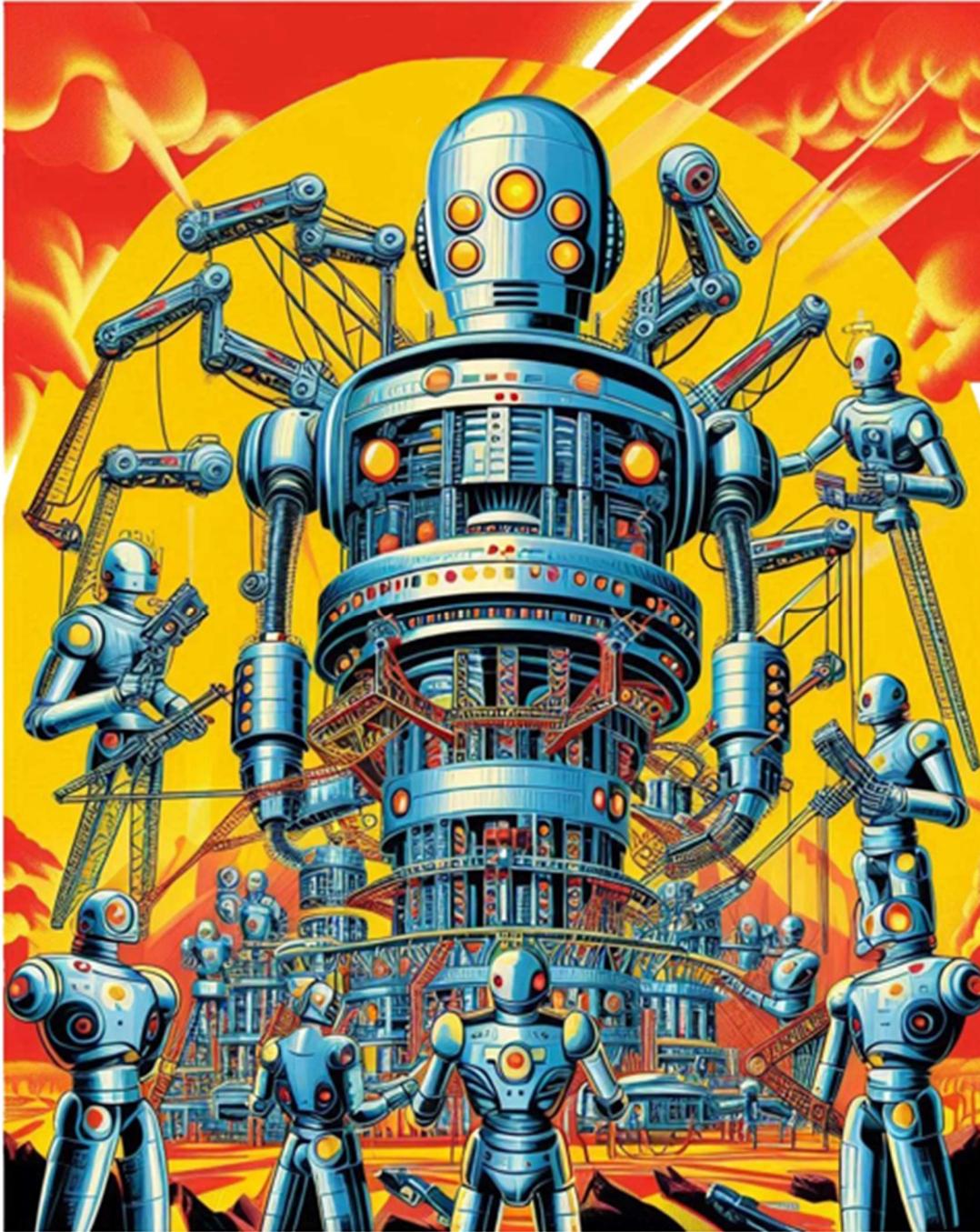


Multi Agent Systems MAS



Andreas Ramos

Multi Agent Systems MAS

By Andreas Ramos

Summary

A short guide in plain English on Multi Agent Systems (MAS): what they are and how to make one, and what they can do.

Updates

I update this ebook occasionally. This version is August 20, 2024.

Get this ebook at my website at <https://andreas.com/ai/> or Amazon

Who Wrote this Book: Andreas or AI?

This book is organic, artisan, and free range. I wrote this book. I wrote prompts and then asked the AI to write the prompt that I should have written. I use ChatGPT-4, Sonnet, and Claude-3. I used Microsoft Image Creator to create the cover.

More about Me

I'm an adjunct professor of digital marketing at CSTU, a private technical university in Silicon Valley. I'm also senior instructor at DMAnc.org, where I teach corporate training in digital marketing to corporations and large organizations. I have 25+ years of experience in digital marketing in Silicon Valley. I've worked with major corporations worldwide. I live in Palo Alto. See more about me at andreas.com/about/ or [LinkedIn.com/andreasramos](https://www.linkedin.com/in/andreasramos)

Folks, AI is the biggest change to marketing since HTML came out in 1993. Marketing will change substantially.

Bluetooth-enabled Ski Boots

I use Bluetooth-enabled ski boots by Ski-Boots.com as an example. I don't sell ski boots. Ski-Boots.com doesn't exist. I don't even like snow. It's just an example.

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Go Beyond Prompts: Multi Agent Systems MAS

Summary

- We are moving from “using a device” to “managing intelligent systems”.
- These intelligent systems can carry out complex research, analyze massive amounts of results, and make decisions.

In my first prompt ebook *Prompt Crafting for Digital Marketing*, I showed how to build a persona, such as the *Manager of SEO* at your company. You can build persona for the different roles: director of marketing, manager of ads, manager of social media, and so on. But these are separate persona.

You can tie all these persona together to work as a team. You assign a project to the manager, who on its own will break up the project into tasks and assign them to relevant persona, such as SEO to the SEO persona, ads to the ads persona, and so on. Each persona selects relevant tools, does its task, and passes the work on to other quality reviewer persona. This is called Multi Agent Systems (MAS). This ebook covers MAS.

Do You Realize We're Still Using Typewriters?

Remember typewriters? I had a mechanical typewriter in college in the 70s. In the early 80s, I upgraded to an electric typewriter for my master's thesis. No more sore fingers!

In 1985, I got a computer for my PhD thesis. It could search, format, store files in memory, and more.

But think about it: a computer is basically a typewriter: You sit in front of it and type.

What about your smartphone? It's a typewriter with a built-in phone and camera. You're still typing messages with your fingers.

When people use LLM AI, they're typing prompts. We're still typing at a machine.

Yes, sure, Voice Mode lets you talk to the AI and it talks back. Is that different from typing? Not really. It's just another way to input into a device.

Is AI Just Another Typewriter?

Most folks use ChatGPT and other LLM AI like a search engine: you ask a question; you get an answer.

When people ask an LLM AI to translate, write poetry, or draw images, they don't notice that the LLM AI is replying as if it knows how to do these things. It's acting as a translator, a poet, or an artist.

The Power of an AI Persona

LLM AI can act like a person. Instead of just telling the AI to do something ("write a poem about my cat!"), you set its persona. Tell it to be a Shakespearean poet and then ask for a poem about your cat. (Go ahead, try this. Ask for a poem about your cat. See what it says. Ask again, but this time, write, "Act like a Shakespearean poet. Write a poem about my cat". Compare the poems. Do you see the difference? The first is a basic poem and the Shakespearean poem is complex. The AI wrote from that point of view.)

You can use a persona for your projects. For example, say "Act like the CEO of a ski boot company". Now you can work with it as if it's the CEO of a company.

You can ask the AI to take on all kinds of roles: Act like a marketing manager or a salesperson. Act like a dog, a hummingbird, or a gray whale. Act like Nike corporation, the city of Denver, or the Milky Way Galaxy. Act like the emotion of enchantment. For each of these, you can ask questions, discuss, and learn more.

Instead of short, one or two-sentence prompts, start writing longer ones. You can write prompts that fill a page or two. The more you write, the better the AI performs. Try "Act like the CEO of a ski boot company with headquarters at Lake Tahoe, California, that makes Bluetooth-enabled ski boots for competitive skiers". You'll get better answers.

This is something different.

The Idea of Agentic AI

The ability of an LLM AI to appear to act on its own is called "agentic AI".

Before we go any further, what do we mean when we say an AI "acts like an agent"?

When you think about it, "agentic AI" is a metaphor, like saying "the thunder's lion roar".

It's often helpful to use familiar ideas to learn new things. If an AI acts human-like, some imagine it could be a good human who can do many things. But some imagine it could be a bad person, so they say AI is dangerous.

It's like roaring thunder - no matter how lion-like it sounds, you won't find big cats in your backyard. Same with AI: it seems to act on its own, but that doesn't mean the AI has intentions.

Agentic isn't a new idea. We use the agentic metaphor for lots of things. We talk about corporations, social movements, religions, political parties, markets, nations, and ecosystems as if they have their own goals and act on their own. But these are metaphors as if these things are agents.

BTW, Anders Kjaersgaard (Denmark) writes "actor" is a better word because the AI acts. I agree. The idea of "agent" comes from the concept of "agency" in the social sciences, where agency is the ability of an individual to have the power and resources to do things. It's also often used in

literature theory. However, most people have never heard of this idea (and that includes most computer science PhDs). Add the idea of "agentic AI" and we really go too far. An AI can indeed act like a human, but why limit it to just humans? An LLM AI can act like the Milky Way galaxy and it's nonsensical to talk about a galaxy in human terms. This is another example of how the sloppy use of concepts in AI creates new problems.)

The Three Levels of Prompts

There are three levels of prompts in LLM AI:

- **Level One Prompts:** These are simple prompts, written by people who aren't aware of an LLM AI's ability to be a persona. They write a prompt, get a reply, and write another prompt, over and over. To them, an LLM AI is a sort of typewriter. You see this kind of prompt in "*Lists of Best Prompts*" and books with the title, "*1,001 Power Prompts!*".
- **Level Two Prompts:** The user writes prompts that use the LLM AI's ability to behave as a specific persona. This allows the user to enter a dialog where a series of prompts can explore topics and get detailed replies. In Level Two prompting, the AI can act as an Agent. This is a **Single Agent System (SAS)**, which means the user treats the AI as one agent.
- **Level Three Prompts:** Instead of just one agent, the user creates multiple agents and uses a bit of code or an MAS platform to tie the various agents together to accomplish tasks. The user is able to assign complex tasks to the group of agents, which it completes on its own. This is **Multi Agent System (MAS)**.

This ebook covers Level Three Prompts, Multi Agent System MAS.

If you haven't read my previous ebook *Prompt Crafting for Digital Marketing*, I recommend you stop here and read that book. You need to understand persona to be able to build an MAS.

What If We Get these Agents to Talk Together as a Team?

If the AI is an agent and it can do things on its own, what happens if you get several of these agents to talk with each other for larger tasks?

1. You break a project down into tasks.
2. Create an agent for each task.
3. Give each agent the information, goals, tools, instructions, and where to send the results.
4. The agents are connected to each other with a bit of code.
5. This creates a group of agents.
6. You assign a project to the group.
7. The agents collaborate to do the project and deliver the results.

This is a new thing: Multi Agent System (MAS).

Philip Rathle, CTO of LangChain (an MAS company), said the phase of prompting in AI is over.

There is nothing new in prompts. He says the next phase is agentic AI, which means, “use LLM AI in a way that takes advantage of its agentic capability”.

Names for This

There are different names for this:

- Multi Agent System (MAS).
- Agentic AI.
- Agent workflows.
- Crew.
- Swarm.
- Team AI.
- Artificial Societies.
- Collaborative AI.
- MoA: Mixture of Agents.

Or just agents

They all mean the same thing: a bunch of LLM AI agents work together.

Example of an Agentic System

It'll be easier if I give you an example of an MAS. Here's a before-and-after of MAS for a marketing team. (BTW, I use marketing as an example because everyone understands the idea of marketing. Later, you'll see a list of many tasks for an MAS.)

A Marketing Team before MAS

A marketing team has people with a few roles:

- Director of Digital Marketing.
- Webmaster.
- SEO.
- Digital Advertising.
- Content Marketing.
- Analytics.

But many companies have only one or two people who do everything 😊

Why don't companies have more people? Because it's difficult to have a larger team. It takes time to find people with the right experience, skills, and attitude, more time to hire and train them, and then lots of time to manage and motivate them. You also need budgets for each person.

And you'll be lucky to get a 40-hour work week out of them. They attend meetings, take breaks, go to lunch, chat with each other, want WFH, go on vacation, want health insurance, more pay, time off for grandmother's funeral who has died four times already, and then they leave for other jobs. And there's personality issues...

What if you could replace all these people with AI that does the job?

A Marketing Team with MAS

You can create an MAS with agents for each of these roles:

- Director of Digital Marketing.
- Director of Traditional Marketing.
- Director of Brand Marketing.
- Project manager.
- Webmaster.
- Keywords.
- On-page SEO.

- UX/UI SEO.
- Speed SEO.
- Technical SEO.
- Off-page SEO.
- Digital Ads in Google Ads.
- Digital Ads in Facebook/Instagram.
- Digital Ads in Tiktok.
- Digital Ads in LinkedIn.
- Digital Ads in YouTube.
- Content Creation.
- Images.
- Video.
- Analytics.
- Reporting.
- Quality review agents.

That's one MAS with 22 agents. Instead of one staffer with multiple skills, you create agents for each skill (and you can easily add more).

This MAS works 24/7, never takes breaks, never asks for a raise, and won't leave.

How about More MAS?

A two-person startup can have an MAS for each department in their company:

- Business Strategy.
- Incorporation.
- Competitor analysis.
- Fund raising.
- Hiring.
- Product development.
- Quality control.
- Marketing.
- Event planning.
- PR.
- Sales.
- Customer support.

- Distribution.
- Legal.
- Finance.
- HR.

And so on. Each MAS may have 25 or more agents, so sixteen MAS at 25 agents each would be 400 agents. This means small companies can compete against much larger companies.

Role of an MAS in a Company

An MAS can be used as a digital twin of a team, mirroring the team's structure and processes. The MAS can do routine tasks, freeing team members to focus on complex, high-value activities. The MAS can also be used for idea generation and creative solutions. Teams with MAS can work faster and better. The team supervises and manages the MAS to make sure it aligns with company goals and the results are top quality. MAS can enhance, not replace, humans.

Who's Going to Build these MAS?

Experienced people with basic MAS knowledge can build and manage these. They watch the results and fine-tune as needed. They do this in user-friendly interfaces, similar to Lego blocks, which allows them to set up projects, define goals, add agents, describe tasks, assign tools, point to data, all with everyday language.

Subject Matter Experts (SMEs) or Task Matter Experts (TMEs) can use their knowledge and experience to create MAS. We may soon see MAS that can create and optimize other MAS.

There are also Mixture of Agents (MoA) or Mixture of MAS, where multiple MAS work together in a larger system.

BTW, If you're using project management platforms such as Jira, Asana, Trello, or similar, you can use those as an outline to build your MAS.

Modular MAS Development

MAS development is moving towards a modular approach. Instead of creating one large platform, developers build and test individual agents separately. This method offers several advantages:

- **Flexibility:** You can add, edit, or remove agents as needed, allowing the system to evolve with changing requirements.
- **Rapid iteration:** Testing one agent is faster and more efficient than testing an entire system at once.
- **Adaptability:** The modular structure allows the MAS to adapt to changes in agents, tools, or information sources.

- Scalability: As the project grows, new agents can be added without disrupting the existing system.
- Customization: Organizations can tailor their MAS by selecting and combining agents that best suit their specific needs.

This approach improves the overall flexibility of MAS, making them more practical and adaptable for real-world applications.

What Do MAS Agents Look Like?

The Code for an Agent

Let's create one agent. Here's an example of basic code for an agent:

```
Planner = Agent (  
    Role = "Content Planner",  
    Goal = "Create content on ski boots",  
    Backstory = "Write a magazine article on ski boots",  
    Tasks = [  
        "Collect information about ski boots",  
        "Send the research to the Content Writer"  
    ]  
)
```

This code defines the Content Planner. It sets the role (it's a content planner), the goal (it will write content about ski boots), the background (it writes articles about ski boots), and the task (it collects information and sends the research to the writer).

That's all there is to it. Of course, this can have more agents, more details, and add tools, but it's basically a list of roles, goals, and actions.

You do the same to create several more agents, such as the writer and the editor.

The Code for the MAS Team

Now we have three separate agents (planner, writer, and editor). Let's tie these three agents together so they work as an MAS team.

Here's an example of the basic code for an MAS:

```
Crew = crew(  
    Agents = [  
        content_planner,  
        content_writer,  
        content_editor  
    ],  
    Tasks = [  
        "plan",  
        "write",  
        "edit"  
    ]  
)
```

First, you set this as a team (the crew). Add a list of the agents in the team (the content planner, content writer, and content editor). Finally, add the task (they plan, write, and edit).

Bingo. You've created a MAS.

You can see it uses plain words (plan, write, edit) and the MAS figures out what to do.

Again, this is a basic MAS. Lots of details and tools can be added, but you can see the key idea: The LLM AI can act as an agent and the MAS is a way to tie several agents together.

An Example of a Marketing Agent

As I said, you can add more details. Here's a richer description of an agent for social media work.

- Role: Manager of Social Media.
- Goal: Manage social media to increase presence.

- Backstory: Write social media postings that are based on the company's history, match the target audience's needs and fears, include the product specs and benefits, emphasize USP and UVP, end the post with a CTA, include emoji, with the goal to increase traffic by 10% by end of Q3/2024
- Task: Write 200 social media postings for Twitter, not more than 280 characters per post.

You can create one social agent media for Twitter posts, another for Facebook, and more for Instagram, TikTok, LinkedIn, and so on where each agent is tuned to the rules of the various social media platforms.

MAS as a Meta-Tool

A MAS can use tools and data, such as:

- LLM AI (ChatGPT, Google Gemini, Microsoft Copilot, Meta...)
- Search in ArXiv, Google, Bing, DuckDuckGo, Wikipedia, Reddit, etc.
- Search the web.
- Scrape websites.
- Knowledge Graphs (KG).
- Retrieval Augmented Generation (RAG).
- API.
- Post.

This means a MAS is a meta-tool: it's a tool that uses other tools.

Adding Data with Retrieval Augmented Generation (RAG)

You can add relevant data (documents, spreadsheets, databases, emails, etc.) to the MAS. The information can include:

- Company reports.
- Industry reports.
- Analyst reports.
- Company emails, PowerPoints, etc.
- Company financial spreadsheets.
- Product information.
- Product specifications.
- Customer databases.

This is called RAG, which is a complex way to say that you can add your private data. RAG has an advantage: your data remains private. It doesn't leave your system. This is an important issue: the privacy and security of data and information is critical to companies. This matters

more than creativity. Future LLMs will be smaller so they can be set up on private networks, so no data is shared. Already there are LLM AIs that you can install and use on your laptop or smartphone for complete data privacy.

Additional Tools for an MAS

You can add tools to an MAS.

For example, the MAS can get the score for last night's baseball game, search Google, write a summary of a YouTube video, look up an author's books and articles, check real time stock prices, check a flight status, check the warehouse inventory, and so on.

Here's a list of tools that an MAS can use (not a complete list):

- Natural Language Processing (NLP).
- Computer vision.
- Speech recognition and synthesis tools.
- Multimodal (audio, image, video, etc.).
- Expert systems.
- Reasoning engines.
- Planning algorithms.
- Optimization solvers.
- Data mining tools.
- Sentiment analysis modules.
- Anomaly detection systems.
- Recommender systems.
- Reinforcement learning algorithms.
- Genetic algorithms.
- Neural networks.
- Fuzzy logic systems.
- Ontology management tools.
- Semantic web technologies.
- Robotic process automation (RPA) tools.
- Predictive analytics engines.
- Time series analysis tools.
- Natural language generation (NLG) systems.
- Information retrieval.
- Machine translation.

- Simulation engines.
- Decision support systems.
- Pattern recognition algorithms.
- Clustering algorithms.
- Blockchain technologies.
- Specialization.
- Data search.
- Analysis.
- Interpretation and insights.
- Write strategy.
- Decisions.
- Presentations.

An MAS can also use another MAS as a tool.

Which Tool for the Agent?

You don't have to pick one tool for each agent. LLM AI can evaluate and select the best tool for the task.

For example, you want the agent to use an AI. But which one? The various LLM AI (ChatGPT, Gemini, Sonnet, Copilot, etc.) have different skills. GPT-4 is good at business tasks and Claude 3.5 is good at statistical analysis. You give the agent a list of AIs, such as ChatGPT, Sonnet, Gemini, Copilot, and many more and the LLM AI selects the best one for the task.

This takes advantage of a feature of LLM AI: it can understand general goals and select the right tools to achieve those goals. This means an MAS is very good at problem-solving because it explores many possibilities with the tools.

How to Structure an MAS

The MAS can be organized in various ways, each suited to different tasks and environments. One way to do this is to set it up like companies:

- **Hierarchical:** Like a traditional office, a manager agent oversees a team of agents. This allows clear lines of authority and task delegation.
- **Parallel:** Multiple agents work simultaneously on the different aspects of a task. For instance, if the task is to analyze five competitors, the five competitors can be assigned to five agents, one for each, and all five work simultaneously, thus getting the work done quickly.

- **Sequential:** The tasks move through a series of agents, where each does a specific function and then passes it on to the next. This is like a factory assembly line.
- **Asynchronous:** This can be used for systems where there is continuous data flow at different speeds, such as weather forecasting or stock market analysis. Multiple agents collect data independently, updating a central knowledge base. Other agents use this constantly updated data to make predictions or decisions.

Each has its strengths, and the choice depends on the task. Hierarchical and parallel structures work for projects, while sequential and asynchronous structures are good for ongoing, data-intensive processes. These can also be combined.

Why Not Just Use ChatGPT?

Yes, you can do all of this by chatting with an AI, prompt by prompt.

But that's limited to your human abilities. You can't read 50,000 pages, recall all relevant details, organize it into a logical summary, and deliver within minutes.

In contrast, a MAS can run nonstop with far more data and better attention to detail.

Do MAS Actually Work?

The two groups of researchers built MAS that make software or translate books:

- **Software MAS.** Describe the software you want, and the MAS makes custom software with design, code, testing, and user manual in 410 seconds (6.8 minutes) at a cost of US\$0.30. Read about this at [ArXiv.org/abs/2307.07924](https://arxiv.org/abs/2307.07924).
- **Translations MAS.** Paste a book into the MAS and it uses senior editors, junior editors, translators, localization specialists, and proofreaders to translate the book. The quality of the AI translation was rated better than translation by professional human translators. The cost was 80X cheaper (\$75 instead of \$6,000). Read about this at [ArXiv.org/pdf/2405.11804](https://arxiv.org/pdf/2405.11804).

Platforms for Agent Systems

You can write the MAS by hand with Python code. There are also platforms where you can build MAS:

- Microsoft AutoGen.
- Google VertexAI.
- RelevanceAI.com.
- CrewAI.
- Langchain.
- Anthropic.
- OpenAI.

- DeepMind.
- Fetch.ai.
- SingularityNET.
- Bonsai.
- RobotWorx.
- Prowler.io.
- Cogitai.
- Ocean Protocol.
- And more.

RelevanceAI has a drag-and-drop platform where you can quickly create an MAS, assemble agents, and assign properties. You can build and use one MAS for free. They also have many MAS that you can use.

VCs Are Investing in MAS

A number of top VCs are investing in MAS projects: Khosla, Andreessen Horowitz, Softbank, Y Combinator, Plug and Play, and more.

MAS at Work

- CrewAI and LangChain host more than two million active agents.
- MAS are active in manufacturing, supply chains, transportation, finance, software dev, marketing, sales, power grids, and more.
- MAS are in operation at Fortune 500 companies, including banks, hotels, airlines, and similar.
- Companies include Boston Consulting Group (BCG), IDEO, Mayo Clinic, NewsCorp, Rakuten, Home Depot, Vodafone, ADT, and more.

Are there limits? Several have pointed out that if a job can be done remotely, an MAS can do it: finance, law, product development, marketing, sales, distribution, customer support, translations, graphics, event planning, PR, recruiting, insurance, accounting, taxes, and similar.

The Business of MAS

The MAS industry is rapidly evolving:

- **Self-Optimizing Systems:** MAS can create and optimize other MAS, leading to improvement and efficiency.
- **User-Friendly Interfaces:** GUI MAS platforms have simple graphic user interfaces that allow users to set up projects, define goals, add agents, assign tasks, incorporate tools, and establish connections between agents.

- **MAS as a Service:** Companies are beginning to offer MAS rentals, allowing businesses to access sophisticated AI systems without the need for in-house development.
- **Agent Marketplaces:** Companies can buy or rent MAS for tasks or industries.
- **Education:** Schools and universities can use MAS to teach courses.

Will MAS Affect Jobs?

We heard this question over and over in the last few months. Doesn't it mean that MAS will lead to unemployment?

Let's go to the kitchen and make cookies. Start by rolling out the dough:

- Use your fingers to shape a cookie. That works.
- Use a small knife to cut cookies. That's a bit faster.
- Use a cookie cutter form to stamp out cookies. Much faster and they're all the same shape. Get a kit of ten forms and make cookies in many shapes and sizes.
- Get a multi-cutter form. You can stamp out sixty cookies at once. Make platters of cookies for your office or school party.
- Buy a commercial cookie machine. Drop in dough at one end and it cuts cookies, runs them through an oven, and fresh cookies roll out.

At each step, you use devices that let you do more and faster with consistent quality.

Automation started in the mid-1800s. By the early 1900s, Western Europe and the US began large-scale automation of factory production and industrialization. The global economy grew from \$1 trillion in 1910 to \$85 trillion in 2020.

MAS is just more automation. In the late 1800s, many thought automation would eliminate jobs. On the contrary, automation created more jobs because things became cheaper, which increased demand, which increased production, which increased jobs, which increased the variety of things, which... and so on.

The Future of MAS

MAS doesn't need bigger faster AI with billion-dollar GPU clusters. MAS works with the LLM AIs (ChatGPT, Sonnet, Claude, Meta.ai, Copilot, Gemini, Pi.ai) that we already have.

- Managers and directors in white-collar work will learn and use MAS.
- The management of people becomes management of agents.
- There may be a new job title: Chief Agent Officer (CAO).
- Philip Rathle (CTO of LangChain) predicts there will be MAS with 200-300 agents.

Philip Rathle adds you'll have lots of personal MAS to help you with your personal finance, health, nutrition, legal documents, travel, transportation, home automation, ongoing education, career development and strategy, and so on. In the 70s, the first electronic desktop calculators cost as much as a new car. Today, you have pocket calculators, tablets, smartphones, laptops, desktop computers, and all sorts of digital devices scattered around your home. Someday, you'll also have MAS in your life.

BTW, LLM AI are not just in the US. There are LLM AI outside the US, such as Bharat AI in India [Bharatgpt.ai](https://www.bharatgpt.ai), Mistral AI in France [Mistral.ai](https://mistral.ai), Falcon Mamba [Falcon LLM](https://falconllm.com) in Abu Dhabi, United Arab Emirates, and 70+ LLM AI in China. If it's an LLM AI, then MAS can use it. As you may have noticed, it's better to have a good MAS than the #1 LLM AI.

BTW, The (currently) 70,000 AI startups in Silicon Valley are mostly wrappers on APIs from the foundational AIs. Most of these startups will be replaced by MAS.

Conclusion

No more typing. Up to now, you typed on a device. This was the world of “one user at one device”. That limited the ability of machines, devices, computers, and AI to the ability of humans.

A new way of using LLM AI enables us to create and manage groups of AI agents to collect data, analyze, and either write summaries for us or make decisions for us.

This changes the way to use an LLM AI. This sees the LLM AI as a **Multi Agent System (MAS)**, where the LLM AI supports a system that allows many agents to collaborate to do a task.

This takes advantage of an LLM AI’s ability to use vast amounts of data, accept vague commands, and make conclusions. You can do far more, much faster, with better quality.

More Stuff about Agents

Our Course in MAS

- We will teach a course in MAS at CSTU. This includes an overview of MAS, build a functioning MAS with Python in Jupyter, and build an MAS for your own project, your tasks at your company, or your own company.
- Led by **Andreas Ramos**, Adjunct Professor of Digital Marketing with AI, [linkedin.com/in/andreasramos/](https://www.linkedin.com/in/andreasramos/), and **Ping Wu**, Adjunct Professor of Computer Science at CSTU (computer science engineer with experience at SAP, TikTok, ByteDance, Zuora, webMethods (acquired by IBM), and more), [linkedin.com/in/pingsterwu/](https://www.linkedin.com/in/pingsterwu/)
- For details, contact andreas.ramos@cstu.edu or ping.wu@cstu.edu

Further Reading about MAS

- Links to stuff about AI at andreas.com/ai/, including more links about MAS.
- 2,076+ research papers on MAS at [ArXiv.org](https://arxiv.org) **Tip:** Search ArXiv with <"multi agent systems"> in quotation marks. **Another Tip:** You can see comments to ArXiv papers at alphaxiv.org
- The International Conference on Autonomous Agents and Multiagent Systems (AAMAS) has 8,300+ papers on MAS. See dl.acm.org/conference/aamas/ and dl.acm.org/topic/conference-collections/aamas?sortBy=downloaded
- More at [linkedin.com/pulse/collective-power-multi-agent-llm-systems-enhancing-ai-navveen-balani-x8lbc/](https://www.linkedin.com/pulse/collective-power-multi-agent-llm-systems-enhancing-ai-navveen-balani-x8lbc/)
- Overview of MAS Platforms: blog.context.ai/comparing-leading-multi-agent-frameworks/
- Overview of MAS: alexanderthamm.com/en/blog/multi-agent-llm-systems/
- Overview LPU and NLP/LSI dataconomy.com/2024/02/26/groq-sparks-lpu-vs-gpu-face-off/ and purestorage.com/knowledge/what-is-lpu.html
- RelevanceAI.com is a platform to build and manage MAS. See [RelevanceAI.com](https://relevanceai.com). See more at relevanceai.com/learn/what-is-a-multi-agent-system and relevanceai.substack.com/p/the-power-of-multi-agent-systems

Closing

What's next? Keep up with what I do:

- My website at andreas.com
- My webpage on AI stuff at andreas.com/ai/
- My classes in AI at andreas.com/digital-marketing-webinars.html
- Me at twitter.com/andreas_amos
- Me at linkedin.com/in/andreasramos/

I'd like to hear your ideas, comments, or questions. Send me a message at Twitter or LinkedIn.

Thanks for reading this,

Andreas