Hybrid-RACA: Hybrid Retrieval-Augmented Composition Assistance for Real-time Text Prediction

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What is Hybrid-RACA?

Hybrid-RACA is a system for **real-time text prediction** that efficiently combines a **cloud-based LLM and data** with a **small client-side model** through **retrieval augmented memory**.

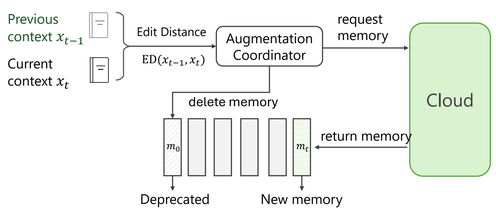
Key Features of Hybrid-RACA

- **Low latency** with hybrid modeling and asynchronous augmentation: Ensures fast response time by using the client model to make predictions
- **Enhanced utility** through hybrid retrieval augmentation and LLM-compressed memory: Improves the client model's suggestions
- **Minimized cloud-client communication:** Employs an augmentation coordinator to reduce the frequency of cloud-client interactions, leveraging LLM-compressed memory for enhanced efficiency.

Key Components of Hybrid-RACA

Step 1: The user types text on the client device.

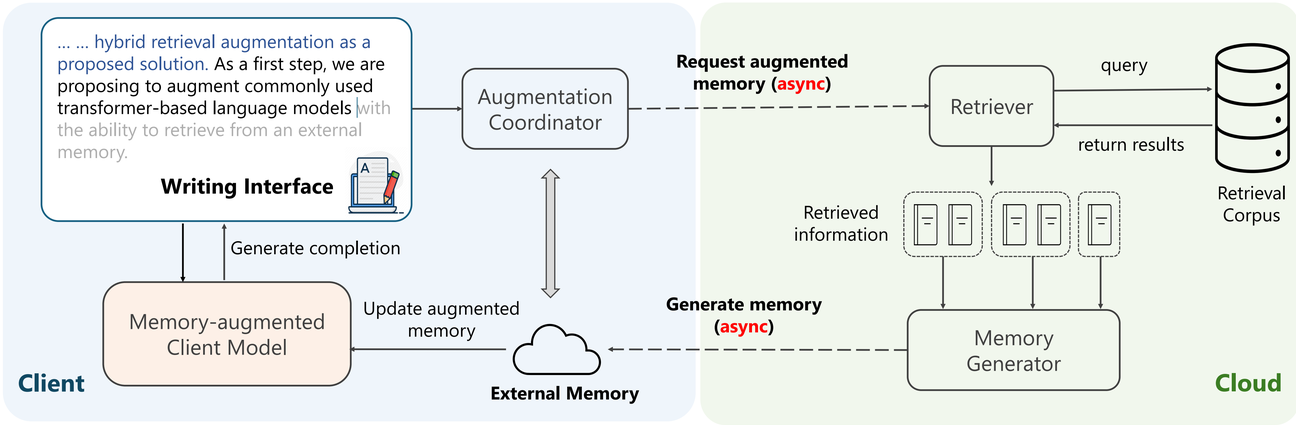
Step 2: The **Augmentation Coordinator** tracks changes to the writing context and sends an *asynchronous* request to the cloud if the changes exceed a predefined threshold.



Step 3: The **Retriever** fetches relevant documents and triggers the **Memory Generator**, a cloud-based LLM, to generate condensed *memory* that captures key takeaways from the retrieved content.

Step 4: The client-side memory is updated asynchronously with the new memory from the cloud.

*Step **: The **Memory-Augmented Client Model** makes more relevant predictions. It is instruction tuned to effectively leverage cloud –generated memory. *This step runs continuously and doesn't need to wait for step 2-4.*



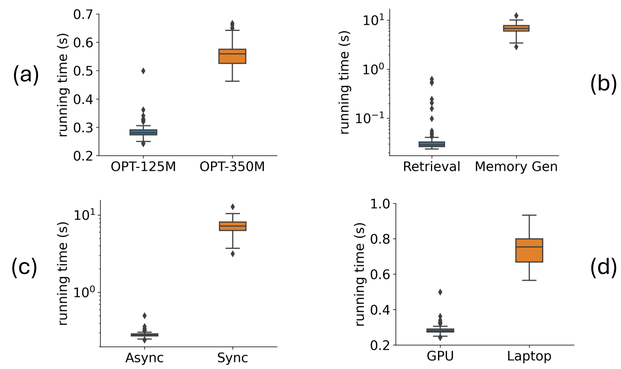
Utility Improvements

- **Substantial utility gains on in-domain evaluation**: Hybrid-RACA demonstrates strong text prediction performance on WikiText data with OPT-125M/OPT-350M
- **Consistent improvements on out-of-domain data** including Enron Emails, NIH ExPorter, Hacker News and Youtube Subtitles (results in paper)

		PPL	GLEU
OPT-125M	Vanilla OPT	9.3	11.4
	HybridRAG	4.3	12.8
	Hybrid-RACA w/o FT	3.8	14.7
	Hybrid-RACA FT	3.4	23.0
	Hybrid-RACA IT	**2.6**	**30.2**
OPT-350M	Vanilla OPT	7.4	13.2
	HybridRAG	3.6	15.4
	Hybrid-RACA w/o FT	3.3	17.6
	Hybrid-RACA FT	3.2	23.9
	Hybrid-RACA IT	**2.4**	**32.6**

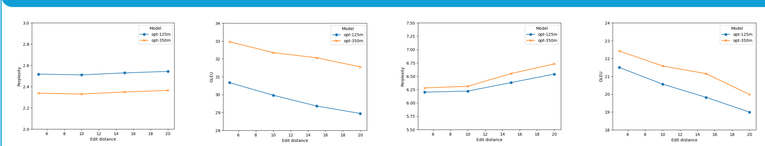
Model	GPT Score
GPT3.5	**7.73**
Vanilla OPT-125M	2.20
Vanilla OPT-350M	2.60
Hybrid-RACA IT OPT-125M	5.27
Hybrid-RACA IT OPT-350M	**5.49**

Latency Improvements



Highlights: Fig (c) showcases a remarkable **138x faster inference speed** achieved by our asynchronous design compared to a synchronous approach.

Trade-off with Asynchronous Memory Updates



- Performance decay with increased threshold for async memory update: As the memory becomes less fresh, performance gradually declines.
- Trade-off between freshness of memory and computation cost

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