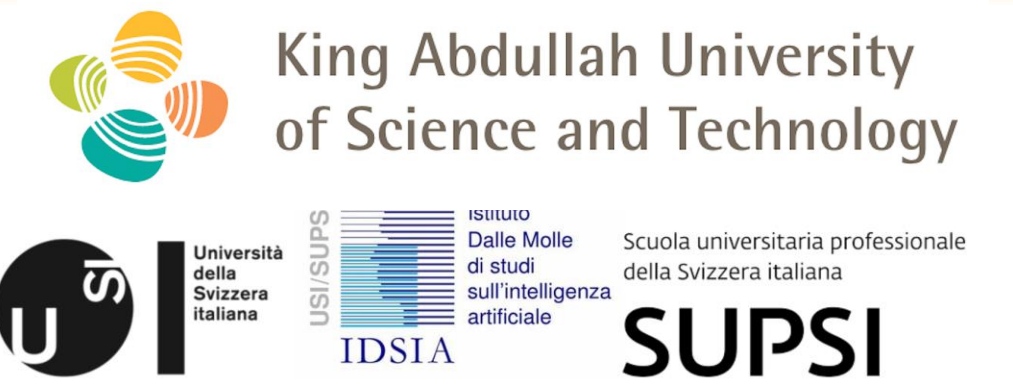




GPTSwarm: Language Agents as Optimizable Graphs

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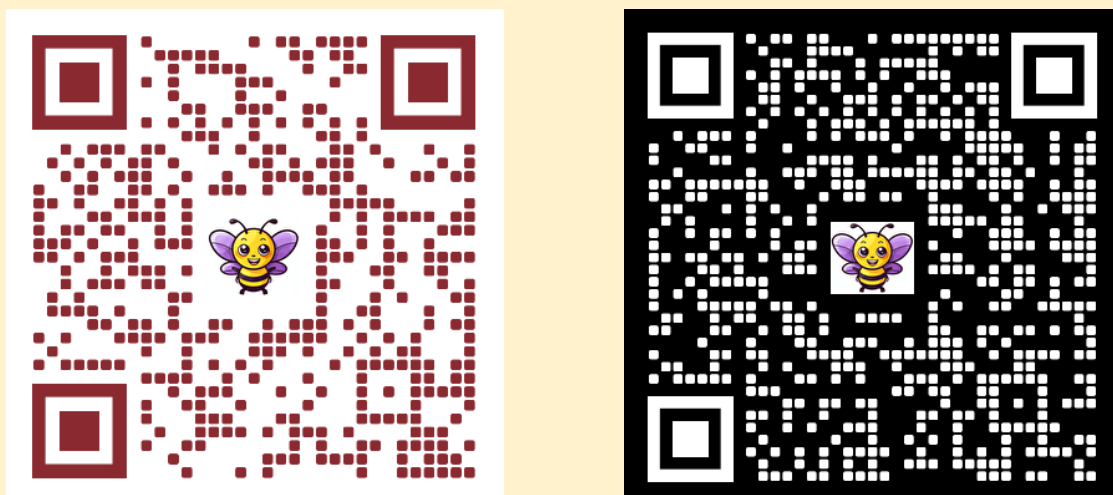
Contributions

- Agents expressed as graphs
- Automated design through graph optimization

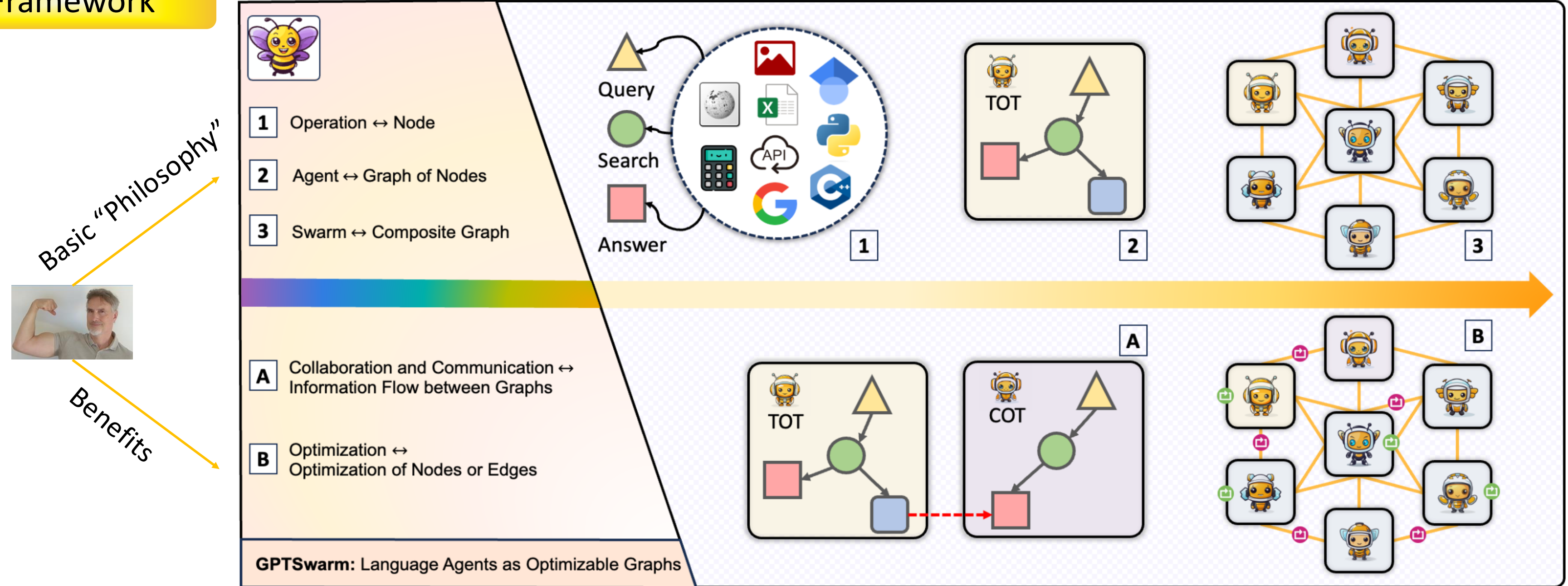
Introduction

Each node implements a function to process multimodal data or query other LLMs. Each edge describes the information flow between operations and agents. Graphs can be recursively combined into larger composite graphs representing hierarchies of inter-agent collaboration. Our novel automatic graph optimizers (1) refine node-level LLM prompts (node optimization) and (2) improve agent orchestration by changing graph connectivity (edge optimization).

Open-Source – try it out here



Framework



Methods

Algorithm 1 Graph Execution

Require: Computational graph $G = (N, E, F, o)$, input x , empty context z for each node without predecessors.

for n in $\text{TopologicalSort}(N)$ **do**
 $z_n \leftarrow \{f_n(z_v, x) : v \in \text{pre}(n)\}$
end for

Ensure: $f_o(z_o, x)$

Algorithm 2 Edge Optimization with REINFORCE

Require: A parameterized probabilistic distribution over computation graphs D_θ , an unbiased utility estimator $\hat{u}_\tau(\cdot)$, and a learning rate α .

Initialize $\theta \in \mathbb{R}^d$.

while terminate condition not met **do**
 Sample $G_i \sim D_\theta$ for $i = 1, 2, \dots, M$.
 Update $\theta \leftarrow \theta + \frac{\alpha}{M} \sum_{i=1}^M \hat{u}_\tau(G_i) \nabla_\theta \log(p_\theta(G_i))$.
end while

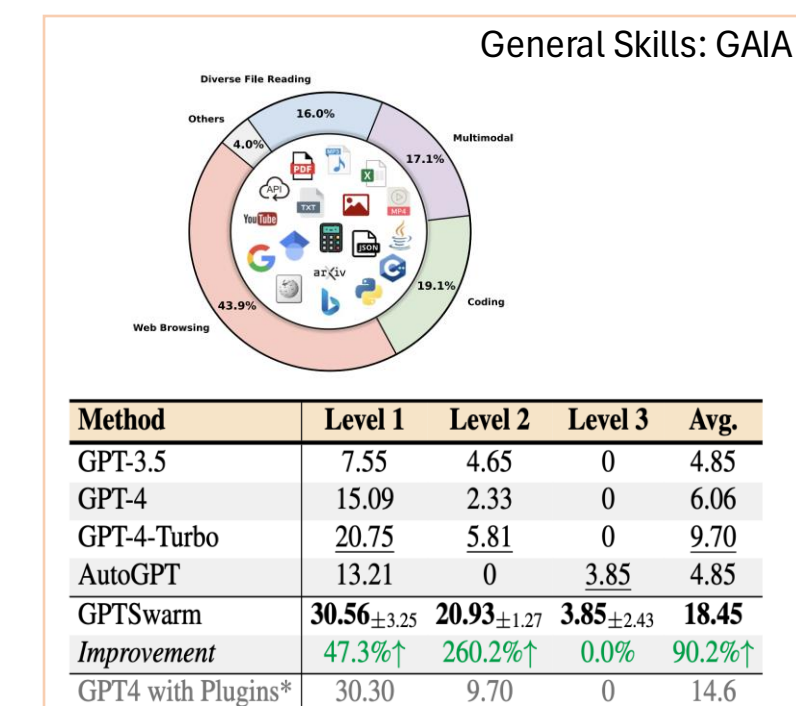
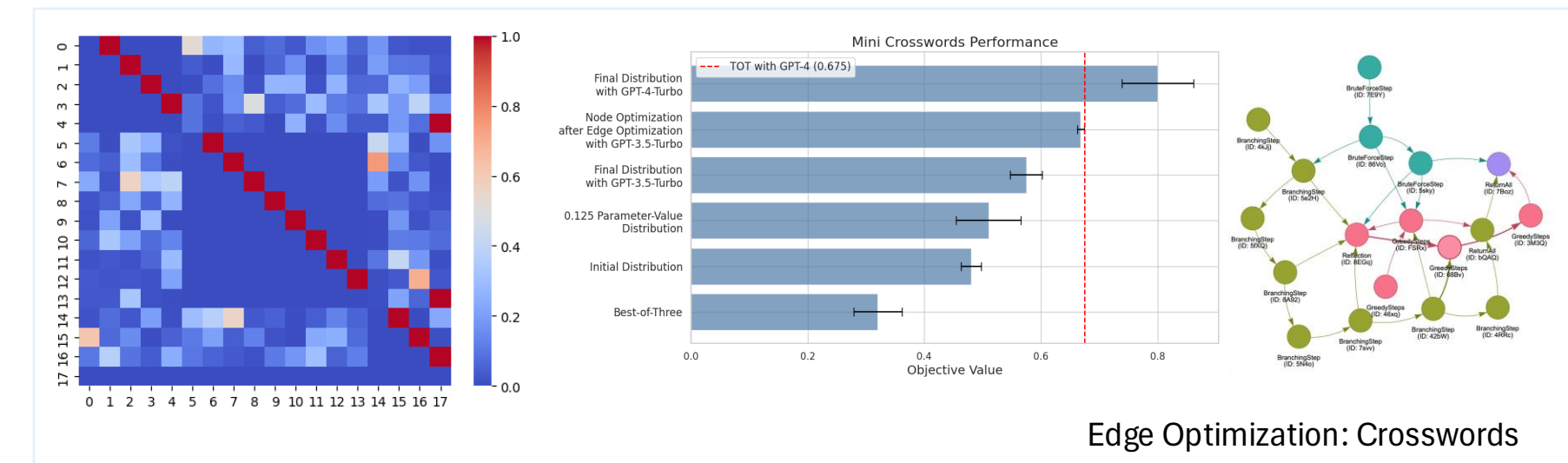
Algorithm 3 Node Optimization

Require: A parameterized graph $G^P = (N, E, F^P, o)$, natural language function descriptions $D = \{d_n\}_{n \in N}$, a prompt improver I , and a distribution of inputs D_X .

Initialize a prompt p_n for all $n \in N$.

Initialize a history record $h_n \leftarrow \emptyset$ for all $n \in N$.

while terminate condition not met **do**
 Sample input $x \sim D_X$.
 $y \leftarrow G^P(x)$ following Algorithm 1.
 $h_n \leftarrow h_n \cup \{(z_n, x), f_n^{p_n}(z_n, x)\}$ for all $n \in N$.
 $p_n \leftarrow I(h_n, p_n, d_n)$, for all $n \in N$.
end while



Experiments

Node Optimization: HumanEval
 76% to 88% accuracy

Edge Optimization: MMLU

