A Statistical Investigation of Long Memory in Language and Music

Alexander Greaves-Tunnell and Zaid Harchaoui

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UNIVERSITY of WASHINGTON

Problem

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- How can it be **estimated** in modern sources of sequence data?
- How can we **evaluate** if a model has captured this property?

Contributions

- Introduce a framework for evaluation of long-range dependence anchored in the literature of **long memory** stochastic processes.

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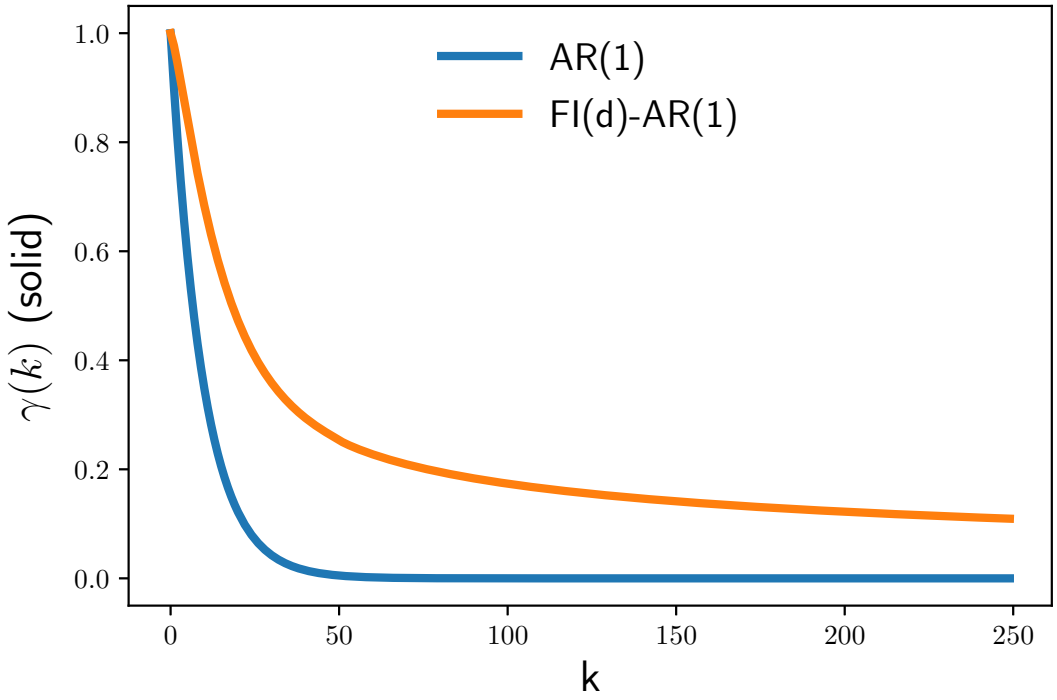

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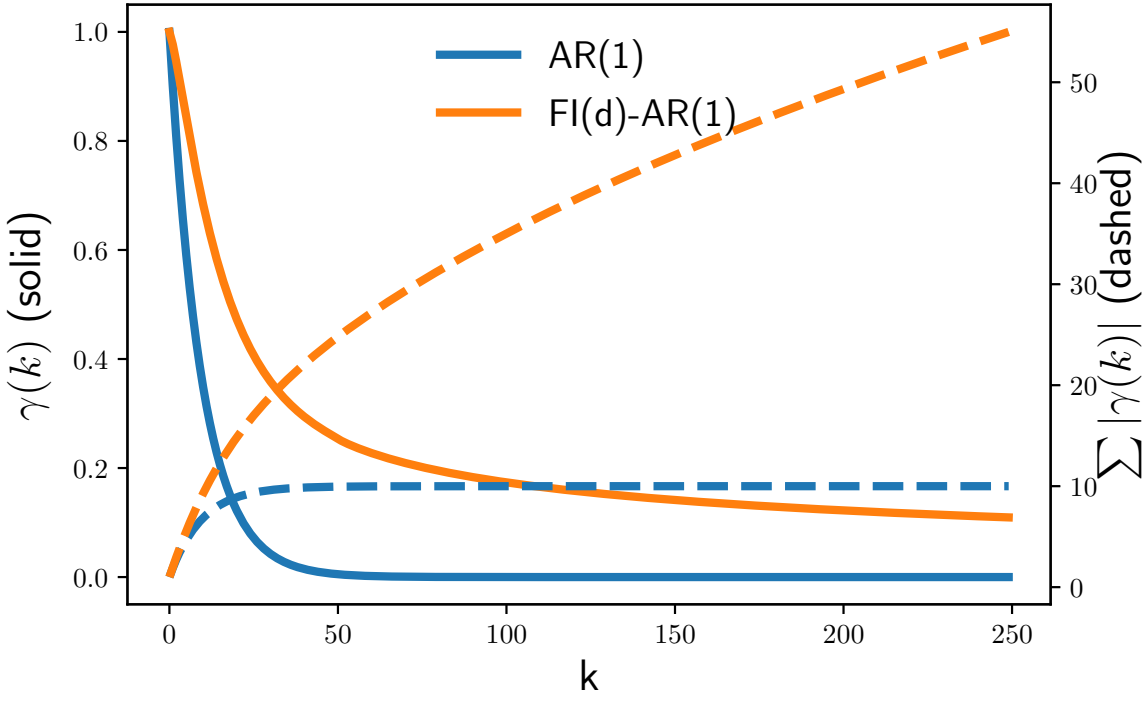

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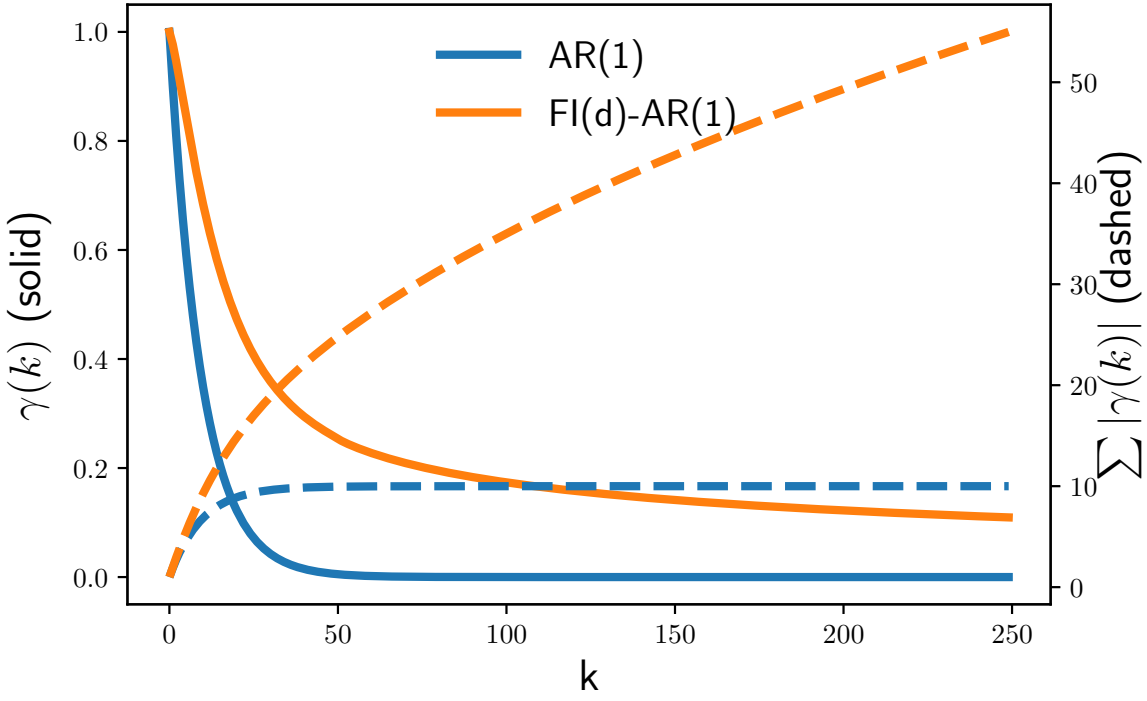

• Adapt **semiparametric** statistical methods to define estimation and testing procedure for long memory in high dimensions.

Results: Language and Music

Do language and music data have long memory?

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Visual heuristic from differing behavior of partial sums:

$$\sum_{k=1}^{K} |\gamma(k)| \to \begin{cases} \infty & \textbf{long} \text{ memory} \\ c < \infty & \textbf{short} \text{ memory} \end{cases}, \text{ as } K \to \infty$$

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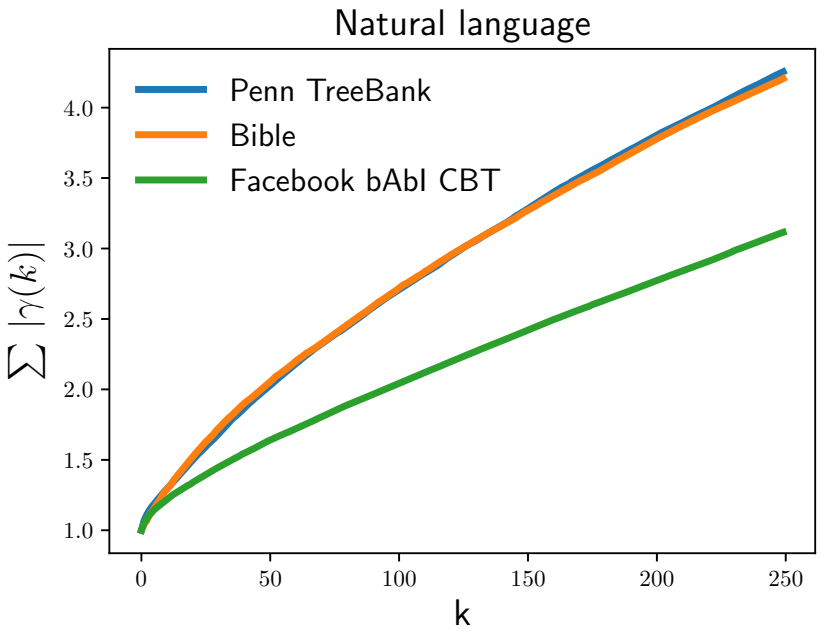

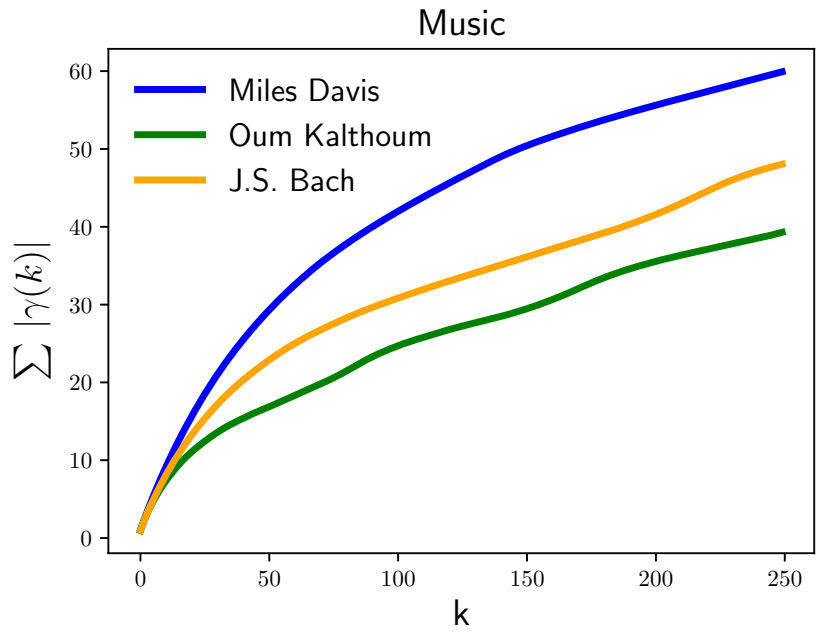

Results: RNN Models

Hypothesis test for long memory:

$$\mathcal{H}_0 : \mathbf{d} = 0 \quad \text{vs.} \quad \overbrace{\mathcal{H}_A : \mathbf{d} > 0}^{\textbf{anticipated result}} \quad .$$

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Model	**memory d**	**p-value**	**Reject $\mathcal{H}_0$?**
LSTM (trained)	-8.59×10^{-4}	0.583	X
LSTM (untrained)	-4.17×10^{-4}	0.572	X
Memory cell	-5.96×10^{-4}	0.552	X
SCRN	2.37×10^{-3}	0.324	X

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