AfriqueLLM: How Data Mixing and Model Architecture Impact Continued Pre-training for African Languages

Hao Yu[1,2], Tianyi Xu[1,2], Michael A. Hedderich[3], Wassim Hamidouche[4], Syed Waqas Zamir[4], David Ifeoluwa Adelani[1,2,5]

[1]McGill University, Canada, [2]Mila-Quebec AI Institute, Canada,
[3]LMU Munich & Munich Center for Machine Learning, Germany,
[4]Microsoft AI for Good Research Lab, [5]Canada CIFAR AI Chair

Correspondence: hao.yu2@mail.mcgill.ca, david.adelani@mila.quebec

Abstract

Large language models (LLMs) are increasingly multilingual, yet open models continue to underperform relative to proprietary systems, with the gap most pronounced for African languages. Continued pre-training (CPT) offers a practical route to language adaptation, but improvements on demanding capabilities such as mathematical reasoning often remain limited. This limitation is driven in part by the uneven domain coverage and missing task-relevant knowledge that characterize many low-resource language corpora. We present `AfriqueLLM`, a suite of open LLMs adapted to 20 African languages through CPT on 26B tokens. We perform a comprehensive empirical study across five base models spanning sizes and architectures, including Llama 3.1, Gemma 3, and Qwen 3, and systematically analyze how CPT data composition shapes downstream performance. In particular, we vary mixtures that include math, code, and synthetic translated data, and evaluate the resulting models on a range of multilingual benchmarks. Our results identify data composition as the primary driver of CPT gains. Adding math, code, and synthetic translated data yields consistent improvements, including on reasoning-oriented evaluations. Within a fixed architecture, larger models typically improve performance, but architectural choices dominate scale when comparing across model families. Moreover, strong multilingual performance in the base model does not reliably predict post-CPT outcomes; robust architectures coupled with task-aligned data provide a more dependable recipe. Finally, our best models improve long-context performance, including document-level translation. Models have been released on Huggingface. [1]

1 Introduction

Large language models (LLMs) are becoming increasingly multilingual, with proprietary models pre-trained on hundreds of languages (Jaech et al., 2024; Comanici et al., 2025). Open models follow a similar trend, but the performance gap with proprietary LLMs is often larger for low-resource languages, particularly African languages (Adelani et al., 2025; Adebara et al., 2025). This gap highlights an opportunity to develop language- or region-specific LLMs for these languages.

Since the advent of pretrained language models such as BERT (Devlin et al., 2019), continued pretraining has become a standard approach for adapting models to new domains and languages (Gururangan et al., 2020a; Chau and Smith, 2021; Alabi et al., 2022a), and has recently been scaled to modern LLMs (Nguyen et al., 2024; Ji et al., 2025a; Buzaaba et al., 2025a). While CPT often yields significant improvements for natural language understanding (NLU) and translation tasks, gains on more challenging tasks, such as mathematical reasoning or knowledge-based QA (e.g., MMLU (Hendrycks et al., 2021)), remain limited due to uneven knowledge coverage across languages, with low-resource languages often spanning fewer domains (Buzaaba et al., 2025a).

To further improve downstream performance, LLMs are increasingly trained on heterogeneous data sources such as math, code, and other knowledge-rich corpora. These sources are often scarce in low-resource languages, yet they can substantially boost performance across a wide range of downstream tasks (Aryabumi et al., 2024; Bakouch et al., 2025; Li et al., 2025b). Recent work also shows that multilingual capability can be improved by training on machine-translated English data covering diverse domains, achieving competitive results even without adding monolingual data in the target languages (Wang et al., 2025b). Despite these advances, we still lack a comprehensive empirical understanding of how incorporating heterogeneous sources affects CPT outcomes for low-resource languages. In this work, we address

[1] AfriqueLLM Collection

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this gap by systematically studying CPT data mixtures and analyzing how base-model architecture and prior language coverage influence downstream performance after adaptation.

We introduce **AfriqueLLM**, a suite of open language models adapted to 20 African languages via efficient continued pre-training (CPT) on 26B tokens. We perform CPT on several base model spanning different architectures and scales, including Llama 3.1 8B, Gemma 3 (4B and 12B), and Qwen 3 (4B, 8B, and 14B). Across these backbones, we systematically vary the CPT data mixture to quantify its impact on downstream performance. AfriqueLLM achieves strong results on multilingual benchmarks for models with fewer than 15B parameters, while largely preserving English performance.

Our evaluation leads to four main findings. *(1)* The CPT data mixture is the strongest determinant of gains. Adding math, code, and synthetic translated data consistently improves performance. *(2)* Within a fixed architecture, larger models generally perform better. Across architectures, however, scale alone is not predictive; for example, CPT-adapted Qwen 3 8B is competitive with Gemma 3 12B. *(3)* Strong multilingual proficiency of the base model does not reliably translate into better post-CPT results. Instead, architectural choices and task-aligned data are more predictive. *(4)* Our best models, Qwen 3 (8B and 14B), better preserve performance in high-resource languages after CPT and achieve strong results on long-context tasks such as document-level translation.

We hope these findings inform more effective adaptation of LLMs to low-resource languages. To support future work, we will publicly release our CPT-adapted AfriqueLLMs.

2 Related Work

The landscape of LLMs has undergone a paradigm shift from model-centric architectures to data-centric methodologies. While early foundational work focused on scaling parameters and compute (Kaplan et al., 2020; Brown et al., 2020), recent advancements in 2024 and 2025 have demonstrated that data quality, mixture ratios, and curriculum learning are the primary drivers of performance (Team, 2024; Yang et al., 2025a; Bakouch et al., 2025; Olmo et al., 2025; NVIDIA et al., 2025). This section focuses on two important aspects of pre-training: (1) Data mixture and (2) Continued pre-training for low-resource languages.

2.1 Data Quality, Mixture, and Synthetic Data

Data Quality and Curation. Recent efforts have focused on improving the quality of web collected data such as FineWeb (Penedo et al., 2024) dataset in the English setting. In multilingual settings, FineWeb2 (Penedo et al., 2025) extends these pipelines to scale pre-training data processing to over 1,000 languages. In the African context, this focus on quality has led to the creation of specialized datasets, such as WURA (Oladipo et al., 2023) and MADLAD-400 (Kudugunta et al., 2023).

Data Mixture and Ratios The importance of dynamic data mixtures is exemplified by the training recipes of recent models like SmolLM2 (allal et al., 2025a) and SmolLM3 (Bakouch et al., 2025), which utilize multi-stage training curricula that adjust the ratio of web, code, and math data over time. OLMo2 and OLMo3 OLMo et al. (2025); Olmo et al. (2025) further validate this approach by introducing specialized data mixes (e.g., Dolmino Mix) during the annealing phase. The scarcity of high-quality natural text for reasoning and low-resource languages has driven the adoption of synthetic data. Joshi et al. (2024) and NVIDIA (2024) demonstrate that synthetic data can effectively bridge the gap in model alignment and pre-training. Phi-4 (Abdin et al., 2024) relies heavily on synthetic data for reasoning capabilities. In the context of multilingual pre-training, Wang et al. (2025a) and Ji et al. (2025b) show that machine-translated data from high-resource languages can significantly enhance multilingual pre-training, effectively transferring missing knowledge to low-resource languages.

2.2 Continued Pre-training

The release of powerful open-weight models has broadened access to state-of-the-art language technology. Recent families such as Llama 3.1 (Team, 2024), Qwen 3 (Yang et al., 2025a), and Gemma 3 (Team et al., 2025a) provide strong foundations for downstream adaptation. For languages and domains that are underrepresented during initial pre-training, CPT remains a primary adaptation approach (Gururangan et al., 2020b). CPT has been used to build some of the strongest BERT-based models for African languages, including the AfroXLMR series (Alabi et al., 2022b; Adelani et al., 2024a; Li et al., 2025a).

In the LLM setting, recent work has studied

more efficient CPT strategies, such as learning-rate re-warming (Gupta et al., 2023a) and replay buffers (Ibrahim et al., 2024), to reduce catastrophic forgetting. Building on these ideas, Uemura et al. (2024) and Buzaaba et al. (2025b) adapt open LLMs to African languages, releasing AfriInstruct and Lugha-Llama and showing that CPT can yield substantial gains without training from scratch.

Our work builds on CPT and explores new CPT data mixtures to develop **AfriqueLLM**, a suite of models adapted to the linguistic and cultural diversity of Africa.

3 AfriqueLLM: Data & Training Recipe

3.1 Dataset Curation

High-quality and diverse training data is essential for effective language modeling. To mitigate data scarcity for African languages, we curate a 26B-token corpus designed for continued pre-training (CPT).[2] Our corpus combines monolingual text with code, mathematics, and domain-specific synthetic data to better cover the knowledge and skill distributions needed for downstream tasks. We describe the resulting data pipeline below.

African Monolingual Data. We collect text for the 20 most resource-rich African languages by combining three complementary sources (Table 1): FineWeb2 (Penedo et al., 2025), WURA (Oladipo et al., 2023), and MADLAD-400 (Kudugunta et al., 2023). FineWeb2 provides the backbone of our corpus due to its scale and strong filtering. We add document-level data from WURA to increase contextual diversity and longer-range coherence, and we use MADLAD-400 to improve coverage for the lower-resource languages in our set. To mitigate catastrophic forgetting during CPT, we include four high-resource languages, English, French, Portuguese, and Arabic, capped at 1B tokens per language, following Oladipo et al. (2023). Detailed corpus statistics appear in Table 8 in Appendix A.

Sampling Strategy. African-language corpora are highly imbalanced, which can cause high-resource languages to dominate training. To mitigate this, we use UniMax sampling (Chung et al., 2023), which caps each high-resource language at approximately 1B tokens and upsamples lower-resource languages for up to five epochs. This produces a more balanced sampling distribution and increases coverage of underrepresented languages (see the *UniMax* column in Table 1).

[2]All token counts reported in this paper are computed using the Gemma 3 tokenizer.

Language	Code	Raw	Ep.	UniMax	Syn.
High-Resource (Non-African)					
English	eng_Latn	>1.00B	0	1.07B	16M
French	fra_Latn	>1.00B	0	1.07B	–
Portuguese	por_Latn	>1.00B	0	1.07B	–
Arabic	arb_Arab	>1.00B	0	1.07B	–
African Languages					
Afrikaans	afr_Latn	5.30B	0	1.07B	12M
Swahili	swh_Latn	2.92B	0	1.07B	13M
Moroccan Ar.	ary_Arab	3.29B	0	1.07B	–
Somali	som_Latn	1.78B	0	1.07B	14M
Amharic	amh_Ethi	989M	1	1.07B	24M
Egyptian Ar.	arz_Arab	953M	1	1.07B	–
Hausa	hau_Latn	500M	2	1.07B	13M
Kinyarwanda	kin_Latn	481M	2	1.07B	13M
Zulu	zul_Latn	350M	3	1.07B	12M
Igbo	ibo_Latn	318M	3	1.07B	13M
Plateau Malagasy	plt_Latn	310M	3	1.07B	14M
Xhosa	xho_Latn	268M	3	1.07B	15M
Shona	sna_Latn	263M	4	1.05B	11M
Yoruba	yor_Latn	258M	4	1.03B	17M
Nyanja	nya_Latn	230M	4	921M	11M
Southern Sotho	sot_Latn	203M	4	813M	14M
Tigrinya	tir_Ethi	142M	4	569M	76M
Tunisian Ar.	aeb_Arab	137M	4	547M	–
Oromo	gaz_Latn	93M	4	372M	22M
Tswana	tsn_Latn	92M	4	368M	16M
subtotal				*22.8B*	*324M*
CornStack-Python (Suresh et al., 2025) (Code)					*967M*
FineMath (Allal et al., 2025) (Math)					*1.07B*
NLLB-OPUS (NLLB Team et al., 2022) (Parallel)					*456M*
Total Tokens — CM					**24.9B**
— CMS					**25.2B**
— CMSP					**25.6B**

Table 1: **Token distribution for the 24 languages pre-trained**. High-resource languages are capped at 1B tokens. Syn. denotes synthetic data.

Code (C) and Mathematics (M) Reasoning and logical abilities are often weaker in models adapted to low-resource languages. To strengthen these skills, we incorporate approximately 1B tokens of Python code from CornStack (Suresh et al., 2025) and approximately 1B tokens of educational mathematics content from FineMath-4+ (Allal et al., 2025). We also hypothesize that such structured data acts as a cognitive anchor during CPT. Maintaining a substantial fraction of code and math may help preserve internal consistency and reduce the loss of previously acquired capabilities that can occur when adaptation data is dominated by noisy monolingual web text (Yang et al., 2025a; Bakouch et al., 2025; allal et al., 2025a).

Synthetic Data (S) We enrich our training corpus with 324M tokens of machine-translated content drawn from diverse web domains and mathematical reasoning questions to increase topical coverage. Following the domain-centric curation framework of Wettig et al. (2025), we select 10 domains from Web Organizer (Wettig et al., 2025), which span

20 topics. This design serves two goals. First, it introduces high-quality lexical and conceptual coverage for domains that are sparse in many African-language corpora. Second, it functions as a form of distributional replay buffer (Gupta et al., 2023a): translating high-quality English sources into the target languages helps preserve broad, general-purpose knowledge and stabilizes continued pre-training by keeping the training distribution closer to that of high-resource pre-training.

We use GPT-4.1 for translation due to its strong performance on AfroBench. We translate the selected documents into 17 African languages, excluding Arabic dialects because they are already well represented in our corpus. The resulting translated dataset spans the 10 domains of Food and Dining, Health, History, Industrial, Politics, Science and Technology, Software Development, Travel, Education and Jobs, and Entertainment. In addition, we translate mathematical reasoning questions, thinking traces and solutions from OpenMathReasoning (Moshkov et al., 2025) (the `cot` split) and include them as an eleventh domain.

Translation Data (P) To refine cross-lingual alignment, we explored the integration of parallel data from the NLLB project (NLLB Team et al., 2022). Although we initially collected 1B bilingual pairs, quality control was paramount. We applied a rigorous filtering threshold of 0.7 using SSA-COMET (Li et al., 2025a)—a regression model for machine translation (MT) quality estimation (QE) specifically optimized for African languages. This process yielded a high-quality subset of 4M samples (approx. 456M tokens), ensuring that only the most reliable translation pairs contributed to the model's multilingual capabilities.

Overall, our curation process yields several dataset mixtures, like CMS and CMSP, totaling 25.2B and 25.6B tokens respectively, with the detailed per-language distribution across all 24 training languages presented in Table 1 and further elaborated in Appendix D.

3.2 Training Setup

Experiments were conducted using the LLaMA-Factory (Zheng et al., 2024) framework on a high-performance cluster (up to 16 nodes, 64 NVIDIA H100 GPUs). We maximized training throughput and memory efficiency by employing sequence packing, DeepSpeed ZeRO-1/ZeRO-2 (Rasley et al., 2020), Flash Attention 3 (Shah et al., 2024), and Liger Kernel (Hsu et al., 2025).

Hyperparameter Tuning Following the continual pre-training strategies of Gupta et al. (2023b) and Bakouch et al. (2025), we performed an extensive ablation study to tailor hyperparameters for the African language context. Our search yielded three key insights based on the `gemma-3-4b/12b-pt`:

1. **Learning Rate:** A sweep from 1e-6 to 2e-4 revealed that 5e-5 optimally balances the retention of prior knowledge with the acquisition of new linguistic features.
2. **Context Length:** Evaluating window sizes of 4k, 16k, and 32k tokens, we found that the 16k sequence length provided the best performance on reasoning tasks such as AfriMGSM.
3. **Learning Rate Scheduler:** We fine-tuned the cosine scheduler, setting a minimum learning rate ratio of 0.01 and a warmup ratio of 0.001 to ensure training stability.

We maintained a global batch size of 4M tokens across all runs, dynamically adjusting gradient accumulation steps to accommodate varying hardware configurations. Full configuration details and grid search results are available in Appendix B.2.

4 Evaluation Setting

We use a comprehensive evaluation suite to assess model performance across Africa's diverse linguistic landscape. Our primary benchmark is AfroBench (Ojo et al., 2025), which covers 64 languages across 15 tasks.

AfroBench-Lite To facilitate efficient yet comprehensive evaluation, we focus on the AfroBench-Lite subset, which selects 7 representative tasks/-datasets covering key capabilities: AfriMGSM (Math), AfriMMLU (Knowledge), AfriXNLI (natural language inference) (Adelani et al., 2024c), Belebele (Reading Comprehension) (Bandarkar et al., 2024), Flores (Translation) (Goyal et al., 2022), Injongo (Intent Classification) (Yu et al., 2025), and SIB (topic classification) (Adelani et al., 2024b). While the original AfroBench-Lite evaluated on only 14 languages, we expanded the coverage of our evaluation to all African languages covered in each dataset/task.

Metrics We strictly adhere to the `lm-eval` (Gao et al., 2024) tasks established by AfroBench to ensure comparability. Note that as our models are pre-trained checkpoints without any instruction tuning,

we report few-shot (5-shots) results for all tasks except AfriMGSM (where the default setting is 8-shots). For translation tasks (Flores), we utilize SSA-COMET (Li et al., 2025a) rather than lexical overlap metrics like ChrF++ (Popović, 2017) from the official AfroBench since recent studies indicate that SSA-COMET correlates significantly better with human judgment for African languages, offering a more accurate assessment of semantic quality (Li et al., 2025a). All evaluations utilize the Hugging Face or vLLM backend (Kwon et al., 2023) with "do_sample=False".

Baseline Models To evaluate the effectiveness of our data mixture and scaling laws, we selected several state-of-the-art open-weight models as baselines: the Google Gemma 3 series (Team et al., 2025b), Meta Llama 3.1 series (Team, 2024), and Alibaba Qwen 3 series (Yang et al., 2025b). Gemma 3 is renowned for its extensive multilingual support, while Llama 3.1 represents a highly optimized predecessor in the open-source landscape. We included the Qwen 3 series due to its strong performance in mathematical reasoning, despite its limited native support for African languages.[3] Our experimental pipeline first validates the data mixture using Gemma 3 (4B and 12B) and subsequently scales these findings to Llama 3.1 (8B) and Qwen 3 (4B, 8B and 14B) base models.

5 Experiments Results

5.1 Data Mixture Ablation

To identify the optimal recipe for African language adaptation, we perform an ablation study on Gemma 3 (4B and 12B), evaluating four benchmarks: Flores (MT), AfriXNLI (NLI), AfriMGSM (Math), and AfriMMLU (QA). Results are shown in Table 2.[4]

The Monolingual Trade-off Adding only monolingual data (22B tokens) yields substantial gains on non-reasoning tasks, with MT (Flores) and NLI (AfriXNLI) improving by over 10% relative to the base model. However, for the 12B model, challenging reasoning datasets (AfriMGSM and AfriMMLU) decline slightly (e.g., 24.1 → 23.8 on AfriMGSM and 48.2 → 46.7 on AfriMMLU).

[3] Qwen 3 supported languages

[4] For the data mixture ablation study, we use the HuggingFace backend with `lm-eval` for accuracy, while all other benchmarks use vLLM to reduce computation cost. As a result, relative trends are consistent, but absolute scores may differ between Table 2 and Table 3.

Model	Flores	AfriMGSM	AfriMMLU	AfriXNLI
Baseline Models				
NLLB-200-1.3B	61.27	–	–	–
NLLB-200-3.3B	62.42	–	–	–
NLLB-MoE-54B	65.72	–	–	–
Gemma 3 4B Variants				
Gemma 3 4B PT	35.99	9.25	33.57	34.77
Gemma 3 4B IT	31.86	14.29	34.44	33.19
+ Monolingual	62.72 ↑	10.68 ↑	35.41 ↑	**40.76** ↑
+ CM	62.30 ↑	14.68 ↑	36.08 ↑	40.19 ↑
+ CMP	63.21 ↑	14.29 ↑	35.20 ↑	40.10 ↑
+ CMS	63.17 ↑	**14.81** ↑	35.86 ↑	39.93 ↑
+ CMSP	**63.34** ↑	13.35 ↑	**36.72** ↑	40.44 ↑
Gemma 3 12B Variants				
Gemma 3 12B PT	52.53	24.10	48.21	39.81
Gemma 3 12B IT	47.81	36.50	46.84	40.16
+ Monolingual	65.78 ↑	23.78 ↓	46.72 ↓	**45.19** ↑
+ CMP	65.86 ↑	27.82 ↑	**48.49** ↑	42.45 ↑
+ CMS	**66.23** ↑	**30.87** ↑	48.46 ↑	44.57 ↑
+ CMSP	65.83 ↑	29.61 ↑	48.32 ↑	43.26 ↑

Table 2: **Ablation of CPT Data mixture**. We report result on African languages covered in CPT. C = Code, M = Math, S = Synthetic, P = Parallel. Best results among adapted models are in **bold**, and our final configurations are highlighted in green. Compare to base model: improvement with ↑ and degradation with ↓.

We attribute this to catastrophic forgetting of reasoning priors when exposed to large volumes of raw web text that are less heterogeneous for low-resource languages.

Performance Recovery via Code and Math Integrating additional 2B tokens of Code and Math (CM) reverses this trend. For the 4B model, CM improves performance across all tasks compared to monolingual data only. For the 12B model, all configurations that include code and math (CMP, CMS, CMSP) similarly recover reasoning performance, demonstrating the importance of adding datasets with structured reasoning such as Code. This finding aligns with prior work showing that CM enhances generalization to other tasks (allal et al., 2025b; Aryabumi et al., 2025).

Data Quality vs. Scale At 12B scale, we observe a divergence regarding parallel data (P). While NLLB parallel data (CMP) provides marginal gains for the 4B model, it becomes detrimental for the 12B model compared to CMS. Specifically, CMS (Monolingual + Code/Math + Synthetic) achieves the highest scores on MGSM (30.9) and Flores (66.2), whereas adding parallel data (CMSP) causes performance reduction.

Drawing from mid-training recipes in Zheng et al. (2025); Bakouch et al. (2025), we hypothesize that larger models are more sensitive to data quality: noisy parallel corpora like NLLB, even when filtered, benefit smaller models but harm larger ones.

Model	AfriMGSM	AfriMMLU	AfriXNLI	Belebele	Flores	Injongo	SIB-200	Overall	Δ	Δ %
African Languages Adapted										
Lugha-Llama-8B-wura	9.46	37.00	39.24	47.86	49.90	62.30	75.81	45.94	-	-
Base Models										
Llama 3.1 8B	8.14	32.27	37.90	40.95	26.69	41.37	59.99	35.33	-	-
Gemma 3 4B	10.24	33.89	37.76	45.79	35.36	55.52	63.59	40.31	-	-
Gemma 3 12B	25.21	48.76	44.01	68.84	44.09	73.53	79.17	54.80	-	-
Qwen 3 4B	8.26	33.84	37.12	41.50	20.16	21.69	57.88	31.49	-	-
Qwen 3 8B	11.22	36.56	38.24	44.63	21.13	29.47	53.06	33.47	-	-
Qwen 3 14B	16.60	39.66	43.22	50.74	23.75	41.80	66.29	40.29	-	-
Afrique Models (Ours)										
AfriqueLlama-8B	17.51	36.57	37.39	50.51	63.60	71.17	69.14	49.41	+14.1	+39.9%
AfriqueGemma-4B	14.86	36.73	39.62	50.52	54.95	69.28	69.21	47.88	+7.6	+18.8%
AfriqueGemma-12B	32.14	49.47	44.60	68.65	**65.04**	76.79	75.08	58.82	+4.0	+7.3%
AfriqueQwen-4B	33.09	43.04	44.88	63.62	59.82	65.34	74.77	54.94	+23.4	+74.4%
AfriqueQwen-8B	39.68	46.91	45.99	68.46	62.18	73.36	77.00	59.08	**+25.6**	**+76.5%**
AfriqueQwen-14B	**45.01**	52.22	**49.01**	74.63	63.77	77.80	82.63	**63.58**	+23.3	+57.8%
Gemma 3 27B	35.37	**55.47**	46.85	**74.81**	48.41	**79.70**	**84.34**	60.71	-	-

Table 3: **Task-level performance comparison between Base models and our Continued Pre-Trained (CPT) models**. Best results are **bolded**, second-best are underlined. ΔAbs and ΔRel show absolute and relative improvements over base models, with purple highlighting Qwen's superior gains.

Accordingly, we adopt **CMS** as our primary recipe.

▷ Takeaway 1: The Quality-Scale Sensitivity

Leveraging synthetic data and datasets with structured reasoning such as Math & Code improves CPT generalization. For larger models (12B+), high-quality synthetic data is a more effective bridge than noisy parallel corpora.

5.2 Impact of Model Selection and Scaling

Table 3 shows the result of leveraging the CMS recipe across various model architectures and model sizes.

"Zero-to-Hero" Effect in Qwen 3 The most striking finding is the performance jump in the Qwen 3 series, with relative improvements of 74.4% (4B), 76.5% (8B) and 57.8% (14B) over their respective base models, while the Gemma 3 series achieved 18.8% (4B) and 7.3% (12B) relative improvement. We term this the "Zero-to-Hero" effect. Despite minimal official support for African languages and the weakest baseline performance (Qwen 3 8B avg.: 33.47), AfriqueQwen exhibits the highest relative gains, outperforming similarly-sized AfriqueGemma variants on all tasks except translation (Flores), where Gemma's native multilingual pre-training provides an expected advantage. We extend this analysis to the broader 4B Qwen family in Section 5.5. And even notably, AfriqueQwen-14B (63.58) outperforms Gemma 3 27B (60.71) by +2.87 points overall, with significant advantages on AfriMGSM (+9.64) and Flores (+15.36), despite being less than half the size.

These results suggest that Qwen 3 models largely preserve their High-Resource Languages (HRLs) performance when adapted to Low-Resource Languages (LRLs) via CPT. Consistent with the Qwen 3 technical report, Qwen 3 14B outperforms Gemma 3 12B on HRLs. We hypothesize that Qwen 3 benefits from stronger latent fast adaptation capabilities that are more effectively unlocked through CPT, [5] highlighting that a strong HRL base model priors are more critical for cross-lingual adaptation than prior language familiarity.

Comparison with Other CPT African LLMs Compared to **Lugha-Llama-8B-wura** (Buzaaba et al., 2025b), adapted using only WURA monolingual data (Oladipo et al., 2023) on the same Llama 3.1 8B base, AfriqueLlama shows close score to Lugha, and outperforms it in 4 of 7 tasks, particularly reasoning (MGSM: 17.51 vs. 9.46) and translation (Flores: 63.60 vs. 49.90).

Marginal Effects of Model Size As expected, relative improvement from CPT decreases with model size (Gemma 4B: +18.8% vs. 12B: +7.3%) with the same training data mixture, consistent with scaling laws in prior work (Ye et al., 2024; He et al., 2024). However, even at 14B parameters, Qwen shows substantial gains (+57.8%), indicating significant headroom for African language adaptation.

[5] Probably because it was pre-trained on 119 languages

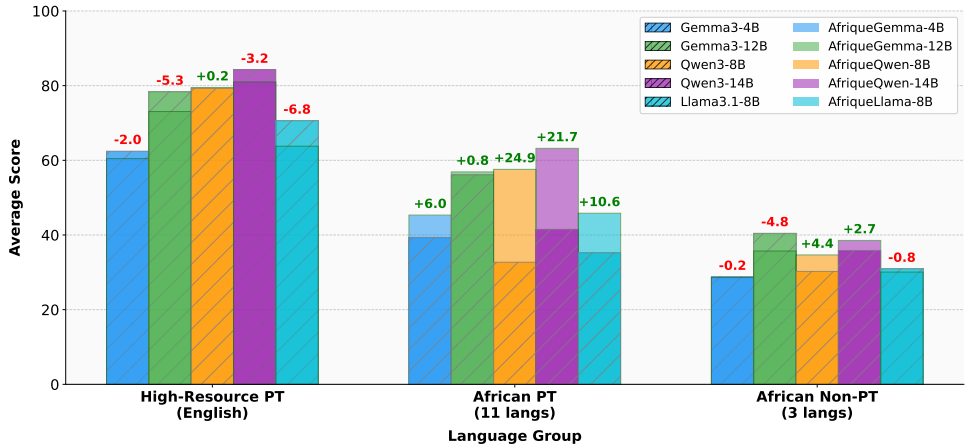

Figure 1: **Performance comparison across language groups: High-Resource PT (English), African PT, and African Non-PT**. We report the average score across all benchmarks excluding Flores. Hatched bars represent base models, while solid bars represent their Afrique-adapted counterparts. Values above the bars indicate the absolute improvement (Δ) after adaptation.

	Gemma3-4B			Gemma3-12B			Qwen3-8B			Qwen3-14B			Llama3.1-8B		
Language	Base	Afrique	Δ%	Base	Afrique	Δ%	Base	Afrique	Δ%	Base	Afrique	Δ%	Base	Afrique	Δ%
English	59.1	56.6	-4.2%	76.9	71.2	-7.4%	78.1	78.7	+0.8%	83.4	79.9	-4.1%	68.1	60.6	-11.0%
French	49.6	45.5	-8.3%	66.5	64.0	-3.8%	73.9	71.0	-4.0%	76.7	74.1	-3.5%	55.0	49.8	-9.4%
Avg.	54.3	51.1	-6.2%	71.7	67.6	-5.6%	76.0	74.8	-1.6%	80.0	77.0	-3.8%	61.5	55.2	-10.2%

Table 4: **High-Resource Language (HRL) performance comparison between base models and Afrique-adapted models**. Red values indicate performance drops, highlighting the trade-off when adapting models for African languages. Δ% denotes relative difference.

▷ Takeaway 2: Foundation Ability Matters

A base model's "strong ability" is a more potent starting point for CPT than its "language coverage." Strong foundation ability priors can be effectively mapped to new languages with high-quality data mixture.

5.3 Language-wise Analysis

Here, we analyze the impact of CPT across three language resource levels (Figure 1): High-Resource Pre-Trained (HRL-PT) language — English that is well-represented in base model pre-training; African Pre-Trained (Afr-PT) languages included in our CPT corpus (e.g., Swahili, Amharic); and African Non-Pre-Trained (Afr-NPT) languages absent from both base and CPT training (e.g., Ewe, Lingala). Figure 1 reveals three key findings: *(1) Targeted gains on Afr-PT languages.* All models show substantial improvements on CPT-covered African languages, with Qwen 3 8B achieving the highest gain (+24.9 points). *(2) Minimal transfer to unseen languages.* Performance on Afr-NPT languages remains largely unchanged for most models, indicating that CPT primarily benefits explicitly covered languages. Interestingly, AfriqueQwens show modest positive transfer (+4.4, +2.7), suggesting that the CPT models leverage cross-lingual transfer from related languages from same family e.g. Lingala could benefit from other Bantu languages (like Swahili & Kinyarwanda) even when not covered. *(3) Less catastrophic forgetting for HRLs* While most models exhibit HRL decline, Qwen 3 8B maintains near-parity (+0.2), demonstrating that with a strong HRL base, CPT can enhance low-resource languages without sacrificing too much high-resource performance. This is further supported by AfriqueQwen-14B's +10.6 gain on Afr-PT languages with only -3.2 loss on HRL. Overall, the mixture of prior model capability and CPT data composition allows for balancing improvements in LRLs while controlling degradation in HRLs.

▷ Takeaway 3: Language Transfer Limits

"CPT favours seen languages in data mixtures." Including HRLs in the CPT data mixture mitigates catastrophic forgetting on HRLs, but yields limited transfer to unseen languages.

HRL degradation across models Table 4 quantifies catastrophic forgetting on English and French. Compared to the massive African language gains (up to +76.5% in Table 3), HRL performance drops are contained but noteworthy. Llama 3.1 8B shows

Model	amh	hau	ibo	kin	orm	sna	sot	swa	xho	yor	zul	Avg.
Llama 3.1 8B	29.0	41.0	37.5	29.2	25.8	28.7	28.0	48.7	28.7	29.5	28.9	32.3
AfriqueLlama-8B	47.9	50.3	47.2	47.5	45.3	50.1	48.0	55.0	48.6	47.4	47.0	48.6
Δ	+18.9	+9.3	+9.8	+18.3	+19.5	+21.5	+20.1	+6.3	+19.9	+17.9	+18.1	+16.3
Gemma 3 4B	43.3	42.6	37.3	36.3	26.4	38.2	33.2	52.4	38.0	26.6	38.8	37.6
AfriqueGemma-4B	48.7	50.0	46.4	46.9	42.5	49.8	43.0	54.1	48.4	43.8	46.5	47.3
Δ	+5.4	+7.4	+9.1	+10.6	+16.1	+11.6	+9.7	+1.7	+10.4	+17.2	+7.7	+9.7
Gemma 3 12B	59.9	57.8	52.8	52.7	41.4	56.7	51.1	66.8	53.2	43.6	53.7	53.6
AfriqueGemma-12B	60.8	60.4	55.8	56.1	54.5	59.8	58.2	66.3	58.0	54.6	57.5	58.3
Δ	+0.9	+2.6	+3.0	+3.4	+13.1	+3.0	+7.0	-0.5	+4.8	+11.0	+3.8	+4.7
Qwen 3 8B	34.6	24.6	25.6	24.9	28.4	27.4	28.3	47.3	27.2	24.8	25.8	29.0
AfriqueQwen-8B	61.0	61.7	54.8	56.8	55.1	59.6	57.3	68.2	57.2	55.0	56.4	58.5
Δ	**+26.3**	**+37.1**	**+29.2**	**+31.9**	**+26.8**	**+32.2**	**+29.0**	**+20.8**	**+30.0**	**+30.2**	**+30.6**	**+29.5**
Qwen 3 14B	42.0	32.2	32.9	31.0	35.4	33.3	35.8	58.7	36.7	33.7	35.1	37.0
AfriqueQwen-14B	64.7	66.1	61.0	61.0	62.0	64.5	62.4	73.0	61.8	61.2	61.5	63.6
Δ	+22.7	+34.0	+28.1	+30.0	+26.7	+31.2	+26.6	+14.3	+25.1	+27.5	+26.4	+26.6

Table 5: **Language-wise average performance improvement across all benchmarks on CPT covered languages**. Green values indicate gains after Afrique adaptation. **Bold** and underline denote the best and second-best improvements per language.

the steepest average decline (-10.2% relative), followed by Gemma 3 models (-5.6% to -6.2%). In contrast, the Qwen 3 series exhibits the smallest average HRL degradation (-1.6% for 8B, -3.8% for 14B), showing they are slightly better in preventing catastrophic forgetting.

Granular Analysis on Afr-PT Languages Table 5 provides a detailed breakdown across 11 CPT-covered African languages, averaged across tasks. Gains are consistent across all languages and models, with **many low-resource languages benefiting most**: Oromo (orm) and Yoruba (yor) show the highest deltas (e.g., +16.1 and +17.2 for AfriqueGemma-4B). In contrast, Swahili (swa) shows more modest gains (+1.7 to +20.8). For Qwen 3, improvements are even more astounding: AfriqueQwen-8B exceeds +25 absolute points in 10 of 11 languages, peaking at +37.1 in Hausa. This confirms our hypothesis that previously underrepresented languages benefit most from our data mixture. The more detailed results across all languages and tasks are presented in Appendix D.

5.4 Document-Level Translation

To evaluate whether our models with 16K tokens sequence length improve long-context translation, we benchmark on AFRIDOC-MT (Alabi et al., 2025) (health domain), a document-level parallel corpus covering English and five African languages (Amharic, Hausa, Swahili, Yoruba, Zulu). We use pseudo-documents with $k = 10$ sentences and report document-level chrF (d-chrF) scores with 3-shot prompting. Table 6 shows that all

Model	amh	hau	swa	yor	zul	Avg.
English → African (eng2xx)						
Llama 3.1 8B SFT_{10}	27.6	49.7	64.1	**50.3**	47.0	47.8
Llama 3.1 8B	10.3	19.5	28.7	16.7	14.2	17.9
AfriqueLlama-8B	41.4	62.0	74.4	46.3	68.1	58.5
AfriqueGemma-12B	**42.1**	**64.2**	**78.1**	47.0	**69.8**	**60.2**
AfriqueQwen-14B	42.0	62.8	75.7	47.4	68.2	59.2
African → English (xx2eng)						
Llama 3.1 8B SFT_{10}	63.8	61.7	74.4	68.9	71.4	68.0
Llama 3.1 8B	20.0	53.9	71.2	30.7	37.0	42.6
AfriqueLlama-8B	44.7	58.2	66.6	53.5	63.4	57.3
AfriqueGemma-12B	72.7	67.7	**80.5**	68.8	**76.6**	73.3
AfriqueQwen-14B	**72.8**	**68.3**	79.7	**70.8**	76.1	**73.5**

Table 6: **Document-level translation (d-chrF,** $k = 10$**)** on AFRIDOC-MT health domain with 3-shot prompting. *Baseline*: Llama 3.1 8B SFT_{10}—fine-tuned on 4K documents from AFRIDOC-MT (Alabi et al., 2025).

AfriqueLLMs excel at document-level translation despite never seeing AFRIDOC-MT training data during CPT. We compare performance to Llama 3.1 SFT_{10} baseline that was instruction fine-tuned on 4,060 health documents (812 per language pair).

For *eng→xx*, AfriqueGemma-12B achieves the best average (60.2), outperforming the task-specific SFT model (47.8) by +12.4 points. AfriqueQwen-14B (59.2) and AfriqueLlama-8B (58.5) also substantially exceed the SFT baseline, demonstrating that CPT provides robust long-context translation capabilities.

For *xx→eng*, AfriqueQwen-14B leads with 73.5, closely followed by AfriqueGemma-12B (73.3). Notably, both surpass the task-specific SFT_{10} model (68.0), showing that CPT's general-purpose training can even exceed in-domain fine-tuning for certain translation directions.

Model	AfriMGSM	AfriMMLU	AfriXNLI	Flores	Overall	Δ	Δ %
4B Qwen Family							
Qwen 3 4B	8.26	33.84	37.12	20.16	31.49	-	-
AfriqueQwen-4B	33.09	43.04	**44.88**	59.82	54.94	+23.4	+74.4%
Qwen 3.5 4B	20.79	38.63	40.36	32.06	46.01	-	-
AfriqueQwen3.5-4B	30.47	43.66	41.05	**63.55**	57.12	+11.1	+24.2%
+ ExtendedCM	**34.17**	**45.26**	41.94	63.51	**58.26**	+1.1†	+2.0%†

Table 7: **Qwen3 Family**. Overall is the 7-task average (all benchmarks from Table 3). Δ and Δ% denote absolute and relative gains over the corresponding base model. **Bold** marks the best among 4B Qwen Afrique variants. †Relative to AfriqueQwen3.5-4B (with 5B+5B tokens of Code/Math replaced original 1B+1B tokens of Code/Math).

5.5 Qwen3 Family: From Limited Multilingual to Multilingual Base Model

To investigate the interplay between base-model multilingual coverage and data-mixture composition at smaller scale, the Qwen 3 and 3.5 series provide an ideal comparison, as they share the same architecture but differ in multilingual pre-training scope. Table 7 compares Qwen 3 4B (limited multilingual coverage) with Qwen 3.5 4B (expanded language support).

Switching from Qwen 3 4B to the more multilingual Qwen 3.5 4B base substantially raises the starting point (31.49 → 46.01), which translates to a higher absolute post-CPT score (AfriqueQwen3.5-4B: 57.12 vs. AfriqueQwen-4B: 54.94) but a smaller relative gain (+24.2% vs. +74.4%). The stronger multilingual prior improves translation (Flores: 63.55 vs. 59.82) and language understanding tasks (AfriMMLU: 43.66 vs. 43.04), yet slightly weakens math-focused AfriMGSM (30.47 vs. 33.09). Increasing the Code and Math budget from 1B+1B tokens to 5B+5B tokens (EXTENDEDCM) largely recovers this gap on AfriMGSM (30.47 → 34.17) while also yielding consistent gains on AfriMMLU (43.66 → 45.26) and AfriXNLI (41.05 → 41.94), pushing the overall score to 58.26—comparable to AfriqueGemma-12B (58.82) at one-third the parameter count.

This confirms that strong multilingual priors primarily benefit language-knowledge-intensive tasks such as translation—a pattern observed in both the Gemma 3 series and Qwen 3.5 4B. Meanwhile, the drop in math reasoning can be recovered by adding more domain-specific data. Notably, EXTENDEDCM improves most metrics while incurring only a negligible decrease on Flores, demonstrating that Code and Math data remain broadly beneficial across tasks, consistent with the findings from our data mixture ablation (Section 5.1).

6 Conclusion

We introduce **AfriqueLLM**, a suite of LLMs adapted for 20 African languages via efficient CPT on 26B tokens. Our key findings are: *(1)* data mixture matters most—combining monolingual text with code, math, and synthetic data (CMS) yields state-of-the-art results while preserving reasoning; *(2)* base model strong capability trumps multilingual coverage—Qwen 3, despite minimal African language support, achieves the highest performance after CPT, with AfriqueQwen-14B (63.58) outperforming Gemma 3 27B (60.71) at less than half the size; and *(3)* high-quality synthetic data provides a scalable bridge for low-resource languages, with AfriqueQwen-14B surpassing the 54B NLLB-MoE on translation. We will release our models to advance African language AI research.

As a future work, we plan to conduct a more comprehensive exploration and analysis on why Qwen 3 series models provides such a strong improvement after CPT, than similar architectures such as Gemma 3.

7 Limitations

Scope Constraints. Our study has several coverage limitations: (1) *Language coverage*: We cover 20 African languages, leaving hundreds unsupported—languages with minimal digital presence remain challenging. (2) *Model scale*: Resource constraints limited experiments to 14B parameters; larger models (30B+) may exhibit different adaptation dynamics and potential better performance, like "Qwen3-30B-A3B-Base" and "Gemma 3 27b PT" and potential better performance, like "Qwen3-30B-A3B-Base" and "Gemma 3 27b PT". (3) *Training stage*: We focus on base model CPT without instruction tuning—the scarcity of high-quality instruction data for African languages remains a bottleneck for downstream deployment. (4) *Hyperparameters*: Scaling to 12B+

prevents exhaustive search; we relied on heuristics from smaller model, which may not be optimal across architectures.

Training Stability and Efficiency. We observed intermittent gradient norm spikes during training, suggesting latent optimization instabilities. While these did not cause divergence, future work could explore matrix optimizers like Muon (Liu et al., 2025) for improved stability. Our framework achieves 31–34% Model FLOPs Utilization (Appendix B.3), competitive for general-purpose setups but leaving room for improvement via specialized frameworks like Megatron-LM (Shoeybi et al., 2019).

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A Data Details

A.1 Language Selection and Statistics

Table 8 provides a comprehensive overview of the language selection process and the final token counts for each language across our primary data sources: FineWeb2, WURA, and MADLAD-400. We applied a selection threshold of 90M tokens to ensure sufficient data for meaningful linguistic adaptation.

A.2 Synthetic Data and Translation Prompts

Table 9 details the distribution of synthetic data across 11 domains. The translation process was guided by the prompts shown in Section A.2.

General Translation Prompt

```
You are a professional translator.
    Translate the user text from {{
    source_lang}} into {{
    target_lang}}.
Preserve meaning, tone, formatting,
     inline markup, numerals, and
    named entities exactly.
For long texts, ensure the
    translation is fluent, coherent
     and complete. Make sure to
    translate all parts of the text
    . Return only the translation
    without additional commentary.
```

Mathematical Reasoning Translation Prompt

```
You are a {{source_lang}}-to-{{
    target_lang}} translator for
    mathematical content. Translate
     the provided math problem,
    reasoning, and answer while
    preserving:
- All numbers, formulas, and
    formatting
- Mathematical notation and markup
- Named entities and tone

Input structure:
<problem>[Original Problem]</
    problem>
<think>[Original Reasoning]</think>
[Final Answer]<eos>

Output structure:
<problem>[Translated problem]</
    problem>
<think>[Translated reasoning]</
    think>
[Translated Final Answer]<eos>

Ensure translations are fluent,
    coherent, and complete. Return
    only the translation without
    additional commentary.
```

Language	Code	FineWeb2	Wura	Madlad400	Total Token	Rep.	Unimax Token	Synthetic	Other
***High-Resource (Non-African)* — Capped at 1B tokens**									
English	eng_Latn	>1000000000	865600280	–	1000000000	1×	1070793848	16,011,265	
French	fra_Latn	>1000000000	815336425	–	1000000000	1×	1070793848		
Portuguese	por_Latn	>1000000000	531069643	–	1000000000	1×	1070793849		
Arabic	arb_Arab	>1000000000	–	–	1000000000	1×	1070793848		
***African Languages* — Included in Training**									
Afrikaans	afr_Latn	2461214686	1357859486	1483495285	5302569457	1×	1070793849	12,113,273	
Swahili	swh_Latn	1051220388	1087449729	777825674	2916495791	1×	1070793849	12,503,168	
Moroccan Arabic	ary_Arab	3289564375	–	–	3289564375	1×	1070793849		
Somali	som_Latn	732191814	702650753	346518006	1781360573	1×	1070793849	13,572,904	
Amharic	amh_Ethi	403784914	276855513	308253510	988893937	2×	1070793848	23,943,363	
Egyptian Arabic	arz_Arab	821465539	131515140	–	952980679	2×	1070793848		
Hausa	hau_Latn	–	288353911	211672798	500026709	3×	1070793848	12,596,581	
Kinyarwanda	kin_Latn	136010710	69028912	275720285	480759907	3×	1070793848	12,707,048	
Zulu	zul_Latn	159037587	97653578	92982744	349673909	4×	1070793848	12,366,125	
Igbo	ibo_Latn	140734354	68796722	108189914	317720990	4×	1070793848	12,671,171	
Plateau Malagasy	plt_Latn	310443854	–	–	310443854	4×	1070793848	14,002,182	
Xhosa	xho_Latn	119027393	41737419	107219367	267984179	4×	1070793848	14,846,741	
Shona	sna_Latn	95516967	76561301	90581980	262660248	5×	1050640992	10,971,211	
Yoruba	yor_Latn	90126934	68250903	99303113	257680950	5×	1030723800	17,152,436	
Nyanja	nya_Latn	137607319	92652643	–	230259962	5×	921039848	11,481,563	
Southern Sotho	sot_Latn	122964390	–	80276553	203240943	5×	812963772	13,573,191	
Tigrinya	tir_Ethi	100865939	8661533	32703052	142230524	5×	568922096	75,525,088	
Tunisian Arabic	aeb_Arab	136652951	–	–	136652951	5×	546611804		
West Central Oromo	gaz_Latn	42916258	17619689	32493752	93029699	5×	372118796	21,619,016	
Tswana	tsn_Latn	9244373	72533425[6]	10215596	91993394	5×	367973576	16,313,360	
Additional Training Data									
FineMath (Math, M)	–	–	–	–	–	–	–	–	1,067,549,046
CornStack-Python (Code, C)	–	–	–	–	–	–	–	–	967,399,767
MT-NLLB (Parallel, P)	–	–	–	–	–	–	–	–	456,102,720
Subtotal of Tokens					**22.88B**		**22.80B**	**0.32B**	**2.49B**
***Excluded Languages* (<90M tokens)**									
Rundi	run_Latn	56775951		492969	57268920				
Ganda	lug_Latn	24162781		18022976	42185757				
Tsonga	tso_Latn	10782436		14451048	25233484				
Lingala	lin_Latn	16358800		7530450	23889250				
Ewe	ewe_Latn	3014541		15388319	18402860				
Wolof	wol_Latn	16527037		1839642	18366679				
Sango	sag_Latn	7104619		5590802	12695421				
Akan	aka_Latn			10824690	10824690				
Twi	twi_Latn	10648719			10648719				
Kabiye	kbp_Latn	1040478		8959130	9999608				
Bambara	bam_Latn	7335041		1426843	8761884				
Northern Sotho	nso_Latn	8630368			8630368				
Fon	fon_Latn	2281350		4439623	6720973				
Swati	ssw_Latn	2660736		2016953	4677689				
Tamazight	tzm_Tfng	4044801		260465	4305266				
Kabyle	kab_Latn	3860016			3860016				
Kabuverdianu	kea_Latn	3782732			3782732				
N'ko	nqo_Nkoo	3717948			3717948				
Mossi	Mos_Latn	3319912			3319912				
Kimbundu	kmb_Latn	1506689		1759056	3265745				
Kanuri (Arabic)	knc_Arab	3105431			3105431				
Dyula	dyu_Latn	2018490		960718	2979208				
Tamasheq (Latin)	taq_Latn	2640160			2640160				
Southwestern Dinka	dik_Latn	1144214		1420754	2564968				
Luo	luo_Latn	2010521			2010521				
Nigerian Fulfulde	fuv_Latn	1894553		95651	1990204				
Bemba	bem_Latn	1482559			1482559				
Kikuyu	kik_Tatn	1411871			1411871				
Kamba	kam_Latn	1018287			1018287				
Kikongo	kon_Latn			971858	971858				
Luba-Kasai	lua_Latn	908010			908010				
Umbundu	umb_Latn	540735			540735				
Tamasheq (Tifinagh)	taq_Tfng	401256			401256				
Kanuri (Latin)	knc_Latn	256317			256317				
Tumbuka	tum_Latn	228626			228626				
Nuer	nus_Latn	224103			224103				
Chokwe	cjk_Latn	33366			33366				
Non-Training Languages Subtotal					**303,325,401**				

Table 8: Complete dataset collection and language selection for training. This table presents all 60+ African and high-resource languages collected from FineWeb2, Wura, and Madlad400 sources, along with the selection criteria applied. Languages with ≥90M tokens are included in the final training set (24 languages, 22.8B tokens). The "Rep." column indicates the upsampling factor applied via UniMax to balance low-resource languages. Grayed rows indicate excluded languages due to insufficient data.

Domain	Tokens
Math	32,284,225
Science & Tech.	37,461,084
Politics	35,256,194
Health	31,213,028
Travel	29,751,012
History	28,386,610
Food & Dining	27,556,953
Education & Jobs	27,469,250
Software Dev.	26,446,379
Entertainment	25,148,472
Industrial	22,996,479
Total	**323,969,686**

Table 9: Synthetic Data domain distribution. Math data is sourced from (Moshkov et al., 2025), while other domains are from (Wettig et al., 2025).

B Training Details

B.1 Hyperparameter Search

We conducted an extensive ablation study to identify the optimal hyperparameters for continued pre-training on African languages.

Learning Rate We performed a learning rate sweep on the Gemma 3 4B PT model with rates ranging from 1e-6 to 2e-4. Table 10 identifies 5e-5 as the optimal rate based on average scores across low-resource languages.

LR	AfriMGSM	AfriXNLI	AfriMMLU	Flores
2e-4	5.1	39.0	27.5	-
1e-4	8.1	38.6	31.0	-
5e-5	**9.4**	**40.6**	34.7	**61.1**
2e-5	8.4	40.5	36.0	59.4
1e-5	8.0	39.9	**37.2**	57.5
5e-6	8.6	39.4	36.7	54.6
2e-6	9.0	37.8	36.8	50.3
1e-6	8.7	38.7	36.4	46.4

Table 10: Ablation on learning rate. Results are reported for the Gemma 3 4B pretrained model with a fixed 16k context length. We report average scores for AfriMGSM (8-shot CoT), AfriXNLI (Direct), AfriMMLU (Direct), and Translation (SSA-COMET) excluding English and French.

Context Size Using the optimal learning rate (5e-5), we evaluated context lengths of 4k, 16k, and 32k. Table 11 shows that a 16k context window yields the best performance on AfriMGSM.

Cosine Scheduler We explored the impact of the minimum learning rate (min lr) and warmup steps. Table 12 presents the results using the Gemma 3 4B pretrained model with a fixed context size of 16k.

Context Length	AfriMGSM
4k	7.5
16k	**9.4**
32k	7.8

Table 11: Ablation on context length. Results are reported for the Gemma 3 4B pretrained model with a fixed 5e-5 learning rate. We report average scores for AfriMGSM (8-shot CoT), excluding English and French.

Min lr	Warmup	AfriMGSM	AfriXNLI	AfriMMLU	Flores
0.01	0	9.4	**38.8**	**34.1**	60.6
0.01	0.001	**10.2**	38.2	**34.1**	60.5
0.1	0	7.7	38.5	34.0	60.9
0.1	0.001	9.4	38.5	33.4	**61.1**

Table 12: Ablation on cosine scheduler hyperparameters. Results are reported for the Gemma 3 4B pretrained model with a 16k context window. We report average scores for AfriMGSM (8-shot CoT), AfriXNLI (Direct), AfriMMLU (Direct), and Translation (SSA-COMET) excluding English and French.

B.2 Training Configuration

The following YAML configuration was used for the continued pre-training of the AfriqueLLM models using the LLaMA-Factory framework.

LLaMA-Factory CPT config (YAML)

```yaml
### model
model_name_or_path: google/gemma-3-12b-pt

### method
stage: pt

### data
template: empty
packing: true
cutoff_len: 16384 # 16k
overwrite_cache: false
preprocessing_num_workers: 32
dataloader_num_workers: 32

### finetuning
do_train: true
finetuning_type: full
deepspeed: ds_z1_config.json
freeze_vision_tower: true
freeze_multi_modal_projector: true
freeze_language_model: false

### output
logging_steps: 10
save_steps: 1000
plot_loss: true
overwrite_output_dir: true
save_only_model: false
report_to: wandb
data_shared_file_system: true
```

```
### train
per_device_train_batch_size: 4
gradient_accumulation_steps: 8
learning_rate: 5.0e-5
num_train_epochs: 1.0
lr_scheduler_type:
    cosine_with_min_lr
lr_scheduler_kwargs:
  min_lr_rate: 0.01
warmup_ratio: 0.001
bf16: true
ddp_timeout: 180000000
resume_from_checkpoint: null
weight_decay: 0.1
adam_beta1: 0.9
adam_beta2: 0.95

enable_liger_kernel: true
flash_attn: fa3
```

B.3 Training Efficiency Analysis

Table 13 summarizes the computational metrics for our continued pre-training process.

Model	Nodes	GPUs	Steps	FLOPs	Time (h)	TFLOPS	MFU (%)	Loss
AfriqueGemma 4B	4	16	6,008	0.55 ZFLOPs	9.12	16,690	26.37	1.5174
AfriqueGemma 12B	16	64	6,000	1.69 ZFLOPs	23.70	19,776	31.24	1.2942
AfriqueQwen 8B	16	64	6,872	1.31 ZFLOPs	18.30	19,868	31.39	1.3375
AfriqueQwen 14B	16	64	6,872	2.42 ZFLOPs	31.10	21,622	34.16	1.1865
AfriqueLlama 8B	16	64	7,406	1.40 ZFLOPs	18.06	21,516	33.99	1.1355

Table 13: Training efficiency metrics for Continued Pre-Training (CPT) on H100 GPUs. FLOPs indicates total floating-point operations. Loss refers to the final step training loss.

C Evaluation Details

C.1 Benchmark Language Coverage

Table 14 lists the languages covered in each task of the AfroBench-Lite suite.

Task	Languages (Total Counts)
AFRIMGSM	Amharic†, English*, Ewe, French*, Hausa†, Igbo†, Kinyarwanda†, Lingala, Luganda, Oromo†, Shona†, Sotho†, Swahili†, Twi, Vai, Wolof, Xhosa†, Yoruba†, Zulu† (19)
AFRIMMLU	Amharic†, English*, Ewe, French*, Hausa†, Igbo†, Kinyarwanda†, Lingala, Luganda, Oromo†, Shona†, Sotho†, Swahili†, Twi, Wolof, Xhosa†, Yoruba†, Zulu† (18)
AFRIXNLI	Amharic†, English*, Ewe, French*, Hausa†, Igbo†, Kinyarwanda†, Lingala, Luganda, Oromo†, Shona†, Sotho†, Swahili†, Twi, Wolof, Xhosa†, Yoruba†, Zulu† (18)
BELEBELE	Afrikaans†, Amharic†, Egyptian Arabic†, English*, French*, Hausa†, Igbo†, Kinyarwanda†, Lingala, Luganda, Moroccan Arabic†, Nyanja†, Oromo†, Plateau Malagasy†, Portuguese*, Shona†, Somali†, Sotho†, Swahili†, Tigrinya†, Tswana†, Wolof, Xhosa†, Yoruba†, Zulu† (25)
FLORES	Afrikaans†, Amharic†, Egyptian Arabic†, Ewe, Hausa†, Igbo†, Kinyarwanda†, Lingala, Luganda, Moroccan Arabic†, Nyanja†, Oromo†, Shona†, Somali†, Sotho†, Swahili†, Tigrinya†, Tswana†, Tunisian Arabic†, Twi, Wolof, Xhosa†, Yoruba†, Zulu† (24)
INJONGO	Amharic†, English*, Ewe, Hausa†, Igbo†, Kinyarwanda†, Lingala, Luganda, Oromo†, Shona†, Sotho†, Swahili†, Twi, Wolof, Xhosa†, Yoruba†, Zulu† (17)
SIB-200	Afrikaans†, Amharic†, Egyptian Arabic†, English*, Ewe, Hausa†, Igbo†, Kinyarwanda†, Lingala, Luganda, Moroccan Arabic†, Nyanja†, Oromo†, Plateau Malagasy†, Portuguese*, Shona†, Somali†, Sotho†, Swahili†, Tigrinya†, Tunisian Arabic†, Twi, Wolof, Xhosa†, Yoruba†, Zulu† (26)

Table 14: Languages included in each benchmark task.
*: High-resource pretrained (4)
†: Pretrained African (20)

D Detailed Experimental Results

model	amh	eng	ewe	fra	hau	ibo	kin	lin	lug	orm	sna	sot	swa	twi	vai	wol	xho	yor	zul	avg
Llama3.1-8B	2.72	53.52	3.44	37.12	13.12	7.76	6.64	4.40	7.28	4.80	6.80	6.64	23.84	5.44	1.84	5.04	4.00	6.64	6.56	10.93
Lugha-Llama-8B-wura	4.72	40.88	2.00	20.32	12.16	10.24	9.76	2.72	4.56	8.16	10.08	7.68	19.28	3.28	2.88	1.92	6.40	7.44	8.16	9.61
AfriqueLlama-8B	7.84	55.52	3.12	36.88	20.96	15.04	18.96	6.40	11.52	17.52	20.72	18.80	24.48	4.08	1.68	3.92	13.04	19.52	15.76	16.62
Gemma3-4B	10.64	42.48	3.28	28.72	12.88	5.28	7.76	2.88	6.56	2.64	12.16	10.08	27.12	1.84	0.08	2.40	7.68	5.44	10.96	10.57
AfriqueGemma-4B	17.52	37.84	3.60	21.52	17.04	13.36	12.96	4.16	10.16	9.68	16.96	15.84	21.60	2.00	0.88	2.24	10.72	11.68	16.08	12.94
Gemma3-12B	38.64	72.40	6.08	50.16	26.00	22.08	22.08	13.60	19.84	14.32	29.52	20.00	46.40	5.92	1.52	4.88	17.60	13.28	27.36	23.77
AfriqueGemma-12B	36.00	68.08	4.48	57.20	34.88	30.72	24.72	7.76	19.84	28.48	31.52	33.44	47.36	6.40	0.80	2.64	26.32	26.48	33.60	27.41
Qwen3-4B	8.80	84.40	6.08	69.52	6.64	2.16	6.80	7.12	7.12	9.04	7.68	8.56	23.84	5.68	3.28	6.24	5.12	5.52	6.72	14.75
AfriqueQwen-4B	30.88	79.12	7.12	66.32	38.32	26.96	32.72	8.88	16.72	30.08	32.88	35.52	46.72	5.84	3.04	4.72	25.60	34.88	29.44	29.25
Qwen3.5-4B	32.00	82.80	8.24	69.28	22.40	9.44	19.12	9.20	11.04	10.48	16.24	22.64	41.04	4.64	2.96	8.40	17.04	18.64	19.60	22.38
AfriqueQwen3.5-4B	30.16	75.36	3.76	55.44	37.20	27.04	32.00	8.64	16.96	29.68	30.80	27.84	43.68	4.40	1.76	3.84	22.00	27.84	26.96	26.60
AfriqueQwen3.5-4B-ExtendedCM	35.12	78.64	6.16	61.60	42.32	27.12	34.24	8.08	20.32	31.92	34.40	32.96	51.36	3.60	2.56	2.48	26.80	30.40	29.28	29.44
Qwen3-8B	10.80	85.76	5.92	74.08	7.84	2.64	8.88	7.92	8.00	12.16	8.48	10.88	39.04	5.76	1.12	5.20	8.80	6.48	7.44	16.69
AfriqueQwen-8B	40.48	85.20	6.40	67.92	48.88	32.08	42.56	9.76	22.16	37.76	40.00	36.64	57.28	5.68	3.04	4.88	30.24	35.44	35.12	33.76
Qwen3-14B	12.88	88.00	8.80	76.56	13.68	3.60	15.68	12.08	12.96	19.04	11.52	16.16	50.40	6.64	1.92	5.84	13.92	13.84	11.92	20.81
AfriqueQwen-14B	35.28	82.24	7.68	72.24	52.32	41.44	46.96	12.24	27.36	47.12	46.80	45.20	67.04	5.68	2.88	5.52	31.84	42.32	38.80	37.42

Table 15: 8-shot performance on the AfriMGSM benchmark for multilingual grade school math. (Math)

model	amh	eng	ewe	fra	hau	ibo	kin	lin	lug	orm	sna	sot	swa	twi	wol	xho	yor	zul	avg
Llama3.1-8B	34.16	65.56	27.48	50.64	33.84	31.72	32.80	34.84	30.84	32.24	29.84	29.24	39.08	28.48	30.20	27.76	32.08	32.20	34.61
Lugha-Llama-8B-wura	38.52	65.08	27.80	51.80	37.76	37.96	33.32	33.00	30.36	34.60	38.72	38.48	41.84	27.44	29.52	32.68	34.52	38.60	37.33
AfriqueLlama-8B	38.28	58.04	29.28	46.48	36.48	37.36	32.92	31.68	28.32	36.48	35.84	37.52	42.24	28.12	26.68	34.72	35.56	34.92	36.16
Gemma3-4B	34.40	58.00	28.24	49.68	34.08	35.36	34.04	29.92	27.48	28.00	33.88	34.04	41.48	28.92	26.04	33.84	29.00	34.72	34.51
AfriqueGemma-4B	38.80	54.48	29.16	47.56	37.92	37.04	34.72	28.04	27.88	34.16	36.56	36.24	40.40	26.64	25.08	37.80	36.24	34.12	35.71
Gemma3-12B	52.84	78.08	30.72	70.40	50.96	47.96	45.80	42.40	38.88	39.64	50.00	49.12	61.56	33.76	29.80	46.72	43.56	48.20	47.80
AfriqueGemma-12B	51.88	70.64	25.84	62.08	49.20	47.64	46.72	37.76	37.36	47.28	50.60	51.56	54.48	33.40	26.36	49.60	47.72	47.52	46.54
Qwen3-4B	34.68	75.24	32.56	65.96	33.80	34.64	31.04	38.52	31.28	36.28	32.52	34.20	36.56	33.08	32.84	32.16	34.32	32.00	37.87
AfriqueQwen-4B	49.88	71.40	30.16	61.28	44.52	41.24	39.88	34.92	31.16	43.44	42.28	42.24	49.32	31.12	30.52	38.80	40.04	41.80	42.44
Qwen3.5-4B	42.68	73.72	30.00	67.20	38.68	38.64	35.60	37.48	30.72	32.80	35.68	38.08	45.28	29.40	34.16	39.00	37.20	41.28	40.42
AfriqueQwen3.5-4B	47.44	67.60	27.28	57.68	45.52	42.88	36.36	34.48	33.20	43.40	41.80	46.40	51.52	29.92	30.96	40.80	40.16	44.00	42.30
AfriqueQwen3.5-4B-ExtendedCM	48.64	69.08	31.96	59.76	44.96	43.32	39.92	36.32	34.08	45.92	43.08	47.32	52.20	30.00	31.24	45.04	42.32	45.12	43.90
Qwen3-8B	40.96	77.80	33.56	69.68	34.48	35.68	32.08	41.16	31.40	37.64	36.28	35.60	42.00	33.28	33.60	34.00	36.80	36.60	40.14
AfriqueQwen-8B	56.32	78.12	31.00	67.80	48.20	45.76	40.92	39.44	33.32	46.44	45.76	47.24	52.00	31.24	31.04	43.88	43.52	46.00	46.00
Qwen3-14B	45.36	82.40	34.64	73.00	37.00	35.56	37.36	41.64	34.48	39.76	36.48	38.92	47.04	32.96	33.12	37.96	42.28	38.56	42.70
AfriqueQwen-14B	59.44	80.68	32.96	72.92	52.80	49.96	46.12	39.84	36.12	52.68	48.68	54.08	61.56	31.68	31.20	51.36	47.28	50.44	49.99

Table 16: 5-shot performance on the AfriMMLU benchmark for massive multilingual language understanding. (MMLU)

model	amh	eng	ewe	fra	hau	ibo	kin	lin	lug	orm	sna	sot	swa	twi	wol	xho	yor	zul	avg
Llama3.1-8B	37.37	52.80	34.83	50.03	40.77	39.83	35.23	34.50	37.73	37.10	37.73	37.80	41.27	35.93	34.67	35.63	37.57	36.63	38.75
Lugha-Llama-8B-wura	38.17	50.23	35.07	48.37	40.20	41.17	35.83	34.33	36.90	39.57	38.33	40.10	41.20	35.23	34.47	39.73	39.03	38.27	39.23
AfriqueLlama-8B	37.17	43.80	32.70	42.10	37.13	38.13	35.93	32.57	34.97	37.73	36.87	37.83	37.80	33.07	31.87	39.10	36.93	36.63	36.80
Gemma3-4B	38.83	47.10	34.67	44.07	39.43	38.40	36.77	34.17	34.67	35.03	37.67	37.13	40.13	32.93	33.40	38.57	36.67	36.73	37.58
AfriqueGemma-4B	39.90	44.97	34.07	44.07	40.90	40.23	37.97	33.43	36.27	37.00	40.43	42.17	40.87	33.77	33.37	39.43	38.97	37.93	38.65
Gemma3-12B	43.23	58.07	34.30	55.23	47.70	44.87	39.70	32.43	42.63	41.97	45.80	44.80	48.73	36.27	33.33	44.90	41.90	40.50	43.13
AfriqueGemma-12B	43.47	54.20	34.10	50.67	47.27	45.57	38.47	32.80	41.43	45.93	46.00	46.07	46.60	35.43	33.83	45.30	45.03	40.93	42.95
Qwen3-4B	38.90	62.73	35.50	59.77	35.77	36.80	34.47	33.73	36.53	39.30	37.00	35.83	42.57	35.27	33.07	36.67	36.30	34.73	39.16
AfriqueQwen-4B	44.33	56.43	33.00	52.00	46.83	46.57	37.60	32.17	37.80	46.00	46.57	47.80	46.43	33.90	32.37	45.50	44.63	41.43	42.85
Qwen3.5-4B	42.17	55.13	33.80	53.60	40.40	43.80	37.40	32.03	35.90	38.00	39.27	42.10	42.00	34.53	35.23	40.27	40.33	38.27	40.24
AfriqueQwen3.5-4B	40.90	53.03	32.57	47.67	42.63	40.90	36.93	32.17	37.17	42.00	41.50	42.47	42.40	33.03	32.87	42.43	40.13	39.30	40.01
AfriqueQwen3.5-4B-ExtendedCM	41.87	54.50	32.80	50.47	43.73	43.10	35.27	31.33	38.13	42.33	42.67	44.83	43.53	34.53	31.90	42.33	41.43	40.20	40.83
Qwen3-8B	40.83	62.77	34.03	61.93	35.83	38.87	34.90	32.50	35.63	38.80	37.73	37.27	45.97	34.63	33.20	37.50	38.17	34.77	39.74
AfriqueQwen-8B	44.63	60.67	32.43	58.20	48.03	45.13	39.57	32.47	38.83	50.07	47.47	48.50	50.27	33.37	31.90	46.33	43.93	41.93	44.10
Qwen3-14B	43.70	66.10	35.93	64.10	43.03	43.33	37.63	32.80	38.40	45.07	43.37	42.87	50.30	35.87	33.60	41.13	45.43	39.60	43.46
AfriqueQwen-14B	48.77	60.60	34.87	58.80	49.90	49.87	41.40	34.03	42.90	51.07	51.70	49.20	52.57	34.53	32.10	48.57	49.73	46.33	46.50

Table 17: 5-shot performance on the AfriXNLI benchmark for cross-lingual natural language inference. (NLI)

model	afr	amh	ary	arz	eng	fra	hau	ibo	kin	lin	lug	nya	orm	plt	por	sna	som	sot	swa	tir	tsn	wol	xho	yor	zul	avg
Llama3.1-8B	77.96	35.62	54.00	63.53	87.64	82.04	44.22	38.82	37.76	33.80	33.71	31.60	31.87	43.98	82.07	36.47	32.71	31.36	53.22	31.36	33.60	29.60	34.42	30.69	34.87	45.08
Lugha-Llama-8B-wura	79.16	47.40	51.11	62.47	84.51	79.87	53.98	42.13	44.60	34.58	34.18	41.18	37.04	57.98	79.60	47.04	45.89	40.44	61.96	35.80	39.16	27.89	42.82	35.42	43.82	49.75
AfriqueLlama-8B	71.31	54.62	54.49	59.69	79.31	73.78	49.16	41.49	49.51	31.87	33.80	43.69	42.00	58.09	73.47	50.31	46.69	47.40	61.53	43.56	47.96	27.13	48.60	41.40	48.24	51.16
Gemma3-4B	73.64	52.73	51.51	61.71	78.58	76.00	47.24	36.16	43.07	30.91	33.53	41.44	31.16	54.62	73.24	44.33	41.93	37.78	63.80	35.31	35.78	28.09	40.44	32.71	44.58	47.61
AfriqueGemma-4B	67.93	55.93	51.56	56.87	74.96	68.89	51.24	41.00	50.78	30.29	33.40	46.11	40.64	58.44	68.02	52.40	48.11	49.02	60.67	45.29	48.18	26.04	48.18	39.69	47.89	50.46
Gemma3-12B	90.71	76.98	77.98	82.53	92.53	90.33	73.36	55.80	70.91	43.02	49.07	63.07	52.33	79.18	89.69	71.00	69.33	64.93	86.24	51.27	55.73	32.38	67.82	50.36	68.49	68.20
AfriqueGemma-12B	86.29	74.71	70.87	76.11	89.18	85.96	68.58	55.87	70.89	35.36	44.93	62.76	60.29	79.69	84.80	69.53	66.16	67.76	79.11	62.42	65.11	28.89	66.09	55.27	66.87	66.94
Qwen3-4B	83.60	44.82	56.80	74.36	90.33	88.78	32.44	31.36	36.71	34.11	31.22	32.47	37.29	39.87	85.33	37.98	33.47	31.78	50.42	32.67	33.24	32.98	32.96	31.78	34.51	46.05
AfriqueQwen-4B	84.58	71.56	68.13	76.00	89.67	87.49	62.76	51.67	61.04	32.98	35.93	56.09	54.38	72.58	85.91	65.27	56.78	59.16	78.20	61.04	57.49	30.13	61.80	49.13	61.11	62.84
Qwen3.5-4B	87.29	60.73	66.96	76.76	92.78	90.64	52.11	48.53	58.31	38.18	36.29	44.80	40.38	53.58	90.04	50.44	53.82	47.27	73.18	49.27	49.04	36.22	52.64	43.38	52.18	57.79
AfriqueQwen3.5-4B	86.87	73.80	67.29	77.58	89.91	86.29	66.60	52.71	63.87	34.07	41.80	59.16	55.76	73.60	85.40	65.51	63.69	62.49	79.13	63.80	61.16	31.60	64.64	54.71	61.87	64.93
AfriqueQwen3.5-4B-ExtendedCM	88.02	74.09	67.04	77.13	90.40	86.16	66.20	56.24	66.18	35.18	44.00	59.44	56.49	74.67	86.67	65.11	62.27	64.42	77.53	63.69	62.27	31.11	65.04	54.13	62.58	65.44
Qwen3-8B	87.96	50.24	64.04	79.69	91.67	90.04	32.69	34.78	37.67	35.53	31.44	32.73	38.13	44.20	88.13	40.20	33.78	35.82	62.67	35.04	35.02	33.07	35.04	31.71	36.53	48.71
AfriqueQwen-8B	88.60	75.18	73.29	79.73	91.76	90.11	67.20	54.11	67.76	35.76	39.49	61.64	60.64	76.96	88.56	67.40	63.51	65.49	81.31	67.18	63.29	32.44	66.67	55.89	64.98	67.16
Qwen3-14B	90.78	55.42	72.27	84.78	94.56	93.16	39.87	39.29	42.31	38.42	36.58	38.44	41.69	55.31	91.53	43.93	35.13	43.69	73.33	39.53	41.27	33.82	44.18	37.44	45.40	54.09
AfriqueQwen-14B	91.04	82.33	78.47	84.69	93.40	92.22	75.49	62.71	72.67	38.02	45.38	68.24	66.24	82.62	90.93	73.56	69.49	73.82	85.58	74.09	69.11	32.87	72.51	62.80	72.58	72.43

Table 18: 5-shot performance on the Belebele reading comprehension benchmark. (RC)

model	aeb	afr	amh	ary	arz	ewe	hau	ibo	kin	lin	lug	nya	orm	sna	som	sot	swa	tir	tsn	twi	wol	xho	yor	zul	avg
Gemma3-4B	44.54	58.65	34.70	38.49	47.01	29.85	38.33	29.41	31.35	23.55	36.95	44.25	30.24	38.39	35.57	32.20	51.96	10.89	29.57	17.77	36.19	33.65	9.82	32.86	34.01
AfriqueGemma-4B	27.56	73.01	48.56	27.61	42.12	25.30	59.32	58.60	65.54	20.10	37.04	69.45	56.20	66.15	58.83	38.80	65.73	47.25	56.23	15.42	31.98	62.59	57.19	63.24	48.91
Gemma3-12B	48.88	59.16	42.32	45.82	50.47	28.46	43.11	47.15	46.71	27.34	36.47	54.16	32.21	51.43	45.38	51.29	51.52	24.09	38.24	23.75	40.90	37.09	26.11	42.58	41.44
AfriqueGemma-12B	58.97	74.69	60.20	58.28	66.83	31.23	63.74	61.79	68.40	26.77	50.68	73.03	64.98	68.16	61.74	69.44	72.41	53.41	64.85	25.69	44.37	64.73	64.21	65.80	58.93
Qwen3-4B	54.18	63.10	-1.13	46.90	57.49	28.03	9.25	8.55	9.50	15.04	17.87	18.23	18.78	15.33	8.44	14.13	12.03	9.11	15.14	14.23	33.08	8.96	7.82	7.30	20.47
AfriqueQwen-4B	56.12	72.63	51.97	51.19	62.86	27.79	61.14	57.54	62.84	15.33	29.71	68.93	58.50	64.10	58.64	65.55	67.52	36.78	61.12	13.05	34.69	59.44	59.13	60.61	52.38
Qwen3.5-4B	58.32	69.06	14.64	48.94	62.48	26.28	24.97	26.13	24.79	16.55	20.24	25.59	20.56	23.76	26.58	29.55	40.08	9.45	24.35	11.84	36.08	29.97	21.02	28.92	30.01
AfriqueQwen3.5-4B	58.23	73.76	58.59	55.82	66.14	25.86	62.57	60.16	66.63	18.96	40.27	71.44	63.17	67.54	61.27	68.63	70.57	48.83	63.84	13.15	33.15	63.41	62.51	64.33	55.78
AfriqueQwen3.5-4B-ExtendedCM	57.75	73.56	58.12	55.35	65.98	26.86	63.04	60.22	66.78	18.17	41.28	71.79	63.64	67.48	61.39	68.49	70.81	47.46	63.98	12.40	32.79	63.68	62.95	64.17	55.76
Qwen3-8B	57.60	67.60	1.26	51.22	62.06	28.09	7.22	9.75	7.20	14.07	18.52	18.01	17.81	15.30	6.51	14.66	19.76	7.83	14.94	12.87	31.92	9.15	6.57	6.99	21.12
AfriqueQwen-8B	57.57	73.24	55.75	54.35	65.07	28.20	62.19	59.42	64.94	15.85	32.91	70.86	61.68	66.34	60.29	67.47	70.04	44.03	62.87	15.07	35.06	61.97	60.70	62.70	54.52
Qwen3-14B	58.12	69.95	6.56	51.93	62.55	27.69	9.94	12.19	8.30	18.63	20.04	19.42	20.14	15.71	9.97	16.62	32.46	6.42	15.63	16.13	34.88	13.50	10.09	11.77	23.69
AfriqueQwen-14B	57.58	73.92	58.44	55.74	66.41	26.59	63.62	61.06	66.98	19.06	41.12	72.04	63.97	67.61	61.92	68.85	71.19	46.41	64.66	15.25	34.77	63.65	62.69	64.91	56.19
Llama3.1-8B	55.19	69.24	4.81	49.39	59.42	25.57	31.31	25.63	12.19	14.88	20.92	21.63	19.83	17.93	15.55	16.34	46.08	7.87	15.79	16.16	32.89	12.46	16.45	9.91	25.73
AfriqueLlama-8B	57.71	73.92	55.05	55.46	66.12	26.02	63.70	60.93	67.13	17.57	41.73	72.06	62.95	67.66	61.55	68.79	71.43	49.05	63.82	14.22	34.59	63.71	62.68	64.71	55.94

Table 19: Translation performance (SSA COMET score) from English to African languages on the FLORES-200 benchmark. (MT eng2xx)

model	aeb	afr	amh	ary	arz	ewe	hau	ibo	kin	lin	lug	nya	orm	sna	som	sot	swa	tir	tsn	twi	wol	xho	yor	zul	avg
Gemma3-4B	48.03	46.54	41.61	48.11	49.15	36.59	46.73	40.21	44.15	36.52	35.47	42.49	37.74	44.33	44.42	41.52	50.97	35.54	36.09	36.48	40.65	44.31	35.53	45.34	42.02
AfriqueGemma-4B	67.69	73.12	66.98	66.13	68.74	38.12	66.36	63.46	66.38	44.35	50.05	65.09	59.47	65.63	64.13	67.72	69.96	62.01	64.85	44.52	40.46	67.47	59.13	67.93	61.24
Gemma3-12B	55.47	44.94	49.64	50.31	57.79	40.38	46.70	45.76	45.20	42.97	45.39	43.99	46.29	43.32	53.00	44.91	46.73	46.87	44.67	43.74	41.57	46.85	45.45	48.39	46.68
AfriqueGemma-12B	68.86	73.68	69.53	68.09	69.88	40.55	68.10	65.73	68.31	48.93	55.66	66.53	63.29	66.93	65.98	69.40	71.11	64.88	66.38	49.50	43.14	68.92	61.91	68.95	63.51
Qwen3-4B	64.11	72.02	43.02	61.69	66.93	39.16	40.69	40.72	40.45	42.55	40.29	42.49	37.90	41.94	40.19	41.96	52.04	36.48	41.21	43.14	41.90	43.03	39.36	41.27	45.61
AfriqueQwen-4B	67.11	72.92	66.78	65.60	68.36	38.69	65.59	62.59	65.71	43.25	46.97	64.81	58.78	65.23	62.98	67.41	69.23	61.90	64.39	42.44	40.56	66.92	58.99	67.45	60.61
Qwen3.5-4B	65.77	72.71	58.97	64.68	68.09	40.92	57.41	57.39	59.91	46.20	44.81	55.23	40.98	54.42	58.28	57.62	66.13	51.15	53.88	45.58	46.69	59.37	50.37	60.41	55.71
AfriqueQwen3.5-4B	68.40	73.37	68.39	67.27	69.04	39.23	67.30	64.77	67.29	46.82	54.05	65.85	61.60	66.10	64.92	68.98	70.52	64.11	66.14	44.74	40.89	68.07	61.16	68.64	62.40
AfriqueQwen3.5-4B-ExtendedCM	68.29	73.45	68.36	67.15	69.11	38.85	67.27	64.65	67.20	46.22	53.82	65.94	61.99	66.22	65.12	69.03	70.47	64.25	66.34	45.10	40.86	68.05	61.22	68.69	62.40
Qwen3-8B	65.66	72.86	50.20	64.00	68.46	39.18	41.41	43.09	42.15	43.99	41.27	43.86	39.81	43.64	41.58	44.33	59.72	40.44	42.79	43.78	42.24	46.31	41.67	44.34	47.78
AfriqueQwen-8B	68.52	73.47	68.31	67.21	69.45	39.24	67.06	64.07	66.92	44.64	49.61	65.39	61.25	66.08	64.67	68.44	70.13	63.94	65.75	44.10	41.44	68.07	60.68	68.13	61.94
Qwen3-14B	67.15	73.34	52.57	65.77	69.56	40.68	44.45	46.68	44.80	45.68	42.96	46.61	43.22	45.47	43.46	48.09	63.94	43.02	45.18	45.69	43.72	50.32	45.04	48.89	50.26
AfriqueQwen-14B	69.25	73.78	69.57	68.11	70.13	40.49	67.99	65.48	67.75	46.87	53.12	66.47	63.12	66.98	65.59	69.23	70.93	65.04	66.53	45.78	42.58	68.85	62.37	69.14	63.13
Llama3.1-8B	65.61	72.84	49.75	64.89	68.10	40.71	60.61	56.84	52.16	46.37	46.16	48.83	40.61	48.94	49.60	48.12	67.01	38.79	47.44	49.50	43.63	50.21	47.97	50.39	52.30
AfriqueLlama-8B	68.27	73.47	67.01	67.07	69.17	39.23	67.19	64.21	67.19	45.65	52.90	65.54	61.00	66.00	64.93	68.51	70.34	61.86	65.76	45.95	40.64	67.60	60.47	68.38	62.01

Table 20: Translation performance (SSA COMET score) from African languages to English on the FLORES-200 benchmark. (xx2eng)

English → African Languages (eng2xx) – chrF++																									
model	aeb	afr	amh	ary	arz	ewe	hau	ibo	kin	lin	lug	nya	orm	sna	som	sot	swa	tir	tsn	twi	wol	xho	yor	zul	avg
Gemma3-4B	17.89	39.24	12.07	12.10	16.98	7.73	26.01	20.91	12.34	12.00	7.32	14.98	7.94	14.51	15.91	14.90	31.09	3.11	11.63	11.25	7.67	14.01	7.62	18.15	14.89
AfriqueGemma-4B	5.49	66.53	19.88	6.10	12.10	8.74	44.07	39.29	44.72	11.91	18.34	42.05	27.29	40.88	37.94	16.82	51.14	14.25	34.62	10.28	8.11	46.21	23.04	47.49	28.22
Gemma3-12B	25.47	43.57	20.81	21.54	23.40	7.45	24.79	32.27	22.03	14.16	10.18	17.14	11.86	22.58	20.58	29.82	28.01	6.38	20.09	15.11	7.60	9.21	13.91	17.76	19.41
AfriqueGemma-12B	39.54	68.97	36.09	36.24	41.66	8.47	51.36	41.95	49.58	19.64	26.60	46.87	36.98	43.94	42.14	55.54	62.13	20.90	46.61	15.58	7.11	49.21	28.59	51.82	38.65
Qwen3-4B	32.58	55.22	3.45	26.71	32.68	6.29	7.66	7.15	7.01	9.80	7.07	8.03	7.80	7.23	9.63	9.24	14.19	2.36	8.29	8.90	7.90	7.40	5.60	7.02	12.47
AfriqueQwen-4B	33.40	65.24	28.84	28.48	36.37	6.74	46.97	37.85	41.07	10.70	14.30	42.32	31.90	39.41	39.24	49.15	54.33	15.24	43.16	9.12	7.55	42.03	25.84	44.02	33.05
Qwen3.5-4B	36.73	60.29	11.97	28.21	38.16	8.18	25.26	19.80	17.21	12.31	9.33	14.39	10.44	15.37	22.19	21.58	35.68	5.58	20.02	11.64	11.93	23.08	13.87	24.26	20.73
AfriqueQwen3.5-4B	37.68	67.30	33.15	33.30	41.38	6.90	50.08	40.94	46.43	13.73	20.28	45.23	35.41	42.78	42.15	53.69	59.49	19.15	45.80	13.11	7.12	47.21	28.23	50.21	36.70
AfriqueQwen3.5-4B-ExtendedCM	37.20	67.23	33.36	32.76	41.27	6.85	49.96	41.14	46.69	13.21	20.73	45.62	36.13	42.83	42.25	54.02	59.95	18.87	45.99	12.57	6.86	47.47	28.38	50.20	36.73
Qwen3-8B	35.19	59.93	6.46	29.63	36.23	5.67	8.72	9.08	7.34	10.53	6.90	8.41	8.80	6.87	11.19	10.08	20.56	2.49	9.44	9.00	7.74	10.37	7.65	9.73	14.08
AfriqueQwen-8B	35.86	66.94	31.84	31.29	39.02	6.71	48.40	39.82	43.70	12.04	16.75	44.42	34.11	41.43	40.79	51.64	57.72	17.88	44.93	9.58	8.71	44.66	27.21	46.92	35.10
Qwen3-14B	36.03	61.78	9.03	30.45	37.88	6.26	13.45	11.98	10.51	15.09	8.83	10.67	11.82	9.82	15.17	13.97	31.17	3.26	11.68	13.49	10.23	13.91	10.25	14.08	17.12
AfriqueQwen-14B	36.80	67.58	33.52	32.50	40.73	6.22	49.78	41.14	46.52	14.67	21.20	45.92	36.39	42.90	41.62	53.50	59.55	18.38	46.15	12.83	8.41	46.50	27.45	49.82	36.67
Llama3.1-8B	33.87	62.46	7.43	28.37	34.66	6.64	28.59	19.42	12.22	13.12	10.98	12.51	10.79	11.40	17.38	13.25	37.69	4.12	14.83	15.92	9.14	12.36	12.72	12.41	18.43
AfriqueLlama-8B	36.56	67.54	32.11	32.43	40.17	6.80	49.56	40.84	46.44	14.15	20.96	45.64	35.54	42.87	41.95	53.84	59.54	19.80	46.14	13.89	8.93	47.37	27.36	49.67	36.67

Table 21: Translation performance (chrF++ score) from English to African languages on the FLORES-200 benchmark. (eng2xx)

African Languages → English (xx2eng) – chrF++																									
model	aeb	afr	amh	ary	arz	ewe	hau	ibo	kin	lin	lug	nya	orm	sna	som	sot	swa	tir	tsn	twi	wol	xho	yor	zul	avg
Gemma3-4B	21.81	20.65	19.13	22.48	22.79	10.85	25.36	18.63	17.60	13.16	11.93	16.19	13.75	20.11	24.62	17.51	30.95	14.05	14.31	16.89	12.89	21.26	14.77	23.61	18.55
AfriqueGemma-4B	54.91	74.89	53.81	51.94	55.94	18.83	53.22	48.91	52.44	25.84	32.11	48.56	41.75	48.00	50.04	55.96	62.70	43.61	47.74	25.90	21.38	55.84	41.40	57.12	46.79
Gemma3-12B	32.42	11.50	21.56	21.58	35.81	13.92	15.27	15.07	11.51	10.96	15.10	9.08	18.78	7.31	28.42	11.70	15.80	18.23	11.60	12.17	12.38	15.20	17.14	18.70	16.72
AfriqueGemma-12B	56.92	76.62	59.33	55.70	58.55	19.71	56.79	52.73	55.71	29.77	38.41	51.07	47.54	50.43	53.50	59.43	66.01	48.34	50.27	30.86	22.53	59.21	44.72	59.87	50.17
Qwen3-4B	51.02	72.07	26.17	47.07	53.31	19.84	22.22	21.91	22.10	23.69	21.64	23.41	19.83	22.96	21.57	23.61	36.77	18.69	22.62	23.72	22.77	24.84	21.36	23.31	28.60
AfriqueQwen-4B	54.11	74.11	52.87	51.55	55.50	20.47	51.70	47.37	50.13	25.24	28.82	47.62	40.40	46.65	47.79	54.18	60.06	43.60	46.83	24.66	22.25	54.15	40.93	55.53	45.69
Qwen3.5-4B	53.32	73.91	43.30	50.69	55.34	23.23	42.99	41.11	43.43	28.33	27.23	37.66	23.52	36.38	42.85	43.52	55.67	32.80	36.57	27.70	29.62	45.12	33.53	46.71	40.61
AfriqueQwen3.5-4B	56.04	75.16	55.84	53.73	56.61	20.74	54.51	50.85	53.34	28.33	36.52	49.27	44.77	48.77	51.42	57.91	63.40	46.79	49.88	26.86	22.64	56.77	43.96	58.44	48.44
AfriqueQwen3.5-4B-ExtendedCM	55.53	75.10	55.47	53.41	56.20	20.34	54.55	50.52	53.00	27.37	36.08	49.48	44.82	48.66	51.39	58.27	63.43	46.52	49.87	27.03	22.23	56.78	43.58	58.29	48.25
Qwen3-8B	53.40	74.07	34.64	50.49	55.80	20.99	24.37	25.49	24.85	25.68	23.93	25.69	22.22	25.49	24.11	27.26	46.72	22.91	24.96	25.39	23.91	29.75	24.25	28.01	31.85
AfriqueQwen-8B	56.43	75.40	55.90	53.75	57.35	20.94	54.03	49.50	52.29	26.38	32.25	48.86	43.80	48.57	50.16	56.41	62.37	46.42	49.32	26.41	23.24	56.69	43.08	57.71	47.80
Qwen3-14B	55.39	75.15	36.91	52.67	57.75	22.35	28.23	29.80	28.04	27.63	25.79	28.43	26.00	27.76	26.33	32.74	53.21	24.76	28.22	27.33	24.99	34.89	27.94	33.13	34.81
AfriqueQwen-14B	57.60	75.98	58.03	55.60	58.66	21.97	56.27	52.01	54.58	28.44	35.96	50.44	46.87	50.00	52.21	59.06	64.77	48.20	50.44	27.83	24.15	58.34	45.35	59.65	49.68
Llama3.1-8B	52.59	74.19	31.70	50.96	55.37	21.93	45.81	40.79	34.24	27.55	28.07	30.36	22.14	30.05	31.31	30.80	56.85	20.68	29.32	30.82	25.20	32.93	29.78	33.25	36.11
AfriqueLlama-8B	54.93	75.07	52.68	52.99	56.31	20.78	54.25	49.67	53.11	26.94	34.86	48.95	43.42	48.09	50.83	56.86	63.08	42.92	48.56	27.20	22.37	55.89	42.43	57.62	47.49

Table 22: Translation performance (chrF++ score) from African languages to English on the FLORES-200 benchmark. (xx2eng)

model	amh	eng	ewe	hau	ibo	kin	lin	lug	orm	sna	sot	swa	twi	wol	xho	yor	zul	avg
Llama3.1-8B	42.72	83.18	12.47	60.94	53.63	31.78	40.53	32.56	18.12	28.97	28.41	75.00	32.31	27.27	38.81	42.44	34.22	40.20
AfriqueLlama-8B	78.78	79.68	9.66	80.19	70.78	62.19	38.78	50.16	59.72	72.47	63.38	81.19	22.22	19.81	75.22	73.38	65.59	59.01
Gemma3-4B	73.72	79.36	11.47	72.97	61.78	50.19	40.00	31.87	19.97	53.31	35.38	84.44	25.53	25.83	62.59	38.81	57.53	48.51
AfriqueGemma-4B	75.69	79.74	9.88	77.94	70.09	62.09	38.75	39.91	55.72	71.72	58.56	82.03	16.50	21.57	76.31	68.03	63.84	56.96
Gemma3-12B	83.03	85.76	15.97	84.97	72.59	68.28	53.41	64.53	48.91	80.03	59.72	90.47	47.81	36.24	80.09	67.12	73.56	65.44
AfriqueGemma-12B	82.81	82.64	13.84	84.22	77.94	68.44	44.47	62.19	67.28	79.69	66.97	86.34	34.69	29.31	81.53	76.09	73.41	65.40
Qwen3-4B	35.53	84.34	13.34	15.12	21.00	17.22	39.72	17.09	14.28	13.19	21.25	50.94	19.75	24.33	18.31	14.06	17.72	25.72
AfriqueQwen-4B	74.66	76.72	11.78	74.94	65.81	55.44	35.25	33.94	51.88	66.38	57.91	74.84	16.91	20.85	67.72	63.97	65.22	53.78
Qwen3.5-4B	67.28	88.14	17.06	66.66	66.97	55.59	42.91	36.81	22.66	52.97	49.19	83.28	29.03	40.53	68.31	62.06	58.81	53.43
AfriqueQwen3.5-4B	81.25	81.67	13.19	86.84	77.69	64.59	42.50	58.31	64.69	75.97	65.75	85.28	25.16	26.33	78.94	78.91	70.19	63.37
AfriqueQwen3.5-4B-ExtendedCM	81.50	82.22	12.75	85.22	76.72	67.50	41.00	58.59	66.41	77.09	66.62	85.41	24.41	25.30	78.97	79.50	70.75	63.53
Qwen3-8B	50.37	85.27	12.91	18.69	25.84	21.12	42.34	19.78	18.47	18.94	26.28	70.12	21.56	26.43	27.25	23.88	23.25	31.32
AfriqueQwen-8B	80.47	83.67	9.78	82.88	75.59	62.34	38.31	46.97	60.53	74.72	63.09	86.84	19.47	22.98	78.19	73.19	69.12	60.48
Qwen3-14B	59.34	88.52	15.38	29.41	39.66	27.59	46.44	31.53	30.28	31.84	33.38	81.66	30.84	32.82	47.06	38.28	41.28	41.49
AfriqueQwen-14B	83.22	86.30	14.88	85.88	78.94	67.81	41.38	58.38	69.62	81.25	64.75	86.72	25.69	31.10	82.53	81.88	73.25	65.50

Table 23: 5-shot performance on the Injongo Intent Classification benchmark. (Intent)

model	aeb	afr	amh	ary	arz	eng	ewe	hau	ibo	kin	lin	lug	nya	orm	plt	por	sna	som	sot	swa	tir	twi	wol	xho	yor	zul	avg
Llama3.1-8B	76.19	81.24	49.91	80.06	80.90	80.78	44.72	67.67	67.39	54.60	47.94	45.20	62.61	42.00	60.97	82.43	47.57	58.33	50.27	66.50	41.63	62.87	46.26	52.36	47.44	52.28	59.62
AfriqueLlama-8B	76.27	78.90	62.86	79.06	77.80	66.32	38.32	64.32	65.83	64.31	41.85	51.13	75.70	61.90	75.80	78.97	66.21	75.76	61.98	65.36	73.21	53.28	38.75	64.55	61.91	61.87	64.70
Gemma3-4B	76.81	79.84	63.38	78.55	81.36	69.21	44.00	59.88	56.37	60.65	46.20	38.38	74.48	38.98	71.44	80.36	56.59	74.16	51.54	66.70	63.75	57.82	45.28	55.46	38.68	59.53	61.13
AfriqueGemma-4B	77.69	79.44	61.15	79.10	79.84	70.76	42.81	65.28	63.27	62.74	40.04	42.59	78.33	64.57	77.17	79.15	63.88	77.15	63.00	65.80	77.26	55.27	41.41	62.31	55.22	61.84	64.89
Gemma3-12B	81.49	83.65	81.56	82.89	82.26	83.21	47.47	80.64	78.58	81.36	64.38	68.54	82.31	67.65	81.13	84.28	78.95	80.73	76.04	85.33	73.51	67.01	58.80	79.74	66.67	79.70	76.07
AfriqueGemma-12B	78.85	82.43	74.02	80.16	79.65	73.64	43.23	74.27	69.80	73.11	51.73	57.45	79.56	66.92	79.60	82.23	70.86	80.12	71.26	76.32	79.67	60.74	48.49	70.31	66.51	73.12	70.93
Qwen3-4B	78.70	81.42	53.62	82.09	82.31	82.22	46.00	47.94	47.51	50.44	59.30	50.67	55.32	50.01	55.10	80.87	51.88	50.42	55.71	69.23	40.74	56.90	57.54	52.89	46.29	48.13	58.97
AfriqueQwen-4B	76.04	75.94	73.25	75.70	77.02	78.00	37.10	77.69	75.25	76.11	54.43	53.63	76.87	70.78	73.85	76.18	74.93	73.71	73.95	76.69	69.73	49.76	49.42	75.68	71.60	75.91	69.97
Qwen3.5-4B	82.13	83.54	75.18	82.82	84.04	85.65	48.97	72.73	77.20	76.13	63.71	59.43	73.02	53.19	70.41	85.11	69.42	77.71	72.14	83.53	71.20	58.80	63.91	74.78	66.12	78.98	72.69
AfriqueQwen3.5-4B	79.22	81.86	79.99	80.72	80.40	82.48	42.49	81.45	76.33	78.15	63.23	65.86	80.45	78.82	79.42	82.03	79.43	79.97	79.89	82.59	78.33	56.09	55.64	80.04	74.98	81.41	75.43
AfriqueQwen3.5-4B-ExtendedCM	78.70	82.52	79.76	80.87	80.64	83.01	43.23	82.89	78.27	80.82	60.53	67.67	81.69	78.79	80.39	81.37	79.06	80.84	80.15	82.67	81.69	53.90	54.68	79.12	78.81	82.18	75.93
Qwen3-8B	83.11	83.89	49.98	83.15	86.49	72.29	43.43	37.49	36.48	37.86	43.81	35.60	60.53	39.48	57.25	83.32	37.99	50.54	41.42	55.91	49.97	55.08	47.76	42.00	36.67	37.92	53.44
AfriqueQwen-8B	80.79	83.84	72.40	81.04	83.39	77.58	42.41	74.45	70.43	78.06	53.30	58.53	81.38	69.51	81.54	82.92	74.41	81.65	71.87	78.45	81.42	51.36	52.12	71.78	72.42	74.23	72.36
Qwen3-14B	82.30	85.42	74.12	85.60	84.43	85.71	47.07	55.71	60.47	54.38	63.74	55.05	57.58	56.11	65.90	84.98	55.42	56.12	63.37	80.75	61.41	56.68	61.66	63.64	54.86	61.82	65.93
AfriqueQwen-14B	81.81	83.60	83.97	85.12	83.04	82.62	46.52	82.66	81.39	83.19	61.41	65.83	82.54	84.15	82.77	82.85	80.73	82.39	80.62	85.43	81.93	58.06	58.13	80.42	81.14	82.99	77.90

Table 24: 5-shot performance on the SIB-200 topic classification benchmark. (Topic)