Cambridge ALTA
Institute for Automated Language Teaching and Assessment

UNIVERSITY OF CAMBRIDGE

Engineering Small Language Models as Learner Models for LLM Interaction and Calibration

Suchir Salhan
Department of Computer Science & Technology, University of Cambridge, U.K. sas245@cam.ac.uk

Small Language Models (SLMs) in ALTA Research: Goals and Rationale

Small Language Models (SLMs), typically under 1B parameters, provide valuable, interpretable, and efficient alternatives to large models. They are especially suitable for proprietary, task-specialised applications such as query routing in chatbot systems or edge/on-device ML.

My PhD Work: SLMs as *Learner Models*

Problem: High-precision learner representations are essential for personalised and adaptive learning and assessment.
Solution: I propose bilingual SLMs for second language adaptation — or **L2LMs** — which simulate the developmental trajectories of second-language learners with a typologically-diverse L1s.

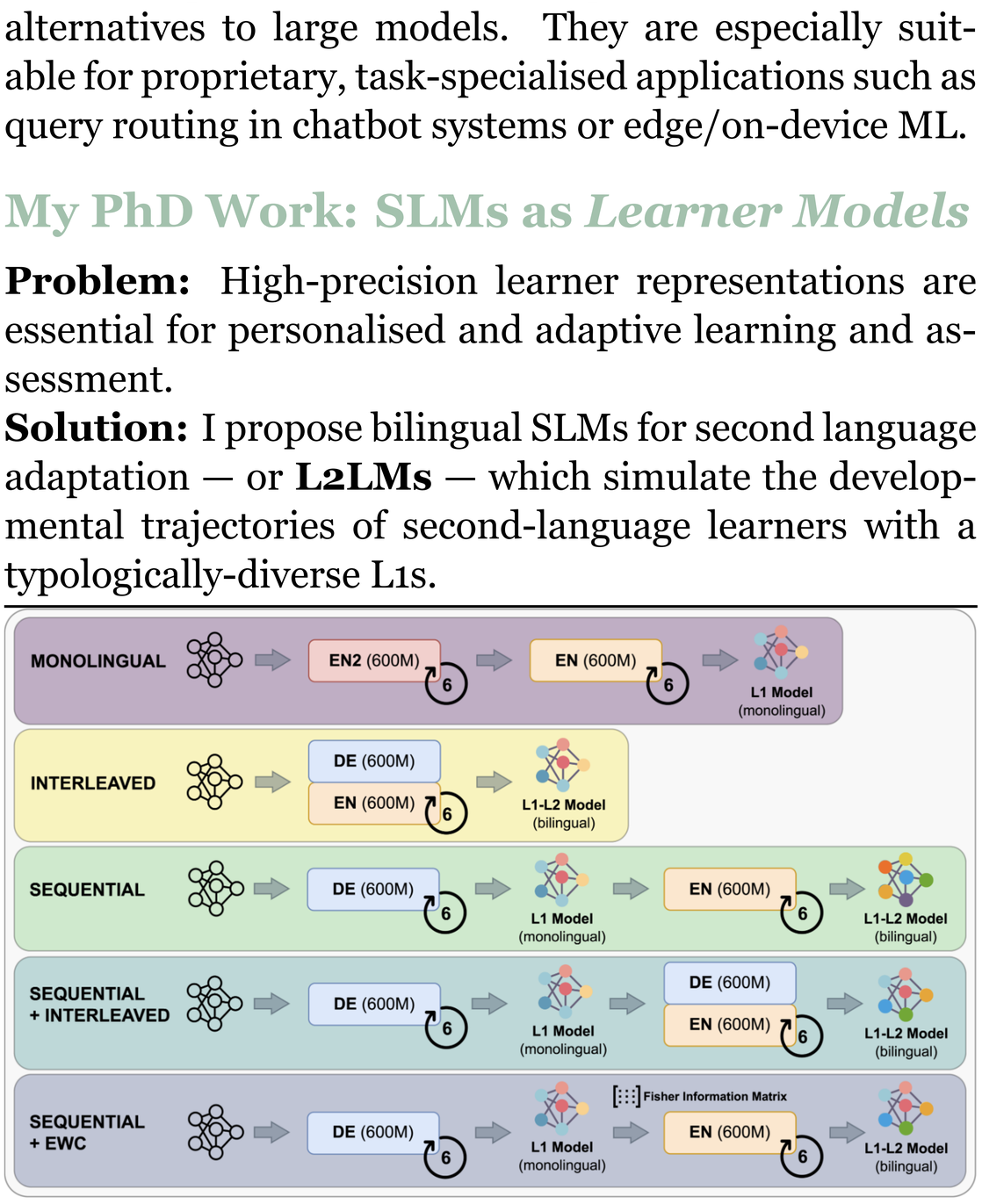


Figure 1:Conceptual Architecture of L2LMs and Sequential/Simultaneous Bilingual SLMs from Constantinescu et al (2025)

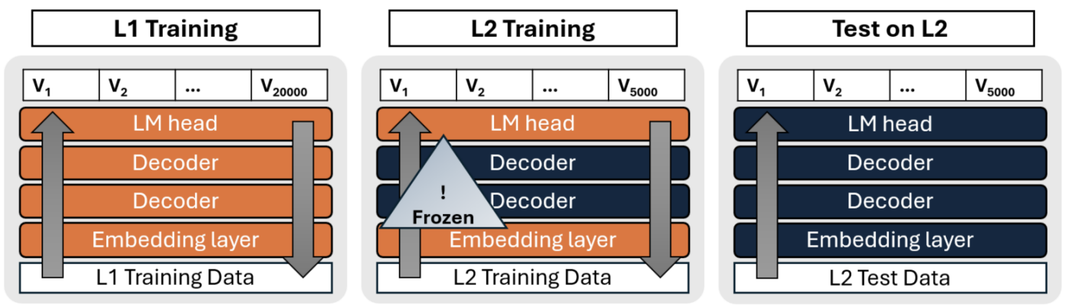
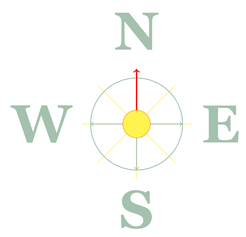


Figure 2:Language Model Architecture of L2LMs from Aoyama & Schneider (2024)

Integration into ALTA CST

Integrated Learning and Assessment: Calibrating LLMs with L2LMs of L1 Background to *identify the right tests for the right purposes*. **Accessibility by Design:** Calibrations LLMs with L2LMs for lower-resourced L1s, especially those that occur infrequently in learner corpora, could help offer more *personalised learning profiles for a diverse population of English L2 learners*.

SLMs and The North Star



Design for EDIB: Model design to reflect the *diversity of L1 backgrounds* trained on naturalistic volumes and distribution of learner corpora.

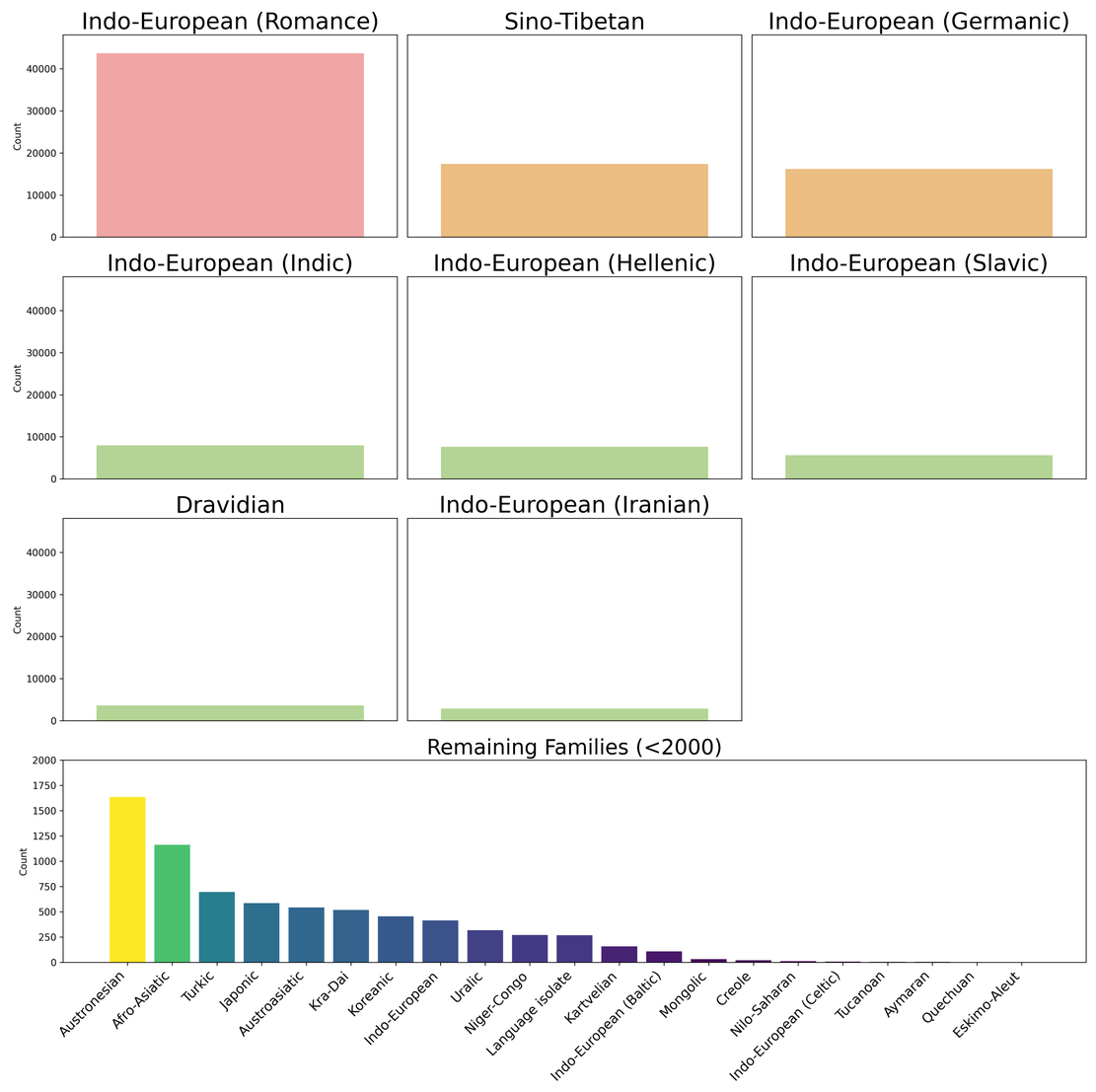


Figure 3:Distribution of L1 Backgrounds (by Language Family) in the Cambridge Learner Corpus

#1 One Brand: Integrating cutting-edge LLM techniques techniques into L2LM pre-training [3,4] and post-training strategies for L2LM-LLM Interaction and Calibration.

Trust *through Interpretability*: Rich Learning Dynamics and Checkpointing of L2LMs in an explicit L2LM Design Philosophy, inspired by the Pico Learning Dynamics Framework [3].

Selected References

[1] **Salhan, S.A** (2025) **Linguistics in the Age of Language Models: What can Cognitively-Inspired Language Models offer to Linguistic Theory?** (Position Paper in *Cambridge Occasional Papers in Linguistics (CoPiL)*, Accepted, Volume 17) [2] Arnett, C. On the Acquisition of Shared Grammatical Representations in Bilingual Language Models *in press* [3] Diehl Martinez, R., Demitri Africa, D., Weiss, Y., **Salhan, S.A.**, Daniels, R., & Buttery. P.J. (2025) **Pico: A Lightweight Framework for Studying Language Model Learning Dynamics** (*under review*) [4] Goriely, Z., **Salhan, S.A.**, Lesci, P.,Cheng. J., & Buttery. P.J. (2025) **ByteSpan: Information-Driven Subword Tokenisation** (Accepted ICML 2025 Tokenisation Workshop (TokShop, Non-Archival)) [5] **Salhan, S.A.**, Diehl Martinez, R., Goriely, Z., & Buttery. P.J. (2024) **Less is More: Pre-Training Cross-Lingual Small-Scale Language Models with Cognitively-Plausible Curriculum Learning Strategies** (Accepted Paper @ BabyLM Workshop in EMNLP 2024).
This work is supported by Cambridge University Press & Assessment