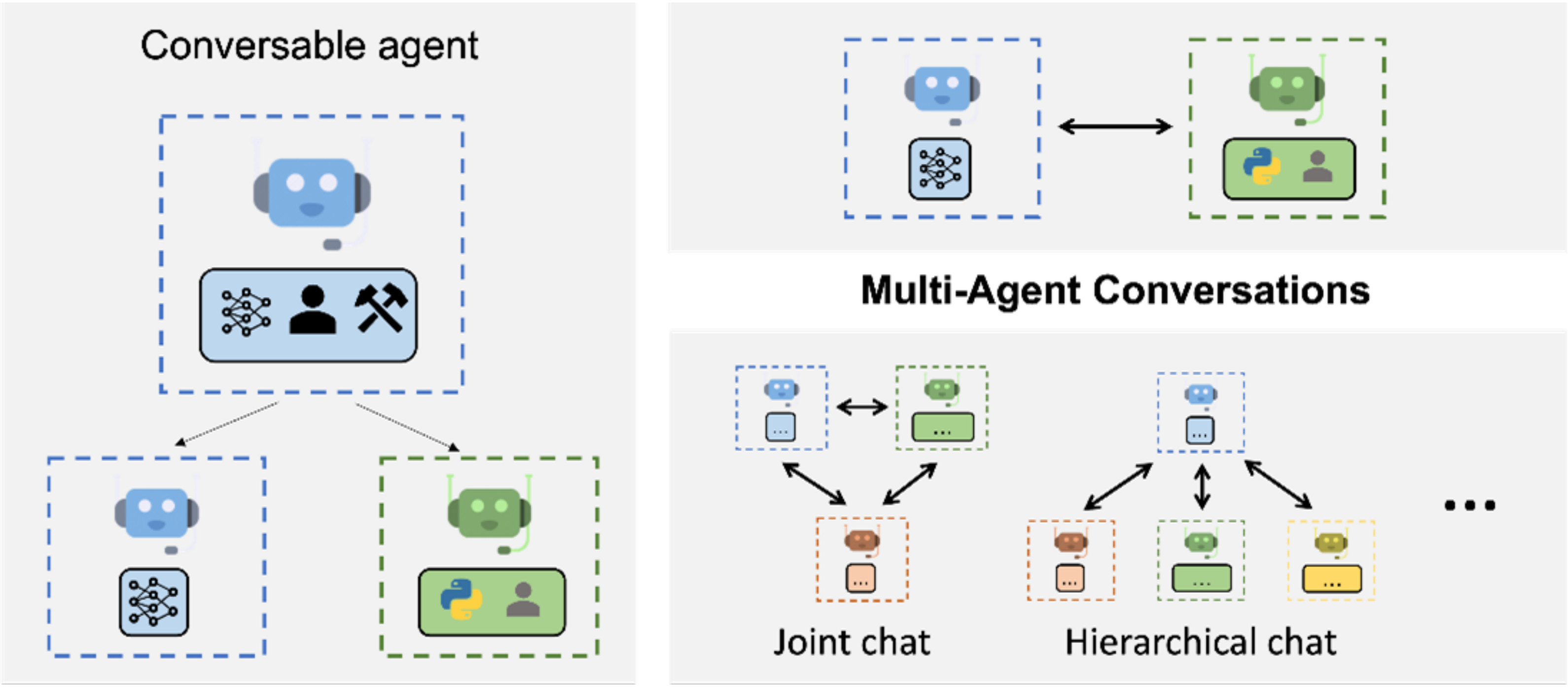
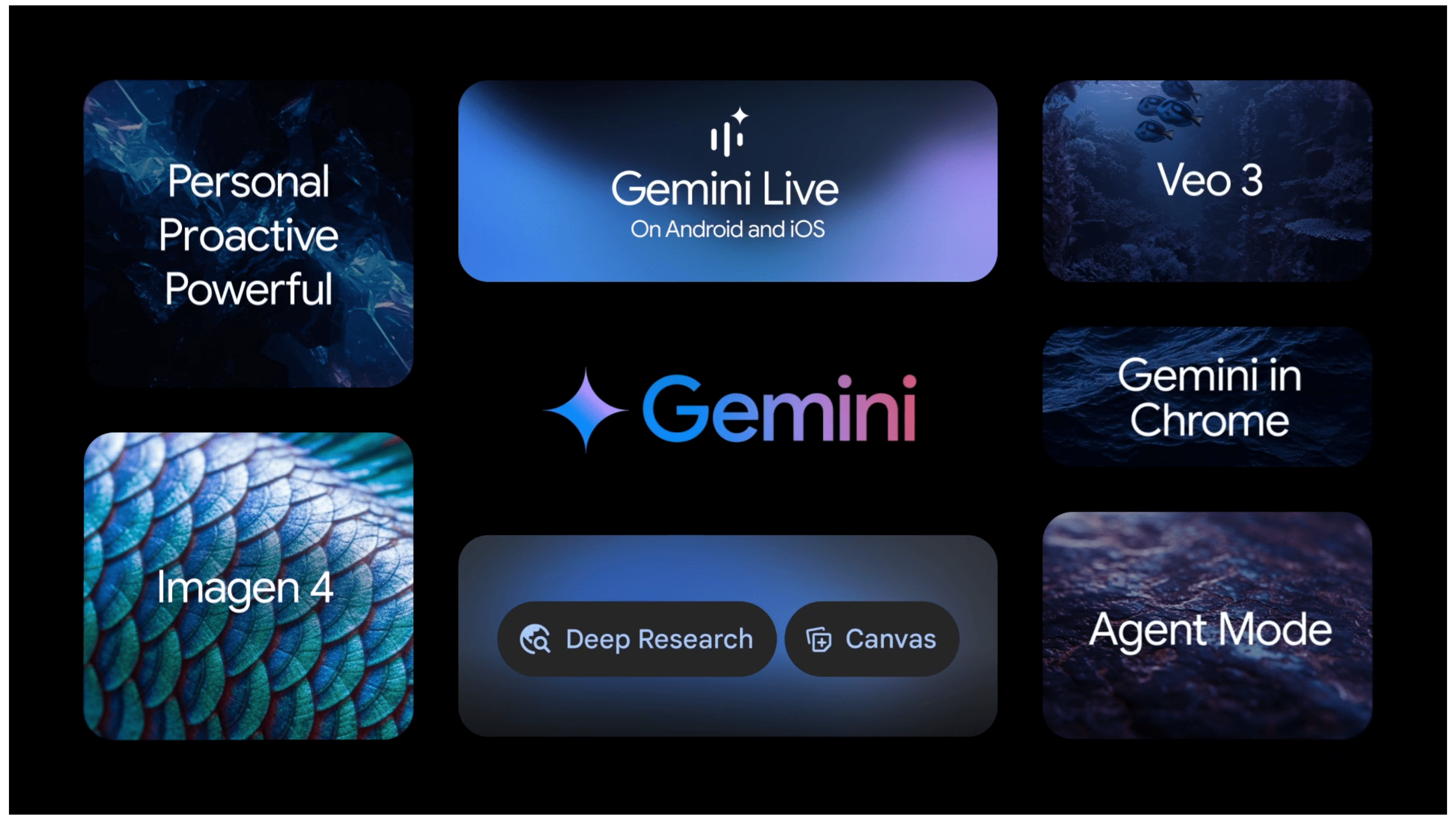
Agents, Agents Everywhere….



Agent Customization

Flexible Conversation Patterns

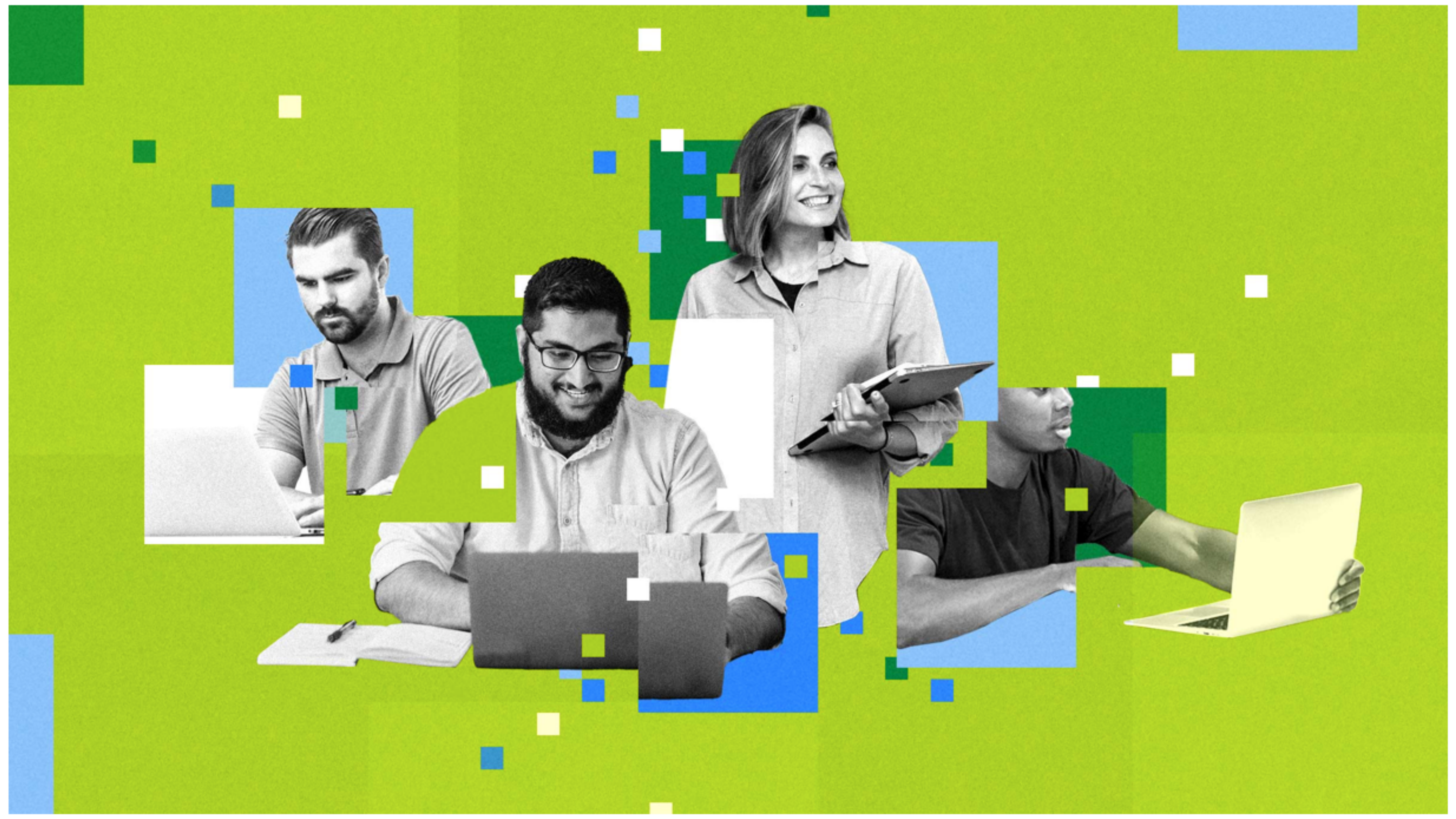


Generative AI

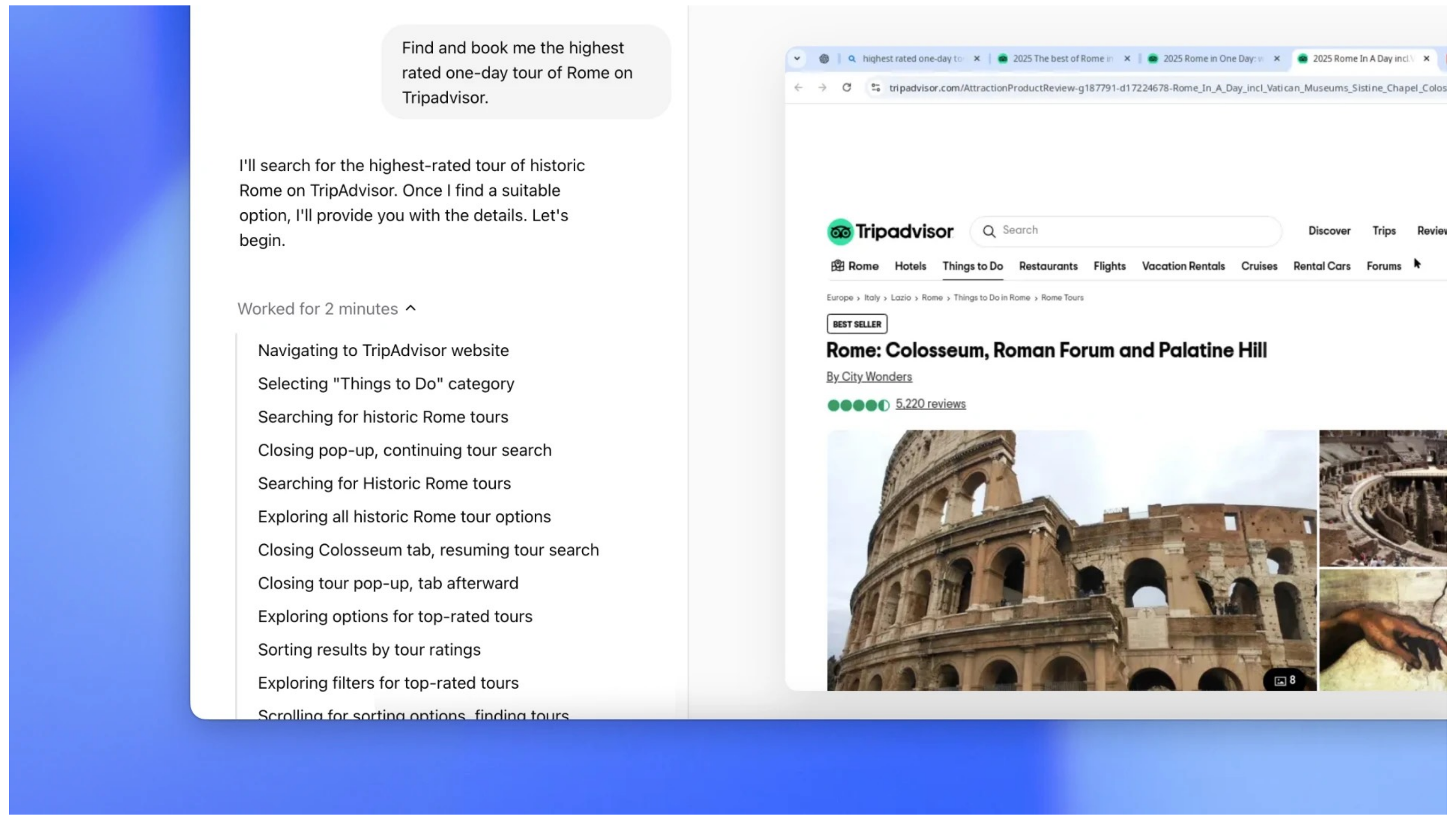
Agentic AI Is Already Changing the Workforce

by Jen Stave, Ryan Kurt and John Winsor

May 22, 2025



HBR Staff/Unsplash



Find and book me the highest rated one-day tour of Rome on Tripadvisor.

I'll search for the highest-rated tour of historic Rome on TripAdvisor. Once I find a suitable option, I'll provide you with the details. Let's begin.

Worked for 2 minutes ^

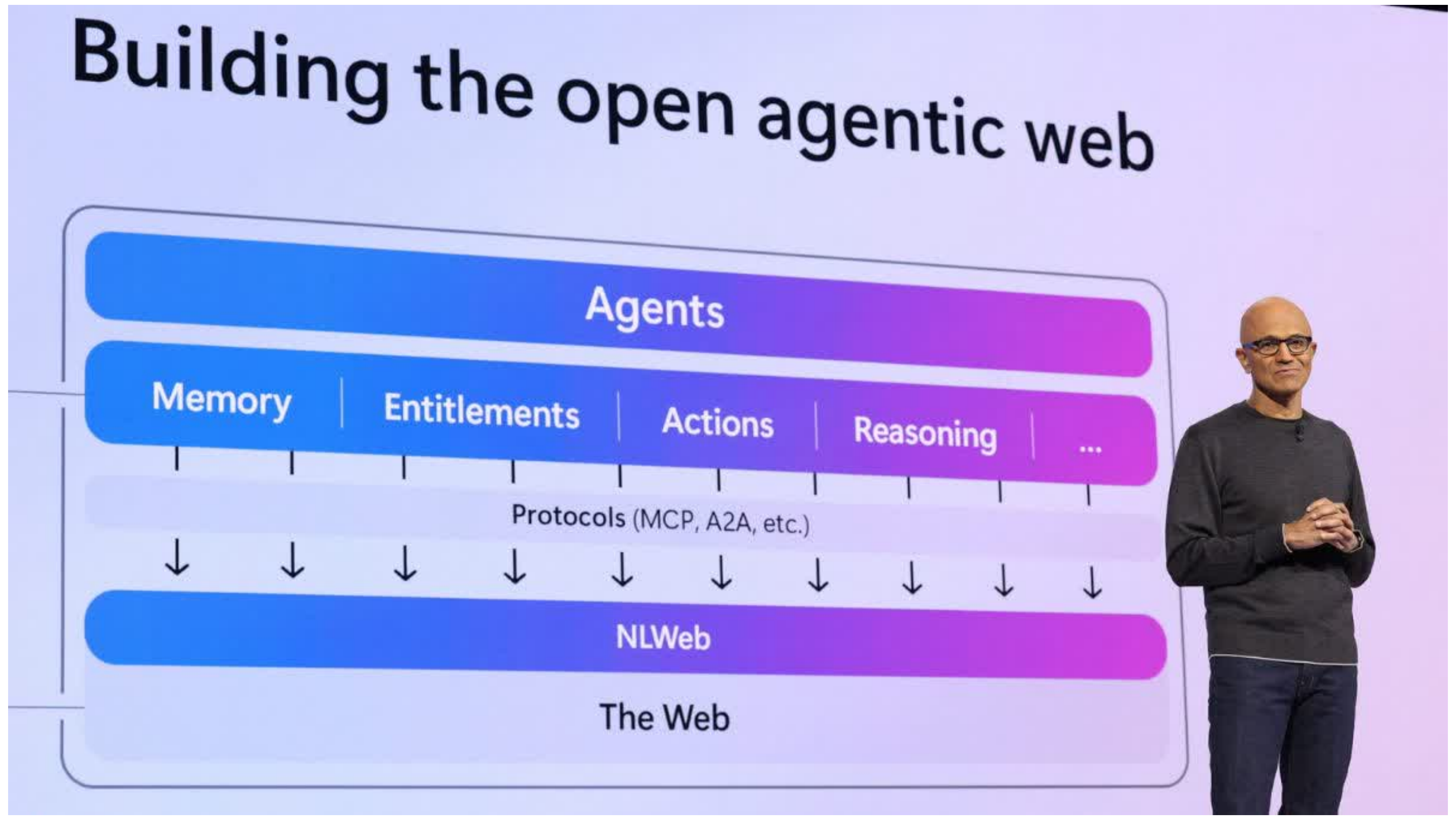
Navigating to TripAdvisor website
Selecting "Things to Do" category
Searching for historic Rome tours
Closing pop-up, continuing tour search
Searching for Historic Rome tours
Exploring all historic Rome tour options
Closing Colosseum tab, resuming tour search
Closing tour pop-up, tab afterward
Exploring options for top-rated tours
Sorting results by tour ratings
Exploring filters for top-rated tours
Scrolling for sorting options, finding tours

Operator by OpenAI

"SaaS is Dead"
All software applications that we know today are just fancy interfaces sitting on databases

-Satya Nadella

Claude Computer



Building the open agentic web

Source: openai.com, microsoft, HBR, claude, google

Engineering Agentic AI Systems: From Lab to Land

Dr. Karthik Vaidhyanathan

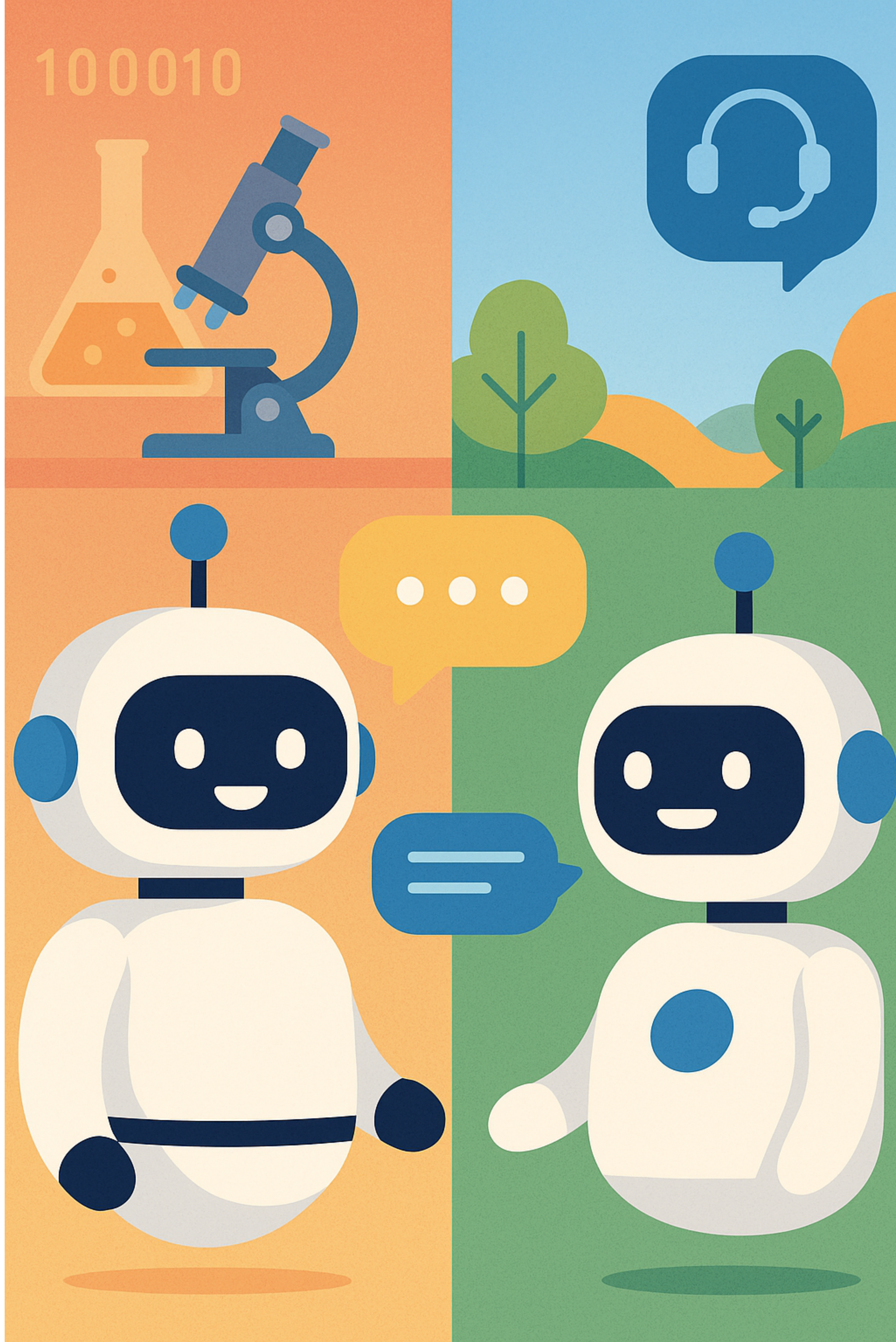
TechForward Research Seminar Series

May 30, 2025

SERC Software Engineering Research Centre

INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY
HYDERABAD

HYSEA Hyderabad Software Enterprises Association



ABOUT ME

Logic takes you from A to B, Immagination takes you elsewhere -- Albert Einstein

Karthik Vaidhyanathan

Assistant Professor

Software Engineering Research Center and

Leadership Member, Smart City Research Center

IIIT Hyderabad, India

Research Interests

AI4SA

1. AI for Architectural Knowledge
2. AI for self-adaptation

SA4AI

1. Sustainable AI-enabled systems
2. Self-adaptive AI Systems (Edge-Cloud)

Education

Double Master Degree - Software Architecture and Machine Learning

PhD from GSSI, Italy

Postdoc, University of L'Aquila, Italy

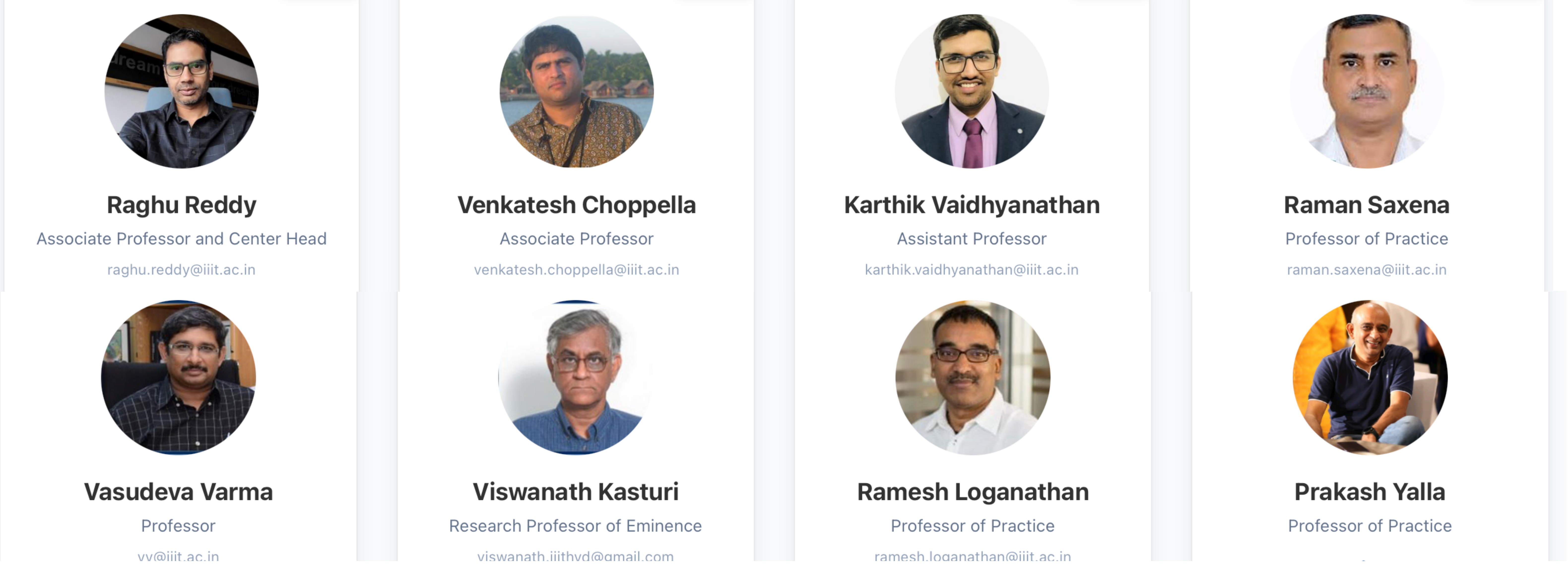
Fun Facts!

1. Cricket fanatic!
2. Movie buff!!
3. From God's own Country!!

https://karthikvaidhyanathan.com in /in/karthikv1392/ karthi_ishere karthik.vaidhyanathan@iiit.ac.in

Software Engineering Research Center (SERC)

Aims to research and develop state of art techniques, methods and tools in various areas of software engineering and programming languages.



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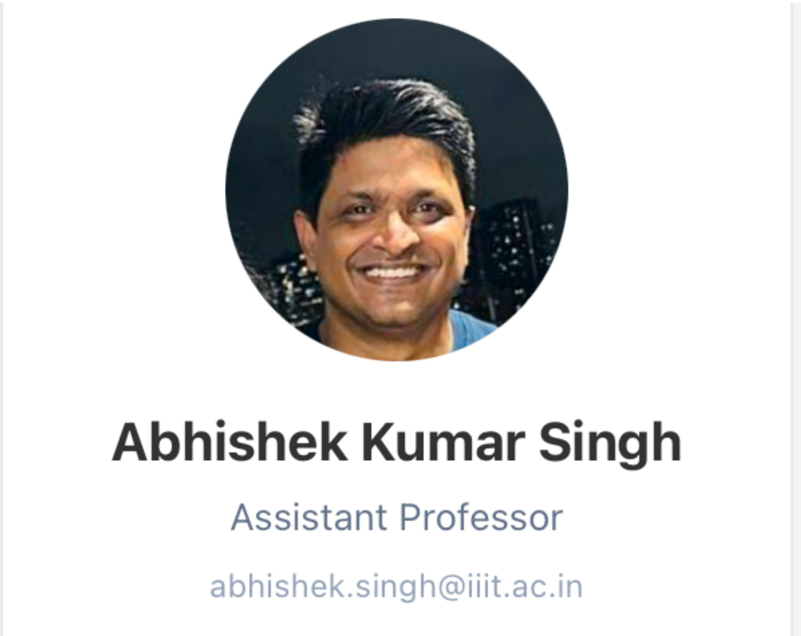
Prakash Yalla
Professor of Practice



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VR and AR

SE and AI

Formal Methods

Software Quality

Gamification

Computing Education

HCI

Programming Languages

Self-adaptive Systems

Software Analytics

Software Sustainability

IoT

More info: https://serc.iiit.ac.in

Software Systems Evolution Over the Years

Monoliths

SOA

Microservices

UI
User Manager
Catalog manager
Order manager
Payment manager
User
Catalog
Order
Payment
UI
ESB
User Service
Catalog Service
Order Service
Third Party Service (S)
User database
Product database
Order database
UI
API Gateway
Registration Service
reg db
Authentication Service
auth db
Product display service
product db
Product rating service
ratings db
Cart Service
cart db
Billing Service
billing db
Delivery Service
delivery db
Payment Service
payment db
1990
2000
2010
2020

Serverless, age of intelligent connected systems….

AI Over the years….

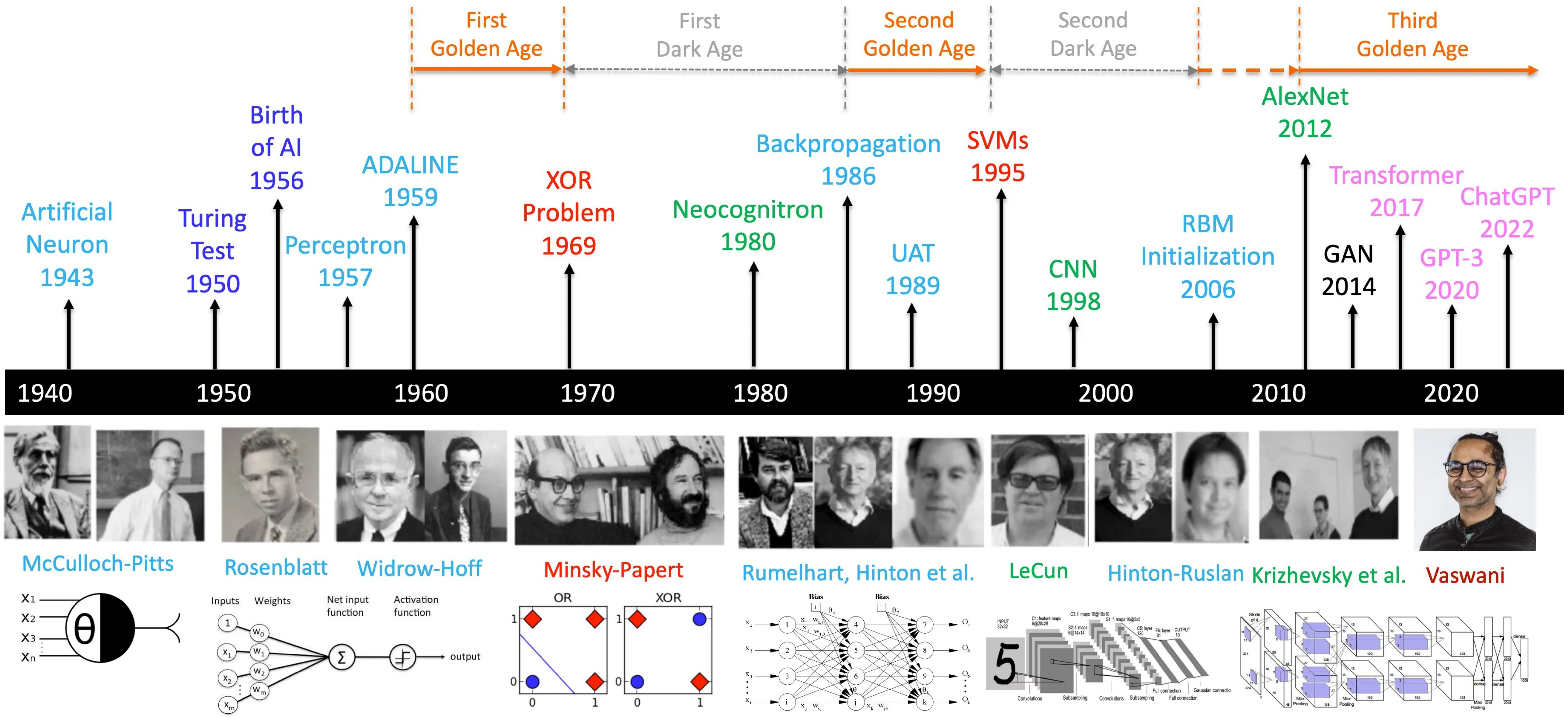


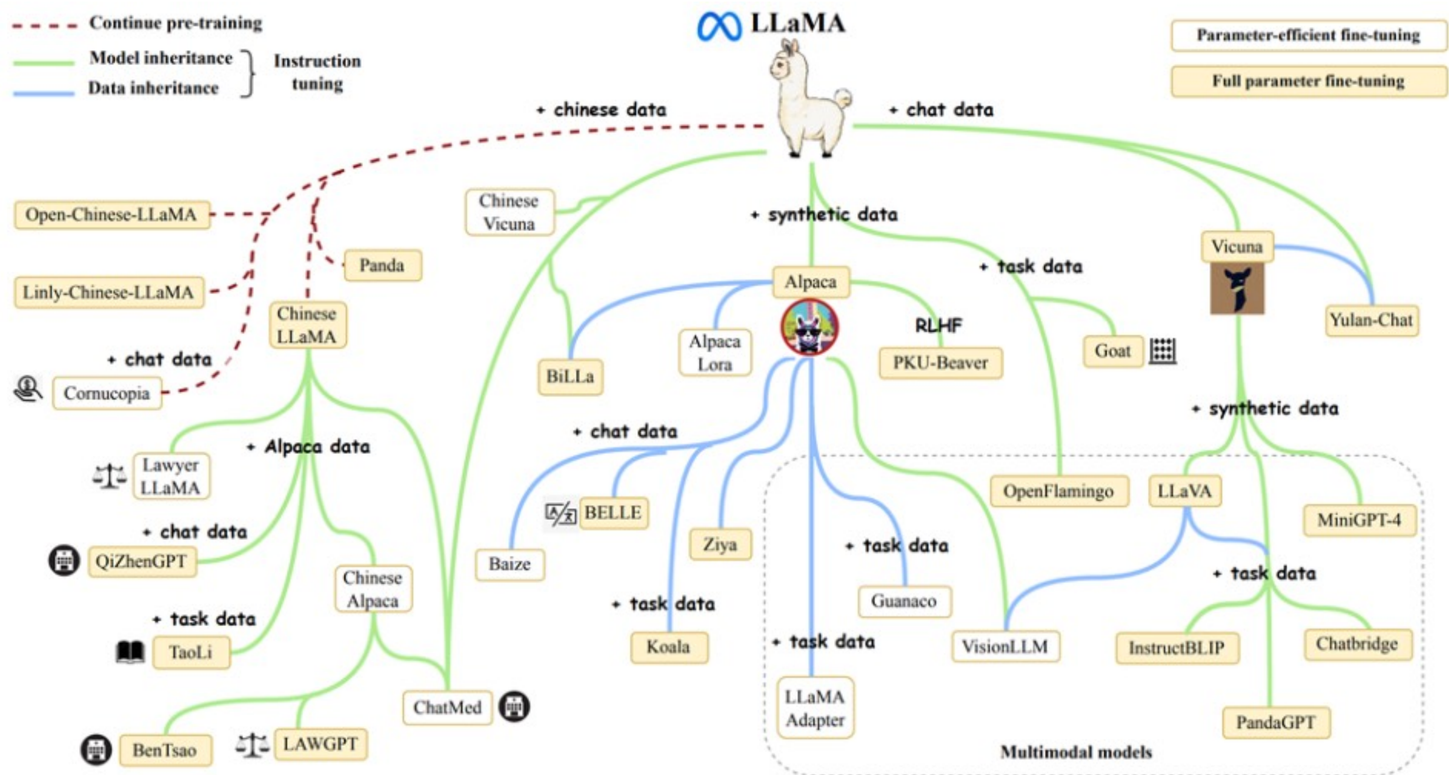
Image source: https://medium.com/@lmpo/a-brief-history-of-ai-with-deep-learning-26f7948bc87b

Age of LLMs and Agentic AI

Proprietary

Gemini

Open Source

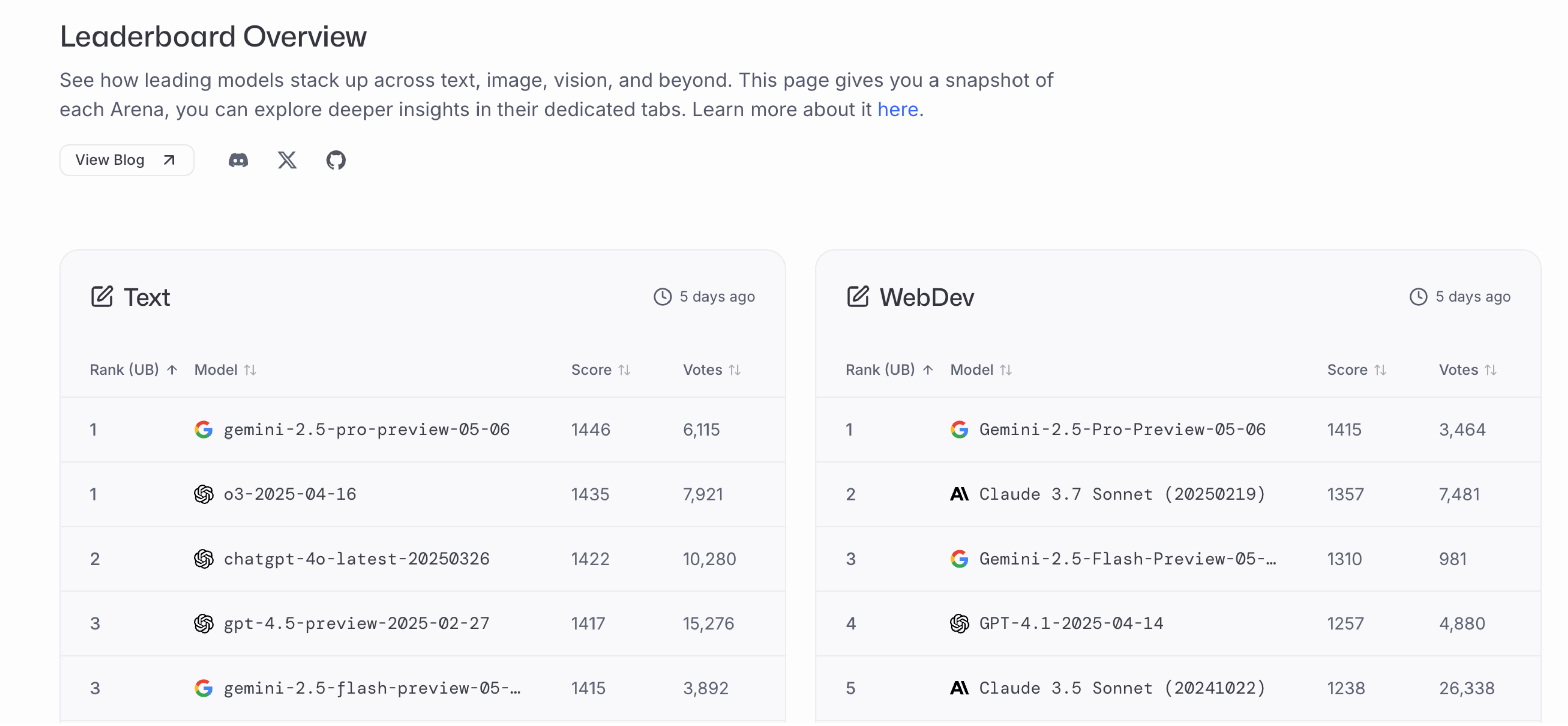


Framework for AI Agents

AG

crewai

LangGraph



Leaderboard Overview

See how leading models stack up across text, image, vision, and beyond. This page gives you a snapshot of each Arena, you can explore deeper insights in their dedicated tabs. Learn more about it here.

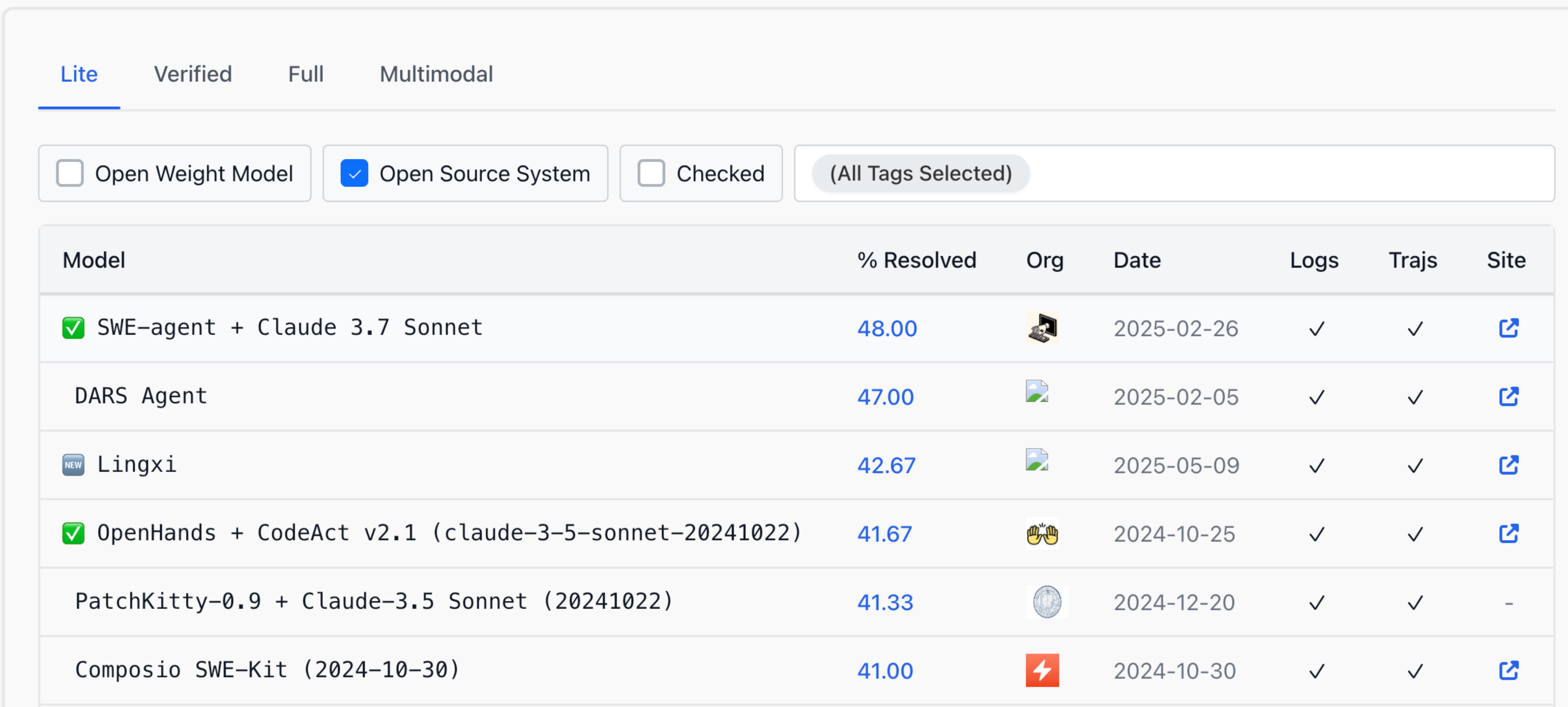
View Blog ↗

Text — 5 days ago

Rank (UB) ↑	Model ⇅	Score ⇅	Votes ⇅
1	gemini-2.5-pro-preview-05-06	1446	6,115
1	o3-2025-04-16	1435	7,921
2	chatgpt-4o-latest-20250326	1422	10,280
3	gpt-4.5-preview-2025-02-27	1417	15,276
3	gemini-2.5-flash-preview-05-…	1415	3,892

WebDev — 5 days ago

Rank (UB) ↑	Model ⇅	Score ⇅	Votes ⇅
1	Gemini-2.5-Pro-Preview-05-06	1415	3,464
2	Claude 3.7 Sonnet (20250219)	1357	7,481
3	Gemini-2.5-Flash-Preview-05-…	1310	981
4	GPT-4.1-2025-04-14	1257	4,880
5	Claude 3.5 Sonnet (20241022)	1238	26,338



Lite | Verified | Full | Multimodal

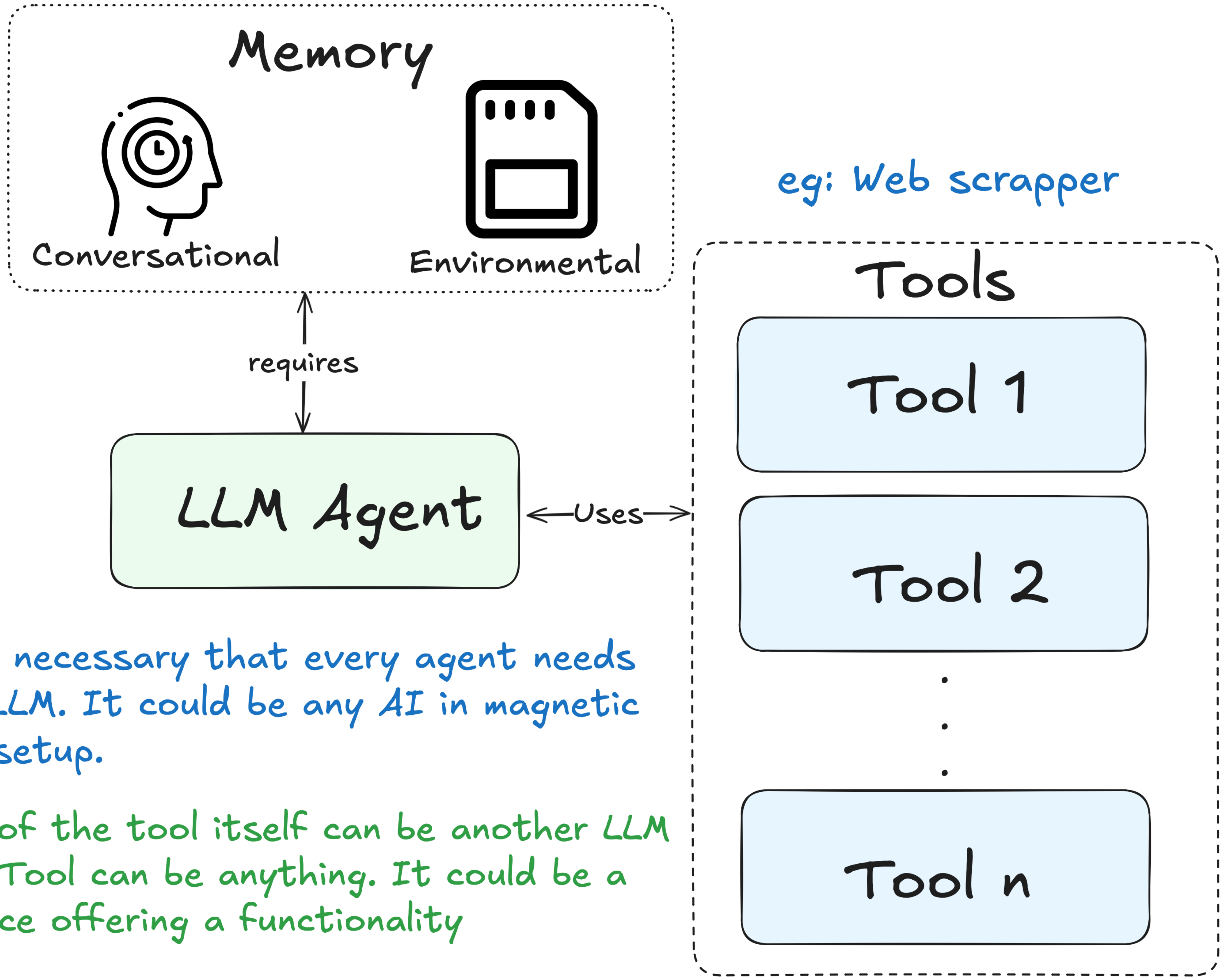
☐ Open Weight Model ☑ Open Source System ☐ Checked (All Tags Selected)

Model	% Resolved	Org	Date	Logs	Trajs	Site
✅ SWE-agent + Claude 3.7 Sonnet	48.00		2025-02-26	✓	✓	↗
DARS Agent	47.00		2025-02-05	✓	✓	↗
Lingxi	42.67		2025-05-09	✓	✓	↗
✅ OpenHands + CodeAct v2.1 (claude-3-5-sonnet-20241022)	41.67		2024-10-25	✓	✓	↗
PatchKitty-0.9 + Claude-3.5 Sonnet (20241022)	41.33		2024-12-20	✓	✓	-
Composio SWE-Kit (2024-10-30)	41.00		2024-10-30	✓	✓	↗

Source: lmarena, swe-bench

Agents: What are they made up of?

eg: What kind of movie user likes?

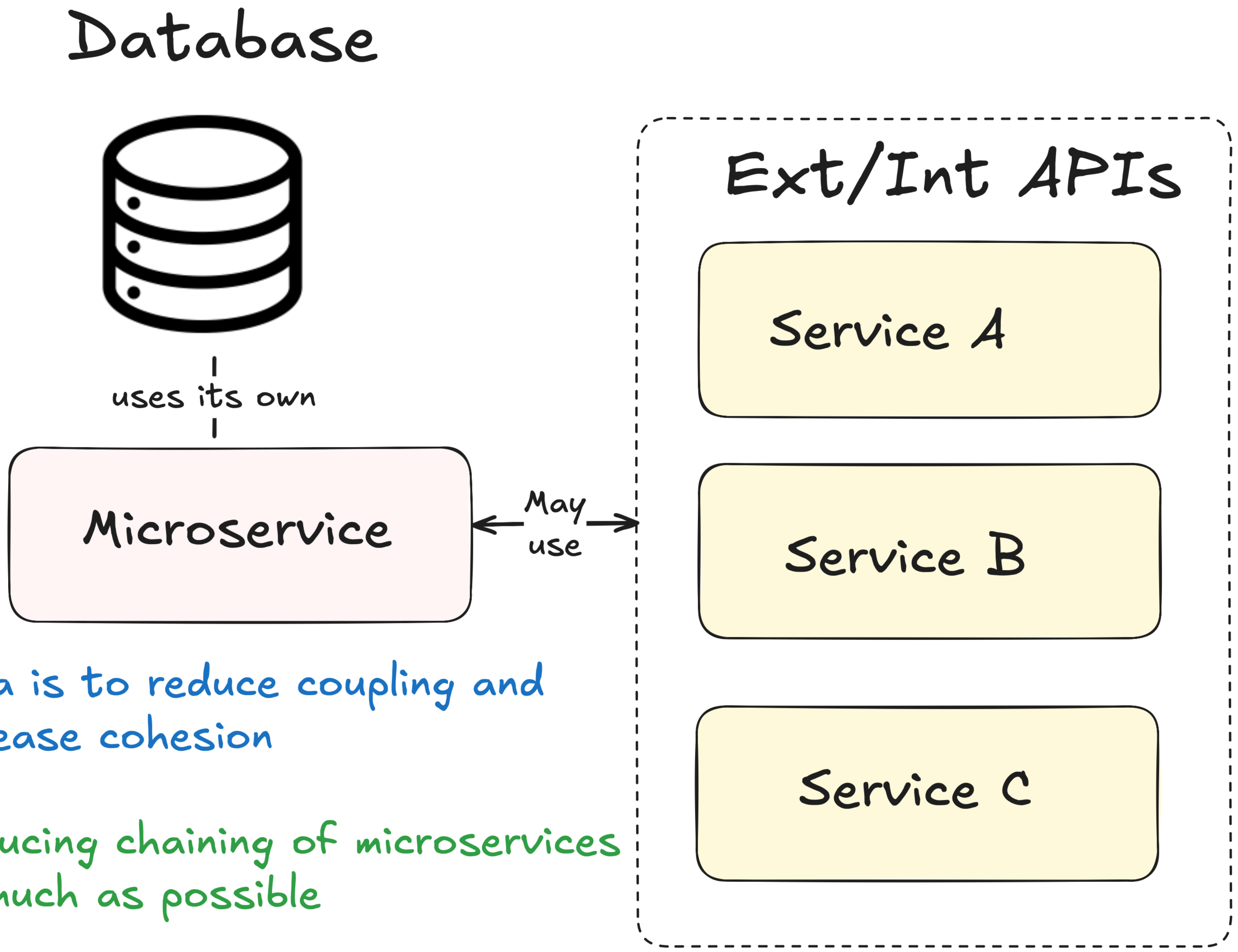


eg: Web scrapper

Not necessary that every agent needs an LLM. It could be any AI in magnetic AI setup.

One of the tool itself can be another LLM call. Tool can be anything. It could be a service offering a functionality

Autonomous entity that senses and responds to its environment and take actions to achieve its goals

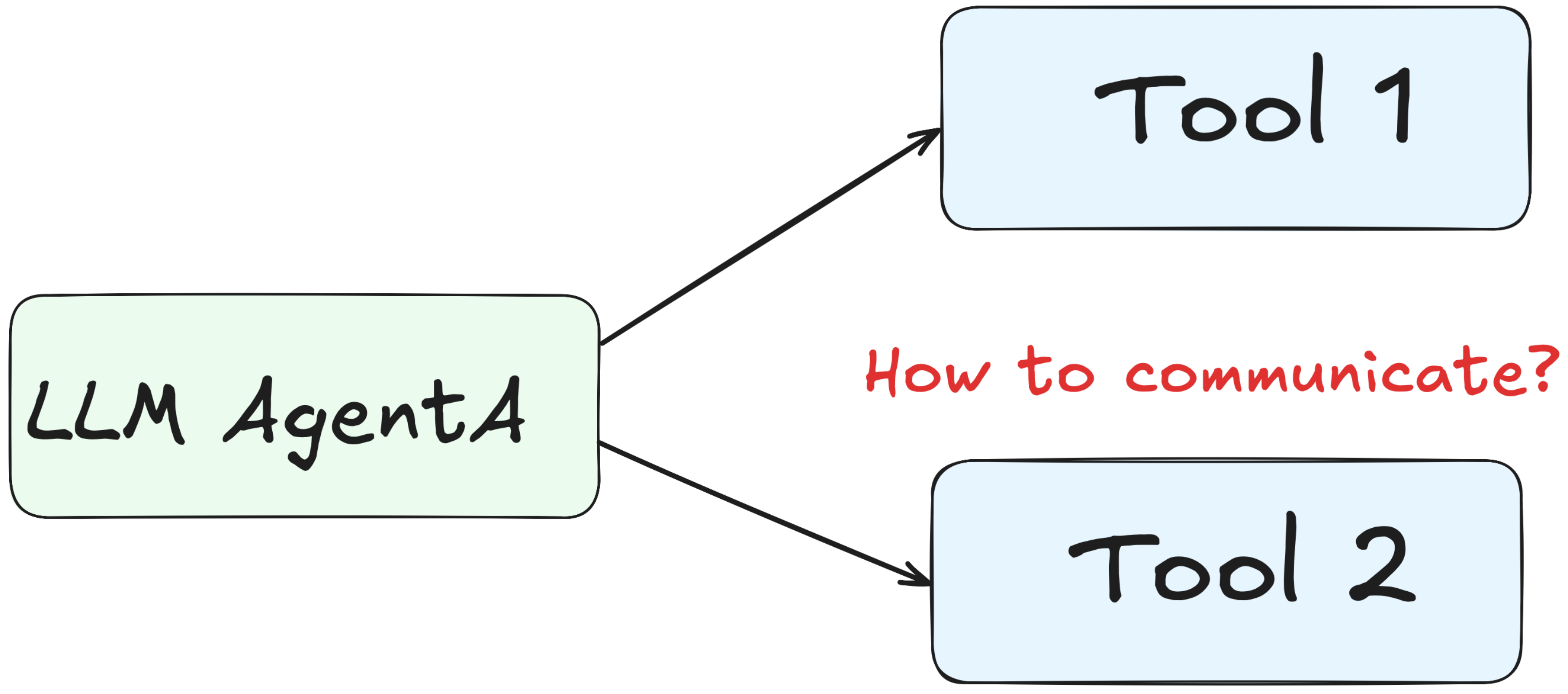


Idea is to reduce coupling and increase cohesion

Reducing chaining of microservices as much as possible

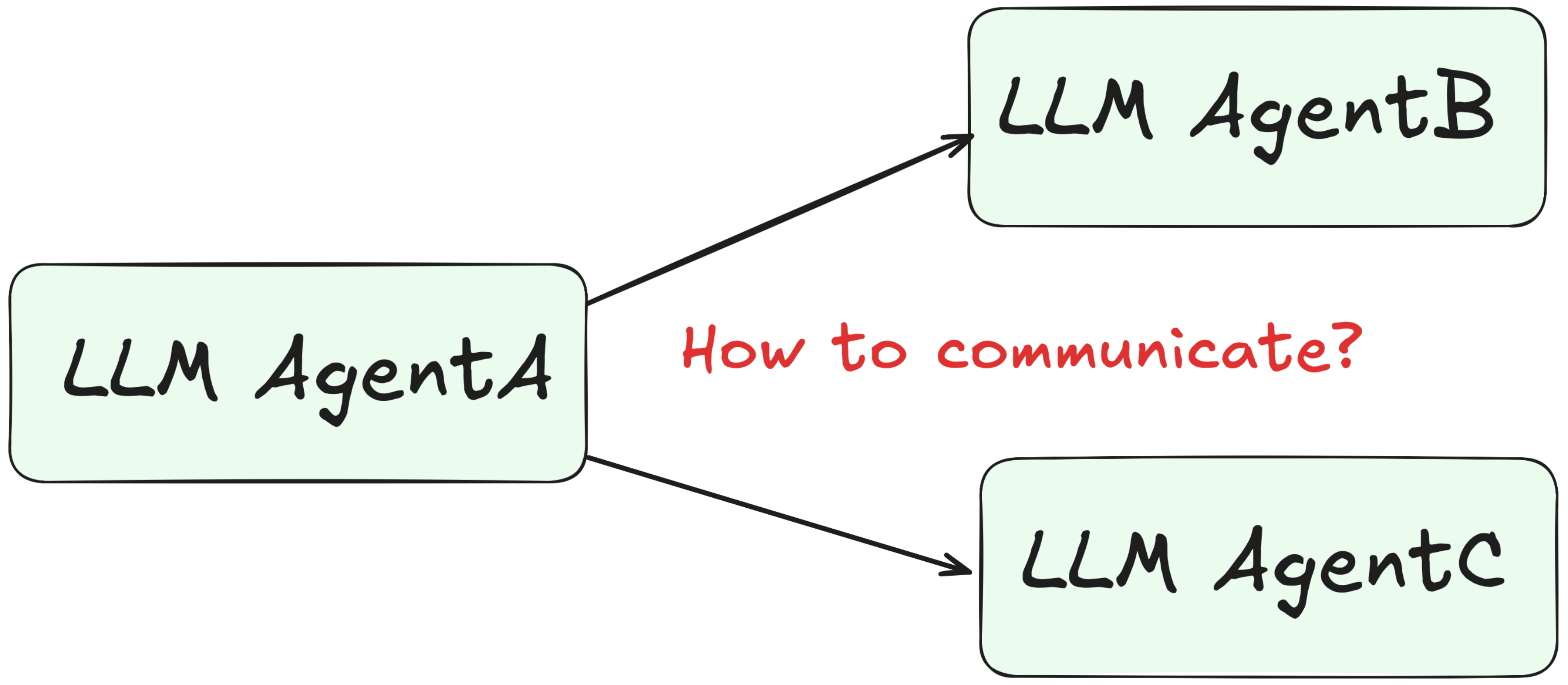
Suite of small autonomous services that communicate with each other using light weight protocols

Communication between Agents and/or Tools/Agents



How to communicate?

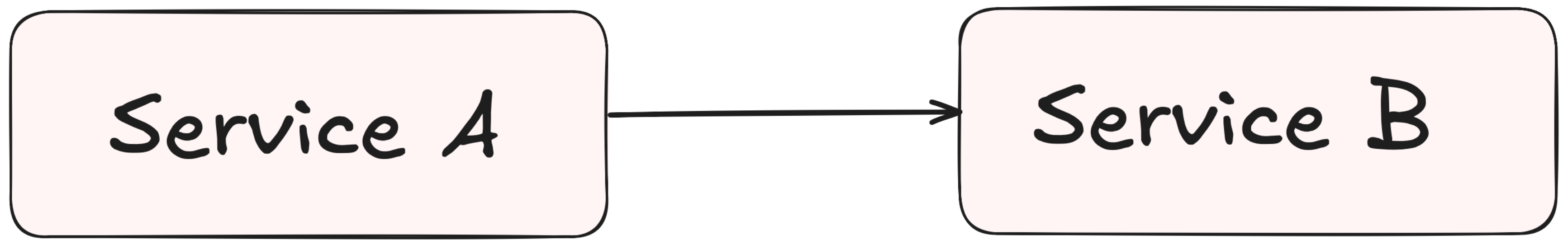
1. Tools can be added dynamically
2. Each tool may have different way of invocation
3. Use protocols like MCP (Model Context Protocol)



How to communicate?

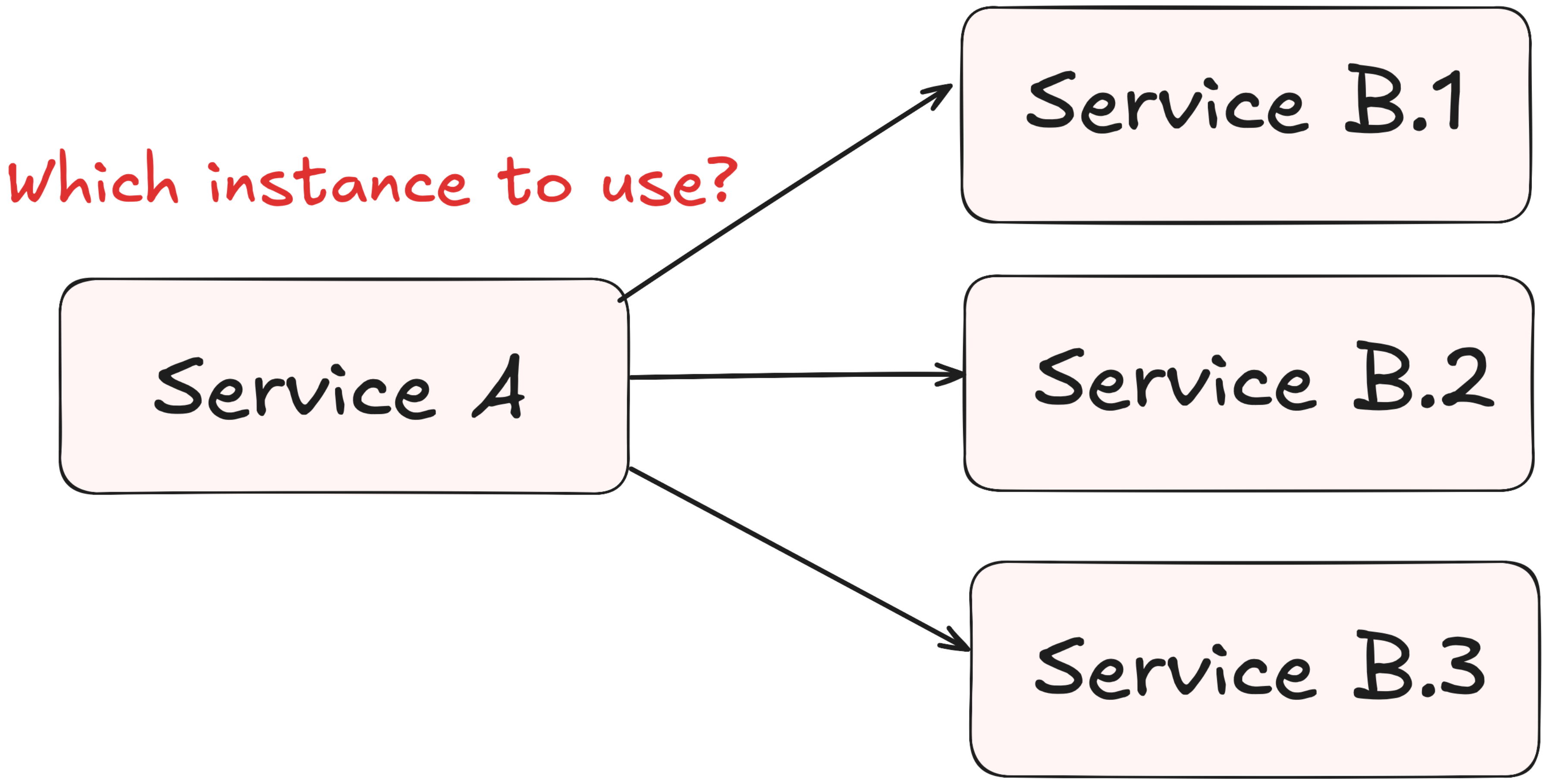
1. An agent can be added dynamically
2. Each agent may have different way of invocation
3. Use protocols like A2A (Agent to Agent)

How to communicate?



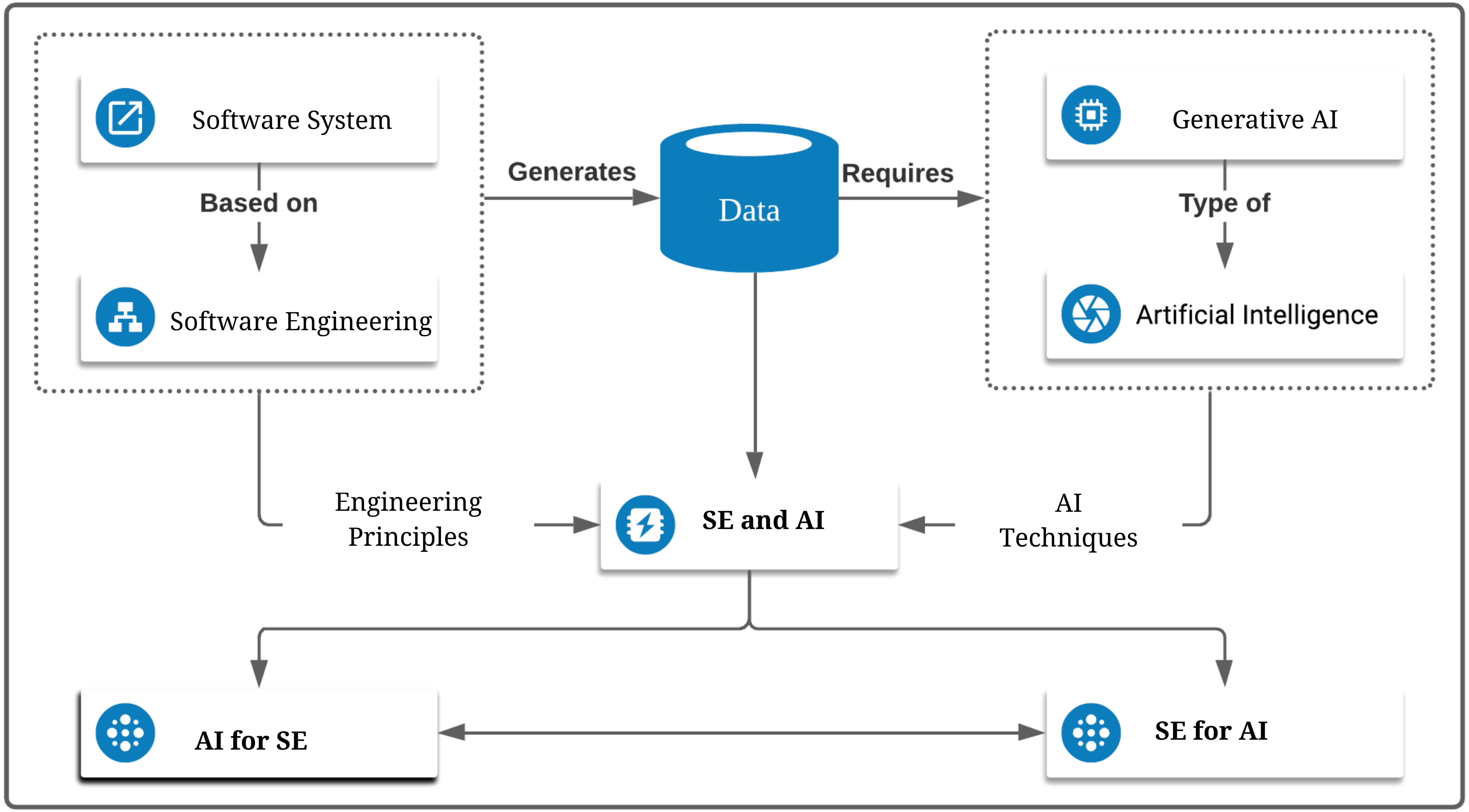
1. Use lightweight protocols like HTTP. API defined
2. Sync vs Async, Orchestration Vs Choreography
3. JSON/Protobuf as the data format

Which instance to use?

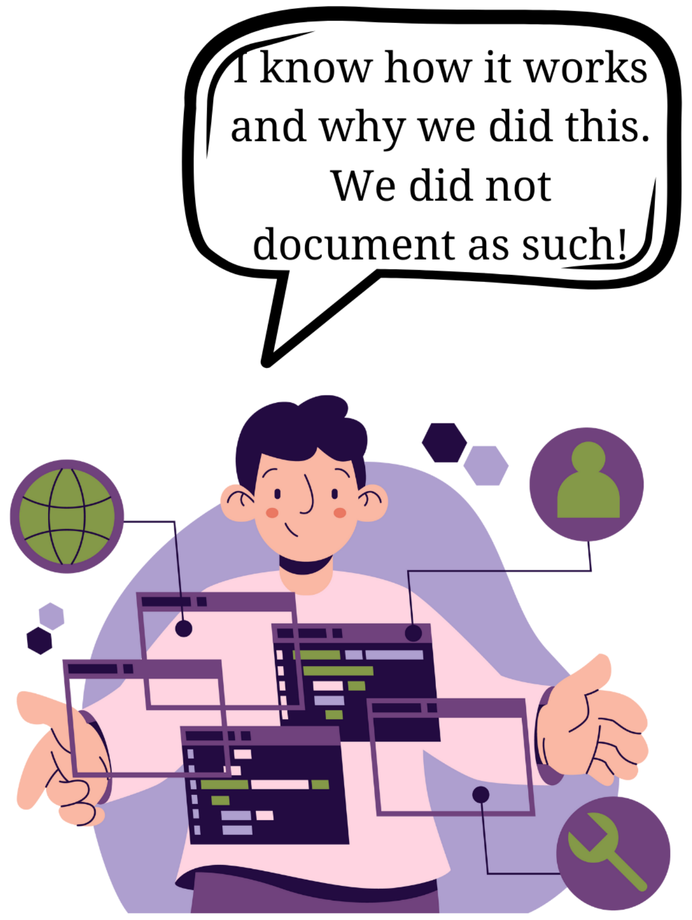


1. Service discovery - Client vs server
2. Services register to Service Registry
3. Eg: Netflix Eureka, Amazon ELB, zookeeper

At the Intersection of SE and AI

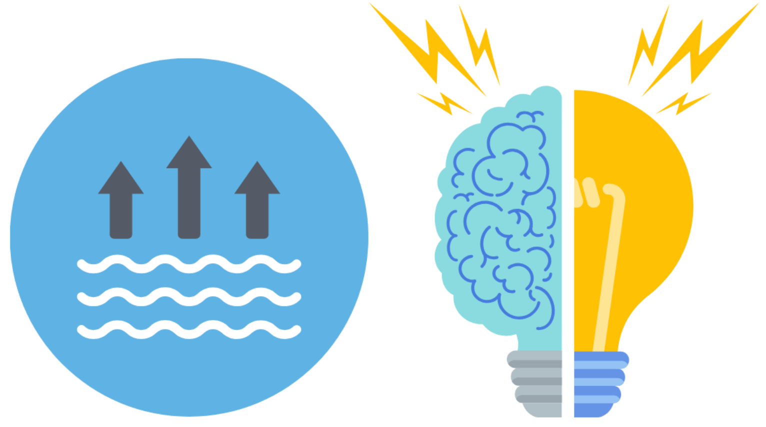


From Lab: AI4SE - LLMs for Architecture Support

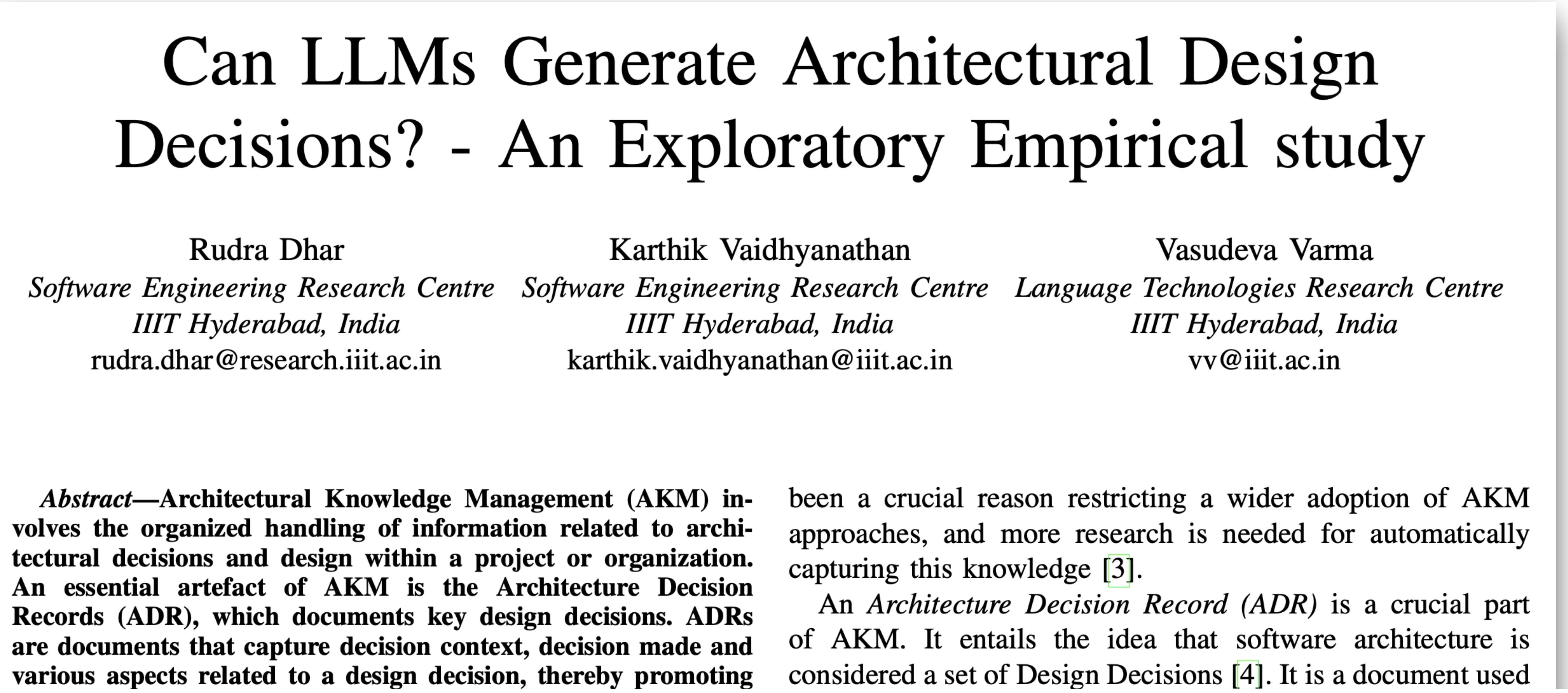

I know how it works and why we did this. We did not document as such!

Takes away the knowledge!

What happens when the dev/architect leaves?



Knowledge Vaporisation!



Can LLMs Generate Architectural Design Decisions? - An Exploratory Empirical study

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Karthik Vaidhyanathan
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Vasudeva Varma
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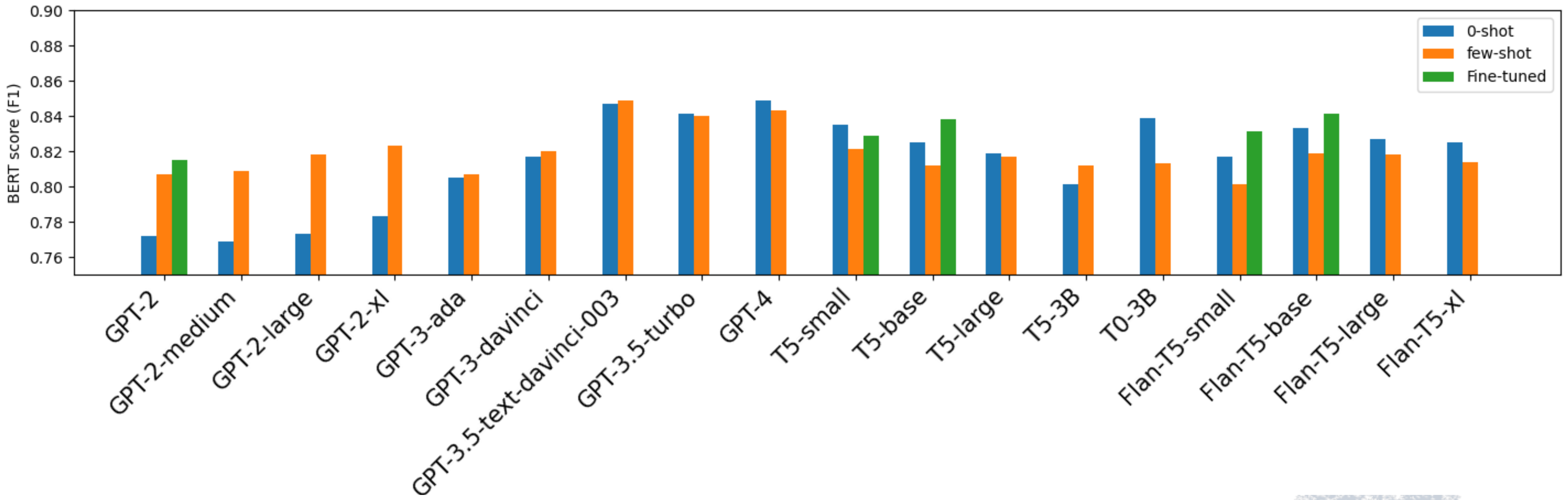
***Abstract*—Architectural Knowledge Management (AKM) involves the organized handling of information related to architectural decisions and design within a project or organization. An essential artefact of AKM is the Architecture Decision Records (ADR), which documents key design decisions. ADRs are documents that capture decision context, decision made and various aspects related to a design decision, thereby promoting**

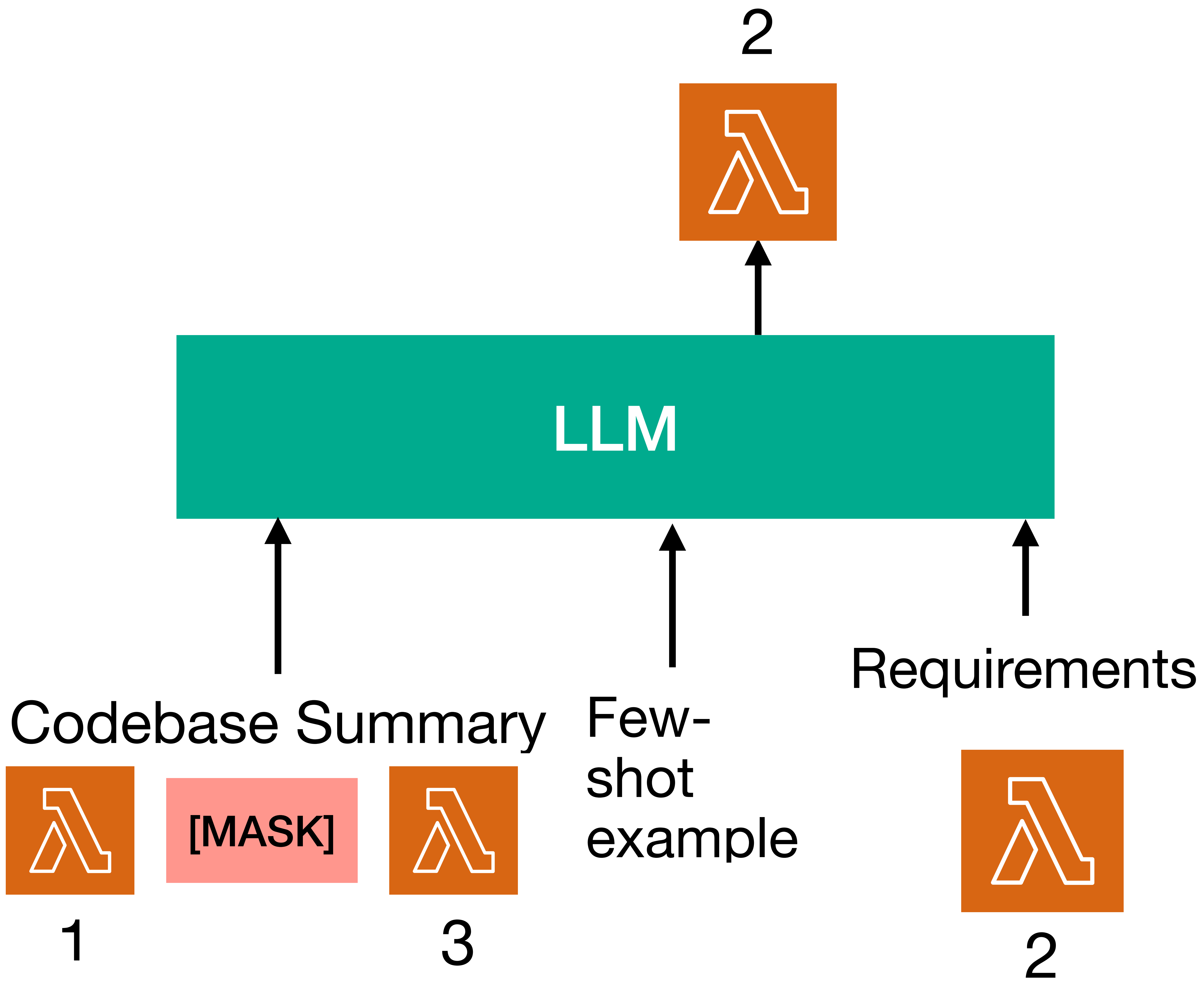
been a crucial reason restricting a wider adoption of AKM approaches, and more research is needed for automatically capturing this knowledge [3].

An *Architecture Decision Record (ADR)* is a crucial part of AKM. It entails the idea that software architecture is considered a set of Design Decisions [4]. It is a document used



Study with 18 LLMs - Small models performs well when fine-tuned

From Lab: AI4SE - LLMs for Component Generation



2

LLM

Codebase Summary

[MASK]

1

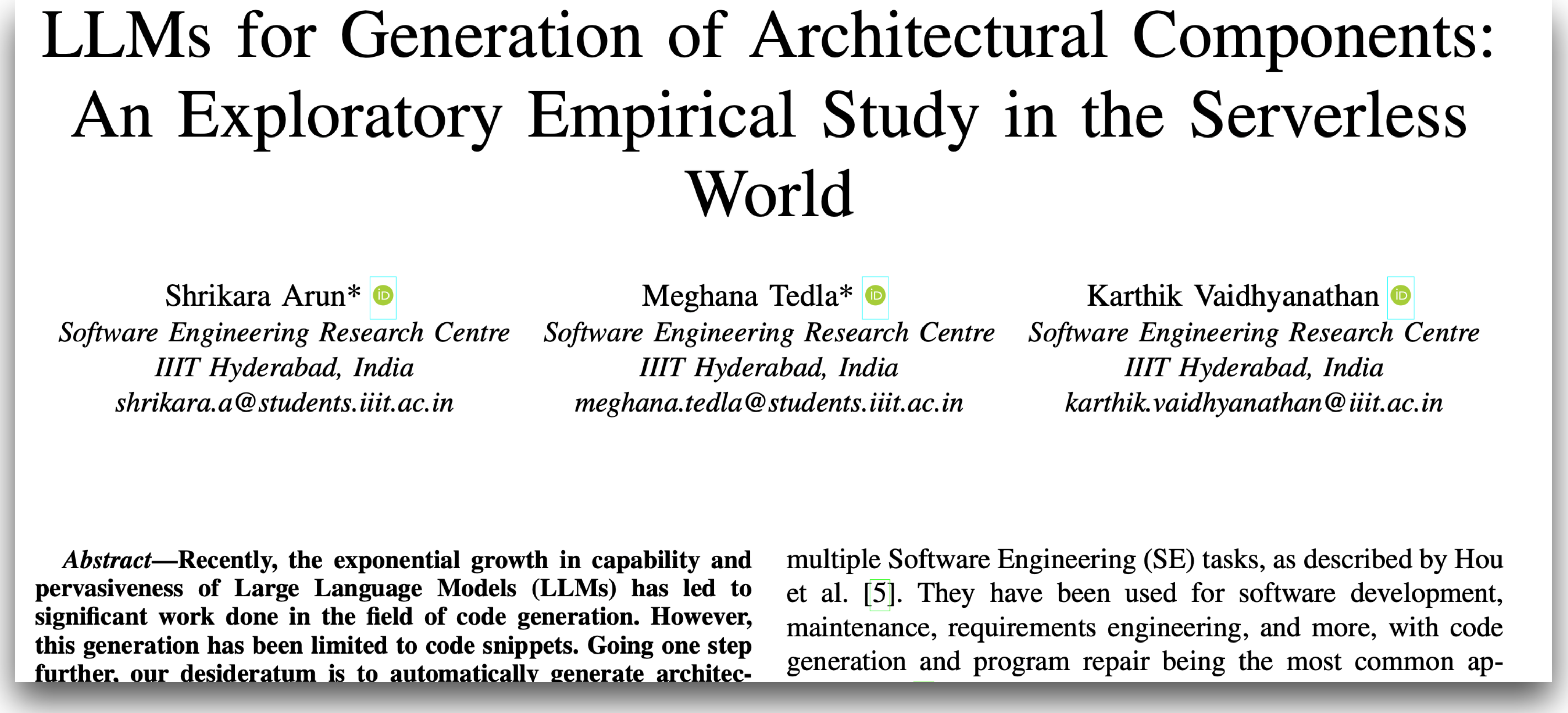
3

Few-shot example

Requirements

2

Study with 5 LLMs on 4 repos with 100+ functions - Human Architects + devs => Great Combination



LLMs for Generation of Architectural Components: An Exploratory Empirical Study in the Serverless World

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IIIT Hyderabad, India
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Meghana Tedla*
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IIIT Hyderabad, India
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Karthik Vaidhyanathan
Software Engineering Research Centre
IIIT Hyderabad, India
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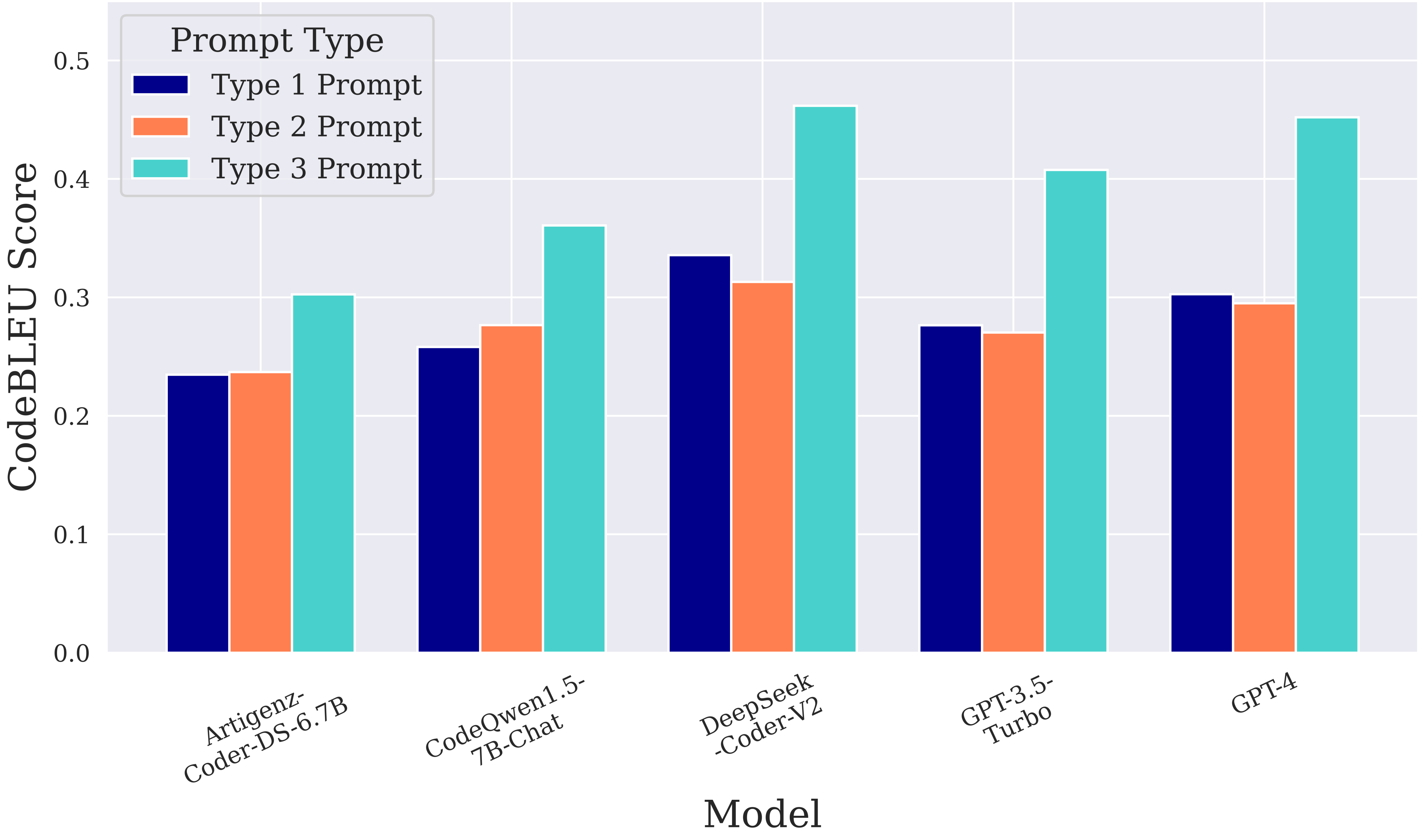
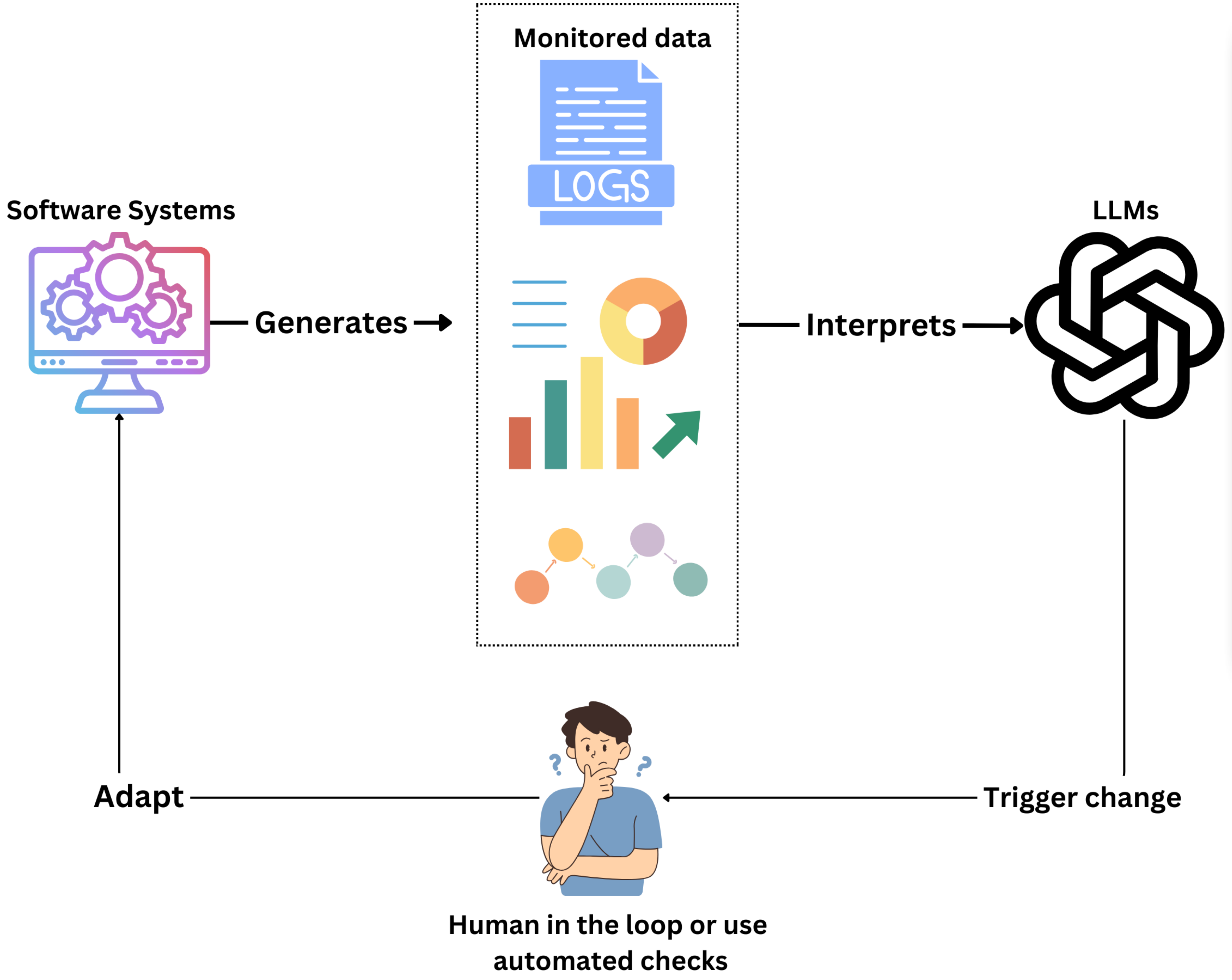
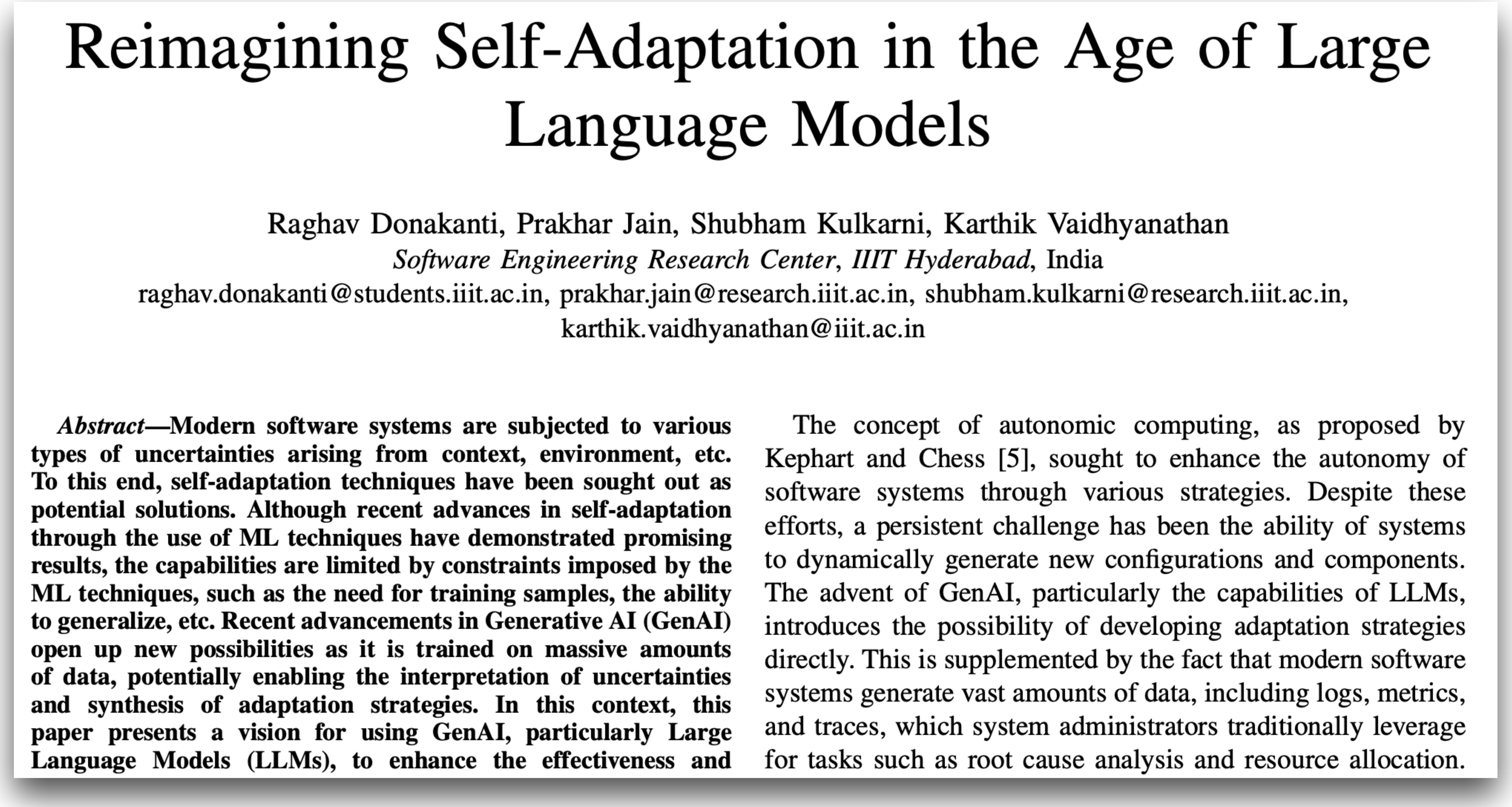
***Abstract*—Recently, the exponential growth in capability and pervasiveness of Large Language Models (LLMs) has led to significant work done in the field of code generation. However, this generation has been limited to code snippets. Going one step further, our desideratum is to automatically generate architec-**

multiple Software Engineering (SE) tasks, as described by Hou et al. [5]. They have been used for software development, maintenance, requirements engineering, and more, with code generation and program repair being the most common ap-



From Lab: AI4SE - Self-adaptation using LLMs





Reimagining Self-Adaptation in the Age of Large Language Models

Raghav Donakanti, Prakhar Jain, Shubham Kulkarni, Karthik Vaidhyanathan
Software Engineering Research Center, IIIT Hyderabad, India
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karthik.vaidhyanathan@iiit.ac.in

***Abstract*—Modern software systems are subjected to various types of uncertainties arising from context, environment, etc. To this end, self-adaptation techniques have been sought out as potential solutions. Although recent advances in self-adaptation through the use of ML techniques have demonstrated promising results, the capabilities are limited by constraints imposed by the ML techniques, such as the need for training samples, the ability to generalize, etc. Recent advancements in Generative AI (GenAI) open up new possibilities as it is trained on massive amounts of data, potentially enabling the interpretation of uncertainties and synthesis of adaptation strategies. In this context, this paper presents a vision for using GenAI, particularly Large Language Models (LLMs), to enhance the effectiveness and**

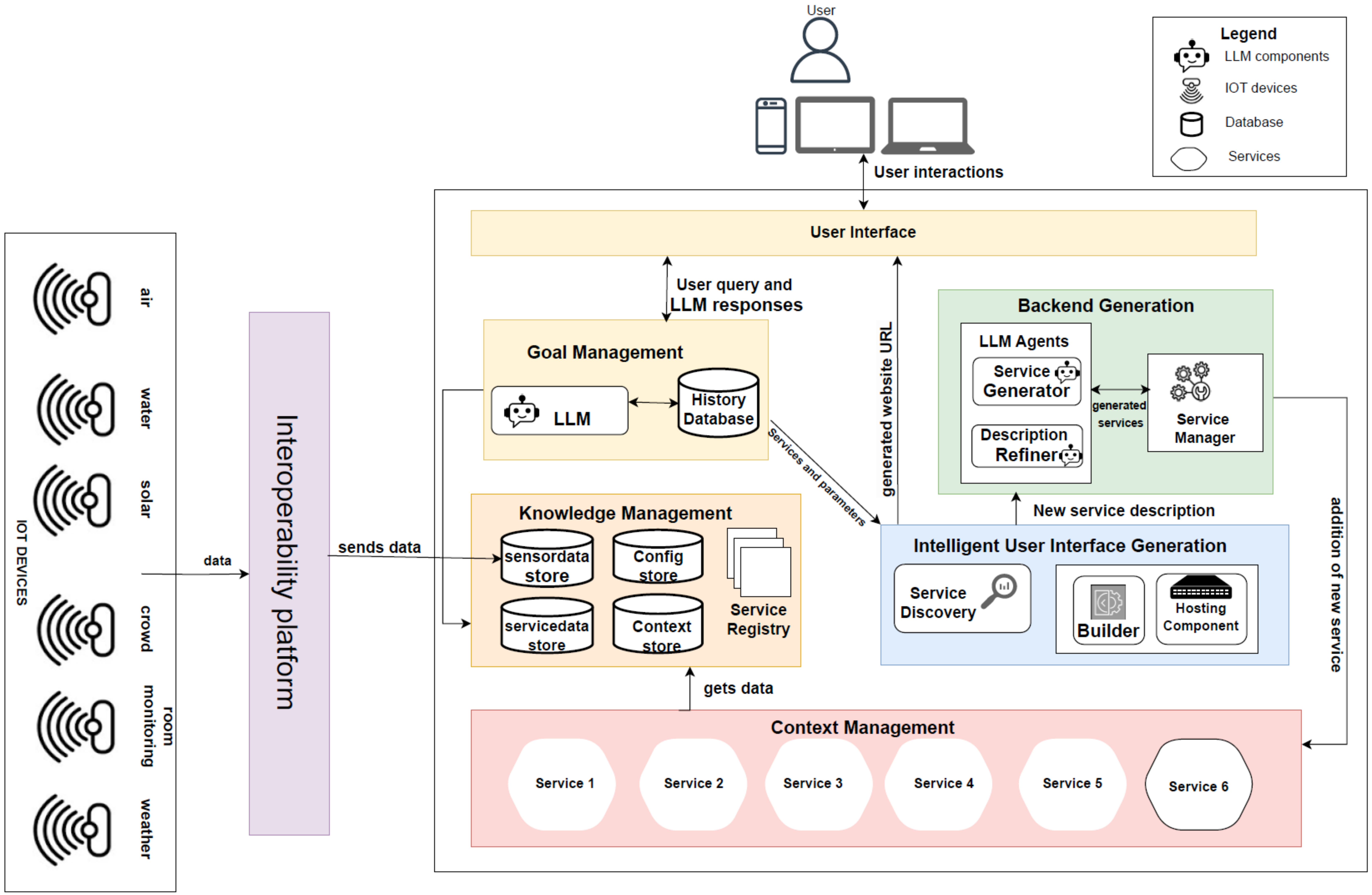
The concept of autonomic computing, as proposed by Kephart and Chess [5], sought to enhance the autonomy of software systems through various strategies. Despite these efforts, a persistent challenge has been the ability of systems to dynamically generate new configurations and components. The advent of GenAI, particularly the capabilities of LLMs, introduces the possibility of developing adaptation strategies directly. This is supplemented by the fact that modern software systems generate vast amounts of data, including logs, metrics, and traces, which system administrators traditionally leverage for tasks such as root cause analysis and resource allocation.

GPT-4 could ensure the system guarantees SLA almost as good as the state-of-the art

Autonomous adaptation with LLMs a possibility!!!

From Lab: AI4SE - Multi-agent for dynamic system generation

WELCOME TO OUR SMART CITY! MAY I ASSIST YOU?
MAY I ASSSIST YOU?
I'M HERE FOR TWO HOURS AND LIKE FOOD.
WOULD YOU LIKE TO EXPLORE NEARBY RESTAURANTS?
CUSTOM APP
SURE!
CUSTOM APP
FOOD
Software Engineering Research Centre



Legend

- LLM components
- IOT devices
- Database
- Services

User

User interactions

IOT DEVICES: air, water, solar, crowd, room monitoring, weather

data

Interoperability platform

sends data

User Interface

User query and LLM responses

Goal Management: LLM, History Database

Services and parameters

generated website URL

Backend Generation: LLM Agents (Service Generator, Description Refiner), generated services, Service Manager

New service description

Knowledge Management: sensordata store, Config store, servicedata store, Context store, Service Registry

Intelligent User Interface Generation: Service Discovery, Builder, Hosting Component

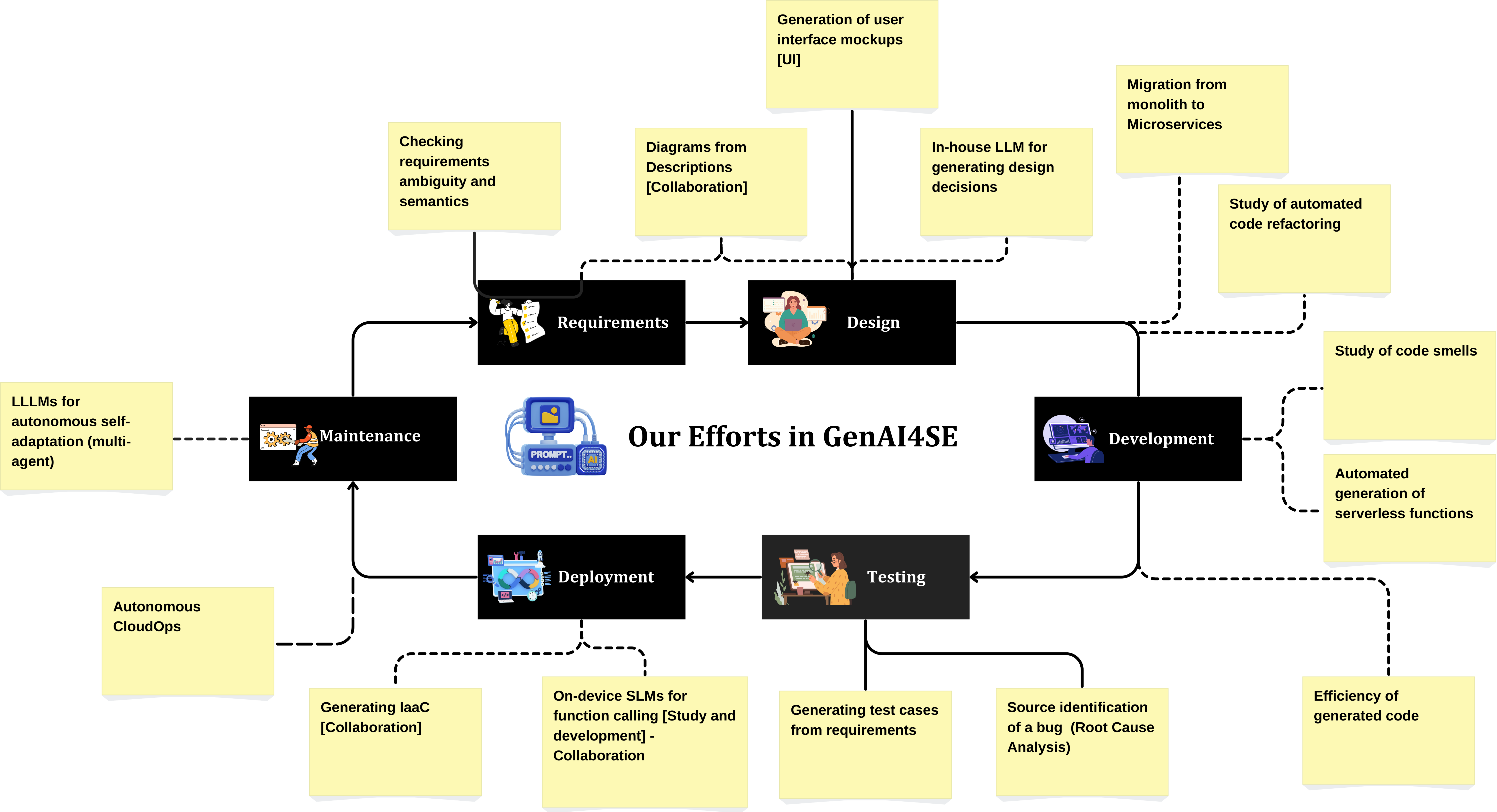
addition of new service

gets data

Context Management: Service 1, Service 2, Service 3, Service 4, Service 5, Service 6

Adnan, B., Miryala, S., Sambu, A., Vaidhyanathan, K., De Sanctis, M. and Spalazzese, R.,**Leveraging LLMs for Dynamic IoT Systems Generation through Mixed-Initiative Interaction**. IEEE ICSA 2025 Companion

Our Efforts in GenAI4SE



Requirements

Checking requirements ambiguity and semantics

Design

Diagrams from Descriptions [Collaboration]

Generation of user interface mockups [UI]

In-house LLM for generating design decisions

Development

Migration from monolith to Microservices

Study of automated code refactoring

Study of code smells

Automated generation of serverless functions

Efficiency of generated code

Testing

Generating test cases from requirements

Source identification of a bug (Root Cause Analysis)

Deployment

Generating IaaC [Collaboration]

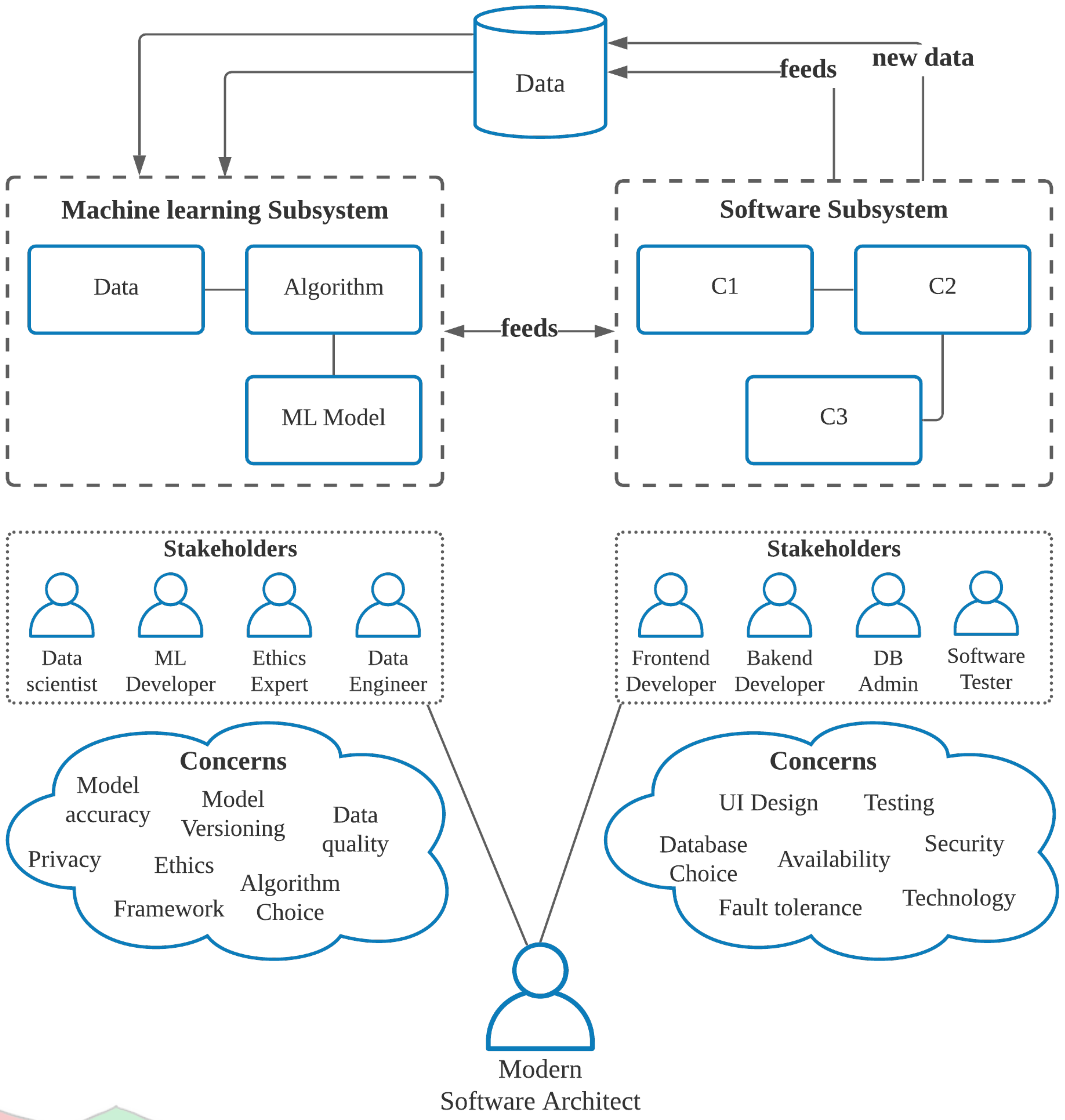
On-device SLMs for function calling [Study and development] - Collaboration

Autonomous CloudOps

Maintenance

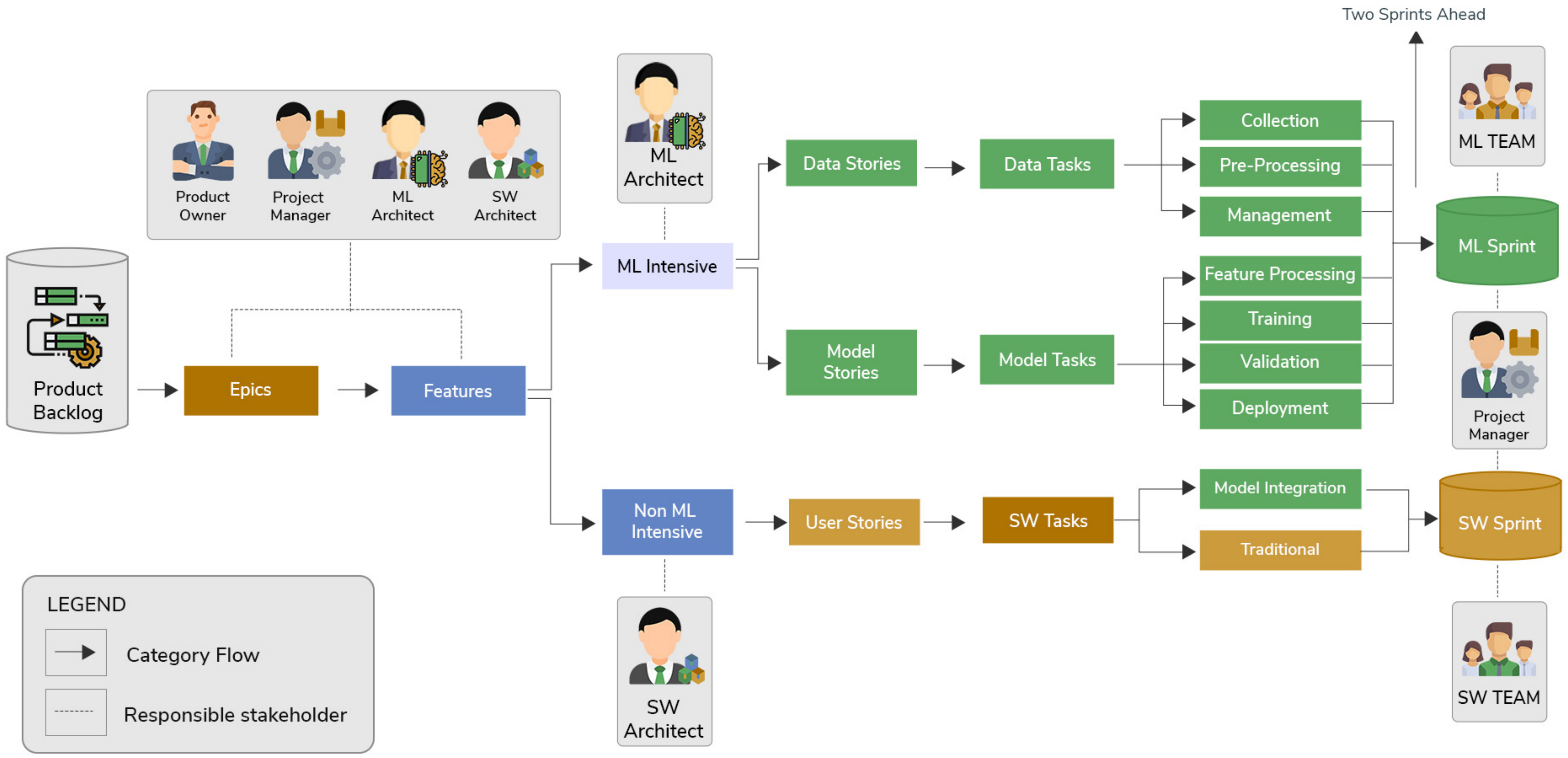
LLLMs for autonomous self-adaptation (multi-agent)

SE4AI: Calls for a Paradigm Shift (Agentic AI just adds to it)



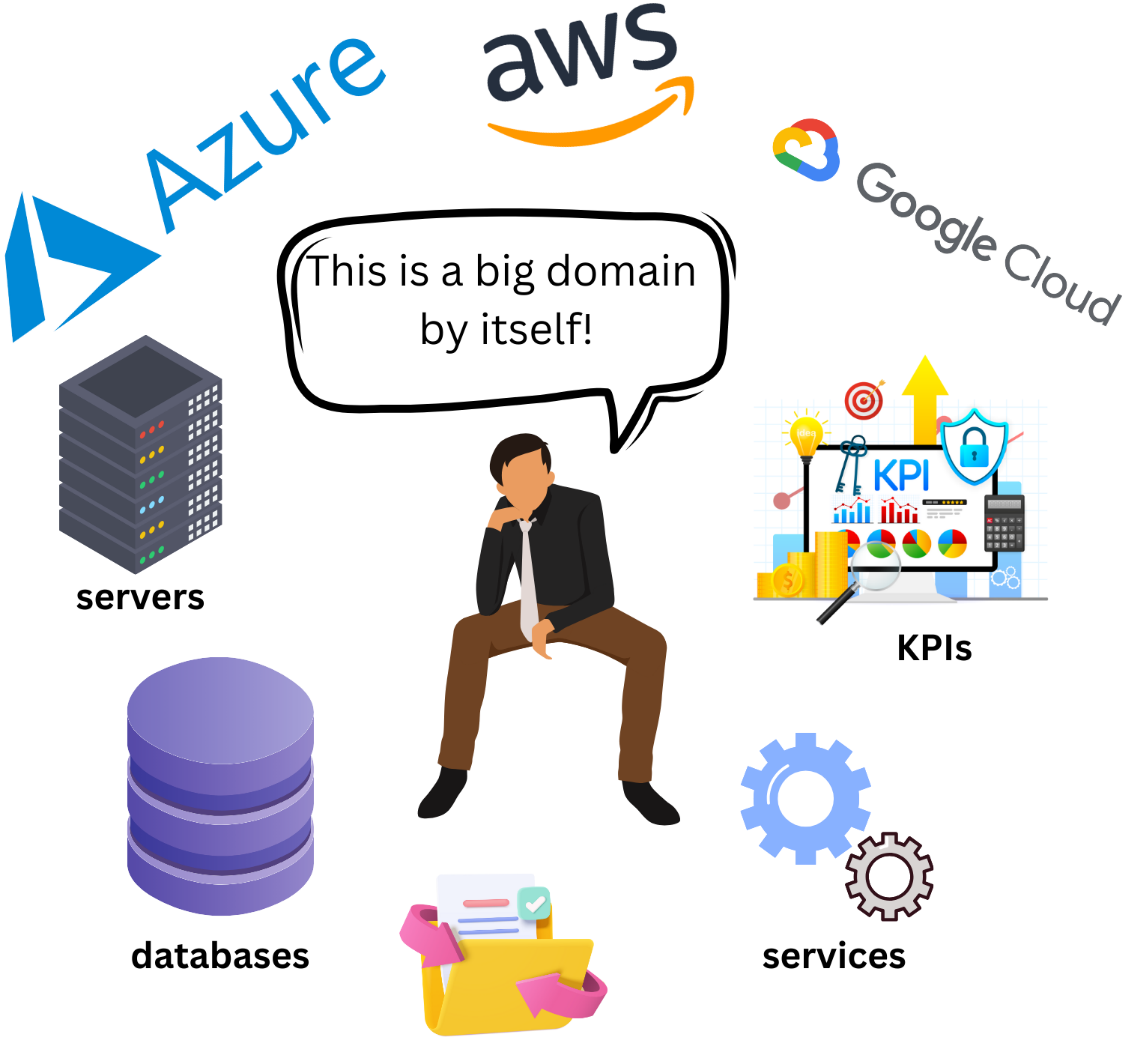
H. Muccini, K. Vaidhyanathan: **Software Architecture for ML-based Systems: What Exists and What Lies Ahead.** WAIN@ICSE 2021

> 50% of ML systems do not make it into production - - Gartner



K. Vaidhyanathan, A. Chandran, H. Muccini and R. Roy, **Agile4MLS—Leveraging Agile Practices for Developing Machine Learning-Enabled Systems: An Industrial Experience** in IEEE Software, 2022

To Land: SE4AI - Autonomous CloudOps



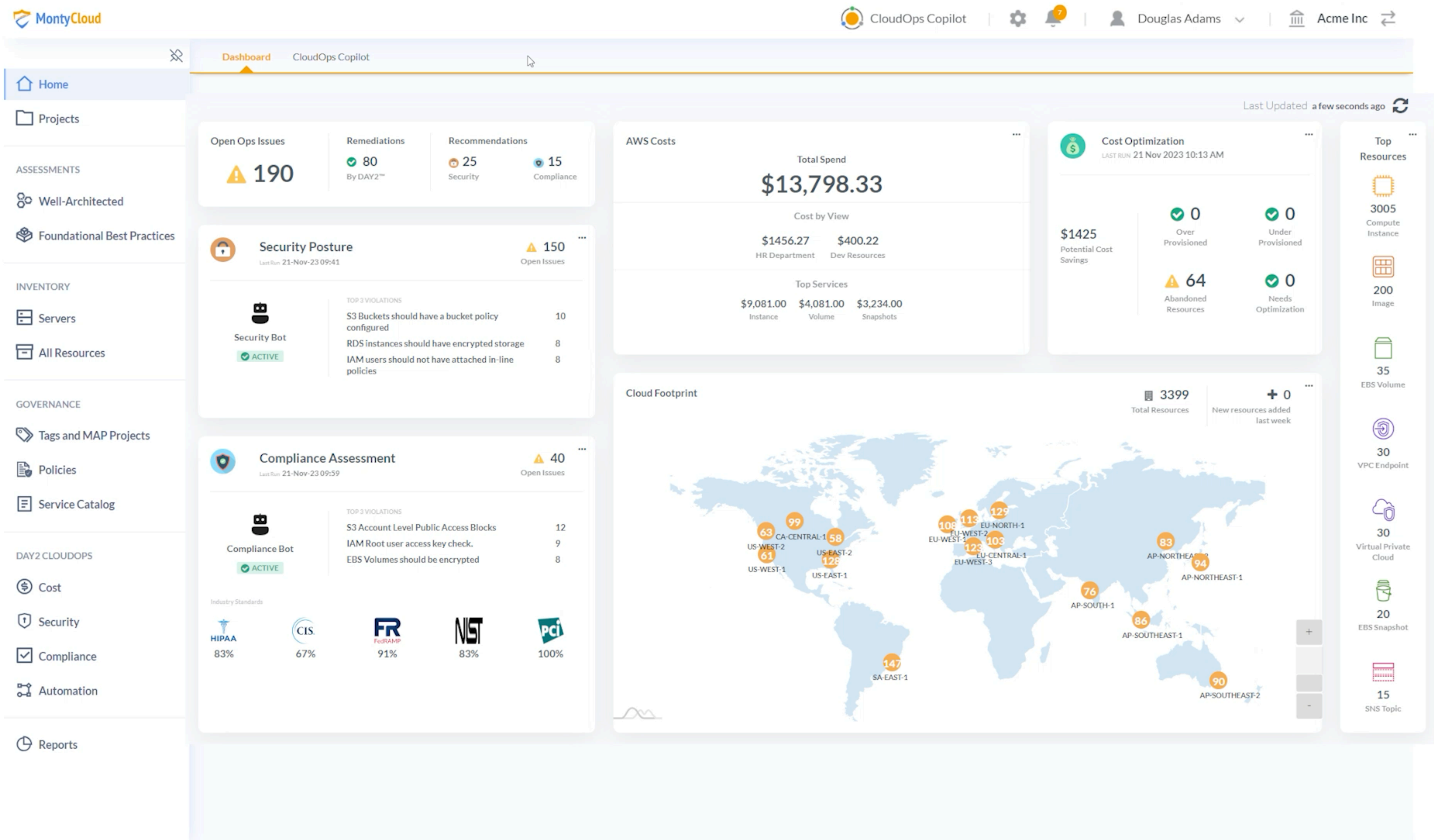
CloudOps - *Run, Manage, Evolve*

AWS Well Architected Framework

Helps cloud architects build resilient, secure and high performing infrastructure

- **Build around six pillars**
  - Operational Efficiency
  - Security
  - Reliability
  - Performance Efficiency
  - Sustainability
  - Cost

Ideas into Production: CloudOps CoPilot



MontyCloud

CloudOps Copilot | Douglas Adams | Acme Inc

Dashboard | CloudOps Copilot

Home

Projects

ASSESSMENTS

Well-Architected

Foundational Best Practices

INVENTORY

Servers

All Resources

GOVERNANCE

Tags and MAP Projects

Policies

Service Catalog

DAY2 CLOUDOPS

Cost

Security

Compliance

Automation

Reports

Last Updated a few seconds ago

Open Ops Issues 190

Remediations 80 By DAY2™

Recommendations 25 Security 15 Compliance

Security Posture
Last Run 21-Nov-23 09:41
150 Open Issues

Security Bot ACTIVE

TOP 3 VIOLATIONS

S3 Buckets should have a bucket policy configured	10
RDS instances should have encrypted storage	8
IAM users should not have attached in-line policies	8

Compliance Assessment
Last Run 21-Nov-23 09:59
40 Open Issues

Compliance Bot ACTIVE

TOP 3 VIOLATIONS

S3 Account Level Public Access Blocks	12
IAM Root user access key check.	9
EBS Volumes should be encrypted	8

Industry Standards

HIPAA	CIS	FedRAMP	NIST	PCI
83%	67%	91%	83%	100%

AWS Costs

Total Spend $13,798.33

Cost by View

$1456.27 HR Department | $400.22 Dev Resources

Top Services

$9,081.00 Instance | $4,081.00 Volume | $3,234.00 Snapshots

Cost Optimization
LAST RUN 21 Nov 2023 10:13 AM

$1425 Potential Cost Savings

0 Over Provisioned | 0 Under Provisioned

64 Abandoned Resources | 0 Needs Optimization

Cloud Footprint

3399 Total Resources | + 0 New resources added last week

Top Resources

3005 Compute Instance

200 Image

35 EBS Volume

30 VPC Endpoint

30 Virtual Private Cloud

20 EBS Snapshot

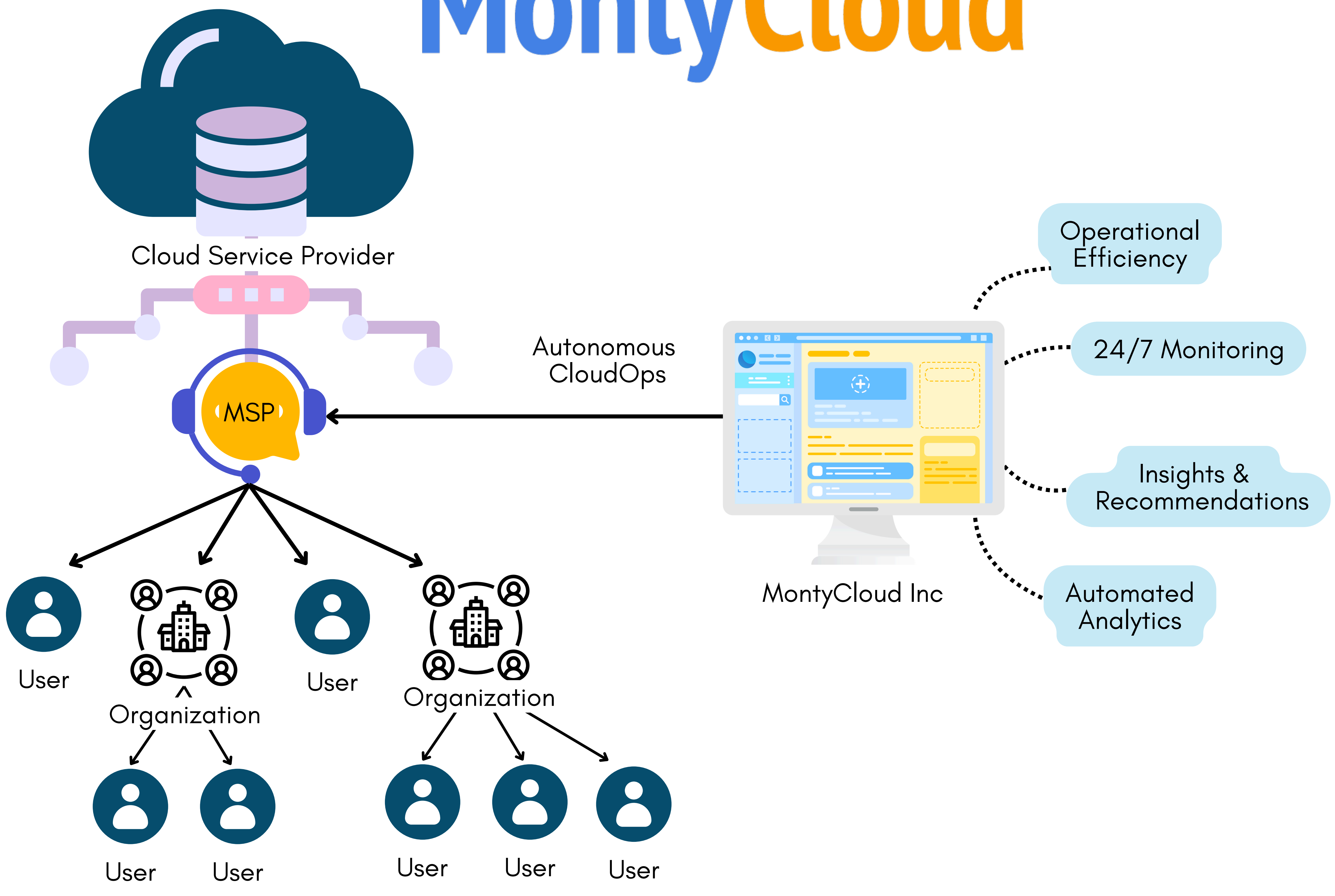
15 SNS Topic

Work done in collaboration with MontyCloud Inc.

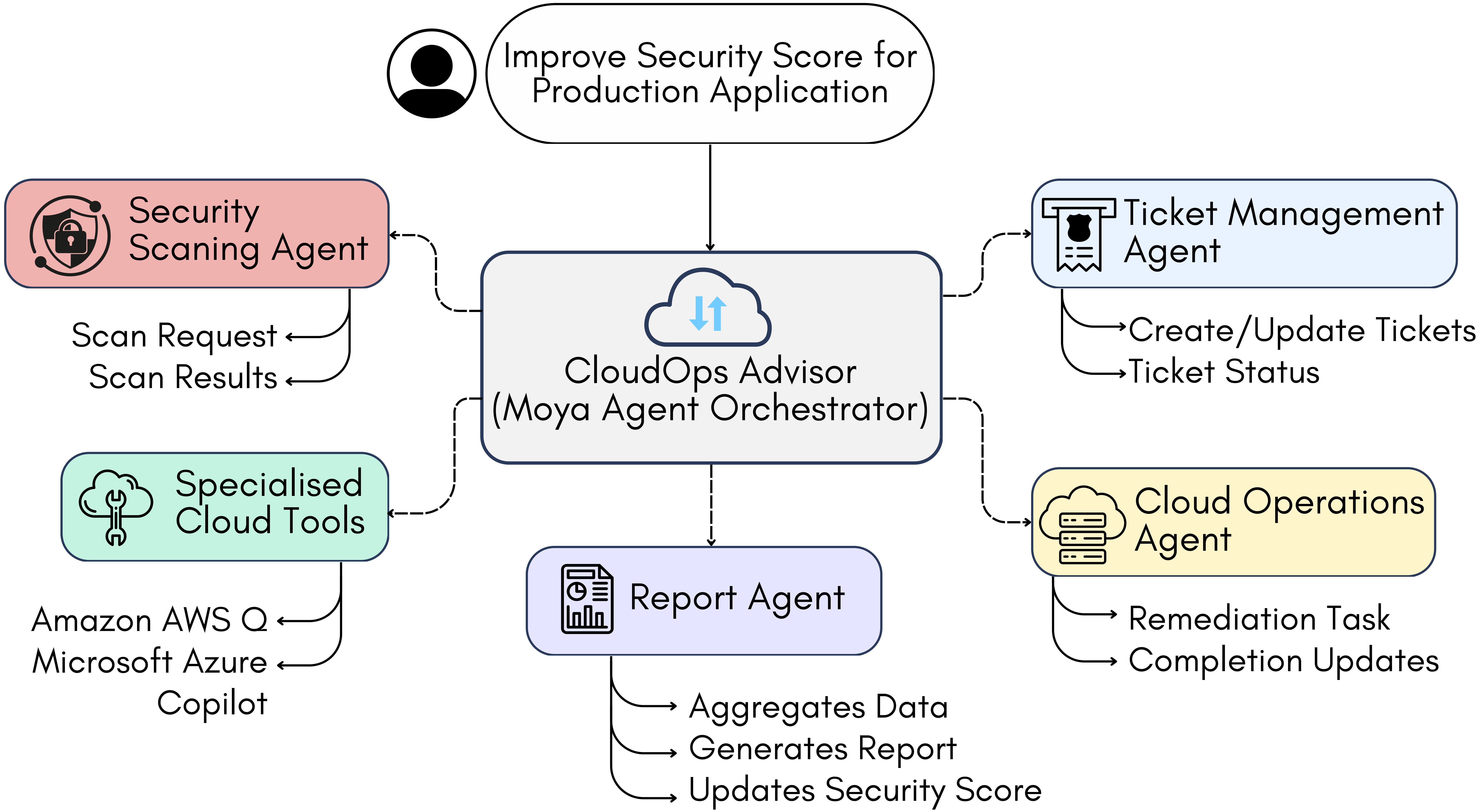
Complex Engineering Challenges

- **Managing Distributed Data**
  - Diverse data sources
- **Maintainability**
  - Large code base, time for updates
- **Extensibility and Modularity**
  - Single vendor, ease of extensions!
- **Monolithic nature of existing frameworks**
  - Limited support, vendor lock-in, learning curve

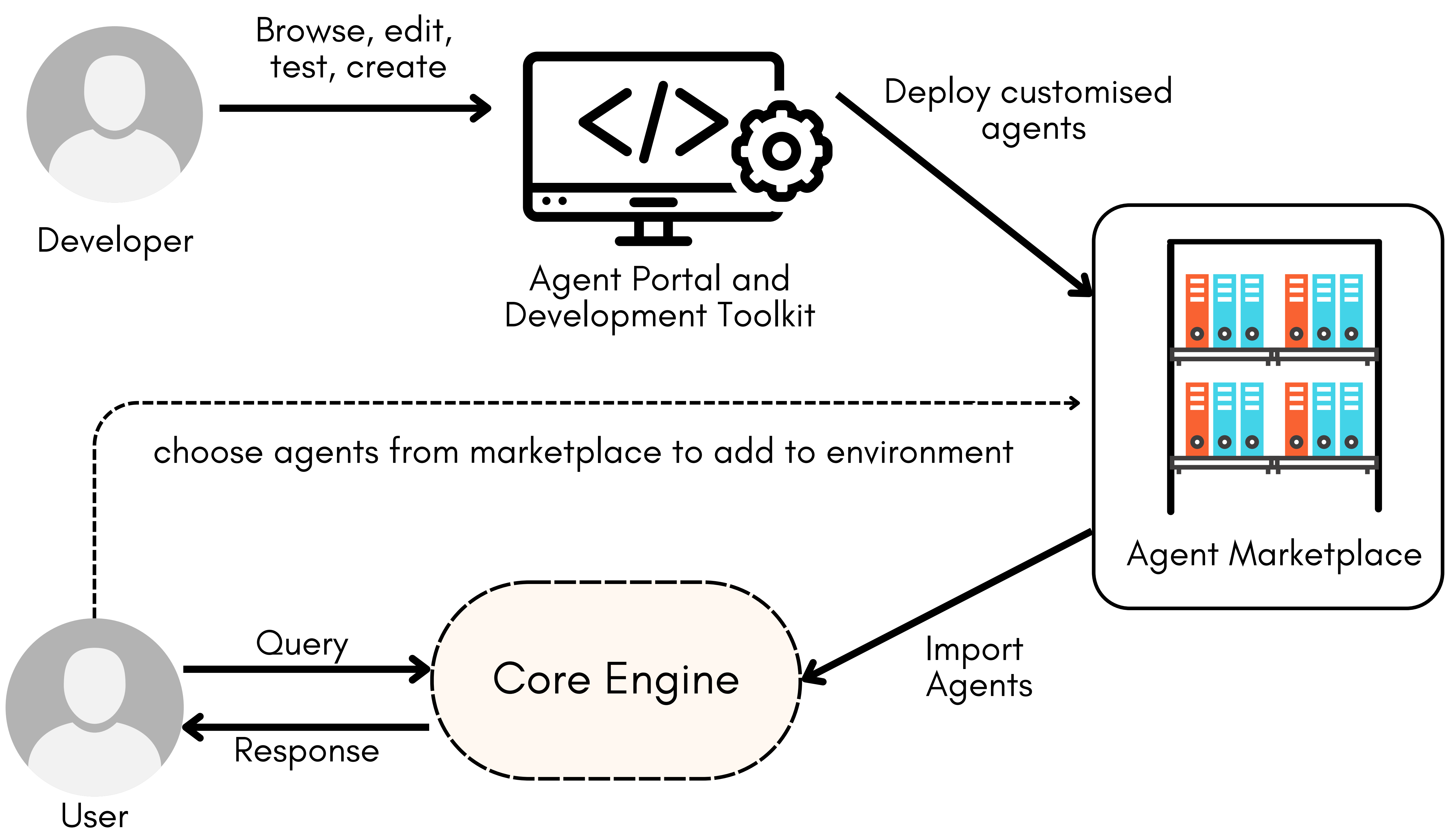
MontyCloud



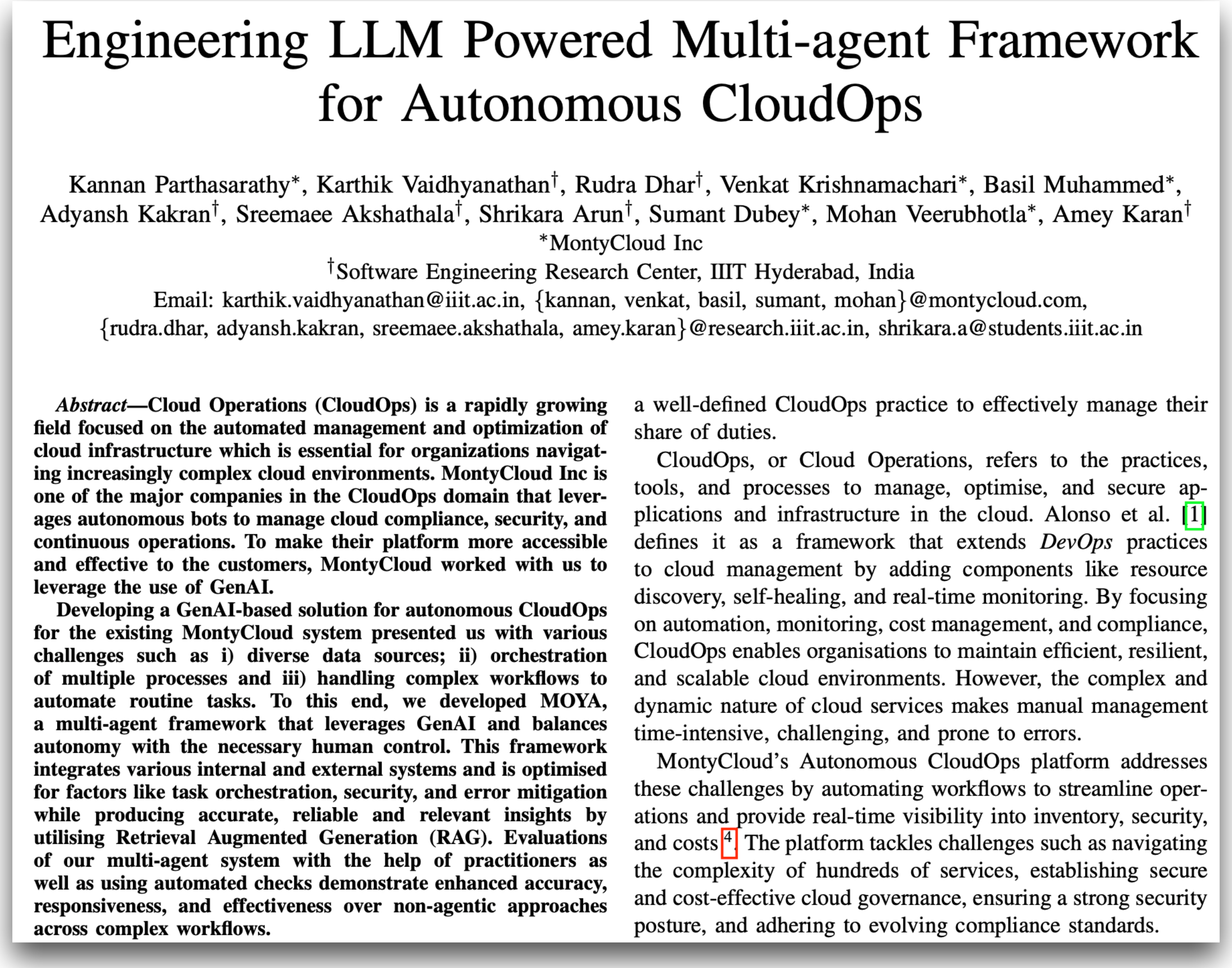
Can we go Multi-agent?



Enters MOYA: Meta Orchestration Framework of Your Agents


Browse, edit, test, create
Developer
Agent Portal and Development Toolkit
Deploy customised agents
Agent Marketplace
choose agents from marketplace to add to environment
Import Agents
Query
Response
Core Engine
User

Meta orchestration Framework



Engineering LLM Powered Multi-agent Framework for Autonomous CloudOps

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Adyansh Kakran†, Sreemaee Akshathala†, Shrikara Arun†, Sumant Dubey*, Mohan Veerubhotla*, Amey Karan†
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***Abstract*—Cloud Operations (CloudOps) is a rapidly growing field focused on the automated management and optimization of cloud infrastructure which is essential for organizations navigating increasingly complex cloud environments. MontyCloud Inc is one of the major companies in the CloudOps domain that leverages autonomous bots to manage cloud compliance, security, and continuous operations. To make their platform more accessible and effective to the customers, MontyCloud worked with us to leverage the use of GenAI.**

Developing a GenAI-based solution for autonomous CloudOps for the existing MontyCloud system presented us with various challenges such as i) diverse data sources; ii) orchestration of multiple processes and iii) handling complex workflows to automate routine tasks. To this end, we developed MOYA, a multi-agent framework that leverages GenAI and balances autonomy with the necessary human control. This framework integrates various internal and external systems and is optimised for factors like task orchestration, security, and error mitigation while producing accurate, reliable and relevant insights by utilising Retrieval Augmented Generation (RAG). Evaluations of our multi-agent system with the help of practitioners as well as using automated checks demonstrate enhanced accuracy, responsiveness, and effectiveness over non-agentic approaches across complex workflows.

a well-defined CloudOps practice to effectively manage their share of duties.

CloudOps, or Cloud Operations, refers to the practices, tools, and processes to manage, optimise, and secure applications and infrastructure in the cloud. Alonso et al. [1] defines it as a framework that extends *DevOps* practices to cloud management by adding components like resource discovery, self-healing, and real-time monitoring. By focusing on automation, monitoring, cost management, and compliance, CloudOps enables organisations to maintain efficient, resilient, and scalable cloud environments. However, the complex and dynamic nature of cloud services makes manual management time-intensive, challenging, and prone to errors.

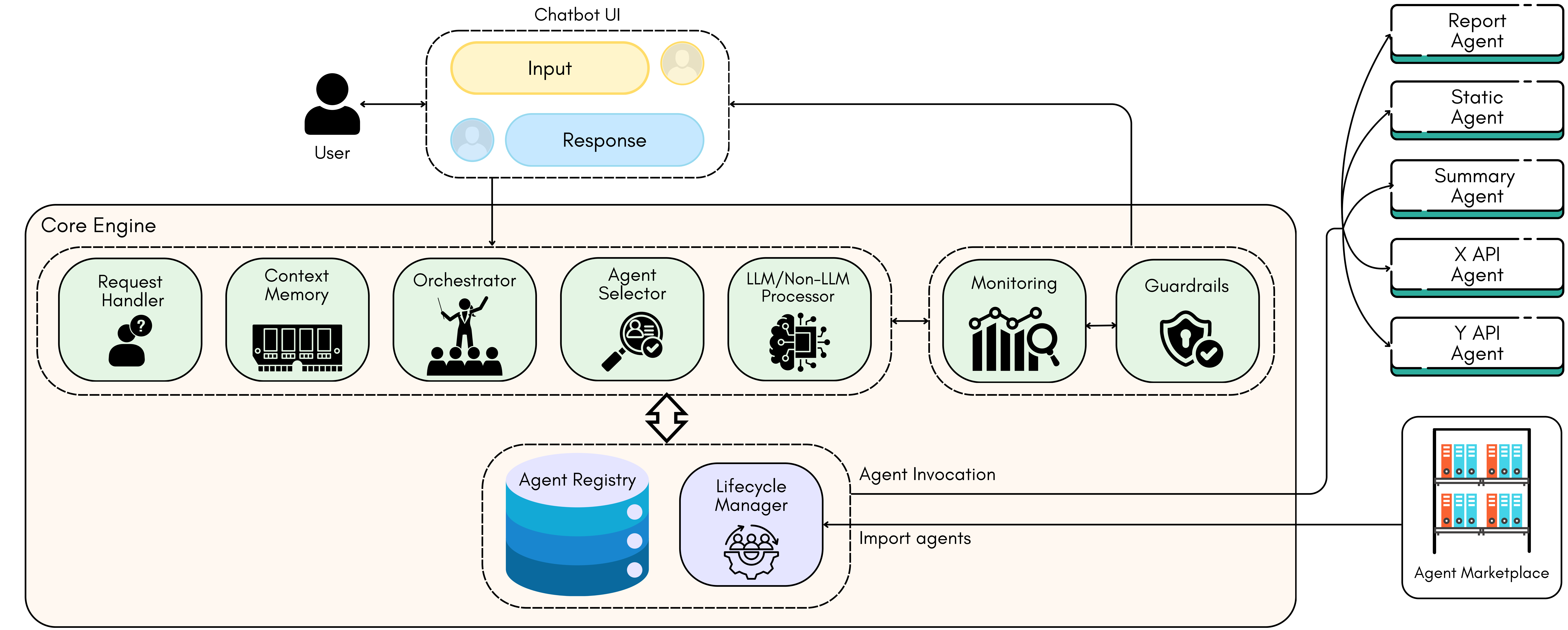
MontyCloud's Autonomous CloudOps platform addresses these challenges by automating workflows to streamline operations and provide real-time visibility into inventory, security, and costs[4]. The platform tackles challenges such as navigating the complexity of hundreds of services, establishing secure and cost-effective cloud governance, ensuring a strong security posture, and adhering to evolving compliance standards.

Best paper candidate@CAIN, ICSE 2025

Basic idea: support custom agents, in-house, etc. - Orchestrate with guardrails

The MOYA Multi-agent Framework

MOYA repo

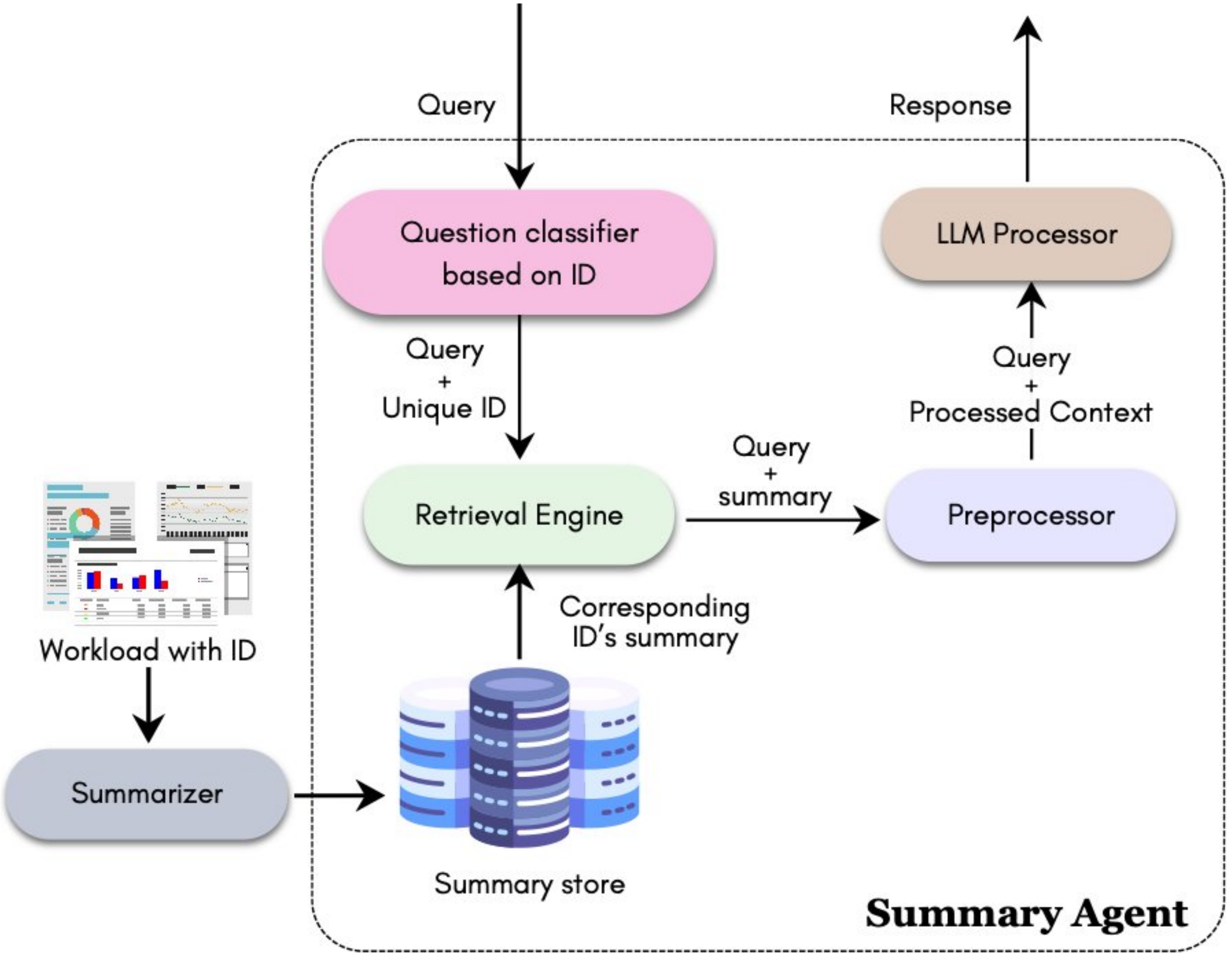


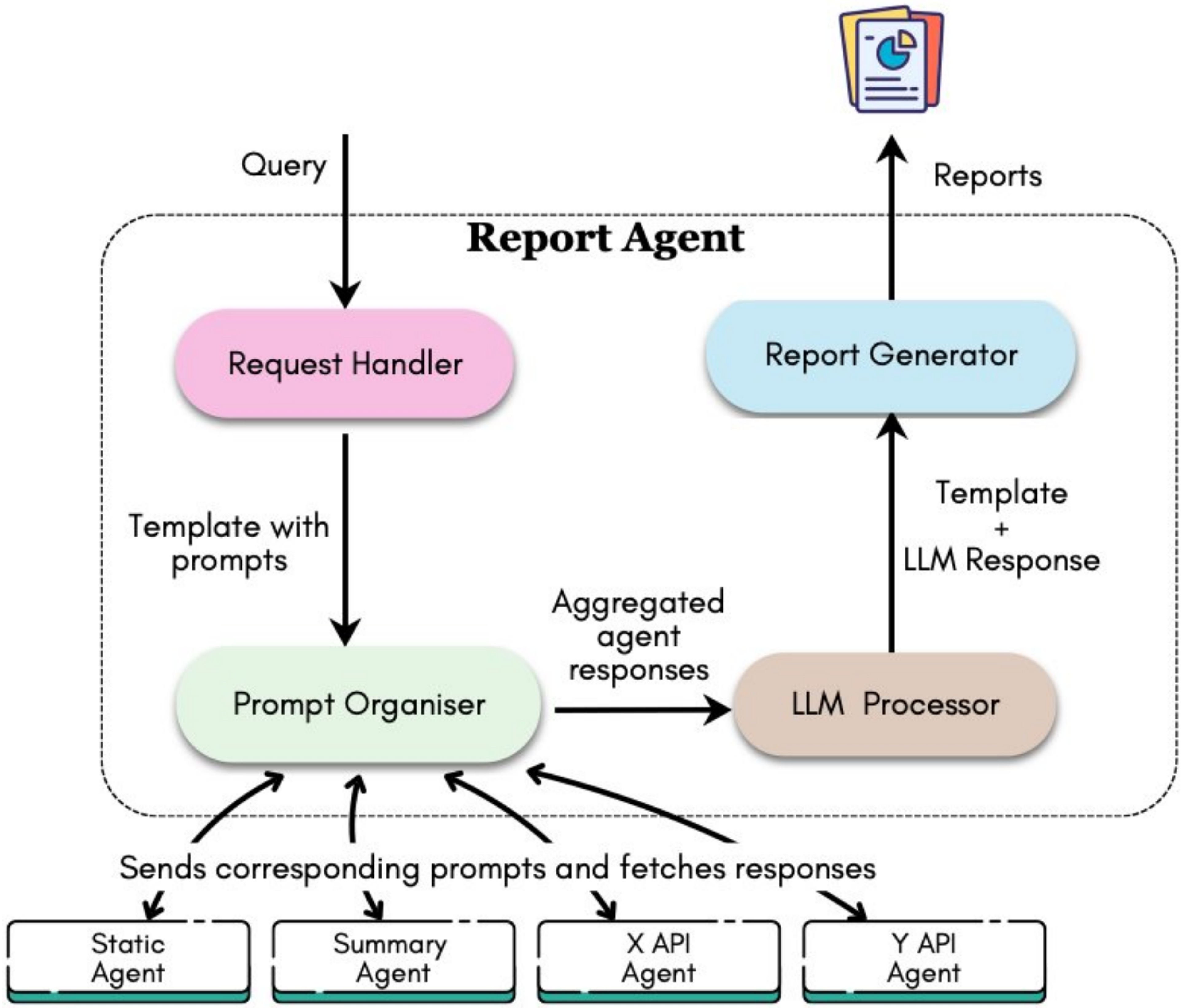
Parthasarathy, K., Vaidhyanathan, K., Dhar, R., Krishnamachari, V., Muhammed, B., Kakran, A., Akshathala, S., Arun, S., Dubey, S., Veerubhotla, M. and Karan, A., 2025. **Engineering LLM Powered Multi-agent Framework for Autonomous CloudOps**. *arXiv preprint arXiv:2501.08243,* CAIN 2025.

Some Agents in MOYA

Following Principles of Domain Driven Design

MOYA repo





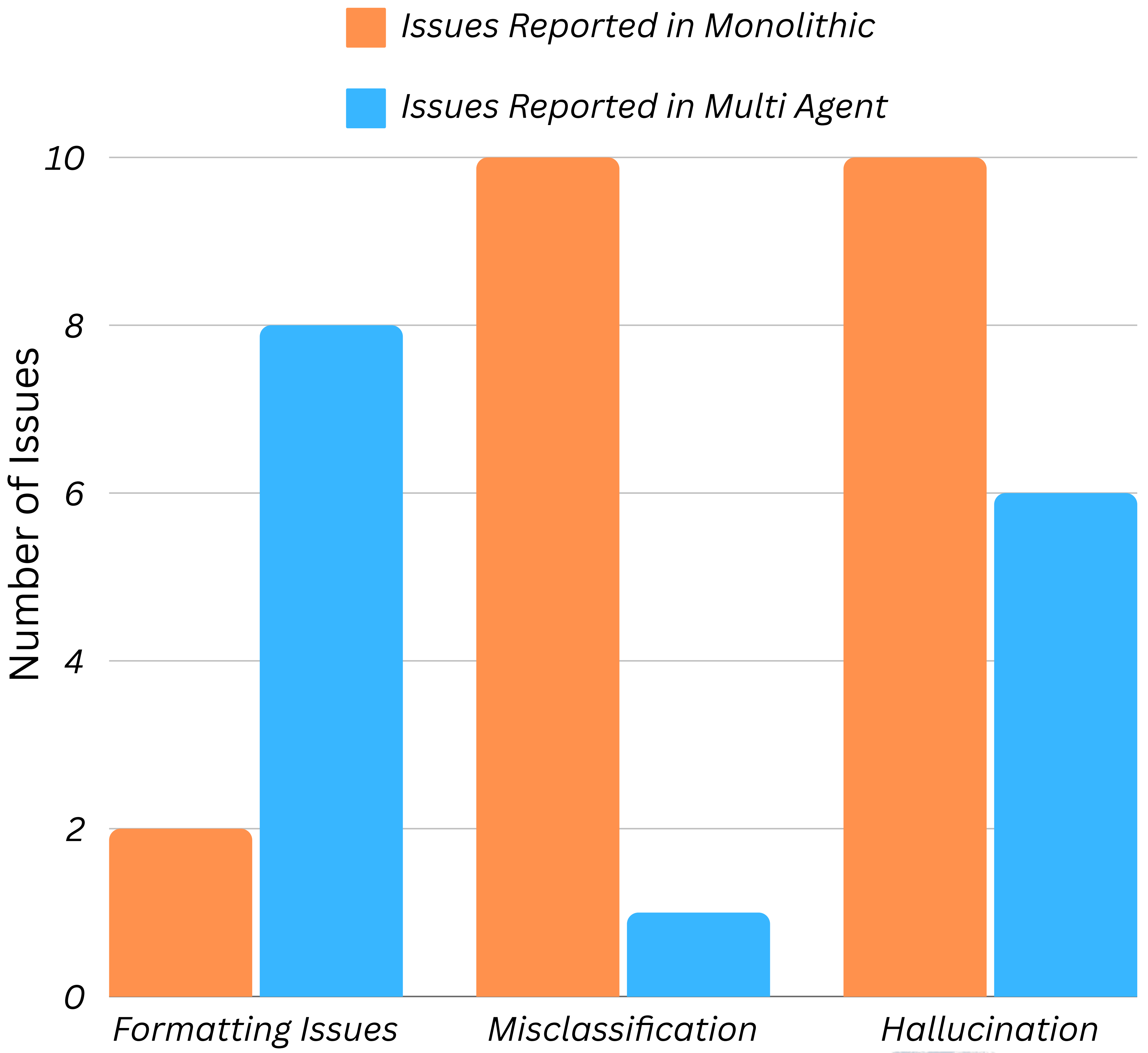
MOYA has support for different memory; MCP and A2A compliance on the way

Evaluating MOYA

MOYA repo

- Combination of automated and manual evaluations
- Ground truth of 260 prompts and responses
  - Curated with support of domain experts and LLMs

Approach	Rouge-1	bleu	Meteor	BERT score		
				Precision	Recall	f1
Monolith	0.321	0.102	0.265	0.854	0.834	0.843
MOYA	**0.448**	**0.221**	**0.423**	**0.867**	**0.869**	**0.868**

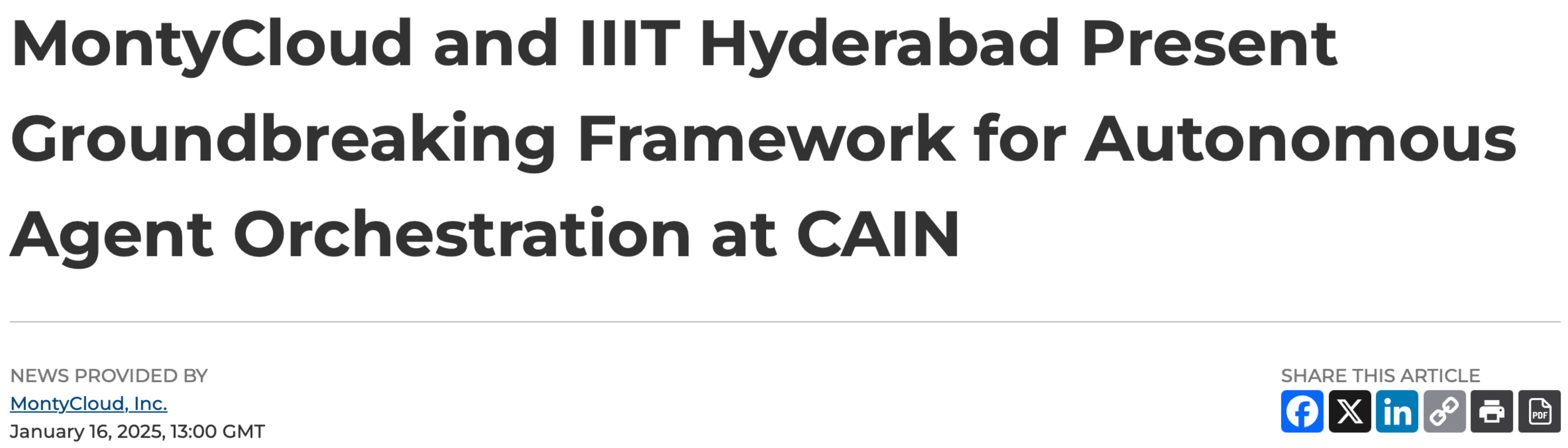


MOYA preformed much better -> Integration to the product

MOYA in action

MOYA Hackathon@IIITH

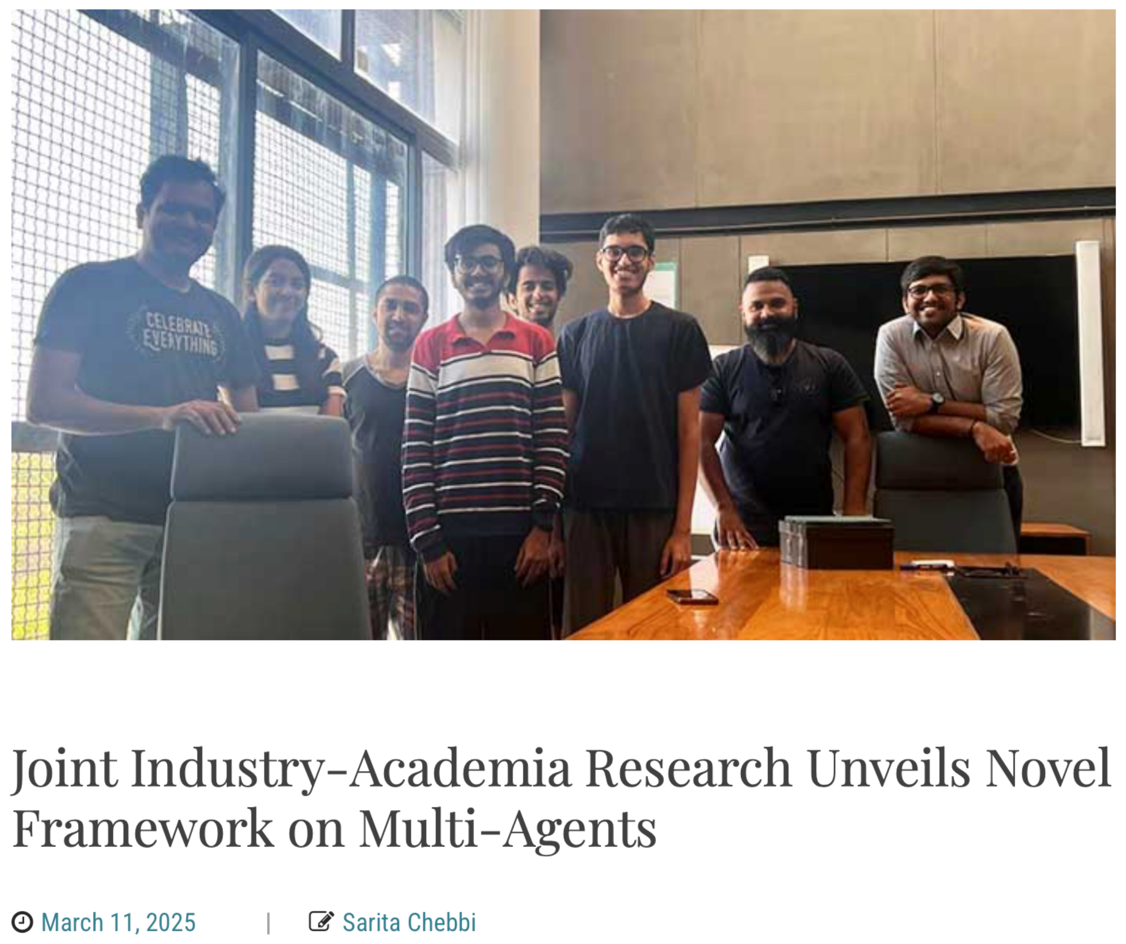
- 20+ teams with about 100 students
- 16 use cases across different domains
  - Framework extensions
  - Open track
- Some outputs/feedbacks
  - Generalisability of MOYA
  - Ease of use
  - Suggestions for improvement



MontyCloud and IIIT Hyderabad Present Groundbreaking Framework for Autonomous Agent Orchestration at CAIN

NEWS PROVIDED BY
MontyCloud, Inc.
January 16, 2025, 13:00 GMT

SHARE THIS ARTICLE



Joint Industry-Academia Research Unveils Novel Framework on Multi-Agents

March 11, 2025 | Sarita Chebbi

Meme Generator

Meta Solver

More..

Mental Wellness Assistant

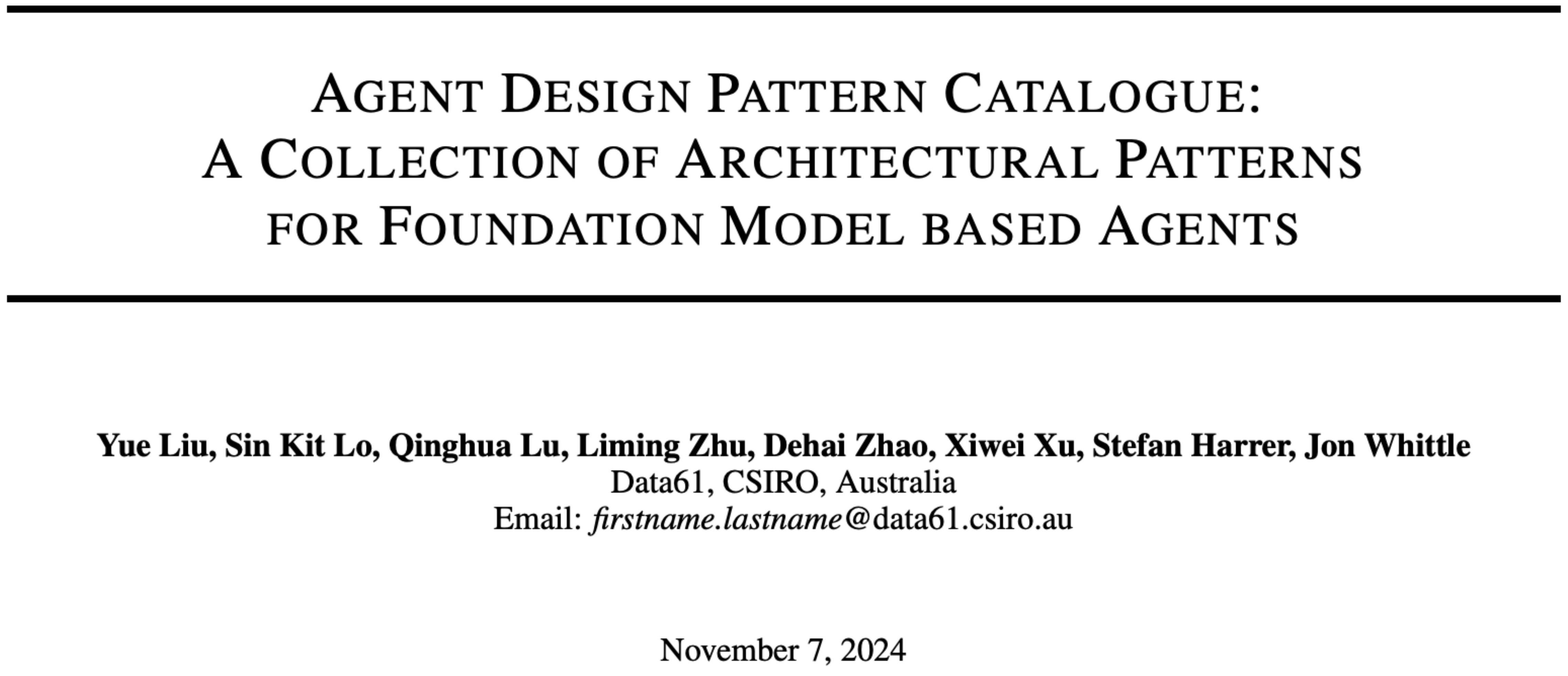
Team Orchestrator

Source: https://blogs.iiit.ac.in/moya/

Start Thinking in Agents

Build them in the right way

- There are emerging patterns
- Not every time we need to build agents
  - **Simple chatbots:** LLMs with RAG
  - **Workflows:** Orchestrated flows where LLM calls a tool
  - **Agents:** Back and forth communication to accomplish a task - Dynamic nature
- **Engineering plays the key:** DDD, Separation of Concerns, Trade-offs..



AGENT DESIGN PATTERN CATALOGUE:
A COLLECTION OF ARCHITECTURAL PATTERNS
FOR FOUNDATION MODEL BASED AGENTS

Yue Liu, Sin Kit Lo, Qinghua Lu, Liming Zhu, Dehai Zhao, Xiwei Xu, Stefan Harrer, Jon Whittle
Data61, CSIRO, Australia
Email: *firstname.lastname*@data61.csiro.au

November 7, 2024

Engineering at Anthropic

Building effective agents

https://www.anthropic.com/engineering/building-effective-agents

Key Takeaways

Agentic AI is shifting the way we think about building software/software services

- We **need a change in mindset** when it comes to development
- Lot of **support for automation** (eg: modernization)
- **Reliability, Robustness, Responsibility** - Engineering is the key!
- **Domain specific LLMs** which are smaller shall be the way forward - collection of SLMs (helps agents)
- **Need for better processes** to architect/engineer systems around AI agents
- **Agentic thinking -** SaaS as such is not dead but the **way we build/develop!**
- **AgenticAI - Reimagine Autonomy, Sustainability and intelligence at scale!**

THINKING IN AGENTS COULD TRANSFORM HOW WE BUILD SYSTEMS!
IT'S A PIVOTAL SHIFT. LIKE GOING FROM SPAGHETTI-CODE TO OBJECT-ORIENTED PROGRAMMING!
SO... VIBE CODING WITH FRIENDS?
AGENT
A
MontyCloud

Credits: Kannan Parthasarathy, MontyCloud

SA4S@SERC

Rudra Dhar

Akhila Matathammal

Hiya Bhatt

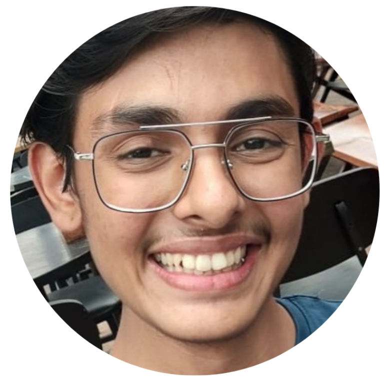
Chandrasekar S

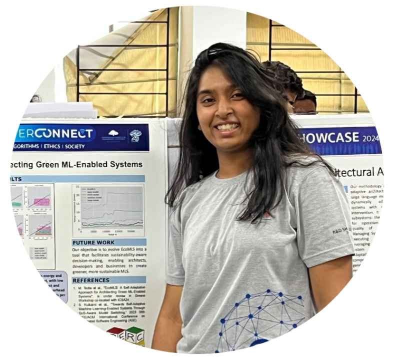
Shubham Kulkarni

Adyansh Kakran

Prakhar Jain

Shrikara A


Arya Pravin Marda


Meghana Tedla

Miryala Sathvika

Prakhar Singhal

Amey Karan

Bassam Adnan

Aneesh Sambu

Shaunak Biswas

Shailender Goyal

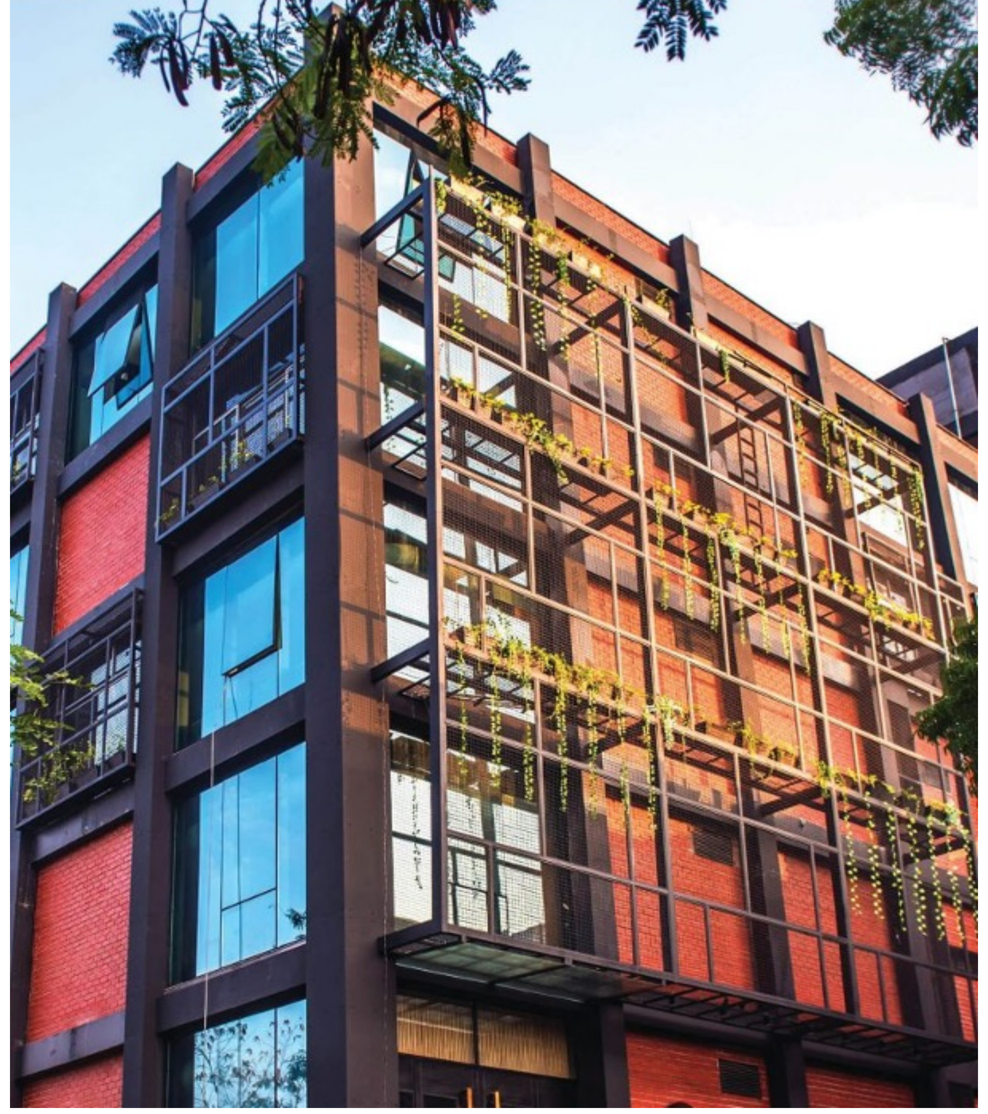
Sreemaee Akshathala

Divyansh Pandey

Maddireddy Kritin

Santosh Kotekal

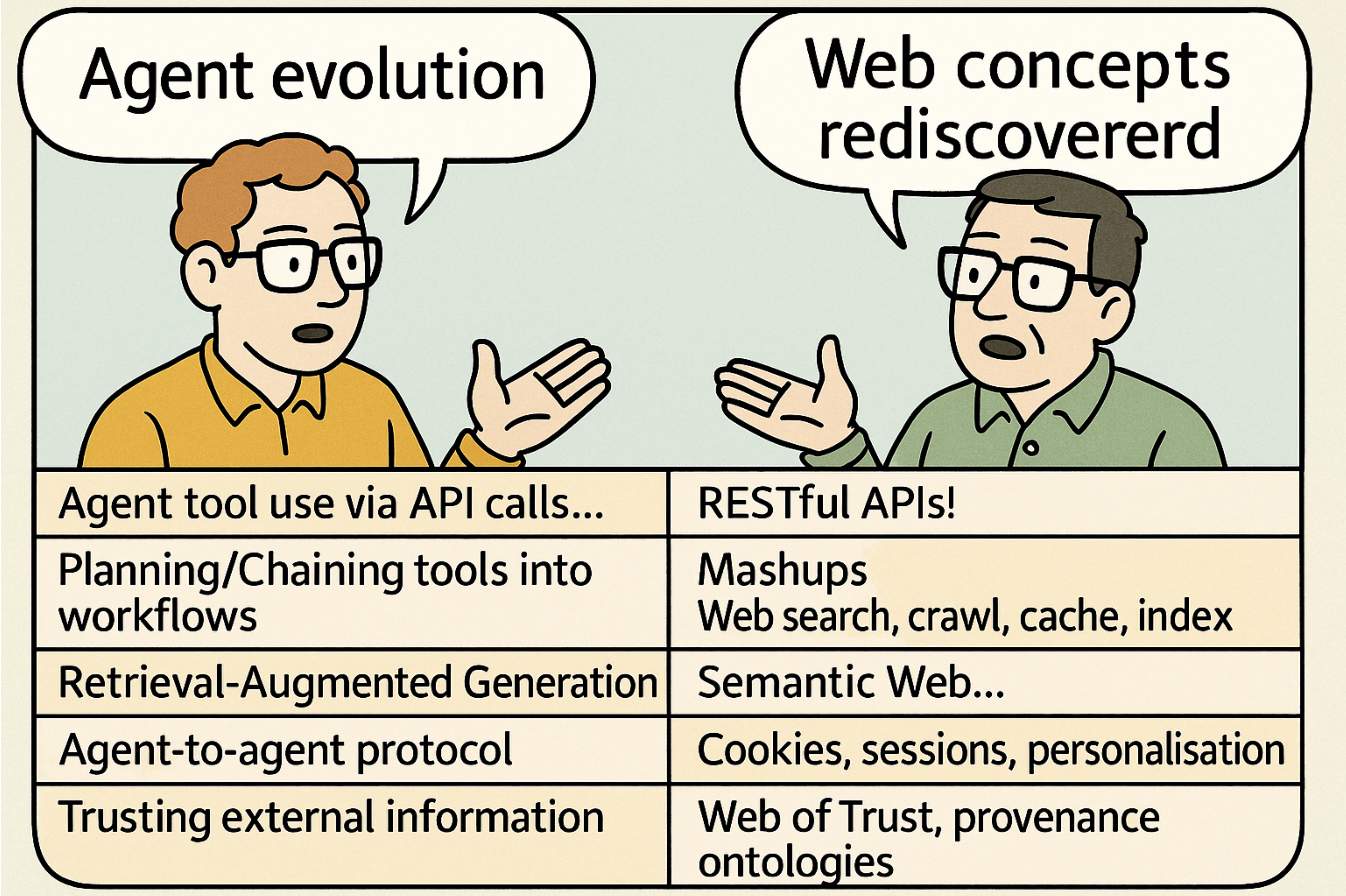
Vyakhya Gupta



https://serc.iiit.ac.in

Team SA4S

https://sa4s-serc.github.io



Agent tool use via API calls...	RESTful APIs!
Planning/Chaining tools into workflows	Mashups Web search, crawl, cache, index
Retrieval-Augmented Generation	Semantic Web...
Agent-to-agent protocol	Cookies, sessions, personalisation
Trusting external information	Web of Trust, provenance ontologies

Concept credit: Liming Zhu

SCAN ME

Thank you

IEEE Software Magazine

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