Figuring out the direction of writing in ancient texts:

Directional asymmetry in language

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Bits & Scripts
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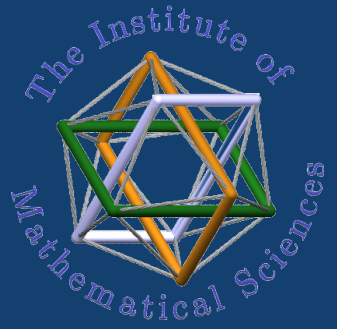
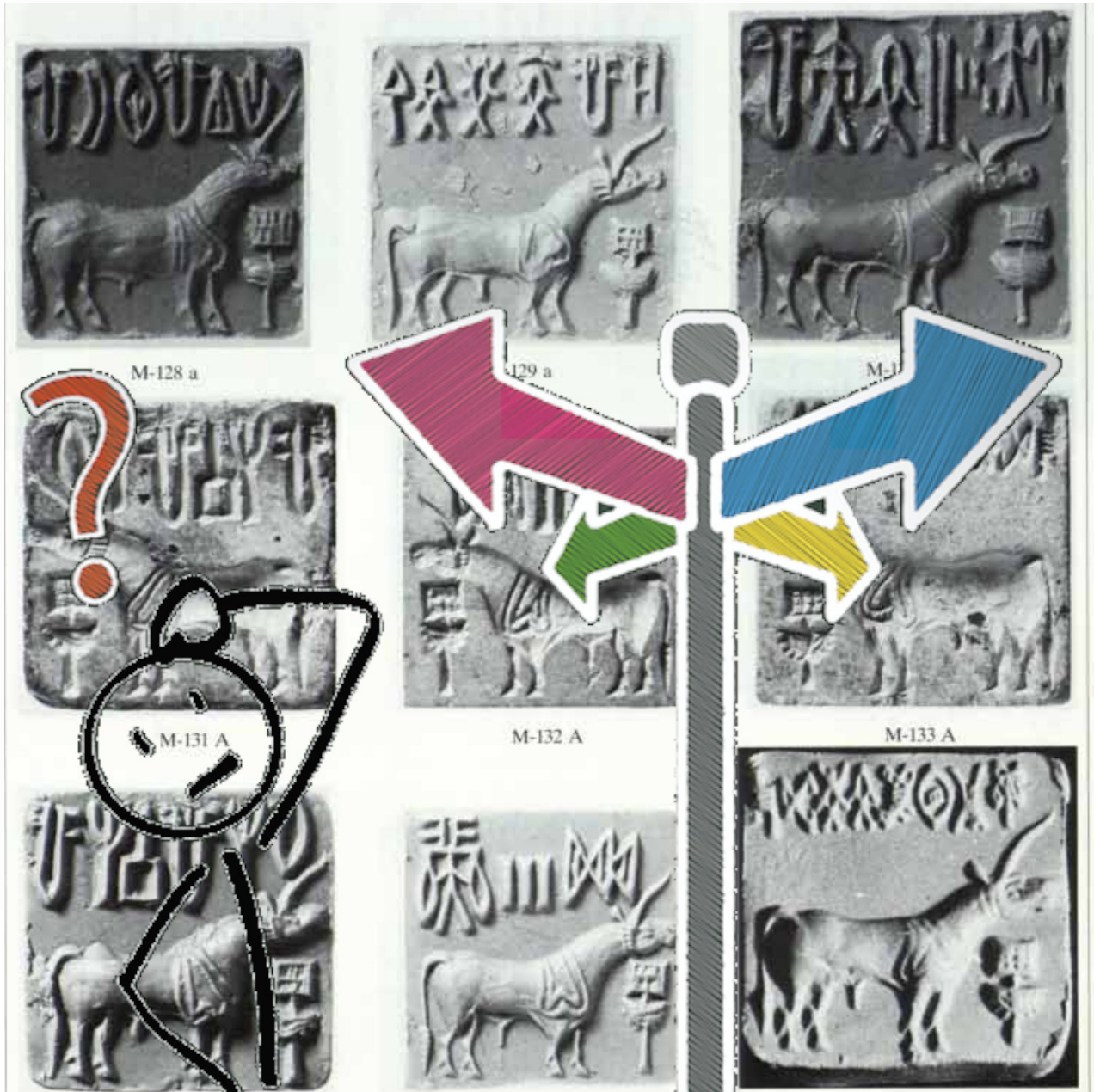
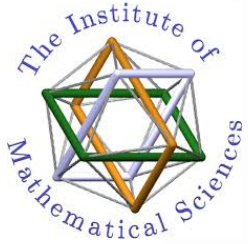


Phaistos Disc

Figure: Minoan artifact, Crete, 1700-1600 BCE, discovered 1908 by Luigi Pernier, one of the most enigmatic and debated finds from the ancient world. *(source: Wikipedia)*

Complexity of direction





Current Status of linguistics directionality?

- The choice of direction of writing for a language is arbitrary(depends on its own history).
- It is contingent on the history of a writing system.
- Most writing systems we are familiar with read from left to right . . .
- . . . but there are many writing systems that use different conventions:
  - from right to left (e.g., Urdu, Arabic, Hebrew . . .)
  - top to bottom (e.g., Chinese, Japanese)
  - and even there is example of bottom to up too. . .

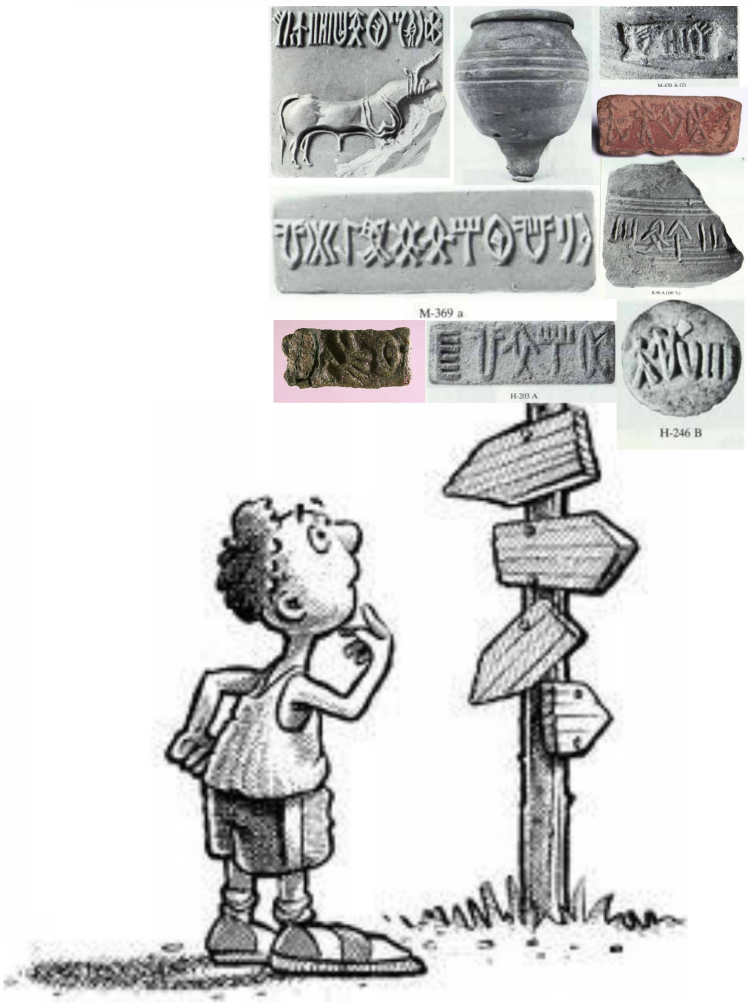
Example of Directional Uniqueness

- Ogham is an ancient writing system from 4th-8th century AD, used mainly in Ireland and parts of Wales, Scotland, and the Isle of Man, represented by marks along a central line.
- It is typically read bottom to top on vertical surfaces and left to right when inscribed horizontally.

Example of Directional Uniqueness

- Boustrophedon style of writing alternates reading direction line by line, seen in Ancient Greek and Hittite scripts.
- Rongorongo script of Easter Island, which requires a 180-degree rotation of the tablet between lines.

What Should We Do. . . ?



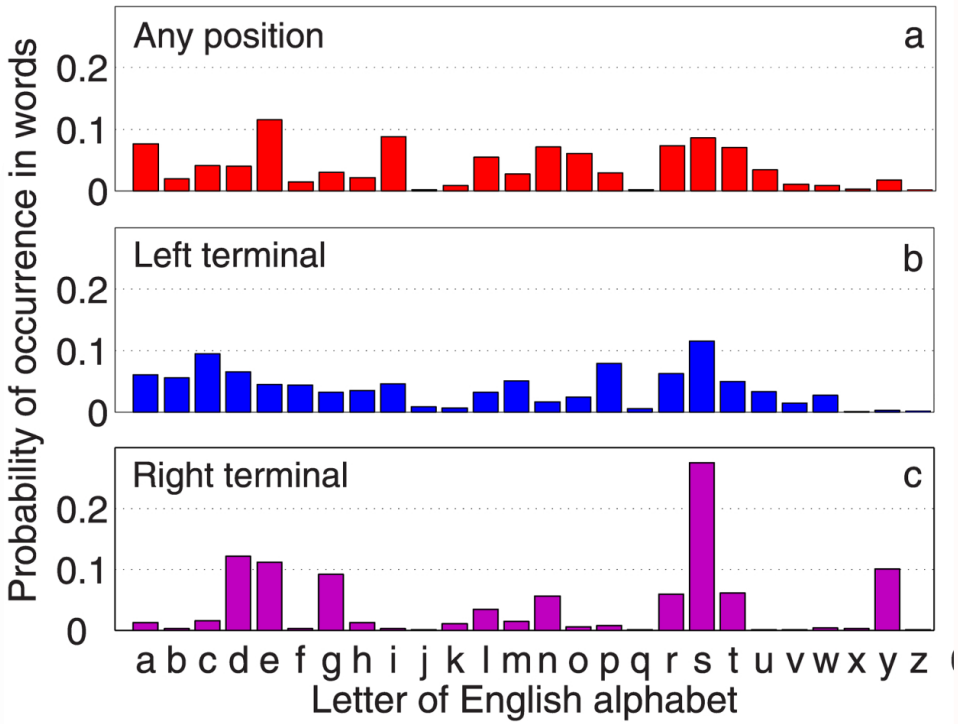
So in that case, we cannot proceed purely on guesswork, especially when dealing with unknown inscriptions.

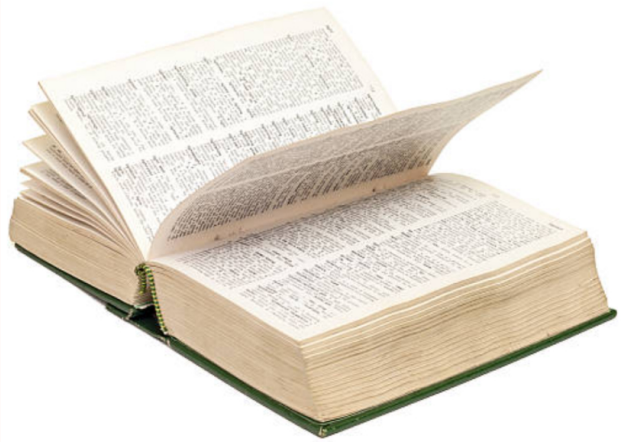
. . . we must have some concrete evidence to make informed decisions. Archaeologists typically look for:

- Cramping
- Diminution in size
- Angular rotation
- Vertical Displacement

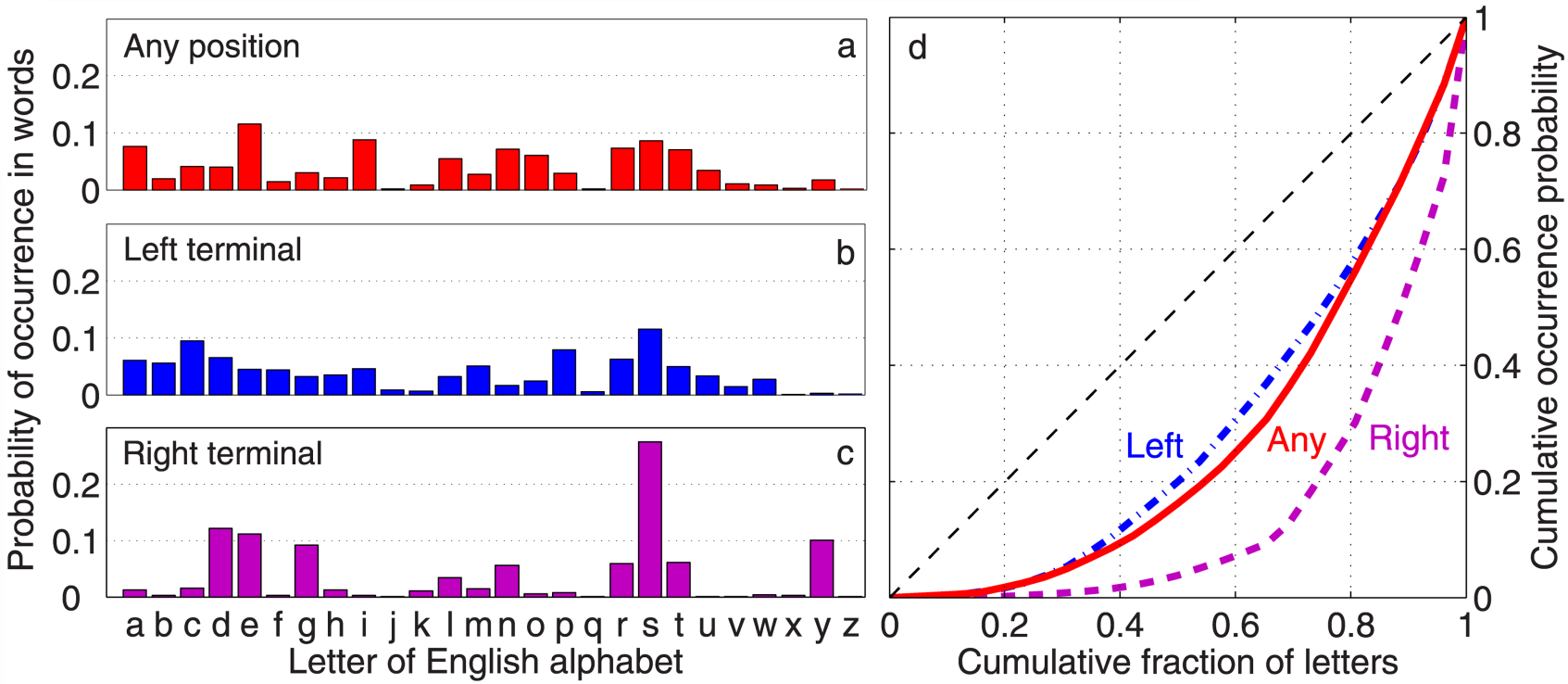
Whether computational methods can do anything here?

Our Pilot Test

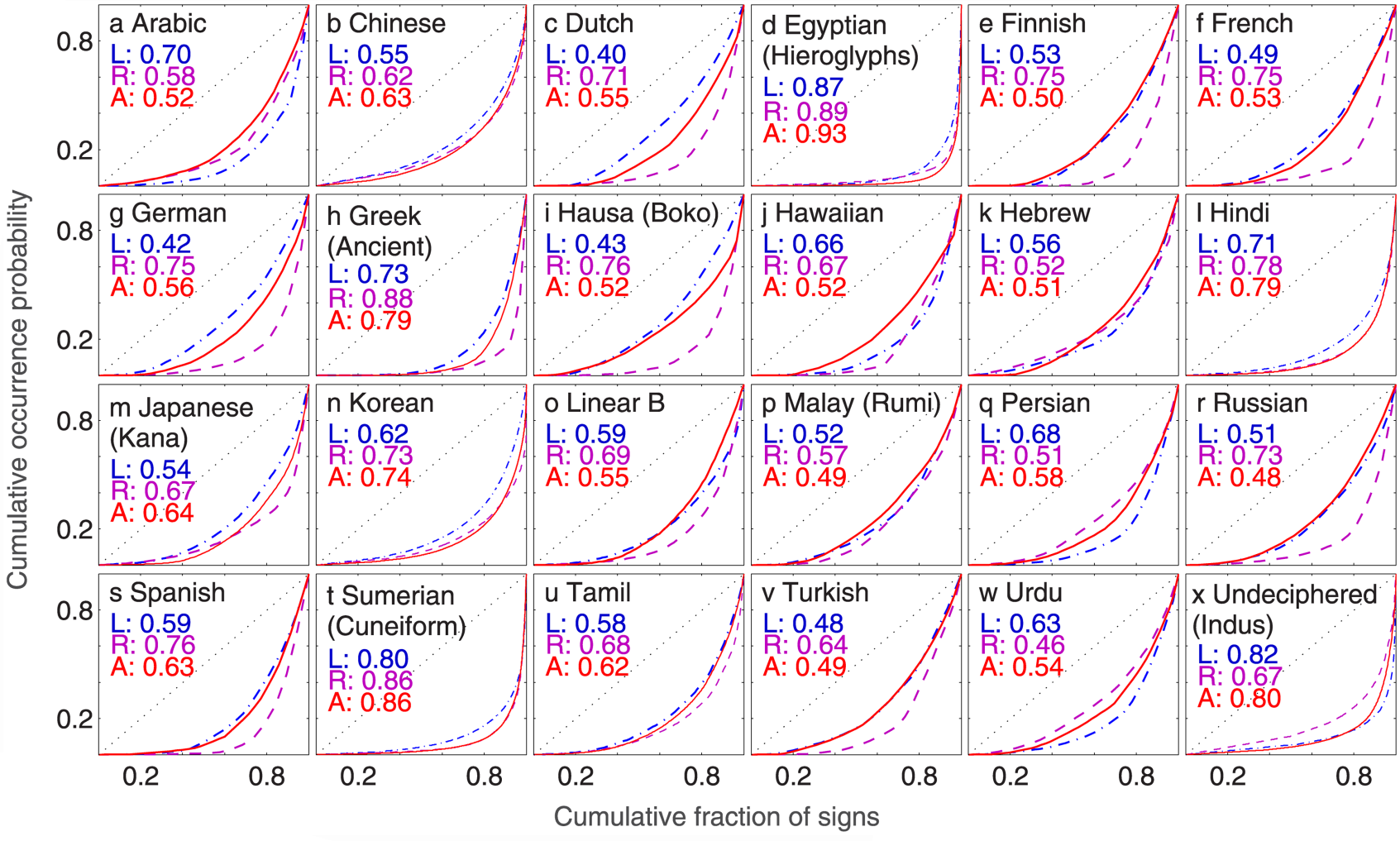




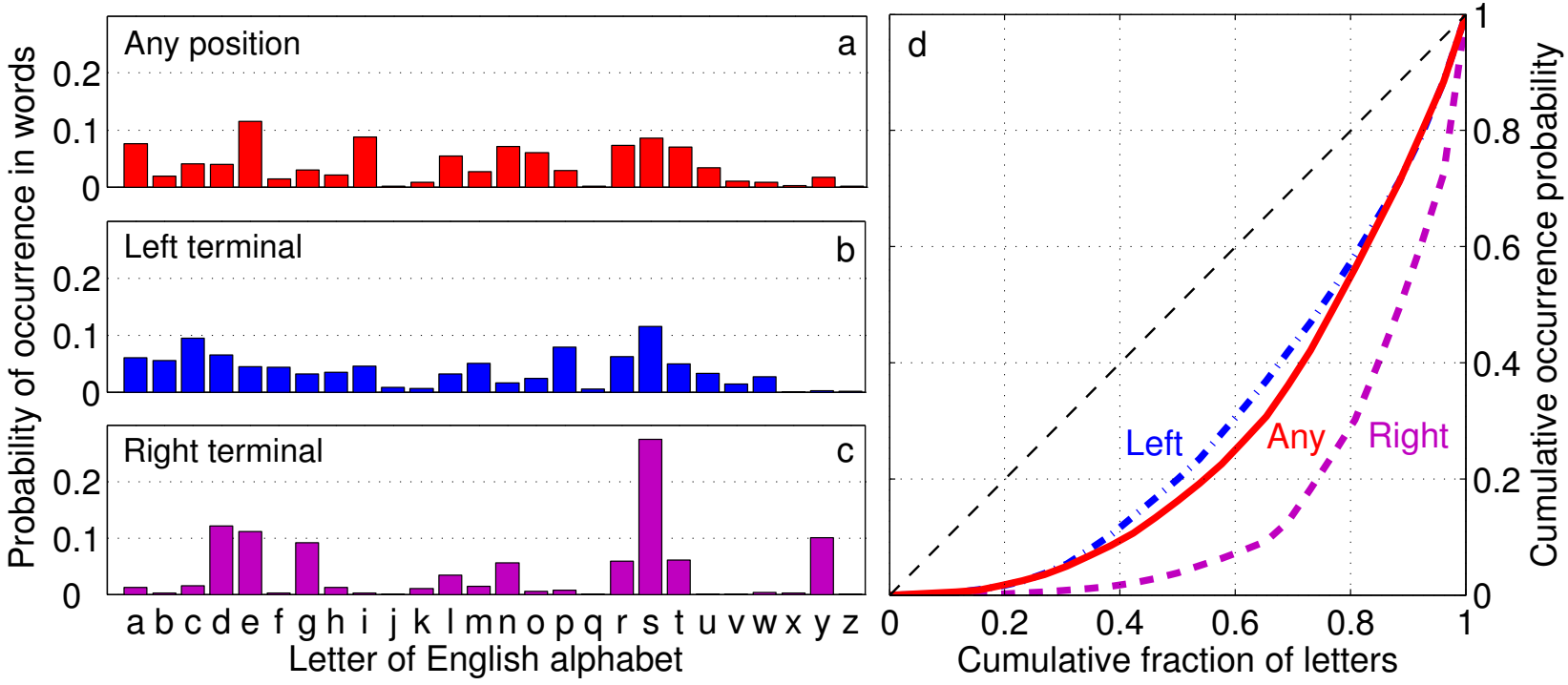
Inequality in sign usages



Inequality across languages



Quantification of inequality



H_{any}	H_{left}	H_{right}	ΔH
4.18	4.26	3.39	0.23

G_{any}	G_{left}	G_{right}	ΔG
0.46	0.42	0.69	-0.50

$H = -sum(P_i * log2(P_i))$ $G = 1 - sum(\Delta X * (Y_j + Y_{j+1}))$

Statistical significance

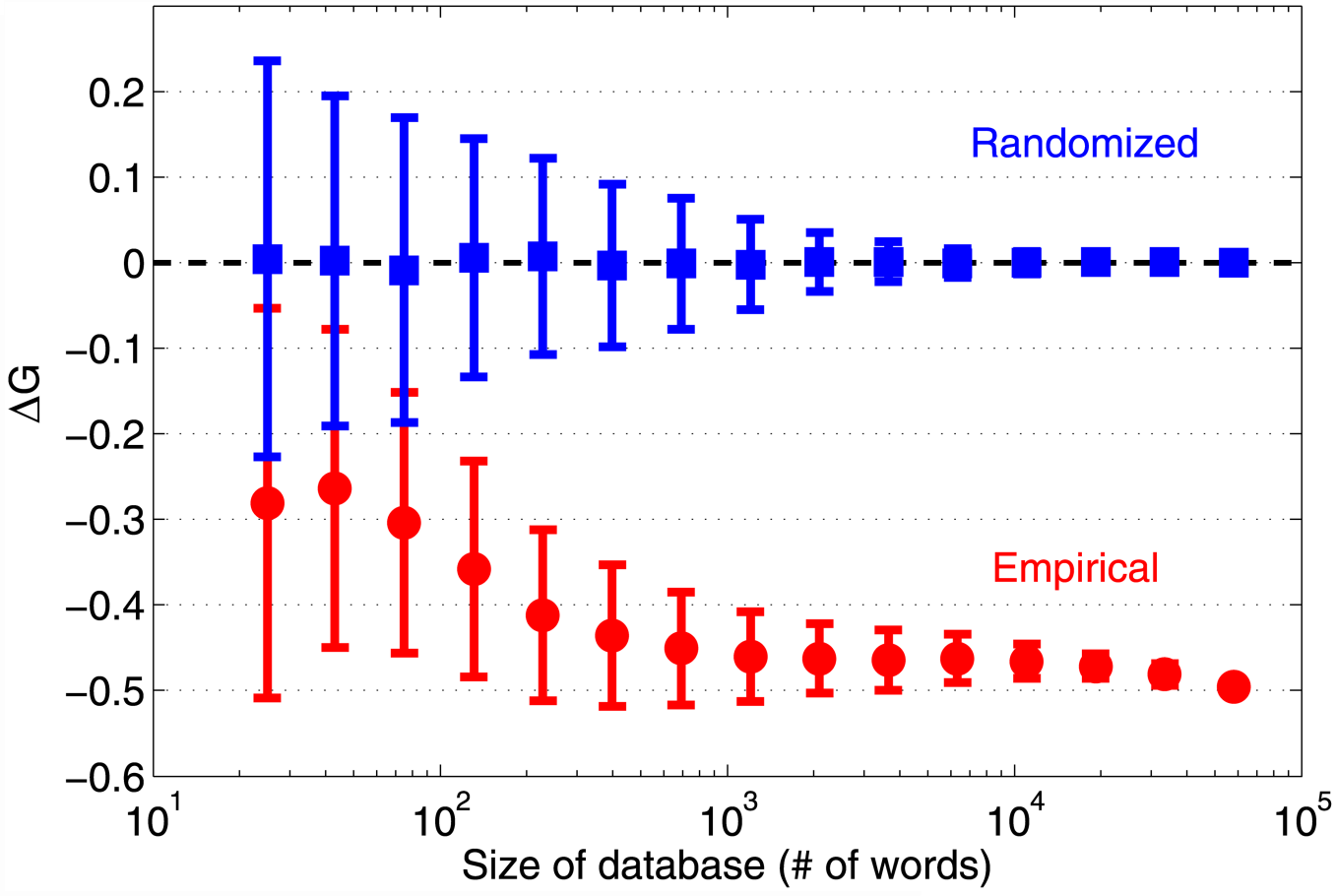
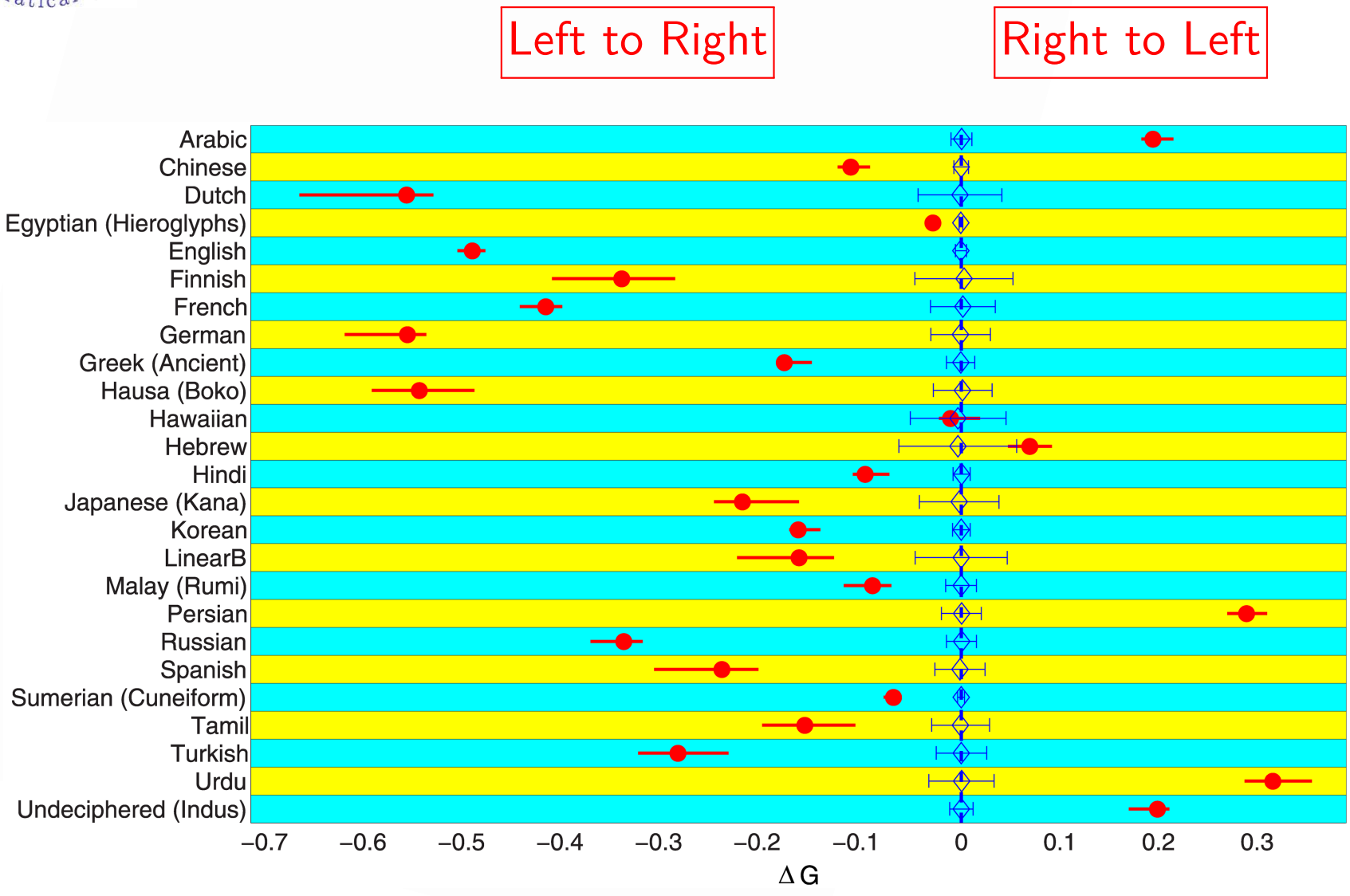


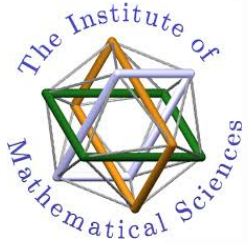
Figure: The observed asymmetry between heterogeneity of letter occurrence probability in left and right terminal positions is significant when the database is sufficiently large.

Directionality



External evidence

Most scholars agree that the majority of Indus inscriptions are written from right to left.



Conclusion

- There is a universal pattern, which we called as “handedness”.
- Using handedness, one can decipher the directionality of Indus inscriptions.
- Not only Indus . . . any unknown writing system.
- In our study, we are **NOT using** any context information or under-line grammar of the language.

M.I. Ashraf and S. Sinha, *"The "handedness" of language: Directional symmetry breaking of sign usage in words"*,**PLoS ONE** 13(1), (2018) 0190735.