Measuring the language distance between the lects with high degree of inner variation (on the material of South Slavic lects)

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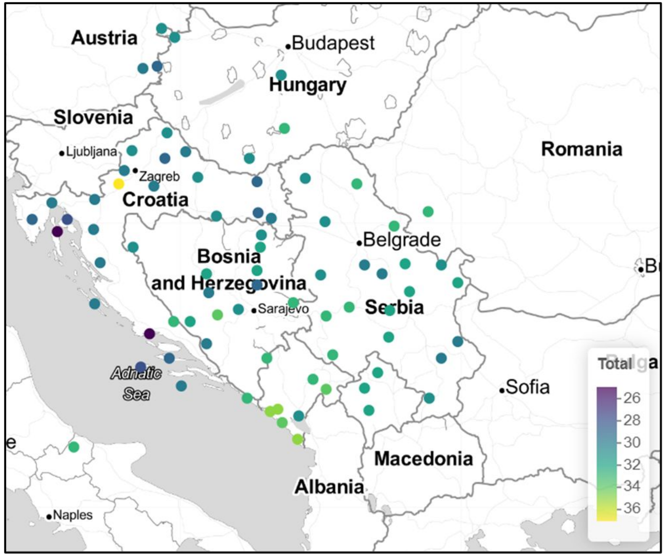
Talk structure

- Introduction: recap & material characterisation
- Problem stated
- Methodology outline
- Experiments & analysis
- Conclusion & further directions

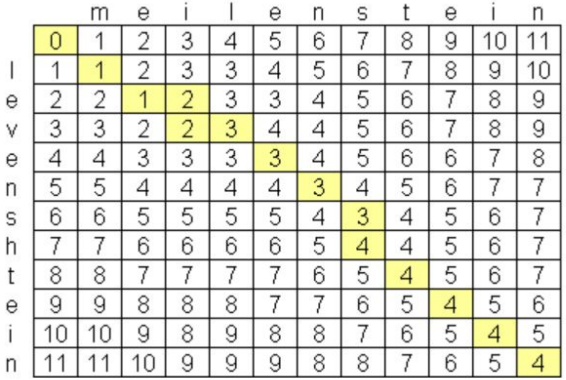
Short recap

- Corpus-based study of language distance: investigating, whether it is possible to build a preliminary (genetic) classification of languages, relying on raw (completely unprocessed) corpus data
- Documenting South Slavic lects
- Testing phylogenetic methods: borrowing methods from computational biology and test, whether they suit a particular research goal



Broader task

- Assemble a 40-item (Holman et al., 2008) Swadesh list for a set of South Slavic lects
- Build a preliminary consensus tree with Levenshtein distance normalised divided (LDND; Holman et al., 2008) and weighted Jaro-Winkler distance normalised divided (WJWDND; Gueddah et al., 2015)
- Use one more lect as an outgroup (cf. Kassian et al., 2021) to build a more precise internal classification



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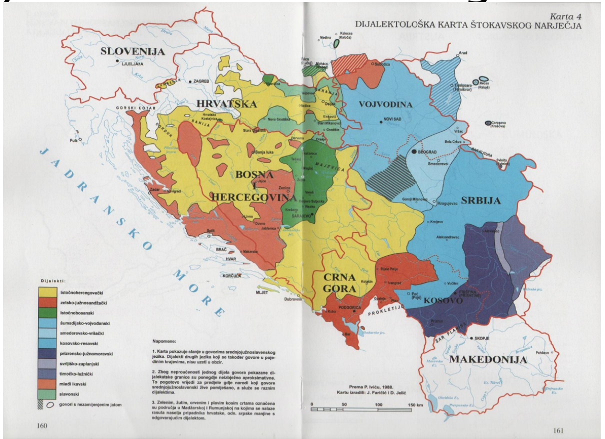
0	1	2	3	4	5	6	7	8	9	10	11
l 1	1	2	3	3	4	5	6	7	8	9	10
e 2	2	1	2	3	3	4	5	6	7	8	9
v 3	3	2	2	3	4	4	5	6	7	8	9
e 4	4	3	3	3	3	4	5	6	6	7	8
n 5	5	4	4	4	4	3	4	5	6	7	7
s 6	6	5	5	5	5	4	3	4	5	6	7
h 7	7	6	6	6	6	5	4	4	5	6	7
t 8	8	7	7	7	7	6	5	4	5	6	7
e 9	9	8	8	8	7	7	6	5	4	5	6
i 10	10	9	8	9	8	8	7	6	5	4	5
n 11	11	10	9	9	9	8	8	7	6	5	4

Terminological clarification

- Lect is any given variety of the language, such as:
    - idiolect
    - doculect
    - dialect
    - sociolect
    - standard
- The term is introduced to reduce the possible synchronous hierarchy discussions (“language - dialect” problem, cf. Koryakov, 2017; Fedotova, 2022)

South Slavic lects - material

1. “Hvar” — Southern Čakavian dialect of Hvar (Benčić 2014).
2. “Kuči” — Zeta-Lovćen Štokavian dialect of Kuči, Eastern Montenegro (Петровић, Ћелић, Капустина 2013).
3. “North Metohija” — Kosovo-Resava Štokavian dialect of the North Metohija region (Букумирић 2012).
4. “Lužnica” — Prizren–Timok Štokavian (or Torlak) dialect of Lužnica region (Ћирић 2018).



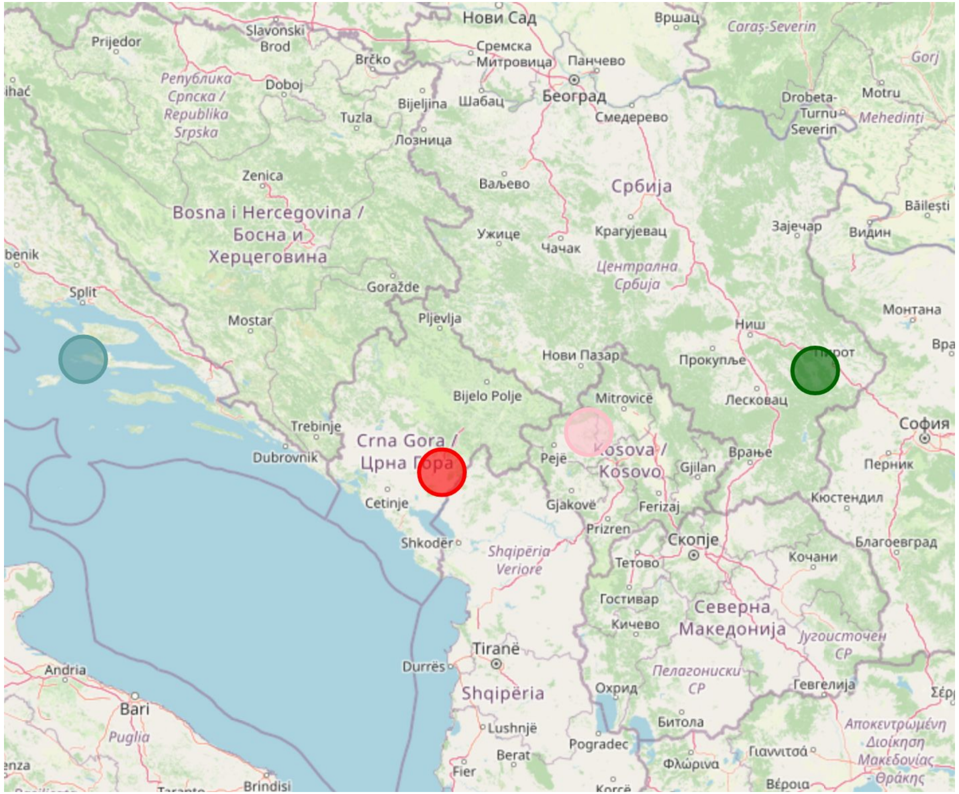
Napomene:

1. Karta pokazuje stanje u govorima srednjojužnoslavenskog jezika. Dijalekti drugih jezika koji se također govore u pojedinim krajevima, nisu uzeti u obzir.

2. Zbog neproučenosti jednog dijela govora pokazane dijalekatske granice su ponegdje neizbježno aproksimativne. To pogotovo vrijedi za predjele gdje narodi koji govore srednjojužnoslavenski žive pomiješano, a služe se raznim dijalektima.

3. Zelenim, žutim, crvenim i plavim kosim crtama označena su područja u Mađarskoj i Rumunjskoj na kojima se nalaze rasuta naselja pripadnika hrvatske, odn. srpske manjine s odgovarajućim dijalektom.

South Slavic lects - map



● Kuči

● North Metohija

● Lužnica

● Hvar

Complications

- Lects possess a high degree of lexical and/or phonetic variation, most notably:
  - Words of historically different roots that represent the single concept within the single lect: *nidra, parsi, sisa* ‘breast’ (Hvar)
  - Words of historically same root but the different phonetic form that represent the single concept within the single lect: *kos, koska, koʧina, koʃʧina* ‘bone’ (Lužnica)
- With the existing material, it is hard to search for a diagnostic contexts and apply rigorous enough criteria (Kassian et al., 2010; Afanasev, 2023)
- This heavily complicates the use of string similarity measures

36. TREE

- Kuči: *drijevo, drvo*
- Lužnica: *drvo*
- North Metohija: *darva, drivo*
- Hvar: *drvo*

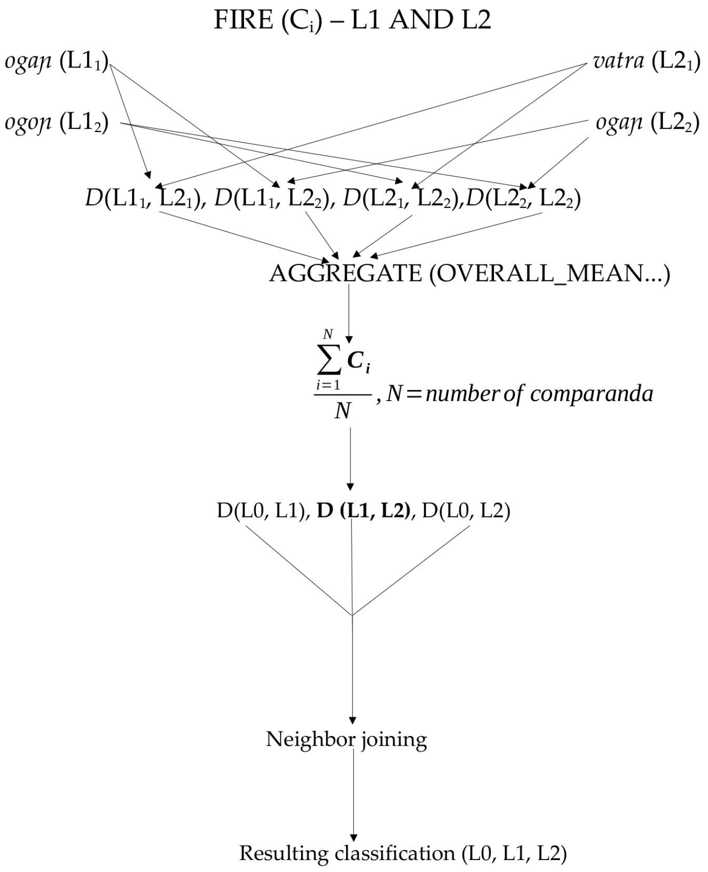
21. MOUNTAIN

- Kuči: *planina*
- Lužnica: *gora, planina*
- North Metohija: *planina*
- Hvar: *muntaɲa*

Possible solutions

- Use different combinations of minimal, mean and maximal values:
    - OVERALL_MEAN: Scoring mean among all the distances (a_i, b_j) for all realisations $a_1…a_n$ and $b_1…b_m$ of concept C between lects A and B
    - MEAN_MEAN: Scoring mean among means of the distances (a_i, b_j) for all realisations $a_1…a_n$ and $b_1…b_n$ of concept C between lects A and B
    - MEAN_MIN: Scoring mean among minimal distances (a_i, b_j) for all realisations $a_1…a_n$ and $b_1…b_n$ of concept C between lects A and B
    - MEAN_MAX: Scoring mean among maximal distances (a_i, b_j) for all realisations $a_1…a_n$ and $b_1…b_n$ of concept C between lects A and B
    - MIN_MEAN: Picking minimal value among means of the distances (a_i, b_j) for all realisations $a_1…a_n$ and $b_1…b_m$ of concept C between lects A and B
    - MAX_MEAN: Picking maximal value among means of the distances (a_i, b_j) for all realisations $a_1…a_n$ and $b_1…b_m$ of concept C between lects A and B
- Use threshold for automatic non-cognate elimination, and pick minimal value afterwards

Workflow



FIRE (C_i) – L1 AND L2

ogaɲ ($L1_1$)

vatra ($L2_1$)

ogoɲ ($L1_2$)

ogaɲ ($L2_2$)

$D(L1_1, L2_1)$, $D(L1_1, L2_2)$, $D(L2_1, L2_2)$,$D(L2_2, L2_2)$

AGGREGATE (OVERALL_MEAN...)

$$\frac{\sum_{i=1}^{N} \boldsymbol{C_i}}{N}, N = number\, of\ comparanda$$

D(L0, L1), **D (L1, L2)**, D(L0, L2)

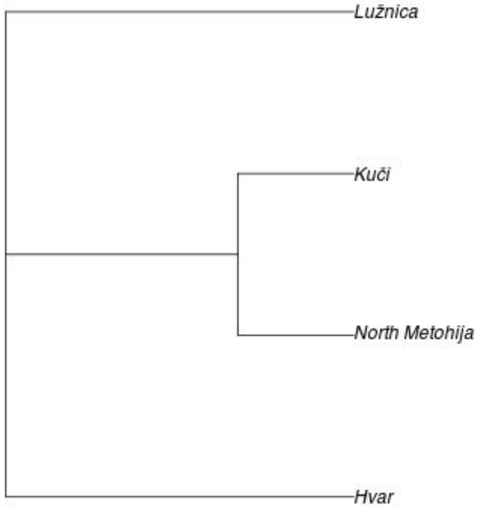
Neighbor joining

Resulting classification (L0, L1, L2)

Experiment flow

- Manually construct the gilded tree
- Use black-box approach (Afanasev, forthc.) as a baseline and to determine complexity of the task
- Score distances by each of the possible aggregated string similarity measures
- Score distances with thresholds of 0.1, 0.33, 0.5, 0.66 and 0.9 (from the most restrictive to the least restrictive)
- Evaluate results with mutual clustering information (MCI; Smith, 2020)
- Conduct a linguistic analysis of the pairs, rejected by given threshold

Gilded tree



Black-box method

- Includes elimination of transparency for both a researcher and explanatory methods (Munn and Pitman, 2022) via
  - Ciphering
  - BPE (byte-pair encoding) tokenisation
  - Vectorisation
  - Classification of concepts by lects with Random Forest Classifier (Ho, 1995)
  - Measuring the distance by loss in mean square error between initial classification and classification after random swap of *M* concepts ($a_i, b_i > b_i, a_i$), with the possibility of imitating borrowing ($a_i, b_i > a_i, a_i$)
- Evaluated through mean MCI within *N* runs
- The least required (we use 1000) number of runs is calculated by formula: $1 - (S - M/S)^N > 0.999$, where *S* is number of concept in given comparison, *M* is number of swapped concepts, and *N* is a number of runs

Black-box method results

Experiment	Number of swaps	Borrowing	Mean MCI (1000 runs)
1	3	0	0.339
2	3	1	0.359
3	14	0	0.475
4	14	1	0.463

Black-box method analysis

- The automatic methods are applicable to the task
- The complexity is higher, than for classifying three East Slavic lects of slightly more shallow relationship (average probability of acquiring correct tree ~= 0.6), and equals to classifying Taa (average probability of acquiring correct tree ~= 0.4; Afanasev, forthc.)

String similarity measures: naive approaches

Experiment	MCI
OVERALL_MEAN	1
MEAN_MEAN	1
MEAN_MIN	1
MEAN_MAX	1
MIN_MEAN	1
MAX_MEAN	1

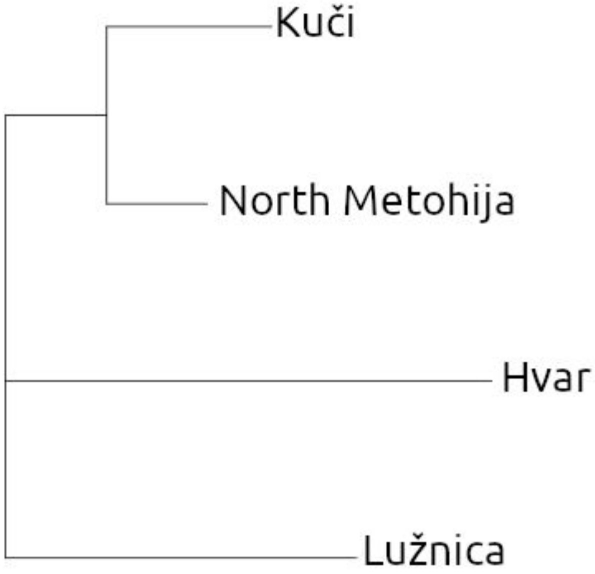
String similarity measures: introducing threshold

Threshold	MCI
0.1	0
0.33	0
0.5	1
0.66	1
0.9	1

String similarity measures: detected (non-)cognates

Concept	Word pair	Lect pair	Threshold	Value
EAR	*uo/uvo*	Kuči/Lužnica	0.1	0.34
HUMAN	*ʧek/ʧovek*	Kuči/North Metohija	0.33	0.4
LIVER	*ʤigeriʦa/utrobiʦa*	Kuči/Lužnica	0.5	0.625
MOUNTAIN	*gora/muntaɲa*	Lužnica/Hvar	0.66	0.857
FIRE	*vatra/ogaɲ*	North Metohija/Hvar	0.9	1

Average tree (threshold = 0.5 & threshold = 0.66)



Preliminary results

- There is no huge difference between naive approaches and implementing threshold in terms of scores
- However, linguistic interpretability of results is significantly higher, when threshold is implemented
- When threshold is too low, a lot of cognates do not pass, which leads to incorrect results
- When threshold is too high, a lot of non-cognates pass through, which creates noise in data
- It seems that optimal threshold is approximately in [0.4; 0.6] interval

Future directions

- Clear dataset further according to guidelines in Kassian et al. (2010)
- Cross-verify with other data
- Cross-verify with WJWDND such cases as *ʤigeriʦa/utrobiʦa* ‘liver’
- Use a more probabilistic approach
- Use an outgroup method and determine, whether it yields more precise classification
- Test a similar approach against corpus data
- Collect 110-item wordlists for given lects

Thank you!

Fond de carte de l'Europe du Sud-Est, dressé initialement sur papier en 1987 par S. I. Cepleanu-Galtier étudiant à l'Inst. de Géographie de l'Université Paris IV-Sorbonne, et scanné en 2012 pour être téléchargé sur internet, par le même auteur devenu contributeur. Usage initial : S. I Cepleanu, *«Atlas géomorphologique des pays danubiens et balkaniques, mémoire de maîtrise de géographie»*.

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