

Find Your Optimal Teacher:

Personalized Data Synthesis via Router-Guided Multi-Teacher Distillation

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Find Your Optimal Teacher: Personalized Data Synthesis via Router-Guided Multi-Teacher Distillation

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The strongest model \neq best teacher. It depends on the student.

THE DEFAULT



Strongest, largest teacher



Highest-quality answers...

...but too complex.

They drift from the small student's distribution
— the student can't absorb them.

Select the Suitable Teacher



Optimal teacher



Answers the student can learn

Match the teacher to the student.

A smaller teacher may provide better results.

How We Select Optimal Teacher Considering Both Teacher and Student Sides



Quality

Estimated by a reward model

How good is the teacher's answer?



Learnability

Avg. token log-probability

How easily can this student absorb that answer?



Quality alone → answers too hard.

Learnability alone → easy to learn but low quality.

How to Learn Effectively

Personalized Data Synthesis

THE DEFAULT



Select Teacher at
Dataset-level



Allocate a static teacher for the student model,
making the synthetic dataset sub-optimal

Our: PerSyn



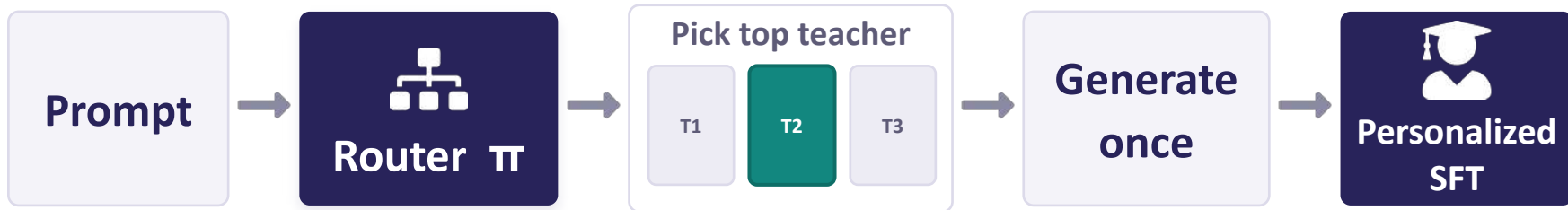
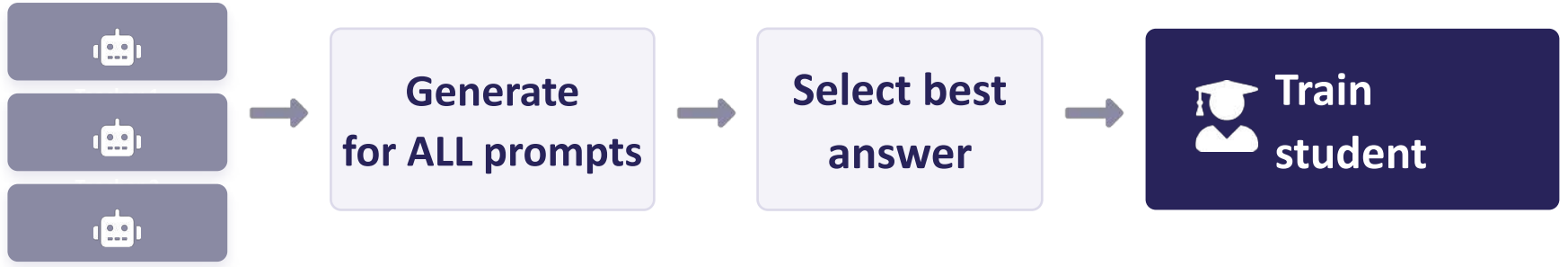
Select Teacher at
Query-level



Each prompt in the dataset is assigned
to its most suitable teacher model.

How to Learn Efficiently

Shift from “generate then select” to “route then generate”



MAIN RESULTS

PerSyn Outperform the Baseline



Avg. score over 6 benchmarks (IFEval · TruthfulQA · LiveBench · GSM8K · MATH · SVAMP)



- Student Models
 - Qwen2.5-0.5B,
 - Qwen2.5-1.5B,
 - Gemma-2-2B,
 - Qwen2.5-3B,
 - Llama-3.2-3B

TAKEAWAY

Stop defaulting to the biggest teacher.

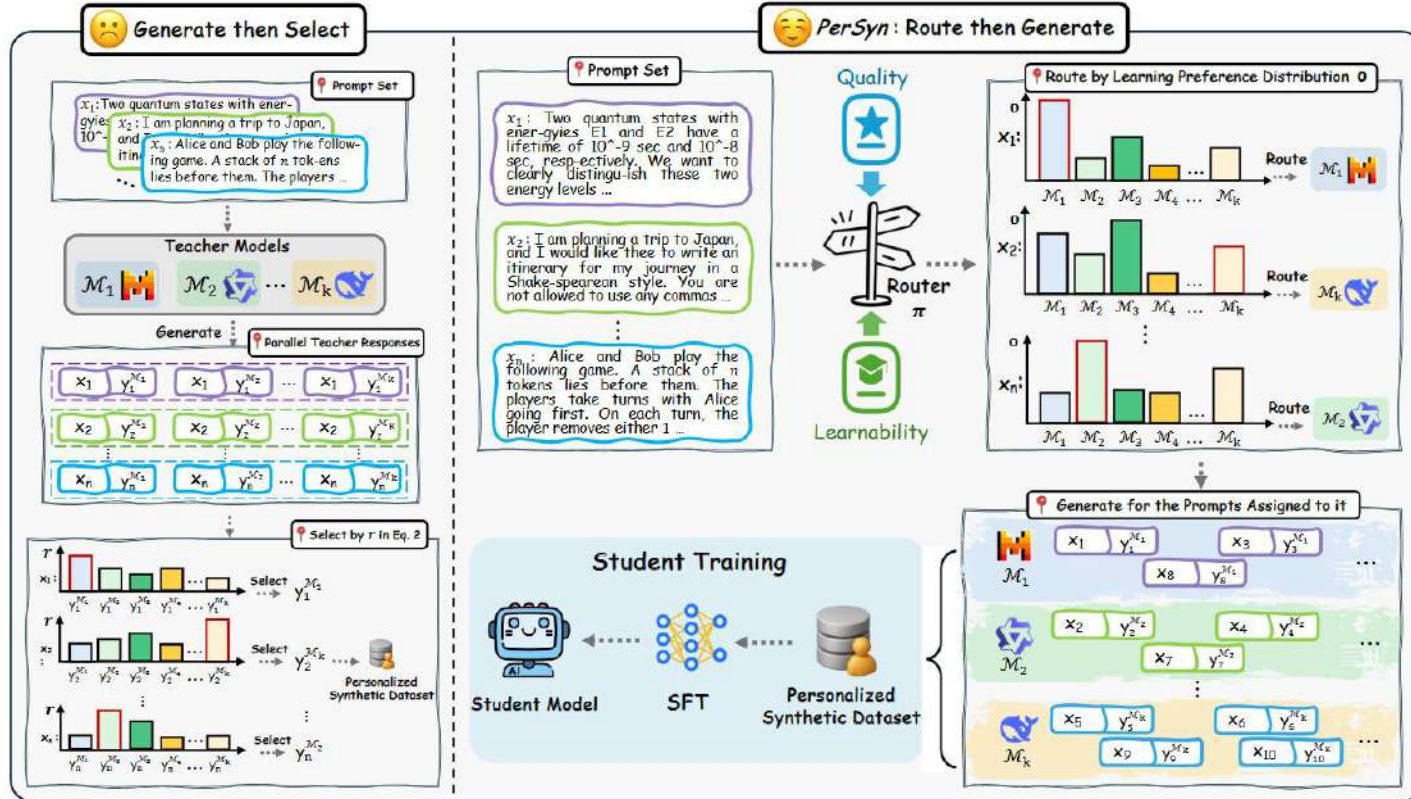
Route each prompt to the teacher the student can best learn from.

- **Quality + learnability** — two signals.
- **Personalized Data Synthesis** — learn effectively.
- **Route then generate** — learn efficiently.

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Thank you!

Generate then Select -> Route then Generate



Efficiency Comparison

N = number of prompts, N_s = number of sampled prompts for training, K = number of teachers

