Markov-k LPE Report (k=1,2,3): Balanced Target, Long Context

Automated run

February 15, 2026

Setup

- Context length fixed to 100 for Step 2/3.
- Target string mode: `balanced` (de Bruijn-style state-balanced construction).
- Target length: 100.
- Posterior samples per estimate: 500.
- Rollout length per k: $100 \cdot 2^k$.
- Transformer checkpoints reused from earlier Step-1 training (no retraining in this rerun).

Transformer vs True Bayes Predictive

k	Model NLL	Bayes NLL	Gap(%)	Step2 MAE (T)	Step2 MAE (B)	Step3 MedErr% (T)	Step3 Med
1	0.426468	0.423051	0.808	0.010084	0.002434	100.000000	1
2	0.516815	0.506216	2.094	0.090302	0.009009	100.000000	9
3	0.524980	0.514922	1.953	0.074324	0.005992	99.999994	9

Table 1: Side-by-side metrics for transformer (T) and true Bayes predictive baseline (B).

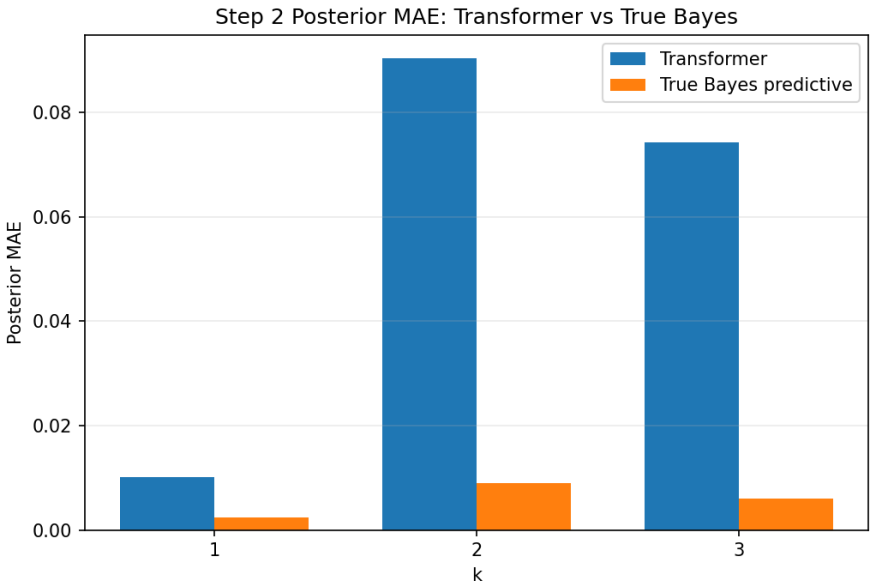

Figure 1: Step 2 posterior MAE comparison.

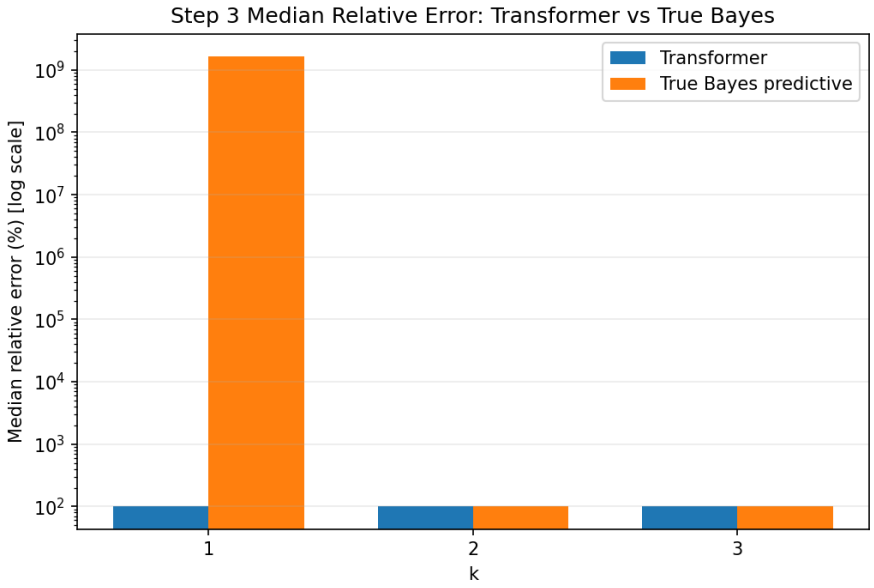

Figure 2: Step 3 median relative-error comparison (log scale).

Training Details (Checkpoint Runs)

Transformer hyperparameters per k:

k	Model (L/D/H/M)	Batch	SeqLen	StepsRun	BestStep	BestGap(%)	FinalTrainLoss
1	L2/D64/H4/M256	64	200	2000	2000	0.614	0.502749
2	L4/D128/H8/M512	32	400	2000	2000	2.076	0.497587
3	L6/D128/H8/M512	16	800	3600	3600	1.746	0.501798

Table 2: Training summary from Step-1 checkpoint runs used in this report.

Optimization process (from training script defaults/recorded setup):

- Optimizer: AdamW, learning rate 3×10^{-4}, weight decay 0.01.
- Gradient clipping: 1.0; gradient accumulation: 1.
- Token-budget-driven steps with early stopping on Bayes-gap target.
- Evaluation cadence during training: periodic held-out NLL checks vs Bayes-optimal predictor.
- Training sequence length matched rollout length ($100 \cdot 2^k$).

Learning-Curve Note

Full per-step learning curves were not persisted in the original checkpoint artifacts. Available training progress fields include `steps_run`, `best_step`, `final_train_loss`, and final/selected eval metrics.

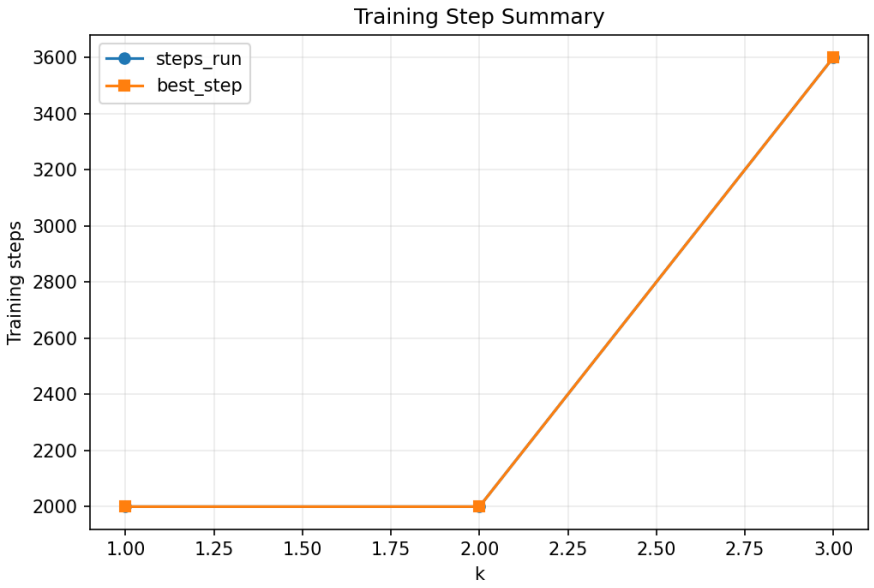

Figure 3: Training-step summary (available checkpoint metadata; not a full loss curve).