FlexOlmo:
Open Language Models for Flexible Data Use

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Presenting work with



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+ Other collaborators at Ai2!

What This Talk Covers

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Standard MoEs: mainly for training & inference efficiency

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- How do we address the challenges using MoE?

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- What are other alternative approaches?
- How do we address the challenges using MoE?
- What results do we get?

Standard LM Training

Centralized access to all data during training

Data access is binary: available or unavailable

In Reality

? Centralized access to all data during training

Data access is binary: available or unavailable

Available

Unavailable

In Reality

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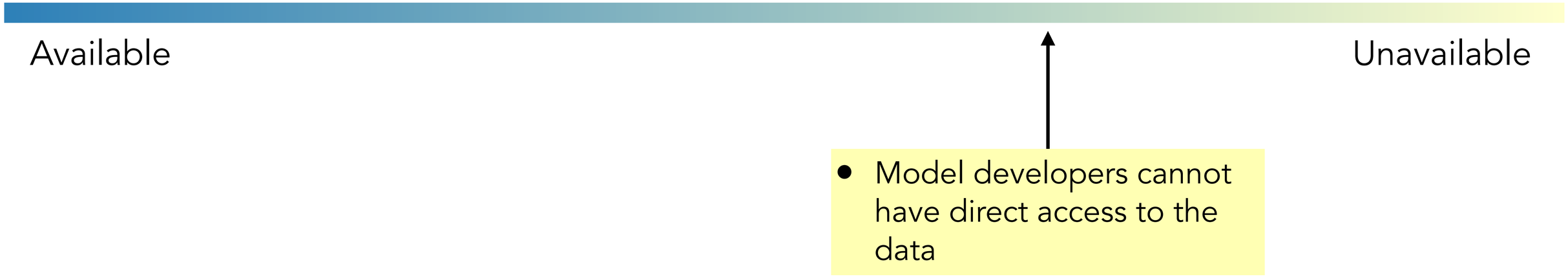

- Model developers cannot have direct access to the data

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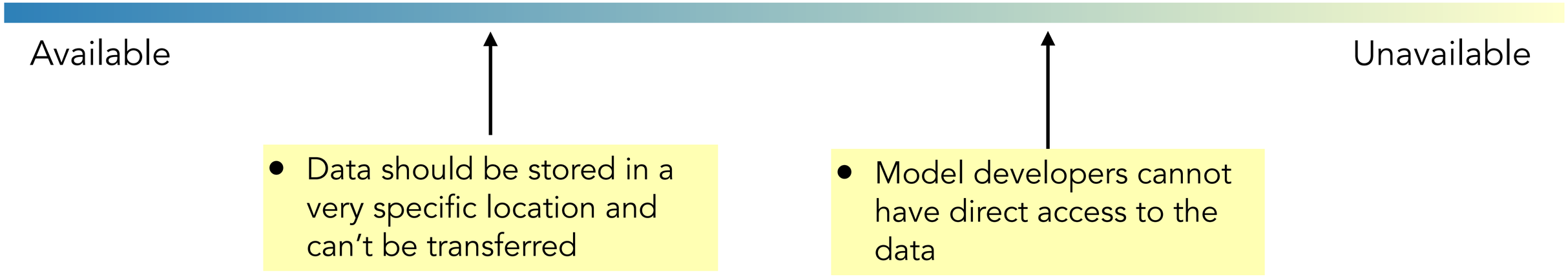
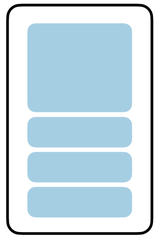


- Data should be stored in a very specific location and can't be transferred
- Model developers cannot have direct access to the data

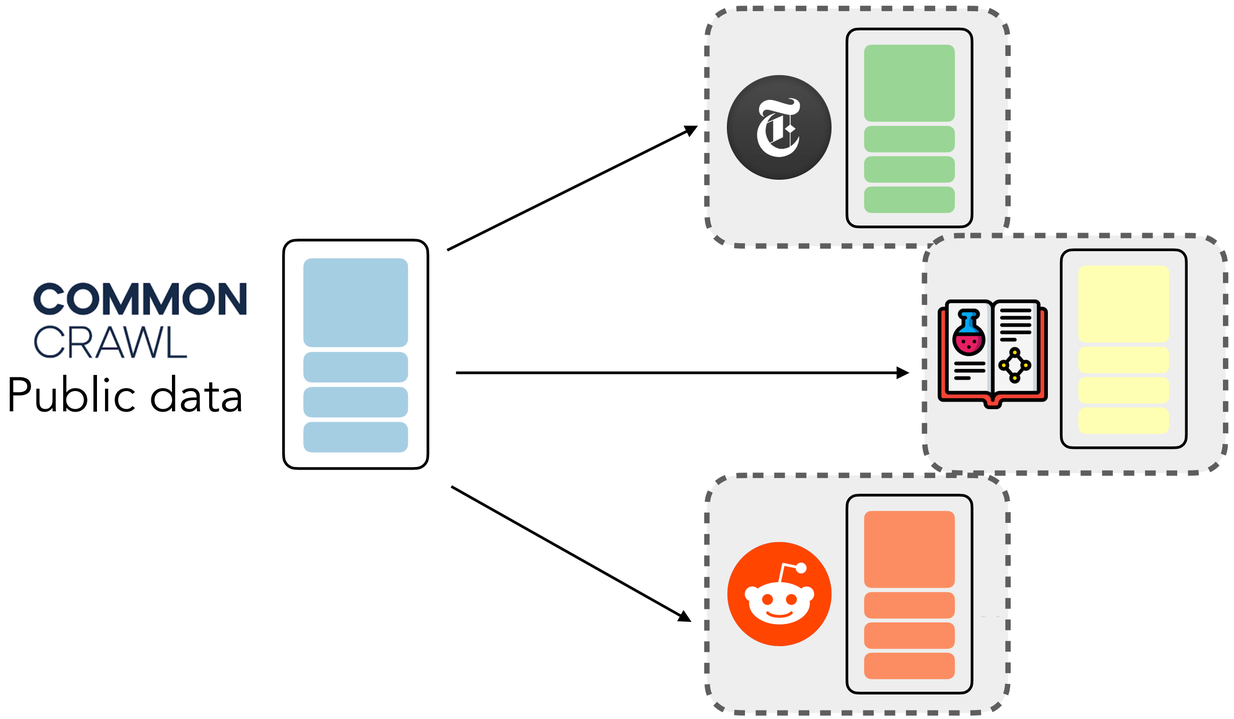
Other Restrictions: Data may become available at different times, may have expiration dates or owner might require opt-out.

FlexOlmo: Modular, Distributed Training

COMMON CRAWL
Public data



FlexOlmo: Modular, Distributed Training



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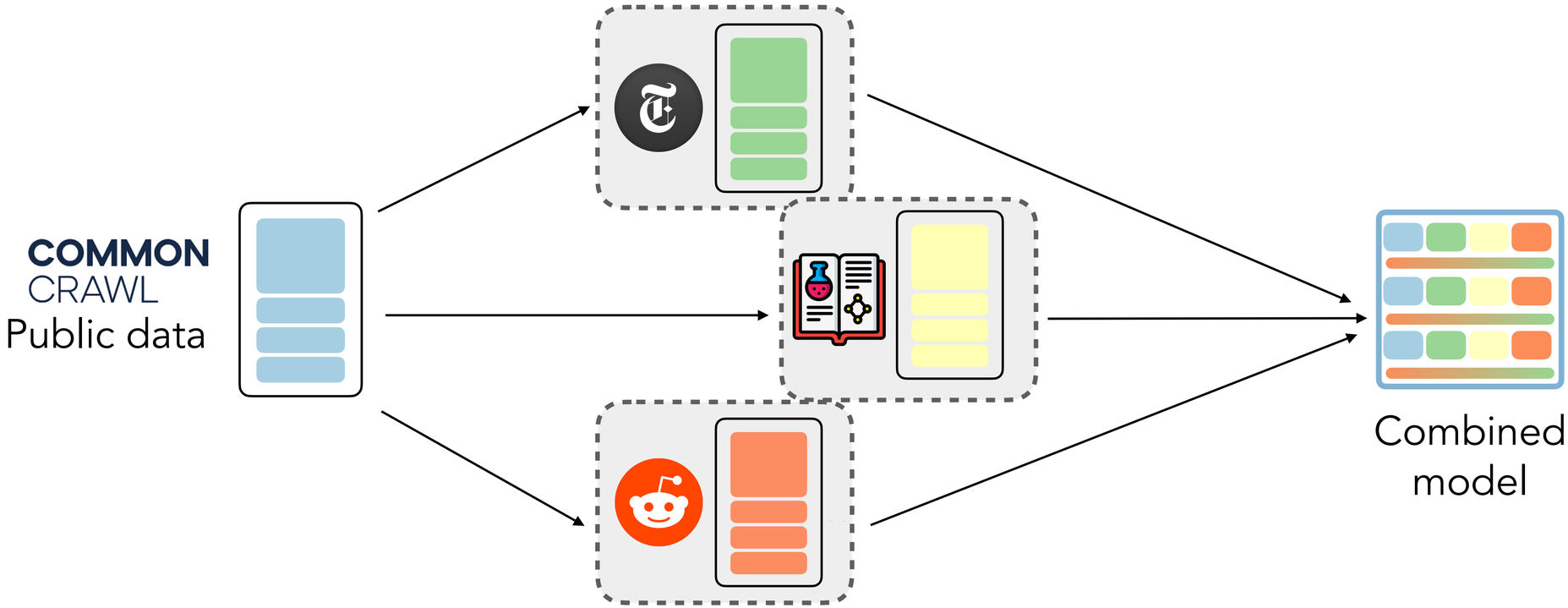

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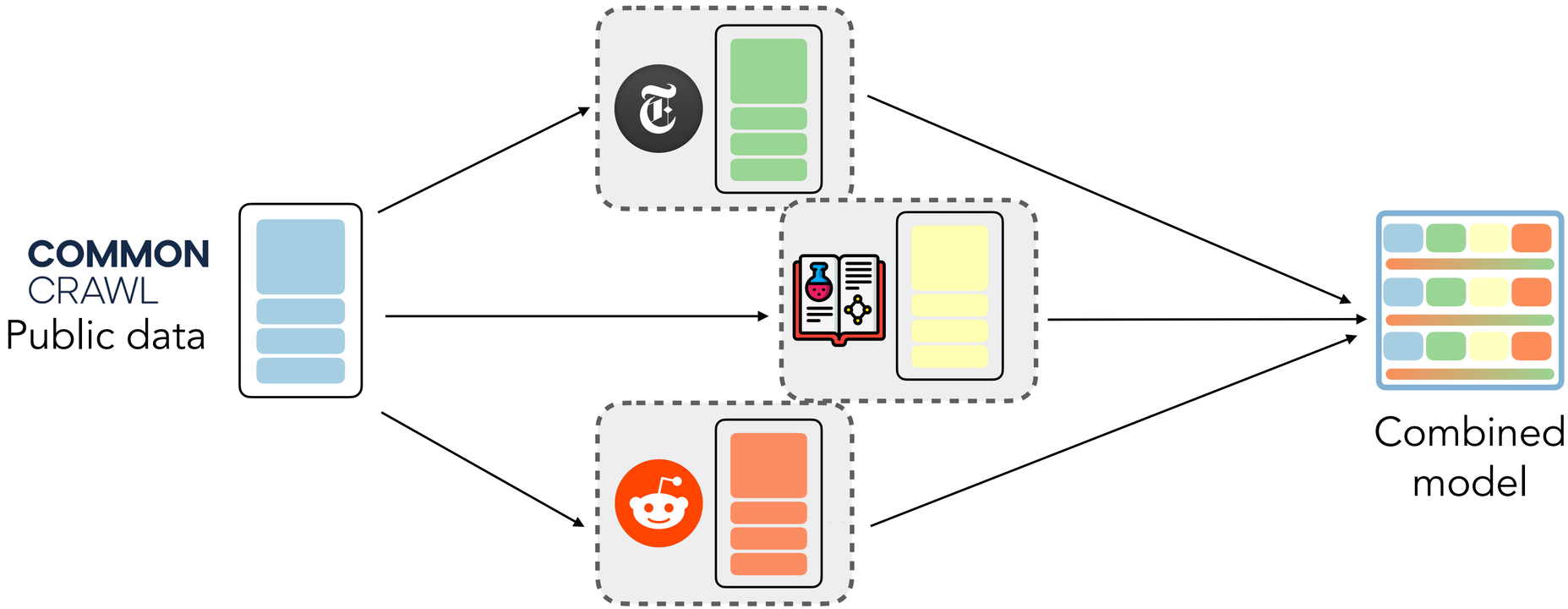

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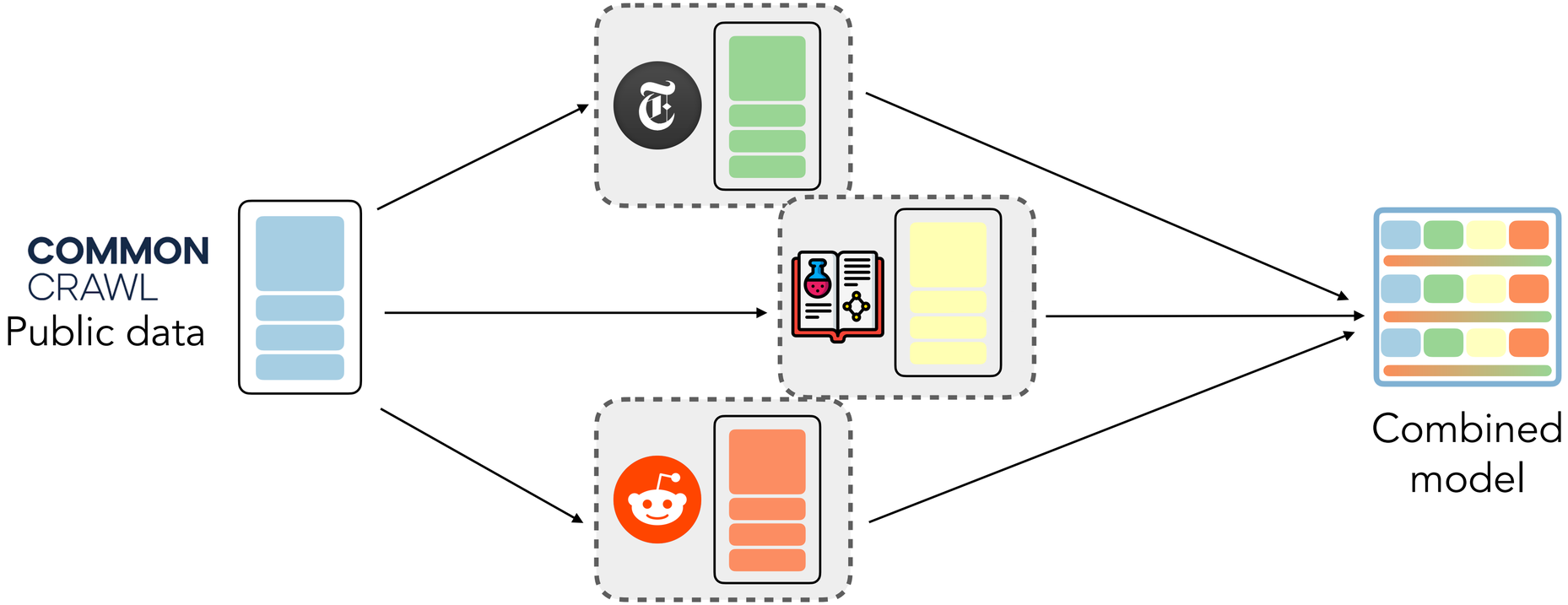
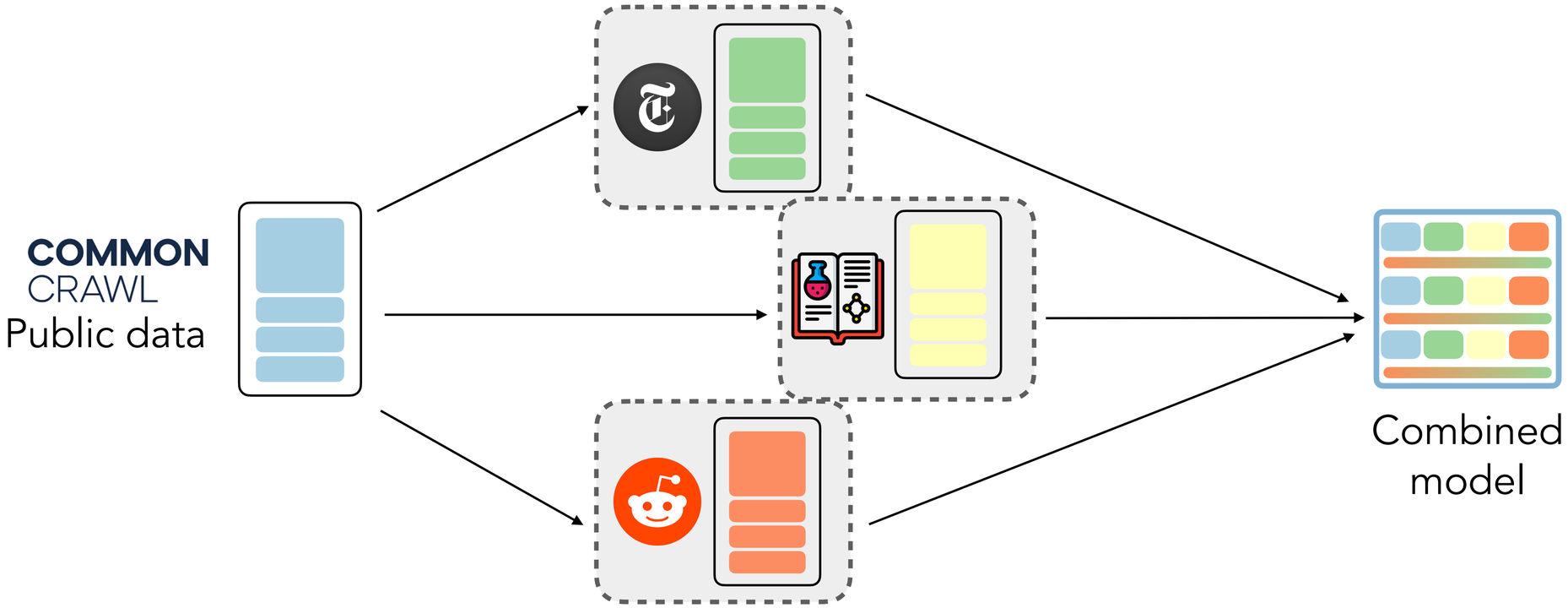


Enables
data contribution
without data sharing

FlexOlmo: Modular, Distributed Training



Enables
data contribution without data sharing

Supports **easy data addition/removal** with no further training

Option 1: Model merging

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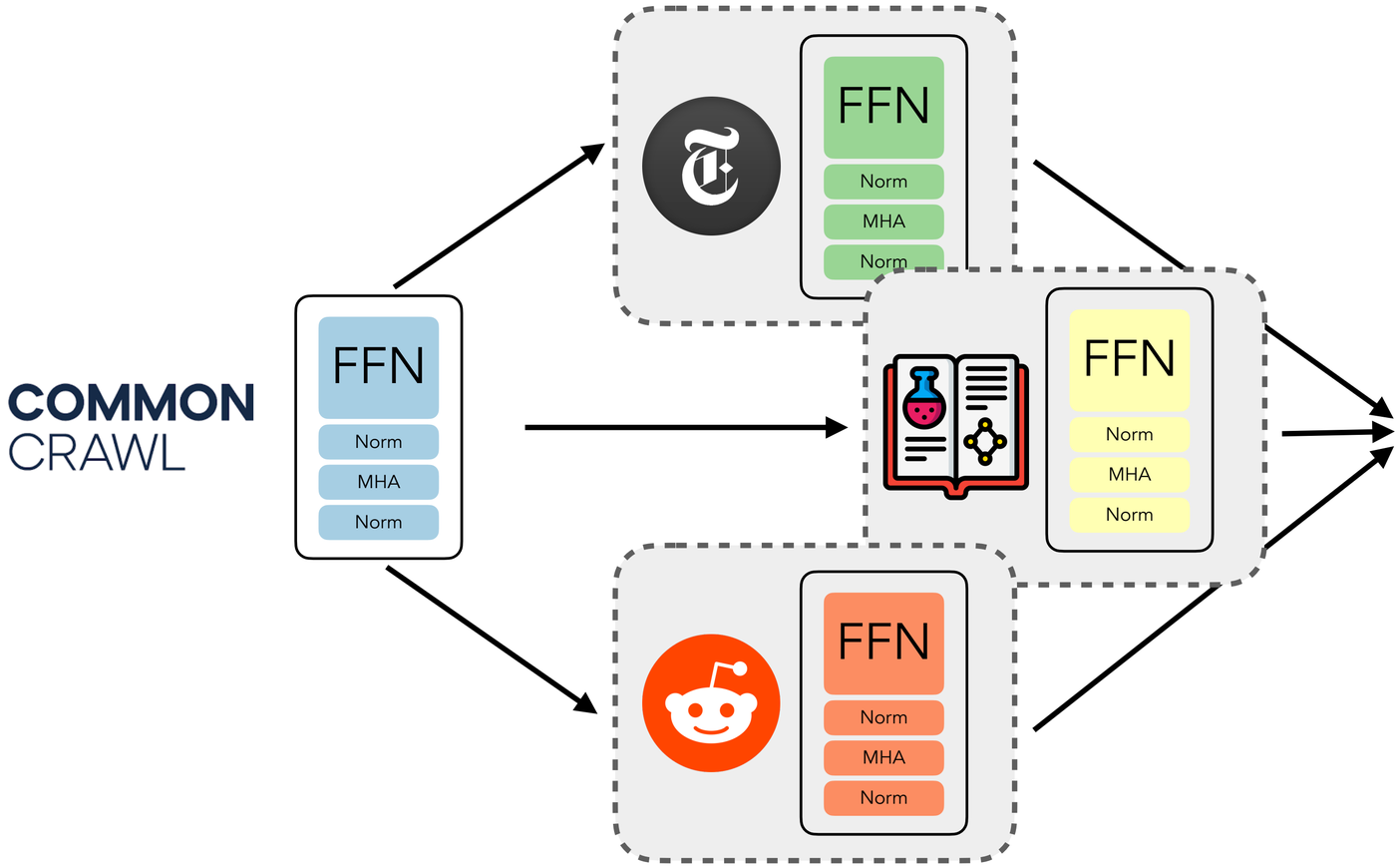

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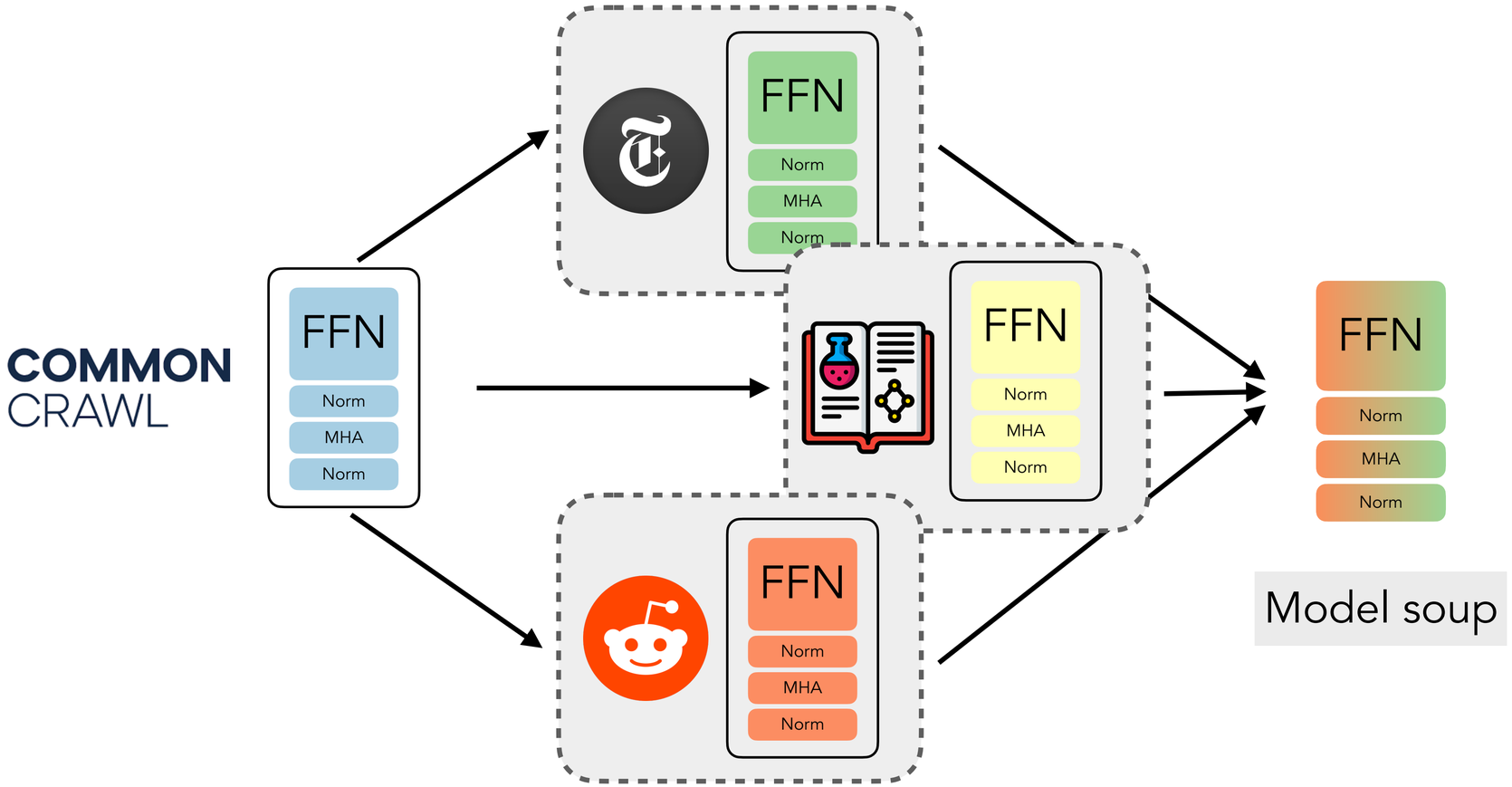

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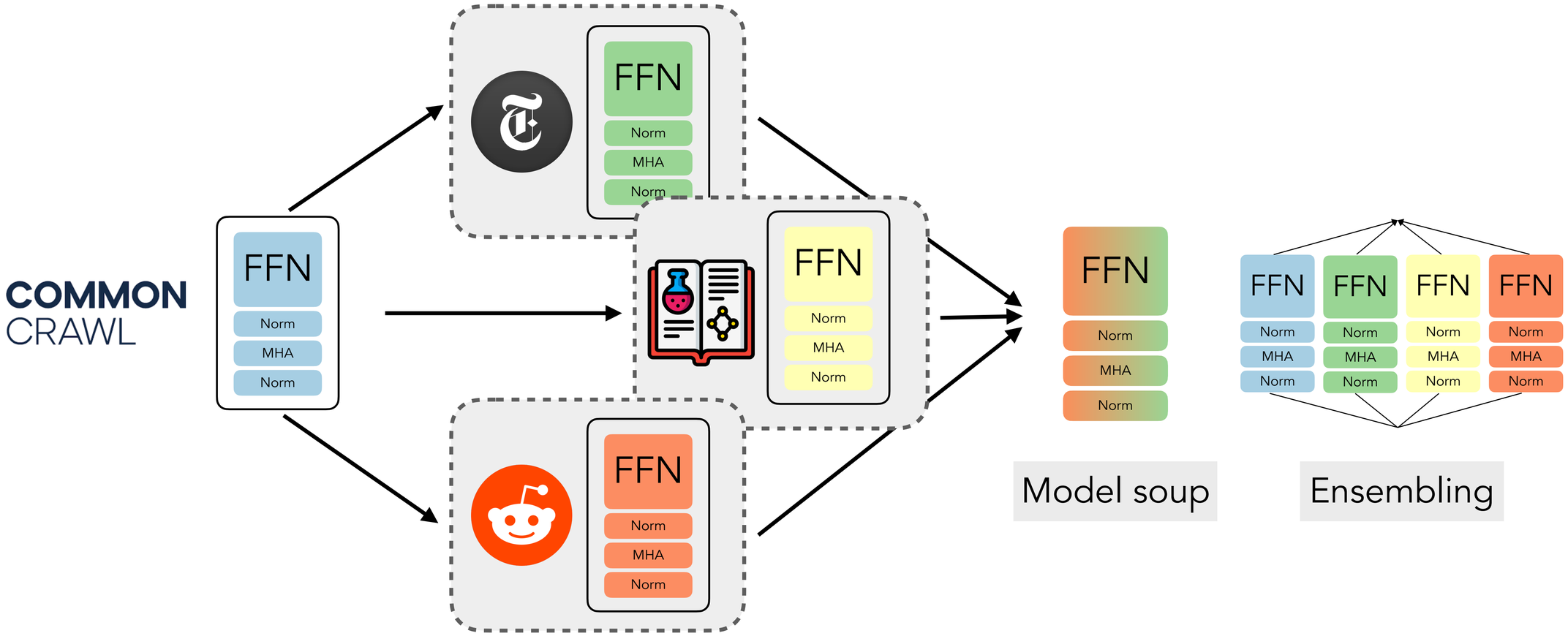

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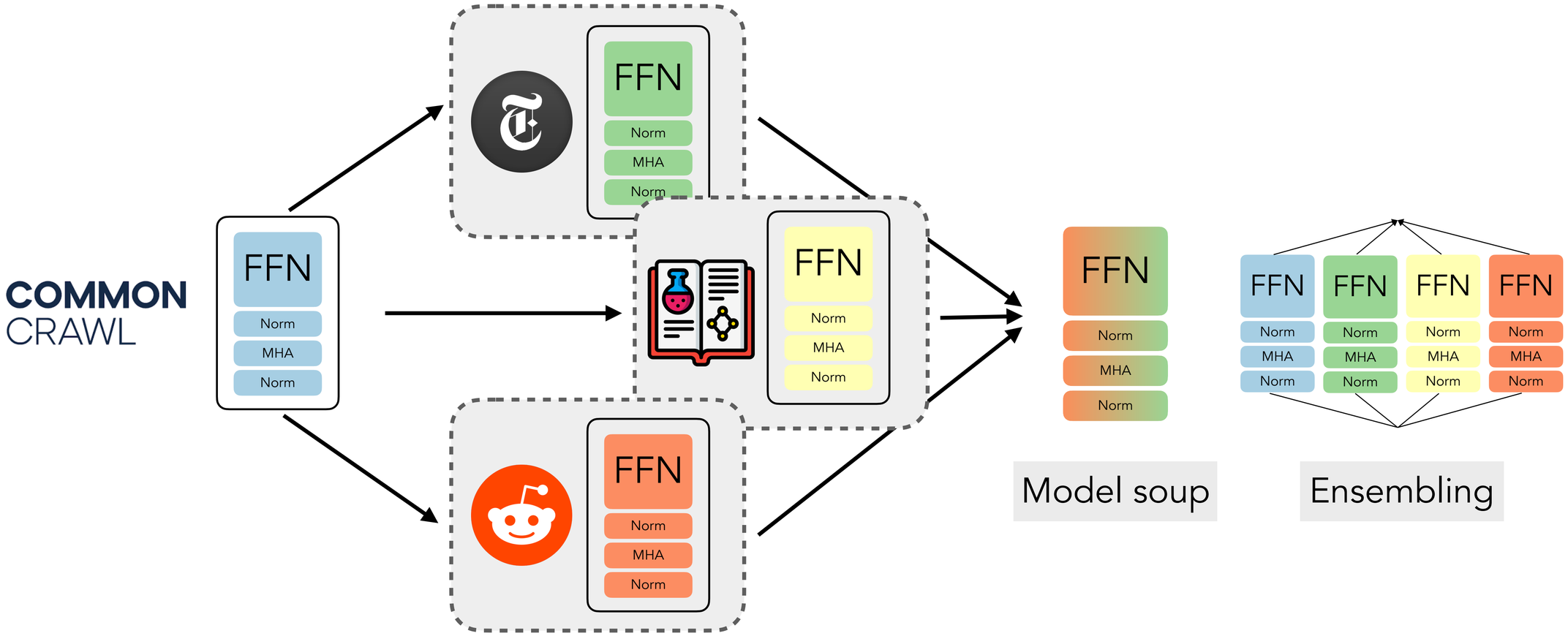
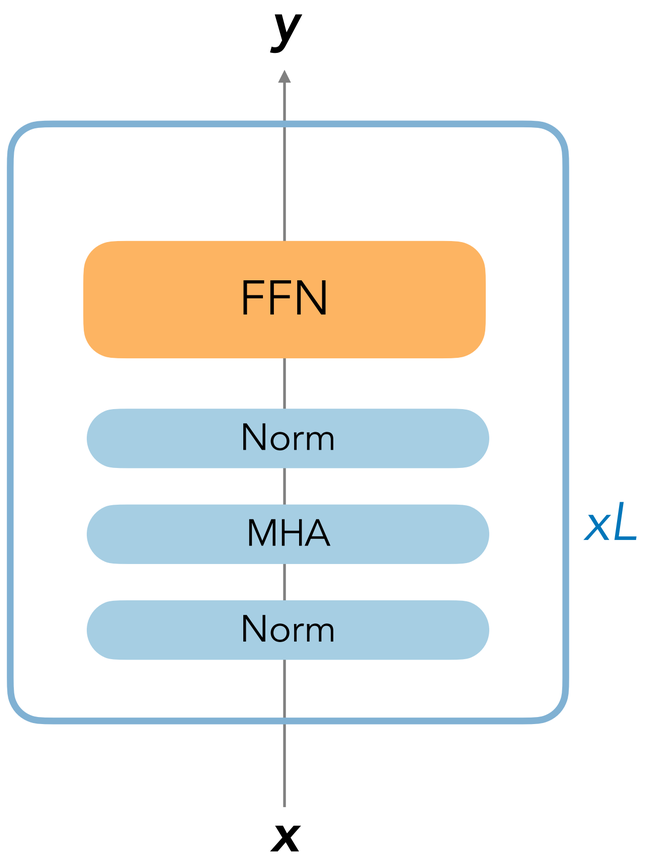


- Standard practice for boosting model performance
- However, merging models trained on disjoint datasets is harder

Option 2: MoE merging

Option 2: MoE merging — What is MoE?



xL

*Residual connection not depicted

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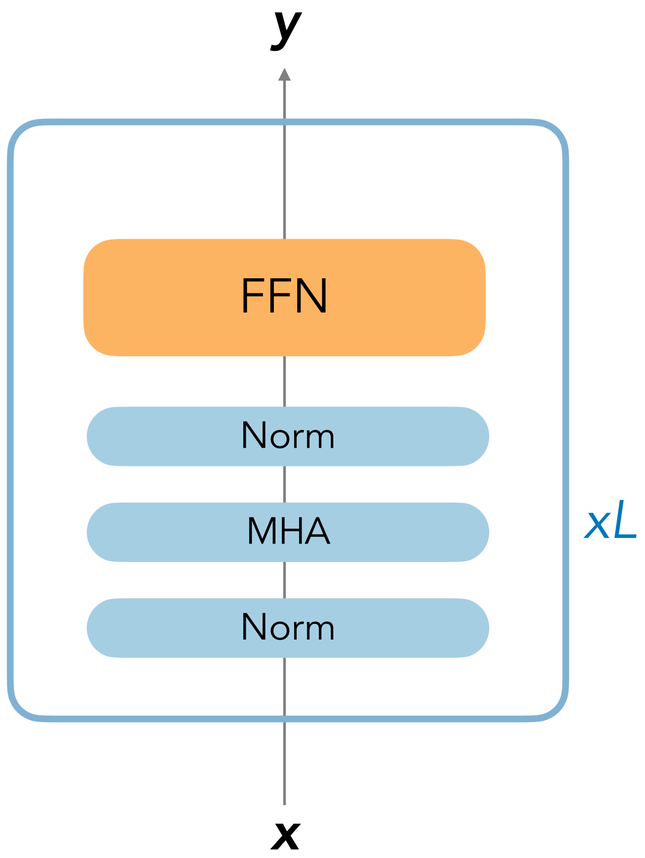

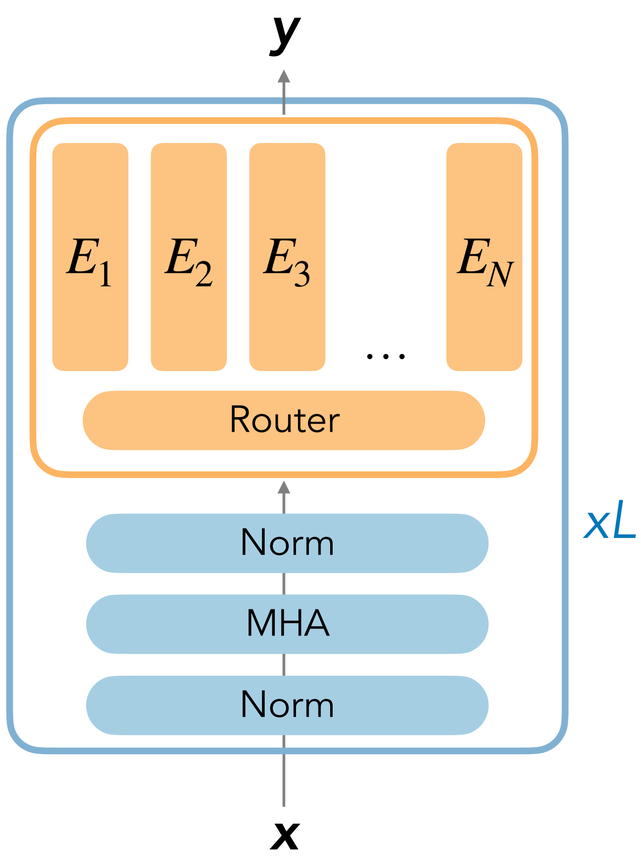

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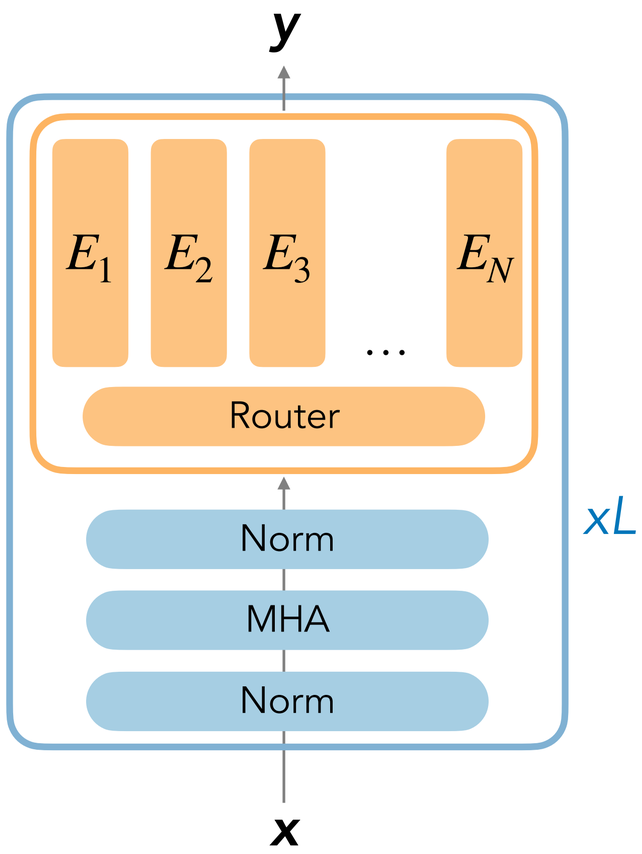

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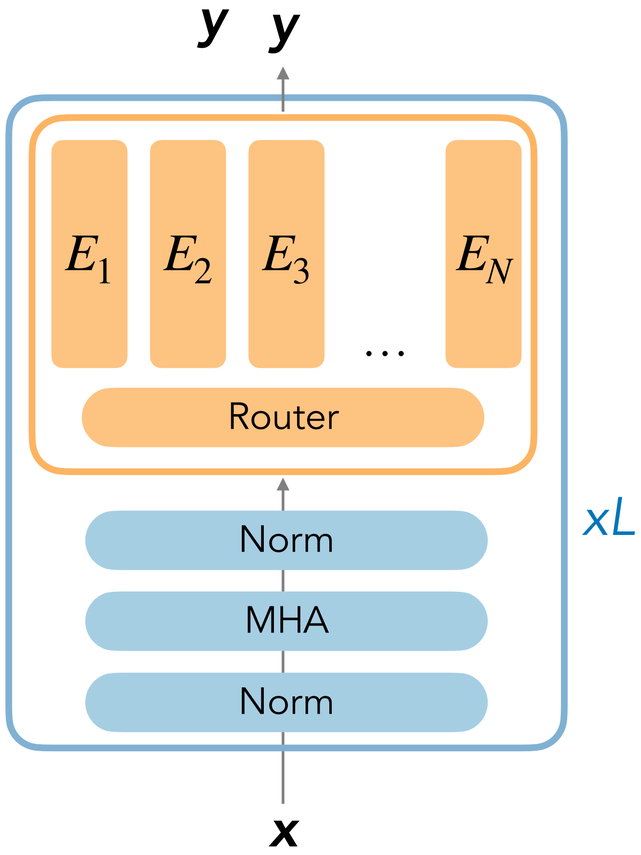

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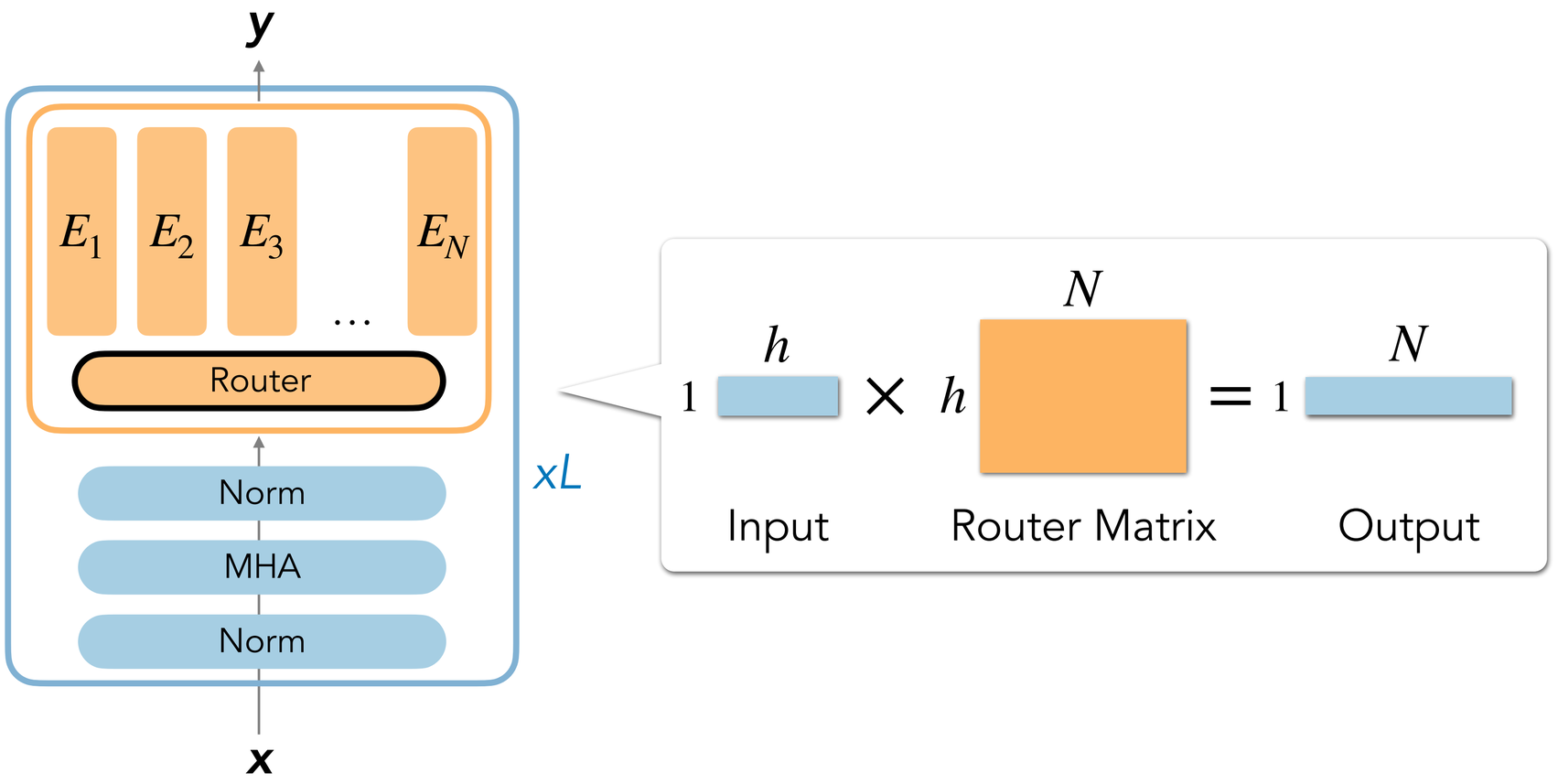

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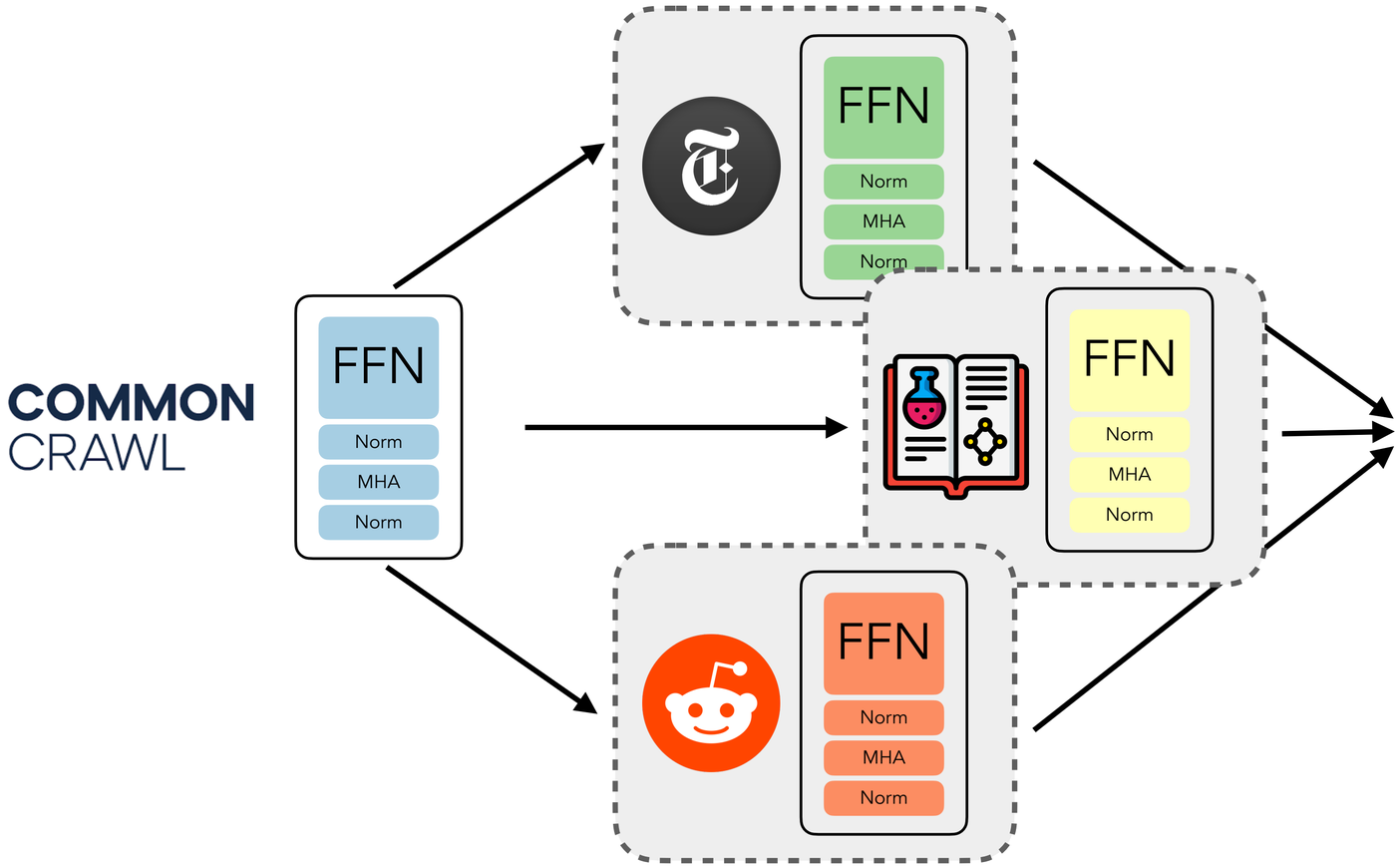

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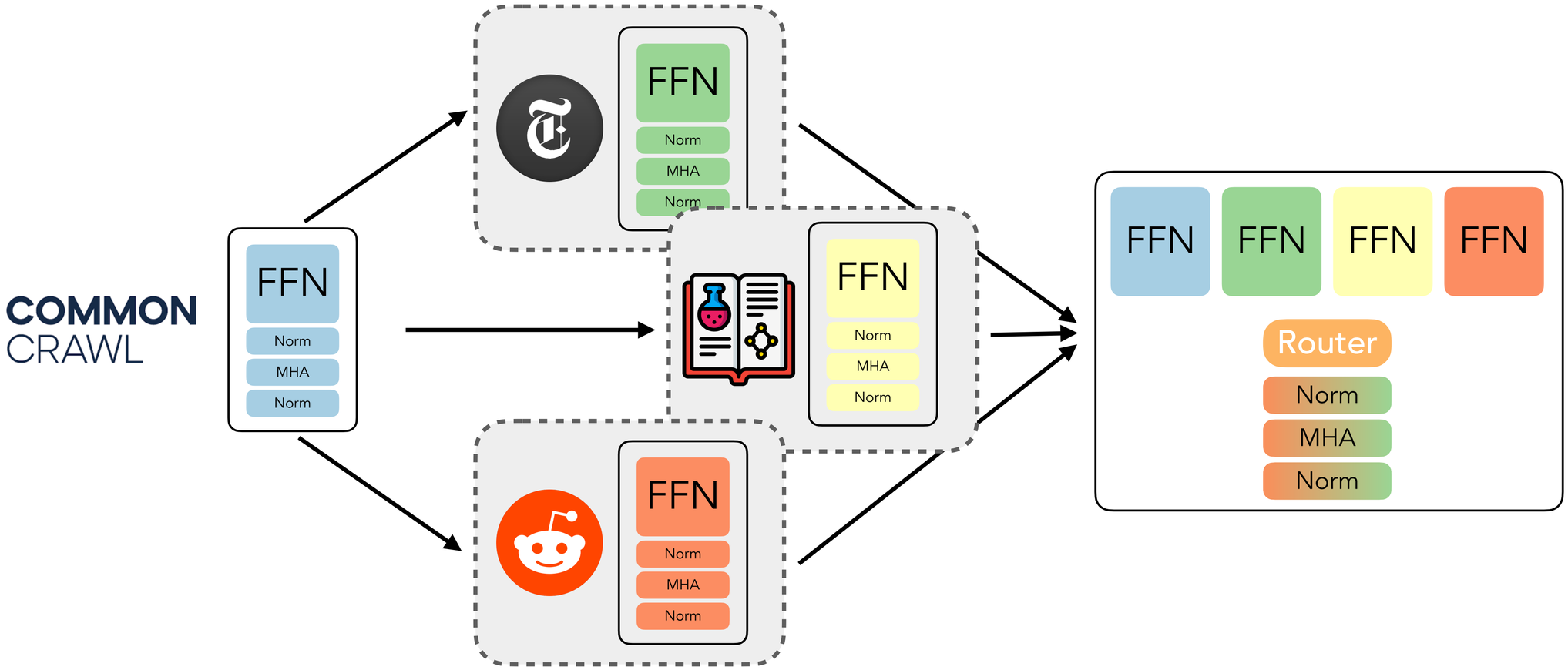

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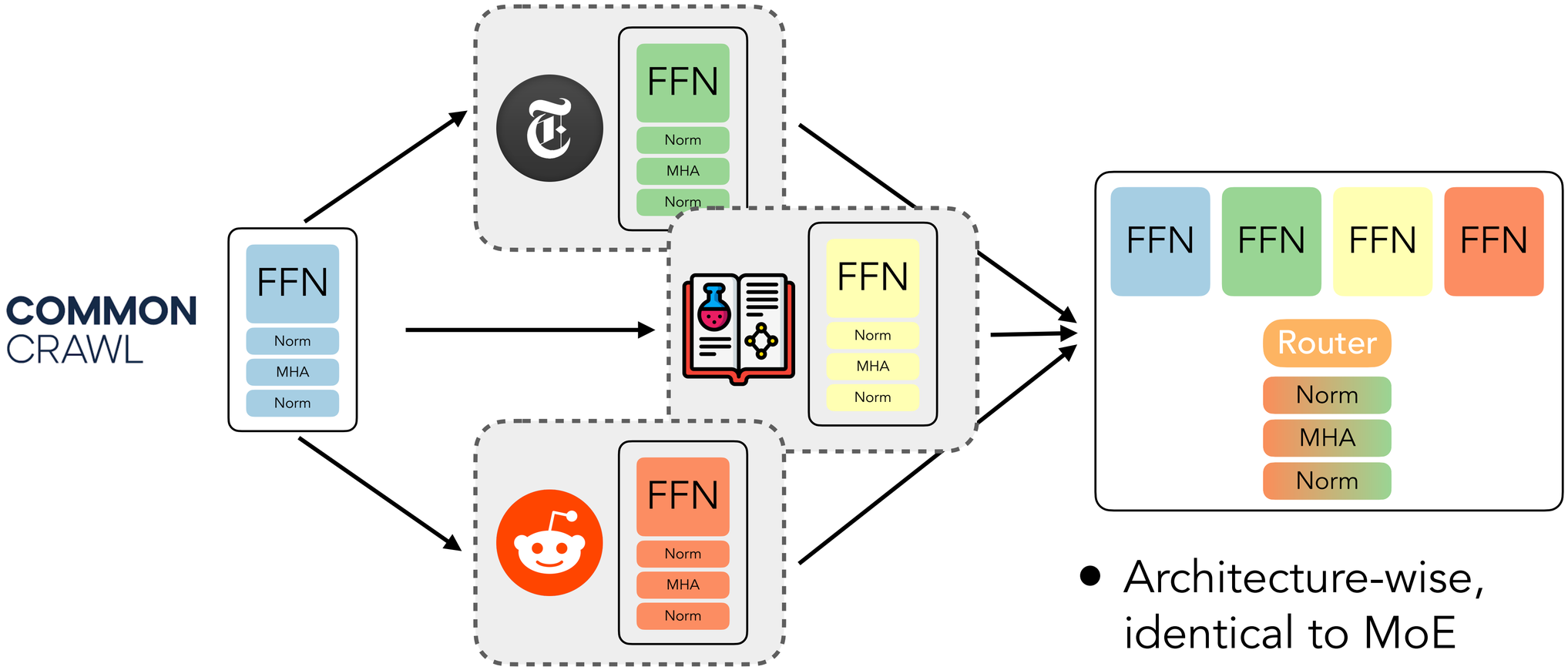

- Architecture-wise, identical to MoE

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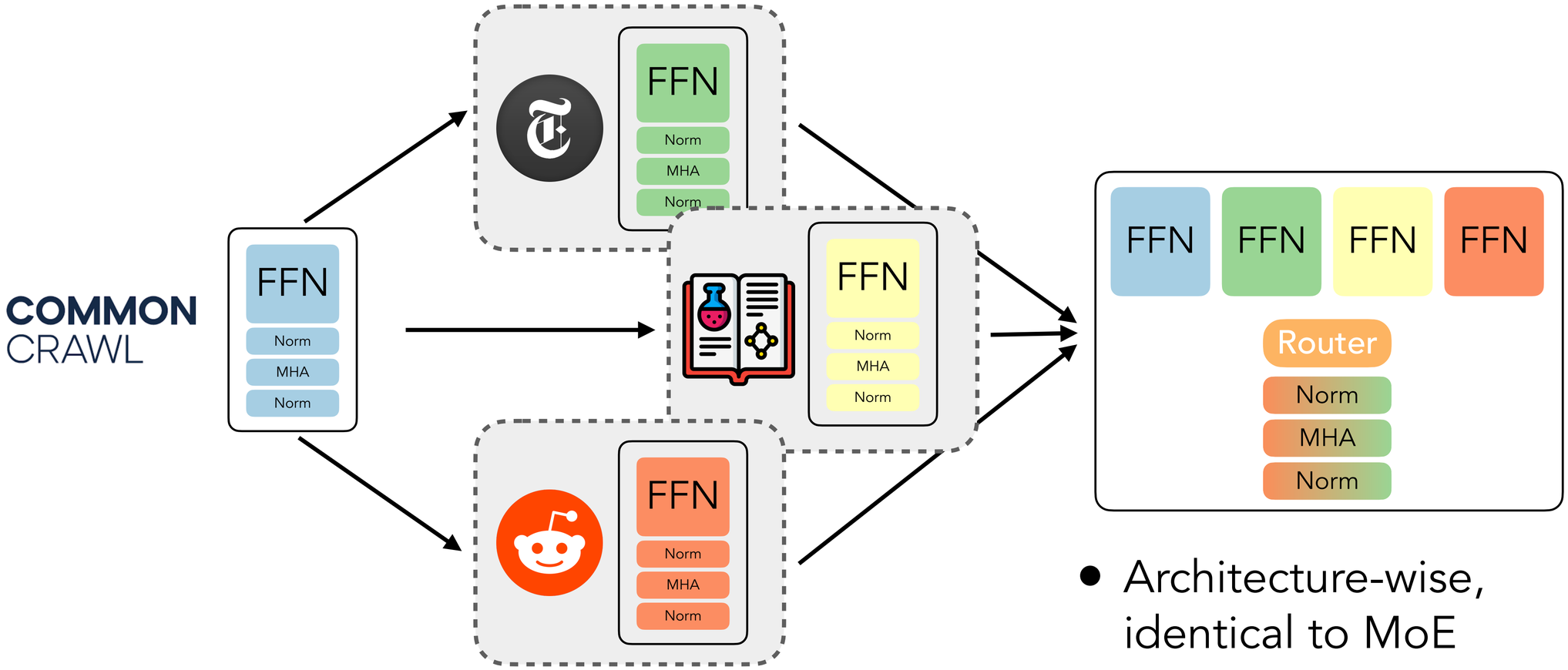

- Architecture-wise, identical to MoE
- Requires training on all datasets after merging

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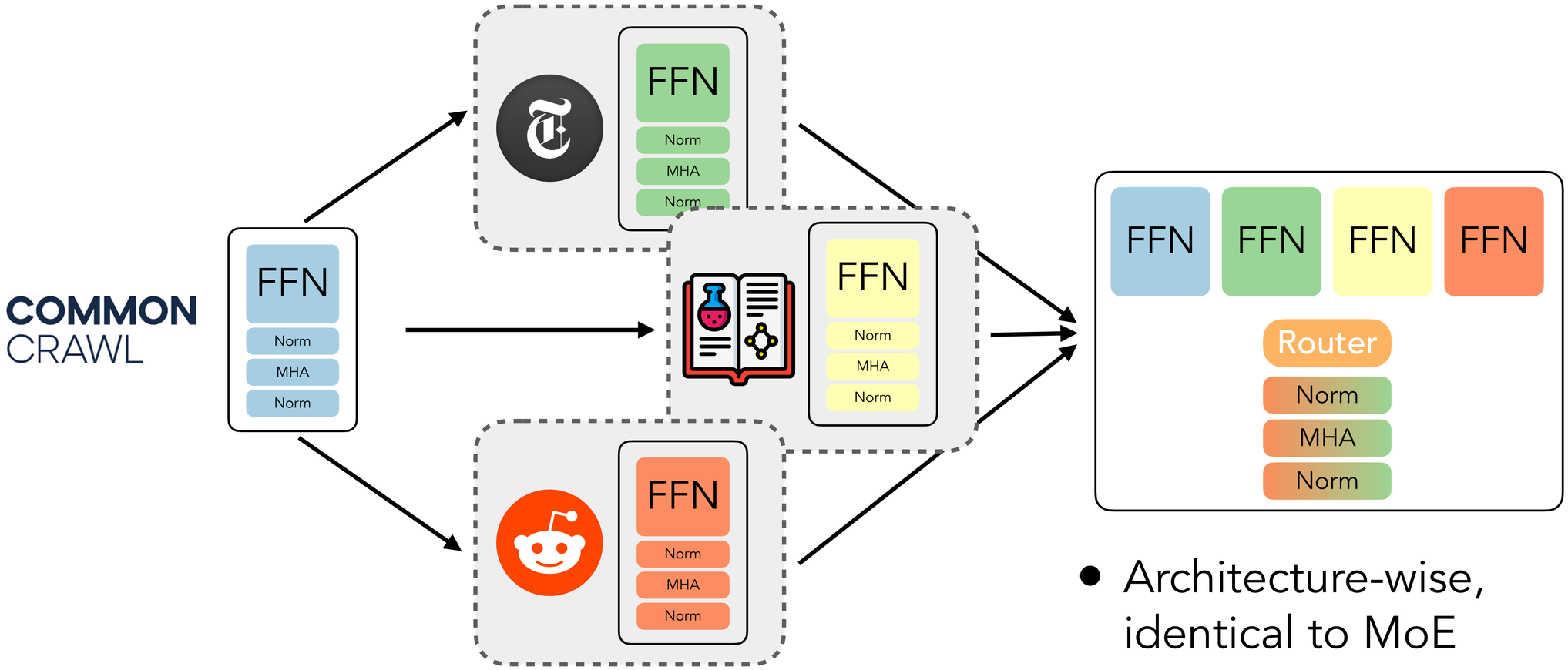

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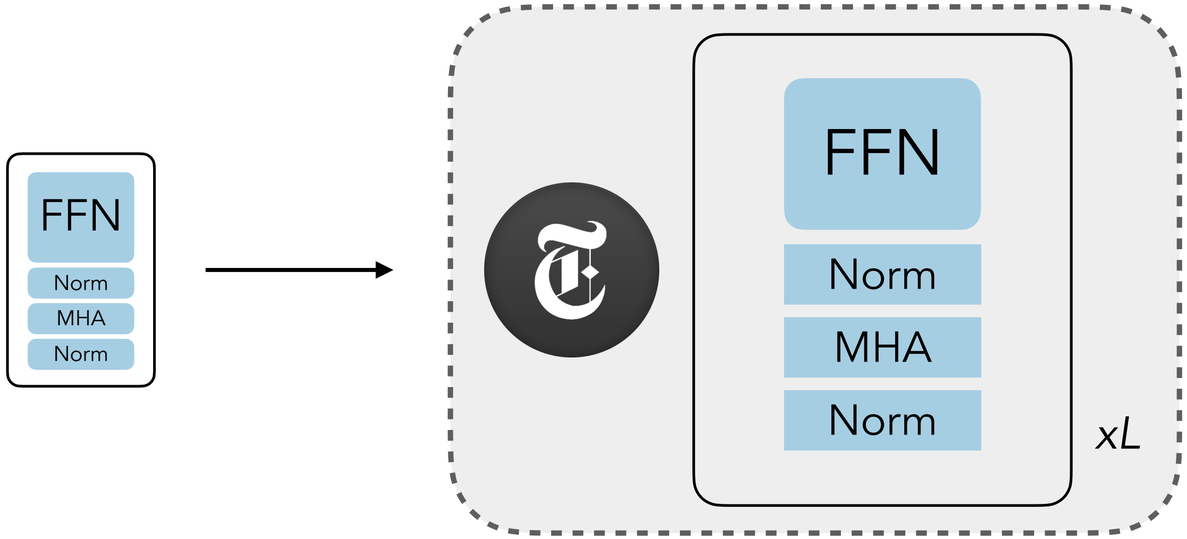
Research Q: How do we leverage MoE but remove the needs for joint data access?

Solution 1: Learning to Coordinate



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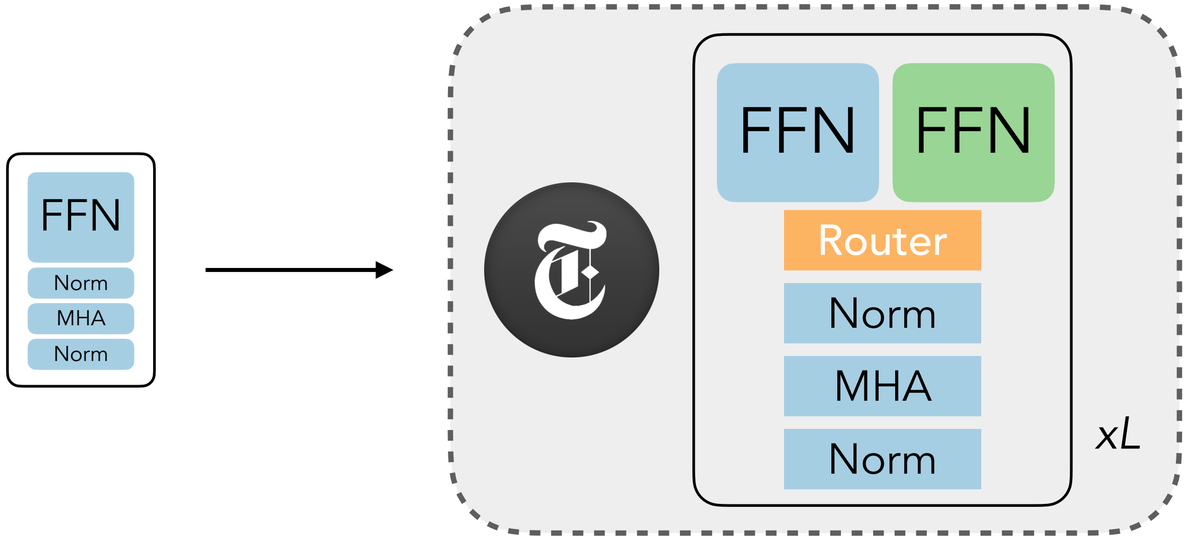

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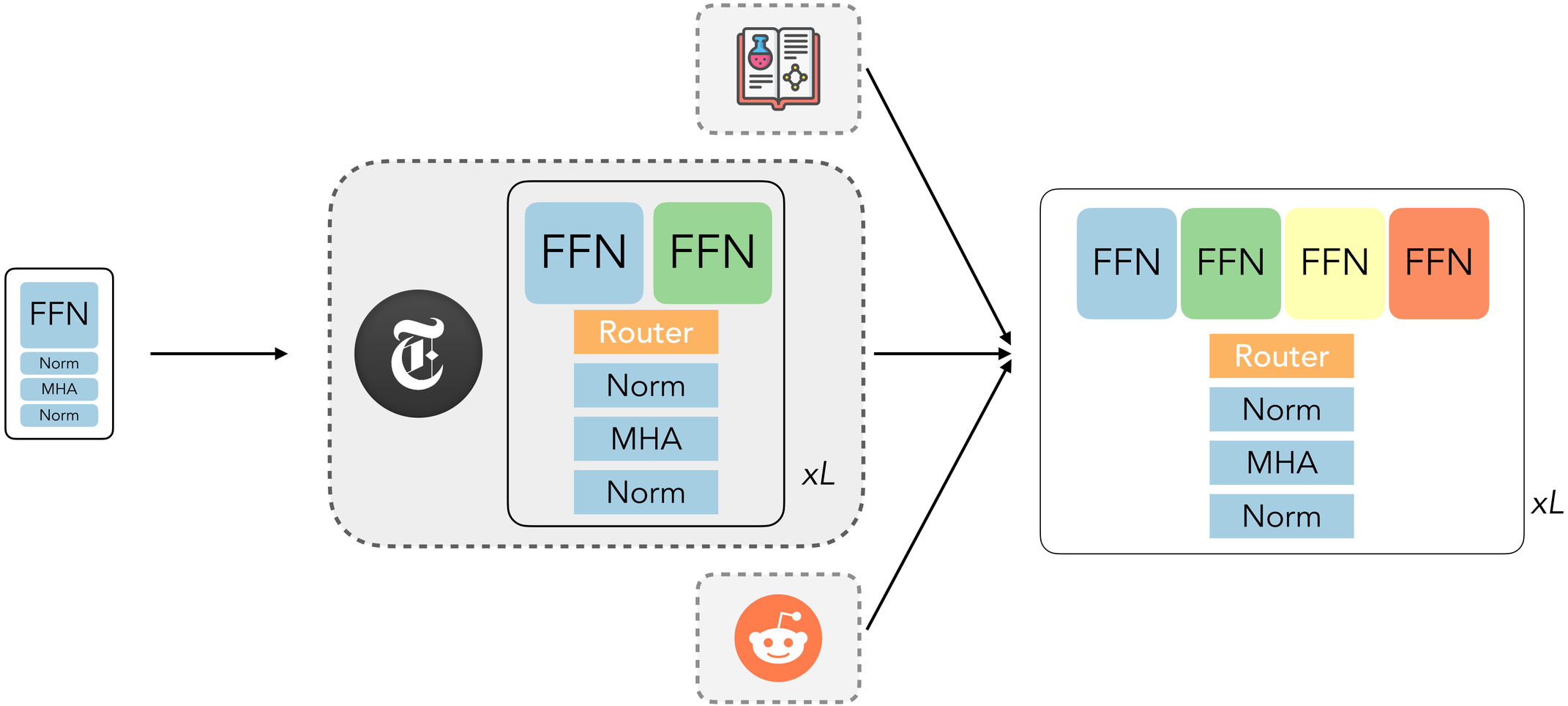

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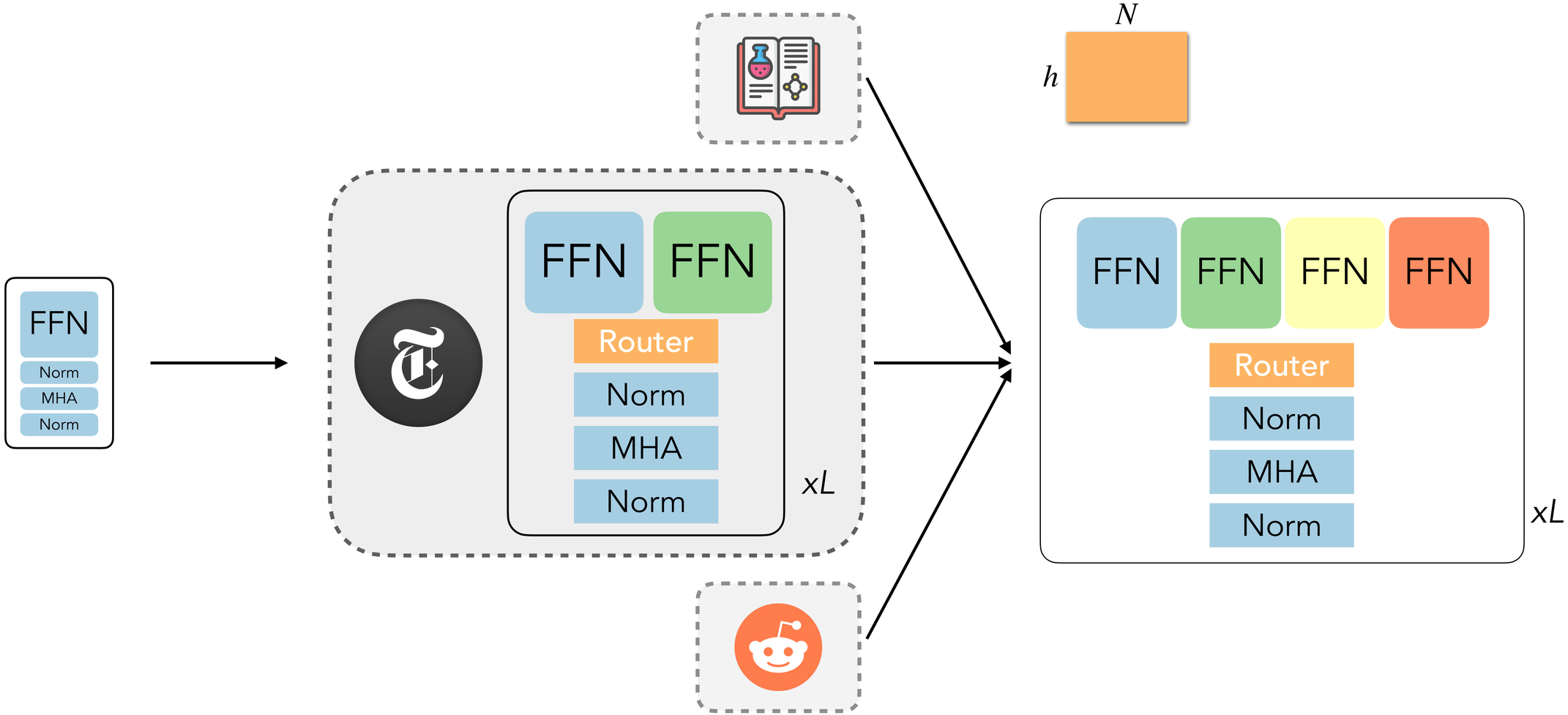
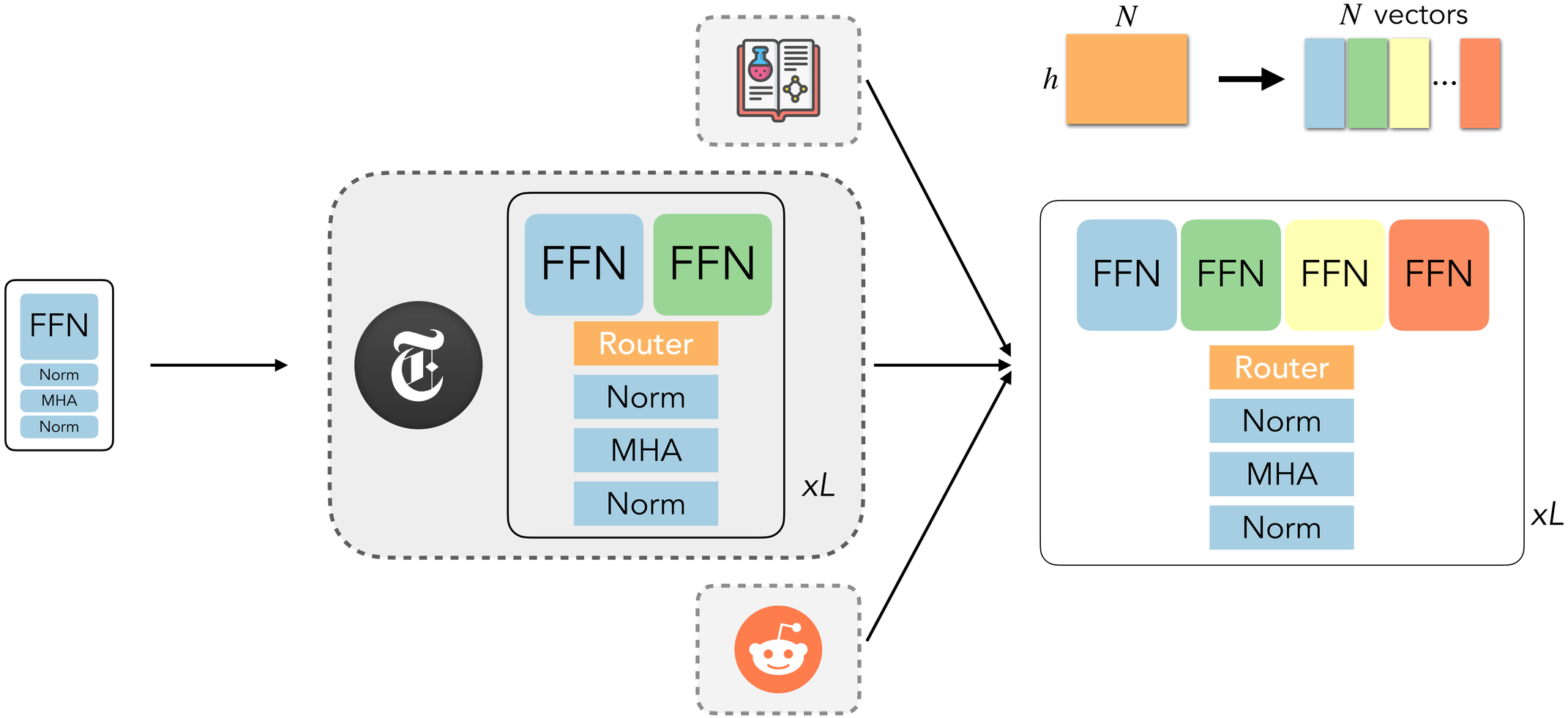


Solution 2: Nonparametric Router



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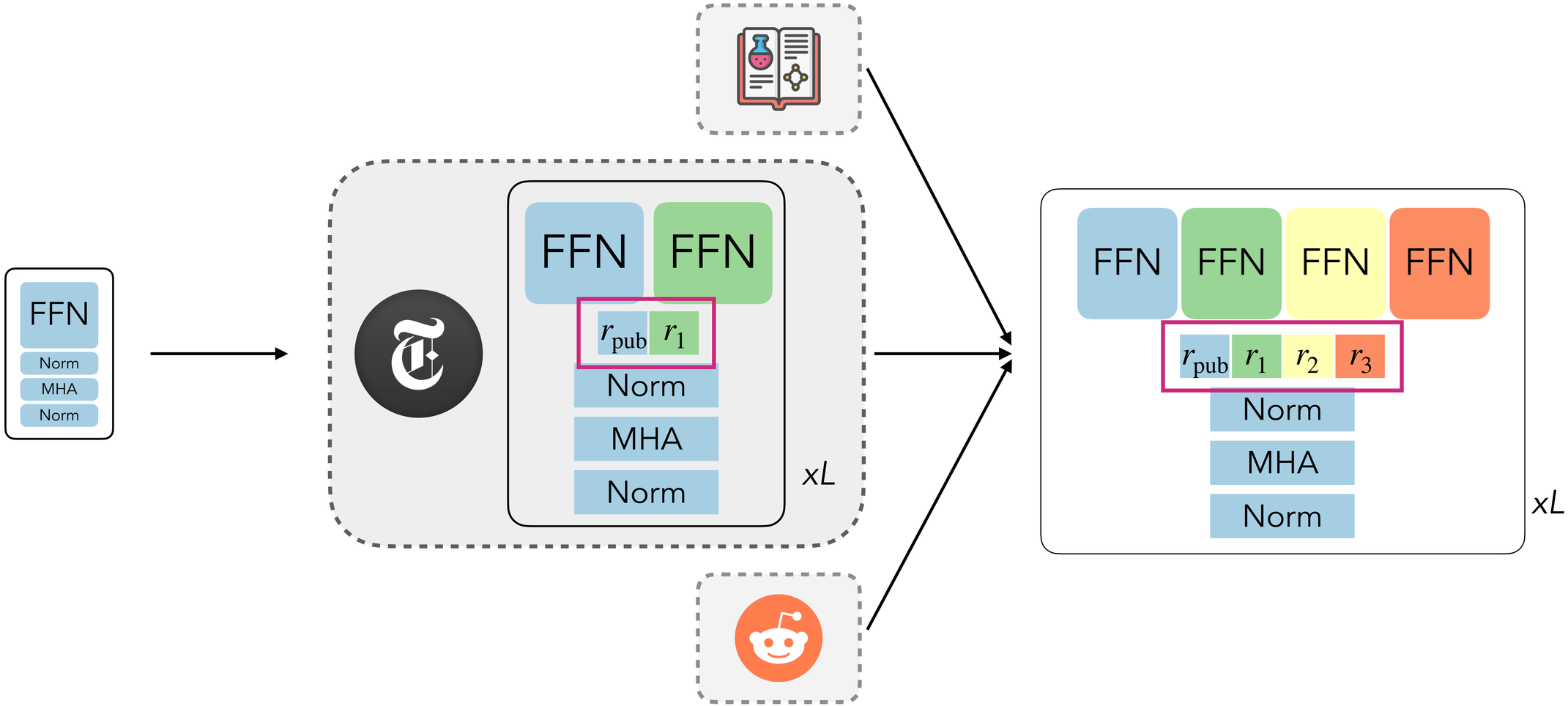
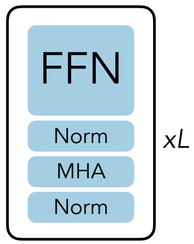


FlexOlmo: Summary



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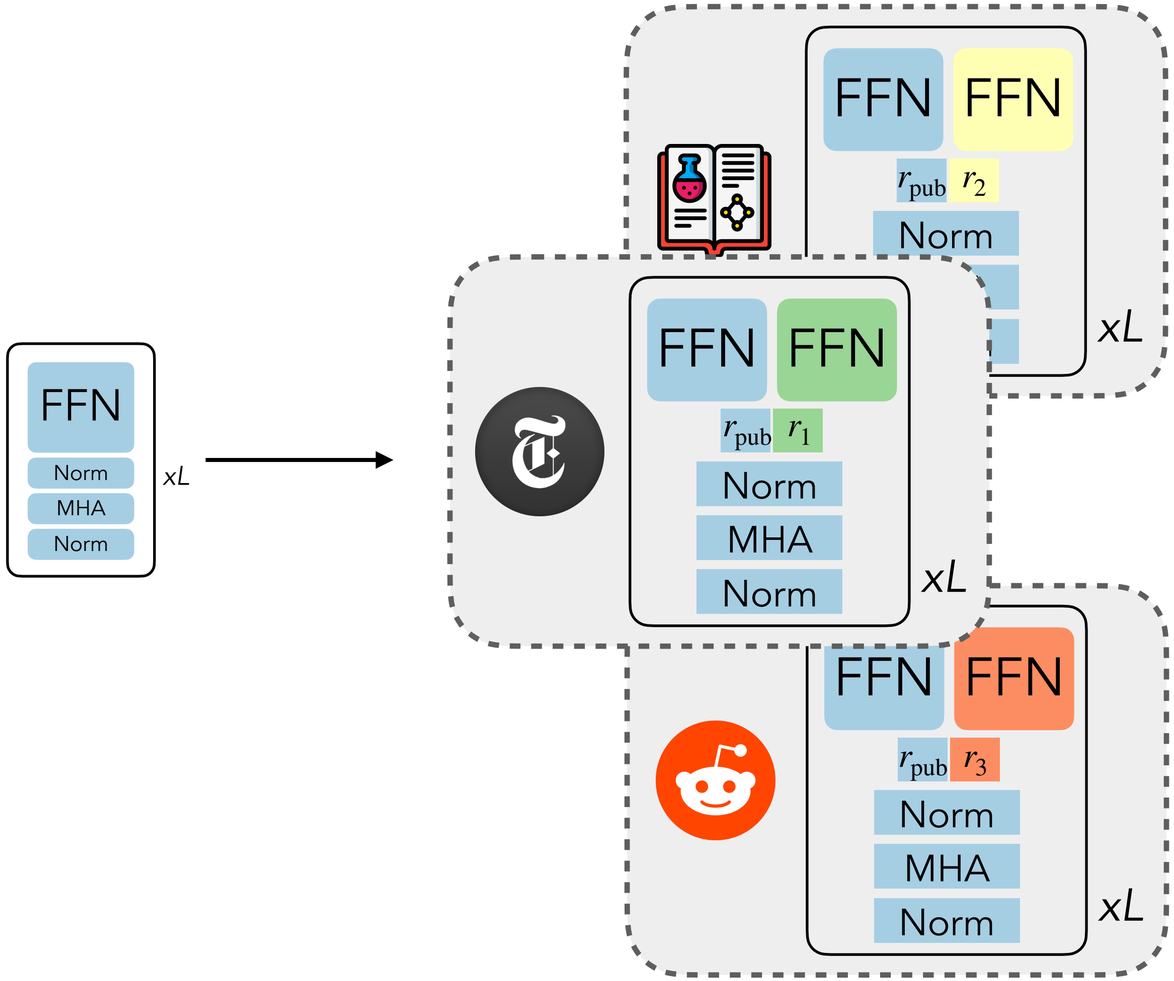

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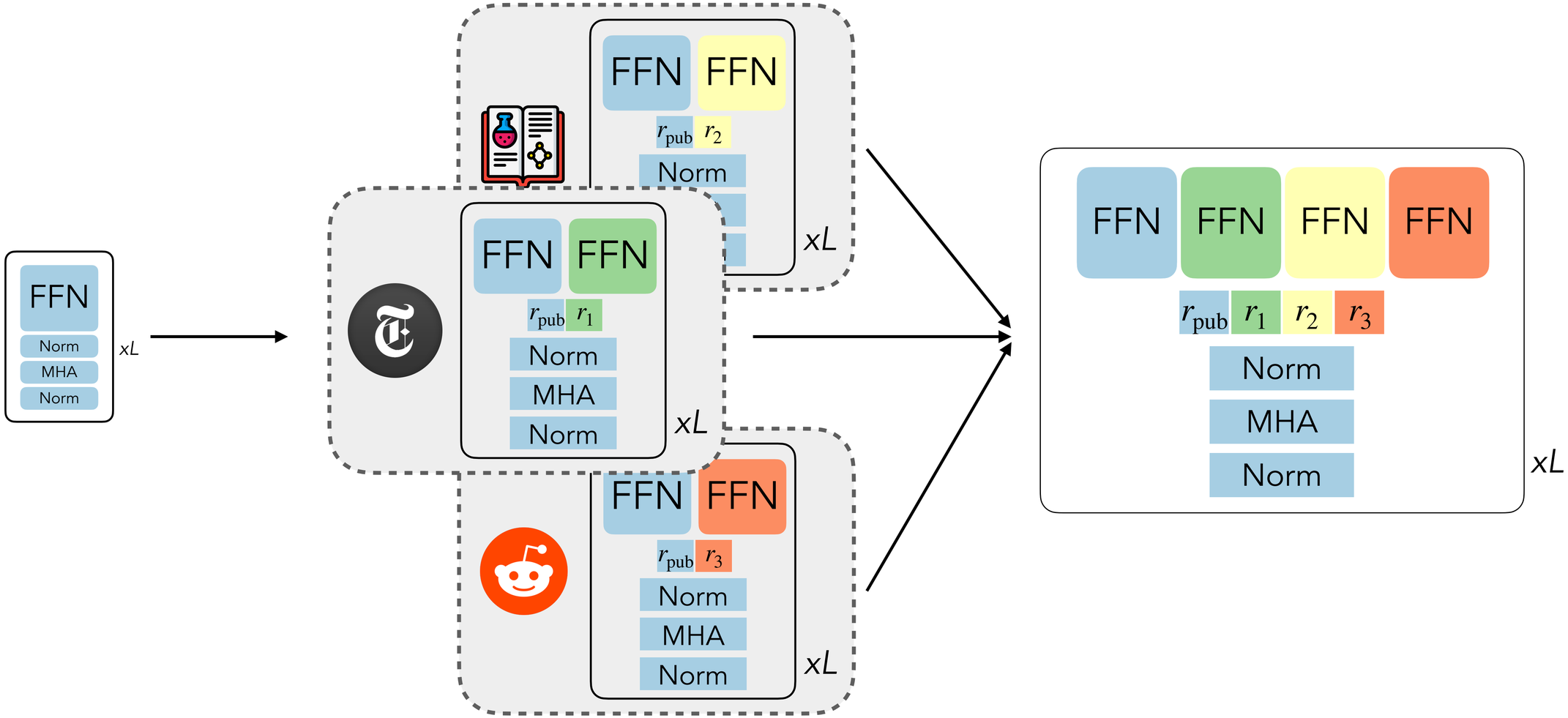

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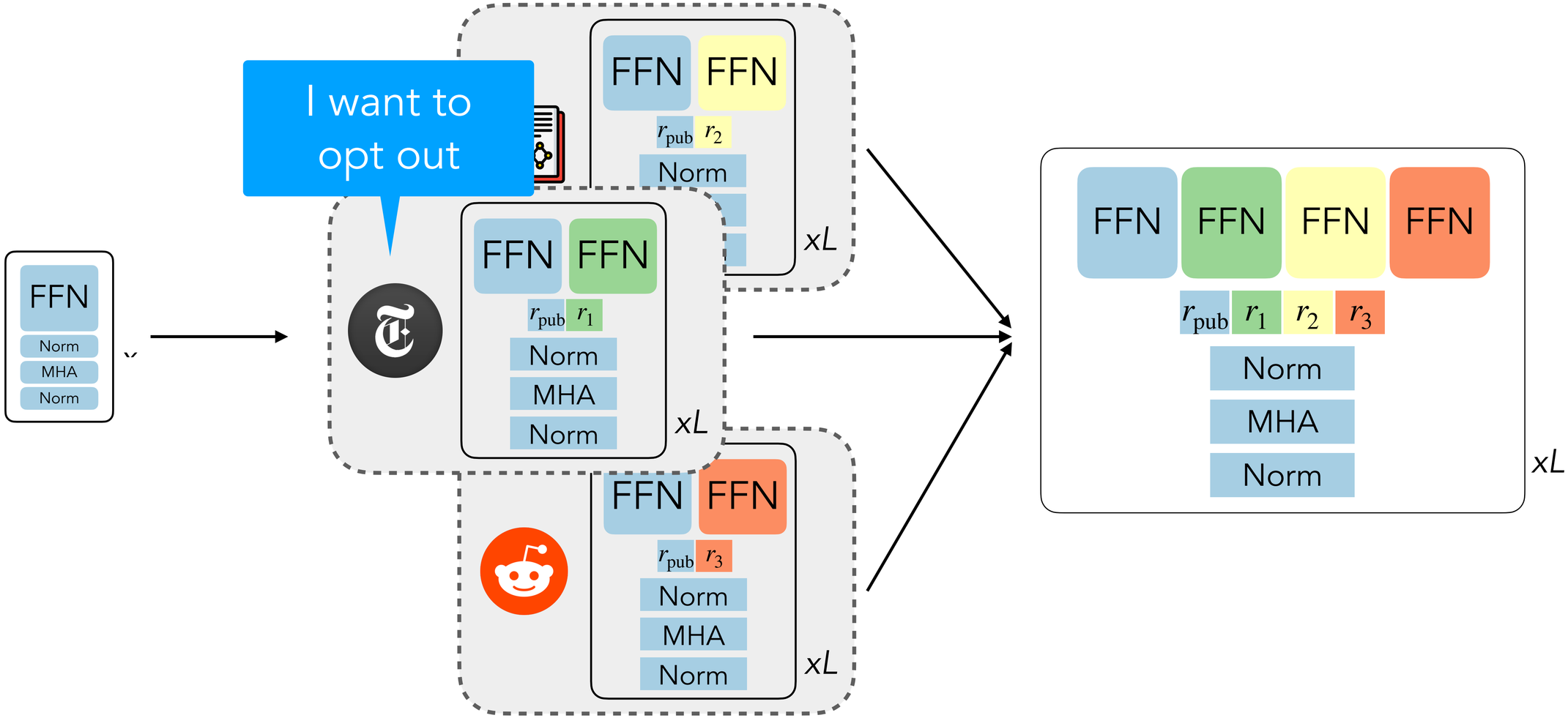

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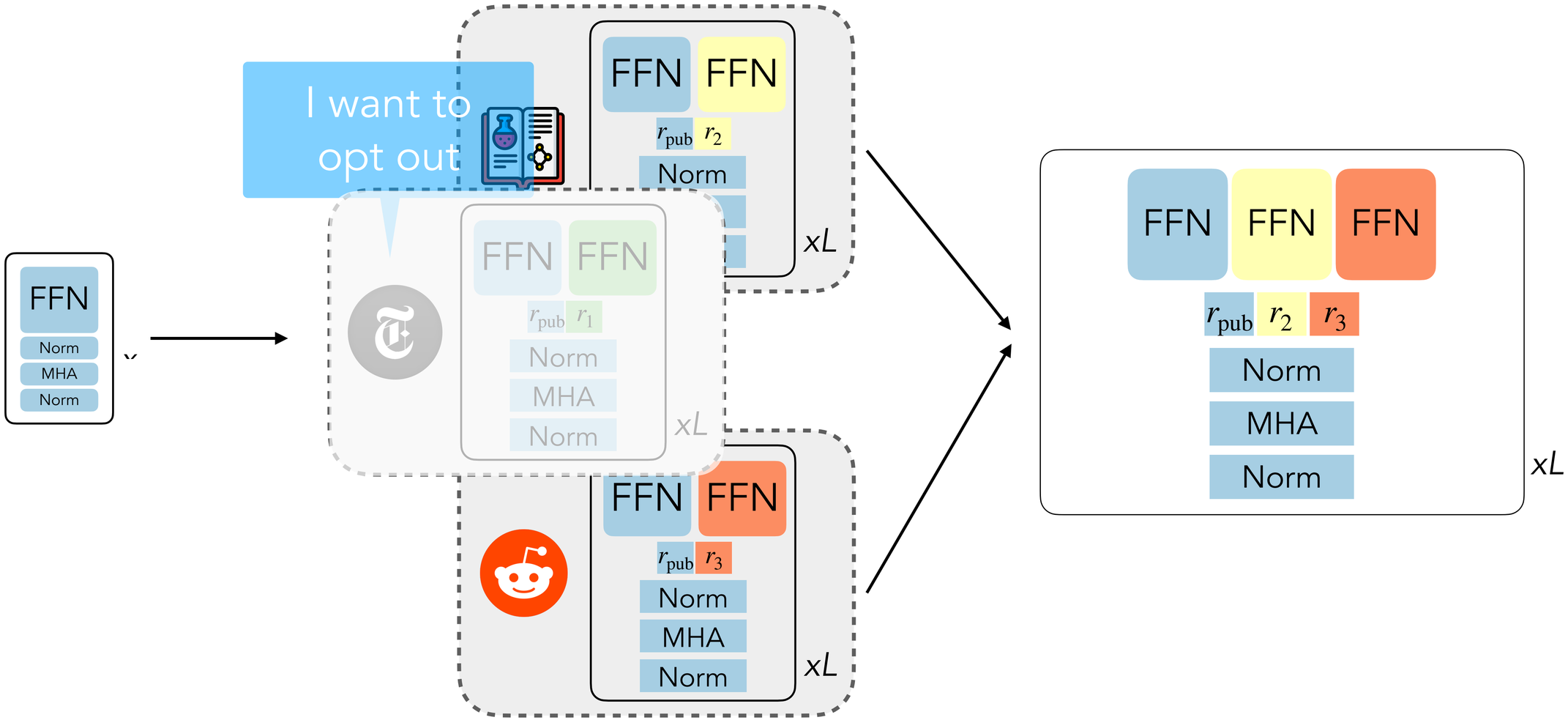


Experimental setup (1/2)

COMMON CRAWL

Public data

Experimental setup (1/2)

COMMON CRAWL

Public data

Math

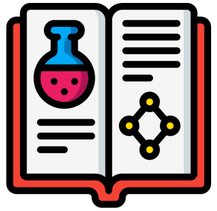
Code

Creative writings

Papers

News

Reddit



Educational Text

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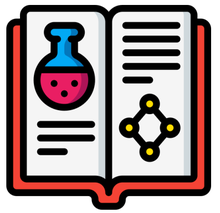

Educational Text

← Actual proprietary data (Can't publicly acquire as of now)

Experimental setup (1/2)

COMMON CRAWL

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Math

Code

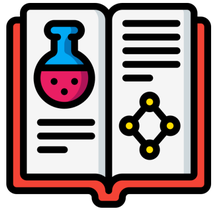
Creative writings

Papers

← Simulated proprietary data (Realistic domains)

News

Reddit



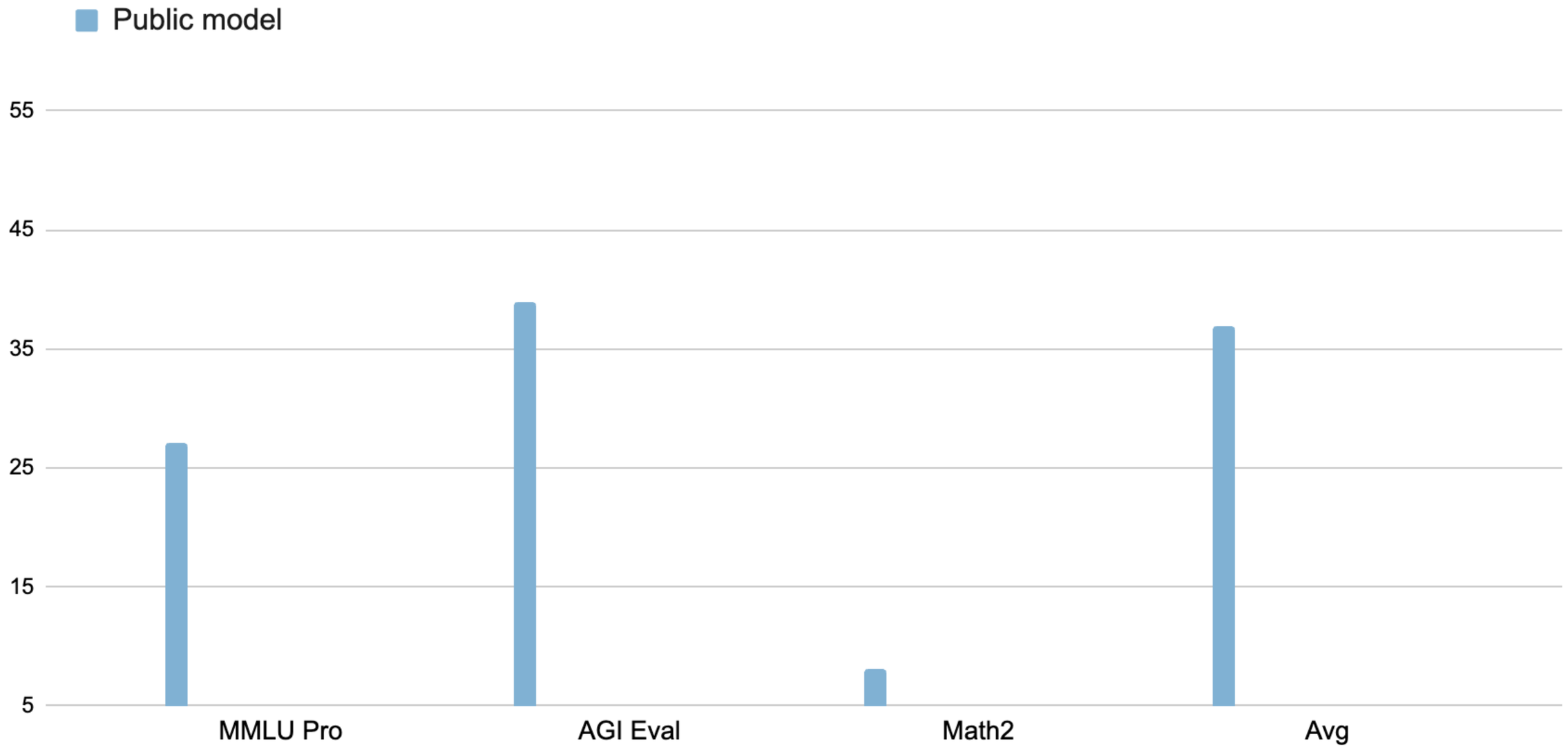
Educational Text

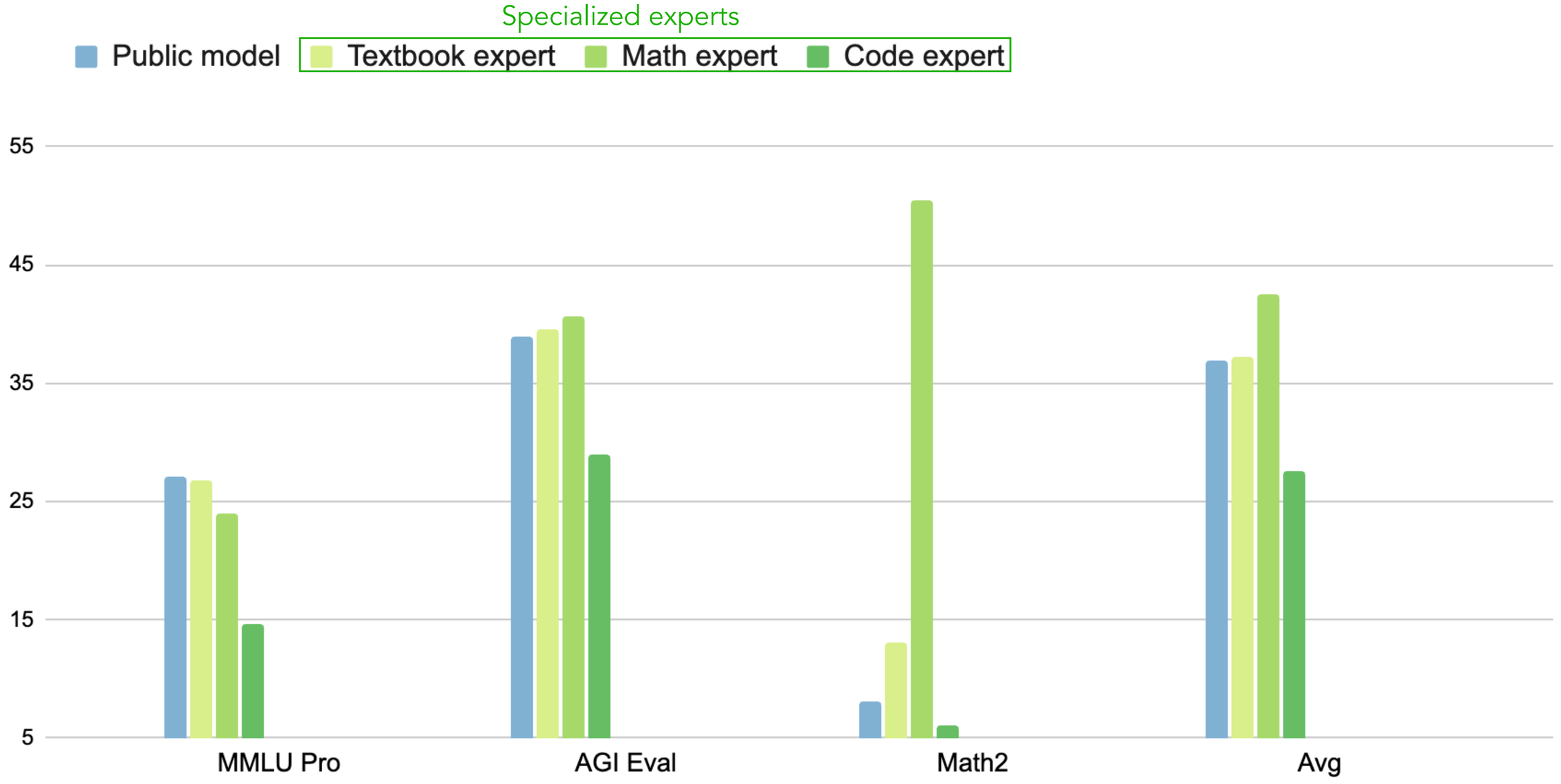
Experimental setup (2/2)

- **7B parameters**
- Hidden dimension: 4096
- Attention heads: 32
- Batch size: 1024
- Sequence length: 4096
- Peak learning rate: 9e-4
- LR warmup 2000 steps
- Learning rate schedule: Cosine decay until 5T tokens, truncated at 1B, then annealed

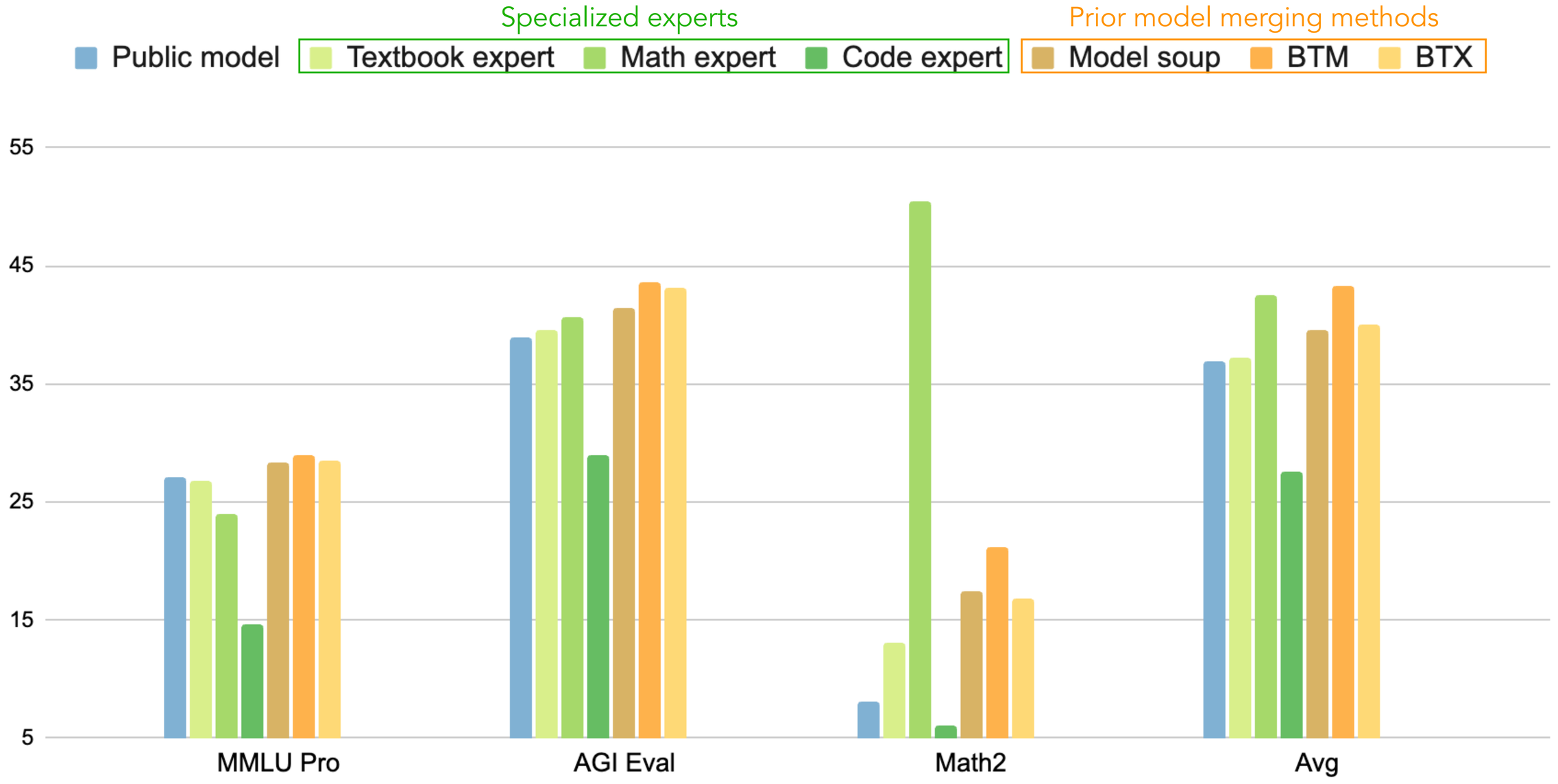
Pre-training on shared data for **1T tokens**

Continual pre-training on each siloed data for **50B tokens**

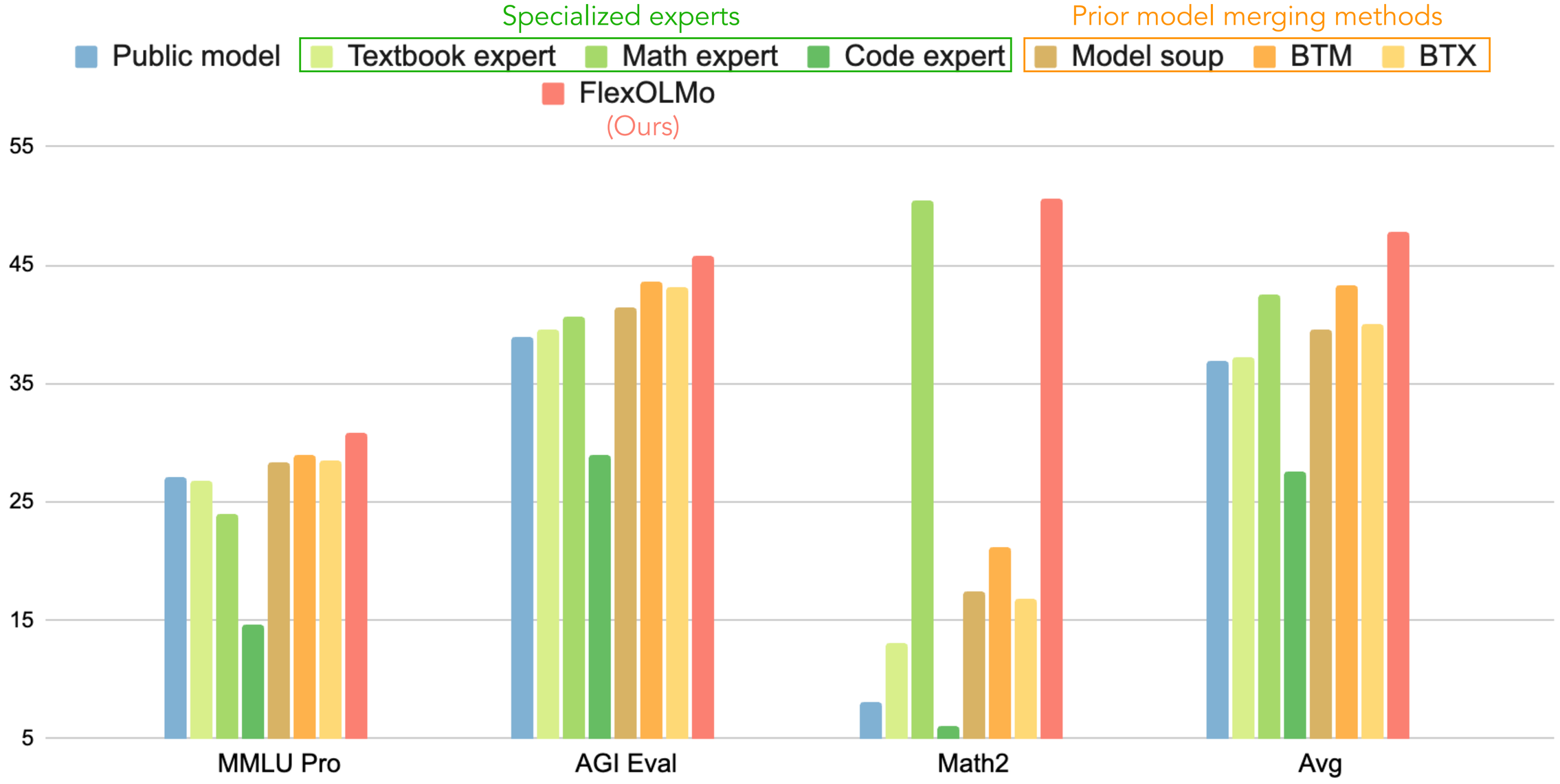

Public model
55
45
35
25
15
5
MMLU Pro
AGI Eval
Math2
Avg



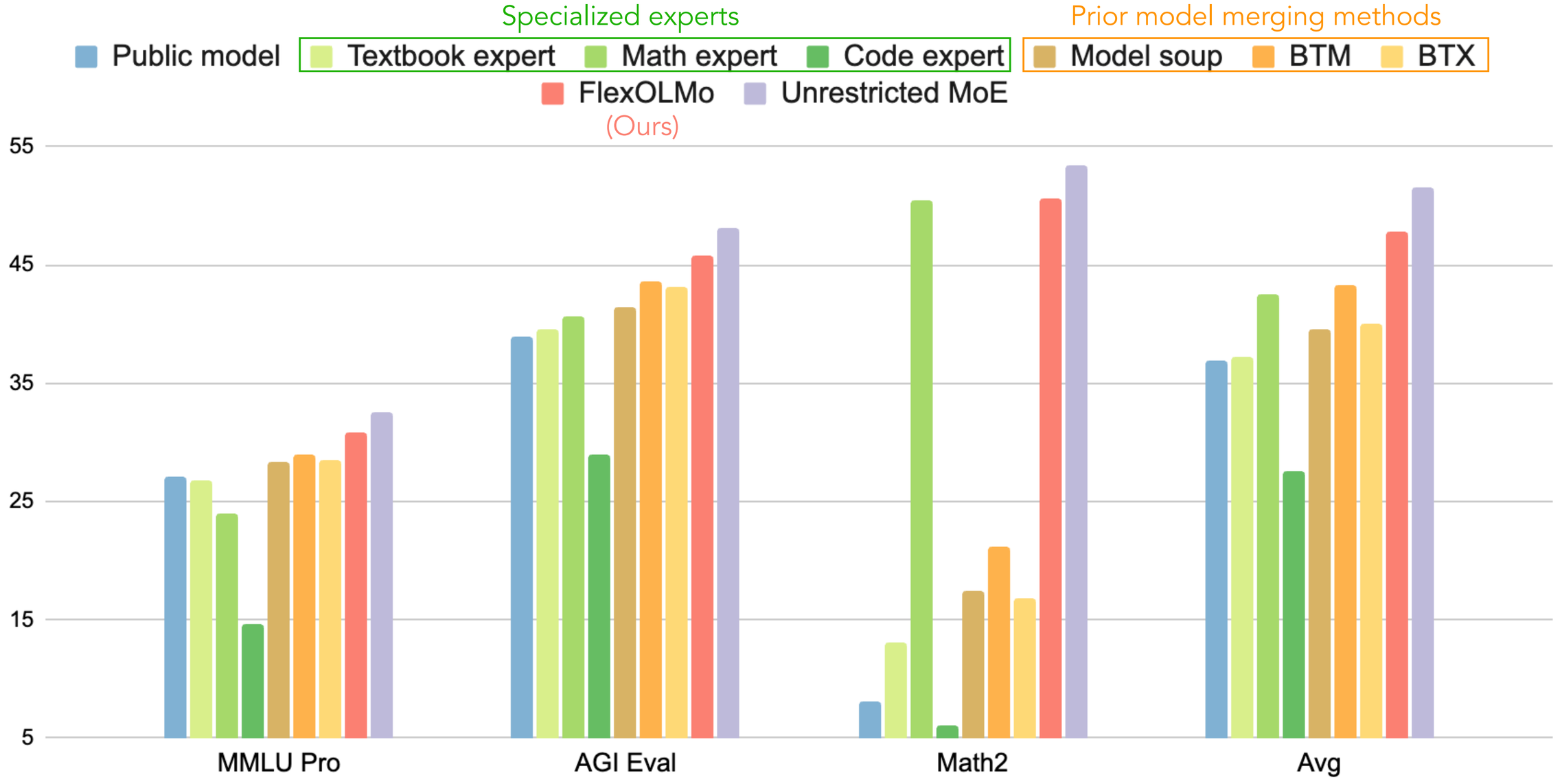
Continual training helps in-domain tasks but hurts out-of-domain



Model merging helps, with BTM being most competitive

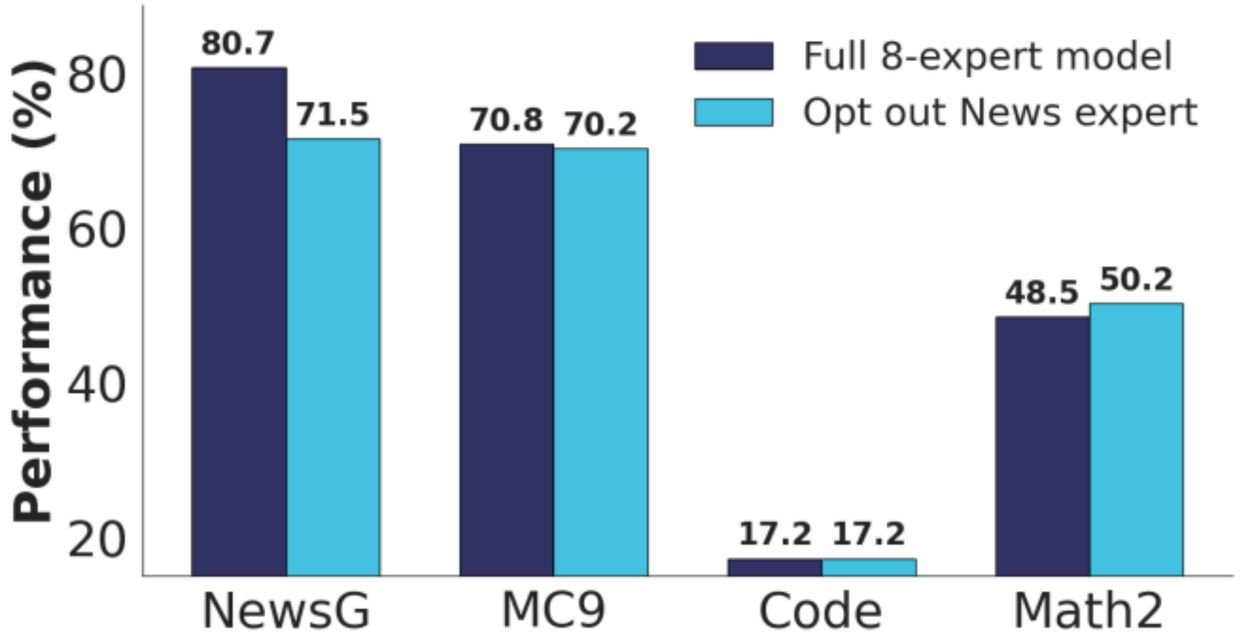


FlexOLMo achieves 41% relative gain over prev public model



FlexOLMo retains 90% of the benefits of fully unrestricted training

Opt-out Experiments



Results when opting out an expert trained on news data

Opt-ing out has minimal impact to other experts

Summary

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Our work: MoE enables training on distributed datasets

- Different experts trained independently by data owners
- Experts merged into a single model
- How? MoE-aware independent training + nonparameteric router

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- How? MoE-aware independent training + nonparameteric router

Results:

- Outperforms training on public data only
- Approaches joint training on all datasets
- Significantly improves training efficiency
- Provides free opting-out for data owners

Open Problems

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- Scaling # of experts (datasets)?
- Can we leverage this architecture & training to allow continual learning?
- How to better train a nonparametric router?

Thank you for listening!

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Please leave feedback at tinyurl.com/sewonm-talk