MONAQ

Multi-Objective Neural Architecture Querying for Time-Series Analysis on Resource-Constrained Devices

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🧩 Motivation

Explosion of time-series data from IoT, wearables, and mobile devices.

Challenge

- Deploying DL models on MCUs (≤ 512kB SRAM) is non-trivial.
- Existing hardware-aware NAS (HW-NAS) methods:
  - Focus on vision tasks.
  - Require fixed search spaces and manual tuning.

Goal

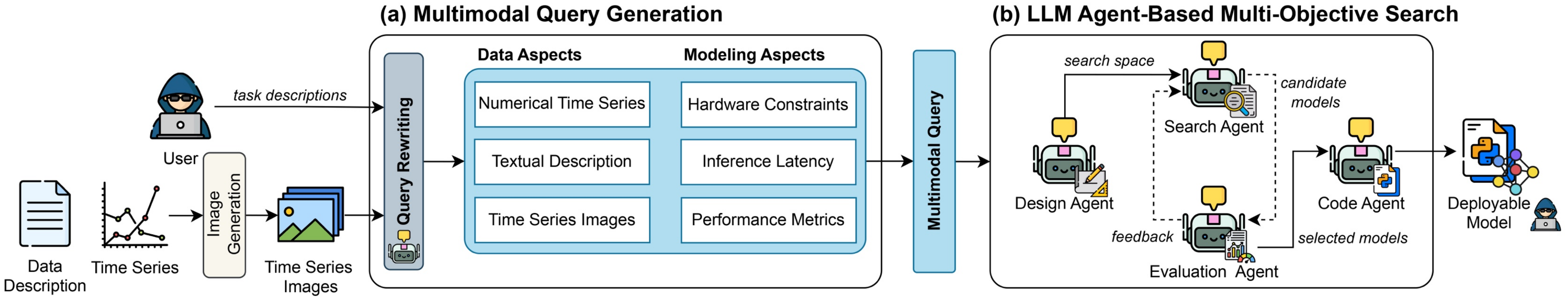
Democratize efficient on-device time-series model design.

🚀 Our Contribution

A LLM-driven framework that reformulates NAS as **Neural Architecture Querying (NAQ)** with:

- **Natural language input only**
  > no need for initial architectures or search spaces.
- **Multimodal query generation**
  > (numerical, textual, visual) for time-series.
- **Multi-agent LLMs**
  > to conduct low-cost, training-free multi-objective search.

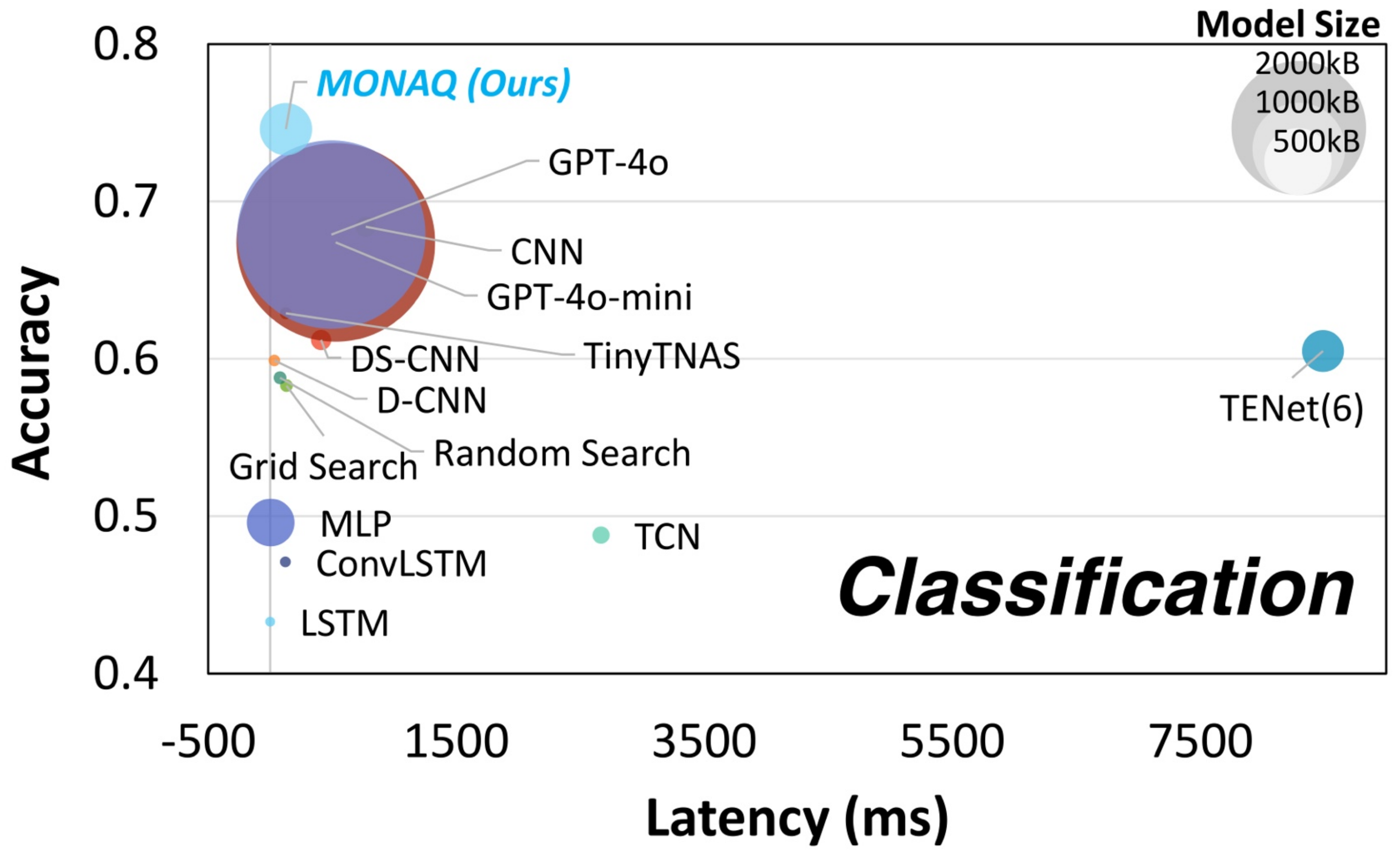
🧱 Framework Overview

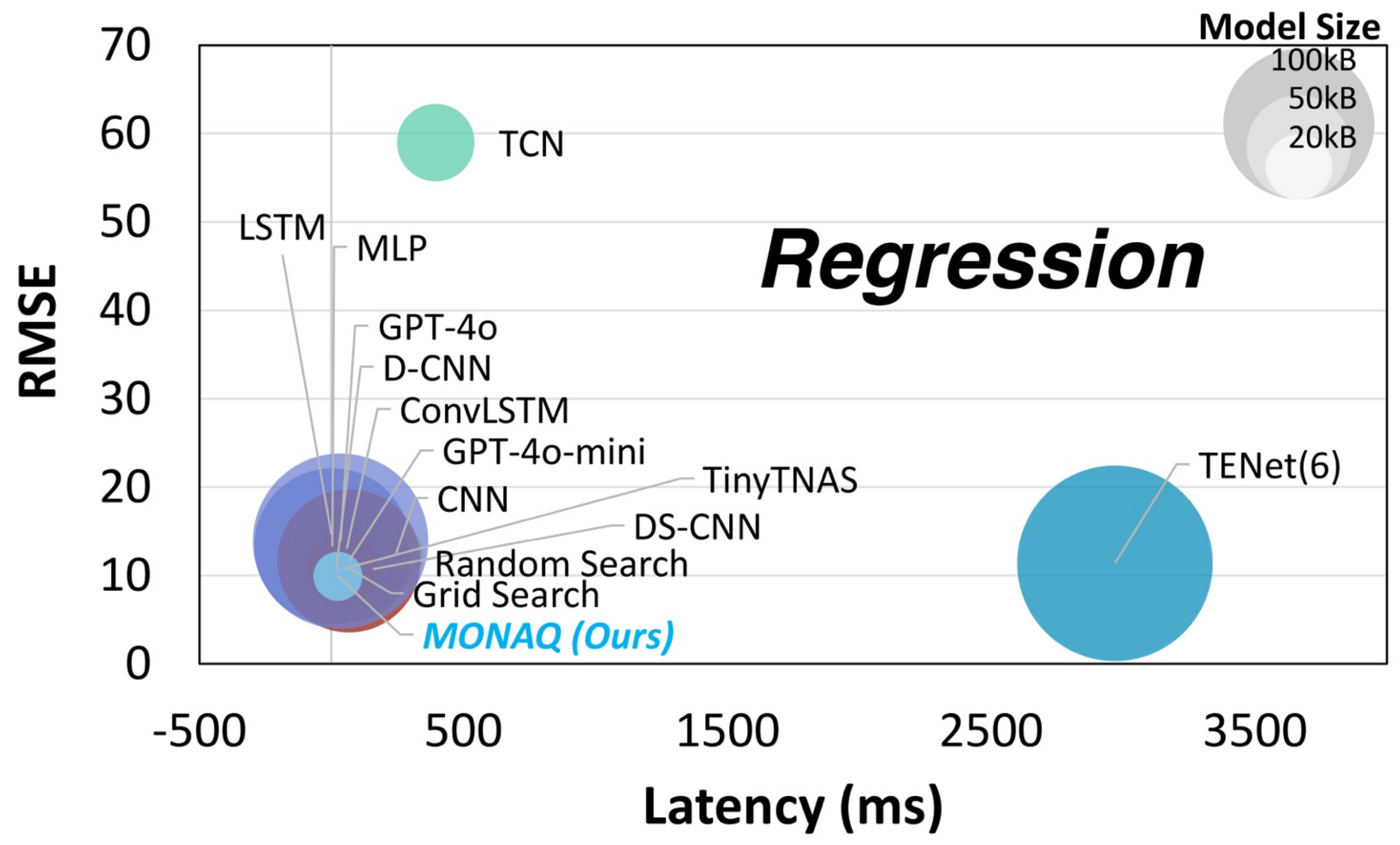


(a) Multimodal Query Generation

(b) LLM Agent-Based Multi-Objective Search

📊 Experimental Results





Ablation Study

Table 3. Ablation study results of multimodal query generation and multi-agent based search components.

Agents	Query Modality			Classification			Regression		
	Numerical Time Series	Textual Descriptions	Time Series Images	Latency (ms)	Accuracy	FLASH (kB)	Latency (ms)	RMSE	FLASH (kB)
Single (GPT-4o Backbone)	✓			519.159	0.679	3349.453	23.797	13.944	125.445
		✓		1017.267	0.665	4126.024	42.779	13.227	134.901
			✓	593.541	0.690	5971.792	35.859	12.562	193.926
	✓	✓		807.459	0.628	4926.157	40.485	13.556	137.581
	✓	✓	✓	557.665	0.629	3871.910	22.726	12.681	90.398
Multiple (GPT-4o Backbone)	✓			149.320	0.434	**12.066**	54.270	12.284	10.611
		✓		170.461	0.440	15.198	110.751	12.084	12.560
			✓	280.198	0.661	15.638	**13.661**	11.653	**7.885**
	✓	✓		205.623	0.517	16.035	28.049	13.207	13.875
	✓	✓	✓	**127.260**	**0.746**	257.742	24.729	**9.902**	10.582

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Paper

Table 2. Ablation study results on query rewriting and various agent combinations.

Variations	Classification			Regression		
	Latency (ms)	Accuracy	FLASH (kB)	Latency (ms)	RMSE	FLASH (kB)
MONAQ	127.260	**0.746**	257.742	24.729	**9.902**	10.582
w/o Query Rewriting	206.871	0.651	17.186	14.623	11.994	10.155
w/o $\mathcal{A}_{design}$	863.358	0.647	518.762	95.654	13.512	33.243
w/o $\mathcal{A}_{eval}$	540.411	0.641	4775.661	26.335	12.783	109.627
w/o $\mathcal{A}_{eval}$ & $\mathcal{A}_{search}$	601.313	0.643	5907.363	188.123	11.261	665.110
Only $\mathcal{A}_{code}$	579.876	0.612	4158.205	21.530	12.274	99.638