Statistical Modeling of Creole Genesis

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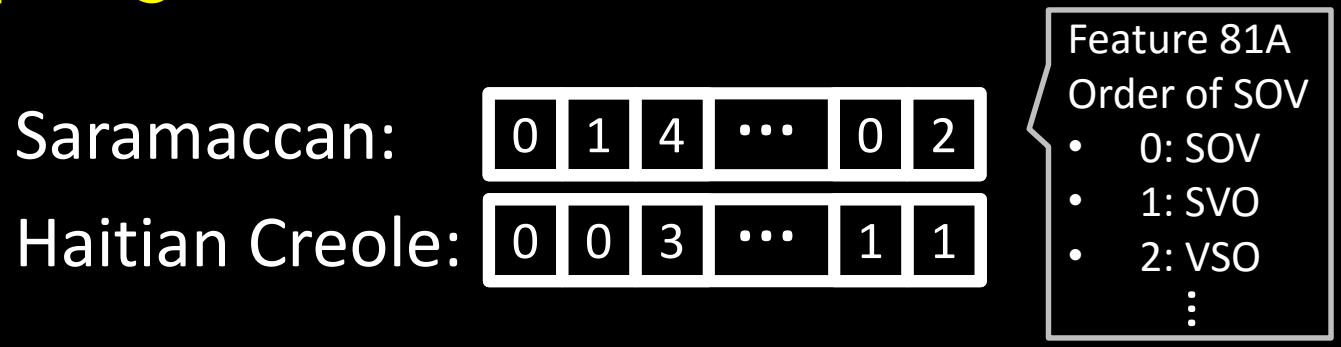
Multilingual processing?

- Technically yes, but I do not process *text* at all
- Each language is represented as a set of typological features



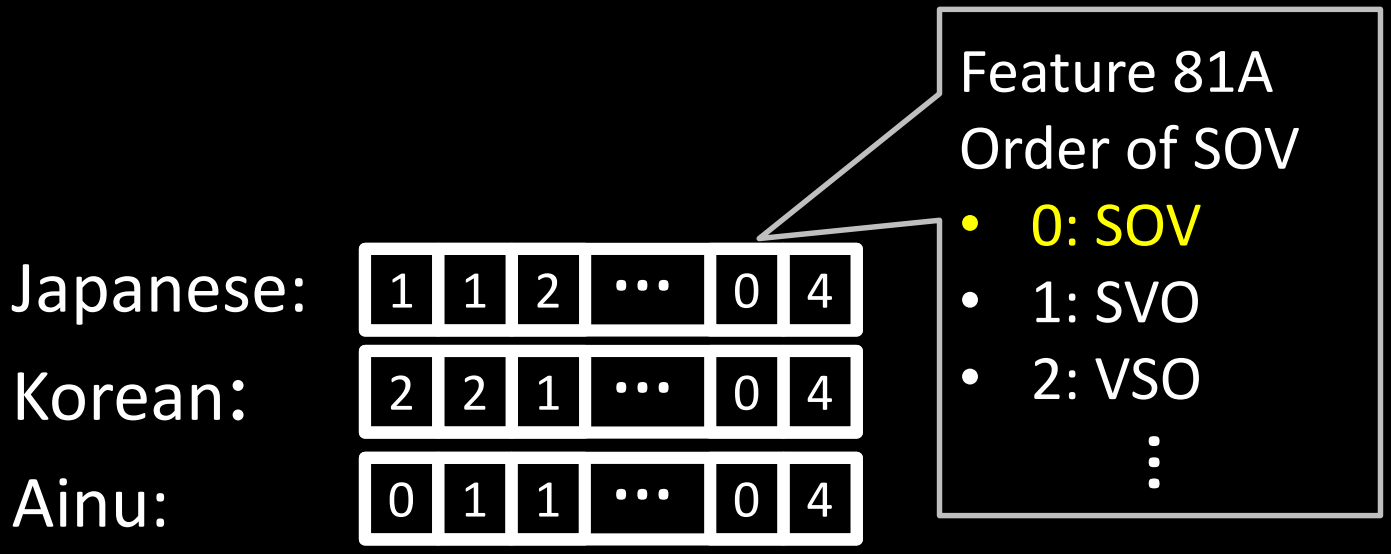
- Not an ordinary NLP task, but *literally* computational linguistics

Why outlier?

- Recent advances in statistical methods come from computational biology
  - Genome sequences → linguistic features
- But I believe that the ACL community can contribute to this field

Why linguistic typology?

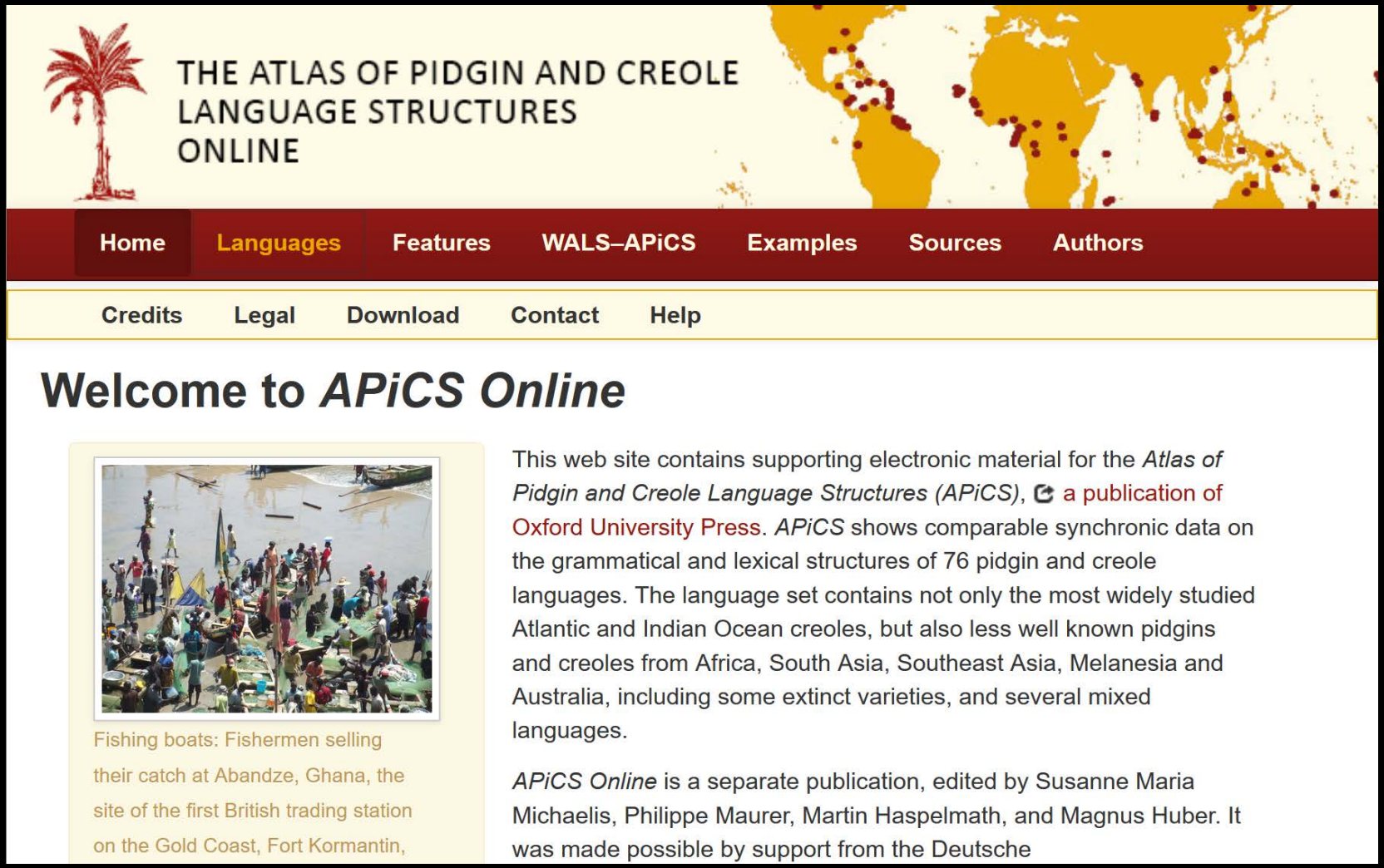
- Last resort for Japanese, for which cognate-based methods are not applicable
- Linguistic typology allows us to compare an arbitrary pair of languages



Why creole genesis?

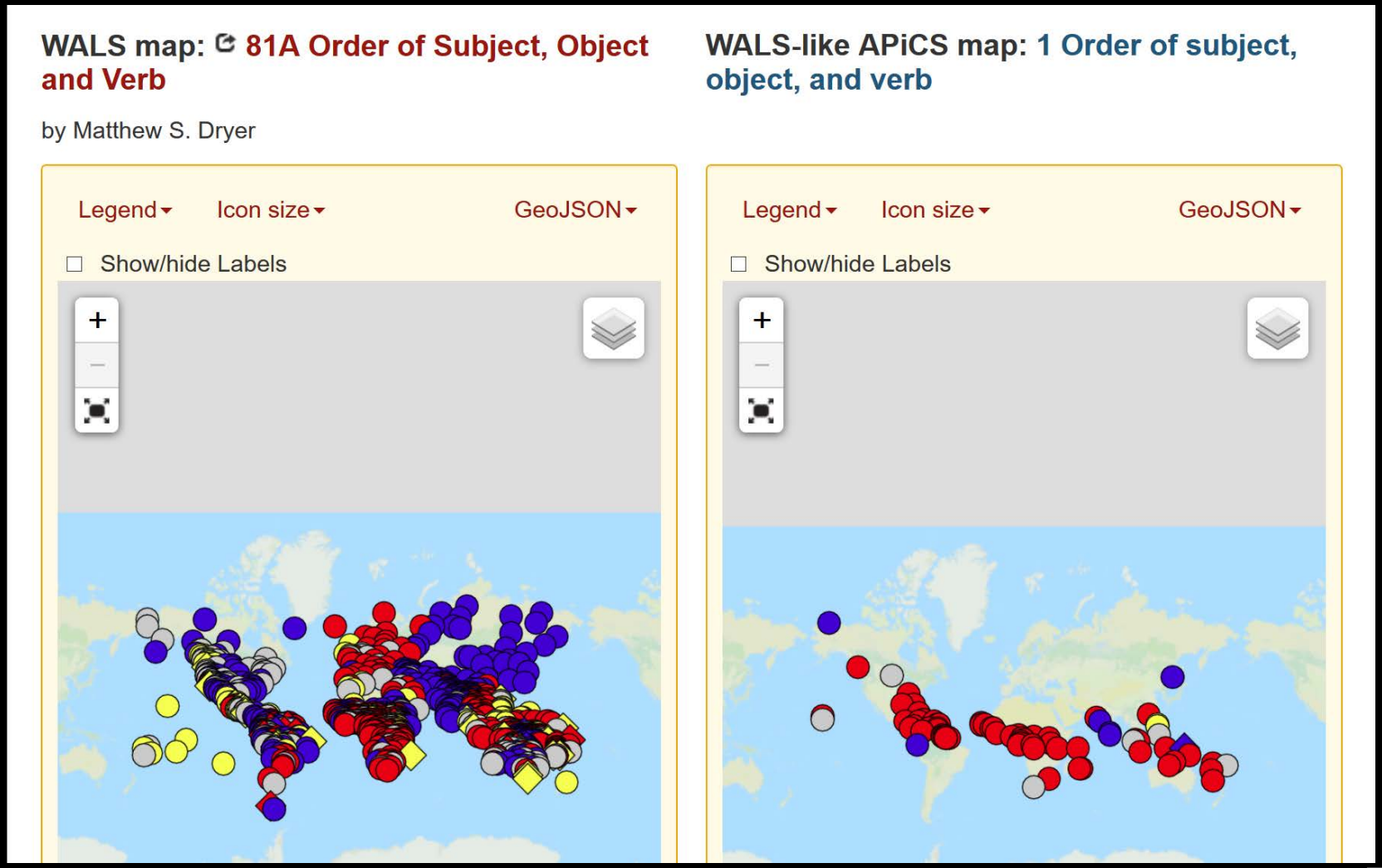
- I am by no means an expert of creole studies
- Some argue that Japanese was a creole [Kawamoto, 1974,1990][Akiba-Reynolds, 1980]
  - The mixed language hypothesis first proposed by Polivanov (1924)
  - Japanese as a hybrid of Altaic (northern) and Austronesian (southern) elements
- No large dataset was available to test this hypothesis

APiCS enables us to take a data-driven approach to the problem



http://apics-online.info/

APiCS features are mapped to WALS, the standard typological database



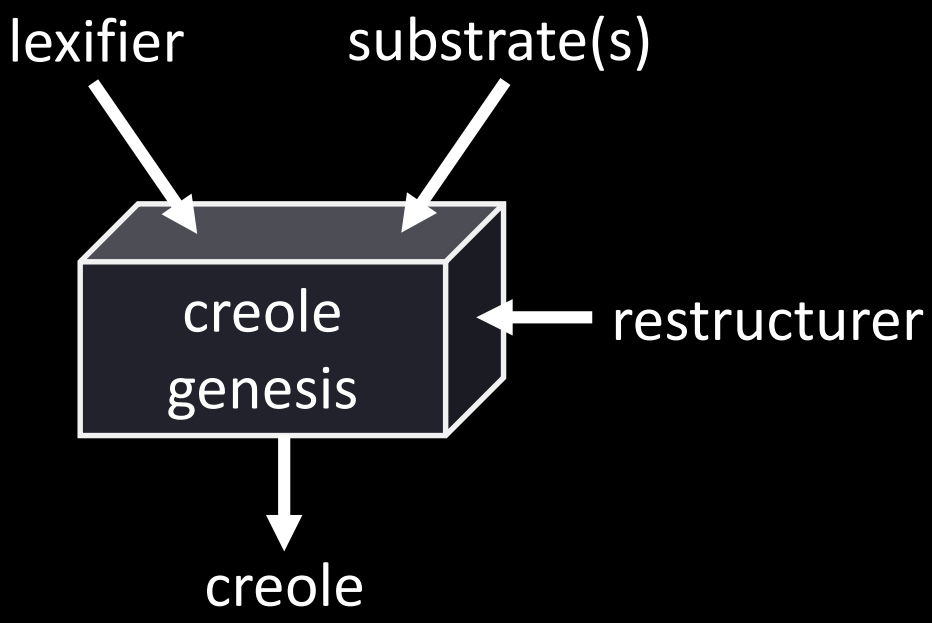
http://apics-online.info/wals/1

Research questions

Two related research questions found in the literature [Bakker+, 2011][Daval-Markussen+, 2012]

1. Are creoles distinct from non-creoles?
   - Casted as a binary classification problem
   - The two distributions are very different but nevertheless overlap
   - Japanese is far from the creole cluster
   - (See paper for details)
2. Which source plays a major role in creole genesis?
   - (Next slide)

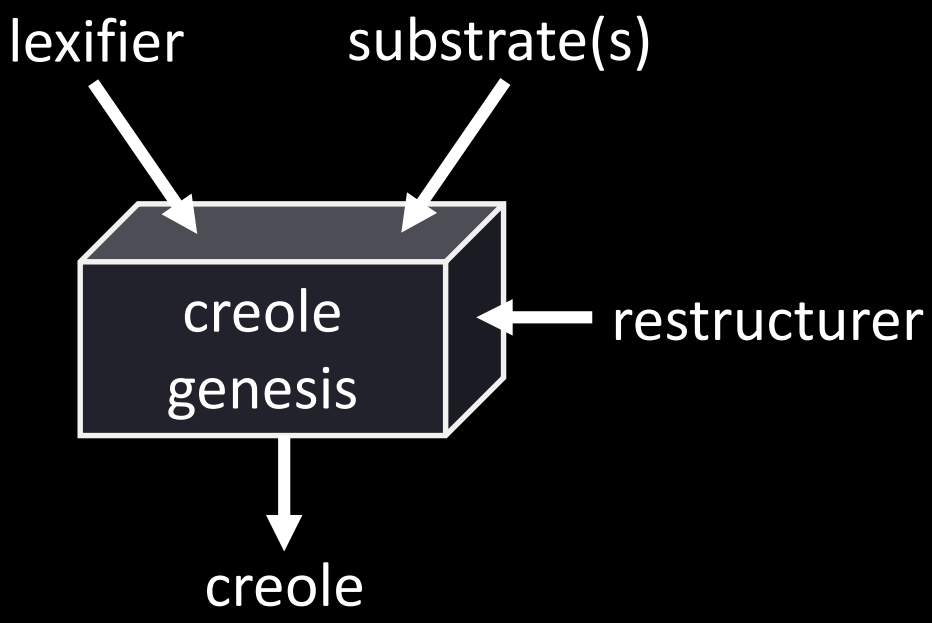
Question: Which source plays a major role in creole genesis?



1. *Superstratist*: Lexifier
2. *Substratist*: Substrate(s)
3. *Feature pool*: Both L & S
4. *Universalist*: Restructuring universals

[Bakker+, 2011]

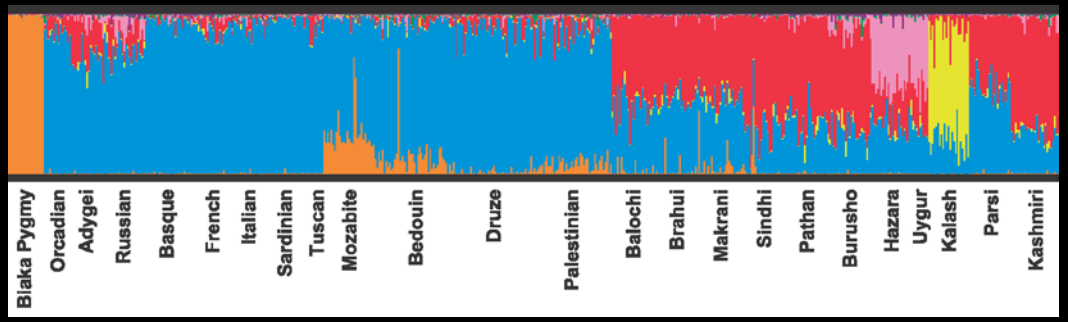
Solution: LDA-like mixture model



- Assumption: each creole is generated by stochastically mixing three types of sources
- Infer mixing proportions from observed data

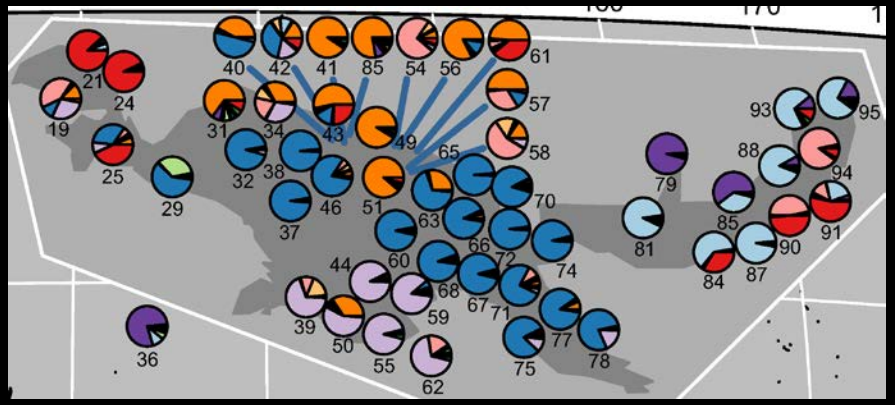
Related work

- Admixture analysis in population genetics [Pritchard+, 2000]
  - Each individual as a mixture of K ancestral components (topics)



[Rosenberg+, 2006]

- An application to linguistic typology
  - Each language as a mixture of K ancestral components (topics)



[Reesink+, 2009]

Mixture model

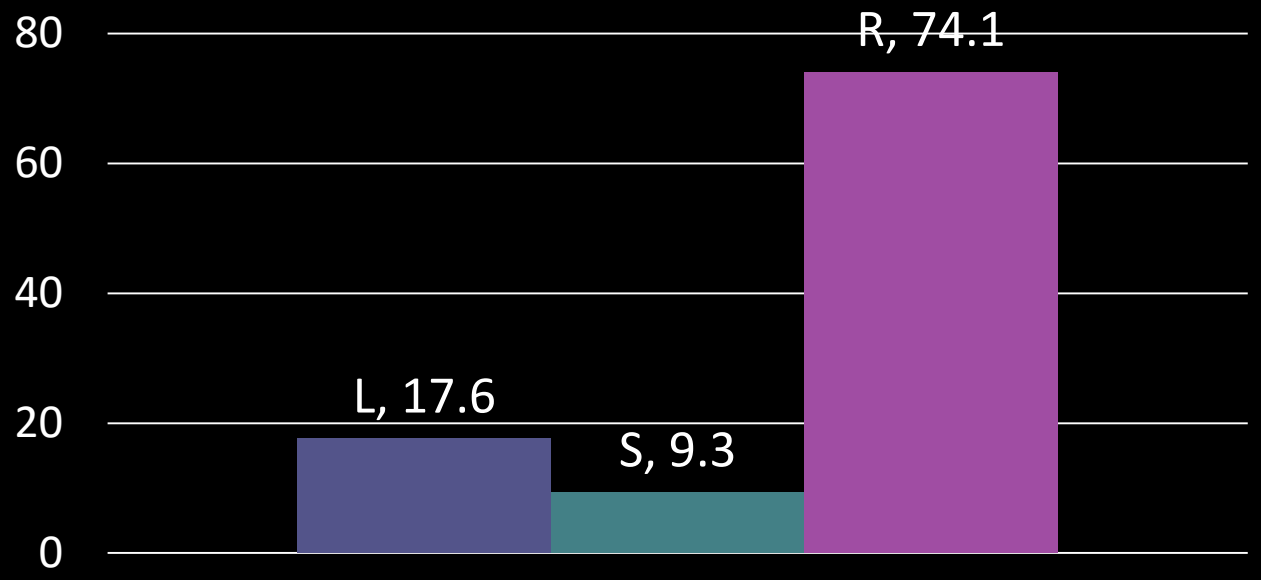
- Assume a creole is a stochastic mixture of L, S, and R

$$\theta_{i,j,k} = \frac{\exp(m_{j,k} + n_{i,k})}{\sum_k \exp(m_{j,k} + n_{i,k})}$$

  - $\theta_{i,j,k}$: prob. of deriving creole i's feature j from source k
  - $m_{j,k}$: per-feature factor (deriving feature j from source k)
  - $n_{i,k}$: per-creole factor (deriving creole i from source k)
- $z_{i,j} \sim \text{Categorical}\left(\theta_{i,j,\text{L}}, \theta_{i,j,\text{S}}, \theta_{i,j,\text{R}}\right)$
- $x_{i,j} \sim \begin{cases} \delta(y_{i,j,\text{L}}) & \text{If } z_{i,j} = \text{L, copy the value of } i\text{'s lexifier} \\ \delta(y_{i,j,\text{S}}) & \text{If } z_{i,j} = \text{S, copy the value of } i\text{'s substrate} \\ \text{Categorical}(\phi_j) & \text{If } z_{i,j} = \text{R, draw from R's feature distribution} \end{cases}$

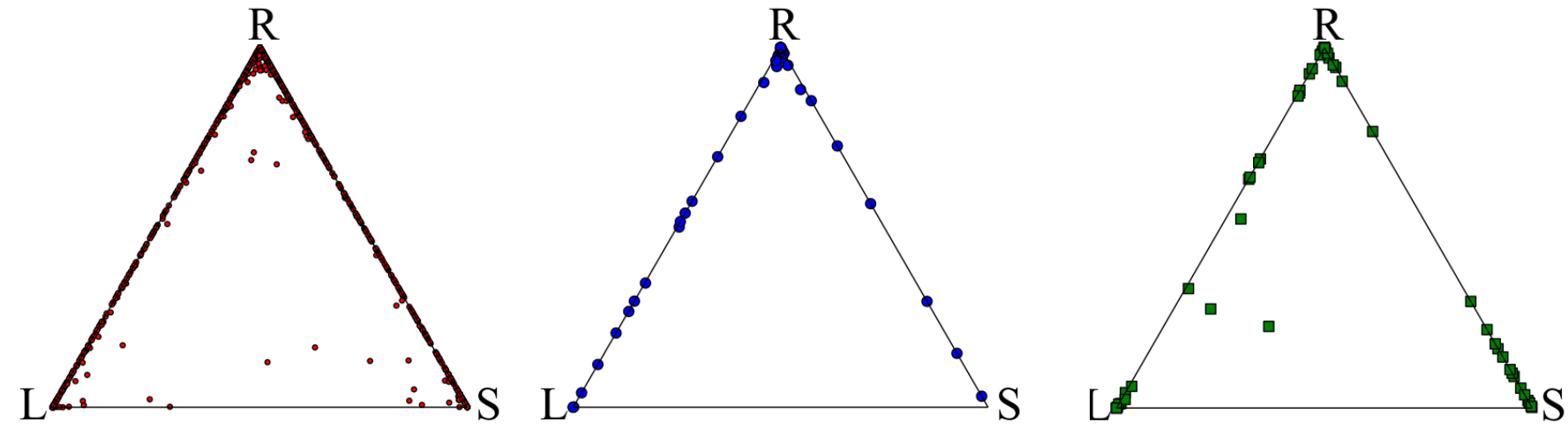
Results: Mixing proportions

- Support the universalist hypothesis
- Negative implications for tree-based phylogenetic inference



Results: Mixing proportions

$\theta_{i,j}$ $m_{j,k}$ (per-feature) $n_{i,k}$ (per-creole)



Results: Top 10 features derived from the restructurer

%	Feature type: value	jpn
91.2%	Numeral Classifiers: Absent	×
74.3%	Gender Distinctions in Independent Personal Pronouns: No gender distinctions	×
72.3%	Negative Indefinite Pronouns and Predicate Negation: Predicate negation also present	✔
70.5%	Occurrence of Nominal Plurality: All nouns, always optional	×
69.7%	Intensifiers and Reflexive Pronouns: Identical	✔
68.4%	Distributive Numerals: No distributive numerals	×
67.2%	Expression of Pronominal Subjects: Obligatory pronouns in subject position	×
66.9%	Politeness Distinctions in Pronouns: No politeness distinction	×
66.6%	Alignment of Case Marking of Pronouns: Nominative - accusative (standard)	✔
66.3%	Order of Numeral and Noun: Numeral-Noun	✔

Conclusion

- Proposed mixture models as a natural choice to analyze creole genesis
- Experiments supported the universalist hypothesis
- Japanese is not like a creole
- Feature work
  - Beyond a proof-of-concept demonstration
  - Data and models for less drastic contact phenomena