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Bivalent verb classes in the languages of Northern Eurasia: genetic and areal factors

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Structure of the talk

- Background and aims
- Data collection
- Distance metrics
- Results
- Conclusions

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Background and aims

- Inspiration: wordlist-based typological studies into valency patterns
  - experiencer encoding [Bossong, 1998; Haspelmath 2001]
  - Split-S: A-like vs. P-like vs. G-like [Nichols 2008]
  - Causative~Inchoative alternation and valence orientation [Nedjalkov 1969; Haspelmath 1993; Nichols et al. 2004; WATP]

  and especially:
  - Transitivity hierarchies, cf. Wichmann's [2015] and Haspelmath's [2015] wordlist-based reassessment of Tsunoda's [1981, 1985] hierarchy, & other studies within the ValPaL project [Malchukov & Comrie (eds.) 2015]

Background and aims

- Typical problems
  - short wordlists (4-70 verbs) ≈ only major patterns
  - *tertium comparationis*, especially if sets of values are pre-established (e.g. agent-like vs. dative-like vs. patient-like experiencer)
- Consequences
  - we know which verbs are most likely to be transitive, but:
  - we don't know much about internal organization of **minor** (non-canonical) valency classes
  - and the ways in which **genetic and areal factors** affect valency class systems

Background and aims

- Research questions
  - To what extent are valency class systems similar in areally and genetically related languages?
  - How can we identify and **measure** these similarities?
  - What is the depth of genetic effects = **how stable** are valency class systems?
  - What is the **granularity** of areal effects? Cf.:

  The scale of geographical patterning is the size of the areal unit – local, subcontinental, larger than continental, global – within which the geagraphical distribution of a feature displays some clear and describable pattern. For example, … nominal classes tend to cluster areally and form hotbeds which are generally smaller than continental in size (subcontinental) [Nichols 1992: 185]

Background and aims

- **Bivalent** verbs
  - Because bivalent verbs are especially prone to show deviant valency behaviour [Bickel et al. 2014] and here, language-internal lexical distributions can be especially complex
- **130** verb meanings
  - Because we need many meanings in order to discern finer signals in the data
- Just one macro-area: **Northern Eurasia**
  - Because this it is possible to rely exclusively on **primary data** (it is not feasible to extract reliable data on as many as 130 verbs from published sources)
  - and still have a relatively dense grid of languages covered

Background and aims

- It comes at a price
  - convenience sample: I depend on availability of experts and speakers
  - the wordlist can be biased in many ways
  - cross-validation is problematic
  - some meanings can be marginal or non-attested in some languages

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Data collection: questionnaire

- 130 predicates
- Predicates are provided with contexts in order to make cross-linguistic comparison more accurate

#21 (Peter was crossing the river in a boat)

	‘Peter	**reached**	the bank’
	A		P

#22. (The wall was covered with fresh paint)

	‘Peter	**touched**	the wall’ (and got dirty)
	A		P

Data collection: questionnaire

- Predicates
  - only predicates that can be expected to be bivalent
  - many predicates that are known to tend to deviate from the transitive prototype
- Translations
  - elicited from native speakers (some exceptions, e.g. Latin)
  - annotated for argument coding devices (flagging and indexing) by language experts
  - variation in argument realization, synonyms etc. are disregarded: one pattern annotated for each predicate

Data collection: questionnaire

- Valency classes: two verbs belong to the same valency class iff their two arguments are coded by identical devices respectively

Armenian (Eastern)

#	Predicate	Translation	Valency Class
…			
21	reach	*Petros-ə hasav ap'-i-n* Petros[**NOM**]-DEF reach:AOR:**3SG** bank-**DAT**-DEF 'P. reached the bank'	**NOM_DAT**
22	touch	*Petros-ə dipav pat-i-n* Petros[**NOM**]-DEF touch:AOR:**3SG** wall-**DAT**-DEF 'Petros touched the wall'	**NOM_DAT**
53	attack	*Arĵ-ə harjakvec' jknors-i vra* bear[**NOM**]-DEF attack:AOR:**3SG** fisherman-**DAT on** 'A bear attacked a fisherman'	**NOM_DATvra**

Data collection: questionnaire

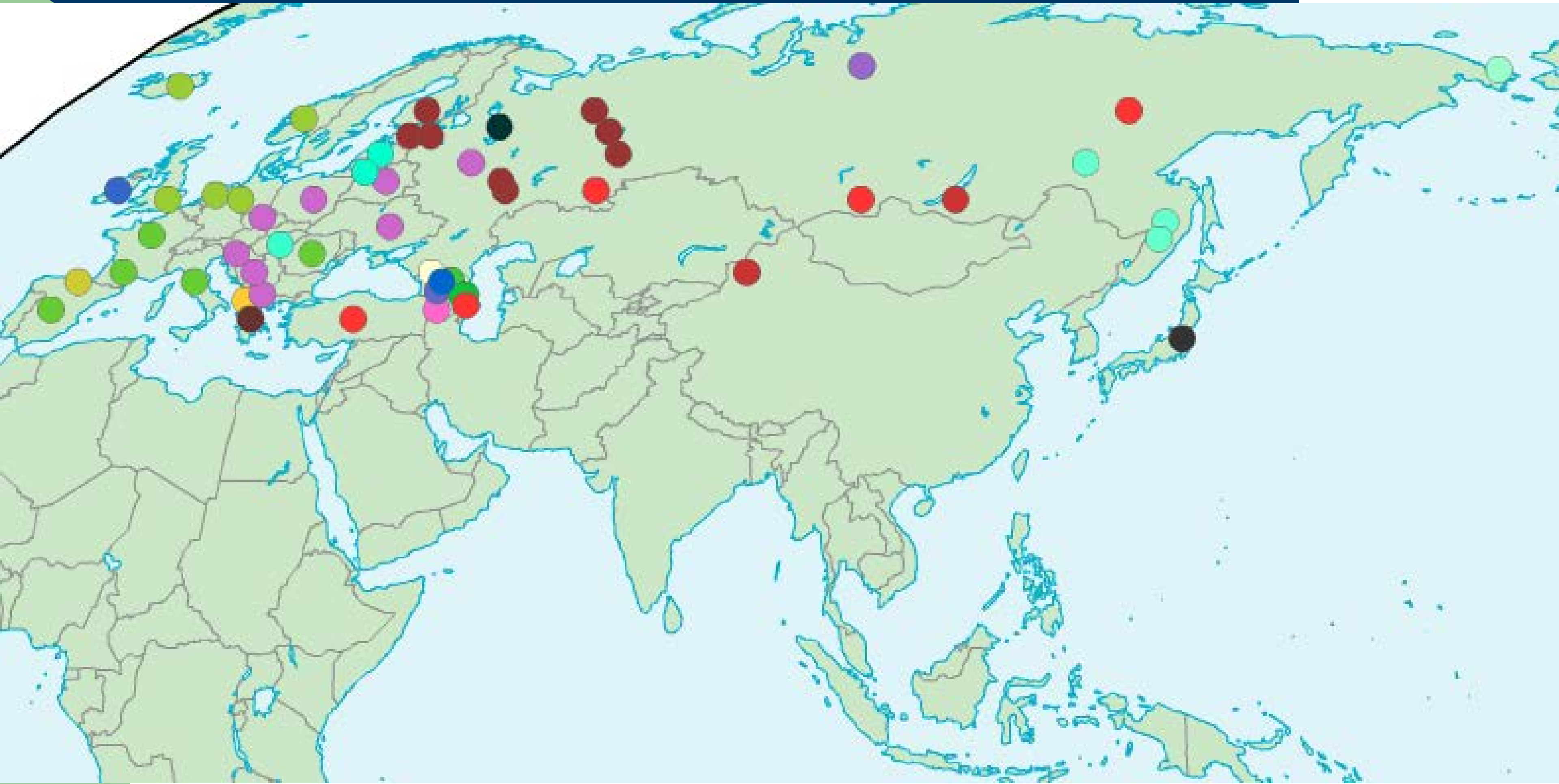
- One class in each language was identified as **transitive**
  - in the sense of e.g. [Haspelmath 2011]: the class encompassing ‘break’
- The number of valency classses: from 7 (Modern Greek) to 33 (Abaza)

Data collection: sample

- 57 languages of Northern Eurasia
  - roughly, to the North of 35°N
  - including two extinct languages: Latin and Ancient Greek
  - 9 families (following WALS)
  - 24 genera (following WALS)
- Total datapoints: 6799

  = 7410 (57 lgs x 130 predicates) − 611 gaps (≈11 per language)

Data collection: sample
(coloured by genera)



Languages and language experts

Lg	Family	Genus	Expert
Abaza	NorthwestCaucasian	NorthwestC	Peter Arkadiev
Albanian	IndoEuropean	Albanian	Varvara Diveeva
ArmenianEastern	IndoEuropean	Armenian	Vasilisa Krylova
Azerbaijani	Altaic	Turkic	Lejla Kurbanova
Bagwalal	NakhDaghestanian	AvarAndicT:	Dmitry Gerasimov
Bashkir	Altaic	Turkic	Sergey Say
Basque	Basque	Basque	Natalia Zaika
Belarusian	IndoEuropean	Slavic	Olga Gorickaja
Buriat	Altaic	Mongolic	Mikhail Knazev
Chukchee	ChukotkoKamchatkan	NorthernCh	Maria Pupynina
Czech	IndoEuropean	Slavic	Anastasija Makarova
Dutch	IndoEuropean	Germanic	Mikhail Knazev
Enets	Uralic	Samoyedic	Maria Ovsjannikova
English	IndoEuropean	Germanic	Dmitry Nikolaev
ErzyaMordvin	Uralic	Finnic	Ksenia Shagal
Estonian	Uralic	Finnic	Irina Külmoja
Evenki	Altaic	Tungusic	Nadezhda Bulatova, Elena Perekhvalskaja
Finnish	Uralic	Finnic	Ksenia Shagal
French	IndoEuropean	Romance	Elena Kordi
Gascon	IndoEuropean	Romance	Natalia Zaika
Georgian	Kartvelian	Kartvelian	Alexander Rostovtsev-
German	IndoEuropean	Germanic	Sandra Birzer
GreekAncient	IndoEuropean	Greek	Ildar Ibragimov
GreekModern	IndoEuropean	Greek	Ekaterina Zheltova
HillMari	Uralic	Finnic	Ksenia Studenikina
Hungarian	Uralic	Ugric	Vasilisa Zhigulskaja
Icelandic	IndoEuropean	Germanic	Ingunn Hreinberg Indr
IngrianFinnish	Uralic	Finnic	Daria Mischenko

Lg	Family	Genus	Expert
Ingush	NakhDaghestanian	Nakh	Johanna Nichols
Irish	IndoEuropean	Celtic	Dmitry Nikolaev
Italian	IndoEuropean	Romance	Anna Alexandrova
Japanese	Japanese	Japanese	Yukari Konuma
Kalmyk	Altaic	Mongolic	Sergey Say
KomiPermyak	Uralic	Finnic	Ekaterina Sergeeva
KomiZyrian	Uralic	Finnic	Ekaterina Sergeeva
Latin	IndoEuropean	Romance	Inna Popova
Latvian	IndoEuropean	Baltic	Natalia Perkova
Lezgi	NakhDaghestanian	Lezgic	Ramazan Mamedshax
Lithuanian	IndoEuropean	Baltic	Natalia Zaika
Macedonian	IndoEuropean	Slavic	Vladimir Fedorov
MokshaMordvin	Uralic	Finnic	Maria Kholodilova
Nanai	Altaic	Tungusic	Daria Mischenko
NorwegianBokmal	IndoEuropean	Germanic	Olga Kuznecova
Ossetic	IndoEuropean	Iranian	Arsenij Vydrin
Polish	IndoEuropean	Slavic	Georgij Moroz
Romanian	IndoEuropean	Romance	Daria Suetina
RomaniKalderash	IndoEuropean	Indic	Kirill Kozhanov
Russian	IndoEuropean	Slavic	Sergey Say
Rutul	NakhDaghestanian	Lezgic	Anastasia Vasilisina, S
Serbian	IndoEuropean	Slavic	A.Makarova
Slovene	IndoEuropean	Slavic	Andreja Žele, Mladen
Spanish	IndoEuropean	Romance	Elena Gorbova
Turkish	Altaic	Turkic	Maria Ovsjannikova
Tuvan	Altaic	Turkic	Arzhaana Syuryun
Udihe	Altaic	Tungusic	Elena Perkhvalskaja
Ukrainian	IndoEuropean	Slavic	Natalia Zaika
Yakut	Altaic	Turkic	Ajtalina Nogovitsyna

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Distance metrics

For each pair of languages

- Genetic distance
- Areal distance
- Structural distances

Distance metrics: genetic

- Three levels, based on WALS:
  - 1: same genus
  - 2: same family, different genera
  - 3: different families

E.g.: DistGenetic (Eastern Armenian, Azerbaijani) = 3

Distance metrics: geographic

- Calculated as the geographic distance (in kilometers) between the two points associated with individual languages
- Coordinates are taken from WALS
- The distance is calculated using `distCosine()` from the R package `geosphere` [Hijmans 2016]
- NB: this is a very coarse metric for languages spoken over vast areas
- For statistical purposes, the decimal logarithm of the distance is used, e.g.

DistGeo (Eastern Armenian, Azerbaijani) = 277 km

LogDistGeo (Eastern Armenian, Azerbaijani) = 2.44

Distance metrics: structural

- Structural distances:
  - **DistTrRat**: measures (dis)similarity in transivity prominence
  - **DistTrProf**: measures (dis)similarity in transivity profiles
  - **DistValPat**: measures (dis)similarity between systems of valency classes

Distance metrics, structural (1)

- Transitivity Ratio (TrRatio): the number of transitive verbs divided by the total number of verbs, cf. [Haspelmath 2015]

E.g. TrRatio (Azerbaijani) = 0.48 (58 transitive verbs / 121 total)

- DistTrRatio is the absolute value of the difference between transitivity prominence in the two languages

DistTrRatio (Azerbaijani, Eastern Armenian) = |0.48 − 0.50| = 0.02

Distance metrics, structural (2)

- Transitivity profile of a language: sets of +/- transitive verbs
- DistTrProf measures (dis)similarity between “transitivity profiles”
- The relative Hamming distance: the ratio of predicates that are transitive in one language and intransitive in the other

Distance metrics, structural (2)

	Eastern Armenian	Azerbaijani
win	TR	INTR
be_afraid	INTR	INTR
believe	INTR	INTR
see	TR	TR
reach	INTR	INTR
touch	INTR	INTR
forget	INTR	TR
wait	TR	TR
know	TR	TR
avoid	INTR	INTR
…		

Distance metrics, structural (2)

		Azerbaijani	
		t	i
Eastern Armenian	t	53	8
	i	5	53

DistrTrProf (Eastern Armenian, Azerbaijani) = (5+8)/(53+8+5+53) = 13 / 119 = 0.109

- Low DistTrProf entails low DistTrRat, but not vice versa.

Distance metrics, structural (2)

- DistrTrProf (Eastern Armenian, Azerbaijani) = 0.109

Is this a big difference or a small difference?

- Standardization: **z-scores**
- Mean value of DistTrProf among all pairs = 0.209, and σ = 0.07

$$z\,(\text{DistrTrProf (Eastern Armenian, Azerbaijani)}) = \frac{0.109 - 0.209}{0.07} = -1.43$$

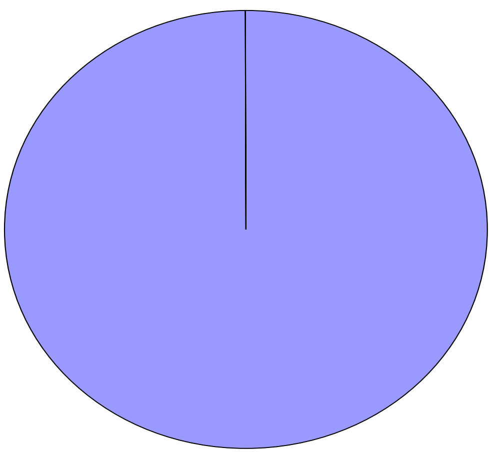
NB: Negative z-scores signal more similarity between languages!

Distance metrics, structural (3)

- Cross-linguistic identification of minor minor valency classes (cf. “ablative verbs”?, “instrumental verbs”?) is not feasible
- Measuring (dis)similarity in valency class systems is the biggest challenge
- I propose **DistValPat**, a metric based on entropy and MI (mutual information)
- Entropy ≈ the amount of information (conveyed by the valency class assignment)

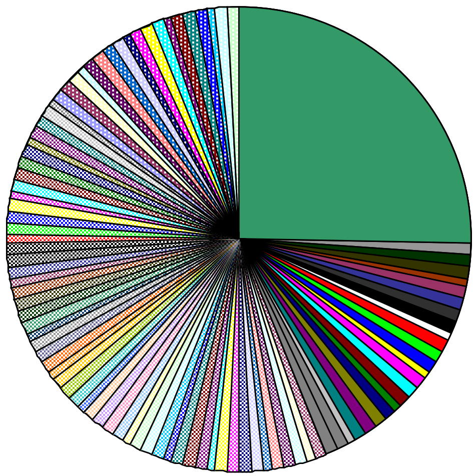
Distance metrics, structural (3)

$$H(x) = -\sum_{i=1}^{k} p(x_i) \cdot \log(p(x_i))$$



Hypothetical Language 1:
All verbs belong to the same class

$H = 0$

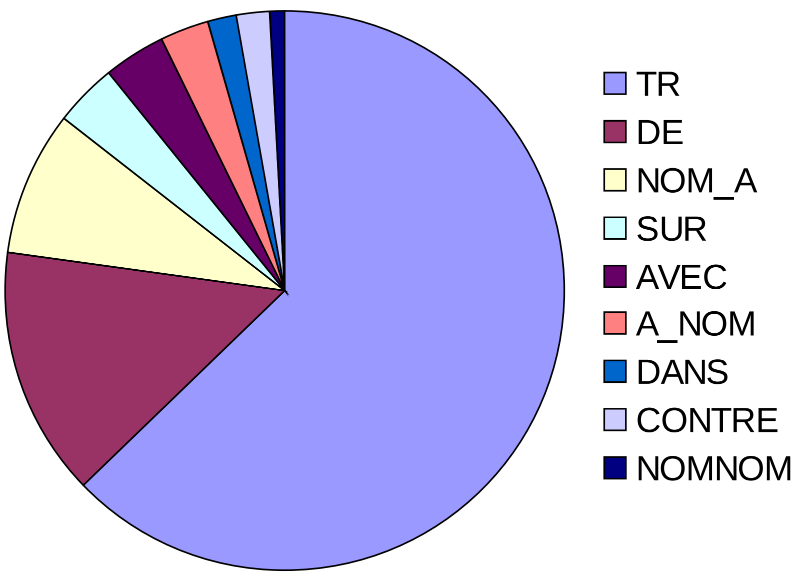


Hypothetical Language 2:
130 verb classes

$$H = -\log\left(\frac{1}{130}\right) \approx 4{,}87$$

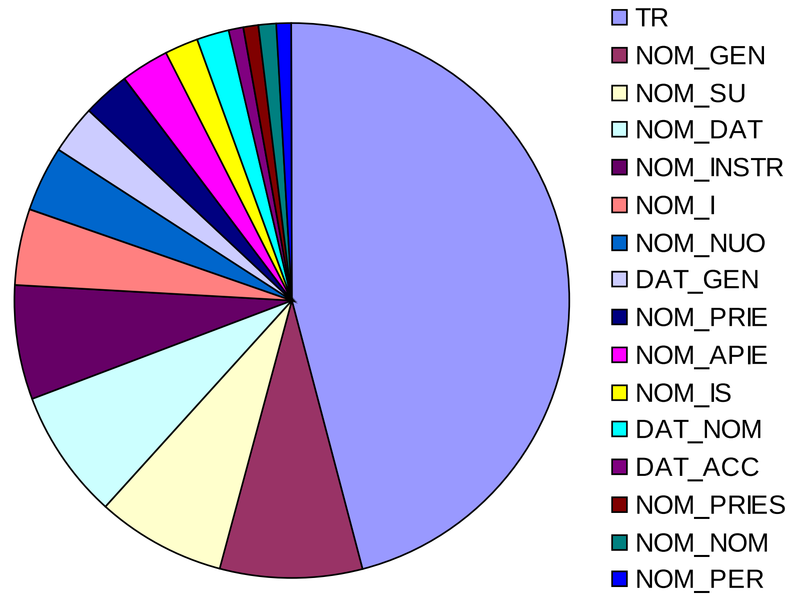
Entropy

French



H ≈ 1.31

Lithuanian



H ≈ 2.02

	Armenian	Azerbaijani
take	TR	TR
see	TR	TR
influence	NOMvra	NOMDAT
encounter	TR	NOMCOM
enter	NOMNOM	NOMCOM
win	TR	NOMDAT
go_out	NOMABL	NOMABL
drive	TR	TR
bend	TR	TR
tell	NOMDAT	TR
hold	TR	TR
catch_up	NOMDAT	NOMDAT
milk	TR	TR
reach	NOMDAT	NOMDAT
touch	NOMDAT	NOMDAT
fight	NOMhet	NOMCOM
be_friends	NOMhet	NOMCOM
think	NOMmasin	NOMABL
…		
H (Entropy)	**1.658**	**1.462**

	Armenian	Azerbaijani	Joint Distribution
take	TR	TR	TR_TR
see	TR	TR	TR_TR
influence	NOMvra	NOMDAT	NOMvra_NOMDAT
encounter	TR	NOMCOM	TR_NOMCOM
enter	NOMNOM	NOMCOM	NOMNOM_NOMCOM
win	TR	NOMDAT	TR_NOMDAT
go_out	NOMABL	NOMABL	NOMABL_NOMABL
drive	TR	TR	TR_TR
bend	TR	TR	TR_TR
tell	NOMDAT	TR	NOMDAT_TR
hold	TR	TR	TR_TR
catch_up	NOMDAT	NOMDAT	NOMDAT_NOMDAT
milk	TR	TR	TR_TR
reach	NOMDAT	NOMDAT	NOMDAT_NOMDAT
touch	NOMDAT	NOMDAT	NOMDAT_NOMDAT
fight	NOMhet	NOMCOM	NOMhet_NOMCOM
be_friends	NOMhet	NOMCOM	NOMhet_NOMCOM
think	NOMmasin	NOMABL	NOMmasin_NOMABL
…			
H (Entropy)	**1.658**	**1.462**	**2.196**

Distance metrics, structural (3)

- MI (Mutual Information) = H (X) + H (Y) − H (X, Y)
- MI (Armenian, Azerbaijani) = 1.658 + 1.462 − 2.196 = 0.924
- Higher MI values reflect higher similarity between valency class systems in the two languages
- MI was calculated using R package `infotheo` [Meyer 2014]

Distance metrics, structural (3)

- Converting MI into a distance metric

$$\text{DistValPat (L1, L2)} = 1 - \frac{\frac{MI\,(L1,L2)}{H\,(L1)} + \frac{MI(L1,L2)}{H(L2)}}{2}$$

- DistValPat is high if the joint entropy is high relative to individual entropies
- DistValPal is higher if valency class systems are divergent

Distance metrics, structural (3)

- DistValPal (Armenian, Azerbaijani) = 0.405

- z (DistValPat(Armenian, Azerbaijani)) = $\frac{0.405-0.499}{0.096} = -0.97$

- This means that valency class assignment in Armenian and Azerbaijani is rather similar: the distance between the two languages is almost one standard deviation below the mean

Distance metrics: summary

- Pairs of languages: 1596 = (57*56)/2
- 5 distance metrics for each pair:
  - genetic
  - geographical
  - 3 structural

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Results

- All the three structural distance metrics correlate positively with both the genetic and areal distance

Results

- All the three structural distance metrics correlate positively with both the genetic and areal distance.

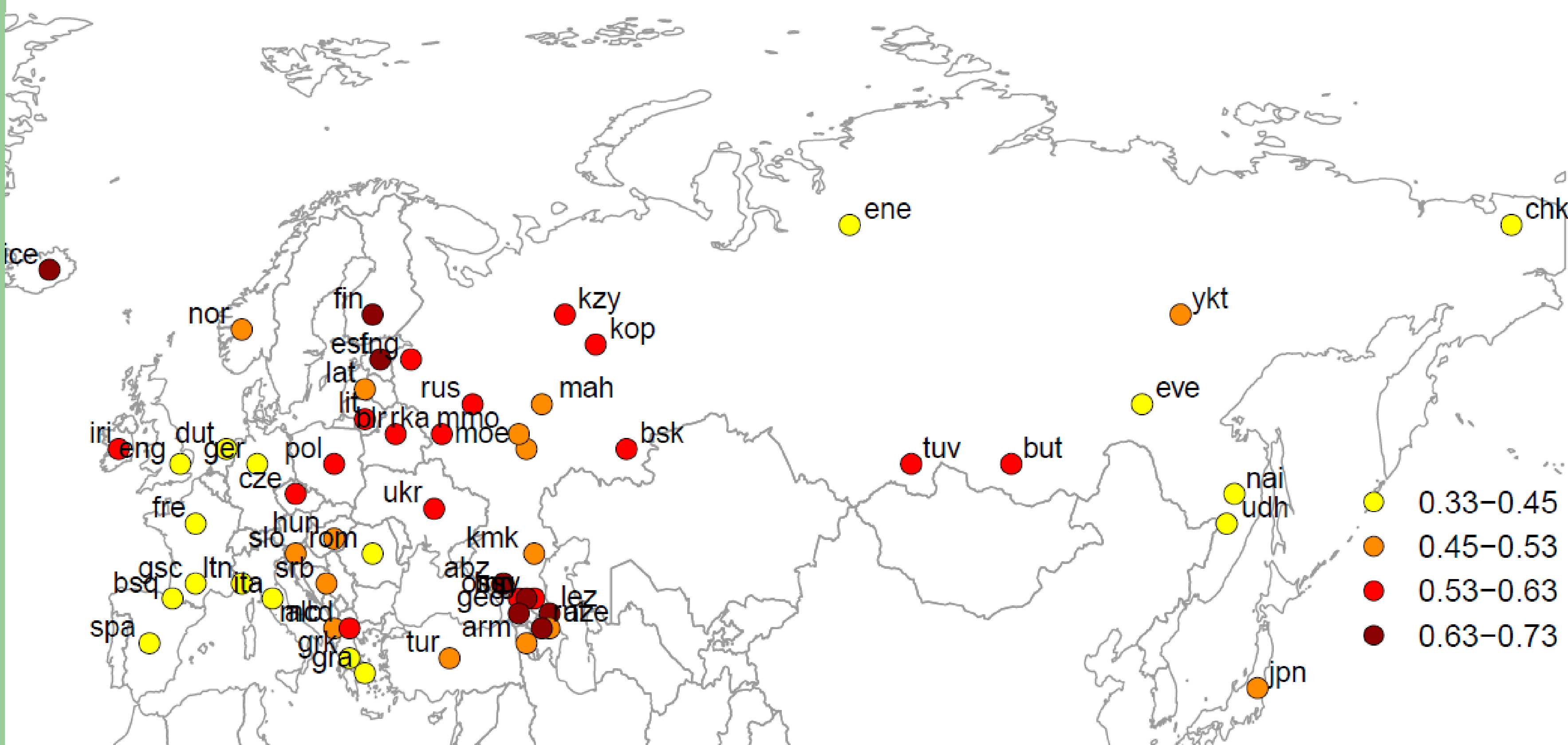
  => Expected
- But the devil is in the detail

Results: transitivity prominence

- Transitivity / intransitivity prominence is primarily an areal phenomenon with **subcontinental** degree of granularity
  - Transitivity peaks are in Central Western Europe and in the Far East
  - Intransitivity peaks are in the Caucasus and in the Eastern Europe

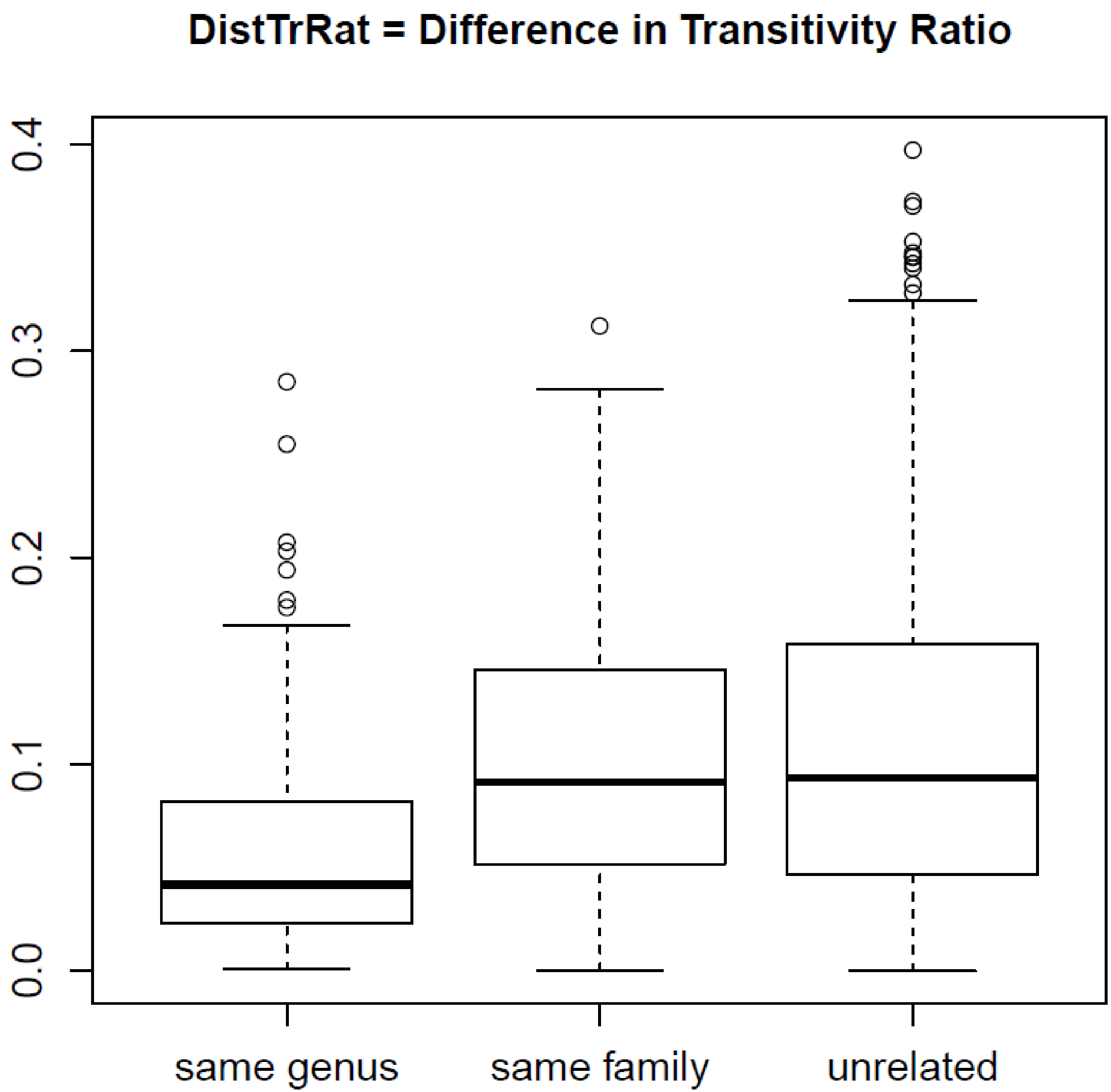
Results: transitivity prominence

The ratio of intransitive verbs



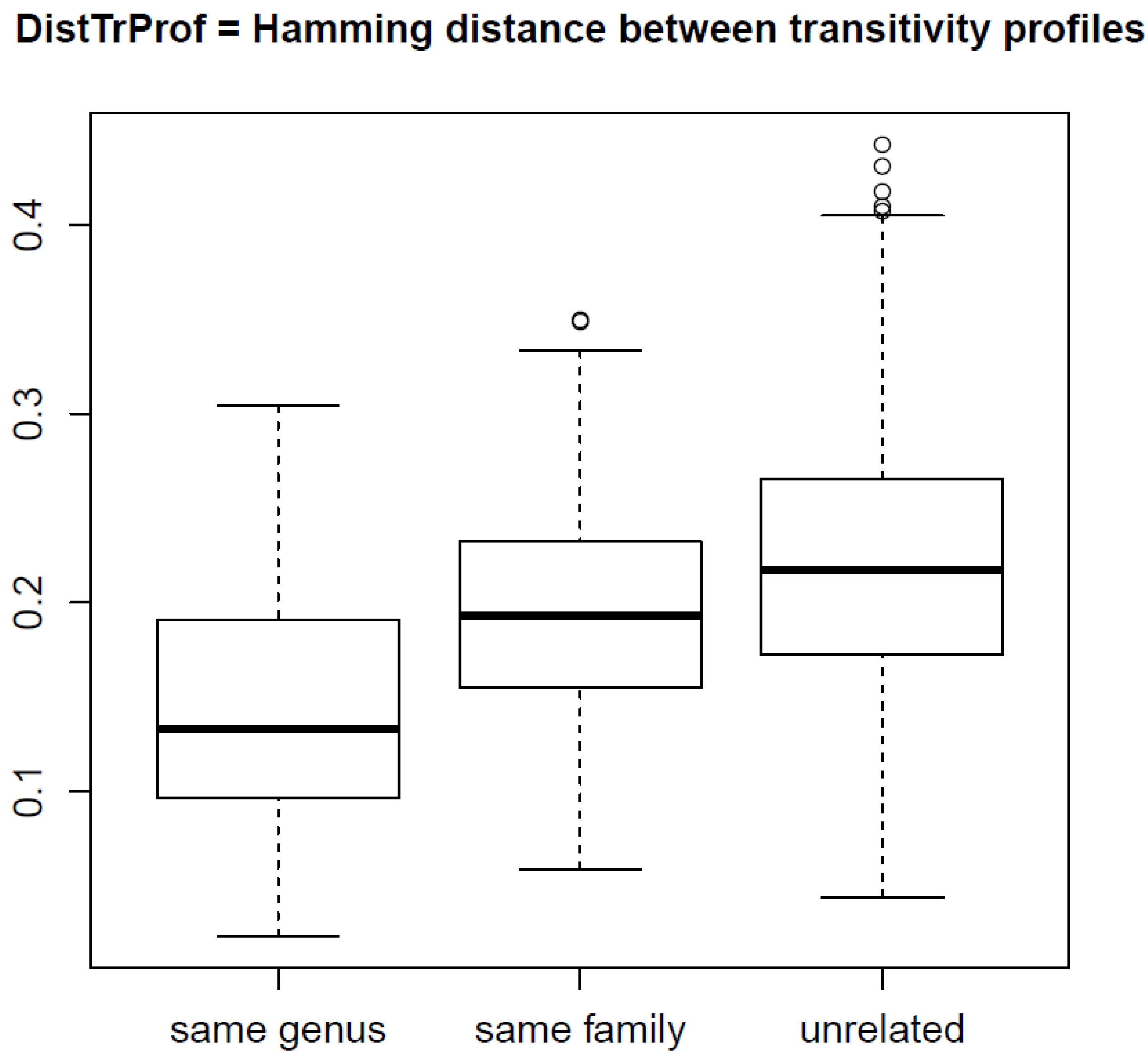
Results: transitivity prominence

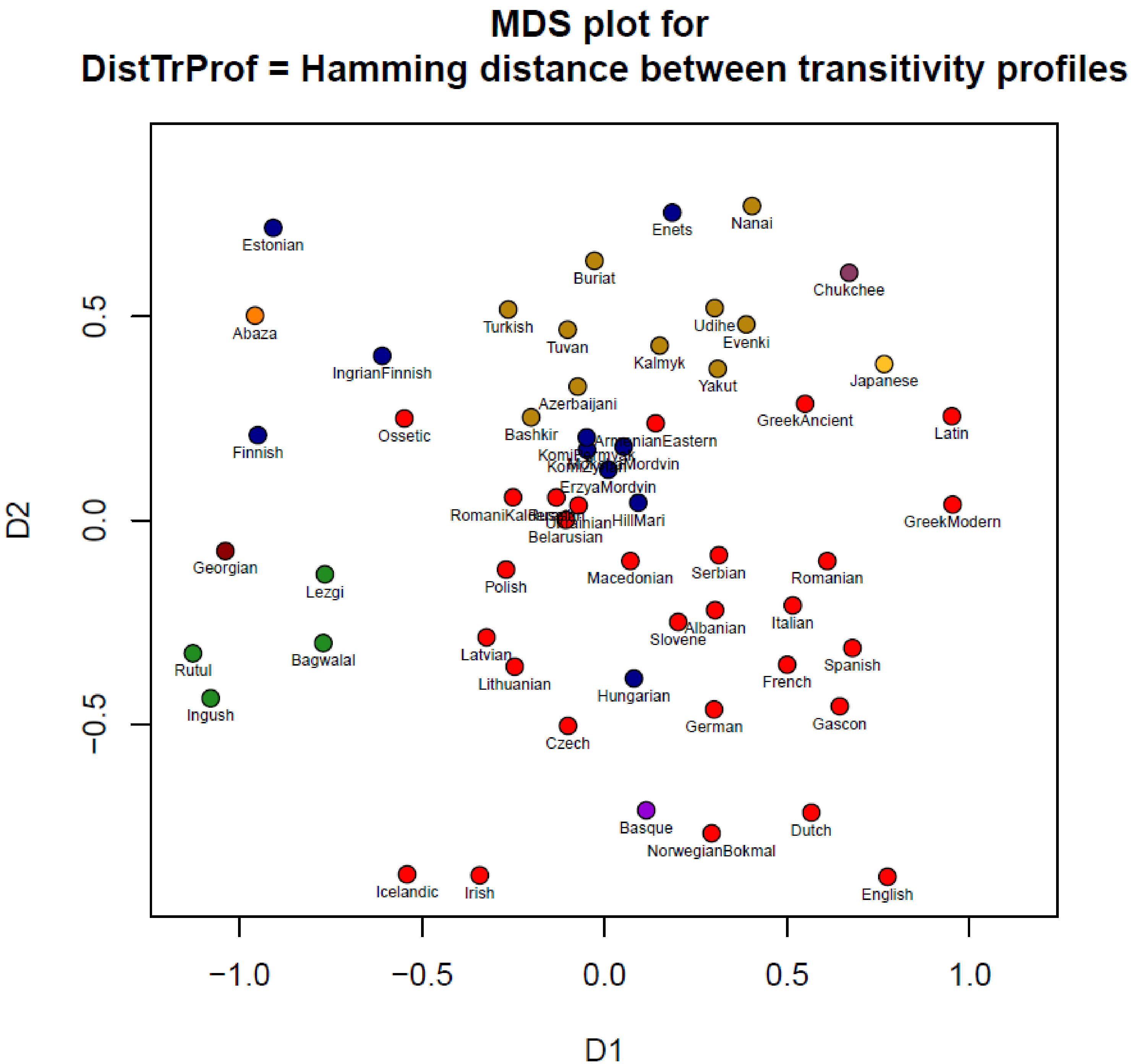
- Genera are relatively homogeneous in terms of transitivity prominence: DistTrRatio's are low
- No traceable family-size effects, e.g. both Indo-European and Uralic languages are very diverse


DistTrRat = Difference in Transitivity Ratio
0.0
0.1
0.2
0.3
0.4
same genus
same family
unrelated

Results: transitivity profiles

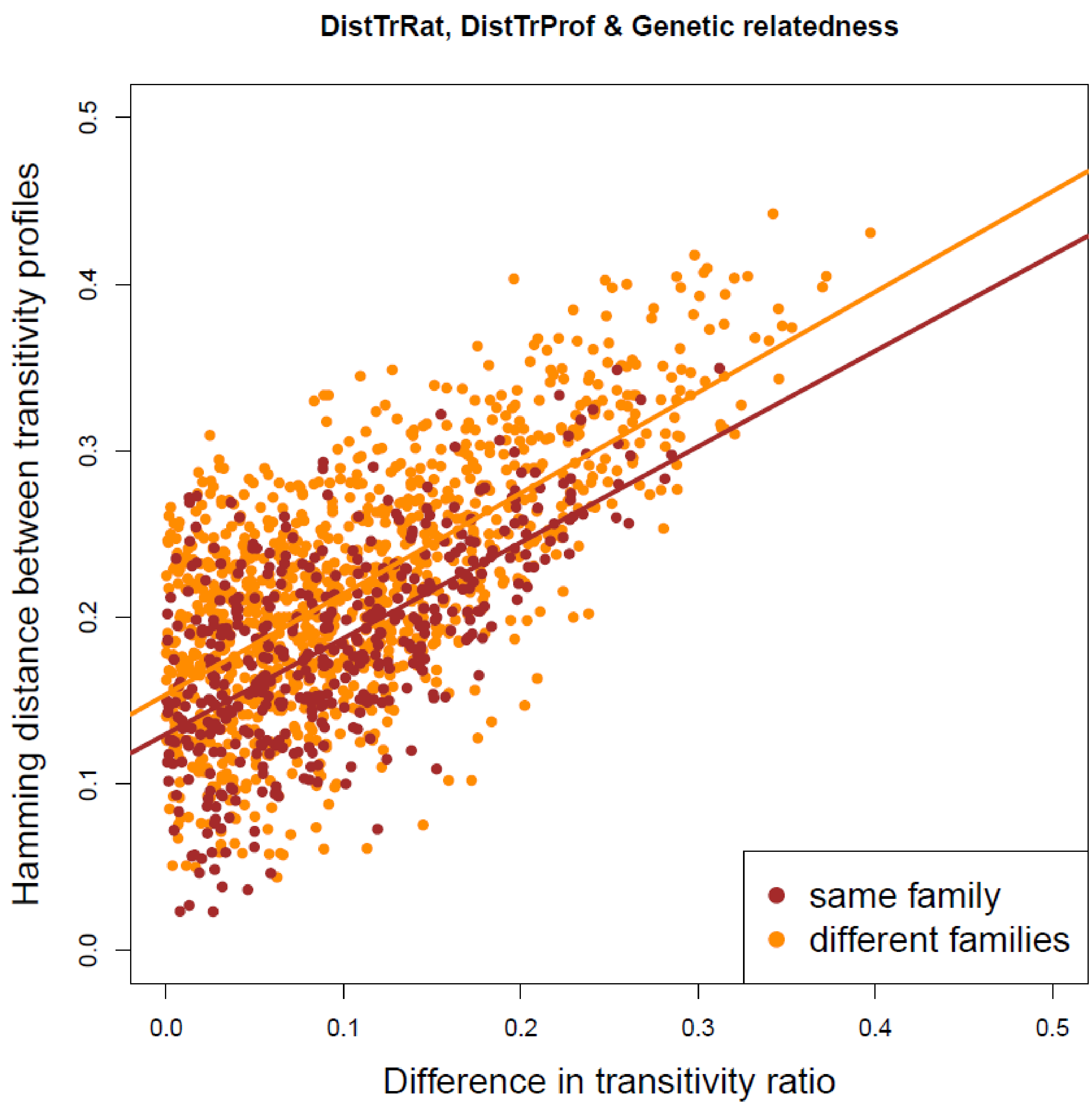
- DistTrProf: significant genetic signal not only on the level of individual genera, but also on the family-size level
- Also visible on the MDS (Multidimensional scaling) plot
  - However, Uralic languages are somewhat distorted


DistTrProf = Hamming distance between transitivity profiles
0.1
0.2
0.3
0.4
same genus
same family
unrelated


MDS plot for
DistTrProf = Hamming distance between transitivity profiles
D2
D1
0.5
0.0
−0.5
−1.0
−0.5
0.0
0.5
1.0
Estonian
Enets
Nanai
Buriat
Chukchee
Abaza
Turkish
Tuvan
Udihe
Evenki
Kalmyk
IngrianFinnish
Yakut
Japanese
Azerbaijani
Ossetic
Bashkir
GreekAncient
Latin
Finnish
ErzyaMordvin
HillMari
GreekModern
Belarusian
Georgian
Lezgi
Polish
Macedonian
Serbian
Romanian
Albanian
Italian
Slovene
Rutul
Bagwalal
Latvian
Spanish
Lithuanian
French
Hungarian
Ingush
German
Gascon
Czech
Basque
Dutch
NorwegianBokmal
Icelandic
Irish
English

Results: transitivity profiles

- Given a certain level of DistTrRat, genetically related languages show lower DistTrProf


DistTrRat, DistTrProf & Genetic relatedness
Hamming distance between transitivity profiles
Difference in transitivity ratio
0.0
0.1
0.2
0.3
0.4
0.5
same family
different families

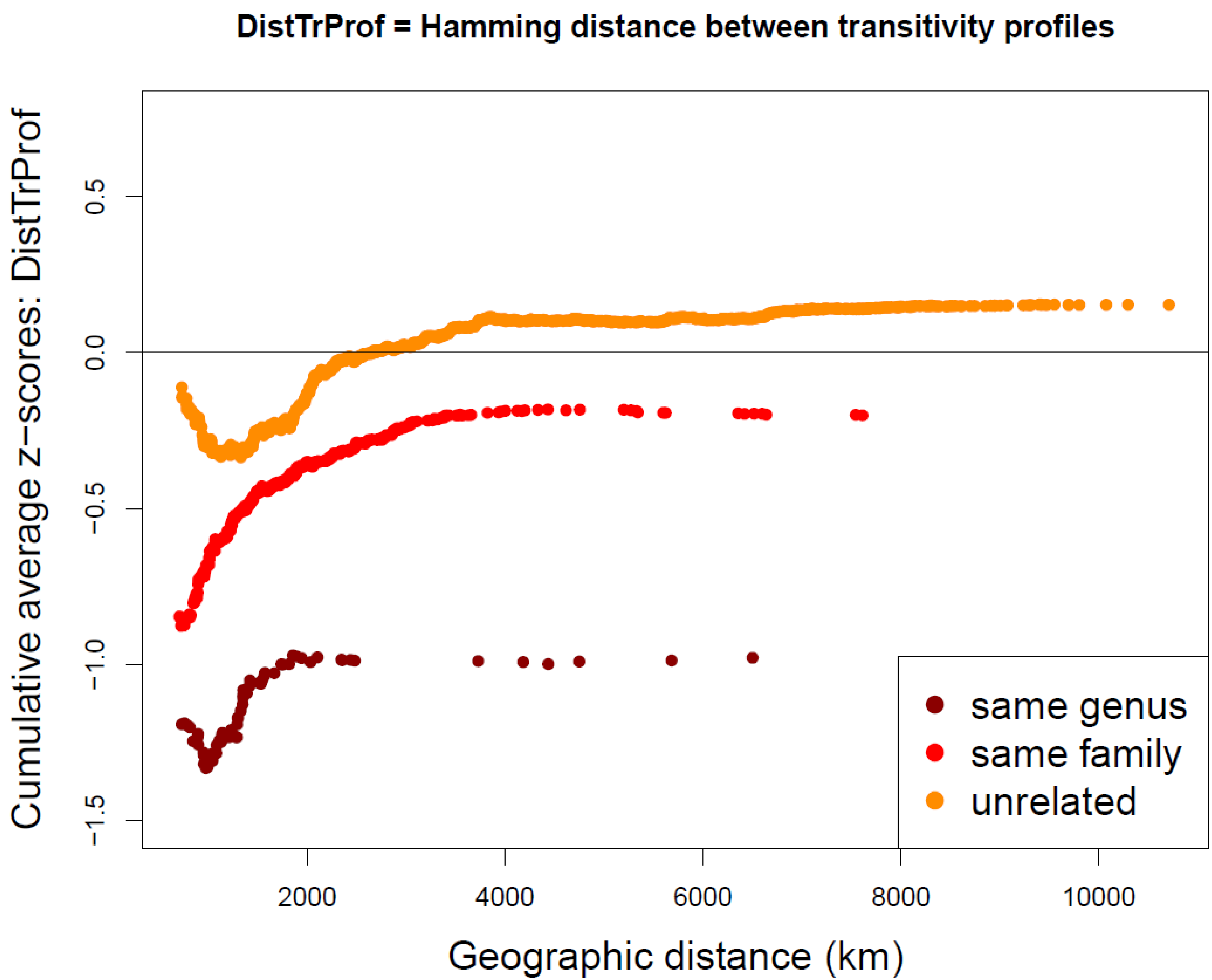
Results: transitivity profiles

- This would not be expected if the transitivity-prominence scale of verbs were universal
- Probably, verb hierarchies of transitivity prominence are family-specific, e.g.:
  - Experiential predicates (‘see’, ‘know’, ‘love’, ‘want’) are especially prone to be intransitive in Nakh-Daghestanian
  - Verbs of contact (‘follow’, ‘reach’, ‘touch’, ‘kiss’, ‘attack’) are especially prone to be intransitive in Uralic (though not Hungarian)
  - etc.

Results: transitivity profiles

- Next slide: the role of geographic distance
  - X-axis: geographic distance in kilometers
  - Y-axis: mean DistTrProf for pairs of languages spoken closer than N kilometers tp each other (cumulative mean)
  - separately for three levels of genetic distance

This method is inspired by [Wichmann & Holman 2009: 75 ff.]



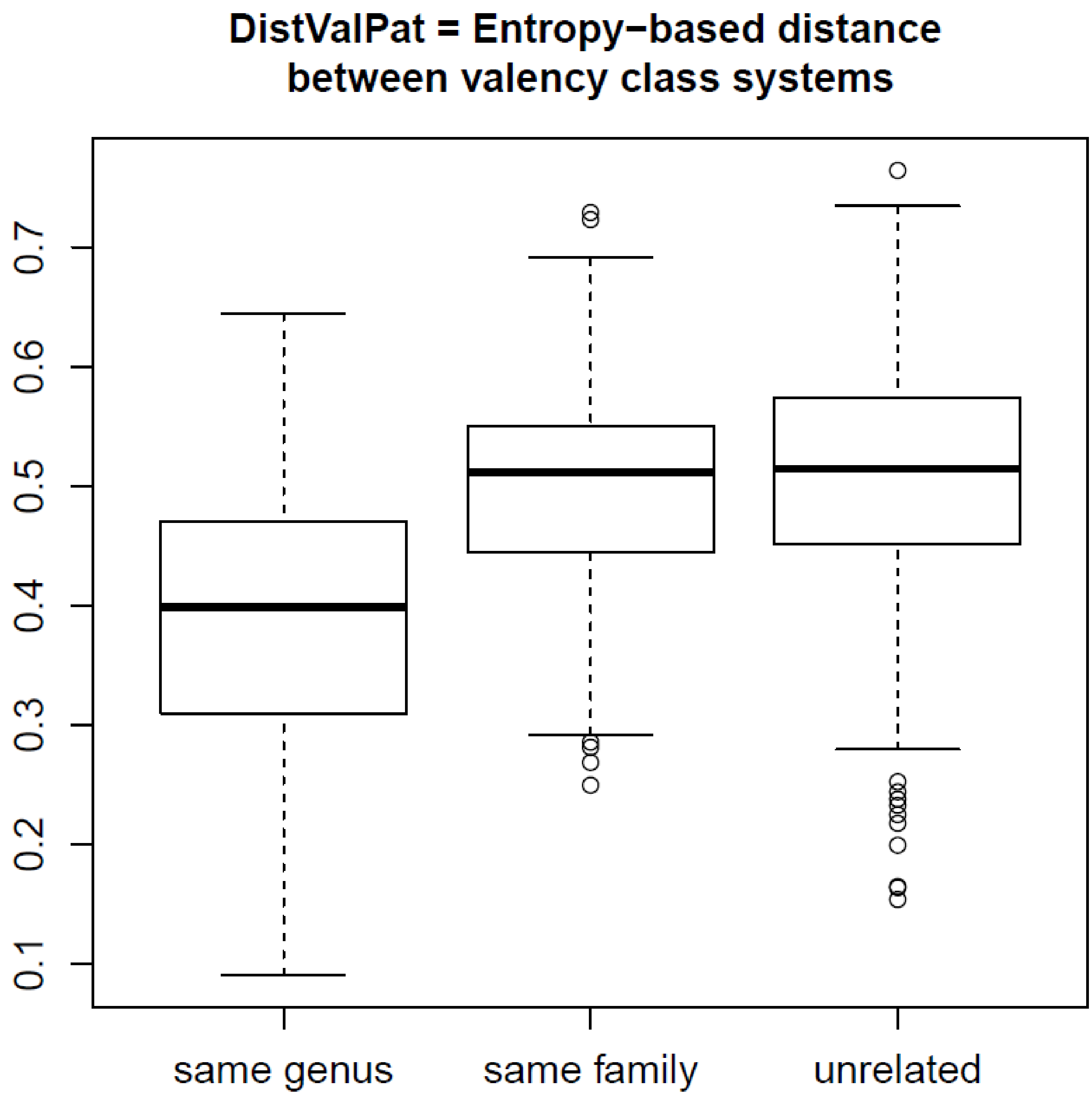
DistTrProf = Hamming distance between transitivity profiles
Cumulative average z−scores: DistTrProf
0.5
0.0
−0.5
−1.0
−1.5
2000
4000
6000
8000
10000
Geographic distance (km)
same genus
same family
unrelated

Results: transitivity profiles

- Robust genetic signal: three curves are very different
- If genetic factor is levelled out, the role of geographic proximity rapidly fades away after ≈2000 km

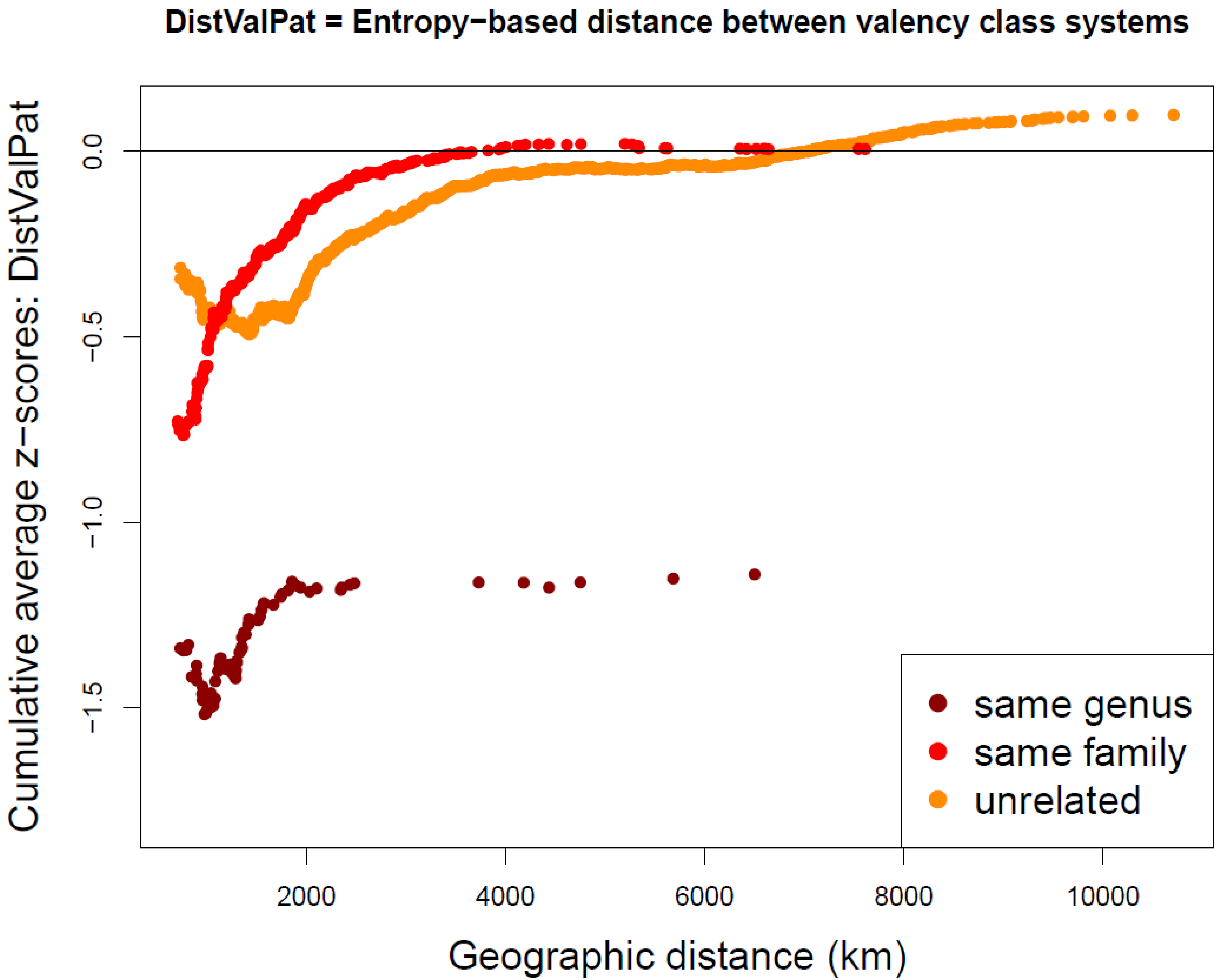
Results: valency class systems

- DistValPat displays no family-level effects, only genus-level effects


DistValPat = Entropy−based distance
between valency class systems
0.1
0.2
0.3
0.4
0.5
0.6
0.7
same genus
same family
unrelated

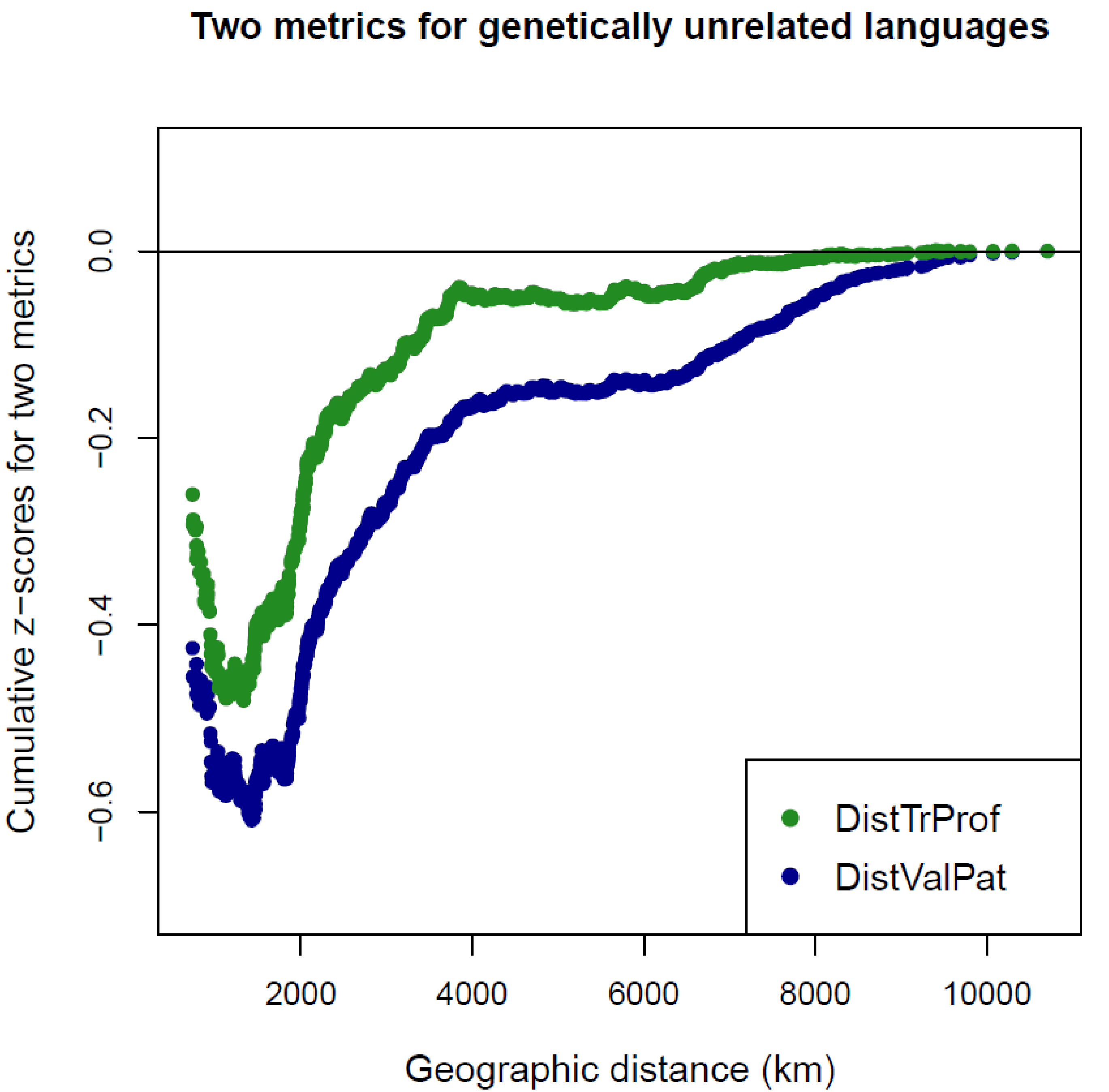
Results: valency class systems

- DistValPat: geographical effects (next slide)
  - The curves for languages from same vs. different families show no consistent effect for distances > 1000 km
  - DistValPat shows the strongest areal signal for both genetically related and unrelated languages
  - Caucasus is an exception: many pairs of geographically proximate languages with huge DistValPat; this accounts for the anomaly on the left margin of the orange curve


DistValPat = Entropy−based distance between valency class systems
Cumulative average z−scores: DistValPat
0.0
−0.5
−1.0
−1.5
2000
4000
6000
8000
10000
Geographic distance (km)
same genus
same family
unrelated

Results: valency class systems

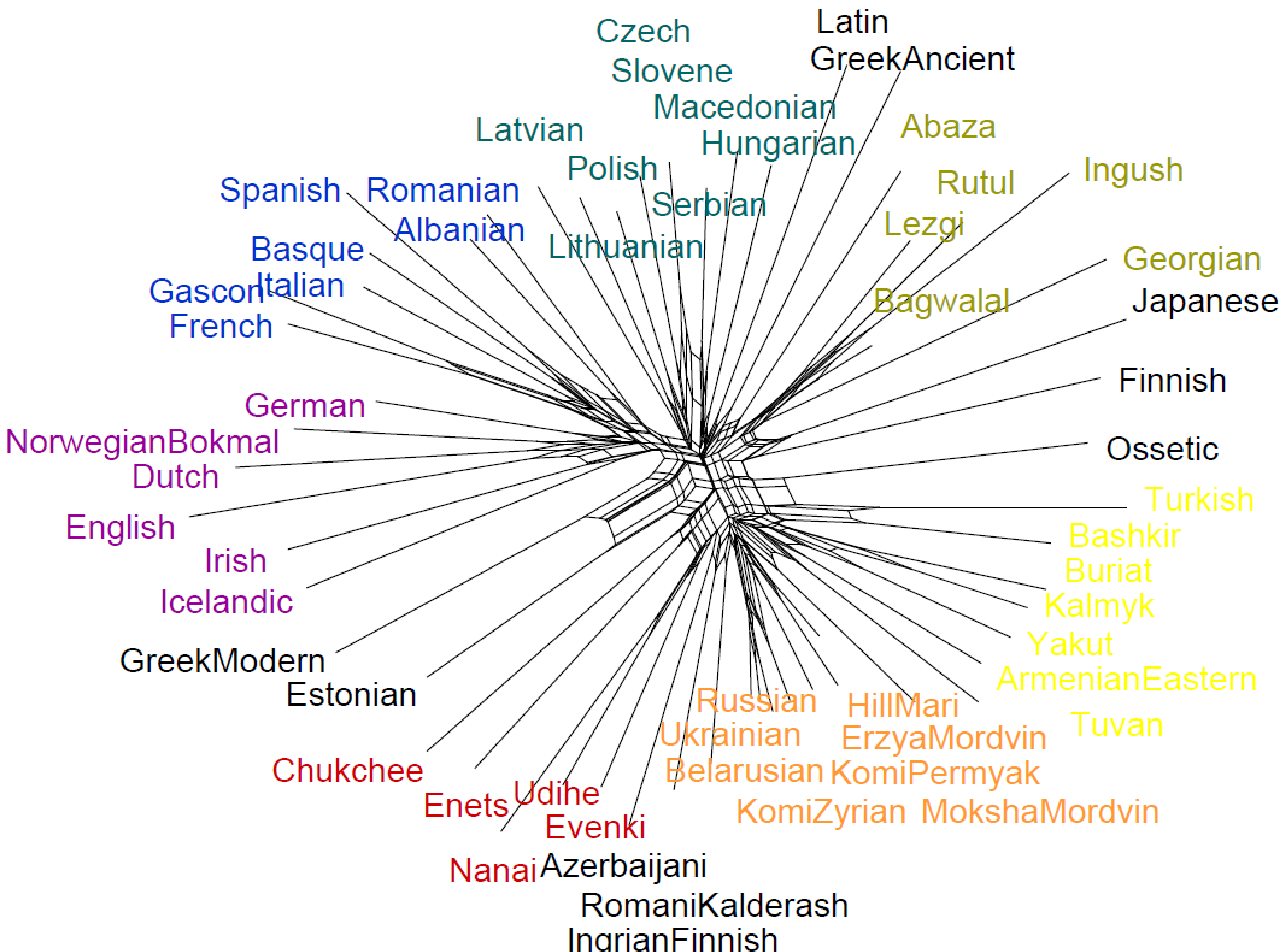
- DisValPat displays a stronger and more lasting effect of geographic distance than DistTrProf
  - See the next slide: pairs of genetically related languages are disregarded, z-scores are re-calculated


Two metrics for genetically unrelated languages
Cumulative z−scores for two metrics
0.0
−0.2
−0.4
−0.6
2000
4000
6000
8000
10000
Geographic distance (km)
DistTrProf
DistValPat

Results

- Areal effects are clearly visible if the distance matrix is visualized using the NeighborNet algorithm
  - implemented in the SplitsTree software [Huson & Bryant 2006]

NeighborNet, DistValPat: (dis)similarity in bivalent valency class systems



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Conclusions

- Transitivity prominence is an areal phenomenon with subcontinental granularity
- Similarities in transitivity profiles: strong genetic effects, no large-scale geographic effects
- Similarities in valency class organization, including minor classes: no family-level genetic effects, strong areal effects

Conclusions

- Plausible explanation
  - valency patterns of individual verbs change relatively fast and are easily transferable in language contact
  - languages are relatively stable in terms of those semantic features that are relevant for the assignment of the [+/-] transitivity values to individual verbs
  - and transitivity hierarchies of verb meanings can be family-specific

Acknowledgements

- Language experts (see above)
- My colleagues from the Institute for linguistic studies, RAS, who participated in research projects supported by Russian Foundation for Humanities (2009-2011; 2011-2013)
- And especially **Maria Ovsjannikova** who created the plots in R

Thank you!

Selected references

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