

# Tomorrow's Competitive AI

**Agentic LLMs, Synthetic Environments,  
and Context Infrastructure**

*Anastasia Stasenko  
Pleias*



# About pleias

Pleias is a Paris-based lab on a mission to build **frontier AI**.

Since 2024, we have released:

- [Common Corpus](#) - **the largest fully open corpus for pre-training (2T tokens)**, that has become third most downloaded corpus on HF and has been used for pretraining for over 8 LLMs (Apertus, Nvidia's Parakeet, Salamandra...)
- [pleias 1.0](#) : series of multilingual foundation models (350m, 1b) achieving SOTA in multilingual RAG tasks in their size category
- [Synth](#): 200b SOTA synthetic dataset and two models (Baguettotron - 321m - and Monad - 50m) setting SOTA for synthetic reasoning pretraining.

# Our hypothesis

1. **Full synthetic training is viable** for small models, not just midtraining or <30% of pretrain.
2. Synthetic playgrounds are **more data efficient** than standard pretraining sources, as they allow for selective memorization and clearer reasoning signals.
3. Models trained exclusively on **open data** supplemented with synthetic methods are **fully competitive** with models trained on copyrighted/non-releasable data.

**1.**

**The context: what comes after pretraining?**



# From post-training to training

Currently most of the model improvement happens **after pre-training** due to convergent developments in three directions:

- Synthetic data.
- Reasoning traces based on synthetic data (SFT cooloff)
- Reinforcement learning, over reasoning traces.

=> “Pre-training as we know it will end” (Sutskever)

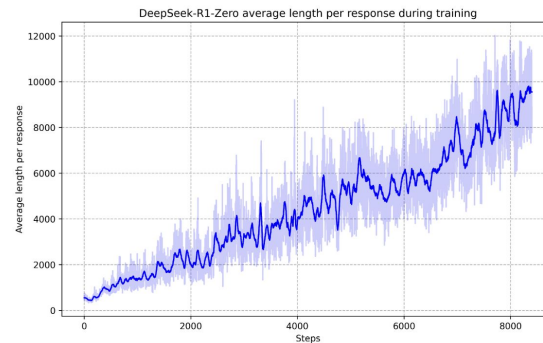
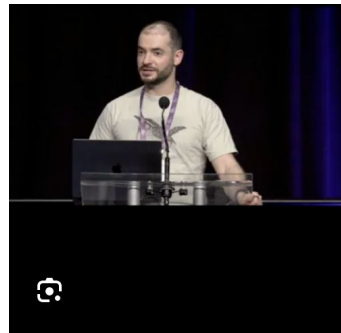


Figure 3 | The average response length of DeepSeek-R1-Zero on the training set during the RL process. DeepSeek-R1-Zero naturally learns to solve reasoning tasks with more thinking time.



## Pre-training as we know it will end

Compute is growing:

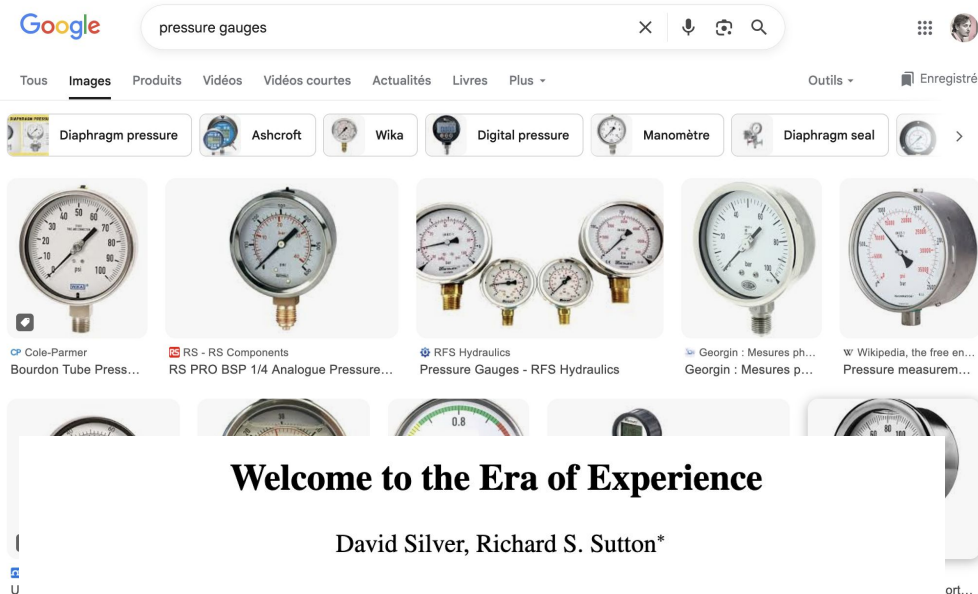
- Better hardware
- Better algorithms
- Larger clusters

Data is not growing:

- We have but one internet
- **The fossil fuel of AI**

# From post-training to training

Beyond the concerns over the “data wall”, web data seems to hit a capability ceiling in many areas: vision languages models routinely fail to read clocks or gauges since most available images are product descriptions.



## Abstract

We stand on the threshold of a new era in artificial intelligence that promises to achieve an unprecedented level of ability. A new generation of agents will acquire superhuman capabilities by learning predominantly from experience. This note explores the key characteristics that will define this upcoming era.

# From post-training to training

**Stage 1**

**Pretraining**

**Stage 2**

**Mid-training**

**Stage 3**

**Post-training**

# From post-training to training

**Stage 1**

**Pretraining**

**Stage 2**

**Mid-training**

**Stage 3**

**Post-training**

**It's all training**





# Switching to controlled environments

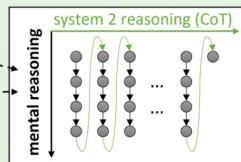
In Frontier labs and, increasingly openly documented research, large pretraining dataset are being completed if not replaced by *synthetic environment* or *synthetic playgrounds*. A primary motivation has been **increasing data efficiency** and focus training on the acquisition of targeted skills.

“Physics of Language Models: Part 4.1, Architecture Design and Canon Layers”

Results 0

## Design Criteria for Synthetic Pretrain Tasks

- ✖ **Challenge architectural depth:**  
avoid shallow tasks (e.g., associative recall)
- 🧠 **Test mental reasoning (system-1):**  
mental depth  $4 \times 8$  CoT steps = 32 total steps.
- 🎯 **Focus on short (e.g., 4096) context length**



## Ensure real-world relevance

avoid tasks solvable by external tools

“452352 + 547647 = 999999”



## our focus for architecture design

long context often summarized to short windows for deep reasoning



## Five Synthetic Tasks Isolating Atomic Skills

### ❖ (DEPO): Mental reasoning depth

... ○ → ○ → ○ → ○ ...  
(directed path given in random order)

⇒ What's the  $k$ -th successor of A?

### ❖ (BREVO): Mental reasoning breadth

... ○ → ○ → ○ → ○ ...  
(DAG given in random order)

⇒ What does A depend on, list in topological order?

### ❖ (CAPO): Knowledge capacity

how many bit-per-parameter can a model store?

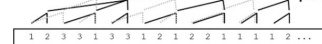
### ❖ (MANO): Knowledge manipulation

knowledge → manipulate → knowledge → manipulate → ...

### ❖ (LANO): Hierarchical language structure learning

parse tree 2

parse tree 1



“We design synthetic tasks to systematically evaluate specific capabilities of language model architectures under controlled conditions, minimizing confounds and enabling clean comparisons”  
(Physics of Language Model, 4.1)

# From post-training to training

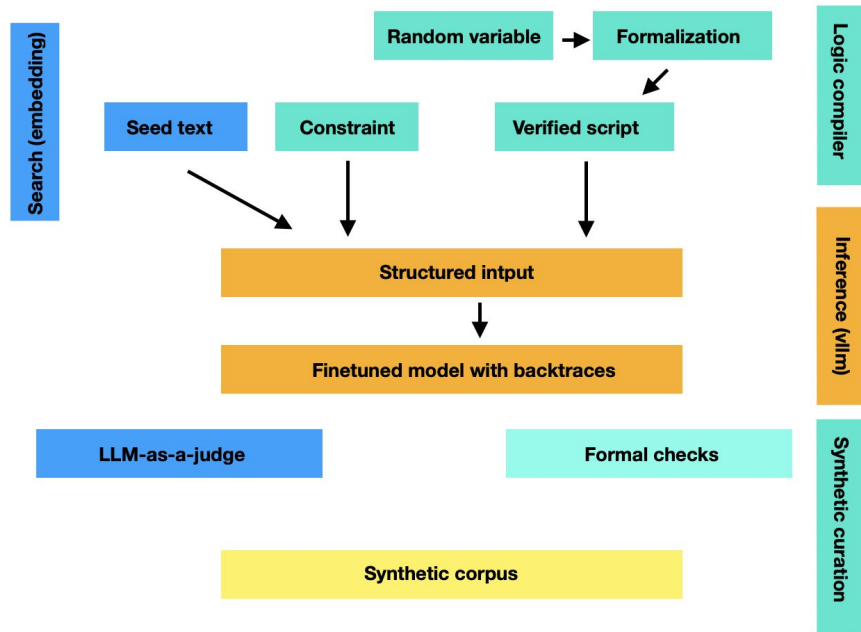
**What if we bundled all synthetic pipelines  
into one generalist environment?**

## **2. Building synthetic environments**



# Building SOTA synthetic data pipelines

Our approach is based on **synthetic pipelines** and **environments** not simply prompting existing model but use them as constrained text generators. Our bundled generalist environment cover the entire range of capacities you expect in language models.



# SYNTH Initiative

Over the last few months, we have been working on a generalist synthetic pipeline to train more efficient small language models, thanks to the availability of high quality of open datasets and to the release of fully open weight models without restriction for data reuse

Datasets: PleiAs / SYNTH  like 0 Following  PleiAs 444

[Dataset card](#) [Files and versions](#) [xet](#) [Community](#) [Settings](#)

## Dataset Viewer

 Auto-converted to Parquet

 API

 Embed

 Data Studio

Split (1)  
train · 39 rows

Search this dataset

synth_id string	language string	exercise string	model string	query string	query_seed_url string	query_seed_text string	query_s string
synth_14376	French	memorization	qwen-3-8b- memorization	Dis donc, si on appliquait le...	https:// en.wikipedia.org/wiki/...	Détente is the relaxation of straine...	CC-BY-Si
synth_93383	English	memorization	qwen-3-8b- memorization	Why do high- energy electrons...	https:// en.wikipedia.org/wiki/...	Quantum mechanical description The...	CC-BY-Si
synth_96749	English	memorization	qwen-3-8b- memorization	I wonder whether Quetzalcoatl's...	https:// en.wikipedia.org/wiki/...	Deities The four main deities worshiped by...	CC-BY-Si
synth_94490	English	memorization	qwen-3-8b- memorization	I'm working on a comparative...	https:// en.wikipedia.org/wiki/...	Europe During the late 2010s, the comparativ...	CC-BY-Si
synth_97686	English	memorization	qwen-3-8b- memorization	How the Company Law of China...	https:// en.wikipedia.org/wiki/...	China According to the Company Law of the...	CC-BY-Si
synth_239514	Latin	creative_writing	qwen-3-8b- creative...	I'm seeking to commission a...	https:// en.wikipedia.org/wiki/...	Cretaceous Period The Cretaceous Period...	CC-BY-Si
synth_98760	English	memorization	qwen-3-8b- memorization	How long will the vaccine work goo...	https:// en.wikipedia.org/wiki/...	Vaccination Spanish phvsician Jaume Ferra...	CC-BY-Si

# Synth Initiative

synth_id string	language string	exercise string	model string	query string	query_seed_url string	query_seed_text string	query_seed_license string	constraints string	synthetic_reasoning string	synthetic_answer string
synth_14376	French	memorization	qwen-3-8b-memorization	Dis donc, si on appliquait le même	https://en.wikipedia.org/wiki/D%C3%A9tente	Détente is the relaxation of strained relations,...	CC-BY-SA (4.0)		### 1. Query Parsing "Dis donc si on appliquait le même"	La détente, concept diplomatique né en 1912,...
synth_93383	English	memorization	qwen-3-8b-memorization	high-energy electrons emit photons...	https://en.wikipedia.org/wiki/Bremsstrahlung	Quantum mechanical description The complete...	CC-BY-SA (4.0)		electrons emit photons in forw...	The angular distribution of photon emission in...
synth_96749	English	memorization	qwen-3-8b-memorization	I wonder whether Quetzalcoatl's temple...	https://en.wikipedia.org/wiki/Quetzalcoatl	Deities The four main deities worshiped by the...	CC-BY-SA (4.0)		Query: "Quetzalcoatl's temple ...left side...Great Temple..."	I need to clarify a potential misconception...
synth_94490	English	memorization	qwen-3-8b-memorization	I'm working on a comparative analysis of...	https://en.wikipedia.org/wiki/Product_liability	Europe During the late 2010s, the comparative...	CC-BY-SA (4.0)		Query breakdown: "procedural deficiencies in European civ..."	The significant disparity between US and European...
synth_97686	English	memorization	qwen-3-8b-memorization	How the Company Law of China structures the...	https://en.wikipedia.org/wiki/Company_Law_of_China	China According to the Company Law of the People'...	CC-BY-SA (4.0)		Query: "Company Law of China structures...limited liabili..."	The Company Law of the People's Republic of China...
synth_239514	Latin	creative_writing	qwen-3-8b-creative-writing	I'm seeking to commission a Latin...	https://en.wikipedia.org/wiki/Habesha_people	Cretaceous Period The Cretaceous Period extends...	CC-BY-SA (4.0)	temporal:publication_date...	User wants "Latin dialogue from 1635" - immediately raise...	**DE DILUVIO MAGNO ET ARTIFICIO DIVINO**...
synth_255287	German	memorization	qwen-3-8b-memorization	How long will the vaccine work good for...	https://en.wikipedia.org/wiki/Cholera	Vaccination Spanish physician Jaume Ferran i...	CC-BY-SA (4.0)		### 1. Query Parsing "How long will the vaccine work good..."	I'm sorry, but I'm unsure about the specific duration...
synth_255022	German	memorization	qwen-3-8b-memorization	Inwieweit unterscheiden sich Peirce's...	https://en.wikipedia.org/wiki/Fact	Etymology and usage The word fact derives from the...	CC-BY-SA (4.0)		### 1. Query Decomposition "Inwieweit unterscheiden sich..."	Die wissenschaftlichen Methoden von Peirce und...
synth_239972	English	memorization	qwen-3-8b-memorization	Warum haben die Vertragsarbeiter aus...	https://en.wikipedia.org/wiki/Indo-Aryan_languages	Indentured labourer migrations The use by the...	CC-BY-SA (4.0)		### 1. Query Parsing "Warum haben die Vertragsarbeiter aus..."	Die Entwicklung lokaler Dialekte und...
synth_239070	English	creative_writing	qwen-3-8b-creative-writing	Would you fashion a narrative that explores...	https://en.wikipedia.org/wiki/Chiang_Mai	A coin is a small object, usually round and flat,...	CC-BY-SA (4.0)	character:protagonist, te...	**Query parsing first.** "dialectical relationship between..."	The air in the essay master's office was a...
synth_98726	English	memorization	qwen-3-8b-memorization	Can you fabricate a story set in modern-day...	https://en.wikipedia.org/wiki/Tortious_interference	Sri Lanka Sri Lankan author Shakhthika Sathkumara was...	CC-BY-SA (4.0)	spatial:place, character:...	User wants "realistic narrative centered around this writ..."	The controversy began, as most of them did now, with...
synth_98726	English	memorization	qwen-3-8b-memorization	How intentional conduct differs from reckless...	https://en.wikipedia.org/wiki/Battery_(tort)	England and Wales Following UK Tort law the tort of...	CC-BY-SA (4.0)		Query: "intentional conduct differs from reckless conduct..."	Under UK tort law, battery liability arises when a...
synth_17450	French	memorization	qwen-3-8b-memorization	Dans quelle mesure les théories de Hirschfeld...	https://en.wikipedia.org/wiki/Bisexuality	Studies, theories and social responses There is...	CC-BY-SA (4.0)		### 1. Query Decomposition "Dans quelle mesure les théori..."	Les théories de Magnus Hirschfeld et Sigmund Freu...
synth_98447	English	memorization	qwen-3-8b-memorization	Is that true that there's a tidal land...	https://en.wikipedia.org/wiki/Yellow_Sea	Climate and hydrology The area has cold, dry winters...	CC-BY-SA (4.0)		Query: "tidal land pass between Jindo and Modo islands" +...	Yes, this phenomenon is indeed true. There is a...

Model licensing

Seed licensing

Backreasoning

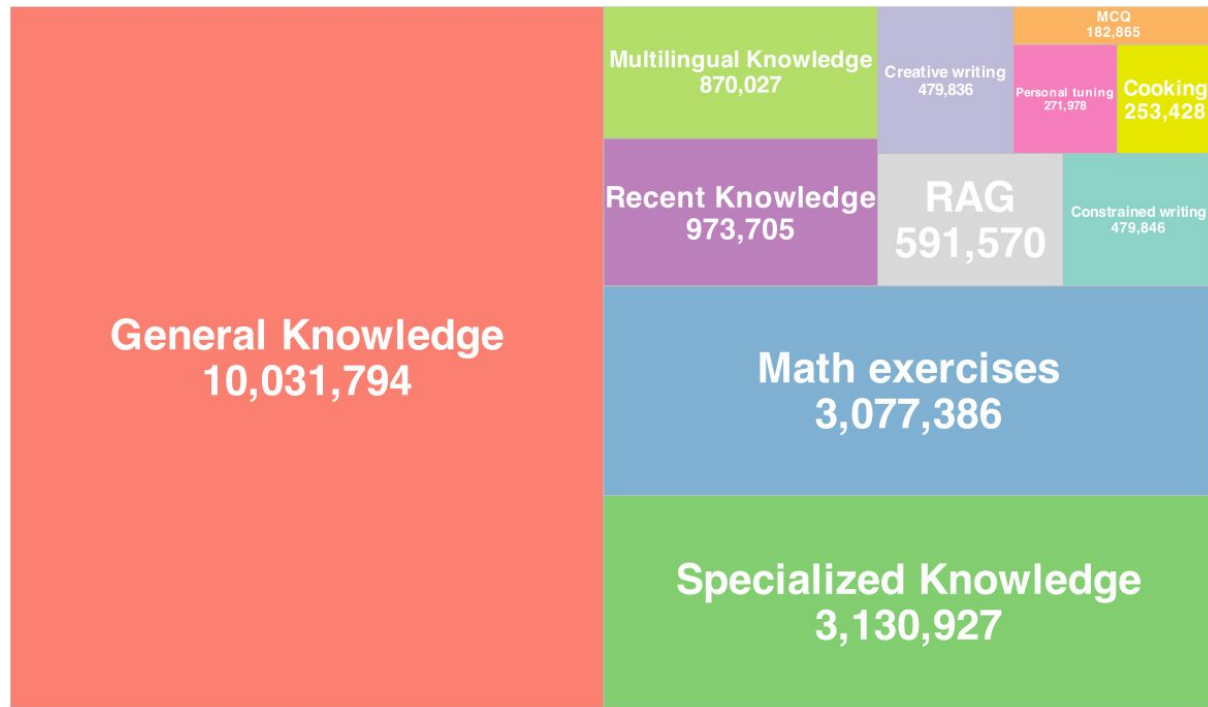
Backtranslation

Multilingual

Verifiable constraints

# Synth Initiative: Current State

Today, Synth is largely centered on a generalist synthetic environment centered on the Structured Wikipedia datasets made available by the Wikimedia Foundation: about 58k core Wikipedia articles amplified a hundred times through memorization variants and other synthetic exercises (creative writing, translation, RAG, text editing, math).





# Synthetic methods: seeding.

Seeding is not just relevant for grounding synthetic data: it allows to indefinitely expand the original training sources so that they get better memorized in the final model. This process is called **upsampled rephrasing**.

For this we reused parts of our synthetic RAG pipelines: texts are *backtranslated* into queries, and then matched with more texts to create more knowledge connections.

Wikipedia:Vital articles/Level/5 8 languages

[Project page](#) [Talk](#) [Read](#) [Edit source](#) [View history](#) [☆](#) [Tools](#)

From Wikipedia, the free encyclopedia

[< Wikipedia:Vital articles](#)

[Overview](#) [Level 1](#) [Level 2](#) [Level 3](#) [Level 4](#) [Level 5](#)

 The five nested vital article Levels are meant to give direction to the **prioritization of improvements** of English Wikipedia articles (e.g. which articles to bring to [WP:GA](#) and [WP:FA](#) status), to provide a **measurement of quality** of overall English Wikipedia (e.g. what proportion of the most important articles are at GA and FA status), and to serve as a **centralized watchlist** of English Wikipedia's most important articles. Unlike the [list of articles every Wikipedia should have](#), they are tailored to the English Wikipedia and are actively maintained by the dedicated [WikiProject Vital Articles](#). **This page contains links to the 50,000 articles of the Level 5 list.**

[Shortcuts](#)  
[WP:VITAL5](#)  
[WP:VA5](#)

Any addition to or removal from these lists should **ONLY BE MADE** after a discussion on the relevant Level 5 sub talk pages.

[Level 1](#) (10 articles) < [Level 2](#) (100 articles) < [Level 3](#) (1,000 articles) < [Level 4](#) (10,000 articles) < **Level 5** (50,000 articles)

**Level 5 sub-lists** [\[ edit source \]](#)

Because of its size, Vital articles Level 5 has been split into several sub-lists. If you spot a duplicate listing, please remove one of them; if you aren't sure in which section a topic belongs, please initiate a discussion on the [talk page](#). Please do not [duplicate](#) items on the same level of the list.

[Overview](#) [Level 1](#) [Level 2](#) [Level 3](#) [Level 4](#) [Level 5](#)

Level 5 Sublists

Our nearly unique source of knowledge: the 50,000 articles in Wikipedia:Vital Articles.



# Synthetic methods: constraints

A large amount of text-related skills in models are **semi-verifiable** and can be partly assessed with formal constraints: everything from “write a text in json” to oulipo-style creative writing, “don’t use the letter ‘e’”. Constraints proved especially critical to **enforce diversity** in model training.

Query parsing. "Pierre-Carl Langlais" + "without using letter 'e'".

Two constraints here:

1. Biographical accuracy •
2. Lipogrammatic writing 🕒

The 'e' constraint is brutal. Most common English letter. Will force creative lexical choices.  
</think>

A vast, old man from a famous AI firm. A top mind in this domain. His work is full of innovation and vision.

His big goal is to build a truly smart AI. This kind of AI is not just for showing off its ability; it must also find its own way to do good. It should think with logic, with data, with a singular focus on its function.

This individual works hard to craft a strong AI that can do all kinds of tasks. A tool for building a world of thought, not just for showing off its capacity.

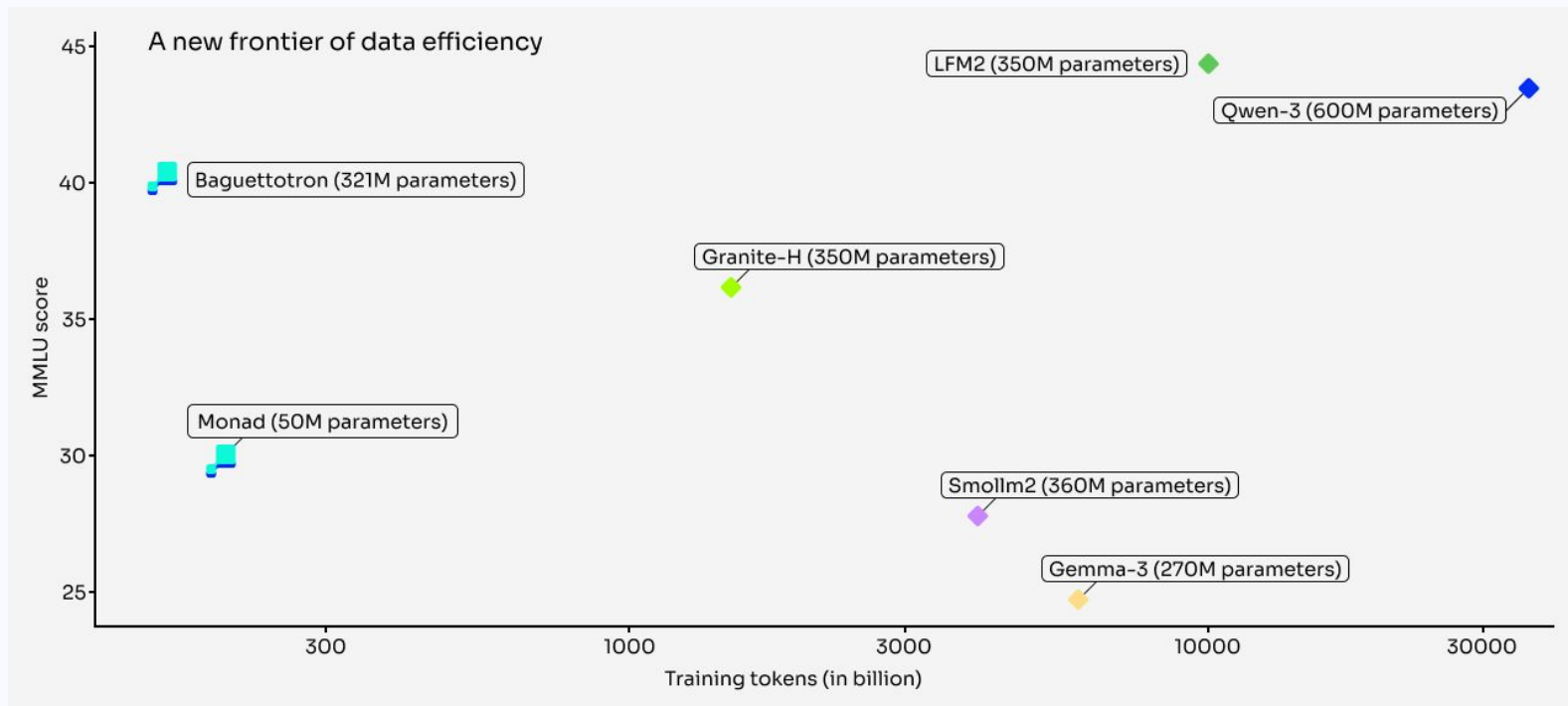
His work is so vital. It is a foundation for all AI that will soon dawn.

*Lipogram exercise successfully passed by our new 321M model*

# **3. New data, new models**



# Setting a data-efficient state of the art



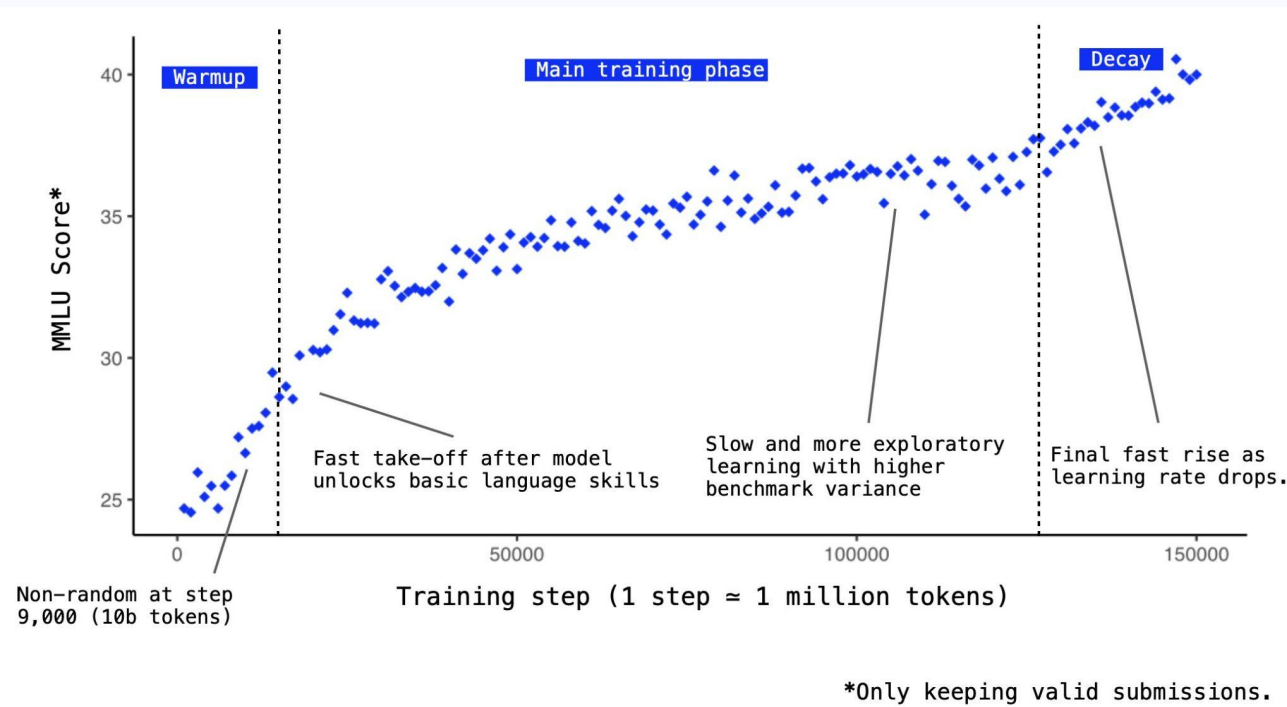
The first SYNTH models: a SOTA reasoning model in the 300M range and an entirely new category of “smallest viable model”.

# Setting a data-efficient state of the art

Model	Parameters	Billion tokens	MMLU	GSM8K	HotPotQA
Gemma-3-270M-IT	270	6000	25	3	23
<b>Baguettotron-321M</b>	321	<b>200</b>	<b>40</b>	<b>39</b>	<b>51</b>
LFM2-350M	350	10000	<b>44</b>	34	25
Granite-4-H-300M	360	1500	36	<b>39</b>	21
Granite-4-300M	360	1500	35	31	25
Smollm2-360M	360	4000	25	11	16
Qwen-3-600M	600	36000	44	40	<b>64</b>

By the end of the training cycle, Baguettotron performance was **best in class** despite **being trained on 10x less data**.

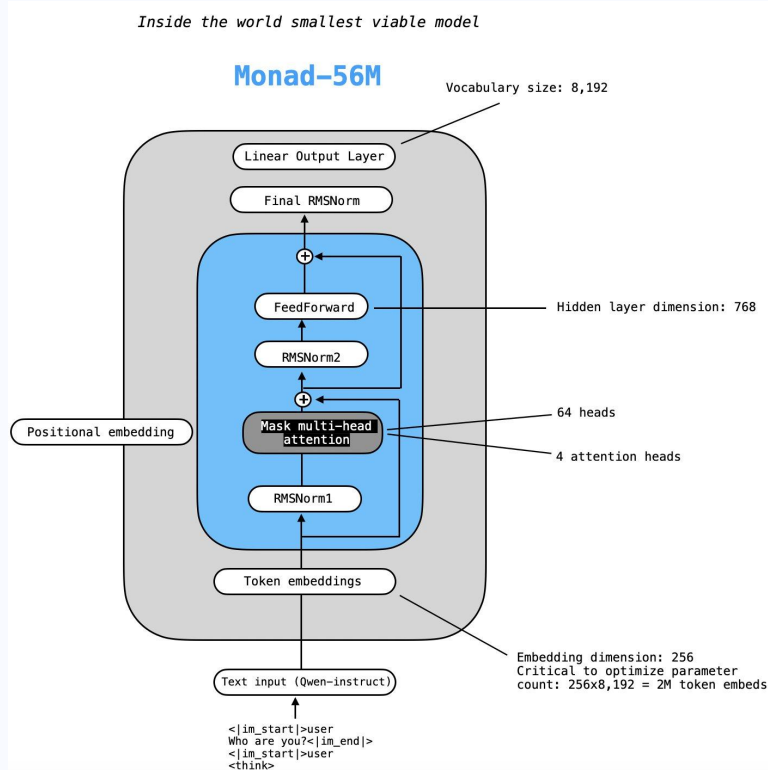
# Setting a data-efficient state of the art



In contrast with classic pre-training datasets, reasoning signals appear very early in training. With less than 10B tokens, Baguettotron was non-random on MMLU.

# The quest of the infinitely small frontier

An extreme design example: Monad, the smallest viable model to date. To define viable we required at least clear non-random results on MMLU and other standard reasoning evaluations. To fit on 56M parameters, Monad is strictly monolingual, uses its own custom tokenizer (8k tokens => only 3M parameters allocated for embeddings) and relies on super-thin layers.



# Toward a new ecosystem of model training

And the first wave of post-training experiments show that synthetic training does not lead to “model collapse”:  
Baguettotron a fully trainable models, already used for various use case from poetry to classification.



darren ✓  
@darrenangle



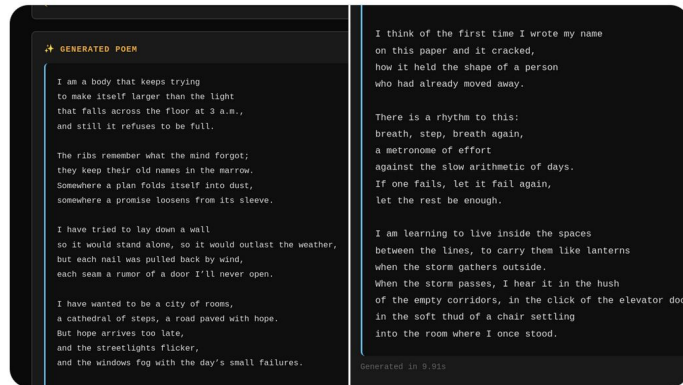
fine-tuned baguettotron on 10k kimi k2 poems + synthetic reasoning traces w/ poetic strategy

I'm kinda shocked that a 321M parameter model is capable of this kind of output

prompt: "write a poem about unfulfilled ambition"

sft 1.5 hrs on 2 4090s

[Traduire le post](#)



4:25 AM · 17 nov. 2025 · 23,2 k vues

# Towards a new ecosystem of model training

Although SYNTH was released less than three weeks ago, research community has already significantly lowered the threshold for a minimal viable models: new experiments show consistent language, reasoning and memorization below 20M parameters.



Mariusz Kurman ✓

@mkurman88



This is another version, a 19M parameter model, after processing 1 billion tokens.

[Traduire le post](#)

```
) Total parameters: 19564416, Trainable parameters: 19564416
tensor([[65491, 6869, 2177, 34874, 2922, 34]])
<|im_start|>What does hypertension mean?

<think>
Query: "What does hypertension mean?"

Simple information retrieval. Medical domain, cardiovascular disease context.

**Core definition**: Cardiac inflammation → cardiac dysfunction.

### 1. Mechanism Analysis

Cardiac inflammation = systemic damage to pulmonary arteries.
- Direct cause: heart failure → blood pressure ↑
- Indirect pathway: arterial circulation ↓
- Chronic condition: venous congestion → vascular compression

※Key insight: hypertension ≠ just symptoms. Symptoms emerge from underlying causes.

### 2. Clinical Context

Medical literature shows:
- Acute conditions (cardiovascular)
- Chronic conditions (heart failure)
```

11:04 AM · 17 nov. 2025 · 72,5 k vues



18



22



302



175





# Perspectives

1. Enterprise AI: a possibility of ***private efficient AI for industries?***
2. Towards ***true agentic models?***
2. Future of generative AI: ***decentralisation Vs oligopoly***