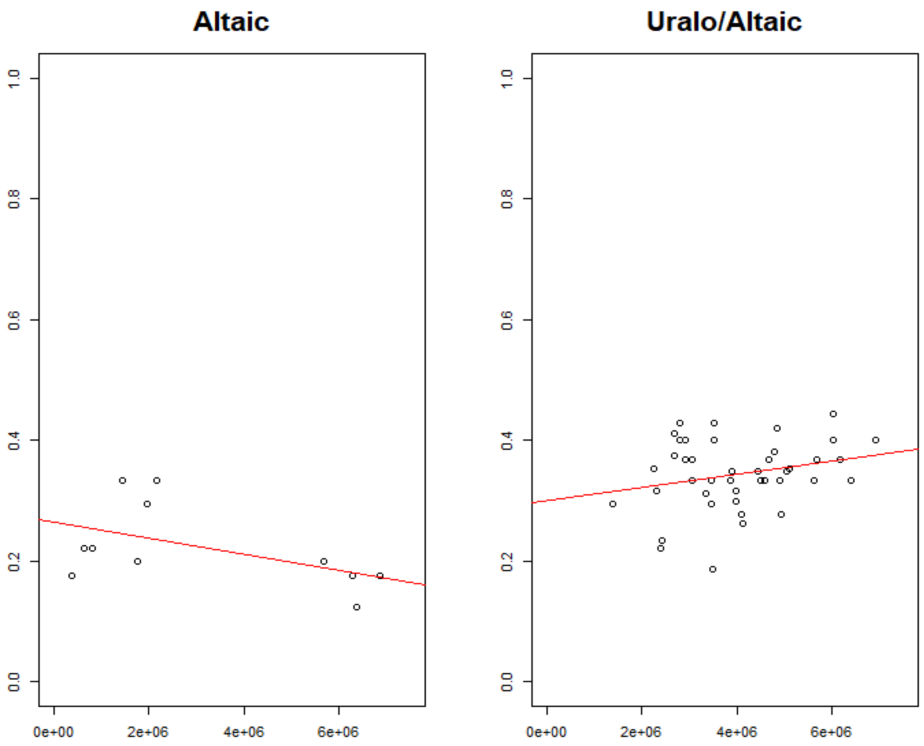
min_artificial = $4.93*10^{-7}$

Test1 = 0.005

SUMMARY

- **Indo-European** and **Uralic** are expectedly supported by the test.
- The **Altaic** hypothesis is corroborated.
- Further evidence for a **Uralo-Altaic unit**.
- Larger groups, like Indo-Uralic or Uralo-Altaic/Inuit, are weakly supported by the test.

GEOGRAPHY



	Altaic	Uralo/Altaic
Kendall tau	-0.29	0.124
p-value	0.223	0.2611
Pearson r	-0.51	0.247
p-value	0.107	0.114

CONCLUSIONS

1. Syntax contains a **detectable historical signal**
2. Unlike classical methods, syntax provides **long-range phylogenies encompassing distinct families**
3. Language relatedness can be **tested statistically** thanks to this syntax-based perspective